



IPB240N04S4-R9

## OptiMOS™-T2 Power-Transistor



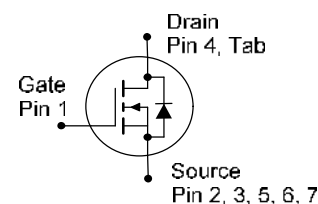
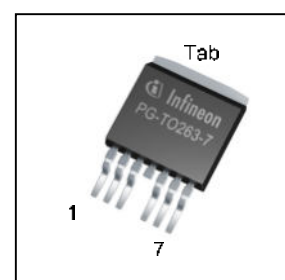
### Features

- N-channel - Enhancement mode
- AEC qualified
- MSL1 up to 260°C peak reflow
- 175°C operating temperature
- Green product (RoHS compliant)
- Ultra low Rds(on)
- 100% Avalanche tested

### Product Summary

|              |      |    |
|--------------|------|----|
| $V_{DS}$     | 40   | V  |
| $R_{DS(on)}$ | 0.87 | mΩ |
| $I_D$        | 240  | A  |

PG-TO263-7-3



| Type           | Package      | Marking |
|----------------|--------------|---------|
| IPB240N04S4-R9 | PG-TO263-7-3 | 4N04R9  |

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

| Parameter                                    | Symbol            | Conditions                                          | Value        | Unit |
|----------------------------------------------|-------------------|-----------------------------------------------------|--------------|------|
| Continuous drain current                     | $I_D$             | $T_C=25\text{ °C}$ , $V_{GS}=10\text{ V}^{(1)}$     | 240          | A    |
|                                              |                   | $T_C=100\text{ °C}$ ,<br>$V_{GS}=10\text{ V}^{(2)}$ | 240          |      |
|                                              |                   |                                                     |              |      |
| Pulsed drain current <sup>2)</sup>           | $I_{D,pulse}$     | $T_C=25\text{ °C}$                                  | 960          |      |
| Avalanche energy, single pulse <sup>2)</sup> | $E_{AS}$          | $I_D=120\text{ A}$                                  | 750          | mJ   |
| Avalanche current, single pulse              | $I_{AS}$          | -                                                   | 190          | A    |
| Gate source voltage                          | $V_{GS}$          | -                                                   | ±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<sup>2)</sup>

|                                     |            |                                              |   |   |     |     |
|-------------------------------------|------------|----------------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case | $R_{thJC}$ | -                                            | - | - | 0.5 | 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           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=230\text{ }\mu\text{A}$                    | 2.0 | 3.0 | 4.0  |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=40\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$      | -   | 0.1 | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=18\text{ V}, V_{GS}=0\text{ V}, T_j=85\text{ °C}^{2)}$ | -   | 20  | 240  |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                        | -   | -   | 100  | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=100\text{ A}$                         | -   | -   | 0.87 | 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>$f=1\text{ MHz}$                                | - | 17700 | 23000 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                             | - | 3850  | 5000  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                             | - | 150   | 345   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=240\text{ A},$<br>$R_{G,ext}=3.5\ \Omega$ | - | 55    | -     | ns |
| Rise time                    | $t_r$        |                                                                                             | - | 28    | -     |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                             | - | 64    | -     |    |
| Fall time                    | $t_f$        |                                                                                             | - | 59    | -     |    |

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

|                       |               |                                                                             |   |     |     |    |
|-----------------------|---------------|-----------------------------------------------------------------------------|---|-----|-----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=32\text{ V}, I_D=240\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 90  | 117 | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                             | - | 32  | 65  |    |
| Gate charge total     | $Q_g$         |                                                                             | - | 220 | 290 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                             | - | 5.4 | -   | V  |

**Reverse Diode**

|                                                |               |                                                                           |   |     |     |    |
|------------------------------------------------|---------------|---------------------------------------------------------------------------|---|-----|-----|----|
| Diode continuous forward current <sup>2)</sup> | $I_S$         | $T_C=25\text{ °C}$                                                        | - | -   | 240 | A  |
| Diode pulse current <sup>2)</sup>              | $I_{S,pulse}$ |                                                                           | - | -   | 960 |    |
| Diode forward voltage                          | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=100\text{ A},$<br>$T_j=25\text{ °C}$              | - | 0.9 | 1.3 | V  |
| Reverse recovery time <sup>2)</sup>            | $t_{rr}$      | $V_R=20\text{ V}, I_F=50\text{ A},$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 85  | -   | ns |
| Reverse recovery charge <sup>2)</sup>          | $Q_{rr}$      |                                                                           | - | 130 | -   | nC |

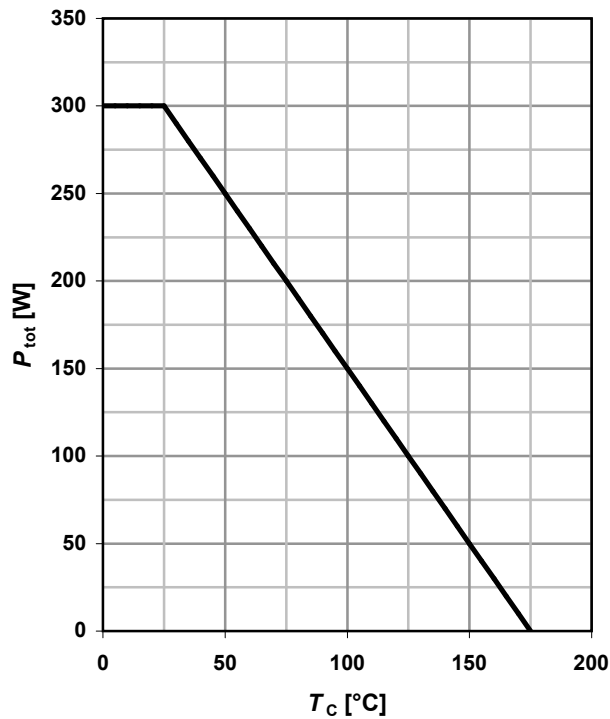
<sup>1)</sup> Current is limited by bondwire; with an  $R_{thJC} = 0.5\text{ K/W}$  the chip is able to carry 451A at 25°C.

<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.

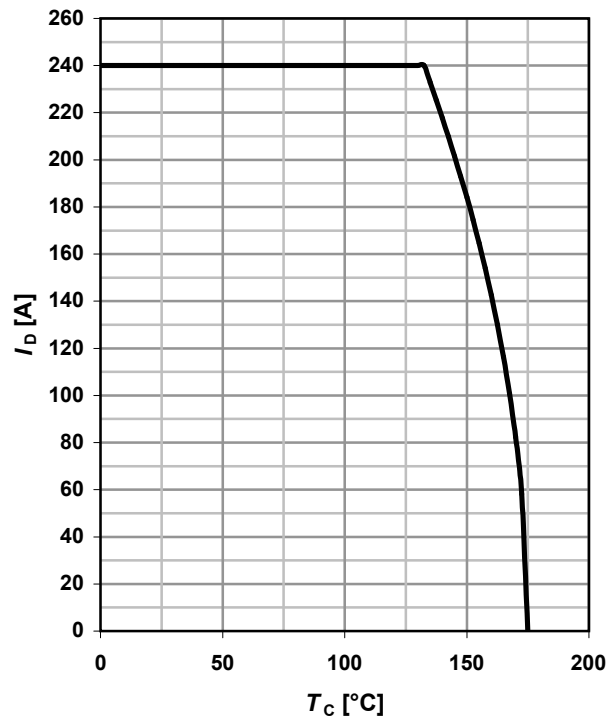
### 1 Power dissipation

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



### 2 Drain current

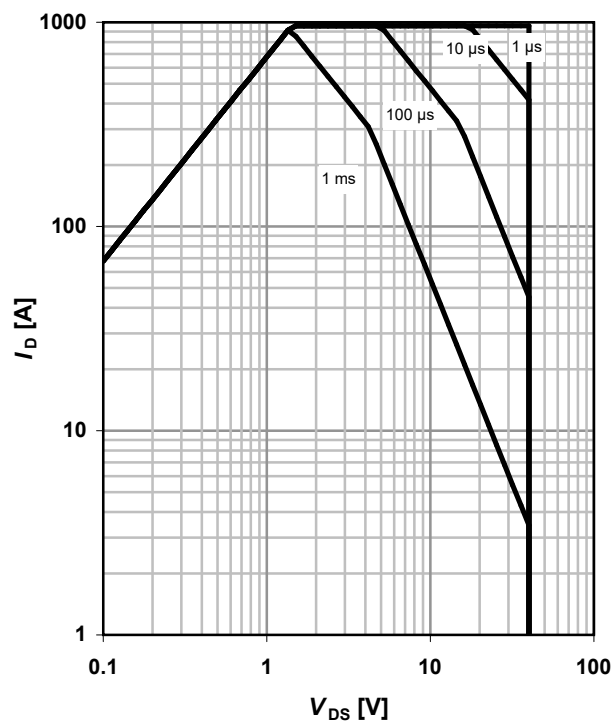
$$I_D = f(T_C); V_{\text{GS}} \geq 6 \text{ V}$$



### 3 Safe operating area

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

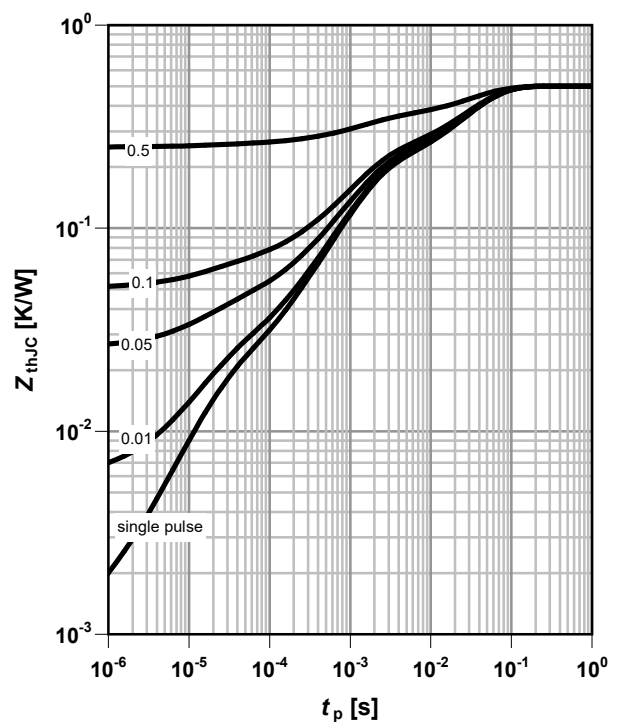
parameter:  $t_p$



### 4 Max. transient thermal impedance

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

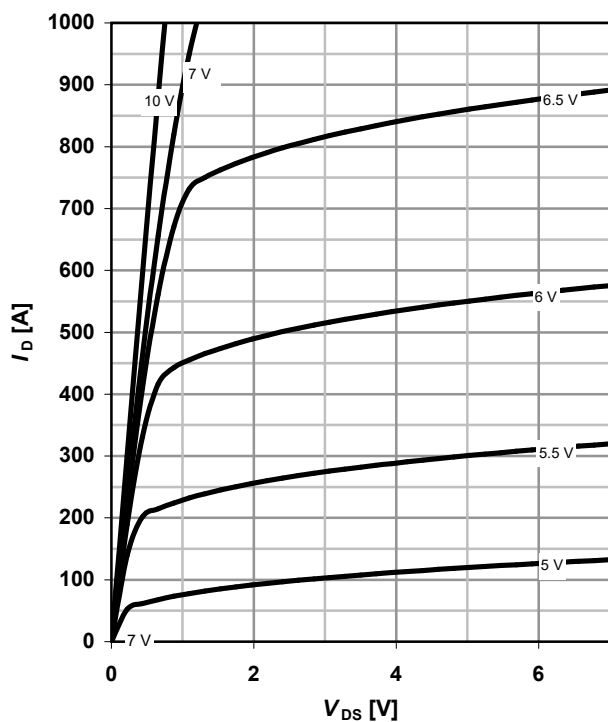
parameter:  $D = t_p/T$



## 5 Typ. output characteristics

$I_D = f(V_{DS}); T_j = 25\text{ °C}$

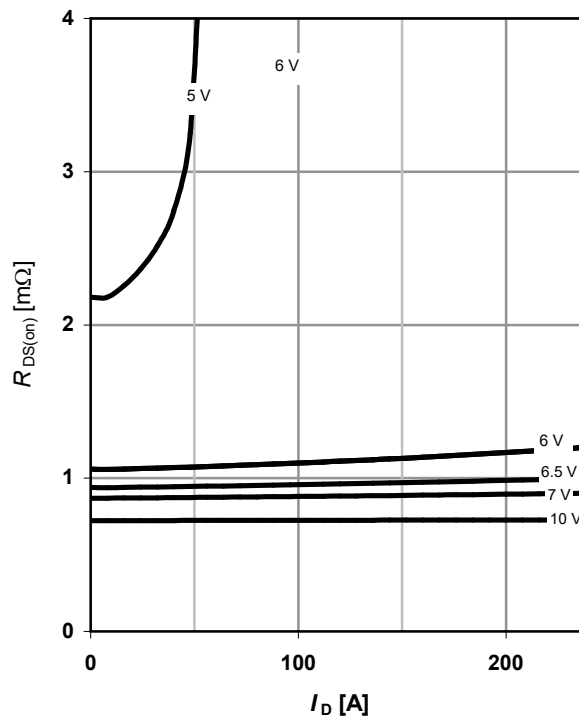
parameter:  $V_{GS}$



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

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

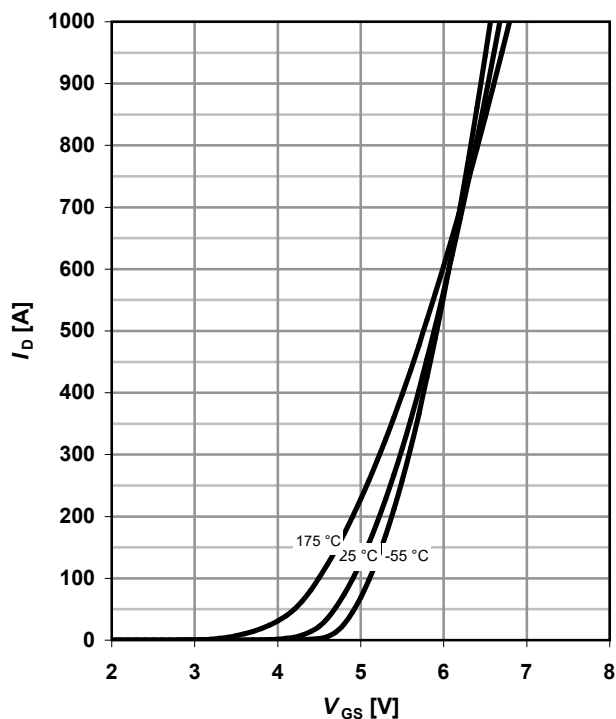
parameter:  $V_{GS}$



## 7 Typ. transfer characteristics

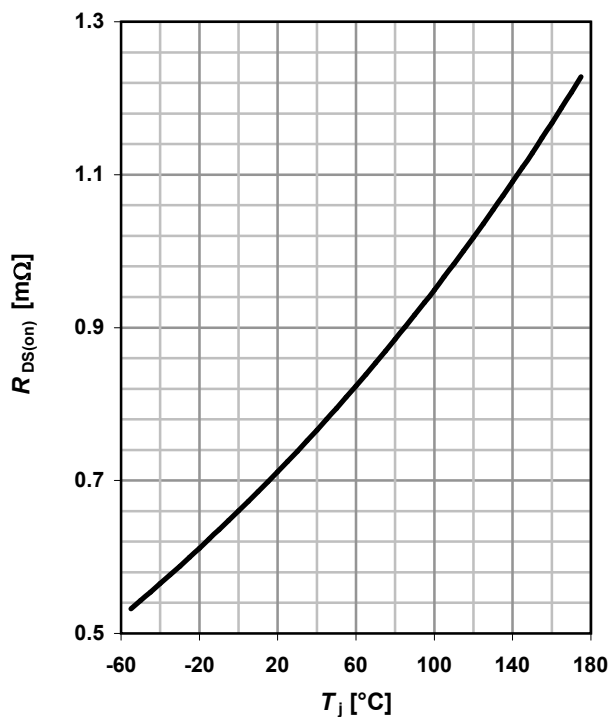
$I_D = f(V_{GS}); V_{DS} = 6\text{ V}$

parameter:  $T_j$



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

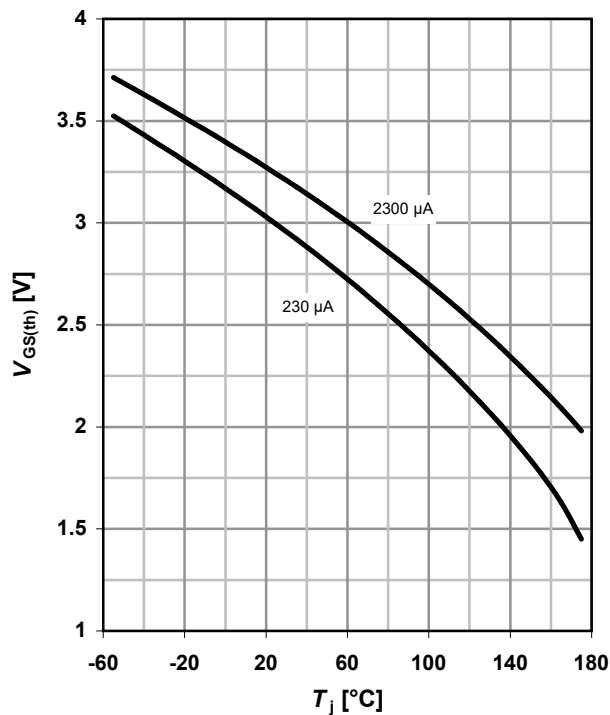
$R_{DS(on)} = f(T_j); I_D = 100\text{ A}; V_{GS} = 10\text{ V}$



## 9 Typ. gate threshold voltage

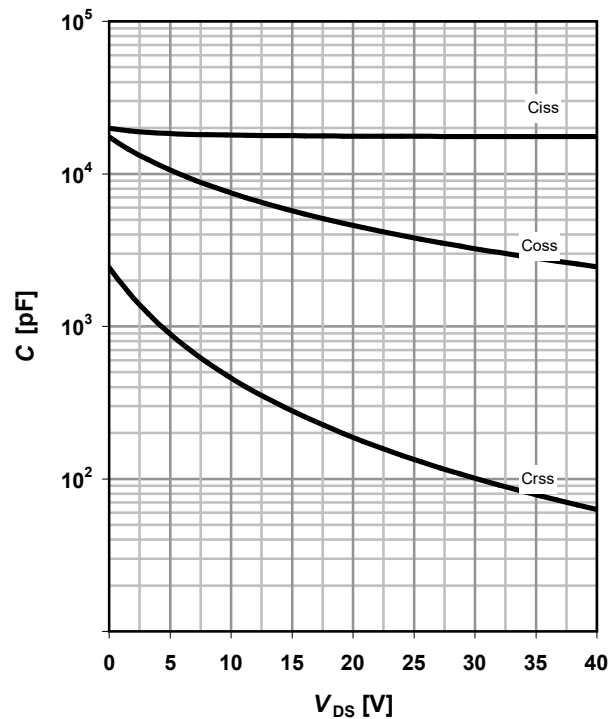
$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$$

parameter:  $I_D$



## 10 Typ. capacitances

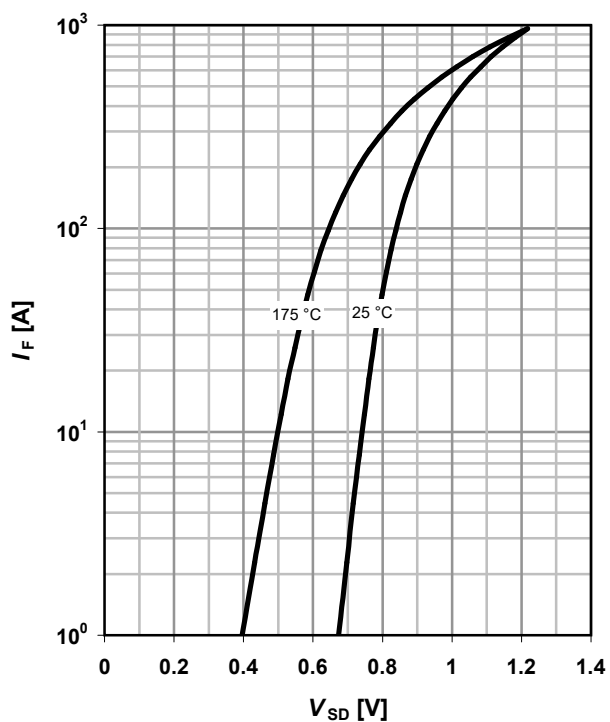
$$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$$



## 11 Typical forward diode characteristics

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

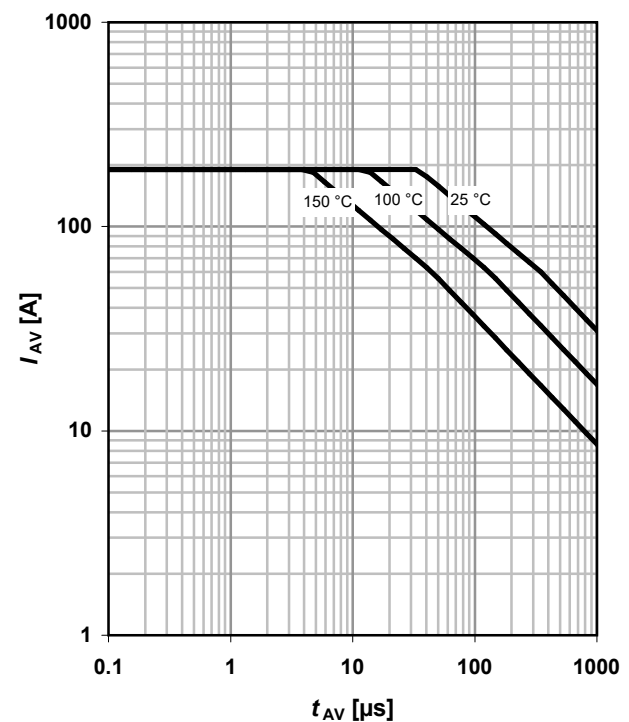
parameter:  $T_j$



## 12 Typ. avalanche characteristics

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

parameter:  $T_{j(start)}$

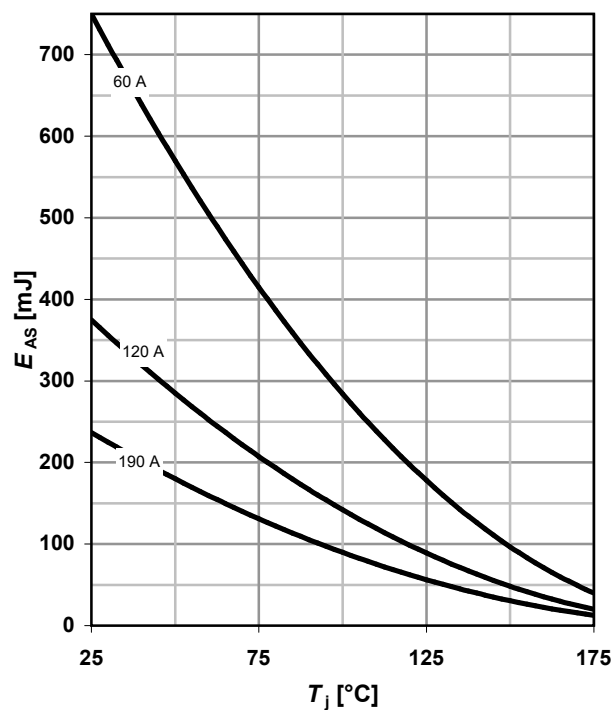




### 13 Typical avalanche energy

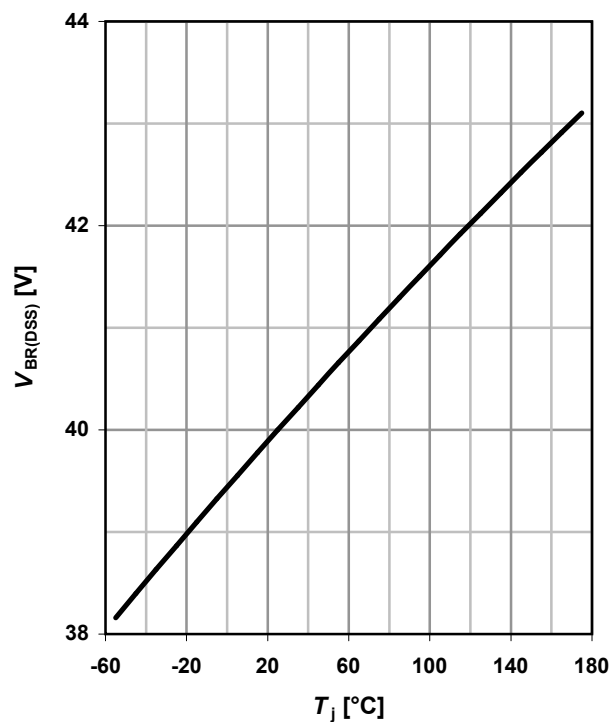
$$E_{AS} = f(T_j)$$

parameter:  $I_D$



### 14 Drain-source breakdown voltage

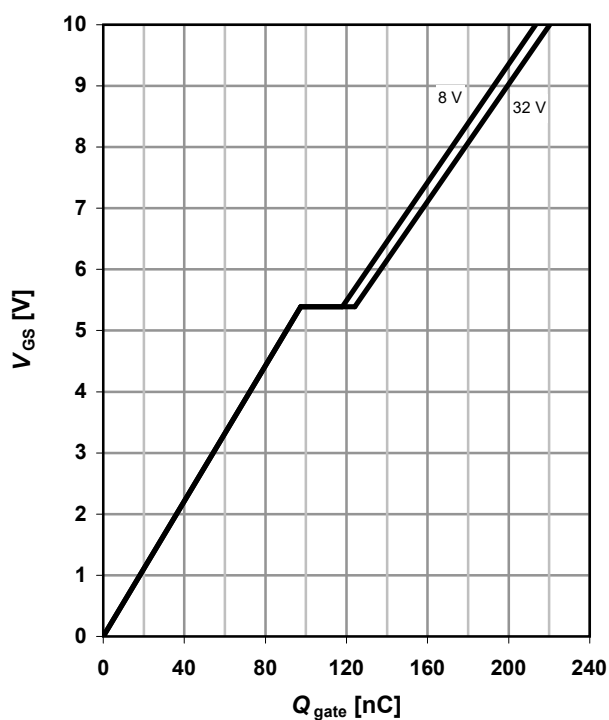
$$V_{BR(DSS)} = f(T_j); I_D = 1 \text{ mA}$$



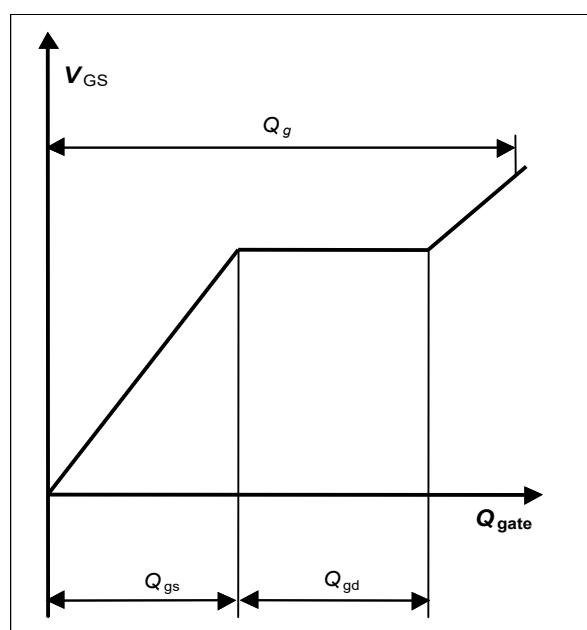
### 15 Typ. gate charge

$$V_{GS} = f(Q_{gate}); I_D = 240 \text{ A pulsed}$$

parameter:  $V_{DD}$



### 16 Gate charge waveforms



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## Revision History

| Version      | Date       | Changes                                                                         |
|--------------|------------|---------------------------------------------------------------------------------|
| Revision 1.0 | 16.08.2013 | Final Data Sheet                                                                |
| Revision 1.1 | 07.04.2014 | Changed Hot Temperature $I_{DSS}$<br>Changed Dynamic Values<br>Changed $E_{AS}$ |