

## 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

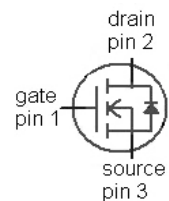
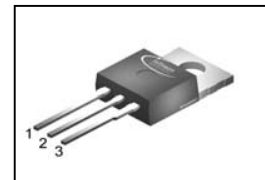
|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550   | V        |
| $R_{DS(on),max}$    | 0.199 | $\Omega$ |
| $Q_{g,typ}$         | 34    | nC       |

### CoolMOS CP is designed for:

- Hard & soft switching SMPS topologies
- CCM PFC for ATX, Notebook adapter and PDP and LCD TV
- PWM for ATX, Notebook adapter, PDP & LCD TV

| Type        | Package  | Marking |
|-------------|----------|---------|
| IPP50R199CP | PG-TO220 | 5R199P  |

PG-TO220



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

| Parameter                                      | Symbol         | Conditions                                | Value       | Unit |
|------------------------------------------------|----------------|-------------------------------------------|-------------|------|
| Continuous drain current                       | $I_D$          | $T_C=25\text{ °C}$                        | 17          | A    |
|                                                |                | $T_C=100\text{ °C}$                       | 11          |      |
| Pulsed drain current <sup>2)</sup>             | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 40          |      |
| Avalanche energy, single pulse                 | $E_{AS}$       | $I_D=6.6\text{ A}$ , $V_{DD}=50\text{ V}$ | 436         | mJ   |
| Avalanche energy, repetitive $t_{AR}^{2),3)}$  | $E_{AR}$       | $I_D=6.6\text{ A}$ , $V_{DD}=50\text{ V}$ | 0.66        |      |
| Avalanche current, repetitive $t_{AR}^{2),3)}$ | $I_{AR}$       |                                           | 6.6         | 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                              | $P_{tot}$      | $T_C=25\text{ °C}$                        | 139         | W    |
| Operating and storage temperature              | $T_j, T_{stg}$ |                                           | -55 ... 150 | °C   |
| Mounting torque                                |                | M3 and M3.5 screws                        | 60          | Ncm  |

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

| Parameter                            | Symbol        | Conditions         | Value | Unit |
|--------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current     | $I_S$         | $T_C=25\text{ °C}$ | 9.9   | A    |
| Diode pulse current <sup>(2)</sup>   | $I_{S,pulse}$ |                    | 40    |      |
| 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                        | $R_{thJC}$   |                                       | - | - | 0.9 | K/W |
| Thermal resistance, junction - ambient                     | $R_{thJA}$   | lead                                  | - | - | 62  |     |
| Soldering temperature, wavesoldering only allowed at leads | $T_{solder}$ | 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           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=0.66\text{ mA}$                         | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=9.9\text{ A}, T_j=25\text{ °C}$    | -   | 0.18 | 0.199 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}, I_D=9.9\text{ A}, T_j=150\text{ °C}$   | -   | 0.45 | -     |               |
| 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>$f=1\text{ MHz}$                           | - | 1800 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                         | - | 80   | - |    |
| 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                                      | - | 75   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |                                                                                         | - | 160  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=9.9\text{ A},$<br>$R_G=16.4\ \Omega$ | - | 35   | - | ns |
| Rise time                                                  | $t_r$        |                                                                                         | - | 14   | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                         | - | 80   | - |    |
| Fall time                                                  | $t_f$        |                                                                                         | - | 10   | - |    |

**Gate Charge Characteristics**

|                       |               |                                                                              |   |     |    |    |
|-----------------------|---------------|------------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=9.9\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 8   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                              | - | 11  | -  |    |
| Gate charge total     | $Q_g$         |                                                                              | - | 34  | 45 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                              | - | 5.2 | -  | V  |

**Reverse Diode**

|                               |           |                                                                          |   |     |     |               |
|-------------------------------|-----------|--------------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=9.9\text{ A},$<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>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 340 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |                                                                          | - | 4   | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                          | - | 24  | -   | 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  $P_{AV}=E_{AR} \cdot f$ .

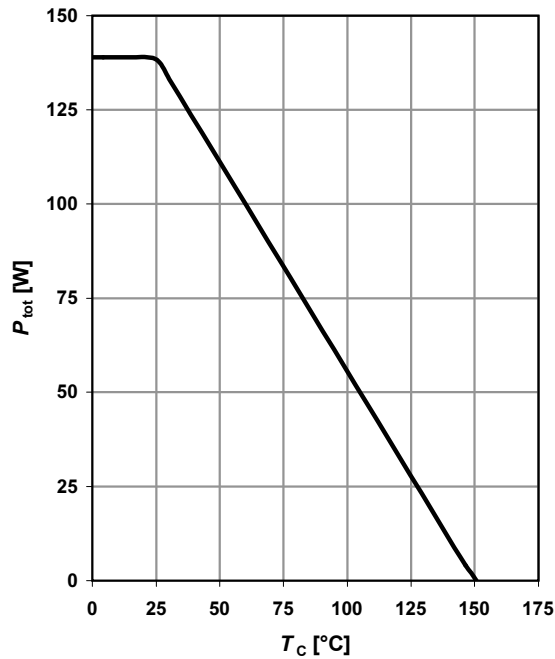
<sup>4)</sup>  $I_{SD} \leq I_D, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$ , identical low and high side switch

<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

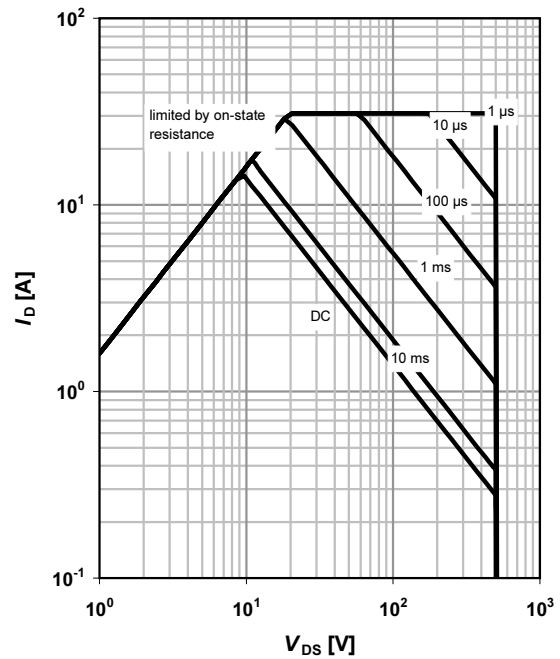
$$P_{\text{tot}} = f(T_C)$$



### 2 Safe operating area

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

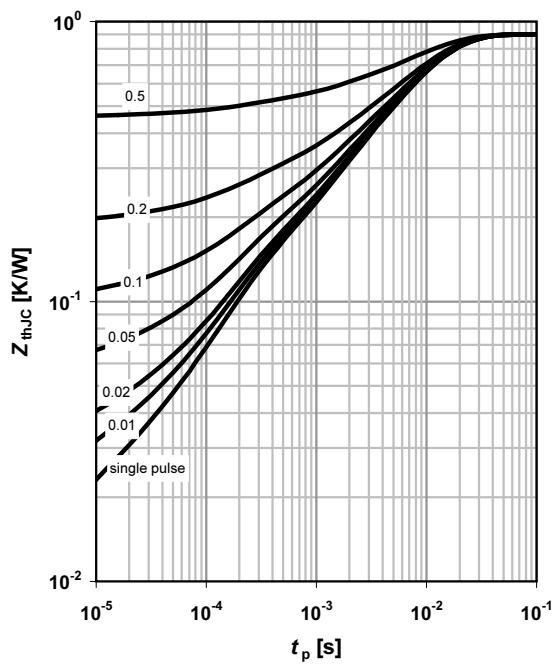
parameter:  $t_p$



### 3 Max. transient thermal impedance

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

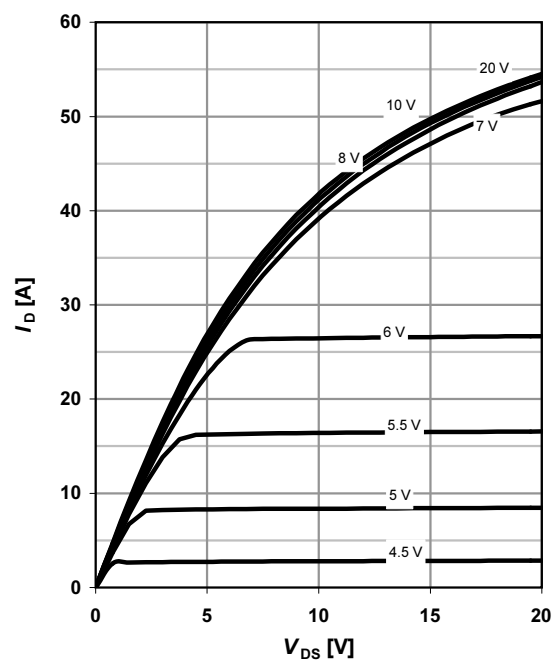
parameter:  $D = t_p / T$



### 4 Typ. output characteristics

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

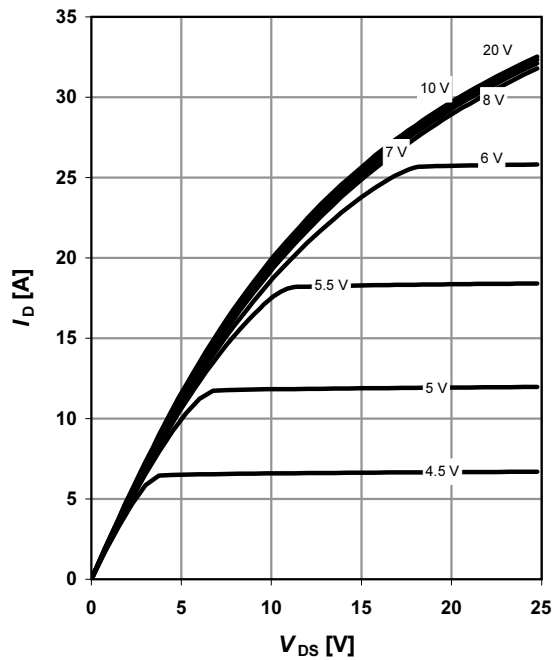
parameter:  $V_{GS}$



### 5 Typ. output characteristics

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

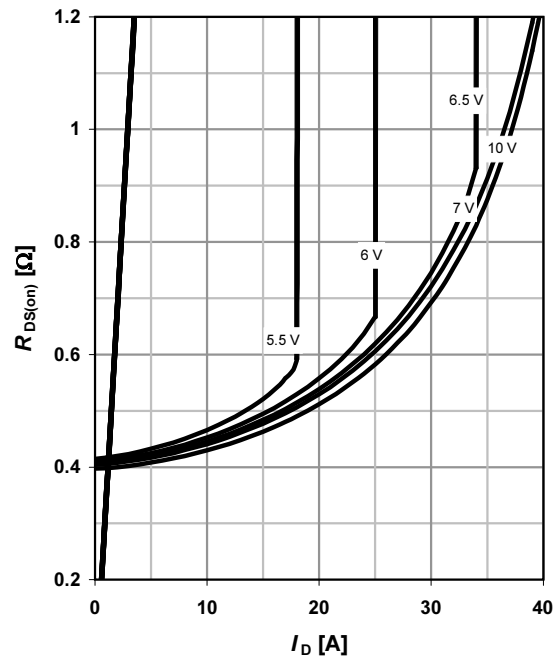
parameter:  $V_{GS}$



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

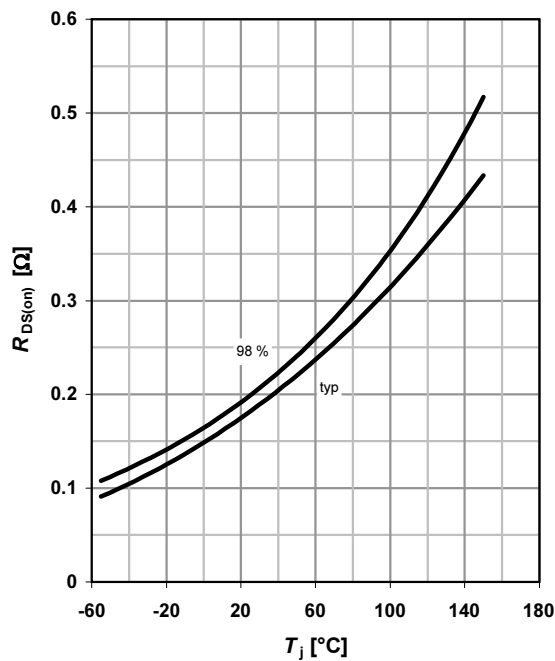
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter:  $V_{GS}$



### 7 Drain-source on-state resistance

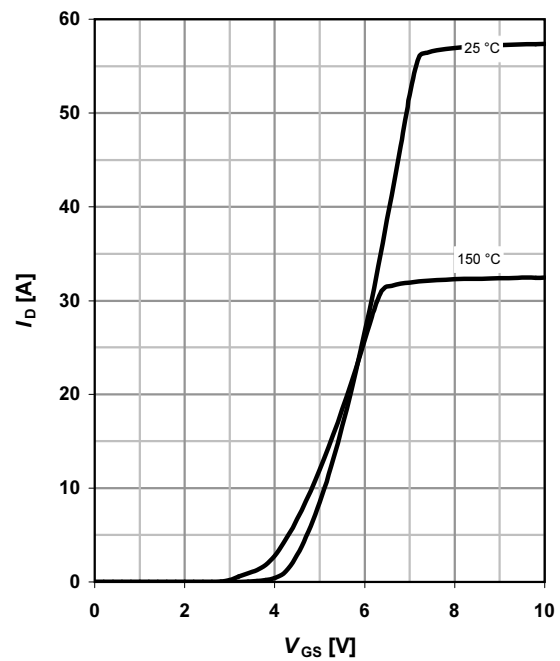
$$R_{DS(on)} = f(T_j); I_D = 9.9\text{ A}; V_{GS} = 10\text{ V}$$



### 8 Typ. transfer characteristics

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

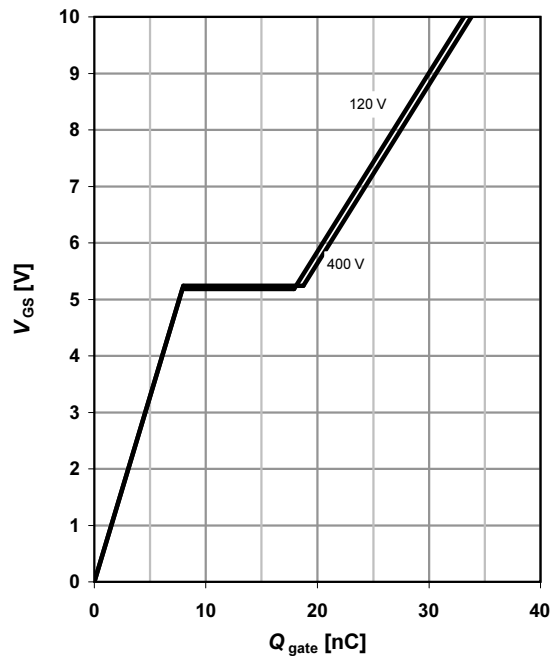
parameter:  $T_j$



### 9 Typ. gate charge

$$V_{GS}=f(Q_{gate}); I_D=9.9 \text{ A pulsed}$$

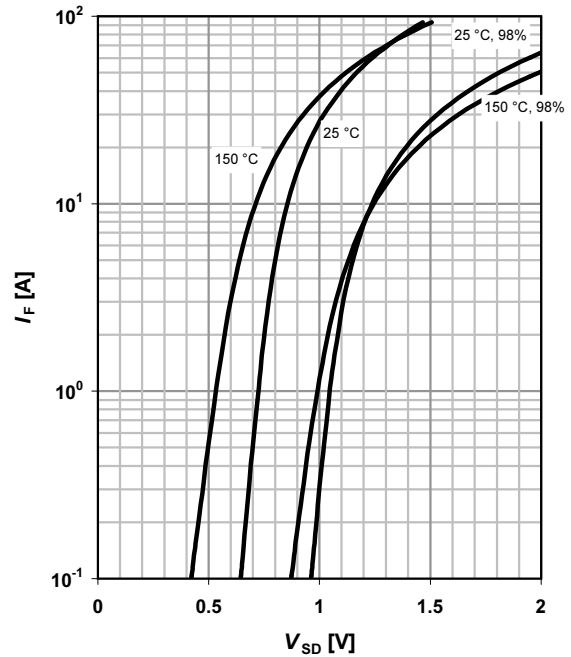
parameter:  $V_{DD}$



### 10 Forward characteristics of reverse diode

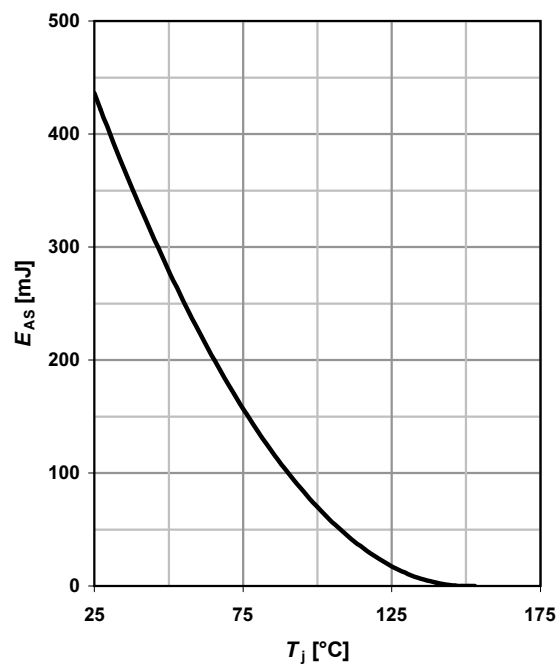
$$I_F=f(V_{SD})$$

parameter:  $T_j$



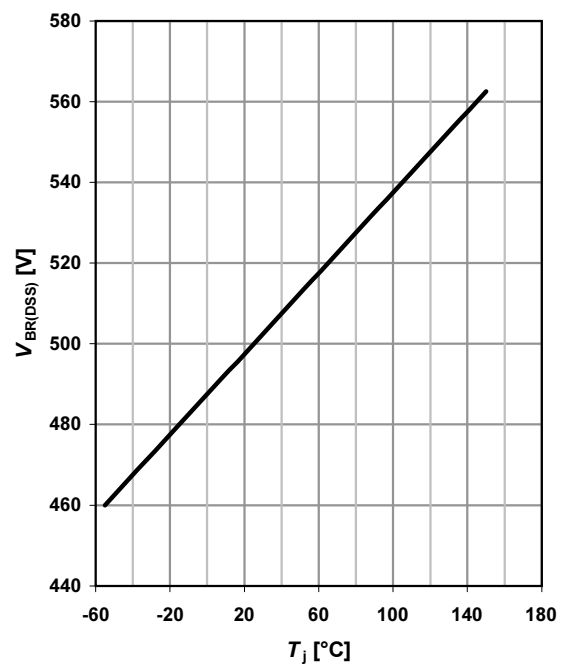
### 11 Avalanche energy

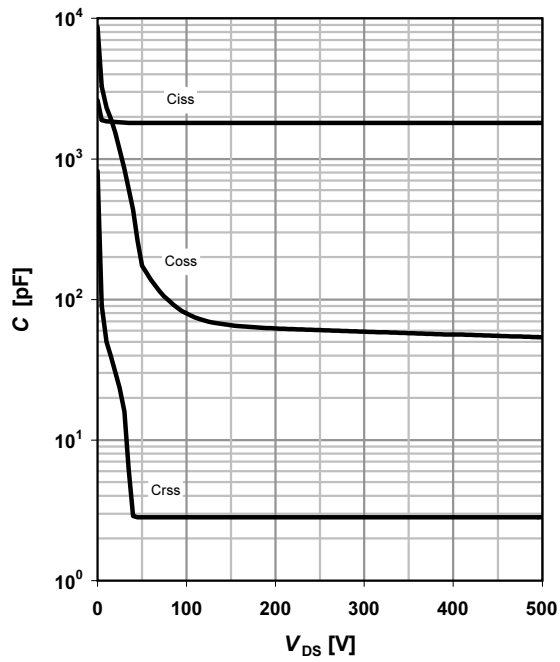
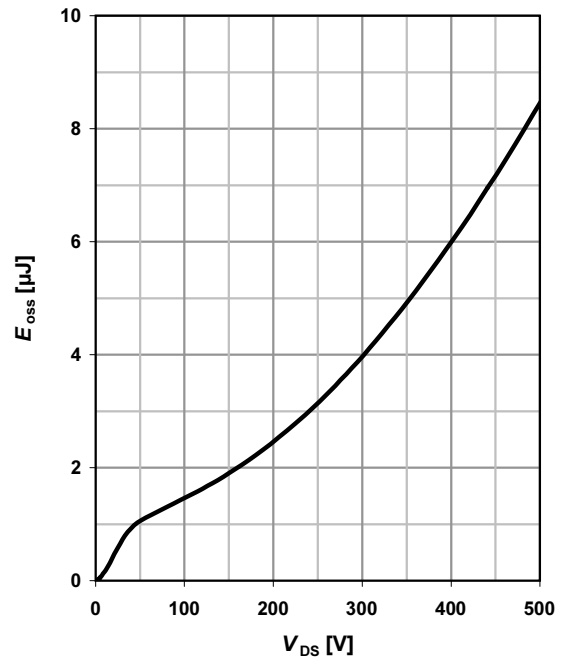
$$E_{AS}=f(T_j); I_D=6.6 \text{ A}; V_{DD}=50 \text{ V}$$



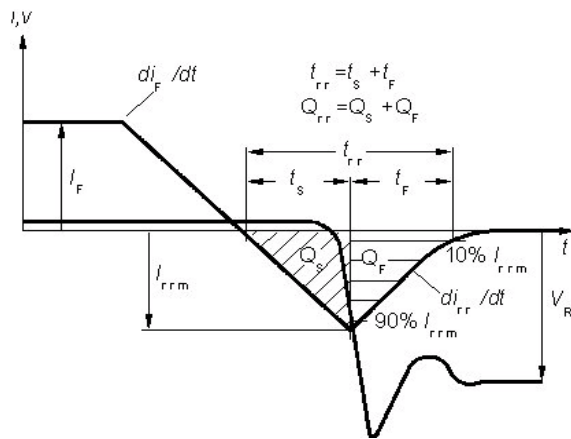
### 12 Drain-source breakdown voltage

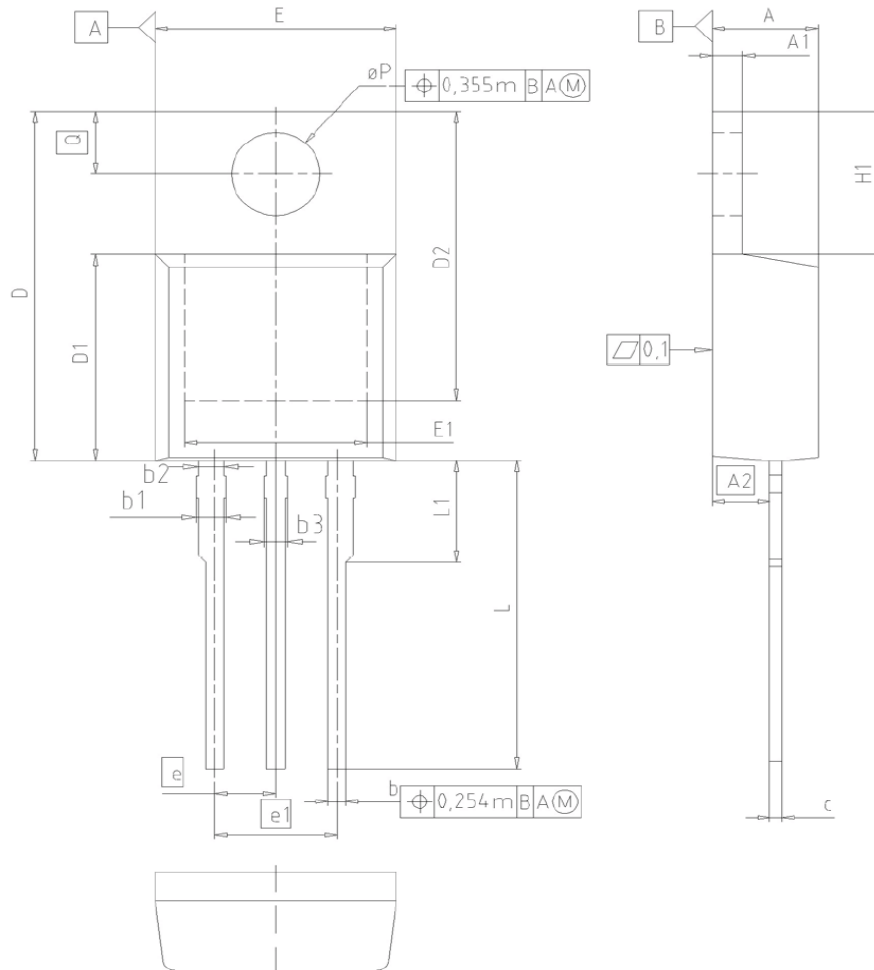
$$V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$$



**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

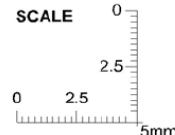


**PG-TO220-3-1/TO220-3-21: Outline**


| DIM | MILLIMETERS |       | INCHES |       |
|-----|-------------|-------|--------|-------|
|     | MIN         | MAX   | MIN    | MAX   |
| A   | 4.30        | 4.57  | 0.169  | 0.180 |
| A1  | 1.17        | 1.40  | 0.046  | 0.055 |
| A2  | 2.15        | 2.72  | 0.085  | 0.107 |
| b   | 0.65        | 0.86  | 0.026  | 0.034 |
| b1  | 0.95        | 1.40  | 0.037  | 0.055 |
| b2  | 0.95        | 1.15  | 0.037  | 0.045 |
| b3  | 0.65        | 1.15  | 0.026  | 0.045 |
| c   | 0.33        | 0.80  | 0.013  | 0.024 |
| D   | 14.81       | 15.95 | 0.583  | 0.628 |
| D1  | 8.51        | 9.45  | 0.335  | 0.372 |
| D2  | 12.19       | 13.10 | 0.480  | 0.516 |
| E   | 9.70        | 10.36 | 0.382  | 0.408 |
| E1  | 6.50        | 8.60  | 0.256  | 0.339 |
| e   | 2.54        |       | 0.100  |       |
| e1  | 5.08        |       | 0.200  |       |
| N   | 3           |       | 3      |       |
| H1  | 5.90        | 6.90  | 0.232  | 0.272 |
| L   | 13.00       | 14.00 | 0.512  | 0.551 |
| L1  | -           | 4.80  | -      | 0.189 |
| øP  | 3.60        | 3.89  | 0.142  | 0.153 |
| Q   | 2.60        | 3.00  | 0.102  | 0.118 |

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**SCALE**



**EUROPEAN PROJECTION**



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