PD - 94620B

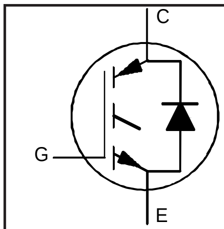
International
IOR Rectifier

IRGIB7B60KD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

- Low VCE (on) Non Punch Through IGBT Technology.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.
- Maximum Junction Temperature rated at 175°C.



n-channel

V_{CES} = 600V

I_C = 8.0A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 1.8V

Benefits

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


TO-220AB
FullPak

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	12	A
I_C @ T_C = 100°C	Continuous Collector Current	8.0	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	24	
I_{LM}	Clamped Inductive Load current ①	24	
I_F @ T_C = 25°C	Diode Continuous Forward Current	9.0	
I_F @ T_C = 100°C	Diode Continuous Forward Current	6.0	
I_{FM}	Diode Maximum Forward Current	18	
V_{ISOL}	RMS Isolation Voltage, Terminal to Case, t=1 min.	2500	V
V_{GE}	Gate-to-Emitter Voltage	±20	
P_D @ T_C = 25°C	Maximum Power Dissipation	39	W
P_D @ T_C = 100°C	Maximum Power Dissipation	20	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°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 / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	–––	–––	3.8	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	–––	–––	6.0	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	–––	0.50	–––	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	–––	–––	62	
Wt	Weight	–––	2.0	–––	g

09/17/03

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 = 500μA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.57	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	1.8	2.2	V	I_C = 8.0A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	2.2	2.5		I_C = 8.0A, V_{GE} = 15V, T_J = 150°C	9,10,11
		—	2.3	2.5		I_C = 8.0A, V_{GE} = 15V, T_J = 175°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	V_{CE} = V_{GE}, I_C = 250μA	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-9.5	—	mV/°C	V_{CE} = V_{GE}, I_C = 1mA (25°C-150°C)	12
gfe	Forward Transconductance	—	3.7	—	S	V_{CE} = 50V, I_C = 8.0A, PW = 80μs	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	V_{GE} = 0V, V_{CE} = 600V	
		—	200	500		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
		—	720	1100		V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C	
V_{FM}	Diode Forward Voltage Drop	—	1.25	1.45	V	I_F = 5.0A, V_{GE} = 0V	8
		—	1.20	1.40		I_F = 5.0A, T_J = 150°C, V_{GE} = 0V	
		—	1.20	1.30		I_F = 5.0A, T_J = 175°C, V_{GE} = 0V	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V, V_{CE} = 0V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Q_g	Total Gate Charge (turn-on)	—	29	44	nC	I_C = 8.0A	23
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	3.7	5.6		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	14	21		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	160	268	μJ	I_C = 8.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	160	268		V_{GE} = 15V, R_G = 50Ω, L = 1.1mH	
E_{tot}	Total Switching Loss	—	320	433		T_J = 25°C ②	
$t_{d(on)}$	Turn-On delay time	—	23	27	ns	I_C = 8.0A, V_{CC} = 400V	
t_r	Rise time	—	22	26		V_{GE} = 15V, R_G = 50Ω, L = 1.1mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	140	150		T_J = 25°C	
t_f	Fall time	—	32	42			
E_{on}	Turn-On Switching Loss	—	220	330	μJ	I_C = 8.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	270	381		V_{GE} = 15V, R_G = 50Ω, L = 1.1mH	13,15
E_{tot}	Total Switching Loss	—	490	711		T_J = 150°C ②	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	22	27	ns	I_C = 8.0A, V_{CC} = 400V	14,16
t_r	Rise time	—	21	25		V_{GE} = 15V, R_G = 50Ω, L = 1.1mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	180	198		T_J = 150°C	WF1
t_f	Fall time	—	40	56			WF2
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	440	660	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	38	57		V_{CC} = 30V	22
C_{res}	Reverse Transfer Capacitance	—	16	24		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 54A, Vp = 600V V_{CC}=500V,V_{GE} = +15V to 0V,R_G = 50Ω	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T_J = 150°C, Vp = 600V, R_G = 100Ω V_{CC}=360V,V_{GE} = +15V to 0V	CT3 WF4
I_{SC} (Peak)	Peak Short Circuit Collector Current	—	70	—	A		WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	100	133	μJ	T_J = 150°C	17,18,19
t_{rr}	Diode Reverse Recovery Time	—	95	120	ns	V_{CC} = 400V, I_F = 8.0A, L = 1.07mH	20,21
I_{rr}	Peak Reverse Recovery Current	—	13	17	A	V_{GE} = 15V, R_G = 50Ω	CT4,WF3
Q_{rr}	Diode Reverse Recovery Charge	—	620	800	nC	di/dt = 500A/μS	

Note ① to ② are on page 12

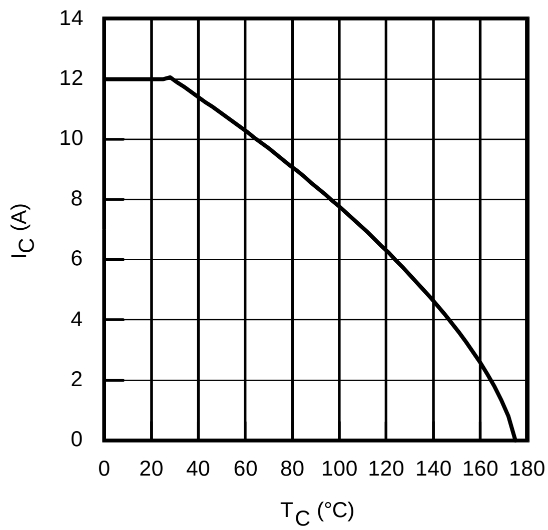


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

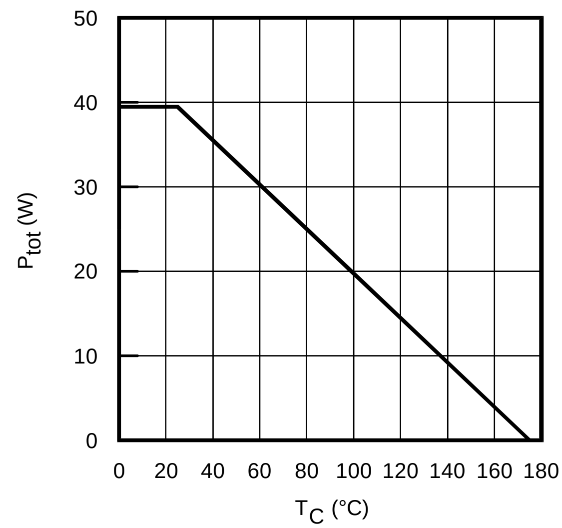


Fig. 2 - Power Dissipation vs. Case Temperature

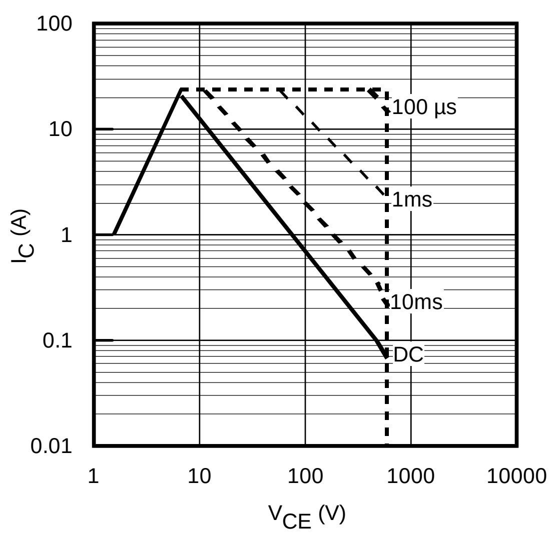


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \leq$ 150°C

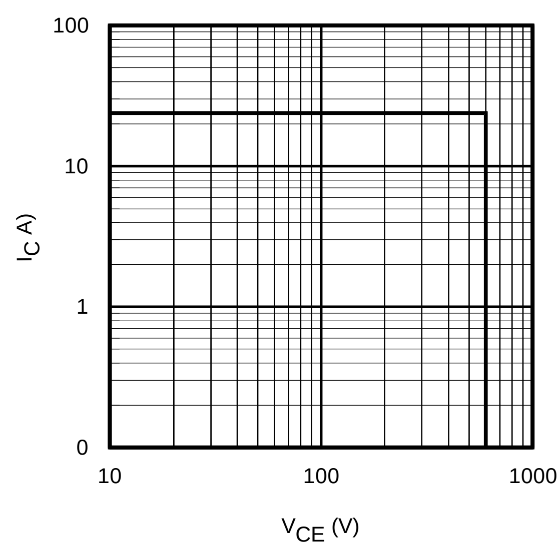


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} =15V

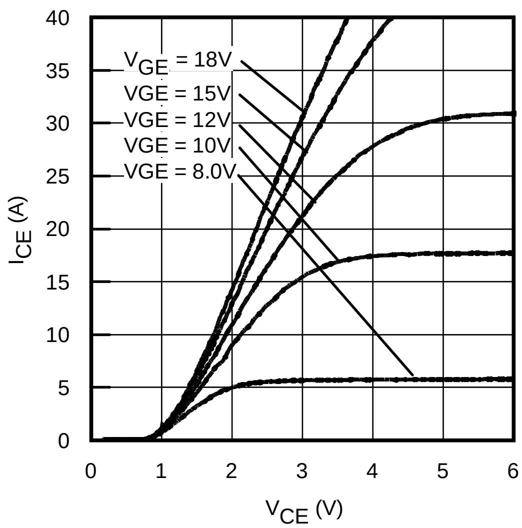


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

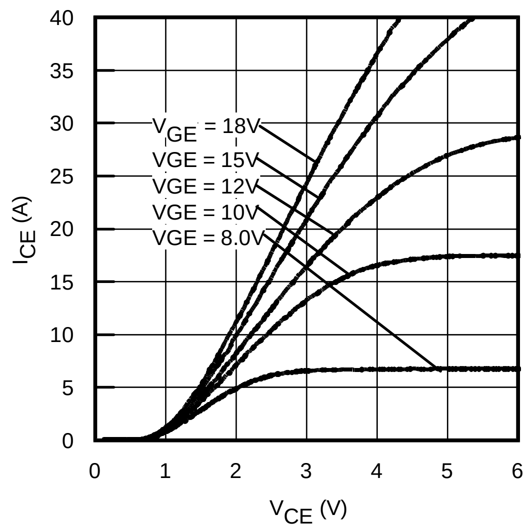


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

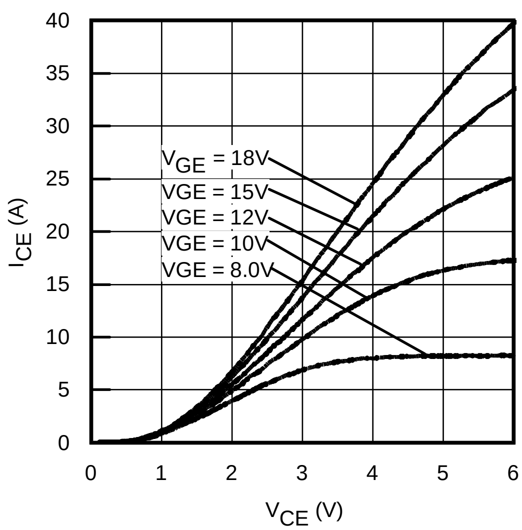


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

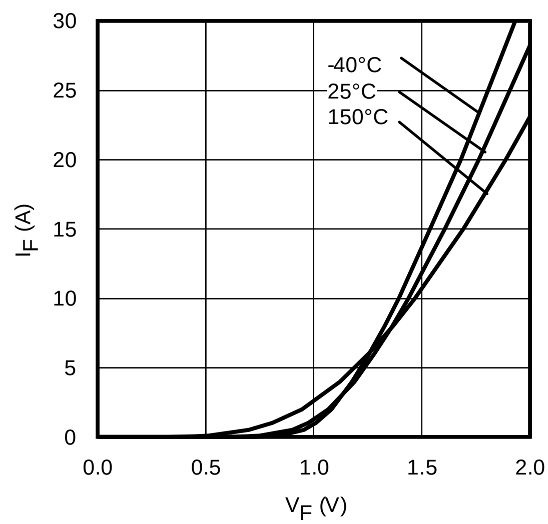


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

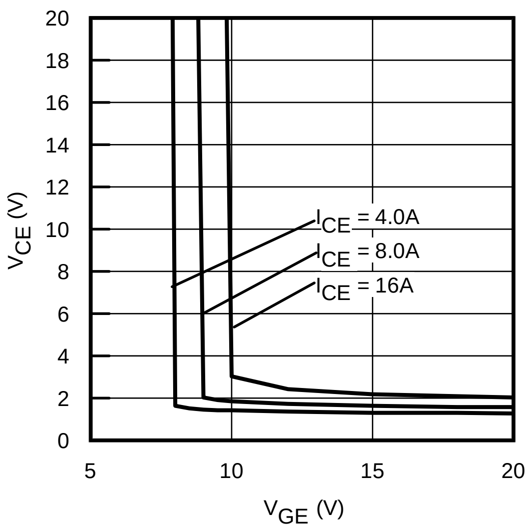


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

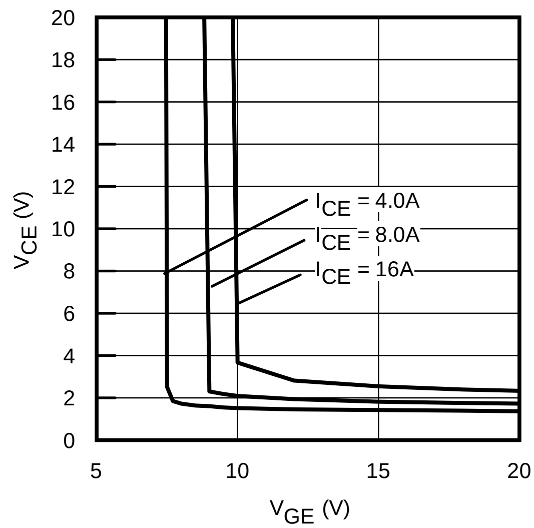


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

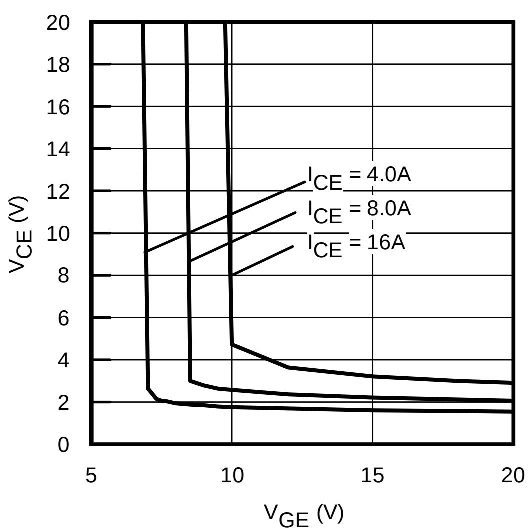


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

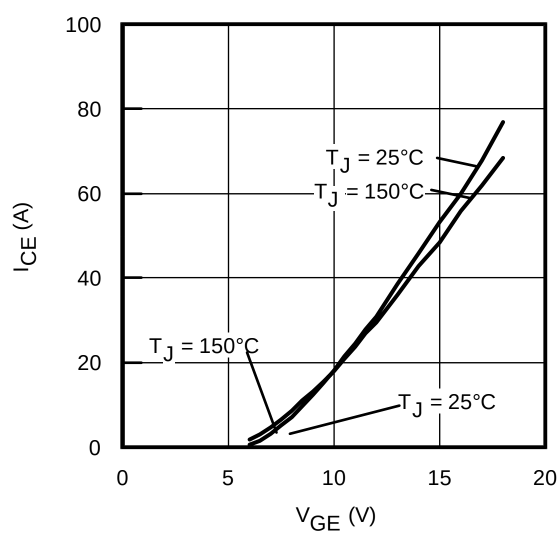


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 360V; tp = 10µs

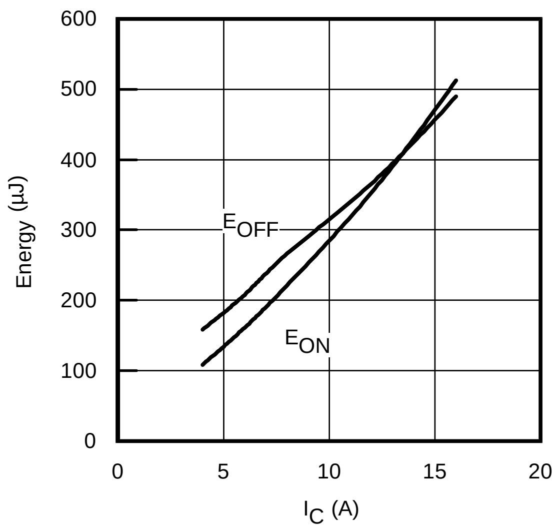


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=1.1mH; V_{CE}= 400V,
R_G= 50Ω; V_{GE}= 15V

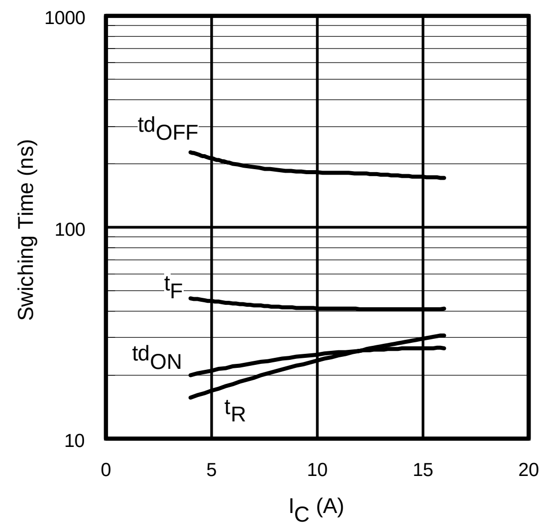


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1.1mH; V_{CE}= 400V
R_G= 50Ω; V_{GE}= 15V

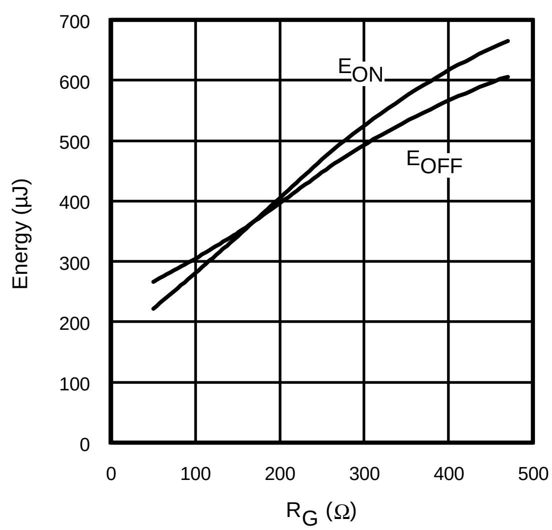


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=1.1mH; V_{CE}= 400V
I_{CE}= 8.0A; V_{GE}= 15V

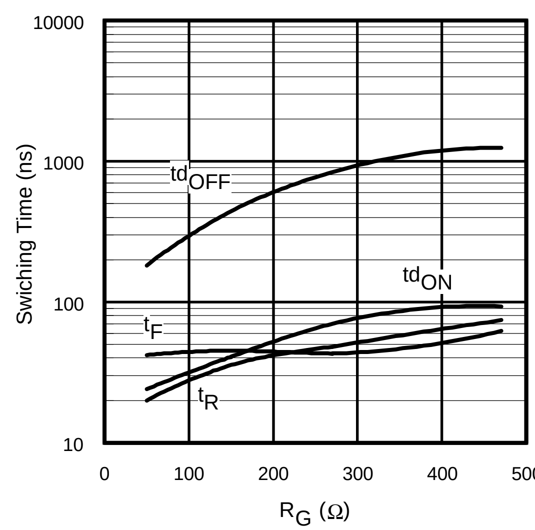


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=1.1mH; V_{CE}= 400V
I_{CE}= 8.0A; V_{GE}= 15V

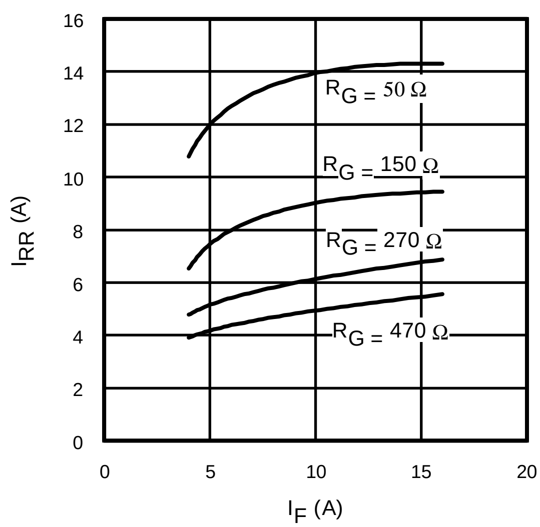


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

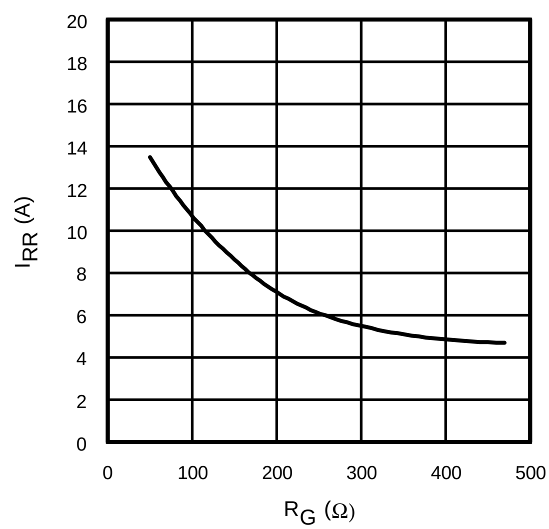


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 8.0A

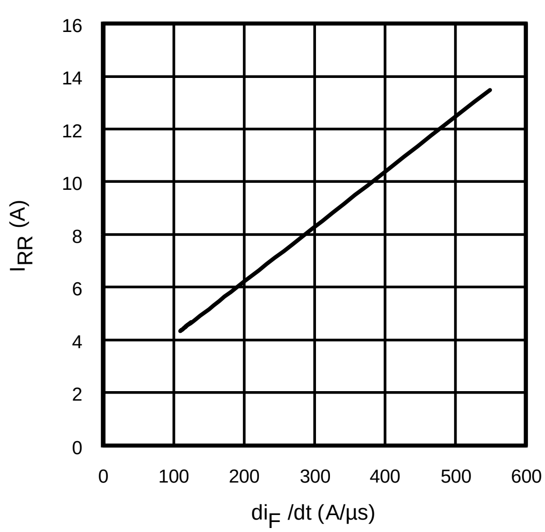


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_F= 8.0A; T_J = 150°C

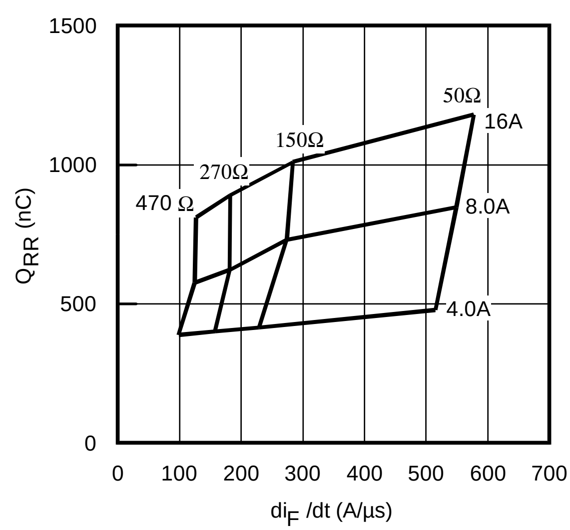


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;T_J = 150°C

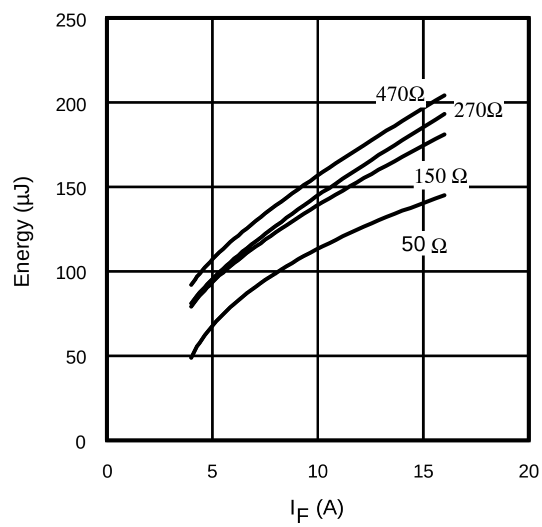


Fig. 21 - Typical Diode E_{RR} vs. I_F
$T_J = 150°C$

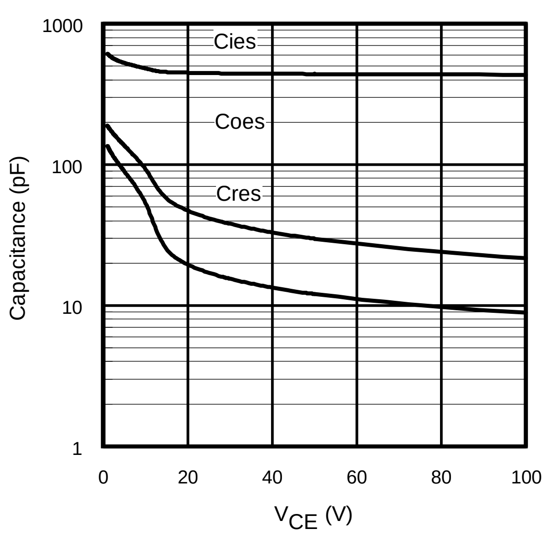


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

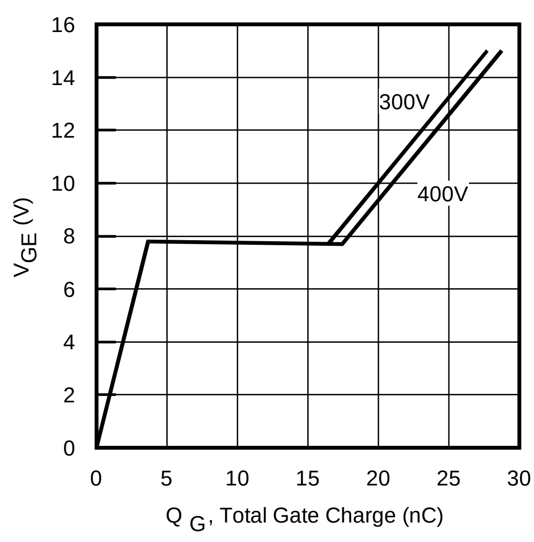
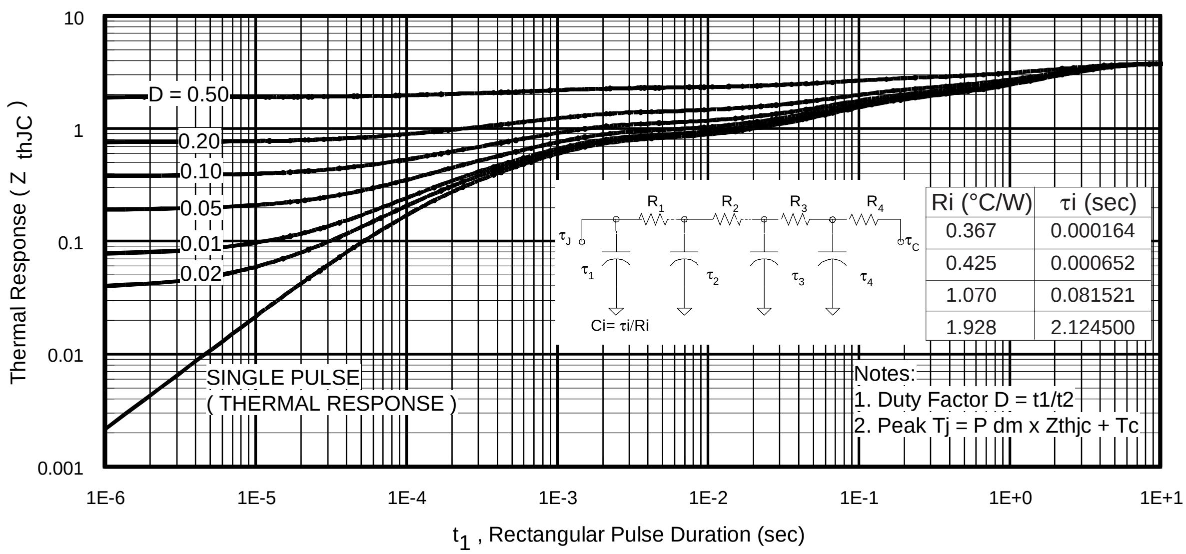
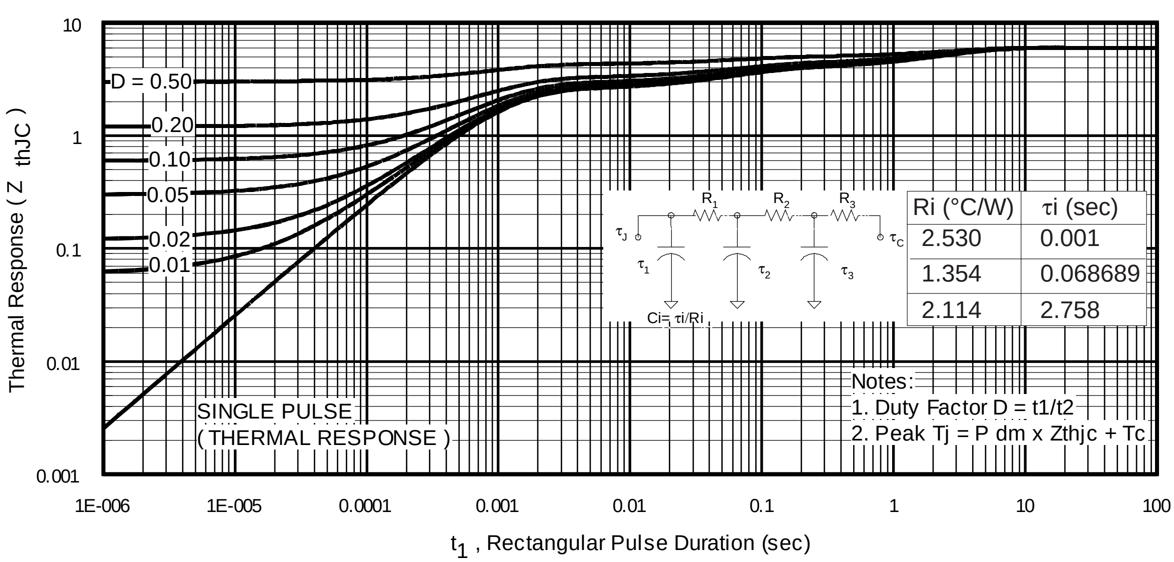


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 8.0A; L = 600µH



Ri (°C/W)	τi (sec)
0.367	0.000164
0.425	0.000652
1.070	0.081521
1.928	2.124500

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



Ri (°C/W)	τi (sec)
2.530	0.001
1.354	0.068689
2.114	2.758

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

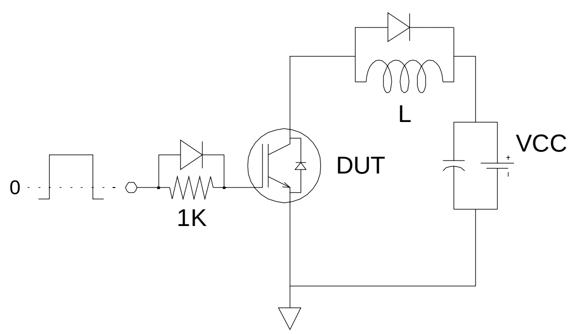


Fig.C.T.1 - Gate Charge Circuit (turn-off)

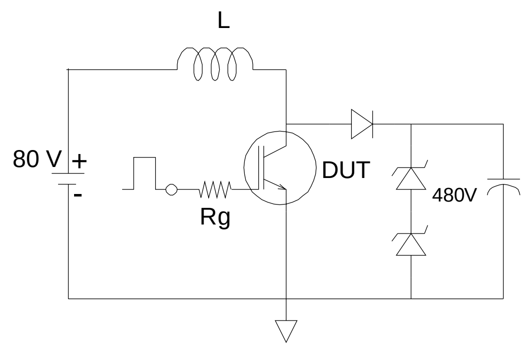


Fig.C.T.2 - RBSOA Circuit

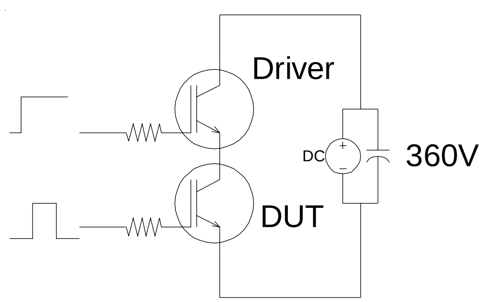


Fig.C.T.3 - S.C.SOA Circuit

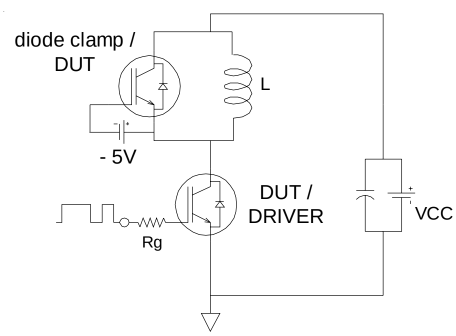


Fig.C.T.4 - Switching Loss Circuit

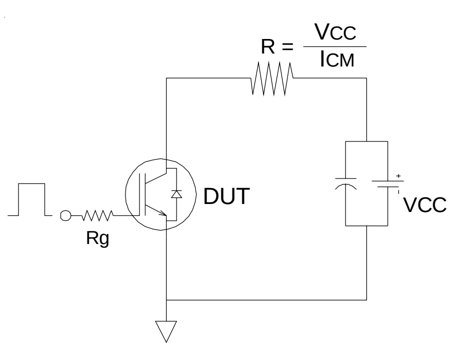


Fig.C.T.5 - Resistive Load Circuit

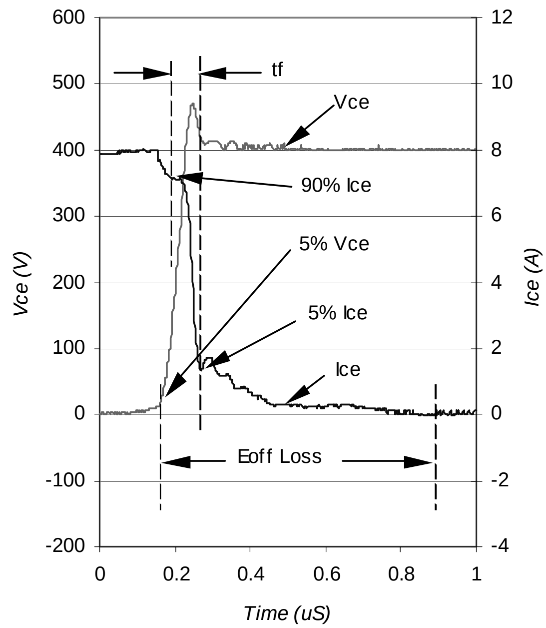


Fig. WF1- Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

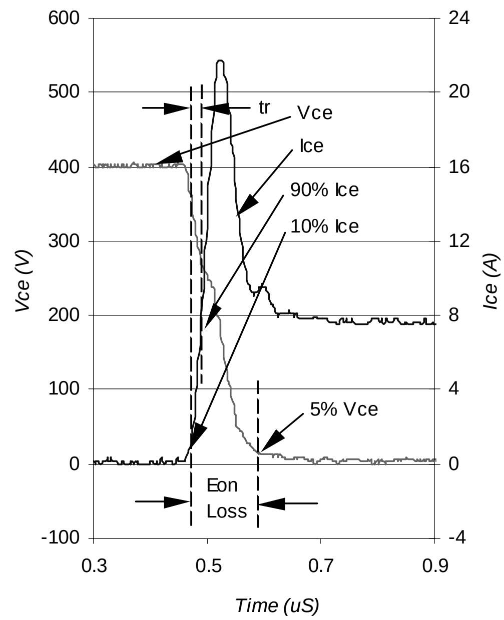


Fig. WF2- Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

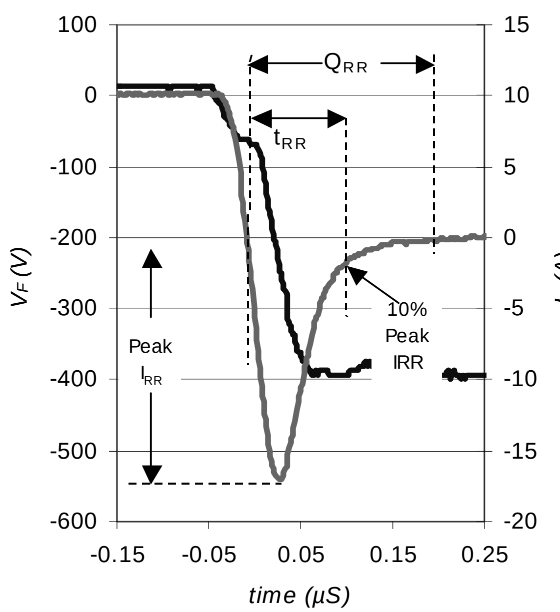


Fig. WF3- Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.3

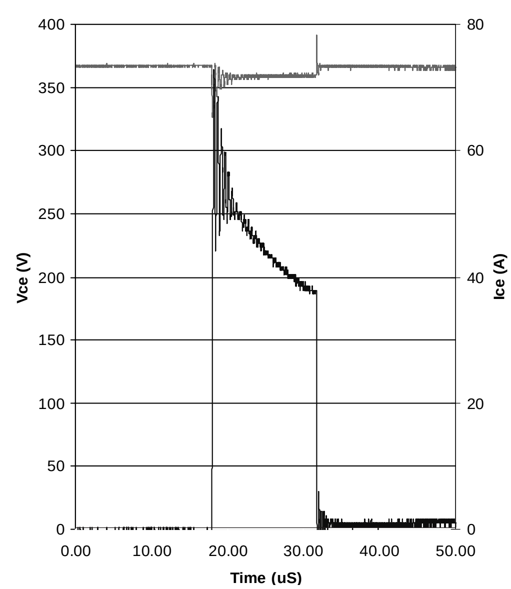
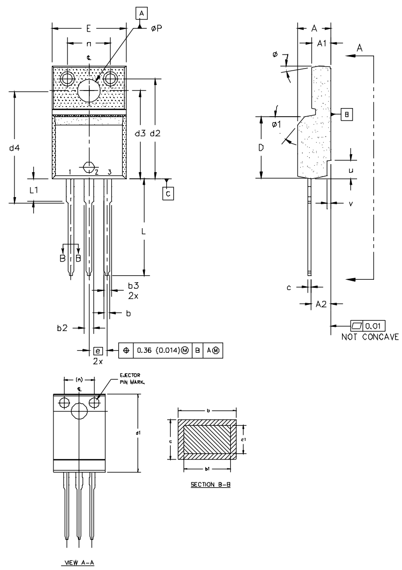


Fig. WF4- Typ. S.C Waveform
@ T_C = 150°C using Fig. CT.3

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

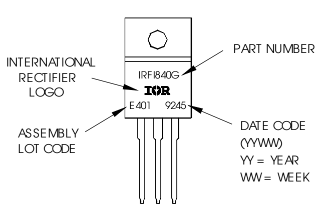
IGBTs, CoPACK

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

TO-220 Full-Pak Part Marking Information

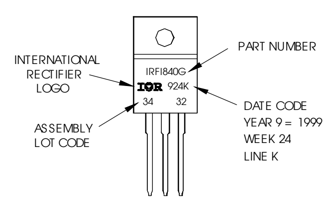
Notes: This part marking information applies to all devices produced before 02/26/2001 and currently for parts manufactured in GB.

EXAMPLE: THIS IS AN IRFI840G WITH ASSEMBLY LOT CODE E401



Notes: This part marking information applies to devices produced after 02/26/2001 in location other than GB.

EXAMPLE: THIS IS AN IRFI840G WITH ASSEMBLY LOT CODE 3432 ASSEMBLED ON WW 24 1999 IN THE ASSEMBLY LINE "K"



Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 100µH, R_G = 50Ω.

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

TO-220AB FullPak package is not recommended for Surface Mount Application.

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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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. 09/03

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