THE DATASHEET OF

IRGI4056DPBF

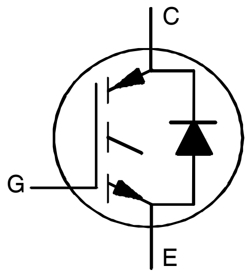
International IOR Rectifier

IRGI4056DPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

- Low $V_{CE\ (ON)}$ trench IGBT technology
- Low switching losses
- 5 µS short circuit SOA
- Square RBSOA
- 100% of the parts tested for I_{LM} ①
- Positive $V_{CE\ (ON)}$ temperature co-efficient
- Ultra fast soft recovery co-pak diode
- Tight parameter distribution
- Lead-Free package



n-channel

V_{CES} = 600V

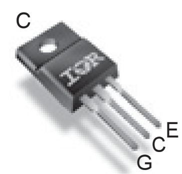
I_C = 9.0A, T_C = 100°C

$t_{SC} \geq$ 5µs, $T_{J(max)}$ = 150°C

$V_{CE(on)}$ typ. = 1.44V

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-220
Full-Pak

G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	18	A
I_C @ T_C = 100°C	Continuous Collector Current	9.0	
I_{CM}	Pulse Collector Current, V_{GE} = 15V	27	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	36	
I_F @ T_C = 25°C	Diode Continous Forward Current	18	
I_F @ T_C = 100°C	Diode Continous Forward Current	9.0	
I_{FM}	Diode Maximum Forward Current ②	36	
V_{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P_D @ T_C = 25°C	Maximum Power Dissipation	34	W
P_D @ T_C = 100°C	Maximum Power Dissipation	14	
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)	—	—	3.7	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	6.6	
$R_{\theta CS}$	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	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 100µA ③	CT6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.66	—	V/°C	V_{GE} = 0V, I_C = 1.0mA (-55°C-150°C)	CT6
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.44	1.65	V	I_C = 9.0A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	1.69	—		I_C = 9.0A, V_{GE} = 15V, T_J = 125°C	9,10,11
		—	1.72	—		I_C = 9..0A, V_{GE} = 15V, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 350µA	9, 10,
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA (-55°C - 150°C)	11, 12
gfe	Forward Transconductance	—	7.1	—	S	V_{CE} = 50V, I_C = 9.0A	
I_{CES}	Collector-to-Emitter Leakage Current	—	—	20	µA	V_{GE} = 0V, V_{CE} = 600V	
		—	60	—		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.3	3.0	V	I_F = 9.0A	8
		—	1.7	—		I_F = 9.0A, T_J = 150°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q_g	Total Gate Charge (turn-on)	—	25	38	nC	I_C = 9.0A	24
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	6.6	9.9		V_{GE} = 15V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	9.5	14		V_{CC} = 400V	
E_{on}	Turn-On Switching Loss	—	59	143	µJ	I_C = 9.0A, V_{CC} = 400V, V_{GE} = 15V	CT4
E_{off}	Turn-Off Switching Loss	—	177	264		R_G = 22Ω, L = 1.0mH, T_J = 25°C	
E_{total}	Total Switching Loss	—	236	407		Energy losses include tail & diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	34	52	ns	I_C = 9.0A, V_{CC} = 400V, V_{GE} = 15V	CT4
t_r	Rise time	—	12	29		R_G = 22Ω, L = 1.0mH, T_J = 25°C	
$t_{d(off)}$	Turn-Off delay time	—	84	103			
t_f	Fall time	—	24	42			
E_{on}	Turn-On Switching Loss	—	131	—	µJ	I_C = 9.0A, V_{CC} = 400V, V_{GE}=15V	13, 15
E_{off}	Turn-Off Switching Loss	—	276	—		R_G=22Ω, L=1.0mH, T_J = 150°C ③	CT4
E_{total}	Total Switching Loss	—	407	—		Energy losses include tail & diode reverse recovery	WF1, WF2
$t_{d(on)}$	Turn-On delay time	—	31	—	ns	I_C = 9.0A, V_{CC} = 400V, V_{GE} = 15V	14, 16
t_r	Rise time	—	15	—		R_G = 22Ω, L = 1.0mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	104	—		T_J = 150°C	WF1
t_f	Fall time	—	86	—			WF2
C_{ies}	Input Capacitance	—	769	—	pF	V_{GE} = 0V	23
C_{oes}	Output Capacitance	—	59	—		V_{CC} = 30V	
C_{res}	Reverse Transfer Capacitance	—	21	—		f = 1.0Mhz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 36A V_{CC} = 480V, Vp =600V Rg = 22Ω, V_{GE} = +20V to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	µs	V_{CC} = 400V, Vp =600V Rg = 75Ω, V_{GE} = +15V to 0V	22, CT3 WF4
Erec	Reverse Recovery Energy of the Diode	—	176	—	µJ	T_J = 150°C	17, 18, 19
t_{rr}	Diode Reverse Recovery Time	—	72	—	ns	V_{CC} = 400V, I_F = 9.0A	20, 21
I_{rr}	Peak Reverse Recovery Current	—	19	—	A	V_{GE} = 15V, Rg = 22Ω, L = 1.0mH	WF3

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 80µH, R_G = 22Ω.
② Pulse width limited by max. junction temperature.
③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

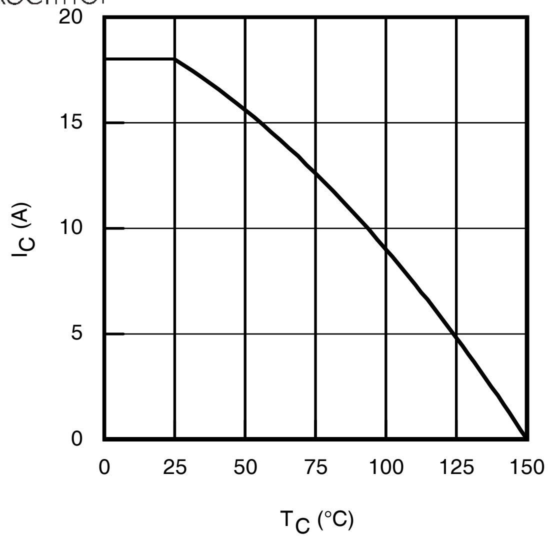


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

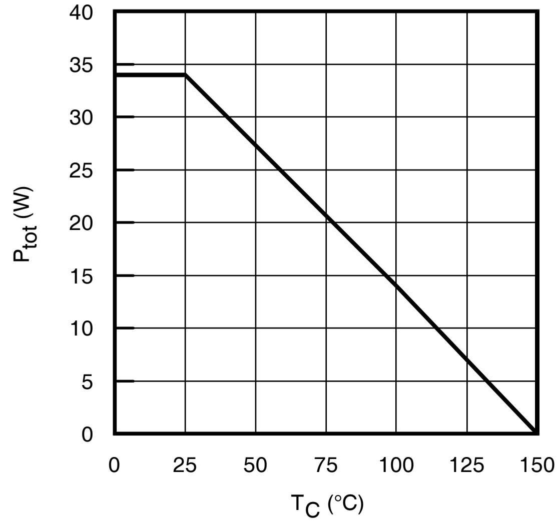


Fig. 2 - Power Dissipation vs. Case Temperature

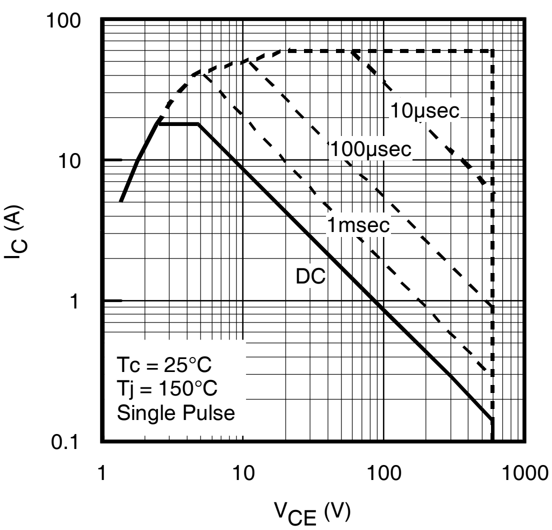


Fig. 3 - Forward SOA
$T_C = 25°C$, $T_J \leq 150°C$; $V_{GE} = 15V$

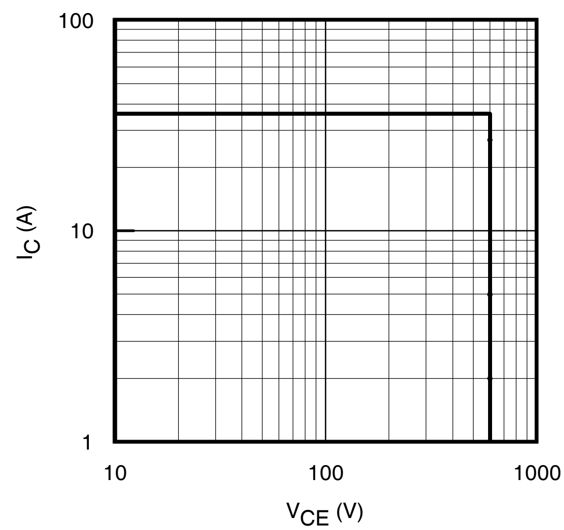


Fig. 4 - Reverse Bias SOA
$T_J = 150°C$; $V_{GE} = 20V$

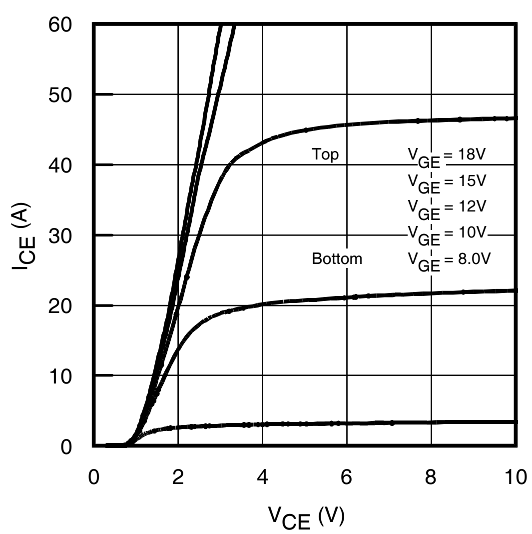


Fig. 5 - Typ. IGBT Output Characteristics
$T_J = -40°C$; tp = 80µs

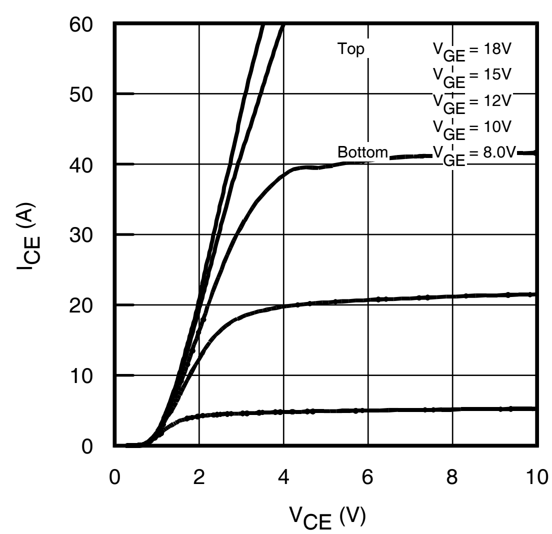


Fig. 6 - Typ. IGBT Output Characteristics
$T_J = 25°C$; tp = 80µs

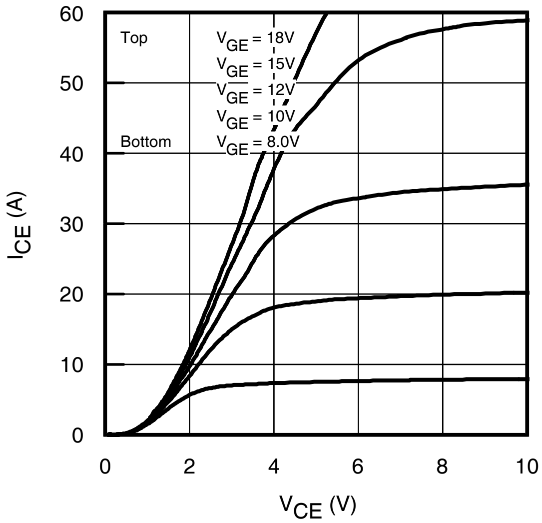


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

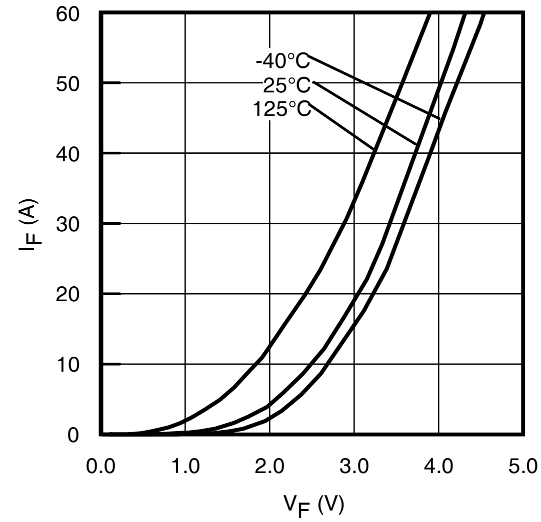


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

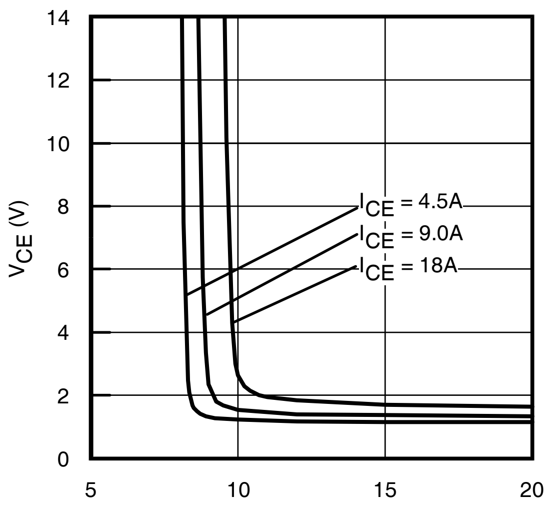


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

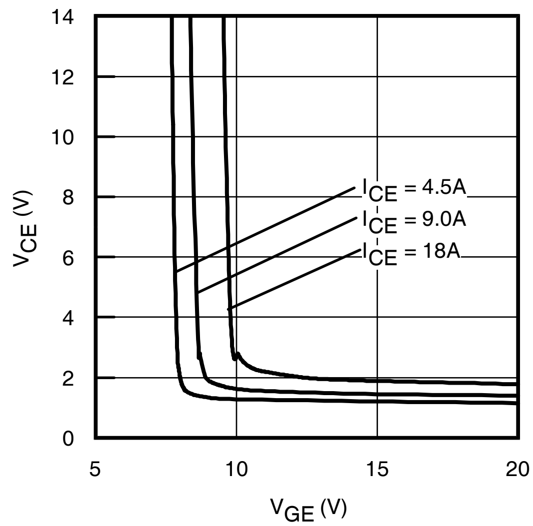


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

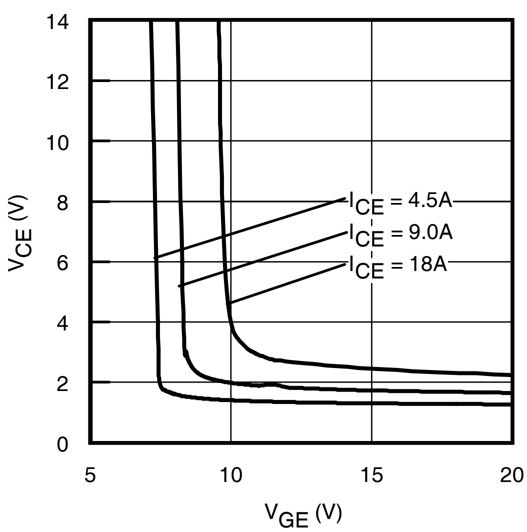


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

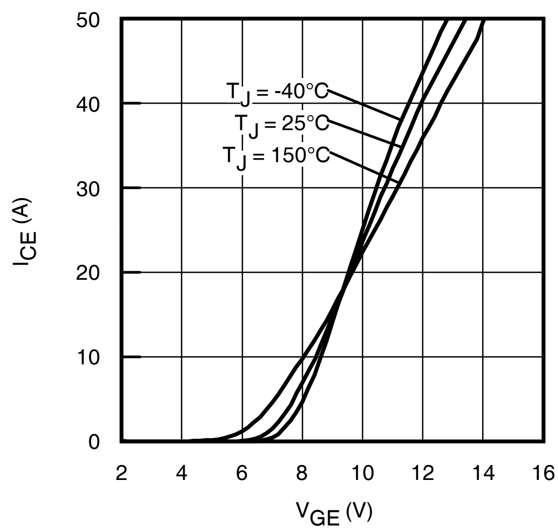


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

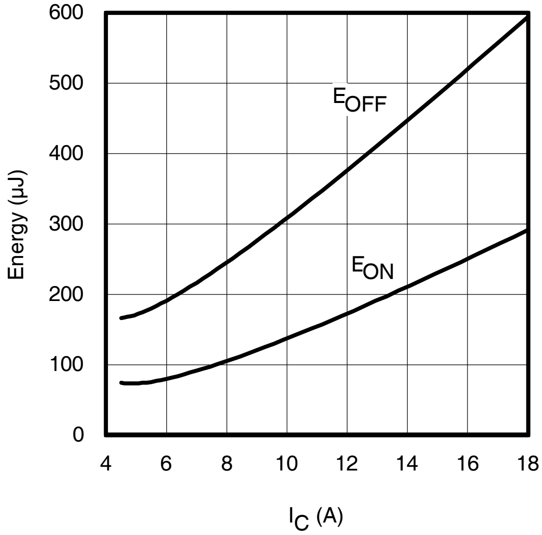


Fig. 13 - Typ. Energy Loss vs. I_C
$T_J = 150°C$; L = 1.0mH; $V_{CE} = 400V$, $R_G = 22\Omega$; $V_{GE} = 15V$

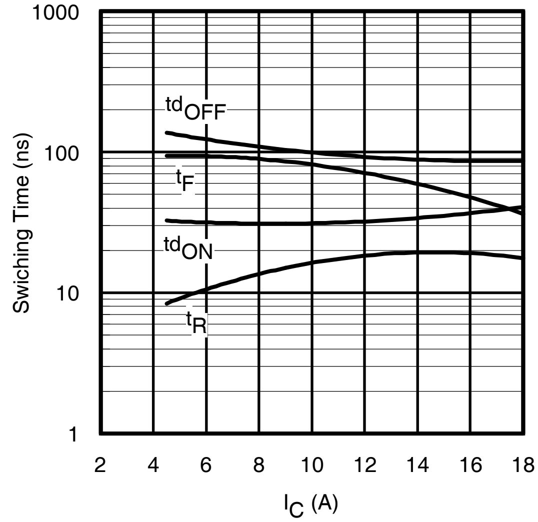


Fig. 14 - Typ. Switching Time vs. I_C
$T_J = 150°C$; L = 1.0mH; $V_{CE} = 400V$, $R_G = 22\Omega$; $V_{GE} = 15V$

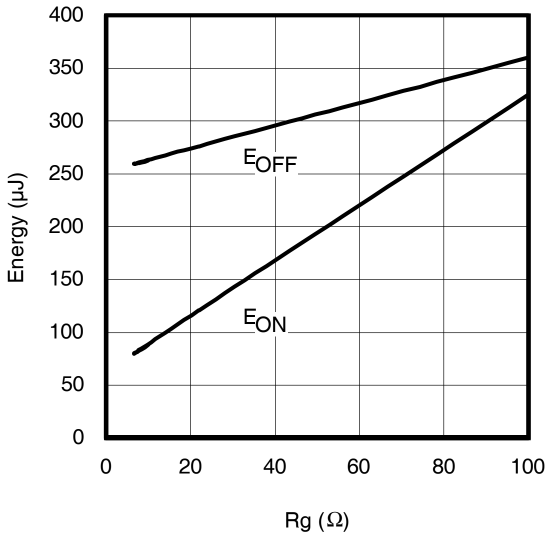


Fig. 15 - Typ. Energy Loss vs. R_G
$T_J = 150°C$; L = 1.0mH; $V_{CE} = 400V$, $I_{CE} = 9.0A$; $V_{GE} = 15V$

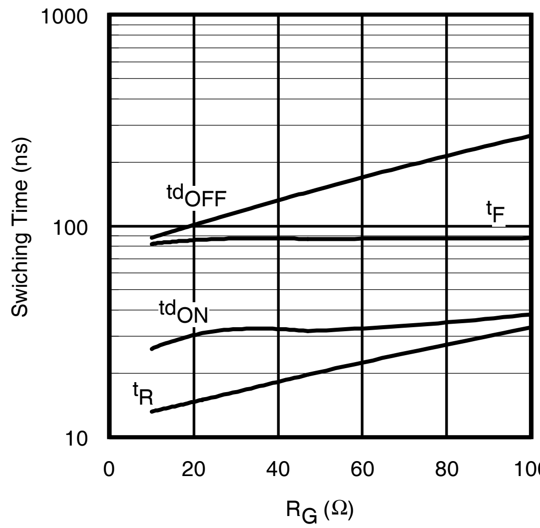


Fig. 16 - Typ. Switching Time vs. R_G
$T_J = 150°C$; L = 1.0mH; $V_{CE} = 400V$, $I_{CE} = 9.0A$; $V_{GE} = 15V$

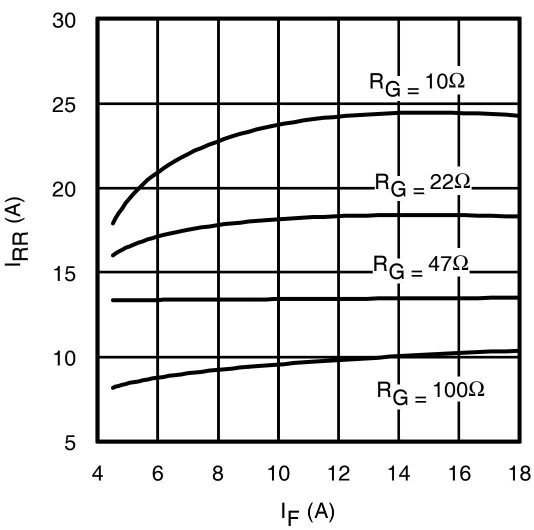


Fig. 17 - Typ. Diode I_{RR} vs. I_F
$T_J = 150°C$

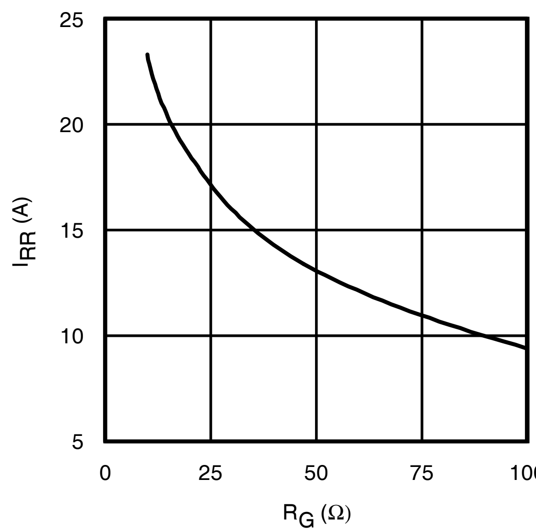


Fig. 18 - Typ. Diode I_{RR} vs. R_G
$T_J = 150°C$

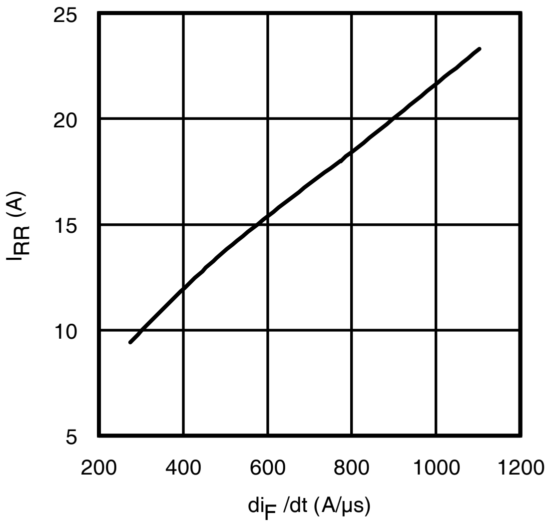


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; I_F = 9.0A; T_J = 150°C

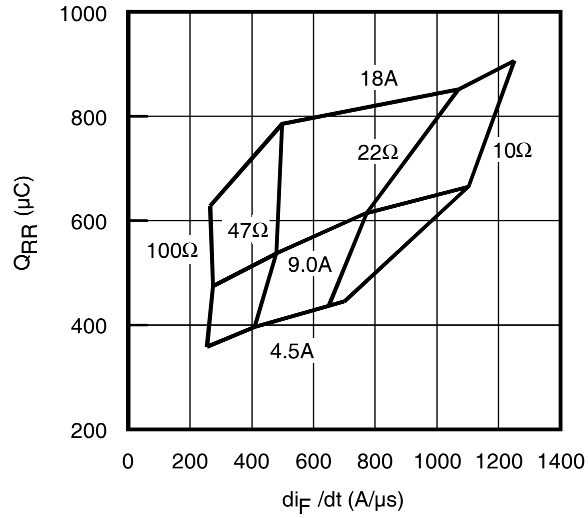


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 400V; V_{GE} = 15V; T_J = 150°C

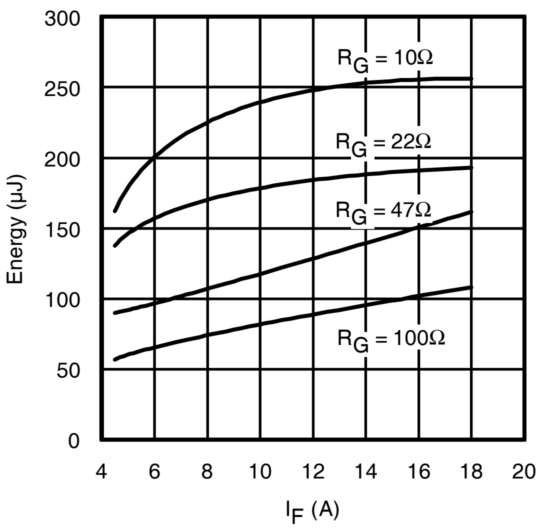


Fig. 21 - Typ. Diode E_{RR} vs. I_F
T_J = 150°C

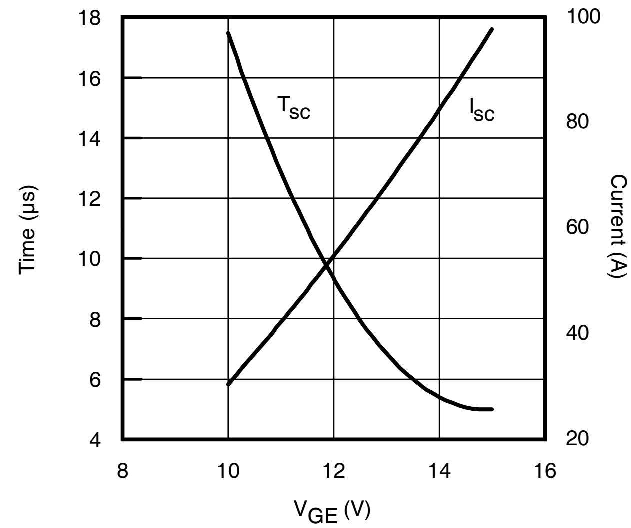


Fig. 22 - V_{GE} vs. Short Circuit Time
V_{CC} = 400V; T_C = 25°C

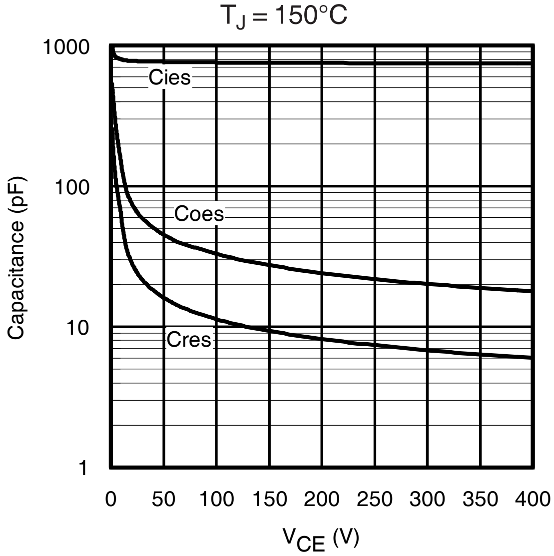


Fig. 23 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

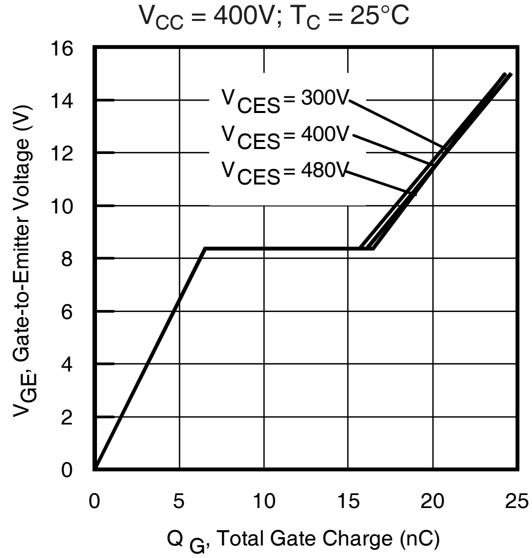


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 9.0A; L = 1.0mH

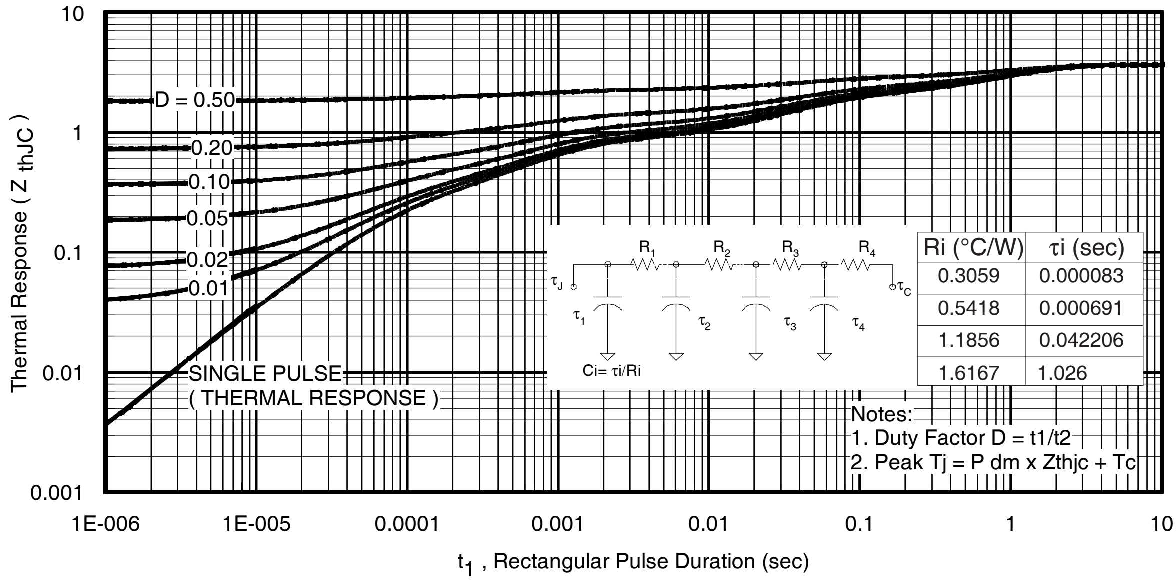


Fig 23. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

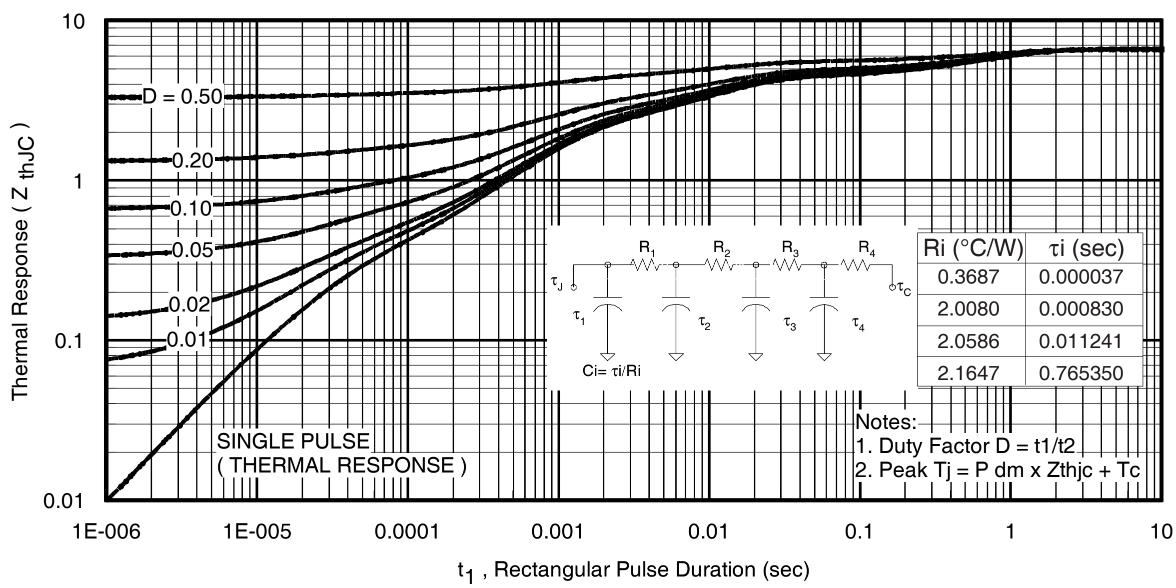


Fig. 24. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

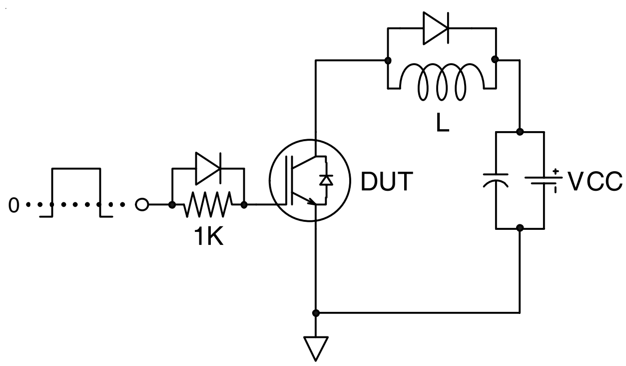


Fig.C.T.1 - Gate Charge Circuit (turn-off)

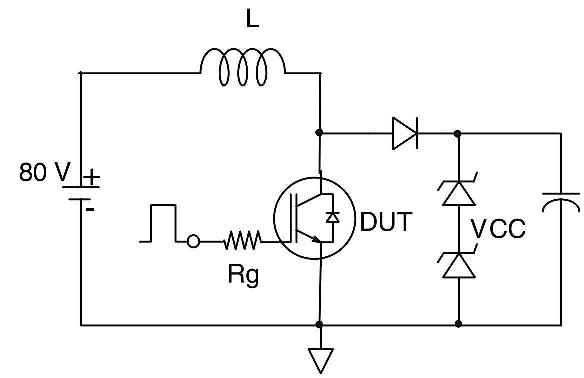


Fig.C.T.2 - RBSOA Circuit

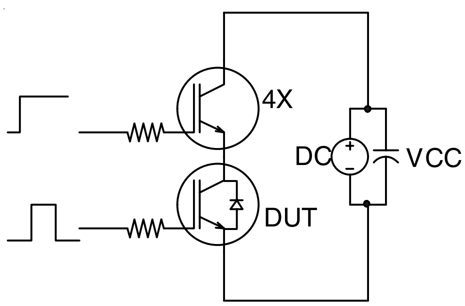


Fig.C.T.3 - S.C. SOA Circuit

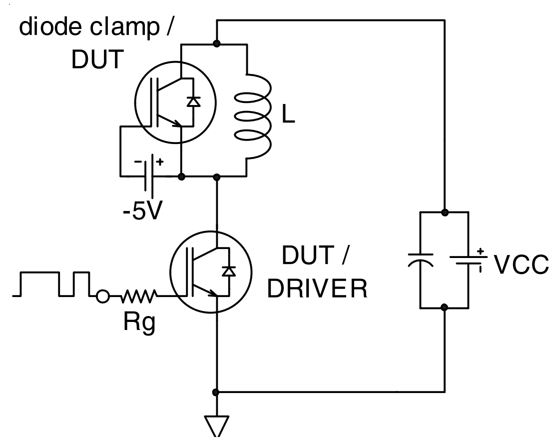


Fig.C.T.4 - Switching Loss Circuit

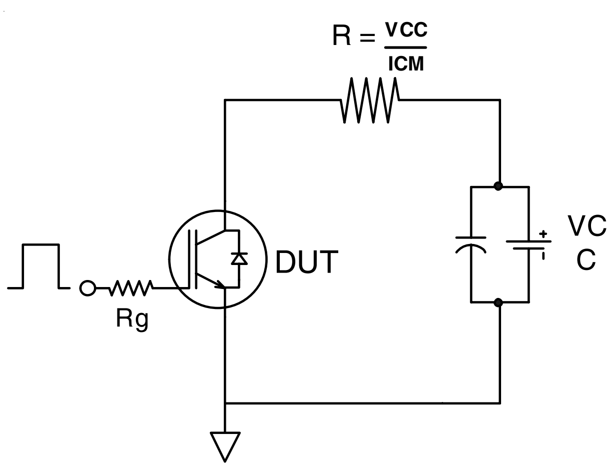


Fig.C.T.5 - Resistive Load Circuit

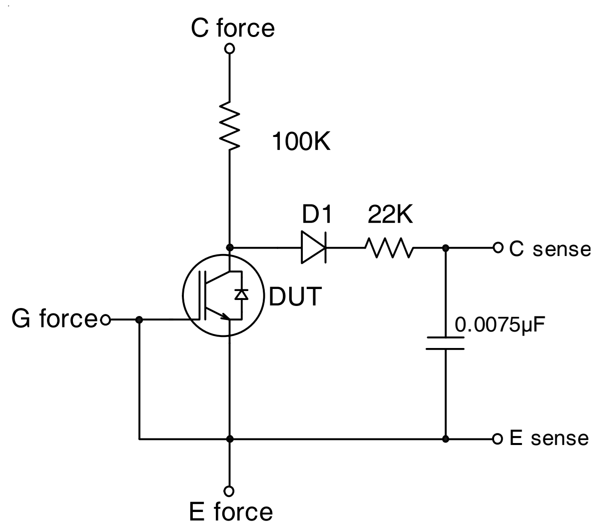


Fig.C.T.6 - BVCES Filter Circuit

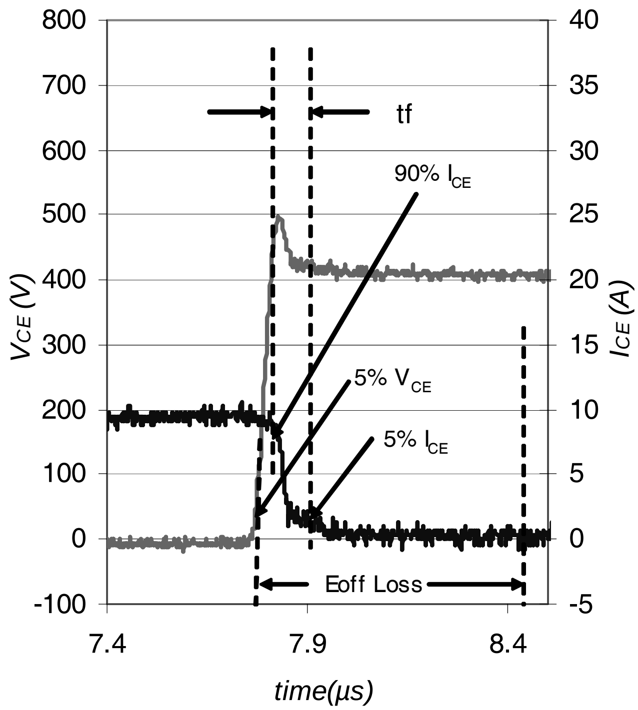


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

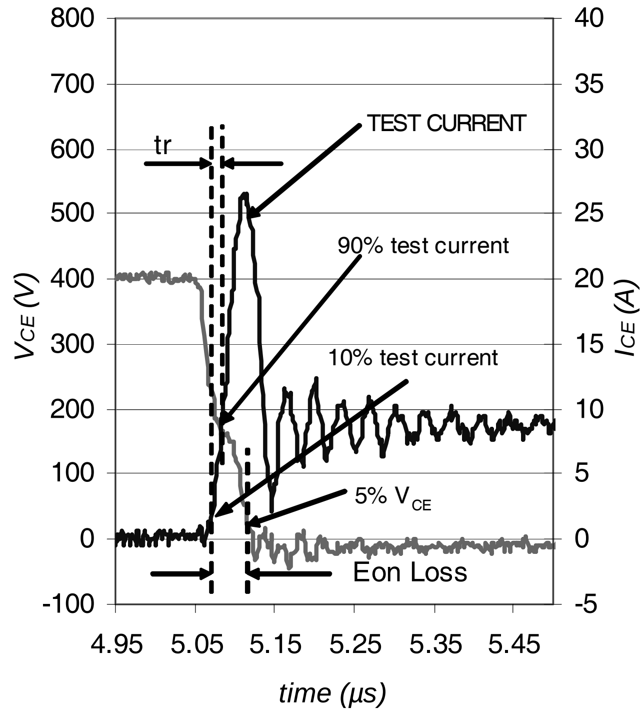


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

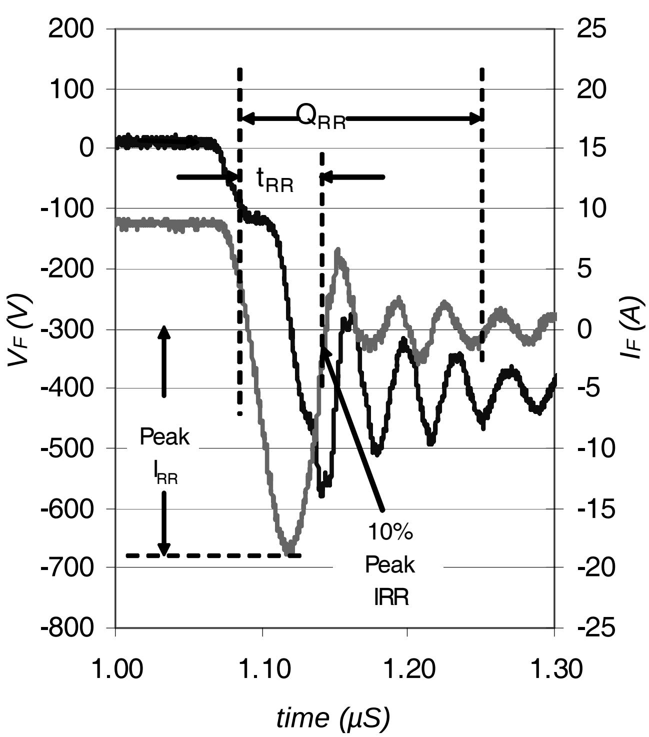


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

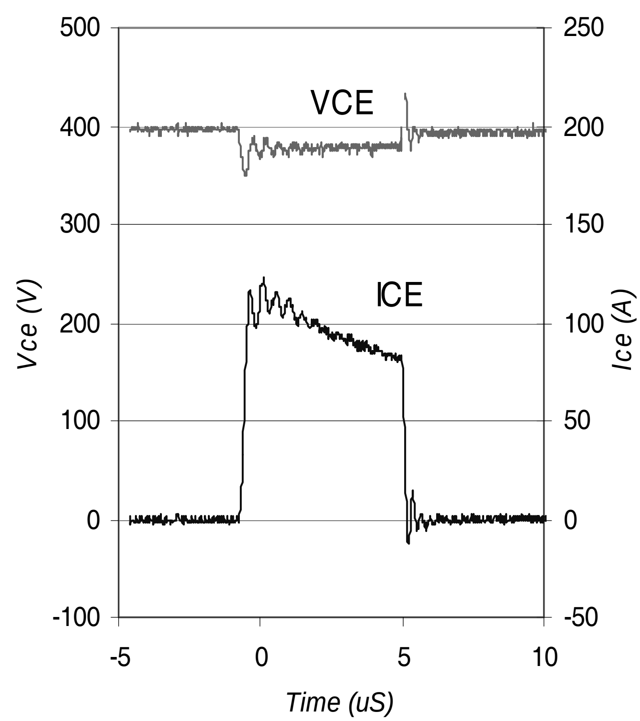
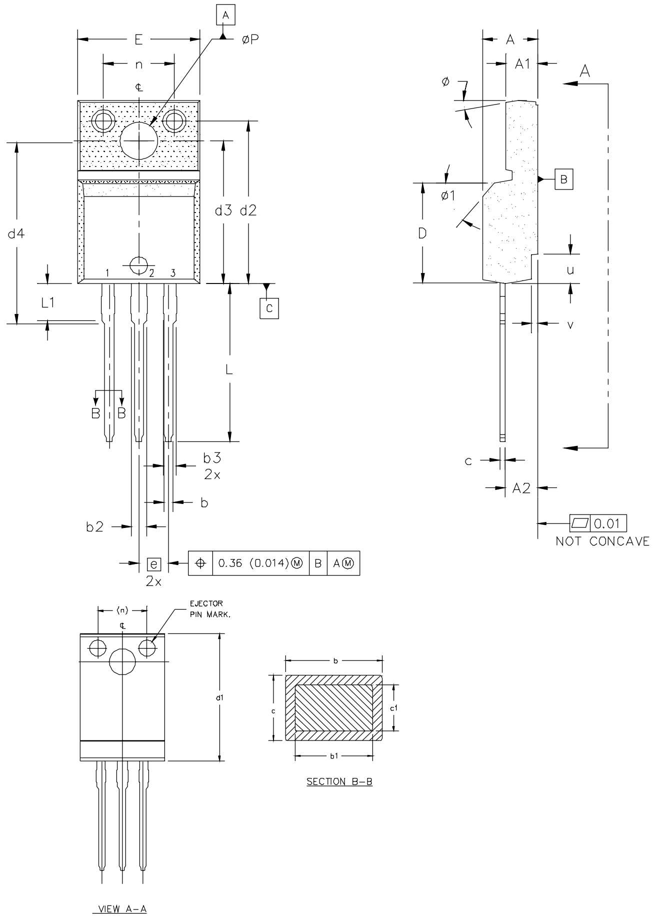


Fig. WF4 - Typ. S.C. Waveform
@ T_J = 25°C using Fig. CT.3

TO-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

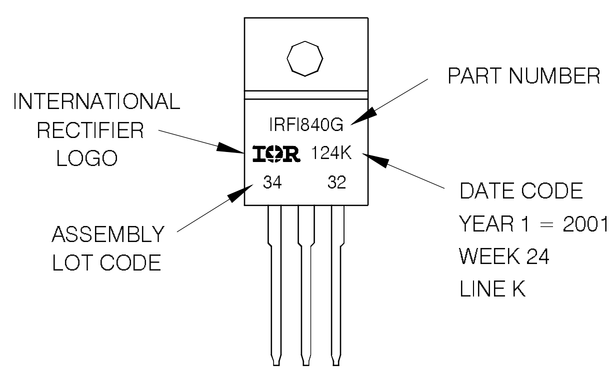
HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE

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.

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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