

**OptiMOS™3 Power-Transistor**
**Features**

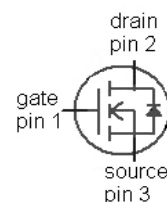
- Fast switching MOSFET for SMPS
- Optimized technology for DC/DC converters
- Qualified according to JEDEC<sup>1)</sup> for target applications
- N-channel, normal level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 100% Avalanche tested
- Pb-free plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

**Product Summary**

|                  |     |            |
|------------------|-----|------------|
| $V_{DS}$         | 40  | V          |
| $R_{DS(on),max}$ | 1.5 | m $\Omega$ |
| $I_D$            | 120 | A          |



| Type           | IPB015N04N G | IPP015N04N G |
|----------------|--------------|--------------|
|                |              |              |
| <b>Package</b> | PG-TO263-3   | PG-TO220-3   |
| <b>Marking</b> | 015N04N      | 015N04N      |


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

| Parameter                                     | Symbol        | Conditions                                  | Value    | Unit |
|---|---------------|---|----------|------|
| Continuous drain current                      | $I_D$         | $V_{GS}=10\text{ V}, T_C=25\text{ °C}$      | 120      | A    |
|   |               | $V_{GS}=10\text{ V}, T_C=100\text{ °C}$     | 120      |      |
| Pulsed drain current <sup>2)</sup>            | $I_{D,pulse}$ | $T_C=25\text{ °C}$                          | 400      |      |
| Avalanche current, single pulse <sup>3)</sup> | $I_{AS}$      | $T_C=25\text{ °C}$                          | 100      |      |
| Avalanche energy, single pulse                | $E_{AS}$      | $I_D=100\text{ A}, R_{GS}=25\text{ }\Omega$ | 865      | mJ   |
| Gate source voltage                           | $V_{GS}$      |   | $\pm 20$ | V    |

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> See figure 3 for more detailed information

<sup>3)</sup> See figure 13 for more detailed information

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

| Parameter                           | Symbol                | Conditions         | Value       | Unit |
|-------------------------------------|-----------------------|--------------------|-------------|------|
| Power dissipation                   | $P_{\text{tot}}$      | $T_c=25\text{ °C}$ | 250         | W    |
| Operating and storage temperature   | $T_j, T_{\text{stg}}$ |                    | -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 | $R_{\text{thJC}}$ |  | - | - | 0.6 | K/W |
| SMD version, device on PCB          | $R_{\text{thJA}}$ | minimal footprint                            | - | - | 62  |     |
|                                     |                   | 6 cm <sup>2</sup> cooling area <sup>4)</sup> | - | - | 40  |     |

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

#### Static characteristics

|  |                             |  |     |     |     |               |
|--|-----------------------------|--|-----|-----|-----|---------------|
| Drain-source breakdown voltage                 | $V_{(\text{BR})\text{DSS}}$ | $V_{\text{GS}}=0\text{ V}, I_{\text{D}}=1\text{ mA}$                             | 40  | -   | -   | V             |
| Gate threshold voltage                         | $V_{\text{GS(th)}}$         | $V_{\text{DS}}=V_{\text{GS}}, I_{\text{D}}=200\text{ }\mu\text{A}$               | 2   | -   | 4   |               |
| Zero gate voltage drain current                | $I_{\text{DSS}}$            | $V_{\text{DS}}=40\text{ V}, V_{\text{GS}}=0\text{ V}, T_j=25\text{ °C}$          | -   | 0.1 | 2   | $\mu\text{A}$ |
|  |                             | $V_{\text{DS}}=40\text{ V}, V_{\text{GS}}=0\text{ V}, T_j=125\text{ °C}$         | -   | 20  | 200 |               |
| Gate-source leakage current                    | $I_{\text{GSS}}$            | $V_{\text{GS}}=20\text{ V}, V_{\text{DS}}=0\text{ V}$                            | -   | 10  | 100 | nA            |
| Drain-source on-state resistance <sup>5)</sup> | $R_{\text{DS(on)}}$         | $V_{\text{GS}}=10\text{ V}, I_{\text{D}}=100\text{ A}$                           | -   | 1.2 | 1.5 | m $\Omega$    |
| Gate resistance                                | $R_{\text{G}}$              |  | -   | 1.5 | -   | $\Omega$      |
| Transconductance                               | $g_{\text{fs}}$             | $ V_{\text{DS}} >2 I_{\text{D}} R_{\text{DS(on)max}}, I_{\text{D}}=100\text{ A}$ | 120 | 230 | -   | S             |

<sup>4)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70  $\mu\text{m}$  thick) copper area for drain connection. PCB is vertical in still air.

<sup>5)</sup> Measured from drain tab to source pin

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

**Dynamic characteristics**

|                              |              |   |   |       |       |    |
|------------------------------|--------------|---|---|-------|-------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=20\text{ V},$<br>$f=1\text{ MHz}$                    | - | 15000 | 20000 | pF |
| Output capacitance           | $C_{oss}$    |   | - | 4000  | 5300  |    |
| Reverse transfer capacitance | $C_{rss}$    |   | - | 160   | -     |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=30\text{ A}, R_G=1.6\ \Omega$ | - | 40    | -     | ns |
| Rise time                    | $t_r$        |   | - | 10    | -     |    |
| Turn-off delay time          | $t_{d(off)}$ |   | - | 64    | -     |    |
| Fall time                    | $t_f$        |   | - | 13    | -     |    |

**Gate Charge Characteristics<sup>6)</sup>**

|                              |               |   |   |     |     |    |
|------------------------------|---------------|---|---|-----|-----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=20\text{ V}, I_D=100\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 76  | -   | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |   | - | 46  | -   |    |
| Gate to drain charge         | $Q_{gd}$      |   | - | 23  | -   |    |
| Switching charge             | $Q_{sw}$      |   | - | 75  | -   |    |
| Gate charge total            | $Q_g$         |   | - | 188 | 250 |    |
| Gate plateau voltage         | $V_{plateau}$ |   | - | 5.0 | -   |    |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$<br>$V_{GS}=0\text{ to }10\text{ V}$                  | - | 177 | -   | nC |
| Output charge                | $Q_{oss}$     | $V_{DD}=20\text{ V}, V_{GS}=0\text{ V}$                                     | - | 147 | -   |    |

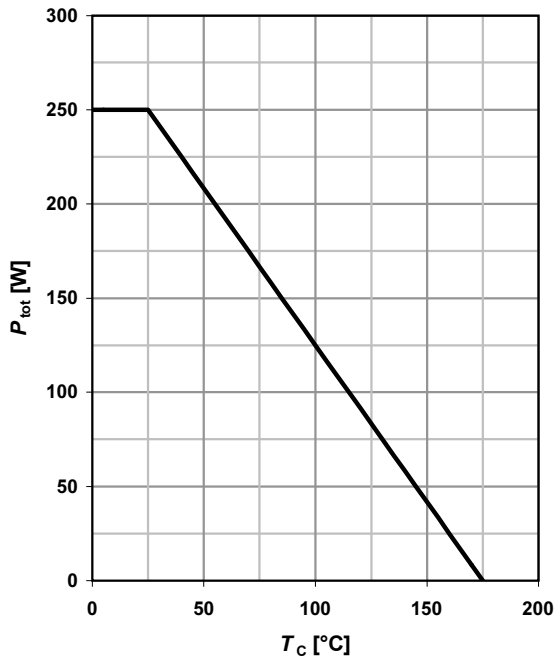
**Reverse Diode**

|                                  |               |  |   |      |     |    |
|----------------------------------|---------------|--|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^\circ\text{C}$   | - | -    | 120 | A  |
| Diode pulse current              | $I_{S,pulse}$ |  | - | -    | 400 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=100\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 0.88 | 1.2 | V  |
| Reverse recovery charge          | $Q_{rr}$      | $V_R=15\text{ V}, I_F=I_S,$<br>$di_F/dt=400\text{ A}/\mu\text{s}$        | - | 141  | -   | nC |

<sup>6)</sup> See figure 16 for gate charge parameter definition

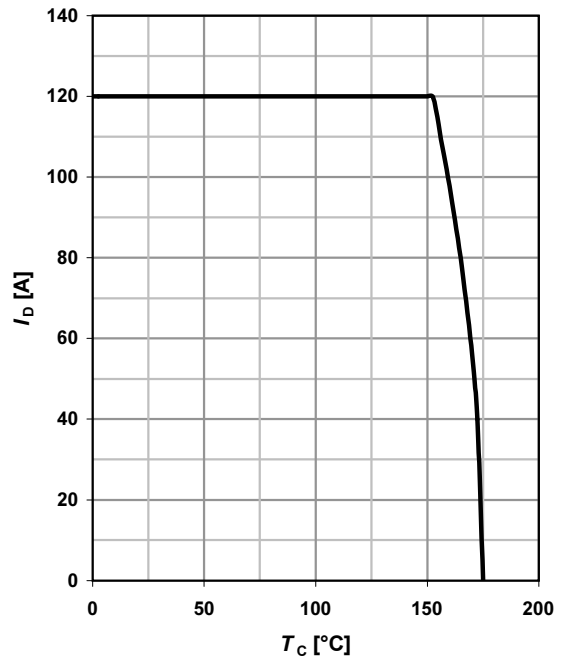
**1 Power dissipation**

$P_{tot}=f(T_C)$



**2 Drain current**

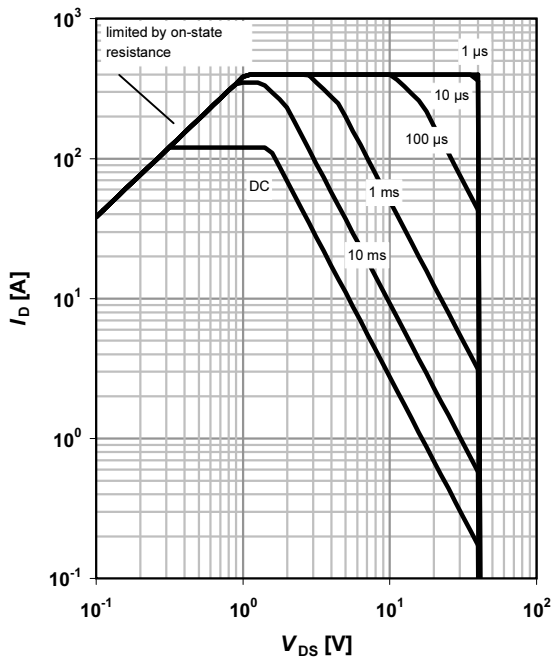
$I_D=f(T_C); V_{GS} \geq 10\text{ V}$



**3 Safe operating area**

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

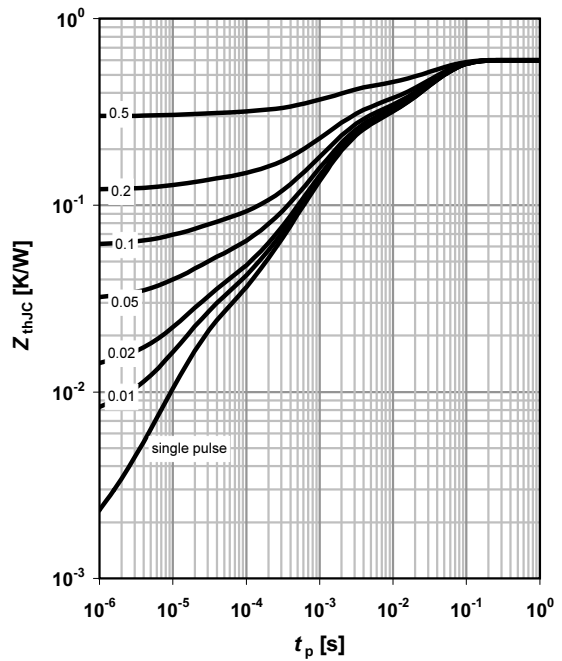
parameter:  $t_p$



**4 Max. transient thermal impedance**

$Z_{thJC}=f(t_p)$

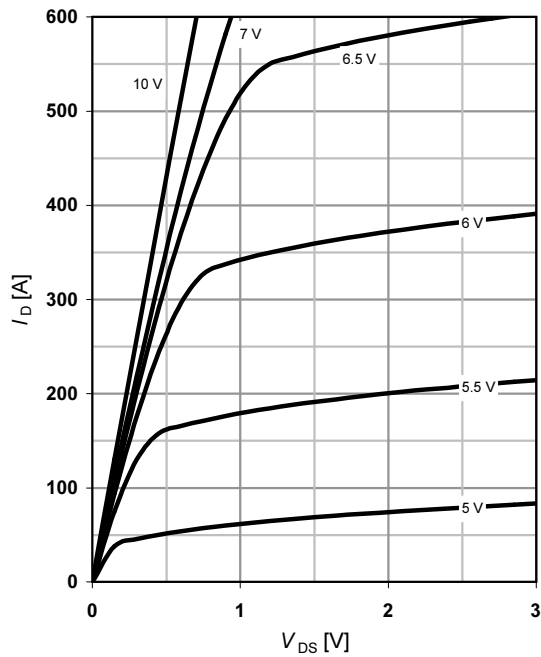
parameter:  $D=t_p/T$



**5 Typ. output characteristics**

$I_D = f(V_{DS}); T_j = 25\text{ °C}$

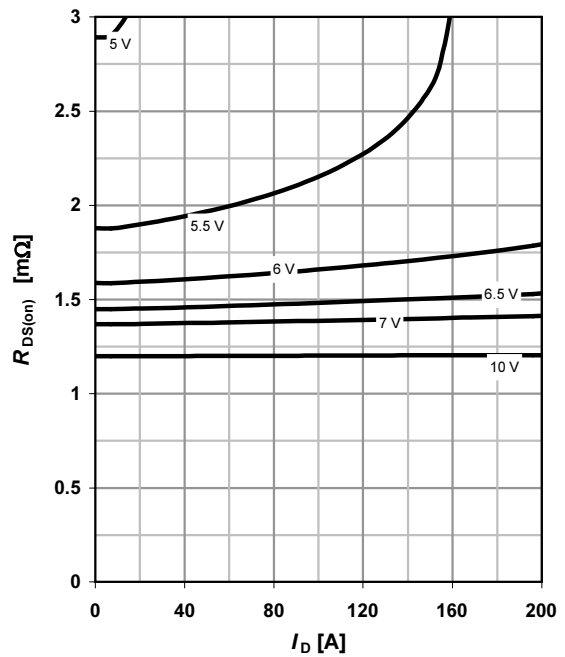
parameter:  $V_{GS}$



**6 Typ. drain-source on resistance**

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

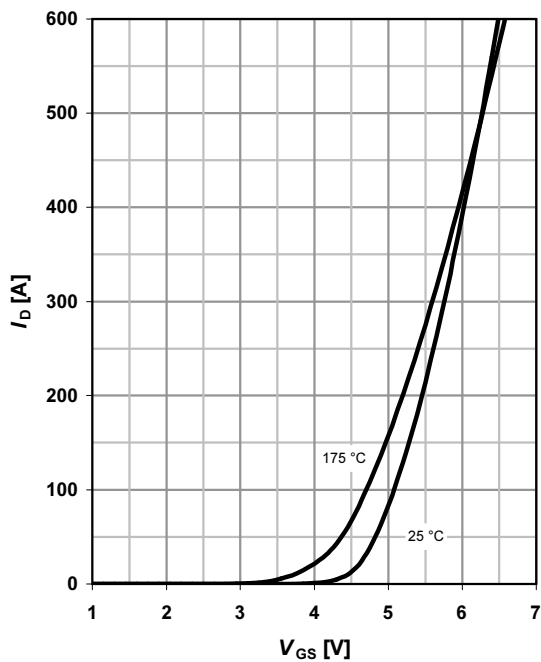
parameter:  $V_{GS}$



**7 Typ. transfer characteristics**

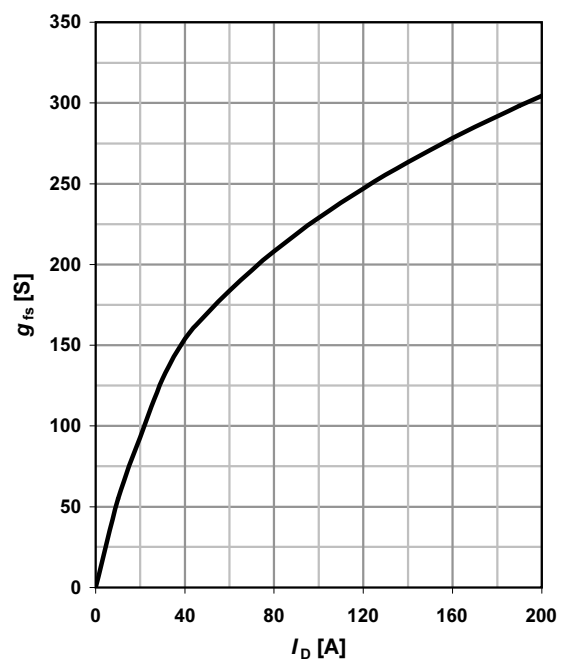
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter:  $T_j$



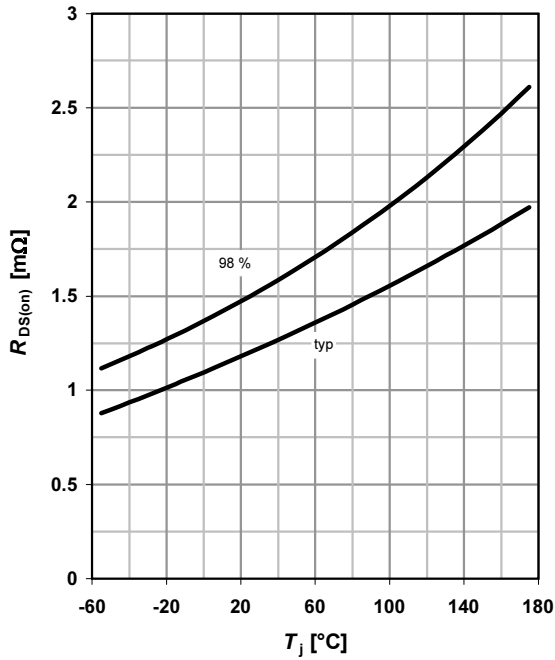
**8 Typ. forward transconductance**

$g_{fs} = f(I_D); T_j = 25\text{ °C}$



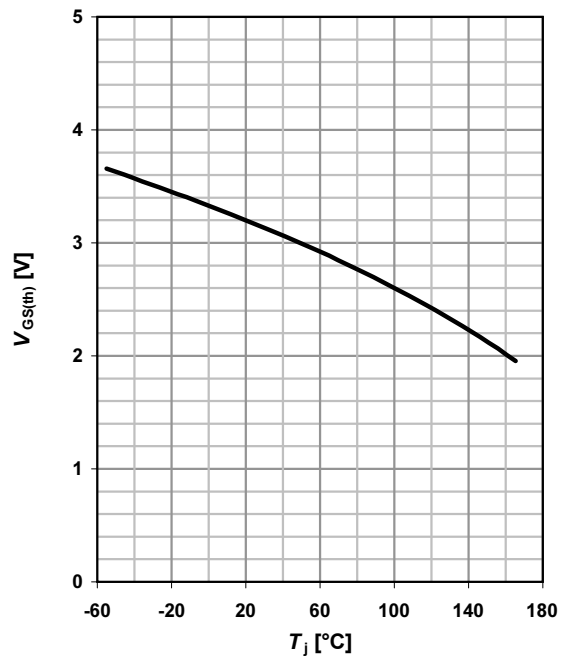
**9 Drain-source on-state resistance**

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



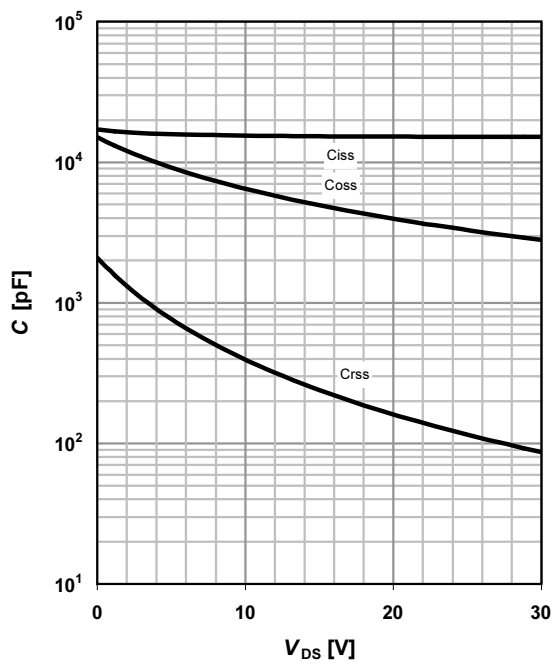
**10 Typ. gate threshold voltage**

$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}; I_D = 1 \text{ mA}$



**11 Typ. capacitances**

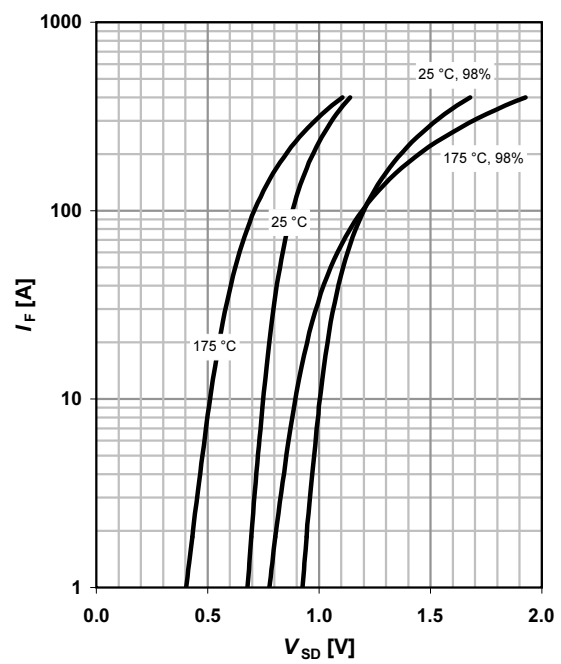
$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



**12 Forward characteristics of reverse diode**

$I_F = f(V_{SD})$

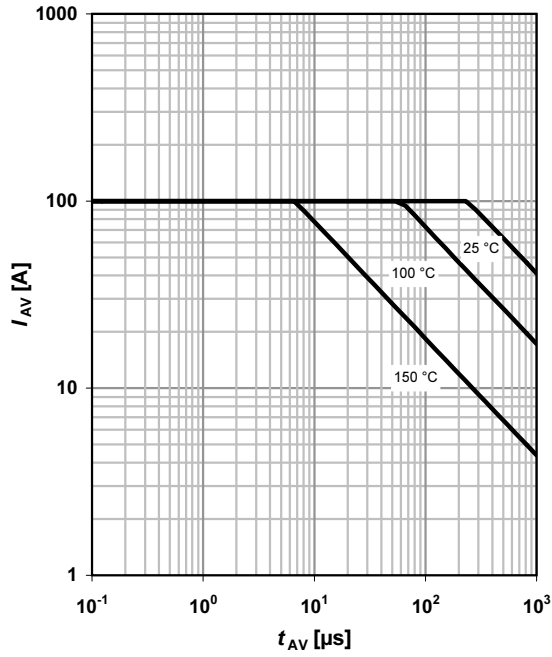
parameter:  $T_j$



**13 Avalanche characteristics**

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

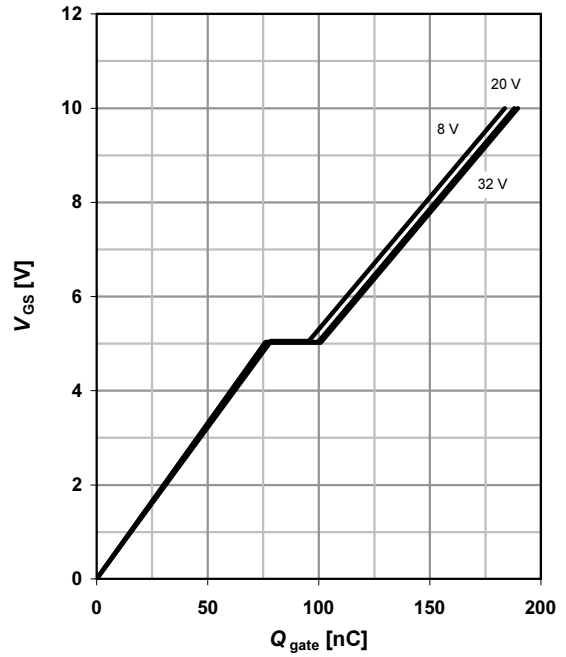
parameter:  $T_{j(start)}$



**14 Typ. gate charge**

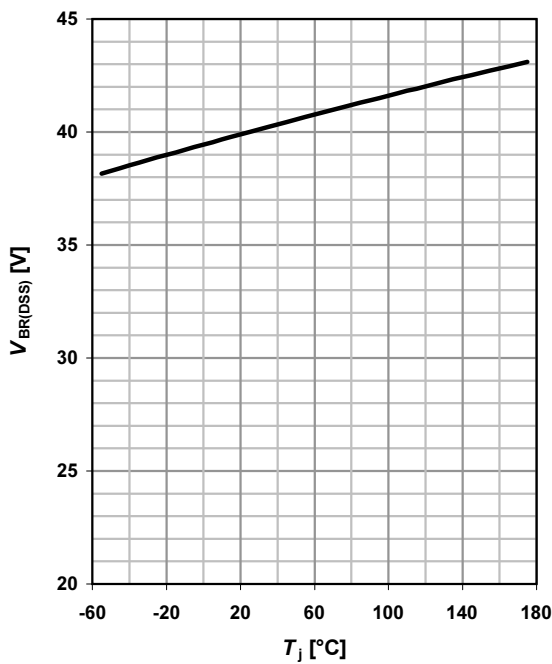
$V_{GS}=f(Q_{gate}); I_D=100 \text{ A pulsed}$

parameter:  $V_{DD}$

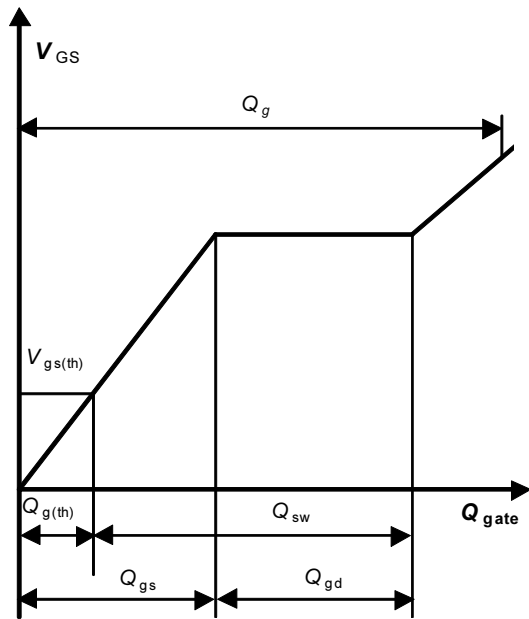


**15 Drain-source breakdown voltage**

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

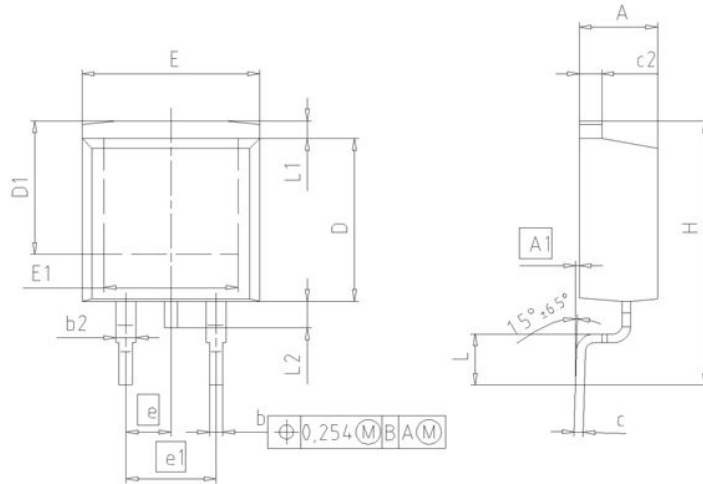


**16 Gate charge waveforms**

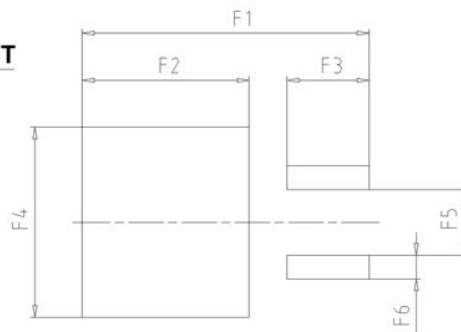


Package Outline

PG-TO263-3



FOOTPRINT



| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 4.30        | 4.57  | 0.169  | 0.180 |
| A1  | 0.00        | 0.25  | 0.000  | 0.010 |
| b   | 0.65        | 0.85  | 0.026  | 0.033 |
| b2  | 0.95        | 1.15  | 0.037  | 0.045 |
| c   | 0.33        | 0.65  | 0.013  | 0.026 |
| c2  | 1.17        | 1.40  | 0.046  | 0.055 |
| D   | 8.51        | 9.45  | 0.335  | 0.372 |
| D1  | 7.10        | 7.90  | 0.280  | 0.311 |
| E   | 9.80        | 10.31 | 0.386  | 0.406 |
| E1  | 6.50        | 8.60  | 0.256  | 0.339 |
| e   | 2.54        |       | 0.100  |       |
| e1  | 5.08        |       | 0.200  |       |
| N   | 2           |       | 2      |       |
| H   | 14.61       | 15.88 | 0.575  | 0.625 |
| L   | 2.29        | 3.00  | 0.090  | 0.118 |
| L1  | 0.70        | 1.60  | 0.028  | 0.063 |
| L2  | 1.00        | 1.78  | 0.039  | 0.070 |
| F1  | 16.05       | 16.25 | 0.632  | 0.640 |
| F2  | 9.30        | 9.50  | 0.366  | 0.374 |
| F3  | 4.50        | 4.70  | 0.177  | 0.185 |
| F4  | 10.70       | 10.90 | 0.421  | 0.429 |
| F5  | 3.65        | 3.85  | 0.144  | 0.152 |
| F6  | 1.25        | 1.45  | 0.049  | 0.057 |

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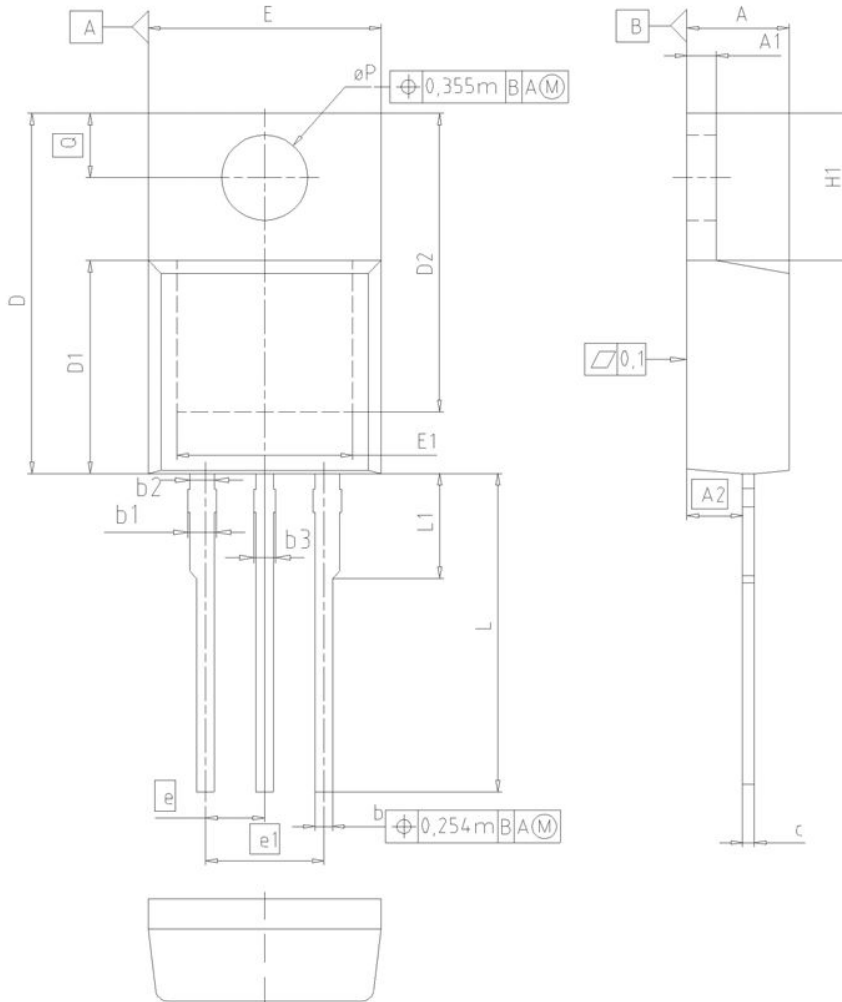
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Package Outline

PG-TO220-3-1



| 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 |
| øP  | 3.60        | 3.89  | 0.142  | 0.153 |
| Q   | 2.60        | 3.00  | 0.102  | 0.118 |

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**EUROPEAN PROJECTION**

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