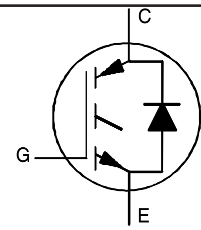
International
IOR Rectifier

IRGB5B120KD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

- Low VCE (on) Non Punch Through IGBT Technology.
- Low Diode VF.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- TO-220 Package.



n-channel

V_{CES} = 1200V

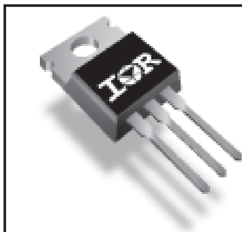
I_C = 6.0A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 2.75V

Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Excellent Current Sharing in Parallel Operation.



TO-220AB

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	12	A
I_C @ T_C = 100°C	Continuous Collector Current	6.0	
I_{CM}	Pulsed Collector Current	24	
I_{LM}	Clamped Inductive Load Current ①	24	
I_F @ T_C = 25°C	Diode Continuous Forward Current	12	
I_F @ T_C = 100°C	Diode Continuous Forward Current	6.0	
I_{FM}	Diode Maximum Forward Current	24	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	89	W
P_D @ T_C = 100°C	Maximum Power Dissipation	36	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw.	10 lbf•in (1.1 N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	——	——	1.4	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	——	——	2.8	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	——	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	——	——	62	
Wt	Weight	——	2 (0.07)	——	g (oz)

07/24/08

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	V_{GE} = 0V, I_C = 500μA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.15	—	V/°C	V_{GE} = 0V, I_C = 1.0mA, (25°C-125°C)	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.75	3.0	V	I_C = 6.0A V_{GE} = 15V	5, 6,7
		—	3.36	3.7		I_C = 6.0A V_{GE} = 15V T_J = 125°C	9,10,11
$V_{GE(th)}$	Gate Threshold Voltage	4.0	5.0	6.0	V	V_{CE} = V_{GE}, I_C = 250μA	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA, (25°C-125°C)	12
g_{fe}	Forward Transconductance	—	2.6	—	S	V_{CE} = 50V, I_C = 6.0A, PW=80μs	
I_{CES}	Zero Gate Voltage Collector Current	—	—	100	μA	V_{GE} = 0V, V_{CE} = 1200V	
		—	66	200		V_{GE} = 0V, V_{CE} = 1200V, T_J = 125°C	
V_{FM}	Diode Forward Voltage Drop	—	2.13	2.45	V	I_F = 6.0A	8
		—	2.38	2.75		I_F = 6.0A T_J = 125°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V	

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Qg	Total Gate Charge (turn-on)	—	25	38	nC	I_C = 6.0A	23
Qge	Gate - Emitter Charge (turn-on)	—	3.7	5.6		V_{CC} = 800V	CT1
Qgc	Gate - Collector Charge (turn-on)	—	13	20		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	390	440	μJ	I_C = 6.0A, V_{CC} = 600V	CT4
E_{off}	Turn-Off Switching Loss	—	330	440		V_{GE} = 15V, R_G = 50Ω, L =3.7mH	
E_{tot}	Total Switching Loss	—	720	880		Ls = 150nH T_J = 25°C ②	
$t_{d(on)}$	Turn-On Delay Time	—	22	29	ns	I_C = 6.0A, V_{CC} = 600V	CT4
t_r	Rise Time	—	19	27		V_{GE} = 15V, R_G = 50Ω L =3.7mH	
$t_{d(off)}$	Turn-Off Delay Time	—	100	120		Ls = 150nH, T_J = 25°C	
t_f	Fall Time	—	19	25			
E_{on}	Turn-On Switching Loss	—	440	660	μJ	I_C = 6.0A, V_{CC} = 600V	CT4
E_{off}	Turn-Off Switching Loss	—	370	560		V_{GE} = 15V, R_G = 50Ω, L =3.7mH	13,15
E_{tot}	Total Switching Loss	—	810	1220		Ls = 150nH T_J = 125°C ②	WF1WF2
$t_{d(on)}$	Turn-On Delay Time	—	21	27	ns	I_C = 6.0A, V_{CC} = 600V	14, 16
t_r	Rise Time	—	18	25		V_{GE} = 15V, R_G = 50Ω L =3.7mH	CT4
$t_{d(off)}$	Turn-Off Delay Time	—	110	150		Ls = 150nH, T_J = 125°C	WF1
t_f	Fall Time	—	22	29			WF2
C_{ies}	Input Capacitance	—	370	—	pF	V_{GE} = 0V	22
C_{oes}	Output Capacitance	—	33	—		V_{CC} = 30V	
C_{res}	Reverse Transfer Capacitance	—	11	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operting Area	FULL SQUARE				T_J = 150°C, I_C = 24A, Vp =1200V V_{CC} = 1000V, V_{GE} = +15V to 0V, R_G=50Ω	4 CT2
SCSOA	Short Circuit Safe Operting Area	10	—	—	μs	T_J = 150°C, Vp =1200V, R_G = 50Ω V_{CC} = 900V, V_{GE} = +15V to 0V	CT3 WF4
Erec	Reverse Recovery energy of the diode	—	360	—	μJ	T_J = 125°C	17,18,19
t_{rr}	Diode Reverse Recovery time	—	160	—	ns	V_{CC} = 600V, I_F = 6.0A, L = 2.0mH	20, 21
I_{rr}	Diode Peak Reverse Recovery Current	—	9.0	—	A	V_{GE} = 15V, R_G = 50Ω, Ls = 150nH	CT4,WF3

Note:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 100μH, R_G = 50Ω.

② Energy losses include "tail" and diode reverse recovery.

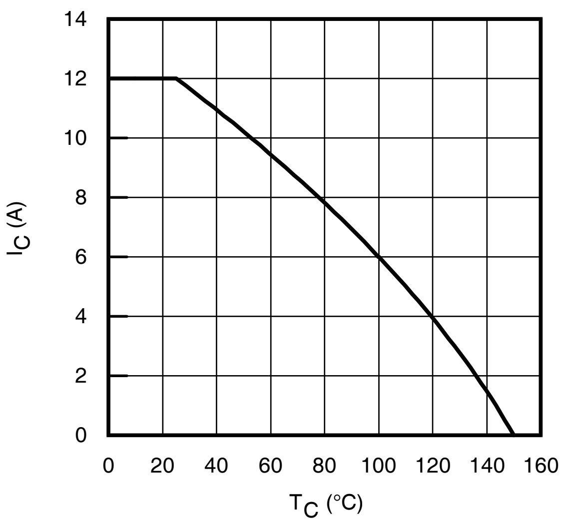


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

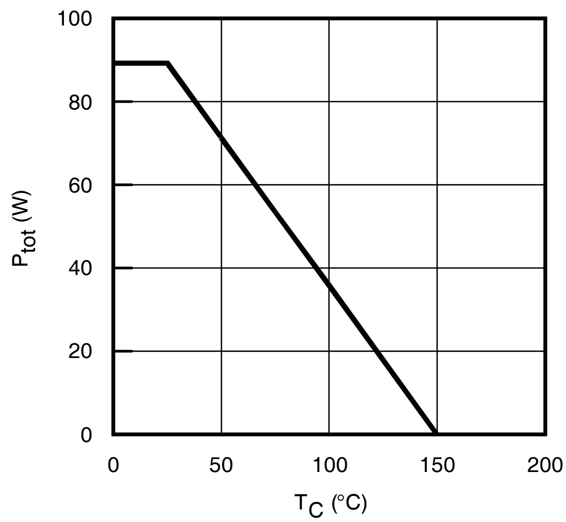


Fig. 2 - Power Dissipation vs. Case Temperature

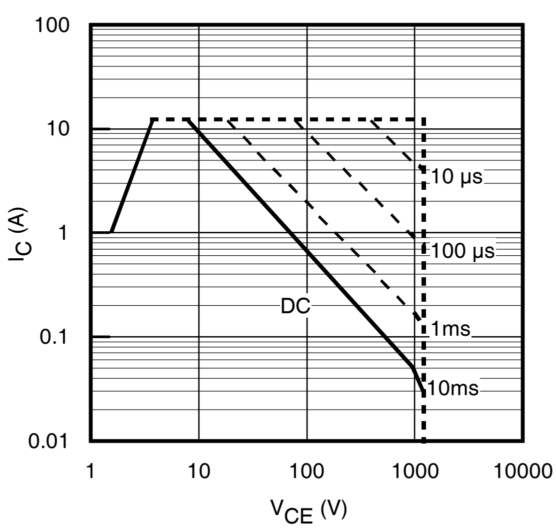


Fig. 3 - Forward SOA
$T_C = 25°C$; $T_J \leq 150°C$

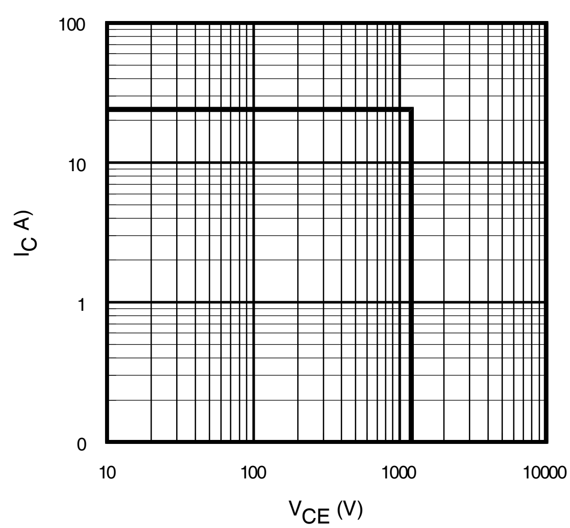


Fig. 4 - Reverse Bias SOA
$T_J = 150°C$; $V_{GE} = 15V$

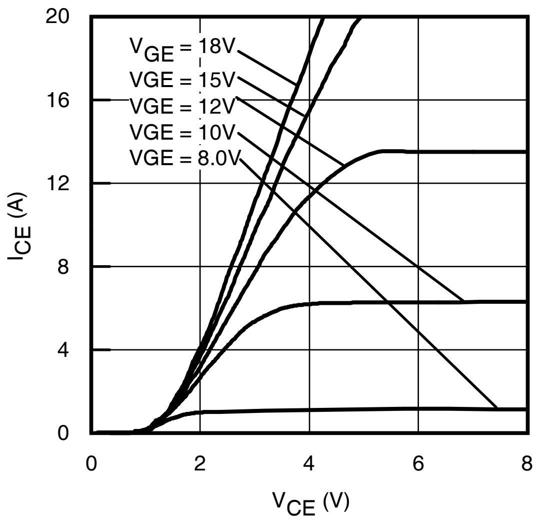


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

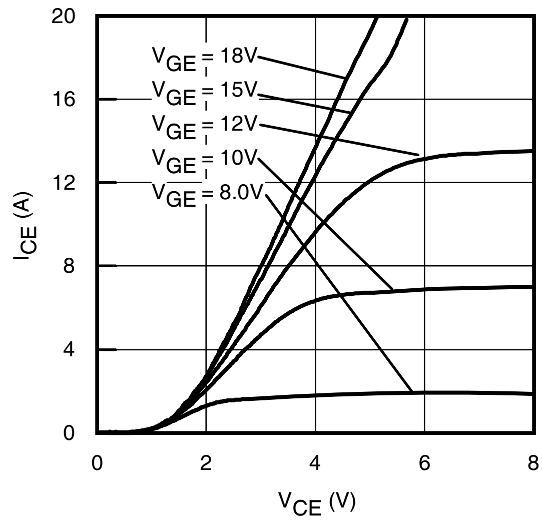


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

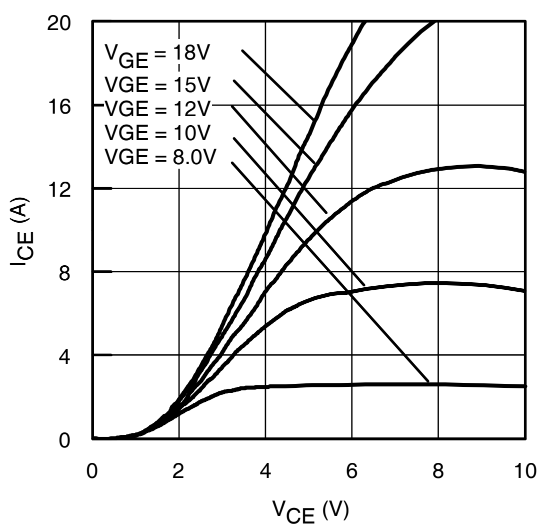


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 125°C; tp = 80µs

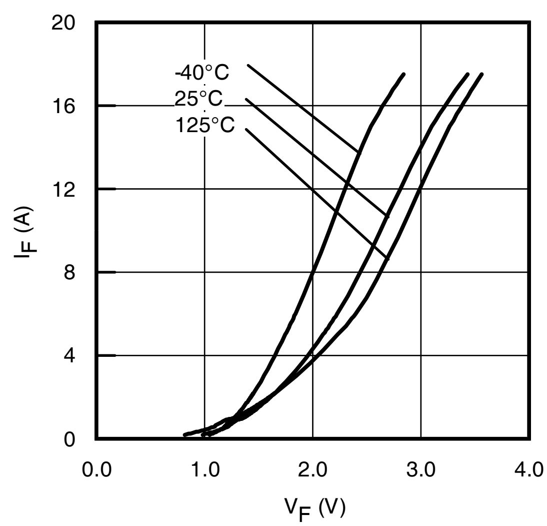


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

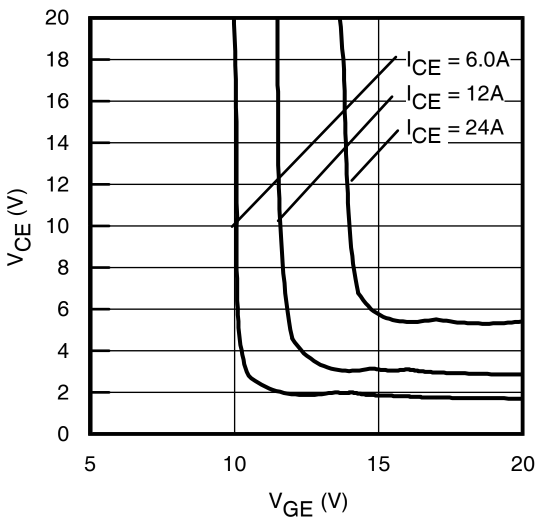


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

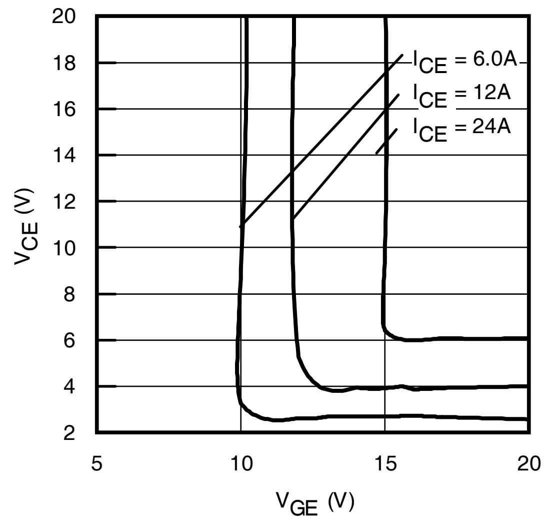


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

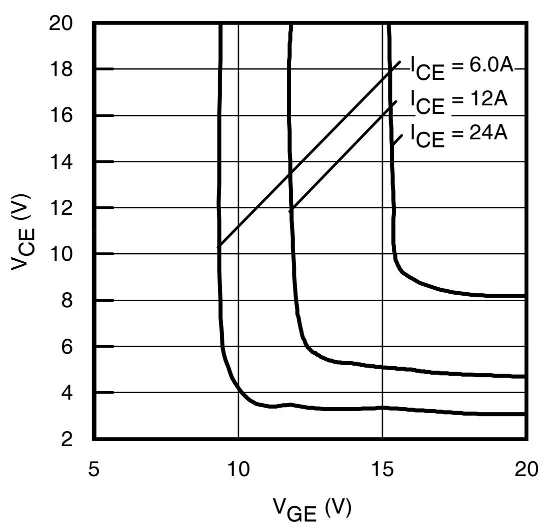


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 125°C

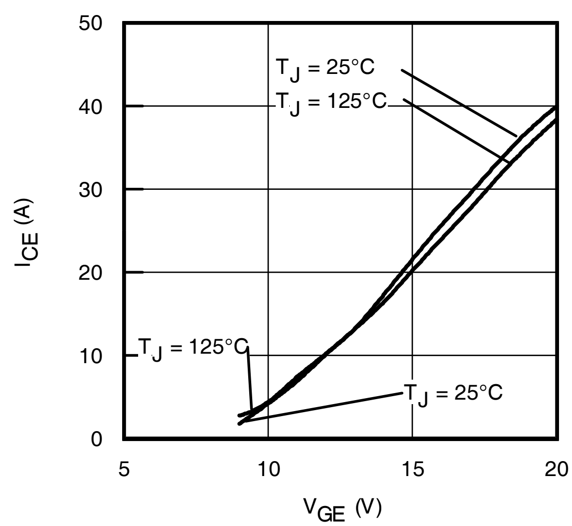


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

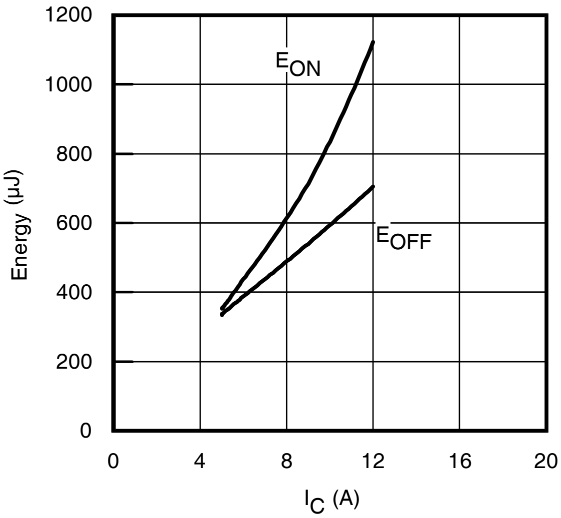


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 125°C; L=3.7mH; V_{CE}= 600V
R_G= 50Ω; V_{GE}= 15V

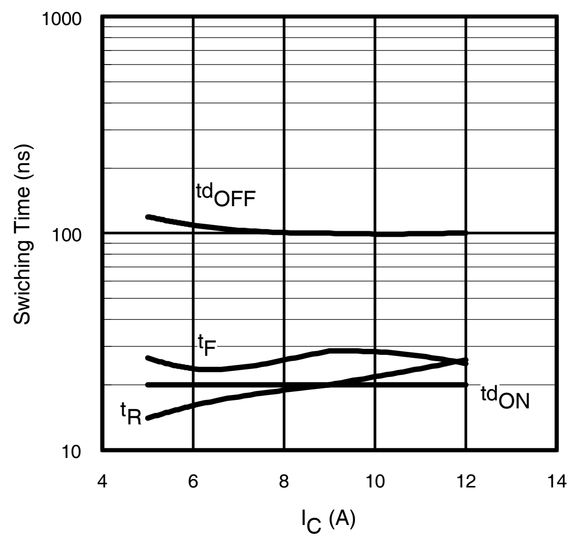


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 125°C; L=3.7mH; V_{CE}= 600V
R_G= 50Ω; V_{GE}= 15V

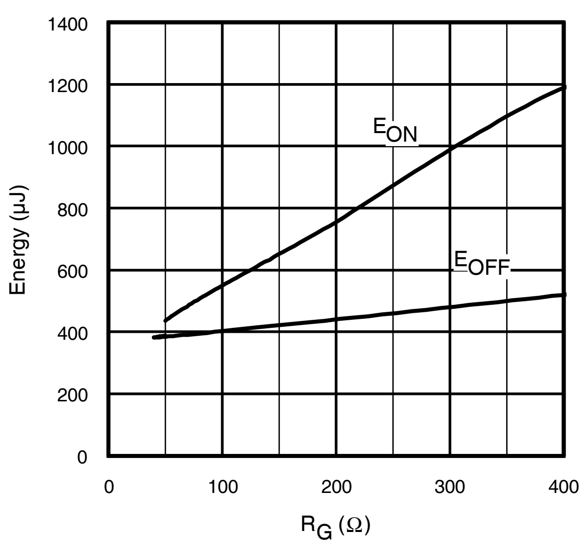


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 125°C; L=3.7mH; V_{CE}= 600V
I_{CE}= 6.0A; V_{GE}= 15V

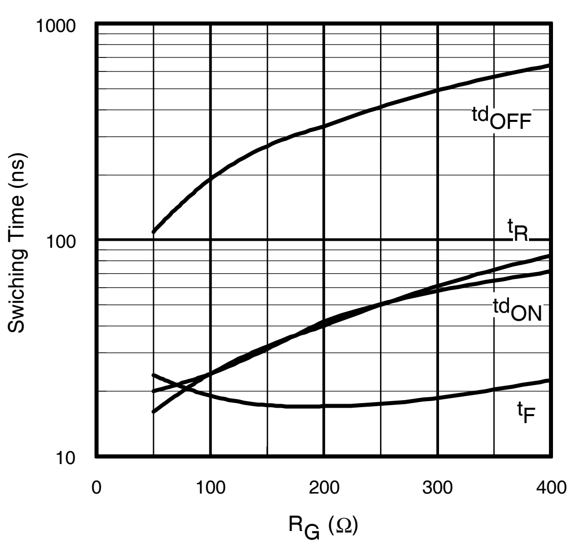


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 125°C; L=3.7mH; V_{CE}= 600V
I_{CE}= 6.0A; V_{GE}= 15V

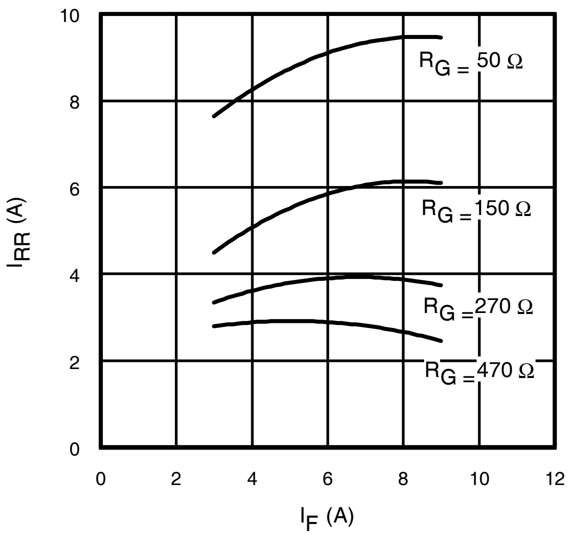


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 125°C

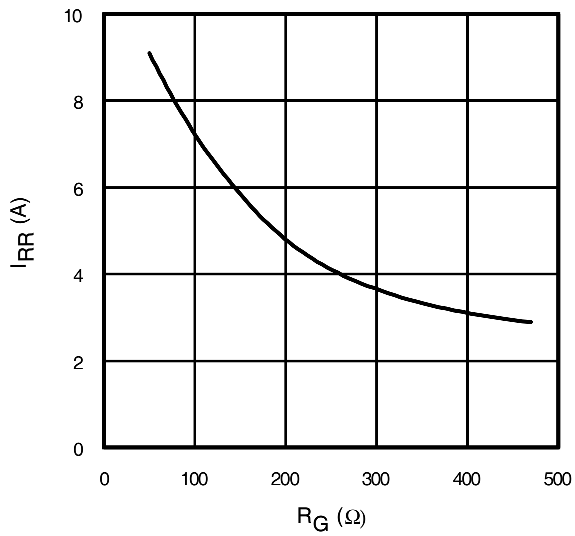


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 125°C; I_F = 6.0A

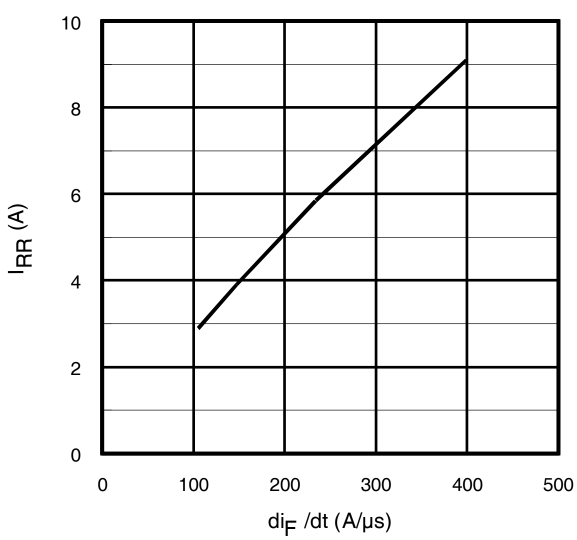


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 600V; V_{GE}= 15V;
I_F = 6.0A; T_J = 125°C

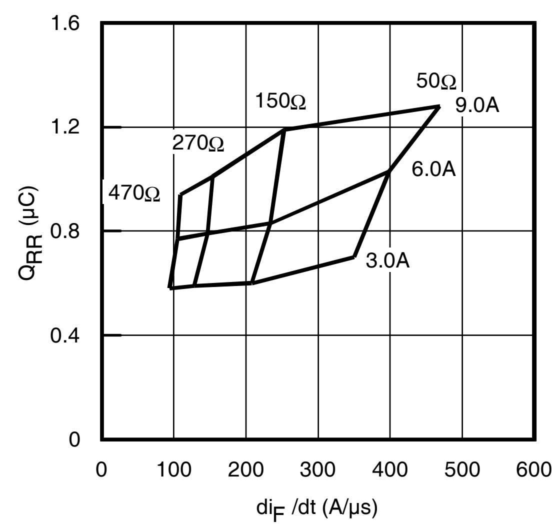


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 600V; V_{GE}= 15V;T_J = 125°C

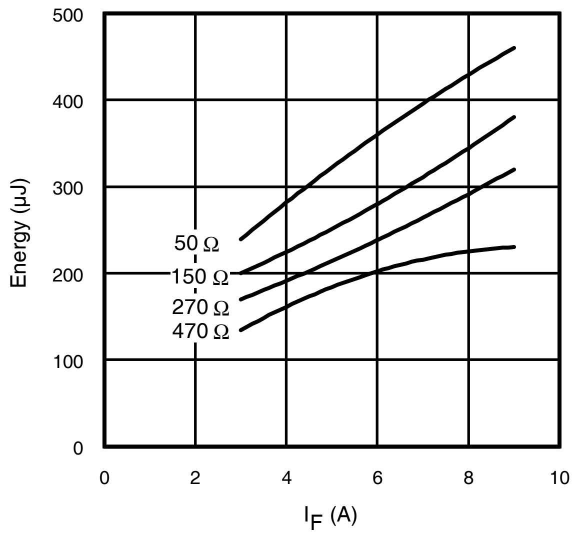


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 125°C

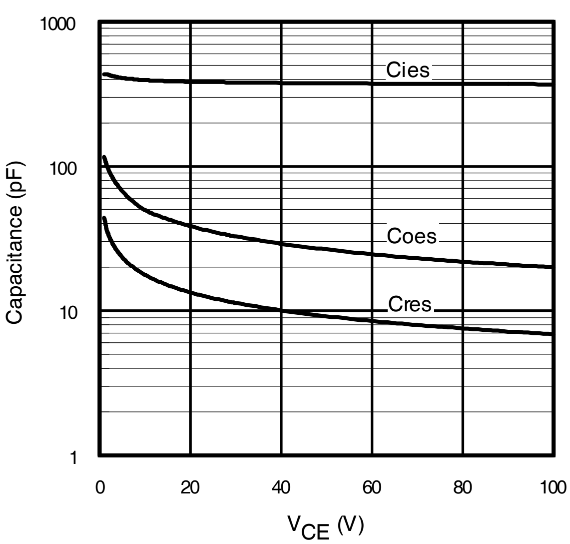


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

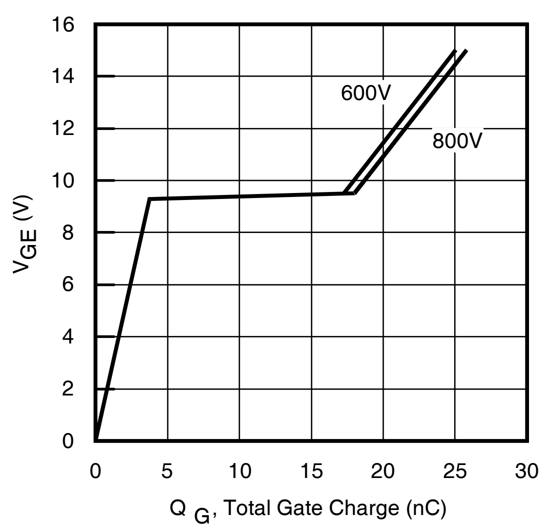


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 6.0A; L = 600µH

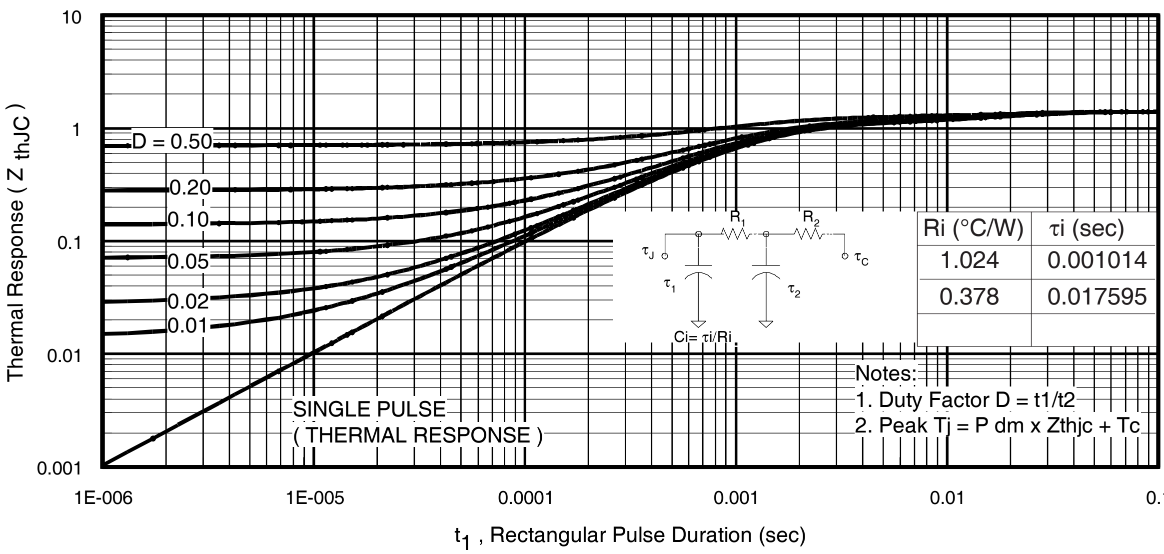


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

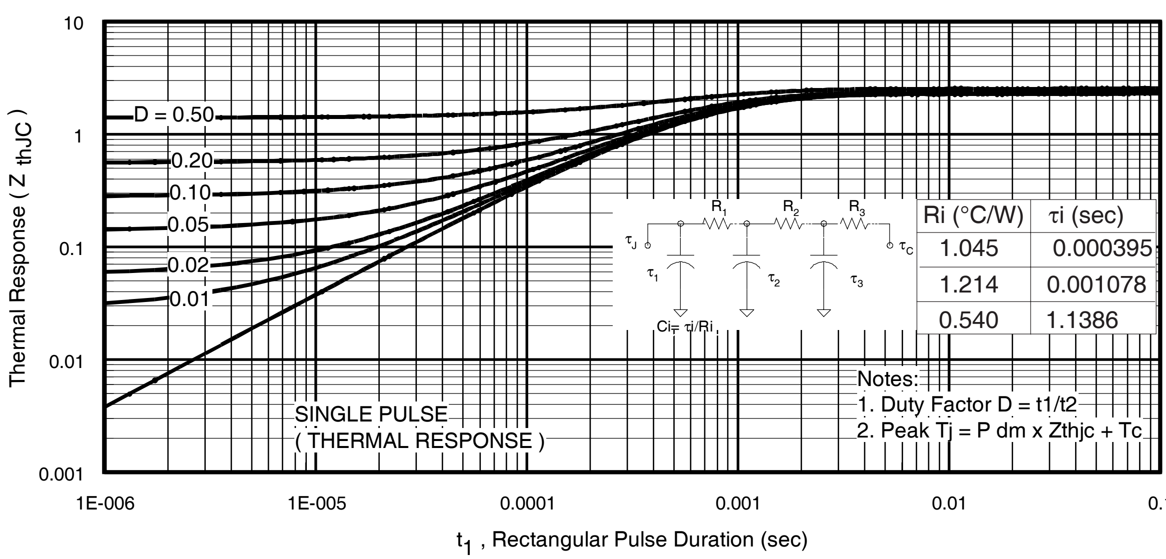


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

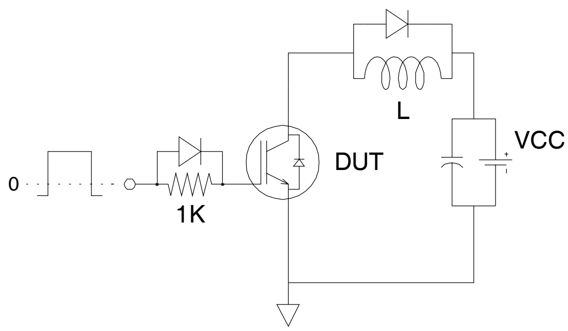


Fig.C.T.1 - Gate Charge Circuit (turn-off)

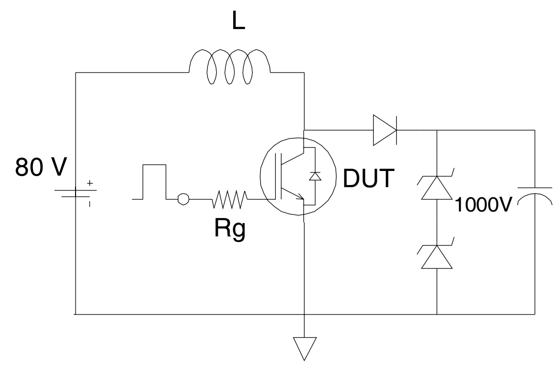


Fig.C.T.2 - RBSOA Circuit

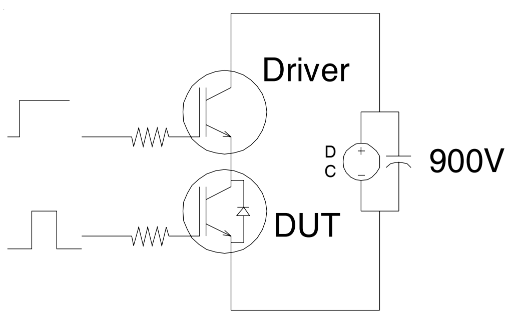


Fig.C.T.3 - S.C. SOA Circuit

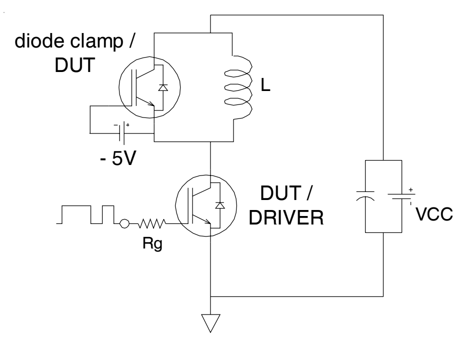


Fig.C.T.4 - Switching Loss Circuit

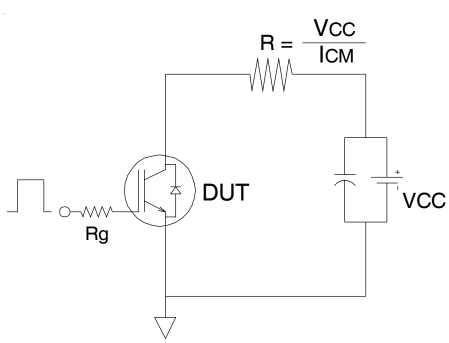


Fig.C.T.5 - Resistive Load Circuit

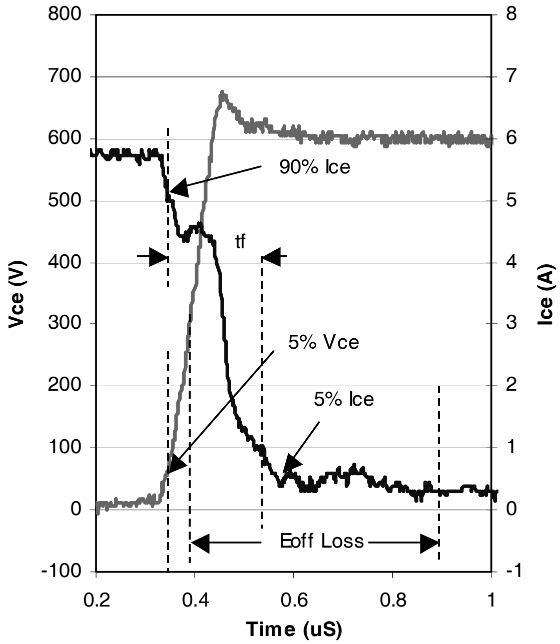


Fig.WF2-Typ. Turn-off Loss Waveform
@ T_J =125°C using Fig. CT4

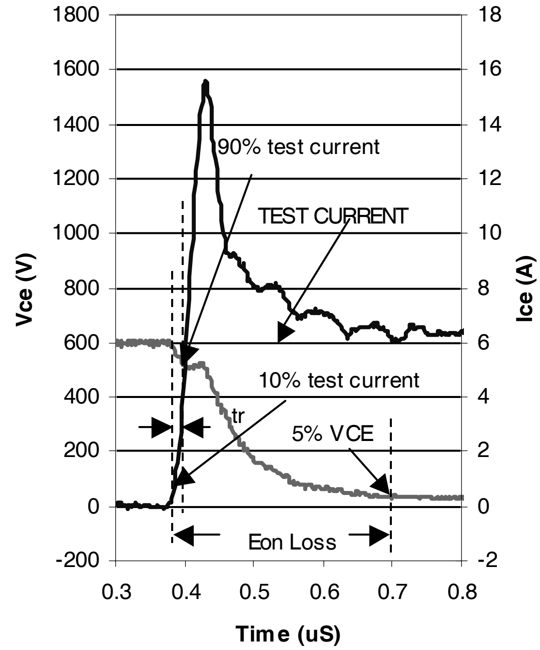


Fig.WF2-Typ. Turn-on Loss Waveform
@ T_J =125°C using Fig. CT4

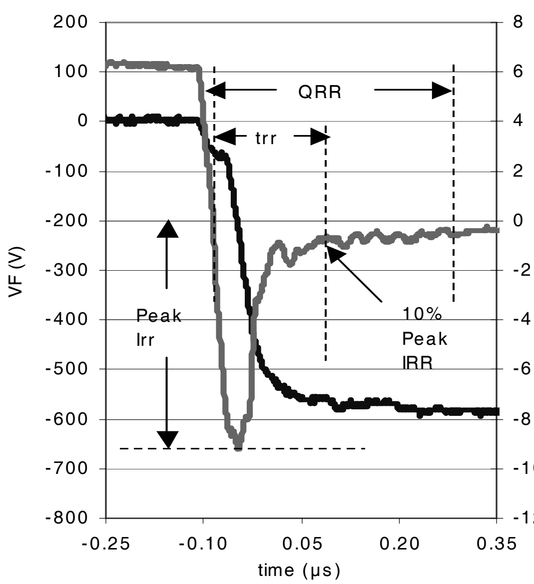


Fig.WF3-Typ. Diode Recovery Waveform
@ T_J =125°C using Fig. CT4

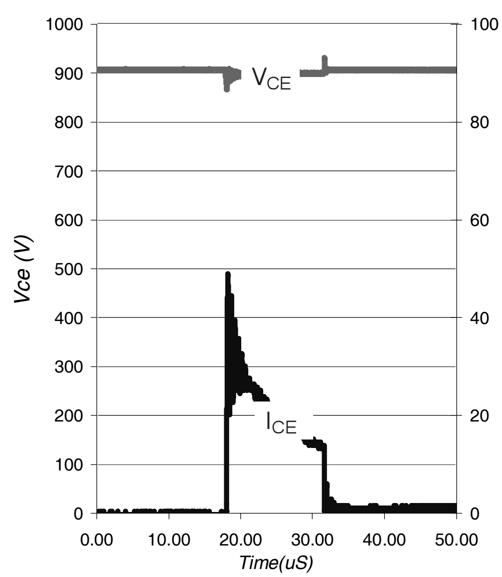
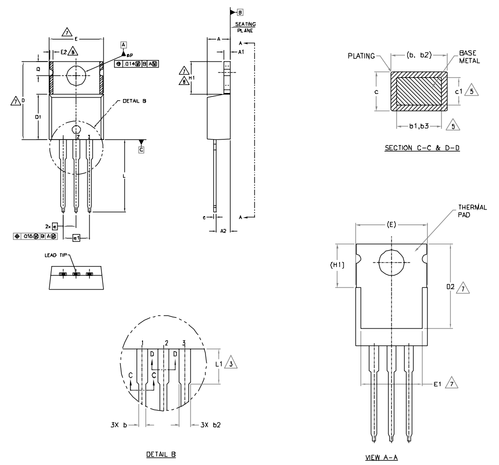


Fig.WF4-Typ. S.C. Waveform
@ T_C =150°C using Fig. CT3

International
IOR Rectifier

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.– DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M– 1994.
2.– DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.– LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.– DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.– CONTROLLING DIMENSION : INCHES.
7.– THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.– DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.– OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.03	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.97	.015	.038	5
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	5
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	–	0.76	–	.030	8
e	2.54 BSC		.100 BSC		
e1	5.08 BSC		.200 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	3.56	4.06	.140	.160	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

LEAD ASSIGNMENTS

HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE

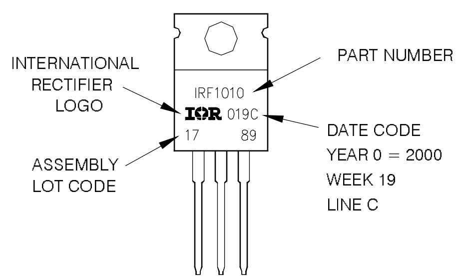
IGBTs, CoPACK
1.– GATE
2.– COLLECTOR
3.– EMITTER

DIODES
1.– ANODE
2.– CATHODE
3.– ANODE

TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 2000
IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position indicates "Lead - Free"



TO-220AB packages are not recommended for Surface Mount Application.

Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

Data and specifications subject to change without notice.
This product has been designed and qualified for Industrial market.
Qualification Standards can be found on IR's Web site.

International
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