

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

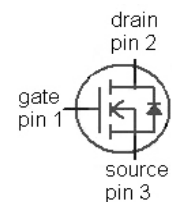
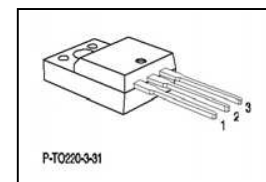
- Lowest figure of merit  $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Pb-free lead plating; RoHS compliant; Halogen free for mold compound
- Qualified for industrial grade applications according to JEDEC<sup>0)</sup>

**Product Summary**

|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550   | V        |
| $R_{DS(on),max}$    | 0.250 | $\Omega$ |
| $Q_{g,typ}$         | 27    | nC       |

**CoolMOS CP is designed for:**

- Hard- & Softswitching SMPS topologies
- CCM PFC for ATX, Notebookadapter, PDP and LCD TV
- PWM for ATX, Notebookadapter, PDP and LCD TV

**TO220 FP**


| Type        | Package    | Marking |
|-------------|------------|---------|
| IPA50R250CP | PG-TO220FP | 5R250P  |

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

| Parameter   | Symbol         | Conditions                                | Value       | Unit               |
|---|----------------|---|-------------|--------------------|
| Continuous drain current <sup>1)</sup>                  | $I_D$          | $T_C=25\text{ °C}$                        | 13          | A                  |
|   |                | $T_C=100\text{ °C}$                       | 9           |                    |
| Pulsed drain current <sup>2)</sup>                      | $I_{D,pulse}$  | $T_C=25\text{ °C}$                        | 31          |                    |
| Avalanche energy, single pulse                          | $E_{AS}$       | $I_D=5.2\text{ A}$ , $V_{DD}=50\text{ V}$ | 345         | mJ                 |
| Avalanche energy, repetitive $t_{AR}$ <sup>2),3)</sup>  | $E_{AR}$       | $I_D=5.2\text{ A}$ , $V_{DD}=50\text{ V}$ | 0.52        |                    |
| Avalanche current, repetitive $t_{AR}$ <sup>2),3)</sup> | $I_{AR}$       |   | 5.2         | A                  |
| MOSFET dv/dt ruggedness                                 | dv/dt          | $V_{DS}=0\text{...}400\text{ V}$          | 50          | V/ns               |
| Gate source voltage                                     | $V_{GS}$       | static                                    | $\pm 20$    | V                  |
|   |                | AC (f>1 Hz)                               | $\pm 30$    |                    |
| Power dissipation                                       | $P_{tot}$      | $T_C=25\text{ °C}$                        | 33          | W                  |
| Operating and storage temperature                       | $T_j, T_{stg}$ |   | -55 ... 150 | $^{\circ}\text{C}$ |
| Mounting torque   |                | M2.5 screws                               | 60          | Ncm                |

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

| Parameter                                      | Symbol        | Conditions         | Value | Unit |
|--|---------------|--------------------|-------|------|
| Continuous diode forward current <sup>1)</sup> | $I_S$         | $T_C=25\text{ °C}$ | 7.8   | A    |
| Diode pulse current <sup>2)</sup>              | $I_{S,pulse}$ |                    | 31    |      |
| 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                        | $R_{thJC}$ |                                       | - | - | 3.75 | 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           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=0.52\text{ mA}$                         | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{ V}, I_D=7.8\text{ A}, T_j=25\text{ °C}$    | -   | 0.22 | 0.25 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}, I_D=7.8\text{ A}, T_j=150\text{ °C}$   | -   | 0.54 | -    |               |
| 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>$f=1\text{ MHz}$                           | - | 1420 | - | pF |
| Output capacitance   | $C_{oss}$    |   | - | 63   | - |    |
| 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                                      | - | 60   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |   | - | 130  | - |    |
| Turn-on delay time   | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=7.8\text{ A},$<br>$R_G=23.1\ \Omega$ | - | 35   | - | ns |
| Rise time  | $t_r$        |   | - | 14   | - |    |
| Turn-off delay time  | $t_{d(off)}$ |   | - | 80   | - |    |
| Fall time  | $t_f$        |   | - | 11.0 | - |    |

**Gate Charge Characteristics**

|                       |               |  |   |     |    |    |
|-----------------------|---------------|--|---|-----|----|----|
| Gate to source charge | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=7.8\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 6   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |  | - | 9   | -  |    |
| Gate charge total     | $Q_g$         |  | - | 27  | 36 |    |
| Gate plateau voltage  | $V_{plateau}$ |  | - | 5.2 | -  | V  |

**Reverse Diode**

|                               |           |  |   |     |     |               |
|-------------------------------|-----------|--|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=7.8\text{ A},$<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>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 300 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |  | - | 3.1 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |  | - | 23  | -   | A             |

<sup>0)</sup> J-STD20 and JESD22

<sup>1)</sup> Limited only by  $T_{j,max}$ 
<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  $P_{AV}=E_{AR} \cdot f$ .

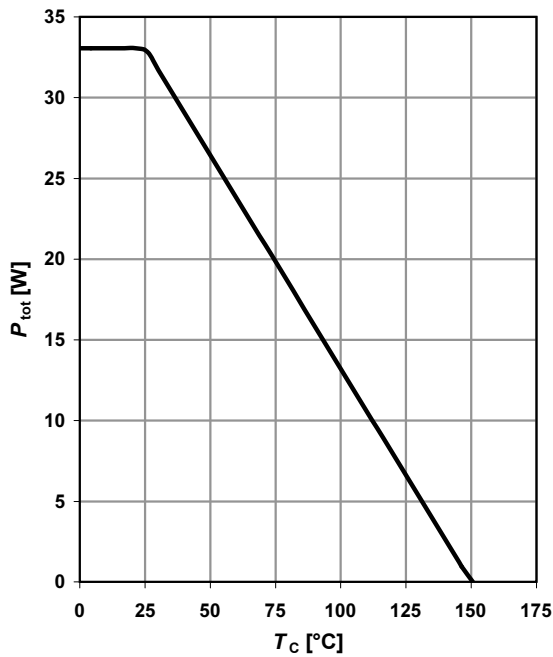
<sup>4)</sup>  $I_{SD} \leq I_D, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$ , identical low and high side switch

<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**

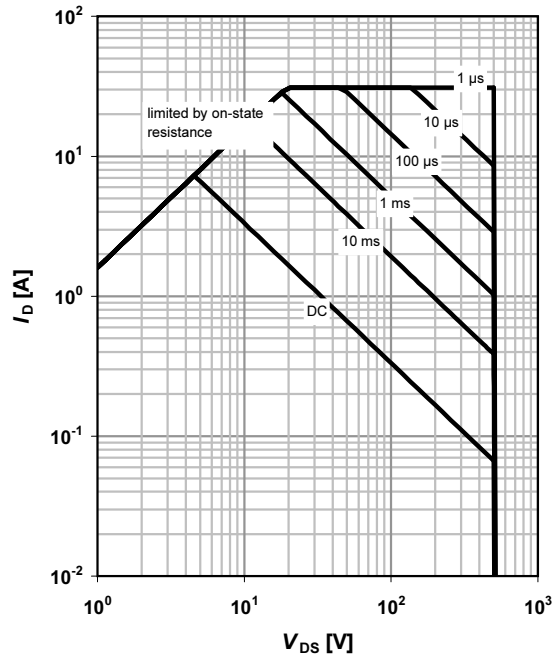
$P_{tot}=f(T_c)$



**2 Safe operating area**

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

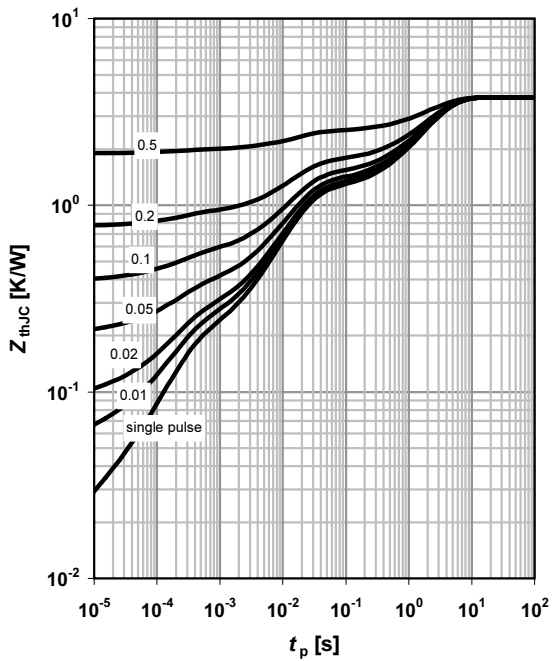
parameter:  $t_p$



**3 Max. transient thermal impedance**

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

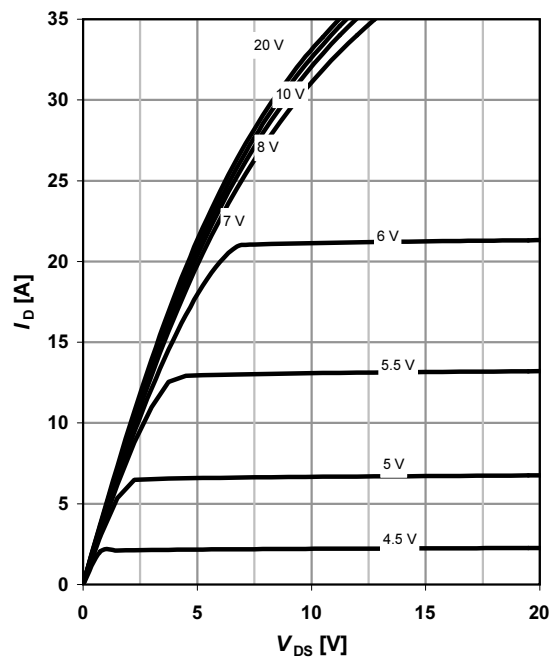
parameter:  $D=t_p/T$



**4 Typ. output characteristics**

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

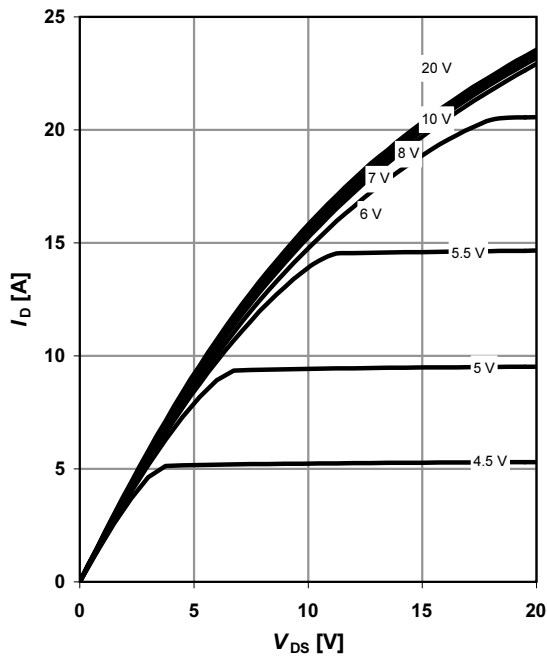
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

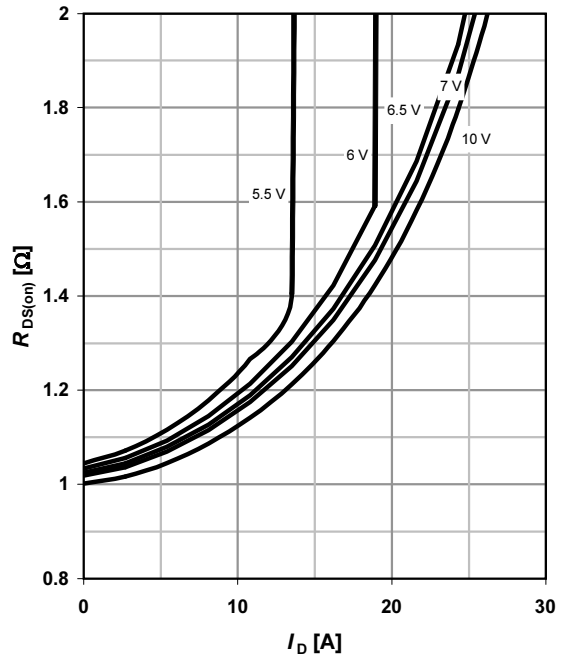
parameter:  $V_{GS}$



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

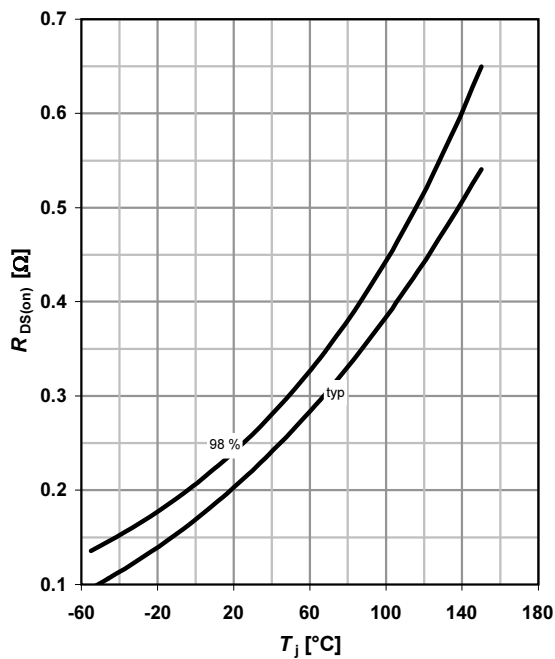
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter:  $V_{GS}$



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

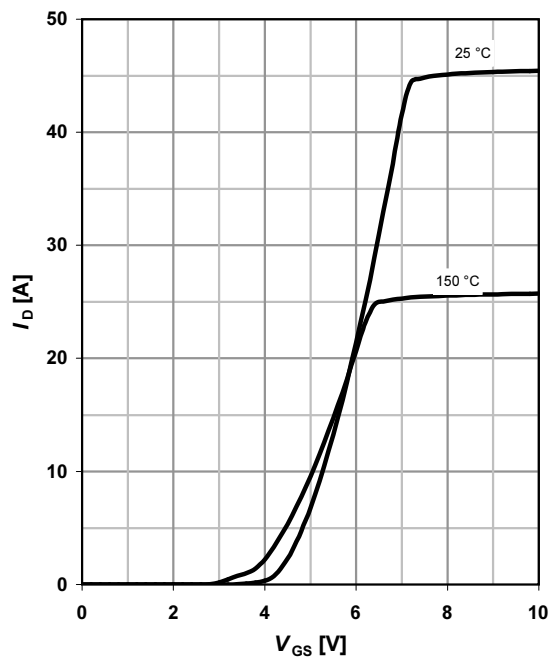
$R_{DS(on)} = f(T_j); I_D = 7.8\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

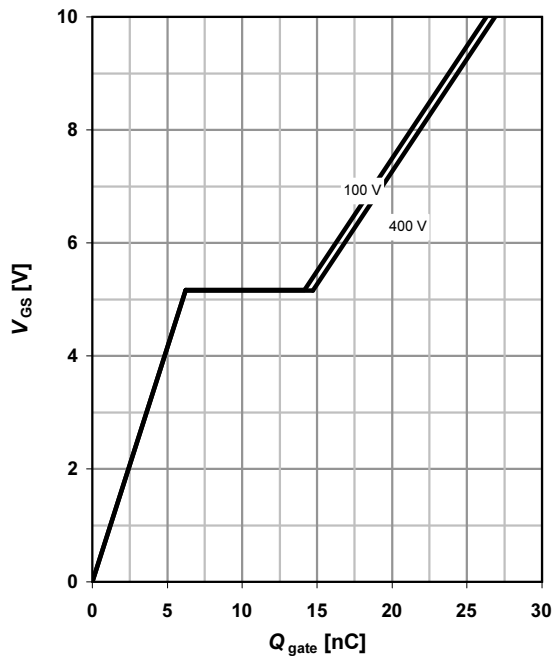
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=7.8 \text{ A pulsed}$

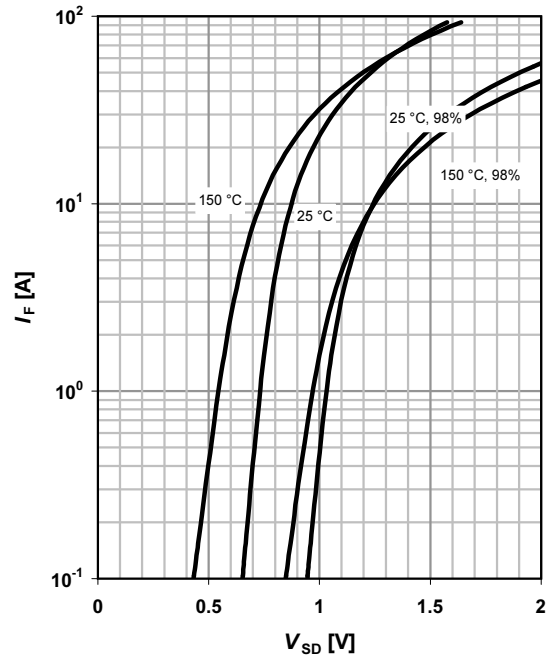
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

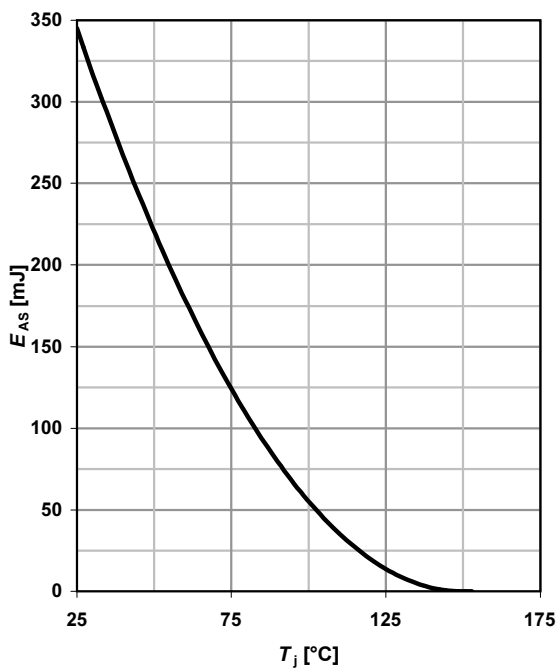
$I_F=f(V_{SD})$

parameter:  $T_j$



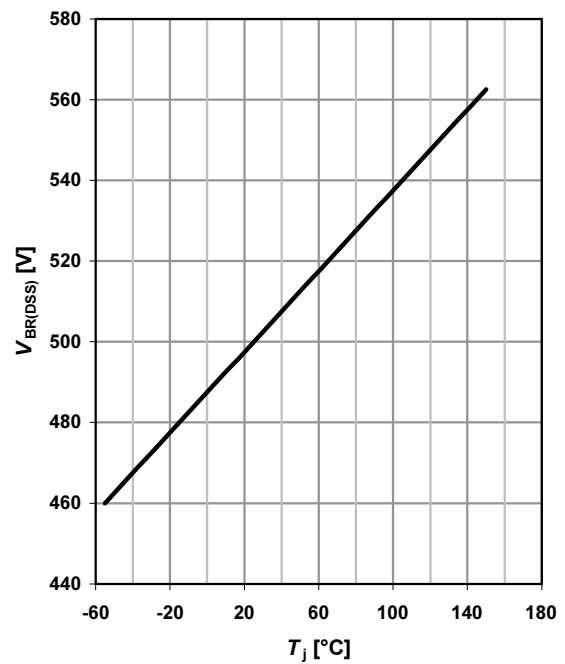
**11 Avalanche energy**

$E_{AS}=f(T_j); I_D=5.2 \text{ A}; V_{DD}=50 \text{ V}$



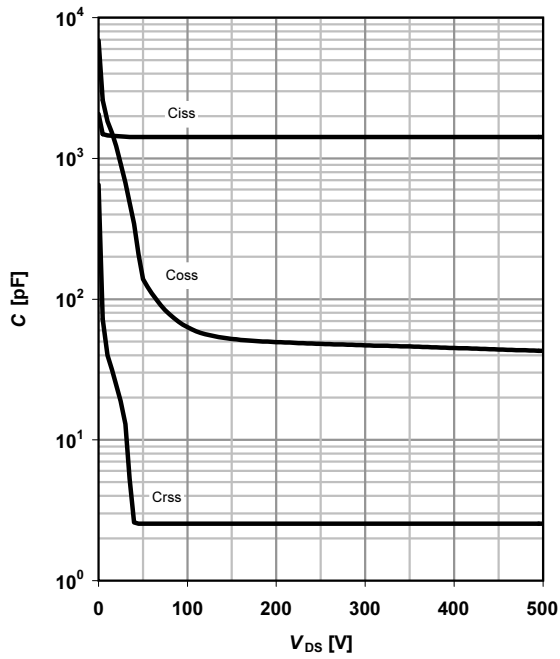
**12 Drain-source breakdown voltage**

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



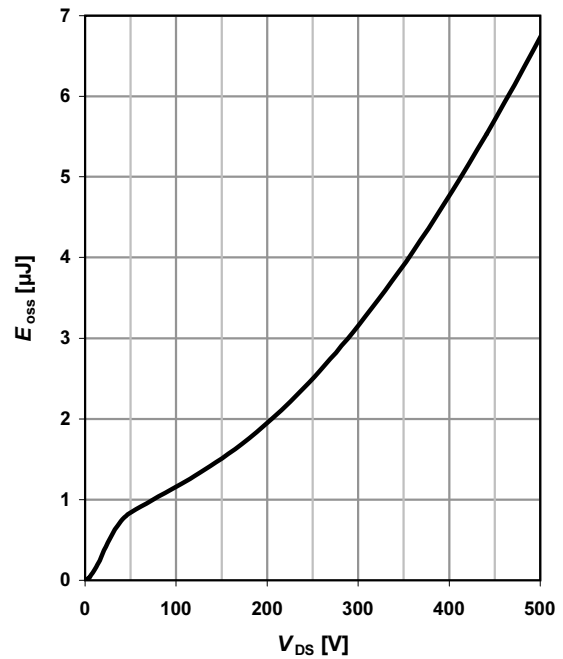
**13 Typ. capacitances**

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

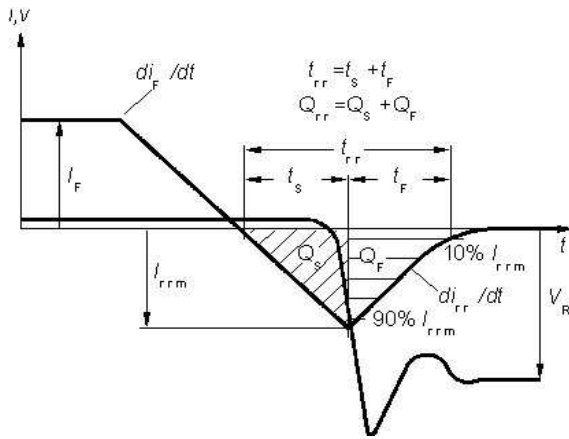


**14 Typ. Coss stored energy**

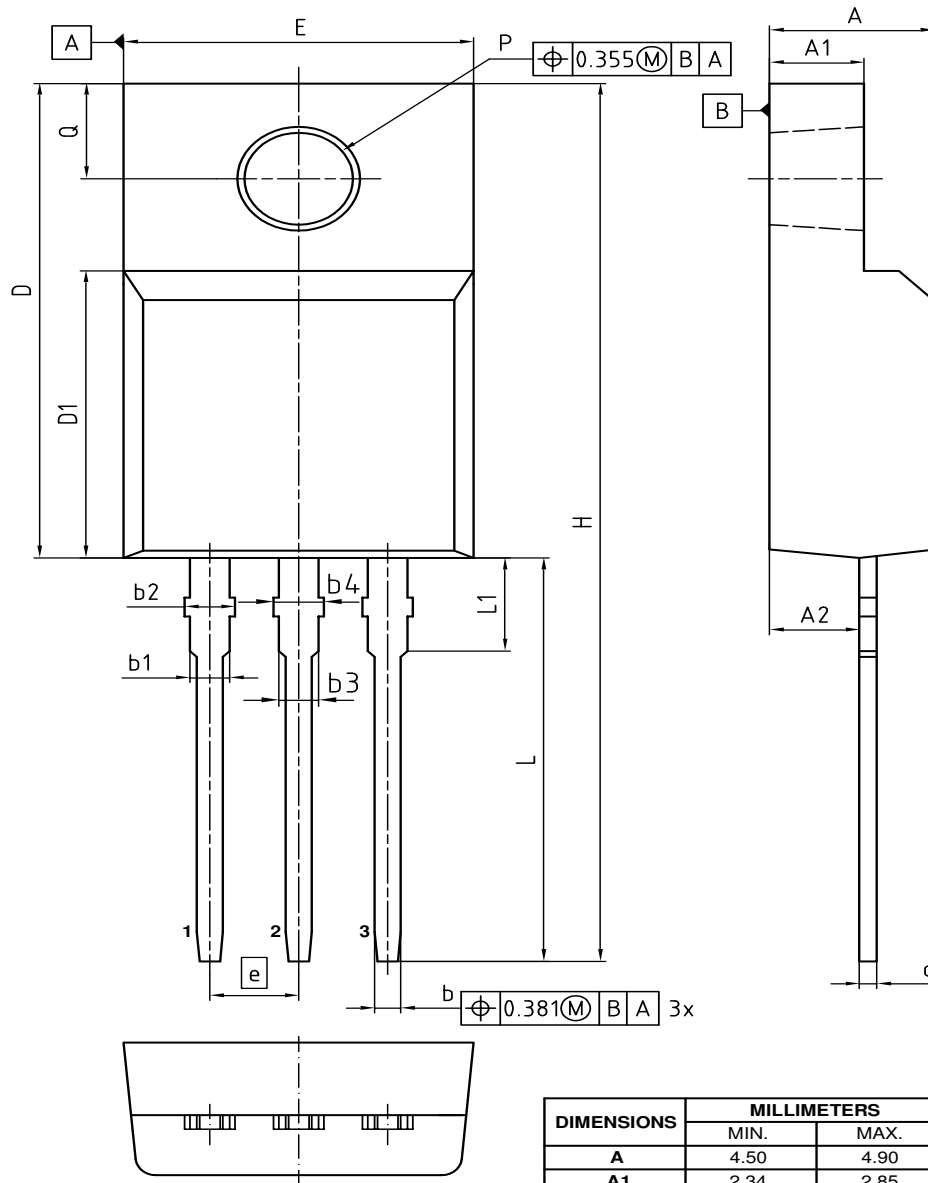
$E_{oss} = f(V_{DS})$



Definition of diode switching characteristics



Outline PG-TO220 FullIPAK



NOTES:  
 ALL DIMENSIONS REFER TO JEDEC STANDARD TO-281  
 AND DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS  
 OR GATE BURRS  
 GATE BURRS ARE LESS THAN 0.5 mm

| DIMENSIONS | MILLIMETERS |       |
|------------|-------------|-------|
|            | MIN.        | MAX.  |
| <b>A</b>   | 4.50        | 4.90  |
| <b>A1</b>  | 2.34        | 2.85  |
| <b>A2</b>  | 2.42        | 2.86  |
| <b>b</b>   | 0.65        | 0.90  |
| <b>b1</b>  | 0.95        | 1.38  |
| <b>b2</b>  | 0.95        | 1.51  |
| <b>b3</b>  | 0.65        | 1.38  |
| <b>b4</b>  | 0.65        | 1.51  |
| <b>c</b>   | 0.40        | 0.63  |
| <b>D</b>   | 15.67       | 16.15 |
| <b>D1</b>  | 8.97        | 9.83  |
| <b>E</b>   | 10.00       | 10.65 |
| <b>e</b>   | 2.54        |       |
| <b>H</b>   | 28.70       | 29.75 |
| <b>L</b>   | 12.78       | 13.75 |
| <b>L1</b>  | 2.83        | 3.45  |
| <b>øP</b>  | 3.00        | 3.30  |
| <b>Q</b>   | 3.15        | 3.50  |

|                                    |
|------------------------------------|
| <b>DOCUMENT NO.</b><br>Z8B00003319 |
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| <b>SCALE 5:1</b><br>0 1 2 3 4 5mm  |
| <b>EUROPEAN PROJECTION</b><br>     |
| <b>ISSUE DATE</b><br>27.01.2017    |

# 500V CoolMOS™ CP Power Transistor

## IPA50R250CP

### Revision History

IPA50R250CP

**Revision: 2018-02-26, Rev. 2.1**

Previous Revision

| Revision | Date       | Subjects (major changes since last revision) |
|----------|------------|--|
| 2.1      | 2018-02-26 | Outline PG-TO220 FullPAK update              |

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