

**CoolMOS™ Power Transistor**
**Features**

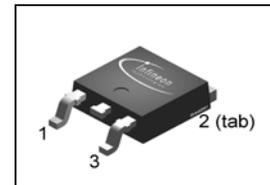
- Lowest figure-of-merit  $R_{ON} \times Q_g$
- Extreme dv/dt rated
- High peak current capability
- Fully qualified according to JEDEC for Industrial Applications
- Pb-free lead plating; RoHS compliant, available in Halogen free mold compound<sup>a)</sup>
- Ultra low gate charge

**Product Summary**

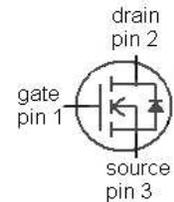
|   |     |          |
|---|-----|----------|
| $V_{DS} @ T_J=25^\circ\text{C}$         | 900 | V        |
| $R_{DS(on),max} @ T_J=25^\circ\text{C}$ | 1.2 | $\Omega$ |
| $Q_{g,typ}$                             | 28  | nC       |

**CoolMOS™ 900V is designed for:**

- Quasi Resonant Flyback / Forward topologies
- PC Silverbox and consumer applications
- Industrial SMPS


**PG-TO252**


| Type        | Package  | Marking |
|-------------|----------|---------|
| IPD90R1K2C3 | PG-TO252 | 9R1K2C  |


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

| Parameter   | Symbol         | Conditions                              | Value       | Unit             |
|---|----------------|---|-------------|------------------|
| Continuous drain current                                | $I_D$          | $T_C=25^\circ\text{C}$                  | 5.1         | A                |
|   |                | $T_C=100^\circ\text{C}$                 | 3.2         |                  |
| Pulsed drain current <sup>2)</sup>                      | $I_{D,pulse}$  | $T_C=25^\circ\text{C}$                  | 10          |                  |
| Avalanche energy, single pulse                          | $E_{AS}$       | $I_D=0.92\text{ A}, V_{DD}=50\text{ V}$ | 68          | mJ               |
| Avalanche energy, repetitive $t_{AR}$ <sup>2),3)</sup>  | $E_{AR}$       | $I_D=0.92\text{ A}, V_{DD}=50\text{ V}$ | 0.31        |                  |
| Avalanche current, repetitive $t_{AR}$ <sup>2),3)</sup> | $I_{AR}$       |   | 0.92        | A                |
| MOSFET dv/dt ruggedness                                 | dv/dt          | $V_{DS}=0\dots400\text{ V}$             | 50          | V/ns             |
| Gate source voltage                                     | $V_{GS}$       | static                                  | $\pm 20$    | V                |
|   |                | AC (f>1 Hz)                             | $\pm 30$    |                  |
| Power dissipation                                       | $P_{tot}$      | $T_C=25^\circ\text{C}$                  | 83          | W                |
| Operating and storage temperature                       | $T_J, T_{stg}$ |   | -55 ... 150 | $^\circ\text{C}$ |

<sup>a)</sup> non-Halogen free (OPN: IPD90R1K2C3BT); Halogen free (OPN: IPD90R1K2C3AT)

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

| Parameter                           | Symbol        | Conditions         | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ °C}$ | 2.8   | A    |
| Diode pulse current <sup>2)</sup>   | $I_{S,pulse}$ |                    | 11    |      |
| Reverse diode $dv/dt$ <sup>4)</sup> | $dv/dt$       |                    | 4     | V/ns |

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

**Thermal characteristics**

|  |            |                                       |   |   |     |     |
|--|------------|---------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case                        | $R_{thJC}$ |                                       | - | - | 1.5 | K/W |
| Thermal resistance, junction - ambient                     | $R_{thJA}$ | leaded                                | - | - | 62  |     |
| Soldering temperature, wavesoldering only allowed at leads | $T_{sold}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C  |

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

|                                  |               |   |     |      |     |               |
|----------------------------------|---------------|---|-----|------|-----|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$             | 900 | -    | -   | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=0.31\text{ mA}$                         | 2.5 | 3    | 3.5 |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=900\text{ V}, V_{GS}=0\text{ V}, T_J=25\text{ °C}$  | -   | -    | 1   | $\mu\text{A}$ |
|                                  |               | $V_{DS}=900\text{ V}, V_{GS}=0\text{ V}, T_J=150\text{ °C}$ | -   | 10   | -   |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                     | -   | -    | 100 | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=2.8\text{ A}, T_J=25\text{ °C}$    | -   | 0.94 | 1.2 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}, I_D=2.8\text{ A}, T_J=150\text{ °C}$   | -   | 2.5  | -   |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                               | -   | 1.3  | -   | $\Omega$      |

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

**Dynamic characteristics**

|  |              |   |   |     |   |    |
|--|--------------|---|---|-----|---|----|
| Input capacitance  | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$<br>$f=1\text{ MHz}$                           | - | 710 | - | pF |
| Output capacitance   | $C_{oss}$    |   | - | 35  | - |    |
| Effective output capacitance, energy related <sup>5)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 500 V                                      | - | 23  | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |   | - | 86  | - |    |
| Turn-on delay time   | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=2.8\text{ A},$<br>$R_G=81.3\ \Omega$ | - | 70  | - | ns |
| Rise time  | $t_r$        |   | - | 20  | - |    |
| Turn-off delay time  | $t_{d(off)}$ |   | - | 400 | - |    |
| Fall time  | $t_f$        |   | - | 40  | - |    |

**Gate Charge Characteristics**

|                       |               |  |   |     |     |    |
|-----------------------|---------------|--|---|-----|-----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=2.8\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 3.2 | -   | nC |
| Gate to drain charge  | $Q_{gd}$      |  | - | 12  | -   |    |
| Gate charge total     | $Q_g$         |  | - | 28  | tbd |    |
| Gate plateau voltage  | $V_{plateau}$ |  | - | 4.6 | -   | V  |

**Reverse Diode**

|                               |           |  |   |     |     |               |
|-------------------------------|-----------|--|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=2.8\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 0.8 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$  | $V_R=400\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 310 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |  | - | 3.7 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |  | - | 19  | -   | A             |

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{J,max}$

<sup>3)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

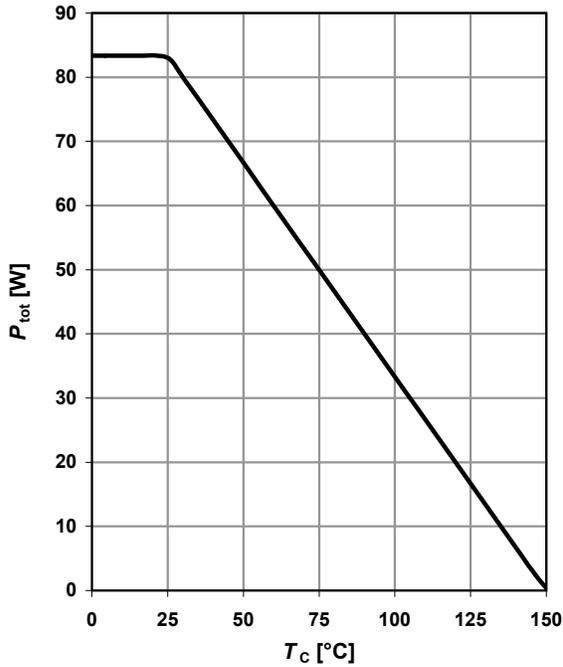
<sup>4)</sup>  $I_{SD} \leq I_D$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{Dlink}=400\text{ V}$ ,  $V_{peak} < V_{(BR)DSS}$ ,  $T_J < T_{J,max}$ , identical low side and high side switch

<sup>5)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 50%  $V_{DSS}$ .

<sup>6)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 50%  $V_{DSS}$ .

**1 Power dissipation**

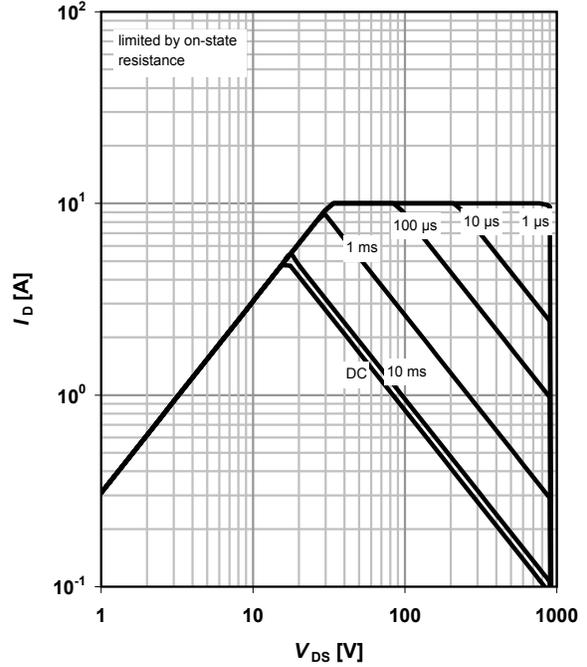
$$P_{tot} = f(T_C)$$



**2 Safe operating area**

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

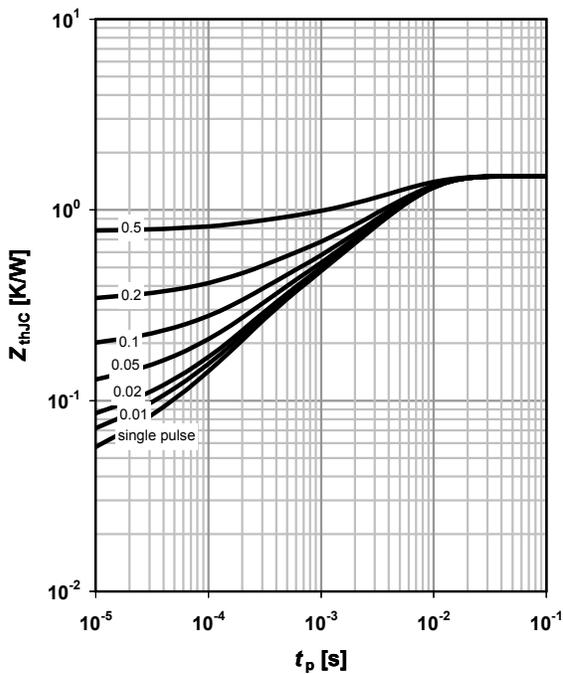
parameter:  $t_p$



**3 Max. transient thermal impedance**

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

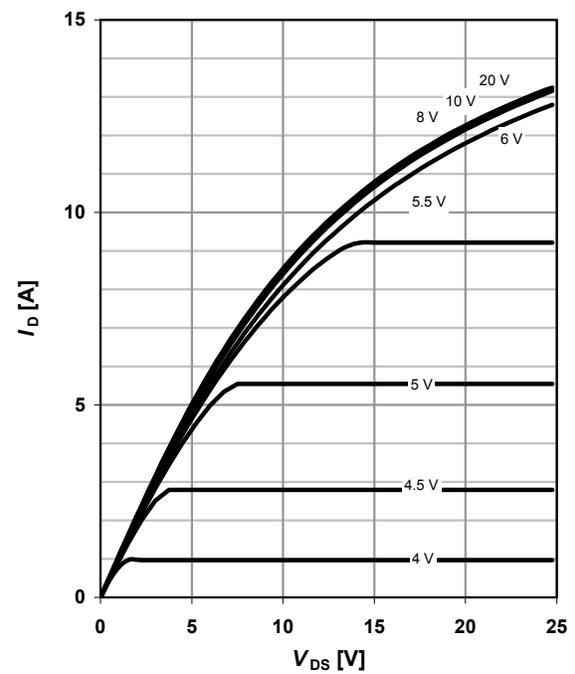
parameter:  $D = t_p / T$



**4 Typ. output characteristics**

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

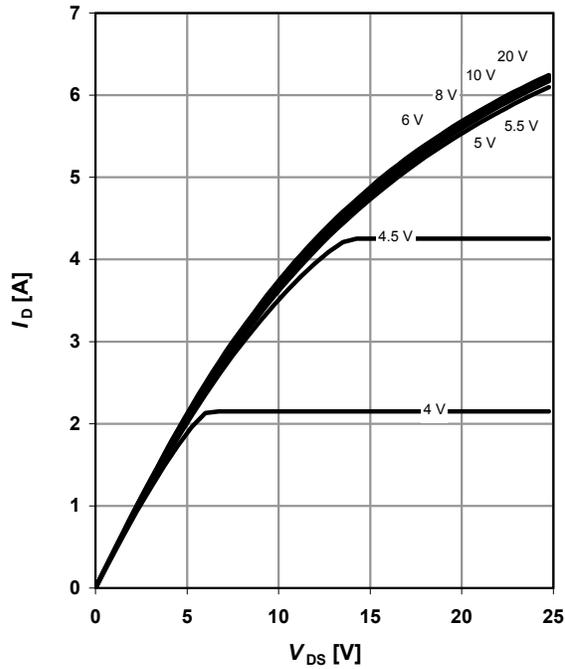
parameter:  $V_{GS}$



**5 Typ. output characteristics**

$I_D = f(V_{DS}); T_J = 150\text{ °C}$

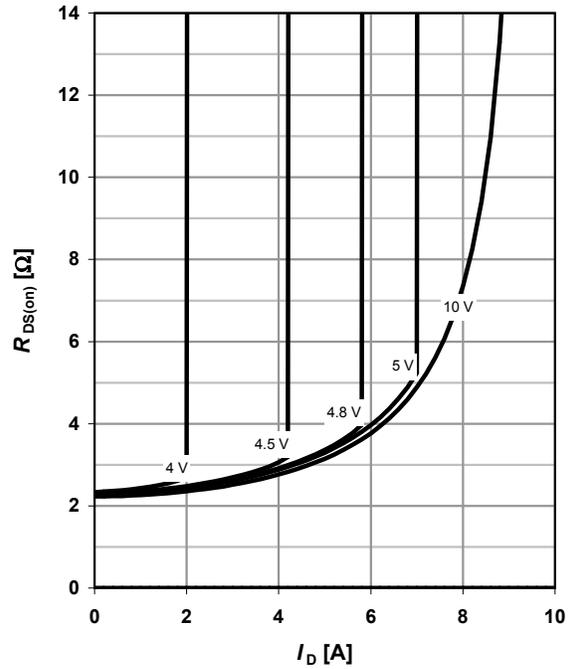
parameter:  $V_{GS}$



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

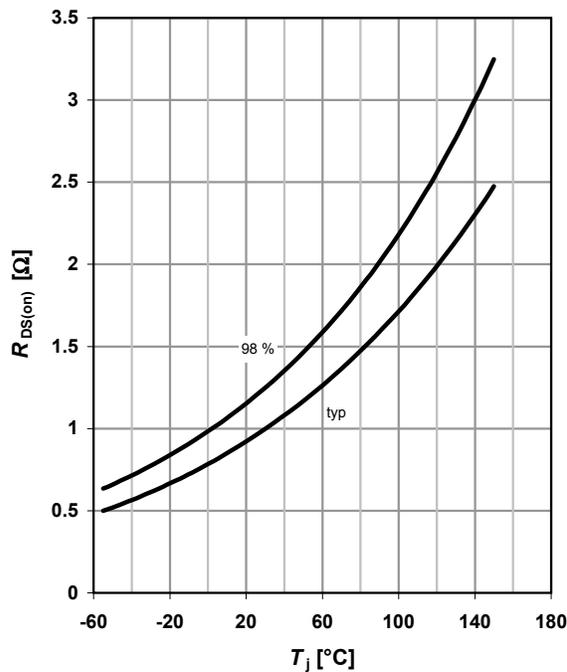
$R_{DS(on)} = f(I_D); T_J = 150\text{ °C}$

parameter:  $V_{GS}$



**7 Drain-source on-state resistance**

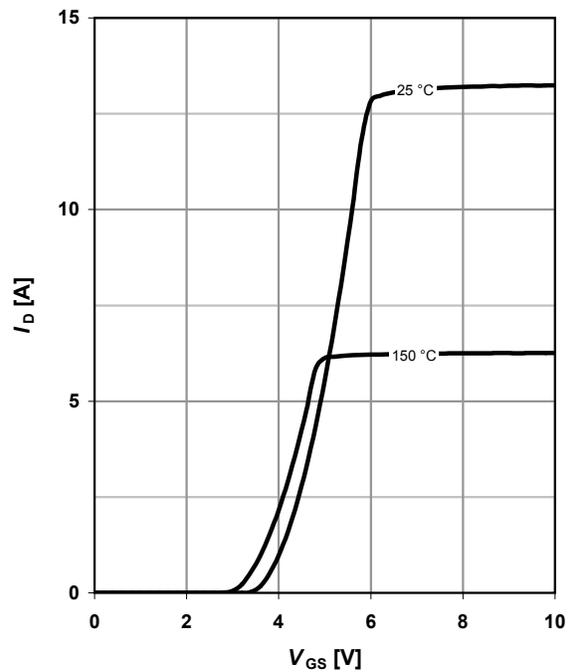
$R_{DS(on)} = f(T_J); I_D = 2.8\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

$I_D = f(V_{GS}); V_{DS} = 20\text{ V}$

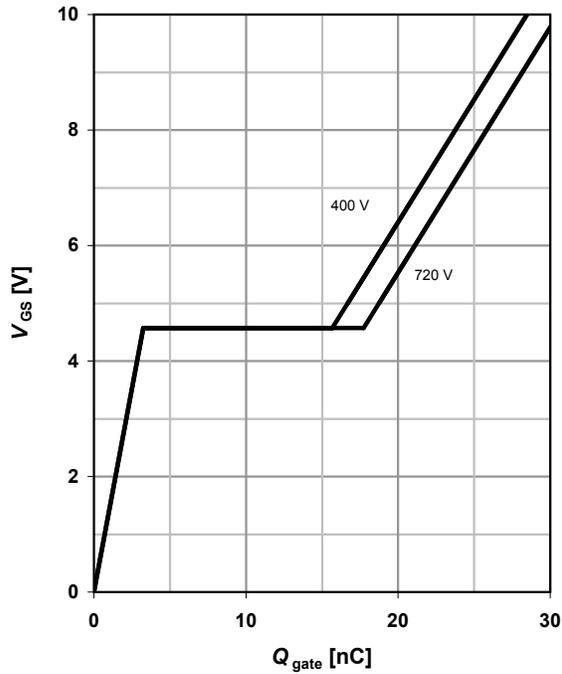
parameter:  $T_J$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=2.8 \text{ A pulsed}$

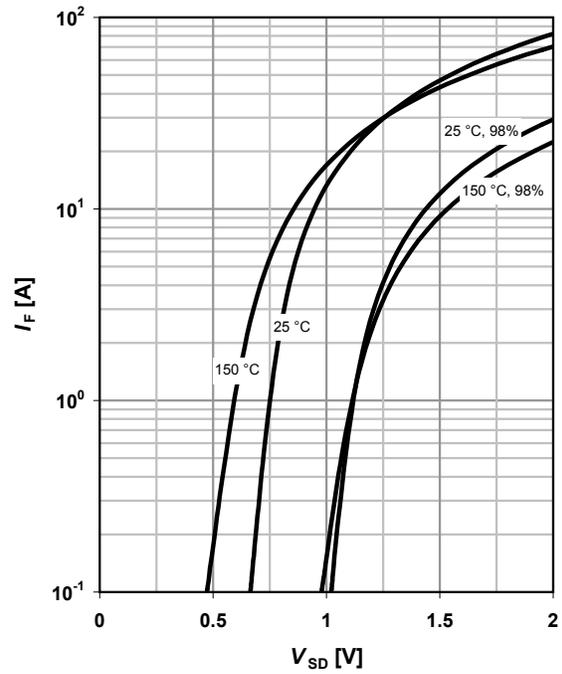
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

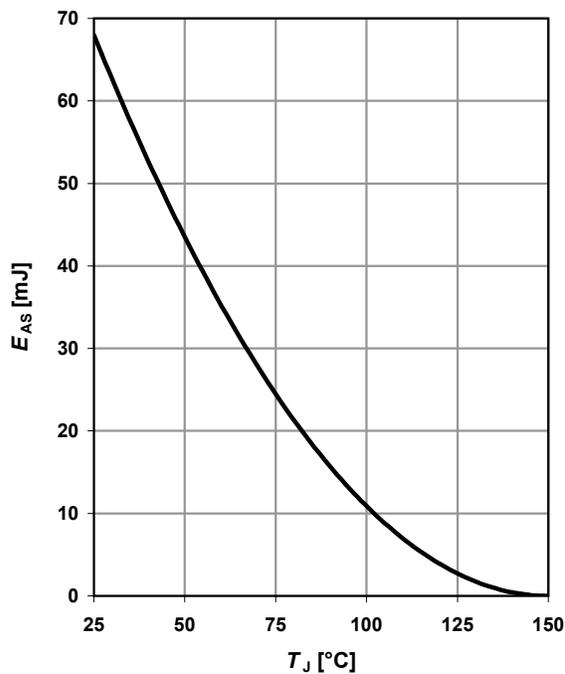
$I_F=f(V_{SD})$

parameter:  $T_J$



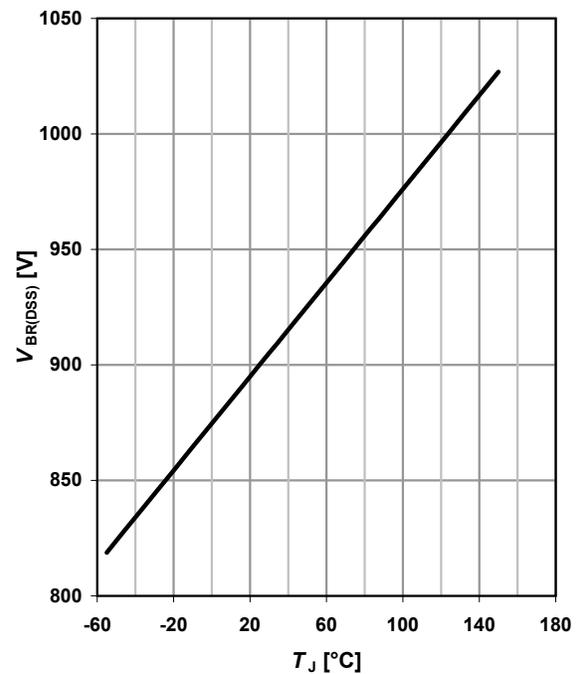
**11 Avalanche energy**

$E_{AS}=f(T_j); I_D=0.92 \text{ A}; V_{DD}=50 \text{ V}$



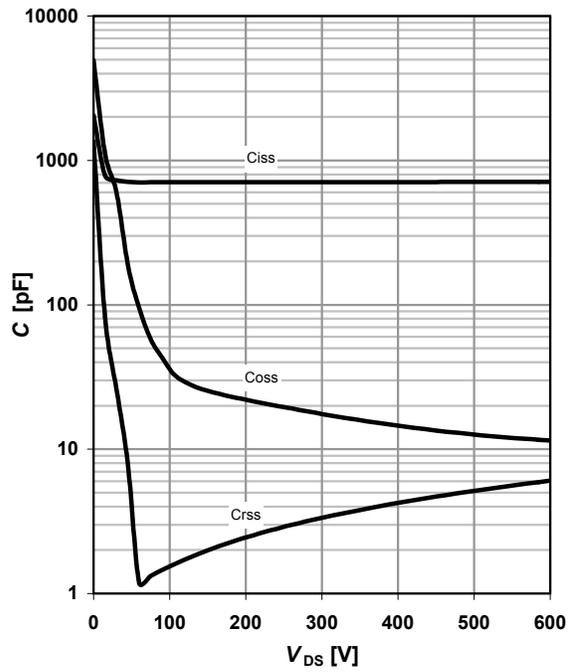
**12 Drain-source breakdown voltage**

$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$



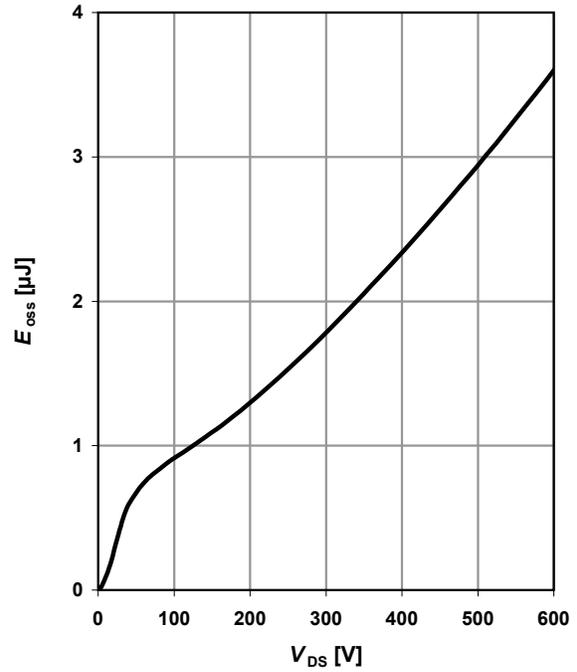
13 Typ. capacitances

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

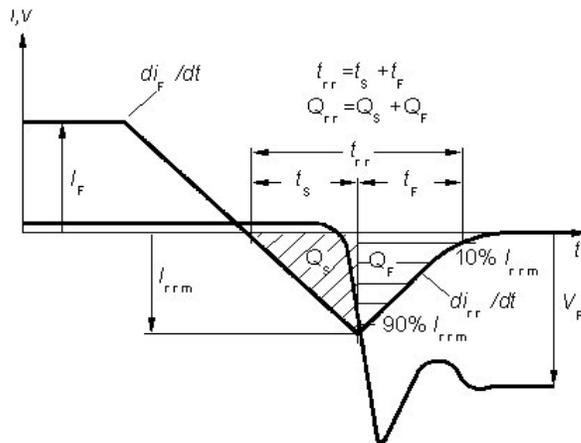


14 Typ. C<sub>oss</sub> stored energy

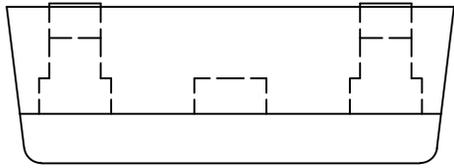
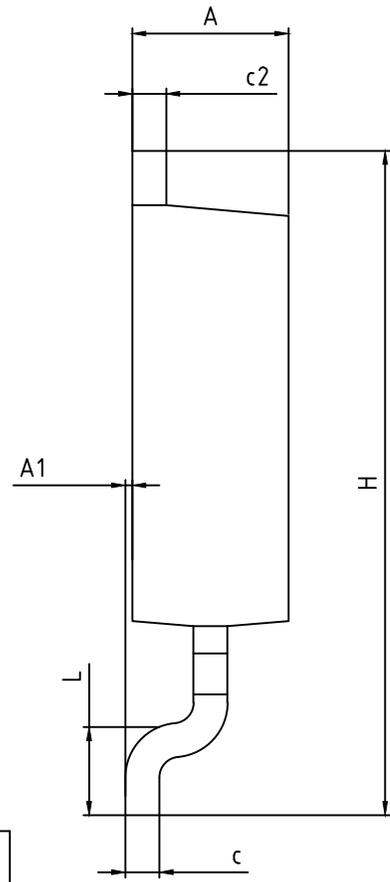
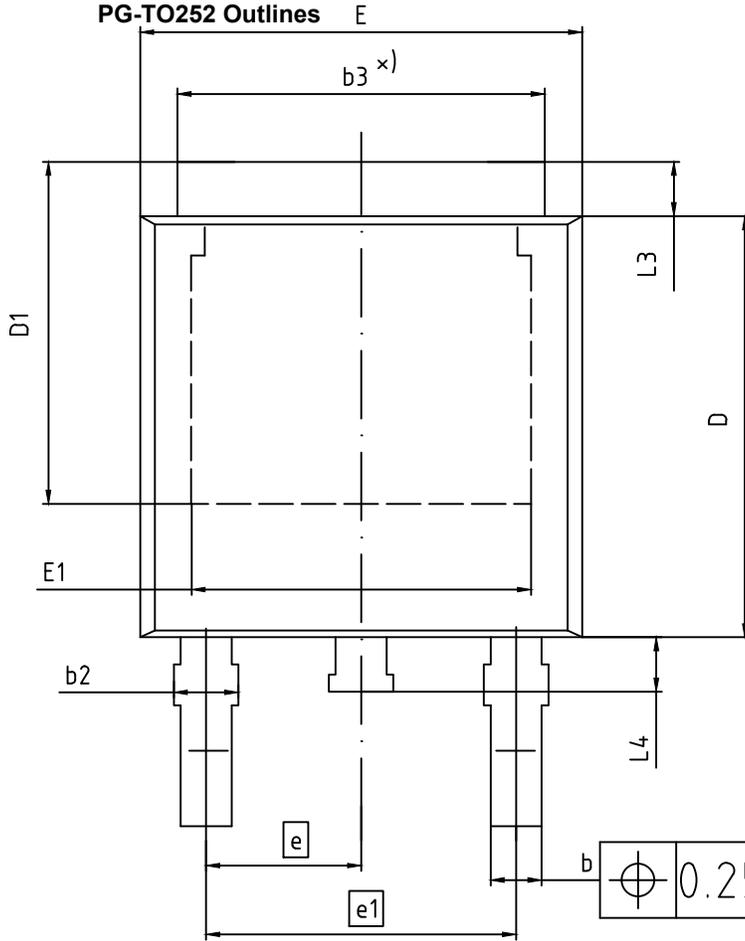
$E_{oss} = f(V_{DS})$



Definition of diode switching characteristics



PG-TO252 Outlines E



ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

| DIMENSION | MILLIMETERS |       |
|-----------|-------------|-------|
|           | MIN.        | MAX.  |
| A         | 2.16        | 2.41  |
| A1        | 0.00        | 0.15  |
| b         | 0.64        | 0.89  |
| b2        | 0.65        | 1.15  |
| b3        | 4.95        | 5.50  |
| c         | 0.46        | 0.61  |
| c2        | 0.40        | 0.98  |
| D         | 5.97        | 6.22  |
| D1        | 5.02        | 5.84  |
| E         | 6.35        | 6.73  |
| E1        | 4.32        | 5.50  |
| e         | 2.29        |       |
| e1        | 4.57        |       |
| N         | 3           |       |
| H         | 9.40        | 10.48 |
| L         | 1.18        | 1.78  |
| L3        | 0.89        | 1.27  |
| L4        | 0.51        | 1.02  |

|                                      |
|--------------------------------------|
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## Revision History

IPD90R1K2C3

**Revision: 2020-05-26, Rev. 2.1**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.1      | 2020-05-26 | Update package outline                       |

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