IRG7IC20FDPbF

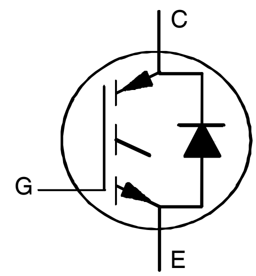
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

V_{CES} = 600V

I_C = 8.0A, T_C = 100°C

t_{sc} > 3µs, T_{jmax} = 150°C

$V_{CE(on)}$ typ. = 1.60V @ I_C = 12A



n-channel

TO-220AB
Full-Pak

G	C	E
Gate	Collector	Emitter

Applications

- Air Conditioner Compressor
- Refrigerator
- Vacuum Cleaner
- Low Frequency Inverter

Features →	Benefits
Low $V_{CE(on)}$	High efficient motor drive application
Zero $V_{CE(on)}$ temperature coefficient	Efficiency stable over temperature
Ultra Fast Soft Recovery Co-pak Diode	Optimized trade-off between low losses and EMI performance
Square RBSOA and 100% Clamp IL Tested	Rugged hard switching operation
3µs Short Circuit Capability	Enables short circuit protection scheme
Fully isolated Fullpak package	Easy heatsink assembly
Lead-Free, RoHS Compliant	Environmentally friendlier

Base part number	Package Type	Standard Pack		Orderable part number
		Form	Quantity	
IRG7IC20FDPbF	TO-220 FullPak	Tube	50	IRG7IC20FDPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	16	A
I_C @ T_C = 100°C	Continuous Collector Current	8.0	
I_{CM}	Pulse Collector Current, V_{GE} = 15V	48	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	48	
I_F @ T_C = 25°C	Diode Continous Forward Current	16	
I_F @ T_C = 100°C	Diode Continous Forward Current	8.0	
I_{FM}	Diode Maximum Forward Current ②	36	
V_{GE}	Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	33	W
P_D @ T_C = 100°C	Maximum Power Dissipation	13	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°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 Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT) ③	——	——	3.8	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ③	——	——	5.1	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	——	0.50	——	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	——	65	——	

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 = 500μA
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.54	—	V/°C	V_{GE} = 0V, I_C = 1.0mA (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.40	—	V	I_C = 6.0A, V_{GE} = 15V, T_J = 25°C ②
		—	1.60	1.85		I_C = 12A, V_{GE} = 15V, T_J = 25°C ②
		—	1.20	—		I_C = 6.0A, V_{GE} = 15V, T_J = 150°C ②
		—	1.60	—		I_C = 12A, V_{GE} = 15V, T_J = 150°C ②
$V_{GE(th)}$	Gate Threshold Voltage	4.5	—	7.0	V	V_{CE} = V_{GE}, I_C = 500μA
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-14	—	mV/°C	V_{CE} = V_{GE}, I_C = 500μA (25°C - 150°C)
gfe	Forward Transconductance	—	12	—	S	V_{CE} = 50V, I_C = 12A, PW = 20μs
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	25	μA	V_{GE} = 0V, V_{CE} = 600V
		—	430	—		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	1.50	1.80	V	I_F = 12A
		—	1.45	—		I_F = 12A, T_J = 150°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±30V

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

	Parameter	Min.	Typ.	Max.④	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	50	75	nC	I_C = 12A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	9.0	13.5		V_{GE} = 15V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	24	36		V_{CC} = 400V
E_{on}	Turn-On Switching Loss	—	431	650	μJ	I_C = 12A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	481	702		R_G = 47Ω, L = 585μH, T_J = 25°C
E_{total}	Total Switching Loss	—	912	1352		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	47	65	ns	
t_r	Rise time	—	36	53		
$t_{d(off)}$	Turn-Off delay time	—	248	272		
t_f	Fall time	—	117	137		
E_{on}	Turn-On Switching Loss	—	555	—	μJ	I_C = 12A, V_{CC} = 400V, V_{GE}=15V
E_{off}	Turn-Off Switching Loss	—	865	—		R_G= 47Ω, L= 585μH, T_J = 150°C
E_{total}	Total Switching Loss	—	1420	—		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	42	—	ns	
t_r	Rise time	—	35	—		
$t_{d(off)}$	Turn-Off delay time	—	284	—		
t_f	Fall time	—	294	—		
C_{ies}	Input Capacitance	—	1270	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	46	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	36	—		f = 1.0Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 48A V_{CC} = 480V, Vp ≤ 600V Rg = 47Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	3	—	—	μs	V_{GE} = 15V, V_{CC} = 400V, Vp ≤ 600V Rg = 47Ω, R_{shunt} = 22mΩ, T_C = 100°C
Erec	Reverse Recovery Energy of the Diode	—	87	—	μJ	T_J = 150°C
t_{rr}	Diode Reverse Recovery Time	—	94	—	ns	V_{CC} = 400V, I_F = 12A
I_{rr}	Peak Reverse Recovery Current	—	14	—	A	V_{GE} = 15V, Rg = 47Ω, L = 585μH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 585μH, R_G = 47Ω.
② Pulse width limited by max. junction temperature.
③ R_θ is measured at T_J of approximately 90°C.
④ Maximum limits are based on statistical sample size characterization.

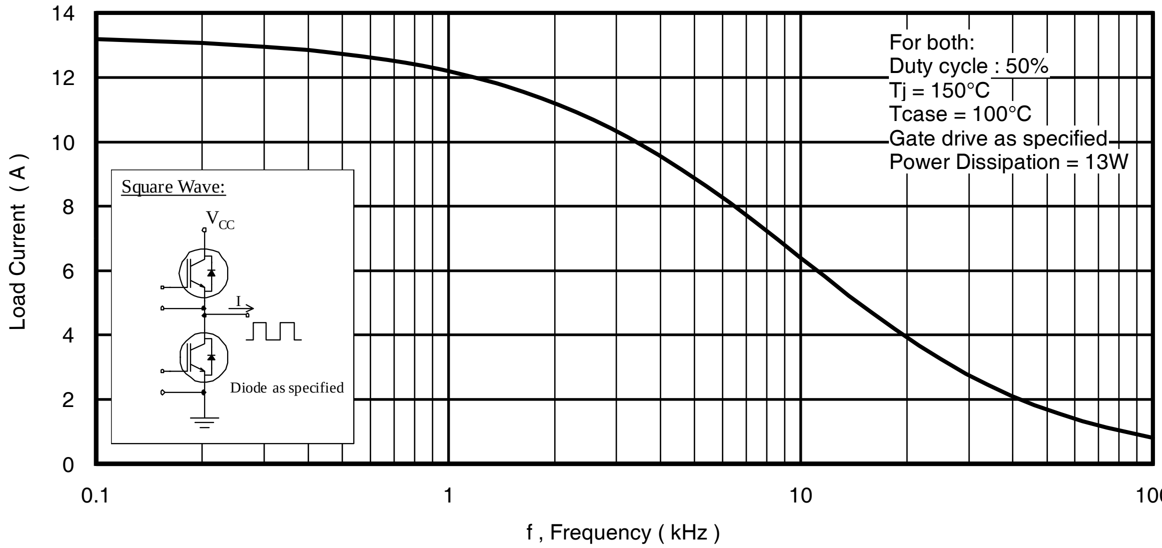


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

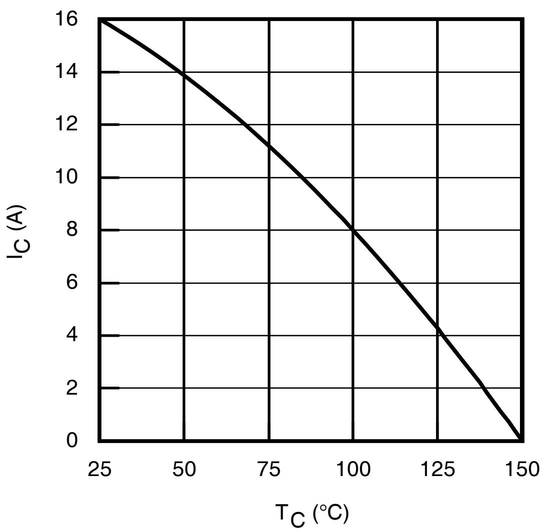


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

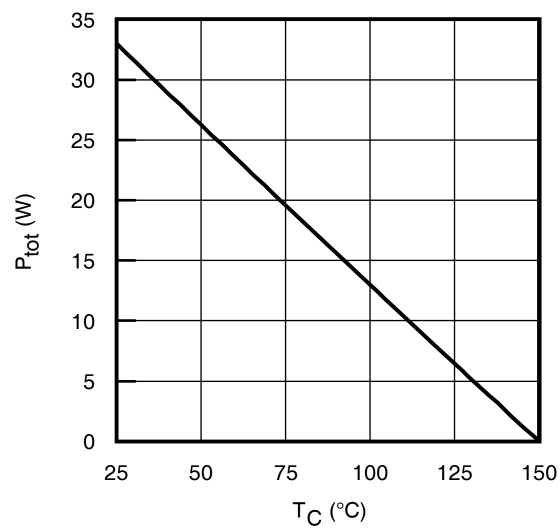


Fig. 3 - Power Dissipation vs. Case Temperature

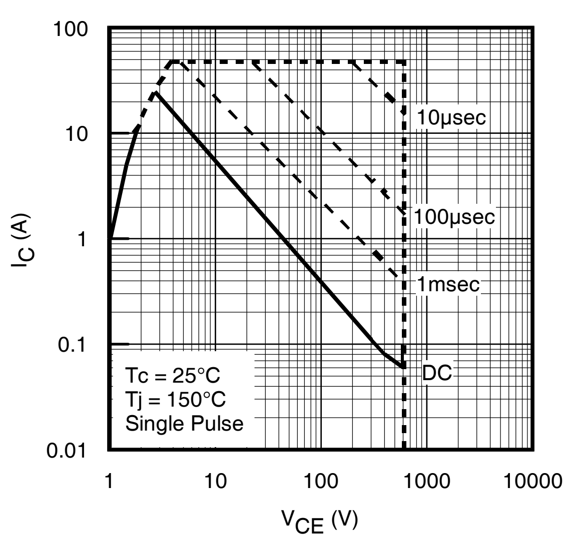


Fig. 4 - Forward SOA
T_C = 25°C, $T_J \leq$ 150°C, V_{GE} =15V

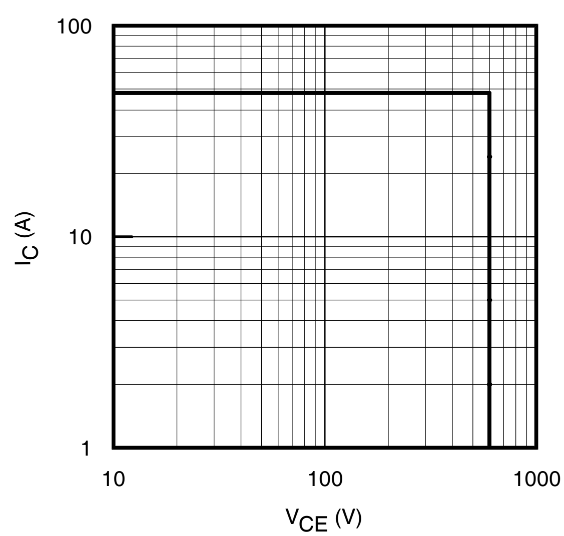


Fig. 5 - Reverse Bias SOA
T_J = 150°C, V_{GE} =20V

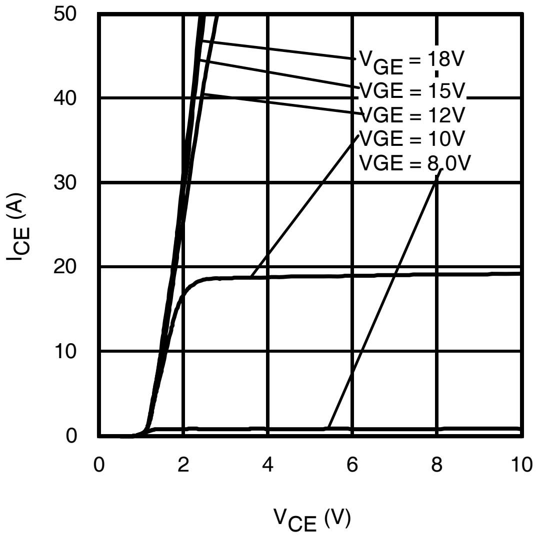


Fig. 6 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 20µs

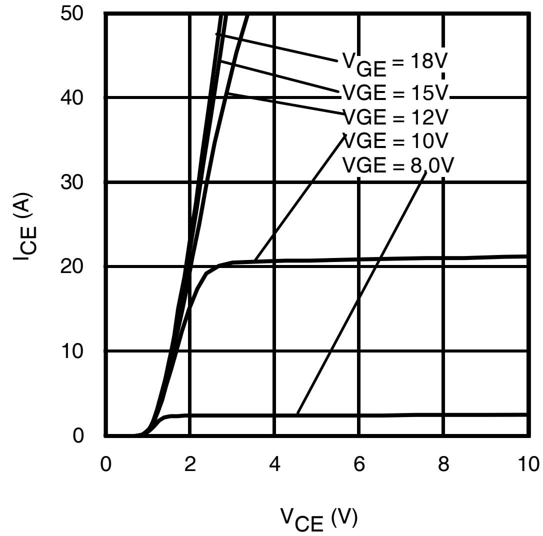


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 20µs

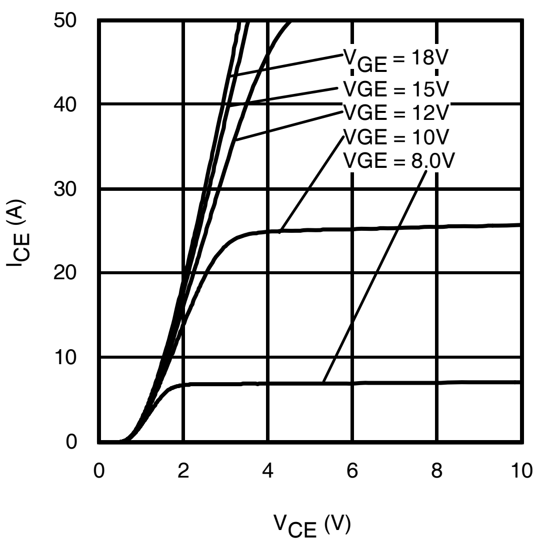


Fig. 8 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 20µs

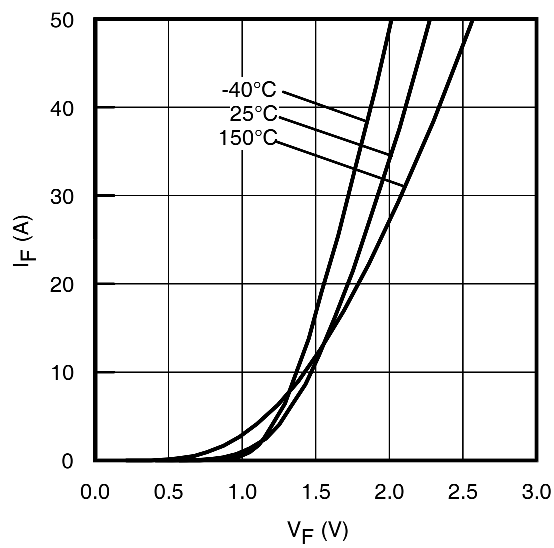


Fig. 9 - Typ. Diode Forward Characteristics
tp = 20µs

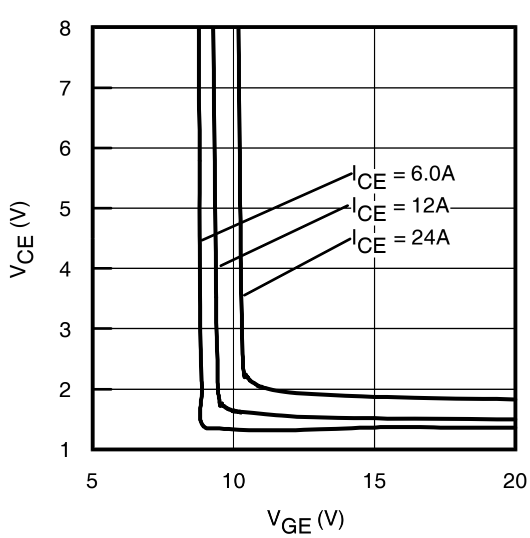


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

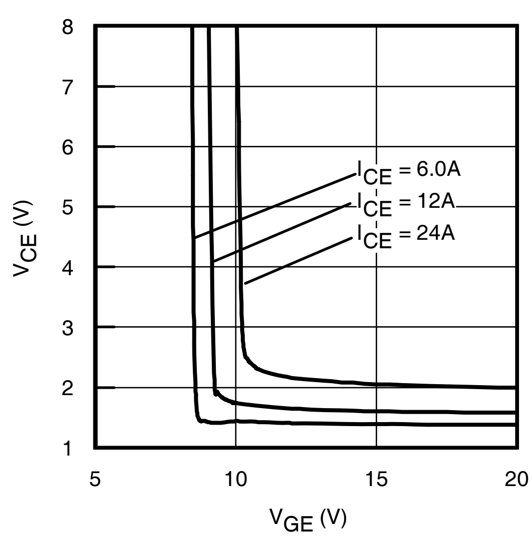


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

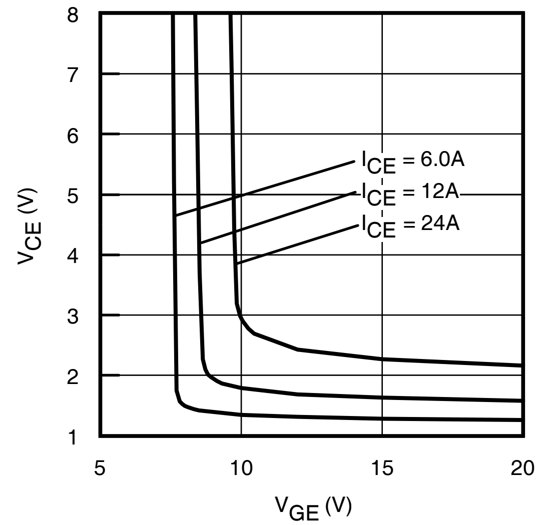


Fig. 12 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

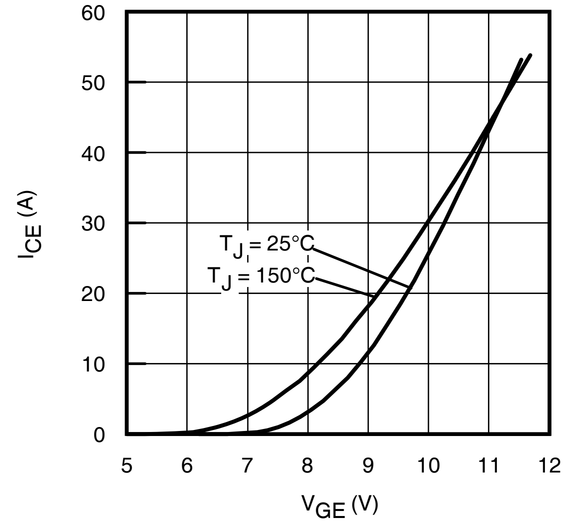


Fig. 13 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 20µs

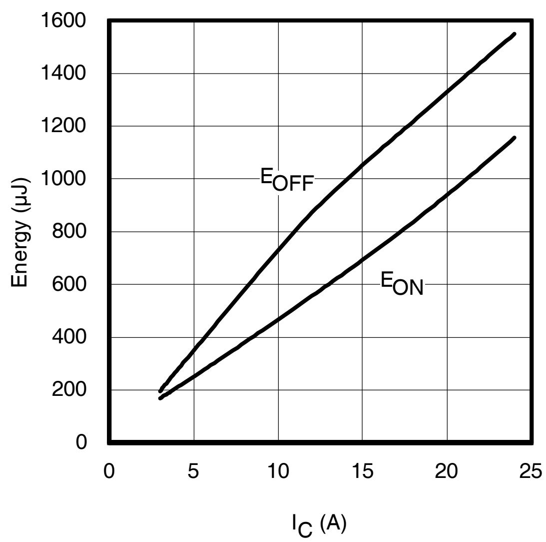


Fig. 14 - Typ. Energy Loss vs. I_C T_J = 150°C
L = 585µH; V_{CE} = 400V, R_G = 47Ω; V_{GE} = 15V

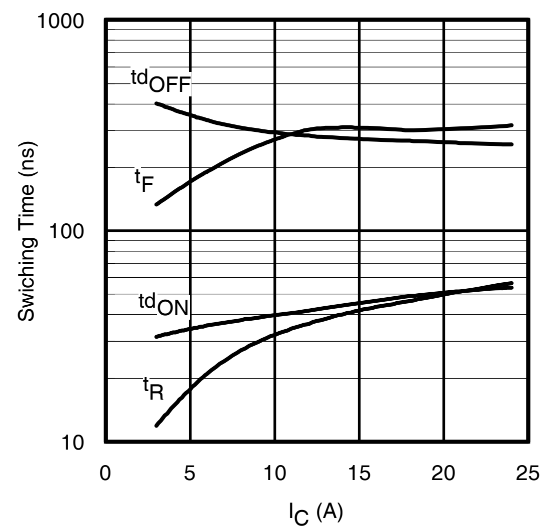


Fig. 15 - Typ. Switching Time vs. I_C T_J = 150°C
L = 585µH; V_{CE} = 400V, R_G = 47Ω; V_{GE} = 15V

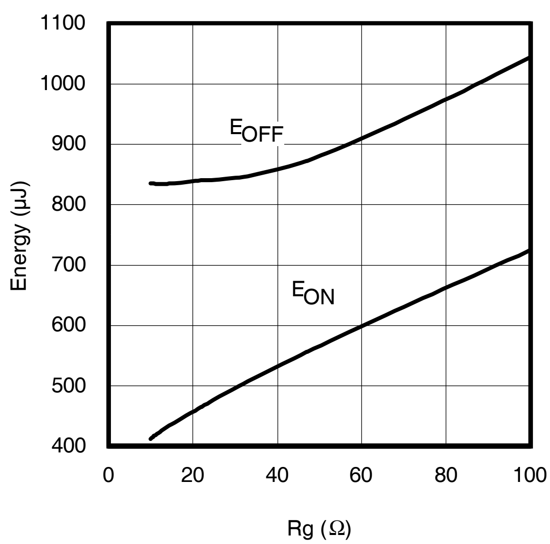


Fig. 16 - Typ. Energy Loss vs. R_G T_J = 150°C
L = 585µH; V_{CE} = 400V, I_{CE} = 12A; V_{GE} = 15V

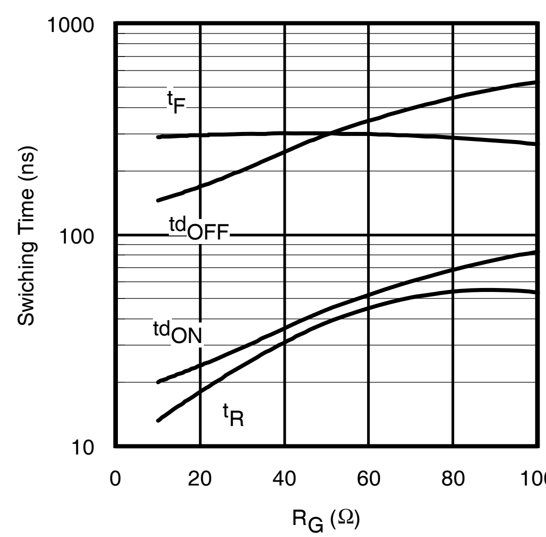


Fig. 17 - Typ. Switching Time vs. R_G T_J = 150°C
L = 585µH; V_{CE} = 400V, I_{CE} = 12A; V_{GE} = 15V

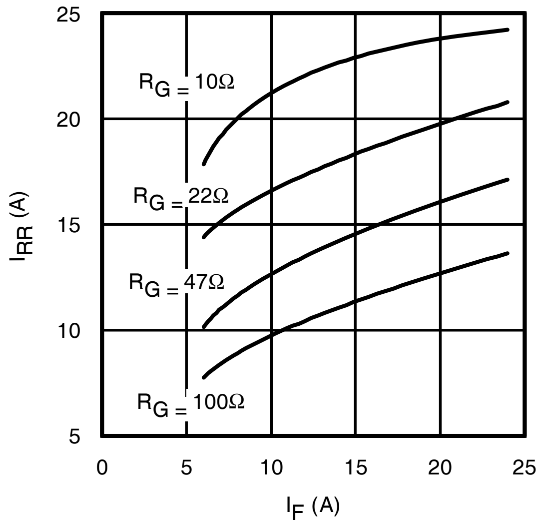


Fig. 18 - Typ. Diode I_{RR} vs. I_F
T_J = 150°C

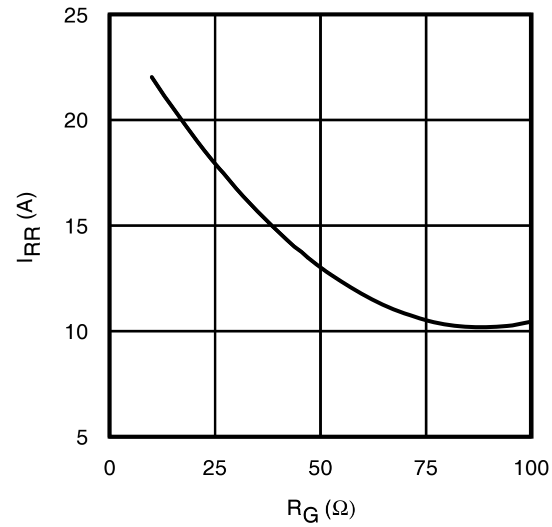


Fig. 19 - Typ. Diode I_{RR} vs. R_G
T_J = 150°C

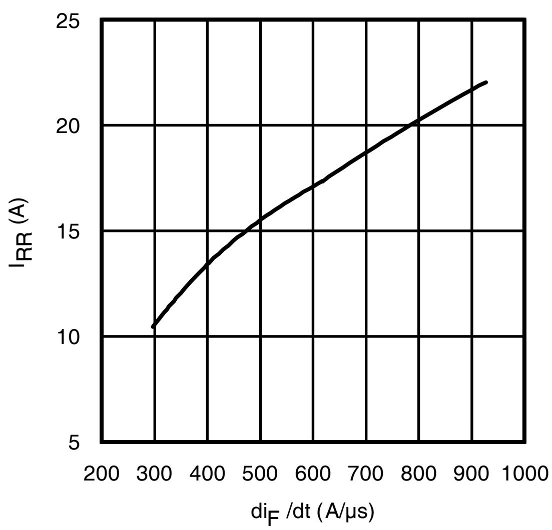


Fig. 20 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 12A; T_J = 150°C

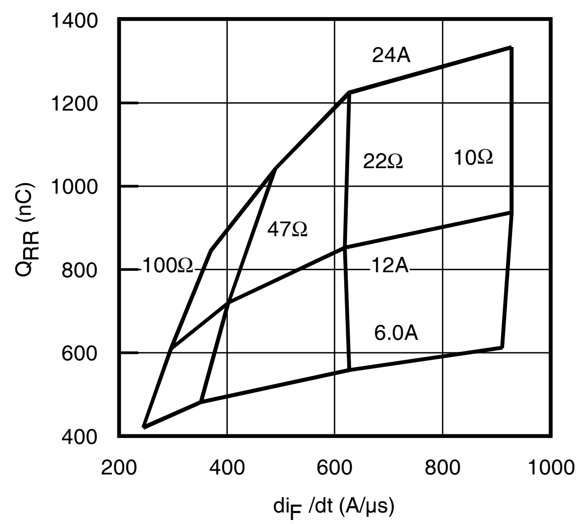


Fig. 21 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 150°C

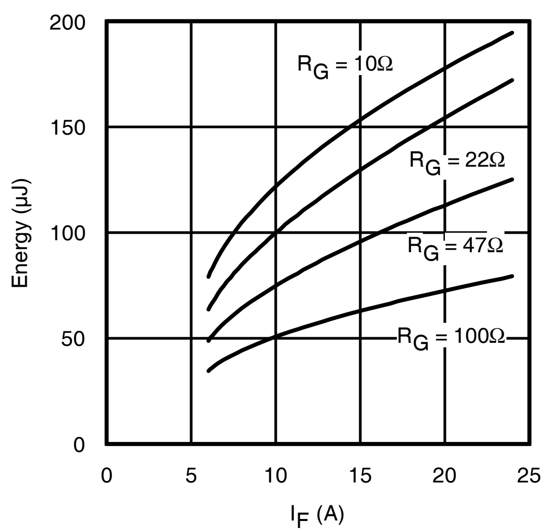


Fig. 22 - Typ. Diode E_{RR} vs. I_F
T_J = 150°C

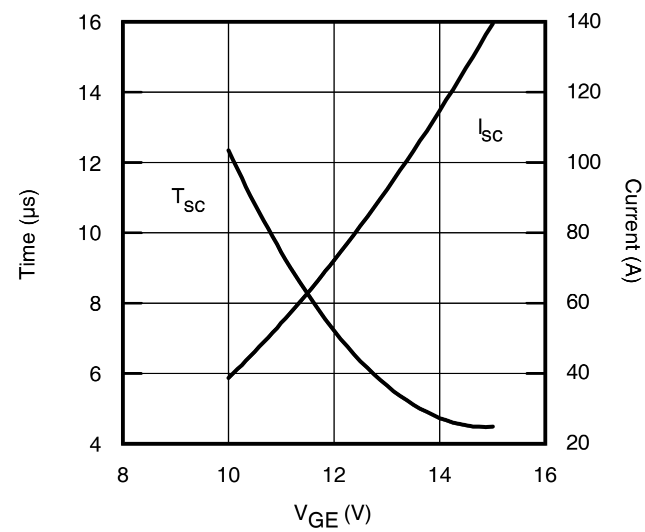


Fig. 23- Typ. V_{GE} vs. Short Circuit Time
V_{CC}=400V, T_C =25°C

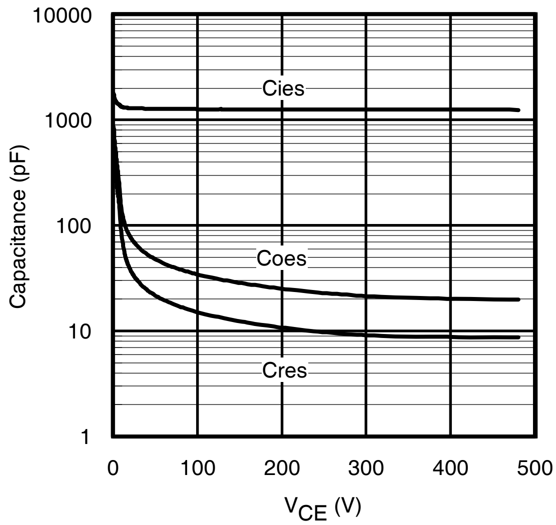


Fig. 24 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

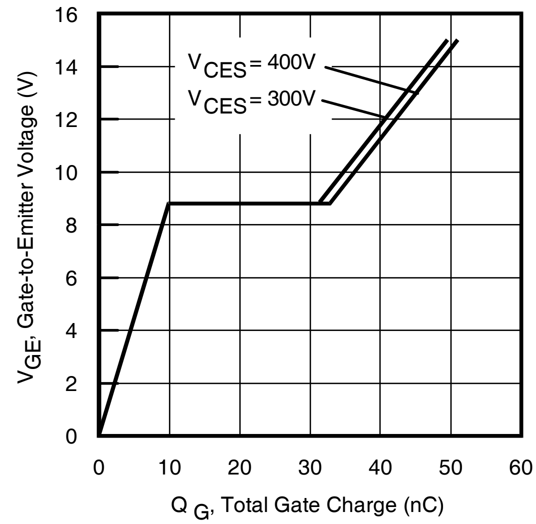
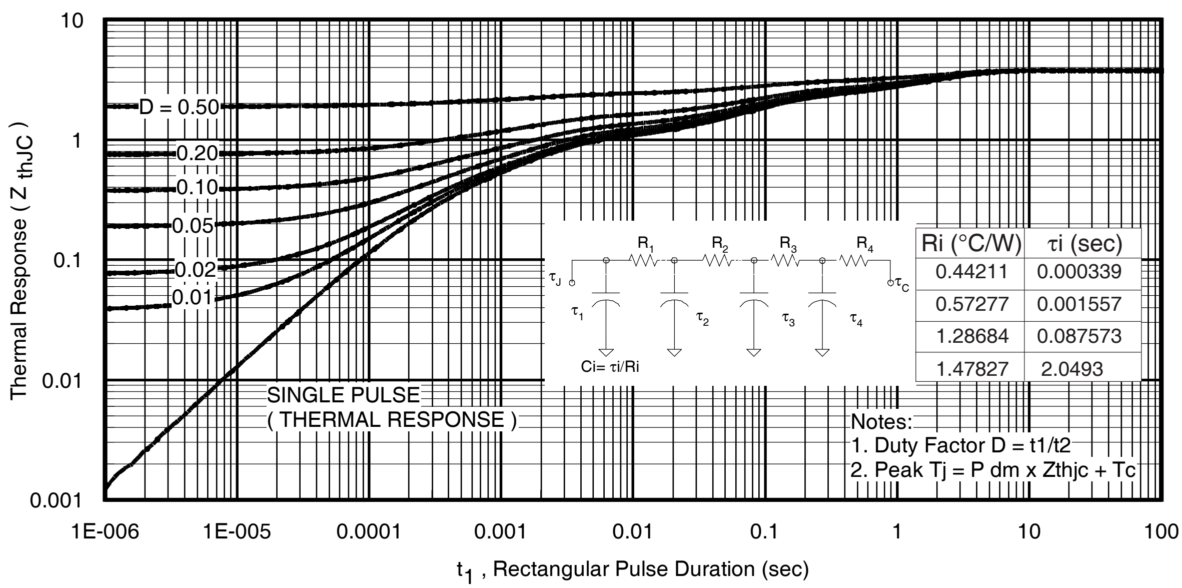
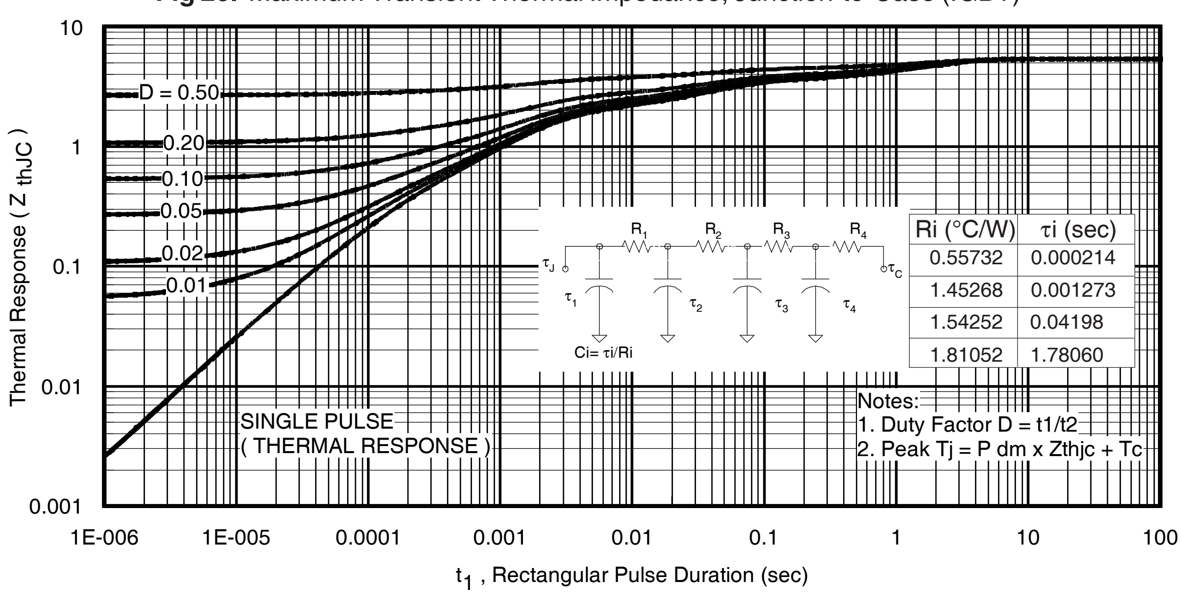


Fig. 25 - Typical Gate Charge vs. V_{GE}
I_{CE} = 12A



Ri (°C/W)	τi (sec)
0.44211	0.000339
0.57277	0.001557
1.28684	0.087573
1.47827	2.0493

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



Ri (°C/W)	τi (sec)
0.55732	0.000214
1.45268	0.001273
1.54252	0.04198
1.81052	1.78060

Fig. 27. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

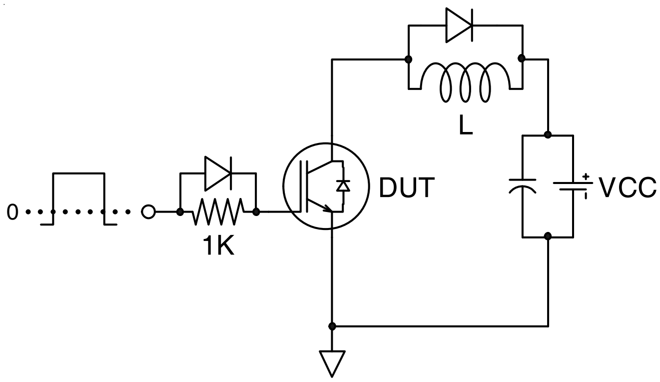


Fig.C.T.1 - Gate Charge Circuit (turn-off)

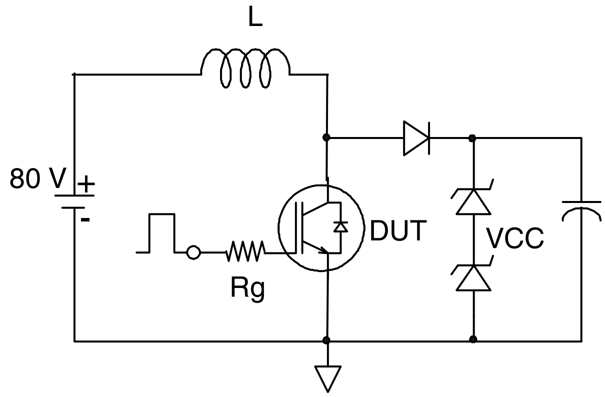


Fig.C.T.2 - RBSOA Circuit

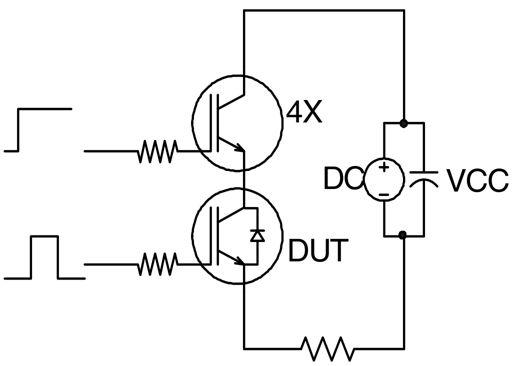


Fig.C.T.3 - S.C. SOA Circuit

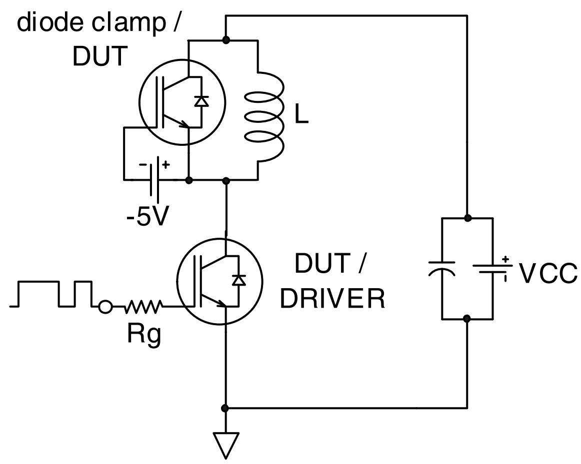


Fig.C.T.4 - Switching Loss Circuit

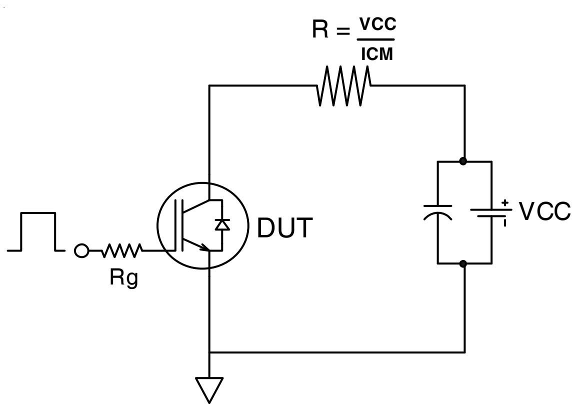


Fig.C.T.5 - Resistive Load Circuit

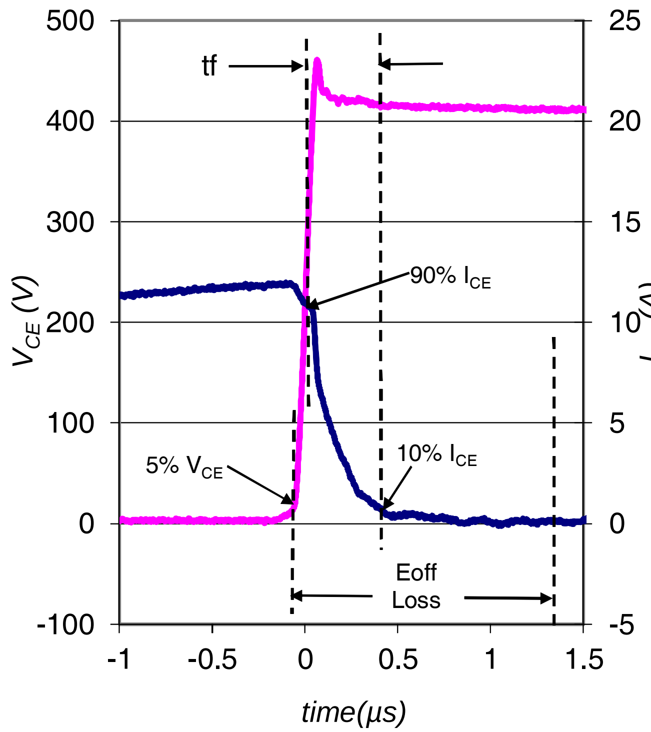


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

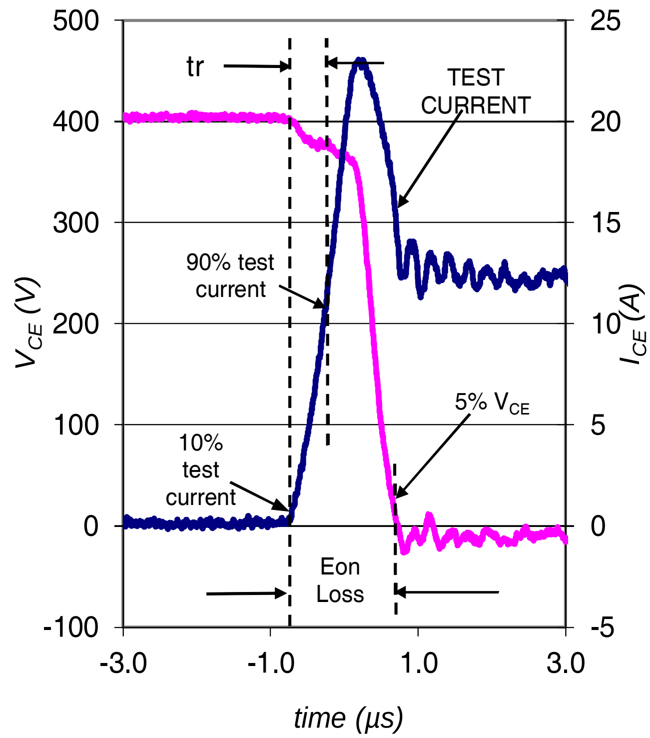


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

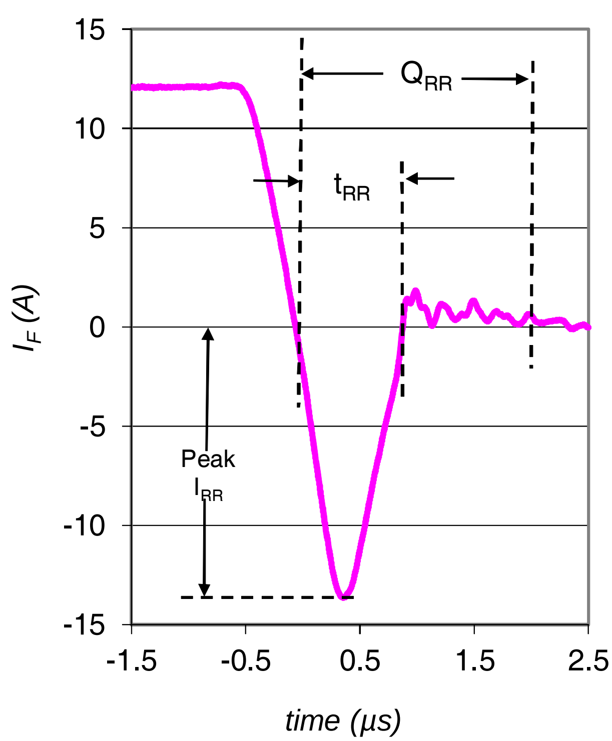


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

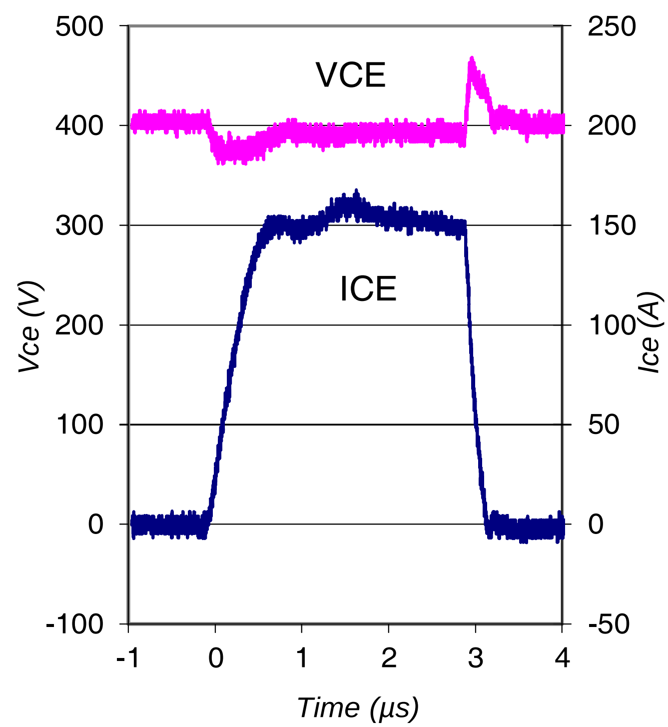
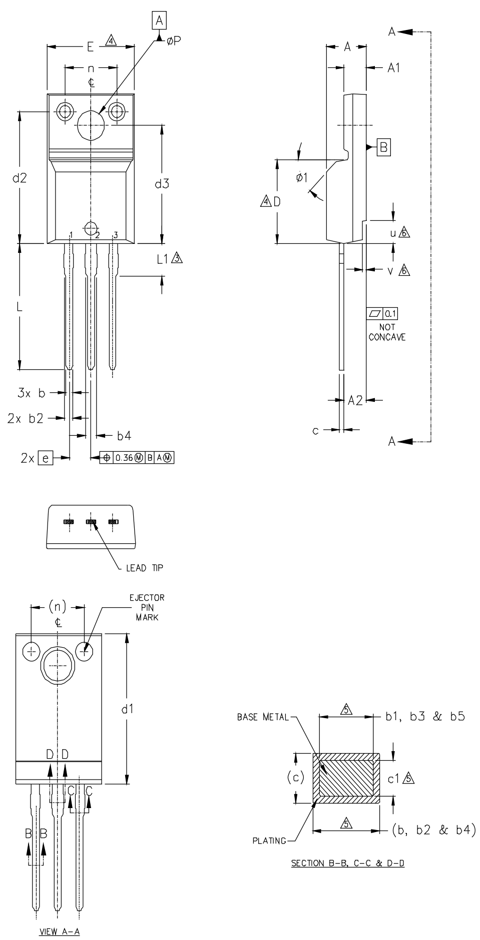


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 25°C using Fig. CT.3

TO-220AB Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	.180	.190	
A1	2.57	2.83	.101	.111	
A2	2.51	2.93	.099	.115	
b	0.61	0.94	.024	.037	
b1	0.61	0.89	.024	.035	5
b2	0.76	1.27	.030	.050	
b3	0.76	1.22	.030	.048	5
b4	1.02	1.52	.040	.060	
b5	1.02	1.47	.040	.058	5
c	0.33	0.63	.013	.025	
c1	0.33	0.58	.013	.023	5
D	8.66	9.80	.341	.386	4
d1	15.80	16.13	.622	.635	
d2	13.97	14.22	.550	.560	
d3	12.30	12.93	.484	.509	
E	9.63	10.75	.379	.423	4
e	2.54 BSC		.100 BSC		
L	13.20	13.72	.520	.540	
L1	3.37	3.67	.122	.145	3
n	6.05	6.60	.238	.260	
ØP	3.05	3.45	.120	.136	
u	2.40	2.50	.094	.098	6
v	0.40	0.50	.016	.020	6
Ø1	–	45°	–	45°	

NOTES:

1.0 DIMENSIONING AND TOLERANCING AS 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 .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTER MOST EXTREMES OF THE PLASTIC BODY.

5.0 DIMENSION b1, b3, b5 & c1 APPLY TO BASE METAL ONLY.

6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.

7.0 CONTROLLING DIMENSION : INCHES.

LEAD ASSIGNMENTS

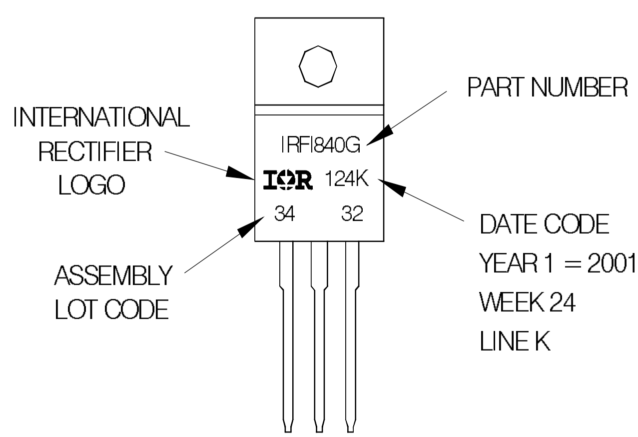
HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

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

TO-220AB 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-220AB 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/

Qualification Information†

Qualification Level	Industrial (per JEDEC JESD47F guidelines)††	
	Comments: This part number(s) passed Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level.	
Moisture Sensitivity Level	TO220 Fullpak	Not Applicable
RoHS Compliant	Yes	

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability

†† Applicable version of JEDEC standard at the time of product release.

Data and specifications subject to change without notice.

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