## CoolMOS™ Power Transistor

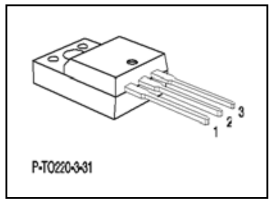
**Product Summary**

| | | |
|---|---|---|
| $V_{DS}$ @ $T_{j,max}$ | 650 | V |
| $R_{DS(on),max}$ | 0.199 | Ω |
| $Q_{g,typ}$ | 33 | nC |

### Features

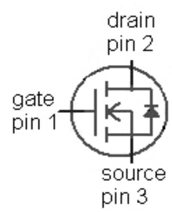
- Lowest figure-of-merit $R_{ON}xQ_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified according to JEDEC[1)] for target applications
- Pb-free lead plating; RoHS compliant

PG-TO220-3-31




**CoolMOS CP is specially designed for:**

- Hard switching SMPS topologies




| Type | Package | Ordering Code | Marking |
|---|---|---|---|
| IPA60R199CP | PG-TO220-3-31 | SP000094146 | 6R199P |

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

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Continuous drain current[2)] | $I_D$ | $T_C$=25 °C | 16 | A |
| | | $T_C$=100 °C | 10 | |
| Pulsed drain current[3)] | $I_{D,pulse}$ | $T_C$=25 °C | 51 | |
| Avalanche energy, single pulse | $E_{AS}$ | $I_D$=6.6 A, $V_{DD}$=50 V | 436 | mJ |
| Avalanche energy, repetitive $t_{AR}$[3),4)] | $E_{AR}$ | $I_D$=6.6 A, $V_{DD}$=50 V | 0.66 | |
| Avalanche current, repetitive $t_{AR}$[3),4)] | $I_{AR}$ | | 6.6 | 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 | 34 | W |
| Operating and storage temperature | $T_j$, $T_{stg}$ | | -55 ... 150 | °C |
| Mounting torque | | M2.5 screws | 50 | Ncm |

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

| Parameter | Symbol | Conditions | Value | Unit |
|---|---|---|---|---|
| Continuous diode forward current[2)] | $I_S$ | $T_C$=25 °C | 16 | A |
| Diode pulse current[3)] | $I_{S,pulse}$ | | 51 | |
| Reverse diode d$v$/d$t$[5)] | d$v$/d$t$ | | 15 | V/ns |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| **Thermal characteristics** | | | | | | |
| Thermal resistance, junction - case | $R_{thJC}$ | | - | - | 3.7 | K/W |
| Thermal resistance, junction - ambient | $R_{thJA}$ | leaded | - | - | 80 | |
| 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 | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$, $I_D$=1.1 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, $I_D$=9.9 A, $T_j$=25 °C | - | 0.18 | 0.199 | Ω |
| | | $V_{GS}$=10 V, $I_D$=9.9 A, $T_j$=150 °C | - | 0.49 | - | |
| Gate resistance | $R_G$ | $f$=1 MHz, open drain | - | 2 | - | 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 | - | 1520 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 72 | - | |
| Effective output capacitance, energy related[6] | $C_{o(er)}$ | $V_{GS}$=0 V, $V_{DS}$=0 V to 480 V | - | 69 | - | |
| Effective output capacitance, time related[7] | $C_{o(tr)}$ | | - | 180 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$=400 V, $V_{GS}$=10 V, $I_D$=9.9 A, $R_G$=3.3 Ω | - | 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 V, $I_D$=9.9 A, $V_{GS}$=0 to 10 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 V, $I_F$=9.9 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 | - | 340 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 5.5 | - | µC |
| Peak reverse recovery current | $I_{rrm}$ | | - | 33 | - | A |

[1] J-STD20 and JESD22

[2] Limited only by maximum temperature

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

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

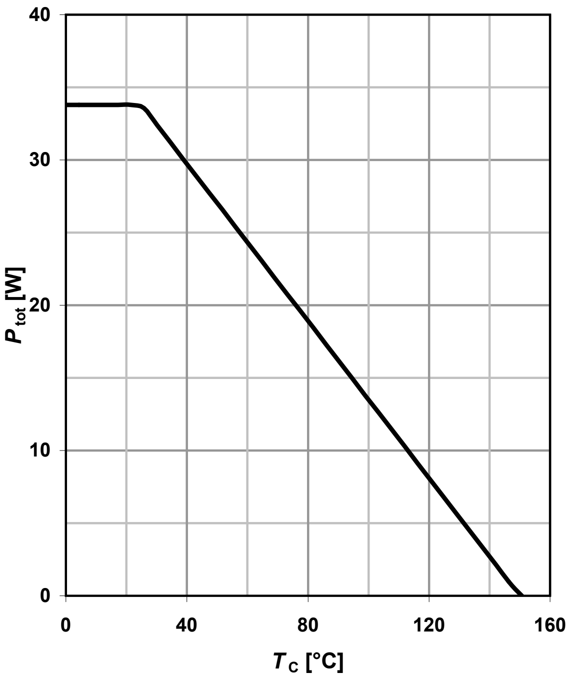
[5] $I_{SD}$<=$I_D$, di/dt<=200A/µs, $V_{DClink}$=400V, $V_{peak}$<$V_{(BR)DSS}$, $T_j$<$T_{jmax}$, identical low side and high side switch.

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

[7] $C_{o(tr)}$ 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**

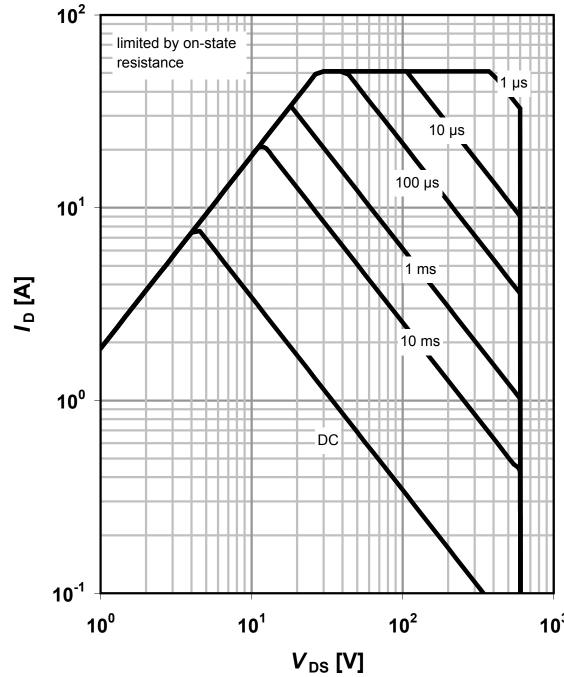
$P_{tot}$=f($T_C$)




**2 Safe operating area**

$I_D$=f($V_{DS}$); $T_C$=25 °C; $D$=0

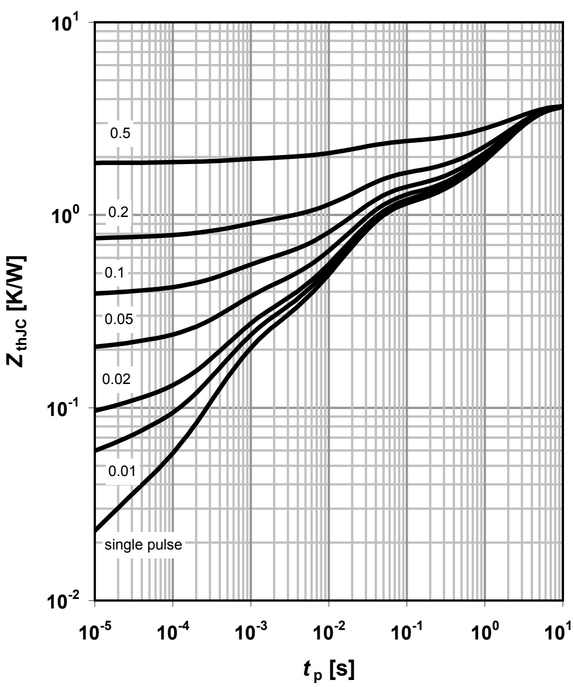
parameter: $t_p$




**3 Max. transient thermal impedance**

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

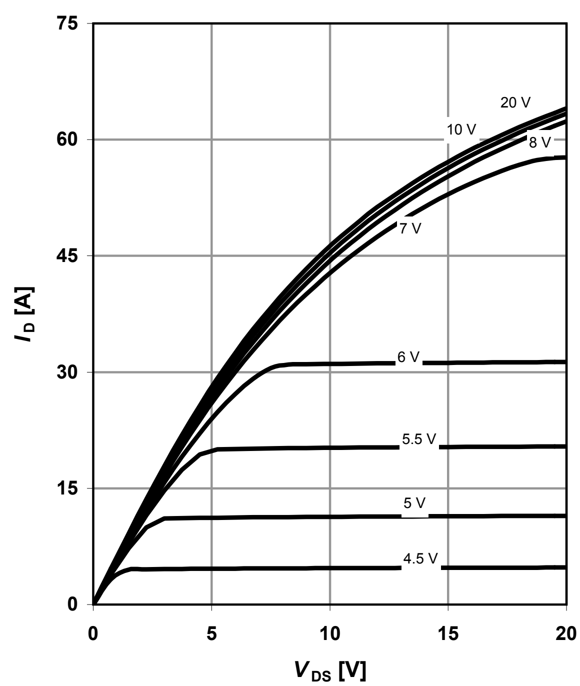
parameter: $D=t_p/T$




**4 Typ. output characteristics**

$I_D$=f($V_{DS}$); $T_j$=25 °C

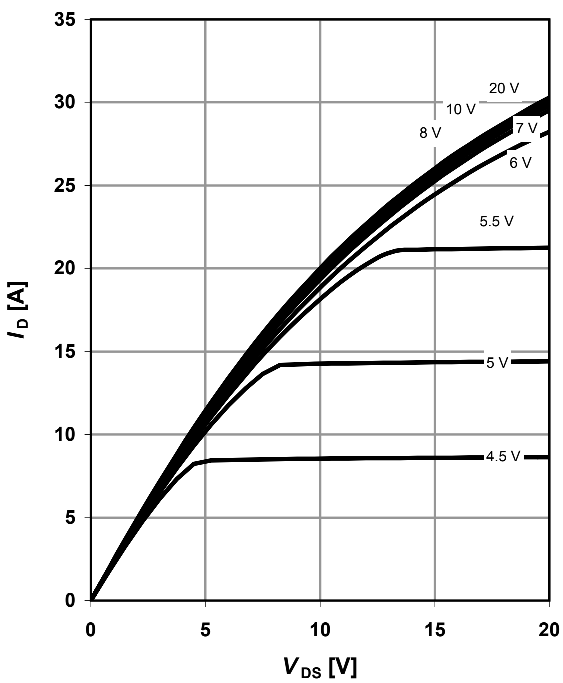
parameter: $V_{GS}$



**5 Typ. output characteristics**

$I_D$=f($V_{DS}$); $T_j$=150 °C

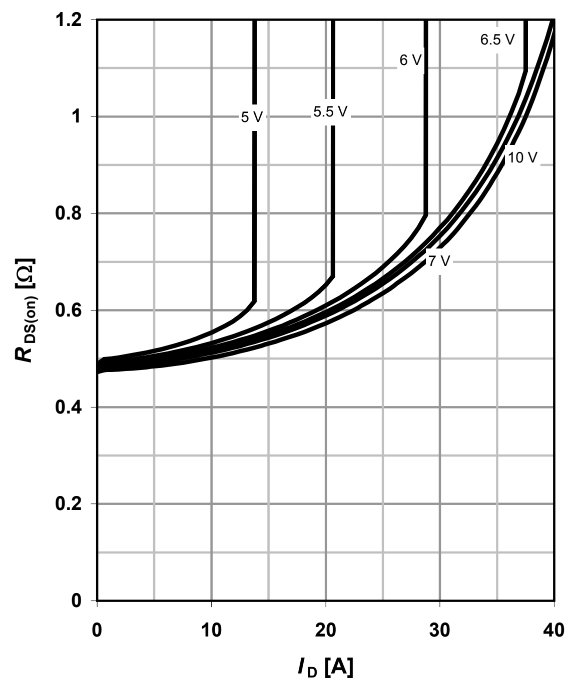
parameter: $V_{GS}$




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

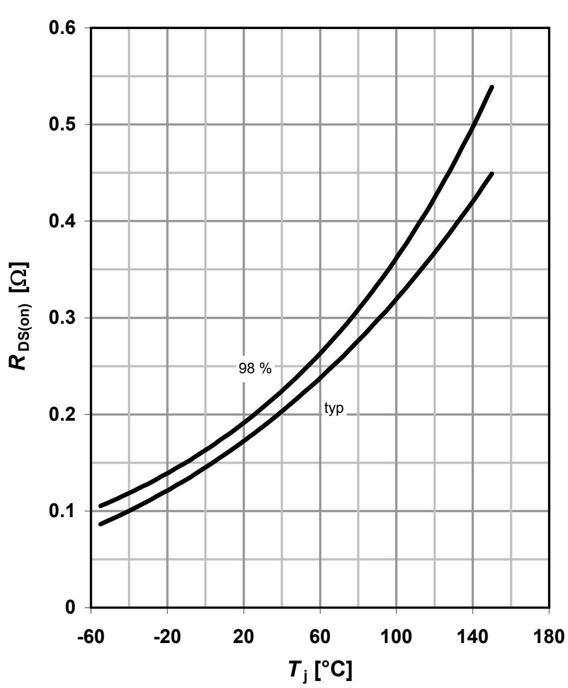
$R_{DS(on)}$=f($I_D$); $T_j$=150 °C

parameter: $V_{GS}$




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

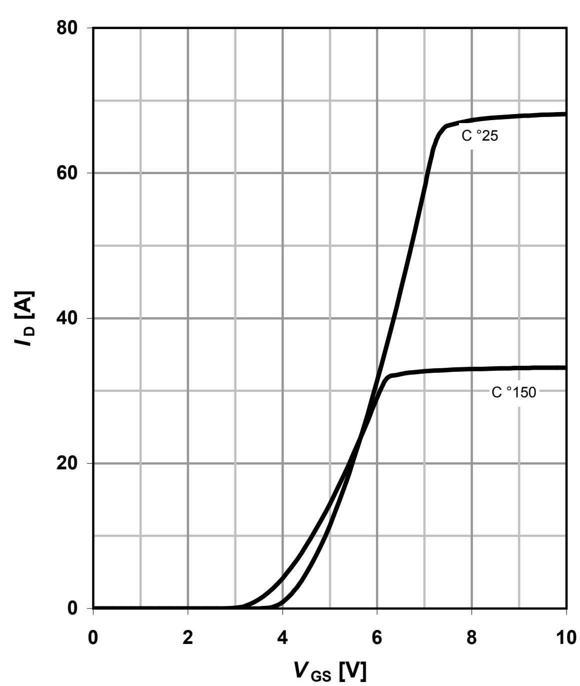
$R_{DS(on)}$=f($T_j$); $I_D$=9.9 A; $V_{GS}$=10 V




**8 Typ. transfer characteristics**

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

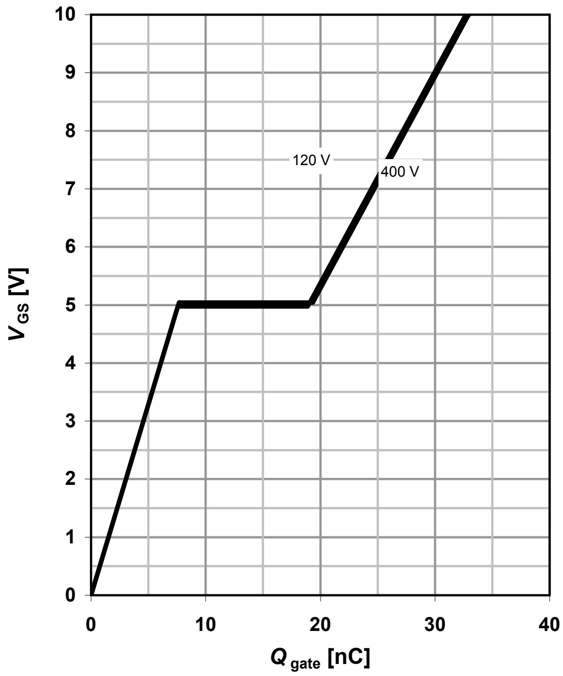
parameter: $T_j$



### 9 Typ. gate charge

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

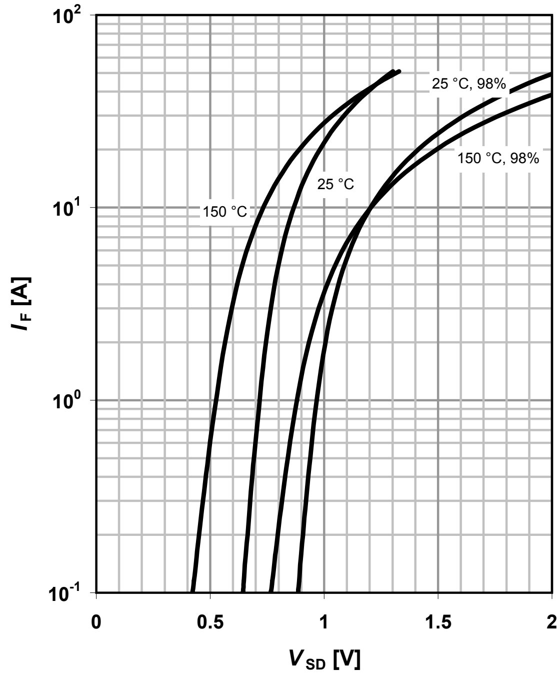
parameter: $V_{DD}$




### 10 Forward characteristics of reverse diode

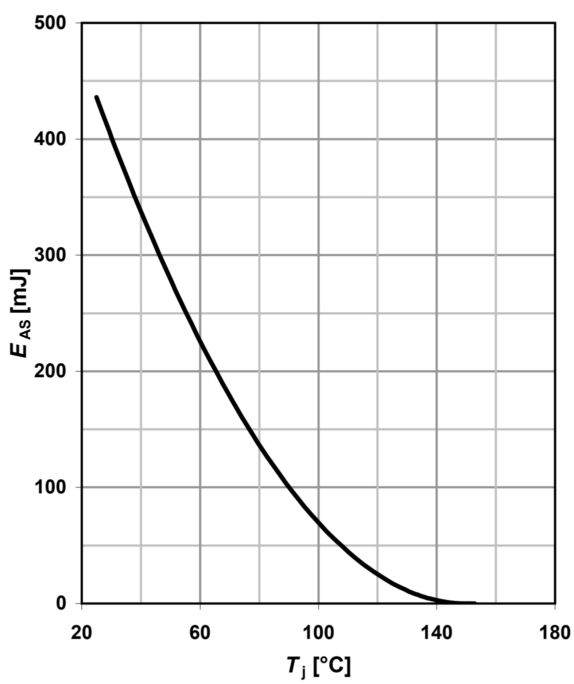
$I_F$=f($V_{SD}$)

parameter: $T_j$



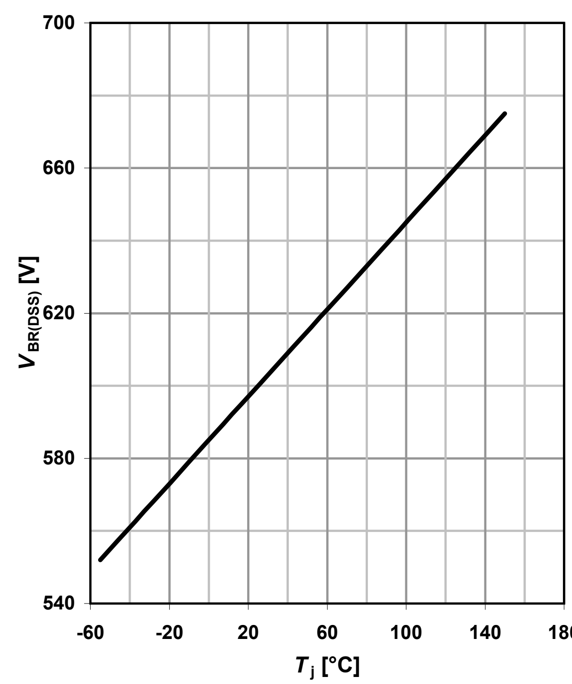

### 11 Avalanche energy

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



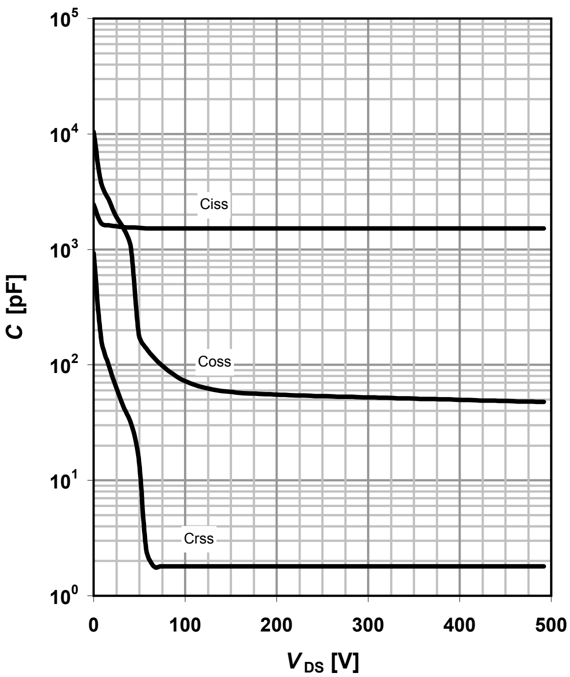

### 12 Drain-source breakdown voltage

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



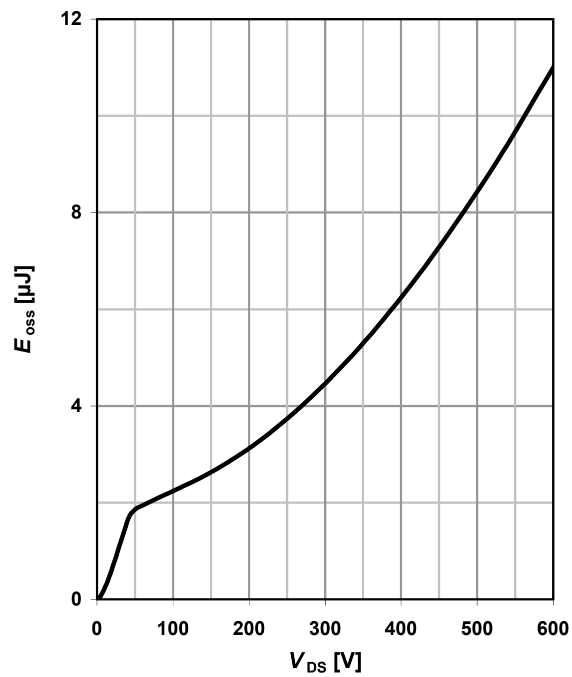
**13 Typ. capacitances**

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

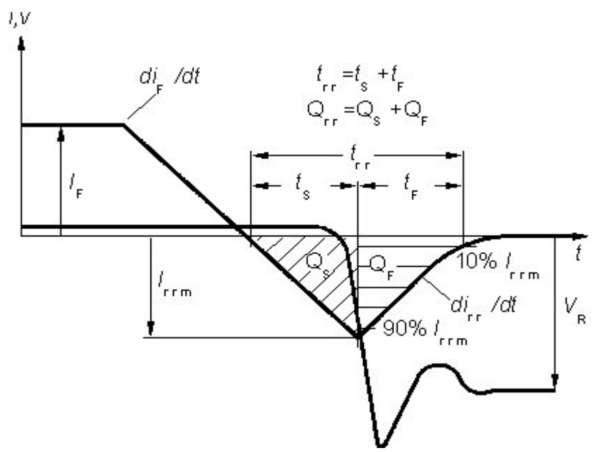



**14 Typ. Coss stored energy**

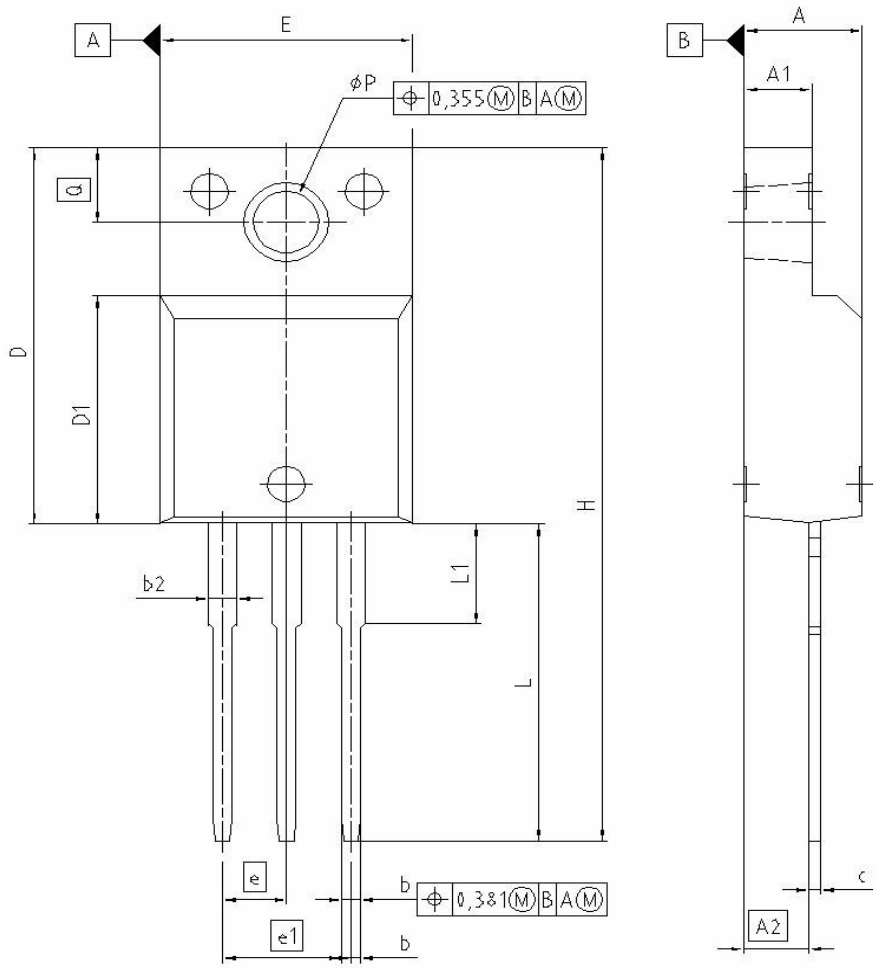
$E_{oss}=f(V_{DS})$



**Definition of diode switching characteristics**



**PG-TO220-3-31: Outline/Fully isolated package (2500VAC; 1 minute)**




| DIM | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 4.572 | 4.826 | 0.180 | 0.190 |
| A1 | 2.573 | 2.827 | 0.101 | 0.111 |
| A2 | 2.514 | 2.616 | 0.099 | 0.103 |
| b | 0.649 | 0.776 | 0.025 | 0.030 |
| b2 | 1.143 | 1.509 | 0.045 | 0.059 |
| c | 0.449 | 0.627 | 0.017 | 0.027 |
| D | 15.863 | 16.117 | 0.624 | 0.634 |
| D1 | 9.554 | 9.808 | 0.376 | 0.386 |
| E | 10.373 | 10.627 | 0.408 | 0.418 |
| e | 2.540 | | 0.100 | |
| e1 | 5.080 | | 0.200 | |
| N | 3 | | 3 | |
| H | 29.463 | 29.717 | 1.160 | 1.170 |
| L | 13.473 | 13.727 | 0.530 | 0.540 |
| L1 | 3.175 | 3.429 | 0.125 | 0.135 |
| øP | 2.949 | 3.025 | 0.119 | 0.116 |
| Q | 3.149 | 3.251 | 0.124 | 0.128 |

**REFERENCE**
../..

**SCALE**
0 2.5 5mm

**EUROPEAN PROJECTION**

**ISSUE DATE**
17-08-2005

**FILE**
TO220_2

Dimensions in mm/inches

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