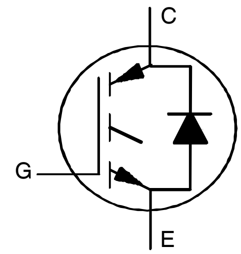
THE DATASHEET OF

IRGB4045DPBF

IRGB4045DPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

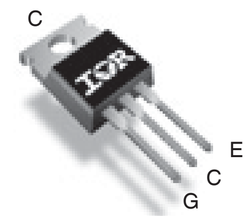
V_{CES} = 600V

I_C = 6.0A, T_C = 100°C

t_{sc} > 5µs, T_{jmax} = 175°C

$V_{CE(on)\ typ.}$ = 1.7V

Features
- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5µs SCSOA
- Square RBSOA
- 100% of the parts tested for I_{LM} ①
- Positive $V_{CE\ (on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free Package



TO-220AB

Benefits
- High Efficiency in a Wide Range of Applications
- Suitable for a Wide Range of Switching Frequencies due to Low $V_{CE\ (ON)}$ and Low Switching Losses
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation
- Low EMI

G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	600	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, V_{GE} = 15V	18	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	24	
I_F@T_C=25°C	Diode Continuous Forward Current	8.0	
I_F@T_C=100°C	Diode Continuous Forward Current	4.0	
I_{FM}	Diode Maximum Forward Current ②	24	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
P_D @ T_C =25°	Maximum Power Dissipation	77	W
P_D @ T_C =100°	Maximum Power Dissipation	39	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT ③	—	—	1.94	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode ③	—	—	6.30	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.5	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount ③	—	—	62	

01/28/2010

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	600	—	—	V	V_{GE} = 0V, I_c =100 µA ④	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.36	—	V/°C	V_{GE} = 0V, I_c = 250µA (25 -175 °C) ④	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	I_C = 6.0A, V_{GE} = 15V, T_J = 25°C	5,6,7,9, 10 ,11
		—	2.07	—		I_C = 6.0A, V_{GE} = 15V, T_J = 150°C	
		—	2.14	—		I_C = 6.0A, V_{GE} = 15V, T_J = 175°C	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 150µA	9,10,11,12
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA (25 -175 °C)	
gfe	Forward Transconductance	—	5.8	—	S	V_{CE} = 25V, I_C = 6.0A, PW =80µs	
I_{CES}	Collector-to-Emitter Leakage Current	—	—	25	µA	V_{GE} = 0V,V_{CE} = 600V	8
		—	—	250		V_{GE} = 0V, V_{CE} = 600V, T_J =175°C	
V_{FM}	Diode Forward Voltage Drop	—	1.60	2.30	V	I_F = 6.0A	
		—	1.30	—		I_F = 6.0A, T_J = 175°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ± 20 V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q_g	Total Gate Charge (turn-on)	—	13	19.5	nC	I_C = 6.0A	24
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	3.1	4.65		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	6.4	9.6		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	56	86	µJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V	CT4
E_{off}	Turn-Off Switching Loss	—	122	143		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 25°C	
E_{total}	Total Switching Loss	—	178	229		Energy losses include tail and diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	27	35	ns	I_C = 6.0A, V_{CC} = 400V	CT4
t_r	Rise time	—	11	15		R_G = 47Ω, L=1mH, L_S= 150nH	
$t_{d(off)}$	Turn-Off delay time	—	75	93		T_J = 25°C	
t_f	Fall time	—	17	22			
E_{on}	Turn-On Switching Loss	—	140	—	µJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V	13,15
E_{off}	Turn-Off Switching Loss	—	189	—		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 175°C	CT4
E_{total}	Total Switching Loss	—	329	—		Energy losses include tail and diode reverse recovery	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	26	—	ns	I_C = 6.0A, V_{CC} = 400V	14,16
t_r	Rise time	—	12	—		R_G = 47Ω, L=1mH, L_S= 150nH	CT4
$t_{d(off)}$	Turn-Off delay time	—	95	—		T_J = 175°C	WF1,WF2
t_f	Fall time	—	32	—			
C_{ies}	Input Capacitance	—	350	—	pF	V_{GE} = 0V	23
C_{oes}	Output Capacitance	—	29	—		V_{CC} = 30V	
C_{res}	Reverse Transfer Capacitance	—	10	—		f = 1Mhz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 24A V_{CC} = 500V, Vp =600V R_G = 100Ω, V_{GE} = +20V to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	µs	V_{CC} = 400V, Vp =600V R_G = 100Ω, V_{GE} = +15V to 0V	22, CT3 WF4
Erec	Reverse recovery energy of the diode	—	178	—	µJ	T_J = 175°C	17,18,19
trr	Diode Reverse recovery time	—	74	—	ns	V_{CC} = 400V, I_F = 6.0A	20,21
Irr	Peak Reverse Recovery Current	—	12	—	A	V_{GE} = 15V, Rg = 47Ω, L=1mH, L_S=150nH	WF3

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 1.0mH, R_G = 47Ω.
② Pulse width limited by max. junction temperature.
③ R_θ is measured at T_J approximately 90°C.
④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

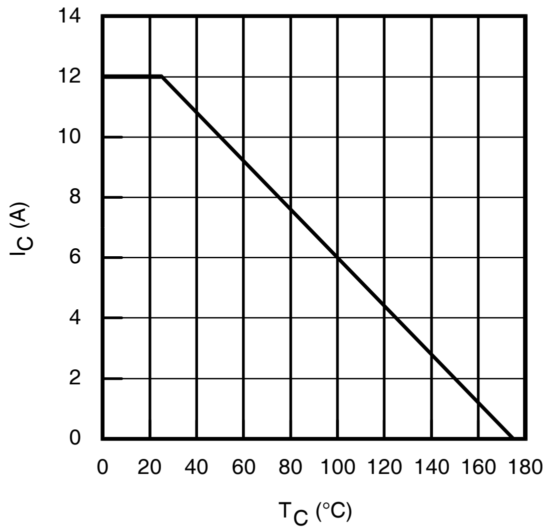


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

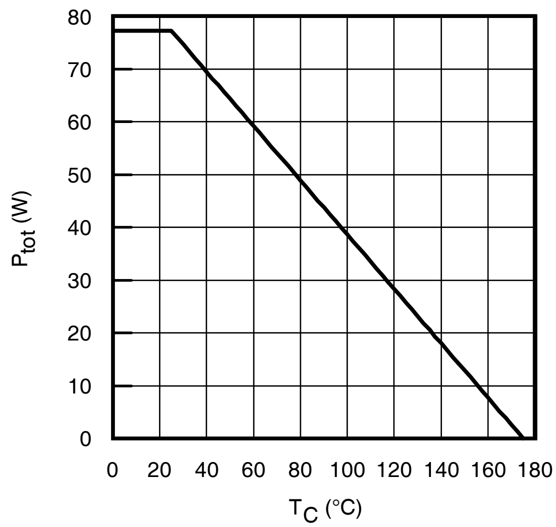


Fig. 2 - Power Dissipation vs. Case Temperature

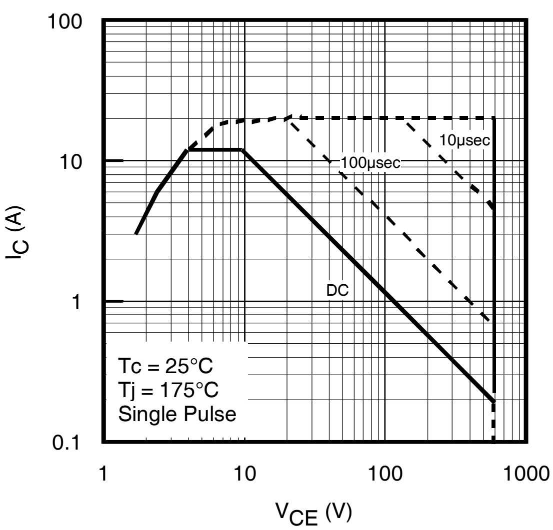


Fig. 3 - Forward SOA, T_C = 25°C, $T_J \leq$ 175°C, V_{GE} = 15V

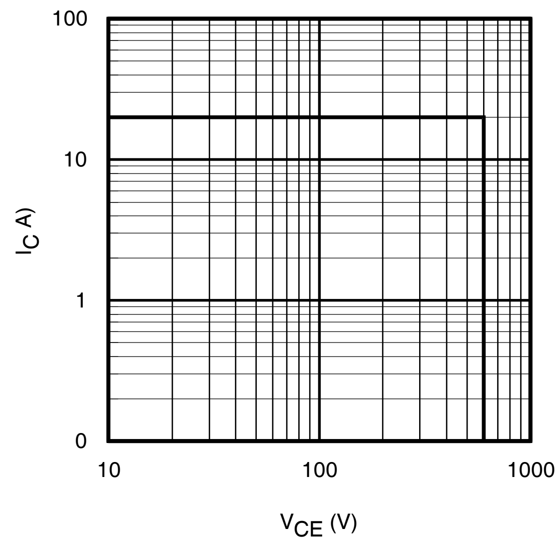


Fig. 4 - Reverse Bias SOA T_J = 175°C, V_{GE} = 20V

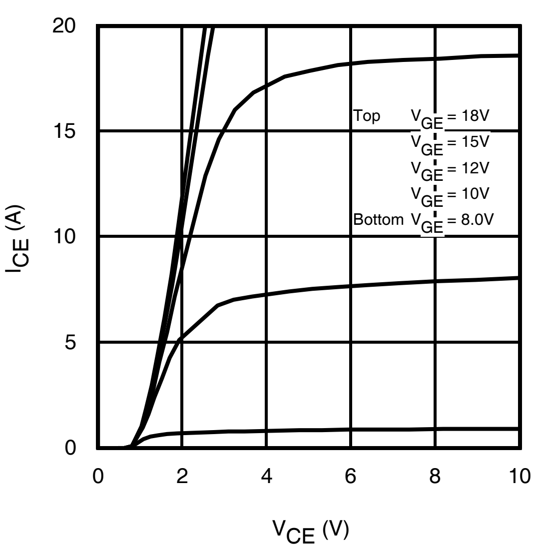


Fig. 5 - Typ. IGBT Output Characteristics T_J = -40°C; tp = 80μs

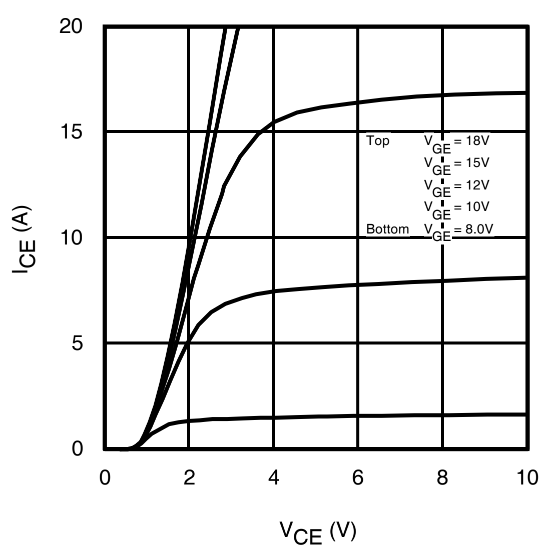


Fig. 6 - Typ. IGBT Output Characteristics T_J = 25°C; tp = 80μs

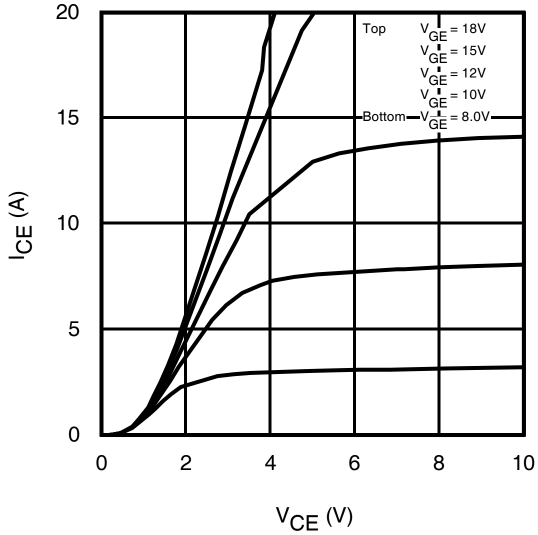


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

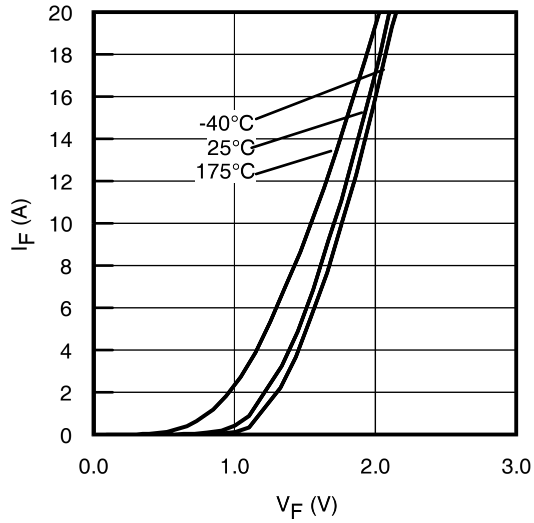


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

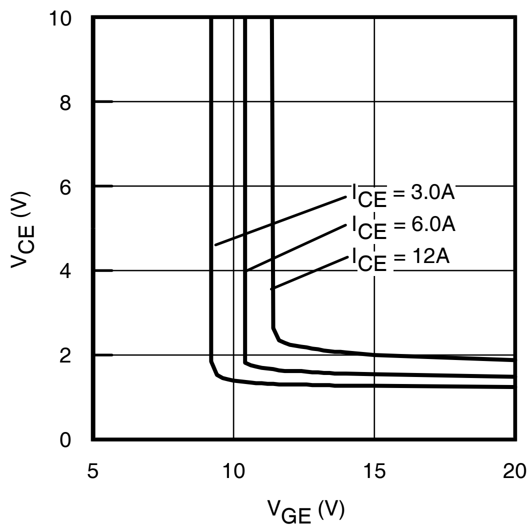


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

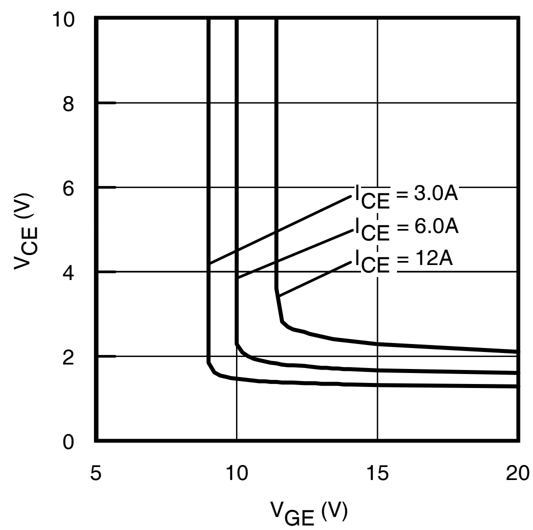


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

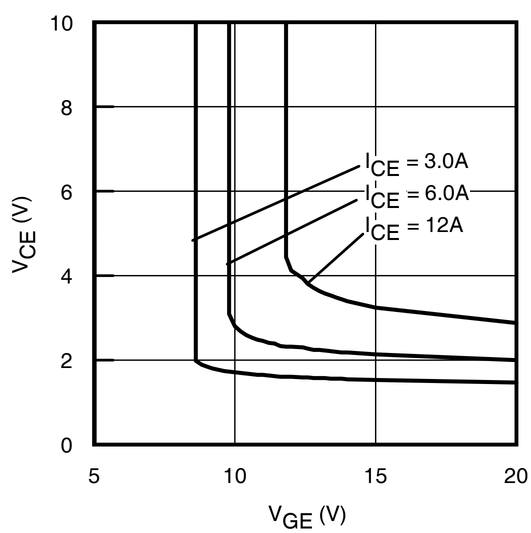


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

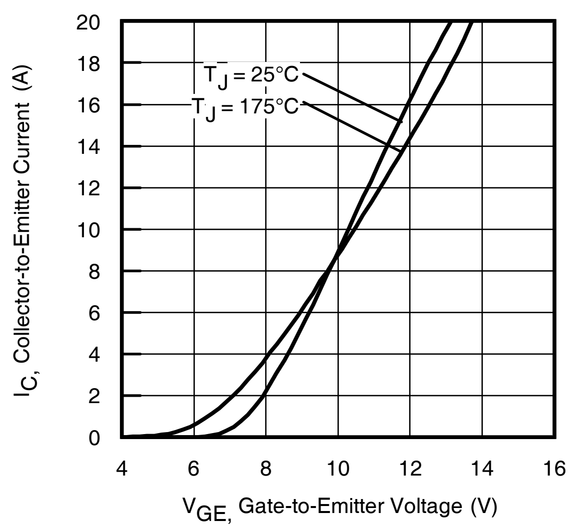


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

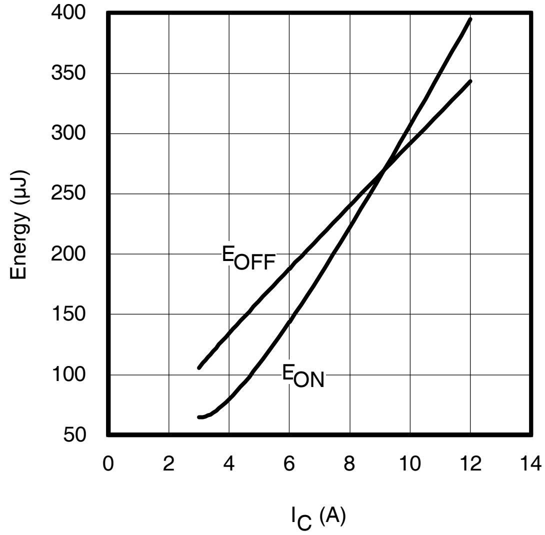


Fig. 13 - Typ. Energy Loss vs. I_C
$T_J = 175°C$; L = 1mH; $V_{CE} = 400V$, $R_G = 47\Omega$; $V_{GE} = 15V$.

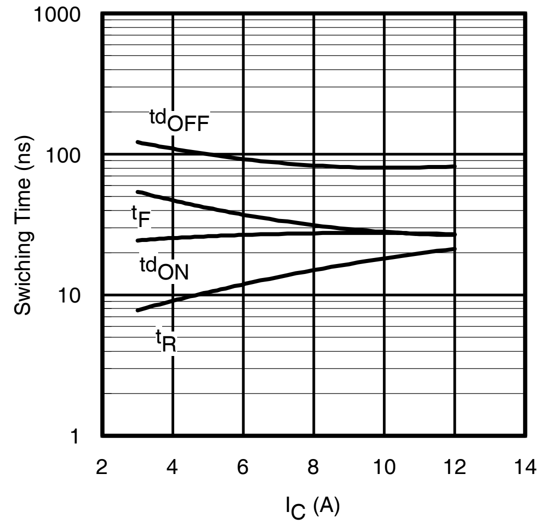


Fig. 14 - Typ. Switching Time vs. I_C
$T_J = 175°C$; L=1mH; $V_{CE}= 400V$
$R_G= 47\Omega$; $V_{GE}= 15V$

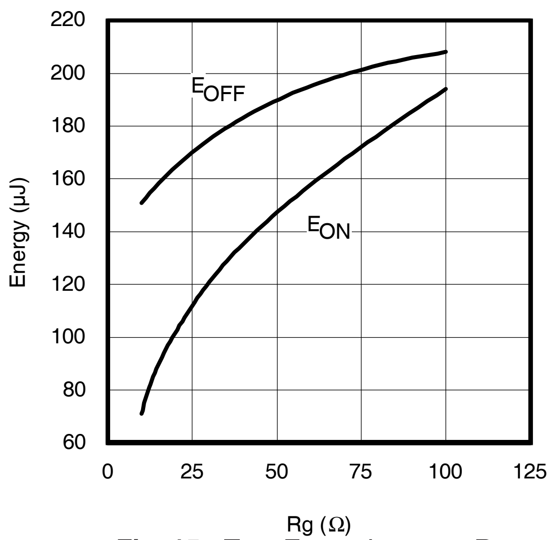


Fig. 15 - Typ. Energy Loss vs. R_G
$T_J = 175°C$; L = 1mH; $V_{CE} = 400V$, $I_{CE} = 6.0A$; $V_{GE} = 15V$

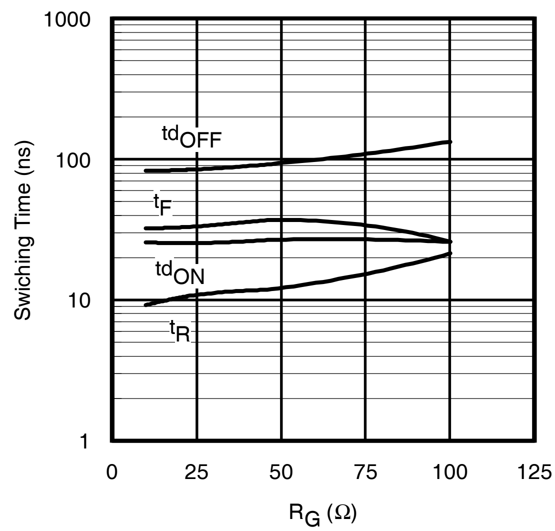


Fig. 16- Typ. Switching Time vs. R_G
$T_J = 175°C$; L=1mH; $V_{CE}= 400V$
$I_{CE}= 6.0A$; $V_{GE}= 15V$

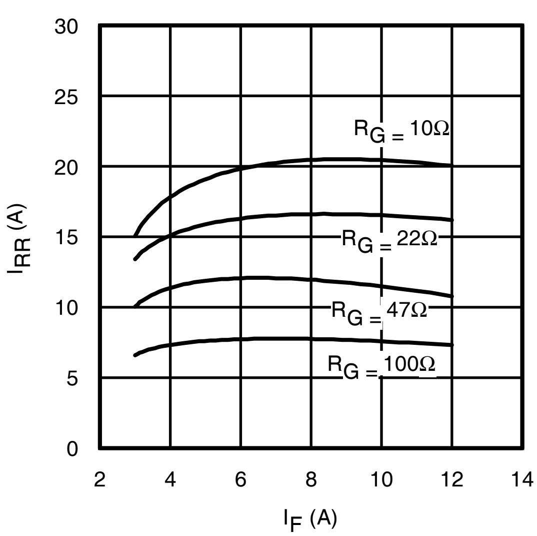


Fig. 17 - Typical Diode I_{RR} vs. I_F
$T_J = 175°C$

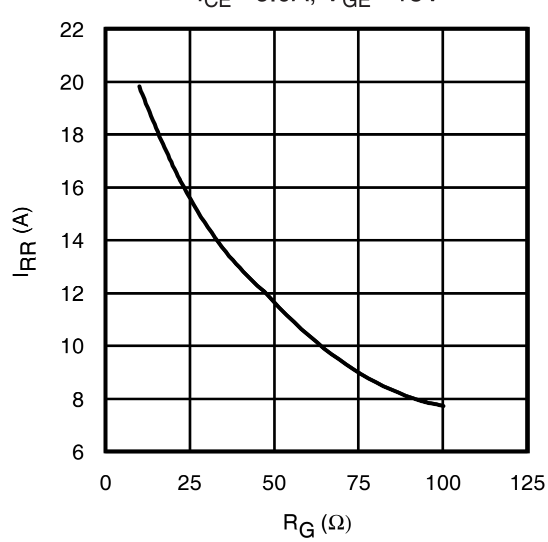


Fig. 18 - Typical Diode I_{RR} vs. R_G
$T_J = 175°C$; $I_F = 6.0A$

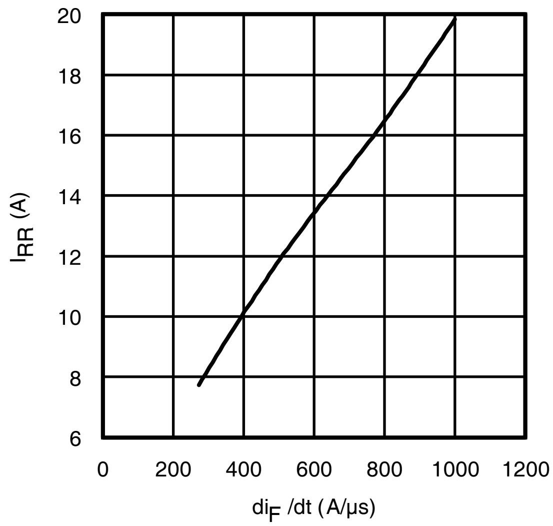


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 6.0A; T_J = 175°C

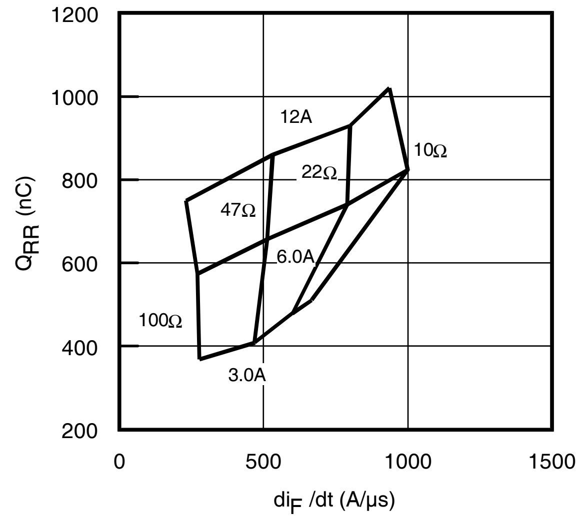


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V; T_J = 175°C

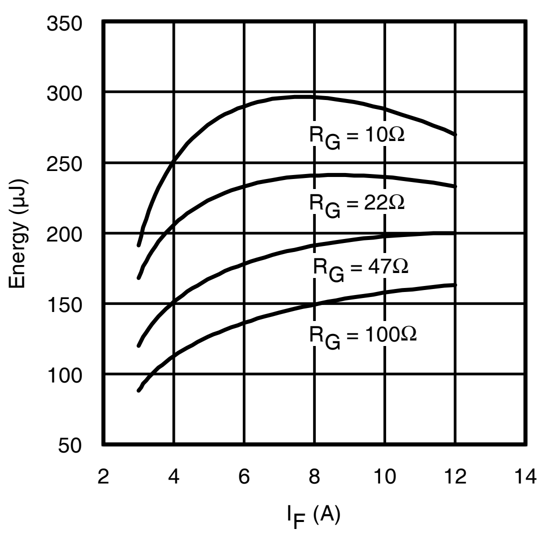


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 175°C

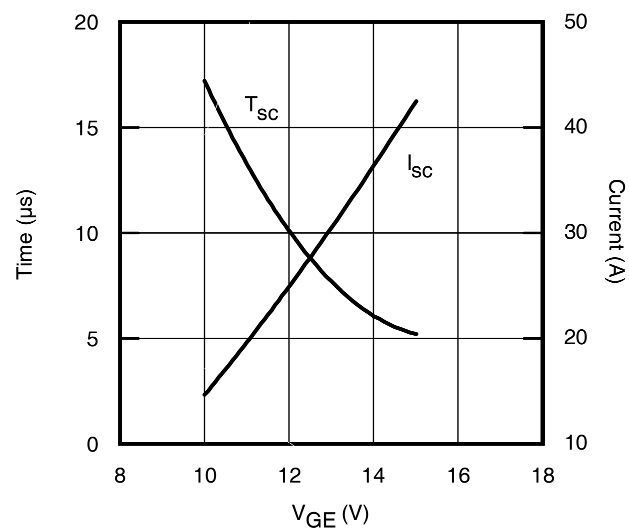


Fig. 22- Typ. V_{GE} vs. Short Circuit Time
V_{CC}=400V, T_C =25°C

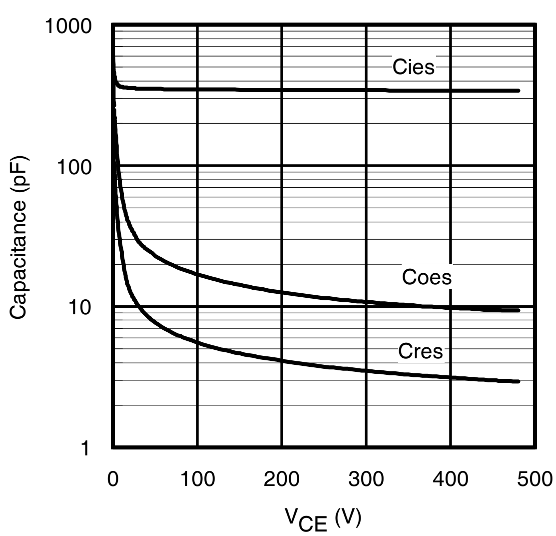


Fig. 23- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

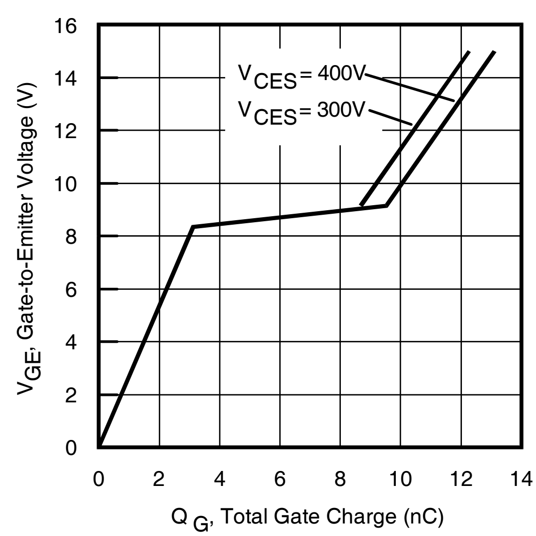


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 6.0A, L=600µH

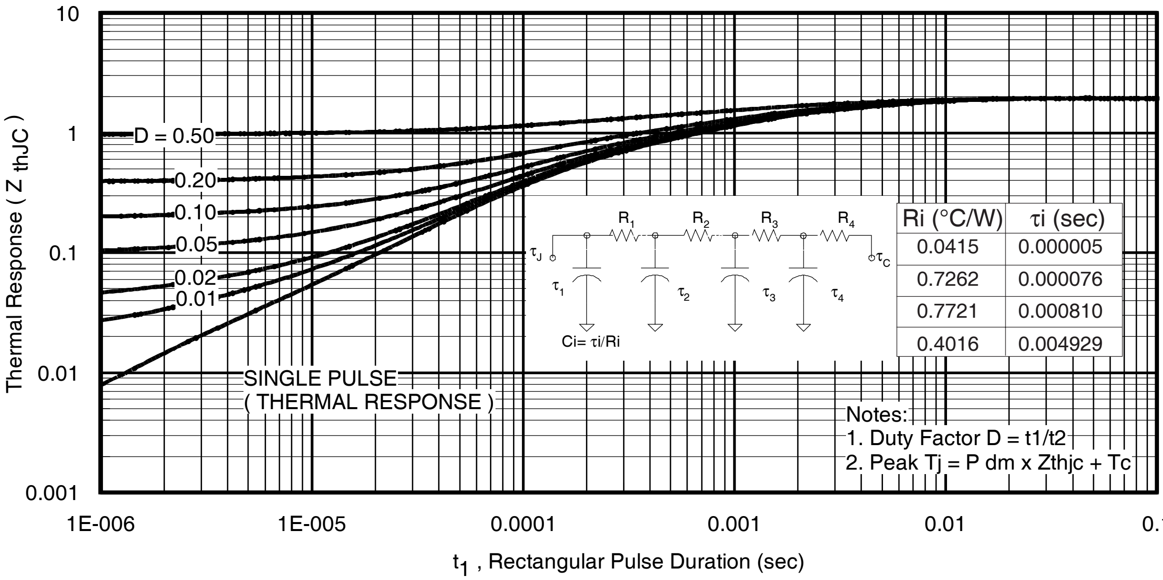


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

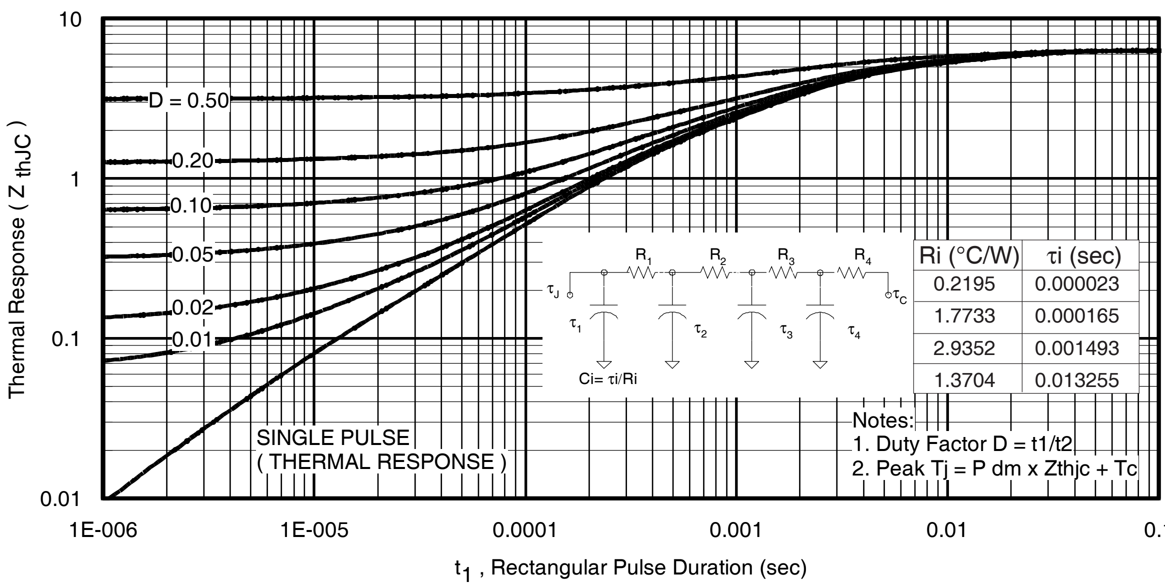


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

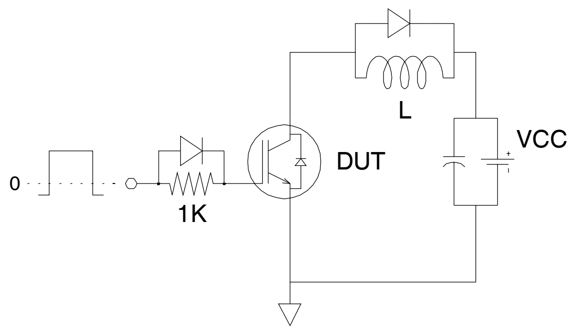


Fig.C.T.1 - Gate Charge Circuit (turn-off)

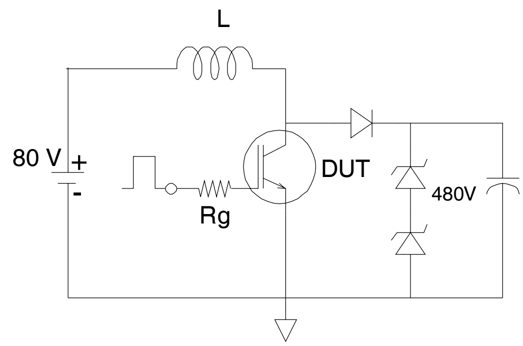


Fig.C.T.2 - RBSOA Circuit

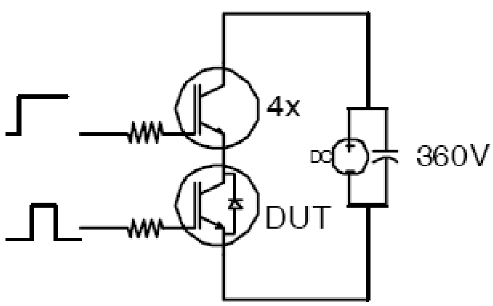


Fig.C.T.3 - S.C.SOA Circuit

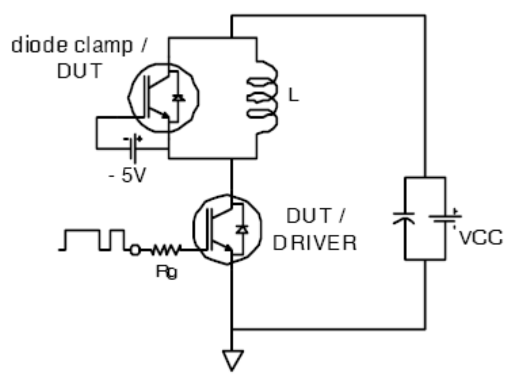


Fig.C.T.4 - Switching Loss Circuit

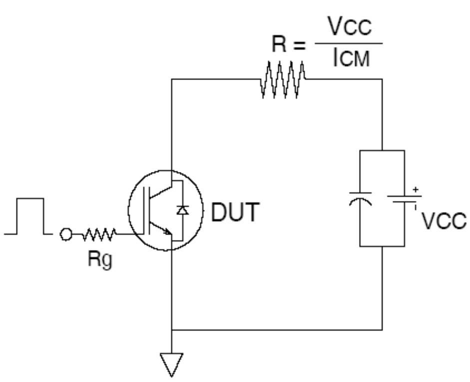


Fig.C.T.5 - Resistive Load Circuit

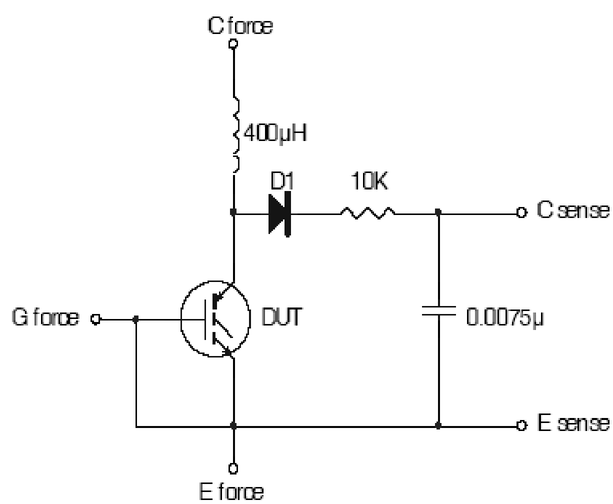


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

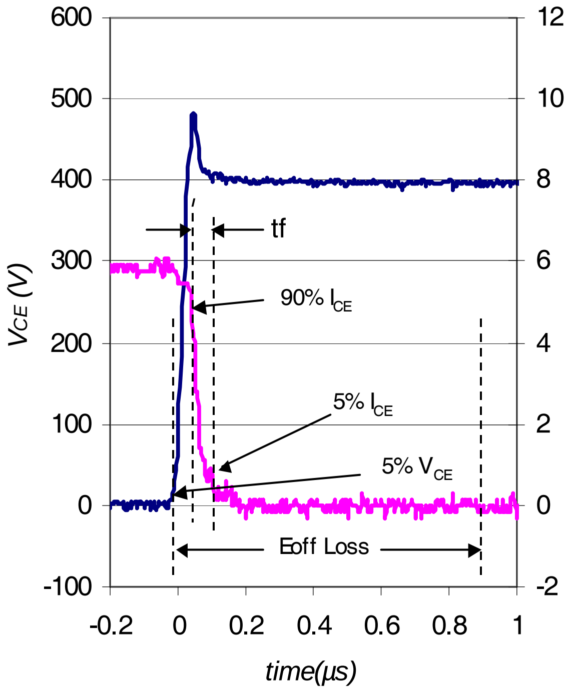


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

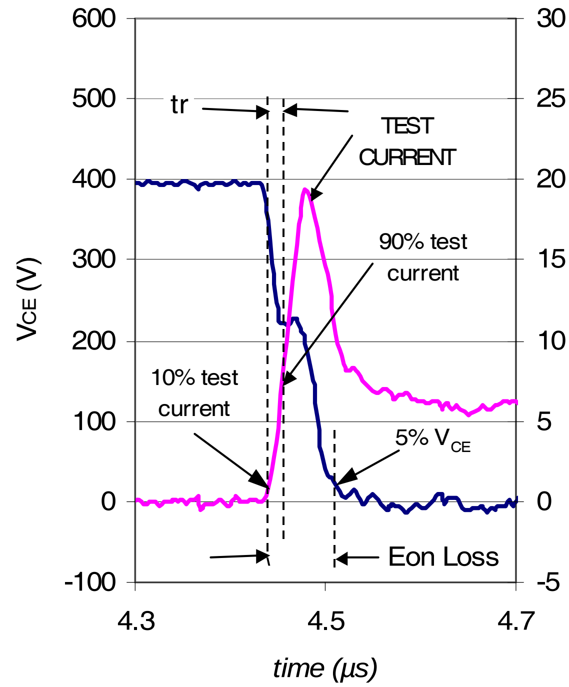
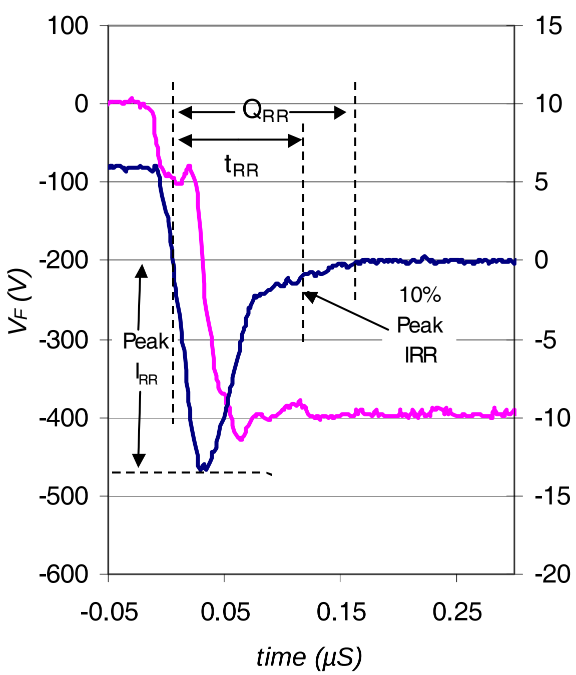
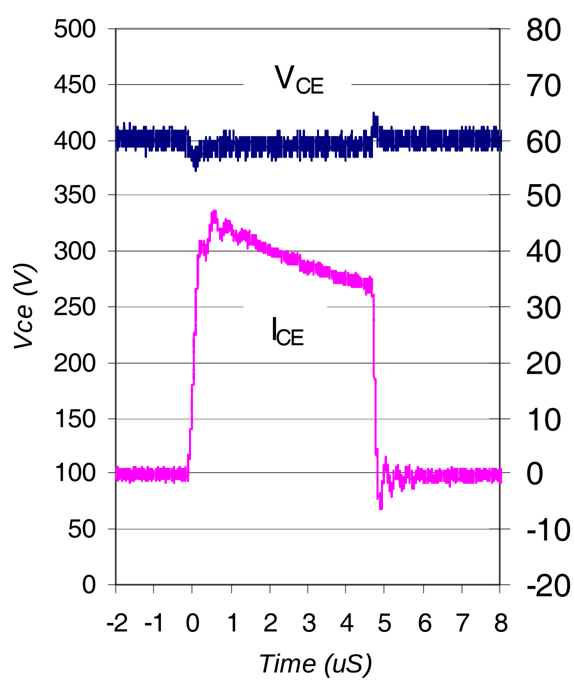


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4

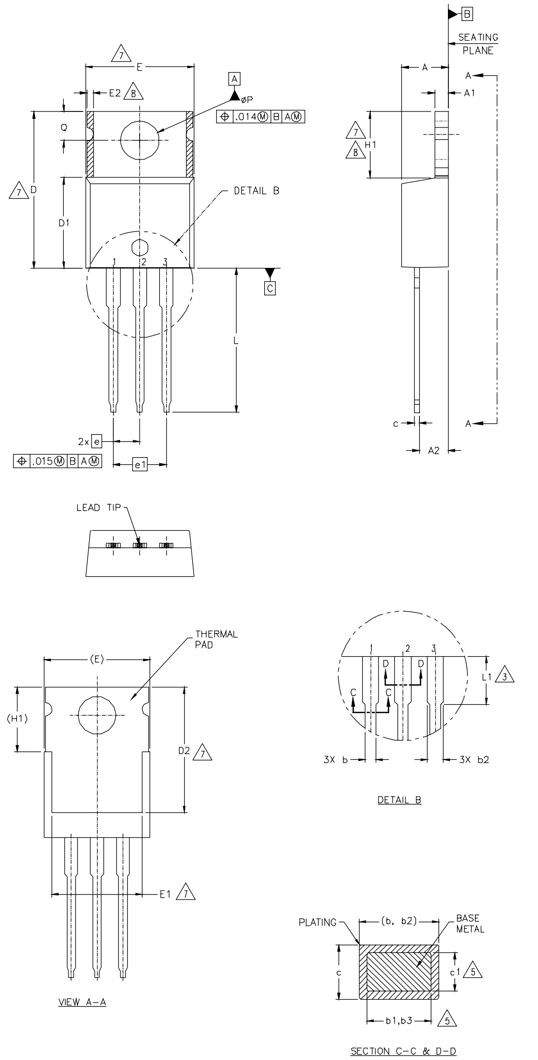


WF.3- Typ. Diode Recovery Waveform
@ T_J = 175°C using CT.4



WF.4- Typ. Short Circuit Waveform
@ T_J = 25°C using CT.3

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	–	6.35	–	.250	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	

LEAD ASSIGNMENTS

HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE

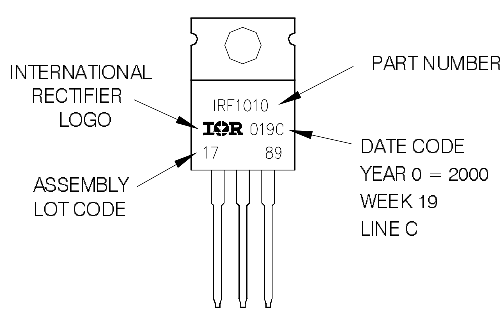
IGBTs, CoPACK
1.– GATE
2.– COLLECTOR
3.– EMITTER

DIODES
1.– ANODE/OPEN
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 Rectifier

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