

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

- for sync. rectification, drives and dc/dc SMPS
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- N-channel, normal level
- Avalanche rated
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

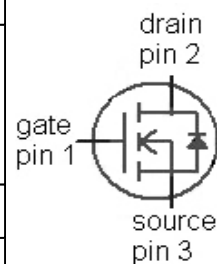
**Product Summary**

|                        |     |    |
|------------------------|-----|----|
| $V_{DS}$               | 60  | V  |
| $R_{DS(on),max}$ (SMD) | 3.7 | mΩ |
| $I_D$                  | 90  | A  |

previous engineering  
sample codes:  
IPP04xN06N  
IPI04xN06N  
IPB04xN06N



| Type    | IPB037N06N3 G                                                                      | IPI040N06N3 G                                                                      | IPP040N06N3 G                                                                       |
|---------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|         |  |  |  |
| Package | PG-TO263-3                                                                         | PG-TO262-3                                                                         | PG-TO220-3                                                                          |
| Marking | 037N06N                                                                            | 040N06N                                                                            | 040N06N                                                                             |



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

| Parameter                           | Symbol            | Conditions                               | Value       | Unit |
|-------------------------------------|-------------------|------------------------------------------|-------------|------|
| Continuous drain current            | $I_D$             | $T_C=25\text{ °C}^{2)}$                  | 90          | A    |
|                                     |                   | $T_C=100\text{ °C}$                      | 90          |      |
| Pulsed drain current <sup>3)</sup>  | $I_{D,pulse}$     | $T_C=25\text{ °C}$                       | 360         |      |
| Avalanche energy, single pulse      | $E_{AS}$          | $I_D=90\text{ A}$ , $R_{GS}=25\text{ Ω}$ | 165         | mJ   |
| Gate source voltage                 | $V_{GS}$          |                                          | ±20         | V    |
| Power dissipation                   | $P_{tot}$         | $T_C=25\text{ °C}$                       | 188         | W    |
| Operating and storage temperature   | $T_j$ , $T_{stg}$ |                                          | -55 ... 175 | °C   |
| IEC climatic category; DIN IEC 68-1 |                   |                                          | 55/175/56   |      |

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

<sup>2)</sup> Current is limited by bondwire; with an  $R_{thJC}=0.8\text{ K/W}$  the chip is able to carry 162 A.

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

<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 μm thick) copper area for drain connection. PCB is vertical in still air.

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

#### Thermal characteristics

|                                           |            |                                              |   |   |     |     |
|-------------------------------------------|------------|----------------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case       | $R_{thJC}$ |                                              | - | - | 0.8 | K/W |
| Thermal resistance,<br>junction - ambient | $R_{thJA}$ | 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   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                       | 60 | -   | -   | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=90\text{ }\mu\text{A}$                 | 2  | 3   | 4   |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=60\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$  | -  | 0.1 | 1   | $\mu\text{A}$ |
|                                  |               | $V_{DS}=60\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ °C}$ | -  | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=90\text{ A}$                      | -  | 3.3 | 4   | m $\Omega$    |
|                                  |               | $V_{GS}=10\text{ V}, I_D=90\text{ A},$<br>(SMD)            | -  | 3.0 | 3.7 |               |
| Gate resistance                  | $R_G$         |                                                            | -  | 1.3 | -   | $\Omega$      |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max},$<br>$I_D=90\text{ A}$       | 61 | 121 | -   | S             |

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

#### Dynamic characteristics

|                              |              |                                                                                 |   |      |       |    |
|------------------------------|--------------|---------------------------------------------------------------------------------|---|------|-------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=30\text{ V},$<br>$f=1\text{ MHz}$                    | - | 8000 | 11000 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                 | - | 1700 | 2300  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                 | - | 58   | 87    |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=30\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=90\text{ A}, R_G=3.5\ \Omega$ | - | 30   | -     | ns |
| Rise time                    | $t_r$        |                                                                                 | - | 70   | -     |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                 | - | 40   | -     |    |
| Fall time                    | $t_f$        |                                                                                 | - | 5    | -     |    |

#### Gate Charge Characteristics<sup>5)</sup>

|                       |               |                                                                            |   |     |   |    |
|-----------------------|---------------|----------------------------------------------------------------------------|---|-----|---|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=30\text{ V}, I_D=90\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 42  | - | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                            | - | 9   | - |    |
| Switching charge      | $Q_{sw}$      |                                                                            | - | 27  | - |    |
| Gate charge total     | $Q_g$         |                                                                            | - | 98  | - |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                            | - | 5.3 | - | V  |
| Output charge         | $Q_{oss}$     | $V_{DD}=30\text{ V}, V_{GS}=0\text{ V}$                                    | - | 79  | - | nC |

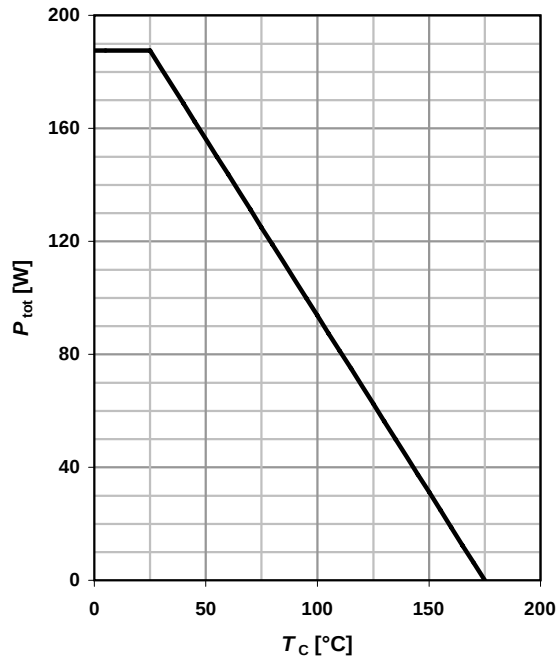
#### Reverse Diode

|                                  |               |                                                                           |   |      |     |    |
|----------------------------------|---------------|---------------------------------------------------------------------------|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ °C}$                                                        | - | -    | 90  | A  |
| Diode pulse current              | $I_{S,pulse}$ |                                                                           | - | -    | 360 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=90\text{ A},$<br>$T_j=25\text{ °C}$               | - | 0.97 | 1.2 | V  |
| Reverse recovery time            | $t_{rr}$      | $V_R=30\text{ V}, I_F=50\text{ A},$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 125  | -   | ns |
| Reverse recovery charge          | $Q_{rr}$      |                                                                           | - | 110  | -   | nC |

<sup>5)</sup> See figure 16 for gate charge parameter definition

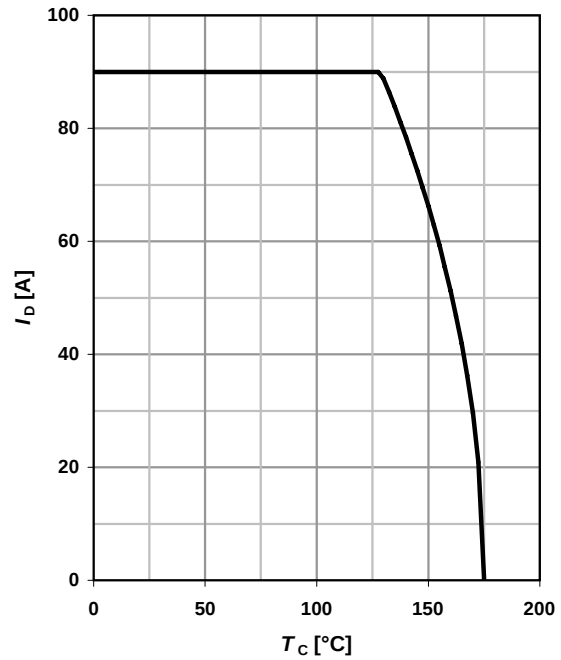
## 1 Power dissipation

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



## 2 Drain current

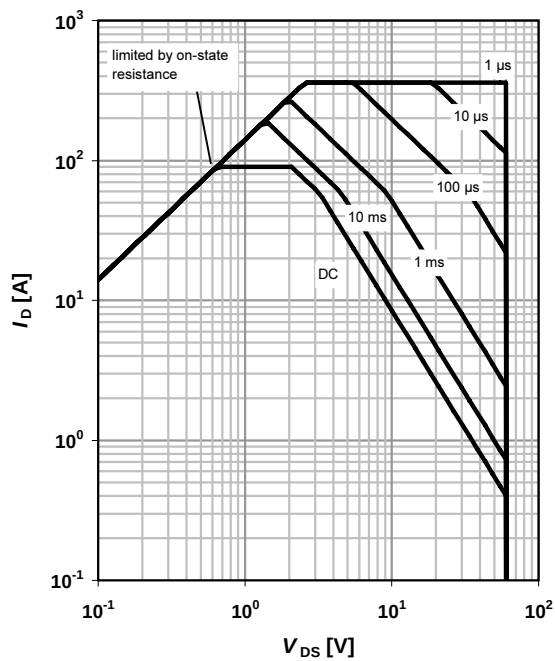
$$I_D = f(T_c); V_{GS} \geq 10 \text{ V}$$



## 3 Safe operating area

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

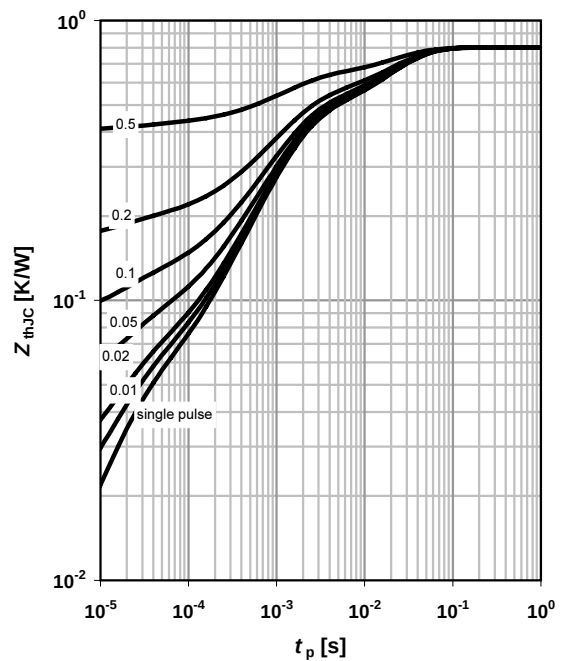
parameter:  $t_p$



## 4 Max. transient thermal impedance

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

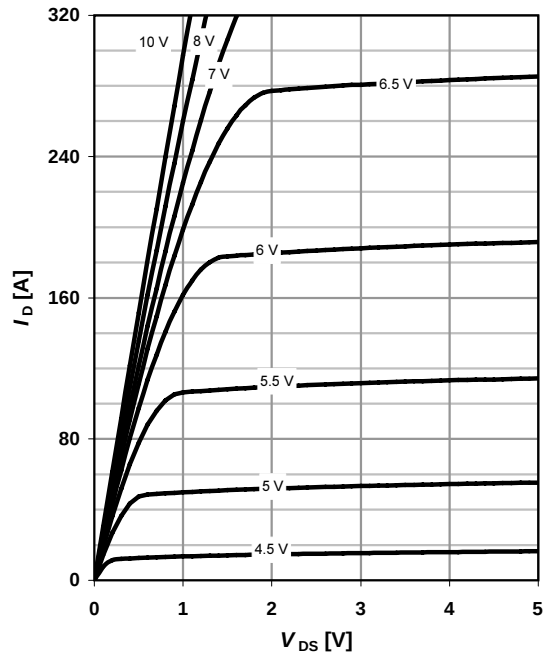
parameter:  $D = t_p/T$



### 5 Typ. output characteristics

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

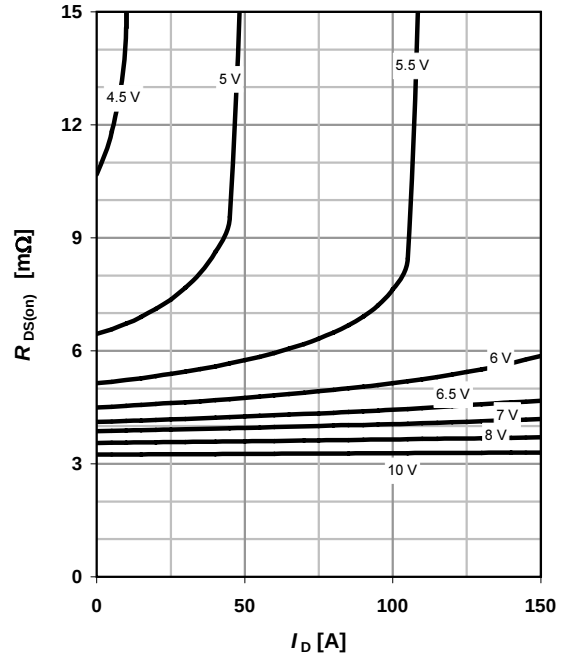
parameter:  $V_{GS}$



### 6 Typ. drain-source on resistance

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

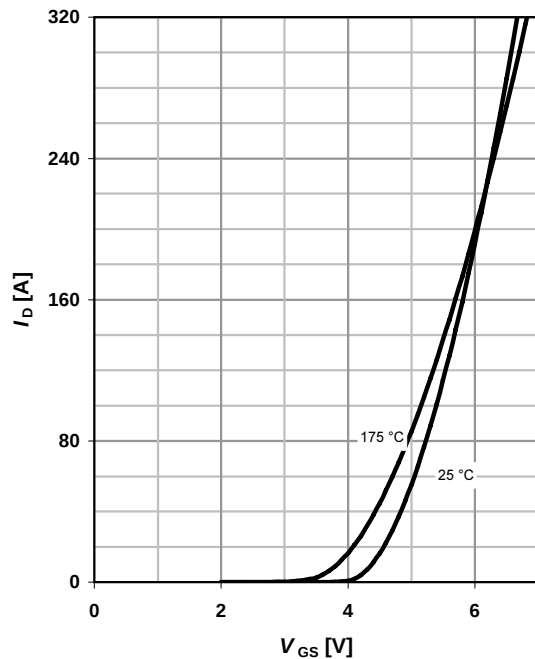
parameter:  $V_{GS}$



### 7 Typ. transfer characteristics

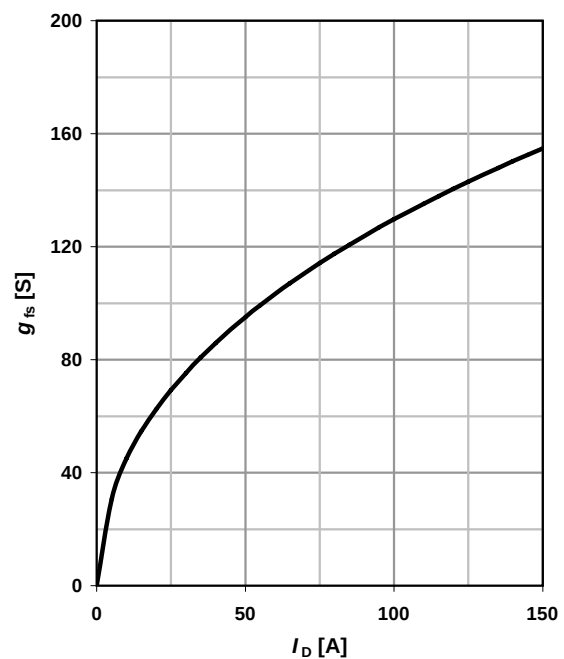
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$$

parameter:  $T_J$



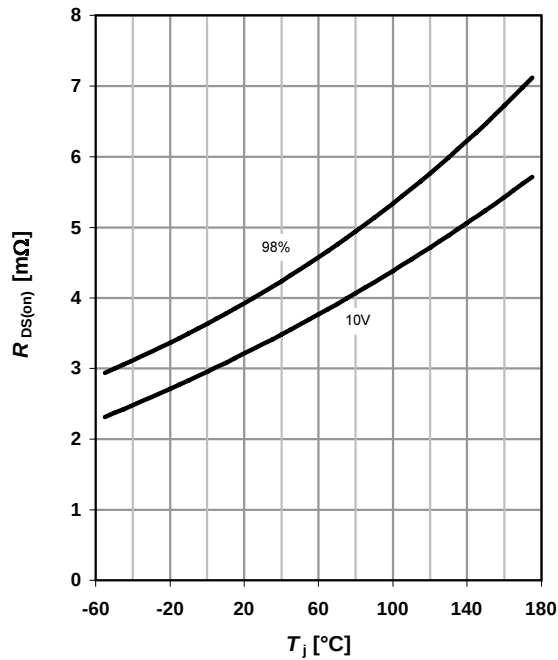
### 8 Typ. forward transconductance

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



### 9 Drain-source on-state resistance

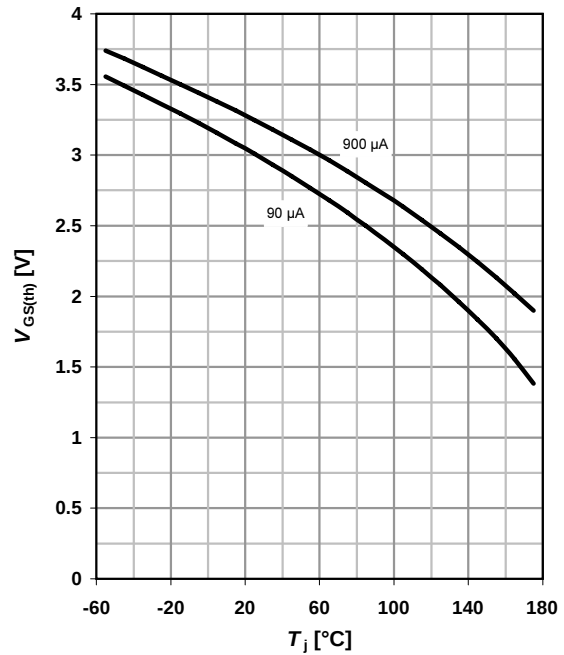
$$R_{DS(on)} = f(T_j); I_D = 90 \text{ A}; V_{GS} = 10 \text{ V}$$



### 10 Typ. gate threshold voltage

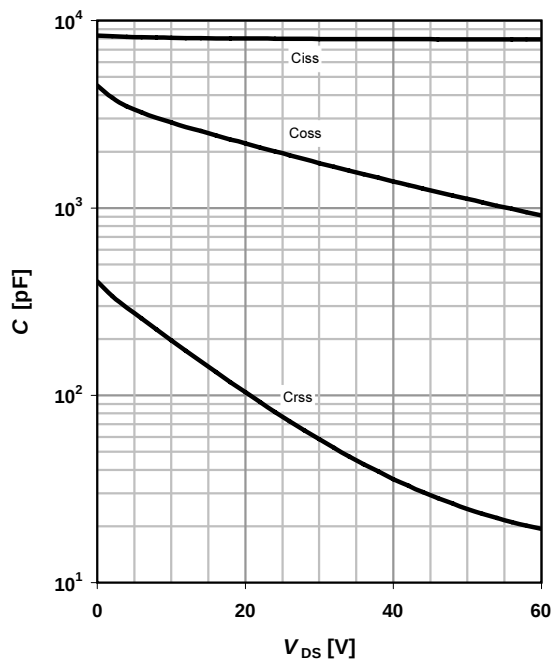
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



### 11 Typ. capacitances

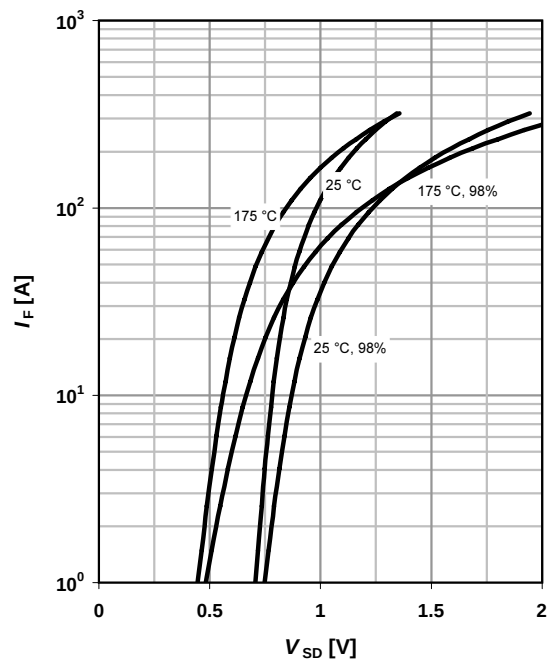
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



### 12 Forward characteristics of reverse diode

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

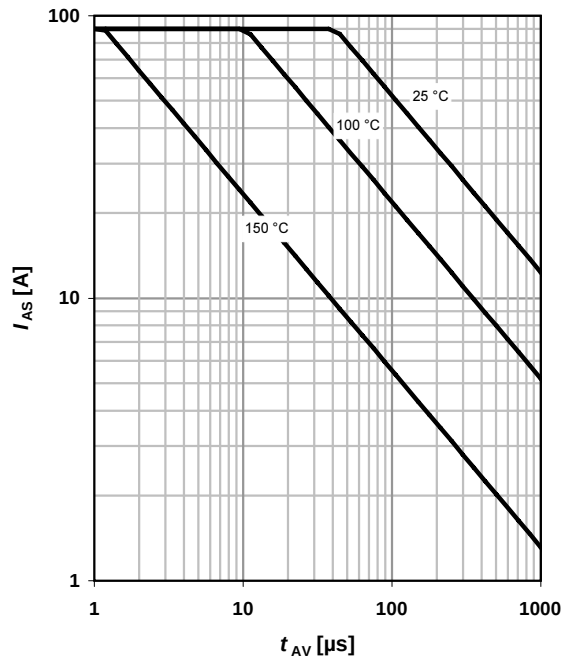
parameter:  $T_j$



### 13 Avalanche characteristics

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

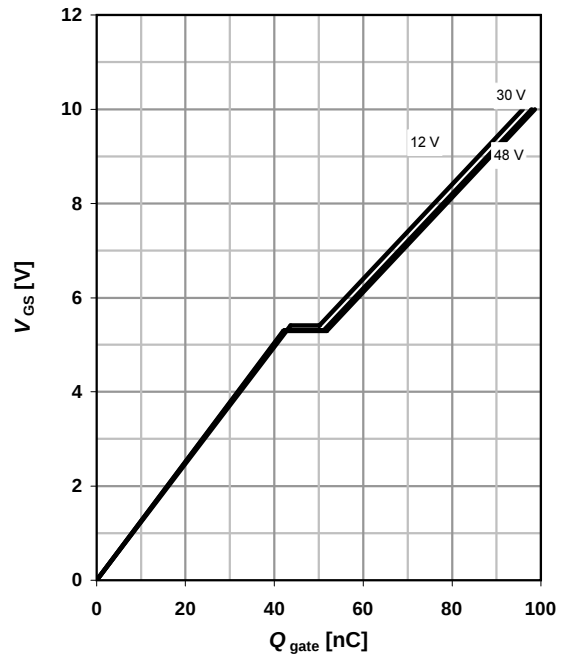
parameter:  $T_{j(\text{start})}$



### 14 Typ. gate charge

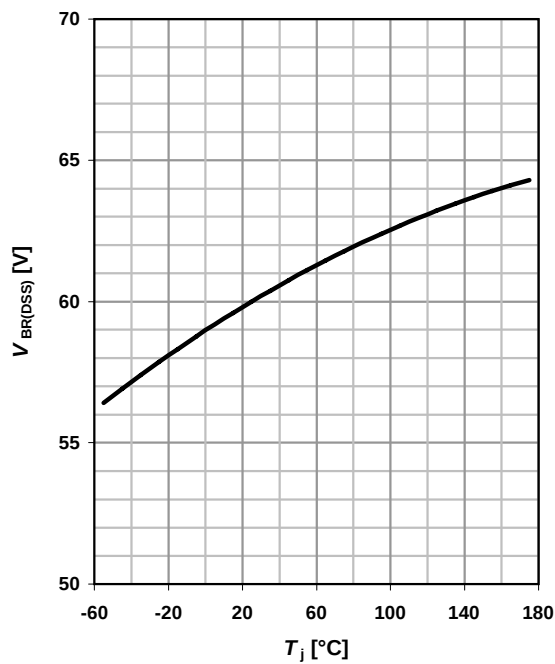
$$V_{GS}=f(Q_{\text{gate}}); I_D=90\ \text{A pulsed}$$

parameter:  $V_{DD}$

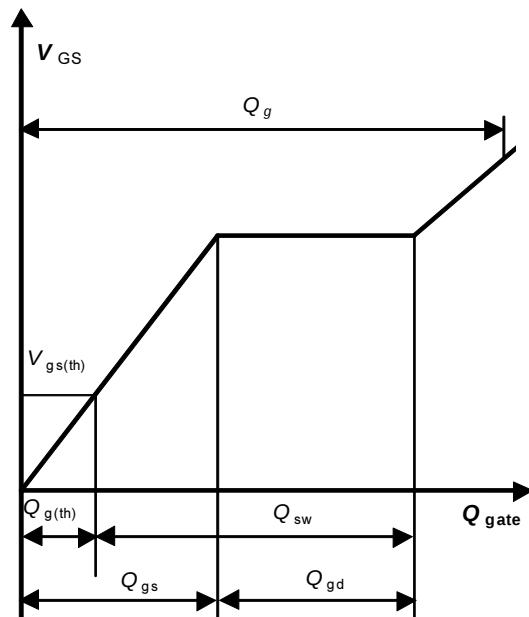


### 15 Drain-source breakdown voltage

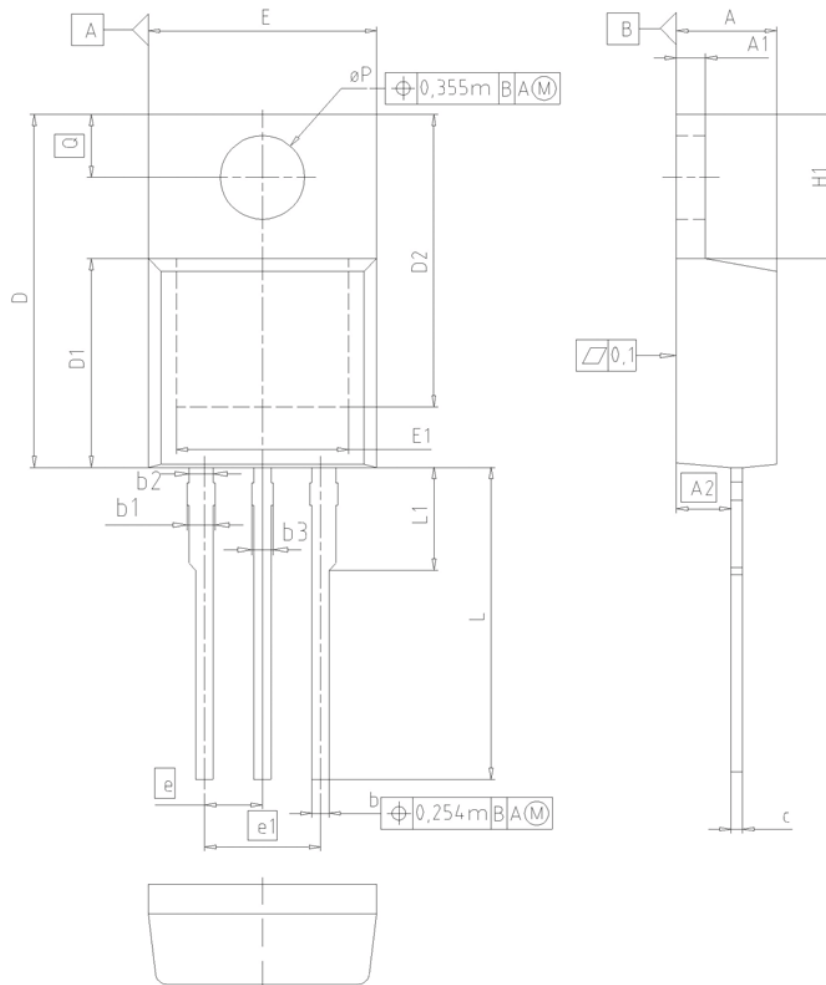
$$V_{BR(DSS)}=f(T_j); I_D=1\ \text{mA}$$



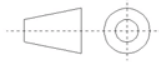
### 16 Gate charge waveforms

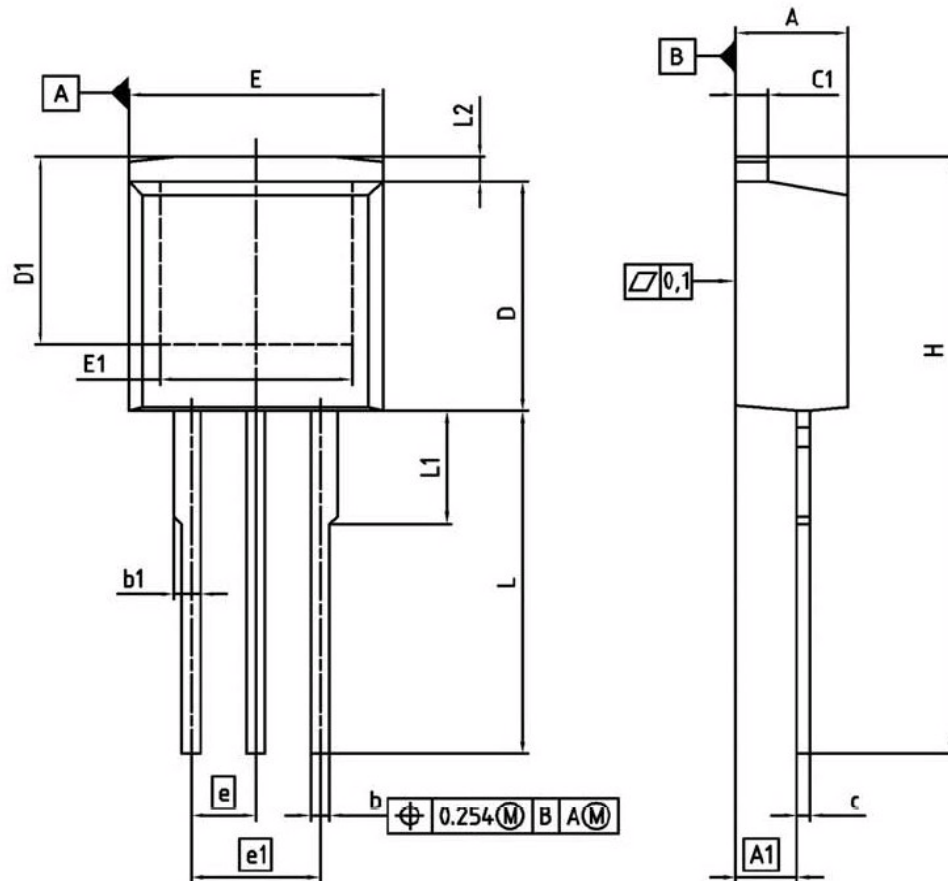


## PG-TO220-3

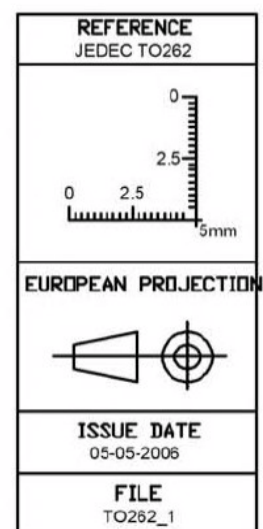


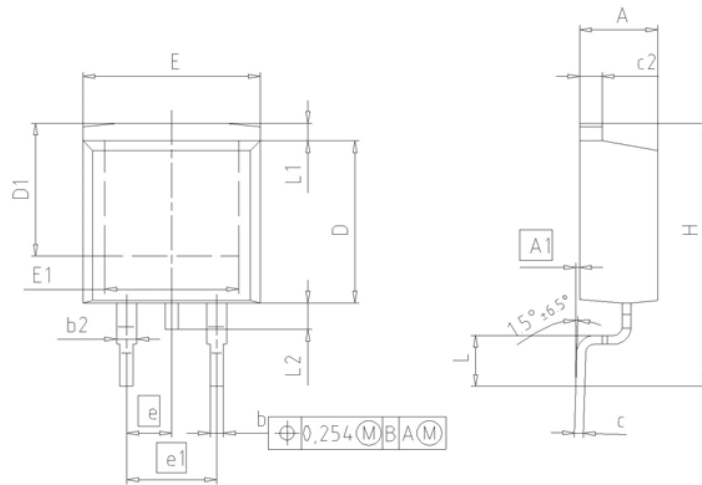
| DIM      | MILLIMETERS |       | INCHES |       |
|----------|-------------|-------|--------|-------|
|          | MIN         | MAX   | MIN    | MAX   |
| A        | 4.30        | 4.57  | 0.169  | 0.180 |
| A1       | 1.17        | 1.40  | 0.046  | 0.055 |
| A2       | 2.15        | 2.72  | 0.085  | 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 |
| $\phi P$ | 3.60        | 3.89  | 0.142  | 0.153 |
| Q        | 2.60        | 3.00  | 0.102  | 0.118 |

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

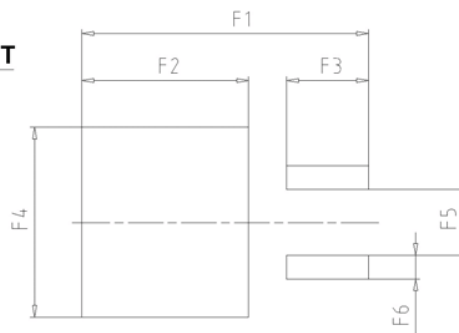
PG-TO262-3 (I<sup>2</sup>-Pak)


| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 4.300       | 4.572  | 0.169  | 0.180 |
| A1  | 2.150       | 2.718  | 0.085  | 0.107 |
| b   | 0.650       | 0.664  | 0.026  | 0.034 |
| b1  | 0.635       | 1.400  | 0.025  | 0.055 |
| c   | 0.330       | 0.600  | 0.013  | 0.024 |
| c1  | 1.170       | 1.400  | 0.046  | 0.055 |
| D   | 8.509       | 9.450  | 0.335  | 0.372 |
| D1  | 6.900       | -      | 0.272  | -     |
| 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      |       |
| L   | 13.000      | 14.000 | 0.512  | 0.551 |
| L1  | -           | 4.800  | -      | 0.189 |
| L2  | -           | 1.727  | -      | 0.068 |

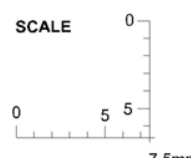




# FOOTPRINT



| 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 |

|                                                                                       |                                                                                       |
|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| DOCUMENT NO.<br>Z8B00003324                                                           |                                                                                       |
| SCALE                                                                                 |  |
| EUROPEAN PROJECTION                                                                   |                                                                                       |
|  |                                                                                       |
| ISSUE DATE<br>30-08-2007                                                              |                                                                                       |
| REVISION<br>01                                                                        |                                                                                       |

**Published by**  
**Infineon Technologies AG**  
**81726 Munich, Germany**  
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