



**THE DATASHEET OF
IPS09N03LAG**



OptiMOS[®] 2 Power-Transistor

Features

- Ideal for high-frequency dc/dc converters
- Qualified according to JEDEC¹⁾ for target application
- N-channel, logic level
- Excellent gate charge x $R_{DS(on)}$ product (FOM)
- Superior thermal resistance
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant

Product Summary

| | | |
|--------------------------------|-----|------------|
| V_{DS} | 25 | V |
| $R_{DS(on),max}$ (SMD version) | 8.6 | m Ω |
| I_D | 50 | A |



| Type | IPD09N03LA | IPF09N03LA | IPS09N03LA | IPU09N03LA |
|----------------|--------------|--------------|--------------|--------------|
| | | | | |
| Package | P-TO252-3-11 | P-TO252-3-23 | P-TO251-3-11 | P-TO251-3-21 |
| Marking | 09N03LA | 09N03LA | 09N03LA | 09N03LA |

Maximum ratings, at $T_j=25\text{ °C}$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|-------------------------------------|-------------------|---|-------------|-------------------|
| Continuous drain current | I_D | $T_C=25\text{ °C}^{2)}$ | 50 | A |
| | | $T_C=100\text{ °C}$ | 45 | |
| Pulsed drain current | $I_{D,pulse}$ | $T_C=25\text{ °C}^{3)}$ | 350 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=45\text{ A}$, $R_{GS}=25\ \Omega$ | 75 | mJ |
| Reverse diode dv/dt | dv/dt | $I_D=50\text{ A}$, $V_{DS}=20\text{ V}$, $di/dt=200\text{ A}/\mu\text{s}$, $T_{j,max}=175\text{ °C}$ | 6 | kV/ μs |
| Gate source voltage ⁴⁾ | V_{GS} | | ± 20 | V |
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 63 | W |
| Operating and storage temperature | T_j , T_{stg} | | -55 ... 175 | °C |
| IEC climatic category; DIN IEC 68-1 | | | 55/175/56 | |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Thermal characteristics

| | | | | | | |
|-------------------------------------|------------|--|---|---|-----|-----|
| Thermal resistance, junction - case | R_{thJC} | | - | - | 2.4 | K/W |
| SMD version, device on PCB | R_{thJA} | minimal footprint | - | - | 75 | |
| | | 6 cm ² cooling area ⁵⁾ | - | - | 50 | |

Electrical characteristics, at $T_j=25\text{ °C}$, unless otherwise specified

Static characteristics

| | | | | | | |
|----------------------------------|---------------|--|-----|------|------|---------------|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$ | 25 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=20\text{ }\mu\text{A}$ | 1.2 | 1.6 | 2 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=25\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$ | - | 0.1 | 1 | μA |
| | | $V_{DS}=25\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ °C}$ | - | 10 | 100 | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$ | - | 10 | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=4.5\text{ V}, I_D=30\text{ A}$ | - | 12 | 15 | m Ω |
| | | $V_{GS}=4.5\text{ V}, I_D=30\text{ A},$ SMD version | - | 11.8 | 14.8 | |
| | | $V_{GS}=10\text{ V}, I_D=30\text{ A}$ | - | 7.4 | 8.8 | |
| | | $V_{GS}=10\text{ V}, I_D=30\text{ A},$ SMD version | - | 7.2 | 8.6 | |
| Gate resistance | R_G | | - | 1 | - | Ω |
| Transconductance | g_{fs} | $ V_{DS} >2 I_D R_{DS(on)max},$ $I_D=30\text{ A}$ | 23 | 46 | - | S |

¹⁾ J-STD20 and JESD22

²⁾ Current is limited by bondwire; with an $R_{thJC}=2.4\text{ K/W}$ the chip is able to carry 67 A.

³⁾ See figure 3

⁴⁾ $T_{j,max}=150\text{ °C}$ and duty cycle $D<0.25$ for $V_{GS}<-5\text{ V}$

⁵⁾ Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm² (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Dynamic characteristics

| | | | | | | |
|------------------------------|--------------|---|---|------|------|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=15\text{ V},$ $f=1\text{ MHz}$ | - | 1235 | 1642 | pF |
| Output capacitance | C_{oss} | | - | 474 | 630 | |
| Reverse transfer capacitance | C_{rss} | | - | 61 | 92 | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=15\text{ V}, V_{GS}=10\text{ V},$ $I_D=25\text{ A}, R_G=2.7\ \Omega$ | - | 7.0 | 10 | ns |
| Rise time | t_r | | - | 5.6 | 8.4 | |
| Turn-off delay time | $t_{d(off)}$ | | - | 20 | 30 | |
| Fall time | t_f | | - | 3.4 | 5.1 | |

Gate Charge Characteristics⁶⁾

| | | | | | | |
|------------------------------|---------------|---|---|-----|-----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=15\text{ V}, I_D=25\text{ A},$ $V_{GS}=0\text{ to }5\text{ V}$ | - | 4.3 | 5.7 | nC |
| Gate charge at threshold | $Q_{g(th)}$ | | - | 2.0 | 2.6 | |
| Gate to drain charge | Q_{gd} | | - | 2.8 | 4.3 | |
| Switching charge | Q_{sw} | | - | 5.2 | 7.3 | |
| Gate charge total | Q_g | | - | 10 | 13 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 3.5 | - | |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$ $V_{GS}=0\text{ to }5\text{ V}$ | - | 8.7 | 12 | nC |
| Output charge | Q_{oss} | $V_{DD}=15\text{ V}, V_{GS}=0\text{ V}$ | - | 10 | 14 | |

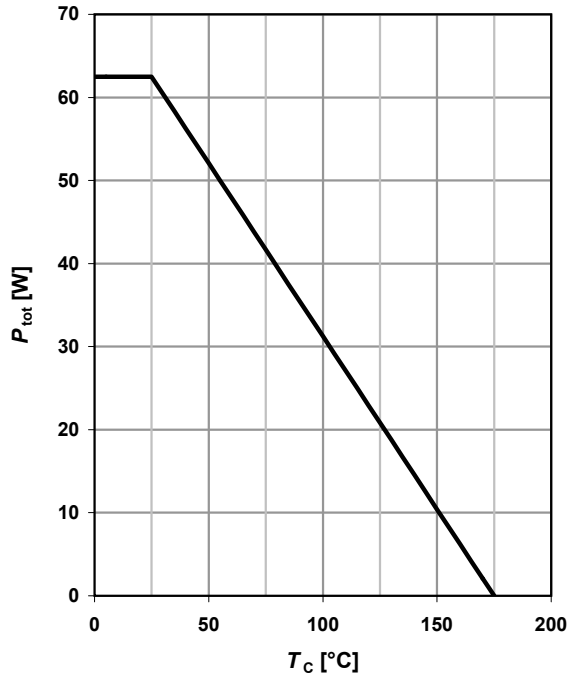
Reverse Diode

| | | | | | | |
|----------------------------------|---------------|---|---|------|-----|----|
| Diode continuous forward current | I_S | $T_C=25\text{ }^\circ\text{C}$ | - | - | 50 | A |
| Diode pulse current | $I_{S,pulse}$ | | - | - | 350 | |
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=50\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.97 | 1.2 | V |
| Reverse recovery charge | Q_{rr} | $V_R=15\text{ V}, I_F=I_S,$ $di_F/dt=400\text{ A}/\mu\text{s}$ | - | - | 10 | nC |

⁶⁾ See figure 16 for gate charge parameter definition

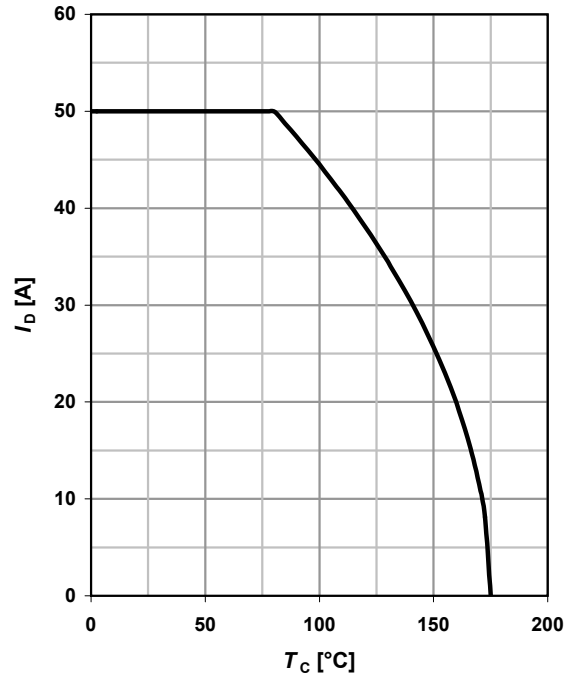
1 Power dissipation

$$P_{\text{tot}} = f(T_C)$$



2 Drain current

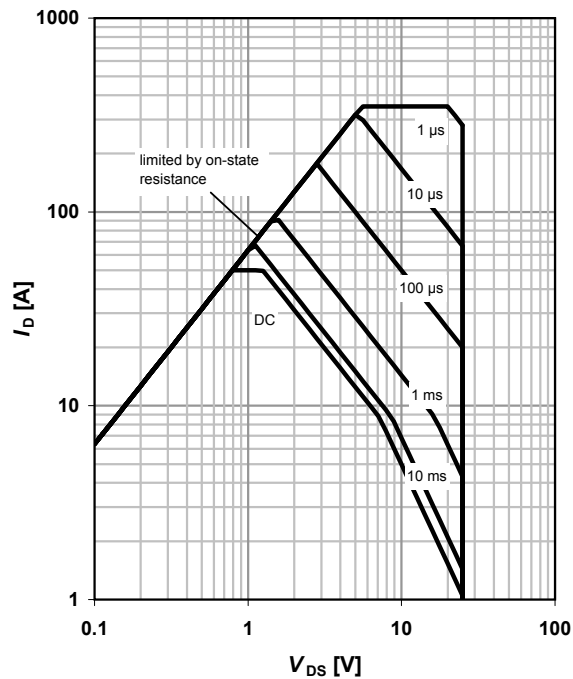
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



3 Safe operating area

$$I_D = f(V_{DS}); T_C = 25 \text{ °C}; D = 0$$

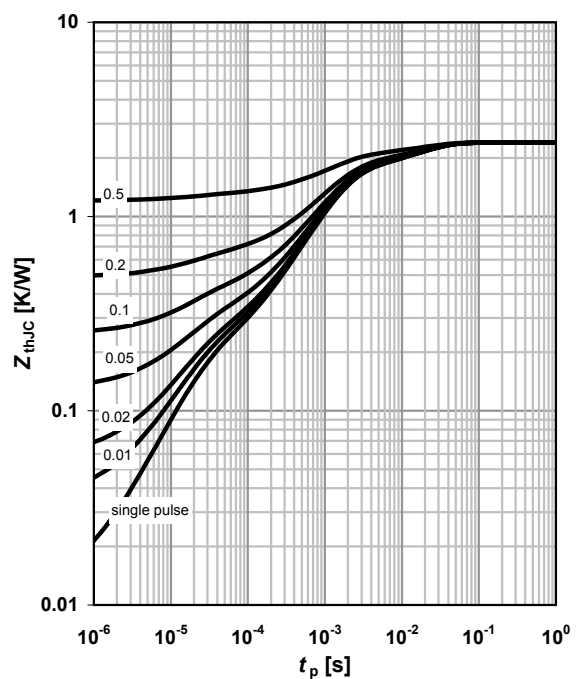
parameter: t_p



4 Max. transient thermal impedance

$$Z_{\text{thJC}} = f(t_p)$$

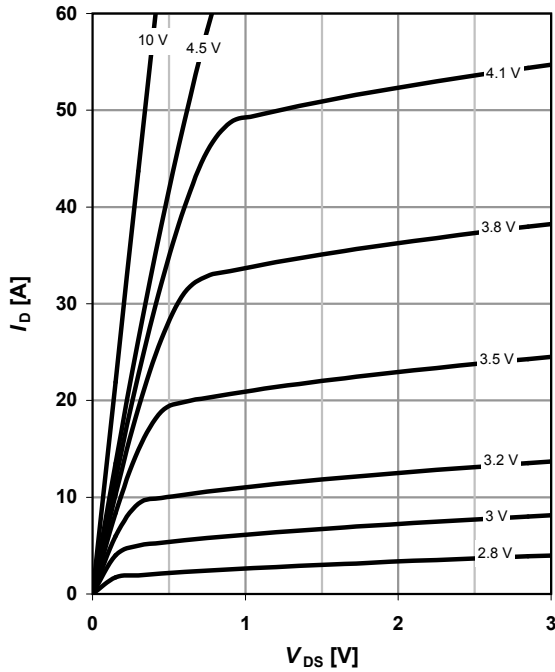
parameter: $D = t_p / T$



5 Typ. output characteristics

$I_D = f(V_{DS}); T_j = 25\text{ }^\circ\text{C}$

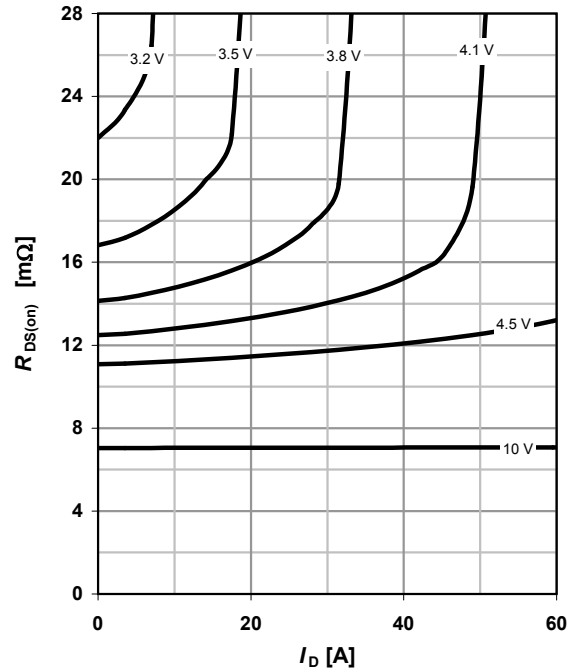
parameter: V_{GS}



6 Typ. drain-source on resistance

$R_{DS(on)} = f(I_D); T_j = 25\text{ }^\circ\text{C}$

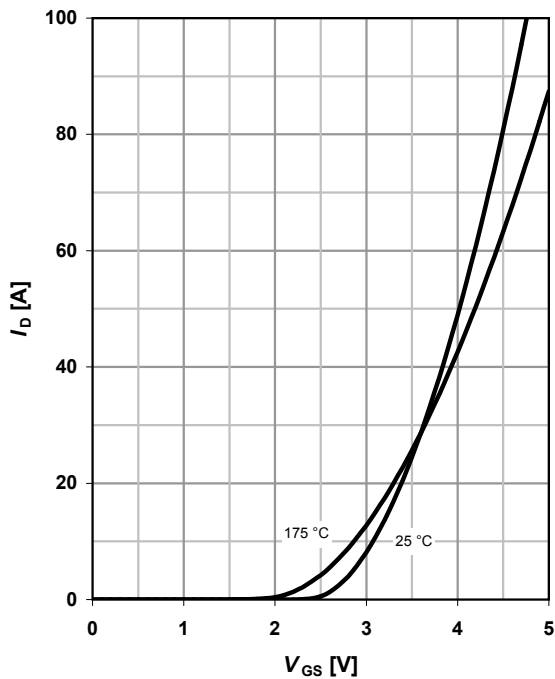
parameter: V_{GS}



7 Typ. transfer characteristics

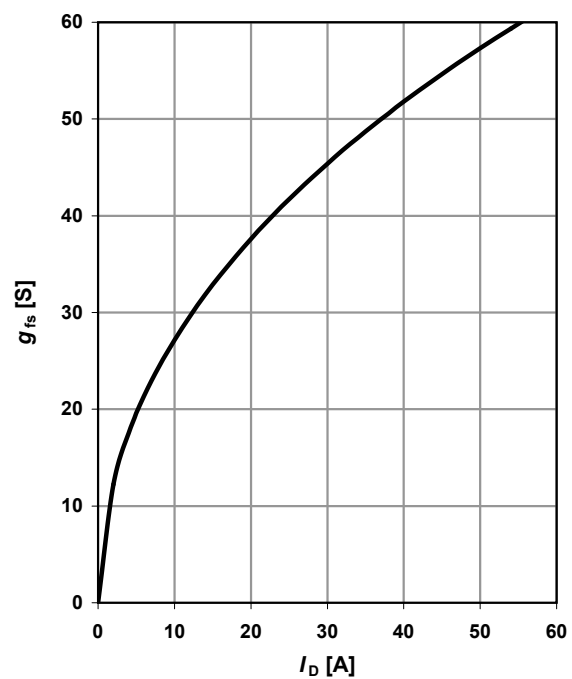
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter: T_j



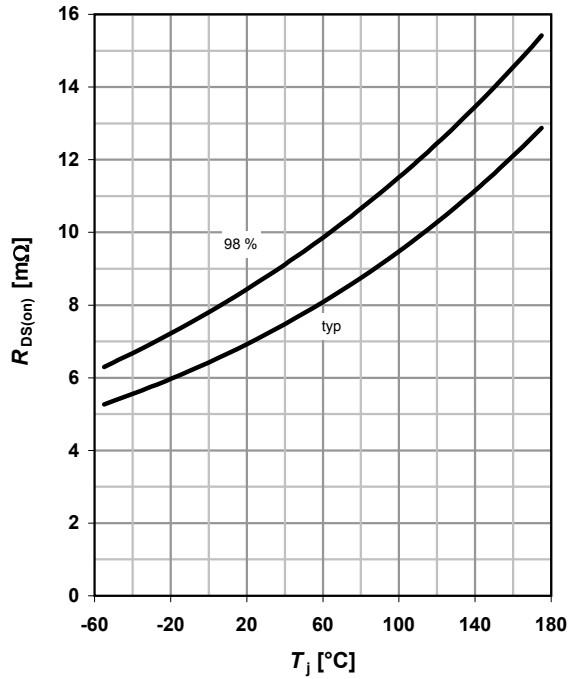
8 Typ. forward transconductance

$g_{fs} = f(I_D); T_j = 25\text{ }^\circ\text{C}$



9 Drain-source on-state resistance

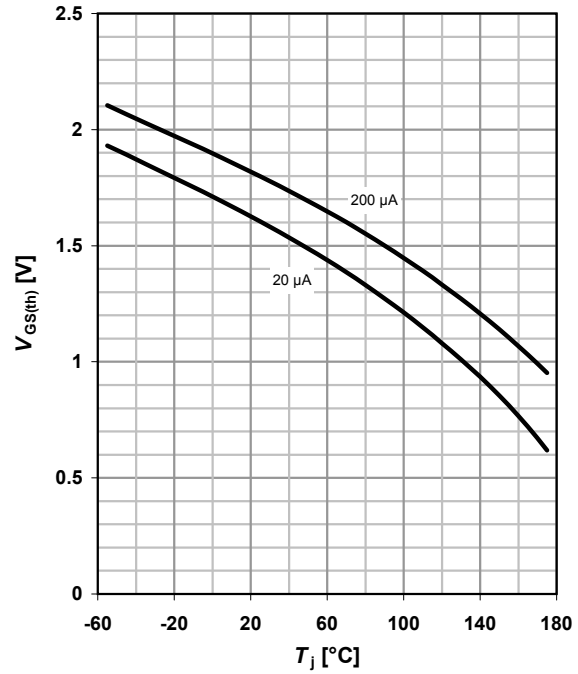
$$R_{DS(on)} = f(T_j); I_D = 30 \text{ A}; V_{GS} = 10 \text{ V}$$



10 Typ. gate threshold voltage

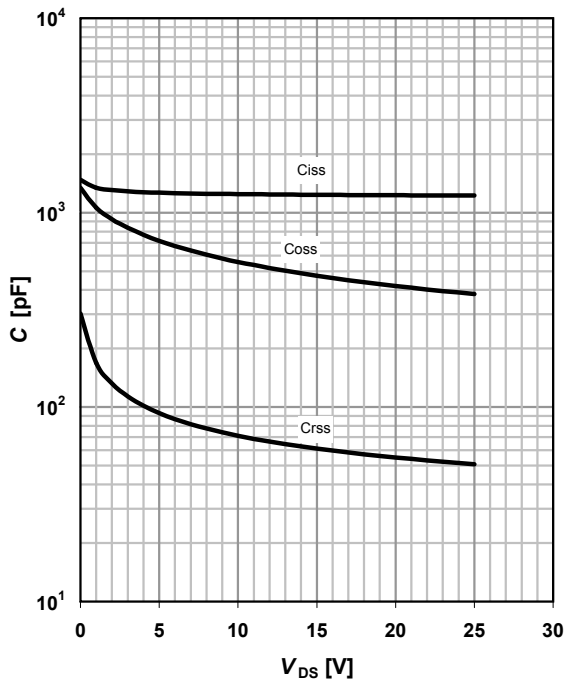
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter: I_D



11 Typ. Capacitances

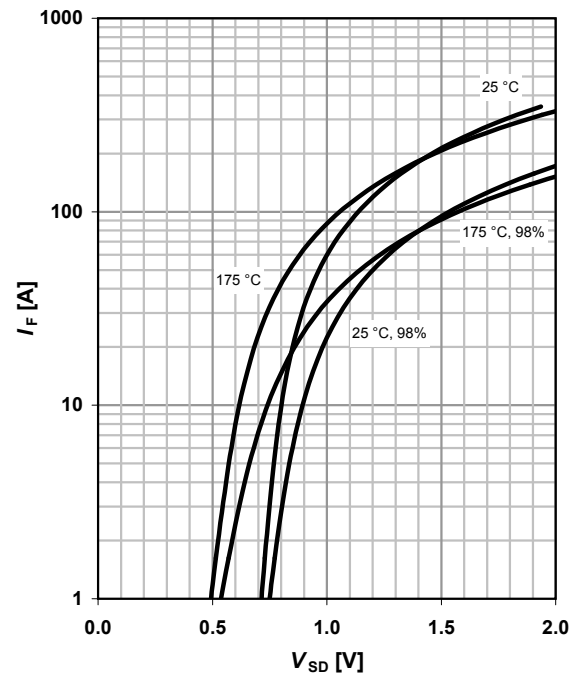
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



12 Forward characteristics of reverse diode

$$I_F = f(V_{SD})$$

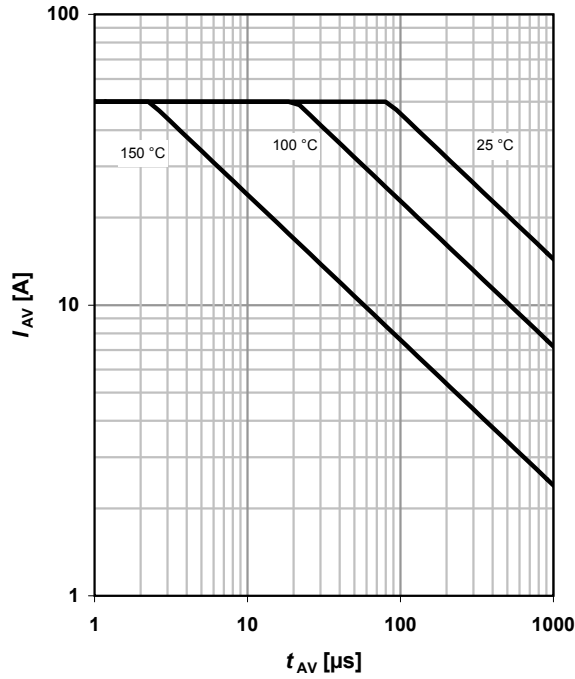
parameter: T_j



13 Avalanche characteristics

$$I_{AS} = f(t_{AV}); R_{GS} = 25 \Omega$$

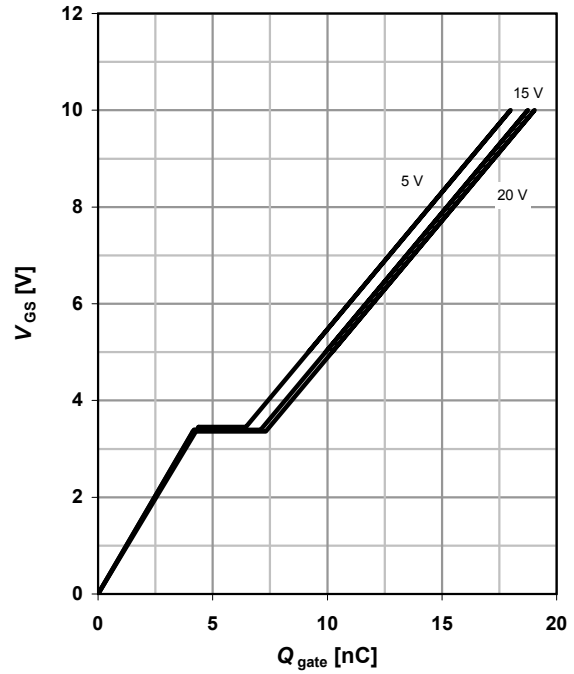
parameter: $T_{j(\text{start})}$



14 Typ. gate charge

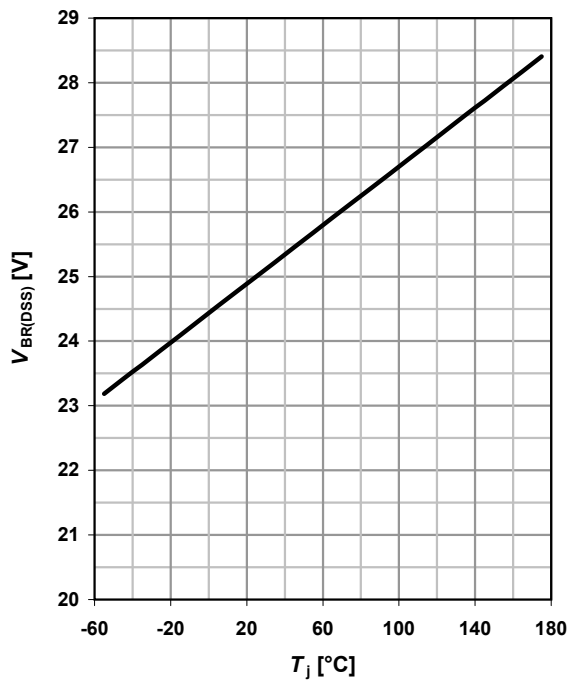
$$V_{GS} = f(Q_{\text{gate}}); I_D = 25 \text{ A pulsed}$$

parameter: V_{DD}



15 Drain-source breakdown voltage

$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$

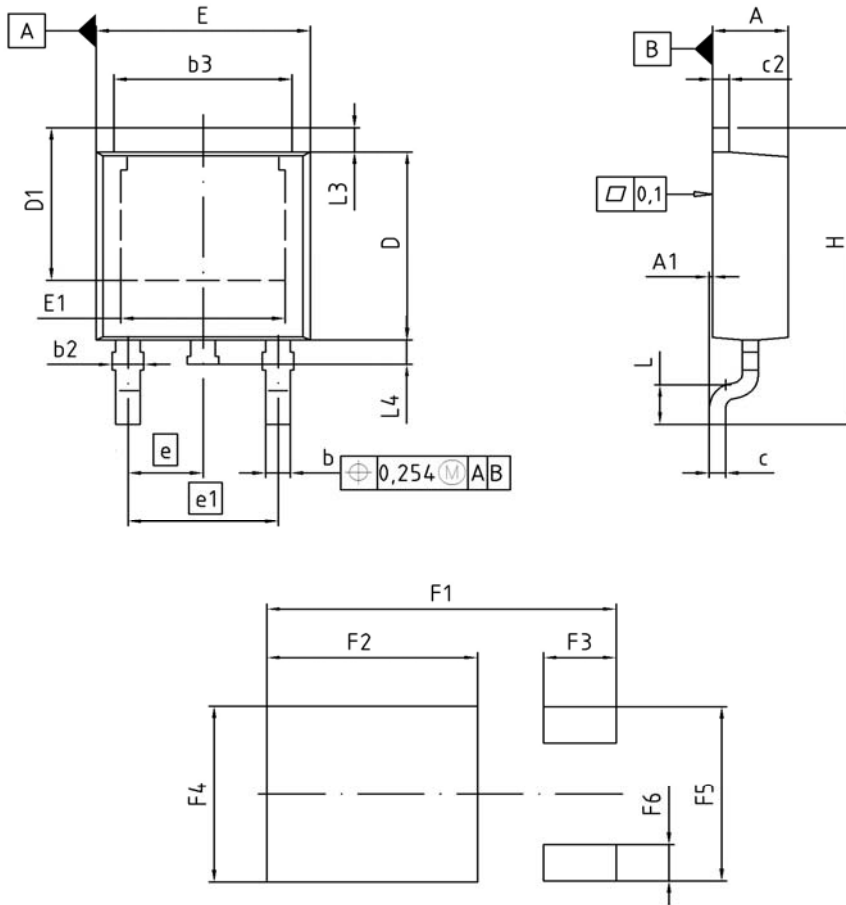


16 Gate charge waveforms



Package Outline

PG-TO252-3-11



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.16 | 2.41 | 0.085 | 0.095 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b3 | 5.00 | 5.50 | 0.197 | 0.217 |
| c | 0.46 | 0.60 | 0.018 | 0.024 |
| c2 | 0.46 | 0.98 | 0.018 | 0.039 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| D1 | 5.02 | 5.84 | 0.198 | 0.230 |
| E | 6.40 | 6.73 | 0.252 | 0.265 |
| E1 | 4.70 | 5.21 | 0.185 | 0.205 |
| e | 2.29 | | 0.090 | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| H | 9.40 | 10.48 | 0.370 | 0.413 |
| L | 1.18 | 1.70 | 0.046 | 0.067 |
| L3 | 0.90 | 1.25 | 0.035 | 0.049 |
| L4 | 0.51 | 1.00 | 0.020 | 0.039 |
| F1 | 10.50 | 10.70 | 0.413 | 0.421 |
| F2 | 6.30 | 6.50 | 0.248 | 0.256 |
| F3 | 2.10 | 2.30 | 0.083 | 0.091 |
| F4 | 5.70 | 5.90 | 0.224 | 0.232 |
| F5 | 5.66 | 5.86 | 0.223 | 0.231 |
| F6 | 1.10 | 1.30 | 0.043 | 0.051 |

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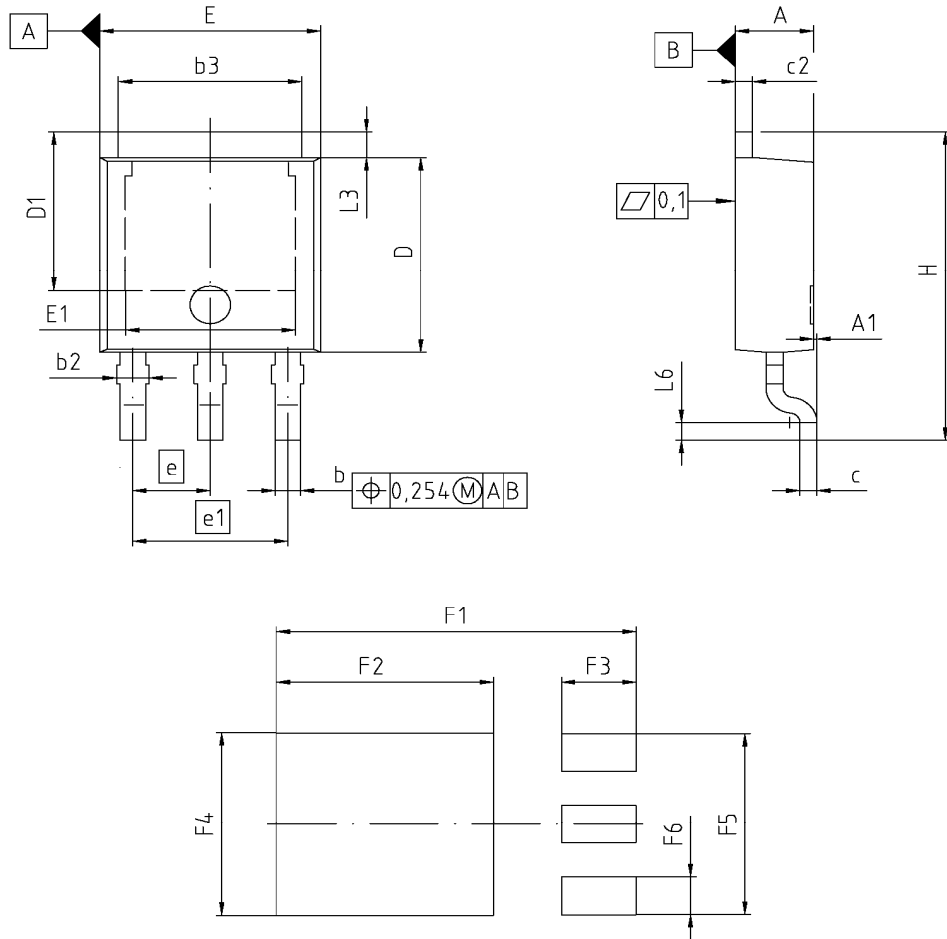
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03

Package Outline

PG-TO252-3-23



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.159 | 2.413 | 0.085 | 0.095 |
| A1 | 0.000 | 0.150 | 0.000 | 0.006 |
| b | 0.635 | 0.889 | 0.025 | 0.035 |
| b2 | 0.650 | 1.150 | 0.026 | 0.045 |
| b3 | 5.004 | 5.500 | 0.197 | 0.217 |
| c | 0.457 | 0.580 | 0.018 | 0.023 |
| c2 | 0.460 | 0.980 | 0.018 | 0.039 |
| D | 5.969 | 6.223 | 0.235 | 0.245 |
| D1 | 5.020 | 5.842 | 0.198 | 0.230 |
| E | 6.400 | 6.731 | 0.252 | 0.265 |
| E1 | 4.850 | 5.207 | 0.191 | 0.205 |
| e | 2.286 | | 0.090 | |
| e1 | 4.572 | | 0.180 | |
| N | 3 | | 3 | |
| H | 9.400 | 10.480 | 0.370 | 0.413 |
| L3 | 0.900 | 1.143 | 0.035 | 0.045 |
| L4 | 0.584 | 0.950 | 0.023 | 0.037 |
| L6 | 0.510 | 0.686 | 0.020 | 0.027 |
| F1 | 10.500 | 10.700 | 0.413 | 0.421 |
| F2 | 6.300 | 6.500 | 0.248 | 0.256 |
| F3 | 2.100 | 2.300 | 0.083 | 0.091 |
| F4 | 5.700 | 5.900 | 0.224 | 0.232 |
| F5 | 5.660 | 5.860 | 0.222 | 0.231 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |

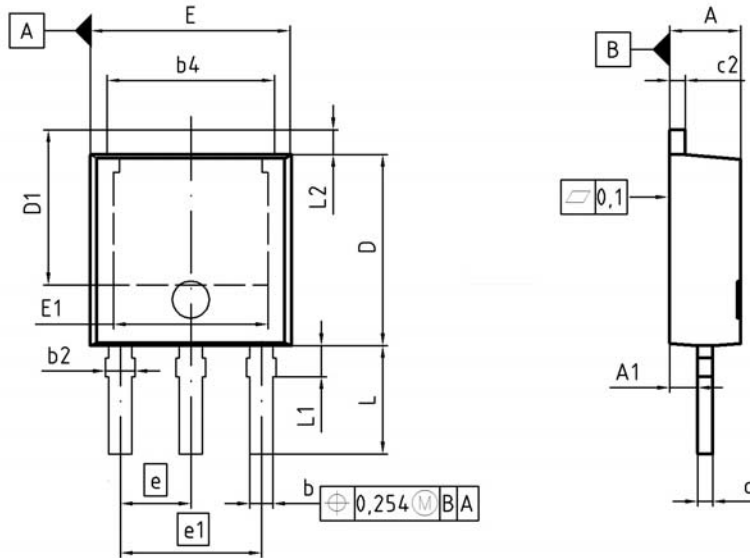
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0 2.0 4mm

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ISSUE DATE
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FILE
TO252_2



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.18 | 2.39 | 0.086 | 0.094 |
| A1 | 0.80 | 1.14 | 0.031 | 0.045 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b4 | 4.95 | 5.50 | 0.195 | 0.217 |
| c | 0.46 | 0.58 | 0.018 | 0.023 |
| c2 | 0.46 | 0.89 | 0.018 | 0.035 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| D1 | 5.04 | 5.44 | 0.198 | 0.214 |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.90 | 5.10 | 0.193 | 0.201 |
| e | 2.29 | | 0.090 | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| L | 3.40 | 3.60 | 0.134 | 0.142 |
| L1 | 0.90 | 1.10 | 0.035 | 0.043 |
| L2 | 0.90 | 1.10 | 0.035 | 0.043 |

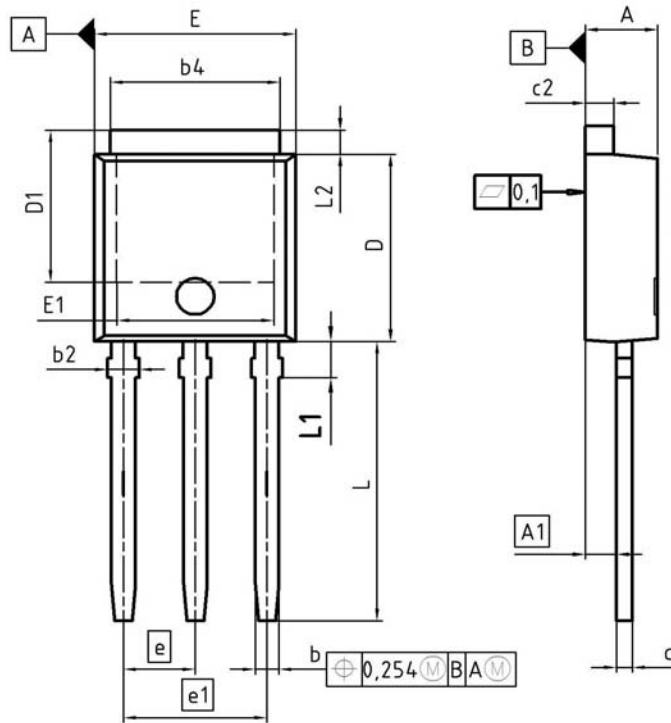
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| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 2.16 | 2.41 | 0.085 | 0.095 |
| A1 | 0.90 | 1.14 | 0.035 | 0.045 |
| b | 0.64 | 0.89 | 0.025 | 0.035 |
| b2 | 0.65 | 1.15 | 0.026 | 0.045 |
| b4 | 4.95 | 5.50 | 0.195 | 0.217 |
| c | 0.46 | 0.60 | 0.018 | 0.024 |
| c2 | 0.46 | 0.89 | 0.018 | 0.035 |
| D | 5.97 | 6.22 | 0.235 | 0.245 |
| D1 | 5.04 | 5.77 | 0.198 | 0.227 |
| E | 6.35 | 6.73 | 0.250 | 0.265 |
| E1 | 4.70 | 5.21 | 0.185 | 0.205 |
| e | 2.29 | | 0.090 | |
| e1 | 4.57 | | 0.180 | |
| N | 3 | | 3 | |
| L | 8.89 | 9.65 | 0.350 | 0.380 |
| L1 | 1.90 | 2.29 | 0.075 | 0.090 |
| L2 | 0.89 | 1.37 | 0.035 | 0.054 |

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