

## 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
- Qualified according to JEDEC<sup>1)</sup> for target applications

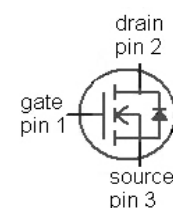
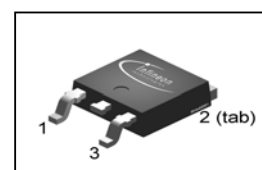
### Product Summary

|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550   | V        |
| $R_{DS(on),max}$    | 0.399 | $\Omega$ |
| $Q_{g,typ}$         | 17    | nC       |

### CoolMOS CP is designed for:

- Hard and softswitching SMPS topologies
- DCM PFC for Lamp Ballast
- PWM for Lamp Ballast & PDP and LCD TV

PG-TO252



| Type        | Package  | Marking |
|-------------|----------|---------|
| IPD50R399CP | PG-TO252 | 5R399P  |

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

| Parameter                                      | Symbol         | Conditions                                | Value       | Unit |
|------------------------------------------------|----------------|-------------------------------------------|-------------|------|
| Continuous drain current                       | $I_D$          | $T_C=25\text{ °C}$                        | 9           | A    |
|                                                |                | $T_C=100\text{ °C}$                       | 6           |      |
| Pulsed drain current <sup>2)</sup>             | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 20          |      |
| Avalanche energy, single pulse                 | $E_{AS}$       | $I_D=3.3\text{ A}$ , $V_{DD}=50\text{ V}$ | 215         | mJ   |
| Avalanche energy, repetitive $t_{AR}^{2),3)}$  | $E_{AR}$       | $I_D=3.3\text{ A}$ , $V_{DD}=50\text{ V}$ | 0.33        |      |
| Avalanche current, repetitive $t_{AR}^{2),3)}$ | $I_{AR}$       |                                           | 3.3         | A    |
| MOSFET dv/dt ruggedness                        | dv/dt          | $V_{DS}=0\ldots 400\text{ V}$             | 50          | V/ns |
| Gate source voltage                            | $V_{GS}$       | static                                    | $\pm 20$    | V    |
|                                                |                | AC ( $f > 1\text{ Hz}$ )                  | $\pm 30$    |      |
| Power dissipation                              | $P_{tot}$      | $T_C=25\text{ °C}$                        | 83          | W    |
| Operating and storage temperature              | $T_j, T_{stg}$ |                                           | -55 ... 150 | °C   |

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

| Parameter                           | Symbol        | Conditions         | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current    | $I_S$         | $T_C=25\text{ °C}$ | 4.9   | A    |
| Diode pulse current <sup>2)</sup>   | $I_{S,pulse}$ |                    | 20    |      |
| 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    | $R_{thJC}$   |                                       | - | - | 1.5 | K/W |
| Thermal resistance, junction - ambient | $R_{thJA}$   | leaded                                | - | - | 62  |     |
| Soldering temperature, reflowsoldering | $T_{solder}$ | 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           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=0.33\text{ mA}$                            | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=4.9\text{ A}$ , $T_j=25\text{ °C}$    | -   | 0.36 | 0.399 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=4.9\text{ A}$ , $T_j=150\text{ °C}$   | -   | 0.90 | -     |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , 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>$f=1\text{ MHz}$                                 | - | 890 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                               | - | 40  | - |    |
| Effective output capacitance, energy related <sup>6)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 400 V                                            | - | 38  | - |    |
| Effective output capacitance, time related <sup>7)</sup>   | $C_{o(tr)}$  |                                                                                               | - | 81  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=4.9\text{ A},$<br>$R_G=35.1\text{ }\Omega$ | - | 35  | - | ns |
| Rise time                                                  | $t_r$        |                                                                                               | - | 14  | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                               | - | 80  | - |    |
| Fall time                                                  | $t_f$        |                                                                                               | - | 14  | - |    |

### Gate Charge Characteristics

|                       |               |                                                                              |   |     |    |    |
|-----------------------|---------------|------------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=4.9\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 4   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                              | - | 6   | -  |    |
| Gate charge total     | $Q_g$         |                                                                              | - | 17  | 23 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                              | - | 5.2 | -  | V  |

### Reverse Diode

|                               |           |                                                                          |   |      |     |               |
|-------------------------------|-----------|--------------------------------------------------------------------------|---|------|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=4.9\text{ A},$<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>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 260  | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |                                                                          | - | 1.9  | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                          | - | 12.2 | -   | 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

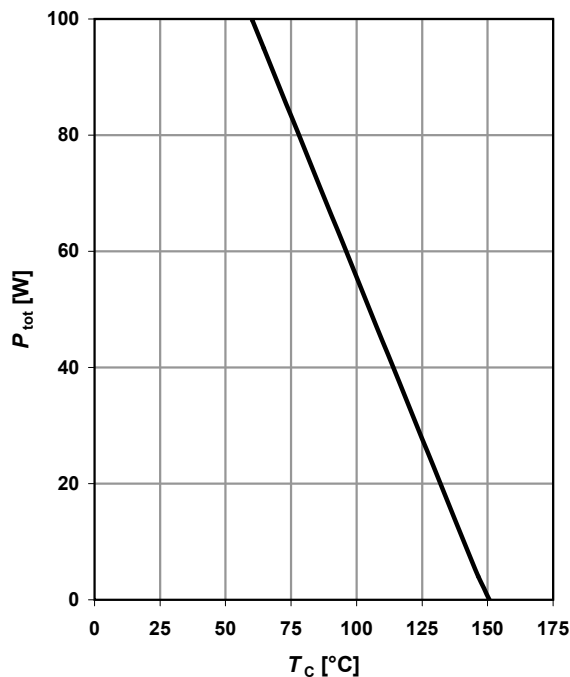
<sup>5)</sup> Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70mm thick) copper area for drain connection. PCB without blown air.

<sup>6)</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>7)</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

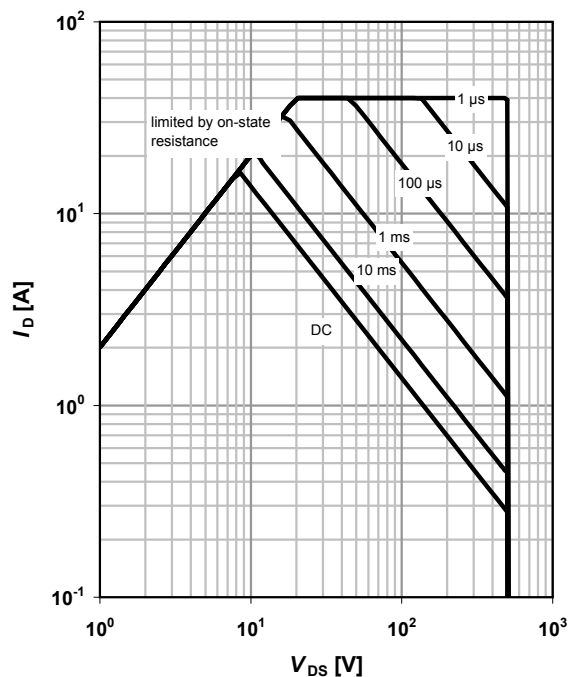
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

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

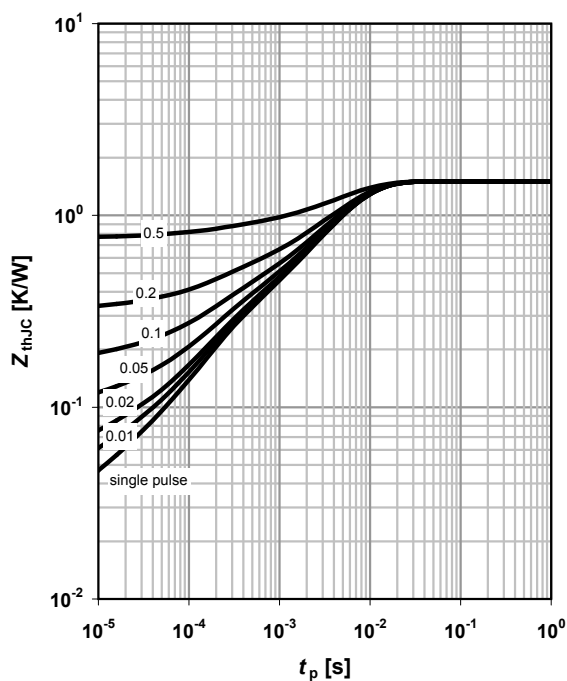
parameter:  $t_p$



### 3 Max. transient thermal impedance

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

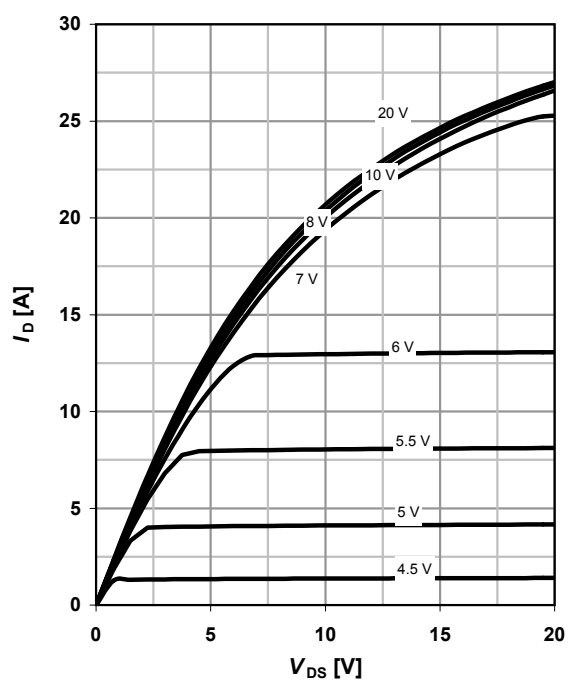
parameter:  $D = t_p/T$



### 4 Typ. output characteristics

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

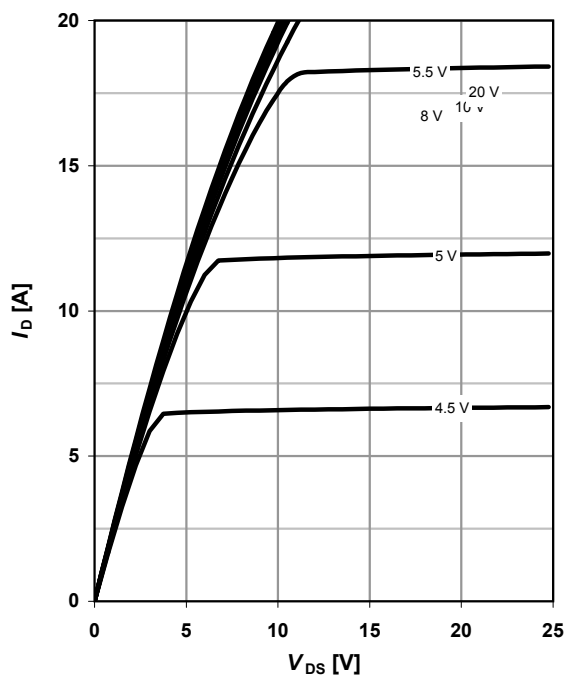
parameter:  $V_{GS}$



### 5 Typ. output characteristics

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

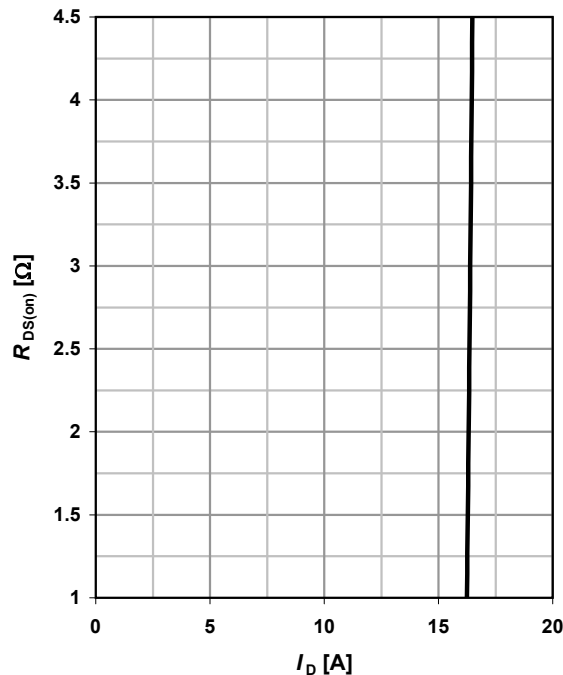
parameter:  $V_{GS}$



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

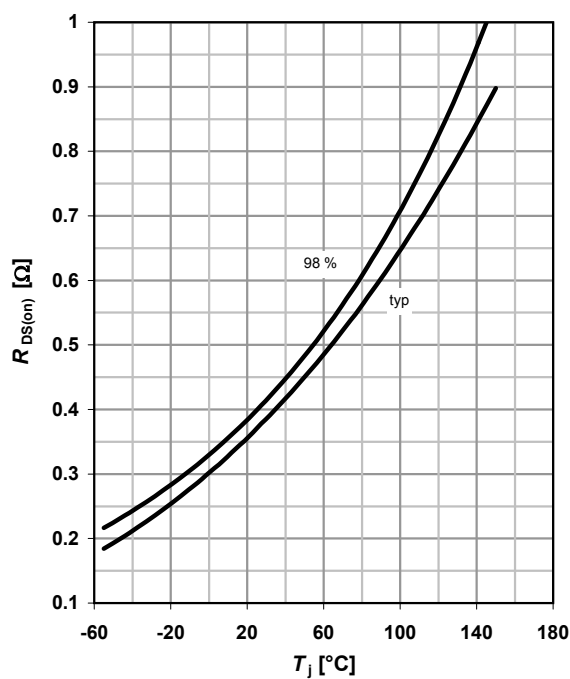
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter:  $V_{GS}$



### 7 Drain-source on-state resistance

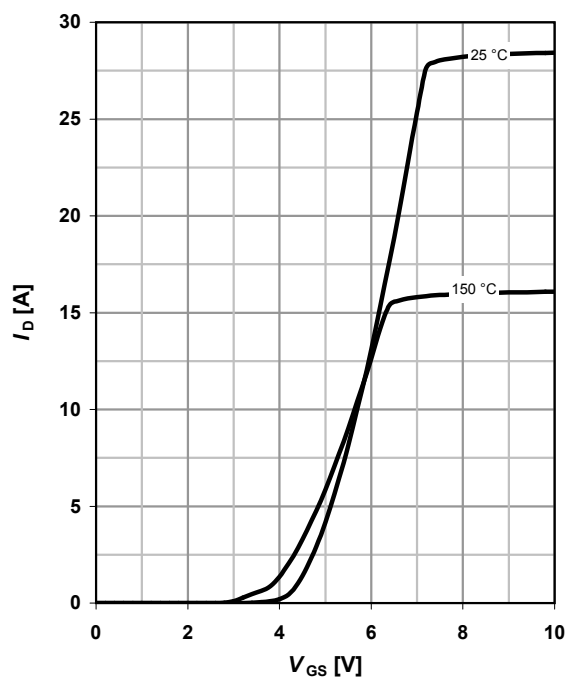
$$R_{DS(on)} = f(T_j); I_D = 4.9\text{ A}; V_{GS} = 10\text{ V}$$



### 8 Typ. transfer characteristics

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

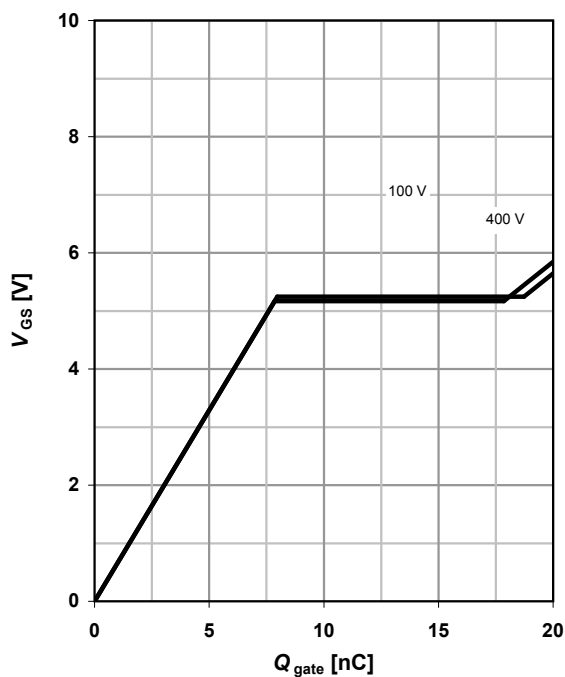
parameter:  $T_j$



### 9 Typ. gate charge

$$V_{GS}=f(Q_{gate}); I_D=4.9 \text{ A pulsed}$$

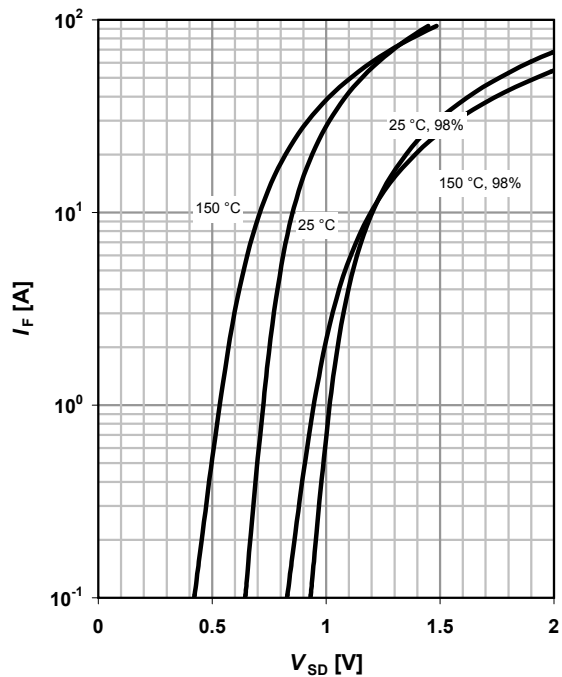
parameter:  $V_{DD}$



### 10 Forward characteristics of reverse diode

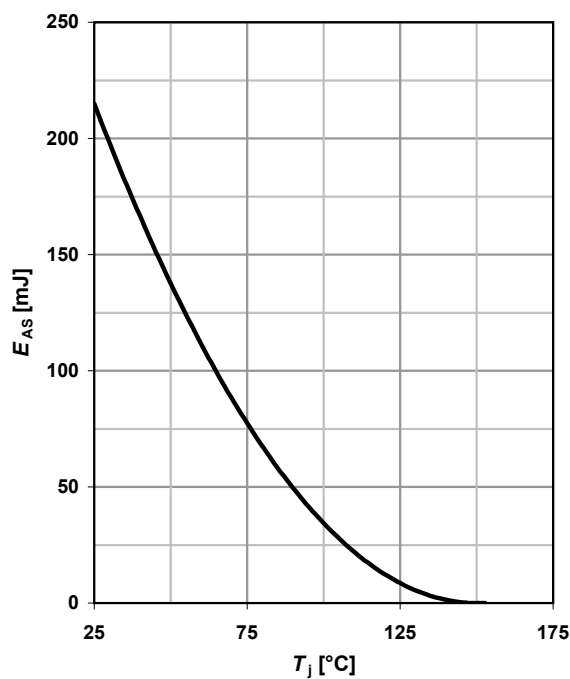
$$I_F=f(V_{SD})$$

parameter:  $T_j$



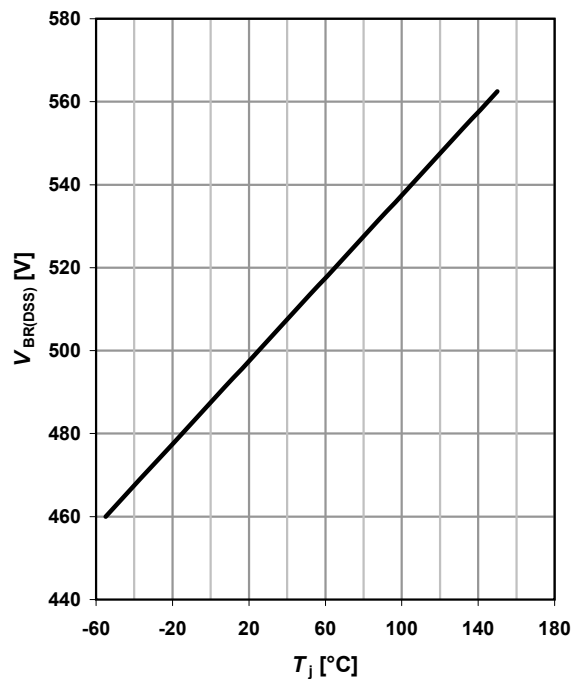
### 11 Avalanche energy

$$E_{AS}=f(T_j); I_D=3.3 \text{ A}; V_{DD}=50 \text{ V}$$



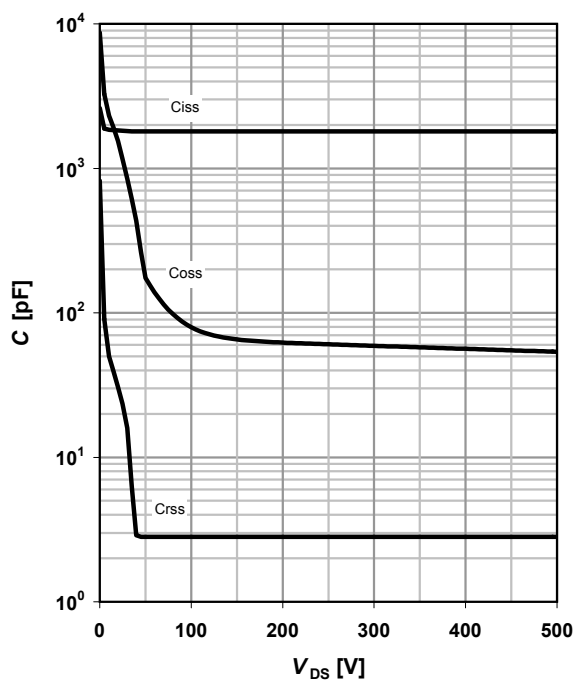
### 12 Drain-source breakdown voltage

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



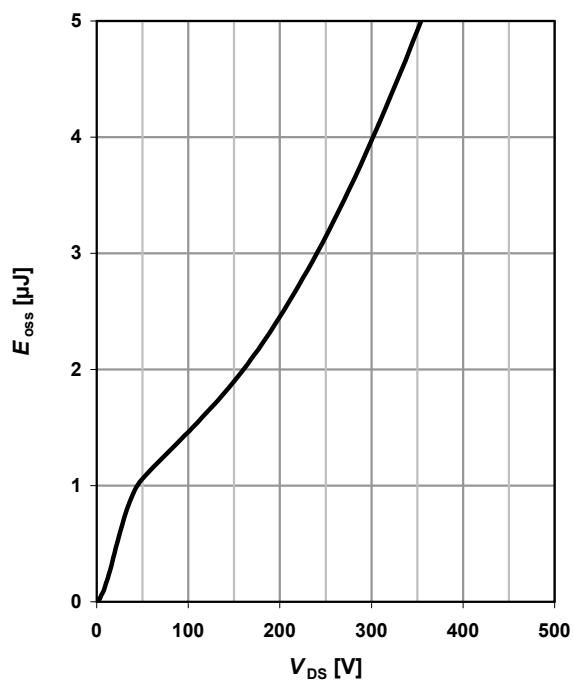
### 13 Typ. capacitances

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

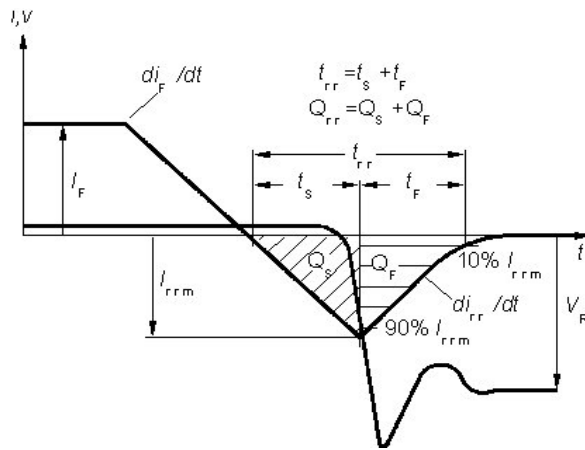


### 14 Typ. Coss stored energy

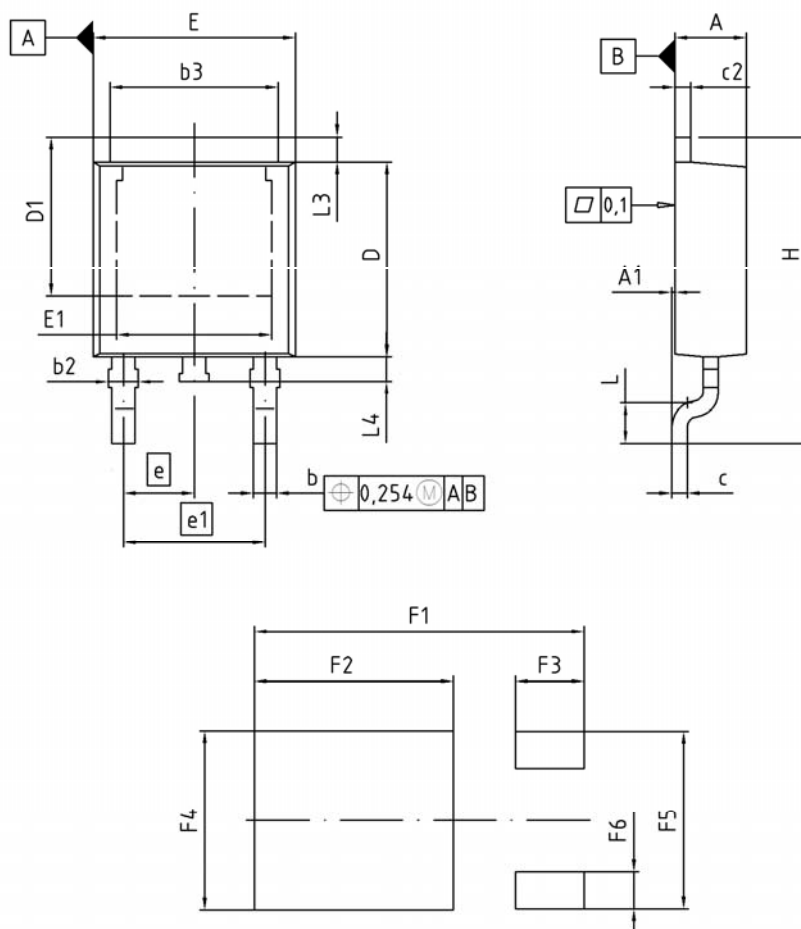
$E_{oss} = f(V_{DS})$



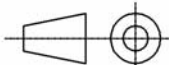
# Definition of diode switching characteristics



## PG-TO252-3-1/PG-TO252-3-11/PG-TO252-3-21: Outline



| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 2.16        | 2.41  | 0.085  | 0.095 |
| A1  | 0.00        | 0.15  | 0.000  | 0.006 |
| b   | 0.64        | 0.89  | 0.025  | 0.035 |
| b2  | 0.65        | 1.15  | 0.026  | 0.045 |
| b3  | 5.00        | 5.50  | 0.197  | 0.217 |
| c   | 0.46        | 0.60  | 0.018  | 0.024 |
| c2  | 0.46        | 0.98  | 0.018  | 0.039 |
| D   | 5.97        | 6.22  | 0.235  | 0.245 |
| D1  | 5.02        | 5.84  | 0.198  | 0.230 |
| E   | 6.40        | 6.73  | 0.252  | 0.265 |
| E1  | 4.70        | 5.21  | 0.185  | 0.205 |
| e   | 2.29        |       | 0.090  |       |
| e1  | 4.57        |       | 0.180  |       |
| N   | 3           |       | 3      |       |
| H   | 9.40        | 10.48 | 0.370  | 0.413 |
| L   | 1.18        | 1.70  | 0.046  | 0.067 |
| L3  | 0.90        | 1.25  | 0.035  | 0.049 |
| L4  | 0.51        | 1.00  | 0.020  | 0.039 |
| F1  | 10.50       | 10.70 | 0.413  | 0.421 |
| F2  | 6.30        | 6.50  | 0.248  | 0.256 |
| F3  | 2.10        | 2.30  | 0.083  | 0.091 |
| F4  | 5.70        | 5.90  | 0.224  | 0.232 |
| F5  | 5.66        | 5.86  | 0.223  | 0.231 |
| F6  | 1.10        | 1.30  | 0.043  | 0.051 |

|                                                                                                              |
|--------------------------------------------------------------------------------------------------------------|
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| SCALE<br>0 2.0 4mm                                                                                           |
| EUROPEAN PROJECTION<br> |
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