

CoolMOS™ Power Transistor
Features

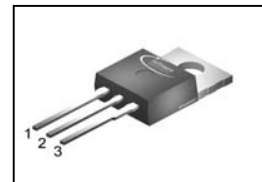
- Lowest figure-of-merit $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Pb-free lead plating; RoHS compliant; Halogen free for mold compound
- Qualified for industrial grade applications according to JEDEC¹⁾

Product Summary

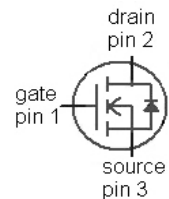
| | | |
|---------------------|-------|----------|
| $V_{DS} @ T_{jmax}$ | 560 | V |
| $R_{DS(on),max}$ | 0.399 | Ω |
| $Q_{g,typ}$ | 17 | nC |

CoolMOS CP is designed for:

- Hard and soft switching SMPS topologies
- DCM PFC for Lamp Ballast
- PWM for Lamp Ballast, LCD & PDP TV

PG-TO220


| Type | Package | Marking |
|-------------|----------|---------|
| IPP50R399CP | PG-TO220 | 5R399P |


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

| Parameter | Symbol | Conditions | Value | Unit |
|------------------------------------------------|----------------|----------------------------------------|-------------|------|
| Continuous drain current | I_D | $T_C=25\text{ °C}$ | 9 | A |
| | | $T_C=100\text{ °C}$ | 6 | |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | $T_C=25\text{ °C}$ | 20 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=3.3\text{ A}, V_{DD}=50\text{ V}$ | 215 | mJ |
| Avalanche energy, repetitive $t_{AR}^{2),3)}$ | E_{AR} | $I_D=3.3\text{ A}, V_{DD}=50\text{ V}$ | 0.33 | |
| Avalanche current, repetitive $t_{AR}^{2),3)}$ | I_{AR} | | 3.3 | A |
| MOSFET dv/dt ruggedness | dv/dt | $V_{DS}=0\dots400\text{ V}$ | 50 | V/ns |
| Gate source voltage | V_{GS} | static | ± 20 | V |
| | | AC (f>1 Hz) | ± 30 | |
| Power dissipation | P_{tot} | $T_C=25\text{ °C}$ | 83 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 150 | °C |
| Mounting torque | | M3 and M3.5 screws | 60 | Ncm |

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

| Parameter | Symbol | Conditions | Value | Unit |
|-------------------------------------|---------------|--------------------|-------|------|
| Continuous diode forward current | I_S | $T_C=25\text{ °C}$ | 4.9 | A |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | | 20 | |
| 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} | | - | - | 1.5 | 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 | $V_{GS(th)}$ | $V_{DS}=V_{GS}, I_D=0.33\text{ mA}$ | 2.5 | 3 | 3.5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$ | - | - | 1 | μA |
| | | $V_{DS}=500\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$ | - | 10 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$ | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10\text{ V}, I_D=4.9\text{ A}, T_j=25\text{ °C}$ | - | 0.36 | 0.399 | Ω |
| | | $V_{GS}=10\text{ V}, I_D=4.9\text{ A}, T_j=150\text{ °C}$ | - | 0.90 | - | |
| 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} | $V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$ | - | 890 | - | pF |
| Output capacitance | C_{oss} | | - | 40 | - | |
| Effective output capacitance, energy related ⁵⁾ | $C_{o(er)}$ | $V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 400 V | - | 38 | - | |
| Effective output capacitance, time related ⁶⁾ | $C_{o(tr)}$ | | - | 81 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=4.9\text{ A},$ $R_G=35.1\ \Omega$ | - | 35 | - | ns |
| Rise time | t_r | | - | 14 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 80 | - | |
| Fall time | t_f | | - | 14 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|---------------|------------------------------------------------------------------------------|---|-----|----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=400\text{ V}, I_D=4.9\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$ | - | 4 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 6 | - | |
| Gate charge total | Q_g | | - | 17 | 23 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.2 | - | V |

Reverse Diode

| | | | | | | |
|-------------------------------|-----------|--------------------------------------------------------------------------|---|------|-----|---------------|
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}, I_F=4.9\text{ A},$ $T_j=25\text{ }^\circ\text{C}$ | - | 0.9 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 260 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 1.9 | - | μC |
| Peak reverse recovery current | I_{rrm} | | - | 12.2 | - | 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 $P_{AV}=E_{AR} \cdot f$.

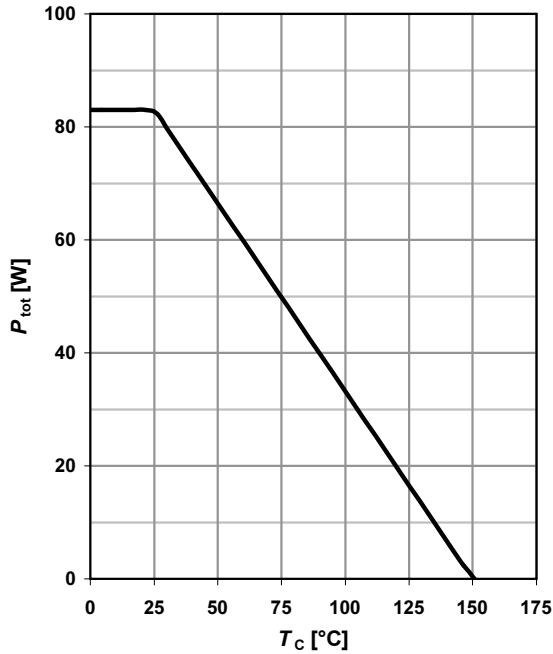
⁴⁾ $I_{SD} \leq I_D, di/dt \leq 400\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$, identical low and high side switch

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} .

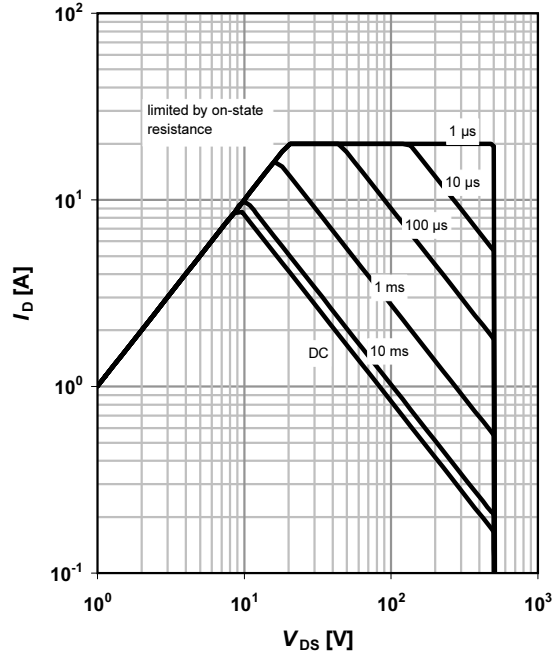
⁶⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

1 Power dissipation

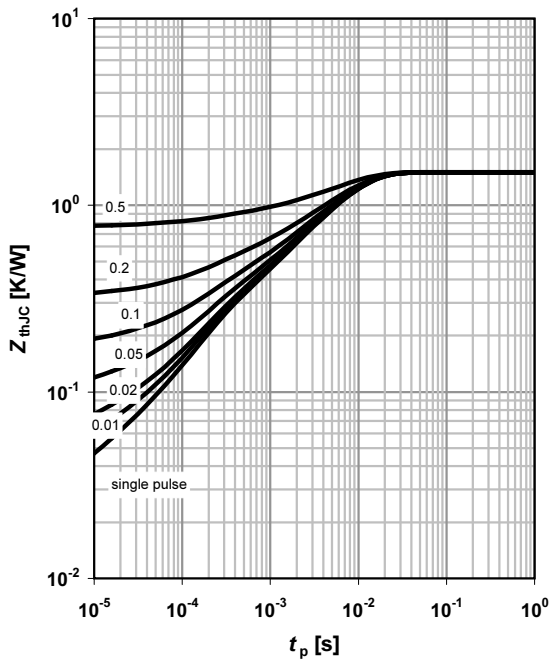
$$P_{\text{tot}} = f(T_C)$$


2 Safe operating area

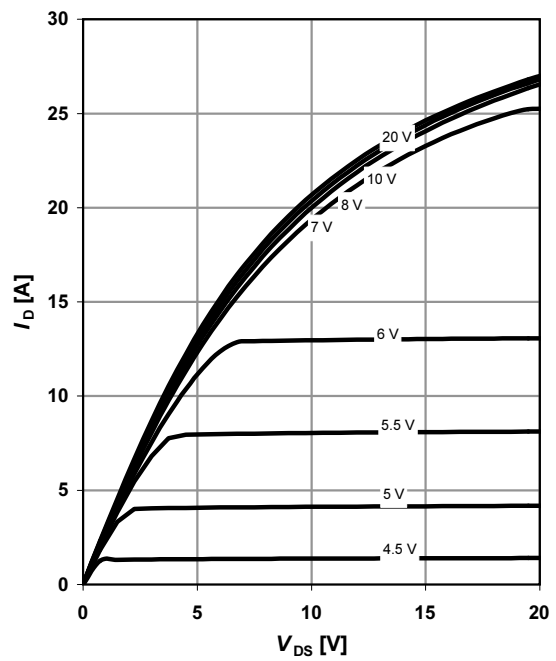
$$I_D = f(V_{DS}); T_C = 25^\circ\text{C}; D = 0$$

 parameter: t_p

3 Max. transient thermal impedance

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

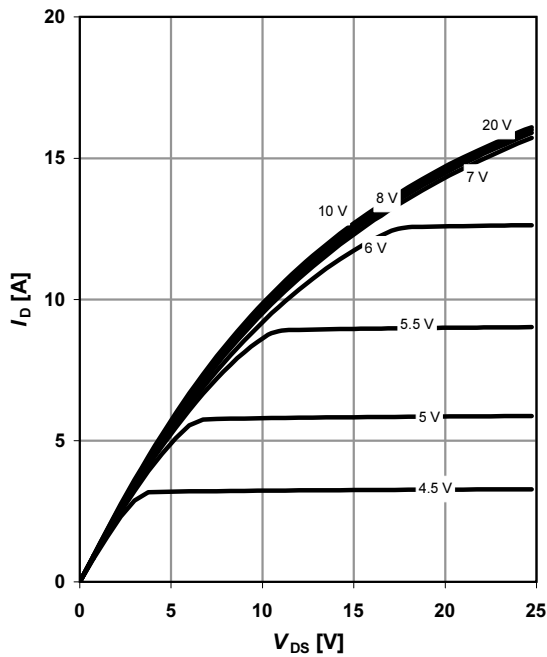
 parameter: $D = t_p / T$

4 Typ. output characteristics

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

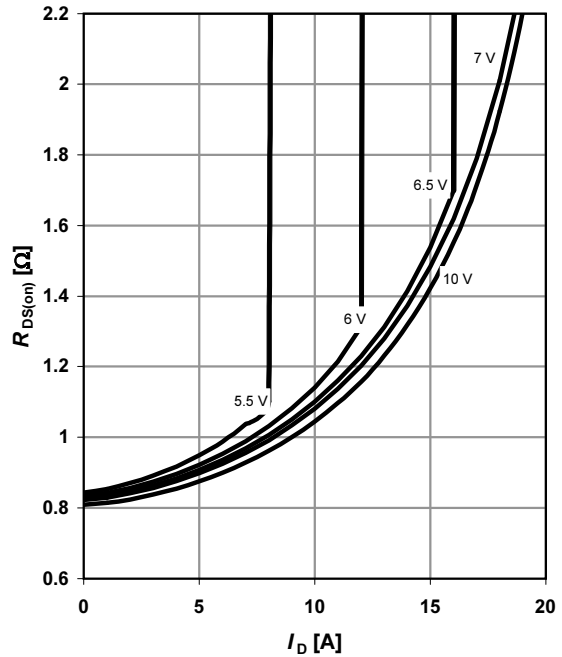
 parameter: V_{GS}


5 Typ. output characteristics

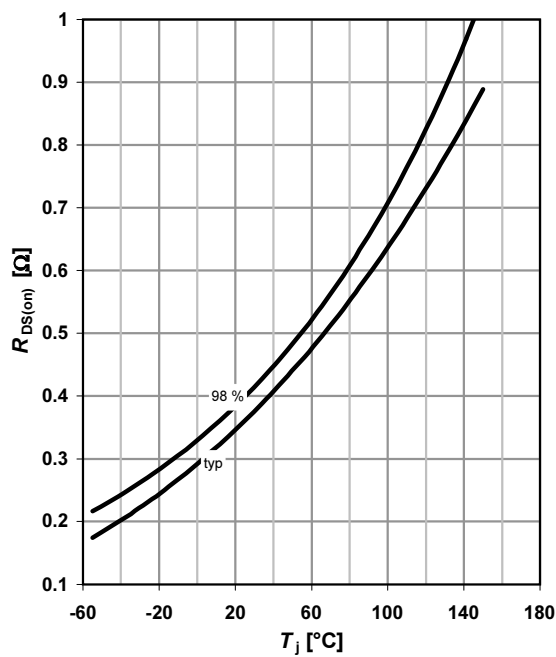
$$I_D = f(V_{DS}); T_j = 150\text{ }^\circ\text{C}$$

 parameter: V_{GS}

6 Typ. drain-source on-state resistance

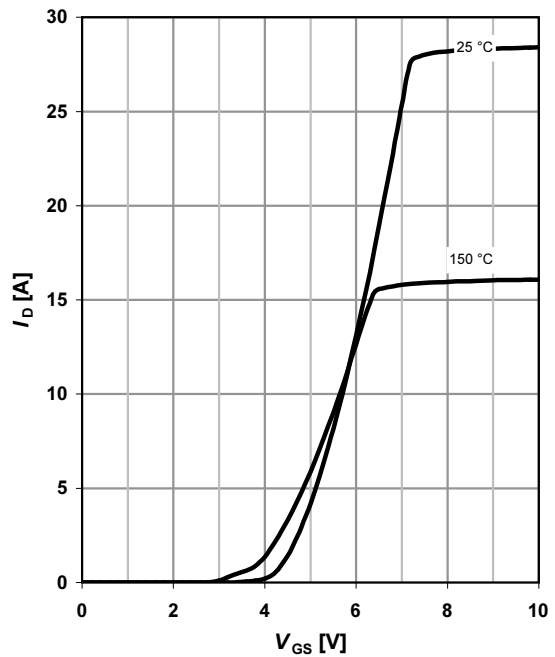
$$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$$

 parameter: V_{GS}

7 Drain-source on-state resistance

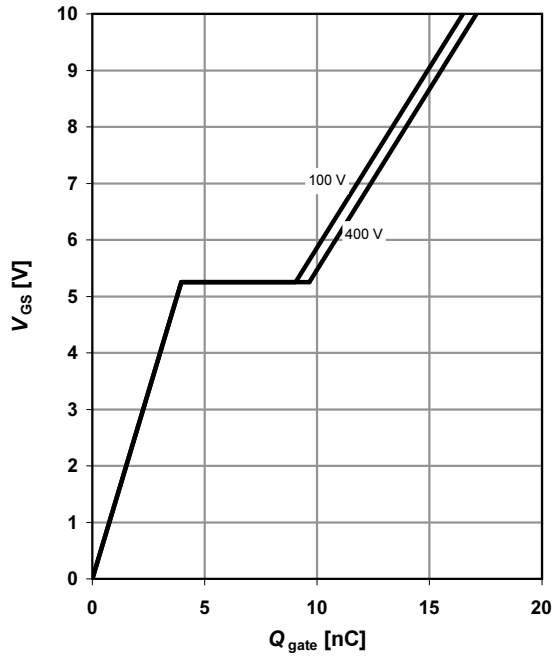
$$R_{DS(on)} = f(T_j); I_D = 4.9\text{ A}; V_{GS} = 10\text{ V}$$

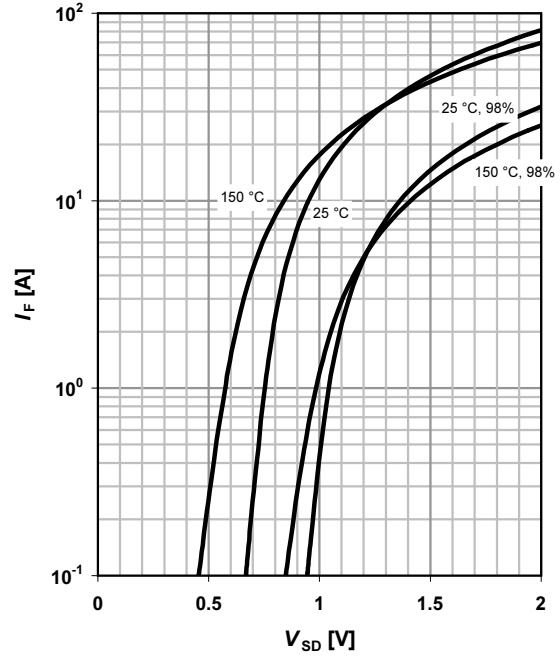
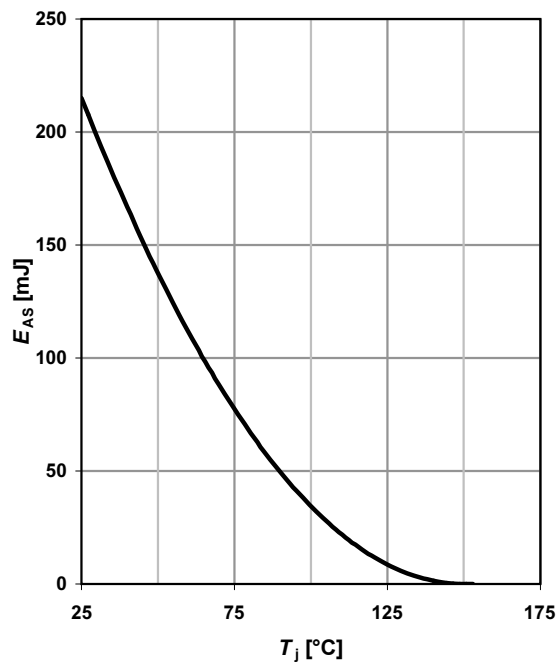
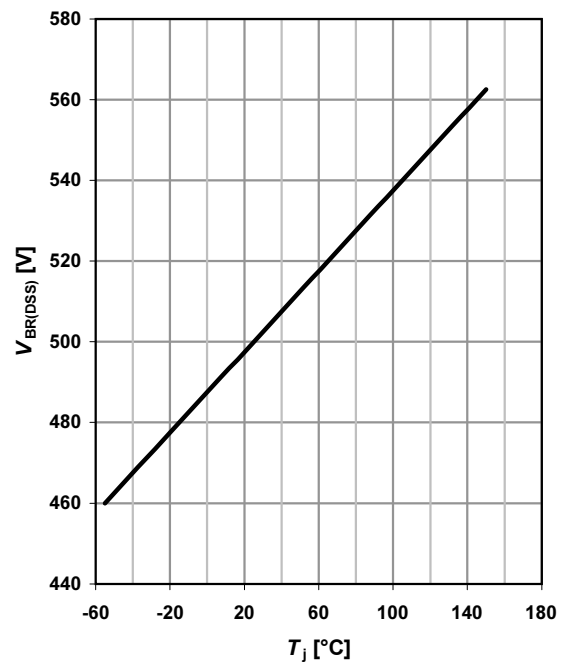

8 Typ. transfer characteristics

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

 parameter: T_j


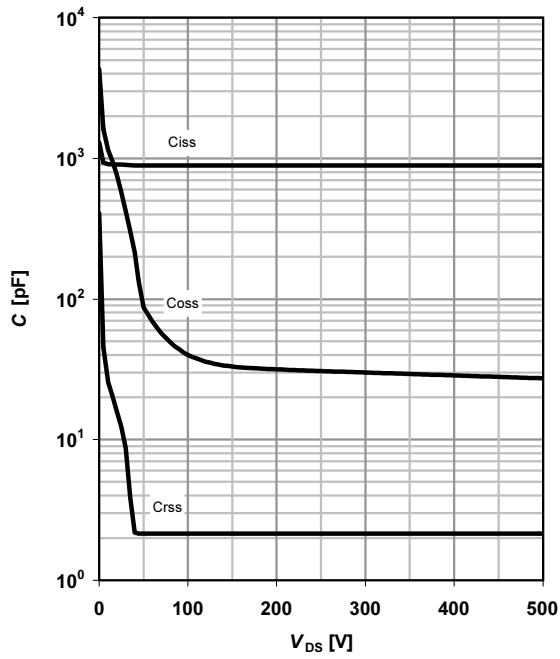
9 Typ. gate charge
 $V_{GS}=f(Q_{gate}); I_D=4.9 \text{ A pulsed}$

 parameter: V_{DD}

10 Forward characteristics of reverse diode
 $I_F=f(V_{SD})$

 parameter: T_j

11 Avalanche energy
 $E_{AS}=f(T_j); I_D=3.3 \text{ A}; V_{DD}=50 \text{ V}$

12 Drain-source breakdown voltage
 $V_{BR(DSS)}=f(T_j); I_D=0.25 \text{ mA}$


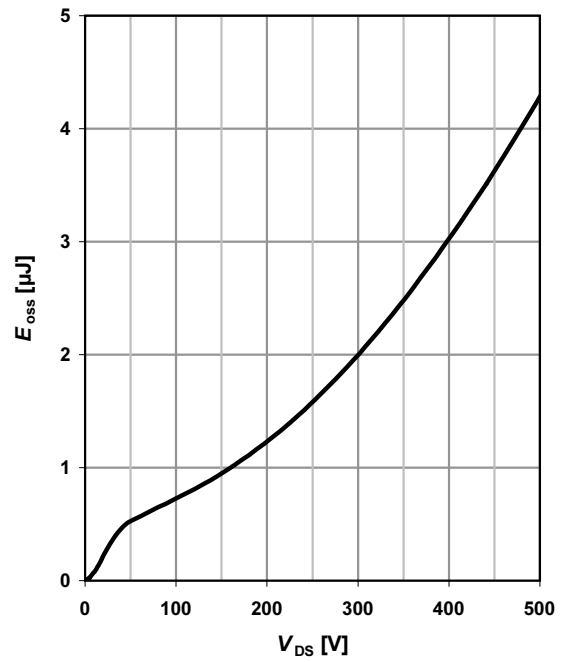
13 Typ. capacitances

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

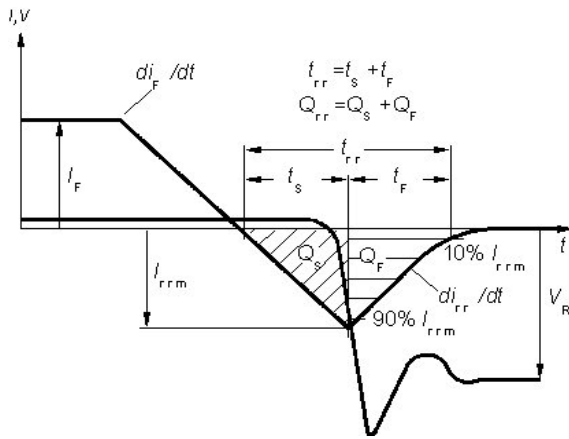


14 Typ. Coss stored energy

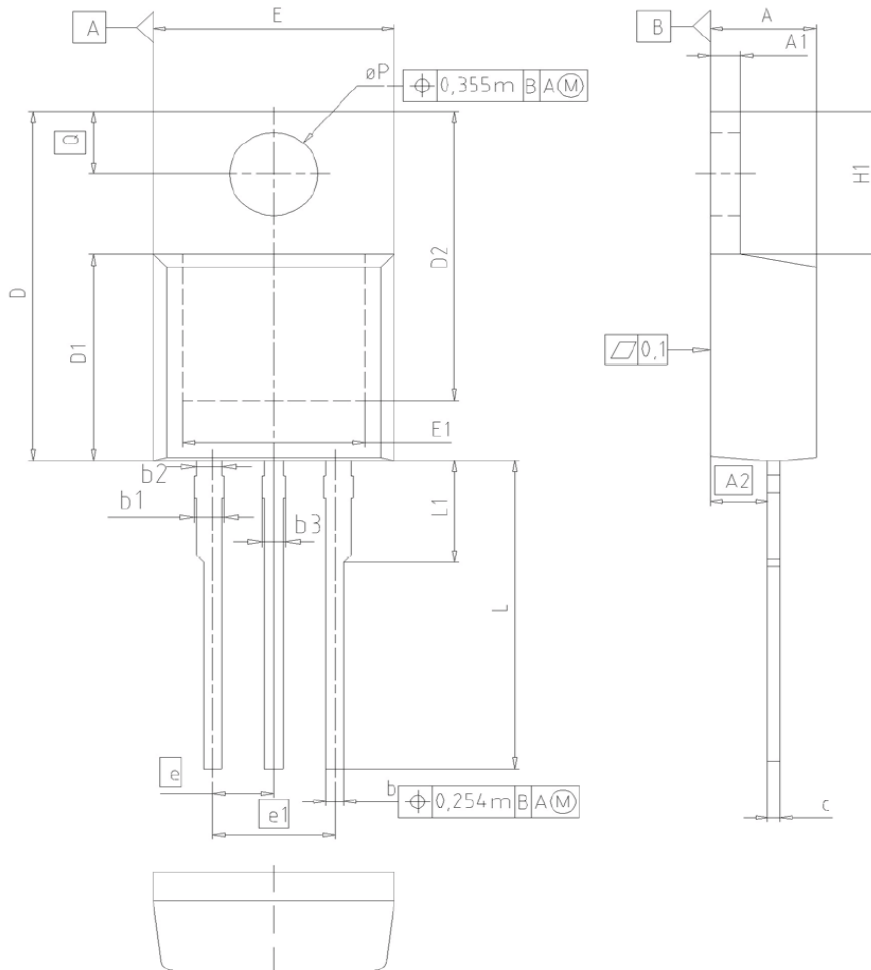
$$E_{oss} = f(V_{DS})$$



Definition of diode switching characteristics



PG-TO220-3-1/PG-TO220-3-21: Outline



| DIM | MILLIMETERS | | INCHES | |
|----------|-------------|-------|--------|-------|
| | MIN | MAX | MIN | MAX |
| A | 4.30 | 4.57 | 0.169 | 0.180 |
| A1 | 1.17 | 1.40 | 0.046 | 0.055 |
| A2 | 2.15 | 2.72 | 0.085 | 0.107 |
| b | 0.65 | 0.86 | 0.026 | 0.034 |
| b1 | 0.95 | 1.40 | 0.037 | 0.055 |
| b2 | 0.95 | 1.15 | 0.037 | 0.045 |
| b3 | 0.65 | 1.15 | 0.026 | 0.045 |
| c | 0.33 | 0.60 | 0.013 | 0.024 |
| D | 14.81 | 15.95 | 0.583 | 0.628 |
| D1 | 8.51 | 9.45 | 0.335 | 0.372 |
| D2 | 12.19 | 13.10 | 0.480 | 0.516 |
| E | 9.70 | 10.36 | 0.382 | 0.408 |
| E1 | 6.50 | 8.60 | 0.256 | 0.339 |
| e | 2.54 | | 0.100 | |
| e1 | 5.08 | | 0.200 | |
| N | 3 | | 3 | |
| H1 | 5.90 | 6.90 | 0.232 | 0.272 |
| L | 13.00 | 14.00 | 0.512 | 0.551 |
| L1 | - | 4.80 | - | 0.189 |
| ϕP | 3.60 | 3.89 | 0.142 | 0.153 |
| Q | 2.60 | 3.00 | 0.102 | 0.118 |

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