

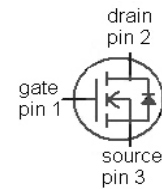
## OptiMOS<sup>®</sup> 2 Power-Transistor

### Features

- N-channel, normal level
- Excellent gate charge  $\times R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>1)</sup> for target application
- Ideal for high-frequency switching and synchronous rectification

### Product Summary

|                          |      |            |
|--------------------------|------|------------|
| $V_{DS}$                 | 85   | V          |
| $R_{DS(on),max}$ (TO252) | 12.4 | m $\Omega$ |
| $I_D$                    | 67   | A          |



| Type    | IPB12CNE8N G | IPD12CNE8N G | IPI12CNE8N G | IPP12CNE8N G |
|---------|--------------|--------------|--------------|--------------|
|         |              |              |              |              |
| Package | PG-TO263-3   | PG-TO252-3   | PG-TO262-3   | PG-TO220-3   |
| Marking | 12CNE8N      | 12CNE8N      | 12CNE8N      | 12CNE8N      |

Maximum ratings, at  $T_j=25$  °C, unless otherwise specified

| Parameter                           | Symbol         | Conditions  | Value       | Unit        |
|-------------------------------------|----------------|---|-------------|-------------|
| Continuous drain current            | $I_D$          | $T_C=25$ °C   | 67          | A           |
|                                     |                | $T_C=100$ °C  | 48          |             |
| Pulsed drain current <sup>2)</sup>  | $I_{D,pulse}$  | $T_C=25$ °C   | 268         |             |
| Avalanche energy, single pulse      | $E_{AS}$       | $I_D=67$ A, $R_{GS}=25$ $\Omega$  | 154         | mJ          |
| Reverse diode $dv/dt$               | $dv/dt$        | $I_D=67$ A, $V_{DS}=68$ V,<br>$di/dt=100$ A/ $\mu$ s,<br>$T_{j,max}=175$ °C | 6           | kV/ $\mu$ s |
| Gate source voltage <sup>3)</sup>   | $V_{GS}$       |   | $\pm 20$    | V           |
| Power dissipation                   | $P_{tot}$      | $T_C=25$ °C   | 125         | 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> see figure 3

<sup>3)</sup>  $T_{j,max}=150$  °C and duty cycle  $D=0.01$  for  $V_{gs}<-5V$

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

#### Thermal characteristics

|  |            |  |   |   |     |     |
|--|------------|--|---|---|-----|-----|
| Thermal resistance, junction - case                          | $R_{thJC}$ |  | - | - | 1.2 | K/W |
| Thermal resistance, junction - ambient (TO220, TO262, TO263) | $R_{thJA}$ | minimal footprint                            | - | - | 62  |     |
|  |            | 6 cm <sup>2</sup> cooling area <sup>4)</sup> | - | - | 40  |     |
| Thermal resistance, junction - ambient (TO252)               | $R_{thJA}$ | minimal footprint                            | - | - | 75  |     |
|  |            | 6 cm <sup>2</sup> cooling area <sup>4)</sup> | - | - | 50  |     |

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

#### Static characteristics

|                                  |               |  |    |     |      |               |
|----------------------------------|---------------|--|----|-----|------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                       | 85 | -   | -    | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=83\text{ }\mu\text{A}$                 | 2  | 3   | 4    |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=68\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$  | -  | 0.1 | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=68\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ °C}$ | -  | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=67\text{ A},$<br>(TO252)          | -  | 9.2 | 12.4 | m $\Omega$    |
|                                  |               | $V_{GS}=10\text{ V}, I_D=67\text{ A},$<br>(TO262)          | -  | 9.4 | 12.6 |               |
|                                  |               | $V_{GS}=10\text{ V}, I_D=67\text{ A},$<br>(TO220, TO263)   | -  | 9.7 | 12.9 |               |
| Gate resistance                  | $R_G$         |  | -  | 1.5 | -    | $\Omega$      |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max},$<br>$I_D=67\text{ A}$       | 39 | 77  | -    | 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.

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

#### Dynamic characteristics

|                              |              |   |   |      |      |    |
|------------------------------|--------------|---|---|------|------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=40\text{ V},$<br>$f=1\text{ MHz}$                      | - | 3260 | 4340 | pF |
| Output capacitance           | $C_{oss}$    |   | - | 608  | 809  |    |
| Reverse transfer capacitance | $C_{rss}$    |   | - | 44   | 66   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=40\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=33.5\text{ A}, R_G=1.6\ \Omega$ | - | 17   | 26   | ns |
| Rise time                    | $t_r$        |   | - | 21   | 31   |    |
| Turn-off delay time          | $t_{d(off)}$ |   | - | 32   | 48   |    |
| Fall time                    | $t_f$        |   | - | 8    | 12   |    |

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

|                       |               |   |   |     |    |    |
|-----------------------|---------------|---|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=40\text{ V}, I_D=100\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 19  | 26 | nC |
| Gate to drain charge  | $Q_{gd}$      |   | - | 12  | 17 |    |
| Switching charge      | $Q_{sw}$      |   | - | 21  | 30 |    |
| Gate charge total     | $Q_g$         |   | - | 48  | 64 |    |
| Gate plateau voltage  | $V_{plateau}$ |   | - | 5.5 | -  | V  |
| Output charge         | $Q_{oss}$     | $V_{DD}=40\text{ V}, V_{GS}=0\text{ V}$                                     | - | 46  | 61 | nC |

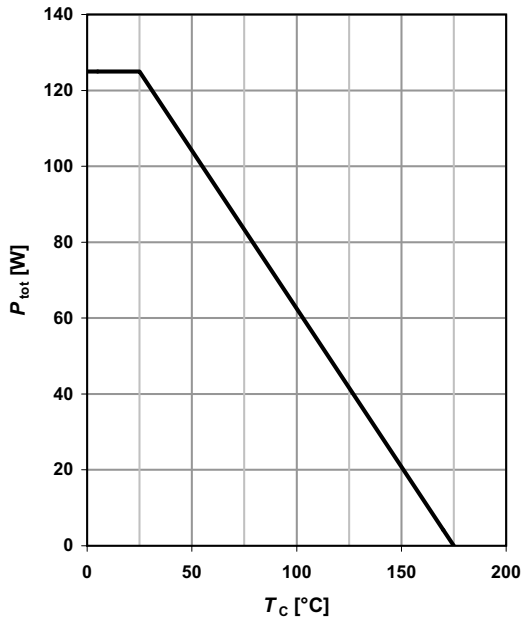
#### Reverse Diode

|                                  |               |   |   |     |     |    |
|----------------------------------|---------------|---|---|-----|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^\circ\text{C}$  | - | -   | 67  | A  |
| Diode pulse current              | $I_{S,pulse}$ |   | - | -   | 268 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=67\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 1   | 1.2 | V  |
| Reverse recovery time            | $t_{rr}$      | $V_R=40\text{ V}, I_F=I_S,$   | - | 103 | -   | ns |
| Reverse recovery charge          | $Q_{rr}$      | $di_F/dt=100\text{ A}/\mu\text{s}$                                      | - | 255 | -   |    |

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

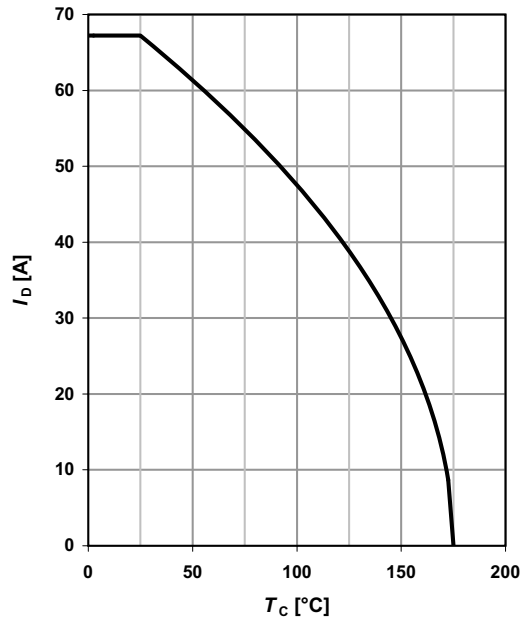
### 1 Power dissipation

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



### 2 Drain current

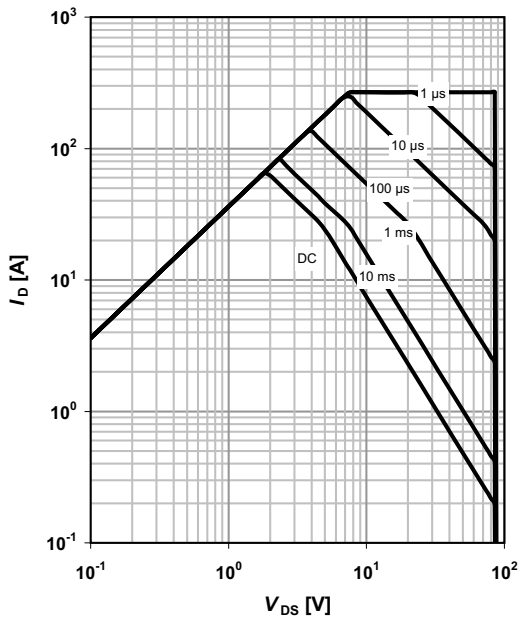
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



### 3 Safe operating area

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

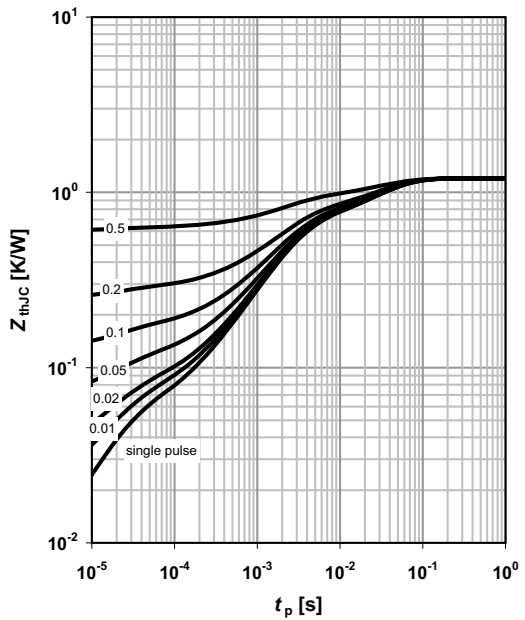
parameter:  $t_p$



### 4 Max. transient thermal impedance

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

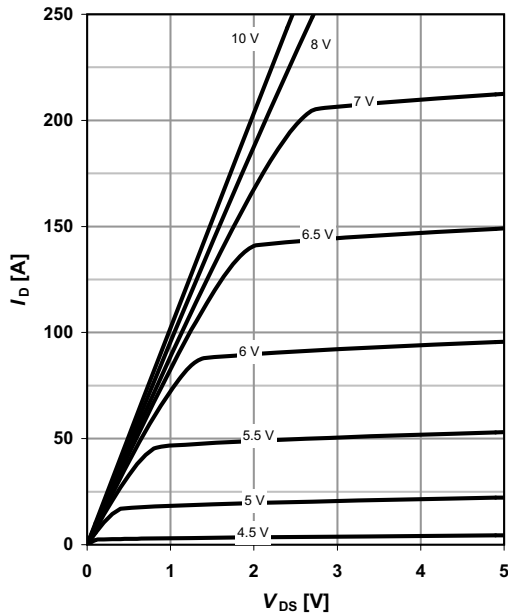
parameter:  $D = t_p/T$



**5 Typ. output characteristics**

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

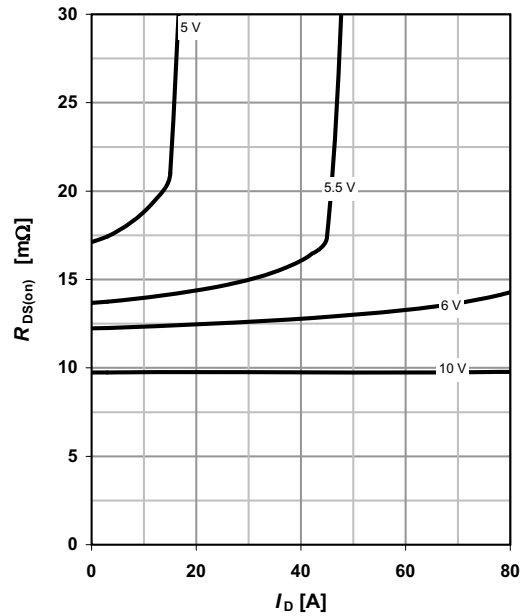
parameter:  $V_{GS}$



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

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

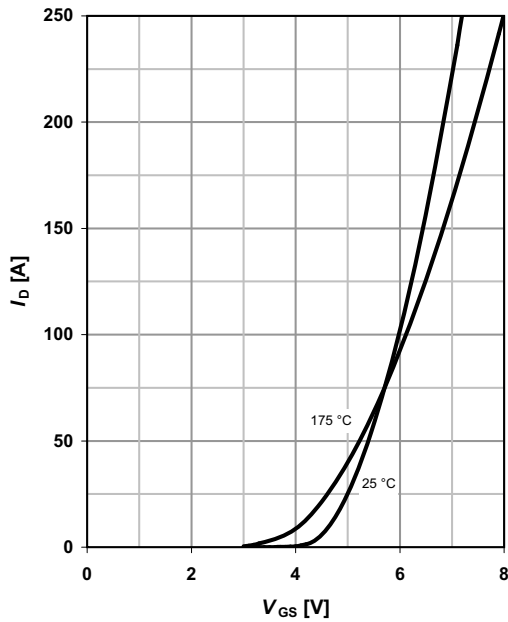
parameter:  $V_{GS}$



**7 Typ. transfer characteristics**

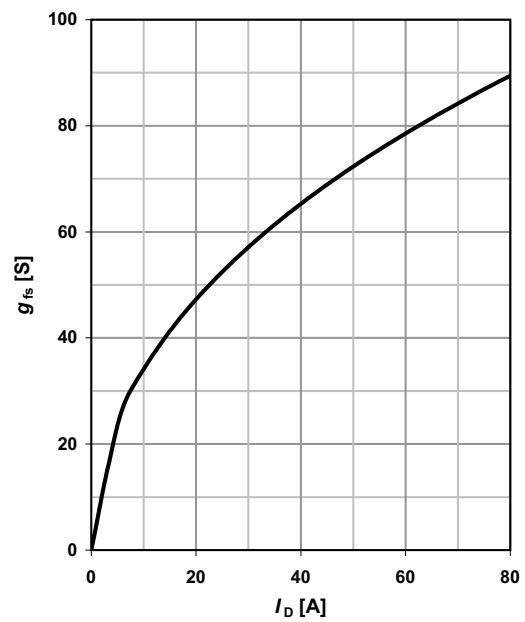
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$$

parameter:  $T_j$



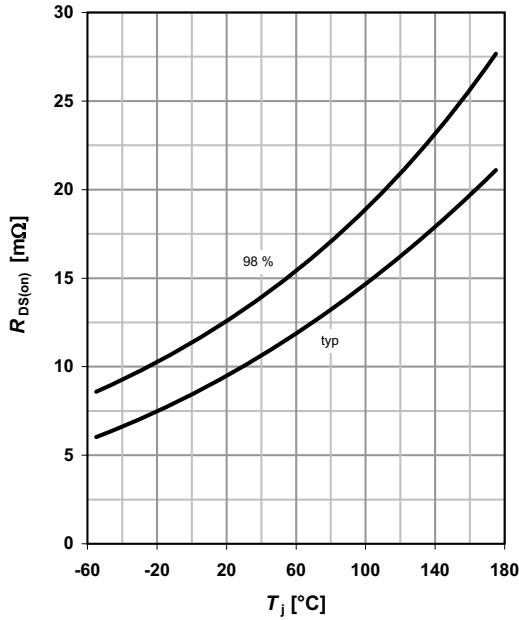
**8 Typ. forward transconductance**

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



### 9 Drain-source on-state resistance

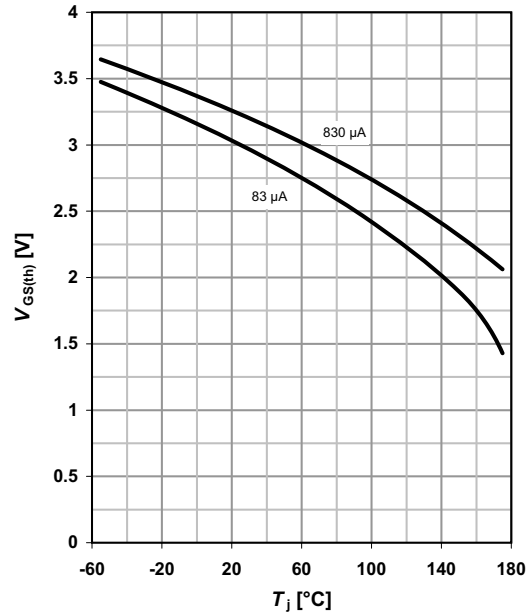
$$R_{DS(on)} = f(T_j); I_D = 67 \text{ A}; V_{GS} = 10 \text{ V}$$



### 10 Typ. gate threshold voltage

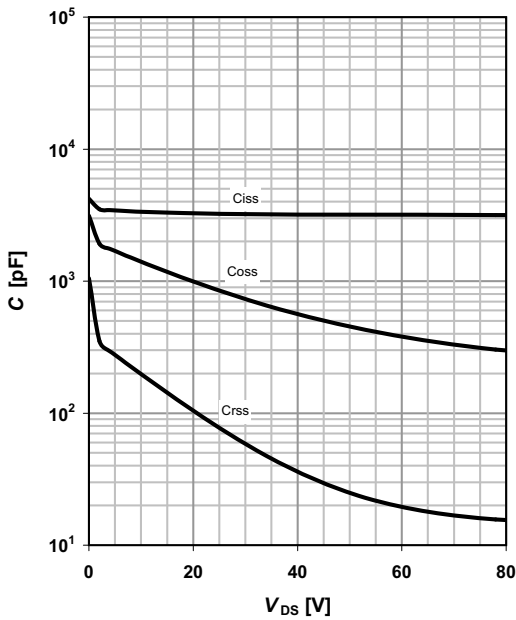
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



### 11 Typ. capacitances

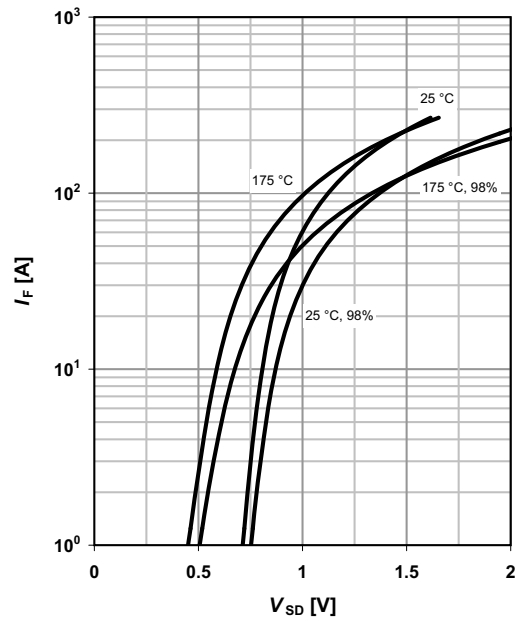
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



### 12 Forward characteristics of reverse diode

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

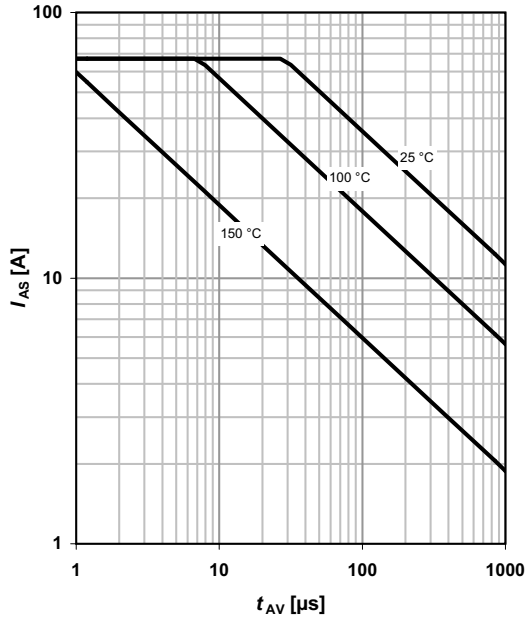
parameter:  $T_j$



### 13 Avalanche characteristics

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

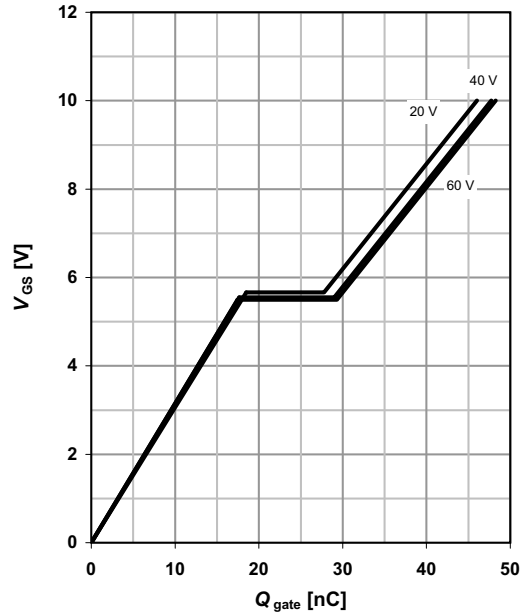
parameter:  $T_{j(\text{start})}$



### 14 Typ. gate charge

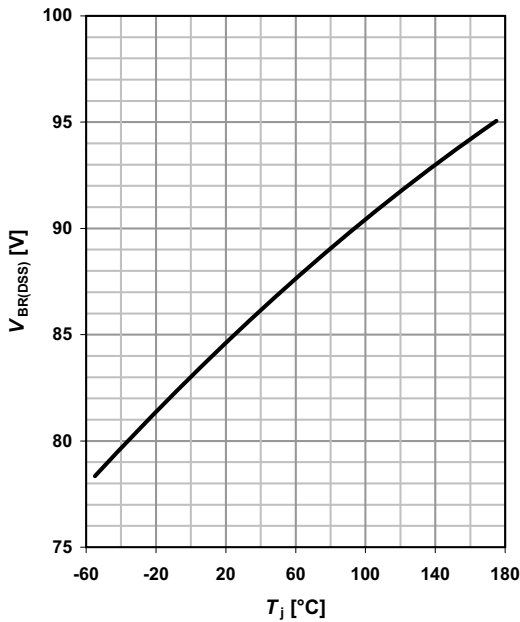
$$V_{GS} = f(Q_{\text{gate}}); I_D = 67 \text{ A pulsed}$$

parameter:  $V_{DD}$

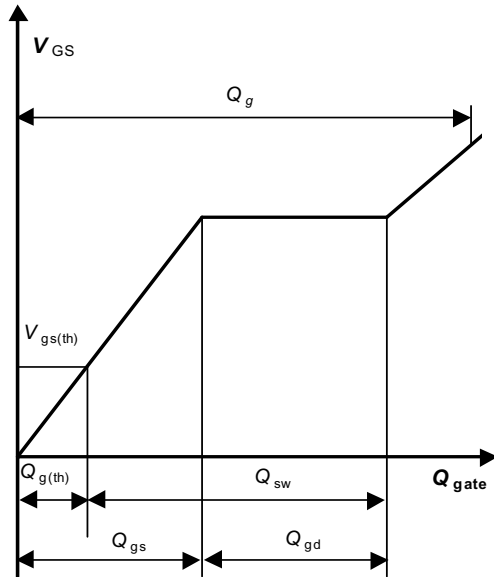


### 15 Drain-source breakdown voltage

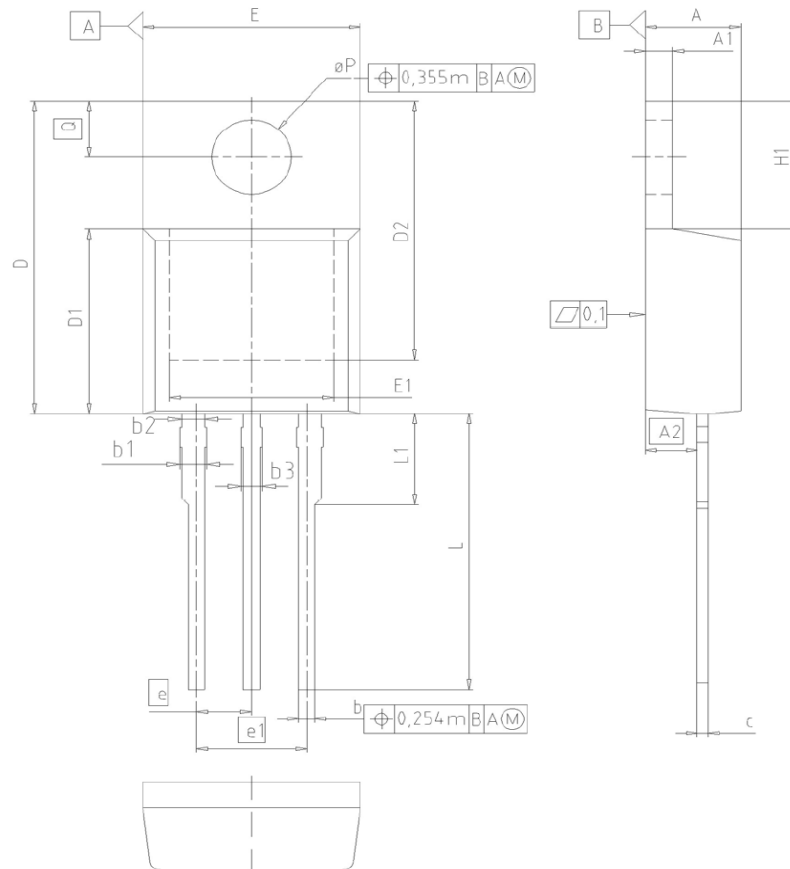
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$



### 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        | 0.80  | 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.**  
Z8B00003318

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 0 2.5 5mm

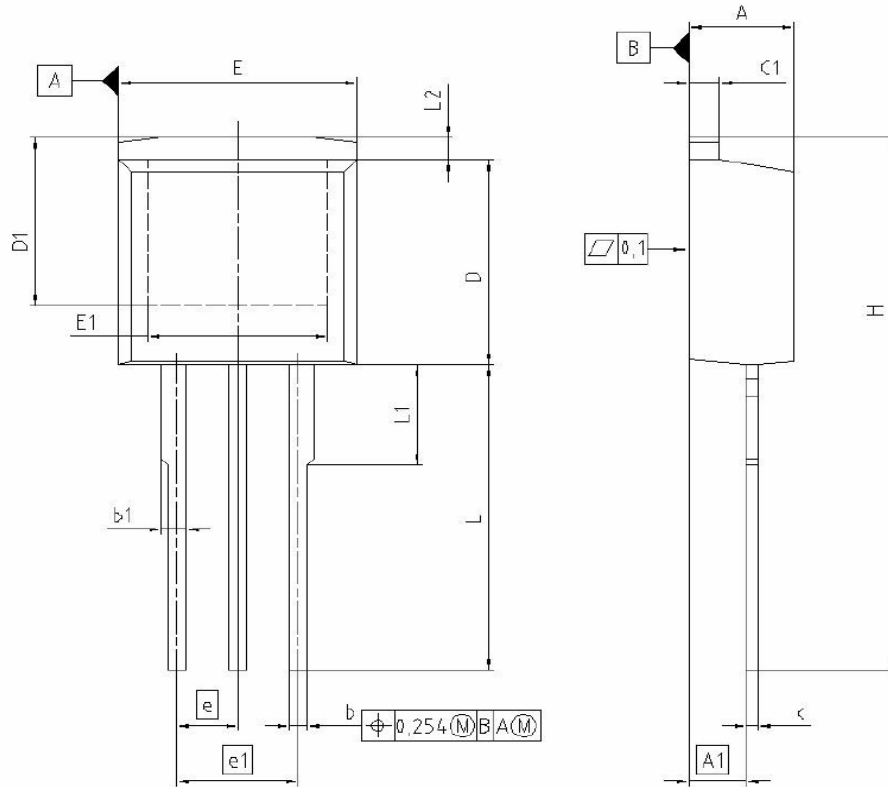
**EUROPEAN PROJECTION**

**ISSUE DATE**  
23-08-2007

**REVISION**  
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 |
| e1  | 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      | 14.600 | 0.512  | 0.551 |
| L1  | 4.350       | 4.750  | 0.171  | 0.187 |
| L2  | 0.700       | 1.300  | 0.028  | 0.051 |

**REFERENCE**  
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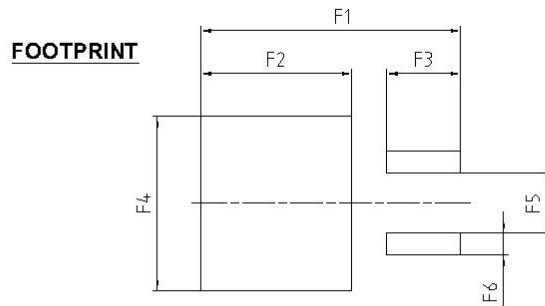
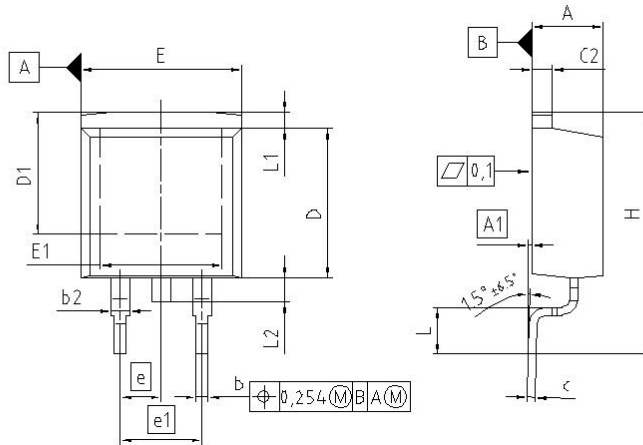
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**EUROPEAN PROJECTION**

**ISSUE DATE**  
01-06-2005

**FILE**  
TO262\_1

PG-TO-263-3 (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       | 0.650  | 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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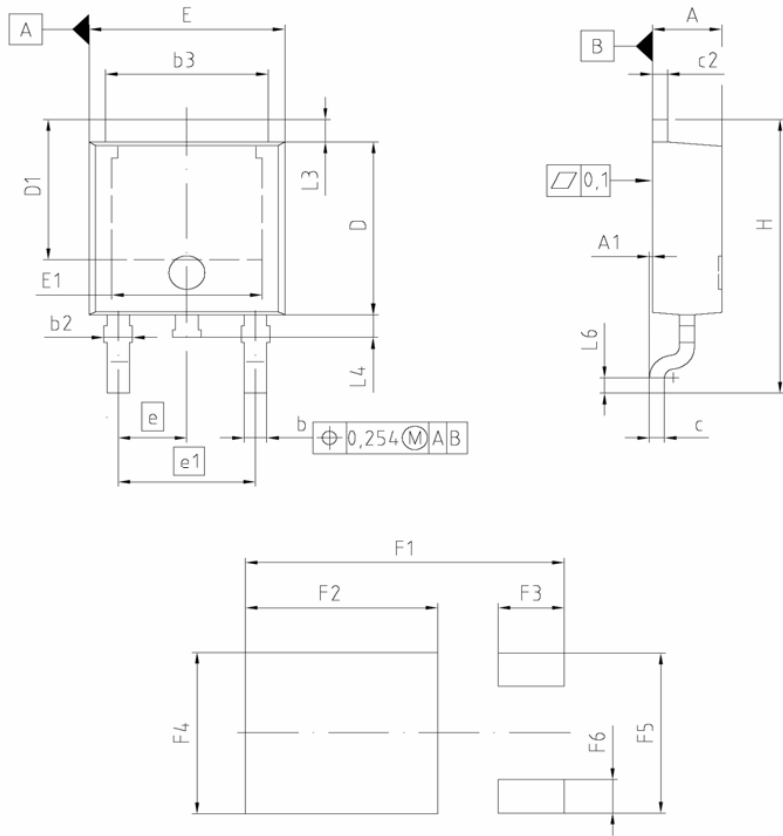
 7.5mm

EUROPEAN PROJECTION

ISSUE DATE  
12-02-2006

FILE  
TO263\_2

PG-TO252-3: Outline



| DIM | MILLIMETERS |        | INCHES |       |
|-----|-------------|--------|--------|-------|
|     | MIN         | MAX    | MIN    | MAX   |
| A   | 2.159       | 2.413  | 0.085  | 0.095 |
| A1  | 0.000       | 0.150  | 0.000  | 0.006 |
| b   | 0.635       | 0.889  | 0.025  | 0.035 |
| b2  | 0.650       | 1.150  | 0.026  | 0.045 |
| b3  | 5.004       | 5.500  | 0.197  | 0.217 |
| c   | 0.457       | 0.580  | 0.018  | 0.023 |
| c2  | 0.460       | 0.980  | 0.018  | 0.039 |
| D   | 5.969       | 6.223  | 0.235  | 0.245 |
| D1  | 5.020       | 5.842  | 0.198  | 0.230 |
| E   | 6.400       | 6.731  | 0.252  | 0.265 |
| E1  | 4.850       | 5.207  | 0.191  | 0.205 |
| e   | 2.286       |        | 0.090  |       |
| e1  | 4.572       |        | 0.180  |       |
| N   | 3           |        | 3      |       |
| H   | 9.400       | 10.480 | 0.370  | 0.413 |
| L3  | 0.900       | 1.143  | 0.035  | 0.045 |
| L4  | 0.584       | 0.950  | 0.023  | 0.037 |
| L6  | 0.510       | 0.686  | 0.020  | 0.027 |
| F1  | 10.500      | 10.700 | 0.413  | 0.421 |
| F2  | 6.300       | 6.500  | 0.248  | 0.256 |
| F3  | 2.100       | 2.300  | 0.083  | 0.091 |
| F4  | 5.700       | 5.900  | 0.224  | 0.232 |
| F5  | 5.660       | 5.860  | 0.222  | 0.231 |
| F6  | 1.100       | 1.300  | 0.043  | 0.051 |

REFERENCE  
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EUROPEAN PROJECTION

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FILE  
TO252\_1



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