

## OptiMOS™3 Power-Transistor

### Features

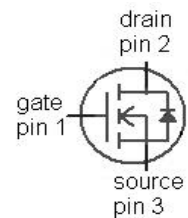
- N-channel, normal level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant, halogen free
- Qualified according to JEDEC<sup>1)</sup> for target application
- Ideal for high-frequency switching 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 <sup>3)</sup>  | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 480         |      |
| Avalanche energy, single pulse      | $E_{AS}$       | $I_D=100\text{ A}$ , $R_{GS}=25\text{ Ω}$ | 900         | mJ   |
| Gate source voltage <sup>4)</sup>   | $V_{GS}$       |                                           | ±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,<br>junction - ambient | $R_{thJA}$ | minimal footprint                            | - | - | 62  |     |
|                                           |            | 6 cm <sup>2</sup> cooling area <sup>5)</sup> | - | - | 40  |     |

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

|                                  |               |                                                             |     |     |     |               |
|----------------------------------|---------------|-------------------------------------------------------------|-----|-----|-----|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                        | 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  | $I_{DSS}$     | $V_{DS}=100\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$  | -   | 0.1 | 1   | $\mu\text{A}$ |
|                                  |               | $V_{DS}=100\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ °C}$ | -   | 10  | 100 |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                     | -   | 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 $\Omega$    |
|                                  |               | $V_{GS}=10\text{ V}, I_D=100\text{ A}, \text{TO263}$        | -   | 3.2 | 3.8 |               |
| Gate resistance                  | $R_G$         |                                                             | -   | 1.4 | -   | $\Omega$      |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max}, I_D=100\text{ A}$            | 83  | 165 | -   | S             |

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

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

<sup>3)</sup> See figure 3

<sup>4)</sup>  $T_{jmax}=150\text{ °C}$  and duty cycle  $D=0.01$  for  $V_{gs}<-5\text{ V}$

<sup>5)</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.

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

**Dynamic characteristics**

|                              |              |                                                                                             |   |       |       |    |
|------------------------------|--------------|---------------------------------------------------------------------------------------------|---|-------|-------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=60\text{ V},$<br>$f=1\text{ MHz}$                                | - | 10400 | 13800 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                             | - | 1320  | 1760  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                             | - | 61    | -     |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=60\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=100\text{ A},$<br>$R_{G,ext}=1.6\ \Omega$ | - | 35    | -     | ns |
| Rise time                    | $t_r$        |                                                                                             | - | 52.0  | -     |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                             | - | 70    | -     |    |
| Fall time                    | $t_f$        |                                                                                             | - | 21    | -     |    |

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

|                       |               |                                                                                    |   |     |     |    |
|-----------------------|---------------|------------------------------------------------------------------------------------|---|-----|-----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=60.1\text{ V},$<br>$I_D=100\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 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 | -   | V  |
| Output charge         | $Q_{oss}$     | $V_{DD}=60.1\text{ V}, V_{GS}=0\text{ V}$                                          | - | 182 | 243 | nC |

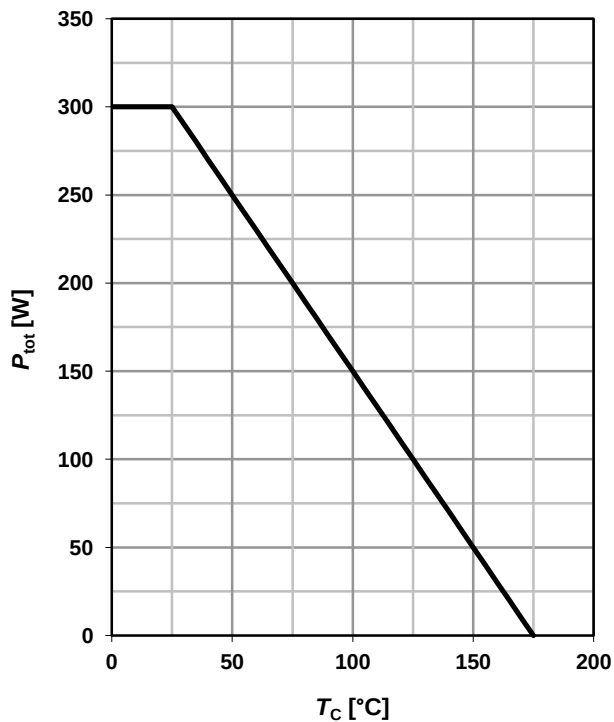
**Reverse Diode**

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

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

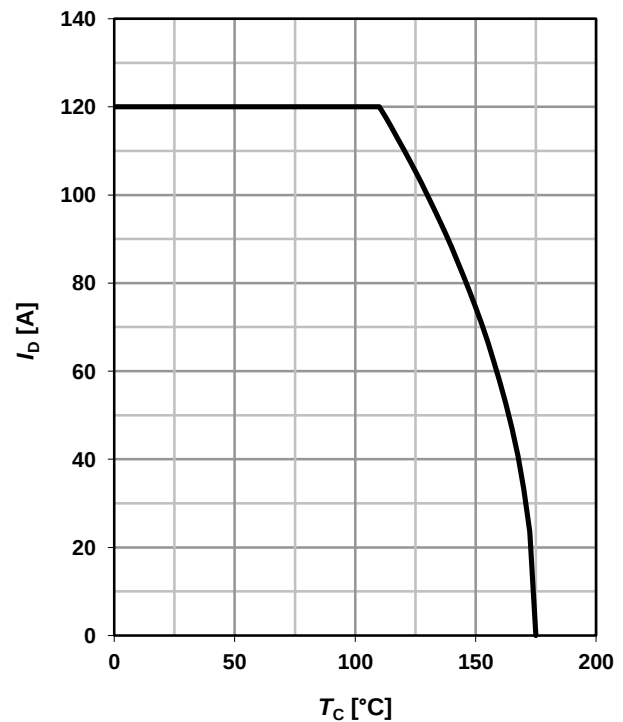
## 1 Power dissipation

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



## 2 Drain current

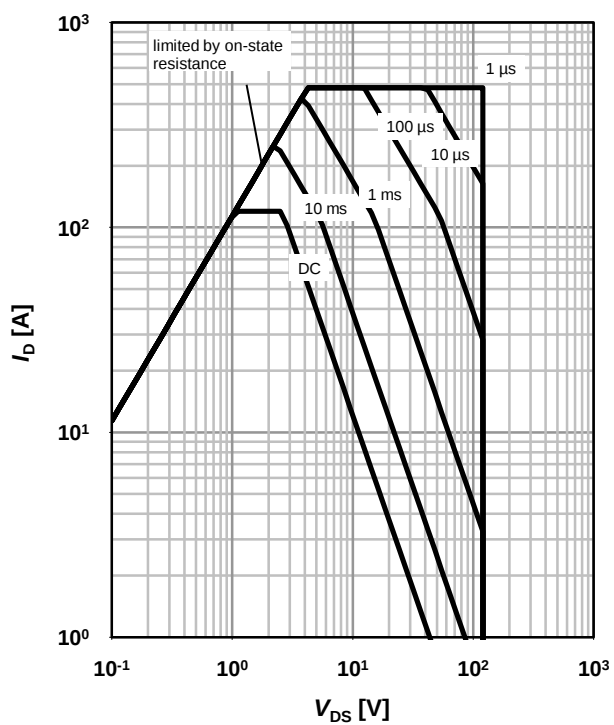
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



## 3 Safe operating area

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

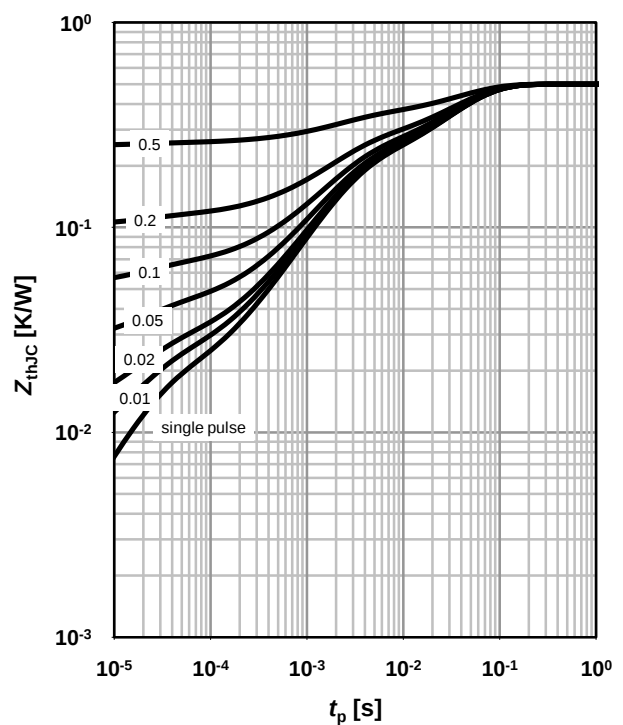
parameter:  $t_p$



## 4 Max. transient thermal impedance

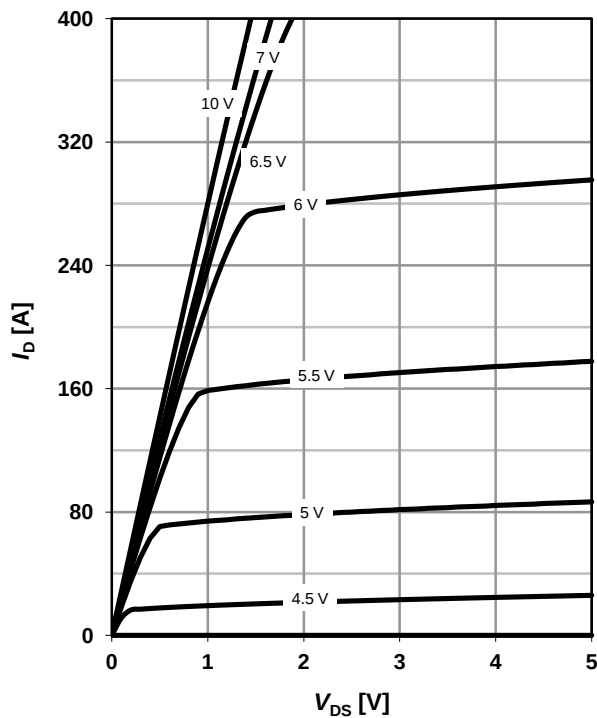
$$Z_{\text{thJC}} = f(t_p)$$

parameter:  $D = t_p/T$



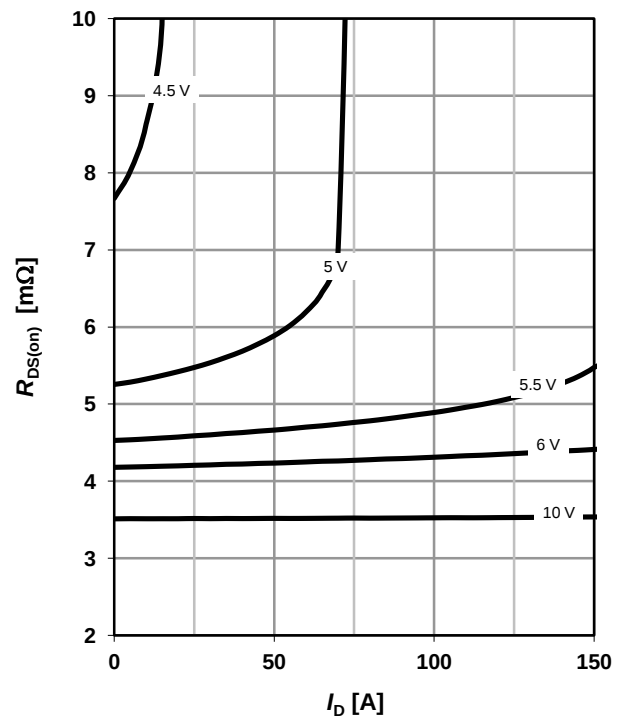
## 5 Typ. output characteristics

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

parameter:  $V_{GS}$ 


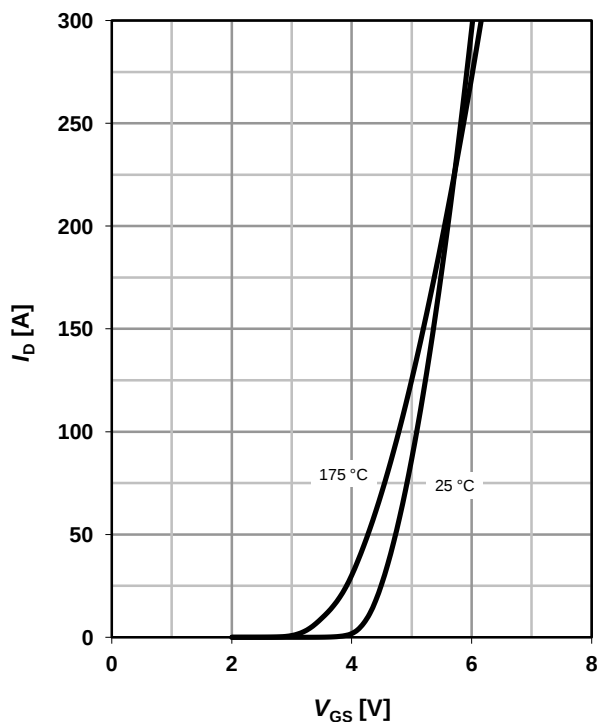
## 6 Typ. drain-source on resistance

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

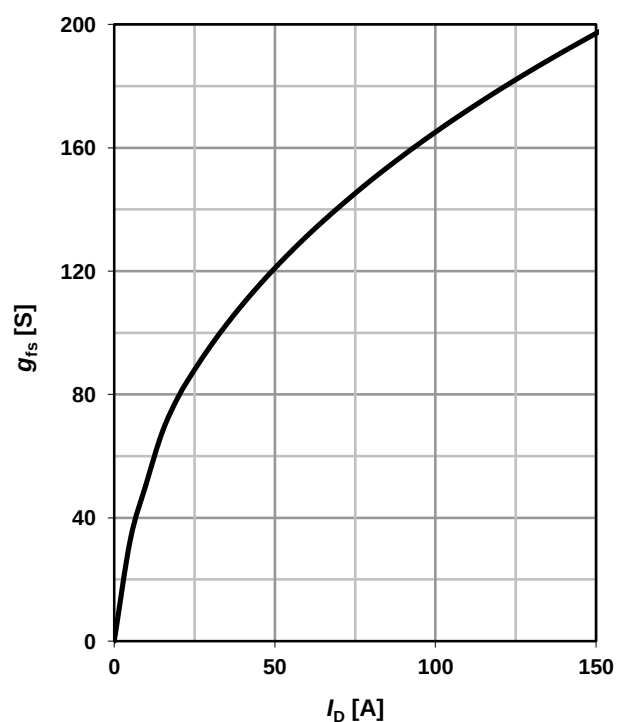
parameter:  $V_{GS}$ 


## 7 Typ. transfer characteristics

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

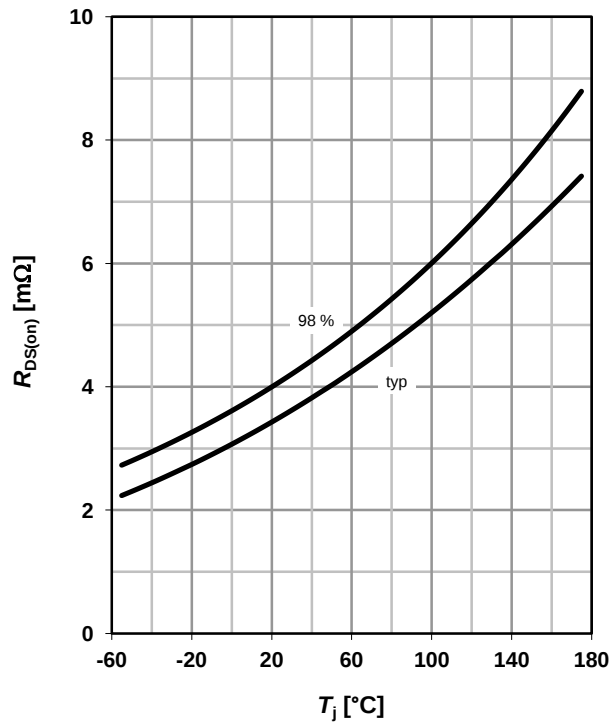
parameter:  $T_j$ 


## 8 Typ. forward transconductance

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


## 9 Drain-source on-state resistance

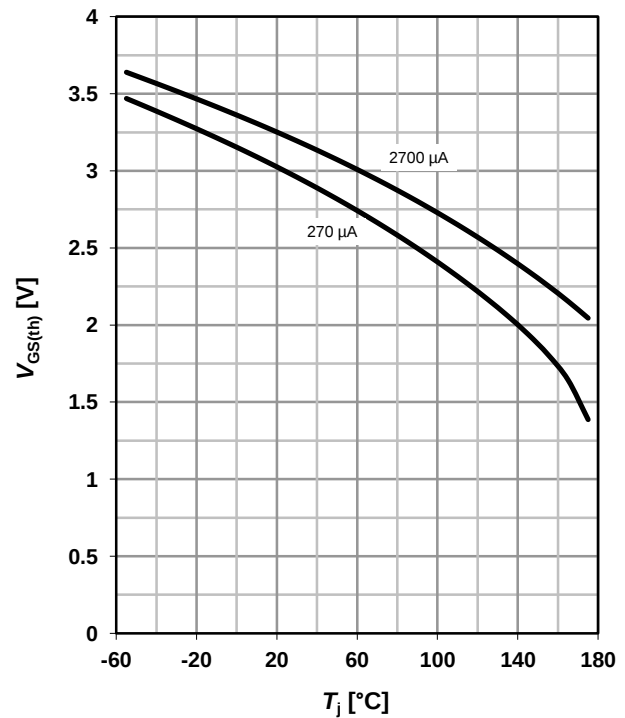
$$R_{DS(on)} = f(T_j); I_D = 100 \text{ A}; V_{GS} = 10 \text{ V}$$



## 10 Typ. gate threshold voltage

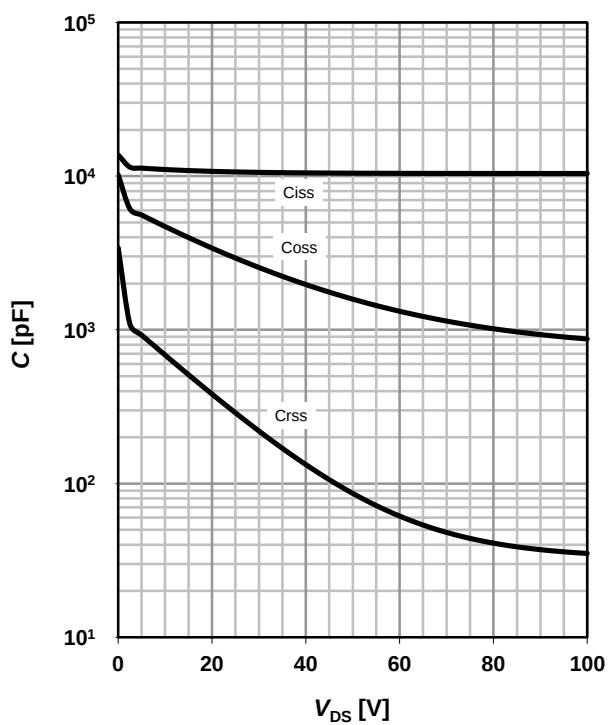
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



## 11 Typ. capacitances

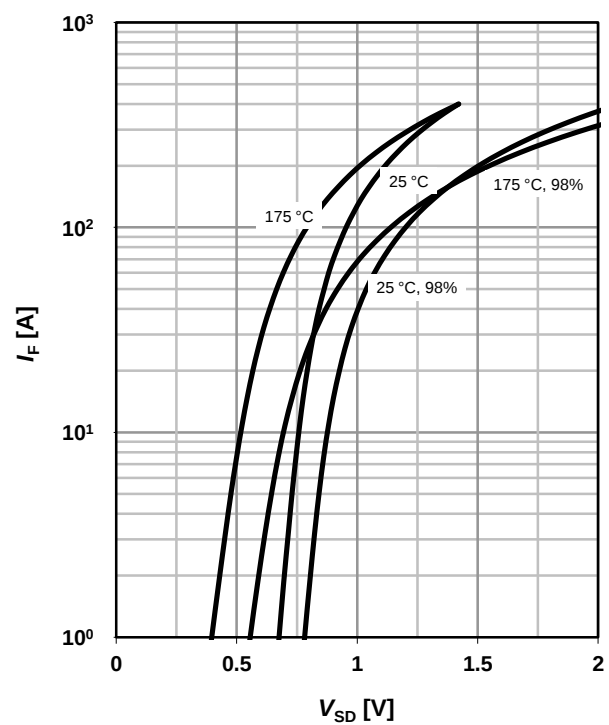
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



## 12 Forward characteristics of reverse diode

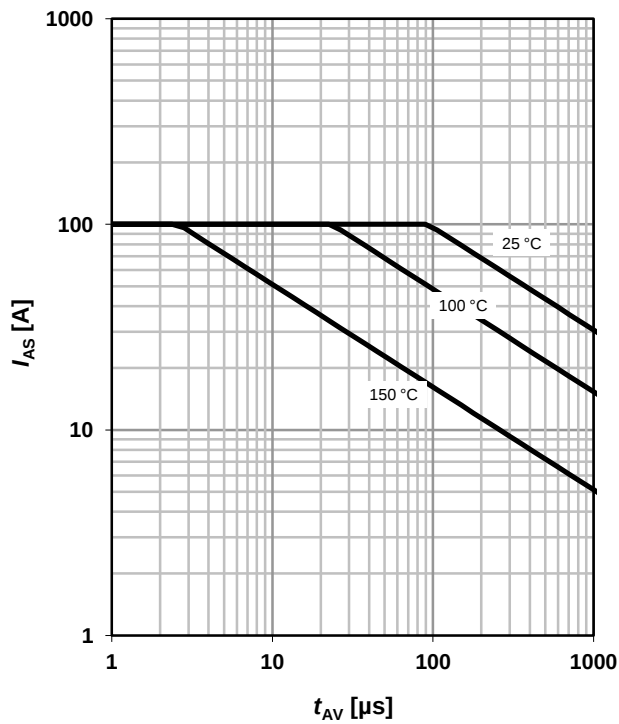
$$I_F = f(V_{SD})$$

parameter:  $T_j$



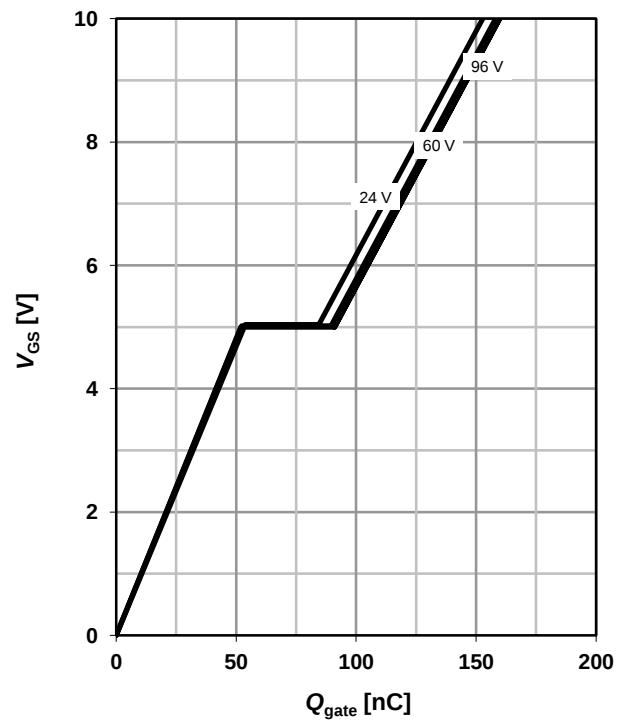
### 13 Avalanche characteristics

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

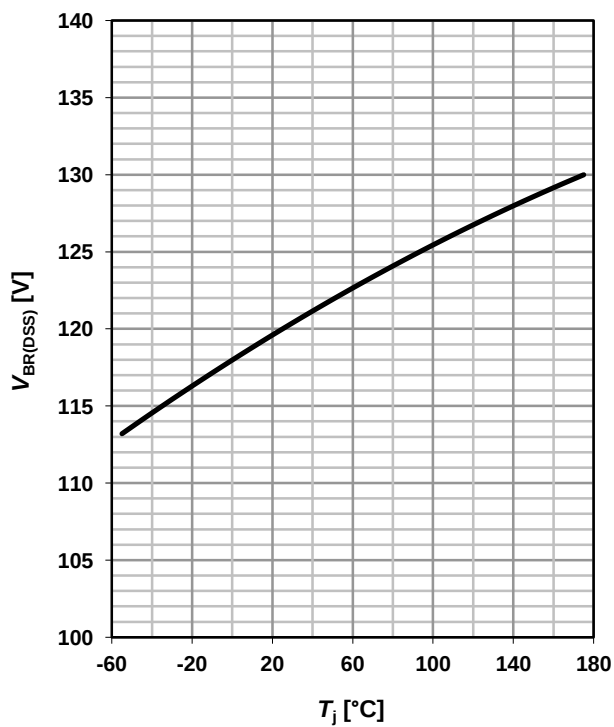
parameter:  $T_{j(start)}$ 


### 14 Typ. gate charge

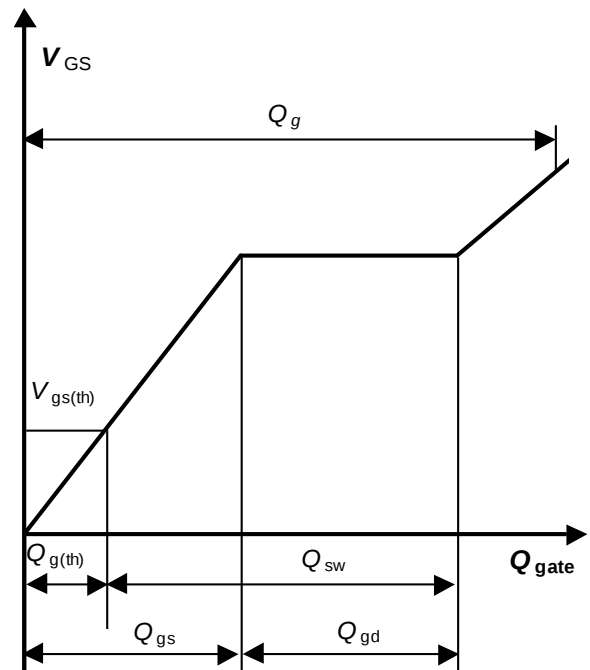
 $V_{GS}=f(Q_{gate}); I_D=100\ A\ pulsed$ 

parameter:  $V_{DD}$ 


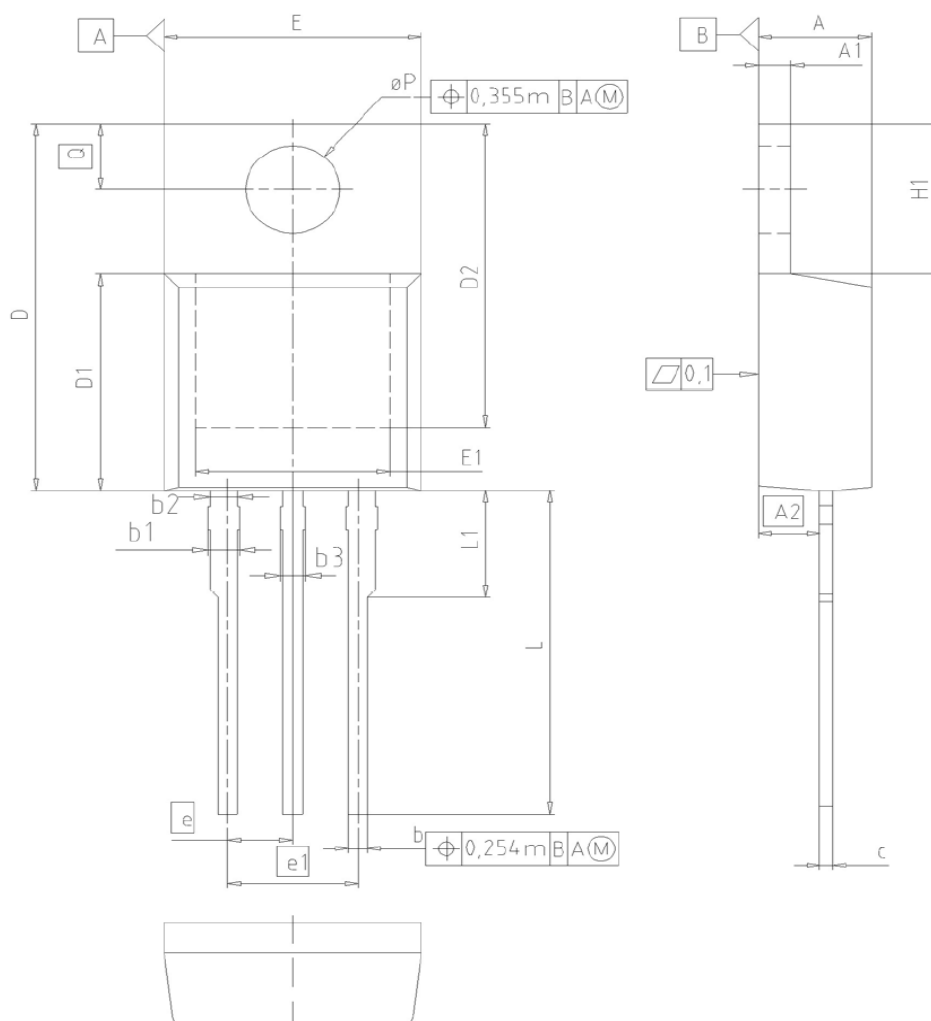
### 15 Drain-source breakdown voltage

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


### 16 Gate charge waveforms

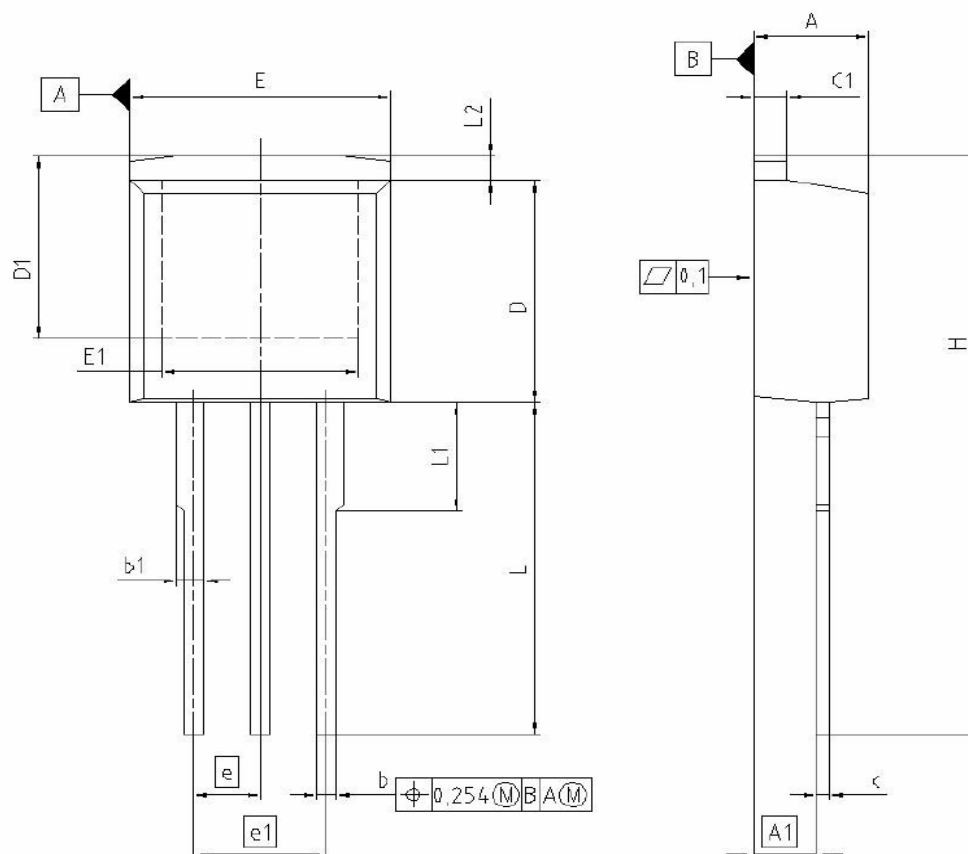


## PG-TO220-3: Outline

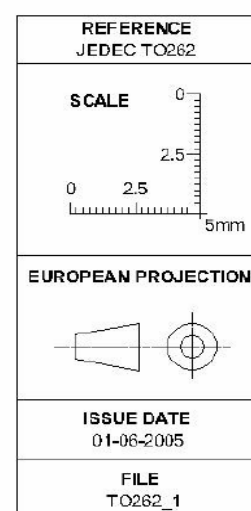


| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 4.30        | 4.57  | 0.169  | 0.180 |
| A1  | 1.17        | 1.40  | 0.046  | 0.055 |
| A2  | 2.15        | 2.72  | 0.085  | 0.107 |
| b   | 0.65        | 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 |
| øP  | 3.60        | 3.89  | 0.142  | 0.153 |
| Q   | 2.60        | 3.00  | 0.102  | 0.118 |

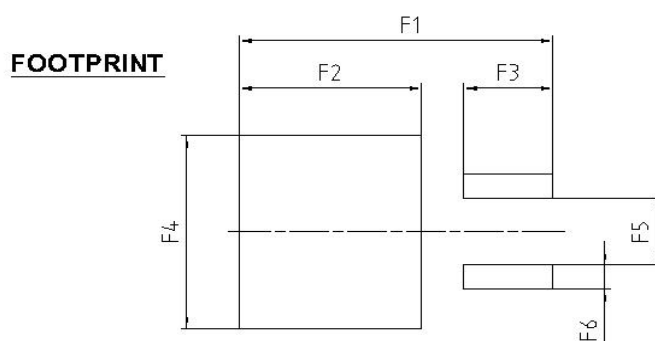
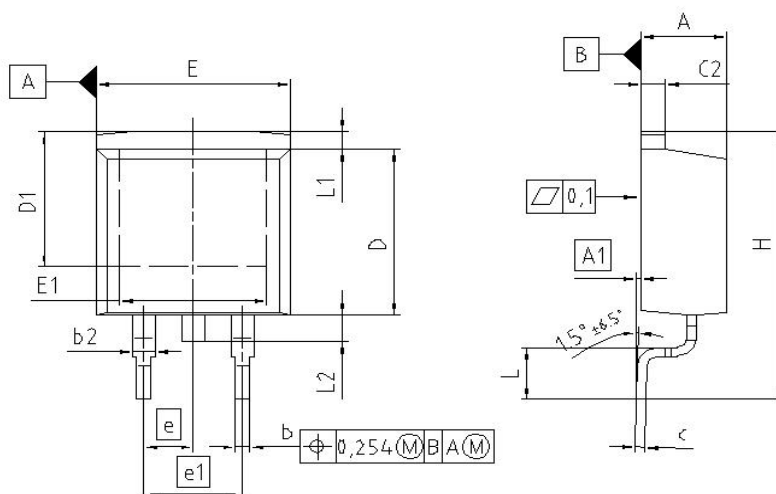
|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003318                                                                                  |
| <b>SCALE</b><br>0 2.5 5mm                                                                                           |
| <b>EUROPEAN PROJECTION</b><br> |
| <b>ISSUE DATE</b><br>23-08-2007                                                                                     |
| <b>REVISION</b><br>05                                                                                               |

PG-TO-262-3-1 (I<sup>2</sup>-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 |



## PG-TO-263 (D<sup>2</sup>-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 |

|                                         |
|-----------------------------------------|
| <p><b>REFERENCE</b><br/>JEDEC TO263</p> |
| <p><b>SCALE</b></p>                     |
| <p><b>EUROPEAN PROJECTION</b></p>       |
| <p><b>ISSUE DATE</b><br/>12-02-2006</p> |
| <p><b>FILE</b><br/>TO263_2</p>          |

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[IPP041N12N3GXKSA1](#) [IPP041N12N3GXK](#)