



**THE DATASHEET OF
IRGIB15B60KD1P**



IRGIB15B60KD1P

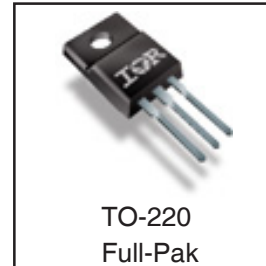
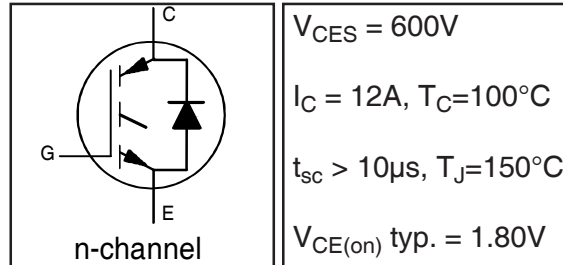
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

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.



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	19	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	12	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	38	
I_{LM}	Clamped Inductive Load current ①	38	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	19	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	12	V
I_{FM}	Diode Maximum Forward Current	38	
V_{ISOL}	RMS Isolation Voltage, Terminal to Case, $t = 1 \text{ min}$	2500	
V_{GE}	Gate-to-Emitter Voltage	± 20	W
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	52	
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	26	°C
T_J	Operating Junction and	-55 to +175	
T_{STG}	Storage Temperature Range		
	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	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	—	—	4.6	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	62	
Wt	Weight	—	2.0	—	g

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

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	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
V _{(BR)CES}	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V _{GE} = 0V, I _C = 500μA	
ΔV _{(BR)CES} /ΔT _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
ΔV _{GE(th)} /ΔT _J	Threshold Voltage temp. coefficient	—	-10	—	mV/°C	V _{CE} = V _{GE} , I _C = 1mA (25°C-150°C)	12
g _{fe}	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		L _S = 150nH, T _J = 25°C ⊙	
t _{d(on)}	Turn-On delay time	—	30	39	ns	I _C = 15A, V _{CC} = 400V	CT4
t _r	Rise time	—	25	35		V _{GE} = 15V, R _G = 22Ω, L = 1.07mH	
t _{d(off)}	Turn-Off delay time	—	173	188		L _S = 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		L _S = 150nH, T _J = 150°C ⊙	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		L _S = 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	22
C _{oes}	Output Capacitance	—	100	150		V _{CC} = 30V	
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, V _p = 600V V _{CC} = 500V, V _{GE} = +15V to 0V, R _G = 22Ω	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T _J = 150°C, V _p = 600V, R _G = 22Ω V _{CC} = 360V, V _{GE} = +15V to 0V	CT3 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	

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

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

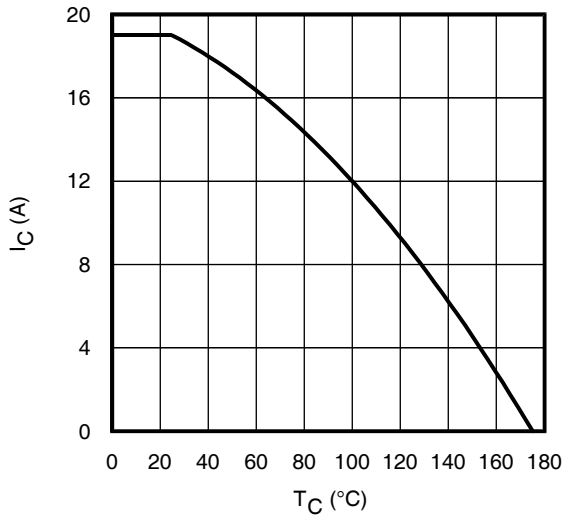


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

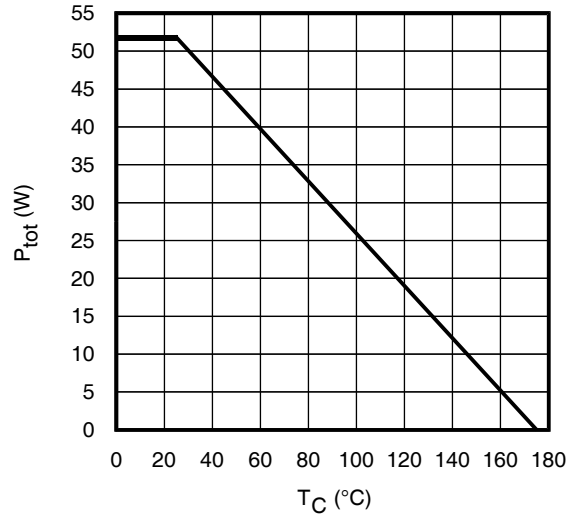


Fig. 2 - Power Dissipation vs. Case Temperature

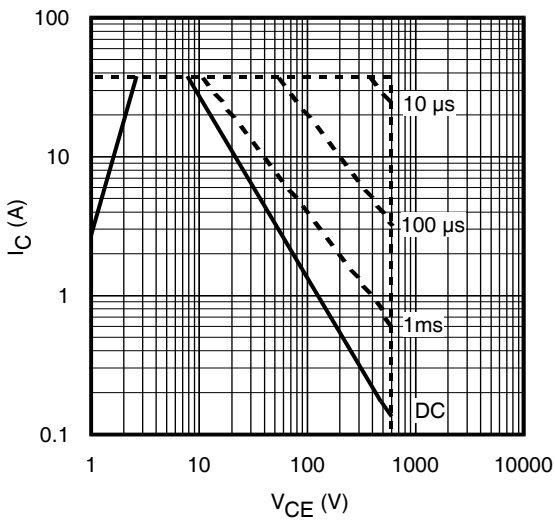


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}C$; $T_J \leq 150^{\circ}C$

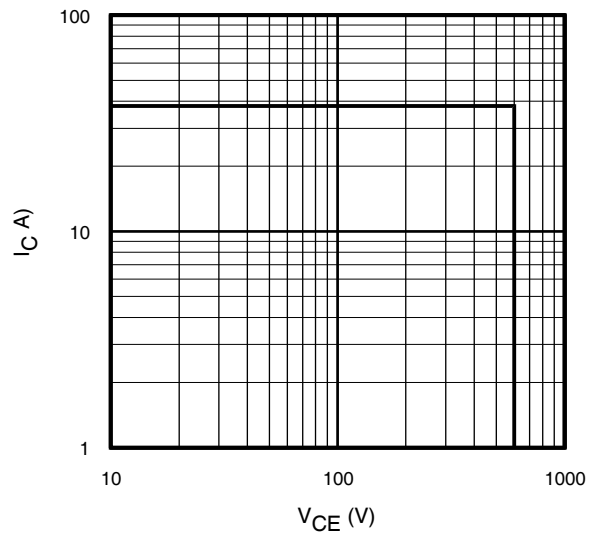


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}C$; $V_{GE} = 15V$

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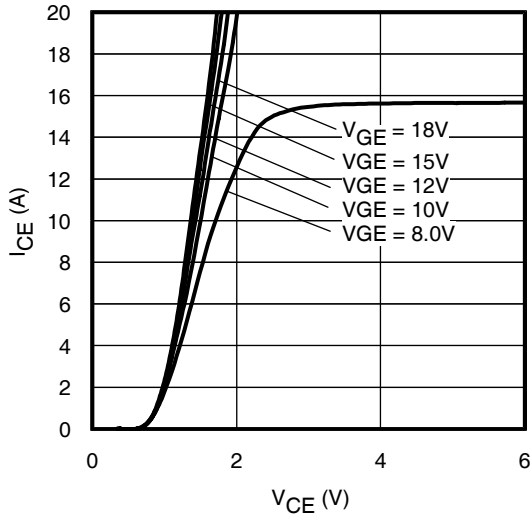


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 60\mu\text{s}$

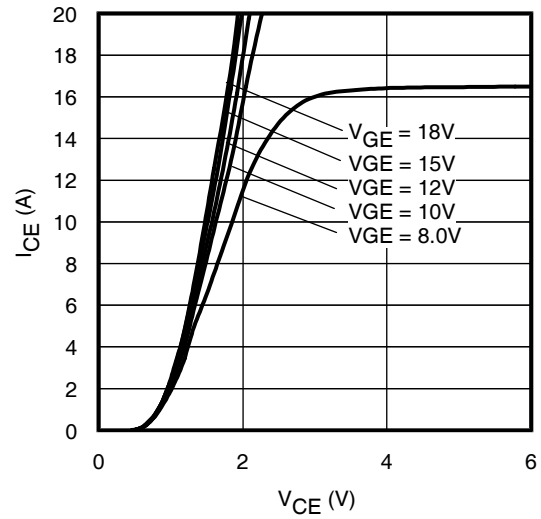


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 60\mu\text{s}$

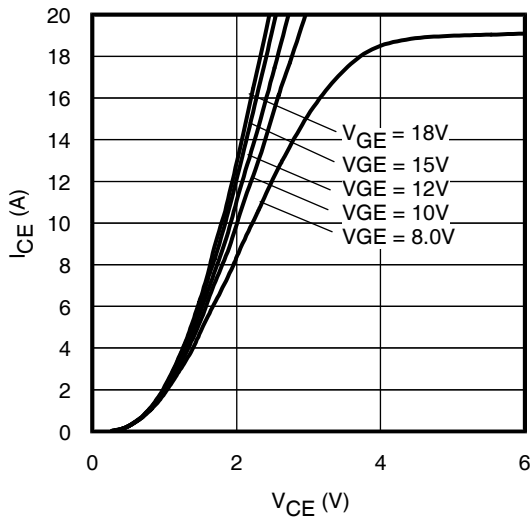


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 60\mu\text{s}$

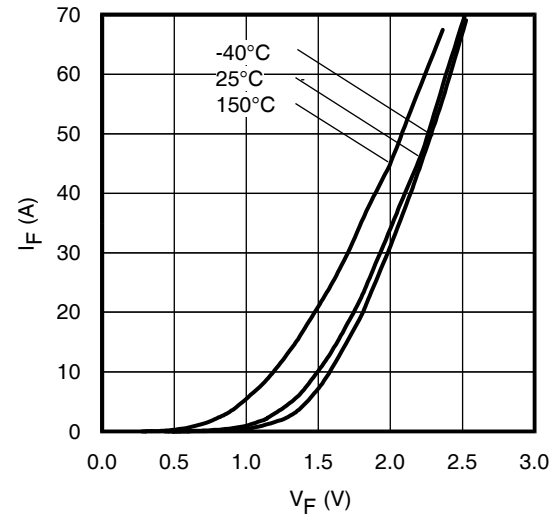


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 60\mu\text{s}$

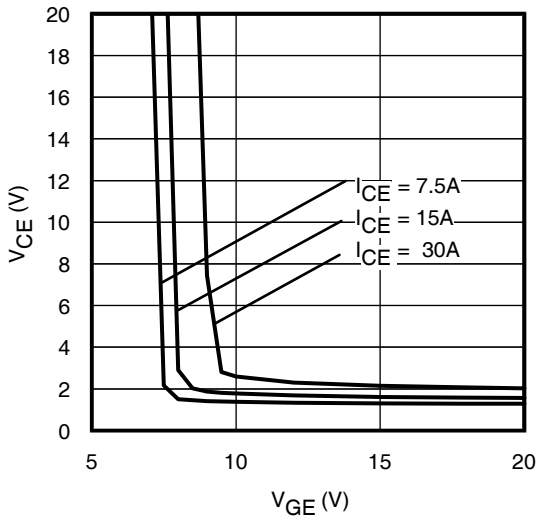


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

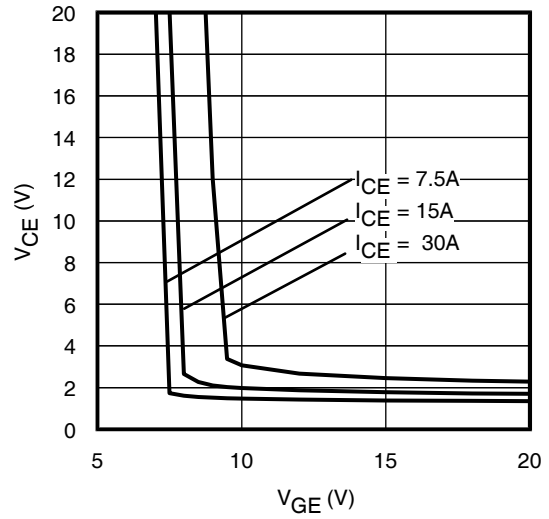


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

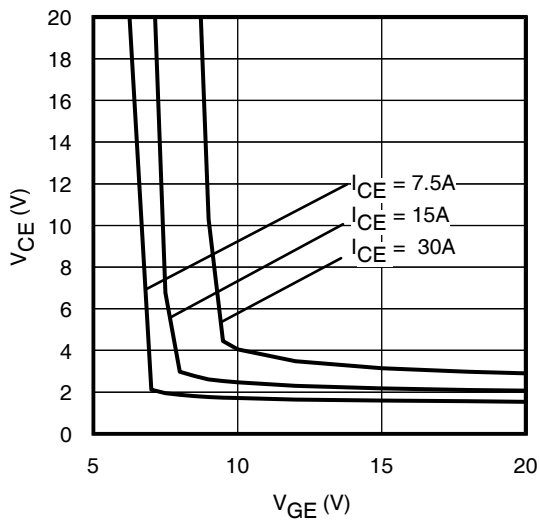


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

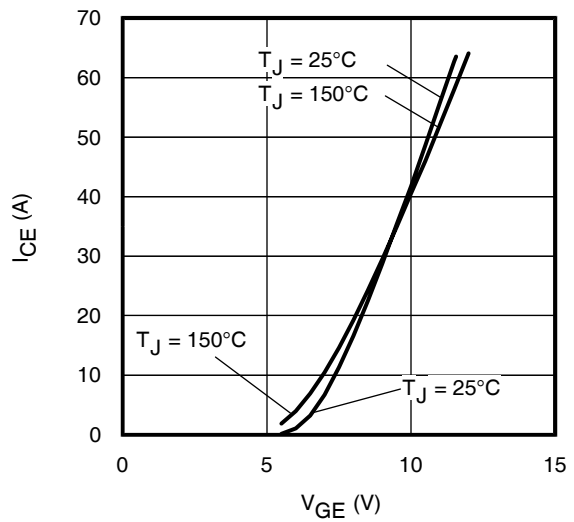


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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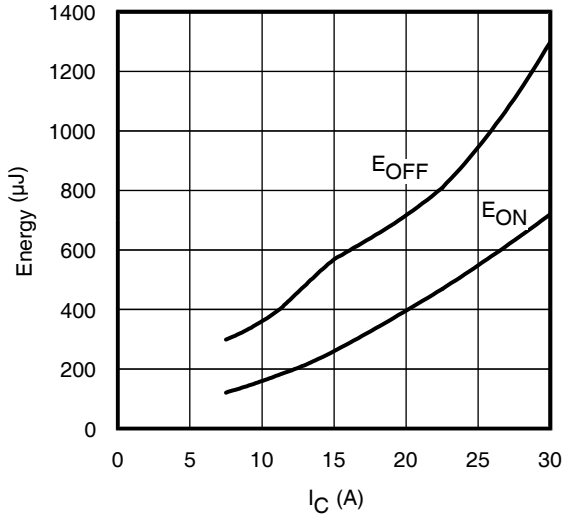


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 22\Omega$; $V_{GE}= 15\text{V}$

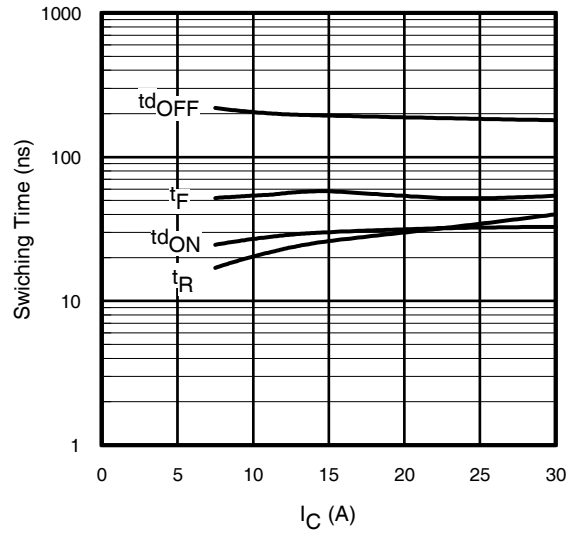


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 22\Omega$; $V_{GE}= 15\text{V}$

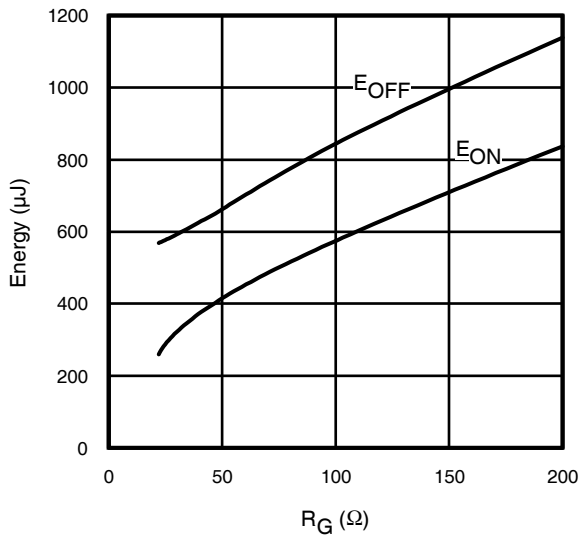


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 15\text{A}$; $V_{GE}= 15\text{V}$

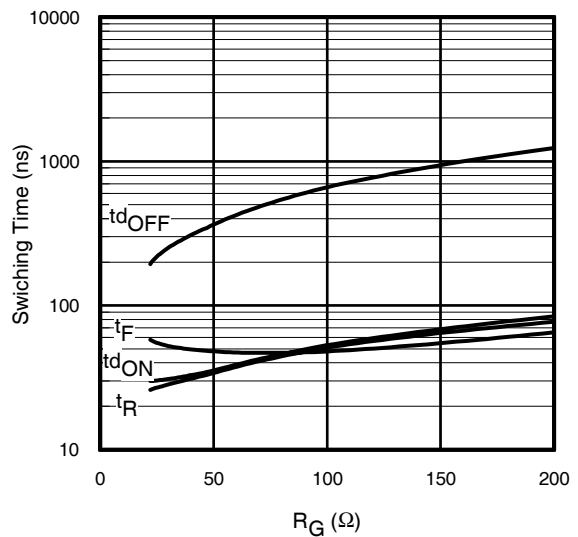


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 15\text{A}$; $V_{GE}= 15\text{V}$

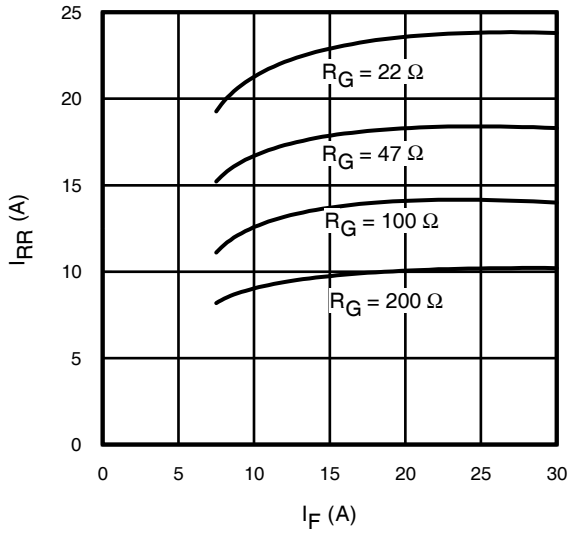


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

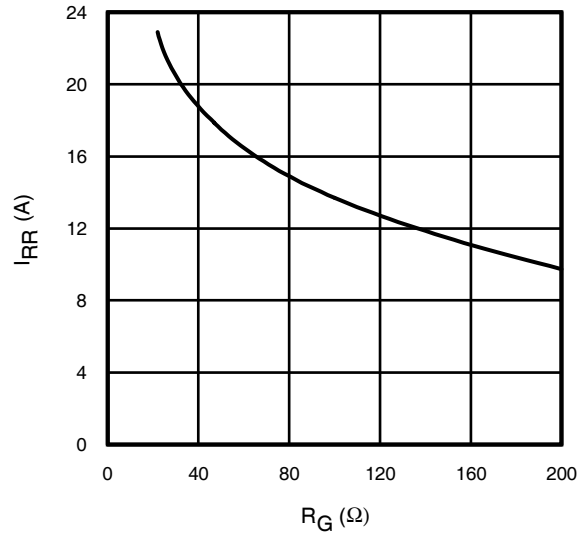


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150^\circ\text{C}$; $I_F = 15\text{A}$

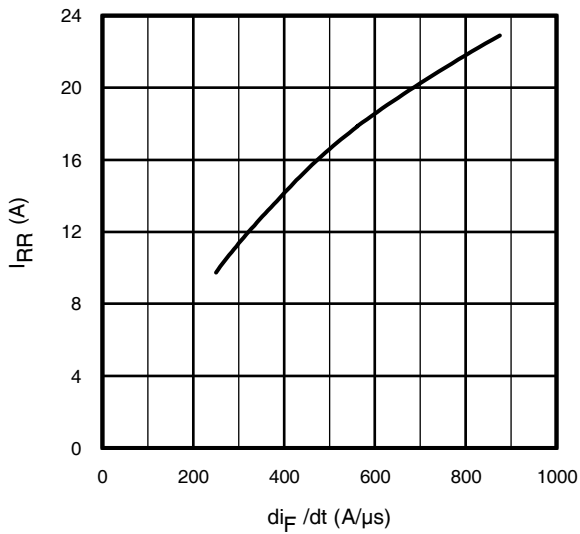


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$;
 $I_{CE} = 15\text{A}$; $T_J = 150^\circ\text{C}$

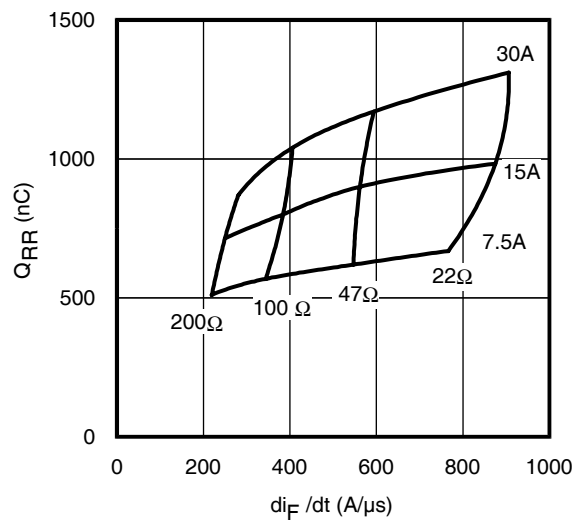


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 150^\circ\text{C}$

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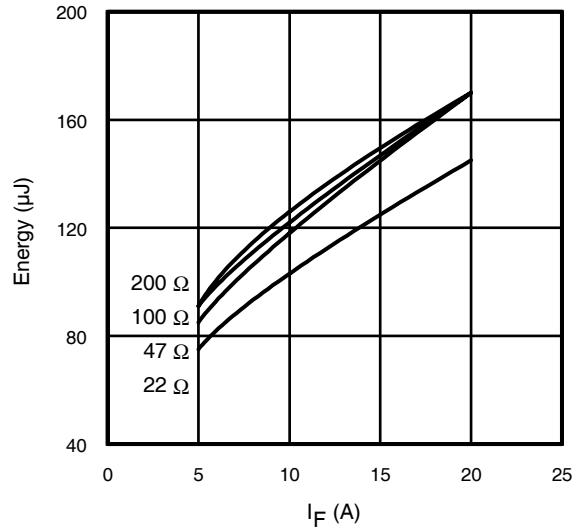


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

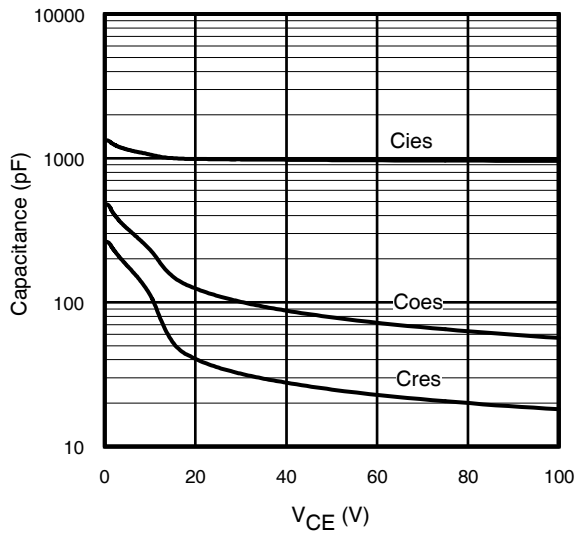


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

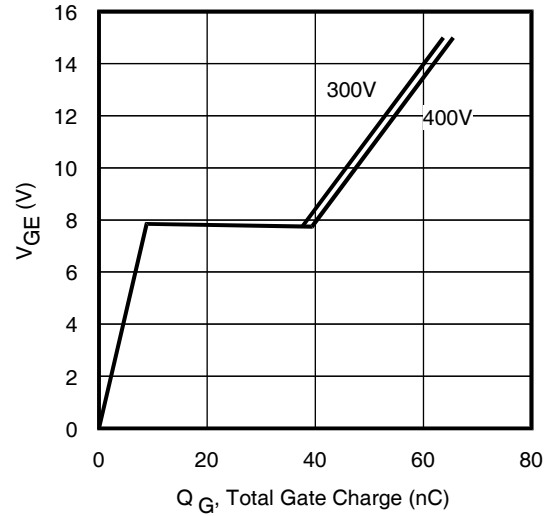


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 15\text{A}$; $L = 2500\ \mu\text{H}$

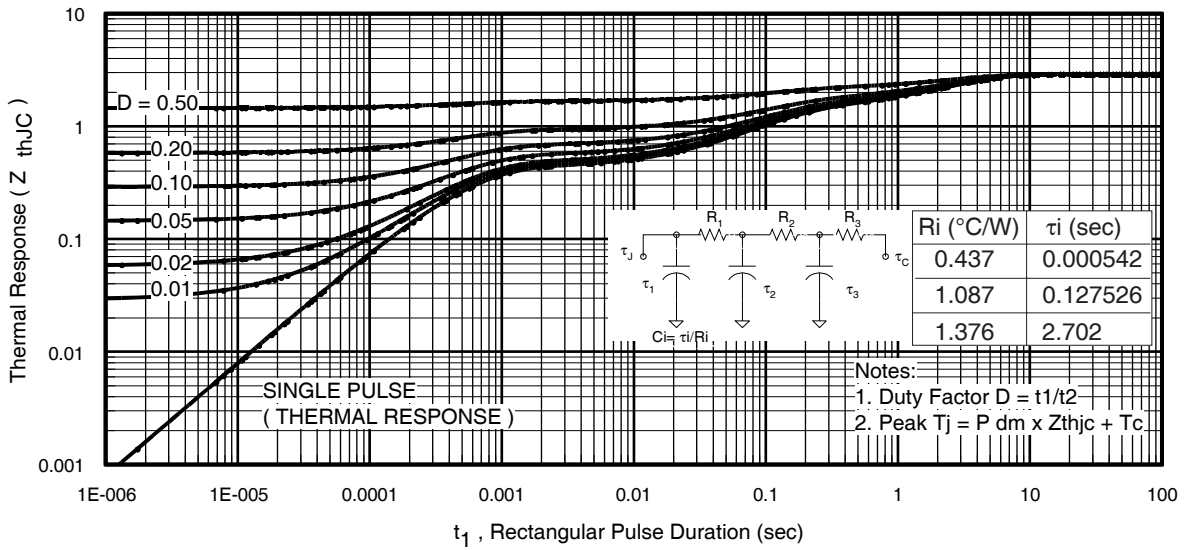


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

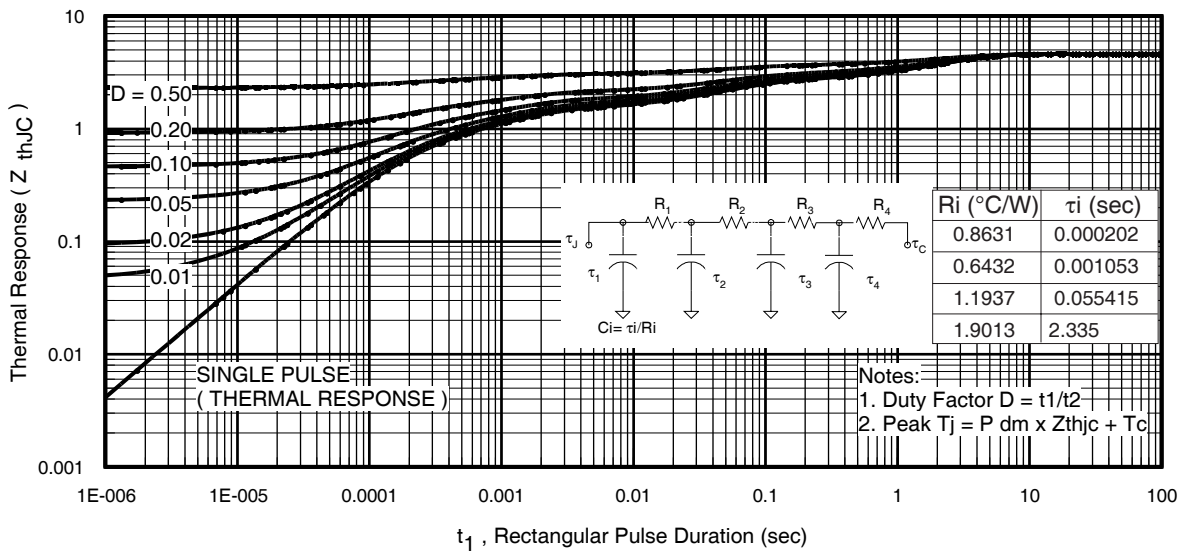


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

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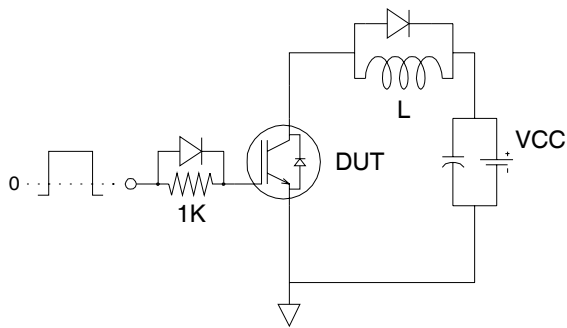


Fig.C.T.1 - Gate Charge Circuit (turn-off)

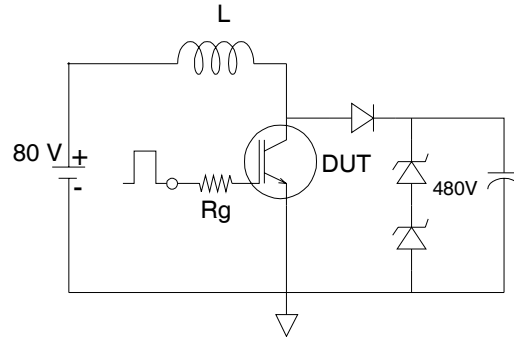


Fig.C.T.2 - RBSOA Circuit

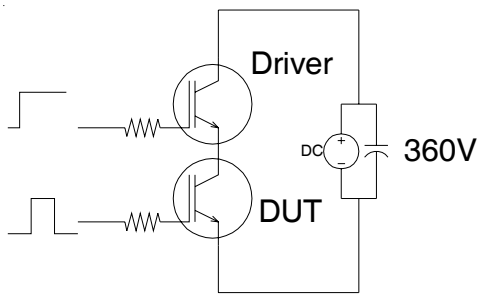


Fig.C.T.3 - S.C.SOA Circuit

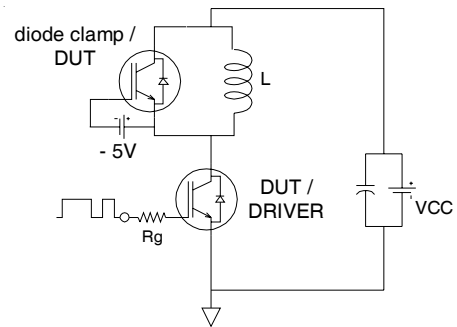


Fig.C.T.4 - Switching Loss Circuit

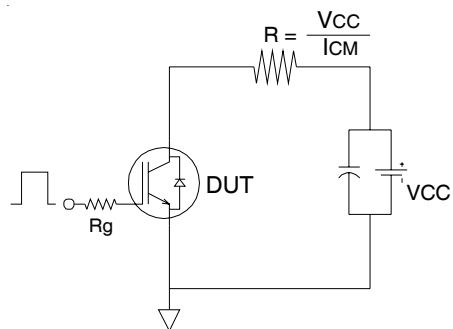


Fig.C.T.5 - Resistive Load Circuit

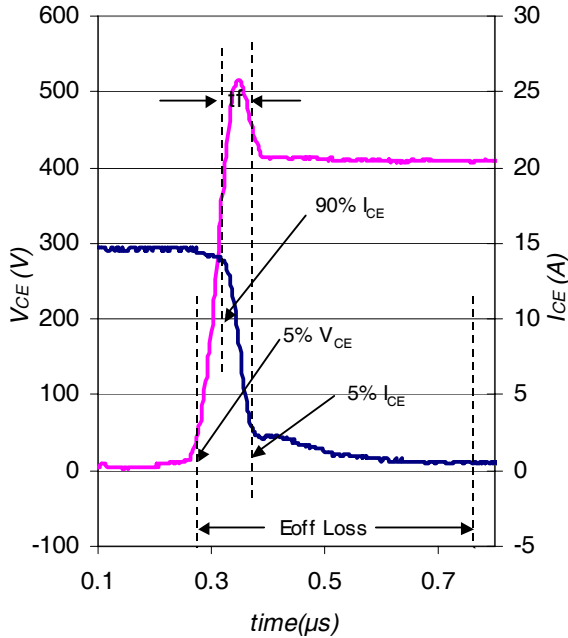


Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

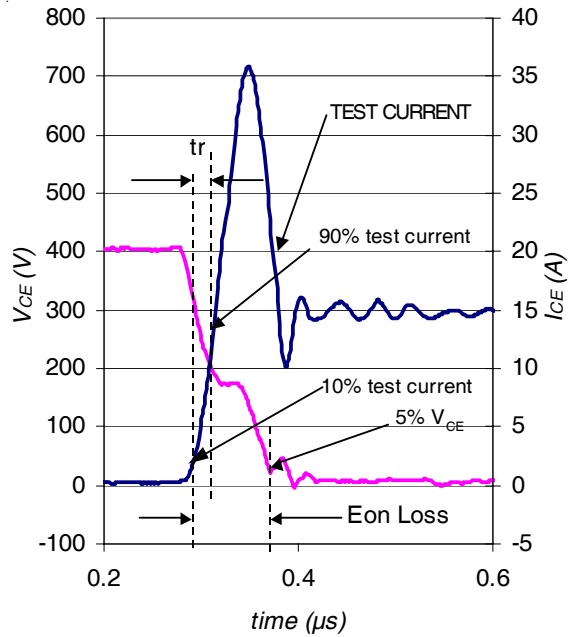


Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

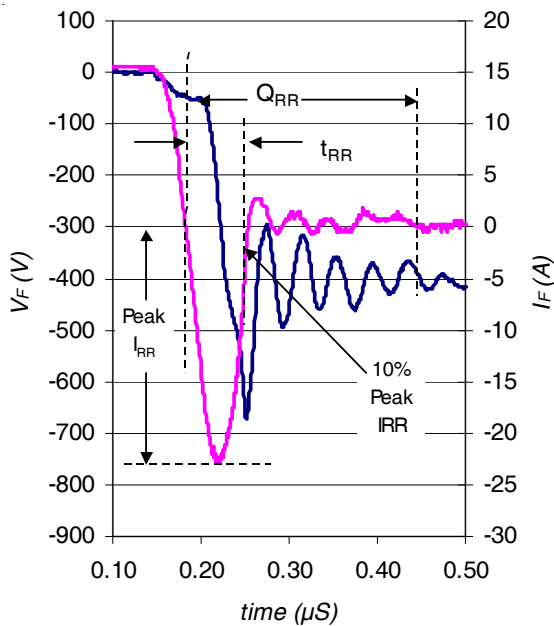


Fig. WF3- Typ. Diode Recovery Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

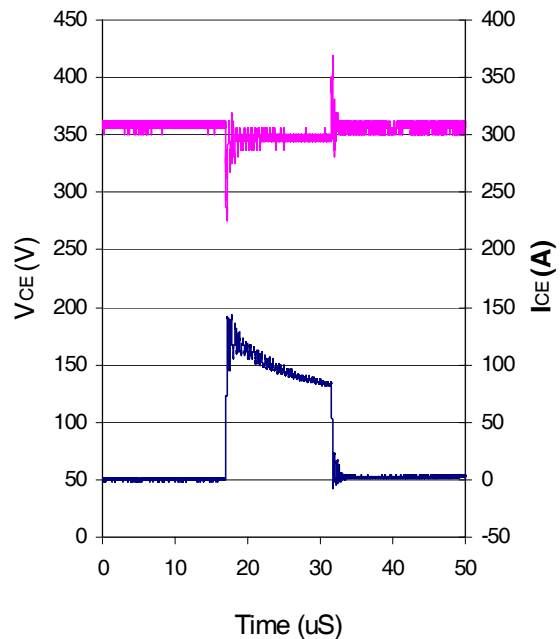


Fig. WF4- Typ. S.C. Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT.3

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

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