

## OptiMOS™ Power-Transistor

### Features

- Optimized for high performance SMPS, e.g. sync. rec.
- 100% avalanche tested
- Superior thermal resistance
- N-channel
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free lead plating; RoHS compliant
- Halogen-free according to IEC61249-2-21



Halogen-Free

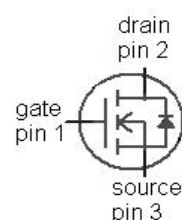
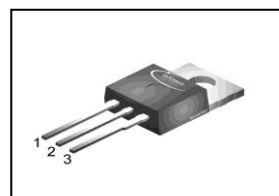


| Type       | Package    | Marking |
|------------|------------|---------|
| IPP060N06N | PG-TO220-3 | 060N06N |

### Product Summary

|                  |     |    |
|------------------|-----|----|
| $V_{DS}$         | 60  | V  |
| $R_{DS(on),max}$ | 6.0 | mΩ |
| $I_D$            | 45  | A  |
| $Q_{OSS}$        | 32  | nC |
| $Q_G(0V..10V)$   | 27  | nC |

PG-TO220-3



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

| Parameter                                    | Symbol        | Conditions                                                              | Value | Unit |
|----------------------------------------------|---------------|-------------------------------------------------------------------------|-------|------|
| Continuous drain current                     | $I_D$         | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$                               | 45    | A    |
|                                              |               | $V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$                              | 45    |      |
|                                              |               | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$ ,<br>$R_{thJA}=50\text{ K/W}$ | 17    |      |
| Pulsed drain current <sup>2)</sup>           | $I_{D,pulse}$ | $T_C=25\text{ °C}$                                                      | 180   |      |
| Avalanche energy, single pulse <sup>3)</sup> | $E_{AS}$      | $I_D=45\text{ A}$ , $R_{GS}=25\text{ Ω}$                                | 60    | mJ   |
| Gate source voltage                          | $V_{GS}$      |                                                                         | ±20   | V    |

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

<sup>2)</sup> See figure 3 for more detailed information

<sup>3)</sup> See figure 13 for more detailed information

<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.

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

| Parameter                           | Symbol                | Conditions                                              | Value       | Unit |
|-------------------------------------|-----------------------|---------------------------------------------------------|-------------|------|
| Power dissipation                   | $P_{\text{tot}}$      | $T_C=25\text{ °C}$                                      | 83          | W    |
|                                     |                       | $T_A=25\text{ °C}$ ,<br>$R_{\text{thJA}}=50\text{ K/W}$ | 3.0         |      |
| Operating and storage temperature   | $T_j, T_{\text{stg}}$ |                                                         | -55 ... 175 | °C   |
| IEC climatic category; DIN IEC 68-1 |                       |                                                         | 55/175/56   |      |

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

#### Thermal characteristics

|                                     |                   |                                              |   |   |     |     |
|-------------------------------------|-------------------|----------------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case | $R_{\text{thJC}}$ | bottom                                       | - | - | 1.8 | K/W |
| Device on PCB                       | $R_{\text{thJA}}$ | 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   | $V_{(\text{BR})\text{DSS}}$ | $V_{\text{GS}}=0\text{ V}$ , $I_{\text{D}}=1\text{ mA}$                               | 60  | -   | -   | V             |
| Gate threshold voltage           | $V_{\text{GS(th)}}$         | $V_{\text{DS}}=V_{\text{GS}}$ , $I_{\text{D}}=36\text{ }\mu\text{A}$                  | 2.1 | 2.8 | 3.3 |               |
| Zero gate voltage drain current  | $I_{\text{DSS}}$            | $V_{\text{DS}}=60\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$      | -   | 0.5 | 1   | $\mu\text{A}$ |
|                                  |                             | $V_{\text{DS}}=60\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<br>$T_j=125\text{ °C}$     | -   | 10  | 100 |               |
| Gate-source leakage current      | $I_{\text{GSS}}$            | $V_{\text{GS}}=20\text{ V}$ , $V_{\text{DS}}=0\text{ V}$                              | -   | 10  | 100 | nA            |
| Drain-source on-state resistance | $R_{\text{DS(on)}}$         | $V_{\text{GS}}=10\text{ V}$ , $I_{\text{D}}=45\text{ A}$                              | -   | 5.2 | 6   | mΩ            |
|                                  |                             | $V_{\text{GS}}=6\text{ V}$ , $I_{\text{D}}=12\text{ A}$                               | -   | 6.7 | 9   |               |
| Gate resistance                  | $R_{\text{G}}$              |                                                                                       | -   | 1.5 | 2.3 | Ω             |
| Transconductance                 | $g_{\text{fs}}$             | $ V_{\text{DS}} >2 I_{\text{D}} R_{\text{DS(on)max}}$ ,<br>$I_{\text{D}}=45\text{ A}$ | 36  | 73  | -   | 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>$f=1\text{ MHz}$                                 | - | 2000 | 2500 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                              | - | 490  | 613  |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                              | - | 22   | 44   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=30\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=45\text{ A},$<br>$R_{G,ext,ext}=3\ \Omega$ | - | 12   | -    | ns |
| Rise time                    | $t_r$        |                                                                                              | - | 12   | -    |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                              | - | 20   | -    |    |
| Fall time                    | $t_f$        |                                                                                              | - | 7    | -    |    |

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

|                              |               |                                                                            |   |     |    |    |
|------------------------------|---------------|----------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=30\text{ V}, I_D=45\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 9   | -  | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |                                                                            | - | 5   | -  |    |
| Gate to drain charge         | $Q_{gd}$      |                                                                            | - | 5   | 7  |    |
| Switching charge             | $Q_{sw}$      |                                                                            | - | 9   | -  |    |
| Gate charge total            | $Q_g$         |                                                                            | - | 27  | 32 |    |
| Gate plateau voltage         | $V_{plateau}$ |                                                                            | - | 4.8 | -  | V  |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$<br>$V_{GS}=0\text{ to }10\text{ V}$                 | - | 24  | -  | nC |
| Output charge                | $Q_{oss}$     | $V_{DD}=30\text{ V}, V_{GS}=0\text{ V}$                                    | - | 32  | -  |    |

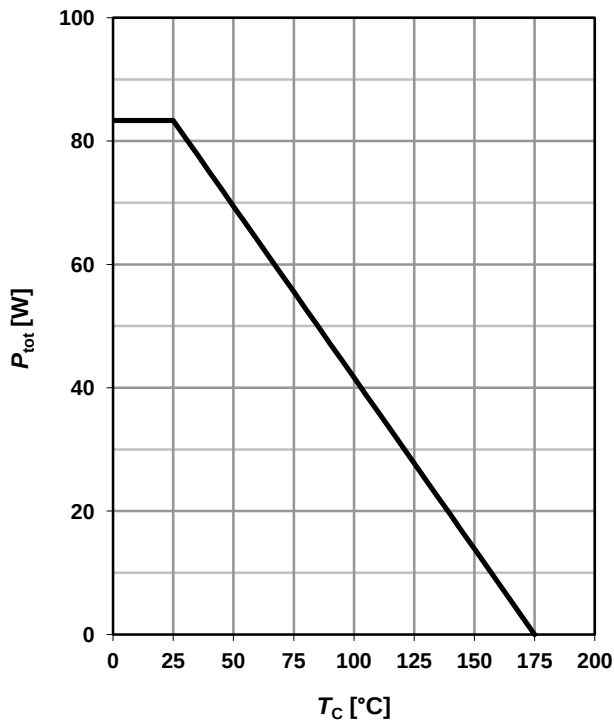
**Reverse Diode**

|                                  |               |                                                                           |   |     |     |    |
|----------------------------------|---------------|---------------------------------------------------------------------------|---|-----|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ °C}$                                                        | - | -   | 45  | A  |
| Diode pulse current              | $I_{S,pulse}$ |                                                                           | - | -   | 180 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=45\text{ A},$<br>$T_J=25\text{ °C}$               | - | 1.0 | 1.2 | V  |
| Reverse recovery time            | $t_{rr}$      | $V_R=30\text{ V}, I_F=45\text{ A},$<br>$di_F/dt=100\text{ A}/\mu\text{s}$ | - | 32  | 51  | ns |
| Reverse recovery charge          | $Q_{rr}$      |                                                                           | - | 28  | -   | nC |

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

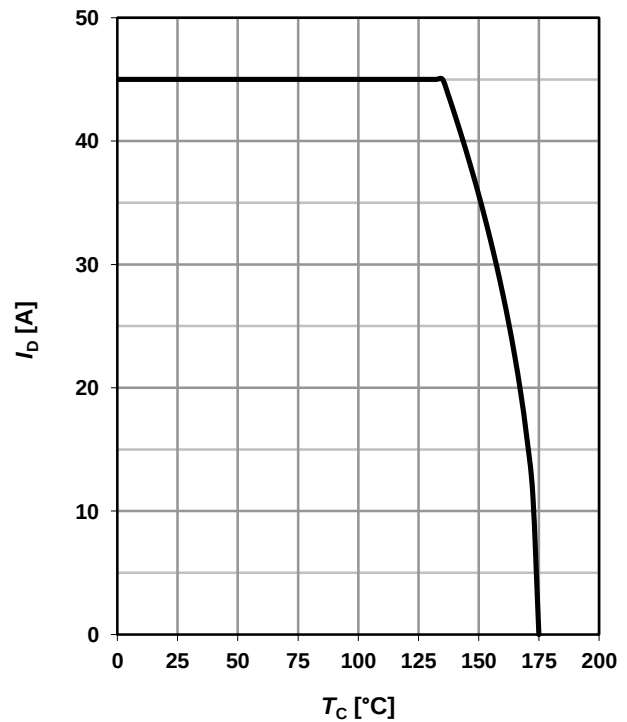
## 1 Power dissipation

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



## 2 Drain current

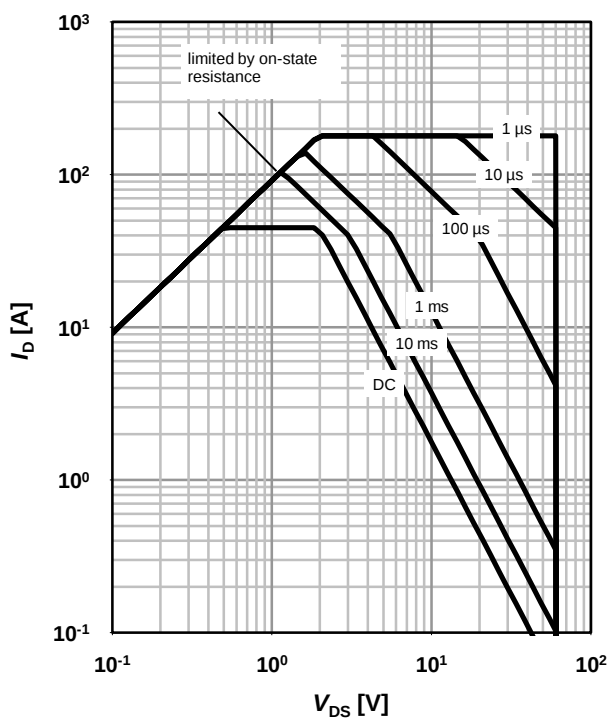
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



## 3 Safe operating area

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

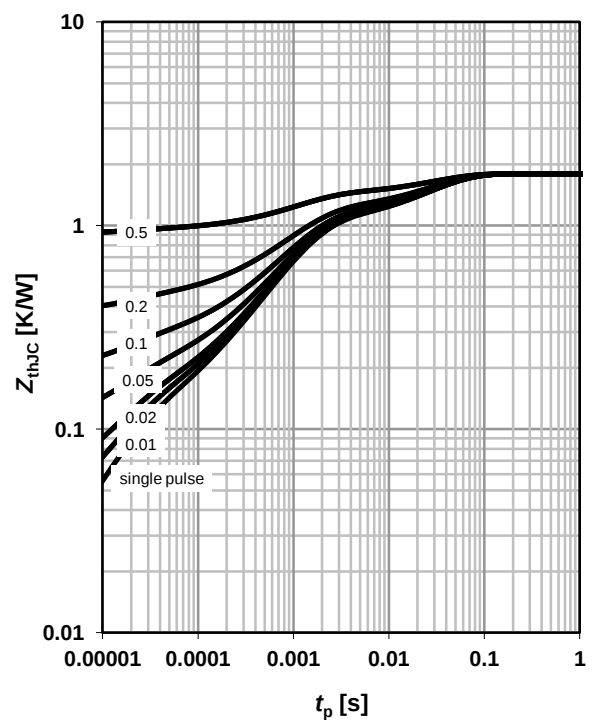
parameter:  $t_p$



## 4 Max. transient thermal impedance

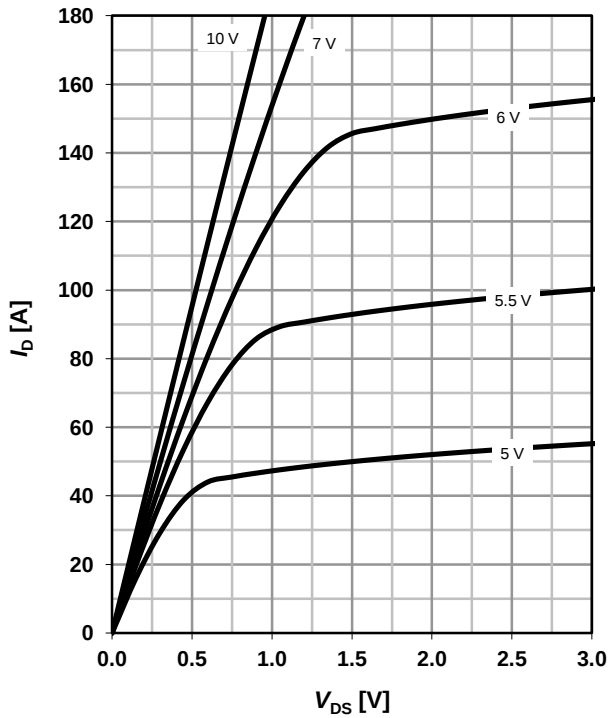
$$Z_{\text{thJC}} = f(t_p)$$

parameter:  $D = t_p/T$



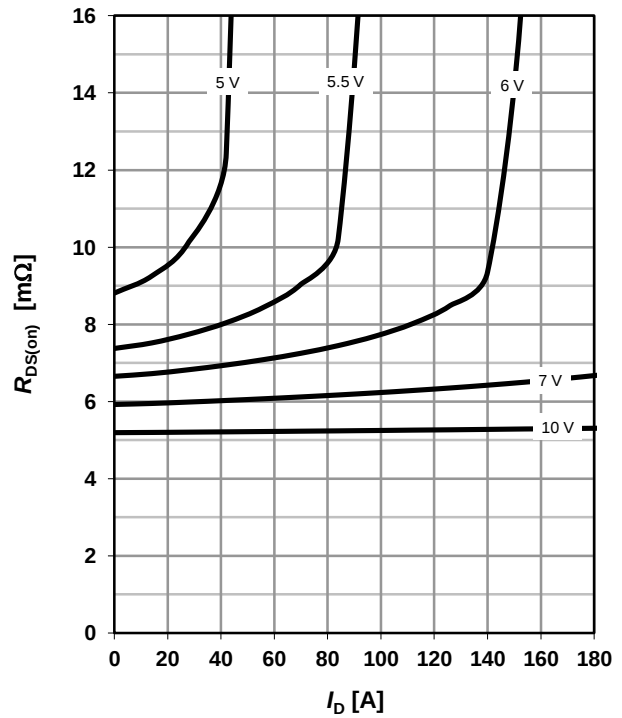
### 5 Typ. output characteristics

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

parameter:  $V_{GS}$ 


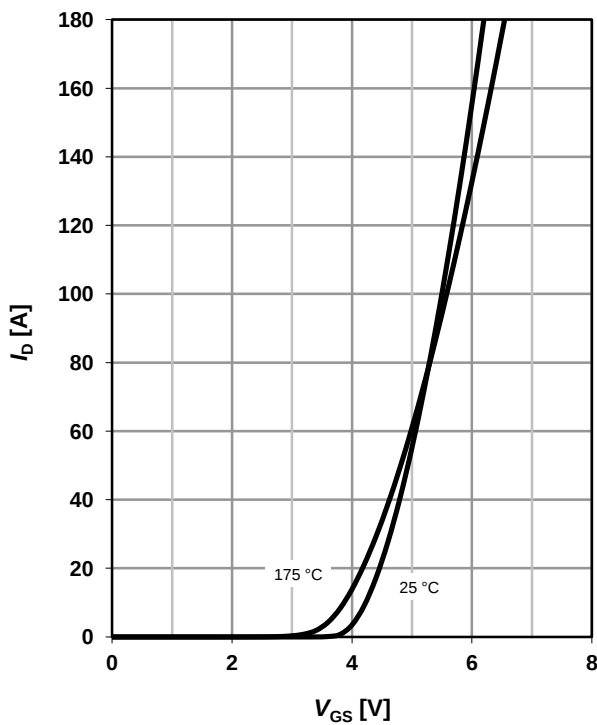
### 6 Typ. drain-source on resistance

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

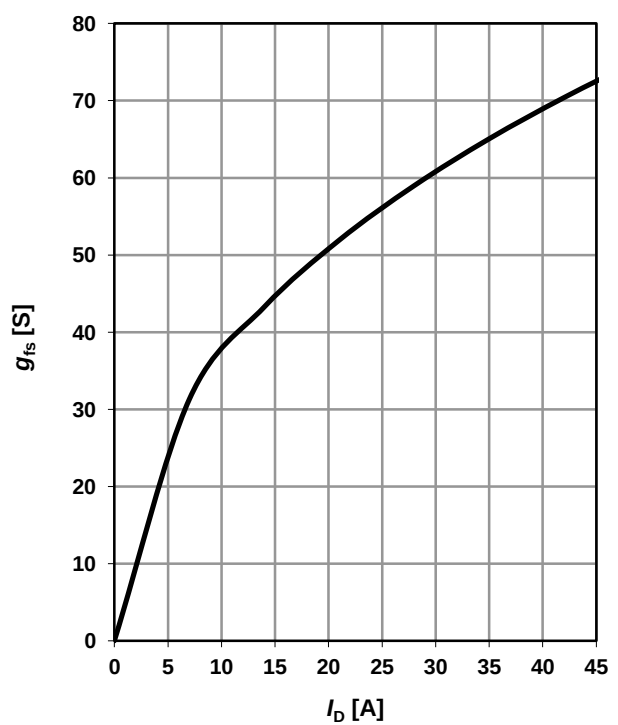
parameter:  $V_{GS}$ 


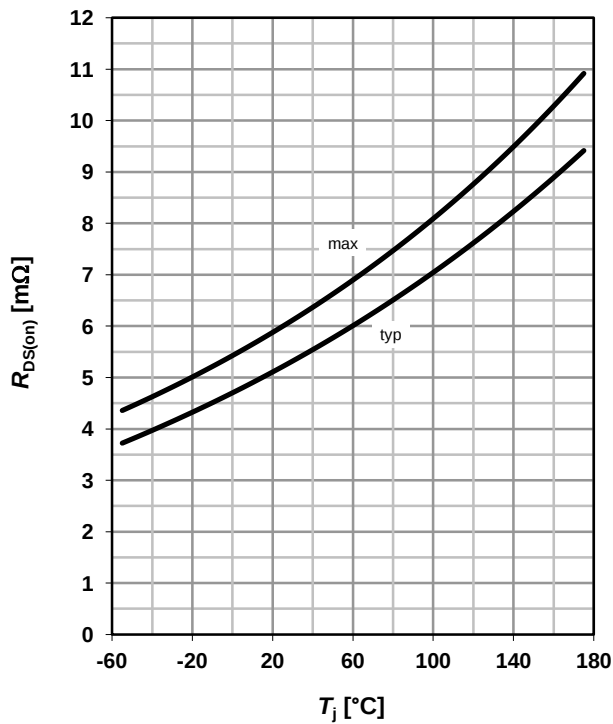
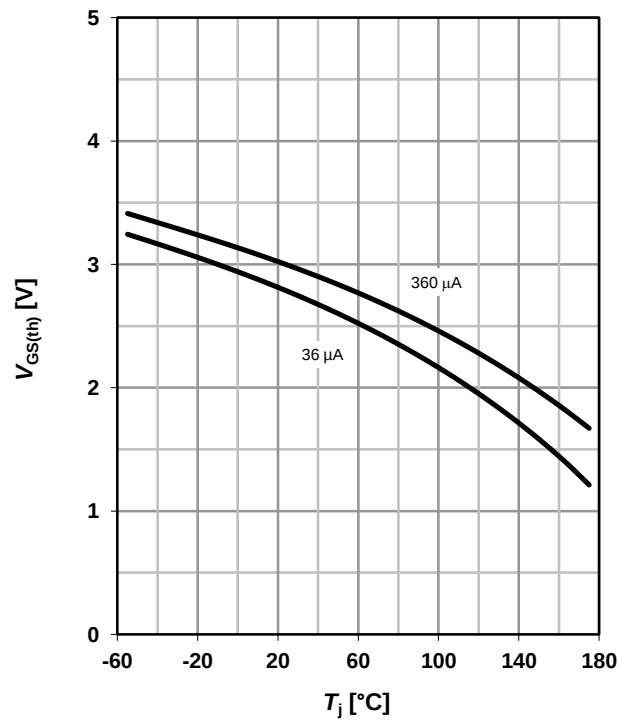
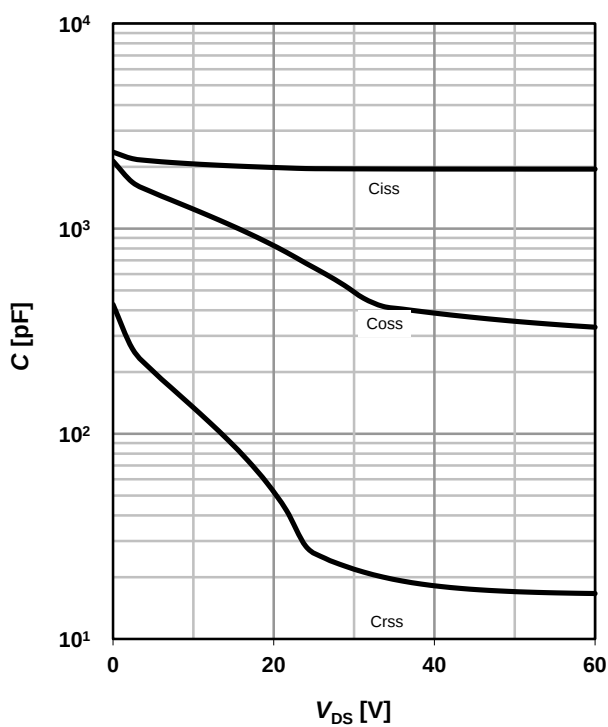
### 7 Typ. transfer characteristics

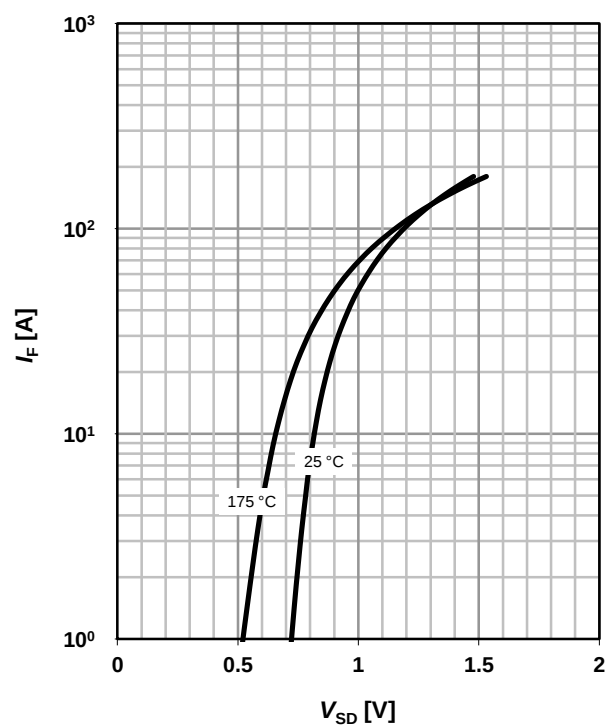
 $I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$ 

parameter:  $T_j$ 


### 8 Typ. forward transconductance

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


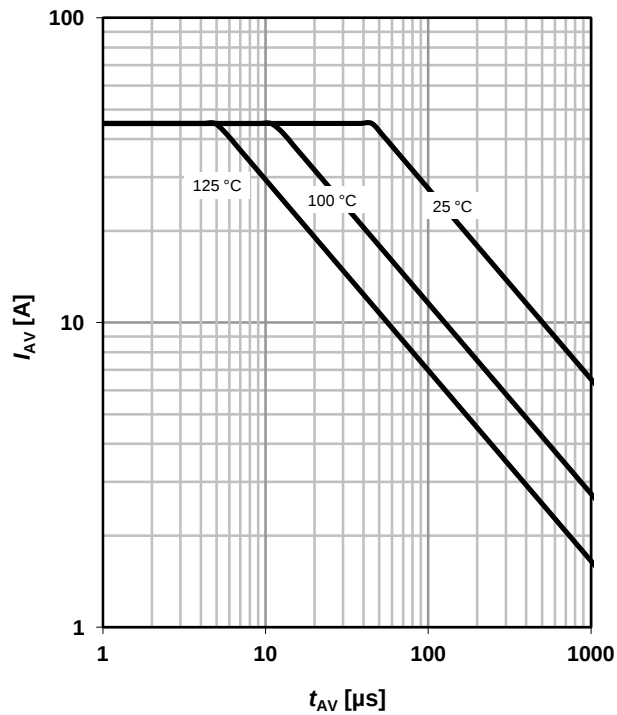
**9 Drain-source on-state resistance**
 $R_{DS(on)} = f(T_j); I_D = 45 \text{ A}; V_{GS} = 10 \text{ V}$ 

**10 Typ. gate threshold voltage**
 $V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$ 

**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

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

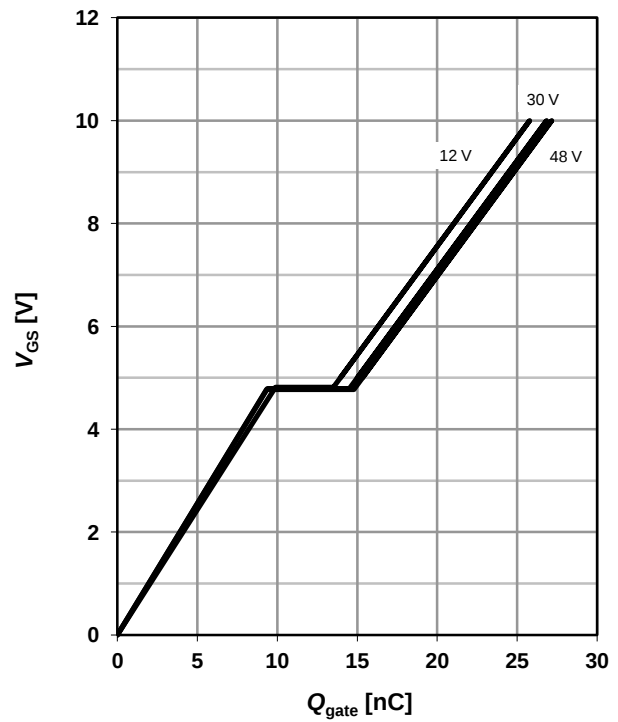
parameter:  $T_{j(\text{start})}$



### 14 Typ. gate charge

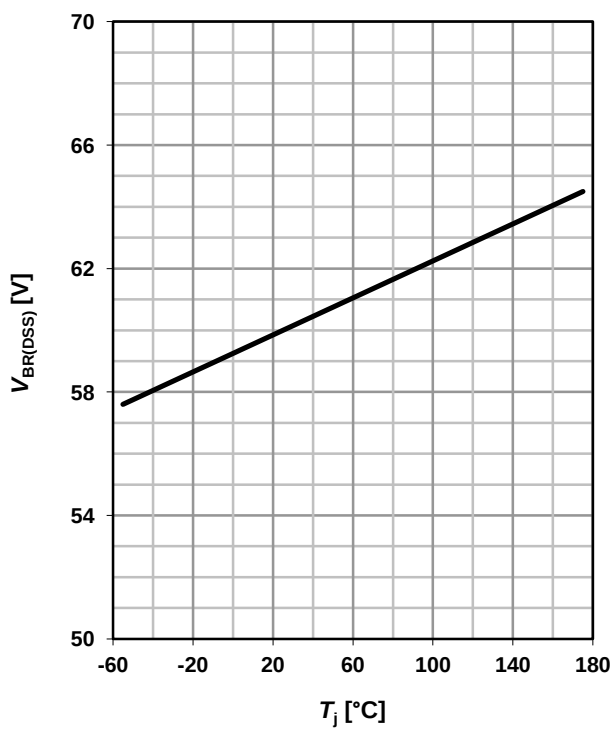
$$V_{GS}=f(Q_{\text{gate}}); I_D=45\ \text{A pulsed}$$

parameter:  $V_{DD}$

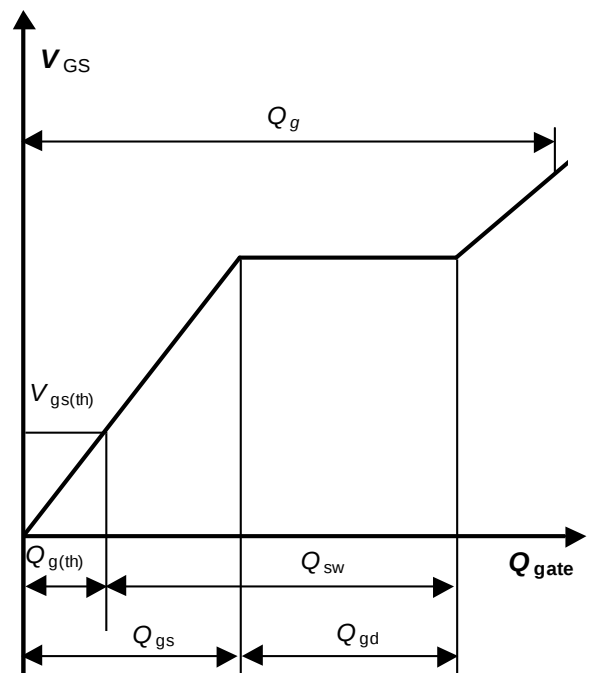


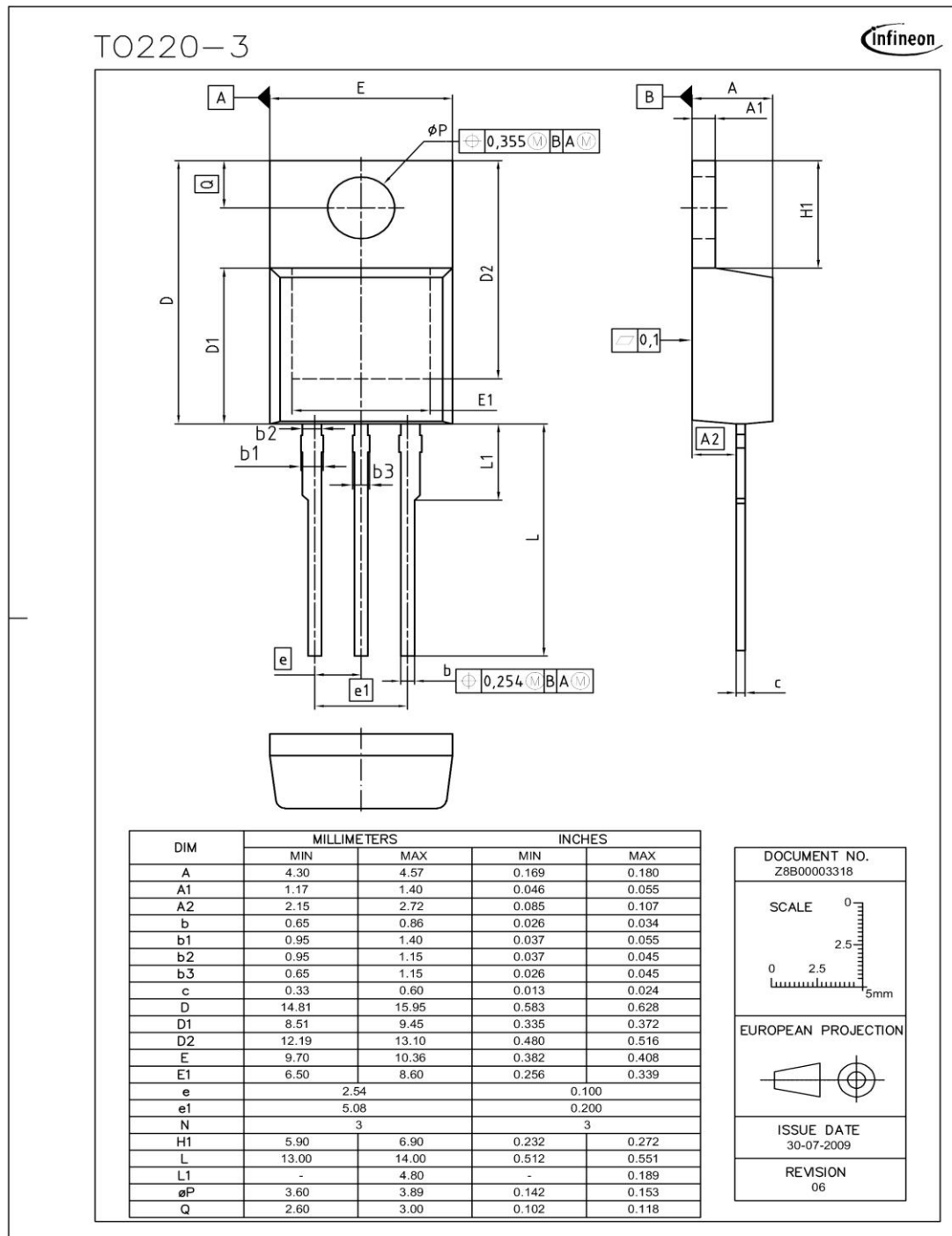
### 15 Drain-source breakdown voltage

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



### 16 Gate charge waveforms





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