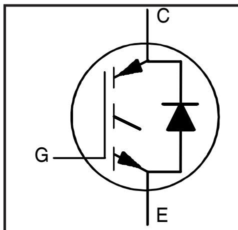
International
IOR Rectifier

PD- 94914

IRGIB15B60KD1P

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

V_{CES} = 600V

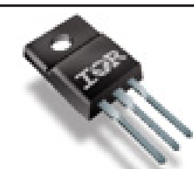
I_C = 12A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 1.80V

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.
- Maximum Junction Temperature Rated at 175°C
- Lead-Free

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


TO-220
Full-Pak

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	19	
I_C @ T_C = 100°C	Continuous Collector Current	12	A
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	38	
I_{LM}	Clamped Inductive Load current ①	38	
I_F @ T_C = 25°C	Diode Continuous Forward Current	19	
I_F @ T_C = 100°C	Diode Continuous Forward Current	12	
I_{FM}	Diode Maximum Forward Current	38	
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	52	W
P_D @ T_C = 100°C	Maximum Power Dissipation	26	
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 (1.1N.m)	

Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	–––	–––	2.9	
$R_{\theta JC}$	Junction-to-Case- Diode	–––	–––	4.6	°C/W
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	–––	0.50	–––	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	–––	–––	62	
Wt	Weight	–––	2.0	–––	g

12/30/03

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	—	0.32	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	1.80	2.20	V	I_C = 15A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	2.05	2.50		I_C = 15A, V_{GE} = 15V, T_J = 150°C	9,10,11
		—	2.10	2.60		I_C = 15A, 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	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 1mA (25°C-150°C)	12
gfe	Forward Transconductance	—	10	—	S	V_{CE} = 50V, I_C = 15A, PW = 80μs	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	V_{GE} = 0V, V_{CE} = 600V	
		—	163	500		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
		—	829	1800		V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C	
V_{FM}	Diode Forward Voltage Drop	—	1.69	2.30	V	I_F = 15A, V_{GE} = 0V	8
		—	1.31	1.75		I_F = 15A, V_{GE} = 0V, T_J = 150°C	
		—	1.25	1.65		I_F = 15A, V_{GE} = 0V, T_J = 175°C	
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)	—	56	84	nC	I_C = 15A	23
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	7.0	10		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	26	39		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	127	140	μJ	I_C = 15A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	334	422		V_{GE} = 15V, R_G = 22Ω, L = 1.07mH	
E_{tot}	Total Switching Loss	—	461	556		Ls= 150nH, T_J = 25°C ②	
$t_{d(on)}$	Turn-On delay time	—	30	39	ns	I_C = 15A, V_{CC} = 400V	
t_r	Rise time	—	25	35		V_{GE} = 15V, R_G = 22Ω, L = 1.07mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	173	188		Ls= 150nH, T_J = 25°C	
t_f	Fall time	—	41	53			
E_{on}	Turn-On Switching Loss	—	258	282	μJ	I_C = 15A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	570	646		V_{GE} = 15V, R_G = 22Ω, L = 1.07mH	13,15
E_{tot}	Total Switching Loss	—	829	915		Ls= 150nH, T_J = 150°C ②	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	30	39	ns	I_C = 15A, V_{CC} = 400V	14,16
t_r	Rise time	—	25	35		V_{GE} = 15V, R_G = 22Ω, L = 1.07mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	194	207		Ls= 150nH, T_J = 150°C	WF1
t_f	Fall time	—	56	73			WF2
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5 mm from package	
C_{ies}	Input Capacitance	—	850	1275	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	100	150		V_{CC} = 30V	22
C_{res}	Reverse Transfer Capacitance	—	32	48		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 38A, Vp = 600V	4
						V_{CC}=500V,V_{GE} = +15V to 0V,R_G = 22Ω	CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T_J = 150°C, Vp = 600V, R_G = 22Ω	CT3
						V_{CC}=360V,V_{GE} = +15V to 0V	WF4
$I_{SC\ (PEAK)}$	Peak Short Circuit Collector Current	—	140	—	A		WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	267	347	μJ	T_J = 150°C	17,18,19
t_{rr}	Diode Reverse Recovery Time	—	67	87	ns	V_{CC} = 400V, I_F = 15A, L = 1.07mH	20,21
I_{rr}	Peak Reverse Recovery Current	—	23	30	A	V_{GE} = 15V, R_G = 22Ω	CT4,WF3
Q_{rr}	Diode Reverse Recovery Charge	—	984	1279	nC	di/dt = 875A/μs	

① Vcc =80% (V_{CES}), V_{GE} = 15V, L =100μH, R_G = 22Ω.

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

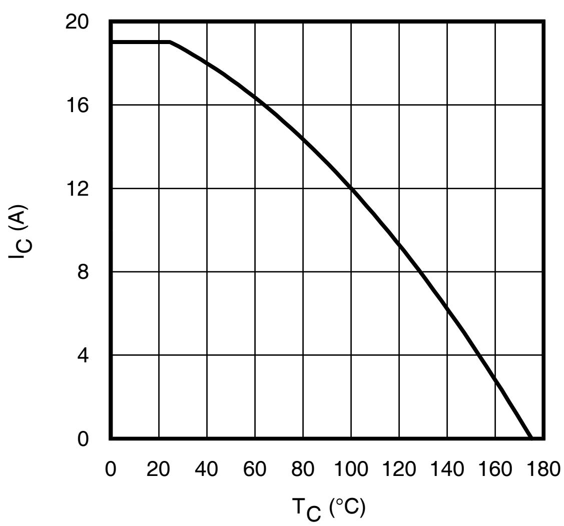


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

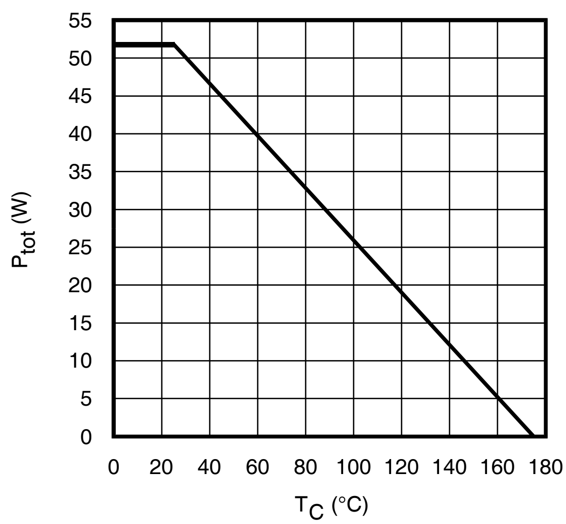


Fig. 2 - Power Dissipation vs. Case Temperature

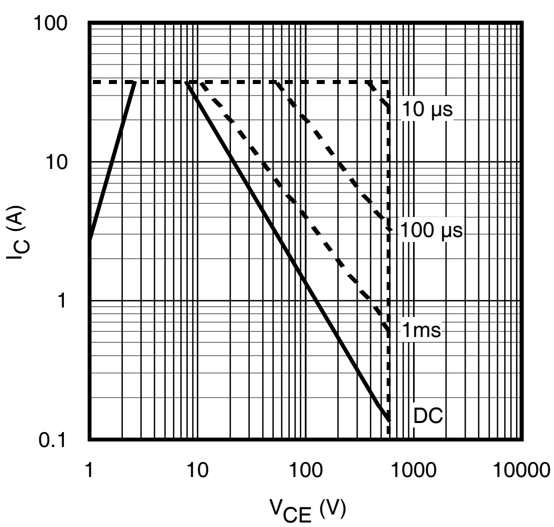


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \leq$ 150°C

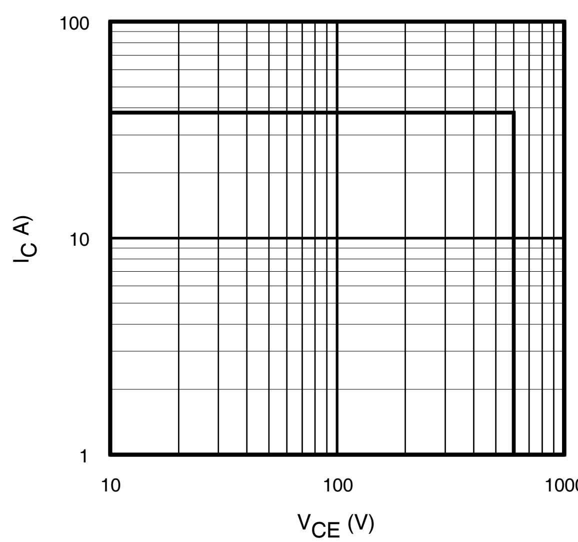


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} =15V

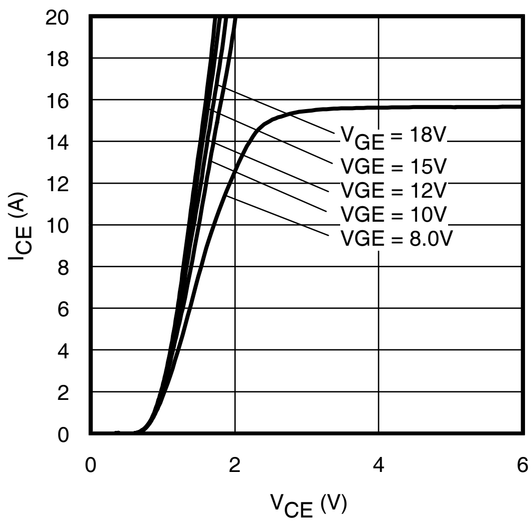


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 60µs

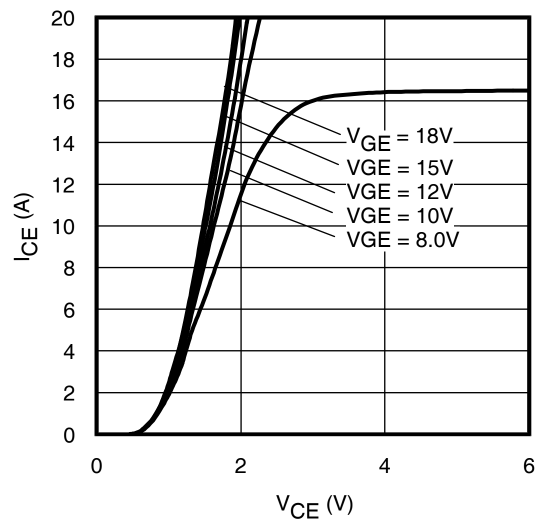


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 60µs

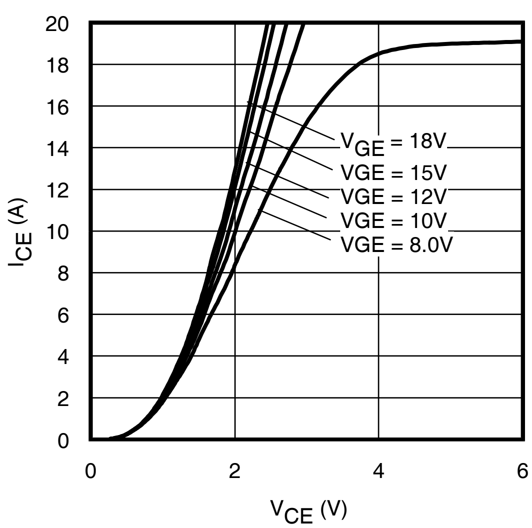


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 60µs

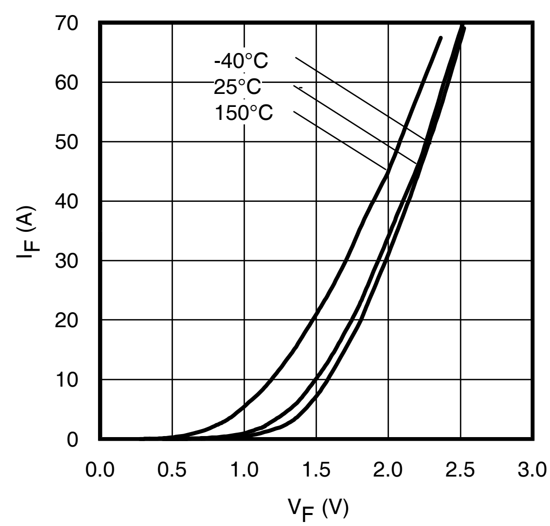


Fig. 8 - Typ. Diode Forward Characteristics
tp = 60µs

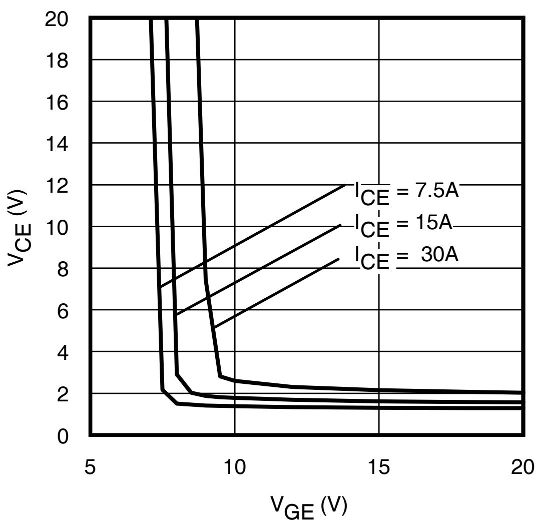


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

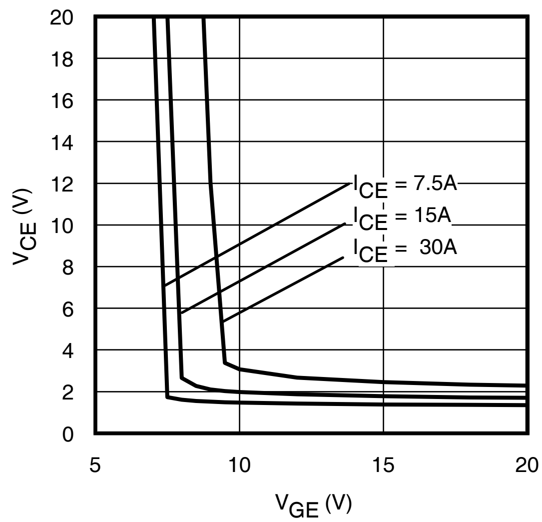


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

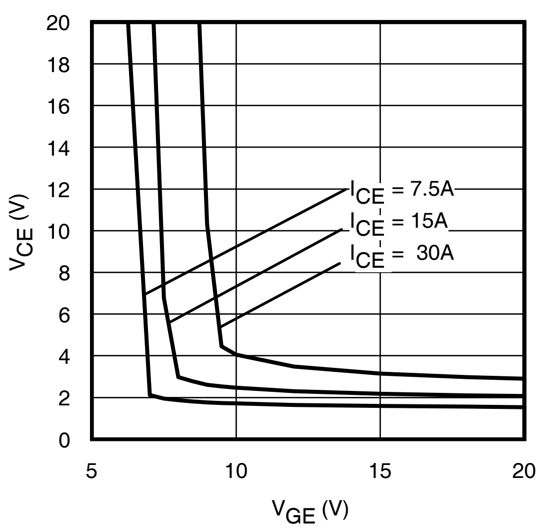


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

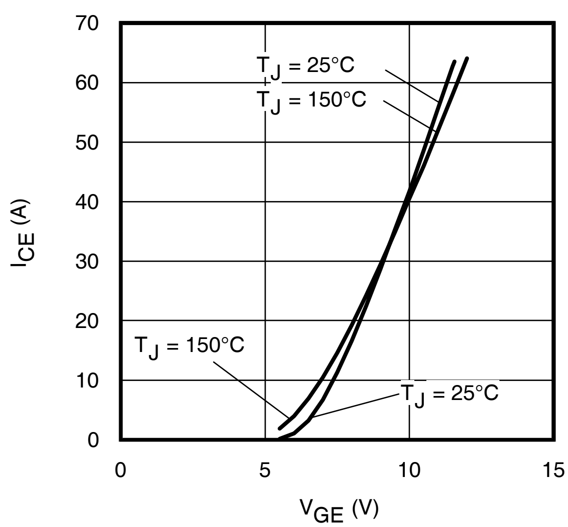


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

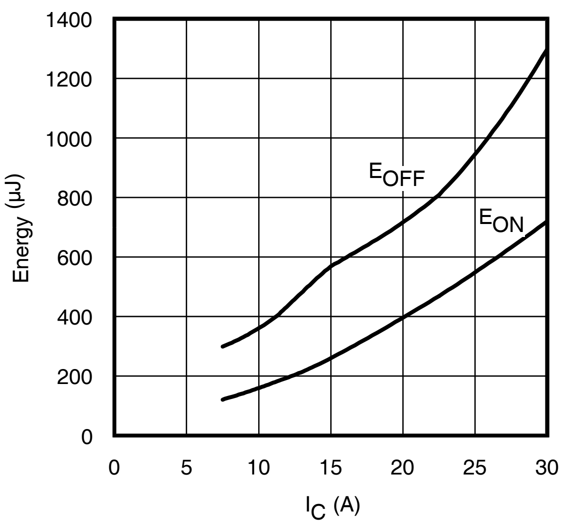


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 22Ω; V_{GE}= 15V

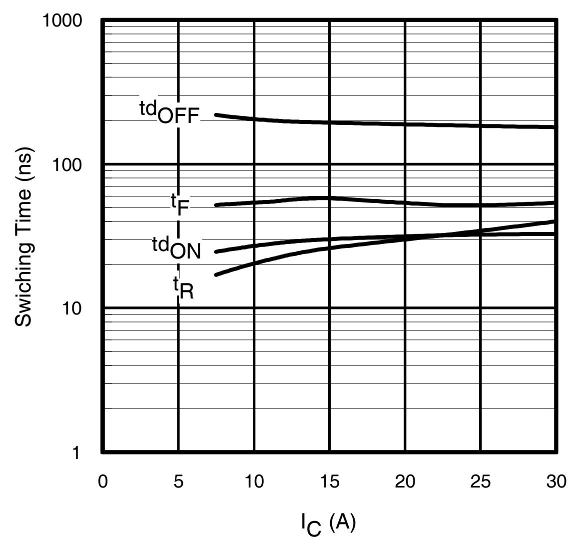


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 22Ω; V_{GE}= 15V

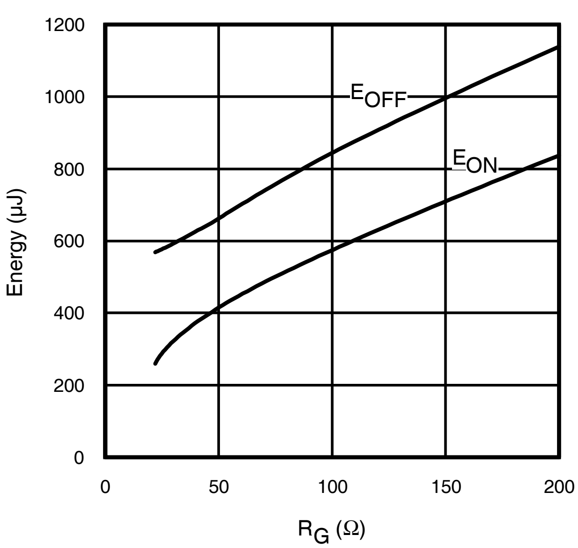


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 15A; V_{GE}= 15V

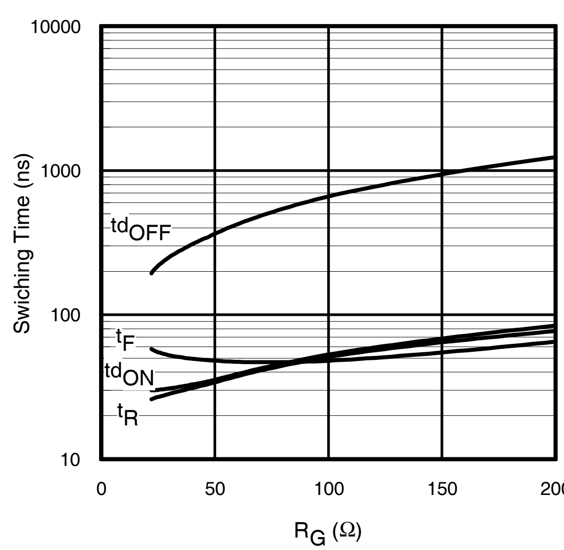


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 15A; V_{GE}= 15V

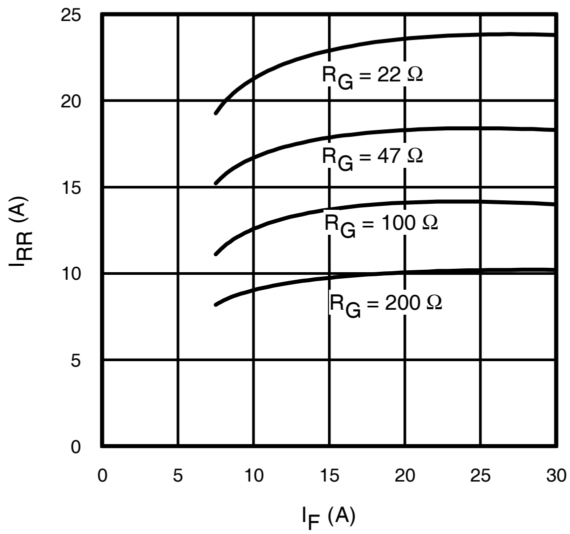


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

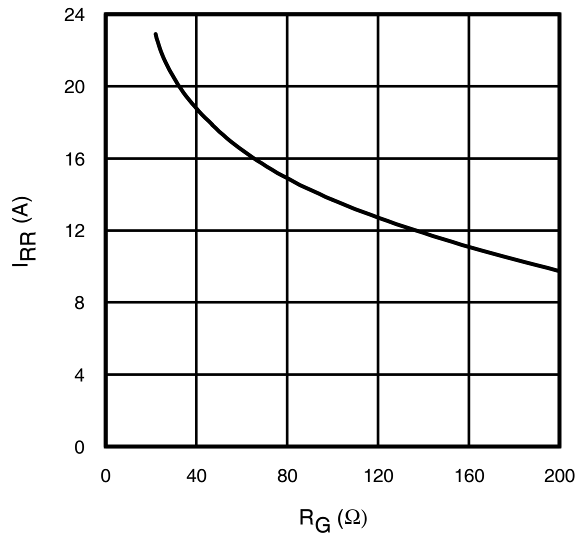


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 15A

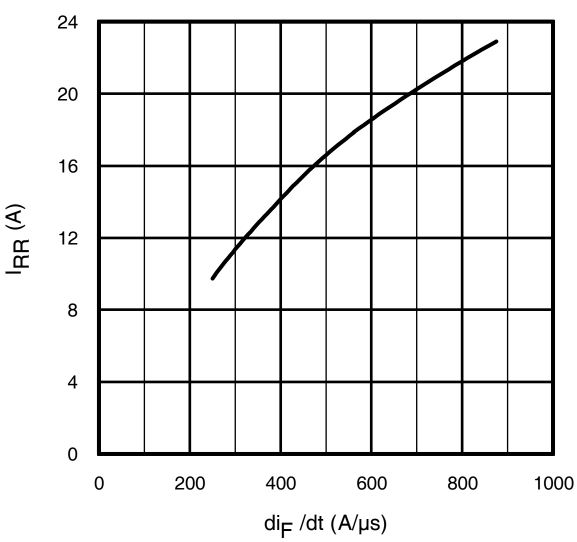


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 15A; T_J = 150°C

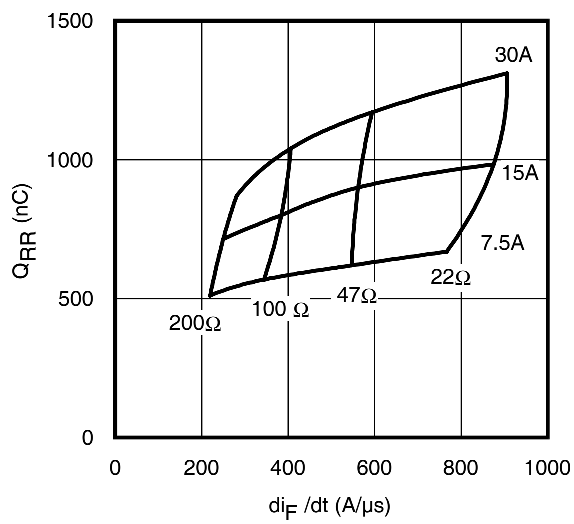


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;T_J = 150°C

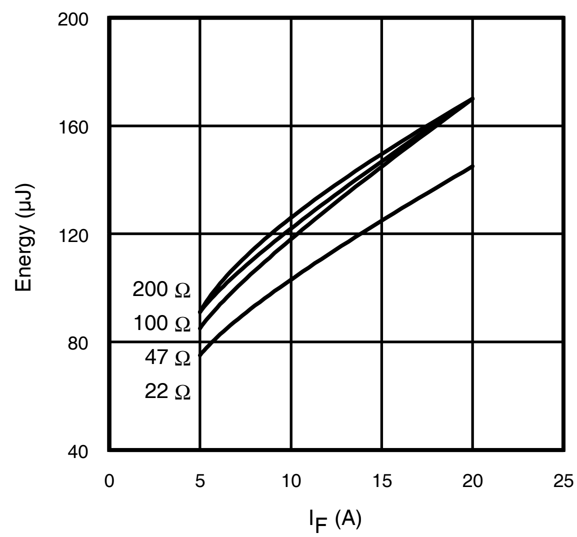


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

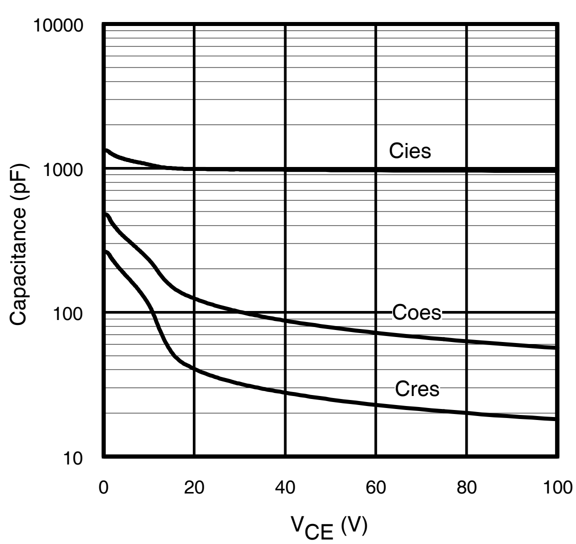


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

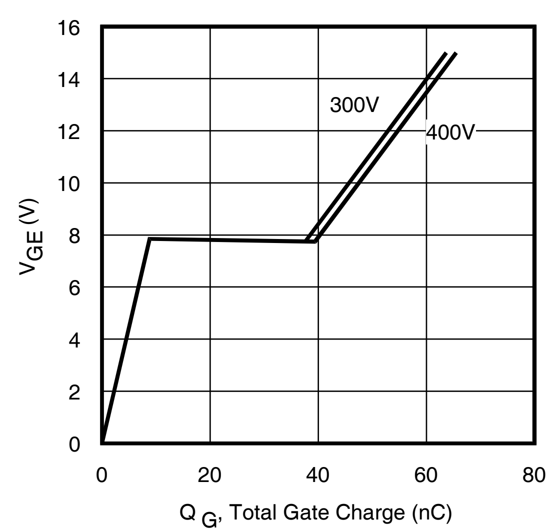


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 15A; L = 2500µH

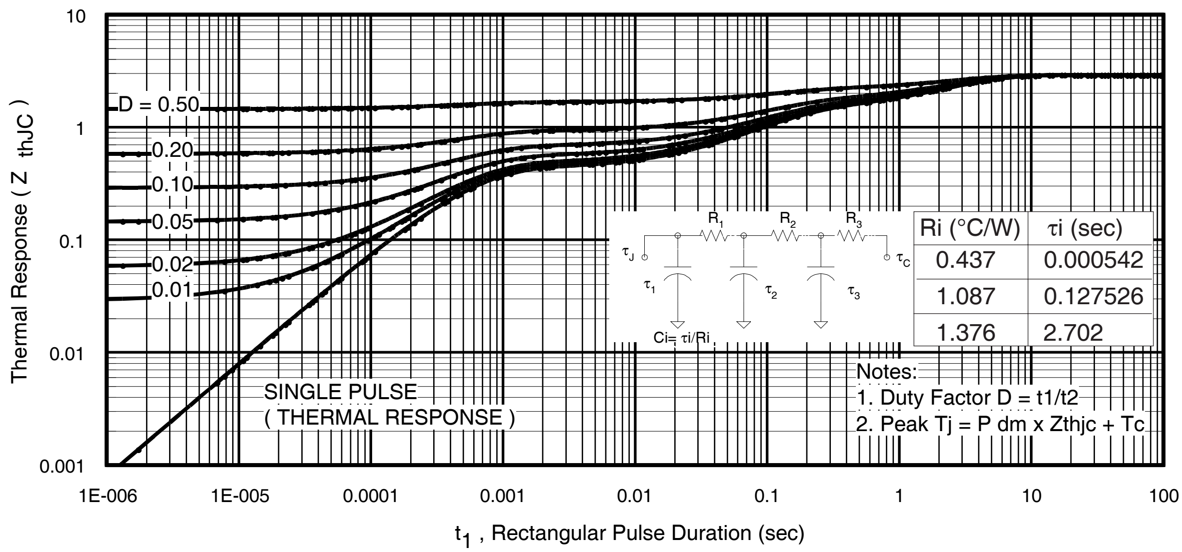


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

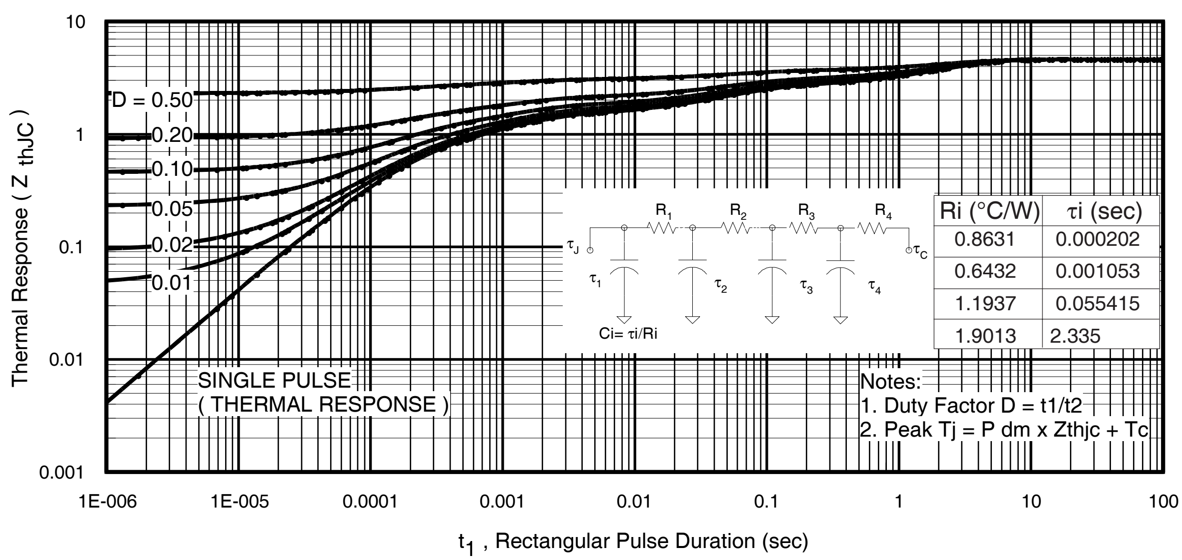


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

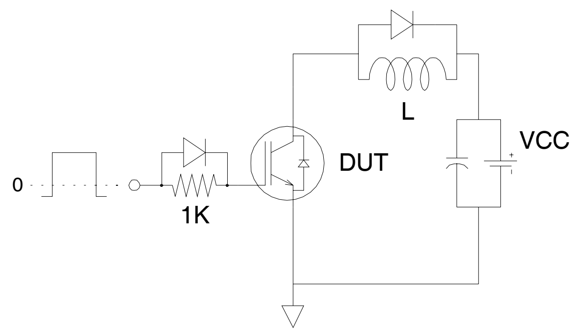


Fig.C.T.1 - Gate Charge Circuit (turn-off)

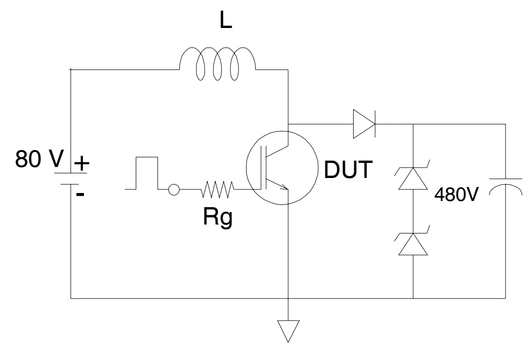


Fig.C.T.2 - RBSOA Circuit

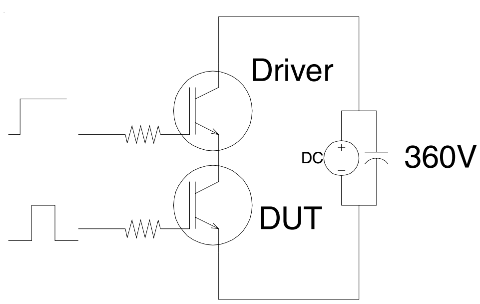


Fig.C.T.3 - S.C.SOA Circuit

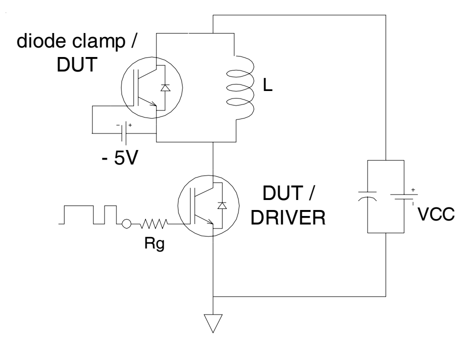


Fig.C.T.4 - Switching Loss Circuit

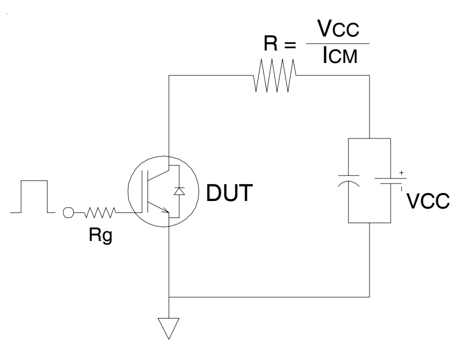


Fig.C.T.5 - Resistive Load Circuit

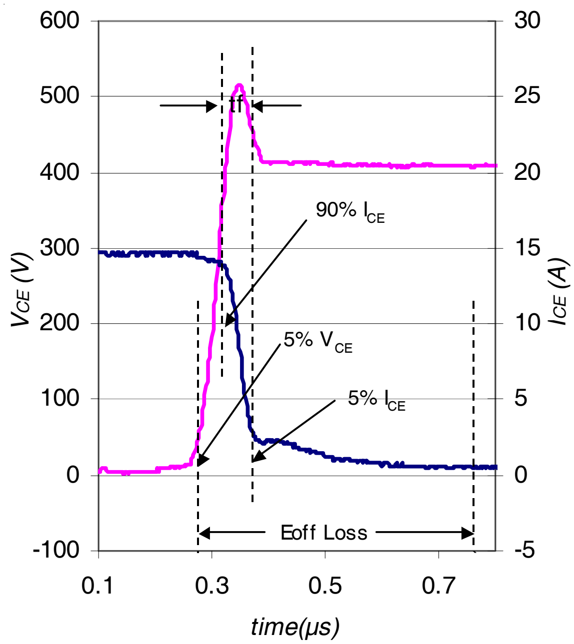


Fig. WF1- Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

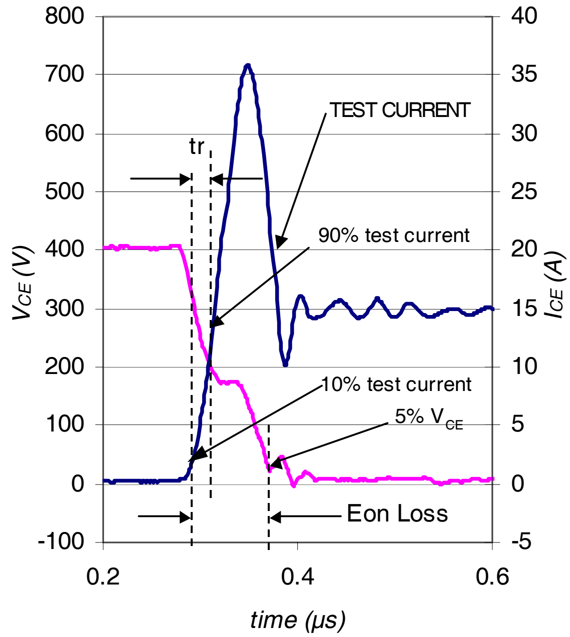


Fig. WF2- Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

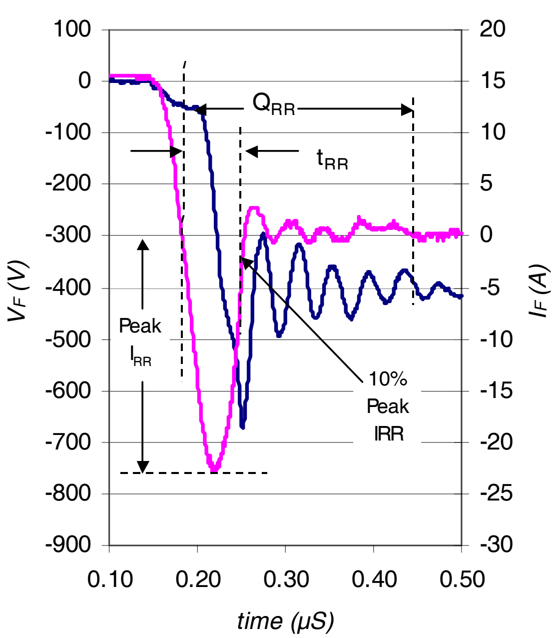


Fig. WF3- Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

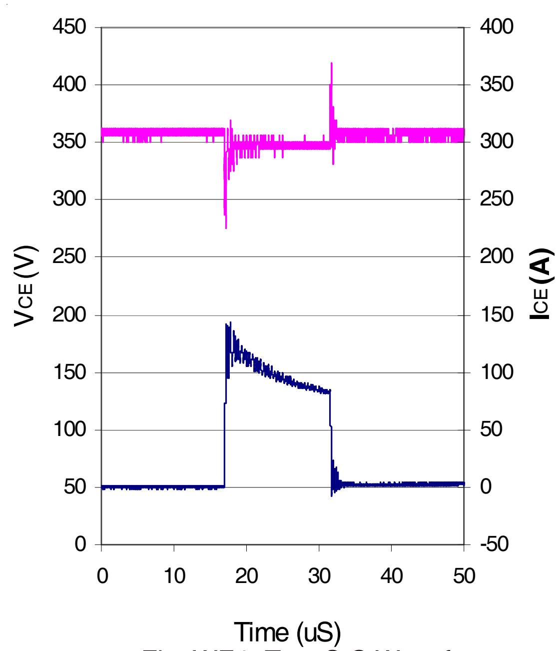
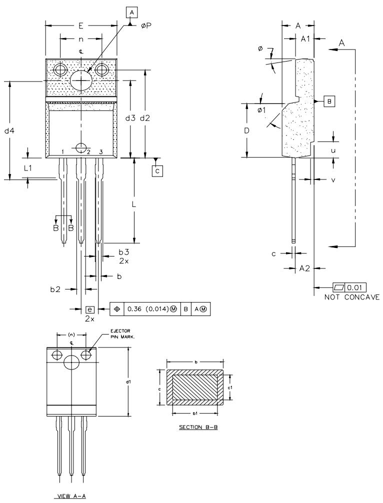


Fig. WF4- Typ. S.C Waveform
@ T_C = 150°C using Fig. CT.3

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

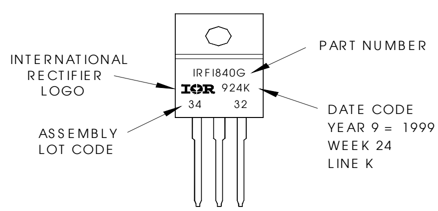
IGBTs, CoPACK

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

TO-220 Full-Pak Part Marking Information

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

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



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

Data and specifications subject to change without notice.
This product has been designed and qualified for the 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.12/03

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