

CoolMOS™ Power Transistor
Features

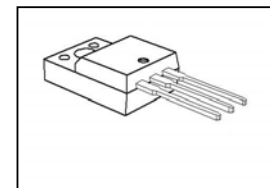
- Lowest figure-of-merit $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified according to JEDEC¹⁾ for target applications
- Pb-free lead plating; RoHS compliant

CoolMOS CP is designed for:

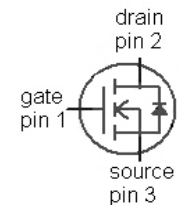
- Hard switching SMPS topologies

Product Summary

| | | |
|-------------------------------------|-------|----------|
| $V_{DS} @ T_{j,max}$ | 650 | V |
| $R_{DS(on),max} @ T_j = 25^\circ C$ | 0.520 | Ω |
| $Q_{g,typ}$ | 24 | nC |

PG-TO220 FP


| Type | Package | Marking |
|-------------|-------------|---------|
| IPA60R520CP | PG-TO220 FP | 6R520P |


Maximum ratings, at $T_j=25^\circ C$, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|---|----------------|--------------------------|-------------|------------|
| Continuous drain current ²⁾ | I_D | $T_C=25^\circ C$ | 6.8 | A |
| | | $T_C=100^\circ C$ | 4.3 | |
| Pulsed drain current ³⁾ | $I_{D,pulse}$ | $T_C=25^\circ C$ | 17 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=2.5 A, V_{DD}=50 V$ | 166 | mJ |
| Avalanche energy, repetitive t_{AR} ^{3),4)} | E_{AR} | $I_D=2.5 A, V_{DD}=50 V$ | 0.25 | |
| Avalanche current, repetitive t_{AR} ^{3),4)} | I_{AR} | | 2.5 | 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} | $T_C=25^\circ C$ | 30 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 150 | $^\circ C$ |

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

| Parameter | Symbol | Conditions | Value | Unit |
|--|---------------|--------------------------------|-------|------|
| Continuous diode forward current ²⁾ | I_S | $T_C=25\text{ }^\circ\text{C}$ | 3.8 | A |
| Diode pulse current ³⁾ | $I_{S,pulse}$ | | 17 | |
| 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} | | - | - | 4.2 | 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 | $^\circ\text{C}$ |

Electrical characteristics, at $T_j=25\text{ }^\circ\text{C}$, unless otherwise specified
Static characteristics

| | | | | | | |
|----------------------------------|---------------|---|-----|------|------|---------------|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$, $I_D=250\text{ }\mu\text{A}$ | 600 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}=V_{GS}$, $I_D=0.25\text{ mA}$ | 2.5 | 3 | 3.5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ }^\circ\text{C}$ | - | - | 1 | μA |
| | | $V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ }^\circ\text{C}$ | - | 10 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}$, $I_D=3.8\text{ A}$, $T_j=25\text{ }^\circ\text{C}$ | - | 0.47 | 0.52 | Ω |
| | | $V_{GS}=10\text{ V}$, $I_D=3.8\text{ A}$, $T_j=150\text{ }^\circ\text{C}$ | - | 1.3 | - | |
| Gate resistance | R_G | $f=1\text{ MHz}$, open drain | - | 1.3 | - | Ω |

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

Dynamic characteristics

| | | | | | | |
|--|--------------|---|---|-----|---|----|
| Input capacitance | C_{iss} | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$ | - | 630 | - | pF |
| Output capacitance | C_{oss} | | - | 32 | - | |
| Effective output capacitance, energy related ⁶⁾ | $C_{o(er)}$ | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V | - | 30 | - | |
| Effective output capacitance, time related ⁷⁾ | $C_{o(tr)}$ | | - | 77 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=3.8\text{ A},$ $R_G=14.7\Omega$ | - | 17 | - | ns |
| Rise time | t_r | | - | 12 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 74 | - | |
| Fall time | t_f | | - | 16 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|---------------|--|---|-----|----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=400\text{ V}, I_D=3.8\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 3 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 11 | - | |
| Gate charge total | Q_g | | - | 24 | 31 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 4.7 | - | V |

Reverse Diode

| | | | | | | |
|-------------------------------|-----------|--|---|-----|-----|---------------|
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=3.8\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.8 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 230 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 2.5 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 20 | - | 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 $P_{AV}=E_{AR} \cdot f$.

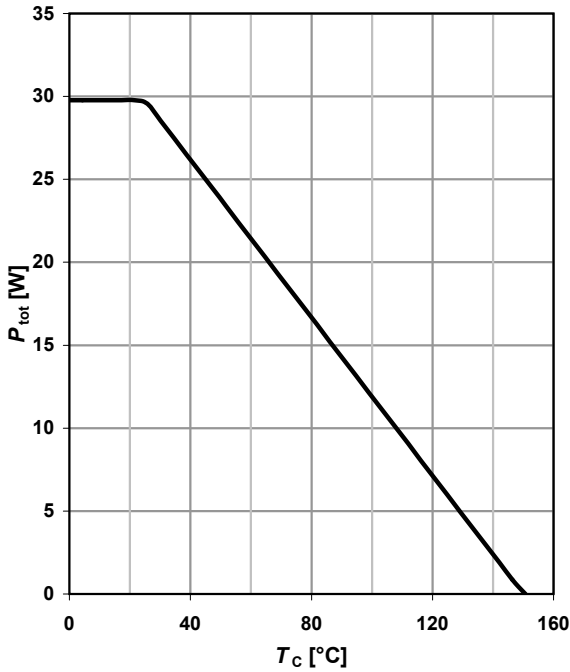
⁵⁾ $I_{SD}=I_D, di/dt \leq 400\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$, identical low side and high side switch

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

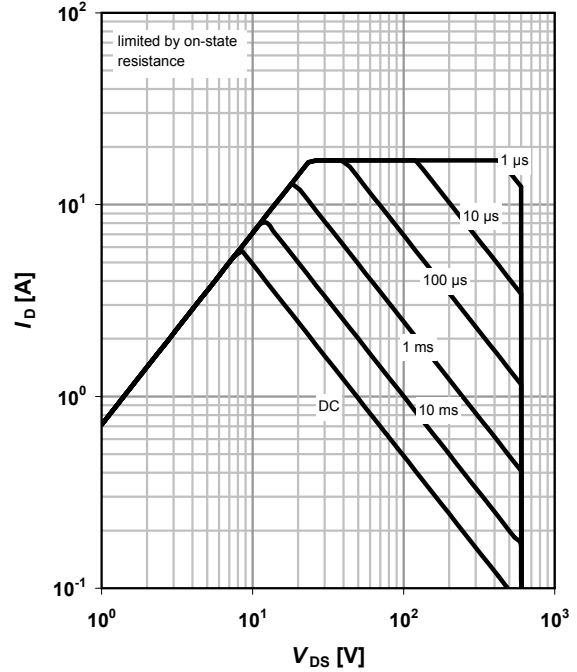
$$P_{tot} = f(T_C)$$



2 Safe operating area

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

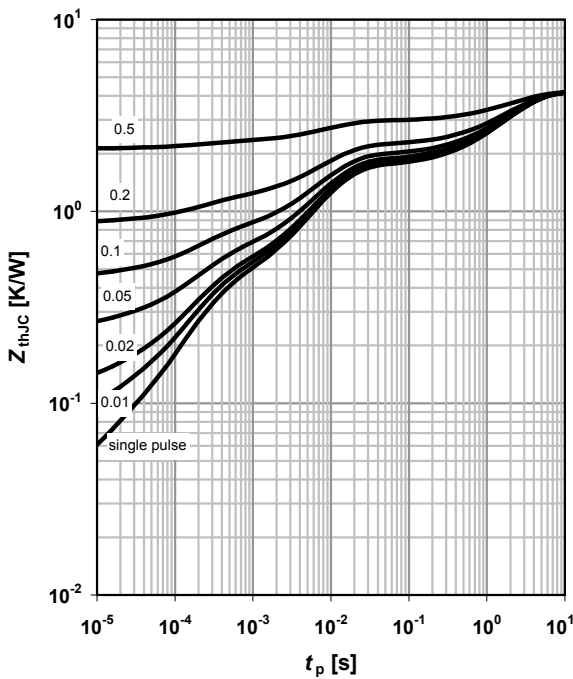
parameter: t_p



3 Max. transient thermal impedance

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

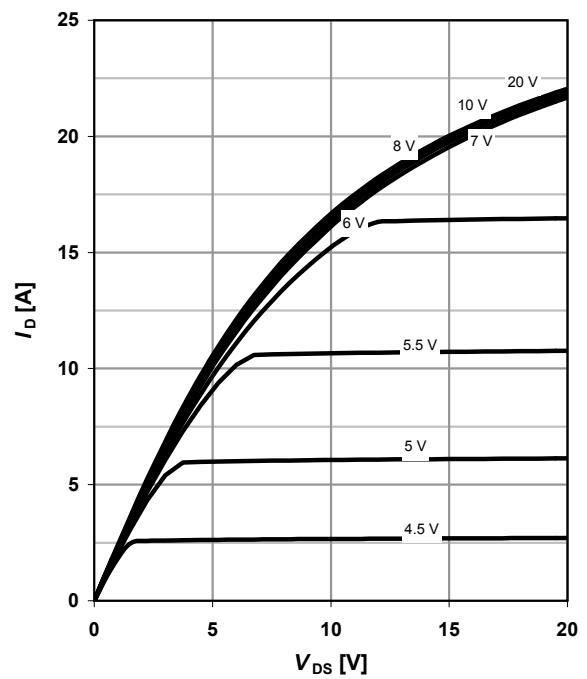
parameter: $D = t_p / T$



4 Typ. output characteristics

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

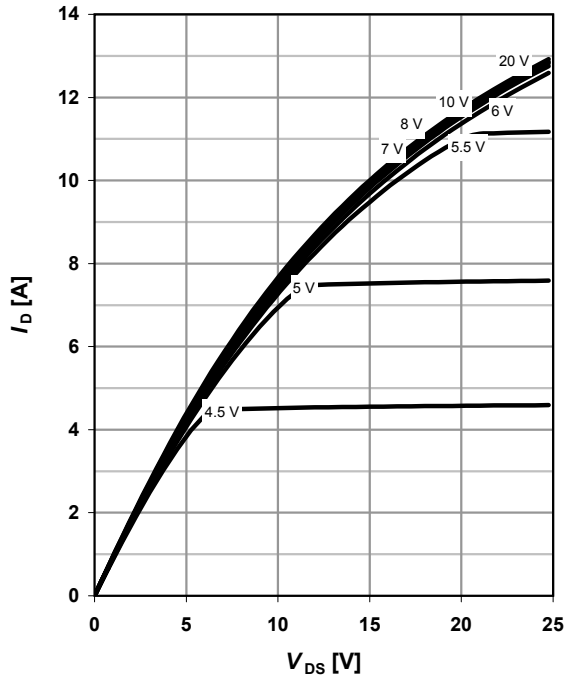
parameter: V_{GS}



5 Typ. output characteristics

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

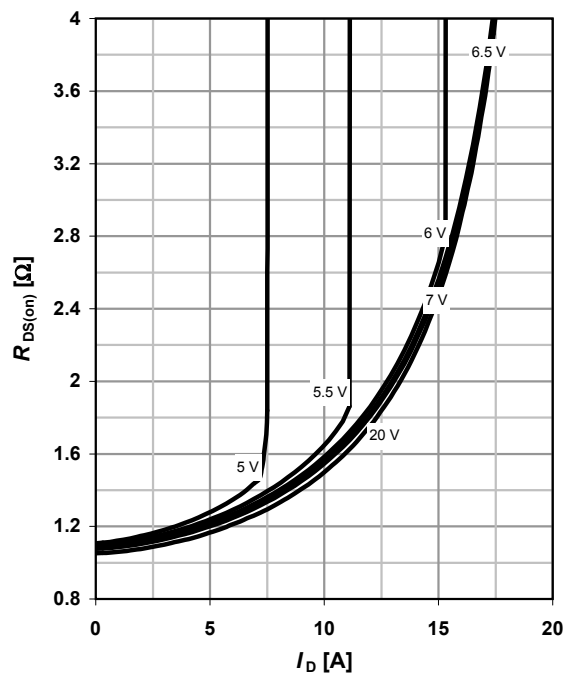
parameter: V_{GS}



6 Typ. drain-source on-state resistance

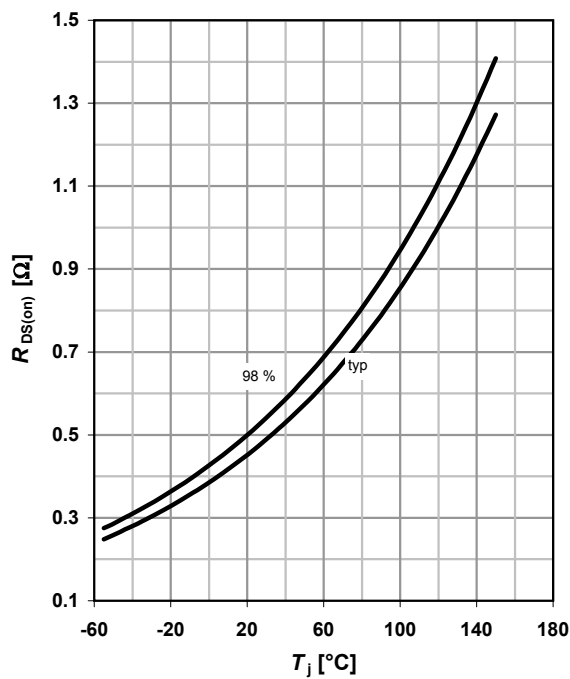
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter: V_{GS}



7 Drain-source on-state resistance

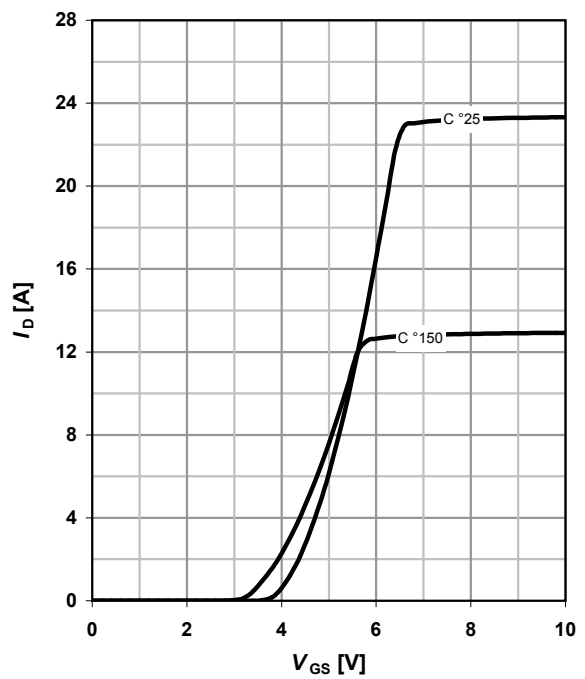
$R_{DS(on)} = f(T_j); I_D = 3.8\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

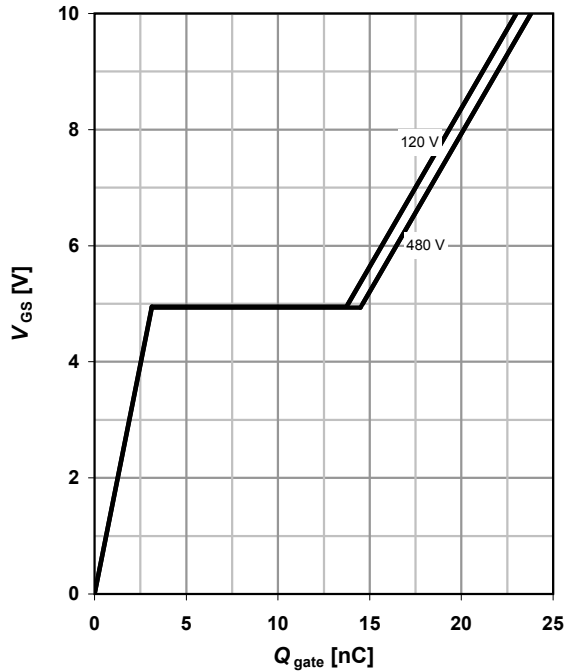
parameter: T_j



9 Typ. gate charge

$V_{GS}=f(Q_{gate}); I_D=3.8\text{ A pulsed}$

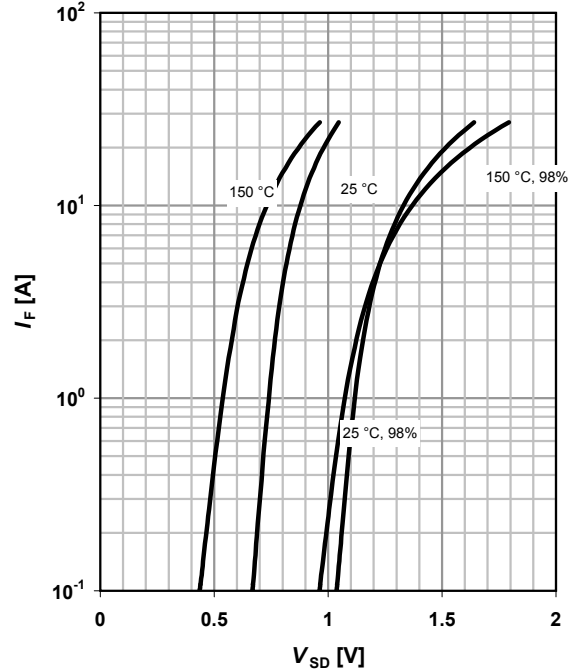
parameter: V_{DD}



10 Forward characteristics of reverse diode

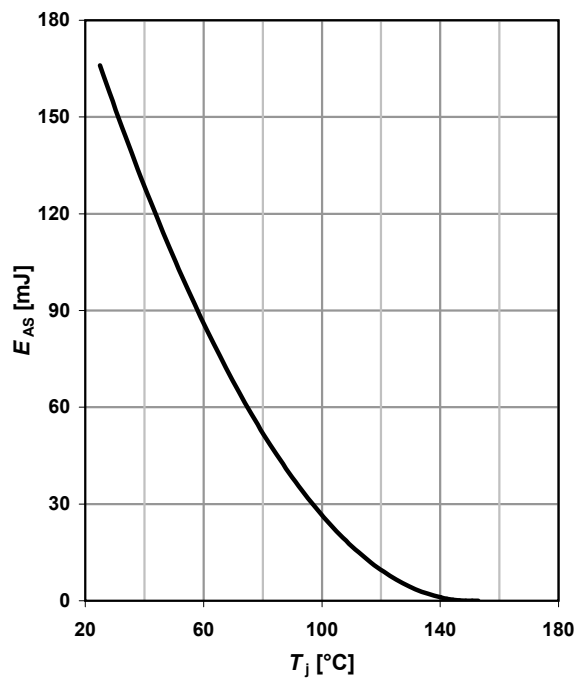
$I_F=f(V_{SD})$

parameter: T_j



11 Avalanche energy

$E_{AS}=f(T_j); I_D=2.5\text{ A}; V_{DD}=50\text{ V}$



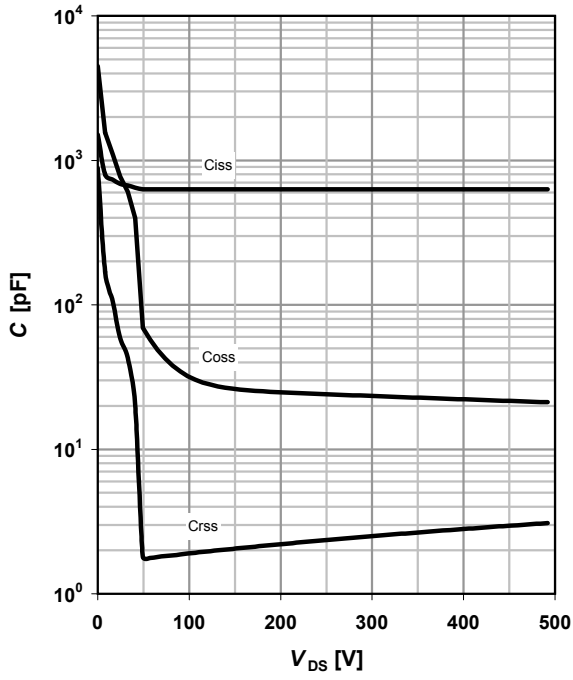
12 Drain-source breakdown voltage

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



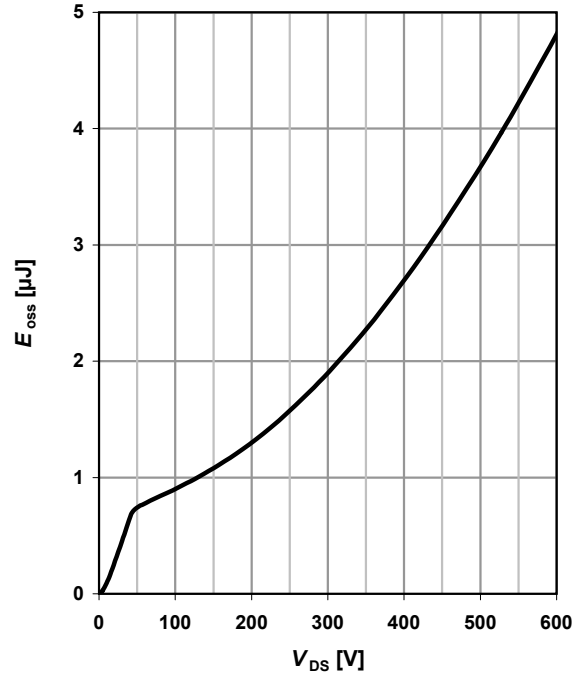
13 Typ. capacitances

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



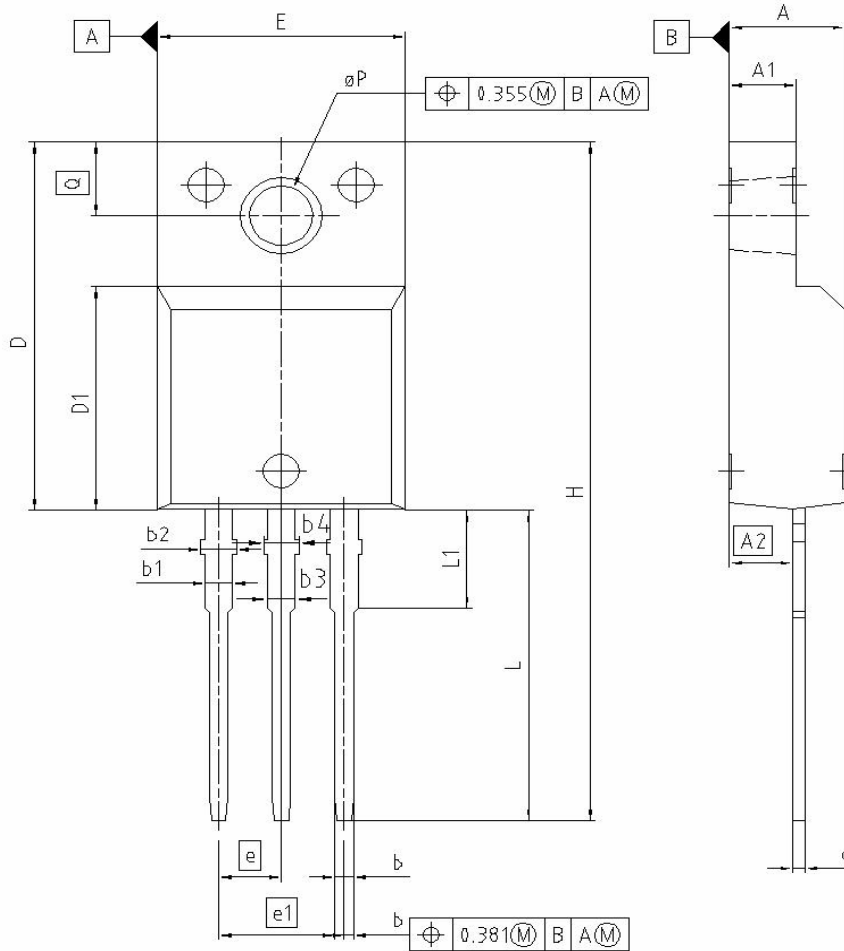
14 Typ. Coss stored energy

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



Definition of diode switching characteristics



PG-TO220 FP-3: Outlines/Fully isolated packages (2500VAC; 1 minute)


| 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 |
| øP | 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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