

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

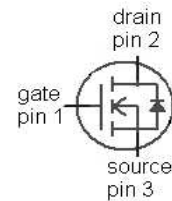
- Fast switching MOSFET for SMPS
- Optimized technology for DC/DC converters
- Qualified according to JEDEC<sup>1)</sup> for target applications
- N-channel, normal level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 100% Avalanche tested
- Pb-free plating;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

**Product Summary**

|                  |     |            |
|------------------|-----|------------|
| $V_{DS}$         | 40  | V          |
| $R_{DS(on),max}$ | 4.1 | m $\Omega$ |
| $I_D$            | 80  | A          |



| Type           | IPB041N04N G | IPP041N04N G |
|----------------|--------------|--------------|
|                |              |              |
| <b>Package</b> | PG-TO263-3   | PG-TO220-3   |
| <b>Marking</b> | 041N04N      | 041N04N      |


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

| Parameter                                     | Symbol        | Conditions                                 | Value    | Unit |
|---|---------------|--|----------|------|
| Continuous drain current                      | $I_D$         | $V_{GS}=10\text{ V}, T_C=25\text{ °C}$     | 80       | A    |
|   |               | $V_{GS}=10\text{ V}, T_C=100\text{ °C}$    | 80       |      |
| Pulsed drain current <sup>2)</sup>            | $I_{D,pulse}$ | $T_C=25\text{ °C}$                         | 400      |      |
| Avalanche current, single pulse <sup>3)</sup> | $I_{AS}$      | $T_C=25\text{ °C}$                         | 80       |      |
| Avalanche energy, single pulse                | $E_{AS}$      | $I_D=80\text{ A}, R_{GS}=25\text{ }\Omega$ | 60       | mJ   |
| Gate source voltage                           | $V_{GS}$      |  | $\pm 20$ | V    |

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

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

| Parameter                           | Symbol                | Conditions         | Value       | Unit |
|-------------------------------------|-----------------------|--------------------|-------------|------|
| Power dissipation                   | $P_{\text{tot}}$      | $T_C=25\text{ °C}$ | 94          | 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 | $R_{\text{thJC}}$ |  | - | - | 1.6 | 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                         | $V_{\text{GS(th)}}$         | $V_{\text{DS}}=V_{\text{GS}}, I_{\text{D}}=45\text{ }\mu\text{A}$               | 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 | 1   | $\mu\text{A}$    |
|  |                             | $V_{\text{DS}}=40\text{ V}, V_{\text{GS}}=0\text{ V}, T_j=125\text{ °C}$        | -  | 10  | 100 |                  |
| 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> | $R_{\text{DS(on)}}$         | $V_{\text{GS}}=10\text{ V}, I_{\text{D}}=80\text{ A}$                           | -  | 3.3 | 4.1 | $\text{m}\Omega$ |
| Gate resistance                                | $R_{\text{G}}$              |   | -  | 1.6 | -   | $\Omega$         |
| Transconductance                               | $g_{\text{fs}}$             | $ V_{\text{DS}} >2 I_{\text{D}} R_{\text{DS(on)max}}, I_{\text{D}}=80\text{ A}$ | 50 | 100 | -   | S                |

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

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

<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>$f=1\text{ MHz}$                    | - | 3400 | 4500 | pF |
| Output capacitance           | $C_{oss}$    |   | - | 980  | 1300 |    |
| Reverse transfer capacitance | $C_{rss}$    |   | - | 36   | -    |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=30\text{ A}, R_G=1.6\ \Omega$ | - | 16   | -    | ns |
| Rise time                    | $t_r$        |   | - | 3.8  | -    |    |
| Turn-off delay time          | $t_{d(off)}$ |   | - | 23   | -    |    |
| Fall time                    | $t_f$        |   | - | 4.8  | -    |    |

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

|                              |               |  |   |      |    |    |
|------------------------------|---------------|--|---|------|----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=20\text{ V}, I_D=30\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 18   | -  | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |  | - | 10.3 | -  |    |
| Gate to drain charge         | $Q_{gd}$      |  | - | 5.3  | -  |    |
| Switching charge             | $Q_{sw}$      |  | - | 12.5 | -  |    |
| Gate charge total            | $Q_g$         |  | - | 42   | 56 |    |
| Gate plateau voltage         | $V_{plateau}$ |  | - | 5.1  | -  |    |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$<br>$V_{GS}=0\text{ to }10\text{ V}$                 | - | 40   | -  | nC |
| Output charge                | $Q_{oss}$     | $V_{DD}=20\text{ V}, V_{GS}=0\text{ V}$                                    | - | 41   | -  |    |

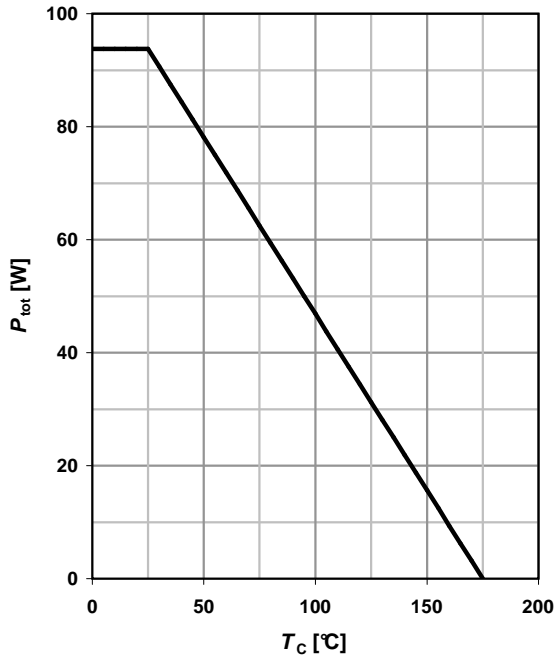
**Reverse Diode**

|                                  |               |   |   |      |     |    |
|----------------------------------|---------------|---|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^\circ\text{C}$  | - | -    | 78  | A  |
| Diode pulse current              | $I_{S,pulse}$ |   | - | -    | 400 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=80\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 0.96 | 1.2 | V  |
| Reverse recovery charge          | $Q_{rr}$      | $V_R=20\text{ V}, I_F=I_S,$<br>$di_F/dt=400\text{ A}/\mu\text{s}$       | - | 46   | -   | nC |

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

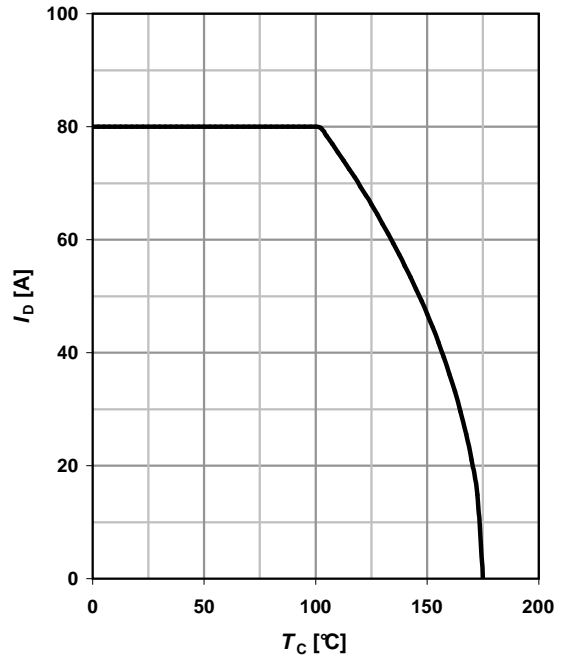
**1 Power dissipation**

$P_{tot}=f(T_C)$



**2 Drain current**

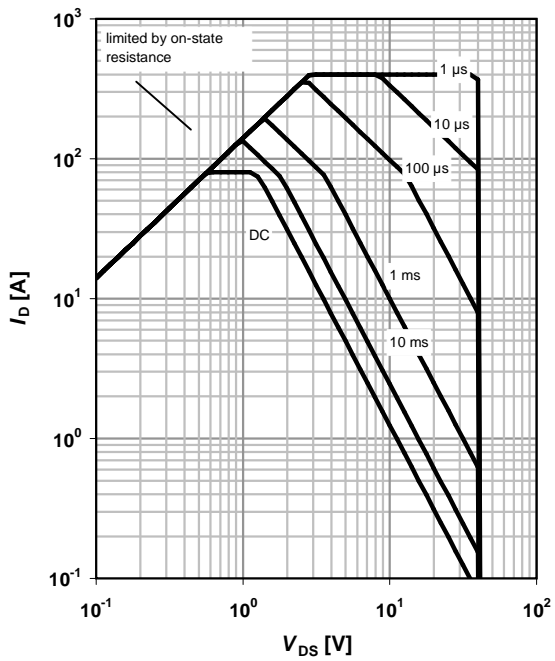
$I_D=f(T_C); V_{GS} \geq 10\text{ V}$



**3 Safe operating area**

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

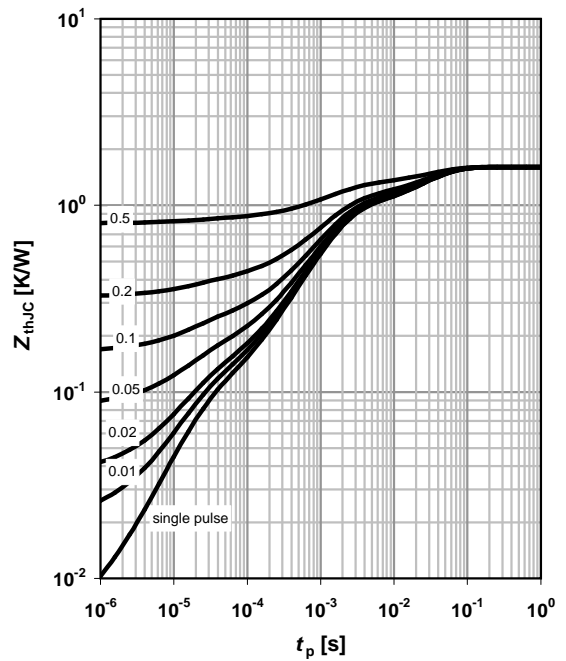
parameter:  $t_p$



**4 Max. transient thermal impedance**

$Z_{thJC}=f(t_p)$

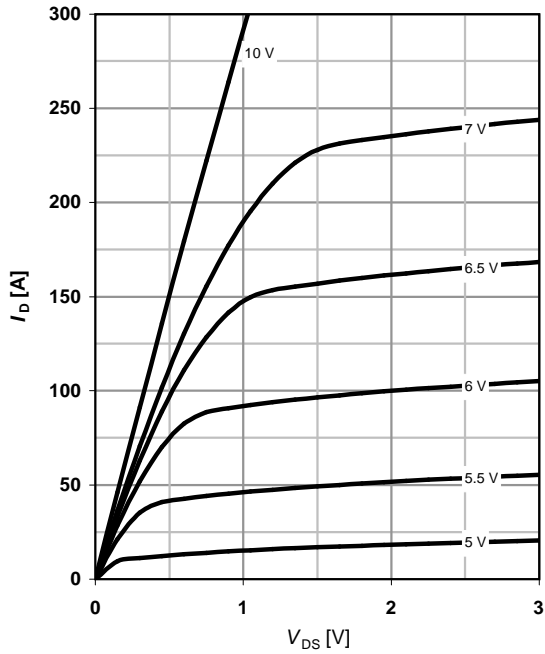
parameter:  $D=t_p/T$



**5 Typ. output characteristics**

$I_D = f(V_{DS}); T_j = 25\text{ °C}$

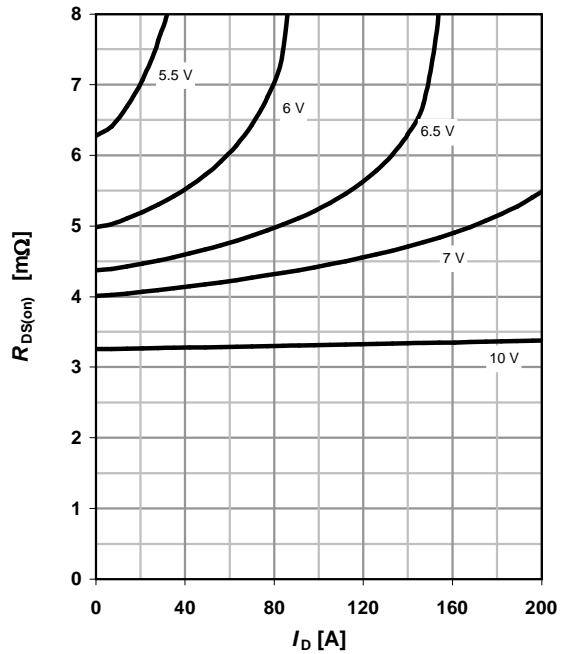
parameter:  $V_{GS}$



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

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

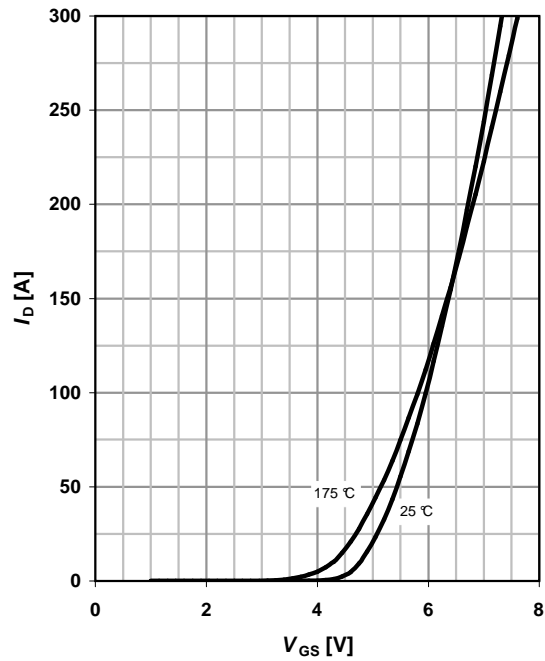
parameter:  $V_{GS}$



**7 Typ. transfer characteristics**

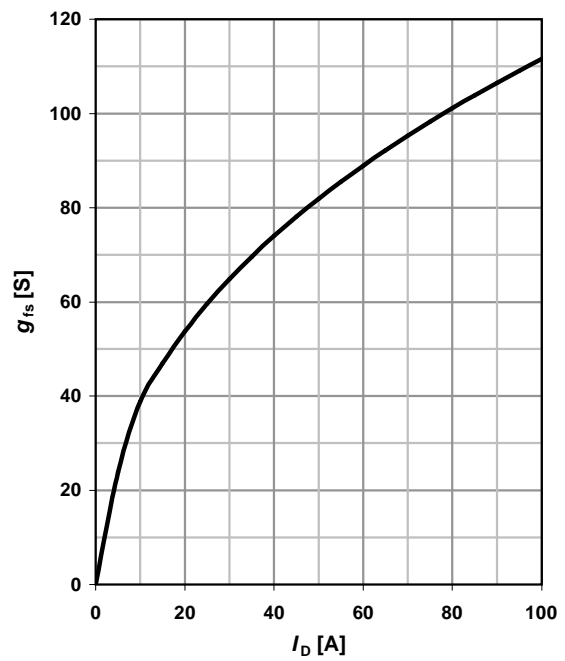
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter:  $T_j$



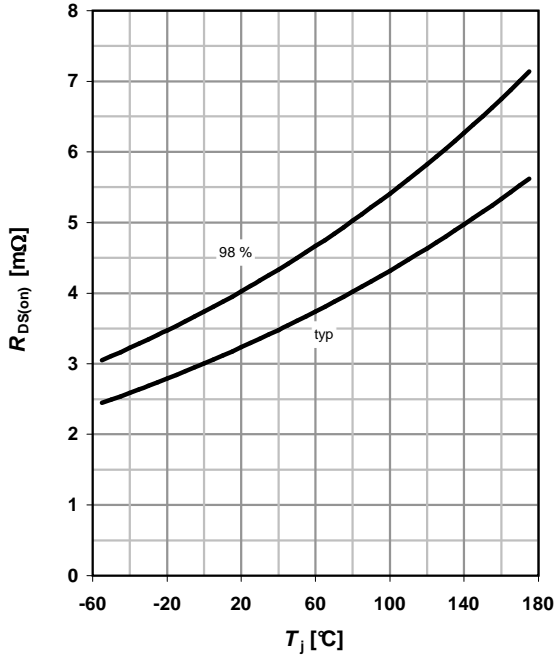
**8 Typ. forward transconductance**

$g_{fs} = f(I_D); T_j = 25\text{ °C}$



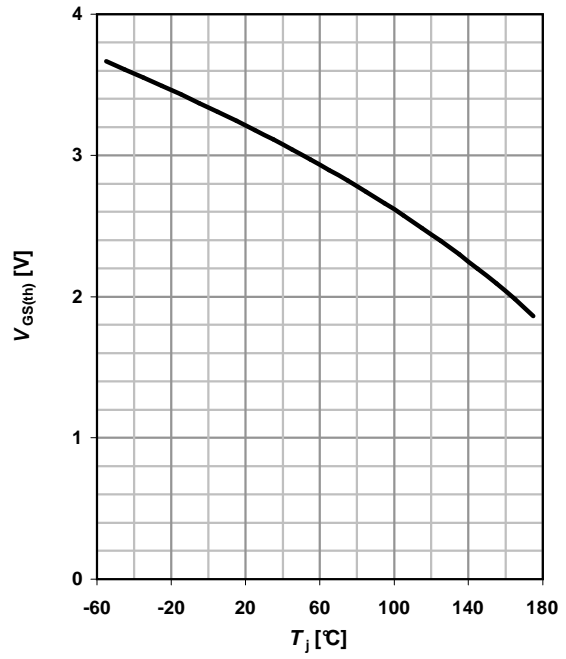
**9 Drain-source on-state resistance**

$R_{DS(on)} = f(T_j); I_D = 80 \text{ A}; V_{GS} = 10 \text{ V}$



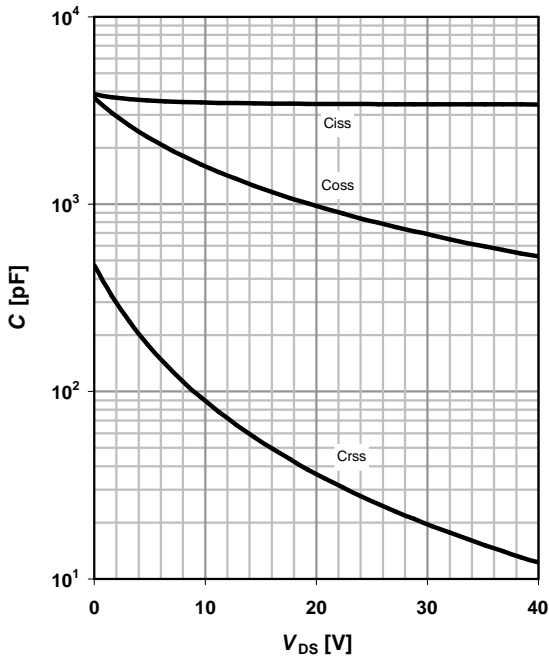
**10 Typ. gate threshold voltage**

$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}; I_D = 250 \mu\text{A}$



**11 Typ. capacitances**

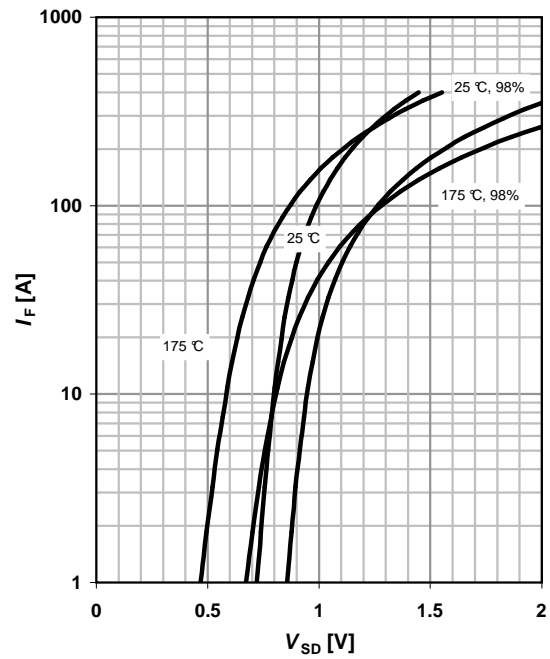
$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



**12 Forward characteristics of reverse diode**

$I_F = f(V_{SD})$

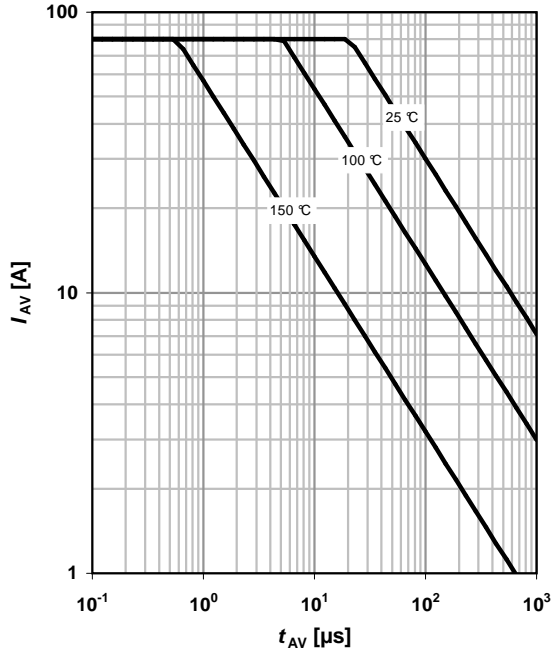
parameter:  $T_j$



**13 Avalanche characteristics**

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

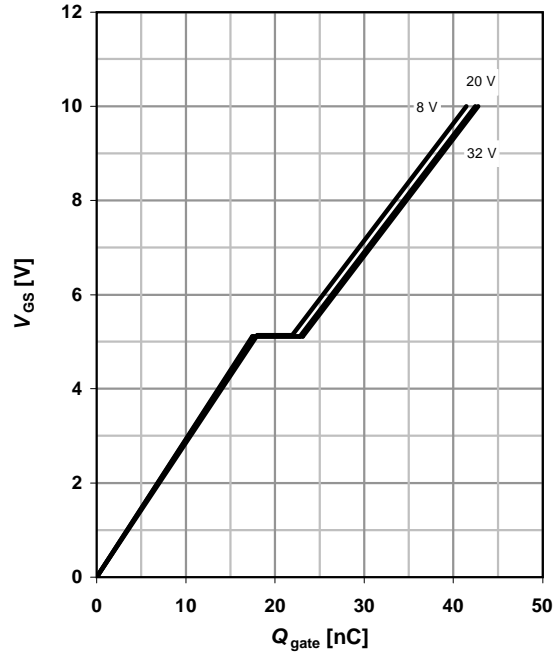
parameter:  $T_{j(start)}$



**14 Typ. gate charge**

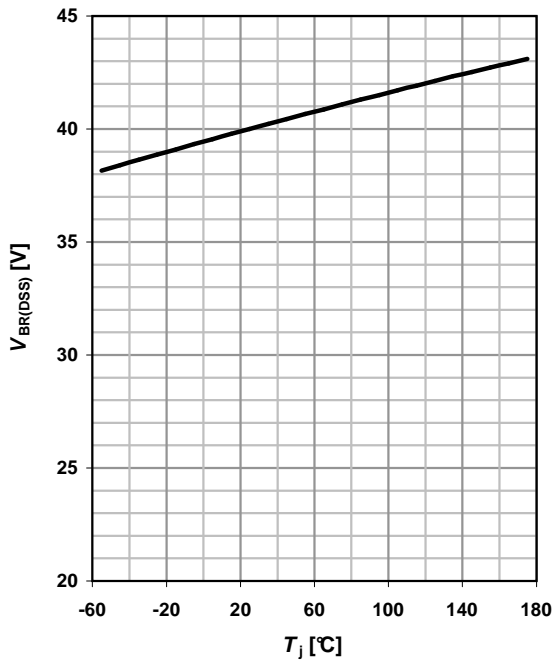
$V_{GS}=f(Q_{gate}); I_D=30 \text{ A pulsed}$

parameter:  $V_{DD}$

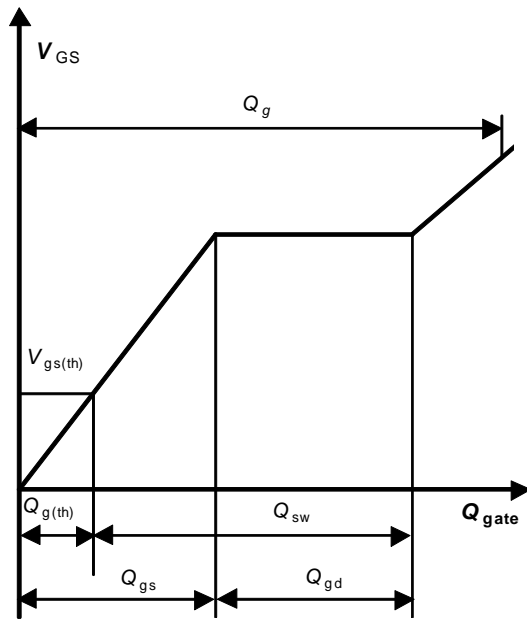


**15 Drain-source breakdown voltage**

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

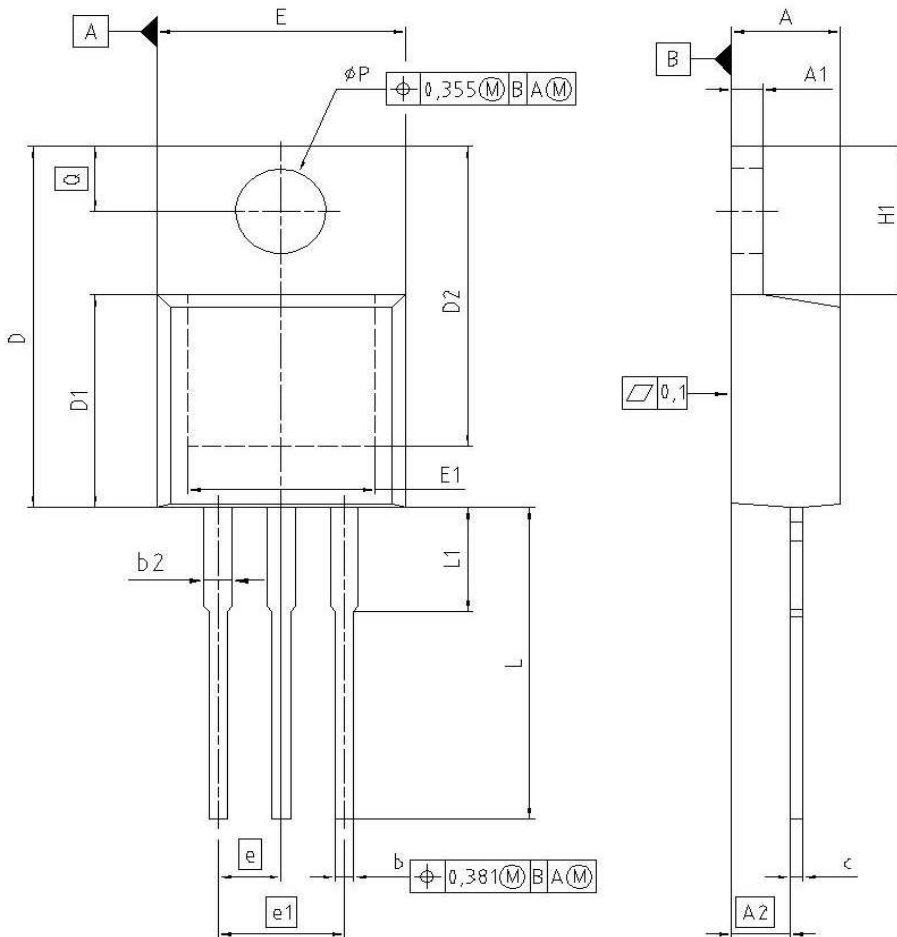


**16 Gate charge waveforms**



Package Outline

PG-TO220-3-1



| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 4.300       | 4.572  | 0.169  | 0.180 |
| A1  | 1.170       | 1.400  | 0.046  | 0.055 |
| A2  | 2.215       | 2.718  | 0.087  | 0.107 |
| b   | 0.650       | 0.864  | 0.026  | 0.034 |
| b2  | 0.635       | 1.778  | 0.025  | 0.070 |
| c   | 0.330       | 0.600  | 0.013  | 0.024 |
| D   | 14.808      | 15.950 | 0.583  | 0.628 |
| D1  | 8.509       | 9.450  | 0.335  | 0.372 |
| D2  | 12.850      | 13.100 | 0.506  | 0.516 |
| E   | 9.700       | 10.363 | 0.382  | 0.408 |
| E1  | 6.500       | 8.600  | 0.256  | 0.339 |
| e   | 2.540       |        | 0.100  |       |
| e1  | 5.080       |        | 0.200  |       |
| N   | 3           |        | 3      |       |
| H1  | 5.900       | 6.900  | 0.232  | 0.272 |
| L   | 13.000      | 14.000 | 0.512  | 0.551 |
| L1  | -           | 4.800  | -      | 0.189 |
| pP  | 3.700       | 3.886  | 0.146  | 0.153 |
| Q   | 2.600       | 3.000  | 0.102  | 0.118 |

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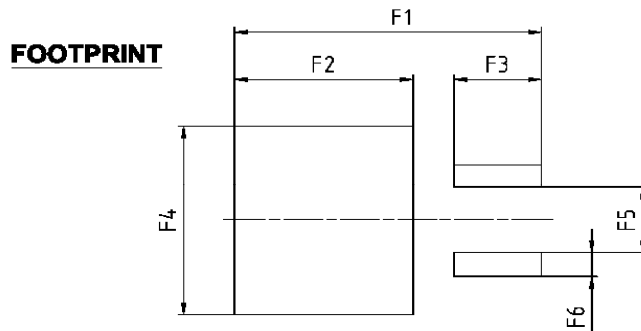
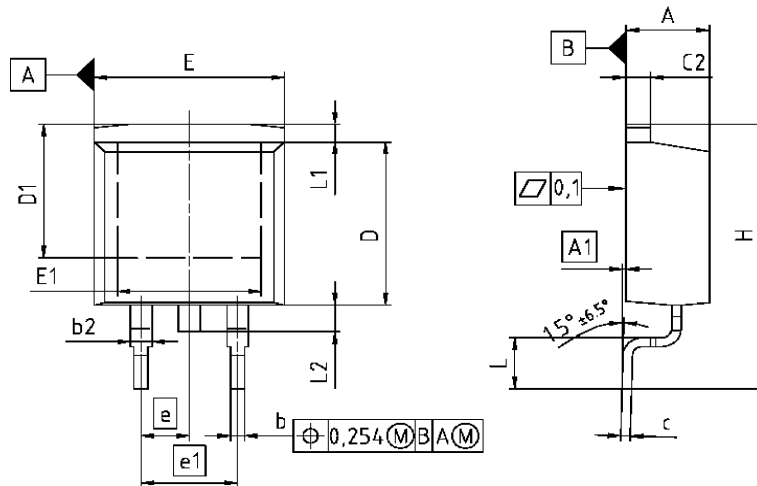
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TO220\_1



## Package Outline

## PG-TO263-3



| 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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**EUROPEAN PROJECTION**

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