

**CoolMOS® Power Transistor**
**Features**

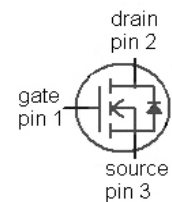
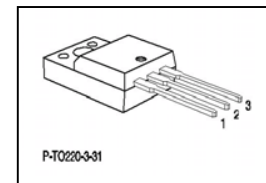
- Lowest figure-of-merit  $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified for industrial grade applications according to JEDEC<sup>1)</sup>
- Pb-free lead plating; RoHS compliant; Halogen free mold compound

**Product Summary**

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max} @ T_j = 25^\circ C$	0.165	$\Omega$
$Q_{g,typ}$	39	nC

**CoolMOS CP is designed for:**

- Hard switching SMPS topologies

**PG-TO220**


Type	Package	Ordering Code	Marking
IPA60R165CP	PG-TO220	SP000096437	6R165P

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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current <sup>2)</sup>	$I_D$	$T_C=25^\circ C$	21	A
		$T_C=100^\circ C$	13	
Pulsed drain current <sup>3)</sup>	$I_{D,pulse}$	$T_C=25^\circ C$	61	
Avalanche energy, single pulse	$E_{AS}$	$I_D=7.9 A, V_{DD}=50 V$	522	mJ
Avalanche energy, repetitive $t_{AR}^{3),4)}$	$E_{AR}$	$I_D=7.9 A, V_{DD}=50 V$	0.79	
Avalanche current, repetitive $t_{AR}^{3),4)}$	$I_{AR}$		7.9	A
MOSFET dv/dt ruggedness	dv/dt	$V_{DS}=0...480 V$	50	V/ns
Gate source voltage	$V_{GS}$	static	$\pm 20$	V
		AC ( $f > 1 Hz$ )	$\pm 30$	
Power dissipation	$P_{tot}$	$T_C=25^\circ C$	34	W
Operating and storage temperature	$T_j, T_{stg}$		-55 ... 150	$^\circ C$
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 <sup>2)</sup>	$I_S$	$T_C=25\text{ °C}$	21	A
Diode pulse current <sup>3)</sup>	$I_{S,pulse}$		61	
Reverse diode $dv/dt$ <sup>5)</sup>	$dv/dt$		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	-	-	80	
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	$V_{(BR)DSS}$	$V_{GS}=0\text{ V}, I_D=250\text{ }\mu\text{A}$	600	-	-	V
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=0.79\text{ mA}$	2.5	3	3.5	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS}=600\text{ V}, V_{GS}=0\text{ V}, T_j=25\text{ °C}$	-	-	1	$\mu\text{A}$
		$V_{DS}=25\text{ V}, V_{GS}=0\text{ V}, T_j=150\text{ °C}$	-	10	-	
Gate-source leakage current	$I_{GSS}$	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=12\text{ A}, T_j=25\text{ °C}$	-	0.15	0.165	$\Omega$
		$V_{GS}=10\text{ V}, I_D=12\text{ A}, T_j=150\text{ °C}$	-	0.40	-	
Gate resistance	$R_G$	$f=1\text{ MHz}, \text{open drain}$	-	1.9	-	$\Omega$

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

**Dynamic characteristics**

Input capacitance	$C_{iss}$	$V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$	-	2000	-	pF
Output capacitance	$C_{oss}$		-	100	-	
Effective output capacitance, energy related <sup>6)</sup>	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	83	-	
Effective output capacitance, time related <sup>7)</sup>	$C_{o(tr)}$		-	220	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=12\text{ A},$ $R_G=3.3\ \Omega$	-	12	-	ns
Rise time	$t_r$		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	50	-	
Fall time	$t_f$		-	5	-	

**Gate Charge Characteristics**

Gate to source charge	$Q_{gs}$	$V_{DD}=400\text{ V}, I_D=12\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	9	-	nC
Gate to drain charge	$Q_{gd}$		-	13.0	-	
Gate charge total	$Q_g$		-	39	52	
Gate plateau voltage	$V_{plateau}$		-	5.0	-	V

**Reverse Diode**

Diode forward voltage	$V_{SD}$	$V_{GS}=0\text{ V}, I_F=12\text{ A},$ $T_j=25\text{ }^\circ\text{C}$	-	0.9	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	390	-	ns
Reverse recovery charge	$Q_{rr}$		-	7.5	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	38	-	A

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

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$ 
<sup>3)</sup> Limited only by maximum temperature

<sup>4)</sup> Repetitive avalanche causes additional power losses that can be calculated as  $P_{AV}=E_{AR} \cdot f$ .

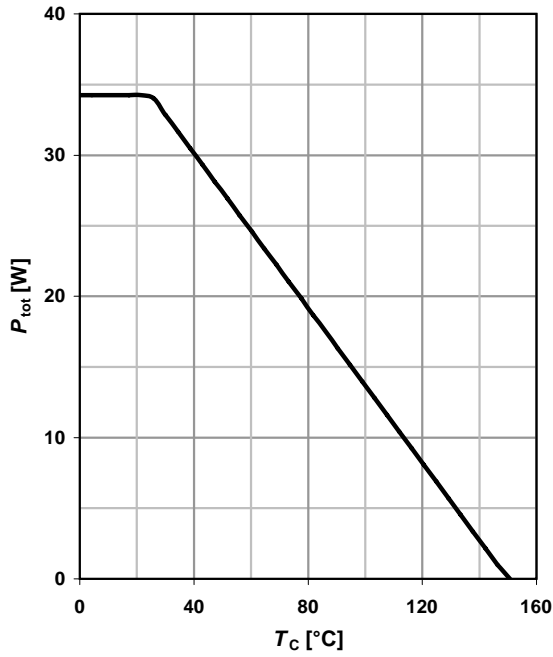
<sup>5)</sup>  $I_{SD} \leq I_D$ ,  $di/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DClink}=400\text{ V}$ ,  $V_{peak} < V_{(BR)DSS}$ ,  $T_j < T_{j,max}$ , identical low side and high side switch.

<sup>6)</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>7)</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**

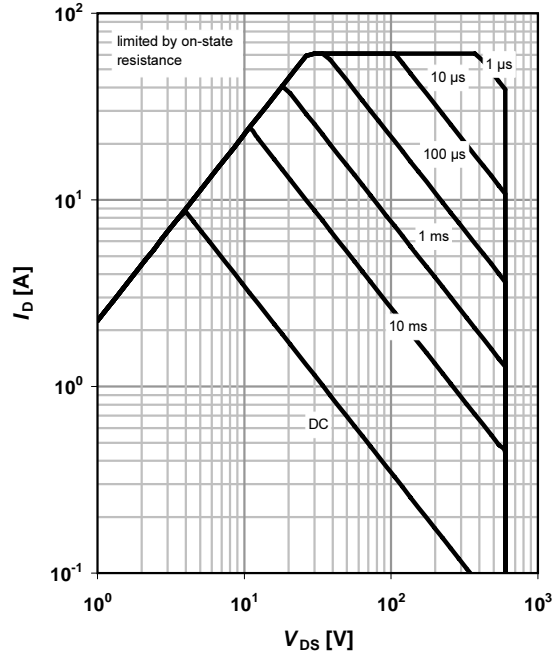
$P_{tot}=f(T_C)$



**2 Safe operating area**

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

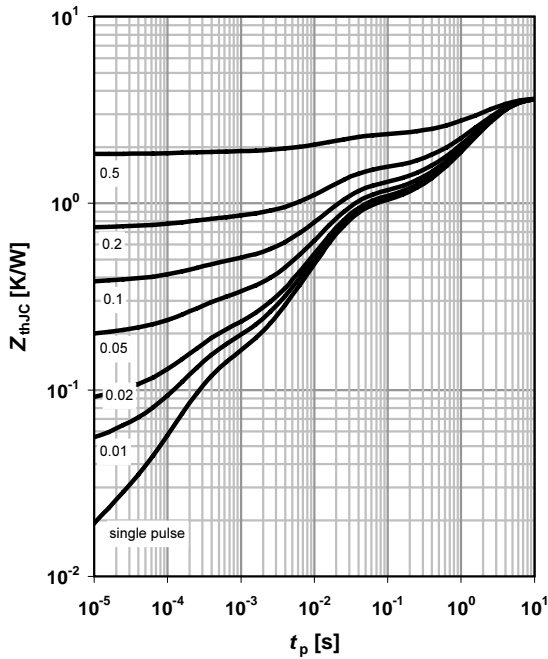
parameter:  $t_p$



**3 Max. transient thermal impedance**

$Z_{thJC}=f(t_p)$

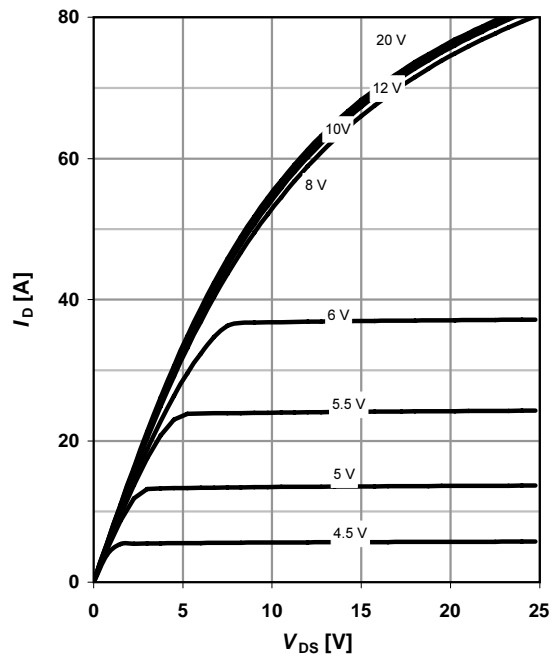
parameter:  $D=t_p/T$



**4 Typ. output characteristics**

$I_D=f(V_{DS}); T_J=25\text{ °C}$

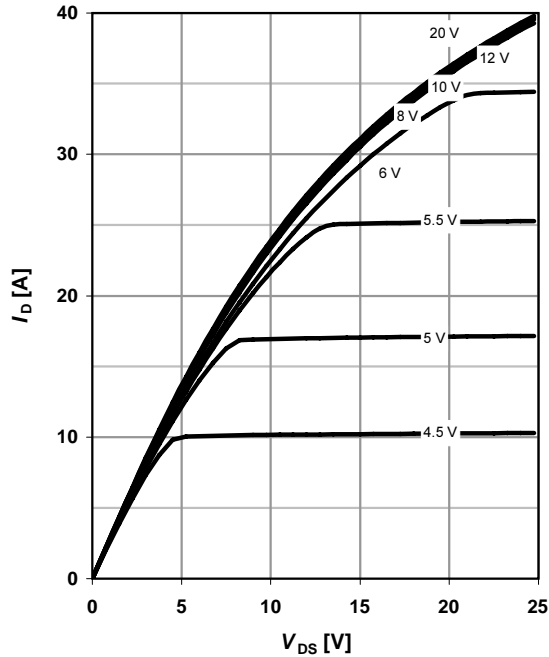
parameter:  $V_{GS}$



**5 Typ. output characteristics**

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

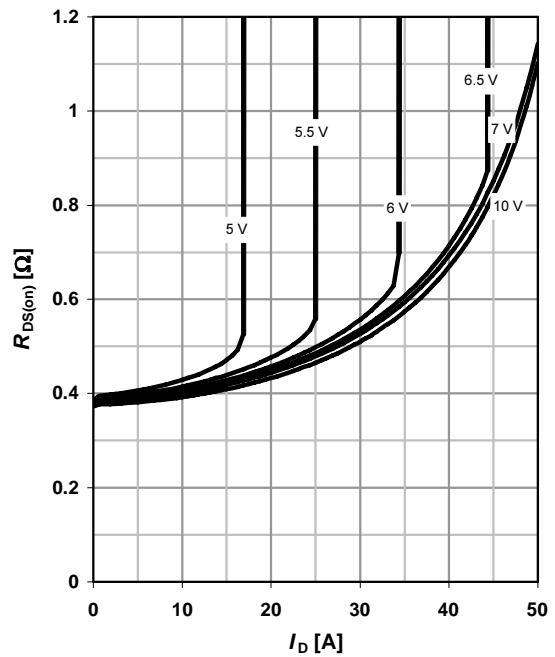
parameter:  $V_{GS}$



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

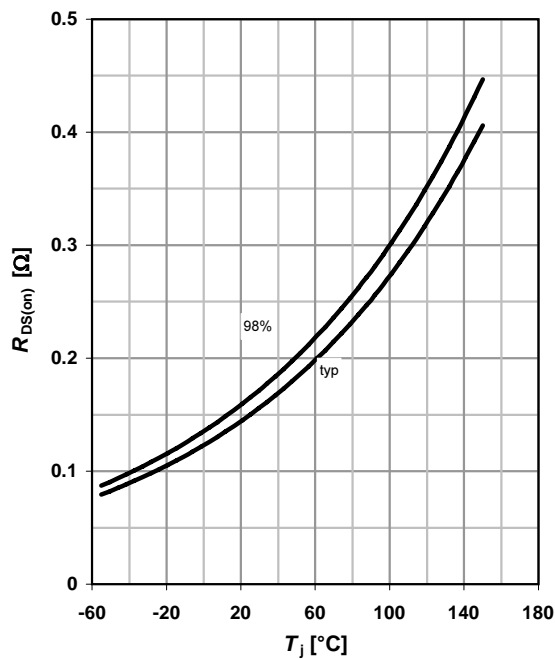
$R_{DS(on)} = f(I_D); T_j = 150\text{ }^\circ\text{C}$

parameter:  $V_{GS}$



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

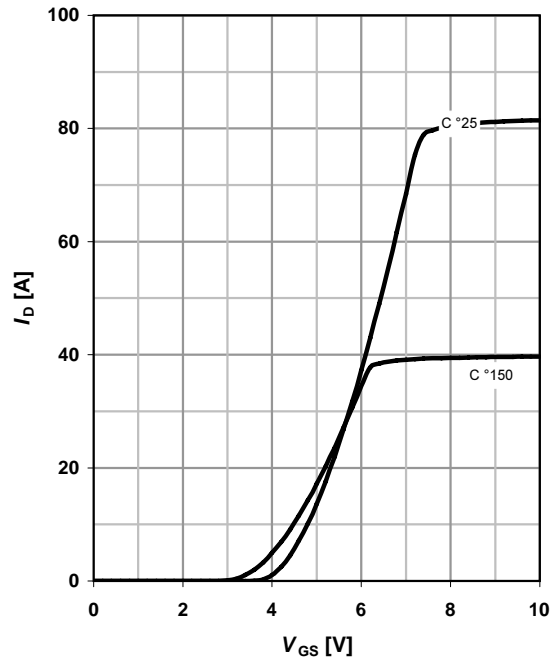
$R_{DS(on)} = f(T_j); I_D = 12\text{ A}; V_{GS} = 10\text{ V}$



**8 Typ. transfer characteristics**

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

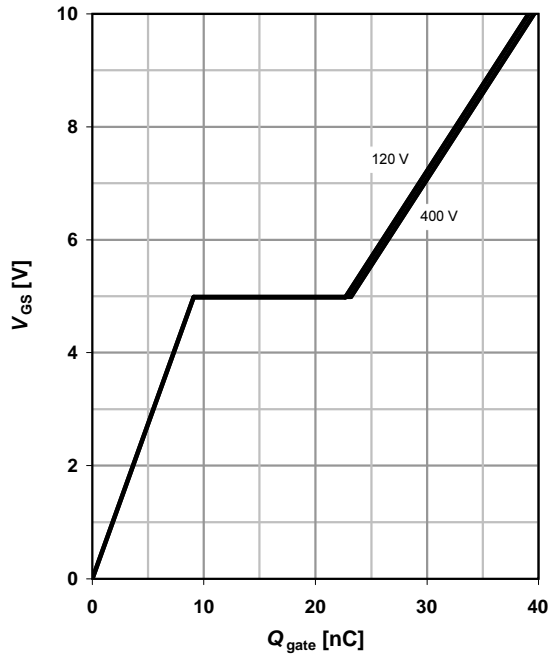
parameter:  $T_j$



**9 Typ. gate charge**

$V_{GS}=f(Q_{gate}); I_D=12\text{ A pulsed}$

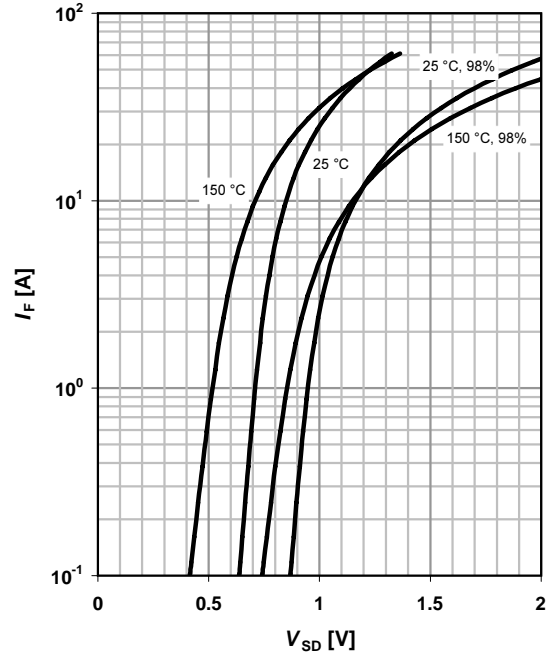
parameter:  $V_{DD}$



**10 Forward characteristics of reverse diode**

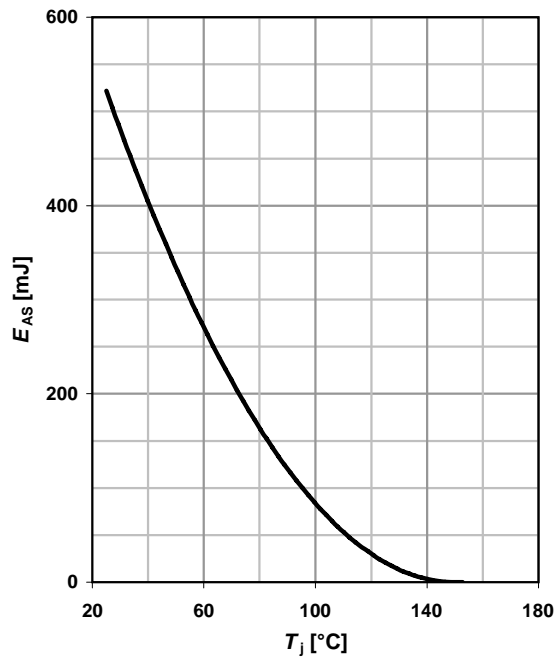
$I_F=f(V_{SD})$

parameter:  $T_j$



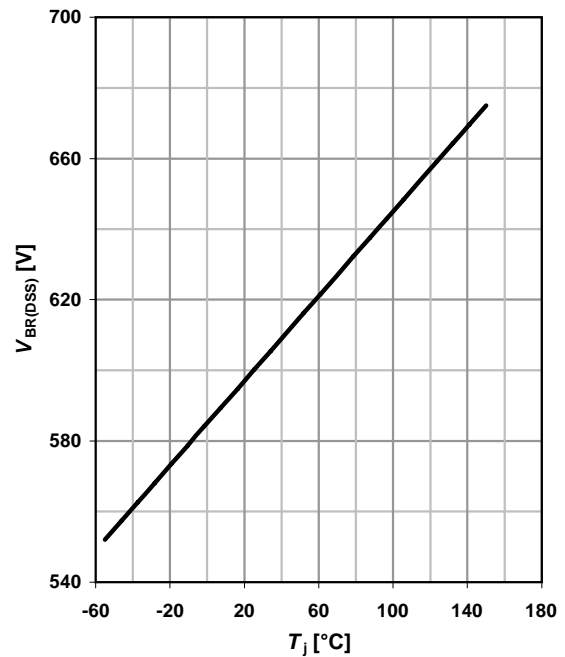
**11 Avalanche energy**

$E_{AS}=f(T_j); I_D=7.9\text{ A}; V_{DD}=50\text{ V}$



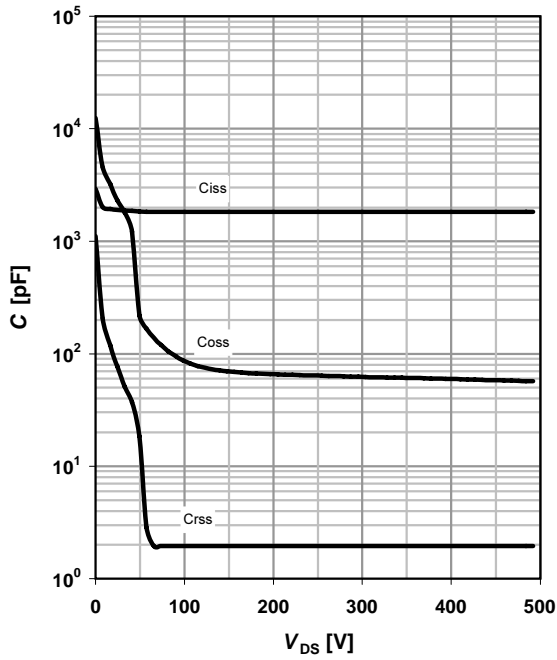
**12 Drain-source breakdown voltage**

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



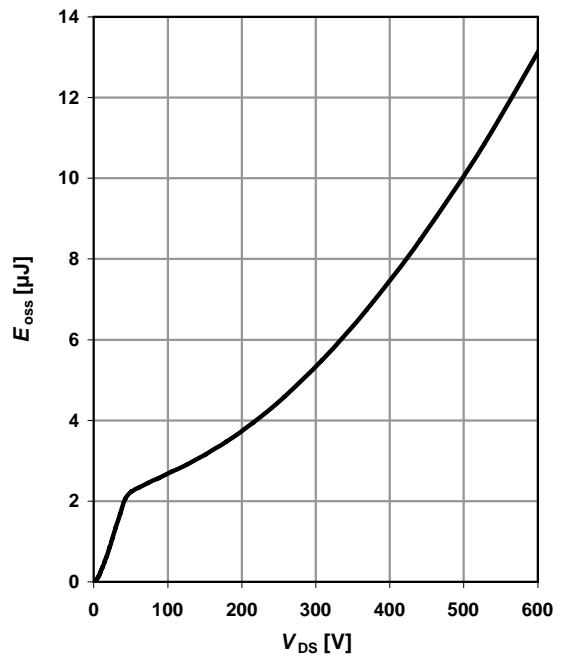
13 Typ. capacitances

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

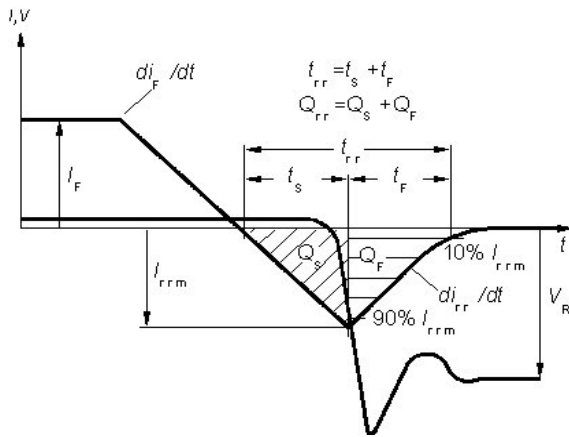


14 Typ. Coss stored energy

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

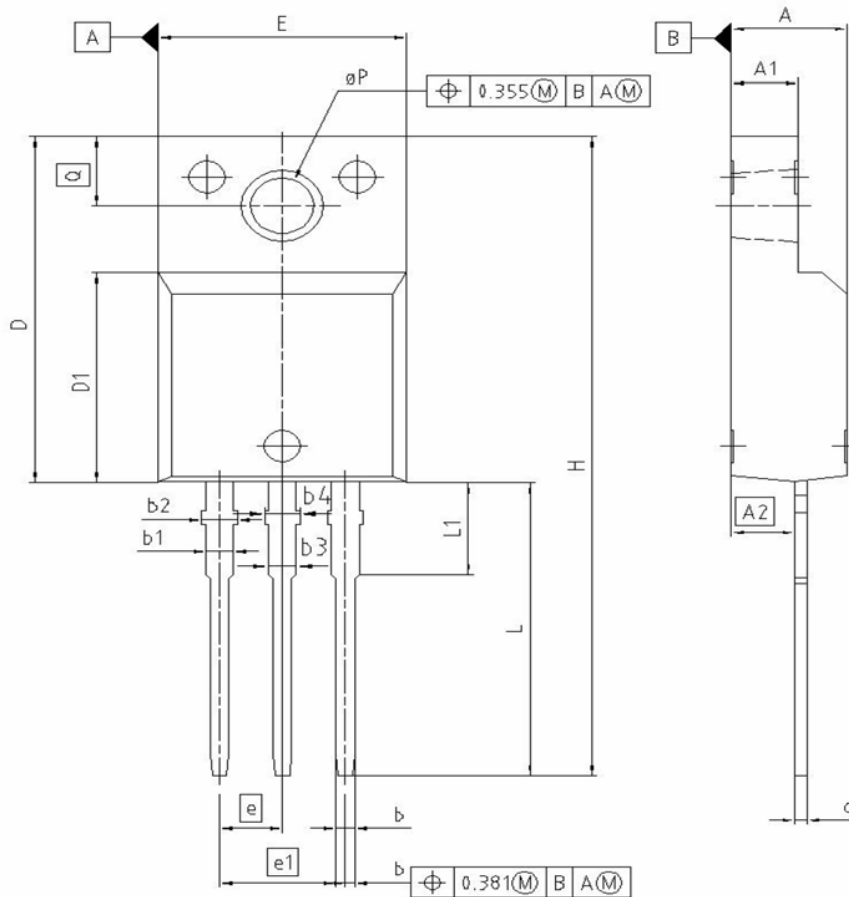


Definition of diode switching characteristics





PG-TO220-3-31/TO220-3-11: Outline/Fully isolated package (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	10.85	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  
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SCALE  
0 2.5 5mm

EUROPEAN PROJECTION

ISSUE DATE  
08-01-2007

FILE  
TO220\_2

Published by  
Infineon Technologies AG  
81726 Munich, Germany  
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