

**CoolMOS™ Power Transistor**
**Features**

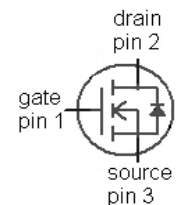
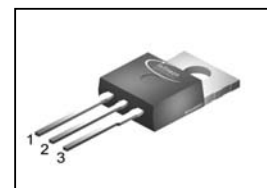
- Lowest figure-of-merit  $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme  $dv/dt$  rated
- High peak current capability
- Pb-free lead plating; RoHS compliant
- Qualified according to JEDEC<sup>1)</sup> for target applications

**Product Summary**

$V_{DS} @ T_{jmax}$	560	V
$R_{DS(on),max}$	0.399	$\Omega$
$Q_{g,typ}$	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 <sup>(2)</sup>	$I_{D,pulse}$	$T_C=25\text{ °C}$	20	
Avalanche energy, single pulse	$E_{AS}$	$I_D=3.3\text{ A}$ , $V_{DD}=50\text{ V}$	215	mJ
Avalanche energy, repetitive $t_{AR}$ <sup>(2),3)</sup>	$E_{AR}$	$I_D=3.3\text{ A}$ , $V_{DD}=50\text{ V}$	0.33	
Avalanche current, repetitive $t_{AR}$ <sup>(2),3)</sup>	$I_{AR}$		3.3	A
MOSFET $dv/dt$ ruggedness	$dv/dt$	$V_{DS}=0\dots400\text{ V}$	50	V/ns
Gate source voltage	$V_{GS}$	static	$\pm 20$	V
		AC ( $f>1\text{ Hz}$ )	$\pm 30$	
Power dissipation	$P_{tot}$	$T_C=25\text{ °C}$	83	W
Operating and storage temperature	$T_j$ , $T_{stg}$		-55 ... 150	$^{\circ}\text{C}$
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 <sup>2)</sup>	$I_{S,pulse}$		20	
Reverse diode $dv/dt$ <sup>4)</sup>	$dv/dt$		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	$\mu\text{A}$
		$V_{DS}=500\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=150\text{ °C}$	-	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	$\Omega$
		$V_{GS}=10\text{ V}$ , $I_D=4.9\text{ A}$ , $T_j=150\text{ °C}$	-	0.90	-	
Gate resistance	$R_G$	$f=1\text{ MHz}$ , open drain	-	2.2	-	$\Omega$

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 <sup>5)</sup>	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 400 V	-	38	-	
Effective output capacitance, time related <sup>6)</sup>	$C_{o(tr)}$		-	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	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	12.2	-	A

<sup>1)</sup> J-STD20 and JESD22

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

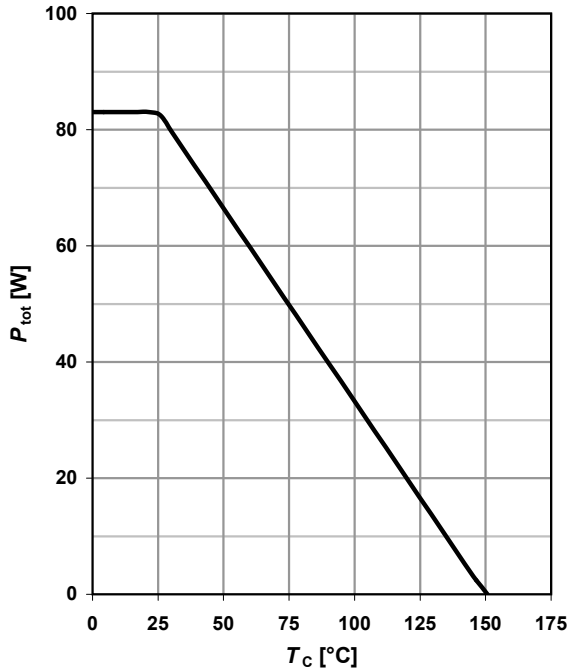
<sup>4)</sup>  $I_{SD} \leq I_D, di/dt \leq 400\text{ A}/\mu\text{s}, V_{DClink}=400\text{ V}, V_{peak} < V_{(BR)DSS}, T_j < T_{j,max}$ , identical low and high side switch

<sup>5)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>6)</sup>  $C_{o(tr)}$  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**

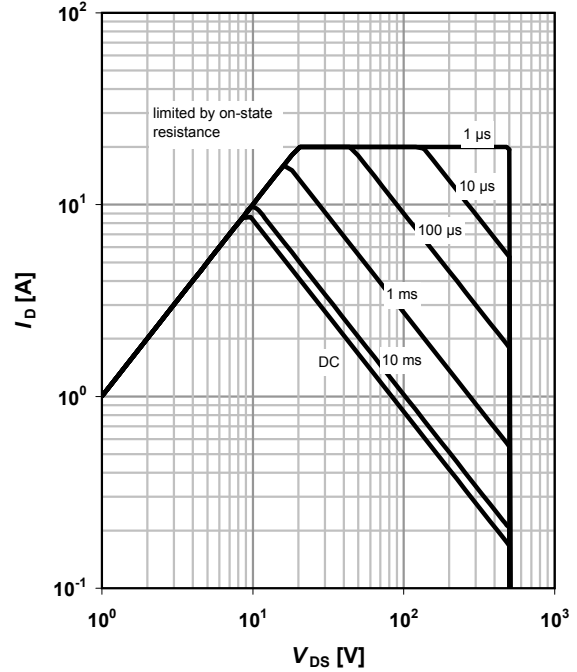
$$P_{tot} = f(T_C)$$



**2 Safe operating area**

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

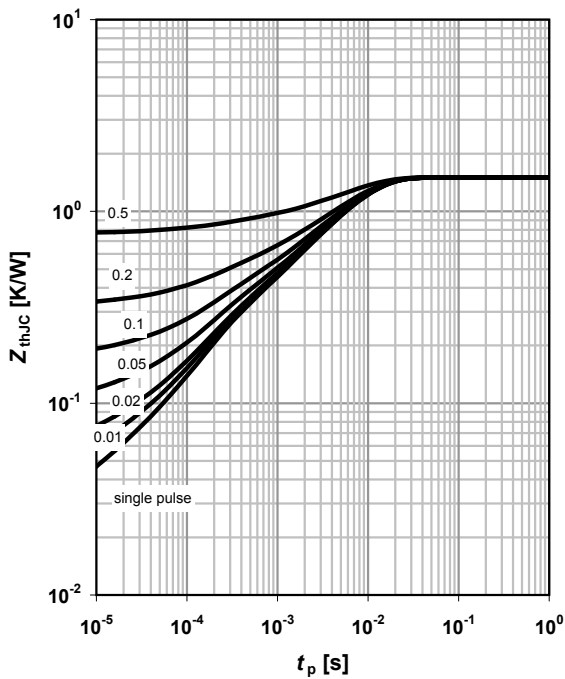
parameter:  $t_p$



**3 Max. transient thermal impedance**

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

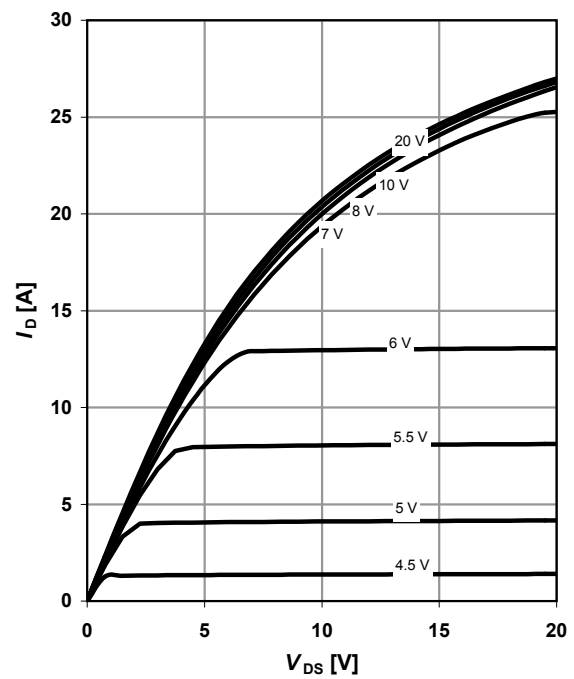
parameter:  $D = t_p / T$



**4 Typ. output characteristics**

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

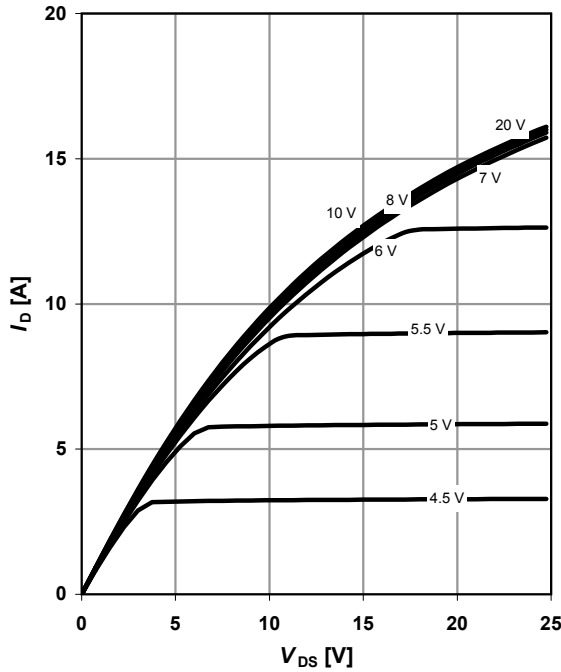
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

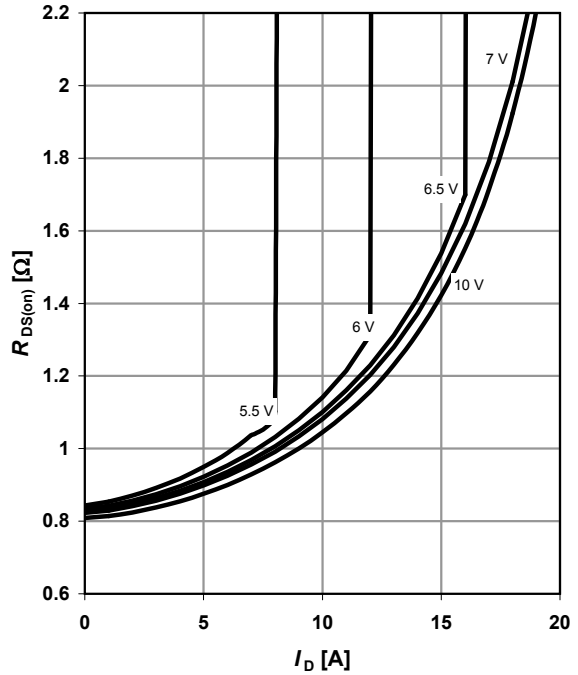
parameter:  $V_{GS}$



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

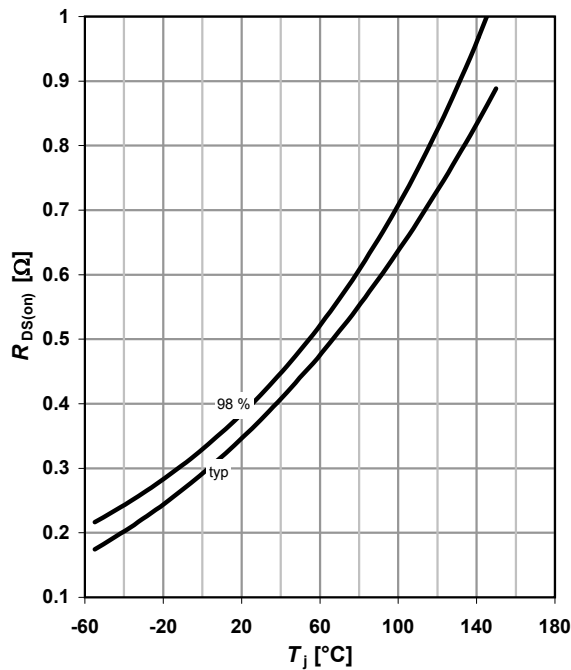
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter:  $V_{GS}$



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

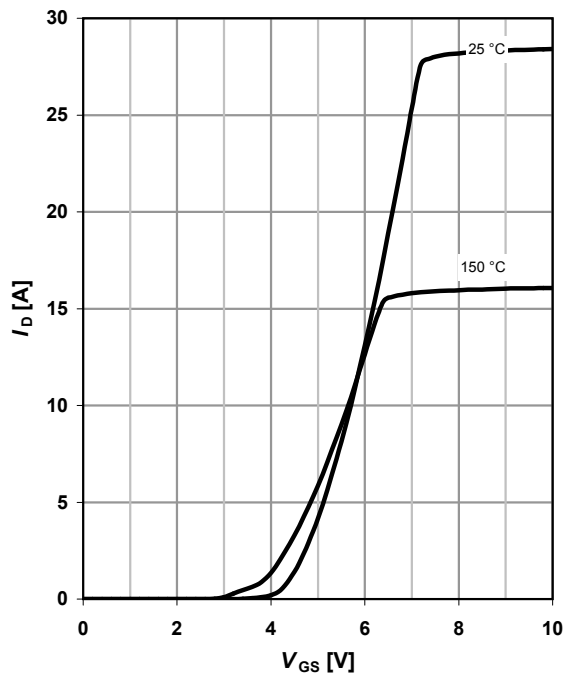
$R_{DS(on)} = f(T_j); I_D = 4.9\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

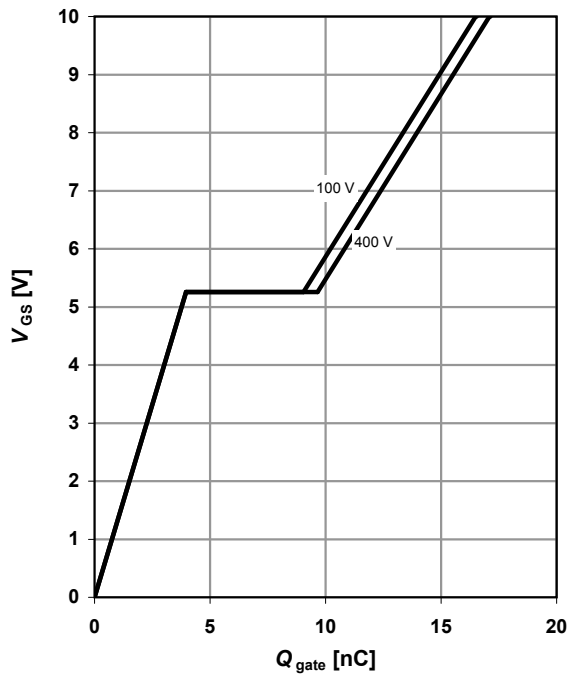
parameter:  $T_j$



**9 Typ. gate charge**

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

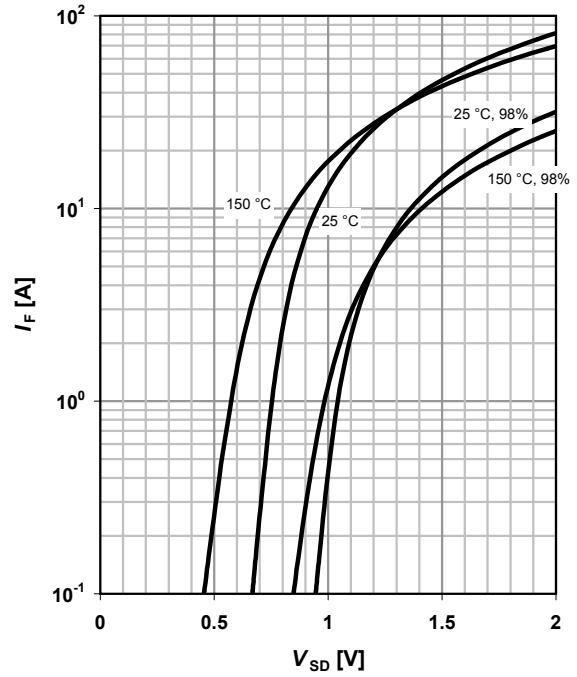
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

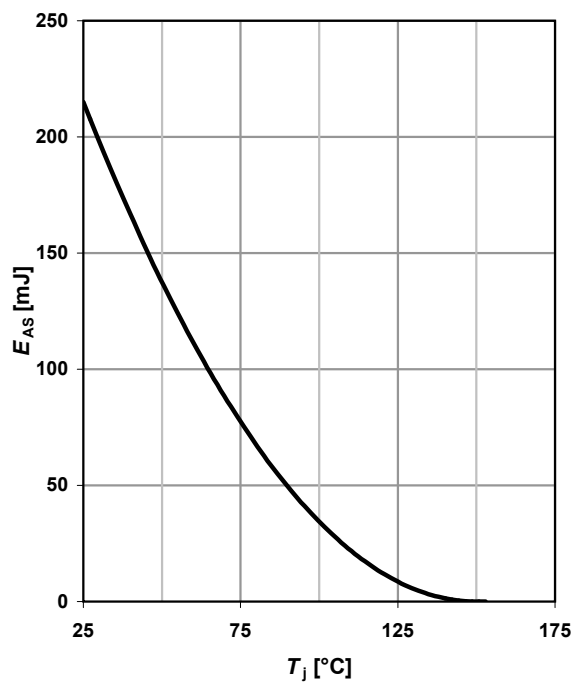
$I_F=f(V_{SD})$

parameter:  $T_j$



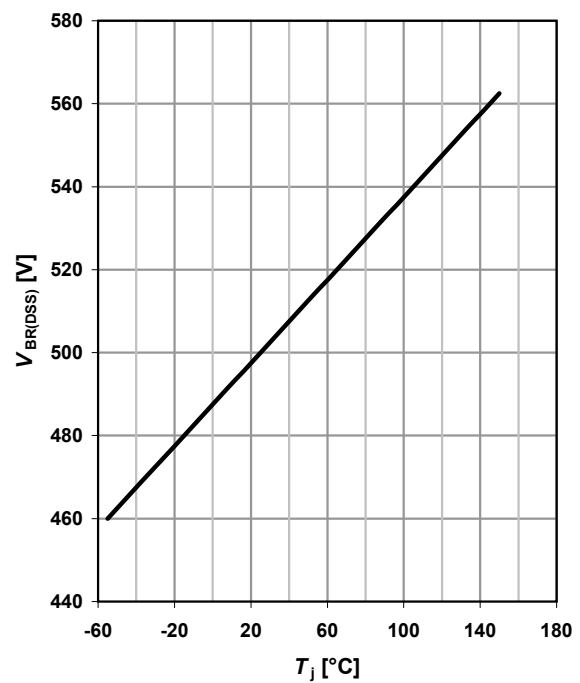
**11 Avalanche energy**

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



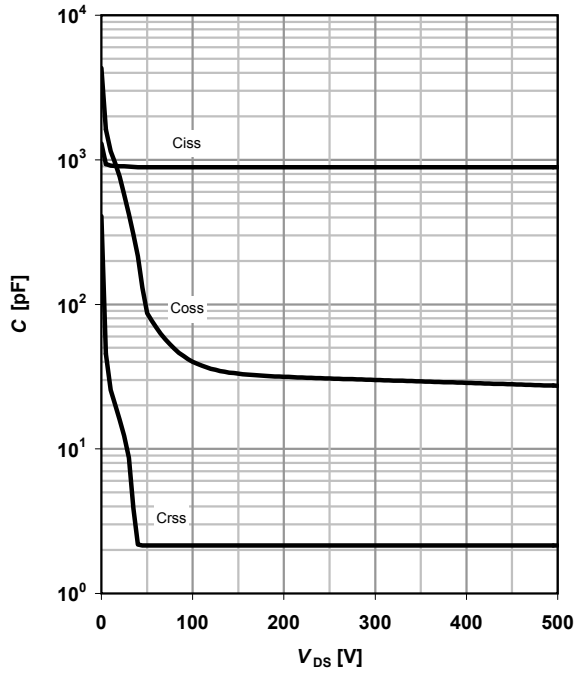
**12 Drain-source breakdown voltage**

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



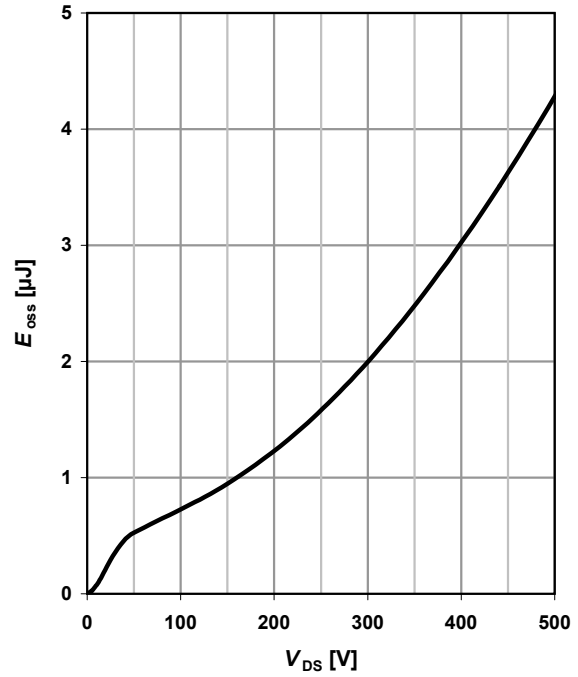
**13 Typ. capacitances**

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



**14 Typ. Coss stored energy**

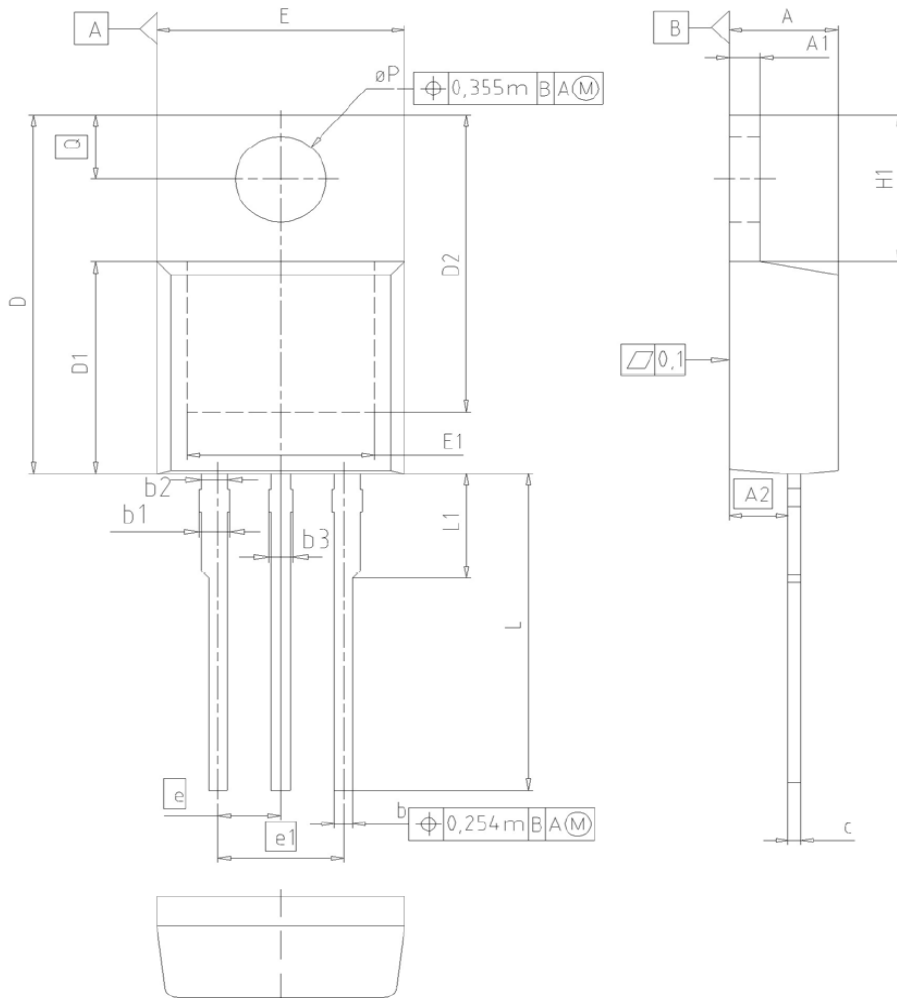
$E_{oss}=f(V_{DS})$



Definition of diode switching characteristics





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


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

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