

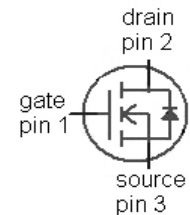
## OptiMOS<sup>®</sup> 2 Power-Transistor



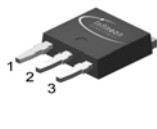
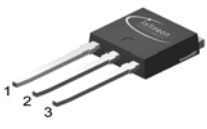
### Features

- Ideal for high-frequency dc/dc converters
- Qualified according to JEDEC<sup>1)</sup> for target application
- N-channel, logic level
- Excellent gate charge x  $R_{DS(on)}$  product (FOM)
- Superior thermal resistance
- 175 °C operating temperature

### Product Summary

|                                |     |            |
|--------------------------------|-----|------------|
| $V_{DS}$                       | 25  | V          |
| $R_{DS(on),max}$ (SMD version) | 8.6 | m $\Omega$ |
| $I_D$                          | 50  | A          |



| Type          | IPD09N03LA  | IPF09N03LA  | IPS09N03LA   | IPU09N03LA  |
|---------------|---|---|--|---|
|               |  |  |  |  |
| Package       | P-TO252-3-11  | P-TO252-3-23  | P-TO251-3-11   | P-TO251-3-21  |
| Ordering Code | Q67042-S4154  | Q67042-S4199  | Q67042-S   | Q67042-S4155  |
| Marking       | 09N03LA   | 09N03LA   | 09N03LA  | 09N03LA   |

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

| Parameter                           | Symbol            | Conditions  | Value       | Unit              |
|-------------------------------------|-------------------|---|-------------|-------------------|
| Continuous drain current            | $I_D$             | $T_C=25\text{ °C}^2)$   | 50          | A                 |
|                                     |                   | $T_C=100\text{ °C}$   | 45          |                   |
| Pulsed drain current                | $I_{D,pulse}$     | $T_C=25\text{ °C}^3)$   | 350         |                   |
| Avalanche energy, single pulse      | $E_{AS}$          | $I_D=45\text{ A}$ , $R_{GS}=25\ \Omega$   | 75          | mJ                |
| Reverse diode $dv/dt$               | $dv/dt$           | $I_D=50\text{ A}$ , $V_{DS}=20\text{ V}$ ,<br>$di/dt=200\text{ A}/\mu\text{s}$ ,<br>$T_{j,max}=175\text{ °C}$ | 6           | kV/ $\mu\text{s}$ |
| Gate source voltage <sup>4)</sup>   | $V_{GS}$          |   | $\pm 20$    | 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**

|                                     |            |  |   |   |     |     |
|-------------------------------------|------------|--|---|---|-----|-----|
| Thermal resistance, junction - case | $R_{thJC}$ |  | - | - | 2.4 | K/W |
| SMD version, device on PCB          | $R_{thJA}$ | minimal footprint                            | - | - | 75  |     |
|                                     |            | 6 cm <sup>2</sup> cooling area <sup>5)</sup> | - | - | 50  |     |

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

|                                  |               |  |     |      |      |               |
|----------------------------------|---------------|--|-----|------|------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=1\text{ mA}$                                   | 25  | -    | -    | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=20\text{ }\mu\text{A}$                             | 1.2 | 1.6  | 2    |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=25\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ }^\circ\text{C}$  | -   | 0.1  | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=25\text{ V}, V_{GS}=0\text{ V}, T_j=125\text{ }^\circ\text{C}$ | -   | 10   | 100  |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                                | -   | 10   | 100  | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=4.5\text{ V}, I_D=30\text{ A}$                                 | -   | 12   | 15   | m $\Omega$    |
|                                  |               | $V_{GS}=4.5\text{ V}, I_D=30\text{ A},$<br>SMD version                 | -   | 11.8 | 14.8 |               |
|                                  |               | $V_{GS}=10\text{ V}, I_D=30\text{ A}$                                  | -   | 7.4  | 8.8  |               |
|                                  |               | $V_{GS}=10\text{ V}, I_D=30\text{ A},$<br>SMD version                  | -   | 7.2  | 8.6  |               |
| Gate resistance                  | $R_G$         |  | -   | 1    | -    | $\Omega$      |
| Transconductance                 | $g_{fs}$      | $ V_{DS} >2 I_D R_{DS(on)max},$<br>$I_D=30\text{ A}$                   | 23  | 46   | -    | S             |

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

<sup>2)</sup> Current is limited by bondwire; with an  $R_{thJC}=2.4\text{ K/W}$  the chip is able to carry 67 A.

<sup>3)</sup> See figure 3

<sup>4)</sup>  $T_{j,max}=150\text{ }^\circ\text{C}$  and duty cycle  $D<0.25$  for  $V_{GS}<-5\text{ V}$

<sup>5)</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.

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

**Dynamic characteristics**

|                              |              |  |   |      |      |    |
|------------------------------|--------------|--|---|------|------|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=15\text{ V}, f=1\text{ MHz}$                    | - | 1235 | 1642 | pF |
| Output capacitance           | $C_{oss}$    |  | - | 474  | 630  |    |
| Reverse transfer capacitance | $C_{rss}$    |  | - | 61   | 92   |    |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DD}=15\text{ V}, V_{GS}=10\text{ V}, I_D=25\text{ A}, R_G=2.7\ \Omega$ | - | 7.0  | 10   | ns |
| Rise time                    | $t_r$        |  | - | 5.6  | 8.4  |    |
| Turn-off delay time          | $t_{d(off)}$ |  | - | 20   | 30   |    |
| Fall time                    | $t_f$        |  | - | 3.4  | 5.1  |    |

**Gate Charge Characteristics<sup>6)</sup>**

|                              |               |  |   |     |     |    |
|------------------------------|---------------|--|---|-----|-----|----|
| Gate to source charge        | $Q_{gs}$      | $V_{DD}=15\text{ V}, I_D=25\text{ A}, V_{GS}=0\text{ to }5\text{ V}$ | - | 4.3 | 5.7 | nC |
| Gate charge at threshold     | $Q_{g(th)}$   |  | - | 2.0 | 2.6 |    |
| Gate to drain charge         | $Q_{gd}$      |  | - | 2.8 | 4.3 |    |
| Switching charge             | $Q_{sw}$      |  | - | 5.2 | 7.3 |    |
| Gate charge total            | $Q_g$         |  | - | 10  | 13  |    |
| Gate plateau voltage         | $V_{plateau}$ |  | - | 3.5 | -   | V  |
| Gate charge total, sync. FET | $Q_{g(sync)}$ | $V_{DS}=0.1\text{ V}, V_{GS}=0\text{ to }5\text{ V}$                 | - | 8.7 | 12  | nC |
| Output charge                | $Q_{oss}$     | $V_{DD}=15\text{ V}, V_{GS}=0\text{ V}$                              | - | 10  | 14  |    |

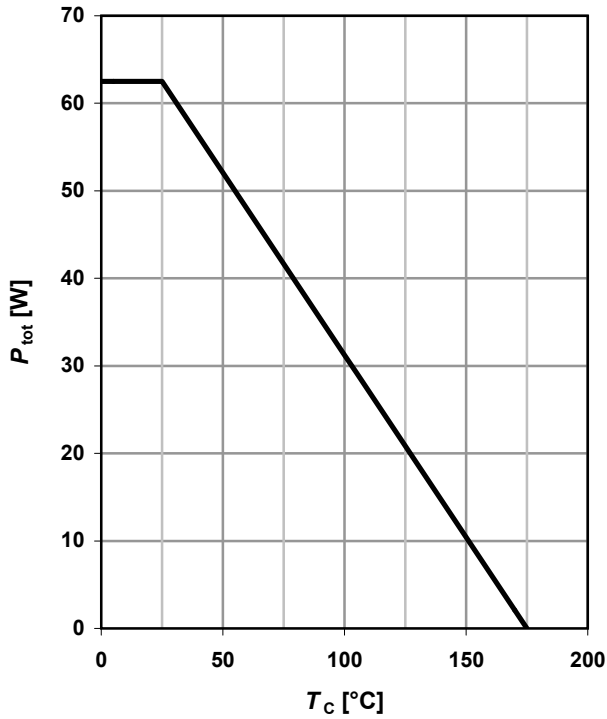
**Reverse Diode**

|                                  |               |  |   |      |     |    |
|----------------------------------|---------------|--|---|------|-----|----|
| Diode continuous forward current | $I_S$         | $T_C=25\text{ }^\circ\text{C}$                                     | - | -    | 50  | A  |
| Diode pulse current              | $I_{S,pulse}$ |  | - | -    | 350 |    |
| Diode forward voltage            | $V_{SD}$      | $V_{GS}=0\text{ V}, I_F=50\text{ A}, T_J=25\text{ }^\circ\text{C}$ | - | 0.97 | 1.2 | V  |
| Reverse recovery charge          | $Q_{rr}$      | $V_R=15\text{ V}, I_F=I_S, di_F/dt=400\text{ A}/\mu\text{s}$       | - | -    | 10  | nC |

<sup>6)</sup> See figure 16 for gate charge parameter definition

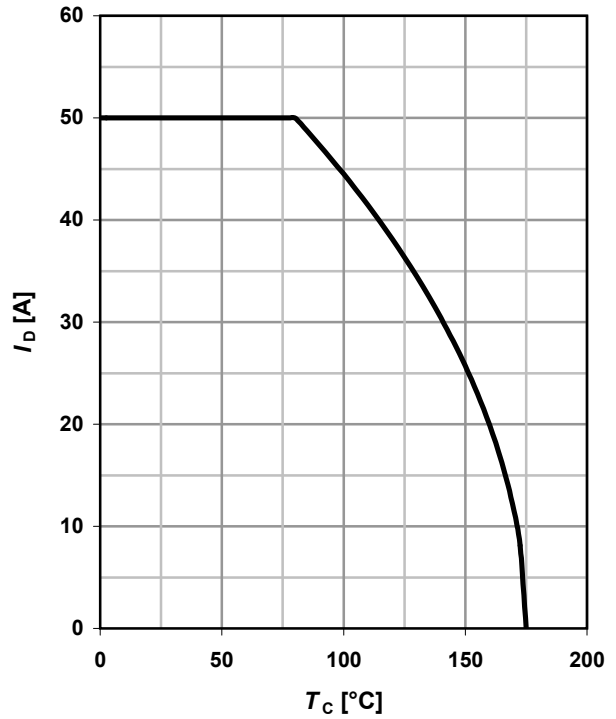
**1 Power dissipation**

$P_{tot}=f(T_C)$



**2 Drain current**

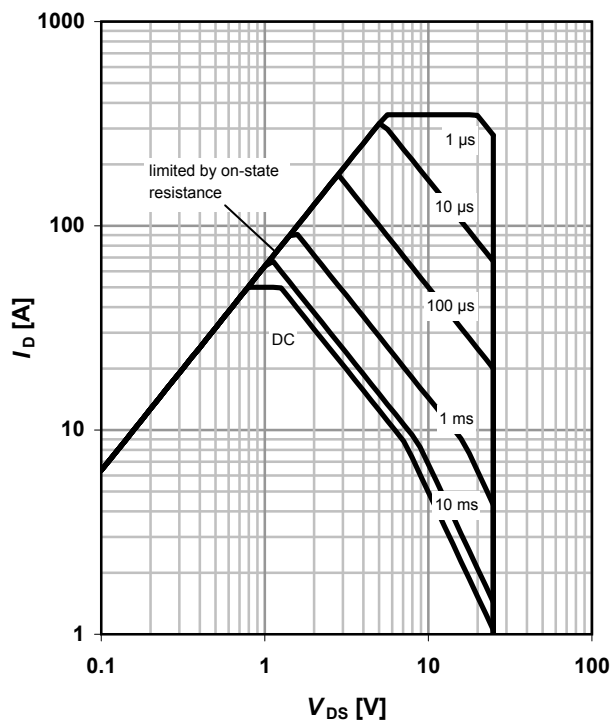
$I_D=f(T_C); V_{GS} \geq 10\text{ V}$



**3 Safe operation area**

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

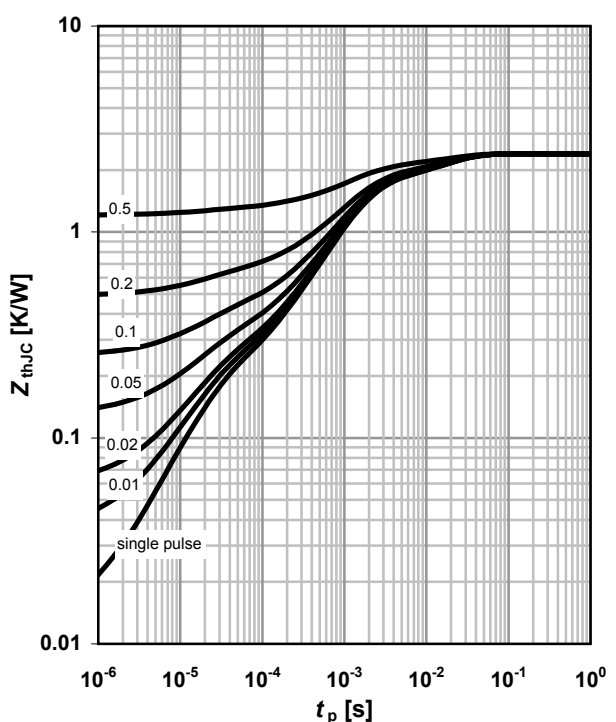
parameter:  $t_p$



**4 Max. transient thermal impedance**

$Z_{thJC}=f(t_p)$

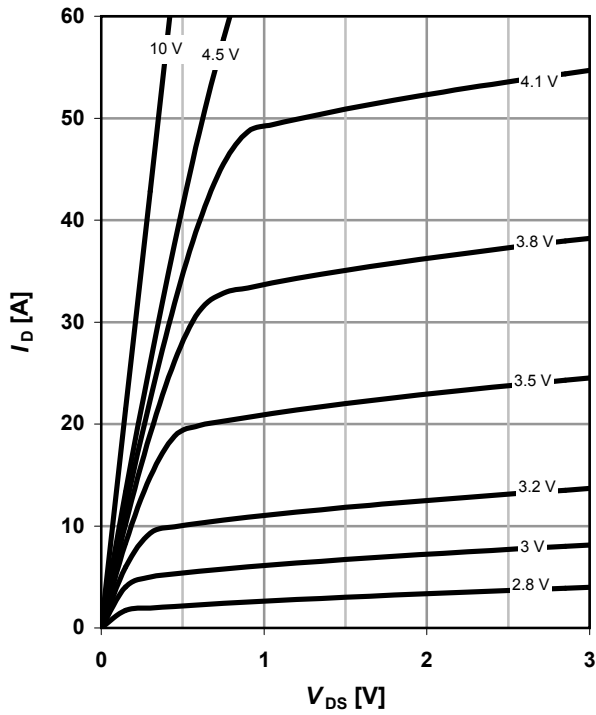
parameter:  $D=t_p/T$



**5 Typ. output characteristics**

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

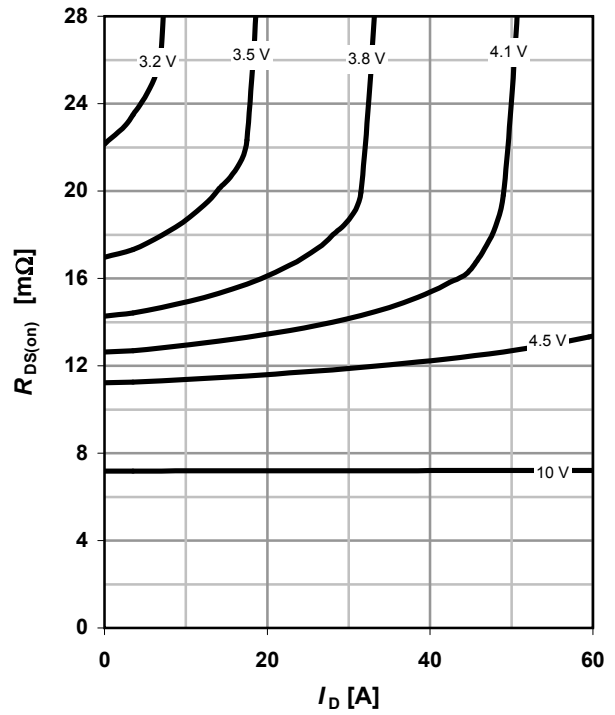
parameter:  $V_{GS}$



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

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

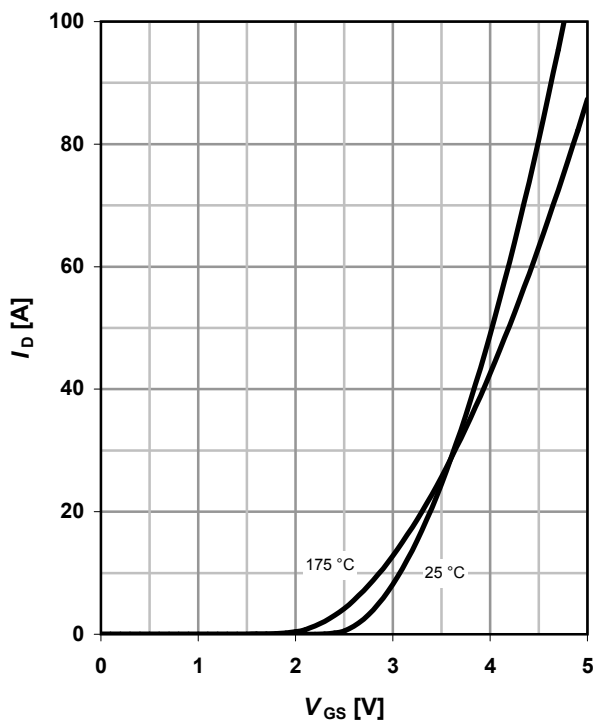
parameter:  $V_{GS}$



**7 Typ. transfer characteristics**

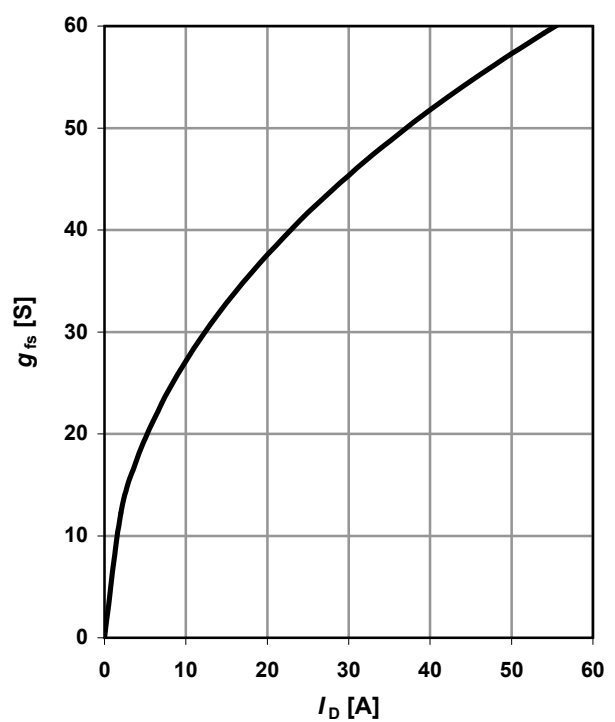
$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)max}$

parameter:  $T_j$



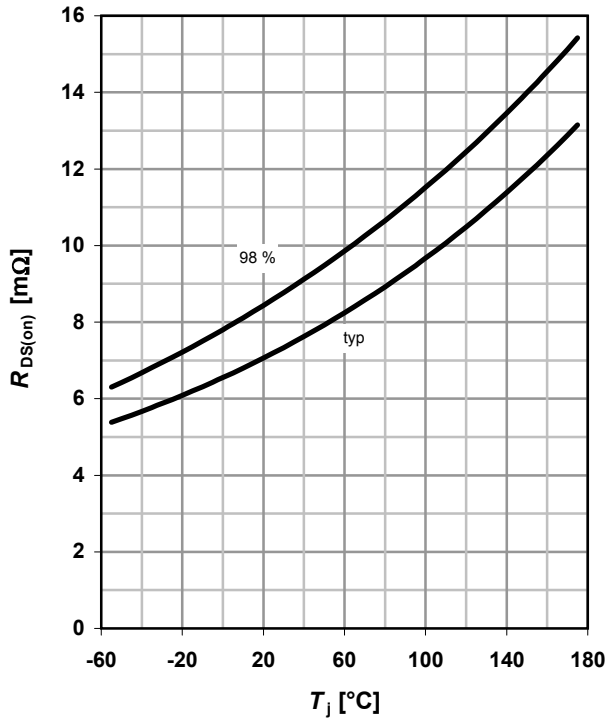
**8 Typ. forward transconductance**

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



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

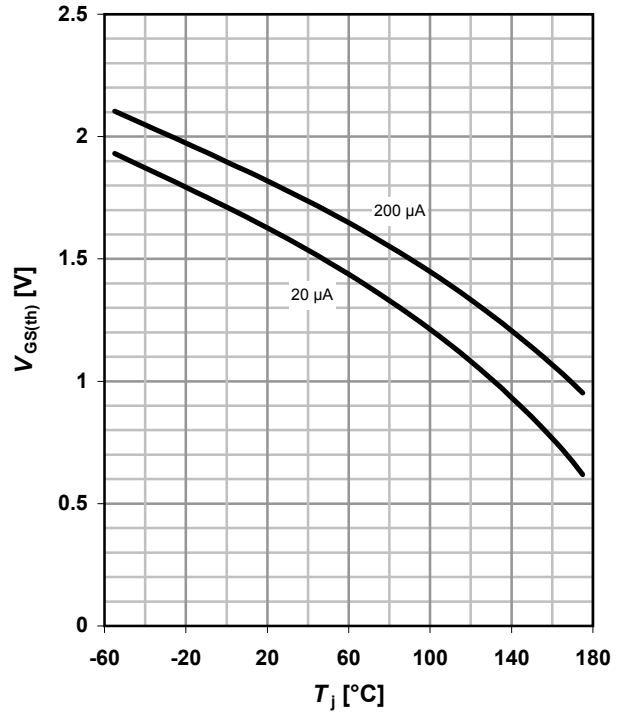
$R_{DS(on)} = f(T_j); I_D = 30 \text{ A}; V_{GS} = 10 \text{ V}$



**10 Typ. gate threshold voltage**

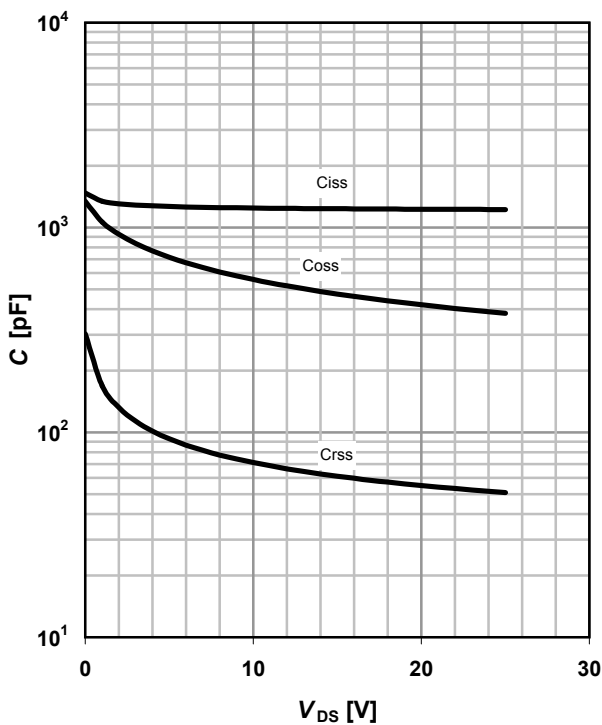
$V_{GS(th)} = f(T_j); V_{GS} = V_{DS}$

parameter:  $I_D$



**11 Typ. Capacitances**

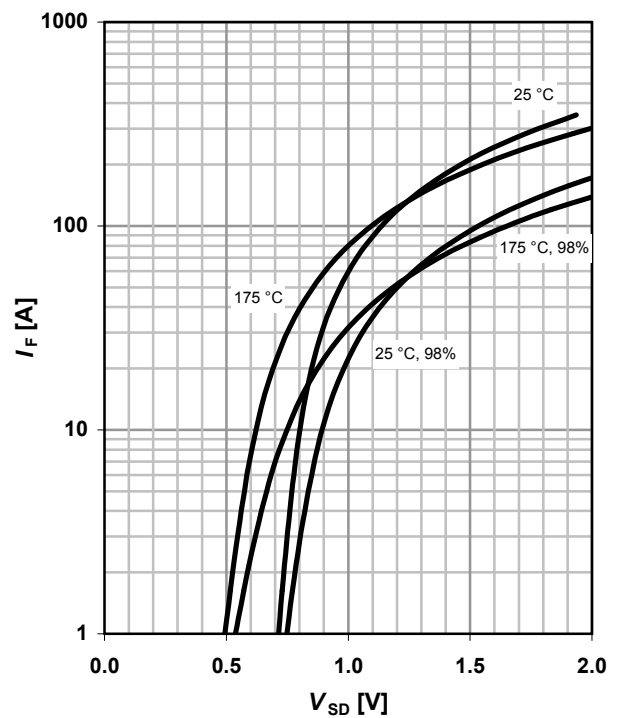
$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$



**12 Forward characteristics of reverse diode**

$I_F = f(V_{SD})$

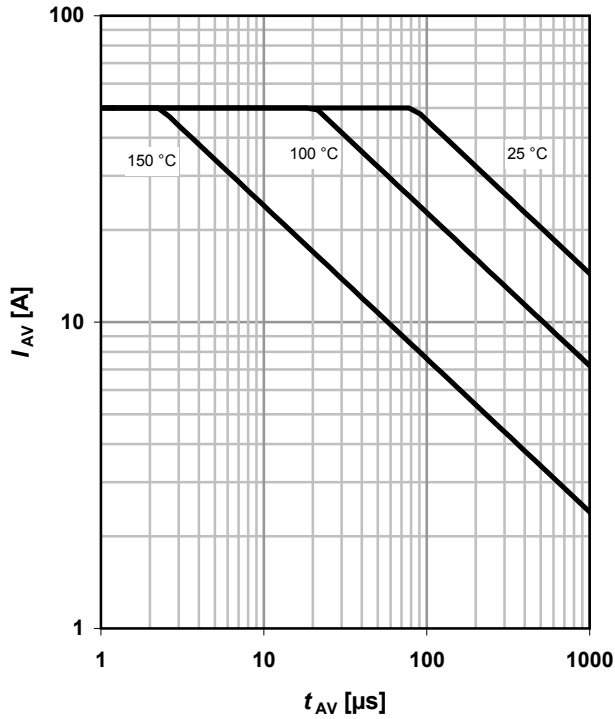
parameter:  $T_j$



**13 Avalanche characteristics**

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

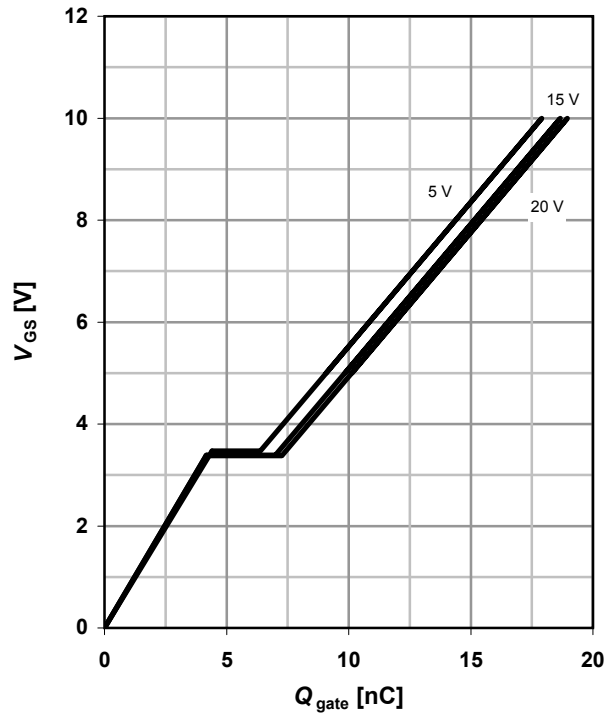
parameter:  $T_{j(start)}$



**14 Typ. gate charge**

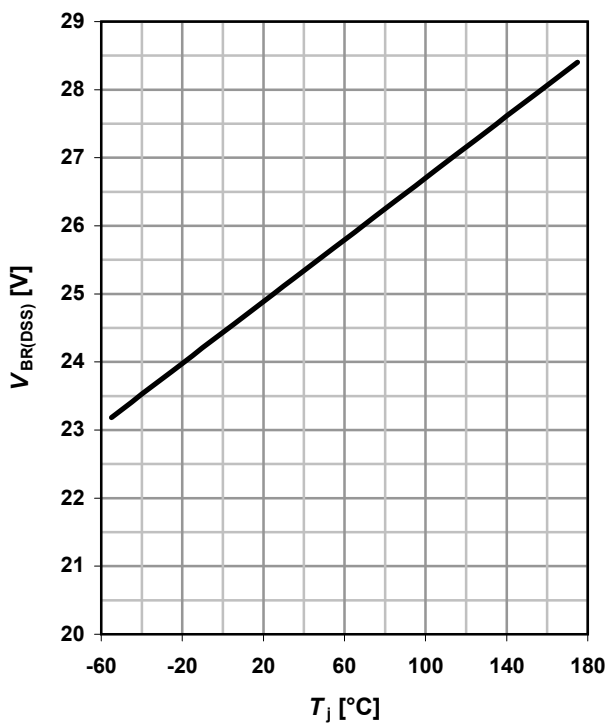
$V_{GS}=f(Q_{gate}); I_D=25 \text{ A pulsed}$

parameter:  $V_{DD}$

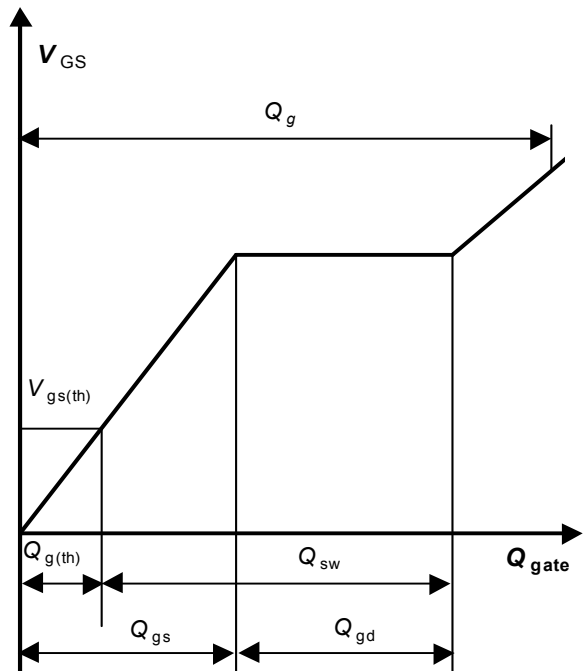


**15 Drain-source breakdown voltage**

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

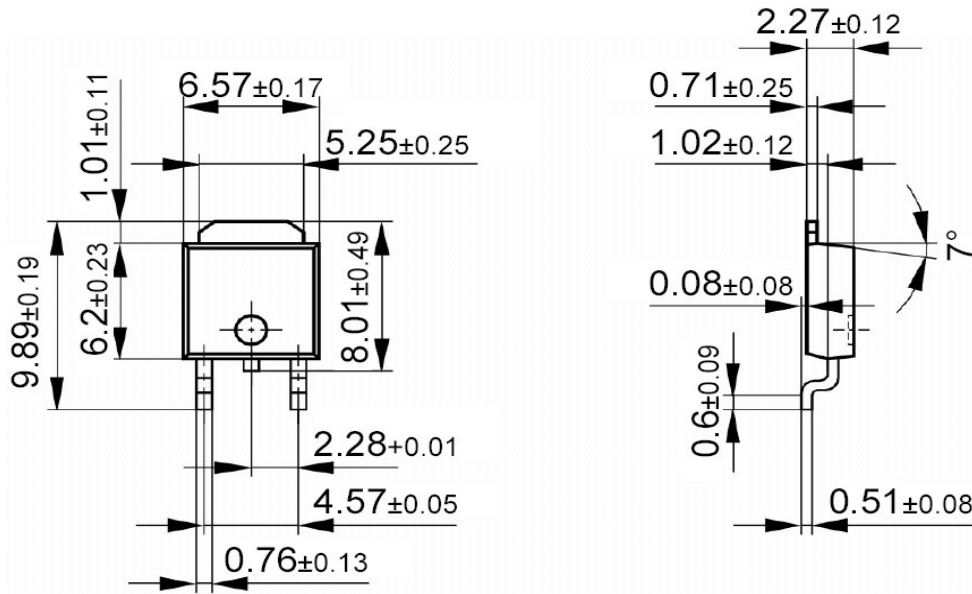


**16 Gate charge waveforms**

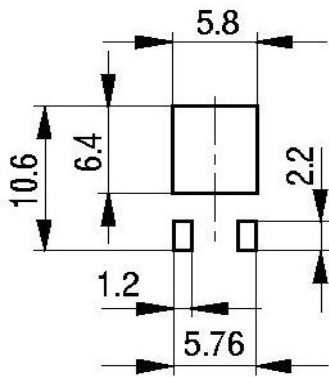


Package Outline

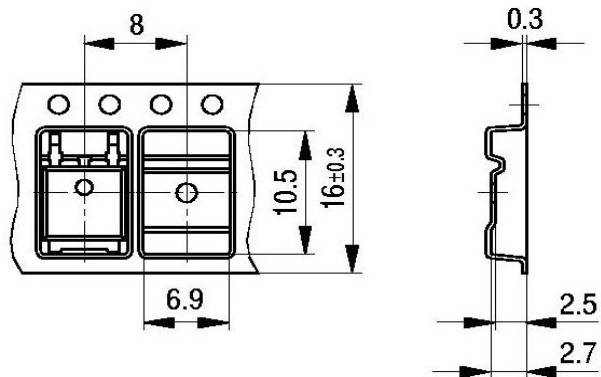
P-TO252-3-11: Outline



Footprint:



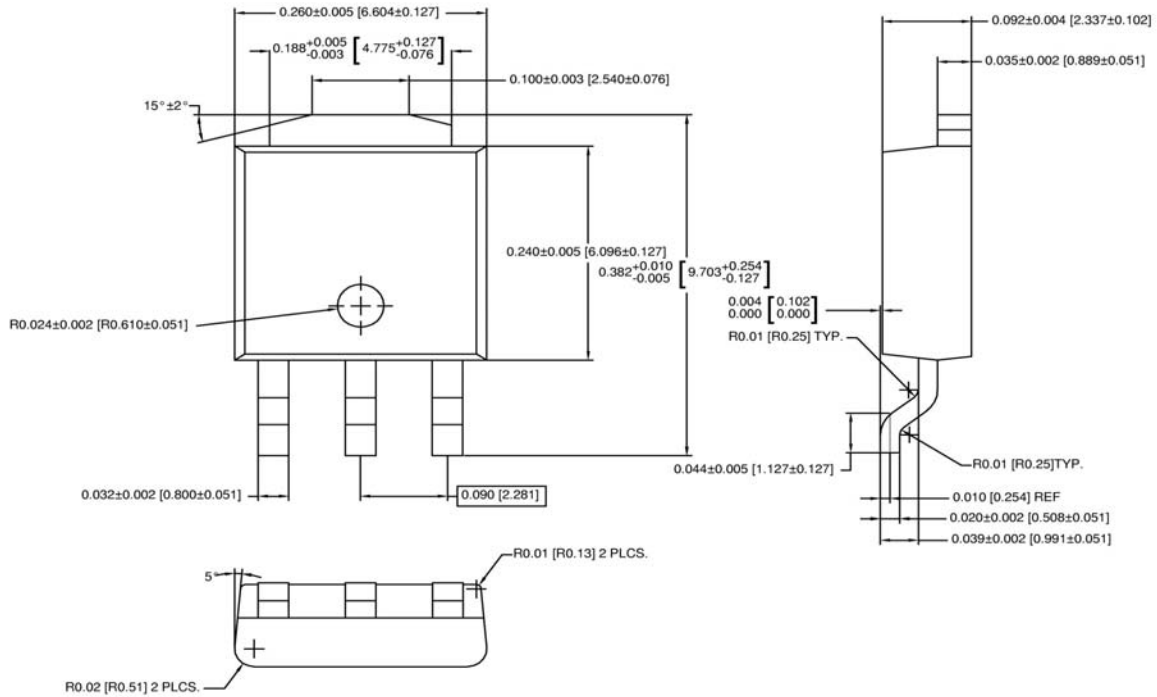
Packaging:



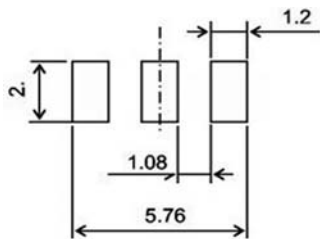
Dimensions in mm

Package Outline

P-TO252-3-23: Outline



Footprint:



Dimensions in mm



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