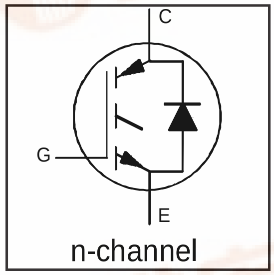
PD-95321

International
IOR Rectifier

IRGIB6B60KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



V_{CES} = 600V

I_C = 6.0A, T_C=90°C

t_{SC} > 10µs, T_J=175°C

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

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.
- 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	11	A
I_C @ T_C = 100°C	Continuous Collector Current	7.0	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	22	
I_{LM}	Clamped Inductive Load current ①	22	
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	38	W
P_D @ T_C = 100°C	Maximum Power Dissipation	19	
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	–––	–––	3.9	°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

05/25/04

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	—	0.30	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)	
$V_{CE(on)}$	Collector-to-Emitter Voltage	1.50	1.80	2.20	V	I_C = 5A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	2.20	2.50		I_C = 5A, V_{GE} = 15V, T_J = 150°C	
		—	2.30	2.60		I_C = 5A, V_{GE} = 15V, T_J = 175°C	9,10,11
$V_{GE(th)}$	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	—	3.0	—	S	V_{CE} = 50V, I_C = 5.0A, 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, V_{GE} = 0V, T_J = 150°C	
		—	1.15	1.35		I_F = 5.0A, 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)	—	18.2	27.3	nC	I_C = 5.0A	23
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	1.9	2.85		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	9.2	13.8		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	110	210	µJ	I_C = 5.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	135	245		V_{GE} = 15V, R_G = 100Ω, L = 1.4mH	
E_{tot}	Total Switching Loss	—	245	455		Ls= 150nH, T_J = 25°C ②	
$t_{d(on)}$	Turn-On delay time	—	25	34	ns	I_C = 5.0A, V_{CC} = 400V	
t_r	Rise time	—	17	26		V_{GE} = 15V, R_G = 100Ω, L = 1.4mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	215	230		Ls= 150nH, T_J = 25°C	
t_f	Fall time	—	13.2	22			
E_{on}	Turn-On Switching Loss	—	150	260	µJ	I_C = 5.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	190	300		V_{GE} = 15V, R_G = 100Ω, L = 1.4mH	13,15
E_{tot}	Total Switching Loss	—	340	560		Ls= 150nH, T_J = 150°C ②	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	28	37	ns	I_C = 5.0A, V_{CC} = 400V	14,16
t_r	Rise time	—	17	26		V_{GE} = 15V, R_G = 100Ω, L = 1.4mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	240	255		Ls= 150nH, T_J = 150°C	WF1
t_f	Fall time	—	18	27			WF2
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5 mm from package	
C_{ies}	Input Capacitance	—	290	435	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	34	51		V_{CC} = 30V	22
C_{res}	Reverse Transfer Capacitance	—	10	15		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 18A, Vp = 600V V_{CC}=500V,V_{GE} = +15V to 0V,R_G = 100Ω	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	—	50	—	A		WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	90	175	µJ	T_J = 150°C	17,18,19
t_{rr}	Diode Reverse Recovery Time	—	70	91	ns	V_{CC} = 400V, I_F = 5.0A, L = 1.4mH	20,21
I_{rr}	Peak Reverse Recovery Current	—	10	13	A	V_{GE} = 15V, R_G = 100Ω, Ls= 150nH	CT4,WF3
Q_{rr}	Diode Reverse Recovery Charge	—	350	455	nC	di/dt = 400A/µs	

① Vcc =80% (V_{CES}), V_{GE} = 20V, L =100µH, R_G = 50Ω.

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

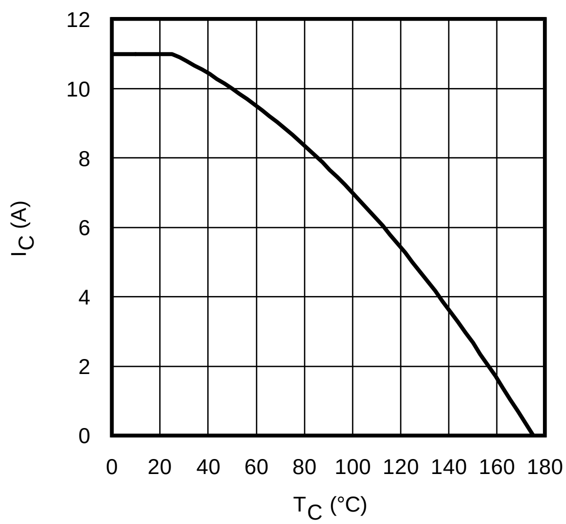


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

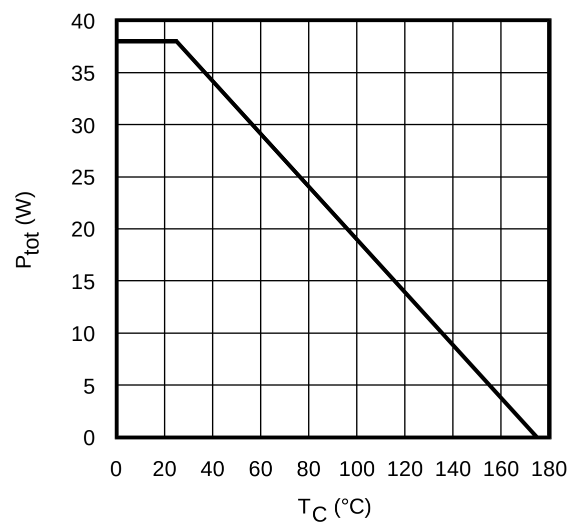


Fig. 2 - Power Dissipation vs. Case Temperature

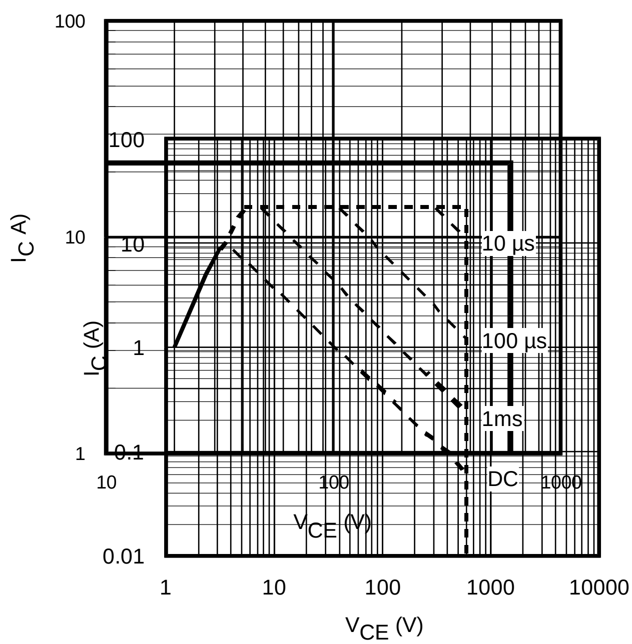


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \leq$ 175°C

Fig. 4 - Reverse Bias SOA
T_J = 175°C; V_{GE} =15V

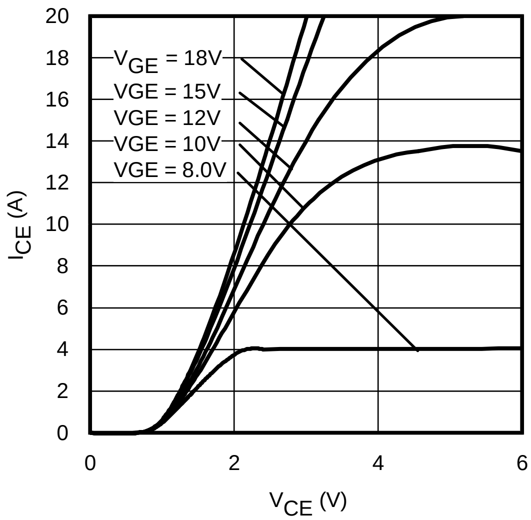


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

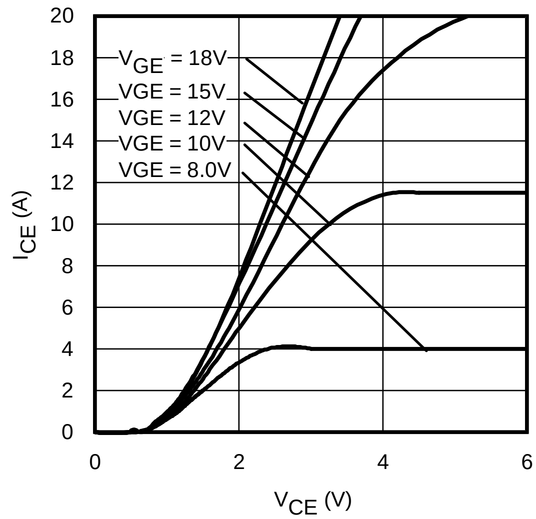


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

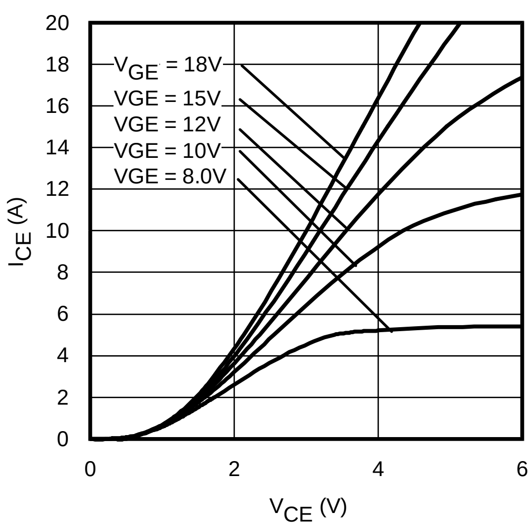


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

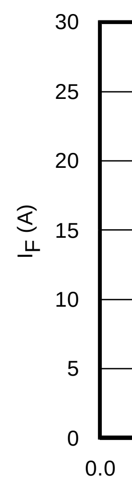


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

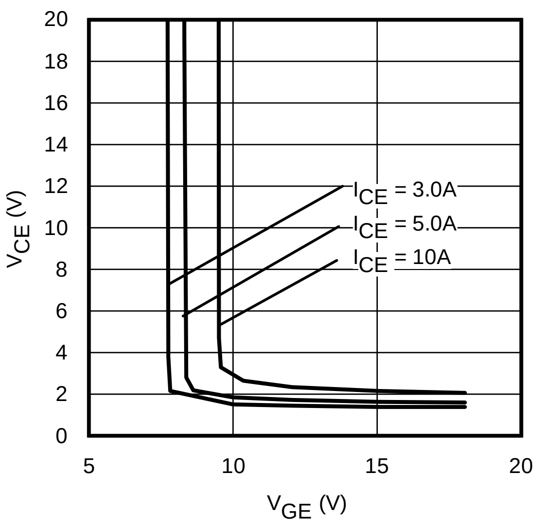


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

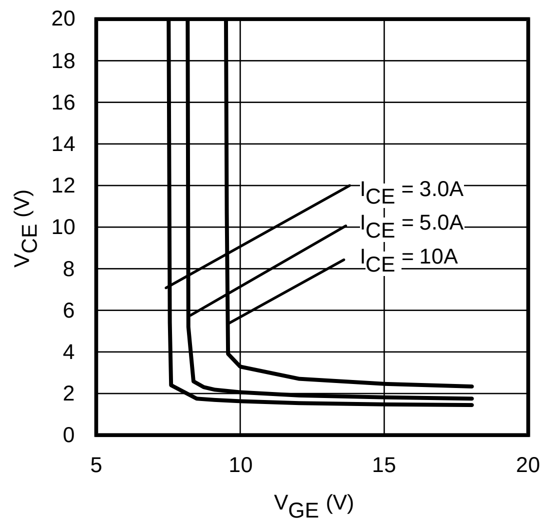


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

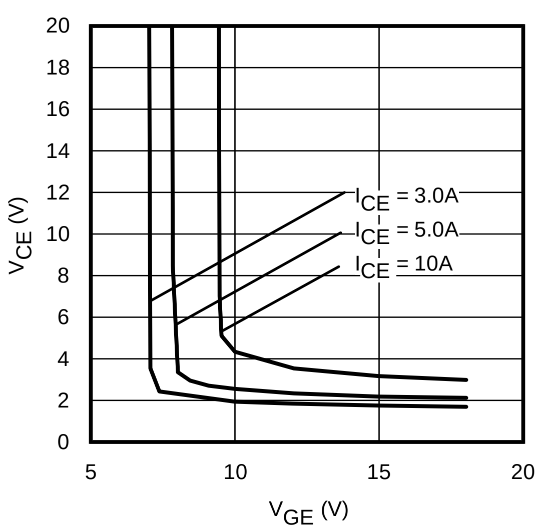


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

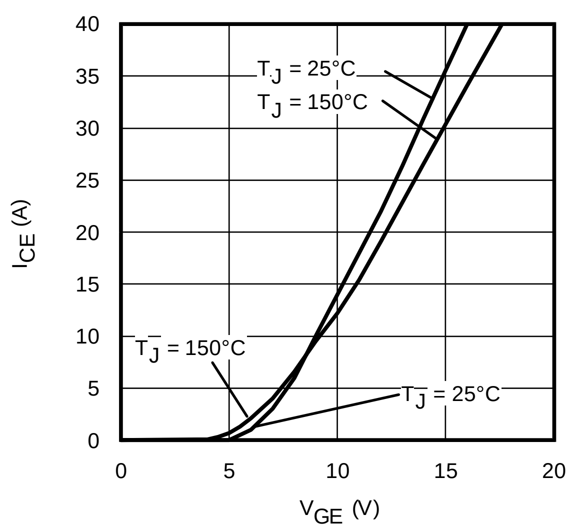


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

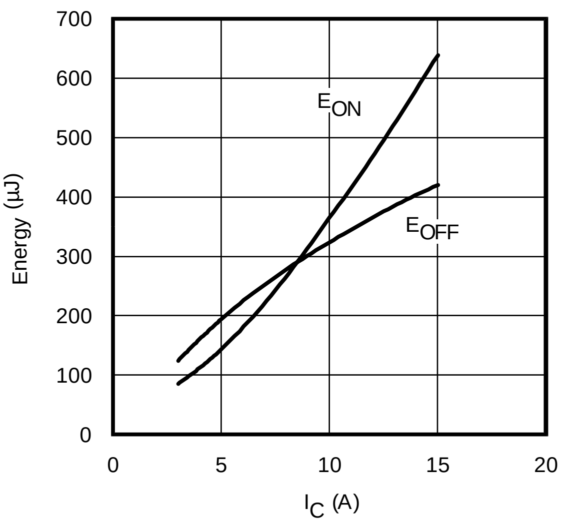


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=1.4mH; V_{CE}= 400V
R_G= 100Ω; V_{GE}= 15V

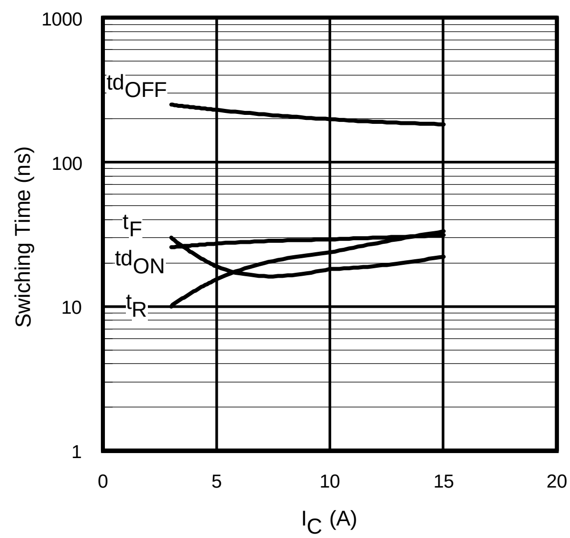


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1.4mH; V_{CE}= 400V
R_G= 100Ω; V_{GE}= 15V

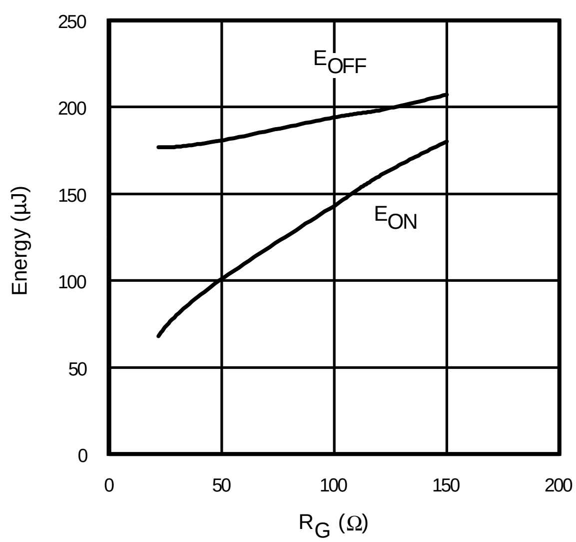


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=1.4mH; V_{CE}= 400V
I_{CE}= 5.0A; V_{GE}= 15V

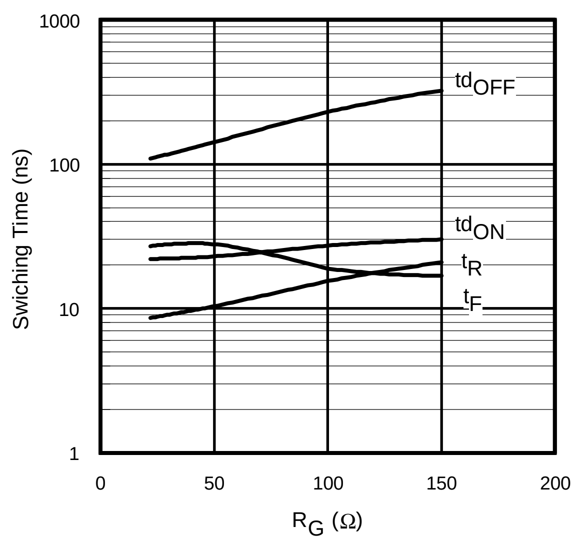


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=1.4mH; V_{CE}= 400V
I_{CE}= 5.0A; V_{GE}= 15V

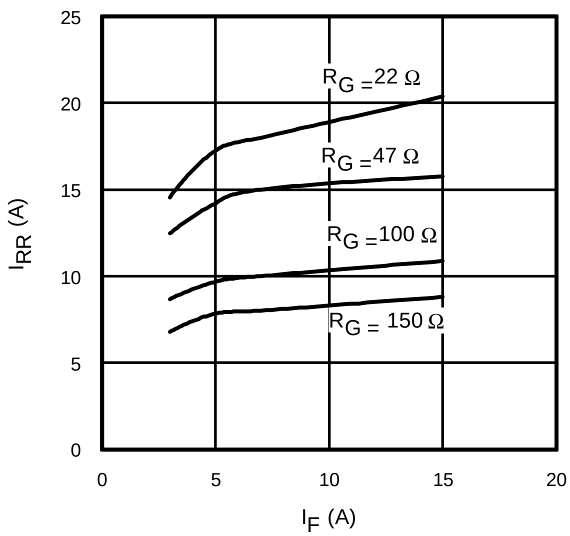


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

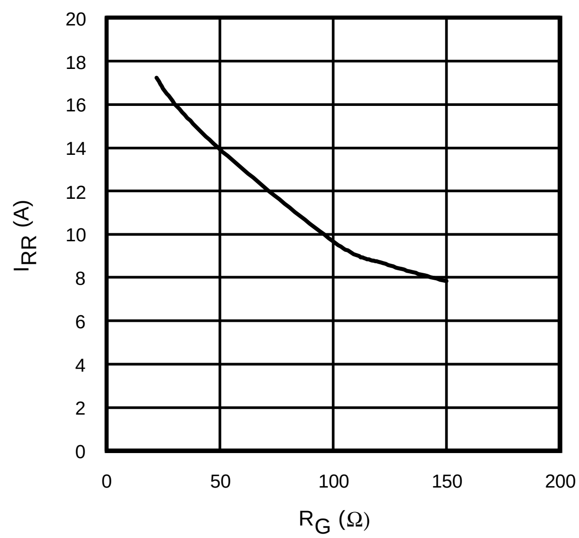


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 5.0A

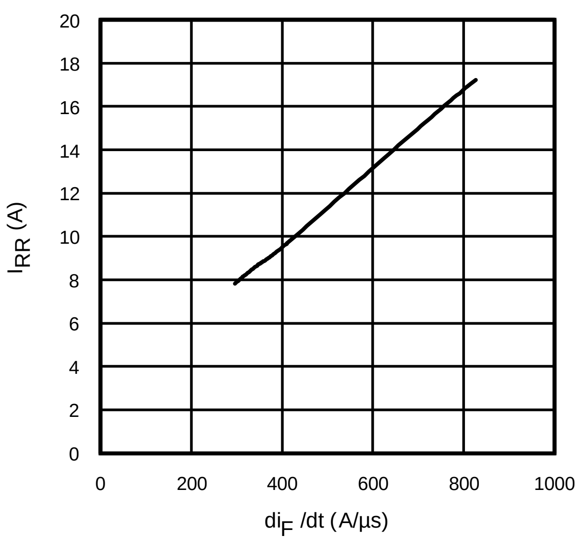


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 5.0A; T_J = 150°C

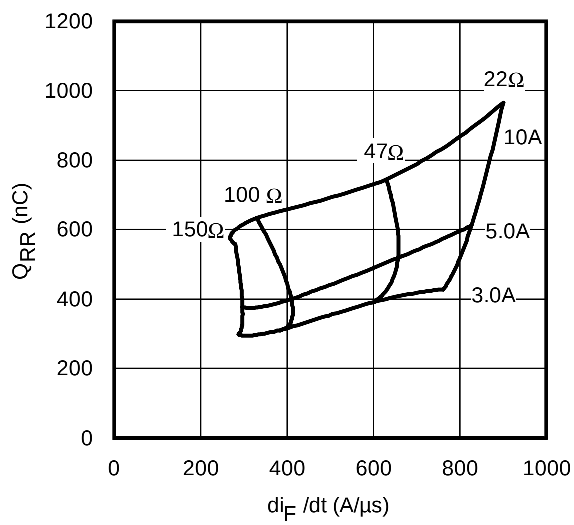


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;T_J = 150°C

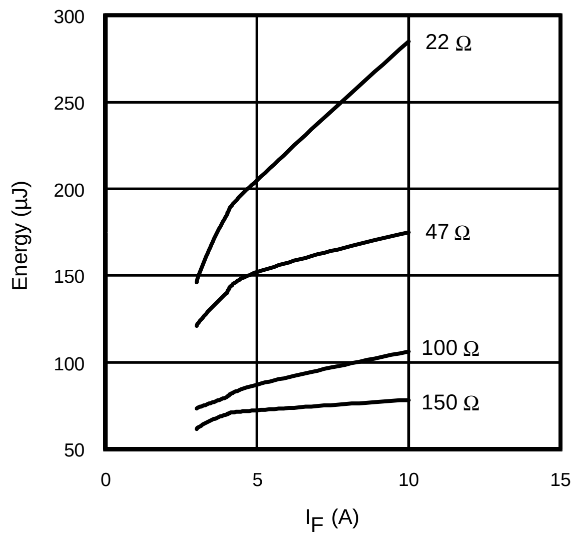


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

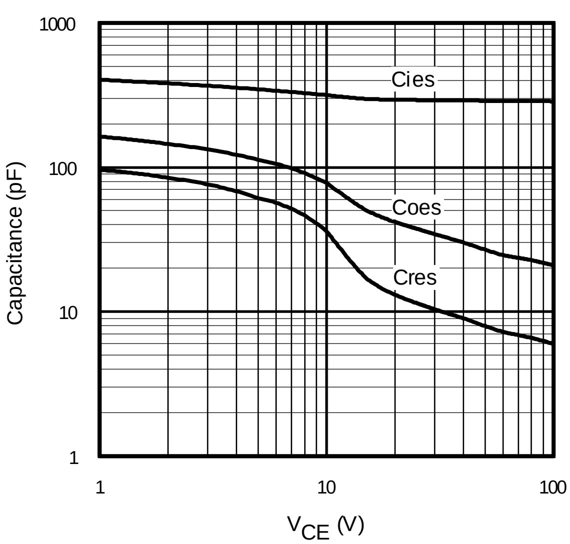


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

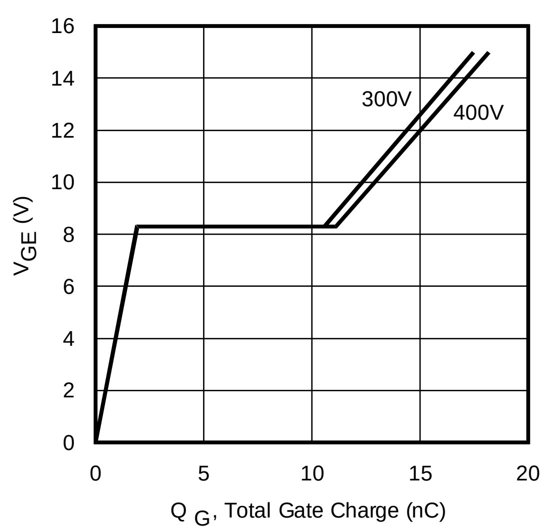


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 5.0A; L = 600µH

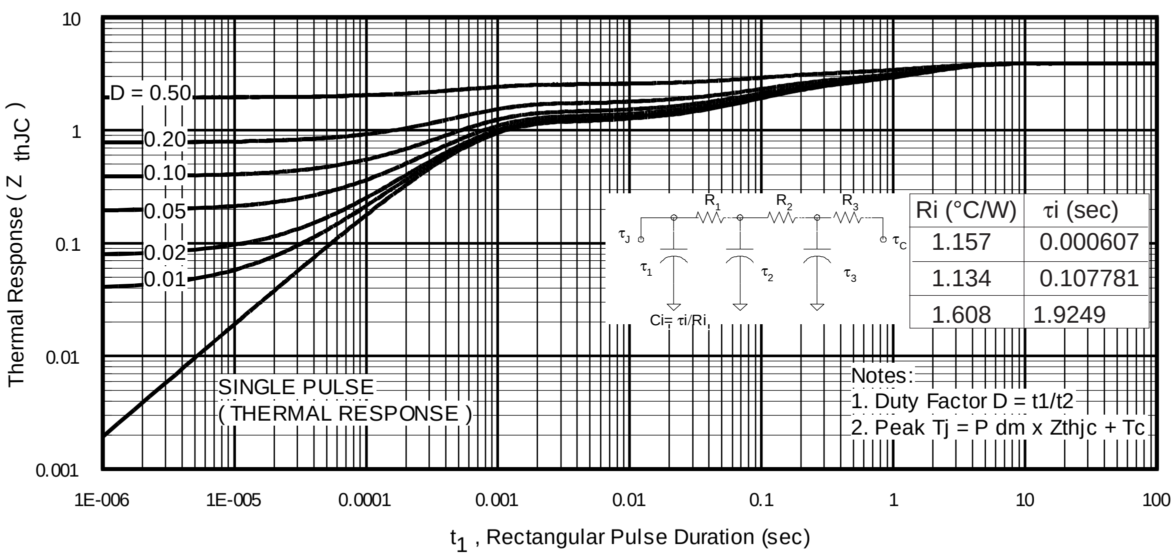


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

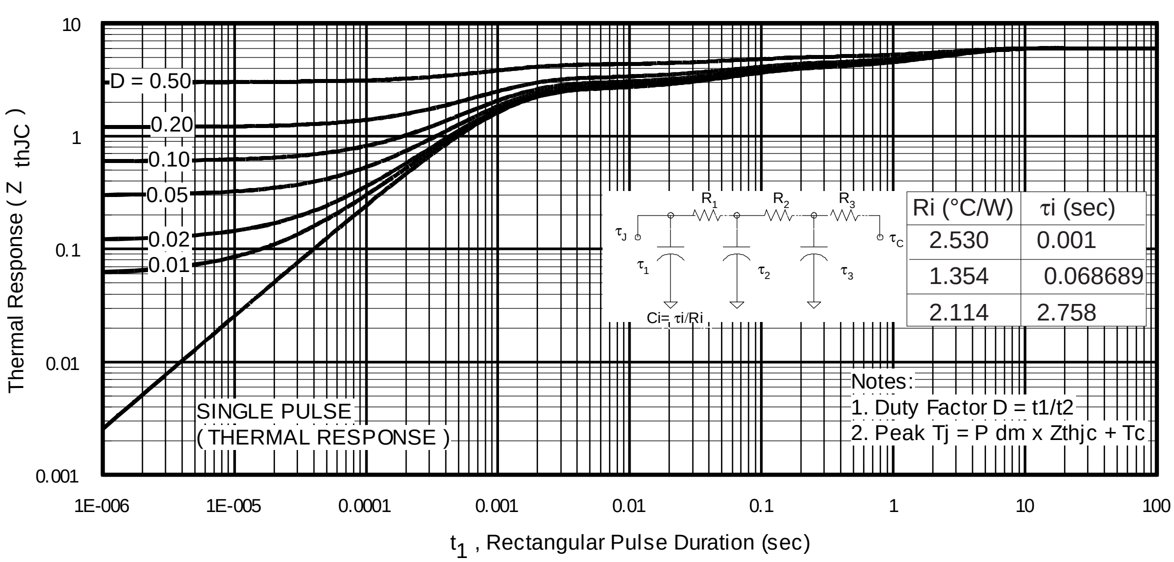


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

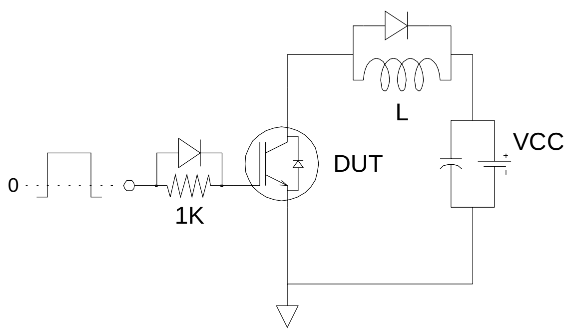


Fig.C.T.1 - Gate Charge Circuit (turn-off)

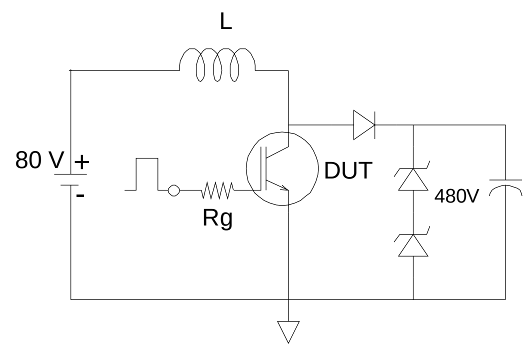


Fig.C.T.2 - RBSOA Circuit

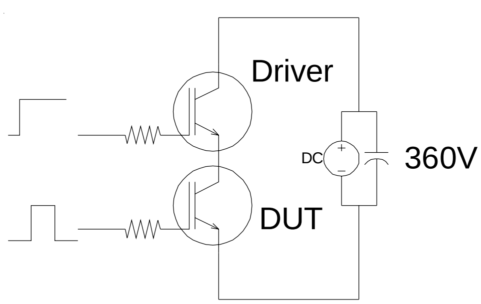


Fig.C.T.3 - S.C.SOA Circuit

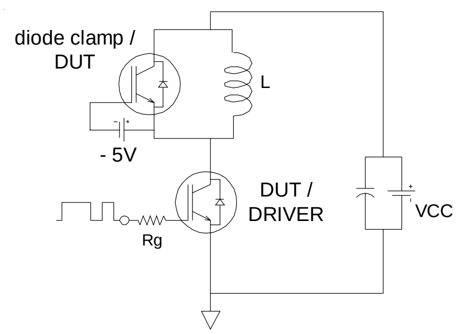


Fig.C.T.4 - Switching Loss Circuit

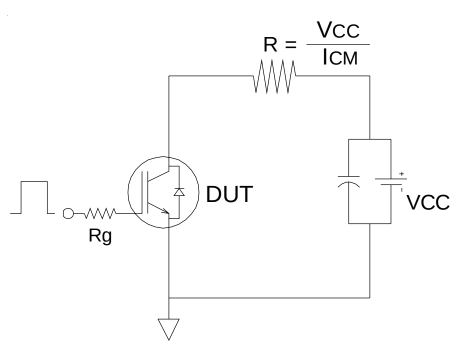


Fig.C.T.5 - Resistive Load Circuit

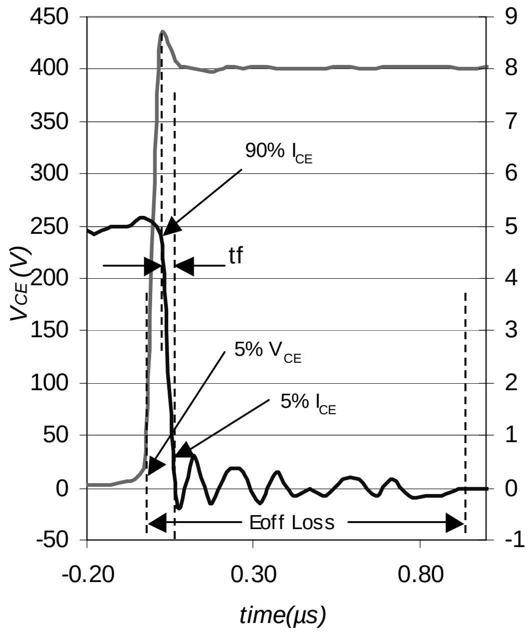


Fig. WF1- Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

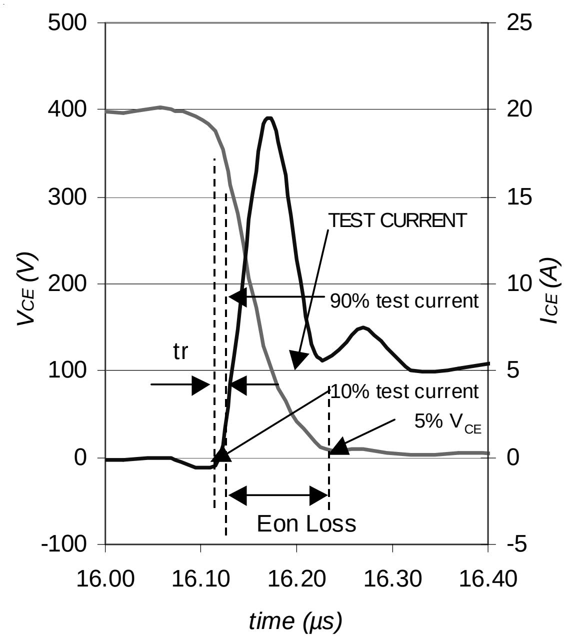


Fig. WF2- Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

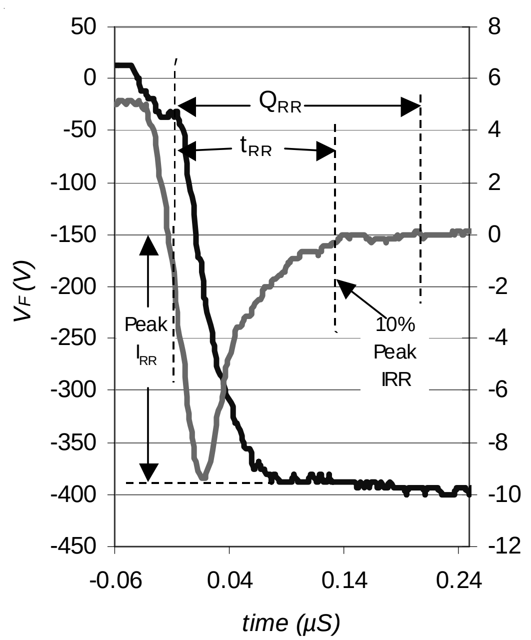


Fig. WF3- Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

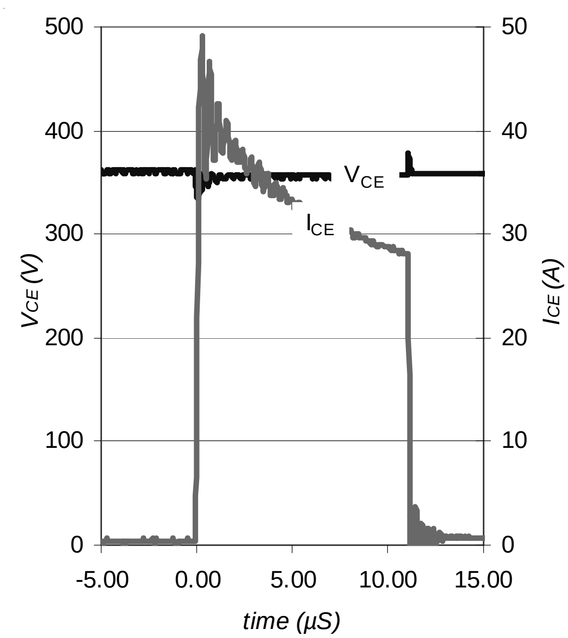
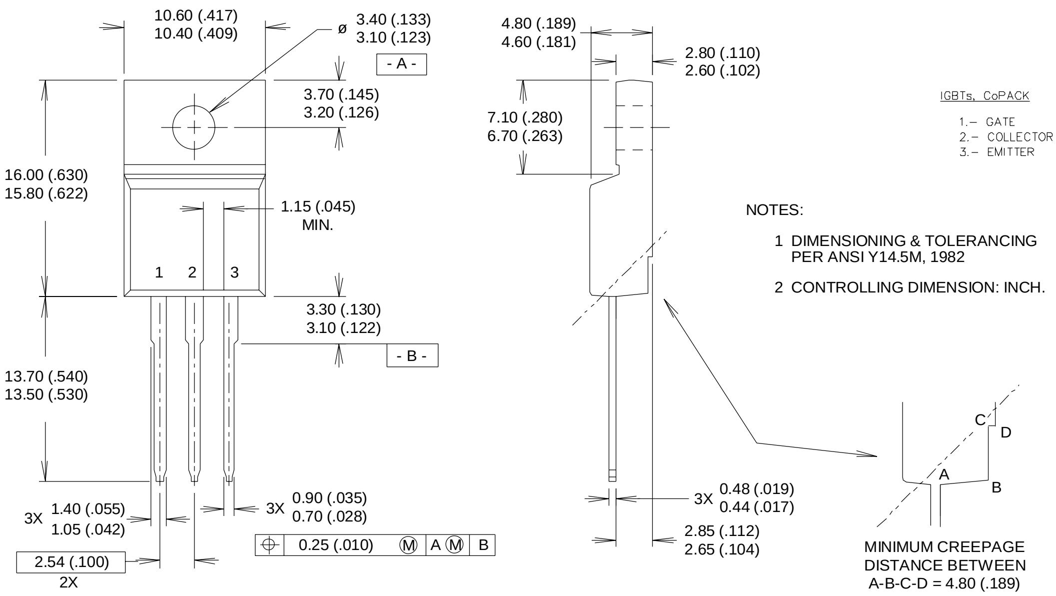


Fig. WF4- Typ. S.C Waveform
@ T_J = 150°C using Fig. CT.3

TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



TO-220 Full-Pak Part Marking Information

EXAMPLE:

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 the 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.05/04