

## OptiMOS™-T2 Power-Transistor



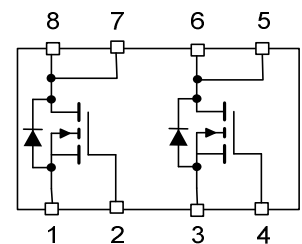
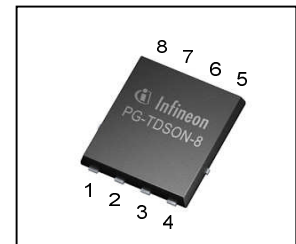
### Features

- Dual N-channel Normal Level - Enhancement mode
- AEC Q101 qualified
- MSL1 up to 260°C peak reflow
- 175°C operating temperature
- Green Product (RoHS compliant)
- 100% Avalanche tested

### Product Summary

|                       |      |    |
|-----------------------|------|----|
| $V_{DS}$              | 40   | V  |
| $R_{DS(on),max}^{4)}$ | 12.2 | mΩ |
| $I_D$                 | 20   | A  |

PG-TDSON-8-4



| Type          | Package      | Marking |
|---------------|--------------|---------|
| IPG20N04S4-12 | PG-TDSON-8-4 | 4N0412  |

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

| Parameter                                                | Symbol         | Conditions                                         | Value        | Unit |
|----------------------------------------------------------|----------------|----------------------------------------------------|--------------|------|
| Continuous drain current<br>one channel active           | $I_D$          | $T_C=25\text{ °C}$ , $V_{GS}=10\text{ V}^{1)}$     | 20           | A    |
|                                                          |                | $T_C=100\text{ °C}$ ,<br>$V_{GS}=10\text{ V}^{2)}$ | 20           |      |
| Pulsed drain current <sup>2)</sup><br>one channel active | $I_{D,pulse}$  | -                                                  | 80           |      |
| Avalanche energy, single pulse <sup>2, 4)</sup>          | $E_{AS}$       | $I_D=10\text{ A}$                                  | 80           | mJ   |
| Avalanche current, single pulse <sup>4)</sup>            | $I_{AS}$       | -                                                  | 15           | A    |
| Gate source voltage                                      | $V_{GS}$       | -                                                  | ±20          | V    |
| Power dissipation<br>one channel active                  | $P_{tot}$      | $T_C=25\text{ °C}$                                 | 41           | W    |
| Operating and storage temperature                        | $T_j, T_{stg}$ | -                                                  | -55 ... +175 | °C   |

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

### Thermal characteristics<sup>2)</sup>

|                                     |            |                                              |   |     |     |     |
|-------------------------------------|------------|----------------------------------------------|---|-----|-----|-----|
| Thermal resistance, junction - case | $R_{thJC}$ | -                                            | - | -   | 3.7 | K/W |
| SMD version, device on PCB          | $R_{thJA}$ | minimal footprint                            | - | 100 | -   |     |
|                                     |            | 6 cm <sup>2</sup> cooling area <sup>3)</sup> | - | 60  | -   |     |

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

#### Static characteristics

|                                                |               |                                                                |     |      |      |               |
|------------------------------------------------|---------------|----------------------------------------------------------------|-----|------|------|---------------|
| Drain-source breakdown voltage                 | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                           | 40  | -    | -    | V             |
| Gate threshold voltage                         | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=15\mu\text{A}$                             | 2.0 | 3.0  | 4.0  |               |
| Zero gate voltage drain current <sup>4)</sup>  | $I_{DSS}$     | $V_{DS}=40\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$      | -   | 0.01 | 1    | $\mu\text{A}$ |
|                                                |               | $V_{DS}=18\text{ V}, V_{GS}=0\text{ V}, T_j=85\text{ °C}^{2)}$ | -   | 1    | 100  |               |
| Gate-source leakage current <sup>4)</sup>      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                        | -   | -    | 100  | nA            |
| Drain-source on-state resistance <sup>4)</sup> | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=17\text{ A}$                          | -   | 11.1 | 12.2 | m $\Omega$    |

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

### Dynamic characteristics<sup>2)</sup>

|                                            |              |                                                                                |   |      |      |    |
|--------------------------------------------|--------------|--------------------------------------------------------------------------------|---|------|------|----|
| Input capacitance <sup>4)</sup>            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$<br>$f=1\text{ MHz}$                   | - | 1130 | 1470 | pF |
| Output capacitance <sup>4)</sup>           | $C_{oss}$    |                                                                                | - | 300  | 390  |    |
| Reverse transfer capacitance <sup>4)</sup> | $C_{rss}$    |                                                                                | - | 9    | 21   |    |
| Turn-on delay time                         | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=20\text{ A}, R_G=11\ \Omega$ | - | 9    | -    | ns |
| Rise time                                  | $t_r$        |                                                                                | - | 2    | -    |    |
| Turn-off delay time                        | $t_{d(off)}$ |                                                                                | - | 10   | -    |    |
| Fall time                                  | $t_f$        |                                                                                | - | 8    | -    |    |

### Gate Charge Characteristics<sup>2, 4)</sup>

|                       |               |                                                                            |   |     |     |    |
|-----------------------|---------------|----------------------------------------------------------------------------|---|-----|-----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=32\text{ V}, I_D=20\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 6   | 8   | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                            | - | 2   | 4.6 |    |
| Gate charge total     | $Q_g$         |                                                                            | - | 14  | 18  |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                            | - | 5.5 | -   | V  |

### Reverse Diode

|                                                                      |               |                                                                   |   |     |     |    |
|----------------------------------------------------------------------|---------------|-------------------------------------------------------------------|---|-----|-----|----|
| Diode continuous forward current <sup>2)</sup><br>one channel active | $I_S$         | $T_C=25\text{ °C}$                                                | - | -   | 20  | A  |
| Diode pulse current <sup>2)</sup><br>one channel active              | $I_{S,pulse}$ |                                                                   | - | -   | 80  |    |
| Diode forward voltage                                                | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=17\text{ A},$<br>$T_J=25\text{ °C}$       | - | 0.9 | 1.3 | V  |
| Reverse recovery time <sup>2)</sup>                                  | $t_{rr}$      | $V_R=20\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 32  | -   | ns |
| Reverse recovery charge <sup>2, 4)</sup>                             | $Q_{rr}$      |                                                                   | - | 25  | -   | nC |

<sup>1)</sup> Current is limited by bondwire; with an  $R_{thJC}=3.7\text{ K/W}$  the chip is able to carry 44A at 25°C.

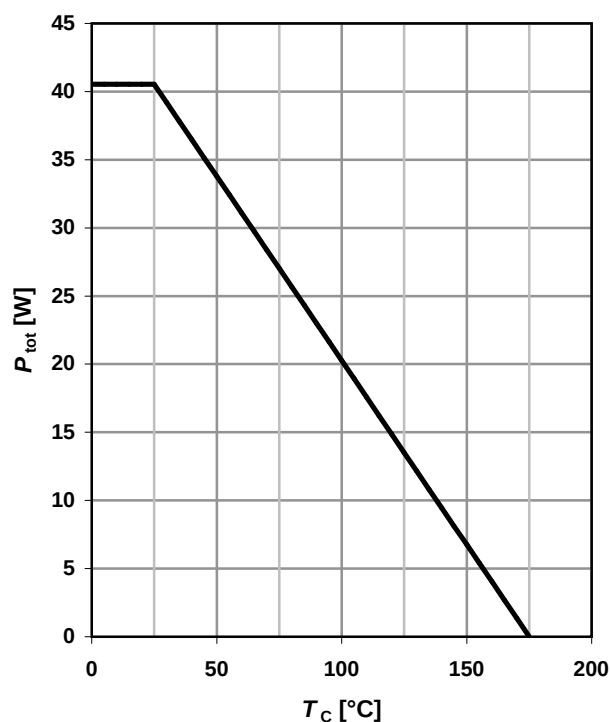
<sup>2)</sup> Specified by design. Not subject to production test.

<sup>3)</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.

<sup>4)</sup> Per channel

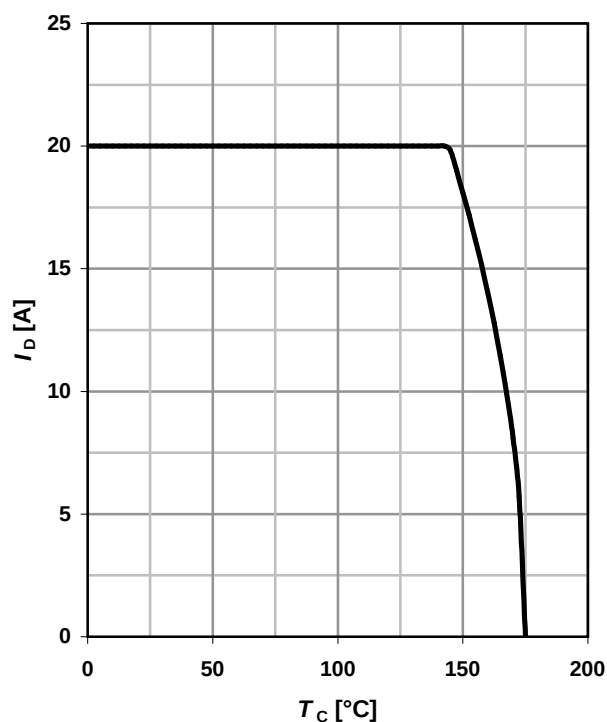
### 1 Power dissipation

$P_{\text{tot}} = f(T_C); V_{\text{GS}} \geq 6 \text{ V}; \text{one channel active}$



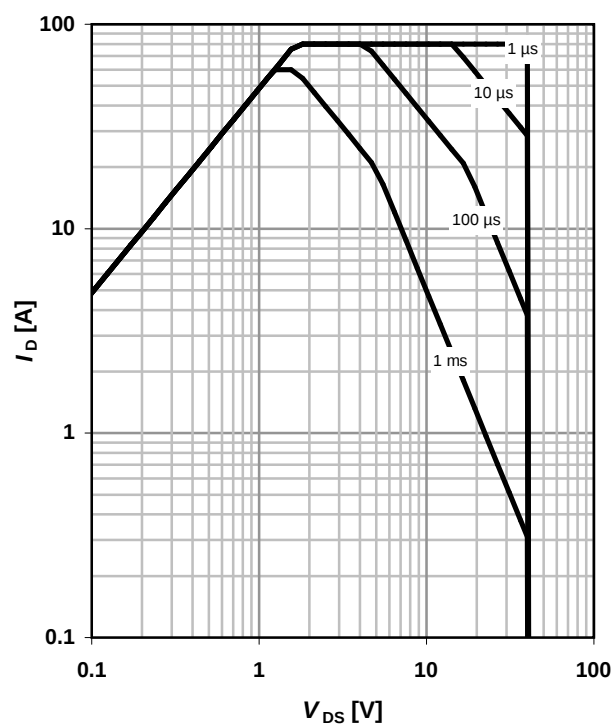
### 2 Drain current

$I_D = f(T_C); V_{\text{GS}} \geq 6 \text{ V}; \text{one channel active}$



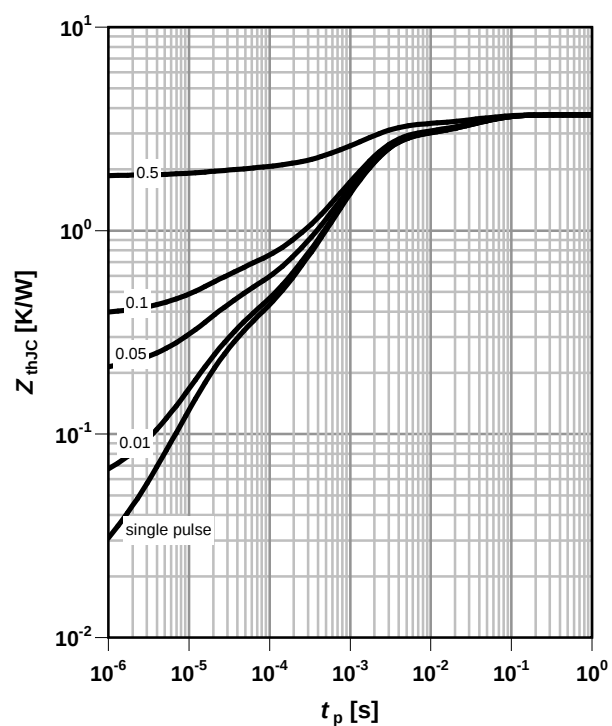
### 3 Safe operating area

$I_D = f(V_{\text{DS}}); T_C = 25^\circ\text{C}; D = 0; \text{one channel active}$   
parameter:  $t_p$



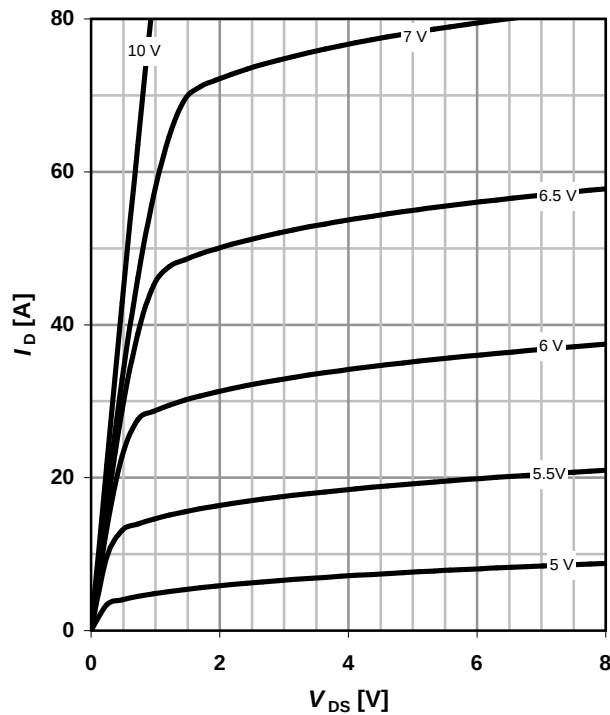
### 4 Max. transient thermal impedance

$Z_{\text{thJC}} = f(t_p)$   
parameter:  $D = t_p/T$



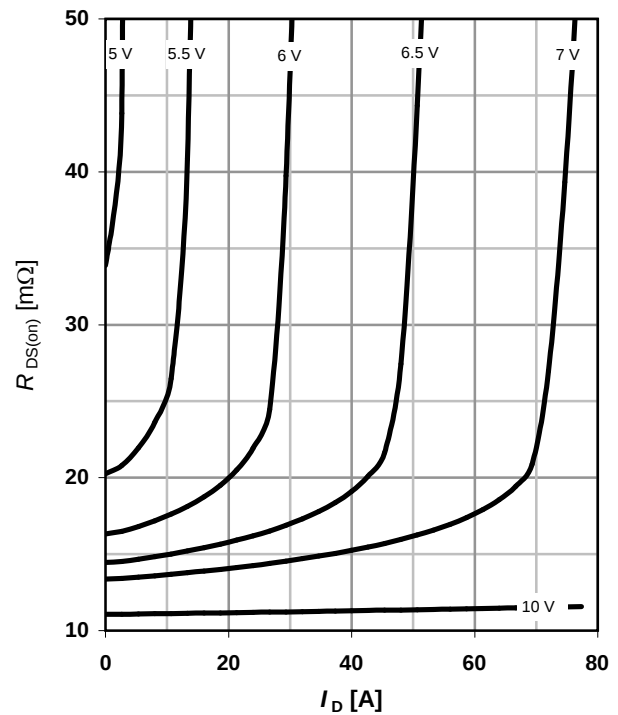
### 5 Typ. output characteristics<sup>4)</sup>

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

parameter:  $V_{GS}$ 


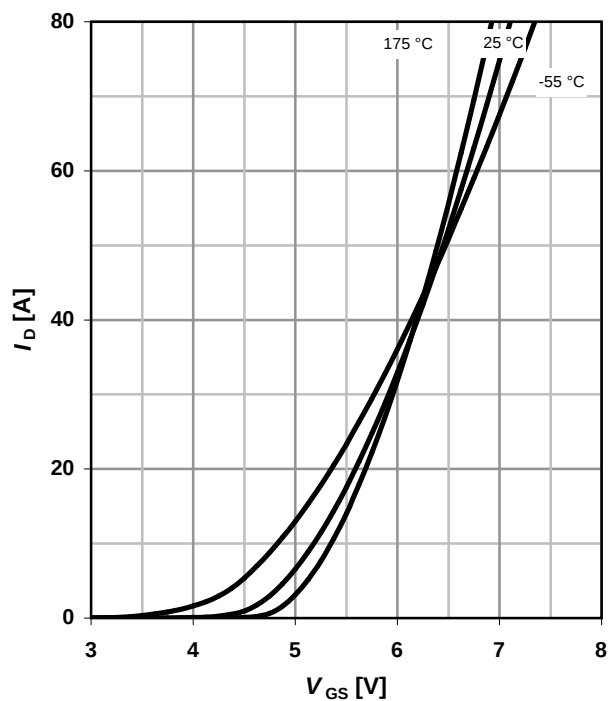
### 6 Typ. drain-source on-state resistance<sup>4)</sup>

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

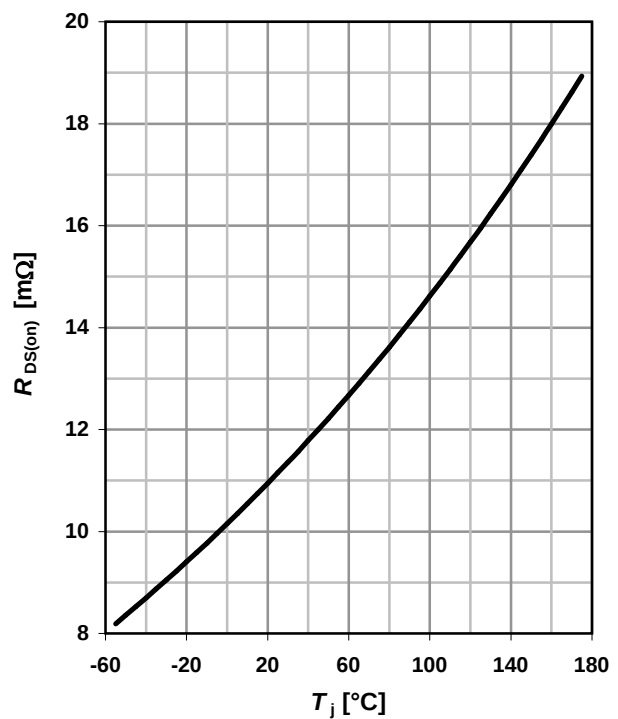
parameter:  $V_{GS}$ 


### 7 Typ. transfer characteristics<sup>4)</sup>

 $I_D = f(V_{GS}); V_{DS} = 6\text{ V}$ 

parameter:  $T_j$ 


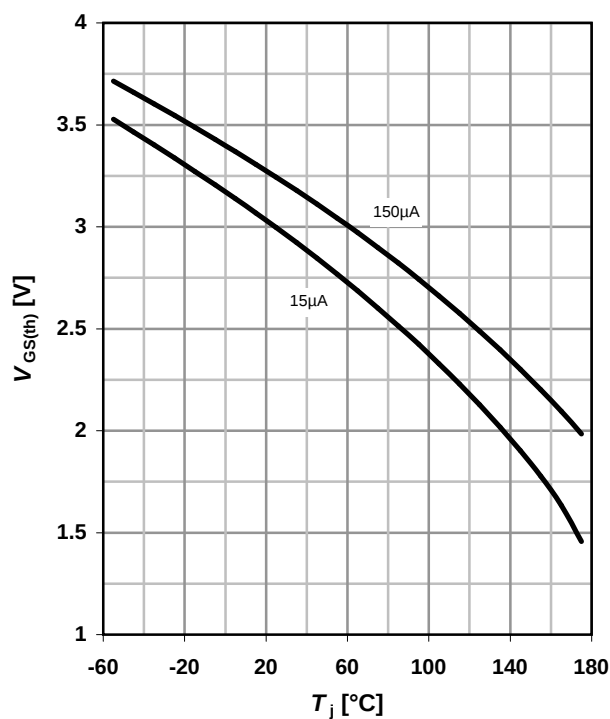
### 8 Typ. drain-source on-state resistance<sup>4)</sup>

 $R_{DS(on)} = f(T_j); I_D = 17\text{ A}; V_{GS} = 10\text{ V}$ 


## 9 Typ. gate threshold voltage

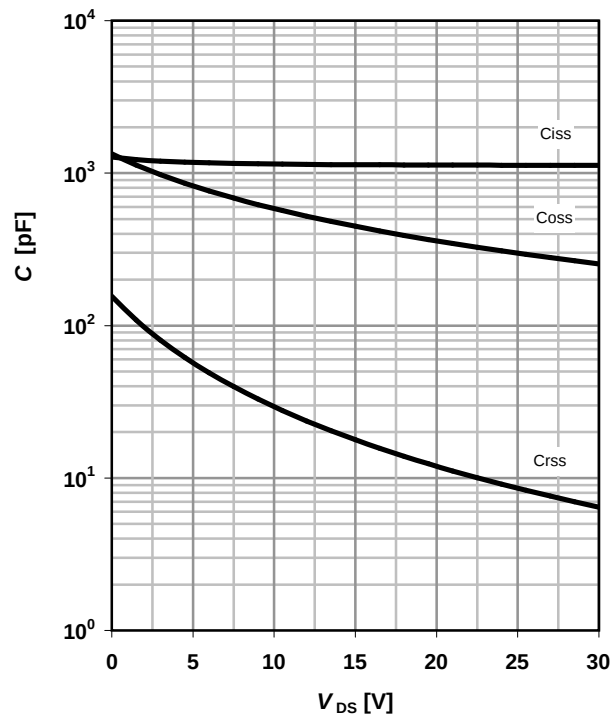
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



## 10 Typ. Capacitances<sup>4)</sup>

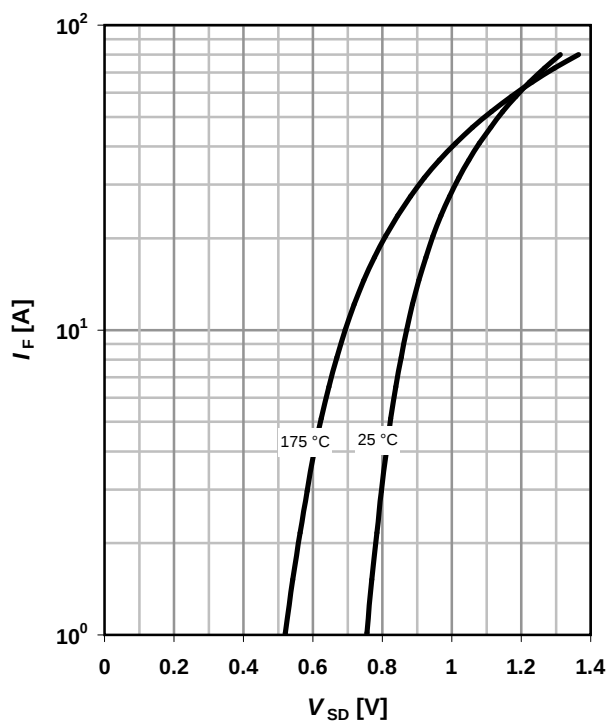
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



## 11 Typical forward diode characteristics<sup>4)</sup>

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

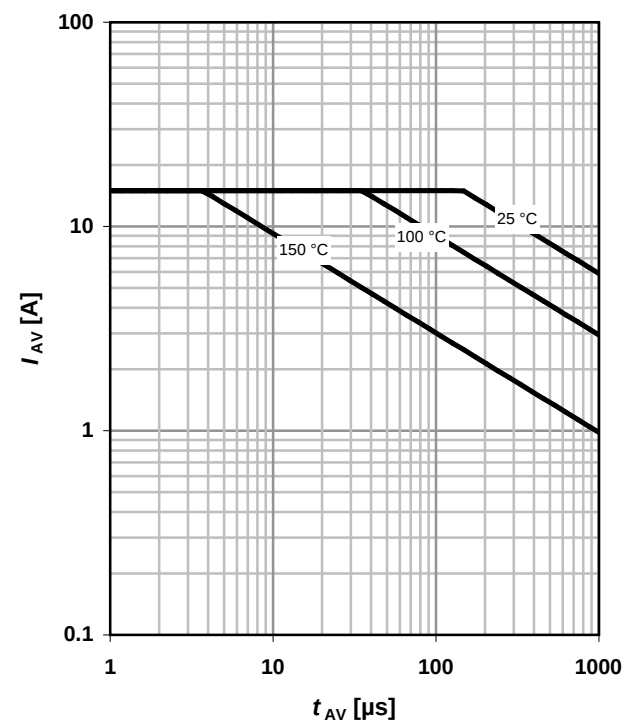
parameter:  $T_j$



## 12 Avalanche characteristics<sup>4)</sup>

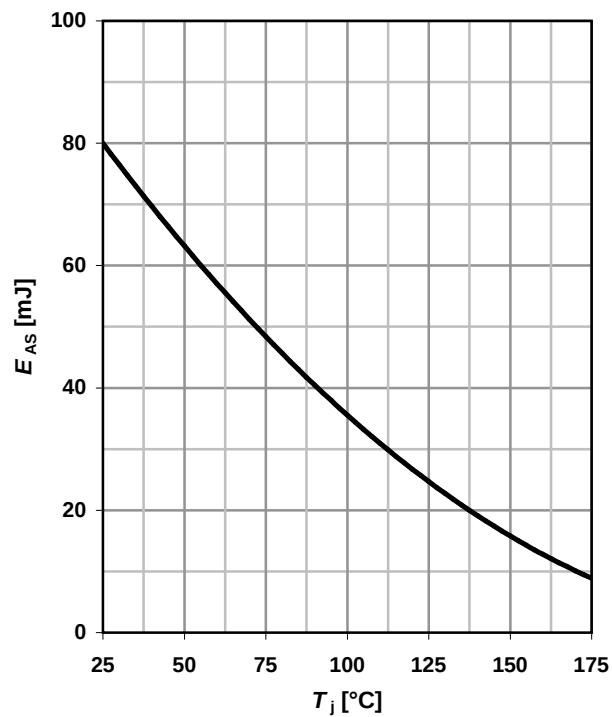
$$I_{AS} = f(t_{AV})$$

parameter:  $T_{j(start)}$



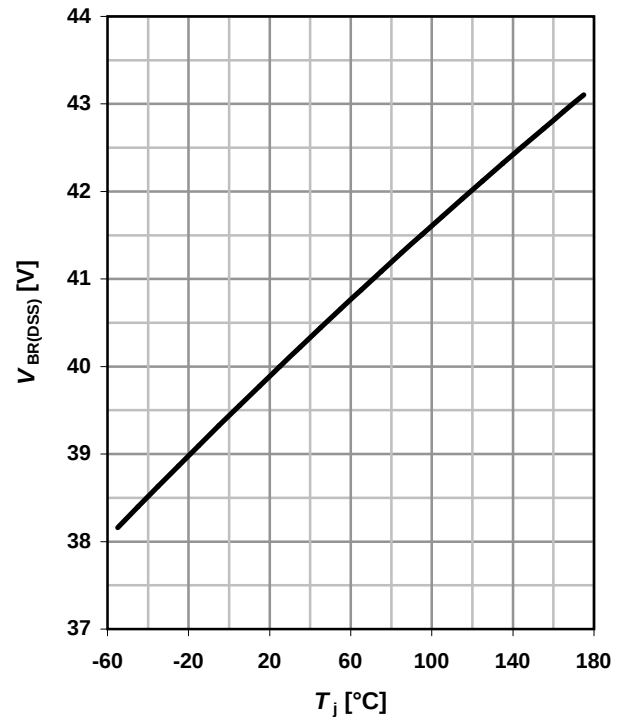
### 13 Avalanche energy<sup>4)</sup>

$$E_{AS} = f(T_j), I_D = 10A$$



### 14 Drain-source breakdown voltage

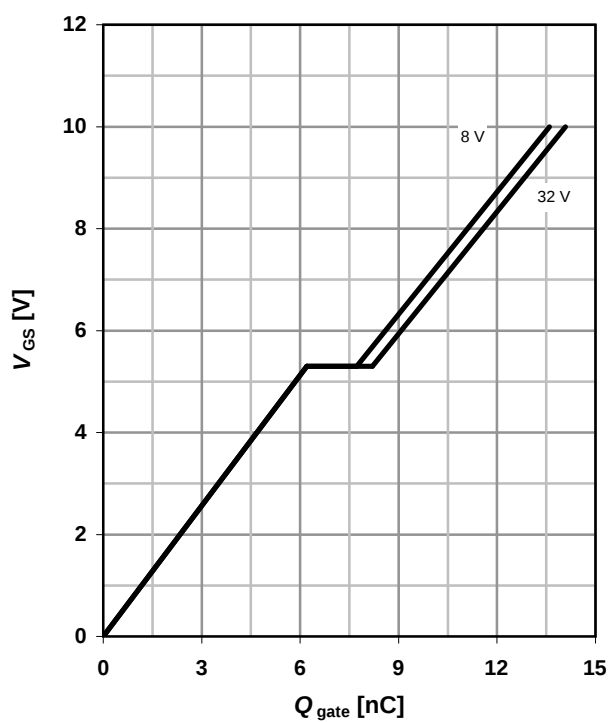
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$



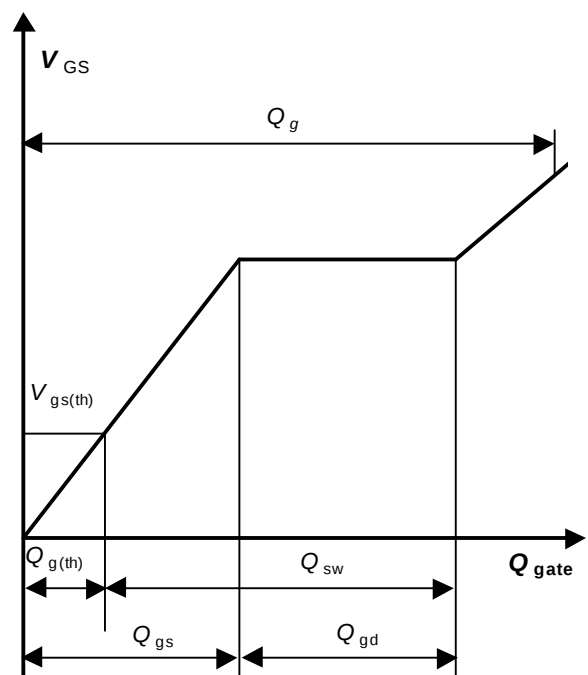
### 15 Typ. gate charge<sup>4)</sup>

$$V_{GS} = f(Q_{gate}); I_D = 20 \text{ A pulsed}$$

parameter:  $V_{DD}$



### 16 Gate charge waveforms



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

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Revision History

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| Version      | Date       | Changes                 |
|--------------|------------|-------------------------|
| Revision 1.0 | 05.10.2010 | Data Sheet revision 1.0 |
|              |            |                         |
|              |            |                         |