

CoolMOS™ Power Transistor
Features

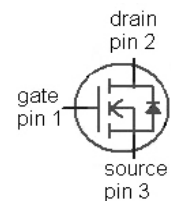
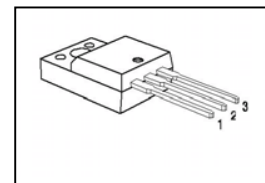
- Worldwide best $R_{DS(on)}$ in TO220
- Lowest figure of merit $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Pb-free lead plating; RoHS compliant; Halogen free for mold compound
- Qualified for industrial grade applications according to JEDEC⁰⁾

Product Summary

| | | |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 550 | V |
| $R_{DS(on),max}$ | 0.140 | Ω |
| $Q_{g,typ}$ | 48 | nC |

CoolMOS CP is designed for:

- Hard and softswitching SMPS for server power supplies
- CCM PFC for ATX, Notebook adapter, PDP and LCD TV
- PWM stages for Server, Adapter

TO- 220 FP


| Type | Package | Marking |
|-------------|------------|---------|
| IPA50R140CP | PG-TO220FP | 5R140P |

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

| Parameter | Symbol | Conditions | Value | Unit |
|---|----------------|---|-------------|--------------------|
| Continuous drain current ¹⁾ | I_D | $T_C=25\text{ °C}$ | 23 | A |
| | | $T_C=100\text{ °C}$ | 15 | |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 56 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=9.3\text{ A}$, $V_{DD}=50\text{ V}$ | 616 | mJ |
| Avalanche energy, repetitive t_{AR} ^{2),3)} | E_{AR} | $I_D=9.3\text{ A}$, $V_{DD}=50\text{ V}$ | 0.93 | |
| Avalanche current, repetitive t_{AR} ^{2),3)} | I_{AR} | | 9.3 | A |
| MOSFET dv/dt ruggedness | dv/dt | $V_{DS}=0\dots 400\text{ V}$ | 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 ¹⁾ | I_S | $T_C=25\text{ °C}$ | 14 | A |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | | 56 | |
| 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} | | - | - | 3.65 | 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 $T_j=25\text{ °C}$, 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 | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=0.93\text{ mA}$ | 2.5 | 3 | 3.5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$ | - | - | 2 | μA |
| | | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$ | - | 20 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}, I_D=14\text{ A}, T_j=25\text{ °C}$ | - | 0.13 | 0.14 | Ω |
| | | $V_{GS}=10\text{ V}, I_D=14\text{ A}, T_j=150\text{ °C}$ | - | 0.32 | - | |
| Gate resistance | R_G | $f=1\text{ MHz}, \text{open drain}$ | - | 2.2 | - | Ω |

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

Dynamic characteristics

| | | | | | | |
|--|--------------|--|---|------|---|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$ | - | 2540 | - | pF |
| Output capacitance | C_{oss} | | - | 110 | - | |
| Effective output capacitance, energy related ⁵⁾ | $C_{o(er)}$ | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 400 V | - | 110 | - | |
| Effective output capacitance, time related ⁶⁾ | $C_{o(tr)}$ | | - | 230 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=14\text{ A},$ $R_G=12.2\ \Omega$ | - | 35 | - | ns |
| Rise time | t_r | | - | 14 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 80 | - | |
| Fall time | t_f | | - | 8.0 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|---------------|---|---|-----|----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=400\text{ V}, I_D=14\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 11 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 15 | - | |
| Gate charge total | Q_g | | - | 48 | 64 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.2 | - | V |

Reverse Diode

| | | | | | | |
|-------------------------------|-----------|---|---|-----|-----|---------------|
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=14\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 400 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 5.6 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 26 | - | A |

⁰⁾ J-STD20 and JESD22

¹⁾ Limited only by $T_{j,max}$
²⁾ Pulse width t_p limited by $T_{j,max}$
³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

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

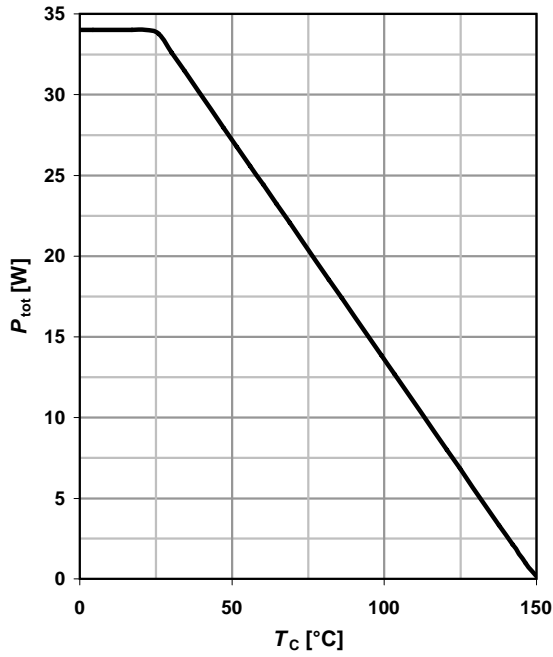
⁵⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

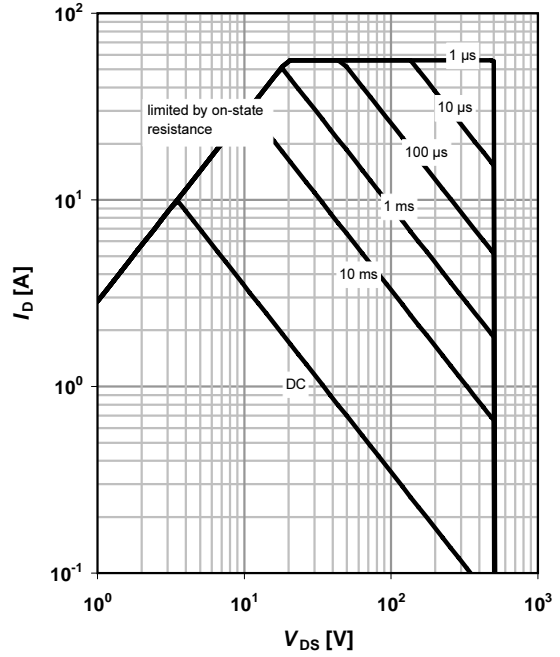
$P_{tot}=f(T_C)$



2 Safe operating area

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

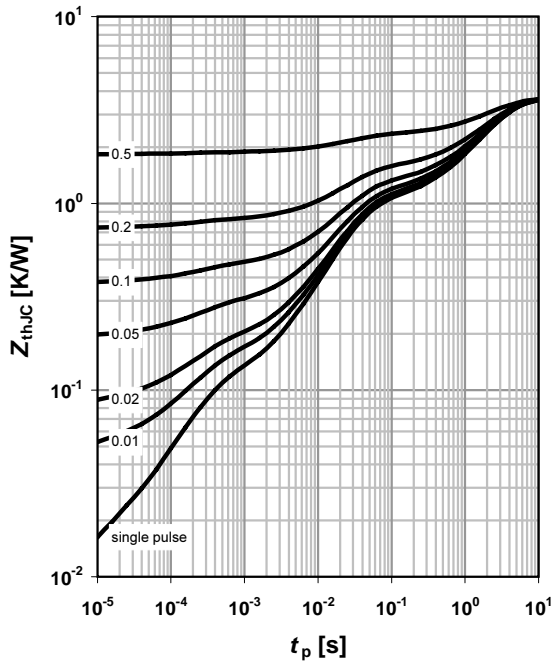
parameter: t_p



3 Max. transient thermal impedance

$Z_{(th)JC}=f(t_p)$

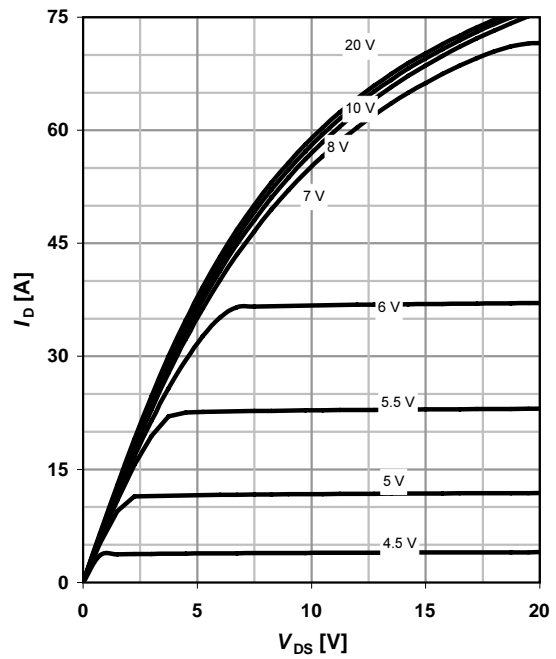
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_J=25\text{ °C}$

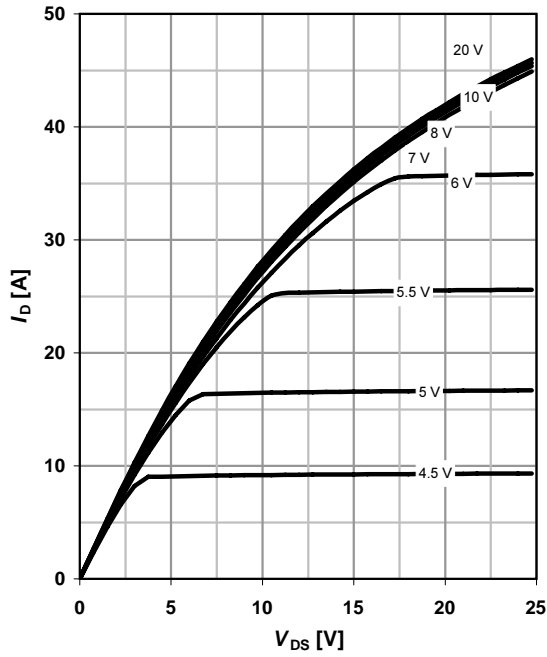
parameter: V_{GS}



5 Typ. output characteristics

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

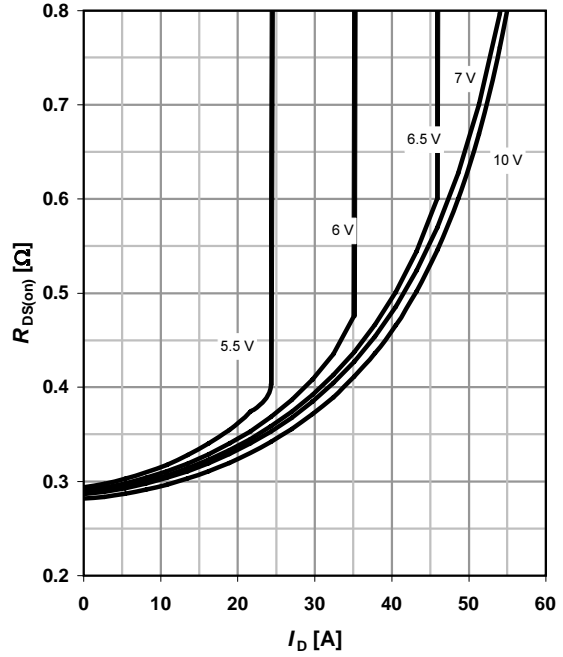
parameter: V_{GS}



6 Typ. drain-source on-state resistance

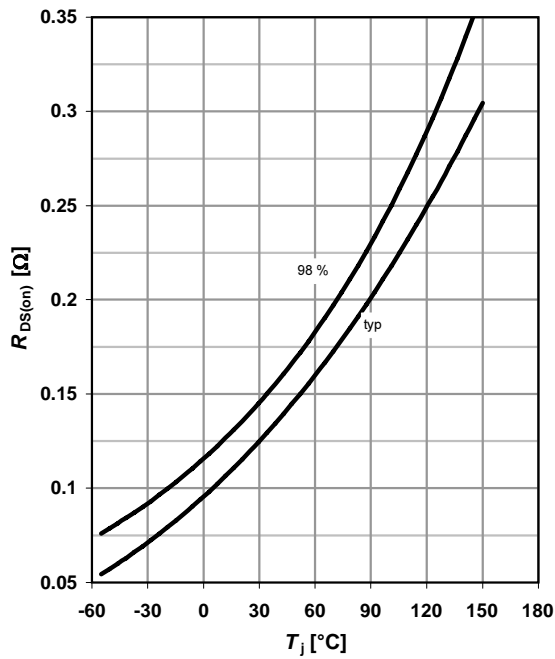
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter: V_{GS}



7 Drain-source on-state resistance

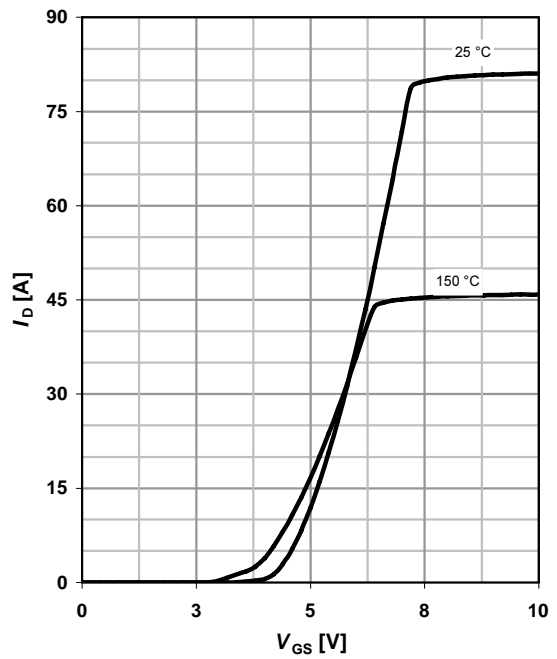
$R_{DS(on)} = f(T_j); I_D = 14\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

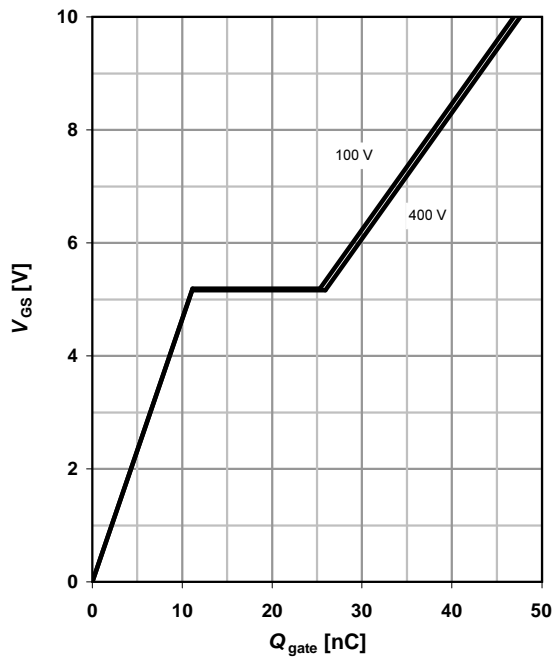
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=14\text{ A pulsed}$

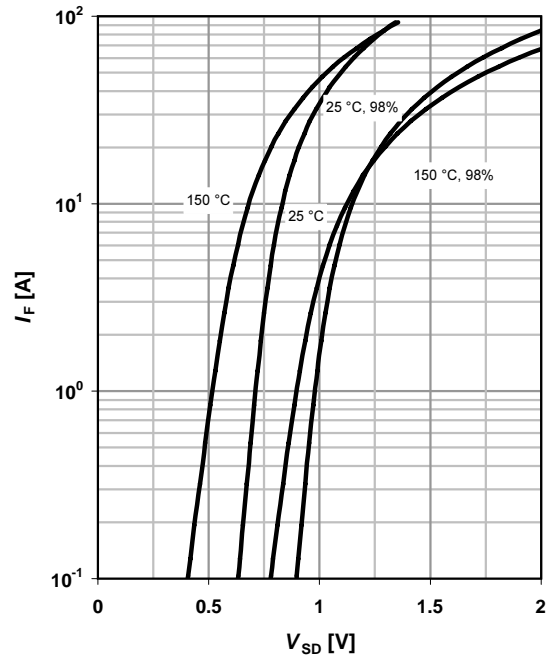
parameter: V_{DD}



10 Forward characteristics of reverse diode

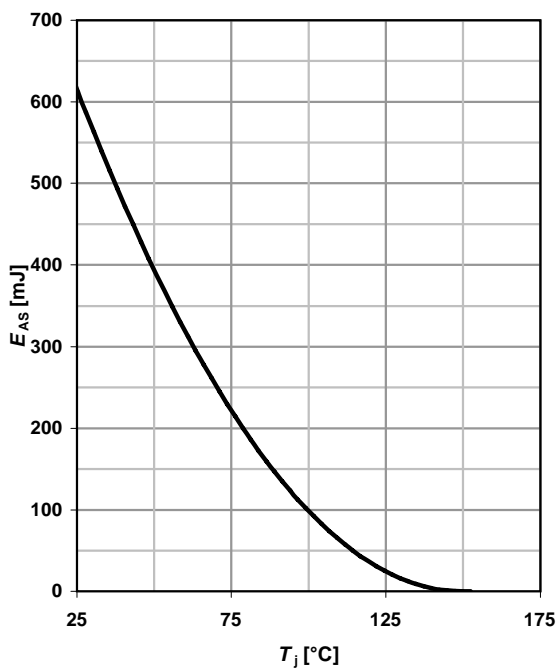
$I_F=f(V_{SD})$

parameter: T_j



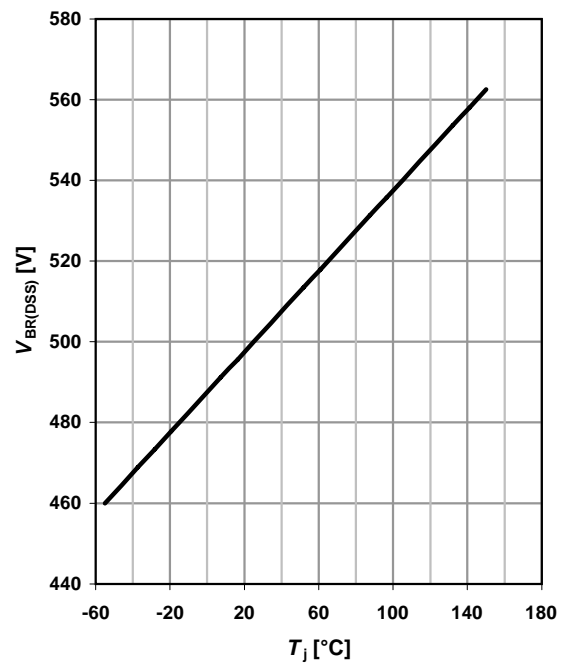
11 Avalanche energy

$E_{AS}=f(T_j); I_D=9.3\text{ A}; V_{DD}=50\text{ V}$



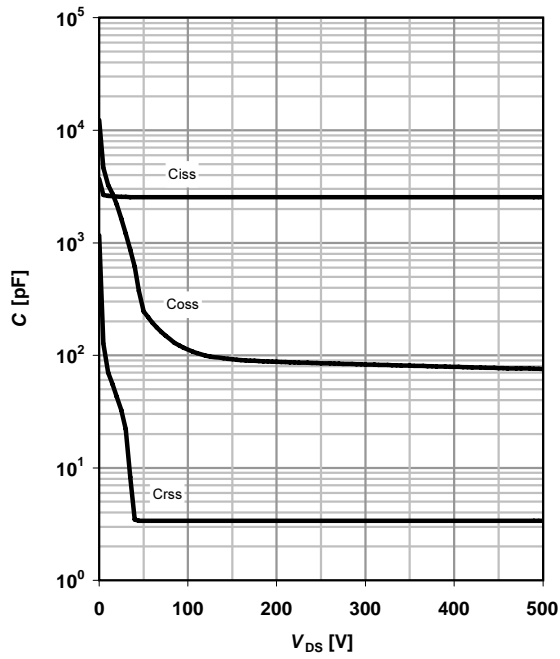
12 Drain-source breakdown voltage

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



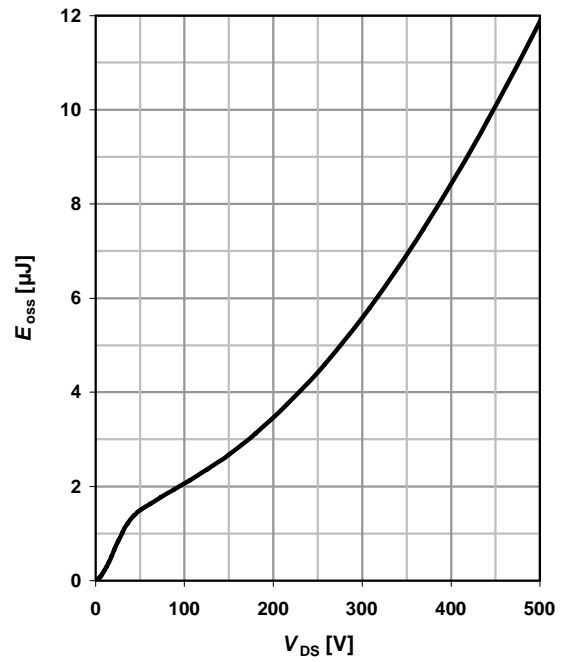
13 Typ. capacitances

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

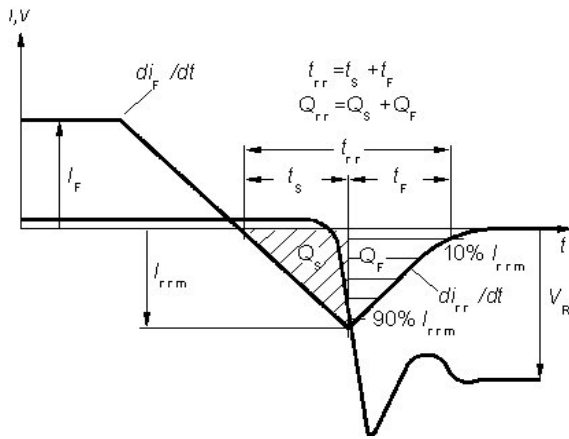


14 Typ. Coss stored energy

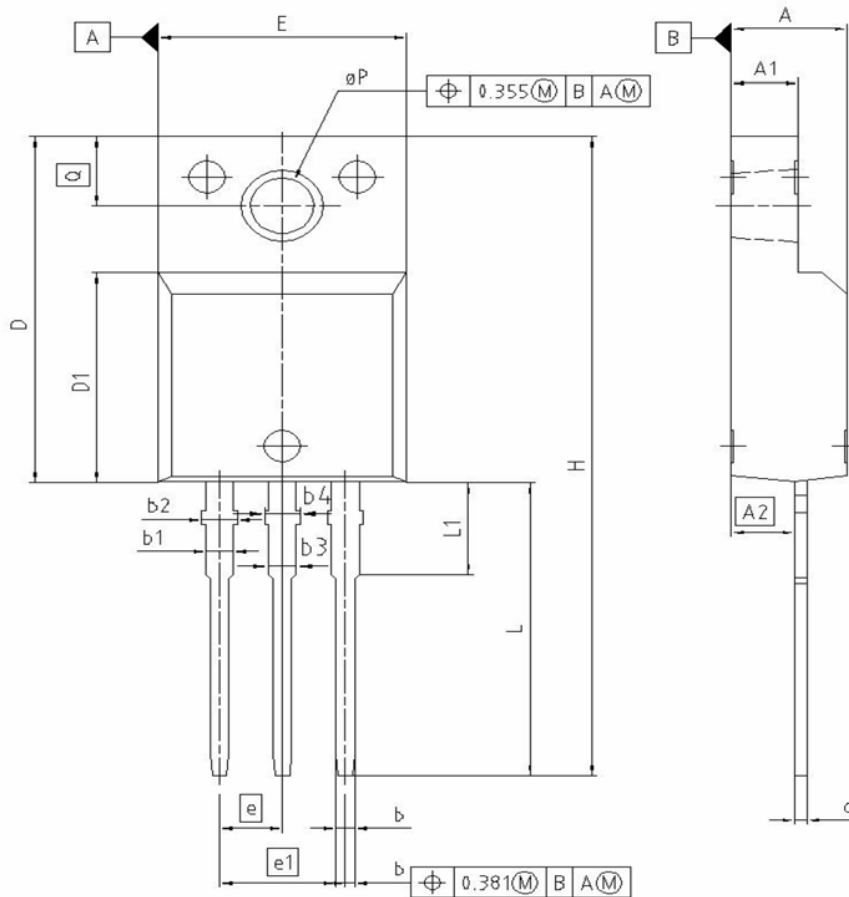
$$E_{oss}=f(V_{DS})$$



Definition of diode switching characteristics



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



| DIM | MILLIMETERS | | INCHES | |
|-------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.55 | 4.85 | 0.179 | 0.191 |
| A1 | 2.55 | 2.85 | 0.100 | 0.112 |
| A2 | 2.42 | 2.72 | 0.095 | 0.107 |
| b | 0.65 | 0.85 | 0.026 | 0.033 |
| b1 | 0.95 | 1.33 | 0.037 | 0.052 |
| b2 | 0.95 | 1.51 | 0.037 | 0.059 |
| b3 | 0.65 | 1.33 | 0.026 | 0.052 |
| b4 | 0.65 | 1.51 | 0.026 | 0.059 |
| c | 0.40 | 0.63 | 0.016 | 0.025 |
| D | 15.85 | 16.15 | 0.624 | 0.636 |
| D1 | 9.53 | 9.83 | 0.375 | 0.387 |
| E | 10.35 | 10.65 | 0.407 | 0.419 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H | 29.45 | 29.75 | 1.159 | 1.171 |
| L | 13.45 | 13.75 | 0.530 | 0.541 |
| L1 | 3.15 | 3.45 | 0.124 | 0.136 |
| phi P | 2.95 | 3.20 | 0.116 | 0.126 |
| Q | 3.15 | 3.50 | 0.124 | 0.138 |

REFERENCE
J..

SCALE
0 2.5 5mm

EUROPEAN PROJECTION

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