

## 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 for industrial grade applications according to JEDEC<sup>1)</sup>

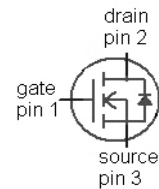
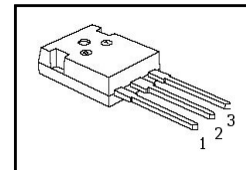
### Product Summary

|                     |       |          |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550   | V        |
| $R_{DS(on),max}$    | 0.299 | $\Omega$ |
| $Q_{g,typ}$         | 23    | nC       |

### CoolMOS CP is designed for:

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

TO-247-3-1



| Type        | Package  | Marking |
|-------------|----------|---------|
| IPW50R299CP | PG-TO247 | 5R299P  |

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

| Parameter                                               | Symbol            | Conditions                                | Value       | Unit |
|---------------------------------------------------------|-------------------|-------------------------------------------|-------------|------|
| Continuous drain current                                | $I_D$             | $T_C=25\text{ °C}$                        | 12          | A    |
|                                                         |                   | $T_C=100\text{ °C}$                       | 8           |      |
| Pulsed drain current <sup>2)</sup>                      | $I_{D,pulse}$     | $T_C=25\text{ °C}$                        | 26          |      |
| Avalanche energy, single pulse                          | $E_{AS}$          | $I_D=4.4\text{ A}$ , $V_{DD}=50\text{ V}$ | 289         | mJ   |
| Avalanche energy, repetitive $t_{AR}$ <sup>2),3)</sup>  | $E_{AR}$          | $I_D=4.4\text{ A}$ , $V_{DD}=50\text{ V}$ | 0.44        |      |
| Avalanche current, repetitive $t_{AR}$ <sup>2),3)</sup> | $I_{AR}$          |                                           | 4.4         | A    |
| MOSFET $dv/dt$ ruggedness                               | $dv/dt$           | $V_{DS}=0\ldots400\text{ V}$              | 50          | V/ns |
| Gate source voltage                                     | $V_{GS}$          | static                                    | $\pm 20$    | V    |
|                                                         |                   | AC ( $f>1\text{ Hz}$ )                    | $\pm 30$    |      |
| Power dissipation                                       | $P_{tot}$         | $T_C=25\text{ °C}$                        | 104         | W    |
| Operating and storage temperature                       | $T_j$ , $T_{stg}$ |                                           | -55 ... 150 | °C   |
| Mounting torque                                         |                   | M3 and M3.5 screws                        | 60          | Ncm  |

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

| Parameter                            | Symbol        | Conditions                       | Value | Unit |
|--------------------------------------|---------------|----------------------------------|-------|------|
| Continuous diode forward current     | $I_S$         | $T_C=25\text{ }^{\circ}\text{C}$ | 6.6   | A    |
| Diode pulse current <sup>(2)</sup>   | $I_{S,pulse}$ |                                  | 26    |      |
| 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                        | $R_{thJC}$   |                                       | - | - | 1.2 | K/W                |
| Thermal resistance, junction - ambient                     | $R_{thJA}$   | leaded                                | - | - | 62  |                    |
| Soldering temperature, wavesoldering only allowed at leads | $T_{solder}$ | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | $^{\circ}\text{C}$ |

**Electrical characteristics, at  $T_j=25\text{ }^{\circ}\text{C}$ , 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           | $V_{GS(th)}$  | $V_{DS}=V_{GS}$ , $I_D=0.44\text{ mA}$                                          | 2.5 | 3    | 3.5   |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=500\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ }^{\circ}\text{C}$  | -   | -    | 1     | $\mu\text{A}$ |
|                                  |               | $V_{DS}=500\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ }^{\circ}\text{C}$ | -   | 10   | -     |               |
| Gate-source leakage current      | $I_{GSS}$     | $V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$                                      | -   | -    | 100   | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{ V}$ , $I_D=6.6\text{ A}$ , $T_j=25\text{ }^{\circ}\text{C}$    | -   | 0.27 | 0.299 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{ V}$ , $I_D=6.6\text{ A}$ , $T_j=150\text{ }^{\circ}\text{C}$   | -   | 0.68 | -     |               |
| 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>$f=1\text{ MHz}$                           | - | 1190 | - | pF |
| Output capacitance                                         | $C_{oss}$    |                                                                                         | - | 53   | - |    |
| 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                                      | - | 50   | - |    |
| Effective output capacitance, time related <sup>6)</sup>   | $C_{o(tr)}$  |                                                                                         | - | 110  | - |    |
| Turn-on delay time                                         | $t_{d(on)}$  | $V_{DD}=400\text{ V},$<br>$V_{GS}=10\text{ V}, I_D=6.6\text{ A},$<br>$R_G=27.9\ \Omega$ | - | 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 | $Q_{gs}$      | $V_{DD}=400\text{ V}, I_D=6.6\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 5   | -  | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                              | - | 7   | -  |    |
| Gate charge total     | $Q_g$         |                                                                              | - | 23  | 31 |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                              | - | 5.2 | -  | V  |

#### Reverse Diode

|                               |           |                                                                          |   |     |     |               |
|-------------------------------|-----------|--------------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$  | $V_{GS}=0\text{ V}, I_F=6.6\text{ A},$<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>$di_F/dt=100\text{ A}/\mu\text{s}$       | - | 260 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$  |                                                                          | - | 2.6 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rrm}$ |                                                                          | - | 21  | -   | 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  $P_{AV}=E_{AR} \cdot f$ .

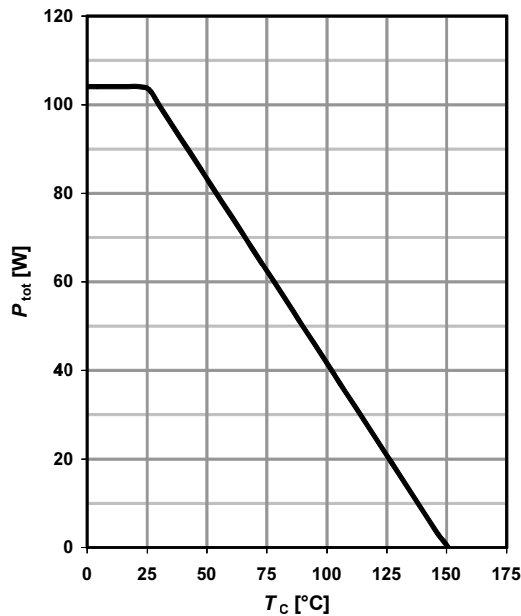
<sup>4)</sup>  $I_{SD} \leq I_D$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DClamp}=400\text{ V}$ ,  $V_{peak} < V_{(BR)DSS}$ ,  $T_j < T_{j,max}$ , identical low and high side switch

<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

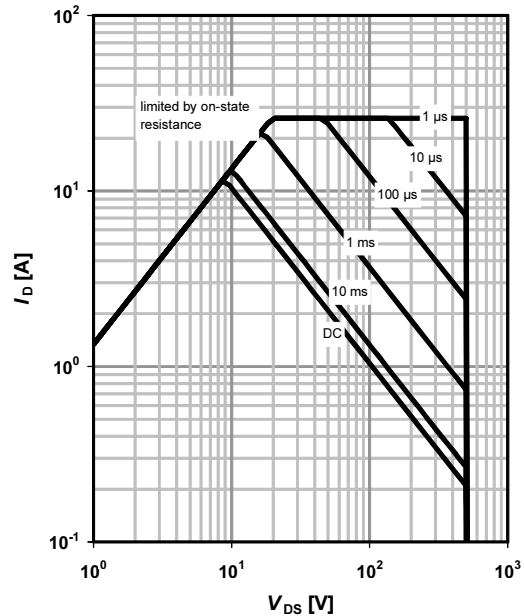
$$P_{\text{tot}} = f(T_C)$$



## 2 Safe operating area

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

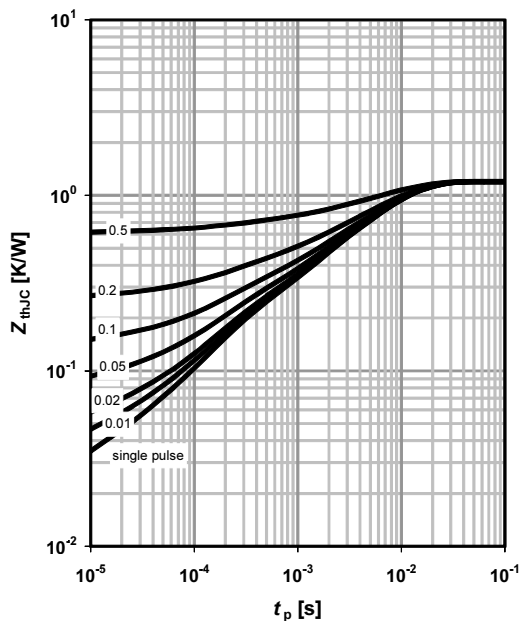
parameter:  $t_p$



## 3 Max. transient thermal impedance

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

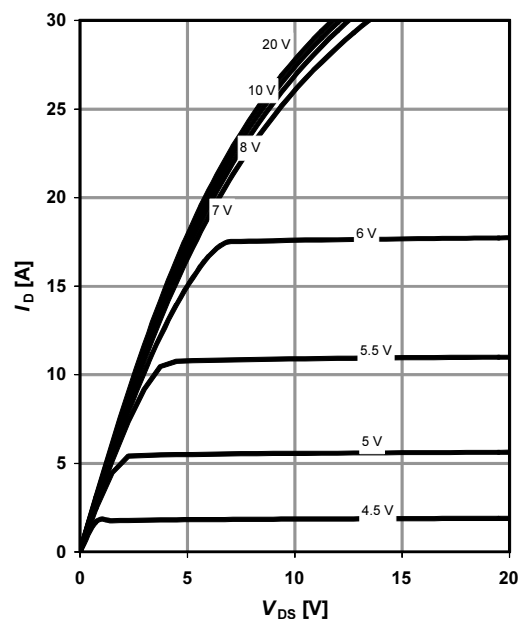
parameter:  $D = t_p/T$



## 4 Typ. output characteristics

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

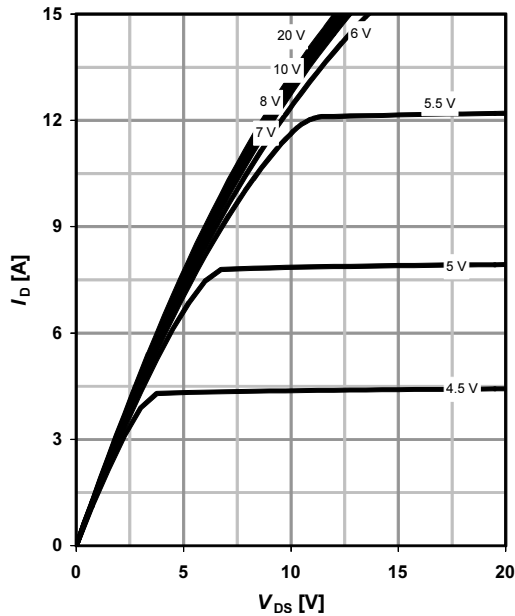
parameter:  $V_{GS}$



### 5 Typ. output characteristics

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

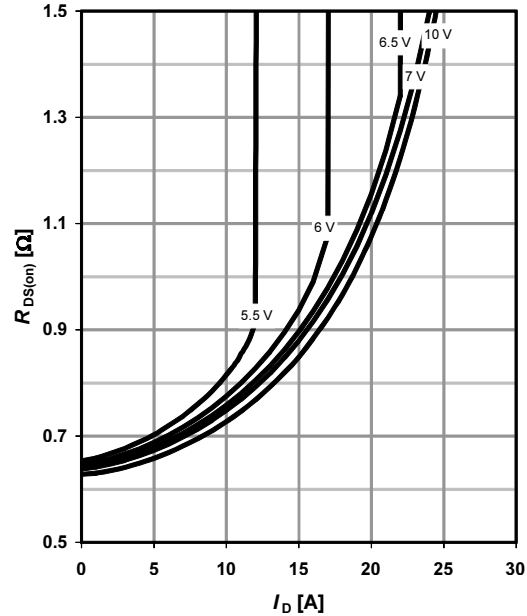
parameter:  $V_{GS}$



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

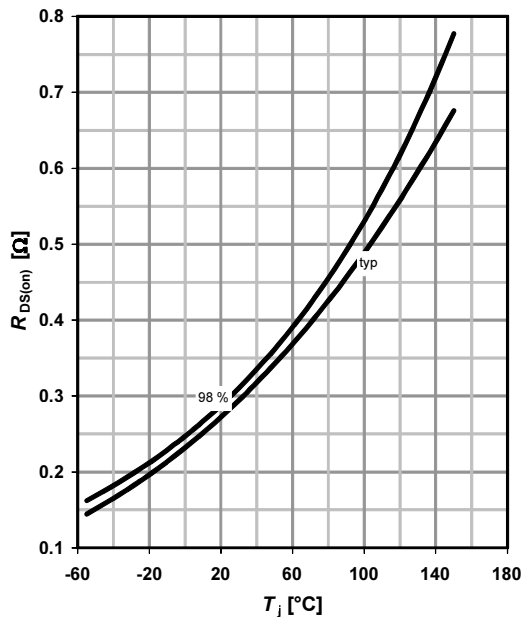
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter:  $V_{GS}$



### 7 Drain-source on-state resistance

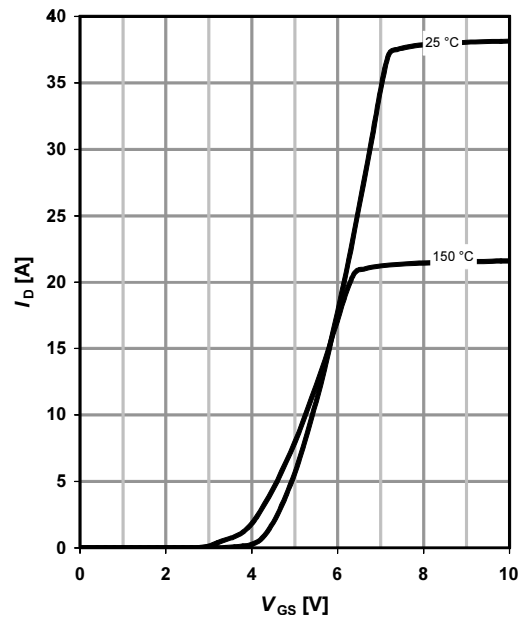
$$R_{DS(on)} = f(T_j); I_D = 6.6\text{ A}; V_{GS} = 10\text{ V}$$



### 8 Typ. transfer characteristics

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

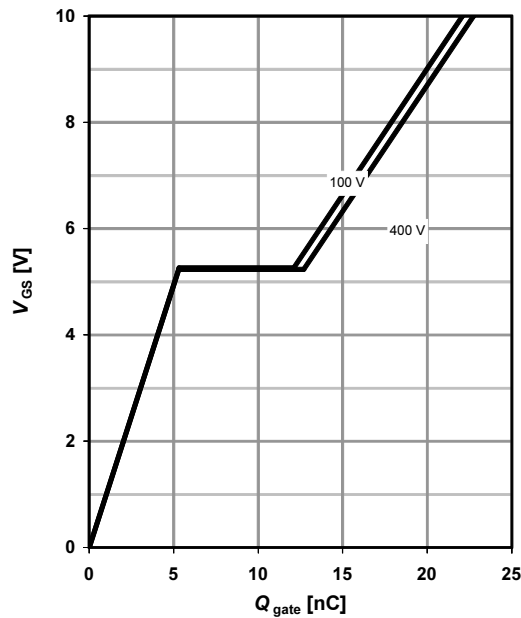
parameter:  $T_j$



### 9 Typ. gate charge

$$V_{GS}=f(Q_{gate}); I_D=6.6 \text{ A pulsed}$$

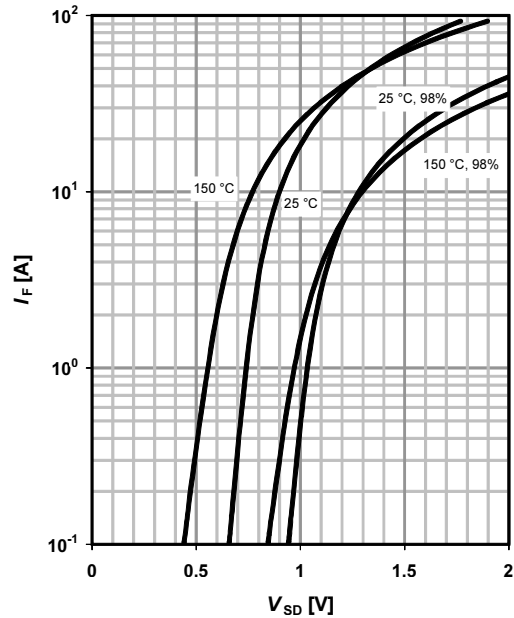
parameter:  $V_{DD}$



### 10 Forward characteristics of reverse diode

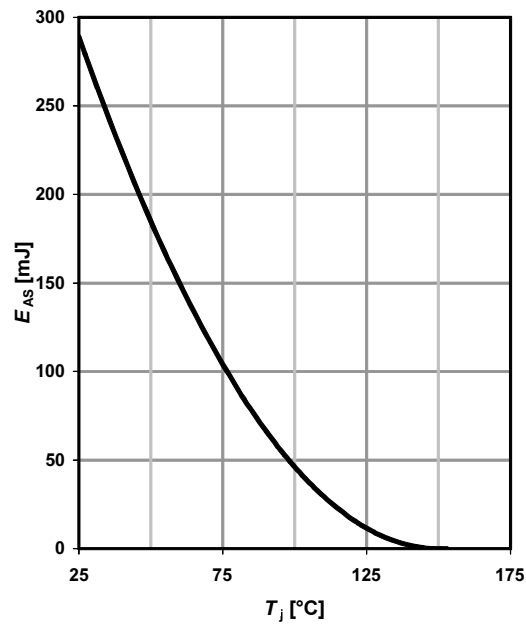
$$I_F=f(V_{SD})$$

parameter:  $T_j$



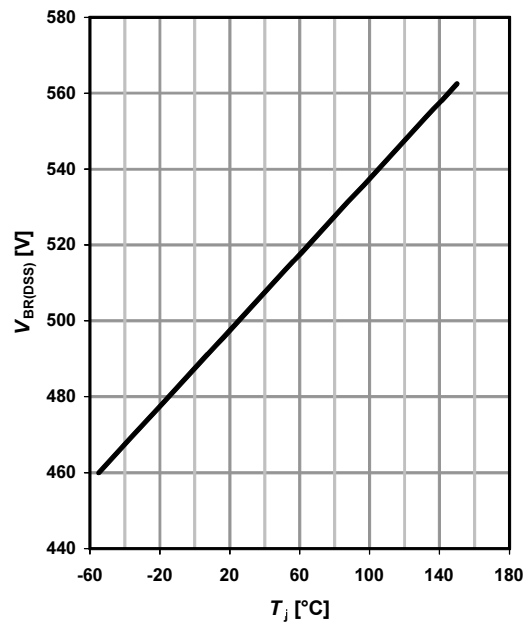
### 11 Avalanche energy

$$E_{AS}=f(T_j); I_D=4.4 \text{ A}; V_{DD}=50 \text{ V}$$



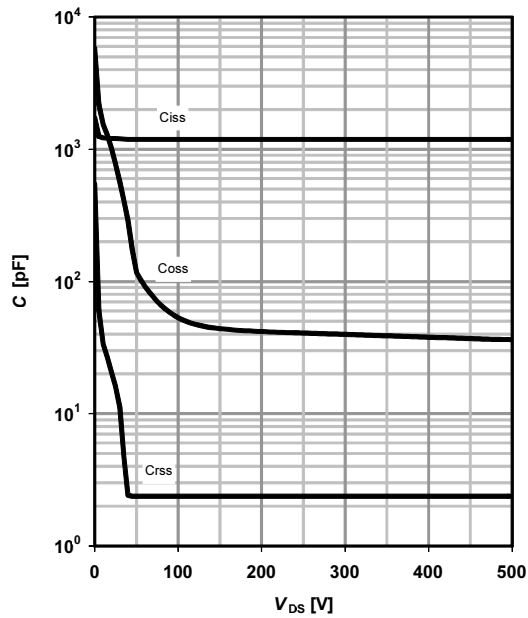
### 12 Drain-source breakdown voltage

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



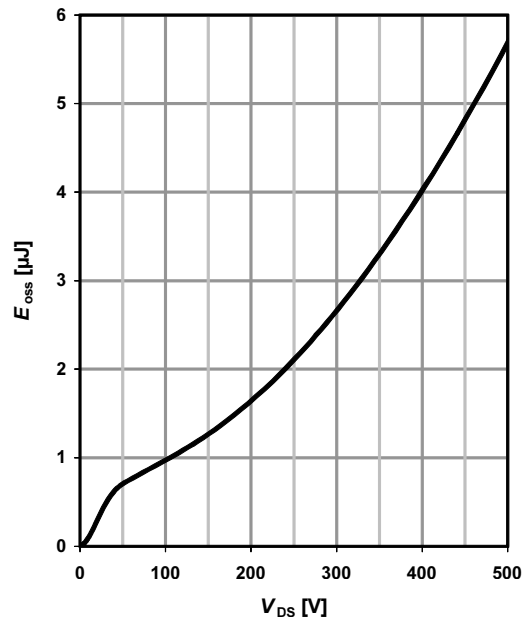
### 13 Typ. capacitances

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



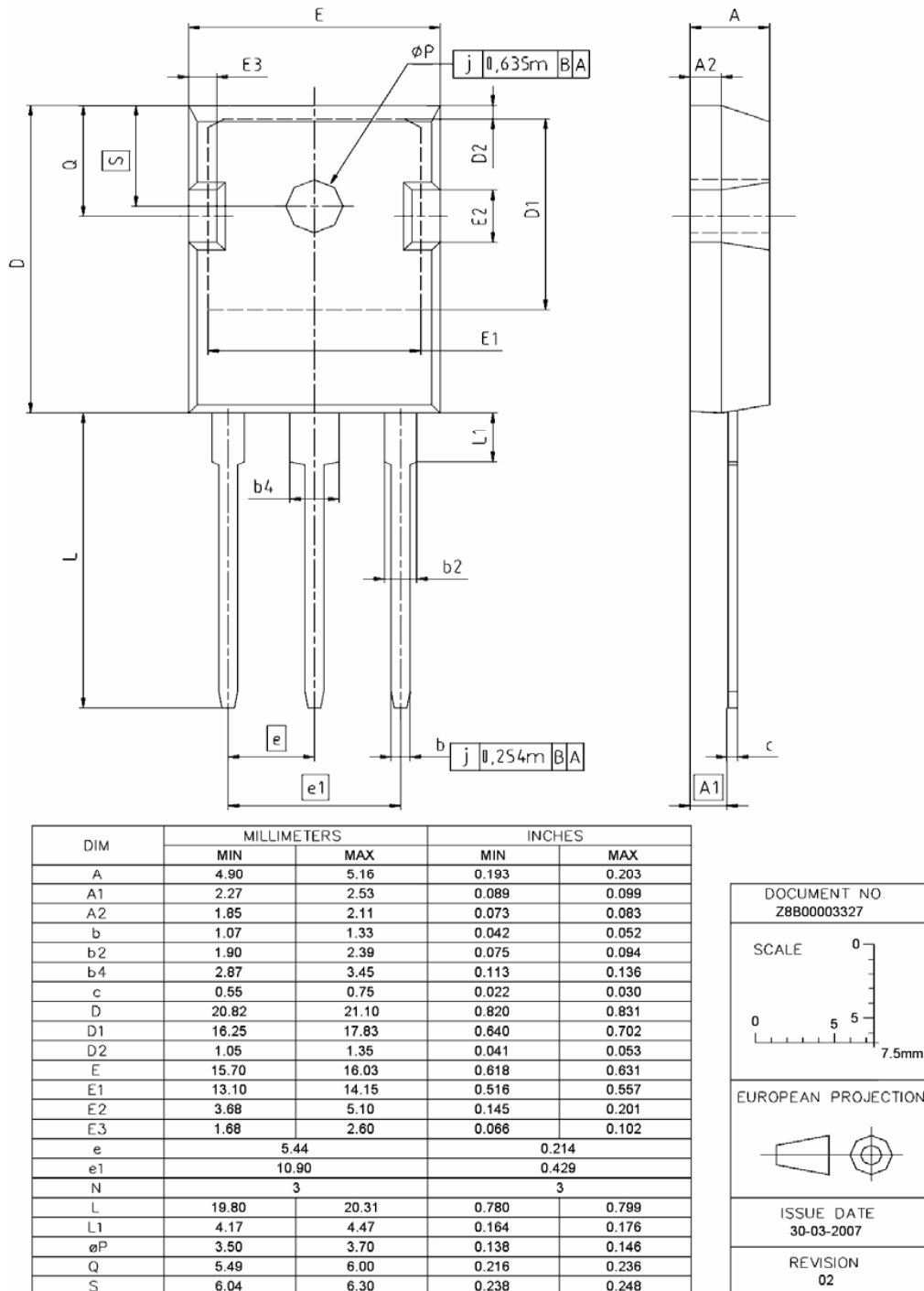
### 14 Typ. Coss stored energy

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



The graph shows the rate of change of the current density,  $di/dt$ , as a function of time  $t$ . The vertical axis is labeled  $i, V$  and the horizontal axis is labeled  $t$ . The curve starts at a constant value  $j_F$  for a duration  $t_S$ , then decreases linearly to a value  $j_{rrm}$ . The total time for this linear decrease is  $t_{rr}$ . The non-linear phase follows, starting at  $j_{rrm}$  and decreasing to a minimum value of  $90\% j_{rrm}$ . The total current density change is  $j_F$ . The total rate of change of the current density is  $Q_{rr} = Q_S + Q_F$ . The non-linear phase is characterized by a  $10\% j_{rrm}$  and a  $90\% j_{rrm}$ .

## PG-TO247 Outline



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## 1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package PG-T0247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)

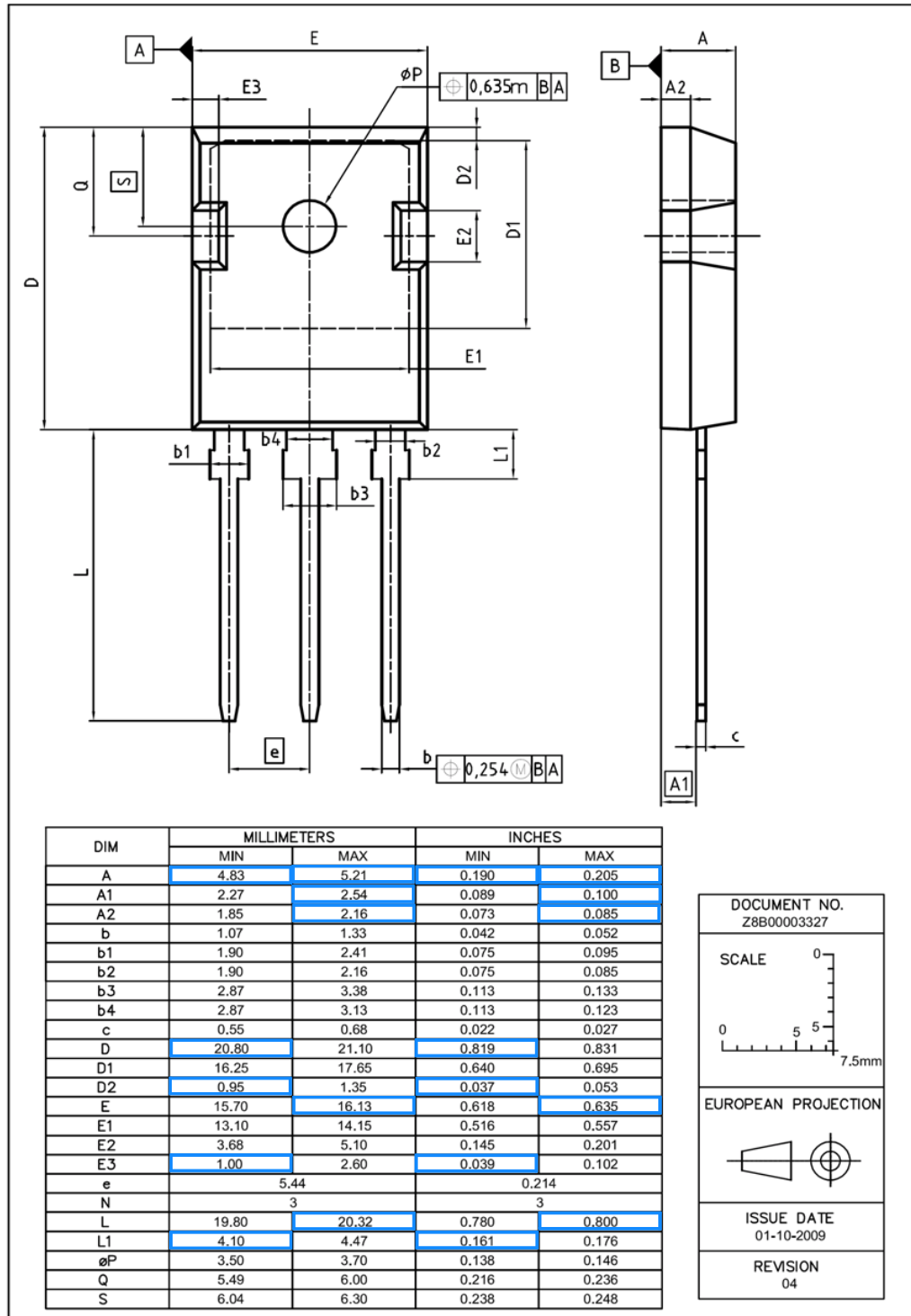


Figure 1 Outlines TO-247, dimensions in mm/inches