

IRGI4060DPbF

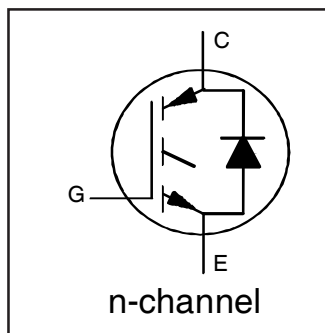
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

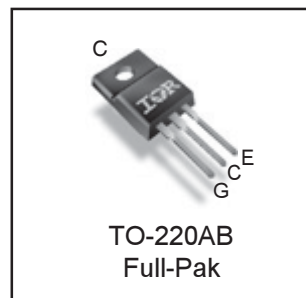
- Low $V_{CE(on)}$ Trench IGBT Technology
- Low Switching Losses
- 5 μ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for I_{LM} ①
- Positive $V_{CE(on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free Package

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



$V_{CES} = 600V$
 $I_C = 7.5A, T_C = 100^\circ C$
 $t_{sc} > 5\mu s, T_{jmax} = 150^\circ C$
 $V_{CE(on) typ.} = 1.50V$



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	Operating Junction and	-55 to + 150	°C
T _{STG}	Storage Temperature Range		
	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	$^\circ C/W$
$R_{\theta JC}$	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 @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100 \mu A$ ④
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.66	—	V/°C	$V_{GE} = 0V, I_C = 250 \mu A$ (-55 -150 °C) ④
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.50	1.72		$I_C = 7.5A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	1.75	—	V	$I_C = 7.5A, V_{GE} = 15V, T_J = 125^\circ\text{C}$
		—	1.81	—		$I_C = 7.5A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0		6.5	V	$V_{CE} = V_{GE}, I_C = 250 \mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-12	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA$ (-55 -150 °C)
g_{fe}	Forward Transconductance	—	5	—	S	$V_{CE} = 50V, I_C = 7.5A, PW = 80\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	25	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	400	—	μA	$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	2.18	3.00	V	$I_F = 7.5A$
		—	1.60	—		$I_F = 7.5A, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20 V$

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (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		$R_G = 47\Omega, L = 1mH, L_S = 150nH, T_J = 25^\circ\text{C}$
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		$R_G = 47\Omega, L = 1mH, L_S = 150nH$
$t_{d(off)}$	Turn-Off delay time	—	101	112		$T_J = 25^\circ\text{C}$
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	—		$R_G = 47\Omega, L = 1mH, L_S = 150nH, T_J = 150^\circ\text{C}$
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	—		$R_G = 47\Omega, L = 1mH, L_S = 150nH$
$t_{d(off)}$	Turn-Off delay time	—	118	—		$T_J = 150^\circ\text{C}$
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				$T_J = 150^\circ\text{C}, I_C = 30A$ $V_{CC} = 480V, V_p = 600V$ $R_G = 47\Omega, V_{GE} = +20V \text{ to } 0V$
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_G = 47\Omega, V_{GE} = +15V \text{ to } 0V$
E_{rec}	Reverse recovery energy of the diode	—	102	—	μJ	$T_J = 150^\circ\text{C}$
t_{rr}	Diode Reverse recovery time	—	73	—	ns	$V_{CC} = 400V, I_F = 7.5A$
I_{rr}	Peak Reverse Recovery Current	—	11	—	A	$V_{GE} = 15V, R_G = 47\Omega, L = 1mH, L_S = 150nH$

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 28 \mu H, R_G = 47 \Omega$
 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

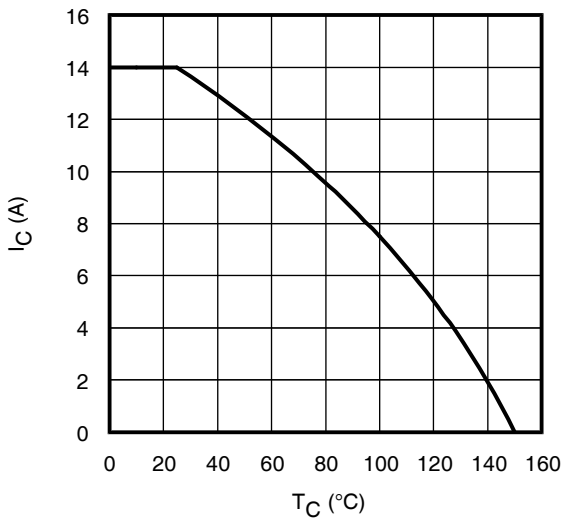


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

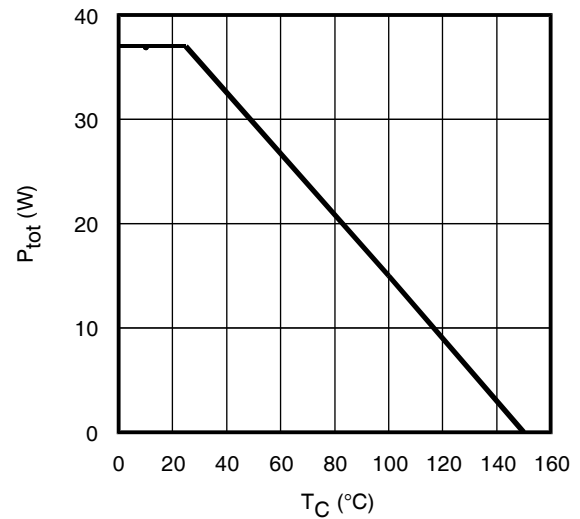


Fig. 2 - Power Dissipation vs. Case Temperature

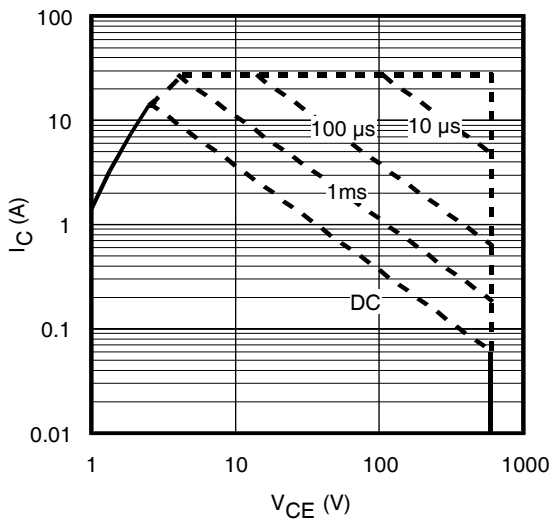


Fig. 3 - Forward SOA,
 $T_C = 25^\circ\text{C}$; $T_J \leq 150^\circ\text{C}$

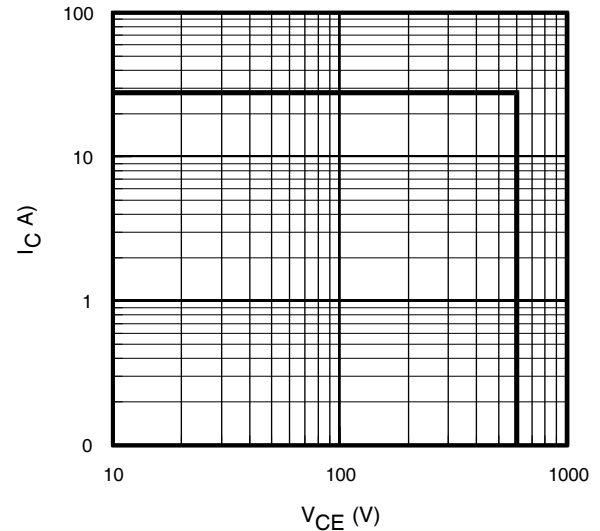


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{CE} = 15\text{V}$

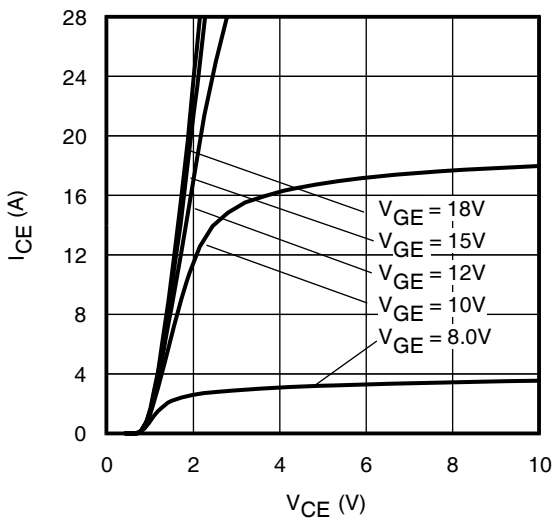


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p < 60\mu\text{s}$

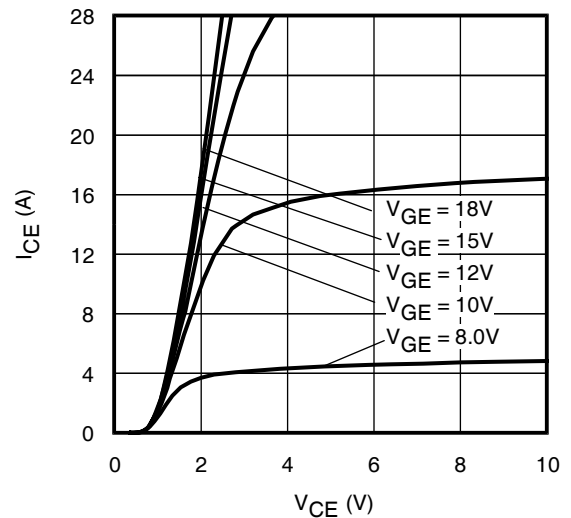


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p < 60\mu\text{s}$

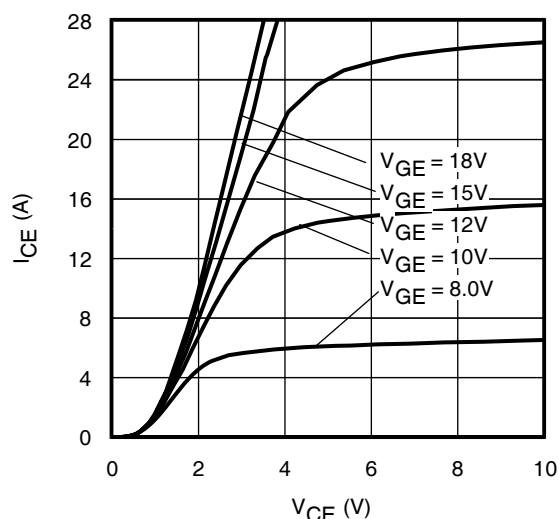


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p < 60\mu\text{s}$

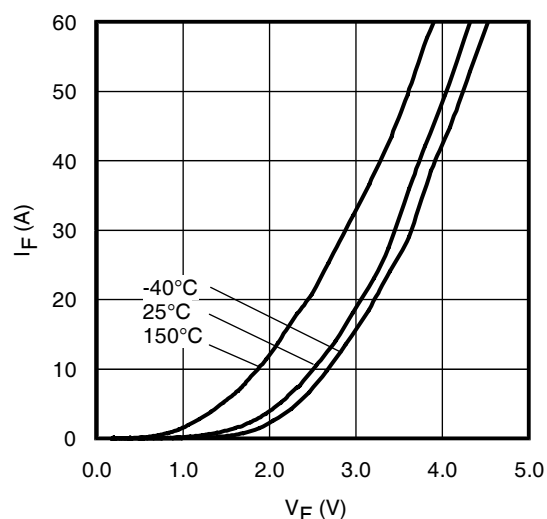


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p < 60\mu\text{s}$

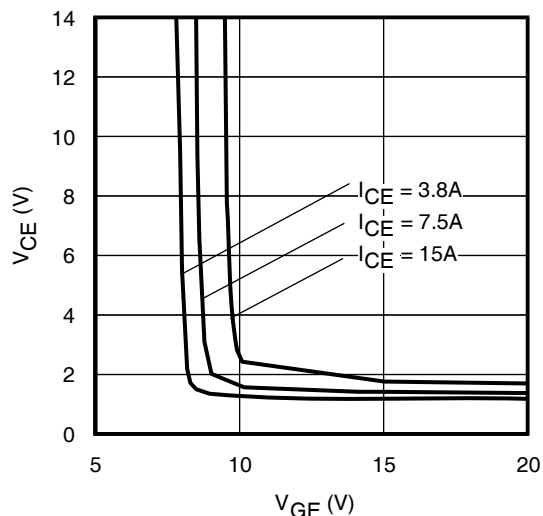


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

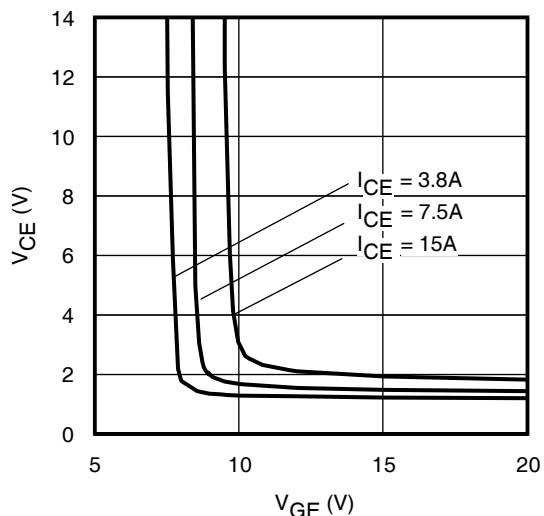


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

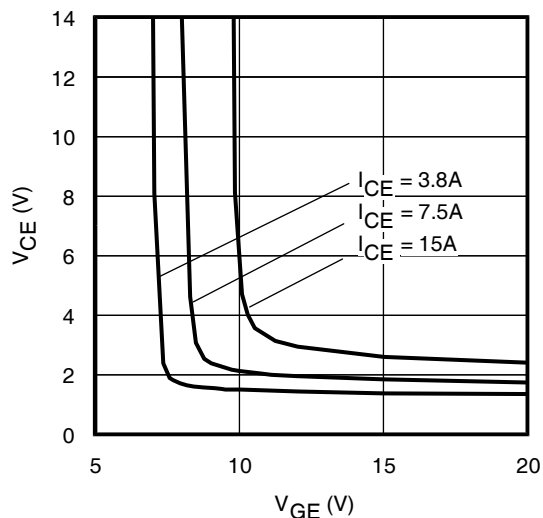


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

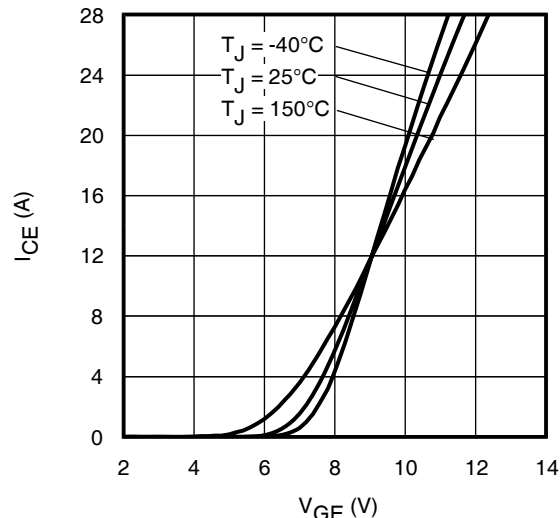


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p < 60\mu\text{s}$

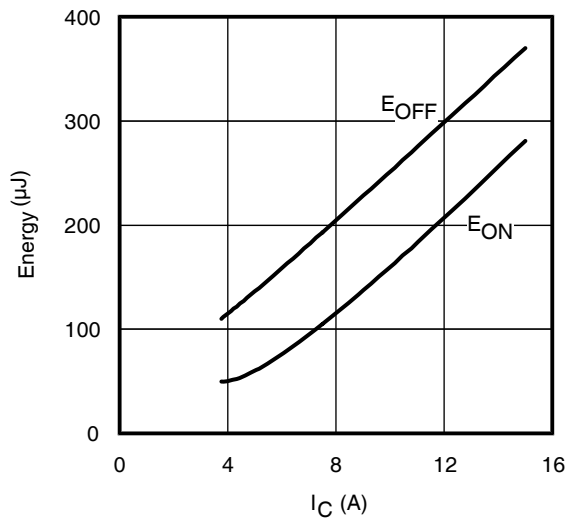


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$; $R_G = 47\Omega$; $V_{GE} = 15\text{V}$.

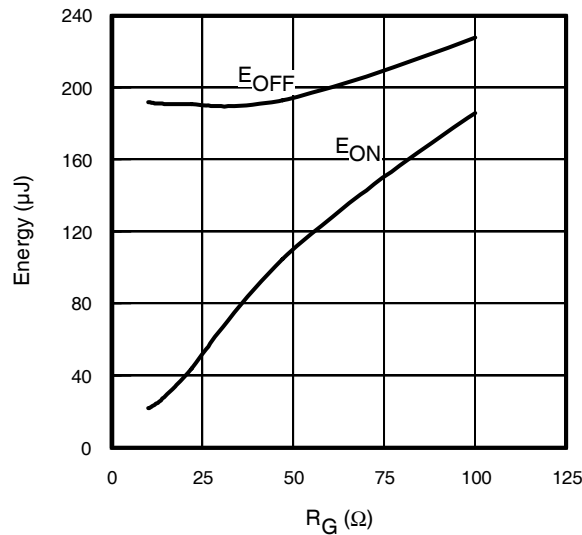


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$; $I_{CE} = 7.5\text{A}$; $V_{GE} = 15\text{V}$

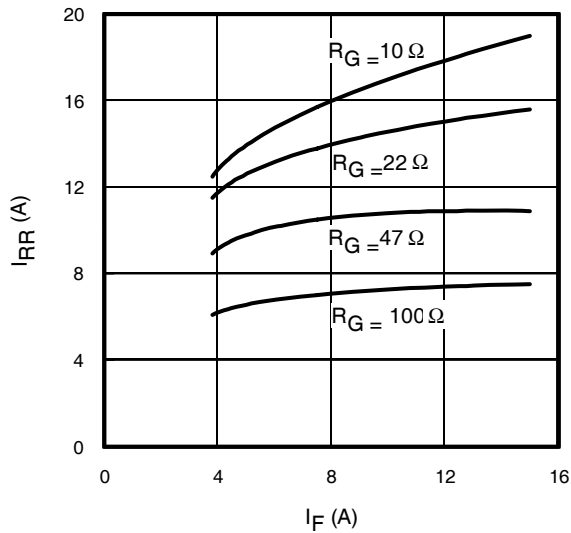


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

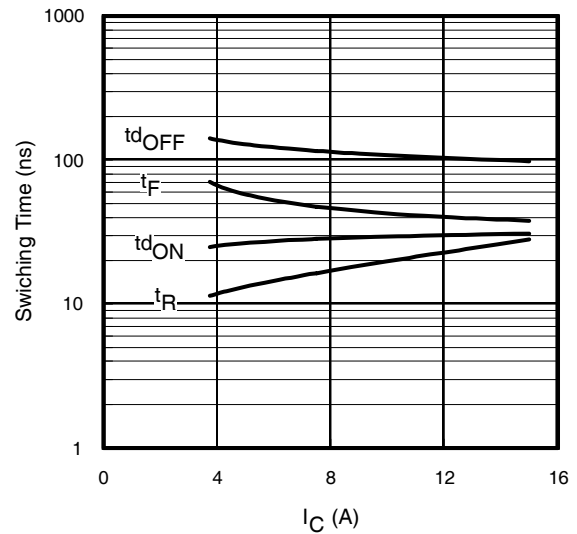


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $R_G = 47\Omega$; $V_{GE} = 15\text{V}$

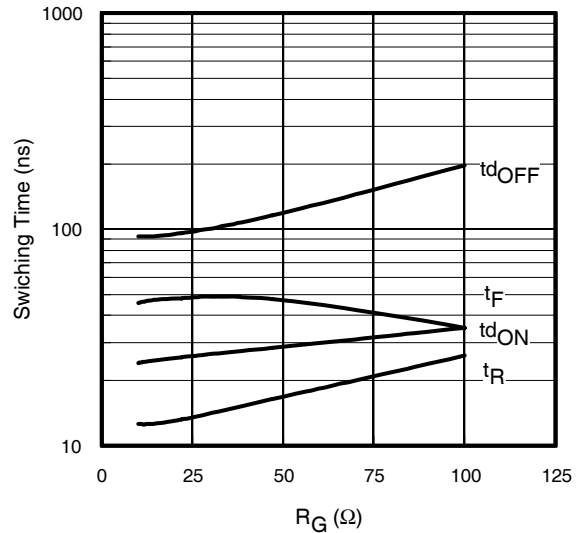


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $I_{CE} = 7.5\text{A}$; $V_{GE} = 15\text{V}$

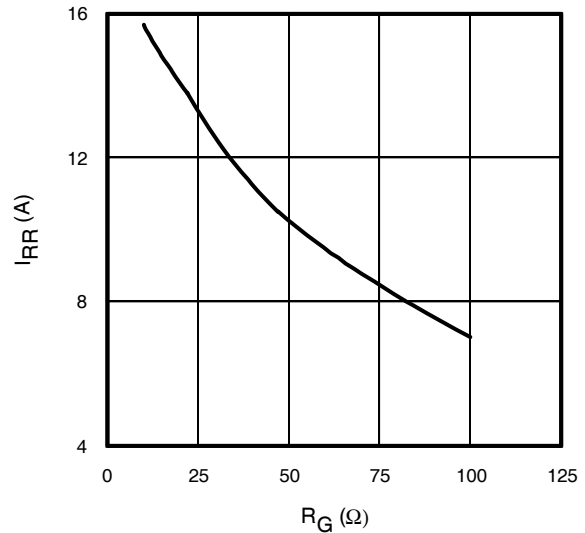


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150^\circ\text{C}$; $I_F = 7.5\text{A}$

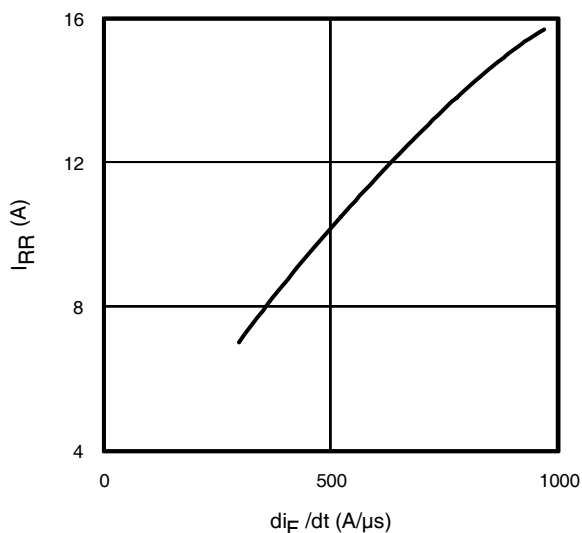


Fig. 19 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC}=400V$; $V_{GE}=15V$;
 $I_{CE}=7.5A$; $T_J=150^{\circ}C$

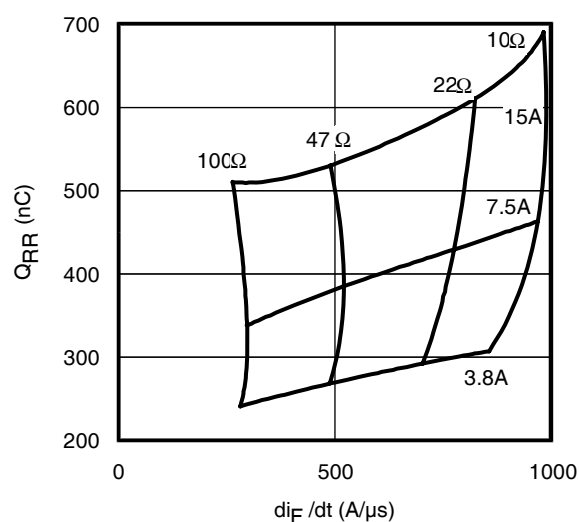


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC}=400V$; $V_{GE}=15V$; $T_J=150^{\circ}C$

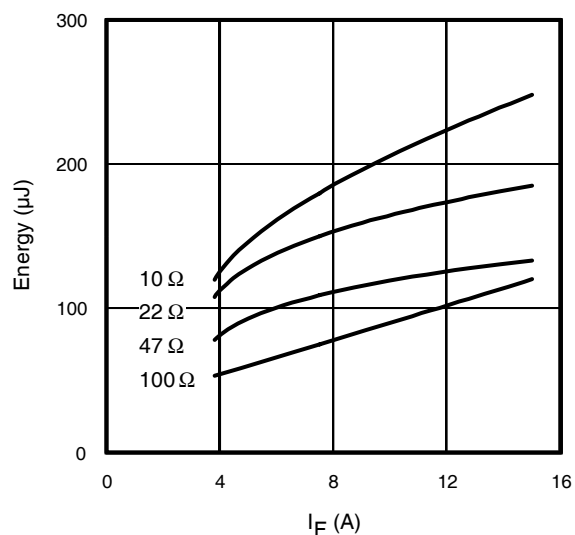


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J=150^{\circ}C$

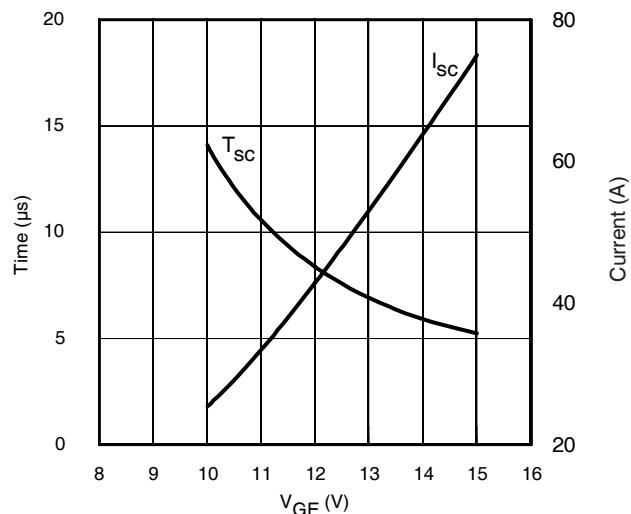


Fig. 22 - Typ. V_{GE} vs Short Circuit Time
 $V_{CC}=400V$, $T_C=25^{\circ}C$

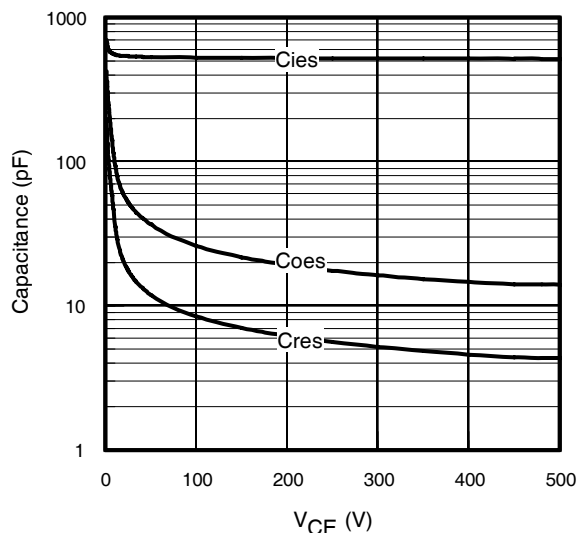


Fig. 23 - Typ. Capacitance vs. V_{CE}
 $V_{GE}=0V$; $f=1MHz$

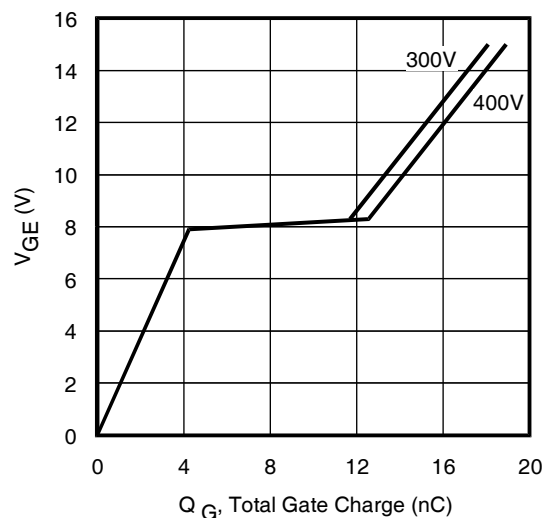


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE}=7.5A$, $L=600\mu H$

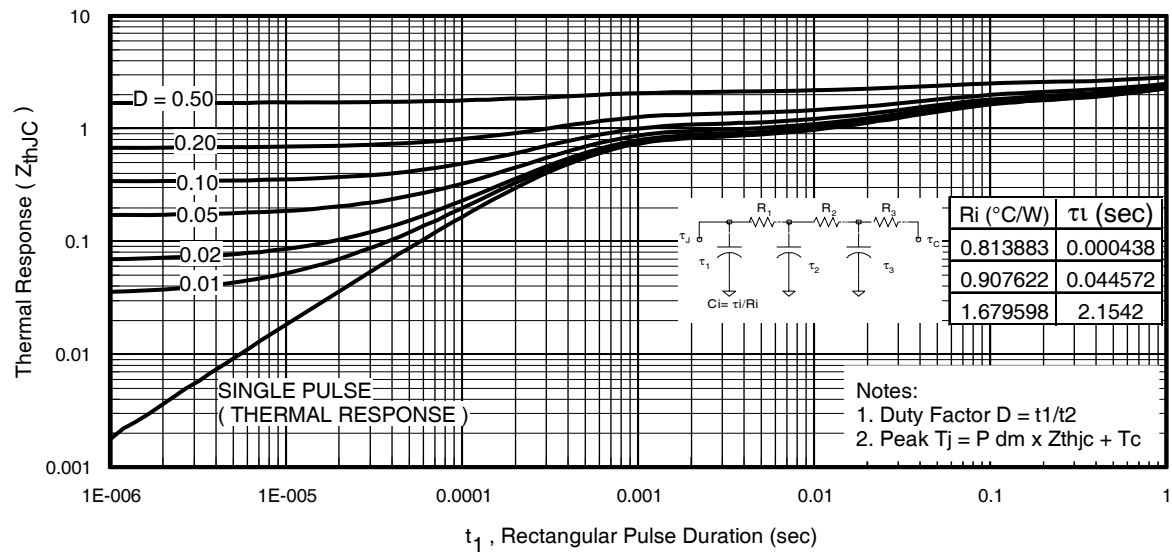


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

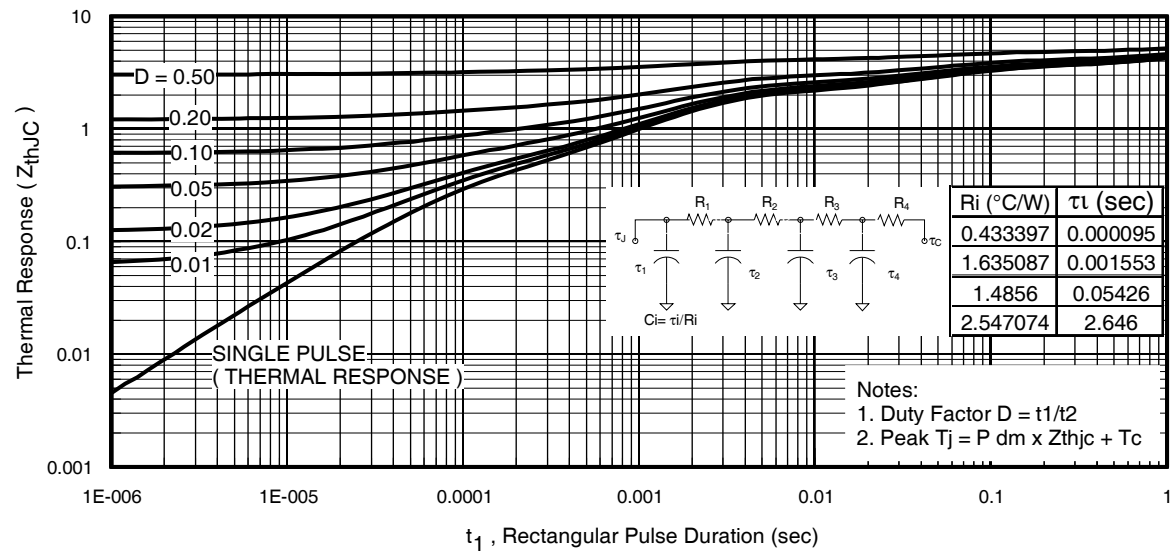


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

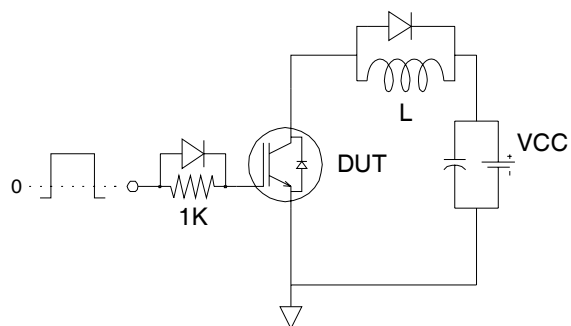


Fig.C.T.1 - Gate Charge Circuit (turn-off)

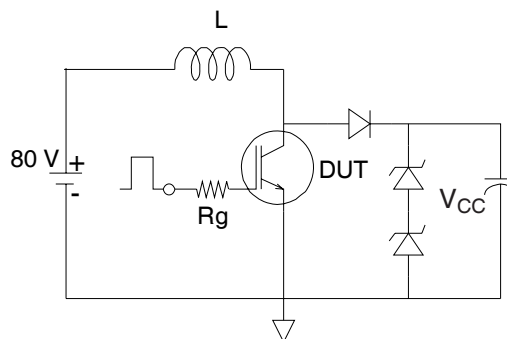


Fig.C.T.2 - RBSOA Circuit

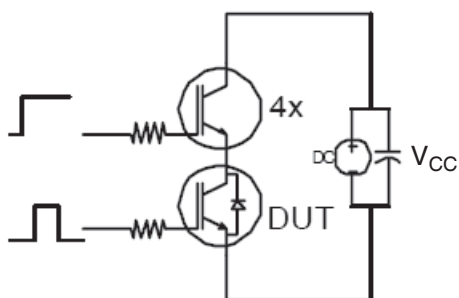


Fig.C.T.3 - S.C.SOA Circuit

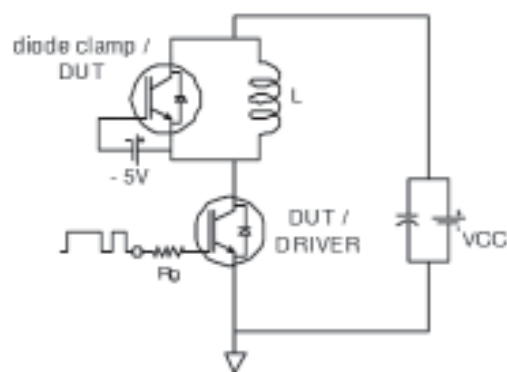


Fig.C.T.4 - Switching Loss Circuit

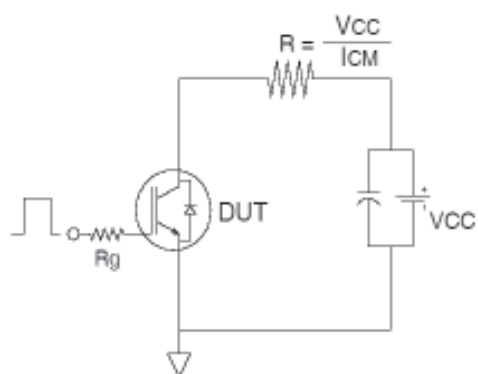


Fig.C.T.5 - Resistive Load Circuit

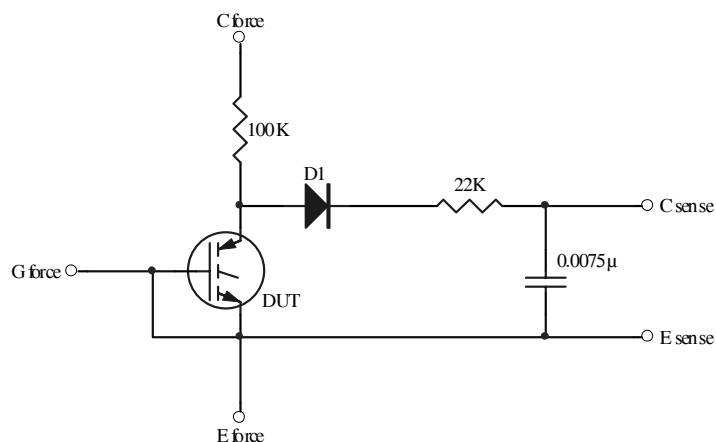


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

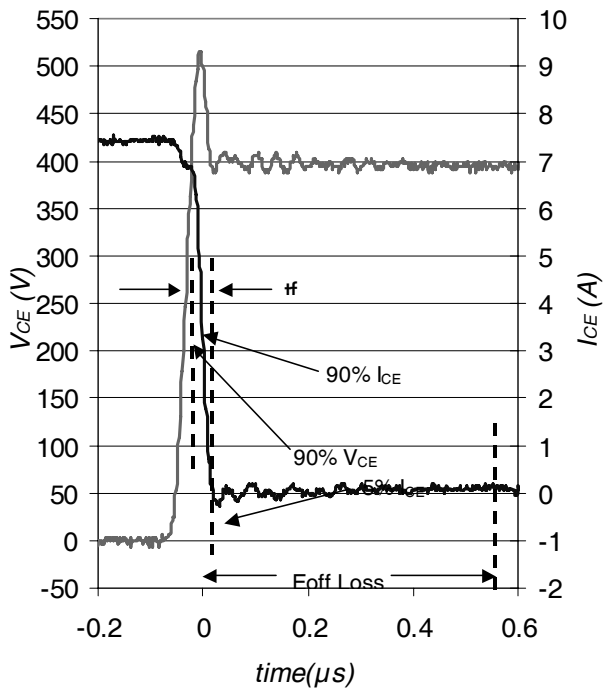


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

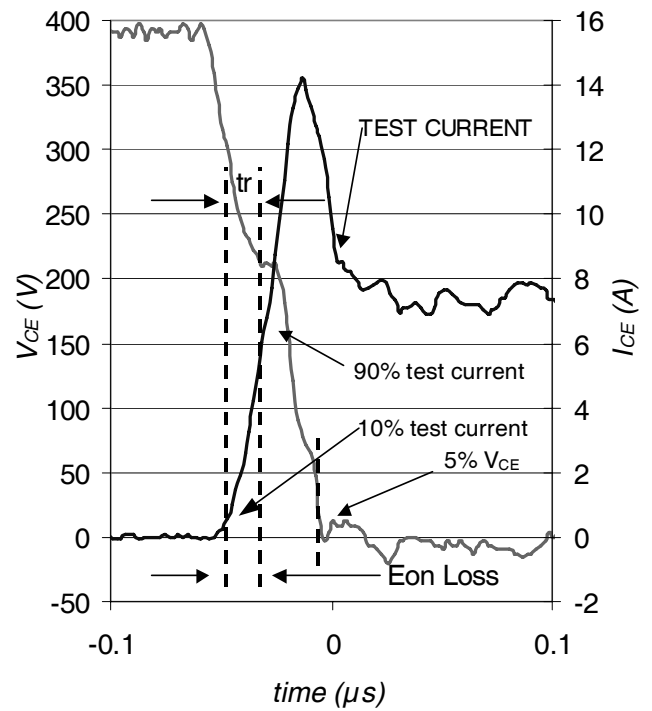
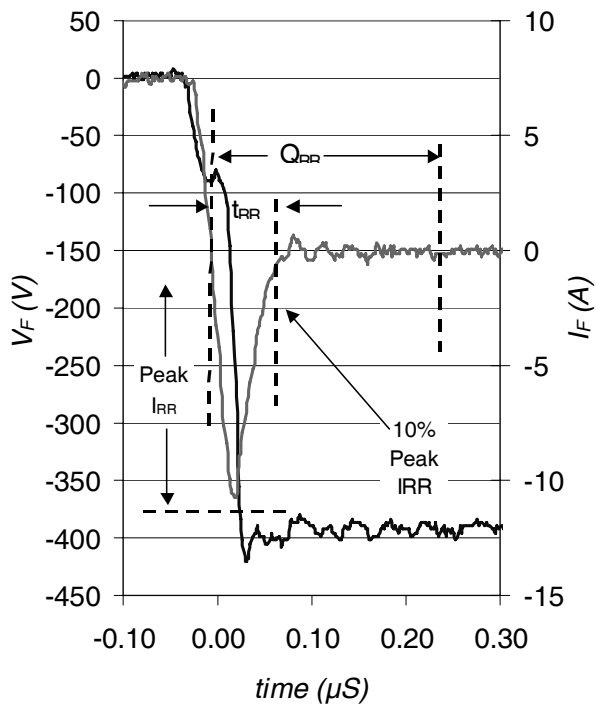
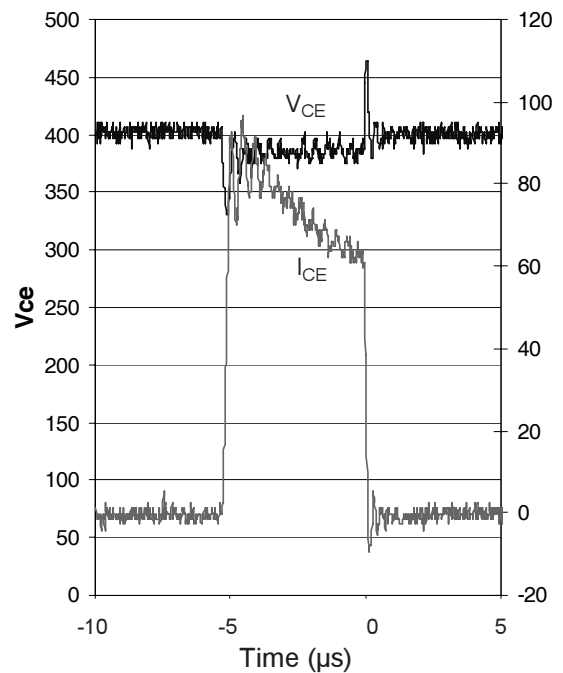


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4



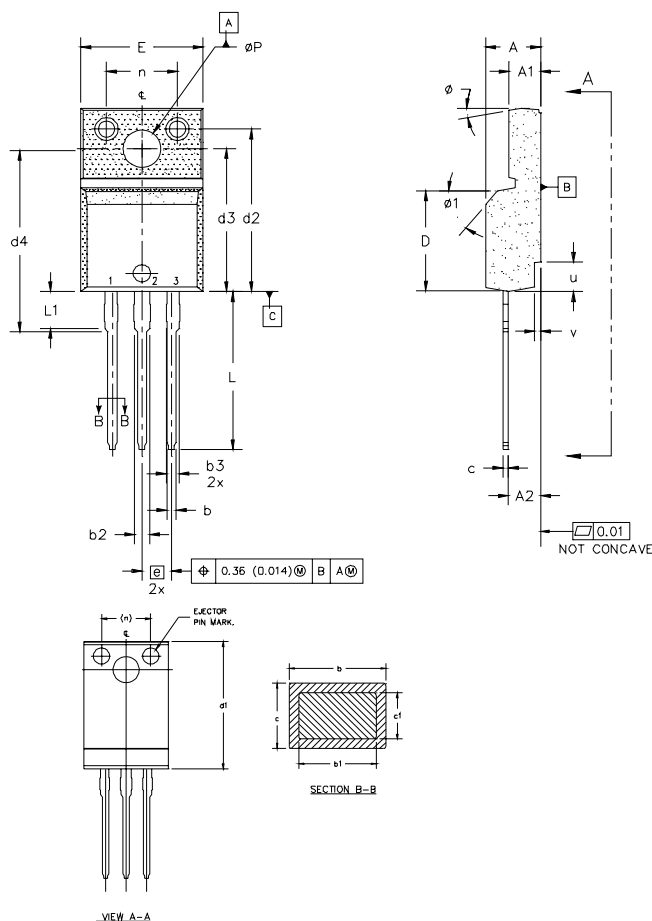
WF.3- Typ. Reverse Recovery Waveform
@ $T_J = 150^\circ\text{C}$ using CT.4



WF.4- Typ. Short Circuit Waveform
@ $T_J = 25^\circ\text{C}$ 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 0.006" (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	5
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	
b2	1.229	1.400	0.048	0.055	4
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	
d1	15.80	16.12	0.622	0.635	4
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	
e	2.54 BSC		0.100 BSC		3
L	13.20	13.73	0.520	0.541	
L1	3.10	3.50	0.122	0.138	
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

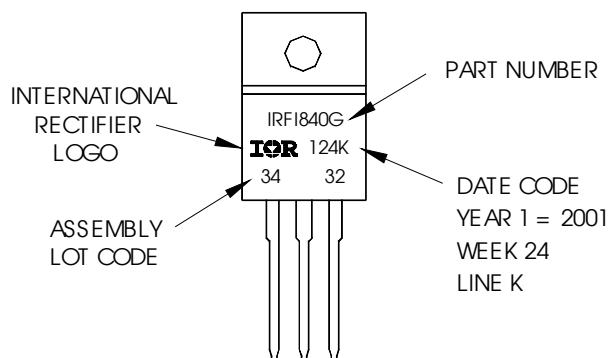
IGBTs, CoPACK

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

TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRF1840G
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.

International
IOR Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105

TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information. 4/09

www.irf.com