

OptiMOS™3 Power-Transistor
Features

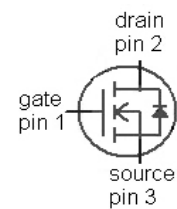
- N-channel, normal level
- Excellent gate charge x $R_{DS(on)}$ product (FOM)
- Very low on-resistance $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant, halogen free
- Qualified according to JEDEC¹⁾ for target application
- Ideal for high-frequency switching and synchronous rectification

Product Summary

| | | |
|---------------------------|-----|----|
| V_{DS} | 120 | V |
| $R_{DS(on),max}$ (TO-263) | 3.8 | mΩ |
| I_D | 120 | A |



| Type | IPB038N12N3 G | IPI041N12N3 G | IPP041N12N3 G |
|----------------|---------------|---------------|---------------|
| | | | |
| Package | PG-TO263-3 | PG-TO262-3 | PG-TO220-3 |
| Marking | 038N12N | 041N12N | 041N12N |


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

| Parameter | Symbol | Conditions | Value | Unit |
|-------------------------------------|-------------------|---|-------------|------|
| Continuous drain current | I_D | $T_C=25\text{ °C}^{2)}$ | 120 | A |
| | | $T_C=100\text{ °C}$ | 120 | |
| Pulsed drain current ³⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 480 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=100\text{ A}$, $R_{GS}=25\text{ Ω}$ | 900 | mJ |
| Gate source voltage ⁴⁾ | V_{GS} | | ±20 | V |
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 300 | 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} | | - | - | 0.5 | K/W |
| Thermal resistance, junction - ambient | R_{thJA} | minimal footprint | - | - | 62 | |
| | | 6 cm ² cooling area ⁵⁾ | - | - | 40 | |

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

Static characteristics

| | | | | | | |
|----------------------------------|---------------|---|-----|-----|-----|---------------|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$ | 120 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=270\text{ }\mu\text{A}$ | 2 | 3 | 4 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=100\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$ | - | 0.1 | 1 | μA |
| | | $V_{DS}=100\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ }^\circ\text{C}$ | - | 10 | 100 | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$ | - | 1 | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}, I_D=100\text{ A}$ | - | 3.5 | 4.1 | m Ω |
| | | $V_{GS}=10\text{ V}, I_D=100\text{ A}, \text{TO263}$ | - | 3.2 | 3.8 | |
| Gate resistance | R_G | | - | 1.4 | - | Ω |
| Transconductance | g_{fs} | $ V_{DS} >2 I_D R_{DS(on)max}, I_D=100\text{ A}$ | 83 | 165 | - | S |

¹⁾J-STD20 and JESD22

²⁾ Current is limited by bondwire; with an $R_{thJC}=0.5\text{ K/W}$ the chip is able to carry 182 A.

³⁾ See figure 3

⁴⁾ $T_{jmax}=150\text{ }^\circ\text{C}$ and duty cycle $D=0.01$ 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} | $V_{GS}=0\text{ V}, V_{DS}=60\text{ V},$ $f=1\text{ MHz}$ | - | 10400 | 13800 | pF |
| Output capacitance | C_{oss} | | - | 1320 | 1760 | |
| Reverse transfer capacitance | C_{rss} | | - | 61 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=60\text{ V}, V_{GS}=10\text{ V},$ $I_D=100\text{ A}, R_G=1.6\ \Omega$ | - | 35 | - | ns |
| Rise time | t_r | | - | 52.0 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 70 | - | |
| Fall time | t_f | | - | 21 | - | |

Gate Charge Characteristics⁶⁾

| | | | | | | |
|-----------------------|---------------|--|---|-----|-----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=60.1\text{ V},$ $I_D=100\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 52 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 37 | - | |
| Switching charge | Q_{sw} | | - | 58 | - | |
| Gate charge total | Q_g | | - | 158 | 211 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.0 | - | |
| Output charge | Q_{oss} | $V_{DD}=60.1\text{ V}, V_{GS}=0\text{ V}$ | - | 182 | 243 | nC |

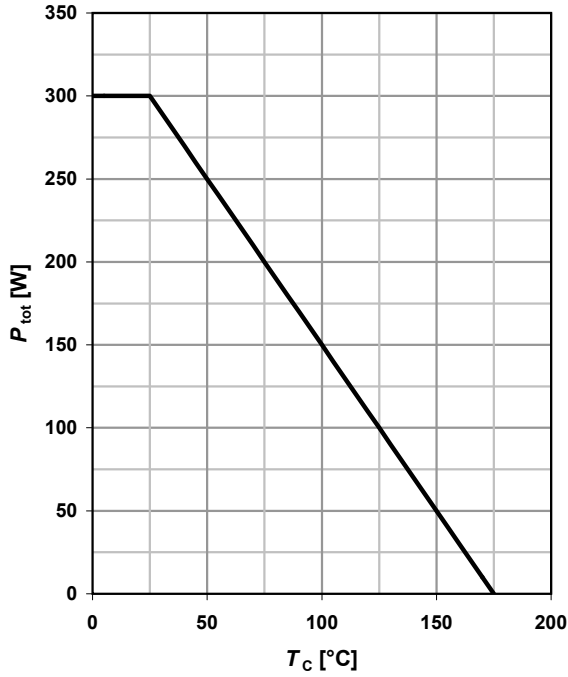
Reverse Diode

| | | | | | | |
|----------------------------------|---------------|--|---|-----|-----|----|
| Diode continuous forward current | I_S | $T_C=25\text{ }^\circ\text{C}$ | - | - | 120 | A |
| Diode pulse current | $I_{S,pulse}$ | | - | - | 480 | |
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=100\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=60\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 123 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 356 | - | nC |

⁶⁾ See figure 16 for gate charge parameter definition

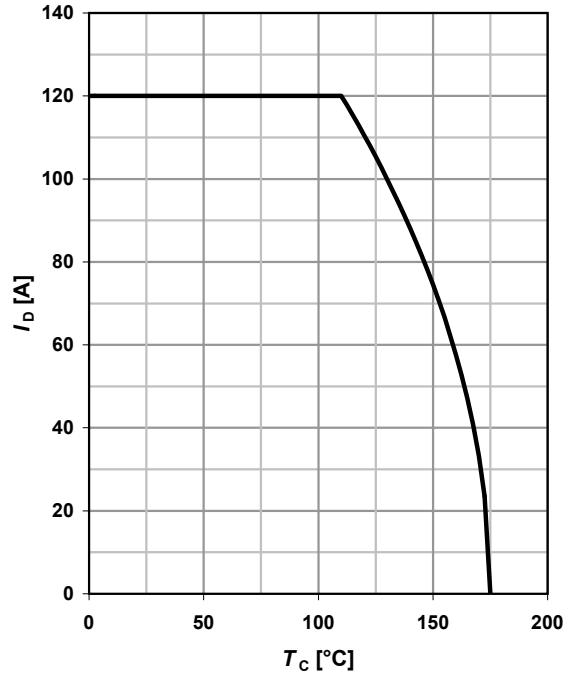
1 Power dissipation

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



2 Drain current

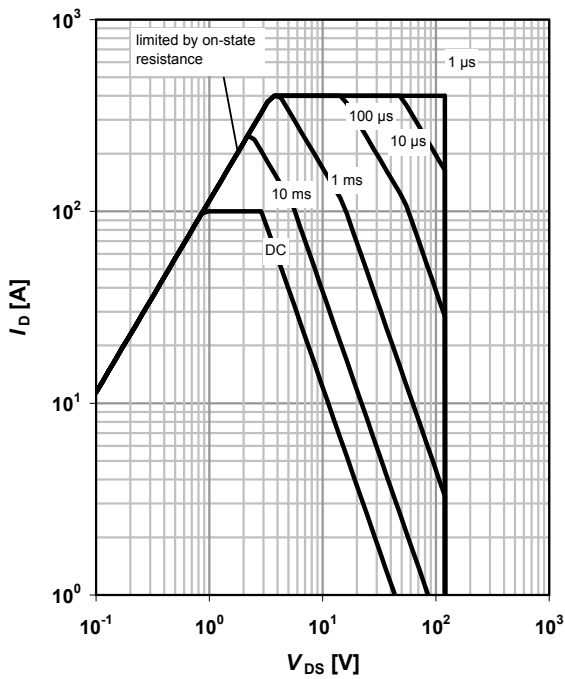
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



3 Safe operating area

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

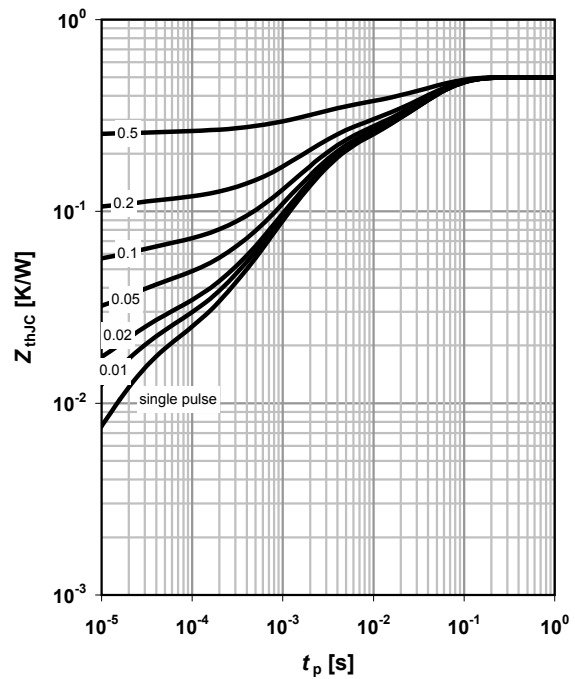
parameter: t_p



4 Max. transient thermal impedance

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

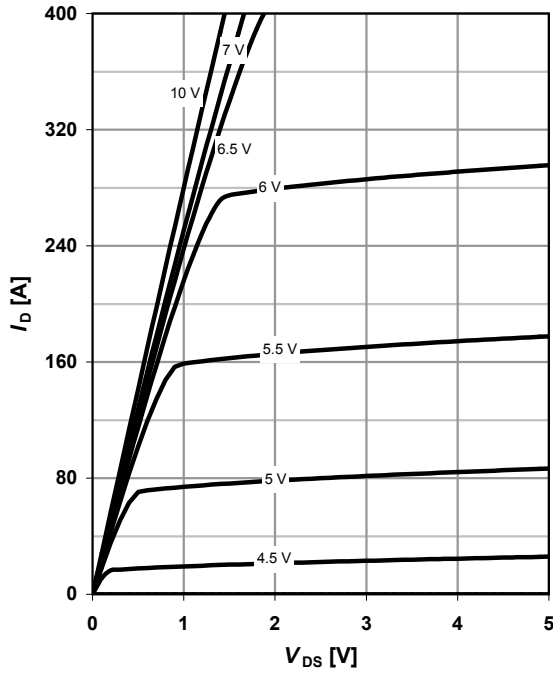
parameter: $D = t_p / T$



5 Typ. output characteristics

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

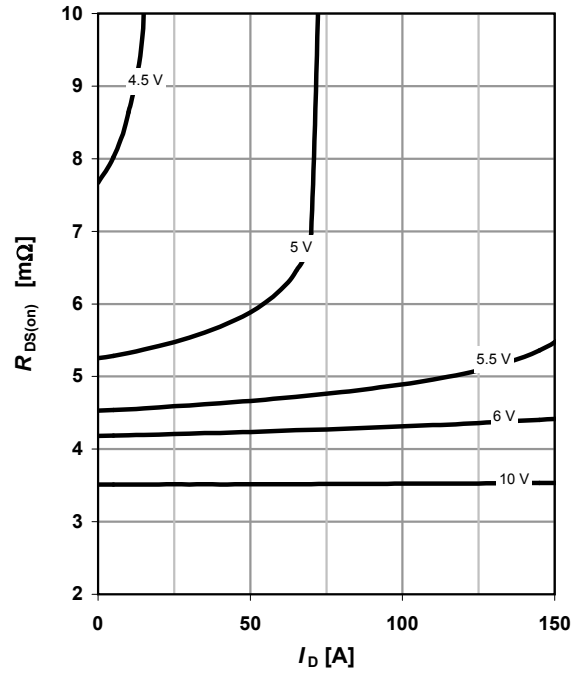
parameter: V_{GS}



6 Typ. drain-source on resistance

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

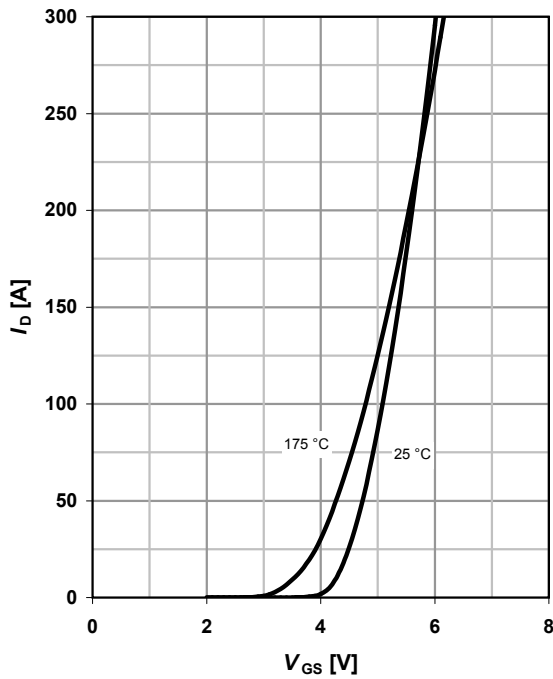
parameter: V_{GS}



7 Typ. transfer characteristics

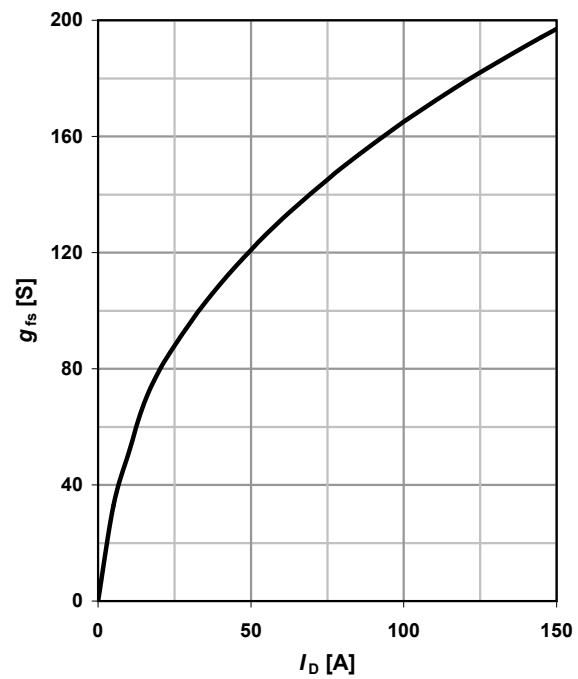
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter: T_j



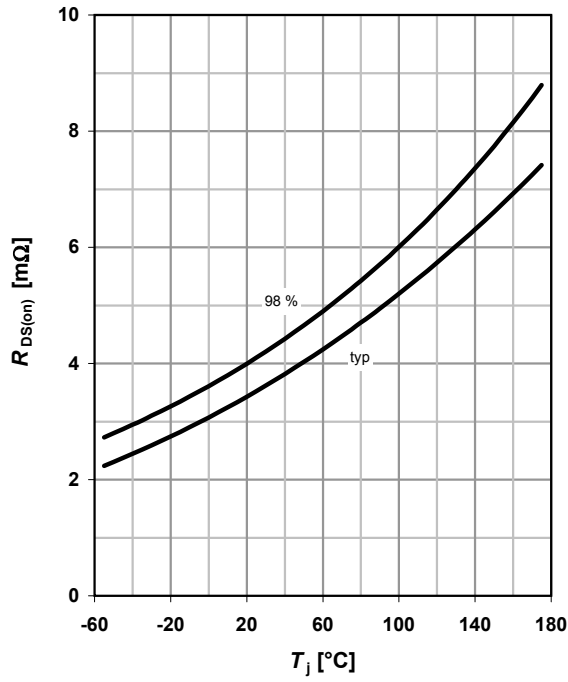
8 Typ. forward transconductance

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



9 Drain-source on-state resistance

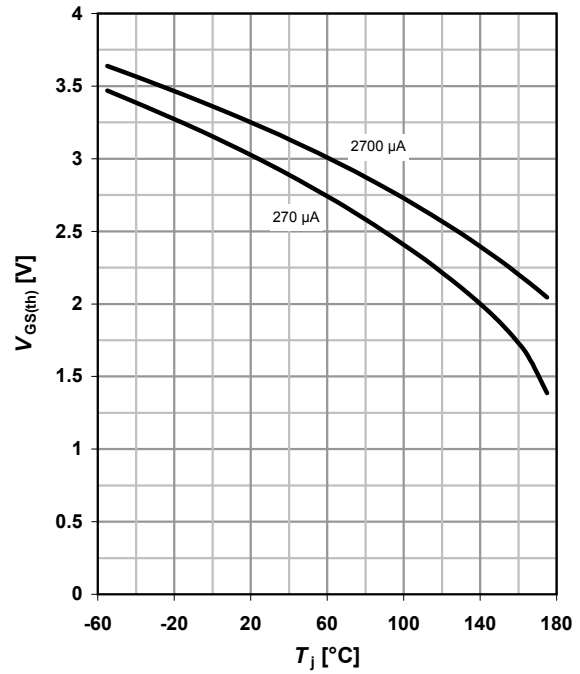
$R_{DS(on)} = f(T_j); I_D = 100 \text{ A}; V_{GS} = 10 \text{ V}$



10 Typ. gate threshold voltage

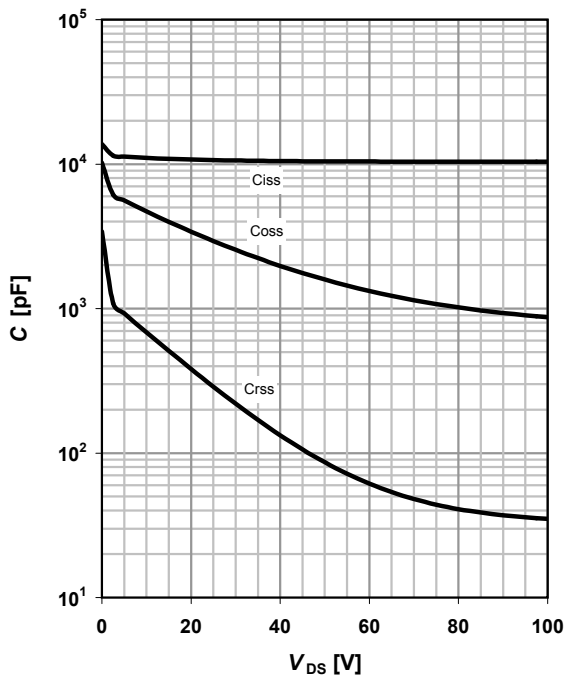
$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$

parameter: I_D



11 Typ. capacitances

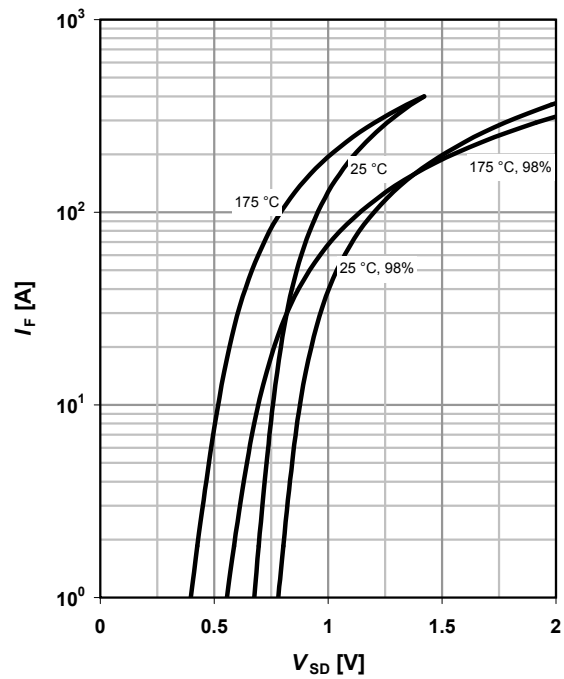
$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



12 Forward characteristics of reverse diode

$I_F = f(V_{SD})$

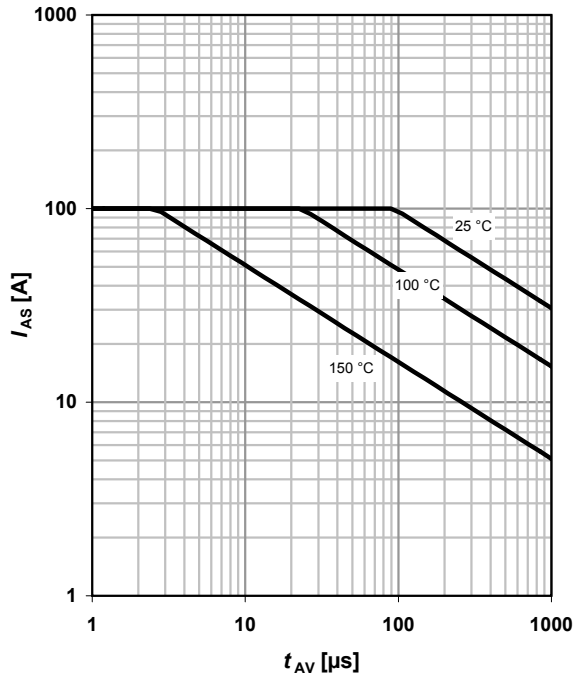
parameter: T_j



13 Avalanche characteristics

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

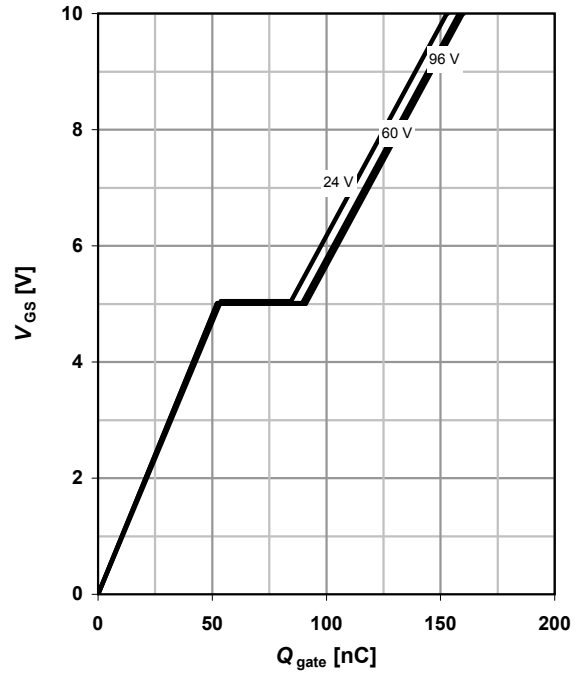
parameter: $T_{j(start)}$



14 Typ. gate charge

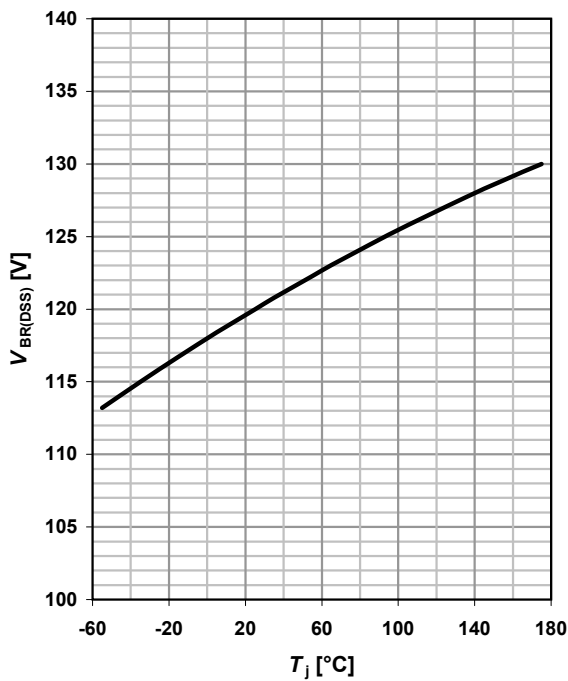
$V_{GS}=f(Q_{gate}); I_D=100 \text{ A pulsed}$

parameter: V_{DD}

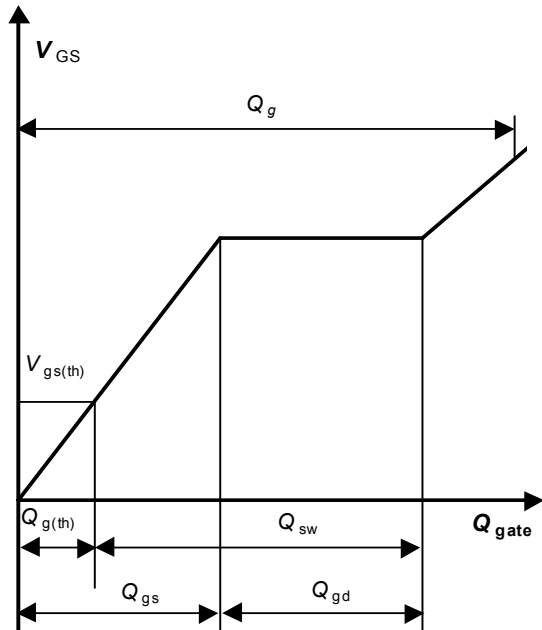


15 Drain-source breakdown voltage

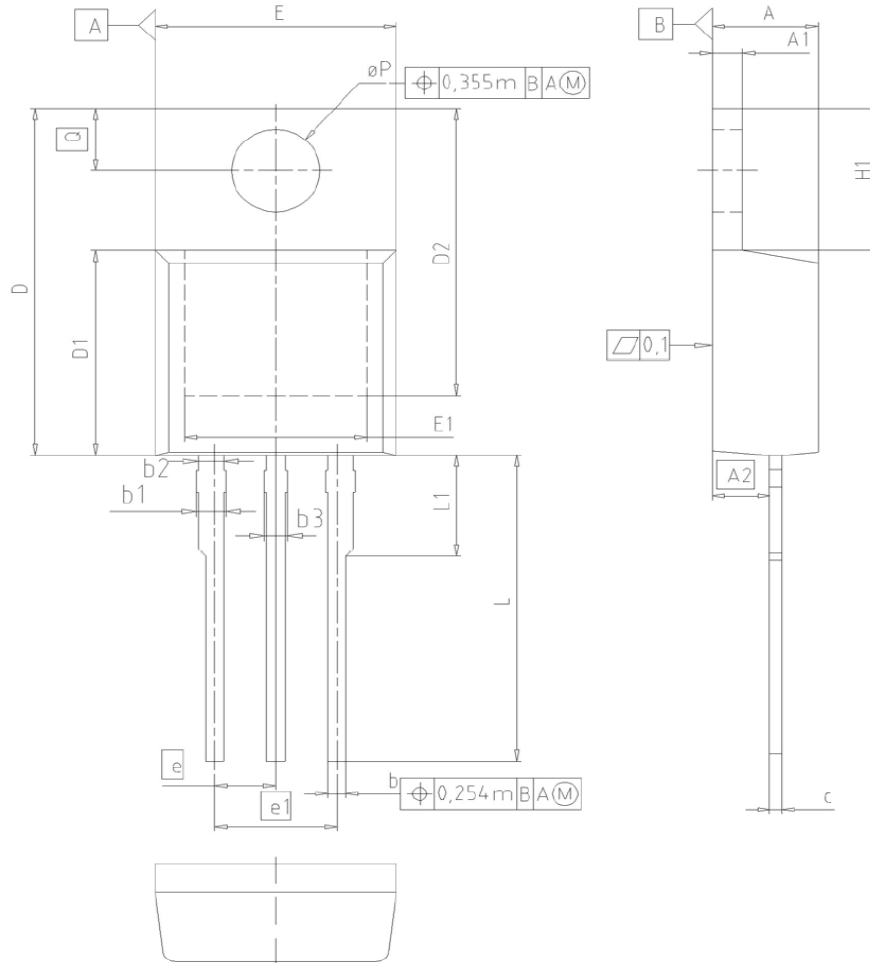
$V_{BR(DSS)}=f(T_j); I_D=1 \text{ mA}$



16 Gate charge waveforms



PG-TO220-3: Outline



| DIM | MILLIMETERS | | INCHES | |
|----------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 1.17 | 1.40 | 0.046 | 0.055 |
| A2 | 2.15 | 2.72 | 0.085 | 0.107 |
| b | 0.65 | 0.86 | 0.026 | 0.034 |
| b1 | 0.95 | 1.40 | 0.037 | 0.055 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| b3 | 0.65 | 1.15 | 0.026 | 0.045 |
| c | 0.33 | 0.60 | 0.013 | 0.024 |
| D | 14.81 | 15.95 | 0.583 | 0.628 |
| D1 | 8.51 | 9.45 | 0.335 | 0.372 |
| D2 | 12.19 | 13.10 | 0.480 | 0.516 |
| E | 9.70 | 10.36 | 0.382 | 0.408 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.90 | 6.90 | 0.232 | 0.272 |
| L | 13.00 | 14.00 | 0.512 | 0.551 |
| L1 | - | 4.80 | - | 0.189 |
| ϕP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

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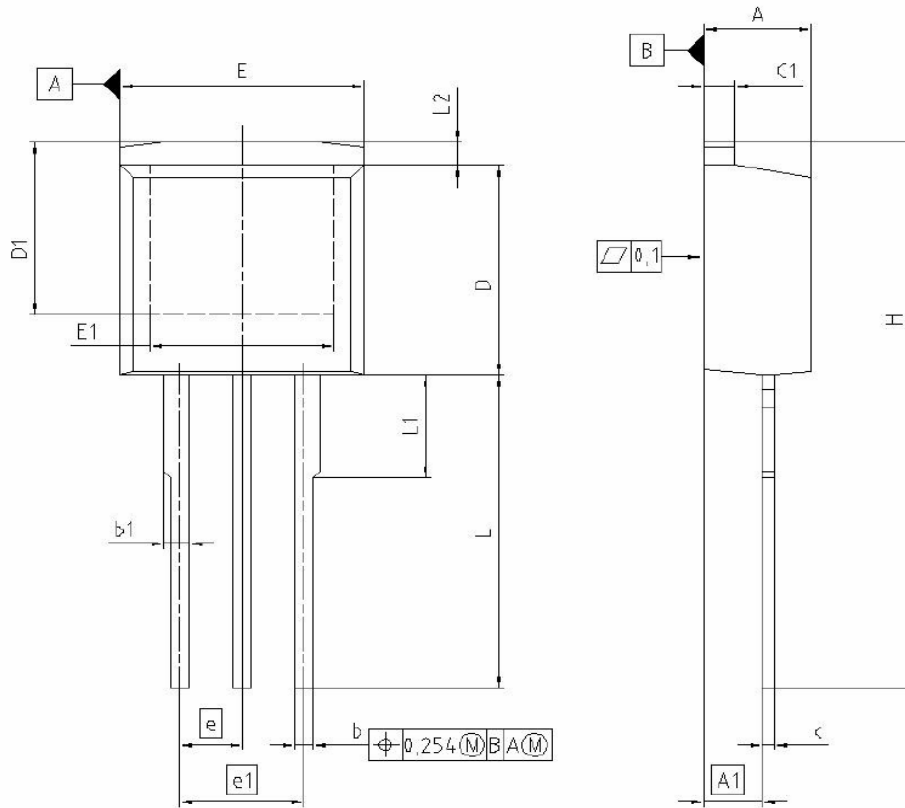
SCALE

EUROPEAN PROJECTION

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REVISION
05

PG-TO-262-3-1 (I²-PAK)



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.500 | 0.169 | 0.177 |
| A1 | 2.150 | 2.650 | 0.085 | 0.104 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b1 | 0.635 | 1.400 | 0.025 | 0.055 |
| c | 0.400 | 0.600 | 0.016 | 0.024 |
| c1 | 1.170 | 1.370 | 0.046 | 0.054 |
| D | 9.050 | 9.450 | 0.356 | 0.372 |
| D1 | 6.900 | 7.650 | 0.272 | 0.301 |
| E | 9.800 | 10.200 | 0.386 | 0.402 |
| E1 | 7.250 | 8.600 | 0.285 | 0.339 |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 3 | | 3 | |
| L | 13.000 | 14.000 | 0.512 | 0.551 |
| L1 | 4.350 | 4.750 | 0.171 | 0.187 |
| L2 | 0.700 | 1.300 | 0.028 | 0.051 |

REFERENCE
JEDEC TO262

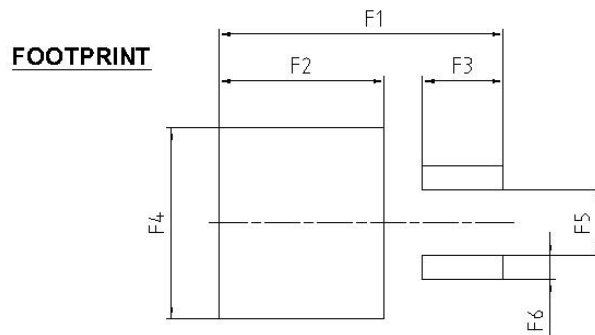
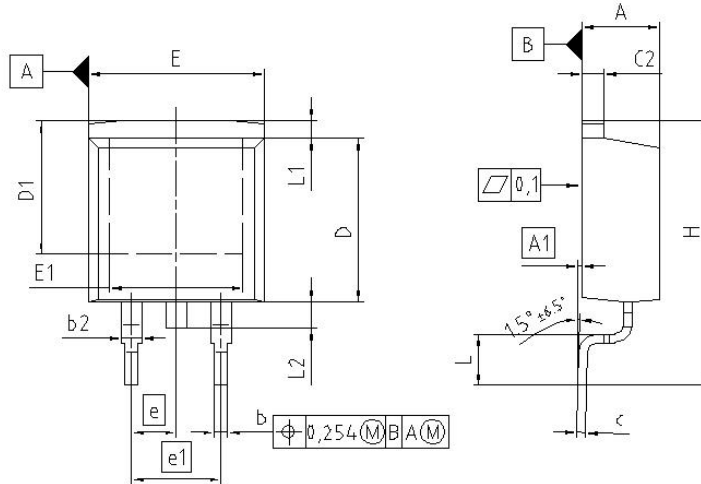
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FILE
TO262_1

PG-TO-263 (D²-Pak)



| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.300 | 4.572 | 0.169 | 0.180 |
| A1 | 0.000 | 0.254 | 0.000 | 0.010 |
| b | 0.650 | 0.850 | 0.026 | 0.033 |
| b2 | 0.950 | 1.321 | 0.037 | 0.052 |
| c | 0.330 | 0.650 | 0.013 | 0.026 |
| c2 | 0.170 | 1.400 | 0.046 | 0.055 |
| D | 8.509 | 9.450 | 0.335 | 0.372 |
| D1 | 7.100 | - | 0.280 | - |
| E | 9.800 | 10.312 | 0.386 | 0.406 |
| E1 | 6.500 | - | 0.256 | - |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 2 | | 2 | |
| H | 14.605 | 15.875 | 0.575 | 0.625 |
| L | 2.200 | 3.000 | 0.087 | 0.118 |
| L1 | - | 1.600 | - | 0.063 |
| L2 | 1.000 | 1.778 | 0.039 | 0.070 |
| F1 | 16.050 | 16.250 | 0.632 | 0.640 |
| F2 | 9.300 | 9.500 | 0.366 | 0.374 |
| F3 | 4.500 | 4.700 | 0.177 | 0.185 |
| F4 | 10.700 | 10.900 | 0.421 | 0.429 |
| F5 | 3.630 | 3.830 | 0.143 | 0.151 |
| F6 | 1.100 | 1.300 | 0.043 | 0.051 |

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