



# THE DATASHEET OF FMEN-2208



**Sanken Electric Co., Ltd.**  
**Overseas Sales Headquarters**  
Metropolitan Plaza Building, 1-11-1 Nishi-Ikebukuro  
Toshima-ku, Tokyo 171-0021, Japan  
Tel: 81-3-3986-6164  
Fax: 81-3-3986-8637

## WORLDWIDE SALES OFFICES

### Asia-Pacific

#### ● China

**Sanken Electric Hong Kong Co., Ltd.**  
Suite 1026 Ocean Centre, Canton Road  
Tsimshatsui, Kowloon, Hong Kong  
Tel: 852-2735-5262  
Fax: 852-2735-5494

**Sanken Electric (Shanghai) Co., Ltd.**  
Room 3202, Maxdo Centre, Xingyi Road 8  
Changning District, Shanghai, China  
Tel: 86-21-5208-1177  
Fax: 86-21-5208-1757

**Sanken Electric (Shanghai) Co., Ltd. Shenzhen Office**  
Room 1013, Xinhua Insurance Building, Mintian Road, Futian District,  
Shenzhen City, Guangdong, China  
Tel : 86-755-8283-6685  
Fax: 86-755-8826-3053

**Taiwan Sanken Electric Co., Ltd.**  
Room 1801, 18th Floor, 88 Jung Shiau East Road  
Sec. 2, Taipei 100, Taiwan R.O.C.  
Tel: 886-2-2356-8161  
Fax: 886-2-2356-8261

#### ● Korea

**Sanken Electric Korea Co., Ltd.**  
(Yeouido B/D 16F)24,Gukjegeumyung-ro 2-gil,  
Yeongdeungpo-gu,Seoul 150-734, Korea  
Tel: 82-2-714-3700  
Fax: 82-2-3272-2145

#### ● Singapore

**Sanken Electric Singapore Pte. Ltd.**  
152 Beach Road, #10-06 The Gateway East,  
Singapore 189721  
Tel: 65-6291-4755  
Fax: 65-6297-1744

#### ● Malaysia

**Sanken Electric (Malaysia) Sdn. Bhd.**  
Block B-20-5, Level 20, Northpoint Midvalley City,  
No.1, Medan Syed Putra Utara, 59200 Kuala Lumpur, Malaysia  
Tel: 60-3-2282-2345  
Fax: 60-3-2282-6345

### Europe

#### ● United Kingdom

**Sanken Power Systems (UK) Ltd.**  
Pencoed Technology Park  
Pencoed, Bridgend CF35 5HY, United Kingdom  
Tel: 44-1656-869-100  
Fax: 44-1656-869-162

### North America

#### ● United States

**Allegro MicroSystems, Inc.**  
115 Northeast Cutoff  
Worcester, Massachusetts 01606, U.S.A.  
Tel: 1-508-853-5000  
Fax: 1-508-853-7895

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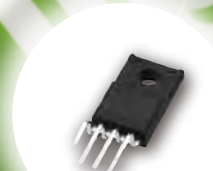
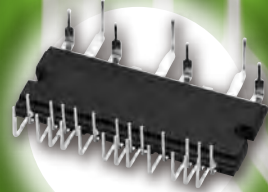
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# SEMICONDUCTORS GENERAL CATALOG

ICs  
Transistors  
Thyristors  
Diodes  
DC/DC Power Modules



**SANKEN ELECTRIC CO., LTD.**  
<http://www.sanken-ele.co.jp/en/>

SEMICONDUCTORS GENERAL CATALOG 2013

SANKEN ELECTRIC CO., LTD.

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# SANKEN SEMICONDUCTORS

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## Ordering Information

All products listed must be ordered in standard packing increments.

| Series Name/<br>Product Name | Package                | Standard Packing Quantities |        |
|------------------------------|------------------------|-----------------------------|--------|
|                              |                        | Bulk                        | Taping |
| LC52xxD                      | DIP8                   | 2500                        | —      |
| LC52xxS                      | SOP8(Surface-mount)    | —                           | 1000   |
| LC55xxD/LD                   | DIP8                   | 2500                        | —      |
| LC55xxF/LF                   | TO220F-7               | 1800                        | —      |
| LC57xxS                      | HSOP8(Surface-mount)   | —                           | 1000   |
| NR110K                       | HSOP8(Surface-mount)   | —                           | 1000   |
| NR111E                       | eSOIC8(Surface-mount)  | —                           | 2500   |
| NR117K                       | HSOP8(Surface-mount)   | —                           | 1000   |
| NR119E                       | eSOIC8(Surface-mount)  | —                           | 2500   |
| NR301E                       | eSOIC8(Surface-mount)  | —                           | 2500   |
| NR885E                       | eSOIC8(Surface-mount)  | —                           | 2500   |
| NR885K                       | HSOP8(Surface-mount)   | —                           | 1000   |
| NR887D                       | DIP8                   | 2500                        | —      |
| SAI                          | PS4(Surface-mount)     | —                           | 2000   |
| SCM1240M                     | DIP33Pin               | LF.No.2551/2552:<br>250     | —      |
| SI-3000KD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-3000KF                    | TO220F-5               | 2000                        | —      |
| SI-3000KS                    | SOP8(Surface-mount)    | —                           | 1000   |
| SI-3000LLSL                  | SOP8(Surface-mount)    | —                           | 1000   |
| SI-3000LSA                   | SOP8(Surface-mount)    | —                           | 1000   |
| SI-3000LU                    | SOT89-5(Surface-mount) | —                           | 1000   |
| SI-3000ZD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-3000ZF                    | TO220F-5               | 2000                        | —      |
| SI-6633C                     | QFN36(Surface-mount)   | —                           | 2500   |
| SI-6633M                     | QFN36(Surface-mount)   | —                           | 2500   |
| SI-7321M                     | HSOP44(Surface-mount)  | —                           | 2000   |
| SI-7510                      | DIP30                  | 680                         | —      |
| SI-8000E                     | TO220F-5               | 2000                        | —      |
| SI-8000FD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-8000FFE                   | TO220F-5               | 2000                        | —      |
| SI-8000GL                    | DIP8                   | 2500                        | —      |
| SI-8000HD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-8000HFE                   | TO220F-5               | 2000                        | —      |
| SI-8000JD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-8000JF                    | TO220F-5               | 2000                        | —      |
| SI-8000Q                     | HSOP8(Surface-mount)   | —                           | 1000   |
| SI-8000S                     | TO220F-5               | 2000                        | —      |
| SI-8000SD                    | TO263-5(Surface-mount) | —                           | 800    |
| SI-8000TFE                   | TO220F-5               | 2000                        | —      |
| SI-8000TM                    | TO252-5(Surface-mount) | —                           | 3000   |
| SI-8000W                     | SOP8(Surface-mount)    | —                           | 1000   |
| SI-8000Y                     | TO220F-7               | 2000                        | —      |
| SI-8100QL                    | DIP8                   | 2500                        | —      |

| Series Name/<br>Product Name | Package                         | Standard Packing Quantities           |        |
|------------------------------|---------------------------------|---------------------------------------|--------|
|                              |                                 | Bulk                                  | Taping |
| SI-8205NHD                   | HSOP8(Surface-mount)            | —                                     | 1000   |
| SI-8205NHG                   | HSOP8(Surface-mount)            | —                                     | 1000   |
| SI-8400L                     | Non-package type (EI-12.5 core) | 864                                   | —      |
| SI-8500L                     | Non-package type (EI-19 core)   | 320                                   | —      |
| SI-8511NVS                   | TSSOP24(Surface-mount)          | —                                     | 2800   |
| SIM6800M                     | DIP40Pin                        | LF.No.2971: 1080                      | —      |
| SLA686xMZ                    | SIP24 with Fin<br>(SLA24Pin)    | LF.No.2171: 648,<br>LF.No.2175: 540   | —      |
| SLA7022MU/<br>7029M          | ZIP15 with Fin<br>(SLA15Pin)    | 1080                                  | —      |
| SLA7024M/<br>7026M/7027MU    | ZIP18 with Fin<br>(SLA18Pin)    | 1080                                  | —      |
| SLA707xMR/MPR<br>/MPRT       | ZIP23 with Fin<br>(SLA23Pin)    | 1080                                  | —      |
| SLA708xMPR                   | ZIP23 with Fin<br>(SLA23Pin)    | 1080                                  | —      |
| SMA682xMH/<br>686xMZ         | SIP24<br>(SMA24Pin)             | LF.No.2451: 1080,<br>LF.No.2452: 1008 | —      |
| SMA7022MU/<br>7029M          | ZIP15<br>(SMA15Pin)             | 1440                                  | —      |
| SPI-6631M                    | HSOP16(Surface-mount)           | —                                     | 1400   |
| SPI-8000A                    | HSOP16(Surface-mount)           | —                                     | 1400   |
| SPI-8000TW                   | HSOP16(Surface-mount)           | —                                     | 1400   |
| SSC2000                      | SOP8(Surface-mount)             | —                                     | 1000   |
| SSC2100                      | SOP8(Surface-mount)             | —                                     | 1000   |
| SSC9512                      | DIP16                           | 1250                                  | —      |
| SSC9522S                     | SOP18(Surface-mount)            | —                                     | 2000   |
| STA6940M                     | ZIP18(STA18Pin)                 | LF.No.434: 1785                       | —      |
| STA713xMPR                   | ZIP18(STA18Pin)                 | LF.No.434: 1785                       | —      |
| STA801M                      | ZIP10(STA10Pin)                 | 100                                   | —      |
| STR2W100                     | TO220F-6                        | 1800                                  | —      |
| STR3A100                     | DIP8                            | 2500                                  | —      |
| STR-A6000                    | DIP8                            | 2500                                  | —      |
| STR-A6100                    | DIP8                            | 2500                                  | —      |
| STR-L400                     | SIP10(STA10Pin)                 | 3300                                  | —      |
| STR-L6400                    | SIP10(STA10Pin)                 | 3300                                  | —      |
| STR-V100                     | SIP8(STA8Pin)                   | 4050                                  | —      |
| STR-V600                     | SIP8(STA8Pin)                   | 4050                                  | —      |
| STR-W6000S                   | TO220F-6                        | 1800                                  | —      |
| STR-W6200D                   | TO220F-6                        | 1800                                  | —      |
| STR-W6700                    | TO220F-6                        | 1800                                  | —      |
| STR-X6700                    | TO3PF-7                         | 500                                   | —      |
| STR-Y6400                    | TO220F-7                        | 1800                                  | —      |
| STR-Y6700                    | TO220F-7                        | 1800                                  | —      |

| Series Name/<br>Product Name | Package              | Standard Packing Quantities |                 |
|------------------------------|----------------------|-----------------------------|-----------------|
|                              |                      | Bulk                        | Taping          |
| SX68000MH                    | SOP27(Surface-mount) | –                           | LF1890:<br>3000 |

## 1-1 Power Management ICs

### 1-1-1 Power Factor Correction (PFC) ICs

#### Control ICs

##### ●Continuous Conduction Mode (CCM) PFC Control IC

For high power and high efficiency applications, with brown-in and brown-out functions

| Series Name | Part Number | Oscillation Frequency | Package |
|-------------|-------------|-----------------------|---------|
| SSC2000     | SSC2001S    | Fixed to 65kHz        | SOP8    |

##### ●Interleaved Discontinuous Conduction Mode (DCM) PFC Control IC

8-pin package, minimum number of discrete components, low noise, and low ripple

| Series Name | Part Number | Maximum on time | Package |
|-------------|-------------|-----------------|---------|
| SSC2100     | SSC2101S    | 15 $\mu$ s      | SOP8    |
|             | SSC2102S    | 20.7 $\mu$ s    | SOP8    |

### 1-1-2 AC/DC Converter ICs

#### ●PWM type

<STR-3A100 Series>

- For small power applications
- Low noise, low standby power (Input power  $P_{IN}$ <15mW at no load)

| Part Number | Oscillation Frequency | MOSFET                 |                           | Overvoltage and Thermal Protection Operation | Package |
|-------------|-----------------------|------------------------|---------------------------|----------------------------------------------|---------|
|             |                       | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                                              |         |
| STR3A151    | 67kHz                 | 650V                   | 4.0Ω                      | Latch                                        | DIP8    |
| STR3A152    |                       |                        | 3.0Ω                      |                                              |         |
| STR3A153    |                       |                        | 1.9Ω                      |                                              |         |
| STR3A154    |                       |                        | 1.4Ω                      |                                              |         |
| STR3A155    |                       |                        | 1.1Ω                      |                                              |         |
| STR3A151D   | 67kHz                 | 650V                   | 4.0Ω                      | Auto restart                                 |         |
| STR3A152D   |                       |                        | 3.0Ω                      |                                              |         |
| STR3A153D   |                       |                        | 1.9Ω                      |                                              |         |
| STR3A154D   |                       |                        | 1.4Ω                      |                                              |         |
| STR3A155D   |                       |                        | 1.1Ω                      |                                              |         |
| STR3A161HD  | 100kHz                | 700V                   | 4.2Ω                      | Auto restart                                 |         |
| STR3A162HD  |                       |                        | 3.2Ω                      |                                              |         |
| STR3A163HD  |                       |                        | 2.2Ω                      |                                              |         |

<STR-A6000 Series>

- For small power applications
- Low noise, low standby power (Input power  $P_{IN}$ <25mW at no load)
- Brown-in and brown-out functions

| Part Number  | Oscillation Frequency | MOSFET                 |                           | Package |
|--------------|-----------------------|------------------------|---------------------------|---------|
|              |                       | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |         |
| STR-A6051M   | 67kHz                 | 650V                   | 3.95 $\Omega$             | DIP8    |
| STR-A6052M   |                       |                        | 2.8 $\Omega$              |         |
| STR-A6053M   |                       |                        | 1.9 $\Omega$              |         |
| STR-A6079M   |                       | 800V                   | 19.2 $\Omega$             |         |
| STR-A6059H   | 100kHz                | 650V                   | 6 $\Omega$                |         |
| STR-A6061H   |                       | 700V                   | 3.95 $\Omega$             |         |
| STR-A6062H   |                       |                        | 2.8 $\Omega$              |         |
| STR-A6069H   |                       |                        | 6 $\Omega$                |         |
| STR-A6061HD* | 100kHz                | 700V                   | 3.95 $\Omega$             |         |
| STR-A6062HD* |                       |                        | 2.8 $\Omega$              |         |
| STR-A6063HD* |                       |                        | 2.3 $\Omega$              |         |
| STR-A6069HD* |                       |                        | 6 $\Omega$                |         |

- In addition to normal overcurrent protection, overcurrent protection that operates in the case of a short circuit at the output coil has been added. This overcurrent protection operates during the leading edge blanking period.

<STR-V600 Series>

- Low height, at least 4 mm of creepage isolation between high and low terminal tips
- Low noise, low standby power (Input power  $P_{IN}$ <25mW at no load)
- SIP8 package version of STR-A6000

| Part Number | Oscillation Frequency | MOSFET                 |                           | Package |
|-------------|-----------------------|------------------------|---------------------------|---------|
|             |                       | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |         |
| STR-V653    | 67kHz                 | 650V                   | 1.9 $\Omega$              | SIP8    |

<STR2W100D Series>

- Low noise, low standby power (Input power  $P_{IN}$ <25mW at no load)

| Part Number | Oscillation Frequency | MOSFET                 |                           | Package  |
|-------------|-----------------------|------------------------|---------------------------|----------|
|             |                       | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |          |
| STR2W152D   | 67kHz                 | 650V                   | 3.0 $\Omega$              | TO220F-6 |
| STR2W153D   |                       |                        | 1.9 $\Omega$              |          |

## &lt;STR-W6000S Series&gt;

- Low noise, low standby power (Input power  $P_{IN}<30\text{mW}$  at no load)
- Brown-in and brown-out functions

| Part Number | Oscillation Frequency | MOSFET         |                    | Package  |
|-------------|-----------------------|----------------|--------------------|----------|
|             |                       | $V_{DS}$ (MIN) | $R_{DS(ON)}$ (MAX) |          |
| STR-W6051S  | 67kHz                 | 650V           | 3.95 $\Omega$      | TO220F-6 |
| STR-W6052S  |                       |                | 2.8 $\Omega$       |          |
| STR-W6053S  |                       |                | 1.9 $\Omega$       |          |

## &lt;STR-W6200D Series&gt;

- Low noise, low standby power (Input power  $P_{IN}<40\text{mW}$  at no load)
- External latch protection (ELP) function

| Part Number | Oscillation Frequency | MOSFET         |                    | Package  |
|-------------|-----------------------|----------------|--------------------|----------|
|             |                       | $V_{DS}$ (MIN) | $R_{DS(ON)}$ (MAX) |          |
| STR-W6251D  | 67kHz                 | 650V           | 3.95 $\Omega$      | TO220F-6 |
| STR-W6252D  |                       |                | 2.8 $\Omega$       |          |
| STR-W6253D  |                       |                | 1.9 $\Omega$       |          |

## ●Pulse ratio control (PRC) type with off-time period fixed (originated by Sanken Electric)

## &lt;STR-A6100 Series&gt;

- For small power applications
- Low noise, low standby power

| Part Number | Fixed off-time period | MOSFET                 |                           | Auto standby function | Package |
|-------------|-----------------------|------------------------|---------------------------|-----------------------|---------|
|             |                       | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                       |         |
| STR-A6131   | 8μs                   | 500V                   | 3.95Ω                     | Yes                   | DIP8    |
| STR-A6132   |                       |                        | 2.62Ω                     |                       |         |
| STR-A6159   |                       | 650V                   | 6Ω                        |                       |         |
| STR-A6151   |                       |                        | 3.95Ω                     |                       |         |
| STR-A6169   |                       | 800V                   | 19.2Ω                     |                       |         |
| STR-A6131M  | 11.5μs                | 500V                   | 3.95Ω                     | No                    |         |
| STR-A6159M  |                       | 650V                   | 6Ω                        |                       |         |
| STR-A6151M  |                       |                        | 3.95Ω                     |                       |         |
| STR-A6153E  |                       |                        | 1.9Ω                      |                       |         |

## &lt;STR-V100 Series&gt;

- Low height, at least 4 mm of creepage isolation between high and low terminal tips
- Low noise, low standby power
- SIP8 package version of STR-A6100

| Part Number | Fixed off-time period | MOSFET         |                    | Package |
|-------------|-----------------------|----------------|--------------------|---------|
|             |                       | $V_{DS}$ (MIN) | $R_{DS(ON)}$ (MAX) |         |
| STR-V152    | 8 $\mu\text{s}$       | 650V           | 2.8 $\Omega$       | SIP8    |
| STR-V153    | 11.5 $\mu\text{s}$    |                | 2 $\Omega$         |         |

## ●Quasi-resonant type

## &lt;STR-Y6700 Series&gt;

- High efficiency in full load range
- Low noise, low standby power

| Part Number | MOSFET         |                    | Package  |
|-------------|----------------|--------------------|----------|
|             | $V_{DS}$ (MIN) | $R_{DS(ON)}$ (MAX) |          |
| STR-Y6735   | 500V           | 0.8 $\Omega$       | TO220F-7 |
| STR-Y6753   | 650V           | 1.9 $\Omega$       |          |
| STR-Y6754   |                | 1.4 $\Omega$       |          |
| STR-Y6763   | 800V           | 3.5 $\Omega$       |          |
| STR-Y6765   |                | 2.2 $\Omega$       |          |
| STR-Y6766   |                | 1.7 $\Omega$       |          |

## &lt;STR-Y6400 Series&gt;

- High efficiency in full load range
- Low noise, low standby power
- Mode change delay time adjustable

| Part Number | MOSFET         |                    | Package  |
|-------------|----------------|--------------------|----------|
|             | $V_{DS}$ (MIN) | $R_{DS(ON)}$ (MAX) |          |
| STR-Y6453   | 650V           | 1.8 $\Omega$       | TO220F-7 |
| STR-Y6456   |                | 0.73 $\Omega$      |          |
| STR-Y6473   | 850V           | 3.6 $\Omega$       |          |
| STR-Y6476   |                | 1.3 $\Omega$       |          |

## 1-1-2 AC/DC Converter ICs

### <STR-L6400 Series>

- Low height, at least 6.5 mm of creepage isolation between high and low terminal tips
- High efficiency in full load range, low noise, and low standby power
- SIP10 package version of STR-Y6400

| Part Number | MOSFET                 |                           | Package |
|-------------|------------------------|---------------------------|---------|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |         |
| STR-L6472   | 850V                   | 6.5Ω                      | SIP10   |

### <STR-L400 Series>

- Low height, at least 6.5 mm of creepage isolation between high and low terminal tips
- Low noise, high efficiency

| Part Number | MOSFET                 |                           | Package |
|-------------|------------------------|---------------------------|---------|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |         |
| STR-L451    | 650V                   | 3.95Ω                     | SIP10   |
| STR-L472    | 900V                   | 7.7Ω                      |         |

### <STR-W6700 Series>

- High efficiency in full load range
- Low noise, undervoltage lockout (UVLO) standby function

| Part Number | MOSFET                 |                           | Auto burst operation | Bottom-skip QR operation | Package  |  |
|-------------|------------------------|---------------------------|----------------------|--------------------------|----------|--|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                      |                          |          |  |
| STR-W6734   | 500V                   | 1.0Ω                      | Yes                  | Yes                      | TO220F-6 |  |
| STR-W6735   |                        | 0.57Ω                     |                      |                          |          |  |
| STR-W6753   | 650V                   | 1.7Ω                      |                      |                          |          |  |
| STR-W6754   |                        | 0.96Ω                     |                      |                          |          |  |
| STR-W6756   |                        | 0.73Ω                     |                      |                          |          |  |
| STR-W6765   | 800V                   | 1.8Ω                      | Yes                  | No                       |          |  |
| STR-W6750F  | 650V                   | 0.73Ω                     |                      |                          |          |  |
| STR-W6723N  | 450V                   | 1.4Ω                      | No                   | Yes                      |          |  |
| STR-W6735N  | 500V                   | 0.57Ω                     |                      |                          |          |  |
| STR-W6756N  | 650V                   | 0.73Ω                     |                      |                          |          |  |
| STR-W6765N  | 800V                   | 1.8Ω                      |                      |                          |          |  |

### <STR-X6700 Series>

- High efficiency in full load range
- Low noise, undervoltage lockout (UVLO) standby function

| Part Number | MOSFET                 |                           | Auto burst operation | Bottom-skip QR operation | Package |
|-------------|------------------------|---------------------------|----------------------|--------------------------|---------|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                      |                          |         |
| STR-X6737   | 500V                   | 0.36Ω                     | Yes                  | Yes                      | TO3PF-7 |
| STR-X6756   | 650V                   | 0.73Ω                     |                      |                          |         |
| STR-X6757   |                        | 0.62Ω                     |                      |                          |         |
| STR-X6769   |                        | 800V                      |                      |                          |         |
| STR-X6750B  | 650V                   | 0.62Ω                     | No                   | No                       |         |
| STR-X6759B  |                        | 0.385Ω                    |                      |                          |         |
| STR-X6769B  | 800V                   | 0.66Ω                     |                      |                          |         |
| STR-X6750F  | 650V                   | 0.62Ω                     |                      |                          |         |
| STR-X6759F  |                        | 0.385Ω                    |                      |                          |         |
| STR-X6729   | 450V                   | 0.189Ω                    | No                   | Yes                      |         |
| STR-X6737M  | 500V                   | 0.36Ω                     |                      |                          |         |
| STR-X6757N  | 650V                   | 0.62Ω                     |                      |                          |         |
| STR-X6759N  |                        | 0.385Ω                    |                      |                          |         |
| STR-X6768N  | 800V                   | 1.0Ω                      |                      |                          |         |

## ●Current resonance type

- Half-bridge resonance
- High efficiency, low noise
- Brown-in and brown-out functions

| Part Number | Package |
|-------------|---------|
| SSC9512     | DIP16   |
| SSC9522S    | SOP18   |

# Selection Guide

## <Single Output>

### Surface-Mount Type

| Series Name | Output Current<br>(A) | Output Voltage<br>(V) |     |     |    | Variable (Reference Voltage)<br>(V) |     |     | Maximum<br>Input Voltage<br>(V) | Oscillation<br>Frequency<br>(kHz) | Package | Remarks                                        | Page |
|-------------|-----------------------|-----------------------|-----|-----|----|-------------------------------------|-----|-----|---------------------------------|-----------------------------------|---------|------------------------------------------------|------|
|             |                       | 3.3                   | 5.0 | 9.0 | 12 | 0.5                                 | 0.8 | 1.0 |                                 |                                   |         |                                                |      |
| SAI         | 0.4                   |                       |     |     | ⊙  |                                     |     |     | 35                              | 60                                | PS-4    |                                                | 12   |
|             | 0.5                   | ⊙                     | ⊙   |     |    |                                     |     |     |                                 |                                   |         |                                                |      |
| SI-8000W    | 0.6                   | ⊙                     | ⊙   |     |    |                                     |     |     | 35                              | 60                                | SOP8    |                                                | 14   |
| SI-8000JD   | 1.5                   | ⊙                     | ⊙   | ⊙   | ⊙  |                                     |     |     | 43                              | 125                               | TO263-5 |                                                | 16   |
| SI-8000TM   | 1.5                   |                       |     |     |    |                                     | ⊙   |     | 43                              | 300                               | TO252-5 |                                                | 18   |
| NR117K      | 1.5                   |                       |     |     |    |                                     | ⊙   |     | 35                              | 30                                | HSOP8   | Current mode control                           | 20   |
| NR119E      | 2.0                   |                       |     |     |    |                                     | ⊙   |     | 35                              | 364                               | eSOIC8  | Current mode control                           | 20   |
| NR885E      | 3.0                   |                       |     |     |    |                                     | ⊙   |     | 20                              | 350                               | eSOIC8  | Current mode control, synchronous rectifier    | 22   |
| NR885K      | 3.0                   |                       |     |     |    |                                     | ⊙   |     | 20                              | 350                               | HSOP8   | Current mode control, synchronous rectifier    | 22   |
| SI-8205NHD  | 3.0                   |                       |     |     |    | ⊙                                   |     |     | 46                              | 200 to 1000                       | HSOP8   | Current mode control, synchronous rectifier    | 24   |
| SI-8205NHG  | 3.0                   |                       |     |     |    | ⊙                                   |     |     | 46                              | 300 to 1000                       | HSOP8   | Current mode control, external synchronization | 24   |
| SI-8000SD   | 3.0                   | ⊙                     | ⊙   |     |    |                                     |     |     | 43 <sup>*1</sup>                | 60                                | TO263-5 |                                                | 26   |
| SPI-8000A   | 3.0                   |                       |     |     |    |                                     |     | ⊙   | 53                              | 250                               | HSOP16  |                                                | 28   |
| SI-8000Q    | 3.5                   |                       |     |     |    | ⊙                                   |     |     | 30                              | 500                               | HSOP8   | Current mode control                           | 32   |
| SI-8000FDE  | 3.5                   |                       |     |     |    |                                     | ⊙   |     | 43                              | 300                               | TO263-5 |                                                | 34   |
| SI-8000FDL  | 3.5                   |                       |     |     |    |                                     | ⊙   |     | 43                              | 300                               | TO263-5 | Active: low                                    | 34   |
| NR110K      | 4.0                   |                       |     |     |    |                                     | ⊙   |     | 35                              | 350                               | HSOP8   | Current mode control                           | 20   |
| NR111E      | 4.0                   |                       |     |     |    |                                     | ⊙   |     | 35                              | 350                               | eSOIC8  | Current mode control                           | 20   |
| SI-8000HD   | 5.5                   |                       |     |     |    |                                     | ⊙   |     | 43                              | 150                               | TO263-5 |                                                | 36   |

\*1: 35V for SI-8033SD

### Thru-Hole Type

| Series Name | Output Current<br>(A) | Output Voltage<br>(V) |     |     |    |    | Variable (Reference Voltage)<br>(V) |     |     |     | Maximum<br>Input Voltage<br>(V) | Oscillation<br>Frequency<br>(kHz) | Package          | Remarks                                     | Page |
|-------------|-----------------------|-----------------------|-----|-----|----|----|-------------------------------------|-----|-----|-----|---------------------------------|-----------------------------------|------------------|---------------------------------------------|------|
|             |                       | 3.3                   | 5.0 | 9.0 | 12 | 15 | 0.5                                 | 0.8 | 1.0 | 1.5 |                                 |                                   |                  |                                             |      |
| SI-8400L    | 0.5                   |                       | ⊙   |     |    |    |                                     |     |     |     | 35                              | 60                                | Non-package type | With coil and built-in diode                | 60   |
| SI-8000E    | 0.6                   |                       | ⊙   |     |    |    |                                     |     |     |     | 43                              | 60                                | TO220F-5         |                                             | 38   |
| SI-8500L    | 1.0                   |                       | ⊙   |     |    |    |                                     |     |     |     | 35                              | 60                                | Non-package type | With coil and built-in diode                | 60   |
| SI-8000JF   | 1.5                   | ⊙                     | ⊙   |     | ⊙  |    |                                     |     |     | ⊙   | 43                              | 125                               | TO220F-5         |                                             | 40   |
| SI-8000TFE  | 1.5                   |                       | ⊙   |     |    |    |                                     | ⊙   |     |     | 43                              | 300                               | TO220F-5         |                                             | 42   |
| SI-8000GL   | 1.5                   |                       |     |     |    |    |                                     |     | ⊙   |     | 53                              | 250                               | DIP8             |                                             | 44   |
| NR887D      | 2.0                   |                       |     |     |    |    |                                     | ⊙   |     |     | 20                              | 500                               | DIP8             | Current mode control, synchronous rectifier | 46   |
| SI-8000S    | 3.0                   | ⊙                     | ⊙   | ⊙   | ⊙  | ⊙  |                                     |     |     |     | 43 <sup>*2</sup>                | 60                                | TO220F-5         |                                             | 48   |
| SI-8100QL   | 3.5                   |                       |     |     |    |    | ⊙                                   |     |     |     | 30                              | 350                               | DIP8             | Current mode control                        | 50   |
| SI-8000FFE  | 3.5                   |                       |     |     |    |    |                                     | ⊙   |     |     | 43                              | 300                               | TO220F-5         |                                             | 52   |
| NR111D      | 4.0                   |                       |     |     |    |    |                                     | ⊙   |     |     | 35                              | 350                               | DIP8             | Current mode control                        | 54   |
| SI-8000HFE  | 5.5                   |                       | ⊙   |     |    |    |                                     | ⊙   |     |     | 43                              | 150                               | TO220F-5         |                                             | 56   |
| SI-8000Y    | 8.0                   |                       | ⊙   |     |    |    |                                     |     | ⊙   |     | 45                              | 130                               | TO220F-7         | Current mode control                        | 58   |

\*2: 35V for SI-8033S

<Multi Output>

| Part Number |     | Output Current | Output Voltage                        | Maximum Input Voltage | Oscillation Frequency | Package | Remarks                 | Page |
|-------------|-----|----------------|---------------------------------------|-----------------------|-----------------------|---------|-------------------------|------|
|             |     | (A)            | (V)                                   | (V)                   | (kHz)                 |         |                         |      |
| STA801M     | ch1 | 0.5            | 5                                     | 43                    | 125                   | ZIP10   | Built-in flywheel diode | 62   |
|             | ch2 | 0.5            | Select from 9.0, 11.5, 12.1, and 15.5 |                       |                       |         |                         |      |
| SPI-8001TW  | ch1 | 1.5            | Variable (1.0 to 16 V)                | 21                    | 250                   | HSOP16  |                         | 64   |
|             | ch2 | 1.5            | Variable (1.0 to 16 V)                |                       |                       |         |                         |      |
| SPI-8002TW  | ch1 | 1.5            | Variable (1.0 to 24 V)                | 40                    | 250                   | HSOP16  |                         | 64   |
|             | ch2 | 1.5            | Variable (1.0 to 24 V)                |                       |                       |         |                         |      |
| SPI-8003TW  | ch1 | 1.5            | Variable (1.0 to 24 V)                | 40                    | 200 to 400            | HSOP16  | Frequency variable      | 64   |
|             | ch2 | 1.5            | Variable (1.0 to 24 V)                |                       |                       |         |                         |      |

<Control ICs>

| Series Name | Variable (Reference Voltage) | Maximum Input Voltage | Oscillation Frequency | Package | Remarks                                   | Page |
|-------------|------------------------------|-----------------------|-----------------------|---------|-------------------------------------------|------|
|             | (V)                          | (V)                   | (kHz)                 |         |                                           |      |
| SI-8511NVS  | 1.1                          | 25                    | 100 to 400            | TSSOP24 | Synchronous rectifier, PRC (fixed to ton) | 68   |

# Application Note

## Heat Dissipation and Reliability

The reliability of an IC is highly dependent on its operating temperature. Please be sure to apply silicone grease to the IC and to mount it to the heatsink with a proper mounting torque.

Heatsink design should pay particular attention to ensuring sufficient heat dissipation capacity.

In addition, please take into account the air convection in operation.

The reliability of discrete components such as capacitors and coils is closely related to temperature. A high operating temperature may reduce the service life. Exceeding the allowable temperature may burn the coils or damage capacitors. It is important to make sure that the temperature of output smoothing coils and input/output capacitors do not exceed their allowable levels during operation. With an adequate derating for the coils, minimize heat emission as far as possible. (For discrete components, refer to the individual user manuals.)

## Internal Power Dissipation

$P_D$  can be obtained from the following formula.

- For the device with built-in flywheel diode:

$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\chi} - 1 \right)$$

- For the device with external flywheel diode:

$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

Efficiency  $\eta\chi$  depends on the input/output conditions. Please refer to the efficiency characteristics of the devices. (Posted on the Web site.)

$V_O$ : Output voltage  
 $V_{IN}$ : Input voltage  
 $I_O$ : Output current  
 $\eta\chi$ : Efficiency(%)  
 $V_F$ : Diode forward voltage

## Thermal Design

The maximum junction temperature  $T_{j(max)}$  given in the Absolute Maximum Ratings is specific to each product type and must be strictly observed. Thus, thermal design must consider the maximum power dissipation  $P_{D(max)}$ , which varies by the conditions of use, and the maximum ambient temperature  $T_{a(max)}$ .

To simplify thermal design,  $T_a$ - $P_D$  characteristic graphs are provided herein. Please observe the following steps for heatsink design:

1. Obtain the maximum ambient temperature  $T_{a(max)}$ .
2. Obtain the maximum power dissipation  $P_{D(max)}$ .
3. Look for the intersection point on the  $T_a$ - $P_D$  characteristic graph and determine the size of the heatsink.

Although the heatsink size is now obtained, in actual applications, 10-to-20% derating factor is generally introduced. Moreover, the heat dissipation capacity of a heatsink highly depends on how it is mounted. Thus, it is recommended to measure the heatsink and case temperature in the actual operating environment.

Please refer to the  $T_a$ - $P_D$  characteristic graphs for respective product types.

## Mounting Torque

|            |                                          |
|------------|------------------------------------------|
| SI-8000E   | 0.588 to 0.686[N•m] (6.0 to 7.0[kgf•cm]) |
| SI-8000JF  |                                          |
| SI-8000S   |                                          |
| SI-8000TFE |                                          |
| SI-8000HFE |                                          |
| SI-8000FFE |                                          |
| SI-8000Y   |                                          |

## Recommended Silicone Grease

- Shin-Etsu Chemical Co., Ltd.: G746
- Momentive Performance Materials Inc.: YG-6260
- Dow Corning Toray Silicone Co., Ltd.: SC102

Please select proper silicone grease carefully since the oil in some grease products may penetrate the device and result in an extremely short device life.

## Others

- Devices can not be operated in parallel connection aiming for a larger current.
- Not applicable for the current boost or voltage step-up use.

## Rectifier Diodes for Power Supplies

To rectify the AC input using rectifier diodes in power supplies, please use SANKEN rectifier diodes shown in the following list. (Please use a center-tap or bridge configuration in using stand-alone type diodes.)

| Series Name | Diodes                                                             |
|-------------|--------------------------------------------------------------------|
| SAI         | SJPM-H4 (Surface-Mount Stand-Alone Type, $V_{RM}=400V, I_O=2.0A$ ) |
| SI-8000W    |                                                                    |
| SI-8000JD   |                                                                    |
| SI-8000TM   |                                                                    |
| NR117K      |                                                                    |
| NR119E      |                                                                    |
| NR885E      |                                                                    |
| NR885K      |                                                                    |
| SI-8205NHD  |                                                                    |
| SI-8205NHG  |                                                                    |
| SI-8000SD   |                                                                    |
| SPI-8000A   |                                                                    |
| SI-8005Q    |                                                                    |
| SI-8001FDE  |                                                                    |
| SI-8001FDL  |                                                                    |
| SI-8008HD   | FMM-22S,R (Center-tap Type, $V_{RM}=200V, I_O=1.0A$ )              |
| SI-8000HFE  |                                                                    |
| SI-8000Y    | AM01Z (Axial Type, $V_{RM}=200V, I_O=1.0A$ )                       |
| SI-8400L    |                                                                    |
| SI-8000E    |                                                                    |
| SI-8500L    |                                                                    |
| SI-8000JF   |                                                                    |
| SI-8000TFE  |                                                                    |
| SI-8000GL   | RM10Z (Axial Type, $V_{RM}=200V, I_O=1.5A$ )                       |
| NR887D      |                                                                    |
| SI-8000S    | RM4Z (Axial Type, $V_{RM}=200V, I_O=3.0A$ )                        |
| NR110K      |                                                                    |
| NR111E      |                                                                    |
| SI-8100QL   | AM01Z (Axial Type, $V_{RM}=200V, I_O=1.0A$ )                       |
| SI-8000FFE  |                                                                    |
| STA801M     | SJPM-H4 (Surface-Mount Stand-Alone Type, $V_{RM}=400V, I_O=2.0A$ ) |
| SPI-8000TW  |                                                                    |

SAI Series

Surface-Mount, Separate Excitation Step-down Switching Mode

Features

- Surface-mount power package
- Output current: 0.4 to 0.5A
- High efficiency: 75 to 88%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage
- Built-in reference oscillator (60kHz)
- Built-in overcurrent and thermal protection circuits

Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

Lineup

| Part Number        | SAI01 | SAI02 | SAI03 |
|--------------------|-------|-------|-------|
| V <sub>o</sub> (V) | 5.0   | 3.3   | 12.0  |
| I <sub>o</sub> (A) | 0.5   |       | 0.4   |

Absolute Maximum Ratings

| Parameter                            | Symbol           | Ratings     | Unit |
|--------------------------------------|------------------|-------------|------|
| DC Input Voltage                     | V <sub>IN</sub>  | 35          | V    |
| Power Dissipation                    | P <sub>D</sub>   | 0.75        | W    |
| Junction Temperature                 | T <sub>j</sub>   | +125        | °C   |
| Storage Temperature                  | T <sub>stg</sub> | −40 to +125 | °C   |
| Thermal Resistance(junction to case) | θ <sub>J-C</sub> | 20          | °C/W |

Recommended Operating Conditions

| Parameter                            | Symbol           | Ratings     |           |          | Unit |
|--------------------------------------|------------------|-------------|-----------|----------|------|
|                                      |                  | SAI01       | SAI02     | SAI03    |      |
| DC Input Voltage Range               | V <sub>IN</sub>  | 7 to 33     | 5.3 to 28 | 15 to 33 | V    |
| Output Current Range                 | I <sub>o</sub>   | 0 to 0.5    |           | 0 to 0.4 | A    |
| Operating Junction Temperature Range | T <sub>jop</sub> | −30 to +125 |           |          | °C   |

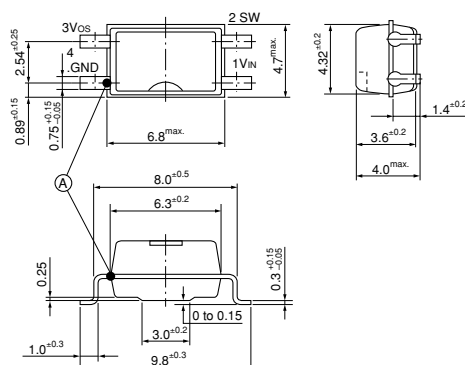
Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                 | Symbol                           | Ratings                                           |      |      |                                                   |      |      |                                                   |       |       | Unit  |
|-------------------------------------------|----------------------------------|---------------------------------------------------|------|------|---------------------------------------------------|------|------|---------------------------------------------------|-------|-------|-------|
|                                           |                                  | SAI01                                             |      |      | SAI02                                             |      |      | SAI03                                             |       |       |       |
|                                           |                                  | min.                                              | typ. | max. | min.                                              | typ. | max. | min.                                              | typ.  | max.  |       |
| Output Voltage                            | V <sub>O</sub>                   | 4.80                                              | 5.00 | 5.20 | 3.17                                              | 3.30 | 3.43 | 11.40                                             | 12.00 | 12.60 | V     |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.3A        |       |       |       |
| Efficiency                                | η                                |                                                   | 80   |      |                                                   | 75   |      |                                                   | 88    |       | %     |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.3A        |       |       |       |
| Oscillation Frequency                     | f                                |                                                   | 60   |      |                                                   | 60   |      |                                                   | 60    |       | kHz   |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.3A        |       |       |       |
| Line Regulation                           | ΔV <sub>OLINE</sub>              |                                                   | 80   | 100  |                                                   | 60   | 80   |                                                   | 100   | 130   | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.3A  |      |      | V <sub>IN</sub> =8 to 28V, I <sub>O</sub> =0.3A   |      |      | V <sub>IN</sub> =18 to 30V, I <sub>O</sub> =0.3A  |       |       |       |
| Load Regulation                           | ΔV <sub>OLOAD</sub>              |                                                   | 30   | 40   |                                                   | 20   | 30   |                                                   | 70    | 95    | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.1 to 0.4A |      |      | V <sub>IN</sub> =15V, I <sub>O</sub> =0.1 to 0.4A |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.1 to 0.4A |       |       |       |
| Temperature Coefficient of Output Voltage | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      |                                                   | ±0.5 |      |                                                   | ±1.5  |       | mV/°C |
| Ripple Rejection                          | R <sub>REJ</sub>                 |                                                   | 45   |      |                                                   | 45   |      |                                                   | 45    |       | dB    |
|                                           | Conditions                       | f=100 to 120Hz                                    |      |      | f=100 to 120Hz                                    |      |      | f=100 to 120Hz                                    |       |       |       |
| Overcurrent Protection Starting Current   | I <sub>S1</sub>                  | 0.55                                              |      |      | 0.55                                              |      |      | 0.45                                              |       |       | A     |
|                                           | Conditions                       | V <sub>IN</sub> =10V                              |      |      | V <sub>IN</sub> =8V                               |      |      | V <sub>IN</sub> =18V                              |       |       |       |

## External Dimensions (PS4)

(Unit : mm)



Ⓐ Case Temperature Measuring Point

Pin Assignment

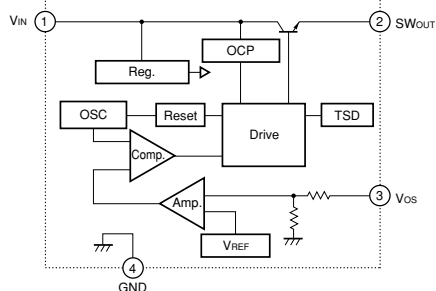
- ①  $V_{IN}$
- ②  $SW_{OUT}$
- ③  $V_{OS}$
- ④ GND

Plastic Mold Package Type

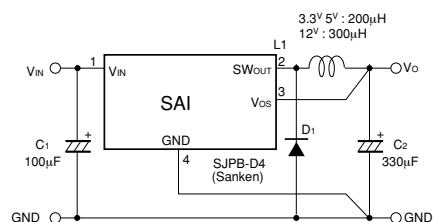
Flammability: UL94V-0

Product Mass: Approx. 0.22g

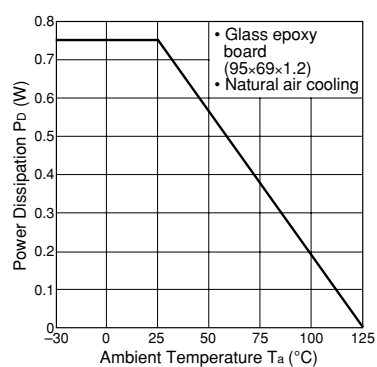
## Block Diagram



## Typical Connection Diagram



## T<sub>a</sub>-P<sub>D</sub> Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

- $V_O$  : Output voltage
- $I_O$  : Output current
- $\eta\chi$  : Efficiency (%)
- $V_F$  : Diode D<sub>1</sub> forward voltage  
SJPB-D4-0.3V

Thermal design for D<sub>1</sub> must be considered separately.

SI-8000W Series

Surface-Mount, Separate Excitation Step-down Switching Mode

Features

- Surface-mount package (SOP8)
- Output current: 0.6A
- High efficiency: 75 to 80%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage adjustment performed internally
- Built-in reference oscillator (60kHz)
- Built-in overcurrent and thermal protection circuits

Absolute Maximum Ratings

| Parameter                                      | Symbol           | Ratings     | Unit |
|------------------------------------------------|------------------|-------------|------|
| DC Input Voltage                               | V <sub>IN</sub>  | 35          | V    |
| Power Dissipation                              | P <sub>D</sub>   | 1           | W    |
| Junction Temperature                           | T <sub>J</sub>   | −30 to +125 | °C   |
| Storage Temperature                            | T <sub>stg</sub> | −40 to +125 | °C   |
| Thermal Resistance (Junction to 7-Pin Lead)    | θ <sub>J-L</sub> | 22          | °C/W |
| Thermal Resistance (Junction to Ambient Air)*1 | θ <sub>J-a</sub> | 100         | °C/W |

\*1: Glass-epoxy board of 40 × 40mm (copper laminate area 4.3%)

Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

Recommended Operating Conditions

| Parameter                            | Symbol           | Ratings     |          | Unit |
|--------------------------------------|------------------|-------------|----------|------|
|                                      |                  | SI-8033W    | SI-8050W |      |
| DC Input Voltage Range               | V <sub>IN</sub>  | 5.3 to 28   | 7 to 33  | V    |
| Output Current Range                 | I <sub>O</sub>   | 0 to 0.6    |          | A    |
| Operating Junction Temperature Range | T <sub>top</sub> | −30 to +125 |          | °C   |

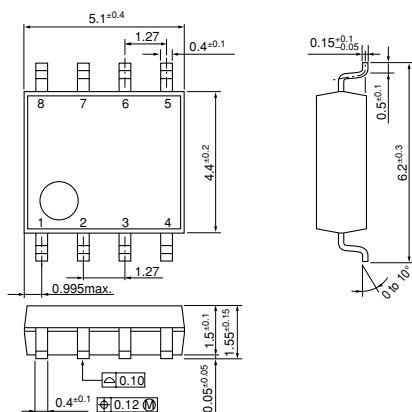
Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                 | Symbol                           | Ratings                                           |      |      |                                                   |      |      | Unit  |
|-------------------------------------------|----------------------------------|---------------------------------------------------|------|------|---------------------------------------------------|------|------|-------|
|                                           |                                  | SI-8033W                                          |      |      | SI-8050W                                          |      |      |       |
|                                           |                                  | min.                                              | typ. | max. | min.                                              | typ. | max. |       |
| Output Voltage                            | V <sub>O</sub>                   | 3.17                                              | 3.30 | 3.43 | 4.80                                              | 5.00 | 5.20 | V     |
|                                           | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Efficiency                                | η                                |                                                   | 75   |      |                                                   | 80   |      | %     |
|                                           | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Oscillation Frequency                     | f                                |                                                   | 60   |      |                                                   | 60   |      | kHz   |
|                                           | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.3A        |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Line Regulation                           | ΔV <sub>OLINE</sub>              |                                                   | 60   | 80   |                                                   | 80   | 100  | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =8 to 28V, I <sub>O</sub> =0.3A   |      |      | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.3A  |      |      |       |
| Load Regulation                           | ΔV <sub>OLOAD</sub>              |                                                   | 20   | 30   |                                                   | 30   | 40   | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.1 to 0.4A |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =0.1 to 0.4A |      |      |       |
| Temperature Coefficient of Output Voltage | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      |                                                   | ±0.5 |      | mV/°C |
| Ripple Rejection                          | R <sub>REJ</sub>                 |                                                   | 45   |      |                                                   | 45   |      | dB    |
|                                           | Conditions                       | f=100 to 120Hz                                    |      |      | f=100 to 120Hz                                    |      |      |       |
| Overcurrent Protection Starting Current   | I <sub>SI</sub>                  | 0.61                                              |      |      | 0.61                                              |      |      | A     |
|                                           | Conditions                       | V <sub>IN</sub> =15V                              |      |      | V <sub>IN</sub> =20V                              |      |      |       |

## External Dimensions (SOP8)

(Unit : mm)



### Pin Assignment

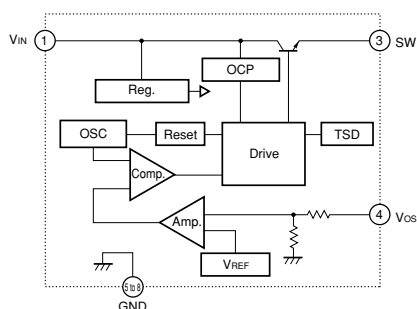
- ①  $V_{IN}$
- ② N.C
- ③ SW
- ④  $V_{OS}$
- ⑤ GND
- ⑥ GND
- ⑦ GND
- ⑧ GND

Plastic Mold Package Type

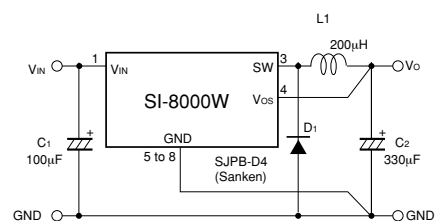
Flammability: UL94V-0

Product Mass: Approx. 0.1g

## Block Diagram

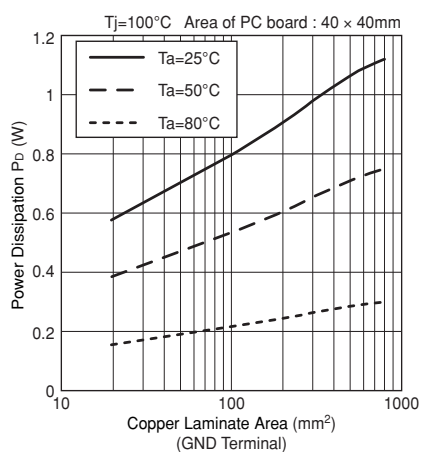


## Typical Connection Diagram

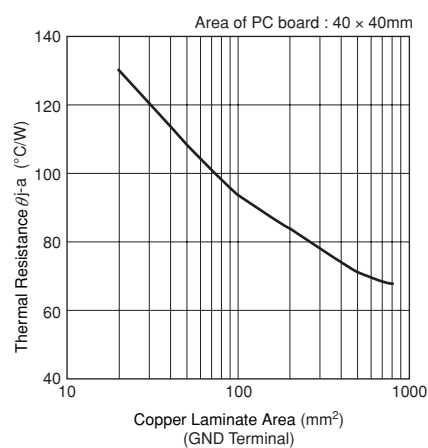


## Reference Data

Copper Laminate Area vs. Power Dissipation



Copper Laminate Area vs. Thermal Resistance  $\theta_{JA}$



## SI-8000JD Series

## Surface-Mount, Separate Excitation Step-down Switching Mode

## ■Features

- Surface-mount package (TO263-5)
- Output current: 1.5A
- High efficiency: 77 to 88%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage
- Capable of downsizing a choke-coil due to IC's high switching frequency (125 kHz). (Compared with conventional Sanken devices)
- Built-in foldback-overcurrent and thermal protection circuits
- Output ON/OFF available (Circuit current at output OFF: 200 $\mu$ A max)
- Soft start available by ON/OFF pin Conditions

## ■Lineup

| Part Number | SI-8033JD | SI-8050JD | SI-8090JD | SI-8120JD |
|-------------|-----------|-----------|-----------|-----------|
| Vo(V)       | 3.3       | 5.0       | 9.0       | 12.0      |
| Io(A)       | 1.5       |           |           |           |

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol           | Ratings     | Unit | Conditions                                                      |
|----------------------------------------------|------------------|-------------|------|-----------------------------------------------------------------|
| DC Input Voltage                             | V <sub>IN</sub>  | 43          | V    |                                                                 |
| Output Current                               | I <sub>O</sub>   | 1.5         | A    |                                                                 |
| Power Dissipation*                           | P <sub>D</sub>   | 3           | W    | When mounted on glass-epoxy board 40 × 40 mm (copper area 100%) |
| Junction Temperature                         | T <sub>J</sub>   | +125        | °C   |                                                                 |
| Storage Temperature                          | T <sub>stg</sub> | -40 to +125 | °C   |                                                                 |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$   | 3           | °C/W |                                                                 |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$   | 33.3        | °C/W | When mounted on glass-epoxy board 40 × 40 mm (copper area 100%) |

\*: Limited by thermal protection circuit

## ■Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies, etc.

## ■Recommended Operating Conditions

| Parameter                            | Symbol           | Ratings     |           |           |           | Unit | Conditions                          |
|--------------------------------------|------------------|-------------|-----------|-----------|-----------|------|-------------------------------------|
|                                      |                  | SI-8033JD   | SI-8050JD | SI-8090JD | SI-8120JD |      |                                     |
| DC Input Voltage Range               | V <sub>IN1</sub> | 5.3 to 40   | 7 to 40   | 11 to 40  | 14 to 40  | V    | I <sub>O</sub> =0 to 1A             |
|                                      | V <sub>IN2</sub> | 6.3 to 40   | 8 to 40   | 12 to 40  | 15 to 40  |      | I <sub>O</sub> =0 to 1.5A           |
| DC Output Current Range*             | I <sub>O</sub>   | 0 to 1.5    |           |           |           | A    | V <sub>IN</sub> ≥V <sub>O</sub> +3V |
| Operating Junction Temperature Range | T <sub>JO</sub>  | -30 to +125 |           |           |           | °C   |                                     |
| Operating Temperature Range*         | T <sub>OP</sub>  | -30 to +125 |           |           |           | °C   |                                     |

\*: Limited by Ta-P<sub>D</sub> characteristics

## ■Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                 |                                                 | Symbol                           | Ratings                                           |                                                 |       |                                                   |                                                 |      |                                                   |                                                 |      |                                                   |       |       | Unit |
|-------------------------------------------|-------------------------------------------------|----------------------------------|---------------------------------------------------|-------------------------------------------------|-------|---------------------------------------------------|-------------------------------------------------|------|---------------------------------------------------|-------------------------------------------------|------|---------------------------------------------------|-------|-------|------|
|                                           |                                                 |                                  | SI-8033JD                                         |                                                 |       | SI-8050JD                                         |                                                 |      | SI-8090JD                                         |                                                 |      | SI-8120JD                                         |       |       |      |
|                                           |                                                 |                                  | min.                                              | typ.                                            | max.  | min.                                              | typ.                                            | max. | min.                                              | typ.                                            | max. | min.                                              | typ.  | max.  |      |
| Output Voltage                            |                                                 | V <sub>O</sub>                   | 3.234                                             | 3.30                                            | 3.366 | 4.90                                              | 5.00                                            | 5.10 | 8.82                                              | 9.00                                            | 9.18 | 11.76                                             | 12.00 | 12.24 | V    |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                                                 |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |       |       |      |
| Efficiency                                |                                                 | η                                |                                                   | 77                                              |       |                                                   | 82                                              |      |                                                   | 86                                              |      |                                                   | 88    | %     |      |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                                                 |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |       |       |      |
| Oscillation Frequency                     |                                                 | f                                |                                                   | 125                                             |       |                                                   | 125                                             |      |                                                   | 125                                             |      |                                                   | 125   | kHz   |      |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                                                 |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0.5A        |                                                 |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |       |       |      |
| Line Regulation                           |                                                 | ΔV <sub>OLINE</sub>              |                                                   | 25                                              | 80    |                                                   | 40                                              | 100  |                                                   | 50                                              | 120  |                                                   | 60    | 130   | mV   |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =8 to 30V, I <sub>O</sub> =0.5A   |                                                 |       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.5A  |                                                 |      | V <sub>IN</sub> =15 to 30V, I <sub>O</sub> =0.5A  |                                                 |      | V <sub>IN</sub> =18 to 30V, I <sub>O</sub> =0.5A  |       |       |      |
| Load Regulation                           |                                                 | ΔV <sub>OLOAD</sub>              |                                                   | 10                                              | 30    |                                                   | 10                                              | 40   |                                                   | 10                                              | 40   |                                                   | 10    | 40    | mV   |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.2 to 0.8A |                                                 |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.2 to 0.8A |                                                 |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0.2 to 0.8A |                                                 |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.2 to 0.8A |       |       |      |
| Temperature Coefficient of Output Voltage |                                                 | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5                                            |       |                                                   | ±0.5                                            |      |                                                   | ±1.0                                            |      |                                                   | ±1.0  | mV/°C |      |
| Overcurrent Protection Starting Current   |                                                 | I <sub>S1</sub>                  | 1.6                                               |                                                 |       | 1.6                                               |                                                 |      | 1.6                                               |                                                 |      | 1.6                                               |       |       | A    |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V                              |                                                 |       | V <sub>IN</sub> =20V                              |                                                 |      | V <sub>IN</sub> =21V                              |                                                 |      | V <sub>IN</sub> =24V                              |       |       |      |
| ON/OFF* Pin                               | Low Level Voltage                               | V <sub>SSL</sub>                 |                                                   |                                                 | 0.5   |                                                   |                                                 | 0.5  |                                                   |                                                 | 0.5  |                                                   |       | 0.5   | V    |
|                                           | Outflow Current at Low Voltage                  | I <sub>SSL</sub>                 |                                                   |                                                 | 100   |                                                   |                                                 | 100  |                                                   |                                                 | 100  |                                                   |       | 100   |      |
|                                           | Conditions                                      | V <sub>SSL</sub> =0V             |                                                   |                                                 |       |                                                   |                                                 |      |                                                   |                                                 |      |                                                   |       |       |      |
| Quiescent Circuit Current                 |                                                 | I <sub>q</sub>                   |                                                   | 7                                               |       |                                                   | 7                                               |      |                                                   | 7                                               |      |                                                   | 7     |       | mA   |
|                                           |                                                 | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0A          |                                                 |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0A          |                                                 |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0A          |                                                 |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0A          |       |       |      |
|                                           |                                                 | I <sub>q</sub> (OFF)             |                                                   |                                                 | 200   |                                                   |                                                 | 200  |                                                   |                                                 | 200  |                                                   |       | 200   |      |
| Conditions                                | V <sub>IN</sub> =15V, V <sub>ON/OFF</sub> =0.3V |                                  |                                                   | V <sub>IN</sub> =20V, V <sub>ON/OFF</sub> =0.3V |       |                                                   | V <sub>IN</sub> =21V, V <sub>ON/OFF</sub> =0.3V |      |                                                   | V <sub>IN</sub> =24V, V <sub>ON/OFF</sub> =0.3V |      |                                                   |       |       |      |

\*: Pin 5 is the ON/OFF pin. Soft start at power on can be performed with a capacitor connected to this pin.

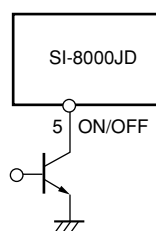
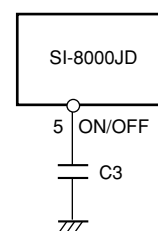
The output can also be turned ON/OFF with this pin.

The output is stopped by setting the voltage of this pin to V<sub>SSL</sub> or lower.

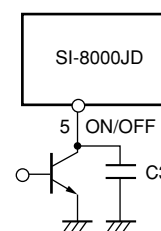
ON/OFF-pin voltage can be changed with an open-collector drive circuit of a transistor.

When using both the soft-start and ON/OFF functions together, the discharge current from C<sub>3</sub> flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C<sub>3</sub> capacitance is large.

The ON/OFF pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

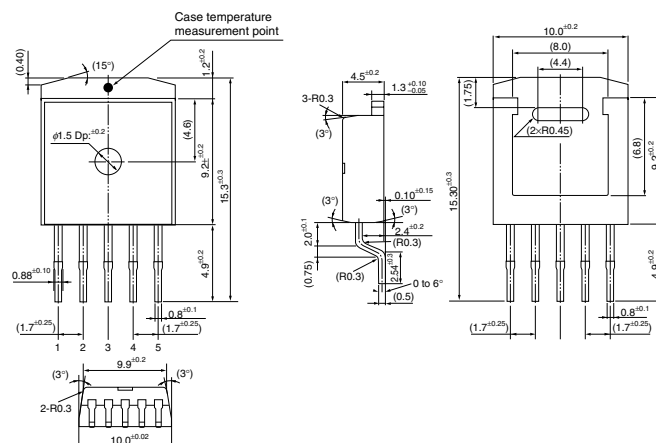
V<sub>OUT</sub>. ON/OFF

Soft Start

Soft Start  
+ V<sub>OUT</sub>. ON/OFF

## External Dimensions (TO263-5)

(Unit : mm)



### Pin Assignment

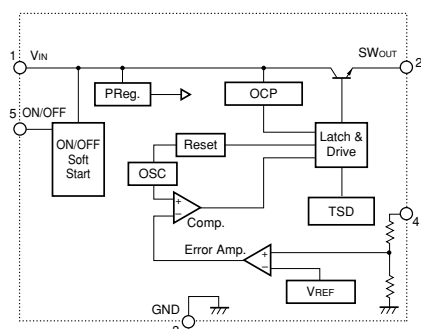
- ① VIN
- ② SWOUT
- ③ GND
- ④ Vos
- ⑤ ON/OFF

Plastic Mold Package Type

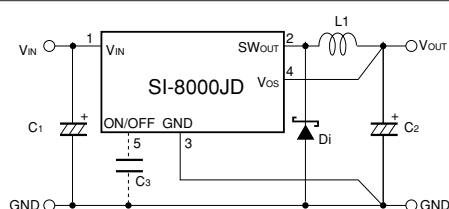
Flammability: 94V-0

Product Mass: Approx. 1.48g

## Block Diagram



## Typical Connection Diagram



C1 : 50V/220μF

C2 : 25V/470μF

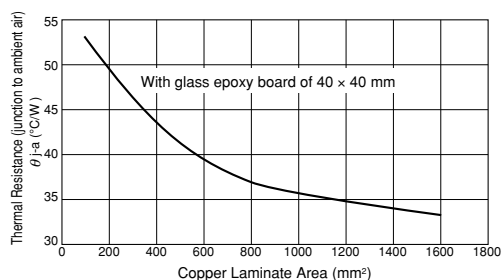
C3 : 10V/0.47μF (Only when using soft-start function)

L1 : 100μH

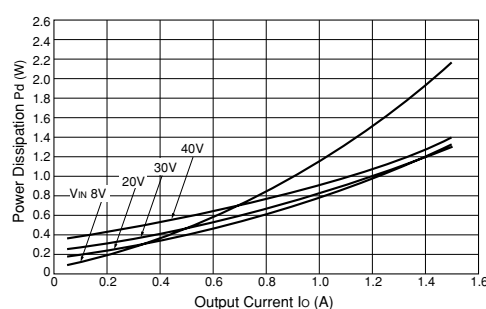
Di : SJPB-H6 (Sanken)

## Reference Data

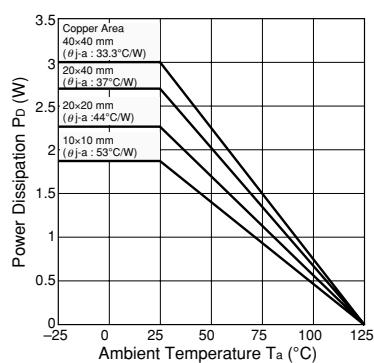
Copper Laminate Area on Glass Epoxy Board vs.  
Thermal Resistance (Junction to Ambient Air) (Typical Value)



Output Current vs. Power Dissipation (Typical)



## Ta-Pd Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

- VO : Output Voltage
- VIN : Input Voltage
- IO : Output Current
- ηχ : Efficiency (%)
- VF : Di forward voltage
- 0.4V (IO=2A) (SJPB-H6)

Thermal design for D1 must be considered separately.

# SI-8000TM Series Surface-Mount, Separate Excitation Step-down Switching Mode

## ■Features

- Compact surface-mount package (TO252-5)
- Output current: 1.5 A
- High efficiency: 81% typ. (at  $V_o = 5\text{ V}$ )
- Requires only 4 discrete components
- Built-in reference oscillator (300 kHz)
- Built-in drooping-type-overcurrent and thermal protection circuits
- Output ON/OFF available (circuit current at output OFF: 200  $\mu\text{A}$  typ.)
- Soft start available by ON/OFF pin

## ■Applications

- Onboard local power supplies
- AV equipment
- OA equipment

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings              | Unit |
|--------------------------------------|-----------|----------------------|------|
|                                      |           | SI-8008TM            |      |
| Input Voltage Range                  | $V_{IN}$  | $V_o + 3^{*1}$ to 40 | V    |
| Output Voltage                       | $V_o$     | 0.8 to 24            | V    |
| Output Current Range                 | $I_o$     | 0 to 1.5             | A    |
| Operating Junction Temperature Range | $T_{jop}$ | -20 to +100          | °C   |
| Operating Temperature Range          | $T_{op}$  | -20 to +85           | °C   |

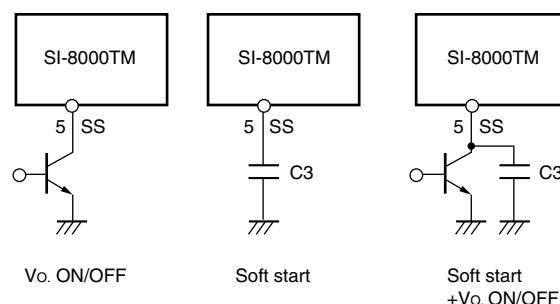
\*1: The minimum value of an input voltage range is the higher of 4.5 V or  $V_o + 3\text{ V}$ .

## ■Electrical Characteristics

( $T_a = 25^\circ\text{C}$ )

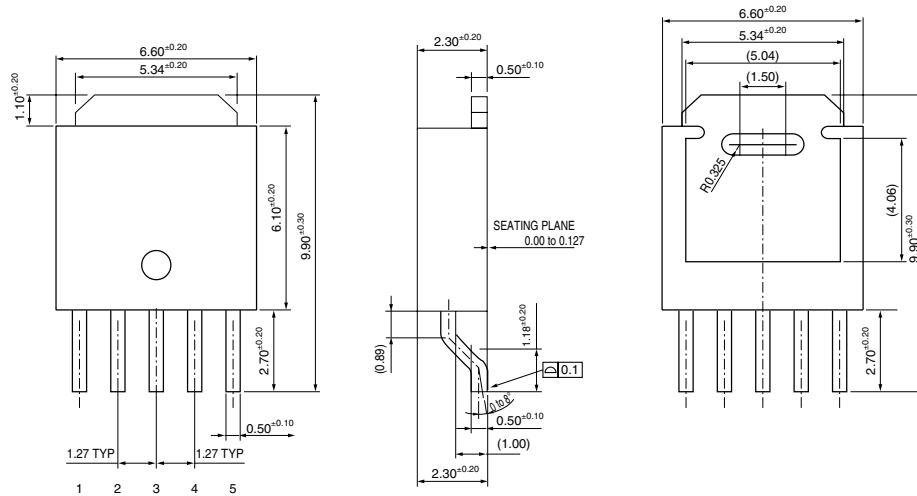
| Parameter                                    |                                | Symbol                | Rating                                                                 |       |       | Unit  |
|----------------------------------------------|--------------------------------|-----------------------|------------------------------------------------------------------------|-------|-------|-------|
|                                              |                                |                       | SI-8008TM                                                              |       |       |       |
|                                              |                                |                       | min.                                                                   | typ.  | max.  |       |
| Reference Voltage                            |                                | V <sub>ADJ</sub>      | 0.784                                                                  | 0.800 | 0.816 | V     |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.1A                             |       |       |       |
| Temperature Coefficient of Reference Voltage |                                | ΔV <sub>ADJ</sub> /ΔT |                                                                        | ±0.1  |       | mV/°C |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.1A, T <sub>c</sub> =0 to 100°C |       |       |       |
| Efficiency                                   |                                | η                     |                                                                        | 81    |       | %     |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.5A                             |       |       |       |
| Oscillation Frequency                        |                                | f <sub>o</sub>        |                                                                        | 300   |       | kHz   |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.5A                             |       |       |       |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>   |                                                                        | 60    | 80    | mV    |
|                                              |                                | Conditions            | V <sub>IN</sub> =10 to 30V, I <sub>o</sub> =0.5A                       |       |       |       |
| Load Regulation                              |                                | ΔV <sub>LOAD</sub>    |                                                                        | 10    | 40    | mV    |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2 to 1.5A                      |       |       |       |
| Overcurrent Protection Starting Current      |                                | I <sub>S</sub>        | 1.6                                                                    |       |       | A     |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V                                                   |       |       |       |
| ON/OFF Pin*                                  | Low Level Voltage              | V <sub>SSL</sub>      |                                                                        |       | 0.5   | V     |
|                                              | Outflow Current at Low Voltage | I <sub>SSL</sub>      |                                                                        | 10    | 40    | μA    |
|                                              |                                | Conditions            | V <sub>SSL</sub> =0V                                                   |       |       |       |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>        |                                                                        | 6     |       | mA    |
|                                              |                                |                       | V <sub>IN</sub> =15V, I <sub>o</sub> =0A                               |       |       |       |
|                                              |                                | I <sub>q</sub> (OFF)  |                                                                        | 200   | 400   | μA    |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V                              |       |       |       |

\*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited. If the pin is not used, leave it open.



## External Dimensions (TO252-5)

(Unit : mm)



### Pin Assignment

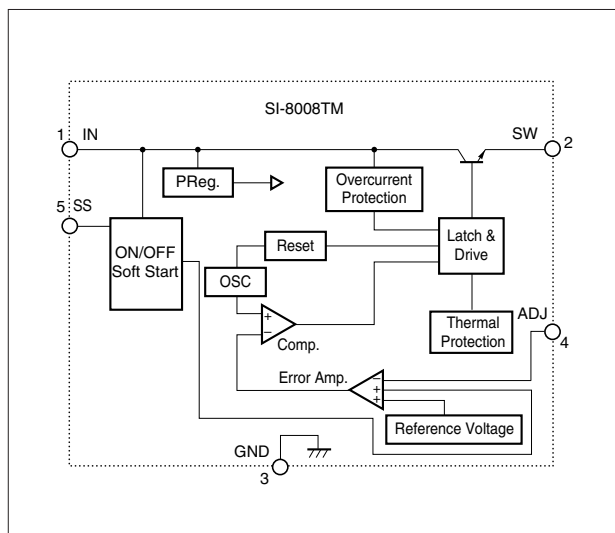
- ① IN
- ② SW
- ③ GND
- ④ ADJ
- ⑤ SS

Plastic Mold Package Type

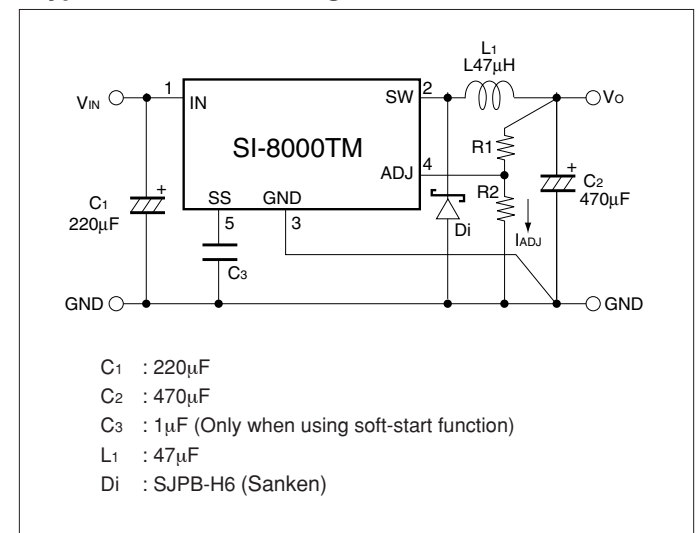
Flammability: UL94V-0

Product Mass: Approx. 0.33 g

## Block Diagram



## Typical Connection Diagram



# NR110E/K Surface-Mount, Current Mode Control Step-down Switching Mode

## Features

- Compact surface-mount package
- Input voltage range ( $V_{IN}$ ):  $V_O + 3$  to 31 V
- Oscillation frequency: 30 kHz, 350 kHz, 364 kHz
- High efficiency under light load
- High efficiency: 94% or higher
- Current mode control
- Stable with low-ESR ceramic output capacitors
- Built-in phase compensation component
- Output current: 1.5 A, 2 A, 4 A
- Reference voltage and accuracy of  $0.8 \text{ V} \pm 2\%$
- Overcurrent protection function that can be adjusted externally
- Output ON/OFF available
- Undervoltage lockout
- Soft start function

## Applications

- Power supply for LCDTV, STB and Blu-Ray
- Power supplies for domestic appliances
- On-board local power supply
- Switching power supplies

## Absolute Maximum Ratings

| Parameter                                      | Symbol         | Ratings    |            |            |            | Unit | Conditions                                                                   |
|------------------------------------------------|----------------|------------|------------|------------|------------|------|------------------------------------------------------------------------------|
|                                                |                | NR110K     | NR111E     | NR117K     | NR119E     |      |                                                                              |
| Input Voltage                                  | $V_{IN}$       | 35         | 35         | 35         | 35         | V    |                                                                              |
| BS Pin Voltage                                 | $V_{BS}$       | 44         | 44         | 44         | 44         | V    |                                                                              |
| Pin Voltage between BS and SW                  | $V_{BS-SW}$    | 8          | 8          | 8          | 8          | V    |                                                                              |
| SW Pin Voltage                                 | $V_{SW}$       | 35         | 35         | 35         | 35         | V    |                                                                              |
| FB Pin Voltage                                 | $V_{FB}$       | 5.5        | 5.5        | 5.5        | 5.5        | V    |                                                                              |
| EN Pin Voltage                                 | $V_{EN}$       | 35         | 35         | 35         | 35         | V    |                                                                              |
| SS Pin Voltage                                 | $V_{SS}$       | 5.5        | 5.5        | 5.5        | 5.5        | V    |                                                                              |
| Power Dissipation                              | $P_D$          | 1.69       | 1.76       | 1.69       | 1.76       | W    | When mounted on 30 × 30 mm glass-epoxy board (with a 25 × 25 mm copper area) |
| Junction Temperature                           | $T_J$          | −40 to 150 | −40 to 150 | −40 to 150 | −40 to 150 | °C   |                                                                              |
| Storage Temperature                            | $T_{stg}$      | −40 to 150 | −40 to 150 | −40 to 150 | −40 to 150 | °C   |                                                                              |
| Thermal Resistance (Junction to Lead (4 pins)) | $\theta_{J-C}$ | 40         | 26         | 40         | 26         | °C/W |                                                                              |
| Thermal Resistance (Junction to Ambient Air)   | $\theta_{J-A}$ | 74         | 71         | 74         | 71         | °C/W | When mounted on 30 × 30 mm glass-epoxy board (with a 25 × 25 mm copper area) |

## Recommended Operating Conditions

| Parameter                   | Symbol    | Ratings                  |                          |                          |                          | Unit |
|-----------------------------|-----------|--------------------------|--------------------------|--------------------------|--------------------------|------|
|                             |           | NR110K                   | NR111E                   | NR117K                   | NR119E                   |      |
| Input Voltage Range         | $V_{IN}$  | 8.0 or $V_O + 3^*$ to 31 | 6.5 or $V_O + 3^*$ to 31 | 8.0 or $V_O + 3^*$ to 31 | 6.5 or $V_O + 3^*$ to 31 | V    |
| Output Current Range        | $I_{OUT}$ | 0 to 4.0**               | 0 to 4.0**               | 0 to 1.5**               | 0 to 2.0**               | A    |
| Output Voltage Range        | $V_O$     | 0.8 to 24                | 0.8 to 24                | 0.8 to 24                | 0.8 to 24                | V    |
| Operating Temperature Range | $T_{op}$  | −40 to 85**              | −40 to 85**              | −40 to 85**              | −40 to 85**              | °C   |

\*: The minimum value of the input voltage range is indicated value or  $V_O + 3 \text{ V}$ , whichever is higher.

\*\* : The device must be used within the range indicated by the  $T_a$ - $P_D$  characteristics.

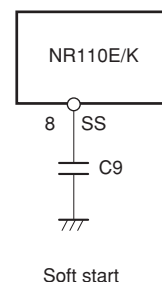
## Electrical Characteristics

( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 12\text{V}$ ,  $V_O = 5.0\text{V}$ , and  $I_O = 1\text{A}$ , unless otherwise specified)

| Parameter                                    |                                | Symbol                | Ratings       |        |       |        |        |       |        |        |       | Unit  | Conditions                                                                           |
|----------------------------------------------|--------------------------------|-----------------------|---------------|--------|-------|--------|--------|-------|--------|--------|-------|-------|--------------------------------------------------------------------------------------|
|                                              |                                |                       | NR110K/NR111E |        |       | NR119E |        |       | NR117K |        |       |       |                                                                                      |
|                                              |                                |                       | min.          | typ.   | max.  | min.   | typ.   | max.  | min.   | typ.   | max.  |       |                                                                                      |
| Reference Voltage                            |                                | V <sub>REF</sub>      | 0.784         | 0.8000 | 0.816 | 0.784  | 0.8000 | 0.816 | 0.784  | 0.8000 | 0.816 | V     |                                                                                      |
| Temperature Coefficient of Reference Voltage |                                | ΔV <sub>REF</sub> /ΔT |               | ±0.05  |       |        | ±0.05  |       |        | ±0.05  |       | mV/°C | Ta=−40°C to +85°C                                                                    |
| Oscillation Frequency                        |                                | f <sub>sw</sub>       |               | 350    |       |        | 364    |       |        | 30     |       | kHz   |                                                                                      |
| Line Regulation                              |                                | V <sub>LINE</sub>     |               | 50     |       |        | 50     |       |        | 50     |       | mV    | V <sub>IN</sub> =V <sub>INmin</sub> to 30V                                           |
| Load Regulation                              |                                | V <sub>Load</sub>     |               | 50     |       |        | 50     |       |        | 50     |       | mV    | V <sub>IN</sub> =12V, V <sub>O</sub> =5.0V, I <sub>O</sub> =0.1 to I <sub>omax</sub> |
| Overcurrent Protection                       |                                | I <sub>s1</sub>       |               | 1.5    |       |        | 0.9    |       |        | 0.3    |       | A     | ISET=OPEN                                                                            |
| Starting Current                             |                                | I <sub>s2</sub>       |               | 5.5    |       |        | 2.8    |       |        | 2.1    |       | A     | ISET=SHORT                                                                           |
| No-load Circuit Current                      |                                | I <sub>IN</sub>       |               | 1      |       |        | 1      |       |        | 1      |       | mA    | V <sub>EN</sub> =10kΩ pull up to V <sub>IN</sub>                                     |
| Quiescent Circuit Current                    |                                | I <sub>IN(off)</sub>  |               | 1      |       |        | 1      |       |        | 1      |       | μA    | I <sub>O</sub> =0A, V <sub>EN</sub> =0V                                              |
| SS Pin                                       | Outflow Current at Low Voltage | I <sub>EN/SS</sub>    | 6             | 10     | 14    | 6      | 10     | 14    | 6      | 10     | 14    | μA    | V <sub>SS</sub> =0V                                                                  |
| EN Pin                                       | Inflow Current                 | I <sub>EN</sub>       |               | 20     | 50    |        | 20     | 50    |        | 20     | 50    | μA    | V <sub>EN</sub> =10V                                                                 |
|                                              | On Threshold Voltage           | V <sub>C/EN</sub>     | 0.7           | 1.4    | 2.1   | 0.7    | 1.4    | 2.1   | 0.7    | 1.4    | 2.1   | V     |                                                                                      |
| ISET Pin                                     | Open Voltage                   | V <sub>ISET</sub>     |               | 1.5    |       |        | 1.5    |       |        | 1.5    |       | V     |                                                                                      |
| Maximum ON Duty                              |                                | D <sub>MAX</sub>      |               | 90     |       |        | 90     |       |        | 90     |       | %     |                                                                                      |
| Minimum ON Time                              |                                | T <sub>ON(MIN)</sub>  |               | 150    |       |        | 150    |       |        | 150    |       | nsec  |                                                                                      |
| Thermal Protection Start Temperature         |                                | T <sub>SD</sub>       | 151           | 165    |       | 151    | 165    |       | 151    | 165    |       | °C    |                                                                                      |
| Thermal Protection Return Hysteresis         |                                | T <sub>SD_hys</sub>   |               | 20     |       |        | 20     |       |        | 20     |       | °C    |                                                                                      |
| SW MOSFET ON Resistance                      |                                | R <sub>onH</sub>      |               | 85     |       |        | 150    |       |        | 150    |       | mΩ    |                                                                                      |

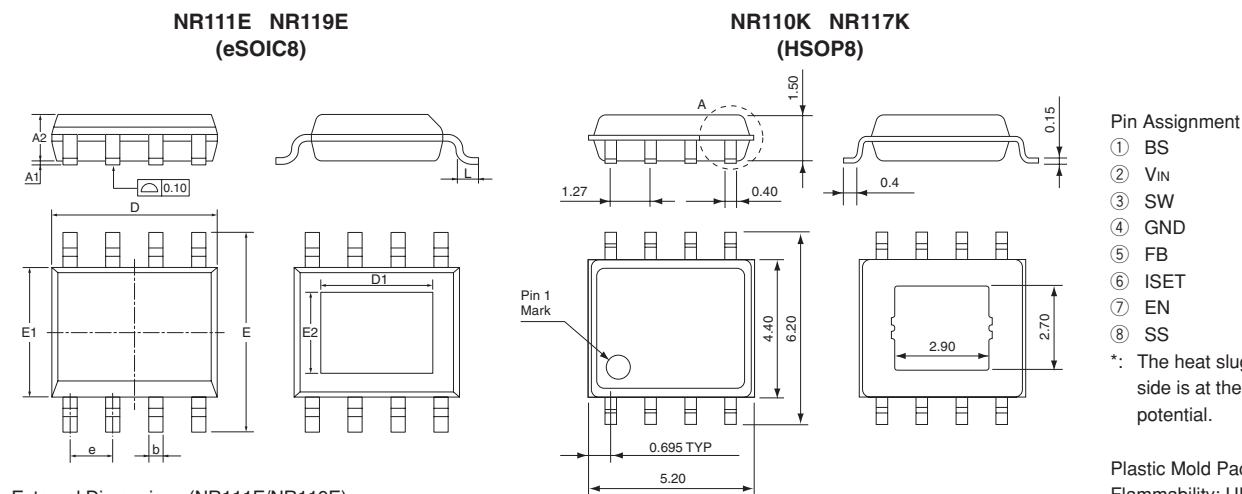
\*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.

The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



## External Dimensions

(Unit : mm)



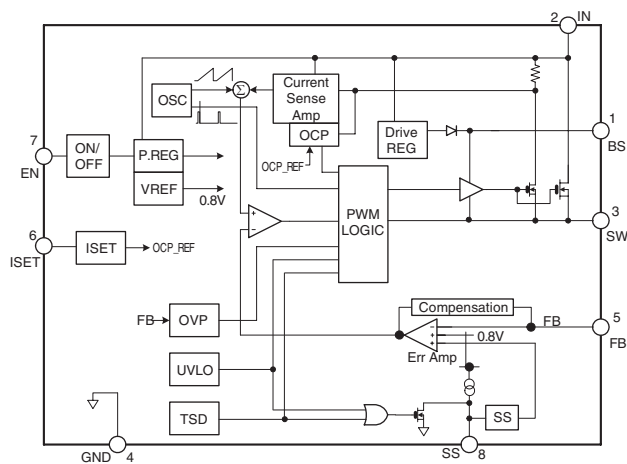
External Dimensions (NR111E/NR119E)

| Symbol | Package A |       |        | Package B |      |      |
|--------|-----------|-------|--------|-----------|------|------|
|        | MIN       | TYP   | MAX    | MIN       | TYP  | MAX  |
| A1     | 0         | —     | 0.1524 | 0         | 0.1  | 0.15 |
| A2     | 1.398     | 1.448 | 1.498  | 1.25      | 1.4  | 1.65 |
| b      | 0.33      | —     | 0.508  | 0.38      | —    | 0.51 |
| D      | 4.8       | 4.902 | 5.004  | 4.8       | 4.9  | 5    |
| D1     | 3.053     | 3.18  | 3.307  | 3.1       | 3.3  | 3.5  |
| E      | 5.893     | —     | 6.918  | 5.8       | 6    | 6.2  |
| E1     | 3.73      | —     | 3.89   | 3.8       | 3.9  | 4    |
| E2     | 2.033     | 2.16  | 2.287  | 2.2       | 2.4  | 2.6  |
| e      | —         | 1.27  | —      | —         | 1.27 | —    |
| L      | 0.508     | —     | 0.762  | 0.45      | 0.6  | 0.8  |

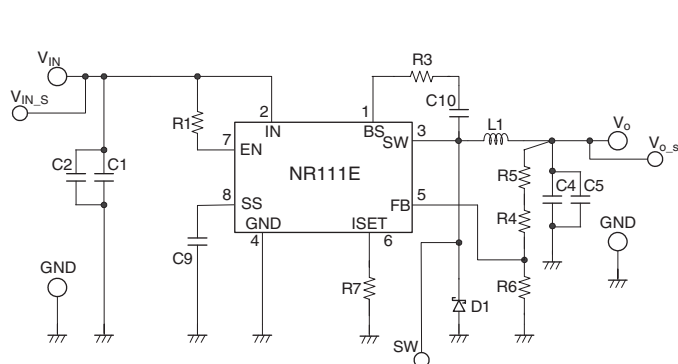
Delivered in Package A or B.

Plastic Mold Package Type  
 Flammability: UL 94V-0  
 Product Mass: Approx. 0.1g

## Block Diagram



## Typical Connection Diagram



- C1 : 10 $\mu$ F / 35V
- C2 : 10 $\mu$ F / 35V
- C4 : 22 $\mu$ F / 16V
- C5 : 22 $\mu$ F / 16V
- C9 : 0.1 $\mu$ F
- C10 : 0.1 $\mu$ F
- R1 : 1.7M $\Omega$
- R3 : 22 $\Omega$
- R4 : 20k $\Omega$
- R5 : 470 $\Omega$  ( $V_o=5.0V$ )
- R6 : 3.9k $\Omega$
- R7 : 0k $\Omega$  (When ISET SHORT)
- L1 : 10 $\mu$ H (NR110K, NR111E, NR119E)  
150 $\mu$ H (NR117K)

NR885K/NR885E

Surface-Mount, Current Mode Control, Synchronous Rectifier Step-down Switching Mode

Features

- Compact surface-mount package
- Input voltage range (VIN): Vo + 3 to 18 V
- Synchronous rectifier mode
- High efficiency: 90%
- Current mode control
- Stable with low-ESR ceramic output capacitors
- Built-in phase compensation component
- Output current: 3 A
- Reference voltage and accuracy of 0.8 V ± 2%
- Oscillation frequency: 350 kHz
- Output ON/OFF available
- Undervoltage lockout
- Soft start function

Applications

- Power supply for LCDTV and PDP
- Power supply for DVD, BD, and STB
- On-board local power supply
- Switching power supplies

Absolute Maximum Ratings

| Parameter                                      | Symbol | Ratings     |             | Unit | Conditions                                                                             |
|------------------------------------------------|--------|-------------|-------------|------|----------------------------------------------------------------------------------------|
|                                                |        | NR885K      | NR885E      |      |                                                                                        |
| Input Voltage                                  | VIN    | 20          | 20          | V    |                                                                                        |
| Power Dissipation                              | PD     | 1.69        | 1.50        | W    | When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |
| Junction Temperature                           | Tj     | −40 to +150 | −40 to +150 | °C   |                                                                                        |
| Storage Temperature                            | Tstg   | −40 to +150 | −40 to +150 | °C   |                                                                                        |
| Thermal Resistance (Junction to Lead (4 pins)) | θj-c   | 40          | 26          | °C/W |                                                                                        |
| Thermal Resistance (Junction to Ambient Air)   | θj-a   | 74          | 71          | °C/W | When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |

Recommended Operating Conditions

| Parameter                   | Symbol | Ratings              | Unit |
|-----------------------------|--------|----------------------|------|
| Input Voltage Range         | VIN    | 4.5 or Vo + 3* to 18 | V    |
| Output Current Range        | Io     | 0 to 3.0             | A    |
| Output Voltage Range        | Vo     | 0.8 to 14            | V    |
| Operating Temperature Range | Top    | −40 to +85           | °C   |

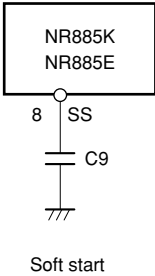
\*: The minimum value of the input voltage range is 4.5 V or Vo + 3 V, whichever is higher.

Electrical Characteristics

(Ta=25°C, VIN=12V, VO=3.3V, and Io=1A, unless otherwise specified)

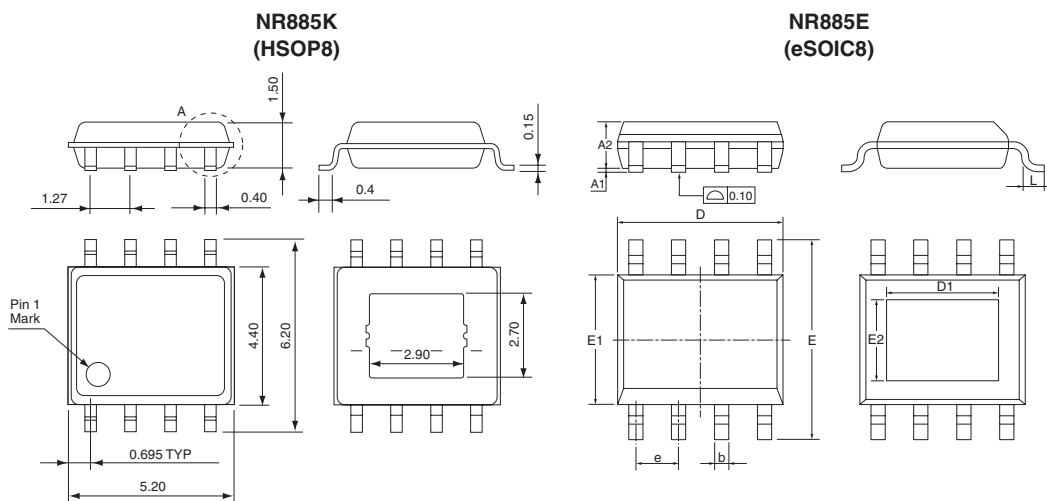
| Parameter                                    |                                | Symbol   | Ratings |       |       | Unit  | Conditions              |
|----------------------------------------------|--------------------------------|----------|---------|-------|-------|-------|-------------------------|
|                                              |                                |          | min.    | typ.  | max.  |       |                         |
| Reference Voltage                            |                                | VREF     | 0.784   | 0.800 | 0.816 | V     |                         |
| Temperature Coefficient of Reference Voltage |                                | ΔVREF/ΔT |         | ±0.05 |       | mV/°C | Ta=−40°C to +85°C       |
| Efficiency                                   |                                | η        |         | 90    |       | %     |                         |
| Oscillation Frequency                        |                                | fo       | 280     | 350   | 420   | kHz   |                         |
| Line Regulation                              |                                | VLINE    |         | 50    |       | mV    | VIN=6.3V to 18V         |
| Load Regulation                              |                                | VLoad    |         | 50    |       | mV    | Io=0.1A to 3A           |
| Overcurrent Protection Starting Current      |                                | Is       | 3.1     |       | 6.0   | A     |                         |
| Quiescent Circuit Current 1                  |                                | IIN      |         | 6     |       | mA    | VEN=10kΩ pull up to VIN |
| Quiescent Circuit Current 2                  |                                | IIN(off) | 0       |       | 10    | μA    | Io=0A, VEN=0V           |
| SS Pin                                       | Outflow Current at Low Voltage | IEN/SS   | 6       | 10    | 14    | μA    | VSS=0V                  |
|                                              | Open Voltage                   | VSSH     |         | 3.0   |       | V     |                         |
| EN Pin                                       | Inflow Current                 | IEN      |         | 50    | 100   | μA    | VEN=10V                 |
|                                              | On Threshold Voltage           | VC/EH    | 0.7     | 1.4   | 2.1   | V     |                         |
| Maximum ON Duty                              |                                | DMAX     |         | 90    |       | %     |                         |
| Minimum ON Time                              |                                | DMIN     |         | 150   |       | nsec  |                         |
| Thermal Protection Start Temperature         |                                | TSD      | 151     | 165   |       | °C    |                         |
| Thermal Protection Return Hysteresis         |                                | TSD_hys  |         | 20    |       | °C    |                         |

\*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



## ■ External Dimensions

(Unit : mm)



## Pin Assignment

- ① BS  
② VIN  
③ SW  
④ GND  
⑤ FB  
⑥ NC  
⑦ EN  
⑧ SS

\*: The heat slug on the rear side is at the ground potential.

Plastic Mold Package Type

Flammability: UL 94V-0

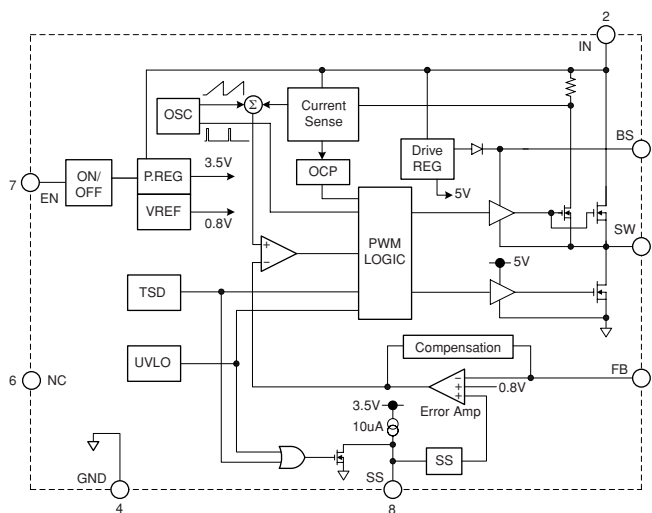
Product Mass: Approx. 0.1g

### External Dimensions (NR885E)

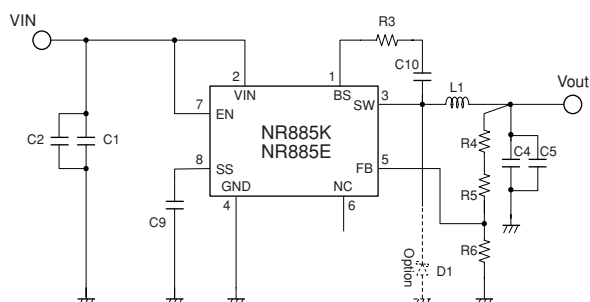
| Symbol | Package A |       |        | Package B |      |      |
|--------|-----------|-------|--------|-----------|------|------|
|        | MIN       | TYP   | MAX    | MIN       | TYP  | MAX  |
| A1     | 0         | —     | 0.1524 | 0         | 0.1  | 0.15 |
| A2     | 1.398     | 1.448 | 1.498  | 1.25      | 1.4  | 1.65 |
| b      | 0.33      | —     | 0.508  | 0.38      | —    | 0.51 |
| D      | 4.8       | 4.902 | 5.004  | 4.8       | 4.9  | 5    |
| D1     | 3.053     | 3.18  | 3.307  | 3.1       | 3.3  | 3.5  |
| E      | 5.893     | —     | 6.918  | 5.8       | 6    | 6.2  |
| E1     | 3.73      | —     | 3.89   | 3.8       | 3.9  | 4    |
| E2     | 2.033     | 2.16  | 2.287  | 2.2       | 2.4  | 2.6  |
| e      | —         | 1.27  | —      | —         | 1.27 | —    |
| L      | 0.508     | —     | 0.762  | 0.45      | 0.6  | 0.8  |

Delivered in Package A or B.

## ■Block Diagram



### ■ Typical Connection Diagram



C1, C2: 10 $\mu$ F/25V  
C4, C5: 22 $\mu$ F/16V  
C9: 0.1 $\mu$ F  
C10: 0.1 $\mu$ F  
L1: 10 $\mu$ H  
R3: 20 $\Omega$  to 47 $\Omega$   
R4+R5: 5k $\Omega$  (V<sub>O</sub>=3.3V)  
R6: 1.6k $\Omega$

## SI-8205NHD/SI-8205NHG

## Surface-Mount, Current Mode Control, Synchronous Rectifier Step-down Switching Mode

## ■Features

- Compact surface-mount (HSOP8) package
- Wide input voltage range ( $V_{IN}$ ):  $V_o + 3$  to 43 V
- Synchronous rectifier mode
- Output current: 3 A
- Reference voltage and accuracy of 0.5 V  $\pm 1\%$
- Oscillation frequency  
SI-8205NHD  
Externally adjusted frequency type: 200 kHz to 1 MHz  
SI-8205NHG  
Externally synchronized frequency type: 300 kHz to 1 MHz
- Stable with low-ESR ceramic output capacitors
- Output can be disabled
- Undervoltage lockout
- Soft start function

## ■Applications

- Power supply for LCD module
- Power supply for notebook PC
- Onboard local power supplies
- Power supply for LBP/PPC

## ■Absolute Maximum Ratings

| Parameter                                     | Symbol         | Ratings     |             | Unit | Conditions                                                                     |
|-----------------------------------------------|----------------|-------------|-------------|------|--------------------------------------------------------------------------------|
|                                               |                | SI-8205NHD  | SI-8205NHG  |      |                                                                                |
| Input Voltage ( $V_{IN}$ Pin)                 | $V_{IN}$       | 46          | 46          | V    |                                                                                |
| SYNC Pin Voltage                              | $V_{SYNC}$     | —           | 5.5         | V    |                                                                                |
| Power Dissipation                             | $P_D$          | 1.35        | 1.35        | W    | When mounted on a 30 × 30 mm glass-epoxy board (with a 25 × 25 mm copper area) |
| Junction Temperature                          | $T_j$          | −40 to +150 | −40 to +150 | °C   |                                                                                |
| Storage Temperature                           | $T_{stg}$      | −40 to +150 | −40 to +150 | °C   |                                                                                |
| Thermal Resistance (Junction to Lead <1 pin>) | $\theta_{j-c}$ | 40          | 40          | °C/W |                                                                                |
| Thermal Resistance (Junction to Ambient Air)  | $\theta_{j-a}$ | 74          | 74          | °C/W | When mounted on a 30 × 30 mm glass-epoxy board (with a 25 × 25 mm copper area) |

## ■Recommended Operating Conditions

| Parameter                               | Symbol     | Ratings                |                        | Unit |
|-----------------------------------------|------------|------------------------|------------------------|------|
|                                         |            | SI-8205NHD             | SI-8205NHG             |      |
| Input Voltage Range                     | $V_{IN}$   | 8 or $V_o + 3^*$ to 43 | 7 or $V_o + 3^*$ to 43 | V    |
| SYNC Pin Voltage Range                  | $V_{SYNC}$ | —                      | 0 to 5                 | V    |
| Output Current Range                    | $I_{OUT}$  | 0 to 3.0               | 0 to 3.0               | A    |
| Output Voltage Range                    | $V_o$      | 0.5 to 24              | 0.5 to 24              | V    |
| Externally Synchronized Frequency Range | $f_{SYNC}$ | —                      | 300 to 1000            | kHz  |
| Operating Temperature Range             | $T_{op}$   | −40 to +85             | −40 to +85             | °C   |

\*: The minimum value of the input voltage range is 8 V or  $V_o + 3$  V, whichever is higher.

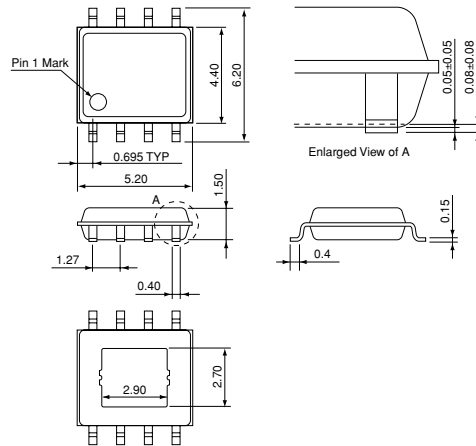
## ■Electrical Characteristics

( $T_a = 25^\circ\text{C}$  and  $f_o = 500\text{kHz}$ , unless otherwise specified)

| Parameter                                    |                                   | Symbol     | Ratings                            |        |       |                                   |        |       | Unit  |
|----------------------------------------------|-----------------------------------|------------|------------------------------------|--------|-------|-----------------------------------|--------|-------|-------|
|                                              |                                   |            | SI-8205NHD                         |        |       | SI-8205NHG                        |        |       |       |
|                                              |                                   |            | min.                               | typ.   | max.  | min.                              | typ.   | max.  |       |
| Reference Voltage                            |                                   | VREF       | 0.495                              | 0.5000 | 0.505 | 0.495                             | 0.5000 | 0.505 | V     |
|                                              |                                   | Conditions | VIN=12V, IO=1.0A                   |        |       | VIN=14V, IO=1.0A                  |        |       |       |
| Temperature Coefficient of Reference Voltage |                                   | ΔVREF/ΔT   | ±0.05                              |        |       | ±0.05                             |        |       | mV/°C |
|                                              |                                   | Conditions | VIN=12V, IO=1.0A, Ta=−40 to +85°C  |        |       | VIN=14V, IO=1.0A, Ta=−40 to +85°C |        |       |       |
| Efficiency                                   |                                   | η          | 90                                 |        |       | 90                                |        |       | %     |
|                                              |                                   | Conditions | VIN=12V, Vo=5V, IO=1.0A            |        |       | VIN=14V, Vo=5V, IO=1.0A           |        |       |       |
| Oscillation Frequency 1                      |                                   | fo1        | 200                                |        |       | —                                 |        |       | kHz   |
|                                              |                                   | Conditions | VIN=12V, Vo=5V, IO=1A, Rfset=375kΩ |        |       | —                                 |        |       |       |
| Oscillation Frequency 2                      |                                   | fo2        | 1                                  |        |       | —                                 |        |       | MHz   |
|                                              |                                   | Conditions | VIN=12V, Vo=5V, IO=1A, Rfset=75kΩ  |        |       | —                                 |        |       |       |
| Internal Oscillation Frequency               |                                   | fo         | —                                  |        |       | 250                               |        |       | kHz   |
|                                              |                                   | Conditions | —                                  |        |       | VIN=14V, Vo=5V, IO=1.0A SYNC=GND  |        |       |       |
| Line Regulation                              |                                   | ΔVOLINE    | 50                                 |        |       | 50                                |        |       | mV    |
|                                              |                                   | Conditions | VIN=8 to 43V, Vo=5V, IO=1A         |        |       | VIN=8 to 43V, Vo=5V, IO=1A        |        |       |       |
| Load Regulation                              |                                   | ΔVOLoad    | 50                                 |        |       | 50                                |        |       | mV    |
|                                              |                                   | Conditions | VIN=12V, Vo=5V, IO=0.1 to 3.0A     |        |       | VIN=12V, Vo=5V, IO=0.1 to 3.0A    |        |       |       |
| Overcurrent Protection Starting Current      |                                   | IS         | 3.1                                | 6      |       | 3.1                               | 6      |       | A     |
|                                              |                                   | Conditions | VIN=12V, Vo=5V                     |        |       | VIN=14V, Vo=5V                    |        |       |       |
| Quiescent Circuit Current 1                  |                                   | IIN        | 8                                  |        |       | 12                                |        |       | mA    |
|                                              |                                   | Conditions | VIN=12V, Vcomp=0V                  |        |       | VIN=14V, Vcomp=0V                 |        |       |       |
| Quiescent Circuit Current 2                  |                                   | IIN(off)   | 40                                 |        |       | 35                                |        |       | μA    |
|                                              |                                   | Conditions | VIN=12V, VEN/SS=0V                 |        |       | VIN=14V, VEN/SS=0V                |        |       |       |
| EN/SS Pin                                    | Outflow Current at Low Voltage    | IEN/SS     | 5                                  |        |       | 5                                 |        |       | μA    |
|                                              |                                   | Conditions | VEN/SS=0V, VIN=12V                 |        |       | VEN/SS=0V, VIN=12V                |        |       |       |
|                                              | Open Voltage                      | VSSH       | 3                                  | 4.5    | 6     | 3                                 | 4.5    | 6     | V     |
|                                              |                                   | Conditions | VIN=12V                            |        |       | VIN=14V                           |        |       |       |
|                                              | On Threshold Voltage              | VC/EH      | 0.6                                | 1.3    | 2.0   | 0.6                               | 1.3    | 2.0   | V     |
|                                              |                                   | Conditions | VIN=12V                            |        |       | VIN=14V                           |        |       |       |
| SYNC Pin                                     | Synchronization Threshold Voltage | VSYNC      | —                                  |        |       | 1.85                              |        |       | V     |
|                                              |                                   | Conditions | —                                  |        |       | VIN=14V, Vo=5V, IO=1.0A           |        |       |       |
|                                              | Synchronization Frequency         | FSYNC      | —                                  |        |       | 300                               | 1000.0 |       | kHz   |
|                                              |                                   | Conditions | —                                  |        |       | VIN=14V, Vo=5V, IO=1.0A           |        |       |       |
| OVP Start Voltage                            |                                   | VOVP       | 0.57                               | 0.60   | 0.63  | —                                 |        |       | V     |
| Thermal Protection Start Temperature         |                                   | TJ         | 151                                | 160    |       | 151                               | 160    |       | °C    |
| Error Amplifier Voltage Gain                 |                                   | AEA        | 800                                |        |       | 800                               |        |       | V/V   |
| Error Amplifier Transformer Conductance      |                                   | GEA        | 800                                |        |       | 800                               |        |       | μA/V  |
| Current Sense Amplifier Impedance            |                                   | GCS        | 3.33                               |        |       | 3.33                              |        |       | A/V   |
| Maximum ON Duty                              |                                   | DMAX       | 80                                 | 90     |       | 90                                |        |       | %     |
|                                              |                                   | Conditions | VIN=12V                            |        |       | VIN=12V                           |        |       |       |
| Minimum ON Time                              |                                   | DMIN       | 150                                |        |       | 250                               |        |       | nsec  |
|                                              |                                   | Conditions | VIN=12V                            |        |       | VIN=12V                           |        |       |       |

## External Dimensions (HSOP8)

(Unit : mm)



### Pin Assignment

| SI-8205NHD | SI-8205NHG |
|------------|------------|
| ① GND      | ① GND      |
| ② EN/SS    | ② EN/SS    |
| ③ VIN      | ③ VIN      |
| ④ FSET     | ④ SYNC     |
| ⑤ COMP     | ⑤ COMP     |
| ⑥ FB       | ⑥ FB       |
| ⑦ BS       | ⑦ BS       |
| ⑧ SW       | ⑧ SW       |

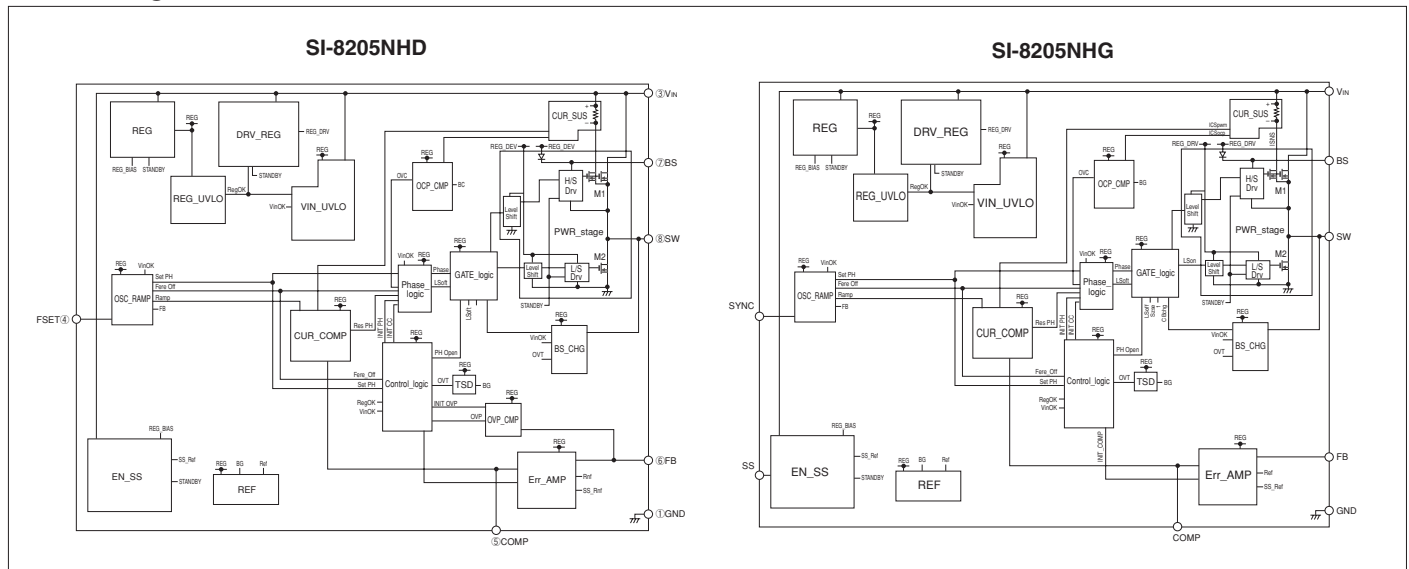
\*: The heat slug on the rear side is at the ground potential.

### Plastic Mold Package Type

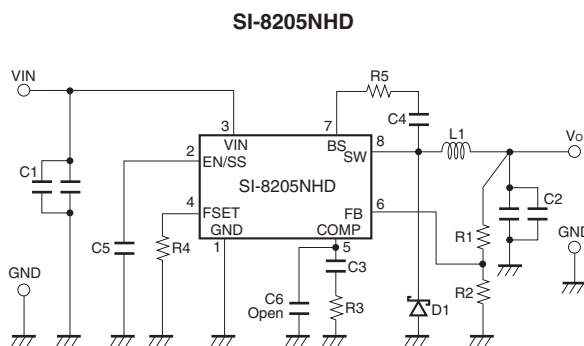
Flammability : UL 94V-0

Product Mass : Approx. 0.1 g

## Block Diagram

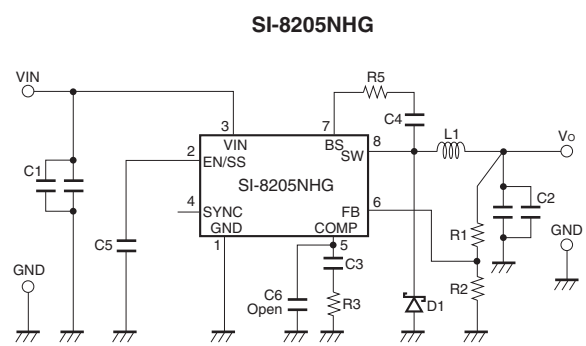


## Typical Connection Diagram



C1:10 $\mu$ F/50V $\times$ 2 (murata:GRM55DB31H106KA87)  
 C2:22 $\mu$ F/16V $\times$ 2 (murata:GRM32ER71A226KE20)  
 C3:270pF<sup>-1</sup> (murata:GRM18 type)  
 C4:10 $\mu$ F (murata: GRM18 type)  
 C5:1 $\mu$ F (murata: GRM18 type)  
 L1:10 $\mu$ H  
 D1: SJPB-L6 (Sanken)

R1:9k $\Omega$ <sup>-1</sup>  
 R2:1k $\Omega$   
 R3:51k $\Omega$ <sup>-1</sup>  
 R4:150k $\Omega$   
 R5:47 $\Omega$



C1:10 $\mu$ F/50V $\times$ 2 (murata:GRM55DB31H106KA87)  
 C2:22 $\mu$ F/16V $\times$ 2 (murata:GRM32ER71A226KE20)  
 C3:270pF<sup>-1</sup> (murata:GRM18 type)  
 C4:0.1 $\mu$ F (murata: GRM18 type)  
 C5:1 $\mu$ F (murata: GRM18 type)  
 L1:10 $\mu$ H  
 D1: SJPB-L6 (Sanken)

R1:9k $\Omega$ <sup>-1</sup>  
 R2:1k $\Omega$   
 R3:51k $\Omega$ <sup>-1</sup>  
 R5:20 to 47 $\Omega$

\*1: When Vo=5V

# SI-8000SD Series Surface Mount, Separate Excitation Step-down Switching Mode

## Features

- Surface-mount package (TO263-5)
- Output current: 3.0A
- High efficiency: 79% typ. (SI-8033SD), 84% typ. (SI-8050SD)
- Requires only 4 discrete external components
- Internally-adjusted phase compensation and output voltage
- Built-in reference oscillator (60kHz)
- Built-in overcurrent and thermal protection circuits
- Output ON/OFF available
- Soft start available by S.S pin

## Lineup

| Part Number        | SI-8033SD | SI-8050SD |
|--------------------|-----------|-----------|
| V <sub>O</sub> (V) | 3.3       | 5.0       |
| I <sub>O</sub> (A) | 3         |           |

## Absolute Maximum Ratings

| Parameter                                    | Symbol           | Ratings          | Unit | Conditions                                                       |
|----------------------------------------------|------------------|------------------|------|------------------------------------------------------------------|
| DC Input Voltage                             | V <sub>IN</sub>  | 43 <sup>*1</sup> | V    |                                                                  |
| Power Dissipation <sup>*2</sup>              | P <sub>D</sub>   | 3                | W    | When mounted on glass-epoxy board 40 × 40 mm (copper area: 100%) |
| Junction Temperature                         | T <sub>j</sub>   | +125             | °C   |                                                                  |
| Storage Temperature                          | T <sub>stg</sub> | -40 to +125      | °C   |                                                                  |
| Thermal Resistance (Junction to Case)        | θ <sub>J-C</sub> | 3                | °C/W |                                                                  |
| Thermal Resistance (Junction to Ambient Air) | θ <sub>J-A</sub> | 33.3             | °C/W | When mounted on glass-epoxy board 40 × 40 mm (copper area: 100%) |

\*1: 35V for SI-8033SD

\*2: Limited by thermal protection circuit.

## Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

## Recommended Operating Conditions

| Parameter                            | Symbol           | Ratings     |           | Unit |
|--------------------------------------|------------------|-------------|-----------|------|
|                                      |                  | SI-8033SD   | SI-8050SD |      |
| DC Input Voltage Range               | V <sub>IN1</sub> | 5.5 to 28   | 7 to 40   | V    |
| Output Current Range*                | I <sub>O</sub>   | 0 to 3.0    |           | A    |
| Operating Junction Temperature Range | T <sub>jop</sub> | -30 to +125 |           | °C   |
| Operating Temperature Range*         | T <sub>op</sub>  | -30 to +125 |           | °C   |

\*: Limited by Ta-Pd characteristics.

## Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                 |                                | Symbol                           | Ratings                                           |      |      |                                                   |      |      | Unit  |
|-------------------------------------------|--------------------------------|----------------------------------|---------------------------------------------------|------|------|---------------------------------------------------|------|------|-------|
|                                           |                                |                                  | SI-8033SD                                         |      |      | SI-8050SD                                         |      |      |       |
|                                           |                                |                                  | min.                                              | typ. | max. | min.                                              | typ. | max. |       |
| Output Voltage                            |                                | V <sub>O</sub>                   | 3.17                                              | 3.3  | 3.43 | 4.8                                               | 5.0  | 5.2  | V     |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1A          |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =1A          |      |      |       |
| Efficiency                                |                                | η                                |                                                   | 79   |      |                                                   | 84   |      | %     |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1A          |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =1A          |      |      |       |
| Oscillation Frequency                     |                                | f                                |                                                   | 60   |      |                                                   | 60   |      | kHz   |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1A          |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =1A          |      |      |       |
| Line Regulation                           |                                | ΔV <sub>OLINE</sub>              |                                                   | 25   | 80   |                                                   | 40   | 100  | mV    |
|                                           |                                | Conditions                       | V <sub>IN</sub> =8 to 28V, I <sub>O</sub> =1A     |      |      | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =1A    |      |      |       |
| Load Regulation                           |                                | ΔV <sub>OLOAD</sub>              |                                                   | 10   | 30   |                                                   | 10   | 40   | mV    |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5 to 1.5A |      |      | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5 to 1.5A |      |      |       |
| Temperature Coefficient of Output Voltage |                                | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      |                                                   | ±0.5 |      | mV/°C |
| Overcurrent Protection Starting Current   |                                | I <sub>S1</sub>                  | 3.1                                               |      |      | 3.1                                               |      |      | A     |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V                              |      |      | V <sub>IN</sub> =20V                              |      |      |       |
| Soft Start Pin*                           | Low-Level Voltage              | V <sub>SSL</sub>                 |                                                   | 0.2  |      |                                                   | 0.2  |      | V     |
|                                           | Outflow Current at Low Voltage | I <sub>SSL</sub>                 | 20                                                | 30   | 40   | 20                                                | 30   | 40   | μA    |
|                                           |                                | Conditions                       | V <sub>SSL</sub> =0.2V                            |      |      |                                                   |      |      |       |

\* Pin 5 is a soft start pin. Soft start at power on can be performed with a capacitor connected to this pin.

The output can also be turned ON/OFF with this pin.

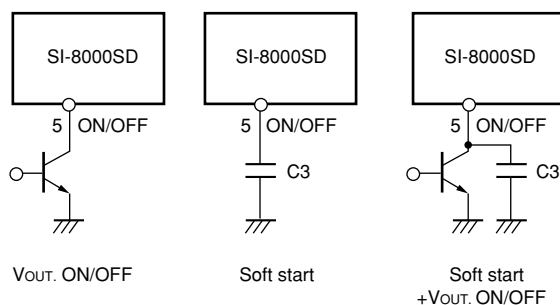
The output is stopped by setting the voltage of this pin to V<sub>SSL</sub> or lower.

Soft-start pin voltage can be changed with an open-collector drive circuit of a transistor.

When using both the soft-start and ON/OFF functions together, the discharge current from C<sub>3</sub> flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C<sub>3</sub> capacitance is large.

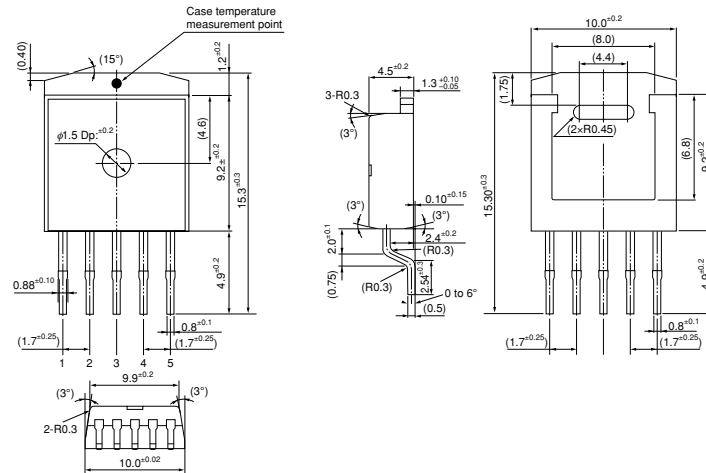
The ON/OFF pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

If this pin is not used, leave it open.



## External Dimensions (TO263-5)

(Unit : mm)

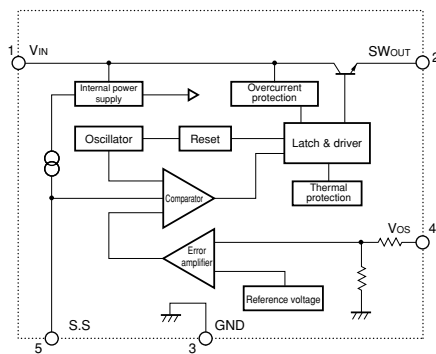


### Pin Assignment

- ①  $V_{IN}$
- ②  $SW_{OUT}$
- ③ GND
- ④  $V_{OS}$
- ⑤ S.S

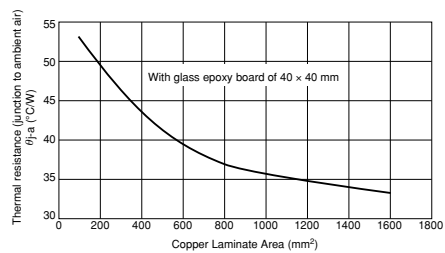
Plastic Mold Package Type  
 Flammability: 94V-0  
 Product Mass: Approx. 1.48g

## Block Diagram

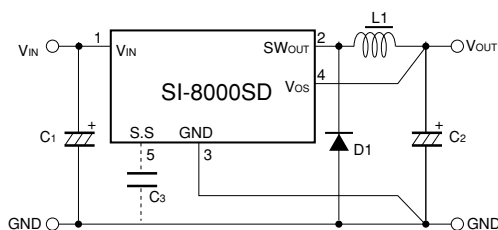


## Reference Data

Copper Laminate Area on Glass Epoxy Board vs.  
thermal resistance (junction to ambient air) (Typical Value)



## Typical Connection Diagram



$C_1$  : 50V/1000 $\mu$ F

$C_2$  : 50V/1000 $\mu$ F

$C_3$  : 0.01 $\mu$ F

(only when soft start function is used)

$L_1$  : 150 $\mu$ H

$D_1$  : SJPB-L6 (Sanken)

### Diode $D_1$

- Be sure to use Schottky-barrier diode as  $D_1$ .

If other diodes like fast recovery diodes are used, ICs may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

### Choke coil $L_1$

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- As the overcurrent protection starting current is about 3.5 A, take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuited load.

### Capacitors $C_1$ , $C_2$ , and $C_3$

- As large ripple currents flow through  $C_1$  and  $C_2$ , use high-frequency and low-impedance capacitors aiming for switching-mode-power-supply use. Especially when the impedance of  $C_2$  is high, the switching waveform may become abnormal at low temperatures.
  - For  $C_2$ , do not use a capacitor with an extremely low equivalent series resistance (ESR) such as an OS capacitor or a tantalum capacitor, which may cause an abnormal oscillation.
  - $C_3$  is a capacitor for soft start. Leave pin 5 open if the soft start function is not used.
- This pin is pulled up with a pull-up resistor inside the ICs.

◎To create the optimum operating conditions, place the components as close as possible to each other.

## SPI-8000A Series Surface Mount, Separate Excitation Step-down Switching Mode

### ■Features

- Surface-mount 16 pin package
- Output current: 3.0A
- High efficiency: 91% (at  $V_{IN} = 10V$ ,  $I_O = 1A$ ,  $V_O = 5V$ )
- Capable of downsizing a choke-coil due to IC's high switching frequency (250kHz). (Compared with conventional Sanken devices)
- The output-voltage-variable type can vary its output voltage from 1V to 14V because of its low reference voltage ( $V_{REF}$ ) of 1V.
- Wide Input Voltage Range (8 to 50V)
- Output ON/OFF available
- Built-in overcurrent and thermal protection circuits

### ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                    | Symbol             | Ratings     | Unit |
|----------------------------------------------|--------------------|-------------|------|
| DC Input Voltage                             | $V_{IN}$           | 53          | V    |
| Power Dissipation                            | $P_D^{*1, *2}$     | 2.4         | W    |
| Junction Temperature                         | $T_j$              | +125        | °C   |
| Storage Temperature                          | $T_{stg}$          | -40 to +125 | °C   |
| Thermal Resistance (junction to case)        | $\theta_{jc}^{*2}$ | 18          | °C/W |
| Thermal Resistance (junction to ambient air) | $\theta_{ja}^{*2}$ | 50          | °C/W |

\*1: Limited due to thermal protection.

\*2: When mounted on glass-epoxy board 700cm<sup>2</sup> (copper laminate area 30.8cm<sup>2</sup>).

### ■Applications

- Onboard local power supplies
- OA equipment
- For stabilization of the secondary-side output voltage of switching power supplies

### ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings                             | Unit |
|--------------------------------------|-----------|-------------------------------------|------|
|                                      |           | SPI-8010A                           |      |
| DC Input Voltage Range               | $V_{IN}$  | (8 or $V_O+3$ )* <sup>1</sup> to 50 | V    |
| Output Voltage Range                 | $V_O$     | 1 to 14                             | V    |
| Output Current Range* <sup>2</sup>   | $I_O$     | 0.02 to 3.0* <sup>2</sup>           | A    |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +125                         | °C   |
| Operating Temperature Range          | $T_{op}$  | -30 to +125                         | °C   |

\*1: The minimum value of an input voltage range is the higher of either 8V or  $V_O+3V$ .

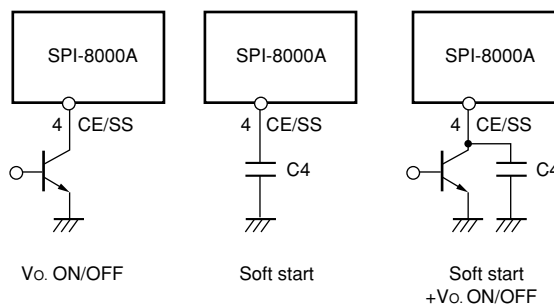
\*2: Please be sure to let the output current run more than 20 mA. When using by less than 20 mA, there is a possibility that the output voltage becomes unstable.

### ■Electrical Characteristics

(T<sub>a</sub>=25°C)

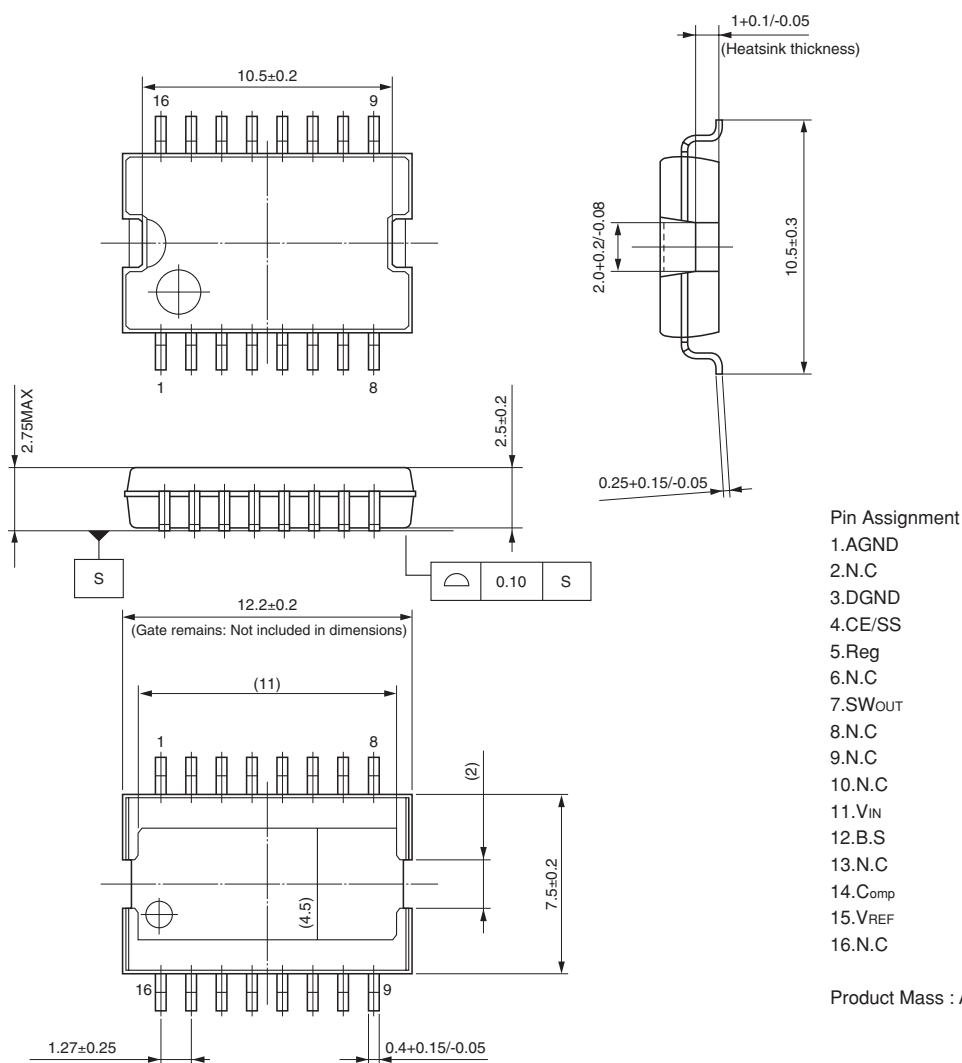
| Parameter                                    |                                | Symbol                             | Ratings                                                      |      |      | Unit  |
|----------------------------------------------|--------------------------------|------------------------------------|--------------------------------------------------------------|------|------|-------|
|                                              |                                |                                    | SPI-8010A (Variable type)                                    |      |      |       |
|                                              |                                |                                    | min.                                                         | typ. | max. |       |
| Reference Voltage                            |                                | V <sub>REF</sub>                   | 0.97                                                         | 1.00 | 1.03 | V     |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V, I <sub>O</sub> =1A                     |      |      |       |
| Efficiency                                   |                                | Eff                                |                                                              | 86   |      | %     |
|                                              |                                | Conditions                         | V <sub>IN</sub> =20V, I <sub>O</sub> =1A, V <sub>O</sub> =5V |      |      |       |
| Oscillation Frequency                        |                                | F <sub>OSC</sub>                   |                                                              | 250  |      | kHz   |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V, I <sub>O</sub> =1A                     |      |      |       |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>                |                                                              | 20   | 40   | mV    |
|                                              |                                | Conditions                         | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =1A               |      |      |       |
| Load Regulation                              |                                | ΔV <sub>OLOAD</sub>                |                                                              | 10   | 30   | mV    |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V, I <sub>O</sub> =0.1 to 1.5A            |      |      |       |
| Temperature Coefficient of Reference Voltage |                                | ΔV <sub>REF</sub> /ΔT <sub>a</sub> |                                                              | ±0.5 |      | mV/°C |
| Overcurrent Protection Starting Current      |                                | I <sub>S</sub>                     | 3.1                                                          |      |      | A     |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V                                         |      |      |       |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>                     |                                                              | 7    |      | mA    |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V, I <sub>O</sub> =0A                     |      |      |       |
| Circuit Current at Output OFF                |                                | I <sub>q(off)</sub>                |                                                              |      | 400  | μA    |
|                                              |                                | Conditions                         | V <sub>IN</sub> =12V, V <sub>ON/OFF</sub> =0.3V              |      |      |       |
| CE/SS Terminal                               | Low Level Voltage              | V <sub>SSL</sub>                   |                                                              |      | 0.5  | V     |
|                                              | Outflow Current at Low Voltage | I <sub>SSL</sub>                   |                                                              |      | 50   | μA    |
|                                              |                                | Conditions                         | V <sub>SSL</sub> =0V                                         |      |      |       |

\* Pin 4 is the CE/SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. CE/SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C<sub>4</sub> flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C<sub>3</sub> capacitance is large. The CE/SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

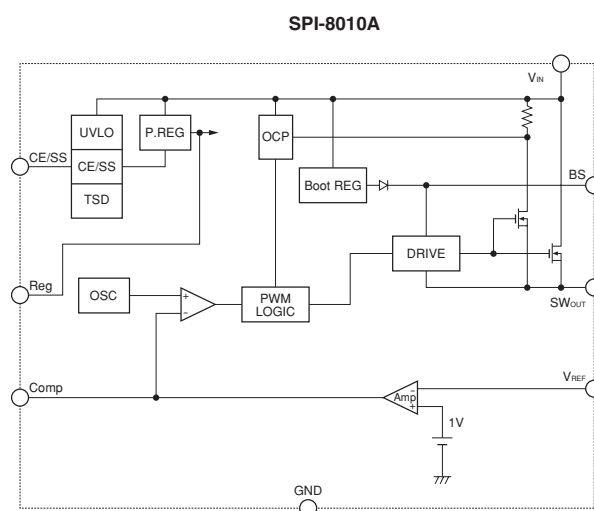


# ■External Dimensions (HSOP16)

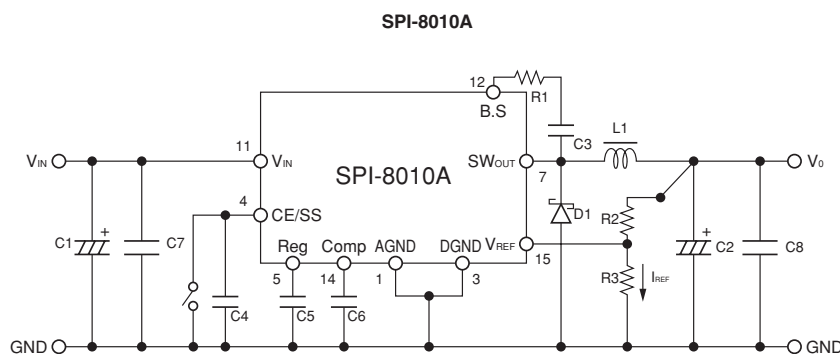
(Unit : mm)



# ■Block Diagram



## Typical Connection Diagram



C1: 220 $\mu$ F/63V  
 C2: 470 $\mu$ F/25V  
 C3: 0.1 $\mu$ F  
 C4: 1000pF  
 C5: 0.1 $\mu$ F  
 C6: 0.047 $\mu$ F  
 C7: 0.1 $\mu$ F  
 C8: 0.1 $\mu$ F  
 R1: 47 $\Omega$   
 L1: 47 $\mu$ H  
 D1: SJPB-L6  
 (Sanken)

### Diode D1

- Be sure to use a Schottky-barrier diode for D1. If other diodes like fast recovery diodes are used, ICs may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

### Choke coil L1

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- As the overcurrent protection starting current is about 4.5A, take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuited load.

### Capacitors C1, C2

- As large ripple currents flow through C1 and C2, use high-frequency and low-impedance capacitors aiming for switching-mode-power-supply use. Especially when the impedance of C2 is high, the switching waveform may become abnormal at low temperatures. For C2, do not use a capacitor with an extremely low equivalent series resistance (ESR) such as an OS capacitor or a tantalum capacitor, which may cause an abnormal oscillation.

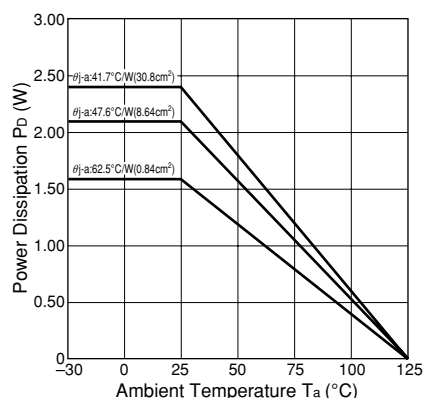
### Resistors R2, R3

- R2 and R3 are the resistors to set the output voltage. Set their values so that IREF becomes approx. 2mA. Obtain R2 and R3 values by the following formula:

$$R2 = \frac{(V_{OUT} - V_{REF})}{I_{REF}} = \frac{(V_{OUT} - 1)}{2 \times 10^{-3}} (\Omega), R3 = \frac{V_{REF}}{I_{REF}} = \frac{1}{2 \times 10^{-3}} \approx 500(\Omega)$$

©To create the optimum operating conditions, place the components as close as possible to each other.

## Ta-Pd Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\%} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

Note 1: The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

Note 2: Thermal design for D1 must be considered separately.

$V_O$  : Output voltage  
 $V_{IN}$  : Input voltage  
 $I_O$  : Output current  
 $\eta\%$  : Efficiency (%)  
 $V_F$  : Diode D1 forward voltage



# SI-8000Q Series Surface Mount, Current Mode Control Step-down Switching Mode

## Features

- Compact surface-mount package (HSOP8)
- Introduction of current mode control method
- Output current: 3.5 A
- High efficiency: 90% ( $V_o = 5\text{ V}$ )
- Built-in reference oscillator (500 kHz)
- A ceramic capacitor can be used for output
- Built-in drooping-type overcurrent and thermal protection circuits
- Built-in soft start circuit
- Built-in on/off function (Active Hi)
- Low current consumption during off

## Absolute Maximum Ratings

| Parameter                                   | Symbol         | Ratings     | Unit | Conditions                                                                   |
|---------------------------------------------|----------------|-------------|------|------------------------------------------------------------------------------|
| Input Voltage                               | $V_{IN}$       | 30          | V    |                                                                              |
| Power Dissipation <sup>*1</sup>             | $P_D$          | 1.35        | W    | When mounted on glass-epoxy board, 30×30 mm (copper laminate area: 25×25 mm) |
| Junction Temperature <sup>*2</sup>          | $T_j$          | −30 to +150 | °C   |                                                                              |
| Storage Temperature                         | $T_{stg}$      | −40 to +150 | °C   |                                                                              |
| Thermal Resistance(junction to case)        | $\theta_{j-c}$ | 40          | °C/W |                                                                              |
| Thermal Resistance(junction to ambient air) | $\theta_{j-a}$ | 74          | °C/W | When mounted on glass-epoxy board, 30×30 mm (copper laminate area: 25×25 mm) |

<sup>\*1</sup>: Limited by thermal protection circuit

<sup>\*2</sup>: Note that the detection temperature for thermal protection is about 140°C.

## Applications

- DVD recorder, FPD-TV
- Onboard local power supplies
- OA equipment

## Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings              | Unit | Conditions |
|--------------------------------------|-----------|----------------------|------|------------|
|                                      |           | SI-8005Q             |      |            |
| DC Input Voltage Range               | $V_{IN}$  | $V_o + 3^{*1}$ to 28 | V    |            |
| Output Voltage Range                 | $V_o$     | 0.5 to 24            | V    |            |
| Output Current Range                 | $I_o$     | 0 to 3.5             | A    |            |
| Operating Junction Temperature Range | $T_{jop}$ | −30 to +125          | °C   |            |
| Operating Temperature Range          | $T_{op}$  | −30 to +85           | °C   |            |

<sup>\*1</sup>: The minimum value of the input voltage range is 4.75 V or  $V_o + 3\text{ V}$ , whichever is higher.

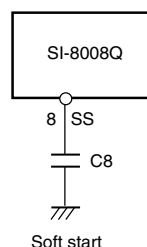
## Electrical Characteristics

( $R_1=4.2\text{ k}\Omega$ ,  $R_2=0.8\text{ k}\Omega$  when  $T_a = 25^\circ\text{C}$  and  $V_o=5\text{ V}$ )

| Parameter                                    |                                | Symbol                | Ratings                                                                |       |       | Unit  |
|----------------------------------------------|--------------------------------|-----------------------|------------------------------------------------------------------------|-------|-------|-------|
|                                              |                                |                       | SI-8005Q                                                               |       |       |       |
|                                              |                                |                       | min.                                                                   | typ.  | max.  |       |
| Reference Voltage                            |                                | V <sub>ADJ</sub>      | 0.485                                                                  | 0.500 | 0.515 | V     |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =1A                               |       |       |       |
| Temperature Coefficient of Reference Voltage |                                | ΔV <sub>ADJ</sub> /ΔT |                                                                        | 0.05  |       | mV/°C |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =1A, T <sub>a</sub> =−40 to +85°C |       |       |       |
| Efficiency                                   |                                | η                     |                                                                        | 90    |       | %     |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =1A                               |       |       |       |
| Oscillation Frequency                        |                                | f <sub>o</sub>        | 450                                                                    | 500   | 550   | kHz   |
|                                              |                                | Conditions            | V <sub>IN</sub> =16V, I <sub>o</sub> =1A                               |       |       |       |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>   |                                                                        | 30    | 60    | mV    |
|                                              |                                | Conditions            | V <sub>IN</sub> =8 to 28V, I <sub>o</sub> =1A                          |       |       |       |
| Load Regulation                              |                                | ΔV <sub>LOAD</sub>    |                                                                        | 30    | 60    | mV    |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =0.1 to 3.5A                      |       |       |       |
| Overcurrent Protection Starting Current      |                                | I <sub>S</sub>        | 3.6                                                                    |       | 6.0   | A     |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V                                                   |       |       |       |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>        |                                                                        | 18    |       | mA    |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =0A, V <sub>EN</sub> =open        |       |       |       |
|                                              |                                | I <sub>q</sub> (OFF)  |                                                                        |       | 20    |       |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V, I <sub>o</sub> =0A, V <sub>EN</sub> =0V          |       |       |       |
| SS Pin                                       | Outflow Current at Low Voltage | I <sub>SSL</sub>      |                                                                        | 5     |       | μA    |
|                                              |                                | Conditions            | V <sub>IN</sub> =16V, V <sub>SSL</sub> =0V                             |       |       |       |
| EN Pin                                       | High Level Voltage             | V <sub>C EN</sub>     | 2.8                                                                    |       |       | V     |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V                                                   |       |       |       |
|                                              | Low Level Voltage              | V <sub>C EL</sub>     |                                                                        |       | 2.2   | V     |
|                                              |                                | Conditions            | V <sub>IN</sub> =12V                                                   |       |       |       |
|                                              |                                | I <sub>C EH</sub>     |                                                                        | 5     |       | μA    |
|                                              |                                | Conditions            | V <sub>EN</sub> =0V                                                    |       |       |       |
| Error Amplifier Voltage Gain                 |                                | AEA                   |                                                                        | 1000  |       | V/V   |
| Error Amplifier Transformer Conductance      |                                | GEA                   |                                                                        | 800   |       | μA/V  |
| Current Sense Amplifier Impedance            |                                | 1/GCS                 |                                                                        | 0.35  |       | V/A   |
| Maximum ON Duty                              |                                | DMAX                  |                                                                        | 92    |       | %     |
| Minimum ON Time                              |                                | DMIN                  |                                                                        | 100   |       | nsec. |

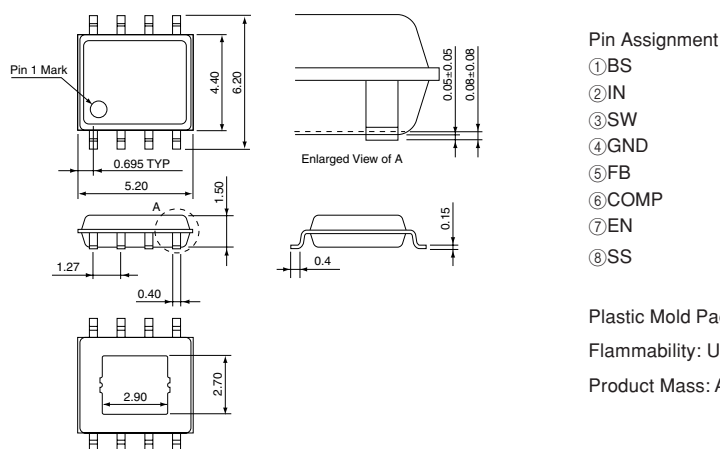
<sup>\*</sup>: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.

The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

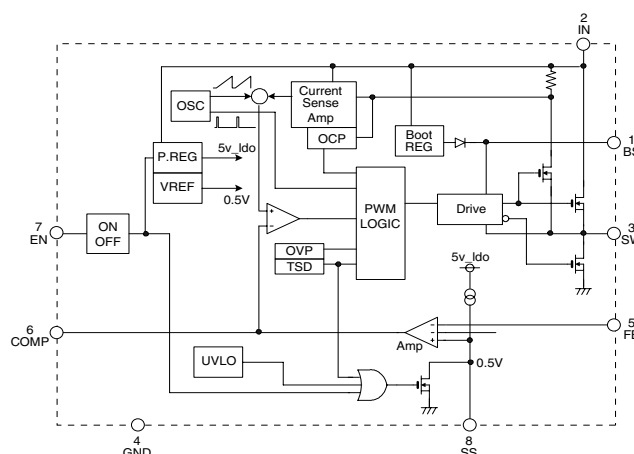


### ■ External Dimensions (HSOP8)

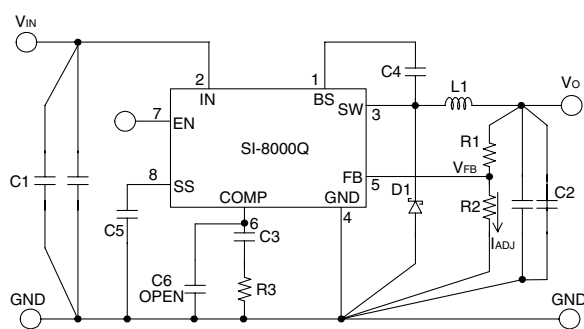
(Unit : mm)



### ■Block Diagram



### ■ Typical Connection Diagram



- C1:10μF/50V  
(Murata:GRM55DB31H106KA87)  
C2:22μF/16V  
(Murata:GRM32ER71A226KE20)  
C3:560pF<sup>1</sup>  
(Murata:GRM18 Type)  
C4:10nF  
(murata: GRM18 Type)  
C5:10nF  
(murata: GRM18 Type)  
L1:10μH  
D1:SJPW-T4 (Sanken)  
R1:46kΩ (Vo=5V)  
R2:5.1kΩ  
R3:24kΩ<sup>1</sup>

\*1: When  $V_o=5V$

# SI-8000FD Series Surface Mount, Separate Excitation Step-down Switching Mode

## ■Features

- Surface-mount package (TO263-5)
- Output current: 3.5 A
- High efficiency: 83% ( $V_o = 5\text{ V}$ ,  $V_{IN} = 15\text{ V}$ ,  $I_o = 2\text{ A}$ )
- Requires only 6 discrete components
- Built-in reference oscillator (300 kHz)
- Built-in drooping-type overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)
  - SI-8001FDE
- Built-in on/off function (active Low)
  - SI-8001FDL
- Low current consumption during off
  - SI-8001FDL

## ■Applications

- DVD recorder, FPD-TV
- OA equipment, such as printers
- Onboard local power supplies

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings              |            | Unit |
|--------------------------------------|-----------|----------------------|------------|------|
|                                      |           | SI-8001FDE           | SI-8001FDL |      |
| Input Voltage Range                  | $V_{IN}$  | $V_o + 3^{*1}$ to 40 |            | V    |
| Output Voltage Range                 | $V_o$     | 0.8 to 24            |            | V    |
| Output Current Range                 | $I_o$     | 0 to 3.5             |            | A    |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +100          |            | °C   |
| Operating Temperature Range          | $T_{op}$  | -30 to +85           |            | °C   |

\*1: The minimum value of the input voltage range is 4.5 V or  $V_o + 3\text{ V}$ , whichever is higher.

## ■Electrical Characteristics

( $R_1 = 4.2\text{ k}\Omega$ ,  $R_2 = 0.8\text{ k}\Omega$  when  $T_a = 25^\circ\text{C}$  and  $V_o = 5\text{ V}$ )

| Parameter                                    |                                     | Symbol                          | Ratings                                                                |       |       |                                                                        |       |       | Unit  |
|----------------------------------------------|-------------------------------------|---------------------------------|------------------------------------------------------------------------|-------|-------|------------------------------------------------------------------------|-------|-------|-------|
|                                              |                                     |                                 | SI-8001FDE                                                             |       |       | SI-8001FDL                                                             |       |       |       |
|                                              |                                     |                                 | min.                                                                   | typ.  | max.  | min.                                                                   | typ.  | max.  |       |
| Reference Voltage                            |                                     | V <sub>ADJ</sub>                | 0.784                                                                  | 0.800 | 0.816 | 0.784                                                                  | 0.800 | 0.816 | V     |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A                             |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A                             |       |       |       |
| Temperature Coefficient of Reference Voltage |                                     | ΔV <sub>ADJ</sub> /ΔT           |                                                                        | ±0.1  |       |                                                                        | ±0.1  |       | mV/°C |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A, T <sub>c</sub> =0 to 100°C |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A, T <sub>c</sub> =0 to 100°C |       |       |       |
| Efficiency                                   |                                     | η                               |                                                                        | 83    |       |                                                                        | 83    |       | %     |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |       |       |       |
| Oscillation Frequency                        |                                     | f <sub>o</sub>                  | 270                                                                    | 300   | 330   | 270                                                                    | 300   | 330   | kHz   |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |       |       |       |
| Line Regulation                              |                                     | ΔV <sub>OLINE</sub>             |                                                                        |       | 80    |                                                                        |       | 80    | mV    |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =10 to 30V, I <sub>o</sub> =2A                         |       |       | V <sub>IN</sub> =10 to 30V, I <sub>o</sub> =2A                         |       |       |       |
| Load Regulation                              |                                     | ΔV <sub>OLOAD</sub>             |                                                                        |       | 50    |                                                                        |       | 50    | mV    |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2 to 3.5A                      |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2 to 3.5A                      |       |       |       |
| Overcurrent Protection Starting Current      |                                     | I <sub>s</sub>                  | 3.6                                                                    |       |       | 3.6                                                                    |       |       | A     |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V                                                   |       |       | V <sub>IN</sub> =15V                                                   |       |       |       |
| SS Pin <sup>1</sup>                          | Low Level Voltage                   | V <sub>SSL</sub>                |                                                                        |       | 0.5   | —                                                                      | —     | —     | V     |
|                                              | Outflow Current at Low Voltage      | I <sub>SSL</sub>                |                                                                        | 6     | 30    | —                                                                      | —     | —     | μA    |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V                              |       |       | —                                                                      | —     | —     |       |
| ON/OFF Pin <sup>2</sup>                      | ON/OFF Control Voltage (Output on)  | V <sub>c</sub> , I <sub>H</sub> | —                                                                      | —     | —     |                                                                        |       | 0.8   | V     |
|                                              | ON/OFF Control Voltage (Output off) | V <sub>c</sub> , I <sub>L</sub> | —                                                                      | —     | —     | 2.0                                                                    |       |       | V     |
|                                              | ON/OFF Control Current (Output on)  | I <sub>c</sub> , I <sub>H</sub> | —                                                                      | —     | —     |                                                                        | 6     | 100   | μA    |
|                                              |                                     | Conditions                      | —                                                                      |       |       | V <sub>c</sub> =2V                                                     |       |       |       |
| Quiescent Circuit Current                    |                                     | I <sub>q</sub>                  |                                                                        | 6     |       |                                                                        | 6     |       | mA    |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, I <sub>o</sub> =0A                               |       |       | V <sub>IN</sub> =15V, I <sub>o</sub> =0A                               |       |       |       |
|                                              |                                     | I <sub>q</sub> (OFF)            |                                                                        | 200   | 600   |                                                                        |       | 30    | 200   |
|                                              |                                     | Conditions                      | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V                              |       |       | V <sub>IN</sub> =15V, V <sub>c</sub> =2V                               |       |       |       |

\*1: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up (3.7 V typ.) to the power supply in the IC, so applying the external voltage is prohibited. If this pin is not used, leave it open.

\*2: Output is OFF when the output control terminal VC is open. Each input level is equivalent to LS-TTL. Therefore, the device can be driven directly by LS-TTLs.

## ■Lineup

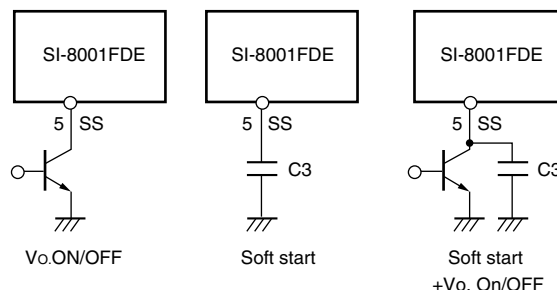
| Part Number     | SI-8001FDE          | SI-8001FDL |
|-----------------|---------------------|------------|
| $V_o(\text{V})$ | Variable(0.8 to 24) |            |
| $I_o(\text{A})$ | 3.5                 |            |
| Function        | Soft start          | ON/OFF     |

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings            |            | Unit | Conditions                                                                        |
|----------------------------------------------|----------------|--------------------|------------|------|-----------------------------------------------------------------------------------|
|                                              |                | SI-8001FDE         | SI-8001FDL |      |                                                                                   |
| Input Voltage                                | $V_{IN}$       | 43                 |            | V    |                                                                                   |
| ON/OFF Control Voltage                       | $V_c$          | —                  | $V_{IN}$   | V    |                                                                                   |
| Power Dissipation <sup>*1</sup>              | $P_D$          | 3                  |            | W    | When mounted on glass-epoxy board measuring 40x40 mm (copper laminate area: 100%) |
| Junction Temperature <sup>*2</sup>           | $T_j$          | +150               |            | °C   |                                                                                   |
| Storage Temperature                          | $T_{stg}$      | -40 to +150        |            | °C   |                                                                                   |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 3 <sup>*1</sup>    |            | °C/W | When mounted on glass-epoxy board measuring 40x40 mm (copper laminate area: 100%) |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 33.3 <sup>*1</sup> |            | °C/W | When mounted on glass-epoxy board measuring 40x40 mm (copper laminate area: 100%) |

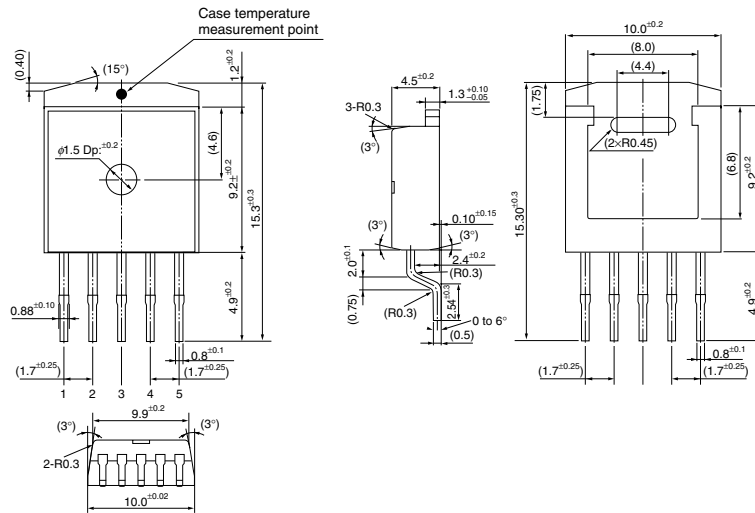
\*1 : Limited by thermal protection circuit

\*2 : This product has built-in thermal protection circuits that may activate when the junction temperature exceeds 130°C. The recommended design for the junction temperature during IC operation is below 125°C.

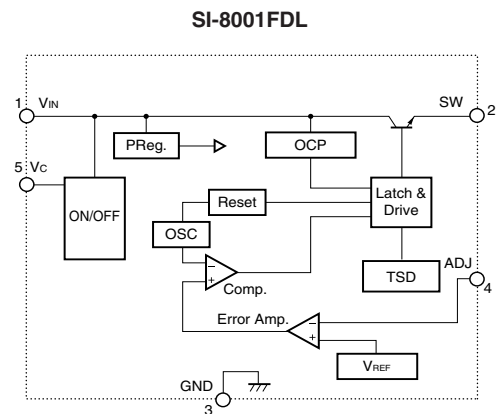
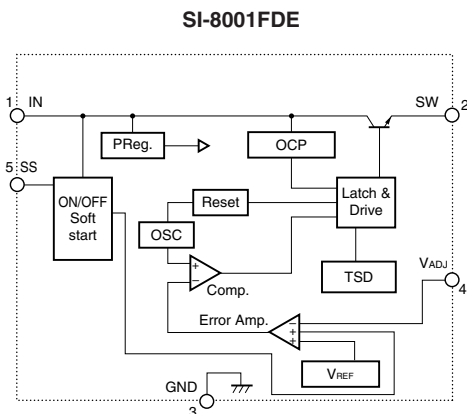


## External Dimensions (TO263-5)

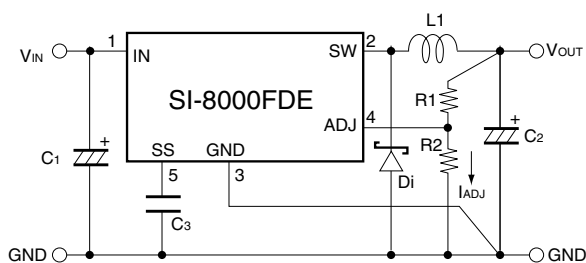
(Unit : mm)



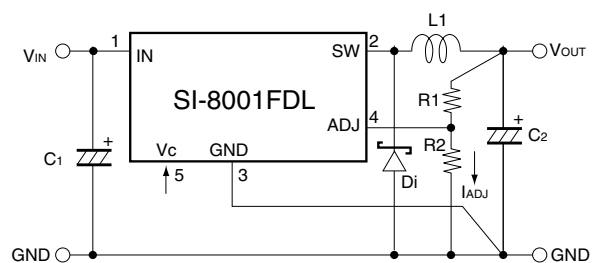
## Block Diagram



## Typical Connection Diagram



C<sub>1</sub> : 470μF  
C<sub>2</sub> : 680μF  
C<sub>3</sub> : 0.1μ (Only when using soft-start function)  
L<sub>1</sub> : 47μH  
Di : FMB-G16L (Sanken)



C<sub>1</sub> : 470μF  
C<sub>2</sub> : 680μF  
L<sub>1</sub> : 47μH  
Di : FMB-G16L (Sanken)

# SI-8000HD Series Surface-Mount, Separate Excitation Step-down Switching Mode

## ■Features

- Surface-mount package (TO263-5)
- Output current: 5.5 A
- High efficiency: 83% (at TYP,  $V_o = 5\text{ V}$ )
- Requires only 5 discrete components (SI-8008HD)
- Built-in reference oscillator (150 kHz)
- Built-in drooping-type overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)
- Low current consumption during off

## ■Applications

- DVD recorder, FPD-TV
- Onboard local power supplies
- OA equipment

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings     | Unit | Conditions                                                                        |
|----------------------------------------------|----------------|-------------|------|-----------------------------------------------------------------------------------|
| Input Voltage                                | $V_{IN}$       | 43          | V    |                                                                                   |
| Power Dissipation <sup>*1</sup>              | $P_D$          | 3           | W    | When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%) |
| Junction Temperature <sup>*2</sup>           | $T_J$          | +150        | °C   |                                                                                   |
| Storage Temperature                          | $T_{stg}$      | -40 to +150 | °C   |                                                                                   |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 3           | °C/W | When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%) |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 33.3        | °C/W | When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%) |

\*1: Limited by thermal protection circuit

\*2: This product has built-in thermal protection circuits that may activate when the junction temperature exceeds 130°C.  
The recommended design for the junction temperature during IC operation is below 125°C.

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings              | Unit | Conditions                    |
|--------------------------------------|-----------|----------------------|------|-------------------------------|
|                                      |           | SI-8008HD            |      |                               |
| Input Voltage Range                  | $V_{IN}$  | $V_o + 3^{*1}$ to 40 | V    |                               |
| Output Voltage Range                 | $V_o$     | 0.8 to 24            | V    |                               |
| Output Current Range                 | $I_o$     | 0 to 5.5             | A    | $V_{IN} \geq V_o + 3\text{V}$ |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +100          | °C   |                               |
| Operating Temperature Range          | $T_{op}$  | -30 to +85           | °C   |                               |

\*1: The minimum value of the input voltage range is 4.5 V or  $V_o + 3\text{ V}$ , whichever is higher.

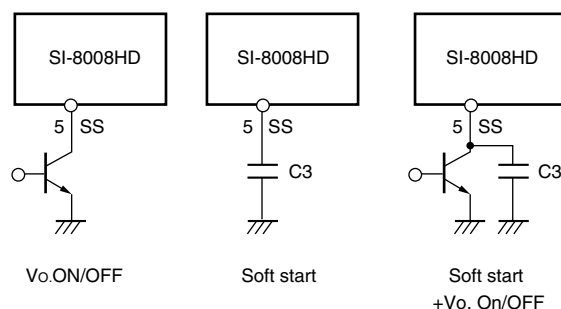
## ■Electrical Characteristics

( $R_1 = 4.2\text{ k}\Omega$ ,  $R_2 = 0.8\text{ k}\Omega$  when  $T_a = 25^\circ\text{C}$  and  $V_o = 5\text{V}$ )

| Paramter                                     |                                | Symbol                  | Ratings                                                              |                                           |       | Unit  |
|----------------------------------------------|--------------------------------|-------------------------|----------------------------------------------------------------------|-------------------------------------------|-------|-------|
|                                              |                                |                         | SI-8008HD                                                            |                                           |       |       |
|                                              |                                |                         | min.                                                                 | typ.                                      | max.  |       |
| Reference Voltage                            |                                | V <sub>ADJ</sub>        | 0.784                                                                | 0.800                                     | 0.816 | V     |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =1A                             |                                           |       |       |
| Temperature Coefficient of Reference Voltage |                                | (ΔV <sub>ADJ</sub> /ΔT) |                                                                      | ±0.1                                      |       | mV/°C |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =1A, T <sub>c</sub> =0 to 100°C |                                           |       |       |
| Efficiency                                   |                                | η                       |                                                                      | 83                                        |       | %     |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =3A                             |                                           |       |       |
| Oscillation Frequency                        |                                | f <sub>o</sub>          |                                                                      | 150                                       |       | kHz   |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =3A                             |                                           |       |       |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>     |                                                                      | 60                                        | 80    | mV    |
|                                              |                                | Conditions              | V <sub>IN</sub> =10 to 30V, I <sub>o</sub> =3A                       |                                           |       |       |
| Load Regulation                              |                                | ΔV <sub>OLOAD</sub>     |                                                                      | 20                                        | 50    | mV    |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2 to 5.5A                    |                                           |       |       |
| Overcurrent Protection Starting Current      |                                | I <sub>s</sub>          | 5.6                                                                  | 6.5                                       | 7.5   | A     |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V                                                 |                                           |       |       |
| SS Pin <sup>*1</sup>                         | Low Level Voltage              | V <sub>SSL</sub>        |                                                                      | 0.5                                       |       | V     |
|                                              | Outflow Current at Low Voltage | I <sub>SSL</sub>        |                                                                      | 10                                        | 30    | μA    |
|                                              |                                | Conditions              | V <sub>SSL</sub> =0V                                                 |                                           |       |       |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>          |                                                                      | 6                                         |       | mA    |
|                                              |                                | Conditions              | V <sub>IN</sub> =15V, I <sub>o</sub> =0A                             |                                           |       |       |
|                                              |                                | I <sub>q</sub> (OFF)    |                                                                      | 200                                       | 400   | μA    |
|                                              |                                |                         | Conditions                                                           | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V |       |       |

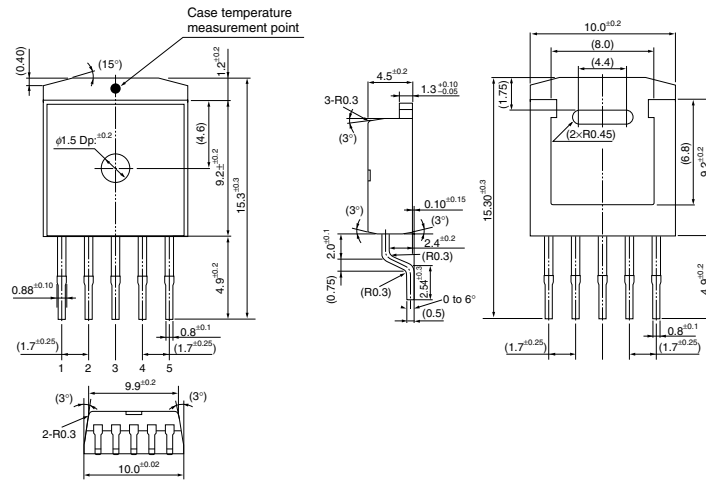
\*1: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin.

The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up (3.7 V typ.) to the power supply in the IC, so applying the external voltage is prohibited. If this pin is not used, leave it open.



## External Dimensions (TO263-5)

(Unit : mm)



### Pin Assignment

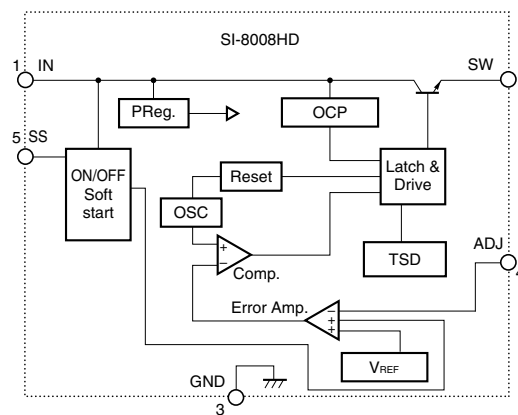
- ① IN
- ② SW
- ③ GND
- ④ ADJ
- ⑤ SS

Plastic Mold Package Type

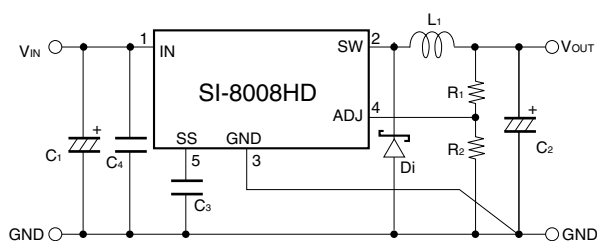
Flammability: UL 94V-0

Product Mass: Approx. 1.48 g

## Block Diagram



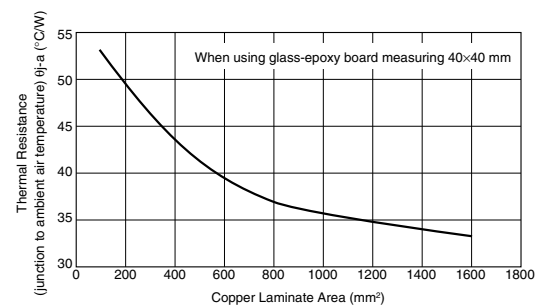
## Typical Connection Diagram



- C1 : 1500 $\mu$ F
- C2 : 1000 $\mu$ F
- C3 : 0.1 $\mu$ F (Only when using soft-start function)
- C4 : 4.7 $\mu$ F (GMR32ER71H475KA88L (Murata Manufacturing) recommended)
- L1 : 100 $\mu$ H
- D1 : FMB-G16L (Sanken)

## Reference Data

The acceptable loss of the package is 3 W for the SI-8000HD series, so some ranges are not available, depending on the relation between the input voltage and output current.



SI-8000E Series

Full-Mold, Separate Excitation Step-down Switching Mode

Features

- Compact full-mold package (equivalent to TO220)
- High efficiency: 80%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage
- Built-in reference oscillator (60kHz)
- Built-in overcurrent and thermal protection circuits

Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

Lineup

| Part Number | SI-8050E |
|-------------|----------|
| Vo(V)       | 5.0      |
| Io(A)       | 0.6      |

Absolute Maximum Ratings

| Parameter                                   | Symbol | Ratings                                      | Unit |
|---------------------------------------------|--------|----------------------------------------------|------|
| DC Input Voltage                            | VIN    | 43                                           | V    |
| Power Dissipation                           | Pd1    | 14(With infinite heatsink)                   | W    |
|                                             | Pd2    | 1.5(Without heatsink, stand-alone operation) | W    |
| Junction Temperature                        | Tj     | +125                                         | °C   |
| Storage Temperature                         | Tstg   | −40 to +125                                  | °C   |
| Thermal Resistance(junction to case)        | θj-c   | 7.0                                          | °C/W |
| Thermal Resistance(junction to ambient air) | θj-a   | 66.7                                         | °C/W |

Recommended Operating Conditions

| Parameter                            | Symbol | Ratings     | Unit |
|--------------------------------------|--------|-------------|------|
|                                      |        | SI-8050E    |      |
| DC Input Voltage Range               | VIN    | 7 to 40     | V    |
| Output Current Range                 | Io     | 0 to 0.6    | A    |
| Operating Junction Temperature Range | Tjop   | −30 to +125 | °C   |
| Operating Temperature Range          | Top    | −30 to +125 | °C   |

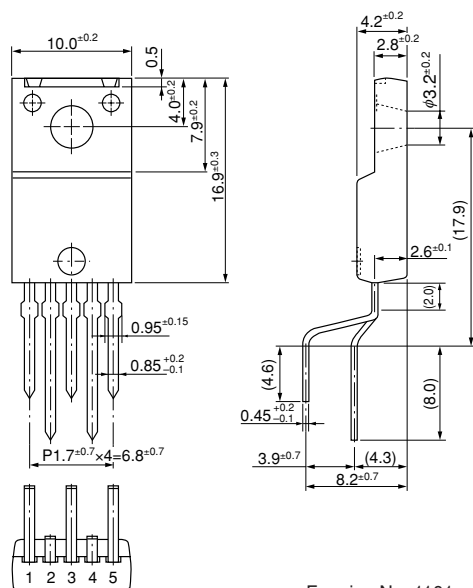
Electrical Characteristics

(Ta=25°C)

| Parameter                                 | Symbol                           | Ratings                                           |      |      | Unit  |
|-------------------------------------------|----------------------------------|---------------------------------------------------|------|------|-------|
|                                           |                                  | SI-8050E                                          |      |      |       |
|                                           |                                  | min.                                              | typ. | max. |       |
| Output Voltage                            | V <sub>O</sub>                   | 4.80                                              | 5.00 | 5.20 | V     |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Efficiency                                | η                                |                                                   | 80   |      | %     |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Oscillation Frequency                     | f                                |                                                   | 60   |      | kHz   |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |       |
| Line Regulation                           | ΔV <sub>OLINE</sub>              |                                                   | 80   | 100  | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.3A  |      |      |       |
| Load Regulation                           | ΔV <sub>LOAD</sub>               |                                                   | 30   | 40   | mV    |
|                                           | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.1 to 0.4A |      |      |       |
| Temperature Coefficient of Output Voltage | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      | mV/°C |
| Overcurrent Protection Starting Current   | I <sub>S1</sub>                  | 0.61                                              |      |      | A     |
|                                           | Conditions                       | V <sub>IN</sub> =10V                              |      |      |       |

## ■External Dimensions (TO220F-5)

(Unit : mm)



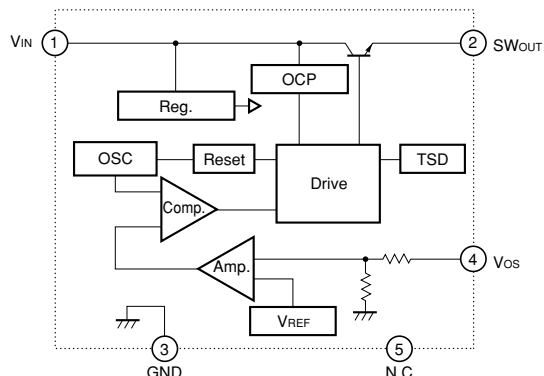
Forming No. 1101

## Pin Assignment

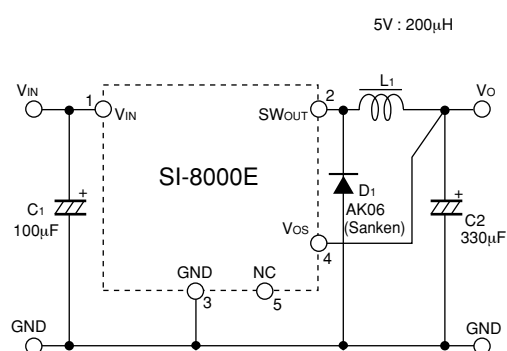
- ① VIN
- ② SWOUT
- ③ GND
- ④ Vos
- ⑤ N.C

Plastic Mold Package Type  
 Flammability: UL94V-0  
 Product Mass: Approx. 2.3g

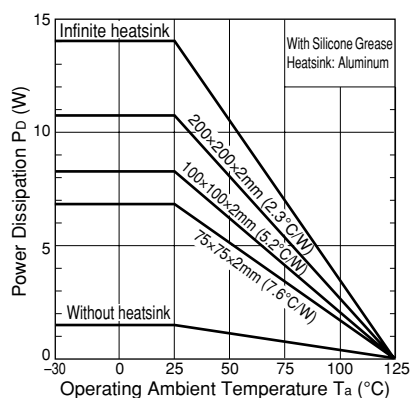
## ■Block Diagram



## ■Typical Connection Diagram



## ■Ta-Pd Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta \chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

Vo : Output voltage  
 VIN : Input voltage  
 Io : Output current  
 ηχ : Efficiency (%)  
 VF : Diode D1 forward voltage  
 0.4V(AK06)

Thermal design for D1 must be considered separately.

# SI-8000JF Series Full-Mold, Separate Excitation Step-down Switching Mode

## Features

- Compact full-mold package (equivalent to TO220)
- Output current: 1.5A
- High efficiency: 67 to 88%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage
- Capable of downsize a choke-coil due to IC's high switching frequency (125kHz). (Compared with conventional Sanken devices)
- Built-in foldback-overcurrent and thermal protection circuits
- Output ON/OFF available (circuit current at output OFF: 200 $\mu$ A max.)
- Soft start available by ON/OFF pin

## Lineup

| Part Number         | SI-8015JF | SI-8033JF | SI-8050JF | SI-8120JF |
|---------------------|-----------|-----------|-----------|-----------|
| V <sub>O</sub> (V)* | 1.59      | 3.3       | 5.0       | 12.0      |
| I <sub>O</sub> (A)  | 1.5       |           |           |           |

\* V<sub>REF</sub>(V) for SI-8015JF

## Absolute Maximum Ratings

| Parameter                             | Symbol           | Ratings                                      | Unit |
|---------------------------------------|------------------|----------------------------------------------|------|
| DC Input Voltage                      | V <sub>IN</sub>  | 43                                           | V    |
| Power Dissipation                     | P <sub>D1</sub>  | 16.6 (with infinite heatsink)                | W    |
|                                       | P <sub>D2</sub>  | 1.5 (without heatsink, standalone operation) | W    |
| Junction Temperature                  | T <sub>j</sub>   | +125                                         | °C   |
| Storage Temperature                   | T <sub>stg</sub> | -40 to +125                                  | °C   |
| Thermal Resistance (Junction to Case) | $\theta_{j-c}$   | 6.0                                          | °C/W |

## Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

## Recommended Operating Conditions

| Parameter                            | Symbol           | Ratings                 |           |           |           | Unit | Conditions                          |
|--------------------------------------|------------------|-------------------------|-----------|-----------|-----------|------|-------------------------------------|
|                                      |                  | SI-8015JF*              | SI-8033JF | SI-8050JF | SI-8120JF |      |                                     |
| DC Input Voltage Range               | V <sub>IN1</sub> | V <sub>O</sub> +2 to 40 | 5.3 to 40 | 7 to 40   | 14 to 40  | V    | I <sub>O</sub> =0 to 1A             |
|                                      | V <sub>IN2</sub> | V <sub>O</sub> +3 to 40 | 6.3 to 40 | 8 to 40   | 15 to 40  | V    | I <sub>O</sub> =0 to 1.5A           |
| Output Current Range                 | I <sub>O</sub>   | 0 to 1.5                |           |           |           | A    | V <sub>IN</sub> ≥V <sub>O</sub> +3V |
| Operating Junction Temperature Range | T <sub>top</sub> | -30 to +125             |           |           |           | °C   |                                     |

\* SI-8015JF is a variable output voltage type. The variable output voltage range is from 2.5 V to 24 V.

## Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                              | Symbol                                        | Ratings                                           |                      |       |                                                   |                      |       |                                                   |                      |      |                                                   |                      |       | Unit  |
|--------------------------------------------------------|-----------------------------------------------|---------------------------------------------------|----------------------|-------|---------------------------------------------------|----------------------|-------|---------------------------------------------------|----------------------|------|---------------------------------------------------|----------------------|-------|-------|
|                                                        |                                               | SI-8015JF                                         |                      |       | SI-8033JF                                         |                      |       | SI-8050JF                                         |                      |      | SI-8120JF                                         |                      |       |       |
|                                                        |                                               | min.                                              | typ.                 | max.  | min.                                              | typ.                 | max.  | min.                                              | typ.                 | max. | min.                                              | typ.                 | max.  |       |
| Output Voltage <sup>1</sup>                            | V <sub>O</sub> <sup>2</sup>                   | 1.558                                             | 1.59                 | 1.622 | 3.234                                             | 3.30                 | 3.366 | 4.90                                              | 5.00                 | 5.10 | 11.76                                             | 12.00                | 12.24 | V     |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |                      |       |       |
| Efficiency                                             | η                                             |                                                   | 67                   |       |                                                   | 77                   |       |                                                   | 82                   |      |                                                   | 88                   |       | %     |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |                      |       |       |
| Oscillation Frequency                                  | f                                             |                                                   | 125                  |       |                                                   | 125                  |       |                                                   | 125                  |      |                                                   | 125                  |       | kHz   |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5A        |                      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |                      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5A        |                      |       |       |
| Line Regulation                                        | ΔV <sub>OLINE</sub>                           |                                                   | 25                   | 80    |                                                   | 25                   | 80    |                                                   | 40                   | 100  |                                                   | 60                   | 130   | mV    |
|                                                        | Conditions                                    | V <sub>IN</sub> =8 to 30V, I <sub>O</sub> =0.5A   |                      |       | V <sub>IN</sub> =8 to 30V, I <sub>O</sub> =1.0A   |                      |       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =1.0A  |                      |      | V <sub>IN</sub> =18 to 30V, I <sub>O</sub> =1.0A  |                      |       |       |
| Load Regulation                                        | ΔV <sub>LOAD</sub>                            |                                                   | 10                   | 30    |                                                   | 10                   | 30    |                                                   | 10                   | 40   |                                                   | 10                   | 40    | mV    |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, I <sub>O</sub> =0.2 to 0.8A |                      |       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5 to 1.5A |                      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5 to 1.5A |                      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5 to 1.5A |                      |       |       |
| Temperature Coefficient of Output Voltage <sup>3</sup> | ΔV <sub>O</sub> /ΔT <sub>a</sub> <sup>4</sup> |                                                   | ±0.5                 |       |                                                   | ±0.5                 |       |                                                   | ±0.5                 |      |                                                   | ±1.0                 |       | mV/°C |
| Overcurrent Protection                                 | I <sub>SI</sub>                               | 1.6                                               |                      |       | 1.6                                               |                      |       | 1.6                                               |                      |      | 1.6                                               |                      |       | A     |
| Starting Current                                       | Conditions                                    | V <sub>IN</sub> =12V                              |                      |       | V <sub>IN</sub> =15V                              |                      |       | V <sub>IN</sub> =20V                              |                      |      | V <sub>IN</sub> =24V                              |                      |       |       |
| ON/OFF <sup>5</sup> Terminal                           | Low Level Voltage                             | V <sub>SSL</sub>                                  |                      | 0.5   |                                                   |                      | 0.5   |                                                   |                      | 0.5  |                                                   |                      | 0.5   | V     |
|                                                        | Outflow Current                               | I <sub>SSL</sub>                                  |                      | 100   |                                                   |                      | 100   |                                                   |                      | 100  |                                                   |                      | 100   | μA    |
|                                                        | at Low Voltage                                | Conditions                                        | V <sub>SSL</sub> =0V |       |                                                   | V <sub>SSL</sub> =0V |       |                                                   | V <sub>SSL</sub> =0V |      |                                                   | V <sub>SSL</sub> =0V |       |       |
| Quiescent Circuit Current                              | I <sub>q</sub>                                |                                                   | 7                    |       |                                                   | 7                    |       |                                                   | 7                    |      |                                                   | 7                    |       | mA    |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, I <sub>O</sub> =0A          |                      |       | V <sub>IN</sub> =15V, I <sub>O</sub> =0A          |                      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0A          |                      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0A          |                      |       |       |
|                                                        | I <sub>q</sub> (OFF)                          |                                                   |                      | 200   |                                                   |                      | 200   |                                                   |                      | 200  |                                                   |                      | 200   | μA    |
|                                                        | Conditions                                    | V <sub>IN</sub> =12V, V <sub>ON/OFF</sub> =0.3V   |                      |       | V <sub>IN</sub> =15V, V <sub>ON/OFF</sub> =0.3V   |                      |       | V <sub>IN</sub> =20V, V <sub>ON/OFF</sub> =0.3V   |                      |      | V <sub>IN</sub> =24V, V <sub>ON/OFF</sub> =0.3V   |                      |       |       |

\*1: Reference voltage for SI-8015JF

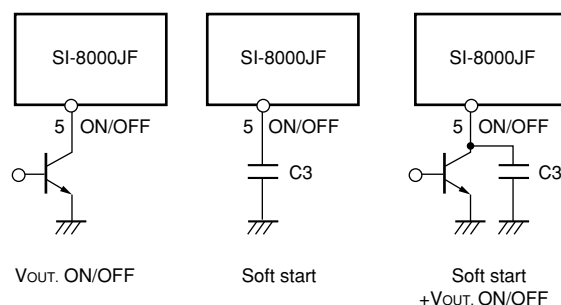
\*3: Temperature Coefficient of Reference Voltage for SI-8015JF

\*2: V<sub>REF</sub> for SI-8015JF

\*4:  $\Delta V_{REF}/\Delta T_a$  for SI-8015JF

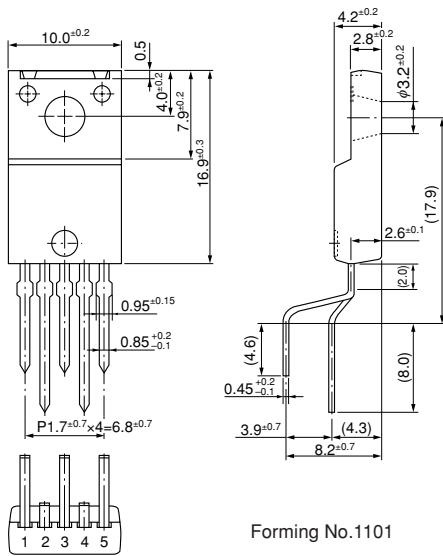
\*5: Pin 5 is the ON/OFF pin. Soft start at power on can be performed with a capacitor connected to this pin.

The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to V<sub>SSL</sub> or lower. ON/OFF-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C<sub>3</sub> flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C<sub>3</sub> capacitance is large. The ON/OFF pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited. If this pin is not used, leave it open.



## ■External Dimensions (TO220F-5)

(Unit : mm)



## Pin Assignment

- ①  $V_{IN}$
- ②  $SW_{OUT}$
- ③ GND
- ④  $V_{OS}$
- ⑤ ON/OFF

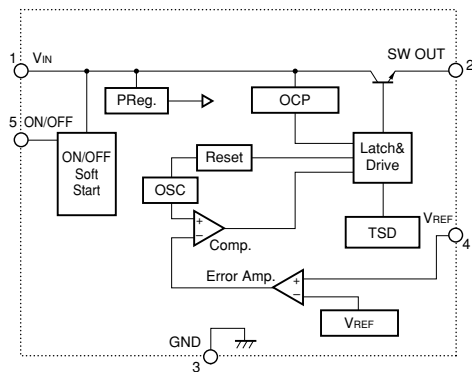
Plastic Mold Package Type

Flammability: UL94V-0

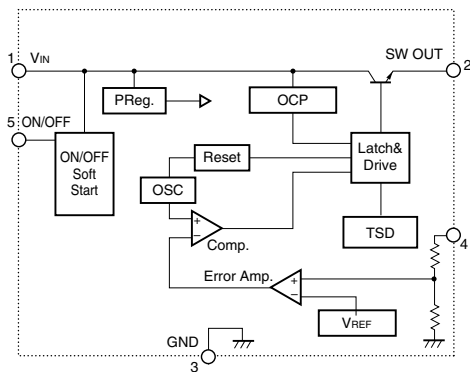
Product Mass: Approx. 2.3g

## ■Block Diagram

SI-8015JF

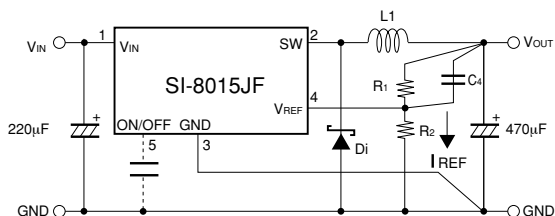


8033JF, 8050JF, 8120JF



## ■Typical Connection Diagram

SI-8015JF

 $I_{REF}$  shall be approx. 2mA.C1 : 50V/220 $\mu$ FC2 : 25V/470 $\mu$ FC3 : 10V/0.47 $\mu$ F (Only when using soft-start function)

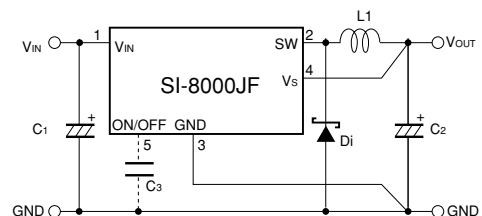
C4 : 6800pF

L1 : 100 $\mu$ H

Di : RK16 (Sanken)

$$V_{OUT} = \frac{V_{REF} \times (R_1 + R_2)}{R_2}$$

8033JF, 8050JF, 8120JF

C1 : 50V/220 $\mu$ FC2 : 25V/470 $\mu$ FC3 : 10V/0.47 $\mu$ F (Only when using soft-start function)L1 : 100 $\mu$ H

Di : RK16 (Sanken)

# SI-8000TFE Series Full-Mold, Separate Excitation Step-down Switching Mode

## Features

- Compact full-mold package (equivalent to TO220)
- Output current: 1.5 A
- High efficiency: 81% typ. (at  $V_o = 5$  V)
- Requires only 4 discrete components
- Built-in reference oscillator (300 kHz)
- Built-in dropping-type-overcurrent and thermal protection circuits
- Output ON/OFF available (circuit current at output OFF: 200  $\mu$ A typ.)
- Soft start available by ON/OFF pin

## Applications

- Onboard local power supplies
- AV equipment
- OA equipment

## Lineup

| Part Number | SI-8008TFE           | SI-8050TFE |
|-------------|----------------------|------------|
| $V_o$ (V)   | Variable (0.8 to 24) | 5          |
| $I_o$ (A)   |                      | 1.5        |

## Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings                                        | Unit                        | Conditions                                                    |
|----------------------------------------------|----------------|------------------------------------------------|-----------------------------|---------------------------------------------------------------|
| DC Input Voltage                             | $V_{IN}$       | 43                                             | V                           |                                                               |
| Power Dissipation                            | $P_{D1-1}$     | 17.8 (with infinite heatsink)                  | W                           | Limited by thermal protection, $T_{jmax}=150^{\circ}\text{C}$ |
|                                              | $P_{D1-2}$     | 14.2 (with infinite heatsink)                  |                             | $T_{jmax}=125^{\circ}\text{C}$                                |
|                                              | $P_{D2-1}$     | 2.15 (without heat sink, standalone operation) |                             | Limited by thermal protection, $T_{jmax}=150^{\circ}\text{C}$ |
|                                              | $P_{D2-2}$     | 1.72 (without heatsink, standalone operation)  |                             | $T_{jmax}=125^{\circ}\text{C}$                                |
| Junction Temperature*                        | $T_j$          | -30 to +150                                    | $^{\circ}\text{C}$          |                                                               |
| Storage Temperature                          | $T_{stg}$      | -40 to +150                                    | $^{\circ}\text{C}$          |                                                               |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 7                                              | $^{\circ}\text{C}/\text{W}$ |                                                               |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 58                                             | $^{\circ}\text{C}/\text{W}$ |                                                               |

\*: This product has built-in thermal protection circuits that may operate when the junction temperature rises above 130 $^{\circ}\text{C}$ . The recommended design for the junction temperature during operation is below 125 $^{\circ}\text{C}$ .

## Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings            |            | Unit               |
|--------------------------------------|-----------|--------------------|------------|--------------------|
|                                      |           | SI-8008TFE         | SI-8050TFE |                    |
| Input Voltage Range                  | $V_{IN}$  | $V_o+3^{*1}$ to 40 | 8 to 40    | V                  |
| Output Voltage Range                 | $V_o$     | 0.8 to 24          | 5.0        | V                  |
| Output Current Range                 | $I_o$     | 0 to 1.5           |            | A                  |
| Operating Junction Temperature Range | $T_{jop}$ | -20 to +125        |            | $^{\circ}\text{C}$ |
| Operating Temperature Range          | $T_{op}$  | -20 to +85         |            | $^{\circ}\text{C}$ |

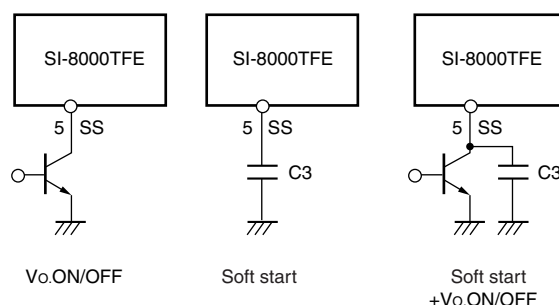
\*1: The minimum value of an input voltage range is the higher of 4.5 V or  $V_o + 3$  V.

## Electrical Characteristics

( $T_a=25^{\circ}\text{C}$ )

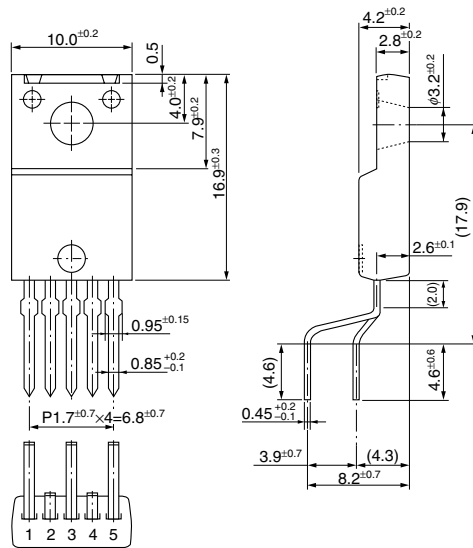
| Parameter                                    |                                | Symbol     | Ratings                         |       |       | Ratings                         |      |      | Unit  |
|----------------------------------------------|--------------------------------|------------|---------------------------------|-------|-------|---------------------------------|------|------|-------|
|                                              |                                |            | SI-8008TFE                      |       |       | SI-8050TFE                      |      |      |       |
|                                              |                                |            | min.                            | typ.  | max.  | min.                            | typ. | max. |       |
| Output Voltage                               |                                | Vo         |                                 |       |       | 4.90                            | 5.00 | 5.10 | V     |
| Reference Voltage                            |                                | VADJ       | 0.784                           | 0.800 | 0.816 |                                 |      |      |       |
|                                              |                                | Conditions | VIN=15V, Io=0.1A                |       |       | VIN=15V, Io=0.1A                |      |      |       |
| Temperature Coefficient of Output Voltage    |                                | ΔVo/ΔT     |                                 |       |       |                                 | ±0.5 |      | mV/°C |
| Temperature Coefficient of Reference Voltage |                                | ΔVREF/ΔT   |                                 | ±0.1  |       |                                 |      |      |       |
|                                              |                                | Conditions | VIN=15V, Io=0.1A, Tc=0 to 100°C |       |       | VIN=15V, Io=0.1A, Tc=0 to 100°C |      |      |       |
| Efficiency                                   |                                | η          |                                 | 81    |       |                                 | 81   |      | %     |
|                                              |                                | Conditions | VIN=15V, Io=0.5A                |       |       | VIN=15V, Io=0.5A                |      |      |       |
| Oscillation Frequency                        |                                | fo         |                                 | 300   |       |                                 | 300  |      | kHz   |
|                                              |                                | Conditions | VIN=15V, Io=0.5A                |       |       | VIN=15V, Io=0.5A                |      |      |       |
| Line Regulation                              |                                | ΔVLINE     |                                 | 60    | 80    |                                 | 60   | 80   | mV    |
|                                              |                                | Conditions | VIN=10 to 30V, Io=0.5A          |       |       | VIN=10 to 30V, Io=0.5A          |      |      |       |
| Load Regulation                              |                                | ΔVOLOAD    |                                 | 10    | 40    |                                 | 10   | 40   | mV    |
|                                              |                                | Conditions | VIN=15V, Io=0.2 to 1.5A         |       |       | VIN=15V, Io=0.2 to 1.5A         |      |      |       |
| Overcurrent Protection Starting Current      |                                | Is         | 1.6                             |       |       | 1.6                             |      |      | A     |
|                                              |                                | Conditions | VIN=15V                         |       |       | VIN=15V                         |      |      |       |
| ON/OFF Pin*                                  | Low Level Voltage              | VSSL       |                                 |       | 0.5   |                                 |      | 0.5  | V     |
|                                              | Outflow Current at Low Voltage | ISSL       |                                 | 10    | 40    |                                 | 10   | 40   | μA    |
|                                              |                                | Conditions | VSSL=0V                         |       |       | VSSL=0V                         |      |      |       |
| Quiescent Circuit Current                    |                                | Iq         |                                 | 6     |       |                                 | 6    |      | mA    |
|                                              |                                | Conditions | VIN=15V, Io=0A                  |       |       | VIN=15V, Io=0A                  |      |      |       |
|                                              |                                | Iq(OFF)    |                                 | 200   | 400   |                                 | 200  | 400  | μA    |
|                                              |                                | Conditions | VIN=15V, VSS=0V                 |       |       | VIN=15V, VSS=0V                 |      |      |       |

\*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited. If the pin is not used, leave it open.



## ■External Dimensions (TO220F-5)

(Unit : mm)

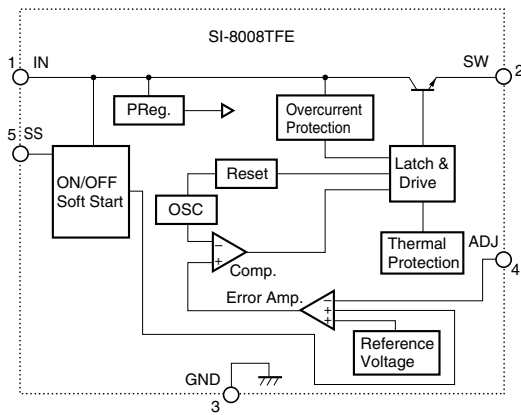


## Pin Assignment

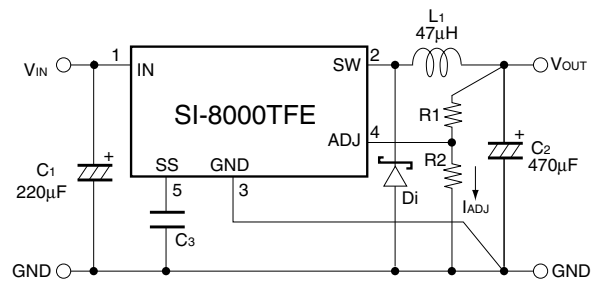
- ① IN
- ② SW
- ③ GND
- ④ ADJ
- ⑤ SS

Plastic Mold Package Type  
 Flammability: UL94V-0  
 Product Mass: Approx. 2.3g

## ■Block Diagram



## ■Typical Connection Diagram



C1 : 220μF  
 C2 : 470μF  
 C3 : 1μF (Only when using soft-start function)  
 L1 : 47μH  
 Di : RK16 (Sanken)

# SI-8000GL Series Compact, Separate Excitation Step-down Switching Mode

## ■Features

- DIP 8 pin package
- Output current: 1.5A
- High efficiency: 86% (at  $V_{IN} = 20V$ ,  $I_O = 1A$ ,  $V_O = 5V$ )
- Capable of downsize a choke-coil due to IC's high switching frequency (250kHz). (Compared with conventional Sanken devices)
- The output-voltage-variable type can vary its output voltage from 1V to 14V because of its low reference voltage ( $V_{REF}$ ) of 1V.
- Wide Input Voltage Range (8 to 50V)
- Output ON/OFF available
- Built-in overcurrent protection and thermal protection circuits

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings     | Unit |
|----------------------------------------------|----------------|-------------|------|
| DC Input Voltage                             | $V_{IN}$       | 53          | V    |
| Power Dissipation                            | $P_D^{*1}$     | 1           | W    |
| Junction Temperature                         | $T_j$          | +125        | °C   |
| Storage Temperature                          | $T_{stg}$      | -40 to +125 | °C   |
| Thermal Resistance (junction to case)        | $\theta_{j-c}$ | 28          | °C/W |
| Thermal Resistance (junction to ambient air) | $\theta_{j-a}$ | 100         | °C/W |

\*1: Limited by thermal protection.

## ■Applications

- Onboard local power supplies
- OA equipment
- For stabilization of the secondary-side output voltage of switching power supplies

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings                             | Unit |
|--------------------------------------|-----------|-------------------------------------|------|
|                                      |           | SI-8010GL                           |      |
| DC Input Voltage Range               | $V_{IN}$  | (8 or $V_O+3$ )* <sup>1</sup> to 50 | V    |
| Output Voltage Range                 | $V_O$     | 1 to 14                             | V    |
| Output Current Range* <sup>2</sup>   | $I_O$     | 0.02 to 1.5* <sup>2</sup>           | A    |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +125                         | °C   |
| Operating Temperature Range          | $T_{op}$  | -30 to +125                         | °C   |

\*1: The minimum value of an input voltage range is the higher of either 8V or  $V_O+3V$ .

\*2: Please be sure to let the output current run more than 20 mA. When using by less than 20 mA, there is a possibility that the output voltage becomes unstable.

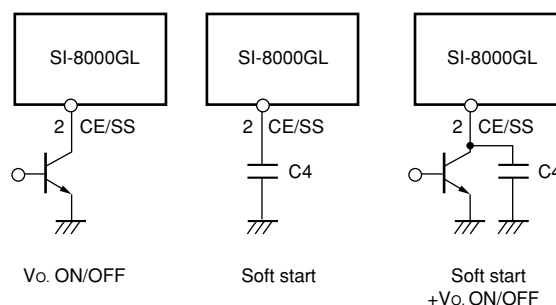
## ■Electrical Characteristics

( $T_a=25^\circ\text{C}$ )

| Parameter                                    |                                         | Symbol     | Ratings                   |      |      | Unit  |
|----------------------------------------------|-----------------------------------------|------------|---------------------------|------|------|-------|
|                                              |                                         |            | SI-8010GL (Variable type) |      |      |       |
|                                              |                                         |            | min.                      | typ. | max. |       |
| Reference Voltage                            |                                         | VREF       | 0.97                      | 1.00 | 1.03 | V     |
|                                              |                                         | Conditions | VIN=12V, IO=1A            |      |      |       |
| Efficiency                                   |                                         | Eff        |                           | 86   |      | %     |
|                                              |                                         | Conditions | VIN=20V, IO=1A, VO=5V     |      |      |       |
| Oscillation Frequency                        |                                         | FOSC       |                           | 250  |      | kHz   |
|                                              |                                         | Conditions | VIN=12V, IO=1A            |      |      |       |
| Line Regulation                              |                                         | ΔVOLUME    |                           | 20   | 40   | mV    |
|                                              |                                         | Conditions | VIN=10 to 30V, IO=1A      |      |      |       |
| Load Regulation                              |                                         | ΔVLOAD     |                           | 10   | 30   | mV    |
|                                              |                                         | Conditions | VIN=12V, IO=0.1 to 1.5A   |      |      |       |
| Temperature Coefficient of Reference Voltage |                                         | ΔVREF/ΔTa  |                           | ±0.5 |      | mV/°C |
| Overcurrent Protection Starting Current      |                                         | IS         | 1.6                       |      |      | A     |
|                                              |                                         | Conditions | VIN=12V                   |      |      |       |
| Quiescent Circuit Current                    |                                         | Iq         |                           | 7    |      | mA    |
|                                              |                                         | Conditions | VIN=12V, IO=0A            |      |      |       |
| Circuit Current at Output OFF                |                                         | Iq(OFF)    |                           |      | 400  | μA    |
|                                              |                                         | Conditions | VIN=12V, VON/OFF=0.3V     |      |      |       |
| CE/SS* Terminal                              | Low Level Voltage                       | VSSL       |                           |      | 0.5  | V     |
|                                              | Terminal Outflow Current at Low Voltage | ISSL       |                           |      | 50   | μA    |
| Conditions                                   |                                         | VSSL=0V    |                           |      |      |       |

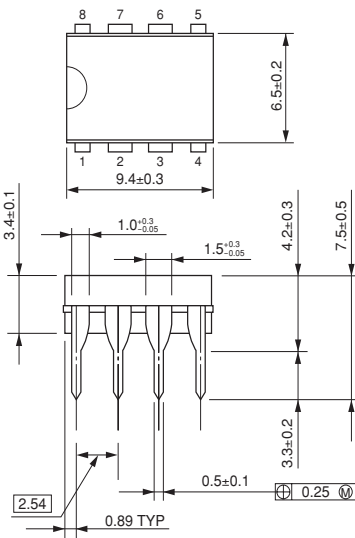
\*: Pin 2 is the CE/SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. CE/SS-pin voltage can be changed with an open-collector drive circuit of a transistor.

When using both the soft-start and ON/OFF functions together, the discharge current from  $C_4$  flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if  $C_3$  capacitance is large. The CE/SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



## ■External Dimensions (DIP8)

(Unit: mm)



## Pin Assignment

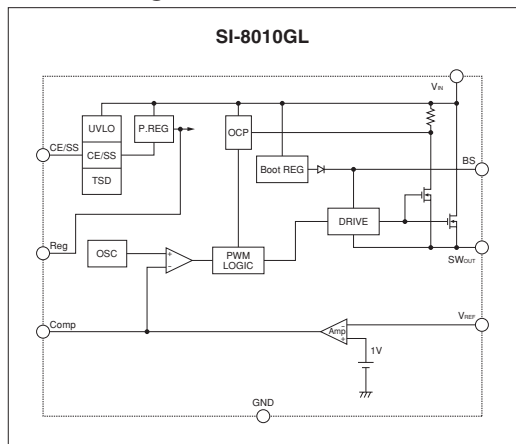
1. GND
2. CE/SS
3. Reg
4. SW<sub>OUT</sub>
5. V<sub>IN</sub>
6. BS
7. Comp
8. V<sub>REF</sub>

Plastic Mold Package Type

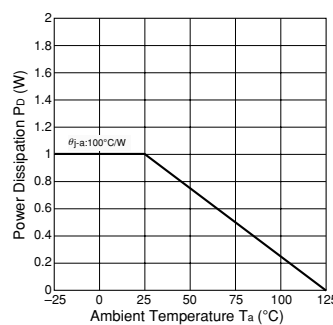
Flammability: UL 94V-0

Product Mass: Approx. 0.49 g

## ■Block Diagram



## ■Ta-PD Characteristics



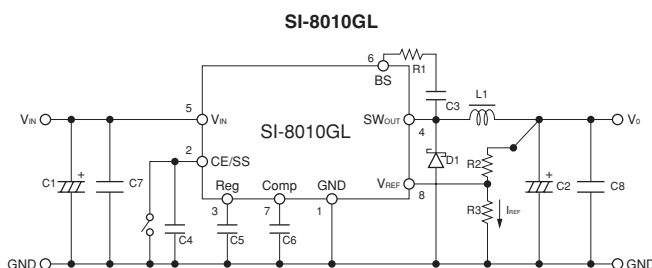
$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

Note 1: The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

Note 2: Thermal design for D<sub>1</sub> must be considered separately.

$V_O$  : Output voltage  
 $V_{IN}$  : Input voltage  
 $I_O$  : Output current  
 $\eta\chi$  : Efficiency  
 $V_F$  : Diode D<sub>1</sub> forward voltage  
 RK16...0.4V ( $I_O=1A$ )

## ■Typical Connection Diagram



C1: 220μF/63V  
 C2: 470μF/25V  
 C3: 0.1μF  
 C4: 1000pF  
 C5: 0.1μF  
 C6: 0.047μF  
 C7: 0.1μF  
 C8: 0.1μF  
 R1: 47Ω  
 L1: 47μH  
 D1: RK16  
 (Sanken)

$$R_2 = \frac{(V_{OUT} - V_{REF})}{I_{REF}} = \frac{(V_{OUT} - 1)}{2 \times 10^{-3}} (\Omega), R_3 = \frac{V_{REF}}{I_{REF}} = \frac{1}{2 \times 10^{-3}} \approx 500 (\Omega)$$

Diode D<sub>1</sub>

- Be sure to use a Schottky-barrier diode as D<sub>1</sub>. If other diodes like fast recovery diodes are used, IC may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

Choke coil L<sub>1</sub>

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- As the overcurrent protection starting current is approx. 2.5 A, take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuited load.

Capacitor C<sub>1</sub>, C<sub>2</sub>

- As large ripple currents flow through C<sub>1</sub> and C<sub>2</sub>, use high-frequency and low-impedance capacitors aiming for switching-mode-power-supply use. Especially when the impedance of C<sub>2</sub> is high, the switching waveform may become abnormal at low temperatures. For C<sub>2</sub>, do not use a capacitor with an extremely low equivalent series resistance (ESR) such as an OS capacitor or a tantalum capacitor, which may cause an abnormal oscillation.

Resistors R<sub>2</sub>, R<sub>3</sub>

- R<sub>2</sub> and R<sub>3</sub> are the resistors to set the output voltage. Set their values so that I<sub>REF</sub> becomes approx. 2 mA. Obtain R<sub>2</sub> and R<sub>3</sub> values by the following formula above.

\* To create the optimum operating conditions, place the components as close as possible to each other.

# NR887D Current Mode Control, Synchronous Rectifier Step-down Switching Mode

## Features

- DIP 8 pin package
- Input voltage range ( $V_{IN}$ ):  $V_O + 3$  to 18 V
- Synchronous rectifier mode
- High efficiency: 90%
- Current mode control
- Stable with low-ESR ceramic output capacitors
- Built-in phase compensation component
- Output current: 2 A
- Reference voltage and accuracy of 0.8 V  $\pm$  2%
- Oscillation frequency: 500 kHz
- Output ON/OFF available
- Undervoltage lockout
- Soft start function

## Absolute Maximum Ratings

| Parameter                                      | Symbol         | Ratings     | Unit | Conditions                                                                               |
|------------------------------------------------|----------------|-------------|------|------------------------------------------------------------------------------------------|
| Input Voltage                                  | $V_{IN}$       | 20          | V    |                                                                                          |
| Power Dissipation                              | $P_D$          | 1.50        | W    | When mounted on a 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |
| Junction Temperature                           | $T_J$          | −40 to +150 | °C   |                                                                                          |
| Storage Temperature                            | $T_{stg}$      | −40 to +150 | °C   |                                                                                          |
| Thermal Resistance (Junction to Lead (4 pins)) | $\theta_{J-C}$ | 25          | °C/W |                                                                                          |
| Thermal Resistance (Junction to Ambient Air)   | $\theta_{J-A}$ | 67          | °C/W | When mounted on a 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |

## Recommended Operating Conditions

| Parameter                   | Symbol   | Ratings                  | Unit |
|-----------------------------|----------|--------------------------|------|
| Input Voltage Range         | $V_{IN}$ | 4.5 or $V_O + 3^*$ to 18 | V    |
| Output Current Range        | $I_O$    | 0 to 2.0                 | A    |
| Output Voltage Range        | $V_O$    | 0.8 to 14                | V    |
| Operating Temperature Range | $T_{OP}$ | −40 to +85               | °C   |

\*: The minimum value of the input voltage range is 4.5 V or  $V_O + 3$  V, whichever is higher.

## Applications

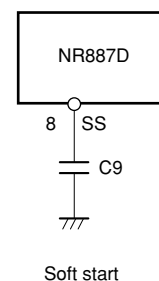
- Power supply for LCDTV and PDP
- Power supply for DVD, BD, and STB
- On-board local power supply
- Power supply for switches

## Electrical Characteristics

( $T_a=25^\circ\text{C}$ ,  $V_{IN}=12\text{V}$ ,  $V_O=3.3\text{V}$ , and  $I_O=1.0\text{A}$ , unless otherwise specified)

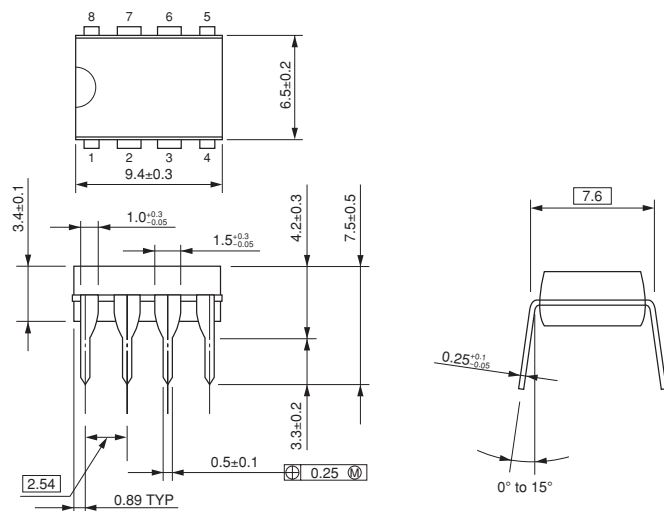
| Parameter                                    | Symbol                         | Ratings |            |       | Unit          | Conditions                                     |
|----------------------------------------------|--------------------------------|---------|------------|-------|---------------|------------------------------------------------|
|                                              |                                | min.    | typ.       | max.  |               |                                                |
| Reference Voltage                            | $V_{REF}$                      | 0.784   | 0.800      | 0.816 | V             |                                                |
| Temperature Coefficient of Reference Voltage | $\Delta V_{REF}/\Delta T$      |         | $\pm 0.05$ |       | mV/°C         | $T_a=-40^\circ\text{C}$ to $+85^\circ\text{C}$ |
| Efficiency                                   | $\eta$                         |         | 90         |       | %             |                                                |
| Oscillation Frequency                        | $f_o$                          | 400     | 500        | 600   | kHz           |                                                |
| Line Regulation                              | $V_{LINE}$                     |         | 50         |       | mV            | $V_{IN}=6.3\text{V}$ to 18V                    |
| Load Regulation                              | $V_{LOAD}$                     |         | 50         |       | mV            | $I_O=0.1$ to 2.0A                              |
| Overcurrent Protection Starting Current      | $I_S$                          | 3.1     |            | 6.0   | A             |                                                |
| Quiescent Circuit Current 1                  | $I_{IN}$                       |         | 6          |       | mA            | $V_{EN}=10\Omega$ pull up to $V_{IN}$          |
| Quiescent Circuit Current 2                  | $I_{IN(Off)}$                  |         |            | 10    | $\mu\text{A}$ | $I_O=0\text{A}$ , $V_{EN}=0\text{V}$           |
| SS Pin                                       | Outflow Current at Low Voltage | 6       | 10         | 14    | $\mu\text{A}$ | $V_{SS}=0\text{V}$                             |
|                                              | Open Voltage                   |         | 3.0        |       | V             |                                                |
| EN Pin                                       | Inflow Current                 |         | 50         | 100   | $\mu\text{A}$ | $V_{EN}=10\text{V}$                            |
|                                              | On Threshold Voltage           | 0.7     | 1.4        | 2.1   | V             |                                                |
| Maximum ON Duty                              | $DMAX$                         |         | 90         |       | %             |                                                |
| Minimum ON Time                              | $DMIN$                         |         | 150        |       | nsec          |                                                |
| Thermal Protection Start Temperature         | $TSD$                          | 151     | 165        |       | °C            |                                                |
| Thermal Protection Return Hysteresis         | $TSD\_hys$                     |         | 20         |       | °C            |                                                |

\*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



## External Dimensions (DIP8)

(Unit : mm)

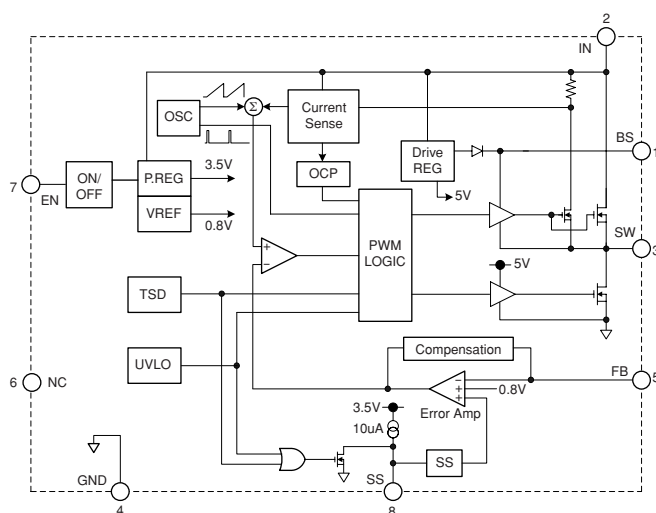


### Pin Assignment

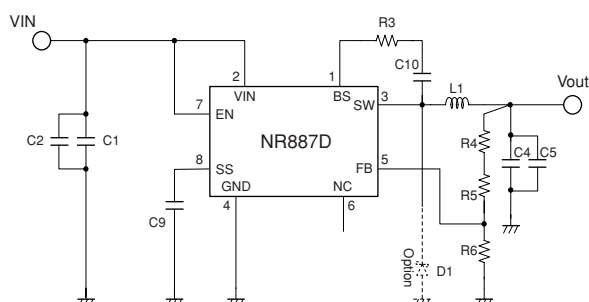
- ① BS
- ② VIN
- ③ SW
- ④ GND
- ⑤ FB
- ⑥ NC
- ⑦ EN
- ⑧ SS

Plastic Mold Package Type  
 Flammability: UL 94V-0  
 Product Mass: Approx. 0.49g

## Block Diagram



## Typical Connection Diagram



C1, C2: 10μF/25V  
 C4, C5: 22μF/16V  
 C9: 0.1μF  
 C10: 0.1μF  
 L1: 10μH  
 R3: 20Ω to 47Ω  
 R4+R5: 5kΩ (Vo=3.3V)  
 R6: 1.6kΩ

SI-8000S Series

Full-Mold, Separate Excitation Step-down Switching Mode

Features

- Compact full-mold package (equivalent to TO220)
- Output current: 3.0A
- High efficiency: 79 to 91%
- Requires only 4 discrete components
- Internally-adjusted phase compensation and output voltage
- Built-in reference oscillator (60kHz)
- Built-in overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)

Lineup

| Part Number | SI-8033S | SI-8050S | SI-8090S | SI-8120S | SI-8150S |
|-------------|----------|----------|----------|----------|----------|
| Vo(V)       | 3.3      | 5.0      | 9.0      | 12.0     | 15.0     |
| Io(A)       | 3.0      |          |          |          |          |

Absolute Maximum Ratings

| Parameter                            | Symbol | Ratings                                      | Unit |
|--------------------------------------|--------|----------------------------------------------|------|
| DC Input Voltage                     | VIN    | 43*                                          | V    |
| Power Dissipation                    | Pd1    | 18(With infinite heatsink)                   | W    |
|                                      | Pd2    | 1.5(Without heatsink, stand-alone operation) | W    |
| Junction Temperature                 | Tj     | +125                                         | °C   |
| Storage Temperature                  | Tstg   | −40 to +125                                  | °C   |
| SW Terminal Applied Reverse Voltage  | Vsw    | −1                                           | V    |
| Thermal Resistance(junction to case) | θj-c   | 5.5                                          | °C/W |

\*35V for SI-8033S

Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

Recommended Operating Conditions

| Parameter                            | Symbol | Ratings     |          |          |          |          | Unit |
|--------------------------------------|--------|-------------|----------|----------|----------|----------|------|
|                                      |        | SI-8033S    | SI-8050S | SI-8090S | SI-8120S | SI-8150S |      |
| DC Input Voltage Range               | VIN    | 5.5 to 28   | 7 to 40  | 12 to 40 | 15 to 40 | 18 to 40 | V    |
| Output Current Range                 | Io     | 0 to 3.0    |          |          |          |          | A    |
| Operating Junction Temperature Range | Tjop   | −30 to +125 |          |          |          |          | °C   |

Electrical Characteristics

(Ta=25°C)

| Parameter                                 |                                | Symbol                           | Ratings                                           |      |       |                                                   |      |      |                                                   |      |      |                                                   |       |       |                                                   |       |       | Unit  |
|-------------------------------------------|--------------------------------|----------------------------------|---------------------------------------------------|------|-------|---------------------------------------------------|------|------|---------------------------------------------------|------|------|---------------------------------------------------|-------|-------|---------------------------------------------------|-------|-------|-------|
|                                           |                                |                                  | SI-8033S                                          |      |       | SI-8050S                                          |      |      | SI-8090S                                          |      |      | SI-8120S                                          |       |       | SI-8150S                                          |       |       |       |
|                                           |                                |                                  | min.                                              | typ. | max.  | min.                                              | typ. | max. | min.                                              | typ. | max. | min.                                              | typ.  | max.  | min.                                              | typ.  | max.  |       |
| Output Voltage                            | SI-8000S*1                     | V <sub>O</sub>                   | 3.17                                              | 3.30 | 3.43  | 4.80                                              | 5.00 | 5.20 | 8.55                                              | 9.00 | 9.45 | 11.50                                             | 12.00 | 12.50 | 14.25                                             | 15.00 | 15.75 | V     |
|                                           | SI-8000SS                      |                                  | 3.234                                             | 3.30 | 3.366 | 4.90                                              | 5.00 | 5.10 |                                                   |      |      |                                                   |       |       |                                                   |       |       |       |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1.0A        |      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =21V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =1.0A        |       |       | V <sub>IN</sub> =25V, I <sub>O</sub> =1.0A        |       |       |       |
| Efficiency                                |                                | η                                | 79                                                |      |       | 84                                                |      |      | 88                                                |      |      | 90                                                |       |       | 91                                                |       |       | %     |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1.0A        |      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =21V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =1.0A        |       |       | V <sub>IN</sub> =25V, I <sub>O</sub> =1.0A        |       |       |       |
| Oscillation Frequency                     |                                | f                                | 60                                                |      |       | 60                                                |      |      | 60                                                |      |      | 60                                                |       |       | 60                                                |       |       | kHz   |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =1.0A        |      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =21V, I <sub>O</sub> =1.0A        |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =1.0A        |       |       | V <sub>IN</sub> =25V, I <sub>O</sub> =1.0A        |       |       |       |
| Line Regulation                           |                                | ΔV <sub>OLINE</sub>              | 25 80                                             |      |       | 40 100                                            |      |      | 50 120                                            |      |      | 60 130                                            |       |       | 60 130                                            |       |       | mV    |
|                                           |                                | Conditions                       | V <sub>IN</sub> =8 to 28V, I <sub>O</sub> =1.0A   |      |       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =1.0A  |      |      | V <sub>IN</sub> =15 to 30V, I <sub>O</sub> =1.0A  |      |      | V <sub>IN</sub> =18 to 30V, I <sub>O</sub> =1.0A  |       |       | V <sub>IN</sub> =21 to 30V, I <sub>O</sub> =1.0A  |       |       |       |
| Load Regulation                           |                                | ΔV <sub>OLOAD</sub>              | 10 30                                             |      |       | 10 40                                             |      |      | 10 40                                             |      |      | 10 40                                             |       |       | 10 40                                             |       |       | mV    |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V, I <sub>O</sub> =0.5 to 1.5A |      |       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5 to 1.5A |      |      | V <sub>IN</sub> =21V, I <sub>O</sub> =0.5 to 1.5A |      |      | V <sub>IN</sub> =24V, I <sub>O</sub> =0.5 to 1.5A |       |       | V <sub>IN</sub> =25V, I <sub>O</sub> =0.5 to 1.5A |       |       |       |
| Temperature Coefficient of Output Voltage |                                | ΔV <sub>O</sub> /ΔT <sub>a</sub> | ±0.5                                              |      |       | ±0.5                                              |      |      | ±1.0                                              |      |      | ±1.0                                              |       |       | ±1.0                                              |       |       | mV/°C |
| Overcurrent Protection Starting Current   |                                | I <sub>SI</sub>                  | 3.1                                               |      |       | 3.1                                               |      |      | 3.1                                               |      |      | 3.1                                               |       |       | 3.1                                               |       |       | A     |
|                                           |                                | Conditions                       | V <sub>IN</sub> =15V                              |      |       | V <sub>IN</sub> =20V                              |      |      | V <sub>IN</sub> =21V                              |      |      | V <sub>IN</sub> =24V                              |       |       | V <sub>IN</sub> =25V                              |       |       |       |
| Soft Start Pin*2                          | Low-Level Voltage              | V <sub>SSL</sub>                 | 0.2                                               |      |       | 0.2                                               |      |      | 0.2                                               |      |      | 0.2                                               |       |       | 0.2                                               |       |       | V     |
|                                           | Outflow Current at Low Voltage | I <sub>SSL</sub>                 | 15                                                | 25   | 35    | 15                                                | 25   | 35   | 15                                                | 25   | 35   | 15                                                | 25    | 35    | 15                                                | 25    | 35    | μA    |
|                                           | Conditions                     | V <sub>SSL</sub> =0.2V           |                                                   |      |       |                                                   |      |      |                                                   |      |      |                                                   |       |       |                                                   |       |       |       |

\*1:“S” may be printed to the right of the marking (except SI-8090S, SI-8120S, SI-8150S).

\*2:Pin 5 is a soft start pin. Soft start at power on can be performed with a capacitor connected to this pin.

The output can also be turned ON/OFF with this pin.

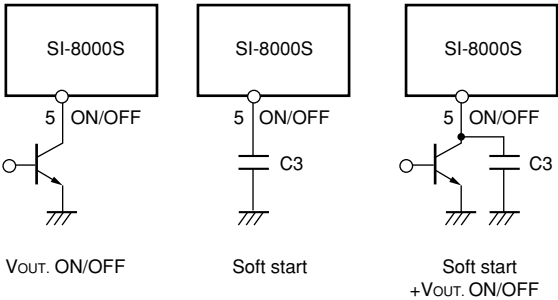
The output is stopped by setting the voltage of this pin to VSSL or lower.

Soft-start pin voltage can be changed with an open-collector drive circuit of a transistor.

When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large.

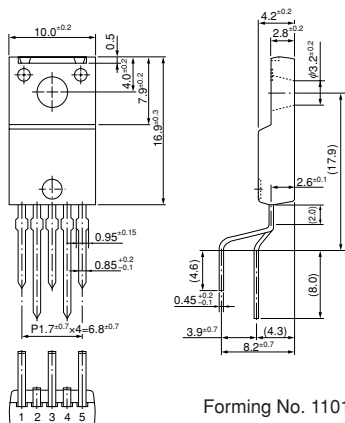
The ON/OFF pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

If this pin is not used, leave it open.



## External Dimensions (TO220F-5)

(Unit : mm)



### Pin Assignment

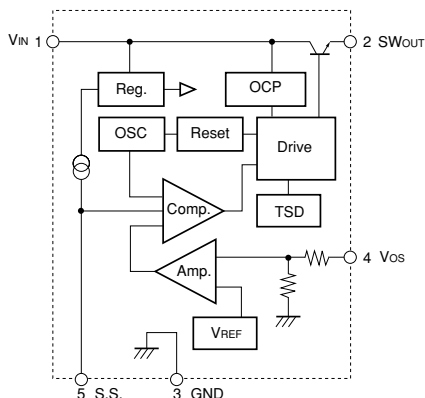
- ①  $V_{IN}$
- ②  $SW_{OUT}$
- ③ GND
- ④  $V_{OS}$
- ⑤ S.S

Plastic Mold Package Type

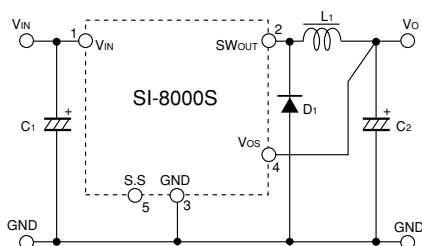
Flammability: UL94V-0

Product Mass: Approx. 2.3g

## Block Diagram

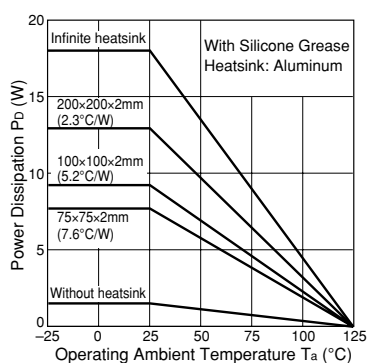


## Typical Connection Diagram



$C_{1,2}$  : 1000 $\mu$ F  
 $L_1$  : 150 $\mu$ H  
 $D_1$  : RK46(Sanken)

## $T_a$ - $P_D$ Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta \chi} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

$V_O$  : Output voltage  
 $V_{IN}$  : Input voltage  
 $I_O$  : Output current  
 $\eta \chi$  : Efficiency (%)  
 $V_F$  : Diode  $D_1$  forward voltage  
 0.5V(RK46)

Thermal design for  $D_1$  must be considered separately.

# SI-8100QL Series Current Mode Control Step-down Switching Mode

## ■Features

- DIP8 package
- Introduction of current mode control method
- Output current: 3.5A
- High efficiency: 90% ( $V_o=5V$ )
- Built-in reference oscillator (350kHz)
- Built-in drooping-type overcurrent and thermal protection circuits
- Built-in soft start circuit
- Built-in on/off function (Active Hi)
- Low current consumption during off

## ■Applications

- DVD recorder, FPD-TV
- Onboard local power supplies
- OA equipment

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings     | Unit | Conditions                                                                                         |
|----------------------------------------------|----------------|-------------|------|----------------------------------------------------------------------------------------------------|
| Input Voltage                                | $V_{IN}$       | 30          | V    |                                                                                                    |
| Power Dissipation <sup>*1</sup>              | $P_D$          | 1.56        | W    | When mounted on glass-epoxy board measuring 70×60 mm (copper laminate area: 1310 mm <sup>2</sup> ) |
| Junction Temperature <sup>*2</sup>           | $T_j$          | −30 to +150 | °C   |                                                                                                    |
| Storage Temperature                          | $T_{stg}$      | −40 to +150 | °C   |                                                                                                    |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 25          | °C/W |                                                                                                    |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 64          | °C/W | When mounted on glass-epoxy board measuring 70×60 mm (copper laminate area: 1310 mm <sup>2</sup> ) |

\*1: Limited by thermal protection circuit

\*2: Note that the detect temperature for thermal protection is about 140°C.

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings            | Unit | Conditions |
|--------------------------------------|-----------|--------------------|------|------------|
|                                      |           | SI-8105QL          |      |            |
| Input Voltage Range                  | $V_{IN}$  | $V_o+3^{*1}$ to 28 | V    |            |
| Output Voltage Range                 | $V_o$     | 0.5 to 24          | V    |            |
| Output Current Range                 | $I_o$     | 0 to 3.5           | A    |            |
| Operating Junction Temperature Range | $T_{jop}$ | −30 to +125        | °C   |            |
| Operating Temperature Range          | $T_{op}$  | −30 to +85         | °C   |            |

\*1: The minimum value of the input voltage range is 4.75 V or  $V_o+3$  V, whichever is higher.

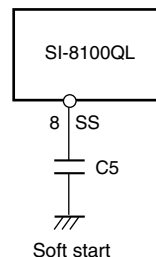
## ■Electrical Characteristics

(When  $T_a=25^\circ\text{C}$  and  $V_o=5V$ )

| Parameter                                    |                                | Symbol                  | Ratings                                                                |       |       | Unit  |
|----------------------------------------------|--------------------------------|-------------------------|------------------------------------------------------------------------|-------|-------|-------|
|                                              |                                |                         | SI-8105QL                                                              |       |       |       |
|                                              |                                |                         | min.                                                                   | typ.  | max.  |       |
| Reference Voltage                            |                                | V <sub>ADJ</sub>        | 0.485                                                                  | 0.500 | 0.515 | V     |
| Temperature Coefficient of Reference Voltage |                                | (ΔV <sub>ADJ</sub> /ΔT) |                                                                        | 0.05  |       | mV/°C |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V, I <sub>o</sub> =1A, T <sub>a</sub> =−40 to +85°C |       |       |       |
| Efficiency                                   |                                | η                       |                                                                        | 90    |       | %     |
| Oscillation Frequency                        |                                | f <sub>o</sub>          | 315                                                                    | 350   | 385   | kHz   |
|                                              |                                | Conditions              | V <sub>IN</sub> =16V, I <sub>o</sub> =1A                               |       |       |       |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>     |                                                                        | 30    | 60    | mV    |
|                                              |                                | Conditions              | V <sub>IN</sub> =8 to 28V, I <sub>o</sub> =1A                          |       |       |       |
| Load Regulation                              |                                | ΔV <sub>OLOAD</sub>     |                                                                        | 30    | 60    | mV    |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V, I <sub>o</sub> =0.1 to 3.5A                      |       |       |       |
| Overcurrent Protection Starting Current      |                                | I <sub>s</sub>          | 3.6                                                                    |       | 6.0   | A     |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>          |                                                                        | 18    |       | mA    |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V, I <sub>o</sub> =0A, V <sub>EN</sub> =open        |       |       |       |
|                                              |                                | I <sub>q(OFF)</sub>     |                                                                        |       | 20    | μA    |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V, I <sub>o</sub> =0A, V <sub>EN</sub> =0V          |       |       |       |
| SS Pin                                       | Outflow Current at Low Voltage | I <sub>SSL</sub>        |                                                                        | 5     |       | μA    |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V, V <sub>SSL</sub> =0V                             |       |       |       |
| EN Pin                                       | High Level Voltage             | V <sub>C/EH</sub>       | 2.8                                                                    |       |       | V     |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V                                                   |       |       |       |
|                                              | Low Level Voltage              | V <sub>C/EL</sub>       |                                                                        |       | 2.2   | V     |
|                                              |                                | Conditions              | V <sub>IN</sub> =12V                                                   |       |       |       |
|                                              | Inflow Current at Low Voltage  | I <sub>C/EH</sub>       |                                                                        | 5     |       | μA    |
|                                              |                                | Conditions              | V <sub>EN</sub> =0V                                                    |       |       |       |
| Error Amplifier Voltage Gain                 |                                | AEA                     |                                                                        | 1000  |       | V/V   |
| Error Amplifier Transformer Conductance      |                                | GEA                     |                                                                        | 800   |       | μA/V  |
| Current Sense Amplifier Impedance            |                                | 1/GCS                   |                                                                        | 0.35  |       | V/A   |
| Maximum ON Duty                              |                                | DMAX                    |                                                                        | 92    |       | %     |
| Minimum ON Time                              |                                | DMIN                    |                                                                        | 100   |       | nsec. |

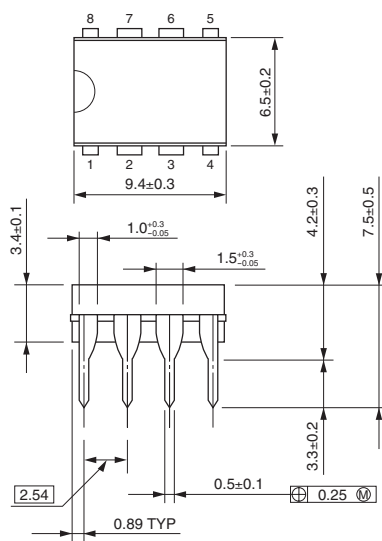
\*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.

The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



## ■External Dimensions (DIP8)

(Unit : mm)



## Pin Assignment

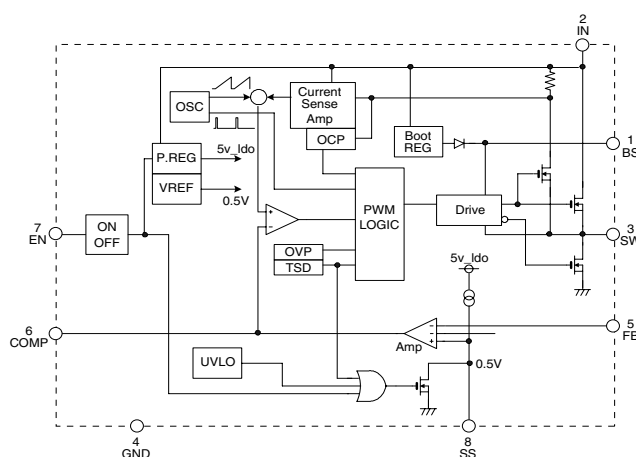
- ① BS
- ② IN
- ③ SW
- ④ GND
- ⑤ FB
- ⑥ COMP
- ⑦ EN
- ⑧ SS

Plastic Mold Package Type

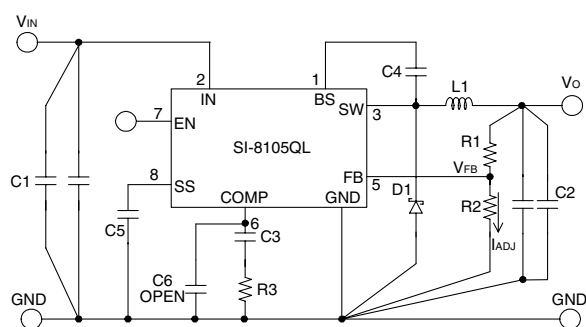
Flammability: UL 94V-0

Product Mass: Approx. 0.49 g

## ■Block Diagram



## ■Typical Connection Diagram



- C1:10μ F/50V  
(Murata: GRM55DB31H106KA87)
- C2:22μ F/16V  
(Murata: GRM32ER71A226KE20)
- C3:560pF<sup>\*</sup>  
(Murata: GRM18 Type)
- C4:10nF  
(Murata: GRM18 Type)
- C5:10nF  
(Murata: GRM18 Type)
- L1:10μ H
- D1:SJPW-T4 (Sanken)
- R1:46kΩ (When Vo = 5 V)
- R2:5.1kΩ
- R3:24kΩ<sup>\*</sup>

\*1: When Vo=5V

# SI-8000FFE Series Full-Mold, Separate Excitation Step-down Switching Mode

## ■Features

- Compact full-mold package (equivalent to TO220)
- Output current: 3.5 A
- High efficiency: 83% ( $V_o = 5\text{ V}$ ,  $V_{in} = 15\text{ V}$ ,  $I_o = 2\text{ A}$ )
- Requires only 6 discrete components
- Built-in reference oscillator (300 kHz)
- Built-in drooping-type overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)

## ■Applications

- DVD recorder, FPD-TV
- OA equipment, such as printers
- Onboard local power supplies

## ■Lineup

| Part Number | SI-8001FFE           |
|-------------|----------------------|
| $V_o$ (V)   | Variable (0.8 to 24) |
| $I_o$ (A)   | 3.5                  |
| Function    | Soft start           |

## ■Absolute Maximum Ratings

| Parameter                                     | Symbol         | Ratings     | Unit               | Conditions                                                            |
|-----------------------------------------------|----------------|-------------|--------------------|-----------------------------------------------------------------------|
|                                               |                | SI-8001FFE  |                    |                                                                       |
| Input Voltage                                 | $V_{in}$       | 43          | V                  |                                                                       |
| Power Dissipation<br>(With infinite heatsink) | $P_{D1-1}$     | 22.7        | W                  | Limited by thermal protection circuit, $T_j = 150^\circ\text{C}$      |
|                                               | $P_{D1-2}$     | 18.2        |                    | $T_j = 125^\circ\text{C}$                                             |
| Power Dissipation<br>(Without heatsink)       | $P_{D2-1}$     | 2.15        | W                  | Limited by thermal protection circuit, $T_{jmax} = 150^\circ\text{C}$ |
|                                               | $P_{D2-2}$     | 1.72        |                    | $T_j = 125^\circ\text{C}$                                             |
| Junction Temperature <sup>*1</sup>            | $T_j$          | +150        | $^\circ\text{C}$   |                                                                       |
| Storage Temperature                           | $T_{stg}$      | -40 to +150 | $^\circ\text{C}$   |                                                                       |
| Thermal Resistance (Junction to Case)         | $\theta_{j-c}$ | 5.5         | $^\circ\text{C/W}$ |                                                                       |
| Thermal Resistance (Junction to Ambient Air)  | $\theta_{j-a}$ | 58          | $^\circ\text{C/W}$ |                                                                       |

\*: This product has built-in thermal protection circuits that may activate when the junction temperature exceeds  $130^\circ\text{C}$ . The recommended design for the junction temperature during IC operation is below  $125^\circ\text{C}$ .

## ■Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings              | Unit             |
|--------------------------------------|-----------|----------------------|------------------|
|                                      |           | SI-8001FFE           |                  |
| Input Voltage Range                  | $V_{in}$  | $V_o + 3^{*1}$ to 40 | V                |
| Output Voltage Range                 | $V_o$     | 0.8 to 24            | V                |
| Output Current Range                 | $I_o$     | 0 to 3.5             | A                |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +125          | $^\circ\text{C}$ |
| Operating Temperature Range          | $T_{op}$  | -30 to +85           | $^\circ\text{C}$ |

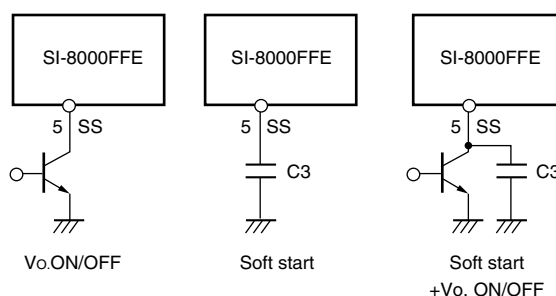
\*: The minimum value of the input voltage range is 4.5 V or  $V_o + 3\text{ V}$ , whichever is higher.

## ■Electrical Characteristics

( $R_1 = 4.2\text{ k}\Omega$ ,  $R_2 = 0.8\text{ k}\Omega$  when  $T_a = 25^\circ\text{C}$  and  $V_o = 5\text{ V}$ )

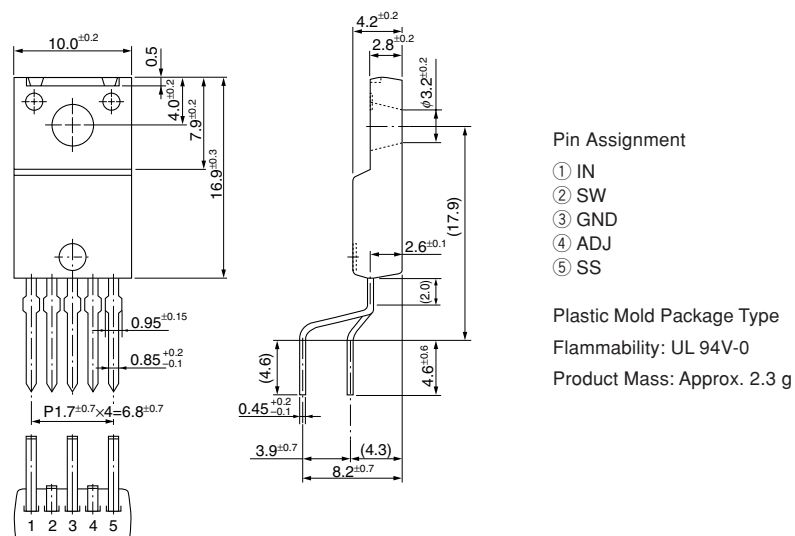
| Parameter                                    |                                | Symbol                | Ratings                                                                |            |                                          | Unit   |  |
|----------------------------------------------|--------------------------------|-----------------------|------------------------------------------------------------------------|------------|------------------------------------------|--------|--|
|                                              |                                |                       | SI-8001FFE                                                             |            |                                          |        |  |
|                                              |                                |                       | min.                                                                   | typ.       | max.                                     |        |  |
| Reference Voltage                            |                                | V <sub>ADJ</sub>      | 0.784                                                                  | 0.800      | 0.816                                    | V      |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A                             |            |                                          |        |  |
| Temperature Coefficient of Reference Voltage |                                | ΔV <sub>ADJ</sub> /ΔT |                                                                        | ±0.1       |                                          | mV/ °C |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2A, T <sub>c</sub> =0 to 100°C |            |                                          |        |  |
| Efficiency                                   |                                | η                     |                                                                        | 83         |                                          | %      |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |            |                                          |        |  |
| Oscillation Frequency                        |                                | f <sub>o</sub>        | 270                                                                    | 300        | 330                                      | kHz    |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =2A                               |            |                                          |        |  |
| Line Regulation                              |                                | ΔV <sub>OLINE</sub>   |                                                                        | 55         | 80                                       | mV     |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =10 to 30V, I <sub>o</sub> =2A                         |            |                                          |        |  |
| Load Regulation                              |                                | ΔV <sub>OLOAD</sub>   |                                                                        | 15         | 50                                       | mV     |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, I <sub>o</sub> =0.2 to 3.5A                      |            |                                          |        |  |
| Overcurrent Protection Starting Current      |                                | I <sub>S</sub>        | 3.6                                                                    |            |                                          | A      |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V                                                   |            |                                          |        |  |
| SS Pin                                       | Low Level Voltage              | V <sub>SSL</sub>      |                                                                        |            | 0.5                                      | V      |  |
|                                              | Outflow Current at Low Voltage | I <sub>SSL</sub>      |                                                                        | 6          | 30                                       | μA     |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V                              |            |                                          |        |  |
| Quiescent Circuit Current                    |                                | I <sub>q</sub>        |                                                                        | 6          |                                          | mA     |  |
|                                              |                                |                       |                                                                        | Conditions | V <sub>IN</sub> =15V, I <sub>o</sub> =0A |        |  |
|                                              |                                | I <sub>q</sub> (OFF)  |                                                                        | 200        | 600                                      | μA     |  |
|                                              |                                | Conditions            | V <sub>IN</sub> =15V, V <sub>SS</sub> =0V                              |            |                                          |        |  |

\*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up ( $3.7\text{ V typ.}$ ) to the power supply in the IC, so applying the external voltage is prohibited. If this pin is not used, leave it open.

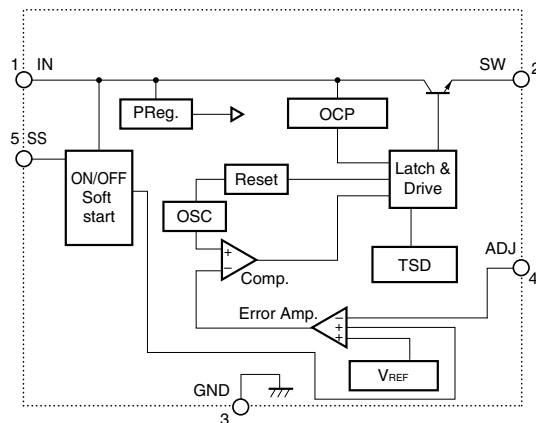


### ■External Dimensions (TO220F-5)

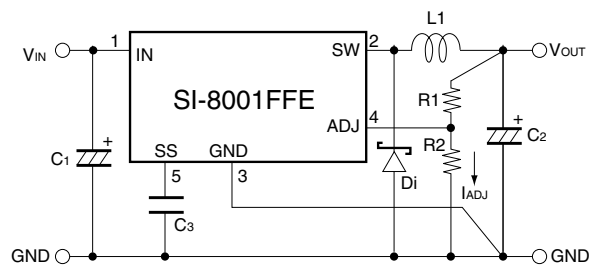
(Unit : mm)



### ■Block Diagram



### ■ Typical Connection Diagram



C1 :470μF  
C2 :680μF  
C3 :0.1μF(Only when using soft-start function)  
L1 :47μH  
D1 :RK46(Sanken)

# NR111D Current Mode Control Step-down Switching Mode

## Features

- 8pin DIP package
- Input voltage range ( $V_{IN}$ ):  $V_O + 3$  to 31 V
- Oscillation frequency: 350 kHz
- High efficiency under light load
- High efficiency: 94% or higher
- Current mode control
- Stable with low-ESR ceramic output capacitors
- Built-in phase compensation component
- Output current: 4 A
- Reference voltage and accuracy of  $0.8 \text{ V} \pm 2\%$
- Adjustable overcurrent threshold
- Output ON/OFF available
- Undervoltage lockout
- Soft start function

## Applications

- Power supply for LCDTV, STB and Blu-Ray
- Power supplies for domestic appliances
- On-board local power supply
- Switching power supplies

## Absolute Maximum Ratings

| Parameter                                      | Symbol         | Ratings     | Unit | Conditions                                                                             |
|------------------------------------------------|----------------|-------------|------|----------------------------------------------------------------------------------------|
|                                                |                | NR111D      |      |                                                                                        |
| Input Voltage                                  | $V_{IN}$       | 35          | V    |                                                                                        |
| BS Pin Voltage                                 | $V_{BS}$       | 44          | V    |                                                                                        |
| Pin Voltage between BS and SW                  | $V_{BS-SW}$    | 8           | V    |                                                                                        |
| SW Pin Voltage                                 | $V_{SW}$       | 35          | V    |                                                                                        |
| FB Pin Voltage                                 | $V_{FB}$       | 5.5         | V    |                                                                                        |
| EN Pin Voltage                                 | $V_{EN}$       | 35          | V    |                                                                                        |
| SS Pin Voltage                                 | $V_{SS}$       | 5.5         | V    |                                                                                        |
| Power Dissipation                              | $P_D$          | 1.47        | W    | When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |
| Junction Temperature                           | $T_J$          | −30 to +150 | °C   |                                                                                        |
| Storage Temperature                            | $T_{stg}$      | −40 to +150 | °C   |                                                                                        |
| Thermal Resistance (Junction to Lead (4 pins)) | $\theta_{J-C}$ | 41          | °C/W |                                                                                        |
| Thermal Resistance (Junction to Ambient Air)   | $\theta_{J-A}$ | 85          | °C/W | When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm <sup>2</sup> copper area) |

## Recommended Operating Conditions

| Parameter                   | Symbol    | Ratings                  | Unit |
|-----------------------------|-----------|--------------------------|------|
|                             |           | NR111D                   |      |
| Input Voltage Range         | $V_{IN}$  | 6.5 or $V_O + 3^*$ to 31 | V    |
| Output Current Range        | $I_{OUT}$ | 0 to 4.0**               | A    |
| Output Voltage Range        | $V_O$     | 0.8 to 24                | V    |
| Operating Temperature Range | $T_{op}$  | −40 to 85**              | °C   |

\*: The minimum value of the input voltage range is indicated value or  $V_O + 3 \text{ V}$ , whichever is higher.

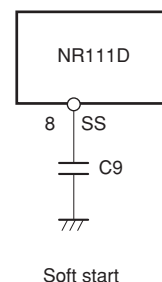
\*\*: The device must be used within the range indicated by the  $T_a$ -PD characteristics.

## Electrical Characteristics

( $T_a = 25^\circ\text{C}$ ,  $V_{IN} = 12\text{V}$ ,  $V_O = 5.0\text{V}$ , and  $I_O = 1\text{A}$ , unless otherwise specified)

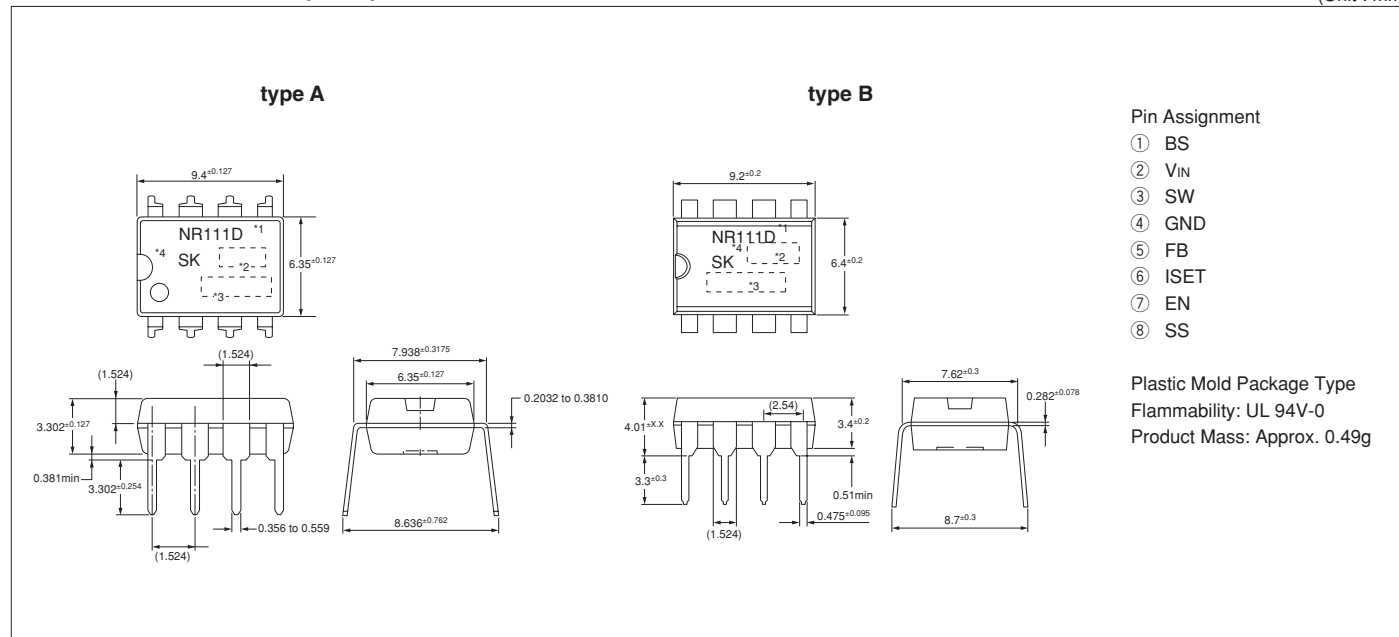
| Parameter                                 |                                | Symbol                | Ratings |       |       | Unit  | Conditions                                                                           |
|-------------------------------------------|--------------------------------|-----------------------|---------|-------|-------|-------|--------------------------------------------------------------------------------------|
|                                           |                                |                       | NR111D  |       |       |       |                                                                                      |
|                                           |                                |                       | min.    | typ.  | max.  |       |                                                                                      |
| Reference Voltage                         |                                | V <sub>REF</sub>      | 0.784   | 0.800 | 0.816 | V     |                                                                                      |
| Temperature Coefficient of Output Voltage |                                | ΔV <sub>REF</sub> /ΔT |         | ±0.05 |       | mV/°C | Ta=−40°C to +85°C                                                                    |
| Oscillation Frequency                     |                                | f <sub>sw</sub>       |         | 350   |       | kHz   |                                                                                      |
| Line Regulation                           |                                | V <sub>LINE</sub>     |         | 50    |       | mV    | V <sub>IN</sub> =V <sub>INmin</sub> to 30V                                           |
| Load Regulation                           |                                | V <sub>Load</sub>     |         | 50    |       | mV    | V <sub>IN</sub> =12V, V <sub>O</sub> =5.0V, I <sub>O</sub> =0.1 to I <sub>Omax</sub> |
| Overcurrent Protection Starting Current   |                                | I <sub>s1</sub>       |         | 1.5   |       | A     | ISET=OPEN                                                                            |
|                                           |                                | I <sub>s2</sub>       |         | 5.5   |       | A     | ISET=SHORT                                                                           |
| No-load Circuit Current                   |                                | I <sub>IN</sub>       |         | 1     |       | mA    | V <sub>EN</sub> =10kΩ pull up to V <sub>IN</sub>                                     |
| Quiescent Circuit Current                 |                                | I <sub>IN(off)</sub>  |         | 1     |       | μA    | I <sub>O</sub> =0A, V <sub>EN</sub> =0V                                              |
| SS Pin                                    | Outflow Current at Low Voltage | I <sub>EN/SS</sub>    | 6       | 10    | 14    | μA    | V <sub>SS</sub> =0V                                                                  |
| EN Pin                                    | Inflow Current                 | I <sub>EN</sub>       |         | 20    | 50    | μA    | V <sub>EN</sub> =10V                                                                 |
|                                           | On Threshold Voltage           | V <sub>C/EH</sub>     | 0.7     | 1.4   | 2.1   | V     |                                                                                      |
| ISET Pin                                  | Open Voltage                   | V <sub>ISET</sub>     |         | 1.5   |       | V     |                                                                                      |
| Maximum ON Duty                           |                                | D <sub>MAX</sub>      |         | 90    |       | %     |                                                                                      |
| Minimum ON Time                           |                                | T <sub>ON(MIN)</sub>  |         | 150   |       | nsec  |                                                                                      |
| Thermal Protection Start Temperature      |                                | T <sub>SD</sub>       | 151     | 165   |       | °C    |                                                                                      |
| Thermal Protection Return Hysteresis      |                                | T <sub>SD_hys</sub>   |         | 20    |       | °C    |                                                                                      |
| SW MOSFET ON Resistance                   |                                | R <sub>onH</sub>      |         | 105   |       | mΩ    |                                                                                      |

\*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.  
The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.

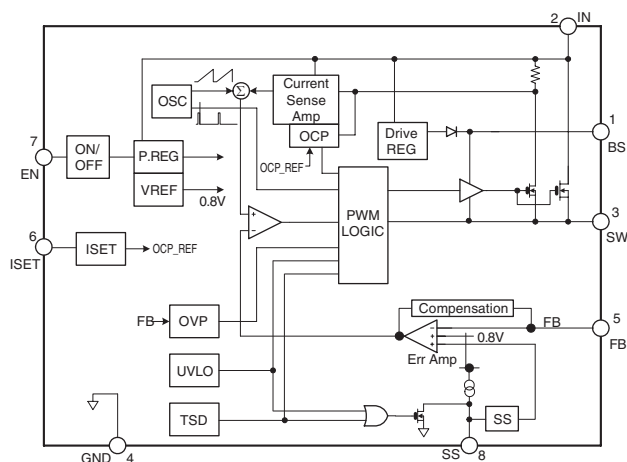


## External Dimensions (DIP8)

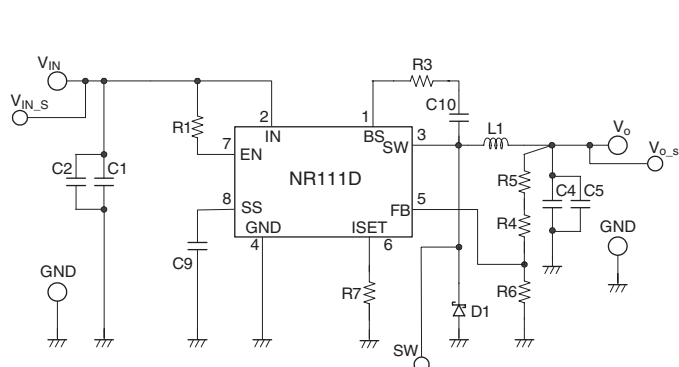
(Unit : mm)



## Block Diagram



## Typical Connection Diagram



- C1 : 10 $\mu$ F / 35V
- C2 : 10 $\mu$ F / 35V
- C4 : 22 $\mu$ F / 16V
- C5 : 22 $\mu$ F / 16V
- C9 : 0.1 $\mu$ F
- C10 : 0.1 $\mu$ F
- R1 : 1.7M $\Omega$
- R3 : 22 $\Omega$
- R4 : 20k $\Omega$
- R5 : 470 $\Omega$  ( $V_o=5.0V$ )
- R6 : 3.9k $\Omega$
- R7 : 0k $\Omega$  (When ISET SHORT)
- L1 : 10 $\mu$ H

# SI-8000HFE Series Full-Mold, Separate Excitation Step-down Switching Mode

## Features

- Compact full-mold package (equivalent to TO220)
- Output current: 5.5 A
- High efficiency: 83% typ. (at  $V_o = 5\text{ V}$ )
- Requires only 4 discrete components
- Built-in reference oscillator (150 kHz)
- Built-in drooping-type-overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)

## Applications

- Onboard local power supplies
- OA equipment

## Lineup

| Part Number | SI-8008HFE           | SI-8050HFE |
|-------------|----------------------|------------|
| $V_o$ (V)   | Variable (0.8 to 15) | 5          |
| $I_o$ (A)   | 5.5                  |            |

## Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings                                        | Unit               | Conditions                                                  |
|----------------------------------------------|----------------|------------------------------------------------|--------------------|-------------------------------------------------------------|
| DC Input Voltage                             | $V_{IN}$       | 43                                             | V                  |                                                             |
| Power Dissipation                            | $P_{D1-1}$     | 25 (with infinite heatsink)                    | W                  | Limited by thermal protection, $T_{jmax}=150^\circ\text{C}$ |
|                                              | $P_{D1-2}$     | 20 (with infinite heatsink)                    |                    | $T_{jmax}=125^\circ\text{C}$                                |
|                                              | $P_{D2-1}$     | 2.15 (without heat sink, standalone operation) |                    | Limited by thermal protection, $T_{jmax}=150^\circ\text{C}$ |
|                                              | $P_{D2-2}$     | 1.72 (without heatsink, standalone operation)  |                    | $T_{jmax}=125^\circ\text{C}$                                |
| Junction Temperature*                        | $T_j$          | +150                                           | $^\circ\text{C}$   |                                                             |
| Storage Temperature                          | $T_{stg}$      | -40 to +150                                    | $^\circ\text{C}$   |                                                             |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 5                                              | $^\circ\text{C/W}$ |                                                             |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 58                                             | $^\circ\text{C/W}$ |                                                             |

\*: This product has built-in thermal protection circuits that may operate when the junction temperature rises above  $130^\circ\text{C}$ . The recommended design for the junction temperature during operation is below  $125^\circ\text{C}$ .

## Recommended Operating Conditions

| Parameter                            | Symbol    | Ratings            |            | Unit             |
|--------------------------------------|-----------|--------------------|------------|------------------|
|                                      |           | SI-8008HFE         | SI-8050HFE |                  |
| Input Voltage Range                  | $V_{IN}$  | $V_o+3^{*1}$ to 40 | 8 to 40    | V                |
| Output Voltage Range                 | $V_o$     | 0.8 to 24          | 5.0        | V                |
| Output Current Range                 | $I_o$     | 0 to 5.5           |            | A                |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +125        |            | $^\circ\text{C}$ |
| Operating Temperature Range          | $T_{op}$  | -30 to +85         |            | $^\circ\text{C}$ |

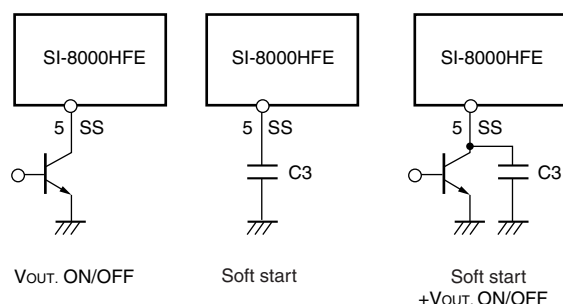
\*1: The minimum value of an input voltage range is the higher of 4.5 V or  $V_o + 3\text{ V}$ .

## Electrical Characteristics

( $T_a=25^\circ\text{C}$ )

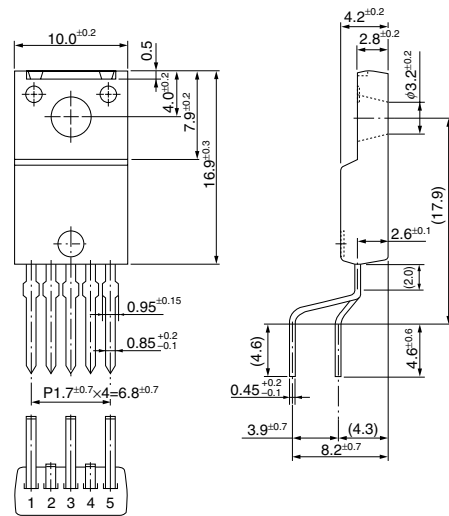
| Parameter                                    |                                | Symbol     | Ratings                       |       |       | Ratings                       |      |      | Unit  |
|----------------------------------------------|--------------------------------|------------|-------------------------------|-------|-------|-------------------------------|------|------|-------|
|                                              |                                |            | SI-8008HFE (at Vo = 5 V)      |       |       | SI-8050HFE                    |      |      |       |
|                                              |                                |            | min.                          | typ.  | max.  | min.                          | typ. | max. |       |
| Output Voltage                               |                                | Vo         |                               |       |       | 4.90                          | 5.00 | 5.10 | V     |
| Reference Voltage                            |                                | VADJ       | 0.784                         | 0.800 | 0.816 |                               |      |      |       |
|                                              |                                | Conditions | VIN=15V, Io=1A                |       |       | VIN=15V, Io=1A                |      |      |       |
| Temperature Coefficient of Output Voltage    |                                | ΔVo/ΔT     |                               |       |       |                               | ±0.5 |      | mV/°C |
| Temperature Coefficient of Reference Voltage |                                | ΔVADJ/ΔT   |                               | ±0.1  |       |                               |      |      |       |
|                                              |                                | Conditions | VIN=15V, Io=1A, Tc=0 to 100°C |       |       | VIN=15V, Io=1A, Tc=0 to 100°C |      |      |       |
| Efficiency                                   |                                | η          |                               | 83    |       |                               | 83   |      | %     |
|                                              |                                | Conditions | VIN=15V, Io=3A                |       |       | VIN=15V, Io=3A                |      |      |       |
| Oscillation Frequency                        |                                | fo         |                               | 150   |       |                               | 150  |      | kHz   |
|                                              |                                | Conditions | VIN=15V, Io=3A                |       |       | VIN=15V, Io=3A                |      |      |       |
| Line Regulation                              |                                | ΔVOLUME    |                               | 60    | 80    |                               | 60   | 80   | mV    |
|                                              |                                | Conditions | VIN=10 to 30V, Io=3A          |       |       | VIN=10 to 30V, Io=3A          |      |      |       |
| Load Regulation                              |                                | ΔVOLOAD    |                               | 20    | 50    |                               | 20   | 50   | mV    |
|                                              |                                | Conditions | VIN=15V, Io=0.2 to 5.5A       |       |       | VIN=15V, Io=0.2 to 5.5A       |      |      |       |
| Overcurrent Protection Starting Current      |                                | Is         | 5.6                           |       |       | 5.6                           |      |      | A     |
|                                              |                                | Conditions | VIN=15V                       |       |       | VIN=15V                       |      |      |       |
| ON/OFF Pin*                                  | Low Level Voltage              | VSSL       |                               |       | 0.5   |                               |      | 0.5  | V     |
|                                              | Outflow Current at Low Voltage | ISSL       |                               | 10    | 30    |                               | 10   | 30   | μA    |
|                                              |                                | Conditions | VSSL=0V                       |       |       | VSSL=0V                       |      |      |       |
| Quiescent Circuit Current                    |                                | Iq         |                               | 6     |       |                               | 6    |      | mA    |
|                                              |                                | Conditions | VIN=15V, Io=0A                |       |       | VIN=15V, Io=0A                |      |      |       |
|                                              |                                | Iq(OFF)    |                               | 200   | 400   |                               | 200  | 400  | μA    |
|                                              |                                | Conditions | VIN=15V, VSS=0V               |       |       | VIN=15V, VSS=0V               |      |      |       |

\*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to  $V_{SSL}$  or lower. SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C3 capacitance is large. The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited. If the pin is not used, leave it open.



## External Dimensions (TO220F-5)

(Unit : mm)

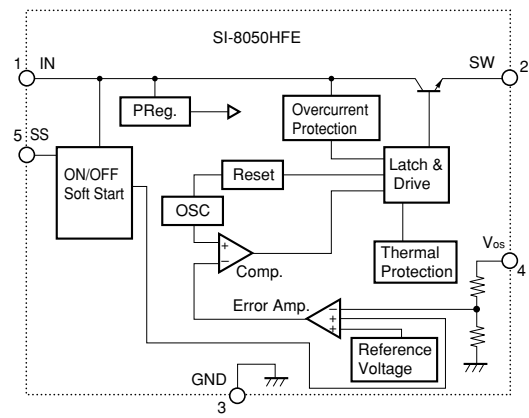
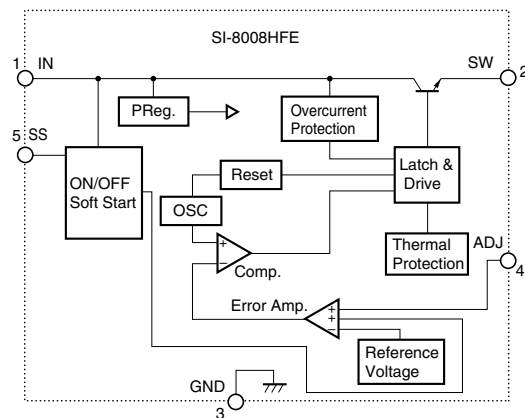


### Pin Assignment

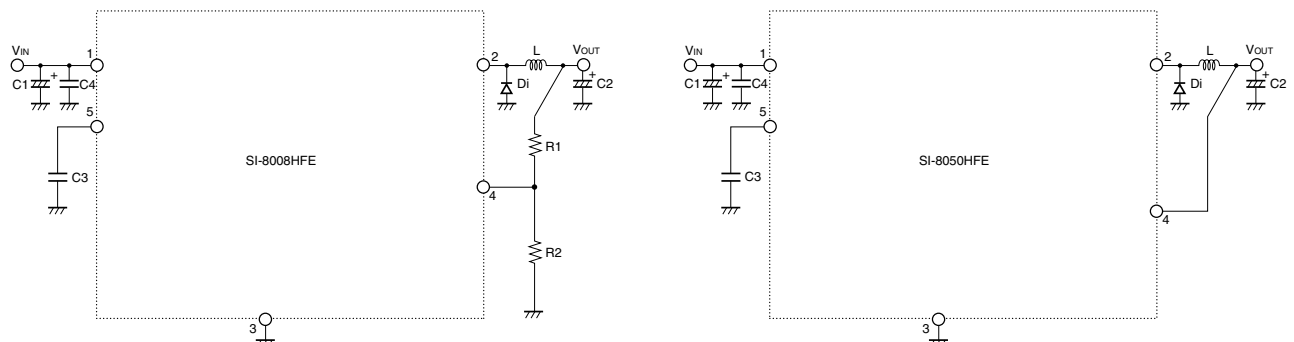
- ①  $V_{IN}$
- ② SW
- ③ GND
- ④ ADJ ( $V_{OS}$  for SI-8050HFE)
- ⑤ SS

Plastic Mold Package Type  
 Flammability: UL94V-0  
 Product Mass: Approx. 2.3g

## Block Diagram



## Typical Connection Diagram



- C1 : 1500 $\mu$ F
- C2 : 1000 $\mu$ F
- C3 : 1 $\mu$ F (Only when using soft-start function)
- C4 : 4.7 $\mu$ F (RPER11H475K5 (Murata Manufacturing) recommended)
- L1 : 100 $\mu$ H
- Di : FMB-G16L (Sanken)

# SI-8000Y Series Current Mode Control Step-down Switching Mode

## ■Features

- Compact (equivalent to TO220) full-mold package
- Output current: 8.0 A
- High efficiency: 86%
- Built-in reference oscillator (130 kHz)
- Built-in drooping-type-overcurrent protection and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)
- Low current consumption during off

## ■Absolute Maximum Ratings

| Parameter                                    | Symbol         | Ratings                                      | Unit |
|----------------------------------------------|----------------|----------------------------------------------|------|
| Input Voltage                                | $V_{IN}$       | 45                                           | V    |
| Power Dissipation                            | $P_{D1}$       | 20.8(With infinite heatsink)                 | W    |
|                                              | $P_{D2}$       | 1.8(Without heatsink, stand-alone operation) | W    |
| Junction Temperature                         | $T_j$          | -30 to +150                                  | °C   |
| Storage Temperature                          | $T_{stg}$      | -40 to +150                                  | °C   |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 6                                            | °C/W |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 66.7                                         | °C/W |

## ■Applications

- AV equipment
- OA equipment
- Gaming equipment
- Onboard local power supplies

## ■Recommended Operating Conditions

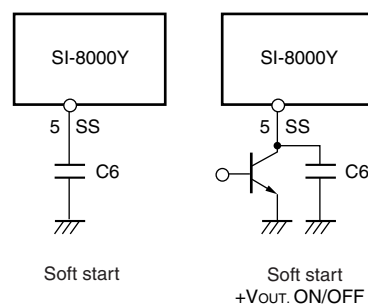
| Parameter                            | Symbol    | Raings               |          | Unit |
|--------------------------------------|-----------|----------------------|----------|------|
|                                      |           | SI-8010Y             | SI-8050Y |      |
| Input Voltage Range                  | $V_{IN}$  | 8 or $V_o+3^*$ to 43 | 8 to 43  | V    |
| Output Voltage Range                 | $V_o$     | 1 to 15              | 5        | V    |
| Output Current Range                 | $I_o$     | 0 to 8.0             |          | A    |
| Operating Junction Temperature Range | $T_{jop}$ | -30 to +135          |          | °C   |
| Operating Temperature Range          | $T_{op}$  | -30 to +85           |          | °C   |

\*: The minimum value of the input voltage range is 8 V or  $V_o + 3V$ , whichever is higher.

## ■Electrical Characteristics

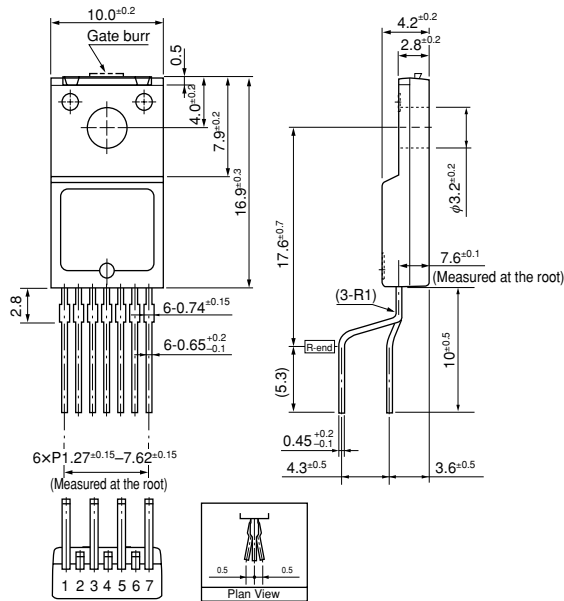
| Parameter                                                                                             |                                | Symbol                             | Ratings                                                                |      |                      |                                                                        |      |      | Unit  |
|-------------------------------------------------------------------------------------------------------|--------------------------------|------------------------------------|------------------------------------------------------------------------|------|----------------------|------------------------------------------------------------------------|------|------|-------|
|                                                                                                       |                                |                                    | SI-8010Y*                                                              |      |                      | SI-8050Y                                                               |      |      |       |
|                                                                                                       |                                |                                    | min.                                                                   | typ. | max.                 | min.                                                                   | typ. | max. |       |
| Output Voltage<br>(Reference voltage for SI-8010Y)                                                    |                                | V <sub>O</sub> (V <sub>REF</sub> ) | 0.98                                                                   | 1.00 | 1.02                 | 4.90                                                                   | 5.00 | 5.10 | V     |
| Temperature Coefficient of Output Voltage<br>(Reference voltage temperature coefficient for SI-8010Y) |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1A                             |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1A                             |      |      | mV/°C |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1A, T <sub>a</sub> =0 to 100°C |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1A, T <sub>a</sub> =0 to 100°C |      |      |       |
| Efficiency                                                                                            |                                | η                                  |                                                                        | 86   |                      |                                                                        | 86   |      | %     |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =3A                               |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =3A                               |      |      |       |
| Oscillation Frequency                                                                                 |                                | f <sub>o</sub>                     |                                                                        | 130  |                      |                                                                        | 130  |      | kHz   |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =3A                               |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =3A                               |      |      |       |
| Line Regulation                                                                                       |                                | ΔV <sub>OLINE</sub>                |                                                                        | 30   | 90                   |                                                                        | 30   | 90   | mV    |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =10 to 43V, I <sub>o</sub> =3A                         |      |                      | V <sub>IN</sub> =10 to 43V, I <sub>o</sub> =3A                         |      |      |       |
| Load Regulation                                                                                       |                                | ΔV <sub>OLOAD</sub>                |                                                                        | 30   | 90                   |                                                                        | 30   | 90   | mV    |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1 to 8A                        |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =0.1 to 8A                        |      |      |       |
| Overcurrent Protection Starting Current                                                               |                                | I <sub>s</sub>                     | 8.1                                                                    |      |                      | 8.1                                                                    |      |      | A     |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =20V                                                   |      |                      | V <sub>IN</sub> =20V                                                   |      |      |       |
| Quiescent Circuit Current                                                                             |                                | I <sub>q</sub>                     |                                                                        | 8    |                      |                                                                        | 8    |      | mA    |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, I <sub>o</sub> =0A, EN/SS=open                   |      |                      | V <sub>IN</sub> =30V, I <sub>o</sub> =0A, EN/SS=open                   |      |      |       |
|                                                                                                       |                                | I <sub>q</sub> (OFF)               |                                                                        | 200  | 500                  |                                                                        | 200  | 500  | μA    |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, EN/SS=0V                                         |      |                      | V <sub>IN</sub> =30V, EN/SS=0V                                         |      |      |       |
| EN/SS Pin*                                                                                            | Outflow Current at Low Voltage | I <sub>SSL</sub>                   |                                                                        | 10   | 30                   |                                                                        | 10   | 30   | μA    |
|                                                                                                       |                                | Conditions                         | V <sub>IN</sub> =30V, EN/SS=0V                                         |      |                      | V <sub>IN</sub> =30V, EN/SS=0V                                         |      |      |       |
|                                                                                                       | Low Level Voltage              | V <sub>SSL</sub>                   |                                                                        |      | 0.5                  |                                                                        |      | 0.5  | V     |
| Conditions                                                                                            |                                | V <sub>IN</sub> =30V               |                                                                        |      | V <sub>IN</sub> =30V |                                                                        |      |      |       |
| Error Amplifier Voltage Gain                                                                          |                                | AEA                                |                                                                        | 300  |                      |                                                                        | 300  |      | V/V   |
| Error Amplifier Transformer Conductance                                                               |                                | GEA                                |                                                                        | 800  |                      |                                                                        | 800  |      | μA/V  |
| Current Sense Amplifier Impedance                                                                     |                                | 1/GCS                              |                                                                        | 0.16 |                      |                                                                        | 0.16 |      | V/A   |
| Maximum ON Duty                                                                                       |                                | DMAX                               |                                                                        | 92   |                      |                                                                        | 92   |      | %     |
| Minimum ON Time                                                                                       |                                | DMIN                               |                                                                        | 200  |                      |                                                                        | 200  |      | nsec  |

\*:  $R_1=8k\Omega$ ,  $R_2=2k\Omega$  when  $T_a=25^\circ C$  and  $V_o=5V$



### ■External Dimensions (TO220F-7)

(Unit : mm)

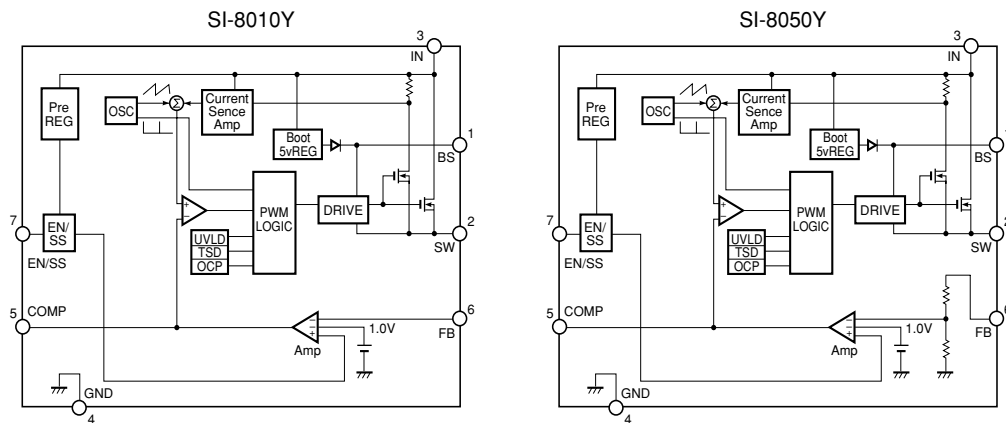


## Pin Assignment

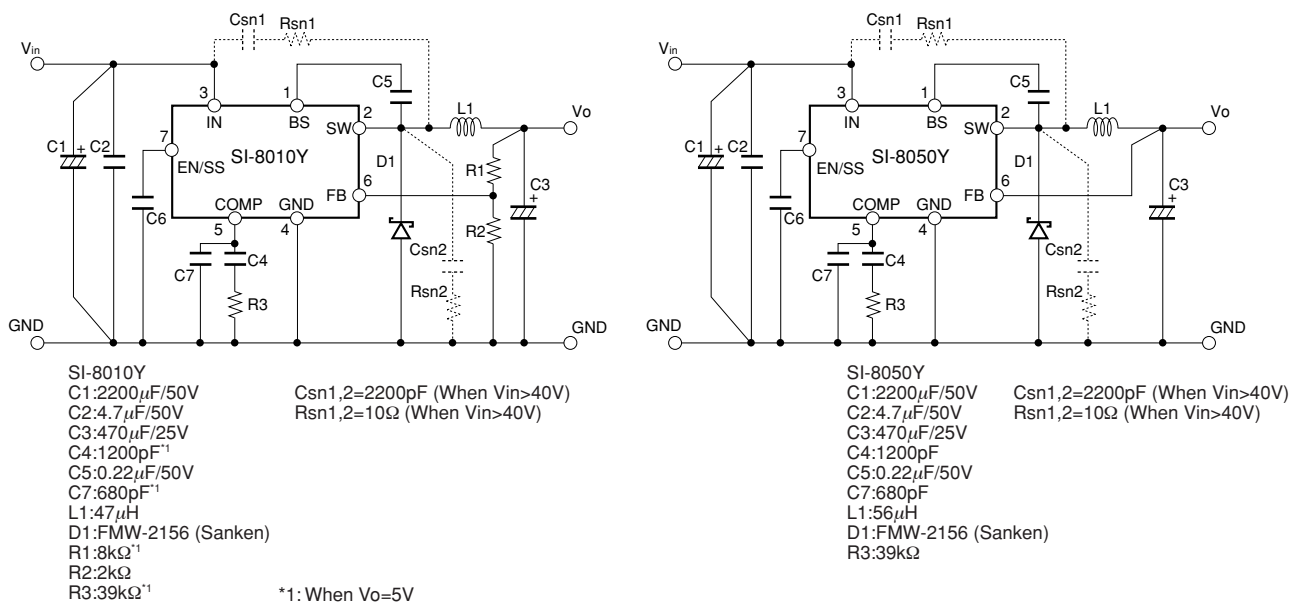
- ① BS  
② SW  
③ VIN  
④ GND  
⑤ COMP  
⑥ FB  
⑦ EN/SS

Plastic Mold Package Type  
Flammability: UL94V-0  
Product Mass: Approx. 2.3g

### ■Block Diagram



### ■ Typical Connection Diagram



SI-8400L/8500L Series Separate Excitation Step-down Switching Mode with Coil

Features

- Switching ICs/Coil combined type
- Requires only 2 discrete components
- Low switching noise
- No heatsink required
- Built-in overcurrent and thermal protection circuits
- Built-in soft start circuit (Output ON/OFF available)...SI-8500L Series

Applications

- Telephone power supplies
- Onboard local power supplies

Lineup

| Part Number | SI-8401L | SI-8501L |
|-------------|----------|----------|
| Vo(V)       | 5.0      | 5.0      |
| Io(A)       | 0.5      | 1.0      |

Absolute Maximum Ratings

| Parameter            | Symbol | Ratings    |          | Unit |
|----------------------|--------|------------|----------|------|
|                      |        | SI-8400L   | SI-8500L |      |
| DC Input Voltage     | VIN    | 35         |          | V    |
| Power Dissipation    | Pd     | 1.25       | 3        | W    |
| Junction Temperature | Tj     | +100       |          | °C   |
| Storage Temperature  | Tstg   | -25 to +85 |          | °C   |

Recommended Operating Conditions

| Parameter                   | Symbol          | Ratings    | Unit |
|-----------------------------|-----------------|------------|------|
|                             |                 | SI-8401L   |      |
| DC Input Voltage Range      | V <sub>IN</sub> | 7 to 33    | V    |
| Output Current Range        | I <sub>o</sub>  | 0 to 0.5   | A    |
| Operating Temperature Range | T <sub>op</sub> | −20 to +85 | °C   |

| Parameter                   | Symbol          | Ratings    | Unit |
|-----------------------------|-----------------|------------|------|
|                             |                 | SI-8501L   |      |
| DC Input Voltage Range      | V <sub>IN</sub> | 7 to 33    | V    |
| Output Current Range        | I <sub>o</sub>  | 0 to 1.0   | A    |
| Operating Temperature Range | T <sub>op</sub> | −20 to +85 | °C   |

Electrical Characteristics

(Ta=25°C)

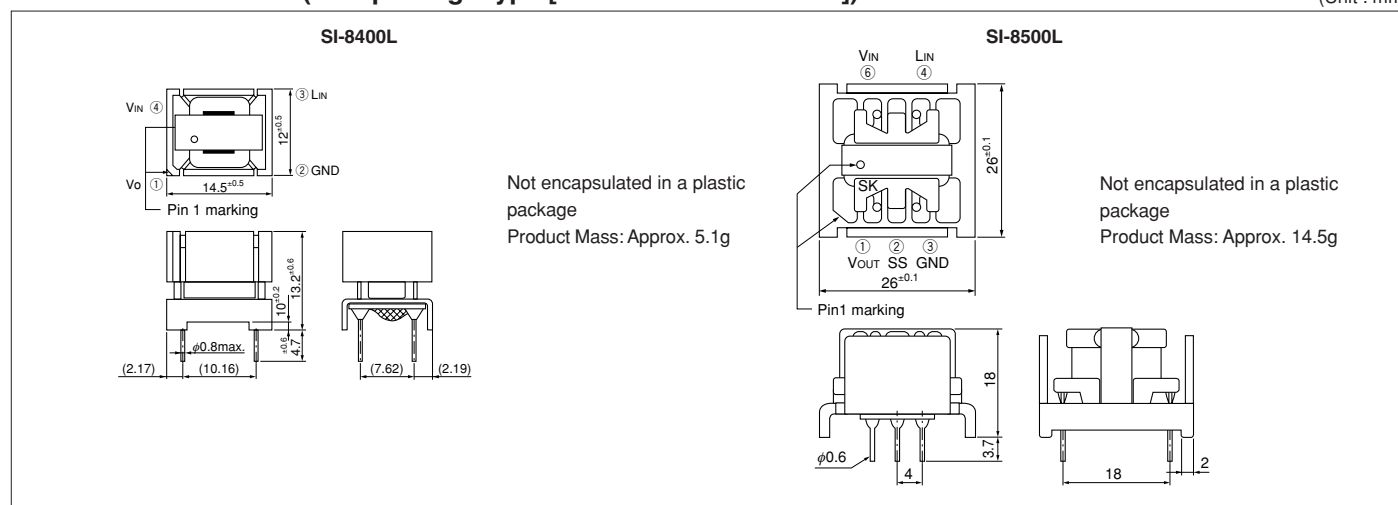
| Parameter                                        | Symbol                           | Ratings                                           |      |      | Unit              |
|--------------------------------------------------|----------------------------------|---------------------------------------------------|------|------|-------------------|
|                                                  |                                  | SI-8401L                                          |      |      |                   |
|                                                  |                                  | min.                                              | typ. | max. |                   |
| Output Voltage                                   | V <sub>O</sub>                   | 4.80                                              | 5.00 | 5.20 | V                 |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |                   |
| Efficiency                                       | η                                |                                                   | 80   |      | %                 |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |                   |
| Oscillation Frequency                            | f                                |                                                   | 60   |      | kHz               |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |                   |
| Line Regulation                                  | ΔV <sub>LINE</sub>               |                                                   | 80   | 100  | mV                |
|                                                  | Conditions                       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.3A  |      |      |                   |
| Load Regulation                                  | ΔV <sub>LOAD</sub>               |                                                   | 30   | 40   | mV                |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.1 to 0.4A |      |      |                   |
| Temperature Coefficient of Output Voltage        | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      | mV/°C             |
| Switching Ripple Voltage (C <sub>2</sub> =470μF) | ΔV <sub>r</sub>                  |                                                   | 20   | 40   | mV <sub>p-p</sub> |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.3A        |      |      |                   |
| Overcurrent Protection Starting Current          | I <sub>S1</sub>                  | 0.55                                              |      |      | A                 |
|                                                  | Conditions                       | V <sub>IN</sub> =10V                              |      |      |                   |

(Ta=25°C)

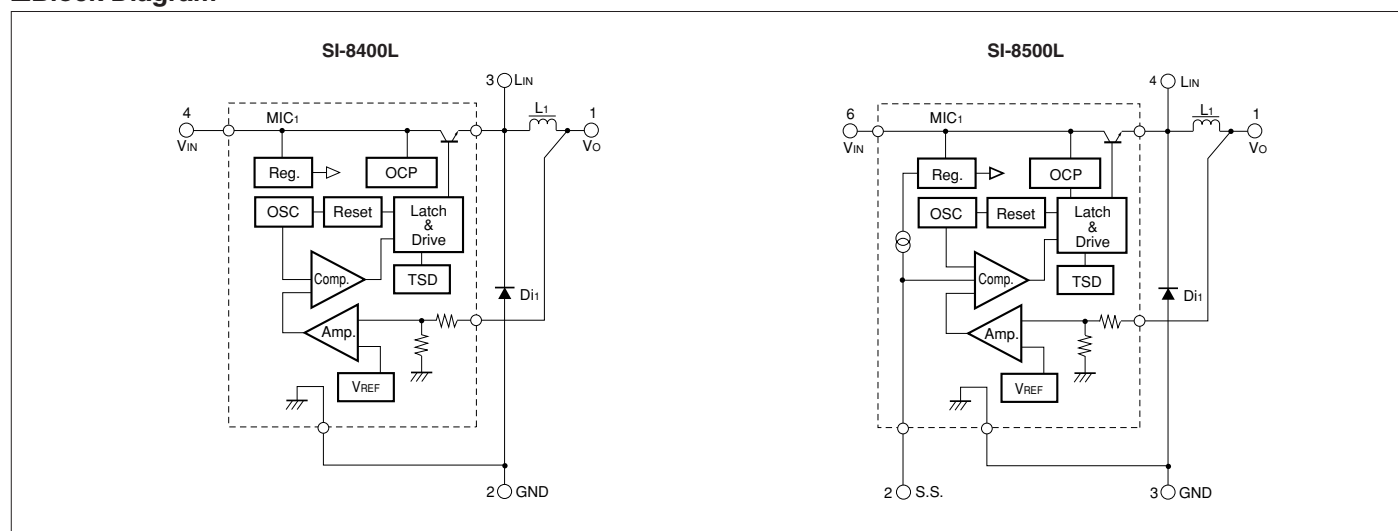
| Parameter                                        | Symbol                           | Ratings                                           |      |      | Unit              |
|--------------------------------------------------|----------------------------------|---------------------------------------------------|------|------|-------------------|
|                                                  |                                  | SI-8501L                                          |      |      |                   |
|                                                  |                                  | min.                                              | typ. | max. |                   |
| Output Voltage                                   | V <sub>O</sub>                   | 4.80                                              | 5.00 | 5.20 | V                 |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |      |      |                   |
| Efficiency                                       | η                                |                                                   | 83   |      | %                 |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |      |      |                   |
| Oscillation Frequency                            | f                                |                                                   | 60   |      | kHz               |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |      |      |                   |
| Line Regulation                                  | ΔV <sub>LINE</sub>               |                                                   | 70   | 130  | mV                |
|                                                  | Conditions                       | V <sub>IN</sub> =10 to 30V, I <sub>O</sub> =0.5A  |      |      |                   |
| Load Regulation                                  | ΔV <sub>LOAD</sub>               |                                                   | 30   | 55   | mV                |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.2 to 0.8A |      |      |                   |
| Temperature Coefficient of Output Voltage        | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                   | ±0.5 |      | mV/°C             |
| Switching Ripple Voltage (C <sub>2</sub> =470μF) | ΔV <sub>r</sub>                  |                                                   | 45   |      | mV <sub>p-p</sub> |
|                                                  | Conditions                       | V <sub>IN</sub> =20V, I <sub>O</sub> =0.5A        |      |      |                   |
| Overcurrent Protection Starting Current          | I <sub>S1</sub>                  | 1.1                                               |      |      | A                 |
|                                                  | Conditions                       | V <sub>IN</sub> =18V                              |      |      |                   |

## External Dimensions (Non-package type [EI-12.5 core/EI-19 core])

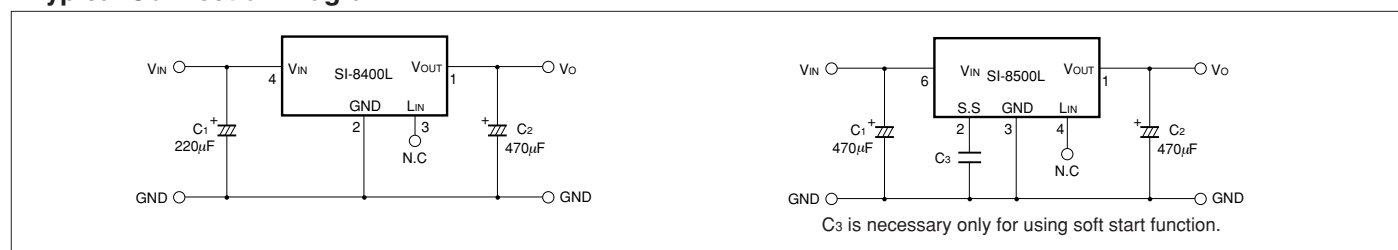
(Unit : mm)



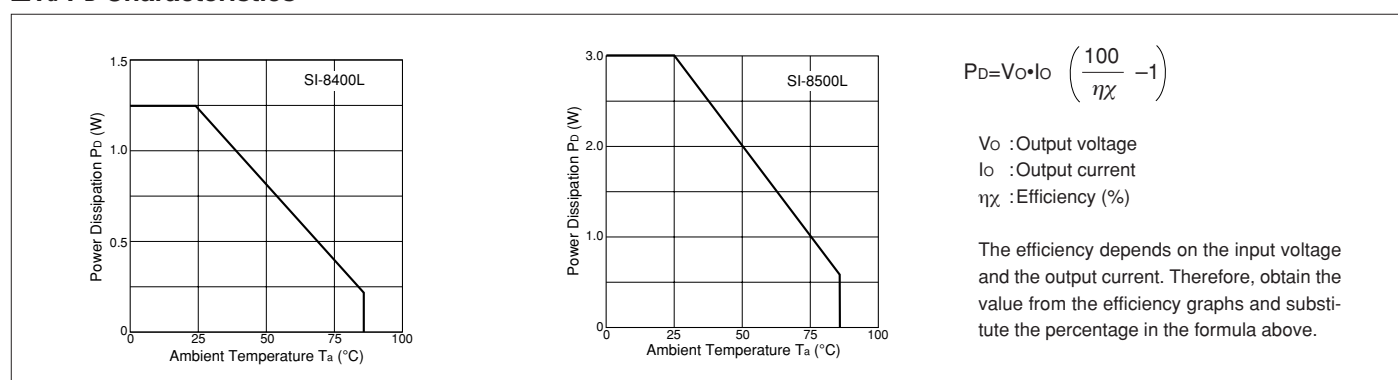
## Block Diagram



## Typical Connection Diagram



## T<sub>a</sub>-P<sub>D</sub> Characteristics



STA801M

2-Output Separate Excitation Step-down Switching Mode

Features

- 2 regulators combined in 1 package
- Compact inline package
- Output current (0.5A × 2 outputs)
- Output voltage of Ch2 selectable from 4 levels
- Built-in flywheel diode (Schottky barrier diode)
- Requires only 7 discrete components (2 outputs)
- Internally-adjusted phase compensations and output voltages
- Built-in reference oscillator (125kHz) - Enables to downsize a choke-coil due to IC's high oscillating frequency. (Compared with conventional Sanken devices)
- Built-in overcurrent and thermal protection circuits
- Built-in soft start circuits (Output ON/OFF available)

Lineup

| Part Number | Output Voltage (V) |                          |
|-------------|--------------------|--------------------------|
|             | Ch1                | Ch2(Select one output)   |
| STA801M     | 5                  | 9.0 / 11.5 / 12.1 / 15.5 |

Absolute Maximum Ratings

| Parameter            | Symbol           | Ratings                                      | Unit |
|----------------------|------------------|----------------------------------------------|------|
| DC Input Voltage     | V <sub>IN</sub>  | 43                                           | V    |
| Power Dissipation    | P <sub>D1</sub>  | 6.7(With infinite heatsink)                  | W    |
|                      | P <sub>D2</sub>  | 1.6(Without heatsink, stand-alone operation) | W    |
| Junction Temperature | T <sub>j</sub>   | +125                                         | °C   |
| Storage Temperature  | T <sub>stg</sub> | −40 to +125                                  | °C   |

Applications

- For BS and CS antenna power supplies
- For stabilization of the secondary stage of switching power supplies
- Electronic equipment

Recommended Operating Conditions

| Parameter                        | Symbol           | Ratings                  |      | Unit |
|----------------------------------|------------------|--------------------------|------|------|
|                                  |                  | min.                     | max. |      |
| DC Input Voltage Range           | V <sub>IN</sub>  | Ch2 V <sub>Omax</sub> +2 | 40   | V    |
| Output Current Range per Channel | I <sub>O</sub>   | 0                        | 0.5  | A    |
| Operating Temperature Range      | T <sub>top</sub> | −20                      | +125 | °C   |

Electrical Characteristics

(T<sub>a</sub>=25°C)

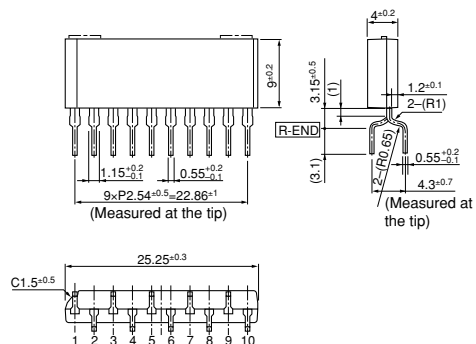
|                            | Parameter                                 | Symbol                                    | Ratings                 |                        |       | Unit  |       |
|----------------------------|-------------------------------------------|-------------------------------------------|-------------------------|------------------------|-------|-------|-------|
|                            |                                           |                                           | STA801M                 |                        |       |       |       |
|                            |                                           |                                           | min.                    | typ.                   | max.  |       |       |
| Ch1                        | Output voltage 1                          | Vo1                                       | 4.80                    | 5.00                   | 5.20  | V     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Efficiency *                              | η1                                        |                         | 80                     |       | %     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Temperature Coefficient of Output Voltage | ΔVo/ΔTa1                                  |                         | ±0.5                   |       | mV/°C |       |
|                            | Line Regulation                           | ΔVOLUME1                                  |                         | 30                     | 90    | mV    |       |
|                            |                                           | Conditions                                | VIN=10 to 30V, IO=0.3A  |                        |       |       |       |
|                            | Load Regulation                           | ΔVOLOAD1                                  |                         | 10                     | 40    | mV    |       |
| Conditions                 |                                           | VIN=20V, IO=0.1 to 0.4A                   |                         |                        |       |       |       |
| Ch2<br>(Select one output) | Output voltage 2-1                        | Vo2-1                                     | 8.64                    | 9.00                   | 9.36  | V     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Output voltage 2-2                        | Vo2-2                                     | 11.04                   | 11.50                  | 11.96 | V     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Output voltage 2-3                        | Vo2-3                                     | 11.62                   | 12.10                  | 12.58 | V     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Output voltage 2-4                        | Vo2-4                                     | 14.88                   | 15.50                  | 16.12 | V     |       |
|                            |                                           | Conditions                                | VIN=20V, IO=0.3A        |                        |       |       |       |
|                            | Vo2-4                                     | Efficiency*                               | η                       |                        | 89    |       | %     |
|                            |                                           |                                           | Conditions              | VIN=20V, IO=0.3A       |       |       |       |
|                            |                                           | Temperature Coefficient of Output Voltage | ΔVo/ΔTa                 |                        | ±2.0  |       | mV/°C |
|                            |                                           | Line Regulation                           | ΔVOLUME                 |                        | 40    | 130   | mV    |
|                            |                                           |                                           | Conditions              | VIN=20 to 30V, IO=0.3A |       |       |       |
|                            |                                           | Load Regulation                           | ΔVOLOAD                 |                        | 30    | 120   | mV    |
| Conditions                 |                                           |                                           | VIN=20V, IO=0.1 to 0.4A |                        |       |       |       |
| Common                     |                                           | No-load Circuit Current                   | Icc                     |                        | 15    |       | mA    |
|                            | Oscillation Frequency                     | f                                         |                         | 125                    |       | kHz   |       |
|                            | Overcurrent Protection Starting Current   | Is1                                       | 0.51                    | 0.7                    |       | A     |       |

\* Efficiency indicates the value when only one channel is active. The value can be calculated as shown below. 7.5mA is deducted for the no-load circuit current of  $\frac{I_{CC}}{2}$  at unused output.

$$\eta = \frac{V_O \cdot I_O}{V_{IN} \cdot (I_{IN} - 0.0075)} \times 100(\%)$$

## External Dimensions (SIP10 [STA 10Pin])

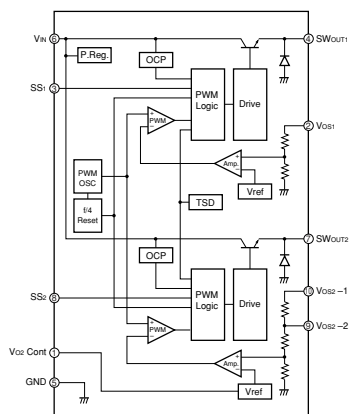
(Unit : mm)



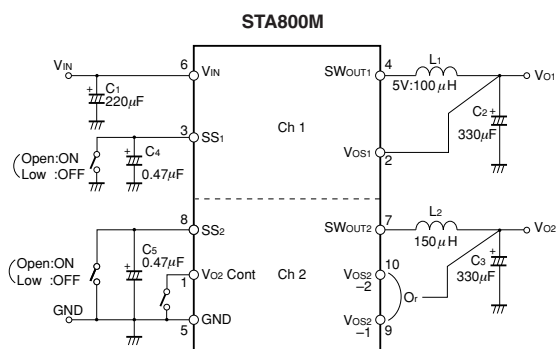
### Pin Assignment

|            |                            |
|------------|----------------------------|
| ① Vo2 Cont | ⑧ SS2                      |
| ② Vos1     | ⑨ Vos2-2                   |
| ③ SS1      | ⑩ Vos2-1                   |
| ④ SWOUT1   |                            |
| ⑤ GND      | Plastic Mold Package Type  |
| ⑥ VIN      | Flammability: UL94V-0      |
| ⑦ SWOUT2   | Product Mass: Approx. 2.5g |

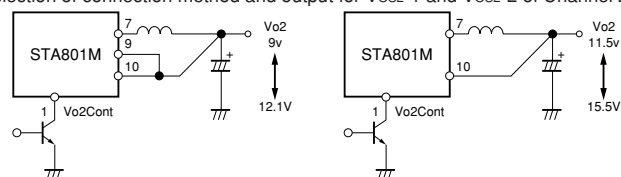
## Block Diagram



## Typical Connection Diagram

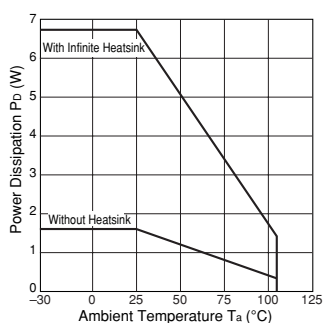


### Selection of connection method and output for Vos2-1 and Vos2-2 of Channel 2



|                 | Vo2Cont Pin |       |
|-----------------|-------------|-------|
|                 | Open        | Low   |
| Vo2 Sensing Pin |             |       |
| Pin 9           | 9V          | 12.1V |
| Pin 10          | 11.5V       | 15.5V |

## Ta-Pd Characteristics



## SPI-8001TW/SPI-8002TW/SPI-8003TW 2-Output, Step-down Switching Mode

### ■Features

- 2 regulators combined in one package
- Output current: 1.5A × 2 (HSOP 16 Pin Surface mount package)
- High efficiency: TYP80% (SPI-8001TW), TYP78% (SPI-8002TW)
- Variable output voltage: 1.0 to 16V (SPI-8001TW), 1.0 to 24V (SPI-8002TW)
- Built-in reference oscillator (250kHz): Enables to downsize a choke-coil
- Low circuit current consumption:  $\leq 1\mu\text{A}$  (at output OFF)
- High accuracy reference voltage:  $\pm 1\%$
- Built-in foldback-overcurrent and thermal protection circuits
- Built-in ON/OFF circuit (soft start available) – per output

### ■Applications

- Onboard local power supplies
- OA equipment
- For stabilization of the secondary-side output voltage of switching power supplies

### ■Absolute Maximum Ratings<sup>\*1</sup>

| Parameter                                                  | Symbol                | Ratings     |            |            | Unit |
|------------------------------------------------------------|-----------------------|-------------|------------|------------|------|
|                                                            |                       | SPI-8001TW  | SPI-8002TW | SPI-8003TW |      |
| Input Voltage                                              | $V_{\text{IN}}$       | 21          | 40         | 40         | V    |
|                                                            | $V_{\text{CC}}$       | 21          | 40         | 40         | V    |
|                                                            | $V_{\text{C/E}}$      | 21          | 40         | 40         | V    |
| Power Dissipation <sup>*2, *3</sup>                        | $P_{\text{D}}$        | 3.0         |            |            | W    |
| Junction Temperature                                       | $T_{\text{J}}$        | +135        |            |            | °C   |
| Storage Temperature                                        | $T_{\text{stg}}$      | -40 to +135 |            |            | °C   |
| Thermal Resistance (junction to case) <sup>*2</sup>        | $\theta_{\text{J-C}}$ | 9.0         |            |            | °C/W |
| Thermal Resistance (junction to ambient air) <sup>*2</sup> | $\theta_{\text{J-A}}$ | 35.8        |            |            | °C/W |

<sup>\*1</sup>: Absolute maximum ratings show the destructive limit. No parameter should exceed the ratings in transient or normal operations.

<sup>\*2</sup>: When mounted on glass-epoxy board 70cm<sup>2</sup> (copper laminate area 30.8cm<sup>2</sup>).

<sup>\*3</sup>: Limited by thermal protection.

### ■Recommended Operating Conditions<sup>\*1</sup>

| Parameter                            | Symbol           | Ratings           |      |                   |      |                   |      | Unit |
|--------------------------------------|------------------|-------------------|------|-------------------|------|-------------------|------|------|
|                                      |                  | SPI-8001TW        |      | SPI-8002TW        |      | SPI-8003TW        |      |      |
|                                      |                  | min.              | max. | min.              | max. | min.              | max. |      |
| Input Voltage Range                  | V <sub>IN</sub>  | V <sub>O</sub> +3 | 20   | V <sub>O</sub> +3 | 38   | V <sub>O</sub> +3 | 38   | V    |
|                                      | V <sub>CC</sub>  | 4.5               | 20   | 4.5               | 38   | 4.5               | 38   | V    |
|                                      | V <sub>C/E</sub> |                   | 20   |                   | 38   |                   | 38   | V    |
| Output Voltage Range                 | V <sub>O</sub>   | 1                 | 16   | 1                 | 24   | 1                 | 24   | V    |
| Output Current Range                 | I <sub>O</sub>   |                   | 1.5  |                   | 1.5  |                   | 1.5  | A    |
| Operating Junction Temperature Range | T <sub>JOP</sub> | −30               | +135 | −30               | +135 | −30               | +125 | °C   |
| Operating Temperature Range          | T <sub>OP</sub>  | −30               | +135 | −30               | +135 | −30               | +85  | °C   |

<sup>\*1</sup>: Recommended operating conditions show the operating conditions required for the normal circuit function described in the electrical characteristics. These conditions must be followed in actual use.

# **Electrical Characteristics\***

(Ta=25°C)

| Parameter                                    |                        | Symbol                                              | Ratings     |       |       |            |       |                                                     |             |       |       | Unit  |
|----------------------------------------------|------------------------|-----------------------------------------------------|-------------|-------|-------|------------|-------|-----------------------------------------------------|-------------|-------|-------|-------|
|                                              |                        |                                                     | SPI-8001TW  |       |       | SPI-8002TW |       |                                                     | SPI-8003TW  |       |       |       |
|                                              |                        |                                                     | min.        | typ.  | max.  | min.       | typ.  | max.                                                | min.        | typ.  | max.  |       |
| Reference Voltage                            | VREF                   |                                                     | 0.996       | 1.006 | 1.016 | 0.996      | 1.006 | 1.016                                               | 0.966       | 1.006 | 1.016 | V     |
|                                              | Conditions             | VIN=10V, VO=1V, IO=0.1A                             |             |       |       |            |       | VIN=14V, IO=0.1A                                    |             |       |       |       |
| Temperature Coefficient of Reference Voltage | ΔVREF/ΔT               |                                                     | ±0.1        |       |       | ±0.1       |       |                                                     |             | ±0.1  |       | mV/°C |
|                                              | Conditions             | VIN=10V, VO=1V, IO=0.1A, Ta=−30 to +135°C           |             |       |       |            |       | VIN=14V, IO=0.1A, Ta=−30 to +125°C                  |             |       |       |       |
| Efficiency 1 <sup>2</sup>                    | Eff1                   |                                                     | 80          |       |       | 78         |       |                                                     |             | 78    |       | %     |
|                                              | Conditions             | VIN=VCC=15V, VO=5V, IO=0.5A, IIN: including ICC     |             |       |       |            |       | VIN= VCC=14V, VO=5V, IO=0.5A, IIN: including ICC    |             |       |       |       |
| Efficiency 2 <sup>2</sup>                    | Eff2                   |                                                     | 83          |       |       | 81         |       |                                                     |             | 81    |       | %     |
|                                              | Conditions             | VIN=15V, VO=5V, IO=0.5A, VCC=5V, IIN: excluding ICC |             |       |       |            |       | VIN=14V, VCC=5V, VO=5V, IO=0.5A, IIN: excluding ICC |             |       |       |       |
| Oscillation Frequency                        | fosc                   |                                                     | 250         |       | 215   | 250        | 285   |                                                     | 200         |       | 400   | kHz   |
|                                              | Conditions             | VIN=VCC=15V, VO=5V, IO=0.5A                         |             |       |       |            |       | VIN=14V, IO=0.1A, COSC=100pF                        |             |       |       |       |
| Line Regulation                              | VLINE                  |                                                     | 30          | 60    |       | 30         | 60    |                                                     |             | 30    | 60    | mV    |
|                                              | Conditions             | VIN=VCC=10 to 20V, VO=5V, IO=1A                     |             |       |       |            |       | VIN=VCC=9 to 18V, VO=5V, IO=1A                      |             |       |       |       |
| Load Regulation                              | VLOAD                  |                                                     | 10          | 40    |       | 10         | 40    |                                                     |             | 10    | 40    | mV    |
|                                              | Conditions             | VIN=VCC=15V, VO=5V, IO=0.2 to 1.5A                  |             |       |       |            |       | VIN=VCC=14V, VO=5V, IO=0.2 to 1.5A                  |             |       |       |       |
| Overcurrent Protection Starting Current      | IS                     |                                                     | 1.6         |       | 1.6   |            |       |                                                     | 1.6         |       |       | A     |
|                                              | Conditions             | VIN=VCC=15V                                         |             |       |       |            |       | VIN=VCC=14V                                         |             |       |       |       |
| Quiescent Circuit Current 1                  | IIN                    |                                                     | 4           |       |       | 4          |       |                                                     |             | 4     |       | mA    |
|                                              | Conditions             | VIN=15V, VCC=5V, IO=0V, VO≤12V                      |             |       |       |            |       | VIN=14V, VCC=5V, IO=0A, VO≤12V                      |             |       |       |       |
| Quiescent Circuit Current 2                  | ICC                    |                                                     | 8.5         |       |       | 8.5        |       |                                                     |             | 8.5   |       | mA    |
|                                              | Conditions             | VCC=15V, IO=0A                                      |             |       |       |            |       | VCC=14V, IO=0A                                      |             |       |       |       |
| Quiescent Circuit Current 3                  | IIN (off)              |                                                     |             | 1     |       |            | 1     |                                                     |             |       | 1     | μA    |
|                                              | Conditions             | VIN=15V, VC/E=0V or Open                            |             |       |       |            |       | VIN=14V, VC/E=0V or Open                            |             |       |       |       |
| Quiescent Circuit Current 4                  | ICC (off)              |                                                     |             | 1     |       |            | 1     |                                                     |             |       | 1     | μA    |
|                                              | Conditions             | VCC=15V, VC/E=0V or Open                            |             |       |       |            |       | VIN=14V, VC/E=0V or Open                            |             |       |       |       |
| Quiescent Circuit Current 5                  | IIN (ssov)             |                                                     |             | —     |       |            |       |                                                     |             | 4     |       | mA    |
|                                              | Conditions             | —                                                   |             |       |       |            |       | VIN=14V, VCC=5V, IO=0A, SS1=SS2=0V                  |             |       |       |       |
| Quiescent Circuit Current 6                  | ICC (ssov)             |                                                     |             | —     |       |            |       |                                                     |             | 8.5   |       | mA    |
|                                              | Conditions             | —                                                   |             |       |       |            |       | VCC=14V, IO=0V, SS1=SS2=0V                          |             |       |       |       |
| C/E Pin                                      | High Level Voltage     | VC/EH                                               | 2           |       |       | 2          |       |                                                     | 2           |       |       | V     |
|                                              |                        | Conditions                                          | VIN=VCC=15V |       |       |            |       |                                                     | VIN=VCC=14V |       |       |       |
|                                              | Low Level Voltage      | VC/EL                                               |             |       | 0.8   |            |       | 0.8                                                 |             |       | 0.8   | V     |
|                                              |                        | Conditions                                          | VIN=VCC=15V |       |       |            |       |                                                     | VIN=VCC=14V |       |       |       |
|                                              | Inflow Current at High | IC/EH                                               |             | 95    |       | 95         |       |                                                     |             | 95    |       | μA    |
|                                              |                        | Conditions                                          | VC/E=20V    |       |       |            |       |                                                     | VC/E=20V    |       |       |       |
| SS Pin <sup>3</sup>                          | Low Level Voltage      | VSSL                                                |             |       | 0.5   |            | 0.5   |                                                     |             |       | 0.5   | V     |
|                                              |                        | Conditions                                          | VIN=VCC=15V |       |       |            |       |                                                     | VIN=VCC=14V |       |       |       |
|                                              | Inflow Current at Low  | ISSL                                                |             | 60    | 80    |            | 60    | 80                                                  |             |       | 60    | 80    |
| Conditions                                   |                        | VSSL=0V, VIN=VCC=15V                                |             |       |       |            |       | VSSL=0V, VIN=VCC=14V                                |             |       |       |       |

\*1: Electrical characteristics show the characteristic ratings guaranteed when operating the ICs under the measurement conditions described in the above table.

\*2: Efficiency is calculated from the following formula.

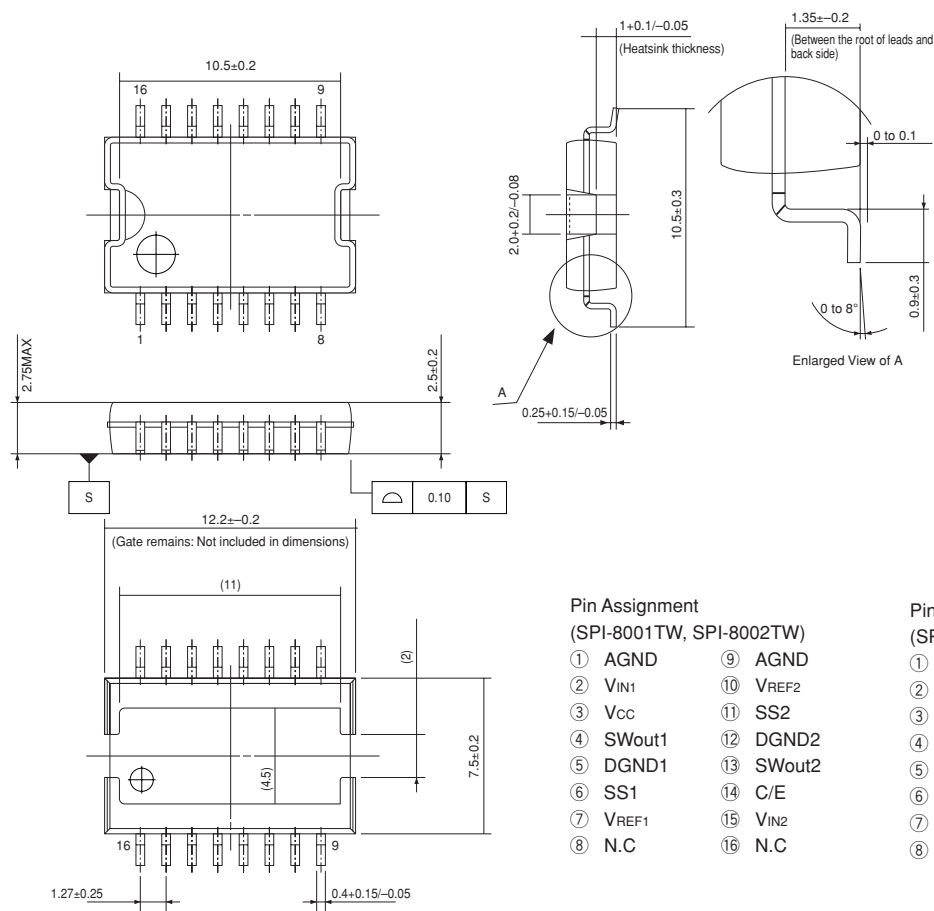
$$\eta (\%) = \frac{V_O \cdot I_O}{V_{IN} \cdot I_{IN}} \times 100$$

\*3: Pin 6 and pin 11 are the SS pins. Soft start at power on can be performed with capacitors connected to these pins. The outputs can also be turned ON/OFF with these pins. The outputs are stopped by setting the voltages of these pins to V<sub>SSL</sub> or lower. SS-pin voltages can be changed with open-collector drive circuits of transistors.

When using both the soft-start and ON/OFF functions together, the discharge currents from C<sub>4</sub> and C<sub>5</sub> flow into the ON/OFF control transistors respectively. Therefore, limit the currents securely to protect the transistors if C<sub>4</sub> and C<sub>5</sub> capacitances are large. The SS pins are pulled up to the power supply in the ICs, so applying the external voltages are prohibited.

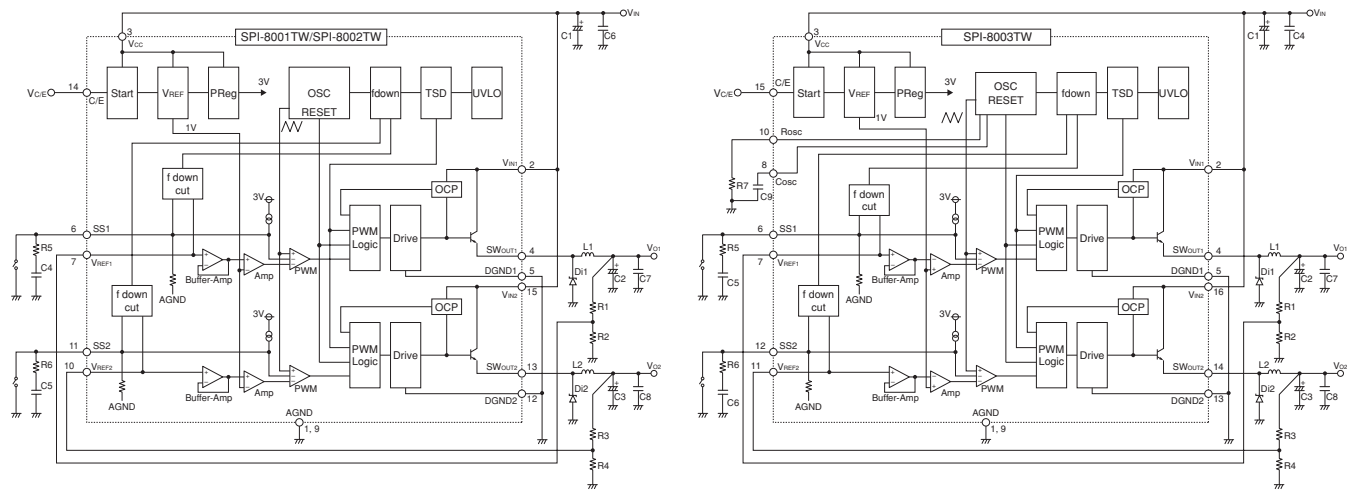
External Dimensions (HSOP16)

(Unit : mm)

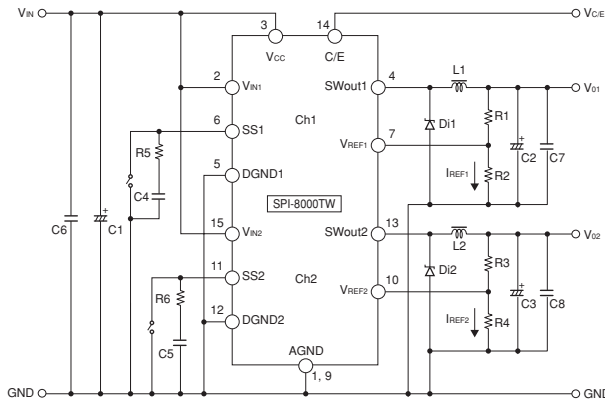


Product Mass : Approx.0.86g

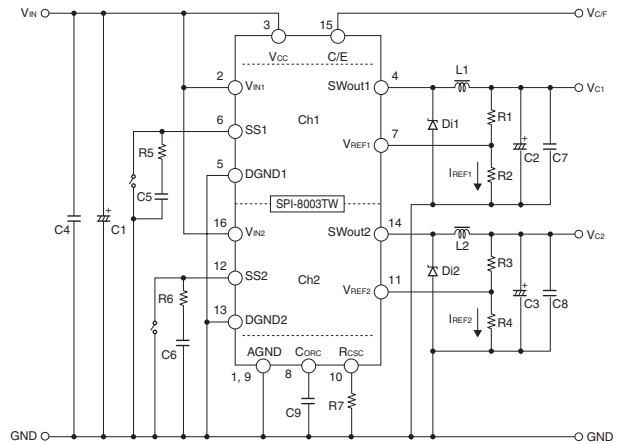
Block Diagram



## Typical Connection Diagram



|            |                   |          |               |
|------------|-------------------|----------|---------------|
| C1         | : 220 $\mu$ F/50V | R5, R6   | : 1k $\Omega$ |
| C2, C3     | : 470 $\mu$ F/25V | L1, L2   | : 47 $\mu$ H  |
| C4, C5     | : 1 $\mu$ F       | Di1, Di2 | : SJPB-H6     |
| C6, C7, C8 | : 0.1 $\mu$ F     |          | (Sanken)      |



|        |                   |          |                    |
|--------|-------------------|----------|--------------------|
| C1     | : 220 $\mu$ F/50V | C9       | : 100pF/10V        |
| C2, C3 | : 470 $\mu$ F/25V | L1, L2   | : 47 $\mu$ H       |
| C4     | : 1 $\mu$ F/50V   | R2, R4   | : 1k $\Omega$      |
| C5, C6 | : 1 $\mu$ F/10V   | R5, R6   | : 1k $\Omega$      |
| C7, C8 | : 0.1 $\mu$ F/50V | Di1, Di2 | : SJPB-H6 (Sanken) |

### Diodes Di1, Di2

- Be sure to use Schottky-barrier diodes for Di1 and Di2.
- If other diodes like fast recovery diodes are used, IC may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

### Choke coils L1, L2

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- As the overcurrent protection starting current is about 2.0A, take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuited load.
- Use a closed-magnetic-path coil to prevent interference between the channels SWout1 and SWout2.

### Capacitors C1, C2, C3

- As large ripple currents flow through C1, C2 and C3, use high-frequency and low-impedance capacitors suitable for switching mode power supplies. Especially when the impedance of C2 and C3 are high, the switching waveforms may become abnormal at low temperatures. For C2 and C3, do not use capacitors with extremely low equivalent series resistance (ESR) such as OS capacitors or tantalum capacitors, which may cause abnormal oscillation.

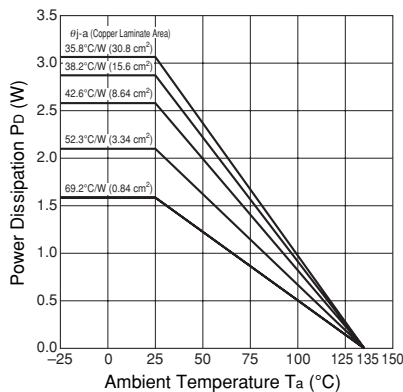
### Resistors R1, R2, R3, R4

- R1, R2, R3 and R4 are resistors for setting output voltages. Set the resistors so that IREF is approx. 1 mA. For example, R1 and R2 can be calculated as shown below.

$$R1 = \frac{(V_{O1} - V_{REF1})}{I_{REF1}} = \frac{(V_{O1} - V)}{1 \times 10^{-3}} (\Omega), R2 = \frac{V_{REF1}}{I_{REF1}} = \frac{1}{1 \times 10^{-3}} \approx 1 (K\Omega)$$

© To create the optimum operating conditions, place the components as close as possible to each other.

## Ta-Pd Characteristics



$$P_D = V_O \cdot I_O \left( \frac{100}{\eta\%} - 1 \right) - V_F \cdot I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

$V_O$  : Output Voltage

$V_{IN}$  : Input Voltage

$I_O$  : Output Current

$\eta\%$  : Efficiency (%)

$V_F$  : Di Forward Voltage

SJPB-H6...0.45V ( $I_O=1A$ )

Note 1: The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

Note 2: Thermal design for Di must be considered separately.

SI-8511NVS

Surface-Mount, Synchronous Rectifier Step-down Switching Mode Control ICs

Features

- Surface-mount package (TSSOP24)
- High efficiency due to synchronous rectification: 92% (at VIN = 5V, IO = 1A, VO = 2.5V)
- Capable of downsize a choke-coil due to IC's high switching frequency (400kHz typ, On Time Control). (Compared with conventional Sanken devices)
- Low reference voltage (Vref) of 1.1V. The output voltage is variable from 1.1V to 6V.
- High-speed response to a load
- Compatible with low ESR capacitors
- Soft start and output ON/OFF available
- Built-in overcurrent and output-overvoltage protection circuits
- PWRGD function to indicate the output voltage status
- High precision reference voltage: 1.1V ± 1.2%

Absolute Maximum Ratings

(Ta=25°C)

| Parameter                       | Symbol | Ratings     | Unit |
|---------------------------------|--------|-------------|------|
| Control-System DC Input Voltage | Vcc    | 7           | V    |
| DC Input Voltage                | VIN    | 25          | V    |
| Boost Block Input Voltage       | VH     | 30          | V    |
| EN Terminal Input Voltage       | VEN    | Vcc         | V    |
| PWRGD Terminal Applied Voltage  | VPWRGD | 7           | V    |
| Junction Temperature            | Tj     | +150        | °C   |
| Storage Temperature             | Tstg   | −40 to +150 | °C   |

Applications

- Power supplies for notebook PCs and mobile devices
- Onboard local power supplies
- OA equipment
- For stabilization of the secondary-side output voltage of switching power supplies

Recommended Operating Conditions

| Parameter                          | Symbol | Ratings    | Unit |
|------------------------------------|--------|------------|------|
| Control System Input Voltage Range | Vcc    | 4.5 to 5.5 | V    |
| Input Voltage Range                | VIN    | 3 to 18    | V    |
| Output Voltage Range               | VO     | 1.1 to 6   | V    |
| Operating Temperature Range        | Top    | −20 to +85 | °C   |

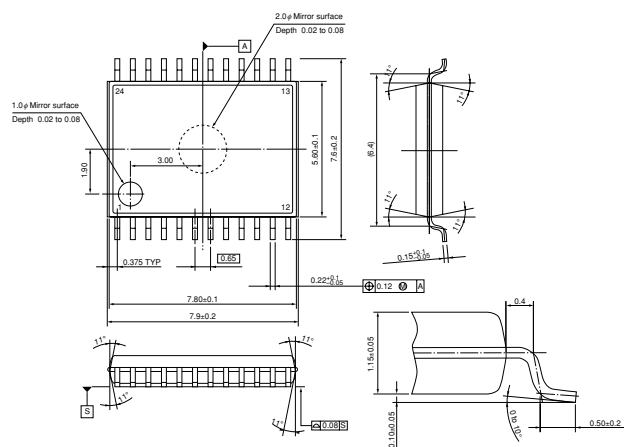
Electrical Characteristics

(Ta=25°C unless otherwise specified)

| Parameter               |                                           | Symbol  | Ratings |       |       | Unit  | Conditions                                                |
|-------------------------|-------------------------------------------|---------|---------|-------|-------|-------|-----------------------------------------------------------|
|                         |                                           |         | min.    | typ.  | max.  |       |                                                           |
| Dynamic Characteristics | Output Voltage                            | VO      | −1.2%   | 1.1   | +1.2% | V     | VIN=5V, VCC=5V, VSNS connected to VO, IO=0A               |
|                         | Temperature Coefficient of Output Voltage | ΔVO/ΔT  |         | ±0.03 |       | mV/°C | VIN=5V, VCC=5V, VSNS connected to VO, IO=0A, Ta=0 to 85°C |
| Circuit Current         | Circuit Current (Vcc Terminal)            | Iop     |         |       | 6     | mA    | VCC=5V, EN=H, FADJ:open                                   |
|                         | Circuit Current (VIN Terminal)            | Iop     |         |       | 1     | mA    | VIN=5V, EN=H                                              |
|                         | Standby Current 1 (Vcc Terminal)          | Istd1   |         |       | 100   | μA    | VCC=5V, EN=L                                              |
|                         | Standby Current 2 (VIN Terminal)          | Istd2   |         |       | 50    | μA    | VIN=5V, EN=L                                              |
| Undervoltage Lockout    | UVLO Operating Voltage 1 (Vcc Terminal)   | Vuvlo1  | 3.7     |       | 4.45  | V     | VIN=5V                                                    |
|                         | UVLO Operating Voltage 2 (VIN Terminal)   | Vuvlo2  | 2.5     |       | 2.9   | V     | VCC=5V                                                    |
| On Time Control         | On Time                                   | Ton     |         | 1.27  |       | μS    | VCC=5V, VIN=5V, VO=2.5V                                   |
|                         | Minimum Off Time                          | Toff    |         | 0.7   |       | μS    | VCC=5V                                                    |
|                         | REF Terminal Voltage                      | Vref    | 1.1     | 1.2   | 1.3   | V     | VCC=5V                                                    |
|                         | REF Terminal Source Current               | Iref    |         |       | 100   | μA    | VCC=5V                                                    |
| High Side Drive         | On Resistance (high side)                 | RonHH   |         | 5.5   |       | Ω     | VH-VLIN=5V                                                |
|                         | On Resistance (low side)                  | RonHL   |         | 5.5   |       | Ω     | VH-VLIN=5V                                                |
| Low Side Drive          | On Resistance (high side)                 | RonLH   |         | 5.5   |       | Ω     | VCC=5V                                                    |
|                         | On Resistance (low side)                  | RonLL   |         | 5.5   |       | Ω     | VCC=5V                                                    |
| Bootstrap               | Bootstrap Voltage                         | VH-VLIN | 4.5     | 5     | 5.5   | V     |                                                           |
| Protection System       | Current for Current Limit Detection       | Ilim    | 90      | 100   | 110   | μA    | VCC=5V, VIN=5V                                            |
|                         | Soft Start Terminal Current               | Iss     |         | ±20   |       | μA    | VCC=5V                                                    |
|                         | EN Low Level Voltage                      | Vcelo   | 0       |       | 0.8   | V     | VCC=5V                                                    |
|                         | EN High Level Voltage                     | Vcshi   | 2.4     |       | VCC   | V     | VCC=5V                                                    |
|                         | EN Bias Level Current                     | ICE     |         |       | 5     | μA    | VCC=5V, EN=5V                                             |
|                         | PWRGD Good Voltage (high side)            | Vsens   |         | 1.32  |       | V     | VCC=5V                                                    |
|                         | PWRGD Good Voltage (low side)             | Vsens   |         | 0.88  |       | V     | VCC=5V                                                    |
|                         | PWRGD Low Output Voltage                  | Vpwrgd  |         |       | 0.4   | V     | VCC=5V, Ipwrgd=120μA                                      |
|                         | PWRGD Terminal Current                    | Ipwrgd  |         |       | 120   | μA    | VCC=5V, Vpwrgd=0.4V                                       |
|                         | PWRGD Leakage Current                     | Ipwrgd  |         |       | 5     | μA    | Vpwrgd=5V                                                 |

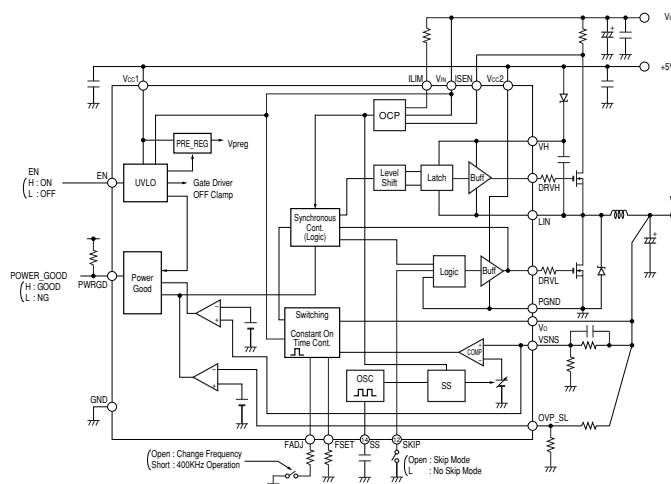
### ■External Dimensions (TSSOP24)

(Unit : mm)

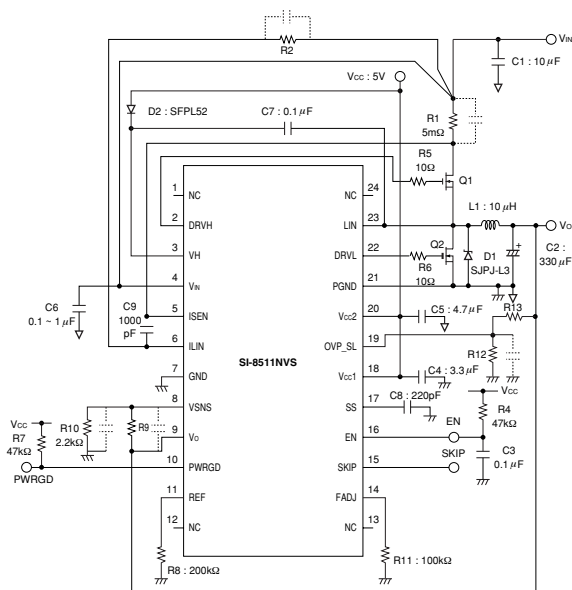


Plastic Mold Package Type  
Flammability: UL94V-0  
Product Mass: Approx. 1.36g

### ■Block Diagram (Pin Assignment)



### ■ Typical Connection Diagram



MOS FET  $Q_1, Q_2$

- Be sure to use logic type MOS FET as  $Q_1$  and  $Q_2$ .  
If you use a normal power MOS FET type, the ON resistance may not drop to a satisfactory level due to a shortage of  $V_{GS}$ . This may deteriorate the efficiency and cause overheating.

Diode D<sub>1</sub>

- Be sure to use a Schottky-barrier diode for D1.  
If other diodes like fast recovery diodes are used, IC may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

Choke coil  $L_1$

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- Take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuit load.

Capacitor C<sub>1</sub>, C<sub>2</sub>

- As large ripple currents flow through  $C_1$  and  $C_2$ , use high-frequency and low-impedance capacitors suitable for switching mode power supplies. Especially when the impedance of  $C_2$  is high, the switching waveform may become abnormal at low temperatures. For  $C_2$ , do not use a capacitor with an extremely low equivalent series resistance (ESR) such as a ceramic capacitor, which may cause an abnormal oscillation.

\* To create the optimum operating conditions, place the components as close as possible to each other.

## Selection Guide

Linear Regulator ICs (low dropout voltage, built-in overcurrent protection and thermal shutdown circuits)

### <Single Output>

#### Surface-Mount Type

| Series Name | Output Current<br>(A) | Output Voltage<br>(V) |     |     |     | Variable (Reference Voltage)<br>(V) |     |      |      | Dropout<br>Voltage<br>(V) | Maximum Input<br>Voltage<br>(V) | Package | Can Use<br>Low ESR<br>Capacitor | Page |
|-------------|-----------------------|-----------------------|-----|-----|-----|-------------------------------------|-----|------|------|---------------------------|---------------------------------|---------|---------------------------------|------|
|             |                       | 1.8                   | 2.5 | 3.3 | 5.0 | 1.0                                 | 1.1 | 1.25 | 1.28 |                           |                                 |         |                                 |      |
| SI-3000LU   | 0.25                  |                       |     |     |     |                                     |     | ⊙    |      | 0.5                       | 18                              | SOT89-5 | Yes                             | 72   |
| NR301E      | 1.0                   |                       |     |     |     | ⊙                                   |     |      |      | 0.6                       | 30                              | eSOIC8  | Yes                             | 74   |
| SI-3000LSA  | 1.0                   | ⊙                     | ⊙   | ⊙   | ⊙   |                                     |     |      |      | 1.2                       | 16                              | SOP8    | No                              | 76   |
| SI-3000KS   | 1.0                   |                       | ⊙   | ⊙   |     |                                     |     |      | ⊙    | 0.6                       | 17                              | SOP8    | Yes                             | 78   |
| SI-3000KD   | 1.0                   |                       |     | ⊙   | ⊙   | ⊙                                   |     |      | ⊙    | 0.6                       | 35*1                            | TO263-5 | Yes*2                           | 80   |
| SI-3000LLSL | 1.5                   |                       |     |     |     | ⊙                                   |     |      |      | 0.3                       | 10                              | SOP8    | Yes                             | 84   |
| SI-3000ZD   | 3.0                   |                       |     | ⊙   |     |                                     | ⊙   |      |      | 0.6                       | 10                              | TO263-5 | No                              | 86   |

\*1: For the SI-3012KD and 3033KD: 17 V

\*2: The SI-3010KD and 3050KD cannot use a low ESR capacitor.

#### Thru-Hole Type

| Series Name | Output Current<br>(A) | Variable (Reference Voltage)<br>(V) |     | Dropout<br>Voltage<br>(V) | Maximum Input<br>Voltage<br>(V) | Package  | Can Use<br>Low ESR<br>Capacitor | Page |
|-------------|-----------------------|-------------------------------------|-----|---------------------------|---------------------------------|----------|---------------------------------|------|
|             |                       | 1.0                                 | 1.1 |                           |                                 |          |                                 |      |
| SI-3000KF   | 1.0                   | ⊙                                   |     | 0.5                       | 35                              | TO220F-5 | No                              | 88   |
| SI-3000ZF   | 3.0                   |                                     | ⊙   | 0.7                       | 10                              | TO220F-5 | No                              | 90   |

## Application Note

### Heat dissipation and Reliability

The reliability of an IC is highly dependent on its operating temperature. Please be sure to apply silicone grease to the IC and to mount it to the heatsink with a proper mounting torque.

Heatsink design should pay particular attention to ensuring sufficient heat dissipation capacity.

In addition, please take into account the air convection in operation.

### Calculating Internal Power Dissipation( $P_D$ )

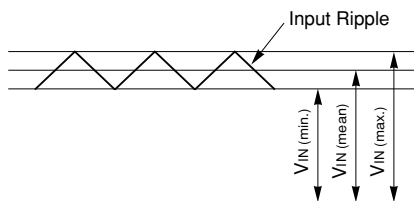
$P_D$  is given by the following formula:

$$P_D = I_O \cdot [V_{IN(\text{mean})} - V_O]$$

Determine the size of the heatsink according to the relationship between allowable power dissipation and ambient temperature.

### Setting DC Input Voltage

The following is the waveform of a DC input voltage.



When setting the DC input voltage, please follow the instructions below:

- Make  $V_{IN(\text{min})} \geq [(\text{Output voltage}) + (\text{Minimum dropout voltage})]$
- Make  $V_{IN(\text{max})} \leq$  DC input voltage shown in the "Absolute Maximum Ratings"

### Thermal Design

The maximum junction temperature  $T_{J(\text{max})}$  given in the absolute maximum ratings is specific to each product type and must be strictly observed. Thus, thermal design must consider the maximum power dissipation  $P_{D(\text{max})}$ , which varies by the conditions of use, and the maximum ambient temperature  $T_{a(\text{max})}$ .

To simplify thermal design,  $T_a$ - $P_D$  characteristic graphs are provided herein.

Please observe the following steps for heatsink design:

1. Obtain the maximum ambient temperature  $T_{a(\text{max})}$ .
2. Obtain the maximum power dissipation  $P_{D(\text{max})}$ .
3. Look for the intersection point on the  $T_a$ - $P_D$  characteristic graph and determine the size of the heatsink.

Although the heatsink size is now obtained, in actual applications, 10-to-20% derating factor is generally introduced. Moreover, the heat dissipation capacity of a heatsink highly depends on how it is mounted. Thus, it is recommended to measure the heatsink and case temperature in the actual operating environment.

Please refer to the  $T_a$ - $P_D$  characteristic graphs for respective product types.

### Mounting Torque

|           |                                                |
|-----------|------------------------------------------------|
| SI-3000KF | } 0.588 to 0.686 [N·m] ( 6.0 to 7.0 [kgf·cm] ) |
| SI-3000ZF |                                                |

### Recommended Silicone Grease

- Shin-Etsu Chemical Co., Ltd.: G746
- Momentive Performance Materials Inc.: YG-6260
- Dow Corning Toray Silicones Co., Ltd.: SC102

Please select proper silicone grease carefully since the oil in some grease products may penetrate the device and result in an extremely short device life.

### Others

- Devices can not be operated in parallel connection aiming for a larger current.
- Diodes for isolation purpose are provided in between input and ground, and also in between output and ground. They may be broken down if the device is reverse biased. In this case, please clamp the device with low  $V_F$  diodes to protect them.

### Rectifier Diodes for Power Supplies

To rectify the AC input voltage using rectifier diodes for power supplies, please use SANKEN rectifier diodes shown in the following list. (Please use a center-tap or bridge configuration in using stand-alone type diodes.)

| Series Name | Diodes                                                               |
|-------------|----------------------------------------------------------------------|
| SI-3000LU   | SJPM-H4(Surface-Mount Stand-Alone Type, $V_{RM}$ :400V, $I_O$ :2.0A) |
| NR301E      |                                                                      |
| SI-3000LSA  |                                                                      |
| SI-3000KS   |                                                                      |
| SI-3000KD   |                                                                      |
| SI-3000LLSL |                                                                      |
| SI-3000ZD   | AM01Z(Axial Type, $V_{RM}$ :200V, $I_O$ :1.0A)                       |
| SI-3000KF   |                                                                      |
| SI-3000ZF   |                                                                      |

# SI-3000LU Series Surface-Mount, Low Current Consumption, Low Dropout Voltage

## Features

- Compact surface-mount package (SOT89-5)
- Output current: 250 mA
- Low current consumption  $I_q$  (OFF)  $\leq 1\mu\text{A}$  ( $V_c = 0\text{ V}$ )
- Low dropout voltage:  $V_{DIF} \leq 0.5\text{ V}$  (at  $I_o = 250\text{ mA}$ )
- Output voltage range (1.5V to 15V)
- Built-in drooping-type-overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                    | Symbol                         | Ratings         | Unit |
|----------------------------------------------|--------------------------------|-----------------|------|
| DC Input Voltage                             | V <sub>IN</sub>                | 18              | V    |
| Output control terminal voltage              | V <sub>c</sub>                 | V <sub>IN</sub> | V    |
| DC Output Current                            | I <sub>o</sub>                 | 250             | mA   |
| Power Dissipation                            | P <sub>D</sub> <sup>*1</sup>   | 0.75            | W    |
| Junction Temperature                         | T <sub>j</sub> <sup>*2</sup>   | −40 to +135     | °C   |
| Storage Temperature                          | T <sub>stg</sub> <sup>*2</sup> | −40 to +125     | °C   |
| Thermal Resistance (Junction to Ambient Air) | θ <sub>JA</sub> <sup>*1</sup>  | 146             | °C/W |

\*1: When mounted on glass-epoxy board 40 × 40 mm (copper laminate area 2%).

\*2: Thermal protection circuits may operate if the junction temperature exceeds 135°C.

## Applications

- Auxiliary power supplies for PC
- Battery-driven electronic equipment

## Recommended Operating Conditions

| Parameter                     | Symbol          | Ratings |                                 | Unit |
|-------------------------------|-----------------|---------|---------------------------------|------|
|                               |                 | min.    | max.                            |      |
| Input Voltage                 | V <sub>IN</sub> | *2, *3  | V <sub>O</sub> +2 <sup>*1</sup> | V    |
| DC Output Current             | I <sub>o</sub>  | 0       | 250                             | mA   |
| Operating Ambient Temperature | T <sub>op</sub> | −20     | 85                              | °C   |

\*1: V<sub>IN</sub> (max) and I<sub>o</sub> (max) are restricted by the relation P<sub>D</sub> = (V<sub>IN</sub> - V<sub>O</sub>) × I<sub>o</sub>.

Calculate these values referring to the reference data on next page.

\*2: Refer to the Dropout Voltage parameter.

\*3: For the SI-3012LU, set the input voltage to V<sub>IN</sub> ≥ 2.4 V, and secure the minimum voltage as explained in "Setting DC Input Voltage" section in Linear Regulator Application Note.

## Electrical Characteristics

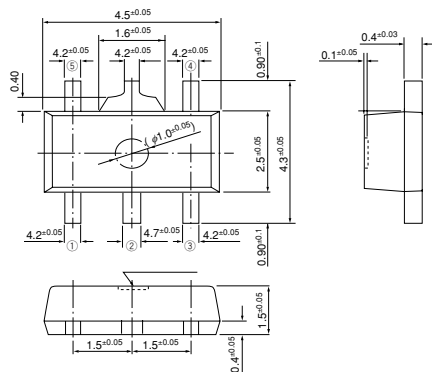
(T<sub>a</sub>=25°C, V<sub>c</sub>=2V, unless otherwise specified)

| Parameter                                             |                                            | Symbol                           | Ratings                                                                                               |       |       | Unit  |
|-------------------------------------------------------|--------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------------------------|-------|-------|-------|
|                                                       |                                            |                                  | SI-3012LU(Variable)                                                                                   |       |       |       |
|                                                       |                                            |                                  | min.                                                                                                  | typ.  | max.  |       |
| Reference Voltage                                     |                                            | V <sub>ADJ</sub>                 | 1.210                                                                                                 | 1.250 | 1.290 | V     |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =10mA                                             |       |       |       |
| Dropout Voltage                                       |                                            | V <sub>DIF</sub>                 |                                                                                                       |       | 0.3   | V     |
|                                                       |                                            | Conditions                       | I <sub>O</sub> =100mA(V <sub>O</sub> =3.3V)                                                           |       |       |       |
|                                                       |                                            |                                  |                                                                                                       |       | 0.5   |       |
|                                                       |                                            | Conditions                       | I <sub>O</sub> =250mA(V <sub>O</sub> =3.3V)                                                           |       |       |       |
| Line Regulation                                       |                                            | ΔV <sub>LINE</sub>               |                                                                                                       |       | 10    | mV    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1 to V <sub>O</sub> +5V, I <sub>O</sub> =10mA( V <sub>O</sub> =3.3V) |       |       |       |
| Load Regulation                                       |                                            | ΔV <sub>LOAD</sub>               |                                                                                                       |       | 20    | mV    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =1 to 250mA( V <sub>O</sub> =3.3V)                |       |       |       |
| Temperature Coefficient of Reference Voltage          |                                            | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                                                                       | ±0.3  |       | mV/°C |
|                                                       |                                            | Conditions                       | T <sub>J</sub> =0 to 100°C                                                                            |       |       |       |
| Ripple Rejection                                      |                                            | R <sub>REJ</sub>                 |                                                                                                       | 55    |       | dB    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V , f=100 to 120Hz( V <sub>O</sub> =3.3V)                           |       |       |       |
| Quiescent Circuit Current                             |                                            | I <sub>q</sub>                   |                                                                                                       |       | 150   | μA    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =0mA<br>V <sub>C</sub> =2V, R <sub>2</sub> =100kΩ |       |       |       |
| Circuit Current at Output OFF                         |                                            | I <sub>q</sub> (OFF)             |                                                                                                       |       | 1     | μA    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, V <sub>C</sub> =0V                                               |       |       |       |
| Overcurrent Protection Starting Current <sup>*1</sup> |                                            | I <sub>S1</sub>                  | 260                                                                                                   |       |       | mA    |
|                                                       |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V                                                                   |       |       |       |
| V <sub>C</sub> Terminal                               | Control Voltage (Output ON) <sup>*2</sup>  | V <sub>C</sub> , I <sub>H</sub>  | 2.0                                                                                                   |       |       | V     |
|                                                       | Control Voltage (Output OFF) <sup>*2</sup> | V <sub>C</sub> , I <sub>L</sub>  |                                                                                                       |       | 0.8   |       |
|                                                       | Control Current (Output ON)                | I <sub>C</sub> , I <sub>H</sub>  |                                                                                                       |       | 40    | μA    |
|                                                       | Conditions                                 | V <sub>C</sub> =2V               |                                                                                                       |       |       |       |
|                                                       | Control Current (Output OFF)               | I <sub>C</sub> , I <sub>L</sub>  |                                                                                                       | 0     | -5    | μA    |
|                                                       | Conditions                                 | V <sub>C</sub> =0V               |                                                                                                       |       |       |       |

\*1: I<sub>S1</sub> is specified at the 5% drop point of output voltage V<sub>O</sub> on the condition that V<sub>IN</sub> = 3.3 V, and I<sub>o</sub> = 10 mA.\*2: Output is OFF when the output control terminal (V<sub>c</sub> terminal) is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

## External Dimensions (SOT89-5)

(Unit : mm)



### Pin Assignment

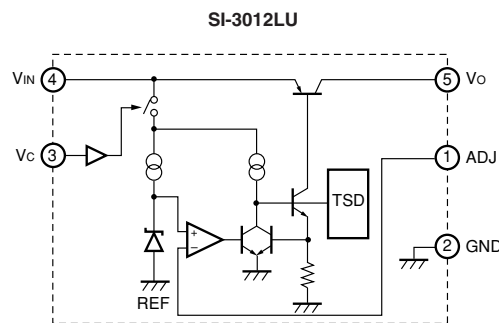
- ① ADJ
- ② GND
- ③ V<sub>c</sub>
- ④ V<sub>IN</sub>
- ⑤ V<sub>O</sub>

Plastic Mold Package Type

Flammability: UL94V-0

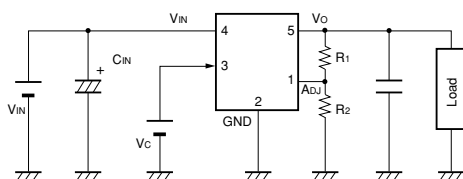
Product Mass: Approx. 0.05g

## Block Diagram



## Typical Connection Diagram

SI-3012LU

Co: Output capacitor (10  $\mu$ F or larger)

For SI-3000LU series, Co has to be a low ESR capacitor such as a ceramic capacitor.

C<sub>IN</sub>: Input capacitor (10  $\mu$ F approx.)

- Setting of SI-3012LU output voltage (recommended voltage: 1.5 V to 15 V)

R1 and R2: Resistors for output setting

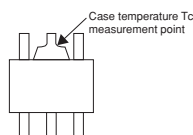
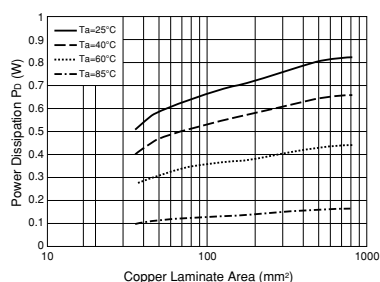
The output voltage can be set by connecting R1 and R2 as shown in the diagram on the left.

R2: 100 k $\Omega$  is recommended

$$R1 = (V_O - V_{ADJ}) / (V_{ADJ} / R2)$$

## Reference Data

Copper Laminate Area vs Power Dissipation  
T<sub>J</sub>=100°C PCB size 40×40



- A monolithic ICs mounts an inner frame stage that is connected to the GND pin (pin 2). Therefore, enlarging the copper laminate area connected to the GND pin improves heat radiation effect.

- Obtaining the junction temperature

Measure the temperature T<sub>c</sub> at the lead part of the GND pin (pin 2) with a thermocouple, etc. Then, substitute this value in the following formula to obtain the junction temperature.

$$T_J = P_D \times \theta_j - c + T_c \quad (\theta_j - c = 5^\circ\text{C/W})$$

## NR301E Surface-Mount, Low Dropout Voltage

### Features

- Adjustable Output voltage type
- Output current: 1 A
- $V_{DIF} (V_{IN}-V_{OUT}) \leq 0.6 \text{ V}$  (at  $I_O = 1 \text{ A}$ )
- Built-in protection circuits (OCP/TSD\*)
  - \* TSD has temperature hysteresis
- Built-in output ON/OFF function

### Applications

- Secondary stabilized power supply (local power supply)

### Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                     | Symbol           | Ratings         | Unit |
|-----------------------------------------------|------------------|-----------------|------|
| DC Input Voltage                              | V <sub>IN</sub>  | 30              | V    |
| Output control terminal voltage               | V <sub>C</sub>   | V <sub>IN</sub> | V    |
| ADJ terminal voltage                          | V <sub>ADJ</sub> | 5               | V    |
| Power Dissipation                             | P <sub>D</sub>   | 1.4*            | W    |
| Junction to Ambient Air Thermal Resistance    | $\theta_{j-a}$   | 71              | °C/W |
| Thermal Resistance (Junction to Lead (pin 4)) | $\theta_{j-L}$   | 26              | °C/W |
| Junction Temperature                          | T <sub>J</sub>   | −30 to +125     | °C   |
| Storage Temperature                           | T <sub>stg</sub> | −30 to +125     | °C   |

\*: When mounted on glass-epoxy board 30 × 30 mm (copper laminate area 25 × 25 mm).

### Recommended Operating Conditions

| Parameter                      | Symbol              | Ratings |      | Unit |
|--------------------------------|---------------------|---------|------|------|
|                                |                     | min.    | max. |      |
| Input Voltage                  | V <sub>IN</sub>     | 2.7     | 27*  | V    |
| DC Output Current              | I <sub>O</sub>      | 0       | 1*   | A    |
| Output Voltage Variable Range  | V <sub>O(ADJ)</sub> | 1.1     | 16   | V    |
| Operating Ambient Temperature  | T <sub>op(a)</sub>  | −30     | 85   | °C   |
| Operating Junction Temperature | T <sub>op(j)</sub>  | −20     | 100  | °C   |

\*: V<sub>IN</sub> (max) and I<sub>O</sub> (max) are restricted by the relation P<sub>D</sub> = (V<sub>IN</sub> − V<sub>O</sub>) × I<sub>O</sub>.

### Electrical Characteristics

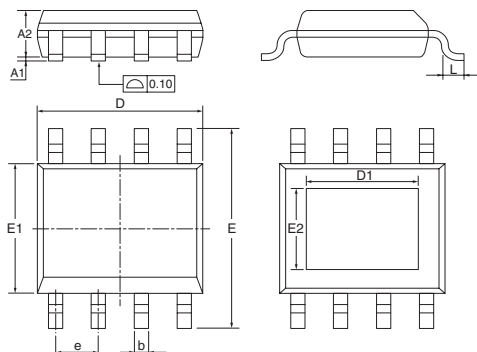
(T<sub>a</sub>=25°C, V<sub>C</sub>=2V, unless otherwise specified)

| Parameter                                    | Symbol                             | Ratings           |      |       | Unit  | Conditions           |
|----------------------------------------------|------------------------------------|-------------------|------|-------|-------|----------------------|
|                                              |                                    | NR301E            |      |       |       |                      |
|                                              |                                    | min.              | typ. | max.  |       |                      |
| Reference Voltage                            | V <sub>ADJ</sub>                   | 0.985             | 1    | 1.015 | V     |                      |
| Line Regulation                              | ΔV <sub>LINE</sub>                 | —                 | 25   | 50    | mV    |                      |
| Load Regulation                              | ΔV <sub>LOAD</sub>                 | —                 | 30   | 60    | mV    |                      |
| Dropout Voltage                              | ΔV <sub>DIF</sub>                  | —                 | 0.3  | 0.4   | V     | I <sub>O</sub> =0.5A |
|                                              |                                    | —                 | 0.6  | 0.8   | V     | I <sub>O</sub> =1.0A |
| Quiescent Circuit Current                    | I <sub>q</sub>                     | 0.5               | 0.9  | 1.6   | mA    |                      |
| Circuit Current at Output OFF                | I <sub>q(off)</sub>                | —                 | 0    | 1     | μA    |                      |
| Temperature Coefficient of Reference Voltage | ΔV <sub>ADJ</sub> /ΔT <sub>a</sub> | —                 | ±0.1 | —     | mV/°C |                      |
| Ripple Rejection                             | R <sub>REJ</sub>                   |                   | 55   |       | dB    |                      |
| Output Control                               | Output ON                          | V <sub>C(H)</sub> | 2    | —     | V     |                      |
| Pin Voltage                                  | Output OFF                         | V <sub>C(L)</sub> | —    | —     | 0.6   | V                    |
| Output Control                               | Output ON                          | I <sub>C(H)</sub> | —    | 4     | 40    | μA                   |
| Pin Current                                  | Output OFF                         | I <sub>C(L)</sub> | −2   | 0     | 0.1   | μA                   |
| Overcurrent Protection Starting Current*     | I <sub>S1</sub>                    | 1.1               | —    | —     | A     |                      |

\*: I<sub>S1</sub> is specified at the 5% drop point of output voltage V<sub>O</sub> on the condition that V<sub>IN</sub> = 3.3 V, and I<sub>O</sub> = 10 mA.

## External Dimensions (eSOIC8)

(Unit : mm)



External Dimensions

| Symbol | Package A |       |        | Package B |      |      |
|--------|-----------|-------|--------|-----------|------|------|
|        | MIN       | TYP   | MAX    | MIN       | TYP  | MAX  |
| A1     | 0         | —     | 0.1524 | 0         | 0.1  | 0.15 |
| A2     | 1.398     | 1.448 | 1.498  | 1.25      | 1.4  | 1.65 |
| b      | 0.33      | —     | 0.508  | 0.38      | —    | 0.51 |
| D      | 4.8       | 4.902 | 5.004  | 4.8       | 4.9  | 5    |
| D1     | 3.053     | 3.18  | 3.307  | 3.1       | 3.3  | 3.5  |
| E      | 5.893     | —     | 6.918  | 5.8       | 6    | 6.2  |
| E1     | 3.73      | —     | 3.89   | 3.8       | 3.9  | 4    |
| E2     | 2.033     | 2.16  | 2.287  | 2.2       | 2.4  | 2.6  |
| e      | —         | 1.27  | —      | —         | 1.27 | —    |
| L      | 0.508     | —     | 0.762  | 0.45      | 0.6  | 0.8  |

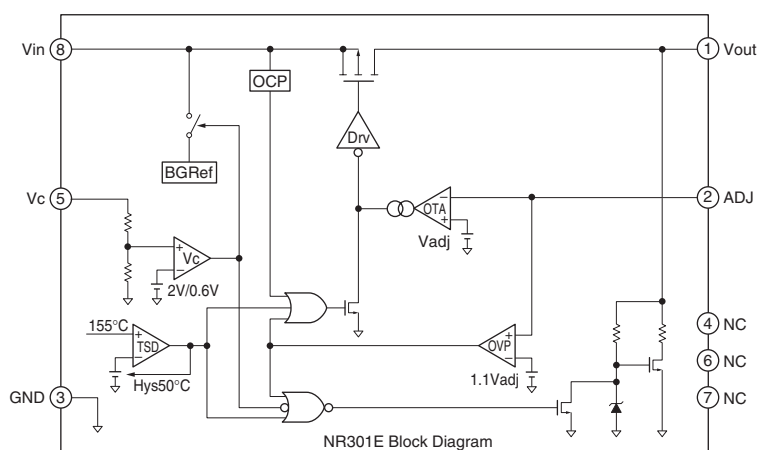
Delivered in Package A or B.

Pin Assignment

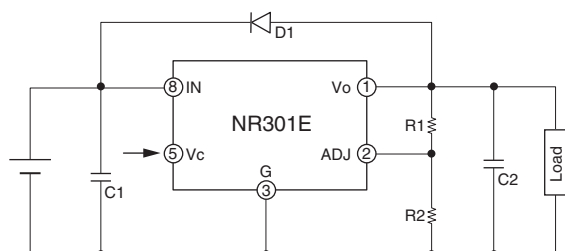
- ① V<sub>OUT</sub>
- ② ADJ
- ③ GND
- ④ NC
- ⑤ V<sub>C</sub>
- ⑥ NC
- ⑦ NC
- ⑧ V<sub>IN</sub>

Plastic Mold Package Type  
 Flammability: UL94V-0  
 Product Mass: Approx. 0.1g

## Block Diagram



## Typical Connection Diagram



C1: Input ceramic capacitor (Approx. 1μF)

Required when the input line contains inductance due to the wiring being long or for some other reason.

C2: Output oscillation prevention ceramic capacitor (Approx. 1μF)

D1: Reverse bias protection diode (This diode is required for protection against reverse biasing between the input and output.)

The output voltage can be set by connecting R1 and R2. Set R2 to 10kΩ (recommended), and calculate R1 from the following formula.

$$V_O = \frac{R1+R2}{R2} V_{ADJ}, \text{ therefore } R1 = \frac{V_O - V_{ADJ}}{V_{ADJ}} R2$$

# SI-3000LSA Series Surface-Mount, Low Current Consumption, Low Dropout Voltage

## Features

- Compact surface-mount package (SOP8)
- Output current: 1 A
- Low circuit current at output OFF:  
 $I_{Q(OFF)} \leq 1 \mu A$  ( $V_C = 0 V$ )
- Low dropout voltage:  $V_{DIF} \leq 0.8 V$  (at  $I_O = 1 A$ )  
 $V_{DIF} \leq 1.2 V$  ( $I_O = 1 A$ ) for SI-3018LSA
- 4 types of output voltages (1.8 V, 2.5 V, 3.3 V, 5.0 V) available
- Output ON/OFF control terminal voltage compatible with LS-TTL
- Built-in foldback-type-overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                     | Symbol                         | Ratings         | Unit |
|-----------------------------------------------|--------------------------------|-----------------|------|
| DC Input Voltage                              | V <sub>IN</sub>                | 16              | V    |
| Output control terminal voltage               | V <sub>C</sub>                 | V <sub>IN</sub> | V    |
| DC Output Current                             | I <sub>O</sub>                 | 1               | A    |
| Power Dissipation                             | P <sub>D1</sub> <sup>*1</sup>  | 1.16            | W    |
|                                               | P <sub>D2</sub> <sup>*2</sup>  | 1.1             | W    |
| Junction Temperature                          | T <sub>J</sub> <sup>*3</sup>   | −30 to +150     | °C   |
| Operating Ambient Temperature                 | T <sub>OP</sub>                | −30 to +150     | °C   |
| Storage Temperature                           | T <sub>stg</sub>               | −30 to +150     | °C   |
| Thermal Resistance (Junction to Lead (pin 8)) | θ <sub>J-L</sub>               | 36              | °C/W |
| Thermal Resistance (Junction to Ambient Air)  | θ <sub>J-a</sub> <sup>*2</sup> | 100             | °C/W |

\*1: When mounted on glass-epoxy board 56.5 × 56.5 mm (copper laminate area 100%).

\*2: When mounted on glass-epoxy board 40 × 40 mm (copper laminate area 100%).

\*3: Thermal protection circuits may be activated if the junction temperature exceeds 135°C.

## Applications

- Auxiliary power supplies for PC
- Battery-driven electronic equipment

## Recommended Operating Conditions

| Parameter                      | Symbol          | Ratings                  |                                      |                                      |                        | Unit |
|--------------------------------|-----------------|--------------------------|--------------------------------------|--------------------------------------|------------------------|------|
|                                |                 | SI-3018LSA               | SI-3025LSA                           | SI-3033LSA                           | SI-3050LSA             |      |
| DC Input Voltage Range         | V <sub>IN</sub> | 3.1 to 3.5 <sup>*1</sup> | <sup>*2</sup> 2 to 3.5 <sup>*1</sup> | <sup>*2</sup> 2 to 5.2 <sup>*1</sup> | <sup>*2</sup> 2 to 8.0 | V    |
| DC Output Current Range        | I <sub>O</sub>  | 0 to 1                   |                                      |                                      |                        | A    |
| Operating Junction Temperature | T <sub>JP</sub> | −20 to +125              |                                      |                                      |                        | °C   |
| Operating Ambient Temperature  | T <sub>AP</sub> | −30 to +85               |                                      |                                      |                        | °C   |

\*1: V<sub>IN</sub> (max) and I<sub>O</sub> (max) are restricted by the relation P<sub>D</sub> = (V<sub>IN</sub> − V<sub>O</sub>) × I<sub>O</sub>.

Please calculate these values referring to the reference data on next page.

\*2: Refer to the Dropout Voltage parameter.

## Electrical Characteristics

(T<sub>a</sub>=25°C, V<sub>C</sub>=2V, unless otherwise specified)

| Parameter                                              |                                           | Symbol                           | Ratings                                                                |       |       |                                                                        |       |       |                                                                      |       |       |                                                                      |      | Unit  |      |
|--------------------------------------------------------|-------------------------------------------|----------------------------------|------------------------------------------------------------------------|-------|-------|------------------------------------------------------------------------|-------|-------|----------------------------------------------------------------------|-------|-------|----------------------------------------------------------------------|------|-------|------|
|                                                        |                                           |                                  | SI-3018LSA                                                             |       |       | SI-3025LSA                                                             |       |       | SI-3033LSA                                                           |       |       | SI-3050LSA                                                           |      |       |      |
|                                                        |                                           |                                  | min.                                                                   | typ.  | max.  | min.                                                                   | typ.  | max.  | min.                                                                 | typ.  | max.  | min.                                                                 | typ. |       | max. |
| Output Voltage                                         |                                           | V <sub>O</sub>                   | 1.764                                                                  | 1.800 | 1.836 | 2.450                                                                  | 2.500 | 2.550 | 3.234                                                                | 3.300 | 3.366 | 4.90                                                                 | 5.00 | 5.10  | V    |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0.5A                            |       |       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0.5A                            |       |       | V <sub>IN</sub> =5V, I <sub>O</sub> =0.5A                            |       |       | V <sub>IN</sub> =6V, I <sub>O</sub> =0.5A                            |      |       |      |
| Dropout Voltage                                        |                                           | V <sub>DIF</sub>                 |                                                                        | —     |       |                                                                        | 0.4   |       |                                                                      | 0.4   |       |                                                                      | 0.4  | V     |      |
|                                                        |                                           | Conditions                       | —                                                                      |       |       | I <sub>O</sub> ≤0.5A                                                   |       |       | I <sub>O</sub> ≤0.5A                                                 |       |       | I <sub>O</sub> ≤0.5A                                                 |      |       |      |
|                                                        |                                           |                                  |                                                                        | 0.6   | 1.2   |                                                                        |       | 0.8   |                                                                      |       | 0.8   |                                                                      |      |       | 0.8  |
| Line Regulation                                        |                                           | ΔV <sub>LINE</sub>               |                                                                        | 2     | 10    |                                                                        | 2     | 10    |                                                                      | 3     | 10    |                                                                      | 3    | 15    | mV   |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.1 to 3.5V, I <sub>O</sub> =0.3A                     |       |       | V <sub>IN</sub> =3.1 to 3.5V, I <sub>O</sub> =0.3A                     |       |       | V <sub>IN</sub> =4.5 to 5.5V, I <sub>O</sub> =0.3A                   |       |       | V <sub>IN</sub> =6 to 7V, I <sub>O</sub> =0.3A                       |      |       |      |
| Load Regulation                                        |                                           | ΔV <sub>LOAD</sub>               |                                                                        | 10    | 20    |                                                                        | 10    | 20    |                                                                      | 10    | 20    |                                                                      | 10   | 30    | mV   |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 1A                         |       |       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 1A                         |       |       | V <sub>IN</sub> =5V, I <sub>O</sub> =0 to 1A                         |       |       | V <sub>IN</sub> =6V, I <sub>O</sub> =0 to 1A                         |      |       |      |
| Temperature Coefficient of Output Voltage              |                                           | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                                        | ±0.3  |       |                                                                        | ±0.3  |       |                                                                      | ±0.3  |       |                                                                      | ±0.5 | mV/°C |      |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =5mA, T <sub>J</sub> =0 to 100°C |       |       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =5mA, T <sub>J</sub> =0 to 100°C |       |       | V <sub>IN</sub> =5V, I <sub>O</sub> =5mA, T <sub>J</sub> =0 to 100°C |       |       | V <sub>IN</sub> =6V, I <sub>O</sub> =5mA, T <sub>J</sub> =0 to 100°C |      |       |      |
| Ripple Rejection                                       |                                           | R <sub>REJ</sub>                 |                                                                        | 60    |       |                                                                        | 57    |       |                                                                      | 55    |       |                                                                      | 55   | dB    |      |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, f=100 to 120Hz                                  |       |       | V <sub>IN</sub> =3.3V, f=100 to 120Hz                                  |       |       | V <sub>IN</sub> =5V, f=100 to 120Hz                                  |       |       | V <sub>IN</sub> =6V, f=100 to 120Hz                                  |      |       |      |
| Quiescent Circuit Current                              |                                           | I <sub>Q</sub>                   |                                                                        | 1.7   | 2.5   |                                                                        | 1.7   | 2.5   |                                                                      | 1.7   | 2.5   |                                                                      | 1.7  | 2.5   | mA   |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A                              |       |       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A                              |       |       | V <sub>IN</sub> =5V, I <sub>O</sub> =0A                              |       |       | V <sub>IN</sub> =6V, I <sub>O</sub> =0A                              |      |       |      |
| Circuit Current at Output OFF                          |                                           | I <sub>Q</sub> (OFF)             |                                                                        |       | 1     |                                                                        |       | 1     |                                                                      |       | 1     |                                                                      |      | 1     | μA   |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A, V <sub>C</sub> =0V          |       |       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A, V <sub>C</sub> =0V          |       |       | V <sub>IN</sub> =5V, I <sub>O</sub> =0A, V <sub>C</sub> =0V          |       |       | V <sub>IN</sub> =6V, I <sub>O</sub> =0A, V <sub>C</sub> =0V          |      |       |      |
| Overcurrent Protection Starting Current <sup>1,3</sup> |                                           | I <sub>S1</sub>                  | 1.2                                                                    |       |       | 1.2                                                                    |       |       | 1.2                                                                  |       |       | 1.2                                                                  |      |       | A    |
|                                                        |                                           | Conditions                       | V <sub>IN</sub> =3.3V                                                  |       |       | V <sub>IN</sub> =3.3V                                                  |       |       | V <sub>IN</sub> =5V                                                  |       |       | V <sub>IN</sub> =6V                                                  |      |       |      |
| V <sub>C</sub> Terminal                                | Control Voltage (Output ON) <sup>2</sup>  | V <sub>C</sub> , I <sub>H</sub>  | 2.0                                                                    |       |       | 2.0                                                                    |       |       | 2.0                                                                  |       |       | 2.0                                                                  |      |       | V    |
|                                                        | Control Voltage (Output OFF) <sup>2</sup> | V <sub>C</sub> , I <sub>L</sub>  |                                                                        |       | 0.8   |                                                                        |       | 0.8   |                                                                      |       | 0.8   |                                                                      |      | 0.8   |      |
|                                                        | Control Current (Output ON)               | I <sub>C</sub> , I <sub>H</sub>  |                                                                        | 40    | 80    |                                                                        | 40    | 80    |                                                                      | 40    | 80    |                                                                      | 40   | 80    | μA   |
|                                                        | Conditions                                | V <sub>C</sub> =2V               |                                                                        |       |       |                                                                        |       |       |                                                                      |       |       |                                                                      |      |       |      |
|                                                        | Control Current (Output OFF)              | I <sub>C</sub> , I <sub>L</sub>  |                                                                        | 0     | −5    |                                                                        | 0     | −5    |                                                                      | 0     | −5    |                                                                      | 0    | −5    | μA   |
| Conditions                                             | V <sub>C</sub> =0V                        |                                  |                                                                        |       |       |                                                                        |       |       |                                                                      |       |       |                                                                      |      |       |      |

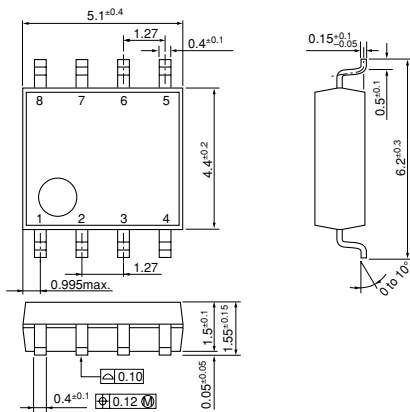
\*1: I<sub>S1</sub> is specified at the 5% drop point of output voltage V<sub>O</sub> on the condition that V<sub>IN</sub> = 3.3 V (5 V for SI-3033LSA), and I<sub>O</sub> = 0.5 A.\*2: Output is OFF when the output control terminal V<sub>C</sub> is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

\*3: These products cannot be used in the following applications. Because these applications require a certain current at start-up and so the built-in foldback-type overcurrent protection may cause errors during start-up stage.

(1) Constant current load (2) Positive and negative power supply (3) Series-connected power supply (4) V<sub>O</sub> adjustment by raising ground voltage

## External Dimensions (SOP8)

(Unit : mm)



### Pin Assignment

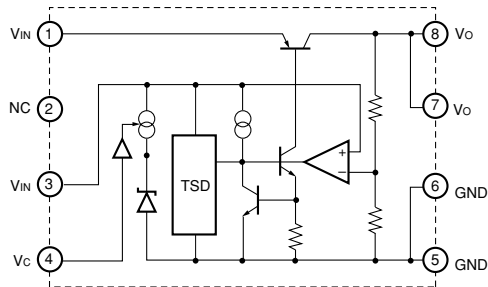
- ①  $V_{IN}$
- ② NC (Leave open)
- ③  $V_{IN}$
- ④  $V_C$
- ⑤ GND
- ⑥ GND
- ⑦  $V_O$
- ⑧  $V_O$

Plastic Mold Package Type

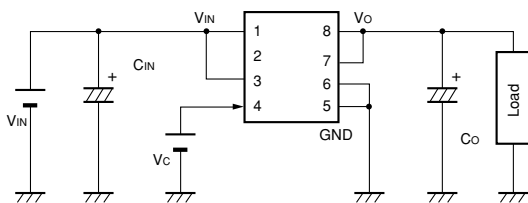
Flammability: UL94V-0

Product Mass: Approx. 0.1g

## Block Diagram



## Typical Connection Diagram

 $C_O$ : Output capacitor (22  $\mu$ F or larger) $C_{IN}$ : Input capacitor (10  $\mu$ F)

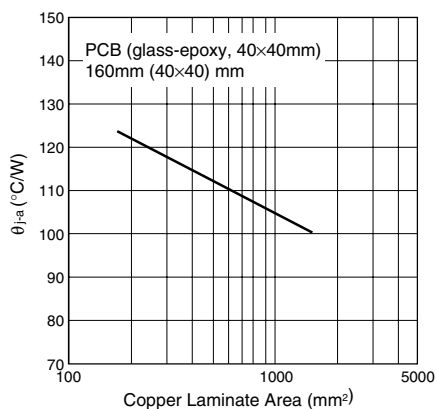
This capacitor is required in the case of an inductive input line or long wiring.

Tantalum capacitors are recommended for  $C_{IN}$  and  $C_O$ , particularly at low temperatures.

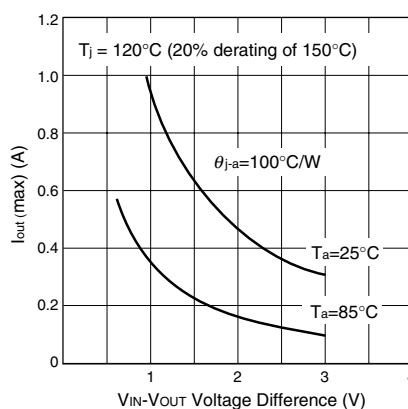
\* Leave pin 2 open.

## Reference Data

PCB Copper Laminate Area vs. Junction to Ambient Air Thermal Resistance



Allowable Output Current (vs.  $V_{IN}-V_{OUT}$  Voltage Difference)  
 $V_{IN}-I_O$  max

The inner frame stage, on which the PTR is mounted, is directly connected to the  $V_{OUT}$  pin.Therefore, enlarging the copper laminate area around the  $V_{OUT}$  pin is really effective for a heat radiation.

# SI-3000KS Series Surface-Mount, Low Current Consumption, Low Dropout Voltage

## Features

- Compact surface-mount package (SOP8)
- Output current: 1.0 A
- Compatible with low ESR capacitor
- Low circuit current at output OFF  $I_q \leq 350 \mu\text{A}$  ( $I_o = 0 \text{ A}$ ,  $V_c = 2 \text{ V}$ )
- Low current consumption  $I_q (\text{OFF}) \leq 1 \mu\text{A}$  ( $V_c = 0 \text{ V}$ )
- Low dropout voltage  $V_{\text{DIF}} \leq 0.6 \text{ V}$  ( $I_o = 1 \text{ A}$ )
- 3 types of output voltages (2.5 V, 3.3 V, and variable type) available
- Output ON/OFF control terminal voltage compatible with LS-TTL
- Built-in drooping-type-overcurrent and thermal protection circuits

## Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                     | Symbol               | Ratings         | Unit |
|-----------------------------------------------|----------------------|-----------------|------|
| DC Input Voltage                              | $V_{\text{IN}}^{*1}$ | 17              | V    |
| Output Control Terminal Voltage               | $V_c$                | $V_{\text{IN}}$ | V    |
| DC Output Current                             | $I_o^{*1}$           | 1.0             | A    |
| Power Dissipation                             | $P_D^{*1, *2}$       | 0.76            | W    |
| Junction Temperature                          | $T_j$                | -40 to +125     | °C   |
| Storage Temperature                           | $T_{\text{stg}}$     | -40 to +125     | °C   |
| Thermal Resistance (Junction to Ambient Air)  | $\theta_{\text{JA}}$ | 130             | °C/W |
| Thermal resistance (Junction to Lead (pin 7)) | $\theta_{\text{JL}}$ | 22              | °C/W |

\*1:  $V_{\text{IN}}$  (max) and  $I_o$  (max) are restricted by the relation  $P_D = (V_{\text{IN}} - V_o) \times I_o$ . Please calculate these values referring to the Copper laminate area vs. Power dissipation data as shown hereinafter.

\*2: When mounted on a glass epoxy board of 1600 mm<sup>2</sup> (copper laminate area 2%).

## Applications

- Local power supplies
- Battery-driven electronic equipment

## Electrical Characteristics

(T<sub>a</sub>=25°C, V<sub>c</sub>=2 V, unless otherwise specified)

| Parameter                                                            |                                           | Symbol                             | Ratings                                                                             |      |      |                                                               |      |      |                                                             |       |       | Unit  |
|----------------------------------------------------------------------|-------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|------|------|---------------------------------------------------------------|------|------|-------------------------------------------------------------|-------|-------|-------|
|                                                                      |                                           |                                    | SI-3012KS (variable type)                                                           |      |      | SI-3025KS                                                     |      |      | SI-3033KS                                                   |       |       |       |
|                                                                      |                                           |                                    | min.                                                                                | typ. | max. | min.                                                          | typ. | max. | min.                                                        | typ.  | max.  |       |
| Input Voltage                                                        |                                           | V <sub>IN</sub>                    | 2.4                                                                                 |      |      | *1                                                            |      |      | *1                                                          |       |       | V     |
| Output Voltage<br>(Reference voltage V <sub>ADJ</sub> for SI-3012KS) |                                           | V <sub>O</sub> (V <sub>ADJ</sub> ) | 1.24                                                                                | 1.28 | 1.32 | 2.45                                                          | 2.50 | 2.55 | 3.234                                                       | 3.300 | 3.366 | V     |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =10mA                                         |      |      | V <sub>IN</sub> =3.3V, I <sub>O</sub> =10mA                   |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =10mA                   |       |       |       |
| Dropout Voltage                                                      |                                           | V <sub>DIF</sub>                   |                                                                                     |      | 0.3  |                                                               |      | 0.4  |                                                             |       | 0.4   | V     |
|                                                                      |                                           | Conditions                         | I <sub>O</sub> =0.5A (V <sub>O</sub> =2.5V)                                         |      |      | I <sub>O</sub> =0.5A                                          |      |      | I <sub>O</sub> =0.5A                                        |       |       |       |
|                                                                      |                                           |                                    |                                                                                     |      | 0.6  |                                                               |      | 0.6  |                                                             |       | 0.6   |       |
|                                                                      |                                           | Conditions                         | I <sub>O</sub> =1A (V <sub>O</sub> =2.5V)                                           |      |      | I <sub>O</sub> =1A                                            |      |      | I <sub>O</sub> =1A                                          |       |       |       |
| Line Regulation                                                      |                                           | ΔV <sub>OLINE</sub>                |                                                                                     |      | 10   |                                                               |      | 10   |                                                             |       | 15    | mV    |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3 to 8V, I <sub>O</sub> =10mA (V <sub>O</sub> =2.5V)             |      |      | V <sub>IN</sub> =3.3 to 8V, I <sub>O</sub> =10mA              |      |      | V <sub>IN</sub> =5 to 10V, I <sub>O</sub> =10mA             |       |       |       |
| Load Regulation                                                      |                                           | ΔV <sub>OLOAD</sub>                |                                                                                     |      | 40   |                                                               |      | 40   |                                                             |       | 50    | mV    |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 1A (V <sub>O</sub> =2.5V)               |      |      | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 1A                |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =0 to 1A                |       |       |       |
| Quiescent Circuit Current                                            |                                           | I <sub>q</sub>                     |                                                                                     |      | 350  |                                                               |      | 350  |                                                             |       | 350   | μA    |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A, V <sub>C</sub> =2V, R <sub>2</sub> =24kΩ |      |      | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |       |       |       |
| Circuit Current at Output OFF                                        |                                           | I <sub>q</sub> (OFF)               |                                                                                     |      | 1    |                                                               |      | 1    |                                                             |       | 1     | μA    |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V, V <sub>C</sub> =0V                                           |      |      | V <sub>IN</sub> =3.3V, V <sub>C</sub> =0V                     |      |      | V <sub>IN</sub> =5V, V <sub>C</sub> =0V                     |       |       |       |
| Temperature Coefficient of Output Voltage                            |                                           | ΔV <sub>O</sub> /ΔT <sub>a</sub>   |                                                                                     | ±0.3 |      | ±0.3                                                          |      | ±0.3 |                                                             |       |       | mV/°C |
|                                                                      |                                           | Conditions                         | T <sub>J</sub> =0 to 100°C (V <sub>O</sub> =2.5V)                                   |      |      | T <sub>J</sub> =0 to 100°C                                    |      |      | T <sub>J</sub> =0 to 100°C                                  |       |       |       |
| Ripple Rejection                                                     |                                           | R <sub>REJ</sub>                   |                                                                                     | 55   |      | 55                                                            |      | 55   |                                                             |       |       | dB    |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V, f=100 to 120Hz (V <sub>O</sub> =2.5V)                        |      |      | V <sub>IN</sub> =3.3V, f=100 to 120Hz                         |      |      | V <sub>IN</sub> =5V, f=100 to 120Hz                         |       |       |       |
| Overcurrent Protection Starting Current <sup>*2</sup>                |                                           | I <sub>S1</sub>                    | 1.2                                                                                 |      |      | 1.2                                                           |      |      | 1.2                                                         |       |       | A     |
|                                                                      |                                           | Conditions                         | V <sub>IN</sub> =3.3V (V <sub>O</sub> =2.5V)                                        |      |      | V <sub>IN</sub> =3.3V                                         |      |      | V <sub>IN</sub> =5V                                         |       |       |       |
| V <sub>C</sub> Terminal                                              | Control Voltage (Output ON) <sup>*3</sup> | V <sub>C</sub> , IH                | 2.0                                                                                 |      |      | 2.0                                                           |      |      | 2.0                                                         |       |       | V     |
|                                                                      | Control Voltage (Output OFF)              | V <sub>C</sub> , IL                |                                                                                     |      | 0.8  |                                                               |      | 0.8  |                                                             |       | 0.8   |       |
|                                                                      | Control Current (Output ON)               | I <sub>C</sub> , IH                |                                                                                     |      | 40   |                                                               |      | 40   |                                                             |       | 40    | μA    |
|                                                                      | Conditions                                | V <sub>C</sub> =2V                 |                                                                                     |      |      |                                                               |      |      |                                                             |       |       |       |
|                                                                      | Control Current (Output OFF)              | I <sub>C</sub> , IL                | -5                                                                                  | 0    |      | -5                                                            | 0    |      | -5                                                          | 0     |       | μA    |
| Conditions                                                           | V <sub>C</sub> =0V                        |                                    |                                                                                     |      |      |                                                               |      |      |                                                             |       |       |       |

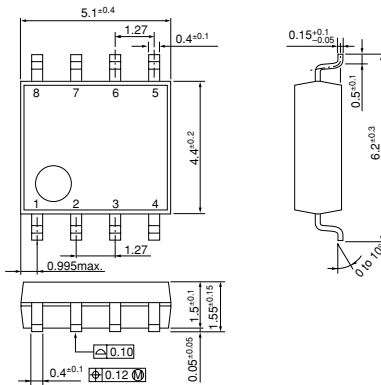
\*1: Refer to the Dropout Voltage parameter.

\*2: The  $I_{\text{S1}}$  is specified at the 5% drop point of output voltage  $V_o$  on the condition that  $V_{\text{IN}} = V_o + 1 \text{ V}$ , and  $I_o = 10 \text{ mA}$ .

\*3: Output is OFF when the output control terminal  $V_c$  is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

## ■External Dimensions (SOP8)

(Unit : mm)



## Pin Assignment

- ①  $V_C$
- ②  $V_{IN}$
- ③  $V_O$
- ④ Sense (ADJ for SI-3012KS)
- ⑤ GND
- ⑥ GND
- ⑦ GND
- ⑧ GND

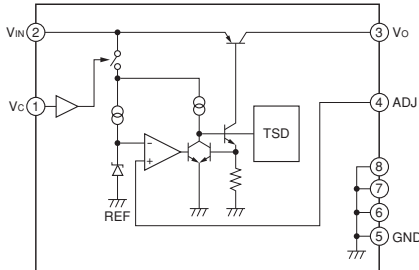
Plastic Mold Package Type

Flammability: UL 94V-0

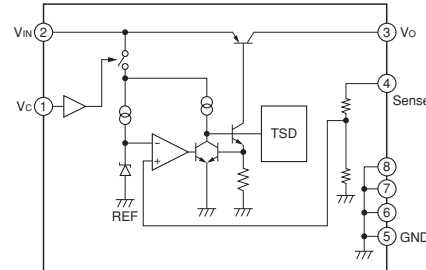
Product Mass: Approx. 0.1 g

## ■Block Diagram

## ●SI-3012KS

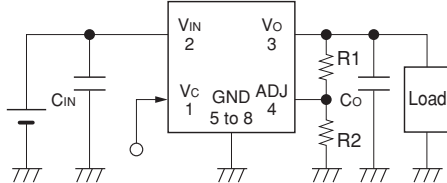


## ●SI-3025KS, SI-3033KS



## ■Typical Connection Diagram

## ●SI-3012KS

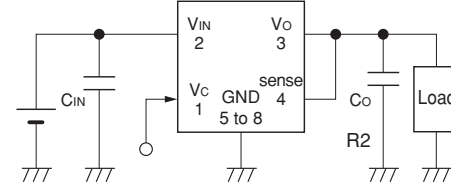


$R_1$ ,  $R_2$ : Output voltage setting resistors  
The output voltage can be set by connecting  $R_1$  and  $R_2$  as shown above.

The recommended value of  $R_2$  is 24 k $\Omega$ .

$$R_1 = (V_O - V_{ADJ}) \div (V_{ADJ} / R_2)$$

## ●SI-3025KS, SI-3033KS



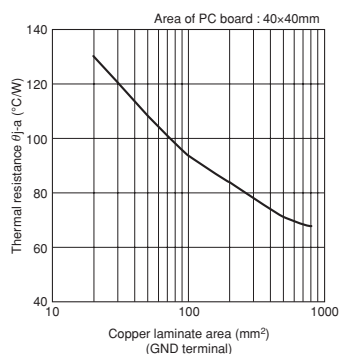
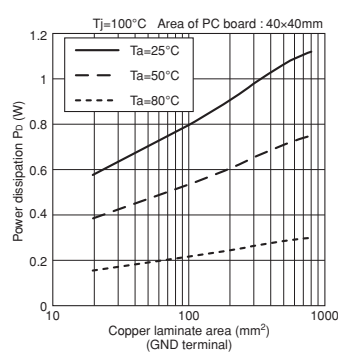
$C_{IN}$ : Input capacitor (22  $\mu$ F or larger)

$C_O$ : Output capacitor (22  $\mu$ F or larger)

For SI-3000KS series,  $C_O$  has to be a low ESR capacitor.

When using the electrolytic capacitor, the SI-3000KS series may oscillate at a low temperature.

## ■Reference Data

Copper Laminate Area vs.  
Thermal ResistanceCopper Laminate Area vs.  
Power Dissipation

- Obtaining the junction temperature  
Measure the temperature  $T_L$  at the lead part of the GND pin (pin 7) with a thermocouple, etc. Then, substitute this value in the following formula to obtain the junction temperature.

$$T_J = P_D \times \theta_{J-L} + T_L \quad (\theta_{J-L} = 22^\circ\text{C/W})$$

# SI-3000KD Series Surface-Mount, Low Current Consumption, Low Dropout Voltage

## ■Features

- Compact surface-mount package (TO263-5)
- Output current: 1.0A
- Low dropout voltage:  $V_{DIF} \leq 0.6V$  (at  $I_O = 1.0A$ )
- Low circuit current consumption:  $I_Q \leq 350 \mu A$  (600  $\mu A$  for SI-3010KD, SI-3050KD)
- Low circuit current at output OFF:  $I_Q (OFF) \leq 1 \mu A$
- Built-in overcurrent, thermal protection circuits
- Compatible with low ESR capacitors (SI-3012KD and SI-3033KD)

## ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                    | Symbol                       | Ratings          |                  | Unit |
|----------------------------------------------|------------------------------|------------------|------------------|------|
|                                              |                              | SI-3012KD/3033KD | SI-3010KD/3050KD |      |
| DC Input Voltage                             | V <sub>IN</sub>              | 17               | 35 <sup>*1</sup> | V    |
| Output Control Terminal Voltage              | V <sub>c</sub>               | V <sub>IN</sub>  |                  | V    |
| DC Output Current                            | I <sub>O</sub>               | 1.0              |                  | A    |
| Power Dissipation                            | P <sub>D</sub> <sup>*2</sup> | 3                |                  | W    |
| Junction Temperature                         | T <sub>j</sub>               | -30 to +125      |                  | °C   |
| Storage Temperature                          | T <sub>stg</sub>             | -30 to +125      |                  | °C   |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{JA}$                | 33.3             |                  | °C/W |
| Thermal Resistance (Junction to Case)        | $\theta_{JC}$                | 3                |                  | °C/W |

\*1: A built-in input-overvoltage-protection circuit shuts down the output voltage at the Input Overvoltage Shutdown Voltage of the electrical characteristics.

\*2: When mounted on glass-epoxy board of 1600mm<sup>2</sup> (copper laminate area 100%).

## ■Applications

- Secondary stabilized power supply (local power supply)

## ■Electrical Characteristics 1 (Low Input Voltage type compatible with low ESR output capacitor)

(T<sub>a</sub>=25°C, V<sub>c</sub>=2V, unless otherwise specified)

| Parameter                                             |                                           | Symbol                             | Ratings                                                                              |      |      |                                                             |       |       | Unit  |
|-------------------------------------------------------|-------------------------------------------|------------------------------------|--------------------------------------------------------------------------------------|------|------|-------------------------------------------------------------|-------|-------|-------|
|                                                       |                                           |                                    | SI-3012KD (Variable type)                                                            |      |      | SI-3033KD                                                   |       |       |       |
|                                                       |                                           |                                    | min.                                                                                 | typ. | max. | min.                                                        | typ.  | max.  |       |
| Input Voltage                                         |                                           | V <sub>IN</sub>                    | 2.4 <sup>*3</sup>                                                                    |      | *4   | *3                                                          |       | *4    | V     |
| Output Voltage<br>(Reference Voltage for SI-3012KD)   |                                           | V <sub>O</sub> (V <sub>ADJ</sub> ) | 1.24                                                                                 | 1.28 | 1.32 | 3.234                                                       | 3.300 | 3.366 | V     |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =10mA                                          |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =10mA                   |       |       |       |
| Line Regulation                                       |                                           | ΔV <sub>OLINE</sub>                |                                                                                      |      | 15   |                                                             |       | 15    | mV    |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3 to 8V, I <sub>O</sub> =10mA (V <sub>O</sub> =2.5V)              |      |      | V <sub>IN</sub> =5 to 10V, I <sub>O</sub> =10mA             |       |       |       |
| Load Regulation                                       |                                           | ΔV <sub>OLOAD</sub>                |                                                                                      |      | 40   |                                                             |       | 50    | mV    |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 1A (V <sub>O</sub> =2.5V)                |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =0 to 1A                |       |       |       |
| Dropout Voltage                                       |                                           | V <sub>DIF</sub>                   |                                                                                      |      | 0.4  |                                                             |       | 0.4   | V     |
|                                                       |                                           | Conditions                         | I <sub>O</sub> =0.5A (V <sub>O</sub> =2.5V)                                          |      |      | I <sub>O</sub> =0.5A                                        |       |       |       |
|                                                       |                                           |                                    |                                                                                      |      | 0.6  |                                                             |       | 0.6   |       |
|                                                       |                                           | Conditions                         | I <sub>O</sub> =1A (V <sub>O</sub> =2.5V)                                            |      |      | I <sub>O</sub> =1A                                          |       |       |       |
| Quiescent Circuit Current                             |                                           | I <sub>Q</sub>                     |                                                                                      |      | 350  |                                                             |       | 350   | μA    |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0A, V <sub>C</sub> =2V, R <sub>2</sub> =2.4kΩ |      |      | V <sub>IN</sub> =5V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |       |       |       |
| Circuit Current at Output OFF                         |                                           | I <sub>Q</sub> (OFF)               |                                                                                      |      | 1    |                                                             |       | 1     | μA    |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V, V <sub>C</sub> =0V                                            |      |      | V <sub>IN</sub> =5V, V <sub>C</sub> =0V                     |       |       |       |
| Temperature Coefficient of Output Voltage             |                                           | ΔV <sub>O</sub> /ΔT <sub>a</sub>   |                                                                                      | ±0.3 |      |                                                             | ±0.3  |       | mV/°C |
|                                                       |                                           | Conditions                         | T <sub>J</sub> =0 to 100°C (V <sub>O</sub> =2.5V)                                    |      |      | T <sub>J</sub> =0 to 100°C                                  |       |       |       |
| Ripple Rejection                                      |                                           | R <sub>REJ</sub>                   |                                                                                      | 55   |      |                                                             | 55    |       | dB    |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V, f=100 to 120Hz, I <sub>O</sub> =0.1A (V <sub>O</sub> =2.5V)   |      |      | V <sub>IN</sub> =5V, f=100 to 120Hz, I <sub>O</sub> =0.1A   |       |       |       |
| Overcurrent Protection Starting Current <sup>*1</sup> |                                           | I <sub>S1</sub>                    | 1.1                                                                                  |      |      | 1.1                                                         |       |       | A     |
|                                                       |                                           | Conditions                         | V <sub>IN</sub> =3.3V                                                                |      |      | V <sub>IN</sub> =5V                                         |       |       |       |
| V <sub>C</sub> Terminal                               | Control Voltage (Output ON) <sup>*2</sup> | V <sub>C</sub> , I <sub>H</sub>    | 2                                                                                    |      |      | 2                                                           |       |       | V     |
|                                                       | Control Voltage (Output OFF)              | V <sub>C</sub> , I <sub>L</sub>    |                                                                                      |      | 0.8  |                                                             |       | 0.8   |       |
|                                                       | Control Current (Output ON)               | I <sub>C</sub> , I <sub>H</sub>    |                                                                                      |      | 40   |                                                             |       | 40    | μA    |
|                                                       |                                           | Conditions                         | V <sub>C</sub> =2V                                                                   |      |      | V <sub>C</sub> =2V                                          |       |       |       |
|                                                       | Control Current (Output OFF)              | I <sub>C</sub> , I <sub>L</sub>    | −5                                                                                   | 0    |      | −5                                                          | 0     |       | μA    |
|                                                       |                                           | Conditions                         | V <sub>C</sub> =0V                                                                   |      |      | V <sub>C</sub> =0V                                          |       |       |       |

\*1: I<sub>S1</sub> is specified at the 5% drop point of output voltage V<sub>O</sub> under the condition of Output Voltage parameter.

\*2: Output is OFF when the output control terminal (V<sub>c</sub> terminal) is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

\*3: Refer to the Dropout Voltage parameter.

\*4: V<sub>IN</sub> (max) and I<sub>O</sub> (max) are restricted by the relation P<sub>D</sub> = (V<sub>IN</sub> - V<sub>O</sub>) × I<sub>O</sub>. Please calculate these values referring to the Copper laminate area vs. Power dissipation data.

## ■Electrical Characteristics 2 (High Input Voltage Type)

| Parameter                                                              |                                            | Symbol                             | Ratings                                                                             |      |                  |                                                                |      |      | Unit             |   |
|------------------------------------------------------------------------|--------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|------|------------------|----------------------------------------------------------------|------|------|------------------|---|
|                                                                        |                                            |                                    | SI-3010KD (Variable type)                                                           |      |                  | SI-3050KD                                                      |      |      |                  |   |
|                                                                        |                                            |                                    | min.                                                                                | typ. | max.             | min.                                                           | typ. | max. |                  |   |
| Input Voltage                                                          |                                            | V <sub>IN</sub>                    | 2.4 <sup>*1</sup>                                                                   |      | 27 <sup>*5</sup> |                                                                | *1   |      | 15 <sup>*5</sup> | V |
| Output Voltage<br>(Reference Voltage V <sub>ADJ</sub> for SI-3010KD)   |                                            | V <sub>O</sub> (V <sub>ADJ</sub> ) | 0.98                                                                                | 1.00 | 1.02             | 4.90                                                           | 5.00 | 5.10 | V                |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V, I <sub>O</sub> =10mA                                           |      |                  | V <sub>IN</sub> =7V, I <sub>O</sub> =10mA                      |      |      |                  |   |
| Line Regulation                                                        |                                            | ΔV <sub>OLINE</sub>                |                                                                                     |      | 30               |                                                                |      | 30   | mV               |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =6 to 11V,<br>I <sub>O</sub> =10mA (V <sub>O</sub> =5V)             |      |                  | V <sub>IN</sub> =6 to 11V, I <sub>O</sub> =10mA                |      |      |                  |   |
| Load Regulation                                                        |                                            | ΔV <sub>OLOAD</sub>                |                                                                                     |      | 75               |                                                                |      | 75   | mV               |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V,<br>I <sub>O</sub> =0 to 1A (V <sub>O</sub> =5V)                |      |                  | V <sub>IN</sub> =7V, I <sub>O</sub> =0 to 1A                   |      |      |                  |   |
| Dropout Voltage                                                        |                                            | V <sub>DIF</sub>                   |                                                                                     |      | 0.3              |                                                                |      | 0.3  | V                |   |
|                                                                        |                                            | Conditions                         | I <sub>O</sub> =0.5A (V <sub>O</sub> =5V)                                           |      |                  | I <sub>O</sub> =0.5A                                           |      |      |                  |   |
|                                                                        |                                            |                                    |                                                                                     |      | 0.6              |                                                                |      | 0.6  |                  |   |
|                                                                        |                                            | Conditions                         | I <sub>O</sub> =1A (V <sub>O</sub> =5V)                                             |      |                  | I <sub>O</sub> =1A                                             |      |      |                  |   |
| Quiescent Circuit Current                                              |                                            | I <sub>q</sub>                     |                                                                                     |      | 600              |                                                                |      | 600  | μA               |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V, I <sub>O</sub> =0A, V <sub>C</sub> =2V<br>R <sub>2</sub> =10kΩ |      |                  | V <sub>IN</sub> =7V, I <sub>O</sub> =0A,<br>V <sub>C</sub> =2V |      |      |                  |   |
| Circuit Current at Output OFF                                          |                                            | I <sub>q</sub> (OFF)               |                                                                                     |      | 1                |                                                                |      | 1    | μA               |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V, V <sub>C</sub> =0V                                             |      |                  | V <sub>IN</sub> =7V, V <sub>C</sub> =0V                        |      |      |                  |   |
| Temperature Coefficient of<br>Output Voltage                           |                                            | ΔV <sub>O</sub> /ΔT <sub>a</sub>   |                                                                                     | ±0.5 |                  |                                                                | ±0.5 |      | mV/°C            |   |
|                                                                        |                                            | Conditions                         | T <sub>J</sub> =0 to 100°C (V <sub>O</sub> =5V)                                     |      |                  | T <sub>J</sub> =0 to 100°C                                     |      |      |                  |   |
| Ripple Rejection                                                       |                                            | R <sub>REJ</sub>                   |                                                                                     | 75   |                  |                                                                | 75   |      | dB               |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V,<br>f=100 to 120Hz, I <sub>O</sub> =0.1A (V <sub>O</sub> =5V)   |      |                  | V <sub>IN</sub> =7V,<br>f=100 to 120Hz, I <sub>O</sub> =0.1A   |      |      |                  |   |
| Overcurrent Protection Starting Current <sup>*2</sup><br><sup>*4</sup> |                                            | I <sub>S1</sub>                    | 1.1                                                                                 |      |                  | 1.1                                                            |      |      | A                |   |
|                                                                        |                                            | Conditions                         | V <sub>IN</sub> =7V                                                                 |      |                  | V <sub>IN</sub> =7V                                            |      |      |                  |   |
| V <sub>C</sub><br>Terminal                                             | Control Voltage (Output ON) <sup>*3</sup>  | V <sub>C</sub> , I <sub>H</sub>    | 2.0                                                                                 |      |                  | 2.0                                                            |      |      | V                |   |
|                                                                        | Control Voltage (Output OFF) <sup>*3</sup> | V <sub>C</sub> , I <sub>L</sub>    |                                                                                     |      | 0.8              |                                                                |      | 0.8  |                  |   |
|                                                                        |                                            | I <sub>C</sub> , I <sub>H</sub>    |                                                                                     |      | 40               |                                                                |      | 40   | μA               |   |
|                                                                        | Control Current (Output ON)                | Conditions                         | V <sub>C</sub> =2V                                                                  |      |                  | V <sub>C</sub> =2V                                             |      |      |                  |   |
|                                                                        | Control Current (Output OFF)               | I <sub>C</sub> , I <sub>L</sub>    | -5                                                                                  | 0    |                  | -5                                                             | 0    |      | μA               |   |
| Input Overvoltage Shutdown<br>Voltage                                  |                                            | V <sub>OVP</sub>                   | 33                                                                                  |      |                  | 26                                                             |      |      | V                |   |
|                                                                        |                                            | Conditions                         | I <sub>O</sub> =10mA                                                                |      |                  | I <sub>O</sub> =10mA                                           |      |      |                  |   |

\*1: Refer to the Dropout Voltage parameter.

\*2:  $I_{S1}$  is specified at the 5% drop point of output voltage  $V_O$  under the condition of Output Voltage parameter.

\*3: Output is OFF when the output control terminal ( $V_C$  terminal) is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

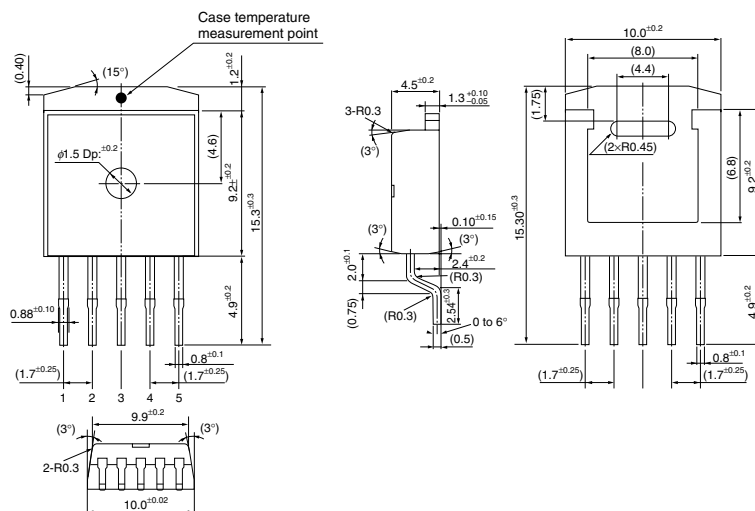
\*4: SI-3010KD, SI-3050KD, cannot be used in the following applications because the built-in foldback-type overcurrent protection may cause errors during start-up stage.

(1) Constant current load (2) Positive and negative power supply (3) Series-connected power supply (4)  $V_O$  adjustment by raising ground voltage

\*5:  $V_{IN}$  (max) and  $I_O$  (max) are restricted by the relation  $P_D = (V_{IN} - V_O) \times I_O$ . Please calculate these values referring to the Copper laminate area vs. Power dissipation data as shown hereinafter.

## ■External Dimensions (TO263-5)

(Unit : mm)



### Pin Assignment

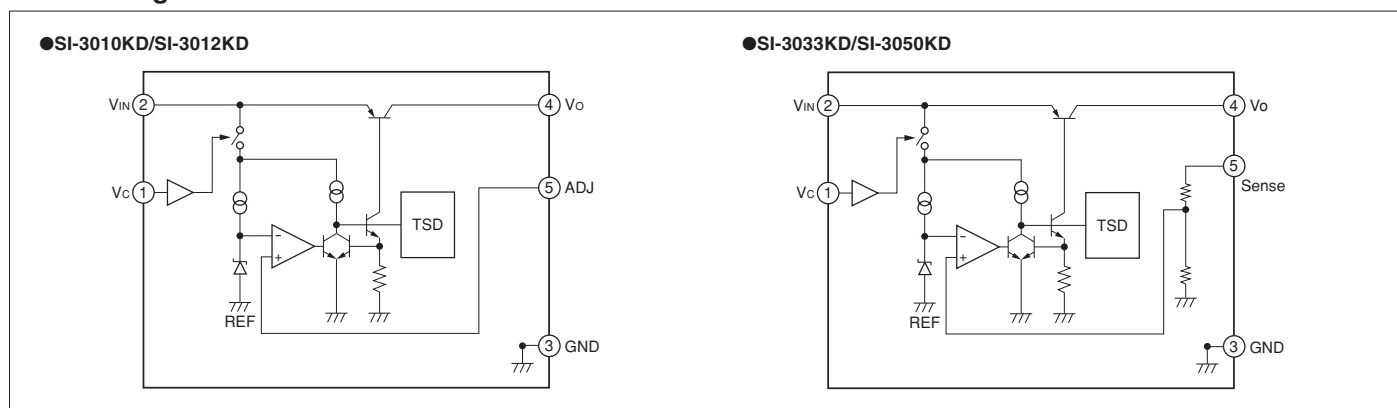
- ①  $V_C$
  - ②  $V_{IN}$
  - ③ GND (Common to the rear side of product)
  - ④  $V_O$
  - ⑤ Sense
- (ADJ for SI-3010KD/3012KD)

Plastic Mold Package Type

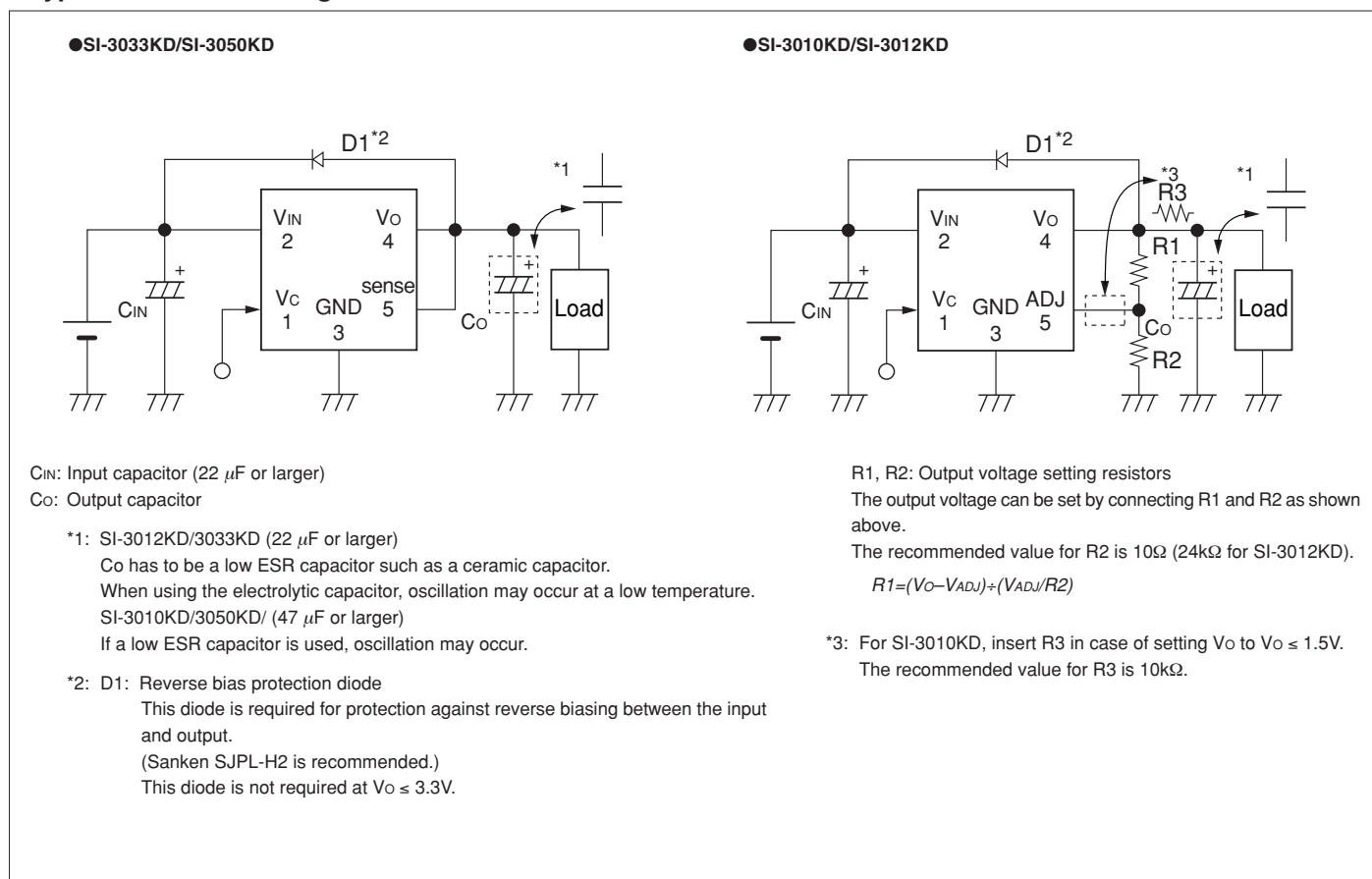
Flammability: UL94V-0

Product Mass: Approx. 1.48g

## Block Diagram

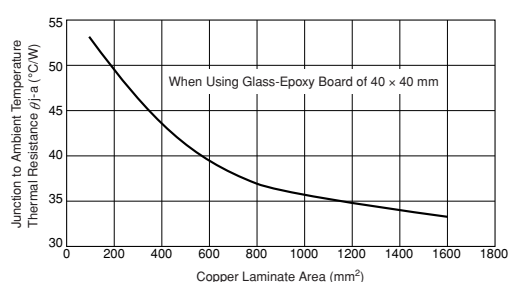


## Typical Connection Diagram



## Reference Data

Copper Laminate Area (on Glass-Epoxy Board) vs.  
Thermal Resistance (from Junction to Ambient Temperature) (Typical Value)



- A higher heat radiation effect can be achieved by enlarging the copper laminate area connected to the inner frame to which a monolithic ICs is mounted.
- Obtaining the junction temperature  
Measure the case temperature  $T_c$  with a thermocouple, etc. Then, substitute this value in the following formula to obtain the junction temperature.

$$T_J = P_D \times \theta_{J-C} + T_C \quad (\theta_{J-C} = 3^\circ\text{C/W}) \quad P_D = (V_{IN} - V_O) \cdot I_{OUT}$$



# SI-3000LLSL Series Surface-Mount, Low Current Consumption, Low Dropout Voltage

## ■Features

- Low input voltage (1.3V) and low output voltage (1.0V)
- Compact surface-mount package (SOP8)
- Low dropout voltage:  $V_{DIF} \leq 0.3V$  (at  $I_o = 1.5A$ )
- Built-in overcurrent, input-overvoltage and thermal protection circuits
- Built-in ON/OFF function (OFF state circuit current:  $1\mu A$  max.)
- Compatible with low ESR capacitors

## ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                     | Symbol              | Ratings         | Unit |
|-----------------------------------------------|---------------------|-----------------|------|
| DC Input Voltage                              | V <sub>IN</sub>     | 10              | V    |
| DC Bias Voltage                               | V <sub>B</sub>      | 10              | V    |
| Output Control Terminal Voltage               | V <sub>C</sub>      | V <sub>IN</sub> | V    |
| DC Output Current                             | I <sub>O</sub>      | 1.5             | A    |
| Power Dissipation                             | P <sub>D</sub> *1   | 1.1             | W    |
| Junction Temperature                          | T <sub>J</sub>      | -30 to +125     | °C   |
| Operating Ambient Temperature                 | T <sub>OP</sub>     | -30 to +100     | °C   |
| Storage Temperature                           | T <sub>stg</sub>    | -30 to +125     | °C   |
| Thermal Resistance (Junction to Lead (Pin 8)) | $\theta_{(J-L)}$    | 36              | °C/W |
| Thermal Resistance (Junction to Ambient Air)  | $\theta_{(J-a)}$ *1 | 100             | °C/W |

\*1: When mounted on glass-epoxy board of 40 × 40mm (copper laminate area 100%).

## ■Applications

- On-board local power supply
- For stabilization of the secondary-side output voltage of switching power supplies

## ■Recommended Operating Conditions

| Parameter                     | Symbol          | Ratings      | Unit |
|-------------------------------|-----------------|--------------|------|
|                               |                 | SI-3010LLSL  |      |
| Input Voltage                 | V <sub>IN</sub> | 1.4 to 3.6*1 | V    |
| Bias Voltage                  | V <sub>B</sub>  | 3.3 to 5.5   | V    |
| Output Current                | I <sub>O</sub>  | 0 to 1.5*1   | A    |
| Operating Ambient Temperature | T <sub>OP</sub> | -20 to +85*1 | °C   |

\*1: V<sub>IN</sub> (max) and I<sub>O</sub> (max) are restricted by the relation  $P_D = (V_{IN} - V_O) \times I_O$ .

## ■Electrical Characteristics

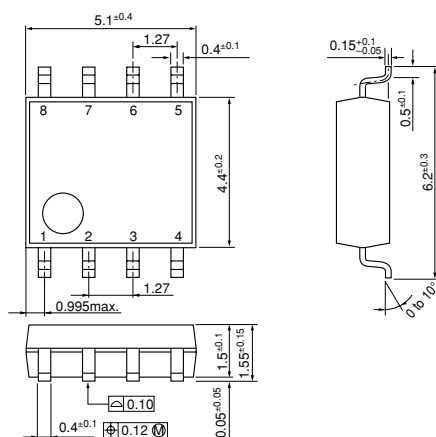
(T<sub>a</sub>=25°C, V<sub>C</sub>=2V, V<sub>IN</sub>=1.8V, V<sub>B</sub>=3.3V, V<sub>O</sub>=1.5V, unless otherwise specified)

| Parameter                                            |                                          | Symbol                                             | Ratings     |       |       | Unit |
|------------------------------------------------------|------------------------------------------|----------------------------------------------------|-------------|-------|-------|------|
|                                                      |                                          |                                                    | SI-3010LLSL |       |       |      |
|                                                      |                                          |                                                    | min.        | typ.  | max.  |      |
| Reference Voltage                                    | V <sub>ADJ</sub>                         | 0.980                                              | 1.000       | 1.020 | V     |      |
|                                                      | Conditions                               | I <sub>O</sub> =10mA                               |             |       |       |      |
| Line Regulation                                      | ΔV <sub>OLINE</sub>                      |                                                    |             | 10    | mV    |      |
|                                                      | Conditions                               | V <sub>IN</sub> =1.7 to 2.5V, I <sub>O</sub> =10mA |             |       |       |      |
| Load Regulation                                      | ΔV <sub>OLOAD</sub>                      |                                                    |             | 30    | mV    |      |
|                                                      | Conditions                               | V <sub>IN</sub> =1.8V, I <sub>O</sub> =0 to 1.5A   |             |       |       |      |
| Dropout Voltage                                      | V <sub>DIF</sub>                         |                                                    |             | 0.3   | V     |      |
|                                                      | Conditions                               | I <sub>O</sub> =1.0A                               |             |       |       |      |
| Quiescent Circuit Current                            | I <sub>q</sub>                           |                                                    | 500         | 800   | μA    |      |
|                                                      | Conditions                               | I <sub>O</sub> =0A, R <sub>2</sub> =10kΩ           |             |       |       |      |
| Circuit Current at Output OFF                        | I <sub>q</sub> (OFF)                     |                                                    |             | 1     | μA    |      |
|                                                      | Conditions                               | V <sub>C</sub> =0V                                 |             |       |       |      |
| Temperature Coefficient of Output Voltage            | ΔV <sub>O</sub> /ΔT <sub>a</sub>         |                                                    | ±0.2        |       | mV/°C |      |
|                                                      | Conditions                               | T <sub>J</sub> =0 to 100°C                         |             |       |       |      |
| Overcurrent Protection Starting Current <sup>1</sup> | I <sub>S1</sub>                          | 1.6                                                |             |       | A     |      |
|                                                      | Conditions                               | V <sub>IN</sub> =1.8V, V <sub>B</sub> =3.3V        |             |       |       |      |
| V <sub>C</sub> Terminal                              | Control Voltage (Output ON) <sup>2</sup> | V <sub>C</sub> , I <sub>H</sub>                    | 2           |       | V     |      |
|                                                      | Control Voltage (Output OFF)             | V <sub>C</sub> , I <sub>L</sub>                    |             | 0.8   | V     |      |
|                                                      | Control Current (Output ON)              | I <sub>C</sub> , I <sub>H</sub>                    |             | 50    | μA    |      |
|                                                      | Conditions                               | V <sub>C</sub> =2.7V                               |             |       |       |      |
|                                                      | Control Current (Output OFF)             | I <sub>C</sub> , I <sub>L</sub>                    |             | 10    | μA    |      |
|                                                      | Conditions                               | V <sub>C</sub> =0.4V                               |             |       |       |      |

\*1: I<sub>S1</sub> is specified at the 5% drop point of output voltage V<sub>O</sub> on the condition that V<sub>IN</sub> = overcurrent protection starting current, I<sub>O</sub> = 10 mA.\*2: Output is OFF when the output control terminal (V<sub>C</sub> terminal) is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

## External Dimensions (SOP8)

(Unit : mm)



### Pin Assignment

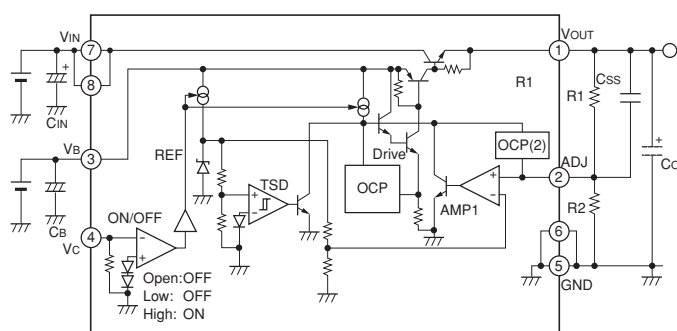
- ①  $V_O$
- ② ADJ
- ③  $V_B$
- ④  $V_C$
- ⑤ GND
- ⑥ GND
- ⑦  $V_{IN}$
- ⑧  $V_{IN}$

Plastic Mold Package Type

Flammability: UL94V-0

Product Mass: Approx. 0.1g

## Typical Connection Diagram/Block Diagram

 $C_{IN}$ ,  $C_B$ : Input and bias capacitors (Approx. 0.1 to 10 $\mu$ F)

Required when the input line contains inductance or when the wiring is long.

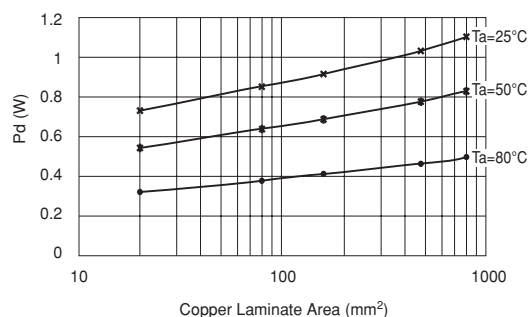
 $C_O$ : Output capacitor (47 $\mu$ F or larger)SI-3010LLSL is designed to use a low ESR capacitor (such as a ceramic capacitor) for the output capacitor. The recommended ESR value for an output capacitor is 500m $\Omega$  or less (at room temperature). $R_1$ ,  $R_2$ : Output voltage setting resistorsThe output voltage can be set by connecting  $R_1$  and  $R_2$  as shown at left.The recommended value for  $R_2$  is 10k $\Omega$ .

$$R_1 = (V_O - V_{ADJ}) / (V_{ADJ} / R_2)$$

 $C_{SS}$ : Soft start capacitorThe rising time of the output voltage can be set by connecting  $C_{SS}$  between  $V_{OUT}$  and ADJ.

## Reference Data

Copper Laminate Area - Power Dissipation



SI-3000ZD Series

Surface-Mount, Low Dropout Voltage

Features

- Compact surface-mount package (TO263-5)
- Output current: 3.0A
- Low dropout voltage:  $V_{DIF} \leq 0.6V$  (at  $I_O = 3.0A$ )
- Low circuit current at output OFF:  $I_q (OFF) \leq 1\mu A$
- Built-in overcurrent and thermal protection circuits

Applications

- Secondary stabilized power supply (local power supply)

Absolute Maximum Ratings

( $T_a=25^{\circ}C$ )

| Parameter                                    | Symbol         | Ratings     | Unit          |
|----------------------------------------------|----------------|-------------|---------------|
| DC Input Voltage                             | $V_{IN}^{*1}$  | 10          | V             |
| Output Control Terminal Voltage              | $V_C$          | 6           | V             |
| DC Output Current                            | $I_O^{*1}$     | 3.0         | A             |
| Power Dissipation                            | $P_D^{*3}$     | 3           | W             |
| Junction Temperature                         | $T_j$          | -30 to +125 | $^{\circ}C$   |
| Operating Ambient Temperature                | $T_{op}$       | -30 to +85  | $^{\circ}C$   |
| Storage Temperature                          | $T_{stg}$      | -40 to +125 | $^{\circ}C$   |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 33.3        | $^{\circ}C/W$ |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 3           | $^{\circ}C/W$ |

Recommended Operating Conditions

| Parameter                      | Symbol       | Ratings             | Unit        | Remarks                                         |
|--------------------------------|--------------|---------------------|-------------|-------------------------------------------------|
| Input Voltage                  | $V_{IN}$     | $^{*2}$ to $6^{*1}$ | V           |                                                 |
| Output Current                 | $I_O$        | 0 to 3              | A           |                                                 |
| Operating Ambient Temperature  | $T_{op} (a)$ | -20 to +85          | $^{\circ}C$ |                                                 |
| Operating Junction Temperature | $T_{op} (j)$ | -20 to +100         | $^{\circ}C$ |                                                 |
| Output Voltage Variable Range  | $V_{OAdj}$   | 1.2 to 5            | V           | Only for SI-3011ZD. Refer to the block diagram. |

\*1:  $V_{IN}$  (max) and  $I_O$  (max) are restricted by the relation  $P_D = (V_{IN} - V_O) \times I_O$ .  
\*2: Set the input voltage to 2.4V or higher when setting the output voltage to 2.0V or lower (SI-3011ZD).  
\*3: When mounted on glass-epoxy board of 40 × 40mm (copper laminate area 100%).

Electrical Characteristics

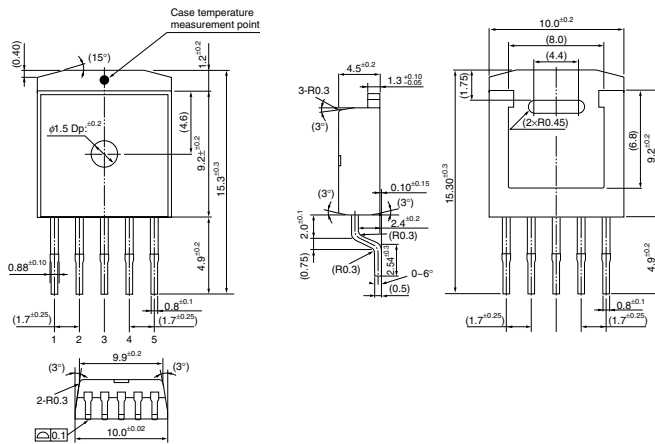
( $T_a=25^{\circ}C$ ,  $V_C=2V$ , unless otherwise specified)

| Parameter                                                            |                                            | Symbol                             | Ratings                                                                     |       |                      |                                                             |       |       | Unit  |
|----------------------------------------------------------------------|--------------------------------------------|------------------------------------|-----------------------------------------------------------------------------|-------|----------------------|-------------------------------------------------------------|-------|-------|-------|
|                                                                      |                                            |                                    | SI-3011ZD (Variable type)                                                   |       |                      | SI-3033ZD                                                   |       |       |       |
|                                                                      |                                            |                                    | min.                                                                        | typ.  | max.                 | min.                                                        | typ.  | max.  |       |
| Output Voltage<br>(Reference Voltage V <sub>ADJ</sub> for SI-3011ZD) |                                            | V <sub>O</sub> (V <sub>ADJ</sub> ) | 1.078                                                                       | 1.100 | 1.122                | 3.234                                                       | 3.300 | 3.366 | V     |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =10mA                   |       |                      | V <sub>IN</sub> =5V, I <sub>O</sub> =10mA                   |       |       |       |
| Line Regulation                                                      |                                            | ΔV <sub>OLINE</sub>                |                                                                             |       | 10                   |                                                             |       | 10    | mV    |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =3.3 to 5V, I <sub>O</sub> =10mA (V <sub>O</sub> =2.5V)     |       |                      | V <sub>IN</sub> =4.5 to 5.5V, I <sub>O</sub> =10mA          |       |       |       |
| Load Regulation                                                      |                                            | ΔV <sub>OLOAD</sub>                |                                                                             |       | 40                   |                                                             |       | 40    | mV    |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 3A (V <sub>O</sub> =2.5V)       |       |                      | V <sub>IN</sub> =5V, I <sub>O</sub> =0 to 3A                |       |       |       |
| Dropout Voltage                                                      |                                            | V <sub>DIF</sub>                   |                                                                             |       | 0.6                  |                                                             |       | 0.6   | V     |
|                                                                      |                                            | Conditions                         | I <sub>O</sub> =3A (V <sub>O</sub> =2.5V)                                   |       |                      | I <sub>O</sub> =3A                                          |       |       |       |
| Quiescent Circuit Current                                            |                                            | I <sub>q</sub>                     |                                                                             | 1     | 1.5                  |                                                             | 1     | 1.5   | mA    |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |       |                      | V <sub>IN</sub> =5V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |       |       |       |
| Circuit Current at Output OFF                                        |                                            | I <sub>q</sub> (OFF)               |                                                                             |       | 1                    |                                                             |       | 1     | μA    |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =V <sub>O</sub> +1V, V <sub>C</sub> =0V                     |       |                      | V <sub>IN</sub> =5V, V <sub>C</sub> =0V                     |       |       |       |
| Temperature Coefficient of Output Voltage                            |                                            | ΔV <sub>O</sub> /ΔT <sub>a</sub>   |                                                                             | ±0.3  |                      |                                                             | ±0.3  |       | mV/°C |
|                                                                      |                                            | Conditions                         | T <sub>J</sub> =0 to 100°C                                                  |       |                      | T <sub>J</sub> =0 to 100°C                                  |       |       |       |
| Ripple Rejection                                                     |                                            | R <sub>REJ</sub>                   |                                                                             | 60    |                      |                                                             | 60    |       | dB    |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =V <sub>O</sub> +1V, f=100 to 120Hz, I <sub>O</sub> =0.1A   |       |                      | V <sub>IN</sub> =5V, f=100 to 120Hz, I <sub>O</sub> =0.1A   |       |       |       |
| Overcurrent Protection Starting Current <sup>*2</sup>                |                                            | I <sub>S1</sub>                    | 3.2                                                                         |       |                      | 3.2                                                         |       |       | A     |
|                                                                      |                                            | Conditions                         | V <sub>IN</sub> =V <sub>O</sub> +1V                                         |       |                      | V <sub>IN</sub> =5V                                         |       |       |       |
| V <sub>C</sub> Terminal                                              | Control Voltage (Output ON) <sup>*3</sup>  | V <sub>C</sub> , IH                | 2                                                                           |       |                      | 2                                                           |       |       | V     |
|                                                                      | Control Voltage (Output OFF) <sup>*3</sup> | V <sub>C</sub> , IL                |                                                                             |       | 0.8                  |                                                             |       | 0.8   |       |
|                                                                      | Control Current(Output ON)                 | I <sub>C</sub> , IH                |                                                                             |       | 100                  |                                                             |       | 100   | μA    |
|                                                                      | Conditions                                 | V <sub>C</sub> =2.7V               |                                                                             |       | V <sub>C</sub> =2.7V |                                                             |       |       |       |
|                                                                      | Control Current(Output OFF)                | I <sub>C</sub> , IL                | -5                                                                          | 0     |                      | -5                                                          | 0     |       | μA    |
|                                                                      | Conditions                                 | V <sub>C</sub> =0V                 |                                                                             |       | V <sub>C</sub> =0V   |                                                             |       |       |       |

\*1: Set the input voltage to 2.4V or higher when setting the output voltage to 2.0V or lower.  
\*2:  $IS_1$  is specified at the -5% drop point of output voltage  $V_O$  under the condition of Output Voltage parameter.  
\*3: Output is OFF when the output control terminal ( $V_C$  terminal) is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.  
\*4: These products cannot be used for the following applications because the built-in foldback-type overcurrent protection may cause errors during start-up stage.  
(1) Constant current load (2) Positive and negative power supply (3) Series-connected power supply (4)  $V_O$  adjustment by raising ground voltage

## ■External Dimensions (TO263-5)

(Unit : mm)



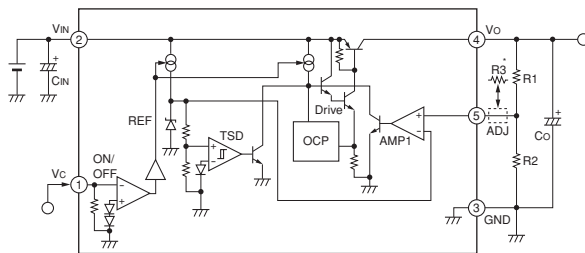
## Pin Assignment

- ① V<sub>C</sub>
  - ② V<sub>IN</sub>
  - ③ GND (Common to the rear side of product)
  - ④ V<sub>O</sub>
  - ⑤ Sense
- (ADJ for SI-3011ZD)

Plastic Mold Package Type  
 Flammability: UL94V-0  
 Product Mass: Approx. 1.48g

## ■Block Diagram

## SI-3011ZD

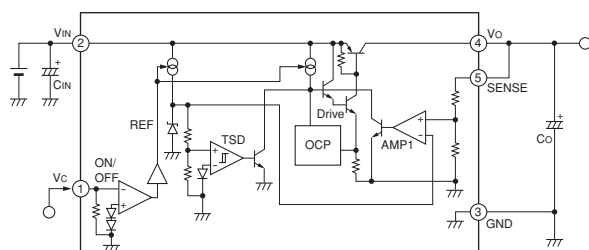


C<sub>IN</sub>: Input capacitor (Approx. 10μF)

C<sub>O</sub>: Output capacitor (47μF or larger)

The output voltage may oscillate if a low ESR type capacitor (such as a ceramic capacitor) is used for the output capacitor in the SI-3000ZD Series.

## SI-3033ZD



R1, R2: Output voltage setting resistors

The output voltage can be set by connecting R1 and R2 as shown at left.

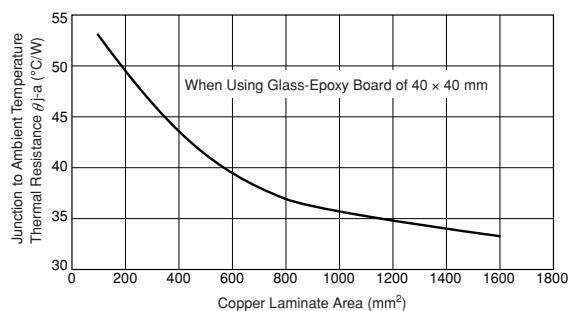
The recommended value for R2 is 10kΩ or 11kΩ.

$$R1 = (V_O - V_{ADJ}) / (V_{ADJ} / R2)$$

\*: Insert R3 in case of setting V<sub>O</sub> to V<sub>O</sub> ≤ 1.8V. The recommended value for R3 is 10kΩ.

## ■Reference Data

Copper Laminate Area (on Glass-Epoxy Board) vs.  
 Thermal Resistance (from Junction to Ambient Temperature) (Typical Value)



- A higher heat radiation effect can be achieved by enlarging the copper laminate area connected to the inner frame to which a monolithic IC is mounted.
- Obtaining the junction temperature  
 Measure GND terminal temperature T<sub>C</sub> with a thermocouple, etc. Then substitute this value in the following formula to obtain the junction temperature.

$$T_J = P_D \times \theta_{JA} + T_C \quad P_D = (V_{IN} - V_O) \times I_{OUT}$$

SI-3000KF Series

Low Current Consumption, Low Dropout Voltage

Features

- Compact full-mold package (equivalent to TO220)
- Output current: 1.0A
- Low dropout voltage:  $V_{DIF} \leq 0.5V$  (at  $I_o = 1.0A$ )
- High ripple rejection: 75dB
- Low circuit current at output OFF:  $I_q (OFF) \leq 1\mu A$
- Built-in overcurrent and thermal protection circuits

Applications

- Secondary stabilized power supply (local power supply)

Recommended Operating Conditions

| Parameter                      | Symbol   | Ratings                 | Unit |
|--------------------------------|----------|-------------------------|------|
|                                |          | SI-3010KF               |      |
| Input Voltage Range            | $V_{IN}$ | $2.4^{*2}$ to $27^{*1}$ | V    |
| Output Current Range           | $I_o$    | 0 to $1.0^{*1}$         | A    |
| Output Voltage Variable Range  | $V_oADJ$ | 1.1 to 16               | V    |
| Operating Ambient Temperature  | $T_{op}$ | -30 to +85              | °C   |
| Operating Junction Temperature | $T_j$    | -20 to +100             | °C   |

\*1:  $V_{IN}$  (max) and  $I_o$  (max) are restricted by the relationship  $P_D$  (max) =  $(V_{IN} - V_o) \times I_o = 16.6W$ .

\*2: Refer to the Dropout Voltage parameter.

Electrical Characteristics

| Parameter                                             |                                           | Symbol                                                                                                           | Ratings                                 |      |       | Unit |
|-------------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------|-------|------|
|                                                       |                                           |                                                                                                                  | SI-3010KF                               |      |       |      |
|                                                       |                                           |                                                                                                                  | min.                                    | typ. | max.  |      |
| Reference Voltage                                     | V <sub>ADJ</sub>                          | 0.98                                                                                                             | 1.00                                    | 1.02 | V     |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, I <sub>o</sub> =0.01A, V <sub>C</sub> =2V, V <sub>O</sub> =5A                               |                                         |      |       |      |
| Line Regulation                                       | ΔV <sub>OLINE</sub>                       |                                                                                                                  |                                         | 30   | mV    |      |
|                                                       | Conditions                                | V <sub>IN</sub> =6 to 15V, I <sub>o</sub> =0.01A, V <sub>C</sub> =2V, V <sub>O</sub> =5A                         |                                         |      |       |      |
| Load Regulation                                       | ΔV <sub>OLOAD</sub>                       |                                                                                                                  |                                         | 75   | mV    |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, I <sub>o</sub> =0 to 1A, V <sub>C</sub> =2V, V <sub>O</sub> =5A                             |                                         |      |       |      |
| Dropout Voltage                                       | V <sub>DIF</sub>                          |                                                                                                                  |                                         | 0.3  | V     |      |
|                                                       | Conditions                                | I <sub>o</sub> =0.5A, V <sub>C</sub> =2V, V <sub>O</sub> =5V                                                     |                                         |      |       |      |
|                                                       |                                           |                                                                                                                  |                                         | 0.5  |       |      |
|                                                       | Conditions                                | I <sub>o</sub> =1.0A, V <sub>C</sub> =2V, V <sub>O</sub> =5V                                                     |                                         |      |       |      |
| Quiescent Circuit Current                             | I <sub>q</sub>                            |                                                                                                                  |                                         | 600  | μA    |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, I <sub>o</sub> =0A, V <sub>C</sub> =2V                                                      |                                         |      |       |      |
| Circuit Current at Output OFF                         | I <sub>q</sub> (OFF)                      |                                                                                                                  |                                         | 1    | μA    |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, V <sub>C</sub> =0V                                                                          |                                         |      |       |      |
| Temperature Coefficient of Output Voltage             | ΔV <sub>O</sub> /ΔT <sub>a</sub>          |                                                                                                                  | ±0.5                                    |      | mV/°C |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, I <sub>o</sub> =0.01A, V <sub>C</sub> =2V, T <sub>J</sub> =0 to 100°C, V <sub>O</sub> =2.5V |                                         |      |       |      |
| Ripple Rejection                                      | R <sub>REJ</sub>                          |                                                                                                                  | 75                                      |      | dB    |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, I <sub>o</sub> =0.1A, V <sub>C</sub> =2V, f=100 to 120Hz, V <sub>O</sub> =5V                |                                         |      |       |      |
| Overcurrent Protection Starting Current <sup>*3</sup> | I <sub>S1</sub>                           | 1.1                                                                                                              |                                         |      | A     |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, V <sub>C</sub> =2V                                                                          |                                         |      |       |      |
| V <sub>C</sub> Terminal                               | Control Voltage (Output ON) <sup>*4</sup> | V <sub>C</sub> , I <sub>H</sub>                                                                                  | 2                                       |      | V     |      |
|                                                       |                                           | Conditions                                                                                                       | V <sub>IN</sub> =7V                     |      |       |      |
|                                                       | Control Voltage (Output OFF)              | V <sub>C</sub> , I <sub>L</sub>                                                                                  |                                         | 0.8  | V     |      |
|                                                       |                                           | Conditions                                                                                                       | V <sub>IN</sub> =7V                     |      |       |      |
|                                                       | Control Current (Output ON)               | I <sub>C</sub> , I <sub>H</sub>                                                                                  |                                         | 40   | μA    |      |
|                                                       |                                           | Conditions                                                                                                       | V <sub>IN</sub> =7V, V <sub>C</sub> =2V |      |       |      |
| Control Current (Output OFF)                          | I <sub>C</sub> , I <sub>L</sub>           | −5                                                                                                               | 0                                       | μA   |       |      |
|                                                       | Conditions                                | V <sub>IN</sub> =7V, V <sub>C</sub> =0V                                                                          |                                         |      |       |      |
| Input Overvoltage Shutdown Voltage                    | V <sub>OVP</sub>                          | 33                                                                                                               |                                         |      | V     |      |
|                                                       | Conditions                                | I <sub>o</sub> =0.01A                                                                                            |                                         |      |       |      |

\*3:  $I_{S1}$  is specified at the 5% drop point of output voltage  $V_o$  on the condition that  $V_{IN}$  = overcurrent protection starting current,  $I_o$  = 10 mA.

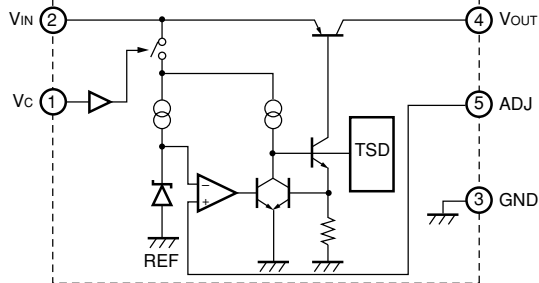
\*4: Output is OFF when the output control terminal  $V_C$  is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.

\*5: SI-3000KFE cannot be used in the following applications because the built-in foldback-type overcurrent protection may cause errors during start-up stage.

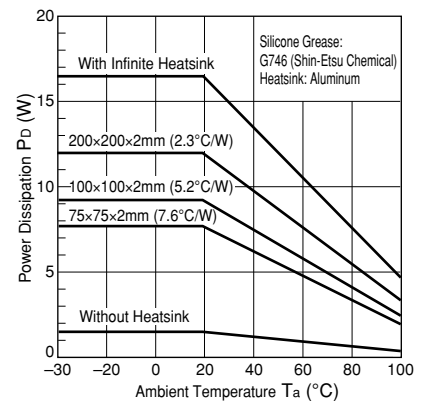
(1) Constant current load (2) Positive and negative power supply (3) Series-connected power supply (4)  $V_o$  adjustment by raising ground voltage

## Block Diagram

SI-3010KF

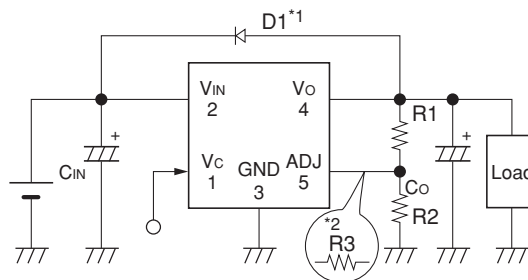


## Ta-PD Characteristics



## Typical Connection Diagram

●SI-3010KF



C<sub>IN</sub>: Input capacitor (22μF or larger)

C<sub>O</sub>: Output capacitor (47μF or larger)

If a low ESR capacitor (such as a ceramic capacitor) is used for the output capacitor, oscillation may occur.

\*1. D1: Reverse bias protection diode

This diode is required for protection against reverse biasing between the input and output.  
(Sanken RU2Z is recommended.)

R1, R2: Output voltage setting resistors

The output voltage can be adjusted by connecting R1 and R2 as shown above.

The recommended value for R2 is 10kΩ.

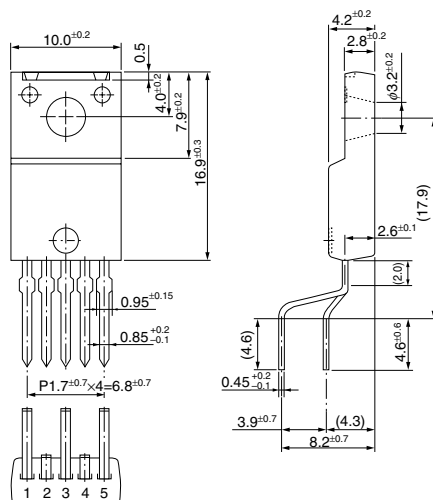
$$R1 = (V_O - V_{ADJ}) \div (V_{ADJ} / R2)$$

\*2: Insert R3 in case of setting V<sub>O</sub> to V<sub>O</sub> ≤ 1.5V.

The recommended value for R3 is 10kΩ.

## External Dimensions (TO220F-5)

(Unit : mm)



### Pin Assignment

- ① V<sub>C</sub>
- ② V<sub>IN</sub>
- ③ GND
- ④ V<sub>OUT</sub>
- ⑤ ADJ

Plastic Mold Package Type

Flammability: UL 94V-0

Product Mass: Approx. 2.3 g

SI-3000ZF Series

5-Terminal, Low Dropout Voltage

Features

- Compact full-mold package (equivalent to TO220)
- Output current: 3.0A
- Low dropout voltage:  $V_{DIF} \leq 0.7V$  (at  $I_o = 3.0A$ )
- Low circuit current at output OFF:  $I_q (OFF) \leq 1\mu A$
- Built-in overcurrent and thermal protection circuits

Applications

- Secondary stabilized power supply (local power supply)

Absolute Maximum Ratings

( $T_a = 25^{\circ}C$ )

| Parameter                                    | Symbol         | Ratings                                        | Unit          |
|----------------------------------------------|----------------|------------------------------------------------|---------------|
| DC Input Voltage                             | $V_{IN}^{*1}$  | 10                                             | V             |
| Output Control Terminal Voltage              | $V_c$          | 6                                              | V             |
| DC Output Current                            | $I_o^{*1}$     | 3.0                                            | A             |
| Power Dissipation                            | $P_{D1}$       | 20 (With infinite heatsink)                    | W             |
|                                              | $P_{D2}$       | 1.5 (Without heatsink, stand-alone operation)  | W             |
| Junction Temperature                         | $T_j$          | -30 to +125                                    | $^{\circ}C$   |
| Operating Ambient Temperature                | $T_{op}$       | -30 to +100                                    | $^{\circ}C$   |
| Storage Temperature                          | $T_{stg}$      | -30 to +125                                    | $^{\circ}C$   |
| Thermal Resistance (Junction to Case)        | $\theta_{j-c}$ | 5.0                                            | $^{\circ}C/W$ |
| Thermal Resistance (Junction to Ambient Air) | $\theta_{j-a}$ | 66.7 (Without heatsink, stand-alone operation) | $^{\circ}C/W$ |

Recommended Operating Conditions

| Parameter                      | Symbol       | Ratings              | Unit        |
|--------------------------------|--------------|----------------------|-------------|
| Input Voltage                  | $V_{IN}$     | $^{*2}$ to 6 $^{*1}$ | V           |
| Output Current                 | $I_o$        | 0 to 3               | A           |
| Operating Ambient Temperature  | $T_{op} (a)$ | -20 to +85           | $^{\circ}C$ |
| Operating Junction Temperature | $T_{op} (j)$ | -20 to +100          | $^{\circ}C$ |
| Output Voltage Variable Range  | $V_{OAJ}$    | 1.2 to 5             | V           |

\*1:  $V_{IN}$  (max) and  $I_o$  (max) are restricted by the relationship  $P_D = (V_{IN} - V_o) \times I_o$ .  
\*2: Set the input voltage to 2.4V or higher when setting the output voltage to 2.0V or lower.

Electrical Characteristics

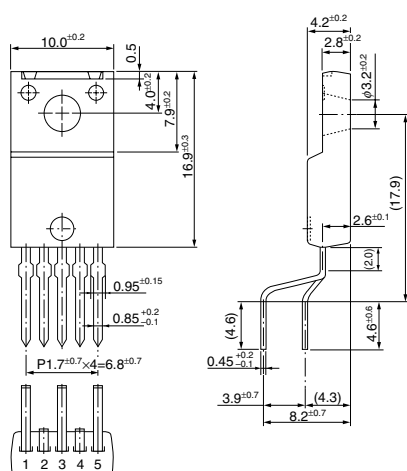
( $T_a = 25^{\circ}C$ ,  $V_c = 2V$ , unless otherwise specified)

| Parameter                                                   |                                            | Symbol                           | SI-3011ZF                                                                   |       |       | Unit  |
|-------------------------------------------------------------|--------------------------------------------|----------------------------------|-----------------------------------------------------------------------------|-------|-------|-------|
|                                                             |                                            |                                  | min.                                                                        | typ.  | max.  |       |
| Reference Voltage                                           |                                            | V <sub>ADJ</sub>                 | 1.078                                                                       | 1.100 | 1.122 | V     |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =10mA                   |       |       |       |
| Line Regulation                                             |                                            | ΔV <sub>OLINE</sub>              |                                                                             |       | 10    | mV    |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =3.3 to 5V, I <sub>O</sub> =10mA (V <sub>O</sub> =2.5V)     |       |       |       |
| Load Regulation                                             |                                            | ΔV <sub>OLOAD</sub>              |                                                                             |       | 40    | mV    |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =3.3V, I <sub>O</sub> =0 to 3A (V <sub>O</sub> =2.5V)       |       |       |       |
| Dropout Voltage                                             |                                            | V <sub>DIF</sub>                 |                                                                             |       | 0.7   | V     |
|                                                             |                                            | Conditions                       | I <sub>O</sub> =3A (V <sub>O</sub> =2.5V)                                   |       |       |       |
| Quiescent Circuit Current                                   |                                            | I <sub>q</sub>                   |                                                                             | 1     | 1.5   | mA    |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, I <sub>O</sub> =0A, V <sub>C</sub> =2V |       |       |       |
| Circuit Current at Output OFF                               |                                            | I <sub>q</sub> (OFF)             |                                                                             |       | 1     | μA    |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, V <sub>C</sub> =0V                     |       |       |       |
| Temperature Coefficient of Output Voltage                   |                                            | ΔV <sub>O</sub> /ΔT <sub>a</sub> |                                                                             | ±0.3  |       | mV/°C |
|                                                             |                                            | Conditions                       | T <sub>J</sub> =0 to 100°C                                                  |       |       |       |
| Ripple Rejection                                            |                                            | R <sub>REJ</sub>                 |                                                                             | 60    |       | dB    |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V, f=100 to 120Hz, I <sub>O</sub> =0.1A   |       |       |       |
| Overcurrent Protection Starting Current <sup>*2</sup><br>*4 |                                            | I <sub>S1</sub>                  | 3.2                                                                         |       |       | A     |
|                                                             |                                            | Conditions                       | V <sub>IN</sub> =V <sub>O</sub> +1V                                         |       |       |       |
| V <sub>C</sub> Terminal                                     | Control Voltage (Output ON) <sup>*3</sup>  | V <sub>C</sub> , I <sub>H</sub>  | 2                                                                           |       |       | V     |
|                                                             | Control Voltage (Output OFF) <sup>*3</sup> | V <sub>C</sub> , I <sub>L</sub>  |                                                                             |       | 0.8   |       |
|                                                             | Control Current(Output ON)                 | I <sub>C</sub> , I <sub>H</sub>  |                                                                             |       | 100   | μA    |
|                                                             |                                            | Conditions                       | V <sub>C</sub> =2.7V                                                        |       |       |       |
|                                                             | Control Current(Output OFF)                | I <sub>C</sub> , I <sub>L</sub>  | -5                                                                          | 0     |       | μA    |
|                                                             | Conditions                                 | V <sub>C</sub> =0V               |                                                                             |       |       |       |

\*1: Set the input voltage to 2.4V or higher when setting the output voltage to 2.0V or lower.  
\*2:  $I_{S1}$  is specified at the 5% drop point of output voltage  $V_o$  under the Output Voltage parameter conditions.  
\*3: Output is OFF when the output control terminal  $V_c$  is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly by LS-TTLs.  
\*4: These products cannot be used in the following applications because the built-in foldback-type overcurrent protection may cause errors during start-up stage.  
(1) Constant current load (2) Positive and negative power supply (3) Series-connected power supply (4)  $V_o$  adjustment by raising ground voltage

## External Dimensions (TO220F-5)

(Unit : mm)



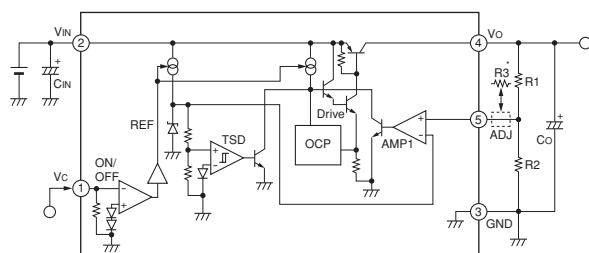
### Pin Assignment

- ①  $V_C$
- ②  $V_{IN}$
- ③ GND
- ④  $V_O$
- ⑤ ADJ

Plastic Mold Package Type  
Flammability: UL94V-0  
Product Mass: Approx. 2.3g

## Typical Connection Diagram/Block Diagram

### SI-3011ZF



$C_{IN}$ : Input capacitor (Approx.  $10\mu F$ )

This capacitor is required when the input line contains inductance or when the wiring is long.

$C_O$ : Output capacitor ( $47\mu F$  or higher)

The output voltage may oscillate if a low ESR type capacitor (such as a ceramic capacitor) is used for the output capacitor in SI-3000ZF.

$R_1$ ,  $R_2$ : Output voltage setting resistors

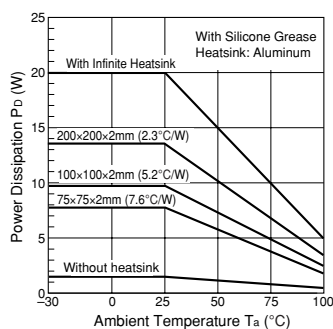
The output voltage can be set by connecting  $R_1$  and  $R_2$  as shown at left.

The recommended value for  $R_2$  is  $10k\Omega$  or  $11k\Omega$ .

$$R_1 = (V_O - V_{ADJ}) / (V_{ADJ} / R_2)$$

\*: Insert  $R_3$  in case of setting  $V_O$  to  $V_O \leq 1.8V$ . The recommended value for  $R_3$  is  $10k\Omega$ .

## $T_a$ - $P_D$ Characteristics



## 1-2 Motor Driver ICs

# Selection Guide

### 2-Phase Stepper Motor Unipolar Driver ICs

| Excitation Method                             | Output Current (A) |             |             |             | Motor Supply Voltage (V) | Package             | Remarks                                                                                       | Page |
|-----------------------------------------------|--------------------|-------------|-------------|-------------|--------------------------|---------------------|-----------------------------------------------------------------------------------------------|------|
|                                               | 1.0                | 1.5         | 2.0         | 3.0         |                          |                     |                                                                                               |      |
| 2-Phase Excitation                            | SLA7022MU          | SLA7029M    |             |             | to 46                    | ZIP15Pin with Fin   |                                                                                               | 96   |
|                                               | SMA7022MU          | SMA7029M    |             |             | to 46                    | ZIP15Pin            |                                                                                               |      |
| 2-Phase/1-2 Phase Excitation                  | SLA7027MU          | SLA7024M    |             | SLA7026M    | to 46                    | ZIP18Pin with Fin   |                                                                                               | 98   |
|                                               | SLA7070MR          | SLA7071MR   | SLA7072MR   | SLA7073MR   | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors                                                 | 100  |
|                                               | SLA7070MPR         | SLA7071MPR  | SLA7072MPR  | SLA7073MPR  | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors, Protection circuit                             |      |
|                                               | SLA7070MPRT        | SLA7071MPRT | SLA7072MPRT | SLA7073MPRT | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors, Protection circuit, Thermal protection circuit |      |
|                                               | SLA7080MPR         | SLA7081MPR  | SLA7082MPR  | SLA7083MPR  | to 46                    | ZIP23Pin with Fin   | Built-in Current sensing resistors, Protection circuit, Thermal protection circuit            | 102  |
| 2W 1-2 Phase Excitation<br>$\mu$ Step Support | STA7130MPR         | STA7131MPR  | STA7132MPR  |             | to 46                    | ZIP18Pin            | Built-in sequencer, Current sensing resistors, Protection circuit, Thermal protection circuit | 104  |
| 4W 1-2 Phase Excitation<br>$\mu$ Step Support |                    | SI-7321M    |             |             | to 46                    | Surface-Mount 44Pin | Built-in sequencer, Protection circuit                                                        | 106  |
|                                               | SLA7075MR          | SLA7076MR   | SLA7077MR   | SLA7078MR   | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors                                                 | 108  |
|                                               | SLA7075MPR         | SLA7076MPR  | SLA7077MPR  | SLA7078MPR  | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors, Protection circuit                             |      |
|                                               | SLA7075MPRT        | SLA7076MPRT | SLA7077MPRT | SLA7078MPRT | to 46                    | ZIP23Pin with Fin   | Built-in sequencer, Current sensing resistors, Protection circuit, Thermal protection circuit |      |

### 5-Phase Stepper Motor Driver ICs

| Excitation Method  | Part Number | Power Supply Voltage(V) | Package  | Remarks                     | Page |
|--------------------|-------------|-------------------------|----------|-----------------------------|------|
| New Pentagon Drive | SI-7510     | to 44                   | DIP30Pin | SLA5073+SLA5074 for Outputs | 110  |

### Brush DC Motor Driver ICs

| Part Number | Output Current (A) |                     | Power Supply Voltage (V) | Package  | Remarks            | Page |
|-------------|--------------------|---------------------|--------------------------|----------|--------------------|------|
|             | Average            | Maximum             |                          |          |                    |      |
| STA6940M    | 4.0                | 8.0(tw<100 $\mu$ S) | 10 to 44                 | ZIP18Pin | Single Full Bridge | 112  |

### Low Voltage 3-Phase Brushless DC Motor Driver ICs

| Part Number | Output Current (A) | Power Supply Voltage(V) | Package   | Remarks        | Page |
|-------------|--------------------|-------------------------|-----------|----------------|------|
| SPI-6631M   | 3.0                | 13 to 33                | HSOP16Pin | Predrive+Power | 114  |
| SI-6633M    | 4.0                | 10 to 38                | QFN36     | 1-chip         | 116  |
| SI-6633C    | —                  | 10 to 38                | QFN36     | Controller     | 118  |

## High Voltage 3-Phase Brushless Motor Driver ICs

| Part Number | Maximum Input Voltage | Output Current | Main Switch | RDS(on)/ VCE(sat) | Package   | Package Type  | Function*1 |      |    |    |    |     |    |        |         |     |     | Main Application                            | Page |
|-------------|-----------------------|----------------|-------------|-------------------|-----------|---------------|------------|------|----|----|----|-----|----|--------|---------|-----|-----|---------------------------------------------|------|
|             |                       |                |             |                   |           |               | 3.3V,5V    | UVLO | OC | OC | TD | TSD | FO | 3Shunt | Boot_Di | STP | Reg |                                             |      |
| SX68001MH   | 250V                  | 2.0A           | MOSFET      | 1.5Ω(max)         | SOP_27Pin | Surface-mount | ○          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | ○   | Fan motor                                   | 120  |
| SX68002MH   | 500V                  | 1.5A           | MOSFET      | 4.0Ω(max)         | SOP_27Pin | Surface-mount | ○          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | ○   |                                             |      |
| SX68003MH   |                       | 2.5A           | MOSFET      | 2.4Ω(max)         | SOP_27Pin | Surface-mount | ○          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | ○   |                                             |      |
| SMA6821MH   | 250V                  | 2.0A           | MOSFET      | 1.5Ω(max)         | SIP_24Pin | Full Mold     | ○          | ○    | —  | —  | ○  | —   | ○  | —      | ○       | —   | ○   | Fan motor                                   | 122  |
| SMA6822MH   |                       | 1.5A           | MOSFET      | 4.0Ω(max)         | SIP_24Pin | Full Mold     | ○          | ○    | —  | —  | ○  | —   | ○  | —      | ○       | —   | ○   |                                             |      |
| SMA6823MH   |                       | 2.5A           | MOSFET      | 2.4Ω(max)         | SIP_24Pin | Full Mold     | ○          | ○    | —  | —  | ○  | —   | ○  | —      | ○       | —   | ○   |                                             |      |
| SMA6862MZ   | 500V                  | 1.5A           | MOSFET      | 4.0Ω(max)         | SIP_24Pin | Full Mold     | —          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | —   | Fan motor                                   | 124  |
| SMA6863MZ   |                       |                | MOSFET      | 2.4Ω(max)         | SIP_24Pin | Full Mold     | —          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | —   |                                             |      |
| SMA6865MZ   |                       | 2.5A           | MOSFET      | 1.7Ω(max)         | SIP_24Pin | Full Mold     | —          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | —   |                                             |      |
| SLA6868MZ   |                       |                | MOSFET      | 2.4Ω(max)         | SIP_24Pin | With Fin      | —          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | —   | Fan motor, pump                             | 126  |
| SLA6870MZ   |                       | 3.0A           | MOSFET      | 1.7Ω(max)         | SIP_24Pin | With Fin      | —          | ○    | ○  | ○  | —  | ○   | ○  | —      | ○       | —   | —   |                                             |      |
| SIM6811M    |                       | 2.0A           | MOSFET      | 4.0Ω(max)         | DIP_40Pin | Full Mold     | ○          | ○    | ○  | ○  | —  | ○   | ○  | ○      | ○       | —   | —   | Fan motor                                   | 128  |
| SIM6812M    |                       | 2.5A           | MOSFET      | 2.4Ω(max)         | DIP_40Pin | Full Mold     | ○          | ○    | ○  | ○  | —  | ○   | ○  | ○      | ○       | —   | —   |                                             |      |
| SIM6822M    | 600V                  | 5A             | IGBT        | 1.75V(typ)        | DIP_40Pin | Full Mold     | ○          | ○    | ○  | ○  | —  | ○   | ○  | ○      | ○       | —   | —   | Fan motor, pump                             | 130  |
| SIM6827M*2  |                       |                | IGBT        | 1.75V(typ)        | DIP_40Pin | Full Mold     | ○          | ○    | ○  | ○  | —  | ○   | ○  | ○      | ○       | —   | —   | Refrigerator compressor                     |      |
| SCM1241M    |                       | 10A            | IGBT        | 1.7V(typ)         | DIP_33Pin | Full Mold     | ○          | ○    | ○  | —  | —  | ○   | ○  | ○      | ○       | ○   | —   | Air-conditioner compressor, Washing machine |      |
| SCM1243MF   |                       |                | IGBT        | 1.7V(typ)         | DIP_33Pin | With Fin      | ○          | ○    | ○  | —  | —  | ○   | ○  | ○      | ○       | ○   | —   | Air-conditioner compressor, Washing machine |      |
| SCM1245MF   |                       |                | IGBT        | 1.7V(typ)         | DIP_33Pin | With Fin      | ○          | ○    | ○  | —  | —  | ○   | ○  | ○      | ○       | ○   | —   | Air-conditioner compressor                  |      |
| SCM1246MF   |                       |                | IGBT        | 1.7V(typ)         | DIP_33Pin | With Fin      | ○          | ○    | ○  | —  | —  | ○   | ○  | ○      | ○       | ○   | —   | Air-conditioner compressor                  |      |
| SCM1248M    | 500V                  | 5A             | MOSFET      | 0.8Ω(max)         | DIP_33Pin | Full Mold     | ○          | ○    | ○  | —  | —  | ○   | ○  | ○      | ○       | ○   | —   | Refrigerator compressor                     |      |

\*1: 3.3V,5V 3.3 V and 5 V input levels are supported

UVLO ..... Under voltage lockout protection

OC ..... Over current protection

OCL ..... Overcurrent limiting

TD ..... Thermal detection

TSD ..... Thermal shutdown

FO ..... Fault output

3shunt ..... 3 shunt support

Boot\_Di .... Built-in bootstrap diode

STP ..... Shoot through prevention

Reg ..... Built-in regulator output

\*2: SIM6827M is the low noise version of SIM6822M.



# Application Note

## ■ Setup Precautions

- Recommended mounting torque  
0.588 to 0.784 [N•m](6.0 to 8.0 [kgf•cm])
- Recommended silicone grease  
Shin-Etsu Chemical Co., Ltd.: G746  
Momentive Performance Materials Inc.: YG-6260  
Dow Corning Toray Silicone Co., Ltd.: SC102  
Please select proper silicone grease carefully since the oil in some grease products may penetrate the device and result in an extremely short device life.

## ■ Handling Precautions

When using the following products that use C-MOS circuits for input terminals, observe the following.

SLA707xMR, MPR, MPRT

SLA708xMPR

SLA6800M Series

SMA6800M Series

STA713xM

STA6940M

SPI-6631M

SCM1200M Series

SX68000M Series

SI-66xx Series

SIM6800M Series

- Carefully control the humidity of the room to prevent the buildup of static electricity. Since static electricity is particularly a problem during the winter, be sure to take sufficient precautions.

Take care to make sure that static electricity is not applied to the IC during wiring and assembly. Take precautions such as shorting the terminals of the printed circuit board to ensure that they are at the same electrical potential.

## SLA7022MU/SLA7029M/SMA7022MU/SMA7029M 2-Phase Excitation

## ■Absolute Maximum Ratings

(Ta=25°C)

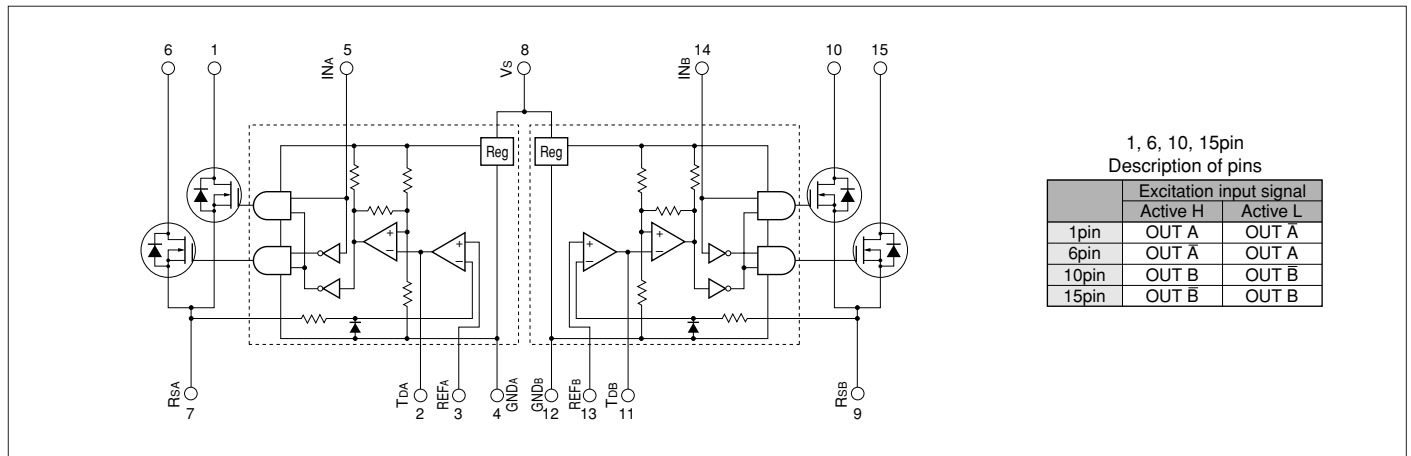
| Parameter                | Symbol           | Ratings                   |          |                           |          | Unit |
|--------------------------|------------------|---------------------------|----------|---------------------------|----------|------|
|                          |                  | SLA7022MU                 | SLA7029M | SMA7022MU                 | SMA7029M |      |
| Motor Supply Voltage     | V <sub>CC</sub>  | 46                        |          |                           |          | V    |
| FET Drain-Source Voltage | V <sub>DSS</sub> | 100                       |          |                           |          | V    |
| Control Supply Voltage   | V <sub>S</sub>   | 46                        |          |                           |          | V    |
| TTL Input Voltage        | V <sub>IN</sub>  | 7                         |          |                           |          | V    |
| Reference Voltage        | V <sub>REF</sub> | 2                         |          |                           |          | V    |
| Output Current           | I <sub>O</sub>   | 1                         | 1.5      | 1                         | 1.5      | A    |
| Power Dissipation        | P <sub>D1</sub>  | 4.5 (Without Heatsink)    |          | 4.0 (Without Heatsink)    |          | W    |
|                          | P <sub>D2</sub>  | 35 (T <sub>C</sub> =25°C) |          | 28 (T <sub>C</sub> =25°C) |          | W    |
| Channel Temperature      | T <sub>ch</sub>  | +150                      |          |                           |          | °C   |
| Storage Temperature      | T <sub>stg</sub> | −40 to +150               |          |                           |          | °C   |

## ■Electrical Characteristics

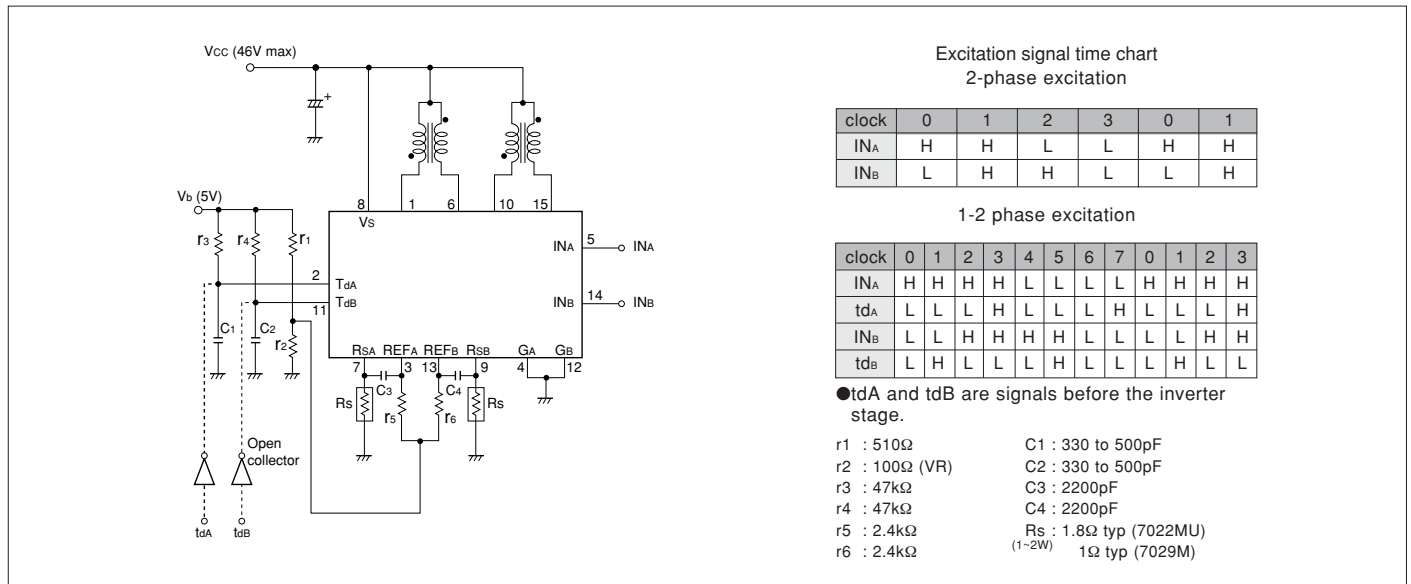
(Ta=25°C)

| Parameter          |                                 | Symbol           | Ratings                                      |                                            |      |                                              |                                            |      |                                              |                                            |      |                                              |                                            |      | Unit |
|--------------------|---------------------------------|------------------|----------------------------------------------|--------------------------------------------|------|----------------------------------------------|--------------------------------------------|------|----------------------------------------------|--------------------------------------------|------|----------------------------------------------|--------------------------------------------|------|------|
|                    |                                 |                  | SLA7022MU                                    |                                            |      | SLA7029M                                     |                                            |      | SMA7022MU                                    |                                            |      | SMA7029M                                     |                                            |      |      |
|                    |                                 |                  | min.                                         | typ.                                       | max. | min.                                         | typ.                                       | max. | min.                                         | typ.                                       | max. | min.                                         | typ.                                       | max. |      |
| DC Characteristics | Control Supply Current          | I <sub>S</sub>   |                                              | 10                                         | 15   |                                              | 10                                         | 15   |                                              | 10                                         | 15   |                                              | 10                                         | 15   | mA   |
|                    |                                 | Condition        | V <sub>S</sub> =44V                          |                                            |      | V <sub>S</sub> =44V                          |                                            |      | V <sub>S</sub> =44V                          |                                            |      | V <sub>S</sub> =44V                          |                                            |      |      |
|                    | Control Supply Voltage          | V <sub>S</sub>   | 10                                           | 24                                         | 44   | 10                                           | 24                                         | 44   | 10                                           | 24                                         | 44   | 10                                           | 24                                         | 44   | V    |
|                    | FET Drain-Source Voltage        | V <sub>DSS</sub> | 100                                          |                                            |      | 100                                          |                                            |      | 100                                          |                                            |      | 100                                          |                                            |      | V    |
|                    |                                 | Condition        | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |      | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |      | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |      | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |      |      |
|                    | FET ON Voltage                  | V <sub>DS</sub>  |                                              |                                            | 0.85 |                                              |                                            | 0.6  |                                              |                                            | 0.85 |                                              |                                            | 0.6  | V    |
|                    |                                 | Condition        | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |      | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |      | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |      | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |      |      |
|                    | FET Drain Leakage Current       | I <sub>DSS</sub> |                                              |                                            | 4    |                                              |                                            | 4    |                                              |                                            | 4    |                                              |                                            | 4    | mA   |
|                    |                                 | Condition        | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |      | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |      | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |      | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |      |      |
|                    | FET Diode Forward Voltage       | V <sub>SD</sub>  |                                              |                                            | 1.2  |                                              |                                            | 1.1  |                                              |                                            | 1.2  |                                              |                                            | 1.1  | V    |
|                    |                                 | Condition        | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      |      |
|                    | TTL Input Current               | I <sub>IH</sub>  |                                              |                                            | 40   |                                              |                                            | 40   |                                              |                                            | 40   |                                              |                                            | 40   | μA   |
|                    |                                 |                  | Condition                                    | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |      |      |
|                    |                                 | I <sub>IL</sub>  |                                              |                                            | -0.8 |                                              |                                            | -0.8 |                                              |                                            | -0.8 |                                              |                                            | -0.8 | mA   |
|                    |                                 |                  | Condition                                    | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |      |                                              | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |      |      |
|                    | TTL Input Voltage (Active High) | V <sub>IH</sub>  | 2                                            |                                            |      | 2                                            |                                            |      | 2                                            |                                            |      | 2                                            |                                            |      | V    |
|                    |                                 |                  | Condition                                    | I <sub>D</sub> =1A                         |      |                                              | I <sub>D</sub> =1A                         |      |                                              | I <sub>D</sub> =1A                         |      |                                              | I <sub>D</sub> =1A                         |      |      |
|                    |                                 | V <sub>IL</sub>  |                                              |                                            | 0.8  |                                              |                                            | 0.8  |                                              |                                            | 0.8  |                                              |                                            | 0.8  | V    |
|                    |                                 |                  | Condition                                    | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |      |
|                    | TTL Input Voltage (Active Low)  | V <sub>IH</sub>  | 2                                            |                                            |      | 2                                            |                                            |      | 2                                            |                                            |      | 2                                            |                                            |      | V    |
|                    |                                 |                  | Condition                                    | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |                                              | V <sub>DSS</sub> =100V                     |      |      |
| V <sub>IL</sub>    |                                 |                  |                                              | 0.8                                        |      |                                              | 0.8                                        |      |                                              | 0.8                                        |      |                                              | 0.8                                        | V    |      |
|                    |                                 | Condition        | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      | I <sub>D</sub> =1A                           |                                            |      |      |
| AC Characteristics | Switching Time                  | T <sub>r</sub>   |                                              | 0.5                                        |      |                                              | 0.5                                        |      |                                              | 0.5                                        |      |                                              | 0.5                                        | μs   |      |
|                    |                                 | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      |      |
|                    |                                 | T <sub>slg</sub> |                                              | 0.7                                        |      |                                              | 0.7                                        |      |                                              | 0.7                                        |      |                                              | 0.7                                        |      |      |
|                    |                                 | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      |      |
|                    |                                 | T <sub>f</sub>   |                                              | 0.1                                        |      |                                              | 0.1                                        |      |                                              | 0.1                                        |      |                                              | 0.1                                        |      |      |
|                    |                                 | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |      | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |      |      |

## Internal Block Diagram

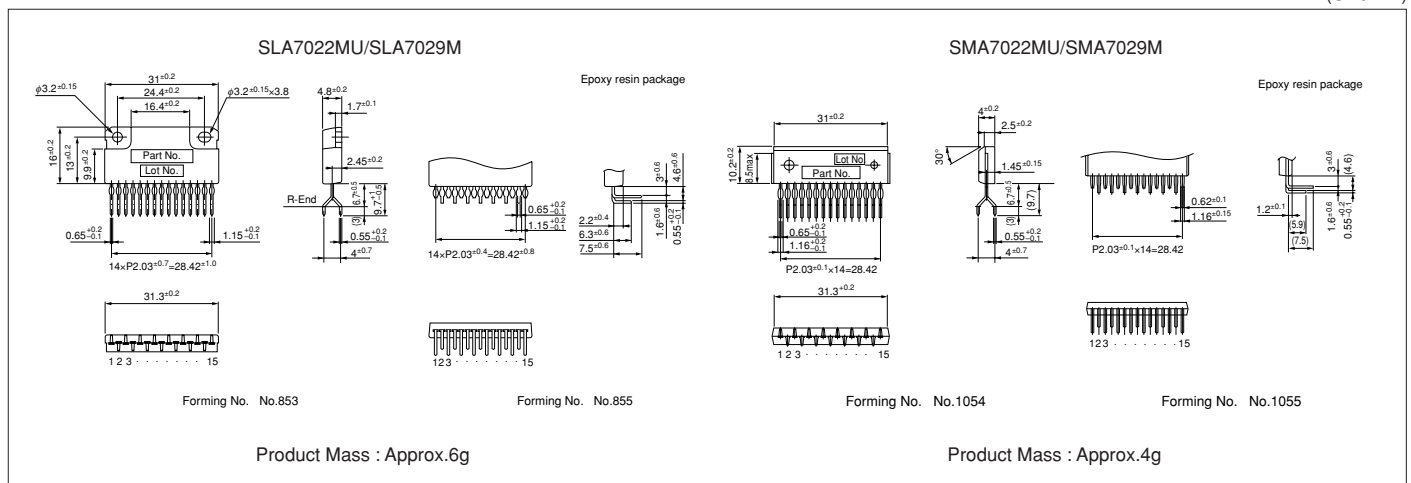


## Typical Connection Diagram (Recommended component values)



## External Dimensions (ZIP15 with Fin [SLA15Pin] /ZIP15[SMA15Pin])

(Unit:mm)



## SLA7027MU/SLA7024M/SLA7026M

## 2-Phase/1-2 Phase Excitation

## ■Absolute Maximum Ratings

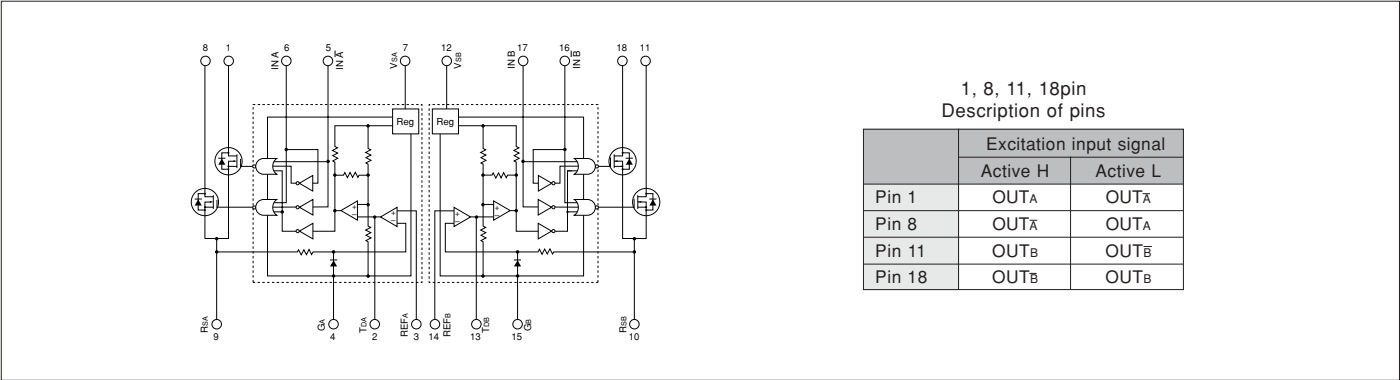
(T<sub>a</sub>=25°C)

| Parameter                | Symbol           | Ratings                   |          |          | Unit |
|--------------------------|------------------|---------------------------|----------|----------|------|
|                          |                  | SLA7027MU                 | SLA7024M | SLA7026M |      |
| Motor Supply Voltage     | V <sub>CC</sub>  | 46                        |          |          | V    |
| FET Drain-Source Voltage | V <sub>DSS</sub> | 100                       |          |          | V    |
| Control Supply Voltage   | V <sub>S</sub>   | 46                        |          |          | V    |
| Input Voltage            | V <sub>IN</sub>  | 7                         |          |          | V    |
| Reference Voltage        | V <sub>REF</sub> | 2                         |          |          | V    |
| Output Current           | I <sub>O</sub>   | 1                         | 1.5      | 3        | A    |
| Power Dissipation        | P <sub>D1</sub>  | 4.5 (Without Heatsink)    |          |          | W    |
|                          | P <sub>D2</sub>  | 35 (T <sub>C</sub> =25°C) |          |          | W    |
| Channel Temperature      | T <sub>ch</sub>  | +150                      |          |          | °C   |
| Storage Temperature      | T <sub>stg</sub> | -40 to +150               |          |          | °C   |

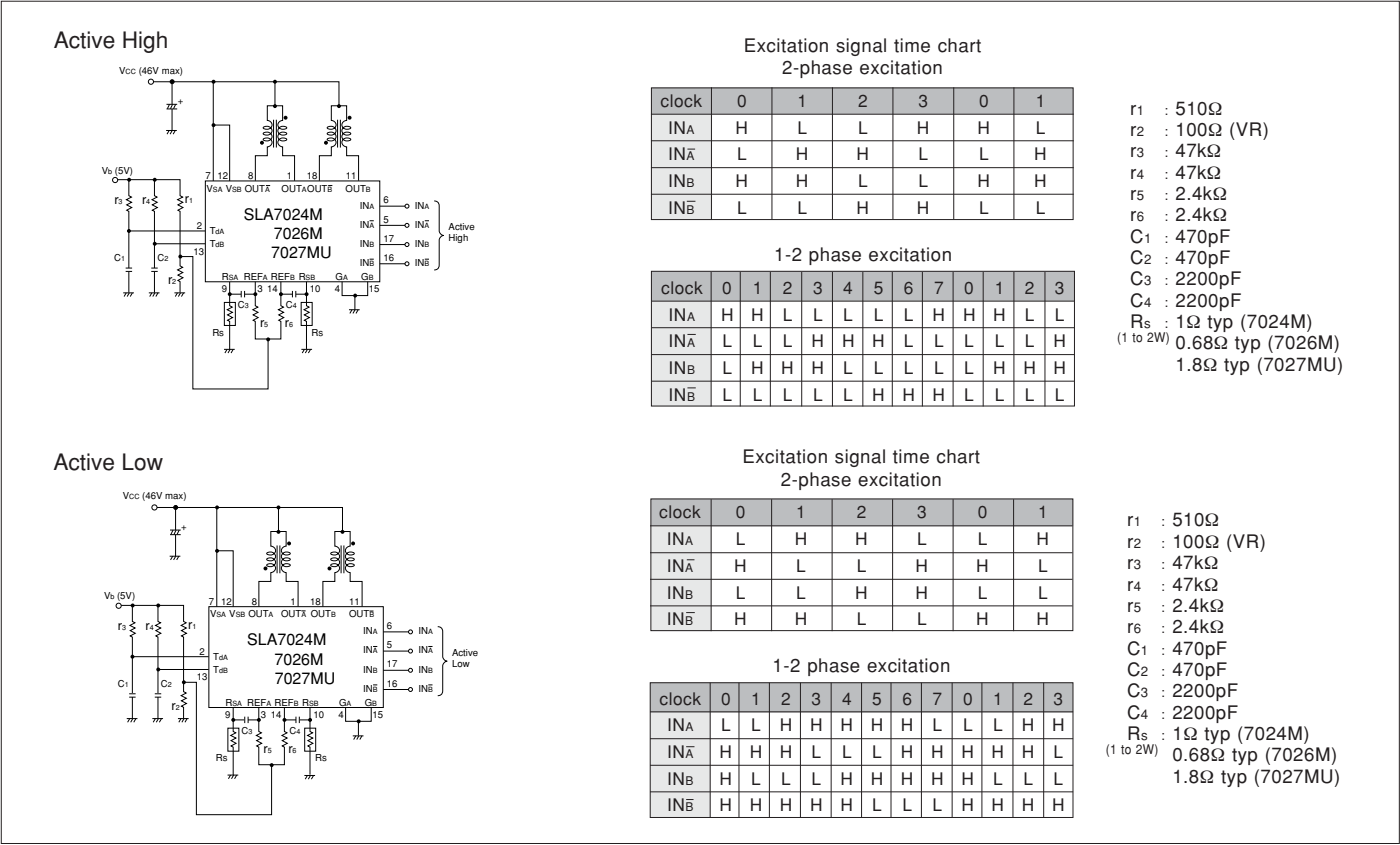
## ■Electrical Characteristics

| Parameter          |                                    | Symbol           | Ratings                                      |                                            |                                            |                                              |                                            |                                            |                                              |                                            |                                            | Unit |    |
|--------------------|------------------------------------|------------------|----------------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------------------------|--------------------------------------------|--------------------------------------------|----------------------------------------------|--------------------------------------------|--------------------------------------------|------|----|
|                    |                                    |                  | SLA7027MU                                    |                                            |                                            | SLA7024M                                     |                                            |                                            | SLA7026M                                     |                                            |                                            |      |    |
|                    |                                    |                  | min.                                         | typ.                                       | max.                                       | min.                                         | typ.                                       | max.                                       | min.                                         | typ.                                       | max.                                       |      |    |
| DC characteristics | Control Supply Current             | I <sub>S</sub>   |                                              | 10                                         | 15                                         |                                              | 10                                         | 15                                         |                                              | 10                                         | 15                                         | mA   |    |
|                    |                                    | Condition        | V <sub>S</sub> =44V                          |                                            |                                            | V <sub>S</sub> =44V                          |                                            |                                            | V <sub>S</sub> =44V                          |                                            |                                            |      |    |
|                    | Control Supply Voltage             | V <sub>S</sub>   | 10                                           | 24                                         | 44                                         | 10                                           | 24                                         | 44                                         | 10                                           | 24                                         | 44                                         | V    |    |
|                    | FET Drain-Source Voltage           | V <sub>DSS</sub> | 100                                          |                                            |                                            | 100                                          |                                            |                                            | 100                                          |                                            |                                            | V    |    |
|                    |                                    | Condition        | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |                                            | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |                                            | V <sub>S</sub> =44V, I <sub>DSS</sub> =250μA |                                            |                                            |      |    |
|                    | FET ON Voltage                     | V <sub>DS</sub>  |                                              |                                            | 0.85                                       |                                              |                                            | 0.6                                        |                                              |                                            | 0.85                                       | V    |    |
|                    |                                    | Condition        | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |                                            | I <sub>D</sub> =1A, V <sub>S</sub> =14V      |                                            |                                            | I <sub>D</sub> =3A, V <sub>S</sub> =14V      |                                            |                                            |      |    |
|                    | FET Drain Leakage Current          | I <sub>DSS</sub> |                                              |                                            | 4                                          |                                              |                                            | 4                                          |                                              |                                            | 4                                          | mA   |    |
|                    |                                    | Condition        | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |                                            | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |                                            | V <sub>DSS</sub> =100V, V <sub>S</sub> =44V  |                                            |                                            |      |    |
|                    | FET Diode Forward Voltage          | V <sub>SD</sub>  |                                              |                                            | 1.2                                        |                                              |                                            | 1.1                                        |                                              |                                            | 2.3                                        | V    |    |
|                    |                                    | Condition        | I <sub>D</sub> =1A                           |                                            |                                            | I <sub>D</sub> =1A                           |                                            |                                            | I <sub>D</sub> =3A                           |                                            |                                            |      |    |
|                    | TTL Input Current                  |                  | I <sub>IH</sub>                              |                                            |                                            | 40                                           |                                            |                                            | 40                                           |                                            |                                            | 40   | μA |
|                    |                                    |                  | Condition                                    | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |                                            |                                              | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |                                            |                                              | V <sub>IH</sub> =2.4V, V <sub>S</sub> =44V |                                            |      |    |
|                    |                                    |                  | I <sub>IL</sub>                              |                                            |                                            | −0.8                                         |                                            |                                            | −0.8                                         |                                            |                                            | −0.8 | mA |
|                    |                                    |                  |                                              | Condition                                  | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |                                              |                                            | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |                                              |                                            | V <sub>IL</sub> =0.4V, V <sub>S</sub> =44V |      |    |
|                    | TTL Input Voltage<br>(Active High) |                  | V <sub>IH</sub>                              | 2                                          |                                            |                                              | 2                                          |                                            |                                              | 2                                          |                                            |      | V  |
|                    |                                    |                  | Condition                                    | I <sub>D</sub> =1A                         |                                            |                                              | I <sub>D</sub> =1A                         |                                            |                                              | I <sub>D</sub> =3A                         |                                            |      |    |
|                    |                                    |                  | V <sub>IL</sub>                              |                                            |                                            | 0.8                                          |                                            |                                            | 0.8                                          |                                            |                                            | 0.8  |    |
|                    |                                    |                  | Condition                                    | V <sub>DSS</sub> =100V                     |                                            |                                              | V <sub>DSS</sub> =100V                     |                                            |                                              | V <sub>DSS</sub> =100V                     |                                            |      |    |
|                    | TTL Input Voltage<br>(Active Low)  |                  | V <sub>IH</sub>                              | 2                                          |                                            |                                              | 2                                          |                                            |                                              | 2                                          |                                            |      | V  |
|                    |                                    |                  | Condition                                    | V <sub>DSS</sub> =100V                     |                                            |                                              | V <sub>DSS</sub> =100V                     |                                            |                                              | V <sub>DSS</sub> =100V                     |                                            |      |    |
|                    |                                    |                  | V <sub>IL</sub>                              |                                            |                                            | 0.8                                          |                                            |                                            | 0.8                                          |                                            |                                            | 0.8  |    |
|                    |                                    |                  | Condition                                    | I <sub>D</sub> =1A                         |                                            |                                              | I <sub>D</sub> =1A                         |                                            |                                              | I <sub>D</sub> =3A                         |                                            |      |    |
| AC characteristics | Switching Time                     | T <sub>r</sub>   |                                              | 0.5                                        |                                            |                                              | 0.5                                        |                                            |                                              | 0.5                                        |                                            | μs   |    |
|                    |                                    | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            |      |    |
|                    |                                    | T <sub>sig</sub> |                                              | 0.7                                        |                                            |                                              | 0.7                                        |                                            |                                              | 0.7                                        |                                            |      |    |
|                    |                                    | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            |      |    |
|                    |                                    | T <sub>f</sub>   |                                              | 0.1                                        |                                            |                                              | 0.1                                        |                                            |                                              | 0.1                                        |                                            |      |    |
|                    |                                    | Condition        | V <sub>S</sub> =24V, I <sub>D</sub> =0.8A    |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            | V <sub>S</sub> =24V, I <sub>D</sub> =1A      |                                            |                                            |      |    |

Internal Block Diagram

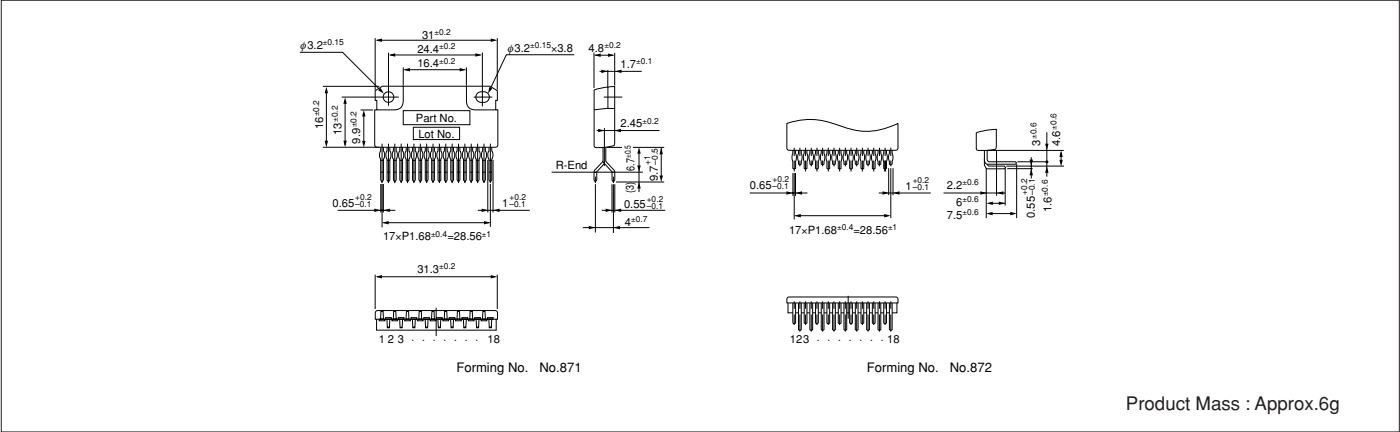


Typical Connection Diagram (Recommended component values)



External Dimensions (ZIP18 with Fin [SLA18Pin])

(Unit : mm)



## SLA7070MR, MPR, MPRT/7071MR, MPR, MPRT/7072MR, MPR, MPRT/7073MR, MPR, MPRT

## 2-Phase/1-2 Phase Excitation Support, Built-in Sequencer

☆ For new designs, use SLA707xMPRT.

## Features

- Lineup of built-in current sense resistor and built-in protection circuit-type
- Power supply voltages,  $V_{BB}$ : 46 V (max), 10 to 44 V normal operating range
- Logic supply voltages,  $V_{DD}$ : 3.0 to 5.5 V
- Maximum output currents: 1 A, 1.5 A, 2 A, and 3 A
- Built-in sequencer
- Self-excitation PWM current control with fixed off-time
- Synchronous PWM chopping function prevents motor noise in Hold mode
- Sleep mode for reducing the IC input current in stand-by state
- ZIP type 23-pin molded package (SLA package)

## Absolute Maximum Ratings

| Parameter                     | Symbol    | Ratings              | Unit       | Remarks                  |
|-------------------------------|-----------|----------------------|------------|--------------------------|
| Motor Supply Voltage          | $V_M$     | 46                   | V          |                          |
| Driver Supply Voltage         | $V_{BB}$  | 46                   | V          |                          |
| Logic Supply Voltage          | $V_{DD}$  | 6                    | V          |                          |
| Output Current                | $I_O$     | *1                   | A          | Mode F                   |
| Logic Input Voltage           | $V_{IN}$  | -0.3 to $V_{DD}+0.3$ | V          |                          |
| REF Input Voltage             | $V_{REF}$ | -0.3 to $V_{DD}+0.3$ | V          |                          |
| Sense Voltage                 | $V_{RS}$  | $\pm 2$              | V          | Excluding $t_w < 1\mu s$ |
| Power Dissipation             | PD        | 4.7                  | W          | When $T_a = 25^\circ C$  |
|                               |           | 17                   |            | When $T_c = 25^\circ C$  |
| Junction Temperature          | $T_j$     | +150                 | $^\circ C$ |                          |
| Operating Ambient Temperature | $T_a$     | -20 to +85           | $^\circ C$ |                          |
| Storage Temperature           | $T_{stg}$ | -30 to +150          | $^\circ C$ |                          |

\*1: Output current value may be limited for the SLA7070MR, MPR, MPRT (1.0 A), SLA7071MR, MPR, MPRT (1.5 A), SLA7072MR, MPR, MPRT (2.0 A), and SA7073MR, MPR, MPRT (3.0 A), depending on the duty ratio, ambient temperature, and heating conditions.

Be sure that junction temperature of  $T_j$  is not exceeded under any circumstances.

## Recommended Operating Conditions

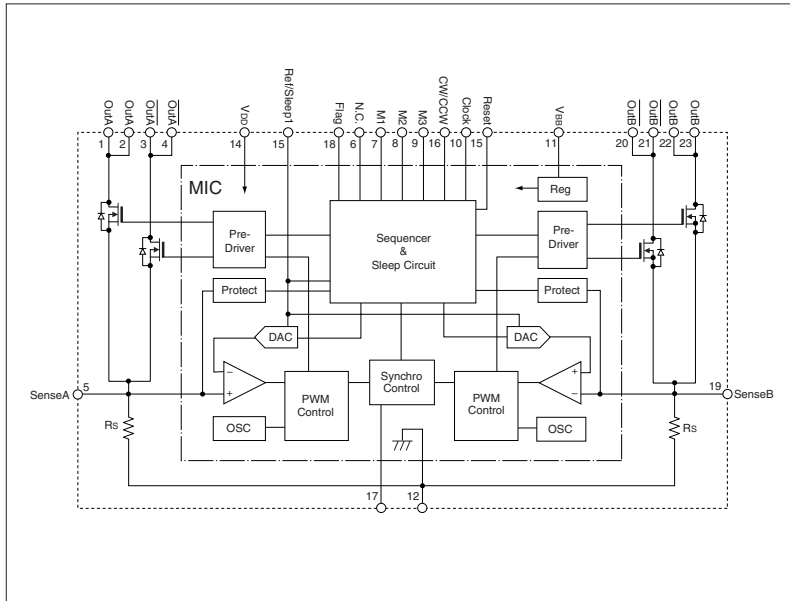
| Parameter             | Symbol   | Rating |      | Unit       | Remarks                                             |
|-----------------------|----------|--------|------|------------|-----------------------------------------------------|
|                       |          | min.   | max. |            |                                                     |
| Motor Supply Voltage  | $V_M$    |        | 44   | V          |                                                     |
| Driver Supply Voltage | $V_{BB}$ | 10     | 44   | V          |                                                     |
| Logic Supply Voltage  | $V_{DD}$ | 3.0    | 5.5  | V          | The $V_{DD}$ surge voltage should be 0.5 V or lower |
| Case Temperature      | $T_c$    |        | 90   | $^\circ C$ | Temperature at Pin-12 Lead (without heatsink)       |

## Electrical Characteristics

| Parameter                           | Symbol        | Ratings  |           |         | Unit       | Conditions                                                |
|-------------------------------------|---------------|----------|-----------|---------|------------|-----------------------------------------------------------|
|                                     |               | min.     | typ.      | max.    |            |                                                           |
| Main Supply Current                 | $I_{BB}$      |          |           | 15      | mA         | In operation                                              |
|                                     | $I_{BBS}$     |          |           | 100     | $\mu A$    | Sleep 1 and Sleep 2 modes                                 |
| Logic Supply Current                | $I_{DD}$      |          |           | 5       | mA         |                                                           |
| Output MOSFET Breakdown Voltage     | $V_{(BR)DSS}$ | 100      |           |         | V          | $V_{BB}=44V, I_D=1mA$                                     |
| Output MOSFET ON Resistance         | $R_{DS(ON)}$  |          | 0.7       | 0.85    | $\Omega$   | SLA7070M, $I_D=1.0A$                                      |
|                                     |               |          | 0.45      | 0.6     |            | SLA7071M, $I_D=1.5A$                                      |
|                                     |               |          | 0.25      | 0.4     |            | SLA7072M, $I_D=2.0A$                                      |
|                                     |               |          | 0.18      | 0.24    |            | SLA7073M, $I_D=3.0A$                                      |
| Output MOSFET Diode Forward Voltage | $V_F$         |          | 0.85      | 1.1     | V          | SLA7070M, $I_D=1.0A$                                      |
|                                     |               |          | 1.0       | 1.25    |            | SLA7071M, $I_D=1.5A$                                      |
|                                     |               |          | 0.95      | 1.2     |            | SLA7072M, $I_D=2.0A$                                      |
|                                     |               |          | 0.95      | 2.1     |            | SLA7073M, $I_D=3.0A$                                      |
|                                     |               |          |           |         |            | When Clock Duty = 50%                                     |
| Maximum Clock Frequency             | $F_{clock}$   | 250      |           |         | kHz        |                                                           |
| Logic Input Voltage                 | $V_{IL}$      |          |           | 0.25VDD | V          |                                                           |
|                                     | $V_{IH}$      | 0.75VDD  |           |         |            |                                                           |
| Logic Input Current                 | $I_{IL}$      |          | $\pm 1$   |         | $\mu A$    |                                                           |
|                                     | $I_{IH}$      |          | $\pm 1$   |         |            |                                                           |
| REF Input Voltage                   | $V_{REF}$     | 0.04     |           | 0.3     | V          | SLA7070M, within the current setting range                |
|                                     |               | 0.04     |           | 0.45    |            | SLA7071M, within the current setting range                |
|                                     |               | 0.04     |           | 0.4     |            | SLA7072M, within the current setting range                |
|                                     |               | 0.04     |           | 0.45    |            | SLA7073M, within the current setting range                |
| REF Input Current                   | $I_{REF}$     | 2        |           | VDD     |            | Output OFF (Sleep 1)                                      |
| Sense Voltage                       | $V_{SENSE}$   |          | $V_{REF}$ |         | V          | When step reference current ratio is 100%                 |
| Sleep-Enable Recovery Time          | $T_{SE}$      | 100      |           |         | $\mu s$    | Sleep1&Sleep2                                             |
| Switching Time                      | $t_{con}$     |          | 2.0       |         | $\mu s$    | Clock $\rightarrow$ Out ON                                |
|                                     | $t_{coff}$    |          | 1.5       |         | $\mu s$    | Clock $\rightarrow$ Out OFF                               |
| Sense Resistance                    | $R_s$         | 0.296    | 0.305     | 0.314   | $\Omega$   | SLA7070M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.296    | 0.305     | 0.314   |            | SLA7071M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.199    | 0.205     | 0.211   |            | SLA7072M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.150    | 0.155     | 0.160   |            | SLA7073M, tolerance of $\pm 3\%$                          |
| Overcurrent Sense Voltage           | $V_{ocp}$     | 0.65     | 0.7       | 0.75    | V          | SLA7070xMPR, MPRT, when motor coil shorts out             |
| Overcurrent Sense Current           | $I_{ocp}$     |          | 2.3       |         | A          | SLA7070MPR, MPRT/7071MPR, MPRT                            |
|                                     |               |          | 3.5       |         |            | SLA7072MPR, MPRT                                          |
|                                     |               |          | 4.6       |         |            | SLA7073MPR, MPRT                                          |
| Thermal Protection Temperature      | $T_{tsd}$     |          | 140       |         | $^\circ C$ | SLA707xMPRT, Rear of case (at the saturation temperature) |
| Flag Output Voltage                 | $V_{FlagL}$   |          |           | 1.25    | V          | SLA707xMPR, MPRT, $I_{FlagL}=1.25mA$                      |
|                                     | $V_{FlagH}$   | 1.25-VDD |           |         |            | SLA707xMPR, MPRT, $I_{FlagH}=-1.25mA$                     |
| Flag Output Current                 | $I_{FlagL}$   |          |           | 1.25    | mA         | SLA707xMPR, MPRT                                          |
|                                     | $I_{FlagH}$   | -1.25    |           |         |            |                                                           |
| Step Reference Current Ratio        | ModeF         |          | 100       |         | %          |                                                           |
|                                     | Mode8         |          | 70.7      |         | %          |                                                           |
| PWM Minimum ON Time                 | $t_{on(min)}$ |          | 3.2       |         | $\mu s$    |                                                           |
| PWM OFF Time                        | $t_{off}$     |          | 12        |         | $\mu s$    |                                                           |

\* The direction in which current flows out of the device is regarded as negative.

## Internal Block Diagram



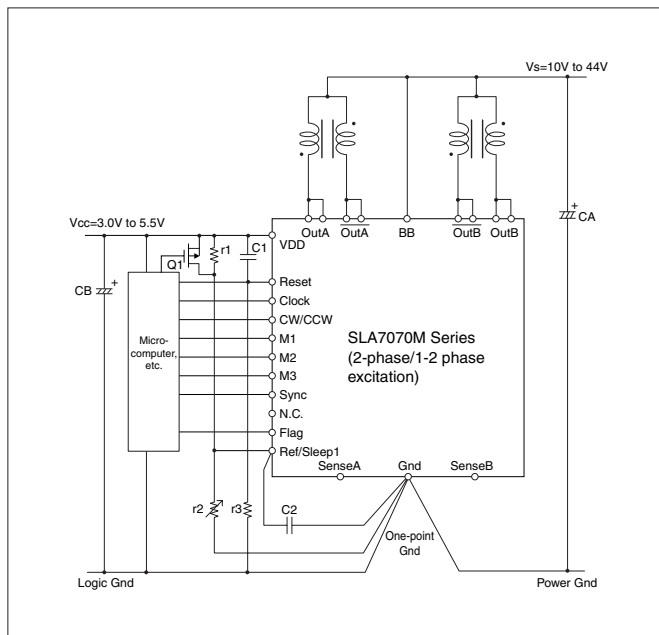
The protect circuit is deleted and the flag pin is N.C. for SLA7070MR, 7071MR, 7072MR, and 7073MR.

## Pin Assignment

| Pin No. | Symbol             | Function                                        |
|---------|--------------------|-------------------------------------------------|
| 1       | OutA               | Phase A output                                  |
| 2       |                    |                                                 |
| 3       | OutA/              | Phase $\bar{A}$ output                          |
| 4       |                    |                                                 |
| 5       | SenseA             | Phase A current sense                           |
| 6       | N.C.               | N.C.                                            |
| 7       | M1                 | Excitation mode/Sleep 2 setting input           |
| 8       | M2                 |                                                 |
| 9       | M3                 |                                                 |
| 10      | Clock              | Step Clock input                                |
| 11      | V <sub>BB</sub>    | Driver supply (motor supply)                    |
| 12      | Gnd                | Device GND                                      |
| 13      | Ref/Sleep1         | Control current mode/Sleep 1 setting input      |
| 14      | V <sub>DD</sub>    | Logic supply                                    |
| 15      | Reset              | Internal logic reset input                      |
| 16      | CW/CCW             | Normal/reverse control input                    |
| 17      | Sync               | PWM control signal input                        |
| 18      | Flag <sup>*1</sup> | Protection circuit monitor output <sup>*1</sup> |
| 19      | SenseB             | Phase B current sense                           |
| 20      | OutB/              | Phase $\bar{B}$ current output                  |
| 21      |                    |                                                 |
| 22      | OutB               | Phase B current output                          |
| 23      |                    |                                                 |

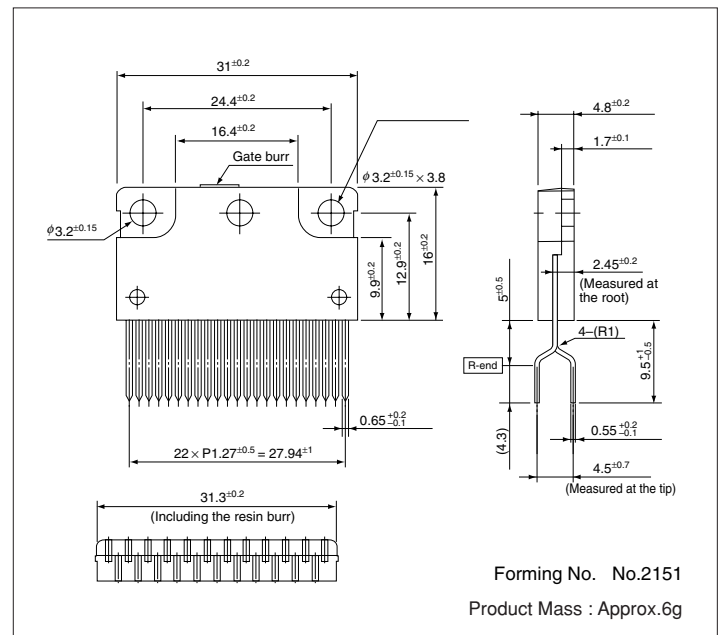
\*1: N.C. pin for SLA7070MR, 7071MR, 7072MR, and 7073MR.

## Typical Connection Diagram



\* There is no Flag pin (Pin-18) for SLA7070MR, 7071MR, 7072MR, and 7073MR.

## External Dimensions (ZIP23 with Fin[SLA23Pin])



## SLA7080MPR/7081MPR/7082MPR/7083MPR 2-Phase/1-2-Phase Excitation

## ■Features

- Lineup of built-in current sense resistor and built-in protection circuit-type
- Power supply voltages, VBB: 46 V (max), 10 to 44 V normal operating range
- Logic supply voltages, VDD: 3.0 to 5.5 V
- Maximum output current I<sub>O</sub>: 1A, 1.5A, 2A, and 3A
- Self-excitation PWM current control with fixed off time
- Synchronous PWM chopping function prevents motor noise in Hold mode
- Sleep mode for reducing the IC input current in stand-by state
- ZIP type 23-pin molded package (SLA package)

## ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                     | Symbol           | Ratings                      | Unit | Conditions                    |
|-------------------------------|------------------|------------------------------|------|-------------------------------|
| Motor Supply Voltage          | V <sub>M</sub>   | 46                           | V    |                               |
| Driver Supply Voltage         | V <sub>BB</sub>  | 46                           | V    |                               |
| Logic Supply Voltage          | V <sub>DD</sub>  | 6                            | V    |                               |
| Output Current                | I <sub>O</sub>   | *1                           | A    |                               |
| Logic Input Voltage           | V <sub>IN</sub>  | −0.3 to V <sub>DD</sub> +0.3 | V    |                               |
| REF Input Voltage             | V <sub>REF</sub> | −0.3 to V <sub>DD</sub> +0.3 | V    |                               |
| Sense Voltage                 | V <sub>RS</sub>  | ±2                           | V    | Excluding t <sub>w</sub> <1μs |
| Power Dissipation             | P <sub>D</sub>   | 4.7                          | W    | When T <sub>a</sub> = 25°C    |
|                               |                  | 17                           |      | When T <sub>c</sub> = 25°C    |
| Junction Temperature          | T <sub>J</sub>   | +150                         | °C   |                               |
| Operating Ambient Temperature | T <sub>a</sub>   | −20 to +85                   | °C   |                               |
| Storage Temperature           | T <sub>stg</sub> | −30 to +150                  | °C   |                               |

\*1: Output current value may be limited for the SLA7080MPR(1.0A), SLA7081MPR(1.5A), SLA7082MPR(2.0A), SLA7083MPR(3.0A), depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed junction temperature of T<sub>J</sub> under any circumstances.

## ■Recommended Operating Conditions

| Parameter             | Symbol           | Ratings |      | Unit | Conditions                                                 |
|-----------------------|------------------|---------|------|------|------------------------------------------------------------|
|                       |                  | min.    | max. |      |                                                            |
| Motor Supply Voltage  | V <sub>M</sub>   |         | 44   | V    |                                                            |
| Driver Supply Voltage | V <sub>BB</sub>  | 10      | 44   | V    |                                                            |
| Logic Supply Voltage  | V <sub>DD</sub>  | 3.0     | 5.5  | V    | The V <sub>DD</sub> surge voltage should be 0.5V or lower. |
| REF Input Voltage     | V <sub>REF</sub> | 0.04    | 0.3  | V    | When controlling the current for SLA7080M                  |
|                       |                  |         | 0.45 |      | When controlling the current for SLA7081M/SLA7083M         |
|                       |                  |         | 0.4  |      | When controlling the current for SLA7082M                  |
| Case Temperature      | T <sub>c</sub>   |         | 90   | °C   | Rear center (without Fin)                                  |

## ■Electrical Characteristics

(V<sub>DD</sub>=5V, V<sub>BB</sub>=24V, T<sub>a</sub>=25°C, unless otherwise specified)

| Parameter                                                  | Symbol               | Ratings                |                  |                        | Unit | Conditions                                                                          |
|------------------------------------------------------------|----------------------|------------------------|------------------|------------------------|------|-------------------------------------------------------------------------------------|
|                                                            |                      | min.                   | typ.             | max.                   |      |                                                                                     |
| Main Supply Current                                        | I <sub>BB</sub>      |                        |                  | 15                     | mA   | In operation                                                                        |
|                                                            | I <sub>BB</sub> S    |                        |                  | 100                    | μA   | Sleep Mode                                                                          |
| Logic Supply Current                                       | I <sub>DD</sub>      |                        |                  | 5                      | mA   |                                                                                     |
| Output MOSFET Breakdown Voltage                            | V <sub>(BR)DSS</sub> | 100                    |                  |                        | V    | V <sub>BB</sub> =44V, I <sub>D</sub> =1mA                                           |
| Output MOSFET ON Resistance                                | R <sub>DS(ON)</sub>  |                        | 0.7              | 0.85                   | Ω    | SLA7080M, I <sub>D</sub> =1.0A                                                      |
|                                                            |                      |                        | 0.45             | 0.6                    |      | SLA7081M, I <sub>D</sub> =1.5A                                                      |
|                                                            |                      |                        | 0.25             | 0.4                    |      | SLA7082M, I <sub>D</sub> =2.0A                                                      |
|                                                            |                      |                        | 0.18             | 0.24                   |      | SLA7083M, I <sub>D</sub> =3.0A                                                      |
| Output MOSFET Diode Forward Voltage                        | V <sub>F</sub>       |                        | 0.85             | 1.1                    | V    | SLA7080M, I <sub>D</sub> =1.0A                                                      |
|                                                            |                      |                        | 1.0              | 1.25                   |      | SLA7081M, I <sub>D</sub> =1.5A                                                      |
|                                                            |                      |                        | 0.95             | 1.2                    |      | SLA7082M, I <sub>D</sub> =2.0A                                                      |
|                                                            |                      |                        | 0.95             | 2.1                    |      | SLA7083M, I <sub>D</sub> =3.0A                                                      |
| Maximum Clock Frequency                                    | F <sub>clk</sub>     | 250                    |                  |                        | kHz  | When Duty = 50%                                                                     |
| Logic Input Voltage                                        | V <sub>IL</sub>      |                        |                  | 0.25V <sub>DD</sub>    | V    |                                                                                     |
|                                                            | V <sub>IH</sub>      | 0.75V <sub>DD</sub>    |                  |                        |      |                                                                                     |
| Logic Input Current                                        | I <sub>IL</sub>      |                        | ±1               |                        | μA   |                                                                                     |
|                                                            | I <sub>IH</sub>      |                        | ±1               |                        |      |                                                                                     |
| REF Input Voltage                                          | V <sub>REF</sub>     | 0.04                   |                  | 0.3                    | V    | SLA7080M                                                                            |
|                                                            |                      | 0.04                   |                  | 0.45                   |      | SLA7081M                                                                            |
|                                                            |                      | 0.04                   |                  | 0.4                    |      | SLA7082M                                                                            |
|                                                            |                      | 0.04                   |                  | 0.45                   |      | SLA7083M                                                                            |
|                                                            | V <sub>REFS</sub>    | 2.0                    |                  | V <sub>DD</sub>        |      | Sleep ("I <sub>BB</sub> S", "output: OFF")                                          |
| REF Input Current                                          | I <sub>REF</sub>     |                        | ±10              |                        | μA   |                                                                                     |
| Sense Voltage                                              | V <sub>SENSE</sub>   | V <sub>REF</sub> −0.03 | V <sub>REF</sub> | V <sub>REF</sub> +0.03 | V    |                                                                                     |
| Sense Resistance                                           | R <sub>S</sub>       | 0.296                  | 0.305            | 0.314                  | Ω    | Including the resistance due to the product configuration (about 5 mΩ) for SLA7080M |
|                                                            |                      | 0.296                  | 0.305            | 0.314                  |      | Including the resistance due to the product configuration (about 5 mΩ) for SLA7081M |
|                                                            |                      | 0.199                  | 0.205            | 0.211                  |      | Including the resistance due to the product configuration (about 5 mΩ) for SLA7082M |
|                                                            |                      | 0.150                  | 0.155            | 0.160                  |      | Including the resistance due to the product configuration (about 5 mΩ) for SLA7083M |
| PWM Minimum ON Time (blanking time)                        | ton(min)             |                        | 3.2              |                        | μs   | B_SEL: Low                                                                          |
| PWM OFF Time                                               | toff                 |                        | 5.2              |                        | μs   | B_SEL: High                                                                         |
| Sleep-Enable Recovery Time                                 | T <sub>SE</sub>      | 100                    | 13               |                        | μs   |                                                                                     |
| Switching Time                                             | t <sub>con</sub>     |                        | 1.5              |                        | μs   | Phase IN → Out ON                                                                   |
|                                                            | t <sub>coff</sub>    |                        | 1.0              |                        | μs   | Phase IN → Out OFF                                                                  |
| Overcurrent Sense Voltage                                  | V <sub>ocp</sub>     | 0.65                   | 0.7              | 0.75                   | V    | When the motor coil shorts out                                                      |
| Overcurrent Sense Current V <sub>ocp</sub> +R <sub>S</sub> | I <sub>ocp</sub>     |                        | 2.3              |                        | A    | SLA7080MPR/7081MPR                                                                  |
|                                                            |                      |                        | 3.5              |                        |      | SLA7082MPR                                                                          |
|                                                            |                      |                        | 4.5              |                        |      | SLA7083MPR                                                                          |
| Blank time for load open                                   | t <sub>opp</sub>     | 1.5                    | 2.0              | 2.5                    | μs   |                                                                                     |
| Thermal Protection Temperature                             | T <sub>isd</sub>     |                        | 140              |                        | °C   | Rear of case (at the saturation temperature)                                        |
| Flag Output Voltage                                        | V <sub>FlagL</sub>   |                        |                  | 1.25                   | V    | I <sub>FlagL</sub> = 1.25mA                                                         |
|                                                            | V <sub>FlagH</sub>   | 1.25V <sub>DD</sub>    |                  |                        |      | I <sub>FlagH</sub> = −1.25mA                                                        |
| Flag Output Current                                        | I <sub>FlagL</sub>   |                        |                  | 1.25                   | mA   |                                                                                     |
|                                                            | I <sub>FlagH</sub>   | −1.25                  |                  |                        |      |                                                                                     |

\*The direction in which current flows out of the device is regarded as negative.



**STA7130MPR/7131MPR/7132MPR** 2-Phase to 2W 1-2 Phase Excitation Support, Built-in Sequencer**■Features**

- Lineup of built-in current sense resistor and built-in protection circuit-type
- Power supply voltages,  $V_{BB}$ : 46 V (max), 10 to 44 V normal operating range
- Maximum output currents: 1 A, 1.5 A, and 2 A
- Supporting the clock-input-method micro-step drive (built-in sequencer)
- Self-excitation PWM current control with fixed off time
- Synchronous PWM chopping function prevents motor noise in Hold mode
- Sleep mode for reducing the IC input current in stand-by state
- ZIP type 18-pin molded package (STA package)

**■Absolute Maximum Ratings**(T<sub>a</sub>=25°C)

| Parameter                     | Symbol           | Ratings     | Unit | Remarks                       |
|-------------------------------|------------------|-------------|------|-------------------------------|
| Motor Supply Voltage          | V <sub>M</sub>   | 46          | V    |                               |
| Driver Supply Voltage         | V <sub>BB</sub>  | 46          | V    |                               |
| Output Current                | I <sub>O</sub>   | *1          | A    | Mode F                        |
| Logic Input Voltage           | V <sub>IN</sub>  | −0.3 to +6  | V    |                               |
| REF Input Voltage             | V <sub>REF</sub> | −0.3 to +6  | V    |                               |
| Sense Voltage                 | V <sub>RS</sub>  | ±0.5        | V    | Excluding t <sub>w</sub> <1μs |
| Power Dissipation             | PD               | 3.5         | W    | When T <sub>a</sub> = 25°C    |
|                               |                  | 12.5        |      | When T <sub>c</sub> = 25°C    |
| Junction Temperature          | T <sub>J</sub>   | +150        | °C   |                               |
| Operating Ambient Temperature | T <sub>a</sub>   | −20 to +80  | °C   |                               |
| Storage Temperature           | T <sub>stg</sub> | −30 to +150 | °C   |                               |

\*1: Output current value may be limited for the STA7130MPR (1.0 A), 7131MPR (1.5 A), and 7132MPR (2.0 A), depending on the duty ratio, ambient temperature, and heating conditions.  
Do not exceed junction temperature of T<sub>J</sub> under any circumstances.

**■Recommended Operating Conditions**

| Parameter             | Symbol          | Rating |      | Unit | Remarks                                  |
|-----------------------|-----------------|--------|------|------|------------------------------------------|
|                       |                 | min.   | max. |      |                                          |
| Motor Supply Voltage  | V <sub>M</sub>  |        | 44   | V    |                                          |
| Driver Supply Voltage | V <sub>BB</sub> | 10     | 44   | V    |                                          |
| Case Temperature      | T <sub>C</sub>  |        | 85   | °C   | Temperature at Pin-10 Lead (without Fin) |

**■Electrical Characteristics**(V<sub>DD</sub>=5V, V<sub>BB</sub>=24V, T<sub>a</sub>=25°C, unless otherwise specified)

| Parameter                                                     | Symbol               | Ratings                  |                     |                          | Unit | Conditions                                   |
|---------------------------------------------------------------|----------------------|--------------------------|---------------------|--------------------------|------|----------------------------------------------|
|                                                               |                      | min.                     | typ.                | max.                     |      |                                              |
| Main Supply Current                                           | I <sub>BB</sub>      |                          |                     | 10                       | mA   | In operation                                 |
|                                                               | I <sub>BBS</sub>     |                          |                     | 3                        | mA   | Sleep 1 and Sleep 2 modes                    |
| Output MOSFET Breakdown Voltage                               | V <sub>(BR)DSS</sub> | 100                      |                     |                          | V    |                                              |
| Output MOSFET ON Resistance                                   | R <sub>DS(ON)</sub>  |                          | 0.7                 | 0.85                     | Ω    | STA7130MPR                                   |
|                                                               |                      |                          | 0.25                | 0.4                      |      | STA7131MPR                                   |
|                                                               |                      |                          | 0.18                | 0.24                     |      | STA7132MPR                                   |
| Output MOSFET Diode Forward Voltage                           | V <sub>F</sub>       |                          | 0.85                | 1.1                      | V    | STA7130MPR                                   |
|                                                               |                      |                          | 0.95                | 1.2                      |      | STA7131MPR                                   |
|                                                               |                      |                          | 0.95                | 2.1                      |      | STA7132MPR                                   |
| Maximum Clock Frequency                                       | F <sub>clock</sub>   | 250                      |                     |                          | kHz  | When Clock Duty = 50%                        |
| Logic Input Voltage                                           | V <sub>IL</sub>      |                          |                     | 0.7                      | V    |                                              |
|                                                               | V <sub>IH</sub>      | 2.3                      |                     |                          |      |                                              |
| Logic Input Current                                           | I <sub>IL</sub>      |                          | ±10                 |                          | μA   |                                              |
|                                                               | I <sub>IH</sub>      |                          | ±10                 |                          |      |                                              |
| REF Input Voltage                                             | V <sub>REF</sub>     | 0                        |                     | 0.9                      | V    |                                              |
|                                                               | V <sub>REFS</sub>    | 2.0                      |                     | 5.5                      |      | Output OFF (Sleep 1)                         |
| REF Input Current                                             | I <sub>REF</sub>     |                          | ±10                 |                          | μA   |                                              |
| Sense Voltage                                                 | V <sub>SENSE</sub>   | V <sub>REF</sub> /3-0.03 | V <sub>REF</sub> /3 | V <sub>REF</sub> /3+0.03 | V    | When step reference current ratio is 100%    |
| Sleep-Enable Recovery Time                                    | T <sub>SE</sub>      | 100                      |                     |                          | μs   | Sleep1&Sleep2                                |
| Switching Time                                                | t <sub>con</sub>     |                          | 1.4                 |                          | μs   | Clock → Out ON                               |
|                                                               | t <sub>coff</sub>    |                          | 0.7                 |                          | μs   | Clock → Out OFF                              |
| Sense Resistance                                              | R <sub>S</sub>       |                          | 0.305               |                          | Ω    | STA7130MPR                                   |
|                                                               |                      |                          | 0.205               |                          |      | STA7131MPR                                   |
|                                                               |                      |                          | 0.155               |                          |      | STA7132MPR                                   |
| Overcurrent Sense Voltage                                     | V <sub>ocp</sub>     | 0.65                     | 0.7                 | 0.75                     | V    | When motor coil shorts out                   |
| Overcurrent Sense Current<br>V <sub>ocp</sub> +R <sub>S</sub> | I <sub>ocp</sub>     |                          | 2.3                 |                          | A    | STA7130MPR                                   |
|                                                               |                      |                          | 3.5                 |                          |      | STA7131MPR                                   |
|                                                               |                      |                          | 4.5                 |                          |      | STA7132MPR                                   |
| Thermal Protection Temperature                                | T <sub>tsd</sub>     |                          | 125                 |                          | °C   | Rear of case (at the saturation temperature) |
| Logic Output Voltage                                          | V <sub>LLOL</sub>    |                          |                     | 0.8                      | V    | I <sub>LLOL</sub> =5mA                       |
| Logic Output Current                                          | I <sub>LLOL</sub>    |                          |                     | 5                        | mA   | V <sub>LLOL</sub> =0.8V                      |
| Step Reference Current Ratio                                  | ModeF                |                          | 100                 |                          | %    | V <sub>REF</sub> =0.1V to 0.9V               |
|                                                               | ModeE                |                          | 98.1                |                          | %    |                                              |
|                                                               | ModeC                |                          | 92.4                |                          | %    |                                              |
|                                                               | ModeA                |                          | 83.1                |                          | %    |                                              |
|                                                               | Mode8                |                          | 70.7                |                          | %    |                                              |
|                                                               | Mode6                |                          | 55.5                |                          | %    |                                              |
|                                                               | Mode4                |                          | 38.2                |                          | %    |                                              |
|                                                               | Mode2                |                          | 19.5                |                          | %    |                                              |
| PWM Minimum ON Time                                           | ton(min)             |                          | 1.5                 |                          | μs   |                                              |
| PWM OFF Time                                                  | toff1                |                          | 11.5                |                          | μs   | Mode 8 to F                                  |
|                                                               | toff2                |                          | 8.5                 |                          | μs   | Mode 4 to 6                                  |
|                                                               | toff3                |                          | 7                   |                          | μs   | Mode 2                                       |

\*The direction in which current flows out of the device is regarded as negative.



# SI-7321M 2-Phase to 4W 1-2 Phase Excitation Support, Built-in Sequencer

## ■Features

- Power supply voltages, VBB: 46 V (max), 10 to 44 V normal operating range
- Logic supply voltages, VDD: 3.0 to 5.5 V
- Output Current I<sub>o</sub>: 1.5A
- Clock input method (built-in sequencer)
- Self-excitation PWM current control with fixed off time
- Synchronous PWM chopping function prevents motor noise in Hold mode
- Sleep mode for reducing the IC input current in stand-by state
- Selectable blanking time (1.8  $\mu$ s or 3.6  $\mu$ s)
- Selectable clock input edge (POS or POS/NEG)
- Selectable protection availability
- 44-pin surface-mount

## ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                     | Symbol           | Ratings                      | Unit | Conditions                 |
|-------------------------------|------------------|------------------------------|------|----------------------------|
| Motor Supply Voltage          | V <sub>M</sub>   | 46                           | V    |                            |
| Driver Supply Voltage         | V <sub>BB</sub>  | 46                           | V    |                            |
| Logic Supply Voltage          | V <sub>DD</sub>  | 6                            | V    |                            |
| Output Current                | I <sub>o</sub>   | 1.5                          | A    | Current ratio: Mode F      |
| Logic Input Voltage           | V <sub>IN</sub>  | -0.3 to V <sub>DD</sub> +0.3 | V    |                            |
| REF Input Voltage             | V <sub>REF</sub> | -0.3 to V <sub>DD</sub> +0.3 | V    |                            |
| Sense Voltage                 | V <sub>RS</sub>  | ±2                           | V    | Excluding tw<1 $\mu$ s     |
| Power Dissipation             | P <sub>D</sub>   | 3.5                          | W    | When T <sub>a</sub> = 25°C |
| Junction Temperature          | T <sub>J</sub>   | +150                         | °C   |                            |
| Operating Ambient Temperature | T <sub>a</sub>   | -20 to +80                   | °C   |                            |
| Storage Temperature           | T <sub>stg</sub> | -30 to +150                  | °C   |                            |

\*: Output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions.

Do not exceed junction temperature of T<sub>J</sub> under any circumstances.

## ■Recommended Operating Conditions

| Parameter             | Symbol           | Ratings |      | Unit | Conditions                                                 |
|-----------------------|------------------|---------|------|------|------------------------------------------------------------|
|                       |                  | min.    | max. |      |                                                            |
| Motor Supply Voltage  | V <sub>M</sub>   |         | 44   | V    |                                                            |
| Driver Supply Voltage | V <sub>BB</sub>  |         | 44   | V    |                                                            |
| Logic Supply Voltage  | V <sub>DD</sub>  | 3.3     | 5.5  | V    | The V <sub>DD</sub> surge voltage should be 0.5V or lower. |
| REF Input Voltage     | V <sub>REF</sub> | 0.04    | 1.0  | V    | When not using protection                                  |
|                       |                  |         | 0.5  |      | When using protection                                      |
| Case Temperature      | T <sub>c</sub>   |         | 85   | °C   | Temperature at the center of the package                   |

## ■Electrical Characteristics

(V<sub>DD</sub>=5V, V<sub>BB</sub>=24V, T<sub>a</sub>=25°C, unless otherwise specified)

| Parameter                           | Symbol               | Ratings               |      |                     | Unit     | Conditions                                |
|-------------------------------------|----------------------|-----------------------|------|---------------------|----------|-------------------------------------------|
|                                     |                      | min.                  | typ. | max.                |          |                                           |
| Driver Supply Current               | I <sub>BB</sub>      |                       |      | 15                  | mA       | In operation                              |
|                                     | I <sub>BBS</sub>     |                       |      | 100                 | $\mu$ A  | Sleep Mode                                |
| Logic Supply Current                | I <sub>DD</sub>      |                       |      | 5                   | mA       |                                           |
| Output MOSFET Breakdown Voltage     | V <sub>(BR)DSS</sub> | 100                   |      |                     | V        | V <sub>BB</sub> =44V, I <sub>D</sub> =1mA |
| Output MOSFET ON Resistance         | R <sub>DS(ON)</sub>  |                       | 0.25 | 0.4                 | $\Omega$ | I <sub>D</sub> =1.5A                      |
| Output MOSFET Diode Forward Voltage | V <sub>F</sub>       |                       | 0.95 | 1.2                 | V        | I <sub>F</sub> =1.5A                      |
| Maximum Clock Frequency             | F <sub>clk</sub>     | 250                   |      |                     | kHz      | When Duty = 50%                           |
| Logic Input Voltage                 | V <sub>IL</sub>      |                       |      | 0.25V <sub>DD</sub> | V        |                                           |
|                                     | V <sub>IH</sub>      | 0.75V <sub>DD</sub>   |      |                     |          |                                           |
| Logic Input Current                 | I <sub>IL</sub>      |                       | ±1   |                     | $\mu$ A  |                                           |
|                                     | I <sub>IH</sub>      |                       | ±1   |                     |          |                                           |
| REF Input Voltage                   | V <sub>REF</sub>     | 0.04                  |      | 1.5                 | V        | When not using protection                 |
|                                     |                      | 0.04                  |      | 0.6                 |          | When using protection                     |
|                                     | V <sub>REFS</sub>    | 2                     |      | V <sub>DD</sub>     |          | Sleep1 Mode                               |
| REF Input Current                   | I <sub>REF</sub>     |                       | ±10  |                     | $\mu$ A  | V <sub>REF</sub> =0 to V <sub>DD</sub>    |
|                                     | V <sub>LOL</sub>     |                       |      | 1.25                | V        | I <sub>LOL</sub> =1.25mA                  |
| Logic Output Voltage                | V <sub>LOH</sub>     | V <sub>DD</sub> -1.25 |      |                     | V        | I <sub>LOH</sub> =-1.25mA                 |
| Logic Output Current                | I <sub>LOL</sub>     |                       |      | 1.25                | mA       |                                           |
|                                     | I <sub>LOH</sub>     | -1.25                 |      |                     | mA       |                                           |
| Sense Voltage                       | V <sub>SENSE</sub>   |                       | 0.2  |                     | V        | V <sub>REF</sub> =0.2V, Mode F            |
| Overcurrent Sense Voltage           | V <sub>ocp</sub>     | 0.65                  | 0.7  | 0.75                | V        | against V <sub>sense</sub>                |
| Step Reference Current Ratio        | Mode F               |                       | 100  |                     | %        | V <sub>REF</sub> =0.04V to 1.5V           |
|                                     | Mode E               |                       | 98.1 |                     | %        |                                           |
|                                     | Mode D               |                       | 95.7 |                     | %        |                                           |
|                                     | Mode C               |                       | 92.4 |                     | %        |                                           |
|                                     | Mode B               |                       | 88.2 |                     | %        |                                           |
|                                     | Mode A               |                       | 83.1 |                     | %        |                                           |
|                                     | Mode 9               |                       | 77.3 |                     | %        |                                           |
|                                     | Mode 8               |                       | 70.7 |                     | %        |                                           |
|                                     | Mode 7               |                       | 63.4 |                     | %        |                                           |
|                                     | Mode 6               |                       | 55.5 |                     | %        |                                           |
|                                     | Mode 5               |                       | 47.1 |                     | %        |                                           |
|                                     | Mode 4               |                       | 38.2 |                     | %        |                                           |
|                                     | Mode 3               |                       | 29.0 |                     | %        |                                           |
|                                     | Mode 2               |                       | 19.5 |                     | %        |                                           |
|                                     | Mode 1               |                       | 9.8  |                     | %        |                                           |
| Sleep-Enable Recovery Time          | T <sub>SE</sub>      | 100                   |      |                     | $\mu$ S  | Sleep1&Sleep2                             |
| Switching Time                      | tp <sub>don1</sub>   |                       | 2.0  |                     | $\mu$ S  | Clock → Out ON                            |
|                                     |                      |                       | 1.5  |                     | $\mu$ S  | Clock → Out OFF                           |
| PWM Minimum ON Time                 | ton(min)             |                       | 1.8  |                     | $\mu$ S  | B_SEL: L                                  |
|                                     |                      |                       | 3.6  |                     | $\mu$ S  | B_SEL: H                                  |
| PWM OFF Time                        | toff1                |                       | 13   |                     | $\mu$ S  | Mode8 to F                                |
|                                     | toff2                |                       | 9.5  |                     | $\mu$ S  | Mode4 to 7                                |
|                                     | toff3                |                       | 7.5  |                     | $\mu$ S  | Mode1 to 3                                |
| Blank time for load open            | topp                 | 1.5                   | 2    | 2.5                 | $\mu$ S  | Starts when the PWM is turned off.        |

The direction in which current flows out of the device is regarded as negative.

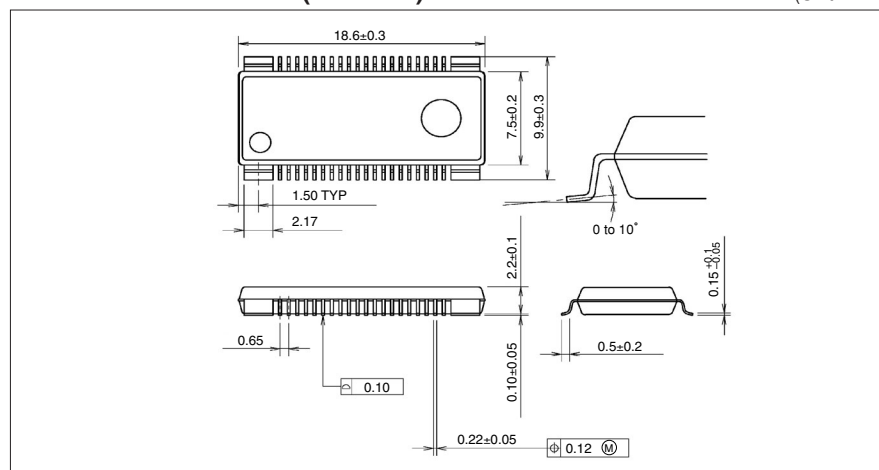
The block diagram illustrates the internal architecture of the TMS320C49 DSP. Key functional blocks include:

- Sequencer & Sleep Circuit:** The central control unit, connected to various pins including  $\overline{\text{Flag}}$ ,  $\text{Mo}$ ,  $\text{B\_SEL}$ ,  $\text{P\_SEL}$ ,  $\text{E\_SEL}$ ,  $\text{M}_3$ ,  $\text{M}_2$ ,  $\text{M}_1$ ,  $\text{CM/COM}$ ,  $\text{Clock}$ ,  $\text{Reset}$ ,  $\text{V}_{\text{REF}}$ ,  $\text{G}_{\text{BA}}$ ,  $\text{G}_{\text{BB}}$ ,  $\text{G}_{\text{BB}}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{ReB}$ , and  $\text{ReB}$ .
- Pre-Driver:** Two blocks, one on each side of the Sequencer, connected to  $\text{V}_{\text{DD}}$ ,  $\text{V}_{\text{REF}}$ , and the Sequencer.
- Protect:** Two blocks, one on each side of the Sequencer, connected to the Pre-Driver and the Sequencer.
- DAC:** Two blocks, one on each side of the Sequencer, connected to the Sequencer and the PWM Control blocks.
- PWM Control:** Two blocks, one on each side of the Sequencer, connected to the DAC, the Synchro Control, and the OSC.
- Synchro Control:** A central block connected to the PWM Control blocks and the OSC.
- OSC:** Two blocks, one on each side of the Sequencer, connected to the PWM Control blocks.
- Comp:** Two blocks, one on each side of the Sequencer, connected to the PWM Control blocks.
- Reg:** A register block connected to the Sequencer and the Pre-Driver.

The diagram also shows various pins and their connections, including  $\text{V}_{\text{DD}}$ ,  $\text{V}_{\text{REF}}$ ,  $\text{G}_{\text{BA}}$ ,  $\text{G}_{\text{BB}}$ ,  $\text{G}_{\text{BB}}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{OutB}$ ,  $\text{ReB}$ , and  $\text{ReB}$ .

| Pin No. | Symbol     | Function                                       |
|---------|------------|------------------------------------------------|
| 1       | Out/A      | Phase A output                                 |
| 2       | Out/A      | Phase A output                                 |
| 3       | N.C.       | No connection                                  |
| 4       | RsA        | Connection terminal for phase A sense resistor |
| 5       | G/A        | Phase A MOSFET gate                            |
| 6       | Gnd1       | Device Gnd1                                    |
| 7       | E_SEL      | Edge selection input                           |
| 8       | P_SEL      | Protection use selection input                 |
| 9       | Sync       | PWM control signal input                       |
| 10      | CW/CCW     | Normal/reverse control input                   |
| 11      | Reset      | Internal logic reset input                     |
| 12      | Clock      | Step clock input                               |
| 13      | M1         | Excitation mode/Sleep 2 setting input          |
| 14      | M2         |                                                |
| 15      | M3         |                                                |
| 16      | B_SEL      | Blanking time selection input                  |
| 17      | Gnd1       | Device Gnd1                                    |
| 18      | G/B        | Phase B MOSFET gate                            |
| 19      | RsB        | Connection terminal for phase B sense resistor |
| 20      | N.C.       | No connection                                  |
| 21      | Out /B     | Phase B output                                 |
| 22      | Out /B     | Phase B output                                 |
| 23      | OutB       | Phase B output                                 |
| 24      | OutB       | Phase B output                                 |
| 25      | N.C.       | No connection                                  |
| 26      | RsB        | Connection terminal for phase B sense resistor |
| 27      | GB         | Phase B MOSFET gate                            |
| 28      | Gnd1       | Device Gnd1                                    |
| 29      | Gnd2       | Device Gnd2                                    |
| 30      | Flag       | Protection circuit monitor output              |
| 31      | Mo         | 2-phase excitation state monitor output        |
| 32      | VDD        | Logic supply                                   |
| 33      | Ref/Sleep1 | Control current mode/Sleep 1 setting input     |
| 34      | Gnd3       | Device Gnd3                                    |
| 35      | N.C.       | No connection                                  |
| 36      | VBB        | Driver supply (motor supply)                   |
| 37      | N.C.       | No connection                                  |
| 38      | Gnd4       | Device Gnd4                                    |
| 39      | Gnd1       | Device Gnd1                                    |
| 40      | GA         | Phase A MOSFET gate                            |
| 41      | RsA        | Connection terminal for phase A sense resistor |
| 42      | N.C.       | No connection                                  |
| 43      | Out A      | Phase A output                                 |
| 44      | Out A      | Phase A output                                 |

(Unit : mm)



## SLA7075MR, MPR, MPRT/7076MR, MPR, MPRT/7077MR, MPR, MPRT/7078MR, MPR, MPRT 2-Phase to 4W 1-2 Phase Excitation Support, Built-in Sequencer

☆ For new designs, use SLA707xMPRT.

## Features

- Lineup of built-in current sense resistor and built-in protection circuit-type
- Power supply voltages,  $V_{BB}$ : 46 V (max), 10 to 44 V normal operating range
- Logic supply voltages,  $V_{DD}$ : 3.0 to 5.5 V
- Maximum output currents: 1 A, 1.5 A, 2 A, and 3 A
- Clock input method (built-in sequencer)
- Self-excitation PWM current control with fixed off-time
- Synchronous PWM chopping function prevents motor noise in Hold mode
- Sleep mode for reducing the IC input current in stand-by state
- ZIP type 23-pin molded package (SLA package)

## Absolute Maximum Ratings

| Parameter                     | Symbol    | Ratings              | Unit       | Remarks                  |
|-------------------------------|-----------|----------------------|------------|--------------------------|
| Motor Supply Voltage          | $V_M$     | 46                   | V          |                          |
| Driver Supply Voltage         | $V_{BB}$  | 46                   | V          |                          |
| Logic Supply Voltage          | $V_{DD}$  | 6                    | V          |                          |
| Output Current                | $I_O$     | *1                   | A          | $V_{ref}=0.4V$ , Mode F  |
| Logic Input Voltage           | $V_{IN}$  | -0.3 to $V_{DD}+0.3$ | V          |                          |
| REF Input Voltage             | $V_{REF}$ | -0.3 to $V_{DD}+0.3$ | V          |                          |
| Sense Voltage                 | $V_{RS}$  | $\pm 2$              | V          | Excluding $t_w < 1\mu s$ |
| Power Dissipation             | PD        | 4.7                  | W          | When $T_a = 25^\circ C$  |
|                               |           | 17                   |            | When $T_c = 25^\circ C$  |
| Junction Temperature          | $T_J$     | +150                 | $^\circ C$ |                          |
| Operating Ambient Temperature | $T_a$     | -20 to +85           | $^\circ C$ |                          |
| Storage Temperature           | $T_{stg}$ | -30 to +150          | $^\circ C$ |                          |

\*1: Output current value may be limited for the SLA7075MR, MPR, MPRT (1.0 A), SLA7076MR, MPR, MPRT (1.5 A), SLA7077MR, MPR, MPRT (2.0 A), and SA7078MR, MPR, MPRT (3.0 A), depending on the duty ratio, ambient temperature, and heating conditions.

Do not exceed junction temperature of  $T_J$  under any circumstances.

## Recommended Operating Conditions

| Parameter             | Symbol   | Rating |      | Unit       | Remarks                                             |
|-----------------------|----------|--------|------|------------|-----------------------------------------------------|
|                       |          | min.   | max. |            |                                                     |
| Motor Supply Voltage  | $V_M$    |        | 44   | V          |                                                     |
| Driver Supply Voltage | $V_S$    | 10     | 44   | V          |                                                     |
| Logic Supply Voltage  | $V_{DD}$ | 3.0    | 5.5  | V          | The $V_{CC}$ surge voltage should be 0.5 V or lower |
| Case Temperature      | $T_C$    |        | 90   | $^\circ C$ | Temperature at Pin-12 Lead (without heatsink)       |

## Electrical Characteristics

| Parameter                           | Symbol        | Ratings       |           |               | Unit       | Conditions                                                |
|-------------------------------------|---------------|---------------|-----------|---------------|------------|-----------------------------------------------------------|
|                                     |               | min.          | typ.      | max.          |            |                                                           |
| Main Supply Current                 | $I_{BB}$      |               |           | 15            | mA         | In operation                                              |
|                                     | $I_{BBS}$     |               |           | 100           | $\mu A$    | Sleep 1 and Sleep 2 modes                                 |
| Logic Supply Current                | $I_{DD}$      |               |           | 5             | mA         |                                                           |
| Output MOSFET Breakdown Voltage     | $V_{(BR)DSS}$ | 100           |           |               | V          | $V_{BB}=44V$ , $I_D=1mA$                                  |
| Output MOSFET ON Resistance         | $R_{DS(ON)}$  |               | 0.7       | 0.85          | $\Omega$   | SLA7075M, $I_D=1.0A$                                      |
|                                     |               |               | 0.45      | 0.6           |            | SLA7076M, $I_D=1.5A$                                      |
|                                     |               |               | 0.25      | 0.4           |            | SLA7077M, $I_D=2.0A$                                      |
|                                     |               |               | 0.18      | 0.24          |            | SLA7078M, $I_D=3.0A$                                      |
| Output MOSFET Diode Forward Voltage | $V_F$         |               | 0.85      | 1.1           | V          | SLA7075M, $I_D=1.0A$                                      |
|                                     |               |               | 1.0       | 1.25          |            | SLA7076M, $I_D=1.5A$                                      |
|                                     |               |               | 0.95      | 1.2           |            | SLA7077M, $I_D=2.0A$                                      |
|                                     |               |               | 0.95      | 2.1           |            | SLA7078M, $I_D=3.0A$                                      |
| Maximum Clock Frequency             | $F_{clock}$   | 250           |           |               | kHz        | When Clock Duty = 50%                                     |
| Logic Input Voltage                 | $V_{IL}$      |               |           | 0.25 $V_{DD}$ | V          |                                                           |
|                                     | $V_{IH}$      | 0.75 $V_{DD}$ |           |               |            |                                                           |
| Logic Input Current                 | $I_{IL}$      |               | $\pm 1$   |               | $\mu A$    |                                                           |
|                                     | $I_{IH}$      |               | $\pm 1$   |               |            |                                                           |
| REF Input Voltage                   | $V_{REF}$     | 0.04          |           | 0.3           | V          | SLA7075M, within the specified current limit              |
|                                     |               | 0.04          |           | 0.45          |            | SLA7076M, within the specified current limit              |
|                                     |               | 0.04          |           | 0.4           |            | SLA7077M, within the specified current limit              |
|                                     |               | 0.04          |           | 0.45          |            | SLA7078M, within the specified current limit              |
|                                     | $V_{REFS}$    | 2             |           | $V_{DD}$      |            | Output (OFF) Sleep 1                                      |
| REF Input Current                   | $I_{REF}$     |               | $\pm 10$  |               | $\mu A$    |                                                           |
| SENSE Sense Voltage                 | $V_{SENSE}$   |               | $V_{REF}$ |               | V          | When step reference current ratio is 100%                 |
| Sleep-Enable Recovery Time          | $T_{SE}$      | 100           |           |               | $\mu s$    | Sleep1&Sleep2                                             |
| Switching Time                      | $t_{con}$     |               | 2.0       |               | $\mu s$    | Clock $\rightarrow$ Out ON                                |
|                                     | $t_{coff}$    |               | 1.5       |               | $\mu s$    | Clock $\rightarrow$ Out OFF                               |
| Sense Resistance                    | $R_S$         | 0.296         | 0.305     | 0.314         | $\Omega$   | SLA7075M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.296         | 0.305     | 0.314         |            | SLA7076M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.199         | 0.205     | 0.211         |            | SLA7077M, tolerance of $\pm 3\%$                          |
|                                     |               | 0.150         | 0.155     | 0.160         |            | SLA7078M, tolerance of $\pm 3\%$                          |
| Overcurrent Sense Voltage           | $V_{ocp}$     | 0.65          | 0.7       | 0.75          | V          | SLA707xMPR, MPRT, when motor coil shorts out              |
| Overcurrent Sense Current           | $I_{ocp}$     |               | 2.3       |               | A          | SLA705MPR, MPRT/7076MPR, MPRT                             |
|                                     |               |               | 3.5       |               |            | SLA7077MPR, MPRT                                          |
|                                     |               |               | 4.6       |               |            | SLA7078MPR, MPRT                                          |
| Thermal Protection Temperature      | $T_{std}$     |               | 140       |               | $^\circ C$ | SLA707xMPRT, Rear of case (at the saturation temperature) |
| Logic Output Voltage                | $V_{LOL}$     |               |           | 1.25          | V          | SLA707xMPR, MPRT, $I_{FlagL}=1.25mA$                      |
|                                     | $V_{LOH}$     | $V_{DD}-1.25$ |           |               |            | SLA707xMPR, MPRT, $I_{FlagH}=-1.25mA$                     |
| Logic Output Current                | $I_{LOL}$     |               |           | 1.25          | mA         | SLA707xMPR, MPRT                                          |
|                                     | $I_{LOH}$     | -1.25         |           |               |            |                                                           |
| Step Reference Current Ratio        | ModeF         |               | 100       |               | %          |                                                           |
|                                     | ModeE         |               | 98.1      |               | %          |                                                           |
|                                     | ModeD         |               | 95.7      |               | %          |                                                           |
|                                     | ModeC         |               | 92.4      |               | %          |                                                           |
|                                     | ModeB         |               | 88.2      |               | %          |                                                           |
|                                     | ModeA         |               | 83.1      |               | %          |                                                           |
|                                     | Mode9         |               | 77.3      |               | %          |                                                           |
|                                     | Mode8         |               | 70.7      |               | %          |                                                           |
|                                     | Mode7         |               | 63.4      |               | %          |                                                           |
|                                     | Mode6         |               | 55.5      |               | %          |                                                           |
|                                     | Mode5         |               | 47.1      |               | %          |                                                           |
|                                     | Mode4         |               | 38.2      |               | %          |                                                           |
|                                     | Mode3         |               | 29.0      |               | %          |                                                           |
|                                     | Mode2         |               | 19.5      |               | %          |                                                           |
|                                     | Mode1         |               | 9.8       |               | %          |                                                           |
| PWM Minimum ON Time                 | $t_{on(min)}$ |               | 1.7       |               | $\mu s$    |                                                           |
| PWM OFF Time                        | $t_{off1}$    |               | 12        |               | $\mu s$    | Mode 8 to F                                               |
|                                     | $t_{off2}$    |               | 9         |               | $\mu s$    | Mode 4 to 7                                               |
|                                     | $t_{off3}$    |               | 7         |               | $\mu s$    | Mode 1 to 3                                               |



SI-7510

New Pentagon Connection

■Absolute Maximum Ratings

| Parameter                     | Symbol             | Ratings                  | Unit | Remarks            |
|-------------------------------|--------------------|--------------------------|------|--------------------|
| Main Supply Voltage           | V <sub>CC1</sub>   | 44                       | V    |                    |
| Logic Supply Voltage          | V <sub>CC2</sub>   | 7                        | V    |                    |
| Logic Input Voltage           | V <sub>IN</sub>    | −0.3 to V <sub>CC2</sub> | V    |                    |
| REF Input Voltage             | V <sub>REF</sub>   | −0.3 to V <sub>CC2</sub> | V    |                    |
| Sense Input Voltage           | V <sub>SENSE</sub> | 2                        | V    | Except when tw<1μs |
| Charge Pump Output Voltage    | V <sub>MC3</sub>   | 48                       | V    |                    |
| Power Dissipation             | P <sub>D</sub>     | 1.6                      | W    |                    |
| Operating Ambient Temperature | T <sub>a</sub>     | −10 to 80                | °C   |                    |
| Storage Temperature           | T <sub>stg</sub>   | −20 to 150               | °C   |                    |
| Junction Temperature          | T <sub>j</sub>     | 150                      | °C   |                    |

■Recommended Operating Ranges

| Parameter            | Symbol           | Operating Ranges | Unit |
|----------------------|------------------|------------------|------|
| Main Supply Voltage  | V <sub>CC1</sub> | 10 to 42*        | V    |
| Logic Supply Voltage | V <sub>CC2</sub> | 3 to 5.5         | V    |
| REF Input Voltage    | V <sub>REF</sub> | 0.1 to 1         | V    |

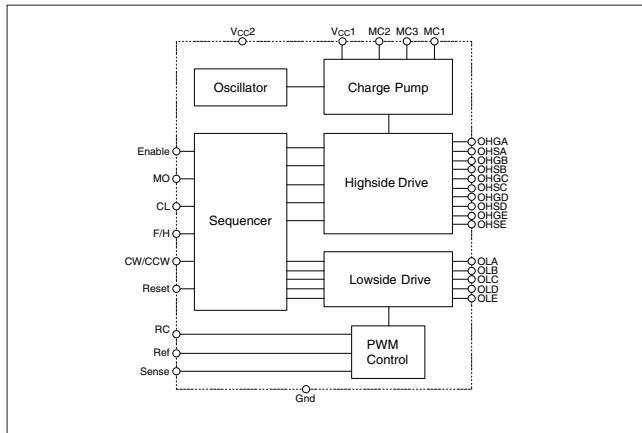
\*: Insert a 5V Zener diode between V<sub>CC1</sub> and V<sub>MC3</sub> when using with V<sub>CC1</sub> of 35 V or more.

■Electrical Characteristics

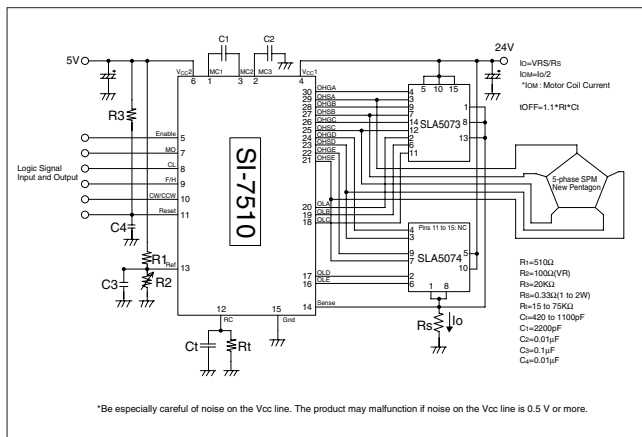
(T<sub>a</sub>=25°C, V<sub>CC1</sub>=24V, V<sub>CC2</sub>=5V, unless otherwise specified)

| Parameter                                          | Symbol             | Ratings |                     |      | Unit | Conditions                  |
|----------------------------------------------------|--------------------|---------|---------------------|------|------|-----------------------------|
|                                                    |                    | min.    | typ.                | max. |      |                             |
| Main Supply Current                                | I <sub>CC1</sub>   |         |                     | 25   | mA   |                             |
| Logic Supply Current                               | I <sub>CC2</sub>   |         |                     | 10   | mA   |                             |
| Logic Input Voltage                                | V <sub>IL</sub>    |         |                     | 1.25 | V    |                             |
|                                                    | V <sub>IH</sub>    | 3.75    |                     |      | V    |                             |
| Logic Input Current                                | I <sub>IL</sub>    | −20     |                     | 20   | μA   | V <sub>IL</sub> =0V         |
|                                                    | I <sub>IH</sub>    | −20     |                     | 20   | μA   | V <sub>IH</sub> =5.5V       |
| ENA Input Current                                  | I <sub>ENA</sub>   | −100    |                     | 20   | μA   | V <sub>ENA</sub> =0V        |
| REF Input Current                                  | I <sub>REF</sub>   | −20     |                     | 20   | μA   | V <sub>REF</sub> =0 to 5.5V |
| SENSE Voltage                                      | V <sub>SENSE</sub> |         | 1                   |      | V    | V <sub>REF</sub> =1V        |
| SENSE Current                                      | I <sub>SENSE</sub> | −20     |                     | 20   | μA   | V <sub>SENSE</sub> =0V, 2V  |
| MO Output Voltage                                  | V <sub>MOL</sub>   |         |                     | 1    | V    | I <sub>MOL</sub> =1mA       |
|                                                    | V <sub>MOH</sub>   | 4       |                     |      | V    | I <sub>MOH</sub> =−1mA      |
| RC Pin Threshold Voltage                           | V <sub>RCL</sub>   |         | 0.5                 |      | V    |                             |
|                                                    | V <sub>RCH</sub>   |         | 1.5                 |      | V    |                             |
| RC Pin Outflow Current                             | I <sub>RC</sub>    |         | 300                 |      | μA   | V <sub>RC</sub> =0V         |
| Charge Pump Output Voltage                         | V <sub>MC3</sub>   |         | V <sub>CC1</sub> +9 |      | V    | Without Zener diode         |
| High Side Output Voltage<br>(between gate sources) | V <sub>HGSL</sub>  |         |                     | 1    | V    |                             |
|                                                    | V <sub>HGSH</sub>  |         | 8.5                 |      | V    |                             |
| Low Side Output Voltage                            | V <sub>LGL</sub>   |         |                     | 1    | V    |                             |
|                                                    | V <sub>LGH</sub>   |         | 7.5                 |      | V    |                             |
| Maximum CL Frequency                               | f <sub>CK</sub>    | 100     |                     |      | KHz  |                             |
| Maximum Input CL Width (on)                        | T <sub>CON</sub>   | 1       |                     |      | μs   |                             |
| Power-on Reset time                                | PTW                |         | 1.5                 |      | μs   |                             |
| Output Delay Time                                  | T <sub>IO</sub>    |         | 2                   |      | μs   |                             |
| CW/CCW, F/H                                        | T <sub>ICS</sub>   | 500     |                     |      | μs   | Against CL ↑                |
| Input Data Setup Time                              |                    |         |                     |      |      |                             |
| CW/CCW, F/H                                        | T <sub>ICH</sub>   | 500     |                     |      | μs   |                             |
| Input Data Hold Time                               |                    |         |                     |      |      |                             |

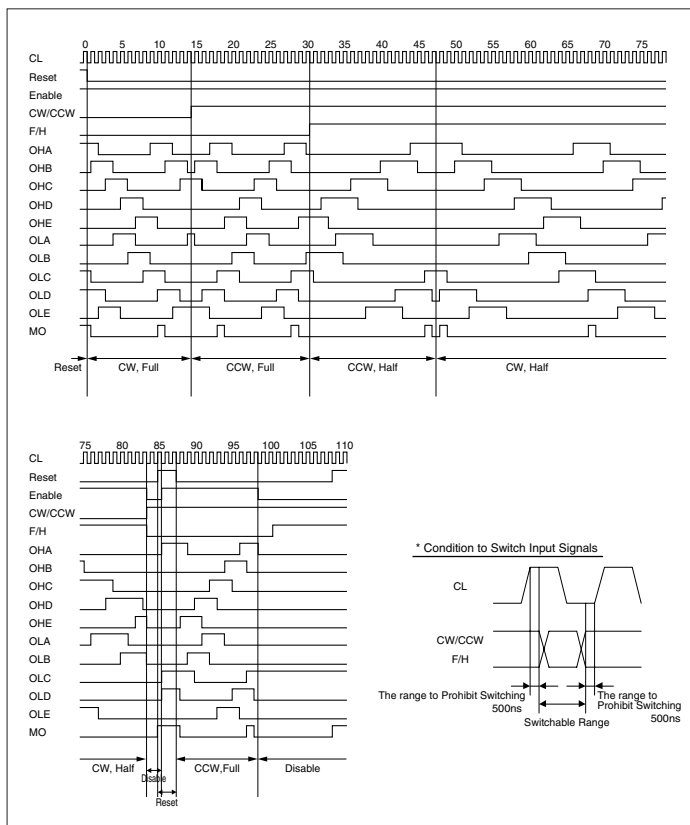
## Internal Block Diagram



## Typical Connection Diagram



## Input and Output Timing Chart



## Pin Assignment and Function Table

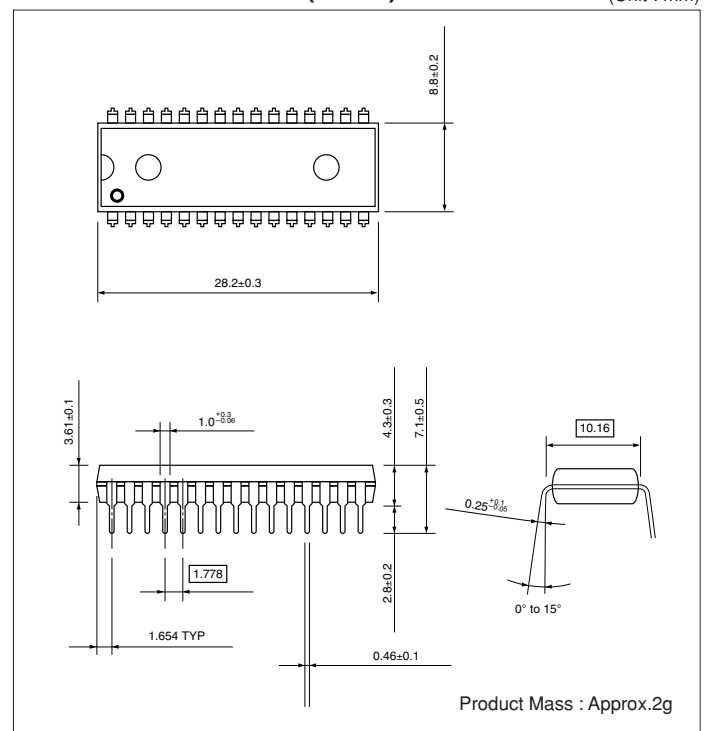
| Pin No. | Symbol | Function                                                |
|---------|--------|---------------------------------------------------------|
| 1       | MC1    | Capacitor Connection Terminal for Charge Pump (for MC2) |
| 2       | MC3    | Capacitor Connection Terminal for Charge Pump (for Gnd) |
| 3       | MC2    | Capacitor Connection Terminal for Charge Pump (for MC1) |
| 4       | Vcc1   | Main Supply Voltage Input                               |
| 5       | Enable | Output OFF                                              |
| 6       | Vcc2   | Logic Voltage Input                                     |
| 7       | MO     | Monitor to Detect Motor Position                        |
| 8       | CL     | Clock                                                   |
| 9       | F/H    | 4-phase, 4-5 phase switching                            |
| 10      | CW/CCW | Switching Between Forward and Backward Rotation         |
| 11      | Reset  | Reset                                                   |
| 12      | RC     | RC Connection for Chopping Off Time Setting             |
| 13      | Ref    | Reference Voltage Input for Motor Current Setting       |
| 14      | Sense  | For Motor Current Detection                             |
| 15      | Gnd    | Gnd                                                     |
| 16      | VOLE   | Low Side MOSFET Gate Connection Pin (E-phase)           |
| 17      | VOLD   | Low Side MOSFET Gate Connection Pin (D-phase)           |
| 18      | VOLC   | Low Side MOSFET Gate Connection Pin (C-phase)           |
| 19      | VOLB   | Low Side MOSFET Gate Connection Pin (B-phase)           |
| 20      | VOLA   | Low Side MOSFET Gate Connection Pin (A-phase)           |
| 21      | VOHSE  | High Side MOSFET Source Connection Pin (E-phase)        |
| 22      | VOHGE  | High Side MOSFET Gate Connection Pin (E-phase)          |
| 23      | VOHSD  | High Side MOSFET Source Connection Pin (D-phase)        |
| 24      | VOHGD  | High Side MOSFET Gate Connection Pin (D-phase)          |
| 25      | VOHSC  | High Side MOSFET Source Connection Pin (C-phase)        |
| 26      | VOHGC  | High Side MOSFET Gate Connection Pin (C-phase)          |
| 27      | VOHSB  | High Side MOSFET Source Connection Pin (B-phase)        |
| 28      | VOHGB  | High Side MOSFET Gate Connection Pin (B-phase)          |
| 29      | VOHSA  | High Side MOSFET Source Connection Pin (A-phase)        |
| 30      | VOHGA  | High Side MOSFET Gate Connection Terminal (A-phase)     |

## Truth Table

| Pin Name  | Low Level             | High Level              |
|-----------|-----------------------|-------------------------|
| Clock     |                       | Positive Edge           |
| CW/CCW    | Forward Rotation (CW) | Backward Rotation (CCW) |
| Full/Half | 4-phase excitation    | 4-5 phase excitation    |
| Enable    | Disable               | Enable                  |
| Reset     | Enable                | Reset                   |

## External Dimensions (DIP30)

(Unit : mm)



# STA6940M

## ■Features

- Output current: 4A (peak: 8A)
- Power supply voltage:  $V_{BB} = 10$  to 40V
- Logic supply voltage:  $V_{DD} = 3.0$  to 5.5V
- Built-in UVLO, OCP, and TSD protection
- Built-in diag output function
- STA 18-pin package

## ■Absolute Maximum Ratings

| Parameter                     | Symbol     | Ratings              | Unit             | Conditions                                             |
|-------------------------------|------------|----------------------|------------------|--------------------------------------------------------|
| Driver Supply Voltage         | $V_{BB}$   | 44                   | V                |                                                        |
| Logic Supply Voltage          | $V_{DD}$   | 6                    | V                |                                                        |
| Output Current                | $I_O$      | 8                    | A                | 100 $\mu$ s or less                                    |
| Logic Input Voltage           | $V_{IN}$   | -0.3 to $V_{DD}+0.3$ | V                |                                                        |
| PWM REF Input Voltage         | $V_{PREF}$ | -0.3 to $V_{DD}+0.3$ | V                |                                                        |
| OCP REF Input Voltage         | $V_{OREF}$ | -0.3 to $V_{DD}+0.3$ | V                |                                                        |
| Sense Voltage                 | $V_{RS}$   | -1 to 2              | V                |                                                        |
| Power Dissipation             | $P_D$      | 2.7                  | W                | DC control ( $T_a = 25^\circ\text{C}$ )                |
|                               |            | 3.0                  | W                | PWM control ( $T_a = 25^\circ\text{C}$ ) at Slow Decay |
|                               |            | 3.2                  | W                | PWM control ( $T_a = 25^\circ\text{C}$ ) at Fast Decay |
| Junction Temperature          | $T_j$      | 150                  | $^\circ\text{C}$ |                                                        |
| Operating Ambient Temperature | $T_a$      | -20 to 85            | $^\circ\text{C}$ |                                                        |
| Storage Temperature           | $T_{stg}$  | -30 to 150           | $^\circ\text{C}$ |                                                        |

\*: Output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed junction temperature of  $T_j$  under any circumstances.

## ■Recommended Operating Conditions

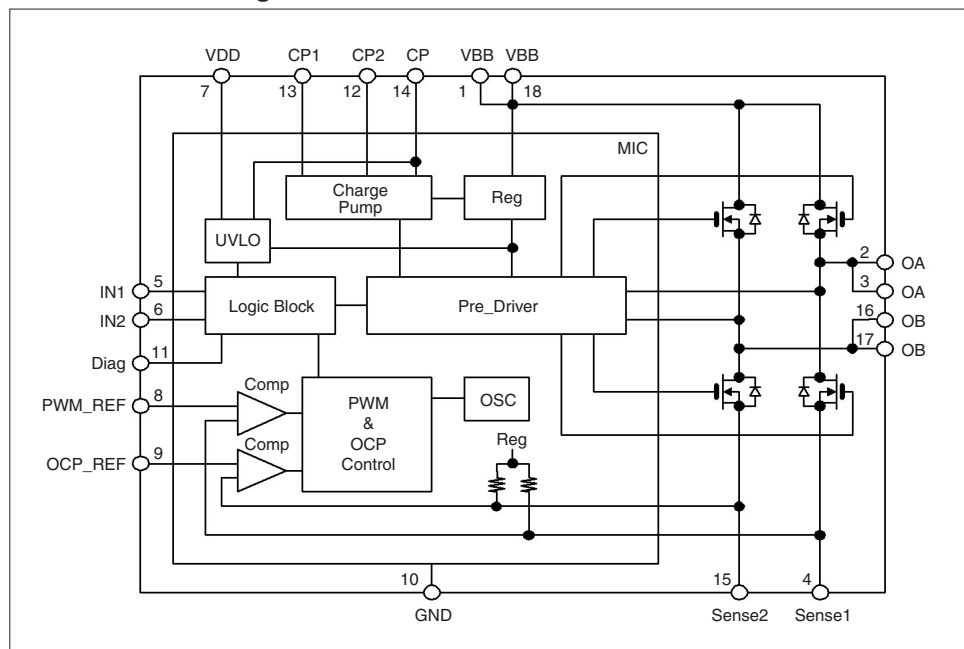
| Parameter             | Symbol     | Ratings |      | Unit             | Conditions                         |
|-----------------------|------------|---------|------|------------------|------------------------------------|
|                       |            | min.    | max. |                  |                                    |
| Main Supply Voltage   | $V_{BB}$   | 10      | 40   | V                |                                    |
| Output Current        | $I_O$      |         | 4.0  | A                |                                    |
| Logic Supply Voltage  | $V_{DD}$   | 3.0     | 5.5  | V                |                                    |
| PWM REF Input Voltage | $V_{PREF}$ |         | 1    | V                | When operating current control     |
| OCP REF Input Voltage | $V_{OREF}$ |         | 2    | V                | When operating overcurrent control |
| Case Temperature      | $T_c$      |         | 85   | $^\circ\text{C}$ | Rear center (without Fin)          |

## ■Electrical Characteristics

( $V_{DD}=5\text{V}$ ,  $V_{BB}=24\text{V}$ ,  $T_a=25^\circ\text{C}$ , unless otherwise specified)

| Parameter                                    | Symbol         | Ratings              |                      |                      | Unit             | Concitions                                     |
|----------------------------------------------|----------------|----------------------|----------------------|----------------------|------------------|------------------------------------------------|
|                                              |                | min.                 | typ.                 | max.                 |                  |                                                |
| Main Supply Current                          | $I_{BB}$       |                      |                      | 20                   | mA               | In operation                                   |
| Logic Supply Current                         | $I_{DD}$       |                      |                      | 5                    | mA               |                                                |
| Charge Pump Voltage                          | $V_{CP}$       |                      | $V_{BB}+5$           |                      | V                | $V_{BB}=10\text{V}$ to 40V                     |
| Charge Pump Oscillation Frequency            | $F_{CP}$       |                      | 360                  |                      | kHz              |                                                |
| Low Driver Supply Voltage Protection Voltage | $V_{UVBL}$     |                      | 7                    |                      | V                |                                                |
|                                              | $V_{UVBH}$     |                      | 7.8                  |                      | V                |                                                |
| Low Logic Supply Voltage Protection Voltage  | $V_{UVDL}$     |                      | 2.3                  |                      | V                |                                                |
|                                              | $V_{UVDH}$     |                      | 2.5                  |                      | V                |                                                |
| Low Charge Pump Voltage Protection Voltage   | $V_{UVC L}$    |                      | 3.8                  |                      | V                | against $V_{BB}$                               |
|                                              | $V_{UVC H}$    |                      | 4                    |                      | V                |                                                |
| Output MOSFET Breakdown Voltage              | $V_{(BR)DS}$   | 60                   |                      |                      | V                | $I_D=250\mu\text{A}$                           |
| Output MOSFET ON Resistance                  | $R_{DS(ON)}$   |                      | 0.1                  | 0.13                 | $\Omega$         | $I_D=4.0\text{A}$                              |
| Output MOSFET Diode Forward Voltage          | $V_F$          |                      | 0.95                 | 2.1                  | V                | $I_F=4.0\text{A}$                              |
| Logic Input Voltage                          | $V_{LIL}$      |                      |                      | 0.25 $V_{DD}$        | V                |                                                |
|                                              | $V_{LIH}$      | 0.75 $V_{DD}$        |                      |                      | V                |                                                |
| Logic Input Current                          | $I_{LIL}$      |                      | $\pm 1$              |                      | $\mu\text{A}$    |                                                |
|                                              | $I_{LIH}$      |                      | $\pm 1$              |                      | $\mu\text{A}$    |                                                |
| Maximum Logic Input Clock Frequency          | $f_{CLK}$      | 100                  |                      |                      | kHz              | duty=50%                                       |
| PWM REF Input Voltage                        | $V_{PREF}$     | 0.1                  |                      | 1                    | V                | When controlling the current                   |
| PWM REF Input Current                        | $I_{PREF}$     |                      | $\pm 10$             |                      | $\mu\text{A}$    | $V_{REF}=0$ to $V_{DD}$                        |
| OCP REF Input Voltage                        | $V_{OREF}$     | 0.1                  |                      | 2                    | V                | When controlling the current                   |
| OCP REF Input Current                        | $I_{OREF}$     |                      | $\pm 10$             |                      | $\mu\text{A}$    | $V_{REF}=0$ to $V_{DD}$                        |
| PWM Sense Voltage                            | $V_{PSEN}$     | $V_{PREF}$<br>-0.045 | $V_{PREF}$<br>-0.015 | $V_{PREF}$<br>+0.015 | V                |                                                |
| Overcurrent Sense Voltage                    | $V_{OSEN}$     | $V_{OREF}$<br>-0.045 | $V_{OREF}$<br>-0.015 | $V_{OREF}$<br>+0.015 | V                |                                                |
| Sense Input Current                          | $I_{SENSE}$    |                      | $\pm 20$             |                      | $\mu\text{A}$    |                                                |
| Diag Output Voltage                          | $V_{LOL}$      |                      |                      | 1.25                 | V                | $I_{LOL}=1.25\text{mA}$                        |
|                                              | $V_{LOH}$      | $V_{DD}-1.25$        |                      |                      | V                | $I_{LOL}=-1.25\text{mA}$                       |
| Diag Output Current                          | $I_{LOL}$      |                      |                      | 1.25                 | mA               | $V_{LOL}=1.25\text{V}$                         |
|                                              | $I_{LOH}$      | -1.25                |                      |                      | mA               | $V_{LOH}=V_{DD}-1.25$                          |
| Diag Output Frequency                        | $f_{DIAG}$     |                      | 90                   |                      | kHz              |                                                |
| PWM Minimum ON Time                          | $t_{PON(min)}$ |                      | 5                    |                      | $\mu\text{s}$    | During PWM operation                           |
| PWM OFF Time                                 | $t_{POFF}$     |                      | 35                   |                      | $\mu\text{s}$    |                                                |
| OCP Minimum ON Time                          | $t_{OON(min)}$ |                      | 5                    |                      | $\mu\text{s}$    | During OCP operation                           |
| OCP OFF Time                                 | $t_{OOFF}$     |                      | 142                  |                      | $\mu\text{s}$    |                                                |
| Crossover Current Delay Time                 | $t_{COCD}$     | 150                  |                      | 750                  | ns               |                                                |
| Switching Time                               | $t_{CON}$      |                      | 3                    |                      | $\mu\text{s}$    | IN→Out ON                                      |
|                                              | $t_{COFF}$     |                      | 2.7                  |                      | $\mu\text{s}$    | IN→Out OFF                                     |
| Thermal Protection Activation Temperature    | $T_{tsdon}$    |                      | 140                  |                      | $^\circ\text{C}$ | Temperature of rear of package (at saturation) |
| Thermal Protection Deactivation Temperature  | $T_{tsdoff}$   |                      | 115                  |                      | $^\circ\text{C}$ |                                                |

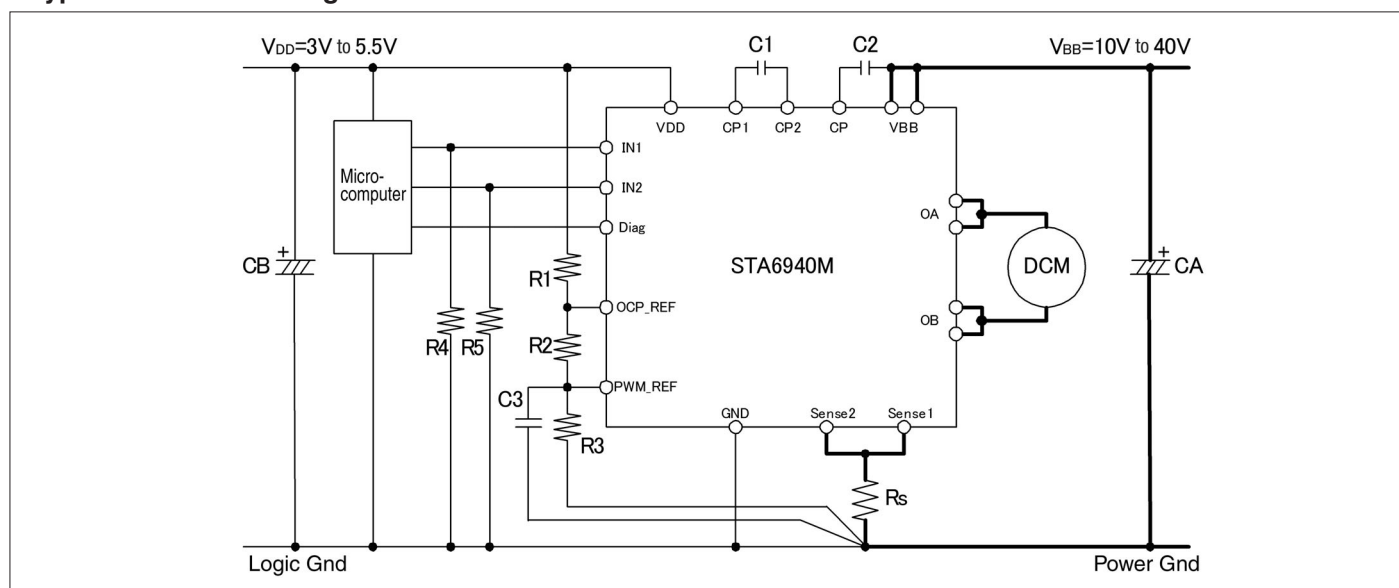
## Internal Block Diagram



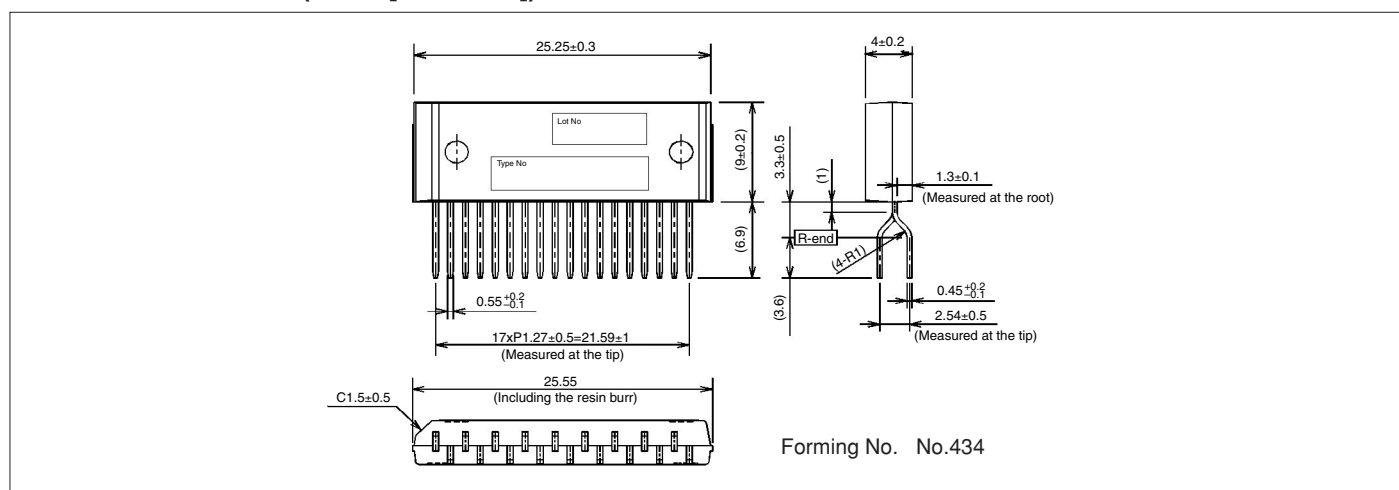
## Pin Assignment

| Pin No. | Symbol          | Function                                      |
|---------|-----------------|-----------------------------------------------|
| 1       | V <sub>BB</sub> | Main supply                                   |
| 2,3     | OA              | Output terminal A                             |
| 4       | Sense 1         | Constant current sense terminal               |
| 5       | IN1             | Output setting terminal                       |
| 6       | IN2             |                                               |
| 7       | V <sub>DD</sub> | Logic supply                                  |
| 8       | PWM_REF         | Constant current setting input terminal       |
| 9       | OCP_REF         | Overcurrent setting input terminal            |
| 10      | Gnd             | Device Gnd                                    |
| 11      | Diag            | Monitor terminal                              |
| 12      | CP2             | Capacitor connection terminal for charge pump |
| 13      | CP1             |                                               |
| 14      | CP              |                                               |
| 15      | Sense 2         | Overcurrent sense terminal                    |
| 16,17   | OB              | Output terminal B                             |
| 18      | V <sub>BB</sub> | Driver supply                                 |

## Typical Connection Diagram



## External Dimensions [ZIP18 [STA18Pin]]



## SPI-6631M

## ■ Features

- Power supply voltages,  $V_{BB}$ : 13 V to 33 V
- Signal power supply configuration
- Output current  $I_{out}$ : 3 A (max)... repetitive current (normal-operation current)
- Built-in current recirculation diode
- Built-in UVLO, TSD and OCP protection
- Built-in dead time function that prevents through current upon phase switching
- Built-in error sense flag output
- HSOP16-pin package

## ■ Absolute Maximum Ratings

| Parameter                       | Symbol      | Ratings     | Unit | Conditions                           |
|---------------------------------|-------------|-------------|------|--------------------------------------|
| Main Supply Voltage             | $V_{BB}$    | 35          | V    |                                      |
| MOSFET Output Breakdown Voltage | $V_{DSS}$   | 35          | V    | DutyCycle=100%*                      |
| Output Current                  | $I_{out}$   | ±3          | A    |                                      |
| Input Voltage                   | $V_{IN}$    | −0.3 to 6.5 | V    |                                      |
| S Terminal Voltage              | $V_{sen}$   | −2 to 2     | V    |                                      |
| Alarm Terminal Voltage          | $V_{alarm}$ | 6.5         | V    |                                      |
| Alarm Input Current             | $I_{alarm}$ | 1           | mA   |                                      |
| Power Dissipation               | $P_D$       | 2.6         | W    | When using a Sanken evaluation board |
| Junction Temperature            | $T_J$       | 150         | °C   |                                      |
| Storage Temperature             | $T_{stg}$   | −30 to 150  | °C   |                                      |
| Operating Ambient Temperature   | $T_a$       | −20 to 85   | °C   |                                      |

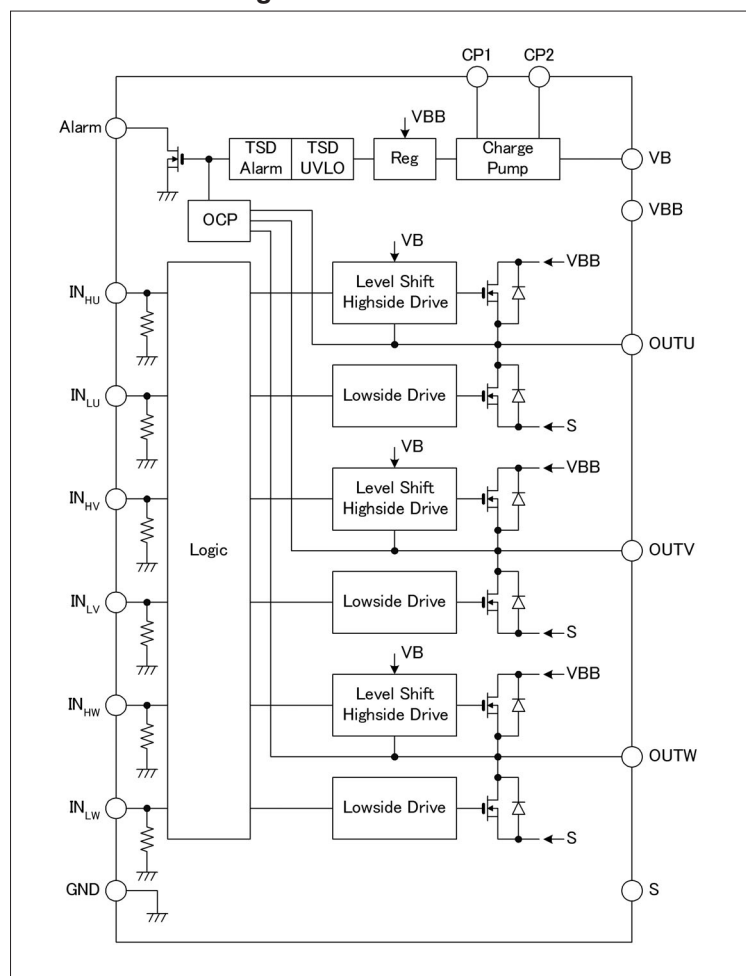
\*: Output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed the rated current or maximum junction temperature ( $T_J = 150^\circ\text{C}$ ).

## ■ Electrical Characteristics

( $T_a=25^\circ\text{C}$ ,  $V_{BB}=24\text{V}$ , unless otherwise specified)

| Parameter                                | Symbol              | Ratings |            |      | Unit          | Conditions                                                                             |
|------------------------------------------|---------------------|---------|------------|------|---------------|----------------------------------------------------------------------------------------|
|                                          |                     | min.    | typ.       | max. |               |                                                                                        |
| Main Supply Voltage                      | $V_{BB}$            | 13      | —          | 33   | V             | In operation                                                                           |
| Main Supply Current                      | $I_{BB}$            | —       | —          | 20   | mA            |                                                                                        |
| Maximum Clock Pulse Width                | $t_w$               | —       | —          | 3    | $\mu\text{s}$ |                                                                                        |
| Input Voltage                            | $V_{IL}$            | —       | —          | 0.8  | V             |                                                                                        |
|                                          | $V_{IH}$            | 2.0     | —          | —    | V             |                                                                                        |
| Input Current                            | $I_{IL}$            | —       | ±8         | —    | $\mu\text{A}$ | $V_{IN(0)}$ , $V_{IN}=0.8\text{V}$                                                     |
|                                          | $I_{IH}$            | —       | ±20        | —    | $\mu\text{A}$ | $V_{IN(1)}$ , $V_{IN}=2.0\text{V}$                                                     |
| Crossover Dead Time                      | $T_{delay}$         | 100     | 500        | 1200 | ns            |                                                                                        |
| VB Terminal Breakdown Voltage            | $V_B$               | —       | $V_{BB}+5$ | —    | V             | Breakdown voltage between VB and GND                                                   |
| VB-OUT Breakdown Voltage                 | $V_{B-OUT}$         | —       | 5          | —    | V             |                                                                                        |
| VB Terminal Current                      | $I_B$               | —       | —          | 3    | mA            | $V_{B-OUT}=5\text{V}$                                                                  |
| Output Leakage Current                   | $I_{DSS}$           | —       | —          | 800  | $\mu\text{A}$ | $V_{OUT}=V_{BB}=35\text{V}$                                                            |
|                                          |                     | −800    | —          | —    | $\mu\text{A}$ | $V_{OUT}=0\text{V}$                                                                    |
| MOSFET ON Resistance                     | $R_{DS(ON)}$        | —       | 0.4        | 0.7  | $\Omega$      | $I_{out}=1\text{A}$ , Between $V_{BB}$ and OUT $I_{out}=1\text{A}$ , Between OUT and S |
| MOSFET Diode Forward Voltage             | $V_{SD}$            | —       | —          | 2.2  | V             | $I_{SD}=1\text{A}$                                                                     |
| Overcurrent Sense Current                | $I_{OCP}$           | 7       | —          | —    | A             | Short between Out and Out                                                              |
| Overcurrent Protection Blank Time        | $t_{blank}$         | 0.7     | 1.2        | 4    | $\mu\text{s}$ |                                                                                        |
| Overcurrent Protection Delay Time        | $t_{ocp}$           | 0.5     | 1          | 2.2  | ms            |                                                                                        |
| Thermal Protection Operation Temperature | $T_J$               | —       | 170        | —    | °C            |                                                                                        |
| Thermal Protection Hysteresis            | $\Delta T_J$        | —       | 15         | —    | °C            |                                                                                        |
| Low Voltage Protection Operation Voltage | UVLO                | 4.0     | 4.5        | 5.0  | V             | $V_{BB}$ voltage                                                                       |
| Low Voltage Protection Hysteresis        | $\Delta\text{UVLO}$ | 0.4     | 0.45       | 0.5  | V             |                                                                                        |
| Alarm Output Voltage                     | $V_{Alarm}$         | —       | —          | 0.5  | V             | $I=1\text{mA}$                                                                         |

### ■ Internal Block Diagram

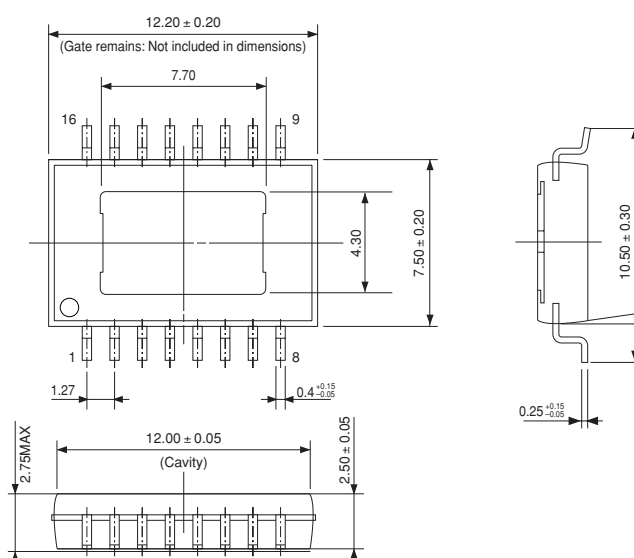


## ■Pin Assignment

| Pin No. | Symbol           | Function                                       |
|---------|------------------|------------------------------------------------|
| 1       | CP2              | Capacitor terminal for charge pump 2           |
| 2       | CP1              | Capacitor terminal for charge pump 1           |
| 3       | OUTU             | DMOSFET phase U output                         |
| 4       | S                | Sense terminal (lower arm source output)       |
| 5       | OUTV             | DMOSFET phase V output                         |
| 6       | OUTW             | DMOSFET phase W output                         |
| 7       | Alarm            | Alarm output                                   |
| 8       | GND              | Ground                                         |
| 9       | IN <sub>LW</sub> | Phase W lower arm input                        |
| 10      | IN <sub>HW</sub> | Phase W upper arm input                        |
| 11      | IN <sub>LV</sub> | Phase V lower arm input                        |
| 12      | IN <sub>HV</sub> | Phase V upper arm input                        |
| 13      | VBB              | Driver supply terminal                         |
| 14      | IN <sub>LU</sub> | Phase U lower arm input                        |
| 15      | IN <sub>HU</sub> | Phase U upper arm input                        |
| 16      | VB               | Capacitor terminal for charging up charge pump |

### ■ External Dimensions (HSOP16)

(Unit : mm)



Product Mass : Approx.0.56g

## SI-6633M

## ■Features

- Built-in power element, normal operation rated output current  $I_{OUT} = 2A$  (DC)/4A (peak)
- Hall element input
- Provides the following current control functions:
  - Peak current control fixed frequency PWM (internal PWM)
  - PWM control (external PWM) based on speed control signal (analog signal)
  - PWM control (logic PWM) based on logic input
- Protection functions
  - Overcurrent protection, overvoltage protection
  - Thermal protection, undervoltage lockout protection
  - Motor lock detection
- Provides alarm output pin for protection function operation
- Provides pin (FG) to output rotation signal generated by state transition of Hall input
- Built-in synchronous rectifier function that reduces power dissipation
- Built-in switching function for synchronous rectifier operation (Active/Passive)
- Standby mode

## ■Absolute Maximum Ratings

(Ta=25°C)

| Parameter                     | Symbol                  | Ratings         | Unit | Conditions              |
|-------------------------------|-------------------------|-----------------|------|-------------------------|
| Supply Voltage                | V <sub>BB</sub>         | -0.3 to 38      | V    |                         |
| Output Voltage                | V <sub>OUT</sub>        | V <sub>BB</sub> | V    |                         |
| Output Current*               | I <sub>OUT(Ave)</sub>   | ±2              | A    | tw<10msec               |
|                               | I <sub>OUT(Peak)</sub>  | ±4              | A    |                         |
| Logic Input Voltage           | V <sub>IN(Logic)</sub>  | -0.3 to 5.5     | V    |                         |
| Analog Input Voltage          | V <sub>IN(Analog)</sub> | -0.3 to 6       | V    |                         |
| Detection Voltage             | V <sub>SENSE</sub>      | ±0.5            | V    |                         |
| Package Power Dissipation     | P <sub>D</sub>          | 2.9             | W    | Sanken Evaluation Board |
| Maximum Junction Temperature  | T <sub>J</sub>          | 150             | °C   |                         |
| Storage Temperature           | T <sub>stg</sub>        | -40 to 150      | °C   |                         |
| Operating Ambient Temperature | T <sub>a</sub>          | -20 to 85       | °C   |                         |

\*: The output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Be sure to perform sufficient evaluation and verification by referring to the thermal design data and application notes so that other ratings will not be exceeded under any circumstances.

## ■Recommended Operating Conditions

| Parameter                     | Symbol                  | Ratings    | Unit | Conditions                                                             |
|-------------------------------|-------------------------|------------|------|------------------------------------------------------------------------|
| Supply Voltage                | V <sub>BB</sub>         | 10 to 30   | V    | During normal operation                                                |
| Logic Input Voltage           | V <sub>IN(Logic)</sub>  | 0 to 5.5   | V    |                                                                        |
| Analog Input Voltage          | V <sub>IN(Analog)</sub> | 0 to 5.5   | V    | Excluding REF                                                          |
| REF Input Voltage             | V <sub>REF</sub>        | 0.5 to 5.5 | V    | The control current precision degrades significantly at 0.5V or lower. |
| Detection Voltage             | V <sub>SEN</sub>        | ±0.5       | V    |                                                                        |
| Package Temperature           | T <sub>C</sub>          | 105        | °C   |                                                                        |
| Operating Ambient Temperature | T <sub>a</sub>          | -20 to 85  | °C   |                                                                        |

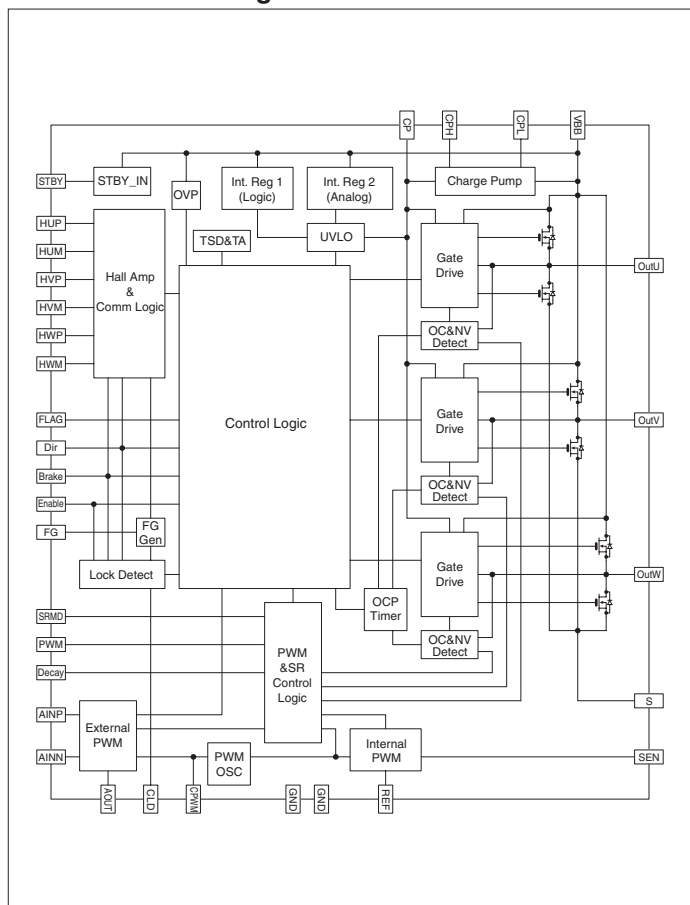
## ■Electrical Characteristics

(Ta=25°C, V<sub>BB</sub>=24V, V<sub>DD</sub>=5V, unless otherwise specified)

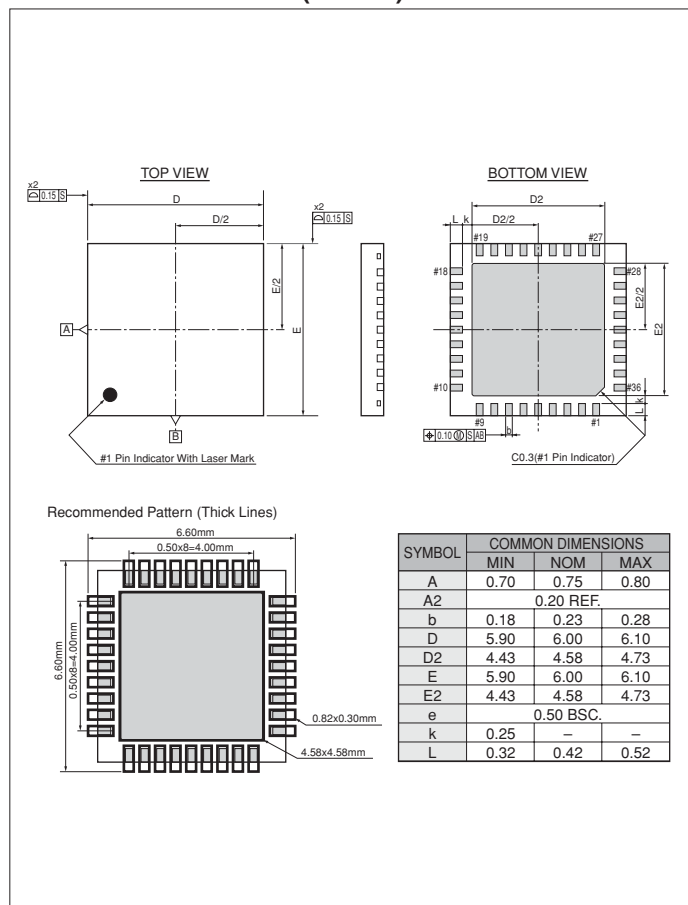
| Parameter                                       | Symbol                             | Ratings            |      |                     | Unit | Conditions                                        |
|-------------------------------------------------|------------------------------------|--------------------|------|---------------------|------|---------------------------------------------------|
|                                                 |                                    | min.               | typ. | max.                |      |                                                   |
| Driver Supply Voltage Range                     | V <sub>BB</sub>                    | 10                 | —    | V <sub>BB(OV)</sub> | V    | During motor driving                              |
| Charge Pump Output Voltage                      | V <sub>CP</sub>                    | 6                  | 7.5  | 9                   | V    | Output disabled, CP-V <sub>BB</sub> voltage       |
| Charge Pump Oscillation Frequency               | f <sub>CP</sub>                    | 90                 | 120  | 150                 | kHz  |                                                   |
| Main Supply Current                             | I <sub>BB</sub>                    | 5                  | 10   | 15                  | mA   | Output disabled                                   |
|                                                 | I <sub>BBSTBY</sub>                | —                  | 100  | 500                 | μA   | V <sub>STBY</sub> =2.5V                           |
| Output Pin Leakage Current                      | I <sub>OLK</sub>                   | -200               | -100 | -50                 | μA   | V <sub>BB</sub> =38V, V <sub>OUT</sub> =0V        |
|                                                 | I <sub>OLKH</sub>                  | 50                 | 100  | 200                 | μA   | V <sub>BB</sub> =V <sub>OUT</sub> =38V            |
| Output MOSFET ON Resistance                     | R <sub>DS(on)</sub>                | 0.1                | 0.2  | 0.3                 | Ω    | I <sub>DS</sub> =2.0A, S pin connected to GND     |
| Output MOSFET Diode Forward Voltage             | V <sub>SD</sub>                    | 0.8                | 1.1  | 1.4                 | V    | I <sub>SD</sub> =2.0A                             |
| STBY Pin Input Voltage                          | V <sub>STBYL</sub>                 | 0                  | —    | 0.8                 | V    |                                                   |
|                                                 | V <sub>STBYH</sub>                 | 2.5                | —    | V <sub>DD</sub>     | V    |                                                   |
|                                                 | ΔV <sub>STBY</sub>                 | 0.1                | 0.25 | 0.4                 | V    | Hysteresis width                                  |
| STBY Pin Input Current                          | I <sub>STBYL</sub>                 | 0                  | ±1   | ±10                 | μA   |                                                   |
|                                                 | I <sub>STBYH</sub>                 | 20                 | 50   | 100                 | μA   | V <sub>STBY</sub> =5V                             |
| Logic Input Voltage                             | V <sub>INPL</sub>                  | 0                  | —    | 0.8                 | V    |                                                   |
|                                                 | V <sub>INPH</sub>                  | 3.5                | —    | V <sub>DD</sub>     | V    |                                                   |
|                                                 | ΔV <sub>INP</sub>                  | 1                  | 1.5  | 2                   | V    | Hysteresis width                                  |
| Logic Input Current                             | I <sub>INPL</sub>                  | 0                  | ±1   | ±10                 | μA   | V <sub>IN</sub> =0V                               |
|                                                 | I <sub>INPH</sub>                  | 0                  | ±1   | ±10                 | μA   | V <sub>IN</sub> =5.5V                             |
| REF Pin Input Current                           | I <sub>REF</sub>                   | -5                 | -0.5 | 1                   | μA   | V <sub>REF</sub> =0 to 5.5V                       |
| REF Pin Input Voltage Range                     | V <sub>REF</sub>                   | 0.5                | —    | 5.5                 | V    |                                                   |
| SEN Pin Input Current                           | I <sub>SEN</sub>                   | 0                  | ±2.5 | ±10                 | μA   | V <sub>SEN</sub> =0 to 0.5V                       |
| Current Detection Voltage Ratio                 | V <sub>SEN</sub> /V <sub>REF</sub> | -10                | —    | 10                  | %    | V <sub>REF</sub> =5.5V                            |
| Current Detection Filter Time                   | t <sub>LPFSEN</sub>                | 0.6                | 1.8  | 3                   | μs   |                                                   |
| CPWM Pin Threshold Voltage                      | V <sub>CPWML</sub>                 | 1.1                | 1.5  | 1.9                 | V    |                                                   |
|                                                 | V <sub>CPWMH</sub>                 | 3                  | 3.5  | 4                   | V    |                                                   |
| CPWM Pin Oscillation Frequency                  | f <sub>CPWM</sub>                  | 15                 | 25   | 35                  | kHz  | CPWM=1000pF                                       |
| CLD Pin Oscillation Frequency                   | f <sub>CLD</sub>                   | 54                 | 64   | 74                  | Hz   | CLD=0.1μF                                         |
| AIN Pin Input Current                           | I <sub>AIN</sub>                   | -1                 | -0.5 | 1                   | μA   | AINP, AINN pin, V <sub>AIN</sub> =0 to 5.5V       |
| AOUT Pin Enable Threshold Voltage               | V <sub>AOENA</sub>                 | —                  | 1.2  | V <sub>CPWML</sub>  | V    | When AOUT pin voltage rises                       |
|                                                 | V <sub>AOENahys</sub>              | 0.05               | 0.1  | 0.15                | V    | Hysteresis width                                  |
| AOUT Pin Maximum Output Voltage                 | V <sub>AOUTH</sub>                 | V <sub>CPWMH</sub> | 4    | 4.45                | V    | During output PWM operation                       |
| AOUT Pin Externally Applied Voltage Range       | V <sub>AOUTEI</sub>                | 4.5                | —    | 5.5                 | V    | Output 100% ON                                    |
| AOUT Pin Maximum Output Current                 | I <sub>AOUT</sub>                  | 7.5                | —    | —                   | mA   | V <sub>AOUT</sub> =0V                             |
| AOUT Pin Pull-down Resistance                   | R <sub>AOUT</sub>                  | 25                 | 32.5 | 40                  | kΩ   | V <sub>AOUT</sub> =2.5V                           |
| Flag Output Pin ON Voltage                      | V <sub>FLAG(ON)</sub>              | 0.1                | 0.2  | 0.5                 | V    | I <sub>FLAG</sub> =2mA                            |
| Flag Output Pin Leakage Current                 | I <sub>FLAG(OFF)</sub>             | 0                  | —    | 20                  | μA   | V <sub>FLAG</sub> =5.5V                           |
| FG Output Pin ON Voltage                        | V <sub>FG(ON)</sub>                | 0.1                | 0.2  | 0.5                 | V    | I <sub>FG</sub> =2mA                              |
| FG Output Pin Leakage Current                   | I <sub>FG(OFF)</sub>               | 0                  | —    | 20                  | μA   | V <sub>FG</sub> =5.5V                             |
| VBB Low Voltage Protection Threshold Voltage    | V <sub>BBUVH</sub>                 | 7                  | 7.5  | 9                   | V    | When V <sub>BB</sub> voltage rises                |
|                                                 | V <sub>BBUVHys</sub>               | 0.1                | 0.3  | 0.5                 | V    | Hysteresis width                                  |
|                                                 | V <sub>BB(OV)</sub>                | 34                 | 35   | 37.5                | V    | When V <sub>BB</sub> voltage rises                |
| Overvoltage Protection Starting Voltage         | V <sub>BB(OV)Hys</sub>             | 1.5                | 2    | 2.5                 | V    | Hysteresis width                                  |
|                                                 | V <sub>OCPHS</sub>                 | 1                  | 1.3  | 1.5                 | V    | OUT-GND voltage, low side detection               |
| Overcurrent Detection Voltage                   | V <sub>OCPHS</sub>                 | 0.7                | 1    | 1.3                 | V    | V <sub>BB</sub> -OUT voltage, high side detection |
|                                                 | t <sub>LPFOC</sub>                 | —                  | 0.6  | t <sub>LPFSEN</sub> | μs   |                                                   |
| Thermal Protection Operation Temperature        | T <sub>TSD</sub>                   | 150                | 165  | —                   | °C   | When temperature rises                            |
|                                                 | ΔT <sub>TSD</sub>                  | —                  | 50   | —                   | °C   | Hysteresis width                                  |
|                                                 | T <sub>Ta</sub>                    | —                  | 120  | —                   | °C   | When temperature rises                            |
| Thermal Alarm Operation Temperature             | ΔT <sub>Ta</sub>                   | —                  | 10   | —                   | °C   | Hysteresis width                                  |
|                                                 | t <sub>PDON</sub>                  | —                  | 2.3  | —                   | μs   | HALL input → Output ON                            |
|                                                 | t <sub>PDOFF</sub>                 | —                  | 2.1  | —                   | μs   | HALL input → Output OFF                           |
| Propagation Delay Time between Input and Output | t <sub>PDPMON</sub>                | —                  | 1.1  | —                   | μs   | PWM input → Output ON                             |
|                                                 | t <sub>PDPMO</sub>                 | —                  | 0.9  | —                   | μs   | PWM input → Output OFF                            |
| OUT Pin Dead Time                               | t <sub>DEAD</sub>                  | 100                | 300  | 800                 | ns   |                                                   |
| Hall Input Current                              | I <sub>HALL</sub>                  | -2                 | -0.5 | 1                   | μA   | V <sub>IN</sub> =0.2 to 4.2V                      |
| Common Mode Input Voltage Range                 | V <sub>CMR</sub>                   | 0.2                | —    | 3.5                 | V    |                                                   |
| AC Input Voltage Range                          | V <sub>HALL</sub>                  | 60                 | —    | —                   | mV   |                                                   |
| Hysteresis                                      | V <sub>HYS</sub>                   | —                  | 20   | V <sub>HALL</sub>   | mV   | Design assurance level                            |
| Pulse Removal Filter                            | t <sub>pulse</sub>                 | 1                  | 2    | 3                   | μs   |                                                   |

\*: Use typ. data for design. The direction in which current flows out of the device is regarded as negative.

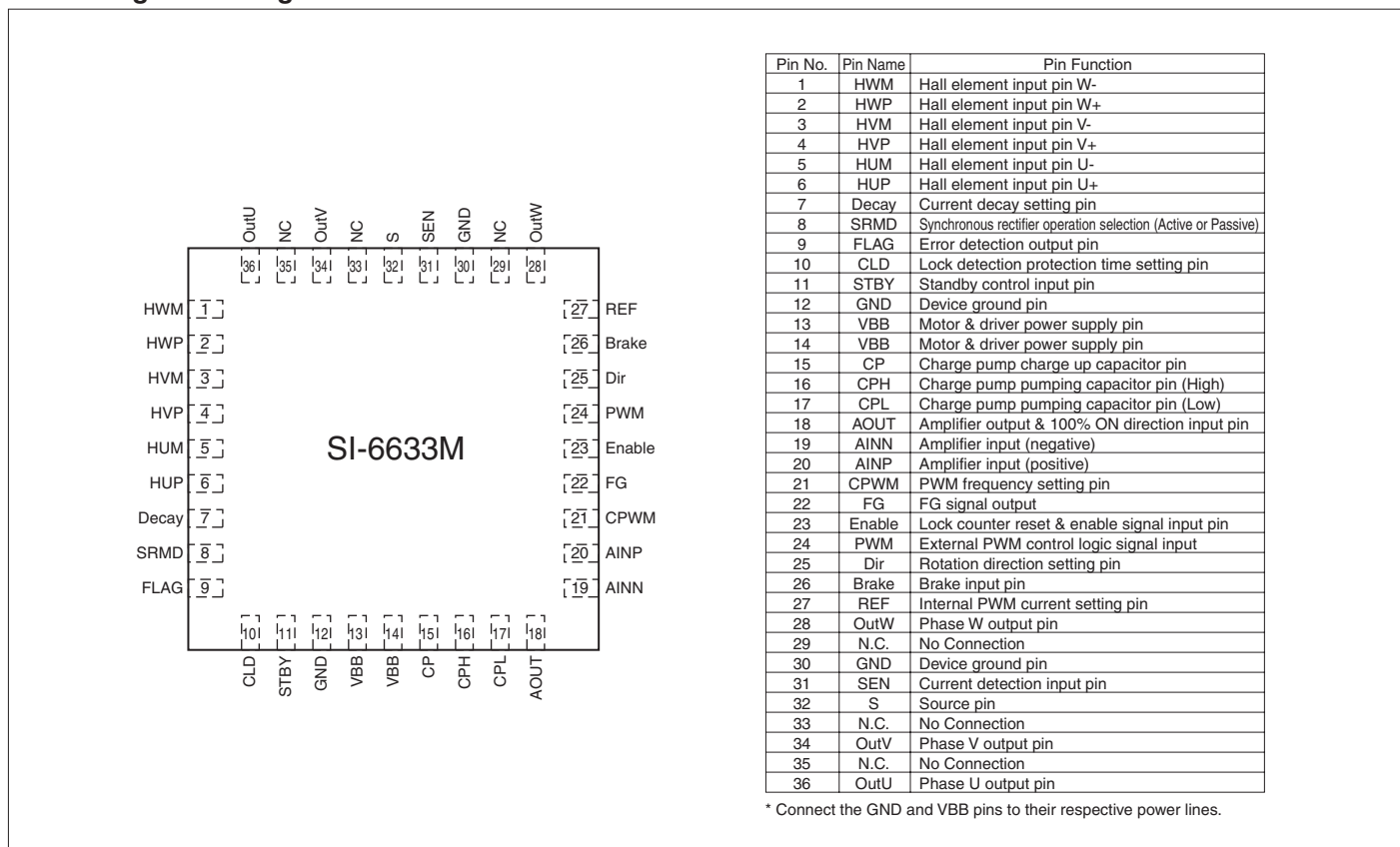
## Internal Block Diagram



## External Dimensions (QFN36)



## Pin Assignment Diagram



## SI-6633C

## Control IC

## ■Features

- Drives 6-element N-channel MOSFET
- Supports Hall element input
- Provides the following current control functions:  
Peak current control fixed frequency PWM (internal PWM)  
PWM control (logic PWM) based on logic input
- Protection functions  
Overcurrent protection, overvoltage protection  
Thermal protection, undervoltage lockout protection  
Motor lock detection
- Provides alarm output pin for protection function operation
- Provides pin (FG) to output rotation signal generated by state transition of Hall input
- Built-in synchronous rectifier function that reduces power dissipation
- Built-in switching function for synchronous rectifier operation (Active/Passive)
- Standby mode

## ■Absolute Maximum Ratings

| Parameter                     | Symbol                 | Ratings    | Unit | Conditions                                              |
|-------------------------------|------------------------|------------|------|---------------------------------------------------------|
| Supply Voltage                | V <sub>BB</sub>        | −0.3 to 38 | V    |                                                         |
| Output Voltage                | V <sub>OUT</sub>       | −1 to 38   | V    |                                                         |
| Logic Input Voltage           | V <sub>IN(Logic)</sub> | −0.3 to 6  | V    |                                                         |
| Hall Input Voltage            | V <sub>HALL</sub>      | −0.3 to 6  | V    |                                                         |
| REF Input Voltage             | V <sub>Ref</sub>       | −0.3 to 6  | V    |                                                         |
| Detection Voltage             | V <sub>SENSE</sub>     | ±0.5       | V    |                                                         |
| Maximum Junction Temperature  | T <sub>j(max)</sub>    | 150        | °C   |                                                         |
| Storage Temperature           | T <sub>stg</sub>       | −40 to 150 | °C   |                                                         |
| Operating Ambient Temperature | T <sub>a</sub>         | −20 to 85  | °C   |                                                         |
| Package Thermal Resistance    | R <sub>θja</sub>       | 43         | °C/W | With Sanken Evaluation Board (2-layer board; 60mm×77mm) |

## ■Recommended Operating Conditions

| Parameter                     | Symbol                 | Ratings    | Unit | Conditions                                                             |
|-------------------------------|------------------------|------------|------|------------------------------------------------------------------------|
| Supply Voltage                | V <sub>BB</sub>        | 10 to 30   | V    |                                                                        |
| Control Supply Voltage        | V <sub>DD</sub>        | 3 to 5.5   | V    |                                                                        |
| Logic Input Voltage           | V <sub>IN(Logic)</sub> | 0 to 5.5   | V    |                                                                        |
| REF Input Voltage             | V <sub>Ref</sub>       | 0.5 to 5.5 | V    | The control current precision degrades significantly at 0.5V or lower. |
| Hall Input Voltage            | V <sub>HALL</sub>      | 0.2 to 4   | V    |                                                                        |
| Detection Voltage             | V <sub>SENSE</sub>     | ±0.5       | V    |                                                                        |
| Package Temperature           | T <sub>c</sub>         | 105        | °C   |                                                                        |
| Operating Ambient Temperature | T <sub>a</sub>         | −20 to 85  | °C   |                                                                        |

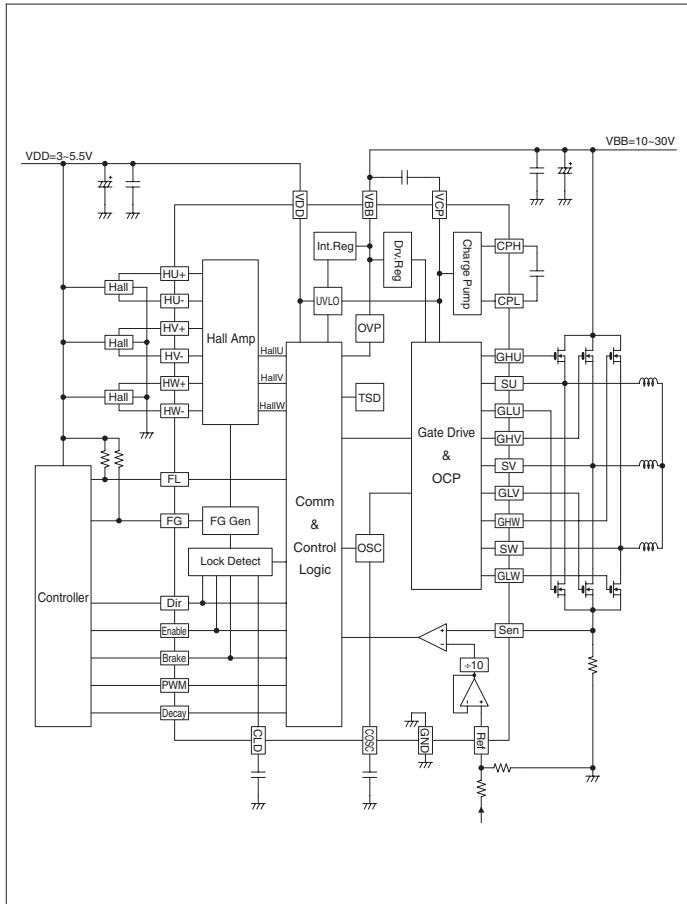
## ■Electrical Characteristics

(T<sub>a</sub>=25°C, V<sub>BB</sub>=24V, V<sub>DD</sub>=5V, unless otherwise specified)

| Parameter                                                | Symbol                         | Ratings                 |                       |                        | Unit              | Conditions                                                                |
|----------------------------------------------------------|--------------------------------|-------------------------|-----------------------|------------------------|-------------------|---------------------------------------------------------------------------|
|                                                          |                                | min.                    | typ.                  | max.                   |                   |                                                                           |
| Output Drivers                                           |                                |                         |                       |                        |                   |                                                                           |
| V <sub>BB</sub> Voltage Range                            | V <sub>BB</sub>                | 10                      | –                     | V <sub>BB0V</sub>      | V                 | During operation                                                          |
| Main Supply Current                                      | I <sub>BB</sub>                | –                       | 10                    | 20                     | mA                | Operating (output is OFF)                                                 |
|                                                          |                                | 50                      | –                     | 200                    | μA                | Standby mode                                                              |
| Control Logic                                            |                                |                         |                       |                        |                   |                                                                           |
| V <sub>DD</sub> Voltage Range                            | V <sub>DD</sub>                | 3                       | –                     | 5.5                    | V                 | During operation                                                          |
| V <sub>DD</sub> Pin Current                              | I <sub>DD</sub>                | –                       | 0.5                   | 3                      | mA                | Operating (output is OFF)                                                 |
|                                                          |                                | 100                     | 180                   | 500                    | μA                | Standby mode                                                              |
| Logic Input Voltage                                      | V <sub>IN(0)</sub>             | 0                       | –                     | V <sub>DD</sub> ×0.25  | V                 |                                                                           |
|                                                          | V <sub>IN(1)</sub>             | V <sub>DD</sub> ×0.75   | –                     | V <sub>DD</sub>        | V                 |                                                                           |
| Logic Input Current                                      | I <sub>IN(0)</sub>             | –1                      | –                     | 1                      | μA                | V <sub>IN(0)</sub> , V <sub>IN</sub> =0V                                  |
|                                                          | I <sub>IN(1)</sub>             | –1                      | –                     | 1                      | μA                | V <sub>IN(1)</sub> , V <sub>IN</sub> =5V                                  |
| Input Pin Filter                                         | t <sub>LOGIC</sub>             | 0.3                     | 0.5                   | 0.95                   | μs                | f <sub>in</sub> =50kHz, Duty=50%                                          |
| Maximum Response Frequency                               | f <sub>PWM</sub>               | (100)                   | –                     | –                      | kHz               | PWM pin, Duty=50%                                                         |
| COSC Pin Oscillation Frequency                           | f <sub>OSC</sub>               | 19                      | 25                    | 32                     | KHz               | C <sub>OSC</sub> =330pF                                                   |
| Gate Drive                                               |                                |                         |                       |                        |                   |                                                                           |
| High Side Output Voltage                                 | V <sub>GS(H)</sub>             | 6                       | –                     | 9                      | V                 | I <sub>GATE</sub> =2mA For V <sub>BB</sub> . I <sub>GATE</sub> =2mA       |
| Low Side Output Voltage                                  | V <sub>GS(L)</sub>             | 6                       | –                     | 9                      | V                 | I <sub>GATE</sub> =2mA                                                    |
| Drive Current                                            | I <sub>GATE</sub>              | 20                      | 30                    | 60                     | mA                | G <sub>H</sub> =G <sub>L</sub> =4V, V <sub>CP</sub> =V <sub>BB</sub> +TBD |
| Dead Time                                                | t <sub>dead</sub>              |                         | 1000                  |                        | ns                |                                                                           |
| Internal PWM                                             |                                |                         |                       |                        |                   |                                                                           |
| REF Pin Input Current                                    | I <sub>ref</sub>               | –5                      | –0.1                  | 1                      | μA                |                                                                           |
| REF Pin Input Voltage Range                              | V <sub>Ref</sub>               | 0.5                     | –                     | 5.5                    | V                 |                                                                           |
| SEN Pin Input Current                                    | I <sub>sen</sub>               | –5                      | –0.1                  | 1                      | μA                | V <sub>Sen</sub> =0 to 1V                                                 |
| Detection Voltage                                        | V <sub>Sen</sub>               | V <sub>REF</sub> ×0.095 | V <sub>REF</sub> ×0.1 | V <sub>REF</sub> ×0.12 | V                 | V <sub>Ref</sub> =1 to 5V                                                 |
| Current Detection Filter Time                            | t <sub>LPF<sub>Sen</sub></sub> | 1                       | 2                     | 4                      | μs                | Design assurance level                                                    |
| Protection                                               |                                |                         |                       |                        |                   |                                                                           |
| FL Output Saturation Voltage                             | V <sub>FI(ON)</sub>            | 0.2                     | 0.4                   | 0.7                    | V                 | I <sub>FG</sub> =2mA                                                      |
| FL Output Pin ON Current                                 | I <sub>FI(ON)</sub>            | 5                       | 7.5                   | 15                     | mA                | V <sub>FI</sub> =2V                                                       |
| FL Output Leakage Current                                | I <sub>FI(OFF)</sub>           | 0                       | –                     | 50                     | μA                | V <sub>FG</sub> =5.5V                                                     |
| Overcurrent Detection Voltage                            | V <sub>OCF</sub>               | 1.4                     | 1.5                   | 1.65                   | V                 | Low-side MOSFET detection (between OUT and GND)                           |
| Overcurrent Detection Filter Time                        | t <sub>FLT<sub>OCF</sub></sub> | 0.75                    | 1.5                   | 3                      | μs                | Design assurance level                                                    |
| OCF Output OFF Timer Count                               | N <sub>OCF_OFF</sub>           | 256                     | 256                   | 256                    |                   |                                                                           |
| V <sub>BB</sub> Overvoltage Protection Threshold Voltage | V <sub>BB0V</sub>              | 33                      | 35                    | 37                     | V                 |                                                                           |
| V <sub>BB</sub> Overvoltage Protection Hysteresis        | V <sub>BB0Vhys</sub>           | 1.25                    | 2                     | 3.5                    | V                 |                                                                           |
| CLD Pin Oscillation Frequency                            | f <sub>LD</sub>                | 100                     | 128                   | 164                    | Hz                | C <sub>LD</sub> =0.1μF                                                    |
| Lock Detection Timer Count                               | N <sub>LD</sub>                | 256                     | 256                   | 256                    |                   |                                                                           |
| Thermal Protection Operation Temperature                 | T <sub>JTSD</sub>              | 151                     | 170                   | 185                    | °C                | When temperature rises, design assurance level                            |
| Thermal Protection Hysteresis                            | T <sub>JTSDhys</sub>           | 10                      | 15                    | 20                     | °C                |                                                                           |
| V <sub>DD</sub> Low Voltage Protection Release Voltage   | V <sub>DDUV</sub>              | 2.65                    | 2.8                   | 2.95                   | V                 | When V <sub>DD</sub> voltage rises                                        |
| V <sub>DD</sub> Low Voltage Protection Hysteresis        | V <sub>DDUVhys</sub>           | 0.1                     | 0.15                  | 0.25                   | V                 |                                                                           |
| V <sub>BB</sub> Low Voltage Protection Release Voltage   | V <sub>BBUV</sub>              |                         | 9                     | 9.9                    | V                 | When V <sub>BB</sub> voltage rises                                        |
| V <sub>BB</sub> Low Voltage Protection Hysteresis        | V <sub>BBUVhys</sub>           |                         | 0.3                   |                        | V                 |                                                                           |
| FG                                                       |                                |                         |                       |                        |                   |                                                                           |
| FG Output Saturation Voltage                             | V <sub>FG(sat)</sub>           | 0.2                     | 0.4                   | 0.7                    | V                 | I <sub>FG</sub> =2mA                                                      |
| FG Output Leakage Current                                | I <sub>FGlk</sub>              | 0                       | –                     | 50                     | μA                | V <sub>FG</sub> =5.5V                                                     |
| Hall Logic                                               |                                |                         |                       |                        |                   |                                                                           |
| Hall Input Current                                       | I <sub>HALL</sub>              | –5                      | –0.1                  | 1                      | μA                | V <sub>IN</sub> =0.2 to 4V                                                |
| Common Mode Input Voltage Range                          | V <sub>CMR</sub>               | 0.2                     | –                     | 4                      | V                 |                                                                           |
| AC Input Voltage Range                                   | V <sub>HALL</sub>              | 60                      | –                     | –                      | mV <sub>p-p</sub> |                                                                           |
| Hysteresis                                               | V <sub>HYS</sub>               | 25                      | 40                    | V <sub>HALL</sub>      | mV                | Design assurance level                                                    |
| Pulse Removal Filter                                     | t <sub>pulse</sub>             | 1                       | 2                     | 4                      | μs                |                                                                           |

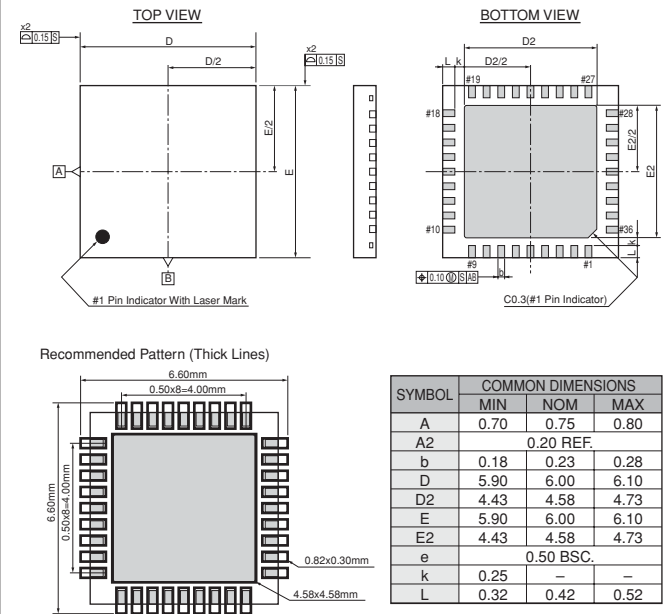
\*: Use typ. data for design. The direction in which current flows out of the device is regarded as negative.

## Internal Block Diagram

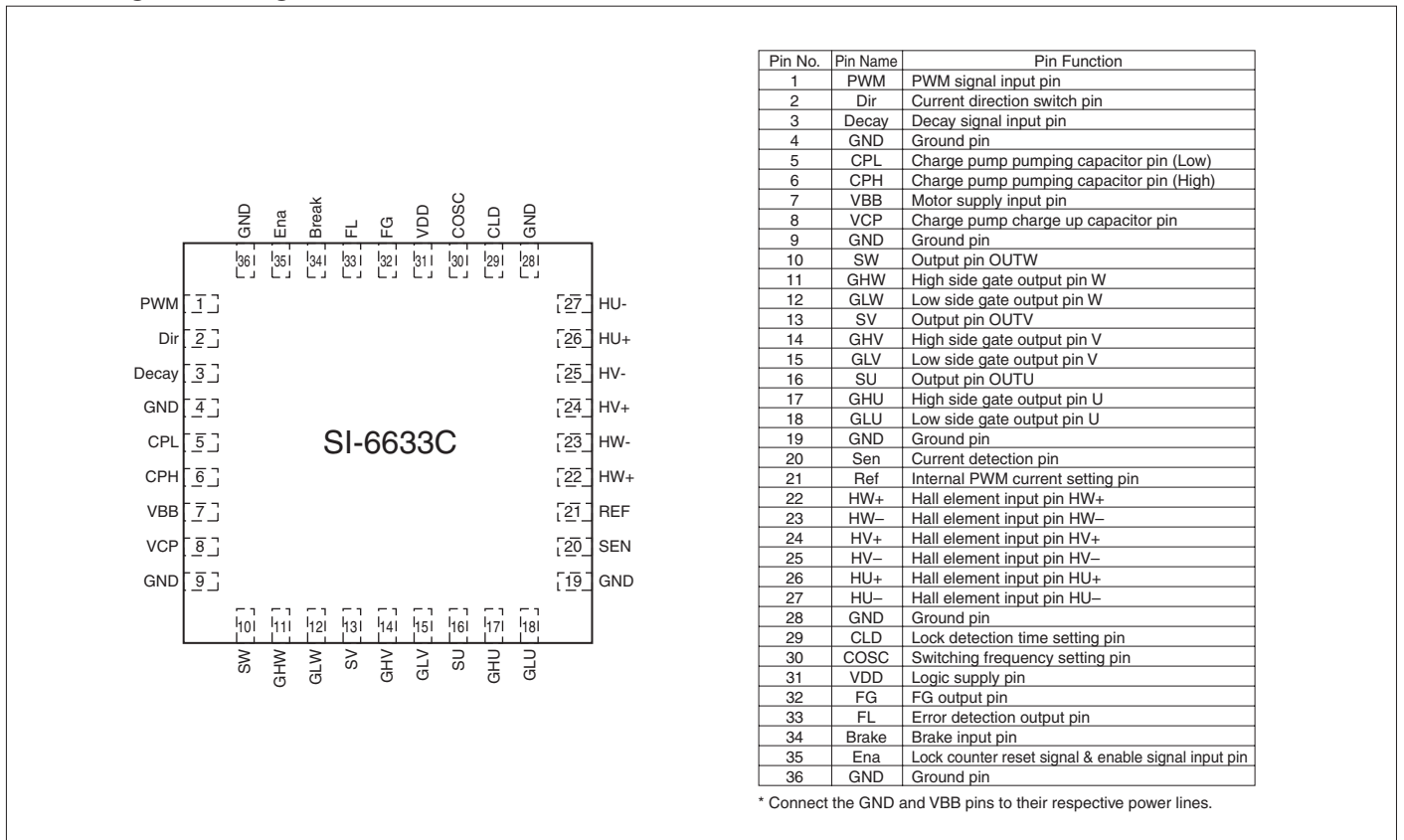


## External Dimensions (QFN36)

(Unit : mm)



## Pin Assignment Diagram



# SX68000MH Series Surface-Mount, Built-in Overcurrent Protection, Thermal Shutdown, and Overcurrent Limiting Circuits

## ■Features

- A package of 6 MOSFET units for 3-phase bridge and pre-drive (HVIC, LVIC)
- Best for driving the fan motor (built-in motor) of air conditioner, etc.
- Built-in boot diode with limited resistance
- Built-in undervoltage lock out (UVLO) circuit
- Built-in overcurrent protection circuit (OCP)
- Built-in Thermal Shut Down (TSD) function
- Built-in current limiter function (OCL)
- Error (FO) terminal with shutdown input function
- 7.5V regulator output function (35mA max.)

## ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                    | Symbol           | Ratings     |             |             | Unit | Conditions                                |
|----------------------------------------------|------------------|-------------|-------------|-------------|------|-------------------------------------------|
|                                              |                  | SX68001MH   | SX68002MH   | SX68003MH   |      |                                           |
| MOSFET Output Breakdown Voltage              | V <sub>DSS</sub> | 250         | 500         | 500         | V    | V <sub>CC</sub> =15V, V <sub>IN</sub> =0V |
| Control Supply Voltage                       | V <sub>CC</sub>  | 20          | 20          | 20          | V    | Between V <sub>CC</sub> and COM           |
| Control Supply Voltage (Bootstrap)           | V <sub>BS</sub>  | 20          | 20          | 20          | V    | Between V <sub>B</sub> and HS (U, V, W)   |
| Output Current (continuous)                  | I <sub>O</sub>   | 2.0         | 1.5         | 2.5         | A    |                                           |
| Output Current (pulse)                       | I <sub>OP</sub>  | 3.0         | 2.25        | 3.75        | A    | PW≤100μs, duty=1%                         |
| Input Voltage                                | V <sub>IN</sub>  | -0.5 to +7  | -0.5 to +7  | -0.5 to +7  | V    |                                           |
| Thermal Resistance (Junction to Case)        | θ <sub>J-C</sub> | 15          | 15          | 15          | °C/W | *1                                        |
| Thermal Resistance (Junction to Ambient/Air) | θ <sub>J-A</sub> | 41.7        | 41.7        | 41.7        | °C/W | *1                                        |
| Operating Case Temperature                   | T <sub>OP</sub>  | -20 to +100 | -20 to +100 | -20 to +100 | °C   |                                           |
| Junction Temperature (Power part)            | T <sub>CH</sub>  | +150        | +150        | +150        | °C   |                                           |
| Storage Temperature                          | T <sub>STG</sub> | -40 to +150 | -40 to +150 | -40 to +150 | °C   |                                           |

\*1: When mounted on a board (1.6 mm, 35μm copper layer, CEM-3, moldless, natural air cooling)

## ■Recommended Operating Conditions

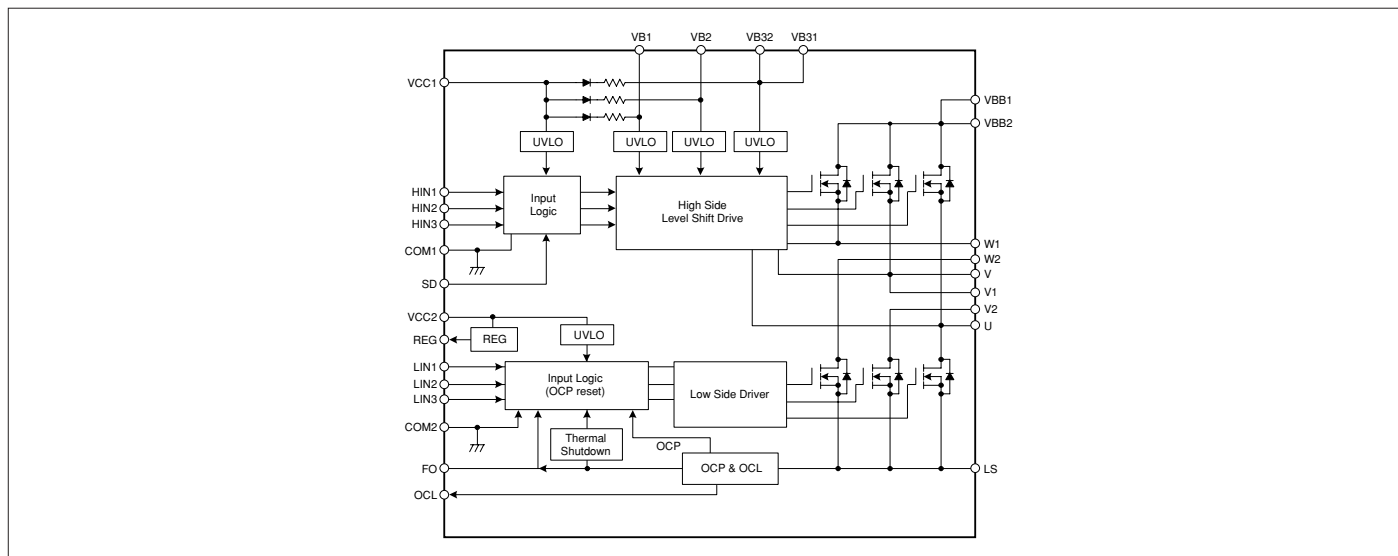
| Parameter                 | Symbol            | Ratings   |      |      |           |      |      |           |      |      | Unit | Conditions                      |
|---------------------------|-------------------|-----------|------|------|-----------|------|------|-----------|------|------|------|---------------------------------|
|                           |                   | SX68001MH |      |      | SX68002MH |      |      | SX68003MH |      |      |      |                                 |
|                           |                   | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. |      |                                 |
| Main Supply Voltage       | V <sub>BB</sub>   | —         | 150  | 200  | —         | 300  | 400  | —         | 300  | 400  | V    | Between V <sub>BB</sub> and LS  |
| Control Supply Voltage    | V <sub>CC</sub>   | 13.5      | —    | 16.5 | 13.5      | —    | 16.5 | 13.5      | —    | 16.5 | V    | Between V <sub>CC</sub> and COM |
| Input Signal Dead Time    | t <sub>dead</sub> | 1.5       | —    | —    | 1.5       | —    | —    | 1.5       | —    | —    | μs   |                                 |
| Minimum Input Pulse Width | t <sub>w</sub>    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | μs   |                                 |

## ■Electrical Characteristics

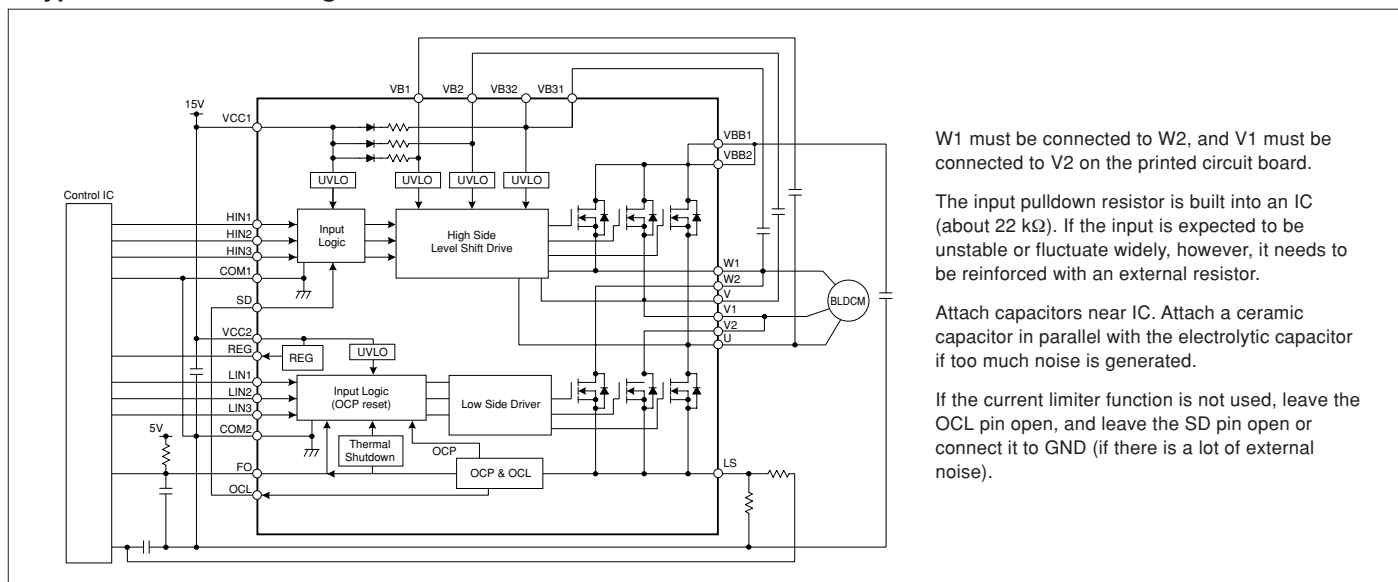
(T<sub>a</sub>=25°C)

| Parameter                                | Symbol               | Ratings   |      |        |           |      |        |           |      |        | Unit | Conditions                                                                                                                                                                  |                                                                                                                                                                             |
|------------------------------------------|----------------------|-----------|------|--------|-----------|------|--------|-----------|------|--------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          |                      | SX68001MH |      |        | SX68002MH |      |        | SX68003MH |      |        |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          |                      | min.      | typ. | max.   | min.      | typ. | max.   | min.      | typ. | max.   |      |                                                                                                                                                                             |                                                                                                                                                                             |
| Control Supply Current                   | I <sub>CC</sub>      | —         | 4.6  | 8.5    | —         | 4.6  | 8.5    | —         | 4.6  | 8.5    | mA   | V <sub>CC1,2</sub> =15V, I <sub>REG</sub> =0A                                                                                                                               |                                                                                                                                                                             |
| Boot Supply Current                      | I <sub>BS</sub>      | —         | 140  | 400    | —         | 140  | 400    | —         | 140  | 400    | μA   | V <sub>B</sub> =HS=15V, H <sub>IN</sub> =5V, per phase, T <sub>C</sub> =20°C to 125°C                                                                                       |                                                                                                                                                                             |
| Input Voltage                            | V <sub>IH</sub>      | —         | 2.0  | 2.5    | —         | 2.0  | 2.5    | —         | 2.0  | 2.5    | V    | V <sub>CC</sub> =15V, Output:ON                                                                                                                                             |                                                                                                                                                                             |
|                                          | V <sub>IL</sub>      | 1.0       | 1.5  | —      | 1.0       | 1.5  | —      | 1.0       | 1.5  | —      | V    | V <sub>CC</sub> =15V, Output:OFF                                                                                                                                            |                                                                                                                                                                             |
| Input Voltage Hysteresis Width           | V <sub>H</sub>       | —         | 0.5  | —      | —         | 0.5  | —      | —         | 0.5  | —      | V    | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| Input Current                            | I <sub>IH</sub>      | —         | 230  | 500    | —         | 230  | 500    | —         | 230  | 500    | μA   | V <sub>CC</sub> =15V, V <sub>IN</sub> =5V                                                                                                                                   |                                                                                                                                                                             |
| Undervoltage Lock Out (high side)        | U <sub>VHL</sub>     | 9.0       | —    | 11.0   | 9.0       | —    | 11.0   | 9.0       | —    | 11.0   | V    | Between V <sub>BS</sub> and U(V, W)                                                                                                                                         |                                                                                                                                                                             |
|                                          | U <sub>VHH</sub>     | 9.5       | —    | 11.5   | 9.5       | —    | 11.5   | 9.5       | —    | 11.5   | V    |                                                                                                                                                                             |                                                                                                                                                                             |
| Undervoltage Lock Out (low side)         | U <sub>VLL</sub>     | 10.0      | —    | 12.0   | 10.0      | —    | 12.0   | 10.0      | —    | 12.0   | V    | Between V <sub>CC</sub> and COM                                                                                                                                             |                                                                                                                                                                             |
|                                          | U <sub>VLH</sub>     | 10.5      | —    | 12.5   | 10.5      | —    | 12.5   | 10.5      | —    | 12.5   | V    |                                                                                                                                                                             |                                                                                                                                                                             |
| FO Terminal Output Voltage               | V <sub>FOL</sub>     | —         | —    | 0.5    | —         | —    | 0.5    | —         | —    | 0.5    | V    | V <sub>CC</sub> =15V, V <sub>FO</sub> =5V, R <sub>FO</sub> =10kΩ                                                                                                            |                                                                                                                                                                             |
|                                          | V <sub>FOH</sub>     | 4.8       | —    | —      | 4.8       | —    | —      | 4.8       | —    | —      | V    |                                                                                                                                                                             |                                                                                                                                                                             |
| OCL Output Voltage                       | V <sub>OCLL</sub>    | —         | —    | 0.5    | —         | —    | 0.5    | —         | —    | 0.5    | V    | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
|                                          | V <sub>OCLH</sub>    | 4.5       | —    | 5.5    | 4.5       | —    | 5.5    | 4.5       | —    | 5.5    | V    |                                                                                                                                                                             |                                                                                                                                                                             |
| Current Limiter Reference Voltage        | V <sub>LIM</sub>     | 0.6175    | 0.65 | 0.6825 | 0.6175    | 0.65 | 0.6825 | 0.6175    | 0.65 | 0.6825 | V    | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| Overcurrent Protection Trip Voltage      | V <sub>TRIP</sub>    | 0.9       | 1.0  | 1.1    | 0.9       | 1.0  | 1.1    | 0.9       | 1.0  | 1.1    | V    | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| Overcurrent Protection Retention Time    | t <sub>p</sub>       | 20        | 25   | —      | 20        | 25   | —      | 20        | 25   | —      | μs   | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| OCP Blanking Time                        | t <sub>bk(ocp)</sub> | —         | 2    | —      | —         | 2    | —      | —         | 2    | —      | μs   | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| SD Terminal Blanking Time                | t <sub>bk(ocl)</sub> | —         | 3.3  | —      | —         | 3.3  | —      | —         | 3.3  | —      | μs   | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
| Thermal Protection and Release Threshold | T <sub>DH</sub>      | 135       | 150  | 165    | 135       | 150  | 165    | 135       | 150  | 165    | °C   | V <sub>CC</sub> =15V                                                                                                                                                        |                                                                                                                                                                             |
|                                          | T <sub>DL</sub>      | 105       | 120  | 135    | 105       | 120  | 135    | 105       | 120  | 135    |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | T <sub>Dhys</sub>    | —         | 30   | —      | —         | 30   | —      | —         | 30   | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
| Regulator Output Voltage                 | V <sub>REG</sub>     | 6.75      | 7.5  | 8.25   | 6.75      | 7.5  | 8.25   | 6.75      | 7.5  | 8.25   | V    | I <sub>REG</sub> =35mA                                                                                                                                                      |                                                                                                                                                                             |
| MOSFET Output Breakdown Voltage          | V <sub>DSS</sub>     | 250       | —    | —      | 500       | —    | —      | 500       | —    | —      | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V                                                                                                            |                                                                                                                                                                             |
| MOSFET Output Leakage Current            | I <sub>DSS</sub>     | —         | —    | 100    | —         | —    | 100    | —         | —    | 100    | μA   | V <sub>CC</sub> =15V, V <sub>DSS</sub> =500V (250 V for SX68001MH), V <sub>IN</sub> =0V                                                                                     |                                                                                                                                                                             |
| MOSFET DC ON Resistance                  | R <sub>DS(ON)</sub>  | —         | 1.25 | 1.5    | —         | 3.2  | 4.0    | —         | 2.0  | 2.4    | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V <sub>IN</sub> =5V                                                                 |                                                                                                                                                                             |
| Diode Forward Voltage                    | V <sub>SD</sub>      | —         | 1.1  | 1.5    | —         | 1.0  | 1.5    | —         | 1.0  | 1.5    | V    | V <sub>CC</sub> =15V, I <sub>SD</sub> =1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V <sub>IN</sub> =0V                                                                |                                                                                                                                                                             |
| Boot Diode Leakage Current               | I <sub>IB</sub>      | —         | —    | 10     | —         | —    | 10     | —         | —    | 10     | μA   | V <sub>B</sub> =500V(250 V for SX68001MH)                                                                                                                                   |                                                                                                                                                                             |
| Boot Diode Forward Voltage               | V <sub>FB</sub>      | —         | 1.0  | 1.3    | —         | 1.0  | 1.3    | —         | 1.0  | 1.3    | V    | I <sub>F</sub> =0.15A                                                                                                                                                       |                                                                                                                                                                             |
| Boot Diode Series Resistance             | R <sub>BD</sub>      | —         | 60   | —      | —         | 60   | —      | —         | 60   | —      | Ω    |                                                                                                                                                                             |                                                                                                                                                                             |
| High Side Switching Time                 | t <sub>d(on)</sub>   | —         | 800  | —      | —         | 810  | —      | —         | 940  | —      | ns   | V <sub>DC</sub> =300V(150V for SX68001MH), V <sub>CC</sub> =15V, I <sub>D</sub> =1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V <sub>IN</sub> =0 to 5V, Inductive load |                                                                                                                                                                             |
|                                          | t <sub>r</sub>       | —         | 45   | —      | —         | 60   | —      | —         | 100  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>rr</sub>      | —         | 75   | —      | —         | 120  | —      | —         | 135  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>d(off)</sub>  | —         | 720  | —      | —         | 815  | —      | —         | 975  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>f</sub>       | —         | 40   | —      | —         | 40   | —      | —         | 45   | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
| Low Side Switching Time                  | t <sub>d(on)</sub>   | —         | 750  | —      | —         | 760  | —      | —         | 900  | —      | ns   |                                                                                                                                                                             | V <sub>DC</sub> =300V(150V for SX68001MH), V <sub>CC</sub> =15V, I <sub>D</sub> =1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V <sub>IN</sub> =0 to 5V, Inductive load |
|                                          | t <sub>r</sub>       | —         | 50   | —      | —         | 60   | —      | —         | 105  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>rr</sub>      | —         | 70   | —      | —         | 110  | —      | —         | 135  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>d(off)</sub>  | —         | 660  | —      | —         | 750  | —      | —         | 905  | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |
|                                          | t <sub>f</sub>       | —         | 20   | —      | —         | 30   | —      | —         | 35   | —      |      |                                                                                                                                                                             |                                                                                                                                                                             |

## Internal Block Diagram

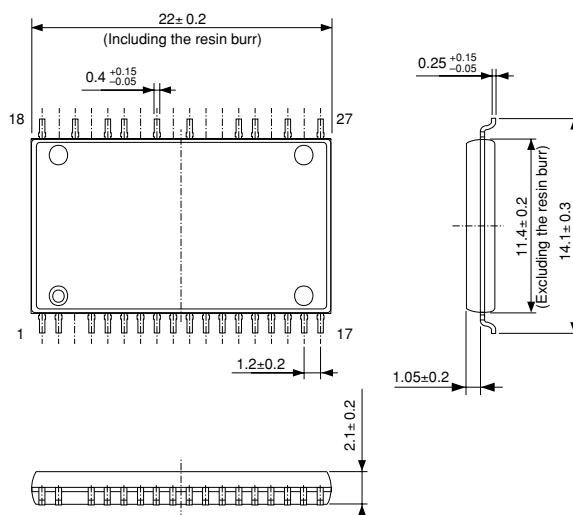


## Typical Connection Diagram



## External Dimensions (SOP27)

(Unit : mm)



Product Mass : Approx.1.4g

SMA6820MH Series Built-in Thermal detection and 7.5 V Regulator

Features

- A package of 6 MOSFET units for 3-phase bridge, pre-drive (HVIC, LVIC) and boot diode
- Best for fan motor inverter control
- High side drive of bootstrap method has been employed.
- Built-in undervoltage lock out (auto regression)
- Built-in Thermal detection circuit (no stopping)
- Built-in fail signal output function (for when the overheat detection circuit and UVLO)
- Built-in 7.5 V regulator output (35 mA, max.)
- Supports CMOS (3.3 and 5.0 V) input levels

Absolute Maximum Ratings

(Ta=25°C)

| Parameter                                    | Symbol | Ratings     |             |             | Unit | Conditions                  |
|----------------------------------------------|--------|-------------|-------------|-------------|------|-----------------------------|
|                                              |        | SMA6821MH   | SMA6822MH   | SMA6823MH   |      |                             |
| MOSFET Output Breakdown Voltage              | VDSS   | 250         | 500         | 500         | V    | Vcc=15V, VIN=0V             |
| Control Supply Voltage                       | Vcc    | 20          | 20          | 20          | V    | Between Vcc and COM         |
| Control Supply Voltage (Bootstrap)           | Vbs    | 20          | 20          | 20          | V    | Between VB and HS (U, V, W) |
| Output Current (continuous)                  | Io     | 2.0         | 1.5         | 2.5         | A    |                             |
| Output Current (pulse)                       | Iop    | 3           | 2.25        | 3.75        | A    | PW 100µs, duty=1%           |
| Regulator Output Current                     | IREG   | 35          | 35          | 35          | mA   |                             |
| Input Voltage                                | VIN    | −0.5 to +7  | −0.5 to +7  | −0.5 to +7  | V    |                             |
| Thermal Resistance (Junction to Case)        | θj-c   | 4.46        | 4.46        | 4.46        | °C/W | When all elements operating |
| Thermal Resistance (Junction to Ambient Air) | θj-a   | 31.25       | 31.25       | 31.25       | °C/W | When all elements operating |
| Operating Case Temperature                   | Top    | −20 to +100 | −20 to +100 | −20 to +100 | °C   |                             |
| Junction Temperature (Power part)            | Tch    | +150        | +150        | +150        | °C   |                             |
| Storage Temperature                          | Tstg   | −40 to +150 | −40 to +150 | −40 to +150 | °C   |                             |

Recommended Operating Conditions

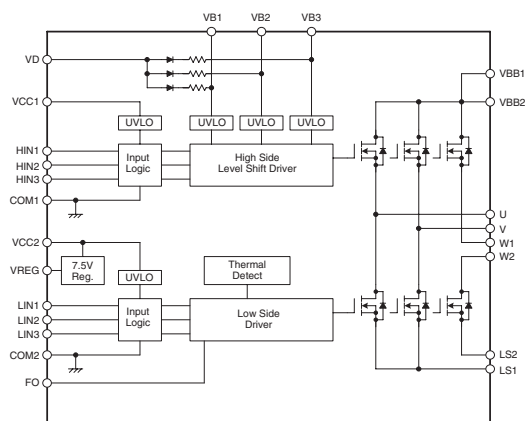
| Parameter                 | Symbol            | Ratings   |      |      |           |      |      |           |      |      | Unit | Conditions                      |
|---------------------------|-------------------|-----------|------|------|-----------|------|------|-----------|------|------|------|---------------------------------|
|                           |                   | SMA6821MH |      |      | SMA6822MH |      |      | SMA6823MH |      |      |      |                                 |
|                           |                   | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. |      |                                 |
| Main Supply Voltage       | V <sub>BS</sub>   | –         | 140  | 200  | –         | 300  | 400  | –         | 300  | 400  | V    | Between V <sub>BS</sub> and LS  |
| Control Supply Voltage    | V <sub>CC</sub>   | 13.5      | –    | 16.5 | 13.5      | –    | 16.5 | 13.5      | –    | 16.5 | V    | Between V <sub>CC</sub> and COM |
| Input Signal Dead Time    | t <sub>dead</sub> | 1.5       | –    | –    | 1.5       | –    | –    | 1.5       | –    | –    | µs   |                                 |
| Minimum Input Pulse Width | t <sub>w</sub>    | 0.5       | –    | –    | 0.5       | –    | –    | 0.5       | –    | –    | µs   |                                 |

Electrical Characteristics

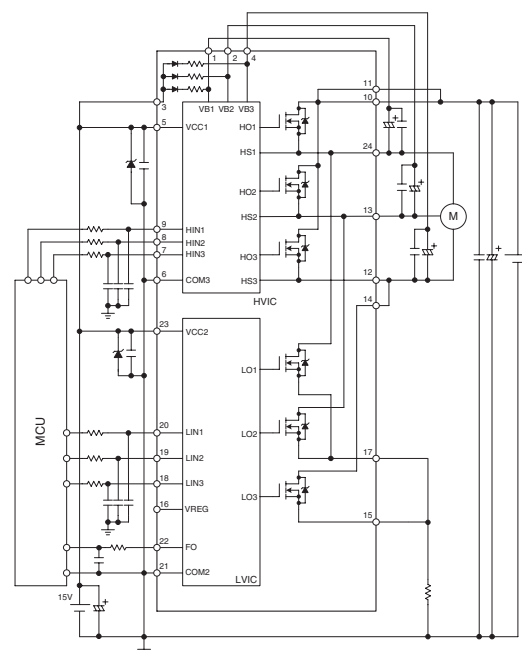
(Ta=25°C)

| Parameter                            | Symbol              | Ratings   |      |      |           |      |      |           |      |      | Unit | Conditions                                                                                                                                                             |  |
|--------------------------------------|---------------------|-----------|------|------|-----------|------|------|-----------|------|------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                      |                     | SMA6821MH |      |      | SMA6822MH |      |      | SMA6823MH |      |      |      |                                                                                                                                                                        |  |
|                                      |                     | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. |      |                                                                                                                                                                        |  |
| Control Supply Current               | I <sub>CC</sub>     | —         | 4    | 6    | —         | 4    | 6    | —         | 4    | 6    | mA   | V <sub>CC</sub> =15V                                                                                                                                                   |  |
| Input Voltage                        | V <sub>IH</sub>     | —         | 2    | 2.5  | —         | 2    | 2.5  | —         | 2    | 2.5  | V    | V <sub>CC</sub> =15V, Output:ON                                                                                                                                        |  |
|                                      | V <sub>IL</sub>     | 1         | 1.5  | —    | 1         | 1.5  | —    | 1         | 1.5  | —    |      | V <sub>CC</sub> =15V, Output:OFF                                                                                                                                       |  |
| Input Current                        | I <sub>IH</sub>     | —         | 50   | 100  | —         | 50   | 100  | —         | 50   | 100  | μA   | V <sub>CC</sub> =15V, V <sub>IN</sub> =5V                                                                                                                              |  |
|                                      | I <sub>IL</sub>     | —         | —    | 2    | —         | —    | 2    | —         | —    | 2    |      | V <sub>CC</sub> =15V, V <sub>IN</sub> =0V                                                                                                                              |  |
| Undervoltage Lock Out (high side)    | U <sub>VHL</sub>    | 9.0       | 10.0 | 11.0 | 9.0       | 10.0 | 11.0 | 9.0       | 10.0 | 11.0 | V    | Between V <sub>B</sub> and U (V, W)                                                                                                                                    |  |
|                                      | U <sub>VHH</sub>    | 9.5       | 10.5 | 11.5 | 9.5       | 10.5 | 11.5 | 9.5       | 10.5 | 11.5 |      |                                                                                                                                                                        |  |
| Undervoltage Lock Out (low side)     | U <sub>VLL</sub>    | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | V    | Between V <sub>CC</sub> and COM                                                                                                                                        |  |
|                                      | U <sub>VLH</sub>    | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 |      |                                                                                                                                                                        |  |
| FO Pin Output Voltage                | V <sub>FOH</sub>    | 0         | —    | 1.0  | 0         | —    | 1.0  | 0         | —    | 1.0  | V    | V <sub>CC</sub> =15V                                                                                                                                                   |  |
|                                      | V <sub>FOH</sub>    | 4.0       | —    | 5.5  | 4.0       | —    | 5.5  | 4.0       | —    | 5.5  |      |                                                                                                                                                                        |  |
| Overheat detection threshold         | T <sub>DH</sub>     | 135       | 150  | 165  | 135       | 150  | 165  | 135       | 150  | 165  | °C   | V <sub>CC</sub> =15V                                                                                                                                                   |  |
| Overheat detection release threshold | T <sub>DL</sub>     | 105       | 120  | 135  | 105       | 120  | 135  | 105       | 120  | 135  |      |                                                                                                                                                                        |  |
| Regulator output voltage             | V <sub>REG</sub>    | —         | 7.5  | —    | —         | 7.5  | —    | —         | 7.5  | —    | V    | I <sub>REG</sub> =35mA                                                                                                                                                 |  |
| Boot Diode Forward Voltage           | V <sub>FB</sub>     | —         | 1.1  | 1.3  | —         | 1.1  | 1.3  | —         | 1.1  | 1.3  | V    | I <sub>F</sub> =0.15A                                                                                                                                                  |  |
| Boot Diode Series Resistance         | R <sub>BD</sub>     | —         | 22   | —    | —         | 22   | —    | —         | 22   | —    | Ω    |                                                                                                                                                                        |  |
| MOSFET Output Breakdown Voltage      | V <sub>DSS</sub>    | 250       | —    | —    | 500       | —    | —    | 500       | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V                                                                                                       |  |
| MOSFET Output Leakage Current        | I <sub>DSS</sub>    | —         | —    | 100  | —         | —    | 100  | —         | —    | 100  | μA   | V <sub>CC</sub> =15V, V <sub>DS</sub> =500V (250V for SMA6821MH), V <sub>IN</sub> =0V                                                                                  |  |
| MOSFET DC On Resistance              | R <sub>DS(ON)</sub> | —         | 1.25 | 1.5  | —         | 3.6  | 4.0  | —         | 2.0  | 2.4  | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =1.0A (0.75A for SMA6822MH, 1.25A for SMA6823MH), V <sub>IN</sub> =5V                                                             |  |
| Diode Forward Voltage                | V <sub>SD</sub>     | —         | 1.1  | 1.5  | —         | 1.1  | 1.5  | —         | 1.1  | 1.5  | V    | V <sub>CC</sub> =15V, I <sub>SD</sub> =1.0A (0.75A for SMA6822MH, 1.25A for SMA6823MH), V <sub>IN</sub> =0V                                                            |  |
| High Side Switching Time             | t <sub>d(on)</sub>  | —         | 430  | —    | —         | 485  | —    | —         | 665  | —    | ns   | V <sub>BB</sub> =300V (150V for SMA6821MH), V <sub>CC</sub> =15V, I <sub>D</sub> =1A (0.75A for SMA6822MH, 1.25A for SMA6823MH), 0V≤V <sub>IN</sub> ≤5V Inductive load |  |
|                                      | t <sub>r</sub>      | —         | 55   | —    | —         | 85   | —    | —         | 145  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>rr</sub>     | —         | 90   | —    | —         | 120  | —    | —         | 150  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>d(off)</sub> | —         | 355  | —    | —         | 420  | —    | —         | 545  | —    |      |                                                                                                                                                                        |  |
| Low Side Switching Time              | t <sub>f</sub>      | —         | 20   | —    | —         | 30   | —    | —         | 40   | —    | ns   |                                                                                                                                                                        |  |
|                                      | t <sub>d(on)</sub>  | —         | 405  | —    | —         | 520  | —    | —         | 720  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>r</sub>      | —         | 60   | —    | —         | 100  | —    | —         | 175  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>rr</sub>     | —         | 90   | —    | —         | 120  | —    | —         | 150  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>d(off)</sub> | —         | 395  | —    | —         | 485  | —    | —         | 605  | —    |      |                                                                                                                                                                        |  |
|                                      | t <sub>f</sub>      | —         | 20   | —    | —         | 25   | —    | —         | 45   | —    |      |                                                                                                                                                                        |  |

## Internal Block Diagram



## Typical Connection Diagram

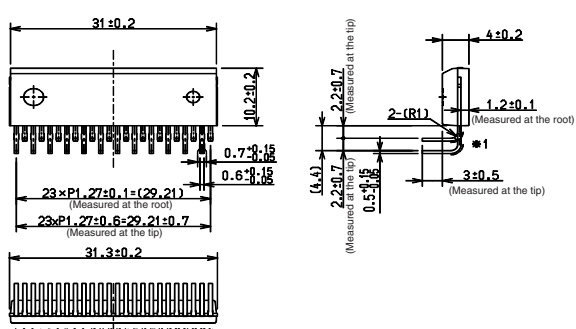


The input pulldown resistor is built into an IC (about 100 kΩ). If the input is expected to be unstable or fluctuate widely, however, it needs to be reinforced with an external resistor.

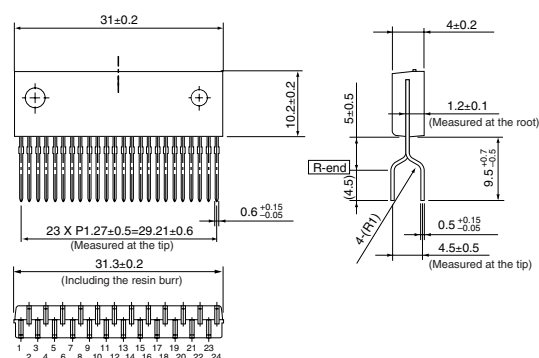
Attach capacitors near IC. Attach a ceramic capacitor in parallel with the electrolytic capacitor if too much noise is generated.

## External Dimensions (ZIP24 [SMA24Pin])

(Unit : mm)



Forming No.2451



Forming No.2452

Product Mass : Approx.3.9g

SMA6860MZ Series

Built-in Overcurrent Protection, Thermal Shutdown, and Overcurrent Limiting Circuits

Features

- Built-in boot diode with 210Ω limiting resistor
- Built-in overcurrent protection circuit (OCP)
- Overcurrent protection with off-time period adjustable by an external capacitor
- Overcurrent limiting operation
- Built-in thermal shutdown (TSD) circuit
- Externally controllable shutdown operation

Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                    | Symbol           | Ratings     |           |           | Unit | Conditions                                                                  |
|----------------------------------------------|------------------|-------------|-----------|-----------|------|-----------------------------------------------------------------------------|
|                                              |                  | SMA6862MZ   | SMA6863MZ | SMA6865MZ |      |                                                                             |
| MOSFET Output Breakdown Voltage              | V <sub>DSS</sub> | 500         |           |           | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V            |
| Control Supply Voltage (V <sub>CC</sub> )    | V <sub>CC</sub>  | 20          |           |           | V    | Between V <sub>CC</sub> and COM                                             |
| Control Supply Voltage (Bootstrap)           | V <sub>BS</sub>  | 20          |           |           | V    | Between V <sub>BS</sub> and HS (U, V, W)                                    |
| Output Current (continuous)                  | I <sub>O</sub>   | 1.5         | 2.5       | 2.5       | A    |                                                                             |
| Output Current (pulse)                       | I <sub>OP</sub>  | 2.25        | 3.75      | 3.75      | A    | PW≤100μs, duty=1%                                                           |
| Input Voltage                                | V <sub>IN</sub>  | −0.5 to +7  |           |           | V    | H <sub>IN1</sub> to H <sub>IN3</sub> , L <sub>IN1</sub> to L <sub>IN3</sub> |
| Thermal Resistance (Junction to Case)        | θ <sub>J-C</sub> | 4.46        |           |           | °C/W | All elements operating                                                      |
| Thermal Resistance (Junction to Ambient Air) | θ <sub>J-A</sub> | 31.25       |           |           | °C/W | All elements operating                                                      |
| Operating Case Temperature                   | T <sub>C</sub>   | −20 to +100 |           |           | °C   |                                                                             |
| Junction Temperature (Power part)            | T <sub>J</sub>   | 150         |           |           | °C   |                                                                             |
| Storage Temperature                          | T <sub>stg</sub> | −40 to +150 |           |           | °C   |                                                                             |

Recommended Operating Conditions

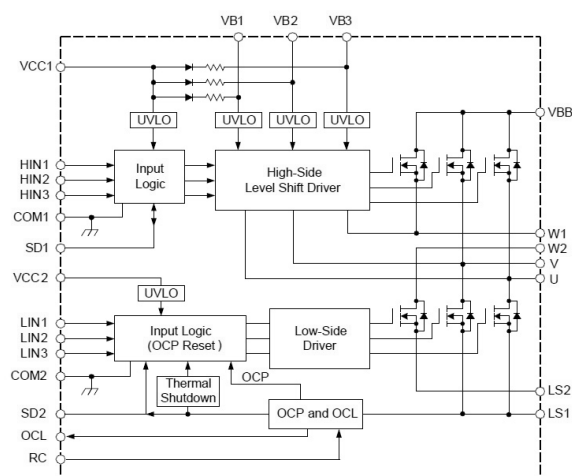
| Parameter                       | Symbol            | Ratings   |      |      |           |      |      |           |      |      | Unit | Conditions                      |
|---------------------------------|-------------------|-----------|------|------|-----------|------|------|-----------|------|------|------|---------------------------------|
|                                 |                   | SMA6862MZ |      |      | SMA6863MZ |      |      | SMA6865MZ |      |      |      |                                 |
|                                 |                   | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. |      |                                 |
| Main Supply Voltage             | V <sub>BB</sub>   | —         | 300  | 400  | —         | 300  | 400  | —         | 300  | 400  | V    | Between V <sub>BB</sub> and LS  |
| Control Supply Voltage          | V <sub>CC</sub>   | 13.5      | —    | 16.5 | 13.5      | —    | 16.5 | 13.5      | —    | 16.5 | V    | Between V <sub>CC</sub> and COM |
| RC Pull-up Resistor             | RR                | 33        | —    | 390  | 33        | —    | 390  | 33        | —    | 390  | kΩ   | V <sub>RC</sub> =5V             |
| RC Noise Eliminating Capacitor  | CC                | 1         | —    | 4.7  | 1         | —    | 4.7  | 1         | —    | 4.7  | nF   | V <sub>RC</sub> =5V             |
| SD1 Pull-up Resistor            | RL                | 3.3       | —    | 10   | 3.3       | —    | 10   | 3.3       | —    | 10   | kΩ   | V <sub>L</sub> =5V              |
| SD1 Noise Eliminating Capacitor | CL                | 1         | —    | 10   | 1         | —    | 10   | 1         | —    | 10   | nF   | V <sub>L</sub> =5V              |
| SD2 Pull-up Resistor            | R <sub>up2</sub>  | 3.3       | —    | 10   | 3.3       | —    | 10   | 3.3       | —    | 10   | kΩ   | V <sub>up2</sub> =5V            |
| SD2 Noise Eliminating Capacitor | C <sub>SD2</sub>  | 1         | —    | 10   | 1         | —    | 10   | 1         | —    | 10   | nF   | V <sub>up2</sub> =5V            |
| Input Signal Dead Time          | t <sub>dead</sub> | 1.5       | —    | —    | 1.5       | —    | —    | 1.5       | —    | —    | μs   | T <sub>J</sub> =−20°C to +150°C |
| Minimum Input Pulse Width       | T <sub>w</sub>    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | μs   |                                 |

Electrical Characteristics

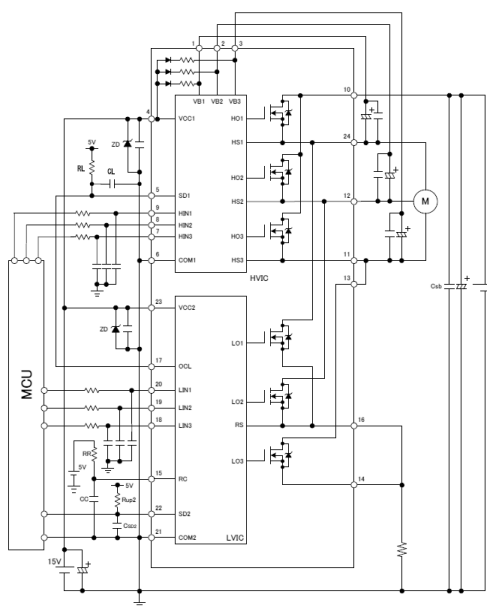
(T<sub>a</sub>=25°C)

| Parameter                                | Symbol              | Ratings   |      |      |           |      |      |           |      |      | Unit | Conditions                                                                                                                                        |  |
|------------------------------------------|---------------------|-----------|------|------|-----------|------|------|-----------|------|------|------|---------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                          |                     | SMA6862MZ |      |      | SMA6863MZ |      |      | SMA6865MZ |      |      |      |                                                                                                                                                   |  |
|                                          |                     | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. |      |                                                                                                                                                   |  |
| Control Supply Current                   | I <sub>CC</sub>     | —         | 4.2  | 7    | —         | 4.2  | 7    | —         | 4.2  | 7    | mA   | V <sub>CC</sub> =15V                                                                                                                              |  |
| Boot Supply Current                      | I <sub>B</sub>      | —         | 135  | 380  | —         | 135  | 380  | —         | 135  | 380  | μA   | V <sub>B</sub> =15V, H <sub>IN</sub> =5V                                                                                                          |  |
| Input Voltage                            | V <sub>IH</sub>     | —         | 2.9  | 3.4  | —         | 2.9  | 3.4  | —         | 2.9  | 3.4  | V    | V <sub>CC</sub> =15V                                                                                                                              |  |
|                                          | V <sub>IL</sub>     | 1.6       | 2.1  | —    | 1.6       | 2.1  | —    | 1.6       | 2.1  | —    |      |                                                                                                                                                   |  |
| Undervoltage Lock Out                    | UV <sub>HL</sub>    | 9.0       | 10.0 | 11.0 | 9.0       | 10.0 | 11.0 | 9.0       | 10.0 | 11.0 | V    | Between V <sub>B</sub> and U (V, W)                                                                                                               |  |
|                                          | UV <sub>HH</sub>    | 9.5       | 10.5 | 11.5 | 9.5       | 10.5 | 11.5 | 9.5       | 10.5 | 11.5 |      |                                                                                                                                                   |  |
| Undervoltage Lock Out                    | UV <sub>LL</sub>    | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | V    | Between V <sub>CC</sub> and COM                                                                                                                   |  |
|                                          | UV <sub>LH</sub>    | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 |      |                                                                                                                                                   |  |
| Thermal Protection and Release Threshold | T <sub>DH</sub>     | 120       | 135  | 150  | 120       | 135  | 150  | 120       | 135  | 150  | °C   | V <sub>CC</sub> =15V                                                                                                                              |  |
|                                          | T <sub>DL</sub>     | 100       | 115  | 130  | 100       | 115  | 130  | 100       | 115  | 130  |      |                                                                                                                                                   |  |
| Overcurrent Protection Trip Voltage      | V <sub>TRIP</sub>   | —         | 1.0  | —    | —         | 1.0  | —    | —         | 1.0  | —    | V    | V <sub>CC</sub> =15V                                                                                                                              |  |
| Current Limiting Reference Voltage       | V <sub>LIM</sub>    | —         | 0.53 | —    | —         | 0.53 | —    | —         | 0.53 | —    | V    | V <sub>CC</sub> =15V                                                                                                                              |  |
| Overcurrent Protection Retention Time    | t <sub>p</sub>      | —         | 2    | —    | —         | 2    | —    | —         | 2    | —    | ms   | V <sub>RC</sub> =5V, R <sub>R</sub> =360kΩ, C <sub>C</sub> =0.0047μF                                                                              |  |
| Boot Diode Leakage Current               | I <sub>LBD</sub>    | —         | —    | 10   | —         | —    | 10   | —         | —    | 10   | μA   | V <sub>R</sub> =500V                                                                                                                              |  |
| Boot Diode Forward Voltage               | V <sub>FB</sub>     | —         | 0.8  | 1.3  | —         | 0.8  | 1.3  | —         | 0.8  | 1.3  | V    | I <sub>F</sub> =0.05A                                                                                                                             |  |
| Boot Diode Series Resistance             | R <sub>BD</sub>     | —         | 210  | —    | —         | 210  | —    | —         | 210  | —    | Ω    |                                                                                                                                                   |  |
| MOSFET Output Breakdown Voltage          | V <sub>DSS</sub>    | 500       | —    | —    | 500       | —    | —    | 500       | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V                                                                                  |  |
| MOSFET Output Leakage Current            | I <sub>DSS</sub>    | —         | —    | 100  | —         | —    | 100  | —         | —    | 100  | μA   | V <sub>CC</sub> =15V, V <sub>DS</sub> =500V, V <sub>IN</sub> =0V                                                                                  |  |
| MOSFET DC ON Resistance                  | R <sub>DS(ON)</sub> | —         | 3.6  | 4.0  | —         | 2.0  | 2.4  | —         | 1.4  | 1.7  | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =1.25A (0.75A for the SMA6862MZ), V <sub>IN</sub> =5V                                                        |  |
| MOSFET Diode Forward Voltage             | V <sub>SD</sub>     | —         | 1.1  | 1.5  | —         | 1.1  | 1.5  | —         | 1.0  | 1.5  | V    | V <sub>CC</sub> =15V, I <sub>SD</sub> =1.25A (0.75A for the SMA6862MZ), V <sub>IN</sub> =0V                                                       |  |
| High Side Switching Time                 | t <sub>d(on)</sub>  | —         | 720  | —    | —         | 820  | —    | —         | 750  | —    | ns   | V <sub>BB</sub> =300V, V <sub>CC</sub> =15V, I <sub>D</sub> =1.5A (2.5A for the SMA6863MZ and SMA6865MZ), V <sub>IN</sub> =0 to 5V Inductive load |  |
|                                          | t <sub>r</sub>      | —         | 60   | —    | —         | 100  | —    | —         | 60   | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>rr</sub>     | —         | 110  | —    | —         | 120  | —    | —         | 100  | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>d(off)</sub> | —         | 690  | —    | —         | 740  | —    | —         | 680  | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>f</sub>      | —         | 30   | —    | —         | 30   | —    | —         | 20   | —    |      |                                                                                                                                                   |  |
| Low Side Switching Time                  | t <sub>d(on)</sub>  | —         | 670  | —    | —         | 790  | —    | —         | 640  | —    | ns   |                                                                                                                                                   |  |
|                                          | t <sub>r</sub>      | —         | 70   | —    | —         | 110  | —    | —         | 65   | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>rr</sub>     | —         | 120  | —    | —         | 130  | —    | —         | 100  | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>d(off)</sub> | —         | 590  | —    | —         | 700  | —    | —         | 560  | —    |      |                                                                                                                                                   |  |
|                                          | t <sub>f</sub>      | —         | 30   | —    | —         | 30   | —    | —         | 20   | —    |      |                                                                                                                                                   |  |

## Internal Block Diagram



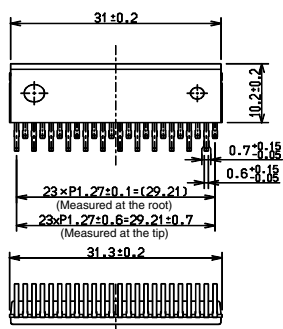
## Typical Connection Diagram



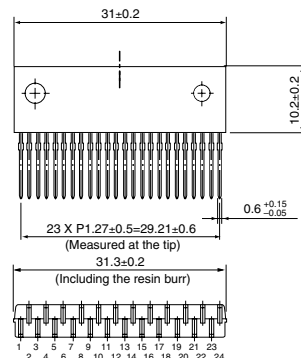
When the current limiter function is used  
(OCL and SD1 are connected)

## External Dimensions (ZIP24 [SMA24Pin])

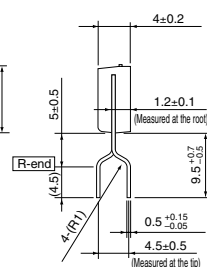
(Unit : mm)



Forming No.2451



Forming No.2452



Product Mass: Approx. 3.9 g

**SLA6860MZ Series****Built-in Overcurrent Protection, Thermal Shutdown, and Overcurrent Limiting Circuits****■Features**

- Built-in boot diode with 210Ω limiting resistor
- Built-in overcurrent protection circuit (OCP)
- Overcurrent protection with off-time period adjustable by an external capacitor
- Overcurrent limiting operation
- Built-in thermal shutdown (TSD) circuit
- Externally controllable shutdown operation

**■Absolute Maximum Ratings**(T<sub>a</sub>=25°C)

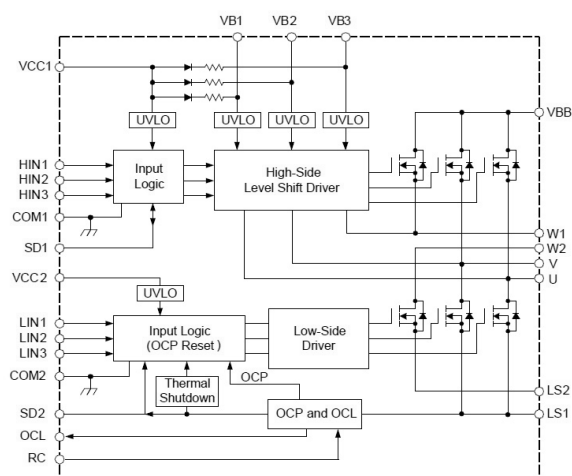
| Parameter                                    | Symbol           | Ratings     |           | Unit | Conditions                                                                     |
|----------------------------------------------|------------------|-------------|-----------|------|--------------------------------------------------------------------------------|
|                                              |                  | SLA6868MZ   | SLA6870MZ |      |                                                                                |
| MOSFET Output Breakdown Voltage              | V <sub>DSS</sub> | 500         |           | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V               |
| Control Supply Voltage (V <sub>CC</sub> )    | V <sub>CC</sub>  | 20          |           | V    | Between V <sub>CC</sub> and COM                                                |
| Control Supply Voltage (Bootstrap)           | V <sub>BS</sub>  | 20          |           | V    | Between V <sub>BS</sub> and HS (U, V, W)                                       |
| Output Current (continuous)                  | I <sub>O</sub>   | 2.5         | 3.0       | A    |                                                                                |
| Output Current (pulse)                       | I <sub>OP</sub>  | 3.75        | 4.5       | A    | PW≤100μs, duty=1%                                                              |
| Input Voltage                                | V <sub>IN</sub>  | -0.5 to +7  |           | V    | H <sub>IN</sub> 1 to H <sub>IN</sub> 3, L <sub>IN</sub> 1 to L <sub>IN</sub> 3 |
| Thermal Resistance (Junction to Case)        | θ <sub>J-C</sub> | 3.8         |           | °C/W | All elements operating                                                         |
| Thermal Resistance (Junction to Ambient Air) | θ <sub>J-A</sub> | 25          |           | °C/W | All elements operating                                                         |
| Operating Case Temperature                   | T <sub>C</sub>   | -20 to +100 |           | °C   |                                                                                |
| Junction Temperature (Power part)            | T <sub>J</sub>   | 150         |           | °C   |                                                                                |
| Storage Temperature                          | T <sub>stg</sub> | -40 to +150 |           | °C   |                                                                                |

**■Recommended Operating Conditions**

| Parameter                       | Symbol            | Ratings   |      |      |           |      |      | Unit | Conditions                      |
|---------------------------------|-------------------|-----------|------|------|-----------|------|------|------|---------------------------------|
|                                 |                   | SLA6868MZ |      |      | SLA6870MZ |      |      |      |                                 |
|                                 |                   | min.      | typ. | max. | min.      | typ. | max. |      |                                 |
| Main Supply Voltage             | V <sub>BB</sub>   | —         | 300  | 400  | —         | 300  | 400  | V    | Between V <sub>BB</sub> and LS  |
| Control Supply Voltage          | V <sub>CC</sub>   | 13.5      | —    | 16.5 | 13.5      | —    | 16.5 | V    | Between V <sub>CC</sub> and COM |
| RC Pull-up Resistor             | RR                | 33        | —    | 390  | 33        | —    | 390  | kΩ   | V <sub>RC</sub> =5V             |
| RC Noise Eliminating Capacitor  | CC                | 1         | —    | 4.7  | 1         | —    | 4.7  | nF   | V <sub>RC</sub> =5V             |
| SD1 Pull-up Resistor            | RL                | 3.3       | —    | 10   | 3.3       | —    | 10   | kΩ   | V <sub>L</sub> =5V              |
| SD1 Noise Eliminating Capacitor | CL                | 1         | —    | 10   | 1         | —    | 10   | nF   | V <sub>L</sub> =5V              |
| SD2 Pull-up Resistor            | R <sub>up2</sub>  | 3.3       | —    | 10   | 3.3       | —    | 10   | kΩ   | V <sub>up2</sub> =5V            |
| SD2 Noise Eliminating Capacitor | C <sub>SD2</sub>  | 1         | —    | 10   | 1         | —    | 10   | nF   | V <sub>up2</sub> =5V            |
| Input Signal Dead Time          | t <sub>dead</sub> | 1.5       | —    | —    | 1.5       | —    | —    | μs   | T <sub>J</sub> =−20°C to +150°C |
| Minimum Input Pulse Width       | T <sub>w</sub>    | 0.5       | —    | —    | 0.5       | —    | —    | μs   |                                 |

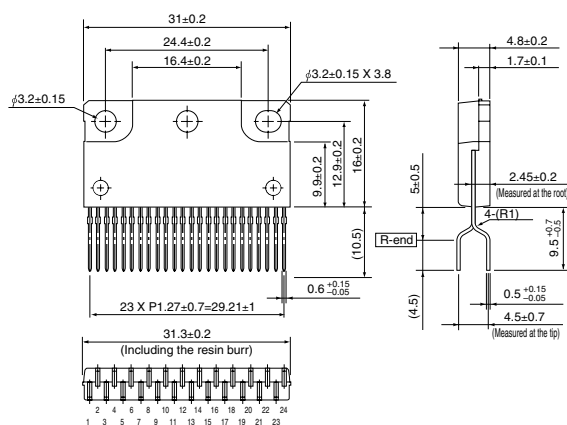
**■Electrical Characteristics**(T<sub>a</sub>=25°C)

| Parameter                                | Symbol              | Ratings   |      |      |           |      |      | Unit | Conditions                                                                                                                      |  |
|------------------------------------------|---------------------|-----------|------|------|-----------|------|------|------|---------------------------------------------------------------------------------------------------------------------------------|--|
|                                          |                     | SLA6868MZ |      |      | SLA6870MZ |      |      |      |                                                                                                                                 |  |
|                                          |                     | min.      | typ. | max. | min.      | typ. | max. |      |                                                                                                                                 |  |
| Control Supply Current                   | I <sub>CC</sub>     | —         | 4.2  | 7    | —         | 4.2  | 7    | mA   | V <sub>CC</sub> =15V                                                                                                            |  |
| Boot Supply Current                      | I <sub>B</sub>      | —         | 135  | 380  | —         | 135  | 380  | μA   | V <sub>B</sub> =15V, H <sub>IN</sub> =5V                                                                                        |  |
| Input Voltage                            | V <sub>IH</sub>     | —         | 2.9  | 3.4  | —         | 2.9  | 3.4  | V    | V <sub>CC</sub> =15V                                                                                                            |  |
|                                          | V <sub>IL</sub>     | 1.6       | 2.1  | —    | 1.6       | 2.1  | —    |      |                                                                                                                                 |  |
| Undervoltage Lock Out                    | UV <sub>HL</sub>    | 9.0       | 10.0 | 11.0 | 9.0       | 10.0 | 11.0 | V    | Between V <sub>B</sub> and U(V,W)                                                                                               |  |
|                                          | UV <sub>HH</sub>    | 9.5       | 10.5 | 11.5 | 9.5       | 10.5 | 11.5 |      |                                                                                                                                 |  |
| Undervoltage Lock Out                    | UV <sub>LL</sub>    | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | V    | Between V <sub>CC</sub> and COM                                                                                                 |  |
|                                          | UV <sub>LH</sub>    | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 |      |                                                                                                                                 |  |
| Thermal Protection and Release Threshold | T <sub>DH</sub>     | 120       | 135  | 150  | 120       | 135  | 150  | °C   | V <sub>CC</sub> =15V                                                                                                            |  |
|                                          | T <sub>DL</sub>     | 100       | 115  | 130  | 100       | 115  | 130  |      |                                                                                                                                 |  |
| Overcurrent Protection Trip Voltage      | V <sub>TRIP</sub>   | —         | 1.0  | —    | —         | 1.0  | —    | V    | V <sub>CC</sub> =15V                                                                                                            |  |
| Current Limiting Reference Voltage       | V <sub>LIM</sub>    | —         | 0.53 | —    | —         | 0.53 | —    | V    | V <sub>CC</sub> =15V                                                                                                            |  |
| Overcurrent Protection Retention Time    | t <sub>p</sub>      | —         | 2    | —    | —         | 2    | —    | ms   | V <sub>RC</sub> =5V, RR=360kΩ, CC=0.0047μF                                                                                      |  |
| Boot Diode Leakage Current               | I <sub>LBD</sub>    | —         | —    | 10   | —         | —    | 10   | μA   | V <sub>R</sub> =500V                                                                                                            |  |
| Boot Diode Forward Voltage               | V <sub>FB</sub>     | —         | 0.8  | 1.3  | —         | 0.8  | 1.3  | V    | I <sub>F</sub> =0.05A                                                                                                           |  |
| Boot Diode Series Resistance             | R <sub>BD</sub>     | —         | 210  | —    | —         | 210  | —    | Ω    |                                                                                                                                 |  |
| MOSFET Output Breakdown Voltage          | V <sub>DSS</sub>    | 500       | —    | —    | 500       | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V                                                                |  |
| MOSFET Output Leakage Current            | I <sub>DSS</sub>    | —         | —    | 100  | —         | —    | 100  | μA   | V <sub>CC</sub> =15V, V <sub>DS</sub> =500V, V <sub>IN</sub> =0V                                                                |  |
| MOSFET DC ON Resistance                  | R <sub>DS(ON)</sub> | —         | 2.0  | 2.4  | —         | 1.4  | 1.7  | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =1.25A (1.5A for SLA6870MZ), V <sub>IN</sub> =5V                                           |  |
| MOSFET Diode Forward Voltage             | V <sub>SD</sub>     | —         | 1.1  | 1.5  | —         | 1.0  | 1.5  | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =1.25A (1.5A for SLA6870MZ), V <sub>IN</sub> =0V                                           |  |
| High Side Switching Time                 | t <sub>d(on)</sub>  | —         | 820  | —    | —         | 755  | —    | ns   | V <sub>BB</sub> =300V, V <sub>CC</sub> =15V, I <sub>D</sub> =2.5A (3.0A for SLA6870MZ), V <sub>IN</sub> =0 to 5V Inductive load |  |
|                                          | t <sub>r</sub>      | —         | 100  | —    | —         | 65   | —    |      |                                                                                                                                 |  |
|                                          | t <sub>rr</sub>     | —         | 120  | —    | —         | 100  | —    |      |                                                                                                                                 |  |
|                                          | t <sub>d(off)</sub> | —         | 740  | —    | —         | 680  | —    |      |                                                                                                                                 |  |
|                                          | t <sub>f</sub>      | —         | 30   | —    | —         | 15   | —    |      |                                                                                                                                 |  |
| Low Side Switching Time                  | t <sub>d(on)</sub>  | —         | 790  | —    | —         | 645  | —    | ns   |                                                                                                                                 |  |
|                                          | t <sub>r</sub>      | —         | 110  | —    | —         | 70   | —    |      |                                                                                                                                 |  |
|                                          | t <sub>rr</sub>     | —         | 130  | —    | —         | 105  | —    |      |                                                                                                                                 |  |
|                                          | t <sub>d(off)</sub> | —         | 700  | —    | —         | 560  | —    |      |                                                                                                                                 |  |
|                                          | t <sub>f</sub>      | —         | 30   | —    | —         | 20   | —    |      |                                                                                                                                 |  |

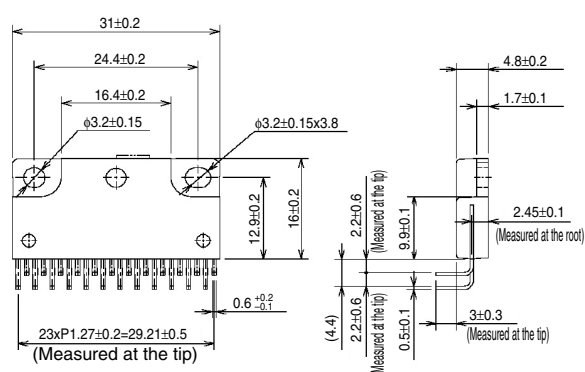


When the current limiter function is used  
(OCL and SD1 are connected)

(Unit : mm)



Forming No.2171



Forming No.2175

Product Mass: Approx. 5.9 g

# SIM6800M Series

## Overcurrent Protection, Thermal Shutdown, Built-in Current Limiting Function, 3 Shunt Support, DIP Package

### ■Features

- Ideal for driving refrigerator compressors and the fan motor (built-in motor) of air conditioners
- Six MOSFETs for 3-phase bridge and pre-drive circuits (HVIC, LVIC) incorporated in single package  
(For SIM6822M and SIM68227M, the 6 MOSFETs are replaced by 6 IGBTs and 6 FRDs)
- New package (DIP-40) that separates control signal pins and high voltage pins
- 3-shunt configuration allows configuration of vector control
- Built-in boot diode with limiting resistor
- Built-in undervoltage lockout (UVLO) circuit
- Built-in overcurrent protection circuit (OCP)
- Built-in thermal shutdown (TSD) function
- Built-in current limiter function (OCL)
- Error (FO) pin with shutdown input function

### ■Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                                                   | Symbol           | Ratings     |             |             |             | Unit | Conditions                                |
|-------------------------------------------------------------|------------------|-------------|-------------|-------------|-------------|------|-------------------------------------------|
|                                                             |                  | SIM6811M    | SIM6812M    | SIM6822M    | SIM6827M    |      |                                           |
| MOSFET Output Breakdown Voltage                             | V <sub>DSS</sub> | 500         | 500         | 600         | 600         | V    | V <sub>CC</sub> =15V, V <sub>IN</sub> =0V |
| Control Supply Voltage                                      | V <sub>CC</sub>  | 20          | 20          | 20          | 20          | V    | Between V <sub>CC</sub> and COM           |
| Control Supply Voltage (Bootstrap)                          | V <sub>BS</sub>  | 20          | 20          | 20          | 20          | V    | Between V <sub>B</sub> and HS(U, V, W)    |
| Output Current (continuous)                                 | I <sub>o</sub>   | 2.0         | 2.5         | 5.0         | 5.0         | A    |                                           |
| Output Current (pulse)                                      | I <sub>op</sub>  | 3.0         | 3.75        | 7.5         | 7.5         | A    | PW≤100μs, duty=1%                         |
| Input Voltage                                               | V <sub>IN</sub>  | -0.5 to +7  | -0.5 to +7  | -0.5 to +7  | -0.5 to +7  | V    |                                           |
| Thermal Resistance (MOSFET or IGBT Junction to Case)        | θ <sub>J-C</sub> | 3.6         | 3.6         | 3.6         | 3.6         | °C/W | All elements operating                    |
| Thermal Resistance (MOSFET or IGBT Junction to Ambient Air) | θ <sub>J-A</sub> | —           | —           | 4.2         | 4.2         | °C/W | All elements operating                    |
| Operating Case Temperature                                  | T <sub>op</sub>  | -20 to +100 | -20 to +100 | -20 to +100 | -20 to +100 | °C   | All elements operating                    |
| Junction Temperature (Power part)                           | T <sub>ch</sub>  | +150        | +150        | +150        | +150        | °C   | All elements operating                    |
| Storage Temperature                                         | T <sub>stg</sub> | -40 to +150 | -40 to +150 | -40 to +150 | -40 to +150 | °C   |                                           |

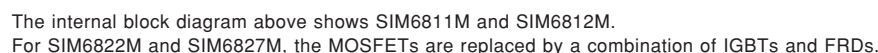
### ■Recommended Operating Conditions

| Parameter                       | Symbol            | Ratings  |      |      |          |      |      |          |      |      |          |      |      | Unit | Conditions                      |
|---------------------------------|-------------------|----------|------|------|----------|------|------|----------|------|------|----------|------|------|------|---------------------------------|
|                                 |                   | SIM6811M |      |      | SIM6812M |      |      | SIM6822M |      |      | SIM6827M |      |      |      |                                 |
|                                 |                   | min.     | typ. | max. | min.     | typ. | max. | min.     | typ. | max. | min.     | typ. | max. |      |                                 |
| Main Supply Voltage             | V <sub>BB</sub>   | —        | —    | 400  | —        | —    | 400  | —        | —    | 400  | —        | —    | 400  | V    | Between V <sub>BB</sub> and LS  |
| Control Supply Voltage          | V <sub>CC</sub>   | 13.5     | 15   | 16.5 | 13.5     | 15   | 16.5 | 13.5     | 15   | 16.5 | 13.5     | 15   | 16.5 | V    | Between V <sub>CC</sub> and COM |
| Input Signal Dead Time          | t <sub>dead</sub> | 1.5      | —    | —    | 1.5      | —    | —    | 1.5      | —    | —    | 1.5      | —    | —    | μs   |                                 |
| Minimum Input Pulse Width       | t <sub>w</sub>    | 0.5      | —    | —    | 0.5      | —    | —    | 0.5      | —    | —    | 0.5      | —    | —    | μs   |                                 |
| Bootstrap Capacitor Capacitance | C <sub>boot</sub> | 1        | —    | —    | 1        | —    | —    | 1        | —    | —    | 1        | —    | —    | μF   |                                 |
| FO Pull-up Resistor             | R <sub>FO</sub>   | 3.3      | —    | 10   | 3.3      | —    | 10   | 3.3      | —    | 10   | 3.3      | —    | 10   | kΩ   |                                 |
| FO Capacitor Capacitance        | C <sub>FO</sub>   | 0.001    | —    | 0.01 | 0.001    | —    | 0.01 | 0.001    | —    | 0.01 | 0.001    | —    | 0.01 | μF   |                                 |

### ■Electrical Characteristics

(T<sub>a</sub>=25°C)

| Parameter                                 | Symbol               | Ratings  |      |      |          |      |      |          |      |      |          |      |      | Unit | Conditions                                                                                                                                                                     |  |
|-------------------------------------------|----------------------|----------|------|------|----------|------|------|----------|------|------|----------|------|------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                           |                      | SIM6811M |      |      | SIM6812M |      |      | SIM6822M |      |      | SIM6827M |      |      |      |                                                                                                                                                                                |  |
|                                           |                      | min.     | typ. | max. | min.     | typ. | max. | min.     | typ. | max. | min.     | typ. | max. |      |                                                                                                                                                                                |  |
| Control Supply Current                    | I <sub>CC</sub>      | —        | 3.2  | 4.5  | —        | 3.2  | 4.5  | —        | 3.2  | 4.5  | —        | 3.2  | 4.5  | mA   | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| Boot Supply Current                       | I <sub>B</sub>       | —        | 140  | 400  | —        | 140  | 400  | —        | 140  | 400  | —        | 140  | 400  | μA   | V <sub>B</sub> =15V, H <sub>IN</sub> =5V, per phase                                                                                                                            |  |
| Input Voltage                             | V <sub>IH</sub>      | —        | 2    | 2.5  | —        | 2    | 2.5  | —        | 2    | 2.5  | —        | 2    | 2.5  | V    | V <sub>CC</sub> =15V, Output:ON                                                                                                                                                |  |
|                                           | V <sub>IL</sub>      | 1        | 1.5  | —    | 1        | 1.5  | —    | 1        | 1.5  | —    | 1        | 1.5  | —    |      | V <sub>CC</sub> =15V, Output:OFF                                                                                                                                               |  |
| FO Input Threshold Voltage                | V <sub>IH</sub>      | —        | 2    | 2.5  | —        | 2    | 2.5  | —        | 2    | 2.5  | —        | 2    | 2.5  | V    | V <sub>CC</sub> =15V, Fo:Passive                                                                                                                                               |  |
|                                           | V <sub>IL</sub>      | 1        | 1.5  | —    | 1        | 1.5  | —    | 1        | 1.5  | —    | 1        | 1.5  | —    |      | V <sub>CC</sub> =15V, Fo:Active                                                                                                                                                |  |
| Input Current                             | I <sub>IH</sub>      | —        | 230  | 500  | —        | 230  | 500  | —        | 230  | 500  | —        | 230  | 500  | μA   | V <sub>CC</sub> =15V, V <sub>IN</sub> =5V                                                                                                                                      |  |
|                                           | I <sub>IL</sub>      | —        | —    | 2    | —        | —    | 2    | —        | —    | 2    | —        | —    | 2    |      | V <sub>CC</sub> =15V, V <sub>IN</sub> =0V                                                                                                                                      |  |
| Undervoltage Lock Out (high side)         | UV <sub>HL</sub>     | 9.0      | 10.0 | 11.0 | 9.0      | 10.0 | 11.0 | 9.0      | 10.0 | 11.0 | 9.0      | 10.0 | 11.0 | V    | Between V <sub>B</sub> and U(V, W)                                                                                                                                             |  |
|                                           | UV <sub>HH</sub>     | 9.5      | 10.5 | 11.5 | 9.5      | 10.5 | 11.5 | 9.5      | 10.5 | 11.5 | 9.5      | 10.5 | 11.5 |      |                                                                                                                                                                                |  |
| Undervoltage Lock Out (low side)          | UV <sub>LL</sub>     | 10.0     | 11.0 | 12.0 | 10.0     | 11.0 | 12.0 | 10.0     | 11.0 | 12.0 | 10.0     | 11.0 | 12.0 | V    | Between V <sub>CC</sub> and COM                                                                                                                                                |  |
|                                           | UV <sub>LH</sub>     | 10.5     | 11.5 | 12.5 | 10.5     | 11.5 | 12.5 | 10.5     | 11.5 | 12.5 | 10.5     | 11.5 | 12.5 |      |                                                                                                                                                                                |  |
| FO Pin Output Voltage                     | V <sub>FOL</sub>     | 0        | —    | 0.5  | 0        | —    | 0.5  | 0        | —    | 0.5  | 0        | —    | 0.5  | V    | V <sub>CC</sub> =15V, V <sub>FO</sub> =5V, R <sub>FO</sub> =10kΩ                                                                                                               |  |
|                                           | V <sub>FOH</sub>     | 4.8      | —    | —    | 4.8      | —    | —    | 4.8      | —    | —    | 4.8      | —    | —    |      |                                                                                                                                                                                |  |
| OCL Pin Output Voltage                    | V <sub>OCLL</sub>    | 0        | —    | 0.5  | 0        | —    | 0.5  | 0        | —    | 0.5  | 0        | —    | 0.5  | V    | V <sub>CC</sub> =15V                                                                                                                                                           |  |
|                                           | V <sub>OCLH</sub>    | 4.5      | —    | 5.5  | 4.5      | —    | 5.5  | 4.5      | —    | 5.5  | 4.5      | —    | 5.5  |      |                                                                                                                                                                                |  |
| Current Limiting Reference Voltage        | V <sub>LIM</sub>     | —        | 0.65 | —    | —        | 0.65 | —    | —        | 0.65 | —    | —        | 0.65 | —    | V    | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| Overcurrent Protection Trip Voltage       | V <sub>TRIP</sub>    | —        | 1.0  | —    | —        | 1.0  | —    | —        | 1.0  | —    | —        | 1.0  | —    | V    | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| Overcurrent Protection Retention Time     | T <sub>p</sub>       | —        | 25   | —    | —        | 25   | —    | —        | 25   | —    | —        | 25   | —    | μs   | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| OCP Blanking Time                         | T <sub>bk(OCP)</sub> | —        | 2.0  | —    | —        | 2.0  | —    | —        | 2.0  | —    | —        | 2.0  | —    | μs   | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| OCL Blanking Time                         | T <sub>bk(OCL)</sub> | —        | 2.0  | —    | —        | 2.0  | —    | —        | 2.0  | —    | —        | 2.0  | —    | μs   | V <sub>CC</sub> =15V                                                                                                                                                           |  |
| Terminal Protection and Release Threshold | T <sub>DH</sub>      | 135      | 150  | 165  | 135      | 150  | 165  | 135      | 150  | 165  | 135      | 150  | 165  | °C   | V <sub>CC</sub> =15V, No FIN                                                                                                                                                   |  |
|                                           | T <sub>DL</sub>      | 105      | 120  | 135  | 105      | 120  | 135  | 105      | 120  | 135  | 105      | 120  | 135  |      |                                                                                                                                                                                |  |
| Boot Diode Forward Voltage                | V <sub>FB</sub>      | —        | 1.0  | 1.3  | —        | 1.0  | 1.3  | —        | 1.0  | 1.3  | —        | 1.0  | 1.3  | V    | I <sub>F</sub> =0.15A                                                                                                                                                          |  |
| Boot Diode Series Resistance              | R <sub>BD</sub>      | —        | 60   | —    | —        | 60   | —    | —        | 60   | —    | —        | 60   | —    | Ω    |                                                                                                                                                                                |  |
| MOSFET Output Breakdown Voltage           | V <sub>DSS</sub>     | 500      | —    | —    | 500      | —    | —    | —        | —    | —    | —        | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =100μA, V <sub>IN</sub> =0V                                                                                                               |  |
| IGBT Output Breakdown Voltage             | V <sub>CES</sub>     | —        | —    | —    | —        | —    | 600  | —        | —    | 600  | —        | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>CE</sub> =1mA, V <sub>IN</sub> =0V                                                                                                                |  |
| MOSFET Output Leakage Current             | I <sub>DSS</sub>     | —        | —    | 100  | —        | —    | 100  | —        | —    | —    | —        | —    | —    | μA   | V <sub>CC</sub> =15V, V <sub>DS</sub> =500V, V <sub>IN</sub> =0V                                                                                                               |  |
| IGBT Output Leakage Current               | I <sub>CES</sub>     | —        | —    | —    | —        | —    | —    | —        | 1    | —    | —        | —    | 1    | mA   | V <sub>CC</sub> =15V, V <sub>CE</sub> =600V, V <sub>IN</sub> =0V                                                                                                               |  |
| MOSFET DC ON Resistance                   | R <sub>DS(ON)</sub>  | —        | 3.2  | 4.0  | —        | 2.0  | 2.4  | —        | —    | —    | —        | —    | —    | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =1.0A (1.25A for the SIM6812M), V <sub>IN</sub> =5V                                                                                       |  |
| IGBT Output Saturation Voltage            | V <sub>CE(sat)</sub> | —        | —    | —    | —        | —    | —    | 1.75     | 2.2  | —    | 1.75     | 2.2  | —    | V    | V <sub>CC</sub> =15V, I <sub>C</sub> =5.0A, V <sub>IN</sub> =5V                                                                                                                |  |
| Diode Forward Voltage                     | V <sub>SD</sub>      | —        | 1.0  | 1.5  | —        | 1.0  | 1.5  | —        | 2.0  | 2.4  | —        | 2.0  | 2.4  | V    | V <sub>CC</sub> =15V, I <sub>SD</sub> =1.0A (1.25A for the SIM6812M, I <sub>EC</sub> =5A for the SIM6822M, 27M), V <sub>IN</sub> =0V                                           |  |
| High Side Switching Time                  | t <sub>d(on)</sub>   | —        | 770  | —    | —        | 910  | —    | —        | 740  | —    | —        | 1030 | —    | ns   | V <sub>BB</sub> =300V, V <sub>CC</sub> =15V,I <sub>D</sub> =1.0A, (1.25A for the SIM6812M, I <sub>C</sub> =5A for the SIM6822M, 27M), V <sub>IN</sub> =0 to 5V, Inductive load |  |
|                                           | t <sub>r</sub>       | —        | 70   | —    | —        | 100  | —    | —        | 70   | —    | —        | 180  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>rr</sub>      | —        | 150  | —    | —        | 140  | —    | —        | 80   | —    | —        | 100  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>d(off)</sub>  | —        | 690  | —    | —        | 700  | —    | —        | 570  | —    | —        | 590  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>f</sub>       | —        | 30   | —    | —        | 40   | —    | —        | 100  | —    | —        | 150  | —    |      |                                                                                                                                                                                |  |
| Low Side Switching Time                   | t <sub>d(on)</sub>   | —        | 690  | —    | —        | 875  | —    | —        | 690  | —    | —        | 1030 | —    | ns   |                                                                                                                                                                                |  |
|                                           | t <sub>r</sub>       | —        | 90   | —    | —        | 110  | —    | —        | 100  | —    | —        | 240  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>rr</sub>      | —        | 150  | —    | —        | 155  | —    | —        | 80   | —    | —        | 100  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>d(off)</sub>  | —        | 650  | —    | —        | 775  | —    | —        | 540  | —    | —        | 540  | —    |      |                                                                                                                                                                                |  |
|                                           | t <sub>f</sub>       | —        | 50   | —    | —        | 35   | —    | —        | 100  | —    | —        | 150  | —    |      |                                                                                                                                                                                |  |



The typical connection diagram above shows SIM6811M and SIM6812M. For SIM6822M and SIM6827M, the MOSFETs are replaced by a combination of IGBTs and FRDs.

SCM1240M Series

IGBT Output Element, Built-in Thermal Shutdown, Overcurrent Protection, and Shoot Through Prevention Circuits

Features

- Six IGBTs and six FRDs for the 3-phase bridge, a pre-drive IC, and a boot diode are integrated into a single package (For SCM1248M, the 6 IGBTs and 6 FRDs are replaced with 6 MOSFETs)
- Best for driving air conditioner compressors, washing machine drums, and refrigerator compressors
- Built-in shoot through prevention (STP) circuit (when the ON signal is input simultaneously)
- All IGBTs can be shut down when commonly connected to the FO pin.
- Three built-in boot diodes with limiting resistors
- Built-in undervoltage lock out (UVLO) circuit
- Built-in overcurrent protection (OCP) circuit
- Built-in thermal shut down (TSD) circuit
- Fail signal output during operation of the UVLO (low side only), OCP, or STP circuit
- Supports CMOS (3.3 and 5 V) input levels

Absolute Maximum Ratings

(T<sub>a</sub>=25°C)

| Parameter                           | Symbol                 | Ratings      |              |              |              |              | Unit | Conditions                                                     |
|-------------------------------------|------------------------|--------------|--------------|--------------|--------------|--------------|------|----------------------------------------------------------------|
|                                     |                        | SCM1241M     | SCM1243MF    | SCM1245MF    | SCM1246MF    | SCM1248M     |      |                                                                |
| Supply Voltage                      | V <sub>DC</sub>        | 450          | 450          | 450          | 450          | 400          | V    | Between V <sub>BB</sub> and LS1 to LS3                         |
| Supply Voltage (Surge)              | V <sub>DC(Surge)</sub> | 500          | 500          | 500          | 500          | 450          | V    | Between V <sub>BB</sub> and LS1 to LS3                         |
| IGBT Output Breakdown Voltage       | V <sub>CEs</sub>       | 600          | 600          | 600          | 600          | —            | V    | V <sub>CC</sub> =15V, I <sub>C</sub> =1mA, V <sub>IN</sub> =0V |
| MOSFET Output Breakdown Voltage     | V <sub>DSS</sub>       | —            | —            | —            | —            | 500          | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =1mA, V <sub>IN</sub> =0V |
| Control Supply Voltage              | V <sub>CC</sub>        | 20           | 20           | 20           | 20           | 20           | V    | Between V <sub>CC</sub> and COM                                |
| Control Supply Voltage (Bootstrap)  | V <sub>BS</sub>        | 20           | 20           | 20           | 20           | 20           | V    | Between V <sub>BS</sub> and HS (U, V, W)                       |
| Output Current (continuous)         | I <sub>O</sub>         | 10           | 15           | 20           | 30           | 5            | A    | T <sub>C</sub> =25°C                                           |
| Output Current (pulse)              | I <sub>OP</sub>        | 20           | 30           | 30           | 45           | 7.5          | A    | PW≤1ms (100μs for the SCM1248M), Duty=1%, T <sub>C</sub> =25°C |
| Input Voltage                       | V <sub>IN</sub>        | −0.5 to +7.0 | −0.5 to +7.0 | −0.5 to +7.0 | −0.5 to +7.0 | −0.5 to +7.0 | V    | Hin, Lin, OCP                                                  |
| FO Pin Voltage                      | V <sub>FO</sub>        | 7            | 7            | 7            | 7            | 7            | V    | Between FO and COM                                             |
| OCP Pin Voltage                     | V <sub>OCP</sub>       | −10 to +5.0  | −10 to +5.0  | −10 to +5.0  | −10 to +5.0  | −10 to +5.0  | V    | Between OCP and COM                                            |
| Thermal Resistance   IGBT or MOSFET | θ <sub>J-C_O</sub>     | 6.0          | 3.0          | 3.0          | 3.0          | 5.5          | °C/W | Per element in operation                                       |
| (Junction to Case)   FRD            | θ <sub>J-C_F</sub>     | 6.5          | 4.0          | 4.0          | 4.0          | —            | °C/W | Per element in operation                                       |
| Operating Case Temperature          | T <sub>OP</sub>        | −20 to +100  | −20 to +100  | −20 to +100  | −20 to +100  | −20 to +100  | °C   |                                                                |
| Junction Temperature (Power part)   | T <sub>J</sub>         | 150          | 150          | 150          | 150          | 150          | °C   |                                                                |
| Storage Temperature                 | T <sub>stg</sub>       | −40 to +150  | −40 to +150  | −40 to +150  | −40 to +150  | −40 to +150  | °C   |                                                                |
| Insulation Breakdown Voltage        | V <sub>ISO</sub>       | 2,000        | 2,000        | 2,000        | 2,000        | 2,000        | V    | Between rear and lead pins, AC one minute                      |

Recommended Operating Conditions

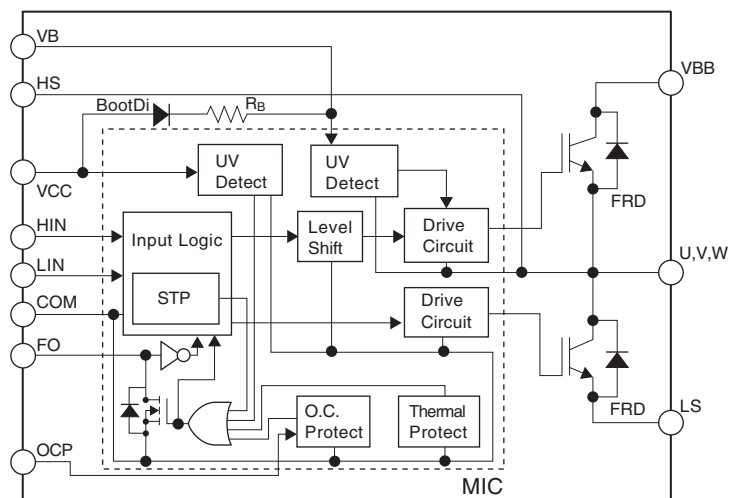
| Parameter                      | Symbol                           | Ratings  |      |      |           |      |      |           |      |      |           |      |      |          |      |      | Unit | Conditions                                                                         |
|--------------------------------|----------------------------------|----------|------|------|-----------|------|------|-----------|------|------|-----------|------|------|----------|------|------|------|------------------------------------------------------------------------------------|
|                                |                                  | SCM1241M |      |      | SCM1243MF |      |      | SCM1245MF |      |      | SCM1246MF |      |      | SCM1248M |      |      |      |                                                                                    |
|                                |                                  | min.     | typ. | max. | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. | min.     | typ. | max. |      |                                                                                    |
| Main Supply Voltage            | V <sub>BB</sub>                  | —        | 300  | 400  | —         | 300  | 400  | —         | 300  | 400  | —         | 300  | 400  | —        | 300  | 400  | V    | Between V <sub>BB</sub> and LS                                                     |
| Control Supply Voltage         | V <sub>CC</sub> ,V <sub>BS</sub> | 13.5     | 15   | 16.5 | 13.5      | 15   | 16.5 | 13.5      | 15   | 16.5 | 13.5      | 15   | 16.5 | 13.5     | 15   | 16.5 | V    | Between V <sub>CC</sub> and COM                                                    |
| Minimum Input Pulse Width      | t <sub>INmin(on)</sub>           | 0.5      | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5      | —    | —    | μs   | ON pulse                                                                           |
|                                | t <sub>INmin(off)</sub>          | 0.5      | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5       | —    | —    | 0.5      | —    | —    | μs   | OFF pulse                                                                          |
| Input Signal Dead Time         | t <sub>dead</sub>                | 1.0      | —    | —    | 1.0       | —    | —    | 1.0       | —    | —    | 1.0       | —    | —    | 1.0      | —    | —    | μs   |                                                                                    |
| FO Pull-up Voltage             | V <sub>FO</sub>                  | 3.0      | —    | 5.5  | 3.0       | —    | 5.5  | 3.0       | —    | 5.5  | 3.0       | —    | 5.5  | 3.0      | —    | 5.5  | V    |                                                                                    |
| FO Pull-up Resistance          | R <sub>FO</sub>                  | 1.0      | —    | 22   | 1.0       | —    | 22   | 1.0       | —    | 22   | 1.0       | —    | 22   | 1.0      | —    | 22   | kΩ   |                                                                                    |
| FO Noise Eliminating Capacitor | C <sub>FO</sub>                  | 0.001    | —    | 0.01 | 0.001     | —    | 0.01 | 0.001     | —    | 0.01 | 0.001     | —    | 0.01 | 0.001    | —    | 0.01 | μF   |                                                                                    |
| Boot Capacitor                 | C <sub>BOOT</sub>                | 10       | —    | 220  | 10        | —    | 220  | 10        | —    | 220  | 10        | —    | 220  | 10       | —    | 220  | μF   |                                                                                    |
| Shunt resistor                 | R <sub>S</sub>                   | 27       | —    | —    | 18        | —    | —    | 18        | —    | —    | 12        | —    | —    | 67       | —    | —    | mΩ   | I <sub>C</sub> <I <sub>OP</sub> (I <sub>D</sub> <I <sub>OP</sub> for the SCM1248M) |
| RC filter resistor             | R <sub>O</sub>                   | —        | —    | 100  | —         | —    | 100  | —         | —    | 100  | —         | —    | 100  | —        | —    | 100  | Ω    |                                                                                    |
| RC filter capacitor            | C <sub>O</sub>                   | —        | —    | 2200 | —         | —    | 2200 | —         | —    | 2200 | —         | —    | 2200 | —        | —    | 2200 | pF   |                                                                                    |
| PWM Carrier Frequency          | f <sub>c</sub>                   | —        | —    | 20   | —         | —    | 20   | —         | —    | 20   | —         | —    | 20   | —        | —    | 20   | kHz  |                                                                                    |

## ■Electrical Characteristics

(T<sub>a</sub>=25°C)

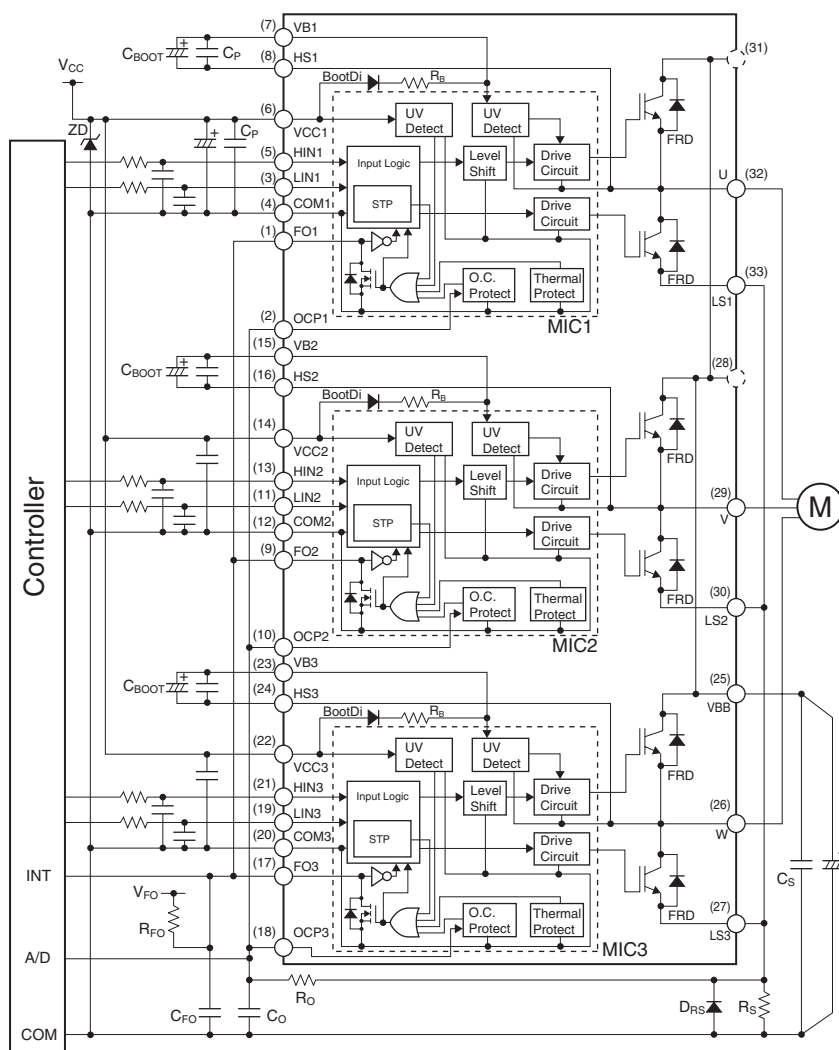
| Parameter                                | Symbol               | Ratings  |      |      |           |      |      |           |      |      |           |      |      |          |      |      | Unit | Conditions                                                                                                                                            |  |
|------------------------------------------|----------------------|----------|------|------|-----------|------|------|-----------|------|------|-----------|------|------|----------|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                          |                      | SCM1241M |      |      | SCM1243MF |      |      | SCM1245MF |      |      | SCM1246MF |      |      | SCM1248M |      |      |      |                                                                                                                                                       |  |
|                                          |                      | min.     | typ. | max. | min.      | typ. | max. | min.      | typ. | max. | min.      | typ. | max. | min.     | typ. | max. |      |                                                                                                                                                       |  |
| Control Supply Current                   | I <sub>CC</sub>      | —        | 3    | —    | —         | 3    | —    | —         | 3    | —    | —         | 3    | —    | —        | 3    | —    | mA   | V <sub>CC</sub> =15V, 3circuit total                                                                                                                  |  |
| Boot Supply Current                      | I <sub>BS</sub>      | —        | 140  | —    | —         | 140  | —    | —         | 140  | —    | —         | 140  | —    | —        | 140  | —    | μA   | V <sub>B</sub> -HS=15V, 1 circuit, V <sub>IN</sub> =5V                                                                                                |  |
| Input Voltage                            | V <sub>IH</sub>      | —        | 2.0  | 2.5  | —         | 2.0  | 2.5  | —         | 2.0  | 2.5  | —         | 2.0  | 2.5  | —        | 2.0  | 2.5  | V    | V <sub>CC</sub> =15V, Output:ON                                                                                                                       |  |
|                                          | V <sub>IL</sub>      | 1.0      | 1.5  | —    | 1.0       | 1.5  | —    | 1.0       | 1.5  | —    | 1.0       | 1.5  | —    | 1.0      | 1.5  | —    |      | V <sub>CC</sub> =15V, Output:OFF                                                                                                                      |  |
| Input Current                            | I <sub>IH</sub>      | —        | 230  | 500  | —         | 230  | 500  | —         | 230  | 500  | —         | 230  | 500  | —        | 230  | 500  | μA   | V <sub>CC</sub> =15V, V <sub>IN</sub> =5V                                                                                                             |  |
| Undervoltage Lock Out (high side)        | UV <sub>HL</sub>     | 10.0     | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0     | 11.0 | 12.0 | V    | Between V <sub>BS</sub> and HS(U, V, W)                                                                                                               |  |
| Undervoltage Lock Out (low side)         | UV <sub>LL</sub>     | 10.0     | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0      | 11.0 | 12.0 | 10.0     | 11.0 | 12.0 |      | Between V <sub>CC</sub> and COM                                                                                                                       |  |
|                                          | UV <sub>LH</sub>     | 10.5     | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 | 10.5      | 11.5 | 12.5 | 10.5     | 11.5 | 12.5 |      |                                                                                                                                                       |  |
| FO Pin Output Voltage                    | V <sub>FOL</sub>     | —        | —    | 0.5  | —         | —    | 0.5  | —         | —    | 0.5  | —         | —    | 0.5  | —        | —    | 0.5  | V    | V <sub>CC</sub> =15V, V <sub>FO</sub> =5V, R <sub>FO</sub> =10kΩ                                                                                      |  |
|                                          | V <sub>FOH</sub>     | 4.8      | —    | —    | 4.8       | —    | —    | 4.8       | —    | —    | 4.8       | —    | —    | 4.8      | —    | —    |      |                                                                                                                                                       |  |
| Overcurrent Protection Trip Voltage      | V <sub>TRIP</sub>    | 0.46     | 0.5  | 0.54 | 0.46      | 0.5  | 0.54 | 0.46      | 0.5  | 0.54 | 0.46      | 0.5  | 0.54 | 0.46     | 0.5  | 0.54 | V    | V <sub>CC</sub> =15V                                                                                                                                  |  |
| Overcurrent Protection Retention Time    | t <sub>p</sub>       | —        | 26   | —    | —         | 26   | —    | —         | 26   | —    | —         | 26   | —    | —        | 26   | —    | μs   | V <sub>CC</sub> =15V                                                                                                                                  |  |
| OCP Blanking Time                        | t <sub>bk</sub>      | —        | 1.65 | —    | —         | 1.65 | —    | —         | 1.65 | —    | —         | 1.65 | —    | —        | 1.65 | —    | μs   | V <sub>CC</sub> =15V                                                                                                                                  |  |
| Thermal Protection and Release Threshold | T <sub>DH</sub>      | —        | 150  | —    | —         | 150  | —    | —         | 150  | —    | —         | 150  | —    | —        | 150  | —    | °C   | V <sub>CC</sub> =15V                                                                                                                                  |  |
|                                          | T <sub>DL</sub>      | —        | 120  | —    | —         | 120  | —    | —         | 120  | —    | —         | 120  | —    | —        | 120  | —    |      |                                                                                                                                                       |  |
| IGBT Output Breakdown Voltage            | V <sub>CES</sub>     | 600      | —    | —    | 600       | —    | —    | 600       | —    | —    | 600       | —    | —    | —        | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>C</sub> =1mA, V <sub>IN</sub> =0V                                                                                        |  |
| MOSFET Output Breakdown Voltage          | V <sub>DSS</sub>     | —        | —    | —    | —         | —    | —    | —         | —    | —    | —         | —    | —    | 500      | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>D</sub> =1mA, V <sub>IN</sub> =0V                                                                                        |  |
| IGBT Output Leakage Current              | I <sub>CES</sub>     | —        | —    | 1    | —         | —    | 1    | —         | —    | 1    | —         | —    | 1    | —        | —    | —    | mA   | V <sub>CC</sub> =15V, V <sub>CES</sub> =600V, V <sub>IN</sub> =0V                                                                                     |  |
| MOSFET Output Leakage Current            | I <sub>DSS</sub>     | —        | —    | —    | —         | —    | —    | —         | —    | —    | —         | —    | —    | —        | —    | 1    | mA   | V <sub>CC</sub> =15V, V <sub>DSS</sub> =500V, V <sub>IN</sub> =0V                                                                                     |  |
| IGBT Output Saturation Voltage           | V <sub>CE(sat)</sub> | —        | 1.7  | 2.2  | —         | 1.7  | 2.2  | —         | 1.7  | 2.2  | —         | 1.7  | 2.2  | —        | —    | —    | V    | V <sub>CC</sub> =15V, I <sub>C</sub> =I <sub>O</sub> (Rated Current), V <sub>IN</sub> =5V                                                             |  |
| MOSFET DC ON Resistance                  | R <sub>DS(ON)</sub>  | —        | —    | —    | —         | —    | —    | —         | —    | —    | —         | —    | —    | —        | 0.55 | 0.8  | Ω    | V <sub>CC</sub> =15V, I <sub>D</sub> =2.5A, V <sub>IN</sub> =5V                                                                                       |  |
| Diode Forward Voltage                    | V <sub>SD</sub>      | —        | 1.7  | 2.2  | —         | 1.75 | 2.2  | —         | 1.9  | 2.4  | —         | 1.5  | 2.0  | —        | 0.9  | 1.4  | V    | V <sub>CC</sub> =15V, I <sub>EC</sub> =I <sub>O</sub> (Rated Current), I <sub>SD</sub> =2.5A (SCM1248M), V <sub>IN</sub> =0V                          |  |
| Boot Diode Forward Voltage               | V <sub>FB</sub>      | —        | 1.1  | 1.3  | —         | 1.1  | 1.3  | —         | 1.1  | 1.3  | —         | 1.1  | 1.3  | —        | 1.1  | 1.3  | V    | I <sub>F</sub> =0.15A                                                                                                                                 |  |
| Boot Diode Series Resistance             | R <sub>B</sub>       | —        | 22   | —    | —         | 22   | —    | —         | 22   | —    | —         | 22   | —    | —        | 22   | —    | Ω    |                                                                                                                                                       |  |
| High Side Switching Time                 | t <sub>d(on)</sub>   | —        | 590  | —    | —         | 600  | —    | —         | 695  | —    | —         | 660  | —    | —        | 820  | —    | ns   | V <sub>DC</sub> =300V, V <sub>CC</sub> =15V, I <sub>C</sub> =I <sub>D</sub> =I <sub>O</sub> (Rated Current), V <sub>IN</sub> =0 to 5V, Inductive load |  |
|                                          | t <sub>r</sub>       | —        | 80   | —    | —         | 70   | —    | —         | 95   | —    | —         | 110  | —    | —        | 90   | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>rr</sub>      | —        | 60   | —    | —         | 70   | —    | —         | 75   | —    | —         | 60   | —    | —        | 130  | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>d(off)</sub>  | —        | 550  | —    | —         | 620  | —    | —         | 675  | —    | —         | 700  | —    | —        | 700  | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>f</sub>       | —        | 90   | —    | —         | 60   | —    | —         | 55   | —    | —         | 50   | —    | —        | 20   | —    |      |                                                                                                                                                       |  |
| Low Side Switching Time                  | t <sub>d(on)</sub>   | —        | 570  | —    | —         | 600  | —    | —         | 715  | —    | —         | 660  | —    | —        | 830  | —    | ns   |                                                                                                                                                       |  |
|                                          | t <sub>r</sub>       | —        | 100  | —    | —         | 100  | —    | —         | 135  | —    | —         | 150  | —    | —        | 90   | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>rr</sub>      | —        | 70   | —    | —         | 80   | —    | —         | 115  | —    | —         | 70   | —    | —        | 140  | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>d(off)</sub>  | —        | 560  | —    | —         | 600  | —    | —         | 670  | —    | —         | 690  | —    | —        | 710  | —    |      |                                                                                                                                                       |  |
|                                          | t <sub>f</sub>       | —        | 100  | —    | —         | 70   | —    | —         | 50   | —    | —         | 50   | —    | —        | 20   | —    |      |                                                                                                                                                       |  |

### Internal Block Diagram (One of three phases)



The internal block diagram above shows an IC other than SCM1248M.  
For SCM1248M, the IGBTs and FRDs are replaced by MOSFETs.

### Typical Connection Diagram



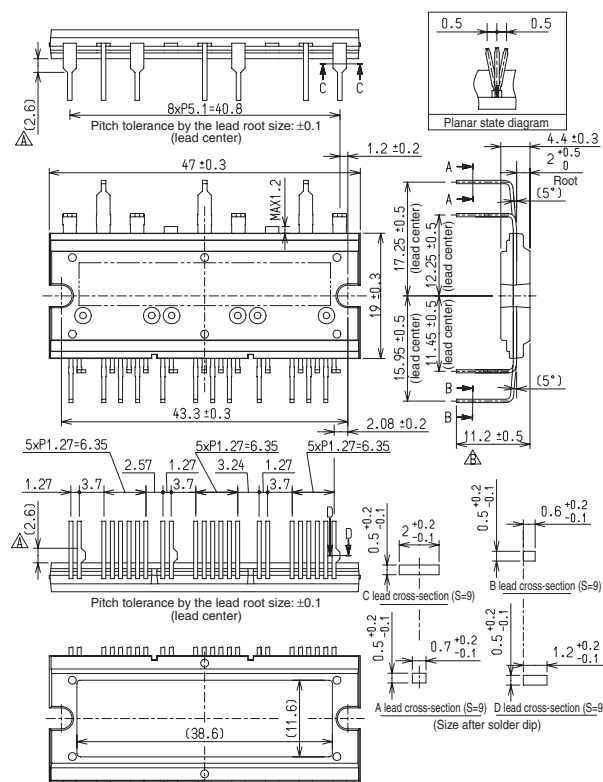
The typical connection diagram above shows an IC other than SCM1248M.  
For SCM1248M, the IGBTs and FRDs are replaced by MOSFETs.

The input pull-down resistor is built in IC (about 22 kΩ). However, if the input is expected to be unstable or very fluctuant, it needs to be reinforced with external resistor.

Attach capacitors near IC. Attach a ceramic capacitor in parallel with the electrolytic capacitor if too much noise is generated.

[illegible]

Forming No. 2551  
Product Mass: Approx. 10.8g



Forming No. 2552  
Product Mass: Approx. 11.8g

## Selection Guide

### <AC/DC>

#### Non-isolated Type

| Series Name | Part Number | Output Current | Input Voltage | R <sub>DS(ON)</sub> (Max) | Package | Circuit Type        | Features                                                                                                                                                                                                                        | Applications                                                       | Page |
|-------------|-------------|----------------|---------------|---------------------------|---------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------|
| LC5200      | LC5202D     | 0.5A           | 250V          | 2.2Ω                      | DIP8    | Buck                | • Low component count<br>• Power factor correction<br>• Built-in analog dimming function<br>• OCP: Latch shutdown<br>• TSD: Auto restart                                                                                        | LED light bulbs, etc.                                              | 136  |
|             | LC5205D     |                | 450V          | 6.0Ω                      | SOP8    |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5202S     |                | 250V          | 2.2Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5205S     |                | 450V          | 6.0Ω                      | DIP8    |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5203D     | 1.0A           | 250V          | 1.3Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5210D     |                | 450V          | 3.0Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
| LC5220      | LC5222D     | 0.5A           | 250V          | 2.2Ω                      | DIP8    | Buck/<br>Buck-boost | • Low component count<br>• Power factor correction<br>• Built-in analog dimming function<br>• External latch function<br>• OCP/OPP: Latch shutdown<br>• TSD: Auto restart                                                       | LED light bulbs, etc.                                              | 138  |
|             | LC5225D     |                | 450V          | 6.0Ω                      | SOP8    |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5222S     |                | 250V          | 2.2Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5225S     |                | 450V          | 6.0Ω                      | DIP8    |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5223D     | 1.0A           | 250V          | 1.3Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
|             | LC5226D     |                | 450V          | 3.0Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
| LC5550      | LC5555LD    | 2.5A           | 650V          | 3.95Ω                     | DIP8    | Buck                | • Power factor correction<br>• Harmonics standard compliant (Class C)<br>• High efficiency<br>• Universal input<br>• OCP: Pulse by pulse<br>• OVP/OLP/TSD: Latch shutdown                                                       | LED light bulbs<br>LED downlights<br>LED straight tube lamps, etc. | 140  |
|             | LC5556LD    | 4.0A           |               | 1.9Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
| LC5510      | LC5511D     | —              | 650V          | 3.95Ω                     | DIP8    | Flyback             | • Power factor correction<br>• Harmonics standard compliant (Class C)<br>• High efficiency<br>• Universal input<br>• OCP: Pulse by pulse<br>• OVP/OLP: Auto restart<br>• TSD: Latch shutdown                                    | LED downlights<br>LED straight tube lamps, etc.                    | 142  |
|             | LC5513D     | —              |               | 1.9Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |
| LC5560      | LC5565LD    | —              | 650V          | 3.95Ω                     | DIP8    | Flyback             | • Power factor correction<br>• Harmonics standard compliant (Class C) with light load<br>• High efficiency<br>• Universal input<br>• Built-in analog dimming function<br>• OCP: Pulse by pulse<br>• OVP/OLP/TSD: Latch shutdown | LED light bulbs<br>LED downlights<br>LED straight tube lamps, etc. | 144  |
|             | LC5566LD    | —              |               | 1.9Ω                      |         |                     |                                                                                                                                                                                                                                 |                                                                    |      |

## Isolated type

| Series Name | Part Number | MOSFET           |                           | Package  | Circuit Type | Features                                                                                                                                                                                                                                                                                    | Applications                                    | Page |
|-------------|-------------|------------------|---------------------------|----------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|------|
|             |             | V <sub>DSS</sub> | R <sub>DS(ON)</sub> (Max) |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
| LC5520      | LC5521D     | 650V             | 3.95Ω                     | DIP8     | Flyback      | <ul style="list-style-type: none"><li>• Power factor correction</li><li>• Harmonics standard compliant (Class C)</li><li>• High efficiency</li><li>• Universal input</li><li>• OCP: Pulse by pulse</li><li>• OVP/OLP: Auto restart</li><li>• TSD: Latch shutdown</li></ul>                  | LED downlights<br>LED straight tube lamps, etc. | 146  |
|             | LC5523D     | 650V             | 1.9Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
|             | LC5523F     | 650V             | 1.9Ω                      | TO220F-7 | Flyback      |                                                                                                                                                                                                                                                                                             | Ceiling lights<br>Street lights, etc.           |      |
|             | LC5525F     | 650V             | 1.1Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
| LC5540      | LC5545LD    | 650V             | 3.95Ω                     | DIP8     | Flyback      | <ul style="list-style-type: none"><li>• Power factor correction</li><li>• Harmonics standard compliant with light load (Class C)</li><li>• High efficiency</li><li>• Universal input</li><li>• Analog dimming</li><li>• OCP: Pulse by pulse</li><li>• OVP/OLP/TSD: Latch shutdown</li></ul> | LED downlights<br>LED straight tube lamps, etc. | 148  |
|             | LC5546LD    | 650V             | 1.9Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
|             | LC5548LD    | 800V             | 3.5Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
|             | LC5546LF    | 650V             | 1.9Ω                      | TO220F-7 | Flyback      |                                                                                                                                                                                                                                                                                             | Ceiling lights<br>Street lights, etc.           |      |
|             | LC5547LF    | 650V             | 1.1Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |
|             | LC5549LF    | 800V             | 1.7Ω                      |          |              |                                                                                                                                                                                                                                                                                             |                                                 |      |

## &lt;DC/DC&gt;

| Series Name | Part Number | Input Voltage Range | Output Current | Package | Features                                                                                     | Applications                              | Page |
|-------------|-------------|---------------------|----------------|---------|----------------------------------------------------------------------------------------------|-------------------------------------------|------|
| LC5700      | LC5720S     | 8.5 to 50V          | 2A             | HSOP8   | Current mode PWM control<br>Buck, Boost, Buck-Boost operations<br>PWM dimming<br>OCP/OVP/TSD | DC input LED lighting<br>RGB LED lighting | 150  |

## LC5200 Series LED Driver ICs

### ■Features

- Buck converter operations
- High breakdown voltage supply input: 250V (MAX), 450V (MAX)
- Built-in constant current control circuit  
Built-in PWM type constant current control circuit  
Output current can be controlled by REF pin input voltage
- Supports external PWM signal  
Inputting PWM signal to PWM pin enables dimming control  
Inputting Low signal to PWM pin enables turning off of all LED loads
- Protection functions  
Undervoltage lockout function (UVLO)  
Overcurrent protection function (OCP)...Latch shutdown  
Thermal shutdown function (TSD)...Auto restart

### ■Applications

- LED light bulbs
- LED lighting equipment

### ■Lineup

| Part Number | Output Current | Input Voltage | R <sub>DS(ON)</sub> (Max) | Package |
|-------------|----------------|---------------|---------------------------|---------|
| LC5202D     | 0.5A           | 250V          | 2.2Ω                      | DIP8    |
| LC5205D     |                | 450V          | 6.0Ω                      |         |
| LC5202S     |                | 250V          | 2.2Ω                      | SOP8    |
| LC5205S     |                | 450V          | 6.0Ω                      |         |
| LC5203D     | 1.0A           | 250V          | 1.3Ω                      | DIP8    |
| LC5210D     |                | 450V          | 3.0Ω                      |         |

### ■Absolute Maximum Ratings

(T<sub>a</sub> = 25°C)

| Parameter                        | Symbol             | Ratings                        |         |         |         |         |         | Unit | Remarks                               |
|----------------------------------|--------------------|--------------------------------|---------|---------|---------|---------|---------|------|---------------------------------------|
|                                  |                    | LC5202D                        | LC5202S | LC5205D | LC5205S | LC5203D | LC5210D |      |                                       |
| Output Current*1                 | I <sub>O</sub>     | 0.5                            |         |         |         | 1.0     |         | A    | Excluding when<br>tw is less than 1μs |
| Main Supply Voltage              | V <sub>BB</sub>    | 250                            |         | 450     |         | 250     | 450     | V    |                                       |
| Output Breakdown Voltage         | V <sub>O(BR)</sub> | 250                            |         | 450     |         | 250     | 450     | V    |                                       |
| PWM Pin Voltage*2                | V <sub>PWM</sub>   | -0.3 to V <sub>Z</sub>         |         |         |         |         |         | V    |                                       |
| REF Pin Voltage                  | V <sub>REF</sub>   | -0.3 to +V <sub>REG</sub> +0.3 |         |         |         |         |         | V    |                                       |
| SEN Pin Voltage                  | V <sub>SEN</sub>   | -0.3 to +4.0                   |         |         |         |         |         | V    | Excluding when<br>tw is less than 1μs |
| Power Dissipation*3              | P <sub>D</sub>     | 1.73                           | 0.85    | 1.73    | 0.85    | 1.73    |         | W    | Sanken<br>Evaluation Board            |
| Operating Ambient<br>Temperature | T <sub>a</sub>     | -40 to +105                    |         |         |         |         |         | °C   |                                       |
| Storage Temperature              | T <sub>stg</sub>   | -40 to +150                    |         |         |         |         |         | °C   |                                       |
| Junction Temperature             | T <sub>J</sub>     | +150                           |         |         |         |         |         | °C   |                                       |

\*1: The output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed the junction temperature T<sub>J</sub> under any circumstances.

\*2: There is a built-in zener diode between the PWM pin and GND. V<sub>Z</sub> is the breakdown voltage of this internal zener diode, and V<sub>Z</sub> = 6.3V (TYP). The maximum value of the inflow current is 1mA.

\*3: The power dissipation P<sub>D</sub> varies depending on the pattern layout of the circuit board used. Refer to the T<sub>a</sub>-P<sub>D</sub> characteristics curve.

### ■Recommended Operating Conditions

| Parameter                | Symbol              | Ratings   |      |         |      |           |      |         |      | Unit |
|--------------------------|---------------------|-----------|------|---------|------|-----------|------|---------|------|------|
|                          |                     | LC5202D/S |      | LC5203D |      | LC5205D/S |      | LC5210D |      |      |
|                          |                     | min.      | max. | min.    | max. | min.      | max. | min.    | max. |      |
| Supply Voltage           | V <sub>BB</sub>     | 25*1      | 200  | 25*1    | 200  | 25*1      | 400  | 25*1    | 400  | V    |
| Output Current (Average) | I <sub>O(AVG)</sub> | —         | 0.4  | —       | 0.8  | —         | 0.4  | —       | 0.8  | A    |
| REF Pin Voltage          | V <sub>REF</sub>    | —         | 0.8  | —       | 0.8  | —         | 0.8  | —       | 0.8  | V    |
| Case Temperature*2       | T <sub>c</sub>      | —         | 105  | —       | 105  | —         | 105  | —       | 105  | °C   |

The recommended operating conditions show the operating conditions required to maintain normal circuit functions as shown in the electrical characteristics.

In actual operation, the device must be used within the recommended operating conditions.

\*1: The minimum voltage depends on the LED used.

\*2: Defined at the center of the package. The junction temperature T<sub>J</sub> is assumed to be 150°C or lower.

### ■Electrical Characteristics

(T<sub>a</sub> = 25°C, V<sub>BB</sub> = 140V, unless otherwise specified)

| Parameter                                | Symbol                 | Measurement Conditions   | Ratings                |                  |                        | Unit | Remarks                     |
|------------------------------------------|------------------------|--------------------------|------------------------|------------------|------------------------|------|-----------------------------|
|                                          |                        |                          | min.                   | typ.             | max.                   |      |                             |
| Supply Current                           | I <sub>BBs</sub>       | When output is OFF       | —                      | 0.8              | 1.2                    | mA   |                             |
|                                          | I <sub>BB</sub>        | During operation         | —                      | 2                | —                      | mA   |                             |
| Output MOSFET Breakdown Voltage          | V <sub>DS(BR)</sub>    | I <sub>D</sub> =1mA      | 250                    | —                | —                      | V    | LC5202D/S, LC5203D          |
|                                          |                        |                          | 450                    | —                | —                      | V    | LC5205D/S, LC5210D          |
| Output MOSFET ON Resistance              | R <sub>DS(ON)</sub>    | I <sub>D</sub> =0.5A     | —                      | 1.2              | 2.2                    | Ω    | LC5202D/S                   |
|                                          |                        | I <sub>D</sub> =1.0A     | —                      | 0.7              | 1.3                    | Ω    | LC5203D                     |
|                                          |                        | I <sub>D</sub> =0.5A     | —                      | 3.5              | 6                      | Ω    | LC5205D/S                   |
|                                          |                        | I <sub>D</sub> =1.0A     | —                      | 1.7              | 3                      | Ω    | LC5210D                     |
| Output MOSFET Body Diode Forward Voltage | V <sub>F</sub>         | I <sub>F</sub> =0.5A     | —                      | 0.8              | 1                      | V    | LC5202D/S                   |
|                                          |                        | I <sub>F</sub> =1.0A     | —                      | 0.75             | 1.2                    | V    | LC5203D                     |
|                                          |                        | I <sub>F</sub> =0.5A     | —                      | 0.8              | 0.9                    | V    | LC5205D/S                   |
|                                          |                        | I <sub>F</sub> =1.0A     | —                      | 0.88             | 1                      | V    | LC5210D                     |
| UVLO Release Voltage                     | V <sub>UVLO(ON)</sub>  |                          | —                      | 14               | —                      | V    | V <sub>BB</sub> pin voltage |
| UVLO Operation Voltage                   | V <sub>UVLO(OFF)</sub> |                          | —                      | 13               | —                      | V    | V <sub>BB</sub> pin voltage |
| REG Pin Output Voltage                   | V <sub>REG</sub>       | I <sub>REG</sub> =-0.1mA | 11.5                   | 12               | 12.5                   | V    |                             |
| REG Pin Output Current                   | I <sub>REG</sub>       | V <sub>REG</sub> =11V    | —                      | —                | -2                     | mA   |                             |
| REF Pin Input Voltage                    | V <sub>REF</sub>       |                          | 0                      | —                | 1                      | V    |                             |
| REF Pin Inflow Current                   | I <sub>REF</sub>       |                          | -10                    | —                | 10                     | μA   |                             |
| Current Control Detection Voltage        | V <sub>SEN</sub>       |                          | V <sub>REF</sub> -0.03 | V <sub>REF</sub> | V <sub>REF</sub> +0.03 | V    |                             |
| OCP Detection Voltage                    | V <sub>OCP</sub>       |                          | —                      | 3                | —                      | V    |                             |
| SEN Pin Inflow Current                   | I <sub>SEN</sub>       |                          | -10                    | —                | 10                     | μA   |                             |
| PWM Blanking Time                        | t <sub>BLK</sub>       |                          | —                      | 400              | —                      | ns   |                             |
| PWM Oscillation Frequency                | f <sub>PWM</sub>       | Duty=50%                 | —                      | —                | 200                    | kHz  |                             |
| Output MOSFET Rising Time                | t <sub>r</sub>         | I <sub>O</sub> =0.4A     | —                      | 20               | —                      | ns   |                             |
| Output MOSFET Falling Time               | t <sub>f</sub>         | I <sub>O</sub> =0.4A     | —                      | 50               | —                      | ns   |                             |
| TSD Operating Temperature*               | T <sub>TSD</sub>       |                          | —                      | 150              | —                      | °C   |                             |
| TSD Temperature Hysteresis*              | T <sub>TSD(HYS)</sub>  |                          | —                      | 55               | —                      | °C   |                             |
| Thermal Resistance                       | θ <sub>J-a</sub>       | Sanken Evaluation Board  | —                      | —                | 72                     | °C/W | LC52xxD                     |
|                                          |                        |                          | —                      | —                | 147                    | °C/W | LC52xxS                     |

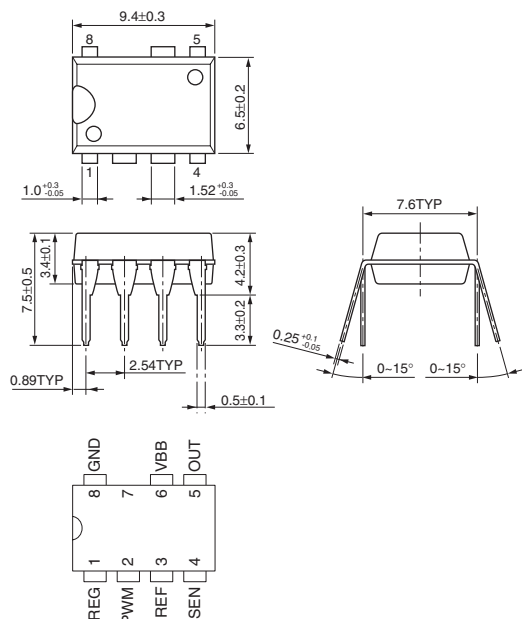
For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

\*: Control IC chip temperature (T<sub>J</sub>)

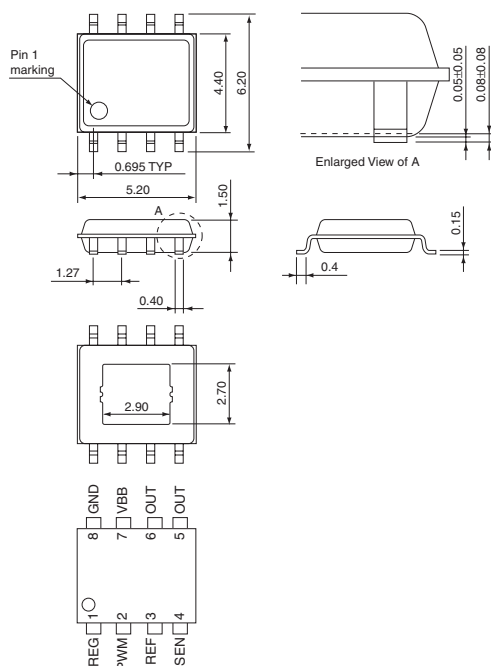
## External Dimensions

(Unit : mm)

### LC52xxD (DIP8)



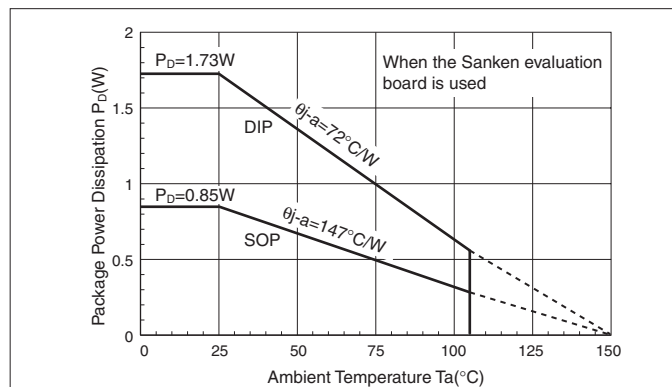
### LC52xxS (SOP8)



## Pin Functions

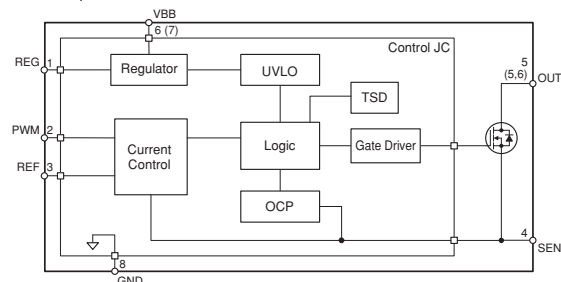
| Symbol | Pin No.        |                | Function                                                                                                                                                                                  |
|--------|----------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | LC52xxD (DIP8) | LC52xxS (SOP8) |                                                                                                                                                                                           |
| REG    | 1              | 1              | Output of the built-in regulator. Supplies current to the internal and external circuits. Connect a 0.1μF bypass capacitor near the pin.                                                  |
| PWM    | 2              | 2              | Connect CR for OFF time setting when using the internal PWM method.<br>Functions as the input pin for PWM signals when using the external PWM method.                                     |
| REF    | 3              | 3              | OUT pin (output MOSFET) for the internal PWM method<br>Input pin for peak current setting<br>Set a peak current based on the REF pin voltage.                                             |
| SEN    | 4              | 4              | Pin for detecting output current<br>Connect the current detection resistor RS. Used for peak current detection and overcurrent detection when using the internal PWM method.              |
| OUT    | 5              | 5,6            | Pin connected to the load. Connected to the drain pin of the built-in MOSFET.                                                                                                             |
| VBB    | 6              | 7              | Main power input pin. Internal power is supplied from this pin via the internal regulator.                                                                                                |
| —      | 7              | —              | Pin removed<br>LC52xxD (DIP8) has been removed to secure the insulating distance of the high voltage pins.<br>For LC52xxS (SOP8), the design criteria of the customer must be considered. |
| GND    | 8              | 8              | GND pin                                                                                                                                                                                   |

## Ta-PD Characteristics

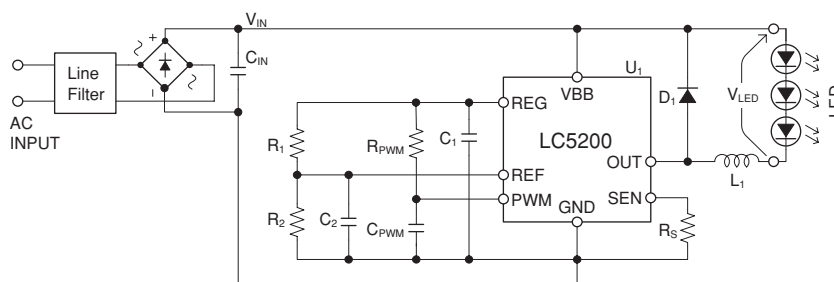


## Block Diagram

If the pin number differs in the DIP8 and SOP8 packages, the pin number for SOP8 is indicated in parentheses.



## Typical Connection Diagram



# LC5220 Series LED Driver ICs

## Features

- Buck and buck-boost converter operations
- Built-in reference voltage for current setting  
Realizes high precision and easy current setting
- SLEEP function  
Output is latched to off when REF pin input voltage  $\geq V_{SLP}$
- ENABLE function  
All LED loads can be turned off by reducing REF pin input voltage
- High breakdown voltage supply input: 250V (MAX), 450V (MAX)
- Built-in constant current control circuit  
Built-in PWM type constant current control circuit  
Output current can be controlled by REF pin input voltage
- Supports external PWM dimming
- Protection functions  
Flywheel diode open protection (OPP)  
function...Latch shutdown  
Undervoltage lockout function (UVLO)  
Variable type overcurrent protection function (OCP)...Latch shutdown  
Thermal shutdown function (TSD)...Auto restart

## Applications

- LED light bulbs
- LED lighting equipment

## Lineup

| Part Number | Output Current | Input Voltage | R <sub>DS(ON)</sub> (Max) | Package |
|-------------|----------------|---------------|---------------------------|---------|
| LC5222D     | 0.5A           | 250V          | 2.2Ω                      | DIP8    |
| LC5225D     |                | 450V          | 6.0Ω                      |         |
| LC5222S     |                | 250V          | 2.2Ω                      |         |
| LC5225S     | 1.0A           | 450V          | 6.0Ω                      | SOP8    |
| LC5223D     |                | 250V          | 1.3Ω                      |         |
| LC5226D     |                | 450V          | 3.0Ω                      |         |

## Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                     | Symbol             | Ratings                |         |         |         |         | Unit    | Remarks                            |
|-------------------------------|--------------------|------------------------|---------|---------|---------|---------|---------|------------------------------------|
|                               |                    | LC5222D                | LC5222S | LC5225D | LC5225S | LC5223D | LC5226D |                                    |
| Output Current*1              | I <sub>O</sub>     | 0.5                    |         |         | 1.0     |         | A       | Excluding when tw is less than 1μs |
| Main Supply Voltage           | V <sub>BB</sub>    | 250                    |         | 450     | 250     | 450     | V       |                                    |
| Output Breakdown Voltage      | V <sub>O(BR)</sub> | 250                    |         | 450     | 250     | 450     | V       |                                    |
| PWM Pin Voltage*2             | V <sub>PWM</sub>   | -0.3 to V <sub>Z</sub> |         |         |         |         | V       |                                    |
| REF Pin Voltage*2             | V <sub>REF</sub>   | -0.3 to V <sub>Z</sub> |         |         |         |         | V       |                                    |
| SEN Pin Voltage               | V <sub>SEN</sub>   | -0.3 to +4.0           |         |         |         |         | V       | Excluding when tw is less than 1μs |
| Power Dissipation*3           | P <sub>D</sub>     | 1.73                   | 0.85    | 1.73    | 0.85    | 1.73    | W       | Sanken Evaluation Board            |
| Operating Ambient Temperature | T <sub>a</sub>     | -40 to +105            |         |         |         |         | °C      |                                    |
| Storage Temperature           | T <sub>stg</sub>   | -40 to +150            |         |         |         |         | °C      |                                    |
| Junction Temperature          | T <sub>J</sub>     | +150                   |         |         |         |         | °C      |                                    |

\*1: The output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed the junction temperature T<sub>J</sub> under any circumstances.

\*2: There is a built-in zener diode between the PWM pin and GND. V<sub>Z</sub> is the breakdown voltage of this internal zener diode, and V<sub>Z</sub> = 6.3V (TYP). The maximum value of the inflow current is 1mA.

\*3: The power dissipation P<sub>D</sub> varies depending on the pattern layout of the circuit board used. Refer to the Ta-PD characteristics curve.

## Recommended Operating Conditions

| Parameter                      | Symbol              | Ratings          |      |                  |      |                  |      |                  |      | Unit |
|--------------------------------|---------------------|------------------|------|------------------|------|------------------|------|------------------|------|------|
|                                |                     | LC5222D/S        |      | LC5223D          |      | LC5225D/S        |      | LC5226D          |      |      |
|                                |                     | min.             | max. | min.             | max. | min.             | max. | min.             | max. |      |
| Supply Voltage                 | V <sub>BB</sub>     | 25 <sup>*1</sup> | 200  | 25 <sup>*1</sup> | 200  | 25 <sup>*1</sup> | 400  | 25 <sup>*1</sup> | 400  | V    |
| Output Current (Average)       | I <sub>O(AVG)</sub> | —                | 0.4  | —                | 0.8  | —                | 0.4  | —                | 0.8  | A    |
| REF Pin Voltage                | V <sub>REF</sub>    | 0.2              | 2.5  | 0.2              | 2.5  | 0.2              | 2.5  | 0.2              | 2.5  | V    |
| Case Temperature* <sup>2</sup> | T <sub>c</sub>      | —                | 105  | —                | 105  | —                | 105  | —                | 105  | °C   |

The recommended operating conditions show the operating conditions required to maintain normal circuit functions as shown in the electrical characteristics.

In actual operation, the device must be used within the recommended operating conditions.

\*1: The minimum voltage depends on the LED used.

\*2: Defined at the center of the package. The junction temperature T<sub>J</sub> is assumed to be 150°C or lower.

## Electrical Characteristics

(Ta = 25°C, V<sub>BB</sub> = 140V, unless otherwise specified)

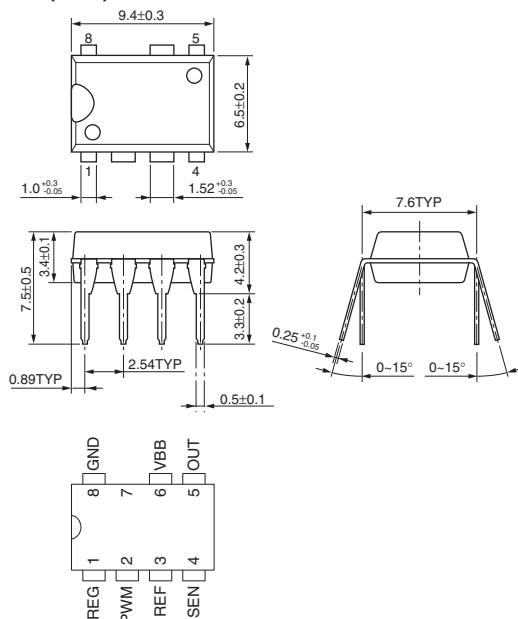
| Parameter                                | Symbol                 | Measurement Conditions        | Ratings                    |                           |                            | Unit | Remarks                     |
|------------------------------------------|------------------------|-------------------------------|----------------------------|---------------------------|----------------------------|------|-----------------------------|
|                                          |                        |                               | min.                       | typ.                      | max.                       |      |                             |
| Supply Current                           | I <sub>BBs</sub>       | When output is OFF            | —                          | 1                         | 1.5                        | mA   |                             |
|                                          | I <sub>BB</sub>        | During operation              | —                          | 2.5                       | 4                          | mA   |                             |
| Output MOSFET Breakdown Voltage          | V <sub>(BR)DSS</sub>   | I <sub>D</sub> =1mA           | 250                        | —                         | —                          | V    | LC5222D/S, LC5223D          |
|                                          |                        |                               | 450                        | —                         | —                          | V    | LC5225D/S, LC5226D          |
| Output MOSFET ON Resistance              | R <sub>DS(ON)</sub>    | I <sub>D</sub> =0.5A          | —                          | 1.2                       | 2.2                        | Ω    | LC5222D/S                   |
|                                          |                        | I <sub>D</sub> =1.0A          | —                          | 0.7                       | 1.3                        | Ω    | LC5223D                     |
|                                          |                        | I <sub>D</sub> =0.5A          | —                          | 3.5                       | 6                          | Ω    | LC5225D/S                   |
|                                          |                        | I <sub>D</sub> =1.0A          | —                          | 1.7                       | 3                          | Ω    | LC5226D                     |
| Output MOSFET Body Diode Forward Voltage | V <sub>F</sub>         | I <sub>F</sub> =0.5A          | —                          | 0.8                       | 1                          | V    | LC5222D/S                   |
|                                          |                        | I <sub>F</sub> =1.0A          | —                          | 0.75                      | 1.2                        | V    | LC5223D                     |
|                                          |                        | I <sub>F</sub> =0.5A          | —                          | 0.8                       | 0.9                        | V    | LC5225D/S                   |
|                                          |                        | I <sub>F</sub> =1.0A          | —                          | 0.88                      | 1                          | V    | LC5226D                     |
| UVLO Release Voltage                     | V <sub>UVLO(ON)</sub>  |                               | —                          | 14                        | —                          | V    | V <sub>BB</sub> pin voltage |
| UVLO Operation Voltage                   | V <sub>UVLO(OFF)</sub> |                               | —                          | 12                        | —                          | V    | V <sub>BB</sub> pin voltage |
| REG Output Voltage                       | V <sub>REG</sub>       | I <sub>REG</sub> =0mA         | 9.6                        | 10                        | 10.4                       | V    |                             |
| REG Output Current                       | I <sub>REG</sub>       | V <sub>REG</sub> =9V          | -2                         | —                         | —                          | mA   |                             |
| ENABLE Voltage                           | V <sub>ENB</sub>       |                               | —                          | 0.15                      | 0.19                       | V    | REF pin Voltage             |
| SLEEP Voltage                            | V <sub>SLP</sub>       |                               | 2.85                       | 3                         | —                          | V    | REF pin Voltage             |
| REF Pin Inflow Current                   | I <sub>REF</sub>       |                               | -10                        | —                         | 10                         | μA   |                             |
| Current Control Detection Voltage        | V <sub>SEN</sub>       | V <sub>REF</sub> =0.2 to 2.0V | 0.4×V <sub>REF</sub> -0.03 | 0.4×V <sub>REF</sub>      | 0.4×V <sub>REF</sub> +0.03 | V    |                             |
|                                          |                        | V <sub>REF</sub> =2.0 to 3.0V | 0.77                       | 0.8                       | 0.83                       | V    |                             |
| OCP Detection Voltage                    | V <sub>OCP</sub>       | V <sub>REF</sub> =0.2 to 2.0V | —                          | 0.4×V <sub>REF</sub> +0.7 | —                          | V    |                             |
|                                          |                        | V <sub>REF</sub> =2.0 to 3.0V | —                          | 1.5                       | —                          | V    |                             |
| SEN Pin Inflow Current                   | I <sub>SEN</sub>       |                               | -10                        | —                         | 10                         | μA   |                             |
| PWM Pin Low Voltage                      | V <sub>PWM(L)</sub>    |                               | —                          | 2                         | —                          | V    |                             |
| PWM Pin High Voltage                     | V <sub>PWM(H)</sub>    |                               | —                          | 3                         | —                          | V    |                             |
| PWM Pin Output Current                   | I <sub>PWM</sub>       |                               | —                          | -20                       | —                          | μA   |                             |
| PWM Blanking Time                        | t <sub>BLK(P)</sub>    |                               | —                          | 0.3                       | —                          | μs   |                             |
| OCP Blanking Time                        | t <sub>BLK(O)</sub>    |                               | —                          | 0.2                       | —                          | μs   |                             |
| PWM Oscillation Frequency                | f <sub>PWM</sub>       | Duty=50%                      | —                          | —                         | 200                        | kHz  |                             |
| PWM OFF Time                             | t <sub>OFF</sub>       | C <sub>PWM</sub> =100pF       | —                          | 17                        | —                          | μs   |                             |
| Output MOSFET Rising Time                | t <sub>r</sub>         | I <sub>O</sub> =0.4A          | —                          | 25                        | —                          | ns   |                             |
| Output MOSFET Falling Time               | t <sub>f</sub>         | I <sub>O</sub> =0.4A          | —                          | 50                        | —                          | ns   |                             |
| TSD Operating Temperature*               | T <sub>TSD</sub>       |                               | —                          | 150                       | —                          | °C   |                             |
| TSD Temperature Hysteresis*              | T <sub>TSD(HYS)</sub>  |                               | —                          | 55                        | —                          | °C   |                             |
| Thermal Resistance                       | θ <sub>JA</sub>        | Sanken Evaluation Board       | —                          | —                         | 72                         | °C/W | LC522xD                     |
|                                          |                        |                               | —                          | —                         | 147                        | °C/W | LC522xS                     |

For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.  
: Control IC chip temperature (T<sub>J</sub>)

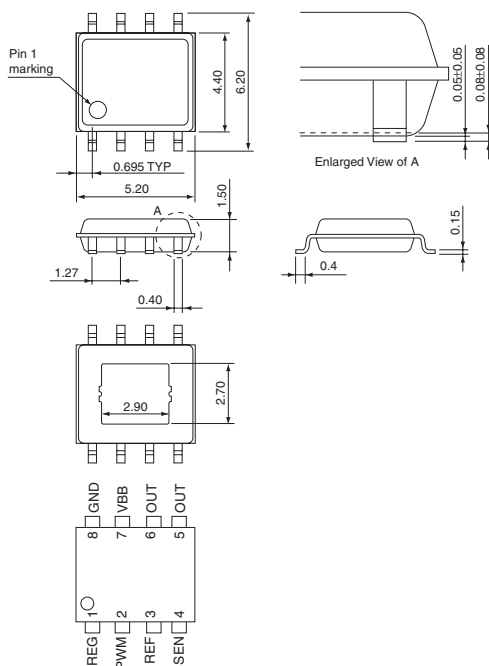
## External Dimensions

(Unit : mm)

### LC522xD (DIP8)



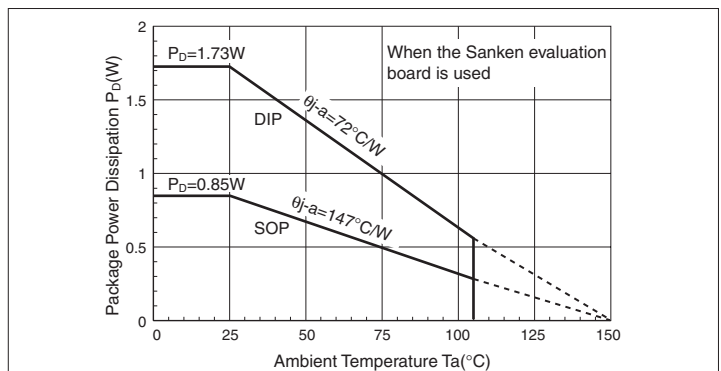
### LC522xS (SOP8)



## Pin Functions

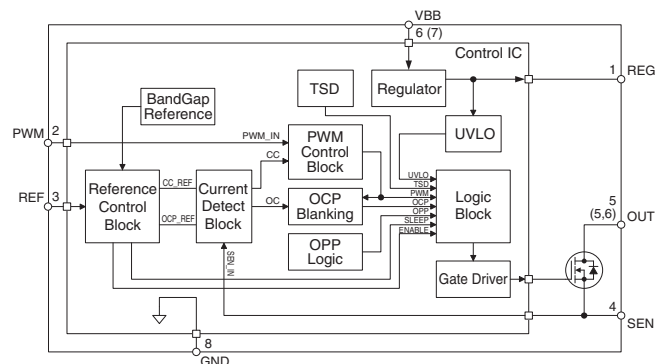
| Symbol | Pin No.        |                | Function                                                                                                                                                                                                                                                                       |
|--------|----------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | LC522xD (DIP8) | LC522xS (SOP8) |                                                                                                                                                                                                                                                                                |
| REG    | 1              | 1              | Output of the built-in regulator. Supplies current to the internal and external circuits. Connect a 0.1μF bypass capacitor near the pin.                                                                                                                                       |
| PWM    | 2              | 2              | Connect CR for OFF time setting when using the internal PWM method. Functions as the input pin for PWM signals when using the external PWM method.                                                                                                                             |
| REF    | 3              | 3              | Input pin for OUT pin (output MOSFET) peak current setting when using the internal PWM method. Set a peak current based on the REF pin voltage. Also, signal input pin for turning the OUT pin (ENABLE function) on and off, and latching the OUT pin to off (SLEEP function). |
| SEN    | 4              | 4              | Pin for detecting output current. For internal PWM, connect a detection resistor. Used as a peak current detection and overcurrent detection pin.                                                                                                                              |
| OUT    | 5              | 5,6            | Pin connected to the load. Connected to the drain pin of the built-in output MOSFET.                                                                                                                                                                                           |
| VBB    | 6              | 7              | Main power input pin. Internal power is supplied from this pin via the internal regulator.                                                                                                                                                                                     |
| —      | 7              | —              | Pin removed. LC522xD (DIP8) has been removed to secure the insulating distance of the high voltage pins. For LC522xS (SOP8), the design criteria of the customer must be considered.                                                                                           |
| GND    | 8              | 8              | GND pin                                                                                                                                                                                                                                                                        |

## Ta-P<sub>D</sub> Characteristics

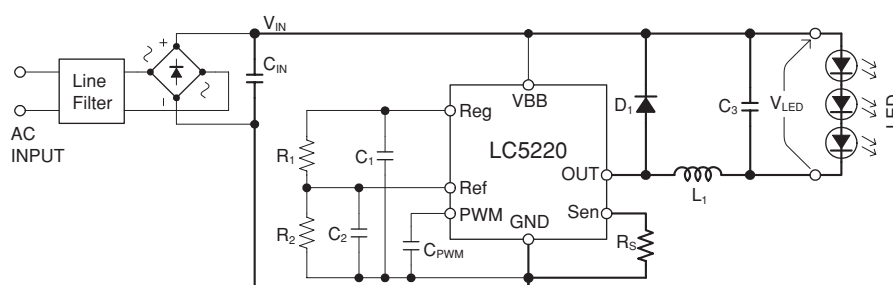


## Block Diagram

If the pin number differs in the DIP8 and SOP8 packages, the pin number for SOP8 is indicated in parentheses.



## Typical Connection Diagram



# LC5550 Series High Efficiency, High Power Factor LED Driver ICs

## ■Features

- Buck converter operations
- Supports PWM type and Quasi-resonant type control
- Built-in ON time control circuit  
(Average current control enables high power factor)
- Built-in soft start function  
(Reduces load on power MOSFET and secondary side rectifier diodes at power-on)
- Built-in bias assist function  
(Improves startup, suppresses VCC voltage drop during operation, lowers capacitance of VCC capacitor, and enables backup of the control circuit supply by using a ceramic capacitor)
- Built-in leading edge blanking function
- Built-in maximum ON time control circuit
- Protection function  
Overcurrent protection (OCP)...Pulse by pulse  
Overvoltage protection (OVP)...Latch shutdown  
Overload protection (OLP)...Latch shutdown  
Thermal shutdown (TSD)...Latch shutdown

## ■Lineup

| Part Number | MOSFET     |               | PWM Oscillation Frequency<br>fosc (TYP) | Maximum ON Time<br>ton(MAX) (TYP) | Pout*<br>AC230V / Universal |
|-------------|------------|---------------|-----------------------------------------|-----------------------------------|-----------------------------|
|             | Vdss (MIN) | Rds(ON) (MAX) |                                         |                                   |                             |
| LC5555LD    | 650V       | 3.95Ω         | 72kHz                                   | 9.3μs                             | 13W / 10W                   |
| LC5556LD    |            | 1.9Ω          | 60kHz                                   | 11.2μs                            | 20W / 16W                   |

\*: The output power values are based on the rated temperature. Output at 120 to 140% of the rated temperature is possible for the maximum output power. Note, however, that the output power may be limited by a low output voltage and by the ON duty specified during transformer design.

## ■Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                     | Symbol | Ratings             |                     | Unit | Remarks                                       |
|-------------------------------|--------|---------------------|---------------------|------|-----------------------------------------------|
|                               |        | LC5555D             | LC5556D             |      |                                               |
| Drain Current                 | IDPEAK | 2.5                 | 4.0                 | A    |                                               |
| Avalanche Energy Capacity     | EAS    | 47<br>(ILPEAK=2.0A) | 86<br>(ILPEAK=2.7A) | mJ   |                                               |
| Control Supply Voltage        | VCC    | 35                  |                     | V    |                                               |
| OCP Pin Voltage               | VOCP   | -2.0 to +5.0        |                     | V    |                                               |
| COMP Pin Voltage              | VCOMP  | -0.3 to +7.0        |                     | V    |                                               |
| ISENSE Pin Voltage            | VSEN   | -0.3 to +5.0        |                     | V    |                                               |
| MOSFET Power Dissipation      | Pd     | 0.97                |                     | W    | Board size when mounted on board<br>15mm×15mm |
| Operating Ambient Temperature | Top    | -55 to +125         |                     | °C   |                                               |
| Storage Temperature           | Tstg   | -55 to +125         |                     | °C   |                                               |
| Channel Temperature           | Tch    | 150                 |                     | °C   |                                               |

## ■Applications

- LED light bulbs
- LED lighting equipment

## ■Electrical Characteristics

(Ta = 25°C, Vcc = 20V, unless otherwise specified)

| Parameter | Symbol | Ratings |      |      | Unit | Remarks |
|-----------|--------|---------|------|------|------|---------|
|           |        | min.    | typ. | max. |      |         |

### Power Supply Startup Operation

|                                          |              |      |      |      |    |         |
|------------------------------------------|--------------|------|------|------|----|---------|
| Operation Startup Voltage                | VCC(ON)      | 13.8 | 15.1 | 17.3 | V  |         |
| Operation Stop Voltage                   | VCC(OFF)     | 8.4  | 9.4  | 10.7 | V  |         |
| Circuit Current During Operation         | ICC(ON)      | —    | —    | 4.7  | mA |         |
| Startup Circuit Operation Voltage        | VSTARTUP     | 18   | 21   | 24   | V  |         |
| Startup Current                          | ICC(STARTUP) | -8.5 | -4.0 | -1.5 | mA | VCC=13V |
| Startup Current Supply Threshold Voltage | VCC(BIAS)    | 9.5  | 11   | 12.5 | V  |         |

### Normal Operation

|                                              |              |       |      |       |     |          |
|----------------------------------------------|--------------|-------|------|-------|-----|----------|
| PWM Oscillation Frequency                    | fosc         | 60    | 72   | 84    | kHz | LC5555LD |
|                                              |              | 50    | 60   | 70    |     | LC5556LD |
| Maximum ON Time                              | ton(MAX)     | 8.0   | 9.3  | 11.2  | μs  | LC5555LD |
|                                              |              | 9.0   | 11.2 | 13.4  |     | LC5556LD |
| COMP Pin Control Lower Voltage               | VCOMP(MIN)   | 0.30  | 0.55 | 0.80  | V   |          |
| Error Amplifier Reference Voltage            | VSEN(TH)     | -0.21 | -0.2 | -0.19 | V   |          |
| Error Amplifier Source Current               | ISEN(SOURCE) | -36   | -24  | -12   | μA  |          |
| Error Amplifier Sink Current                 | ISEN(SINK)   | 12    | 24   | 36    | μA  |          |
| Leading Edge Blanking Time                   | ton(LEB)     | —     | 600  | —     | ns  |          |
| Quasi-Resonant Operation Threshold Voltage 1 | VBD(TH1)     | 0.14  | 0.24 | 0.34  | V   |          |
| Quasi-Resonant Operation Threshold Voltage 2 | VBD(TH2)     | 0.11  | 0.16 | 0.21  | V   |          |

### Protection Operation

|                                         |            |       |      |       |    |  |
|-----------------------------------------|------------|-------|------|-------|----|--|
| Overcurrent Detection Threshold Voltage | VOCP       | -0.92 | -0.8 | -0.68 | V  |  |
| OCP Pin Outflow Current                 | IOCP       | -120  | -40  | -10   | μA |  |
| OCP Pin OVP Threshold Voltage           | VBD(OVP)   | 2.2   | 2.6  | 3.0   | V  |  |
| OLP Threshold Voltage                   | VCOMP(OLP) | 4.1   | 4.5  | 4.9   | V  |  |
| VCC Pin OVP Threshold Voltage           | VCC(OVP)   | 28.5  | 31.5 | 34.0  | V  |  |
| TSD Operating Temperature               | Tj(TSD)    | 135   | —    | —     | °C |  |

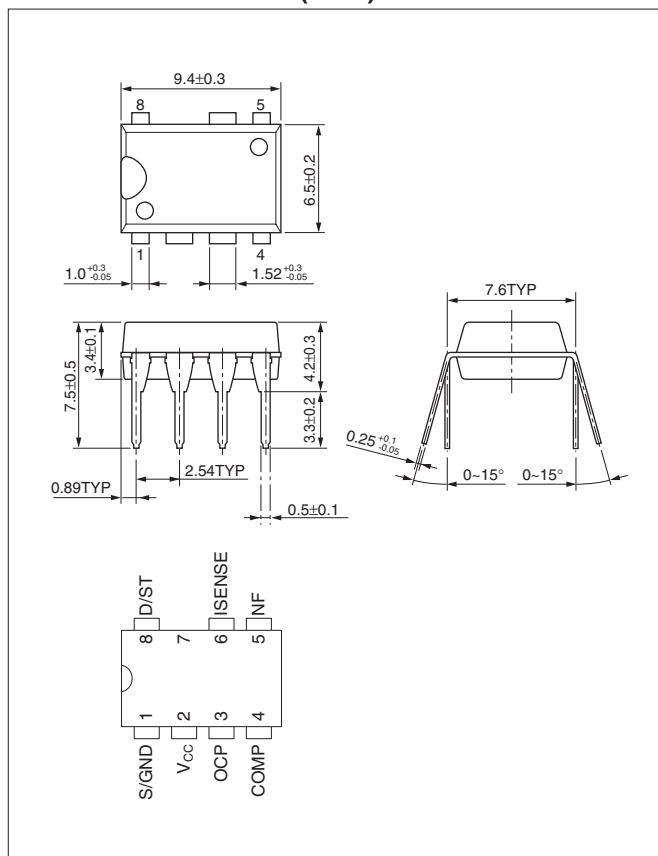
### MOSFET

|                       |         |     |   |      |      |         |
|-----------------------|---------|-----|---|------|------|---------|
| Drain-Source Voltage  | Vdss    | 650 | — | —    | V    |         |
| Drain Leakage Current | Idss    | —   | — | 300  | μA   |         |
| ON Resistance         | Rds(ON) | —   | — | 3.95 | Ω    | LC5555D |
|                       |         | —   | — | 1.9  |      | LC5556D |
| Switching Time        | tr      | —   | — | 250  | ns   | LC5555D |
|                       |         | —   | — | 400  |      | LC5556D |
| Thermal Resistance    | θch-c   | —   | — | 42   | °C/W | LC5555D |
|                       |         | —   | — | 35.5 |      | LC5556D |

For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

## External Dimensions (DIP8)

(Unit : mm)

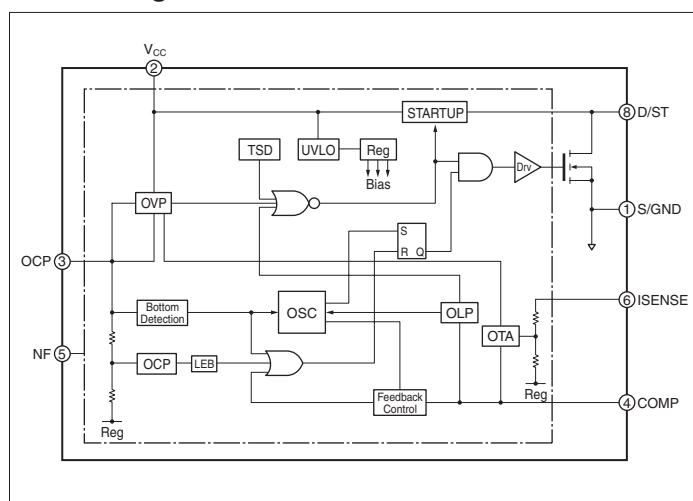


## Pin Functions

| Pin No. | Symbol          | Function                                                                                       |
|---------|-----------------|------------------------------------------------------------------------------------------------|
| 1       | S/GND           | MOSFET source and GND for control                                                              |
| 2       | V <sub>CC</sub> | Control circuit power input and Overvoltage protection signal input                            |
| 3       | OCP             | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 4       | COMP            | Feedback phase compensation                                                                    |
| 5       | NF              | (No function*)                                                                                 |
| 6       | ISENSE          | Feedback current detection                                                                     |
| 7       | —               | (Pin removed)                                                                                  |
| 8       | D/ST            | MOSFET drain and Startup current input                                                         |

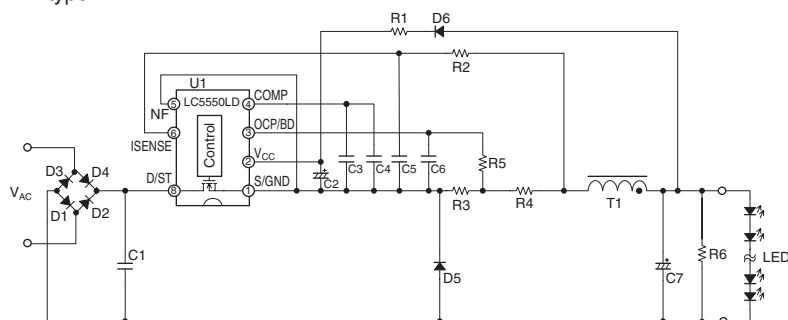
\*: NF (pin 5) connects to the stable potential S/GND pattern (pin 1 potential) via the shortest distance for stable operation.

## Block Diagram

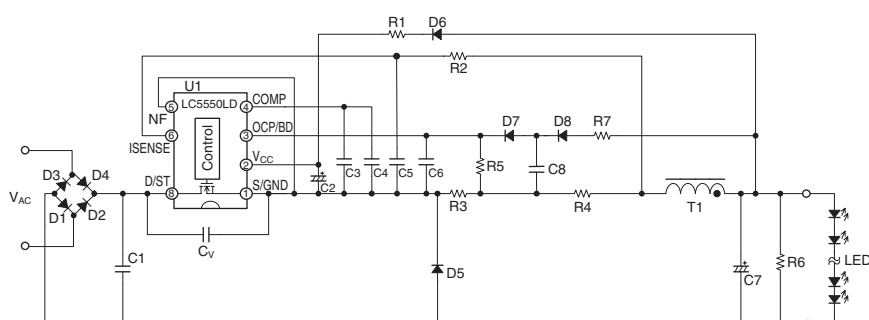


## Typical Connection Diagram

PWM type



Quasi resonance type



# LC5510 Series LED Driver ICs with Harmonics Standard (ICE61000-3-2 Class C) at all load condition

## Features

- Non-isolated type
- Built-in ON time control circuit  
(Average current control enables high power factor)
- Built-in soft start function  
(Reduces load on power MOSFET and secondary side rectifier diodes at power-on)
- Built-in bias assist function  
(Improves startup, suppresses VCC voltage drop during operation, lowers capacitance of VCC capacitor, and enables backup of the control circuit supply by using a ceramic capacitor)
- Built-in leading edge blanking function
- Built-in maximum ON time control circuit
- Protection function  
Overcurrent protection (OCP)...Pulse by pulse  
Overvoltage protection (OVP)...Auto restart  
Overload protection (OLP)...Auto restart  
Thermal shutdown (TSD)...Latch shutdown

## Lineup

| Part Number | MOSFET                 |                           | P <sub>OUT</sub> *<br>AC230V / Universal |
|-------------|------------------------|---------------------------|------------------------------------------|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                                          |
| LC5511D     | 650V                   | 3.95Ω                     | 13W / 10W                                |
| LC5513D     |                        | 1.9Ω                      | 20W / 16W                                |

\*: The output power values are based on the rated temperature. Output at 120 to 140% of the rated temperature is possible for the maximum output power. Note, however, that the output power may be limited by a low output voltage and by the ON duty specified during transformer design.

## Absolute Maximum Ratings

(T<sub>a</sub> = 25°C)

| Parameter                     | Symbol             | Ratings                          |                                  | Unit | Remarks                                       |
|-------------------------------|--------------------|----------------------------------|----------------------------------|------|-----------------------------------------------|
|                               |                    | LC5511D                          | LC5513D                          |      |                                               |
| Drain Current                 | I <sub>DPEAK</sub> | 2.5                              | 4.0                              | A    | Single Pulse                                  |
| Avalanche Energy Capacity     | E <sub>AS</sub>    | 47<br>(I <sub>LPEAK</sub> =2.0A) | 86<br>(I <sub>LPEAK</sub> =2.7A) | mJ   | Single Pulse, V <sub>DD</sub> =99V, L=20mH    |
| Control Supply Voltage        | V <sub>CC</sub>    | 35                               |                                  | V    |                                               |
| OCP Pin Voltage               | V <sub>OCP</sub>   | -2.0 to +5.0                     |                                  | V    |                                               |
| COMP Pin Voltage              | V <sub>COMP</sub>  | -0.3 to +7.0                     |                                  | V    |                                               |
| ISENSE Pin Voltage            | V <sub>SEN</sub>   | -0.3 to +5.0                     |                                  | V    |                                               |
| MOSFET Power Dissipation      | P <sub>D</sub>     | 0.97                             |                                  | W    | Board size when mounted on board<br>15mm×15mm |
| Operating Ambient Temperature | T <sub>OP</sub>    | -55 to +125                      |                                  | °C   |                                               |
| Storage Temperature           | T <sub>STG</sub>   | -55 to +125                      |                                  | °C   |                                               |
| Channel Temperature           | T <sub>CH</sub>    | 150                              |                                  | °C   |                                               |

## Applications

- LED light bulbs
- LED lighting equipment

## Electrical Characteristics

(T<sub>a</sub> = 25°C, V<sub>CC</sub> = 20V, unless otherwise specified)

| Parameter | Symbol | Ratings |      |      | Unit | Remarks |
|-----------|--------|---------|------|------|------|---------|
|           |        | min.    | typ. | max. |      |         |

### Power Supply Startup Operation

|                                              |                          |      |      |      |    |                      |
|----------------------------------------------|--------------------------|------|------|------|----|----------------------|
| Operation Startup Voltage                    | V <sub>CC(ON)</sub>      | 13.8 | 15.1 | 17.3 | V  |                      |
| Operation Stop Voltage*1                     | V <sub>CC(OFF)</sub>     | 8.4  | 9.4  | 10.7 | V  |                      |
| Circuit Current During Operation             | I <sub>CC(ON)</sub>      | —    | —    | 3.7  | mA |                      |
| Startup Circuit Operation Voltage            | V <sub>STARTUP</sub>     | 42   | 57   | 72   | V  |                      |
| Startup Current                              | I <sub>CC(STARTUP)</sub> | -5.5 | -3.0 | -1.0 | mA | V <sub>CC</sub> =13V |
| Startup Current Supply Threshold Voltage 1*1 | V <sub>CC(BIAS) 1</sub>  | 9.5  | 11   | 12.5 | V  |                      |
| Startup Current Supply Threshold Voltage 2   | V <sub>CC(BIAS) 2</sub>  | 14.4 | 16.6 | 18.8 | V  |                      |

### Normal Operation

|                                              |                          |      |      |      |     |  |
|----------------------------------------------|--------------------------|------|------|------|-----|--|
| PWM Oscillation Frequency                    | f <sub>OSC</sub>         | 11.0 | 14.0 | 18.0 | kHz |  |
| Maximum ON Time                              | t <sub>ON(MAX)</sub>     | 30.0 | 40.0 | 50.0 | μs  |  |
| COMP Pin Control Lower Voltage               | V <sub>COMP(MIN)</sub>   | 0.55 | 0.90 | 1.25 | V   |  |
| Error Amplifier Reference Voltage            | V <sub>SEN(TH)</sub>     | 0.27 | 0.30 | 0.33 | V   |  |
| Error Amplifier Source Current               | I <sub>SEN(SOURCE)</sub> | -11  | -7   | -3   | μA  |  |
| Error Amplifier Sink Current                 | I <sub>SEN(SINK)</sub>   | 3    | 7    | 11   | μA  |  |
| Leading Edge Blanking Time                   | t <sub>ON(LEB)</sub>     | —    | 500  | —    | ns  |  |
| Quasi-Resonant Operation Threshold Voltage 1 | V <sub>BD(TH1)</sub>     | 0.14 | 0.24 | 0.34 | V   |  |
| Quasi-Resonant Operation Threshold Voltage 2 | V <sub>BD(TH2)</sub>     | 0.12 | 0.17 | 0.22 | V   |  |

### Protection Operation

|                                         |                        |       |       |       |    |  |
|-----------------------------------------|------------------------|-------|-------|-------|----|--|
| Overcurrent Detection Threshold Voltage | V <sub>OCP</sub>       | -0.66 | -0.60 | -0.54 | V  |  |
| OCP Pin Outflow Current                 | I <sub>OCP</sub>       | -120  | -40   | -10   | μA |  |
| OCP Pin OVP Threshold Voltage           | V <sub>BD(OVP)</sub>   | 2.2   | 2.6   | 3.0   | V  |  |
| OLP Threshold Voltage                   | V <sub>COMP(OLP)</sub> | 4.1   | 4.5   | 4.9   | V  |  |
| VCC Pin OVP Threshold Voltage           | V <sub>CC(OVP)</sub>   | 28.5  | 31.5  | 34.0  | V  |  |
| TSD Operating Temperature               | T <sub>J(TSD)</sub>    | 135   | —     | —     | °C |  |

### MOSFET

|                       |                     |     |   |      |      |         |
|-----------------------|---------------------|-----|---|------|------|---------|
| Drain-Source Voltage  | V <sub>DSS</sub>    | 650 | — | —    | V    |         |
| Drain Leakage Current | I <sub>DSS</sub>    | —   | — | 300  | μA   |         |
| ON Resistance         | R <sub>DS(ON)</sub> | —   | — | 3.95 | Ω    | LC5511D |
|                       |                     | —   | — | 1.9  |      | LC5513D |
| Switching Time        | t <sub>r</sub>      | —   | — | 250  | ns   | LC5511D |
|                       |                     | —   | — | 400  |      | LC5513D |
| Thermal Resistance*2  | θ <sub>CH-C</sub>   | —   | — | 42   | °C/W | LC5511D |
|                       |                     | —   | — | 35.5 |      | LC5513D |

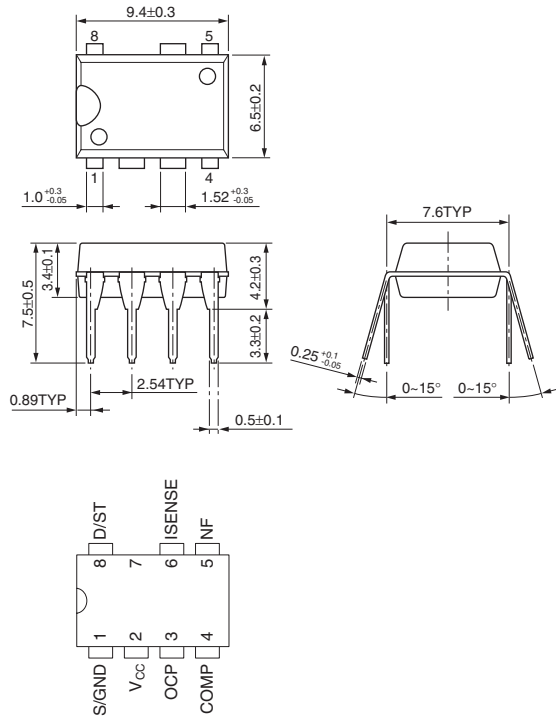
For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

\*1: The relationship V<sub>CC(BIAS)1</sub> > V<sub>CC(OFF)</sub> holds true for all products.

\*2: Thermal resistance between the MOSFET channel and the case. The case temperature T<sub>c</sub> is determined by the temperature at the center of the marking surface.

## External Dimensions (DIP8)

(Unit : mm)

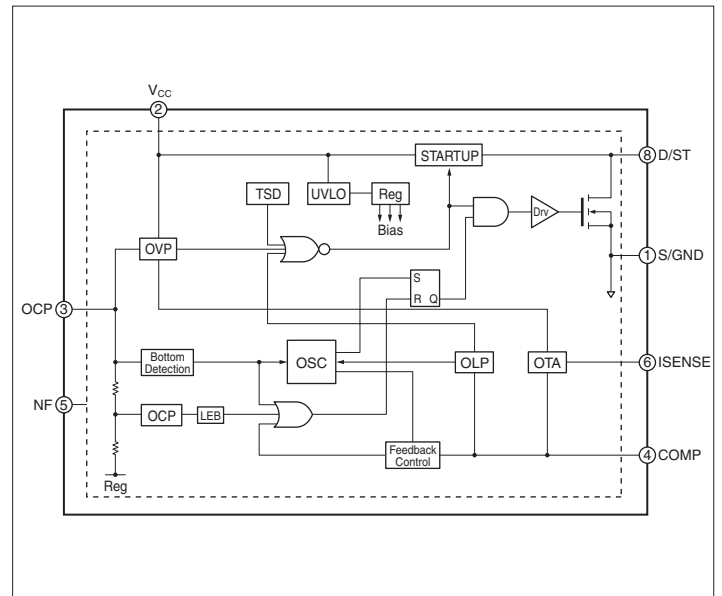


## Pin Functions

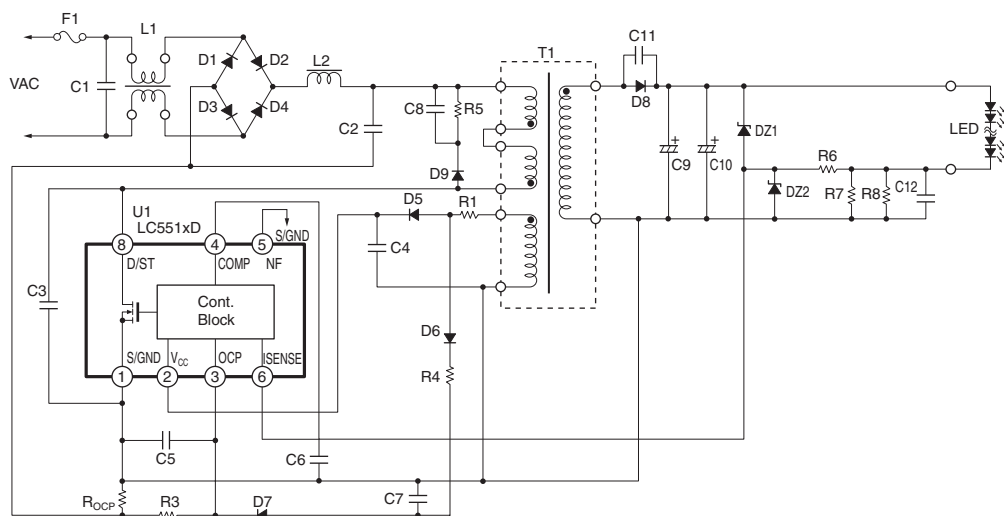
| Pin No. | Symbol | Function                                                                                       |
|---------|--------|------------------------------------------------------------------------------------------------|
| 1       | S/GND  | MOSFET source and GND for control                                                              |
| 2       | Vcc    | Control circuit power input and Overvoltage protection signal input                            |
| 3       | OCP    | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 4       | COMP   | Feedback phase compensation                                                                    |
| 5       | NF     | (No function*)                                                                                 |
| 6       | ISENSE | Feedback current detection and Overvoltage protection signal input                             |
| 7       | —      | (Pin removed)                                                                                  |
| 8       | D/ST   | MOSFET drain and Startup current input                                                         |

\*: NF (pin 5) connects to the stable potential S/GND pattern (pin 1 potential) via the shortest distance for stable operation.

## Block Diagram



## Typical Connection Diagram



## LC5560 Series High Power Factor LED Driver ICs with Harmonics Standard (ICE61000-3-2 Class C) at all load condition

### Features

- Non-isolated type
- Built-in ON time control circuit  
(Average current control enables high power factor)
- Built-in soft start function  
(Reduces load on power MOSFET and secondary side rectifier diodes at power-on)
- Built-in bias assist function  
(Improves startup, suppresses VCC voltage drop during operation, lowers capacitance of VCC capacitor, and enables backup of the control circuit supply by using a ceramic capacitor)
- Built-in leading edge blanking function
- Built-in maximum ON time control circuit
- Protection function  
Overcurrent protection (OCP)...Pulse by pulse  
Overvoltage protection (OVP)...Latch shutdown  
Overload protection (OLP)...Latch shutdown  
Thermal shutdown (TSD)...Latch shutdown

### Lineup

| Part Number | MOSFET     |               | PWM Oscillation<br>Frequency<br>fosc (TYP) | Maximum ON Time<br>ton(MAX) (TYP) | Pout*<br>AC230V / Universal |
|-------------|------------|---------------|--------------------------------------------|-----------------------------------|-----------------------------|
|             | Vdss (MIN) | Rds(ON) (MAX) |                                            |                                   |                             |
| LC5565LD    | 650V       | 3.95Ω         | 72kHz                                      | 9.3μs                             | 13W / 10W                   |
| LC5566LD    |            | 1.9Ω          | 60kHz                                      | 11.2μs                            | 20W / 16W                   |

\*: The output power values are based on the rated temperature. Output at 120 to 140% of the rated temperature is possible for the maximum output power. Note, however, that the output power may be limited by a low output voltage and by the ON duty specified during transformer design.

### Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                     | Symbol | Ratings             |                     | Unit | Remarks                                       |
|-------------------------------|--------|---------------------|---------------------|------|-----------------------------------------------|
|                               |        | LC5565LD            | LC5566LD            |      |                                               |
| Drain Current                 | IDPEAK | 2.5                 | 4.0                 | A    | Single Pulse                                  |
| Avalanche Energy Capacity     | EAS    | 47<br>(ILPEAK=2.0A) | 86<br>(ILPEAK=2.7A) | mJ   | Single Pulse, VDD=99V, L=20mH                 |
| Control Supply Voltage        | VCC    | 35                  |                     | V    |                                               |
| OCP Pin Voltage               | VOCP   | -2.0 to +5.0        |                     | V    |                                               |
| COMP Pin Voltage              | VCOMP  | -0.3 to +7.0        |                     | V    |                                               |
| VREF Pin Voltage              | VREF   | -0.3 to +5.0        |                     | V    |                                               |
| ISENSE Pin Voltage            | VSEN   | -0.3 to +5.0        |                     | V    |                                               |
| MOSFET Power Dissipation      | PD     | 0.97                |                     | W    | Board size when mounted on board<br>15mm×15mm |
| Operating Ambient Temperature | Top    | -55 to +125         |                     | °C   |                                               |
| Storage Temperature           | Tstg   | -55 to +125         |                     | °C   |                                               |
| Channel Temperature           | Tch    | 150                 |                     | °C   |                                               |

### Applications

- LED light bulbs
- LED lighting equipment

### Electrical Characteristics

(Ta = 25°C, VCC = 20V, unless otherwise specified)

| Parameter | Symbol | Ratings |      |      | Unit | Remarks |
|-----------|--------|---------|------|------|------|---------|
|           |        | min.    | typ. | max. |      |         |

#### Power Supply Startup Operation

|                                            |              |      |      |      |    |         |
|--------------------------------------------|--------------|------|------|------|----|---------|
| Operation Startup Voltage                  | VCC(ON)      | 13.8 | 15.1 | 17.3 | V  |         |
| Operation Stop Voltage*1                   | VCC(OFF)     | 8.4  | 9.4  | 10.7 | V  |         |
| Circuit Current During Operation           | ICC(ON)      | —    | —    | 4.7  | mA |         |
| Startup Circuit Operation Voltage          | VSTARTUP     | 18   | 21   | 24   | V  |         |
| Startup Current                            | ICC(STARTUP) | -8.5 | -4.0 | -1.5 | mA | VCC=13V |
| Startup Current Supply Threshold Voltage*1 | VCC(BIAS)    | 9.5  | 11.0 | 12.5 | V  |         |

#### Normal Operation

|                                              |              |       |       |       |     |          |
|----------------------------------------------|--------------|-------|-------|-------|-----|----------|
| PWM Oscillation Frequency                    | fosc         | 60    | 72    | 84    | kHz | LC5565LD |
|                                              |              | 50    | 60    | 70    |     | LC5566LD |
| Maximum ON Time                              | ton(MAX)     | 8.0   | 9.3   | 11.2  | μs  | LC5565LD |
|                                              |              | 9.0   | 11.2  | 13.4  |     | LC5566LD |
| COMP Pin Control Lower Voltage               | VCOMP(MIN)   | 0.30  | 0.55  | 0.80  | V   |          |
| Error Amplifier Reference Voltage            | VSEN(TH)     | 0.312 | 0.335 | 0.358 | V   |          |
| Error Amplifier Source Current               | ISEN(SOURCE) | -22   | -14   | -6    | μA  |          |
| Error Amplifier Sink Current                 | ISEN(SINK)   | 6     | 14    | 22    | μA  |          |
| Leading Edge Blanking Time                   | tON(LEB)     | —     | 600   | —     | ns  |          |
| Quasi-Resonant Operation Threshold Voltage 1 | VBD(TH1)     | 0.14  | 0.24  | 0.34  | V   |          |
| Quasi-Resonant Operation Threshold Voltage 2 | VBD(TH2)     | 0.11  | 0.16  | 0.21  | V   |          |

#### Protection Operation

|                                         |            |       |       |       |    |  |
|-----------------------------------------|------------|-------|-------|-------|----|--|
| Overcurrent Detection Threshold Voltage | VOCP       | -0.66 | -0.60 | -0.54 | V  |  |
| OCP Pin Outflow Current                 | IOCP       | -120  | -40   | -10   | μA |  |
| OCP Pin OVP Threshold Voltage           | VBD(OVP)   | 2.2   | 2.6   | 3.0   | V  |  |
| OLP Threshold Voltage                   | VCOMP(OLP) | 4.1   | 4.5   | 4.9   | V  |  |
| VCC Pin OVP Threshold Voltage           | VCC(OVP)   | 28.5  | 31.5  | 34.0  | V  |  |
| TSD Operating Temperature               | Tj(TSD)    | 135   | —     | —     | °C |  |

#### MOSFET

|                      |         |   |   |      |      |          |
|----------------------|---------|---|---|------|------|----------|
| ON Resistance        | RDS(ON) | — | — | 3.95 | Ω    | LC5565LD |
|                      |         | — | — | 1.9  |      | LC5566LD |
| Switching Time       | tr      | — | — | 250  | ns   | LC5565LD |
|                      |         | — | — | 400  |      | LC5566LD |
| Thermal Resistance*2 | θch-c   | — | — | 42   | °C/W | LC5565LD |
|                      |         | — | — | 35.5 |      | LC5566LD |

For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

\*1: The relationship  $V_{CC(BIAS)1} > V_{CC(OFF)}$  holds true for all products.

\*2: Thermal resistance between the MOSFET channel and the case. The case temperature Tc is determined by the temperature at the center of the marking surface.



# LC5520 Series LED Driver ICs with Harmonics Standard (ICE61000-3-2 Class C) at all load condition

## Features

- Isolated type
- Built-in ON time control circuit  
(Average current control enables high power factor)
- Built-in soft start function  
(Reduces load on power MOSFET and secondary side rectifier diodes at power-on)
- Built-in bias assist function  
(Improves startup, suppresses VCC voltage drop during operation, lowers capacitance of VCC capacitor, and enables backup of the control circuit supply by using a ceramic capacitor)
- Built-in leading edge blanking function
- Built-in maximum ON time control circuit
- Protection function  
Overcurrent protection (OCP)...Pulse by pulse  
Overvoltage protection (OVP)...Auto restart  
Overload protection (OLP)...Auto restart  
Thermal shutdown (TSD)...Latch shutdown

## Applications

- LED light bulbs
- LED lighting equipment

## Lineup

| Part Number | MOSFET                 |                           | P <sub>OUT</sub> *<br>AC230V / Universal | Package  |
|-------------|------------------------|---------------------------|------------------------------------------|----------|
|             | V <sub>DSS</sub> (MIN) | R <sub>DS(ON)</sub> (MAX) |                                          |          |
| LC5521D     | 650V                   | 3.95Ω                     | 13W / 10W                                | DIP8     |
| LC5523D     |                        | 1.9Ω                      | 20W / 16W                                |          |
| LC5523F     |                        | 1.9Ω                      | 60W / 40W                                |          |
| LC5525F     | 650V                   | 1.1Ω                      | 80W / 55W                                | TO220F-7 |

\*: The output power values are based on the rated temperature. Output at 120 to 140% of the rated temperature is possible for the maximum output power. Note, however, that the output power may be limited by a low output voltage and by the ON duty specified during transformer design.

## Absolute Maximum Ratings

(T<sub>a</sub> = 25°C)

| Parameter                     | Symbol             | Ratings                          |                                  |                                  |                                   | Unit | Remarks                                       |
|-------------------------------|--------------------|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|------|-----------------------------------------------|
|                               |                    | LC5521D                          | LC5523D                          | LC5523F                          | LC5525F                           |      |                                               |
| Drain Current                 | I <sub>DPEAK</sub> | 2.5                              | 4.0                              | 9.2                              | 13.0                              | A    | Single Pulse                                  |
| Avalanche Energy Capacity     | E <sub>AS</sub>    | 47<br>(I <sub>LPEAK</sub> =2.0A) | 86<br>(I <sub>LPEAK</sub> =2.7A) | 99<br>(I <sub>LPEAK</sub> =2.9A) | 233<br>(I <sub>LPEAK</sub> =4.4A) | mJ   | Single Pulse,<br>V <sub>DD</sub> =99V, L=20mH |
| Control Supply Voltage        | V <sub>CC</sub>    | 35                               |                                  |                                  |                                   | V    |                                               |
| OCP Pin Voltage               | V <sub>OCP</sub>   | -2.0 to +5.0                     |                                  |                                  |                                   | V    |                                               |
| FB Pin Voltage                | V <sub>FB</sub>    | -0.3 to +7.0                     |                                  |                                  |                                   | V    |                                               |
| OVP Pin Voltage               | V <sub>OVP</sub>   | -0.3 to +5.0                     |                                  |                                  |                                   | V    |                                               |
| MOSFET Power Dissipation      | P <sub>D</sub>     | 0.97                             |                                  | 1.8                              |                                   | W    |                                               |
|                               | P <sub>D2</sub>    | —                                |                                  | 20.2                             | 23.6                              | W    | With infinite heatsink                        |
| Operating Ambient Temperature | Top                | -55 to +125                      |                                  |                                  |                                   | °C   |                                               |
| Storage Temperature           | T <sub>stg</sub>   | -55 to +125                      |                                  |                                  |                                   | °C   |                                               |
| Channel Temperature           | T <sub>ch</sub>    | 150                              |                                  |                                  |                                   | °C   |                                               |

## Electrical Characteristics

(T<sub>a</sub> = 25°C, V<sub>CC</sub> = 20V, unless otherwise specified)

| Parameter | Symbol | Ratings |      |      | Unit | Remarks |
|-----------|--------|---------|------|------|------|---------|
|           |        | min.    | typ. | max. |      |         |

### Power Supply Startup Operation

|                                            |                          |      |      |      |    |                      |
|--------------------------------------------|--------------------------|------|------|------|----|----------------------|
| Operation Startup Voltage                  | V <sub>CC(ON)</sub>      | 13.8 | 15.1 | 17.3 | V  |                      |
| Operation Stop Voltage*1                   | V <sub>CC(OFF)</sub>     | 8.4  | 9.4  | 10.7 | V  |                      |
| Circuit Current During Operation           | I <sub>CC(ON)</sub>      | —    | —    | 3.7  | mA |                      |
| Startup Circuit Operation Voltage          | V <sub>STARTUP</sub>     | 42   | 57   | 72   | V  |                      |
| Startup Current                            | I <sub>CC(STARTUP)</sub> | -5.5 | -3.0 | -1.0 | mA | V <sub>CC</sub> =13V |
| Startup Current Supply Threshold Voltage*1 | V <sub>CC(BIAS)</sub>    | 9.5  | 11.0 | 12.5 | V  |                      |

### Normal Operation

|                                              |                      |      |      |      |     |  |
|----------------------------------------------|----------------------|------|------|------|-----|--|
| PWM Oscillation Frequency                    | f <sub>OSC</sub>     | 11.0 | 14.0 | 18.0 | kHz |  |
| Maximum ON Time                              | t <sub>ON(MAX)</sub> | 30.0 | 40.0 | 50.0 | μs  |  |
| FB Pin Control Lower Voltage                 | V <sub>FB(MIN)</sub> | 0.55 | 0.90 | 1.25 | V   |  |
| Maximum Feedback Current                     | I <sub>FB(MAX)</sub> | -40  | -25  | -10  | μA  |  |
| Leading Edge Blanking Time                   | t <sub>ON(LEB)</sub> | —    | 500  | —    | ns  |  |
| Quasi-Resonant Operation Threshold Voltage 1 | V <sub>BD(TH1)</sub> | 0.14 | 0.24 | 0.34 | V   |  |
| Quasi-Resonant Operation Threshold Voltage 2 | V <sub>BD(TH2)</sub> | 0.12 | 0.17 | 0.22 | V   |  |

### Protection Operation

|                                         |                          |       |       |       |    |  |
|-----------------------------------------|--------------------------|-------|-------|-------|----|--|
| Overcurrent Detection Threshold Voltage | V <sub>OCP</sub>         | -0.66 | -0.60 | -0.54 | V  |  |
| OCP Pin Outflow Current                 | I <sub>OCP</sub>         | -120  | -40   | -10   | μA |  |
| OCP Pin OVP Threshold Voltage           | V <sub>BD(OVP)</sub>     | 2.2   | 2.6   | 3.0   | V  |  |
| OLP Threshold Voltage                   | V <sub>COMP(OLP) 1</sub> | 5.0   | 5.5   | 6.0   | V  |  |
|                                         | V <sub>COMP(OLP) 2</sub> | 4.1   | 4.5   | 4.9   |    |  |
| OVP Pin OVP Threshold Voltage           | V <sub>OVP(OVP)</sub>    | 1.6   | 2.0   | 2.4   | V  |  |
| VCC Pin OVP Threshold Voltage           | V <sub>CC(OVP)</sub>     | 28.5  | 31.5  | 34.0  | V  |  |
| TSD Operating Temperature               | T <sub>J(TSD)</sub>      | 135   | —     | —     | °C |  |

### MOSFET

|                       |                     |     |   |      |      |         |
|-----------------------|---------------------|-----|---|------|------|---------|
| Drain-Source Voltage  | V <sub>DSS</sub>    | 650 | — | —    | V    |         |
| Drain Leakage Current | I <sub>DSS</sub>    | —   | — | 300  | μA   |         |
| ON Resistance         | R <sub>DS(ON)</sub> | —   | — | 3.95 | Ω    | LC5521D |
|                       |                     | —   | — | 1.9  |      | LC5523D |
|                       |                     | —   | — | 1.9  |      | LC5523F |
|                       |                     | —   | — | 1.1  |      | LC5535F |
| Switching Time        | t <sub>r</sub>      | —   | — | 250  | ns   | LC5521D |
|                       |                     | —   | — | 400  |      | LC5523D |
|                       |                     | —   | — | 400  |      | LC5523F |
|                       |                     | —   | — | 400  |      | LC5535F |
| Thermal Resistance*2  | θ <sub>ch-c</sub>   | —   | — | 42   | °C/W | LC5521D |
|                       |                     | —   | — | 35.5 |      | LC5523D |
|                       |                     | —   | — | 3.1  |      | LC5523F |
|                       |                     | —   | — | 2.2  |      | LC5535F |

For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

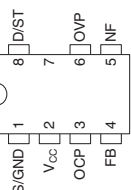
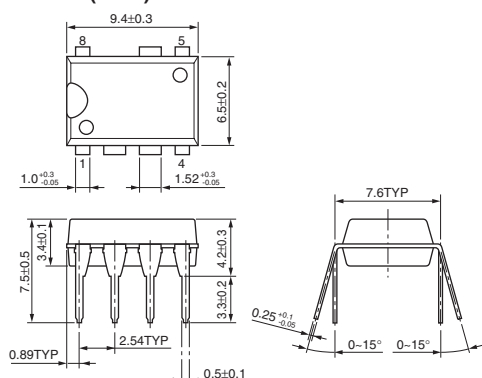
\*1: The relationship V<sub>CC(BIAS)</sub>1 > V<sub>CC(OFF)</sub> holds true for all products.

\*2: Thermal resistance between the MOSFET channel and the case. The case temperature T<sub>c</sub> is determined by the temperature at the center of the marking surface.

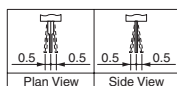
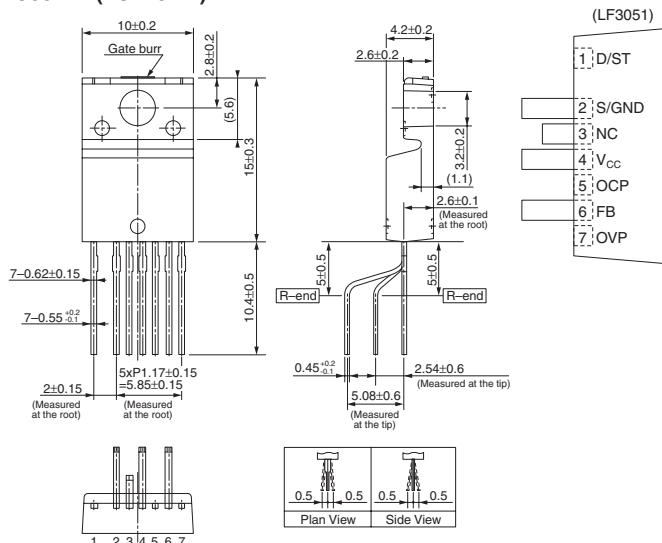
## External Dimensions

(Unit : mm)

### LC552xD (DIP8)



### LC552xF (TO220F-7)



## Pin Functions

### LC552xD (DIP8)

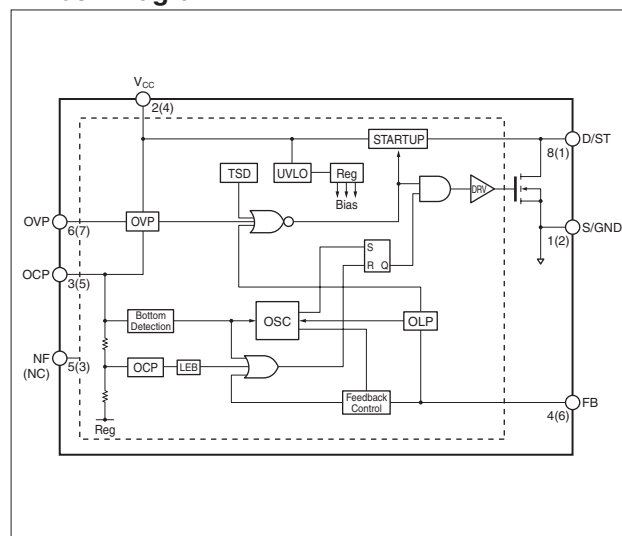
| Pin No. | Symbol | Function                                                                                       |
|---------|--------|------------------------------------------------------------------------------------------------|
| 1       | S/GND  | MOSFET source and GND for control                                                              |
| 2       | Vcc    | Control circuit power input and Overvoltage protection signal input                            |
| 3       | OCP    | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 4       | FB     | Feedback signal input and Overload protection signal input                                     |
| 5       | NF     | (No function*)                                                                                 |
| 6       | OVP    | Overvoltage protection signal input                                                            |
| 7       | —      | (Pin removed)                                                                                  |
| 8       | D/ST   | MOSFET drain and Startup current input                                                         |

\*: NF (pin 5) connects to the stable potential S/GND pattern (pin 1 potential) via the shortest distance for stable operation.

### LC552xF (TO220F-7)

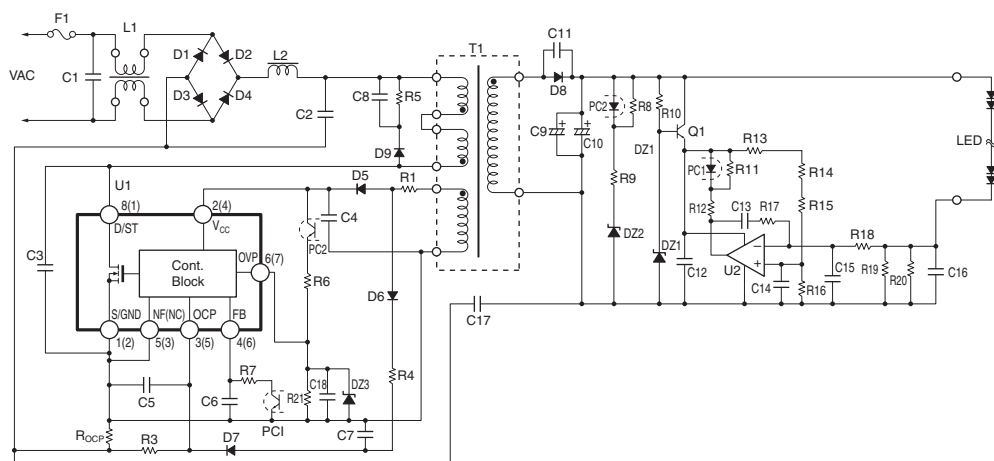
| Pin No. | Symbol | Function                                                                                       |
|---------|--------|------------------------------------------------------------------------------------------------|
| 1       | D/ST   | MOSFET drain and Startup current input                                                         |
| 2       | S/GND  | MOSFET source and GND for control                                                              |
| 3       | NC     | —                                                                                              |
| 4       | Vcc    | Control circuit power input and Overvoltage protection signal input                            |
| 5       | OCP    | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 6       | FB     | Feedback signal input and Overload protection signal input                                     |
| 7       | OVP    | Overvoltage protection signal input                                                            |

## Block Diagram



## Typical Connection Diagram

The pin number for DIP8 is indicated. The pin number for TO220F-7 is indicated in parentheses.



# LC5540 Series LED Driver ICs with Harmonics Standard (ICE61000-3-2 Class C) at all load conditon

## Features

- Isolated type
- Built-in ON time control circuit  
(Average current control enables high power factor)
- Built-in soft start function  
(Reduces load on power MOSFET and secondary side rectifier diodes at power-on)
- Built-in bias assist function  
(Improves startup, suppresses VCC voltage drop during operation, lowers capacitance of VCC capacitor, and enables backup of the control circuit supply by using a ceramic capacitor)
- Built-in leading edge blanking function
- Built-in maximum ON time control circuit
- Avalanche energy capacity guaranteed  
(Enables simplification of the surge absorption circuit.)
- Protection function  
Overcurrent protection (OCP)...Pulse by pulse  
Overvoltage protection (OVP)...Latch shutdown  
Overload protection (OLP)...Latch shutdown  
Thermal shutdown (TSD)...Latch shutdown

## Applications

- LED light bulbs
- LED lighting equipment

## Lineup

| Part Number | MOSFET     |               | PWM Oscillation Frequency<br>fosc (TYP) | Maximum ON Time<br>ton(MAX) (TYP) | Pout*<br>AC230V / Universal | Package  |
|-------------|------------|---------------|-----------------------------------------|-----------------------------------|-----------------------------|----------|
|             | Voss (MIN) | Rds(ON) (MAX) |                                         |                                   |                             |          |
| LC5545LD    | 650V       | 3.95Ω         | 72kHz                                   | 9.3μs                             | 13W / 10W                   | DIP8     |
| LC5546LD    |            | 1.9Ω          | 60kHz                                   | 11.2μs                            | 20W / 16W                   |          |
| LC5548LD    | 800V       | 3.5Ω          | 72kHz                                   | 9.3μs                             | 13W / 10W                   |          |
| LC5546LF    | 650V       | 1.9Ω          | 40kHz                                   | 17.5μs                            | 60W / 40W                   | TO220F-7 |
| LC5547LF    |            | 1.1Ω          |                                         |                                   | 80W / 55W                   |          |
| LC5549LF    | 800V       | 1.7Ω          |                                         |                                   | 60W / 40W                   |          |

\*: The output power values are based on the rated temperature. Output at 120 to 140% of the rated temperature is possible for the maximum output power. Note, however, that the output power may be limited by a low output voltage and by the ON duty specified during transformer design.

## Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                            | Symbol | Ratings             |                     |                     |                     |                      |                     | Unit | Remarks                          |
|--------------------------------------|--------|---------------------|---------------------|---------------------|---------------------|----------------------|---------------------|------|----------------------------------|
|                                      |        | LC5545LD            | LC5546LD            | LC5548LD            | LC5546LF            | LC5547LF             | LC5549LF            |      |                                  |
| Drain Current                        | IDPEAK | 2.5                 | 4.0                 | 2.6                 | 9.2                 | 13.0                 | 10.5                | A    | Single Pulse                     |
| Avalanche Energy Capacity            | EAS    | 47<br>(ILPEAK=2.0A) | 86<br>(ILPEAK=2.7A) | 56<br>(ILPEAK=2.3A) | 99<br>(ILPEAK=2.9A) | 233<br>(ILPEAK=4.4A) | 92<br>(ILPEAK=2.8A) | mJ   | Single Pulse,<br>VDD=99V, L=20mH |
| Control Supply Voltage               | VCC    | 35                  |                     |                     |                     |                      |                     | V    |                                  |
| OCP Pin Voltage                      | VOCP   | -2.0 to +5.0        |                     |                     |                     |                      |                     | V    |                                  |
| FB Pin Voltage                       | VFB    | -0.3 to +7.0        |                     |                     |                     |                      |                     | V    |                                  |
| OVP Pin Voltage                      | VOVP   | -0.3 to +5.0        |                     |                     |                     |                      |                     | V    |                                  |
| MOSFET Power Dissipation             | PD     | 0.97                |                     |                     | 1.8                 |                      |                     | W    |                                  |
|                                      | PD2    | —                   |                     |                     | 20.2                | 23.6                 |                     | W    | With infinite heatsink           |
| Operating Internal Frame Temperature | TF     | —                   |                     |                     | -20 to +115         |                      |                     | °C   |                                  |
| Operating Ambient Temperature        | Top    | -55 to +125         |                     |                     | -55 to +115         |                      |                     | °C   |                                  |
| Storage Temperature                  | Tstg   | -55 to +125         |                     |                     |                     |                      |                     | °C   |                                  |
| Channel Temperature                  | Tch    | 150                 |                     |                     |                     |                      |                     | °C   |                                  |

## Electrical Characteristics

(Ta = 25°C, Vcc = 20V, unless otherwise specified)

| Parameter | Symbol | Ratings |      |      | Unit | Remarks |
|-----------|--------|---------|------|------|------|---------|
|           |        | min.    | typ. | max. |      |         |

### Power Supply Startup Operation

|                                          |              |      |      |      |    |         |
|------------------------------------------|--------------|------|------|------|----|---------|
| Operation Startup Voltage                | VCC(ON)      | 13.8 | 15.1 | 17.3 | V  |         |
| Operation Stop Voltage                   | VCC(OFF)     | 8.4  | 9.4  | 10.7 | V  |         |
| Circuit Current During Operation         | ICC(ON)      | —    | —    | 4.7  | mA |         |
| Startup Circuit Operation Voltage        | VSTARTUP     | 18   | 21   | 24   | V  |         |
| Startup Current                          | ICC(STARTUP) | -8.5 | -4.0 | -1.5 | mA | VCC=13V |
| Startup Current Supply Threshold Voltage | VCC(BIAS)    | 9.5  | 11   | 12.5 | V  |         |

### Normal Operation

|                                              |          |      |      |      |     |              |
|----------------------------------------------|----------|------|------|------|-----|--------------|
| PWM Oscillation Frequency                    | fosc     | 60   | 72   | 84   | kHz | LC5545LD/48L |
|                                              |          | 50   | 60   | 70   |     | LC5546LD     |
|                                              |          | 33   | 40   | 47   |     | LC554xLF     |
| Maximum ON Time                              | ton(MAX) | 8.0  | 9.3  | 11.2 | μs  | LC5545LD/48L |
|                                              |          | 9.0  | 11.2 | 13.4 |     | LC5546LD     |
|                                              |          | 14   | 17.5 | 21   |     | LC554xLF     |
| FB Pin Control Lower Voltage                 | VFB(MIN) | 0.50 | 0.85 | 1.20 | V   |              |
| Maximum Feedback Current                     | IFB(MAX) | -40  | -25  | -10  | μA  |              |
| Leading Edge Blanking Time                   | ton(LEB) | —    | 600  | —    | ns  |              |
| Quasi-Resonant Operation Threshold Voltage 1 | VBD(TH1) | 0.14 | 0.24 | 0.34 | V   |              |
| Quasi-Resonant Operation Threshold Voltage 2 | VBD(TH2) | 0.11 | 0.16 | 0.21 | V   |              |

### Protection Operation

|                                         |            |       |       |       |    |  |
|-----------------------------------------|------------|-------|-------|-------|----|--|
| Overcurrent Detection Threshold Voltage | VOCP       | -0.66 | -0.60 | -0.54 | V  |  |
| OCP Pin Outflow Current                 | IOCP       | -120  | -40   | -10   | μA |  |
| OCP Pin OVP Threshold Voltage           | VBD(OVP)   | 2.2   | 2.6   | 3.0   | V  |  |
| OLP Threshold Voltage                   | VCOMP(OLP) | 4.1   | 4.5   | 4.9   | V  |  |
| OVP Pin OVP Threshold Voltage           | VOVP(OVP)  | 1.6   | 2.0   | 2.4   | V  |  |
| VCC Pin OVP Threshold Voltage           | VCC(OVP)   | 28.5  | 31.5  | 34.0  | V  |  |
| TSD Operating Temperature               | Tj(TSD)    | 135   | —     | —     | °C |  |

### MOSFET

|                      |         |   |   |        |      |          |
|----------------------|---------|---|---|--------|------|----------|
| ON Resistance        | Rds(ON) | — | — | 3.95   | Ω    | LC5545LD |
|                      |         | — | — | 1.9    |      | LC5546LD |
|                      |         | — | — | 3.5    |      | LC5548LD |
|                      |         | — | — | 1.9    |      | LC5546LF |
|                      |         | — | — | 1.1    |      | LC5547LF |
| Switching Time       | tr      | — | — | 1.7    | ns   | LC5549LF |
|                      |         | — | — | 250    |      | LC5545LD |
|                      |         | — | — | 400    |      | LC5546LD |
|                      |         | — | — | 400    |      | LC5548LD |
|                      |         | — | — | 400    |      | LC5546LF |
| Thermal Resistance*3 | θch-c   | — | — | 400    | °C/W | LC5547LF |
|                      |         | — | — | 300    |      | LC5549LF |
|                      |         | — | — | 42*2   |      | LC5545LD |
|                      | θch-F   | — | — | 35.5*2 |      | LC5546LD |
|                      |         | — | — | 40*2   |      | LC5548LD |
|                      |         | — | — | 3.1*3  |      | LC5546LF |
|                      |         | — | — | 2.2*3  |      | LC5547LF |
|                      |         | — | — | 2.2*3  |      | LC5549LF |

For the polarity of current values, the sink is defined as "positive" and the source is defined as "negative" with respect to the IC.

\*1: The relationship  $V_{CC(BIAS)} > V_{CC(OFF)}$  holds true for all products.

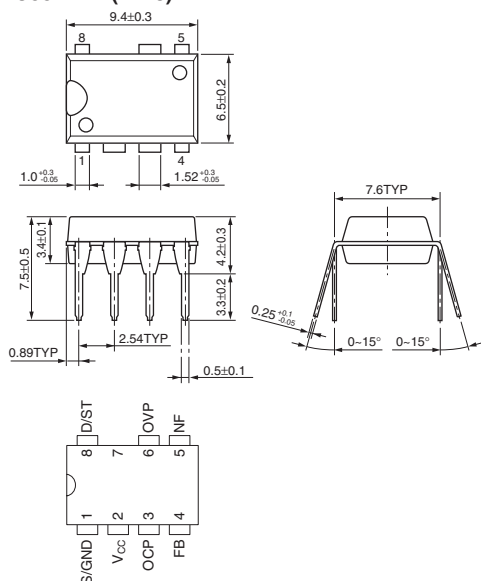
\*2: Thermal resistance between the MOSFET channel and the case. The case temperature Tc is determined by the temperature at the center of the marking surface.

\*3: Thermal resistance between the MOSFET channel and the internal frame

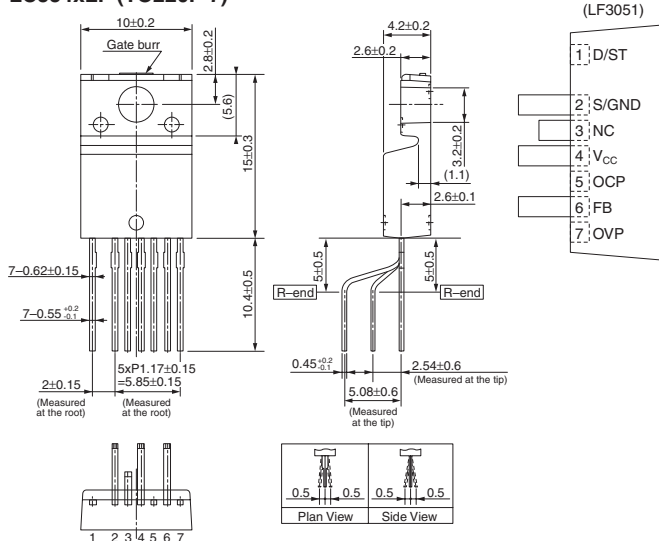
## External Dimensions

(Unit : mm)

### LC554xLD (DIP8)



### LC554xLF (TO220F-7)



## Pin Functions

### LC554xLD (DIP8)

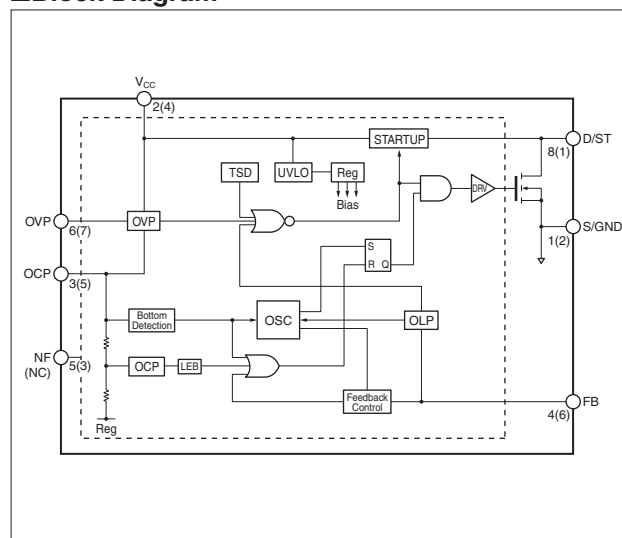
| Pin No. | Symbol | Function                                                                                       |
|---------|--------|------------------------------------------------------------------------------------------------|
| 1       | S/GND  | MOSFET source and GND for control                                                              |
| 2       | Vcc    | Control circuit power input and Overvoltage protection signal input                            |
| 3       | OCP    | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 4       | FB     | Feedback signal input and Overload protection signal input                                     |
| 5       | NF     | (No function*)                                                                                 |
| 6       | OVP    | Overvoltage protection signal input                                                            |
| 7       | —      | (Pin removed)                                                                                  |
| 8       | D/ST   | MOSFET drain and Startup current input                                                         |

\*: NF (pin 5) connects to the stable potential S/GND pattern (pin 1 potential) via the shortest distance for stable operation.

### LC554xLF (TO220F-7)

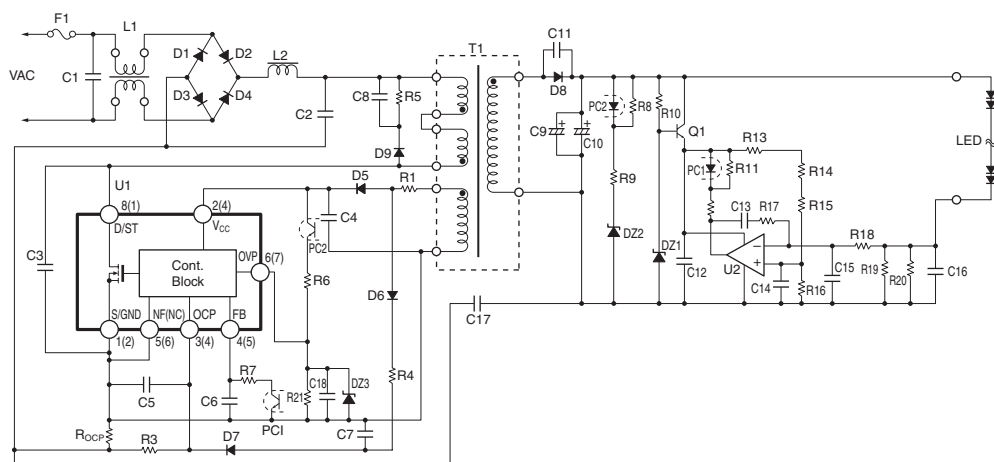
| Pin No. | Symbol | Function                                                                                       |
|---------|--------|------------------------------------------------------------------------------------------------|
| 1       | D/ST   | MOSFET drain and Startup current input                                                         |
| 2       | S/GND  | MOSFET source and GND for control                                                              |
| 3       | Vcc    | Control circuit power input and Overvoltage protection signal input                            |
| 4       | OCP    | Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input |
| 5       | FB     | Feedback signal input and Overload protection signal input                                     |
| 6       | NC     | —                                                                                              |
| 7       | OVP    | Overvoltage protection signal input                                                            |

## Block Diagram



## Typical Connection Diagram

The pin number for DIP8 is indicated. The pin number for TO220F-7 is indicated in parentheses.



# LC5720S Series Current Mode PWM Control LED Lighting IC

## ■Features

- HSOP8 package
- Input voltage range (VIN): 8.5 to 50V
- High efficiency of at least 90%
- Current mode PWM control
- Buck, Boost, Buck-Boost operations
- PWM dimming
- Output current: 2A
- Oscillation frequency: 500kHz
- Protection functions
  - Overcurrent protection (OCP)
  - Overvoltage protection (OVP)
  - Thermal shutdown (TSD)

## ■Applications

- DC input LED lighting
- Indoor/outdoor LED lighting
- LED spotlights
- RGB LED lighting

## ■Absolute Maximum Ratings

(Ta = 25°C)

| Parameter                                    | Symbol   | Ratings     | Unit | Conditions                                                                      |
|----------------------------------------------|----------|-------------|------|---------------------------------------------------------------------------------|
| VIN Pin Voltage                              | VIN      | −0.3 to 50  | V    |                                                                                 |
| SW Pin Voltage                               | VSW      | −0.3 to 50  | V    |                                                                                 |
| CSP Pin Voltage                              | VCSP     | −0.3 to 50  | V    |                                                                                 |
| CSN Pin Voltage                              | VCSN     | −0.3 to 50  | V    |                                                                                 |
| CSP/CSN Pin Differential Voltage             | VCSP-CSN | −0.3 to 5.5 | V    |                                                                                 |
| COMP Pin Voltage                             | VCOMP    | −0.3 to 5.5 | V    |                                                                                 |
| DIM Pin Voltage                              | VDIM     | −0.3 to 5.5 | V    |                                                                                 |
| Power Dissipation                            | Pd       | 1.35        | W    | Measured on a 30×30mm glass-epoxy board (with a 625mm <sup>2</sup> copper area) |
| Junction Temperature                         | TJ       | 125         | °C   |                                                                                 |
| Storage Temperature                          | Tstg     | −40 to 150  | °C   |                                                                                 |
| Thermal Resistance (Junction to Ambient Air) | θj-a     | 74          | °C/W | Measured on a 30×30mm glass-epoxy board (with a 625mm <sup>2</sup> copper area) |

## ■Recommended Operating Conditions

| Parameter                         | Symbol | Ratings     | Unit |
|-----------------------------------|--------|-------------|------|
| Input Voltage Range               | VIN    | 9 to 46     | V    |
| Output Current Range              | IOUT   | Up to 2.0   | A    |
| PK- PK Inductor Ripple Current    | ΔIL    | Up to 0.8   | A    |
| PWM Dimmer Signal Frequency Range | fPWM   | 32 to 20000 | Hz   |
| Operating Temperature Range       | TOP    | −40 to 85   | °C   |

\*: Exceeding these ratings may damage the device.

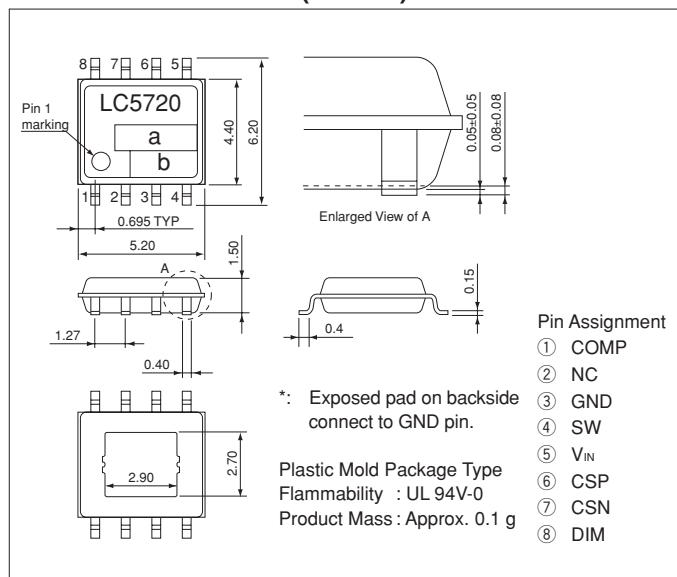
## ■Electrical Characteristics

(Ta = 25°C, VIN = 15V, unless otherwise specified)

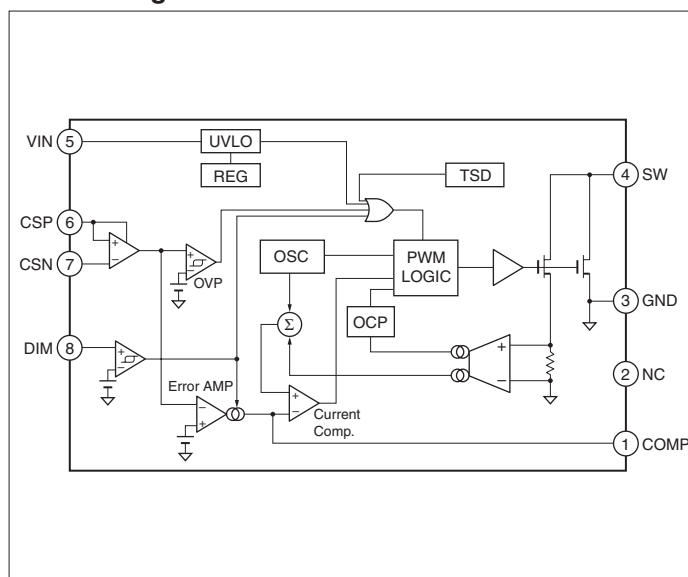
| Parameter                         | Symbol     | Ratings |      |      | Unit | Conditions          |
|-----------------------------------|------------|---------|------|------|------|---------------------|
|                                   |            | min.    | typ. | max. |      |                     |
| Operation Startup Voltage         | VIN (ON)   | 7.7     | 8.5  | 9.4  | V    |                     |
| Operation Stop Voltage            | VIN (OFF)  | 7.2     | 8.0  | 8.9  | V    |                     |
| Operation Startup/Stop Hysteresis | VIN (HYS)  | 0.1     | 0.3  | 0.5  | V    |                     |
| Supply Current (Operating)        | IIN (ON)   |         |      | 7.0  | mA   |                     |
| Supply Current (Shutdown)         | IIN (OFF)  |         |      | 1000 | μA   | VIN=6.5V            |
| Oscillation Frequency             | fosc       | 420     | 500  | 570  | kHz  |                     |
| Minimum ON Time                   | tON (MIN)  | 35      | 75   | 100  | nsec | VCOMP=0V            |
| Maximum ON Duty                   | DMAX       | 89      | 94   | 98   | %    | VCOMP=4V            |
| ON Time 1                         | tON (1)    | 300     | 600  | 800  | nsec | VCOMP=0.7V          |
| ON Time 2                         | tON (2)    | 0.85    | 1.4  | 1.8  | usec | VCOMP=1.2V          |
| Current Sense Voltage             | VCS        | 95      | 100  | 105  | mV   |                     |
| CSP Pin Input Current             | ICSP       | 85      | 130  | 175  | μA   |                     |
| CSN Pin Input Current             | ICSN       | 40      | 65   | 95   | μA   |                     |
| CSP Pin Operation Voltage         | VCSP (OPR) | 4.75    |      | 50   | V    |                     |
| COMP Pin Source Current           | ICOMP (SO) | −95     | −60  | −38  | μA   | VCS=20mV, VCOMP=2V  |
| COMP Pin Sink Current             | ICOMP (SI) | 38      | 60   | 95   | μA   | VCS=180mV, VCOMP=2V |
| OVP Threshold                     | VCS (OVP)  | 200     | 240  | 280  | mV   |                     |
| SW Pin Leakage Current            | ISW (LEAK) |         |      | 100  | μA   |                     |
| DIM Pin Voltage During LED ON     | VDIM (ON)  | 1.2     | 1.4  | 1.7  | V    |                     |
| DIM Pin Voltage During LED OFF    | VDIM (OFF) | 0.75    | 1.0  | 1.2  | V    |                     |
| DIM Pin Hysteresis                | VDIM (HYS) | 0.3     | 0.5  | 0.7  | V    |                     |
| Error Amplifier Conductance       | GM         |         | 750  |      | μS   |                     |
| SW ON Resistance                  | RSW (L)    |         | 215  |      | mΩ   | ISW=1A              |
| SW Pin Limiting Current           | ISW (LIM)  |         | 3.5  |      | A    |                     |
| Thermal Shutdown                  | TSD        |         | 160  |      | °C   |                     |
| Thermal Shutdown Hysteresis       | TSD_hys    |         | 15   |      | °C   |                     |

## ■External Dimensions (HSOP8)

(Unit : mm)

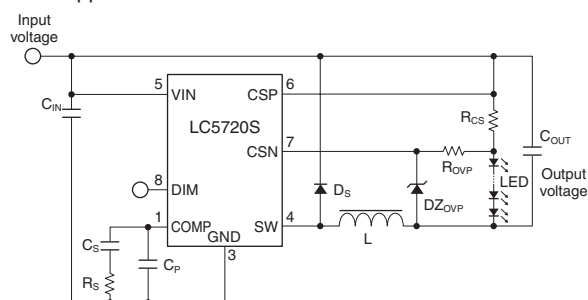


## ■Block Diagram



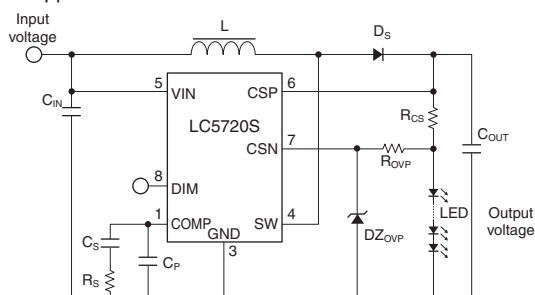
## ■Typical Connection Diagram

## Buck Application



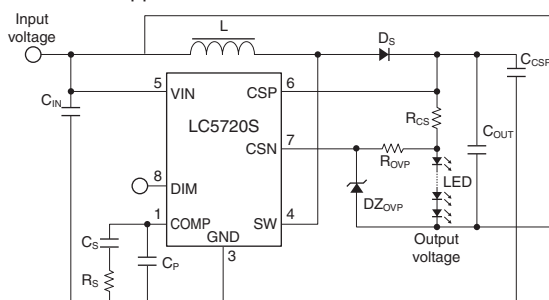
$C_{IN}$ : 1 $\mu$ F/50V  
 $C_{OUT}$ : 1 $\mu$ F/50V  
 $C_S$ : 0.22 $\mu$ F  
 $C_P$ : 0.022 $\mu$ F  
 $R_S$ : 33k $\Omega$   
 $R_{CS}$ : 0.1 $\Omega$  (When  $I_{LED}$ =1A)  
 $D_S$ : SJPB-L6  
 $L$ : 22 $\mu$ H (When  $V_{IN}$ =18V,  $V_{LED}$ =10V)

## Boost Application



$C_{IN}$ : 1 $\mu$ F/50V  
 $C_{OUT}$ : 1 $\mu$ F/50V  
 $C_S$ : 0.22 $\mu$ F  
 $C_P$ : 0.022 $\mu$ F  
 $R_S$ : 33k $\Omega$   
 $R_{CS}$ : 0.1 $\Omega$  (When  $I_{LED}$ =1A)  
 $D_S$ : SJPB-L6  
 $L$ : 22 $\mu$ H (When  $V_{IN}$ =10V,  $V_{LED}$ =18V)

## Buck-Boost Application



$C_{IN}$ : 1 $\mu$ F/50V  
 $C_{OUT}$ : 1 $\mu$ F/50V  
 $C_S$ : 0.22 $\mu$ F  
 $C_P$ : 0.022 $\mu$ F  
 $R_S$ : 33k $\Omega$   
 $R_{CS}$ : 0.1 $\Omega$  (When  $I_{LED}$ =1A)  
 $D_S$ : SJPB-L6  
 $L$ : 22 $\mu$ H (When  $V_{IN}$ =15V,  $V_{LED}$ =18V)



# *Transistors*

|                                                                     |            |
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Ordering Information

All products listed must be ordered in standard packing increments.

| Series Name/<br>Product Name | Package | Standard Packing Quantities |        |
|------------------------------|---------|-----------------------------|--------|
|                              |         | Bulk                        | Taping |
| 2SA1186                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1215                      | MT200   | 250(Box)                    | –      |
| 2SA1216                      | MT200   | 250(Box)                    | –      |
| 2SA1294                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1295                      | MT200   | 250(Box)                    | –      |
| 2SA1303                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1386                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1386A                     | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1488                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1488A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1492                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1493                      | MT200   | 250(Box)                    | –      |
| 2SA1494                      | MT200   | 250(Box)                    | –      |
| 2SA1567                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1568                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1667                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1668                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1673                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA1693                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1694                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1695                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA1725                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1746                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA1859                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1859A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SA1860                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA1907                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA1908                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA1909                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SA2151                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA2151A                     | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SA2223                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1257                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SB1258                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SB1259                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SB1351                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SB1382                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SB1383                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1420                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1559                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1560                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1570                      | MT200   | 250(Box)                    | –      |
| 2SB1587                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SB1588                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SB1647                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SB1648                      | MT200   | 250(Box)                    | –      |
| 2SB1649                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC2837                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC2921                      | MT200   | 250(Box)                    | –      |
| 2SC2922                      | MT200   | 250(Box)                    | –      |
| 2SC3263                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3264                      | MT200   | 250(Box)                    | –      |

| Series Name/<br>Product Name | Package | Standard Packing Quantities |        |
|------------------------------|---------|-----------------------------|--------|
|                              |         | Bulk                        | Taping |
| 2SC3284                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3519                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3519A                     | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3835                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3851                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC3851A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC3852                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC3852A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC3856                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC3857                      | MT200   | 250(Box)                    | –      |
| 2SC3858                      | MT200   | 250(Box)                    | –      |
| 2SC3927                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4024                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4131                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC4138                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4140                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4153                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4300                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC4301                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC4304                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4381                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4382                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4388                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC4445                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC4466                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4467                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4468                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4495                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4511                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4518                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4518A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4546                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4706                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC4883                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4883A                     | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC4886                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC5071                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC5099                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC5100                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC5101                      | TO3PF   | 500(Box)/1080(Stick)        | –      |
| 2SC5130                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SC5287                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC6011                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC6011A                     | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SC6145                      | TO3P    | 500(Box)/1080(Stick)        | –      |
| 2SD1785                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD1796                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD2014                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD2015                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD2016                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD2017                      | TO220F  | 1000(Box)/3750(Stick)       | –      |
| 2SD2045                      | TO3PF   | 500(Box)/1080(Stick)        | –      |

| Series Name/<br>Product Name | Package               | Standard Packing Quantities |        |
|------------------------------|-----------------------|-----------------------------|--------|
|                              |                       | Bulk                        | Taping |
| 2SD2081                      | TO220F                | 1000(Box)/3750(Stick)       | —      |
| 2SD2082                      | TO3PF                 | 500(Box)/1080(Stick)        | —      |
| 2SD2083                      | TO3P                  | 500(Box)/1080(Stick)        | —      |
| 2SD2141                      | TO220F                | 1000(Box)/3750(Stick)       | —      |
| 2SD2389                      | TO3P                  | 500(Box)/1080(Stick)        | —      |
| 2SD2390                      | TO3P                  | 500(Box)/1080(Stick)        | —      |
| 2SD2401                      | MT200                 | 250(Box)                    | —      |
| 2SD2438                      | TO220F                | 1000(Box)/3750(Stick)       | —      |
| 2SD2439                      | TO3PF                 | 500(Box)/1080(Stick)        | —      |
| 2SD2560                      | TO3P                  | 500(Box)/1080(Stick)        | —      |
| 2SD2561                      | MT200                 | 250(Box)                    | —      |
| 2SD2562                      | TO3PF                 | 500(Box)/1080(Stick)        | —      |
| 2SD2641                      | TO3P                  | 500(Box)/1080(Stick)        | —      |
| 2SD2642                      | TO220F                | 1000(Box)/3750(Stick)       | —      |
| 2SD2643                      | TO3PF                 | 500(Box)/1080(Stick)        | —      |
| 2SK2420                      | TO220F                | 3750(Stick)                 | —      |
| 2SK2701A                     | TO220F                | 3750(Stick)                 | —      |
| 2SK2803                      | TO220F                | 3750(Stick)                 | —      |
| 2SK2848                      | TO220F                | 3750(Stick)                 | —      |
| 2SK2943                      | TO220F                | 3750(Stick)                 | —      |
| 2SK3003                      | TO220F                | 3750(Stick)                 | —      |
| 2SK3004                      | TO220F                | 3750(Stick)                 | —      |
| 2SK3199                      | TO220F                | 3750(Stick)                 | —      |
| 2SK3710                      | TO220S(Surface-mount) | —                           | 1000   |
| 2SK3711                      | TO3P                  | 1080(Stick)                 | —      |
| 2SK3800                      | TO220S(Surface-mount) | —                           | 1000   |
| 2SK3801                      | TO3P                  | 1080(Stick)                 | —      |
| EKG1020                      | TO220                 | 4000(Stick)                 | —      |
| EKH04100                     | TO220                 | 4000(Stick)                 | —      |
| EKH06100                     | TO220                 | 4000(Stick)                 | —      |
| EKH1070                      | TO220                 | 4000(Stick)                 | —      |
| EKV550                       | TO220                 | 1000(Stick)                 | —      |
| FGM603                       | TO3PF                 | 1080(Stick)                 | —      |
| FGM622S                      | TO3PF                 | 1080(Stick)                 | —      |
| FGM623S                      | TO3PF                 | 1080(Stick)                 | —      |
| FKG1020                      | TO220F-A              | 4000(Stick)                 | —      |
| FKH0470                      | TO220F-A              | 4000(Stick)                 | —      |
| FKH0660                      | TO220F-A              | 4000(Stick)                 | —      |
| FKH1040                      | TO220F-A              | 4000(Stick)                 | —      |
| FKP202                       | TO220F                | 3750(Stick)                 | —      |
| FKP250A                      | TO3PF                 | 1080(Stick)                 | —      |
| FKP252                       | TO220F                | 3750(Stick)                 | —      |
| FKP253                       | TO220F                | 3750(Stick)                 | —      |
| FKP280A                      | TO3PF                 | 1080(Stick)                 | —      |
| FKP300A                      | TO3PF                 | 1080(Stick)                 | —      |
| FKP330C                      | TO3PF                 | 1080(Stick)                 | —      |
| FKV460S                      | TO220S(Surface-mount) | —                           | 1000   |
| FKV550N                      | TO220F                | 3750(Stick)                 | —      |
| FKV575                       | TO220F                | 3750(Stick)                 | —      |
| FKV660S                      | TO220S(Surface-mount) | —                           | 1000   |
| MGD623N                      | TO3P                  | 1080(Stick)                 | —      |
| MGD623S                      | TO3P                  | 1080(Stick)                 | —      |

| Series Name/<br>Product Name | Package              | Standard Packing Quantities |        |
|------------------------------|----------------------|-----------------------------|--------|
|                              |                      | Bulk                        | Taping |
| MKS5015                      | TO3P                 | 1440(Stick)                 | —      |
| MKS5020                      | TO3P                 | 1440(Stick)                 | —      |
| SKH04100                     | TO263(Surface-mount) | —                           | 6400   |
| SKH06100                     | TO263(Surface-mount) | —                           | 6400   |
| SKH1070                      | TO263(Surface-mount) | —                           | 6400   |
| SKP202                       | TO263(Surface-mount) | —                           | 6400   |
| SKP253                       | TO263(Surface-mount) | —                           | 6400   |
| SLA4xxx                      | SLA12Pin             | 250(Box)/1080(Stick)        | —      |
| SLA4xxx                      | SLA21Pin             | 250(Box)/1080(Stick)        | —      |
| SLA5xxx                      | SLA12Pin             | 250(Box)/1080(Stick)        | —      |
| SLA5xxx                      | SLA15Pin             | 250(Box)/1080(Stick)        | —      |
| SLA6xxx                      | SLA12Pin             | 250(Box)/1080(Stick)        | —      |
| SMA4xxx                      | SMA12Pin             | 1440(Stick)                 | —      |
| SMA5xxx                      | SMA12Pin             | 1440(Stick)                 | —      |
| SMA5xxx                      | SMA15Pin             | 1440(Stick)                 | —      |
| SMA6xxx                      | SMA12Pin             | 1440(Stick)                 | —      |
| STAxxx                       | STA8Pin              | 1000(Box)/4050(Stick)       | —      |
| STAxxx                       | STA10Pin             | 3200(Box)/3300(Stick)       | —      |
| STD01N                       | TO3P-5               | 500(Box)/1080(Stick)        | —      |
| STD01P                       | TO3P-5               | 500(Box)/1080(Stick)        | —      |
| STD03N                       | TO3P-5               | 500(Box)/1080(Stick)        | —      |
| STD03P                       | TO3P-5               | 500(Box)/1080(Stick)        | —      |

# Application Note

Since reliability can be affected adversely by improper storage environment or handling methods during Characteristic tests, please observe the following cautions.

## Cautions for Storage

- Ensure that storage conditions comply with the normal temperature (5 to 35°C) and the normal relative humidity (around 40 to 75%), and avoid storage locations that experience high temperature and humidity, or extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present, and avoid direct sunlight.
- Reinspect the devices for rust in leads and solderability after stored for a long time.

## Cautions for Characteristic Tests and Handling

On characteristics test at incoming inspection, etc, take good care to avoid the surge voltages from the test equipment, the short circuit at terminals, or the wrong connection.

## Silicone Grease

When using a heatsink, please coat thinly and evenly the back surface of the device and both surfaces of the insulating plate with silicone grease to lower the thermal resistance between the device and the heatsink. Please select proper silicone grease carefully since the oil in some grease products may penetrate the device and result in an extremely short device life.

- Recommended Silicone Grease
- G-746 (Shin-Etsu Chemical)
  - YG6260 (Momentive Performance Materials Inc.)
  - SC102 (Dow Corning Toray Silicone)

## Mounting Torque

When mounting torque is insufficient, thermal resistance increases, and so heat radiation effect is decreased. When the torque is excessive, the screw may be broken, the heatsink may be deformed, and the device frame may be distorted, resulting in the device damage. Recommended mounting torque per package is as follows:

● Mounting Torque Table

| Package                      | Screw Torque                      |
|------------------------------|-----------------------------------|
| TO-220                       | 0.490 to 0.686 N•m (5 to 7kgf•cm) |
| TO-220F (FM20)               |                                   |
| TO-3P (MT-100)               |                                   |
| TO-3PF(FM100 )               | 0.686 to 0.882 N•m (7 to 9kgf•cm) |
| MT-200 (fixed at two points) |                                   |
| SIP with Fin (SLA)           | 0.588 to 0.784 N•m (6 to 8kgf•cm) |

- \* When the surface of a heatsink where Full Mold package is to be mounted is not flat due to the burred metal bracket for screwing around the mounting hole of the heatsink, the resin of the package might be cracked even if the torque is lower than the recommended value.
- \* When a screw is fastened with an air driver for the Full Mold package, a large impact is generated at the time of stop, and the resin may crack even if the torque is lower than the recommended value. An electric driver, therefore, should be used instead of an air driver.

## Heatsink

A larger contact area between the device and the heatsink is required for more effective heat radiation. To ensure a larger contact area, minimize mounting holes. And select a heatsink with a surface smooth enough and free from burrs and slivers.

## Soldering Temperature

In general, the device mounted on a printed circuit board is subjected to high temperatures from flow solder in a solder bath, or, from a soldering iron at hand soldering.  
The testing method and test conditions for a device's heat resistance to soldering are:  
At a distance of 1.5mm from the device's main body, apply 260°C for 10 seconds, and 350°C for 3 seconds.  
Please observe these limits and finish soldering in as short a time as possible.

## Antistatic Measure for Power MOS FET Arrays

- When handling the device, body grounding is necessary. Wear a wrist strap with a 1 MΩ resistor close to the body in the wrist strap to prevent electric shock.
- Use a conductive tablemat and a floor mat at the device-handling workbench and ground them properly.
- When using a curve tracer or other measuring equipment, ground them as well.
- In soldering, ground the soldering iron tip and the solder bath to prevent a leakage voltage from damaging the device.
- As an antistatic measure for device containers, use Sanken shipping containers or a conductive containers, or use aluminum foils.  
Since reliability can be affected adversely by improper storage environment or handling methods during Characteristic tests, please observe the following cautions.

# Selection Guide

 $V_{CEO}-I_C$ 

|                                                   |     |                                         |                                  |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|---------------------------------------------------|-----|-----------------------------------------|----------------------------------|---------------------------|--------------------------|----------------------------------------------------|----------------------------------|----------------------------------------------------|----------------|----------------------------------|----------------------------------|------------------------------------------------------|-------------------------|----------------|-------|----------------|
| Collector–Emitter Voltage    V <sub>ceo</sub> (V) | 800 |                                         | C4304<br>C4445                   |                           | C4300                    |                                                    | C4301                            |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 600 |                                         |                                  |                           |                          |                                                    |                                  |                                                    |                | C4706                            |                                  |                                                      |                         |                |       |                |
|                                                   | 550 |                                         |                                  |                           | C4518<br>C4518A<br>C5287 |                                                    |                                  |                                                    | C3927          |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 400 |                                         |                                  |                           | C5130                    |                                                    | C4546                            |                                                    | C4138          | C5071                            |                                  |                                                      |                         |                | C4140 |                |
|                                                   | 380 |                                         |                                  |                           |                          | D2141                                              |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 250 |                                         |                                  |                           |                          | D2017                                              |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 230 |                                         |                                  |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  | A1294<br>C3263<br>A2151A<br>C6011A<br>A2223<br>C6145 |                         | A1295<br>C3264 |       |                |
|                                                   | 200 | A1668<br>C4382                          | D2016                            |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  | A1493<br>C3857<br>A2151<br>C6011                     |                         | A1494<br>C3858 |       |                |
|                                                   | 180 | A1859A<br>C4883A                        |                                  |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  | A1386A<br>A1492<br>A1673<br>C3519A<br>C3856<br>C4388 |                         | A1216<br>C2922 |       |                |
|                                                   | 160 |                                         |                                  |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  | A1215<br>A1386<br>C2921<br>C3519                     |                         |                |       |                |
|                                                   | 150 | A1667<br>A1859<br>C4381<br>C4883        |                                  |                           |                          |                                                    | B1559<br>B1587<br>D2389<br>D2438 | A1186<br>B1560<br>B1588<br>C2837<br>D2390<br>D2439 | B1570<br>D2401 | A1303<br>A1860<br>C3284<br>C4886 | B1647<br>B1649<br>D2560<br>D2562 |                                                      | B1648<br>D2561          |                |       |                |
|                                                   | 140 |                                         |                                  |                           |                          |                                                    |                                  | A1695<br>A1909<br>C4468<br>C5101                   |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 120 |                                         |                                  | D2015                     |                          | D1785<br>D2045                                     | C3835<br>C4153                   | A1694<br>A1908<br>C4467<br>C5100                   | B1259<br>D2081 |                                  |                                  |                                                      | B1382<br>B1420<br>D2082 |                |       | B1383<br>D2083 |
|                                                   | 110 |                                         |                                  |                           |                          | D2641<br>D2642<br>D2643                            |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 100 |                                         |                                  |                           |                          | B1258                                              |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
|                                                   | 80  |                                         | C3852A                           | A1488A<br>C3851A<br>D2014 |                          | A1693<br>A1725<br>A1907<br>C4466<br>C4511<br>C5099 |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |
| 60                                                |     | C3852                                   | A1488<br>B1257<br>C3851<br>D1796 |                           |                          |                                                    |                                  |                                                    | A1568<br>B1351 |                                  |                                  |                                                      |                         |                |       |                |
| 50                                                |     | C4495                                   |                                  |                           |                          |                                                    |                                  | C4024                                              | A1567<br>A1746 |                                  | C4131                            |                                                      |                         |                |       |                |
|                                                   |     | 2                                       | 3                                | 4                         | 5                        | 6                                                  | 7                                | 8                                                  | 10             | 12                               | 14                               | 15                                                   | 16                      | 17             | 18    | 25             |
|                                                   |     | Collector Current    I <sub>c</sub> (A) |                                  |                           |                          |                                                    |                                  |                                                    |                |                                  |                                  |                                                      |                         |                |       |                |

Collector Current  $I_C(A)$

Audio Transistors

Output Transistors

| Pc<br>(W) | Ic<br>(A) | V <sub>CE0</sub><br>(V) | Chip               |          |          |          |            |         | Package                      |
|-----------|-----------|-------------------------|--------------------|----------|----------|----------|------------|---------|------------------------------|
|           |           |                         | Single Transistors |          |          |          | Darlington |         |                              |
|           |           |                         | General            |          | LAPT     |          |            |         |                              |
| 30        | 6         | 80                      | 2SA1725            | 2SC4511  |          |          |            |         | TO-220F (FM20)               |
| 60        | 6         | 80                      | 2SA1693            | 2SC4466  |          |          |            |         | TO-3P (MT-100)               |
|           | 6         | 80                      | 2SA1907            | 2SC5099  |          |          |            |         | TO-3PF (FM100)               |
| 75        | 8         | 120                     | 2SA1908            | 2SC5100  |          |          |            |         | TO-3PF (FM100)               |
|           | 8         | 150                     |                    |          |          |          | 2SB1587    | 2SD2438 | TO-3PF (FM100)               |
| 80        | 8         | 120                     | 2SA1694            | 2SC4467  |          |          |            |         | TO-3P (MT-100)               |
|           | 10        | 140                     | 2SA1909            | 2SC5101  |          |          |            |         | TO-3PF (FM100)               |
|           | 8         | 150                     |                    |          |          |          | 2SB1559    | 2SD2389 | TO-3P (MT-100)               |
|           | 10        | 150                     |                    |          |          |          | 2SB1588    | 2SD2439 | TO-3PF (FM100)               |
|           | 14        | 150                     |                    |          | 2SA1860  | 2SC4886  |            |         | TO-3PF (FM100)               |
| 85        | 15        | 150                     |                    |          |          |          | 2SB1649    | 2SD2562 | TO-3PF (FM100)               |
|           | 15        | 180                     | 2SA1673            | 2SC4388  |          |          |            |         | TO-3PF (FM100)               |
| 100       | 10        | 140                     | 2SA1695            | 2SC4468  |          |          |            |         | TO-3P (MT-100)               |
|           | 10        | 150                     |                    |          | 2SA1186  | 2SC2837  |            |         | TO-3P (MT-100)               |
|           | 10        | 150                     |                    |          |          |          | 2SB1560    | 2SD2390 | TO-3P (MT-100)               |
| 125       | 14        | 150                     |                    |          | 2SA1303  | 2SC3284  |            |         | TO-3P (MT-100)               |
| 130       | 15        | 150                     |                    |          |          |          | 2SB1647    | 2SD2560 | TO-3P (MT-100)               |
|           | 15        | 160                     |                    |          | 2SA1386  | 2SC3519  |            |         | TO-3P (MT-100)               |
|           | 15        | 180                     | 2SA1492            | 2SC3856  |          |          |            |         | TO-3P (MT-100)               |
|           | 15        | 180                     |                    |          | 2SA1386A | 2SC3519A |            |         | TO-3P (MT-100)               |
|           | 15        | 230                     |                    |          | 2SA1294  | 2SC3263  |            |         | TO-3P (MT-100)               |
| 150       | 12        | 150                     |                    |          |          |          | 2SB1570    | 2SD2401 | MT-200 (fixed at two points) |
|           | 15        | 160                     |                    |          | 2SA1215  | 2SC2921  |            |         | MT-200 (fixed at two points) |
|           | 15        | 200                     | 2SA1493            | 2SC3857  |          |          |            |         | MT-200 (fixed at two points) |
| 160       | 15        | 200                     | 2SA2151            | 2SC6011  |          |          |            |         | TO-3P (MT-100)               |
|           | 15        | 230                     | 2SA2151A           | 2SC6011A |          |          |            |         | TO-3P (MT-100)               |
|           | 15        | 230                     | 2SA2223            | 2SC6145  |          |          |            |         | TO-3P (MT-100)               |
| 200       | 17        | 150                     |                    |          |          |          | 2SB1648    | 2SD2561 | MT-200 (fixed at two points) |
|           | 17        | 180                     |                    |          | 2SA1216  | 2SC2922  |            |         | MT-200 (fixed at two points) |
|           | 17        | 200                     | 2SA1494            | 2SC3858  |          |          |            |         | MT-200 (fixed at two points) |
|           | 17        | 230                     |                    |          | 2SA1295  | 2SC3264  |            |         | MT-200 (fixed at two points) |

LAPT (Linear Amplified Power Transistor): Multi-Emitter Transistor for High-Frequency

Output Transistors with Temperature Compensating Function (Refer to our Web site for applications)

| Part Number |        | Pc (W) | Ic (A) | VCE0 (V) | Package   |
|-------------|--------|--------|--------|----------|-----------|
| STD01P      | STD01N | 100    | 10     | 150      | TO3P-5pin |
| STD03P      | STD03N | 160    | 15     | 160      | TO3P-5pin |

Driver and Temperature Compensating Transistors

| Part Number |          | Pc (W) | VCE0 (V) | Ic (A) | hFE (min) | fT (MHz) | Package        | Remarks                      |
|-------------|----------|--------|----------|--------|-----------|----------|----------------|------------------------------|
| 2SC4495     |          | 25     | 50       | 3      | 500       | 40       | TO-220F (FM20) | For temperature compensation |
| 2SA1859     | 2SC4883  | 20     | 150      | 2      | 60        | 60/120   | TO-220F (FM20) | Driver                       |
| 2SA1859A    | 2SC4883A | 20     | 180      | 2      | 60        | 60/120   | TO-220F (FM20) | Driver                       |
| 2SA1667     | 2SC4381  | 25     | 150      | 2      | 60        | 20/15    | TO-220F (FM20) | Driver                       |
| 2SA1668     | 2SC4382  | 25     | 200      | 2      | 60        | 20/15    | TO-220F (FM20) | Driver                       |

Refer to our Web site for the hFE ranks.

## Switching Transistors

### ■DC-DC Converter

| Part Number | V <sub>CE0</sub><br>(V) | V <sub>CE0</sub><br>(V) | I <sub>C</sub><br>(A) | P <sub>C</sub><br>(W) | Package |
|-------------|-------------------------|-------------------------|-----------------------|-----------------------|---------|
| 2SC4024     | 100                     | 50                      | 10                    | 35                    | TO-220F |
| 2SC4131     |                         |                         | 15                    | 60                    | TO-3PF  |
| 2SC4153     | 200                     | 120                     | 7                     | 30                    | TO-220F |
| 2SC3835     |                         |                         |                       | 70                    | TO-3P   |

### ■For AC100V Input

| Part Number | V <sub>CE0</sub><br>(V) | V <sub>CE0</sub><br>(V) | I <sub>C</sub><br>(A) | P <sub>C</sub><br>(W) | Package |
|-------------|-------------------------|-------------------------|-----------------------|-----------------------|---------|
| 2SC4138     | 500                     | 400                     | 10                    | 80                    | TO-3P   |
| 2SC5071     |                         |                         | 12                    | 100                   | TO-3P   |
| 2SC4140     |                         |                         | 18                    | 130                   | TO-3P   |
| 2SC5130     | 600                     | 400                     | 5                     | 30                    | TO-220F |
| 2SC4546     |                         |                         | 7                     | 30                    | TO-220F |

### ■For AC200V Input

| Part Number | V <sub>CE0</sub><br>(V) | V <sub>CE0</sub><br>(V) | I <sub>C</sub><br>(A) | P <sub>C</sub><br>(W) | Package |
|-------------|-------------------------|-------------------------|-----------------------|-----------------------|---------|
| 2SC4518     | 900                     | 550                     | 5                     | 35                    | TO-220F |
| 2SC5287     |                         |                         |                       | 80                    | TO-3P   |
| 2SC3927     |                         |                         | 10                    | 120                   | TO-3P   |
| 2SC4706     |                         | 600                     | 14                    | 130                   | TO-3P   |
| 2SC4304     |                         | 800                     | 3                     | 35                    | TO-220F |
| 2SC4445     |                         |                         |                       | 60                    | TO-3PF  |
| 2SC4300     |                         |                         | 5                     | 75                    | TO-3PF  |
| 2SC4301     |                         |                         | 7                     | 80                    | TO-3PF  |
| 2SC4518A    | 1000                    | 550                     | 5                     | 35                    | TO-220F |

## Specifications List by Part Number

| Part Number | Applications                                              | Absolute Maximum Ratings |                  |                 |                |                  |                 |                        |       |     |      |                        |
|-------------|-----------------------------------------------------------|--------------------------|------------------|-----------------|----------------|------------------|-----------------|------------------------|-------|-----|------|------------------------|
|             |                                                           | V <sub>CB0</sub>         | V <sub>CEO</sub> | I <sub>c</sub>  | P <sub>c</sub> | I <sub>CB0</sub> | h <sub>FE</sub> |                        |       |     |      |                        |
|             |                                                           | (V)                      | (V)              | (A)             | (W)            |                  | (μA)            | Conditions             | min   | max |      | Conditions             |
|             |                                                           |                          |                  |                 |                |                  |                 | V <sub>CB</sub><br>(V) |       |     |      | V <sub>CE</sub><br>(V) |
| 2SA1186     | Audio, general-purpose                                    | -150                     | -150             | -10             | 100            | -100             | -150            | 50                     | 180   | -4  | -3   |                        |
| 2SA1215     | Audio, general-purpose                                    | -160                     | -160             | -15             | 150            | -100             | -160            | 50                     | 180   | -4  | -5   |                        |
| 2SA1216     | Audio, general-purpose                                    | -180                     | -180             | -17             | 200            | -100             | -180            | 30                     | 180   | -4  | -8   |                        |
| 2SA1294     | Audio, general-purpose                                    | -230                     | -230             | -15             | 130            | -100             | -230            | 50                     | 140   | -4  | -5   |                        |
| 2SA1295     | Audio, general-purpose                                    | -230                     | -230             | -17             | 200            | -100             | -230            | 50                     | 140   | -4  | -5   |                        |
| 2SA1303     | Audio, general-purpose                                    | -150                     | -150             | -14             | 125            | -100             | -150            | 50                     | 180   | -4  | -5   |                        |
| 2SA1386     | Audio, general-purpose                                    | -160                     | -160             | -15             | 130            | -100             | -160            | 50                     | 180   | -4  | -5   |                        |
| 2SA1386A    | Audio, general-purpose                                    | -180                     | -180             | -15             | 130            | -100             | -180            | 50                     | 180   | -4  | -5   |                        |
| 2SA1488     | Audio, general-purpose                                    | -60                      | -60              | -4              | 25             | -100             | -60             | 40                     |       | -4  | -1   |                        |
| 2SA1488A    | Audio, general-purpose                                    | -80                      | -80              | -4              | 25             | -100             | -80             | 40                     |       | -4  | -1   |                        |
| 2SA1492     | Audio, general-purpose                                    | -180                     | -180             | -15             | 130            | -100             | -180            | 50                     | 180   | -4  | -3   |                        |
| 2SA1493     | Audio, general-purpose                                    | -200                     | -200             | -15             | 150            | -100             | -200            | 50                     | 180   | -4  | -5   |                        |
| 2SA1494     | Audio, general-purpose                                    | -200                     | -200             | -17             | 200            | -100             | -200            | 50                     | 180   | -4  | -8   |                        |
| 2SA1567     | DC motor driver, chopper regulator, general-purpose       | -50                      | -50              | -12             | 35             | -100             | -50             | 50                     |       | -1  | -6   |                        |
| 2SA1568     | DC motor driver, chopper regulator, general-purpose       | -60                      | -60              | ±12             | 35             | -100             | -60             | 50                     |       | -1  | -6   |                        |
| 2SA1667     | TV vertical output, audio output driver, general-purpose  | -150                     | -150             | -2              | 25             | -10              | -150            | 60                     |       | -10 | -0.7 |                        |
| 2SA1668     | TV vertical output, audio output driver, general-purpose  | -200                     | -200             | -2              | 25             | -10              | -200            | 60                     |       | -10 | -0.7 |                        |
| 2SA1673     | Audio, general-purpose                                    | -180                     | -180             | -15             | 85             | -10              | -180            | 50                     | 180   | -4  | -3   |                        |
| 2SA1693     | Audio, general-purpose                                    | -80                      | -80              | -6              | 60             | -10              | -80             | 50                     | 180   | -4  | -2   |                        |
| 2SA1694     | Audio, general-purpose                                    | -120                     | -120             | -8              | 80             | -10              | -120            | 50                     | 180   | -4  | -3   |                        |
| 2SA1695     | Audio, general-purpose                                    | -140                     | -140             | -10             | 100            | -10              | -140            | 50                     | 180   | -4  | -3   |                        |
| 2SA1725     | Audio, general-purpose                                    | -80                      | -80              | -6              | 30             | -10              | -80             | 50                     | 180   | -4  | -2   |                        |
| 2SA1746     | Chopper regulator, switch, general-purpose                | -70                      | -50              | -12 (Pulse -20) | 60             | -10              | -70             | 50                     |       | -1  | -5   |                        |
| 2SA1859     | Audio output driver, TV velocity modulation               | -150                     | -150             | -2              | 20             | -10              | -150            | 60                     | 240   | -10 | -0.7 |                        |
| 2SA1859A    | Audio output driver, TV velocity modulation               | -180                     | -180             | -2              | 20             | -10              | -180            | 60                     | 240   | -10 | -0.7 |                        |
| 2SA1860     | Audio, general-purpose                                    | -150                     | -150             | -14             | 80             | -100             | -150            | 50                     | 180   | -4  | -5   |                        |
| 2SA1907     | Audio, general-purpose                                    | -80                      | -80              | -6              | 60             | -10              | -80             | 50                     | 180   | -4  | -2   |                        |
| 2SA1908     | Audio, general-purpose                                    | -120                     | -120             | -8              | 75             | -10              | -120            | 50                     | 180   | -4  | -3   |                        |
| 2SA1909     | Audio, general-purpose                                    | -140                     | -140             | -10             | 80             | -10              | -140            | 50                     | 180   | -4  | -3   |                        |
| 2SA2151     | Audio, general-purpose                                    | -200                     | -200             | -15             | 160            | -10              | -200            | 50                     | 180   | -4  | -3   |                        |
| 2SA2151A    | Audio, general-purpose                                    | -230                     | -230             | -15             | 160            | -10              | -230            | 50                     | 180   | -4  | -3   |                        |
| 2SA2223     | Audio, general-purpose                                    | -230                     | -230             | -15             | 160            | -10              | -230            | 40                     | 140   | -4  | -5   |                        |
| 2SB1257     | Solenoid/relay/motor driver, general-purpose              | -60                      | -60              | -4 (Pulse -6)   | 25             | -10              | -60             | 2000                   |       | -4  | -3   |                        |
| 2SB1258     | Solenoid/relay/motor driver, general-purpose              | -100                     | -100             | -6 (Pulse -10)  | 30             | -10              | -100            | 1000                   |       | -2  | -3   |                        |
| 2SB1259     | Solenoid/relay/motor driver, general-purpose              | -120                     | -120             | -10 (Pulse -15) | 30             | -10              | -120            | 2000                   |       | -4  | -5   |                        |
| 2SB1351     | Printer head/solenoid/relay/motor driver, general-purpose | -60                      | -60              | -12 (Pulse -20) | 30             | -10              | -60             | 2000                   |       | -4  | -10  |                        |
| 2SB1382     | Chopper regulator, DC motor driver, general-purpose       | -120                     | -120             | -16 (Pulse -26) | 75             | -10              | -120            | 2000                   |       | -4  | -8   |                        |
| 2SB1383     | Chopper regulator, DC motor driver, general-purpose       | -120                     | -120             | -25 (Pulse -40) | 120            | -10              | -120            | 2000                   |       | -4  | -12  |                        |
| 2SB1420     | Chopper regulator, DC motor driver, general-purpose       | -120                     | -120             | -16 (Pulse -26) | 80             | -10              | -120            | 2000                   |       | -4  | -8   |                        |
| 2SB1559     | Audio, series regulator, general-purpose                  | -160                     | -150             | -8              | 80             | -100             | -160            | 5000                   | 30000 | -4  | -6   |                        |
| 2SB1560     | Audio, series regulator, general-purpose                  | -160                     | -150             | -10             | 100            | -100             | -160            | 5000                   | 30000 | -4  | -7   |                        |
| 2SB1570     | Audio, series regulator, general-purpose                  | -160                     | -150             | -12             | 150            | -100             | -160            | 5000                   | 30000 | -4  | -7   |                        |
| 2SB1587     | Audio, series regulator, general-purpose                  | -160                     | -150             | -8              | 75             | -100             | -160            | 5000                   | 30000 | -4  | -6   |                        |
| 2SB1588     | Audio, series regulator, general-purpose                  | -160                     | -150             | -10             | 80             | -100             | -160            | 5000                   | 30000 | -4  | -7   |                        |
| 2SB1647     | Audio, series regulator, general-purpose                  | -150                     | -150             | -15             | 130            | -100             | -150            | 5000                   | 30000 | -4  | -10  |                        |
| 2SB1648     | Audio, series regulator, general-purpose                  | -150                     | -150             | -17             | 200            | -100             | -150            | 5000                   | 30000 | -4  | -10  |                        |
| 2SB1649     | Audio, series regulator, general-purpose                  | -150                     | -150             | -15             | 85             | -100             | -150            | 5000                   | 30000 | -4  | -10  |                        |

| Electrical Characteristics |                       |                       |            |        |                |                |                |                 |                  |                |        | Complementary | Package        | Mass |  |
|----------------------------|-----------------------|-----------------------|------------|--------|----------------|----------------|----------------|-----------------|------------------|----------------|--------|---------------|----------------|------|--|
|                            | V <sub>CE</sub> (sat) | V <sub>BE</sub> (sat) | Conditions |        | f <sub>T</sub> | Conditions     |                | Switching Time  |                  |                | Cob    |               |                |      |  |
|                            |                       |                       |            |        |                |                |                | t <sub>on</sub> | t <sub>stg</sub> | t <sub>r</sub> |        |               |                |      |  |
|                            |                       |                       | (V)        | (V)    |                | I <sub>C</sub> | I <sub>B</sub> | MHz             | V <sub>CE</sub>  | I <sub>E</sub> |        |               |                |      |  |
|                            | max                   | max                   | (A)        | (A)    |                | (V)            | (A)            |                 |                  |                |        |               |                |      |  |
|                            | −2.0                  |                       | −5         | −0.5   | 60             | −12            | 1              | 0.25typ         | 0.8typ           | 0.2typ         | 110typ | 2SC2837       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 50             | −12            | 2              | 0.25typ         | 0.85typ          | 0.2typ         | 400typ | 2SC2921       | MT-200         | 18.4 |  |
|                            | −2.0                  |                       | −8         | −0.8   | 40             | −12            | 2              | 0.3typ          | 0.7typ           | 0.2typ         | 500typ | 2SC2922       | MT-200         | 18.4 |  |
|                            | −2.0                  |                       | −5         | −0.5   | 35             | −12            | 2              | 0.35typ         | 1.5typ           | 0.3typ         | 500typ | 2SC3263       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 35             | −12            | 2              | 0.35typ         | 1.5typ           | 0.3typ         | 500typ | 2SC3264       | MT-200         | 18.4 |  |
|                            | −2.0                  |                       | −5         | −0.5   | 50             | −12            | 2              | 0.25typ         | 0.85typ          | 0.2typ         | 400typ | 2SC3284       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 40             | −12            | 2              | 0.3typ          | 0.7typ           | 0.2typ         | 500typ | 2SC3519       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 40             | −12            | 2              | 0.3typ          | 0.7typ           | 0.2typ         | 500typ | 2SC3519A      | TO-3P (MT-100) | 6.0  |  |
|                            | −0.5                  |                       | −2         | −0.2   | 15             | −12            | 0.2            | 0.25typ         | 0.75typ          | 0.25typ        | 90typ  | 2SC3851       | TO-220F (FM20) | 2.0  |  |
|                            | −0.5                  |                       | −2         | −0.2   | 15             | −12            | 0.2            | 0.25typ         | 0.75typ          | 0.25typ        | 90typ  | 2SC3851A      | TO-220F (FM20) | 2.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 20             | −12            | 0.5            | 0.6typ          | 0.9typ           | 0.2typ         | 500typ | 2SC3856       | TO-3P (MT-100) | 6.0  |  |
|                            | −3.0                  |                       | −10        | −1     | 20             | −12            | 0.5            | 0.3typ          | 0.9typ           | 0.2typ         | 400typ | 2SC3857       | MT-200         | 18.4 |  |
|                            | −2.5                  |                       | −10        | −1     | 20             | −12            | 1              | 0.6typ          | 0.9typ           | 0.2typ         | 500typ | 2SC3858       | MT-200         | 18.4 |  |
|                            | −0.35                 |                       | −6         | −0.3   | 40             | −12            | 0.5            | 0.4typ          | 0.4typ           | 0.2typ         | 330typ |               | TO-220F (FM20) | 2.0  |  |
|                            | −0.35                 |                       | −6         | −0.3   | 40             | −12            | 0.5            | 0.4typ          | 0.4typ           | 0.2typ         | 330typ |               | TO-220F (FM20) | 2.0  |  |
|                            | −1.0                  |                       | −0.7       | −0.07  | 20             | −12            | 0.2            | 0.4typ          | 1.5typ           | 0.5typ         | 60typ  | 2SC4381       | TO-220F (FM20) | 2.0  |  |
|                            | −1.0                  |                       | −0.7       | −0.07  | 20             | −12            | 0.2            | 0.4typ          | 1.5typ           | 0.5typ         | 60typ  | 2SC4382       | TO-220F (FM20) | 2.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 20             | −12            | 0.5            | 0.6typ          | 0.9typ           | 0.2typ         | 500typ | 2SC4388       | TO-3PF (FM100) | 6.5  |  |
|                            | −1.5                  |                       | −2         | −0.2   | 20             | −12            | 0.5            | 0.18typ         | 1.1typ           | 0.21typ        | 150typ | 2SC4466       | TO-3P (MT-100) | 6.0  |  |
|                            | −1.5                  |                       | −3         | −0.3   | 20             | −12            | 0.5            | 0.14typ         | 1.4typ           | 0.21typ        | 300typ | 2SC4467       | TO-3P (MT-100) | 6.0  |  |
|                            | −0.5                  |                       | −5         | −0.5   | 20             | −12            | 0.5            | 0.17typ         | 1.86typ          | 0.27typ        | 400typ | 2SC4468       | TO-3P (MT-100) | 6.0  |  |
|                            | −0.5                  |                       | −2         | −0.2   | 20             | −12            | 0.5            | 0.18typ         | 1.1typ           | 0.21typ        | 150typ | 2SC4511       | TO-220F (FM20) | 2.0  |  |
|                            | −0.5                  | −1.2                  | −5         | −0.08  | 25             | −12            | 1              | 0.5typ          | 0.6typ           | 0.3typ         | 400typ |               | TO-3PF (FM100) | 6.5  |  |
|                            | −1.0                  |                       | −0.7       | −0.07  | 60             | −12            | 0.7            | 0.5typ          | 1typ             | 0.5typ         | 30typ  | 2SC4883       | TO-220F (FM20) | 2.0  |  |
|                            | −1.0                  |                       | −0.7       | −0.07  | 60             | −12            | 0.7            | 0.5typ          | 1typ             | 0.5typ         | 30typ  | 2SC4883A      | TO-220F (FM20) | 2.0  |  |
|                            | −2.0                  |                       | −5         | −0.5   | 50             | −12            | 2              | 0.25typ         | 0.85typ          | 0.2typ         | 400typ | 2SC4886       | TO-3PF (FM100) | 6.5  |  |
|                            | −0.5                  |                       | −12        | −0.2   | 20             | −12            | 0.5            | 0.18typ         | 1.1typ           | 0.21typ        | 150typ | 2SC5099       | TO-3PF (FM100) | 6.5  |  |
|                            | −0.5                  |                       | −3         | −0.3   | 20             | −12            | 0.5            | 0.14typ         | 1.4typ           | 0.21typ        | 300typ | 2SC5100       | TO-3PF (FM100) | 6.5  |  |
|                            | −0.5                  |                       | −5         | −0.5   | 20             | −12            | 0.5            | 0.17typ         | 1.86typ          | 0.27typ        | 400typ | 2SC5101       | TO-3PF (FM100) | 6.5  |  |
|                            | −0.5                  |                       | −5         | −0.5   | 20             | −12            | −0.5           | −               | −                | −              | 450typ | 2SC6011       | TO-3P (MT-100) | 6.0  |  |
|                            | −0.5                  |                       | −5         | −0.5   | 20             | −12            | −0.5           | −               | −                | −              | 450typ | 2SC6011A      | TO-3P (MT-100) | 6.0  |  |
|                            | −0.5                  |                       | −5         | −0.5   | 35             | −12            | 2              | −               | −                | −              | 500typ | 2SC6145       | TP-3P (MT-100) | 6.0  |  |
|                            | −1.5                  | −2.0                  | −3         | −0.006 | 200            | −12            | 0.2            | 0.4typ          | 0.8typ           | 0.6typ         | 75typ  | 2SD2014       | TO-220F (FM20) | 2.0  |  |
|                            | −1.5                  | −2.0                  | −3         | −0.006 | 100            | −12            | 0.2            | 0.6typ          | 1.6typ           | 0.5typ         | 100typ | 2SD1785       | TO-220F (FM20) | 2.0  |  |
|                            | −1.5                  | −2.0                  | −5         | −0.01  | 100            | −12            | 0.2            | 0.6typ          | 1.6typ           | 0.5typ         | 145typ | 2SD2081       | TO-220F (FM20) | 2.0  |  |
|                            | −1.5                  | −2.0                  | −10        | −0.02  | 130            | −12            | 1              | 0.7typ          | 1.5typ           | 0.6typ         | 170typ |               | TO-220F (FM20) | 2.0  |  |
|                            | −1.5                  | −2.5                  | −8         | −0.016 | 50             | −12            | 1              | 0.8typ          | 1.8typ           | 1typ           | 350typ | 2SD2082       | TO-3PF (FM100) | 6.5  |  |
|                            | −1.8                  | −2.5                  | −12        | −0.024 | 50             | −12            | 1              | 1typ            | 3typ             | 1typ           | 230typ | 2SD2083       | TO-3P (MT-100) | 6.0  |  |
|                            | −1.5                  | −2.5                  | −8         | −0.016 | 50             | −12            | 1              | 1typ            | 3typ             | 1typ           | 350typ |               | TO-3P (MT-100) | 6.0  |  |
|                            | −2.5                  | −3.0                  | −6         | −0.006 | 65             | −12            | 1              | 0.7typ          | 3.6typ           | 0.9typ         | 160typ | 2SD2389       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.5                  | −3.0                  | −7         | −0.007 | 50             | −12            | 2              | 0.8typ          | 3typ             | 1.2typ         | 230typ | 2SD2390       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.5                  | −3.0                  | −7         | −0.007 | 50             | −12            | 2              | 0.8typ          | 3typ             | 1.2typ         | 230typ | 2SD2401       | MT-200         | 18.4 |  |
|                            | −2.5                  | −3.0                  | −6         | −0.006 | 65             | −12            | 1              | 0.7typ          | 3.6typ           | 0.9typ         | 160typ | 2SD2438       | TO-3PF (FM100) | 6.5  |  |
|                            | −2.5                  | −3.0                  | −7         | −0.007 | 50             | −12            | 2              | 0.8typ          | 3typ             | 1.2typ         | 230typ | 2SD2439       | TO-3PF (FM100) | 6.5  |  |
|                            | −2.5                  | −3.0                  | −10        | −0.01  | 45             | −12            | 2              | 0.7typ          | 1.6typ           | 1.1typ         | 320typ | 2SD2560       | TO-3P (MT-100) | 6.0  |  |
|                            | −2.5                  | −3.0                  | −10        | −0.01  | 45             | −12            | 2              | 0.7typ          | 1.6typ           | 1.1typ         | 320typ | 2SD2561       | MT-200         | 18.4 |  |
|                            | −2.5                  | −3.0                  | −10        | −0.01  | 45             | −12            | 2              | 0.7typ          | 1.6typ           | 1.1typ         | 320typ | 2SD2562       | TO-3PF (FM100) | 6.5  |  |

| Part Number | Applications                                              | Absolute Maximum Ratings |                  |                |                |                  |                 |     |      |                 |     |                 |
|-------------|-----------------------------------------------------------|--------------------------|------------------|----------------|----------------|------------------|-----------------|-----|------|-----------------|-----|-----------------|
|             |                                                           | V <sub>CB0</sub>         | V <sub>CE0</sub> | I <sub>c</sub> | P <sub>c</sub> | I <sub>CBO</sub> | h <sub>FE</sub> |     |      |                 |     |                 |
|             |                                                           |                          |                  |                |                |                  | Conditions      | min | max  | Conditions      |     |                 |
|             |                                                           |                          |                  |                |                |                  |                 |     |      | V <sub>CB</sub> |     | V <sub>CE</sub> |
| (V)         | (V)                                                       | (A)                      | (W)              | (μA)           | (V)            | (V)              | (A)             |     |      |                 |     |                 |
| 2SC2837     | Audio, general-purpose                                    | 150                      | 150              | 10             | 100            | 100              | 150             | 50  | 180  | 4               | 3   |                 |
| 2SC2921     | Audio, general-purpose                                    | 160                      | 160              | 15             | 150            | 100              | 160             | 50  | 180  | 4               | 5   |                 |
| 2SC2922     | Audio, general-purpose                                    | 180                      | 180              | 17             | 200            | 100              | 180             | 30  | 180  | 4               | 8   |                 |
| 2SC3263     | Audio, general-purpose                                    | 230                      | 230              | 15             | 130            | 100              | 230             | 50  | 140  | 4               | 5   |                 |
| 2SC3264     | Audio, general-purpose                                    | 230                      | 230              | 17             | 200            | 100              | 230             | 50  | 140  | 4               | 5   |                 |
| 2SC3284     | Audio, general-purpose                                    | 150                      | 150              | 14             | 125            | 100              | 150             | 50  | 180  | 4               | 5   |                 |
| 2SC3519     | Audio, general-purpose                                    | 160                      | 160              | 15             | 130            | 100              | 160             | 50  | 180  | 4               | 5   |                 |
| 2SC3519A    | Audio, general-purpose                                    | 180                      | 180              | 15             | 130            | 100              | 180             | 50  | 180  | 4               | 5   |                 |
| 2SC3835     | Humidifier, DC-DC converter, general-purpose              | 200                      | 120              | 7 (Pulse 14)   | 70             | 100              | 200             | 70  | 220  | 4               | 3   |                 |
| 2SC3851     | Audio, PPC high voltage power supply, general-purpose     | 80                       | 60               | 4              | 25             | 100              | 80              | 40  | 320  | 4               | 1   |                 |
| 2SC3851A    | Audio, PPC high voltage power supply, general-purpose     | 100                      | 80               | 4              | 25             | 100              | 100             | 40  | 320  | 4               | 1   |                 |
| 2SC3852     | Solenoid/motor driver/series regulator, general-purpose   | 80                       | 60               | 3              | 25             | 10               | 80              | 500 |      | 4               | 0.5 |                 |
| 2SC3852A    | Solenoid/motor driver/series regulator, general-purpose   | 100                      | 80               | 3              | 25             | 10               | 100             | 500 |      | 4               | 0.5 |                 |
| 2SC3856     | Audio, general-purpose                                    | 200                      | 180              | 15             | 130            | 100              | 200             | 80  | 180  | 4               | 3   |                 |
| 2SC3857     | Audio, general-purpose                                    | 200                      | 200              | 15             | 150            | 100              | 200             | 50  | 180  | 4               | 5   |                 |
| 2SC3858     | Audio, general-purpose                                    | 200                      | 200              | 17             | 200            | 100              | 200             | 50  | 180  | 4               | 8   |                 |
| 2SC3927     | Switching regulator, general-purpose                      | 900                      | 550              | 10 (Pulse 15)  | 120            | 100              | 800             | 10  | 28   | 4               | 5   |                 |
| 2SC4024     | DC-DC converter, emergency lamp inverter, general-purpose | 100                      | 50               | 10             | 35             | 100              | 100             | 300 | 1600 | 4               | 1   |                 |
| 2SC4131     | DC-DC converter, emergency lamp inverter, general-purpose | 100                      | 50               | 15 (Pulse 20)  | 60             | 10               | 100             | 60  | 360  | 1               | 5   |                 |
| 2SC4138     | Switching regulator, general-purpose                      | 500                      | 400              | 10 (Pulse 20)  | 80             | 100              | 500             | 10  | 30   | 4               | 6   |                 |
| 2SC4140     | Switching regulator, general-purpose                      | 500                      | 400              | 18 (Pulse 36)  | 130            | 100              | 500             | 10  | 30   | 4               | 10  |                 |
| 2SC4153     | Humidifier, DC-DC converter, general-purpose              | 200                      | 120              | 7 (Pulse 14)   | 30             | 100              | 200             | 70  | 220  | 4               | 3   |                 |
| 2SC4300     | Switching regulator, general-purpose                      | 900                      | 800              | 5 (Pulse 10)   | 75             | 100              | 800             | 10  | 30   | 4               | 2   |                 |
| 2SC4301     | Switching regulator, lighting inverter, general-purpose   | 900                      | 800              | 7 (Pulse 14)   | 80             | 100              | 800             | 10  | 30   | 4               | 3   |                 |
| 2SC4304     | Switching regulator, general-purpose                      | 900                      | 800              | 3 (Pulse 6)    | 35             | 100              | 800             | 10  | 30   | 4               | 0.7 |                 |
| 2SC4381     | TV vertical output, audio output driver, general-purpose  | 150                      | 150              | 2              | 25             | 10               | 150             | 60  |      | 10              | 0.7 |                 |
| 2SC4382     | TV vertical output, audio output driver, general-purpose  | 200                      | 200              | 2              | 25             | 10               | 200             | 60  |      | 10              | 0.7 |                 |
| 2SC4388     | Audio, general-purpose                                    | 200                      | 180              | 15             | 85             | 10               | 200             | 50  | 180  | 4               | 3   |                 |
| 2SC4445     | Switching regulator, general-purpose                      | 900                      | 800              | 3 (Pulse 6)    | 60             | 100              | 800             | 10  | 30   | 4               | 0.7 |                 |
| 2SC4466     | Audio, general-purpose                                    | 120                      | 80               | 6              | 60             | 10               | 120             | 50  | 180  | 4               | 2   |                 |
| 2SC4467     | Audio, general-purpose                                    | 160                      | 120              | 8              | 80             | 10               | 160             | 50  | 180  | 4               | 3   |                 |
| 2SC4468     | Audio, general-purpose                                    | 200                      | 140              | 10             | 100            | 10               | 200             | 50  | 180  | 4               | 3   |                 |
| 2SC4495     | For audio temperature compensation, general-purpose       | 80                       | 50               | 3              | 25             | 10               | 80              | 500 |      | 4               | 0.5 |                 |
| 2SC4511     | Audio, general-purpose                                    | 120                      | 80               | 6              | 30             | 10               | 120             | 50  | 180  | 4               | 2   |                 |
| 2SC4518     | Switching regulator, lighting inverter, general-purpose   | 900                      | 550              | 5 (Pulse 10)   | 35             | 100              | 800             | 10  | 25   | 4               | 1.8 |                 |
| 2SC4518A    | Switching regulator, lighting inverter, general-purpose   | 1000                     | 550              | 5 (Pulse 10)   | 35             | 100              | 800             | 10  | 25   | 4               | 1.8 |                 |
| 2SC4546     | Switching regulator, lighting inverter, general-purpose   | 600                      | 400              | 7 (Pulse 14)   | 30             | 100              | 600             | 10  | 25   | 4               | 3   |                 |
| 2SC4706     | Switching regulator, general-purpose                      | 900                      | 600              | 14 (Pulse 28)  | 130            | 100              | 800             | 10  | 25   | 4               | 7   |                 |
| 2SC4883     | Audio output driver, TV velocity modulation               | 150                      | 150              | 2              | 20             | 10               | 150             | 60  | 240  | 10              | 0.7 |                 |
| 2SC4883A    | Audio output driver, TV velocity modulation               | 180                      | 180              | 2              | 20             | 10               | 180             | 60  | 240  | 10              | 0.7 |                 |
| 2SC4886     | Audio, general-purpose                                    | 150                      | 150              | 14             | 80             | 100              | 150             | 50  | 180  | 4               | 5   |                 |
| 2SC5071     | Switching regulator, general-purpose                      | 500                      | 400              | 12 (Pulse 24)  | 100            | 100              | 500             | 10  | 30   | 4               | 7   |                 |
| 2SC5099     | Audio, general-purpose                                    | 120                      | 80               | 6              | 60             | 10               | 120             | 50  | 180  | 4               | 2   |                 |
| 2SC5100     | Audio, general-purpose                                    | 160                      | 120              | 8              | 75             | 10               | 160             | 50  | 180  | 4               | 3   |                 |
| 2SC5101     | Audio, general-purpose                                    | 200                      | 140              | 10             | 80             | 10               | 200             | 50  | 180  | 4               | 3   |                 |
| 2SC5130     | Switching regulator, general-purpose                      | 600                      | 400              | 5 (Pulse 10)   | 30             | 100              | 500             | 10  | 30   | 4               | 1.5 |                 |
| 2SC5287     | Switching regulator, general-purpose                      | 900                      | 550              | 5 (Pulse 10)   | 80             | 100              | 800             | 10  | 25   | 4               | 1.8 |                 |
| 2SC6011     | Audio, general-purpose                                    | 200                      | 200              | 15             | 160            | 10               | 200             | 50  | 180  | 4               | 3   |                 |
| 2SC6011A    | Audio, general-purpose                                    | 230                      | 230              | 15             | 160            | 10               | 230             | 50  | 180  | 4               | 3   |                 |
| 2SC6145     | Audio, general-purpose                                    | 230                      | 230              | 15             | 160            | 10               | 230             | 40  | 140  | 4               | 5   |                 |

| Electrical Characteristics |                       |                       |                |                |                       |                 |                |                 |                  |                |                         | Complementary | Package        | Mass |
|----------------------------|-----------------------|-----------------------|----------------|----------------|-----------------------|-----------------|----------------|-----------------|------------------|----------------|-------------------------|---------------|----------------|------|
|                            | V <sub>CE</sub> (sat) | V <sub>BE</sub> (sat) | Conditions     |                | f <sub>T</sub><br>MHz | Conditions      |                | Switching Time  |                  |                | C <sub>ob</sub><br>(pF) |               |                | (g)  |
|                            | (V)                   | (V)                   | I <sub>C</sub> | I <sub>B</sub> |                       | V <sub>CE</sub> | I <sub>E</sub> | t <sub>on</sub> | t <sub>stg</sub> | t <sub>f</sub> |                         |               |                |      |
|                            | max                   | max                   | (A)            | (A)            |                       | (V)             | (A)            | (μS)            | (μS)             | (μS)           |                         |               |                |      |
|                            | 2.0                   |                       | 5              | 0.5            | 70                    | 12              | −1             | 0.2typ          | 1.4typ           | 0.35typ        | 60typ                   | 2SA1186       | TO-3P (MT-100) | 6.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 60                    | 12              | −2             | 0.2typ          | 1.5typ           | 0.35typ        | 200typ                  | 2SA1215       | MT-200         | 18.4 |
|                            | 2.0                   |                       | 8              | 0.8            | 50                    | 12              | −2             | 0.2typ          | 1.3typ           | 0.45typ        | 250typ                  | 2SA1216       | MT-200         | 18.4 |
|                            | 2.0                   |                       | 5              | 0.5            | 60                    | 12              | −2             | 0.3typ          | 2.4typ           | 0.5typ         | 250typ                  | 2SA1294       | TO-3P (MT-100) | 6.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 60                    | 12              | −2             | 0.3typ          | 2.4typ           | 0.5typ         | 250typ                  | 2SA1295       | MT-200         | 18.4 |
|                            | 2.0                   |                       | 5              | 0.5            | 60                    | 12              | −2             | 0.2typ          | 1.5typ           | 0.35typ        | 200typ                  | 2SA1303       | TO-3P (MT-100) | 6.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 50                    | 12              | −2             | 0.2typ          | 1.3typ           | 0.45typ        | 250typ                  | 2SA1386       | TO-3P (MT-100) | 6.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 50                    | 12              | −2             | 0.2typ          | 1.3typ           | 0.45typ        | 250typ                  | 2SA1386A      | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   | 1.2                   | 3              | 0.3            | 30                    | 12              | −0.5           | 0.5max          | 3max             | 0.5max         | 110typ                  |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 2              | 0.2            | 15                    | 12              | −0.2           | 0.2typ          | 1typ             | 0.3typ         | 60typ                   | 2SA1488       | TO-220F (FM20) | 2.0  |
|                            | 0.5                   |                       | 2              | 0.2            | 15                    | 12              | −0.2           | 0.2typ          | 1typ             | 0.3typ         | 60typ                   | 2SA1488A      | TO-220F (FM20) | 2.0  |
|                            | 0.5                   |                       | 2              | 0.05           | 15                    | 12              | −0.2           | 0.8typ          | 3typ             | 1.2typ         | 50typ                   |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   |                       | 2              | 0.05           | 15                    | 12              | −0.2           | 0.8typ          | 3typ             | 1.2typ         | 50typ                   |               | TO-220F (FM20) | 2.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | 0.5typ          | 1.8typ           | 0.6typ         | 300typ                  | 2SA1492       | TO-3P (MT-100) | 6.0  |
|                            | 3.0                   |                       | 10             | 1              | 20                    | 12              | −0.5           | 0.3typ          | 2.4typ           | 0.4typ         | 250typ                  | 2SA1493       | MT-200         | 18.4 |
|                            | 2.5                   |                       | 10             | 1              | 20                    | 12              | −1             | 0.5typ          | 1.8typ           | 0.6typ         | 300typ                  | 2SA1494       | MT-200         | 18.4 |
|                            | 0.5                   | 1.2                   | 5              | 1              | 6                     | 12              | −1             | 1max            | 5max             | 0.5max         | 105typ                  |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 5              | 0.1            | 24                    | 12              | −0.5           | 0.5typ          | 2typ             | 0.5typ         | 150typ                  |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 5              | 0.08           | 18                    | 12              | −1             | 0.5typ          | 2typ             | 0.4typ         | 210typ                  |               | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.3                   | 6              | 1.2            | 10                    | 12              | −0.7           | 1max            | 3max             | 0.5max         | 85typ                   |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   | 1.3                   | 10             | 2              | 10                    | 12              | −2.0           | 1max            | 3max             | 0.5max         | 165typ                  |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   | 1.2                   | 3              | 0.3            | 30                    | 12              | −0.5           | 0.5max          | 3max             | 0.5max         | 110typ                  |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 2              | 0.4            | 6                     | 12              | −0.5           | 1max            | 5max             | 1max           | 75typ                   |               | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.2                   | 3              | 0.6            | 6                     | 12              | −1             | 1max            | 5max             | 1max           | 105typ                  |               | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.2                   | 7              | 0.14           | 15                    | 12              | −0.3           | 0.7max          | 4max             | 0.7max         | 50typ                   |               | TO-220F (FM20) | 2.0  |
|                            | 1.0                   |                       | 7              | 0.07           | 15                    | 12              | −0.2           | 1typ            | 3typ             | 1.5typ         | 35                      | 2SA1667       | TO-220F (FM20) | 2.0  |
|                            | 1.0                   |                       | 7              | 0.07           | 15                    | 12              | −0.2           | 1typ            | 3typ             | 1.5typ         | 35                      | 2SA1668       | TO-220F (FM20) | 2.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | 0.5max          | 1.8max           | 0.6max         | 300                     | 2SA1673       | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.2                   | 0.7            | 0.14           | 15                    | 12              | −0.3           | 0.7max          | 4max             | 0.7max         | 50                      |               | TO-3PF (FM100) | 6.5  |
|                            | 1.5                   |                       | 2              | 0.2            | 20                    | 12              | −0.5           | 0.16typ         | 2.6typ           | 0.34typ        | 110                     | 2SA1693       | TO-3P (MT-100) | 6.0  |
|                            | 1.5                   |                       | 3              | 0.3            | 20                    | 12              | −0.5           | 0.13typ         | 3.5typ           | 0.32typ        | 200                     | 2SA1694       | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | 0.24typ         | 4.32typ          | 0.4typ         | 250                     | 2SA1695       | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 4              | 0.02           | 40                    | 12              | −0.1           | 0.45typ         | 1.6typ           | 0.85typ        | 30                      |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   |                       | 2              | 0.2            | 20                    | 12              | −0.5           | 0.16typ         | 2.6typ           | 0.34typ        | 110                     | 2SA1725       | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 1.8            | 0.36           | 6                     | 12              | −0.35          | 0.7max          | 4max             | 0.5max         | 50                      |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 1.8            | 0.36           | 6                     | 12              | −0.35          | 0.7max          | 4max             | 0.5max         | 50                      |               | TO-220F (FM20) | 2.0  |
|                            | 0.7                   | 1.3                   | 3              | 0.6            | 10                    | 12              | −0.5           | 0.5max          | 2max             | 0.15max        | 55                      |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 7              | 1.4            | 6                     | 12              | −1.5           | 1max            | 5max             | 0.7max         | 160                     |               | TO-3P (MT-100) | 6.0  |
|                            | 1.0                   |                       | 0.7            | 0.07           | 120                   | 12              | −0.7           | 0.5typ          | 1.5typ           | 0.5typ         | 30                      | 2SA1859       | TO-220F (FM20) | 2.0  |
|                            | 1.0                   |                       | 0.7            | 0.07           | 120                   | 12              | −0.7           | 0.5typ          | 1.5typ           | 0.5typ         | 30                      | 2SA1859A      | TO-220F (FM20) | 2.0  |
|                            | 2.0                   |                       | 5              | 0.5            | 60                    | 12              | −2             | 0.26typ         | 1.5typ           | 0.35typ        | 200                     | 2SA1860       | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.3                   | 7              | 1.4            | 10                    | 12              | −1             | 1max            | 3max             | 0.5max         | 105                     |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 2              | 0.2            | 20                    | 12              | −0.5           | 0.16typ         | 2.6typ           | 0.34typ        | 110                     | 2SA1907       | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   |                       | 3              | 0.3            | 20                    | 12              | −0.5           | 0.13typ         | 3.5typ           | 0.32typ        | 200                     | 2SA1908       | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | 0.24typ         | 4.32typ          | 0.4typ         | 250                     | 2SA1909       | TO-3PF (FM100) | 6.5  |
|                            | 0.5                   | 1.3                   | 1.5            | 0.3            | 20                    | 12              | −0.3           | 1max            | 2max             | 0.3max         | 30                      |               | TO-220F (FM20) | 2.0  |
|                            | 0.5                   | 1.2                   | 1.8            | 0.36           | 6                     | 12              | −0.35          | 0.7max          | 4max             | 0.5max         | 50                      |               | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | —               | —                | —              | 270                     | 2SA2151       | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 5              | 0.5            | 20                    | 12              | −0.5           | —               | —                | —              | 270                     | 2SA2151A      | TO-3P (MT-100) | 6.0  |
|                            | 0.5                   |                       | 5              | 0.5            | 60                    | 12              | −2             | —               | —                | —              | 250                     | 2SA2223       | TP-3P (MT-100) | 6.0  |

| Part Number | Applications                                                  | Absolute Maximum Ratings |                  |                |                |                  |                        |                 |       |                        |                       |  |
|-------------|---------------------------------------------------------------|--------------------------|------------------|----------------|----------------|------------------|------------------------|-----------------|-------|------------------------|-----------------------|--|
|             |                                                               | V <sub>CB0</sub>         | V <sub>CEO</sub> | I <sub>c</sub> | P <sub>c</sub> | I <sub>CB0</sub> |                        | h <sub>FE</sub> |       |                        |                       |  |
|             |                                                               | (V)                      | (V)              | (A)            | (W)            | (μA)             | Conditions             | min             | max   | V <sub>CE</sub><br>(V) | I <sub>c</sub><br>(A) |  |
|             |                                                               |                          |                  |                |                |                  | V <sub>CB</sub><br>(V) |                 |       |                        |                       |  |
| 2SD1785     | Solenoid/relay/motor driver/series regulator, general-purpose | 120                      | 120              | 6 (Pulse 10)   | 30             | 10               | 120                    | 2000            |       | 2                      | 3                     |  |
| 2SD1796     | Solenoid/relay/motor driver, general-purpose                  | 60±10                    | 60±10            | 4              | 25             | 10               | 50                     | 2000            |       | 4                      | 3                     |  |
| 2SD2014     | Solenoid/relay/motor driver/series regulator, general-purpose | 120                      | 80               | 4              | 25             | 10               | 120                    | 2000            |       | 2                      | 3                     |  |
| 2SD2015     | Solenoid/relay/motor driver, general-purpose                  | 150                      | 120              | 4              | 25             | 10               | 150                    | 2000            |       | 2                      | 2                     |  |
| 2SD2016     | Igniter, relay, general-purpose                               | 200                      | 200              | 3              | 25             | 10               | 200                    | 1000            | 15000 | 4                      | 1                     |  |
| 2SD2017     | Solenoid/relay/motor driver, general-purpose                  | 300                      | 250              | 6              | 35             | 100              | 300                    | 2000            |       | 2                      | 2                     |  |
| 2SD2045     | Solenoid/motor driver, general-purpose                        | 120                      | 120              | 6 (Pulse 10)   | 50             | 10               | 120                    | 2000            |       | 2                      | 3                     |  |
| 2SD2081     | Solenoid/motor driver, general-purpose                        | 120                      | 120              | 10 (Pulse 15)  | 30             | 10               | 120                    | 2000            |       | 4                      | 5                     |  |
| 2SD2082     | Solenoid/motor driver, general-purpose                        | 120                      | 120              | 16 (Pulse 26)  | 75             | 10               | 120                    | 2000            |       | 4                      | 8                     |  |
| 2SD2083     | Solenoid/motor driver, general-purpose                        | 120                      | 120              | 25 (Pulse 40)  | 120            | 10               | 120                    | 2000            |       | 4                      | 12                    |  |
| 2SD2141     | Igniter, solenoid, motor driver, general-purpose              | 380±50                   | 380±50           | 6 (Pulse 10)   | 35             | 10               | 330                    | 1500            |       | 2                      | 3                     |  |
| 2SD2389     | Audio, series regulator, general-purpose                      | 160                      | 150              | 8              | 80             | 100              | 160                    | 5000            | 30000 | 4                      | 6                     |  |
| 2SD2390     | Audio, series regulator, general-purpose                      | 160                      | 150              | 10             | 100            | 100              | 160                    | 5000            | 30000 | 4                      | 7                     |  |
| 2SD2401     | Audio, series regulator, general-purpose                      | 160                      | 150              | 12             | 150            | 100              | 160                    | 5000            | 30000 | 4                      | 7                     |  |
| 2SD2438     | Audio, series regulator, general-purpose                      | 160                      | 150              | 8              | 75             | 100              | 160                    | 5000            | 30000 | 4                      | 6                     |  |
| 2SD2439     | Audio, series regulator, general-purpose                      | 160                      | 150              | 10             | 80             | 100              | 160                    | 5000            | 30000 | 4                      | 7                     |  |
| 2SD2560     | Audio, series regulator, general-purpose                      | 150                      | 150              | 15             | 130            | 100              | 150                    | 5000            | 30000 | 4                      | 10                    |  |
| 2SD2561     | Audio, series regulator, general-purpose                      | 150                      | 150              | 17             | 200            | 100              | 150                    | 5000            | 30000 | 4                      | 10                    |  |
| 2SD2562     | Audio, series regulator, general-purpose                      | 150                      | 150              | 15             | 85             | 100              | 150                    | 5000            | 30000 | 4                      | 10                    |  |
| 2SD2641     | Series regulator, general-purpose                             | 110                      | 110              | 6              | 60             | 100              | 110                    | 5000            | 30000 | 4                      | 5                     |  |
| 2SD2642     | Series regulator, general-purpose                             | 110                      | 110              | 6              | 30             | 100              | 110                    | 5000            | 30000 | 4                      | 5                     |  |
| 2SD2643     | Series regulator, general-purpose                             | 110                      | 110              | 6              | 60             | 100              | 110                    | 5000            | 30000 | 4                      | 5                     |  |
| STD01N      | Audio                                                         | 150                      | 150              | 10             | 100            | 100              | 150                    | 5000            | 20000 | 4                      | 6                     |  |
| STD01P      | Audio                                                         | -150                     | -150             | -10            | 100            | -100             | -150                   | 5000            | 20000 | -4                     | -6                    |  |
| STD03N      | Audio                                                         | 160                      | 160              | 15             | 160            | 100              | 160                    | 5000            | 20000 | 4                      | 10                    |  |
| STD03P      | Audio                                                         | -160                     | -160             | -15            | 160            | -100             | -160                   | 5000            | 20000 | -4                     | -10                   |  |

| Electrical Characteristics |                       |                       |                |                |                |                 |                  |                |        |        |      | Complementary | Package        | Mass |
|----------------------------|-----------------------|-----------------------|----------------|----------------|----------------|-----------------|------------------|----------------|--------|--------|------|---------------|----------------|------|
|                            | V <sub>CE</sub> (sat) | V <sub>BE</sub> (sat) | Conditions     |                | f <sub>T</sub> | Switching Time  |                  |                | Cob    | (g)    |      |               |                |      |
|                            |                       |                       |                |                |                | t <sub>on</sub> | t <sub>stg</sub> | t <sub>f</sub> |        |        |      |               |                |      |
|                            | (V)                   | (V)                   | I <sub>C</sub> | I <sub>B</sub> | MHz            | V <sub>CE</sub> | I <sub>E</sub>   | (μS)           | (μS)   |        | (μS) |               |                | (pF) |
| max                        | max                   | (A)                   | (A)            |                | (V)            | (A)             |                  |                |        |        |      |               |                |      |
|                            | 1.5                   |                       | 2              | 3mA            | 100            | 12              | −0.1             | 0.5typ         | 5.5typ | 1.5typ | 70   | 2SB1258       | TO-220F (FM20) | 2.0  |
|                            | 1.5                   |                       | 3              | 10mA           | 60             | 12              | −0.2             | 1typ           | 4typ   | 1.5typ | 45   |               | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.0                   | 3              | 3mA            | 75             | 12              | −0.1             | 1typ           | 4typ   | 1.5typ | 45   | 2SB1257       | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.0                   | 2              | 2mA            | 40             | 12              | −0.1             | 0.6typ         | 5typ   | 2typ   | 40   |               | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.0                   | 1              | 1.5mA          | 90             | 12              | −0.1             |                |        |        | 40   |               | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.0                   | 2              | 2mA            | 20             | 12              | −1               | 0.6typ         | 16typ  | 3typ   | 65   |               | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.0                   | 3              | 3mA            | 50             | 12              | −1               | 0.5typ         | 5.5typ | 1.5typ | 70   |               | TO-3PF (FM100) | 6.5  |
|                            | 1.5                   | 2.0                   | 5              | 5mA            | 60             | 12              | −0.5             |                |        |        | 95   | 2SB1259       | TO-220F (FM20) | 2.0  |
|                            | 1.5                   | 2.5                   | 8              | 16mA           | 20             | 12              | −1               | 0.6typ         | 7typ   | 1.5typ | 210  | 2SB1382       | TO-3PF (FM100) | 6.5  |
|                            | 1.8                   | 2.5                   | 12             | 24mA           | 20             | 12              | −1               | 1typ           | 6typ   | 1typ   | 340  | 2SB1383       | TO-3P (MT-100) | 6.0  |
|                            | 1.5                   |                       | 4              | 20mA           | 20             | 12              | −0.5             |                |        |        | 95   |               | TO-220F (FM20) | 2.0  |
|                            | 2.5                   | 3.0                   | 6              | 6mA            | 80             | 12              | −1               | 0.6typ         | 10typ  | 0.9typ | 85   | 2SB1559       | TO-3P (MT-100) | 6.0  |
|                            | 2.5                   | 3.0                   | 7              | 7mA            | 55             | 12              | −2               | 0.5typ         | 10typ  | 1.1typ | 95   | 2SB1560       | TO-3P (MT-100) | 6.0  |
|                            | 2.5                   | 3.0                   | 7              | 7mA            | 55             | 12              | −2               | 0.5typ         | 10typ  | 1.1typ | 95   | 2SB1570       | MT-200         | 18.4 |
|                            | 2.5                   | 3.0                   | 6              | 6mA            | 80             | 12              | −1               | 0.6typ         | 10typ  | 0.9typ | 85   | 2SB1587       | TO-3PF (FM100) | 6.5  |
|                            | 2.5                   | 3.0                   | 7              | 7mA            | 55             | 12              | −2               | 0.5typ         | 10typ  | 1.1typ | 95   | 2SB1588       | TO-3PF (FM100) | 6.5  |
|                            | 2.5                   | 3.0                   | 10             | 10mA           | 70             | 12              | −2               | 0.8typ         | 4typ   | 1.2typ | 120  | 2SB1647       | TO-3P (MT-100) | 6.0  |
|                            | 2.5                   | 3.0                   | 10             | 10mA           | 70             | 12              | −2               | 0.8typ         | 4typ   | 1.2typ | 120  | 2SB1648       | MT-200         | 18.4 |
|                            | 2.5                   | 3.0                   | 10             | 10mA           | 70             | 12              | −2               | 0.8typ         | 4typ   | 1.2typ | 120  | 2SB1649       | TO-3PF (FM100) | 6.5  |
|                            | 2.5                   | 3.0                   | 5              | 5mA            | 60             | 12              | −2               | 0.8typ         | 6.2typ | 1.1typ | 55   |               | TO-3P (MT-100) | 6.0  |
|                            | 2.5                   | 3.0                   | 5              | 5mA            | 60             | 12              | −0.5             | 0.8typ         | 6.2typ | 1.1typ | 55   |               | TO-220F (FM20) | 2.0  |
|                            | 2.5                   | 3.0                   | 5              | 5mA            | 60             | 12              | −0.5             | 0.8typ         | 6.2typ | 1.1typ | 55   |               | TO-3PF (FM100) | 6.5  |
|                            | 2.0                   | 2.5                   | 6              | 6mA            |                |                 |                  |                |        |        |      | STD01P        | TO3P-5Pin      | 6.2  |
|                            | −2.0                  | −2.5                  | −6             | −6mA           |                |                 |                  |                |        |        |      | STD01N        | TO3P-5Pin      | 6.2  |
|                            | 2.0                   | 2.5                   | 10             | 10mA           |                |                 |                  |                |        |        |      | STD03P        | TO-3P-5pin     | 6.2  |
|                            | −2.0                  | −2.5                  | −10            | −10mA          |                |                 |                  |                |        |        |      | STD03N        | TO-3P-5pin     | 6.2  |



## Selection Guide

By  $V_{DS}$ 

| $V_{DS}$<br>(V) | $R_{DS}$ (ON)<br>( $\Omega$ ) max | $I_D$<br>(A) | $P_D$<br>(W) | Part Number | Package                |
|-----------------|-----------------------------------|--------------|--------------|-------------|------------------------|
| 40              | 3.6m                              | $\pm 100$    | 100          | SKH04100    | TO263 (Surface-mount)  |
|                 | 3.8m                              | $\pm 100$    | 100          | EKH04100    | TO220                  |
|                 | 3.8m                              | $\pm 70$     | 40           | FKH0470     | TO220F-A               |
|                 | 6.0m                              | $\pm 70$     | 80           | 2SK3800     | TO220S (Surface-mount) |
|                 | 6.0m                              | $\pm 70$     | 100          | 2SK3801     | TO3P (MT100)           |
|                 | 9m                                | $\pm 60$     | 60           | FKV460S     | TO220S (Surface-mount) |
| 50              | 10m                               | $\pm 75$     | 40           | FKV575      | TO220F (FM20)          |
|                 | 15m                               | $\pm 50$     | 35           | FKV550N     | TO220F (FM20)          |
|                 | 15m                               | $\pm 50$     | 85           | EKV550      | TO220                  |
| 60              | 4.8m                              | $\pm 100$    | 100          | SKH06100    | TO263 (Surface-mount)  |
|                 | 5.0m                              | $\pm 100$    | 100          | EKH06100    | TO220                  |
|                 | 5.0m                              | $\pm 60$     | 40           | FKH0660     | TO220F-A               |
|                 | 6.0m                              | $\pm 70$     | 90           | 2SK3710     | TO220S (Surface-mount) |
|                 | 6.0m                              | $\pm 70$     | 130          | 2SK3711     | TO3P (MT100)           |
|                 | 14m                               | $\pm 60$     | 60           | FKV660S     | TO220S (Surface-mount) |
|                 | 28m                               | $\pm 30$     | 40           | 2SK2420     | TO220F (FM20)          |
| 100             | 11.3m                             | $\pm 70$     | 100          | SKH1070     | TO263 (Surface-mount)  |
|                 | 11.5m                             | $\pm 70$     | 100          | EKH1070     | TO220                  |
|                 | 11.5m                             | $\pm 40$     | 40           | FKH1040     | TO220F-A               |
|                 | 52m                               | $\pm 20$     | 55           | EKG1020     | TO220                  |
|                 | 52m                               | $\pm 20$     | 40           | FKG1020     | TO220F-A               |
| 200             | 53m                               | $\pm 45$     | 40           | FKP202      | TO220F (FM20)          |
|                 | 53m                               | $\pm 45$     | 95           | SKP202      | TO263 (Surface-mount)  |
|                 | 0.175                             | $\pm 18$     | 35           | 2SK3003     | TO220F (FM20)          |
| 250             | 43m                               | $\pm 50$     | 85           | FKP250A     | TO3PF (FM100)          |
|                 | 75m                               | $\pm 25$     | 40           | FKP252      | TO220F (FM20)          |
|                 | 95m                               | $\pm 20$     | 40           | FKP253      | TO220F (FM20)          |
|                 | 95m                               | $\pm 20$     | 90           | SKP253      | TO263 (Surface-mount)  |
|                 | 0.25                              | $\pm 18$     | 35           | 2SK3004     | TO220F (FM20)          |
| 280             | 53m                               | $\pm 40$     | 85           | FKP280A     | TO3PF (FM100)          |
| 300             | 65m                               | $\pm 30$     | 85           | FKP300A     | TO3PF (FM100)          |
| 330             | 63m                               | $\pm 30$     | 85           | FKP330C     | TO3PF (FM100)          |
| 450             | 1.1                               | $\pm 7$      | 35           | 2SK2701A    | TO220F (FM20)          |
|                 | 2.8                               | $\pm 3$      | 30           | 2SK2803     | TO220F (FM20)          |
| 500             | 0.27                              | $\pm 20$     | 150          | MKS5020     | TO3P                   |
|                 | 0.4                               | $\pm 15$     | 150          | MKS5015     | TO3P                   |
|                 | 1.5                               | $\pm 5$      | 30           | 2SK3199     | TO220F (FM20)          |
| 600             | 3.8                               | $\pm 2$      | 30           | 2SK2848     | TO220F (FM20)          |
| 900             | 5.0                               | $\pm 3$      | 30           | 2SK2943     | TO220F (FM20)          |

Specifications List by Part Number

| Part Number | Absolute Maximum Ratings |                  |                |                        |                |                 |                  |                 |                  |                 |                 |                 |                |     |      |  |
|-------------|--------------------------|------------------|----------------|------------------------|----------------|-----------------|------------------|-----------------|------------------|-----------------|-----------------|-----------------|----------------|-----|------|--|
|             | V <sub>DSS</sub>         | V <sub>GSS</sub> | I <sub>D</sub> | I <sub>D</sub> (pulse) | P <sub>D</sub> | E <sub>AS</sub> | I <sub>GSS</sub> |                 | I <sub>DSS</sub> |                 | V <sub>TH</sub> |                 |                |     |      |  |
|             |                          |                  |                |                        |                |                 | Conditions       |                 | Conditions       |                 | Conditions      |                 | Conditions     |     |      |  |
|             | (V)                      | (V)              | (A)            | (A)                    | (W)            | (mJ)            | (nA)             | V <sub>GS</sub> | (μA)             | V <sub>DS</sub> | (V)             | V <sub>DS</sub> | I <sub>D</sub> | (V) | (μA) |  |
|             |                          |                  |                |                        |                |                 | max              | (V)             | min              | max             | (V)             | min             | max            | (V) | (μA) |  |
| 2SK2420     | 60                       | ±20              | ±30            | ±120                   | 40             | 38              | ±100             | ±20             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 250  |  |
| 2SK2701A    | 450                      | ±30              | ±7             | ±28                    | 35             | 130             | ±100             | ±30             |                  | 100             | 450             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK2803     | 450                      | ±30              | ±3             | ±12                    | 30             | 30              | ±100             | ±30             |                  | 100             | 450             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK2848     | 600                      | ±30              | ±2             | ±8                     | 30             | 10              | ±100             | ±30             |                  | 100             | 600             | 2.0             | 4.0            | 10  | 250  |  |
| 2SK2943     | 900                      | ±30              | ±3             | ±12                    | 30             | 60              | ±100             | ±30             |                  | 100             | 900             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3003     | 200                      | ±20              | ±18            | ±72                    | 35             | 120             | ±100             | ±20             |                  | 100             | 200             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3004     | 250                      | ±20              | ±18            | ±72                    | 35             | 120             | ±100             | ±20             |                  | 100             | 250             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3199     | 500                      | ±30              | ±5             | ±20                    | 30             | 35              | ±100             | ±30             |                  | 100             | 500             | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3710     | 60                       | ±20              | ±70            | ±140                   | 90             | 468             | ±10μ             | ±15             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3711     | 60                       | ±20              | ±70            | ±140                   | 130            |                 | ±10μ             | +15             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3800     | 40                       | ±20              | ±70            | ±140                   | 80             | 400             | ±10              | ±15             |                  | 100             | 40              | 2.0             | 4.0            | 10  | 1m   |  |
| 2SK3801     | 40                       | ±20              | ±70            | ±140                   | 100            | 400             | ±10              | ±15             |                  | 100             | 40              | 2.0             | 4.0            | 10  | 1m   |  |
| EKG1020     | 100                      | ±20              | ±20            | ±60                    | 55             | 50              | ±10μ             | ±20             |                  | 100             | 100             | 1.5             | 2.5            | 10  | 1m   |  |
| EKH04100    | 40                       | ±20              | ±100           | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 40              | 2.0             | 4.0            | 10  | 1m   |  |
| EKH06100    | 60                       | ±20              | ±100           | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 1m   |  |
| EKH1070     | 100                      | ±20              | ±70            | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 100             | 2.0             | 4.0            | 10  | 1m   |  |
| EKV550      | 50                       | ±20              | ±50            | ±150                   | 85             | 150             | ±10μ             | ±20             |                  | 100             | 50              | 3.0             | 4.2            | 10  | 250  |  |
| FKG1020     | 100                      | ±20              | ±20            | ±60                    | 40             | 50              | ±10μ             | ±20             |                  | 100             | 100             | 1.5             | 2.5            | 10  | 1m   |  |
| FKH0470     | 40                       | ±20              | ±70            | ±200                   | 40             | 300             | ±20μ             | ±15             |                  | 100             | 40              | 2.0             | 4.0            | 10  | 1m   |  |
| FKH0660     | 60                       | ±20              | ±60            | ±200                   | 40             | 300             | ±20μ             | ±15             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 1m   |  |
| FKH1040     | 100                      | ±20              | ±40            | ±200                   | 40             | 300             | ±20μ             | ±15             |                  | 100             | 100             | 2.0             | 4.0            | 10  | 1m   |  |
| FKP202      | 200                      | ±30              | ±45            | ±180                   | 40             | 200             | ±100             | ±30             |                  | 100             | 200             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP250A     | 250                      | ±30              | ±50            | ±200                   | 85             | 400             | ±100             | ±30             |                  | 100             | 250             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP252      | 250                      | ±30              | ±25            | ±100                   | 40             | 200             | ±100             | ±30             |                  | 100             | 250             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP253      | 250                      | ±30              | ±20            | ± 80                   | 40             | 160             | ±100             | ±30             |                  | 100             | 250             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP280A     | 280                      | ±30              | ±40            | ±160                   | 85             | 400             | ±100             | ±30             |                  | 100             | 280             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP300A     | 300                      | ±30              | ±30            | ±120                   | 85             | 400             | ±100             | ±30             |                  | 100             | 300             | 3.0             | 4.5            | 10  | 1m   |  |
| FKP330C     | 330                      | ±30              | ±30            | ±120                   | 85             | 500             | ±100             | ±30             |                  | 100             | 330             | 3.0             | 4.5            | 10  | 1m   |  |
| FKV460S     | 40                       | +20, -10         | ±60            | ±180                   | 60             |                 | +10, -5μ         | +20, -10        |                  | 100             | 40              | 1.0             | 2.5            | 10  | 250  |  |
| FKV550N     | 50                       | ±20              | ±50            | ±150                   | 35             | 150             | ±10μ             | ±20             |                  | 100             | 50              | 3.0             | 4.2            | 10  | 250  |  |
| FKV575      | 50                       | ±20              | ±75            | ±200                   | 40             | 300             | ±100             | ±20             |                  | 100             | 50              | 3.0             | 4.5            | 10  | 250  |  |
| FKV660S     | 60                       | +20, -10         | ±60            | ±180                   | 60             |                 | +10, -5μ         | +20, -10        |                  | 100             | 60              | 1.0             | 2.5            | 10  | 250  |  |
| MKS5015     | 500                      | ±30              | ±15            | ±30                    | 150            | 125             | ±100             | ±30             |                  | 100             | 500             | 2.0             | 4.0            | 10  | 1m   |  |
| MKS5020     | 500                      | ±30              | ±20            | ±40                    | 150            | 200             | ±100             | ±30             |                  | 100             | 500             | 2.0             | 4.0            | 10  | 1m   |  |
| SKH04100    | 40                       | ±20              | ±100           | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 40              | 2.0             | 4.0            | 10  | 1m   |  |
| SKH06100    | 60                       | ±20              | ±100           | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 60              | 2.0             | 4.0            | 10  | 1m   |  |
| SKH1070     | 100                      | ±20              | ±70            | ±200                   | 100            | 300             | ±20μ             | ±15             |                  | 100             | 100             | 2.0             | 4.0            | 10  | 1m   |  |
| SKP202      | 200                      | ±30              | ±45            | ±180                   | 95             | 200             | ±100             | ±30             |                  | 100             | 200             | 3.0             | 4.5            | 10  | 1m   |  |
| SKP253      | 250                      | ±30              | ±20            | ± 80                   | 40             | 160             | ±100             | ±30             |                  | 100             | 250             | 3.0             | 4.5            | 10  | 1m   |  |

| Electrical Characteristics |     |                 |                |                  |                  |                      |      |            |      |            |                 |                 |                 |                |     |                 | Package               | Mass           |
|----------------------------|-----|-----------------|----------------|------------------|------------------|----------------------|------|------------|------|------------|-----------------|-----------------|-----------------|----------------|-----|-----------------|-----------------------|----------------|
| R <sub>e</sub> (yfs)       |     |                 |                | C <sub>iss</sub> | C <sub>rss</sub> | R <sub>DS</sub> (ON) |      |            |      |            |                 |                 |                 |                |     |                 |                       |                |
| (S)                        |     | Conditions      |                |                  |                  | (pF)                 | (pF) | Conditions |      | Conditions |                 |                 |                 |                |     |                 |                       |                |
|                            |     | V <sub>DS</sub> | I <sub>D</sub> |                  |                  |                      |      |            |      | (Ω)        | Conditions      |                 | V <sub>GS</sub> | I <sub>D</sub> |     |                 |                       |                |
|                            |     |                 |                |                  |                  |                      |      |            |      |            | V <sub>GS</sub> | V <sub>DS</sub> |                 |                | (Ω) | V <sub>GS</sub> |                       | I <sub>D</sub> |
| min                        | typ | (V)             | (A)            | typ              | typ              | (V)                  | (V)  | typ        | max  | (V)        | (A)             | typ             | max             | (V)            | (A) | (g)             |                       |                |
|                            | 13  | 20              | 10             | 15               | 2200             |                      | 0    | 25         | 21m  | 28m        | 10              | 15              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 3.5 | 5               | 20             | 3.5              | 720              | 62                   | 0    | 10         | 0.84 | 1.1        | 10              | 3.5             |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 1.5 | 2.1             | 20             | 1.5              | 340              | 26                   | 0    | 10         | 2.1  | 2.8        | 10              | 1.5             |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 1.2 | 1.7             | 20             | 1                | 290              | 30                   | 0    | 10         | 3    | 3.8        | 10              | 1               |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 1.8 | 2.8             | 20             | 1.5              | 600              | 40                   | 0    | 10         | 4    | 5          | 10              | 1.5             |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 7   | 11              | 10             | 9                | 850              | 250                  | 0    | 10         | 130m | 175m       | 10              | 9               |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 7   | 11              | 10             | 9                | 850              | 250                  | 0    | 10         | 0.2  | 0.25       | 10              | 9               |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 3.5 | 5.2             | 20             | 2.5              | 650              | 110                  | 0    | 10         | 1.2  | 1.5        | 10              | 2.5             |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 30  | 80              | 10             | 35               | 8000             | 1000                 | 0    | 10         | 5m   | 6m         | 10              | 35              |                 |                |     |                 | TO220S(Surface-mount) | 1.5            |
|                            | 30  | 80              | 10             | 35               | 8000             | 1000                 | 0    | 10         | 5m   | 6m         | 10              | 35              |                 |                |     |                 | TO3P(MT100)           | 6.0            |
|                            | 30  | 50              | 10             | 35               | 5100             | 860                  | 0    | 10         | 5m   | 6m         | 10              | 35              |                 |                |     |                 | TO220S(Surface-mount) | 1.5            |
|                            | 30  | 50              | 10             | 35               | 5100             | 860                  | 0    | 10         | 5m   | 6m         | 10              | 35              |                 |                |     |                 | TO3P(MT100)           | 6.0            |
|                            | 9   |                 | 10             | 10               | 2200             | 210                  | 0    | 10         | 41m  | 52m        | 10              | 10              | 45m             | 49m            | 4.5 | 10              | TO220                 | 2.0            |
|                            |     | 140             | 10             | 50               | 11500            | 1800                 | 0    | 10         | 3m   | 3.8m       | 10              | 50              |                 |                |     |                 | TO220                 | 2.0            |
|                            |     | 140             | 10             | 50               | 11500            | 1100                 | 0    | 10         | 3.8m | 5m         | 10              | 50              |                 |                |     |                 | TO220                 | 2.0            |
|                            |     | 120             | 10             | 35               | 11500            | 780                  | 0    | 10         | 8.8m | 11.5m      | 10              | 35              |                 |                |     |                 | TO220                 | 2.0            |
|                            | 17  |                 | 10             | 25               | 2000             | 500                  | 0    | 10         | 12m  | 15m        | 10              | 25              |                 |                |     |                 | TO220                 | 2.0            |
|                            | 9   |                 | 10             | 10               | 2200             | 210                  | 0    | 10         | 41m  | 52m        | 10              | 10              | 45m             | 49m            | 4.5 | 10              | TO220F-A              | 2.0            |
|                            |     | 140             | 10             | 50               | 11500            | 1800                 | 0    | 10         | 3m   | 3.8m       | 10              | 50              |                 |                |     |                 | TO220F-A              | 2.0            |
|                            |     | 140             | 10             | 50               | 11500            | 1100                 | 0    | 10         | 3.8m | 5m         | 10              | 50              |                 |                |     |                 | TO220F-A              | 2.0            |
|                            |     | 120             | 10             | 35               | 11500            | 780                  | 0    | 10         | 8.8m | 11.5m      | 10              | 35              |                 |                |     |                 | TO220F-A              | 2.0            |
|                            | 18  | 28              | 10             | 22               | 2000             | 80                   | 0    | 25         | 45m  | 53m        | 10              | 22              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 30  | 42              | 10             | 25               | 3800             | 210                  | 0    | 25         | 37m  | 43m        | 10              | 25              |                 |                |     |                 | TO3PF(FM100)          | 6.5            |
|                            | 13  | 21              | 10             | 12               | 2000             | 70                   | 0    | 25         | 68m  | 75m        | 10              | 12              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 8   | 17              | 10             | 10               | 1600             | 50                   | 0    | 25         | 86m  | 95m        | 10              | 10              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 25  | 38              | 10             | 20               | 3800             | 190                  | 0    | 25         | 46m  | 53m        | 10              | 20              |                 |                |     |                 | TO3PF(FM100)          | 6.5            |
|                            | 20  | 33              | 10             | 15               | 3800             | 180                  | 0    | 25         | 57m  | 65m        | 10              | 15              |                 |                |     |                 | TO3PF(FM100)          | 6.5            |
|                            | 23  | 37              | 10             | 15               | 4600             | 220                  | 0    | 25         | 50m  | 63m        | 10              | 15              |                 |                |     |                 | TO3PF(FM100)          | 6.5            |
|                            | 20  |                 | 10             | 25               | 2800             | 600                  | 0    | 10         | 7m   | 9m         | 10              | 25              |                 |                |     |                 | TO220S(Surface-mount) | 1.5            |
|                            | 17  |                 | 10             | 25               | 2000             | 500                  | 0    | 10         | 12m  | 15m        | 10              | 25              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 30  |                 | 10             | 37               | 3200             | 750                  | 0    | 10         | 7m   | 10m        | 10              | 37              |                 |                |     |                 | TO220F(FM20)          | 2.0            |
|                            | 20  |                 | 10             | 25               | 2500             | 150                  | 0    | 10         | 11m  | 14m        | 10              | 25              |                 |                |     |                 | TO220S(Surface-mount) | 1.5            |
|                            | 4   |                 | 10             | 7.5              | 2000             | 900                  | 0    | 10         | 0.3  | 0.4        | 10              | 7.5             |                 |                |     |                 | TO3P                  | 6.0            |
|                            | 4   |                 | 10             | 10               | 3300             | 1500                 | 0    | 10         | 0.21 | 0.27       | 10              | 10              |                 |                |     |                 | TO3P                  | 6.0            |
|                            |     | 140             | 10             | 50               | 11500            | 1800                 | 0    | 10         | 2.8m | 3.6m       | 10              | 50              |                 |                |     |                 | TO263(Surface-mount)  | 1.5            |
|                            |     | 140             | 10             | 50               | 11500            | 1100                 | 0    | 10         | 3.6m | 4.8m       | 10              | 50              |                 |                |     |                 | TO263(Surface-mount)  | 1.5            |
|                            |     | 120             | 10             | 35               | 11500            | 780                  | 0    | 10         | 8.6m | 11.3m      | 10              | 35              |                 |                |     |                 | TO263(Surface-mount)  | 1.5            |
|                            | 18  | 28              | 10             | 22               | 2000             | 80                   | 0    | 25         | 45m  | 53m        | 10              | 22              |                 |                |     |                 | TO263(Surface-mount)  | 1.5            |
|                            | 8   | 17              | 10             | 10               | 1600             | 50                   | 0    | 25         | 86m  | 95m        | 10              | 10              |                 |                |     |                 | TO263(Surface-mount)  | 1.5            |



## Selection Guide

By  $V_{CES}$

| $V_{CES}$<br>(V) | $I_C$<br>(A) | $P_C$<br>(W) | Part Number | Package      |
|------------------|--------------|--------------|-------------|--------------|
| 600              | 25           | 60           | FGM622S     | TO3PF(FM100) |
|                  | 30           | 60           | FGM603      | TO3PF(FM100) |
|                  | 30           | 60           | FGM623S     | TO3PF(FM100) |
|                  | 50           | 150          | MGD623N     | TO3P(MT100)  |
|                  | 50           | 150          | MGD623S     | TO3P(MT100)  |

Specifications List by Part Number

| Part Number | Absolute Maximum Ratings (Ta=25°C) |                 |                |                       |                             |                  |                 |                  |                 |                     |     |                |                 |                      |     |                |                 |                  |                  |                  |                 |                 |  |  |
|-------------|------------------------------------|-----------------|----------------|-----------------------|-----------------------------|------------------|-----------------|------------------|-----------------|---------------------|-----|----------------|-----------------|----------------------|-----|----------------|-----------------|------------------|------------------|------------------|-----------------|-----------------|--|--|
|             | V <sub>CES</sub>                   | V <sub>GE</sub> | I <sub>C</sub> | I <sub>C(pulse)</sub> | P <sub>C</sub><br>(Ta=25°C) | I <sub>GES</sub> |                 | I <sub>CES</sub> |                 | V <sub>GE(th)</sub> |     |                |                 | V <sub>CE(sat)</sub> |     |                |                 | C <sub>ies</sub> | C <sub>oes</sub> | C <sub>res</sub> |                 |                 |  |  |
|             |                                    |                 |                |                       |                             | Conditions       |                 | Conditions       |                 | Conditions          |     |                |                 | Conditions           |     |                |                 |                  |                  |                  | Conditions      |                 |  |  |
|             | (V)                                | (V)             | (A)            | (A)                   | (W)                         | (nA)             | V <sub>GE</sub> | (μA)             | V <sub>CE</sub> | (V)                 |     | I <sub>C</sub> | V <sub>CE</sub> | (V)                  |     | I <sub>C</sub> | V <sub>GE</sub> | (pF)             | (pF)             | (pF)             | V <sub>CE</sub> | V <sub>GE</sub> |  |  |
|             |                                    |                 |                |                       |                             | max              | (V)             | max              | (V)             | min                 | max | (mA)           | (V)             | typ                  | max | (A)            | (V)             | typ              | typ              | typ              | (V)             | (V)             |  |  |
| FGM603      | 600                                | ±20             | 30             | 90                    | 60                          | ±100             | ±20             | 100              | 600             | 4                   | 7   | 1              | 10              | 1.6                  | 2.0 | 30             | 15              | 4600             | 110              | 80               | 20              | 0               |  |  |
| FGM622S     | 600                                | ±30             | 25             | 75                    | 60                          | ±500             | ±30             | 100              | 600             | 4                   | 7   | 1              | 10              | 1.7                  | 1.9 | 25             | 15              | 1300             | 80               | 40               | 20              | 0               |  |  |
| FGM623S     | 600                                | ±30             | 30             | 100                   | 60                          | ±500             | ±30             | 100              | 600             | 3                   | 6   | 1              | 10              | 1.5                  | 1.7 | 30             | 15              | 2500             | 150              | 80               | 20              | 0               |  |  |
| MGD623N     | 600                                | ±30             | 50             | 100                   | 150                         | ±100             | ±30             | 100              | 600             | 3                   | 6   | 1              | 10              | 1.7                  | 2.3 | 50             | 15              | 2500             | 150              | 80               | 20              | 0               |  |  |
| MGD623S     | 600                                | ±30             | 50             | 100                   | 150                         | ±100             | ±30             | 100              | 600             | 3                   | 6   | 1              | 10              | 1.8                  | 2.4 | 50             | 15              | 2500             | 150              | 80               | 20              | 0               |  |  |

| Electrical Characteristics (Ta=25°C) |        |      |         |      |            |     |        |      |      |      |            |     |     |     |     |            |      |            |        |             | Package      | Mass        |  |
|--------------------------------------|--------|------|---------|------|------------|-----|--------|------|------|------|------------|-----|-----|-----|-----|------------|------|------------|--------|-------------|--------------|-------------|--|
|                                      | td(on) | tr   | td(off) | tf   | Conditions |     |        | Qg   | Qge  | Qgc  | Conditions |     |     | VF  |     | Conditions | trr  | Conditions |        |             |              |             |  |
|                                      | (ns)   | (ns) | (ns)    | (ns) | Ic         | VCE |        | (nC) | (nC) | (nC) | Ic         | VCE | VGE | (V) |     | IF         | (μs) | IF         | di/dt  |             |              |             |  |
|                                      | typ    | typ  | typ     | typ  | (A)        | (V) |        | typ  | typ  | typ  | (A)        | (V) | (V) | typ | max | (A)        | typ  | (A)        | (A/μs) |             |              |             |  |
|                                      | 130    | 70   | 340     | 200  | 30         | 300 | L Load | 120  | 30   | 30   | 30         | 300 | 15  |     |     |            |      |            |        |             | TO3PF(FM100) | 6.5         |  |
|                                      | 50     | 60   | 200     | 120  | 25         | 300 | L Load | 40   | 10   | 10   | 25         | 300 | 15  |     |     |            |      |            |        |             | TO3PF(FM100) | 6.5         |  |
|                                      | 100    | 80   | 300     | 120  | 30         | 300 | L Load | 65   | 20   | 20   | 30         | 300 | 15  |     |     |            |      |            |        |             | TO3PF(FM100) | 6.5         |  |
|                                      | 75     | 70   | 250     | 200  | 50         | 300 | L Load | 65   | 15   | 20   | 50         | 300 | 15  | 1.2 | 1.6 | 30         | 0.3  | 30         | 100    | TO3P(MT100) | 6.0          | Built-in Di |  |
|                                      | 75     | 70   | 250     | 120  | 50         | 300 | L Load | 65   | 15   | 20   | 50         | 300 | 15  | 1.2 | 1.6 | 30         | 0.3  | 30         | 100    | TO3P(MT100) | 6.0          | Built-in Di |  |

## 2-4 Transistor and MOS FET Arrays

### Specifications List by Part Number

| Part Number | Category                  | Circuit Count   | $V_{CE0} \cdot V_{DSS} \cdot V_{CES}$ (V) | $I_C \cdot I_D$ (A) | hFE (min) | $R_{DS(ON)}$ max( $\Omega$ ) | Package                   | Mass (g) |
|-------------|---------------------------|-----------------|-------------------------------------------|---------------------|-----------|------------------------------|---------------------------|----------|
| SLA4030     | For sink driver           | 4               | 100                                       | 4                   | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4031     | For sink driver           | 4               | 120                                       | 4                   | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4036     | For sink driver           | 6               | 120                                       | 2                   | 2000      |                              | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA4041     | For sink driver           | 4               | 200                                       | 3                   | 1000      |                              | SIP12 with Fin (SLA15Pin) | 6.0      |
| SLA4051     | For sink driver           | 9               | 120                                       | 2                   | 2000      |                              | SIP21 with Fin (SLA21Pin) | 6.0      |
| SLA4052     | For sink driver           | 9               | 120                                       | 3                   | 2000      |                              | SIP21 with Fin (SLA21Pin) | 6.0      |
| SLA4060     | For sink driver           | 4               | 120                                       | 5                   | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4061     | For sink driver           | 4               | 120                                       | 5                   | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4070     | For source driver         | 4               | -100                                      | -5                  | 1000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4071     | For source driver         | 4               | -100                                      | -5                  | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA4390     | H bridge                  | 4               | $\pm 100$                                 | $\pm 5$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5037     | For sink driver           | 4               | 100                                       | 10                  |           | 0.08                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5041     | For sink driver           | 4               | 200                                       | 10                  |           | 0.175                        | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5059     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 4$             |           | 0.55                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5060     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 6$             |           | 0.22                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5061     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 10$            |           | 0.14                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5064     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 10$            |           | 0.14                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5065     | For 5-phase motor driver  | 4               | 60                                        | 7                   |           | 0.1                          | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5068     | For 5-phase motor driver  | 6               | 60                                        | 7                   |           | 0.1                          | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5073     | For 5-phase motor driver  | 6               | 60                                        | 5                   |           | 0.3                          | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5074     | For 5-phase motor driver  | 4               | 60                                        | 5                   |           | 0.3                          | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5075     | For 3-phase motor driver  | 6               | 500                                       | $\pm 5$             |           | 1.4                          | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5085     | For sink driver           | 5               | 60                                        | 5                   |           | 0.22                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5086     | For source driver         | 5               | -60                                       | -5                  |           | 0.22                         | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5096     | For 3-phase motor driver  | 6               | 55                                        | 8                   |           | 0.08                         | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5201     | For 3-phase motor driver  | 6               | 600                                       | 7                   |           | 1.85Vtyp( $V_{CE(sat)}$ )    | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5212     | For 3-phase motor driver  | 6               | 35                                        | $\pm 8$             |           | 0.07                         | SIP15 with Fin (SLA15Pin) | 6.0      |
| SLA5222     | For Partial switching PFC | 1+Di $\times$ 4 | 600                                       | 30                  |           | 1.3Vtyp( $V_{CE(sat)}$ )     | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA5227     | For Partial switching PFC | 1+Di $\times$ 4 | 600                                       | 30                  |           | 1.3Vtyp( $V_{CE(sat)}$ )     | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6012     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 4$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6020     | For 3-phase motor driver  | 6               | $\pm 100$                                 | $\pm 5$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6022     | For 3-phase motor driver  | 6               | $\pm 80$                                  | $\pm 5$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6023     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 6$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6024     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 8$             | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |
| SLA6026     | For 3-phase motor driver  | 6               | $\pm 60$                                  | $\pm 10$            | 2000      |                              | SIP12 with Fin (SLA12Pin) | 6.0      |

| Part Number | Category                                     | Circuit Count | $V_{CE0} \cdot V_{DSS} \cdot V_{CES}$ (V) | $I_C \cdot I_D$ (A) | hFE (min) | $R_{DS(ON)} \max(\Omega)$ | Package          | Mass (g) |
|-------------|----------------------------------------------|---------------|-------------------------------------------|---------------------|-----------|---------------------------|------------------|----------|
| SMA4020     | For source driver                            | 4             | -60                                       | -4                  | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA4021     | For source driver                            | 4             | -60                                       | -3                  | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA4030     | For sink driver                              | 4             | 100                                       | 3                   | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA4032     | For sink driver                              | 4             | 100                                       | 3                   | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA4033     | For sink driver                              | 4             | 100                                       | 2                   | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA4036     | For sink driver                              | 6             | 120                                       | 2                   | 2000      |                           | SIP15 (SMA15Pin) | 4.0      |
| SMA4038     | For sink driver                              | 6             | 120                                       | 3                   | 2000      |                           | SIP15 (SMA15Pin) | 4.0      |
| SMA5106     | For sink driver                              | 4             | 100                                       | 4                   |           | 0.55                      | SIP12 (SMA12Pin) | 4.0      |
| SMA5112     | For 3-phase motor driver                     | 6             | 250                                       | 7                   |           | 0.5                       | SIP12 (SMA12Pin) | 4.0      |
| SMA5117     | For 3-phase motor driver                     | 6             | 250                                       | 7                   |           | 0.25                      | SIP12 (SMA12Pin) | 4.0      |
| SMA5118     | For 3-phase motor driver                     | 6             | 500                                       | $\pm 5$             |           | 1.4                       | SIP12 (SMA12Pin) | 4.0      |
| SMA5125     | For 3-phase motor driver                     | 6             | $\pm 60$                                  | $\pm 10$            |           | 0.14                      | SIP12 (SMA12Pin) | 4.0      |
| SMA5127     | For 3-phase motor driver                     | 6             | $\pm 60$                                  | $\pm 4$             |           | 0.55                      | SIP12 (SMA12Pin) | 4.0      |
| SMA5130     | For 3-phase motor driver                     | 6             | 250                                       | 2.5                 | 2000      | 0.9                       | SIP15 (SMA15Pin) | 4.0      |
| SMA5131     | For 3-phase motor driver                     | 6             | 250                                       | 2                   |           | 1.8                       | SIP12 (SMA12Pin) | 4.0      |
| SMA5132     | For 3-phase motor driver                     | 6             | 500                                       | 1.5                 |           | 4                         | SIP12 (SMA12Pin) | 4.0      |
| SMA5133     | For 3-phase motor driver                     | 6             | 500                                       | 2.5                 |           | 2                         | SIP12 (SMA12Pin) | 4.0      |
| SMA6010     | For 3-phase motor driver                     | 6             | $\pm 60$                                  | $\pm 4$             | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA6080     | For 3-phase motor driver                     | 6             | $\pm 60$                                  | $\pm 2$             | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| SMA6511     | For driving stepping motor with two supplies | 5             | 100 $\pm$ 15/-60                          | 1.5/-3              | 2000      |                           | SIP12 (SMA12Pin) | 4.0      |
| STA301A     | For sink driver                              | 3             | 60 $\pm$ 10                               | 4                   | 1000      |                           | SIP8 (STA8Pin)   | 2.0      |
| STA302A     | For source driver/3-phase motor driver       | 3             | -50                                       | -4                  | 1000      |                           | SIP8 (STA8Pin)   | 2.0      |
| STA303A     | For sink driver/3-phase motor driver         | 3             | 100                                       | 4                   | 1000      |                           | SIP8 (STA8Pin)   | 2.0      |
| STA322A     | For source driver                            | 3             | -50                                       | -3                  | 100       |                           | SIP8 (STA8Pin)   | 2.0      |
| STA401A     | For sink driver                              | 4             | 60 $\pm$ 10                               | 4                   | 1000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA402A     | For source driver                            | 4             | -50                                       | -4                  | 1000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA403A     | For sink driver                              | 4             | 100                                       | 4                   | 1000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA404A     | For sink driver                              | 4             | 200                                       | 3                   | 1000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA406A     | For sink driver                              | 4             | 60 $\pm$ 10                               | 6                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA408A     | For source driver                            | 4             | -120                                      | -4                  | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA412A     | For sink driver                              | 4             | 60                                        | 3                   | 300       |                           | SIP10 (STA10Pin) | 2.6      |
| STA413A     | For sink driver                              | 4             | 35 $\pm$ 5                                | 3                   | 500       |                           | SIP10 (STA10Pin) | 2.6      |
| STA421A     | For source driver                            | 4             | -60                                       | -3                  | 40        |                           | SIP10 (STA10Pin) | 2.6      |
| STA431A     | H bridge                                     | 4             | $\pm 60$                                  | $\pm 3$             | 40        |                           | SIP10 (STA10Pin) | 2.6      |
| STA434A     | H bridge                                     | 4             | $\pm 60$                                  | $\pm 4$             | 1000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA457C     | H bridge                                     | 4             | $\pm 60$                                  | $\pm 4$             | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA460C     | For sink driver                              | 2             | 60 $\pm$ 10                               | 6                   | 700       |                           | SIP10 (STA10Pin) | 2.6      |
| STA471A     | For sink driver                              | 4             | 60 $\pm$ 10                               | 2                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA472A     | For source driver                            | 4             | -60                                       | -2                  | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA473A     | For sink driver                              | 4             | 100                                       | 2                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA475A     | For sink driver                              | 4             | 100 $\pm$ 15                              | 2                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA481A     | For sink driver                              | 4             | 60 $\pm$ 10                               | 1                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |
| STA485A     | For sink driver                              | 4             | 100 $\pm$ 15                              | 1                   | 2000      |                           | SIP10 (STA10Pin) | 2.6      |

## Specifications List by Application Sink Driver Arrays

### ●Built-in Avalanche Diodes, between Collector and Base

| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package          |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|------------------|
| STA460C     | 2             | 60±10                                      | 6                                      | 700                   |                             | 1                  | SIP10 (STA10Pin) |
| STA301A     | 3             | 60±10                                      | 4                                      | 1000                  |                             | 2                  | SIP8 (STA8Pin)   |
| STA413A     | 4             | 35±5                                       | 3                                      | 500                   |                             | 3                  | SIP10 (STA10Pin) |
| STA481A     | 4             | 60±10                                      | 1                                      | 2000                  |                             | 4                  | SIP10 (STA10Pin) |
| STA471A     | 4             | 60±10                                      | 2                                      | 2000                  |                             | 4                  | SIP10 (STA10Pin) |
| STA401A     | 4             | 60±10                                      | 4                                      | 1000                  |                             | 4                  | SIP10 (STA10Pin) |
| STA406A     | 4             | 60±10                                      | 6                                      | 2000                  |                             | 4                  | SIP10 (STA10Pin) |
| STA485A     | 4             | 100±15                                     | 1                                      | 2000                  |                             | 4                  | SIP10 (STA10Pin) |
| STA475A     | 4             | 100±15                                     | 2                                      | 2000                  |                             | 4                  | SIP10 (STA10Pin) |

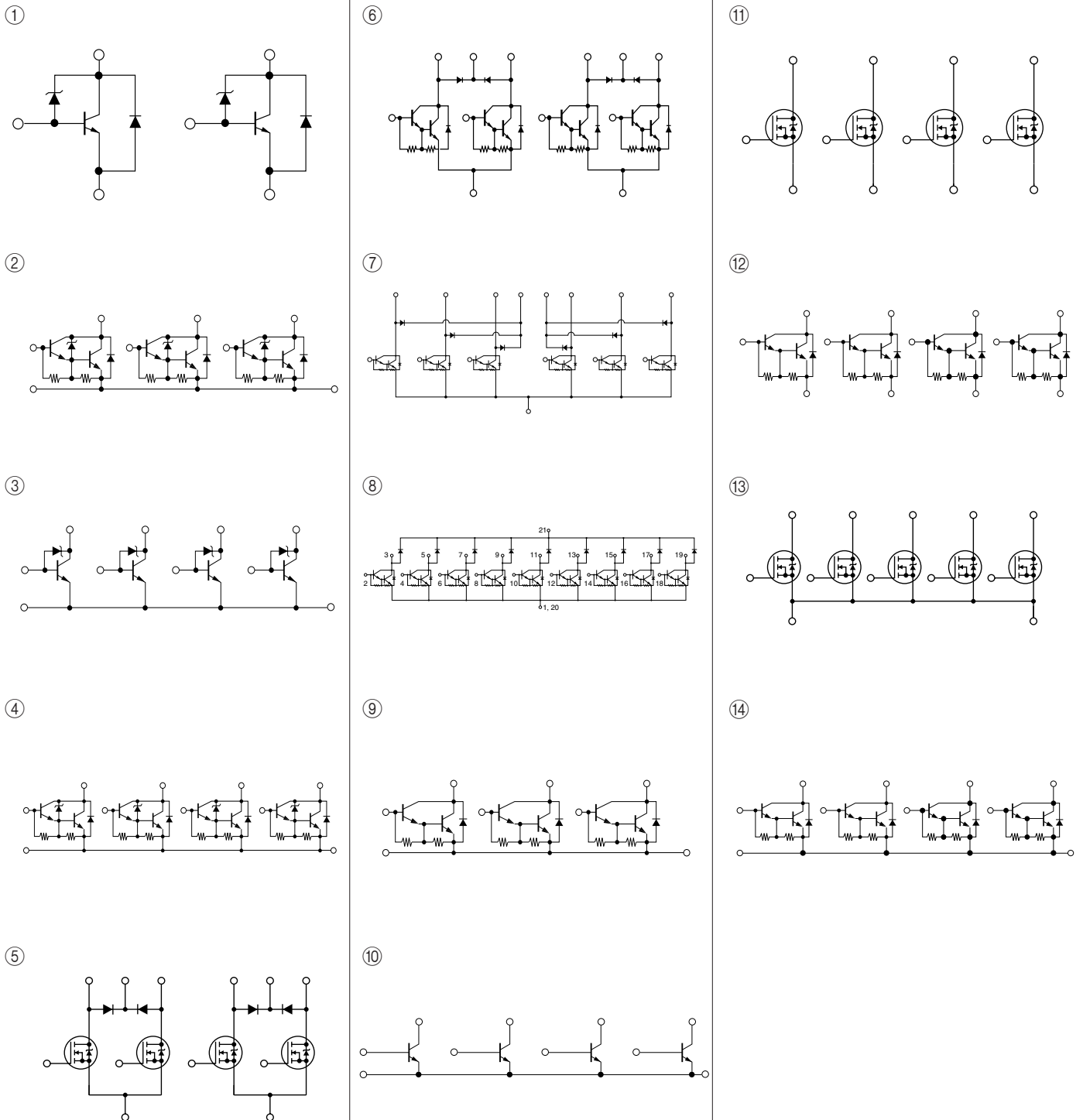
### ●Built-in Flywheel Diodes

| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| SMA4033     | 4             | 100                                        | 2                                      | 2000                  |                             | 6                  | SIP12 (SMA12Pin)          |
| SMA4032     | 4             | 100                                        | 3                                      | 2000                  |                             | 6                  | SIP12 (SMA12Pin)          |
| SMA5106     | 4             | 100                                        | 4                                      |                       | 0.55                        | 5                  | SIP12 (SMA12Pin)          |
| SLA4031     | 4             | 120                                        | 4                                      | 2000                  |                             | 6                  | SIP12 with Fin (SLA12Pin) |
| SLA4061     | 4             | 120                                        | 5                                      | 2000                  |                             | 6                  | SIP12 with Fin (SLA12Pin) |
| SLA4041     | 4             | 200                                        | 3                                      | 1000                  |                             | 6                  | SIP12 with Fin (SLA12Pin) |
| SMA4036     | 6             | 120                                        | 2                                      | 2000                  |                             | 7                  | SIP15 (SMA15Pin)          |
| SLA4036     | 6             | 120                                        | 2                                      | 2000                  |                             | 7                  | SIP15 with Fin (SLA15Pin) |
| SMA4038     | 6             | 120                                        | 3                                      | 2000                  |                             | 7                  | SIP15 (SMA15Pin)          |
| SLA4051     | 9             | 120                                        | 2                                      | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SLA4052     | 9             | 120                                        | 3                                      | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |

### ●General-Purpose

| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| STA303A     | 3             | 100                                        | 4                                      | 100                   |                             | 9                  | SIP8 (STA8Pin)            |
| STA412A     | 4             | 60                                         | 3                                      | 300                   |                             | 10                 | SIP10 (STA10Pin)          |
| STA473A     | 4             | 100                                        | 2                                      | 2000                  |                             | 14                 | SIP10 (STA10Pin)          |
| SMA4030     | 4             | 100                                        | 3                                      | 2000                  |                             | 12                 | SIP12 (SMA12Pin)          |
| STA403A     | 4             | 100                                        | 4                                      | 1000                  |                             | 14                 | SIP10 (STA10Pin)          |
| SLA4030     | 4             | 100                                        | 4                                      | 2000                  |                             | 12                 | SIP12 with Fin (SLA12Pin) |
| SLA5037     | 4             | 100                                        | 10                                     |                       | 0.08                        | 11                 | SIP12 with Fin (SLA12Pin) |
| SLA4060     | 4             | 120                                        | 5                                      | 2000                  |                             | 12                 | SIP12 with Fin (SLA12Pin) |
| STA404A     | 4             | 200                                        | 3                                      | 1000                  |                             | 14                 | SIP10 (STA10Pin)          |
| SLA5041     | 4             | 200                                        | 10                                     |                       | 0.175                       | 11                 | SIP12 with Fin (SLA12Pin) |
| SLA5085     | 5             | 60                                         | 5                                      |                       | 0.22                        | 13                 | SIP12 with Fin (SLA12Pin) |

### ●Equivalent Circuit (for Sink Driver)



## Specifications List by Application Source Driver Arrays

### ●Built-in Flywheel Diodes

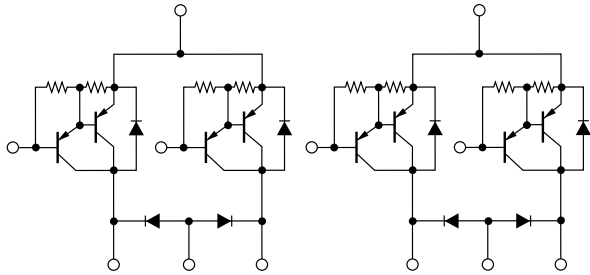
| Part Number | Circuit Count | V <sub>CEO</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| SMA4021     | 4             | −60                                        | −3                                     | 2000                  |                             | 1                  | SIP12 (SMA12Pin)          |
| SLA4071     | 4             | −100                                       | −5                                     | 2000                  |                             | 1                  | SIP12 with Fin (SLA12Pin) |

### ●General-Purpose

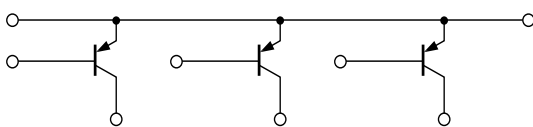
| Part Number | Circuit Count | V <sub>CEO</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| STA322A     | 3             | −50                                        | −3                                     | 100                   |                             | 2                  | SIP8 (STA8Pin)            |
| STA302A     | 3             | −50                                        | −4                                     | 1000                  |                             | 3                  | SIP8 (STA8Pin)            |
| STA402A     | 4             | −50                                        | −4                                     | 1000                  |                             | 4                  | SIP10 (STA10Pin)          |
| STA472A     | 4             | −60                                        | −2                                     | 2000                  |                             | 4                  | SIP10 (STA10Pin)          |
| STA421A     | 4             | −60                                        | −3                                     | 40                    |                             | 6                  | SIP10 (STA10Pin)          |
| SMA4020     | 4             | −60                                        | −4                                     | 2000                  |                             | 5                  | SIP12 (SMA12Pin)          |
| SLA4070     | 4             | −100                                       | −5                                     | 1000                  |                             | 5                  | SIP12 with Fin (SLA12Pin) |
| STA408A     | 4             | −120                                       | −4                                     | 2000                  |                             | 7                  | SIP10 (STA10Pin)          |
| SLA5086     | 5             | −60                                        | −5                                     |                       | 0.22                        | 8                  | SIP12 with Fin (SLA12Pin) |

### ●Equivalent Circuit (for Source Driver)

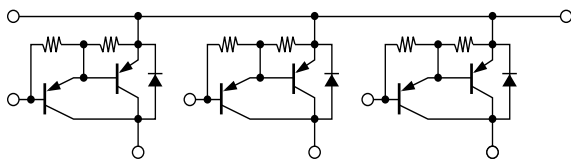
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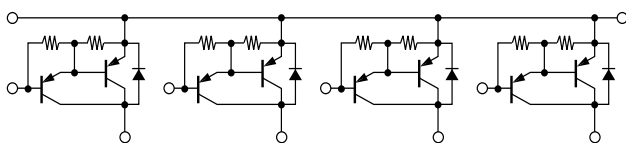
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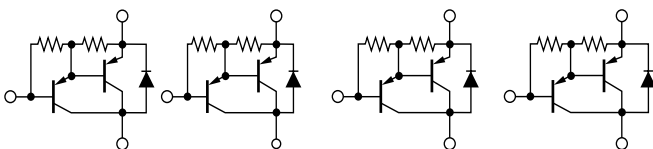
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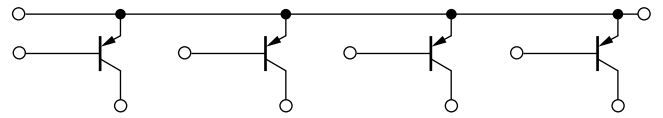
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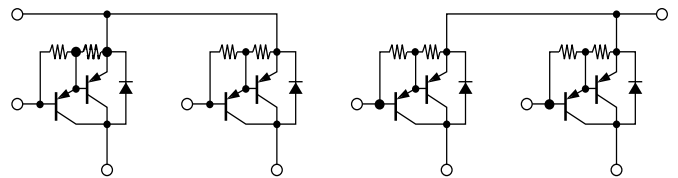
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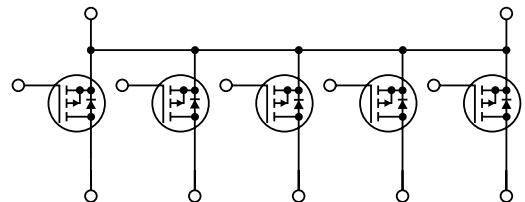
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⑧



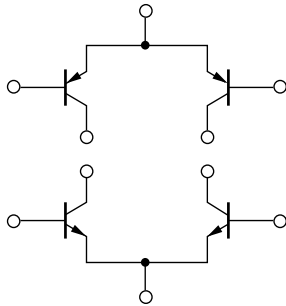
Specifications List by Application Motor Driver Arrays

●H Bridge

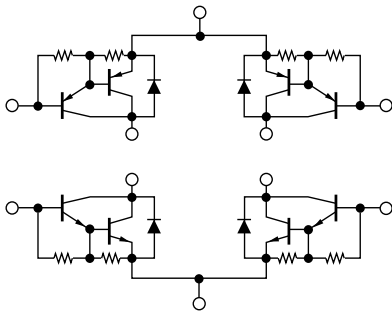
| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>C</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| STA431A     | 4             | ±60                                        | ±3                                     | 40                    |                             | 1                  | SIP10 (STA10Pin)          |
| STA434A     | 4             | ±60                                        | ±4                                     | 1000                  |                             | 2                  | SIP10 (STA10Pin)          |
| STA457C     | 4             | ±60                                        | ±4                                     | 2000                  |                             | 3                  | SIP10 (STA10Pin)          |
| SLA4390     | 4             | ±100                                       | ±5                                     | 2000                  |                             | 2                  | SIP12 with Fin (SLA12Pin) |

**●Equivalent Circuit (for Motor Driver)**

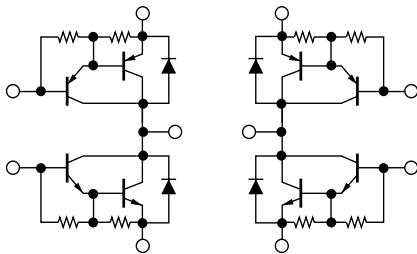
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### ●For 3-Phase Motor Drivers

| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V)/ V <sub>CEs</sub> (V) | I <sub>c</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|------------------------------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| STA303A     | 3             | 100                                                              | 4                                      | 1000                  |                             | 4                  | SIP8 (STA8Pin)            |
| STA302A     | 3             | −50                                                              | −4                                     | 1000                  |                             | 5                  | SIP8 (STA8Pin)            |
| SLA5212     | 6             | 35                                                               | ±8                                     |                       | 70m                         | 13                 | SIP15 with Fin (SLA15Pin) |
| SLA5096     | 6             | 55                                                               | ±8                                     |                       | 80m                         | 13                 | SIP15 with Fin (SLA15Pin) |
| SLA5059     | 6             | 60                                                               | ±4                                     |                       | 0.55                        | 6                  | SIP12 with Fin (SLA12Pin) |
| SLA5060     | 6             | 60                                                               | ±6                                     |                       | 0.22                        | 6                  | SIP12 with Fin (SLA12Pin) |
| SLA5061     | 6             | 60                                                               | ±10                                    |                       | 0.14                        | 6                  | SIP12 with Fin (SLA12Pin) |
| SLA5064     | 6             | 60                                                               | ±10                                    |                       | 0.14                        | 7                  | SIP12 with Fin (SLA12Pin) |
| SMA6080     | 6             | ±60                                                              | ±2                                     | 2000                  |                             | 9                  | SIP12 (SMA12Pin)          |
| SMA6010     | 6             | ±60                                                              | ±4                                     | 2000                  |                             | 9                  | SIP12 (SMA12Pin)          |
| SLA6012     | 6             | ±60                                                              | ±4                                     | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SMA5127     | 6             | ±60                                                              | ±4                                     |                       | 0.55                        | 10                 | SIP12 (SMA12Pin)          |
| SLA6023     | 6             | ±60                                                              | ±6                                     | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SLA6024     | 6             | ±60                                                              | ±8                                     | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SLA6026     | 6             | ±60                                                              | ±10                                    | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SMA5125     | 6             | ±60                                                              | ±10                                    |                       | 0.14                        | 7                  | SIP12 (SMA12Pin)          |
| SLA6022     | 6             | ±80                                                              | ±5                                     | 2000                  |                             | 8                  | SIP12 with Fin (SLA12Pin) |
| SLA6020     | 6             | ±100                                                             | ±5                                     | 2000                  |                             | 9                  | SIP12 with Fin (SLA12Pin) |
| SMA5130     | 6             | ±250                                                             | ±2.5                                   | 2000                  | 0.9                         | 15                 | SIP15 (SMA15Pin)          |
| SMA5131     | 6             | 250                                                              | 2                                      |                       | 1.8                         | 12                 | SIP12 (SMA12Pin)          |
| SMA5112     | 6             | 250                                                              | 7                                      |                       | 0.5                         | 12                 | SIP12 (SMA12Pin)          |
| SMA5117     | 6             | 250                                                              | 7                                      |                       | 0.25                        | 12                 | SIP12 (SMA12Pin)          |
| SMA5132     | 6             | 500                                                              | 1.5                                    |                       | 4                           | 12                 | SIP12 (SMA12Pin)          |
| SMA5133     | 6             | 500                                                              | 2.5                                    |                       | 2                           | 12                 | SIP12 (SMA12Pin)          |
| SLA5075     | 6             | 500                                                              | ±5                                     |                       | 1.4                         | 11                 | SIP15 with Fin (SLA15Pin) |
| SMA5118     | 6             | 500                                                              | ±5                                     |                       | 1.4                         | 12                 | SIP12 (SMA12Pin)          |
| SLA5201     | 6             | 600                                                              | 7                                      |                       |                             | 14                 | SIP15 with Fin (SLA15Pin) |

### ●For Driving Stepping Motor with Two Supplies

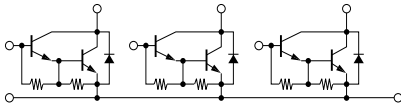
| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>c</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package          |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|------------------|
| SMA6511     | 5             | 100±15/−60                                 | 1.5/−3                                 | 2000                  |                             | 16                 | SIP12 (SMA12Pin) |

### ●For 5-Phase Motor Drive

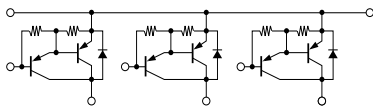
| Part Number | Circuit Count | V <sub>CE0</sub> (V)/ V <sub>DSS</sub> (V) | I <sub>c</sub> (A)/ I <sub>D</sub> (A) | h <sub>FE</sub> (min) | R <sub>DS(ON)</sub> max (Ω) | Equivalent Circuit | Package                   |
|-------------|---------------|--------------------------------------------|----------------------------------------|-----------------------|-----------------------------|--------------------|---------------------------|
| SLA5074     | 4             | 60                                         | 5                                      |                       | 0.3                         | 17                 | SIP15 with Fin (SLA15Pin) |
| SLA5065     | 4             | 60                                         | 7                                      |                       | 0.1                         | 17                 | SIP15 with Fin (SLA15Pin) |
| SLA5073     | 6             | 60                                         | 5                                      |                       | 0.3                         | 13                 | SIP15 with Fin (SLA15Pin) |
| SLA5068     | 6             | 60                                         | 7                                      |                       | 0.1                         | 13                 | SIP15 with Fin (SLA15Pin) |

### ●Equivalent Circuit (for Motor Driver)

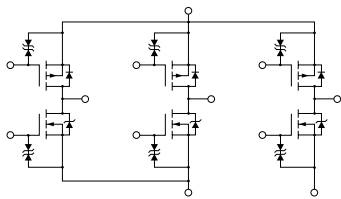
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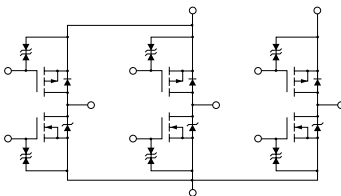
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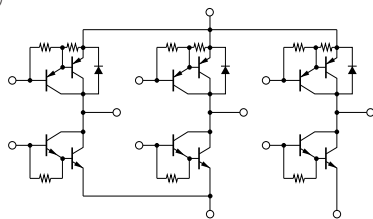
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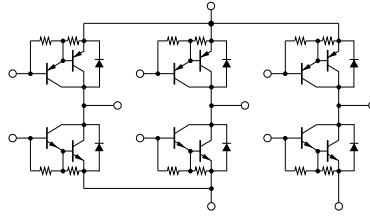
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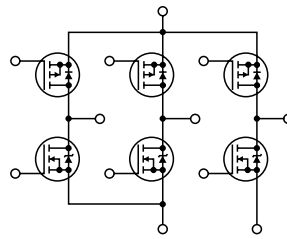
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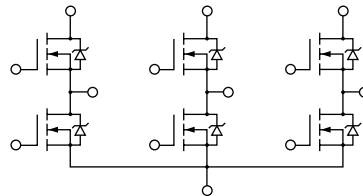
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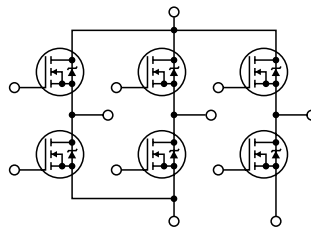
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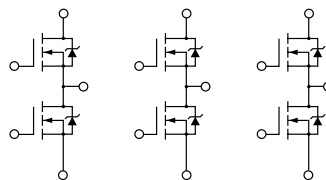
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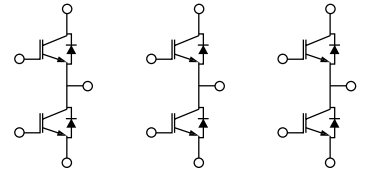
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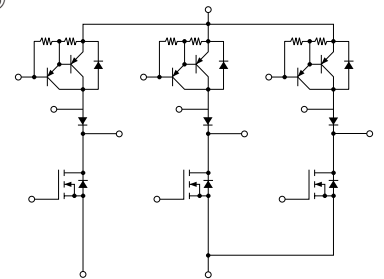
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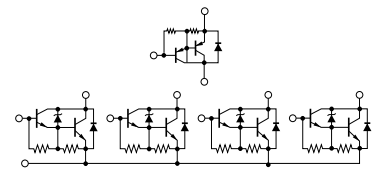
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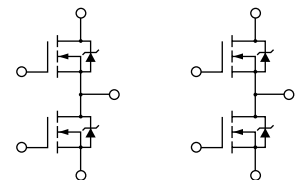
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⑰



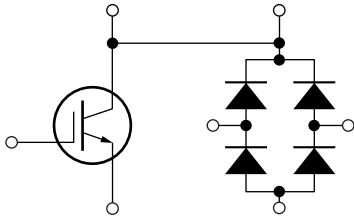
Specifications List by Application Partial switching PFC Arrays

●For Partial switching PFC

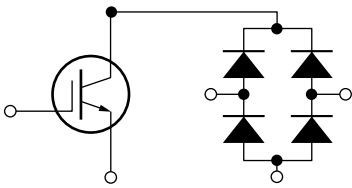
| Part Number | Circuit Count | V <sub>CES</sub> (V) | I <sub>C</sub> (A) | V <sub>CE(sat)</sub> (V) | Equivalent Circuit | Package                   |
|-------------|---------------|----------------------|--------------------|--------------------------|--------------------|---------------------------|
| SLA5222     | 1+Di X 4      | 600                  | 30                 | 1.3typ                   | 1                  | SIP12 with Fin (SLA12Pin) |
| SLA5227     | 1+Di X 4      | 600                  | 30                 | 1.3typ                   | 2                  | SIP12 with Fin (SLA12Pin) |

**●Equivalent Circuit (for Partial switching PFC)**

①

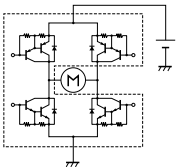
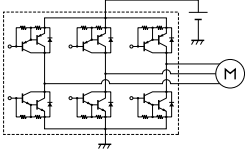
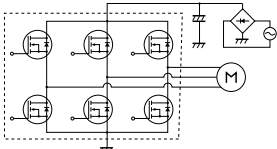
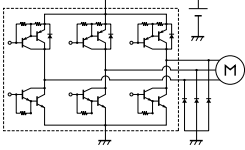
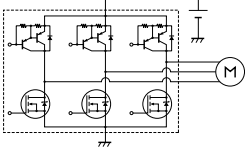
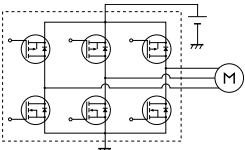


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Part Number List by Application

| Applications            | Typical Connection Diagram | Part Number                                                               |                    |          |
|-------------------------|----------------------------|---------------------------------------------------------------------------|--------------------|----------|
|                         |                            | Transistors                                                               |                    | MOS FETs |
|                         |                            | Darlington                                                                | Single             |          |
| ●Solenoid<br><br>●Relay |                            | STA301A<br>STA401A<br>STA406A<br>STA471A<br>STA475A<br>STA481A<br>STA485A | STA460C<br>STA413A |          |
|                         |                            | SLA4031<br>SLA4041<br>SLA4060<br>SMA4032<br>SMA4033<br>SMA4036            |                    | SMA5106  |
|                         |                            | SLA4071<br>SMA4021                                                        |                    |          |
|                         |                            | STA302A<br>STA402A<br>STA408A<br>STA472A<br>SLA4070<br>SMA4020            | STA322A<br>STA421A |          |

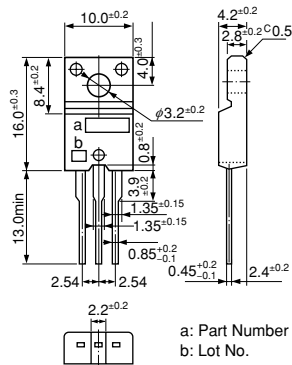
| Applications |                                 | Typical Connection Diagram                                                          | Part Number                                         |                    |                                                                           |
|--------------|---------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------|--------------------|---------------------------------------------------------------------------|
|              |                                 |                                                                                     | Transistors                                         |                    | MOS FETs                                                                  |
|              |                                 |                                                                                     | Darlington                                          | Single             |                                                                           |
| ●DC Motor    | Normal/Reverse Rotation Control |    | STA434A<br>STA457C<br>SLA4390                       | STA431A<br>STA474A |                                                                           |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              | AC100V Direct Driver            |    | STA302A+STA303A<br>SMA6010<br>SLA6020<br>SMA6080    |                    |                                                                           |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              | AC200V Direct Driver            |    |                                                     |                    | SLA5075<br>SMA5112<br>SMA5117<br>SMA5118<br>SMA5131<br>SMA5132<br>SMA5133 |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              |                                 |                                                                                     |                                                     |                    |                                                                           |
|              | PWM Control                     |  | SLA6012<br>SLA6022<br>SLA6023<br>SLA6024<br>SLA6026 |                    |                                                                           |
|              |                                 |  |                                                     |                    |                                                                           |
|              |                                 |  |                                                     |                    |                                                                           |
|              |                                 |                                                                                     | SMA5130                                             |                    |                                                                           |
|              |                                 |                                                                                     |                                                     |                    | SLA5059<br>SLA5060<br>SLA5061<br>SLA5064<br>SMA5125<br>SMA5127            |

| Applications    |                         | Typical Connection Diagram | Part Number                                                                                                           |                    |          |
|-----------------|-------------------------|----------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------|----------|
|                 |                         |                            | Transistors                                                                                                           |                    | MOS FETs |
|                 |                         |                            | Darlington                                                                                                            | Single             |          |
| ●Stepping Motor | Constant Voltage Driver |                            | STA401A<br>STA406A<br>STA435A<br>STA471A<br>STA475A<br>STA481A<br>STA485A<br>SLA4010                                  | STA460C<br>STA413A |          |
|                 | Two Supplies Driver     |                            | SMA6511                                                                                                               |                    |          |
|                 | Bipolar Driver          |                            | STA473A<br>STA472A<br>STA408A<br>STA404A<br>STA403A<br>STA402A<br>SMA4030<br>SMA4020<br>SLA4070<br>SLA4060<br>SLA4030 | STA421A<br>STA412A |          |

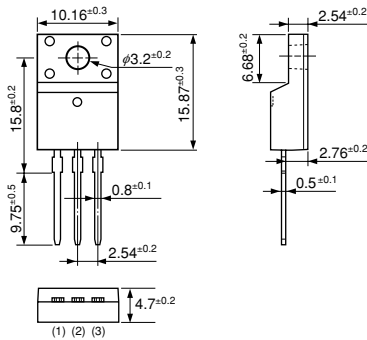
| Applications   | Typical Connection Diagram | Part Number                                   |         |
|----------------|----------------------------|-----------------------------------------------|---------|
|                |                            | N-CH                                          | P-CH    |
| ●5-Phase Motor |                            | SLA5065+SLA5068<br>SLA5073+SLA5074<br>SLA5085 | SLA5086 |

## Package Type (Dimensions)

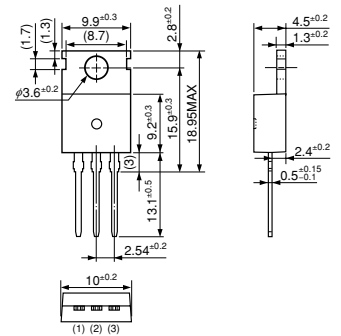
### • TO-220F (FM20)



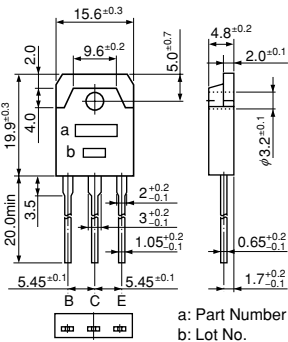
### • TO-220F-A



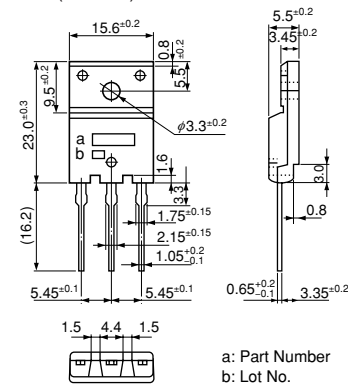
### • TO-220 (MT-25)



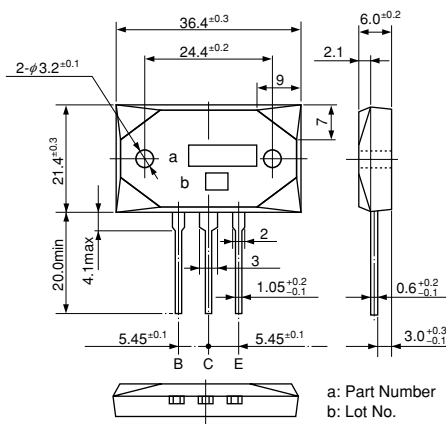
### • TO-3P (MT-100)



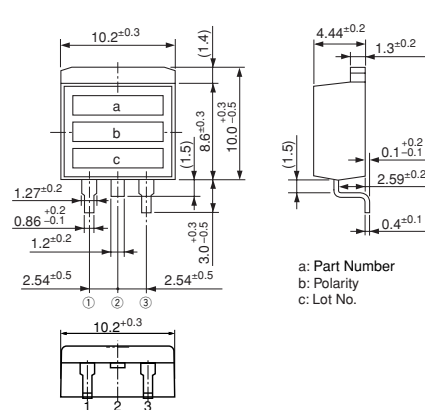
### • TO-3PF (FM100)



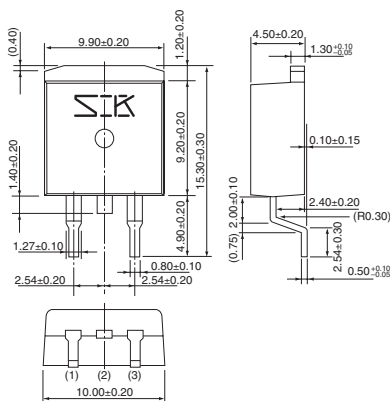
### • MT-200



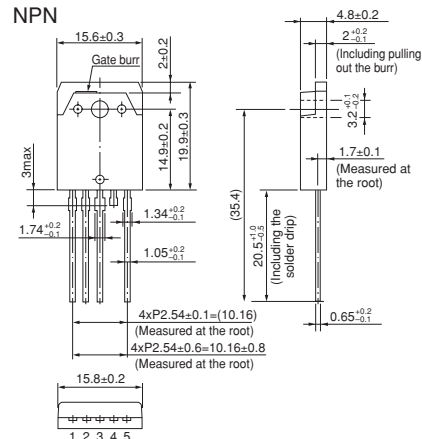
### • TO-220S



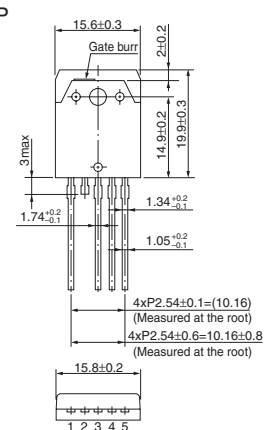
### • TO-263



### • TO3P-5Pin NPN

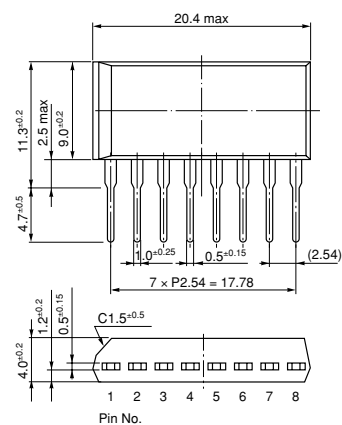


### PNP

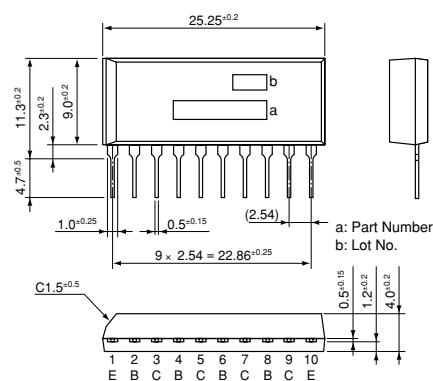


(Unit : mm)

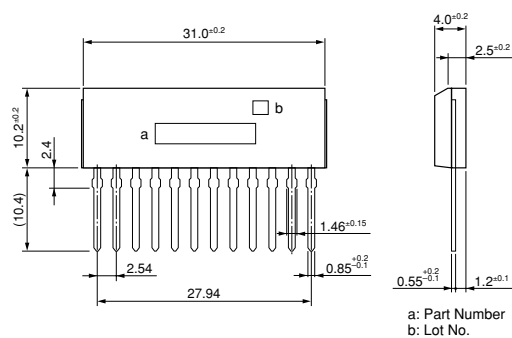
• SIP 8 (STA8Pin)



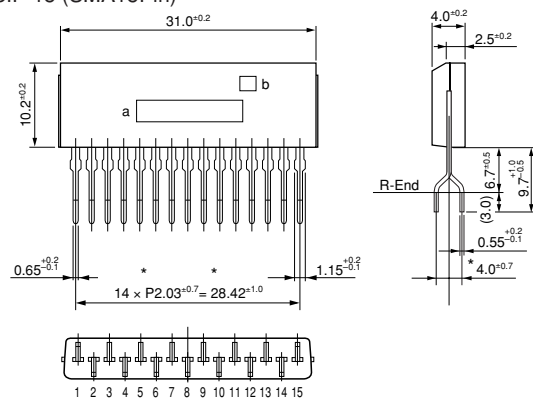
• SIP 10 (STA10Pin)



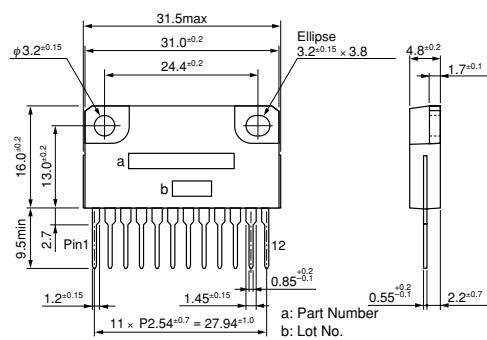
• SIP 12 (SMA12Pin)



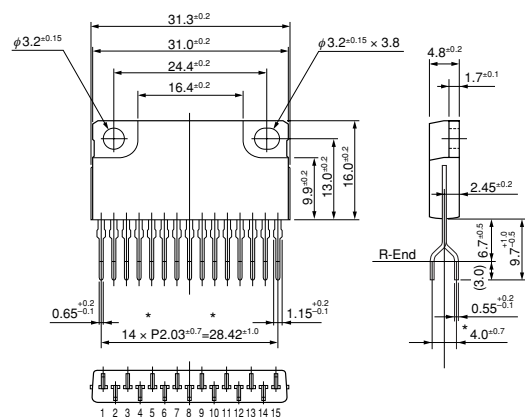
• SIP 15 (SMA15Pin)



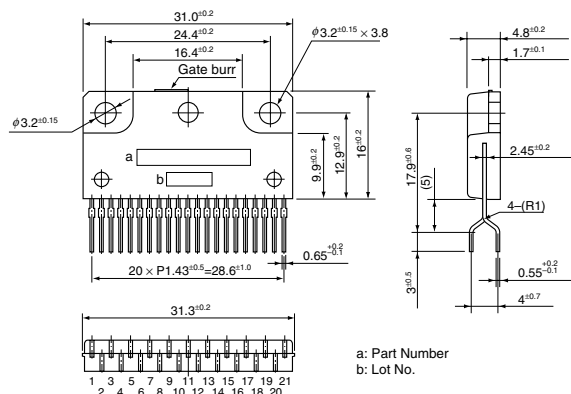
• SIP 12 with Fin (SLA12Pin)



• SIP 15 with Fin (SLA15Pin)



• SIP 15 with Fin (SLA15Pin)



(Unit:mm)

# *Thyristors*

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## Ordering Information

All products listed must be ordered in standard packing increments.

| Product Name | Package          | Standard Packing Quantities (Bulk) |
|--------------|------------------|------------------------------------|
| TFC563D      | TO220S(Straight) | 600(Stick)                         |
| TF541S-A     | TO220F           | 1000(Box)/3750(Stick)              |
| TF561S-A     | TO220F           | 1000(Box)/3750(Stick)              |
| TFA37S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA38S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA57S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA58S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA87S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA88S       | TO220F           | 1000(Box)/3750(Stick)              |
| TFA107S      | TO220F           | 1000(Box)/3750(Stick)              |
| TFA108S      | TO220F           | 1000(Box)/3750(Stick)              |
| TMA104S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA106G-L    | TO220            | 4000(Stick)                        |
| TMA106H-L    | TO220F-A         | 4000(Stick)                        |
| TMA106S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA124S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA126G-L    | TO220            | 4000(Stick)                        |
| TMA126H-L    | TO220F-A         | 4000(Stick)                        |
| TMA126S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA164B-L    | TO3PF            | 500(Box)/1080(Stick)               |
| TMA164P-L    | TO3P             | 500(Box)/1080(Stick)               |
| TMA164S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA166B-L    | TO3PF            | 500(Box)/1080(Stick)               |
| TMA166G-L    | TO220            | 4000(Stick)                        |
| TMA166H-L    | TO220F-A         | 4000(Stick)                        |
| TMA166P-L    | TO3P             | 500(Box)/1080(Stick)               |
| TMA166S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA204S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA206S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMA254B-L    | TO3PF            | 500(Box)/1080(Stick)               |
| TMA256B-L    | TO3PF            | 500(Box)/1080(Stick)               |
| TMA34S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMA36G-L     | TO220            | 4000(Stick)                        |
| TMA36H-L     | TO220F-A         | 4000(Stick)                        |
| TMA36S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMA54S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMA56G-L     | TO220            | 4000(Stick)                        |
| TMA56H-L     | TO220F-A         | 4000(Stick)                        |
| TMA56S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMA84S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMA86G-L     | TO220            | 4000(Stick)                        |
| TMA86H-L     | TO220F-A         | 4000(Stick)                        |
| TMA86S-L     | TO220F           | 1000(Box)/3750(Stick)              |
| TMB166S-L    | TO220F           | 1000(Box)/3750(Stick)              |
| TMB206S-L    | TO220F           | 1000(Box)/3750(Stick)              |

## Application Note

Since reliability can be affected adversely by improper storage environment or handling methods during Characteristic tests, please observe the following cautions.

### ■ Cautions for Storage

- Ensure that storage conditions comply with the normal temperature (5 to 35°C) and the normal relative humidity (around 40 to 75%), and avoid storage locations that experience high temperature and humidity, or extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present, and avoid direct sunlight.
- Reinspect the devices for rust in leads and solderability after stored for a long time.

### ■ Cautions for Characteristic Tests and Handling

On characteristics test at incoming inspection, etc, take good care to avoid the surge voltages from the test equipment, the short circuit at terminals, or the wrong connection.

### ■ Silicone Grease

When using a heatsink, please coat thinly and evenly the back surface of the device and both surfaces of the insulating plate with silicone grease to lower the thermal resistance between the device and the heatsink. Please select proper silicone grease carefully since the oil in some grease products may penetrate the device and result in an extremely short device life.

Recommended Silicone Grease

- G-746 (Shin-Etsu Chemical)
- YG6260 (Momentive Performance Materials Inc.)
- SC102 (Dow Corning Toray Silicone)

### ■ Mounting Torque

When mounting torque is insufficient, thermal resistance increases, and so heat radiation effect is decreased. When the torque is excessive, the screw may be broken, the heatsink may be deformed, and the device frame may be distorted, resulting in the device damage. Recommended mounting torque per package is as follows:

#### ● Mounting Torque Table

| Package                 | Screw Torque                      |
|-------------------------|-----------------------------------|
| TO220                   | 0.490 to 0.686 N·m (5 to 7kgf·cm) |
| TO220F-A, TO220F (FM20) |                                   |
| TO3P (MT100)            |                                   |
| TO3PF (FM100)           | 0.686 to 0.882 N·m (7 to 9kgf·cm) |

- \* When the surface of a heatsink where Full Mold package is to be mounted is not flat due to the burred metal bracket for screwing around the mounting hole of the heatsink, the resin of the package might be cracked even if the torque is lower than the recommended value.
- \* When a screw is fastened with an air driver for the Full Mold package, a large impact is generated at the time of stop, and the resin may crack even if the torque is lower than the recommended value. An electric driver, therefore, should be used instead of an air driver.

### ■ Heatsink

A larger contact area between the device and the heatsink is required for more effective heat radiation. To ensure a larger contact area, minimize mounting holes. And select a heatsink with a surface smooth enough and free from burrs and slivers.

### ■ Soldering Temperature

In general, the device mounted on a printed circuit board is subjected to high temperatures from flow solder in a solder bath, or, from a soldering iron at hand soldering.

The testing method and test conditions for a device's heat resistance to soldering are:

At a distance of 1.5mm from the device's main body, apply 260°C for 10 seconds, and 350°C for 3 seconds.

Please observe these limits and finish soldering in as short a time as possible.

Since reliability can be affected adversely by improper storage environment or handling methods during Characteristic tests, please observe the following cautions.

## 3-1 Thyristors

### Thyristors

| Part Number | Absolute Maximum Ratings |                  |                     |                                      |                                |                                                                                            |                 |                     |                  |                  |                        |                          |                                                     |                                      |
|-------------|--------------------------|------------------|---------------------|--------------------------------------|--------------------------------|--------------------------------------------------------------------------------------------|-----------------|---------------------|------------------|------------------|------------------------|--------------------------|-----------------------------------------------------|--------------------------------------|
|             | V <sub>RSM</sub>         | V <sub>RRM</sub> | I <sub>T</sub> (AV) | Conditions<br>T <sub>c</sub><br>(°C) | I <sub>T</sub> (RMS)<br>(50Hz) | I <sub>TSM</sub><br>50Hz Single<br>Half Sine<br>Wave, Default<br>T <sub>j</sub> =125°C (A) | P <sub>GM</sub> | P <sub>G</sub> (AV) | V <sub>RGM</sub> | I <sub>FGM</sub> | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | I <sub>RRM</sub><br>I <sub>DRM</sub><br>(mA)<br>max | Conditions<br>T <sub>j</sub><br>(°C) |
|             | (V)                      | (V)              |                     |                                      |                                |                                                                                            |                 |                     |                  |                  |                        |                          |                                                     |                                      |
| TF541S-A    | 500                      | 400              | 5.0                 | 88                                   | 7.8                            | 80                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +125            |                          | 2.0                                                 | 125                                  |
| TF561S-A    | 700                      | 600              | 5.0                 | 88                                   | 7.8                            | 80                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +125            |                          | 2.0                                                 | 125                                  |
| TFA37S      | —                        | 700              | 3.0                 | 127                                  | 4.7                            | 60                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA57S      | —                        | 700              | 5.0                 | 115                                  | 7.8                            | 80                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA87S      | —                        | 700              | 8.0                 | 98                                   | 12.6                           | 120                                                                                        | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA107S     | —                        | 700              | 10                  | 86                                   | 15.7                           | 160                                                                                        | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA38S      | —                        | 800              | 3.0                 | 50                                   | 4.7                            | 60                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA58S      | —                        | 800              | 5.0                 | 50                                   | 7.8                            | 80                                                                                         | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA88S      | —                        | 800              | 8.0                 | 50                                   | 12.6                           | 120                                                                                        | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |
| TFA108S     | —                        | 800              | 10                  | 50                                   | 15.7                           | 160                                                                                        | 5.0             | 0.5                 | 5.0              | 2.0              | -40 to +150            |                          | 2.0                                                 | 150                                  |

### 3-Pin Reverse Conducting Thyristors for HID Lamp Ignition

| Part Number | Absolute Maximum Ratings |                     |         |                 |                     |                  |                     |                  |                        |                          |                                 |                                      |                               |                        |                        |
|-------------|--------------------------|---------------------|---------|-----------------|---------------------|------------------|---------------------|------------------|------------------------|--------------------------|---------------------------------|--------------------------------------|-------------------------------|------------------------|------------------------|
|             | V <sub>DRM</sub>         | I <sub>TRM</sub> *1 | di/dt*1 | P <sub>GM</sub> | P <sub>G</sub> (AV) | V <sub>RGM</sub> | I <sub>FGM</sub> *2 | I <sub>FRM</sub> | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | I <sub>DRM</sub><br>(mA)<br>max | Conditions<br>T <sub>j</sub><br>(°C) | V <sub>TM</sub><br>(V)<br>max | Conditions             |                        |
|             | (V)                      | (A)                 | (A/μs)  |                 |                     |                  |                     |                  |                        |                          |                                 |                                      |                               | T <sub>c</sub><br>(°C) | I <sub>TM</sub><br>(A) |
| TFC563D     | 600                      | 500                 | 1500    | 5.0             | 0.5                 | 5.0              | 2.0                 | 450              | -40 to +125            |                          | 1.0                             | 125                                  | 1.4                           | 25                     | 10                     |

\*1: T<sub>c</sub>≤100°C, V<sub>D</sub>≤430V, W<sub>p</sub>≤1.0μs, I<sub>G</sub>≥70mA, di/dt≥0.5A/μs, 100kcycles

\*2: T<sub>c</sub>≤100°C, V<sub>D</sub>≤430V, W<sub>p</sub>≤1.0μs, 100kcycles

| Electrical Characteristics |                                   |                                                             |    |                            |     |                             |     |                                      |                            |     |                     |                            |     |                                                            |     |                                   | Package | Mass                                 |   |
|----------------------------|-----------------------------------|-------------------------------------------------------------|----|----------------------------|-----|-----------------------------|-----|--------------------------------------|----------------------------|-----|---------------------|----------------------------|-----|------------------------------------------------------------|-----|-----------------------------------|---------|--------------------------------------|---|
|                            | V <sub>TM</sub><br><br>(V)<br>max | Conditions<br>T <sub>c</sub> I <sub>TM</sub><br>(°C)    (A) |    | V <sub>GT</sub><br><br>(V) |     | I <sub>GT</sub><br><br>(mA) |     | Conditions<br>T <sub>c</sub><br>(°C) | V <sub>GD</sub><br><br>(V) |     |                     | dV/dt<br><br>(V/μs)<br>typ |     | Conditions<br>T <sub>j</sub> V <sub>D</sub><br>(°C)    (V) |     | I <sub>H</sub><br><br>(mA)<br>typ |         | R <sub>th</sub><br><br>(°C/W)<br>max | g |
|                            |                                   |                                                             |    |                            |     |                             |     |                                      |                            |     |                     |                            |     |                                                            |     |                                   |         |                                      |   |
|                            |                                   |                                                             |    |                            |     |                             |     |                                      |                            |     |                     |                            |     |                                                            |     |                                   |         |                                      |   |
|                            | 1.4                               | 25                                                          | 10 |                            | 1.5 | 0.03                        | 0.2 | 25                                   | 0.1                        | 125 | 1/2V <sub>DRM</sub> | 20                         | 125 | 1/2V <sub>DRM</sub>                                        | 4.0 | 4.0                               | TO220F  | 2.0                                  |   |
|                            | 1.4                               | 25                                                          | 10 |                            | 1.5 | 0.03                        | 0.2 | 25                                   | 0.1                        | 125 | 1/2V <sub>DRM</sub> | 20                         | 125 | 1/2V <sub>DRM</sub>                                        | 4.0 | 4.0                               | TO220F  | 2.0                                  |   |
|                            | 1.5                               | 25                                                          | 10 | —                          | 1.0 | 7.0                         | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 15  | 4.1                               | TO220F  | 2.0                                  |   |
|                            | 1.5                               | 25                                                          | 15 | —                          | 1.0 | 7.0                         | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 15  | 3.8                               | TO220F  | 2.0                                  |   |
|                            | 1.4                               | 25                                                          | 20 | —                          | 1.0 | 7.0                         | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 20  | 3.5                               | TO220F  | 2.0                                  |   |
|                            | 1.35                              | 25                                                          | 20 | —                          | 1.0 | 7.0                         | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 20  | 3.4                               | TO220F  | 2.0                                  |   |
|                            | 1.5                               | 25                                                          | 10 | —                          | 1.0 | —                           | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 15  | 4.1                               | TO220F  | 2.0                                  |   |
|                            | 1.5                               | 25                                                          | 15 | —                          | 1.0 | —                           | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 15  | 3.8                               | TO220F  | 2.0                                  |   |
|                            | 1.5                               | 25                                                          | 20 | —                          | 1.0 | —                           | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 20  | 3.5                               | TO220F  | 2.0                                  |   |
|                            | 1.35                              | 25                                                          | 20 | —                          | 1.0 | —                           | 15  | 25                                   | 0.2                        | 125 | 1/2V <sub>DRM</sub> | 300                        | 125 | 1/2V <sub>DRM</sub>                                        | 20  | 3.4                               | TO220F  | 2.0                                  |   |

| Electrical Characteristics |                 |      |                 |     |                                      |                 |        |                |                 |                |                                     |    | Package | Mass |     |
|----------------------------|-----------------|------|-----------------|-----|--------------------------------------|-----------------|--------|----------------|-----------------|----------------|-------------------------------------|----|---------|------|-----|
|                            | V <sub>GT</sub> |      | I <sub>GT</sub> |     | Conditions<br>T <sub>C</sub><br>(°C) | V <sub>GD</sub> |        | I <sub>H</sub> | R <sub>th</sub> | V <sub>F</sub> | Conditions<br>I <sub>F</sub><br>(A) |    |         | Mass |     |
|                            | (V)             | (mA) | (V)             | (V) |                                      | (mA)            | (°C/W) |                |                 |                |                                     |    |         | (V)  |     |
|                            | typ             | max  | typ             | max |                                      | min             | (°C)   |                |                 |                |                                     |    |         | (V)  | typ |
|                            |                 | 1.5  |                 | 30  | 25                                   | 0.1             | 125    | 480            | 12              | 4.0            | 1.4                                 | 10 | TO-220S | 1.5  |     |

## 3-2 Triacs

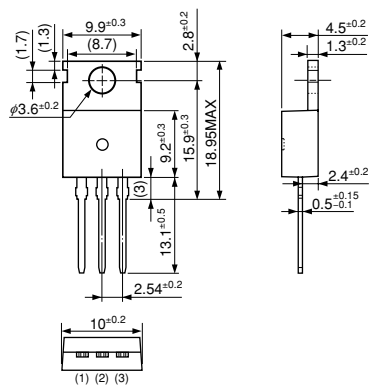
### Triacs

| Part Number | Absolute Maximum Ratings |                      |                                      |                  |            |                 |                     |                 |                |                  |                   |            |                   |            |                 |                                      |
|-------------|--------------------------|----------------------|--------------------------------------|------------------|------------|-----------------|---------------------|-----------------|----------------|------------------|-------------------|------------|-------------------|------------|-----------------|--------------------------------------|
|             | V <sub>DRM</sub>         | I <sub>T</sub> (RMS) | Conditions<br>T <sub>e</sub><br>(°C) | I <sub>TSM</sub> | Conditions | P <sub>GM</sub> | P <sub>G</sub> (AV) | I <sub>GM</sub> | T <sub>J</sub> | T <sub>stg</sub> | I <sub>DRM1</sub> | Conditions | I <sub>DRM2</sub> | Conditions | V <sub>TM</sub> | Conditions<br>I <sub>TM</sub><br>(A) |
|             | (V)                      | (A)                  |                                      | (A)              |            | (W)             | (W)                 | (A)             | (°C)           | (°C)             | (mA)<br>max       |            | (mA)<br>max       |            | (V)<br>max      |                                      |
| TMA34S-L    | 400                      | 3                    | 109                                  | 30               | 125        | 3               | 0.3                 | 0.5             | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 4.5                                  |
| TMA54S-L    | 400                      | 5                    | 102                                  | 50               | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 7                                    |
| TMA84S-L    | 400                      | 8                    | 92                                   | 80               | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 12                                   |
| TMA104S-L   | 400                      | 10                   | 85                                   | 100              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 14                                   |
| TMA124S-L   | 400                      | 12                   | 77                                   | 120              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 17                                   |
| TMA164S-L   | 400                      | 16                   | 66                                   | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.45            | 20                                   |
| TMA164P-L   | 400                      | 16                   | 108                                  | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMA164B-L   | 400                      | 16                   | 98                                   | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMA204S-L   | 400                      | 20                   | 53                                   | 190              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMA254B-L   | 400                      | 25                   | 83                                   | 250              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.3             | 20                                   |
| TMA36S-L    | 600                      | 3                    | 109                                  | 30               | 125        | 3               | 0.3                 | 0.5             | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 4.5                                  |
| TMA36G-L    | 600                      | 3                    | 115                                  | 30               | 25         | 3               | 0.5                 | 0.5             | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 4.5                                  |
| TMA36H-L    | 600                      | 3                    | 109                                  | 30               | 25         | 3               | 0.5                 | 0.5             | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 4.5                                  |
| TMA56S-L    | 600                      | 5                    | 102                                  | 50               | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 7                                    |
| TMA56G-L    | 600                      | 5                    | 111                                  | 50               | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 7                                    |
| TMA56H-L    | 600                      | 5                    | 101                                  | 50               | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 7                                    |
| TMA86S-L    | 600                      | 8                    | 92                                   | 80               | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               | 25°C       | 2                 | 125°C      | 1.5             | 12                                   |
| TMA86G-L    | 600                      | 8                    | 107                                  | 80               | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 12                                   |
| TMA86H-L    | 600                      | 8                    | 91                                   | 80               | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 12                                   |
| TMA106S-L   | 600                      | 10                   | 85                                   | 100              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 14                                   |
| TMA106G-L   | 600                      | 10                   | 105                                  | 100              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 14                                   |
| TMA106H-L   | 600                      | 10                   | 83                                   | 100              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 14                                   |
| TMA126S-L   | 600                      | 12                   | 77                                   | 120              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 17                                   |
| TMA126G-L   | 600                      | 12                   | 103                                  | 120              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 17                                   |
| TMA126H-L   | 600                      | 12                   | 78                                   | 120              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.5             | 17                                   |
| TMA166S-L   | 600                      | 16                   | 66                                   | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.45            | 20                                   |
| TMA166G-L   | 600                      | 16                   | 100                                  | 160              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.45            | 20                                   |
| TMA166H-L   | 600                      | 16                   | 65                                   | 160              | 25         | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.45            | 20                                   |
| TMA166P-L   | 600                      | 16                   | 108                                  | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMA166B-L   | 600                      | 16                   | 98                                   | 160              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMB166S-L   | 600                      | 16                   | 94                                   | 160              | 125        | 5               | 0.5                 | 2               | −40 to +150    |                  | 0.1               |            | 2                 |            | 1.45            | 20                                   |
| TMA206S-L   | 600                      | 20                   | 53                                   | 190              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMB206S-L   | 600                      | 20                   | 85                                   | 200              | 125        | 5               | 0.5                 | 2               | −40 to +150    |                  | 0.1               |            | 2                 |            | 1.4             | 20                                   |
| TMA256B-L   | 600                      | 25                   | 83                                   | 250              | 125        | 5               | 0.5                 | 2               | −40 to +125    |                  | 0.1               |            | 2                 |            | 1.3             | 20                                   |

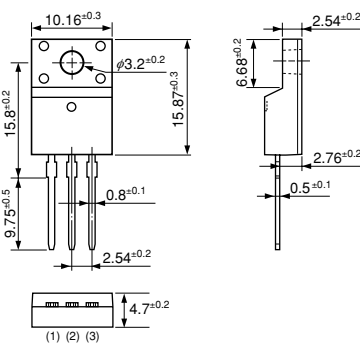
| Electrical Characteristics (T <sub>J</sub> = 25°C, unless otherwise specified) |                     |                      |                       |                       |                       |                     |                      |                       |                       |                       |                 |                        |                       |                        |                       |         |               |                      |               |
|--------------------------------------------------------------------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|---------------------|----------------------|-----------------------|-----------------------|-----------------------|-----------------|------------------------|-----------------------|------------------------|-----------------------|---------|---------------|----------------------|---------------|
|                                                                                | V <sub>GT</sub>     |                      |                       |                       |                       | I <sub>GT</sub>     |                      |                       |                       |                       | V <sub>GD</sub> | (dv/dt) c              |                       |                        | R <sub>th (j-c)</sub> | Package | Mass          |                      |               |
|                                                                                | Mode I<br>(T2+, G+) | Mode II<br>(T2+, G-) | Mode III<br>(T2-, G-) | Conditions            |                       | Mode I<br>(T2+, G+) | Mode II<br>(T2+, G-) | Mode III<br>(T2-, G-) | Conditions            |                       |                 | Conditions             |                       | T <sub>J</sub><br>(°C) |                       |         |               |                      |               |
|                                                                                | (V)<br>max          | (V)<br>max           | (V)<br>max            | V <sub>D</sub><br>(V) | R <sub>L</sub><br>(Ω) | (mA)<br>max         | (mA)<br>max          | (mA)<br>max           | V <sub>D</sub><br>(V) | R <sub>L</sub><br>(Ω) |                 | T <sub>J</sub><br>(°C) | V <sub>O</sub><br>(V) |                        |                       |         | (V/us)<br>min | (dv/dt) c<br>(-A/ms) | (°C/W)<br>max |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20                  | 20                   | 20                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 1.5                   | 125     | 4.5           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20                  | 20                   | 20                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 2.5                   | 125     | 4             | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 4                     | 125     | 3.7           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 5                     | 125     | 3.6           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.1             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 6                     | 125     | 3.5           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 3.3           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 1.2           | TO3P                 | 6.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 1.8           | TO3PF                | 6.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 10                    | 125     | 3.2           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 12                    | 125     | 1.6           | TO3PF                | 6.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 15/20               | 15/20                | 15/20                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 1.5                   | 125     | 4.5           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 1.5                   | 125     | 3             | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 1.5                   | 125     | 4.6           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 15/20               | 15/20                | 15/20                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 2.5                   | 125     | 4             | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 2.5                   | 125     | 2.5           | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 5                      | 2.5                   | 125     | 4.2           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20/30               | 20/30                | 20/30                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 4                     | 125     | 3.7           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 4                     | 125     | 2             | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 4                     | 125     | 3.8           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20/30               | 20/30                | 20/30                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 5                     | 125     | 3.6           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 5                     | 125     | 1.8           | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 5                     | 125     | 3.7           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20/30               | 20/30                | 20/30                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 6                     | 125     | 3.5           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 6                     | 125     | 1.6           | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 6                     | 125     | 3.5           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20/30               | 20/30                | 20/30                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 3.3           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 1.4           | TO220                | 2.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 3.3           | TO220F-A             | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 1.2           | TO3P                 | 6.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 8                     | 125     | 1.8           | TO3PF                | 6.5           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 10                    | 125     | 3.0           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 20/30               | 20/30                | 20/30                 | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 10                    | 125     | 3.2           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 10                    | 125     | 2.7           | TO220F               | 2.0           |
|                                                                                | 1.5                 | 1.5                  | 1.5                   | 12                    | 20                    | 30                  | 30                   | 30                    | 12                    | 20                    | 0.2             | 125                    | 1/2V <sub>DRM</sub>   | 10                     | 12                    | 125     | 1.6           | TO3PF                | 6.5           |

## Package Type (Dimensions)

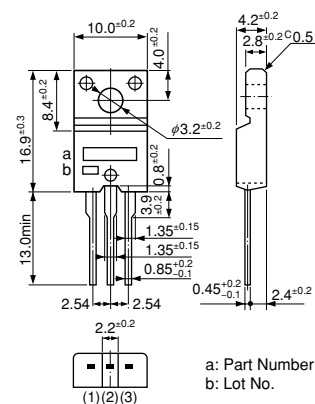
### • TO-220



### • TO-220F-A

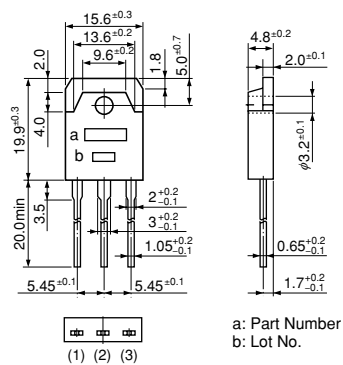


### • TO-220F

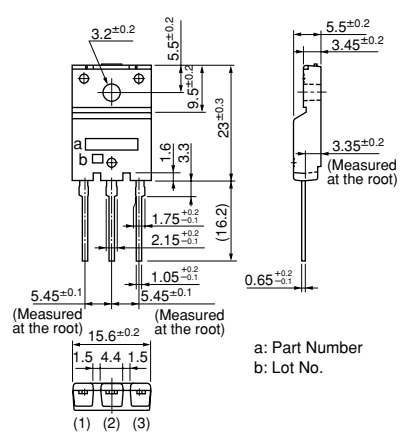


| Pin No. |                           |
|---------|---------------------------|
| (1)     | Cathode (T <sub>1</sub> ) |
| (2)     | Anode (T <sub>2</sub> )   |
| (3)     | Gate (G)                  |
| ( )     | Triacs                    |

### • TO-3P

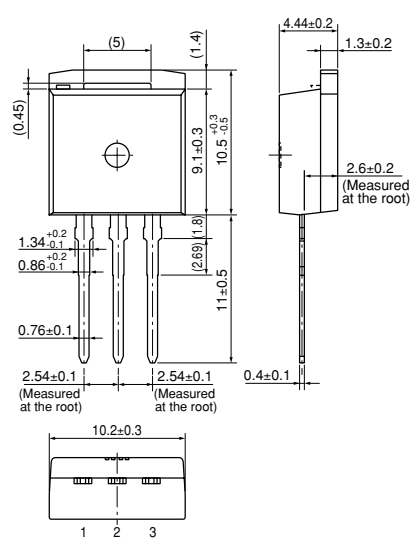


### • TO-3PF



- (1) Terminal 1 (T<sub>1</sub>)  
 (2) Terminal 2 (T<sub>2</sub>)  
 (3) Gate (G)

### • TO-220S Straight



(Unit: mm)

# Diodes

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Ordering Information

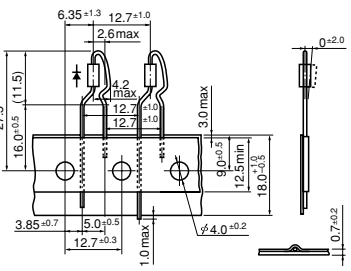
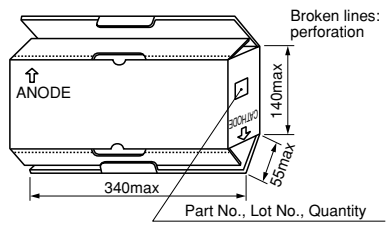
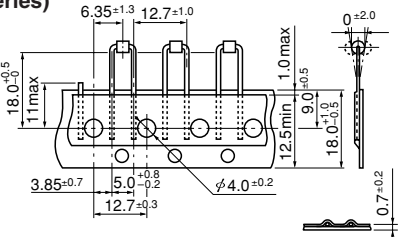
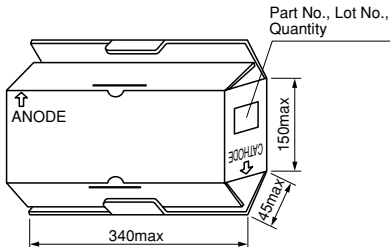
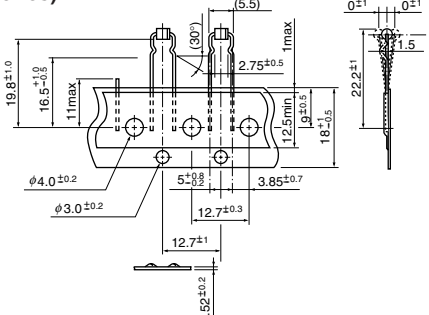
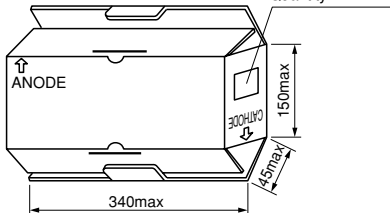
All products listed must be ordered in standard packing increments.

| Series Name/Product Name | Package                     | Standard Packing Quantities |              |              |              |              |              |
|--------------------------|-----------------------------|-----------------------------|--------------|--------------|--------------|--------------|--------------|
|                          |                             | Bulk                        | Taping       |              |              |              |              |
| AG01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AK0x                     | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AL01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AM01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AP01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AS01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AU01x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| AU02x                    | Axial(φ2.4 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:3000(Box) | V0:3000(Box) | WS:2500(Box) | WK:2500(Box) |
| EG01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EK0x                     | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EL02x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EM01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EN01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EP01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| ES01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EU01x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EU02x                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| SVxx                     | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| VR-xx                    | Axial(φ2.7 body/φ0.6 lead)  | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) | W:4000(Box)  |              |
| EG1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EH1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EK1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EL1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EM1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EM2x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| ES1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EU1x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| EU2x                     | Axial(φ2.7 body/φ0.78 lead) | —                           | V:5000(Reel) | V1:2000(Box) | V0:2000(Box) |              |              |
| RA1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RC2                      | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RF1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RG10x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RG1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RH1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RK1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RL10x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RM10x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RM11x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RM1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RN1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RP1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RS1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RU1x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RU20x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RU2x                     | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RX10x                    | Axial(φ4.0 body/φ0.78 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RD2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RG2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RH2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RK3x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RL2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RM2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RN2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RO2x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RU3x                     | Axial(φ4.0 body/φ0.98 lead) | —                           | V:3000(Reel) | V1:1000(Box) |              |              |              |
| RG4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RH4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RJ4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RK4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RL4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RM4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RN4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RS4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RU4x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |
| RW5x                     | Axial(φ6.5 body/φ1.4 lead)  | 500                         | —            |              |              |              |              |

| Series Name/Product Name | Package                | Standard Packing Quantities |               |              |  |  |  |
|--------------------------|------------------------|-----------------------------|---------------|--------------|--|--|--|
|                          |                        | Bulk                        | Taping        |              |  |  |  |
| SJPA-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPB-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPE-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPJ-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPL-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPM-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPW-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPX-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SJPZ-xx                  | SJP                    | –                           | V:1800(Reel)  |              |  |  |  |
| SZ-10xx                  | SZ-10(Surface-mount)   | –                           | VL:750(Reel)  | VR:750(Reel) |  |  |  |
| FMC-2xU                  | TO220F(2-element)      | 500                         | –             |              |  |  |  |
| FM2-2202                 | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMB-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMEN-2x                  | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMG-1x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMG-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMJ-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FML-1x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FML-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMM-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMU-1x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMU-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMW-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMX-1x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMX-2x                   | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMXA-2x                  | TO220F(Center-tap)     | 500                         | –             |              |  |  |  |
| FMB-G1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMB-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMC-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMD-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMG-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FML-G1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FML-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMN-G1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMN-1x                   | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMU-G1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMU-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMXA-1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMX-G1x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMX-G2x                  | TO220F-2Pin            | 500                         | –             |              |  |  |  |
| FMC-2xUA                 | TO220F-2Pin(2-element) | 500                         | –             |              |  |  |  |
| MPE-2x                   | TO220S(Surface-mount)  | –                           | VR:1000(Reel) |              |  |  |  |
| MPL-102S                 | TO220S(Surface-mount)  | –                           | VR:1000(Reel) |              |  |  |  |
| MPEN-2x                  | TO263(Surface-mount)   | –                           | VL:800(Reel)  | VR:800(Reel) |  |  |  |
| MPL-1036S                | TO220S(Surface-mount)  | –                           | VL:800(Reel)  | VR:800(Reel) |  |  |  |
| FMD-4x                   | TO3PF(Center-tap)      | 500                         | –             |              |  |  |  |
| FMXA-4x                  | TO3PF(Center-tap)      | 500                         | –             |              |  |  |  |
| FML-4x                   | TO3PF(Center-tap)      | 500                         | –             |              |  |  |  |
| FMW-4x                   | TO3PF(Center-tap)      | 500                         | –             |              |  |  |  |
| FMN-3x                   | TO3PF-2Pin             | 500                         | –             |              |  |  |  |

Taping Specifications

| Taping Name                                                            | Taping Type, Dimensions (mm) | Packing Dimensions (mm) and Packing Note | Quantity                                                                                                                 |
|------------------------------------------------------------------------|------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <div>V</div> <div>To specify the taping type, add a suffix [V]</div>   | <div>Axial taping</div>      | <div>Reel</div>                          | <div>5,000 pcs/reel<br/>( 2.7φ body )</div> <div>3,000 pcs/reel<br/>(4φ body)</div>                                      |
| <div>V1</div> <div>To specify the taping type, add a suffix [V1]</div> | <div>Axial taping</div>      | <div>Ammunition (Ammo) pack</div>        | <div>2,000 pcs/box<br/>(2.7φ body)</div> <div>3,000 pcs/box<br/>(2.4φ body)</div> <div>1,000 pcs/box<br/>(4φ body)</div> |
| <div>V0</div> <div>To specify the taping type, add a suffix [V0]</div> | <div>Axial taping</div>      | <div>Ammunition (Ammo) pack</div>        | <div>2,000 pcs/box<br/>(2.7φ body)</div> <div>3,000 pcs/box<br/>(2.4φ body)</div>                                        |

| Taping Name                                                           | Taping Type, Dimensions (mm)                                                                                                        | Packing Dimensions (mm) and Packing Note                                                                                 | Quantity                                                  |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| <p><b>W</b></p> <p>To specify the taping type, add a suffix [W]</p>   | <p><b>Radial taping</b></p>                        | <p><b>Ammunition (Ammo) pack</b></p>   | <p>4,000 pcs/box<br/>( 2.7φ body<br/>0.6φ lead only )</p> |
| <p><b>WS</b></p> <p>To specify the taping type, add a suffix [WS]</p> | <p><b>Radial taping<br/>(for A0 series)</b></p>    | <p><b>Ammunition (Ammo) pack</b></p>  | <p>2,500 pcs/box<br/>(2.4φ body)</p>                      |
| <p><b>WK</b></p> <p>To specify the taping type, add a suffix [WK]</p> | <p><b>Radial taping<br/>(for A0 series)</b></p>  | <p><b>Ammunition (Ammo) pack</b></p>  | <p>2,500 pcs/box<br/>(2.4φ body)</p>                      |

Surface-Mount Taping Specifications

| Taping Name |          | Taping Type, Dimensions (mm)                                                                                                                                                                                                                                                    | Packing Dimensions (mm) and Packing Note | Quantity |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|----------|
| SJP         | VL<br>VR | <div>Emboss Taping</div> <p>(1) Device is placed in the embossed pocket with the mounting electrode down.<br/>(2) 150 to 200mm leader tape is attached to the tip of the tape.<br/>(3) 10 or more blank pockets are provided at both the beginning and the end of the tape.</p> | <div>Reel</div> <p>1800 pcs/reel</p>     |          |
|             | VR       | <div>Emboss Taping</div> <p>1000 pcs/reel</p>                                                                                                                                                                                                                                   | <div>Reel</div> <p>1000 pcs/reel</p>     |          |

Power Zener Surface-Mount Taping Specifications

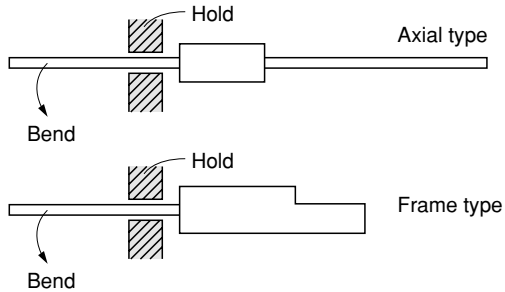
| Taping Name                                                            | Taping Type, Dimensions (mm)                 | Packing Dimensions (mm) and Packing Note | Quantity |
|------------------------------------------------------------------------|----------------------------------------------|------------------------------------------|----------|
| <div>VL</div> <div>To specify the taping type, add a suffix [VL]</div> | <div>Emboss Taping</div> <p>750 pcs/reel</p> | <div>Reel</div> <p>750 pcs/reel</p>      |          |
| <div>VR</div> <div>To specify the taping type, add a suffix [VR]</div> | <div>Emboss Taping</div> <p>750 pcs/reel</p> | <div>Reel</div> <p>750 pcs/reel</p>      |          |

# Application Note

## General Description

### (1) Lead Forming

When forming leads, hold the lead wire on the main body's side so as to prevent stress from being applied to the main body.



### (2) Mounting

To mount a frame-type diode on a heatsink, use its screw hole. Do not fix its resin body as the silicon chip may get broken.

### (3) Temperature Measurement

For an axial type diode, measure the temperature of the lead wire on the main body side. The thermocouple to be used must be as thin as possible (approximately  $\phi 0.125\text{mm}$ ).

### (4) Temperature Rise Consideration

A diode's temperature increases due to losses from forward current, reverse current and reverse recovery time. In normal use, losses are mainly attributable to forward current and voltage. However, in high frequency circuits such as switching power supplies, losses due to reverse recovery time also occurs. Moreover, in diodes having large reverse currents like Schottky barrier diode losses due to reverse current cannot be disregarded. Forward loss tends to decrease at high temperatures. However, reverse loss tends to increase at high temperatures. Therefore, it is necessary to consider the ambient temperature when verifying operation.

### (5) Inrush Current

In a capacitor-input type rectifier circuit, inrush current flows when the power supply is switched on. The peak value of this inrush current shall be set less than peak forward surge current  $I_{FSM}$  ( $I^2t$  can also be obtained but set the minimum pulse width to 1 msec). The value of  $I_{FSM}$  is guaranteed for a single shot only. If the inrush current is repeated within a short period of time, the derating has to be taken into account.

### (6) Peak Value Current

Considering normal use, limit of the peak value current must be set to 10 times of the average current  $I_F$  (AV). If the peak value increases, the diode's forward loss also increases. In this case, check the temperature rise.

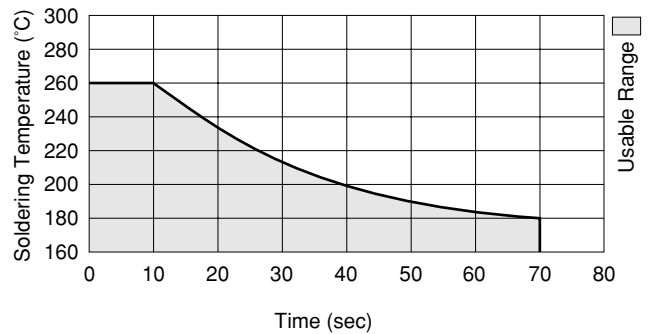
- Carefully study the mounting method when the usage environment is prone to creeping discharge.

## Surface-Mount Diodes

(Part Number Type: SJP)

### Soldering (common to flow and reflow)

- Use rosin based flux. Never use acidic fluxes.
- To prevent a large thermal stress, preheat within 1 to 2 minutes at  $150^\circ\text{C}$  and solder within the usable range shown below.



- For using a soldering iron, use the following references:

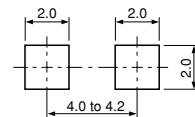
Temperature of soldering iron tip:

Lower than  $300^\circ\text{C}$   
(Power of the soldering iron: 30W or lower)  
The soldering tip must be as thin as possible.

Soldering time: Less than 10 seconds

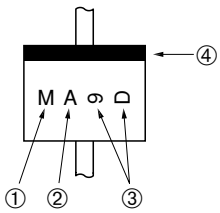
## Reference SJP Series Copper Laminate Pattern

(Unit : mm)



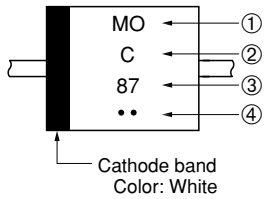
# Marking Guide

## 1 Axial (A0)



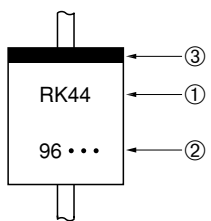
- ① Part Number (abbreviation)  
The AM01 is indicated as "M."
- ② Class  
Z: 200V None: 400V A: 600V  
B: 800V C: 1000V
- ③ Manufacturing date  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)
- ④ Cathode band: Continuous band  
Color of the band: White (Yellow for AU02 series)

## 2 Axial (E0, E1)



- ① Part Number (abbreviation)  
EM01, EM2, EM1 are indicated as MO, M2 and M1, respectively.
- ② Class  
Z: 200V None: 400V A: 600V  
B: 800V C: 1000V F: 1500V  
But EU02A is indicated as A2 and EU2YX as Y.
- ③ Manufacturing date  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)
- ④ Manufacturing period  
• First 10 days of month  
• Middle 10 days of month  
• Last 10 days of month

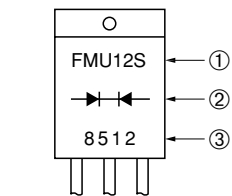
## 3 Axial (R1, R2, R3, R4)



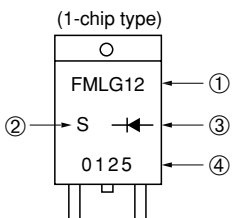
- ① Part Number: 2 set marking
- ② Manufacturing date and period: 2 set marking  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)  
• First 10 days of month  
• Middle 10 days of month  
• Last 10 days of month
- ③ Cathode band  
Color of the band:   

|         |                          |
|---------|--------------------------|
| White:  | For Power Supply and SBD |
| Yellow: | For Medium speed         |
| Red:    | For Fast and ultrafast   |

## 4 TO-220F type

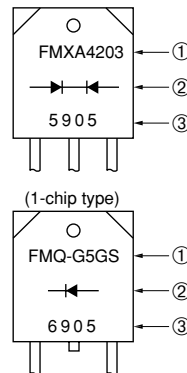


- ① Part Number  
FMU-12S is indicated as "FMU12S."
- ② Polarity: Rectifier Symbol
- ③ Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)  
Third and fourth letters: Day  
Laser marking or White ink marking



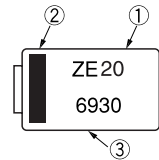
- ① Part Number: Excluding last letter  
FML-G12S is indicated as "FML-G12."
- ② Last letter of Part Number
- ③ Polarity: Rectifier Symbol
- ④ Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)  
Third and fourth letters: Day  
Laser marking or White ink marking

## 5 TO-3PF, FM100 type



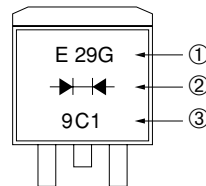
- ① Part Number: Full name
- ② Polarity: Rectifier Symbol
- ③ Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, D)  
Third and fourth letters: Day  
Laser marking or White ink marking

## 6 Surface-Mount (SJP)



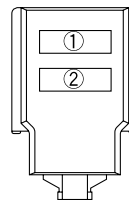
- ① Part Number
- ② Polarity: Rectifier Symbol
- ③ Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, and D)  
Third and fourth letters: Day

## 7 Surface-Mount (TO-220S)



- ① Part Number
- ② Polarity: Rectifier Symbol
- ③ Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (A to M except I)  
Third letter: Week

## 8 SZ-10 Series



- ① Part Number
- ② Lot No.  
First letter: Year (Last digit of year)  
Second letter: Month (1 to 9, O, N, and D)  
Third letter: Day

## 9 Silicon Varistors

Refer to P217

## 4-1 Rectifier Diodes

### ●Surface-Mount

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package             | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(μA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------------------------|---------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                                                                                                                |                     |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 400                    | 2.0                                                                                                            | Surface-Mount (SJP) | SJPM-H4     | 45                            | -40 to +150            |                          | 1.1                          | 2.0                   | 10                                     | 50                                     | 150                    | 20                                                     | 0.072       |

### ●Thru-Hole

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(μA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                                                                                                                |                                                   |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 100                    | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1Y       | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 3.0                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4Y       | 200                           | -40 to +150            |                          | 0.95                         | 3.0                   | 10                                     | 50                                     | 150                    | 8.0                                                    | 1.2         |
| 200                    | 1.0                                                                                                            | Axial(φ2.4/φ0.6)                                  | AM01Z       | 35                            | -40 to +150            |                          | 0.98                         | 1.0                   | 10                                     | 50                                     | 100(Ta)                | 22                                                     | 0.13        |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.6)                                  | EM01Z       | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 50                                     | 100                    | 20                                                     | 0.2         |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1Z       | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.0                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 1Z       | 50                            | -40 to +150            |                          | 0.95                         | 1.0                   | 5.0                                    | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RO 2Z       | 80                            | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 12                                                     | 0.61        |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RM 2Z       | 100                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 12                                                     | 0.6         |
|                        | 1.5                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 10Z      | 120                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 15                                                     | 0.4         |
|                        | 3.0                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4Z       | 200                           | -40 to +150            |                          | 0.95                         | 3.0                   | 10                                     | 50                                     | 100(Ta)                | 8.0                                                    | 1.2         |
|                        | 10                                                                                                             | TO-220F(Center-tap)                               | FMM-22S, R  | 100                           | -40 to +150            |                          | 1.1                          | 5.0                   | 10                                     | 100                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 1.0                                                                                                            | Axial(φ2.4/φ0.6)                                  | AM01        | 35                            | -40 to +150            |                          | 0.98                         | 1.0                   | 10                                     | 50                                     | 100(Ta)                | 22                                                     | 0.13        |
| 400                    | 1.0                                                                                                            | Axial(φ2.7/φ0.6)                                  | EM01        | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 50                                     | 100(Ta)                | 20                                                     | 0.2         |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1        | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.0                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 1        | 50                            | -40 to +150            |                          | 0.95                         | 1.0                   | 5.0                                    | 50                                     | 100(Ta)                | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 2        | 80                            | -40 to +150            |                          | 0.92                         | 1.2                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RO 2        | 80                            | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 12                                                     | 0.61        |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RM 2        | 100                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 12                                                     | 0.6         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 10       | 150                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 3.0                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4        | 200                           | -40 to +150            |                          | 0.95                         | 3.0                   | 10                                     | 50                                     | 150                    | 8.0                                                    | 1.2         |
|                        | 10                                                                                                             | TO-220F(Center-tap)                               | FMM-24S, R  | 100                           | -40 to +150            |                          | 1.1                          | 5.0                   | 10                                     | 100                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 1.0                                                                                                            | Axial(φ2.4/φ0.6)                                  | AM01A       | 35                            | -40 to +150            |                          | 0.98                         | 1.0                   | 10                                     | 50                                     | 100(Ta)                | 22                                                     | 0.13        |
| 600                    | 1.0                                                                                                            | Axial(φ2.7/φ0.6)                                  | EM01A       | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 50                                     | 100(Ta)                | 20                                                     | 0.2         |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1A       | 45                            | -40 to +150            |                          | 0.97                         | 1.0                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.0                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 1A       | 50                            | -40 to +150            |                          | 0.95                         | 1.0                   | 5.0                                    | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 2A       | 80                            | -40 to +150            |                          | 0.92                         | 1.2                   | 10                                     | 50                                     | 100                    | 17                                                     | 0.3         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 11A      | 100                           | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RM 2A       | 100                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 12                                                     | 0.6         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 10A      | 150                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 3.0                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4A       | 200                           | -40 to +150            |                          | 0.95                         | 3.0                   | 10                                     | 50                                     | 150                    | 8.0                                                    | 1.2         |
|                        | 3.2                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4AM      | 350                           | -40 to +150            |                          | 0.92                         | 3.5                   | 10                                     | 50                                     | 100                    | 8.0                                                    | 1.2         |
|                        | 10                                                                                                             | TO-220F(Center-tap)                               | FMM-26S, R  | 100                           | -40 to +150            |                          | 1.1                          | 5.0                   | 10                                     | 100                                    | 150                    | 4.0                                                    | 2.1         |
| 800                    | 0.8                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 1B       | 40                            | -40 to +150            |                          | 1.2                          | 1.0                   | 5.0                                    | 50                                     | 100(Ta)                | 15                                                     | 0.4         |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1B       | 35                            | -40 to +150            |                          | 1.05                         | 1.0                   | 20                                     | 200                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.2                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 2B       | 80                            | -40 to +150            |                          | 0.92                         | 1.2                   | 10                                     | 500                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 11B      | 100                           | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RM 2B       | 100                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 12                                                     | 0.6         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 10B      | 150                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 15                                                     | 0.4         |
| 1000                   | 0.8                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 1C       | 40                            | -40 to +150            |                          | 1.2                          | 1.0                   | 5.0                                    | 100                                    | 100(Ta)                | 15                                                     | 0.4         |
|                        | 1.0                                                                                                            | Axial(φ2.7/φ0.78)                                 | EM 1C       | 35                            | -40 to +150            |                          | 1.05                         | 1.0                   | 20                                     | 200                                    | 150                    | 17                                                     | 0.3         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RO 2C       | 80                            | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100(Ta)                | 12                                                     | 0.61        |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.78)                                 | RM 11C      | 100                           | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 50                                     | 100                    | 15                                                     | 0.4         |
|                        | 1.2                                                                                                            | Axial(φ4.0/φ0.98)                                 | RM 2C       | 100                           | -40 to +150            |                          | 0.91                         | 1.5                   | 10                                     | 50                                     | 100                    | 12                                                     | 0.6         |
|                        | 3.0                                                                                                            | Axial(φ6.5/φ1.4)                                  | RM 4C       | 150                           | -40 to +150            |                          | 0.97                         | 3.0                   | 10                                     | 50                                     | 100                    | 8.0                                                    | 1.2         |

## 4-2 Fast Recovery Diodes

### ●Thru-Hole

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (A)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package<br>Axial<br><small>(Body Diameter/Lead Diameter)</small> | Part<br>Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(μA)             | T <sub>j</sub><br>(°C) | trr <sup>(1)</sup><br>(μs) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | trr <sup>(2)</sup><br>(μs) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | R <sub>th</sub> (j-l)<br>R <sub>th</sub> (j-c)<br>(°C/W) | Mass<br>(g) |
|------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|----------------------------|-----------------------------------------|----------------------------|-----------------------------------------|----------------------------------------------------------|-------------|
|                        |                                                                                                               |                                                                  |                | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                            |                                         |                            |                                         |                                                          |             |
|                        |                                                                                                               |                                                                  |                |                               |                        |                          |                              |                       |                                        |                                        |                        |                            |                                         |                            |                                         |                                                          |             |
| 200                    | 0.5                                                                                                           | Axial(φ2.7/φ0.6)                                                 | EU01Z          | 15                            | -40 to +150            |                          | 1.0                          | 0.5                   | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 20                                                       | 0.2         |
|                        | 0.5                                                                                                           | Axial(φ2.7/φ0.78)                                                | EU 1Z          | 15                            | -40 to +150            |                          | 1.0                          | 0.5                   | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 17                                                       | 0.3         |
|                        | 0.5                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU01Z          | 15                            | -40 to +150            |                          | 1.7                          | 0.5                   | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RH 1Z          | 35                            | -40 to +150            |                          | 1.3                          | 0.6                   | 5.0                                    | 70                                     | 150(Ta)                | 4.0                        | 10/10                                   | 1.3                        | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.7                                                                                                           | Axial(φ2.7/φ0.78)                                                | ES 1Z          | 30                            | -40 to +150            |                          | 2.5                          | 0.8                   | 10                                     | 200                                    | 100(Ta)                | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 17                                                       | 0.3         |
|                        | 0.8                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU02Z          | 25                            | -40 to +150            |                          | 1.3                          | 0.8                   | 10                                     | 250                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.6)                                                 | EU02Z          | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 20                                                       | 0.2         |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.78)                                                | EU 2Z          | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 3000                                   | 150                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 17                                                       | 0.3         |
|                        | 1.0                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2Z          | 20                            | -40 to +150            |                          | 1.5                          | 1.0                   | 10                                     | 300                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 3.5                                                                                                           | Axial(φ6.5/φ1.4)                                                 | RU 4Z          | 70                            | -40 to +150            |                          | 1.3                          | 3.5                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 8.0                                                      | 1.2         |
|                        | 5.0                                                                                                           | TO-220F(Center-tap)                                              | FMU-12S, R     | 30                            | -40 to +150            |                          | 1.5                          | 2.5                   | 50                                     | 500                                    | 100(Ta)                | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
| 10                     | TO-220F(Center-tap)                                                                                           | FMU-22S, R                                                       | 40             | -40 to +150                   |                        | 1.5                      | 5.0                          | 50                    | 3000                                   | 150                                    | 0.4                    | 100/100                    | 0.18                                    | 100/200                    | 4.0                                     | 2.1                                                      |             |
| 400                    | 0.25                                                                                                          | Axial(φ2.7/φ0.6)                                                 | EU01           | 15                            | -40 to +150            |                          | 2.5                          | 0.25                  | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 20                                                       | 0.2         |
|                        | 0.25                                                                                                          | Axial(φ2.7/φ0.78)                                                | EU 1           | 15                            | -40 to +150            |                          | 2.5                          | 0.25                  | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 17                                                       | 0.3         |
|                        | 0.25                                                                                                          | Axial(φ4.0/φ0.78)                                                | RU 1           | 15                            | -40 to +150            |                          | 2.5                          | 0.25                  | 10                                     | 200                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.5                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU01           | 15                            | -40 to +150            |                          | 1.7                          | 0.5                   | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 0.6                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AS01           | 20                            | -40 to +150            |                          | 1.5                          | 0.6                   | 10                                     | 50                                     | 100                    | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 22                                                       | 0.13        |
|                        | 0.6                                                                                                           | Axial(φ2.7/φ0.78)                                                | EH 1           | 30                            | -40 to +150            |                          | 1.35                         | 0.6                   | 10                                     | 200                                    | 100(Ta)                | 4.0                        | 10/10                                   | 1.3                        | 10/20                                   | 17                                                       | 0.3         |
|                        | 0.7                                                                                                           | Axial(φ2.7/φ0.78)                                                | ES 1           | 30                            | -40 to +150            |                          | 2.5                          | 0.8                   | 10                                     | 200                                    | 100(Ta)                | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 17                                                       | 0.3         |
|                        | 0.8                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU02           | 25                            | -40 to +150            |                          | 1.3                          | 0.8                   | 10                                     | 250                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.6)                                                 | EU02           | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 20                                                       | 0.2         |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.78)                                                | EU 2           | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 17                                                       | 0.3         |
|                        | 1.1                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2M          | 20                            | -40 to +150            |                          | 1.2                          | 1.1                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3           | 20                            | -40 to +150            |                          | 1.5                          | 1.5                   | 10                                     | 400                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 12                                                       | 0.6         |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3M          | 50                            | -40 to +150            |                          | 1.1                          | 1.5                   | 10                                     | 350                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 12                                                       | 0.6         |
|                        | 1.5(3.0)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4           | 50                            | -40 to +150            |                          | 1.5                          | 3.0                   | 10                                     | 300                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 8.0                                                      | 1.2         |
|                        | 2.0(3.5)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4M          | 70                            | -40 to +150            |                          | 1.3                          | 3.5                   | 10                                     | 300                                    | 100                    | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 8.0                                                      | 1.2         |
|                        | 5.0                                                                                                           | TO-220F(Center-tap)                                              | FMU-14S, R     | 30                            | -40 to +150            |                          | 1.5                          | 2.5                   | 50                                     | 500                                    | 100(Ta)                | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 10                                                                                                            | TO-220F(Center-tap)                                              | FMU-24S, R     | 40                            | -40 to +150            |                          | 1.5                          | 5.0                   | 50                                     | 3000                                   | 150                    | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
| 600                    | 0.25                                                                                                          | Axial(φ4.0/φ0.78)                                                | RU 1A          | 15                            | -40 to +150            |                          | 2.5                          | 0.25                  | 10                                     | 150                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.5                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU01A          | 15                            | -40 to +150            |                          | 1.7                          | 0.5                   | 10                                     | 150                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RF 1A          | 15                            | -40 to +150            |                          | 2.0                          | 0.6                   | 10                                     | 200                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.6                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AS01A          | 20                            | -40 to +150            |                          | 1.5                          | 0.6                   | 10                                     | 50                                     | 100                    | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 22                                                       | 0.13        |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RH 1A          | 35                            | -40 to +150            |                          | 1.3                          | 0.6                   | 5.0                                    | 70                                     | 150(Ta)                | 4.0                        | 10/10                                   | 1.3                        | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.7                                                                                                           | Axial(φ2.7/φ0.6)                                                 | ES01A          | 20                            | -40 to +150            |                          | 3.0                          | 0.8                   | 10                                     | 200                                    | 100(Ta)                | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 20                                                       | 0.2         |
|                        | 0.7                                                                                                           | Axial(φ4.0/φ0.78)                                                | RS 1A          | 30                            | -40 to +150            |                          | 2.5                          | 0.8                   | 10                                     | 2000                                   | 150                    | 1.5                        | 10/10                                   | 0.6                        | 10/20                                   | 15                                                       | 0.4         |
|                        | 0.8                                                                                                           | Axial(φ2.4/φ0.6)                                                 | AU02A          | 25                            | -40 to +150            |                          | 1.3                          | 0.8                   | 10                                     | 250                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 22                                                       | 0.13        |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.6)                                                 | EU02A          | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 20                                                       | 0.2         |
|                        | 1.0                                                                                                           | Axial(φ2.7/φ0.78)                                                | EU 2A          | 15                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 300                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 17                                                       | 0.3         |
|                        | 1.0                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2           | 20                            | -40 to +150            |                          | 1.5                          | 1.0                   | 10                                     | 300                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 1.1                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2AM         | 20                            | -40 to +150            |                          | 1.2                          | 1.1                   | 10                                     | 300                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3A          | 20                            | -40 to +150            |                          | 1.5                          | 1.5                   | 10                                     | 400                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 12                                                       | 0.6         |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 20A         | 50                            | -40 to +150            |                          | 1.1                          | 1.5                   | 10                                     | 350                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 15                                                       | 0.4         |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3AM         | 50                            | -40 to +150            |                          | 1.1                          | 1.5                   | 10                                     | 350                                    | 100                    | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 12                                                       | 0.6         |
|                        | 1.5(3.0)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4A          | 50                            | -40 to +150            |                          | 1.5                          | 3.0                   | 10                                     | 300                                    | 100(Ta)                | 0.4                        | 10/10                                   | 0.18                       | 10/20                                   | 8                                                        | 1.2         |
|                        | 3.0                                                                                                           | Axial(φ4.0/φ0.98)                                                | RY 2A          | 50                            | -40 to +150            |                          | 1.15                         | 3.0                   | 10                                     | 1000                                   | 150                    | 0.2                        | 100/100                                 | 0.1                        | 100/200                                 | 12                                                       | 0.6         |
|                        | 3.0                                                                                                           | TO-220F2Pin                                                      | FMY-1036S      | 50                            | -40 to +150            |                          | 1.15                         | 3.0                   | 10                                     | 1000                                   | 150                    | 0.2                        | 100/100                                 | 0.1                        | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 5.0                                                                                                           | TO-220F2Pin                                                      | FMU-G16S       | 30                            | -40 to +150            |                          | 1.25                         | 5.0                   | 50                                     | 500                                    | 100(Ta)                | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 5.0                                                                                                           | TO-220F(Center-tap)                                              | FMU-16S, R     | 30                            | -40 to +150            |                          | 1.5                          | 2.5                   | 50                                     | 500                                    | 100(Ta)                | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 10                                                                                                            | TO-220F(Center-tap)                                              | FMU-26S, R     | 40                            | -40 to +150            |                          | 1.5                          | 5.0                   | 50                                     | 3000                                   | 150                    | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 10                                                                                                            | TO-220F2Pin                                                      | FMU-G26S       | 40                            | -40 to +150            |                          | 1.35                         | 10                    | 50                                     | 500                                    | 150                    | 0.4                        | 100/100                                 | 0.18                       | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 10                                                                                                            | TO-220F2Pin                                                      | FMY-1106S      | 180                           | -40 to +150            |                          | 1.15                         | 10                    | 30                                     | 3000                                   | 150                    | 0.2                        | 100/100                                 | 0.1                        | 100/200                                 | 4.0                                                      | 2.1         |
|                        | 20                                                                                                            | TO-220F(Center-tap)                                              | FMY-2206S*     | 180                           | -40 to +150            |                          | 1.15                         | 10                    | 30                                     | 3000                                   | 150                    | 0.2                        | 100/100                                 | 0.1                        | 100/200                                 | 4.0                                                      | 2.1         |

\*Under development

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (A)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package<br>Axial<br><small>(Body Diameter/Lead Diameter)</small> | Part<br>Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(μA)             | T <sub>j</sub><br>(°C) | trr <sup>(1)</sup><br>(μs)              |                                         | trr <sup>(2)</sup><br>(μs) |     | R <sub>th</sub> (j-l)<br>R <sub>th</sub> (j-c)<br>(°C/W) | Mass<br>(g) |
|------------------------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|-----------------------------------------|-----------------------------------------|----------------------------|-----|----------------------------------------------------------|-------------|
|                        |                                                                                                               |                                                                  |                | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) |                            |     |                                                          |             |
|                        |                                                                                                               |                                                                  |                |                               |                        |                          |                              |                       |                                        |                                        |                        |                                         |                                         |                            |     |                                                          |             |
| 800                    | 0.25                                                                                                          | Axial(φ4.0/φ0.78)                                                | RU 1B          | 15                            | -40 to +150            | 2.5                      | 0.25                         | 10                    | 200                                    | 100(Ta)                                | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 15  | 0.4                                                      |             |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RF 1B          | 15                            | -40 to +150            | 2.0                      | 1.0                          | 10                    | 200                                    | 100                                    | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 15  | 0.4                                                      |             |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RH 1B          | 35                            | -40 to +150            | 1.3                      | 0.6                          | 5.0                   | 70                                     | 150(Ta)                                | 4.0                    | 10/10                                   | 1.3                                     | 10/20                      | 15  | 0.4                                                      |             |
|                        | 0.7                                                                                                           | Axial(φ4.0/φ0.78)                                                | RS 1B          | 30                            | -40 to +150            | 2.5                      | 0.8                          | 10                    | 2000                                   | 150                                    | 1.5                    | 10/10                                   | 0.6                                     | 10/20                      | 15  | 0.4                                                      |             |
|                        | 1.0                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2B          | 20                            | -40 to +150            | 1.5                      | 1.0                          | 10                    | 300                                    | 100                                    | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 15  | 0.4                                                      |             |
|                        | 1.1                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3B          | 20                            | -40 to +150            | 1.5                      | 1.0                          | 10                    | 400                                    | 100                                    | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 12  | 0.6                                                      |             |
|                        | 1.5(3.0)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4B          | 50                            | -40 to +150            | 1.6                      | 3.0                          | 10                    | 500                                    | 100(Ta)                                | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 8.0 | 1.2                                                      |             |
| 1000                   | 0.2                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 1C          | 15                            | -40 to +150            | 3.0                      | 0.25                         | 10                    | 250                                    | 100                                    | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 15  | 0.4                                                      |             |
|                        | 0.6                                                                                                           | Axial(φ4.0/φ0.78)                                                | RH 1C          | 35                            | -40 to +150            | 1.3                      | 0.6                          | 5.0                   | 70                                     | 150(Ta)                                | 4.0                    | 10/10                                   | 1.3                                     | 10/20                      | 15  | 0.4                                                      |             |
|                        | 0.8                                                                                                           | Axial(φ4.0/φ0.78)                                                | RU 2C          | 20                            | -40 to +150            | 1.5                      | 1.0                          | 10                    | 300                                    | 100(Ta)                                | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 15  | 0.4                                                      |             |
|                        | 1.5                                                                                                           | Axial(φ4.0/φ0.98)                                                | RU 3C          | 20                            | -40 to +150            | 2.5                      | 1.5                          | 10                    | 400                                    | 100                                    | 0.4                    | 10/10                                   | 0.18                                    | 10/20                      | 12  | 0.6                                                      |             |
|                        | 1.5(2.5)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4C          | 50                            | -40 to +150            | 1.6                      | 3.0                          | 50                    | 500                                    | 100                                    | 0.4                    | 100/100                                 | 0.18                                    | 100/200                    | 8.0 | 1.2                                                      |             |
| 1300                   | 1.5                                                                                                           | Axial(φ6.5/φ1.4)                                                 | RU 4D          | 50                            | -40 to +150            | 1.8                      | 1.5                          | 50                    | 500                                    | 100                                    | 0.4                    | 500/500                                 | 0.18                                    | 500/1000                   | 8.0 | 1.2                                                      |             |
|                        | 1.5(2.5)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RU 4DS         | 50                            | -40 to +150            | 1.6                      | 3.0                          | 10                    | 500                                    | 100                                    | 0.4                    | 500/500                                 | 0.18                                    | 500/1000                   | 8.0 | 1.2                                                      |             |
| 1500                   | 0.5                                                                                                           | Axial(φ2.7/φ0.6)                                                 | ES01F          | 15                            | -40 to +150            | 2.0                      | 0.5                          | 10                    | 200                                    | 100(Ta)                                | 1.5                    | 10/10                                   | 0.6                                     | 10/20                      | 20  | 0.2                                                      |             |
|                        | 0.5                                                                                                           | Axial(φ2.7/φ0.78)                                                | ES 1F          | 20                            | -40 to +150            | 2.0                      | 0.5                          | 10                    | 200                                    | 100(Ta)                                | 1.5                    | 10/10                                   | 0.6                                     | 10/20                      | 17  | 0.3                                                      |             |
|                        | 1.5(2.5)                                                                                                      | Axial(φ6.5/φ1.4)                                                 | RS 4FS         | 50                            | -40 to +150            | 1.5                      | 3.0                          | 50                    | 500                                    | 100                                    | 1.0                    | 100/100                                 | 0.4                                     | 100/200                    | 8.0 | 1.2                                                      |             |
| 2000                   | 0.2                                                                                                           | Axial(φ4.0/φ0.78)                                                | RC 2           | 20                            | -40 to +150            | 2.0                      | 0.2                          | 10                    | 300                                    | 100                                    | 4.0                    | 10/10                                   | 1.3                                     | 10/20                      | 15  | 0.4                                                      |             |

## 4-3 Ultrafast Recovery Diodes

### ●Surface-Mount

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package                | Part<br>Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | trr <sup>(1)</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | trr <sup>(2)</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | R <sub>th(j-l)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------------------------|------------------------|----------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|----------------------------|-----------------------------------------|----------------------------|-----------------------------------------|--------------------------------|-------------|
|                        |                                                                                                                |                        |                | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                            |                                         |                            |                                         |                                |             |
| 200                    | 1.0                                                                                                            | Surface-Mount (SJP)    | SJPL-D2        | 25                            | -40 to +150            |                          | 0.98                         | 1.0                   | 25                                     | 0.1                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
|                        | 1.5                                                                                                            | Surface-Mount (SJP)    | SJPX-F2        | 30                            | -40 to +150            |                          | 0.98                         | 1.5                   | 10                                     | 2.0                                    | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 20                             | 0.072       |
|                        | 2.0                                                                                                            | Surface-Mount (SJP)    | SJPL-H2        | 25                            | -40 to +150            |                          | 0.98                         | 2.0                   | 50                                     | 0.2                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
|                        | 3.0                                                                                                            | Surface-Mount (SJP)    | SJPL-L2        | 60                            | -40 to +150            |                          | 0.98                         | 3.0                   | 50                                     | 0.3                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
|                        | 10                                                                                                             | Surface-Mount (TO220S) | MPL-102S       | 65                            | -40 to +150            |                          | 0.98                         | 5.0                   | 100                                    | 0.2                                    | 150(Ta)                | 40                         | 100/100                                 | 30                         | 100/200                                 | 2.5                            | 1.4         |
| 300                    | 2.0                                                                                                            | Surface-Mount (SJP)    | SJPX-H3        | 20                            | -40 to +150            |                          | 1.3                          | 2.0                   | 50                                     | 3.0                                    | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 20                             | 0.072       |
| 400                    | 1.5                                                                                                            | Surface-Mount (SJP)    | SJPL-F4        | 25                            | -40 to +150            |                          | 1.3                          | 1.5                   | 10                                     | 0.05                                   | 150(Ta)                | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
|                        | 3.0                                                                                                            | Surface-Mount (SJP)    | SJPL-L4        | 30                            | -40 to +150            |                          | 1.3                          | 3.0                   | 50                                     | 0.1                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
| 500                    | 1.0                                                                                                            | Surface-Mount (SJP)    | SJPD-D5*       | 20                            | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                     | 0.1                                    | 150                    | 40                         | 100/100                                 | 30                         | 100/200                                 | 20                             | 0.072       |
|                        | 3.0                                                                                                            | Surface-Mount (SJP)    | SJPD-L5        | 50                            | -40 to +150            |                          | 1.4                          | 3.0                   | 15                                     | 0.15                                   | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
| 600                    | 2.0                                                                                                            | Surface-Mount (SJP)    | SJPL-H6        | 30                            | -40 to +150            |                          | 1.5                          | 2.0                   | 50                                     | 0.1                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 20                             | 0.072       |
|                        | 2.0                                                                                                            | Surface-Mount (SJP)    | SJPX-H6        | 20                            | -40 to +150            |                          | 1.5                          | 2.0                   | 10                                     | 3.0                                    | 150                    | 30                         | 100/100                                 | 20                         | 100/200                                 | 20                             | 0.072       |
|                        | 3.0                                                                                                            | Surface-Mount (TO220S) | MPL-1036S      | 50                            | -40 to +150            |                          | 1.75                         | 3.0                   | 50                                     | 0.1                                    | 150                    | 50                         | 100/100                                 | —                          | —                                       | 2.5                            | 1.4         |

\*Under development

### ●Thru-Hole

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part<br>Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | trr <sup>(1)</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | trr <sup>(2)</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | R <sub>th(j-l)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|----------------------------|-----------------------------------------|----------------------------|-----------------------------------------|--------------------------------|-------------|
|                        |                                                                                                                |                                                   |                | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                            |                                         |                            |                                         |                                |             |
| 200                    | 1.0                                                                                                            | Axial (φ 2.4/φ 0.6)                               | AL01Z          | 25                            | -40 to +150            |                          | 0.98                         | 1.0                   | 50                                     | 0.1                                    | 100                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 22                             | 0.13        |
|                        | 1.5                                                                                                            | Axial (φ 2.7/φ 0.6)                               | EN01Z          | 50                            | -40 to +150            |                          | 0.92                         | 1.5                   | 10                                     | 2.0                                    | 150                    | 100                        | 100/100                                 | 50                         | 100/200                                 | 20                             | 0.2         |
|                        | 1.5                                                                                                            | Axial (φ 2.7/φ 0.78)                              | EL 1Z          | 25                            | -40 to +150            |                          | 0.98                         | 1.5                   | 50                                     | 0.1                                    | 100                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 17                             | 0.3         |
|                        | 1.5                                                                                                            | Axial (φ 2.7/φ 0.6)                               | EL02Z          | 25                            | -40 to +150            |                          | 0.98                         | 1.5                   | 50                                     | 0.1                                    | 100                    | 40                         | 100/100                                 | 30                         | 100/200                                 | 20                             | 0.2         |
|                        | 1.5                                                                                                            | Axial (φ 4.0/φ 0.78)                              | RN 1Z          | 60                            | -40 to +150            |                          | 0.92                         | 1.5                   | 20                                     | 3.0                                    | 150                    | 100                        | 100/100                                 | 50                         | 100/200                                 | 15                             | 0.4         |
|                        | 2.0                                                                                                            | Axial (φ 4.0/φ 0.78)                              | RX 10Z         | 30                            | -40 to +150            |                          | 0.98                         | 2.0                   | 50                                     | 3.0                                    | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 15                             | 0.4         |
|                        | 2.0                                                                                                            | Axial (φ 4.0/φ 0.78)                              | RL 10Z         | 30                            | -40 to +150            |                          | 0.98                         | 2.0                   | 50                                     | 0.1                                    | 100(Ta)                | 50                         | 100/100                                 | 35                         | 100/200                                 | 15                             | 0.4         |
|                        | 2.0                                                                                                            | Axial (φ 4.0/φ 0.98)                              | RL 2Z          | 30                            | -40 to +150            |                          | 0.98                         | 2.0                   | 50                                     | 0.1                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 12                             | 0.6         |
|                        | 2.0                                                                                                            | Axial (φ 4.0/φ 0.98)                              | RN 2Z          | 70                            | -40 to +150            |                          | 0.92                         | 2.0                   | 50                                     | 4.0                                    | 150                    | 100                        | 100/100                                 | 50                         | 100/200                                 | 12                             | 0.6         |
|                        | 3.5                                                                                                            | Axial (φ 6.5/φ 1.4)                               | RL 4Z          | 80                            | -40 to +150            |                          | 0.95                         | 3.5                   | 150                                    | 0.5                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 8.0                            | 1.2         |
|                        | 3.5                                                                                                            | Axial (φ 6.5/φ 1.4)                               | RN 4Z          | 120                           | -40 to +150            |                          | 0.92                         | 3.5                   | 50                                     | 6.0                                    | 150                    | 100                        | 100/100                                 | 50                         | 100/200                                 | 8.0                            | 1.2         |
|                        | 5.0                                                                                                            | TO-220F (Center-tap)                              | FML-12S        | 35                            | -40 to +150            |                          | 0.98                         | 2.5                   | 50                                     | 0.1                                    | 150                    | 40                         | 100/100                                 | 30                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F (Center-tap)                              | FMX-12S        | 35                            | -40 to +150            |                          | 0.98                         | 2.5                   | 50                                     | 10                                     | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F2Pin                                       | FML-G12S       | 65                            | -40 to +150            |                          | 0.98                         | 5.0                   | 100                                    | 0.2                                    | 150                    | 40                         | 100/100                                 | 30                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F2Pin                                       | FMX-G12S       | 65                            | -40 to +150            |                          | 0.98                         | 5.0                   | 100                                    | 20                                     | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F2Pin                                       | FMN-G12S       | 100                           | -40 to +150            |                          | 0.92                         | 5.0                   | 100                                    | 10                                     | 150(Ta)                | 100                        | 100/100                                 | 50                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F (Center-tap)                              | FMXA-2102ST    | 100                           | -40 to +150            |                          | 1.2                          | 5.0                   | 100                                    | 20                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F (Center-tap)                              | FML-22S        | 65                            | -40 to +150            |                          | 0.98                         | 5.0                   | 100                                    | 0.2                                    | 150                    | 40                         | 100/100                                 | 30                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F (Center-tap)                              | FMX-22S        | 65                            | -40 to +150            |                          | 0.98                         | 5.0                   | 100                                    | 20                                     | 100(Ta)                | 30                         | 100/100                                 | 25                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F2Pin                                       | FML-G22S       | 150                           | -40 to +150            |                          | 0.98                         | 10                    | 200                                    | 0.4                                    | 150                    | 40                         | 500/500                                 | 30                         | 500/1000                                | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F2Pin                                       | FMX-G22S       | 150                           | -40 to +150            |                          | 0.98                         | 10                    | 200                                    | 50                                     | 100(Ta)                | 30                         | 500/500                                 | 25                         | 500/1000                                | 4.0                            | 2.1         |
|                        | 15                                                                                                             | TO-220F (Center-tap)                              | FMX-22SL       | 100                           | -40 to +150            |                          | 0.98                         | 7.5                   | 150                                    | 30                                     | 150                    | 30                         | 500/500                                 | 25                         | 500/1000                                | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-220F (Center-tap)                              | FM2-2202       | 110                           | -40 to +150            |                          | 0.98                         | 10                    | 200                                    | 0.4                                    | 150                    | 50                         | 100/100                                 | 35                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-220F (Center-tap)                              | FMXA-2202S     | 100                           | -40 to +150            |                          | 1.2                          | 10                    | 100                                    | 30                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FML-4202S      | 150                           | -40 to +150            |                          | 0.98                         | 10                    | 10                                     | 0.4                                    | 150                    | 40                         | 500/500                                 | 30                         | 500/1000                                | 2.0                            | 6.5         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FMX-4202S      | 150                           | -40 to +150            |                          | 0.98                         | 10                    | 200                                    | 50                                     | 150                    | 30                         | 500/500                                 | 25                         | 500/1000                                | 2.0                            | 6.5         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FMXA-4202S*    | 100                           | -40 to +150            |                          | 1.2                          | 10                    | 100                                    | 30                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 2.0                            | 6.5         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FMXS-4202S     | 150                           | -40 to +150            |                          | 1.05                         | 10                    | 50                                     | 30                                     | 150                    | 30                         | 500/500                                 | 25                         | 500/1000                                | 2.0                            | 6.5         |
| 300                    | 5.0                                                                                                            | TO-220F (Center-tap)                              | FML-13S        | 40                            | -40 to +150            |                          | 1.3                          | 2.5                   | 50                                     | 0.25                                   | 100(Ta)                | 50                         | 100/100                                 | 35                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F2Pin                                       | FML-G13S       | 70                            | -40 to +150            |                          | 1.3                          | 5.0                   | 100                                    | 0.2                                    | 100(Ta)                | 50                         | 100/100                                 | 35                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F (Center-tap)                              | FML-23S        | 75                            | -40 to +150            |                          | 1.3                          | 5.0                   | 100                                    | 0.2                                    | 150                    | 50                         | 100/100                                 | 30                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                                             | TO-220F (Center-tap)                              | FMX-23S        | 65                            | -40 to +150            |                          | 1.3                          | 5.0                   | 50                                     | 15                                     | 150                    | 30                         | 100/100                                 | 25                         | 100/200                                 | 4.0                            | 2.1         |
|                        | 15                                                                                                             | TO-220F (Center-tap)                              | FMXA-2153S     | 75                            | -40 to +150            |                          | 1.3                          | 7.5                   | 75                                     | 23                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-220F (Center-tap)                              | FMX-2203       | 100                           | -40 to +150            |                          | 1.3                          | 10                    | 100                                    | 30                                     | 150(Ta)                | 30                         | 500/500                                 | 25                         | 500/1000                                | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FMX-4203S      | 100                           | -40 to +150            |                          | 1.3                          | 10                    | 100                                    | 30                                     | 150                    | 30                         | 500/500                                 | 25                         | 500/1000                                | 2.0                            | 6.5         |
|                        | 20                                                                                                             | TO-220F (Center-tap)                              | FMXA-2203S     | 100                           | -40 to +150            |                          | 1.3                          | 10                    | 100                                    | 30                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                                             | TO-3PF (Center-tap)                               | FMXA-4203S     | 100                           | -40 to +150            |                          | 1.3                          | 10                    | 100                                    | 30                                     | 150                    | 25                         | 500/500                                 | —                          | —                                       | 2.0                            | 6.5         |

\*Under development

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (A)<br>(A)<br>Values in parentheses<br>are for the products<br>with heatsinks | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part<br>Number | I <sub>FSM</sub><br>(A)<br>50Hz<br>Single Half Sine Wave | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(μA)<br>V <sub>R</sub> =V <sub>RM</sub><br>max | I <sub>R</sub> (H)<br>(mA)<br>V <sub>R</sub> =V <sub>RM</sub><br>max | T <sub>J</sub><br>(°C) | trr <sup>①</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | trr <sup>②</sup><br>(ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | R <sub>th(j-l)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------|---------------------------------------------------|----------------|----------------------------------------------------------|------------------------|--------------------------|------------------------------|-----------------------|------------------------------------------------------------------|----------------------------------------------------------------------|------------------------|--------------------------|-----------------------------------------|--------------------------|-----------------------------------------|--------------------------------|-------------|
|                        |                                                                                              |                                                   |                |                                                          |                        |                          |                              |                       |                                                                  |                                                                      |                        |                          |                                         |                          |                                         |                                |             |
| 400                    | 0.7                                                                                          | Axial (φ 2.4/ f 0.6)                              | AG01           | 15                                                       | -40 to +150            |                          | 1.8                          | 0.7                   | 100                                                              | 0.5                                                                  | 100(Ta)                | 100                      | 100/100                                 | 50                       | 100/200                                 | 22                             | 0.13        |
|                        | 0.7                                                                                          | Axial (φ 2.7/ f 0.6)                              | EG01           | 15                                                       | -40 to +150            |                          | 2.0                          | 0.7                   | 50                                                               | 0.3                                                                  | 100                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 20                             | 0.2         |
|                        | 0.8                                                                                          | Axial (φ 2.7/ f 0.78)                             | EG 1           | 15                                                       | -40 to +150            |                          | 1.8                          | 0.8                   | 50                                                               | 0.3                                                                  | 100                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 17                             | 0.3         |
|                        | 1.0                                                                                          | Axial (φ 2.4/ f 0.6)                              | AL01           | 20                                                       | -40 to +150            |                          | 1.4                          | 1.0                   | 10                                                               | 0.05                                                                 | 150                    | 50                       | 100/100                                 | 35                       | 100/200                                 | 22                             | 0.13        |
|                        | 1.2                                                                                          | Axial (φ 2.7/ f 0.78)                             | RG 10          | 50                                                       | -40 to +150            |                          | 1.8                          | 1.5                   | 500                                                              | 2.5                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 15                             | 0.4         |
|                        | 1.2                                                                                          | Axial (φ 4.0/ f 0.98)                             | RG 2           | 50                                                       | -40 to +150            |                          | 1.8                          | 1.5                   | 500                                                              | 2.5                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 12                             | 0.6         |
|                        | 1.5                                                                                          | Axial (φ 2.7/ f 0.78)                             | EL 1           | 40                                                       | -40 to +150            |                          | 1.3                          | 1.5                   | 10                                                               | 0.05                                                                 | 150                    | 50                       | 100/100                                 | 35                       | 100/200                                 | 17                             | 0.3         |
|                        | 2.0                                                                                          | Axial (φ 4.0/ f 0.98)                             | RL 2           | 40                                                       | -40 to +150            |                          | 1.3                          | 2.0                   | 10                                                               | 0.1                                                                  | 150                    | 50                       | 100/100                                 | 35                       | 100/200                                 | 12                             | 0.6         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMXA-1054S     | 50                                                       | -40 to +150            |                          | 1.5                          | 5.0                   | 50                                                               | 15                                                                   | 150                    | 20                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F (Center-tap)                              | FMG-14S, R     | 35                                                       | -40 to +150            |                          | 2.0                          | 2.5                   | 500                                                              | 1.5                                                                  | 100                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F (Center-tap)                              | FML-14S        | 40                                                       | -40 to +150            |                          | 1.3                          | 2.5                   | 50                                                               | 0.1                                                                  | 100(Ta)                | 50                       | 100/100                                 | 35                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMX-G14S       | 70                                                       | -40 to +150            |                          | 1.3                          | 5.0                   | 50                                                               | 15                                                                   | 150                    | 30                       | 100/100                                 | 25                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FML-G14S       | 70                                                       | -40 to +150            |                          | 1.3                          | 5.0                   | 100                                                              | 0.2                                                                  | 150                    | 50                       | 100/100                                 | 35                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMN-G14S       | 70                                                       | -40 to +150            |                          | 1.0                          | 5.0                   | 50                                                               | 10                                                                   | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 8.0                                                                                          | TO-220F (Center-tap)                              | FMG-24S, R     | 65                                                       | -40 to +150            |                          | 2.0                          | 5.0                   | 500                                                              | 2.5                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F (Center-tap)                              | FML-24S        | 70                                                       | -40 to +150            |                          | 1.3                          | 5.0                   | 100                                                              | 0.2                                                                  | 100(Ta)                | 50                       | 100/100                                 | 35                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMXA-1104S     | 100                                                      | -40 to +150            |                          | 1.5                          | 10                    | 100                                                              | 30                                                                   | 150                    | 25                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FML-4204S      | 100                                                      | -40 to +150            |                          | 1.3                          | 10                    | 50                                                               | 0.4                                                                  | 150                    | 50                       | 500/500                                 | 35                       | 500/1000                                | 2.0                            | 6.5         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FMXA-4204S*    | 100                                                      | -40 to +150            |                          | 1.5                          | 10                    | 100                                                              | 30                                                                   | 150                    | 25                       | 500/500                                 | —                        | —                                       | 2.0                            | 6.5         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FMD-4204S      | 100                                                      | -40 to +150            |                          | 1.4                          | 10                    | 20                                                               | 0.2                                                                  | 150                    | 50                       | 500/500                                 | 30                       | 500/1000                                | 2.0                            | 6.5         |
| 600                    | 0.5                                                                                          | Axial (φ 2.7/ φ 0.6)                              | EG01A          | 10                                                       | -40 to +150            |                          | 2.0                          | 0.5                   | 100                                                              | 0.5                                                                  | 100                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 20                             | 0.2         |
|                        | 0.5                                                                                          | Axial (φ 2.4/ φ 0.6)                              | AG01A          | 15                                                       | -40 to +150            |                          | 1.8                          | 0.5                   | 100                                                              | 0.5                                                                  | 100(Ta)                | 100                      | 100/100                                 | 50                       | 100/200                                 | 22                             | 0.13        |
|                        | 0.6                                                                                          | Axial (φ 2.7/ φ 0.78)                             | EG 1A          | 10                                                       | -40 to +150            |                          | 2.0                          | 0.6                   | 100                                                              | 0.5                                                                  | 100                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 17                             | 0.3         |
|                        | 1.0                                                                                          | Axial (φ 4.0/ φ 0.78)                             | RG 10A         | 50                                                       | -40 to +150            |                          | 2.0                          | 1.0                   | 500                                                              | 1.0                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 15                             | 0.4         |
|                        | 1.0                                                                                          | Axial (φ 4.0/ φ 0.98)                             | RG 2A          | 50                                                       | -40 to +150            |                          | 2.0                          | 1.0                   | 500                                                              | 1.0                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 12                             | 0.6         |
|                        | 1.2                                                                                          | Axial (φ 4.0/ φ 0.98)                             | RD 2A          | 30                                                       | -40 to +150            |                          | 1.55                         | 1.2                   | 50                                                               | 0.1                                                                  | 150                    | 50                       | 100/100                                 | 35                       | 100/200                                 | 12                             | 0.6         |
|                        | 3.0                                                                                          | TO-220F (Two elements)                            | FMC-26U        | 50                                                       | -40 to +150            |                          | 2.0                          | 3.0                   | 500                                                              | 3.0                                                                  | 150                    | 70                       | 500/500                                 | 35                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 3.0                                                                                          | Axial (φ 6.5/ φ 1.4)                              | RL 4A          | 80                                                       | -40 to +150            |                          | 1.5                          | 3.0                   | 50                                                               | 0.1                                                                  | 150                    | 50                       | 500/500                                 | 35                       | 500/1000                                | 8.0                            | 1.2         |
|                        | 3.0                                                                                          | Axial (φ 6.5/ φ 1.4)                              | RN 4A          | 50                                                       | -40 to +150            |                          | 1.3                          | 3.0                   | 50                                                               | 5.0                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 8.0                            | 1.2         |
|                        | 4.0                                                                                          | TO-220F2Pin                                       | FMG-G26S       | 50                                                       | -40 to +150            |                          | 2.5                          | 4.0                   | 500                                                              | 3.0                                                                  | 100(Ta)                | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMX-G16S       | 50                                                       | -40 to +150            |                          | 1.5                          | 5.0                   | 50                                                               | 15                                                                   | 150                    | 30                       | 100/100                                 | 25                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FML-G16S       | 50                                                       | -40 to +150            |                          | 1.5                          | 5.0                   | 100                                                              | 0.5                                                                  | 150                    | 50                       | 500/500                                 | 35                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMN-1056S      | 60                                                       | -40 to +150            |                          | 1.3                          | 5.0                   | 50                                                               | 5.0                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 5.0                                                                                          | TO-220F2Pin                                       | FMD-1056S*     | 90                                                       | -40 to +150            |                          | 1.7                          | 5.0                   | 10                                                               | 0.1                                                                  | 150                    | 50                       | 500/500                                 | 35                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 6.0                                                                                          | TO-220F (Center-tap)                              | FMG-26S, R     | 50                                                       | -40 to +150            |                          | 2.2                          | 3.0                   | 500                                                              | 3.0                                                                  | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 8.0                                                                                          | TO-220F2Pin                                       | FMXK-1086S     | 100                                                      | -40 to +150            |                          | 1.75                         | 8.0                   | 30                                                               | 6.0                                                                  | 150                    | 27                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMX-1106S      | 50                                                       | -40 to +150            |                          | 1.5                          | 5.0                   | 50                                                               | 15                                                                   | 150                    | 30                       | 100/100                                 | 25                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMX-G26S       | 100                                                      | -40 to +150            |                          | 1.5                          | 10                    | 100                                                              | 20                                                                   | 150(Ta)                | 30                       | 100/100                                 | 25                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMD-G26S       | 100                                                      | -40 to +150            |                          | 1.7                          | 10                    | 100                                                              | 0.3                                                                  | 100(Ta)                | 50                       | 500/500                                 | 30                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMXA-1106S     | 100                                                      | -40 to +150            |                          | 1.98                         | 10                    | 100                                                              | 30                                                                   | 150                    | 28                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMNS-1106S     | 100                                                      | -40 to +150            |                          | 1.3                          | 10                    | 100                                                              | 10                                                                   | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMN-1106S      | 150                                                      | -40 to +150            |                          | 1.3                          | 10                    | 100                                                              | 10                                                                   | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMD-1106S*     | 180                                                      | -40 to +150            |                          | 1.7                          | 10                    | 20                                                               | 0.2                                                                  | 150                    | 50                       | 500/500                                 | 35                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 10                                                                                           | TO-220F2Pin                                       | FMXK-1106S     | 100                                                      | -40 to +150            |                          | 1.75                         | 10                    | 100                                                              | 10                                                                   | 150                    | 27                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-220F2Pin                                       | FMN-1206S      | 150                                                      | -40 to +150            |                          | 1.3                          | 20                    | 200                                                              | 20                                                                   | 150                    | 150                      | 500/500                                 | 100                      | 500/1000                                | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-220F (Center-tap)                              | FMN-2206S      | 150                                                      | -40 to +150            |                          | 1.3                          | 10                    | 100                                                              | 10                                                                   | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-220F (Center-tap)                              | FMXK-2206S     | 100                                                      | -40 to +150            |                          | 1.75                         | 10                    | 100                                                              | 10                                                                   | 150                    | 27                       | 500/500                                 | —                        | —                                       | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-220F (Center-tap)                              | FMXS-2206S     | 100                                                      | -40 to +150            |                          | 1.6                          | 10                    | 50                                                               | 15                                                                   | 150                    | 30                       | 500/500                                 | 25                       | 500/1000                                | 4.0                            | 2.1         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FMD-4206S      | 100                                                      | -40 to +150            |                          | 1.7                          | 10                    | 100                                                              | 0.3                                                                  | 150                    | 50                       | 500/500                                 | 30                       | 500/1000                                | 2.0                            | 6.5         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FMX-4206S*     | 100                                                      | -40 to +150            |                          | 1.5                          | 10                    | 100                                                              | 20                                                                   | 150                    | 30                       | 500/500                                 | —                        | —                                       | 2.0                            | 6.5         |
|                        | 20                                                                                           | TO-3PF (Center-tap)                               | FMXA-4206S*    | 100                                                      | -40 to +150            |                          | 1.98                         | 10                    | 100                                                              | 30                                                                   | 150                    | 28                       | 500/500                                 | —                        | —                                       | 2.0                            | 6.5         |
|                        | 30                                                                                           | TO-3PF2Pin                                        | FMN-3306S      | 150                                                      | -40 to +150            |                          | 1.3                          | 30                    | 200                                                              | 20                                                                   | 150                    | 150                      | 500/500                                 | 100                      | 500/1000                                | 2.0                            | 6.5         |
|                        | 30                                                                                           | TO-3PF (Center-tap)                               | FMN-4306S      | 150                                                      | -40 to +150            |                          | 1.5                          | 15                    | 100                                                              | 10                                                                   | 150                    | 100                      | 100/100                                 | 50                       | 100/200                                 | 2.0                            | 6.5         |

\*Under development

## 4-3 Ultrafast Recovery Diodes

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A)<br><small>Values in parentheses<br/>are for the products<br/>with heatsinks</small> | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part<br>Number | I <sub>FSM</sub><br>(A) | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max |                       | I <sub>R</sub><br>(μA)                 | I <sub>R</sub> (H)<br>(mA)             |                        | trr① |                                         | trr② |                                         | R <sub>th(j-l)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------|-------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|------|-----------------------------------------|------|-----------------------------------------|--------------------------------|-------------|
|                        |                                                                                                                |                                                   |                | 50Hz                    |                        |                          |                              | I <sub>F</sub><br>(A) | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max | T <sub>j</sub><br>(°C) | (ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) | (ns) | I <sub>F</sub> /I <sub>RP</sub><br>(mA) |                                |             |
|                        |                                                                                                                |                                                   |                | Single Half Sine Wave   |                        |                          |                              |                       |                                        |                                        |                        |      |                                         |      |                                         |                                |             |
| 800                    | 0.5                                                                                                            | Axial ( ϕ 2.4/ ϕ 0.6 )                            | AB01B          | 10                      | -40 to +150            |                          | 2.0                          | 0.5                   | 10                                     | 0.2                                    | 150                    | 200  | 100/100                                 | 80   | 100/200                                 | 22                             | 0.13        |
|                        | 3.0                                                                                                            | TO-220F (Two elements)                            | FMC-28U        | 50                      | -40 to +150            |                          | 3.0                          | 3.0                   | 100                                    | 0.5                                    | 150                    | 70   | 500/500                                 | 35   | 500/1000                                | 4.0                            | 2.1         |
|                        | 3.0                                                                                                            | TO-220F2Pin                                       | FMC-G28S       | 50                      | -40 to +150            |                          | 3.0                          | 3.0                   | 100                                    | 1.0                                    | 150                    | 70   | 500/500                                 | 35   | 500/1000                                | 4.0                            | 2.1         |
|                        | 5.0                                                                                                            | TO-220F2Pin                                       | FMC-G28SL      | 60                      | -40 to +150            |                          | 3.0                          | 5.0                   | 200                                    | 2.0                                    | 150                    | 70   | 500/500                                 | 35   | 500/1000                                | 4.0                            | 2.1         |
| 1000                   | 0.2                                                                                                            | Axial ( ϕ 2.4/ ϕ 0.6 )                            | AP01C          | 5.0                     | -40 to +150            |                          | 4.0                          | 0.2                   | 100                                    | 0.5                                    | 100                    | 200  | 100/100                                 | 80   | 100/200                                 | 22                             | 0.13        |
|                        | 0.2                                                                                                            | Axial ( ϕ 2.7/ ϕ 0.6 )                            | EP01C          | 5.0                     | -40 to +150            |                          | 4.0                          | 0.2                   | 5.0                                    | 0.05                                   | 100(Ta)                | 200  | 100/100                                 | 80   | 100/200                                 | 20                             | 0.2         |
|                        | 0.4                                                                                                            | Axial ( ϕ 4.0/ ϕ 0.78 )                           | RU 1P          | 10                      | -40 to +150            |                          | 4.0                          | 0.4                   | 5.0                                    | 0.5                                    | 150                    | 100  | 100/100                                 | 50   | 100/200                                 | 15                             | 0.4         |
|                        | 0.5                                                                                                            | Axial ( ϕ 2.7/ ϕ 0.6 )                            | EG01C          | 10                      | -40 to +150            |                          | 3.3                          | 0.5                   | 50                                     | 0.5                                    | 100(Ta)                | 100  | 100/100                                 | 50   | 100/200                                 | 20                             | 0.2         |
|                        | 0.7                                                                                                            | Axial ( ϕ 4.0/ ϕ 0.78 )                           | RG 1C          | 10                      | -40 to +150            |                          | 3.3                          | 0.7                   | 20                                     | 0.25                                   | 150                    | 100  | 100/100                                 | 50   | 100/200                                 | 15                             | 0.4         |
|                        | 2.0                                                                                                            | Axial ( ϕ 6.5/ ϕ 1.4 )                            | RG 4C          | 60                      | -40 to +150            |                          | 3.0                          | 2.0                   | 500                                    | 2.5                                    | 100                    | 100  | 500/500                                 | 50   | 500/1000                                | 8.0                            | 1.2         |
|                        | 3.0                                                                                                            | TO-220F2Pin                                       | FMG-G2CS       | 30                      | -40 to +150            |                          | 4.0                          | 3.0                   | 50                                     | 0.3                                    | 100                    | 100  | 500/500                                 | 50   | 500/1000                                | 4.0                            | 2.1         |
| 1200                   | 3.0                                                                                                            | TO-220F2Pin (Two elements)                        | FMC-26UA       | 50                      | -40 to +150            |                          | 4.0                          | 3.0                   | 500                                    | 3.0                                    | 150                    | 70   | 500/500                                 | 35   | 500/1000                                | 4.0                            | 2.1         |
| 1600                   | 3.0                                                                                                            | TO-220F2Pin (Two elements)                        | FMC-28UA       | 50                      | -40 to +150            |                          | 6.0                          | 3.0                   | 100                                    | 0.5                                    | 150                    | 70   | 500/500                                 | 35   | 500/1000                                | 4.0                            | 2.1         |
| 2000                   | 0.1                                                                                                            | Axial ( ϕ 4.0/ ϕ 0.78 )                           | RP 1H          | 5.0                     | -40 to +150            |                          | 7.0                          | 0.1                   | 2.0                                    | 0.01                                   | 100                    | 100  | 10/20                                   | 50   | 10/20                                   | 15                             | 0.4         |

## 4-4 Schottky Barrier Diodes

### Standard

#### ●Surface-Mount

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package                          | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|----------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                  |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 40                     | 1.0                        | Surface-Mount (SJP)              | SJPB-D4     | 30                            | -40 to +150            |                          | 0.55                         | 1.0                   | 0.1                                    | 35                                     | 150                    | 20                                                     | 0.072       |
|                        | 2.0                        | Surface-Mount (SJP)              | SJPB-H4     | 50                            | -40 to +150            |                          | 0.55                         | 2.0                   | 0.2                                    | 70                                     | 150                    | 20                                                     | 0.072       |
|                        | 3.0                        | Surface-Mount (SJP)              | SJPB-L4     | 60                            | -40 to +150            |                          | 0.55                         | 3.0                   | 0.3                                    | 100                                    | 150                    | 20                                                     | 0.072       |
|                        | 5.0                        | Surface-Mount (SJP)              | SJPW-T4     | 80                            | -40 to +150            |                          | 0.55                         | 5.0                   | 0.5                                    | 150                                    | 150                    | 20                                                     | 0.072       |
| 60                     | 1.0                        | Surface-Mount (SJP)              | SJPB-D6     | 20                            | -40 to +150            |                          | 0.68                         | 1.0                   | 0.1                                    | 30                                     | 150                    | 20                                                     | 0.072       |
|                        | 1.5                        | Surface-Mount (SJP)              | SJPW-F6     | 25                            | -40 to +150            |                          | 0.70                         | 1.5                   | 1.0                                    | 70                                     | 150                    | 20                                                     | 0.072       |
|                        | 2.0                        | Surface-Mount (SJP)              | SJPB-H6     | 40                            | -40 to +150            |                          | 0.69                         | 2.0                   | 0.2                                    | 55                                     | 150                    | 20                                                     | 0.072       |
|                        | 3.0                        | Surface-Mount (SJP)              | SJPB-L6     | 50                            | -40 to +150            |                          | 0.70                         | 3.0                   | 0.3                                    | 70                                     | 150                    | 20                                                     | 0.072       |
| 90                     | 1.0                        | Surface-Mount (SJP)              | SJPB-D9     | 20                            | -40 to +150            |                          | 0.85                         | 1.0                   | 0.1                                    | 30                                     | 150                    | 20                                                     | 0.072       |
|                        | 2.0                        | Surface-Mount (SJP)              | SJPB-H9     | 40                            | -40 to +150            |                          | 0.85                         | 2.0                   | 0.2                                    | 55                                     | 150                    | 20                                                     | 0.072       |
| 100                    | 20                         | Surface-Mount (TO220S)Center-tap | MPE-220A    | 120                           | -40 to +150            |                          | 0.85                         | 10                    | 1.0                                    | 100                                    | 150                    | 2.5                                                    | 1.04        |

#### ●Thru-Hole

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                                   |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 40                     | 1.0                        | Axial(φ2.4/φ0.6)                                  | AK 04       | 25                            | -40 to +150            |                          | 0.55                         | 1.0                   | 5.0                                    | 35                                     | 150                    | 22                                                     | 0.13        |
|                        | 1.0                        | Axial(φ2.7/φ0.6)                                  | EK 04       | 40                            | -40 to +150            |                          | 0.55                         | 1.0                   | 5.0                                    | 35                                     | 150                    | 20                                                     | 0.3         |
|                        | 1.5                        | Axial(φ2.7/φ0.78)                                 | EK 14       | 40                            | -40 to +150            |                          | 0.55                         | 1.5                   | 5.0                                    | 50                                     | 150                    | 17                                                     | 0.3         |
|                        | 1.7                        | Axial(φ4.0/φ0.78)                                 | RK 14       | 60                            | -40 to +150            |                          | 0.55                         | 2.0                   | 5.0                                    | 70                                     | 150                    | 15                                                     | 0.45        |
|                        | 2.5                        | Axial(φ4.0/φ0.98)                                 | RK 34       | 50                            | -40 to +150            |                          | 0.55                         | 2.5                   | 5.0                                    | 100                                    | 150                    | 12                                                     | 0.6         |
|                        | 3.0                        | TO-220F2Pin                                       | FMB-G14     | 60                            | -40 to +150            |                          | 0.60                         | 3.0                   | 2.0                                    | 70                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 3.0                        | Axial(φ6.5/φ1.4)                                  | RK 44       | 80                            | -40 to +150            |                          | 0.55                         | 3.0                   | 5.0                                    | 100                                    | 150                    | 8.0                                                    | 1.2         |
|                        | 4.0                        | TO-220F(Center-tap)                               | FMB-24      | 50                            | -40 to +150            |                          | 0.55                         | 2.0                   | 5.0                                    | 250                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 5.0                        | Axial(φ6.5/φ1.4)                                  | RW54        | 120                           | -40 to +150            |                          | 0.55                         | 5.0                   | 1.0                                    | 150                                    | 150                    | 8.0                                                    | 1.2         |
|                        | 5.0                        | TO-220F2Pin                                       | FMB-G14L    | 60                            | -40 to +150            |                          | 0.55                         | 5.0                   | 5.0                                    | 175                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 6.0                        | TO-220F(Center-tap)                               | FMB-24M     | 60                            | -40 to +150            |                          | 0.55                         | 3.0                   | 5.0                                    | 100                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 10                         | TO-220F(Center-tap)                               | FMB-24L     | 60                            | -40 to +150            |                          | 0.55                         | 5.0                   | 5.0                                    | 175                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 10                         | TO-220F(Center-tap)                               | FMW-24L     | 100                           | -40 to +150            |                          | 0.55                         | 5.0                   | 0.5                                    | 175                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 10                         | TO-220F2Pin                                       | FMB-G24H    | 150                           | -40 to +150            |                          | 0.55                         | 10                    | 10                                     | 350                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 15                         | TO-220F(Center-tap)                               | FMB-24H     | 100                           | -40 to +150            |                          | 0.55                         | 7.5                   | 7.5                                    | 250                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 15                         | TO-220F(Center-tap)                               | FMW-24H     | 120                           | -40 to +150            |                          | 0.55                         | 7.5                   | 7.5                                    | 250                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-220F(Center-tap)                               | FMB-2204    | 150                           | -40 to +150            |                          | 0.55                         | 10                    | 10                                     | 350                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-220F(Center-tap)                               | FMW-2204    | 120                           | -40 to +150            |                          | 0.55                         | 10                    | 1.0                                    | 350                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-220F(Center-tap)                               | FMB-2304    | 150                           | -40 to +150            |                          | 0.55                         | 15                    | 15                                     | 500                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-3PF(Center-tap)                                | FMW-4304    | 150                           | -40 to +150            |                          | 0.55                         | 15                    | 1.5                                    | 500                                    | 150                    | 2.0                                                    | 6.5         |

## 4-4 Schottky Barrier Diodes

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                                |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 60                     | 0.7                        | Axial(φ2.4/φ0.6)                               | AK 06       | 10                            | -40 to +150            |                          | 0.62                         | 0.7                   | 1.0                                    | 30                                     | 150                    | 22                                                     | 0.13        |
|                        | 0.7                        | Axial(φ2.7/φ0.6)                               | EK 06       | 10                            | -40 to +150            |                          | 0.62                         | 0.7                   | 1.0                                    | 30                                     | 150                    | 20                                                     | 0.3         |
|                        | 1.5                        | Axial(φ2.7/φ0.78)                              | EK 16       | 25                            | -40 to +150            |                          | 0.62                         | 1.5                   | 1.0                                    | 55                                     | 150                    | 17                                                     | 0.3         |
|                        | 1.5                        | Axial(φ4.0/φ0.78)                              | RK 16       | 25                            | -40 to +150            |                          | 0.62                         | 1.5                   | 1.0                                    | 55                                     | 150                    | 15                                                     | 0.45        |
|                        | 2.0                        | Axial(φ4.0/φ0.98)                              | RK 36       | 40                            | -40 to +150            |                          | 0.62                         | 2.0                   | 2.0                                    | 70                                     | 150                    | 12                                                     | 0.6         |
|                        | 3.5                        | Axial(φ6.5/φ1.4)                               | RK 46       | 70                            | -40 to +150            |                          | 0.62                         | 3.5                   | 3.0                                    | 125                                    | 150                    | 8.0                                                    | 1.2         |
|                        | 4.0                        | TO-220F(Center-tap)                            | FMB-26      | 40                            | -40 to +150            |                          | 0.62                         | 2.0                   | 2.0                                    | 70                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 6.0                        | TO-220F2Pin                                    | FMB-G16L    | 50                            | -40 to +150            |                          | 0.72                         | 6.0                   | 5.0                                    | 200                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 10                         | TO-220F(Center-tap)                            | FMW-2106    | 100                           | -40 to +150            |                          | 0.70                         | 5.0                   | 3.0                                    | 125                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 15                         | TO-220F(Center-tap)                            | FMW-2156    | 100                           | -40 to +150            |                          | 0.70                         | 7.5                   | 5.0                                    | 175                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-220F(Center-tap)                            | FMW-2206    | 120                           | -40 to +150            |                          | 0.70                         | 10                    | 1.0                                    | 250                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-220F(Center-tap)                            | FMB-2306    | 150                           | -40 to +150            |                          | 0.70                         | 15                    | 8.0                                    | 400                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-3PF(Center-tap)                             | FMW-4306    | 150                           | -40 to +150            |                          | 0.70                         | 15                    | 3.0                                    | 350                                    | 150                    | 2.0                                                    | 6.5         |
| 90                     | 0.7                        | Axial(φ2.4/φ0.6)                               | AK 09       | 10                            | -40 to +150            |                          | 0.81                         | 0.7                   | 1.0                                    | 30                                     | 150                    | 22                                                     | 0.13        |
|                        | 0.7                        | Axial(φ2.7/φ0.6)                               | EK 09       | 10                            | -40 to +150            |                          | 0.81                         | 0.7                   | 1.0                                    | 30                                     | 150                    | 20                                                     | 0.3         |
|                        | 1.5                        | Axial(φ2.7/φ0.78)                              | EK 19       | 40                            | -40 to +150            |                          | 0.81                         | 1.5                   | 2.0                                    | 55                                     | 150                    | 17                                                     | 0.3         |
|                        | 1.5                        | Axial(φ4.0/φ0.78)                              | RK 19       | 40                            | -40 to +150            |                          | 0.81                         | 1.5                   | 2.0                                    | 55                                     | 150                    | 15                                                     | 0.45        |
|                        | 2.0                        | Axial(φ4.0/φ0.98)                              | RK 39       | 50                            | -40 to +150            |                          | 0.81                         | 2.0                   | 3.0                                    | 70                                     | 150                    | 12                                                     | 0.6         |
|                        | 3.5                        | Axial(φ6.5/φ1.4)                               | RK 49       | 60                            | -40 to +150            |                          | 0.81                         | 3.5                   | 5.0                                    | 125                                    | 150                    | 8.0                                                    | 1.2         |
|                        | 4.0                        | TO-220F(Center-tap)                            | FMB-29      | 50                            | -40 to +150            |                          | 0.81                         | 2.0                   | 3.0                                    | 55                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 4.0                        | TO-220F2Pin                                    | FMB-G19L    | 60                            | -40 to +150            |                          | 0.81                         | 4.0                   | 5.0                                    | 125                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 8.0                        | TO-220F(Center-tap)                            | FMB-29L     | 60                            | -40 to +150            |                          | 0.81                         | 4.0                   | 5.0                                    | 125                                    | 150                    | 4.0                                                    | 2.1         |

### Low V<sub>F</sub> "A Series"

#### ●Surface-Mount

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package             | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                     |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 30                     | 1.0                        | Surface-Mount (SJP) | SJPA-D3     | 30                            | -40 to +125            |                          | 0.36                         | 1.0                   | 1.5                                    | 70                                     | 100                    | 20                                                     | 0.072       |
|                        | 2.0                        | Surface-Mount (SJP) | SJPA-H3*    | 40                            | -40 to +125            |                          | 0.36                         | 2.0                   | 3.0                                    | 140                                    | 100                    | 20                                                     | 0.072       |
|                        | 3.0                        | Surface-Mount (SJP) | SJPA-L3     | 70                            | -40 to +125            |                          | 0.36                         | 3.0                   | 4.5                                    | 210                                    | 100                    | 20                                                     | 0.072       |

\*Under development

#### ●Thru-Hole

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>j</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                                |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 30                     | 2.0                        | Axial(φ4.0/φ0.78)                              | RA 13       | 50                            | -40 to +125            |                          | 0.36                         | 2.0                   | 3.0                                    | 140                                    | 100                    | 15                                                     | 0.45        |

**Low IR “E Series”****●Surface-Mount**

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                                   |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 30                     | 2.0                        | Surface-Mount (SJP)                               | SJPE-H3*    | 40                            | -40 to +150            |                          | 0.55                         | 2.0                   | 0.2                                    | 70                                     | 150                    | 20                                                     | 0.072       |
| 40                     | 2.0                        | Surface-Mount (SJP)                               | SJPE-H4     | 40                            | -40 to +150            |                          | 0.6                          | 2.0                   | 0.05                                   | 20                                     | 150                    | 20                                                     | 0.072       |

\*Under development

**●Thru-Hole**

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package             | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                     |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 80                     | 20                         | TO-220F(Center-tap) | FMEN-2208   | 120                           | -40 to +150            |                          | 0.76                         | 10                    | 0.2                                    | 100                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-220F(Center-tap) | FMEN-2308   | 150                           | -40 to +150            |                          | 0.765                        | 15                    | 0.3                                    | 150                                    | 150                    | 4.0                                                    | 2.1         |
| 100                    | 10                         | TO-220F(Center-tap) | FMEN-210A   | 100                           | -40 to +150            |                          | 0.85                         | 5.0                   | 0.1                                    | 50                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 15                         | TO-220F(Center-tap) | FMEN-215A*  | 100                           | -40 to +150            |                          | 0.85                         | 7.5                   | 0.15                                   | 75                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-220F(Center-tap) | FMEN-220A   | 120                           | -40 to +150            |                          | 0.85                         | 10                    | 0.2                                    | 100                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-3PF(Center-tap)  | FMEN-420A*  | 120                           | -40 to +150            |                          | 0.85                         | 10                    | 0.2                                    | 100                                    | 150                    | 2.0                                                    | 6.5         |
|                        | 30                         | TO-220F(Center-tap) | FMEN-230A   | 150                           | -40 to +150            |                          | 0.85                         | 15                    | 0.3                                    | 150                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-262              | MPEN-230AF  | 150                           | -40 to +150            |                          | 0.90                         | 15                    | 0.25                                   | 125                                    | 150                    | 1.5                                                    | 1.55        |
|                        | 30                         | TO-3PF(Center-tap)  | FMEN-430A   | 150                           | -40 to +150            |                          | 0.85                         | 15                    | 0.3                                    | 150                                    | 150                    | 2.0                                                    | 6.5         |
| 150                    | 10                         | TO-220F(Center-tap) | FMEN-210B   | 100                           | -40 to +150            |                          | 0.92                         | 5.0                   | 0.1                                    | 25                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-220F(Center-tap) | FMEN-220B   | 120                           | -40 to +150            |                          | 0.92                         | 10                    | 0.2                                    | 50                                     | 150                    | 4.0                                                    | 2.1         |
|                        | 20                         | TO-3PF(Center-tap)  | FMEN-420B*  | 120                           | -40 to +150            |                          | 0.85                         | 10                    | 0.2                                    | 100                                    | 150                    | 2.0                                                    | 6.5         |
|                        | 30                         | TO-220F(Center-tap) | FMEN-230B   | 150                           | -40 to +150            |                          | 0.92                         | 15                    | 0.3                                    | 75                                     | 150                    | 4.0                                                    | 2.1         |

\*Under development

**Low V<sub>F</sub>/Low I<sub>R</sub> Balance “J Series”****●Surface-Mount**

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package             | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                     |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 30                     | 1.0                        | Surface-Mount (SJP) | SJPJ-D3     | 30                            | -40 to +150            |                          | 0.45                         | 1.0                   | 0.1                                    | 35                                     | 150                    | 20                                                     | 0.072       |
|                        | 2.0                        | Surface-Mount (SJP) | SJPJ-H3*    | 50                            | -40 to +150            |                          | 0.45                         | 2.0                   | 0.2                                    | 70                                     | 150                    | 20                                                     | 0.072       |
|                        | 3.0                        | Surface-Mount (SJP) | SJPJ-L3     | 60                            | -40 to +150            |                          | 0.45                         | 3.0                   | 0.3                                    | 150                                    | 150                    | 20                                                     | 0.072       |

\*Under development

**●Thru-Hole**

| V <sub>RM</sub><br>(V) | I <sub>F</sub> (AV)<br>(A) | Package<br>Axial<br>(Body Diameter/Lead Diameter) | Part Number | I <sub>FSM</sub><br>(A)       | T <sub>J</sub><br>(°C) | T <sub>stg</sub><br>(°C) | V <sub>F</sub><br>(V)<br>max | I <sub>F</sub><br>(A) | I <sub>R</sub><br>(mA)                 | I <sub>R</sub> (H)<br>(mA)             | T <sub>J</sub><br>(°C) | R <sub>th(j-l)</sub><br>R <sub>th(j-c)</sub><br>(°C/W) | Mass<br>(g) |
|------------------------|----------------------------|---------------------------------------------------|-------------|-------------------------------|------------------------|--------------------------|------------------------------|-----------------------|----------------------------------------|----------------------------------------|------------------------|--------------------------------------------------------|-------------|
|                        |                            |                                                   |             | 50Hz<br>Single Half Sine Wave |                        |                          |                              |                       | V <sub>R</sub> =V <sub>RM</sub><br>max | V <sub>R</sub> =V <sub>RM</sub><br>max |                        |                                                        |             |
| 30                     | 3.0                        | Axial(φ6.5/φ1.4)                                  | RJ 43       | 50                            | -40 to +150            |                          | 0.45                         | 3.0                   | 3.0                                    | 100                                    | 150                    | 8.0                                                    | 1.2         |
|                        | 10                         | TO-220F(Center-tap)                               | FMJ-23L     | 100                           | -40 to +150            |                          | 0.45                         | 5.0                   | 5.0                                    | 175                                    | 150                    | 4.0                                                    | 2.1         |
|                        | 30                         | TO-220F(Center-tap)                               | FMJ-2303    | 150                           | -40 to +150            |                          | 0.48                         | 15                    | 15                                     | 500                                    | 150                    | 4.0                                                    | 2.1         |

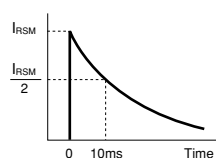
## 4-5 Power Zener Diodes

| P<br>(W) | VZ<br>1mA<br>(V) | PR<br>(W)    | Package              | Part Number | VDC<br>(V) | I <sub>ZSM</sub><br>(A) | Conditions           | T <sub>j</sub> T <sub>stg</sub><br>(°C) | IR<br>(μA)<br>max | Mass(g) |
|----------|------------------|--------------|----------------------|-------------|------------|-------------------------|----------------------|-----------------------------------------|-------------------|---------|
|          |                  |              |                      |             |            |                         |                      |                                         |                   |         |
| 1        | 28±3             | 50 (5ms)     | Surface-Mount(SJP)   | SJPZ-K28    | 20         | 2                       | 5ms rectangular wave | -55 to +150                             | 10                | 0.07    |
| 1        | 18.8 to 21.2     | 95 (500 μs)  | Surface-Mount(SJP)   | SJPZ-E20    | 15         | —                       | —                    | -55 to +150                             | 10                | 0.07    |
| 1        | 31.0 to 35.0     |              | Surface-Mount(SJP)   | SJPZ-E33    | 25         | —                       | —                    | -55 to +150                             | 10                | 0.07    |
| 2        | 16.8 to 19.1     | 500 (500 μs) | Surface-Mount(SJP)   | SJPZ-N18    | 13         | —                       | —                    | -55 to +150                             | 1                 | 0.07    |
| 2        | 25.1 to 28.9     |              | Surface-Mount(SJP)   | SJPZ-N27    | 20         | —                       | —                    | -55 to +150                             | 1                 | 0.07    |
| 2        | 31.0 to 35.0     |              | Surface-Mount(SJP)   | SJPZ-N33    | 25         | —                       | —                    | -55 to +150                             | 1                 | 0.07    |
| 2        | 37.8 to 42.2     |              | Surface-Mount(SJP)   | SJPZ-N40*   | 30         | —                       | —                    | -55 to +150                             | 1                 | 0.07    |
| 5        | 24 to 30         | —            | Surface-Mount(SZ-10) | SZ-10N27    | 22         | 70                      | Fig.1                | -55 to +175                             | 10                | 2.55    |
| 5        | 36 to 44         | —            | Surface-Mount(SZ-10) | SZ-10N40*   | 22         | 40                      | Fig.1                | -55 to +175                             | 10                | 2.55    |
| 6        | 24 to 30         | —            | Surface-Mount(SZ-10) | SZ-10NN27   | 22         | 90                      | Fig.1                | -55 to +175                             | 10                | 2.55    |
| 6        | 36 to 44         | —            | Surface-Mount(SZ-10) | SZ-10NN40   | 22         | 55                      | Fig.1                | -55 to +175                             | 10                | 2.55    |

\*Under development

Figure1

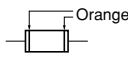
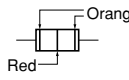
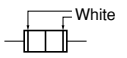
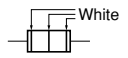
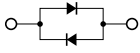
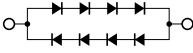
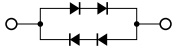
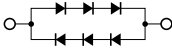
I<sub>ZSM</sub> Condition



## 4-6 Silicon Varistors

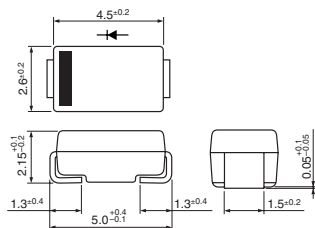
### ●Symmetrical

| V <sub>F</sub><br>(V) | I <sub>F</sub><br>(mA) | Part Number | I <sub>F</sub><br>( $\mu$ A)<br>max | V <sub>F</sub><br>(V) | I <sub>TSM</sub><br>(A)       | T <sub>j</sub><br>(°C) | T <sub>stg</sub><br>(°C) | R <sub>th(j-l)</sub><br>(°C/W) | Mass<br>(g) | Package                        |
|-----------------------|------------------------|-------------|-------------------------------------|-----------------------|-------------------------------|------------------------|--------------------------|--------------------------------|-------------|--------------------------------|
|                       |                        |             |                                     |                       | 50Hz<br>Single Half Sine Wave |                        |                          |                                |             |                                |
| 1.5max                | 1000                   | VR-60SS     | 20                                  | 0.2                   | 15                            | -40 to +100            |                          | 20                             | 0.3         | Axial( $\phi$ 2.7/ $\phi$ 0.6) |
| 2.3 $\pm$ 0.25        | 1                      | VR-61SS     |                                     |                       | 7.5                           | -40 to +100            |                          | 20                             | 0.3         | Axial( $\phi$ 2.7/ $\phi$ 0.6) |
| 2.75 $\pm$ 0.25       | 10                     |             |                                     |                       |                               |                        |                          |                                |             |                                |
| 3.1 $\pm$ 0.25        | 70                     |             |                                     |                       |                               |                        |                          |                                |             |                                |
| 2.0max                | 100                    | SV-3SS      | 50                                  | 0.6                   |                               | -40 to +100            |                          | 20                             | 0.3         | Axial( $\phi$ 2.7/ $\phi$ 0.6) |
| 1.8 $\pm$ 0.2         | 1                      | SV-4SS      | 50                                  | 0.9                   |                               | -40 to +100            |                          | 20                             | 0.3         | Axial( $\phi$ 2.7/ $\phi$ 0.6) |
| 2.15 $\pm$ 0.2        | 10                     |             |                                     |                       |                               |                        |                          |                                |             |                                |
| 2.4 $\pm$ 0.25        | 30                     |             |                                     |                       |                               |                        |                          |                                |             |                                |

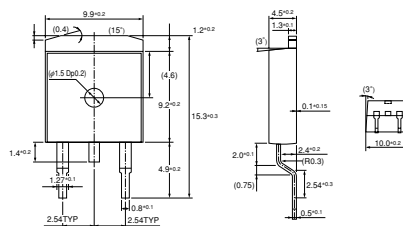
| Part Number         | VR-60SS                                                                           | VR-61SS                                                                           | SV-3SS                                                                              | SV-4SS                                                                              |
|---------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Display Color       |  |  |  |  |
| Internal Connection |  |  |   |  |

## Package Type (Dimensions)

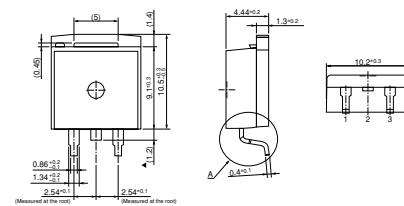
### • No. 1 Surface-Mount (SJP)



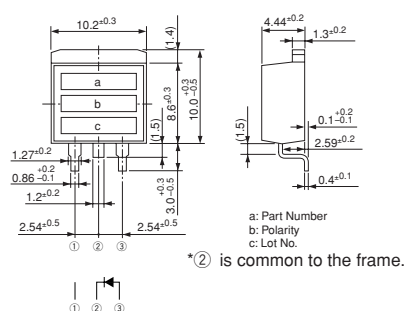
### • No. 2 Surface-Mount (TO263)



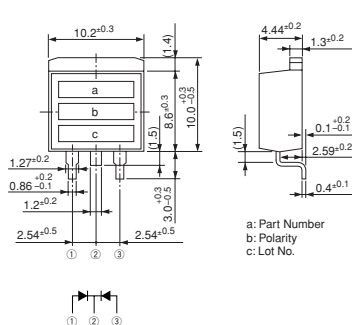
### • No. 3 Surface-Mount (TO220S) MPL-102S, MP2-202S, MPL-1036



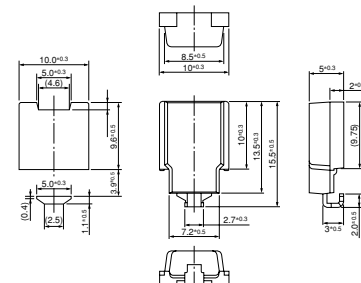
### • No. 4 Surface-Mount (TO220S)



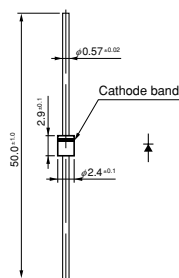
### • No. 5 Surface-Mount (TO220S) Center-tap



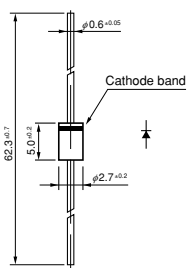
### • No. 6 Surface-Mount (SZ-10)



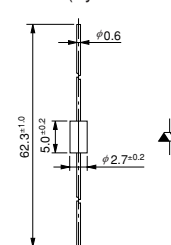
### • No. 7 Axial ( $\phi 2.4/\phi 0.6$ )



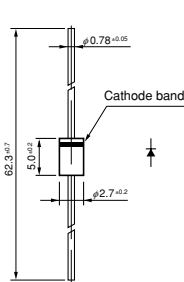
### • No. 8 Axial ( $\phi 2.7/\phi 0.6$ )



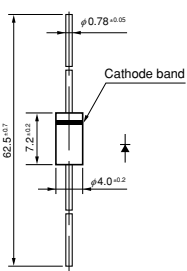
### • No. 9 Axial ( $\phi 2.7/\phi 0.6$ ) Silicon Varistors (Symmetrical)



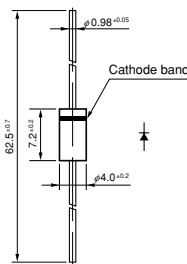
### • No. 10 Axial ( $\phi 2.7/\phi 0.78$ )



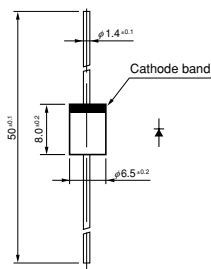
### • No. 11 Axial ( $\phi 4.0/\phi 0.78$ )



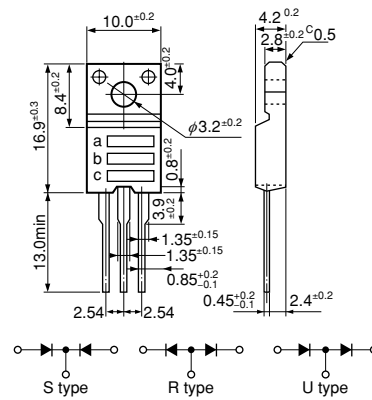
### • No. 12 Axial ( $\phi 4.0/\phi 0.98$ )



• No. 13 Axial ( $\phi 6.5/\phi 1.4$ )

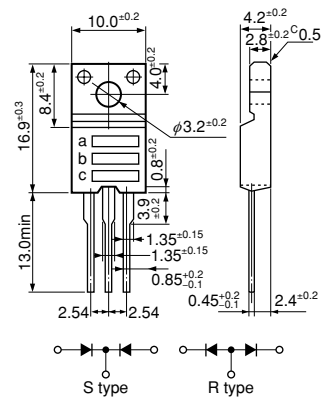


• No. 14 TO-220F (Two Elements)



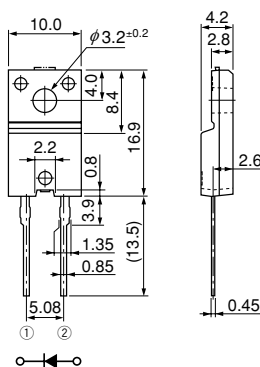
a: Part Number  
b: Polarity  
c: Lot No.

• No. 15 TO-220F (Center-tap)

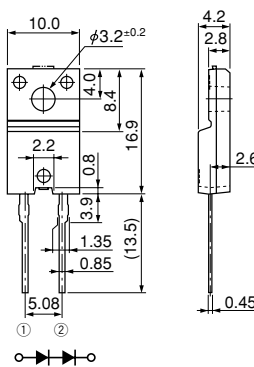


a: Part Number  
b: Polarity  
c: Lot No.

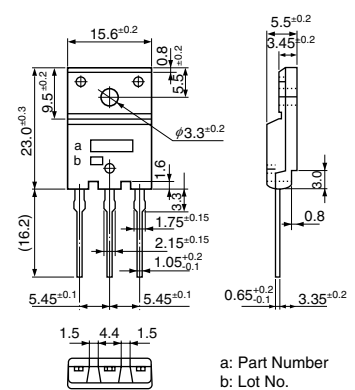
• No. 16 TO-220F2Pin



• No. 17 TO-220F2Pin (Two Elements)

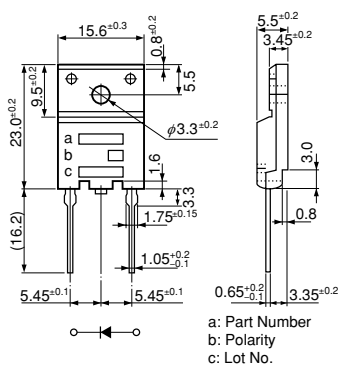


• No. 18 TO-3PF



a: Part Number  
b: Lot No.

• No. 19 TO-3PF2Pin



a: Part Number  
b: Polarity  
c: Lot No.



# ***DC/DC Power Modules***

**5**

|                            |     |
|----------------------------|-----|
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| Selection Guide .....      | 222 |
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Ordering Information

All products listed must be ordered in standard packing increments.

| Product Name | Package                  | Standard Packing Quantities (Bulk) | Standard Packing Quantities (Taping) |
|--------------|--------------------------|------------------------------------|--------------------------------------|
| MPM01        | ZIP 9                    | 50                                 | –                                    |
| MPM04        | ZIP 9                    | 50                                 | –                                    |
| BR200        | Board surface-mount type | 42                                 | –                                    |
| BR201        | Board surface-mount type | 42                                 | –                                    |
| BR202        | Board surface-mount type | 30                                 | –                                    |
| BR203        | Board surface-mount type | 30                                 | –                                    |
| BR204        | Board surface-mount type | 42                                 | –                                    |
| BR205        | Board surface-mount type | 42                                 | –                                    |
| BR206        | Board surface-mount type | 30                                 | –                                    |
| BR300        | Board lead type          | 50                                 | –                                    |
| BR301        | Board lead type          | 50                                 | –                                    |

Selection Guide

Mold type

| Part Number | Package | Size (L×W×H) | Input Voltage | Output Voltage | Output Current | Oscillation Frequency | Remarks | Page |
|-------------|---------|--------------|---------------|----------------|----------------|-----------------------|---------|------|
|             |         | [mm]         | [V]           | [V]            | [A]            | [kHz]                 |         |      |
| MPM01       | ZIP9    | 24×23×5.5    | 9 to 40       | 1.8 to 12      | 3              | 250                   |         | 224  |
| MPM04       | ZIP9    | 24×23×5.5    | 16 to 40      | 12 to 24       | 3              | 250                   |         | 224  |

Board Surface-Mount Type

| Part Number | Size (L×W)  | Height | Input Voltage | Output Voltage | Output Current | Oscillation Frequency | Remarks | Page |
|-------------|-------------|--------|---------------|----------------|----------------|-----------------------|---------|------|
|             | [mm]        | [mm]   | [V]           | [V]            | [A]            | [kHz]                 |         |      |
| BR200       | 20.32×11.43 | 4.2    | 12±10%        | 0.75 to 1.65   | 10             | 300                   |         | 226  |
| BR201       | 20.32×11.43 | 4.2    | 12±10%        | 1.60 to 3.63   | 10             | 600                   |         |      |
| BR202       | 33.02×13.46 | 4.2    | 12±10%        | 0.75 to 1.65   | 20             | 300                   |         | 228  |
| BR203       | 33.02×13.46 | 4.2    | 12±10%        | 1.60 to 3.63   | 20             | 400                   |         |      |
| BR204       | 20.32×11.43 | 4.2    | 12±10%        | 1.60 to 5.50   | 10             | 600                   |         | 226  |
| BR205       | 20.32×11.43 | 4.2    | 4.5 to 7.0    | 0.75 to 3.63   | 10             | 600                   |         | 230  |
| BR206       | 33.02×13.46 | 4.2    | 4.5 to 7.0    | 0.75 to 3.63   | 20             | 500                   |         | 232  |

Board lead type

| Part Number | Size (L×W) | Height | Input Voltage | Output Voltage | Output Current | Oscillation Frequency | Remarks | Page |
|-------------|------------|--------|---------------|----------------|----------------|-----------------------|---------|------|
|             | [mm]       | [mm]   | [V]           | [V]            | [A]            | [kHz]                 |         |      |
| BR300       | 14×14      | 4.2    | 8 to 30       | 5.0            | 1.0            | 350                   |         | 234  |
| BR301       | 14×14      | 4.2    | 8 to 30       | 3.3            | 1.0            | 350                   |         |      |

# Application Note

## <Mold Type>

### ■ Heat Dissipation and Reliability

Generally, the service life of electronic parts becomes shorter as the temperature increases. Electronic parts can be used without fins, depending on the input and output conditions, but suppressing increases in temperature is the most effective way to enable longer use. The package temperature can be reduced by derating the output current. To get the desired expected service life, implement cooling techniques such as attaching heatsinks or carrying out forced air cooling by using fans. Pay attention to heat dissipation. When mounting the module power supply on the heatsink, make sure to apply silicone grease and attach it securely. Allow sufficient margins in heatsink design. To thoroughly dissipate the heat, consider implementing air convection. The reliability of input/output capacitors is related to temperature. A high operating temperature may reduce the service life. Only use the capacitors in applications recommended by the capacitor manufacturer.

### ■ Internal Power Dissipation

$P_D$  can be obtained from the following formula.

$$P_D = P_{in} - P_o \\ = V_{in} \times I_{in} - V_o \times I_o$$

Or, if Efficiency  $\eta$  is known,

$$P_D = P_o \times (\frac{1}{\eta} + 100) - P_o$$

$P_D$  : Internal power dissipation  
 $P_{in}$  : Input power  
 $P_o$  : Output power  
 $V_{in}$  : Input voltage  
 $I_{in}$  : Input current  
 $V_o$  : Output voltage  
 $I_o$  : Output current  
 $\eta$  : Efficiency

### ■ Thermal Design

The maximum junction temperature  $T_{j(max)}$  given in the Absolute Maximum Ratings is specific to each product type and must be strictly observed. Thus, thermal design must consider the maximum power dissipation  $P_{D(max)}$ , which varies according to the conditions of use, and the maximum ambient temperature  $T_{a(max)}$ .

To simplify thermal design,  $T_a$ - $P_D$  characteristic graphs are provided herein. Please observe the following steps for heatsink design:

1. Obtain the maximum ambient temperature  $T_{a(max)}$ .
2. Obtain the maximum power dissipation  $P_{D(max)}$ .
3. Look for the intersection point on the  $T_a$ - $P_D$  characteristic graph and determine the size of the heatsink.

Although the heatsink size is now obtained, in actual applications, derating factor of 10-to-20% is generally used. Moreover, the heat dissipation capacity of a heatsink highly depends on how it is mounted. Thus, it is recommended to measure the heatsink and case temperature in the actual operating environment.

For details, refer to the  $T_a$ - $P_D$  characteristic graphs for each product type.

### ■ Mounting Torque

MPM01/04      0.588 to 0.785[N•m]

### ■ Recommended Silicone Grease

- Shin-Etsu Chemical Co., Ltd.: G746
- Momentive Performance Materials Inc.: YG-6260
- Dow Corning Toray Silicone Co., Ltd.: SC102

Be sure to select proper silicone grease carefully since the oil in some grease products may penetrate the device, resulting in an extremely short device life.

### ■ Other notes

- Devices cannot be operated connected in parallel in order to obtain a larger current.
- Module power supplies cannot be used for current boosting or voltage step-up applications.

# MPM Series Step-down Synchronous Rectifier Type DC/DC Converter Module

## Features

- Switch element, coil, control circuit and peripheral components incorporated in single package
- Fewer external parts: Only 3 components required: Cin, Co, and RFB
- Oscillation frequency: 250kHz
- Synchronous rectifier type
- High efficiency: 91% typ (VIN=33V, Vo=12V, Io=3A)
- Built-in H/S (40mΩ typ.), L/S (26mΩ typ.) ON resistance switching MOSFETs
- Full mold, stand-alone, IC type package: SIP9 (resin dimensions 24×23×5.5mm)

## Applications

- FA equipment, communication equipment
- Consumer equipment, gaming equipment
- Other

## Absolute Maximum Ratings

| Parameter                                              | Symbol  | Ratings      | Unit | Remarks |
|--------------------------------------------------------|---------|--------------|------|---------|
| VIN Pin Voltage                                        | VIN     | −0.3 to 41   | V    |         |
| FB Pin Voltage                                         | VFB     | −0.3 to 6    | V    |         |
| Vo Pin Voltage                                         | Vo      | −0.3 to 13   | V    | MPM01   |
| Vo Pin Voltage                                         | Vo      | −0.3 to 28.8 | V    | MPM04   |
| VIN-SW Voltage                                         | VVIN-SW | 55           | V    |         |
| Junction Temperature*1                                 | Tj      | −20 to 150   | °C   |         |
| Storage Temperature                                    | Tstg    | −20 to 120   | °C   |         |
| Thermal Resistance<br>(Between MIC Junction and Frame) | θj-f    | 7.7          | °C/W |         |

\*1: Limited by thermal protection circuit. The thermal protection detection temperature is approx. 160°C.

## Recommended Operating Conditions

| Parameter                             | Symbol | Ratings |      | Unit | Conditions        |
|---------------------------------------|--------|---------|------|------|-------------------|
|                                       |        | min.    | max. |      |                   |
| Input Voltage Range (MPM01)           | VIN    | Vo+4*4  | 40   | V    |                   |
| Input Voltage Range (MPM04)           | VIN    | Vo+4    | 40   | V    | When Vo=12 to 18V |
|                                       |        | 30      | 40   | V    | When Vo=20V       |
|                                       |        | 36      | 40   | V    | When Vo=24V       |
| Output Current Range*3                | Io     | 0       | 3    | A    |                   |
| Operating Junction Temperature        | Tjop   | −20     | 125  | °C   |                   |
| Operating Ambient Temperature Range*3 | Ta     | −20     | 85   | °C   | With derating     |

\*2: The recommended operating conditions show the operating conditions required to maintain normal circuit functions as shown in the electrical characteristics.

In actual operation, the device must be used within the recommended operating conditions.

\*3: But the device must be used within the derating curve.

\*4: The minimum value of the input voltage range is the higher of 9V or Vo+4V.

## Electrical Characteristics

(Ta = 25°C)

| Parameter                                  | Symbol | Ratings |       |       | Unit | Conditions                                                                             |
|--------------------------------------------|--------|---------|-------|-------|------|----------------------------------------------------------------------------------------|
|                                            |        | min.    | typ.  | max.  |      |                                                                                        |
| Reference Voltage                          | VFBref | 0.490   | 0.500 | 0.510 | V    | VIN=33V, Io=1A                                                                         |
| Efficiency*6                               | η      | —       | 91    | —     | %    | VIN=33V, Vo=12V, Io=3A                                                                 |
| Oscillation Frequency                      | fo     | 212     | 250   | 288   | kHz  | VIN=33V, Vo=12V, Io=3A                                                                 |
| Line Regulation*7                          | Vline  | —       | —     | ±2    | %    | VIN=16 to 40V, Vo=12V, Io=1A                                                           |
| Load Regulation*7                          | Vload  | —       | —     | ±3    | %    | VIN=33V, Vo=12V, Io=0 to 3A                                                            |
| Overcurrent Protection Starting Current    | Is     | 3.2     | 5.60  | 7.0   | A    | VIN=33V, Vo=12V, Drooping/Auto restore*8                                               |
| Circuit Current                            | Iin    | —       | 12    | —     | mA   | VIN=33V, Io=0A, VFB=1V                                                                 |
| MIC Thermal Protection Start Temperature*9 | Tj     | 151     | 160   | —     | °C   | VIN=16V to 40V                                                                         |
| Input Voltage Undervoltage Protection      | UVLO   | —       | 7.3   | 8.0   | V    |                                                                                        |
| Startup Delay Time                         | Tstart | —       | 50    | —     | ms   | VIN=16 to 40V. Time from VIN application to when Vo reaches constant voltage precision |

\*5: The electrical characteristics are characteristic values guaranteed when the IC is operated under the measurement conditions shown for each of the items in the table above.

\*6: The efficiency is calculated by Formula 1.

$$\eta (\%) = \frac{V_o \times I_o}{V_{IN} \times I_{in}} \times 100 \dots\dots\dots \text{Formula 1}$$

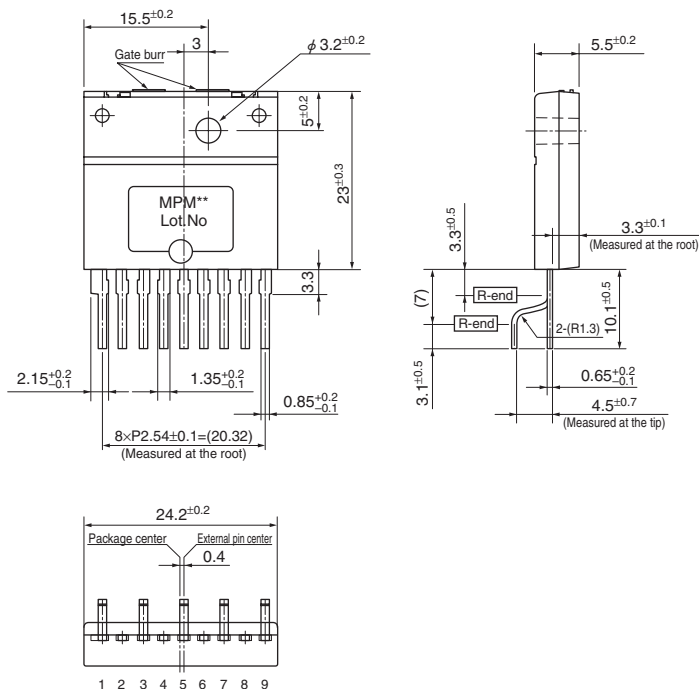
\*7: The line/load regulations do not include the setting deviation of the output voltage. The output voltage setting deviation is affected by the precision of the external RFB.

\*8: When an output voltage of other than Vo=12V is set, the OCP operation point may fluctuate compared to the point when Vo=12V because the inductance of the built-in coil is constant and the frequency is constant for the specified output voltage.

\*9: Auto restore is used for thermal protection.

## External Dimensions (ZIP9)

(Unit : mm)

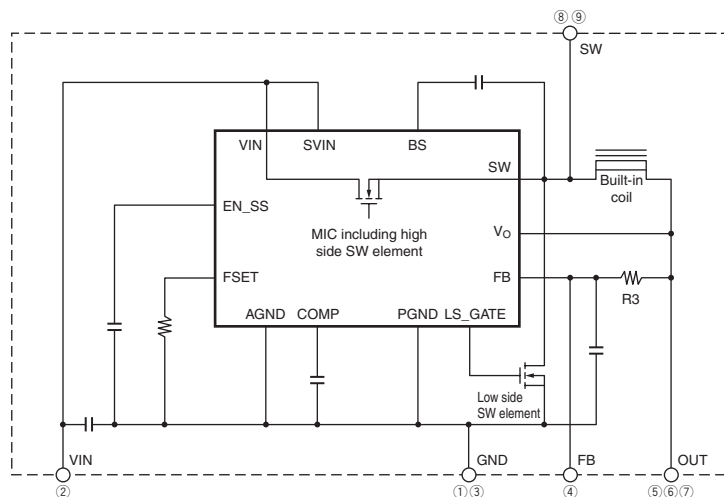


### Pin Assignment

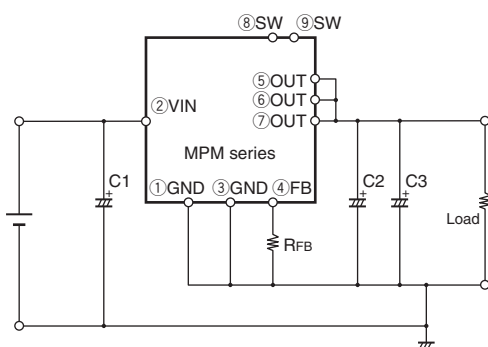
- ① GND
- ② VIN
- ③ GND
- ④ FB
- ⑤ OUT
- ⑥ OUT
- ⑦ OUT
- ⑧ SW
- ⑨ SW

Plastic Mold Package Type  
Flammability: UL94V-0  
Product Mass: Approx. 20g

## Block Diagram



## Typical Connection Diagram



Pins⑧ and ⑨ (SW pins) are detection pins for measuring the oscillation frequency. Normally, leave these pins open.

C1 : 50V/1000μF

C2, C3 : 25V/1000μF×2 in parallel

\*: For C1, C2, and C3, use capacitors specifically for switching power supplies rather than for generic electronic circuits.

R<sub>FB</sub> is a resistor for setting the output voltage.

BR200 Series 12V System, For Intermediate Bus, Output 10A Type POL Converter Module

Features

- Industry standard footprint
- Solderability improved by adopting cut through holes
- Low height: 4.2mm
- High power
- High efficiency  
BR200: 89.9%typ. (Vin=12.0V, Vo=1.5V, Io=7A)  
BR201: 93.8%typ. (Vin=12.0V, Vo=3.3V, Io=7A)  
BR204: 95.5%typ. (Vin=12.0V, Vo=5.0V, Io=7A)
- Downsizing achieved by using high frequency switching technology  
External dimensions 20.3mm×11.4mm×4.2mmH

Applications

- Communication equipment
- Servers
- Other

Lineup

| Product Name | Vo[V]        | Io[A] |
|--------------|--------------|-------|
| BR200        | 0.75 to 1.65 | 10    |
| BR201        | 1.60 to 3.63 | 10    |
| BR204        | 1.60 to 5.50 | 10    |

Environmental Conditions

|                             |             |                     |
|-----------------------------|-------------|---------------------|
| Operating Temperature Range | −40 to 85°C | With derating curve |
| Operating Humidity Range    | 20 to 85%   | Non condensing      |
| Storage Temperature Range   | −40 to 85°C |                     |
| Storage Humidity Range      | 10 to 95%   | Non condensing      |

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

| Pin | Symbol | Ratings | Unit | Remarks      |
|-----|--------|---------|------|--------------|
| 1   | ON/OFF | 7       | V    |              |
| 9   | PG     | 7       | V    |              |
|     |        | 7       | mA   | Sink current |

Electrical Characteristics

(Ta = 25°C, unless otherwise specified)

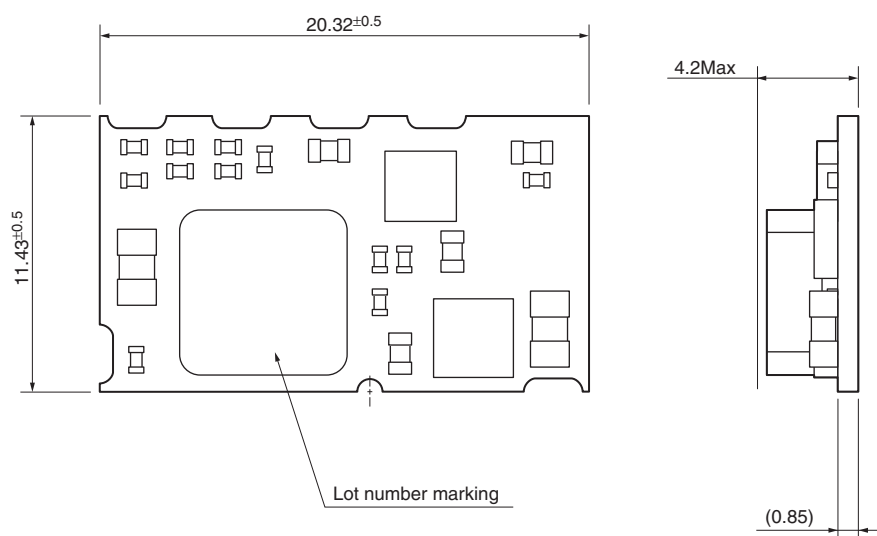
| Parameter                |       | Symbol | Ratings |      |      | Unit  | Remarks                                                                        |
|--------------------------|-------|--------|---------|------|------|-------|--------------------------------------------------------------------------------|
|                          |       |        | min.    | typ. | max. |       |                                                                                |
| Input Voltage Range      |       | Vin    | 10.8    | 12.0 | 13.2 | V     |                                                                                |
| Output Voltage           | BR200 | Vout   | 0.75    | —    | 1.65 | V     | Adjusted by Rtrim                                                              |
|                          | BR201 | Vout   | 1.60    | —    | 3.63 | V     | Adjusted by Rtrim                                                              |
|                          | BR204 | Vout   | 1.60    | —    | 5.50 | V     | Adjusted by Rtrim                                                              |
| Output Current           |       | Io     | 0       | —    | 10   | A     | With temperature derating                                                      |
| Output Voltage Precision |       | Vo tol | −2.0    | —    | 2.0  | %     | Vin=10.8 to 13.2V, 0 to Iomax, Operating temperature range, Rtrim=1% precision |
| Ripple Voltage           | BR200 | Vrip   | —       | —    | 50   | mVp-p | Vout=1.2V*1                                                                    |
|                          | BR201 |        | —       | —    | 50   |       | Vout=3.3V*2                                                                    |
|                          | BR204 |        | —       | —    | 50   |       | Vout=5.0V*2                                                                    |
| Efficiency               | BR200 | Eff    | —       | 85.5 | —    | %     | Vin=12V, Io=10A, Vo=1.5V                                                       |
|                          | BR201 | Eff    | —       | 93.2 | —    |       | Vin=12V, Io=10A, Vo=3.3V                                                       |
|                          | BR204 | Eff    | —       | 95.0 | —    |       | Vin=12V, Io=10A, Vo=5.0V                                                       |
| Oscillation Frequency    | BR200 | frq    | —       | 300  | —    | kHz   |                                                                                |
|                          | BR201 |        | —       | 600  | —    |       |                                                                                |
|                          | BR204 |        | —       | 600  | —    |       |                                                                                |
| Overcurrent Protection   |       | OCP    | —       | 24.5 | —    | A     | Hiccup                                                                         |
| Rising Time              | BR200 | Tr     |         | 1.5  |      | ms    | Vo=10 to 90%                                                                   |
|                          | BR201 |        |         | 1.0  |      |       |                                                                                |
|                          | BR204 |        |         | 0.7  |      |       |                                                                                |

\*1: BW=20MHz, Iout=0 to 10A, Cout=400μF

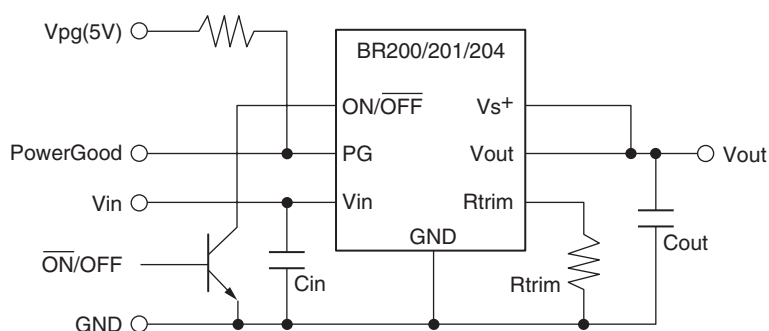
\*2: BW=20MHz, Iout=0 to 10A, Cout=100μF

## External Dimensions

(Unit : mm)

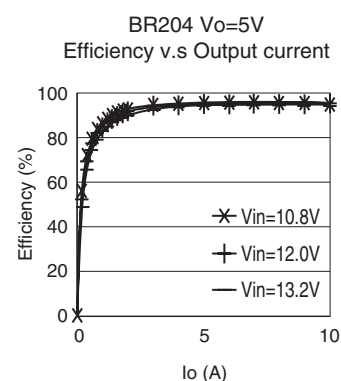
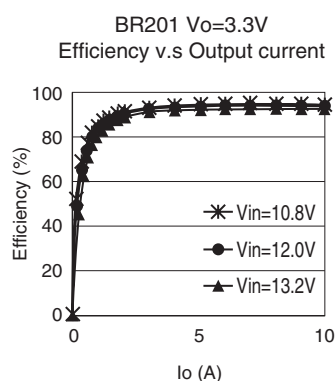
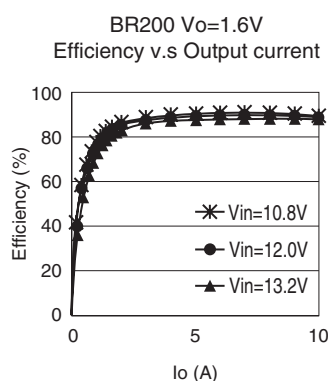


## Typical Connection Diagram



Place the input/output capacitors near the input and output pins of the DC/DC converter.

## Reference Data



BR200 Series

12V System, For Intermediate Bus, Output 20A Type POL Converter Module

Features

- Industry standard footprint
- Solderability improved by adopting cut through holes
- Low height: 4.2mm
- High power
- High efficiency  
BR202: 88.5%typ. (Vin=12.0V, Vo=1.2V, Io=11A)  
BR203: 93.4%typ. (Vin=12.0V, Vo=3.3V, Io=12A)
- Downsizing achieved by using high frequency switching technology  
External dimensions 33.02mm×13.46mm×4.2mmH

Applications

- Communication equipment
- Servers
- Other

Lineup

| Product Name | Vo[V]        | Io[A] |
|--------------|--------------|-------|
| BR202        | 0.75 to 1.65 | 20    |
| BR203        | 1.60 to 3.63 | 20    |

Environmental Conditions

|                             |             |                     |
|-----------------------------|-------------|---------------------|
| Operating Temperature Range | −40 to 85°C | With derating curve |
| Operating Humidity Range    | 20 to 85%   | Non condensing      |
| Storage Temperature Range   | −40 to 85°C |                     |
| Storage Humidity Range      | 10 to 95%   | Non condensing      |

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

| Pin | Symbol | Ratings | Unit | Remarks      |
|-----|--------|---------|------|--------------|
| 1   | ON/OFF | 7       | V    |              |
| 9   | PG     | 7       | V    |              |
|     |        | 7       | mA   | Sink current |

Electrical Characteristics

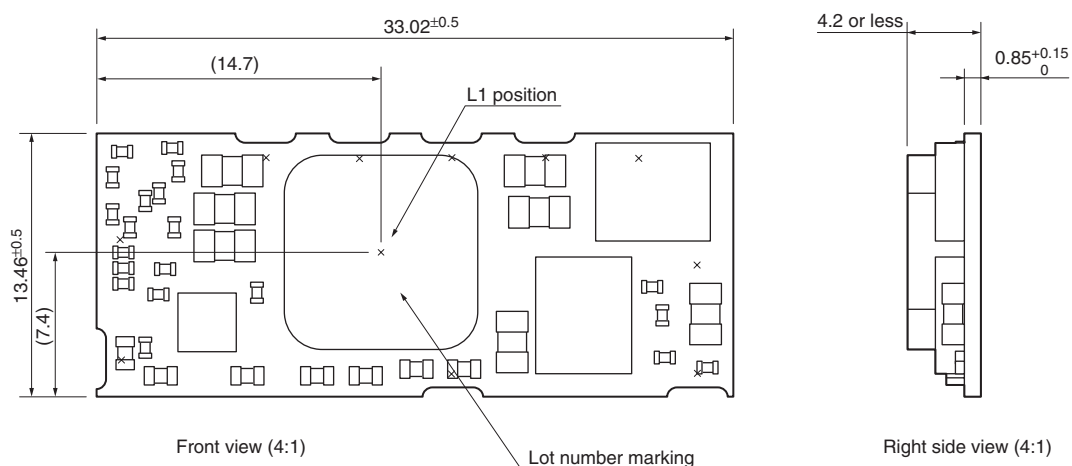
(Ta = 25°C, unless otherwise specified)

| Parameter                |       | Symbol | Ratings |      |      | Unit  | Remarks                                                                        |
|--------------------------|-------|--------|---------|------|------|-------|--------------------------------------------------------------------------------|
|                          |       |        | min.    | typ. | max. |       |                                                                                |
| Input Voltage Range      |       | Vin    | 10.8    | 12.0 | 13.2 | V     |                                                                                |
| Output Voltage           | BR202 | Vout   | 0.75    | —    | 1.65 | V     | Adjusted by Rtrim                                                              |
|                          | BR203 | Vout   | 1.60    | —    | 3.63 | V     | Adjusted by Rtrim                                                              |
| Output Current           |       | Io     | 0       | —    | 20   | A     | With temperature derating                                                      |
| Output Voltage Precision |       | Vo tol | −2.0    | —    | 2.0  | %     | Vin=10.8 to 13.2V, 0 to Iomax, Operating temperature range, Rtrim=1% precision |
| Ripple Voltage           | BR202 | Vrip   | —       | 15   | 100  | mVp-p | Vout=1.2V*1                                                                    |
|                          | BR203 |        | —       | 25   | 100  |       | Vout=3.3V*1                                                                    |
| Efficiency               | BR202 | Eff    | —       | 86.1 | —    | %     | Vin=12V, Io=20A, Vo=1.2V                                                       |
|                          | BR203 | Eff    | —       | 92.3 | —    |       | Vin=12V, Io=20A, Vo=3.3V                                                       |
| Oscillation Frequency    | BR202 | frq    | —       | 300  | —    | kHz   |                                                                                |
|                          | BR203 |        | —       | 400  | —    |       |                                                                                |
| Overcurrent Protection   |       | OCP    | —       | 30   | —    | A     | Hiccup                                                                         |
| Rising Time              | BR202 | Tr     |         | 2.0  |      | ms    | Vo=10 to 90%                                                                   |
|                          | BR203 |        |         | 1.5  |      |       |                                                                                |

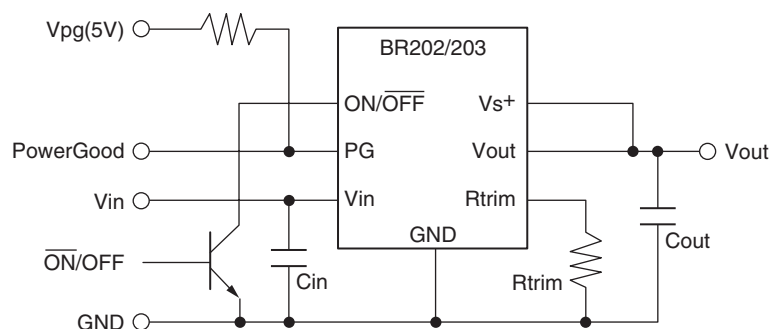
\*1: BW=20MHz, Iout=0 to 20A, Cout=400μF

## External Dimensions

(Unit : mm)

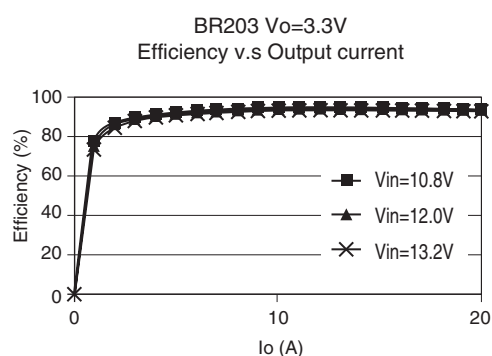
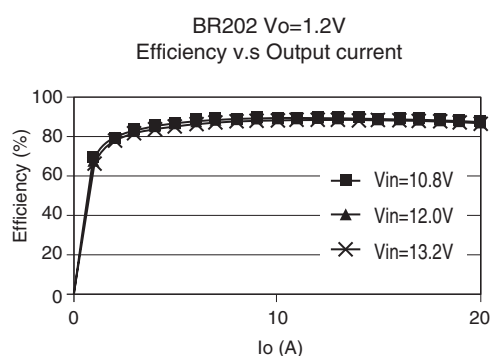


## Typical Connection Diagram



Place the input/output capacitors near the input and output pins of the DC/DC converter.

## Reference Data



BR200 Series 5V System, For Intermediate Bus, Output 10A Type POL Converter Module

Features

- Industry standard footprint
- Solderability improved by adopting cut through holes
- Low height: 4.2mm
- High power
- High efficiency  
BR205: 96.4%typ. (Vin=5.0V, Vo=3.3V, Io=5A)
- Downsizing achieved by using high frequency switching technology  
External dimensions 20.3mm×11.4mm×4.2mmH

Applications

- Communication equipment
- Servers
- Other

Lineup

| Product Name | Vo[V]        | Io[A] |
|--------------|--------------|-------|
| BR205        | 0.75 to 3.63 | 10    |

Environmental Conditions

|                             |             |                     |
|-----------------------------|-------------|---------------------|
| Operating Temperature Range | −40 to 85°C | With derating curve |
| Operating Humidity Range    | 20 to 85%   | Non condensing      |
| Storage Temperature Range   | −40 to 85°C |                     |
| Storage Humidity Range      | 10 to 95%   | Non condensing      |

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

| Pin | Symbol | Ratings | Unit | Remarks      |
|-----|--------|---------|------|--------------|
| 1   | ON/OFF | 7       | V    |              |
| 9   | PG     | 7       | V    |              |
|     |        | 7       | mA   | Sink current |

Electrical Characteristics

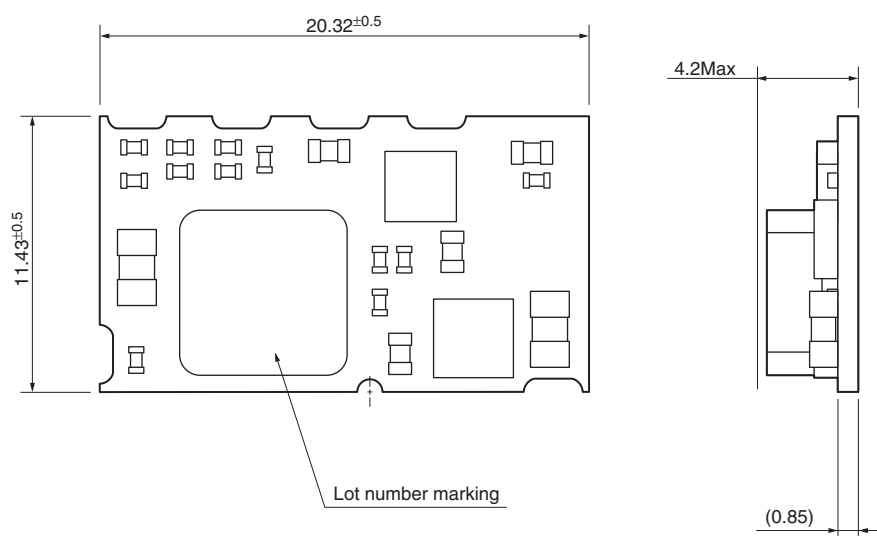
(Ta = 25°C, unless otherwise specified)

| Parameter                | Symbol | Ratings |      |      | Unit  | Remarks                                                                      |
|--------------------------|--------|---------|------|------|-------|------------------------------------------------------------------------------|
|                          |        | min.    | typ. | max. |       |                                                                              |
| Input Voltage Range      | Vin    | 4.5     | 5.0  | 7.0  | V     |                                                                              |
| Output Voltage           | Vout   | 0.75    | —    | 3.63 | V     | Adjusted by Rtrim                                                            |
| Output Current           | Io     | 0       | —    | 10   | A     | With temperature derating                                                    |
| Output Voltage Precision | Vo tol | −2.0    | —    | 2.0  | %     | Vin=4.5 to 7.0V, 0 to Iomax, Operating temperature range, Rtrim=1% precision |
| Ripple Voltage           | Vrip   | —       | —    | 50   | mVp-p | Vout=1.2V*1                                                                  |
| Efficiency               | Eff    | —       | 94.5 | —    | %     | Vin=5.0V, Io=10A, Vo=3.3V                                                    |
|                          |        | —       | 87.8 | —    |       | Vin=5.0V, Io=10A, Vo=1.5V                                                    |
| Oscillation Frequency    | frq    | —       | 600  | —    | kHz   |                                                                              |
| Overcurrent Protection   | OCP    | —       | 24.5 | —    | A     | Hiccup                                                                       |
| Rising Time              | Tr     |         | 0.5  |      | ms    | Vo=10 to 90%                                                                 |

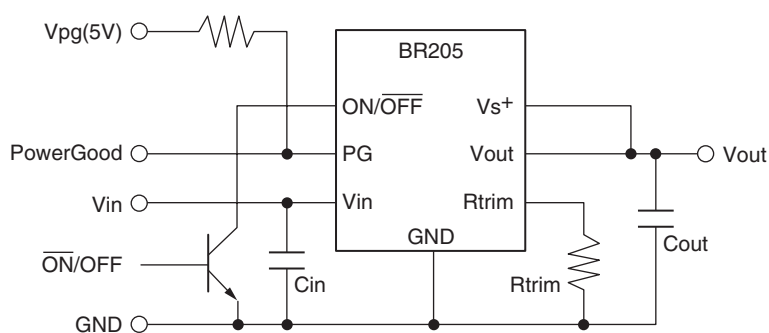
\*1: BW=20MHz, Iout=0 to 10A, Cout=400μF

## External Dimensions

(Unit : mm)

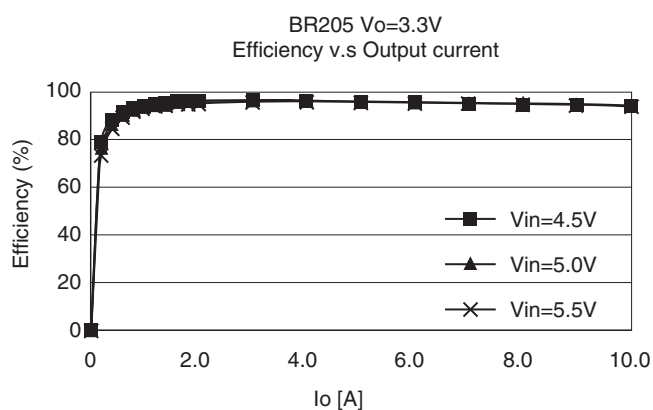


## Typical Connection Diagram



Place the input/output capacitors near the input and output pins of the DC/DC converter.

## Reference Data



BR200 Series

5V System, For Intermediate Bus, Output 20A Type POL Converter Module

Features

- Industry standard footprint
- Solderability improved by adopting cut through holes
- Low height: 4.2mm
- High power
- High efficiency  
BR206: 95.2%typ. (Vin=5.0V, Vo=3.3V, Io=14A)
- Downsizing achieved by using high frequency switching technology  
External dimensions 30.02mm×13.46mm×4.2mmH

Applications

- Communication equipment
- Servers
- Other

Lineup

| Product Name | Vo[V]        | Io[A] |
|--------------|--------------|-------|
| BR206        | 0.75 to 3.63 | 20    |

Environmental Conditions

|                             |             |                     |
|-----------------------------|-------------|---------------------|
| Operating Temperature Range | −40 to 85°C | With derating curve |
| Operating Humidity Range    | 20 to 85%   | Non condensing      |
| Storage Temperature Range   | −40 to 85°C |                     |
| Storage Humidity Range      | 10 to 95%   | Non condensing      |

Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

| Pin | Symbol | Ratings | Unit | Remarks      |
|-----|--------|---------|------|--------------|
| 1   | ON/OFF | 7       | V    |              |
| 9   | PG     | 7       | V    |              |
|     |        | 7       | mA   | Sink current |

Electrical Characteristics

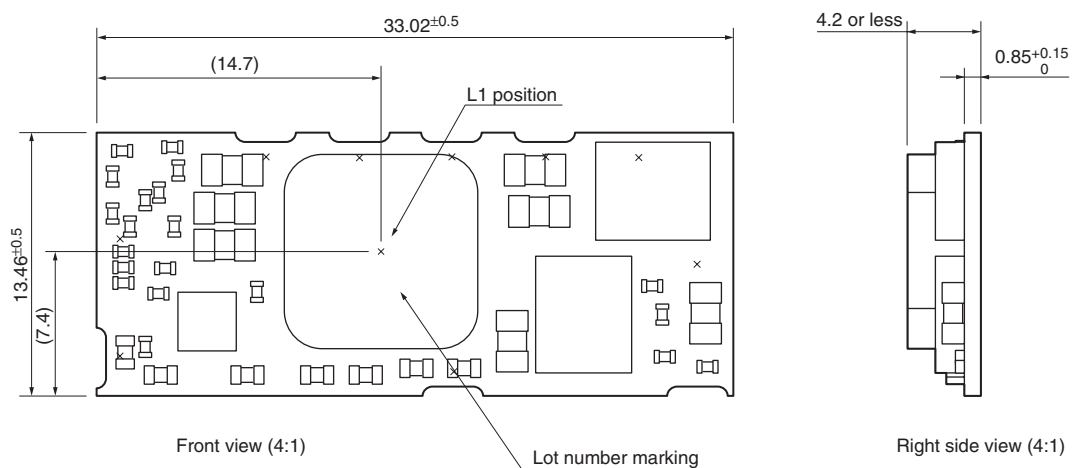
(Ta = 25°C, unless otherwise specified)

| Parameter                | Symbol | Ratings |      |      | Unit  | Remarks                                                                                       |
|--------------------------|--------|---------|------|------|-------|-----------------------------------------------------------------------------------------------|
|                          |        | min.    | typ. | max. |       |                                                                                               |
| Input Voltage Range      | Vin    | 4.5     | 5.0  | 7.0  | V     |                                                                                               |
| Output Voltage           | Vout   | 0.75    | —    | 3.63 | V     | Adjusted by Rtrim                                                                             |
| Output Current           | Io     | 0       | —    | 20   | A     | With temperature derating                                                                     |
| Output Voltage Precision | Vo tol | −2.0    | —    | 2.0  | %     | Vin=4.5 to 7.0V, 0 to Iomax, Operating temperature range, Rtrim=1% precision, Vo=1.5V or less |
| Ripple Voltage           | Vrip   | —       | —    | 50   | mVp-p | Vout=1.2V*1                                                                                   |
| Efficiency               | Eff    | —       | 93.7 | —    | %     | Vin=5.0V, Io=20A, Vo=3.3V                                                                     |
|                          |        | —       | 85.9 | —    |       | Vin=5.0V, Io=20A, Vo=1.2V                                                                     |
| Oscillation Frequency    | frq    | —       | 400  | —    | kHz   |                                                                                               |
| Overcurrent Protection   | OCP    | —       | 30   | —    | A     | Hiccup                                                                                        |
| Rising Time              | Tr     | —       | 2.0  | —    | ms    | Vo=10 to 90%                                                                                  |

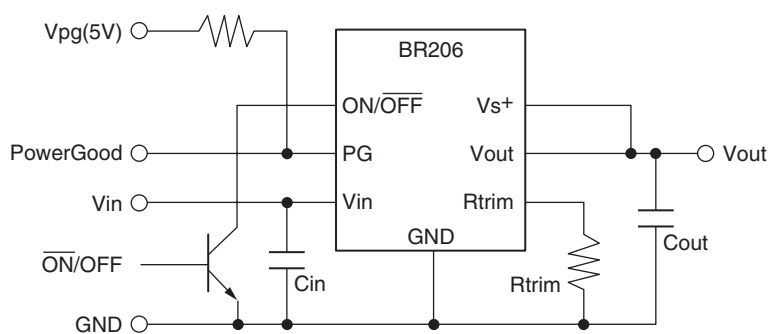
\*1: BW=20MHz, Iout=0 to 20A, Cout=400μF

## External Dimensions

(Unit : mm)

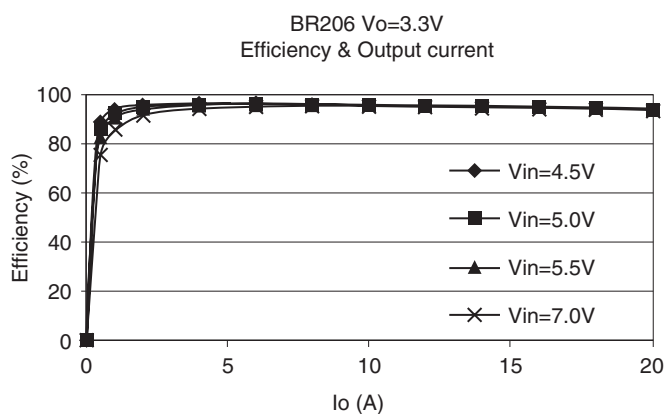


## Typical Connection Diagram



Place the input/output capacitors near the input and output pins of the DC/DC converter.

## Reference Data



BR300 Series

5V/3.3V 1A Non-Isolated Step-down DC/DC Converter Module

Features

- Output 5V 1A 5W / 3.3V 1A 3.3W
- External dimensions 14mm×14mm×10mm (W×D×H)
- Weight 1.6g
- All-in-one
- Free design
- High efficiency  
BR300: 91%typ. (Vin=8V, Io=0.6A)  
BR301: 87%typ. (Vin=8V, Io=0.6A)
- Downsizing achieved by using high frequency switching technology
- Protection functions  
Overcurrent Protection  
Thermal protection

Applications

- FA equipment
- Communication equipment
- Consumer equipment
- Other

Recommended Operating Conditions

(Ta = 25°C, unless otherwise specified)

| Parameter            | Pin | Symbol | Ratings |      | Unit | Remarks |
|----------------------|-----|--------|---------|------|------|---------|
|                      |     |        | min.    | max. |      |         |
| Input Voltage Range  | 4-2 | VIN    | 8       | 30   | V    |         |
| Output Current Range | 1-2 | Io     | 0       | 1    | A    |         |

Electrical Characteristics

(Ta = 25°C, unless otherwise specified)

| Parameter                     | Pin | Symbol              | Ratings |      |      |       |      |      | Unit              | Remarks                                  |
|-------------------------------|-----|---------------------|---------|------|------|-------|------|------|-------------------|------------------------------------------|
|                               |     |                     | BR300   |      |      | BR301 |      |      |                   |                                          |
|                               |     |                     | min.    | typ. | max. | min.  | typ. | max. |                   |                                          |
| Input Current                 | 4-2 | I <sub>IN</sub>     | —       | 0.24 | —    | —     | 0.17 | —    | A                 | V <sub>IN</sub> =24V, I <sub>O</sub> =1A |
| Standby Power                 | 4-2 | P <sub>STB</sub>    | —       | 0.16 | —    | —     | 0.13 | —    | W                 | V <sub>IN</sub> =24V, I <sub>O</sub> =0A |
| Output Voltage                | 1-2 | V <sub>O</sub>      | —       | 5.0  | —    | —     | 3.3  | —    | V                 |                                          |
| Constant Voltage Precision    | 1-2 | V <sub>ACC</sub>    | −3      | —    | 3    | −3    | —    | 3    | %                 |                                          |
| Output Current                | 1-2 | I <sub>O</sub>      | 0       | —    | 1    | 0     | —    | 1    | A                 |                                          |
| Maximum Output Power          | 1-2 | P <sub>O(MAX)</sub> | —       | —    | 5    | —     | —    | 3.3  | W                 |                                          |
| Output Ripple                 | 1-2 | V <sub>RIP</sub>    | —       | 50   | —    | —     | 50   | —    | mV <sub>P-P</sub> | V <sub>IN</sub> =24V, I <sub>O</sub> =1A |
| Output Noise                  | 1-2 | V <sub>NOISE</sub>  | —       | 50   | —    | —     | 50   | —    | mV <sub>P-P</sub> | V <sub>IN</sub> =24V, I <sub>O</sub> =1A |
| Output Overcurrent Protection | 1-2 | I <sub>OCP</sub>    | 1.1     | —    | —    | 1.1   | —    | —    | A                 |                                          |

Lineup

| Product Name | Vo[V] | Io[A] |
|--------------|-------|-------|
| BR300        | 5.0   | 1.0   |
| BR301        | 3.3   | 1.0   |

Environmental Conditions

|                             |             |                     |
|-----------------------------|-------------|---------------------|
| Operating Temperature Range | −20 to 85°C | With derating curve |
| Operating Humidity Range    | 10 to 90%   | Non condensing      |
| Storage Temperature Range   | −25 to 85°C |                     |
| Storage Humidity Range      | 5 to 95%    | Non condensing      |

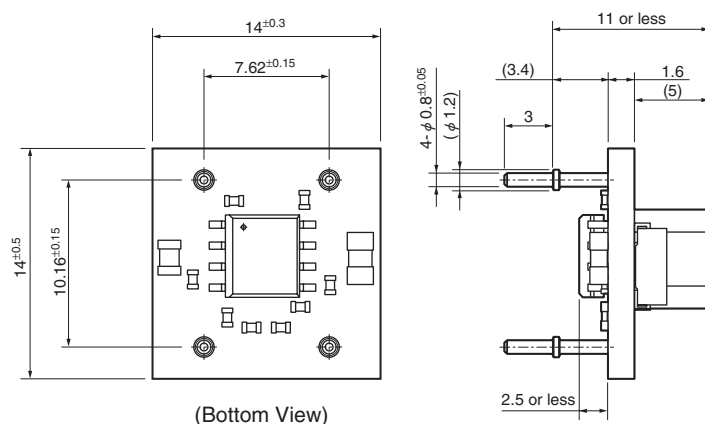
Absolute Maximum Ratings

(Ta = 25°C, unless otherwise specified)

| Parameter     | Pin | Symbol | Ratings     | Unit | Remarks |
|---------------|-----|--------|-------------|------|---------|
| Input Voltage | 4-2 | VIN    | −0.3 to +35 | V    |         |

## External Dimensions

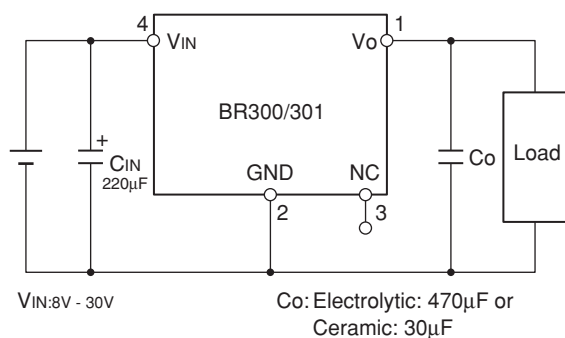
(Unit : mm)



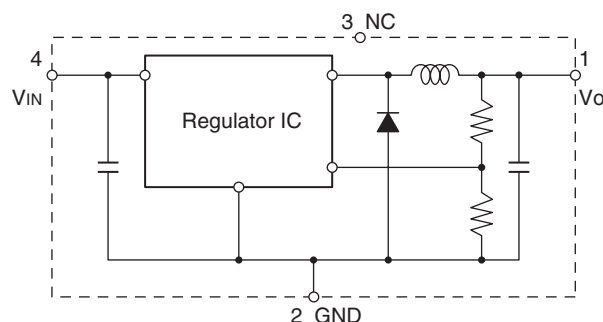
### NOTES:

- 1) Unit: mm
- 2) Tolerance is 0.3mm unless otherwise specified.
- 3) Dimensions in parentheses are reference dimensions.
- 4) Pb-free device (RoHS compliant).

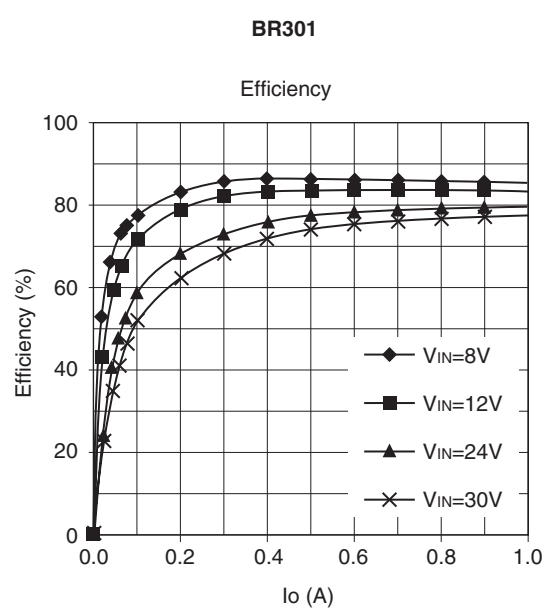
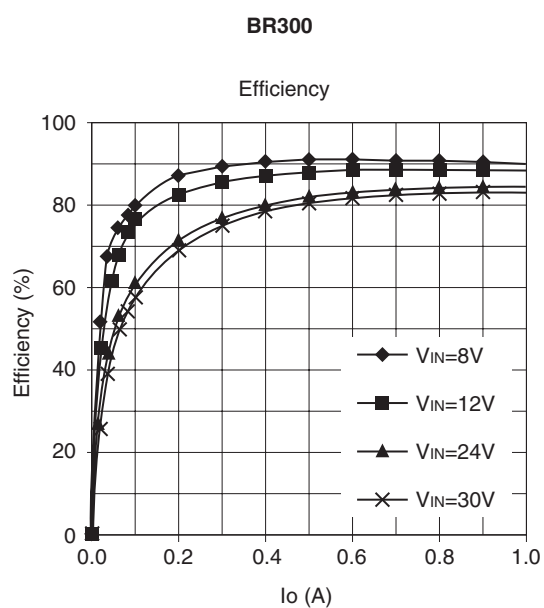
## Typical Connection Diagram



## Block Diagram



## Reference Data



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| EL1Z     | Diode              | Ultrafast Recovery Diode (Axial) | 210  |
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| EM01Z    | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1      | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1A     | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1B     | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1C     | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1Y     | Diode              | Rectifier Diode (Axial)          | 207  |
| EM1Z     | Diode              | Rectifier Diode (Axial)          | 207  |
| EM2      | Diode              | Rectifier Diode (Axial)          | 207  |
| EM2A     | Diode              | Rectifier Diode (Axial)          | 207  |
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| EP01C     | Diode      | Ultrafast Recovery Diode (Axial) | 212  |
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| ES01F     | Diode      | Fast Recovery Diode (Axial)      | 209  |
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| ES1F      | Diode      | Fast Recovery Diode (Axial)      | 209  |
| ES1Z      | Diode      | Fast Recovery Diode (Axial)      | 208  |
| EU01      | Diode      | Fast Recovery Diode (Axial)      | 208  |
| EU01Z     | Diode      | Fast Recovery Diode (Axial)      | 208  |
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| FKH0470   | Transistor | MOS FET                          | 168  |
| FKH0660   | Transistor | MOS FET                          | 168  |
| FKH1040   | Transistor | MOS FET                          | 168  |
| FKP202    | Transistor | MOS FET                          | 168  |
| FKP250A   | Transistor | MOS FET                          | 168  |
| FKP252    | Transistor | MOS FET                          | 168  |
| FKP253    | Transistor | MOS FET                          | 168  |
| FKP280A   | Transistor | MOS FET                          | 168  |
| FKP300A   | Transistor | MOS FET                          | 168  |
| FKP330C   | Transistor | MOS FET                          | 168  |
| FKV460S   | Transistor | MOS FET                          | 168  |
| FKV550N   | Transistor | MOS FET                          | 168  |
| FKV575    | Transistor | MOS FET                          | 168  |
| FKV660S   | Transistor | MOS FET                          | 168  |
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| FMB-24    | Diode      | Schottky Barrier Diode (Frame)   | 213  |
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| FMB-24M   | Diode      | Schottky Barrier Diode (Frame)   | 213  |
| FMB-26    | Diode      | Schottky Barrier Diode (Frame)   | 214  |
| FMB-29    | Diode      | Schottky Barrier Diode (Frame)   | 214  |
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| FMB-G19L  | Diode      | Schottky Barrier Diode (F2pin)   | 214  |
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| FMD-4204S | Diode      | Ultrafast Recovery Diode (Frame) | 211  |
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| FMXA-4202S  | Diode    | Ultrafast Recovery Diode (Frame) | 210  |
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| FMX-G12S    | Diode    | Ultrafast Recovery Diode (F2Pin) | 210  |
| FMX-G14S    | Diode    | Ultrafast Recovery Diode (F2Pin) | 211  |
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| FMY-2206S   | Diode    | Fast Recovery Diode (Frame)      | 208  |
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| MGD623S    | Transistor         | IGBT                                     | 172  |
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| RU4Z        | Diode    | Fast Recovery Diode (Axial)          | 208  |
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| SCM1243MF   | IC       | High Voltage 3 Phase Motor Driver IC | 130  |
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| SI-8008TM  | IC       | DC/DC Converter IC (Surface Mount)       | 18   |
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| SI-8015JF  | IC       | DC/DC Converter IC                       | 40   |
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| STR-W6756N  | IC       | AC/DC Converter IC | 8    |
| STR-W6765   | IC       | AC/DC Converter IC | 8    |
| STR-W6765N  | IC       | AC/DC Converter IC | 8    |
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## **Sanken Electric Co., Ltd.**

### **Overseas Sales Headquarters**

Metropolitan Plaza Building, 1-11-1 Nishi-Ikebukuro

Toshima-ku, Tokyo 171-0021, Japan

Tel: 81-3-3986-6164

Fax: 81-3-3986-8637

## **WORLDWIDE SALES OFFICES**

### **Asia-Pacific**

#### ● **China**

##### **Sanken Electric Hong Kong Co., Ltd.**

Suite 1026 Ocean Centre, Canton Road

Tsimshatsui, Kowloon, Hong Kong

Tel: 852-2735-5262

Fax: 852-2735-5494

##### **Sanken Electric (Shanghai) Co., Ltd.**

Room 3202, Maxdo Centre, Xingyi Road 8

Changning District, Shanghai, China

Tel: 86-21-5208-1177

Fax: 86-21-5208-1757

##### **Sanken Electric (Shanghai) Co., Ltd. Shenzhen Office**

Room 1013, Xinhua Insurance Building, Mintian Road, Futian District,

Shenzhen City, Guangdong, China

Tel: 86-755-8283-6685

Fax: 86-755-8826-3053

##### **Taiwan Sanken Electric Co., Ltd.**

Room 1801, 18th Floor, 88 Jung Shiao East Road

Sec. 2, Taipei 100, Taiwan R.O.C.

Tel: 886-2-2356-8161

Fax: 886-2-2356-8261

#### ● **Korea**

##### **Sanken Electric Korea Co., Ltd.**

(Yeouido B/D 16F)24, Gukjegeumyung-ro 2-gil,

Yeongdeungpo-gu, Seoul 150-734, Korea

Tel: 82-2-714-3700

Fax: 82-2-3272-2145

#### ● **Singapore**

##### **Sanken Electric Singapore Pte. Ltd.**

152 Beach Road, #10-06 The Gateway East,

Singapore 189721

Tel: 65-6291-4755

Fax: 65-6297-1744

#### ● **Malaysia**

##### **Sanken Electric (Malaysia) Sdn. Bhd.**

Block B-20-5, Level 20, Northpoint Midvalley City,

No.1, Medan Syed Putra Utara, 59200 Kuala Lumpur, Malaysia

Tel: 60-3-2282-2345

Fax: 60-3-2282-6345

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Pencoed Technology Park

Pencoed, Bridgend CF35 5HY, United Kingdom

Tel: 44-1656-869-100

Fax: 44-1656-869-162

### **North America**

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##### **Allegro MicroSystems, Inc.**

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Worcester, Massachusetts 01606, U.S.A.

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