

## 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
- Qualified according to JEDEC<sup>1)</sup> for target applications
- Pb-free lead plating; RoHS compliant

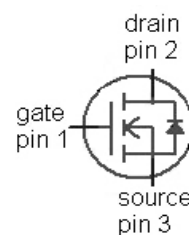
### Product Summary

|                      |       |          |
|----------------------|-------|----------|
| $V_{DS} @ T_{j,max}$ | 650   | V        |
| $R_{DS(on),max}$     | 0.199 | $\Omega$ |
| $Q_{g,typ}$          | 32    | nC       |

### CoolMOS CP is specially designed for:

- Hard switching topologies, for Server and Telecom

PG-TO262



| Type        | Package  | Ordering Code | Marking |
|-------------|----------|---------------|---------|
| IPI60R199CP | PG-TO262 | SP000103248   | 6R199P  |

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

| Parameter                                      | Symbol         | Conditions                                | Value       | Unit |
|------------------------------------------------|----------------|-------------------------------------------|-------------|------|
| Continuous drain current                       | $I_D$          | $T_C=25\text{ °C}$                        | 16          | A    |
|                                                |                | $T_C=100\text{ °C}$                       | 10          |      |
| Pulsed drain current <sup>2)</sup>             | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 51          |      |
| 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          | $V_{DS}=0\ldots480\text{ V}$              | 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   |

**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>   | $I_{S,pulse}$ |                    | 51    |      |
| 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                     | $R_{thJA}$ | 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   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                | 600 | -    | -     | 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  | $I_{DSS}$     | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$  | -   | -    | 1     | $\mu\text{A}$ |
|                                  |               | $V_{DS}=600\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$ | -   | 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 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=9.9\text{ A}$ , $T_j=150\text{ °C}$   | -   | 0.49 | -     |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                     | -   | 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>$f=1\text{ MHz}$                          | - | 1520 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                        | - | 72   | - |    |
| Effective output capacitance, energy related <sup>5)</sup> | $C_{o(er)}$  | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$<br>to 480 V                                     | - | 69   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |                                                                                        | - | 180  | - |    |
| 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>$R_G=3.3\ \Omega$ | - | 10   | - | ns |
| Rise time                                                  | $t_r$        |                                                                                        | - | 5    | - |    |
| Turn-off delay time                                        | $t_{d(off)}$ |                                                                                        | - | 50   | - |    |
| Fall time                                                  | $t_f$        |                                                                                        | - | 5    | - |    |

**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     | $Q_g$         |                                                                              | - | 32  | 43 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                              | - | 5.0 | -  | V  |

**Reverse Diode**

|                               |           |                                                                    |   |     |     |               |
|-------------------------------|-----------|--------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=9.9\text{ A},$<br>$T_j=25\text{ °C}$       | - | 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       | $Q_{rr}$  |                                                                    | - | 5.5 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                    | - | 33  | -   | 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  $P_{AV}=E_{AR} \cdot f$ .

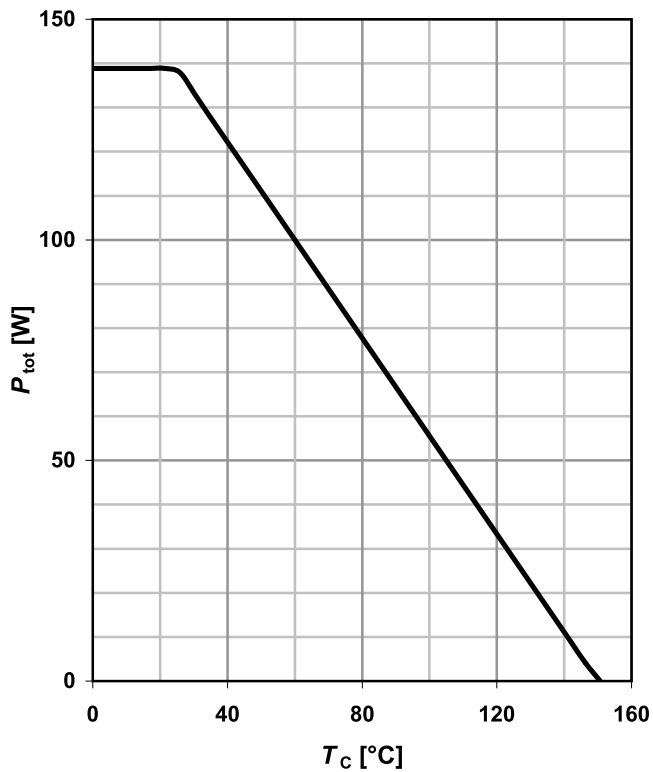
<sup>4)</sup>  $I_{SD} \leq I_D$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DClamp}=400\text{ V}$ ,  $V_{peak} < V_{(BR)DSS}$ ,  $T_j < T_{j,max}$ , identical low side and high side switch.

<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 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%  $V_{DSS}$ .

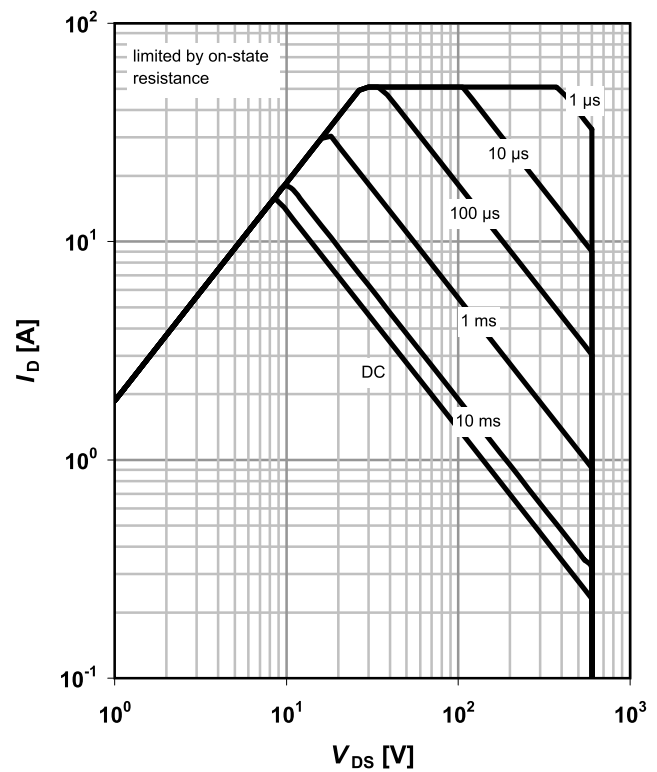
## 1 Power dissipation

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



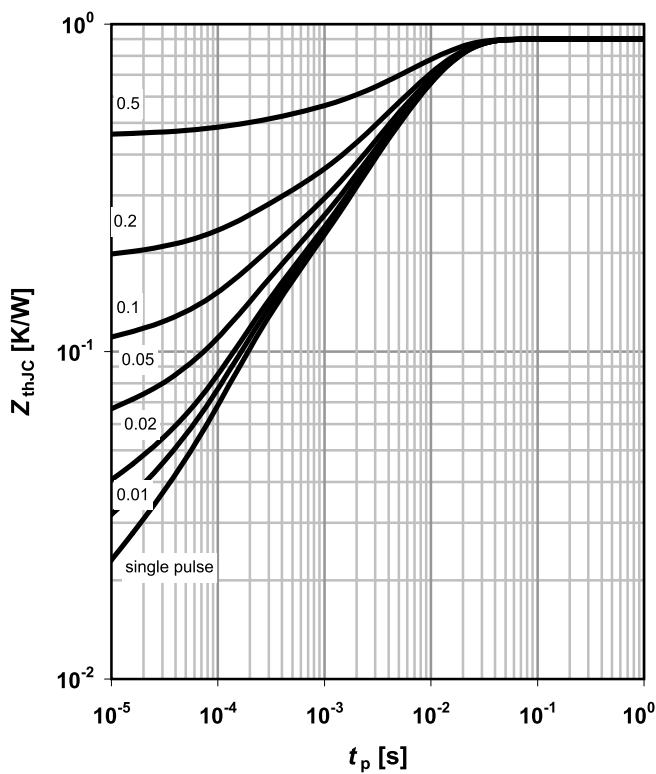
## 2 Safe operating area

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

parameter:  $t_p$ 


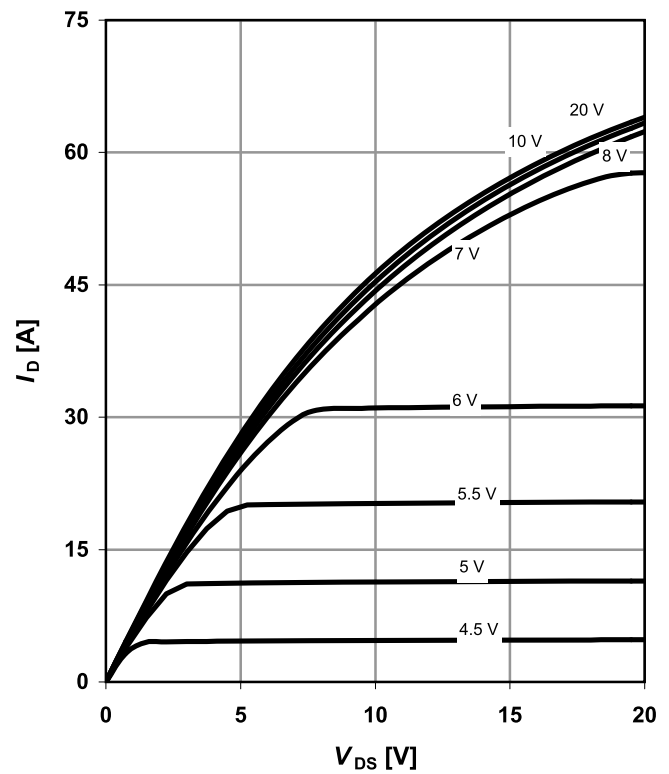
## 3 Max. transient thermal impedance

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

parameter:  $D = t_p / T$ 


## 4 Typ. output characteristics

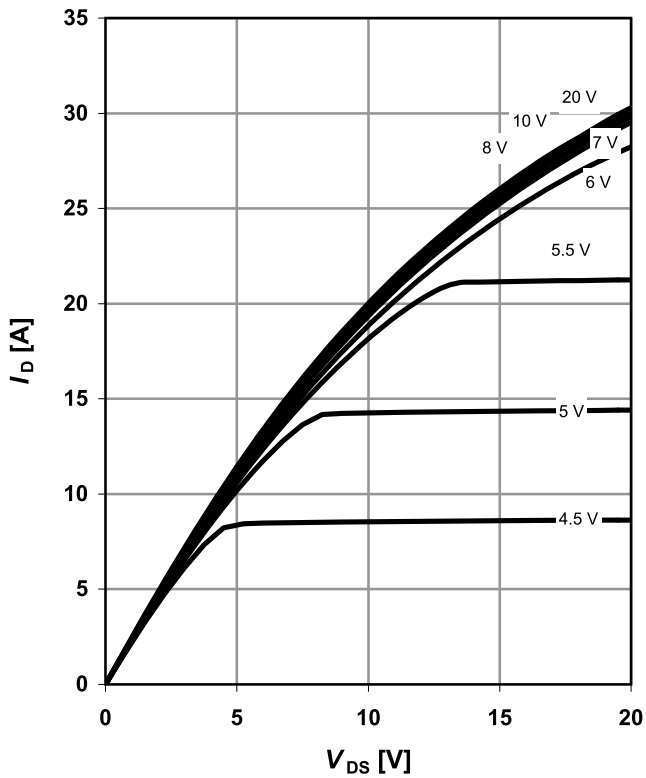
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}$$

parameter:  $V_{GS}$ 


**5 Typ. output characteristics**

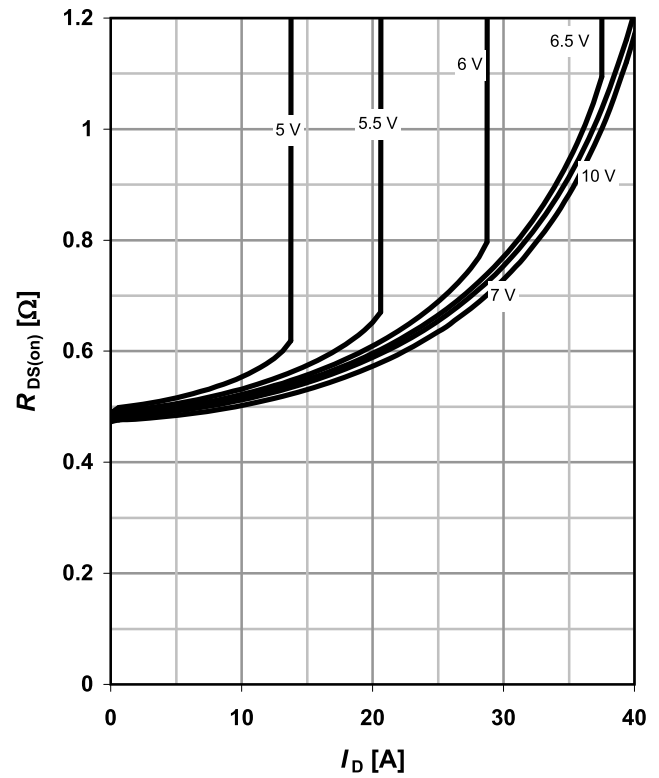
$$I_D = f(V_{DS}); T_j = 150^\circ\text{C}$$

parameter:  $V_{GS}$

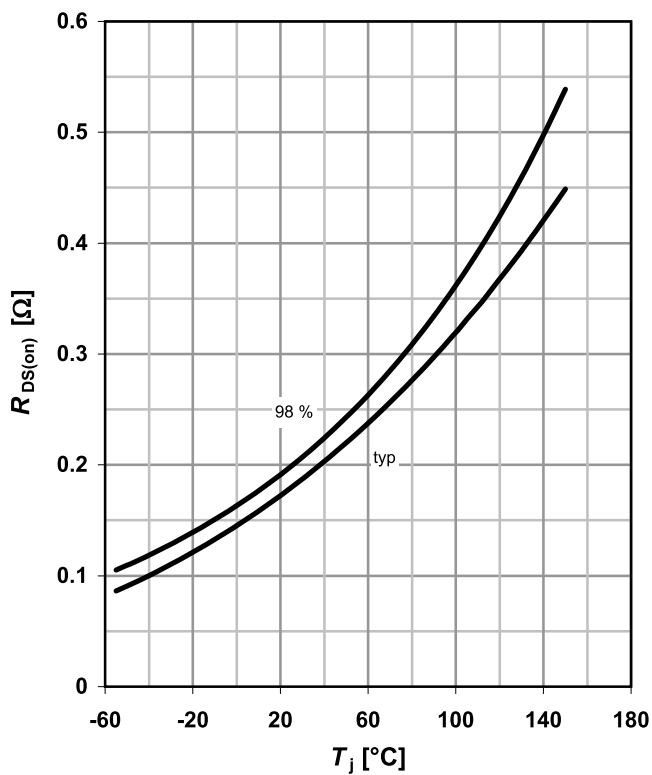

**6 Typ. drain-source on-state resistance**

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

parameter:  $V_{GS}$

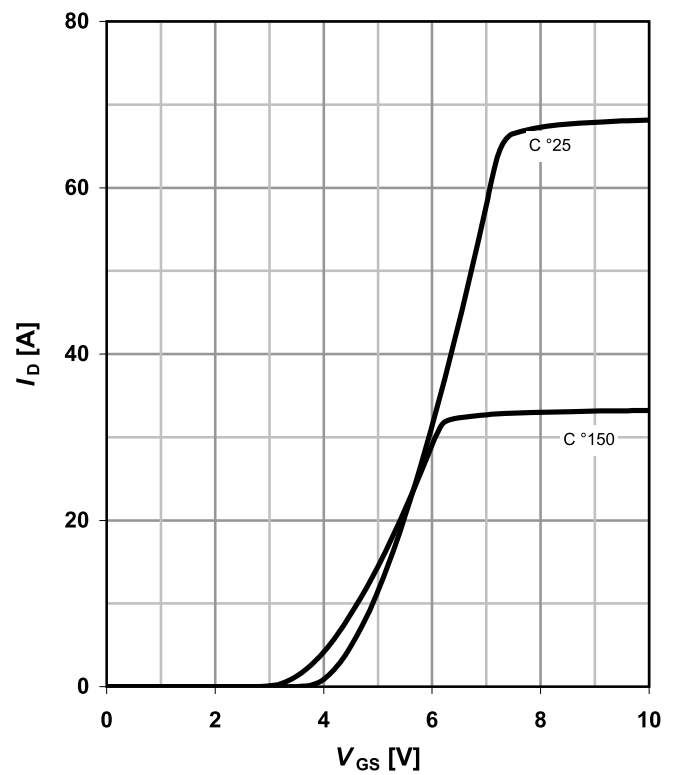

**7 Drain-source on-state resistance**

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


**8 Typ. transfer characteristics**

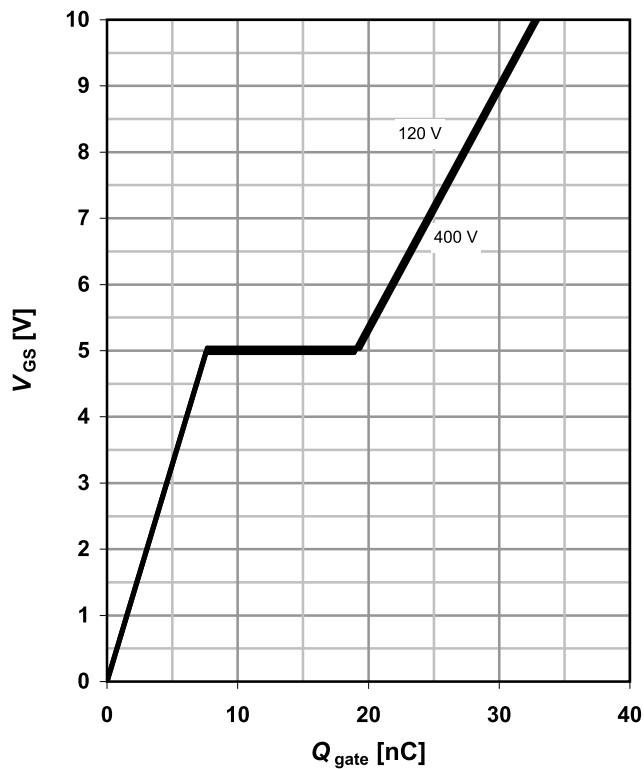
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)\text{max}}$$

parameter:  $T_j$



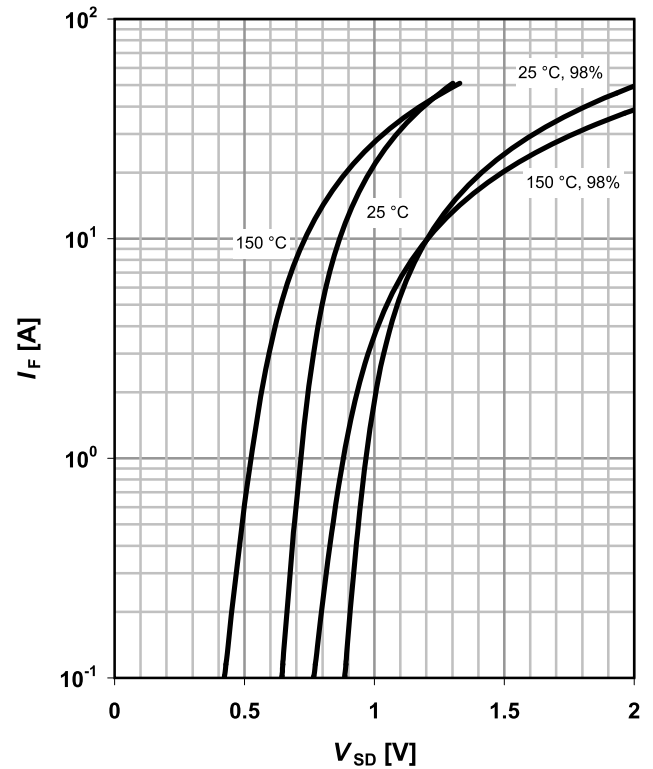
## 9 Typ. gate charge

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

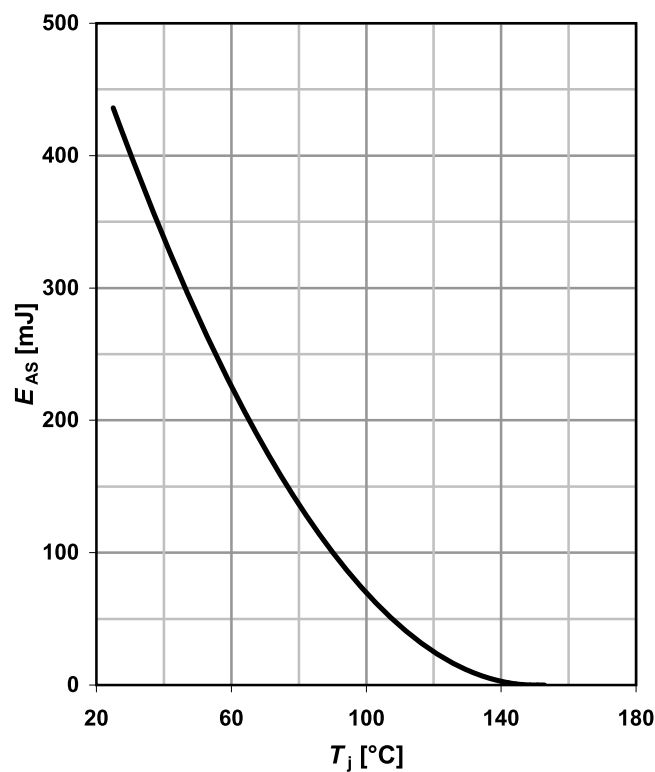
parameter:  $V_{DD}$ 


## 10 Forward characteristics of reverse diode

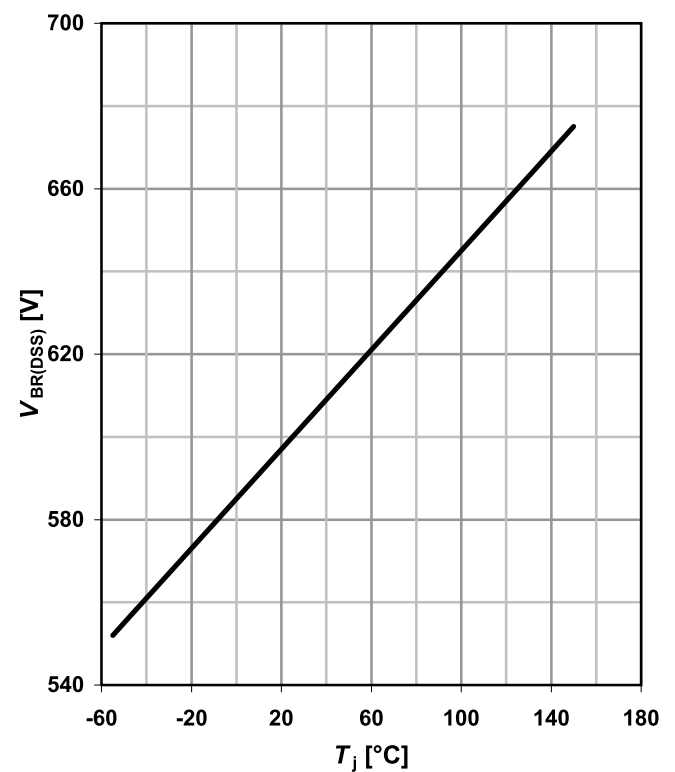
 $I_F=f(V_{SD})$ 

parameter:  $T_j$ 


## 11 Avalanche energy

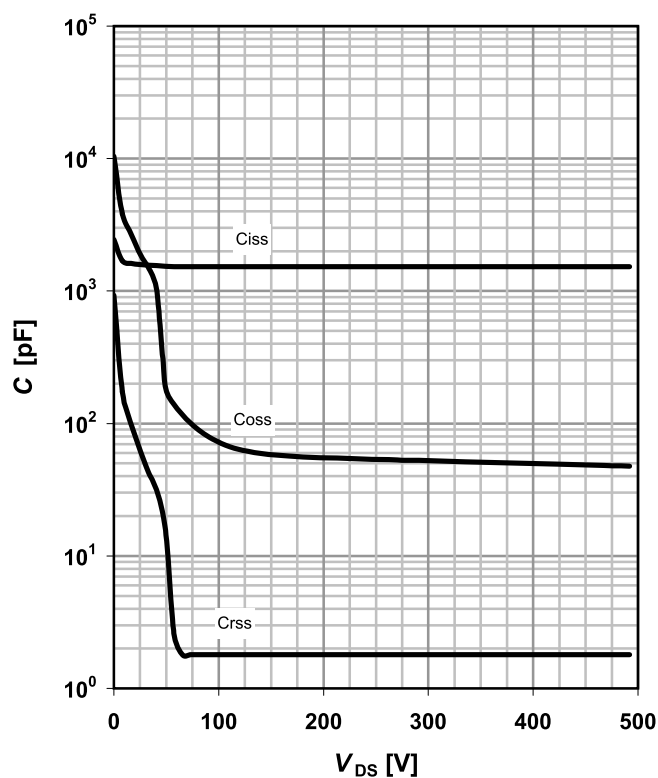
 $E_{AS}=f(T_j); I_D=6.6 \text{ A}; V_{DD}=50 \text{ V}$ 


## 12 Drain-source breakdown voltage

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


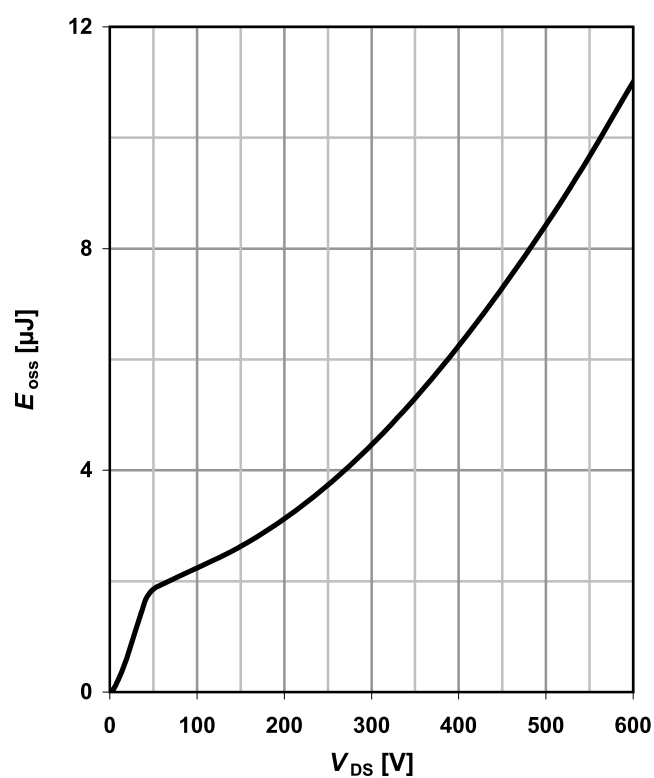
### 13 Typ. capacitances

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

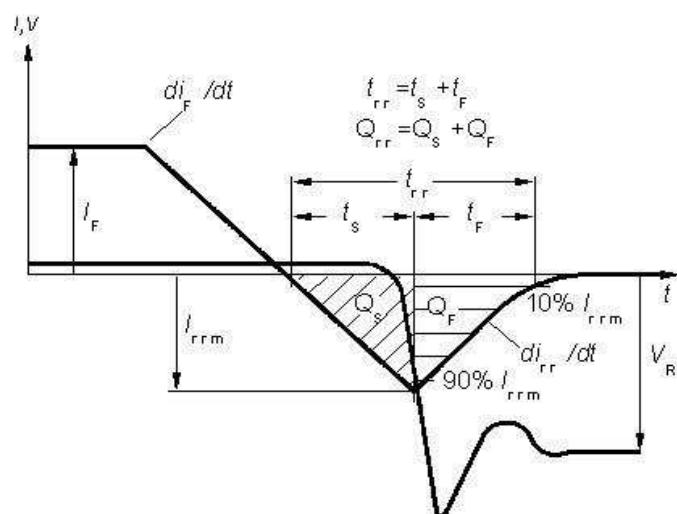


### 14 Typ. Coss stored energy

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

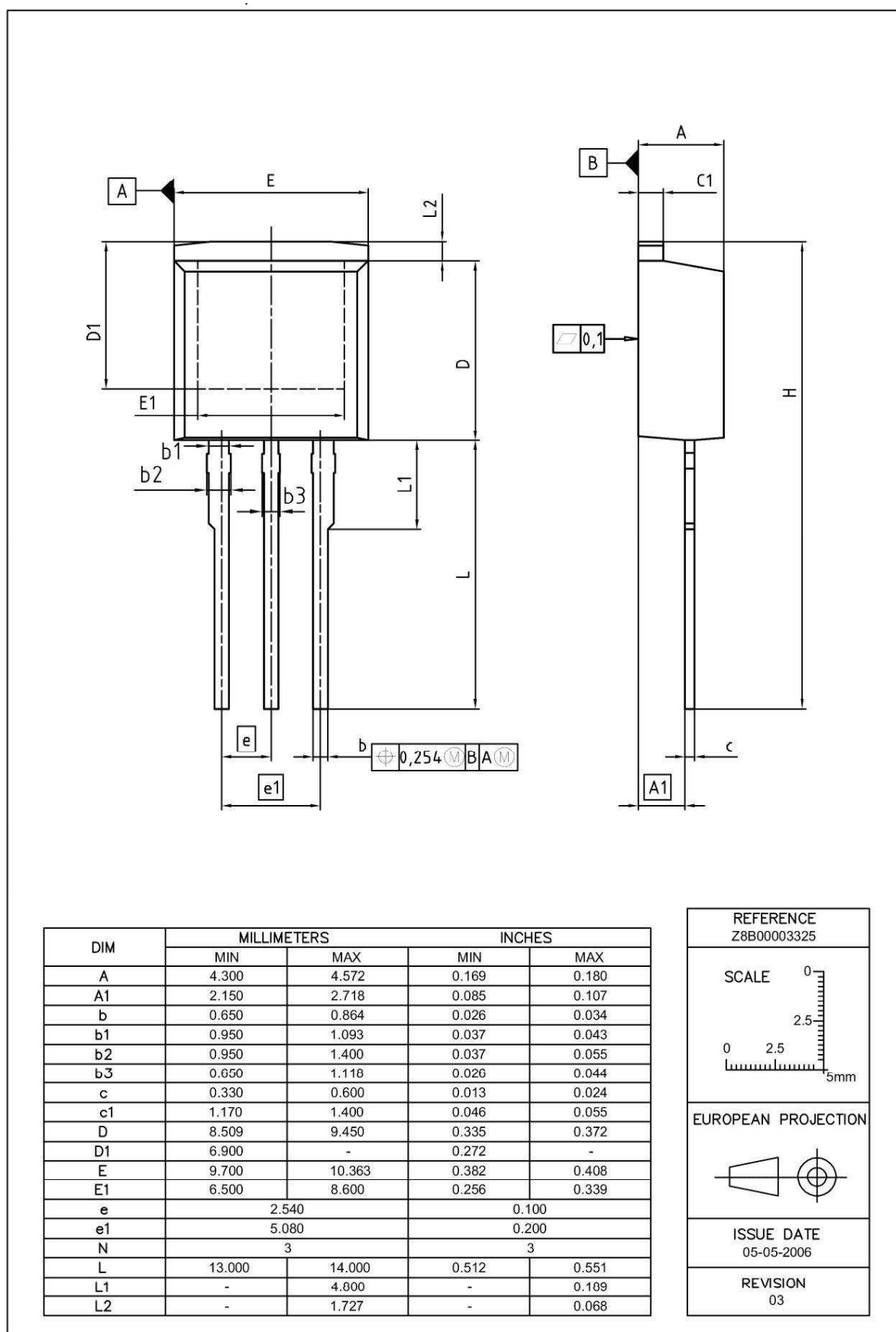


## Definition of diode switching characteristics





## 6 Package Outlines



**Figure 1 Outline PG-TO 262, dimensions in mm/inches**

## Revision History

IPI60R199CP

**Revision: 2017-08-11, Rev. 2.3**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|----------------------------------------------|
| 2.3      | 2017-08-11 | Revised package drawing on Page 9            |

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