

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



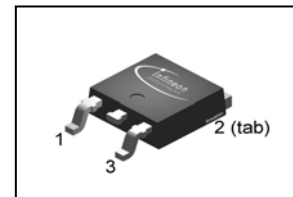
### Features

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

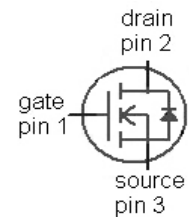
### Product Summary

|                  |    |    |
|------------------|----|----|
| $V_{DS}$         | 40 | V  |
| $R_{DS(on),max}$ | 9  | mΩ |
| $I_D$            | 50 | A  |

PG-TO252-3-11



| Type          | Package       | Marking |
|---------------|---------------|---------|
| IPD50N04S3-09 | PG-TO252-3-11 | 3N0409  |



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

| Parameter                                     | Symbol            | Conditions                                          | Value        | Unit |
|-----------------------------------------------|-------------------|-----------------------------------------------------|--------------|------|
| Continuous drain current                      | $I_D$             | $T_C=25\text{ °C}$ , $V_{GS}=10\text{ V}^{(1)}$     | 50           | A    |
|                                               |                   | $T_C=100\text{ °C}$ ,<br>$V_{GS}=10\text{ V}^{(2)}$ | 43           |      |
| Pulsed drain current <sup>(2)</sup>           | $I_{D,pulse}$     | $T_C=25\text{ °C}$                                  | 200          |      |
| Avalanche energy, single pulse <sup>(2)</sup> | $E_{AS}$          | $I_D=25\text{ A}$                                   | 140          | mJ   |
| Avalanche current, single pulse               | $I_{AS}$          |                                                     | 50           | A    |
| Gate source voltage                           | $V_{GS}$          |                                                     | ±20          | V    |
| Power dissipation                             | $P_{tot}$         | $T_C=25\text{ °C}$                                  | 63           | 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<sup>2)</sup>

|                                     |            |                                              |   |   |     |     |
|-------------------------------------|------------|----------------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case | $R_{thJC}$ |                                              | - | - | 2.4 | K/W |
| SMD version, device on PCB          | $R_{thJA}$ | minimal footprint                            | - | - | 62  |     |
|                                     |            | 6 cm <sup>2</sup> cooling area <sup>3)</sup> | - | - | 40  |     |

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

#### Static characteristics

|                                  |               |                                                                          |     |     |     |               |
|----------------------------------|---------------|--------------------------------------------------------------------------|-----|-----|-----|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=1\text{ mA}$                                  | 40  | -   | -   | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=28\text{ }\mu\text{A}$                            | 2.1 | 3.0 | 4.0 |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$       | -   | -   | 1   | $\mu\text{A}$ |
|                                  |               | $V_{DS}=40\text{ V}$ , $V_{GS}=0\text{ V}$ ,<br>$T_j=125\text{ °C}^{2)}$ | -   | -   | 100 |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                               | -   | -   | 100 | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=50\text{ A}$                                 | -   | 7.5 | 9.0 | m $\Omega$    |

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

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

|                              |              |                                                                                 |   |      |      |    |
|------------------------------|--------------|---------------------------------------------------------------------------------|---|------|------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V},$<br>$f=1\text{ MHz}$                    | - | 1350 | 1750 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                 | - | 720  | 940  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                 | - | 55   | 85   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=50\text{ A}, R_G=3.5\ \Omega$ | - | 11   | -    | ns |
| Rise time                    | $t_r$        |                                                                                 | - | 7    | -    |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                 | - | 16   | -    |    |
| Fall time                    | $t_f$        |                                                                                 | - | 6    | -    |    |

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

|                       |               |                                                                            |   |     |    |    |
|-----------------------|---------------|----------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=32\text{ V}, I_D=50\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 8   | 11 | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                            | - | 5   | 8  |    |
| Gate charge total     | $Q_g$         |                                                                            | - | 20  | 26 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                            | - | 5.8 | -  | V  |

### Reverse Diode

|                                                |               |                                                                   |   |     |     |    |
|------------------------------------------------|---------------|-------------------------------------------------------------------|---|-----|-----|----|
| Diode continuous forward current <sup>2)</sup> | $I_S$         | $T_C=25\text{ °C}$                                                | - | -   | 50  | A  |
| Diode pulse current <sup>2)</sup>              | $I_{S,pulse}$ |                                                                   | - | -   | 200 |    |
| Diode forward voltage                          | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=50\text{ A},$<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>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 30  | -   | ns |
| Reverse recovery charge <sup>2)</sup>          | $Q_{rr}$      |                                                                   | - | 32  | -   | nC |

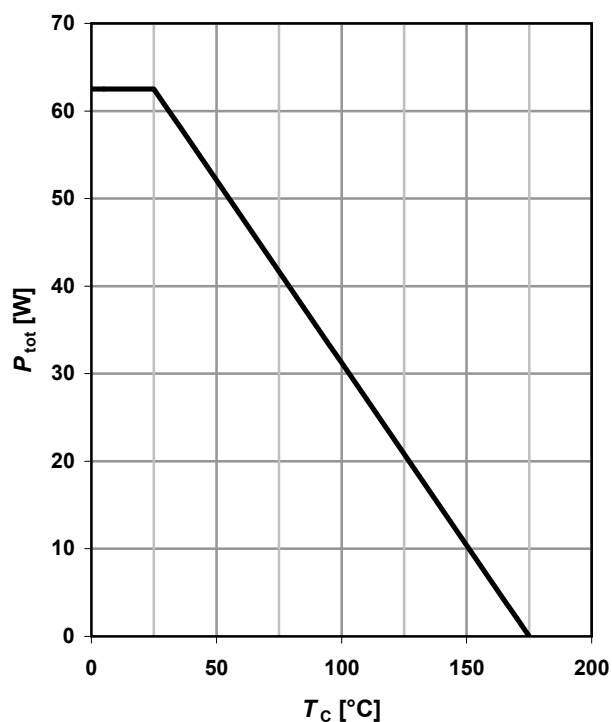
<sup>1)</sup> Current is limited by bondwire; with an  $R_{thJC} = 2.4\text{K/W}$  the chip is able to carry 61A at 25°C.

<sup>2)</sup> Defined 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.

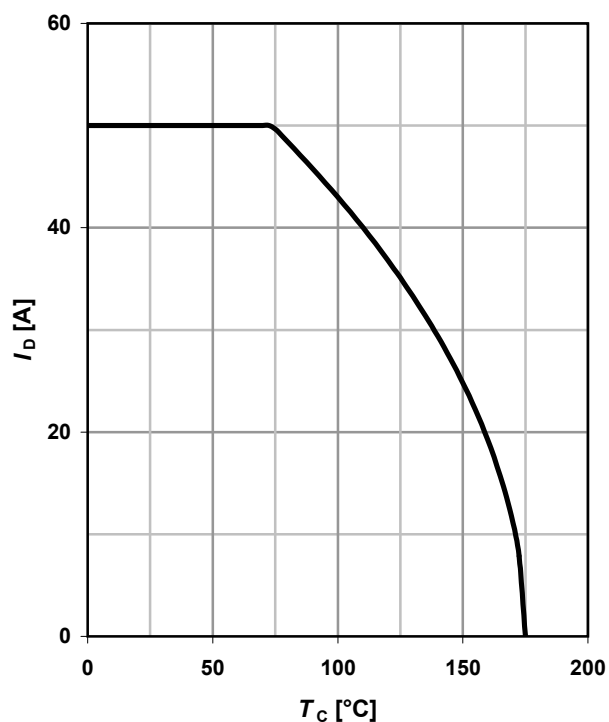
### 1 Power dissipation

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



### 2 Drain current

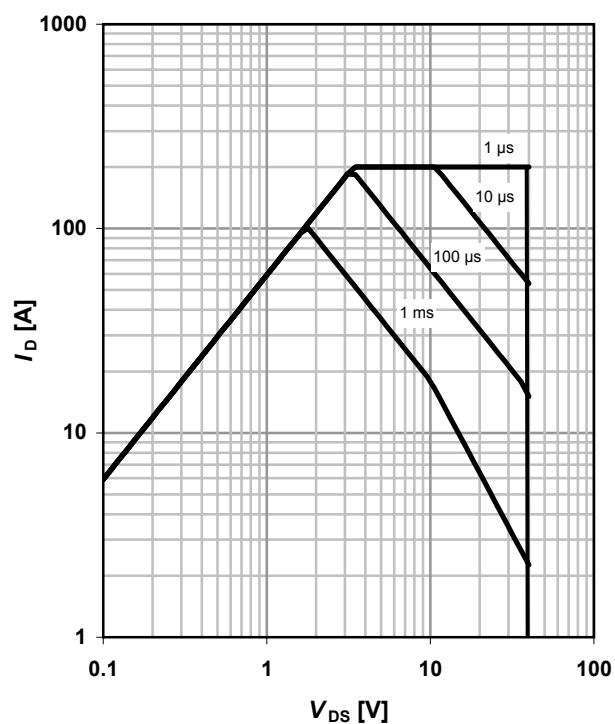
$$I_D = f(T_C); V_{\text{GS}} \geq 6 \text{ V}$$



### 3 Safe operating area

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

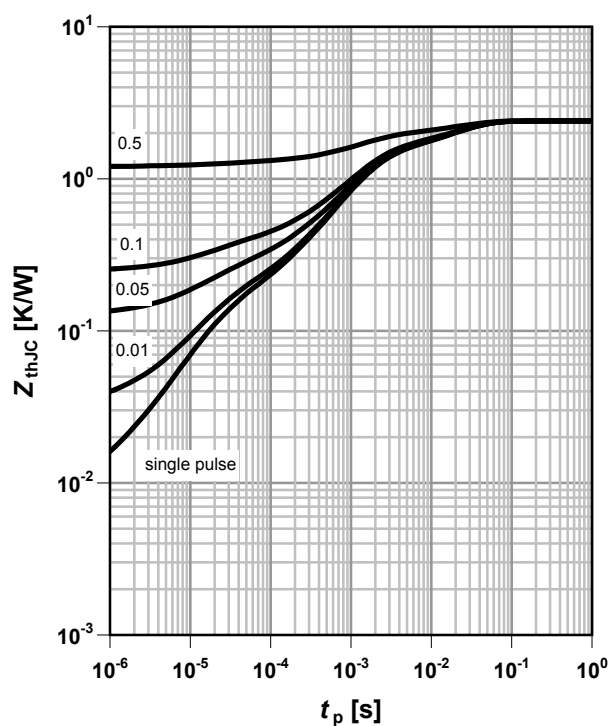
parameter:  $t_p$



### 4 Max. transient thermal impedance

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

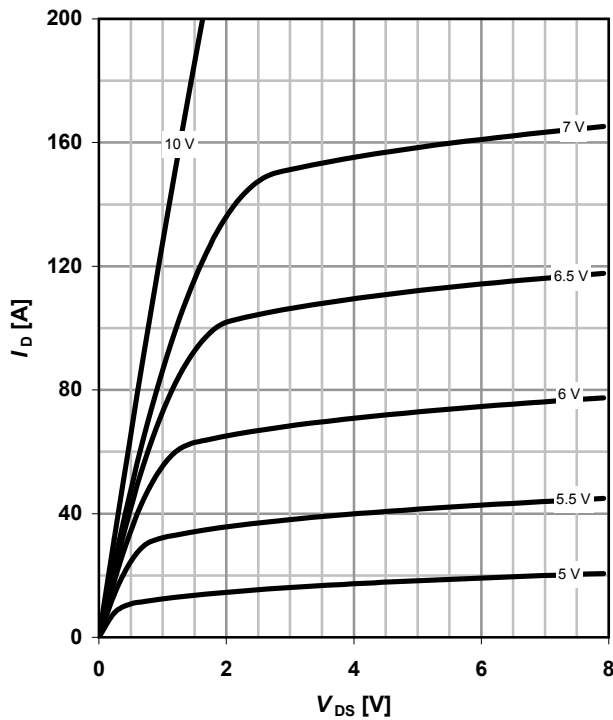
parameter:  $D = t_p/T$



### 5 Typ. output characteristics

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

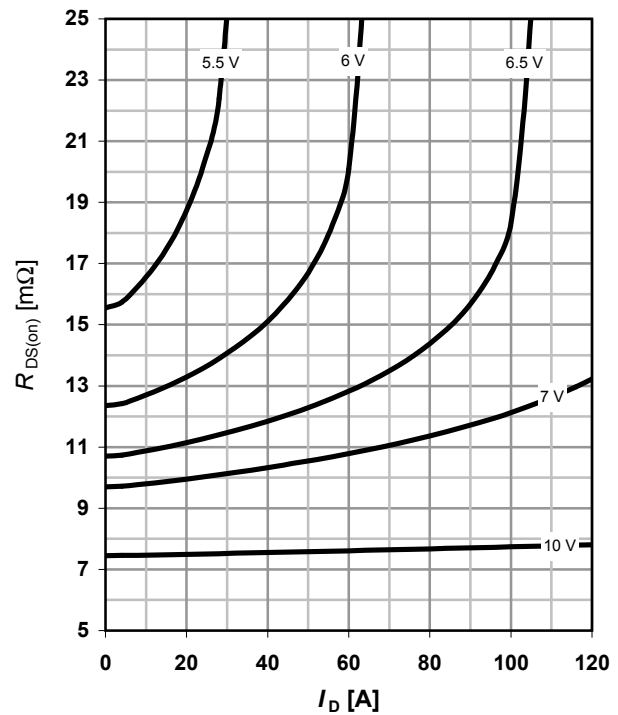
parameter:  $V_{GS}$



### 6 Typ. drain-source on-state resistance

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

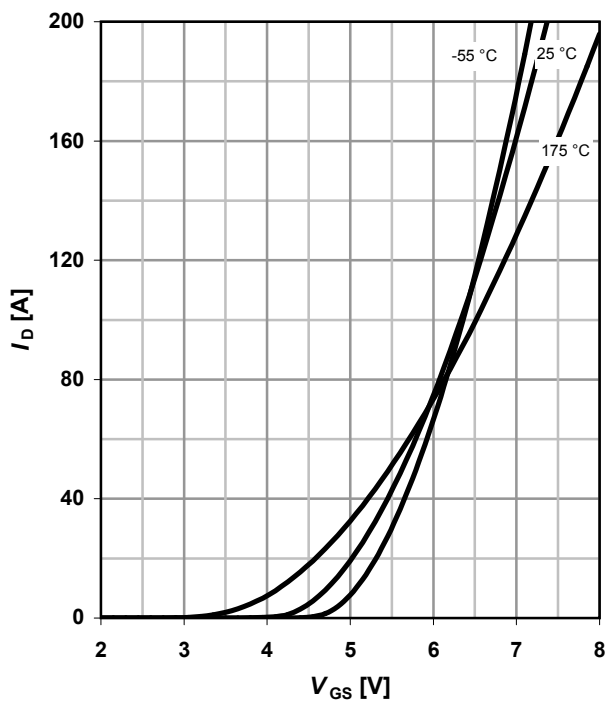
parameter:  $V_{GS}$



### 7 Typ. transfer characteristics

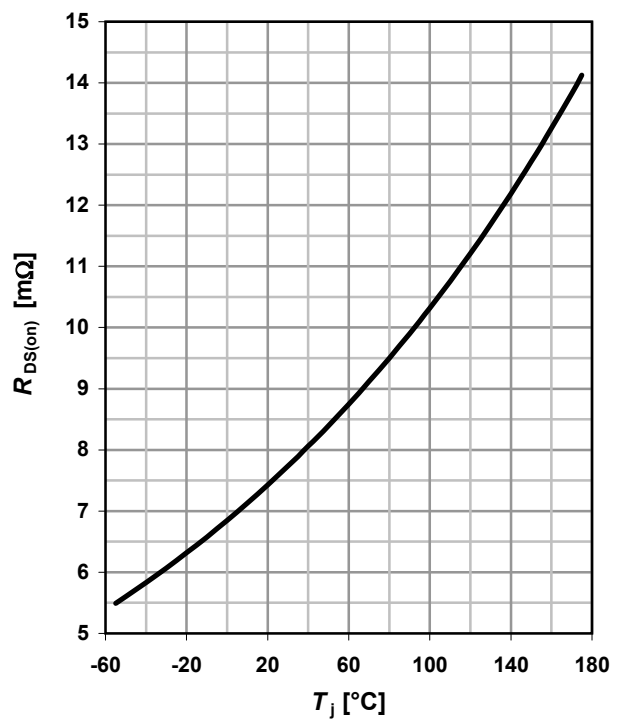
$$I_D = f(V_{GS}); V_{DS} = 6\text{ V}$$

parameter:  $T_j$



### 8 Typ. drain-source on-state resistance

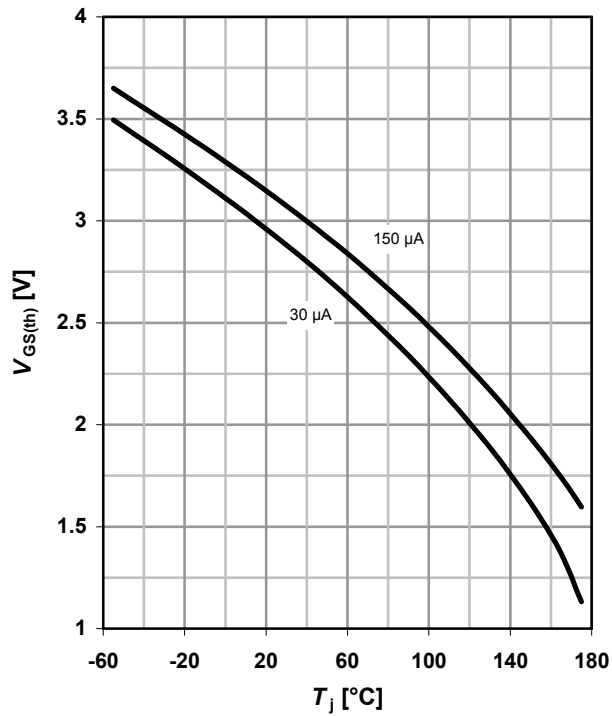
$$R_{DS(on)} = f(T_j); I_D = 50\text{ A}; V_{GS} = 10\text{ V}$$



## 9 Typ. gate threshold voltage

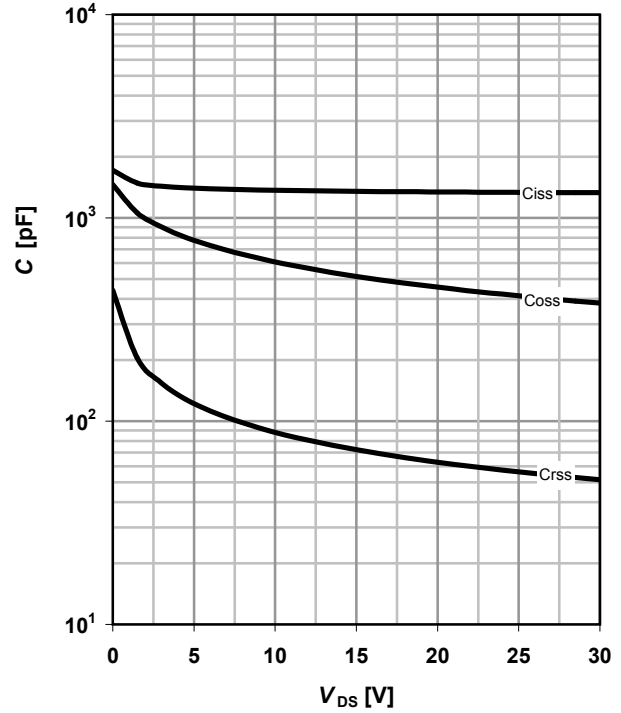
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



## 10 Typ. capacitances

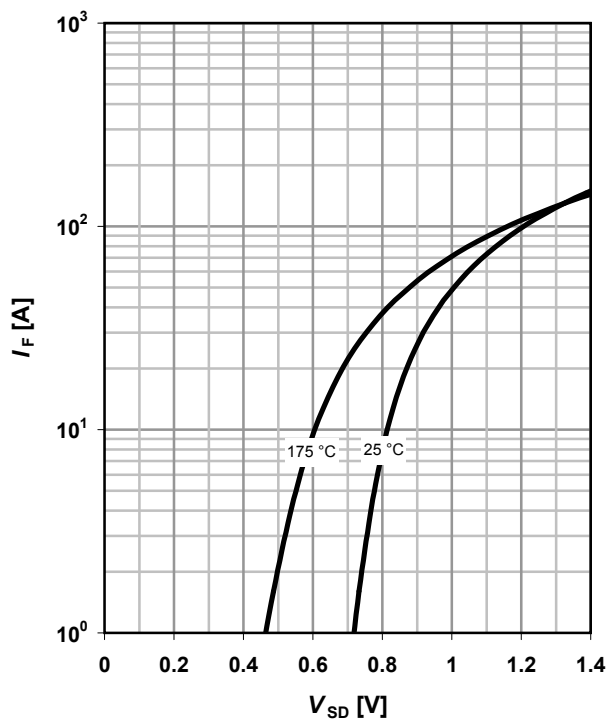
$$C = f(V_{DS}); V_{GS} = 0 V; f = 1 MHz$$



## 11 Typical forward diode characteristics

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

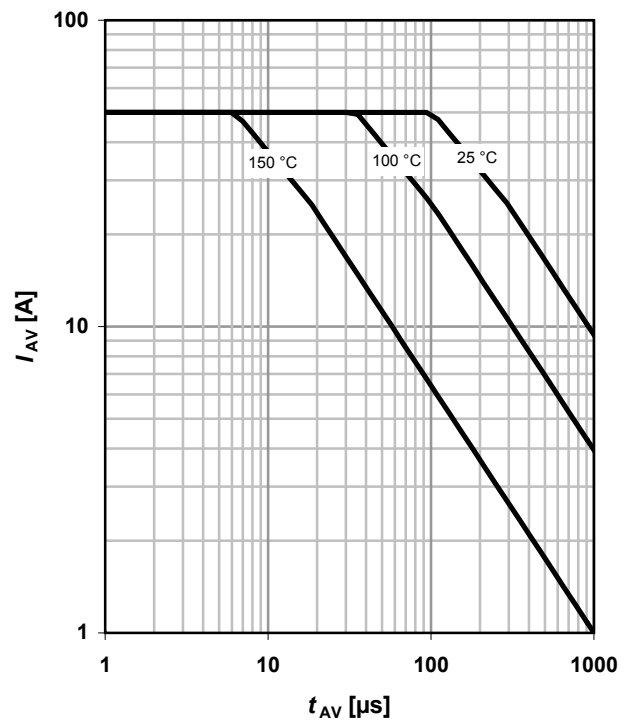
parameter:  $T_j$



## 12 Typ. avalanche characteristics

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

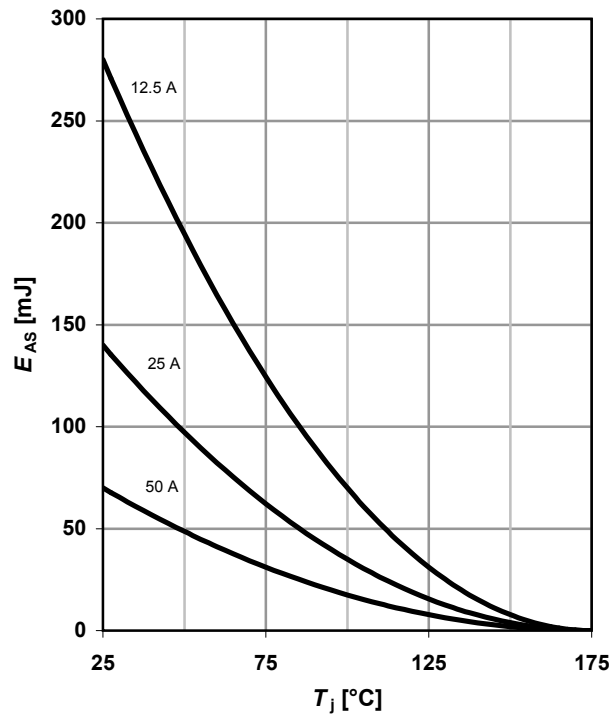
parameter:  $T_{j(start)}$



### 13 Typical avalanche energy

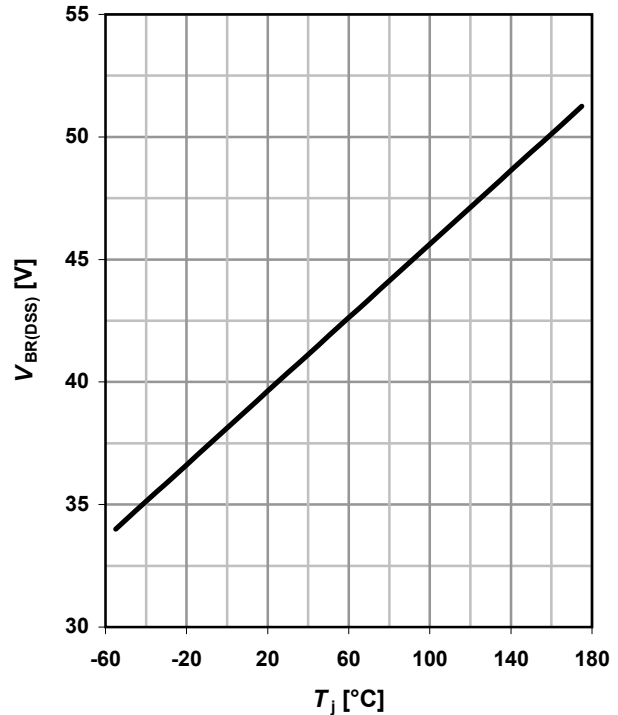
$$E_{AS} = f(T_j)$$

parameter:  $I_D$



### 14 Typ. drain-source breakdown voltage

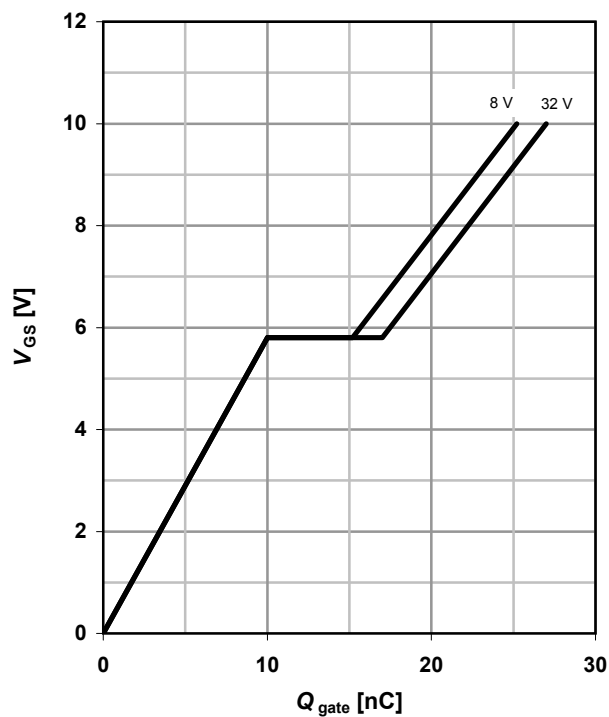
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$



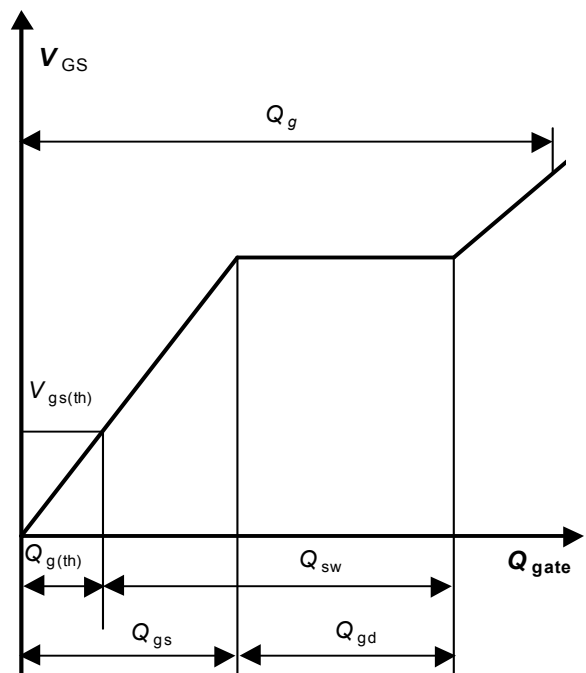
### 15 Typ. gate charge

$$V_{GS} = f(Q_{gate}); I_D = 50 \text{ A pulsed}$$

parameter:  $V_{DD}$



### 16 Gate charge waveforms



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Revision History

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| Version  | Date       | Changes                             |
|----------|------------|-------------------------------------|
| Rev. 1.1 | 03.10.2009 | Update of SOA diagram for 1ms curve |