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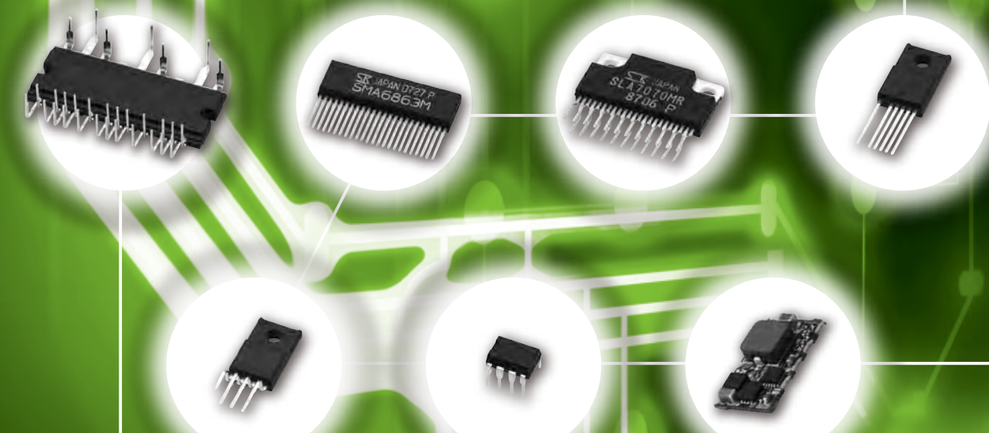
O03EH0
(Mar, 2013)

SEMICONDUCTORS GENERAL CATALOG

ICs
Transistors
Thyristors
Diodes
DC/DC Power Modules



SEMICONDUCTORS GENERAL CATALOG 2013

SANKEN ELECTRIC CO., LTD.

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

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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
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: 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/ 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 (SLA24Pin)	LF.No.2171: 648, LF.No.2175: 540	–
SLA7022MU/ 7029M	ZIP15 with Fin (SLA15Pin)	1080	–
SLA7024M/ 7026M/7027MU	ZIP18 with Fin (SLA18Pin)	1080	–
SLA707xMR/MPR /MPRT	ZIP23 with Fin (SLA23Pin)	1080	–
SLA708xMPR	ZIP23 with Fin (SLA23Pin)	1080	–
SMA682xMH/ 686xMZ	SIP24 (SMA24Pin)	LF.No.2451: 1080, LF.No.2452: 1008	–
SMA7022MU/ 7029M	ZIP15 (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/ Product Name	Package	Standard Packing Quantities	
		Bulk	Taping
SX68000MH	SOP27(Surface-mount)	–	LF1890: 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	15μs	SOP8
	SSC2102S	20.7μs	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_{DSS} (MIN)	$R_{DS(ON)}$ (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_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)	
STR-A6051M	67kHz	650V	3.95Ω	DIP8
STR-A6052M			2.8Ω	
STR-A6053M			1.9Ω	
STR-A6079M		800V	19.2Ω	
STR-A6059H	100kHz	650V	6Ω	
STR-A6061H		700V	3.95Ω	
STR-A6062H			2.8Ω	
STR-A6069H			6Ω	
STR-A6061HD*	100kHz	700V	3.95Ω	
STR-A6062HD*			2.8Ω	
STR-A6063HD*			2.3Ω	
STR-A6069HD*			6Ω	

- 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_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)	
STR-V653	67kHz	650V	1.9Ω	SIP8

<STR2W100D Series>

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

Part Number	Oscillation Frequency	MOSFET		Package
		V_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)	
STR2W152D	67kHz	650V	3.0Ω	TO220F-6
STR2W153D			1.9Ω	

<STR-W6000S Series>
- Low noise, low standby power (Input power P_{IN}<30mW at no load)
- Brown-in and brown-out functions

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

<STR-W6200D Series>
- Low noise, low standby power (Input power P_{IN}<40mW at no load)
- External latch protection (ELP) function

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

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

<STR-A6100 Series>
- For small power applications
- Low noise, low standby power

Part Number	Fixed off-time period	MOSFET		Auto standby function	Package
		V_{DSS} (MIN)	$R_{DS(ON)}$ (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		

<STR-V100 Series>
- 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_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)	
STR-V152	8μs	650V	2.8Ω	SIP8
STR-V153	11.5μs		2Ω	

●Quasi-resonant type

<STR-Y6700 Series>
- High efficiency in full load range
- Low noise, low standby power

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

<STR-Y6400 Series>
- High efficiency in full load range
- Low noise, low standby power
- Mode change delay time adjustable

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

<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_{DSS} (MIN)	$R_{DS(ON)}$ (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_{DSS} (MIN)	$R_{DS(ON)}$ (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_{DSS} (MIN)	$R_{DS(ON)}$ (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			
STR-W6750F	650V	0.73Ω	Yes	No	
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_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)			
STR-X6737	500V	0.36Ω	Yes	Yes	TO3PF-7
STR-X6756	650V	0.73Ω			
STR-X6757		0.62Ω			
STR-X6769	800V	0.66Ω			
STR-X6750B	650V	0.62Ω	No	No	
STR-X6759B		0.385Ω			
STR-X6769B	800V	0.66Ω			
STR-X6750F	650V	0.62Ω	Yes	No	
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	Output Voltage (V)				Variable (Reference Voltage) (V)			Maximum Input Voltage	Oscillation Frequency	Package	Remarks	Page
	(A)	3.3	5.0	9.0	12	0.5	0.8	1.0	(V)	(kHz)			
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*1	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	Output Voltage (V)					Variable (Reference Voltage) (V)				Maximum Input Voltage	Oscillation Frequency	Package	Remarks	Page
	(A)	3.3	5.0	9.0	12	15	0.5	0.8	1.0	1.5	(V)	(kHz)			
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*2	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 (A)	Output Voltage (V)	Maximum Input Voltage (V)	Oscillation Frequency (kHz)	Package	Remarks	Page
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) (V)	Maximum Input Voltage (V)	Oscillation Frequency (kHz)	Package	Remarks	Page
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:

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

- For the device with external flywheel diode:

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

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
SI-8000JF
SI-8000S
SI-8000TFE
SI-8000HFE
SI-8000FFE
SI-8000Y

0.588 to 0.686[N•m] (6.0 to 7.0[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.

■ 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=10A)
SI-8000HFE	
SI-8000Y	
SI-8400L	AM01Z (Axial Type,V_{RM}=200V,I_O=1.0A)
SI-8000E	
SI-8500L	
SI-8000JF	
SI-8000TFE	
SI-8000GL	
NR887D	RM10Z (Axial Type,V_{RM}=200V,I_O=1.5A)
SI-8000S	
NR110K	RM4Z (Axial Type,V_{RM}=200V,I_O=3.0A)
NR111E	
SI-8100QL	
SI-8000FFE	
STA801M	AM01Z (Axial Type,V_{RM}=200V,I_O=1.0A)
SPI-8000TW	SJPM-H4 (Surface-Mount Stand-Alone Type, V_{RM}=400V,I_O=2.0A)

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_O(V)	5.0	3.3	12.0
I_O(A)	0.5		0.4

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	35	V
Power Dissipation	P_D	0.75	W
Junction Temperature	T_j	+125	°C
Storage Temperature	T_{stg}	–40 to +125	°C
Thermal Resistance(junction to case)	$\theta_{j\text{-}c}$	20	°C/W

■Recommended Operating Conditions

Parameter	Symbol	Ratings			Unit
		SAI01	SAI02	SAI03	
DC Input Voltage Range	V_{IN}	7 to 33	5.3 to 28	15 to 33	V
Output Current Range	I_O	0 to 0.5		0 to 0.4	A
Operating Junction Temperature Range	T_{jop}	–30 to +125			°C

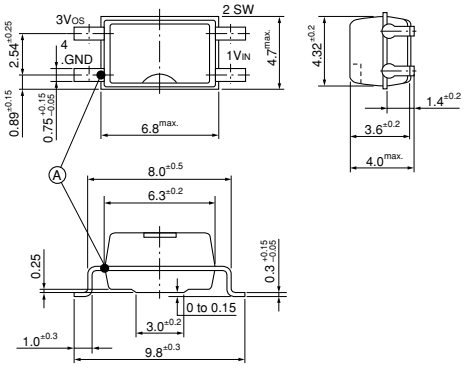
■Electrical Characteristics

(T_a=25°C)

Parameter	Symbol	Ratings									Unit
		SAI01			SAI02			SAI03			
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	
Output Voltage	V_O	4.80	5.00	5.20	3.17	3.30	3.43	11.40	12.00	12.60	V
	Conditions	V_{IN}=20V, I_O=0.3A			V_{IN}=15V, I_O=0.3A			V_{IN}=24V, I_O=0.3A			
Efficiency	η		80			75			88		%
	Conditions	V_{IN}=20V, I_O=0.3A			V_{IN}=15V, I_O=0.3A			V_{IN}=24V, I_O=0.3A			
Oscillation Frequency	f		60			60			60		kHz
	Conditions	V_{IN}=20V, I_O=0.3A			V_{IN}=15V, I_O=0.3A			V_{IN}=24V, I_O=0.3A			
Line Regulation	ΔV_{OLINE}		80	100		60	80		100	130	mV
	Conditions	V_{IN}=10 to 30V, I_O=0.3A			V_{IN}=8 to 28V, I_O=0.3A			V_{IN}=18 to 30V, I_O=0.3A			
Load Regulation	ΔV_{OLOAD}		30	40		20	30		70	95	mV
	Conditions	V_{IN}=20V, I_O=0.1 to 0.4A			V_{IN}=15V, I_O=0.1 to 0.4A			V_{IN}=24V, I_O=0.1 to 0.4A			
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±0.5			±0.5			±1.5		mV/°C
Ripple Rejection	R_{REJ}		45			45			45		dB
	Conditions	f=100 to 120Hz			f=100 to 120Hz			f=100 to 120Hz			
Overcurrent Protection Starting Current	I_{S1}	0.55			0.55			0.45			A
	Conditions	V_{IN}=10V			V_{IN}=8V			V_{IN}=18V			

■External Dimensions (PS4)

(Unit : mm)

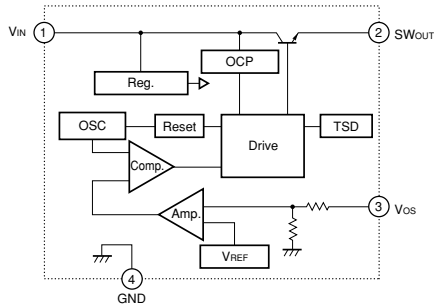


Ⓐ Case Temperature Measuring Point

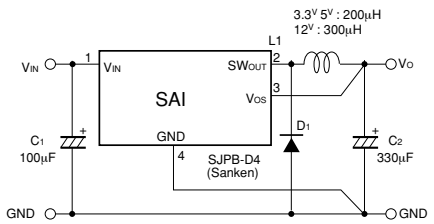
Pin Assignment
① VIN
② SWOUT
③ VOS
④ GND

Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 0.22g

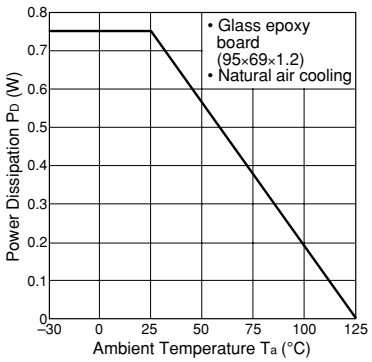
■Block Diagram



■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
IO : Output current
ηχ : Efficiency (%)
VF : Diode D1 forward voltage
SJPB-D4-0.3V

Thermal design for D1 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_{IN}	35	V
Power Dissipation	P_D	1	W
Junction Temperature	T_j	–30 to +125	°C
Storage Temperature	T_{stg}	–40 to +125	°C
Thermal Resistance (Junction to 7-Pin Lead)	$\theta_{j\text{-}L}$	22	°C/W
Thermal Resistance (Junction to Ambient Air)*1	$\theta_{j\text{-}a}$	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_{IN}	5.3 to 28	7 to 33	V
Output Current Range	I_O	0 to 0.6		A
Operating Junction Temperature Range	T_{jop}	–30 to +125		°C

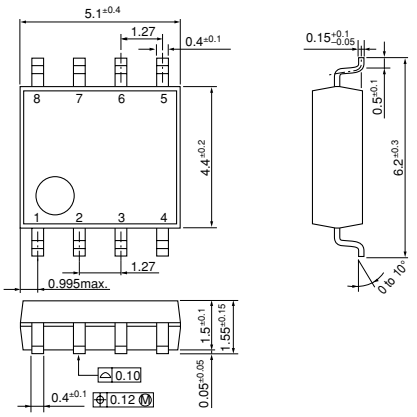
■Electrical Characteristics

(T_a=25°C)

Parameter	Symbol	Ratings						Unit
		SI-8033W			SI-8050W			
		min.	typ.	max.	min.	typ.	max.	
Output Voltage	V_O	3.17	3.30	3.43	4.80	5.00	5.20	V
	Conditions	V_{IN}=15V, I_O=0.3A			V_{IN}=20V, I_O=0.3A			
Efficiency	η		75			80		%
	Conditions	V_{IN}=15V, I_O=0.3A			V_{IN}=20V, I_O=0.3A			
Oscillation Frequency	f		60			60		kHz
	Conditions	V_{IN}=15V, I_O=0.3A			V_{IN}=20V, I_O=0.3A			
Line Regulation	ΔV_{OLINE}		60	80		80	100	mV
	Conditions	V_{IN}=8 to 28V, I_O=0.3A			V_{IN}=10 to 30V, I_O=0.3A			
Load Regulation	ΔV_{OLOAD}		20	30		30	40	mV
	Conditions	V_{IN}=15V, I_O=0.1 to 0.4A			V_{IN}=20V, I_O=0.1 to 0.4A			
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±0.5			±0.5		mV/°C
Ripple Rejection	R_{REJ}		45			45		dB
	Conditions	f=100 to 120Hz			f=100 to 120Hz			
Overcurrent Protection Starting Current	I_{S1}	0.61			0.61			A
	Conditions	V_{IN}=15V			V_{IN}=20V			

■External Dimensions (SOP8)

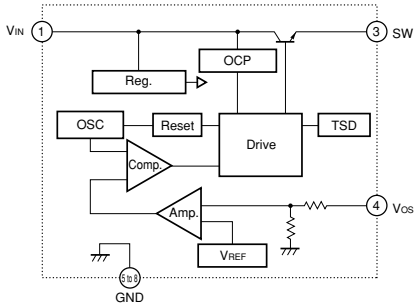
(Unit : mm)



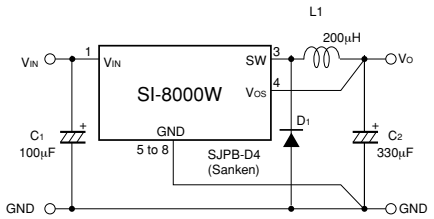
Pin Assignment
① V_{IN}
② N.C
③ SW
④ V_{OS}
⑤ GND
⑥ GND
⑦ GND
⑧ GND

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

■Block Diagram

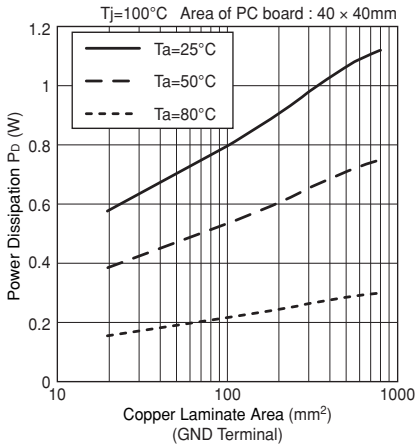


■Typical Connection Diagram

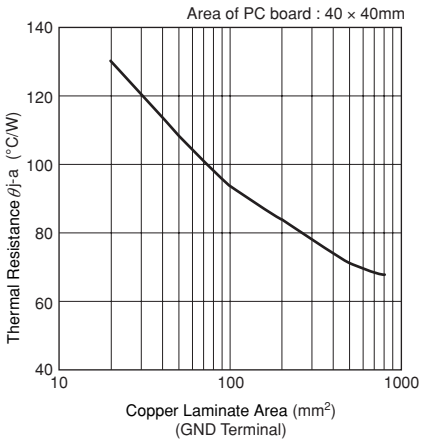


■Reference Data

Copper Laminate Area vs. Power Dissipation



Copper Laminate Area vs. Thermal Resistance $\theta_{j\text{-}a}$



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: 200μA max)
- Soft start available by ON/OFF pin Conditions

■Lineup

Part Number	SI-8033JD	SI-8050JD	SI-8090JD	SI-8120JD
V_O(V)	3.3	5.0	9.0	12.0
I_O(A)	1.5			

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
DC Input Voltage	V_{IN}	43	V	
Output Current	I_O	1.5	A	
Power Dissipation*	P_D	3	W	When mounted on glass-epoxy board 40 × 40 mm (copper area 100%)
Junction Temperature	T_j	+125	°C	
Storage Temperature	T_{stg}	–40 to +125	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	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_{IN1}	5.3 to 40	7 to 40	11 to 40	14 to 40	V	I_O=0 to 1A
	V_{IN2}	6.3 to 40	8 to 40	12 to 40	15 to 40		I_O=0 to 1.5A
DC Output Current Range*	I_O	0 to 1.5				A	V_{IN}≥V_O+3V
Operating Junction Temperature Range	T_{jop}	–30 to +125				°C	
Operating Temperature Range*	T_{op}	–30 to +125				°C	

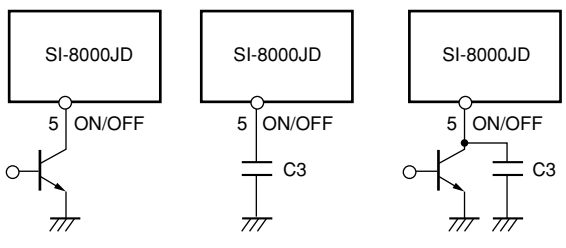
*: Limited by Ta–P_D characteristics

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol	SI-8033JD			SI-8050JD			SI-8090JD			SI-8120JD			Unit
			min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	
Output Voltage		V_O	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_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=21V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Efficiency		η		77			82			86			88		%
		Conditions	V_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=21V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Oscillation Frequency		f		125			125			125			125		kHz
		Conditions	V_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=21V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Line Regulation		ΔV_{OLINE}		25	80		40	100		50	120		60	130	mV
		Conditions	V_{IN}=8 to 30V, I_O=0.5A			V_{IN}=10 to 30V, I_O=0.5A			V_{IN}=15 to 30V, I_O=0.5A			V_{IN}=18 to 30V, I_O=0.5A			
Load Regulation		ΔV_{OLOAD}		10	30		10	40		10	40		10	40	mV
		Conditions	V_{IN}=15V, I_O=0.2 to 0.8A			V_{IN}=20V, I_O=0.2 to 0.8A			V_{IN}=21V, I_O=0.2 to 0.8A			V_{IN}=24V, I_O=0.2 to 0.8A			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.5			±0.5			±1.0			±1.0		mV/°C
Overcurrent Protection Starting Current		I_{S1}	1.6			1.6			1.6			1.6			A
		Conditions	V_{IN}=15V			V_{IN}=20V			V_{IN}=21V			V_{IN}=24V			
ON/OFF* Pin	Low Level Voltage	V_{SSL}			0.5			0.5			0.5			0.5	V
	Outflow Current at Low Voltage	I_{SSL}			100			100			100			100	μA
		Conditions	V_{SSL}=0V												
Quiescent Circuit Current		I_q		7			7			7			7		mA
		Conditions	V_{IN}=15V, I_O=0A			V_{IN}=20V, I_O=0A			V_{IN}=21V, I_O=0A			V_{IN}=24V, I_O=0A			
		$I_{q(OFF)}$			200			200			200			200	μA
		Conditions	V_{IN}=15V, $V_{ON/OFF}$=0.3V			V_{IN}=20V, $V_{ON/OFF}$=0.3V			V_{IN}=21V, $V_{ON/OFF}$=0.3V			V_{IN}=24V, $V_{ON/OFF}$=0.3V			

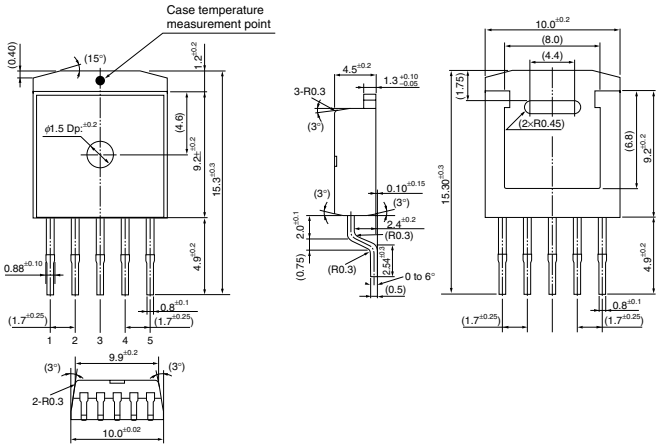
*: Pin 5 is the ON/OFF pin. Soft start at power on can be performed with a capacitor connected to this pin.
The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to V_{SSL} or lower.
ON/OFF-pin voltage can be changed with an open-collector drive circuit of a transistor.
When using both the soft-start and ON/OFF functions together, the discharge current from C_3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C_3 capacitance is large.
The ON/OFF pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



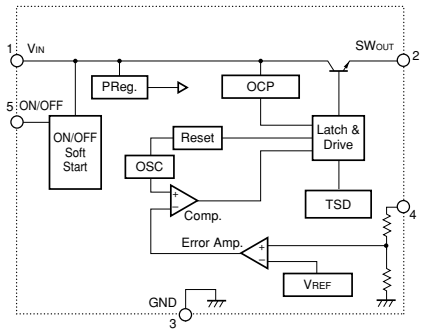
$V_{OUT.}$ ON/OFF | Soft Start | Soft Start +$V_{OUT.}$ ON/OFF

■External Dimensions (TO263-5)

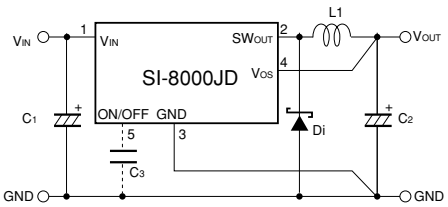
(Unit : mm)



■Block Diagram



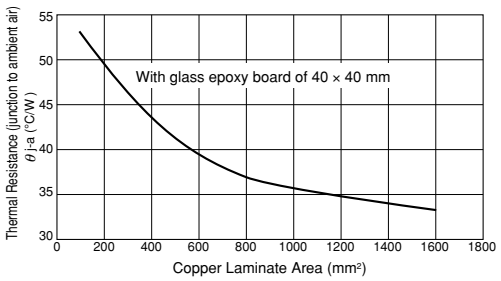
■Typical Connection Diagram



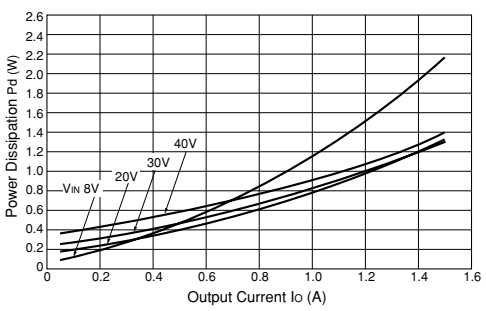
C1 : 50V/220μF
C2 : 25V/470μF
C3 : 10V/0.47μF (Only when using soft-start function)
L1 : 100μH
Di : SJPB-H6 (Sanken)

■Reference Data

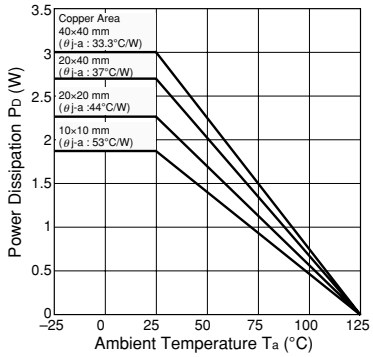
Copper Laminate Area on Glass Epoxy Board vs. Thermal Resistance (Junction to Ambient Air) (Typical Value)



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 : D1 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 Vo = 5 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 μA typ.)
- Soft start available by ON/OFF pin

■Applications

- Onboard local power supplies
- AV equipment
- OA equipment

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
DC Input Voltage	V_{IN}	43	V	
Power Dissipation	P_{D1}	1.06	W	When mounted on glass-epoxy board (900 mm² copper area 4.3%)
	P_{D2}	1.65		When mounted on glass-epoxy board (900 mm² copper area 50%)
Junction Temperature*	T_j	–30 to +150	°C	
Storage Temperature	T_{stg}	–40 to +150	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	6	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	95	°C/W	When mounted on glass-epoxy board (900 mm² copper area 4.3%)

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

■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

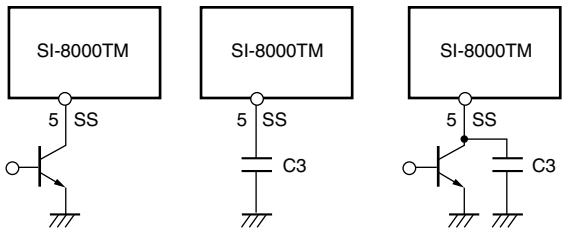
*1: The minimum value of an input voltage range is the higher of 4.5 V or V_O + 3 V.

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol	Rating SI-8008TM min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	0.784	0.800	0.816	V
		Conditions	V_{IN}=15V, I_o=0.1A			
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T$		±0.1		mV/°C
		Conditions	V_{IN}=15V, I_o=0.1A, T_C=0 to 100°C			
Efficiency		η		81		%
		Conditions	V_{IN}=15V, I_o=0.5A			
Oscillation Frequency		fo		300		kHz
		Conditions	V_{IN}=15V, I_o=0.5A			
Line Regulation		ΔV_{OLINE}		60	80	mV
		Conditions	V_{IN}=10 to 30V, I_o=0.5A			
Load Regulation		ΔV_{OLOAD}		10	40	mV
		Conditions	V_{IN}=15V, I_o=0.2 to 1.5A			
Overcurrent Protection Starting Current		I_S	1.6			A
		Conditions	V_{IN}=15V			
ON/OFF Pin*	Low Level Voltage	V_{SSL}			0.5	V
	Outflow Current at Low Voltage	I_{SSL}		10	40	μA
		Conditions	V_{SSL}=0V			
Quiescent Circuit Current		I_q		6		mA
		Conditions	V_{IN}=15V, I_o=0A			
		$I_{q\ (OFF)}$		200	400	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			

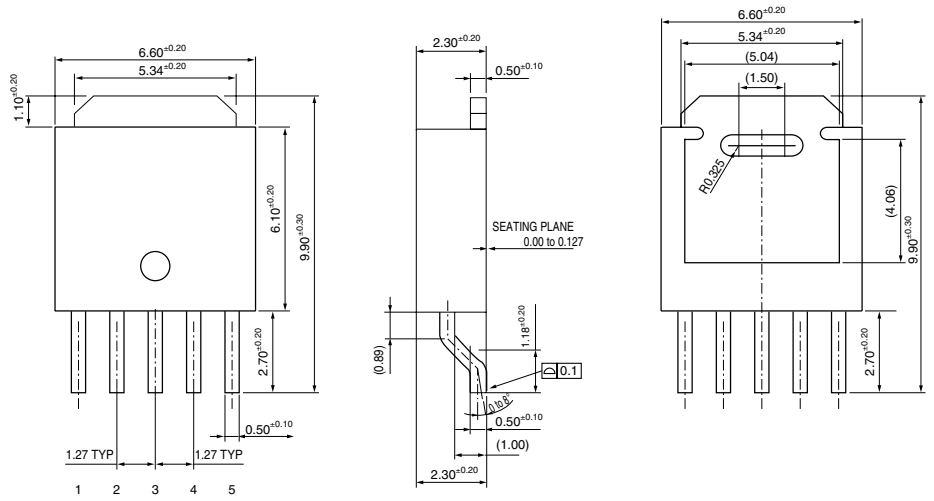
*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to VSSL or lower. SS-pin voltage can be changed with an open-collector drive circuit of 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.



Vo. ON/OFF | Soft start | Soft start +Vo. ON/OFF

■External Dimensions (TO252-5)

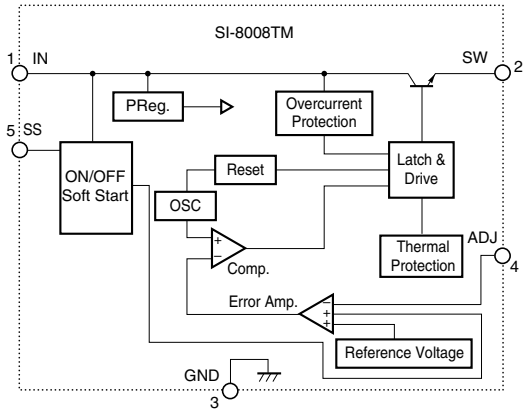
(Unit : mm)



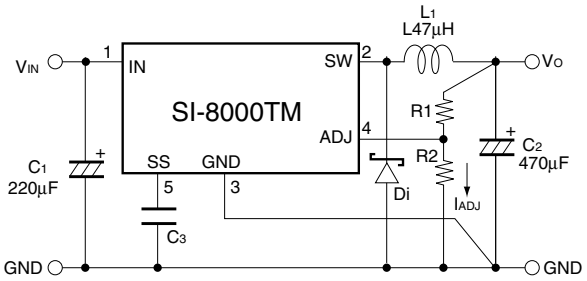
Pin Assignment
① IN
② SW
③ GND
④ ADJ
⑤ SS

Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 0.33 g

■Block Diagram



■Typical Connection Diagram



C_1 : 220μF
C_2 : 470μF
C_3 : 1μF (Only when using soft-start function)
L_1 : 47μF
Di : SJPB-H6 (Sanken)

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 V ± 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))	θ_{j-c}	40	26	40	26	°C/W	
Thermal Resistance (Junction to Ambient Air)	θ_{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**	℃

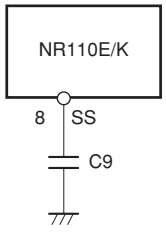
*: The minimum value of the input voltage range is indicated value or V_O + 3 V, whichever is higher.
**: The device must be used within the range indicated by the Ta-PD characteristics.

■Electrical Characteristics

(Ta=25°C, V_{IN}=12V, V_O=5.0V, and I_O=1A, unless otherwise specified)

Parameter		Symbol	Ratings									Unit	Conditions
			NR110K/NR111E			NR119E			NR117K				
			min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Reference Voltage		V_{REF}	0.784	0.8000	0.816	0.784	0.8000	0.816	0.784	0.8000	0.816	V	
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T$		±0.05			±0.05			±0.05		mV/°C	Ta=–40°C to +85°C
Oscillation Frequency		f_{SW}		350			364			30		kHz	
Line Regulation		V_{LINE}		50			50			50		mV	V_{IN}=VINmin to 30V
Load Regulation		V_{Load}		50			50			50		mV	V_{IN}=12V, V_o=5.0V, I_O=0.1 to I_{omax}
Overcurrent Protection		I_{s1}		1.5			0.9			0.3		A	ISET=OPEN
Starting Current		I_{s2}		5.5			2.8			2.1		A	ISET=SHORT
No-load Circuit Current		I_{IN}		1			1			1		mA	V_{EN}=10kΩ pull up to V_{IN}
Quiescent Circuit Current		$I_{IN(off)}$		1			1			1		μA	I_O=0A, V_{EN}=0V
SS Pin	Outflow Current at Low Voltage	$I_{EN/SS}$	6	10	14	6	10	14	6	10	14	μA	V_{SS}=0V
EN Pin	Inflow Current	I_{EN}		20	50		20	50		20	50	μA	V_{EN}=10V
	On Threshold Voltage	$V_{C/EH}$	0.7	1.4	2.1	0.7	1.4	2.1	0.7	1.4	2.1	V	
ISET Pin	Open Voltage	V_{ISET}		1.5			1.5			1.5		V	
Maximum ON Duty		D_{MAX}		90			90			90		%	
Minimum ON Time		$T_{ON(MIN)}$		150			150			150		nsec	
Thermal Protection Start Temperature		TSD	151	165		151	165		151	165		°C	
Thermal Protection Return Hysteresis		TSD_hys		20			20			20		°C	
SW MOSFET ON Resistance		$R_{on}H$		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.

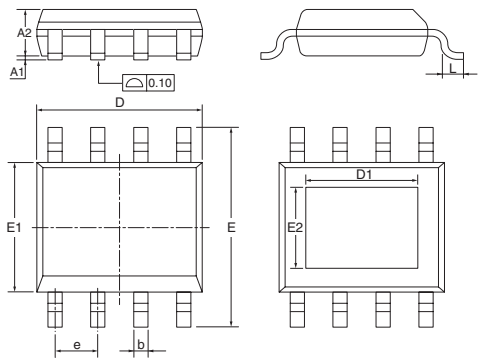


Soft start

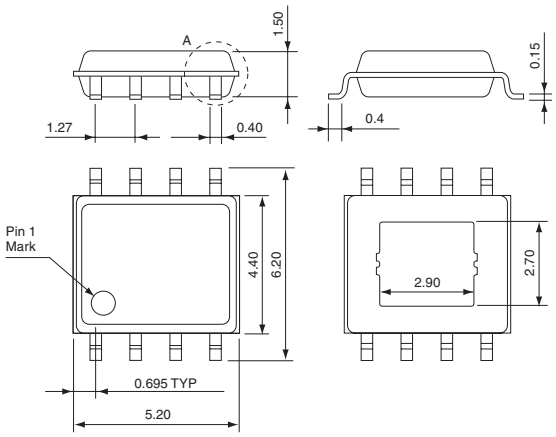
■External Dimensions

(Unit : mm)

NR111E NR119E
(eSOIC8)



NR110K NR117K
(HSOP8)



Pin Assignment
① BS
② V_{IN}
③ SW
④ GND
⑤ FB
⑥ ISET
⑦ EN
⑧ SS
*: The heat slug on the rear side is at the ground potential.

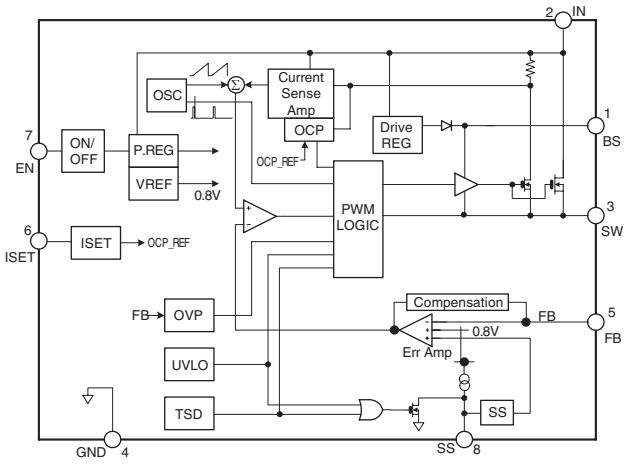
Plastic Mold Package Type
Flammability: UL 94V-0
Product Mass: Approx. 0.1g

External Dimensions (NR111E/NR119E)

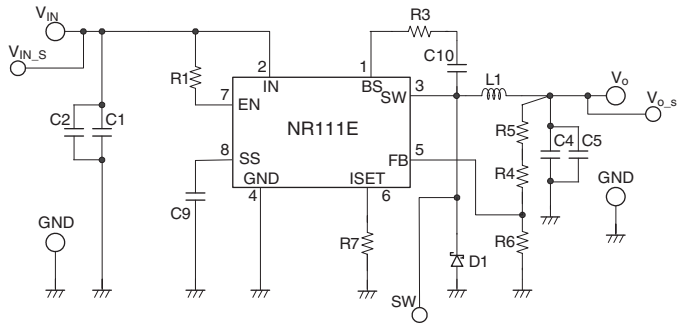
Symbol	Package A			Package B		
	MIN	TYP	MAX	MIN	TYP	MAX
A1	0	–	0.1524	0	0.1	0.15
A2	1.398	1.448	1.498	1.25	1.4	1.65
b	0.33	–	0.508	0.38	–	0.51
D	4.8	4.902	5.004	4.8	4.9	5
D1	3.053	3.18	3.307	3.1	3.3	3.5
E	5.893	–	6.918	5.8	6	6.2
E1	3.73	–	3.89	3.8	3.9	4
E2	2.033	2.16	2.287	2.2	2.4	2.6
e	–	1.27	–	–	1.27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

Delivered in Package A or B.

■Block Diagram



■Typical Connection Diagram



C1 : 10μF / 35V
C2 : 10μF / 35V
C4 : 22μF / 16V
C5 : 22μF / 16V
C9 : 0.1μF
C10 : 0.1μF
R1 : 1.7MΩ
R3 : 22Ω
R4 : 20kΩ
R5 : 470Ω (Vo=5.0V)
R6 : 3.9kΩ
R7 : 0kΩ (When ISET SHORT)
L1 : 10μH (NR110K, NR111E, NR119E)
150μH (NR117K)

NR885K/NR885E Surface-Mount, Current Mode Control, Synchronous Rectifier Step-down Switching Mode

■Features

- Compact surface-mount 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: 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	V_{IN}	20	20	V	
Power Dissipation	P_D	1.69	1.50	W	When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm^2 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 (4 pins))	$\theta_{j\text{-}c}$	40	26	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	74	71	°C/W	When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm^2 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 3.0	A
Output Voltage Range	V_o	0.8 to 14	V
Operating Temperature Range	T_{op}	–40 to +85	°C

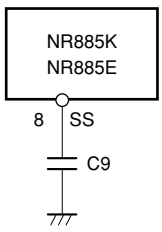
*: The minimum value of the input voltage range is 4.5 V or V_O + 3 V, whichever is higher.

■Electrical Characteristics

(Ta=25°C, V_{IN}=12V, V_O=3.3V, and I_O=1A, 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		$\Delta V_{REF}/\Delta T$		±0.05		mV/℃	Ta=–40℃ to +85℃
Efficiency		η		90		%	
Oscillation Frequency		fo	280	350	420	kHz	
Line Regulation		V_{LINE}		50		mV	V_{IN}=6.3V to 18V
Load Regulation		V_{Load}		50		mV	I_O=0.1A to 3A
Overcurrent Protection Starting Current		I_S	3.1		6.0	A	
Quiescent Circuit Current 1		I_{IN}		6		mA	V_{EN}=10kΩ pull up to V_{IN}
Quiescent Circuit Current 2		$I_{IN(off)}$	0		10	μA	I_O=0A, V_{EN}=0V
SS Pin	Outflow Current at Low Voltage	$I_{EN/SS}$	6	10	14	μA	V_{SS}=0V
	Open Voltage	V_{SSH}		3.0		V	
EN Pin	Inflow Current	I_{EN}		50	100	μA	V_{EN}=10V
	On Threshold Voltage	$V_{C/EH}$	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		℃	
Thermal Protection Return Hysteresis		TSD_hys		20		℃	

*: 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.

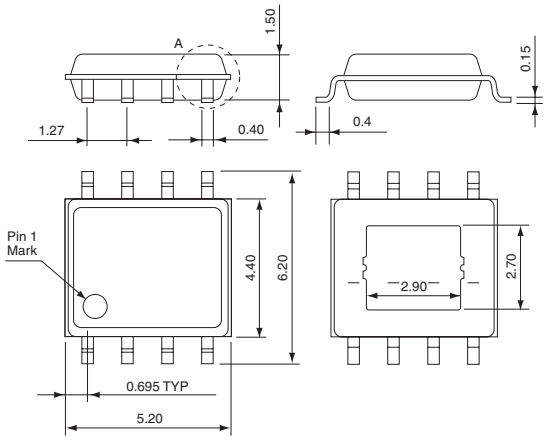


Soft start

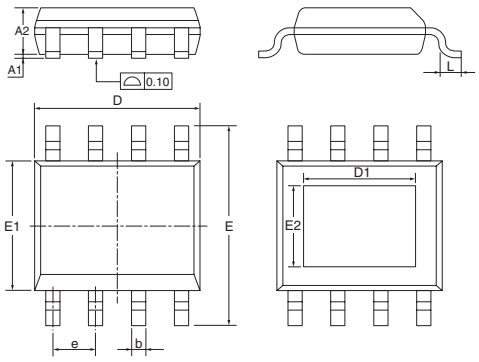
■External Dimensions

(Unit : mm)

NR885K
(HSOP8)



NR885E
(eSOIC8)



Pin Assignment
① BS
② V_{IN}
③ SW
④ GND
⑤ FB
⑥ NC
⑦ EN
⑧ SS
*: The heat slug on the rear side is at the ground potential.

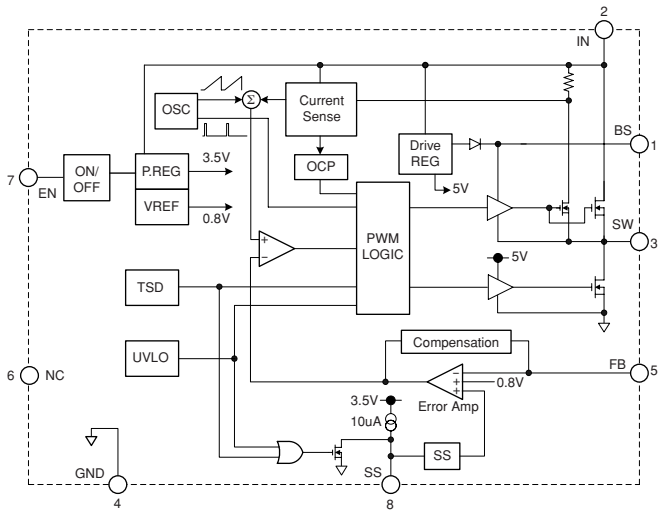
Plastic Mold Package Type
Flammability: UL 94V-0
Product Mass: Approx. 0.1g

External Dimensions (NR885E)

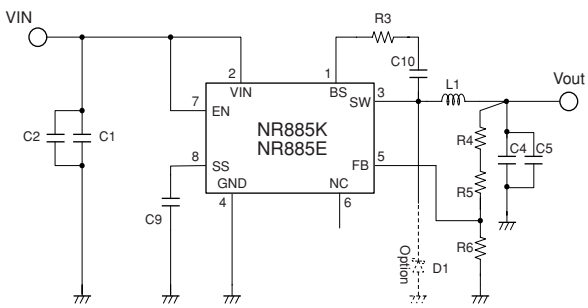
Symbol	Package A			Package B		
	MIN	TYP	MAX	MIN	TYP	MAX
A1	0	–	0.1524	0	0.1	0.15
A2	1.398	1.448	1.498	1.25	1.4	1.65
b	0.33	–	0.508	0.38	–	0.51
D	4.8	4.902	5.004	4.8	4.9	5
D1	3.053	3.18	3.307	3.1	3.3	3.5
E	5.893	–	6.918	5.8	6	6.2
E1	3.73	–	3.89	3.8	3.9	4
E2	2.033	2.16	2.287	2.2	2.4	2.6
e	–	1.27	–	–	1.27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

Delivered in Package A or B.

■Block Diagram



■Typical Connection Diagram



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

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}): Vo + 3 to 43 V
- Synchronous rectifier mode
- Output current: 3 A
- Reference voltage and accuracy of 0.5 V ±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 (VIN 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>)	$\theta_{j\text{-}c}$	40	40	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	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 Vo + 3V, whichever is higher.

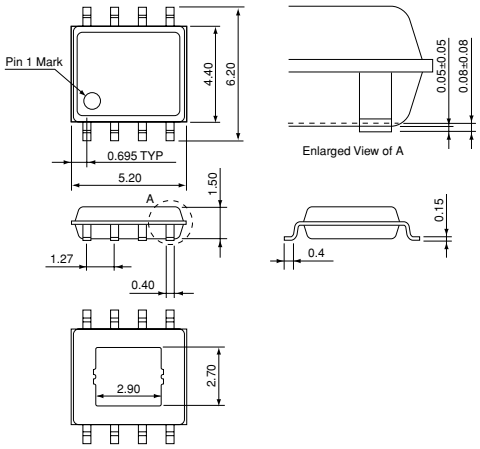
■Electrical Characteristics

(T_a = 25°C and f_o = 500kHz, unless otherwise specified)

Parameter		Symbol	Ratings						Unit
			SI-8205NHD			SI-8205NHG			
			min.	typ.	max.	min.	typ.	max.	
Reference Voltage		V_{REF}	0.495	0.5000	0.505	0.495	0.5000	0.505	V
		Conditions	V_{IN}=12V, I_O=1.0A			V_{IN}=14V, I_O=1.0A			
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T$		±0.05			±0.05		mV/°C
		Conditions	V_{IN}=12V, I_O=1.0A, Ta=–40 to +85°C			V_{IN}=14V, I_O=1.0A, Ta=–40 to +85°C			
Efficiency		η		90			90		%
		Conditions	V_{IN}=12V, Vo=5V, I_O=1.0A			V_{IN}=14V, Vo=5V, I_O=1.0A			
Oscillation Frequency 1		fo1		200			–		kHz
		Conditions	V_{IN}=12V, Vo=5V, Io=1A, Rfset=375kΩ			–			
Oscillation Frequency 2		fo2		1			–		MHz
		Conditions	V_{IN}=12V, Vo=5V, Io=1A, Rfset=75kΩ			–			
Internal Oscillation Frequency		fo		–			250		kHz
		Conditions	–			V_{IN}=14V, Vo=5V, I_O=1.0A SYNC=GND			
Line Regulation		ΔV_{oLINE}		50			50		mV
		Conditions	V_{IN}=8 to 43V, Vo=5V, Io=1A			V_{IN}=8 to 43V, Vo=5V, Io=1A			
Load Regulation		ΔV_{oLoad}		50			50		mV
		Conditions	V_{IN}=12V, Vo=5V, Io=0.1 to 3.0A			V_{IN}=12V, Vo=5V, Io=0.1 to 3.0A			
Overcurrent Protection Starting Current		I_S	3.1		6	3.1		6	A
		Conditions	V_{IN}=12V, Vo=5V			V_{IN}=14V, Vo=5V			
Quiescent Circuit Current 1		I_{IN}		8			12		mA
		Conditions	V_{IN}=12V, Vcomp=0V			V_{IN}=14V, Vcomp=0V			
Quiescent Circuit Current 2		$I_{IN(off)}$			40			35	μA
		Conditions	V_{IN}=12V, $V_{EN/SS}$=0V			V_{IN}=14V, $V_{EN/SS}$=0V			
EN/SS Pin	Outflow Current at Low Voltage	$I_{EN/SS}$		5			5		μA
		Conditions	$V_{EN/SS}$=0V, V_{IN}=12V			$V_{EN/SS}$=0V, V_{IN}=12V			
	Open Voltage	V_{SSH}	3	4.5	6	3	4.5	6	V
		Conditions	V_{IN}=12V			V_{IN}=14V			
	On Threshold Voltage	$V_{C/EH}$	0.6	1.3	2.0	0.6	1.3	2.0	V
		Conditions	V_{IN}=12V			V_{IN}=14V			
SYNC Pin	Synchronization Threshold Voltage	V_{SYNC}		–			1.85		V
		Conditions		–		V_{IN}=14V, Vo=5V, I_O=1.0A			
	Synchronization Frequency	F_{SYNC}		–		300		1000.0	kHz
		Conditions		–		V_{IN}=14V, Vo=5V, I_O=1.0A			
OVP Start Voltage		V_{OVP}	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	V_{IN}=12V			V_{IN}=12V			
Minimum ON Time		DMIN		150			250		nsec
		Conditions	V_{IN}=12V			V_{IN}=12V			

■External Dimensions (HSOP8)

(Unit : mm)



Pin Assignment

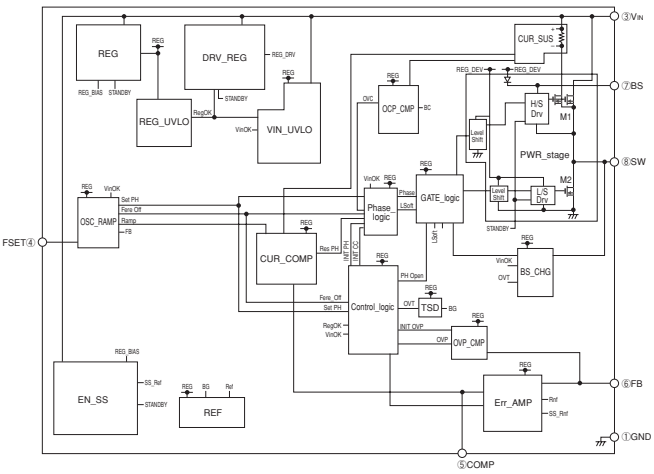
SI-8205NHD	SI-8205NHG
① GND	① GND
② EN/SS	② EN/SS
③ V_{IN}	③ V_{IN}
④ FSET	④ SYNC
⑤ COMP	⑤ COMP
⑥ FB	⑥ FB
⑦ BS	⑦ BS
⑧ SW	⑧ SW

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

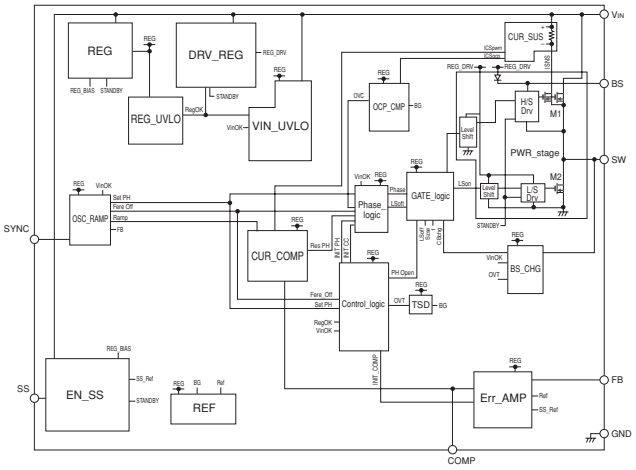
Plastic Mold Package Type
Flammability : UL 94V-0
Product Mass : Approx. 0.1 g

■Block Diagram

SI-8205NHD

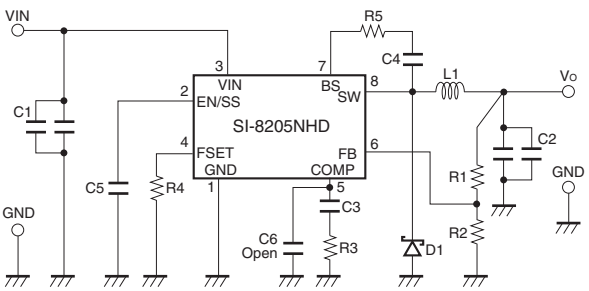


SI-8205NHG



■Typical Connection Diagram

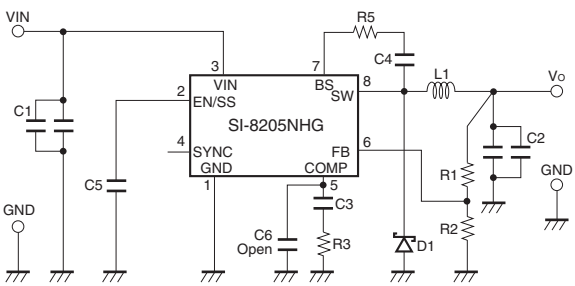
SI-8205NHD



C1:10μF/50V×2 (murata:GRM55DB31H106KA87)
C2:22μF/16V×2 (murata:GRM32ER71A226KE20)
C3:270pF*1 (murata:GRM18 type)
C4:10μF (murata: GRM18 type)
C5:1μF (murata: GRM18 type)
L1:10μH
D1: SJPB-L6 (Sanken)

R1:9kΩ*1
R2:1kΩ
R3:51kΩ*1
R4:150kΩ
R5:47Ω

SI-8205NHG



C1:10μF/50V×2 (murata:GRM55DB31H106KA87)
C2:22μF/16V×2 (murata:GRM32ER71A226KE20)
C3:270pF*1 (murata:GRM18 type)
C4:0.1μF (murata: GRM18 type)
C5:1μF (murata: GRM18 type)
L1:10μH
D1: SJPB-L6 (Sanken)

R1:9kΩ*1
R2:1kΩ
R3:51kΩ*1
R5:20 to 47Ω

*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

■Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

■Lineup

Part Number	SI-8033SD	SI-8050SD
V_O (V)	3.3	5.0
I_O (A)	3	

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Conditions
DC Input Voltage	V_{IN}	43*1	V	
Power Dissipation*2	P_D	3	W	When mounted on glass-epoxy board 40 × 40 mm (copper area: 100%)
Junction Temperature	T_j	+125	°C	
Storage Temperature	T_{stg}	–40 to +125	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	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.

■Recommended Operating Conditions

Parameter	Symbol	Ratings		Unit
		SI-8033SD	SI-8050SD	
DC Input Voltage Range	V_{IN1}	5.5 to 28	7 to 40	V
Output Current Range*	I_O	0 to 3.0		A
Operating Junction Temperature Range	T_{jop}	–30 to +125		°C
Operating Temperature Range*	T_{op}	–30 to +125		°C

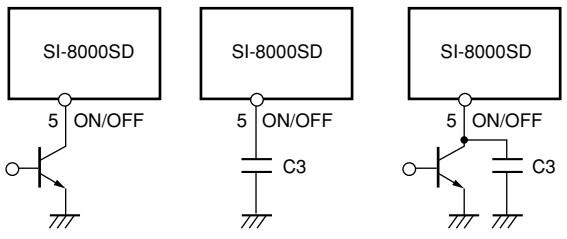
*: Limited by Ta-P_D characteristics.

■Electrical Characteristics

(T_a=25°C)

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

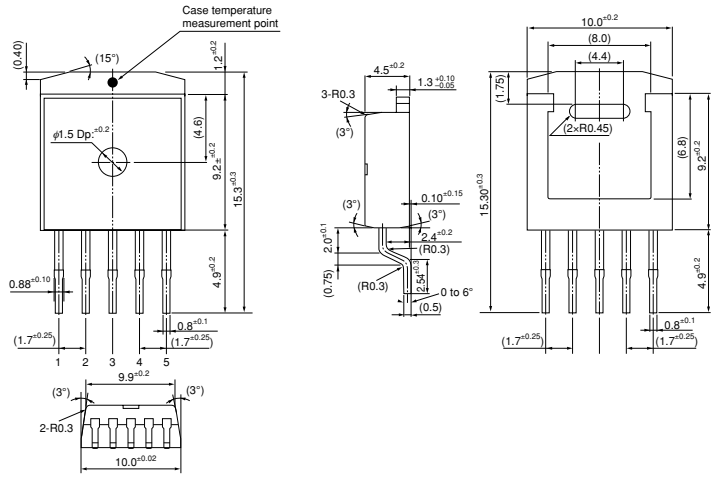
* Pin 5 is a soft start pin. Soft start at power on can be performed with a capacitor connected to this pin.
The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to V_{SSL} or lower.
Soft-start pin voltage can be changed with an open-collector drive circuit of a transistor.
When using both the soft-start and ON/OFF functions together, the discharge current from C_3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C_3 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.



$V_{OUT.}$ ON/OFF | Soft start | Soft start +$V_{OUT.}$ ON/OFF

■External Dimensions (TO263-5)

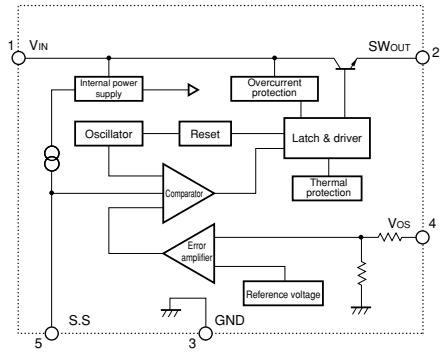
(Unit : mm)



Pin Assignment
① V_{IN}
② SW_{OUT}
③ GND
④ V_{OS}
⑤ S.S

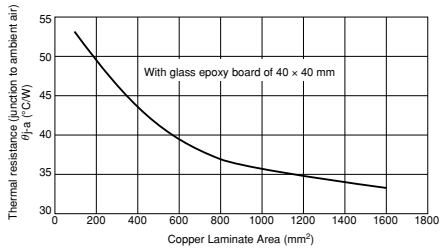
Plastic Mold Package Type
Flammability: 94V-0
Product Mass: Approx. 1.48g

■Block Diagram

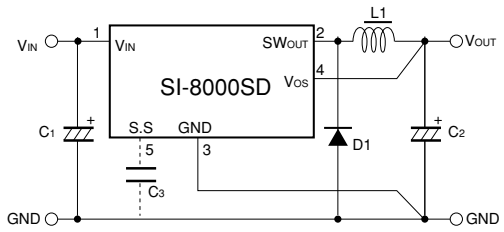


■Reference Data

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



■Typical Connection Diagram



C_1 : 50V/1000μF
C_2 : 50V/1000μF
C_3 : 0.01μF
(only when soft start function is used)
L_1 : 150μH
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 (Vref) of 1V.
- Wide Input Voltage Range (8 to 50V)
- Output ON/OFF available
- Built-in overcurrent and thermal protection circuits

■Absolute Maximum Ratings

(T_a=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)	$\theta_{j\text{-}c}$*2	18	°C/W
Thermal Resistance (junction to ambient air)	$\theta_{j\text{-}a}$*2	50	°C/W

*1: Limited due to thermal protection.
*2: When mounted on glass-epoxy board 700cm^2 (copper laminate area 30.8cm^2).

■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)*1 to 50	V
Output Voltage Range	V_O	1 to 14	V
Output Current Range*2	I_O	0.02 to 3.0*2	A
Operating Junction Temperature Range	T_{jop}	–30 to +125	°C
Operating Temperature Range	T_{op}	–30 to +125	°C

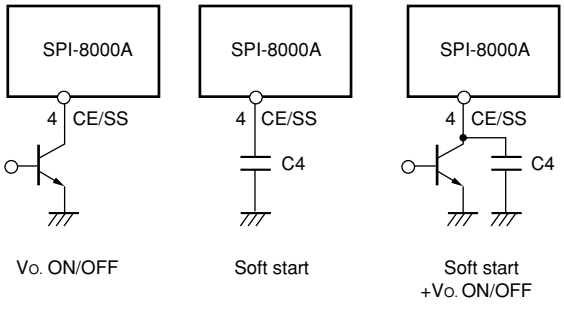
*1: The minimum value of an input voltage range is the higher of either 8V or V_O+3V.
*2: Please be sure to let the output current run more than 20 mA. When using by less than 20 mA, there is a possibility that the output voltage becomes unstable.

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol	Ratings			Unit
			SPI-8010A (Variable type)			
			min.	typ.	max.	
Reference Voltage		V_{REF}	0.97	1.00	1.03	V
		Conditions	V_{IN}=12V, I_O=1A			
Efficiency		Eff		86		%
		Conditions	V_{IN}=20V, I_O=1A, V_O=5V			
Oscillation Frequency		F_{OSC}		250		kHz
		Conditions	V_{IN}=12V, I_O=1A			
Line Regulation		ΔV_{OLINE}		20	40	mV
		Conditions	V_{IN}=10 to 30V, I_O=1A			
Load Regulation		ΔV_{OLOAD}		10	30	mV
		Conditions	V_{IN}=12V, I_O=0.1 to 1.5A			
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T_a$		±0.5		mV/°C
Overcurrent Protection Starting Current		I_S	3.1			A
		Conditions	V_{IN}=12V			
Quiescent Circuit Current		I_q		7		mA
		Conditions	V_{IN}=12V, I_O=0A			
Circuit Current at Output OFF		$I_{q(off)}$			400	μA
		Conditions	V_{IN}=12V, $V_{ON/OFF}$=0.3V			
CE/SS Terminal	Low Level Voltage	V_{SSL}			0.5	V
	Outflow Current at Low Voltage	I_{SSL}			50	μA
		Conditions	V_{SSL}=0V			

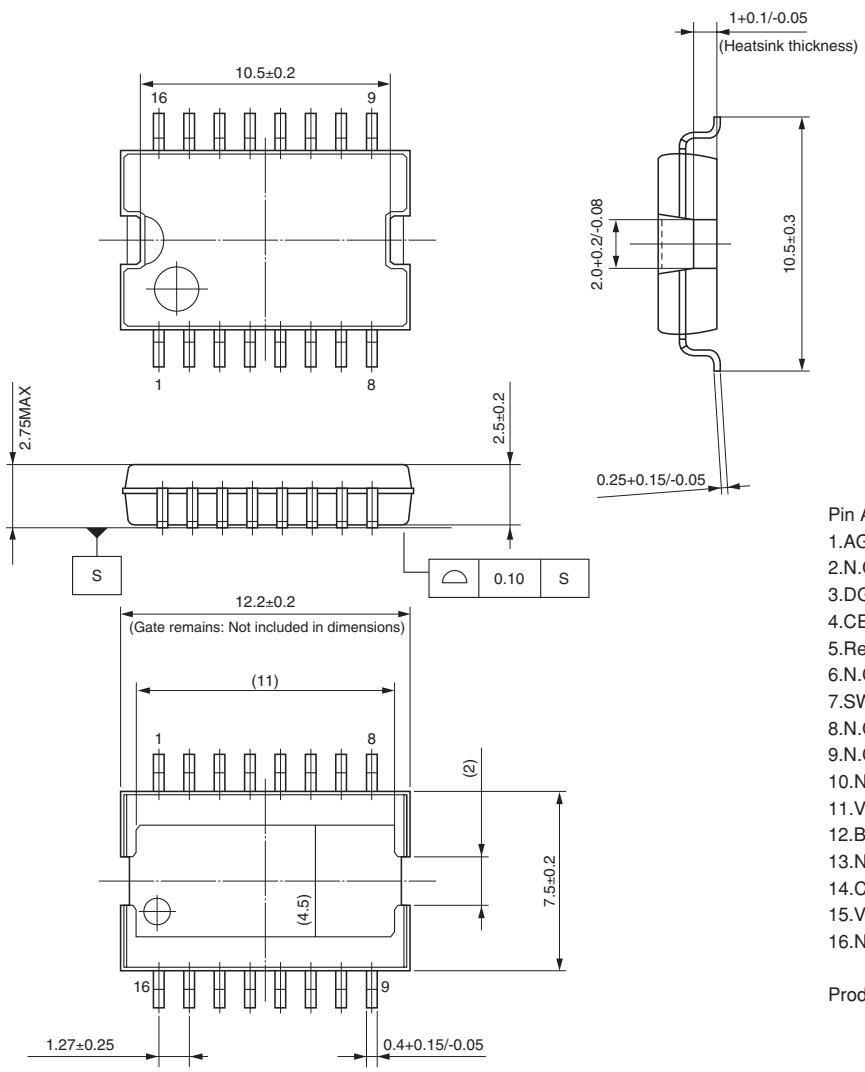
* Pin 4 is the CE/SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to V_{SSL} or lower. CE/SS-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C_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.



V_O. ON/OFF　Soft start　Soft start +V_O. ON/OFF

■External Dimensions (HSOP16)

(Unit : mm)

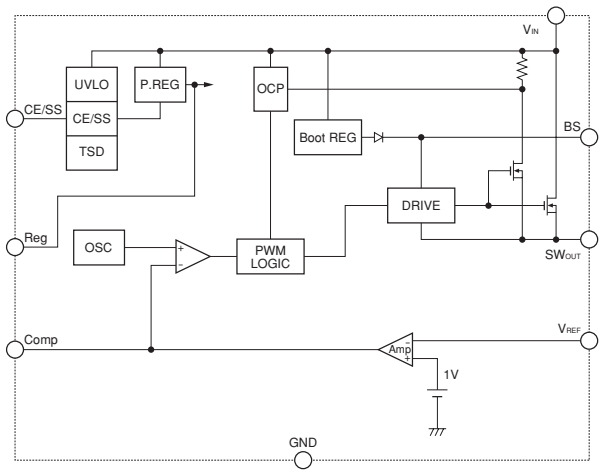


Pin Assignment
1.AGND
2.N.C
3.DGND
4.CE/SS
5.Reg
6.N.C
7.SW_{OUT}
8.N.C
9.N.C
10.N.C
11.V_{IN}
12.B.S
13.N.C
14.C_{omp}
15.V_{REF}
16.N.C

Product Mass : Approx 0.86g

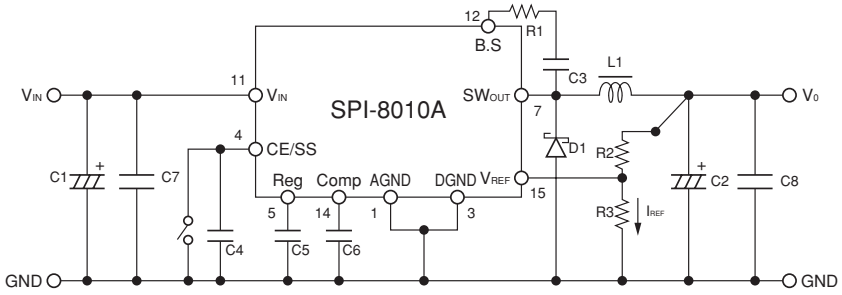
■Block Diagram

SPI-8010A



■Typical Connection Diagram

SPI-8010A



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: SJPB-L6
(Sanken)

Diode D_1

- Be sure to use a Schottky-barrier diode for 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 4.5A, 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

- 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.

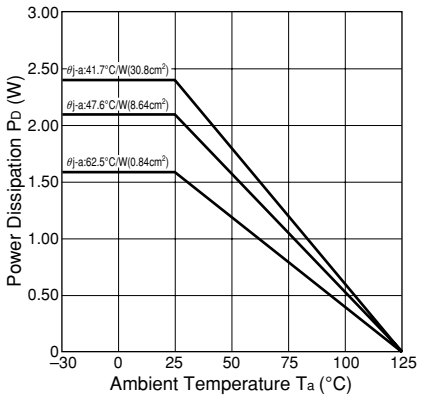
Resistors R_2, R_3

- R_2 and R_3 are the resistors to set the output voltage. Set their values so that I_{REF} becomes approx. 2mA. Obtain R_2 and R_3 values by the following formula:

$$R2=\frac{(V_{OUT}-V_{REF})}{I_{REF}}=\frac{(V_{OUT}-1)}{2\times10^{-3}}(\Omega),\ R3=\frac{V_{REF}}{I_{REF}}=\frac{1}{2\times10^{-3}}\fallingdotseq500(\Omega)$$

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

■T_a-P_D Characteristics



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

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_1 must be considered separately.

V_O : Output voltage
V_{IN} : Input voltage
I_O : Output current
$\eta\chi$: Efficiency (%)
V_F : Diode D_1 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% (Vo = 5 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*1	P_D	1.35	W	When mounted on glass-epoxy board, 30×30 mm (copper laminate area: 25×25 mm)
Junction Temperature*2	T_j	–30 to +150	°C	
Storage Temperature	T_{stg}	–40 to +150	°C	
Thermal Resistance(junction to case)	$\theta_{j\text{-}c}$	40	°C/W	
Thermal Resistance(junction to ambient air)	$\theta_{j\text{-}a}$	74	°C/W	When mounted on glass-epoxy board, 30×30 mm (copper laminate area: 25×25 mm)

*1: Limited by thermal protection circuit
*2: 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}	Vo+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	

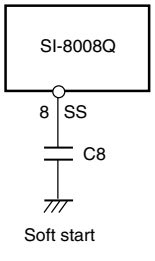
*1: The minimum value of the input voltage range is 4.75 V or Vo +3 V, whichever is higher.

■Electrical Characteristics

(R1=4.2kΩ, R2=0.8kΩ when Ta = 25°C and Vo=5V)

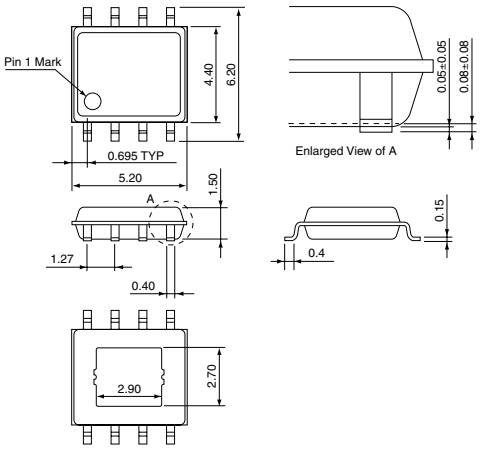
Parameter		Symbol	Ratings SI-8005Q min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	0.485	0.500	0.515	V
		Conditions	V_{IN}=12V, Io=1A			
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T$		0.05		mV/°C
		Conditions	V_{IN}=12V, Io=1A, Ta=–40 to +85°C			
Efficiency		η		90		%
		Conditions	V_{IN}=12V, Io=1A			
Oscillation Frequency		fo	450	500	550	kHz
		Conditions	V_{IN}=16V, Io=1A			
Line Regulation		ΔV_{OLINE}		30	60	mV
		Conditions	V_{IN}=8 to 28V, Io=1A			
Load Regulation		ΔV_{OLOAD}		30	60	mV
		Conditions	V_{IN}=12V, Io=0.1 to 3.5A			
Overcurrent Protection Starting Current		I_S	3.6		6.0	A
		Conditions	V_{IN}=12V			
Quiescent Circuit Current		Iq		18		mA
		Conditions	V_{IN}=12V, Io=0A, V_{EN}=open			
		$I_{q(OFF)}$			20	μA
		Conditions	V_{IN}=12V, Io=0A, V_{EN}=0V			
SS Pin	Outflow Current at Low Voltage	I_{SSL}		5		μA
		Conditions	V_{IN}=16V, V_{SSL}=0V			
EN Pin	High Level Voltage	$V_{C/EN}$	2.8			V
		Conditions	V_{IN}=12V			
	Low Level Voltage	$V_{C/EL}$			2.2	V
		Conditions	V_{IN}=12V			
	Inflow Current at Low Low Voltage	$I_{C/EH}$		5		μA
		Conditions	V_{EN}=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 (HSOP8)

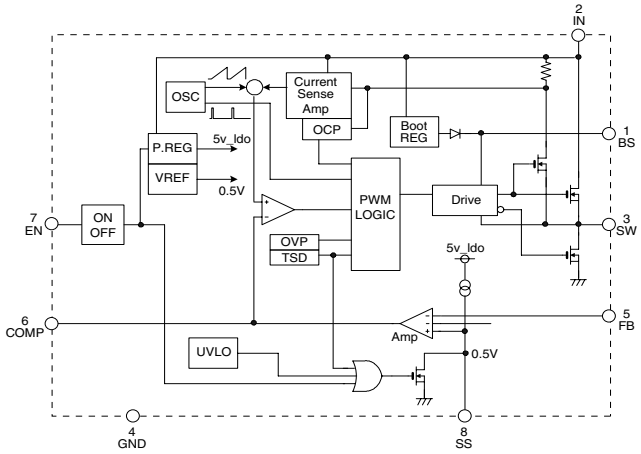
(Unit : mm)



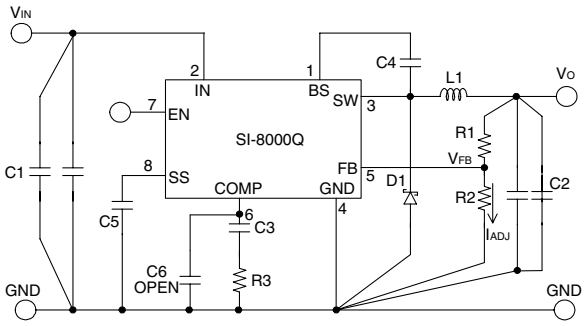
Pin Assignment
①BS
②IN
③SW
④GND
⑤FB
⑥COMP
⑦EN
⑧SS

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

■Block Diagram



■Typical Connection Diagram



C1:10μF/50V
(Murata:GRM55DB31H106KA87)
C2:22μF/16V
(Murata:GRM32ER71A226KE20)
C3:560pF*1
(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*1

*1: When Vo=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% (Vo = 5 V, V_{IN} = 15 V, Io = 2 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

■Lineup

Part Number	SI-8001FDE	SI-8001FDL
V_O(V)	Variable(0.8 to 24)	
Io(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*1	P_D	3		W	When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%)
Junction Temperature*2	T_j	+150		°C	
Storage Temperature	T_{stg}	–40 to +150		°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3*1		°C/W	When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%)
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	33.3*1		°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
		SI-8001FDE	SI-8050FDL	
Input Voltage Range	V_{IN}	Vo+3*1 to 40		V
Output Voltage Range	V_O	0.8 to 24		V
Output Current Range	Io	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 Vo + 3 V, whichever is higher.

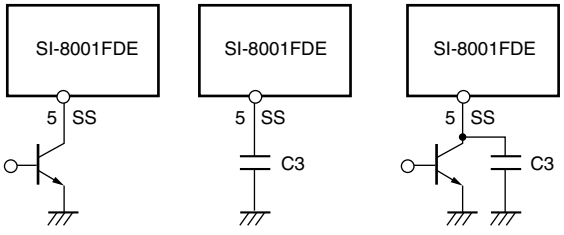
■Electrical Characteristics

(R1=4.2kΩ, R2=0.8kΩ when Ta = 25°C and Vo=5V)

Parameter		Symbol	Ratings						Unit
			SI–8001FDE			SI–8001FDL			
			min.	typ.	max.	min.	typ.	max.	
Reference Voltage		V_{ADJ}	0.784	0.800	0.816	0.784	0.800	0.816	V
		Conditions	V_{IN}=15V, Io=0.2A			V_{IN}=15V, Io=0.2A			
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T$		±0.1			±0.1		mV/°C
		Conditions	V_{IN}=15V, Io=0.2A, Tc=0 to 100°C			V_{IN}=15V, Io=0.2A, Tc=0 to 100°C			
Efficiency		η		83			83		%
		Conditions	V_{IN}=15V, Io=2A			V_{IN}=15V, Io=2A			
Oscillation Frequency		fo	270	300	330	270	300	330	kHz
		Conditions	V_{IN}=15V, Io=2A			V_{IN}=15V, Io=2A			
Line Regulation		ΔV_{OLINE}			80			80	mV
		Conditions	V_{IN}=10 to 30V, Io=2A			V_{IN}=10 to 30V, Io=2A			
Load Regulation		ΔV_{OLOAD}			50			50	mV
		Conditions	V_{IN}=15V, Io=0.2 to 3.5A			V_{IN}=15V, Io=0.2 to 3.5A			
Overcurrent Protection Starting Current		Is	3.6			3.6			A
		Conditions	V_{IN}=15V			V_{IN}=15V			
SS Pin*1	Low Level Voltage	V_{SSL}			0.5	–	–	–	V
	Outflow Cuurent at Low Voltage	I_{SSL}		6	30	–	–	–	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			–	–	–	
ON/OFF Pin*2	ON/OFF Control Voltage (Output on)	Vc, IH	–	–	–			0.8	V
	ON/OFF Control Voltage (Output off)	Vc, IL	–	–	–	2.0			V
	ON/OFF Controll Current (Output on)	Ic, IH	–	–	–		6	100	μA
		Conditions	–			V_C=2V			
Quiescent Circuit Current		Iq		6			6		mA
		Conditions	V_{IN}=15V, Io=0A			V_{IN}=15V, Io=0A			
		Iq(OFF)		200	600		30	200	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			V_{IN}=15V, V_C=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 VSSL 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.

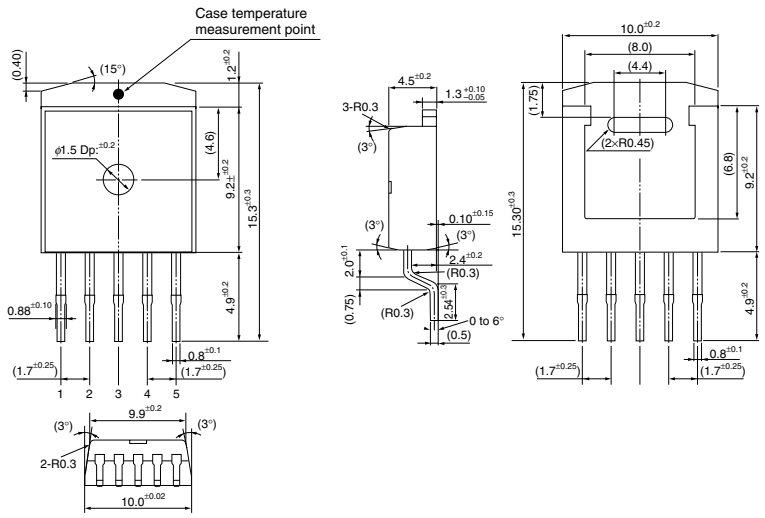
*2: Output is OFF when the output control terminal VC is open. Each input level is equivalent to LS-TTL. Therefore, the device can be driven directly by LS-TTLs.



Vo.ON/OFF　　Soft start　　Soft start +Vo. On/OFF

■External Dimensions (TO263-5)

(Unit : mm)

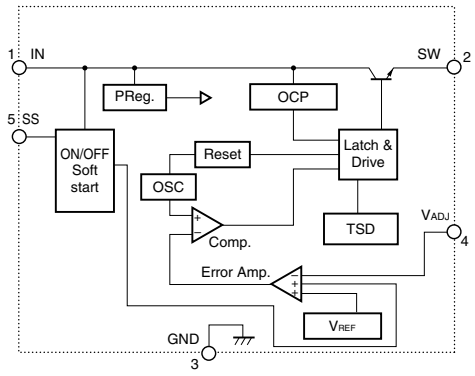


Pin Assignment
① IN
② SW
③ GND (Common to the rear side of the product)
④ V_{ADJ}
⑤ SS or Vc

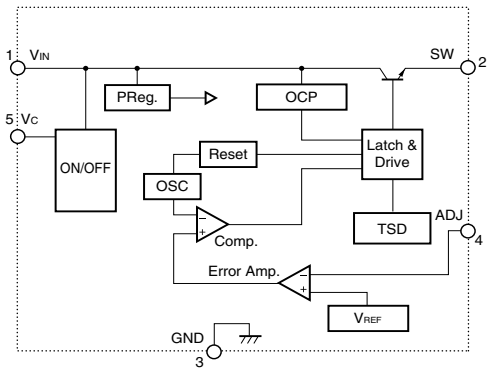
Plastic Mold Package Type
Flammability: UL 94V-0
Product Mass: Approx. 1.48g

■Block Diagram

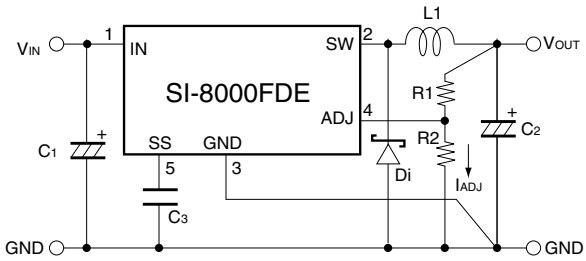
SI-8001FDE



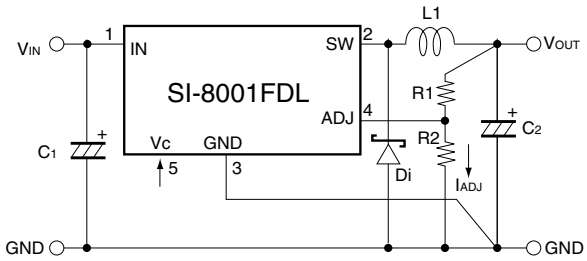
SI-8001FDL



■Typical Connection Diagram



C1 : 470μF
C2 : 680μF
C3 : 0.1μ (Only when using soft-start function)
L1 : 47μH
Di : FMB-G16L (Sanken)



C1 : 470μF
C2 : 680μF
L1 : 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, Vo = 5 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*1	P_D	3	W	When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%)
Junction Temperature*2	T_j	+150	°C	
Storage Temperature	T_{stg}	–40 to +150	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3	°C/W	When mounted on glass-epoxy board measuring 40×40 mm (copper laminate area: 100%)
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	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}	Vo+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	$V_{IN} \geq$ Vo+3V
Operating Junction Temperature Range	T_{jop}	–30 to +100	°C	
Operating Temperature Range	T_{op}	–30 to +85	°C	

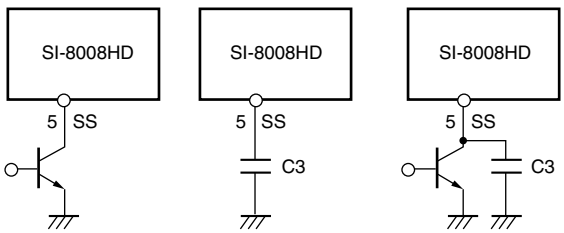
*1: The minimum value of the input voltage range is 4.5 V or Vo+3 V, whichever is higher.

■Electrical Characteristics

(R1=4.2kΩ, R2=0.8kΩ when Ta=25°C and Vo=5V)

Paramter		Symbol	Ratings SI-8008HD min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	0.784	0.800	0.816	V
		Conditions	V_{IN}=15V, Io=1A			
Temperature Coefficient of Reference Voltage		$(\Delta V_{ADJ}/\Delta T)$		±0.1		mV/°C
		Conditions	V_{IN}=15V, Io=1A, Tc=0 to 100°C			
Efficiency		η		83		%
		Conditions	V_{IN}=15V, Io=3A			
Oscillation Frequency		fo		150		kHz
		Conditions	V_{IN}=15V, Io=3A			
Line Regulation		ΔV_{OLINE}		60	80	mV
		Conditions	V_{IN}=10 to 30V, Io=3A			
Load Regulation		ΔV_{OLOAD}		20	50	mV
		Conditions	V_{IN}=15V, Io=0.2 to 5.5A			
Overcurrent Protection Starting Current		I_S	5.6	6.5	7.5	A
		Conditions	V_{IN}=15V			
SS Pin*1	Low Level Voltage	V_{SSL}			0.5	V
	Outflow Current at Low Voltage	I_{SSL}		10	30	μA
		Conditions	V_{SSL}=0V			
Quiescent Circuit Current		I_q		6		mA
		Conditions	V_{IN}=15V, Io=0A			
		$I_{q(OFF)}$		200	400	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			

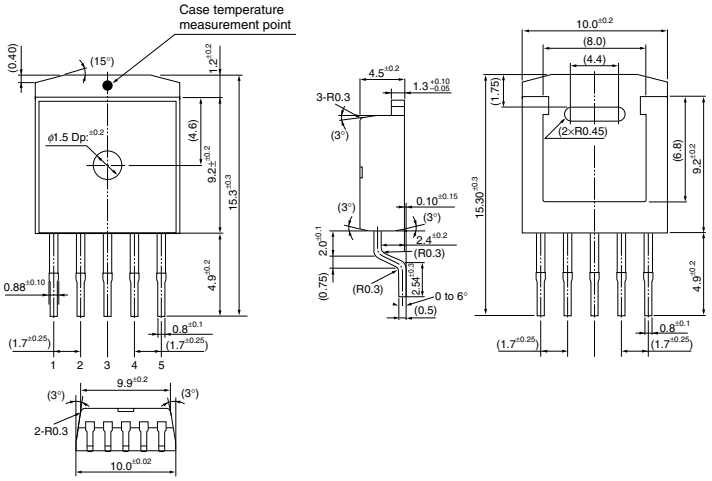
*1: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to VSSL or lower. SS-pin voltage can be changed with an open-collector drive circuit of 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.



Vo.ON/OFF | Soft start | Soft start +Vo. On/OFF

■External Dimensions (TO263-5)

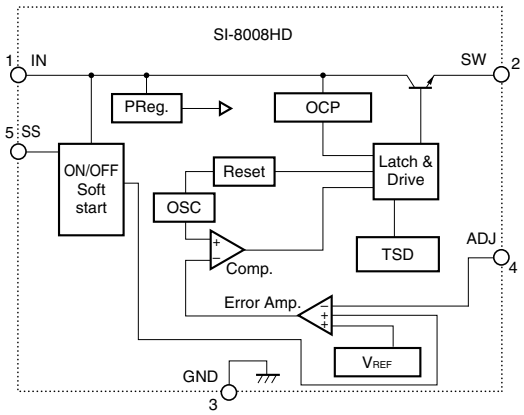
(Unit : mm)



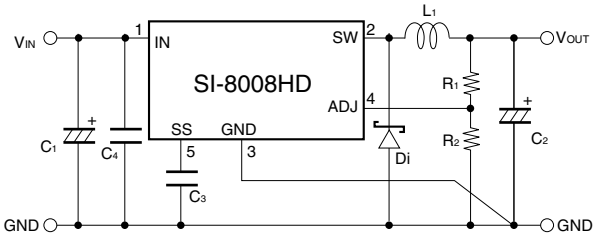
Pin Assignment
① IN
② SW
③ GND
④ ADJ
⑤ SS

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

■Block Diagram



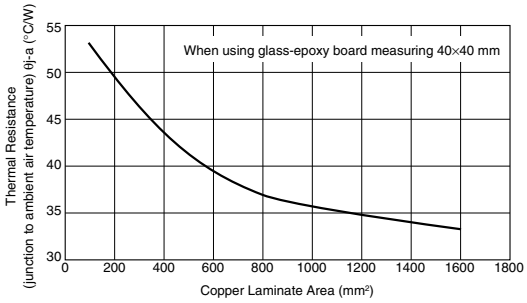
■Typical Connection Diagram



C_1 : 1500μF
C_2 : 1000μF
C_3 : 0.1μF (Only when using soft-start function)
C_4 : 4.7μF (GMR32ER71H475KA88L (Murata Manufacturing) recommended)
L_1 : 100μH
D_i : 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
V_O(V)	5.0
I_O(A)	0.6

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	43	V
Power Dissipation	P_{D1}	14(With infinite heatsink)	W
	P_{D2}	1.5(Without heatsink, stand-alone operation)	W
Junction Temperature	T_j	+125	°C
Storage Temperature	T_{stg}	–40 to +125	°C
Thermal Resistance(junction to case)	$\theta_{j\text{-}c}$	7.0	°C/W
Thermal Resistance(junction to ambient air)	$\theta_{j\text{-}a}$	66.7	°C/W

■Recommended Operating Conditions

Parameter	Symbol	Ratings	Unit
		SI-8050E	
DC Input Voltage Range	V_{IN}	7 to 40	V
Output Current Range	I_O	0 to 0.6	A
Operating Junction Temperature Range	T_{jop}	–30 to +125	°C
Operating Temperature Range	T_{op}	–30 to +125	°C

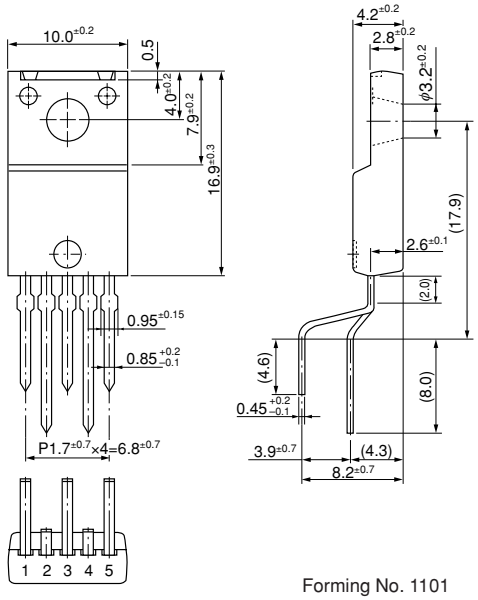
■Electrical Characteristics

(T_a=25°C)

Parameter	Symbol	Ratings SI-8050E min.	typ.	max.	Unit
Output Voltage	V_O	4.80	5.00	5.20	V
	Conditions	V_{IN}=20V, I_O=0.3A			
Efficiency	η		80		%
	Conditions	V_{IN}=20V, I_O=0.3A			
Oscillation Frequency	f		60		kHz
	Conditions	V_{IN}=20V, I_O=0.3A			
Line Regulation	ΔV_{OLINE}		80	100	mV
	Conditions	V_{IN}=10 to 30V, I_O=0.3A			
Load Regulation	ΔV_{OLOAD}		30	40	mV
	Conditions	V_{IN}=20V, I_O=0.1 to 0.4A			
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±0.5		mV/°C
Overcurrent Protection Starting Current	I_{S1}	0.61			A
	Conditions	V_{IN}=10V			

■External Dimensions (TO220F-5)

(Unit : mm)

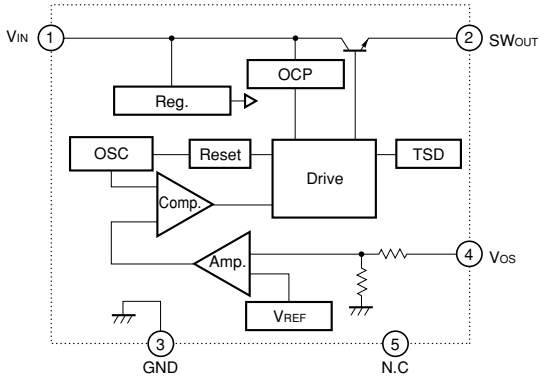


Forming No. 1101

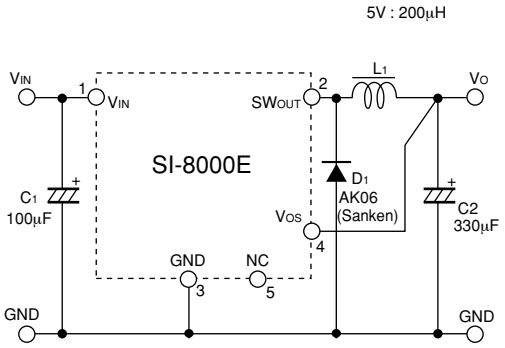
Pin Assignment
① VIN
② SWOUT
③ GND
④ VOS
⑤ N.C

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

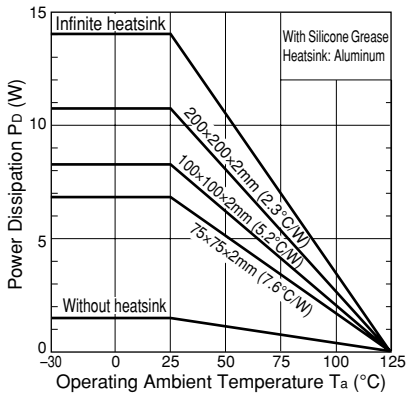
■Block Diagram



■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
ηx : 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: 200μA max.)
- Soft start available by ON/OFF pin

■Lineup

Part Number	SI-8015JF	SI-8033JF	SI-8050JF	SI-8120JF
V_O (V)*	1.59	3.3	5.0	12.0
I_O (A)	1.5			

* V_{REF}(V) for SI-8015JF

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	43	V
Power Dissipation	P_{D1}	16.6 (with infinite heatsink)	W
	P_{D2}	1.5 (without heatsink, standalone operation)	W
Junction Temperature	T_j	+125	°C
Storage Temperature	T_{stg}	–40 to +125	°C
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	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	$V_{IN}1$	V_O+2 to 40	5.3 to 40	7 to 40	14 to 40	V	I_O=0 to 1A
	$V_{IN}2$	V_O+3 to 40	6.3 to 40	8 to 40	15 to 40	V	I_O=0 to 1.5A
Output Current Range	I_O	0 to 1.5				A	$V_{IN}\geq V_O$+3V
Operating Junction Temperature Range	T_{jop}	–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_a=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*1	V_O*2	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_{IN}=12V, I_O=0.5A			V_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Efficiency	η		67			77			82			88		%
	Conditions	V_{IN}=12V, I_O=0.5A			V_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Oscillation Frequency	f		125			125			125			125		kHz
	Conditions	V_{IN}=12V, I_O=0.5A			V_{IN}=15V, I_O=0.5A			V_{IN}=20V, I_O=0.5A			V_{IN}=24V, I_O=0.5A			
Line Regulation	ΔV_{OLINE}		25	80		25	80		40	100		60	130	mV
	Conditions	V_{IN}=8 to 30V, I_O=0.5A			V_{IN}=8 to 30V, I_O=1.0A			V_{IN}=10 to 30V, I_O=1.0A			V_{IN}=18 to 30V, I_O=1.0A			
Load Regulation	ΔV_{OLOAD}		10	30		10	30		10	40		10	40	mV
	Conditions	V_{IN}=12V, I_O=0.2 to 0.8A			V_{IN}=15V, I_O=0.5 to1.5A			V_{IN}=20V, I_O=0.5 to 1.5A			V_{IN}=24V, I_O=0.5 to 1.5A			
Temperature Coefficient of Output Voltage*3	$\Delta V_O/\Delta T_a$*4		±0.5			±0.5			±0.5			±1.0		mV/°C
Overcurrent Protection Starting Current	I_{S1}	1.6			1.6			1.6			1.6			A
	Conditions	V_{IN}=12V			V_{IN}=15V			V_{IN}=20V			V_{IN}=24V			
ON/OFF*5 Terminal Low Level Voltage	V_{SSL}			0.5			0.5			0.5			0.5	V
ON/OFF*5 Terminal Outflow Current at Low Voltage	I_{SSL}			100			100			100			100	μA
	Conditions	V_{SSL}=0V			V_{SSL}=0V			V_{SSL}=0V			V_{SSL}=0V			
Quiescent Circuit Current	I_q		7			7			7			7		mA
	Conditions	V_{IN}=12V, I_O=0A			V_{IN}=15V, I_O=0A			V_{IN}=20V, I_O=0A			V_{IN}=24V, I_O=0A			
	$I_{q(OFF)}$			200			200			200			200	μA
	Conditions	V_{IN}=12V, $V_{ON/OFF}$=0.3V			V_{IN}=15V, $V_{ON/OFF}$=0.3V			V_{IN}=20V, $V_{ON/OFF}$=0.3V			V_{IN}=24V, $V_{ON/OFF}$=0.3V			

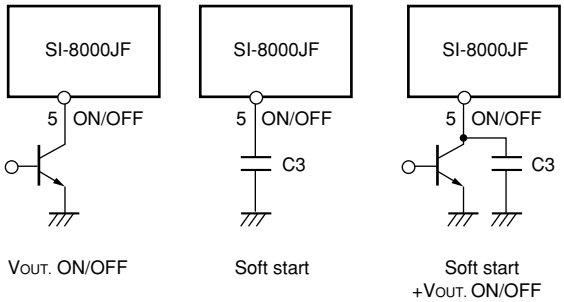
*1: Reference voltage for SI-8015JF

*2: V_{REF} for SI-8015JF

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

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

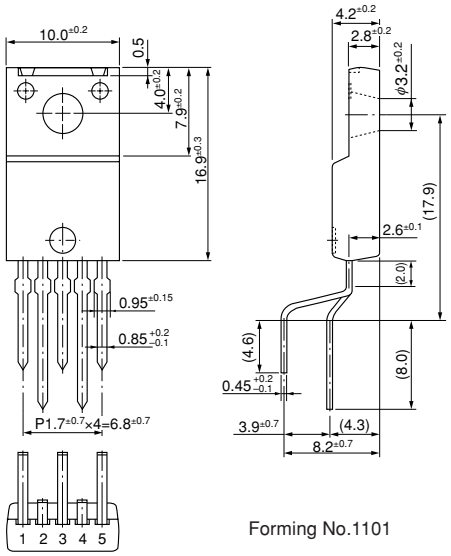
*5: Pin 5 is the ON/OFF pin. Soft start at power on can be performed with a capacitor connected to this pin.
The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to V_{SSL} or lower. ON/OFF-pin voltage can be changed with an open-collector drive circuit of a transistor. When using both the soft-start and ON/OFF functions together, the discharge current from C_3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C_3 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.



$V_{OUT.}$ ON/OFF | Soft start | Soft start +$V_{OUT.}$ ON/OFF

■External Dimensions (TO220F-5)

(Unit : mm)



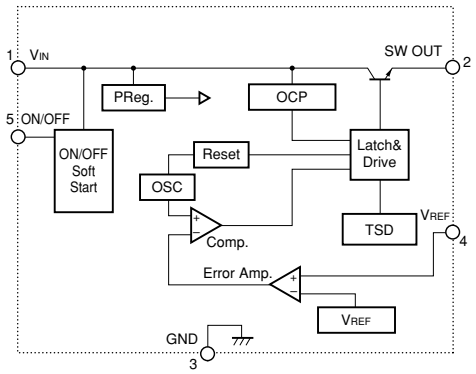
Forming No.1101

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

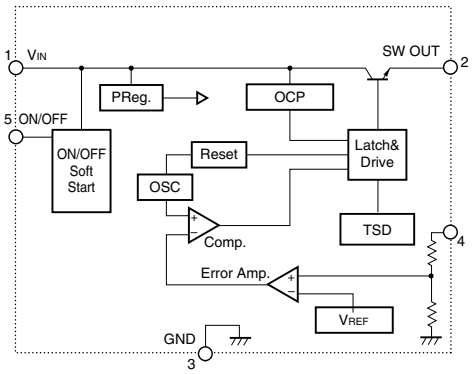
Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 2.3g

■Block Diagram

SI-8015JF

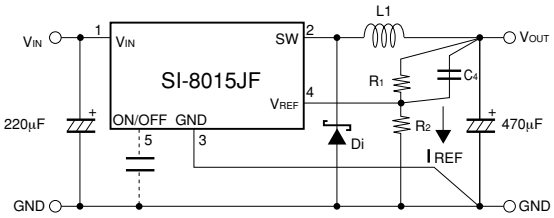


8033JF, 8050JF, 8120JF



■Typical Connection Diagram

SI-8015JF

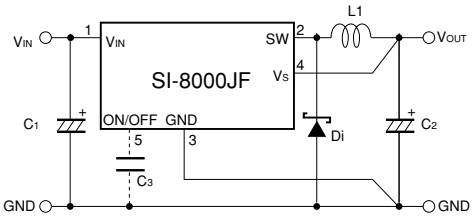


IREF shall be approx. 2mA.

C1 : 50V/220μF
C2 : 25V/470μF
C3 : 10V/0.47μF (Only when using soft-start function)
C4 : 6800pF
L1 : 100μH
Di : RK16 (Sanken)

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

8033JF, 8050JF, 8120JF



C1 : 50V/220μF
C2 : 25V/470μF
C3 : 10V/0.47μF (Only when using soft-start function)
L1 : 100μH
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 Vo = 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: 200μA 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	$P_{D1\text{-}1}$	17.8 (with infinite heatsink)	W	Limited by thermal protection, T_{jmax}=150°C
	$P_{D1\text{-}2}$	14.2 (with infinite heatsink)		T_{jmax}=125°C
	$P_{D2\text{-}1}$	2.15 (without heat sink, standalone operation)		Limited by thermal protection, T_{jmax}=150°C
	$P_{D2\text{-}2}$	1.72 (without heatsink, standalone operation)		T_{jmax}=125°C
Junction Temperature*	T_j	–30 to +150	°C	
Storage Temperature	T_{stg}	–40 to +150	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	7	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	58	°C/W	

*: This product has built-in thermal protection circuits that may operate when the junction temperature rises above 130°C. The recommended design for the junction temperature during operation is below 125°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		°C
Operating Temperature Range	T_{op}	–20 to +85		°C

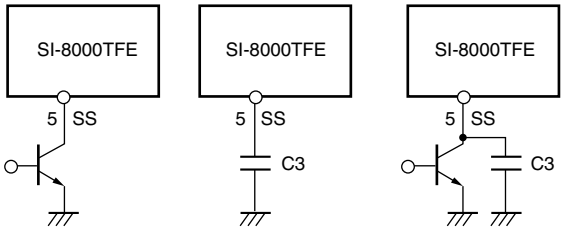
*1: The minimum value of an input voltage range is the higher of 4.5 V or V_O + 3 V.

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol		Ratings SI-8008TFE min.	typ.	max.	Ratings SI-8050TFE min.	typ.	max.	Unit
Output Voltage		Vo					4.90	5.00	5.10	
Reference Voltage		V_{ADJ}		0.784	0.800	0.816				V
			Conditions	V_{IN}=15V, I_o=0.1A			V_{IN}=15V, I_o=0.1A			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T$						±0.5		
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T$			±0.1					mV/°C
			Conditions	V_{IN}=15V, I_o=0.1A, T_C=0 to 100°C			V_{IN}=15V, I_o=0.1A, T_C=0 to 100°C			
Efficiency		η			81			81		%
			Conditions	V_{IN}=15V, I_o=0.5A			V_{IN}=15V, I_o=0.5A			
Oscillation Frequency		fo			300			300		kHz
			Conditions	V_{IN}=15V, I_o=0.5A			V_{IN}=15V, I_o=0.5A			
Line Regulation		ΔV_{OLINE}			60	80		60	80	mV
			Conditions	V_{IN}=10 to 30V, I_o=0.5A			V_{IN}=10 to 30V, I_o=0.5A			
Load Regulation		ΔV_{OLOAD}			10	40		10	40	mV
			Conditions	V_{IN}=15V, I_o=0.2 to 1.5A			V_{IN}=15V, I_o=0.2 to 1.5A			
Overcurrent Protection Starting Current		I_S		1.6			1.6			A
			Conditions	V_{IN}=15V			V_{IN}=15V			
ON/OFF Pin*	Low Level Voltage	V_{SSL}				0.5			0.5	V
	Outflow Current at Low Voltage	I_{SSL}			10	40		10	40	µA
			Conditions	V_{SSL}=0V			V_{SSL}=0V			
Quiescent Circuit Current		I_q			6			6		mA
			Conditions	V_{IN}=15V, I_o=0A			V_{IN}=15V, I_o=0A			
		$I_{q(OFF)}$			200	400		200	400	µA
			Conditions	V_{IN}=15V, V_{SS}=0V			V_{IN}=15V, V_{SS}=0V			

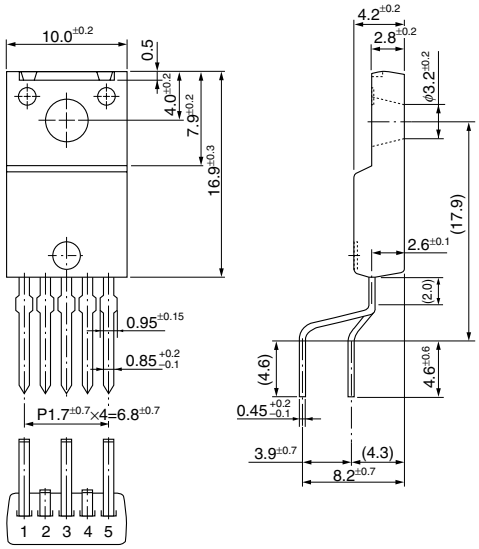
*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to VSSL or lower. SS-pin voltage can be changed with an open-collector drive circuit of 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.



Vo.ON/OFF　　Soft start　　Soft start +Vo.ON/OFF

■External Dimensions (TO220F-5)

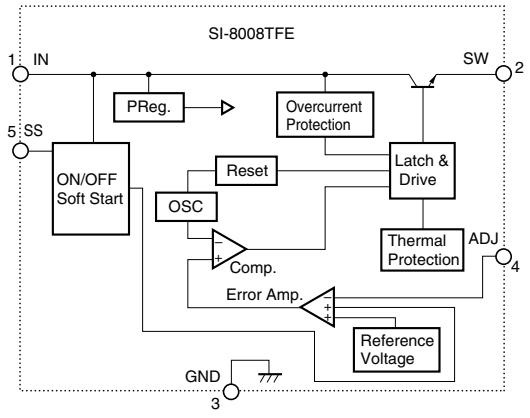
(Unit : mm)



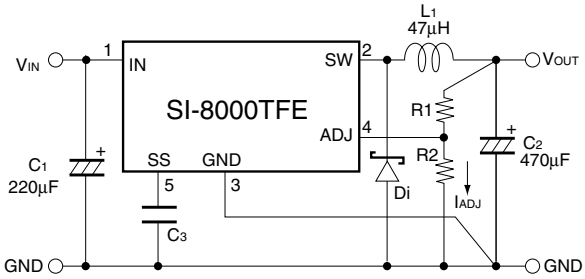
Pin Assignment
① IN
② SW
③ GND
④ ADJ
⑤ SS

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 (Vref) 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)	$\theta_{j\text{-}c}$	28	°C/W
Thermal Resistance (junction to ambient air)	$\theta_{j\text{-}a}$	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)*1 to 50	V
Output Voltage Range	V_O	1 to 14	V
Output Current Range*2	I_O	0.02 to 1.5*2	A
Operating Junction Temperature Range	T_{jop}	–30 to +125	°C
Operating Temperature Range	T_{op}	–30 to +125	°C

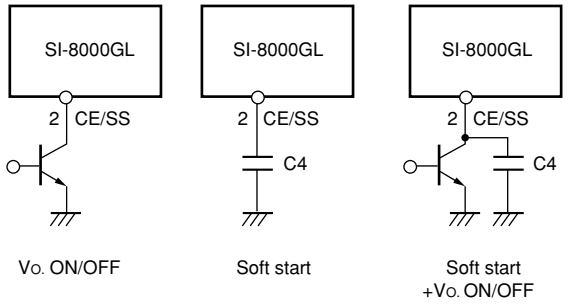
*1: The minimum value of an input voltage range is the higher of either 8V or V_O+3V.
*2: Please be sure to let the output current run more than 20 mA. When using by less than 20 mA, there is a possibility that the output voltage becomes unstable.

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol	Ratings SI-8010GL (Variable type) min.	typ.	max.	Unit
Reference Voltage		V_{REF}	0.97	1.00	1.03	V
		Conditions	V_{IN}=12V, I_O=1A			
Efficiency		Eff		86		%
		Conditions	V_{IN}=20V, I_O=1A, V_O=5V			
Oscillation Frequency		F_{OSC}		250		kHz
		Conditions	V_{IN}=12V, I_O=1A			
Line Regulation		ΔV_{OLINE}		20	40	mV
		Conditions	V_{IN}=10 to 30V, I_O=1A			
Load Regulation		ΔV_{OLOAD}		10	30	mV
		Conditions	V_{IN}=12V, I_O=0.1 to 1.5A			
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T_a$		±0.5		mV/°C
Overcurrent Protection Starting Current		I_S	1.6			A
		Conditions	V_{IN}=12V			
Quiescent Circuit Current		I_q		7		mA
		Conditions	V_{IN}=12V, I_O=0A			
Circuit Current at Output OFF		$I_{q(OFF)}$			400	μA
		Conditions	V_{IN}=12V, $V_{ON/OFF}$=0.3V			
CE/SS* Terminal	Low Level Voltage	V_{SSL}			0.5	V
	Terminal Outflow Current at Low Voltage	I_{SSL}			50	μA
		Conditions	V_{SSL}=0V			

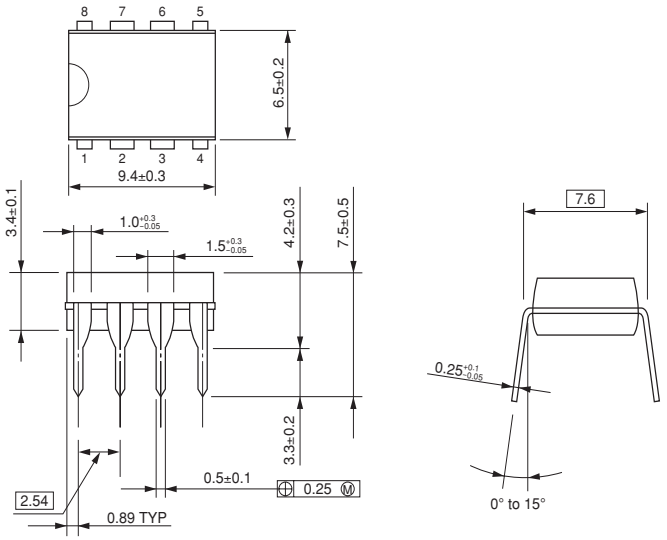
*: Pin 2 is the CE/SS pin. Soft start at power on can be performed with a capacitor connected to this pin.The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to V_{SSL} or lower. CE/SS-pin voltage can be changed with an open-collector drive circuit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



V_O ON/OFF　Soft start　Soft start +V_O ON/OFF

■External Dimensions (DIP8)

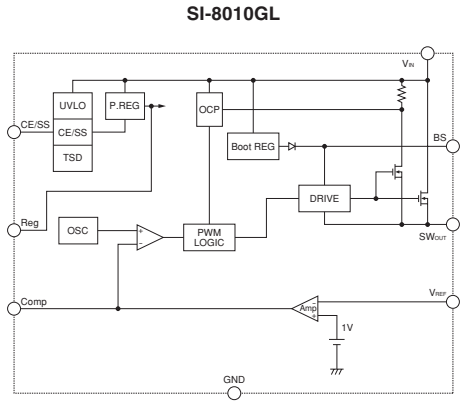
(Unit: mm)



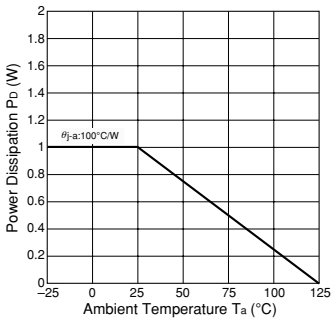
Pin Assignment
1. GND
2. CE/SS
3. Reg
4. SW_{OUT}
5. V_{IN}
6. BS
7. Comp
8. V_{REF}

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

■Block Diagram



■T_a-P_D Characteristics



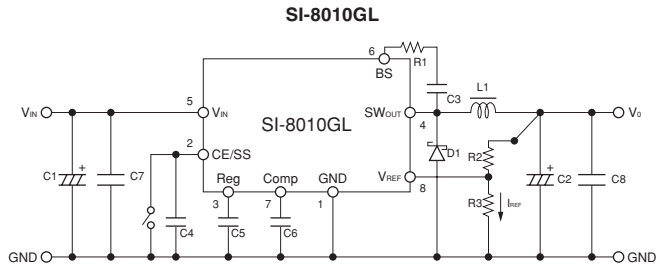
$$P_D = V_O \cdot I_O \left(\frac{100}{\eta\chi} - 1 \right) - V_F \cdot I_O \left(1 - \frac{V_O}{V_{IN}} \right)$$

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_1 must be considered separately.

V_O : Output voltage
V_{IN} : Input voltage
I_O : Output current
$\eta\chi$: Efficiency
V_F : Diode D_1 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)

$$R2 = \frac{(V_{OUT} - V_{REF})}{I_{REF}} = \frac{(V_{OUT} - 1)}{2\times10^{-3}} (\Omega),\ R3 = \frac{V_{REF}}{I_{REF}} = \frac{1}{2\times10^{-3}} \fallingdotseq 500(\Omega)$$

Diode D_1
- Be sure to use a Schottky-barrier diode as D_1. 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.
- 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_1, C_2
- 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.

Resistors R_2, R_3
- R_2 and R_3 are the resistors to set the output voltage. Set their values so that I_{REF} becomes approx. 2 mA. Obtain R_2 and R_3 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 ± 2%
- Oscillation frequency: 500 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
- Power supply for switches

■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 mm² 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))	$\theta_{j\text{-}c}$	25	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	67	°C/W	When mounted on a 70 × 60 mm glass-epoxy board (with a 1310 mm² 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

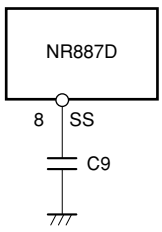
*: The minimum value of the input voltage range is 4.5 V or V_O + 3 V, whichever is higher.

■Electrical Characteristics

(Ta=25°C, V_{IN}=12V, V_O=3.3V, and I_O=1.0A, 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		$\Delta V_{REF}/\Delta T$		±0.05		mV/℃	Ta=–40℃ to +85℃
Efficiency		η		90		%	
Oscillation Frequency		fo	400	500	600	kHz	
Line Regulation		V_{LINE}		50		mV	V_{IN}=6.3V 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}=10Ω pull up to V_{IN}
Quiescent Circuit Current 2		$I_{IN(off)}$			10	μA	I_o=0A, V_{EN}=0V
SS Pin	Outflow Current at Low Voltage	$I_{EN/SS}$	6	10	14	μA	V_{SS}=0V
	Open Voltage	V_{SSH}		3.0		V	
EN Pin	Inflow Current	I_{EN}		50	100	μA	V_{EN}=10V
	On Threshold Voltage	$V_{C/EH}$	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		℃	
Thermal Protection Return Hysteresis		TSD_hys		20		℃	

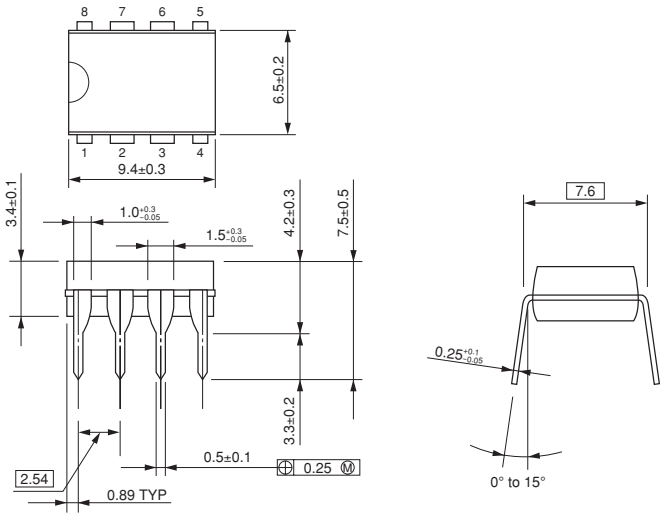
*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.
The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



Soft start

■External Dimensions (DIP8)

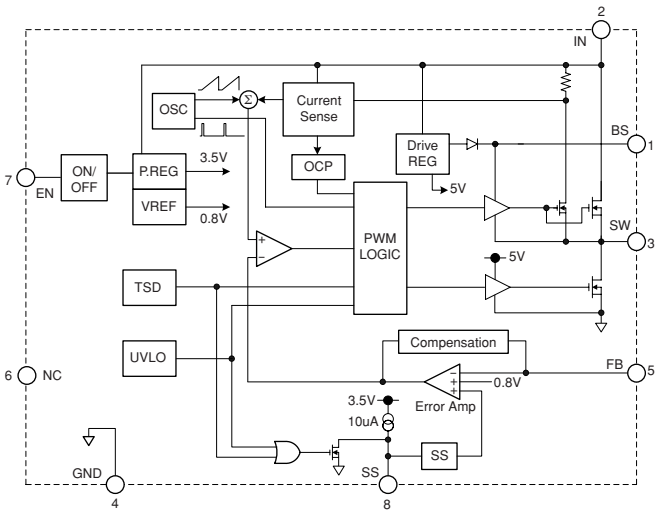
(Unit : mm)



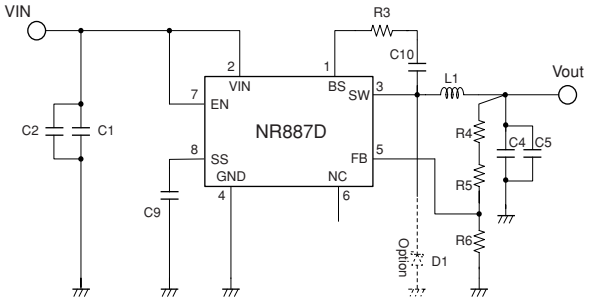
Pin Assignment
① BS
② VIN
③ SW
④ GND
⑤ FB
⑥ NC
⑦ EN
⑧ SS

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)

■Applications

- Power supplies for telecommunication equipment
- Onboard local power supplies

■Lineup

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

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	43*	V
Power Dissipation	P_{D1}	18(With infinite heatsink)	W
	P_{D2}	1.5(Without heatsink, stand-alone operation)	W
Junction Temperature	T_j	+125	°C
Storage Temperature	T_{stg}	–40 to +125	°C
SW Terminal Applied Reverse Voltage	V_{SW}	–1	V
Thermal Resistance(junction to case)	$\theta_{j\text{-}c}$	5.5	°C/W

*35V for SI-8033S

■Recommended Operating Conditions

Parameter	Symbol	Ratings					Unit
		SI-8033S	SI-8050S	SI-8090S	SI-8120S	SI-8150S	
DC Input Voltage Range	V_{IN}	5.5 to 28	7 to 40	12 to 40	15 to 40	18 to 40	V
Output Current Range	I_O	0 to 3.0					A
Operating Junction Temperature Range	T_{jop}	–30 to +125					°C

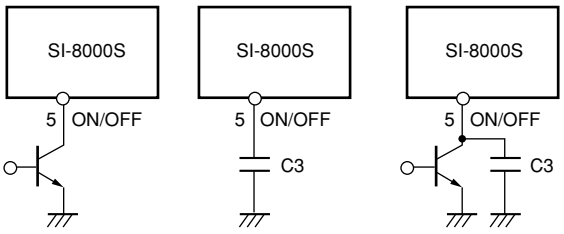
■Electrical Characteristics

(T_a=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_O	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_{IN}=15V, I_O=1.0A			V_{IN}=20V, I_O=1.0A			V_{IN}=21V, I_O=1.0A			V_{IN}=24V, I_O=1.0A			V_{IN}=25V, I_O=1.0A			
Efficiency		η		79			84			88			90			91		%
	Conditions		V_{IN}=15V, I_O=1.0A			V_{IN}=20V, I_O=1.0A			V_{IN}=21V, I_O=1.0A			V_{IN}=24V, I_O=1.0A			V_{IN}=25V, I_O=1.0A			
Oscillation Frequency		f		60			60			60			60			60		kHz
	Conditions		V_{IN}=15V, I_O=1.0A			V_{IN}=20V, I_O=1.0A			V_{IN}=21V, I_O=1.0A			V_{IN}=24V, I_O=1.0A			V_{IN}=25V, I_O=1.0A			
Line Regulation		ΔV_{OLINE}		25	80		40	100		50	120		60	130		60	130	mV
	Conditions		V_{IN}=8 to 28V, I_O=1.0A			V_{IN}=10 to 30V, I_O=1.0A			V_{IN}=15 to 30V, I_O=1.0A			V_{IN}=18 to 30V, I_O=1.0A			V_{IN}=21 to 30V, I_O=1.0A			
Load Regulation		ΔV_{OLOAD}		10	30		10	40		10	40		10	40		10	40	mV
	Conditions		V_{IN}=15V, I_O=0.5 to 1.5A			V_{IN}=20V, I_O=0.5 to 1.5A			V_{IN}=21V, I_O=0.5 to 1.5A			V_{IN}=24V, I_O=0.5 to 1.5A			V_{IN}=25V, I_O=0.5 to 1.5A			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.5			±0.5			±1.0			±1.0			±1.0		mV/°C
Overcurrent Protection Starting Current		I_{S1}	3.1			3.1			3.1			3.1			3.1			A
	Conditions		V_{IN}=15V			V_{IN}=20V			V_{IN}=21V			V_{IN}=24V			V_{IN}=25V			
Soft Start Pin*2	Low-Level Voltage	V_{SSL}		0.2			0.2			0.2			0.2			0.2		V
	Outflow Current at Low Voltage	I_{SSL}	15	25	35	15	25	35	15	25	35	15	25	35	15	25	35	μA
	Conditions		V_{SSL}=0.2V															

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

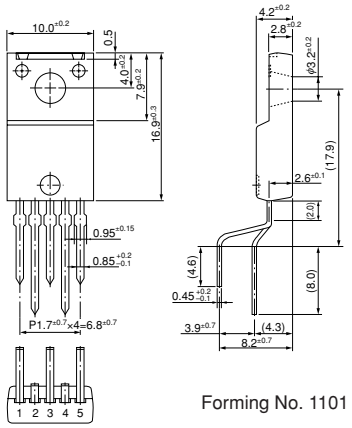
*2:Pin 5 is a soft start pin. Soft start at power on can be performed with a capacitor connected to this pin.
The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to V_{SSL} or lower.
Soft-start pin voltage can be changed with an open-collector drive circuit of a transistor.
When using both the soft-start and ON/OFF functions together, the discharge current from C_3 flows into the ON/OFF control transistor. Therefore, limit the current securely to protect the transistor if C_3 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.



$V_{OUT.}$ ON/OFF　Soft start　Soft start +$V_{OUT.}$ ON/OFF

■External Dimensions (TO220F-5)

(Unit : mm)

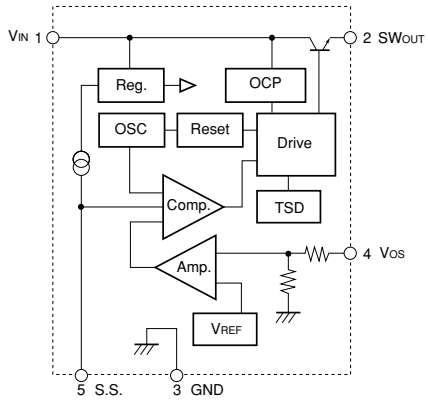


Forming No. 1101

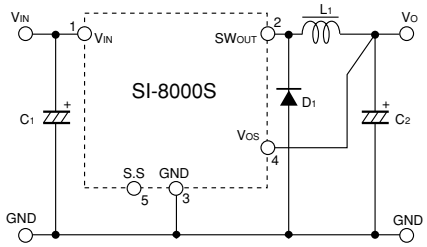
Pin Assignment
① V_{IN}
② SW_{OUT}
③ GND
④ V_{OS}
⑤ S.S

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

■Block Diagram

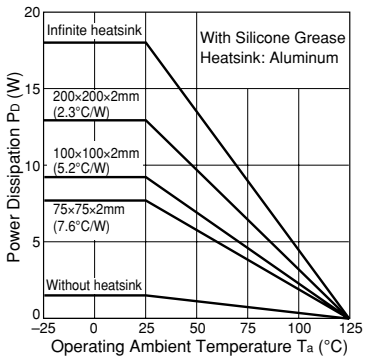


■Typical Connection Diagram



$C_{1,2}$: 1000μF
L_1 : 150μH
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
ηx : 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% (Vo=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*1	P_D	1.56	W	When mounted on glass-epoxy board measuring 70×60 mm (copper laminate area: 1310 mm^2)
Junction Temperature*2	Tj	–30 to +150	°C	
Storage Temperature	Tstg	–40 to +150	°C	
Thermal Resistance (Junction to Case)	θj-c	25	°C/W	
Thermal Resistance (Junction to Ambient Air)	θj-a	64	°C/W	When mounted on glass-epoxy board measuring 70×60 mm (copper laminate area: 1310 mm^2)

*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}	Vo+3*1 to 28	V	
Output Voltage Range	Vo	0.5 to 24	V	
Output Current Range	Io	0 to 3.5	A	
Operating Junction Temperature Range	Tjop	–30 to +125	°C	
Operating Temperature Range	Top	–30 to +85	°C	

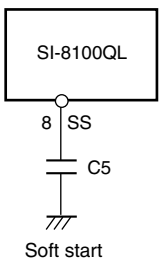
*1: The minimum value of the input voltage range is 4.75 V or Vo +3 V, whichever is higher.

■Electrical Characteristics

(When Ta=25°C and Vo=5V)

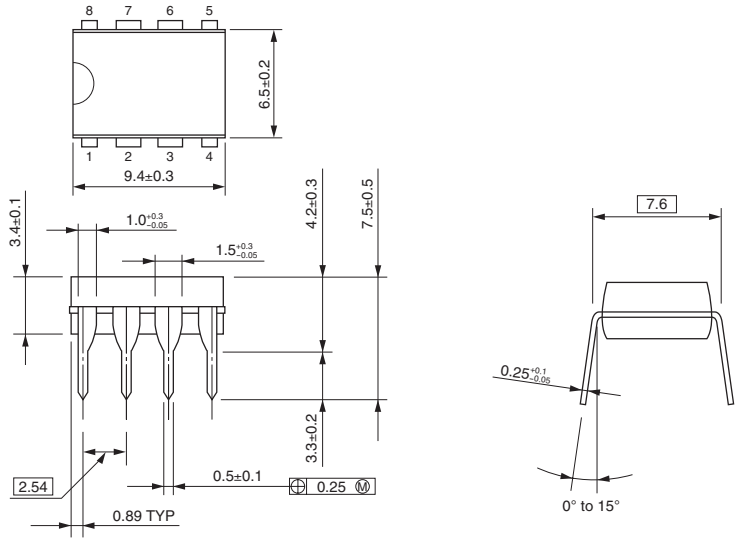
Parameter		Symbol	Ratings SI-8105QL min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	0.485	0.500	0.515	V
		Conditions	V_{IN}=12V, Io=1A			
Temperature Coefficient of Reference Voltage		$(\Delta V_{ADJ}/\Delta T)$		0.05		mV/°C
		Conditions	V_{IN}=12V, Io=1A, Ta=–40 to +85°C			
Efficiency		η		90		%
		Conditions	V_{IN}=12V, Io=1A			
Oscillation Frequency		fo	315	350	385	kHz
		Conditions	V_{IN}=16V, Io=1A			
Line Regulation		ΔV_{OLINE}		30	60	mV
		Conditions	V_{IN}=8 to 28V, Io=1A			
Load Regulation		ΔV_{OLOAD}		30	60	mV
		Conditions	V_{IN}=12V, Io=0.1 to 3.5A			
Overcurrent Protection Starting Current		Is	3.6		6.0	A
		Conditions	V_{IN}=12V			
Quiescent Circuit Current		Iq		18		mA
		Conditions	V_{IN}=12V, Io=0A, V_{EN}=open			
		$I_{q(OFF)}$			20	μA
		Conditions	V_{IN}=12V, Io=0A, V_{EN}=0V			
SS Pin	Outflow Current at Low Voltage	I_{SSL}		5		μA
		Conditions	V_{IN}=12V, V_{SSL}=0V			
EN Pin	High Level Voltage	$V_{C/EH}$	2.8			V
		Conditions	V_{IN}=12V			
	Low Level Voltage	$V_{C/EL}$			2.2	V
		Conditions	V_{IN}=12V			
	Inflow Current at Low Voltage	$I_{C/EH}$		5		μA
		Conditions	V_{EN}=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)

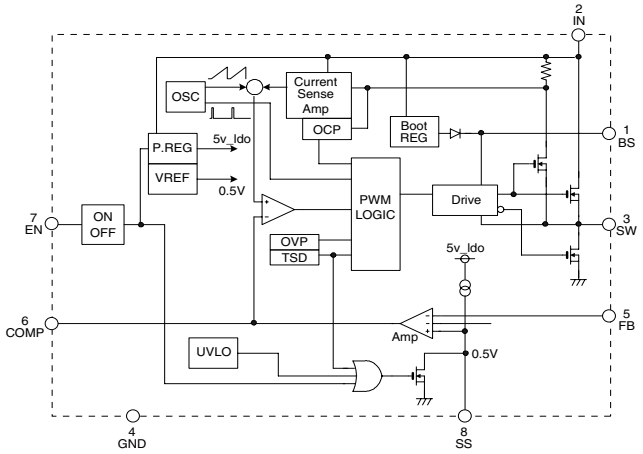
(Unit : mm)



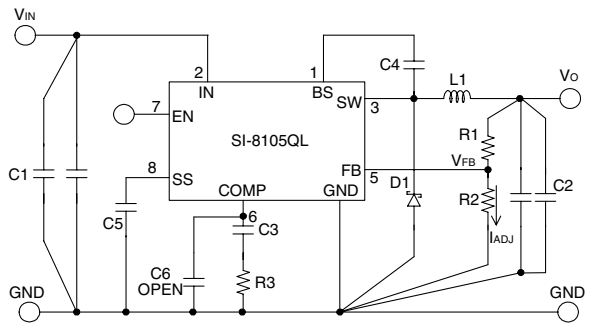
Pin Assignment
① BS
② IN
③ SW
④ GND
⑤ FB
⑥ COMP
⑦ EN
⑧ SS

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*1
(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*1

*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% (Vo = 5 V, V_{IN} = 15 V, Io = 2 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
Vo (V)	Variable (0.8 to 24)
Io (A)	3.5
Function	Soft start

■Absolute Maximum Ratings

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

*: 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
		SI-8001FFE	
Input Voltage Range	V_{IN}	Vo+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	°C
Operating Temperature Range	T_{op}	–30 to +85	°C

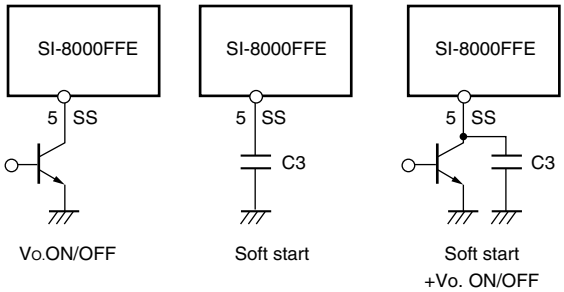
*: The minimum value of the input voltage range is 4.5 V or Vo +3 V, whichever is higher.

■Electrical Characteristics

(R1=4.2kΩ, R2=0.8kΩ when Ta=25°C and Vo=5V)

Parameter		Symbol	Ratings			Unit
			SI-8001FFE			
			min.	typ.	max.	
Reference Voltage		V_{ADJ}	0.784	0.800	0.816	V
		Conditions	V_{IN}=15V, Io=0.2A			
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T$		±0.1		mV/°C
		Conditions	V_{IN}=15V, Io=0.2A, Tc=0 to 100°C			
Efficiency		η		83		%
		Conditions	V_{IN}=15V, Io=2A			
Oscillation Frequency		fo	270	300	330	kHz
		Conditions	V_{IN}=15V, Io=2A			
Line Regulation		ΔV_{OLINE}		55	80	mV
		Conditions	V_{IN}=10 to 30V, Io=2A			
Load Regulation		ΔV_{OLOAD}		15	50	mV
		Conditions	V_{IN}=15V, Io=0.2 to 3.5A			
Overcurrent Protection Starting Current		I_S	3.6			A
		Conditions	V_{IN}=15V			
SS Pin	Low Level Voltage	V_{SSL}			0.5	V
	Outflow Current at Low Voltage	I_{SSL}		6	30	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			
Quiescent Circuit Current		I_q		6		mA
		Conditions	V_{IN}=15V, Io=0A			
		$I_{q(OFF)}$		200	600	μA
		Conditions	V_{IN}=15V, V_{SS}=0V			

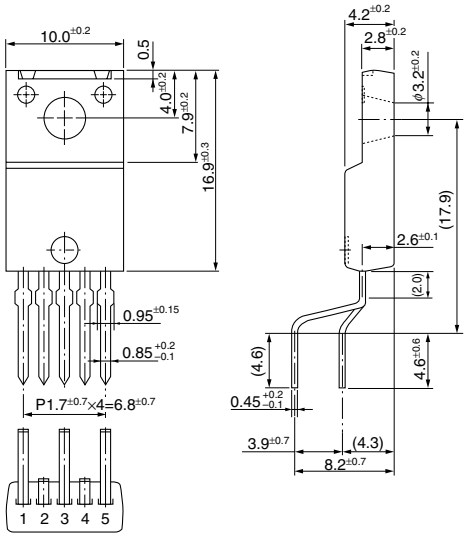
*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin.
The output is stopped by setting the voltage of this pin to VSSL or lower. SS-pin voltage can be changed with an open-collector drive circuit of 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.



Vo.ON/OFF | Soft start | Soft start +Vo. ON/OFF

■External Dimensions (TO220F-5)

(Unit : mm)



Pin Assignment

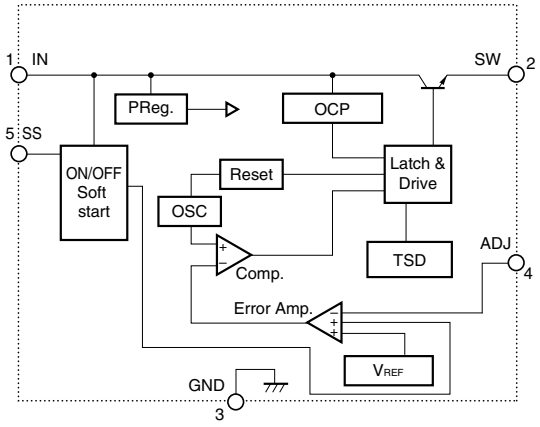
① IN
② SW
③ GND
④ ADJ
⑤ SS

Plastic Mold Package Type

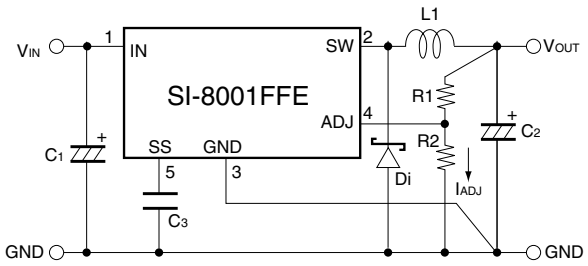
Flammability: UL 94V-0

Product Mass: Approx. 2.3 g

■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 V ± 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^2 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))	$\theta_{j\text{-}c}$	41	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	85	°C/W	When mounted on 70 × 60 mm glass-epoxy board (with a 1310 mm^2 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**	℃

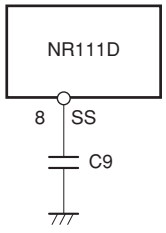
*: The minimum value of the input voltage range is indicated value or V_O + 3 V, whichever is higher.
**: The device must be used within the range indicated by the Ta-PD characteristics.

■Electrical Characteristics

(Ta=25°C, V_{IN}=12V, V_O=5.0V, and I_O=1A, unless otherwise specified)

Parameter		Symbol	Ratings			Unit	Conditions
			NR111D				
			min.	typ.	max.		
Reference Voltage		V_{REF}	0.784	0.800	0.816	V	
Temperature Coefficient of Output Voltage		$\Delta V_{REF}/\Delta T$		±0.05		mV/°C	Ta=–40°C to +85°C
Oscillation Frequency		f_{SW}		350		kHz	
Line Regulation		V_{LINE}		50		mV	V_{IN}=VINmin to 30V
Load Regulation		V_{Load}		50		mV	V_{IN}=12V, V_o=5.0V, I_O=0.1 to I_{omax}
Overcurrent Protection Starting Current		I_s1		1.5		A	ISET=OPEN
		I_s2		5.5		A	ISET=SHORT
No-load Circuit Current		I_{IN}		1		mA	V_{EN}=10kΩ pull up to V_{IN}
Quiescent Circuit Current		$I_{IN(off)}$		1		μA	Io=0A, V_{EN}=0V
SS Pin	Outflow Current at Low Voltage	$I_{EN/SS}$	6	10	14	μA	V_{SS}=0V
EN Pin	Inflow Current	I_{EN}		20	50	μA	V_{EN}=10V
	On Threshold Voltage	$V_{C/EH}$	0.7	1.4	2.1	V	
ISET Pin	Open Voltage	V_{ISET}		1.5		V	
Maximum ON Duty		D_{MAX}		90		%	
Minimum ON Time		$T_{ON(MIN)}$		150		nsec	
Thermal Protection Start Temperature		TSD	151	165		°C	
Thermal Protection Return Hysteresis		TSD_hys		20		°C	
SW MOSFET ON Resistance		$R_{on}H$		105		mΩ	

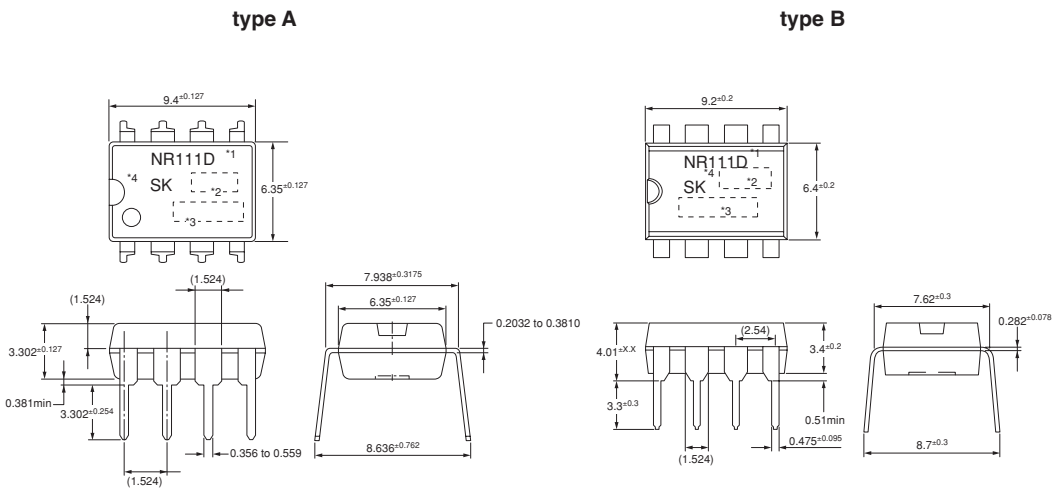
*: Pin 8 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin.
The SS pin is pulled up to the power supply in the IC, so applying the external voltage is prohibited.



Soft start

■External Dimensions (DIP8)

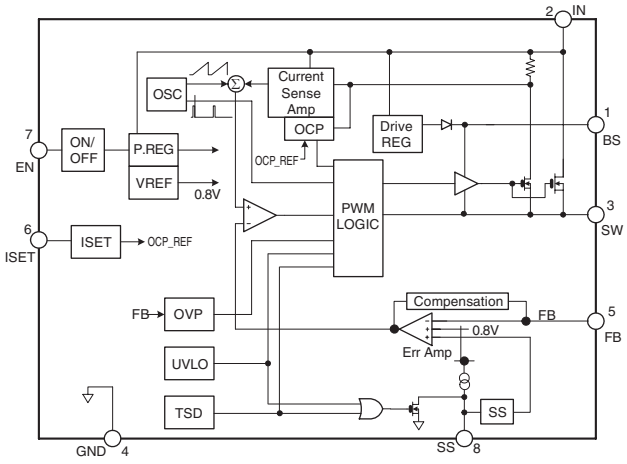
(Unit : mm)



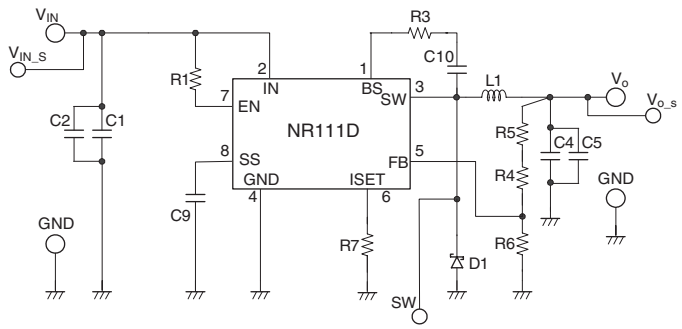
Pin Assignment
① BS
② V_{IN}
③ SW
④ GND
⑤ FB
⑥ ISET
⑦ EN
⑧ SS

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

■Block Diagram



■Typical Connection Diagram



C1 : 10μF / 35V
C2 : 10μF / 35V
C4 : 22μF / 16V
C5 : 22μF / 16V
C9 : 0.1μF
C10 : 0.1μF
R1 : 1.7MΩ
R3 : 22Ω
R4 : 20kΩ
R5 : 470Ω (Vo=5.0V)
R6 : 3.9kΩ
R7 : 0kΩ (When ISET SHORT)
L1 : 10μH

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 Vo = 5 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	$P_{D1\text{-}1}$	25 (with infinite heatsink)	W	Limited by thermal protection, T_{jmax}=150°C
	$P_{D1\text{-}2}$	20 (with infinite heatsink)		T_{jmax}=125°C
	$P_{D2\text{-}1}$	2.15 (without heat sink, standalone operation)		Limited by thermal protection, T_{jmax}=150°C
	$P_{D2\text{-}2}$	1.72 (without heatsink, standalone operation)		T_{jmax}=125°C
Junction Temperature*	T_j	+150	°C	
Storage Temperature	T_{stg}	–40 to +150	°C	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	5	°C/W	
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	58	°C/W	

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

■Recommended Operating Conditions

Parameter	Symbol	Ratings		Unit
		SI-8008HFE	SI-8050HFE	
Input Voltage Range	V_{IN}	Vo+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		°C
Operating Temperature Range	T_{op}	–30 to +85		°C

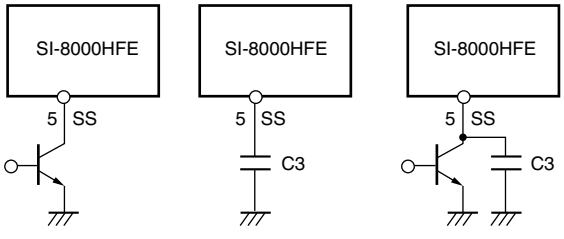
*1: The minimum value of an input voltage range is the higher of 4.5 V or V_O + 3 V.

■Electrical Characteristics

(T_a=25°C)

Parameter		Symbol		Ratings SI-8008HFE (at Vo = 5 V) min.	typ.	max.	Ratings SI-8050HFE min.	typ.	max.	Unit
Output Voltage		Vo					4.90	5.00	5.10	V
Reference Voltage		V_{ADJ}		0.784	0.800	0.816				
			Conditions	V_{IN}=15V, I_o=1A			V_{IN}=15V, I_o=1A			
Temperature Coefficient of Output Voltage		$\Delta Vo/\Delta T$						±0.5		mV/°C
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T$			±0.1					
			Conditions	V_{IN}=15V, I_o=1A, T_c=0 to 100°C			V_{IN}=15V, I_o=1A, T_c=0 to 100°C			
Efficiency		η			83			83		%
			Conditions	V_{IN}=15V, I_o=3A			V_{IN}=15V, I_o=3A			
Oscillation Frequency		fo			150			150		kHz
			Conditions	V_{IN}=15V, I_o=3A			V_{IN}=15V, I_o=3A			
Line Regulation		ΔV_{OLINE}			60	80		60	80	mV
			Conditions	V_{IN}=10 to 30V, I_o=3A			V_{IN}=10 to 30V, I_o=3A			
Load Regulation		ΔV_{OLOAD}			20	50		20	50	mV
			Conditions	V_{IN}=15V, I_o=0.2 to 5.5A			V_{IN}=15V, I_o=0.2 to 5.5A			
Overcurrent Protection Starting Current		I_S		5.6			5.6			A
			Conditions	V_{IN}=15V			V_{IN}=15V			
ON/OFF Pin*	Low Level Voltage	V_{SSL}				0.5			0.5	V
	Outflow Current at Low Voltage	I_{SSL}			10	30		10	30	µA
			Conditions	V_{SSL}=0V			V_{SSL}=0V			
Quiescent Circuit Current		I_q			6			6		mA
			Conditions	V_{IN}=15V, I_o=0A			V_{IN}=15V, I_o=0A			
		$I_{q(OFF)}$			200	400		200	400	µA
			Conditions	V_{IN}=15V, V_{SS}=0V			V_{IN}=15V, V_{SS}=0V			

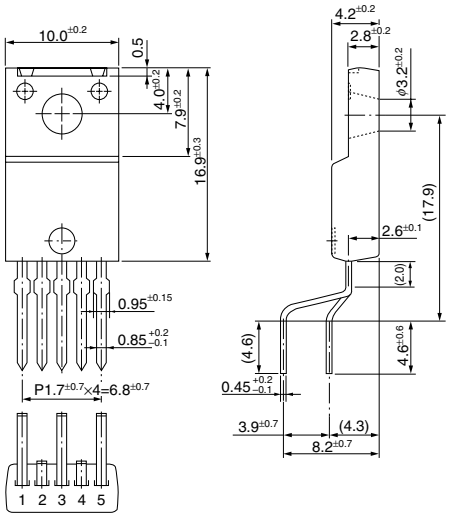
*: Pin 5 is the SS pin. Soft start at power on can be performed with a capacitor connected to this pin. The output can also be turned ON/OFF with this pin. The output is stopped by setting the voltage of this pin to VSSL or lower. SS-pin voltage can be changed with an open-collector drive circuit of 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.



$V_{OUT.}$ ON/OFF | Soft start | Soft start +$V_{OUT.}$ ON/OFF

■External Dimensions (TO220F-5)

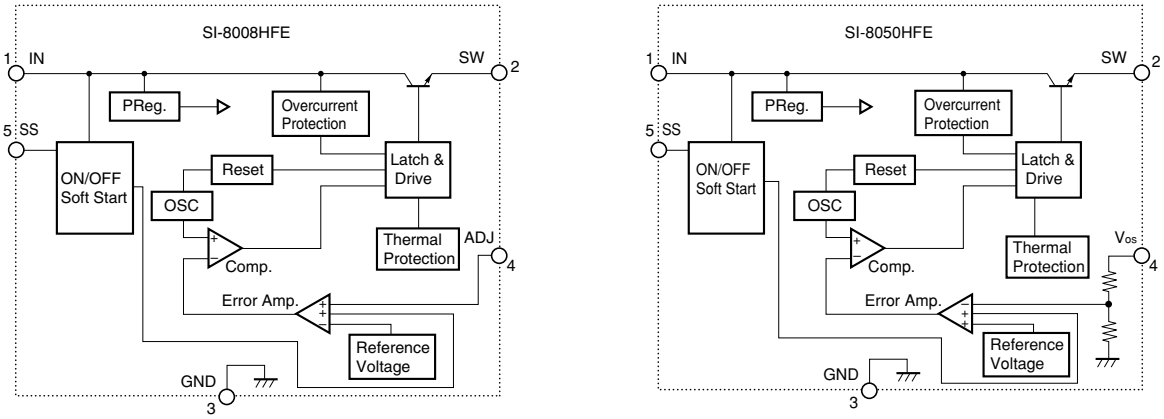
(Unit : mm)



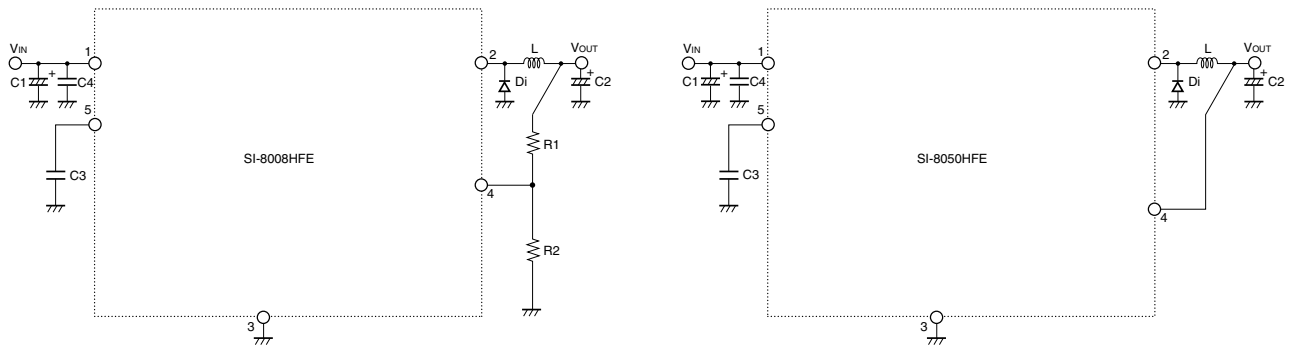
Pin Assignment
① VIN
② SW
③ GND
④ ADJ (VOS for SI-8050HFE)
⑤ SS

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

■Block Diagram



■Typical Connection Diagram



C1 : 1500μF
C2 : 1000μF
C3 :1μF (Only when using soft-start function)
C4 :4.7μF (RPER11H475K5 (Murata Manufacturing) recommended)
L1 :100μH
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

■Applications

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

■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)	$\theta_{j\text{-}c}$	6	°C/W
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	66.7	°C/W

■Recommended Operating Conditions

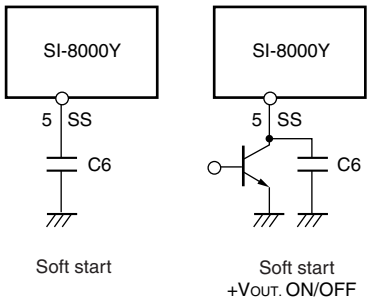
Parameter	Symbol	Raings		Unit
		SI-8010Y	SI-8050Y	
Input Voltage Range	V_{IN}	8 or V_O+3* to 43	8 to 43	V
Output Voltage Range	V_o	1 to 15	5	V
Output Current Range	I_o	0 to 8.0		A
Operating Junction Temperature Range	T_{jop}	–30 to +135		°C
Operating Temperature Range	T_{op}	–30 to +85		°C

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

■Electrical Characteristics

Parameter		Symbol	Ratings						Unit
			SI-8010Y*			SI-8050Y			
			min.	typ.	max.	min.	typ.	max.	
Output Voltage (Reference voltage for SI-8010Y)		V_O(V_{REF})	0.98	1.00	1.02	4.90	5.00	5.10	V
		Conditions	V_{IN}=30V, Io=0.1A			V_{IN}=30V, Io=0.1A			
Temperature Coefficient of Output Voltage (Reference voltage temperature coefficient for SI-8010Y)		$\Delta V_O/\Delta T$($\Delta V_{REF}/\Delta T$)		±0.1			±0.5		mV/°C
		Conditions	V_{IN}=30V, Io=0.1A, Ta=0 to 100°C			V_{IN}=30V, Io=0.1A, Ta=0 to 100°C			
Efficiency		η		86			86		%
		Conditions	V_{IN}=30V, Io=3A			V_{IN}=30V, Io=3A			
Oscillation Frequency		f_o		130			130		kHz
		Conditions	V_{IN}=30V, Io=3A			V_{IN}=30V, Io=3A			
Line Regulation		ΔV_{OLINE}		30	90		30	90	mV
		Conditions	V_{IN}=10 to 43V, Io=3A			V_{IN}=10 to 43V, Io=3A			
Load Regulation		ΔV_{OLOAD}		30	90		30	90	mV
		Conditions	V_{IN}=30V, Io=0.1 to 8A			V_{IN}=30V, Io=0.1 to 8A			
Overcurrent Protection Starting Current		I_s	8.1			8.1			A
		Conditions	V_{IN}=20V			V_{IN}=20V			
Quiescent Circuit Current		I_q		8			8		mA
		Conditions	V_{IN}=30V, Io=0A, EN/SS=open			V_{IN}=30V, Io=0A, EN/SS=open			
		$I_{q(OFF)}$		200	500		200	500	μA
		Conditions	V_{IN}=30V, EN/SS=0V			V_{IN}=30V, EN/SS=0V			
EN/SS Pin*	Outflow Current at Low Voltage	I_{SSL}		10	30		10	30	μA
		Conditions	V_{IN}=30V, EN/SS=0V			V_{IN}=30V, EN/SS=0V			
	Low Level Voltage	V_{SSL}			0.5			0.5	V
		Conditions	V_{IN}=30V			V_{IN}=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

*:R1=8kΩ, R2=2kΩ when Ta=25°C and Vo=5V

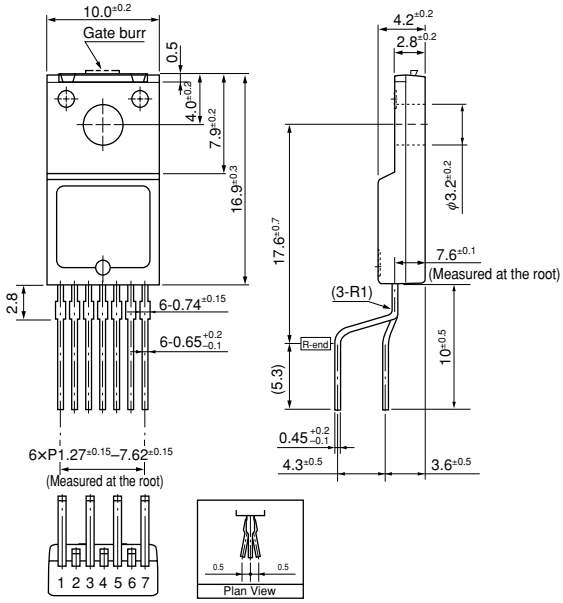


Soft start

Soft start
+$V_{OUT.}$ ON/OFF

■External Dimensions (TO220F-7)

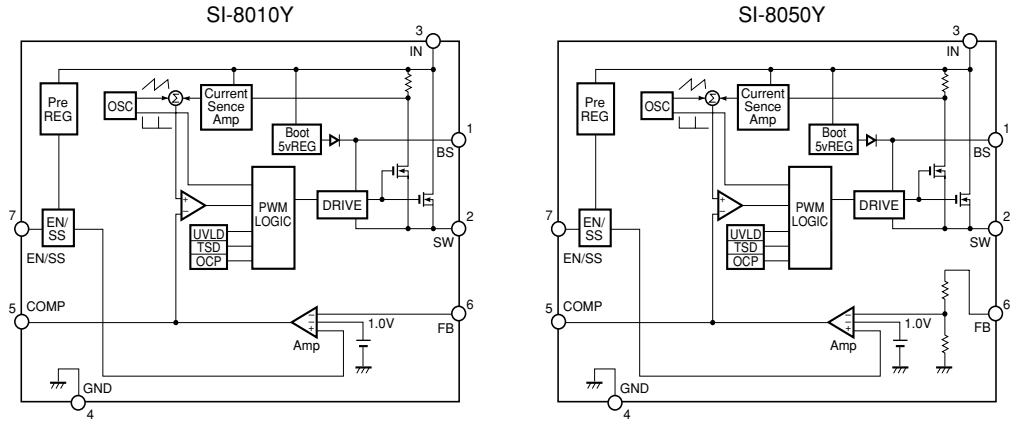
(Unit : mm)



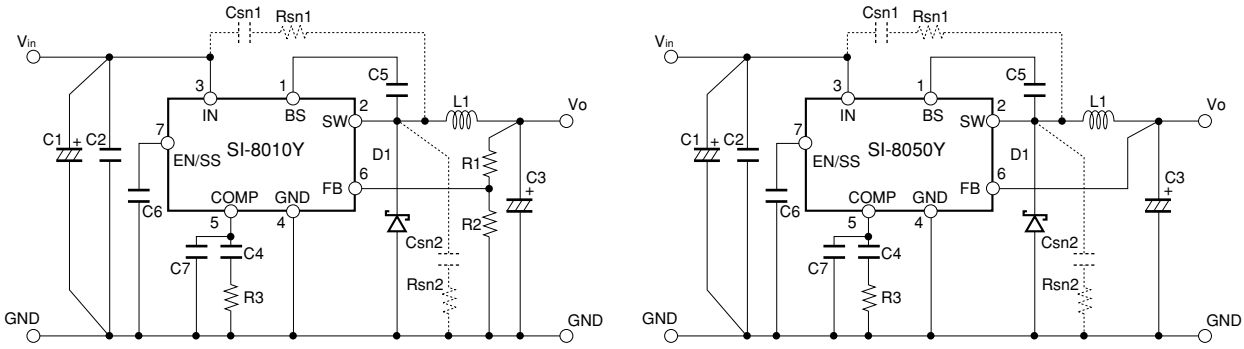
Pin Assignment
① BS
② SW
③ V_{IN}
④ GND
⑤ COMP
⑥ FB
⑦ EN/SS

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

■Block Diagram



■Typical Connection Diagram



SI-8010Y
C1:2200μF/50V
C2:4.7μF/50V
C3:470μF/25V
C4:1200pF*1
C5:0.22μF/50V
C7:680pF*1
L1:47μH
D1:FMW-2156 (Sanken)
R1:8kΩ*1
R2:2kΩ
R3:39kΩ*1

Csn1,2=2200pF (When Vin>40V)
Rsn1,2=10Ω (When Vin>40V)

*1: When Vo=5V

SI-8050Y
C1:2200μF/50V
C2:4.7μF/50V
C3:470μF/25V
C4:1200pF
C5:0.22μF/50V
C7:680pF
L1:56μH
D1:FMW-2156 (Sanken)
R3:39kΩ

Csn1,2=2200pF (When Vin>40V)
Rsn1,2=10Ω (When Vin>40V)

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
V_O(V)	5.0	5.0
I_O(A)	0.5	1.0

■Absolute Maximum Ratings

Parameter	Symbol	Ratings		Unit
		SI-8400L	SI-8500L	
DC Input Voltage	V_{IN}	35		V
Power Dissipation	P_D	1.25	3	W
Junction Temperature	T_j	+100		°C
Storage Temperature	T_{stg}	–25 to +85		°C

■Recommended Operating Conditions

Parameter	Symbol	Ratings	Unit
		SI-8401L	
DC Input Voltage Range	V_{IN}	7 to 33	V
Output Current Range	I_O	0 to 0.5	A
Operating Temperature Range	T_{op}	–20 to +85	°C

Parameter	Symbol	Ratings	Unit
		SI-8501L	
DC Input Voltage Range	V_{IN}	7 to 33	V
Output Current Range	I_O	0 to 1.0	A
Operating Temperature Range	T_{op}	–20 to +85	°C

■Electrical Characteristics

(T_a=25°C)

Parameter	Symbol	Ratings SI-8401L			Unit
		min.	typ.	max.	
Output Voltage	V_O	4.80	5.00	5.20	V
	Conditions	V_{IN}=20V, I_O=0.3A			
Efficiency	η		80		%
	Conditions	V_{IN}=20V, I_O=0.3A			
Oscillation Frequency	f		60		kHz
	Conditions	V_{IN}=20V, I_O=0.3A			
Line Regulation	ΔV_{OLINE}		80	100	mV
	Conditions	V_{IN}=10 to 30V, I_O=0.3A			
Load Regulation	ΔV_{OLOAD}		30	40	mV
	Conditions	V_{IN}=20V, I_O=0.1 to 0.4A			
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±0.5		mV/°C
Switching Ripple Voltage (C_2=470μF)	ΔV_r		20	40	mV_{p-p}
	Conditions	V_{IN}=20V, I_O=0.3A			
Overcurrent Protection Starting Current	I_{S1}	0.55			A
	Conditions	V_{IN}=10V			

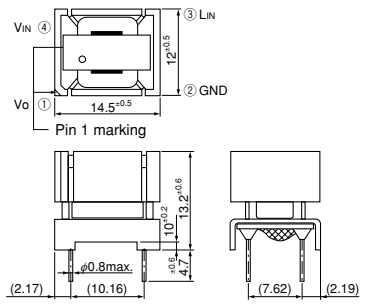
(T_a=25°C)

Parameter	Symbol	Ratings SI-8501L			Unit
		min.	typ.	max.	
Output Voltage	V_O	4.80	5.00	5.20	V
	Conditions	V_{IN}=20V, I_O=0.5A			
Efficiency	η		83		%
	Conditions	V_{IN}=20V, I_O=0.5A			
Oscillation Frequency	f		60		kHz
	Conditions	V_{IN}=20V, I_O=0.5A			
Line Regulation	ΔV_{OLINE}		70	130	mV
	Conditions	V_{IN}=10 to 30V, I_O=0.5A			
Load Regulation	ΔV_{OLOAD}		30	55	mV
	Conditions	V_{IN}=20V, I_O=0.2 to 0.8A			
Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±0.5		mV/°C
Switching Ripple Voltage (C_2=470μF)	ΔV_r		45		mV_{p-p}
	Conditions	V_{IN}=20V, I_O=0.5A			
Overcurrent Protection Starting Current	I_{S1}	1.1			A
	Conditions	V_{IN}=18V			

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

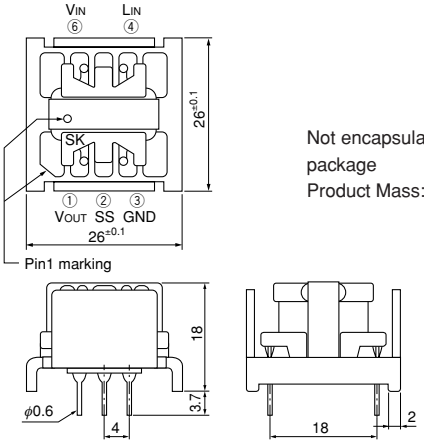
(Unit : mm)

SI-8400L



Not encapsulated in a plastic package
Product Mass: Approx. 5.1g

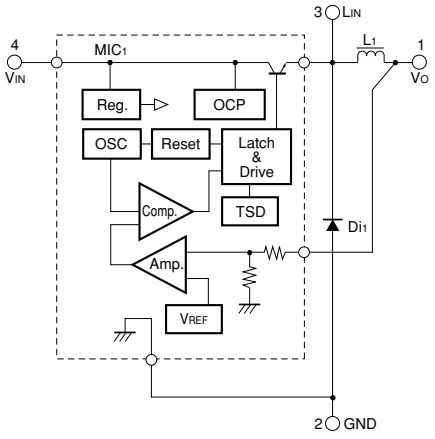
SI-8500L



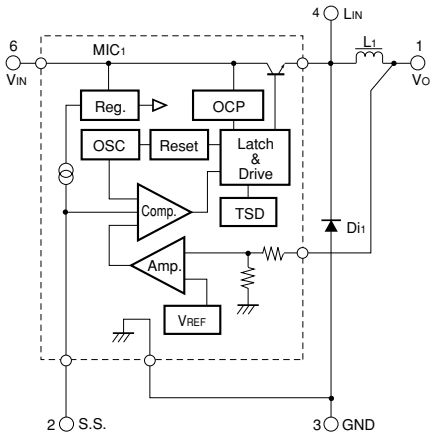
Not encapsulated in a plastic package
Product Mass: Approx. 14.5g

■Block Diagram

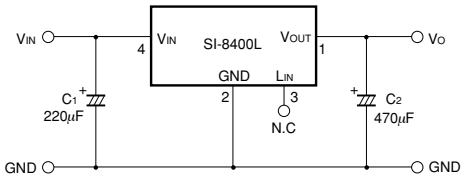
SI-8400L

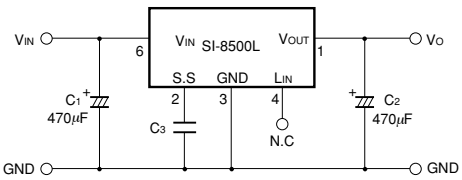


SI-8500L



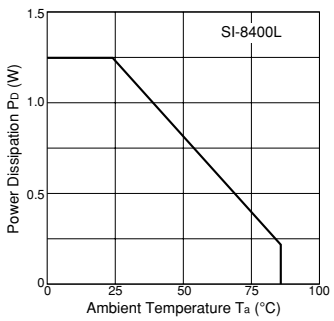
■Typical Connection Diagram

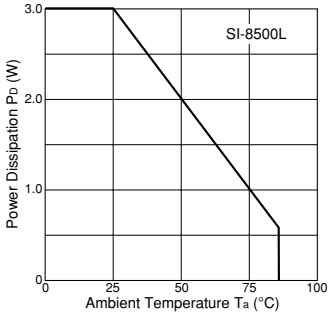




C3 is necessary only for using soft start function.

■Ta-PD Characteristics





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

VO : Output voltage
IO : Output current
ηχ : Efficiency (%)

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

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_{IN}	43	V
Power Dissipation	P_{D1}	6.7(With infinite heatsink)	W
	P_{D2}	1.6(Without heatsink, stand-alone operation)	W
Junction Temperature	T_j	+125	°C
Storage Temperature	T_{stg}	–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_{IN}	Ch2 $V_{Omax.}$+2	40	V
Output Current Range per Channel	I_O	0	0.5	A
Operating Temperature Range	T_{jop}	–20	+125	°C

■Electrical Characteristics

(T_a=25°C)

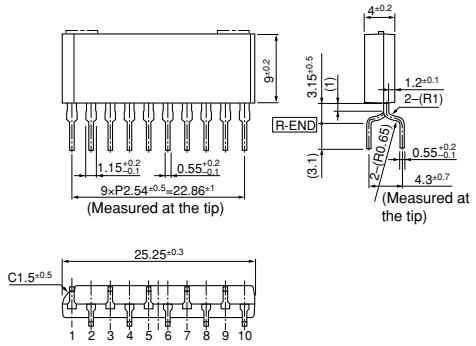
	Parameter	Symbol	Ratings STA801M min.	typ.	max.	Unit
Ch1	Output voltage 1	V_{O1}	4.80	5.00	5.20	V
		Conditions	V_{IN}=20V, I_O=0.3A			
	Efficiency *	η1		80		%
		Conditions	V_{IN}=20V, I_O=0.3A			
	Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_{a1}$		±0.5		mV/°C
	Line Regulation	ΔV_{OLINE1}		30	90	mV
		Conditions	V_{IN}=10 to 30V, I_O=0.3A			
	Load Regulation	ΔV_{OLOAD1}		10	40	mV
		Conditions	V_{IN}=20V, I_O=0.1 to 0.4A			
Ch2 (Select one output)	Output voltage 2-1	V_{O2}-1	8.64	9.00	9.36	V
		Conditions	V_{IN}=20V, I_O=0.3A			
	Output voltage 2-2	V_{O2}-2	11.04	11.50	11.96	V
		Conditions	V_{IN}=20V, I_O=0.3A			
	Output voltage 2-3	V_{O2}-3	11.62	12.10	12.58	V
		Conditions	V_{IN}=20V, I_O=0.3A			
	Output voltage 2-4	V_{O2}-4	14.88	15.50	16.12	V
		Conditions	V_{IN}=20V, I_O=0.3A			
	V_{O2}-4 Efficiency*	η		89		%
		Conditions	V_{IN}=20V, I_O=0.3A			
	Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T_a$		±2.0		mV/°C
	Line Regulation	ΔV_{OLINE}		40	130	mV
		Conditions	V_{IN}=20 to 30V, I_O=0.3A			
	Load Regulation	ΔV_{OLOAD}		30	120	mV
		Conditions	V_{IN}=20V, I_O=0.1 to 0.4A			
Common	No-load Circuit Current	I_{CC}		15		mA
	Oscillation Frequency	f		125		kHz
	Overcurrent Protection Starting Current	I_{S1}	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])

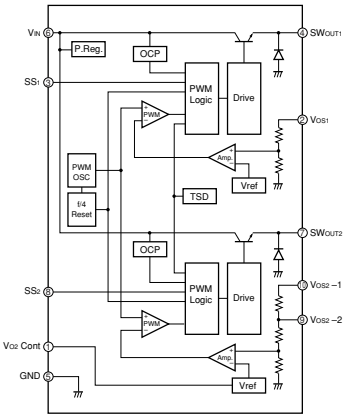
(Unit : mm)



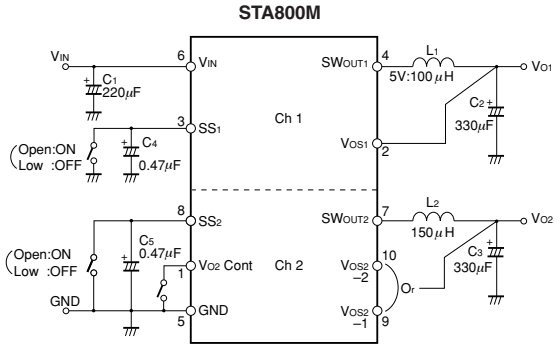
Pin Assignment

①	V_{O2} Cont	⑧	SS2
②	V_{OS1}	⑨	V_{OS2}–2
③	SS1	⑩	V_{OS2}–1
④	SW_{OUT1}		
⑤	GND		Plastic Mold Package Type
⑥	V_{IN}		Flammability: UL94V-0
⑦	SW_{OUT2}		Product Mass: Approx. 2.5g

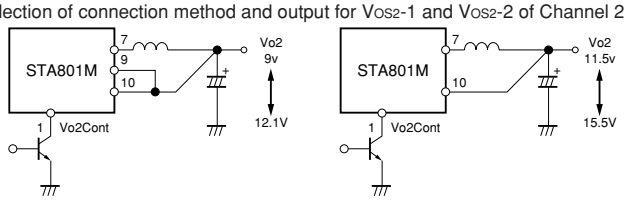
■Block Diagram



■Typical Connection Diagram

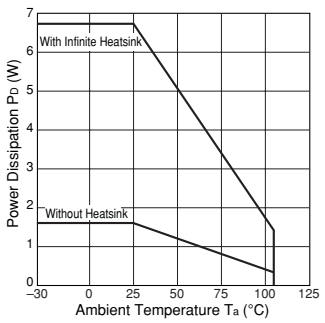


Selection of connection method and output for V_{OS2}-1 and V_{OS2}-2 of Channel 2



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

■T_a-P_D 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: ≤ 1μA (at output OFF)
- High accuracy reference voltage: ±1%
- Built-in foldback-overcurrent and thermal protection circuits
- Built-in ON/OFF circuit (soft start available) – per output

■Absolute Maximum Ratings*1

Parameter	Symbol	Ratings			Unit
		SPI-8001TW	SPI-8002TW	SPI-8003TW	
Input Voltage	V_{IN}	21	40	40	V
	V_{CC}	21	40	40	V
	$V_{C/E}$	21	40	40	V
Power Dissipation*2, *3	P_D	3.0			W
Junction Temperature	T_j	+135		+150	°C
Storage Temperature	T_{stg}	–40 to +135		–40 to +150	°C
Thermal Resistance (junction to case)*2	$\theta_{j\text{-}c}$	9.0			°C/W
Thermal Resistance (junction to ambient air)*2	$\theta_{j\text{-}a}$	35.8			°C/W

*1: Absolute maximum ratings show the destructive limit. No parameter should exceed the ratings in transient or normal operations.
*2: When mounted on glass-epoxy board 70cm^2 (copper laminate area 30.8cm^2).
*3: 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*1

Parameter	Symbol	Ratings						Unit
		SPI-8001TW		SPI-8002TW		SPI-8003TW		
		min.	max.	min.	max.	min.	max.	
Input Voltage Range	V_{IN}	V_O+3	20	V_O+3	38	V_O+3	38	V
	V_{CC}	4.5	20	4.5	38	4.5	38	V
	$V_{C/E}$		20		38		38	V
Output Voltage Range	V_O	1	16	1	24	1	24	V
Output Current Range	I_O		1.5		1.5		1.5	A
Operating Junction Temperature Range	T_{jop}	–30	+135	–30	+135	–30	+125	°C
Operating Temperature Range	T_{op}	–30	+135	–30	+135	–30	+85	°C

*1: 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[*1]

(T_a=25°C)

Parameter		Symbol	Ratings									Unit
			SPI-8001TW			SPI-8002TW			SPI-8003TW			
			min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	
Reference Voltage		V_{REF}	0.996	1.006	1.016	0.996	1.006	1.016	0.966	1.006	1.016	V
		Conditions	V_{IN}=10V, V_O=1V, I_O=0.1A						V_{IN}=14V, I_O=0.1A			
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T$		±0.1			±0.1			±0.1		mV/°C
		Conditions	V_{IN}=10V, V_O=1V, I_O=0.1A, Ta=–30 to +135°C						V_{IN}=14V, I_O=0.1A, Ta=–30 to +125°C			
Efficiency 1[*2]		Eff1		80			78			78		%
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.5A, I_{IN}: including I_{CC}						V_{IN}= V_{CC}=14V, V_O=5V, I_O=0.5A, I_{IN} : including I_{CC}			
Efficiency 2[*2]		Eff2		83			81			81		%
		Conditions	V_{IN}=15V, V_O=5V, I_O=0.5A, V_{CC}=5V, I_{IN}: excluding I_{CC}						V_{IN}=14V, V_{CC}=5V, V_O=5V, I_O=0.5A, I_{IN}: excluding I_{CC}			
Oscillation Frequency		f_{osc}		250		215	250	285	200		400	kHz
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.5A						V_{IN}=14V, I_O=0.1A, C_{OSC}=100pF			
Line Regulation		V_{LINE}		30	60		30	60		30	60	mV
		Conditions	V_{IN}=V_{CC}=10 to 20V, V_O=5V, I_O=1A						V_{IN}=V_{CC}=9 to 18V, V_O=5V, I_O=1A			
Load Regulation		V_{LOAD}		10	40		10	40		10	40	mV
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.2 to 1.5A						V_{IN}=V_{CC}=14V, V_O=5V, I_O=0.2 to 1.5A			
Overcurrent Protection Starting Current		I_S	1.6			1.6			1.6			A
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
Quiescent Circuit Current 1		I_{IN}		4			4			4		mA
		Conditions	V_{IN}=15V, V_{CC}=5V, I_O=0V, V_O≤12V						V_{IN}=14V, V_{CC}=5V, I_O=0A, V_O≤12V			
Quiescent Circuit Current 2		I_{CC}		8.5			8.5			8.5		mA
		Conditions	V_{CC}=15V, I_O=0A						V_{CC}=14V, I_O=0A			
Quiescent Circuit Current 3		$I_{IN\ (off)}$			1			1			1	μA
		Conditions	V_{IN}=15V, $V_{C/E}$=0V or Open						V_{IN}=14V, $V_{C/E}$=0V or Open			
Quiescent Circuit Current 4		$I_{CC\ (off)}$			1			1			1	μA
		Conditions	V_{CC}=15V, $V_{C/E}$=0V or Open						V_{IN}=14V, $V_{C/E}$=0V or Open			
Quiescent Circuit Current 5		$I_{IN\ (ssov)}$	—							4		mA
		Conditions	—						V_{IN}=14V, V_{CC}=5V, I_O=0A, SS1=SS2=0V			
Quiescent Circuit Current 6		$I_{CC\ (ssov)}$	—							8.5		mA
		Conditions	—						V_{CC}=14V, I_O=0V, SS1=SS2=0V			
C/E Pin	High Level Voltage	$V_{C/EH}$	2			2			2			V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Low Level Voltage	$V_{C/EL}$			0.8			0.8			0.8	V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Inflow Current at High	$I_{C/EH}$		95			95			95		μA
		Conditions	$V_{C/E}$=20V						$V_{C/E}$=20V			
SS Pin[*3]	Low Level Voltage	V_{SSL}			0.5			0.5			0.5	V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Inflow Current at Low	I_{SSL}		60	80		60	80		60	80	μA
		Conditions	V_{SSL}=0V, V_{IN}=V_{CC}=15V						V_{SSL}=0V, V_{IN}=V_{CC}=14V			

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

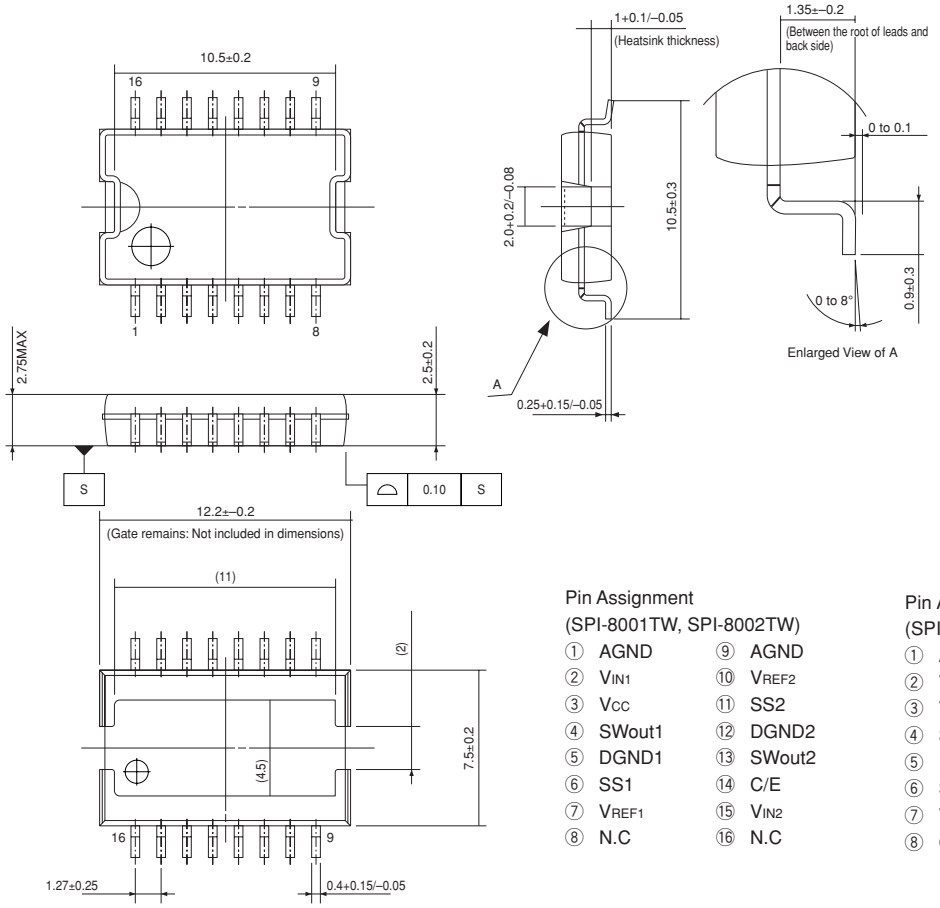
*2: Efficiency is calculated from the following formula.

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

*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_{SSL} 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_4 and C_5 flow into the ON/OFF control transistors respectively. Therefore, limit the currents securely to protect the transistors if C_4 and C_5 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)



Pin Assignment
(SPI-8001TW, SPI-8002TW)

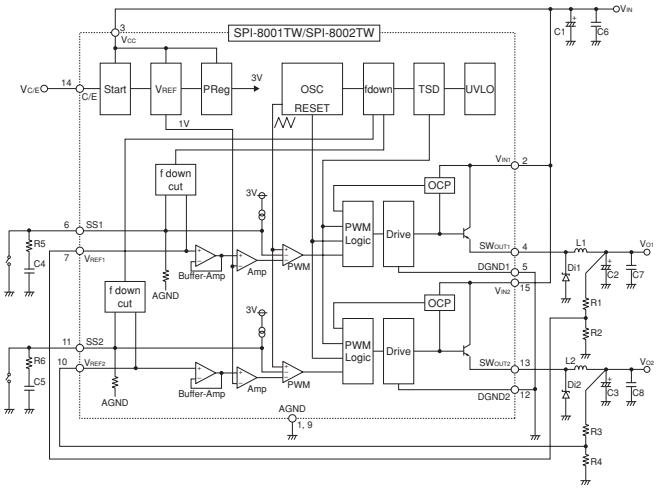
①	AGND	⑨	AGND
②	V_{IN1}	⑩	V_{REF2}
③	V_{CC}	⑪	SS2
④	SWout1	⑫	DGND2
⑤	DGND1	⑬	SWout2
⑥	SS1	⑭	C/E
⑦	V_{REF1}	⑮	V_{IN2}
⑧	N.C	⑯	N.C

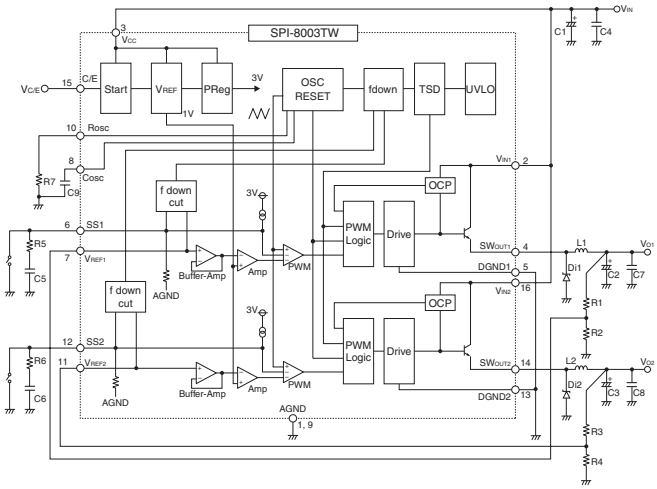
Pin Assignment
(SPI-8003TW)

①	AGND	⑨	AGND
②	V_{IN1}	⑩	Rosc
③	V_{CC}	⑪	V_{REF2}
④	SWout1	⑫	SS2
⑤	DGND1	⑬	DGND2
⑥	SS1	⑭	SWout2
⑦	V_{REF1}	⑮	C/E
⑧	Cosc	⑯	V_{IN2}

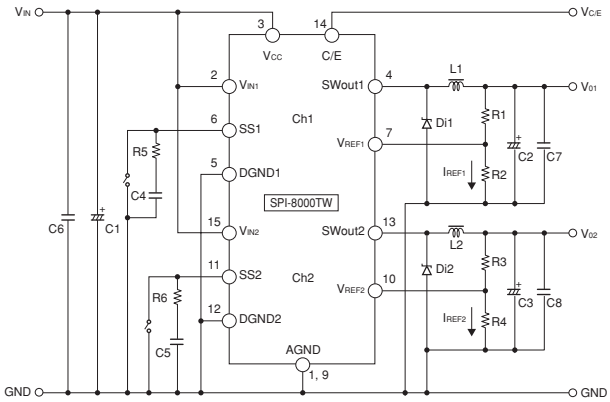
Product Mass : Approx.0.86g

■Block Diagram

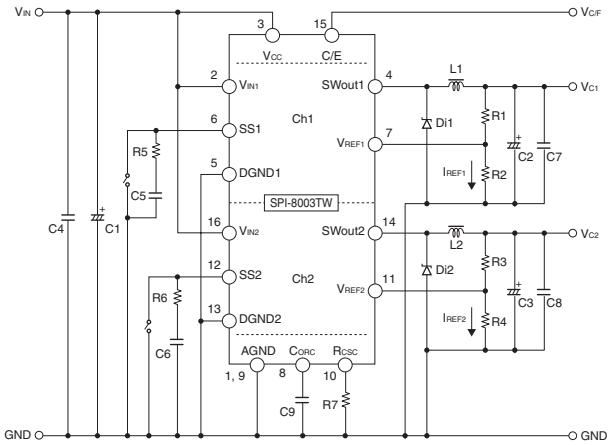




■Typical Connection Diagram



C1	: 220 μF/50V	R5, R6	: 1kΩ
C2, C3	: 470 μF/25V	L1, L2	: 47 μH
C4, C5	: 1 μF	Di1, Di2	: SJPB-H6
C6, C7, C8	: 0.1 μF	(Sanken)	



C1	: 220 μF/50V	C9	: 100pF/10V
C2, C3	: 470 μF/25V	L1, L2	: 47 μH
C4	: 1 μF/50V	R2, R4	: 1kΩ
C5, C6	: 1 μF/10V	R5, R6	: 1kΩ
C7, C8	: 0.1 μF/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 $SW_{out}1$ and $SW_{out}2$.

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.

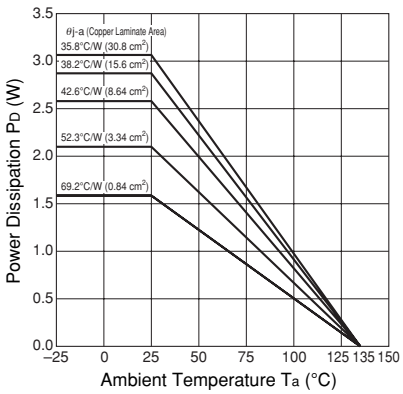
Resistors R1, R2, R3, R4

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

$$R1 = \frac{(V_{O1}-V_{REF1})}{I_{REF1}} = \frac{(V_{O1}-V)}{1\times10^{-3}}\ (\Omega),\ R2 = \frac{V_{REF1}}{I_{REF1}} = \frac{1}{1\times10^{-3}} \fallingdotseq 1\ (K\Omega)$$

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

■T_a-P_D Characteristics



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

V_O : Output Voltage
V_{IN} : Input Voltage
I_O : Output Current
$\eta\chi$: Efficiency (%)
V_F : D_1 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 D_1 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 V_{IN} = 5V, I_O = 1A, V_O = 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 (V_{ref}) 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

(T_a=25°C)

Parameter	Symbol	Ratings	Unit
Control-System DC Input Voltage	V_{CC}	7	V
DC Input Voltage	V_{IN}	25	V
Boost Block Input Voltage	V_H	30	V
EN Terminal Input Voltage	V_{EN}	V_{CC}	V
PWRGD Terminal Applied Voltage	V_{PWRGD}	7	V
Junction Temperature	T_j	+150	°C
Storage Temperature	T_{stg}	–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	V_{CC}	4.5 to 5.5	V
Input Voltage Range	V_{IN}	3 to 18	V
Output Voltage Range	V_O	1.1 to 6	V
Operating Temperature Range	T_{op}	–20 to +85	°C

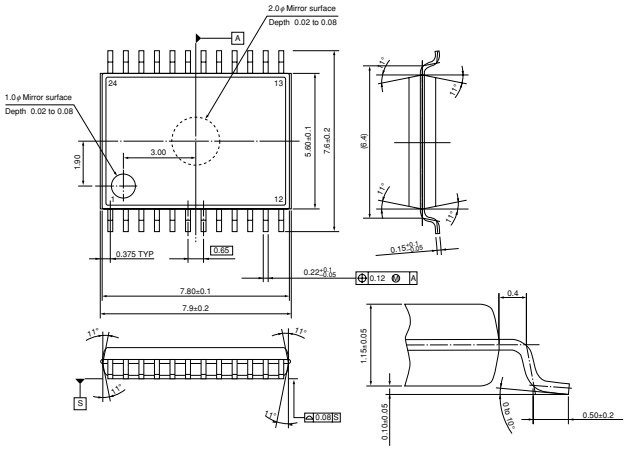
■Electrical Characteristics

(T_a=25°C unless otherwise specified)

Parameter		Symbol	Ratings			Unit	Conditions
			min.	typ.	max.		
Dynamic Characteristics	Output Voltage	V_O	–1.2%	1.1	+1.2%	V	V_{IN}=5V, V_{CC}=5V, VSNS connected to VO, I_O=0A
	Temperature Coefficient of Output Voltage	$\Delta V_O/\Delta T$		±0.03		mV/°C	V_{IN}=5V, V_{CC}=5V, VSNS connected to VO, I_O=0A, T_a=0 to 85°C
Circuit Current	Circuit Current (V_{CC} Terminal)	I_{op}			6	mA	V_{CC}=5V, EN=H, FADJ:open
	Circuit Current (V_{IN} Terminal)	I_{op}			1	mA	V_{IN}=5V, EN=H
	Standby Current 1 (V_{CC} Terminal)	I_{std1}			100	μA	V_{CC}=5V, EN=L
	Standby Current 2 (V_{IN} Terminal)	I_{std2}			50	μA	V_{IN}=5V, EN=L
Undervoltage Lockout	UVLO Operating Voltage 1 (V_{CC} Terminal)	V_{uvlo1}	3.7		4.45	V	V_{IN}=5V
	UVLO Operating Voltage 2 (V_{IN} Terminal)	V_{uvlo2}	2.5		2.9	V	V_{CC}=5V
On Time Control	On Time	T_{on}		1.27		μS	V_{CC}=5V, V_{IN}=5V, V_O=2.5V
	Minimum Off Time	T_{off}		0.7		μS	V_{CC}=5V
	REF Terminal Voltage	V_{ref}	1.1	1.2	1.3	V	V_{CC}=5V
	REF Terminal Source Current	I_{ref}			100	μA	V_{CC}=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	V_{CC}=5V
	On Resistance (low side)	RonLL		5.5		Ω	V_{CC}=5V
Bootstrap	Bootstrap Voltage	VH-VLIN	4.5	5	5.5	V	
Protection System	Current for Current Limit Detection	I_{lim}	90	100	110	μA	V_{CC}=5V, V_{IN}=5V
	Soft Start Terminal Current	I_{ss}		±20		μA	V_{CC}=5V
	EN Low Level Voltage	V_{celo}	0		0.8	V	V_{CC}=5V
	EN High Level Voltage	V_{cehi}	2.4		V_{CC}	V	V_{CC}=5V
	EN Bias Level Current	ICE			5	μA	V_{CC}=5V, EN=5V
	PWRGD Good Voltage (high side)	V_{sens}		1.32		V	V_{CC}=5V
	PWRGD Good Voltage (low side)	V_{sens}		0.88		V	V_{CC}=5V
	PWRGD Low Output Voltage	V_{pwrgd}			0.4	V	V_{CC}=5V, Ipwrgd=120μA
	PWRGD Terminal Current	I_{pwrgd}			120	μA	V_{CC}=5V, Vpwrgd=0.4V
	PWRGD Leakage Current	I_{pwrgd}			5	μA	Vpwrgd=5V

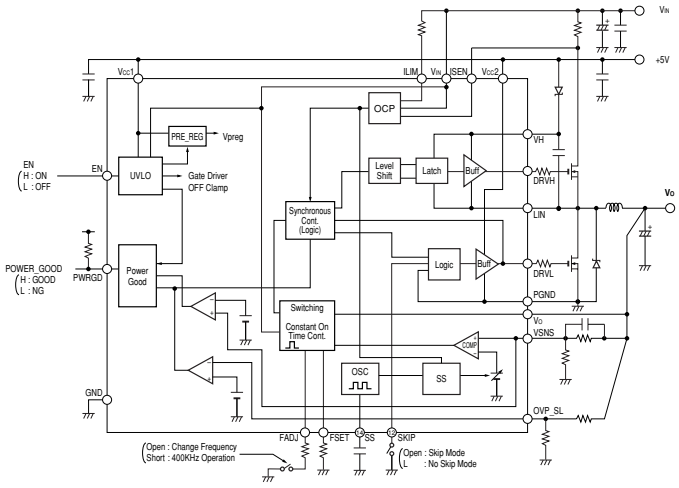
■External Dimensions (TSSOP24)

(Unit : mm)

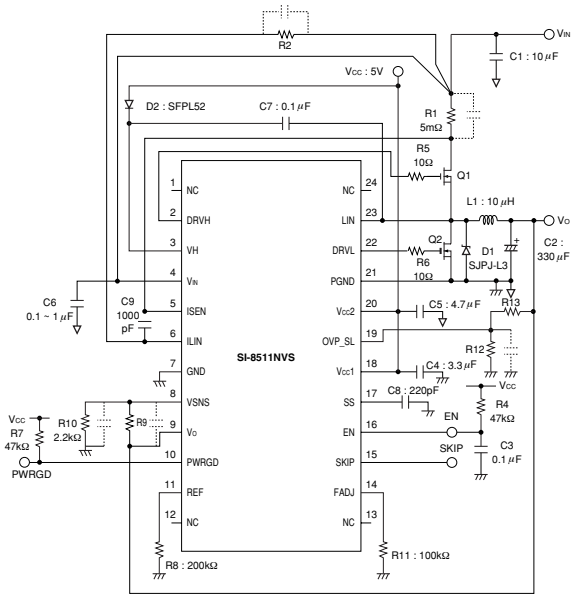


Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 1.36g

■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_1

- Be sure to use a Schottky-barrier diode for D_1.
  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_1, C_2

- 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	Output Voltage (V)				Variable (Reference Voltage) (V)				Dropout Voltage	Maximum Input Voltage	Package	Can Use Low ESR Capacitor	Page
	(A)	1.8	2.5	3.3	5.0	1.0	1.1	1.25	1.28	(V)	(V)			
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	Variable (Reference Voltage) (V)		Dropout Voltage	Maximum Input Voltage	Package	Can Use Low ESR Capacitor	Page
	(A)	1.0	1.1	(V)	(V)			
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

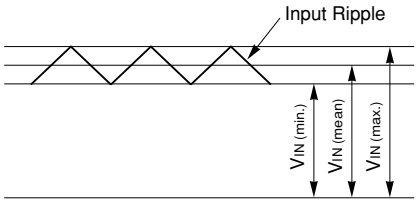
The reliability of an IC is highly dependent on its operating temperature. Please be sure to apply silicone grease to the IC and to mount it to the heatsink with a proper mounting torque.
Heatsink design should pay particular attention to ensuring sufficient heat dissipation capacity.
In addition, please take into account the air convection in operation.

■ Calculating Internal Power Dissipation(P_D)

P_D is given by the following formula:
$P_D = I_O \cdot [V_{IN(mean)} - V_O]$
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 $V_{IN(min)} \geq$ [(Output voltage) + (Minimum dropout voltage)]
●Make $V_{IN(max)} \leq$ DC input voltage shown in the "Absolute Maximum Ratings"

■ 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-3000KF
SI-3000ZF
0.588 to 0.686 [N•m] (6.0 to 7.0 [kgf•cm])

■ 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	
SI-3000KF	AM01Z(Axial Type, V_{RM}:200V, I_O:1.0A)
SI-3000ZF	RM10Z(Axial Type, V_{RM}:200V, I_O:1.5A)

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 Iq (OFF) ≤ 1μA (V_C = 0 V)
- Low dropout voltage: V_{DIF} ≤ 0.5 V (at I_O = 250 mA)
- Output voltage range (1.5V to 15V)
- Built-in drooping-type-overcurrent and thermal protection circuits

■Absolute Maximum Ratings

(T_a=25°C)

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	18	V
Output control terminal voltage	V_C	V_{IN}	V
DC Output Current	I_O	250	mA
Power Dissipation	P_D*1	0.75	W
Junction Temperature	T_j*2	–40 to +135	°C
Storage Temperature	T_{stg}*2	–40 to +125	°C
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$*1	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_{IN}	*2, *3	V_O+2*1	V
DC Output Current	I_O	0	250	mA
Operating Ambient Temperature	T_{op}	–20	85	°C

*1: V_{IN} (max) and I_O (max) are restricted by the relation $P_D = (V_{IN} - V_O) \times I_O$.
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 Vin ≥ 2.4 V, and secure the minimum voltage as explained in "Setting DC Input Voltage" section in Linear Regulator Application Note.

■Electrical Characteristics

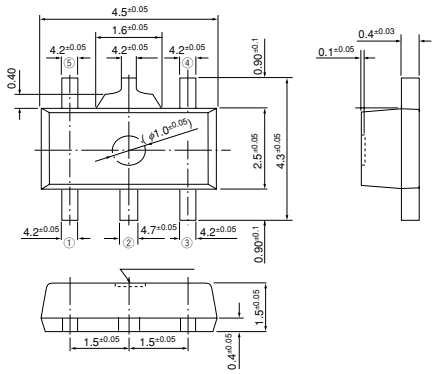
(T_a=25°C, V_C=2V, unless otherwise specified)

Parameter		Symbol	Ratings SI-3012LU(Variable) min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	1.210	1.250	1.290	V
		Conditions	V_{IN}=V_O+1V, I_O=10mA			
Dropout Voltage		V_{DIF}			0.3	V
		Conditions	I_O=100mA(V_O=3.3V)			
					0.5	
		Conditions	I_O=250mA(V_O=3.3V)			
Line Regulation		ΔV_{LINE}			10	mV
		Conditions	V_{IN}=V_O+1 to V_O+5V, I_O=10mA(V_O=3.3V)			
Load Regulation		ΔV_{LOAD}			20	mV
		Conditions	V_{IN}=V_O+1V, I_O=1 to 250mA(V_O=3.3V)			
Temperature Coefficient of Reference Voltage		$\Delta V_O/\Delta T_a$		±0.3		mV/°C
		Conditions	T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		55		dB
		Conditions	V_{IN}=V_O+1V, f=100 to 120Hz(V_O=3.3V)			
Quiescent Circuit Current		I_q			150	μA
		Conditions	V_{IN}=V_O+1V, I_O=0mA V_C=2V, R2=100kΩ			
Circuit Current at Output OFF		I_q(OFF)			1	μA
		Conditions	V_{IN}=V_O+1V, V_C=0V			
Overcurrent Protection Starting Current*1		I_{S1}	260			mA
		Conditions	V_{IN}=V_O+1V			
V_C Terminal	Control Voltage (Output ON)*2	V_C, IH	2.0			V
	Control Voltage (Output OFF)*2	V_C, IL			0.8	
	Control Current (Output ON)	I_C, IH			40	μA
		Conditions	V_C=2V			
	Control Current (Output OFF)	I_C, IL		0	–5	μA
		Conditions	V_C=0V			

*1: I_{S1} is specified at the 5% drop point of output voltage V_O on the condition that V_{IN} = 3.3 V, and I_O = 10 mA.
*2: 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.

■External Dimensions (SOT89-5)

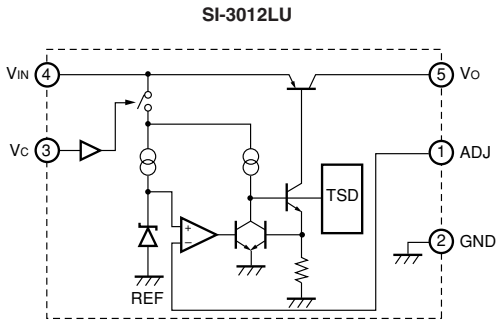
(Unit : mm)



Pin Assignment
① ADJ
② GND
③ V_C
④ V_{IN}
⑤ V_O

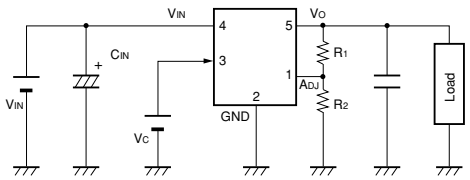
Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 0.05g

■Block Diagram



■Typical Connection Diagram

SI-3012LU

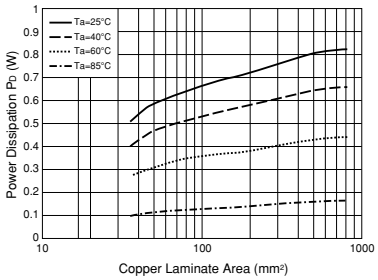


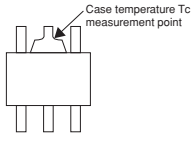
C_O: Output capacitor (10 μF or larger)
For SI-3000LU series, Co has to be a low ESR capacitor such as a ceramic capacitor.
C_{IN}: Input capacitor (10 μF approx.)

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

■Reference Data

Copper Laminate Area vs Power Dissipation
T_j=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_C 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.

$$T_j=P_D\times\theta j\text{–}c+Tc \quad (\theta j\text{–}c=5°C/W)$$

NR301E Surface-Mount, Low Dropout Voltage

■Features

- Adjustable Output voltage type
- Output current: 1 A
- V_{DIF} (V_{IN}-V_{OUT}) ≤0.6 V (at I_O = 1 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_a=25°C)

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	30	V
Output control terminal voltage	V_C	V_{IN}	V
ADJ terminal voltage	V_{ADJ}	5	V
Power Dissipation	P_D	1.4*	W
Junction to Ambient Air Thermal Resistance	$\theta_{j\text{-}a}$	71	°C/W
Thermal Resistance (Junction to Lead (pin 4))	$\theta_{j\text{-}L}$	26	°C/W
Junction Temperature	T_j	–30 to +125	°C
Storage Temperature	T_{stg}	–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_{IN}	2.7	27*	V
DC Output Current	I_O	0	1*	A
Output Voltage Variable Range	$V_{O(ADJ)}$	1.1	16	V
Operating Ambient Temperature	$T_{op(a)}$	–30	85	°C
Operating Junction Temperature	$T_{op(j)}$	–20	100	°C

*: V_{IN} (max) and I_O (max) are restricted by the relation $P_D = (V_{IN} - V_O) \times I_O$.

■Electrical Characteristics

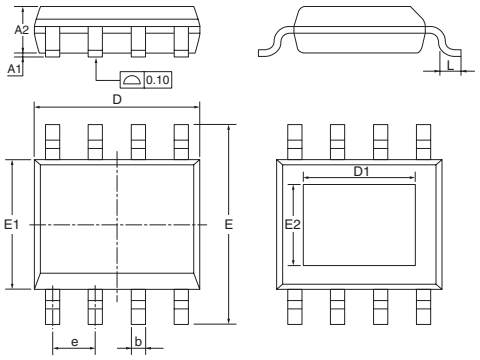
(T_a=25°C, V_C=2V, unless otherwise specified)

Parameter		Symbol	Ratings NR301E			Unit	Conditions
			min.	typ.	max.		
Reference Voltage		V_{ADJ}	0.985	1	1.015	V	
Line Regulation		ΔV_{LINE}	–	25	50	mV	
Load Regulation		ΔV_{LOAD}	–	30	60	mV	
Dropout Voltage		ΔV_{DIF}	–	0.3	0.4	V	I_O=0.5A
			–	0.6	0.8	V	I_O=1.0A
Quiescent Circuit Current		I_q	0.5	0.9	1.6	mA	
Circuit Current at Output OFF		$I_{q(off)}$	–	0	1	μA	
Temperature Coefficient of Reference Voltage		$\Delta V_{ADJ}/\Delta T_a$	–	±0.1	–	mV/°C	
Ripple Rejection		R_{REJ}		55		dB	
Output Control Pin Voltage	Output ON	$V_{C(H)}$	2	–	–	V	
	Output OFF	$V_{C(L)}$	–	–	0.6	V	
Output Control Pin Current	Output ON	$I_{C(H)}$	–	4	40	μA	
	Output OFF	$I_{C(L)}$	–2	0	0.1	μA	
Overcurrent Protection Starting Current*		I_{S1}	1.1	–	–	A	

*: I_{S1} is specified at the 5% drop point of output voltage V_O on the condition that V_{IN} = 3.3 V, and I_O = 10 mA.

■External Dimensions (eSOIC8)

(Unit : mm)



External Dimensions

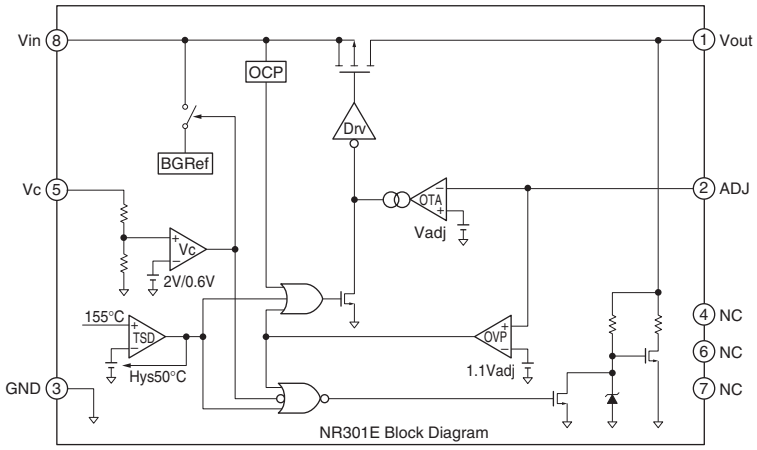
Symbol	Package A			Package B		
	MIN	TYP	MAX	MIN	TYP	MAX
A1	0	–	0.1524	0	0.1	0.15
A2	1.398	1.448	1.498	1.25	1.4	1.65
b	0.33	–	0.508	0.38	–	0.51
D	4.8	4.902	5.004	4.8	4.9	5
D1	3.053	3.18	3.307	3.1	3.3	3.5
E	5.893	–	6.918	5.8	6	6.2
E1	3.73	–	3.89	3.8	3.9	4
E2	2.033	2.16	2.287	2.2	2.4	2.6
e	–	1.27	–	–	1.27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

Delivered in Package A or B.

Pin Assignment
① V_{OUT}
② ADJ
③ GND
④ NC
⑤ V_C
⑥ NC
⑦ NC
⑧ V_{IN}

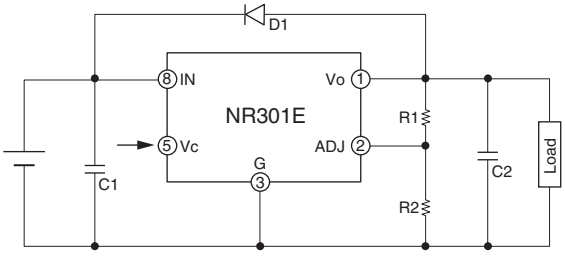
Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 0.1g

■Block Diagram



NR301E 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.

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

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: Iq(OFF) ≤ 1 μA (V_C = 0 V)
- Low dropout voltage: V_{DIF}≤0.8 V (at I_O = 1 A)
  V_{DIF} ≤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_a=25°C)

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	16	V
Output control terminal voltage	V_C	V_{IN}	V
DC Output Current	I_O	1	A
Power Dissipation	P_{D1}*1	1.16	W
	P_{D2}*2	1.1	W
Junction Temperature	T_j*3	–30 to +150	°C
Operating Ambient Temperature	T_{op}	–30 to +150	°C
Storage Temperature	T_{stg}	–30 to +150	°C
Thermal Resistance (Junction to Lead (pin 8))	$\theta_{j\text{-}L}$	36	°C/W
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$*2	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_{IN}	3.1 to 3.5*1	*2 to 3.5*1	*2 to 5.2*1	*2 to 8.0	V
DC Output Current Range	I_O	0 to 1				A
Operating Junction Temperature	T_{jop}	–20 to +125				°C
Operating Ambient Temperature	T_{aop}	–30 to +85				°C

*1: 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 reference data on next page.
*2: Refer to the Dropout Voltage parameter.

■Electrical Characteristics

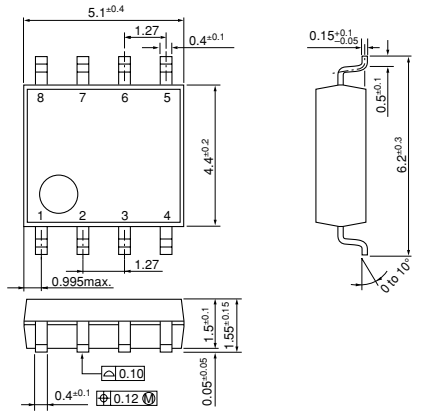
(T_a=25°C, V_C=2V, unless otherwise specified)

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_O	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_{IN}=3.3V, I_O=0.5A			V_{IN}=3.3V, I_O=0.5A			V_{IN}=5V, I_O=0.5A			V_{IN}=6V, I_O=0.5A			
Dropout Voltage		V_{DIF}		–				0.4			0.4			0.4	V
		Conditions		–		I_O≤0.5A			I_O≤0.5A			I_O≤0.5A			
				0.6	1.2			0.8			0.8			0.8	
		Conditions	I_O≤1A												
Line Regulation		ΔV_{LINE}		2	10		2	10		3	10		3	15	mV
		Conditions	V_{IN}=3.1 to 3.5V, I_O=0.3A			V_{IN}=3.1 to 3.5V, I_O=0.3A			V_{IN}=4.5 to 5.5V, I_O=0.3A			V_{IN}=6 to 7V, I_O=0.3A			
Load Regulation		ΔV_{OLOAD}		10	20		10	20		10	20		10	30	mV
		Conditions	V_{IN}=3.3V, I_O=0 to 1A			V_{IN}=3.3V, I_O=0 to 1A			V_{IN}=5V, I_O=0 to 1A			V_{IN}=6V, I_O=0 to 1A			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.3			±0.3			±0.3			±0.5		mV/°C
		Conditions	V_{IN}=3.3V, I_O=5mA, T_j=0 to 100°C			V_{IN}=3.3V, I_O=5mA, T_j=0 to 100°C			V_{IN}=5V, I_O=5mA, T_j=0 to 100°C			V_{IN}=6V, I_O=5mA, T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		60			57			55			55		dB
		Conditions	V_{IN}=3.3V, f=100 to 120Hz			V_{IN}=3.3V, f=100 to 120Hz			V_{IN}=5V, f=100 to 120Hz			V_{IN}=6V, f=100 to 120Hz			
Quiescent Circuit Current		I_q		1.7	2.5		1.7	2.5		1.7	2.5		1.7	2.5	mA
		Conditions	V_{IN}=3.3V, I_O=0A			V_{IN}=3.3V, I_O=0A			V_{IN}=5V, I_O=0A			V_{IN}=6V, I_O=0A			
Circuit Current at Output OFF		I_q(OFF)			1			1			1			1	μA
		Conditions	V_{IN}=3.3V, I_O=0A, V_C=0V			V_{IN}=3.3V, I_O=0A, V_C=0V			V_{IN}=5V, I_O=0A, V_C=0V			V_{IN}=6V, I_O=0A, V_C=0V			
Overcurrent Protection Starting Current*1,3		I_{S1}	1.2			1.2			1.2			1.2			A
		Conditions	V_{IN}=3.3V			V_{IN}=3.3V			V_{IN}=5V			V_{IN}=6V			
V_C Terminal	Control Voltage (Output ON)*2	V_C, IH	2.0			2.0			2.0			2.0			V
	Control Voltage (Output OFF)*2	V_C, IL			0.8			0.8			0.8			0.8	
	Control Current (Output ON)	I_C, IH		40	80		40	80		40	80		40	80	μA
		Conditions	V_C=2V												
	Control Current (Output OFF)	I_C, IL		0	–5		0	–5		0	–5		0	–5	μA
		Conditions	V_C=0V												

*1: I_{S1} is specified at the 5% drop point of output voltage V_O on the condition that V_{IN} = 3.3 V (5 V for SI-3033LSA), and I_O = 0.5 A.
*2: Output is OFF when the output control terminal VC 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_O adjustment by raising ground voltage

■External Dimensions (SOP8)

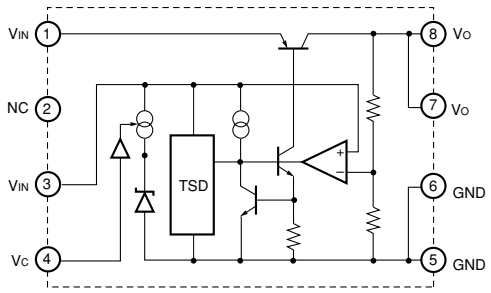
(Unit : mm)



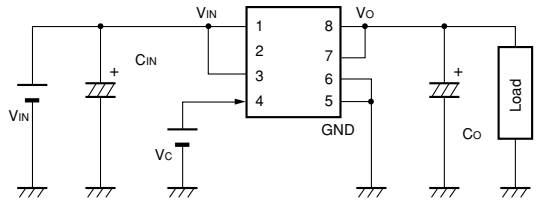
Pin Assignment
① V_{IN}
② NC (Leave open)
③ V_{IN}
④ V_C
⑤ GND
⑥ GND
⑦ V_O
⑧ V_O

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

■Block Diagram



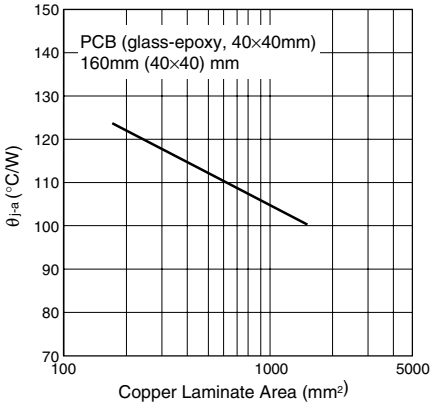
■Typical Connection Diagram



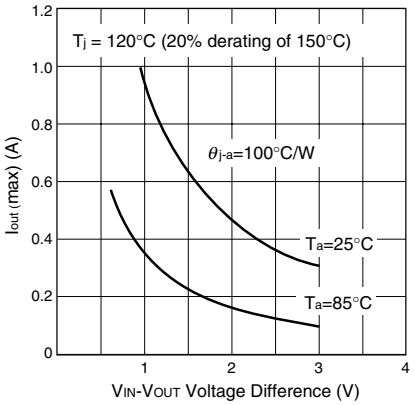
C_O: Output capacitor (22 μF or larger)
C_{IN}: Input capacitor (10 μF)
This capacitor is required in the case of an inductive input line or long wiring.
Tantalum capacitors are recommended for C_{IN} and C_O, particularly at low temperatures.
* Leave pin 2 open.

■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}-Io 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 Iq ≤ 350 μA (I_O = 0 A, V_C = 2 V)
- Low current consumption Iq (OFF) ≤ 1 μA (V_C = 0 V)
- Low dropout voltage V_{DIF} ≤ 0.6 V (I_O = 1 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_a=25°C)

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}*1	17	V
Output Control Terminal Voltage	V_C	V_{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_{stg}	–40 to +125	°C
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	130	°C/W
Thermal resistance (Junction to Lead (pin 7))	$\theta_{j\text{-}L}$	22	°C/W

*1: V_{IN} (max) and I_O (max) are restricted by the relation PD = (V_{IN} - V_O) × 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^2 (copper laminate area 2%).

■Applications

- Local power supplies
- Battery-driven electronic equipment

■Electrical Characteristics

(T_a=25°C, V_C=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_{IN}	2.4			*1			*1			V
Output Voltage (Reference voltage V_{ADJ} for SI-3012KS)		V_O (V_{ADJ})	1.24	1.28	1.32	2.45	2.50	2.55	3.234	3.300	3.366	V
		Conditions	V_{IN}=3.3V, I_O=10mA			V_{IN}=3.3V, I_O=10mA			V_{IN}=5V, I_O=10mA			
Dropout Voltage		V_{DIF}			0.3			0.4			0.4	V
		Conditions	I_O=0.5A (V_O=2.5V)			I_O=0.5A			I_O=0.5A			
					0.6			0.6			0.6	
		Conditions	I_O=1A (V_O=2.5V)			I_O=1A			I_O=1A			
Line Regulation		ΔV_{OLINE}			10			10			15	mV
		Conditions	V_{IN}=3.3 to 8V, I_O=10mA (V_O=2.5V)			V_{IN}=3.3 to 8V, I_O=10mA			V_{IN}=5 to 10V, I_O=10mA			
Load Regulation		ΔV_{OLOAD}			40			40			50	mV
		Conditions	V_{IN}=3.3V, I_O=0 to 1A (V_O=2.5V)			V_{IN}=3.3V, I_O=0 to 1A			V_{IN}=5V, I_O=0 to 1A			
Quiescent Circuit Current		I_q			350			350			350	μA
		Conditions	V_{IN}=3.3V, I_O=0A, V_C=2V, R2=24kΩ			V_{IN}=3.3V, I_O=0A, V_C=2V			V_{IN}=5V, I_O=0A, V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1			1			1	μA
		Conditions	V_{IN}=3.3V, V_C=0V			V_{IN}=3.3V, V_C=0V			V_{IN}=5V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.3			±0.3			±0.3		mV/°C
		Conditions	T_j=0 to 100°C (V_O=2.5V)			T_j=0 to 100°C			T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		55			55			55		dB
		Conditions	V_{IN}=3.3V, f=100 to 120Hz (V_O=2.5V)			V_{IN}=3.3V, f=100 to 120Hz			V_{IN}=5V, f=100 to 120Hz			
Overcurrent Protection Starting Current*2		I_{S1}	1.2			1.2			1.2			A
		Conditions	V_{IN}=3.3V (V_O=2.5V)			V_{IN}=3.3V			V_{IN}=5V			
V_C Terminal	Control Voltage (Output ON)*3	V_C, IH	2.0			2.0			2.0			V
	Control Voltage (Output OFF)	V_C, IL			0.8			0.8			0.8	
	Control Current (Output ON)	I_C, IH			40			40			40	μA
		Conditions	V_C=2V									
	Control Current (Output OFF)	I_C, IL	–5	0		–5	0		–5	0		μA
		Conditions	V_C=0V									

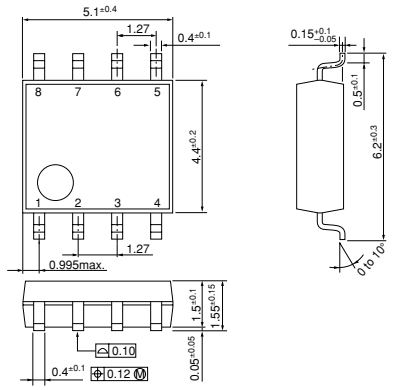
*1: Refer to the Dropout Voltage parameter.

*2: The I_{S1} is specified at the 5% drop point of output voltage V_O on the condition that V_{IN} = V_O + 1 V, and I_O = 10 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)

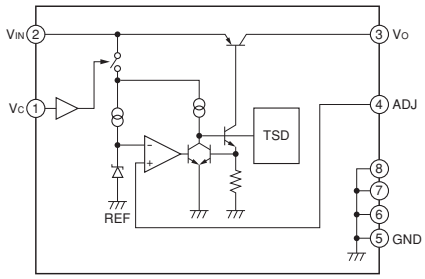


Pin Assignment
① V_C
② V_{IN}
③ V_O
④ Sence (ADJ for SI-3012KS)
⑤ GND
⑥ GND
⑦ GND
⑧ GND

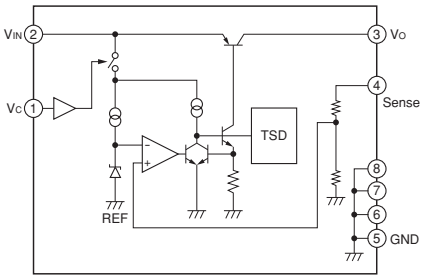
Plastic Mold Package Type
Flammability: UL 94V-0
Product Mass: Approx. 0.1 g

■Block Diagram

●SI-3012KS

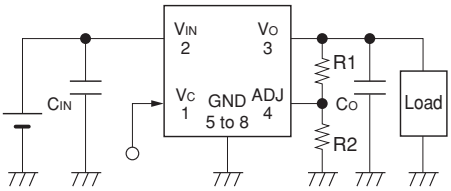


●SI-3025KS, SI-3033KS

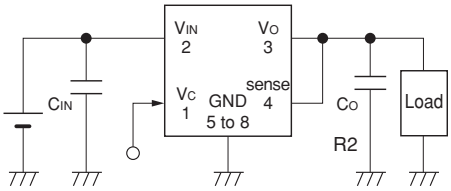


■Typical Connection Diagram

●SI-3012KS



●SI-3025KS, SI-3033KS



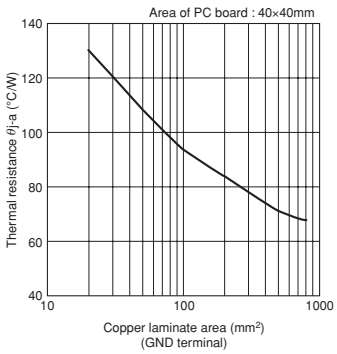
R_1, R_2: Output voltage setting resistors
The output voltage can be set by connecting R_1 and R_2 as shown above.
The recommended value of R_2 is 24 kΩ .

$R1=(V_O–V_{ADJ})÷(V_{ADJ}/R2)$

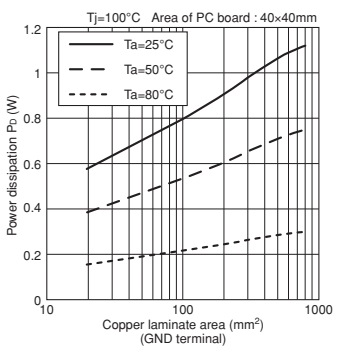
C_{IN}: Input capacitor (22 μF or larger)
C_O: Output capacitor (22 μF or larger)
For SI-3000KS series, Co has to be a low ESR capacitor.
When using the electrolytic capacitor, the SI-3000KS series may oscillate at a low temperature.

■Reference Data

Copper Laminate Area vs. Thermal Resistance



Copper 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.

$T_j=P_D \times \theta_{j-L} + T_L$ ($\theta_{j-L} = 22°C/W$)

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} ≤ 0.6V (at I_O = 1.0A)
- Low circuit current consumption: Iq ≤ 350 μA (600 μA for SI-3010KD, SI-3050KD)
- Low circuit current at output OFF: Iq (OFF) ≤ 1 μA
- Built-in overcurrent, thermal protection circuits
- Compatible with low ESR capacitors (SI-3012KD and SI-3033KD)

■Absolute Maximum Ratings

(T_a=25°C)

Parameter	Symbol	Ratings		Unit
		SI-3012KD/3033KD	SI-3010KD/3050KD	
DC Input Voltage	V_{IN}	17	35*1	V
Output Control Terminal Voltage	V_C	V_{IN}		V
DC Output Current	I_O	1.0		A
Power Dissipation	P_D*2	3		W
Junction Temperature	T_j	–30 to +125		°C
Storage Temperature	T_{stg}	–30 to +125		°C
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	33.3		°C/W
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	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^2 (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_a=25°C, V_C=2V, unless otherwise specified)

Parameter		Symbol	Ratings						Unit
			SI-3012KD (Variable type)			SI-3033KD			
			min.	typ.	max.	min.	typ.	max.	
Input Voltage		V_{IN}	2.4*3		*4	*3		*4	V
Output Voltage (Reference Voltage for SI-3012KD)		V_O (V_{ADJ})	1.24	1.28	1.32	3.234	3.300	3.366	V
	Conditions		V_{IN}=3.3V, I_O=10mA			V_{IN}=5V, I_O=10mA			
Line Regulation		ΔV_{OLINE}			15			15	mV
	Conditions		V_{IN}=3.3 to 8V, I_O=10mA (V_O=2.5V)			V_{IN}=5 to 10V, I_O=10mA			
Load Regulation		ΔV_{OLOAD}			40			50	mV
	Conditions		V_{IN}=3.3V, I_O=0 to 1A (V_O=2.5V)			V_{IN}=5V, I_O=0 to 1A			
Dropout Voltage		V_{DIF}			0.4			0.4	V
	Conditions		I_O=0.5A (V_O=2.5V)			I_O=0.5A			
					0.6			0.6	
	Conditions		I_O=1A (V_O=2.5V)			I_O=1A			
Quiescent Circuit Current		I_q			350			350	μA
	Conditions		V_{IN}=3.3V, I_O=0A, V_C=2V, R2=2.4kΩ			V_{IN}=5V, I_O=0A,V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1			1	μA
	Conditions		V_{IN}=3.3V, V_C=0V			V_{IN}=5V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.3			±0.3		mV/°C
	Conditions		T_j=0 to 100°C (V_O=2.5V)			T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		55			55		dB
	Conditions		V_{IN}=3.3V, f=100 to 120Hz, I_O=0.1A (V_O=2.5V)			V_{IN}=5V, f=100 to 120Hz, I_O=0.1A			
Overcurrent Protection Starting Current*1		I_{S1}	1.1			1.1			A
	Conditions		V_{IN}=3.3V			V_{IN}=5V			
V_C Terminal	Control Voltage (Output ON)*2	V_C, IH	2			2			V
	Control Voltage (Output OFF)	V_C, IL			0.8			0.8	
	Control Current (Output ON)	I_C, IH			40			40	μA
		Conditions	V_C=2V			V_C=2V			
	Control Current (Output OFF)	I_C, IL	–5	0		–5	0		μA
		Conditions	V_C=0V			V_C=0V			

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

*2: 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.

*3: Refer to the Dropout Voltage parameter.

*4: 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.

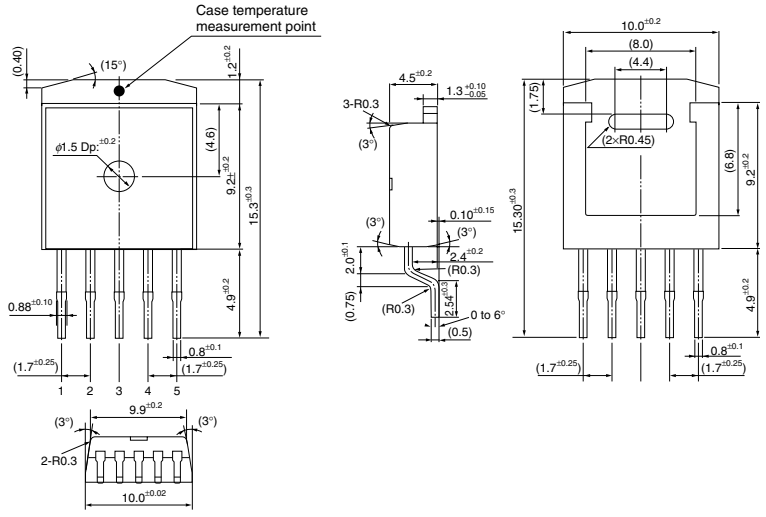
■Electrical Characteristics 2 (High Input Voltage Type)

Parameter		Symbol	Ratings						Unit
			SI-3010KD (Variable type)			SI-3050KD			
			min.	typ.	max.	min.	typ.	max.	
Input Voltage		V_{IN}	2.4[*1]		27[*5]	[*1]		15[*5]	V
Output Voltage (Reference Voltage V_{ADJ} for SI-3010KD)		V_O (V_{ADJ})	0.98	1.00	1.02	4.90	5.00	5.10	V
		Conditions	V_{IN}=7V, I_O=10mA			V_{IN}=7V, I_O=10mA			
Line Regulation		ΔV_{OLINE}			30			30	mV
		Conditions	V_{IN}=6 to 11V, I_O=10mA (V_O=5V)			V_{IN}=6 to 11V, I_O=10mA			
Load Regulation		ΔV_{OLOAD}			75			75	mV
		Conditions	V_{IN}=7V, I_O=0 to 1A (V_O=5V)			V_{IN}=7V, I_O=0 to 1A			
Dropout Voltage		V_{DIF}			0.3			0.3	V
		Conditions	I_O=0.5A (V_O=5V)			I_O=0.5A			
					0.6			0.6	
		Conditions	I_O=1A (V_O=5V)			I_O=1A			
Quiescent Circuit Current		I_q			600			600	μA
		Conditions	V_{IN}=7V, I_O=0A, V_C=2V R2=10kΩ			V_{IN}=7V, I_O=0A, V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1			1	μA
		Conditions	V_{IN}=7V, V_C=0V			V_{IN}=7V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.5			±0.5		mV/°C
		Conditions	T_j=0 to 100°C (V_O=5V)			T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		75			75		dB
		Conditions	V_{IN}=7V, f=100 to 120Hz, I_O=0.1A (V_O=5V)			V_{IN}=7V, f=100 to 120Hz, I_O=0.1A			
Overcurrent Protection Starting Current[*2] [*4]		I_{S1}	1.1			1.1			A
		Conditions	V_{IN}=7V			V_{IN}=7V			
V_C Terminal	Control Voltage (Output ON)[*3]	V_C, IH	2.0			2.0			V
	Control Voltage (Output OFF)[*3]	V_C, IL			0.8			0.8	
	Control Current (Output ON)	I_C, IH			40			40	μA
		Conditions	V_C=2V			V_C=2V			
	Control Current (Output OFF)	I_C, IL	–5	0		–5	0		μA
		Conditions	V_C=0V			V_C=0V			
Input Overvoltage Shutdown Voltage		V_{OVP}	33			26			V
		Conditions	I_O=10mA			I_O=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)

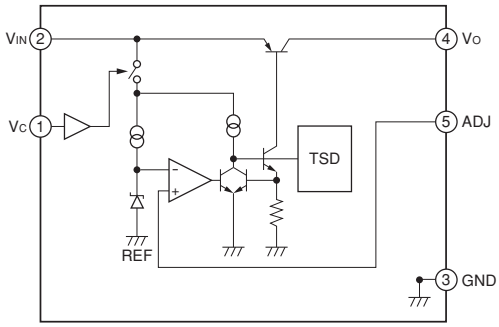


Pin Assignment
① V_C
② V_{IN}
③ GND (Common to the rear side of product)
④ V_O
⑤ Sense
(ADJ for SI-3010KD/3012KD)

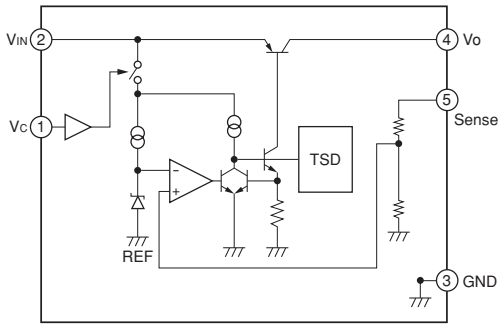
Plastic Mold Package Type
Flammability: UL94V-0
Product Mass: Approx. 1.48g

■Block Diagram

●SI-3010KD/SI-3012KD

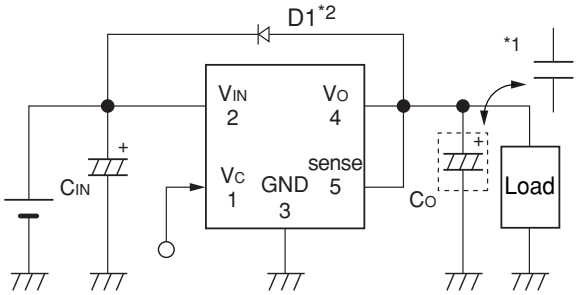


●SI-3033KD/SI-3050KD

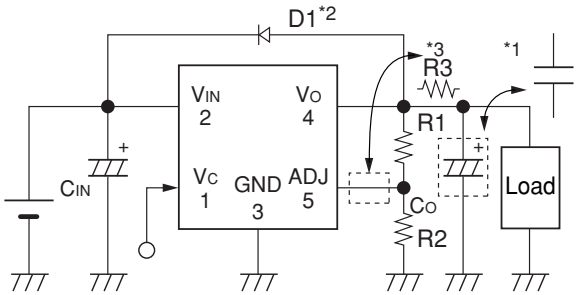


■Typical Connection Diagram

●SI-3033KD/SI-3050KD



●SI-3010KD/SI-3012KD



CIN: Input capacitor (22 μF or larger)
CO: Output capacitor

*1: SI-3012KD/3033KD (22 μF or larger)
Co has to be a low ESR capacitor such as a ceramic capacitor.
When using the electrolytic capacitor, oscillation may occur at a low temperature.
SI-3010KD/3050KD/ (47 μF or larger)
If a low ESR capacitor is used, oscillation may occur.

*2: D1: Reverse bias protection diode
This diode is required for protection against reverse biasing between the input and output.
(Sanken SJPL-H2 is recommended.)
This diode is not required at VO ≤ 3.3V.

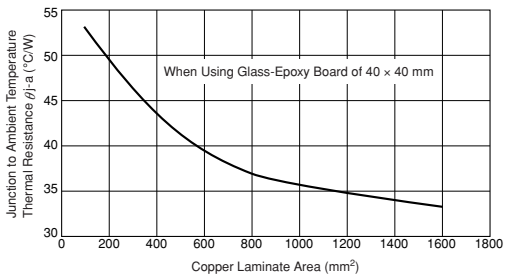
R1, R2: Output voltage setting resistors
The output voltage can be set by connecting R1 and R2 as shown above.
The recommended value for R2 is 10Ω (24kΩ for SI-3012KD).

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

*3: For SI-3010KD, insert R3 in case of setting VO to VO ≤ 1.5V.
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 ICs is mounted.
- Obtaining the junction temperature
  Measure the case temperature TC with a thermocouple, etc. Then, substitute this value in the following formula to obtain the junction temperature.

$T_j=P_D \times \theta_{j-C} + T_C \quad (\theta_{j-C} = 3°C/W) \quad P_D= (V_{IN}-V_O)\bullet I_{OUT}$

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: 1μA max.)
- Compatible with low ESR capacitors

■Absolute Maximum Ratings

(T_a=25°C)

Parameter	Symbol	Ratings	Unit
DC Input Voltage	V_{IN}	10	V
DC Bias Voltage	V_B	10	V
Output Control Terminal Voltage	V_C	V_{IN}	V
DC Output Current	I_O	1.5	A
Power Dissipation	P_D*1	1.1	W
Junction Temperature	T_j	–30 to +125	°C
Operating Ambient Temperature	T_{op}	–30 to +100	°C
Storage Temperature	T_{stg}	–30 to +125	°C
Thermal Resistance (Junction to Lead (Pin 8))	$\theta_{(j\text{-}L)}$	36	°C/W
Thermal Resistance (Junction to Ambient Air)	$\theta_{(j\text{-}a)}$*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_{IN}	1.4 to 3.6*1	V
Bias Voltage	V_B	3.3 to 5.5	V
Output Current	I_O	0 to 1.5*1	A
Operating Ambient Temperature	T_{op}	–20 to +85*1	°C

*1: V_{IN} (max) and I_O (max) are restricted by the relation $P_D = (V_{IN} - V_O) \times I_O$.

■Electrical Characteristics

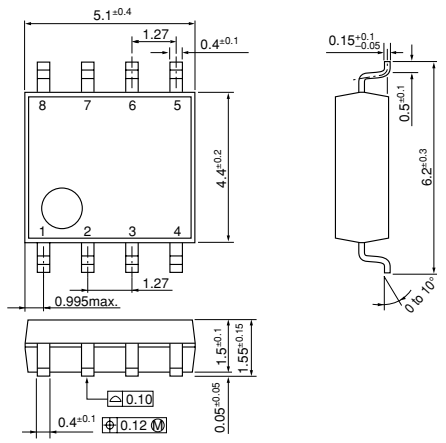
(T_a=25°C, V_C=2V, V_{IN}=1.8V, V_B=3.3V, V_O=1.5V, unless otherwise specified)

Parameter		Symbol	Ratings			Unit
			SI-3010LLSL			
			min.	typ.	max.	
Reference Voltage		V_{ADJ}	0.980	1.000	1.020	V
		Conditions	I_O=10mA			
Line Regulation		ΔV_{OLINE}			10	mV
		Conditions	V_{IN}=1.7 to 2.5V, I_O=10mA			
Load Regulation		ΔV_{OLOAD}			30	mV
		Conditions	V_{IN}=1.8V, I_O=0 to 1.5A			
Dropout Voltage		V_{DIF}			0.3	V
		Conditions	I_O=1.0A			
Quiescent Circuit Current		I_q		500	800	μA
		Conditions	I_O=0A, R_2=10kΩ			
Circuit Current at Output OFF		$I_{q\ (OFF)}$			1	μA
		Conditions	V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.2		mV/°C
		Conditions	T_j=0 to 100°C			
Overcurrent Protection Starting Current*1		I_{S1}	1.6			A
		Conditions	V_{IN}=1.8V, V_B=3.3V			
V_C Terminal	Control Voltage (Output ON)*2	V_C, IH	2			V
	Control Voltage (Output OFF)	V_C, IL			0.8	V
	Control Current (Output ON)	I_C, IH			50	μA
		Conditions	V_C=2.7V			
	Control Current (Output OFF)	I_C, IL			10	μA
		Conditions	V_C=0.4V			

*1: 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.
*2: 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.

■External Dimensions (SOP8)

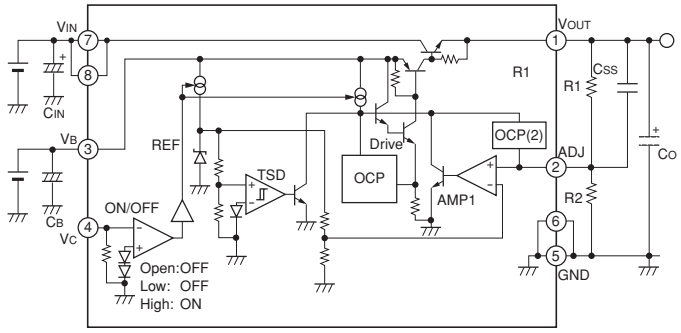
(Unit : mm)



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 10μF)
Required when the input line contains inductance or when the wiring is long.

C_O: Output capacitor (47μF 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 500mΩ or less (at room temperature).

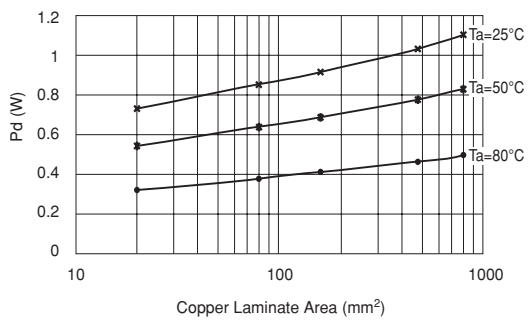
R1, R2: Output voltage setting resistors
The output voltage can be set by connecting R1 and R2 as shown at left.
The recommended value for R2 is 10kΩ.

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

C_{SS}: Soft start capacitor
The 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: Iq (OFF) ≤ 1μA
- Built-in overcurrent and thermal protection circuits

■Applications

- Secondary stabilized power supply (local power supply)

■Absolute Maximum Ratings

(T_a=25°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	°C
Operating Ambient Temperature	T_{op}	–30 to +85	°C
Storage Temperature	T_{stg}	–40 to +125	°C
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	33.3	°C/W
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3	°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	°C	
Operating Junction Temperature	$T_{op\,(j)}$	–20 to +100	°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

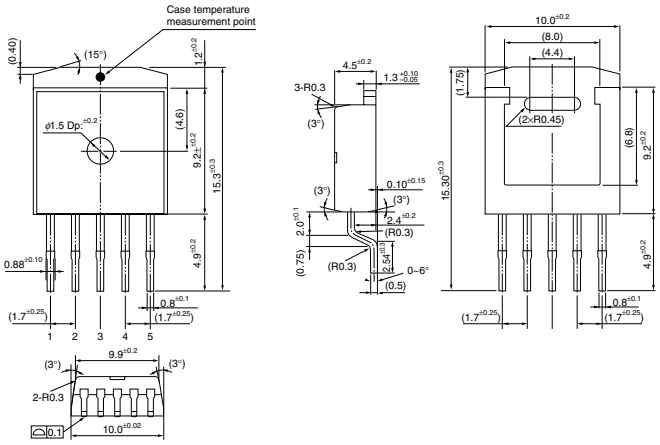
(T_a=25°C, V_C=2V, unless otherwise specified)

Parameter		Symbol	Ratings						Unit
			SI-3011ZD (Variable type)			SI-3033ZD			
			min.	typ.	max.	min.	typ.	max.	
Output Voltage (Reference Voltage V_{ADJ} for SI-3011ZD)		V_O (V_{ADJ})	1.078	1.100	1.122	3.234	3.300	3.366	V
		Conditions	V_{IN}=V_O+1V, I_O=10mA			V_{IN}=5V, I_O=10mA			
Line Regulation		ΔV_{OLINE}			10			10	mV
		Conditions	V_{IN}=3.3 to 5V, I_O=10mA (V_O=2.5V)			V_{IN}=4.5 to 5.5V, I_O=10mA			
Load Regulation		ΔV_{OLOAD}			40			40	mV
		Conditions	V_{IN}=3.3V, I_O=0 to 3A (V_O=2.5V)			V_{IN}=5V, I_O=0 to 3A			
Dropout Voltage		V_{DIF}			0.6			0.6	V
		Conditions	I_O=3A (V_O=2.5V)			I_O=3A			
Quiescent Circuit Current		I_q		1	1.5		1	1.5	mA
		Conditions	V_{IN}=V_O+1V, I_O=0A, V_C=2V			V_{IN}=5V, I_O=0A, V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1			1	μA
		Conditions	V_{IN}=V_O+1V, V_C=0V			V_{IN}=5V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.3			±0.3		mV/°C
		Conditions	T_j=0 to 100°C			T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		60			60		dB
		Conditions	V_{IN}=V_O+1V, f=100 to 120Hz, I_O=0.1A			V_{IN}=5V, f=100 to 120Hz, I_O=0.1A			
Overcurrent Protection Starting Current*2 *4		I_{S1}	3.2			3.2			A
		Conditions	V_{IN}=V_O+1V			V_{IN}=5V			
V_C Terminal	Control Voltage (Output ON)*3	V_C, IH	2			2			V
	Control Voltage (Output OFF)*3	V_C, IL			0.8			0.8	
	Control Current(Output ON)	I_C, IH			100			100	μA
		Conditions	V_C=2.7V			V_C=2.7V			
	Control Current(Output OFF)	I_C, IL	–5	0		–5	0		μA
		Conditions	V_C=0V			V_C=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 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)

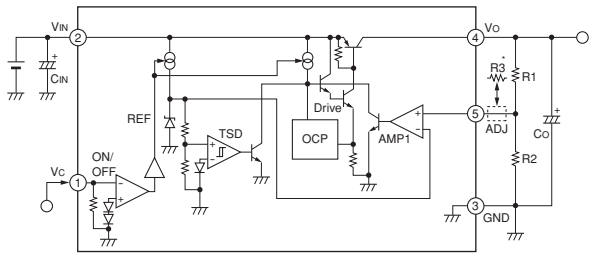


Pin Assignment
① V_C
② V_{IN}
③ GND (Common to the rear side of product)
④ V_O
⑤ Sense
(ADJ for SI-3011ZD)

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

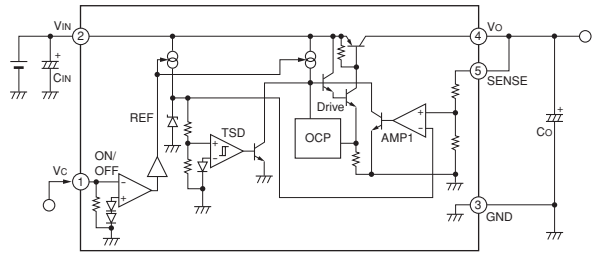
■Block Diagram

SI-3011ZD



C_{IN}: Input capacitor (Approx. 10μF)
C_O: 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



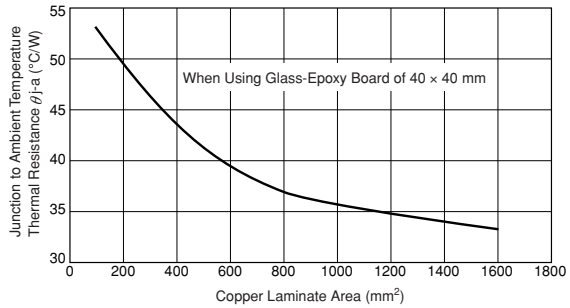
R1, R2: Output voltage setting resistors
The output voltage can be set by connecting R1 and R2 as shown at left.
The recommended value for R2 is 10kΩ or 11kΩ.

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

*: Insert R3 in case of setting V_O to $V_O \leq 1.8V$. 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_C with a thermocouple, etc. Then substitute this value in the following formula to obtain the junction temperature.

$$T_j = P_D \times \theta_{j-c} + T_C \qquad P_D = (V_{IN} - V_O) \cdot I_{OUT}$$

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: Iq (OFF) ≤ 1μA
- Built-in overcurrent and thermal protection circuits

■Applications

- Secondary stabilized power supply (local power supply)

■Absolute Maximum Ratings

(T_a=25°C)

Parameter	Symbol	Ratings SI-3010KF	Unit	Remarks
DC Input Voltage	V_{IN}	35*1	V	
Output Control Terminal Voltage	Vc	V_{IN}	V	
DC Output Current	Io	1.0	A	
Power Dissipation	P_{D1}	16.6	W	With infinite heatsink
	P_{D2}	1.72	W	Without heatsink, stand-alone operation
Junction Temperature	Tj	–40 to +125	°C	
Storage Temperature	Tstg	–40 to +125	°C	
Operating Ambient Temperature	Top	–40 to +100	°C	
Thermal Resistance (Junction to Case)	θj-c	6.0	°C/W	
Thermal Resistance (Junction to Ambient Air)	θj-a	58	°C/W	Without heatsink, stand-alone operation

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

■Recommended Operating Conditions

Parameter	Symbol	Ratings SI-3010KF	Unit
Input Voltage Range	V_{IN}	2.4*2 to 27*1	V
Output Current Range	Io	0 to 1.0*1	A
Output Voltage Variable Range	VoADJ	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) × I_O = 16.6W.
*2: Refer to the Dropout Voltage parameter.

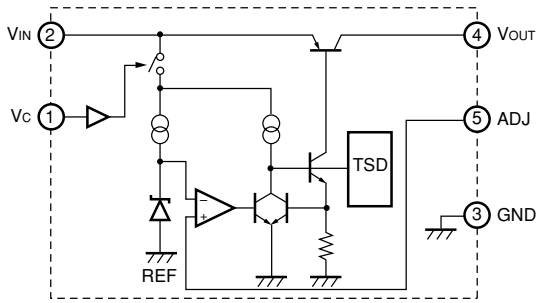
■Electrical Characteristics

Parameter		Symbol	Ratings SI-3010KF min.	typ.	max.	Unit
Reference Voltage		V_{ADJ}	0.98	1.00	1.02	V
		Conditions	V_{IN}=7V, I_O=0.01A, V_C=2V, V_O=5A			
Line Regulation		ΔV_{OLINE}			30	mV
		Conditions	V_{IN}=6 to 15V, I_O=0.01A, V_C=2V, V_O=5A			
Load Regulation		ΔV_{OLOAD}			75	mV
		Conditions	V_{IN}=7V, I_O=0 to 1A, V_C=2V, V_O=5A			
Dropout Voltage		V_{DIF}			0.3	V
		Conditions	I_O=0.5A, V_C=2V, V_O=5V			
					0.5	
		Conditions	I_O=1.0A, V_C=2V, V_O=5V			
Quiescent Circuit Current		I_q			600	μA
		Conditions	V_{IN}=7V, I_O=0A, V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1	μA
		Conditions	V_{IN}=7V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.5		mV/°C
		Conditions	V_{IN}=7V, I_O=0.01A, V_C=2V, Tj=0 to 100°C, V_O=2.5V			
Ripple Rejection		R_{REJ}		75		dB
		Conditions	V_{IN}=7V, I_O=0.1A, V_C=2V, f=100 to 120Hz, V_O=5V			
Overcurrent Protection Starting Current*3		I_{S1}	1.1			A
		Conditions	V_{IN}=7V, V_C=2V			
Vc Terminal	Control Voltage (Output ON)*4	$V_{C, IH}$	2			V
		Conditions	V_{IN}=7V			
	Control Voltage (Output OFF)	$V_{C, IL}$			0.8	V
		Conditions	V_{IN}=7V			
	Control Current (Output ON)	$I_{C, IH}$			40	μA
		Conditions	V_{IN}=7V, V_C=2V			
	Control Current (Output OFF)	$I_{C, IL}$	–5	0		μA
		Conditions	V_{IN}=7V, V_C=0V			
Input Overvoltage Shutdown Voltage		V_{OVP}	33			V
		Conditions	I_O=0.01A			

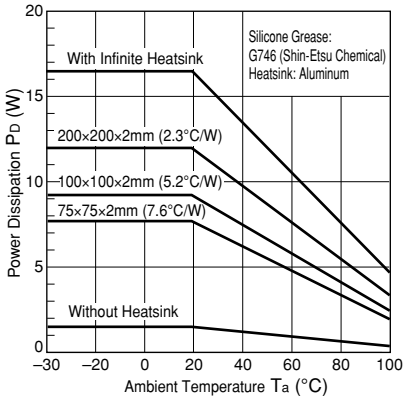
*3: I_{S1} is specified at the 5% drop point of output voltage V_O on the condition that V_{IN} = overcurrent protection starting current, I_O = 10 mA.
*4: Output is OFF when the output control terminal V_C is open. Each input level is equivalent to LS-TTL level. Therefore, the device can be driven directly 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

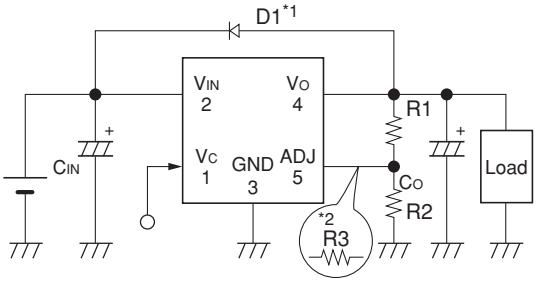


■TA-PD Characteristics



■Typical Connection Diagram

●SI-3010KF



CIN: Input capacitor (22μF or larger)
CO: 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.)

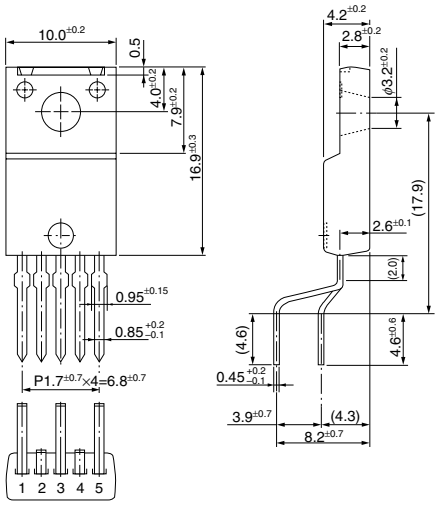
R1, R2: Output voltage setting resistors
The output voltage can be adjusted by connecting R1 and R2 as shown above.
The recommended value for R2 is 10kΩ.

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

*2: Insert R3 in case of setting VO to VO ≤ 1.5V.
The recommended value for R3 is 10kΩ.

■External Dimensions (TO220F-5)

(Unit : mm)



Pin Assignment
① Vc
② VIN
③ GND
④ Vout
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} ≤ 0.7V (at I_O = 3.0A)
- Low circuit current at output OFF: Iq (OFF) ≤ 1μA
- Built-in overcurrent and thermal protection circuits

■Applications

- Secondary stabilized power supply (local power supply)

■Absolute Maximum Ratings

(T_a = 25°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	°C
Operating Ambient Temperature	T_{op}	–30 to +100	°C
Storage Temperature	T_{stg}	–30 to +125	°C
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	5.0	°C/W
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	66.7 (Without heatsink, stand-alone operation)	°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	°C
Operating Junction Temperature	$T_{op\,(j)}$	–20 to +100	°C
Output Voltage Variable Range	V_{OADJ}	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

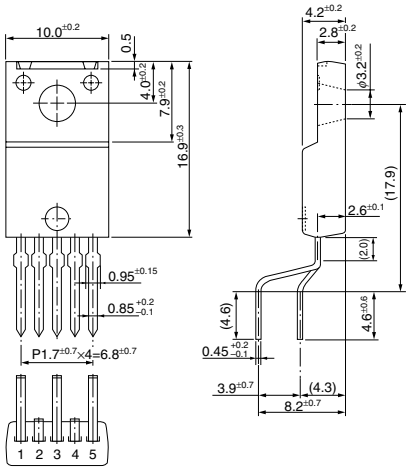
(T_a = 25°C, V_C = 2V, unless otherwise specified)

Parameter		Symbol	SI-3011ZF min.	SI-3011ZF typ.	SI-3011ZF max.	Unit
Reference Voltage		V_{ADJ}	1.078	1.100	1.122	V
		Conditions	V_{IN}=V_O+1V, I_O=10mA			
Line Regulation		ΔV_{OLINE}			10	mV
		Conditions	V_{IN}=3.3 to 5V, I_O=10mA (V_O=2.5V)			
Load Regulation		ΔV_{OLOAD}			40	mV
		Conditions	V_{IN}=3.3V, I_O=0 to 3A (V_O=2.5V)			
Dropout Voltage		V_{DIF}			0.7	V
		Conditions	I_O=3A (V_O=2.5V)			
Quiescent Circuit Current		I_q		1	1.5	mA
		Conditions	V_{IN}=V_O+1V, I_O=0A, V_C=2V			
Circuit Current at Output OFF		I_q (OFF)			1	μA
		Conditions	V_{IN}=V_O+1V, V_C=0V			
Temperature Coefficient of Output Voltage		$\Delta V_O/\Delta T_a$		±0.3		mV/°C
		Conditions	T_j=0 to 100°C			
Ripple Rejection		R_{REJ}		60		dB
		Conditions	V_{IN}=V_O+1V, f=100 to 120Hz, I_O=0.1A			
Overcurrent Protection Starting Current*2 *4		I_{S1}	3.2			A
		Conditions	V_{IN}=V_O+1V			
V_C Terminal	Control Voltage (Output ON)*3	V_C, IH	2			V
	Control Voltage (Output OFF)*3	V_C, IL			0.8	
	Control Current(Output ON)	I_C, IH			100	μA
		Conditions	V_C=2.7V			
	Control Current(Output OFF)	I_C, IL	–5	0		μA
		Conditions	V_C=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)

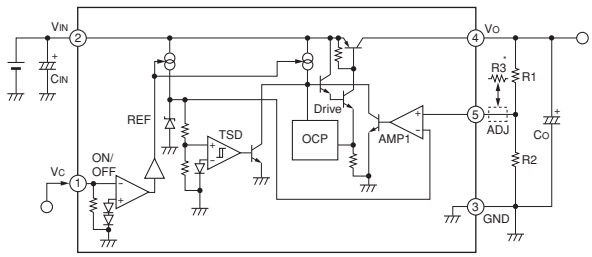


Pin Assignment
① V_C
② V_{IN}
③ GND
④ V_O
⑤ ADJ

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

■Typical Connection Diagram/Block Diagram

SI-3011ZF



C_{IN}: Input capacitor (Approx. 10μF)
This capacitor is required when the input line contains inductance or when the wiring is long.

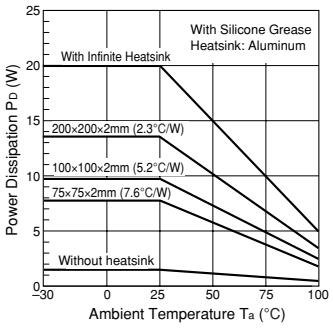
C_O: Output capacitor (47μF or higher)
The output voltage may oscillate if a low ESR type capacitor (such as a ceramic capacitor) is used for the output capacitor in SI-3000ZF.

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_O to $V_O \leq 1.8V$. The recommended value for R3 is 10kΩ.

■T_a-P_D Characteristics



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 μ 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 μ 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<100μS)	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	OCP	OCL	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	500V	1.5A	MOSFET	4.0Ω(max)	SIP_24Pin	Full Mold	○	○	—	—	○	—	○	—	○	—	○		
SMA6823MH		2.5A	MOSFET	2.4Ω(max)	SIP_24Pin	Full Mold	○	○	—	—	○	—	○	—	○	—	○		
SMA6862MZ		1.5A	MOSFET	4.0Ω(max)	SIP_24Pin	Full Mold	—	○	○	○	—	○	○	—	○	—	—	Fan motor	124
SMA6863MZ		2.5A	MOSFET	2.4Ω(max)	SIP_24Pin	Full Mold	—	○	○	○	—	○	○	—	○	—	—		
SMA6865MZ			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	
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	130
SCM1243MF		15A	IGBT	1.7V(typ)	DIP_33Pin	With Fin	○	○	○	—	—	○	○	○	○	○	—	Air-conditioner compressor, Washing machine	
SCM1245MF		20A	IGBT	1.7V(typ)	DIP_33Pin	With Fin	○	○	○	—	—	○	○	○	○	○	—	Air-conditioner compressor	
SCM1246MF		30A	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
OCP ..... 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

(T_a=25°C)

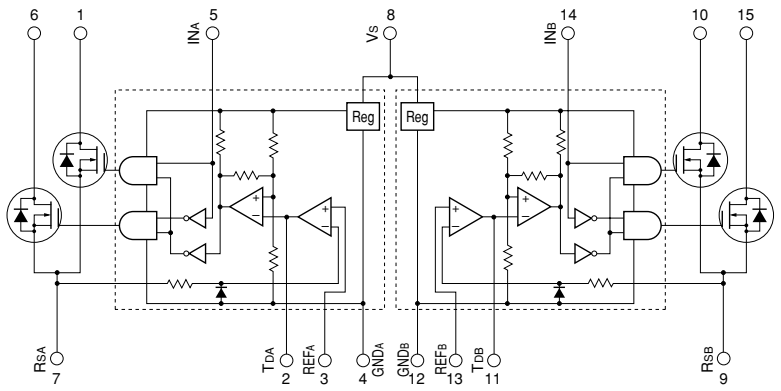
Parameter	Symbol	Ratings				Unit
		SLA7022MU	SLA7029M	SMA7022MU	SMA7029M	
Motor Supply Voltage	V_{CC}	46				V
FET Drain-Source Voltage	V_{DSS}	100				V
Control Supply Voltage	V_S	46				V
TTL Input Voltage	V_{IN}	7				V
Reference Voltage	V_{REF}	2				V
Output Current	I_O	1	1.5	1	1.5	A
Power Dissipation	P_{D1}	4.5 (Without Heatsink)		4.0 (Without Heatsink)		W
	P_{D2}	35 (T_C=25°C)		28 (T_C=25°C)		W
Channel Temperature	T_{ch}	+150				°C
Storage Temperature	T_{stg}	–40 to +150				°C

■Electrical Characteristics

(T_a=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_S		10	15		10	15		10	15		10	15	mA
		Condition	V_S=44V			V_S=44V			V_S=44V			V_S=44V			
	Control Supply Voltage	V_S	10	24	44	10	24	44	10	24	44	10	24	44	V
	FET Drain-Source Voltage	V_{DSS}	100			100			100			100			V
		Condition	V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			
	FET ON Voltage	V_{DS}			0.85			0.6			0.85			0.6	V
		Condition	I_D=1A, V_S=14V			I_D=1A, V_S=14V			I_D=1A, V_S=14V			I_D=1A, V_S=14V			
	FET Drain Leakage Current	I_{DSS}			4			4			4			4	mA
		Condition	V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			
	FET Diode Forward Voltage	V_{SD}			1.2			1.1			1.2			1.1	V
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
	TTL Input Current	I_{IH}			40			40		40			40		μA
		Condition	V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			
		I_{IL}			–0.8			–0.8			–0.8			–0.8	mA
		Condition	V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			
	TTL Input Voltage (Active High)	V_{IH}	2			2			2			2			V
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
		V_{IL}			0.8			0.8			0.8			0.8	
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
	TTL Input Voltage (Active Low)	V_{IH}	2			2			2			2			V
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
		V_{IL}			0.8			0.8			0.8			0.8	
		Condition	I_D=1A			I_D=1A			I_D=1A			I_D=1A			
AC Characteristics	Switching Time	T_r		0.5			0.5			0.5			0.5		μs
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			
		T_{stg}		0.7			0.7			0.7			0.7		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			
		T_f		0.1			0.1			0.1			0.1		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			

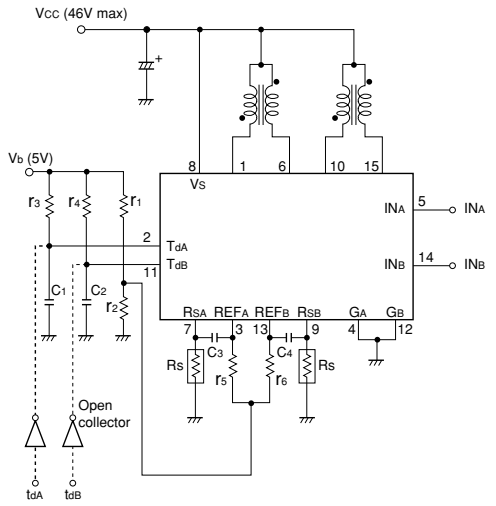
■Internal Block Diagram



1, 6, 10, 15pin
Description of pins

	Excitation input signal	
	Active H	Active L
1pin	OUT A	OUT $\bar{A}$
6pin	OUT $\bar{A}$	OUT A
10pin	OUT B	OUT $\bar{B}$
15pin	OUT $\bar{B}$	OUT B

■Typical Connection Diagram (Recommended component values)



Excitation signal time chart
2-phase excitation

clock	0	1	2	3	0	1
INA	H	H	L	L	H	H
INB	L	H	H	L	L	H

1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
INA	H	H	H	H	L	L	L	L	H	H	H	H
tdA	L	L	L	H	L	L	L	H	L	L	L	H
INB	L	L	H	H	H	H	L	L	L	L	H	H
tdB	L	H	L	L	L	H	L	L	L	H	L	L

●tdA and tdB are signals before the inverter stage.

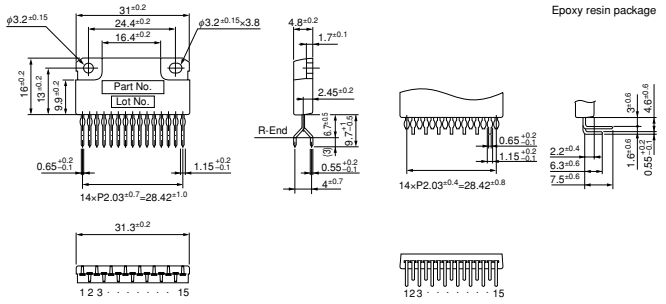
r1 : 510Ω
r2 : 100Ω (VR)
r3 : 47kΩ
r4 : 47kΩ
r5 : 2.4kΩ
r6 : 2.4kΩ

C1 : 330 to 500pF
C2 : 330 to 500pF
C3 : 2200pF
C4 : 2200pF
Rs : 1.8Ω typ (7022MU) (1~2W)
1Ω typ (7029M)

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

(Unit:mm)

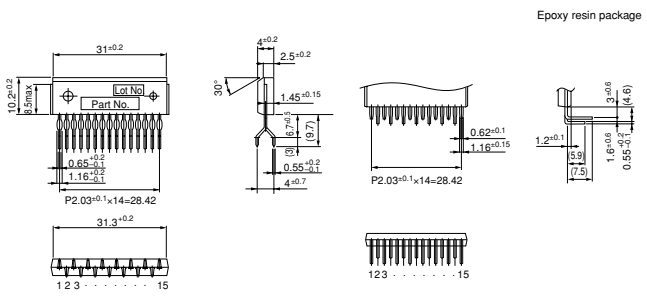
SLA7022MU/SLA7029M



Forming No. No.853
Forming No. No.855

Product Mass : Approx.6g

SMA7022MU/SMA7029M



Forming No. No.1054
Forming No. No.1055

Product Mass : Approx.4g

SLA7027MU/SLA7024M/SLA7026M 2-Phase/1-2 Phase Excitation

■Absolute Maximum Ratings

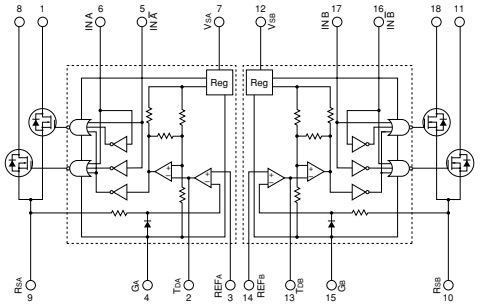
(T_a=25°C)

Parameter	Symbol	Ratings			Unit
		SLA7027MU	SLA7024M	SLA7026M	
Motor Supply Voltage	V_{CC}	46			V
FET Drain-Source Voltage	V_{DSS}	100			V
Control Supply Voltage	V_S	46			V
Input Voltage	V_{IN}	7			V
Reference Voltage	V_{REF}	2			V
Output Current	I_O	1	1.5	3	A
Power Dissipation	P_{D1}	4.5 (Without Heatsink)			W
	P_{D2}	35 (T_C=25°C)			W
Channel Temperature	T_{ch}	+150			°C
Storage Temperature	T_{stg}	–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_S		10	15		10	15		10	15	mA
		Condition	V_S=44V			V_S=44V			V_S=44V			
	Control Supply Voltage	V_S	10	24	44	10	24	44	10	24	44	V
	FET Drain-Source Voltage	V_{DSS}	100			100			100			V
		Condition	V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			V_S=44V, I_{DSS}=250μA			
	FET ON Voltage	V_{DS}			0.85			0.6			0.85	V
		Condition	I_D=1A, V_S=14V			I_D=1A, V_S=14V			I_D=3A, V_S=14V			
	FET Drain Leakage Current	I_{DSS}			4			4			4	mA
		Condition	V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			V_{DSS}=100V, V_S=44V			
	FET Diode Forward Voltage	V_{SD}			1.2			1.1			2.3	V
		Condition	I_D=1A			I_D=1A			I_D=3A			
	TTL Input Current	I_{IH}			40			40			40	μA
		Condition	V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			V_{IH}=2.4V, V_S=44V			
		I_{IL}			–0.8			–0.8			–0.8	mA
		Condition	V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			V_{IL}=0.4V, V_S=44V			
	TTL Input Voltage (Active High)	V_{IH}	2			2			2			V
		Condition	I_D=1A			I_D=1A			I_D=3A			
		V_{IL}			0.8			0.8			0.8	
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
	TTL Input Voltage (Active Low)	V_{IH}	2			2			2			V
		Condition	V_{DSS}=100V			V_{DSS}=100V			V_{DSS}=100V			
		V_{IL}			0.8			0.8			0.8	
		Condition	I_D=1A			I_D=1A			I_D=3A			
AC characteristics	Switching Time	T_r		0.5			0.5			0.5		μs
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=1A			
		T_{stg}		0.7			0.7			0.7		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=1A			
		T_f		0.1			0.1			0.1		
		Condition	V_S=24V, I_D=0.8A			V_S=24V, I_D=1A			V_S=24V, I_D=1A			

■Internal Block Diagram

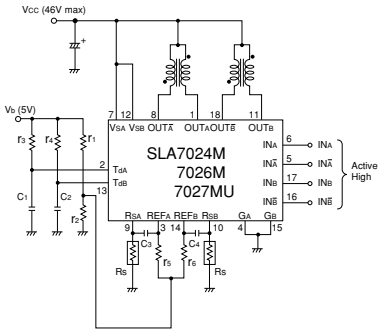


1, 8, 11, 18pin
Description of pins

	Excitation input signal	
	Active H	Active L
Pin 1	OUT_A	$OUT_{\bar{A}}$
Pin 8	$OUT_{\bar{A}}$	OUT_A
Pin 11	OUT_B	$OUT_{\bar{B}}$
Pin 18	OUT_B	OUT_B

■Typical Connection Diagram (Recommended component values)

Active High



Excitation signal time chart
2-phase excitation

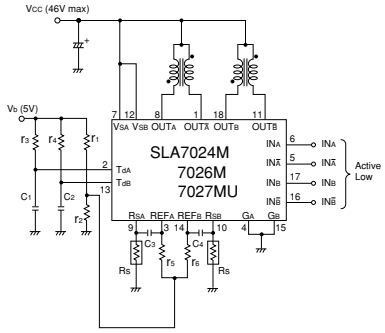
clock	0	1	2	3	0	1
IN_A	H	L	L	H	H	L
$IN_{\bar{A}}$	L	H	H	L	L	H
IN_B	H	H	L	L	H	H
$IN_{\bar{B}}$	L	L	H	H	L	L

1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
IN_A	H	H	L	L	L	L	L	H	H	H	L	L
$IN_{\bar{A}}$	L	L	L	H	H	H	L	L	L	L	L	H
IN_B	L	H	H	H	L	L	L	L	L	H	H	H
$IN_{\bar{B}}$	L	L	L	L	L	H	H	H	L	L	L	L

r_1 : 510Ω
r_2 : 100Ω (VR)
r_3 : 47kΩ
r_4 : 47kΩ
r_5 : 2.4kΩ
r_6 : 2.4kΩ
C_1 : 470pF
C_2 : 470pF
C_3 : 2200pF
C_4 : 2200pF
R_S : 1Ω typ (7024M)
(1 to 2W) 0.68Ω typ (7026M)
1.8Ω typ (7027MU)

Active Low



Excitation signal time chart
2-phase excitation

clock	0	1	2	3	0	1
IN_A	L	H	H	L	L	H
$IN_{\bar{A}}$	H	L	L	H	H	L
IN_B	L	L	H	H	L	L
$IN_{\bar{B}}$	H	H	L	L	H	H

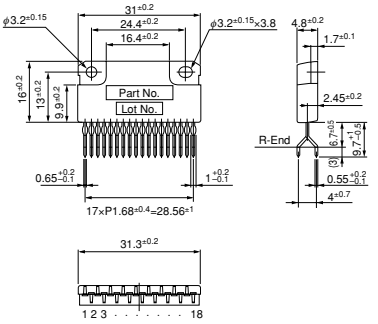
1-2 phase excitation

clock	0	1	2	3	4	5	6	7	0	1	2	3
IN_A	L	L	H	H	H	H	H	L	L	L	H	H
$IN_{\bar{A}}$	H	H	H	L	L	L	H	H	H	H	H	L
IN_B	H	L	L	L	H	H	H	H	H	L	L	L
$IN_{\bar{B}}$	H	H	H	H	H	L	L	L	H	H	H	H

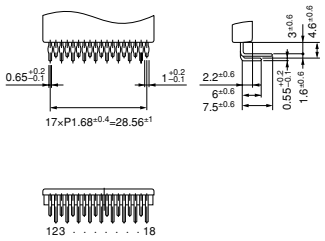
r_1 : 510Ω
r_2 : 100Ω (VR)
r_3 : 47kΩ
r_4 : 47kΩ
r_5 : 2.4kΩ
r_6 : 2.4kΩ
C_1 : 470pF
C_2 : 470pF
C_3 : 2200pF
C_4 : 2200pF
R_S : 1Ω typ (7024M)
(1 to 2W) 0.68Ω typ (7026M)
1.8Ω typ (7027MU)

■External Dimensions (ZIP18 with Fin [SLA18Pin])

(Unit : mm)



Forming No. No.871



Forming No. No.872

Product Mass : Approx.6g

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	Io	*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}	±2	V	Excluding tw<1μs
Power Dissipation	PD	4.7	W	When T_a = 25°C
		17		When T_c = 25°C
Junction Temperature	T_j	+150	°C	
Operating Ambient Temperature	T_a	–20 to +85	°C	
Storage Temperature	T_{stg}	–30 to +150	°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

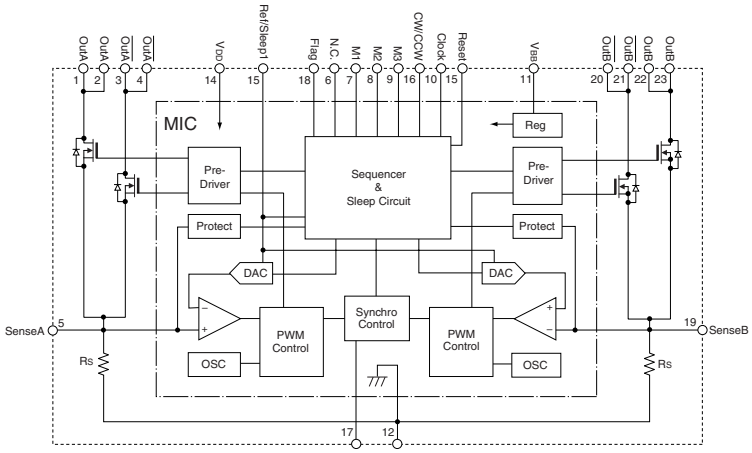
Parameter	Symbol	Rating		Unit	Remarks
		min.	max.		
Motor Supply Voltage	V_M		44	V	
Driver Supply Voltage	V_{BB}	10	44	V	
Logic Supply Voltage	V_{DD}	3.0	5.5	V	The V_{DD} surge voltage should be 0.5 V or lower
Case Temperature	T_C		90	°C	Temperature at Pin-12 Lead (without heatsink)

■Electrical Characteristics

Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Main Supply Current	I_{BB}			15	mA	In operation
	I_{BBS}			100	μA	Sleep 1 and Sleep 2 modes
Logic Supply Current	I_{DD}			5	mA	
Output MOSFET Breakdown Voltage	$V_{(BR)DSS}$	100			V	VBB=44V, I_D=1mA
Output MOSFET ON Resistance	$R_{DS(ON)}$		0.7	0.85	Ω	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
Maximum Clock Frequency	Fclock	250			kHz	When Clock Duty = 50%
Logic Input Voltage	V_{IL}			0.25VDD	V	
	V_{IH}	0.75VDD				
Logic Input Current	I_{IL}		±1		μA	
	I_{IH}		±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
	V_{REFS}	2		VDD		Output OFF (Sleep 1)
REF Input Current	I_{REF}		±10		μA	
Sense Voltage	V_{SENSE}		V_{REF}		V	When step reference current ratio is 100%
Sleep-Enable Recovery Time	T_{SE}	100			μS	Sleep1&Sleep2
Switching Time	t_{con}		2.0		μS	Clock → Out ON
	t_{coff}		1.5		μS	Clock → Out OFF
Sense Resistance	R_S	0.296	0.305	0.314	Ω	SLA7070M, tolerance of ±3%
		0.296	0.305	0.314		SLA7071M, tolerance of ±3%
		0.199	0.205	0.211		SLA7072M, tolerance of ±3%
		0.150	0.155	0.160		SLA7073M, tolerance of ±3%
Overcurrent Sense Voltage	Vocp	0.65	0.7	0.75	V	SLA7070xMPR, MPRT, when motor coil shorts out
Overcurrent Sense Current	Iocp		2.3		A	SLA7070MPR, MPRT/7071MPR, MPRT
			3.5			SLA7072MPR, MPRT
			4.6			SLA7073MPR, MPRT
Thermal Protection Temperature	T_{tsd}		140		°C	SLA707xMPRT, Rear of case (at the saturation temperature)
Flag Output Voltage	V_{FlagL}			1.25	V	SLA707xMPR, MPRT, IFlagL=1.25mA
	V_{FlagH}	1.25–VDD				SLA707xMPR, MPRT, IFlagH=–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	ton(min)		3.2		μs	
PWM OFF Time	toff		12		μs	

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

■Internal Block Diagram



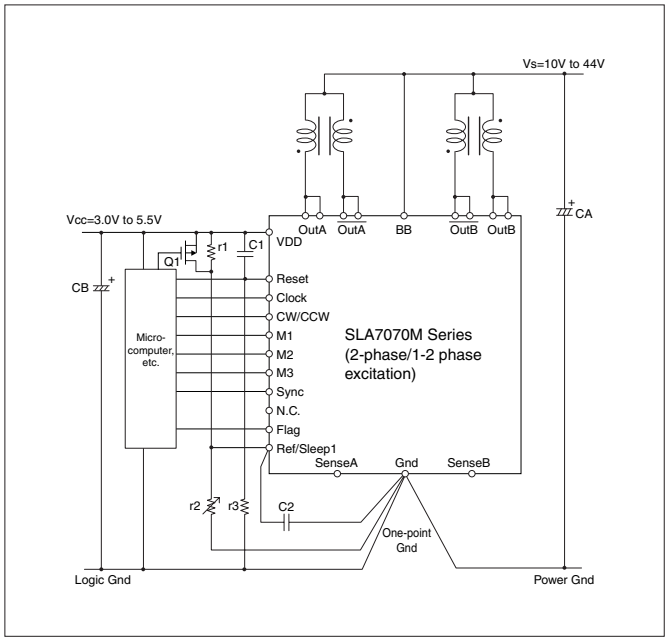
The protect circuit is deleted and the flag pin is N.C. for SLA7070MR, 7071MR, 7072MR, and 7073MR.

■Pin Assignment

Pin No.	Symbol	Function
1	OutA	Phase A output
2		
3	OutA/	Phase $\overline{A}$ 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_{BB}	Driver supply (motor supply)
12	Gnd	Device GND
13	Ref/Sleep1	Control current mode/Sleep 1 setting input
14	V_{DD}	Logic supply
15	Reset	Internal logic reset input
16	CW/CCW	Normal/reverse control input
17	Sync	PWM control signal input
18	Flag*1	Protection circuit monitor output*1
19	SenseB	Phase B current sense
20	OutB/	Phase $\overline{B}$ current output
21		
22	OutB	Phase B current output
23		

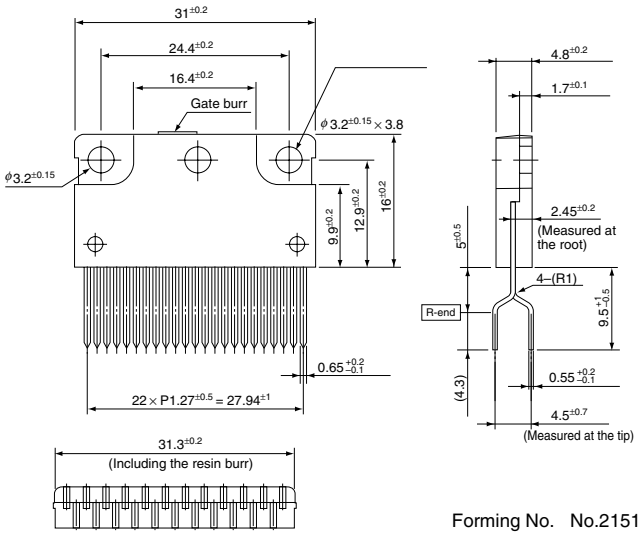
*1: N.C. pin for SLA7070MR, 7071MR, 7072MR, and 7073MR.

■Typical Connection Diagram



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

■External Dimensions (ZIP23 with Fin[SLA23Pin])



Forming No. No.2151

Product Mass : Approx.6g

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 Io: 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_a=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Motor Supply Voltage	V_M	46	V	
Driver Supply Voltage	V_{BB}	46	V	
Logic Supply Voltage	V_{DD}	6	V	
Output Current	Io	*1	A	
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}	±2	V	Excluding tw<1μs
Power Dissipation	P_D	4.7	W	When Ta = 25°C
		17		When Tc = 25°C
Junction Temperature	Tj	+150	°C	
Operating Ambient Temperature	Ta	–20 to +85	°C	
Storage Temperature	Tstg	–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 Tj under any circumstances.

■Recommended Operating Conditions

Parameter	Symbol	Ratings		Unit	Conditions
		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 0.5V or lower.
REF Input Voltage	V_{REF}	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	Tc		90	°C	Rear center (without Fin)

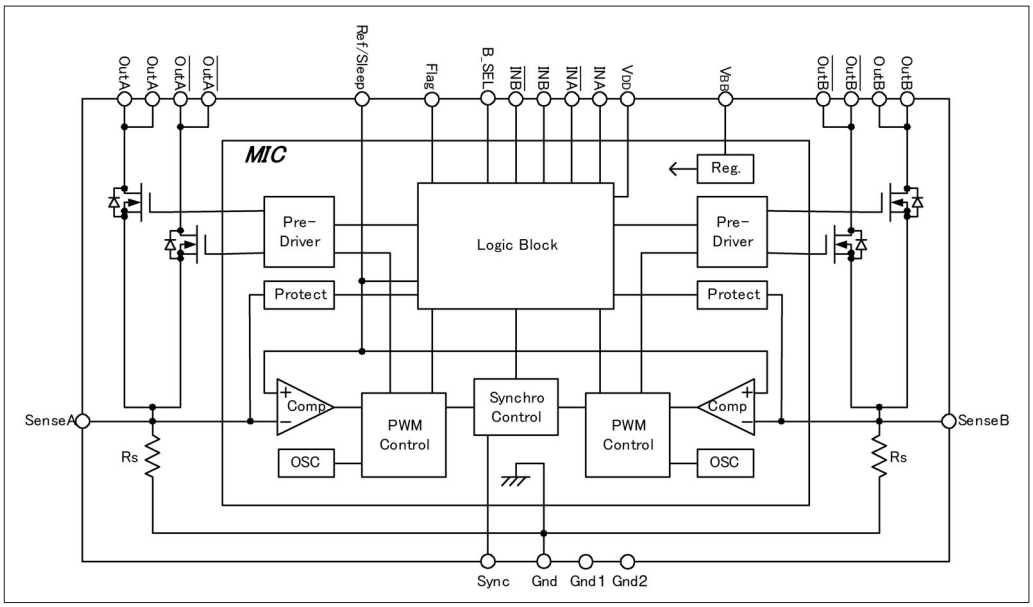
■Electrical Characteristics

(V_{DD}=5V, V_{BB}=24V, T_a=25°C, unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Main Supply Current	I_{BB}			15	mA	In operation
	I_{BBS}			100	μA	Sleep Mode
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	Ω	SLA7080M, I_D=1.0A
			0.45	0.6		SLA7081M, I_D=1.5A
			0.25	0.4		SLA7082M, I_D=2.0A
			0.18	0.24		SLA7083M, I_D=3.0A
Output MOSFET Diode Forward Voltage	V_F		0.85	1.1	V	SLA7080M, I_D=1.0A
			1.0	1.25		SLA7081M, I_D=1.5A
			0.95	1.2		SLA7082M, I_D=2.0A
			0.95	2.1		SLA7083M, I_D=3.0A
Maximum Clock Frequency	Fclk	250			kHz	When Duty = 50%
Logic Input Voltage	V_{IL}			0.25V_{DD}	V	
	V_{IH}	0.75V_{DD}				
Logic Input Current	I_{IL}		±1		μA	
	I_{IH}		±1			
REF Input Voltage	V_{REF}	0.04		0.3	V	SLA7080M
		0.04		0.45		SLA7081M
		0.04		0.4		SLA7082M
		0.04		0.45		SLA7083M
	V_{REFS}	2.0		V_{DD}		Sleep ("I_{BBS}", "output: OFF")
REF Input Current	I_{REF}		±10		μA	
Sense Voltage	V_{SENSE}	V_{REF}–0.03	V_{REF}	V_{REF}+0.03	V	
Sense Resistance	Rs	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
			5.2			B_SEL: High
PWM OFF Time	toff		13		μs	
Sleep-Enable Recovery Time	T_{SE}	100			μS	Sleep
Switching Time	tcon		1.5		μS	Phase IN → Out ON
	tcoff		1.0		μS	Phase IN → Out OFF
Overcurrent Sense Voltage	Vocp	0.65	0.7	0.75	V	When the motor coil shorts out
Overcurrent Sense Current Vocp÷Rs	Iocp		2.3		A	SLA7080MPR/7081MPR
			3.5			SLA7082MPR
			4.5			SLA7083MPR
Blank time for load open	topp	1.5	2.0	2.5	μS	
Thermal Protection Temperature	T_{tsd}		140		°C	Rear of case (at the saturation temperature)
Flag Output Voltage	V_{FlagL}			1.25	V	IFlagL= 1.25mA
	V_{FlagH}	1.25V_{DD}				IFlagH= –1.25mA
Flag Output Current	I_{FlagL}			1.25	mA	
	I_{FlagH}	–1.25				

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

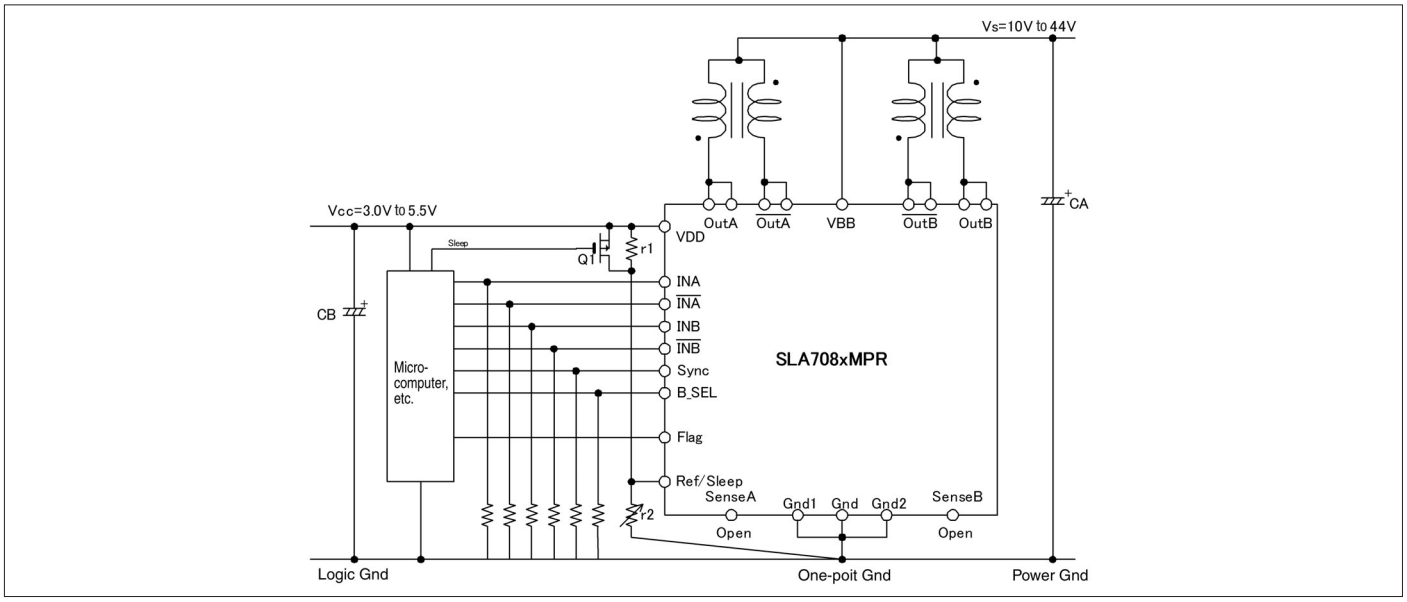
■Internal Block Diagram



■Pin Assignment

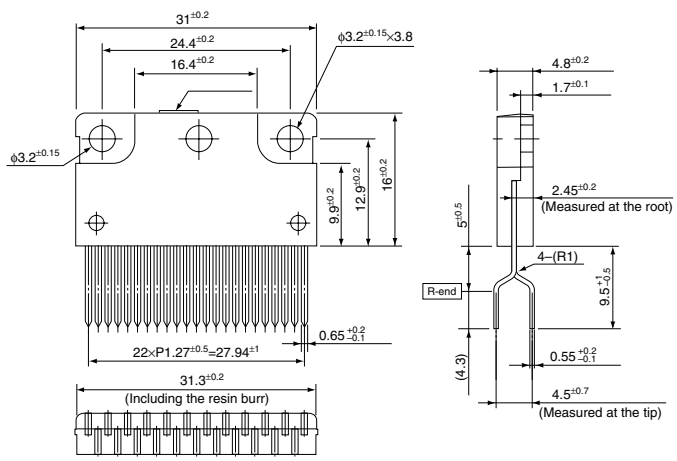
Pin No.	Symbol	Function
1	Out A	Phase A output
2		
3	/Out A	Phase $\overline{A}$ output
4		
5	Sense A	Phase A current sense
6	B_SEL	Blanking time switching input
7	INA	Phase A switching input
8	/INA	
9	INB	Phase B switching input
10	/INB	
11	V_{BB}	Driver supply (motor supply)
12	Gnd	Device GND
13	Ref/Sleep	Control current/Sleep setting input
14	V_{DD}	Logic supply
15	Gnd1	Gnd1
16	Gnd2	Gnd2
17	Sync	PWM synchronous/asynchronous switching input
18	Flag	Protection circuit monitor output
19	Sense B	Phase B current sense
20	/Out B	Phase $\overline{B}$ output
21		
22	Out B	Phase B output
23		

■Typical Connection Diagram



■External Dimensions (ZIP23 with Fin [SLA23Pin])

(Unit : mm)



Forming No. No.2151

Product Mass : Approx.6g

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_a=25°C)

Parameter	Symbol	Ratings	Unit	Remarks
Motor Supply Voltage	V_M	46	V	
Driver Supply Voltage	V_{BB}	46	V	
Output Current	Io	*1	A	Mode F
Logic Input Voltage	V_{IN}	–0.3 to +6	V	
REF Input Voltage	V_{REF}	–0.3 to +6	V	
Sense Voltage	V_{RS}	±0.5	V	Excluding tw<1μs
Power Dissipation	PD	3.5	W	When T_a = 25°C
		12.5		When T_c = 25°C
Junction Temperature	T_j	+150	°C	
Operating Ambient Temperature	T_a	–20 to +80	°C	
Storage Temperature	T_{stg}	–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_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_{BB}	10	44	V	
Case Temperature	T_C		85	°C	Temperature at Pin-10 Lead (without Fin)

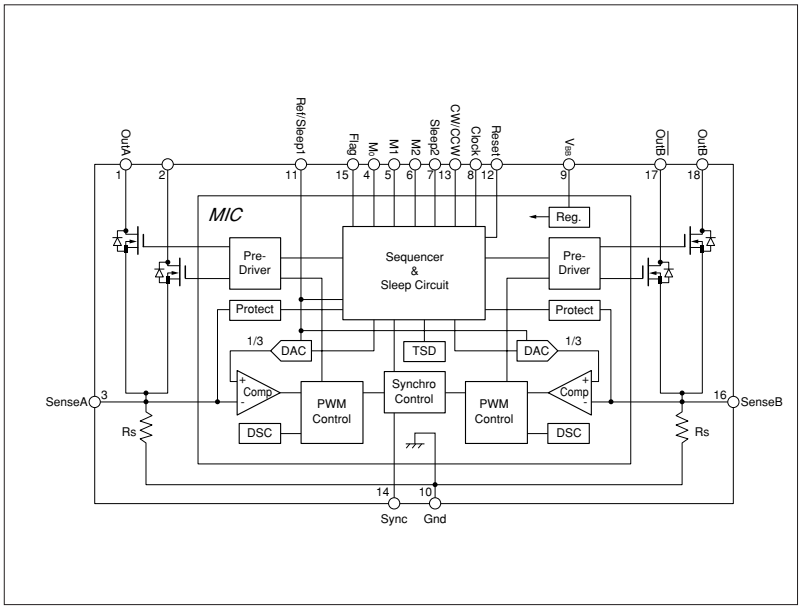
■Electrical Characteristics

(V_{DD}=5V, V_{BB}=24V, T_a=25°C, unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Main Supply Current	I_{BB}			10	mA	In operation
	I_{BBS}			3	mA	Sleep 1 and Sleep 2 modes
Output MOSFET Breakdown Voltage	$V_{(BR)DSS}$	100			V	
Output MOSFET ON Resistance	$R_{DS(ON)}$		0.7	0.85	Ω	STA7130MPR
			0.25	0.4		STA7131MPR
			0.18	0.24		STA7132MPR
Output MOSFET Diode Forward Voltage	V_F		0.85	1.1	V	STA7130MPR
			0.95	1.2		STA7131MPR
			0.95	2.1		STA7132MPR
Maximum Clock Frequency	Fclock	250			kHz	When Clock Duty = 50%
Logic Input Voltage	V_{IL}			0.7	V	
	V_{IH}	2.3				
Logic Input Current	I_{IL}		±10		μA	
	I_{IH}		±10			
REF Input Voltage	V_{REF}	0		0.9	V	
	V_{REFS}	2.0		5.5		Output OFF (Sleep 1)
REF Input Current	I_{REF}		±10		μA	
Sense Voltage	V_{SENSE}	V_{REF}/3-0.03	V_{REF}/3	V_{REF}/3+0.03	V	When step reference current ratio is 100%
Sleep-Enable Recovery Time	T_{SE}	100			μS	Sleep1&Sleep2
Switching Time	t_{con}		1.4		μS	Clock → Out ON
	t_{coff}		0.7		μS	Clock → Out OFF
Sense Resistance	R_S		0.305		Ω	STA7130MPR
			0.205			STA7131MPR
			0.155			STA7132MPR
Overcurrent Sense Voltage	V_{ocp}	0.65	0.7	0.75	V	When motor coil shorts out
Overcurrent Sense Current Vocp÷Rs	I_{ocp}		2.3		A	STA7130MPR
			3.5			STA7131MPR
			4.5			STA7132MPR
Thermal Protection Temperature	T_{tsd}		125		°C	Rear of case (at the saturation temperature)
Logic Output Voltage	V_{LOL}			0.8	V	I_{LOL} =5mA
Logic Output Current	I_{LOL}			5	mA	V_{LOL} =0.8V
Step Reference Current Ratio	ModeF		100		%	VREF=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.

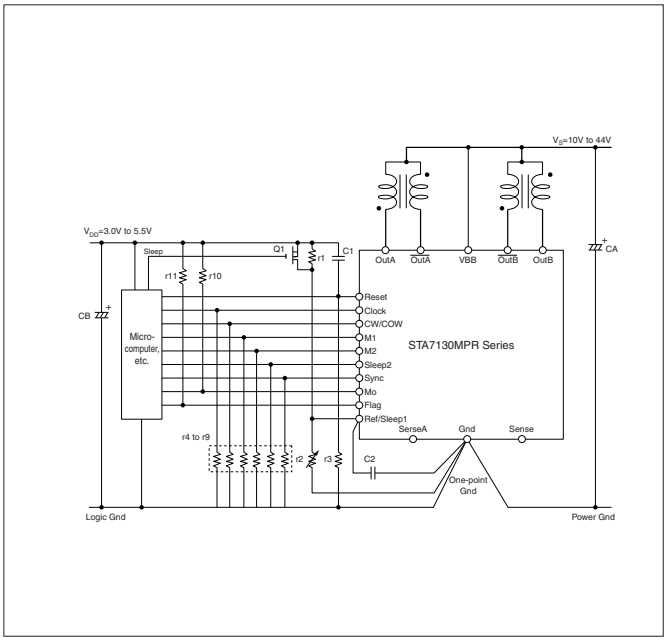
■Internal Block Diagram



■Pin Assignment

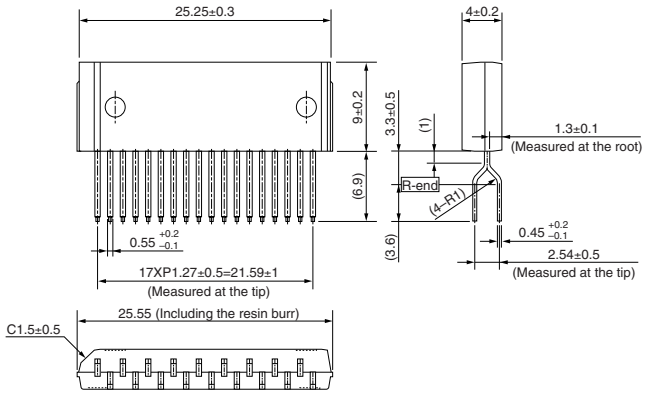
Pin No.	Symbol	Function
1	OutA	Phase A output
2	OutA/	Phase $\overline{A}$ output
3	SenseA	Phase A current sense
4	M_O	2 phase excitation state output monitor output
5	M1	Excitation mode setting input
6	M2	
7	Sleep2	Sleep 2 setting input
8	Clock	Step Clock input
9	V_{BB}	Driver supply (motor supply)
10	Gnd	Device GND
11	Ref/Sleep1	Control current mode/Sleep 1 setting input
12	Reset	Internal logic reset input
13	CW/CCW	Normal/reverse control input
14	Sync	PWM control signal input
15	Flag	Coil open/shorted detection output
16	SenseB	Phase B current sense
17	OutB/	Phase $\overline{B}$ output
18	OutB	Phase B output

■Typical Connection Diagram



■External Dimensions (ZIP18 with Fin [STA18Pin])

(Unit : mm)



Forming No. No.434

Product Mass : Approx.6g

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 Io: 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 us or 3.6 us)
- Selectable clock input edge (POS or POS/NEG)
- Selectable protection availability
- 44-pin surface-mount

■Absolute Maximum Ratings

(T_a=25°C)

Parameter	Symbol	Ratings	Unit	Conditions
Motor Supply Voltage	V_M	46	V	
Driver Supply Voltage	V_{BB}	46	V	
Logic Supply Voltage	V_{DD}	6	V	
Output Current	Io	1.5	A	Current ratio: 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}	±2	V	Excluding tw<1μs
Power Dissipation	P_D	3.5	W	When Ta = 25°C
Junction Temperature	Tj	+150	℃	
Operating Ambient Temperature	Ta	–20 to +80	℃	
Storage Temperature	Tstg	–30 to +150	℃	

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

■Recommended Operating Conditions

Parameter	Symbol	Ratings		Unit	Conditions
		min.	max.		
Motor Supply Voltage	V_M		44	V	
Driver Supply Voltage	V_{BB}	10	44	V	
Logic Supply Voltage	V_{DD}	3.3	5.5	V	The V_{DD} surge voltage should be 0.5V or lower.
REF Input Voltage	V_{REF}	0.04	1.0	V	When not using protection
			0.5		When using protection
Case Temperature	Tc		85	℃	Temperature at the center of the package

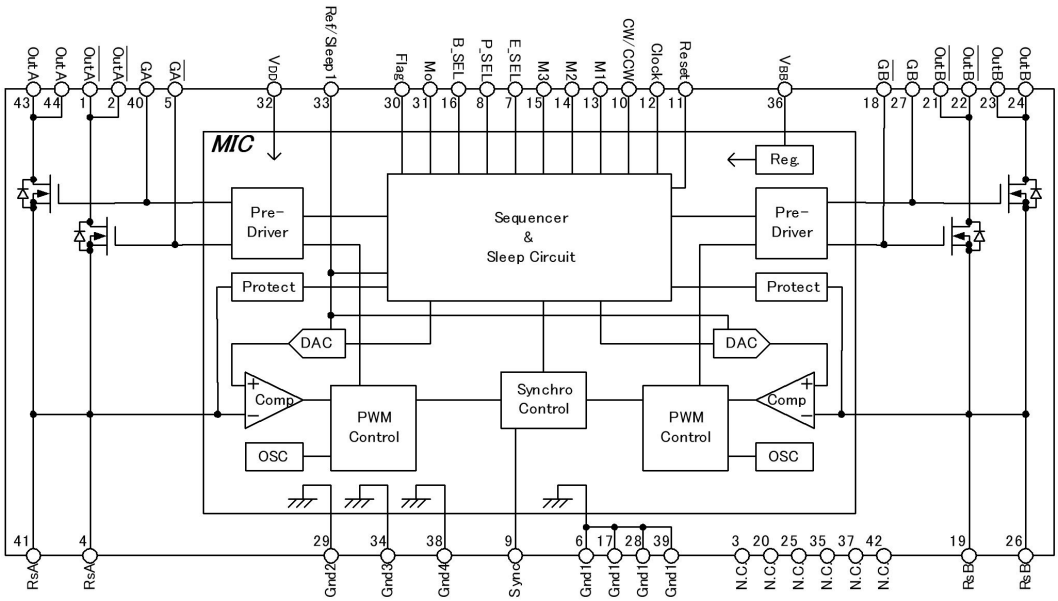
■Electrical Characteristics

(V_{DD}=5V, V_{BB}=24V, T_a=25°C, unless otherwise specified)

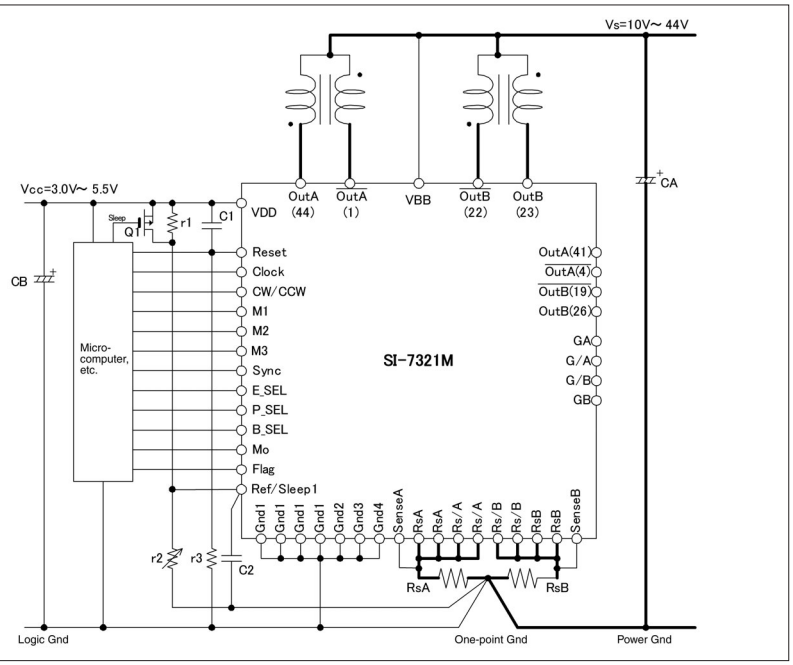
Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Driver Supply Current	I_{BB}			15	mA	In operation
	I_{BBS}			100	μA	Sleep Mode
Logic Supply Current	I_{DD}			5	mA	
Output MOSFET Breakdown Voltage	$V_{(BR)DSS}$	100			V	V_{BB}=44V, I_D=1mA
Output MOSFET ON Resistance	$R_{DS(ON)}$		0.25	0.4	Ω	I_D=1.5A
Output MOSFET Diode Forward Voltage	V_F		0.95	1.2	V	I_F=1.5A
Maximum Clock Frequency	Fclk	250			kHz	When Duty = 50%
Logic Input Voltage	V_{IL}			0.25V_{DD}	V	
	V_{IH}	0.75V_{DD}				
Logic Input Current	I_{IL}		±1		μA	
	I_{IH}		±1			
REF Input Voltage	V_{REF}	0.04		1.5	V	When not using protection
		0.04		0.6		When using protection
	V_{REFS}	2		V_{DD}		Sleep1 Mode
REF Input Current	I_{REF}		±10		μA	V_{REF}=0 to V_{DD}
Logic Output Voltage	V_{LOL}			1.25	V	I_{LOL}=1.25mA
	V_{LOH}	V_{DD}-1.25			V	I_{LOH}=–1.25mA
Logic Output Current	I_{LOL}			1.25	mA	
	I_{LOH}	–1.25			mA	
Sense Voltage	V_{SENSE}		0.2		V	V_{REF}=0.2V, Mode F
Overcurrent Sense Voltage	Vocp	0.65	0.7	0.75	V	against Vsence
Step Reference Current Ratio	Mode F		100		%	V_{REF}=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_{SE}	100			μS	Sleep1&Sleep2
Switching Time	tpdon1		2.0		μS	Clock → Out ON
			1.5		μS	Clock → Out OFF
PWM Minimum ON Time	ton(min)		1.8		μs	B_SEL: L
			3.6		μs	B_SEL: H
PWM OFF Time	toff1		13		μs	Mode8 to F
	toff2		9.5		μs	Mode4 to 7
	toff3		7.5		μs	Mode1 to 3
Blank time for load open	topp	1.5	2	2.5	μs	Starts when the PWM is turned off.

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

■Internal Block Diagram



■Typical Connection Diagram

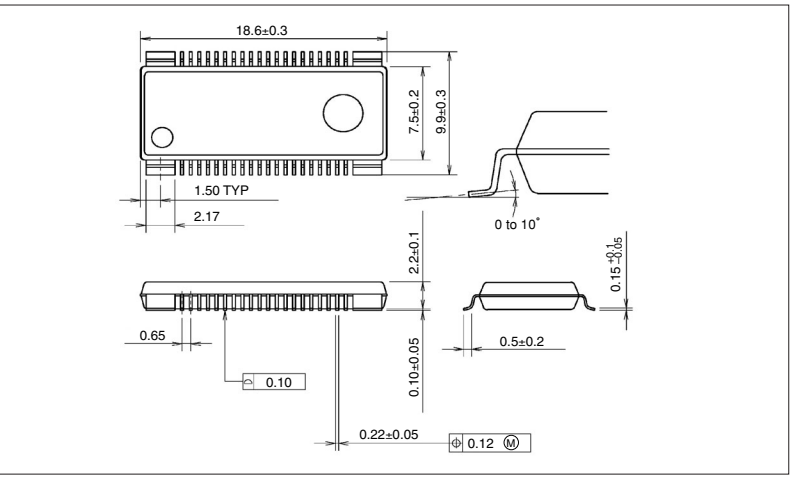


■Pin Assignment

Pin No.	Symbol	Function
1	Out/A	Phase $\overline{A}$ output
2	Out/A	Phase $\overline{A}$ output
3	N.C.	No connection
4	RsA	Connection terminal for phase A sense resistor
5	G/A	Phase $\overline{A}$ 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 $\overline{B}$ MOSFET gate
19	RsB	Connection terminal for phase B sense resistor
20	N.C.	No connection
21	Out /B	Phase $\overline{B}$ output
22	Out /B	Phase $\overline{B}$ 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

■External Dimensions (HSOP44)

(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	Io	*1	A	Vref=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}	±2	V	Excluding tw<1μs
Power Dissipation	PD	4.7	W	When T_a = 25°C
		17		When T_c = 25°C
Junction Temperature	T_j	+150	°C	
Operating Ambient Temperature	T_a	–20 to +85	°C	
Storage Temperature	T_{stg}	–30 to +150	°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.

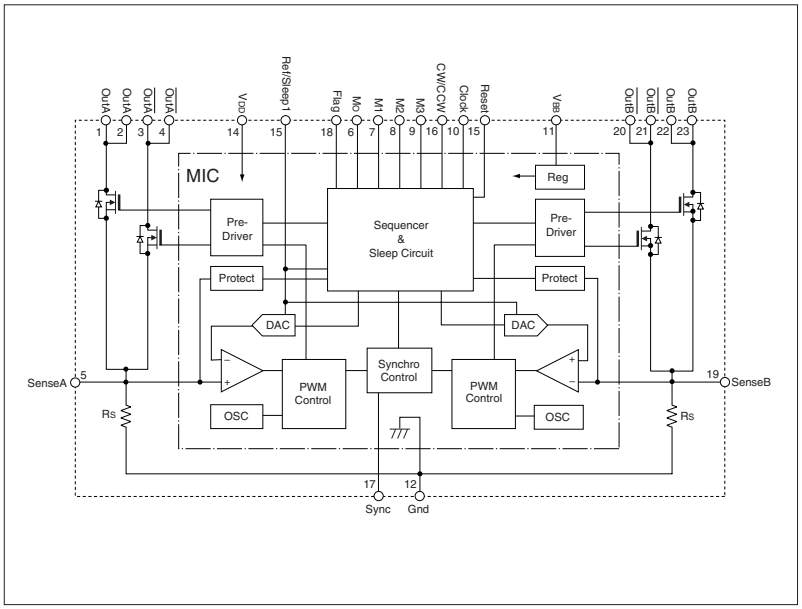
■Recommended Operating Conditions

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	°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	μA	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	Ω	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	Fclock	250			kHz	When Clock Duty = 50%
Logic Input Voltage	V_{IL}			0.25V_{DD}	V	
	V_{IH}	0.75V_{DD}				
Logic Input Current	I_{IL}		±1		μA	
	I_{IH}		±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}		±10		μA	
SENSE Sense Voltage	V_{SENSE}		V_{REF}		V	When step reference current ratio is 100%
Sleep-Enable Recovery Time	T_{SE}	100			μS	Sleep1&Sleep2
Switching Time	t_{con}		2.0		μS	Clock → Out ON
	t_{coff}		1.5		μS	Clock → Out OFF
Sense Resistance	R_S	0.296	0.305	0.314	Ω	SLA7075M, tolerance of ±3%
		0.296	0.305	0.314		SLA7076M, tolerance of ±3%
		0.199	0.205	0.211		SLA7077M, tolerance of ±3%
		0.150	0.155	0.160		SLA7078M, tolerance of ±3%
Overcurrent Sense Voltage	Vocp	0.65	0.7	0.75	V	SLA707xMPR, MPRT, when motor coil shorts out
Overcurrent Sense Current	Iocp		2.3		A	SLA7075MPR, MPRT/7076MPR, MPRT
			3.5			SLA7077MPR, MPRT
			4.6			SLA7078MPR, MPRT
Thermal Protection Temperature	T_{std}		140		°C	SLA707xMPRT, Rear of case (at the saturation temperature)
Logic Output Voltage	V_{LOL}			1.25	V	SLA707xMPR, MPRT, IFlagL=1.25mA
	V_{LOH}	V_{DD}–1.25				SLA707xMPR, MPRT, IFlagH=-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	ton(min)		1.7		μS	
PWM OFF Time	toff1		12		μS	Mode 8 to F
	toff2		9		μS	Mode 4 to 7
	toff3		7		μS	Mode 1 to 3

■Internal Block Diagram



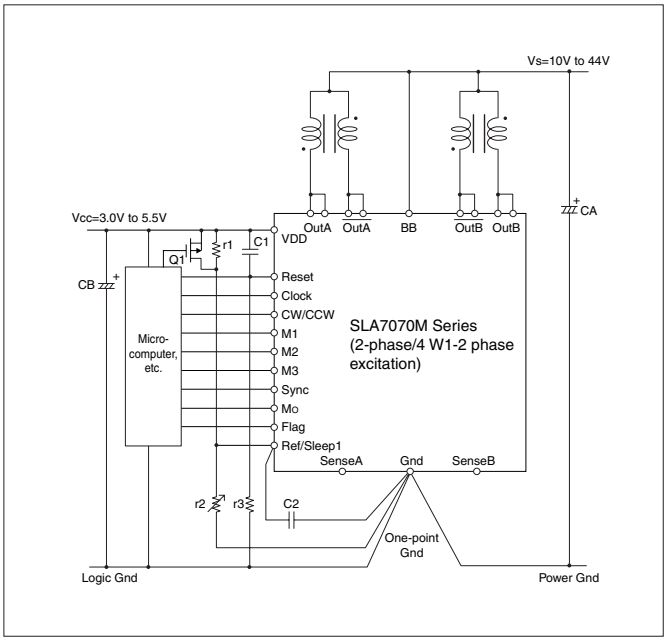
The protect circuit is deleted and the flag pin is N.C. for SLA7075MR, 7076MR, 7077MR, and 7078MR.

■Pin Assignment

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

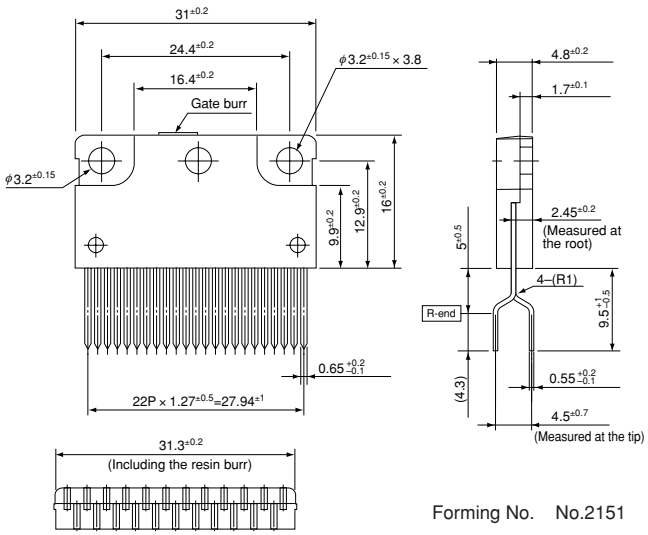
*1: N.C. pin for SLA7075MR, 7076MR, 7077MR, and 7078MR.

■Typical Connection Diagram



* There is no Flag pin (pin 18) for SLA7075MR, 7076MR, 7077MR, and 7078MR.

■External Dimensions (ZIP23 with Fin [SLA23Pin])



Forming No. No.2151

Product Mass : Approx.6g

SI-7510 New Pentagon Connection

■Absolute Maximum Ratings

Parameter	Symbol	Ratings	Unit	Remarks
Main Supply Voltage	$V_{CC}1$	44	V	
Logic Supply Voltage	$V_{CC}2$	7	V	
Logic Input Voltage	V_{IN}	–0.3 to $V_{CC}2$	V	
REF Input Voltage	V_{REF}	–0.3 to $V_{CC}2$	V	
Sense Input Voltage	V_{SENSE}	2	V	Except when tw<1μs
Charge Pump Output Voltage	V_{MC3}	48	V	
Power Dissipation	P_D	1.6	W	
Operating Ambient Temperature	T_a	–10 to 80	°C	
Storage Temperature	T_{stg}	–20 to 150	°C	
Junction Temperature	T_j	150	°C	

■Recommended Operating Ranges

Parameter	Symbol	Operating Ranges	Unit
Main Supply Voltage	$V_{CC}1$	10 to 42*	V
Logic Supply Voltage	$V_{CC}2$	3 to 5.5	V
REF Input Voltage	V_{REF}	0.1 to 1	V

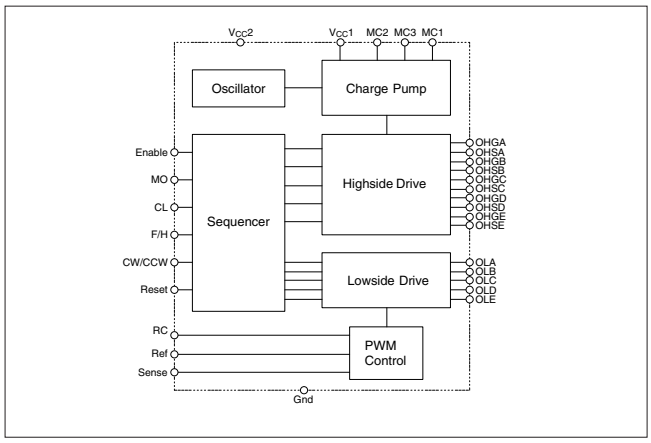
*: Insert a 5V Zener diode between V_{CC1} and V_{MC3} when using with V_{CC1} of 35 V or more.

■Electrical Characteristics

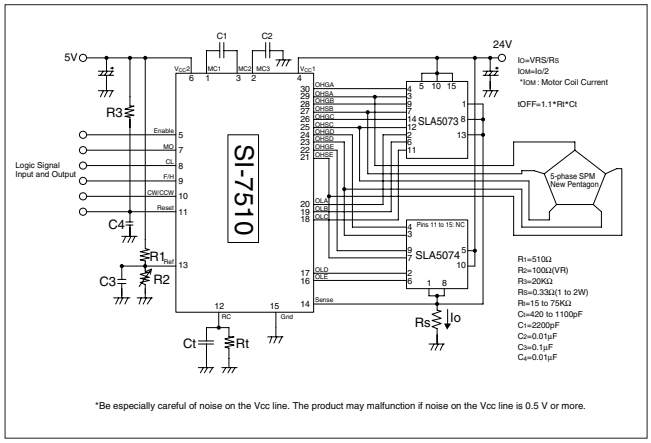
(Ta=25°C, Vcc1=24V, VCC2=5V, unless otherwise specified)

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

■Internal Block Diagram

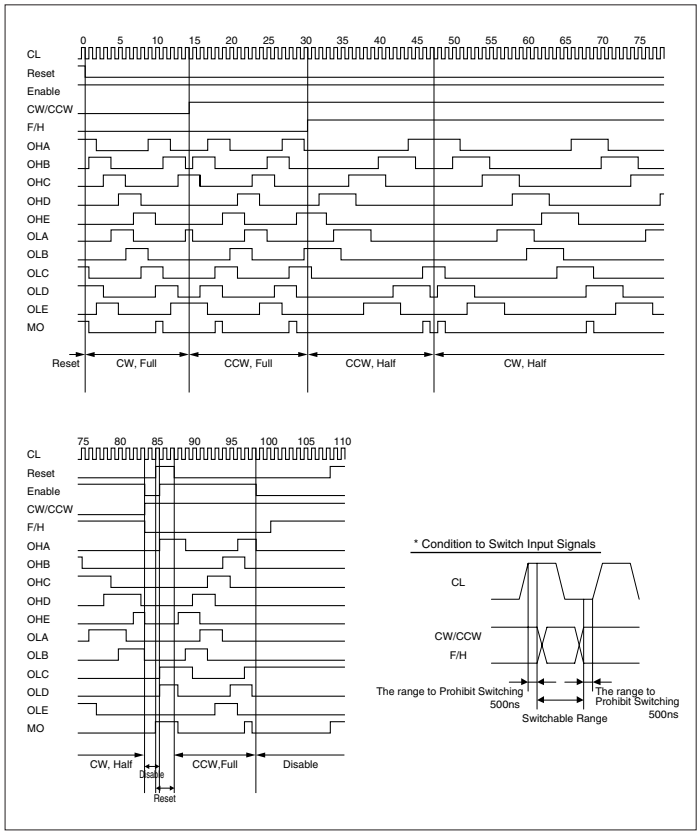


■Typical Connection Diagram



*Be especially careful of noise on the Vcc line. The product may malfunction if noise on the Vcc line is 0.5 V or more.

■Input and Output Timing Chart



■Pin Assignment and Function Table

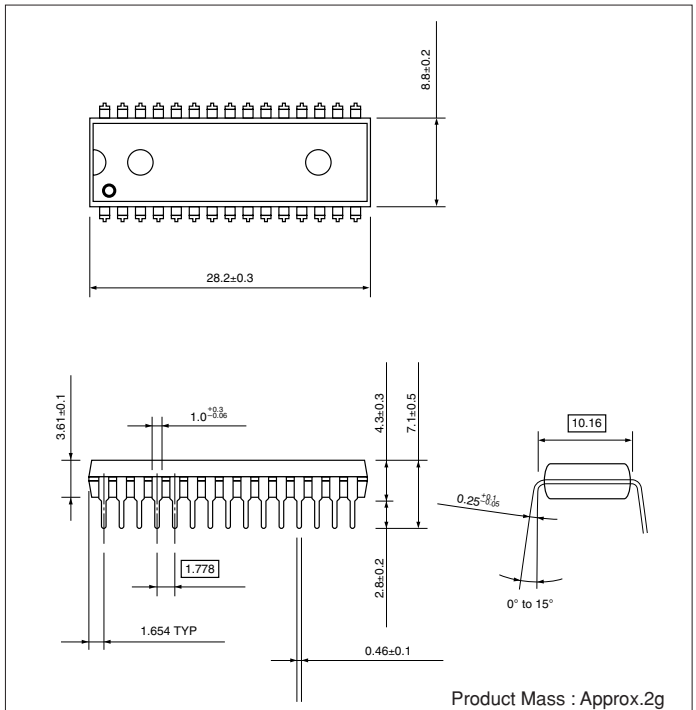
Pin No.	Symbol	Function
1	MC1	Capacitor Connection Terminal for Charge Pump (for MC2)
2	MC3	Capacitor Connection Terminal for Charge Pump (for Gnd)
3	MC2	Capacitor Connection Terminal for Charge Pump (for MC1)
4	$V_{CC}1$	Main Supply Voltage Input
5	Enable	Output OFF
6	$V_{CC}2$	Logic Voltage Input
7	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)



Product Mass : Approx.2g

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	Io	8	A	100μs 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 (Ta = 25°C)
		3.0	W	PWM control (Ta = 25°C) at Slow Decay
		3.2	W	PWM control (Ta = 25°C) at Fast Decay
Junction Temperature	Tj	150	°C	
Operating Ambient Temperature	Ta	–20 to 85	°C	
Storage Temperature	Tstg	–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 Tj under any circumstances.

■Recommended Operating Conditions

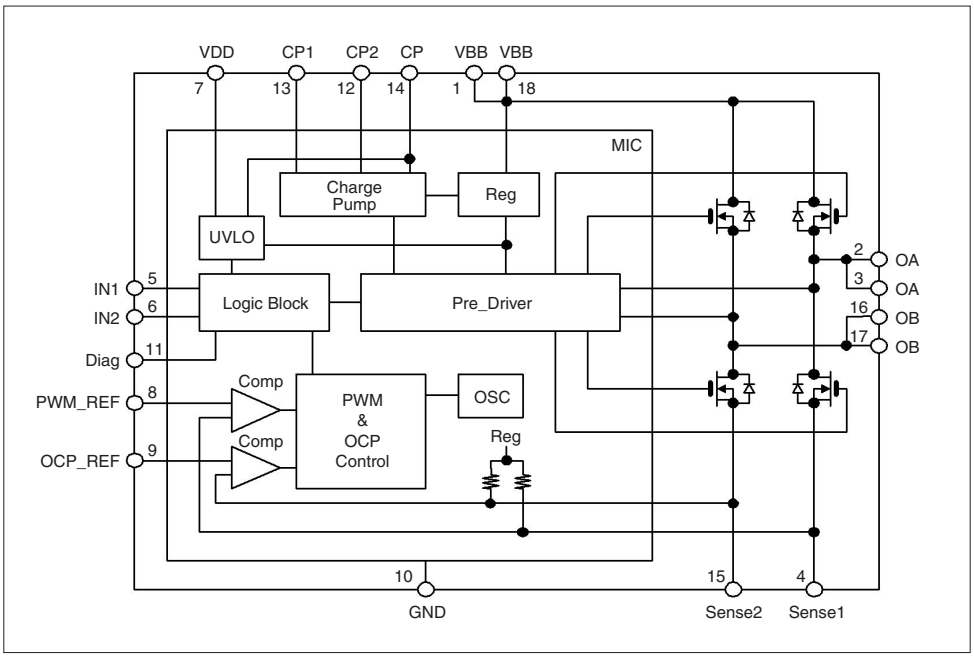
Parameter	Symbol	Ratings		Unit	Conditions
		min.	max.		
Main Supply Voltage	V_{BB}	10	40	V	
Output Current	Io		4.0	A	
Logic Supply Voltage	V_{DD}	3.0	5.5	V	
PWM REF Input Voltage	V_{PREF}		1	V	When operating current control
OCP REF Input Voltage	V_{OREF}		2	V	When operating overcurrent control
Case Temperature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

■Electrical Characteristics

(V_{DD}=5V, V_{BB}=24V, Ta=25°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	Vcp		V_{BB}+5		V	V_{BB}=10V to 40V
Charge Pump Oscillation Frequency	Fcp		360		kHz	
Low Driver Supply Voltage Protection Voltage	V_{UVB}L		7		V	
	V_{UVB}H		7.8		V	
Low Logic Supply Voltage Protection Voltage	V_{UVD}L		2.3		V	
	V_{UVD}H		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=250μA
Output MOSFET ON Resistance	$R_{DS(ON)}$		0.1	0.13	Ω	I_D=4.0A
Output MOSFET Diode Forward Voltage	V_F		0.95	2.1	V	I_F=4.0A
Logic Input Voltage	V_{LIL}			0.25V_{DD}	V	
	V_{LIH}	0.75V_{DD}			V	
Logic Input Current	I_{LIL}		±1		μA	
	I_{LIH}		±1		μA	
Maximum Logic Input Clock Frequency	fclk	100			kHz	duty=50%
PWM REF Input Voltage	V_{PREF}	0.1		1	V	When controlling the current
PWM REF Input Current	I_{PREF}		±10		μA	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}		±10		μA	V_{REF}=0 to V_{DD}
PWM Sense Voltage	V_{PSEN}	V_{PREF} –0.045	V_{PREF} –0.015	V_{PREF} +0.015	V	
Overcurrent Sense Voltage	V_{OSEN}	V_{OREF} –0.045	V_{OREF} –0.015	V_{OREF} +0.015	V	
Sense Input Current	I_{SENSE}		±20		μA	
Diag Output Voltage	V_{LOL}			1.25	V	I_{LOL}=1.25mA
	V_{LOH}	V_{DD}–1.25			V	I_{LOL}=–1.25mA
Diag Output Current	I_{LOL}			1.25	mA	V_{LOL}=1.25V
	I_{LOH}	–1.25			mA	V_{LOH}=V_{DD}-1.25
Diag Output Frequency	f_{DIAG}		90		kHz	
PWM Minimum ON Time	tpon(min)		5		μs	During PWM operation
PWM OFF Time	t_{POFF}		35		μs	
OCP Minimum ON Time	toon(min)		5		μs	During OCP operation
OCP OFF Time	t_{OOFF}		142		μs	
Crossover Current Delay Time	t_{COCD}	150		750	ns	
Switching Time	tcon		3		μs	IN→Out ON
	tcoff		2.7		μs	IN→Out OFF
Thermal Protection Activation Temperature	Ttsdon		140		°C	Temperature of rear of package (at saturation)
Thermal Protection Deactivation Temperature	Ttsdoff		115		°C	

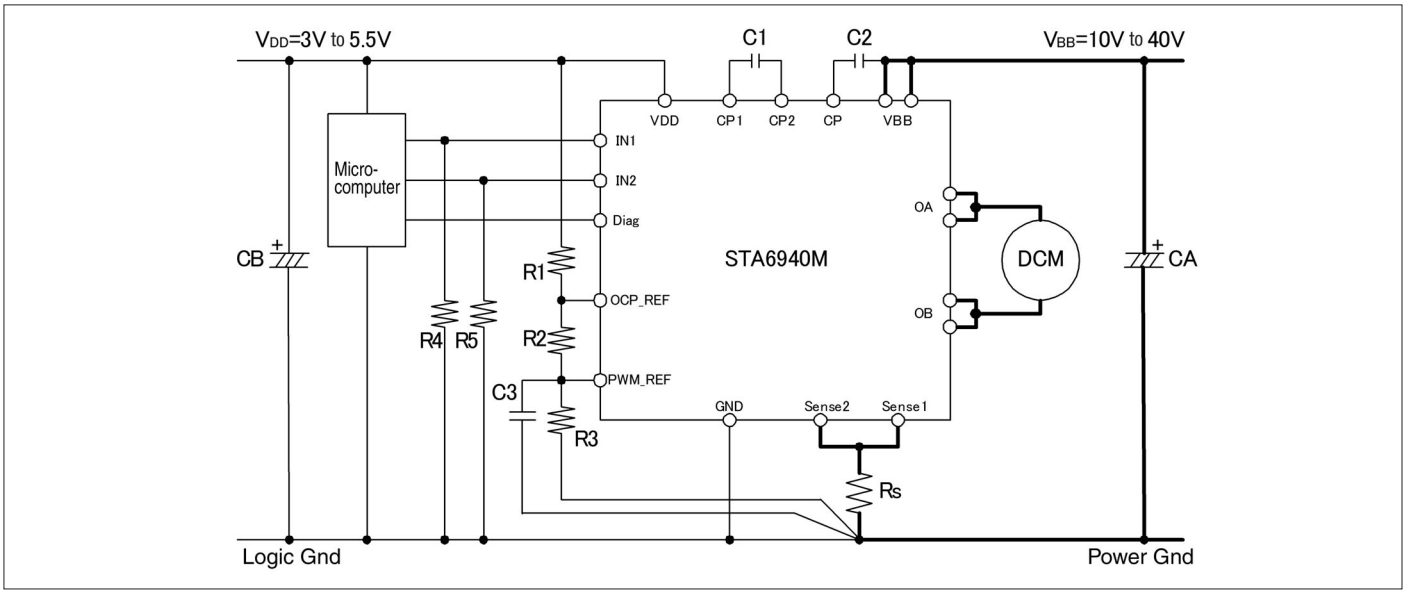
■Internal Block Diagram



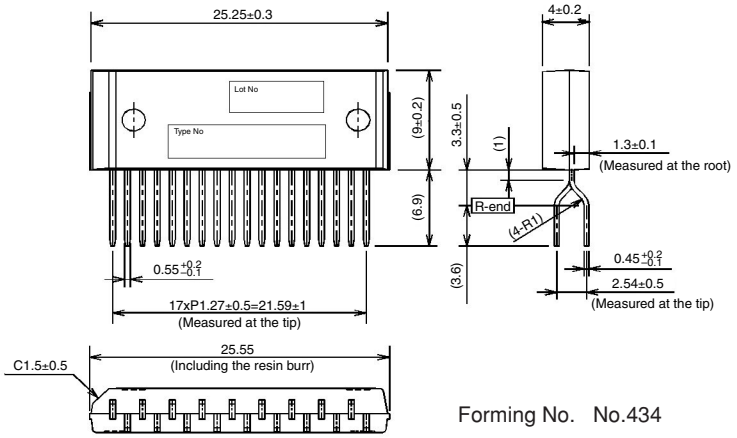
■Pin Assignment

Pin No.	Symbol	Function
1	V_{BB}	Main supply
2,3	OA	Output terminal A
4	Sense 1	Constant current sense terminal
5	IN1	Output setting terminal
6	IN2	
7	V_{DD}	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_{BB}	Driver supply

■Typical Connection Diagram



■External Dimensions (ZIP18 [STA18Pin])



Forming No. No.434

SPI-6631M

■Features

- Power supply voltages, V_{BB}: 13 V to 33 V
- Signal power supply configuration
- Output current Iout: 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	Iout	±3	A	
Input Voltage	VIN	–0.3 to 6.5	V	
S Terminal Voltage	Vsen	–2 to 2	V	
Alarm Terminal Voltage	Valarm	6.5	V	
Alarm Input Current	Ialarm	1	mA	
Power Dissipation	P_D	2.6	W	When using a Sanken evaluation board
Junction Temperature	Tj	150	°C	
Storage Temperature	Tstg	–30 to 150	°C	
Operating Ambient Temperature	Ta	–20 to 85	°C	

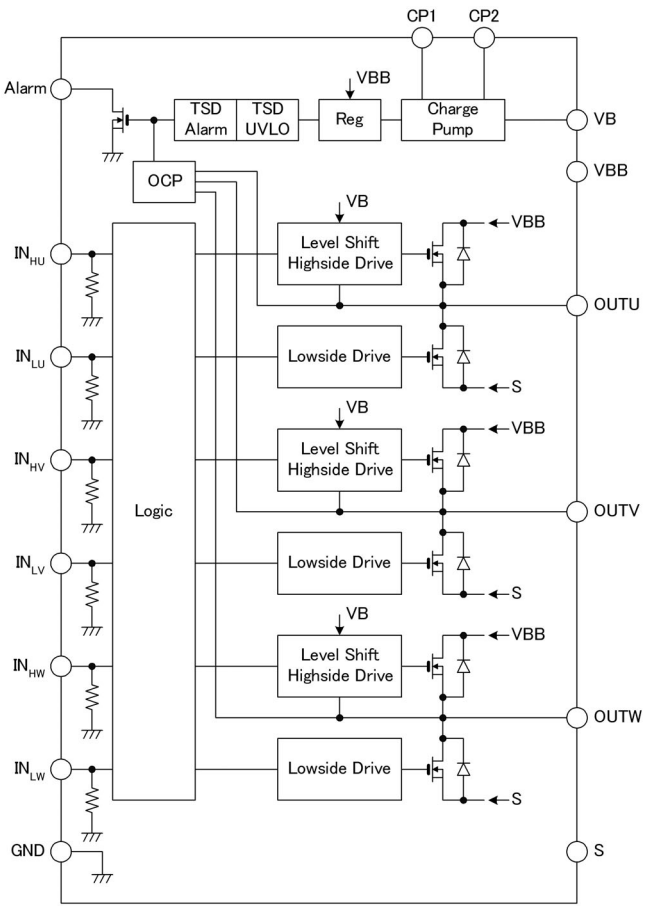
*: Output current value may be limited, depending on the duty ratio, ambient temperature, and heating conditions. Do not exceed the rated current or maximum junction temperature (Tj = 150°C).

■Electrical Characteristics

(Ta=25°C, V_{BB}=24V, 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	μs	
Input Voltage	V_{IL}	–	–	0.8	V	
	V_{IH}	2.0	–	–	V	
Input Current	I_{IL}	–	±8	–	μA	$V_{IN(0)}$, V_{IN}=0.8V
	I_{IH}	–	±20	–	μA	$V_{IN(1)}$, V_{IN}=2.0V
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	VB-OUT=5V
Output Leakage Current	I_{DSS}	–	–	800	μA	V_{OUT}=V_{BB}=35V
		–800	–	–	μA	V_{OUT}=0V
MOSFET ON Resistance	$R_{DS(ON)}$	–	0.4	0.7	Ω	I_{OUT}=–1A, Between VBB and OUT I_{OUT}=1A, Between OUT and S
MOSFET Diode Forward Voltage	V_{SD}	–	–	2.2	V	I_{SD}=1A
Overcurrent Sense Current	I_{OCP}	7	–	–	A	Short between Out and Out
Overcurrent Protection Blank Time	tblank	0.7	1.2	4	μs	
Overcurrent Protection Delay Time	tocp	0.5	1	2.2	ms	
Thermal Protection Operation Temperature	T_J	–	170	–	°C	
Thermal Protection Hysteresis	ΔT_J	–	15	–	°C	
Low Voltage Protection Operation Voltage	UVLO	4.0	4.5	5.0	V	V_{BB} voltage
Low Voltage Protection Hysteresis	ΔUVLO	0.4	0.45	0.5	V	
Alarm Output Voltage	V_{Alarm}	–	–	0.5	V	I=1mA

■Internal Block Diagram

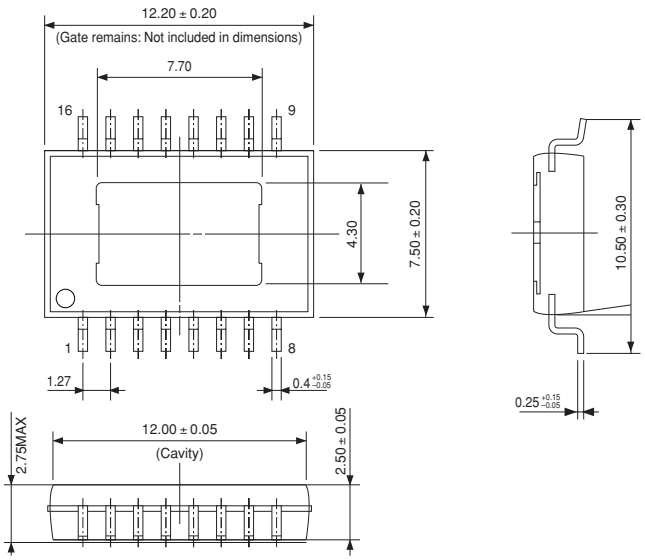


■Pin Assignment

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_{LW}	Phase W lower arm input
10	IN_{HW}	Phase W upper arm input
11	IN_{LV}	Phase V lower arm input
12	IN_{HV}	Phase V upper arm input
13	VBB	Driver supply terminal
14	IN_{LU}	Phase U lower arm input
15	IN_{HU}	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 Iout = 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_{BB}	–0.3 to 38	V	
Output Voltage	V_{OUT}	V_{BB}	V	
Output Current*	$I_{OUT(Ave)}$	±2	A	
	$I_{OUT(Peak)}$	±4	A	tw<10msec
Logic Input Voltage	$V_{IN(Logic)}$	–0.3 to 5.5	V	
Analog Input Voltage	$V_{IN(Analog)}$	–0.3 to 6	V	
Detection Voltage	V_{SENSE}	±0.5	V	
Package Power Dissipation	P_D	2.9	W	Sanken Evaluation Board
Maximum Junction Temperature	T_j	150	°C	
Storage Temperature	T_{stg}	–40 to 150	°C	
Operating Ambient Temperature	T_a	–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_{BB}	10 to 30	V	During normal operation
Logic Input Voltage	$V_{IN(Logic)}$	0 to 5.5	V	
Analog Input Voltage	$V_{IN(Analog)}$	0 to 5.5	V	Excluding REF
REF Input Voltage	V_{Ref}	0.5 to 5.5	V	The control current precision degrades significantly at 0.5V or lower.
Detection Voltage	V_{SEN}	±0.5	V	
Package Temperature	T_C	105	°C	
Operating Ambient Temperature	T_a	–20 to 85	°C	

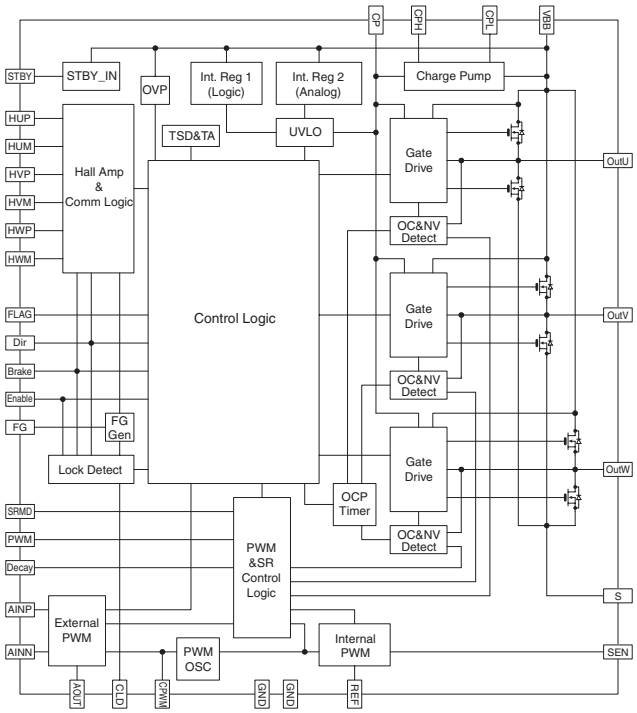
■Electrical Characteristics

(Ta=25°C, V_{BB}=24V, V_{DD}=5V, unless otherwise specified)

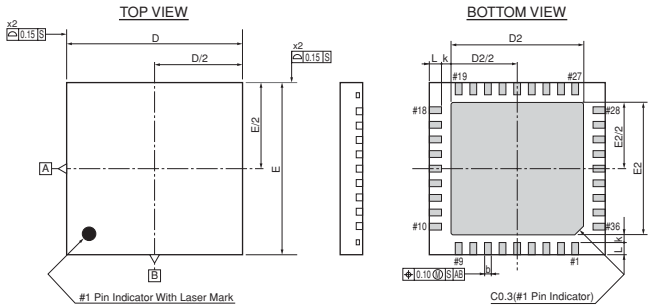
Parameter	Symbol	Ratings min.	Ratings typ.	Ratings max.	Unit	Conditions	
Driver Supply Voltage Range	V_{BB}	10	–	V_{BBOV}	V	During motor driving	
Charge Pump Output Voltage	V_{CP}	6	7.5	9	V	Output disabled, CP-VBB voltage	
Charge Pump Oscillation Frequency	f_{CP}	90	120	150	kHz		
Main Supply Current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

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

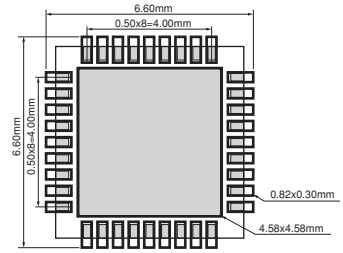
■Internal Block Diagram



■External Dimensions (QFN36)

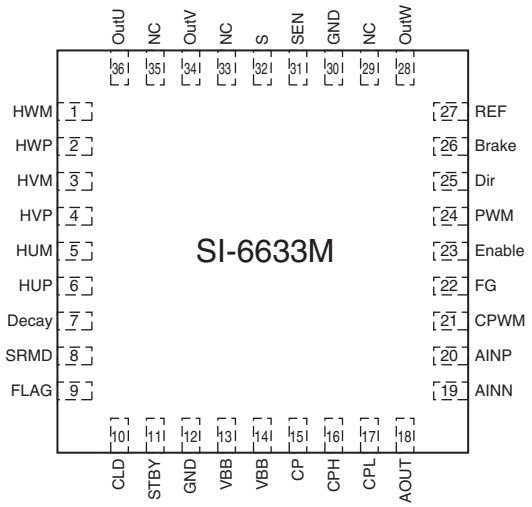


Recommended Pattern (Thick Lines)



SYMBOL	COMMON DIMENSIONS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A2		0.20 REF.	
b	0.18	0.23	0.28
D	5.90	6.00	6.10
D2	4.43	4.58	4.73
E	5.90	6.00	6.10
E2	4.43	4.58	4.73
e		0.50 BSC.	
k	0.25	–	–
L	0.32	0.42	0.52

■Pin Assignment Diagram



Pin No.	Pin Name	Pin Function
1	HWM	Hall element input pin W-
2	HWP	Hall element input pin W+
3	HVM	Hall element input pin V-
4	HVP	Hall element input pin V+
5	HUM	Hall element input pin U-
6	HUP	Hall element input pin U+
7	Decay	Current decay setting pin
8	SRMD	Synchronous rectifier operation selection (Active or Passive)
9	FLAG	Error detection output pin
10	CLD	Lock detection protection time setting pin
11	STBY	Standby control input pin
12	GND	Device ground pin
13	VBB	Motor & driver power supply pin
14	VBB	Motor & driver power supply pin
15	CP	Charge pump charge up capacitor pin
16	CPH	Charge pump pumping capacitor pin (High)
17	CPL	Charge pump pumping capacitor pin (Low)
18	AOUT	Amplifier output & 100% ON direction input pin
19	AINN	Amplifier input (negative)
20	AINP	Amplifier input (positive)
21	CPWM	PWM frequency setting pin
22	FG	FG signal output
23	Enable	Lock counter reset & enable signal input pin
24	PWM	External PWM control logic signal input
25	Dir	Rotation direction setting pin
26	Brake	Brake input pin
27	REF	Internal PWM current setting pin
28	OutW	Phase W output pin
29	N.C.	No Connection
30	GND	Device ground pin
31	SEN	Current detection input pin
32	S	Source pin
33	N.C.	No Connection
34	OutV	Phase V output pin
35	N.C.	No Connection
36	OutU	Phase U output pin

* Connect the GND and VBB pins to their respective power lines.

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_{BB}	–0.3 to 38	V	
Output Voltage	V_{OUT}	–1 to 38	V	
Logic Input Voltage	$V_{IN(Logic)}$	–0.3 to 6	V	
Hall Input Voltage	V_{HALL}	–0.3 to 6	V	
REF Input Voltage	V_{Ref}	–0.3 to 6	V	
Detection Voltage	V_{SENSE}	±0.5	V	
Maximum Junction Temperature	$T_{j(max)}$	150	°C	
Storage Temperature	T_{stg}	–40 to 150	°C	
Operating Ambient Temperature	T_a	–20 to 85	°C	
Package Thermal Resistance	$R_{\theta ja}$	43	°C/W	With Sanken Evaluation Board (2-layer board; 60mm×77mm)

■Recommended Operating Conditions

Parameter	Symbol	Ratings	Unit	Conditions
Supply Voltage	V_{BB}	10 to 30	V	
Control Supply Voltage	V_{DD}	3 to 5.5	V	
Logic Input Voltage	$V_{IN(Logic)}$	0 to 5.5	V	
REF Input Voltage	V_{Ref}	0.5 to 5.5	V	The control current precision degrades significantly at 0.5V or lower.
Hall Input Voltage	V_{HALL}	0.2 to 4	V	
Detection Voltage	V_{SENSE}	±0.5	V	
Package Temperature	T_C	105	°C	
Operating Ambient Temperature	T_a	–20 to 85	°C	

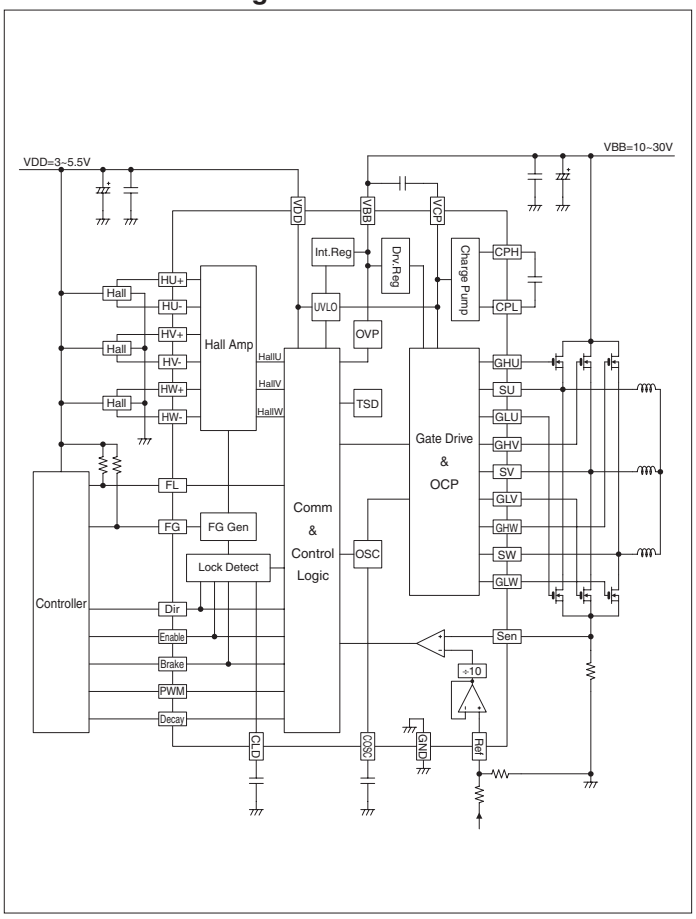
■Electrical Characteristics

(Ta=25°C, V_{BB}=24V, V_{DD}=5V, unless otherwise specified)

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

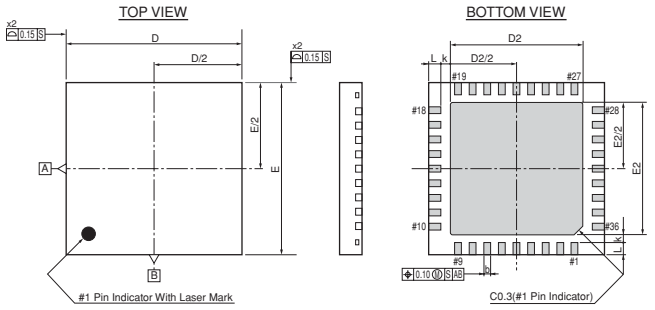
*: Use typ. data for design. The direction in which current flows out of the device is regarded as negative.

■Internal Block Diagram

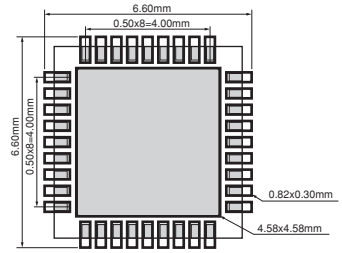


■External Dimensions (QFN36)

(Unit : mm)

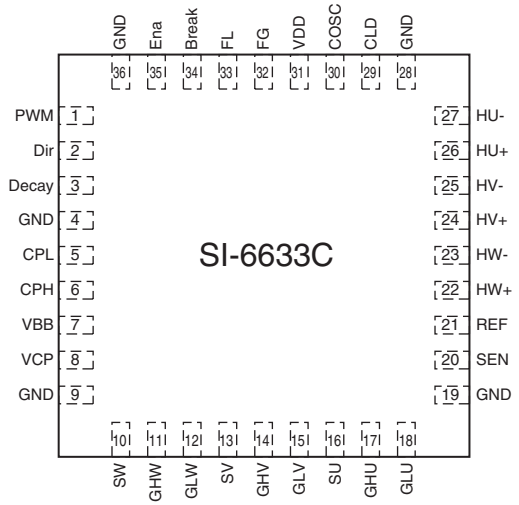


Recommended Pattern (Thick Lines)



SYMBOL	COMMON DIMENSIONS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A2		0.20 REF.	
b	0.18	0.23	0.28
D	5.90	6.00	6.10
D2	4.43	4.58	4.73
E	5.90	6.00	6.10
E2	4.43	4.58	4.73
e		0.50 BSC.	
k	0.25	–	–
L	0.32	0.42	0.52

■Pin Assignment Diagram



Pin No.	Pin Name	Pin Function
1	PWM	PWM signal input pin
2	Dir	Current direction switch pin
3	Decay	Decay signal input pin
4	GND	Ground pin
5	CPL	Charge pump pumping capacitor pin (Low)
6	CPH	Charge pump pumping capacitor pin (High)
7	VBB	Motor supply input pin
8	VCP	Charge pump charge up capacitor pin
9	GND	Ground pin
10	SW	Output pin OUTW
11	GHW	High side gate output pin W
12	GLW	Low side gate output pin W
13	SV	Output pin OUTV
14	GHV	High side gate output pin V
15	GLV	Low side gate output pin V
16	SU	Output pin OUTU
17	GHU	High side gate output pin U
18	GLU	Low side gate output pin U
19	GND	Ground pin
20	Sen	Current detection pin
21	Ref	Internal PWM current setting pin
22	HW+	Hall element input pin HW+
23	HW–	Hall element input pin HW–
24	HV+	Hall element input pin HV+
25	HV–	Hall element input pin HV–
26	HU+	Hall element input pin HU+
27	HU–	Hall element input pin HU–
28	GND	Ground pin
29	CLD	Lock detection time setting pin
30	COSC	Switching frequency setting pin
31	VDD	Logic supply pin
32	FG	FG output pin
33	FL	Error detection output pin
34	Brake	Brake input pin
35	Ena	Lock counter reset signal & enable signal input pin
36	GND	Ground pin

* Connect the GND and VBB pins to their respective power lines.

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_a=25°C)

Parameter	Symbol	Ratings			Unit	Conditions
		SX68001MH	SX68002MH	SX68003MH		
MOSFET Output Breakdown Voltage	V_{DSS}	250	500	500	V	V_{CC}=15V,VIN=0V
Control Supply Voltage	V_{CC}	20	20	20	V	Between V_{CC} and COM
Control Supply Voltage (Bootstrap)	V_{BS}	20	20	20	V	Between VB and HS (U, V, W)
Output Current (continuous)	I_o	2.0	1.5	2.5	A	
Output Current (pulse)	I_{op}	3.0	2.25	3.75	A	PW≤100μs, duty=1%
Input Voltage	V_{IN}	–0.5 to +7	–0.5 to +7	–0.5 to +7	V	
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	15	15	15	°C/W	*1
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	41.7	41.7	41.7	°C/W	*1
Operating Case Temperature	T_{op}	–20 to +100	–20 to +100	–20 to +100	°C	
Junction Temperature (Power part)	T_{ch}	+150	+150	+150	°C	
Storage Temperature	T_{stg}	–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

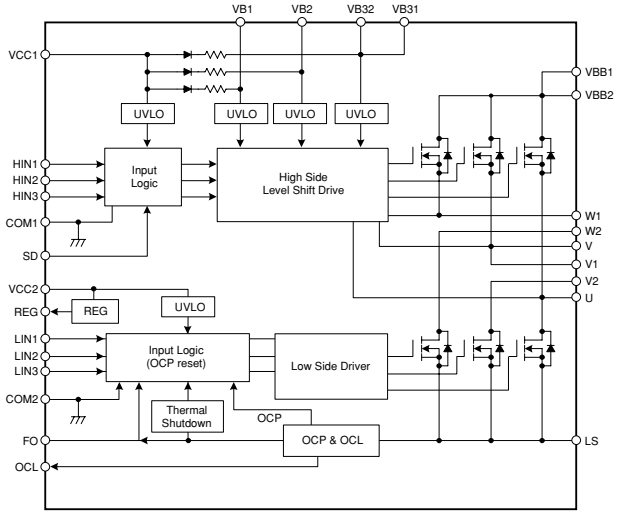
Parameter	Symbol	Ratings									Unit	Conditions
		SX68001MH			SX68002MH			SX68003MH				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	V_{BB}	–	150	200	–	300	400	–	300	400	V	Between V_{BB} and LS
Control Supply Voltage	Vcc	13.5	–	16.5	13.5	–	16.5	13.5	–	16.5	V	Between V_{CC} and COM
Input Signal Dead Time	tdead	1.5	–	–	1.5	–	–	1.5	–	–	μs	
Minimum Input Pulse Width	tw	0.5	–	–	0.5	–	–	0.5	–	–	μs	

■Electrical Characteristics

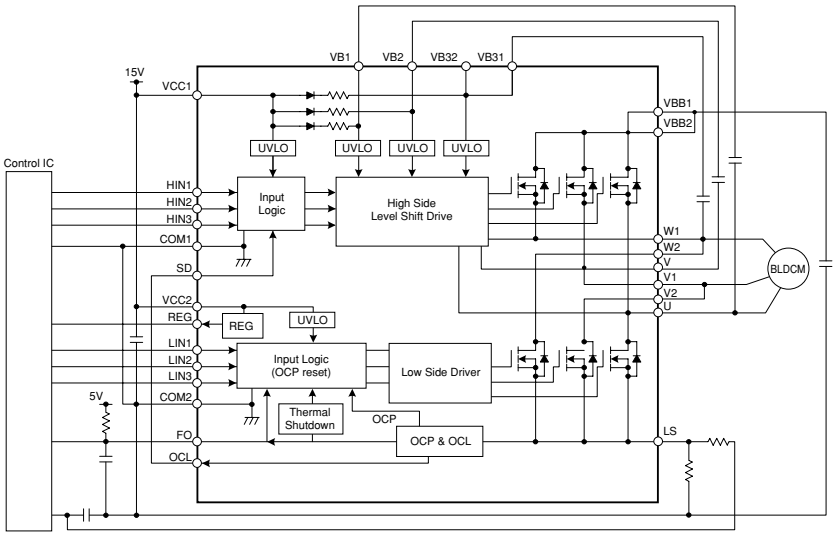
(T_a=25°C)

Parameter	Symbol	Ratings									Unit	Conditions
		SX68001MH			SX68002MH			SX68003MH				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Control Supply Current	Icc	–	4.6	8.5	–	4.6	8.5	–	4.6	8.5	mA	Vcc1,2=15V, I_{REG}=0A
Boot Supply Current	Ibs	–	140	400	–	140	400	–	140	400	μA	V_B-HS=15V, H_{IN}=5V, per phase, T_C=20°C to 125°C
Input Voltage	V_{IH}	–	2.0	2.5	–	2.0	2.5	–	2.0	2.5	V	Vcc=15V, Output:ON
	V_{IL}	1.0	1.5	–	1.0	1.5	–	1.0	1.5	–		Vcc=15V, Output:OFF
Input Voltage Hysteresis Width	V_H	–	0.5	–	–	0.5	–	–	0.5	–	V	Vcc=15V
Input Current	I_{IH}	–	230	500	–	230	500	–	230	500	μA	Vcc=15V, V_{IN}=5V
Undervoltage Lock Out (high side)	U_{VHL}	9.0	–	11.0	9.0	–	11.0	9.0	–	11.0	V	Between V_{BB} and U(V, W)
	U_{VHH}	9.5	–	11.5	9.5	–	11.5	9.5	–	11.5		
Undervoltage Lock Out (low side)	U_{VLL}	10.0	–	12.0	10.0	–	12.0	10.0	–	12.0	V	Between Vcc and COM
	U_{VLH}	10.5	–	12.5	10.5	–	12.5	10.5	–	12.5		
FO Terminal Output Voltage	V_{FOL}	–	–	0.5	–	–	0.5	–	–	0.5	V	Vcc=15V, V_{FO}=5V, R_{FO}=10kΩ
	V_{FOH}	4.8	–	–	4.8	–	–	4.8	–	–		
OCL Output Voltage	V_{OCLL}	–	–	0.5	–	–	0.5		–	0.5	V	Vcc=15V
	V_{OCLH}	4.5	–	5.5	4.5	–	5.5	4.5	–	5.5		
Current Limiter Reference Voltage	V_{LIM}	0.6175	0.65	0.6825	0.6175	0.65	0.6825	0.6175	0.65	0.6825	V	Vcc=15V
Overcurrent Protection Trip Voltage	V_{TRIP}	0.9	1.0	1.1	0.9	1.0	1.1	0.9	1.0	1.1	V	Vcc=15V
Overcurrent Protection Retention Time	tp	20	25	–	20	25	–	20	25	–	μs	Vcc=15V
OCP Blanking Time	tbk(ocp)	–	2	–	–	2	–	–	2	–	μs	Vcc=15V
SD Terminal Blanking Time	tbk(ocl)	–	3.3	–	–	3.3	–	–	3.3	–	μs	Vcc=15V
Thermal Protection and Release Threshold	T_{DH}	135	150	165	135	150	165	135	150	165	°C	Vcc=15V
	T_{DL}	105	120	135	105	120	135	105	120	135		
	T_{Dhys}	–	30	–	–	30	–	–	30	–		
Regulator Output Voltage	V_{REG}	6.75	7.5	8.25	6.75	7.5	8.25	6.75	7.5	8.25	V	I_{REG}=35mA
MOSFET Output Breakdown Voltage	V_{DSS}	250	–	–	500	–	–	500	–	–	V	Vcc=15V, I_D=100μA, V_{IN}=0V
MOSFET Output Leakage Current	I_{DSS}	–	–	100	–	–	100	–	–	100	μA	Vcc=15V, V_{DS}=500V (250 V for SX68001MH),V_{IN}=0V
MOSFET DC ON Resistance	$R_{DS\,(ON)}$	–	1.25	1.5	–	3.2	4.0	–	2.0	2.4	Ω	Vcc=15V, I_D=1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V_{IN}=5V
Diode Forward Voltage	V_{SD}	–	1.1	1.5	–	1.0	1.5	–	1.0	1.5	V	Vcc=15V, I_{SD}=1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V_{IN}=0V
Boot Diode Leakage Current	I_{IB}	–	–	10	–	–	10	–	–	10	μA	V_R=500V(250 V for SX68001MH)
Boot Diode Forward Voltage	V_{FB}	–	1.0	1.3	–	1.0	1.3	–	1.0	1.3	V	I_F=0.15A
Boot Diode Series Resistance	R_{BD}	–	60	–	–	60	–	–	60	–	Ω	
High Side Switching Time	td(on)	–	800	–	–	810	–	–	940	–	ns	V_{DC}=300V(150V for SX68001MH), Vcc=15V, I_D=1A(0.75 A for SX68002MH or 1.25 A for SX68003MH), V_{IN}=0 to 5V, Inductive load
	tr	–	45	–	–	60	–	–	100	–		
	trr	–	75	–	–	120	–	–	135	–		
	td(off)	–	720	–	–	815	–	–	975	–		
	tf	–	40	–	–	40	–	–	45	–		
Low Side Switching Time	td(on)	–	750	–	–	760	–	–	900	–	ns	
	tr	–	50	–	–	60	–	–	105	–		
	trr	–	70	–	–	110	–	–	135	–		
	td(off)	–	660	–	–	750	–	–	905	–		
	tf	–	20	–	–	30	–	–	35	–		

■Internal Block Diagram



■Typical Connection Diagram



W1 must be connected to W2, and V1 must be connected to V2 on the printed circuit board.

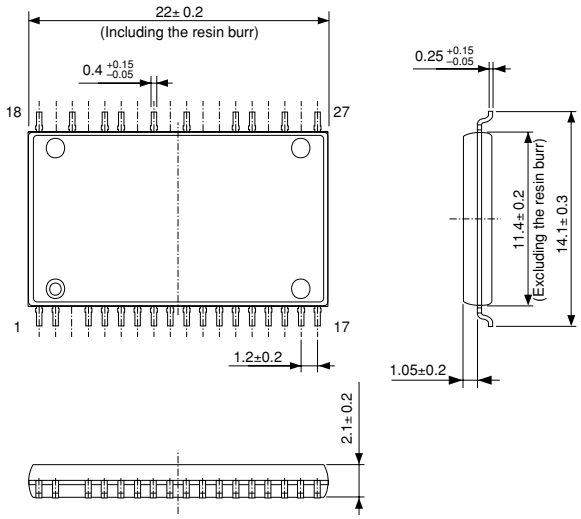
The input pulldown resistor is built into an IC (about 22 kΩ). If the input is expected to be unstable or fluctuate widely, however, it needs to be reinforced with an external resistor.

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

If the current limiter function is not used, leave the OCL pin open, and leave the SD pin open or connect it to GND (if there is a lot of external noise).

■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

(T_a=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

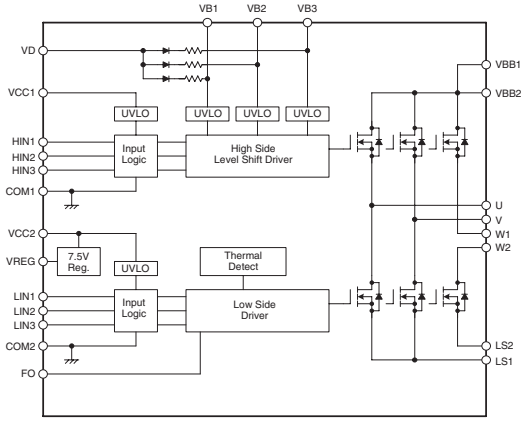
Parameter	Symbol	Ratings									Unit	Conditions
		SMA6821MH			SMA6822MH			SMA6823MH				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	VBB	–	140	200	–	300	400	–	300	400	V	Between VBB and LS
Control Supply Voltage	Vcc	13.5	–	16.5	13.5	–	16.5	13.5	–	16.5	V	Between Vcc and COM
Input Signal Dead Time	tdead	1.5	–	–	1.5	–	–	1.5	–	–	µs	
Minimum Input Pulse Width	tw	0.5	–	–	0.5	–	–	0.5	–	–	µs	

■Electrical Characteristics

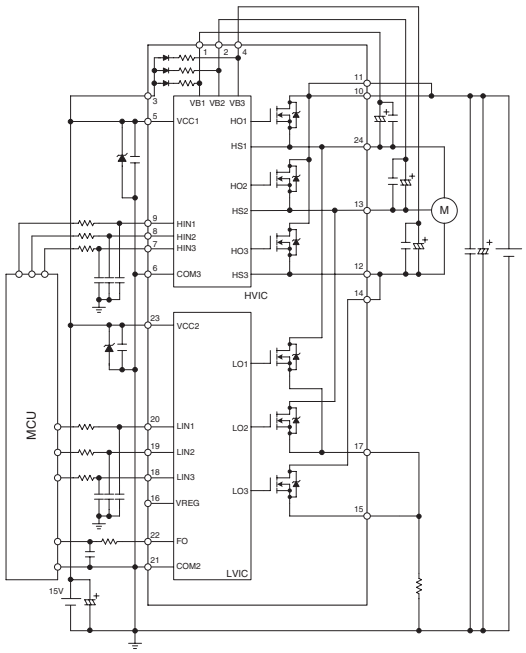
(T_a=25°C)

Parameter	Symbol	Ratings									Unit	Conditions
		SMA6821MH			SMA6822MH			SMA6823MH				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Control Supply Current	Icc	–	4	6	–	4	6	–	4	6	mA	Vcc=15V
Input Voltage	VIH	–	2	2.5	–	2	2.5	–	2	2.5	V	Vcc=15V, Output:ON
	VIL	1	1.5	–	1	1.5	–	1	1.5	–		Vcc=15V, Output:OFF
Input Current	IIH	–	50	100	–	50	100	–	50	100	µA	Vcc=15V, VIN=5V
	IIL	–	–	2	–	–	2	–	–	2		Vcc=15V, VIN=0V
Undevoltage Lock Out (high side)	UVHL	9.0	10.0	11.0	9.0	10.0	11.0	9.0	10.0	11.0	V	Between VB and U (V, W)
	UVHH	9.5	10.5	11.5	9.5	10.5	11.5	9.5	10.5	11.5		
Undevoltage Lock Out (low side)	UVLL	10.0	11.0	12.0	10.0	11.0	12.0	10.0	11.0	12.0	V	Between Vcc and COM
	UVLH	10.5	11.5	12.5	10.5	11.5	12.5	10.5	11.5	12.5		
FO Pin Output Voltage	VFOL	0	–	1.0	0	–	1.0	0	–	1.0	V	Vcc=15V
	VFOH	4.0	–	5.5	4.0	–	5.5	4.0	–	5.5		
Overheat detection threshold	TDH	135	150	165	135	150	165	135	150	165	°C	Vcc=15V
Overheat detection release threshold	TDL	105	120	135	105	120	135	105	120	135		
Regulator output voltage	VREG	–	7.5	–	–	7.5	–	–	7.5	–	V	IREG=35mA
Boot Diode Forward Voltage	VFB	–	1.1	1.3	–	1.1	1.3	–	1.1	1.3	V	IF=0.15A
Boot Diode Series Resistance	RBD	–	22	–	–	22	–	–	22	–	Ω	
MOSFET Output Breakdown Voltage	VDSS	250	–	–	500	–	–	500	–	–	V	Vcc=15V, ID=100µA, VIN=0V
MOSFET Output Leakage Current	IDSS	–	–	100	–	–	100	–	–	100	µA	Vcc=15V, VDS=500V (250V for SMA6821MH), VIN=0V
MOSFET DC On Resistance	RDS(ON)	–	1.25	1.5	–	3.6	4.0	–	2.0	2.4	Ω	Vcc=15V, ID=1.0A (0.75A for SMA6822MH, 1.25A for SMA6823MH), VIN=5V
Diode Forward Voltage	VSD	–	1.1	1.5	–	1.1	1.5	–	1.1	1.5	V	Vcc=15V, ISD=1.0A (0.75A for SMA6822MH, 1.25A for SMA6823MH), VIN=0V
High Side Switching Time	td(on)	–	430	–	–	485	–	–	665	–	ns	VBB=300V (150V for SMA6821MH), Vcc=15V, ID=1A (0.75A for SMA6822MH, 1.25A for SMA6823MH), 0V≤VIN≤5V Inductive load
	tr	–	55	–	–	85	–	–	145	–		
	trr	–	90	–	–	120	–	–	150	–		
	td(off)	–	355	–	–	420	–	–	545	–		
	tf	–	20	–	–	30	–	–	40	–		
Low Side Switching Time	td(on)	–	405	–	–	520	–	–	720	–	ns	
	tr	–	60	–	–	100	–	–	175	–		
	trr	–	90	–	–	120	–	–	150	–		
	td(off)	–	395	–	–	485	–	–	605	–		
	tf	–	20	–	–	25	–	–	45	–		

■Internal Block Diagram



■Typical Connection Diagram

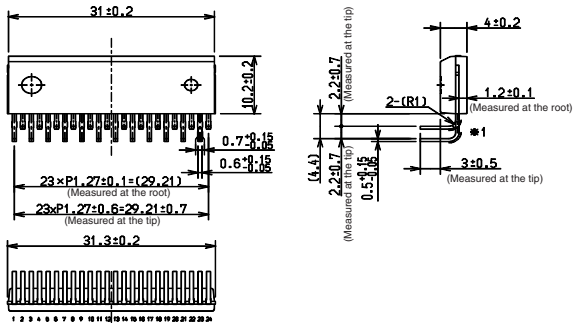


The input pulldown resistor is built into an IC (about 100 kΩ). If the input is expected to be unstable or fluctuate widely, however, it needs to be reinforced with an external resistor.

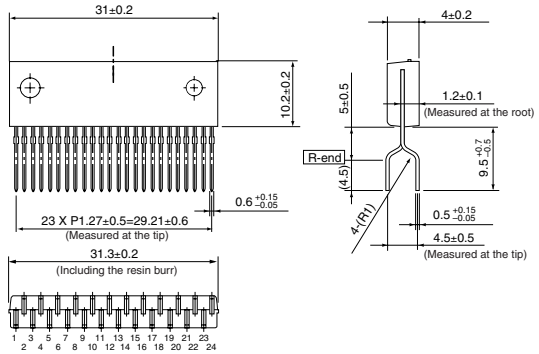
Attach capacitors near IC. Attach a ceramic capacitor in parallel with the electrolytic capacitor if too much noise is generated.

■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_a=25°C)

Parameter	Symbol	Ratings			Unit	Conditions
		SMA6862MZ	SMA6863MZ	SMA6865MZ		
MOSFET Output Breakdown Voltage	V_{DSS}	500			V	V_{CC}=15V, I_D=100uA, V_{IN}=0V
Control Supply Voltage (V_{CC})	V_{CC}	20			V	Between V_{CC} and COM
Control Supply Voltage (Bootstrap)	V_{BS}	20			V	Between V_B and HS (U, V, W)
Output Current (continuous)	I_o	1.5	2.5	2.5	A	
Output Current (pulse)	I_{op}	2.25	3.75	3.75	A	PW≤100μs, duty=1%
Input Voltage	V_{IN}	−0.5 to +7			V	H_{IN}1 to H_{IN}3, L_{IN}1 to L_{IN}3
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	4.46			°C/W	All elements operating
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	31.25			°C/W	All elements operating
Operating Case Temperature	T_c	−20 to +100			°C	
Junction Temperature (Power part)	T_j	150			°C	
Storage Temperature	T_{stg}	−40 to +150			°C	

■Recommended Operating Conditions

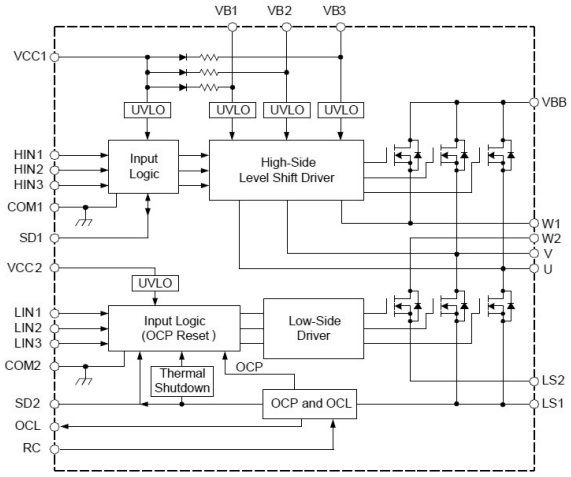
Parameter	Symbol	Ratings									Unit	Conditions
		SMA6862MZ			SMA6863MZ			SMA6865MZ				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	V_{BB}	–	300	400	–	300	400	–	300	400	V	Between V_{BB} and LS
Control Supply Voltage	V_{CC}	13.5	–	16.5	13.5	–	16.5	13.5	–	16.5	V	Between V_{CC} and COM
RC Pull-up Resistor	RR	33	–	390	33	–	390	33	–	390	kΩ	V_{RC}=5V
RC Noise Eliminating Capacitor	CC	1	–	4.7	1	–	4.7	1	–	4.7	nF	V_{RC}=5V
SD1 Pull-up Resistor	RL	3.3	–	10	3.3	–	10	3.3	–	10	kΩ	V_L=5V
SD1 Noise Eliminating Capacitor	CL	1	–	10	1	–	10	1	–	10	nF	V_L=5V
SD2 Pull-up Resistor	R_{up2}	3.3	–	10	3.3	–	10	3.3	–	10	kΩ	V_{up2}=5V
SD2 Noise Eliminating Capacitor	C_{SD2}	1	–	10	1	–	10	1	–	10	nF	V_{up2}=5V
Input Signal Dead Time	tdead	1.5	–	–	1.5	–	–	1.5	–	–	μs	T_j=−20°C to +150°C
Minimum Input Pulse Width	T_w	0.5	–	–	0.5	–	–	0.5	–	–	μs	

■Electrical Characteristics

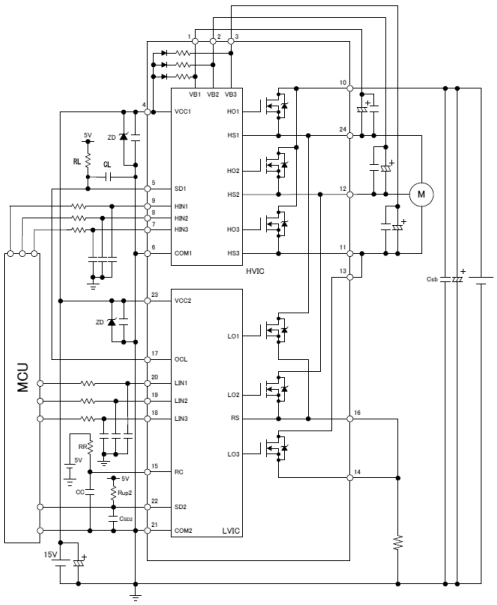
(T_a=25°C)

Parameter	Symbol	Ratings									Unit	Conditions
		SMA6862MZ			SMA6863MZ			SMA6865MZ				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Control Supply Current	I_{CC}	–	4.2	7	–	4.2	7	–	4.2	7	mA	V_{CC}=15V
Boot Supply Current	I_B	–	135	380	–	135	380	–	135	380	μA	V_B=15V, H_{IN}=5V
Input Voltage	V_{IH}	–	2.9	3.4	–	2.9	3.4	–	2.9	3.4	V	V_{CC}=15V
	V_{IL}	1.6	2.1	–	1.6	2.1	–	1.6	2.1	–		
Undervoltage Lock Out	UV_{HL}	9.0	10.0	11.0	9.0	10.0	11.0	9.0	10.0	11.0	V	Between V_B and U (V, W)
	UV_{HH}	9.5	10.5	11.5	9.5	10.5	11.5	9.5	10.5	11.5		
Undervoltage Lock Out	UV_{LL}	10.0	11.0	12.0	10.0	11.0	12.0	10.0	11.0	12.0	V	Between V_{CC} and COM
	UV_{LH}	10.5	11.5	12.5	10.5	11.5	12.5	10.5	11.5	12.5		
Termal Protection and Release Threshold	T_{DH}	120	135	150	120	135	150	120	135	150	℃	V_{CC}=15V
	T_{DL}	100	115	130	100	115	130	100	115	130		
Overcurrent Protection Trip Voltage	V_{TRIP}	–	1.0	–	–	1.0	–	–	1.0	–	V	V_{CC}=15V
Current Limiting Reference Voltage	V_{LIM}	–	0.53	–	–	0.53	–	–	0.53	–	V	V_{CC}=15V
Overcurrent Protection Retention Time	tp	–	2	–	–	2	–	–	2	–	ms	V_{RC}=5V, RR=360kΩ, CC=0.0047μF
Boot Diode Leakage Current	I_{LBD}	–	–	10	–	–	10	–	–	10	μA	V_R=500V
Boot Diode Forward Voltage	V_{FB}	–	0.8	1.3	–	0.8	1.3	–	0.8	1.3	V	I_F=0.05A
Boot Diode Series Resistance	R_{BD}	–	210	–	–	210	–	–	210	–	Ω	
MOSFET Output Breakdown Voltage	V_{DSS}	500	–	–	500	–	–	500	–	–	V	V_{CC}=15V, I_D=100μA, V_{IN}=0V
MOSFET Output Leakage Current	I_{DSS}	–	–	100	–	–	100	–	–	100	μA	V_{CC}=15V, V_{DS}=500V, V_{IN}=0V
MOSFET DC ON Resistance	$R_{DS(ON)}$	–	3.6	4.0	–	2.0	2.4	–	1.4	1.7	Ω	V_{CC}=15V, I_D=1.25A (0.75A for the SMA6862MZ), V_{IN}=5V
MOSFET Diode Forward Voltage	V_{SD}	–	1.1	1.5	–	1.1	1.5	–	1.0	1.5	V	V_{CC}=15V, I_{SD}=1.25A (0.75A for the SMA6862MZ), V_{IN}=0V
High Side Switching Time	td(on)	–	720	–	–	820	–	–	750	–	ns	V_{BB}=300V, V_{CC}=15V, I_D=1.5A (2.5A for the SMA6863MZ and SMA6865MZ), V_{IN}=0 to 5V Inductive load
	tr	–	60	–	–	100	–	–	60	–		
	trr	–	110	–	–	120	–	–	100	–		
	td(off)	–	690	–	–	740	–	–	680	–		
	tf	–	30	–	–	30	–	–	20	–		
Low Side Switching Time	td(on)	–	670	–	–	790	–	–	640	–	ns	
	tr	–	70	–	–	110	–	–	65	–		
	trr	–	120	–	–	130	–	–	100	–		
	td(off)	–	590	–	–	700	–	–	560	–		
	tf	–	30	–	–	30	–	–	20	–		

■Internal Block Diagram



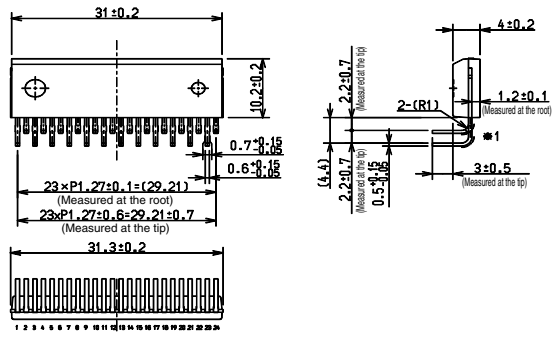
■Typical Connection Diagram



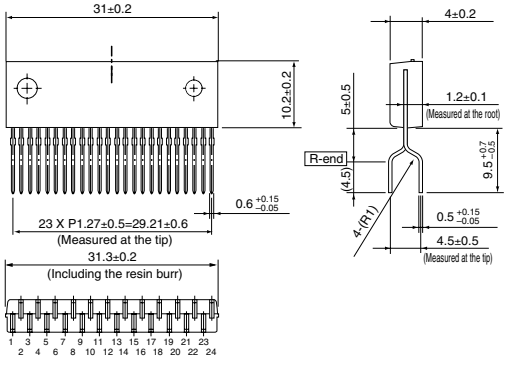
When the current limiter function is used
(OCL and SD1 are connected)

■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_a=25°C)

Parameter	Symbol	Ratings		Unit	Conditions
		SLA6868MZ	SLA6870MZ		
MOSFET Output Breakdown Voltage	V_{DSS}	500		V	V_{CC}=15V, I_D=100μA, V_{IN}=0V
Control Supply Voltage (V_{CC})	V_{CC}	20		V	Between V_{CC} and COM
Control Supply Voltage (Bootstrap)	V_{BS}	20		V	Between V_B and HS (U, V, W)
Output Current (continuous)	I_o	2.5	3.0	A	
Output Current (pulse)	I_{op}	3.75	4.5	A	PW≤100μs, duty=1%
Input Voltage	V_{IN}	–0.5 to +7		V	H_{IN}1 to H_{IN}3, L_{IN}1 to L_{IN}3
Thermal Resistance (Junction to Case)	$\theta_{j\text{-}c}$	3.8		°C/W	All elements operating
Thermal Resistance (Junction to Ambient Air)	$\theta_{j\text{-}a}$	25		°C/W	All elements operating
Operating Case Temperature	T_c	–20 to +100		°C	
Junction Temperature (Power part)	T_j	150		°C	
Storage Temperature	T_{stg}	–40 to +150		°C	

■Recommended Operating Conditions

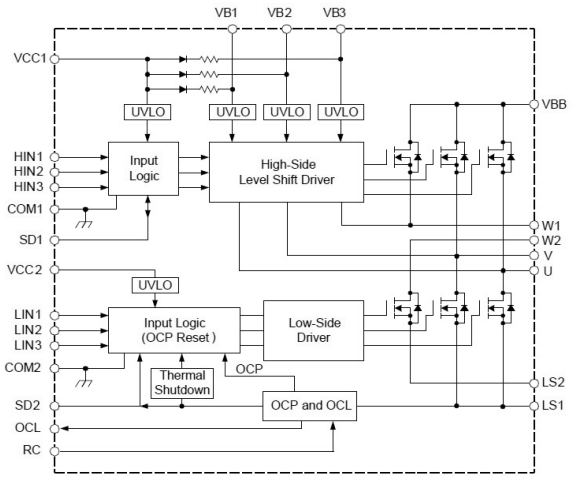
Parameter	Symbol	Ratings						Unit	Conditions
		SLA6868MZ			SLA6870MZ				
		min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	V_{BB}	–	300	400	–	300	400	V	Between V_{BB} and LS
Control Supply Voltage	V_{cc}	13.5	–	16.5	13.5	–	16.5	V	Between V_{CC} and COM
RC Pull-up Resistor	RR	33	–	390	33	–	390	kΩ	V_{RC}=5V
RC Noise Eliminating Capacitor	CC	1	–	4.7	1	–	4.7	nF	V_{RC}=5V
SD1 Pull-up Resistor	RL	3.3	–	10	3.3	–	10	kΩ	V_L=5V
SD1 Noise Eliminating Capacitor	CL	1	–	10	1	–	10	nF	V_L=5V
SD2 Pull-up Resistor	R_{up2}	3.3	–	10	3.3	–	10	kΩ	V_{up2}=5V
SD2 Noise Eliminating Capacitor	C_{SD2}	1	–	10	1	–	10	nF	V_{up2}=5V
Input Signal Dead Time	tdead	1.5	–	–	1.5	–	–	μs	T_j=–20°C to +150°C
Minimum Input Pulse Width	T_w	0.5	–	–	0.5	–	–	μs	

■Electrical Characteristics

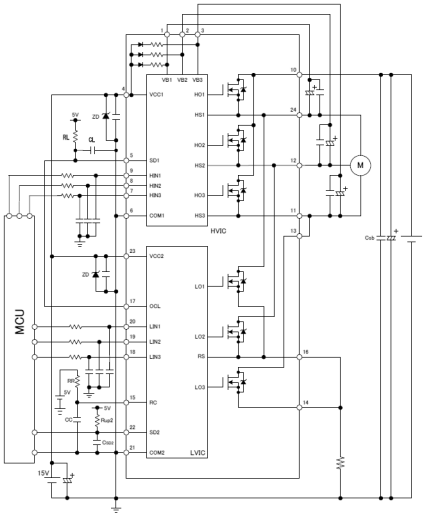
(T_a=25°C)

Parameter	Symbol	Ratings						Unit	Conditions
		SLA6868MZ			SLA6870MZ				
		min.	typ.	max.	min.	typ.	max.		
Control Supply Current	I_{cc}	–	4.2	7	–	4.2	7	mA	V_{CC}=15V
Boot Supply Current	I_B	–	135	380	–	135	380	μA	V_B=15V, H_{IN}=5V
Input Voltage	V_{IH}	–	2.9	3.4	–	2.9	3.4	V	V_{CC}=15V
	V_{IL}	1.6	2.1	–	1.6	2.1	–		
Undervoltage Lock Out	UV_{HL}	9.0	10.0	11.0	9.0	10.0	11.0	V	Between V_B and U(V,W)
	UV_{HH}	9.5	10.5	11.5	9.5	10.5	11.5		
Undervoltage Lock Out	UV_{LL}	10.0	11.0	12.0	10.0	11.0	12.0	V	Between V_{CC} and COM
	UV_{LH}	10.5	11.5	12.5	10.5	11.5	12.5		
Thermal Protection and Release Threshold	T_{DH}	120	135	150	120	135	150	°C	V_{CC}=15V
	T_{DL}	100	115	130	100	115	130		
Overcurrent Protection Trip Voltage	V_{TRIP}	–	1.0	–	–	1.0	–	V	V_{CC}=15V
Current Limiting Reference Voltage	V_{LIM}	–	0.53	–	–	0.53	–	V	V_{CC}=15V
Overcurrent Protection Retention Time	t_p	–	2	–	–	2	–	ms	V_{RC}=5V, RR=360kΩ, CC=0.0047μF
Boot Diode Leakage Current	I_{LBD}	–	–	10	–	–	10	μA	V_R=500V
Boot Diode Forward Voltage	V_{FB}	–	0.8	1.3	–	0.8	1.3	V	I_F=0.05A
Boot Diode Series Resistance	R_{BD}	–	210	–	–	210	–	Ω	
MOSFET Output Breakdown Voltage	V_{DSS}	500	–	–	500	–	–	V	V_{CC}=15V, I_D=100μA, V_{IN}=0V
MOSFET Output Leakage Current	I_{DSS}	–	–	100	–	–	100	μA	V_{CC}=15V, V_{DS}=500V, V_{IN}=0V
MOSFET DC ON Resistance	$R_{DS(ON)}$	–	2.0	2.4	–	1.4	1.7	Ω	V_{CC}=15V, I_D=1.25A (1.5A for SLA6870MZ), V_{IN}=5V
MOSFET Diode Forward Voltage	V_{SD}	–	1.1	1.5	–	1.0	1.5	V	V_{CC}=15V, I_D=1.25A (1.5A for SLA6870MZ), V_{IN}=0V
High Side Switching Time	td(on)	–	820	–	–	755	–	ns	V_{BB}=300V, V_{CC}=15V, I_D=2.5A (3.0A for SLA6870MZ), V_{IN}=0 to 5V Inductive load
	tr	–	100	–	–	65	–		
	trr	–	120	–	–	100	–		
	td(off)	–	740	–	–	680	–		
	tf	–	30	–	–	15	–		
Low Side Switching Time	td(on)	–	790	–	–	645	–	ns	
	tr	–	110	–	–	70	–		
	trr	–	130	–	–	105	–		
	td(off)	–	700	–	–	560	–		
	tf	–	30	–	–	20	–		

■Internal Block Diagram



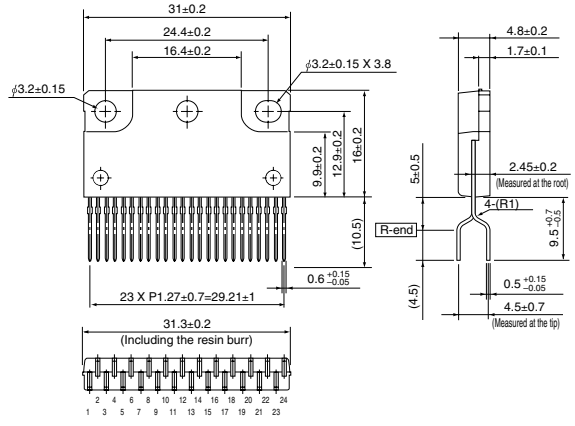
■Typical Connection Diagram



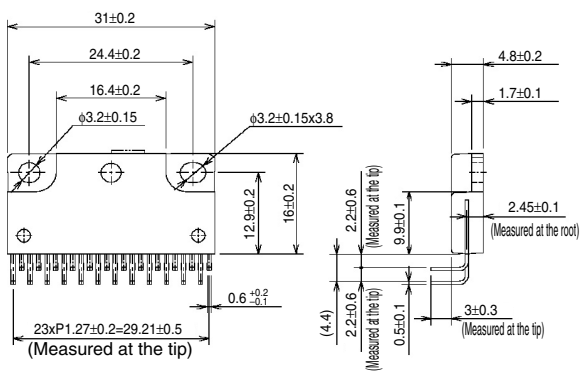
When the current limiter function is used
(OCL and SD1 are connected)

■External Dimensions (ZIP24 with Fin [SLA24Pin])

(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 SIM682227M, 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_a=25°C)

Parameter		Symbol	Ratings				Unit	Conditions
			SIM6811M	SIM6812M	SIM6822M	SIM6827M		
MOSFET Output Breakdown Voltage		V_{DSS}	500	500	600	600	V	V_{CC}=15V,V_{IN}=0V
Control Supply Voltage		V_{CC}	20	20	20	20	V	Between V_{CC} and COM
Control Supply Voltage (Bootstrap)		V_{BS}	20	20	20	20	V	Between VB and HS(U, V, W)
Output Current (continuous)		I_o	2.0	2.5	5.0	5.0	A	
Output Current (pulse)		I_{op}	3.0	3.75	7.5	7.5	A	PW≤100μs, duty=1%
Input Voltage		V_{IN}	–0.5 to +7	–0.5 to +7	–0.5 to +7	–0.5 to +7	V	
Thermal Resistance (Junction to Case)	MOSFET or IGBT	θ_{j-c}	3.6	3.6	3.6	3.6	°C/W	All elements operating
	FRD	θ_{j-c_FRD}	–	–	4.2	4.2		All elements operating
Thermal Resistance (Junction to Ambient Air)	MOSFET or IGBT	θ_{j-a}	25	25	25	25	°C/W	All elements operating
	FRD	θ_{j-a_FRD}	–	–	29	29		All elements operating
Operating Case Temperature		T_{op}	–20 to +100	–20 to +100	–20 to +100	–20 to +100	°C	
Junction Temperature (Power part)		T_{ch}	+150	+150	+150	+150	°C	
Storage Temperature		T_{stg}	–40 to +150	–40 to +150	–40 to +150	–40 to +150	°C	

■Recommended Operating Conditions

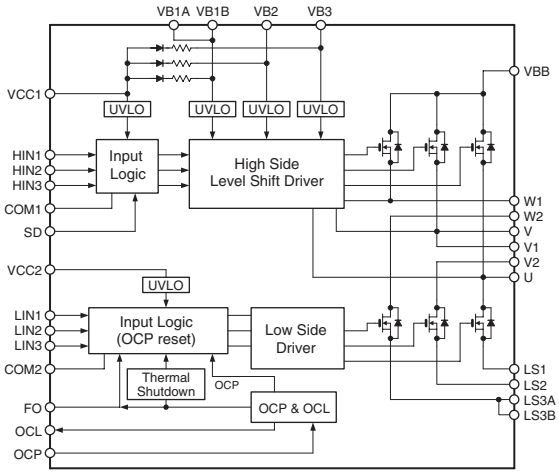
Parameter	Symbol	Ratings												Unit	Conditions
		SIM6811M			SIM6812M			SIM6822M			SIM6827M				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	V_{BB}	–	–	400	–	–	400	–	–	400	–	–	400	V	Between V_{BB} and LS
Control Supply Voltage	V_{CC}	13.5	15	16.5	13.5	15	16.5	13.5	15	16.5	13.5	15	16.5	V	Between V_{CC} and COM
Input Signal Dead Time	t_{dead}	1.5	–	–	1.5	–	–	1.5	–	–	1.5	–	–	μs	
Minimum Input Pulse Width	t_w	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	μs	
Bootstrap Capacitor Capacitance	C_{boot}	1	–	–	1	–	–	1	–	–	1	–	–	μF	
FO Pull-up Resistor	R_{FO}	3.3	–	10	3.3	–	10	3.3	–	10	3.3	–	10	kΩ	
FO Capacitor Capacitance	C_{FO}	0.001	–	0.01	0.001	–	0.01	0.001	–	0.01	0.001	–	0.01	μF	

■Electrical Characteristics

(T_a=25°C)

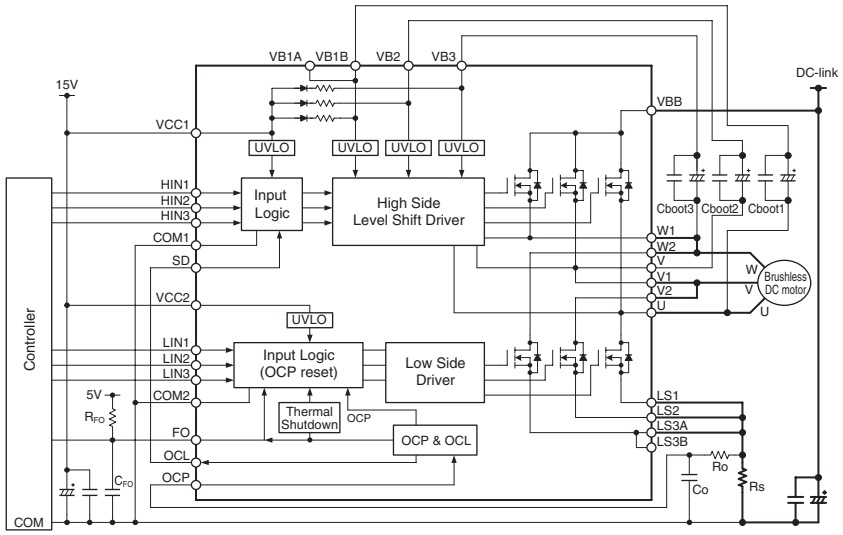
Parameter	Symbol	Ratings												Unit	Conditions
		SIM6811M			SIM6812M			SIM6822M			SIM6827M				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Control Supply Current	I_{CC}	–	3.2	4.5	–	3.2	4.5	–	3.2	4.5	–	3.2	4.5	mA	V_{CC}=15V
Boot Supply Current	I_B	–	140	400	–	140	400	–	140	400	–	140	400	μA	V_B=15V, H_{IN}=5V, per phase
Input Voltage	V_{IH}	–	2	2.5	–	2	2.5	–	2	2.5	–	2	2.5	V	V_{CC}=15V, Output:ON
	V_{IL}	1	1.5	–	1	1.5	–	1	1.5	–	1	1.5	–		V_{CC}=15V, Output:OFF
FO Input Threshold Voltage	V_{IH}	–	2	2.5	–	2	2.5	–	2	2.5	–	2	2.5	V	V_{CC}=15V, Fo:Passive
	V_{IL}	1	1.5	–	1	1.5	–	1	1.5	–	1	1.5	–		V_{CC}=15V, Fo:Active
Input Current	I_{IH}	–	230	500	–	230	500	–	230	500	–	230	500	μA	V_{CC}=15V, V_{IN}=5V
	I_{IL}	–	–	2	–	–	2	–	–	2	–	–	2		V_{CC}=15V, V_{IN}=0V
Undervoltage Lock Out (high side)	UV_{HL}	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_B and U(V, W)
	UV_{HH}	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_{LL}	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_{CC} and COM
	UV_{LH}	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_{FOL}	0	–	0.5	0	–	0.5	0	–	0.5	0	–	0.5	V	V_{CC}=15V, VFO=5V, RFO=10kΩ
	V_{FOH}	4.8	–	–	4.8	–	–	4.8	–	–	4.8	–	–		
OCL Pin Output Voltage	V_{OCLL}	0	–	0.5	0	–	0.5	0	–	0.5	0	–	0.5	V	V_{CC}=15V
	V_{OCLH}	4.5	–	5.5	4.5	–	5.5	4.5	–	5.5	4.5	–	5.5		
Current Limiting Reference Voltage	V_{LIM}	–	0.65	–	–	0.65	–	–	0.65	–	–	0.65	–	V	V_{CC}=15V
Overcurrent Protection Trip Voltage	V_{TRIP}	–	1.0	–	–	1.0	–	–	1.0	–	–	1.0	–	V	V_{CC}=15V
Overcurrent Protection Retention Time	Tp	–	25	–	–	25	–	–	25	–	–	25	–	μs	V_{CC}=15V
OCP Blanking Time	$Tbk_{(OCP)}$	–	2.0	–	–	2.0	–	–	2.0	–	–	2.0	–	μs	V_{CC}=15V
OCL Blanking Time	$Tbk_{(OCL)}$	–	2.0	–	–	2.0	–	–	2.0	–	–	2.0	–	μs	V_{CC}=15V
Terminal Protection and Release Threshold	T_{DH}	135	150	165	135	150	165	135	150	165	135	150	165	°C	V_{CC}=15V, No FIN
	T_{DL}	105	120	135	105	120	135	105	120	135	105	120	135		
Boot Diode Forward Voltage	V_{FB}	–	1.0	1.3	–	1.0	1.3	–	1.0	1.3	–	1.0	1.3	V	I_F=0.15A
Boot Diode Series Resistance	R_{BD}	–	60	–	–	60	–	–	60	–	–	60	–	Ω	
MOSFET Output Breakdown Voltage	V_{DSS}	500	–	–	500	–	–	–	–	–	–	–	–	V	V_{CC}=15V, I_D=100μA, V_{IN}=0V
IGBT Output Breakdown Voltage	V_{CES}	–	–	–	–	–	–	600	–	–	600	–	–	V	V_{CC}=15V, ICE=1mA, V_{IN}=0V
MOSFET Output Leakage Current	I_{DSS}	–	–	100	–	–	100	–	–	–	–	–	–	μA	V_{CC}=15V, V_{DS}=500V, V_{IN}=0V
IGBT Output Leakage Current	I_{CES}	–	–	–	–	–	–	–	–	1	–	–	1	mA	V_{CC}=15V, V_{CE}=600V, V_{IN}=0V
MOSFET DC ON Resistance	$R_{DS(ON)}$	–	3.2	4.0	–	2.0	2.4	–	–	–	–	–	–	Ω	V_{CC}=15V, I_D=1.0A (1.25A for the SIM6812M), V_{IN}=5V
IGBT Output Saturation Voltage	$V_{CE(sat)}$	–	–	–	–	–	–	–	1.75	2.2	–	1.75	2.2	V	V_{CC}=15V, I_C=5.0A, V_{IN}=5V
Diode Forward Voltage	V_{SD}	–	1.0	1.5	–	1.0	1.5	–	2.0	2.4	–	2.0	2.4	V	V_{CC}=15V, I_{SD}=1.0A (1.25A for the SIM6812M, I_{EC}=5A for the SIM6822M, 27M), V_{IN}=0V
High Side Switching Time	td(on)	–	770	–	–	910	–	–	740	–	–	1030	–	ns	V_{BB}=300V, V_{CC}=15V,I_D=1.0A, (1.25A for the SIM6812M, I_C=5A for the SIM6822M, 27M), V_{IN}=0 to 5V, Inductive load
	tr	–	70	–	–	100	–	–	70	–	–	180	–		
	trr	–	150	–	–	140	–	–	80	–	–	100	–		
	td(off)	–	690	–	–	700	–	–	570	–	–	590	–		
	tf	–	30	–	–	40	–	–	100	–	–	150	–		
Low Side Switching Time	td(on)	–	690	–	–	875	–	–	690	–	–	1030	–	ns	
	tr	–	90	–	–	110	–	–	100	–	–	240	–		
	trr	–	150	–	–	155	–	–	80	–	–	100	–		
	td(off)	–	650	–	–	775	–	–	540	–	–	540	–		
	tf	–	50	–	–	35	–	–	100	–	–	150	–		

■Internal Block Diagram



The internal block diagram above shows SIM6811M and SIM6812M.
For SIM6822M and SIM6827M, the MOSFETs are replaced by a combination of IGBTs and FRDs.

■Typical Connection Diagram



W1 must be connected to W2, and V1 must be connected to V2 on the printed circuit board.

The input pulldown resistor is built into an IC (about 22 kΩ). If the input is expected to be unstable or fluctuate widely, however, it needs to be reinforced with an external resistor.

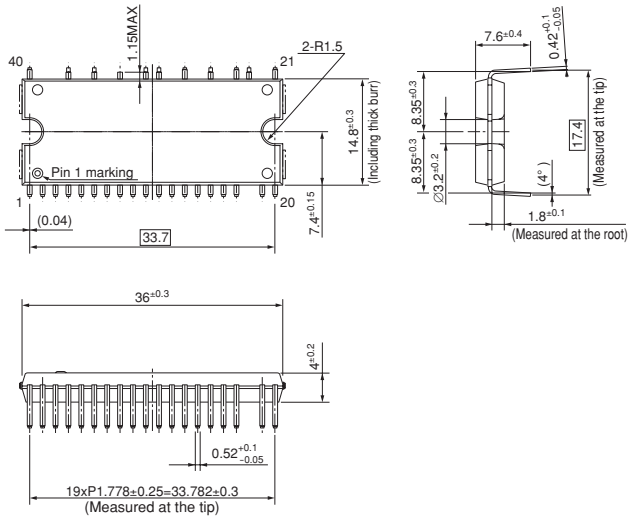
Attach capacitors near IC. Attach a ceramic capacitor in parallel with the electrolytic capacitor if too much noise is generated.

If the current limiter function is not used, leave the OCL pin open, and leave the SD pin open or connect it to GND (if there is a lot of external noise).

The typical connection diagram above shows SIM6811M and SIM6812M.
For SIM6822M and SIM6827M, the MOSFETs are replaced by a combination of IGBTs and FRDs.

■External Dimensions

(Unit : mm)



Product Mass: Approx. 5.5 g

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_a=25°C)

Parameter	Symbol	Ratings					Unit	Conditions
		SCM1241M	SCM1243MF	SCM1245MF	SCM1246MF	SCM1248M		
Supply Voltage	V_{DC}	450	450	450	450	400	V	Between V_{BB} and LS1 to LS3
Supply Voltage (Surge)	$V_{DC(Surge)}$	500	500	500	500	450	V	Between V_{BB} and LS1 to LS3
IGBT Output Breakdown Voltage	V_{CES}	600	600	600	600	–	V	V_{CC}=15V, I_C=1mA, V_{IN}=0V
MOSFET Output Breakdown Voltage	V_{DSS}	–	–	–	–	500	V	V_{CC}=15V, I_D=1mA, V_{IN}=0V
Control Supply Voltage	V_{CC}	20	20	20	20	20	V	Between V_{CC} and COM
Control Supply Voltage (Bootstrap)	V_{BS}	20	20	20	20	20	V	Between V_B and HS (U, V, W)
Output Current (continuous)	I_o	10	15	20	30	5	A	T_C=25°C
Output Current (pulse)	I_{op}	20	30	30	45	7.5	A	PW≤1ms (100μs for the SCM 1248M), Duty=1%, T_C=25°C
Input Voltage	V_{IN}	–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_{FO}	7	7	7	7	7	V	Between Fo and COM
OCP Pin Voltage	V_{OCP}	–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 (Junction to Case) IGBT or MOSFET	θ_{j-c_Q}	6.0	3.0	3.0	3.0	5.5	°C/W	Per element in operation
Thermal Resistance (Junction to Case) FRD	θ_{j-c_F}	6.5	4.0	4.0	4.0	–	°C/W	Per element in operation
Operating Case Temperature	T_{op}	–20 to +100	–20 to +100	–20 to +100	–20 to +100	–20 to +100	°C	
Junction Temperature (Power part)	T_j	150	150	150	150	150	°C	
Storage Temperature	T_{stg}	–40 to +150	–40 to +150	–40 to +150	–40 to +150	–40 to +150	°C	
Insulation Breakdown Voltage	V_{iso}	2,000	2,000	2,000	2,000	2,000	V	Between rear and lead pins, AC one minute

■Recommended Operating Conditions

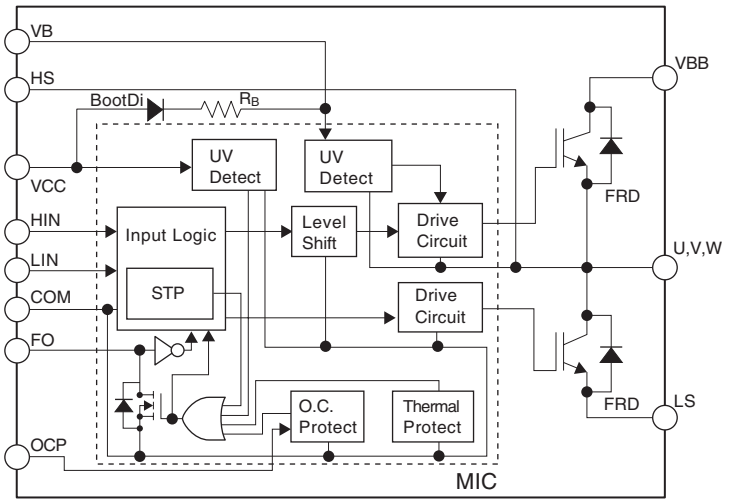
Parameter	Symbol	Ratings															Unit	Conditions
		SCM1241M			SCM1243MF			SCM1245MF			SCM1246MF			SCM1248M				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Main Supply Voltage	V_{BB}	–	300	400	–	300	400	–	300	400	–	300	400	–	300	400	V	Between V_{BB} and LS
Control Supply Voltage	V_{CC},V_{BS}	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_{CC} and COM
Minimum Input Pulse Width	$t_{INmin(on)}$	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	μs	ON pulse
	$t_{INmin(off)}$	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	μs	OFF pulse
Input Signal Dead Time	t_{dead}	1.0	–	–	1.0	–	–	1.0	–	–	1.0	–	–	1.0	–	–	μs	
FO Pull-up Voltage	V_{FO}	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_{FO}	1.0	–	22	1.0	–	22	1.0	–	22	1.0	–	22	1.0	–	22	kΩ	
FO Noise Eliminating Capacitor	C_{FO}	0.001	–	0.01	0.001	–	0.01	0.001	–	0.01	0.001	–	0.01	0.001	–	0.01	μF	
Boot Capacitor	C_{BOOT}	10	–	220	10	–	220	10	–	220	10	–	220	10	–	220	μF	
Shunt resistor	Rs	27	–	–	18	–	–	18	–	–	12	–	–	67	–	–	mΩ	Ic<Iop (ID<Iop for the SCM1248M)
RC filter resistor	Ro	–	–	100	–	–	100	–	–	100	–	–	100	–	–	100	Ω	
RC filter capacitor	Co			2200			2200			2200			2200			2200	pF	
PWM Carrier Frequency	fc	–	–	20	–	–	20	–	–	20	–	–	20	–	–	20	kHz	

■Electrical Characteristics

(T_a=25°C)

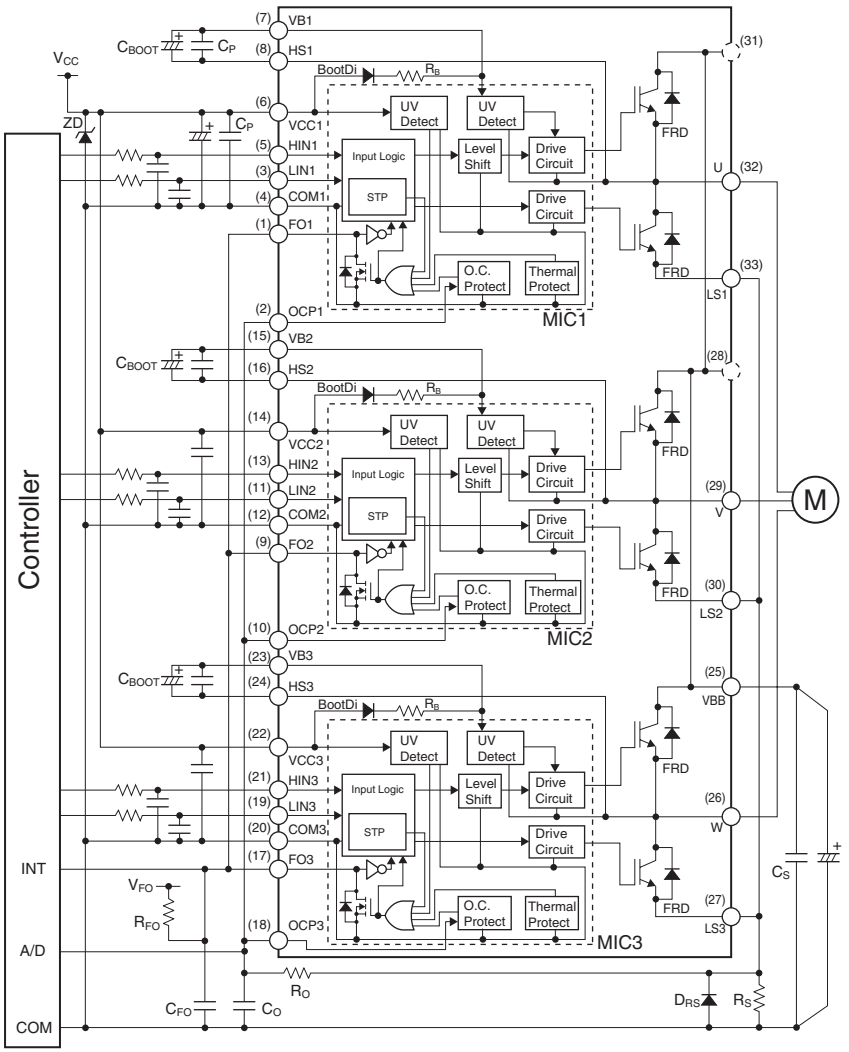
Parameter	Symbol	Ratings															Unit	Conditions
		SCM1241M			SCM1243MF			SCM1245MF			SCM1246MF			SCM1248M				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Control Supply Current	I_{CC}	–	3	–	–	3	–	–	3	–	–	3	–	–	3	–	mA	V_{CC}=15V, 3circuit total
Boot Supply Current	Ibs	–	140	–	–	140	–	–	140	–	–	140	–	–	140	–	μA	V_B-HS=15V, 1 circuit, V_{IN}=5V
Input Voltage	V_{IH}	–	2.0	2.5	–	2.0	2.5	–	2.0	2.5	–	2.0	2.5	–	2.0	2.5	V	V_{CC}=15V, Output:ON
	V_{IL}	1.0	1.5	–	1.0	1.5	–	1.0	1.5	–	1.0	1.5	–	1.0	1.5	–		V_{CC}=15V, Output:OFF
Input Current	I_{IH}	–	230	500	–	230	500	–	230	500	–	230	500	–	230	500	μA	V_{CC}=15V, V_{IN}=5V
Undervoltage Lock Out (high side)	UV_{HL}	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_{BB} and HS(U, V, W)
	UV_{HH}	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		
Undervoltage Lock Out (low side)	UV_{LL}	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_{CC} and COM
	UV_{LH}	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_{FOL}	–	–	0.5	–	–	0.5	–	–	0.5	–	–	0.5	–	–	0.5	V	V_{CC}=15V, V_{FO}=5V, R_{FO}=10kΩ
	V_{FOH}	4.8	–	–	4.8	–	–	4.8	–	–	4.8	–	–	4.8	–	–		
Overcurrent Protection Trip Voltage	V_{TRIP}	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_{CC}=15V
Overcurrent Protection Retention Time	tp	–	26	–	–	26	–	–	26	–	–	26	–	–	26	–	μs	V_{CC}=15V
OCP Blanking Time	tbk	–	1.65	–	–	1.65	–	–	1.65	–	–	1.65	–	–	1.65	–	μs	V_{CC}=15V
Thermal Protection and Release Threshold	T_{DH}	–	150	–	–	150	–	–	150	–	–	150	–	–	150	–	°C	V_{CC}=15V
	T_{DL}	–	120	–	–	120	–	–	120	–	–	120	–	–	120	–		
IGBT Output Breakdown Voltage	V_{CES}	600	–	–	600	–	–	600	–	–	600	–	–	–	–	–	V	V_{CC}=15V, I_C=1mA, V_{IN}=0V
MOSFET Output Breakdown Voltage	V_{DSS}	–	–	–	–	–	–	–	–	–	–	–	–	500	–	–	V	V_{CC}=15V, I_D=1mA, V_{IN}=0V
IGBT Output Leakage Current	I_{CES}	–	–	1	–	–	1	–	–	1	–	–	1	–	–	–	mA	V_{CC}=15V, V_{CE}=600V, V_{IN}=0V
MOSFET Output Leakage Current	I_{DSS}	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	mA	V_{CC}=15V, V_{DS}=500V, V_{IN}=0V
IGBT Output Saturation Voltage	$V_{CE(sat)}$	–	1.7	2.2	–	1.7	2.2	–	1.7	2.2	–	1.7	2.2	–	–	–	V	V_{CC}=15V, I_C=Io (Rated Current), V_{IN}=5V
MOSFET DC ON Resistance	$R_{DS(ON)}$	–	–	–	–	–	–	–	–	–	–	–	–	–	0.55	0.8	Ω	V_{CC}=15V, I_D=2.5A, V_{IN}=5V
Diode Forward Voltage	V_{SD}	–	1.7	2.2	–	1.75	2.2	–	1.9	2.4	–	1.5	2.0	–	0.9	1.4	V	V_{CC}=15V, I_{EC}=Io (Rated Current), I_{SD}=2.5A (SCM1248M), V_{IN}=0V
Boot Diode Forward Voltage	V_{FB}	–	1.1	1.3	–	1.1	1.3	–	1.1	1.3	–	1.1	1.3	–	1.1	1.3	V	I_F=0.15A
Boot Diode Series Resistance	R_B	–	22	–	–	22	–	–	22	–	–	22	–	–	22	–	Ω	
High Side Switching Time	td(on)	–	590	–	–	600	–	–	695	–	–	660	–	–	820	–	ns	V_{DC}=300V, V_{CC}=15V, I_C=I_D=Io (Rated Current), V_{IN}=0 to 5V, Inductive load
	tr	–	80	–	–	70	–	–	95	–	–	110	–	–	90	–		
	trr	–	60	–	–	70	–	–	75	–	–	60	–	–	130	–		
	td(off)	–	550	–	–	620	–	–	675	–	–	700	–	–	700	–		
	tf	–	90	–	–	60	–	–	55	–	–	50	–	–	20	–		
Low Side Switching Time	td(on)	–	570	–	–	600	–	–	715	–	–	660	–	–	830	–	ns	
	tr	–	100	–	–	100	–	–	135	–	–	150	–	–	90	–		
	trr	–	70	–	–	80	–	–	115	–	–	70	–	–	140	–		
	td(off)	–	560	–	–	600	–	–	670	–	–	690	–	–	710	–		
	tf	–	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



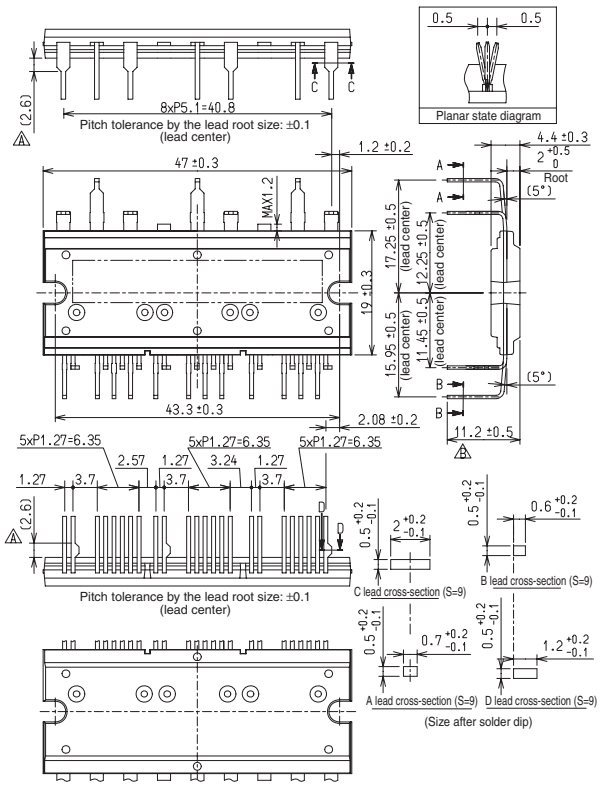
The input pulldown resistor is built in IC (about 22 kΩ). However, if the input is expected to be unstable or very fluctuant, it needs to be reinforced with external resistor.

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

The typical connection diagram above shows an IC other than SCM1248M.
For SCM1248M, the IGBTs and FRDs are replaced by MOSFETs.

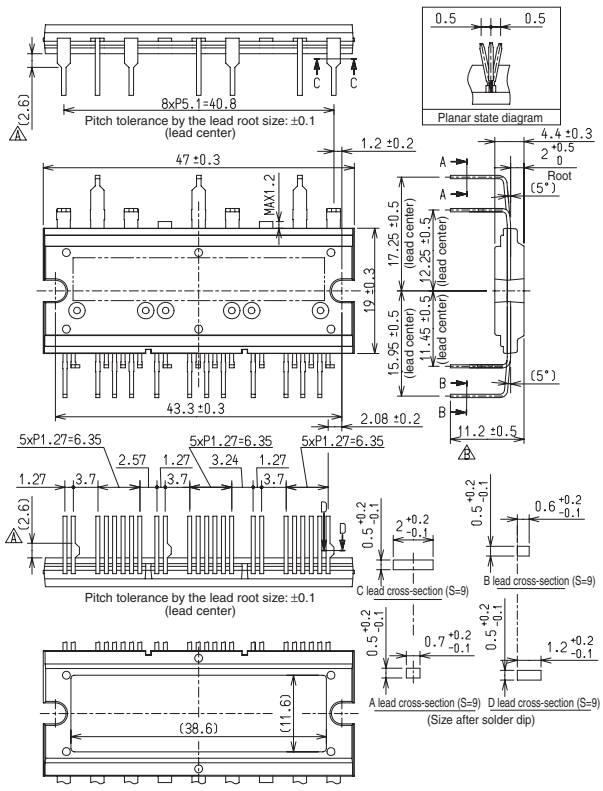
■External Dimensions (DIP33)

(Unit : mm)



Without Fin
(SCM1240M)

Forming No. 2551
Product Mass: Approx. 10.8g



With Fin
(SCM1240MF)

Forming No. 2552
Product Mass: Approx. 11.8g

Selection Guide

<AC/DC>

Non-isolated Type

Series Name	Part Number	Output Current	Input Voltage	$R_{DS(ON)}$ (Max)	Package	Circuit Type	Features	Applications	Page
LC5200	LC5202D	0.5A	250V	2.2Ω	DIP8	Buck	• Low component count • Power factor correction • Built-in analog dimming function • OCP: Latch shutdown • TSD: Auto restart	LED light bulbs, etc.	136
	LC5205D		450V	6.0Ω					
	LC5202S		250V	2.2Ω	SOP8				
	LC5205S		450V	6.0Ω					
	LC5203D	1.0A	250V	1.3Ω	DIP8				
	LC5210D		450V	3.0Ω					
LC5220	LC5222D	0.5A	250V	2.2Ω	DIP8	Buck/ Buck-boost	• Low component count • Power factor correction • Built-in analog dimming function • External latch function • OCP/OPP: Latch shutdown • TSD: Auto restart	LED light bulbs, etc.	138
	LC5225D		450V	6.0Ω					
	LC5222S		250V	2.2Ω	SOP8				
	LC5225S		450V	6.0Ω					
	LC5223D	1.0A	250V	1.3Ω	DIP8				
	LC5226D		450V	3.0Ω					
LC5550	LC5555LD	2.5A	650V	3.95Ω	DIP8	Buck	• Power factor correction • Harmonics standard compliant (Class C) • High efficiency • Universal input • OCP: Pulse by pulse • OVP/OLP/TSD: Latch shutdown	LED light bulbs LED downlights LED straight tube lamps, etc.	140
	LC5556LD	4.0A		1.9Ω					
LC5510	LC5511D	–	650V	3.95Ω	DIP8	Flyback	• Power factor correction • Harmonics standard compliant (Class C) • High efficiency • Universal input • OCP: Pulse by pulse • OVP/OLP: Auto restart • TSD: Latch shutdown	LED downlights LED straight tube lamps, etc.	142
	LC5513D	–		1.9Ω					
LC5560	LC5565LD	–	650V	3.95Ω	DIP8	Flyback	• Power factor correction • Harmonics standard compliant (Class C) with light load • High efficiency • Universal input • Built-in analog dimming function • OCP: Pulse by pulse • OVP/OLP/TSD: Latch shutdown	LED light bulbs LED downlights LED straight tube lamps, etc.	144
	LC5566LD	–		1.9Ω					

Isolated type

Series Name	Part Number	MOSFET		Package	Circuit Type	Features	Applications	Page
		V_{DSS}	$R_{DS(ON)}$ (Max)					
LC5520	LC5521D	650V	3.95Ω	DIP8	Flyback	• Power factor correction • Harmonics standard compliant (Class C) • High efficiency • Universal input • OCP: Pulse by pulse • OVP/OLP: Auto restart • TSD: Latch shutdown	LED downlights LED straight tube lamps, etc.	146
	LC5523D	650V	1.9Ω					
	LC5523F	650V	1.9Ω	TO220F-7	Flyback		Ceiling lights Street lights, etc.	
	LC5525F	650V	1.1Ω					
LC5540	LC5545LD	650V	3.95Ω	DIP8	Flyback	• Power factor correction • Harmonics standard compliant with light load (Class C) • High efficiency • Universal input • Analog dimming • OCP: Pulse by pulse • OVP/OLP/TSD: Latch shutdown	LED downlights LED straight tube lamps, etc.	148
	LC5546LD	650V	1.9Ω					
	LC5548LD	800V	3.5Ω					
	LC5546LF	650V	1.9Ω	TO220F-7	Flyback		Ceiling lights Street lights, etc.	
	LC5547LF	650V	1.1Ω					
	LC5549LF	800V	1.7Ω					

<DC/DC>

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 Buck, Boost, Buck-Boost operations PWM dimming OCP/OVP/TSD	DC input LED lighting 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	$R_{DS(ON)}$ (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_a = 25°C)

Parameter	Symbol	Ratings						Unit	Remarks
		LC5202D	LC5202S	LC5205D	LC5205S	LC5203D	LC5210D		
Output Current*1	Io	0.5				1.0		A	Excluding when tw is less than 1μs
Main Supply Voltage	V_{BB}	250		450		250	450	V	
Output Breakdown Voltage	$V_{O(BR)}$	250		450		250	450	V	
PWM Pin Voltage*2	V_{PWM}	–0.3 to Vz						V	
REF Pin Voltage	V_{REF}	–0.3 to +V_{REG}+0.3						V	
SEN Pin Voltage	V_{SEN}	–0.3 to +4.0						V	Excluding when tw is less than 1μs
Power Dissipation*3	P_D	1.73	0.85	1.73	0.85	1.73		W	Sanken Evaluation Board
Operating Ambient Temperature	Ta	–40 to +105						°C	
Storage Temperature	Tstg	–40 to +150						°C	
Junction Temperature	Tj	+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 Tj under any circumstances.
*2: There is a built-in zener diode between the PWM pin and GND. VZ is the breakdown voltage of this internal zener diode, and VZ = 6.3V (TYP). The maximum value of the inflow current is 1mA.
*3: The power dissipation PD 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
		LC5202D/S		LC5203D		LC5205D/S		LC5210D		
		min.	max.	min.	max.	min.	max.	min.	max.	
Supply Voltage	V_{BB}	25*1	200	25*1	200	25*1	400	25*1	400	V
Output Current (Average)	$I_{O(AVG)}$	–	0.4	–	0.8	–	0.4	–	0.8	A
REF Pin Voltage	V_{REF}	–	0.8	–	0.8	–	0.8	–	0.8	V
Case Temperature*2	Tc	–	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 Tj is assumed to be 150°C or lower.

■Electrical Characteristics

(T_a = 25°C, V_{BB} = 140V, unless otherwise specified)

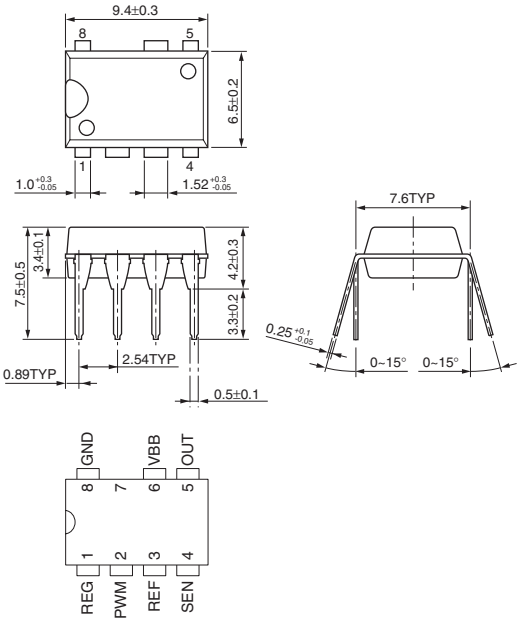
Parameter	Symbol	Measurement Conditions	Ratings			Unit	Remarks
			min.	typ.	max.		
Supply Current	I_{BBs}	When output is OFF	–	0.8	1.2	mA	
	I_{BB}	During operation	–	2	–	mA	
Output MOSFET Breakdown Voltage	$V_{DS(BR)}$	I_D=1mA	250	–	–	V	LC5202D/S, LC5203D
			450	–	–	V	LC5205D/S, LC5210D
Output MOSFET ON Resistance	$R_{DS(ON)}$	I_D=0.5A	–	1.2	2.2	Ω	LC5202D/S
		I_D=1.0A	–	0.7	1.3	Ω	LC5203D
		I_D=0.5A	–	3.5	6	Ω	LC5205D/S
		I_D=1.0A	–	1.7	3	Ω	LC5210D
Output MOSFET Body Diode Forward Voltage	V_F	I_F=0.5A	–	0.8	1	V	LC5202D/S
		I_F=1.0A	–	0.75	1.2	V	LC5203D
		I_F=0.5A	–	0.8	0.9	V	LC5205D/S
		I_F=1.0A	–	0.88	1	V	LC5210D
UVLO Release Voltage	$V_{UVLO(ON)}$		–	14	–	V	VBB pin voltage
UVLO Operation Voltage	$V_{UVLO(OFF)}$		–	13	–	V	VBB pin voltage
REG Pin Output Voltage	V_{REG}	I_{REG}=–0.1mA	11.5	12	12.5	V	
REG Pin Output Current	I_{REG}	V_{REG}=11V	–	–	–2	mA	
REF Pin Input Voltage	V_{REF}		0	–	1	V	
REF Pin Inflow Current	I_{REF}		–10	–	10	μA	
Current Control Detection Voltage	V_{SEN}		V_{REF}–0.03	V_{REF}	V_{REF}+0.03	V	
OCP Detection Voltage	V_{OCP}		–	3	–	V	
SEN Pin Inflow Current	I_{SEN}		–10	–	10	μA	
PWM Blanking Time	t_{BLK}		–	400	–	ns	
PWM Oscillation Frequency	f_{PWM}	Duty=50%	–	–	200	kHz	
Output MOSFET Rising Time	t_r	Io=0.4A	–	20	–	ns	
Output MOSFET Falling Time	t_f	Io=0.4A	–	50	–	ns	
TSD Operating Temperature*	T_{TSD}		–	150	–	°C	
TSD Temperature Hysteresis*	$T_{TSD(HYS)}$		–	55	–	°C	
Thermal Resistance	θ_{j-a}	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 (Tj)

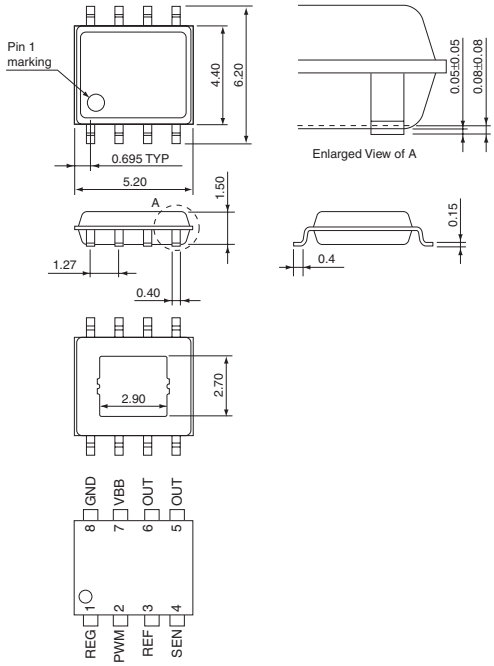
■External Dimensions

(Unit : mm)

LC52xxD (DIP8)



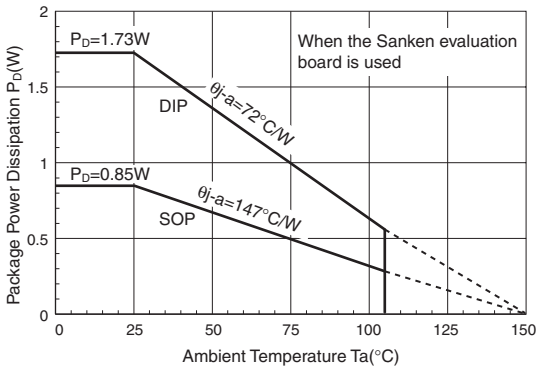
LC52xxS (SOP8)



■Pin Functions

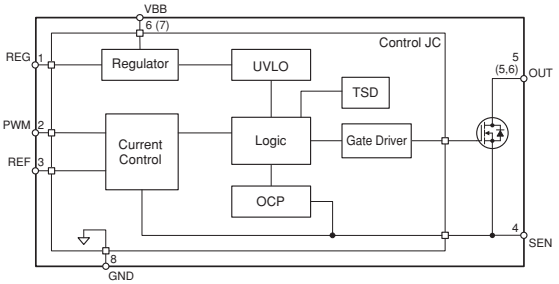
Symbol	Pin No. LC52xxD (DIP8)	Pin No. LC52xxS (SOP8)	Function
REG	1	1	Output of the built-in regulator. Supplies current to the internal and external circuits. Connect a 0.1μF bypass capacitor near the pin.
PWM	2	2	Connect CR for OFF time setting when using the internal PWM method. Functions as the input pin for PWM signals when using the external PWM method.
REF	3	3	OUT pin (output MOSFET) for the internal PWM method Input pin for peak current setting Set a peak current based on the REF pin voltage.
SEN	4	4	Pin for detecting output current 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 LC52xxD (DIP8) has been removed to secure the insulating distance of the high voltage pins. For LC52xxS (SOP8), the design criteria of the customer must be considered.
GND	8	8	GND pin

■TA-PD Characteristics

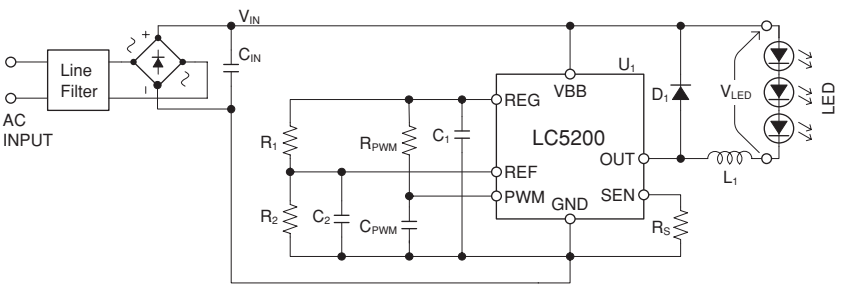


■Block Diagram

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 ≥ 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	$R_{DS(ON)}$ (Max)	Package
LC5222D	0.5A	250V	2.2Ω	DIP8
LC5225D		450V	6.0Ω	
LC5222S		250V	2.2Ω	SOP8
LC5225S		450V	6.0Ω	
LC5223D	1.0A	250V	1.3Ω	DIP8
LC5226D		450V	3.0Ω	

■Absolute Maximum Ratings

(T_a = 25°C)

Parameter	Symbol	Ratings						Unit	Remarks
		LC5222D	LC5222S	LC5225D	LC5225S	LC5223D	LC5226D		
Output Current*1	Io	0.5				1.0		A	Excluding when tw is less than 1μs
Main Supply Voltage	V_{BB}	250		450		250	450	V	
Output Breakdown Voltage	$V_{O(BR)}$	250		450		250	450	V	
PWM Pin Voltage*2	V_{PWM}	–0.3 to Vz						V	
REF Pin Voltage*2	V_{REF}	–0.3 to Vz						V	
SEN Pin Voltage	V_{SEN}	–0.3 to +4.0						V	Excluding when tw is less than 1μs
Power Dissipation*3	P_D	1.73	0.85	1.73	0.85	1.73		W	Sanken Evaluation Board
Operating Ambient Temperature	Ta	–40 to +105						°C	
Storage Temperature	Tstg	–40 to +150						°C	
Junction Temperature	Tj	+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 Tj under any circumstances.
*2: There is a built-in zener diode between the PWM pin and GND. VZ is the breakdown voltage of this internal zener diode, and VZ = 6.3V (TYP). The maximum value of the inflow current is 1mA.
*3: The power dissipation PD 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_{BB}	25*1	200	25*1	200	25*1	400	25*1	400	V
Output Current (Average)	$I_{O(AVG)}$	–	0.4	–	0.8	–	0.4	–	0.8	A
REF Pin Voltage	V_{REF}	0.2	2.5	0.2	2.5	0.2	2.5	0.2	2.5	V
Case Temperature*2	Tc	–	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 Tj is assumed to be 150°C or lower.

■Electrical Characteristics

(T_a = 25°C, V_{BB} = 140V, unless otherwise specified)

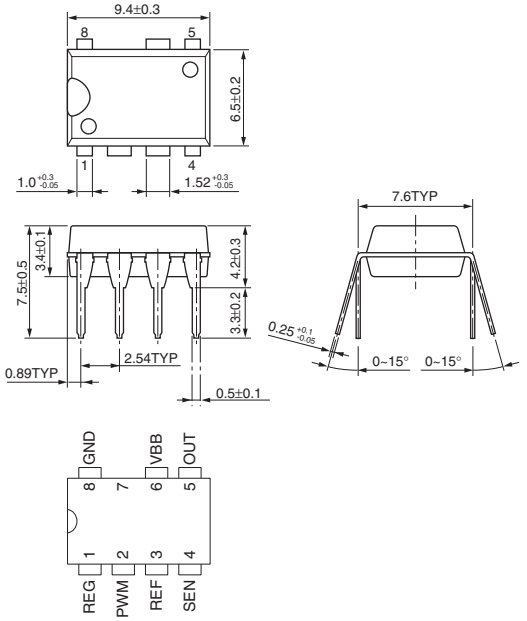
Parameter	Symbol	Measurement Conditions	Ratings			Unit	Remarks
			min.	typ.	max.		
Supply Current	I_{BBs}	When output is OFF	–	1	1.5	mA	
	I_{BB}	During operation	–	2.5	4	mA	
Output MOSFET Breakdown Voltage	$V_{(BR)DSS}$	I_D=1mA	250	–	–	V	LC5222D/S, LC5223D
			450	–	–	V	LC5225D/S, LC5226D
Output MOSFET ON Resistance	$R_{DS(ON)}$	I_D=0.5A	–	1.2	2.2	Ω	LC5222D/S
		I_D=1.0A	–	0.7	1.3	Ω	LC5223D
		I_D=0.5A	–	3.5	6	Ω	LC5225D/S
		I_D=1.0A	–	1.7	3	Ω	LC5226D
Output MOSFET Body Diode Forward Voltage	V_F	I_F=0.5A	–	0.8	1	V	LC5222D/S
		I_F=1.0A	–	0.75	1.2	V	LC5223D
		I_F=0.5A	–	0.8	0.9	V	LC5225D/S
		I_F=1.0A	–	0.88	1	V	LC5226D
UVLO Release Voltage	$V_{UVLO(ON)}$		–	14	–	V	VBB pin voltage
UVLO Operation Voltage	$V_{UVLO(OFF)}$		–	12	–	V	VBB pin voltage
REGOutput Voltage	V_{REG}	I_{REG}=0mA	9.6	10	10.4	V	
REGOutput Current	I_{REG}	V_{REG}=9V	–2	–	–	mA	
ENABLE Voltage	V_{ENB}		–	0.15	0.19	V	REF pin Voltage
SLEEP Voltage	V_{SLP}		2.85	3	–	V	REF pin Voltage
REF Pin Inflow Current	I_{REF}		–10	–	10	μA	
Current Control Detection Voltage	V_{SEN}	V_{REF}=0.2 to 2.0V	0.4×V_{REF}–0.03	0.4×V_{REF}	0.4×V_{REF}+0.03	V	
		V_{REF}=2.0 to 3.0V	0.77	0.8	0.83	V	
OCP Detection Voltage	V_{OCP}	V_{REF}=0.2 to 2.0V	–	0.4×V_{REF}+0.7	–	V	
		V_{REF}=2.0 to 3.0V	–	1.5	–	V	
SEN Pin Inflow Current	I_{SEN}		–10	–	10	μA	
PWM Pin Low Voltage	$V_{PWM(L)}$		–	2	–	V	
PWM Pin High Voltage	$V_{PWM(H)}$		–	3	–	V	
PWM Pin Output Current	I_{PWM}		–	–20	–	μA	
PWM Blanking Time	$t_{BLK(P)}$		–	0.3	–	μs	
OCP Blanking Time	$t_{BLK(O)}$		–	0.2	–	μs	
PWM Oscillation Frequency	f_{PWM}	Duty=50%	–	–	200	kHz	
PWM OFF Time	t_{Off}	C_{PWM}=100pF	–	17	–	μs	
Output MOSFET Rising Time	t_r	Io=0.4A	–	25	–	ns	
Output MOSFET Falling Time	t_f	Io=0.4A	–	50	–	ns	
TSD Operating Temperature*	T_{TSD}		–	150	–	°C	
TSD Temperature Hysteresis*	$T_{TSD(HYS)}$		–	55	–	°C	
Thermal Resistance	θ_{j-a}	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 (Tj)

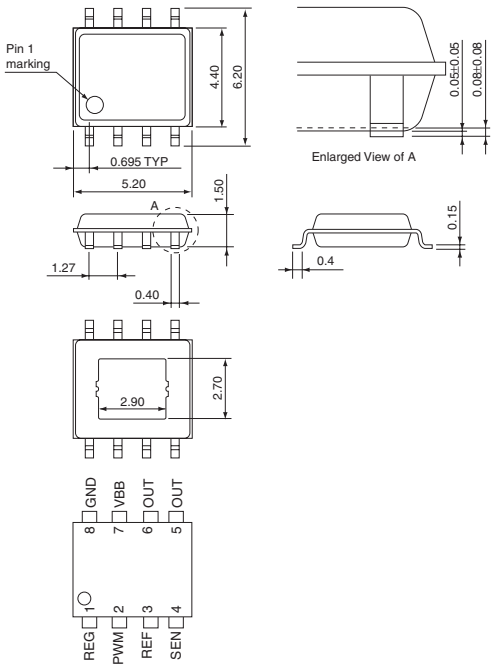
■External Dimensions

(Unit : mm)

LC522xD (DIP8)



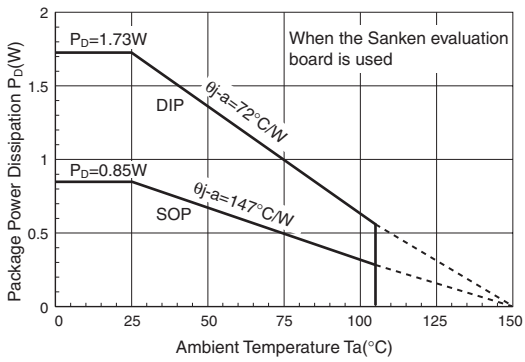
LC522xS (SOP8)



■Pin Functions

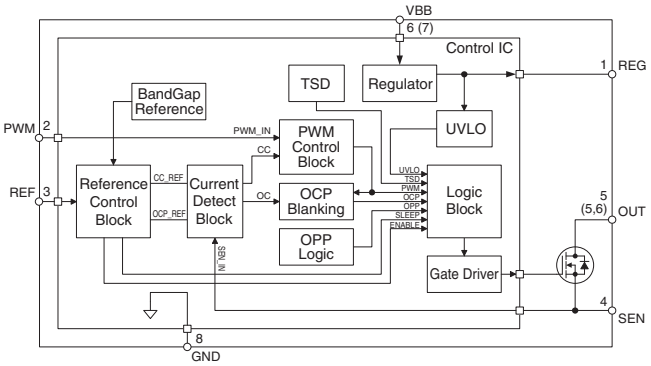
Symbol	Pin No. LC522xD (DIP8)	Pin No. LC522xS (SOP8)	Function
REG	1	1	Output of the built-in regulator. Supplies current to the internal and external circuits. Connect a 0.1μF bypass capacitor near the pin.
PWM	2	2	Connect CR for OFF time setting when using the internal PWM method. Functions as the input 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 LC52xxD (DIP8) has been removed to secure the insulating distance of the high voltage pins. For LC52xxS (SOP8), the design criteria of the customer must be considered.
GND	8	8	GND pin

■Ta-PD Characteristics

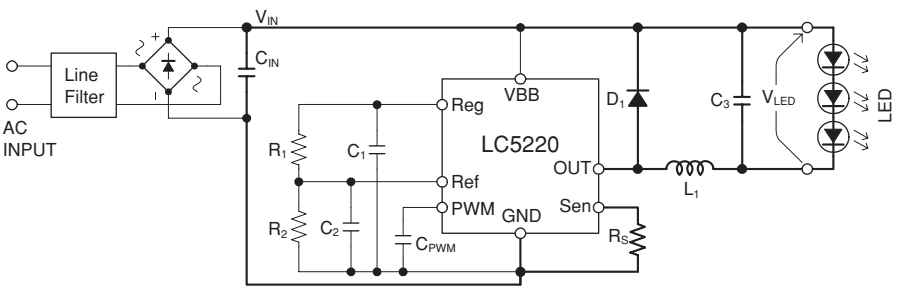


■Block Diagram

If the pin number differs in the DIP8 and SOP8 packages, the pin number for SOP8 is indicated in parentheses.



■Typical Connection Diagram



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	Maximum ON Time	POUT*
	VDSS (MIN)	RDS(ON) (MAX)	fOSC (TYP)	tON(MAX) (TYP)	AC230V / Universal
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 (ILPEAK=2.0A)	86 (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 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

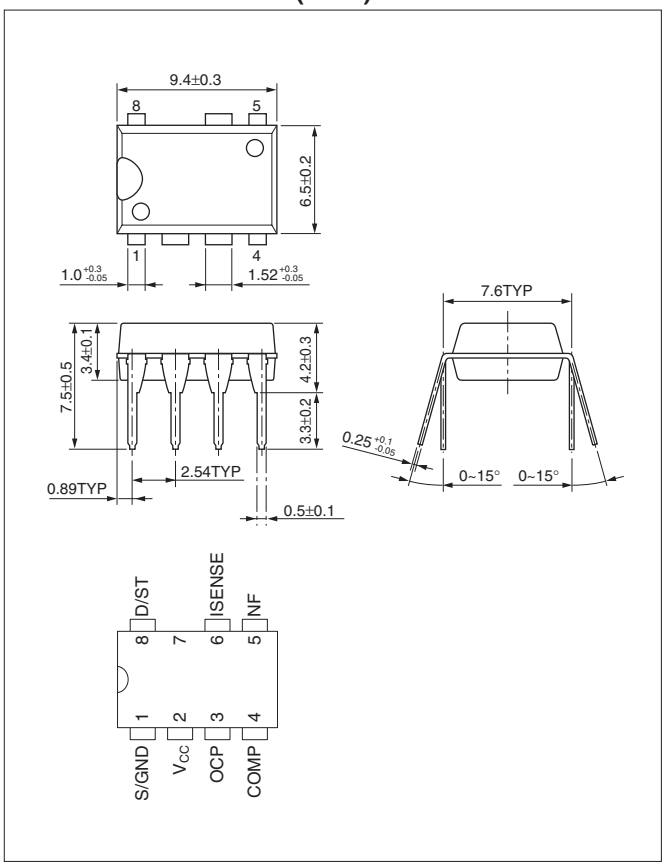
(Ta = 25°C, VCC = 20V, unless otherwise specified)

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	tf	–	–	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)

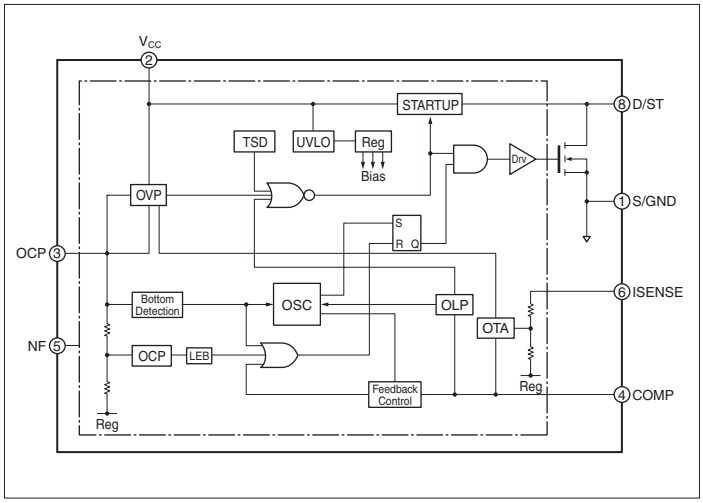


■Pin Functions

Pin No.	Symbol	Function
1	S/GND	MOSFET source and GND for control
2	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
7	–	(Pin removed)
8	D/ST	MOSFET drain and Startup current input

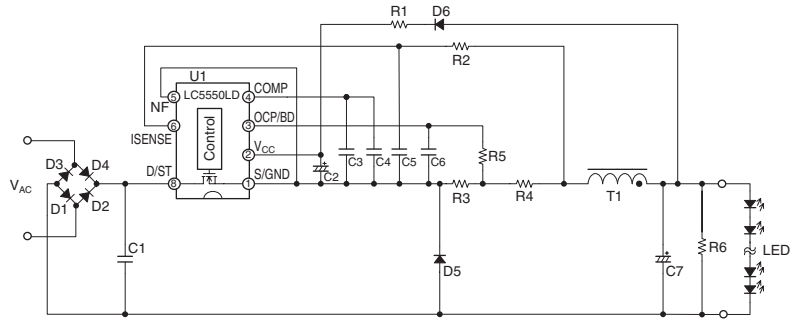
*: NF (pin 5) connects to the stable potential S/GND pattern (pin 1 potential) via the shortest distance for stable operation.

■Block Diagram

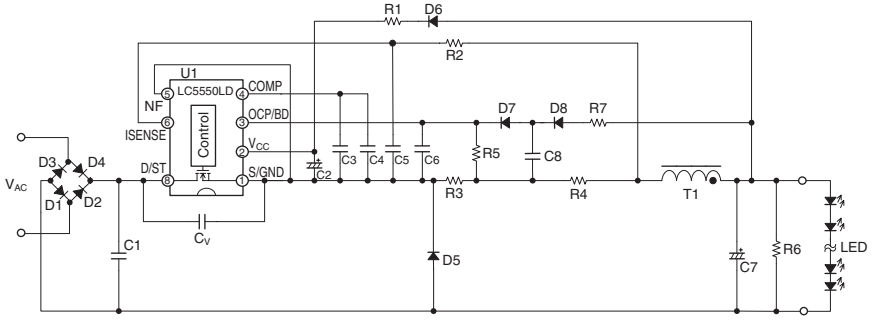


■Typical Connection Diagram

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_{OUT}*
	V_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)	AC230V / Universal
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_a = 25°C)

Parameter	Symbol	Ratings		Unit	Remarks
		LC5511D	LC5513D		
Drain Current	I_{DPEAK}	2.5	4.0	A	Single Pulse
Avalanche Energy Capacity	E_{AS}	47 (I_{LPEAK}=2.0A)	86 (I_{LPEAK}=2.7A)	mJ	Single Pulse, V_{DD}=99V, L=20mH
Control Supply Voltage	V_{CC}	35		V	
OCP Pin Voltage	V_{OCP}	–2.0 to +5.0		V	
COMP Pin Voltage	V_{COMP}	–0.3 to +7.0		V	
ISENSE Pin Voltage	V_{SEN}	–0.3 to +5.0		V	
MOSFET Power Dissipation	P_D	0.97		W	Board size when mounted on board 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

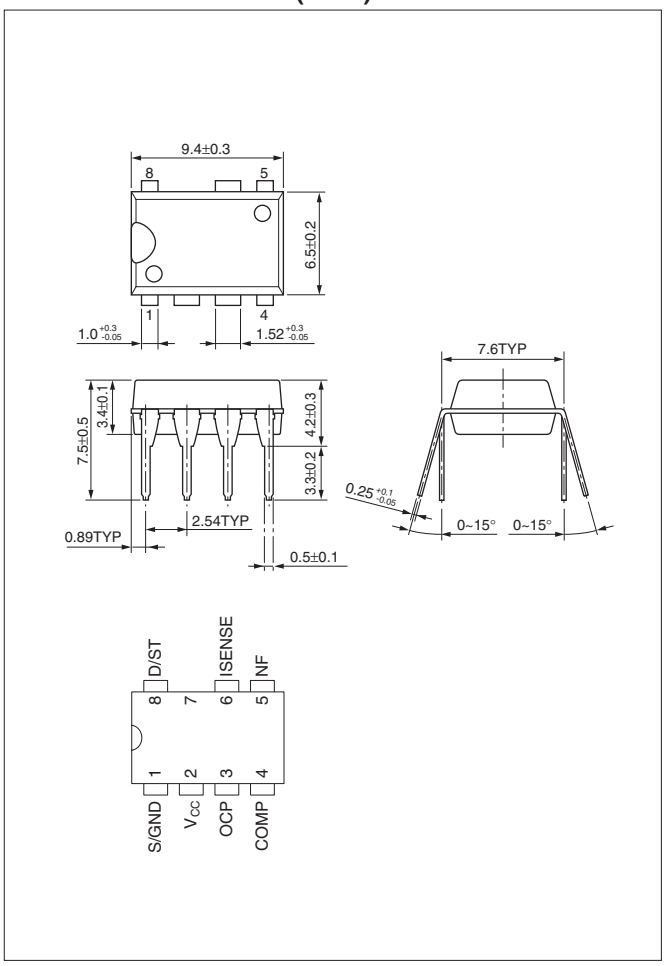
(T_a = 25°C, V_{CC} = 20V, unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Remarks
		min.	typ.	max.		
Power Supply Startup Operation						
Operation Startup Voltage	$V_{CC(ON)}$	13.8	15.1	17.3	V	
Operation Stop Voltage*1	$V_{CC(OFF)}$	8.4	9.4	10.7	V	
Circuit Current During Operation	$I_{CC(ON)}$	–	–	3.7	mA	
Startup Circuit Operation Voltage	$V_{STARTUP}$	42	57	72	V	
Startup Current	$I_{CC(STARTUP)}$	–5.5	–3.0	–1.0	mA	V_{CC}=13V
Startup Current Supply Threshold Voltage 1*1	$V_{CC(BIAS)1}$	9.5	11	12.5	V	
Startup Current Supply Threshold Voltage 2	$V_{CC(BIAS)2}$	14.4	16.6	18.8	V	
Normal Operation						
PWM Oscillation Frequency	f_{OSC}	11.0	14.0	18.0	kHz	
Maximum ON Time	$t_{ON(MAX)}$	30.0	40.0	50.0	μs	
COMP Pin Control Lower Voltage	$V_{COMP(MIN)}$	0.55	0.90	1.25	V	
Error Amplifier Reference Voltage	$V_{SEN(TH)}$	0.27	0.30	0.33	V	
Error Amplifier Source Current	$I_{SEN(SOURCE)}$	–11	–7	–3	μA	
Error Amplifier Sink Current	$I_{SEN(SINK)}$	3	7	11	μA	
Leading Edge Blanking Time	$t_{ON(LEB)}$	–	500	–	ns	
Quasi-Resonant Operation Threshold Voltage 1	$V_{BD(TH1)}$	0.14	0.24	0.34	V	
Quasi-Resonant Operation Threshold Voltage 2	$V_{BD(TH2)}$	0.12	0.17	0.22	V	
Protection Operation						
Overcurrent Detection Threshold Voltage	V_{OCP}	–0.66	–0.60	–0.54	V	
OCP Pin Outflow Current	I_{OCP}	–120	–40	–10	μA	
OCP Pin OVP Threshold Voltage	$V_{BD(OVP)}$	2.2	2.6	3.0	V	
OLP Threshold Voltage	$V_{COMP(OLP)}$	4.1	4.5	4.9	V	
VCC Pin OVP Threshold Voltage	$V_{CC(OVP)}$	28.5	31.5	34.0	V	
TSD Operating Temperature	$T_{j(TSD)}$	135	–	–	°C	
MOSFET						
Drain-Source Voltage	V_{DSS}	650	–	–	V	
Drain Leakage Current	I_{DSS}	–	–	300	μA	
ON Resistance	$R_{DS(ON)}$	–	–	3.95	Ω	LC5511D
		–	–	1.9		LC5513D
Switching Time	t_f	–	–	250	ns	LC5511D
		–	–	400		LC5513D
Thermal Resistance*2	θch-c	–	–	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 $V_{CC(BIAS)}1 > V_{CC(OFF)}$ holds true for all products.
*2: Thermal resistance between the MOSFET channel and the case. The case temperature T_C is determined by the temperature at the center of the marking surface.

■External Dimensions (DIP8)

(Unit : mm)

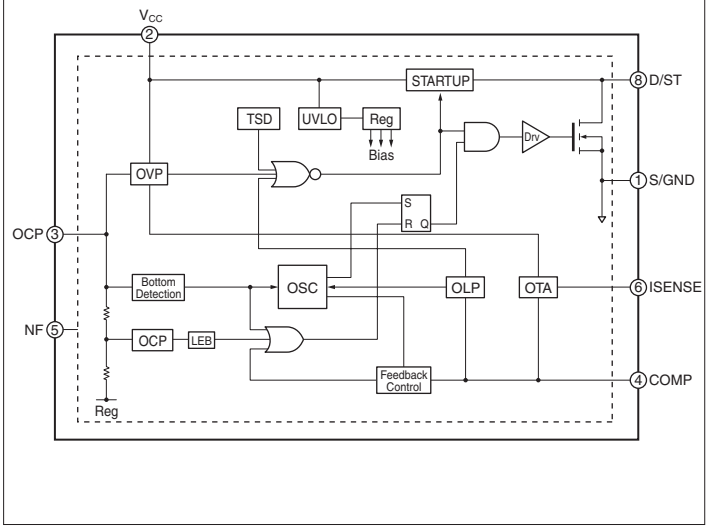


■Pin Functions

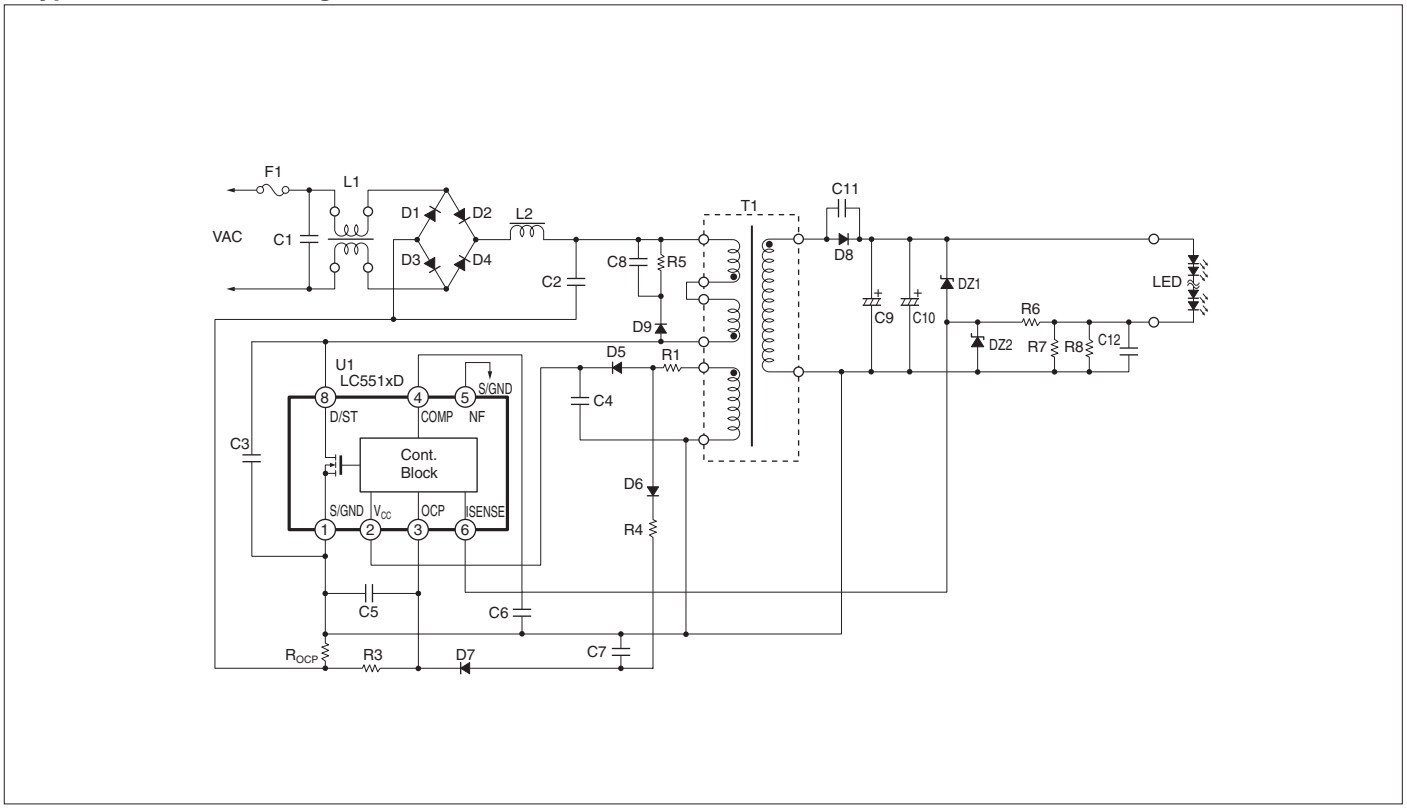
Pin No.	Symbol	Function
1	S/GND	MOSFET source and GND for control
2	Vcc	Control circuit power input and Overvoltage protection signal input
3	OCP	Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input
4	COMP	Feedback phase compensation
5	NF	(No function*)
6	ISENSE	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 Frequency f_{OSC} (TYP)	Maximum ON Time $t_{ON(MAX)}$ (TYP)	P_{OUT}* AC230V / Universal
	V_{DSS} (MIN)	$R_{DS(ON)}$ (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

(T_a = 25°C)

Parameter	Symbol	Ratings		Unit	Remarks
		LC5565LD	LC5566LD		
Drain Current	I_{DPEAK}	2.5	4.0	A	Single Pulse
Avalanche Energy Capacity	E_{AS}	47 (I_{LPEAK}=2.0A)	86 (I_{LPEAK}=2.7A)	mJ	Single Pulse, V_{DD}=99V, L=20mH
Control Supply Voltage	V_{CC}	35		V	
OCP Pin Voltage	V_{OCP}	–2.0 to +5.0		V	
COMP Pin Voltage	V_{COMP}	–0.3 to +7.0		V	
V_{REF} Pin Voltage	V_{REF}	–0.3 to +5.0		V	
ISENSE Pin Voltage	V_{SEN}	–0.3 to +5.0		V	
MOSFET Power Dissipation	P_D	0.97		W	Board size when mounted on board 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

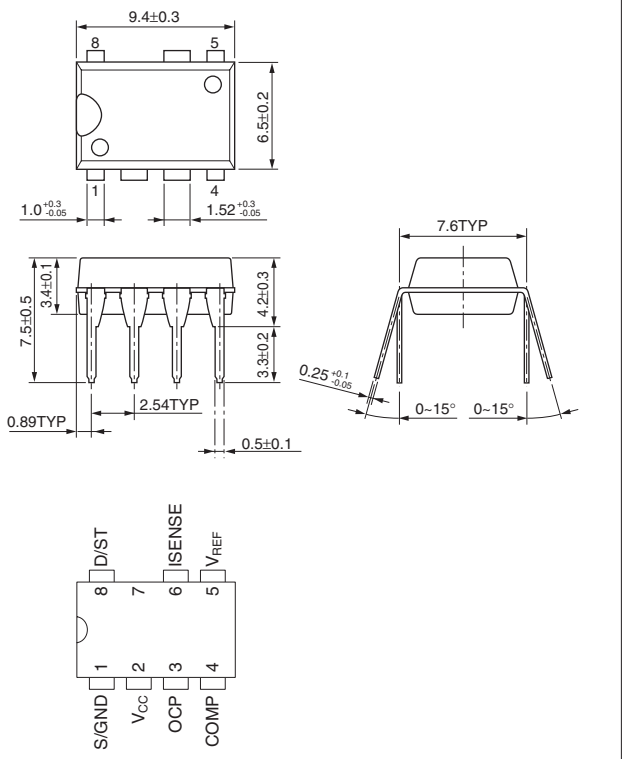
(T_a = 25°C, V_{CC} = 20V, unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Remarks
		min.	typ.	max.		
Power Supply Startup Operation						
Operation Startup Voltage	$V_{CC(ON)}$	13.8	15.1	17.3	V	
Operation Stop Voltage*1	$V_{CC(OFF)}$	8.4	9.4	10.7	V	
Circuit Current During Operation	$I_{CC(ON)}$	–	–	4.7	mA	
Startup Circuit Operation Voltage	$V_{STARTUP}$	18	21	24	V	
Startup Current	$I_{CC(STARTUP)}$	–8.5	–4.0	–1.5	mA	V_{CC}=13V
Startup Current Supply Threshold Voltage*1	$V_{CC(BIAS)}$	9.5	11.0	12.5	V	
Normal Operation						
PWM Oscillation Frequency	f_{OSC}	60	72	84	kHz	LC5565LD
		50	60	70		LC5566LD
Maximum ON Time	$t_{ON(MAX)}$	8.0	9.3	11.2	μs	LC5565LD
		9.0	11.2	13.4		LC5566LD
COMP Pin Control Lower Voltage	$V_{COMP(MIN)}$	0.30	0.55	0.80	V	
Error Amplifier Reference Voltage	$V_{SEN(TH)}$	0.312	0.335	0.358	V	
Error Amplifier Source Current	$I_{SEN(SOURCE)}$	–22	–14	–6	μA	
Error Amplifier Sink Current	$I_{SEN(SINK)}$	6	14	22	μA	
Leading Edge Blanking Time	$t_{ON(LEB)}$	–	600	–	ns	
Quasi-Resonant Operation Threshold Voltage 1	$V_{BD(TH1)}$	0.14	0.24	0.34	V	
Quasi-Resonant Operation Threshold Voltage 2	$V_{BD(TH2)}$	0.11	0.16	0.21	V	
Protection Operation						
Overcurrent Detection Threshold Voltage	V_{OCP}	–0.66	–0.60	–0.54	V	
OCP Pin Outflow Current	I_{OCP}	–120	–40	–10	μA	
OCP Pin OVP Threshold Voltage	$V_{BD(OVP)}$	2.2	2.6	3.0	V	
OLP Threshold Voltage	$V_{COMP(OLP)}$	4.1	4.5	4.9	V	
VCC Pin OVP Threshold Voltage	$V_{CC(OVP)}$	28.5	31.5	34.0	V	
TSD Operating Temperature	$T_{j(TSD)}$	135	–	–	°C	
MOSFET						
ON Resistance	$R_{DS(ON)}$	–	–	3.95	Ω	LC5565LD
		–	–	1.9		LC5566LD
Switching Time	t_f	–	–	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 T_C is determined by the temperature at the center of the marking surface.

■External Dimensions (DIP8)

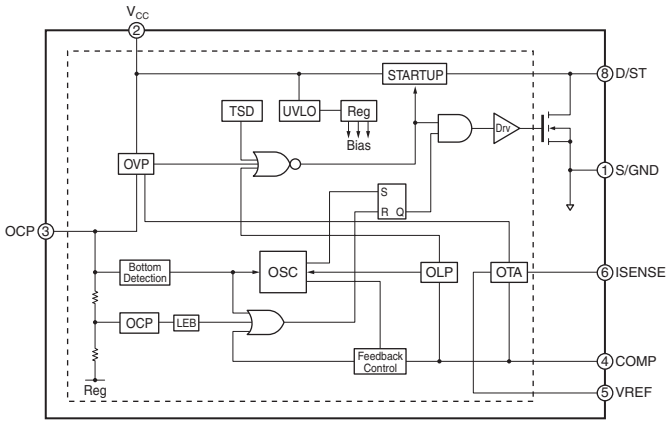
(Unit : mm)



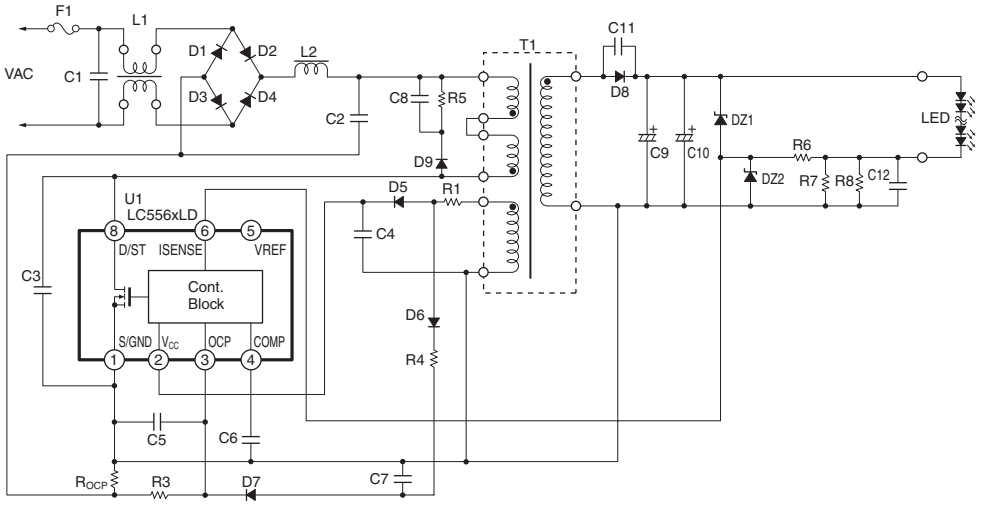
■Pin Functions

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	V_{REF}	Dimmer signal input
6	ISENSE	Feedback current detection and Overvoltage protection signal input
7	–	(Pin removed)
8	D/ST	MOSFET drain and Startup current input

■Block Diagram



■Typical Connection Diagram



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_{OUT}* AC230V / Universal	Package
	V_{DSS} (MIN)	$R_{DS(ON)}$ (MAX)		
LC5521D	650V	3.95Ω	13W / 10W	DIP8
LC5523D		1.9Ω	20W / 16W	
LC5523F	650V	1.9Ω	60W / 40W	TO220F–7
LC5525F		1.1Ω	80W / 55W	

*: 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_a = 25°C)

Parameter	Symbol	Ratings				Unit	Remarks
		LC5521D	LC5523D	LC5523F	LC5525F		
Drain Current	I_{DPEAK}	2.5	4.0	9.2	13.0	A	Single Pulse
Avalanche Energy Capacity	E_{AS}	47 (I_{LPEAK}=2.0A)	86 (I_{LPEAK}=2.7A)	99 (I_{LPEAK}=2.9A)	233 (I_{LPEAK}=4.4A)	mJ	Single Pulse, V_{DD}=99V, L=20mH
Control Supply Voltage	V_{CC}	35				V	
OCP Pin Voltage	V_{OCP}	–2.0 to +5.0				V	
FB Pin Voltage	V_{FB}	–0.3 to +7.0				V	
OVP Pin Voltage	V_{OVP}	–0.3 to +5.0				V	
MOSFET Power Dissipation	P_D	0.97		1.8		W	
	P_D2	–		20.2	23.6	W	With infinite heatsink
Operating Ambient Temperature	Top	–55 to +125				°C	
Storage Temperature	Tstg	–55 to +125				°C	
Channel Temperature	Tch	150				°C	

■Electrical Characteristics

(T_a = 25°C, V_{CC} = 20V, unless otherwise specified)

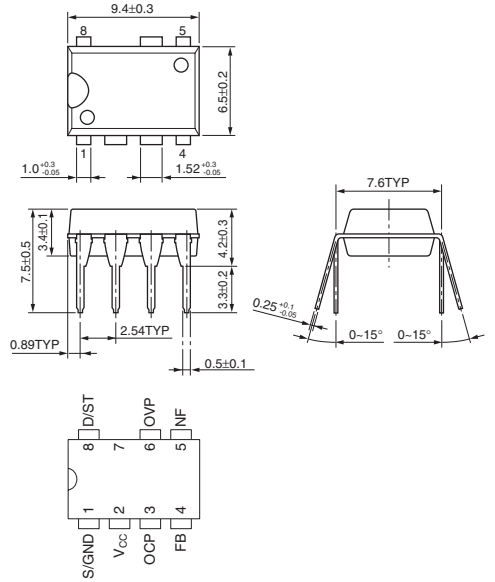
Parameter	Symbol	Ratings			Unit	Remarks
		min.	typ.	max.		
Power Supply Startup Operation						
Operation Startup Voltage	$V_{CC(ON)}$	13.8	15.1	17.3	V	
Operation Stop Voltage*1	$V_{CC(OFF)}$	8.4	9.4	10.7	V	
Circuit Current During Operation	$I_{CC(ON)}$	–	–	3.7	mA	
Startup Circuit Operation Voltage	$V_{STARTUP}$	42	57	72	V	
Startup Current	$I_{CC(STARTUP)}$	–5.5	–3.0	–1.0	mA	V_{CC}=13V
Startup Current Supply Threshold Voltage*1	$V_{CC(BIAS)}$	9.5	11.0	12.5	V	
Normal Operation						
PWM Oscillation Frequency	f_{OSC}	11.0	14.0	18.0	kHz	
Maximum ON Time	$t_{ON(MAX)}$	30.0	40.0	50.0	μs	
FB Pin Control Lower Voltage	$V_{FB(MIN)}$	0.55	0.90	1.25	V	
Maximum Feedback Current	$I_{FB(MAX)}$	–40	–25	–10	μA	
Leading Edge Blanking Time	$t_{ON(LEB)}$	–	500	–	ns	
Quasi-Resonant Operation Threshold Voltage 1	$V_{BD(TH1)}$	0.14	0.24	0.34	V	
Quasi-Resonant Operation Threshold Voltage 2	$V_{BD(TH2)}$	0.12	0.17	0.22	V	
Protection Operation						
Overcurrent Detection Threshold Voltage	V_{OCP}	–0.66	–0.60	–0.54	V	
OCP Pin Outflow Current	I_{OCP}	–120	–40	–10	μA	
OCP Pin OVP Threshold Voltage	$V_{BD(OVP)}$	2.2	2.6	3.0	V	
OLP Threshold Voltage	$V_{COMP(OLP)1}$	5.0	5.5	6.0	V	
	$V_{COMP(OLP)2}$	4.1	4.5	4.9		
OVP Pin OVP Threshold Voltage	$V_{OVP(OVP)}$	1.6	2.0	2.4	V	
VCC Pin OVP Threshold Voltage	$V_{CC(OVP)}$	28.5	31.5	34.0	V	
TSD Operating Temperature	$T_{j(TSD)}$	135	–	–	°C	
MOSFET						
Drain-Source Voltage	V_{DSS}	650	–	–	V	
Drain Leakage Current	I_{DSS}	–	–	300	μA	
ON Resistance	$R_{DS(ON)}$	–	–	3.95	Ω	LC5521D
		–	–	1.9		LC5523D
		–	–	1.9		LC5523F
		–	–	1.1		LC5535F
Switching Time	t_f	–	–	250	ns	LC5521D
		–	–	400		LC5523D
		–	–	400		LC5523F
		–	–	400		LC5535F
Thermal Resistance*2	θch–c	–	–	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 $V_{CC(BIAS)}1 > V_{CC(OFF)}$ holds true for all products.
*2: Thermal resistance between the MOSFET channel and the case. The case temperature T_C is determined by the temperature at the center of the marking surface.

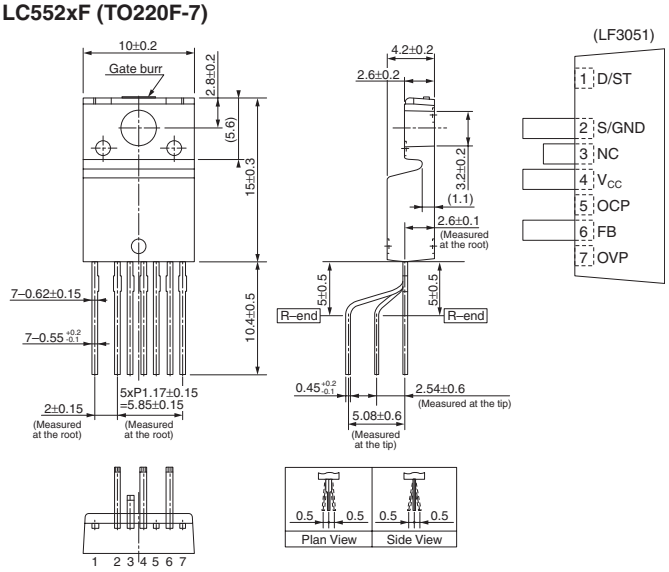
■External Dimensions

(Unit : mm)

LC552xD (DIP8)



LC552xF (TO220F-7)



■Pin Functions

LC552xD (DIP8)

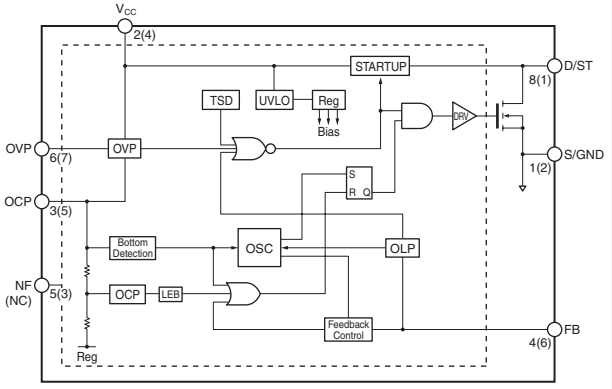
Pin No.	Symbol	Function
1	S/GND	MOSFET source and GND for control
2	Vcc	Control circuit power input and Overvoltage protection signal input
3	OCP	Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input
4	FB	Feedback signal input and Overload protection signal input
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)

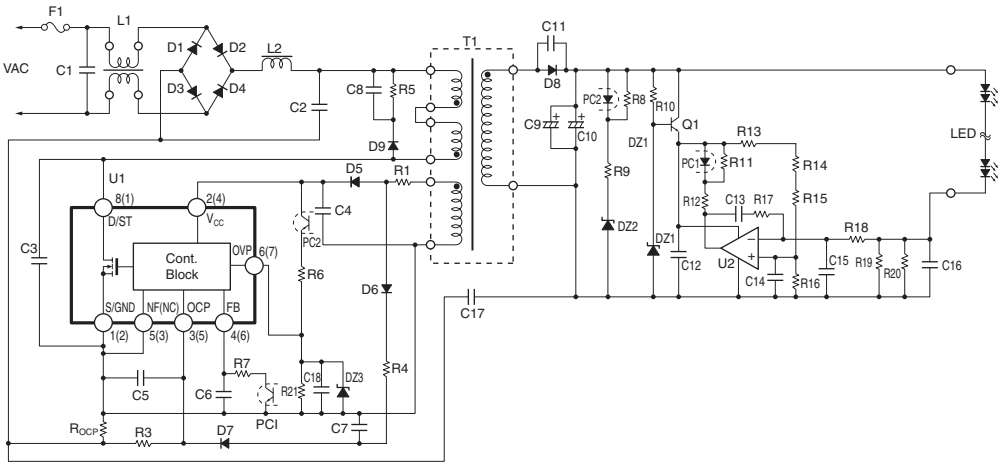
Pin No.	Symbol	Function
1	D/ST	MOSFET drain and Startup current input
2	S/GND	MOSFET source and GND for control
3	NC	–
4	Vcc	Control circuit power input and Overvoltage protection signal input
5	OCP	Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input
6	FB	Feedback 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	Maximum ON Time	POUT*	Package
	VDSS (MIN)	RDS(ON) (MAX)	fOSC (TYP)	tON(MAX) (TYP)	AC230V / Universal	
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 (ILPEAK=2.0A)	86 (ILPEAK=2.7A)	56 (ILPEAK=2.3A)	99 (ILPEAK=2.9A)	233 (ILPEAK=4.4A)	92 (ILPEAK=2.8A)	mJ	Single Pulse, 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)

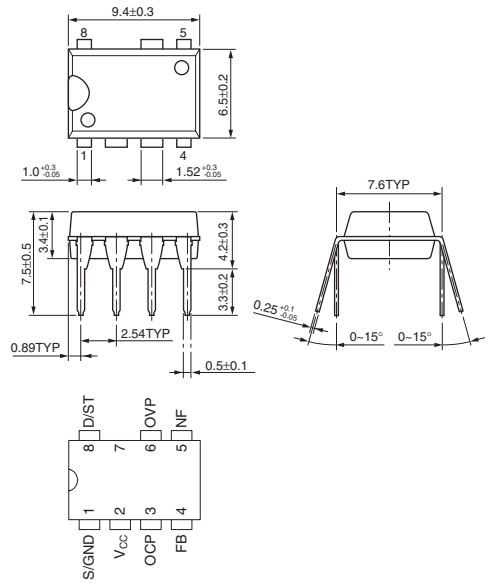
Parameter	Symbol	Ratings			Unit	Remarks
		min.	typ.	max.		
Power Supply Startup Operation						
Operation Startup Voltage	VCC(ON)	13.8	15.1	17.3	V	
Operation Stop Voltage	VCC(OFF)	8.4	9.4	10.7	V	
Circuit Current During Operation	ICC(ON)	–	–	4.7	mA	
Startup Circuit Operation Voltage	VSTARTUP	18	21	24	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
		–	–	1.7		LC5549LF
Switching Time	tf	–	–	250	ns	LC5545LD
		–	–	400		LC5546LD
		–	–	400		LC5548LD
		–	–	400		LC5546LF
		–	–	400		LC5547LF
		–	–	300		LC5549LF
Thermal Resistance*3	θch–c	–	–	42*2	°C/W	LC5545LD
		–	–	35.5*2		LC5546LD
		–	–	40*2		LC5548LD
	θch–F	–	–	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 VCC(BIAS)1 > VCC(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

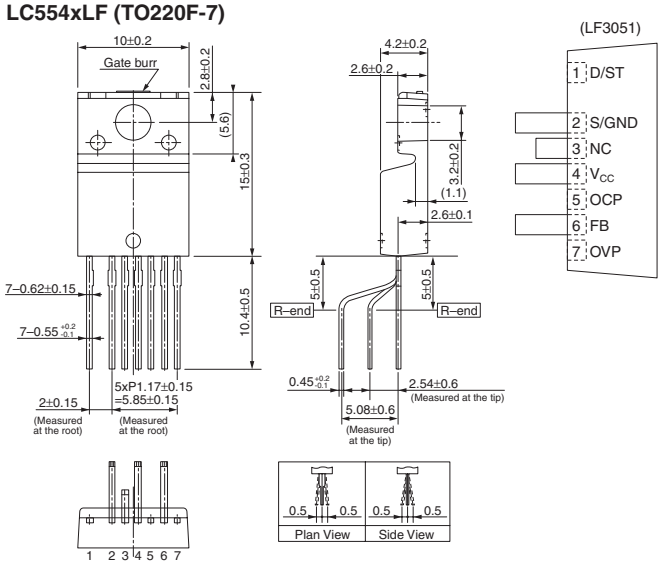
■External Dimensions

(Unit : mm)

LC554xLD (DIP8)



LC554xLF (TO220F-7)



■Pin Functions

LC554xLD (DIP8)

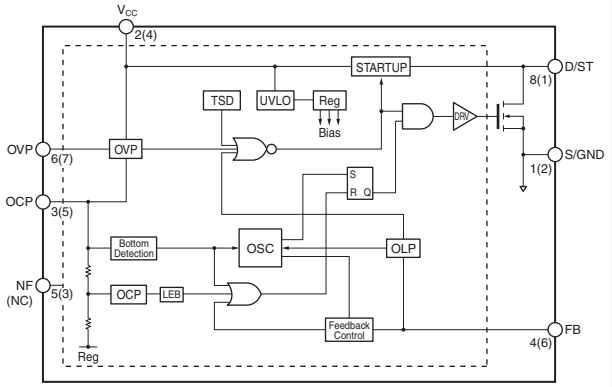
Pin No.	Symbol	Function
1	S/GND	MOSFET source and GND for control
2	Vcc	Control circuit power input and Overvoltage protection signal input
3	OCP	Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input
4	FB	Feedback signal input and Overload protection signal input
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)

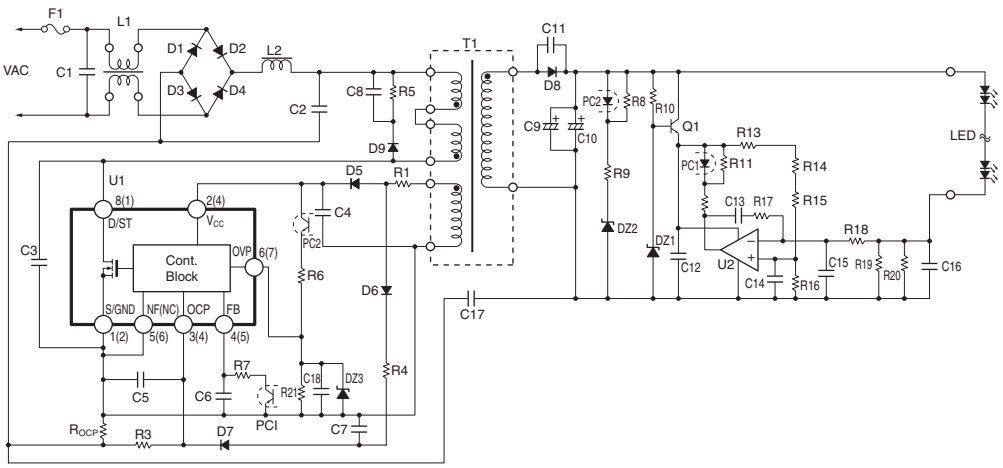
Pin No.	Symbol	Function
1	D/ST	MOSFET drain and Startup current input
2	S/GND	MOSFET source and GND for control
3	Vcc	Control circuit power input and Overvoltage protection signal input
4	OCP	Overcurrent protection and Quasi-resonant signal input and Overvoltage protection signal input
5	FB	Feedback 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

(T_a = 25°C)

Parameter	Symbol	Ratings	Unit	Conditions
VIN Pin Voltage	V_{IN}	–0.3 to 50	V	
SW Pin Voltage	V_{SW}	–0.3 to 50	V	
CSP Pin Voltage	V_{CSP}	–0.3 to 50	V	
CSN Pin Voltage	V_{CSN}	–0.3 to 50	V	
CSP/CSN Pin Differential Voltage	$V_{CSP-CSN}$	–0.3 to 5.5	V	
COMP Pin Voltage	V_{COMP}	–0.3 to 5.5	V	
DIM Pin Voltage	V_{DIM}	–0.3 to 5.5	V	
Power Dissipation	Pd	1.35	W	Measured on a 30×30mm glass-epoxy board (with a 625mm^2 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^2 copper area)

■Recommended Operating Conditions

Parameter	Symbol	Ratings	Unit
Input Voltage Range	V_{IN}	9 to 46	V
Output Current Range	I_{OUT}	Up to 2.0	A
PK- PK Inductor Ripple Current	ΔI_L	Up to 0.8	A
PWM Dimmer Signal Frequency Range	f_{PWM}	32 to 20000	Hz
Operating Temperature Range	T_{OP}	–40 to 85	°C

*: Exceeding these ratings may damage the device.

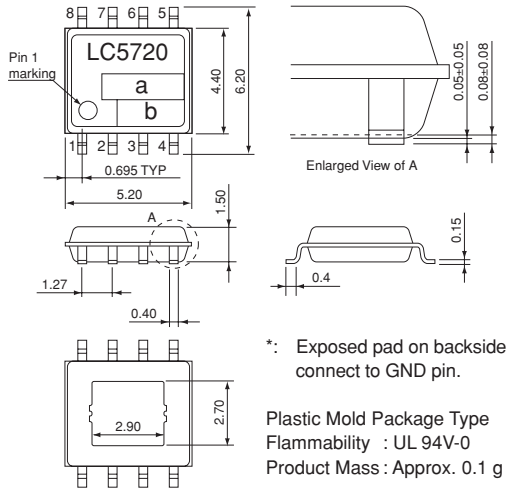
■Electrical Characteristics

(T_a = 25°C, V_{IN} = 15V, unless otherwise specified)

Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Operation Startup Voltage	$V_{IN\ (ON)}$	7.7	8.5	9.4	V	
Operation Stop Voltage	$V_{IN\ (OFF)}$	7.2	8.0	8.9	V	
Operation Startup/Stop Hysteresis	$V_{IN\ (HYS)}$	0.1	0.3	0.5	V	
Supply Current (Operating)	$I_{IN\ (ON)}$			7.0	mA	
Supply Current (Shutdown)	$I_{IN\ (OFF)}$			1000	μA	V_{IN}=6.5V
Oscillation Frequency	f_{osc}	420	500	570	kHz	
Minimum ON Time	$t_{on\ (MIN)}$	35	75	100	nsec	V_{COMP}=0V
Maximum ON Duty	D_{MAX}	89	94	98	%	V_{COMP}=4V
ON Time 1	$t_{on\ (1)}$	300	600	800	nsec	V_{COMP}=0.7V
ON Time 2	$t_{on\ (2)}$	0.85	1.4	1.8	usec	V_{COMP}=1.2V
Current Sense Voltage	V_{CS}	95	100	105	mV	
CSP Pin Input Current	I_{CSP}	85	130	175	μA	
CSN Pin Input Current	I_{CSN}	40	65	95	μA	
CSP Pin Operation Voltage	$V_{CSP\ (OPR)}$	4.75		50	V	
COMP Pin Source Current	$I_{COMP\ (SO)}$	–95	–60	–38	μA	V_{CS}=20mV, V_{COMP}=2V
COMP Pin Sink Current	$I_{COMP\ (SI)}$	38	60	95	μA	V_{CS}=180mV, V_{COMP}=2V
OVP Threshold	$V_{CS\ (OVP)}$	200	240	280	mV	
SW Pin Leakage Current	$I_{SW\ (LEAK)}$			100	μA	
DIM Pin Voltage During LED ON	$V_{DIM\ (ON)}$	1.2	1.4	1.7	V	
DIM Pin Voltage During LED OFF	$V_{DIM\ (OFF)}$	0.75	1.0	1.2	V	
DIM Pin Hysteresis	$V_{DIM\ (HYS)}$	0.3	0.5	0.7	V	
Error Amplifier Conductance	G_M		750		μS	
SW ON Resistance	$R_{SW\ (L)}$		215		mΩ	I_{SW}=1A
SW Pin Limiting Current	$I_{SW\ (LIM)}$		3.5		A	
Thermal Shutdown	TSD		160		°C	
Thermal Shutdown Hysteresis	TSD_hys		15		°C	

■External Dimensions (HSOP8)

(Unit : mm)

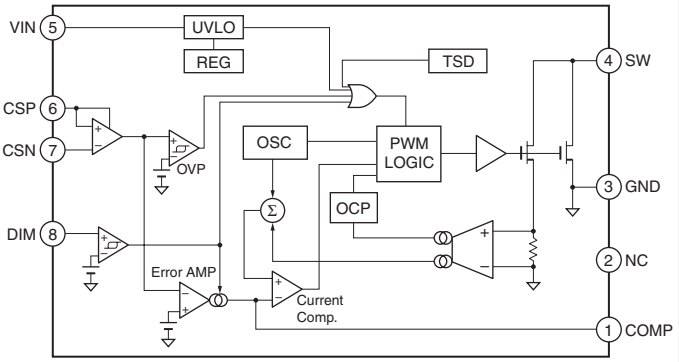


*: Exposed pad on backside connect to GND pin.

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

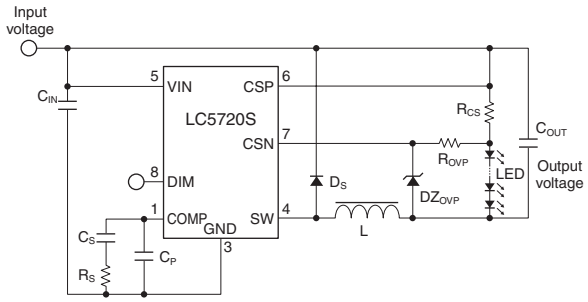
Pin Assignment
① COMP
② NC
③ GND
④ SW
⑤ V_{IN}
⑥ CSP
⑦ CSN
⑧ DIM

■Block Diagram



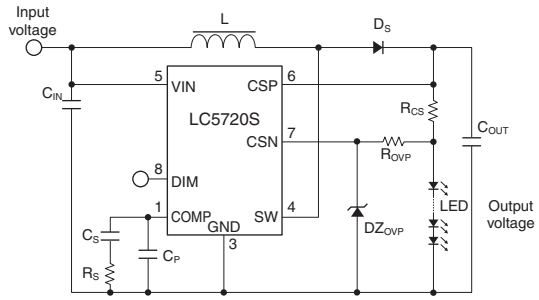
■Typical Connection Diagram

Buck Application



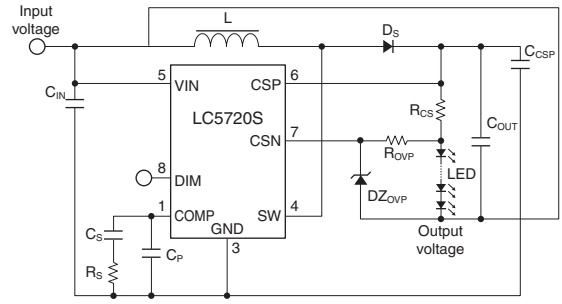
C_{IN}: 1μF/50V
C_{OUT}: 1μF/50V
C_S: 0.22μF
C_P: 0.022μF
R_S: 33kΩ
R_{CS}: 0.1Ω (When I_{LED}=1A)
D_S: SJPB-L6
L: 22μH (When V_{IN}=18V, V_{LED}=10V)

Boost Application



C_{IN}: 1μF/50V
C_{OUT}: 1μF/50V
C_S: 0.22μF
C_P: 0.022μF
R_S: 33kΩ
R_{CS}: 0.1Ω (When I_{LED}=1A)
D_S: SJPB-L6
L: 22μH (When V_{IN}=10V, V_{LED}=18V)

Buck-Boost Application



C_{IN}: 1μF/50V
C_{OUT}: 1μF/50V
C_S: 0.22μF
C_P: 0.022μF
R_S: 33kΩ
R_{CS}: 0.1Ω (When I_{LED}=1A)
D_S: SJPB-L6
L: 22μH (When V_{IN}=15V, V_{LED}=18V)

2

Transistors

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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
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/ 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/ 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/ 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)	0.686 to 0.882 N•m (7 to 9kgf•cm)
TO-3PF(FM100)	
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_{CEO}(V)	2	3	4	5	6	7	8	10	12	14	15	16	17	18	25
800		C4304 C4445		C4300		C4301									
600										C4706					
550				C4518 C4518A C5287				C3927							
400				C5130		C4546		C4138	C5071					C4140	
380					D2141										
250					D2017										
230											A1294 C3263 A2151A C6011A A2223 C6145		A1295 C3264		
200	A1668 C4382	D2016									A1493 C3857 A2151 C6011		A1494 C3858		
180	A1859A C4883A										A1386A A1492 A1673 C3519A C3856 C4388		A1216 C2922		
160											A1215 A1386 C2921 C3519				
150	A1667 A1859 C4381 C4883						B1559 B1587 D2389 D2438	A1186 B1560 B1588 C2837 D2390 D2439	B1570 D2401	A1303 A1860 C3284 C4886	B1647 B1649 D2560 D2562		B1648 D2561		
140								A1695 A1909 C4468 C5101							
120			D2015		D1785 D2045	C3835 C4153	A1694 A1908 C4467 C5100	B1259 D2081				B1382 B1420 D2082			B1383 D2083
110					D2641 D2642 D2643										
100					B1258										
80		C3852A	A1488A C3851A D2014		A1693 A1725 A1907 C4466 C4511 C5099										
60		C3852	A1488 B1257 C3851 D1796						A1568 B1351						
50		C4495						C4024	A1567 A1746		C4131				

Collector Current I_C(A)

Audio Transistors

■Output Transistors

Pc (W)	Ic (A)	V_{CEO} (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 (**L**inear **A**mplified **P**ower **T**ransistor): Multi-Emitter Transistor for High-Frequency

■Output Transistors with Temperature Compensating Function (Refer to our Web site for applications)

Part Number		Pc (W)	I_C (A)	V_{CEO} (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)	V_{CEO} (V)	Ic (A)	h_{FE} (min)	f_T (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 h_{FE} ranks.

Switching Transistors

■DC-DC Converter

Part Number	V_{CBO} (V)	V_{CEO} (V)	I_C (A)	P_C (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_{CBO} (V)	V_{CEO} (V)	I_C (A)	P_C (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_{CBO} (V)	V_{CEO} (V)	I_C (A)	P_C (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				I_{CBO}		h_{FE}			
		V_{CBO}	V_{CEO}	I_C	P_C		Conditions			Conditions	
							V_{CB}			V_{CE}	I_C
		(V)	(V)	(A)	(W)	(μA)	(V)	min	max	(V)	(A)
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
	$V_{CE(sat)}$	$V_{BE(sat)}$	Conditions		fT	Conditions		Switching Time			Cob			
	(V)	(V)	I_C	I_B	MHz	V_{CE}	I_E	t_{on} (μS)	t_{stg} (μS)	t_f (μS)	(pF)			(g)
	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				I_{CBO}		h_{FE}			
		V_{CBO}	V_{CEO}	Ic	Pc		Conditions			Conditions	
							V_{CB}			V_{CE}	Ic
		(V)	(V)	(A)	(W)	(μA)	(V)	min	max	(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
	$V_{CE\ (sat)}$	$V_{BE\ (sat)}$	Conditions		fT	Conditions		Switching Time			Cob			
								t_{on}	t_{stg}	t_f				
	(V)	(V)	I_C	I_B	MHz	V_{CE}	I_E	(μS)	(μS)	(μS)	(pF)			(g)
	max	max	(A)	(A)		(V)	(A)							
	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				I_{CBO}		h_{FE}			
		V_{CBO}	V_{CEO}	I_C	P_C		Conditions			Conditions	
							V_{CB}			V_{CE}	I_C
		(V)	(V)	(A)	(W)	(μA)	(V)	min	max	(V)	(A)
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
	$V_{CE(sat)}$	$V_{BE(sat)}$	Conditions		fT	Conditions		Switching Time			Cob			
	(V)	(V)	I_C	I_B	MHz	V_{CE}	I_E	t_{on} (μS)	t_{stg} (μS)	t_f (μS)	(pF)			(g)
	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_{DSS}

V_{DSS} (V)	R_{DS} (ON) (Ω) max	I_D (A)	P_D (W)	Part Number	Package
40	3.6m	±100	100	SKH04100	TO263 (Surface-mount)
	3.8m	±100	100	EKH04100	TO220
	3.8m	±70	40	FKH0470	TO220F-A
	6.0m	±70	80	2SK3800	TO220S (Surface-mount)
	6.0m	±70	100	2SK3801	TO3P (MT100)
	9m	±60	60	FKV460S	TO220S (Surface-mount)
50	10m	±75	40	FKV575	TO220F (FM20)
	15m	±50	35	FKV550N	TO220F (FM20)
	15m	±50	85	EKV550	TO220
60	4.8m	±100	100	SKH06100	TO263 (Surface-mount)
	5.0m	±100	100	EKH06100	TO220
	5.0m	±60	40	FKH0660	TO220F-A
	6.0m	±70	90	2SK3710	TO220S (Surface-mount)
	6.0m	±70	130	2SK3711	TO3P (MT100)
	14m	±60	60	FKV660S	TO220S (Surface-mount)
	28m	±30	40	2SK2420	TO220F (FM20)
100	11.3m	±70	100	SKH1070	TO263 (Surface-mount)
	11.5m	±70	100	EKH1070	TO220
	11.5m	±40	40	FKH1040	TO220F-A
	52m	±20	55	EKG1020	TO220
	52m	±20	40	FKG1020	TO220F-A
200	53m	±45	40	FKP202	TO220F (FM20)
	53m	±45	95	SKP202	TO263 (Surface-mount)
	0.175	±18	35	2SK3003	TO220F (FM20)
250	43m	±50	85	FKP250A	TO3PF (FM100)
	75m	±25	40	FKP252	TO220F (FM20)
	95m	±20	40	FKP253	TO220F (FM20)
	95m	±20	90	SKP253	TO263 (Surface-mount)
	0.25	±18	35	2SK3004	TO220F (FM20)
280	53m	±40	85	FKP280A	TO3PF (FM100)
300	65m	±30	85	FKP300A	TO3PF (FM100)
330	63m	±30	85	FKP330C	TO3PF (FM100)
450	1.1	±7	35	2SK2701A	TO220F (FM20)
	2.8	±3	30	2SK2803	TO220F (FM20)
500	0.27	±20	150	MKS5020	TO3P
	0.4	±15	150	MKS5015	TO3P
	1.5	±5	30	2SK3199	TO220F (FM20)
600	3.8	±2	30	2SK2848	TO220F (FM20)
900	5.0	±3	30	2SK2943	TO220F (FM20)

Specifications List by Part Number

Part Number	Absolute Maximum Ratings						I_{GSS}		I_{DSS}			V_{TH}			
	V_{DSS}	V_{GSS}	I_D	$I_{D\ (pulse)}$	P_D	E_{AS}		Conditions			Conditions			Conditions	
	(V)	(V)	(A)	(A)	(W)	(mJ)	(nA)	V_{GS}	(μA)		V_{DS}	(V)		V_{DS}	I_D
							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
$R_{e\ (yfs)}$				C_{iss}	C_{rss}			$R_{DS\ (ON)}$									
		Conditions				Conditions				Conditions				Conditions			
(S)		V_{DS}	I_D	(pF)	(pF)	V_{GS}	V_{DS}	(Ω)		V_{GS}	I_D	(Ω)		V_{GS}	I_D		(g)
min	typ	(V)	(A)	typ	typ	(V)	(V)	typ	max	(V)	(A)	typ	max	(V)	(A)		
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} (V)	I_C (A)	P_C (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_{CES}	V_{GE}	I_C	$I_{C(pulse)}$	P_C (Ta=25°C)	I_{GES}		I_{CES}		$V_{GE(th)}$				$V_{CE(sat)}$				Cies	Coes	Cres		
							Conditions		Conditions			Conditions				Conditions						Conditions	
	(V)	(V)	(A)	(A)	(W)	(nA)	V_{GE}	(μA)	V_{CE}	(V)		I_C	V_{CE}	(V)		I_C	V_{GE}	(pF)	(pF)	(pF)	V_{CE}	V_{GE}
						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	
	$t_{d(on)}$	tr	$t_{d(off)}$	tf	Conditions			Qg	Qge	Qgc	Conditions			VF		Conditions	trr	Conditions				(g)	
	(ns)	(ns)	(ns)	(ns)	I_C	V_{CE}		(nC)	(nC)	(nC)	I_C	V_{CE}	V_{GE}	(V)		I_F	(μs)	I_F	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

Specifications List by Part Number

Part Number	Category	Circuit Count	V_{CEO} · V_{DSS} · V_{CES} (V)	IC · ID (A)	hFE (min)	$R_{DS(ON)}$ max(Ω)	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	±100	±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	±60	±4		0.55	SIP12 with Fin (SLA12Pin)	6.0
SLA5060	For 3-phase motor driver	6	±60	±6		0.22	SIP12 with Fin (SLA12Pin)	6.0
SLA5061	For 3-phase motor driver	6	±60	±10		0.14	SIP12 with Fin (SLA12Pin)	6.0
SLA5064	For 3-phase motor driver	6	±60	±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	±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	±8		0.07	SIP15 with Fin (SLA15Pin)	6.0
SLA5222	For Partial switching PFC	1+Di×4	600	30		1.3Vtyp(V_{CE}(sat))	SIP12 with Fin (SLA12Pin)	6.0
SLA5227	For Partial switching PFC	1+Di×4	600	30		1.3Vtyp(V_{CE}(sat))	SIP12 with Fin (SLA12Pin)	6.0
SLA6012	For 3-phase motor driver	6	±60	±4	2000		SIP12 with Fin (SLA12Pin)	6.0
SLA6020	For 3-phase motor driver	6	±100	±5	2000		SIP12 with Fin (SLA12Pin)	6.0
SLA6022	For 3-phase motor driver	6	±80	±5	2000		SIP12 with Fin (SLA12Pin)	6.0
SLA6023	For 3-phase motor driver	6	±60	±6	2000		SIP12 with Fin (SLA12Pin)	6.0
SLA6024	For 3-phase motor driver	6	±60	±8	2000		SIP12 with Fin (SLA12Pin)	6.0
SLA6026	For 3-phase motor driver	6	±60	±10	2000		SIP12 with Fin (SLA12Pin)	6.0

Part Number	Category	Circuit Count	V_{CEO} · V_{DSS} · V_{CES} (V)	IC · ID (A)	hFE (min)	$R_{DS\ (ON)}$ max(Ω)	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	±5		1.4	SIP12 (SMA12Pin)	4.0
SMA5125	For 3-phase motor driver	6	±60	±10		0.14	SIP12 (SMA12Pin)	4.0
SMA5127	For 3-phase motor driver	6	±60	±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	±60	±4	2000		SIP12 (SMA12Pin)	4.0
SMA6080	For 3-phase motor driver	6	±60	±2	2000		SIP12 (SMA12Pin)	4.0
SMA6511	For driving stepping motor with two supplies	5	100±15/–60	1.5/–3	2000		SIP12 (SMA12Pin)	4.0
STA301A	For sink driver	3	60±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±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±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±5	3	500		SIP10 (STA10Pin)	2.6
STA421A	For source driver	4	–60	–3	40		SIP10 (STA10Pin)	2.6
STA431A	H bridge	4	±60	±3	40		SIP10 (STA10Pin)	2.6
STA434A	H bridge	4	±60	±4	1000		SIP10 (STA10Pin)	2.6
STA457C	H bridge	4	±60	±4	2000		SIP10 (STA10Pin)	2.6
STA460C	For sink driver	2	60±10	6	700		SIP10 (STA10Pin)	2.6
STA471A	For sink driver	4	60±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±15	2	2000		SIP10 (STA10Pin)	2.6
STA481A	For sink driver	4	60±10	1	2000		SIP10 (STA10Pin)	2.6
STA485A	For sink driver	4	100±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_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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)

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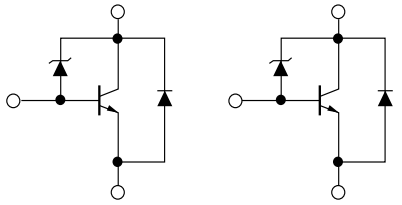

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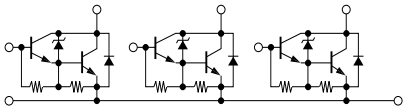

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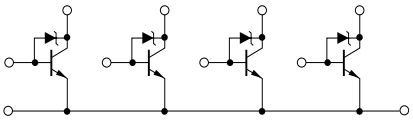

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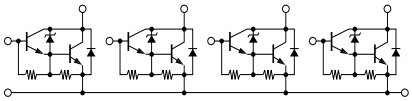

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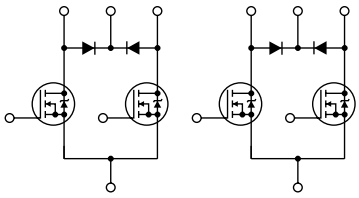

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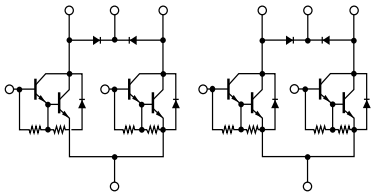

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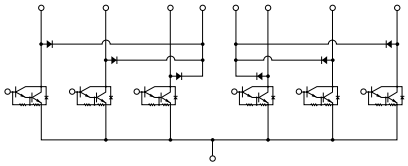

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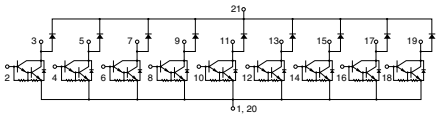

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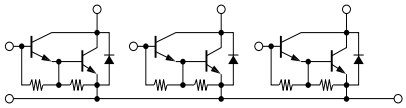

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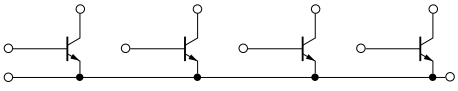

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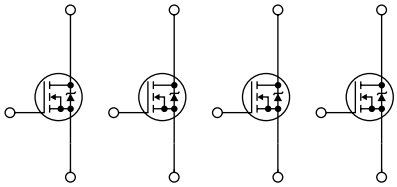

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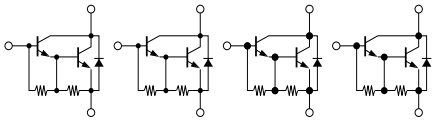

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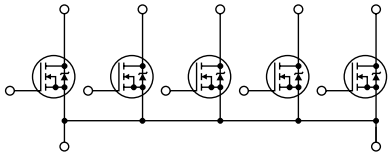

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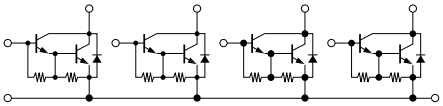

Specifications List by Application — Source Driver Arrays

●Built-in Flywheel Diodes

Part Number	Circuit Count	V_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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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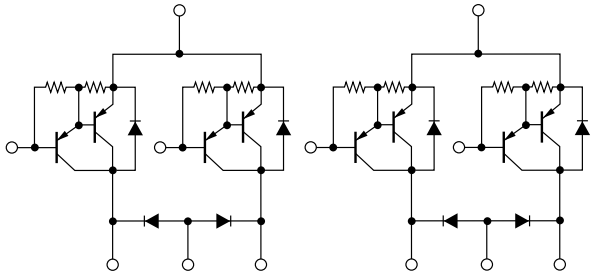

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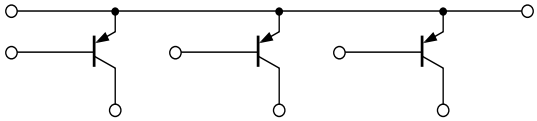

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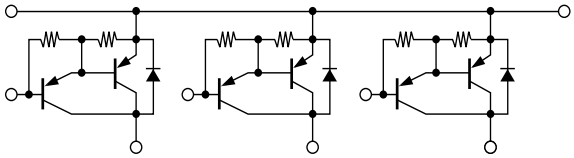

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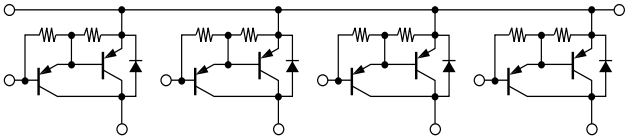

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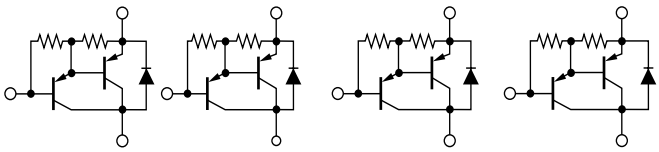

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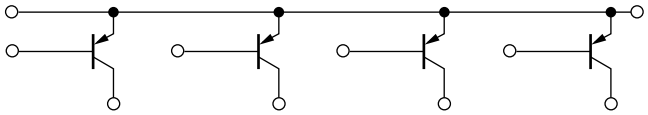

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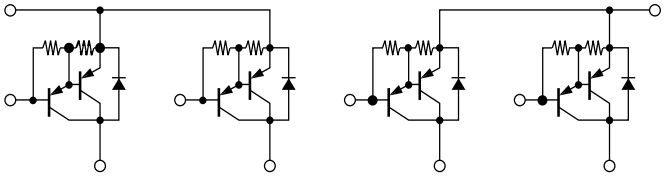

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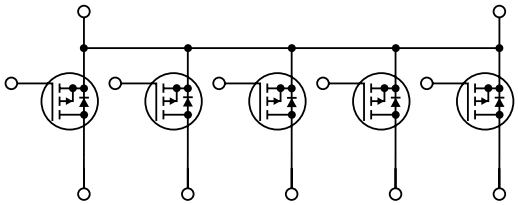


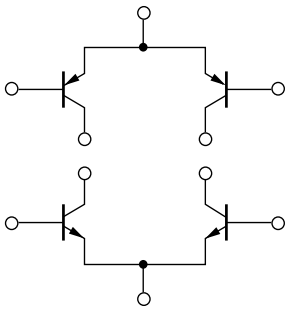
Specifications List by Application — Motor Driver Arrays

●H Bridge

Part Number	Circuit Count	V_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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)

①



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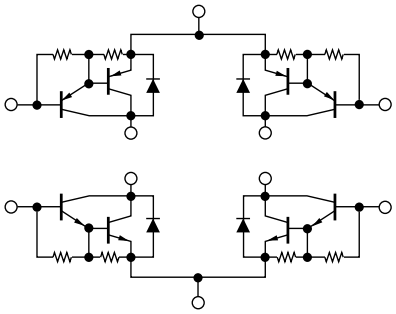

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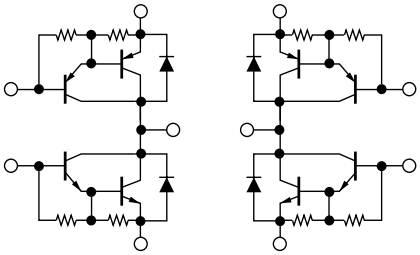


●For 3-Phase Motor Drivers

Part Number	Circuit Count	V_{CEO} (V)/ V_{DSS} (V)/ V_{CES} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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

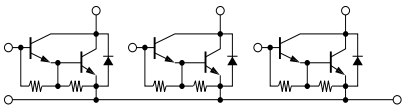
Part Number	Circuit Count	V_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$max (Ω)	Equivalent Circuit	Package
SMA6511	5	100±15/–60	1.5/–3	2000		16	SIP12 (SMA12Pin)

●For 5-Phase Motor Drive

Part Number	Circuit Count	V_{CEO} (V)/ V_{DSS} (V)	I_C (A)/ I_D (A)	h_{FE} (min)	$R_{DS(ON)}$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)

④



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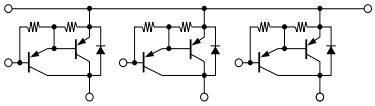

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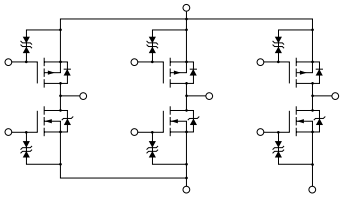

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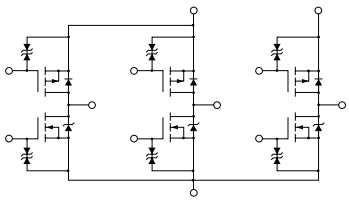

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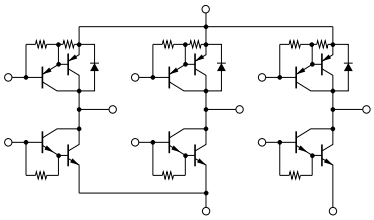

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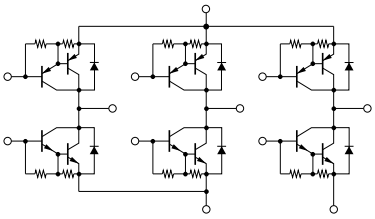

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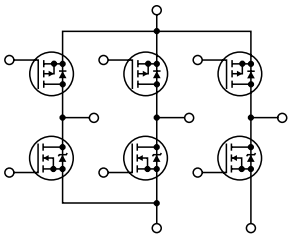

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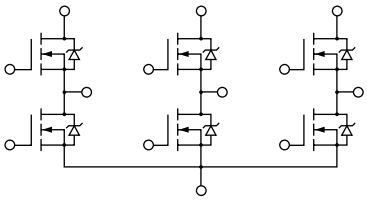

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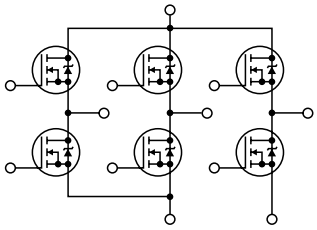

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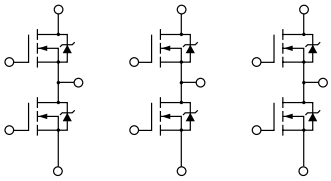

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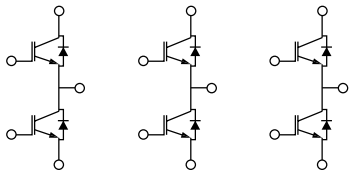

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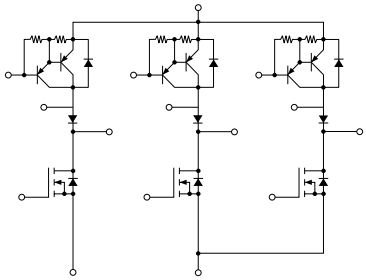

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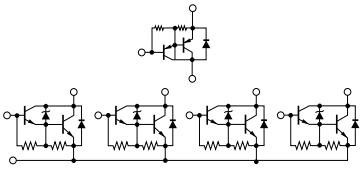

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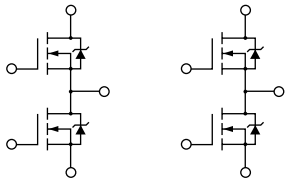


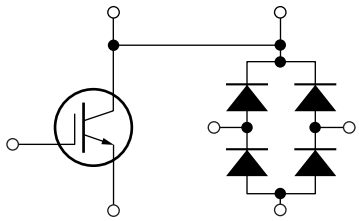
Specifications List by Application — Partial switching PFC Arrays

●For Partial switching PFC

Part Number	Circuit Count	V_{CES}(V)	I_C(A)	V_{CE}(sat)(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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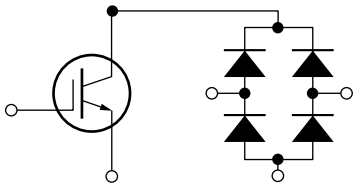
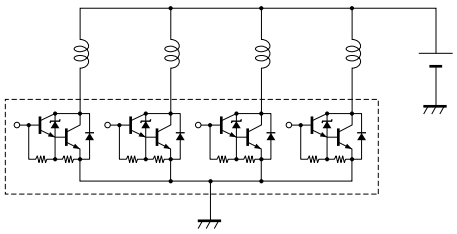
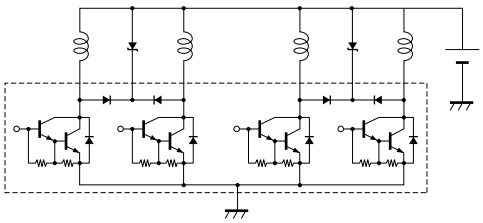
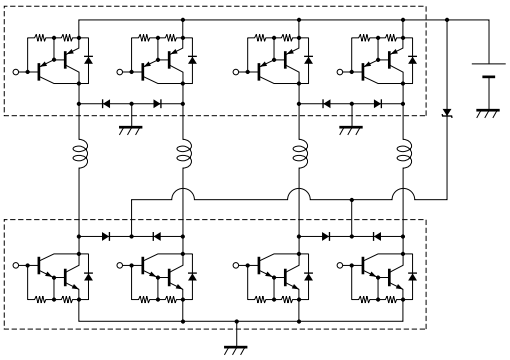
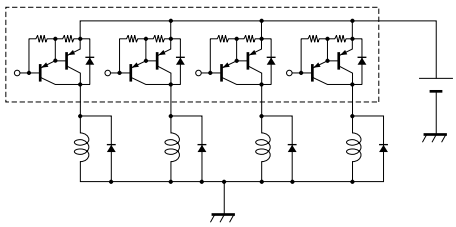
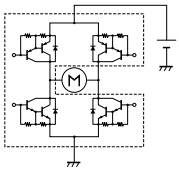
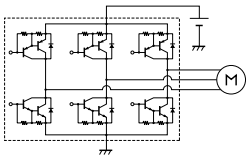
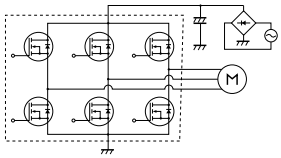
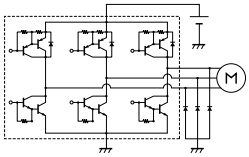
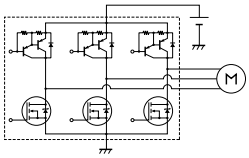
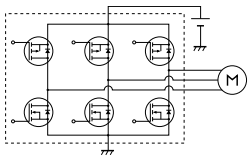
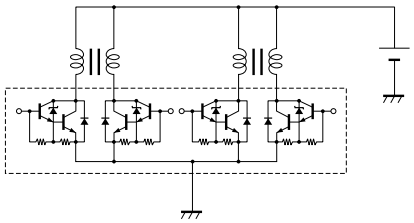
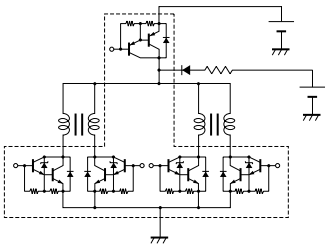
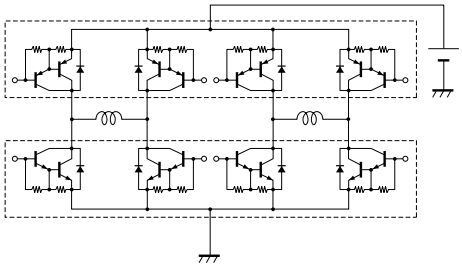
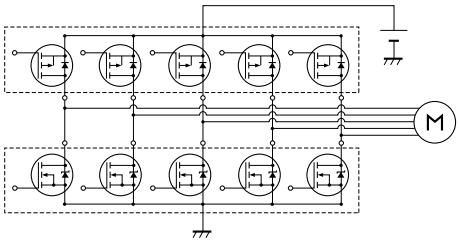


Part Number List by Application

Applications	Typical Connection Diagram	Part Number		
		Transistors		MOS FETs
		Darlington	Single	
●Solenoid ●Relay		STA301A STA401A STA406A STA471A STA475A STA481A STA485A	STA460C STA413A	
		SLA4031 SLA4041 SLA4060 SMA4032 SMA4033 SMA4036		SMA5106
		SLA4071 SMA4021		
		STA302A STA402A STA408A STA472A SLA4070 SMA4020	STA322A STA421A	

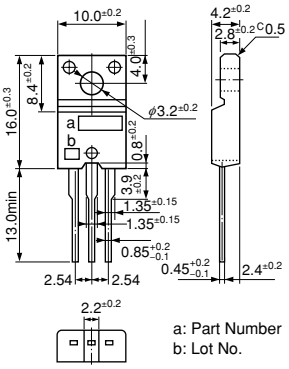
Applications		Typical Connection Diagram	Part Number		
			Transistors		MOS FETs
			Darlington	Single	
●DC Motor	Normal/Reverse Rotation Control		STA434A STA457C SLA4390	STA431A STA474A	
●3-Phase DC Brushless Motor	AC100V Direct Driver		STA302A+STA303A SMA6010 SLA6020 SMA6080		
	AC200V Direct Driver				SLA5075 SMA5112 SMA5117 SMA5118 SMA5131 SMA5132 SMA5133
	PWM Control		SLA6012 SLA6022 SLA6023 SLA6024 SLA6026		
			SMA5130		
					SLA5059 SLA5060 SLA5061 SLA5064 SMA5125 SMA5127

Applications		Typical Connection Diagram	Part Number		
			Transistors		MOS FETs
			Darlington	Single	
●Stepping Motor	Constant Voltage Driver		STA401A STA406A STA435A STA471A STA475A STA481A STA485A SLA4010	STA460C STA413A	
	Two Supplies Driver		SMA6511		
	Bipolar Driver		STA473A STA472A STA408A STA404A STA403A STA402A SMA4030 SMA4020 SLA4070 SLA4060 SLA4030	STA421A STA412A	

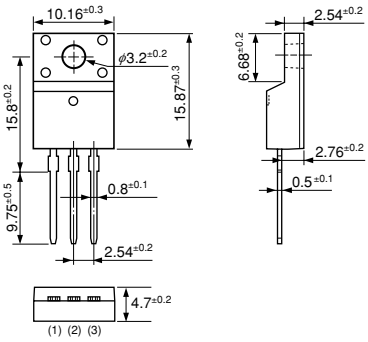
Applications	Typical Connection Diagram	Part Number	
		N-CH	P-CH
●5-Phase Motor		SLA5065+SLA5068 SLA5073+SLA5074 SLA5085	SLA5086

Package Type (Dimensions)

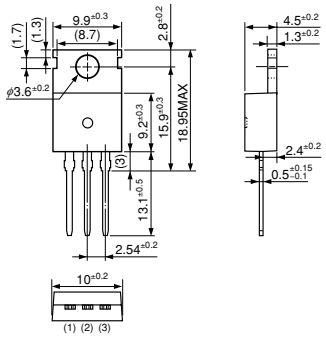
• TO-220F (FM20)



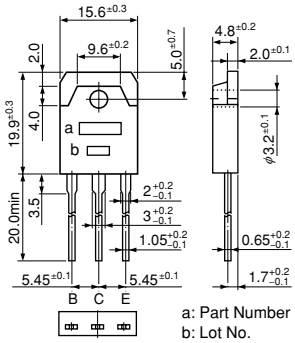
• TO-220F-A



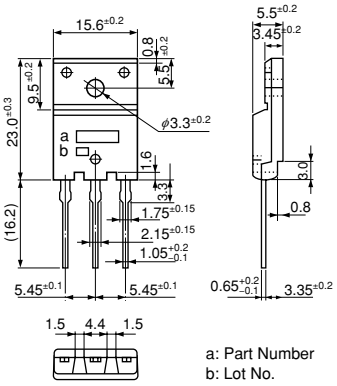
• TO-220 (MT-25)



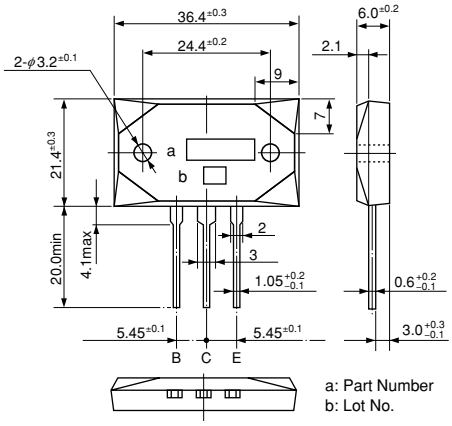
• TO-3P (MT-100)



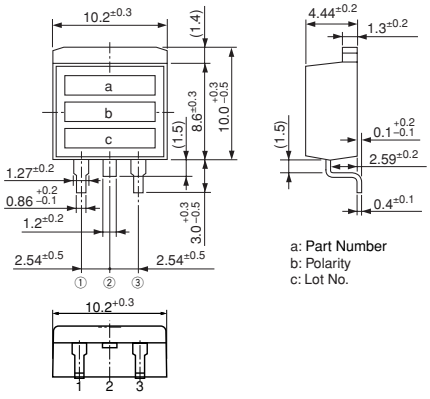
• TO-3PF (FM100)



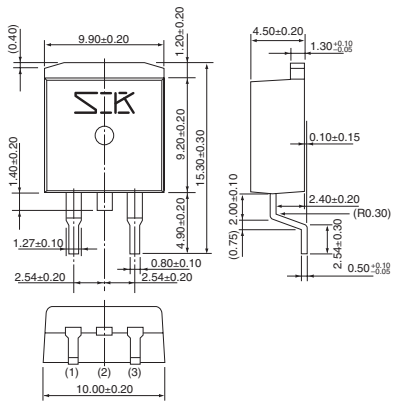
• MT-200



• TO-220S

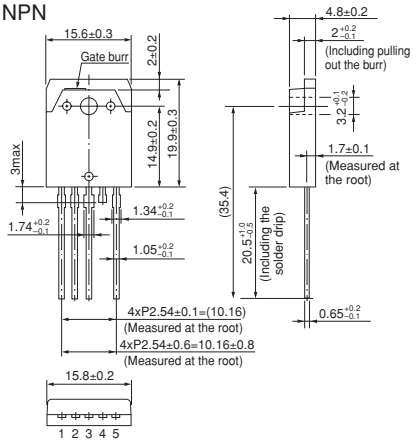


• TO-263

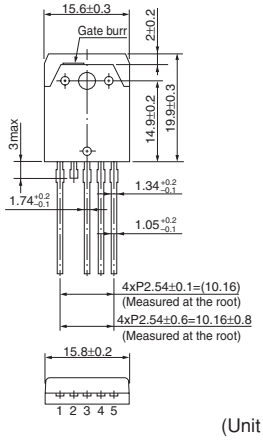


• TO3P-5Pin

NPN

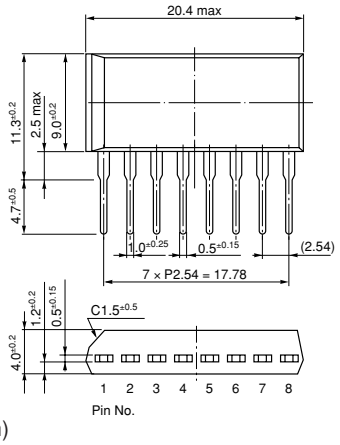


PNP

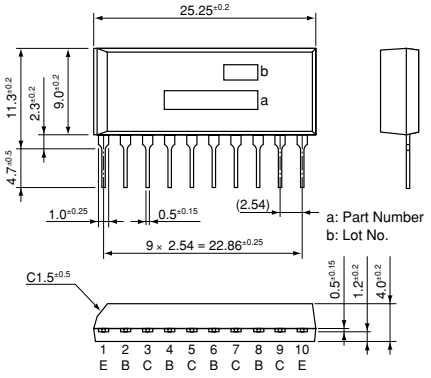


(Unit : mm)

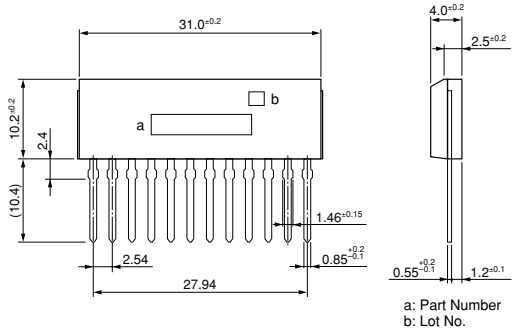
• SIP 8 (STA8Pin)



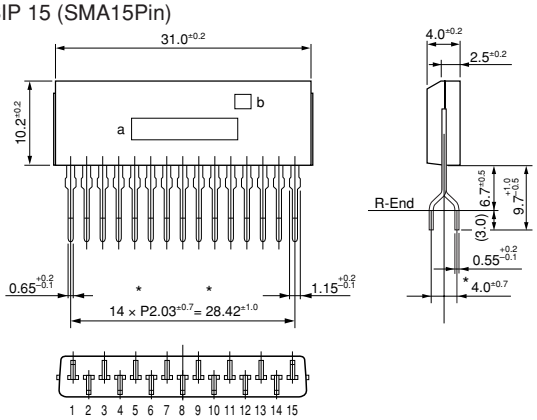
• SIP 10 (STA10Pin)



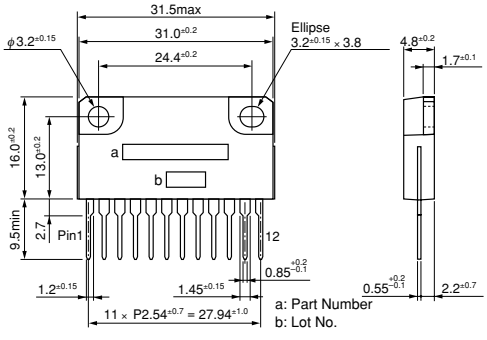
• SIP 12 (SMA12Pin)



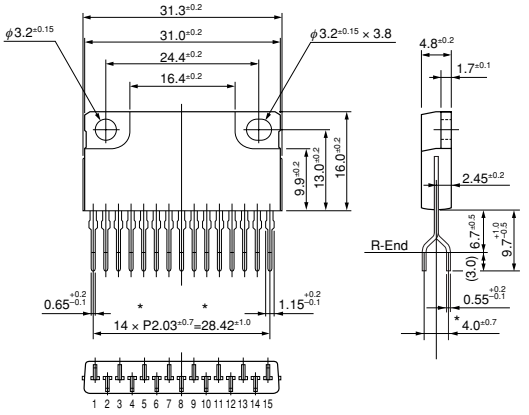
• SIP 15 (SMA15Pin)



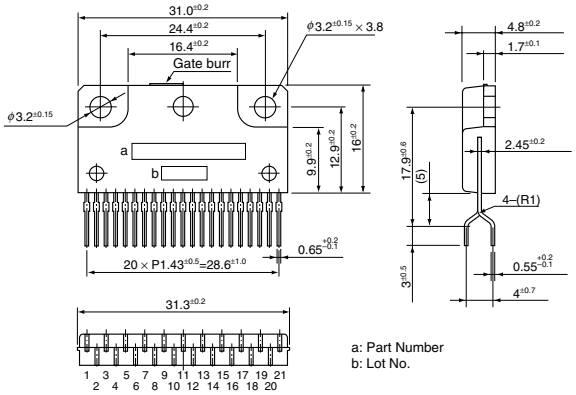
• SIP 12 with Fin (SLA12Pin)



• SIP 15 with Fin (SLA15Pin)



• SIP 15 with Fin (SLA15Pin)



(Unit:mm)

3

Thyristors

Ordering Information & Standard Packing Quantities 192

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3-1 Thyristors 194

3-2 Triacs 196

Package Type (Dimensions) 198

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)	0.686 to 0.882 N•m (7 to 9kgf•cm)
TO3PF (FM100)	

* 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.

Thyristors

Part Number	Absolute Maximum Ratings													
	V_{RSM} V_{DSM} (V)	V_{RRM} V_{DRM} (V)	$I_{T(AV)}$ (A)	Conditions Tc (°C)	$I_{T(RMS)}$ (50Hz) (A)	I_{TSM} 50Hz Single Half Sine Wave, Default T_j=125°C (A)	P_{GM} (W)	$P_{G(AV)}$ (W)	V_{RGM} (V)	I_{FGM} (A)	T_j (°C)	T_{stg} (°C)	I_{RRM} I_{DRM} (mA) max	Conditions T_j (°C)
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_{DRM} (V)	I_{TRM}*1 (A)	di/dt*1 (A/μs)	P_{GM} (W)	$P_{G(AV)}$ (W)	V_{RGM} (V)	I_{FGM}*2 (A)	I_{FRM} (A)	T_j (°C)	T_{stg} (°C)	I_{DRM} (mA) max	Conditions T_j (°C)	V_{TM} (V) max	Conditions T_c (°C)	Conditions I_{TM} (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_C≤100°C, V_D≤430V, W_p≤1.0μs, I_G≥70mA, dig/dt≥0.5A/μs, 100kcycles
*2: T_C≤100°C, V_D≤430V, W_p≤1.0μs, 100kcycles

Electrical Characteristics																	Package	Mass
	V_{TM}	Conditions		V_{GT}		I_{GT}		Conditions	V_{GD}			dv/dt			I_H	R_{th}		
		T_c	I_{TM}					Tc		T_j	Conditions V_D		Conditions T_j	V_D				
	(V)	(°C)	(A)	(V)		(mA)		(°C)	(V)	(°C)	(V)	(V/μs)	(°C)	(V)	(mA)	(°C/W)		g
	max			typ	max	typ	max		min			t_{yp}			typ	max		
	1.4	25	10		1.5	0.03	0.2	25	0.1	125	1/2V_{DRM}	20	125	1/2V_{DRM}	4.0	4.0	TO220F	2.0
	1.4	25	10		1.5	0.03	0.2	25	0.1	125	1/2V_{DRM}	20	125	1/2V_{DRM}	4.0	4.0	TO220F	2.0
	1.5	25	10	—	1.0	7.0	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	15	4.1	TO220F	2.0
	1.5	25	15	—	1.0	7.0	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	15	3.8	TO220F	2.0
	1.4	25	20	—	1.0	7.0	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	20	3.5	TO220F	2.0
	1.35	25	20	—	1.0	7.0	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	20	3.4	TO220F	2.0
	1.5	25	10	—	1.0	—	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	15	4.1	TO220F	2.0
	1.5	25	15	—	1.0	—	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	15	3.8	TO220F	2.0
	1.5	25	20	—	1.0	—	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	20	3.5	TO220F	2.0
	1.35	25	20	—	1.0	—	15	25	0.2	125	1/2V_{DRM}	300	125	1/2V_{DRM}	20	3.4	TO220F	2.0

Electrical Characteristics														Package	Mass
	V_{GT}		I_{GT}		Conditions	V_{GD}	Conditions		I_H	Rth	V_F	Conditions			
					Tc		Tj	V_D				IF			
	(V)		(mA)		(°C)	(V)	(°C)	(V)	(mA)	(°C/W)	(V)	(A)			(g)
	typ	max	typ	max		min			typ	max	max				
		1.5		30	25	0.1	125	480	12	4.0	1.4	10		TO-220S	1.5

Triacs

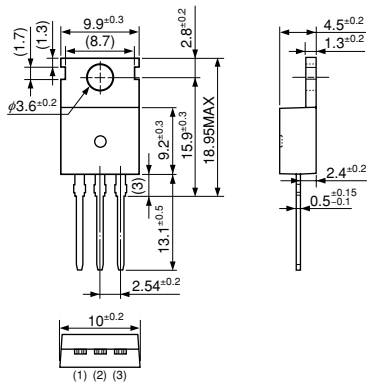
Part Number	Absolute Maximum Ratings																
	V_{DRM} (V)	$I_{T\ (RMS)}$ (A)	Conditions T_c (°C)	I_{TSM} (A)	Conditions	P_{GM} (W)	$P_{G\ (AV)}$ (W)	I_{GM} (A)	T_j (°C)	T_{stg} (°C)	I_{DRM1} (mA) max	Conditions	I_{DRM2} (mA) max	Conditions	V_{TM} (V) max	Conditions I_{TM} (A)	
TMA34S-L	400	3	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_j = 25°C, unless otherwise specified)

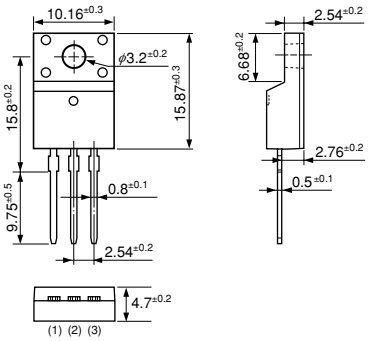
V_{GT}					I_{GT}					V_{GD}			(dv/dt) c			$R_{th\ (j-c)}$	Package	Mass
Mode I (T2+, G+) (V) max	Mode II (T2+, G–) (V) max	Mode III (T2–, G–) (V) max	Conditions V_D (V)	Conditions R_L (Ω)	Mode I (T2+, G+) (mA) max	Mode II (T2+, G–) (mA) max	Mode III (T2–, G–) (mA) max	Conditions V_D (V)	Conditions R_L (Ω)		Conditions T_j (°C)	Conditions V_O (V)	(V/us) min	Conditions (dv/dt) c (–A/ms)	Conditions T_j (°C)	(°C/W) max		(g)
1.5	1.5	1.5	12	20	20	20	20	12	20	0.2	125	1/2V_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	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_{DRM}	10	12	125	1.6	TO3PF	6.5

Package Type (Dimensions)

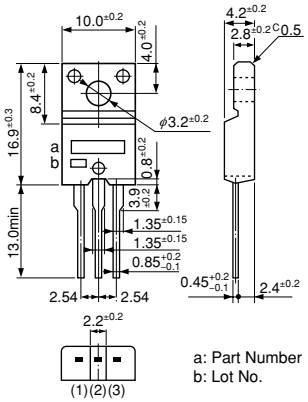
• TO-220



• TO-220F-A



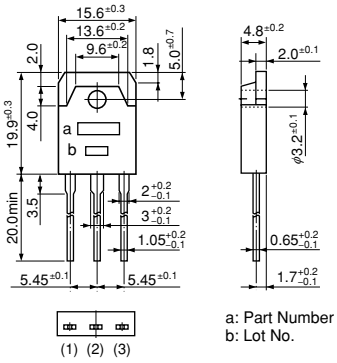
• TO-220F



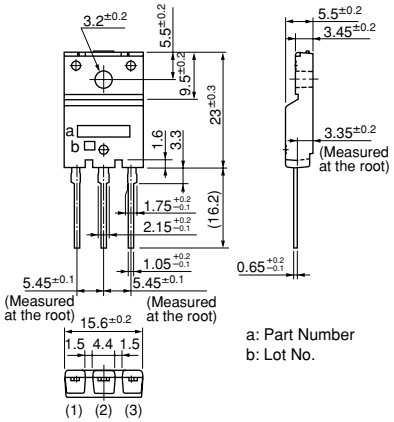
Pin No.	
(1)	Cathode (T_1)
(2)	Anode (T_2)
(3)	Gate (G)

( ): Triacs

• TO-3P

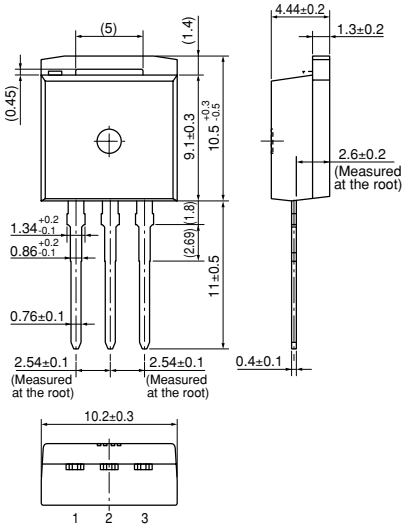


• TO-3PF



(1) Terminal 1 (T_1)
(2) Terminal 2 (T_2)
(3) Gate (G)

• TO-220S Straight



(Unit: mm)

4

Diodes

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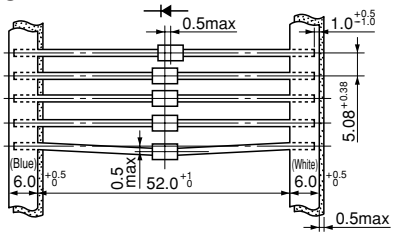
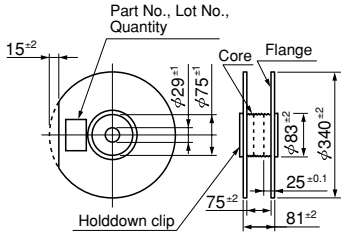
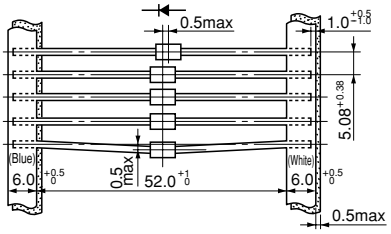
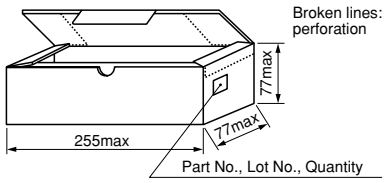
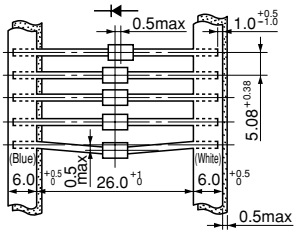
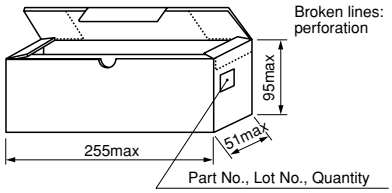
Ordering Information

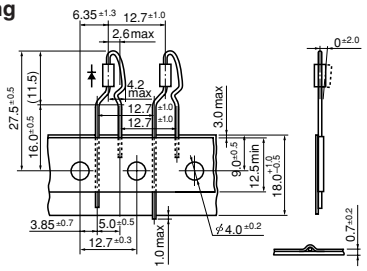
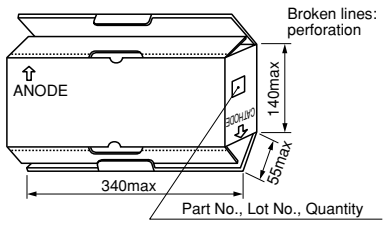
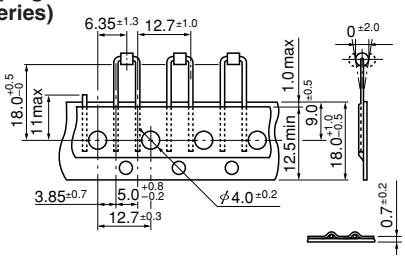
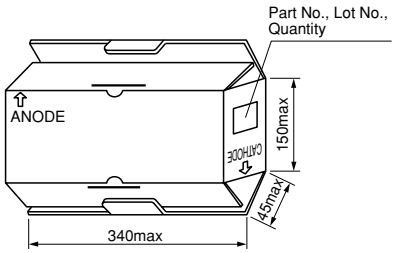
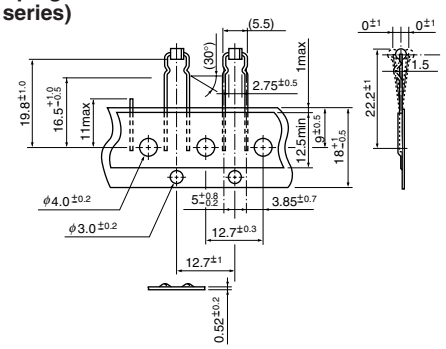
All products listed must be ordered in standard packing increments.

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	–				

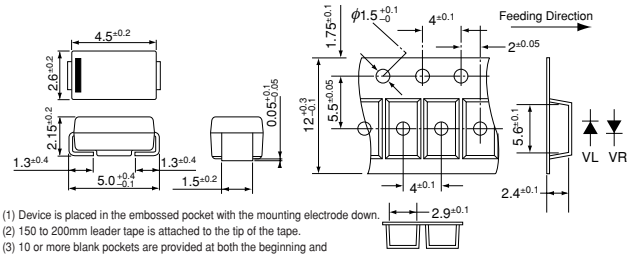
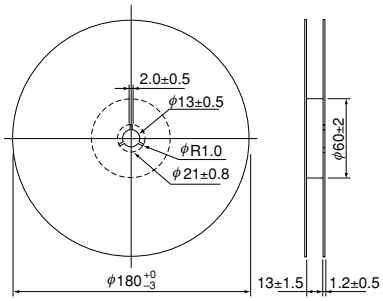
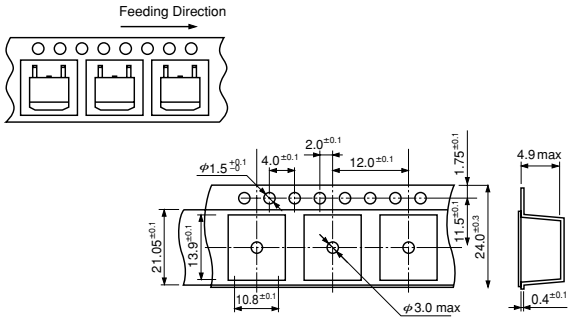
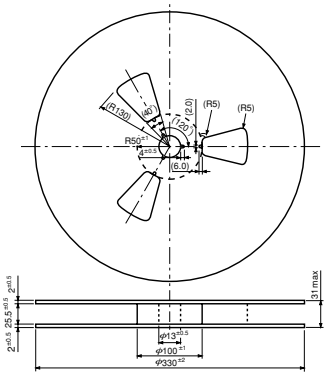
Series Name/Product Name	Package	Standard Packing Quantities					
		Bulk	Taping				
SJPA-xx	SJP	–	V:1800(Reel)				
SJPB-xx	SJP	–	V:1800(Reel)				
SJPE-xx	SJP	–	V:1800(Reel)				
SJPJ-xx	SJP	–	V:1800(Reel)				
SJPL-xx	SJP	–	V:1800(Reel)				
SJPM-xx	SJP	–	V:1800(Reel)				
SJPW-xx	SJP	–	V:1800(Reel)				
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

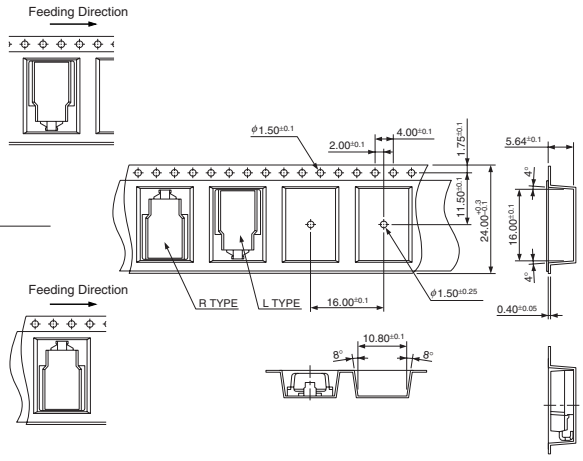
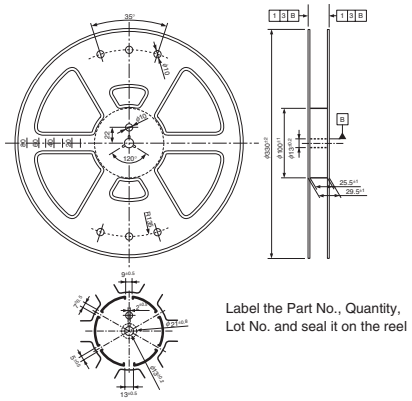
Taping Name	Taping Type, Dimensions (mm)	Packing Dimensions (mm) and Packing Note	Quantity
V To specify the taping type, add a suffix [V]	**Axial taping** 	**Reel** 	5,000 pcs/reel (2.7φ body 2.4φ body) 3,000 pcs/reel (4φ body)
V1 To specify the taping type, add a suffix [V1]	**Axial taping** 	**Ammunition (Ammo) pack** 	2,000 pcs/box (2.7φ body) 3,000 pcs/box (2.4φ body) 1,000 pcs/box (4φ body)
V0 To specify the taping type, add a suffix [V0]	**Axial taping** 	**Ammunition (Ammo) pack** 	2,000 pcs/box (2.7φ body) 3,000 pcs/box (2.4φ body)

Taping Name	Taping Type, Dimensions (mm)	Packing Dimensions (mm) and Packing Note	Quantity
W To specify the taping type, add a suffix [W]	**Radial taping** 	**Ammunition (Ammo) pack** 	4,000 pcs/box (2.7φ body 0.6φ lead only)
WS To specify the taping type, add a suffix [WS]	**Radial taping (for A0 series)** 	**Ammunition (Ammo) pack** 	2,500 pcs/box (2.4φ body)
WK To specify the taping type, add a suffix [WK]	**Radial taping (for A0 series)** 		

Surface-Mount Taping Specifications

Taping Name	Taping Type, Dimensions (mm)	Packing Dimensions (mm) and Packing Note	Quantity
SJP **VL / VR** To specify the taping type, add a suffix [VL] or [VR]	**Emboss Taping**  (1) Device is placed in the embossed pocket with the mounting electrode down. (2) 150 to 200mm leader tape is attached to the tip of the tape. (3) 10 or more blank pockets are provided at both the beginning and the end of the tape.	**Reel** 	1800 pcs/reel
TO-220 **VR** To specify the taping type, add a suffix [VR]			1000 pcs/reel

Power Zener Surface-Mount Taping Specifications

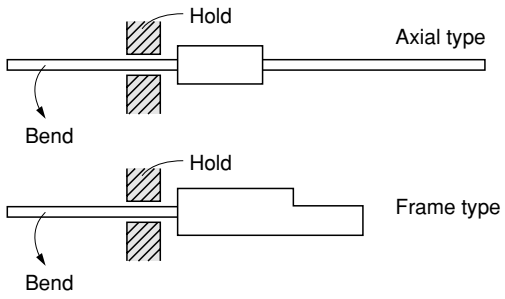
Taping Name	Taping Type, Dimensions (mm)	Packing Dimensions (mm) and Packing Note	Quantity
VL To specify the taping type, add a suffix [VL]		 Label the Part No., Quantity, Lot No. and seal it on the reel	750 pcs/reel
VR To specify the taping type, add a suffix [VR]			750 pcs/reel

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 ϕ0.125mm).

(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 IFSM 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 IF (AV). If the peak value increases. the diode's forward loss also increases. In this case, check the temperature rise.

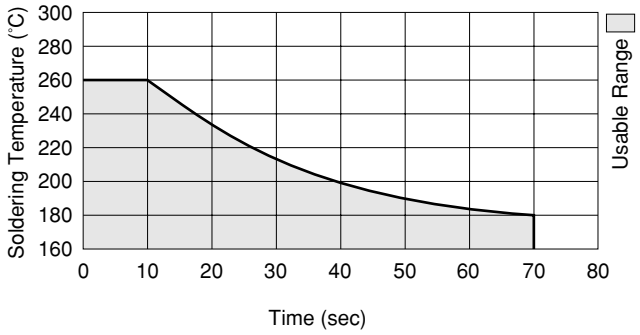
● Carefully study the mounting method when the usage environment is prone to creeping discharge.

■ Surface-Mount Diodes

(Part Number Type: SJP)

Soldering (common to flow and reflow)

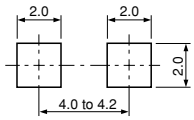
i) Use rosin based flux. Never use acidic fluxes.
ii) To prevent a large thermal stress, preheat within 1 to 2 minutes at 150°C and solder within the usable range shown below.



iii) For using a soldering iron, use the following references:
Temperature of soldering iron tip:
Lower than 300ºC
(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

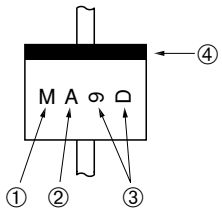
(Unit : mm)



Contact us if there is any unclear point.

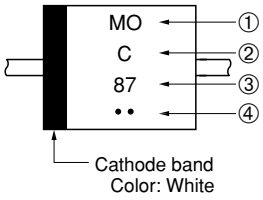
Marking Guide

1 Axial (A0)



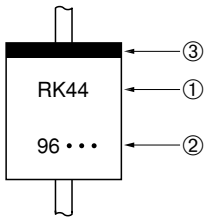
①Part Number (abbreviation)
The AM01 is indicated as "M."
②Class
Z: 200V None: 400V A: 600V
B: 800V C: 1000V
③Manufacturing date
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
④Cathode band: Continuous band
Color of the band: White(Yellow for AU02 series)

2 Axial (E0, E1)



①Part Number (abbreviation)
EM01, EM2, EM1 are indicated as MO, M2 and M1, respectively.
②Class
Z: 200V None: 400V A: 600V
B: 800V C: 1000V F: 1500V
But EU02A is indicated as A2 and EU2YX as Y.
③Manufacturing date
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
④Manufacturing period
• First 10 days of month
•• Middle 10 days of month
••• Last 10 days of month

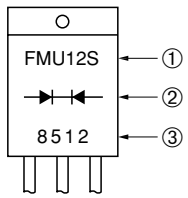
3 Axial (R1, R2, R3, R4)



①Part Number: 2 set marking
②Manufacturing 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
③Cathode band

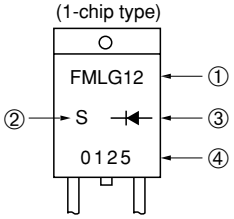
Color of the band:
- White: For Power Supply and SBD
- Yellow: For Medium speed
- Red: For Fast and ultrafast

4 TO-220F type



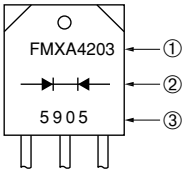
①Part Number
FMU-12S is indicated as "FMU12S."
②Polarity: Rectifier Symbol
③Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
Third and fourth letters: Day
Laser marking or White ink marking

(1-chip type)

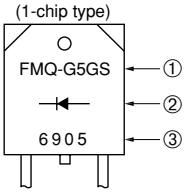


①Part Number: Excluding last letter
FML-G12S is indicated as "FML-G12."
②Last letter of Part Number
③Polarity: Rectifier Symbol
④Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
Third and fourth letters: Day
Laser marking or White ink marking

5 TO-3PF, FM100 type

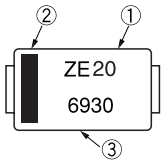


(1-chip type)



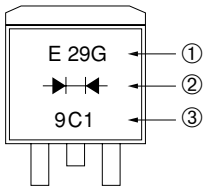
①Part Number: Full name
②Polarity: Rectifier Symbol
③Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, D)
Third and fourth letters: Day
Laser marking or White ink marking

6 Surface-Mount (SJP)



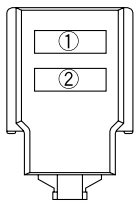
①Part Number
②Polarity: Rectifier Symbol
③Lot No.
First letter: Year (Last digit of year)
Second letter: Month (1 to 9, O, N, and D)
Third and fourth letters: Day

7 Surface-Mount (TO-220S)



①Part Number
②Polarity: Rectifier Symbol
③Lot No.
First letter: Year (Last digit of year)
Second letter: Month (A to M except I)
Third letter: Week

8 SZ-10 Series



①Part Number
②Lot 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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (μA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (μA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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
400	1.0	Axial(ϕ2.4/ϕ0.6)	AM01	35	–40 to +150		0.98	1.0	10	50	100(Ta)	22	0.13
	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
600	1.0	Axial(ϕ2.4/ϕ0.6)	AM01A	35	–40 to +150		0.98	1.0	10	50	100(Ta)	22	0.13
	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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (μA) $V_R=V_{RM}$ max	T_j (°C)	trr① (μs)	I_F/I_{RP} (mA)	trr② (μs)	I_F/I_{RP} (mA)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	$I_{R(H)}$ (μA) $V_R=V_{RM}$ max	T_j (°C)	trr① (μs)	I_F/I_{RP} (mA)	trr② (μs)	I_F/I_{RP} (mA)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (mA) $V_R=V_{RM}$ max	T_j (°C)	trr① (ns)	I_F/I_{RP} (mA)	trr② (ns)	I_F/I_{RP} (mA)	Rth(j-l) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (mA) $V_R=V_{RM}$ max	T_j (°C)	trr① (ns)	I_F/I_{RP} (mA)	trr② (ns)	I_F/I_{RP} (mA)	Rth(j-l) (°C/W)	Mass (g)
200	1.0	Axial(φ2.4/φ0.6)	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(φ2.7/φ0.6)	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(φ2.7/φ0.78)	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(φ2.7/φ0.6)	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(φ4.0/φ0.78)	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(φ4.0/φ0.78)	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(φ4.0/φ0.78)	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(φ4.0/φ0.98)	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(φ4.0/φ0.98)	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(φ6.5/φ1.4)	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(φ6.5/φ1.4)	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_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (mA) $V_R=V_{RM}$ max	T_j (°C)	trr① (ns)	I_F/I_{RP} (mA)	trr② (ns)	I_F/I_{RP} (mA)	Rth(j-l) (°C/W)	Mass (g)
400	0.7	Axial (ϕ2.4/ 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 (ϕ2.7/ 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 (ϕ2.7/ 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 (ϕ2.4/ 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 (ϕ4.0/ 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 (ϕ4.0/ 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 (ϕ2.7/ 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 (ϕ4.0/ 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 (ϕ2.7/ ϕ0.6)	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 (ϕ2.4/ ϕ0.6)	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 (ϕ2.7/ ϕ0.78)	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 (ϕ4.0/ ϕ0.78)	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 (ϕ4.0/ ϕ0.98)	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 (ϕ4.0/ ϕ0.98)	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 (ϕ6.5/ ϕ1.4)	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 (ϕ6.5/ ϕ1.4)	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

V_{RM} (V)	I_F (AV) (A) Values in parentheses are for the products with heatsinks	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (μA) $V_R=V_{RM}$ max	I_R(H) (mA) $V_R=V_{RM}$ max	T_j (°C)	trr① (ns)	I_F/I_{RP} (mA)	trr② (ns)	I_F/I_{RP} (mA)	Rth(j-l) (°C/W)	Mass (g)
800	0.5	Axial(φ2.4/φ0.6)	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(φ2.4/φ0.6)	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(φ2.7/φ0.6)	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(φ4.0/φ0.78)	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(φ2.7/φ0.6)	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(φ4.0/φ0.78)	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(φ6.5/φ1.4)	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(φ4.0/φ0.78)	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_{RM} (V)	I_F (AV) (A)	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A)	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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

V_{RM} (V)	I_F (AV) (A)	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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 VF "A Series"

●Surface-Mount

V_{RM} (V)	I_F (AV) (A)	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A)	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A)	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A)	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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 VF/Low IR Balance "J Series"

●Surface-Mount

V_{RM} (V)	I_F (AV) (A)	Package	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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_{RM} (V)	I_F (AV) (A)	Package Axial (Body Diameter/Lead Diameter)	Part Number	I_{FSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	V_F (V) max	I_F (A)	I_R (mA) $V_R=V_{RM}$ max	$I_{R(H)}$ (mA) $V_R=V_{RM}$ max	T_j (°C)	Rth(j-l) Rth(j-c) (°C/W)	Mass (g)
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

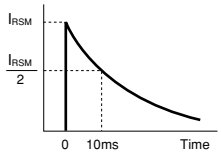
4-5 Power Zener Diodes

P (W)	VZ 1mA (V)	PR (W)	Package	Part Number	VDC (V)	I_{ZSM} (A)	Conditions	Tj Tstg (°C)	IR (μA) 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

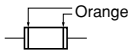
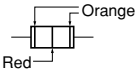
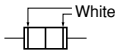
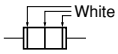
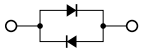
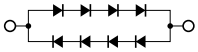
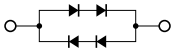
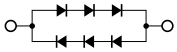
I_{ZSM} Condition



4-6 Silicon Varistors

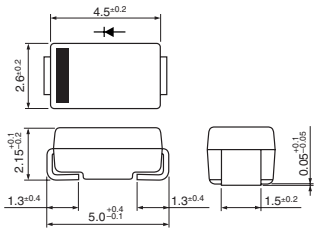
●Symmetrical

V_F (V)	I_F (mA)	Part Number	I_F (μA) max	V_F (V)	I_{TSM} (A) 50Hz Single Half Sine Wave	T_j (°C)	T_{stg} (°C)	Rth(j-l) (°C/W)	Mass (g)	Package
1.5max	1000	VR-60SS	20	0.2	15	-40 to +100		20	0.3	Axial(ϕ2.7/ϕ0.6)
2.3±0.25	1	VR-61SS			7.5	-40 to +100		20	0.3	Axial(ϕ2.7/ϕ0.6)
2.75±0.25	10									
3.1±0.25	70									
2.0max	100	SV-3SS	50	0.6		-40 to +100		20	0.3	Axial(ϕ2.7/ϕ0.6)
1.8±0.2	1	SV-4SS	50	0.9		-40 to +100		20	0.3	Axial(ϕ2.7/ϕ0.6)
2.15±0.2	10									
2.4±0.25	30									

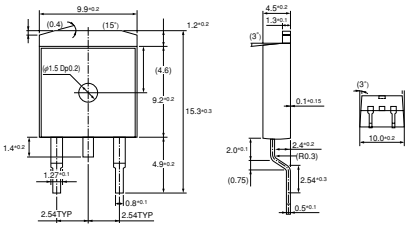
Part Number	VR-60SS	VR-61SS	SV-3SS	SV-4SS
Display Color				
Internal Connection				

Package Type (Dimensions)

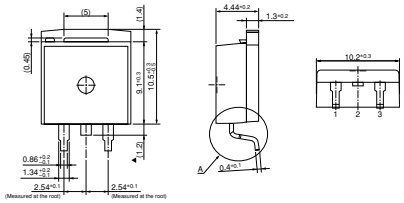
• No. 1 Surface-Mount (SJP)



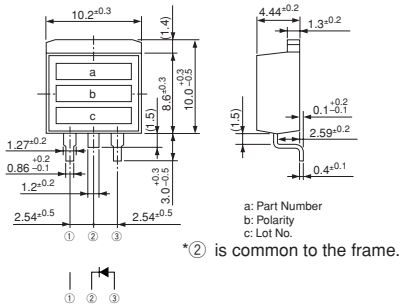
• No. 2 Surface-Mount (TO263)



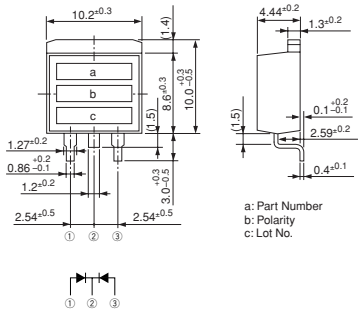
• No. 3 Surface-Mount (TO220S)
MPL-102S, MP2-202S, MPL-1036



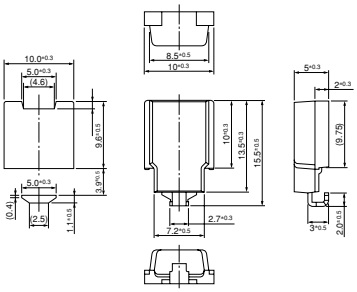
• No. 4 Surface-Mount (TO220S)



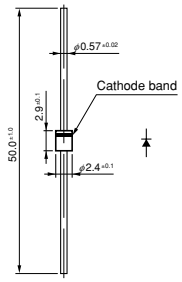
• No. 5 Surface-Mount (TO220S) Center-tap



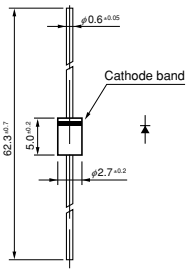
• No. 6 Surface-Mount (SZ-10)



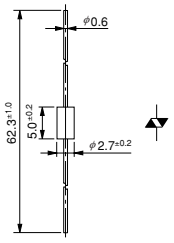
• No. 7 Axial (ϕ2.4/ϕ0.6)



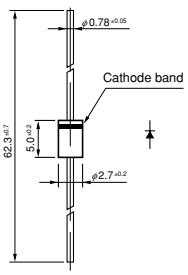
• No. 8 Axial (ϕ2.7/ϕ0.6)



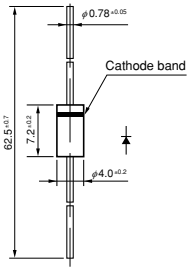
• No. 9 Axial (ϕ2.7/ϕ0.6)
Silicon Varistors (Symmetrical)



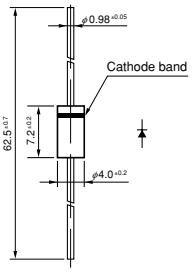
• No. 10 Axial (ϕ2.7/ϕ0.78)



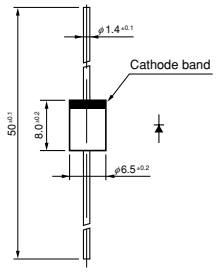
• No. 11 Axial (ϕ4.0/ϕ0.78)



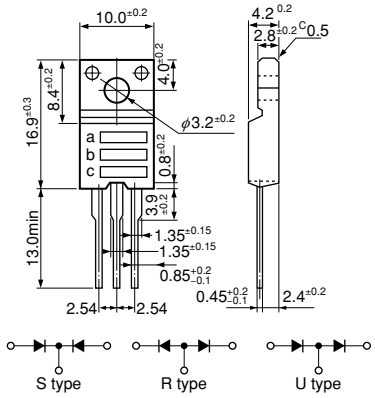
• No. 12 Axial (ϕ4.0/ϕ0.98)



• No. 13 Axial (ϕ6.5/ϕ1.4)

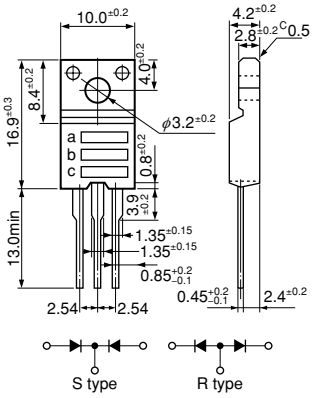


• No. 14 TO-220F (Two Elements)



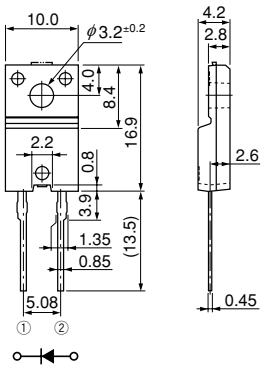
a: Part Number
b: Polarity
c: Lot No.

• No. 15 TO-220F (Center-tap)

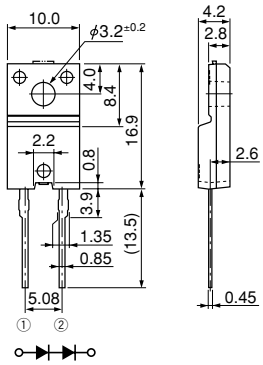


a: Part Number
b: Polarity
c: Lot No.

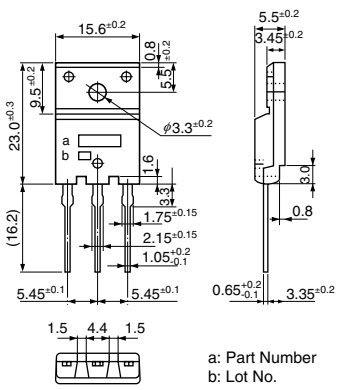
• No. 16 TO-220F2Pin



• No. 17 TO-220F2Pin (Two Elements)

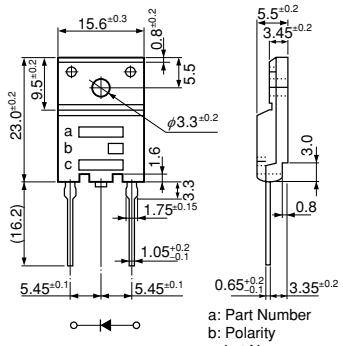


• No. 18 TO-3PF



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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DC/DC Power Modules 224

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) [mm]	Input Voltage [V]	Output Voltage [V]	Output Current [A]	Oscillation Frequency [kHz]	Remarks	Page
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) [mm]	Height [mm]	Input Voltage [V]	Output Voltage [V]	Output Current [A]	Oscillation Frequency [kHz]	Remarks	Page
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) [mm]	Height [mm]	Input Voltage [V]	Output Voltage [V]	Output Current [A]	Oscillation Frequency [kHz]	Remarks	Page
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.

$$P_D = Pin - P_O$$
$$= Vin \times Iin - V_O \times I_O$$

Or, if Efficiency η is known,

$$P_D = P_O \div (\eta \div 100) - P_O$$

P_D : Internal power dissipation
Pin : Input power
P_O : Output power
Vin : Input voltage
Iin : Input current
V_O : Output voltage
I_O : Output current
η : 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 R_{FB}
- Oscillation frequency: 250kHz
- Synchronous rectifier type
- High efficiency: 91% typ (V_{IN}=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	V_{IN}	–0.3 to 41	V	
FB Pin Voltage	V_{FB}	–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	V_{VIN-SW}	55	V	
Junction Temperature*1	Tj	–20 to 150	°C	
Storage Temperature	Tstg	–20 to 120	°C	
Thermal Resistance (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)	V_{IN}	Vo+4*4	40	V	
Input Voltage Range (MPM04)	V_{IN}	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

(T_a = 25°C)

Parameter	Symbol	Ratings			Unit	Conditions
		min.	typ.	max.		
Reference Voltage	V_{FBref}	0.490	0.500	0.510	V	V_{IN}=33V, Io=1A
Efficiency*6	η	–	91	–	%	V_{IN}=33V, Vo=12V, Io=3A
Oscillation Frequency	fo	212	250	288	kHz	V_{IN}=33V, Vo=12V, Io=3A
Line Regulation*7	V_{line}	–	–	±2	%	V_{IN}=16 to 40V, Vo=12V, Io=1A
Load Regulation*7	V_{load}	–	–	±3	%	V_{IN}=33V, Vo=12V, Io=0 to 3A
Overcurrent Protection Starting Current	Is	3.2	5.60	7.0	A	V_{IN}=33V, Vo=12V, Drooping/Auto restore*8
Circuit Current	I_{in}	–	12	–	mA	V_{IN}=33V, Io=0A, V_{FB}=1V
MIC Thermal Protection Start Temperature*9	Tj	151	160	–	°C	V_{IN}=16V to 40V
Input Voltage Undervoltage Protection	UVLO	–	7.3	8.0	V	
Startup Delay Time	T_{start}	–	50	–	ms	V_{IN}=16 to 40V. Time from V_{IN} application to when Vo reaches constant voltage precision

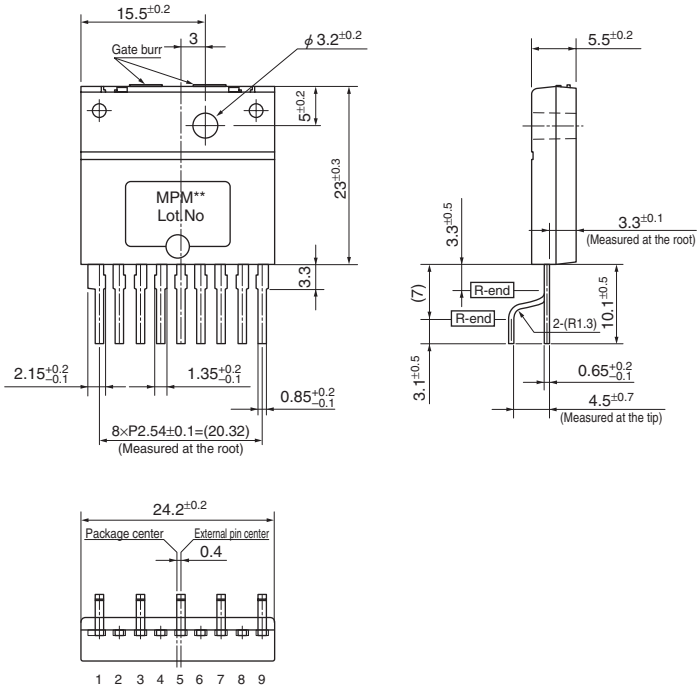
*5: The electrical characteristics are characteristic values guaranteed when the IC is operated under the measurement conditions shown for each of the items in the table above.
*6: The efficiency is calculated by Formula 1.

$$\eta\,(\%) = \frac{Vo \times Io}{V_{IN} \times Iin} \times 100 \quad \text{..... Formula 1}$$

*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 V_O=12V is set, the OCP operation point may fluctuate compared to the point when V_O=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)

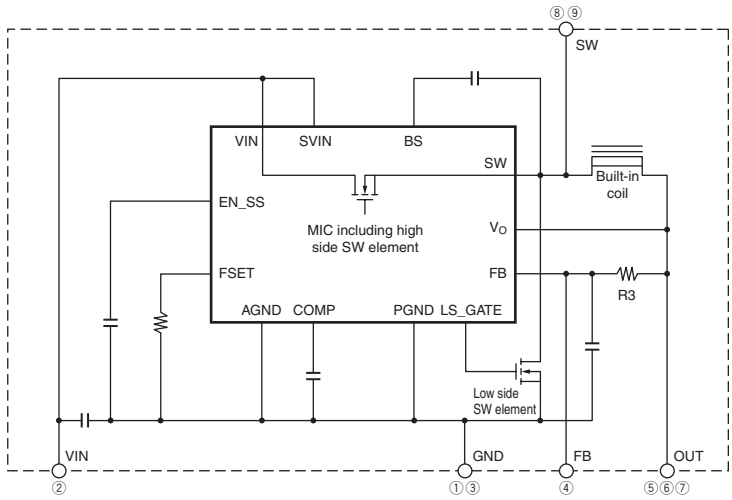
(Unit : mm)



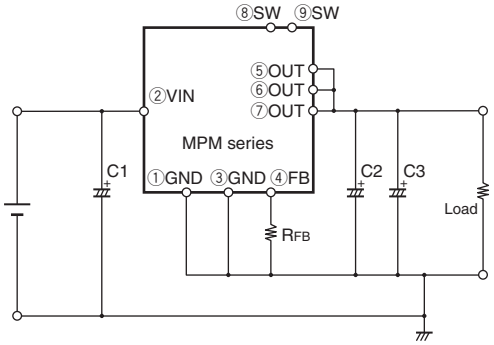
Pin Assignment
① GND
② VIN
③ GND
④ FB
⑤ OUT
⑥ OUT
⑦ OUT
⑧ SW
⑨ SW

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_{FB} 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

(T_a = 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

(T_a = 25°C, unless otherwise specified)

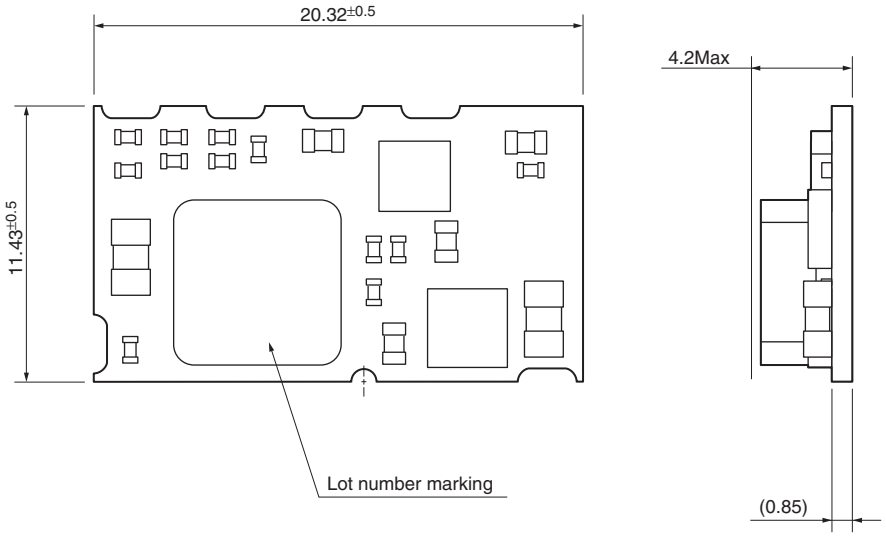
Parameter		Symbol	Ratings			Unit	Remarks
			min.	typ.	max.		
Input Voltage Range		Vin	10.8	12.0	13.2	V	
Output Voltage	BR200	Vout	0.75	–	1.65	V	Adjusted by Rtrim
	BR201	Vout	1.60	–	3.63	V	Adjusted by Rtrim
	BR204	Vout	1.60	–	5.50	V	Adjusted by Rtrim
Output Current		Io	0	–	10	A	With temperature derating
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

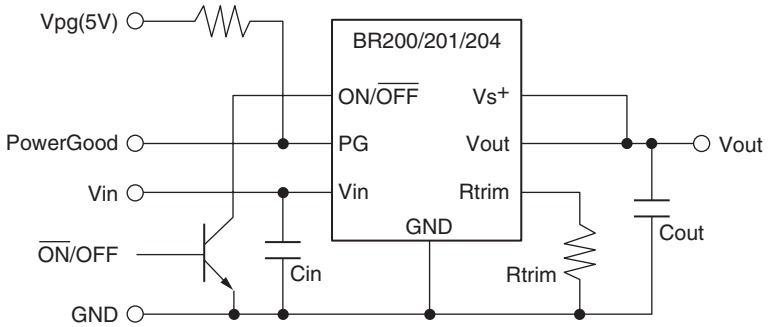
*2: BW=20MHz, Iout=0 to 10A, Cout=100μF

■External Dimensions

(Unit : mm)



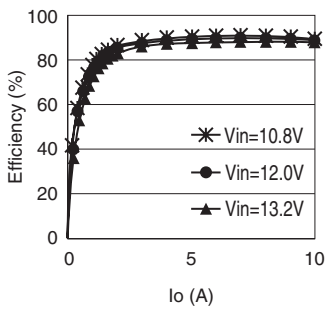
■Typical Connection Diagram



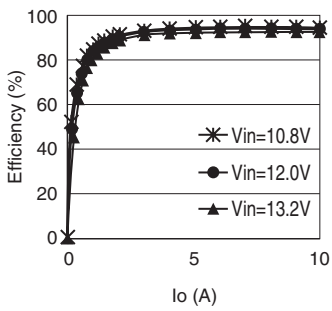
Place the input/output capacitors near the input and output pins of the DC/DC converter.

■Reference Data

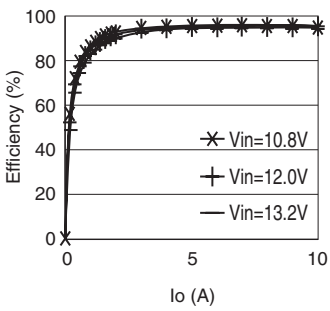
BR200 Vo=1.6V
Efficiency v.s Output current



BR201 Vo=3.3V
Efficiency v.s Output current



BR204 Vo=5V
Efficiency v.s Output current



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

(T_a = 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

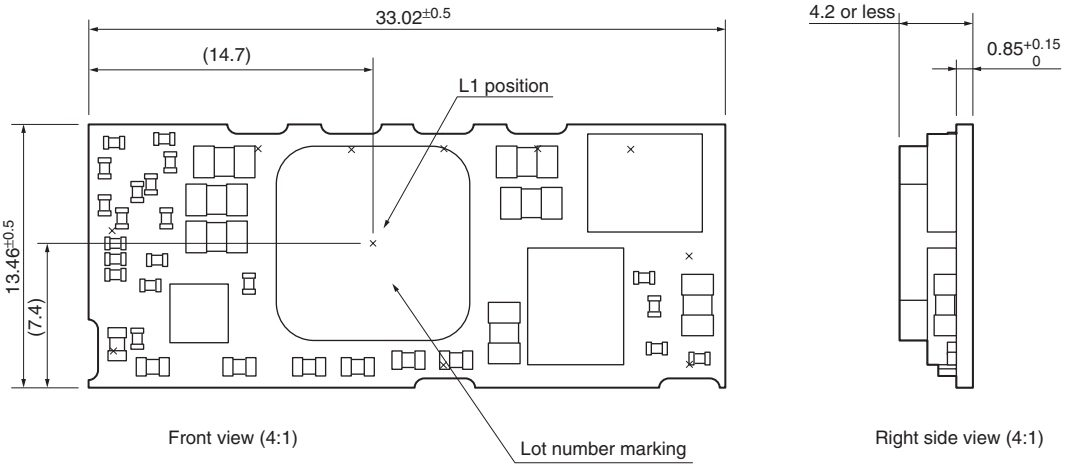
(T_a = 25°C, unless otherwise specified)

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			

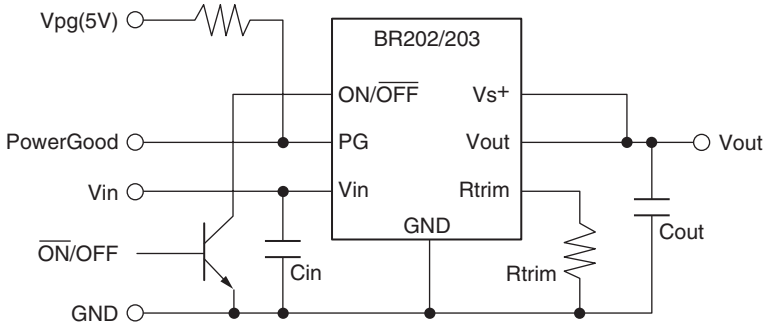
*1: BW=20MHz, Iout=0 to 20A, Cout=400μF

■External Dimensions

(Unit : mm)



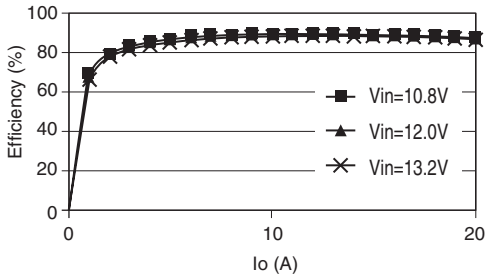
■Typical Connection Diagram



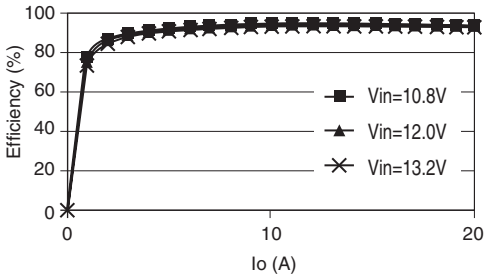
Place the input/output capacitors near the input and output pins of the DC/DC converter.

■Reference Data

BR202 Vo=1.2V
Efficiency v.s Output current



BR203 Vo=3.3V
Efficiency v.s Output current



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

(T_a = 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

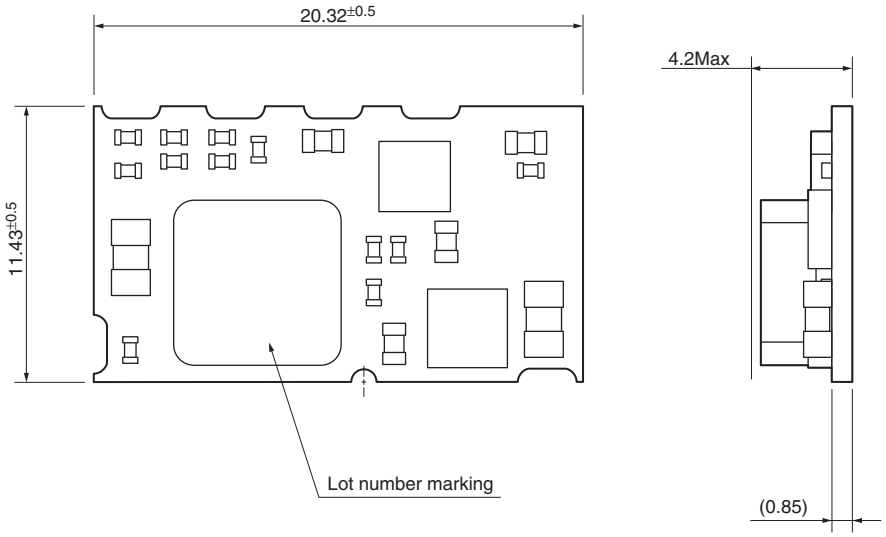
(T_a = 25°C, unless otherwise specified)

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%

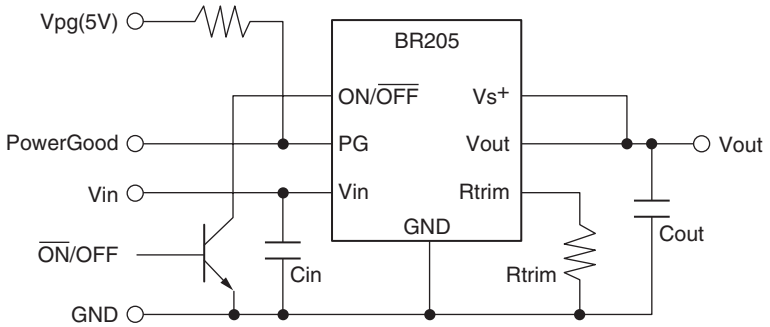
*1: BW=20MHz, Iout=0 to 10A, Cout=400μF

■External Dimensions

(Unit : mm)

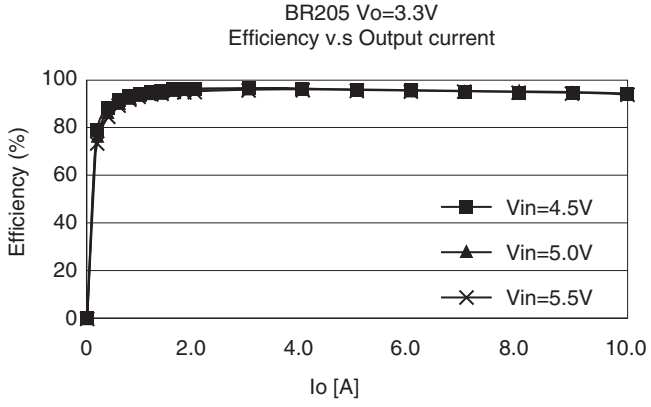


■Typical Connection Diagram



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

(T_a = 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

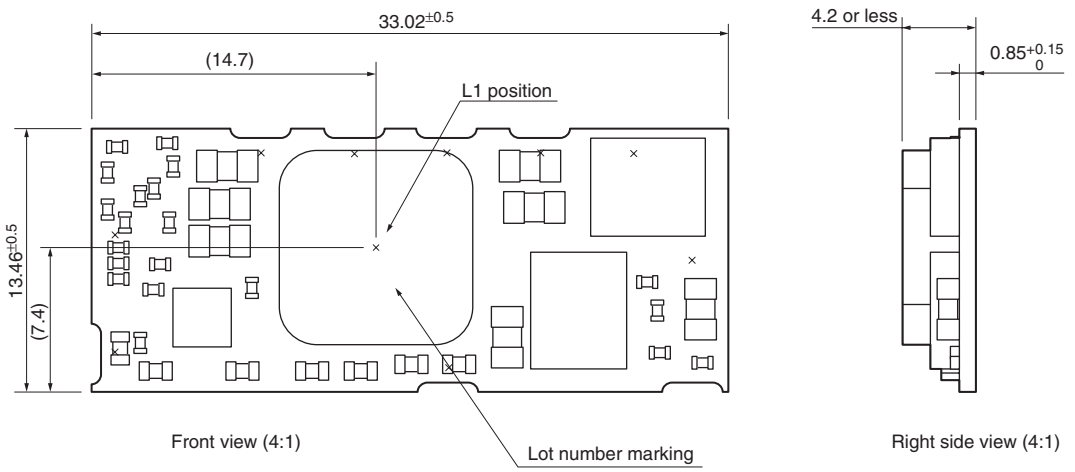
(T_a = 25°C, unless otherwise specified)

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, V_O=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%

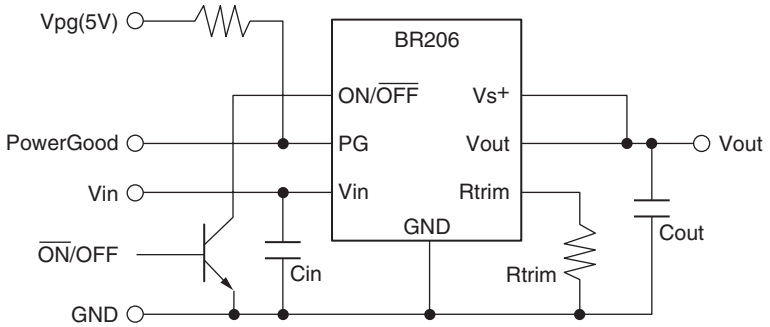
*1: BW=20MHz, Iout=0 to 20A, Cout=400μF

■External Dimensions

(Unit : mm)

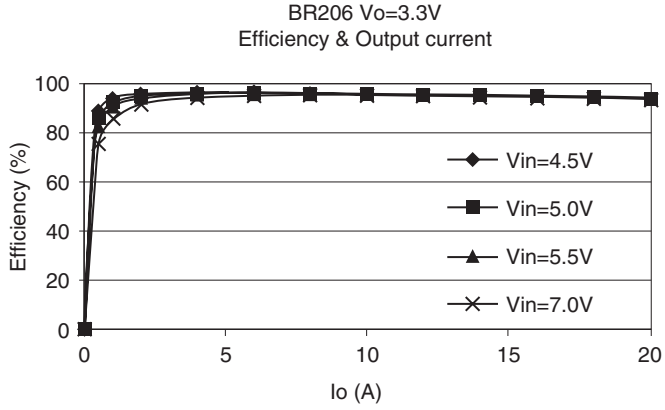


■Typical Connection Diagram



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

■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

(T_a = 25°C, unless otherwise specified)

Parameter	Pin	Symbol	Ratings	Unit	Remarks
Input Voltage	4–2	V_{IN}	–0.3 to +35	V	

■Recommended Operating Conditions

(T_a = 25°C, unless otherwise specified)

Parameter	Pin	Symbol	Ratings		Unit	Remarks
			min.	max.		
Input Voltage Range	4–2	V_{IN}	8	30	V	
Output Current Range	1–2	I_O	0	1	A	

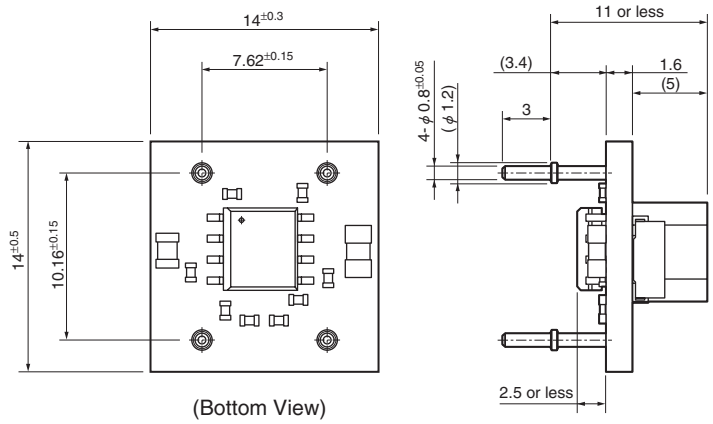
■Electrical Characteristics

(T_a = 25°C, unless otherwise specified)

Parameter	Pin	Symbol	Ratings						Unit	Remarks
			BR300			BR301				
			min.	typ.	max.	min.	typ.	max.		
Input Current	4–2	I_{IN}	–	0.24	–	–	0.17	–	A	V_{IN}=24V, I_O=1A
Standby Power	4–2	P_{STB}	–	0.16	–	–	0.13	–	W	V_{IN}=24V, I_O=0A
Output Voltage	1–2	V_O	–	5.0	–	–	3.3	–	V	
Constant Voltage Precision	1–2	V_{ACC}	–3	–	3	–3	–	3	%	
Output Current	1–2	I_O	0	–	1	0	–	1	A	
Maximum Output Power	1–2	$P_{O(MAX)}$	–	–	5	–	–	3.3	W	
Output Ripple	1–2	V_{RIP}	–	50	–	–	50	–	mV_{P-P}	V_{IN}=24V, I_O=1A
Output Noise	1–2	V_{NOISE}	–	50	–	–	50	–	mV_{P-P}	V_{IN}=24V, I_O=1A
Output Overcurrent Protection	1–2	I_{OCP}	1.1	–	–	1.1	–	–	A	

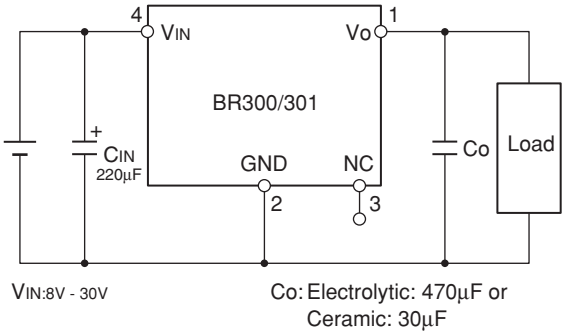
■External Dimensions

(Unit : mm)

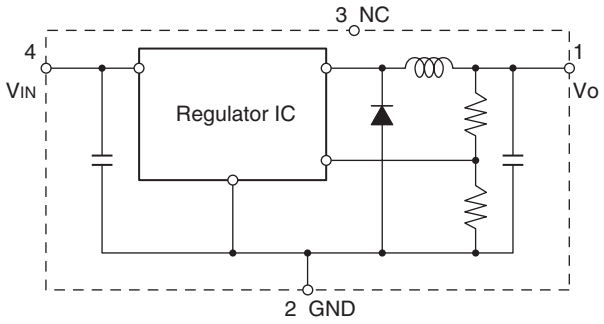


NOTES:
1) Unit: mm
2) Tolerance is 0.3mm unless otherwise specified.
3) Dimensions in parentheses are reference dimensions.
4) Pb-free device (RoHS compliant).

■Typical Connection Diagram

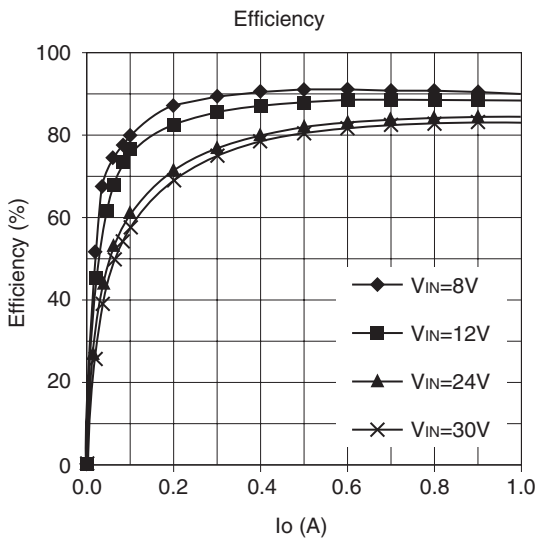


■Block Diagram

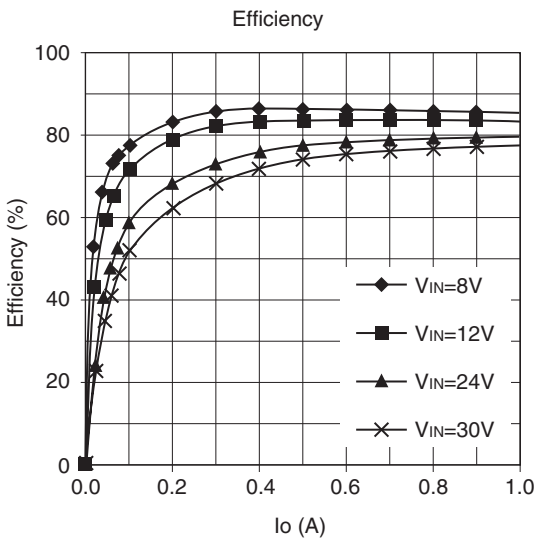


■Reference Data

BR300



BR301



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