

CoolMOS™ Power Transistor
Features

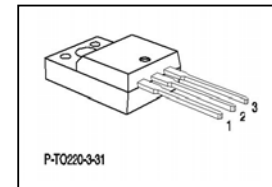
- Lowest figure-of-merit $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified according to JEDEC⁽¹⁾ for target applications
- Pb-free lead plating; RoHS compliant

CoolMOS CP is specially designed for:

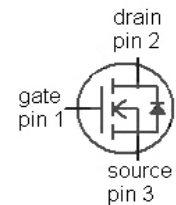
- Hard switching SMPS topologies

Product Summary

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

PG-TO220-3-31


| Type | Package | Ordering Code | Marking |
|-------------|---------------|---------------|---------|
| IPA60R165CP | PG-TO220-3-31 | SP000096437 | 6R165P |


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

| Parameter | Symbol | Conditions | Value | Unit |
|---|----------------|---|-------------|--------------------|
| Continuous drain current ⁽²⁾ | I_D | $T_C=25\text{ °C}$ | 21 | A |
| | | $T_C=100\text{ °C}$ | 13 | |
| Pulsed drain current ⁽³⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 61 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=7.9\text{ A}$, $V_{DD}=50\text{ V}$ | 522 | mJ |
| Avalanche energy, repetitive t_{AR} ^(3,4) | E_{AR} | $I_D=7.9\text{ A}$, $V_{DD}=50\text{ V}$ | 0.79 | |
| Avalanche current, repetitive t_{AR} ^(3,4) | I_{AR} | | 7.9 | A |
| MOSFET dv/dt ruggedness | dv/dt | $V_{DS}=0\dots480\text{ V}$ | 50 | V/ns |
| Gate source voltage | V_{GS} | static | ± 20 | V |
| | | AC ($f>1\text{ Hz}$) | ± 30 | |
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 34 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 150 | $^{\circ}\text{C}$ |
| Mounting torque | | M2.5 screws | 50 | Ncm |

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

| Parameter | Symbol | Conditions | Value | Unit |
|--|---------------|--------------------|-------|------|
| Continuous diode forward current ²⁾ | I_S | $T_C=25\text{ °C}$ | 21 | A |
| Diode pulse current ³⁾ | $I_{S,pulse}$ | | 61 | |
| Reverse diode dv/dt ⁵⁾ | dv/dt | | 15 | V/ns |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Thermal characteristics

| | | | | | | |
|--|------------|---------------------------------------|---|---|------|-----|
| Thermal resistance, junction - case | R_{thJC} | | - | | 3.65 | 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 $T_j=25\text{ °C}$, 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 | $V_{GS(th)}$ | $V_{DS}=V_{GS}$, $I_D=0.79\text{ mA}$ | 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 | μA |
| | | $V_{DS}=25\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$ | - | 10 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}$, $I_D=12\text{ A}$, $T_j=25\text{ °C}$ | - | 0.15 | 0.165 | Ω |
| | | $V_{GS}=10\text{ V}$, $I_D=12\text{ A}$, $T_j=150\text{ °C}$ | - | 0.40 | - | |
| Gate resistance | R_G | $f=1\text{ MHz}$, open drain | - | 1.9 | - | Ω |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Dynamic characteristics

| | | | | | | |
|--|--------------|---|---|------|---|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$ | - | 2000 | - | pF |
| Output capacitance | C_{oss} | | - | 100 | - | |
| Effective output capacitance, energy related ⁶⁾ | $C_{o(er)}$ | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V | - | 83 | - | |
| Effective output capacitance, time related ⁷⁾ | $C_{o(tr)}$ | | - | 220 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=12\text{ A},$ $R_G=3.3\ \Omega$ | - | 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} | $V_{DD}=400\text{ V}, I_D=12\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 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} | $V_{GS}=0\text{ V}, I_F=12\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 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⁾ Limited only by maximum temperature

⁴⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

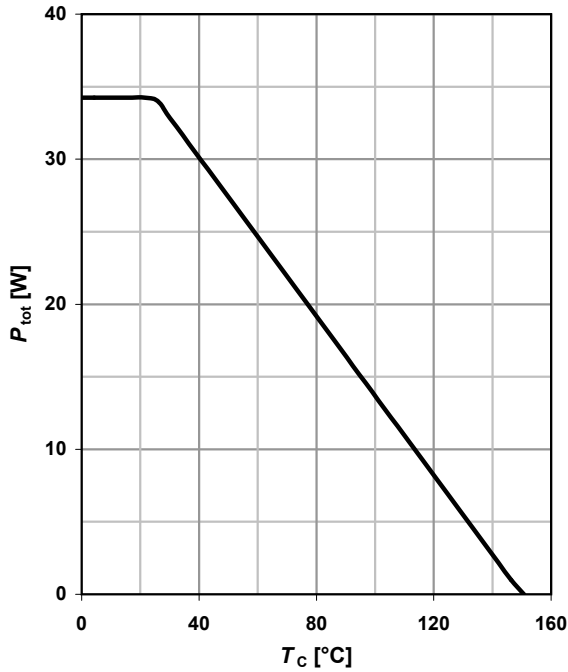
⁵⁾ $I_{SD} \leq I_D, di/dt \leq 200\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$, identical low side and high side switch.

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

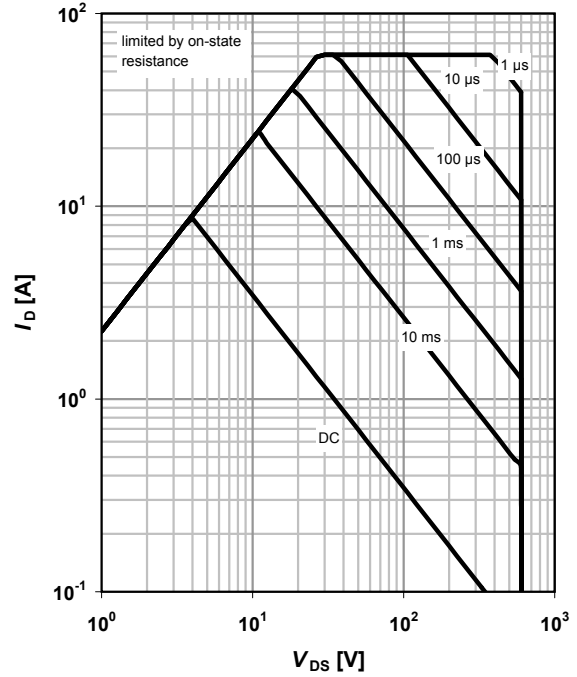
$$P_{tot} = f(T_C)$$



2 Safe operating area

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

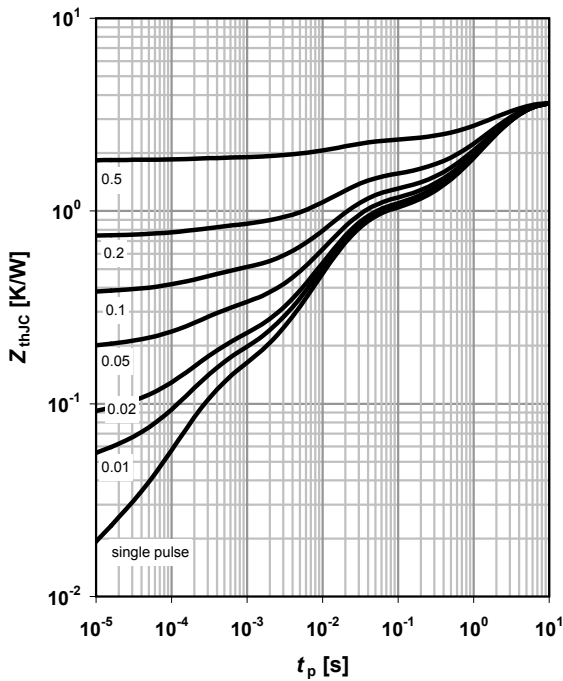
parameter: t_p



3 Max. transient thermal impedance

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

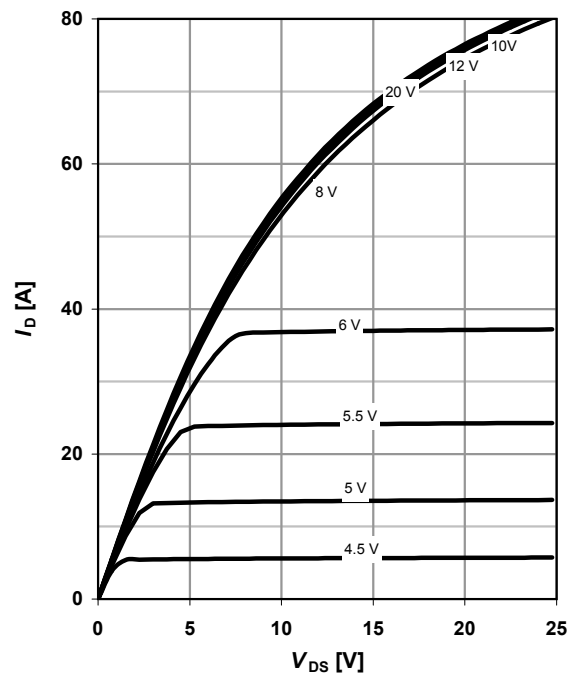
parameter: $D = t_p / T$



4 Typ. output characteristics

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

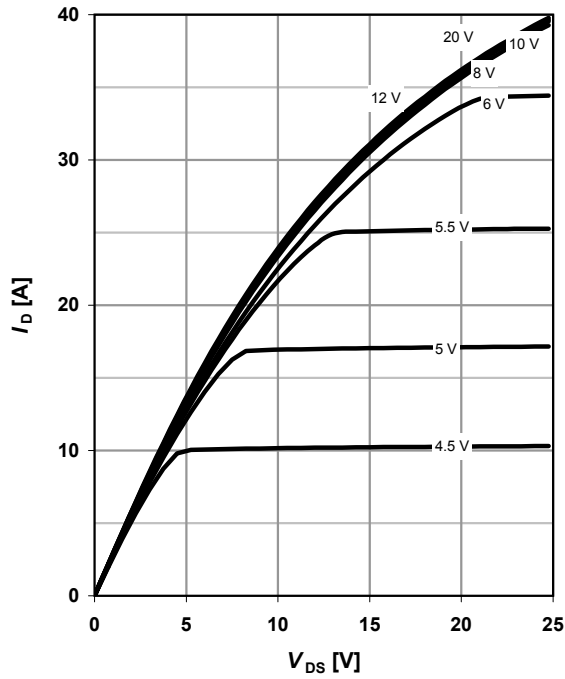
parameter: V_{GS}



5 Typ. output characteristics

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

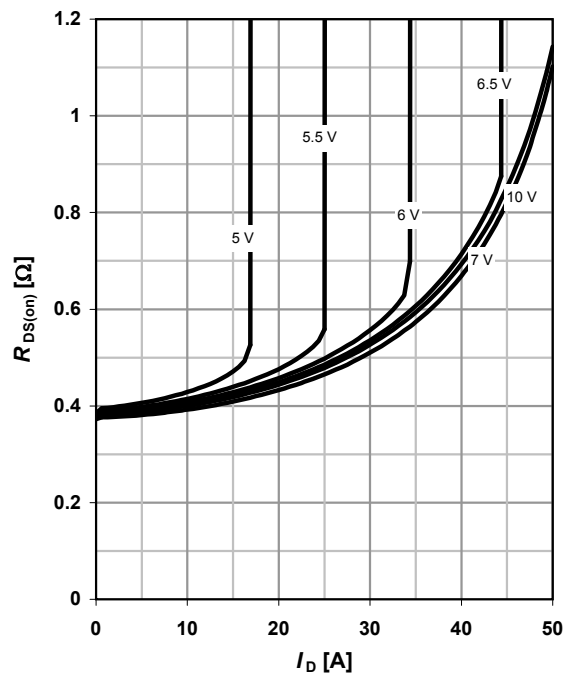
parameter: V_{GS}



6 Typ. drain-source on-state resistance

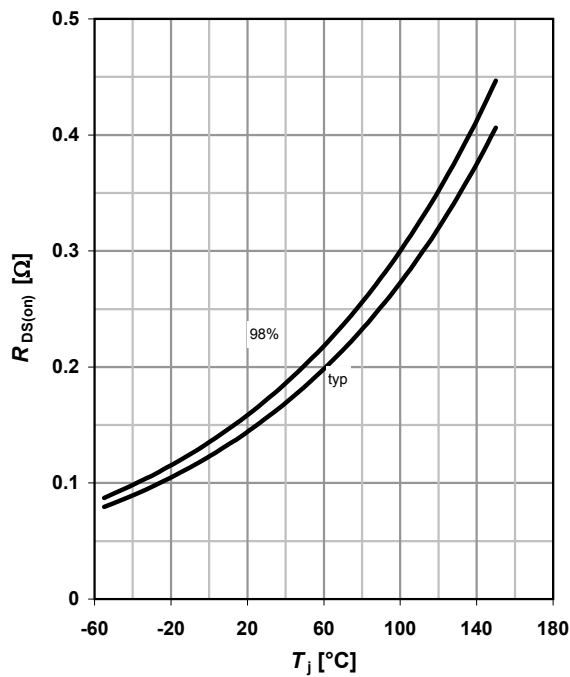
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

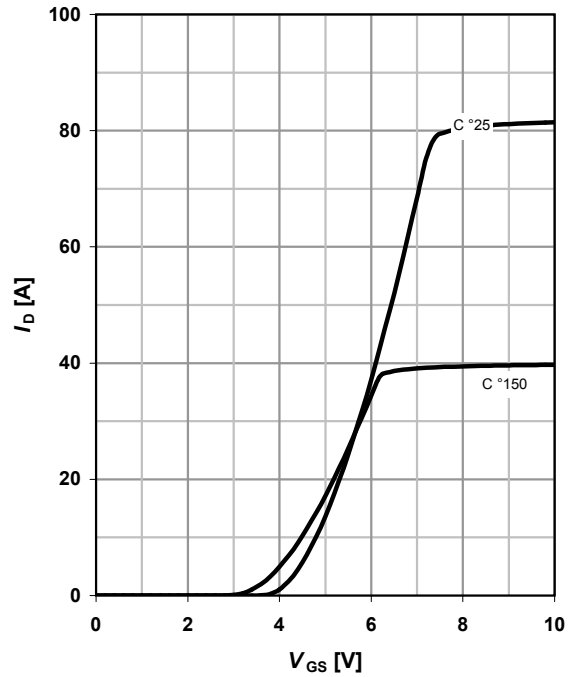
$R_{DS(on)} = f(T_j); I_D = 12\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

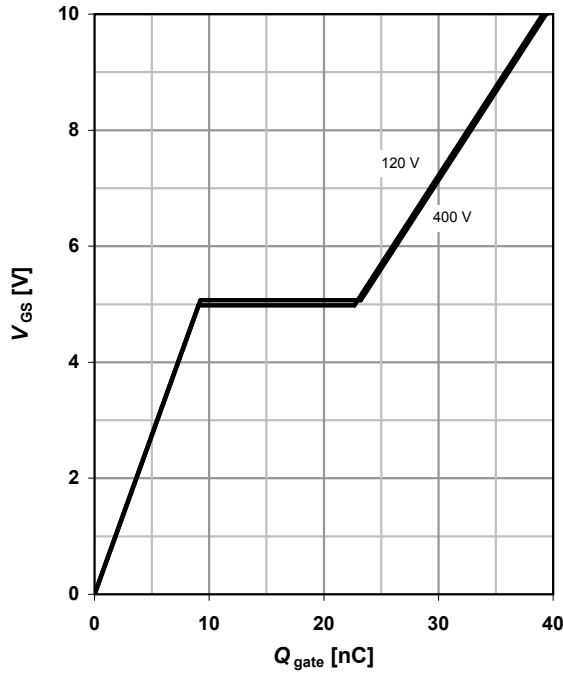
parameter: T_j



9 Typ. gate charge

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

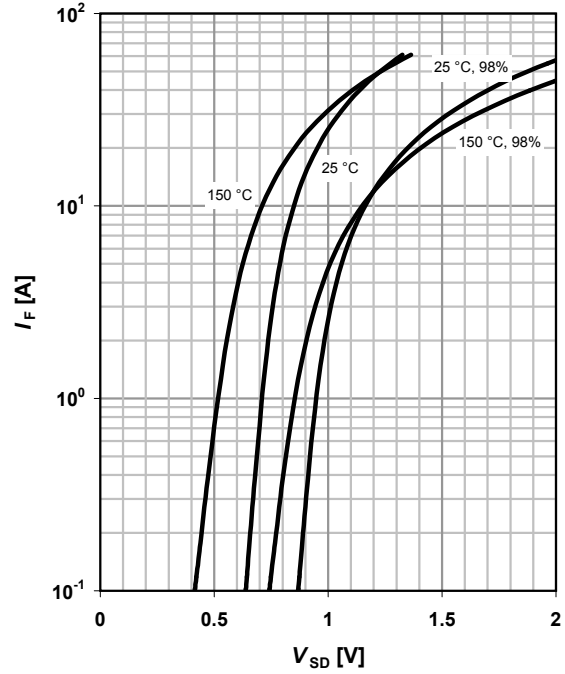
parameter: V_{DD}



10 Forward characteristics of reverse diode

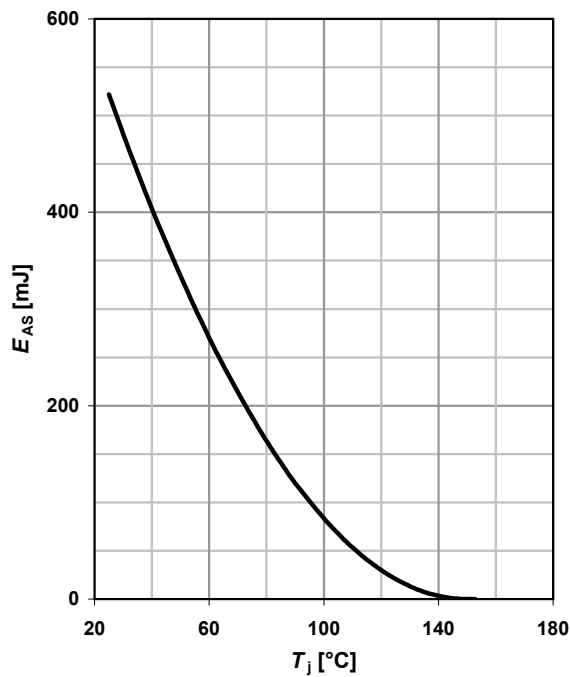
$I_F=f(V_{SD})$

parameter: T_j



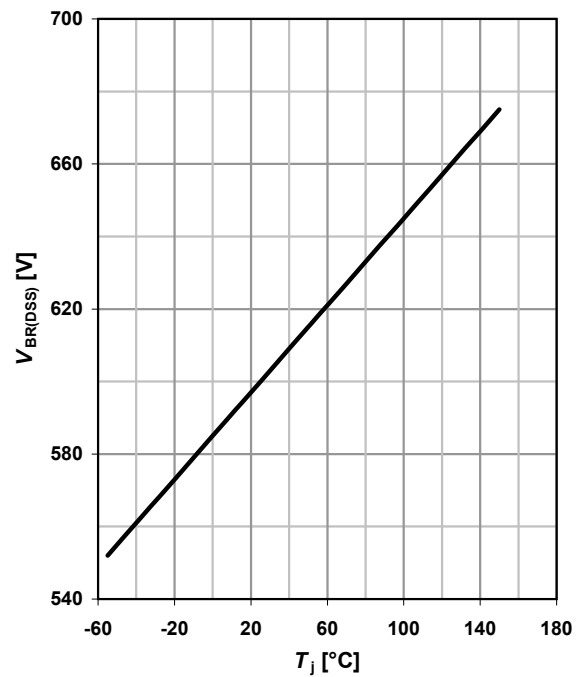
11 Avalanche energy

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



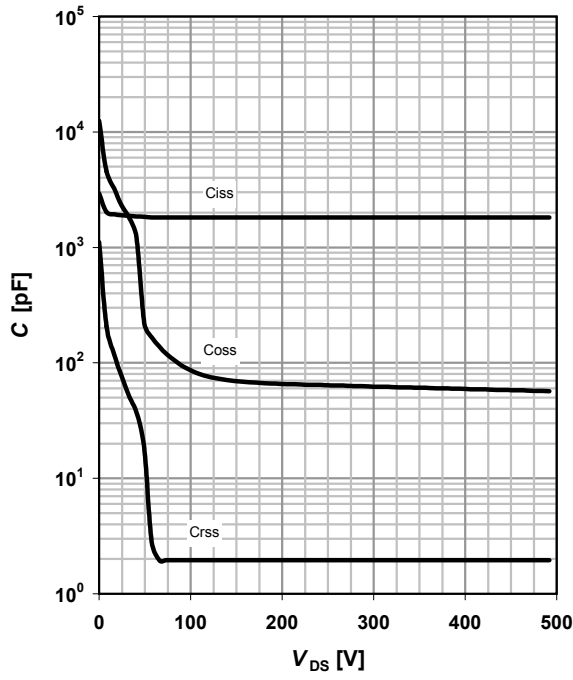
12 Drain-source breakdown voltage

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



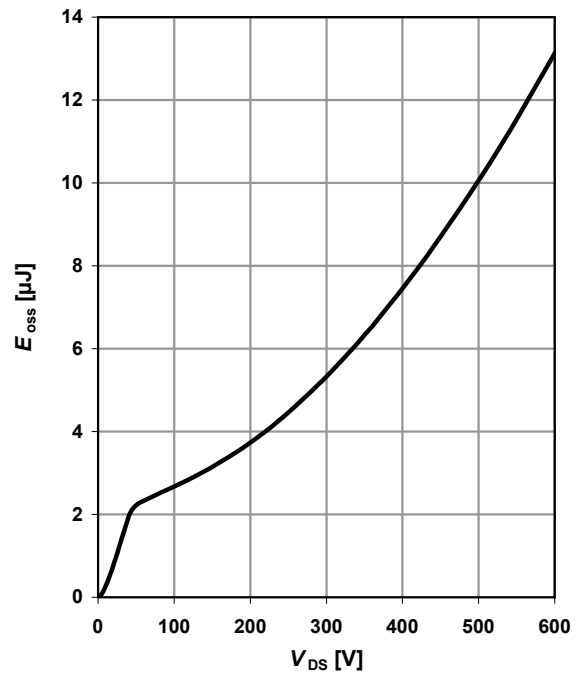
13 Typ. capacitances

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



14 Typ. Coss stored energy

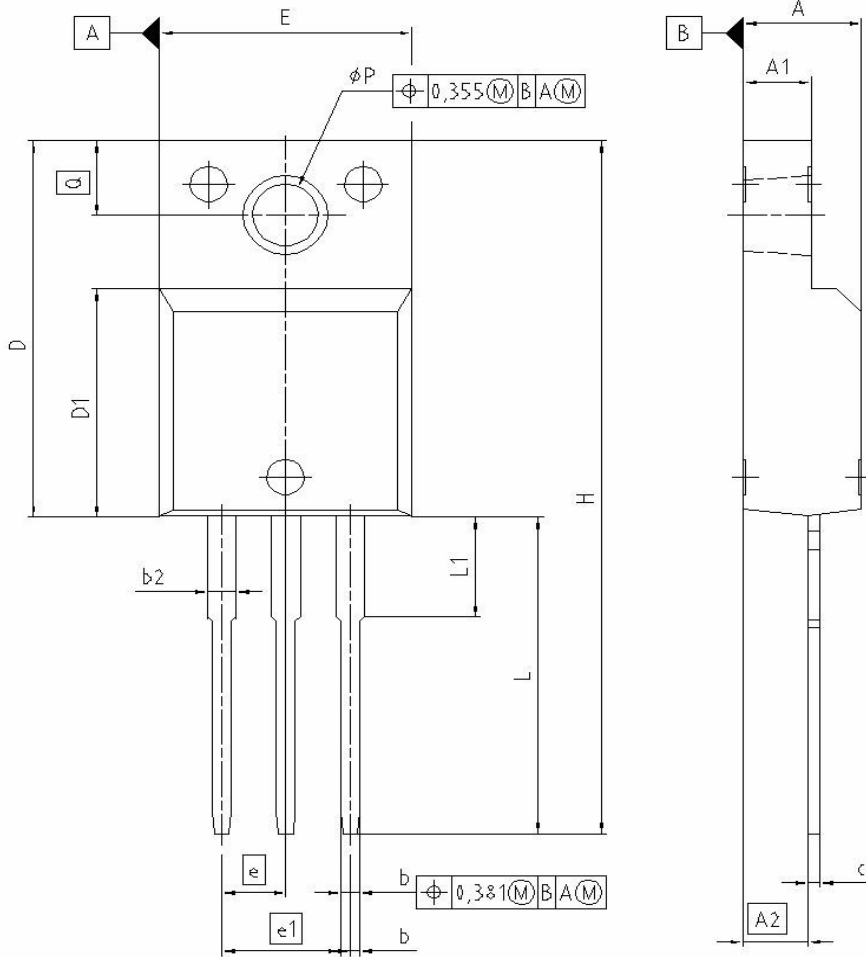
$E_{oss}=f(V_{DS})$



Definition of diode switching characteristics



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

EUROPEAN PROJECTION

ISSUE DATE
17-08-2005

FILE
TO220_2

Dimensions in mm/inches

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