

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

- Lowest figure of merit  $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Pb-free lead plating; RoHS compliant; Halogen free for mold compound
- Qualified for industrial grade applications according to JEDEC<sup>1)</sup>

**Product Summary**

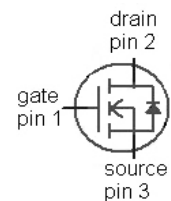
|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550   | V        |
| $R_{DS(on),max}$    | 0.350 | $\Omega$ |
| $Q_{g,typ}$         | 19    | nC       |

**CoolMOS CP is specially designed for:**

- Hard and softswitching SMPS for server power supplies
- CCM PFC for Notebook adapter, PDP and LCD TV
- PWM for Notebook adapter, PDP and LCD TV

**PG-TO262**


| Type        | Package  | Marking |
|-------------|----------|---------|
| IPI50R350CP | PG-TO262 | 5R350P  |


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

| Parameter                                      | Symbol         | Conditions                                | Value       | Unit               |
|--|----------------|---|-------------|--------------------|
| Continuous drain current                       | $I_D$          | $T_C=25\text{ °C}$                        | 10          | A                  |
|  |                | $T_C=100\text{ °C}$                       | 6           |                    |
| Pulsed drain current <sup>2)</sup>             | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 22          |                    |
| Avalanche energy, single pulse                 | $E_{AS}$       | $I_D=3.7\text{ A}$ , $V_{DD}=50\text{ V}$ | 246         | mJ                 |
| Avalanche energy, repetitive $t_{AR}^{2),3)}$  | $E_{AR}$       | $I_D=3.7\text{ A}$ , $V_{DD}=50\text{ V}$ | 0.37        |                    |
| Avalanche current, repetitive $t_{AR}^{2),3)}$ | $I_{AR}$       |   | 3.7         | 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 ( $f > 1\text{ Hz}$ )                  | $\pm 30$    |                    |
| Power dissipation                              | $P_{tot}$      | $T_C=25\text{ °C}$                        | 89          | W                  |
| Operating and storage temperature              | $T_j, T_{stg}$ |   | -55 ... 150 | $^{\circ}\text{C}$ |

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

| Parameter                           | Symbol        | Conditions         | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ °C}$ | 5.6   | A    |
| Diode pulse current <sup>2)</sup>   | $I_{S,pulse}$ |                    | 22    |      |
| Reverse diode $dv/dt$ <sup>4)</sup> | $dv/dt$       |                    | 15    | V/ns |

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

**Thermal characteristics**

|  |            |                                       |   |   |     |     |
|--|------------|---------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case                        | $R_{thJC}$ |                                       | - | - | 1.4 | 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   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$             | 500 | -    | -    | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=0.37\text{ mA}$                         | 2.5 | 3    | 3.5  |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$  | -   | -    | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$ | -   | 10   | -    |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$                     | -   | -    | 100  | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=5.6\text{ A}, T_j=25\text{ °C}$    | -   | 0.32 | 0.35 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}, I_D=5.6\text{ A}, T_j=150\text{ °C}$   | -   | 0.80 | -    |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}, \text{open drain}$                         | -   | 2.2  | -    | $\Omega$      |

| 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>$f=1\text{ MHz}$                           | - | 1020 | - | pF |
| Output capacitance   | $C_{oss}$    |   | - | 46   | - |    |
| Effective output capacitance, energy related <sup>5)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 400 V                                      | - | 43   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |   | - | 92   | - |    |
| Turn-on delay time   | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=5.6\text{ A},$<br>$R_G=30.9\ \Omega$ | - | 35   | - | ns |
| Rise time  | $t_r$        |   | - | 14   | - |    |
| Turn-off delay time  | $t_{d(off)}$ |   | - | 80   | - |    |
| Fall time  | $t_f$        |   | - | 12   | - |    |

**Gate Charge Characteristics**

|                       |               |  |   |     |    |    |
|-----------------------|---------------|--|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=5.6\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 4   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |  | - | 6   | -  |    |
| Gate charge total     | $Q_g$         |  | - | 19  | 25 |    |
| Gate plateau voltage  | $V_{plateau}$ |  | - | 5.2 | -  | V  |

**Reverse Diode**

|                               |           |  |   |     |     |               |
|-------------------------------|-----------|--|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=5.6\text{ A},$<br>$T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$  | $V_R=400\text{ V}, I_F=I_S,$<br>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 250 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |  | - | 2.3 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |  | - | 19  | -   | A             |

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

<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  $P_{AV}=E_{AR} \cdot f$ .

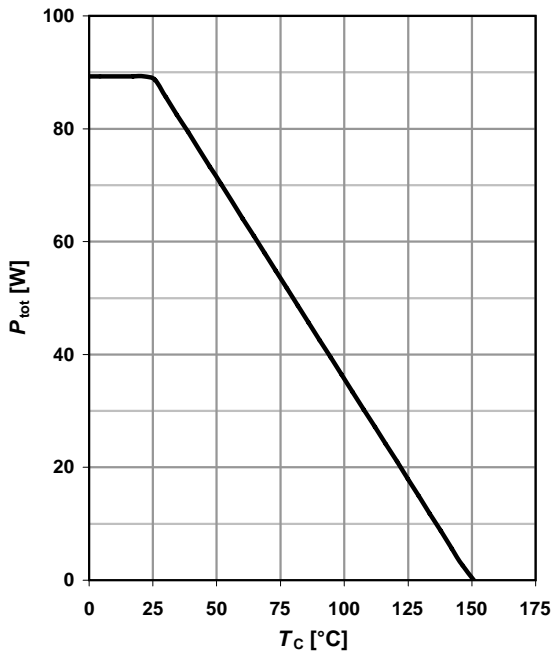
<sup>4)</sup>  $I_{SD} \leq I_D, di/dt \leq 400\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$ , identical low and high side switch

<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 80%  $V_{DSS}$ .

<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 80%  $V_{DSS}$ .

**1 Power dissipation**

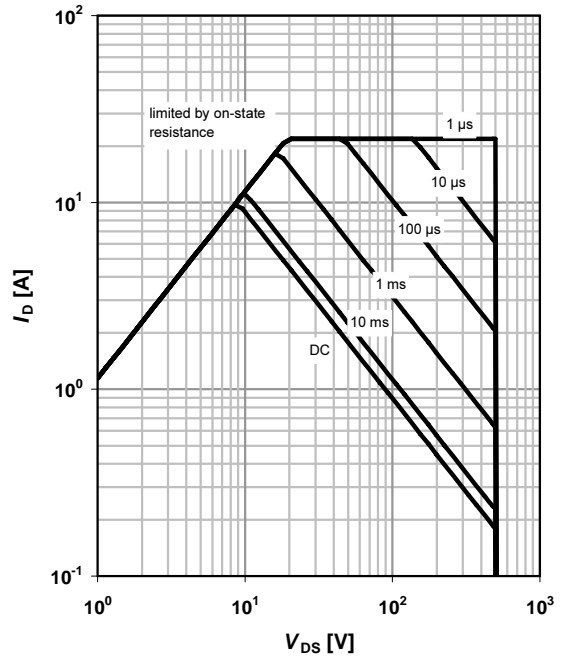
$P_{tot}=f(T_C)$



**2 Safe operating area**

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

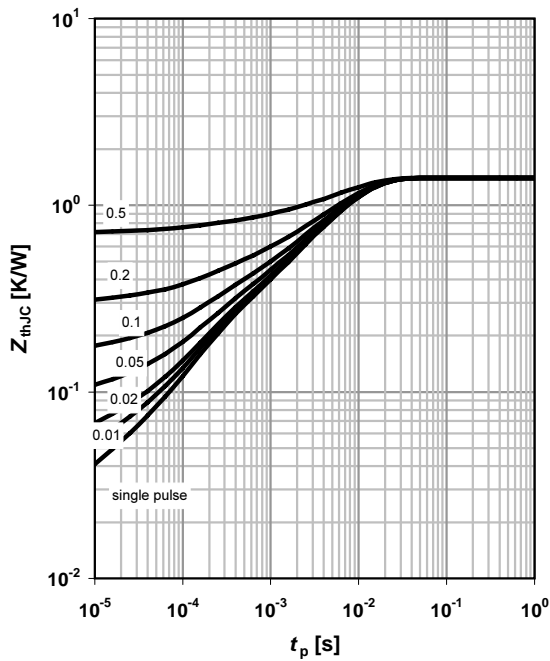
parameter:  $t_p$



**3 Max. transient thermal impedance**

$Z_{(th)JC}=f(t_p)$

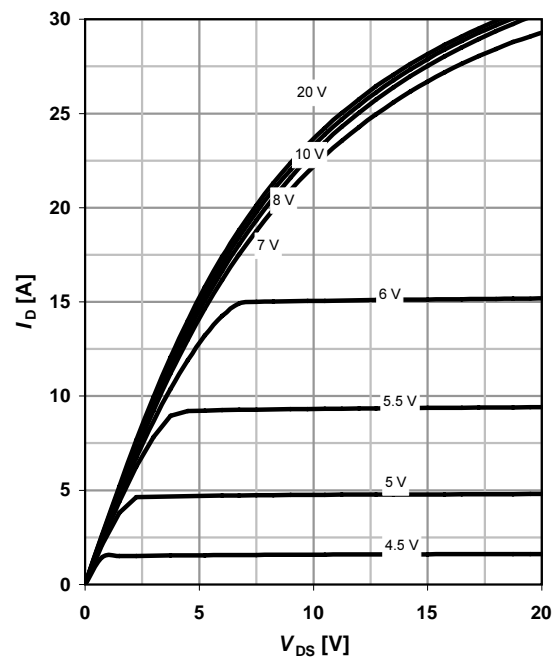
parameter:  $D=t_p/T$



**4 Typ. output characteristics**

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

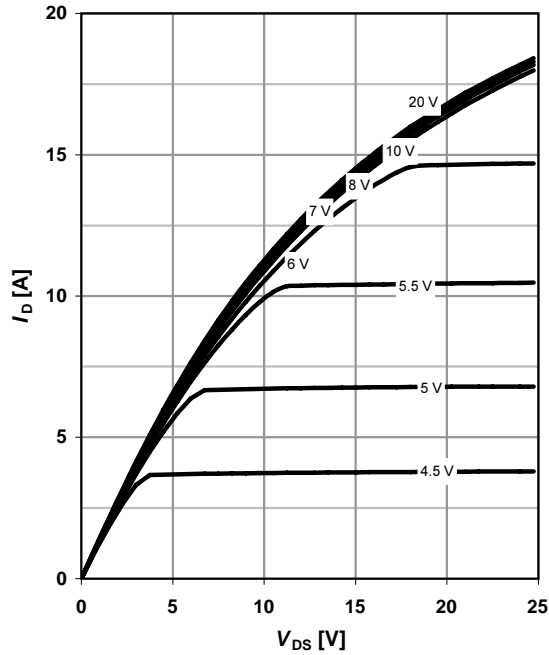
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

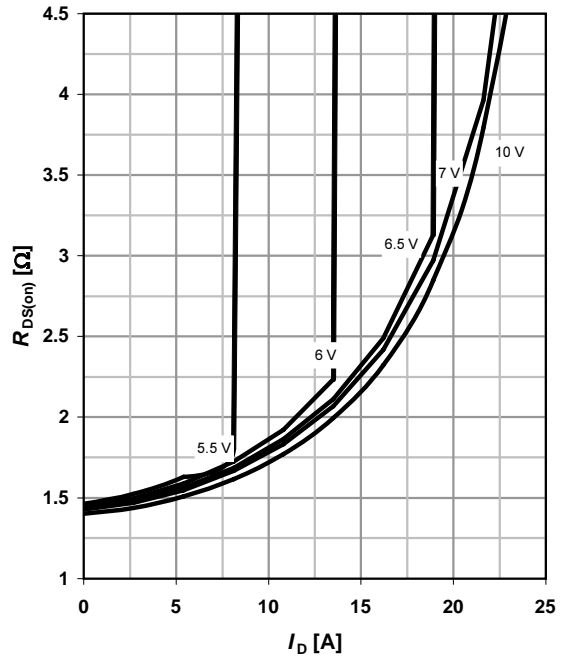
parameter:  $V_{GS}$



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

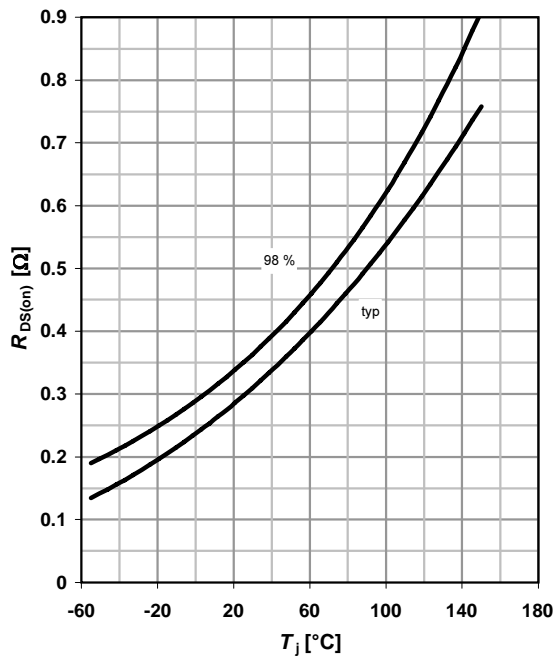
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter:  $V_{GS}$



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

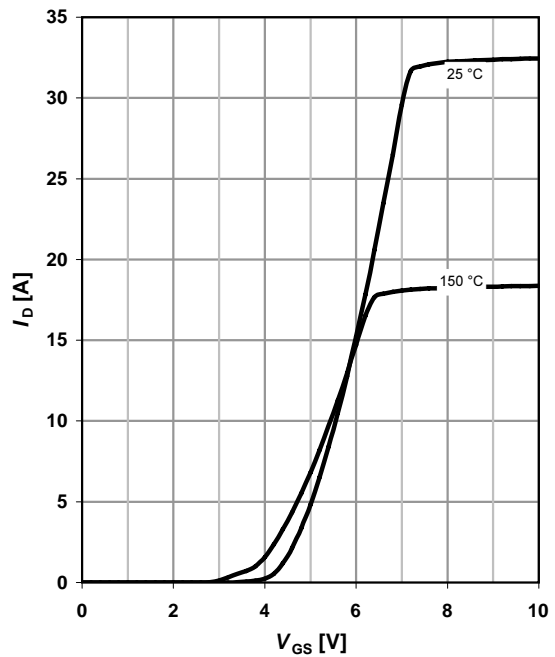
$R_{DS(on)} = f(T_j); I_D = 5.6\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

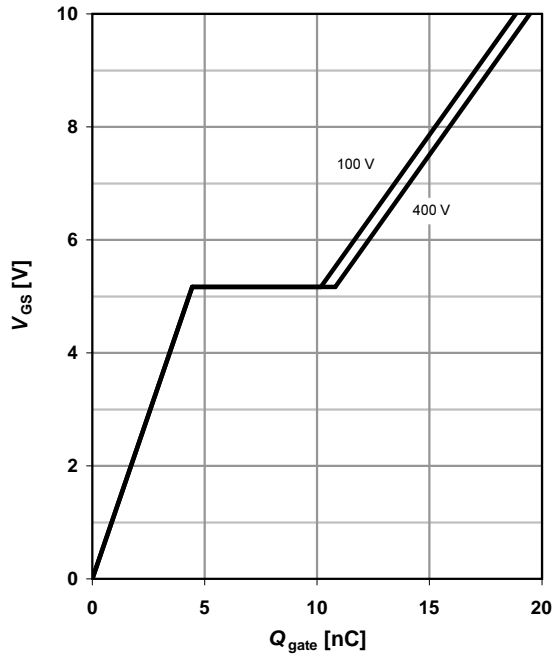
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=5.6 \text{ A pulsed}$

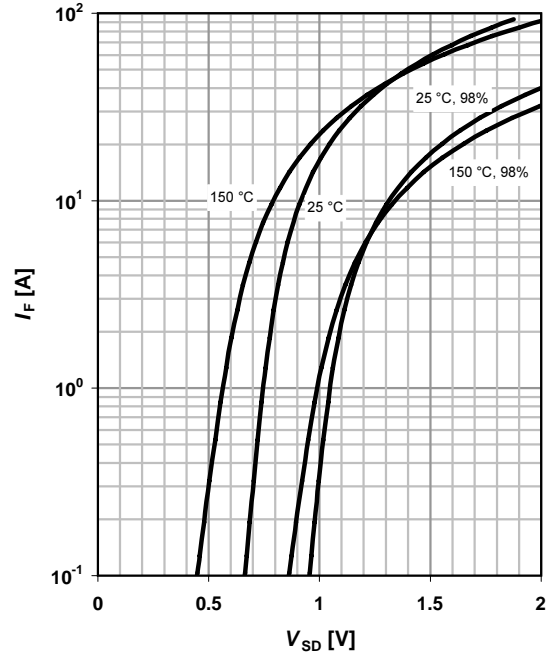
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

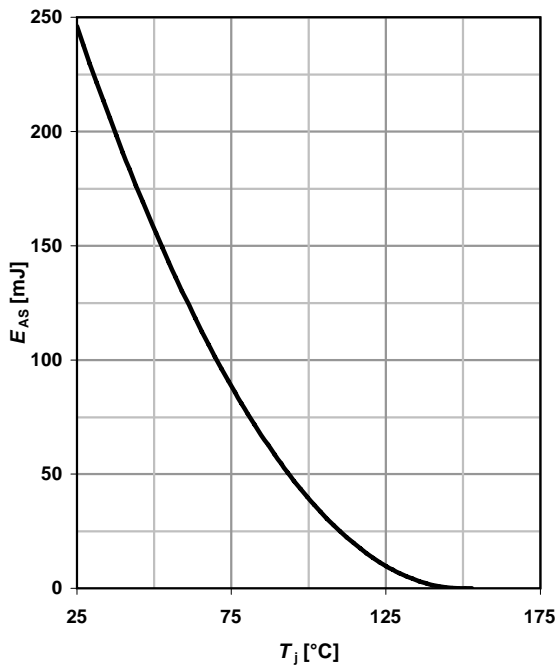
$I_F=f(V_{SD})$

parameter:  $T_j$



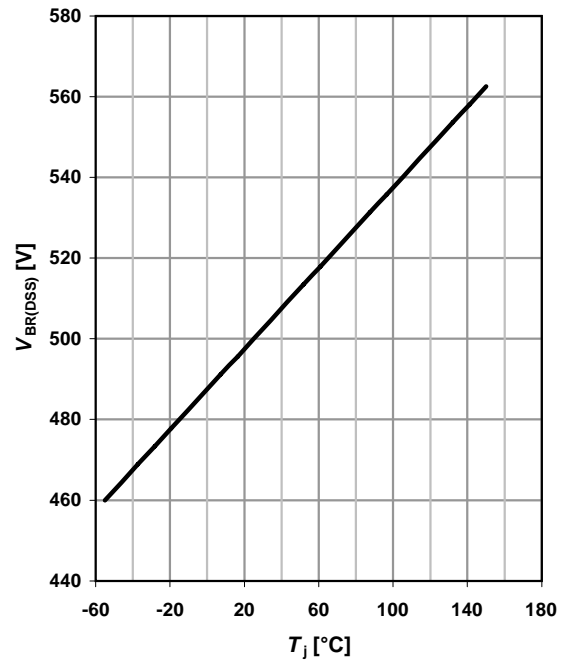
**11 Avalanche energy**

$E_{AS}=f(T_j); I_D=3.7 \text{ A}; V_{DD}=50 \text{ V}$



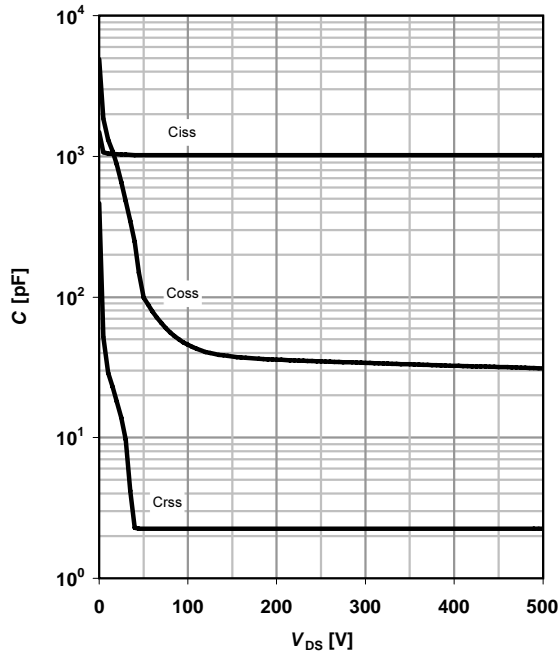
**12 Drain-source breakdown voltage**

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



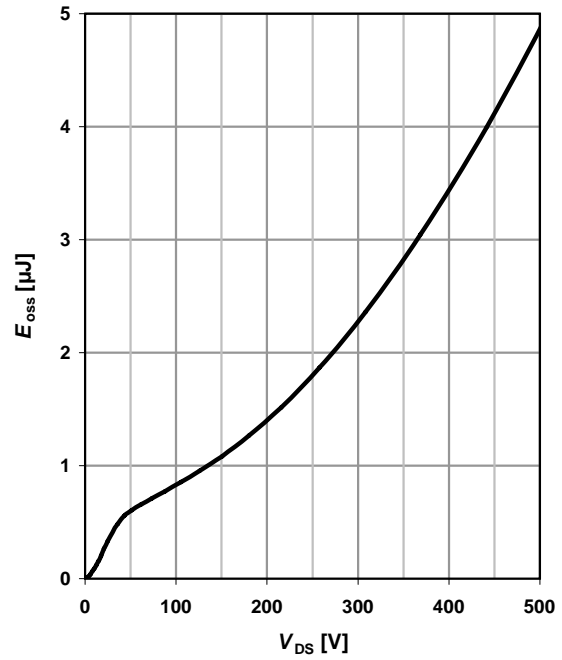
13 Typ. capacitances

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

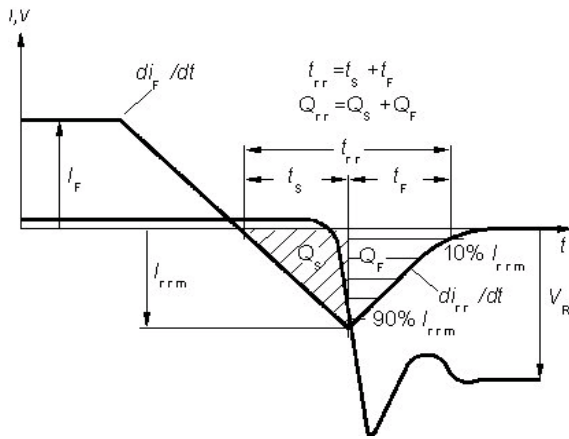


14 Typ. Coss stored energy

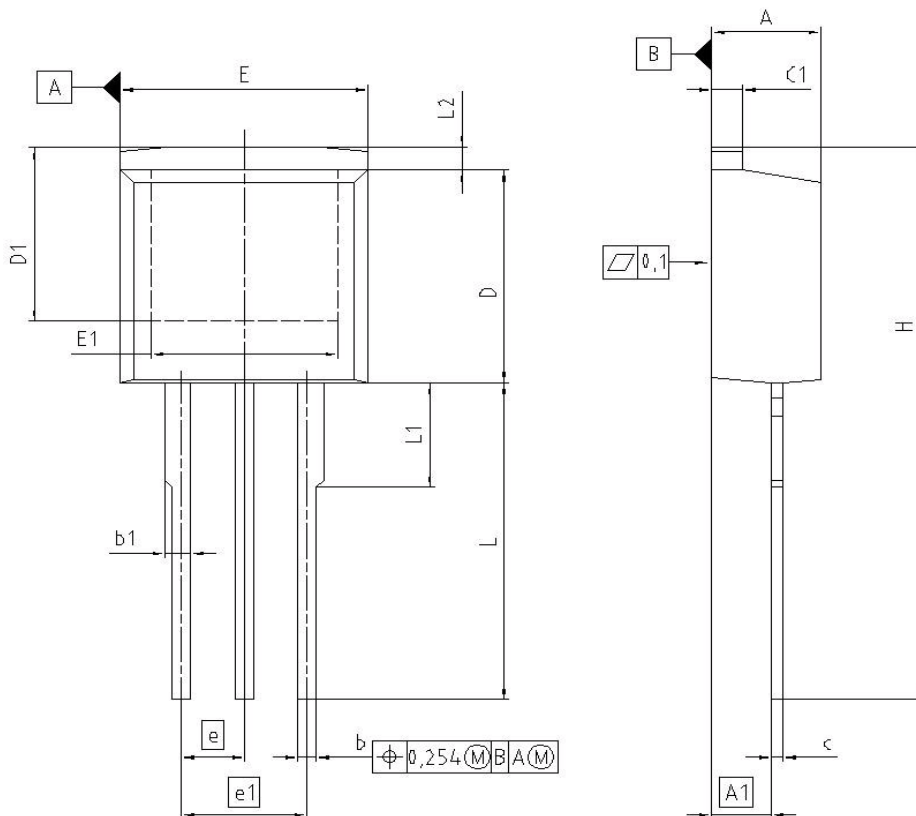
$$E_{oss} = f(V_{DS})$$



Definition of diode switching characteristics





**PG-TO262-3-1: Outline**


| DIM       | MILLIMETERS |        | INCHES |       |
|-----------|-------------|--------|--------|-------|
|           | MIN         | MAX    | MIN    | MAX   |
| <b>A</b>  | 4.300       | 4.500  | 0.169  | 0.177 |
| <b>A1</b> | 2.150       | 2.650  | 0.085  | 0.104 |
| <b>b</b>  | 0.650       | 0.850  | 0.026  | 0.033 |
| <b>b1</b> | 0.635       | 1.400  | 0.025  | 0.055 |
| <b>c</b>  | 0.400       | 0.600  | 0.016  | 0.024 |
| <b>c1</b> | 1.170       | 1.370  | 0.046  | 0.054 |
| <b>D</b>  | 9.050       | 9.450  | 0.356  | 0.372 |
| <b>D1</b> | 6.900       | 7.650  | 0.272  | 0.301 |
| <b>E</b>  | 9.800       | 10.200 | 0.386  | 0.402 |
| <b>E1</b> | 7.250       | 8.600  | 0.285  | 0.339 |
| <b>e</b>  | 2.540       |        | 0.100  |       |
| <b>e1</b> | 5.080       |        | 0.200  |       |
| <b>N</b>  | 3           |        | 3      |       |
| <b>L</b>  | 13.000      | 14.000 | 0.512  | 0.551 |
| <b>L1</b> | 4.350       | 4.750  | 0.171  | 0.187 |
| <b>L2</b> | 0.700       | 1.300  | 0.028  | 0.051 |

|                                 |
|---------------------------------|
| <b>REFERENCE</b><br>JEDEC TO262 |
| <b>SCALE</b><br>                |
| <b>EUROPEAN PROJECTION</b><br>  |
| <b>ISSUE DATE</b><br>01-06-2005 |
| <b>FILE</b><br>TO262_1          |

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