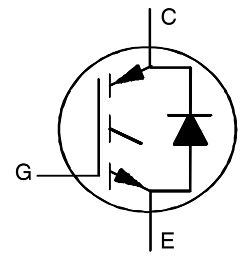
International
IOR Rectifier

IRGI4060DPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

V_{CES} = 600V

I_C = 7.5A, T_C = 100°C

t_{sc} > 5µs, T_{jmax} = 150°C

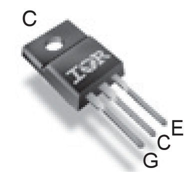
$V_{CE(on)\ typ.}$ = 1.50V

Features

- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- 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

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



TO-220AB
Full-Pak

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	14	A
I_C@ T_C = 100°C	Continuous Collector Current	7.5	
I_{CM}	Pulse Collector Current, V_{GE}=15V	23	
I_{LM}	Clamped Inductive Load Current, V_{GE}=20V ①	30	
I_F@T_C=25°C	Diode Continuous Forward Current	14	
I_F@T_C=100°C	Diode Continuous Forward Current	7.5	
I_{FM}	Diode Maximum Forward Current ②	30	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
P_D @ T_C =25°C	Maximum Power Dissipation	37	W
P_D @ T_C =100°C	Maximum Power Dissipation	15	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C
	Soldering Temperature, for 10 seconds	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 ③	—	—	3.40	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode ③	—	—	6.10	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.5	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount ③	—	—	65	
Wt	Weight	—	2.0	—	g

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_c = 100 µA ④
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.66	—	V/°C	V_{GE} = 0V, I_c = 250 µA (-55 -150 °C) ④
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.50	1.72	V	I_C = 7.5A, V_{GE} = 15V, T_J = 25°C
		—	1.75	—		I_C = 7.5A, V_{GE} = 15V, T_J = 125°C
		—	1.81	—		I_C = 7.5A, V_{GE} = 15V, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	4.0		6.5	V	V_{CE} = V_{GE}, I_C = 250 µA
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-12	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA (-55 -150 °C)
gfe	Forward Transconductance	—	5	—	S	V_{CE} = 50V, I_C = 7.5A, PW =80µs
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	25	µA	V_{GE} = 0V, V_{CE} = 600V
		—	400	—	µA	V_{GE} = 0v, V_{CE} = 600V, T_J =150°C
V_{FM}	Diode Forward Voltage Drop	—	2.18	3.00	V	I_F = 7.5A
		—	1.60	—		I_F = 7.5A, T_J = 150°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
Q_g	Total Gate Charge (turn-on)	—	19	29	nC	I_C = 7.5A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	4.3	6		V_{CC} = 400V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	8.3	12		V_{GE} = 15V
E_{on}	Turn-On Switching Loss	—	47	89	µJ	I_C = 7.5A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	141	248		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 25°C
E_{total}	Total Switching Loss	—	188	337		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	29	38	ns	I_C = 7.5A, V_{CC} = 400V
t_r	Rise time	—	16	25		R_G = 47Ω, L=1mH, L_S= 150nH
$t_{d(off)}$	Turn-Off delay time	—	101	112		T_J = 25°C
t_f	Fall time	—	28	37		
E_{on}	Turn-On Switching Loss	—	107	—	µJ	I_C = 7.5A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	196	—		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 150°C
E_{total}	Total Switching Loss	—	304	—		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	28	—	ns	I_C = 7.5A, V_{CC} = 400V
t_r	Rise time	—	17	—		R_G = 47Ω, L=1mH, L_S= 150nH
$t_{d(off)}$	Turn-Off delay time	—	118	—		T_J = 150°C
t_f	Fall time	—	53	—		
C_{ies}	Input Capacitance	—	537	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	47	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	16	—		f = 1Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 30A V_{CC} = 480V, Vp =600V Rg = 47Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	µs	V_{CC} = 400V, Vp =600V R_G = 47Ω, V_{GE} = +15V to 0V
Erec	Reverse recovery energy of the diode	—	102	—	µJ	T_J = 150°C
trr	Diode Reverse recovery time	—	73	—	ns	V_{CC} = 400V, I_F = 7.5A
Irr	Peak Reverse Recovery Current	—	11	—	A	V_{GE} = 15V, Rg = 47Ω, L=1mH, L_S=150nH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 28 µH, R_G = 47 Ω
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

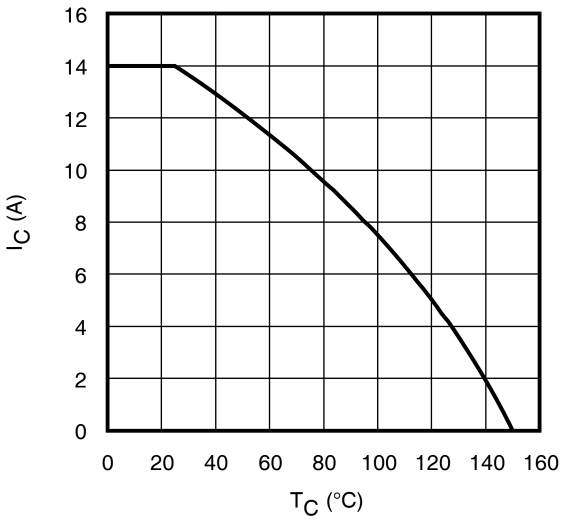


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

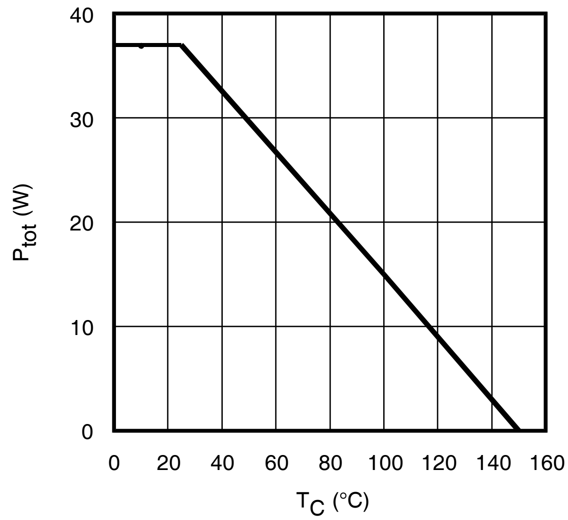


Fig. 2 - Power Dissipation vs. Case Temperature

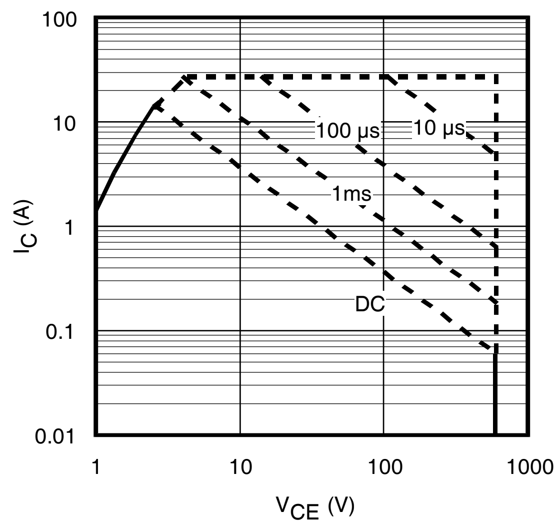


Fig. 3 - Forward SOA, $T_C = 25°C$; $T_J \leq 150°C$

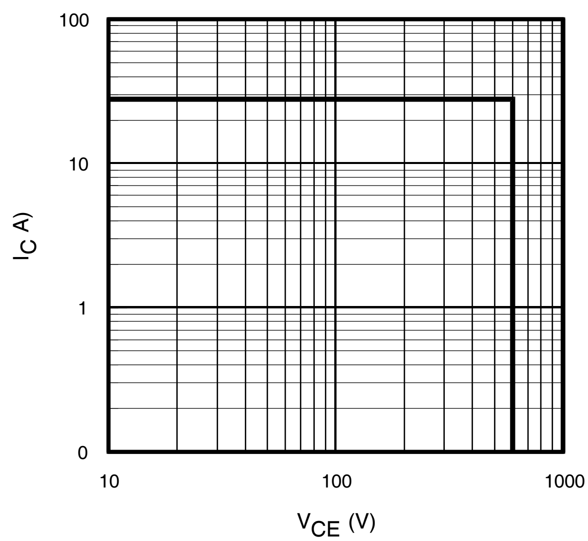


Fig. 4 - Reverse Bias SOA $T_J = 150°C$; $V_{CE} = 15V$

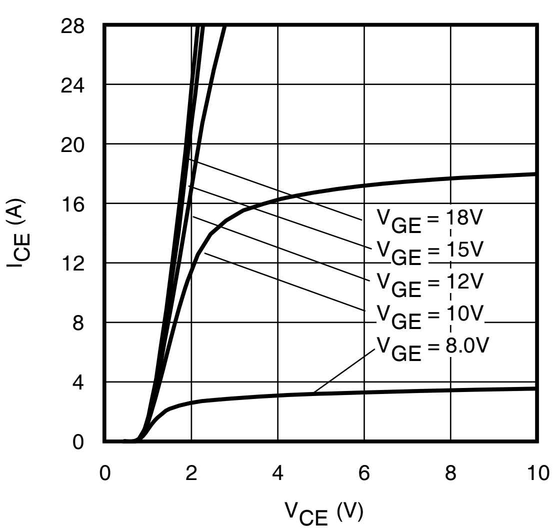


Fig. 5 - Typ. IGBT Output Characteristics $T_J = -40°C$; tp <60µs

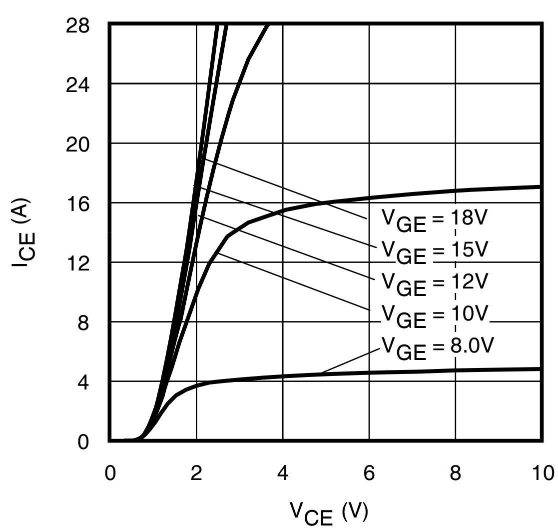


Fig. 6 - Typ. IGBT Output Characteristics $T_J = 25°C$; tp < 60µs

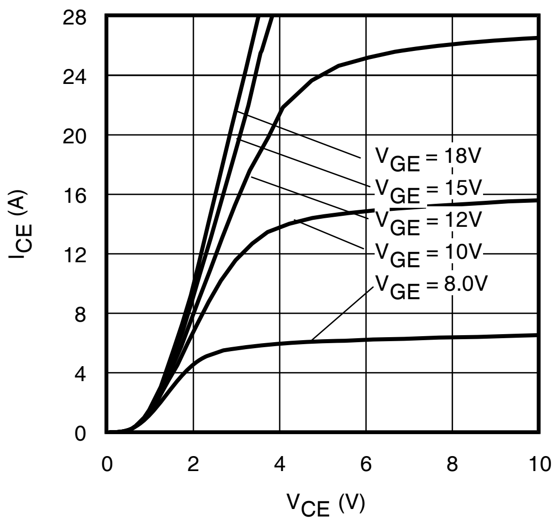


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp < 60µs

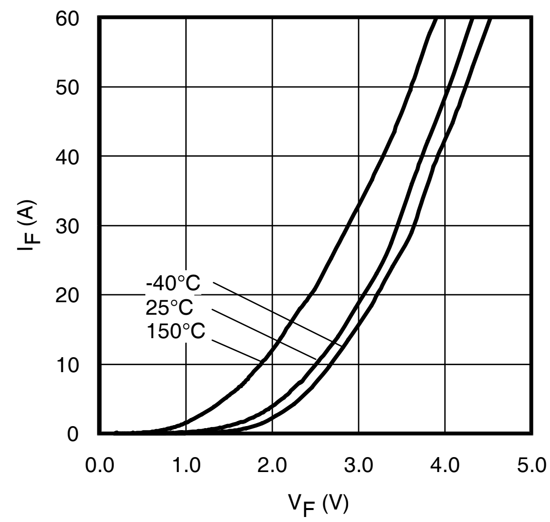


Fig. 8 - Typ. Diode Forward Characteristics
tp < 60µs

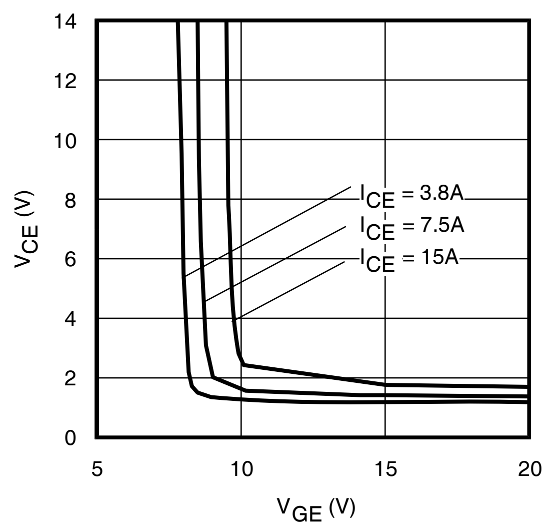


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

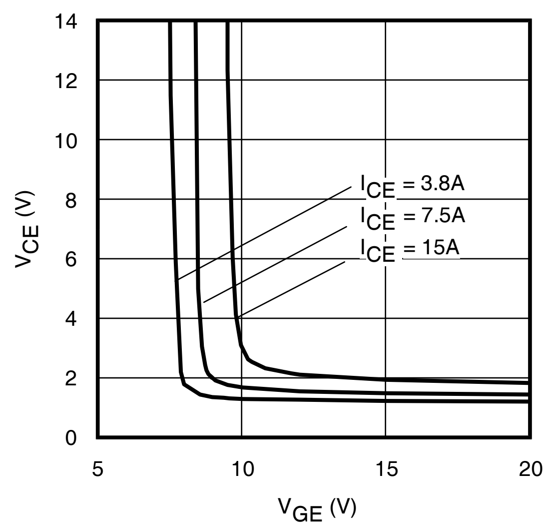


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

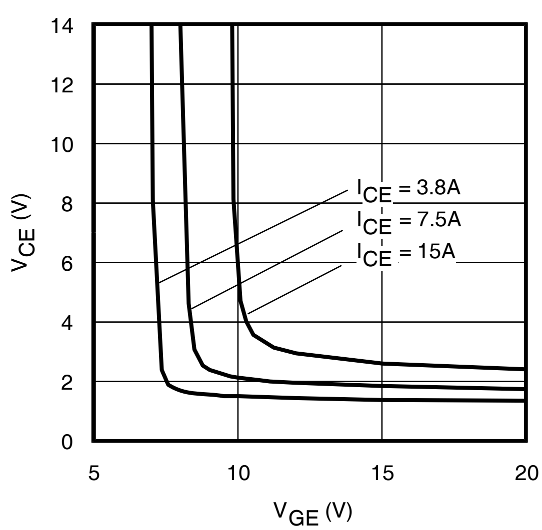


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

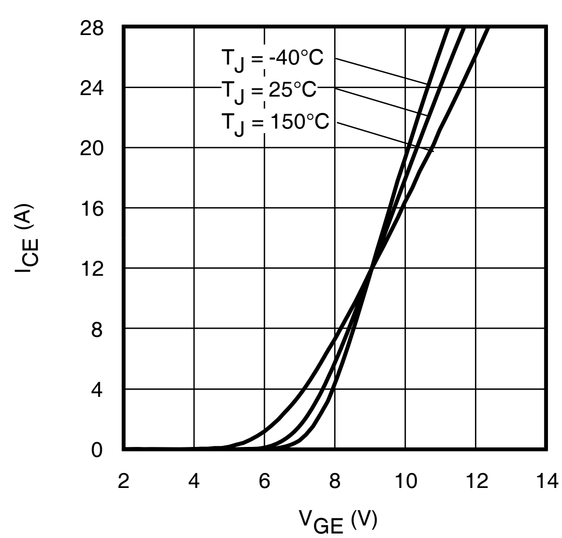


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp < 60µs

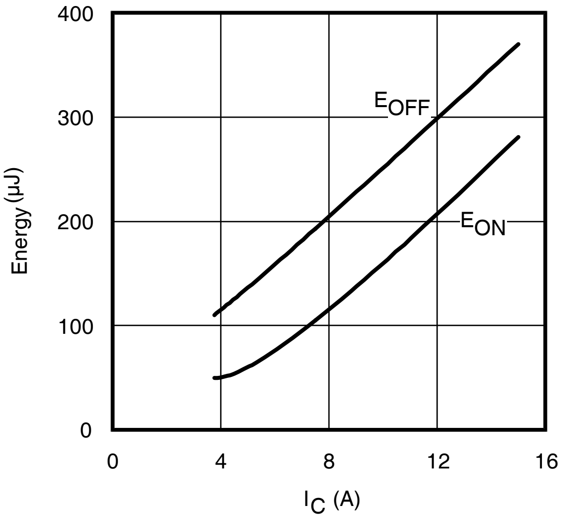


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L = 1mH; V_{CE} = 400V, R_G = 47Ω; V_{GE} = 15V.

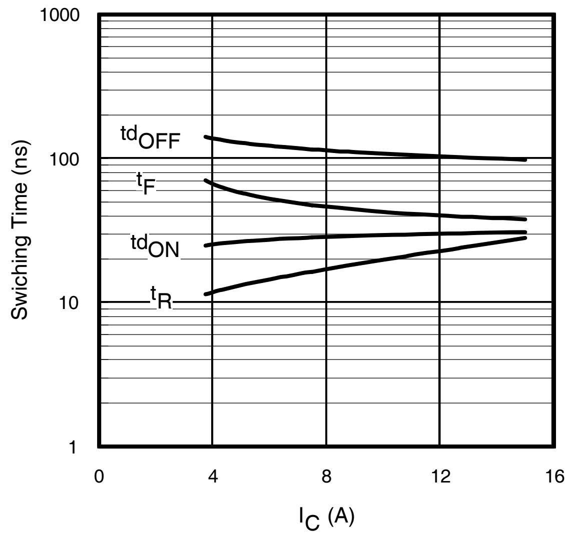


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1mH; V_{CE}= 400V
R_G= 47Ω; V_{GE}= 15V

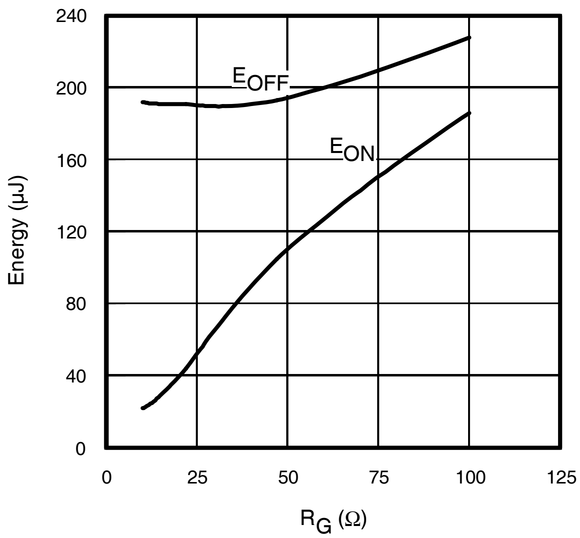


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L = 1mH; V_{CE} = 400V, I_{CE} = 7.5A; V_{GE} = 15V

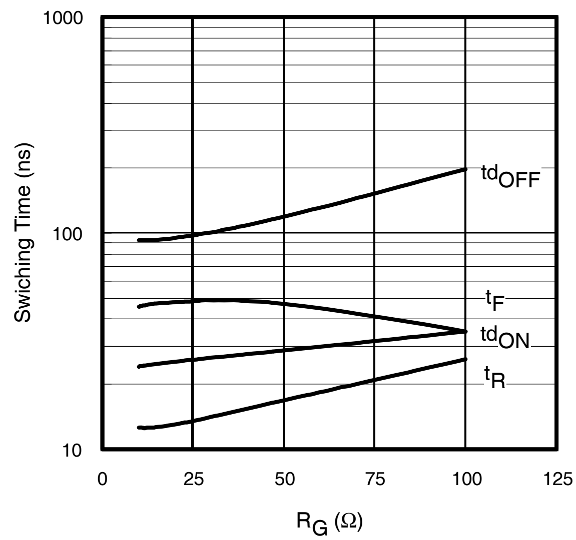


Fig. 16- Typ. Switching Time vs. R_G
T_J = 150°C; L=1mH; V_{CE}= 400V
I_{CE}= 7.5A; V_{GE}= 15V

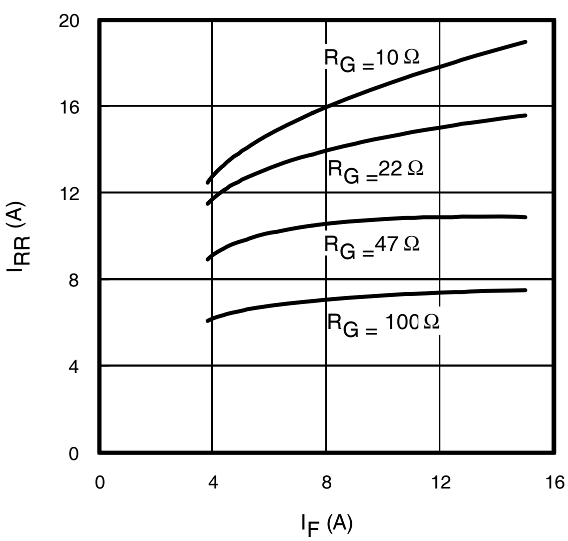


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

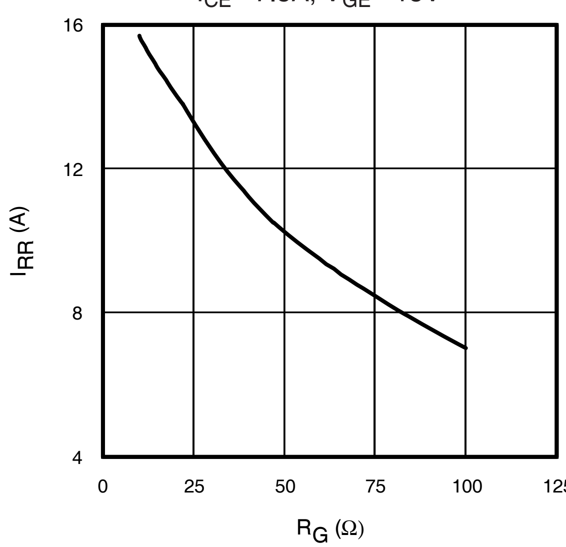


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 7.5A

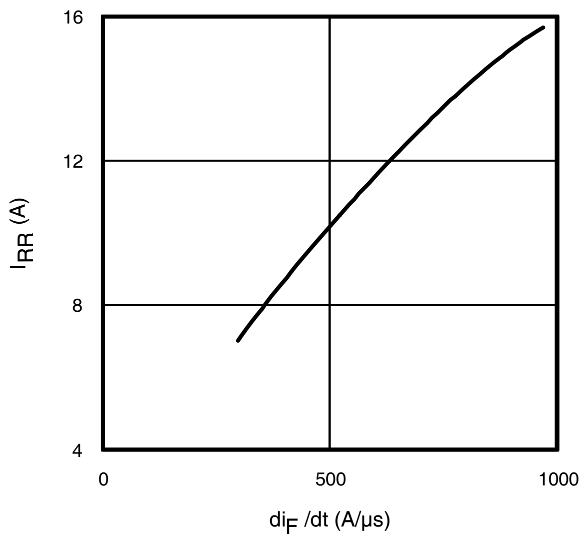


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 7.5A; T_J = 150°C

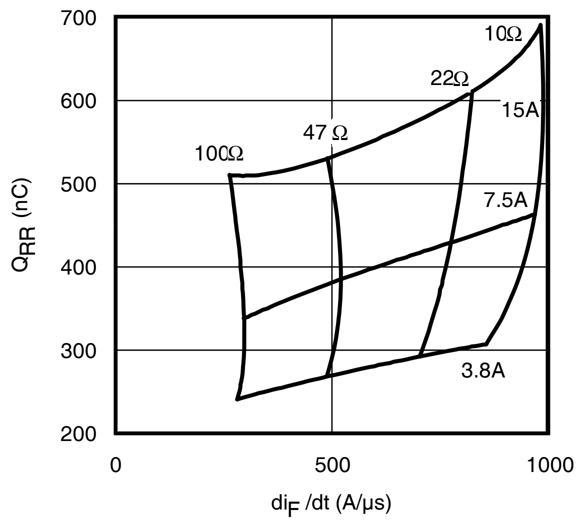


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V; T_J = 150°C

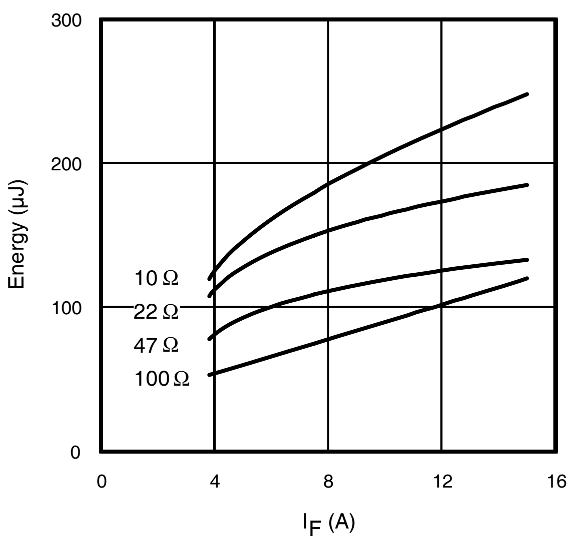


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

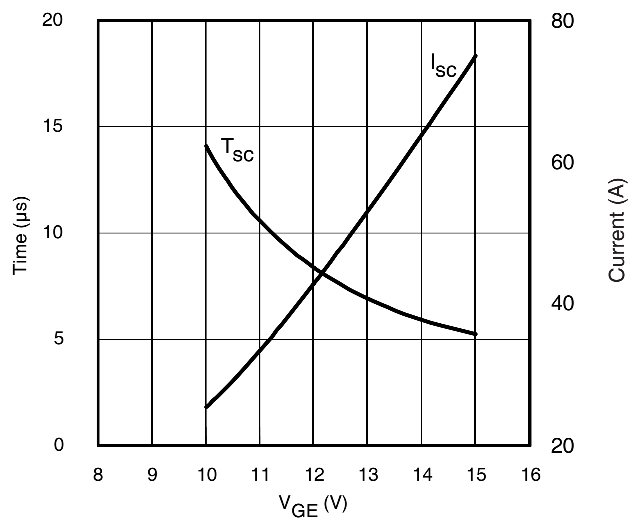


Fig. 22- Typ. V_{GE} vs Short Circuit Time
V_{CC}=400V, T_C =25°C

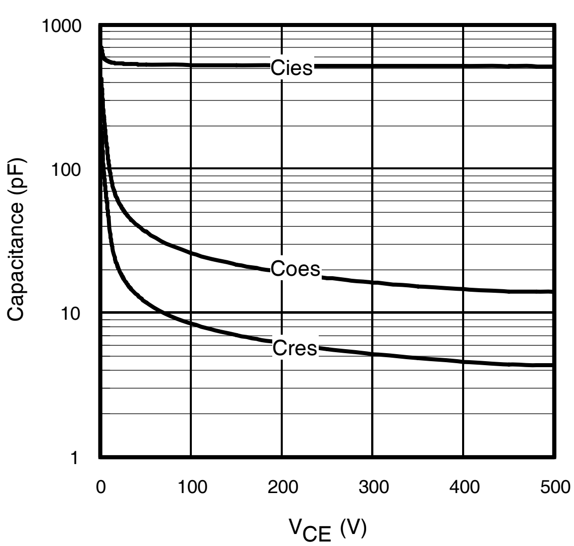


Fig. 23- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

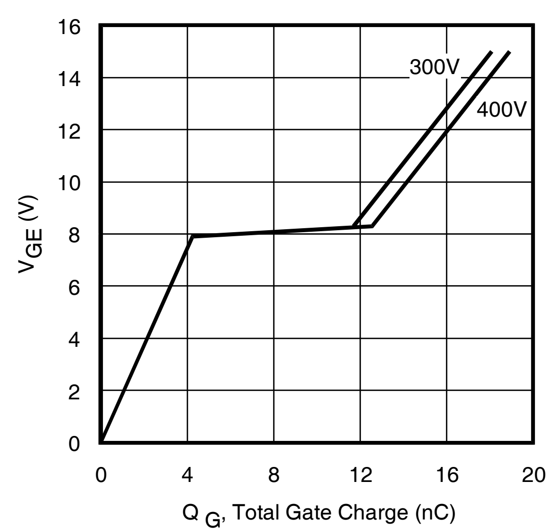


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 7.5A, L=600µH

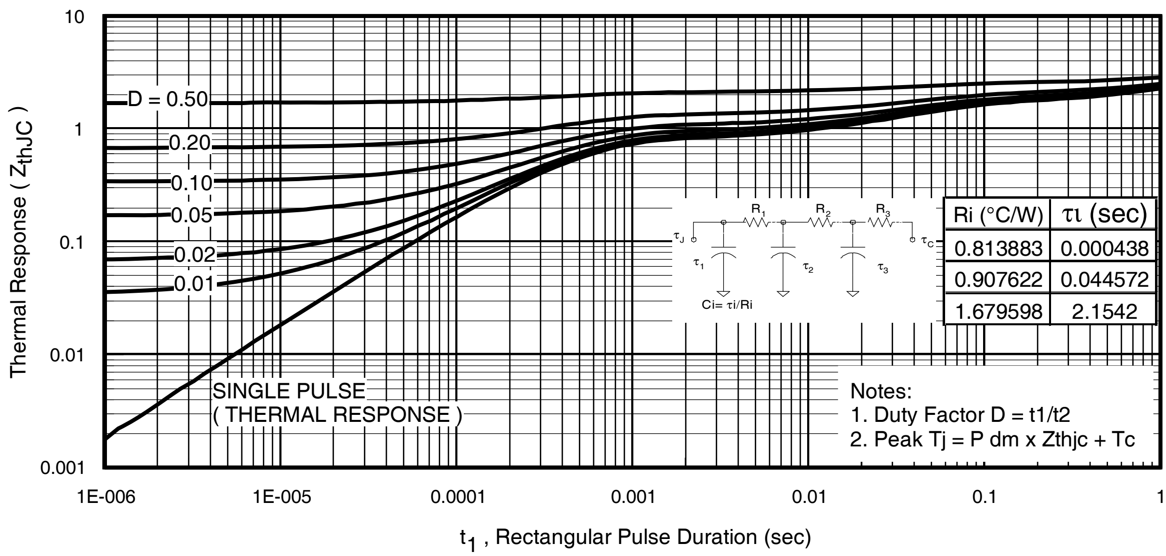


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

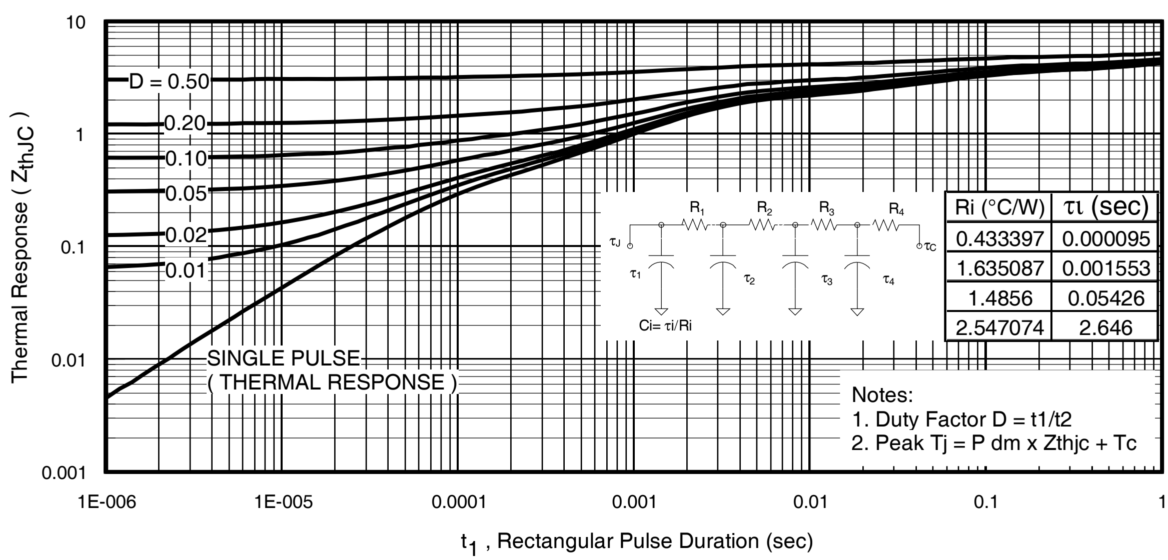


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

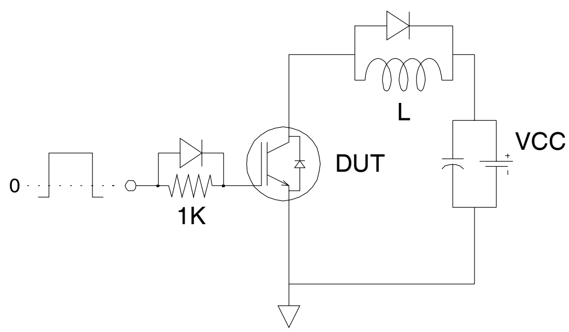


Fig.C.T.1 - Gate Charge Circuit (turn-off)

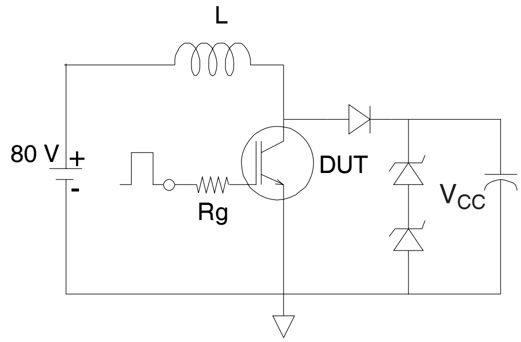


Fig.C.T.2 - RBSOA Circuit

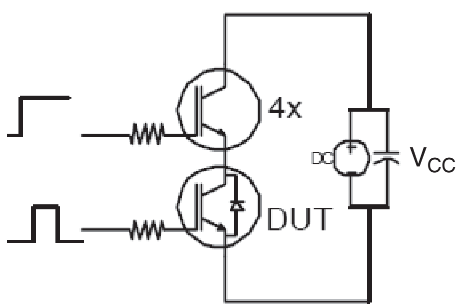


Fig.C.T.3 - S.C.SOA Circuit

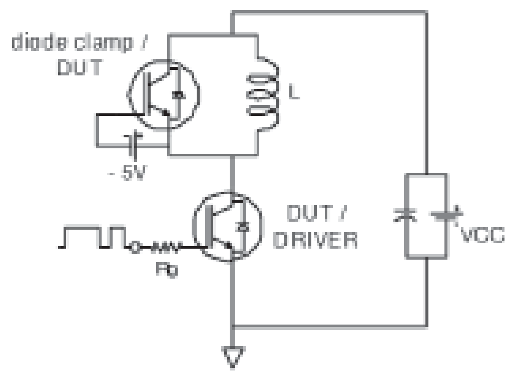


Fig.C.T.4 - Switching Loss Circuit

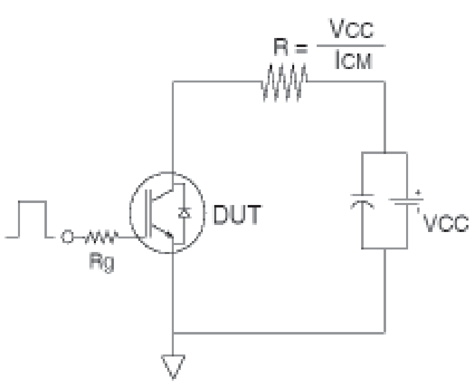


Fig.C.T.5 - Resistive Load Circuit

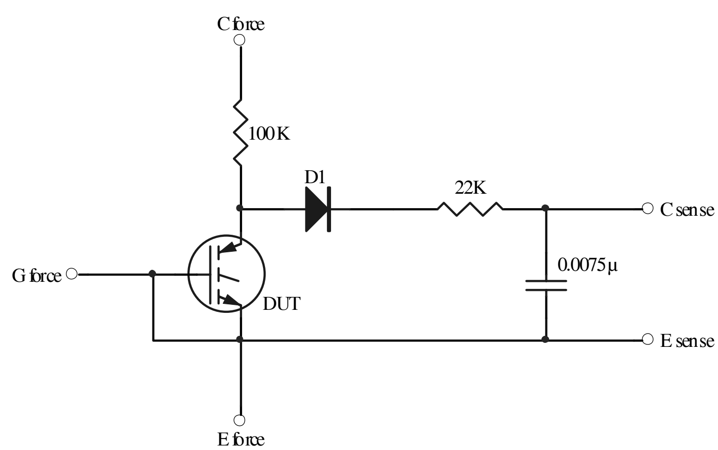


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

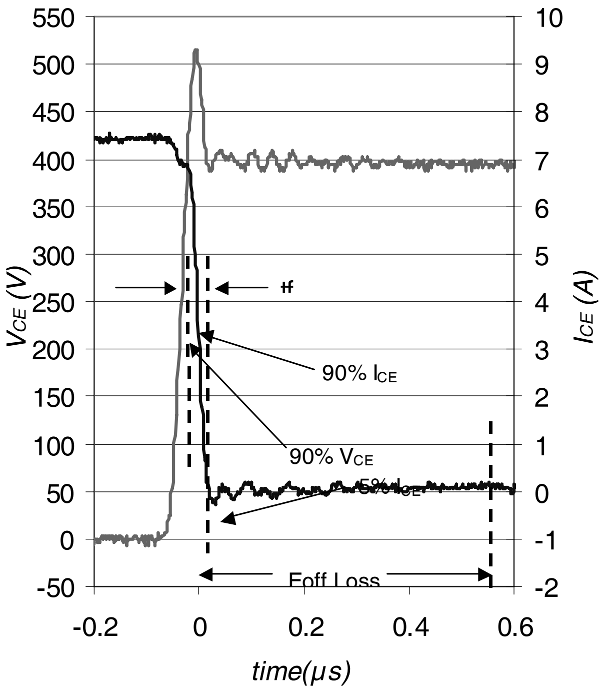


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

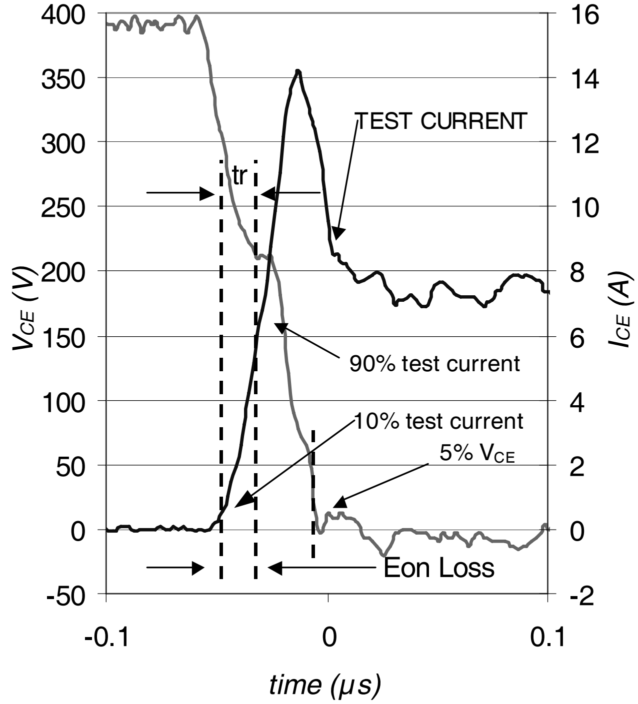
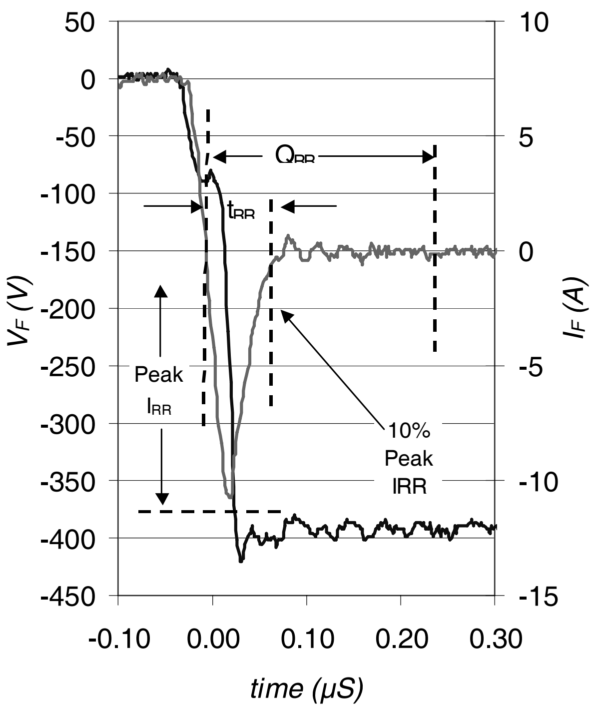
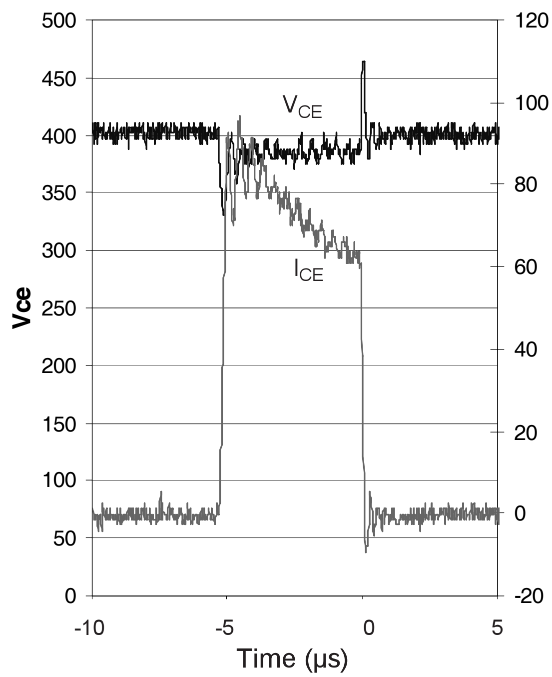


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4



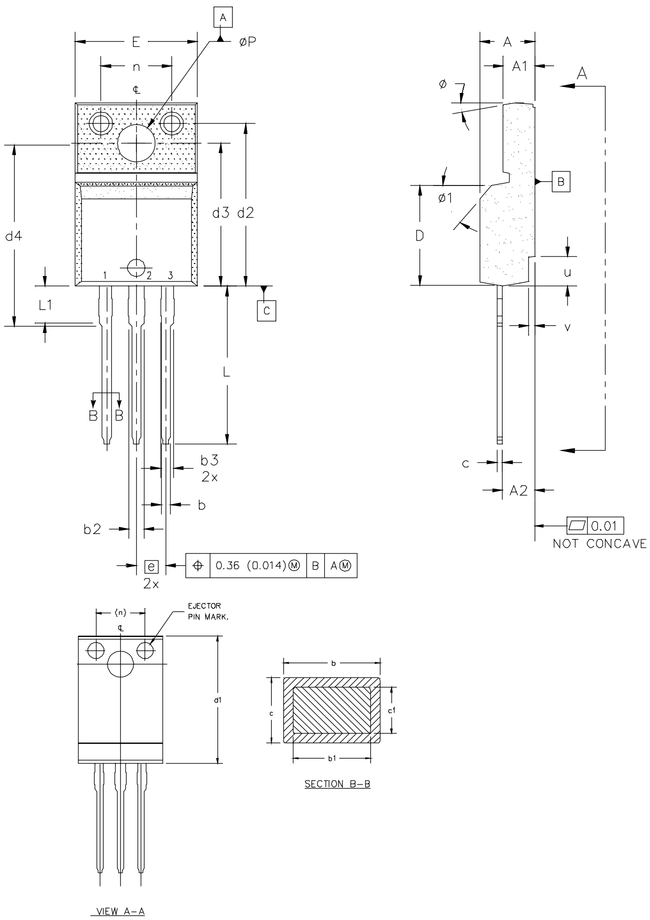
WF.3- Typ. Reverse Recovery Waveform
@ T_J = 150°C using CT.4



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

TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5.0 DIMENSION b1 APPLY TO BASE METAL ONLY.
6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
7.0 CONTROLLING DIMENSION : INCHES.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	0.180	0.190	
A1	2.57	2.83	0.101	0.114	
A2	2.51	2.85	0.099	0.112	
b	0.622	0.89	0.024	0.035	
b1	0.622	0.838	0.024	0.033	5
b2	1.229	1.400	0.048	0.055	
b3	1.229	1.400	0.048	0.055	
c	0.440	0.629	0.017	0.025	
c1	0.440	0.584	0.017	0.023	
D	8.65	9.80	0.341	0.386	4
d1	15.80	16.12	0.622	0.635	
d2	13.97	14.22	0.550	0.560	
d3	12.30	12.92	0.484	0.509	
d4	8.64	9.91	0.340	0.390	
E	10.36	10.63	0.408	0.419	4
e	2.54 BSC		0.100 BSC		
L	13.20	13.73	0.520	0.541	
L1	3.10	3.50	0.122	0.138	3
n	6.05	6.15	0.238	0.242	
øP	3.05	3.45	0.120	0.136	
u	2.40	2.50	0.094	0.098	6
v	0.40	0.50	0.016	0.020	6
ø	3°	7°	3°	7°	
ø1		45°		45°	

LEAD ASSIGNMENTS

HEXFET

1.- GATE
2.- DRAIN
3.- SOURCE

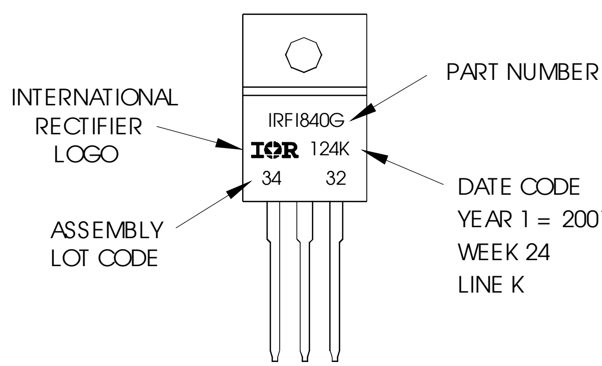
IGBTs, CoPACK

1.- GATE
2.- COLLECTOR
3.- EMITTER

TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI840G
WITH ASSEMBLY
LOT CODE 3432
ASSEMBLED ON WW 24, 2001
IN THE ASSEMBLY LINE "K"

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



TO-220 Full-Pak package is 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.

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