

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

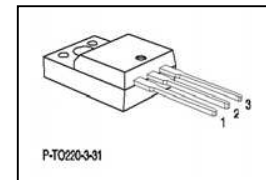
Product Summary

$V_{DS} @ T_{j,max}$	650	V
$R_{DS(on),max} @ T_j = 25^\circ C$	0.385	Ω
$Q_{g,typ}$	17	nC

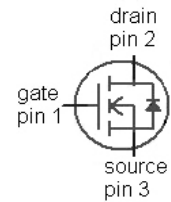
CoolMOS is specially designed for:

- Hard switching SMPS topologies

PG-TO220



Type	Package	Ordering Code	Marking
IPA60R385CP	PG-TO220	SP000089316	6R385P



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

Parameter	Symbol	Conditions	Value	Unit
Continuous drain current ²⁾	I_D	$T_C = 25^\circ C$	9.0	A
		$T_C = 100^\circ C$	5.7	
Pulsed drain current ³⁾	$I_{D,pulse}$	$T_C = 25^\circ C$	27	
Avalanche energy, single pulse	E_{AS}	$I_D = 3.4 A, V_{DD} = 50 V$	227	mJ
Avalanche energy, repetitive $t_{AR}^{3,4)}$	E_{AR}	$I_D = 3.4 A, V_{DD} = 50 V$	0.3	
Avalanche current, repetitive $t_{AR}^{3,4)}$	I_{AR}		3	A
MOSFET dv/dt ruggedness	dv/dt	$V_{DS} = 0 \dots 480 V$	50	V/ns
Gate source voltage	V_{GS}	static	± 20	V
		AC ($f > 1 Hz$)	± 30	
Power dissipation	P_{tot}	$T_C = 25^\circ C$	31	W
Operating and storage temperature	T_j, T_{stg}		-55 ... 150	$^\circ C$
Mounting torque		M2.5 screws	50	Ncm

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

Parameter	Symbol	Conditions	Value	Unit
Continuous diode forward current ²⁾	I_S	$T_C=25\text{ }^{\circ}\text{C}$	9	A
Diode pulse current ³⁾	$I_{S,pulse}$		27	
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}		-	-	4	K/W
Thermal resistance, junction - ambient	R_{thJA}	leaded	-	-	80	
Soldering temperature, wavesoldering only allowed at leads	T_{solder}	1.6 mm (0.063 in.) from case for 10 s	-	-	260	$^{\circ}\text{C}$

Electrical characteristics, at $T_j=25\text{ }^{\circ}\text{C}$, 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	$V_{GS(th)}$	$V_{DS}=V_{GS}$, $I_D=0.34\text{ mA}$	2.5	3	3.5	
Zero gate voltage drain current	I_{DSS}	$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=25\text{ }^{\circ}\text{C}$	-	-	1	μA
		$V_{DS}=600\text{ V}$, $V_{GS}=0\text{ V}$, $T_j=150\text{ }^{\circ}\text{C}$	-	10	-	
Gate-source leakage current	I_{GSS}	$V_{GS}=20\text{ V}$, $V_{DS}=0\text{ V}$	-	-	100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}$, $I_D=5.2\text{ A}$, $T_j=25\text{ }^{\circ}\text{C}$	-	0.35	0.385	Ω
		$V_{GS}=10\text{ V}$, $I_D=5.2\text{ A}$, $T_j=150\text{ }^{\circ}\text{C}$	-	0.94	-	
Gate resistance	R_G	$f=1\text{ MHz}$, open drain	-	1.8	-	Ω

Parameter	Symbol	Conditions	Values			Unit
			min.	typ.	max.	

Dynamic characteristics

Input capacitance	C_{iss}	$V_{GS}=0\text{ V}, V_{DS}=100\text{ V},$ $f=1\text{ MHz}$	-	790	-	pF
Output capacitance	C_{oss}		-	38	-	
Effective output capacitance, energy related ⁶⁾	$C_{o(er)}$	$V_{GS}=0\text{ V}, V_{DS}=0\text{ V}$ to 480 V	-	36	-	
Effective output capacitance, time related ⁷⁾	$C_{o(tr)}$		-	96	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD}=400\text{ V},$ $V_{GS}=10\text{ V}, I_D=5.2\text{ A},$ $R_G=3.3\ \Omega$	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	40	-	
Fall time	t_f		-	5	-	

Gate Charge Characteristics

Gate to source charge	Q_{gs}	$V_{DD}=400\text{ V}, I_D=5.2\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	4	-	nC
Gate to drain charge	Q_{gd}		-	6	-	
Gate charge total	Q_g		-	17	22	
Gate plateau voltage	$V_{plateau}$		-	5.0	-	V

Reverse Diode

Diode forward voltage	V_{SD}	$V_{GS}=0\text{ V}, I_F=5.2\text{ A},$ $T_j=25\text{ °C}$	-	0.9	1.2	V
Reverse recovery time	t_{rr}	$V_R=400\text{ V}, I_F=I_S,$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	260	-	ns
Reverse recovery charge	Q_{rr}		-	3.1	-	μC
Peak reverse recovery current	I_{rrm}		-	24	-	A

¹⁾ J-STD20 and JESD22

²⁾ Limited only by maximum temperature

³⁾ Pulse width t_p limited by $T_{j,max}$

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

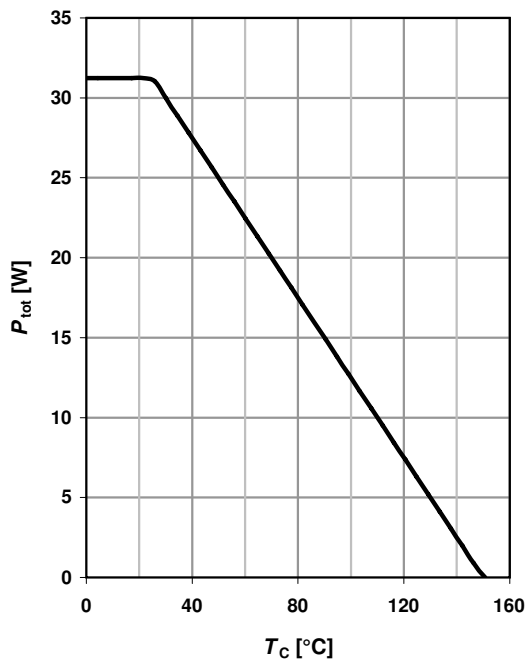
⁵⁾ $I_{SD} \leq I_D$, $di/dt \leq 400\text{ A}/\mu\text{s}$, $V_{DClink}=400\text{ V}$, $V_{peak} < V_{(BR)DSS}$, $T_j < T_{j,max}$, identical low side and high side switch.

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

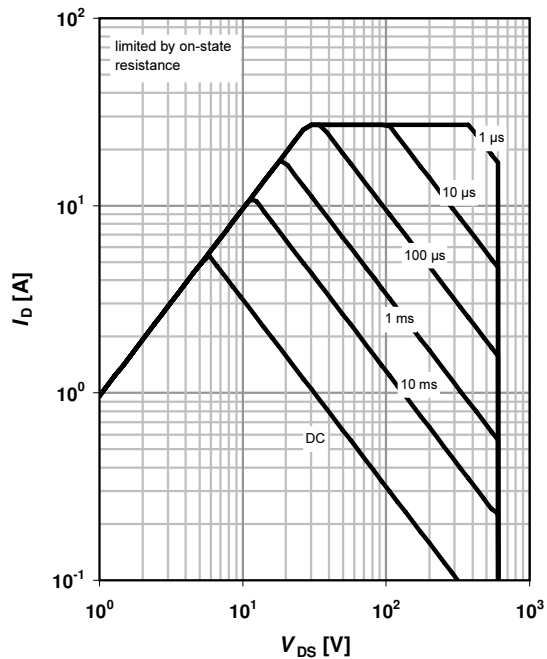
$$P_{\text{tot}} = f(T_C)$$



2 Safe operating area

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

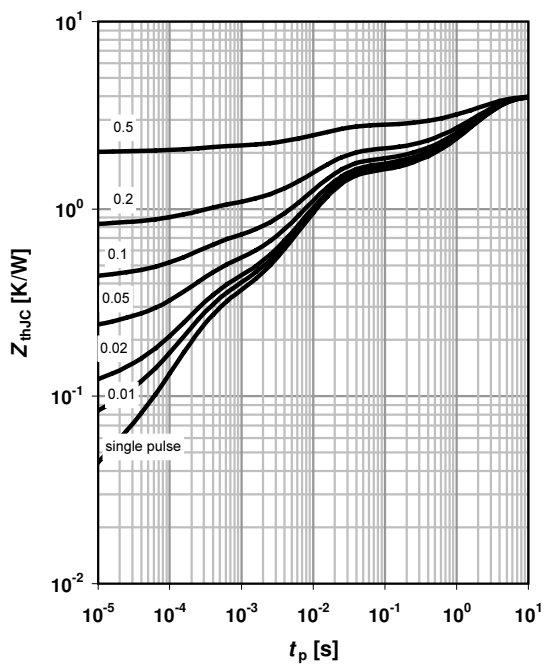
parameter: t_p



3 Max. transient thermal impedance

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

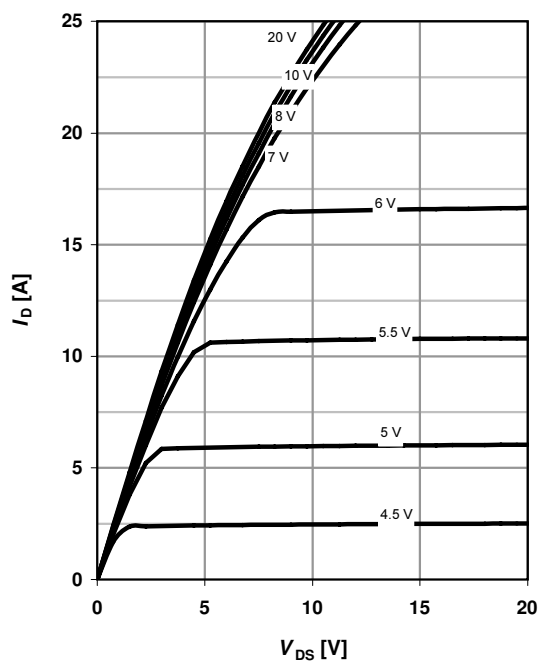
parameter: $D = t_p / T$



4 Typ. output characteristics

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

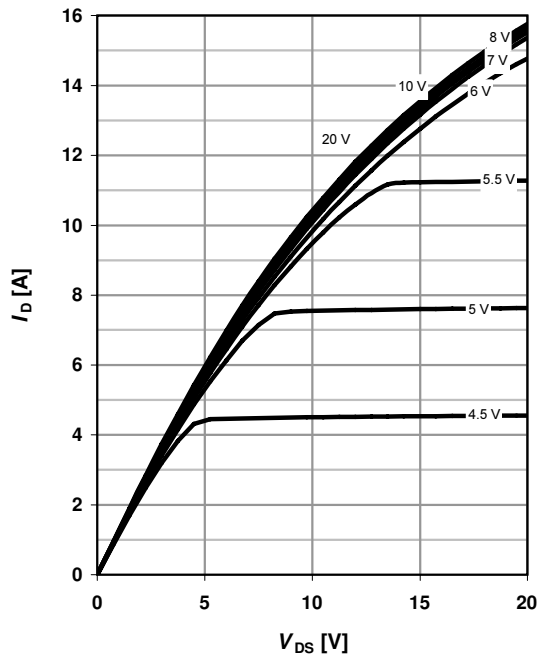
parameter: V_{GS}



5 Typ. output characteristics

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

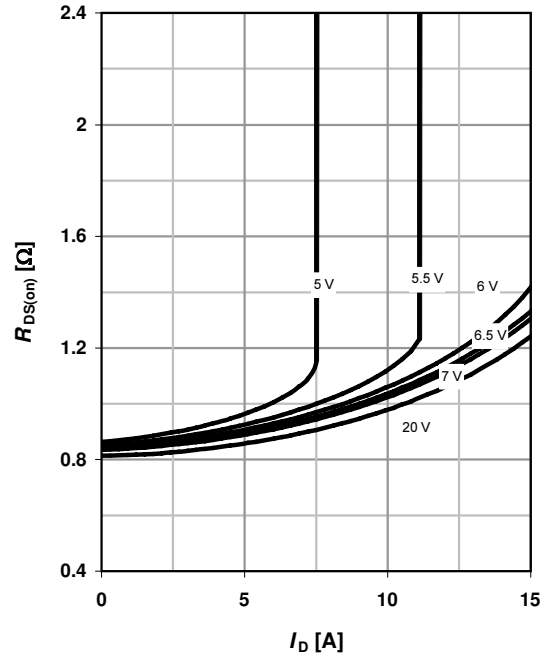
parameter: V_{GS}



6 Typ. drain-source on-state resistance

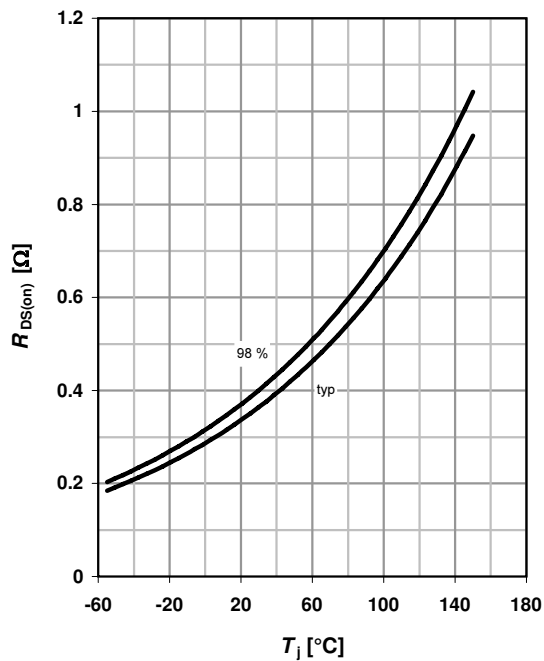
$$R_{DS(on)} = f(I_D); T_J = 150^\circ\text{C}$$

parameter: V_{GS}



7 Drain-source on-state resistance

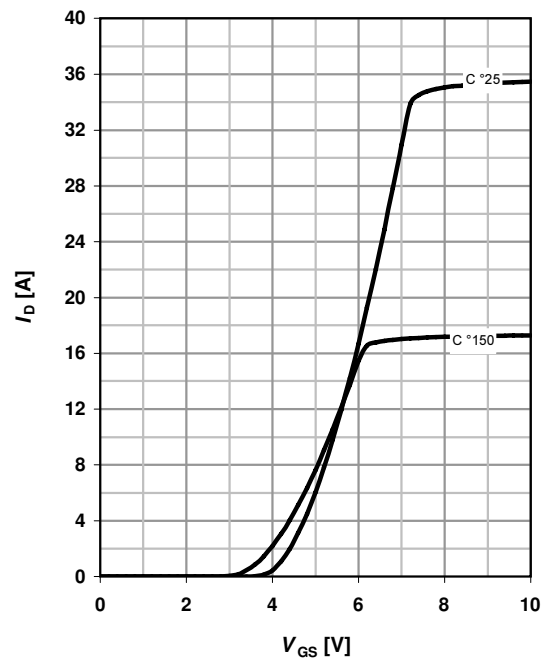
$$R_{DS(on)} = f(T_J); I_D = 5.2\text{ A}; V_{GS} = 10\text{ V}$$



8 Typ. transfer characteristics

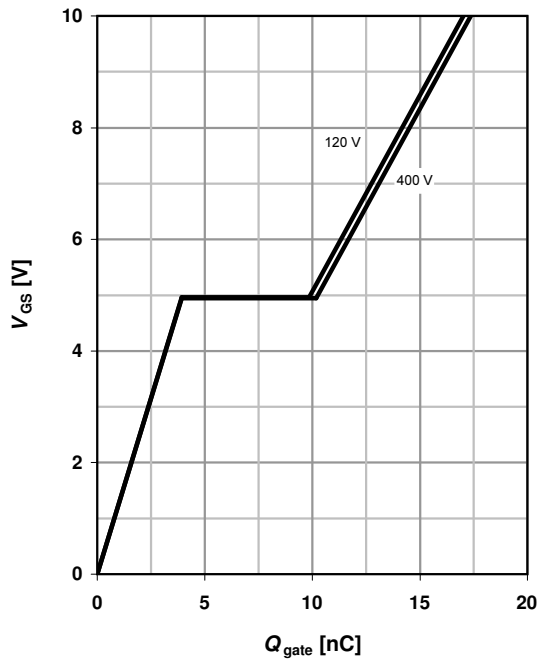
$$I_D = f(V_{GS}); |V_{DS}| > 2|I_D|R_{DS(on)\max}$$

parameter: T_J



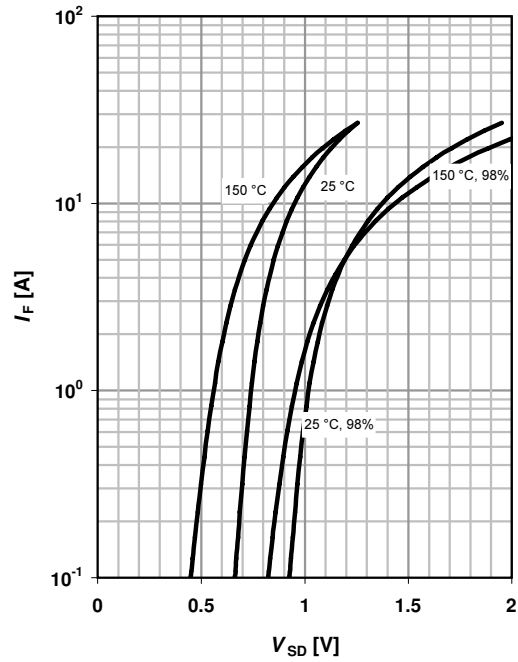
9 Typ. gate charge

 $V_{GS}=f(Q_{gate}); I_D=5.2 \text{ A pulsed}$

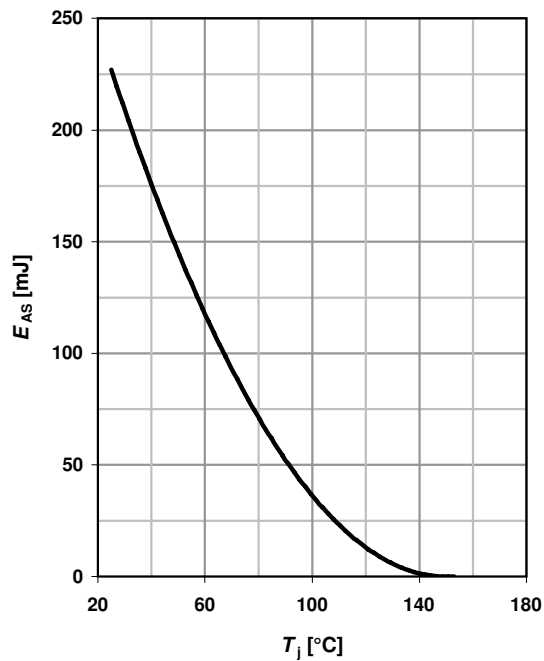
parameter: V_{DD}


10 Forward characteristics of reverse diode

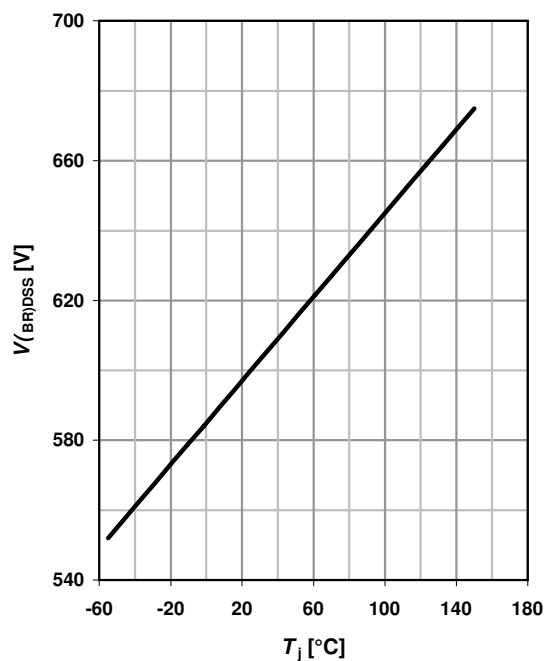
 $I_F=f(V_{SD})$

parameter: T_j


11 Avalanche energy

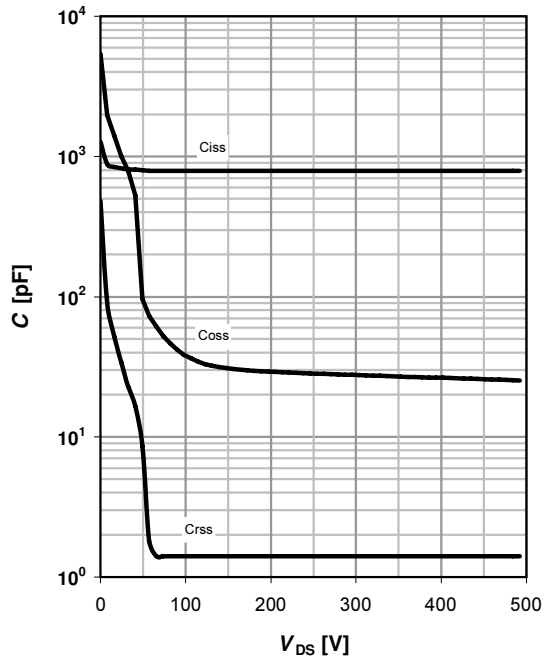
 $E_{AS}=f(T_j); I_D=3.4 \text{ A}; V_{DD}=50 \text{ V}$


12 Drain-source breakdown voltage

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


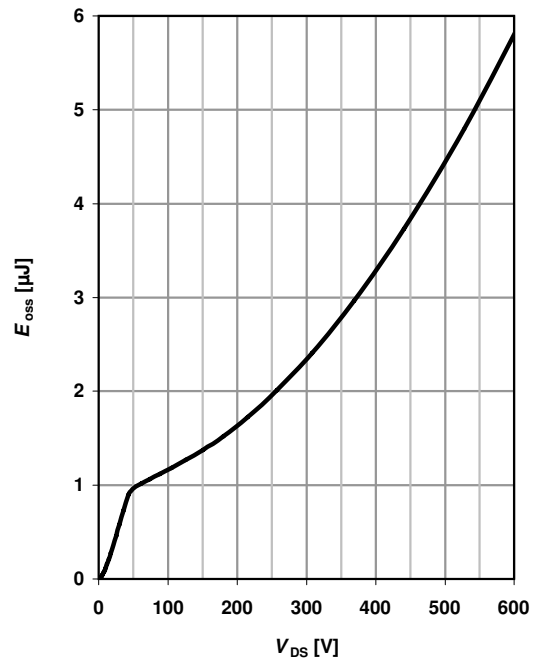
13 Typ. capacitances

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

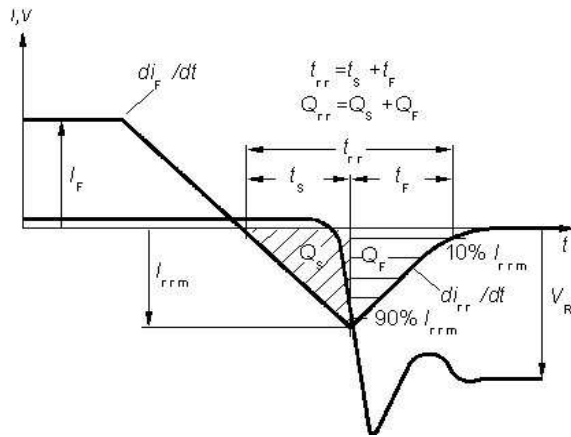


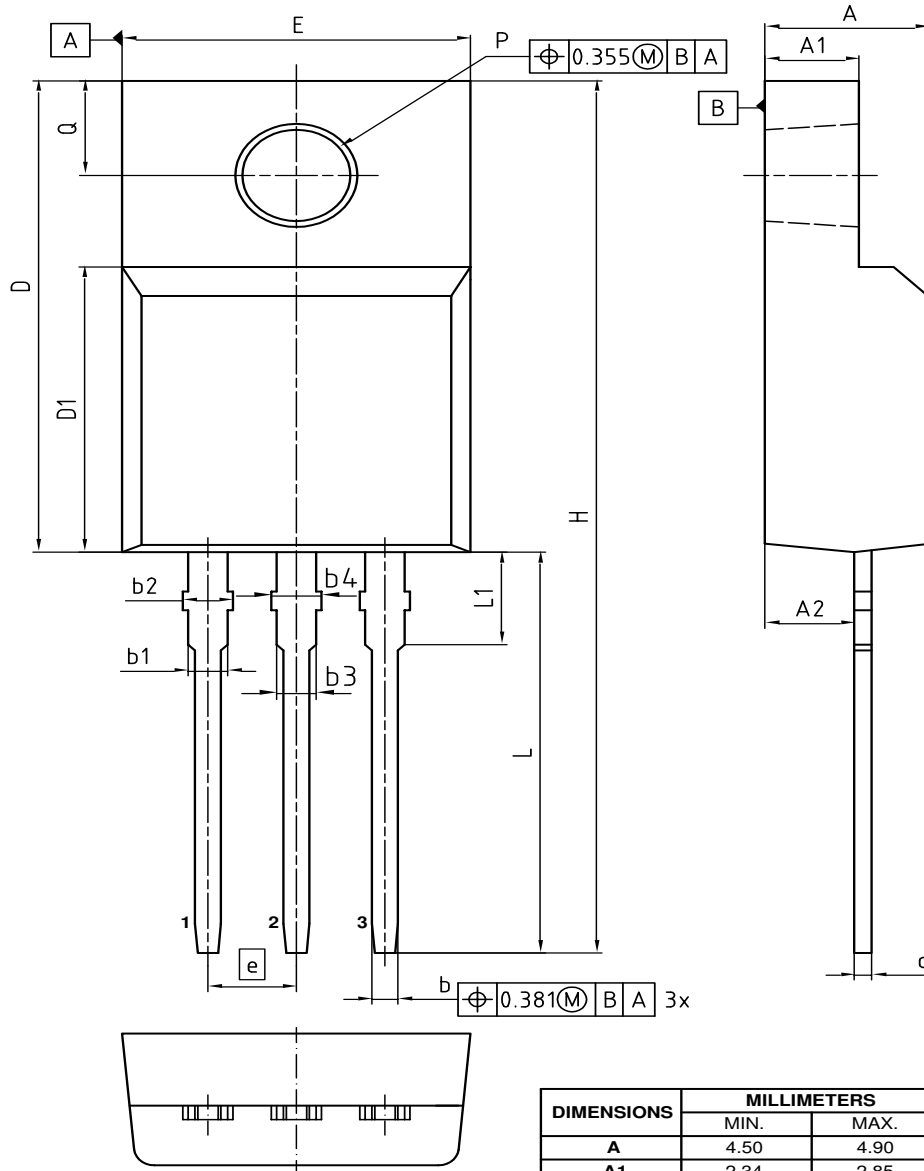
14 Typ. Coss stored energy

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



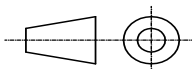
Definition of diode switching characteristics



Outline PG-TO220 FullPAK


NOTES:
ALL DIMENSIONS REFER TO JEDEC STANDARD TO-281
AND DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS
OR GATE BURRS
GATE BURRS ARE LESS THAN 0.5 mm

DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
A	4.50	4.90
A1	2.34	2.85
A2	2.42	2.86
b	0.65	0.90
b1	0.95	1.38
b2	0.95	1.51
b3	0.65	1.38
b4	0.65	1.51
c	0.40	0.63
D	15.67	16.15
D1	8.97	9.83
E	10.00	10.65
e	2.54	
H	28.70	29.75
L	12.78	13.75
L1	2.83	3.45
øP	3.00	3.30
Q	3.15	3.50

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Revision History

IPA60R385CP

Revision: 2018-02-22, Rev. 2.3

Previous Revision

Revision	Date	Subjects (major changes since last revision)
2.3	2018-02-22	Outline PG-TO220 FullPAK Update

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