## CoolMOS® Power Transistor

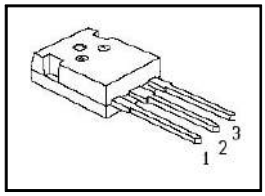
### Features

- Lowest figure-of-merit $R_{ON}xQ_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified for industrial grade applications according to JEDEC[1)]
- Pb-free lead plating; RoHS compliant

### Product Summary

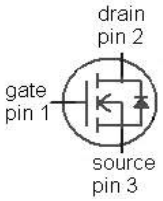
| | | |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.165 | Ω |
| $Q_{g,typ}$ | 39 | nC |

PG-TO247-3




### CoolMOS CP is specially designed for:

- Hard switching topologies, for Server and Telecom




| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| IPW60R165CP | PG-TO247-3 | SP000095483 | 6R165P |

**Maximum ratings,** at $T_j$=25 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Continuous drain current | $I_D$ | $T_C$=25 °C | 21 | A |
| | | $T_C$=100 °C | 13 | |
| Pulsed drain current[2)] | $I_{D,pulse}$ | $T_C$=25 °C | 61 | |
| Avalanche energy, single pulse | $E_{AS}$ | $I_D$=7.9 A, $V_{DD}$=50 V | 522 | mJ |
| Avalanche energy, repetitive $t_{AR}$[2),3)] | $E_{AR}$ | $I_D$=7.9 A, $V_{DD}$=50 V | 0.79 | |
| Avalanche current, repetitive $t_{AR}$[2),3)] | $I_{AR}$ | | 7.9 | A |
| MOSFET $dv/dt$ ruggedness | $dv/dt$ | $V_{DS}$=0...480 V | 50 | V/ns |
| Gate source voltage | $V_{GS}$ | static | ±20 | V |
| | | AC ($f$>1 Hz) | ±30 | |
| Power dissipation | $P_{tot}$ | $T_C$=25 °C | 192 | 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 °C, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Continuous diode forward current | $I_S$ | $T_C$=25 °C | 12 | A |
| Diode pulse current[2)] | $I_{S,pulse}$ | | 61 | |
| Reverse diode $dv/dt$[4)] | $dv/dt$ | | 15 | V/ns |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Thermal characteristics** | | | | | | |
| Thermal resistance, junction - case | $R_{thJC}$ | | - | - | 0.65 | 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 °C, unless otherwise specified

| **Static characteristics** | | | | | | |
|---|---|---|---|---|---|---|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$=0 V, $I_D$=250 µA | 600 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$, $I_D$=0,79 mA | 2.5 | 3 | 3.5 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$=600 V, $V_{GS}$=0 V, $T_j$=25 °C | - | - | 1 | µA |
| | | $V_{DS}$=600 V, $V_{GS}$=0 V, $T_j$=150 °C | - | 10 | - | |
| Gate-source leakage current | $I_{GSS}$ | $V_{GS}$=20 V, $V_{DS}$=0 V | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}$=10 V, $I_D$=12 A, $T_j$=25 °C | - | 0.15 | 0.165 | Ω |
| | | $V_{GS}$=10 V, $I_D$=12 A, $T_j$=150 °C | - | 0.40 | - | |
| Gate resistance | $R_G$ | $f$=1 MHz, open drain | - | 1.9 | - | Ω |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Dynamic characteristics** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0 V, $V_{DS}$=100 V, $f$=1 MHz | - | 2000 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 100 | - | |
| Effective output capacitance, energy related[5] | $C_{o(er)}$ | $V_{GS}$=0 V, $V_{DS}$=0 V to 480 V | - | 83 | - | |
| Effective output capacitance, time related[6] | $C_{o(tr)}$ | | - | 220 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=400 V, $V_{GS}$=10V, $I_D$=12 A, $R_G$=3.3 Ω | - | 12 | - | 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 V, $I_D$=12 A, $V_{GS}$=0 to 10 V | - | 9 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 13.0 | - | |
| Gate charge total | $Q_g$ | | - | 39 | 52 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.0 | - | V |
| **Reverse Diode** | | | | | | |
| Diode forward voltage | $V_{SD}$ | $V_{GS}$=0 V, $I_F$=12 A, $T_j$=25 °C | - | 0.9 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_R$=400 V, $I_F$=$I_S$, d$i_F$/d$t$=100 A/µs | - | 390 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 7.5 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 38 | - | A |

[1] J-STD20 and JESD22

[2] Pulse width $t_p$ limited by $T_{j,max}$

[3] Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}$=$E_{AR}$*$f$.

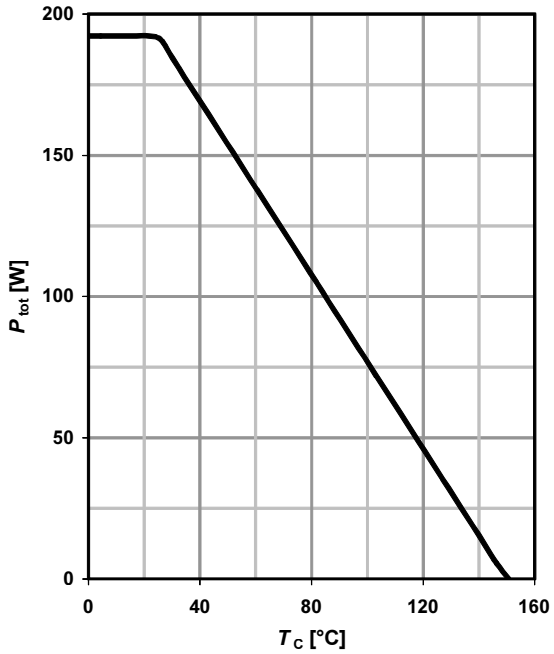
[4] $I_{SD}$≤$I_D$, di/dt≤200A/µs, $V_{DClink}$=400V, $V_{peak}$<$V_{(BR)DSS}$, $T_j$<$T_{jmax}$, identical low side and high side switch.

[5] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 to 80% $V_{DSS}$.

[6] $C_{o(tr)}$ 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

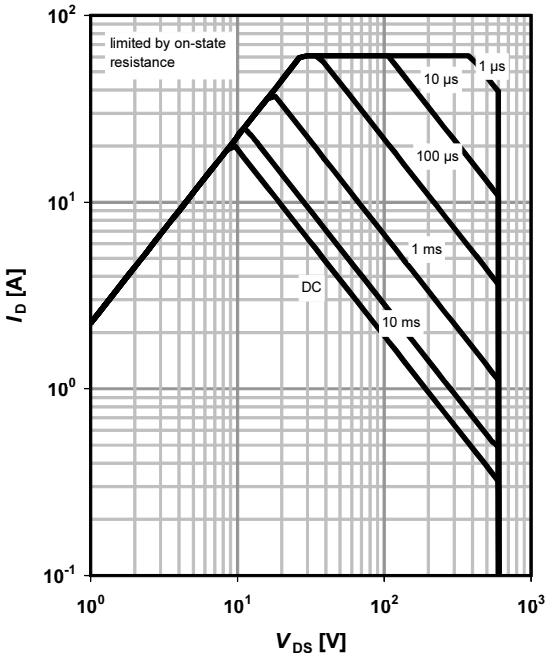
$P_{tot}=f(T_C)$




### 2 Safe operating area

$I_D=f(V_{DS})$; $T_C=25$ °C; $D=0$

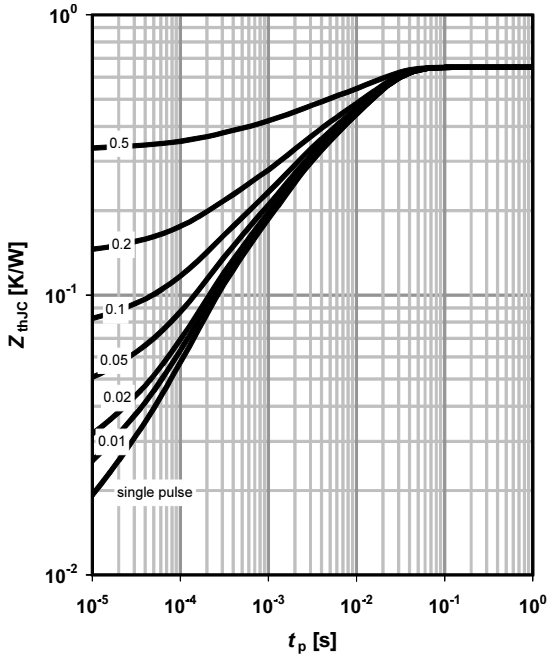
parameter: $t_p$




### 3 Max. transient thermal impedance

$Z_{thJC}=f(t_P)$

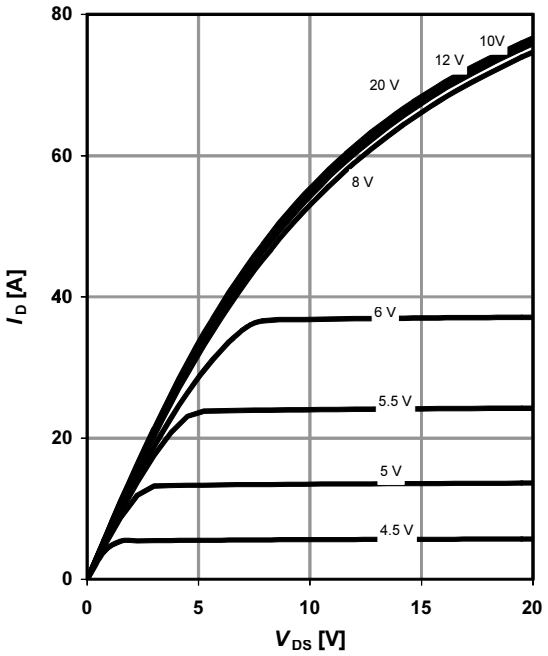
parameter: $D=t_p/T$




### 4 Typ. output characteristics

$I_D=f(V_{DS})$; $T_j=25$ °C

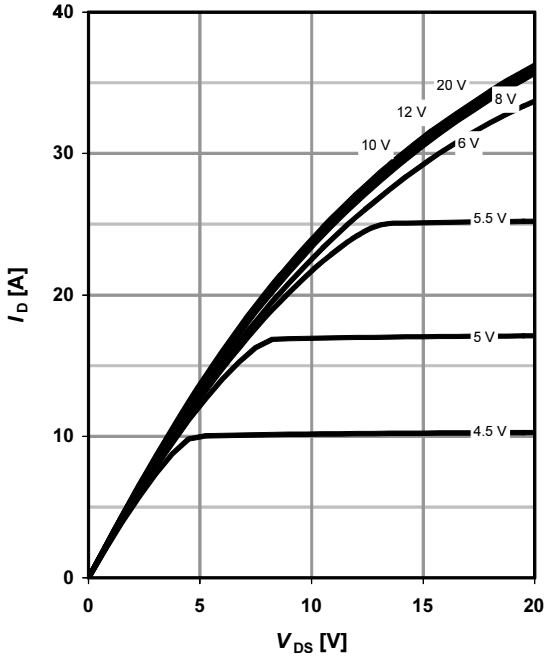
parameter: $V_{GS}$



**5 Typ. output characteristics**

$I_D=f(V_{DS})$; $T_j=150$ °C

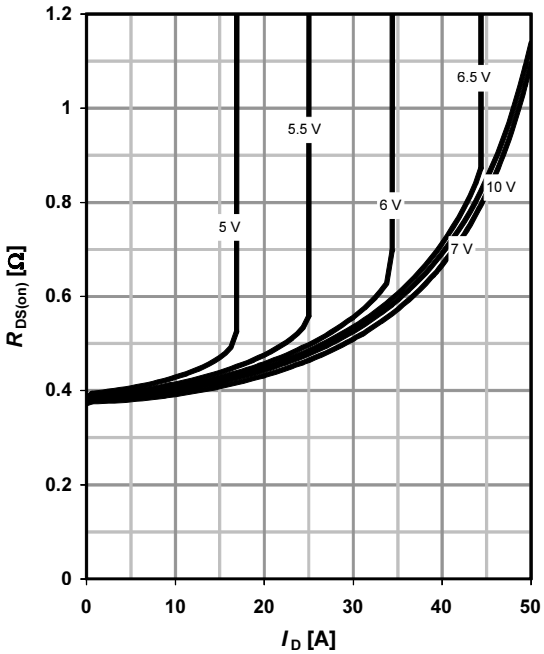
parameter: $V_{GS}$




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

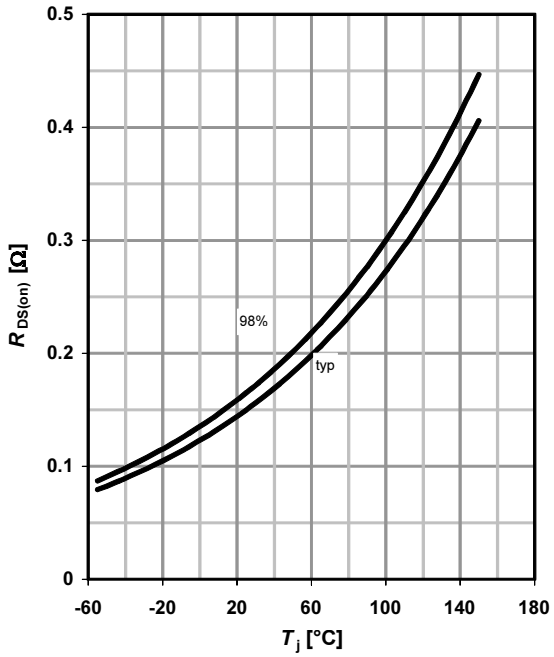
$R_{DS(on)}=f(I_D)$; $T_j=150$ °C

parameter: $V_{GS}$




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

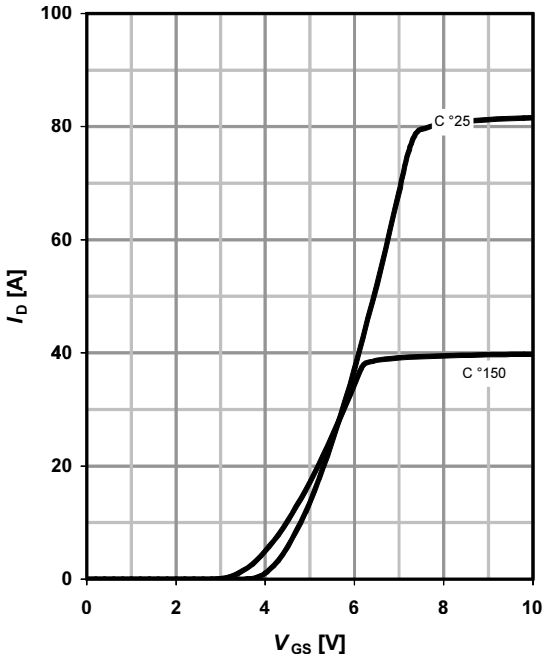
$R_{DS(on)}=f(T_j)$; $I_D=12$ A; $V_{GS}=10$ V




**8 Typ. transfer characteristics**

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

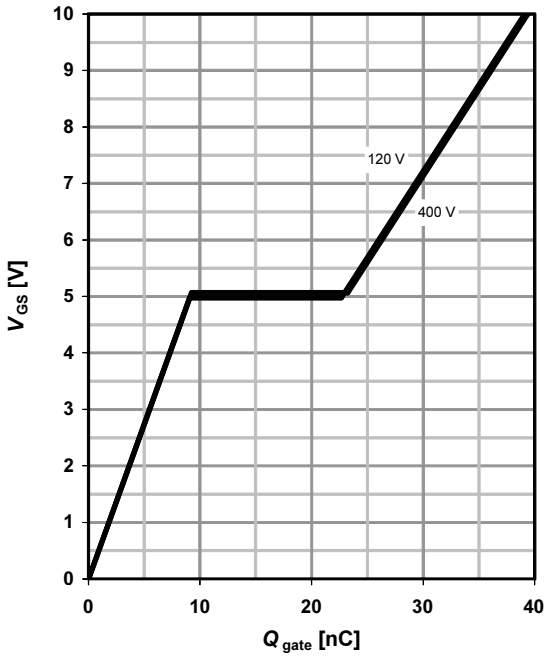
parameter: $T_j$



### 9 Typ. gate charge

$V_{GS}$=f($Q_{gate}$); $I_D$=12 A pulsed

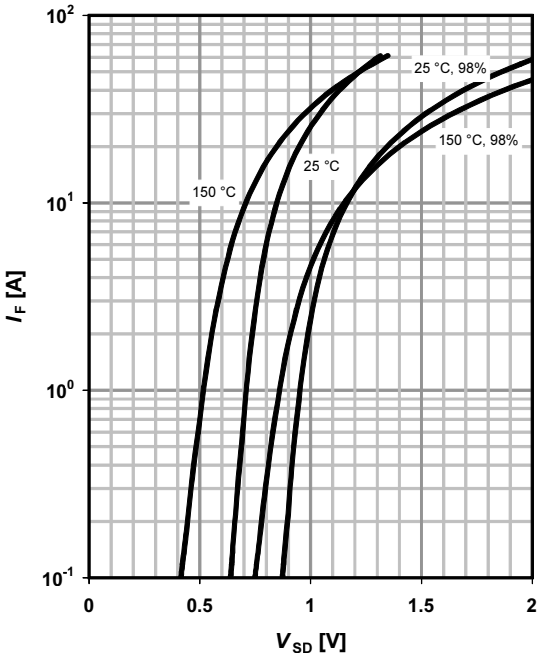
parameter: $V_{DD}$




### 10 Forward characteristics of reverse diode

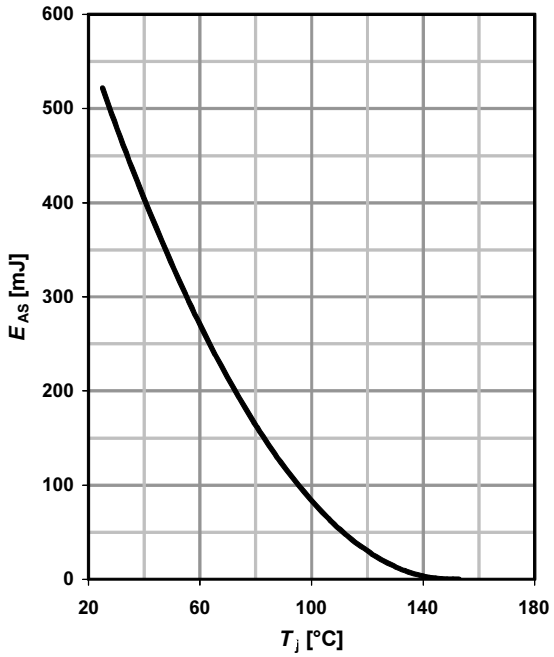
$I_F$=f($V_{SD}$)

parameter: $T_j$



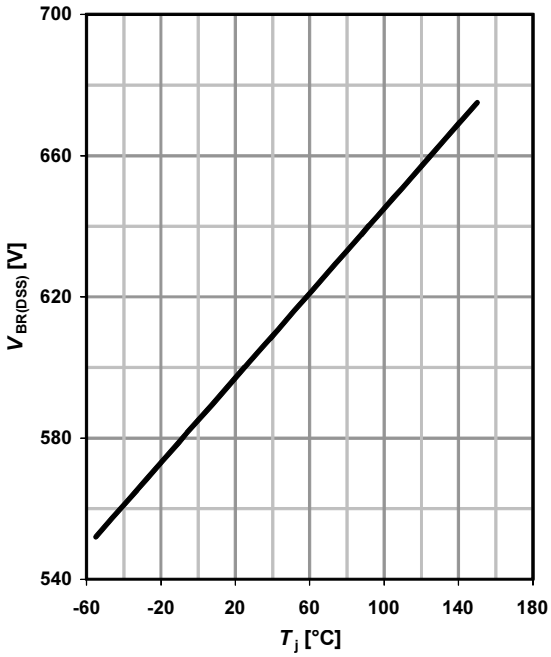

### 11 Avalanche energy

$E_{AS}$=f($T_j$); $I_D$=7.9 A; $V_{DD}$=50 V



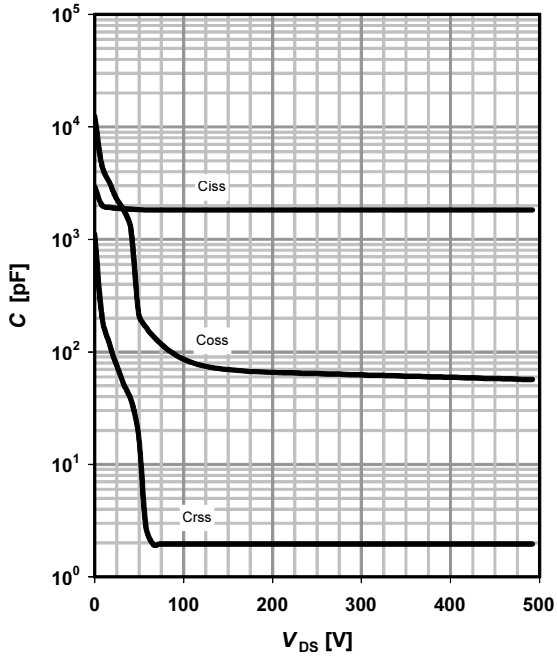

### 12 Drain-source breakdown voltage

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



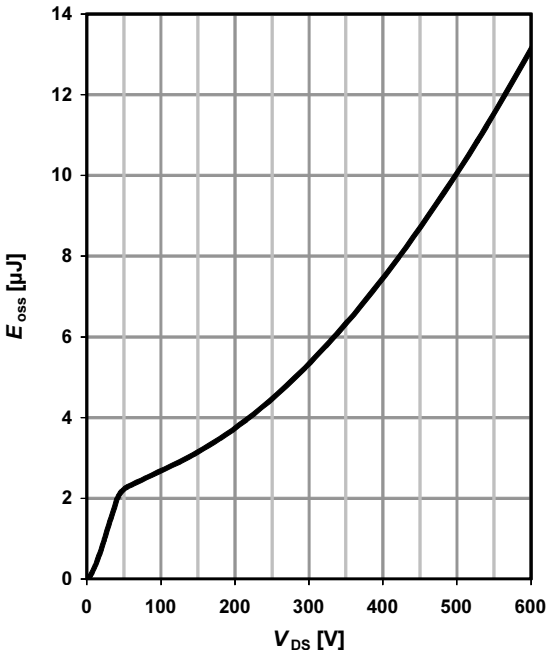
**13 Typ. capacitances**

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

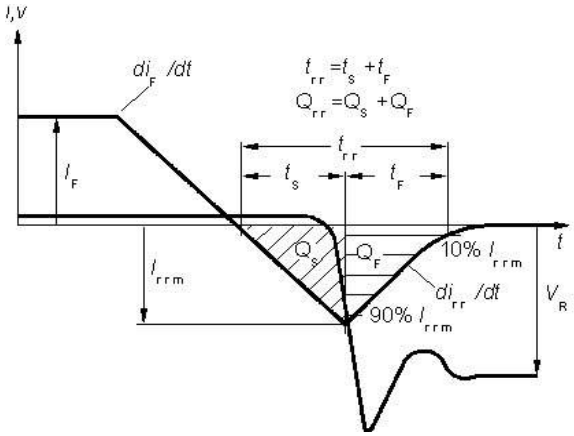



**14 Typ. Coss stored energy**

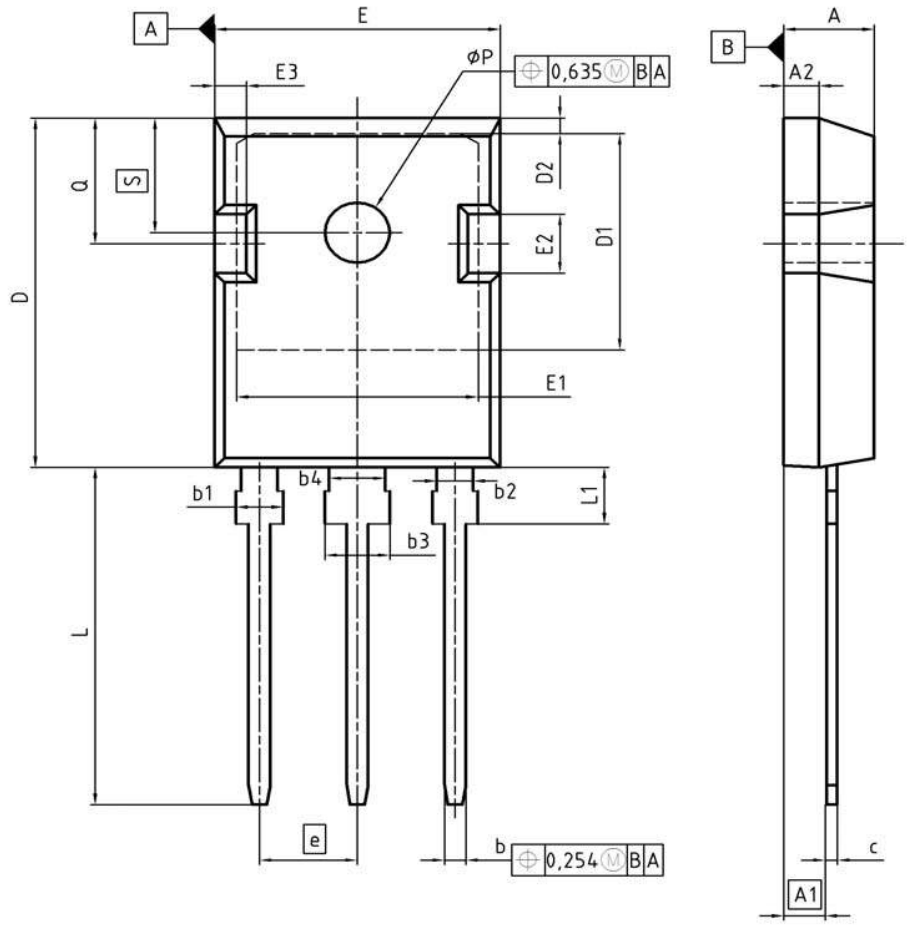
$E_{oss} = f(V_{DS})$



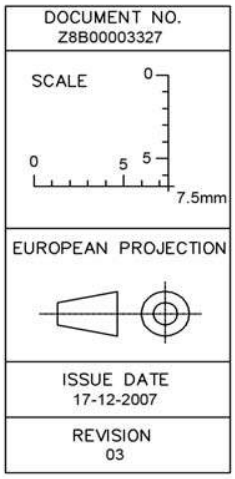
**Definition of diode switching characteristics**



**PG-TO247-3: Outline**




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.16 | 0.193 | 0.203 |
| A1 | 2.27 | 2.53 | 0.089 | 0.099 |
| A2 | 1.85 | 2.11 | 0.073 | 0.083 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b3 | 2.87 | 3.38 | 0.113 | 0.133 |
| b4 | 2.87 | 3.13 | 0.113 | 0.123 |
| c | 0.55 | 0.68 | 0.022 | 0.027 |
| D | 20.82 | 21.10 | 0.820 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 1.05 | 1.35 | 0.041 | 0.053 |
| E | 15.70 | 16.03 | 0.618 | 0.631 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.68 | 2.60 | 0.066 | 0.102 |
| e | 5.44 | | 0.214 | |
| N | 3 | | 3 | |
| L | 19.80 | 20.31 | 0.780 | 0.799 |
| L1 | 4.17 | 4.47 | 0.164 | 0.176 |
| øP | 3.50 | 3.70 | 0.138 | 0.146 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |






Please note the new package dimensions arccording to PCN 2009-134-A

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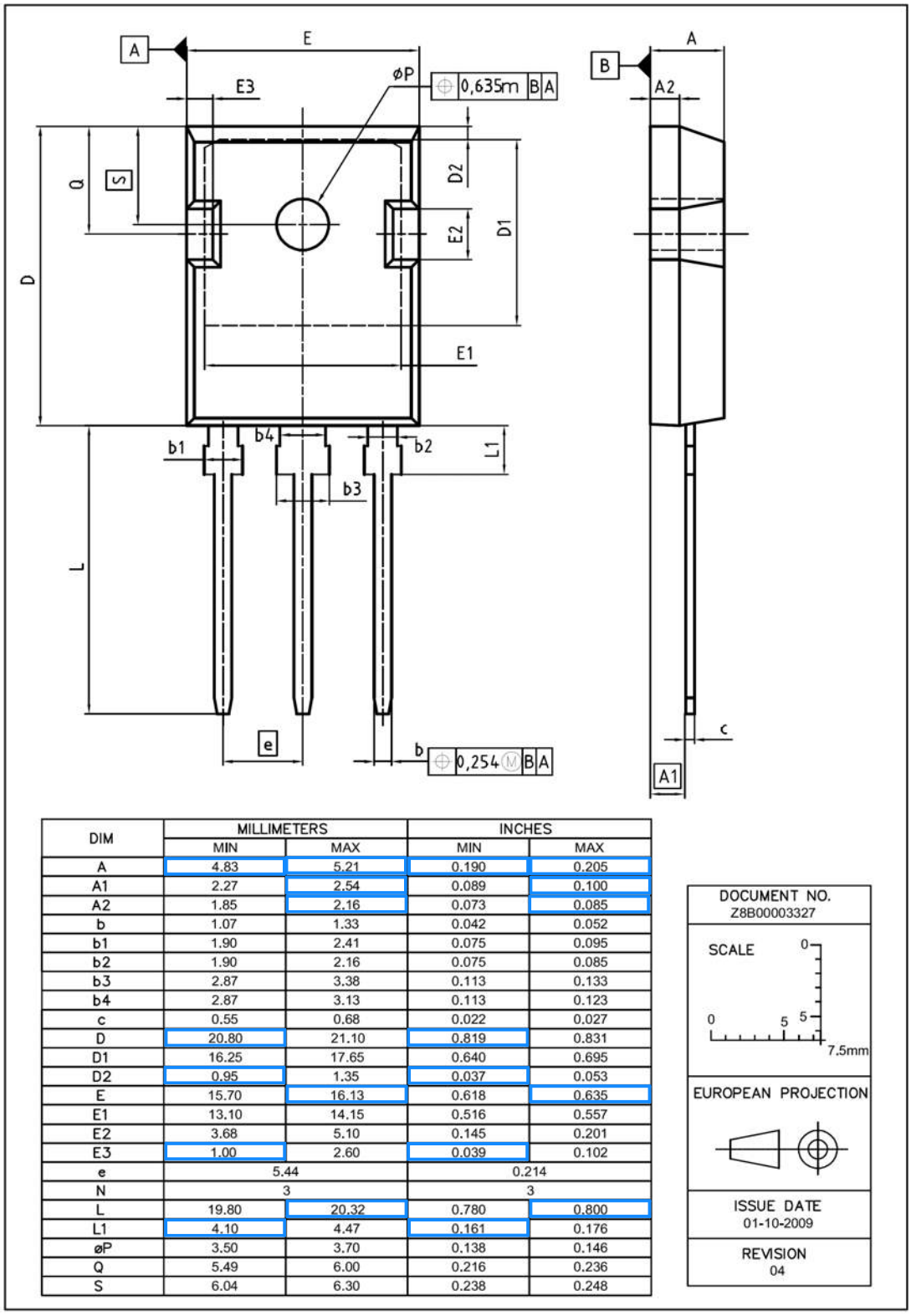
# 1 New package outlines TO-247

Assembly capacity extension for CoolMOSTM technology products assembled in lead-free package PG-TO247-3 at subcontractor ASE (Weihai) Inc., China (Changes are marked in blue.)




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.83 | 5.21 | 0.190 | 0.205 |
| A1 | 2.27 | 2.54 | 0.089 | 0.100 |
| A2 | 1.85 | 2.16 | 0.073 | 0.085 |
| b | 1.07 | 1.33 | 0.042 | 0.052 |
| b1 | 1.90 | 2.41 | 0.075 | 0.095 |
| b2 | 1.90 | 2.16 | 0.075 | 0.085 |
| b3 | 2.87 | 3.38 | 0.113 | 0.133 |
| b4 | 2.87 | 3.13 | 0.113 | 0.123 |
| c | 0.55 | 0.68 | 0.022 | 0.027 |
| D | 20.80 | 21.10 | 0.819 | 0.831 |
| D1 | 16.25 | 17.65 | 0.640 | 0.695 |
| D2 | 0.95 | 1.35 | 0.037 | 0.053 |
| E | 15.70 | 16.13 | 0.618 | 0.635 |
| E1 | 13.10 | 14.15 | 0.516 | 0.557 |
| E2 | 3.68 | 5.10 | 0.145 | 0.201 |
| E3 | 1.00 | 2.60 | 0.039 | 0.102 |
| e | 5.44 | | 0.214 | |
| N | 3 | | 3 | |
| L | 19.80 | 20.32 | 0.780 | 0.800 |
| L1 | 4.10 | 4.47 | 0.161 | 0.176 |
| øP | 3.50 | 3.70 | 0.138 | 0.146 |
| Q | 5.49 | 6.00 | 0.216 | 0.236 |
| S | 6.04 | 6.30 | 0.238 | 0.248 |



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