

**OptiMOS™3 Power-Transistor**
**Features**

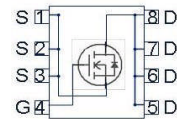
- Fast switching MOSFET for SMPS
- Optimized technology for DC/DC converters
- Qualified according to JEDEC<sup>1)</sup> for target applications
- N-channel; Normal level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Very low on-resistance  $R_{DS(on)}$
- Superior thermal resistance
- 100% Avalanche tested
- Pb-free plating; RoHS compliant
- Halogen-free according to IEC61249-2-21

**Product Summary**

|                  |      |    |
|------------------|------|----|
| $V_{DS}$         | 40   | V  |
| $R_{DS(on),max}$ | 16.5 | mΩ |
| $I_D$            | 31   | A  |

**PG-TSDSON-8**


| Type          | Package     | Marking |
|---------------|-------------|---------|
| BSZ165N04NS G | PG-TSDSON-8 | 165N04N |



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

| Parameter                                     | Symbol        | Conditions                                                                   | Value | Unit |
|-----------------------------------------------|---------------|------------------------------------------------------------------------------|-------|------|
| Continuous drain current                      | $I_D$         | $V_{GS}=10\text{ V}$ , $T_C=25\text{ °C}$                                    | 31    | A    |
|                                               |               | $V_{GS}=10\text{ V}$ , $T_C=100\text{ °C}$                                   | 20    |      |
|                                               |               | $V_{GS}=10\text{ V}$ , $T_A=25\text{ °C}$ ,<br>$R_{thJA}=60\text{ K/W}^{2)}$ | 8.9   |      |
| Pulsed drain current <sup>3)</sup>            | $I_{D,pulse}$ | $T_C=25\text{ °C}$                                                           | 124   |      |
| Avalanche current, single pulse <sup>4)</sup> | $I_{AS}$      | $T_C=25\text{ °C}$                                                           | 20    |      |
| Avalanche energy, single pulse                | $E_{AS}$      | $I_D=20\text{ A}$ , $R_{GS}=25\text{ Ω}$                                     | 5     | mJ   |
| Gate source voltage                           | $V_{GS}$      |                                                                              | ±20   | V    |

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

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

| Parameter                           | Symbol                | Conditions                                                    | Value       | Unit |
|-------------------------------------|-----------------------|---------------------------------------------------------------|-------------|------|
| Power dissipation                   | $P_{\text{tot}}$      | $T_c=25\text{ °C}$                                            | 25          | W    |
|                                     |                       | $T_A=25\text{ °C}$ ,<br>$R_{\text{thJA}}=60\text{ K/W}^{(2)}$ | 2.1         |      |
| Operating and storage temperature   | $T_j, T_{\text{stg}}$ |                                                               | -55 ... 150 | °C   |
| IEC climatic category; DIN IEC 68-1 |                       |                                                               | 55/150/56   |      |

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

#### Thermal characteristics

|                                     |                   |                                               |   |   |    |     |
|-------------------------------------|-------------------|-----------------------------------------------|---|---|----|-----|
| Thermal resistance, junction - case | $R_{\text{thJC}}$ |                                               | - | - | 5  | K/W |
| Device on PCB                       | $R_{\text{thJA}}$ | 6 cm <sup>2</sup> cooling area <sup>(2)</sup> | - | - | 60 |     |

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

#### Static characteristics

|                                  |                             |                                                                                       |    |      |      |               |
|----------------------------------|-----------------------------|---------------------------------------------------------------------------------------|----|------|------|---------------|
| Drain-source breakdown voltage   | $V_{(\text{BR})\text{DSS}}$ | $V_{\text{GS}}=0\text{ V}$ , $I_{\text{D}}=1\text{ mA}$                               | 40 | -    | -    | V             |
| Gate threshold voltage           | $V_{\text{GS(th)}}$         | $V_{\text{DS}}=V_{\text{GS}}$ , $I_{\text{D}}=10\text{ }\mu\text{A}$                  | 2  | -    | 4    |               |
| Zero gate voltage drain current  | $I_{\text{DSS}}$            | $V_{\text{DS}}=40\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<br>$T_j=25\text{ °C}$      | -  | 0.1  | 1    | $\mu\text{A}$ |
|                                  |                             | $V_{\text{DS}}=40\text{ V}$ , $V_{\text{GS}}=0\text{ V}$ ,<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 | $R_{\text{DS(on)}}$         | $V_{\text{GS}}=10\text{ V}$ , $I_{\text{D}}=20\text{ A}$                              | -  | 13.8 | 16.5 | m $\Omega$    |
| Gate resistance                  | $R_{\text{G}}$              |                                                                                       | -  | 1.1  | -    | $\Omega$      |
| Transconductance                 | $g_{\text{fs}}$             | $ V_{\text{DS}} >2 I_{\text{D}} R_{\text{DS(on)max}}$ ,<br>$I_{\text{D}}=20\text{ A}$ | 12 | 24   | -    | S             |

<sup>(2)</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.

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

<sup>(4)</sup> See figure 13 for more detailed information

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

**Dynamic characteristics**

|                              |              |                                                                                 |   |     |     |    |
|------------------------------|--------------|---------------------------------------------------------------------------------|---|-----|-----|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=20\text{ V},$<br>$f=1\text{ MHz}$                    | - | 630 | 840 | pF |
| Output capacitance           | $C_{oss}$    |                                                                                 | - | 220 | 290 |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                 | - | 6.7 | -   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=20\text{ V}, V_{GS}=10\text{ V},$<br>$I_D=20\text{ A}, R_G=1.6\ \Omega$ | - | 5.4 | -   | ns |
| Rise time                    | $t_r$        |                                                                                 | - | 1.0 | -   |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                 | - | 6.8 | -   |    |
| Fall time                    | $t_f$        |                                                                                 | - | 2.2 | -   |    |

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

|                              |               |                                                                            |   |     |    |    |
|------------------------------|---------------|----------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=20\text{ V}, I_D=20\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 3.7 | -  | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |                                                                            | - | 1.9 | -  |    |
| Gate to drain charge         | $Q_{gd}$      |                                                                            | - | 1.0 | -  |    |
| Switching charge             | $Q_{sw}$      |                                                                            | - | 2.9 | -  |    |
| Gate charge total            | $Q_g$         |                                                                            | - | 7.8 | 10 |    |
| Gate plateau voltage         | $V_{plateau}$ |                                                                            | - | 5.9 | -  | V  |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V},$<br>$V_{GS}=0\text{ to }10\text{ V}$                 | - | 7.4 | -  | nC |
| Output charge                | $Q_{oss}$     | $V_{DD}=20\text{ V}, V_{GS}=0\text{ V}$                                    | - | 8.0 | -  |    |

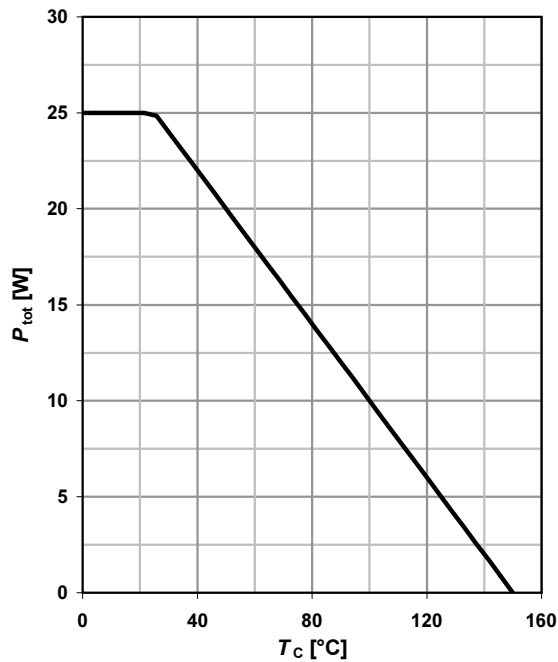
**Reverse Diode**

|                                  |               |                                                                   |   |      |     |    |
|----------------------------------|---------------|-------------------------------------------------------------------|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ °C}$                                                | - | -    | 21  | A  |
| Diode pulse current              | $I_{S,pulse}$ |                                                                   | - | -    | 124 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=20\text{ A},$<br>$T_j=25\text{ °C}$       | - | 0.92 | 1.2 | V  |
| Reverse recovery charge          | $Q_{rr}$      | $V_R=20\text{ V}, I_F=I_S,$<br>$di_F/dt=400\text{ A}/\mu\text{s}$ | - | 10   | -   | nC |

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

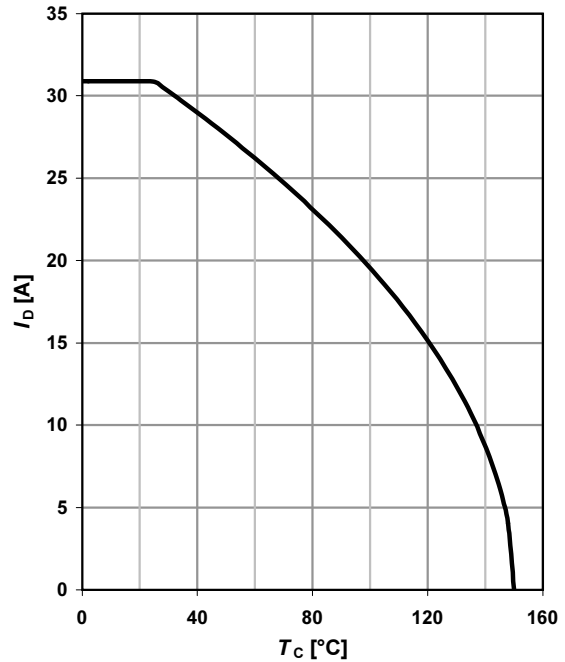
### 1 Power dissipation

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



### 2 Drain current

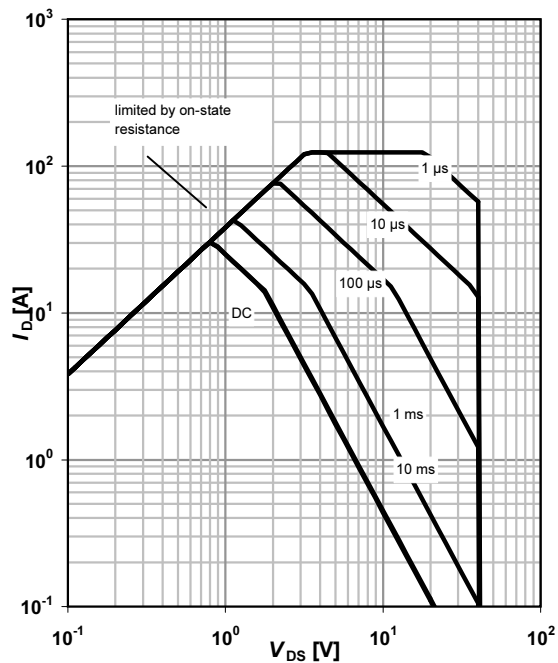
$$I_D = f(T_C); V_{GS} \geq 10 \text{ V}$$



### 3 Safe operating area

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

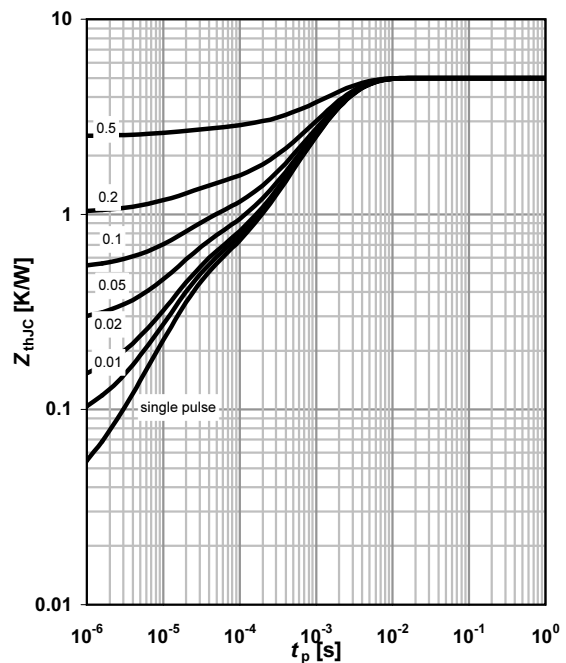
parameter:  $t_p$



### 4 Max. transient thermal impedance

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

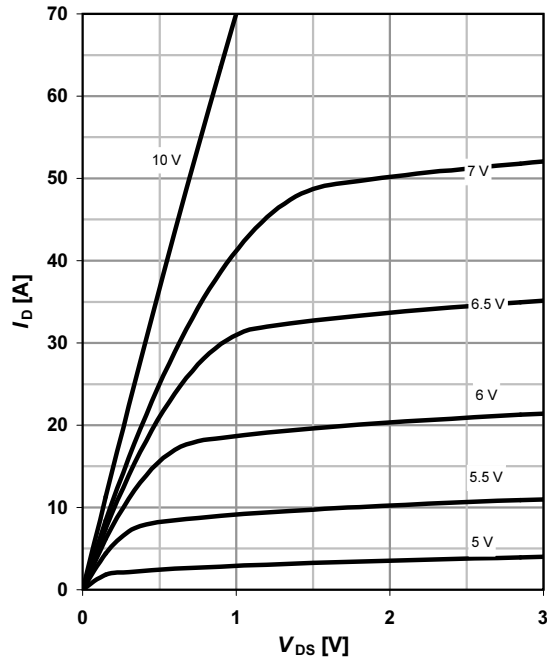
parameter:  $D = t_p/T$



**5 Typ. output characteristics**

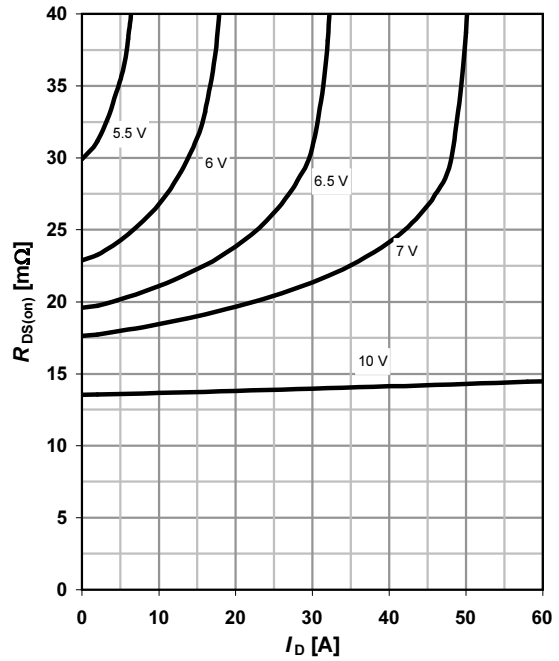
$$I_D = f(V_{DS}); T_J = 25^\circ\text{C}$$

parameter:  $V_{GS}$


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

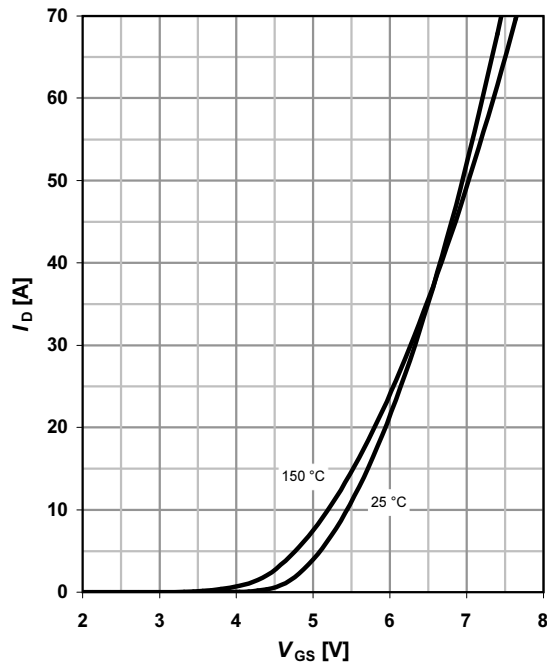
$$R_{DS(on)} = f(I_D); T_J = 25^\circ\text{C}$$

parameter:  $V_{GS}$

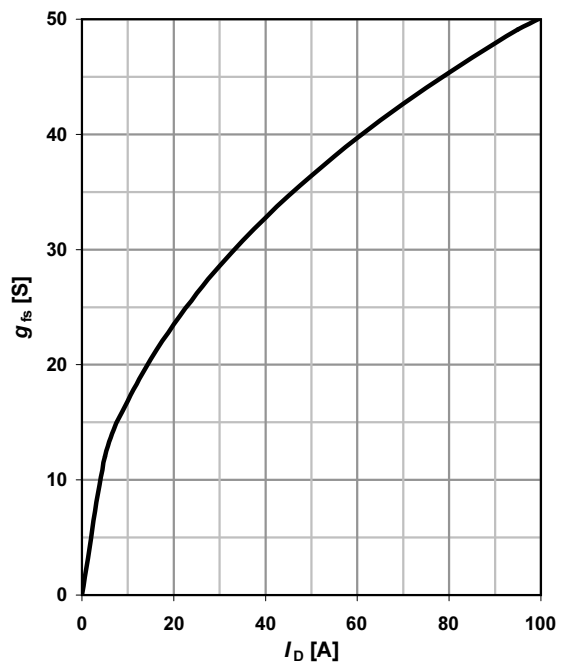

**7 Typ. transfer characteristics**

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

parameter:  $T_J$

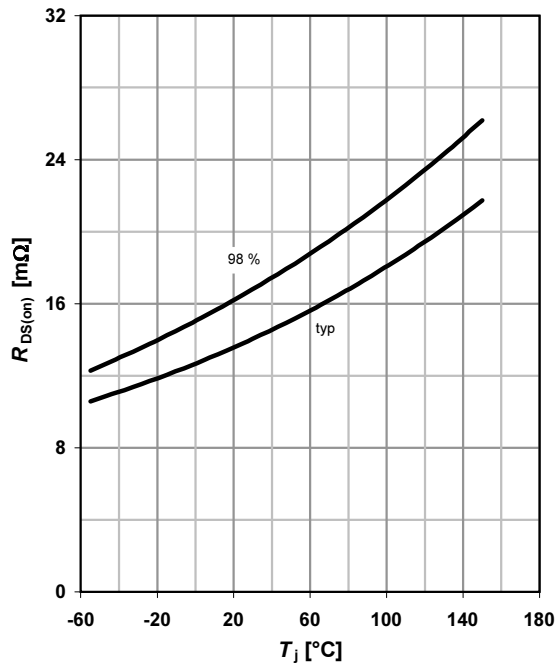

**8 Typ. forward transconductance**

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

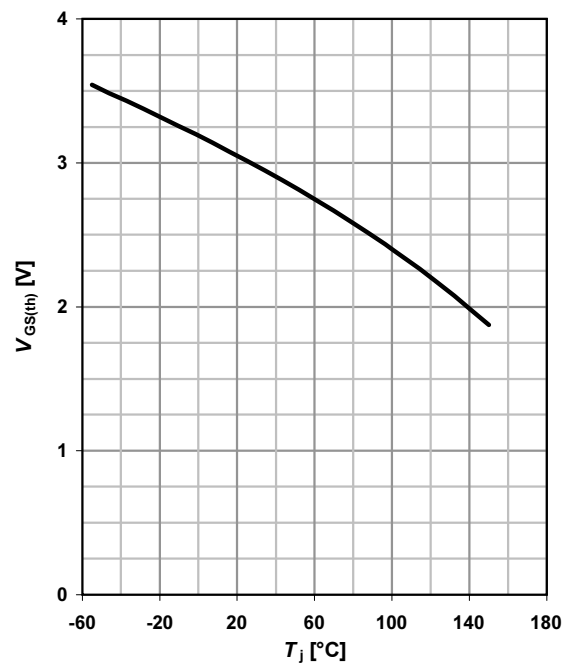


**9 Drain-source on-state resistance**

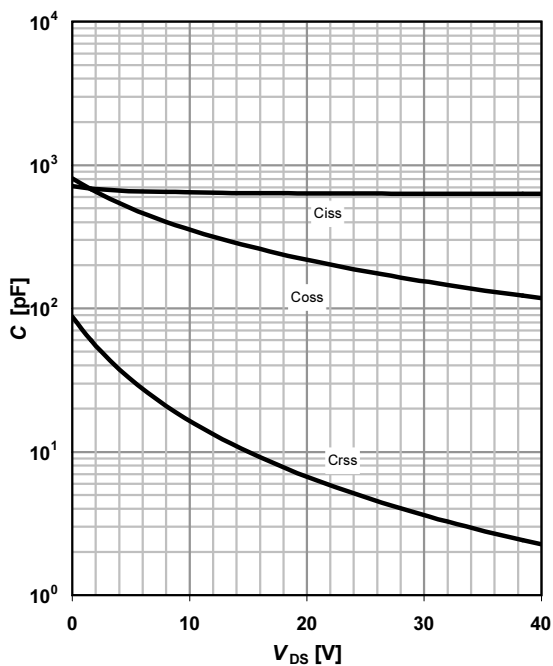
$$R_{DS(on)} = f(T_j); I_D = 20 \text{ A}; V_{GS} = 10 \text{ V}$$


**10 Typ. gate threshold voltage**

$$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}; I_D = 10 \text{ } \mu\text{A}$$

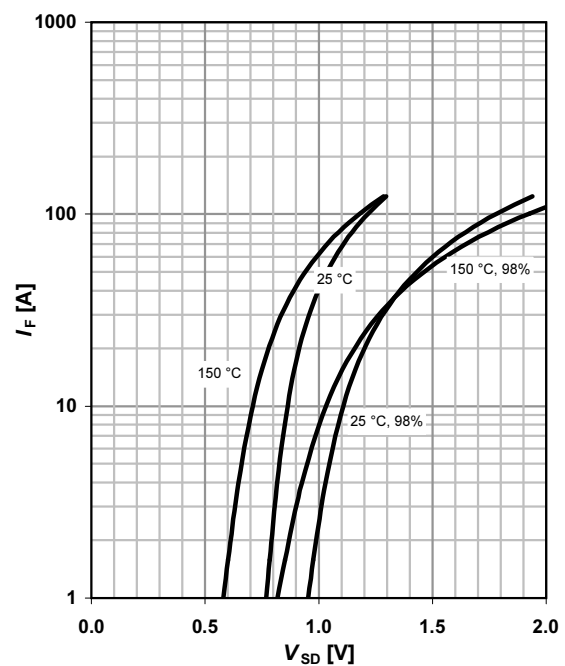

**11 Typ. capacitances**

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


**12 Forward characteristics of reverse diode**

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

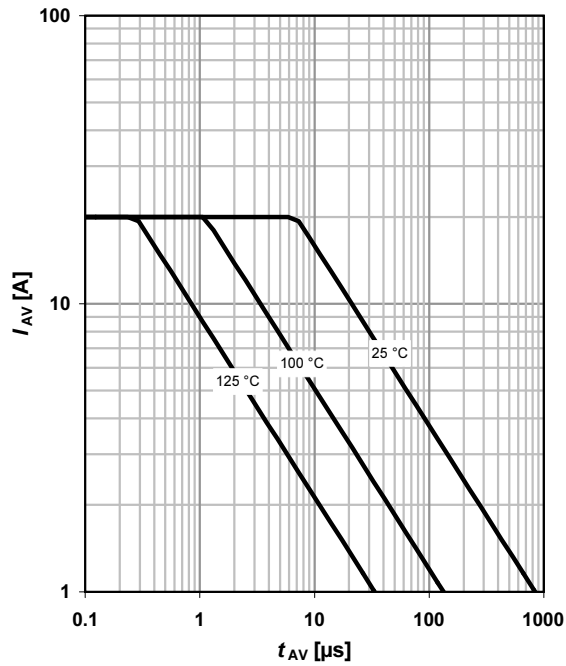
parameter:  $T_j$



### 13 Avalanche characteristics

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

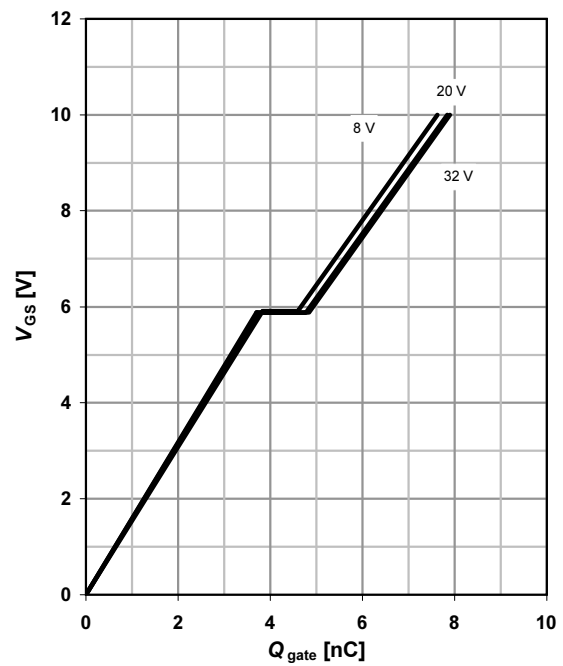
parameter:  $T_{j(\text{start})}$



### 14 Typ. gate charge

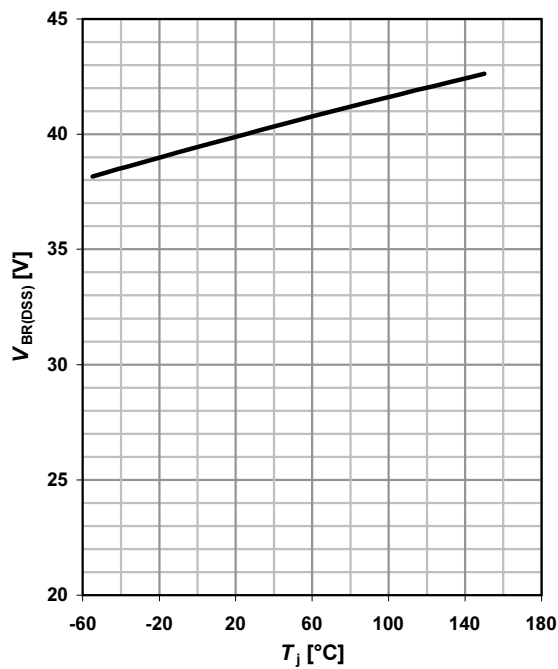
$$V_{GS}=f(Q_{\text{gate}}); I_D=20\ \text{A pulsed}$$

parameter:  $V_{DD}$

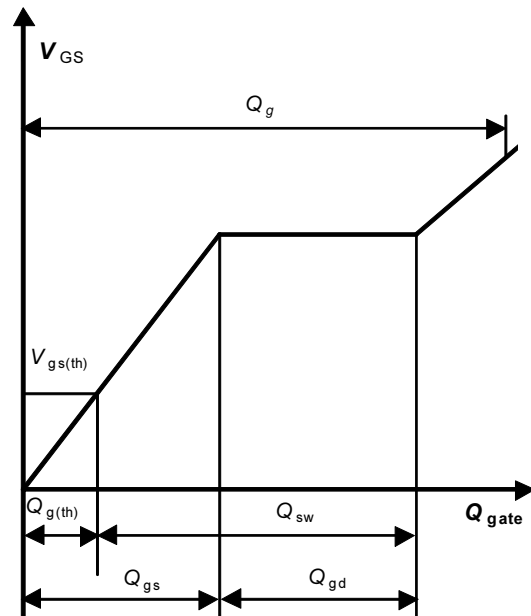


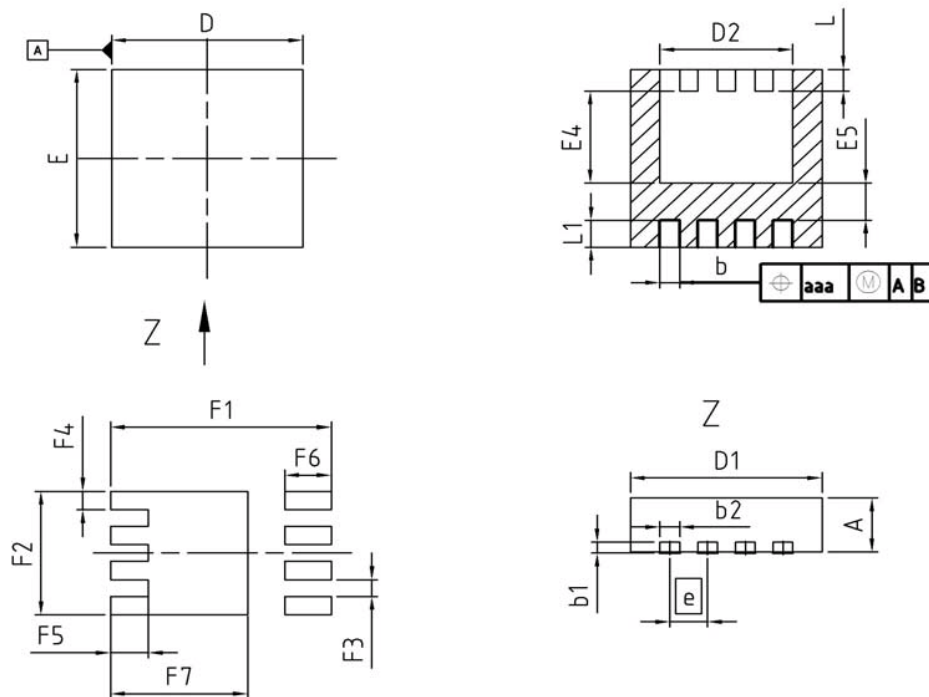
### 15 Drain-source breakdown voltage

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

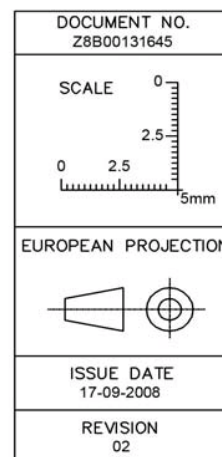


### 16 Gate charge waveforms



**Package Outline**
**PG-TSDSON-8**


| DIM  | MILLIMETERS |      | INCHES |       |
|------|-------------|------|--------|-------|
|      | MIN         | MAX  | MIN    | MAX   |
| A    | 0.90        | 1.10 | 0.035  | 0.043 |
| b    | 0.24        | 0.44 | 0.009  | 0.017 |
| b1   | 0.10        | 0.30 | 0.004  | 0.012 |
| b2   | 0.20        | 0.44 | 0.008  | 0.017 |
| D=D1 | 3.20        | 3.40 | 0.126  | 0.134 |
| D2   | 2.15        | 2.45 | 0.085  | 0.096 |
| E    | 3.20        | 3.40 | 0.126  | 0.134 |
| E4   | 1.60        | 1.81 | 0.063  | 0.071 |
| E5   | 0.59        | 0.86 | 0.023  | 0.034 |
| e    | 0.65        |      | 0.026  |       |
| N    | 8           |      | 8      |       |
| L    | 0.30        | 0.56 | 0.012  | 0.022 |
| L1   | 0.33        | 0.60 | 0.013  | 0.024 |
| aaa  | 0.25        |      | 0.010  |       |
| F1   | 3.80        |      | 0.150  |       |
| F2   | 2.29        |      | 0.090  |       |
| F3   | 0.31        |      | 0.012  |       |
| F4   | 0.34        |      | 0.013  |       |
| F5   | 0.65        |      | 0.026  |       |
| F6   | 0.80        |      | 0.031  |       |
| F7   | 2.36        |      | 0.093  |       |



Published by  
Infineon Technologies AG  
81726 Munich, Germany  
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