

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⁾

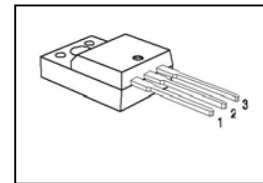
CoolMOS CP is designed for:

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

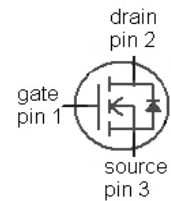
Product Summary

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

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	$V_{DS}=0\ldots 400\text{ V}$	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	°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}	lead	-	-	62	
Soldering temperature, wavesoldering only allowed at leads	T_{solder}	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	$f=1\text{ MHz}$, 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}	$V_{GS}=0\text{ V}, I_F=14\text{ A},$ $T_j=25\text{ °C}$	-	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

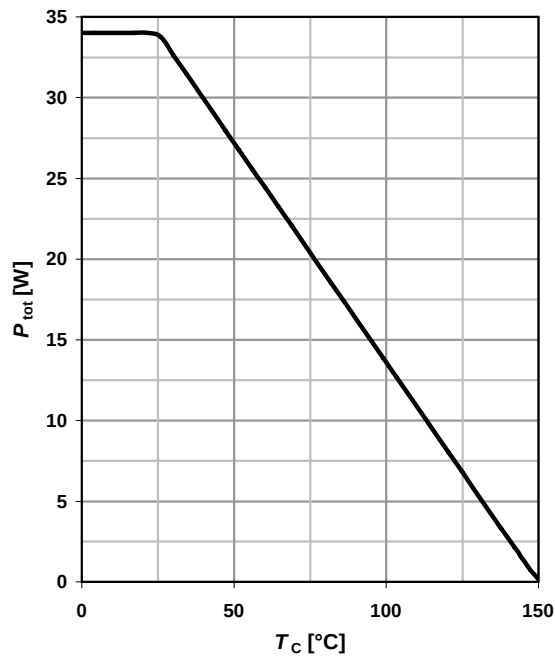
⁵⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

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

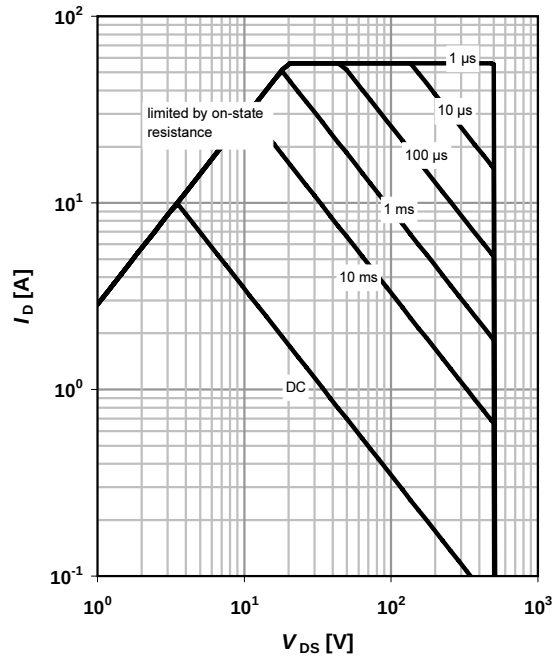
$$P_{\text{tot}} = f(T_C)$$



2 Safe operating area

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

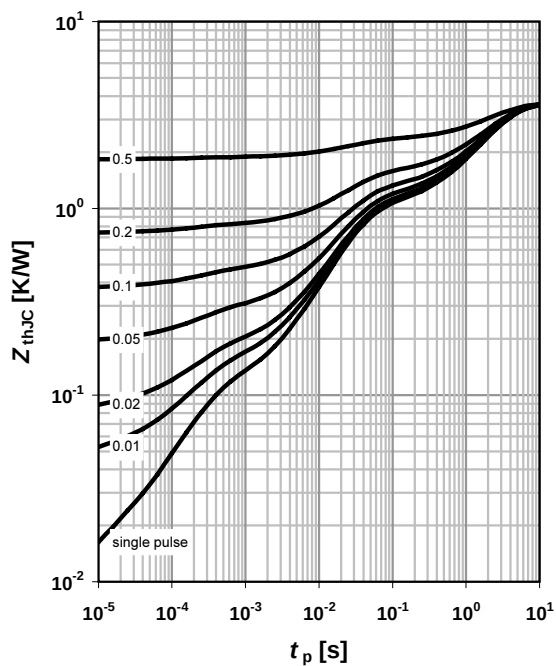
parameter: t_p



3 Max. transient thermal impedance

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

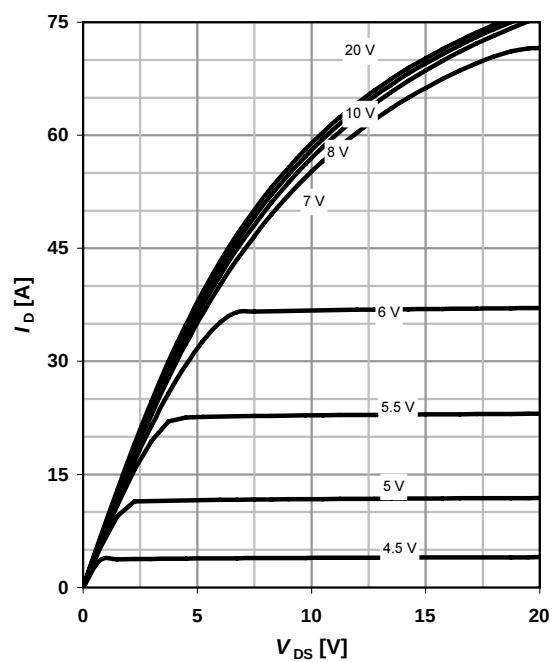
parameter: $D = t_p / T$



4 Typ. output characteristics

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

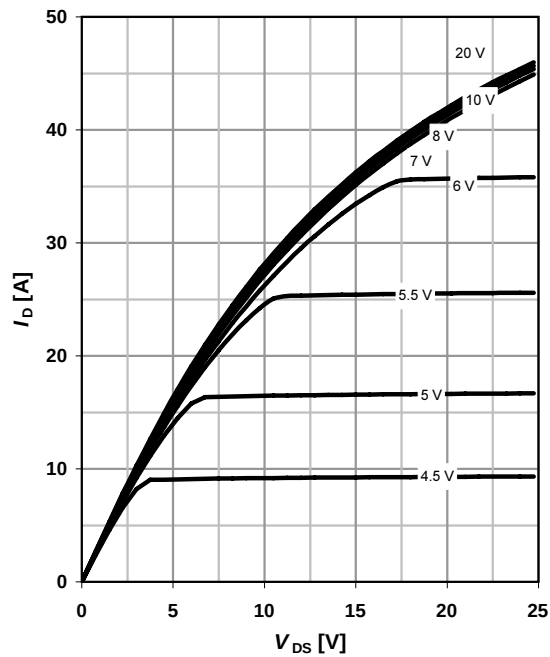
parameter: V_{GS}



5 Typ. output characteristics

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

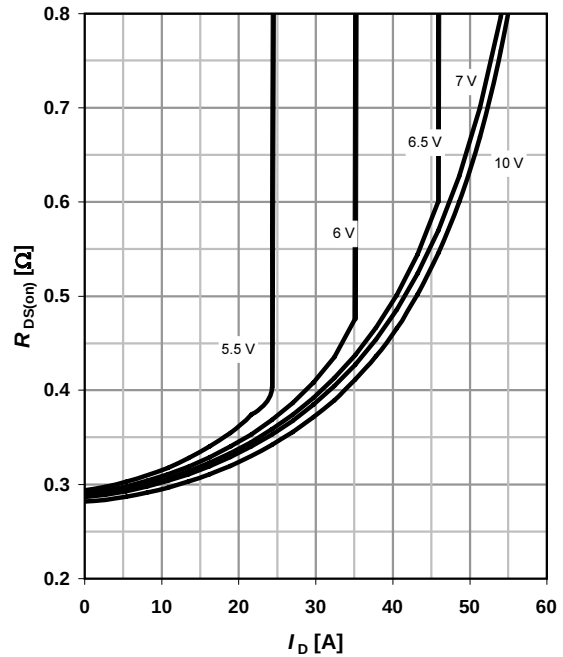
parameter: V_{GS}



6 Typ. drain-source on-state resistance

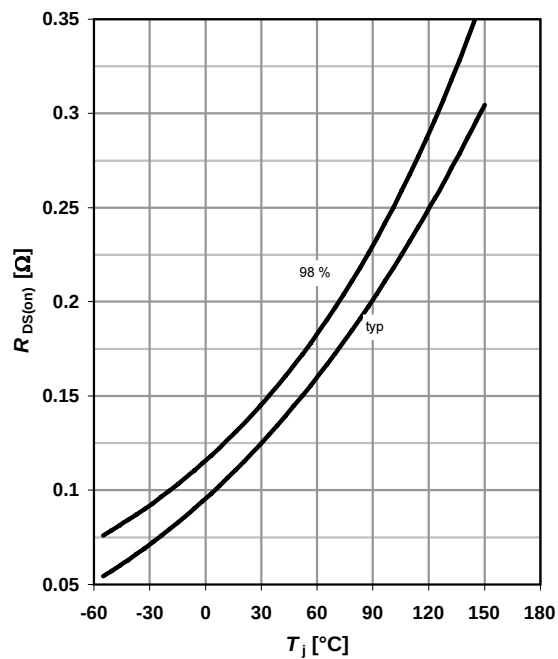
$$R_{DS(on)} = f(I_D); T_j = 150^\circ\text{C}$$

parameter: V_{GS}



7 Drain-source on-state resistance

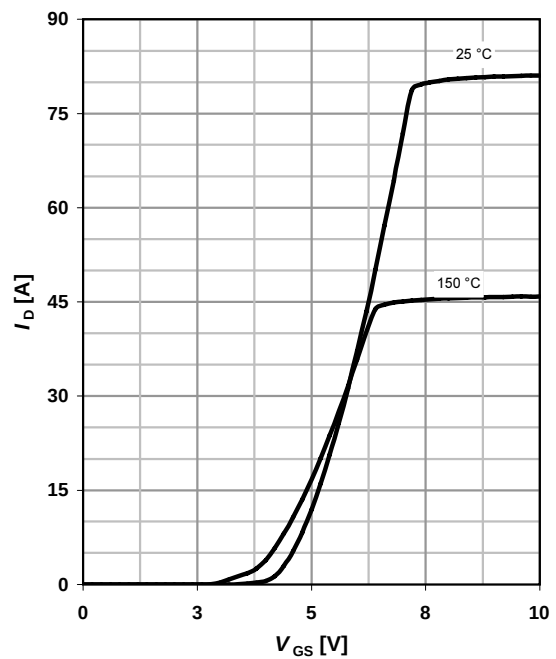
$$R_{DS(on)} = f(T_j); I_D = 14\text{ A}; V_{GS} = 10\text{ V}$$



8 Typ. transfer characteristics

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

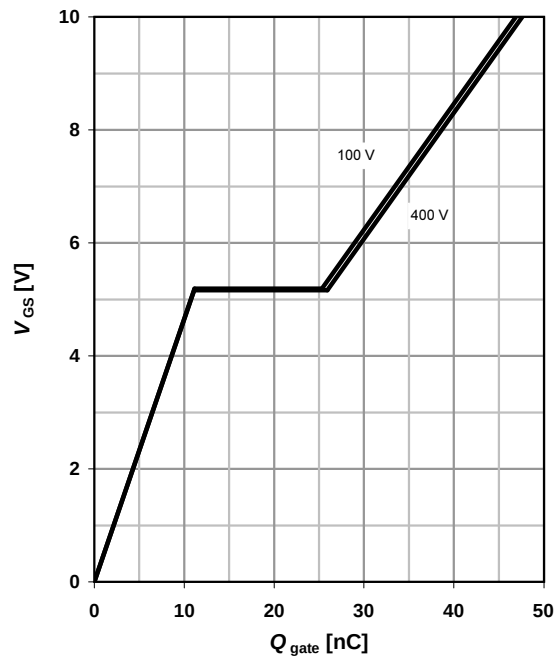
parameter: T_j



9 Typ. gate charge

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

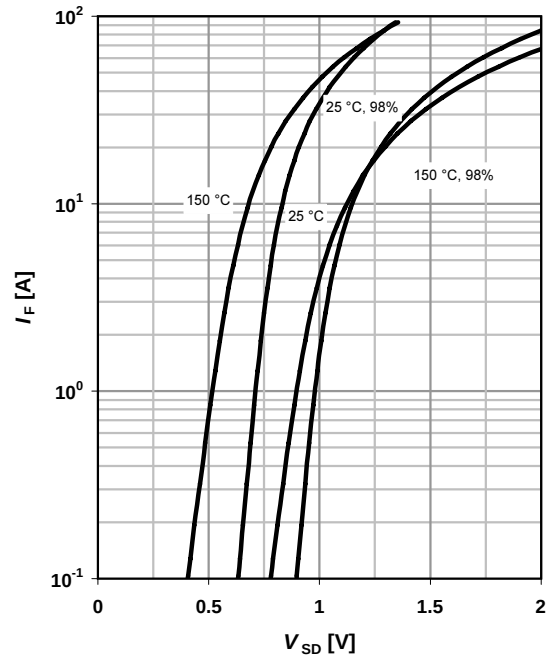
parameter: V_{DD}



10 Forward characteristics of reverse diode

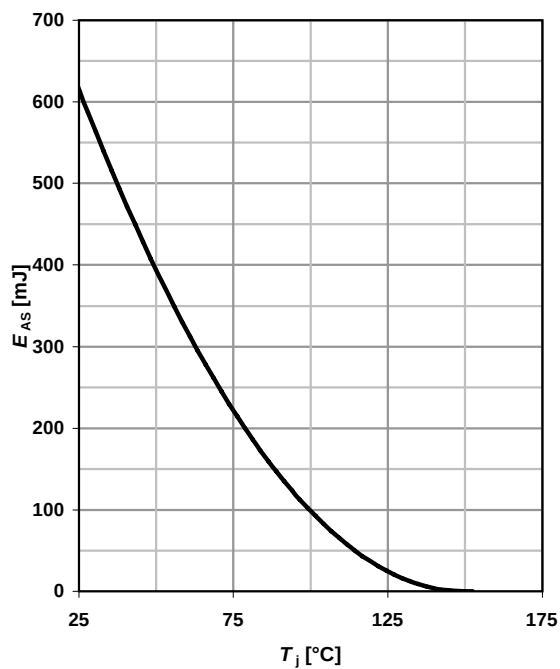
$$I_F=f(V_{SD})$$

parameter: T_j



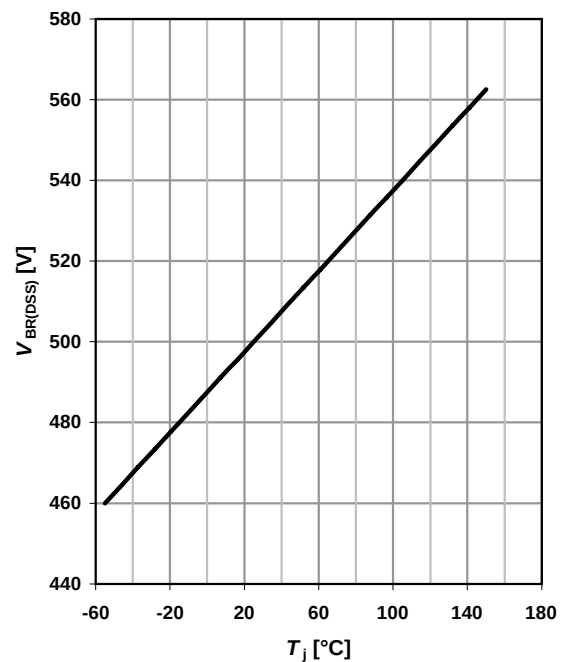
11 Avalanche energy

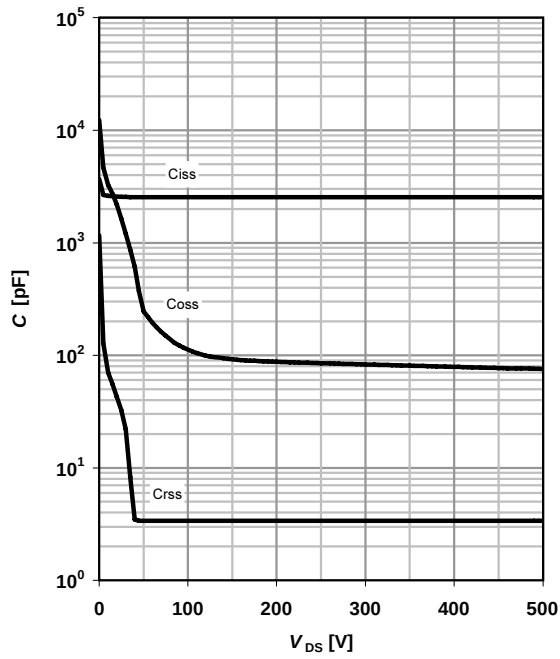
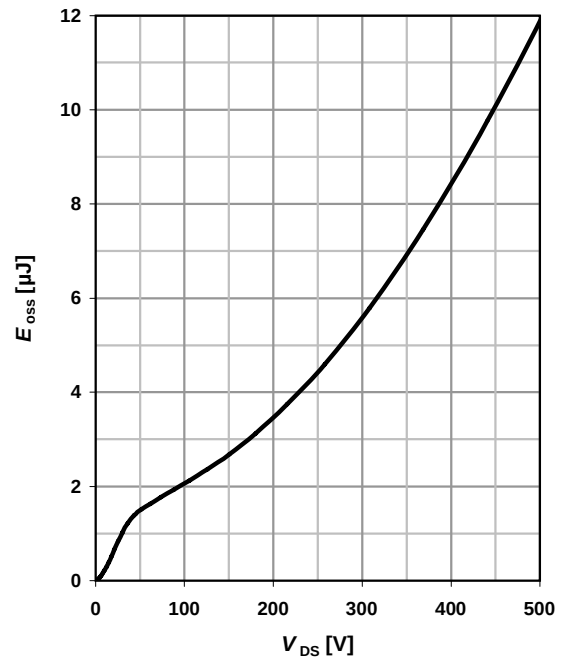
$$E_{AS}=f(T_j); I_D=9.3 \text{ A}; V_{DD}=50 \text{ V}$$



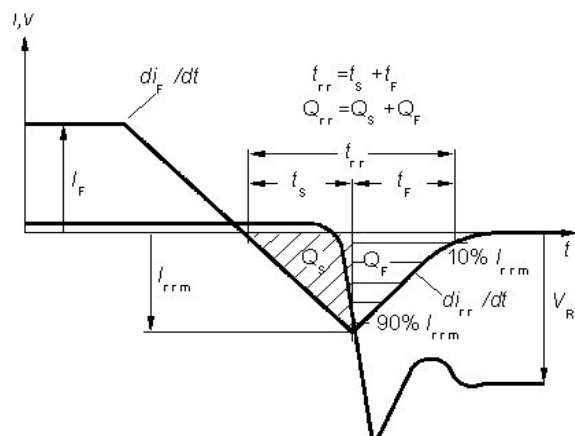
12 Drain-source breakdown voltage

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

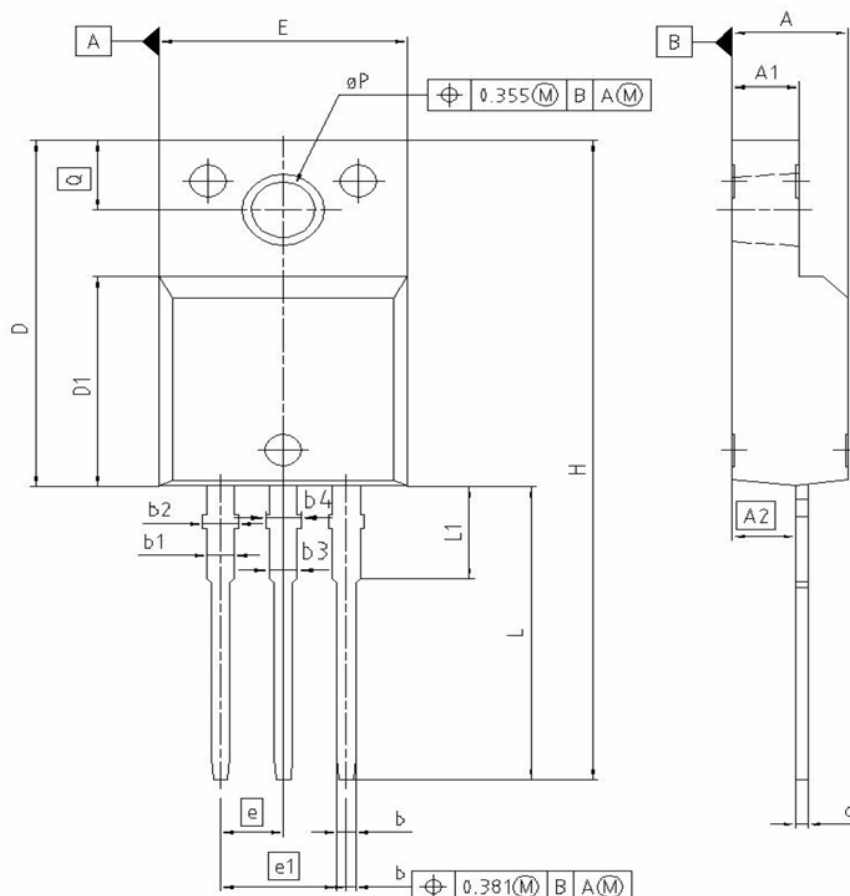


13 Typ. capacitances
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

14 Typ. Coss stored energy
 $E_{oss} = f(V_{DS})$


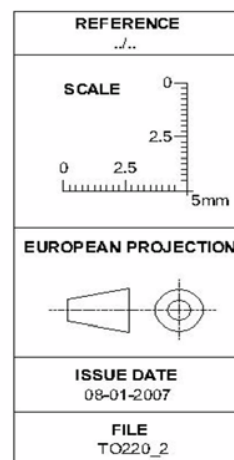
Definition of diode switching characteristics



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
øP	2.95	3.20	0.116	0.126
Q	3.15	3.50	0.124	0.138



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