

CoolMOS® Power Transistor
Features

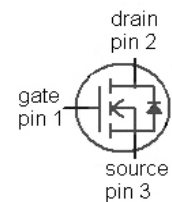
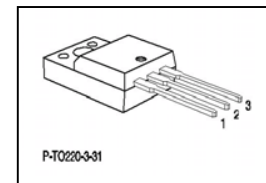
- Lowest figure-of-merit $R_{ON} \times Q_g$
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Qualified for industrial grade applications according to JEDEC¹⁾
- Pb-free lead plating; RoHS compliant; Halogen free mold compound

Product Summary

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max} @ T_j = 25^\circ C$	0.165	Ω
$Q_{g,typ}$	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 ²⁾	I_D	$T_C=25^\circ C$	21	A
		$T_C=100^\circ C$	13	
Pulsed drain current ³⁾	$I_{D,pulse}$	$T_C=25^\circ C$	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	± 20	V
		AC ($f > 1 Hz$)	± 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 ²⁾	I_S	$T_C=25\text{ °C}$	21	A
Diode pulse current ³⁾	$I_{S,pulse}$		61	
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}		-		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	μA
		$V_{DS}=25\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ °C}$	-	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	Ω
		$V_{GS}=10\text{ V}$, $I_D=12\text{ A}$, $T_j=150\text{ °C}$	-	0.40	-	
Gate resistance	R_G	$f=1\text{ MHz}$, open drain	-	1.9	-	Ω

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$	-	2000	-	pF
Output capacitance	C_{oss}		-	100	-	
Effective output capacitance, energy related ⁶⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	83	-	
Effective output capacitance, time related ⁷⁾	$C_{o(tr)}$		-	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	-	μC
Peak reverse recovery current	I_{rrm}		-	38	-	A

¹⁾ J-STD20 and JESD22

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

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

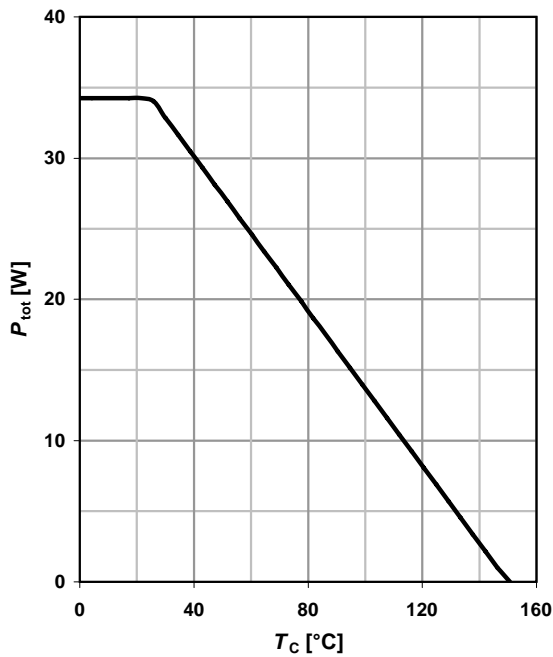
⁵⁾ $I_{SD} \leq I_D$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DClink}=400\text{ V}$, $V_{peak} < V_{(BR)DSS}$, $T_j < T_{j,max}$, identical low side and high side switch.

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

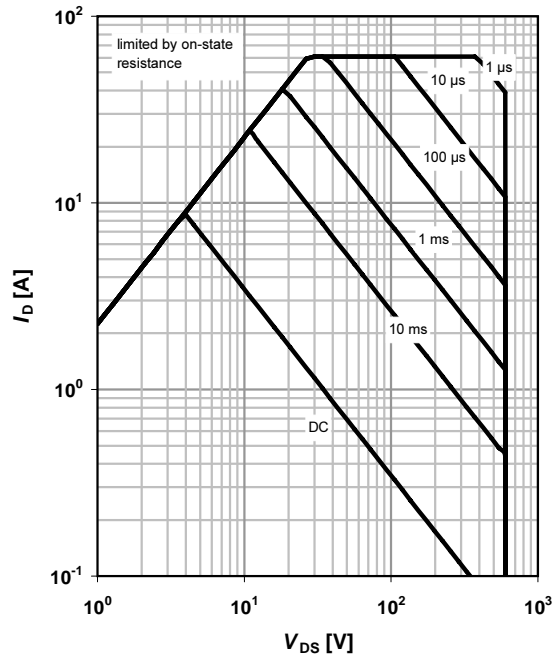
$P_{tot}=f(T_C)$



2 Safe operating area

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

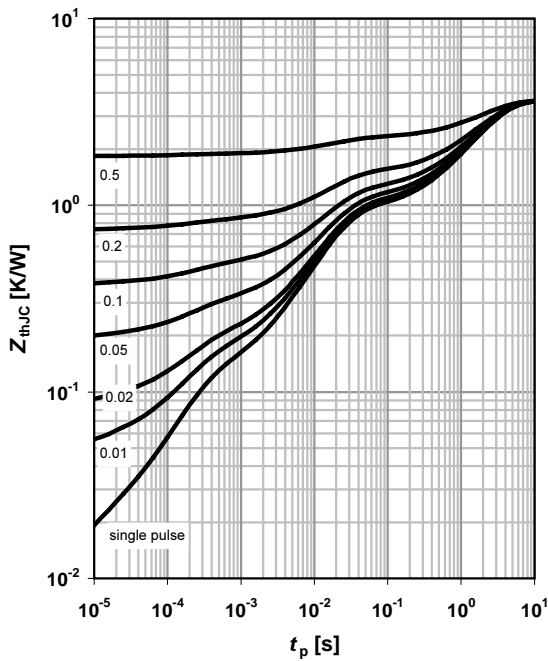
parameter: t_p



3 Max. transient thermal impedance

$Z_{thJC}=f(t_p)$

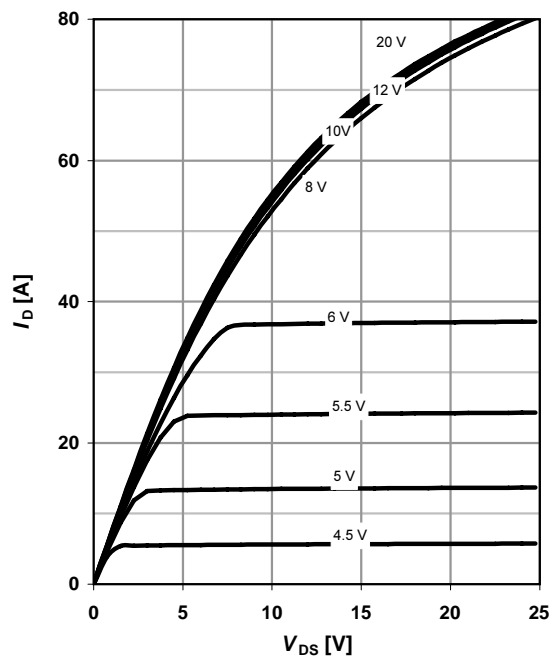
parameter: $D=t_p/T$



4 Typ. output characteristics

$I_D=f(V_{DS}); T_J=25\text{ °C}$

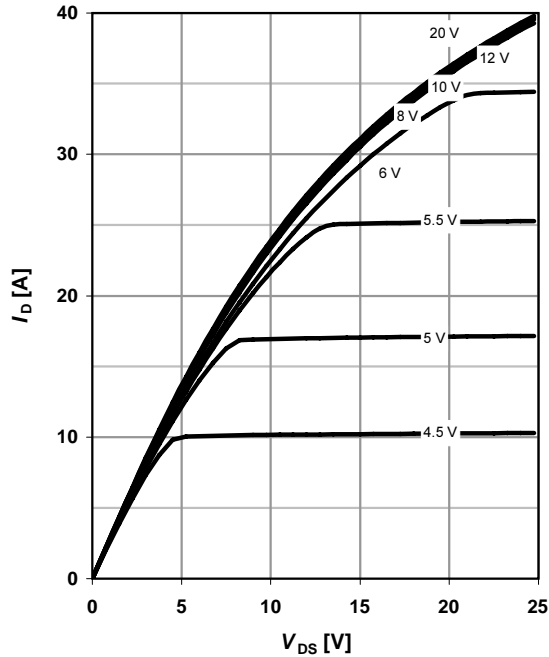
parameter: V_{GS}



5 Typ. output characteristics

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

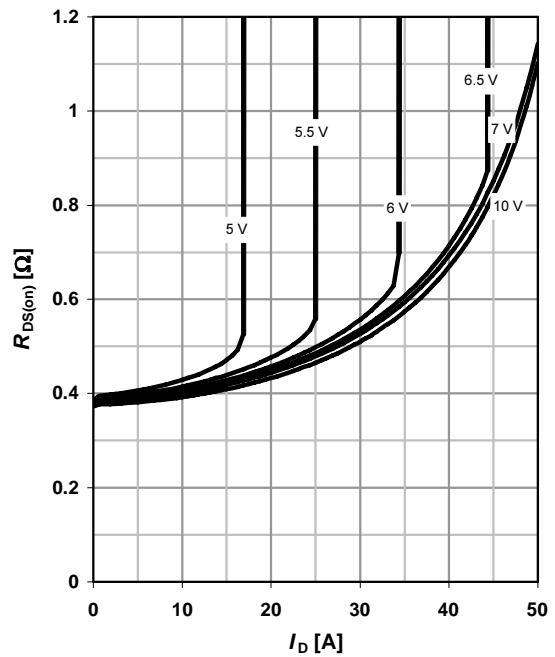
parameter: V_{GS}



6 Typ. drain-source on-state resistance

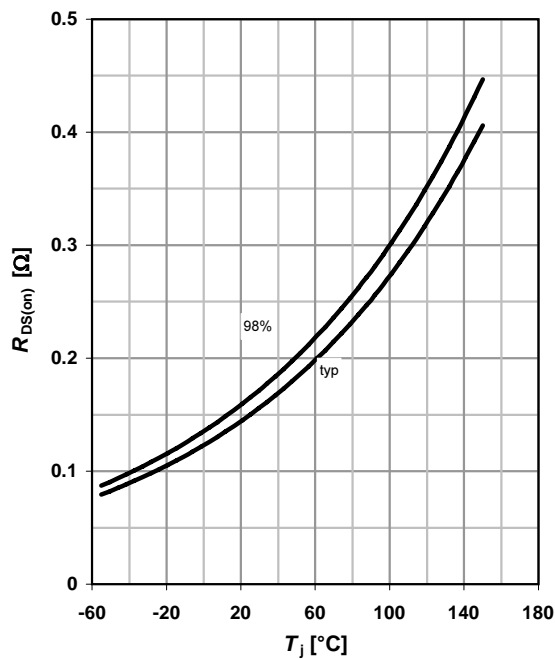
$R_{DS(on)} = f(I_D); T_j = 150\text{ °C}$

parameter: V_{GS}



7 Drain-source on-state resistance

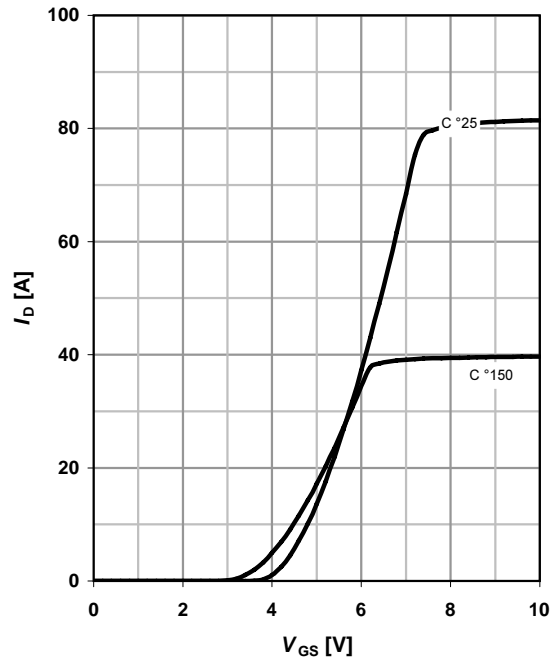
$R_{DS(on)} = f(T_j); I_D = 12\text{ A}; V_{GS} = 10\text{ V}$



8 Typ. transfer characteristics

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

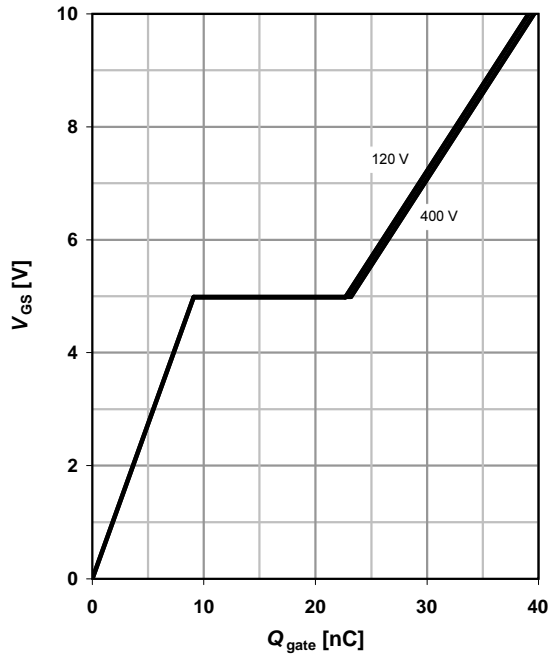
parameter: T_j



9 Typ. gate charge

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

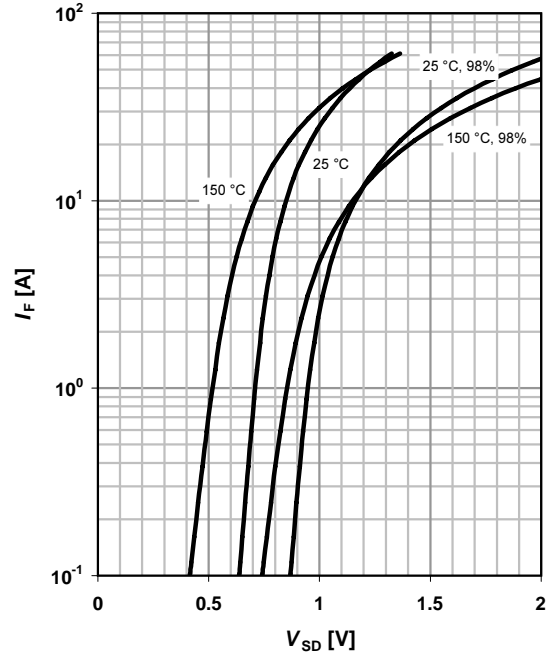
parameter: V_{DD}



10 Forward characteristics of reverse diode

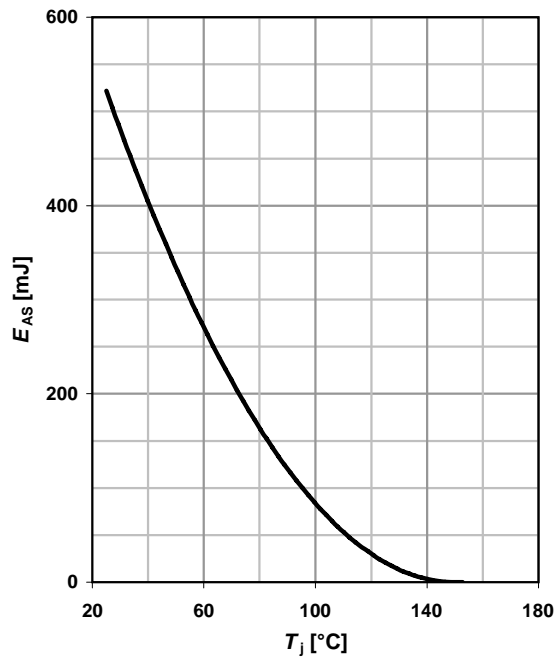
$I_F=f(V_{SD})$

parameter: T_j



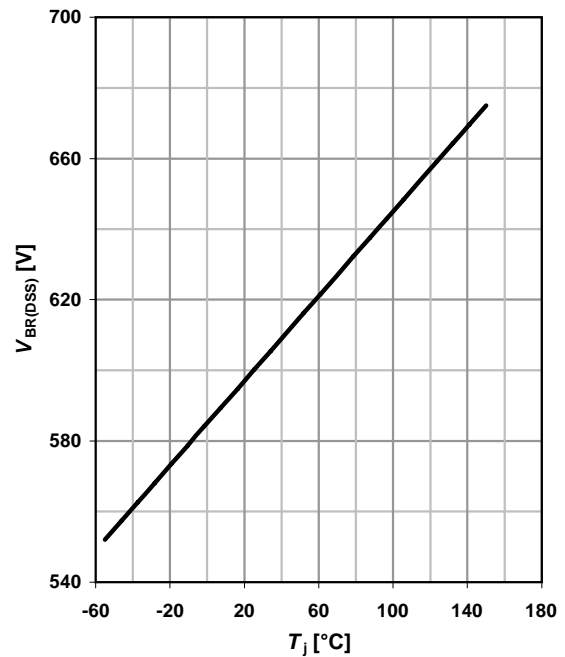
11 Avalanche energy

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



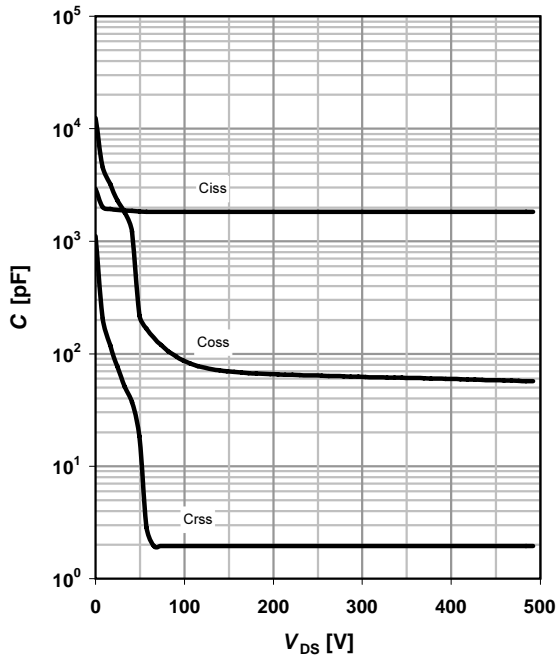
12 Drain-source breakdown voltage

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



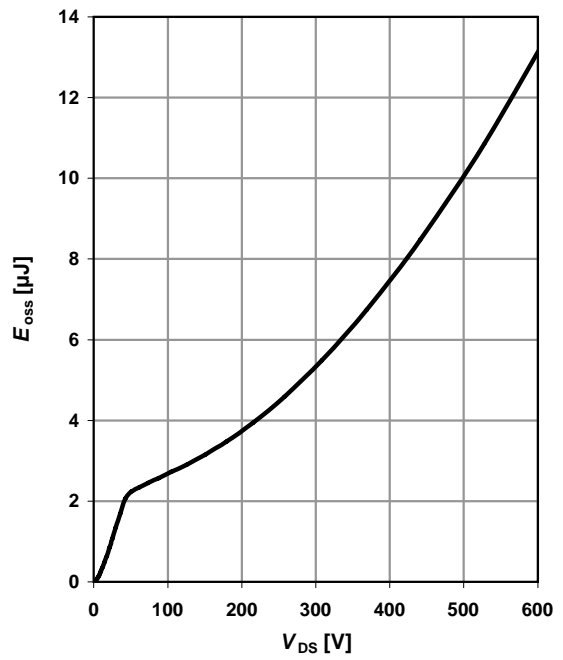
13 Typ. capacitances

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

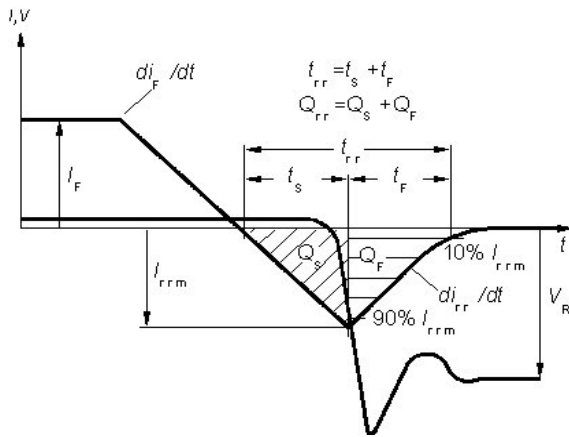


14 Typ. Coss stored energy

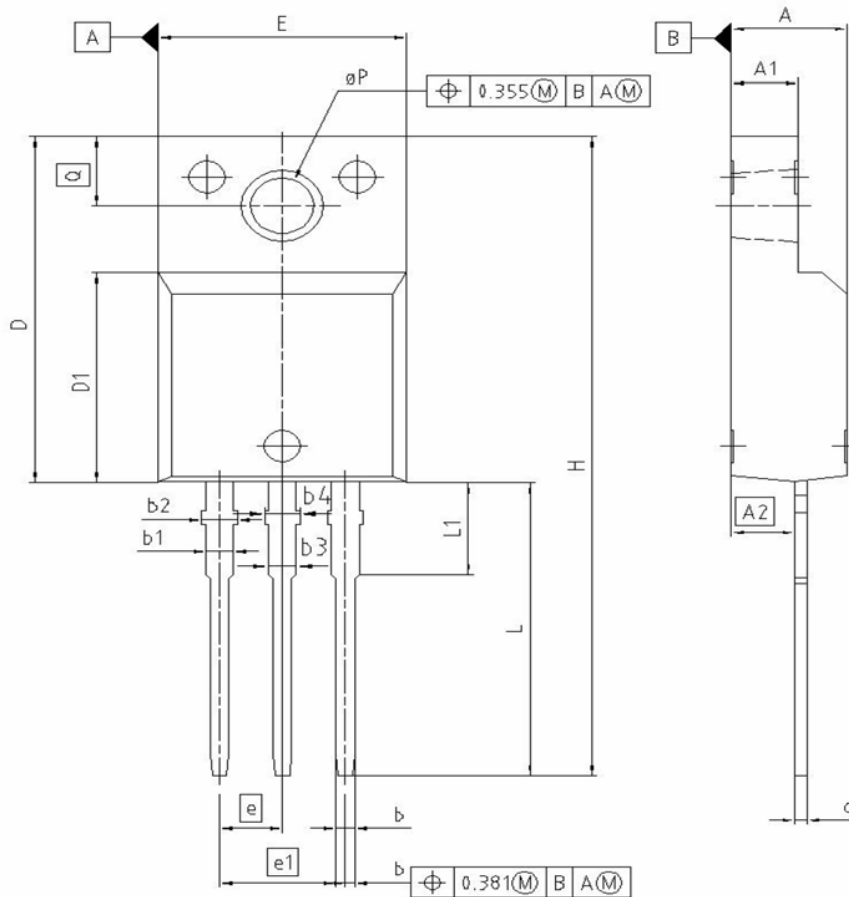
$$E_{oss}=f(V_{DS})$$



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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