

IRGIB15B60KD1

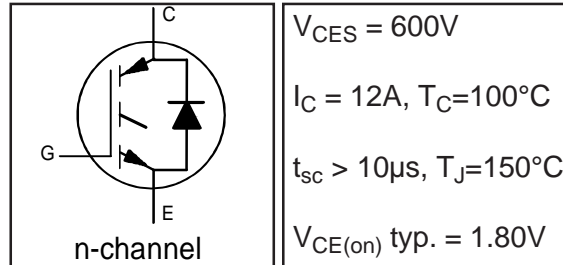
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

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

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	
I_{FM}	Diode Maximum Forward Current	38	
V_{ISOL}	RMS Isolation Voltage, Terminal to Case, $t = 1 \text{ min}$	2500	V
V_{GE}	Gate-to-Emitter Voltage	± 20	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	52	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	26	
T_J	Operating Junction and	-55 to +175	°C
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 @ $T_J = 25^\circ\text{C}$ (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	$V_{GE} = 0V, I_C = 500\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.32	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	1.80	2.20	V	$I_C = 15A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	2.05	2.50		$I_C = 15A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	9,10,11
		—	2.10	2.60		$I_C = 15A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	$V_{CE} = V_{GE}, I_C = 250\mu A$	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-10	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$	12
gfe	Forward Transconductance	—	10	—	S	$V_{CE} = 50V, I_C = 15A, PW = 80\mu s$	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	163	500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$	
		—	829	1800		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	1.69	2.30	V	$I_F = 15A, V_{GE} = 0V$	8
		—	1.31	1.75		$I_F = 15A, V_{GE} = 0V, T_J = 150^\circ\text{C}$	
		—	1.25	1.65		$I_F = 15A, V_{GE} = 0V, T_J = 175^\circ\text{C}$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V, V_{CE} = 0V$	

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (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		$V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$	
E_{tot}	Total Switching Loss	—	461	556		$L_S = 150nH, T_J = 25^\circ\text{C}$ ①	
$t_{d(on)}$	Turn-On delay time	—	30	39	ns	$I_C = 15A, V_{CC} = 400V$	CT4
t_r	Rise time	—	25	35		$V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$	
$t_{d(off)}$	Turn-Off delay time	—	173	188		$L_S = 150nH, T_J = 25^\circ\text{C}$	
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		$V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$	13,15
E_{tot}	Total Switching Loss	—	829	915		$L_S = 150nH, T_J = 150^\circ\text{C}$ 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		$V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$	CT4
$t_{d(off)}$	Turn-Off delay time	—	194	207		$L_S = 150nH, T_J = 150^\circ\text{C}$	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				$T_J = 150^\circ\text{C}, I_C = 38A, V_p = 600V$ $V_{CC} = 500V, V_{GE} = +15V \text{ to } 0V, R_G = 22\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_p = 600V, R_G = 22\Omega$ $V_{CC} = 360V, V_{GE} = +15V \text{ to } 0V$	CT3 WF4
$I_{SC(PEAK)}$	Peak Short Circuit Collector Current	—	140	—	A		WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	267	347	μJ	$T_J = 150^\circ\text{C}$	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	$V_{GE} = 15V, R_G = 22\Omega$	CT4,WF3
Q_{rr}	Diode Reverse Recovery Charge	—	984	1279	nC	$di/dt = 875A/\mu s$	

① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 22\Omega.$

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

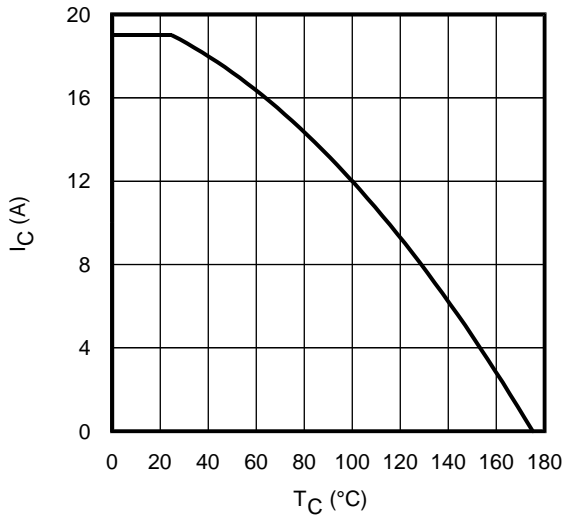


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

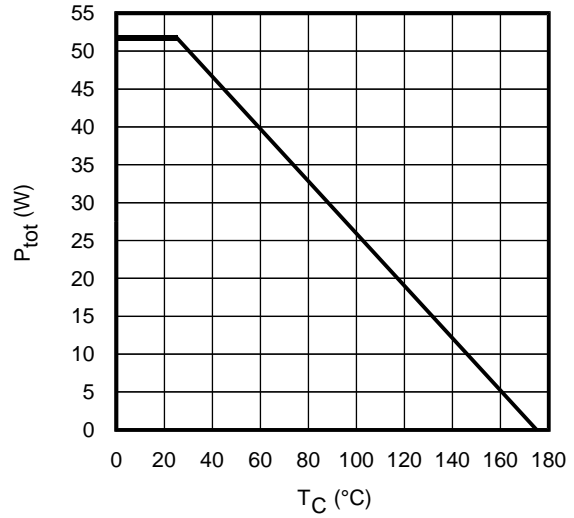


Fig. 2 - Power Dissipation vs. Case Temperature

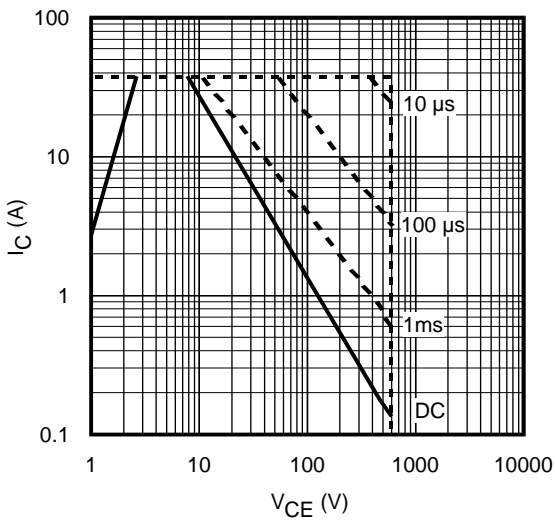


Fig. 3 - Forward SOA
 $T_C = 25^\circ\text{C}$; $T_J \leq 150^\circ\text{C}$

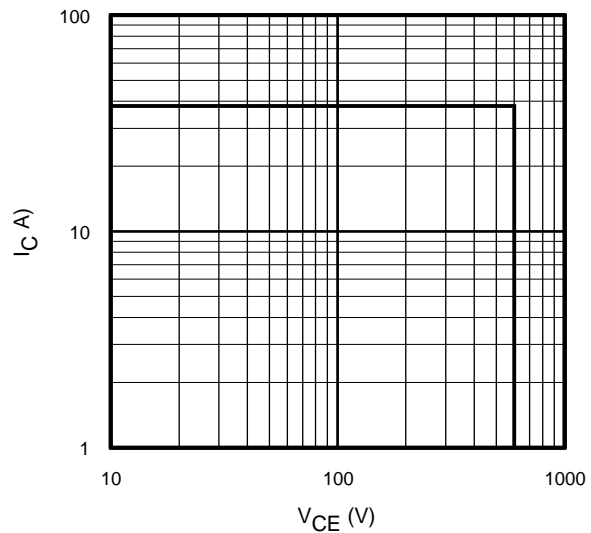


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 15\text{V}$

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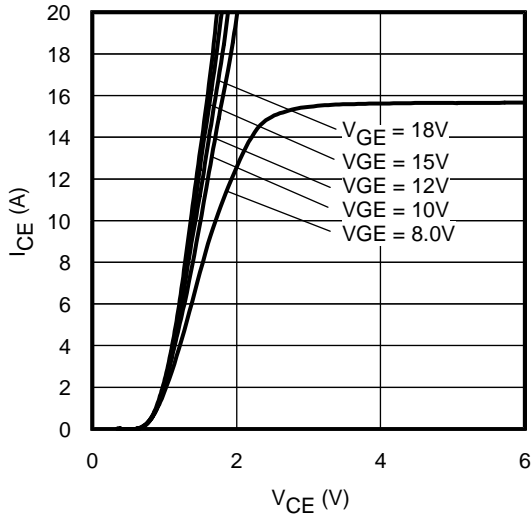


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 60\mu\text{s}$

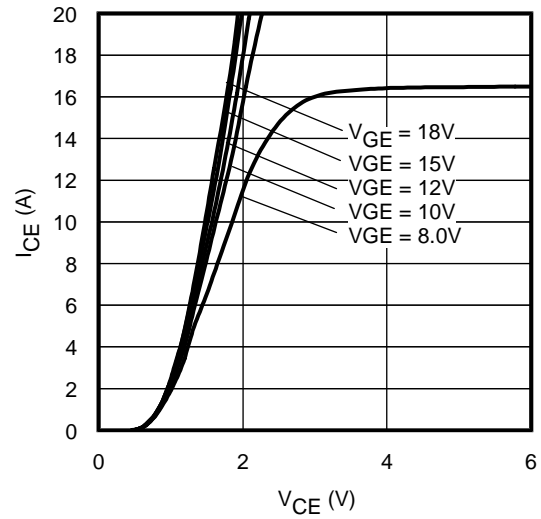


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 60\mu\text{s}$

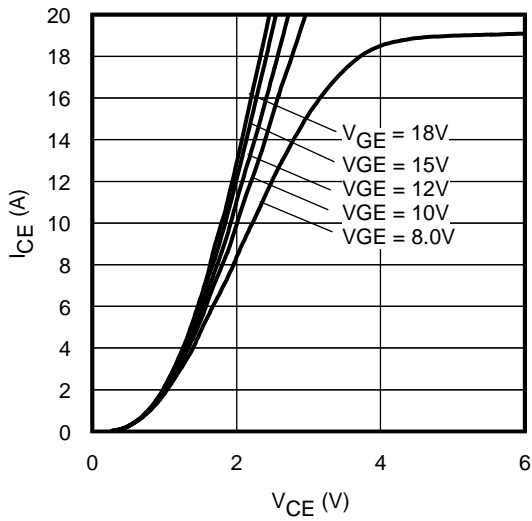


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 60\mu\text{s}$

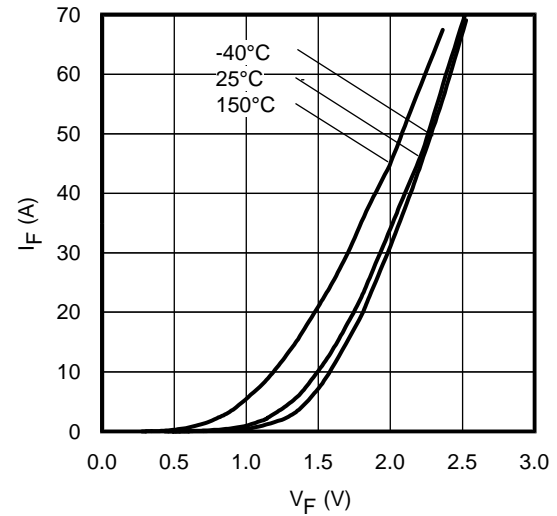


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 60\mu\text{s}$

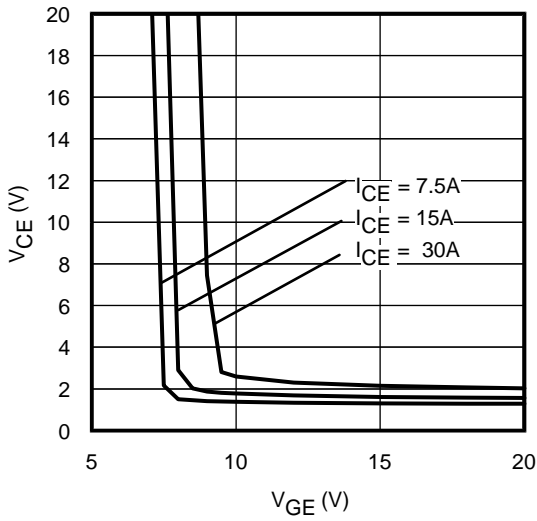


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

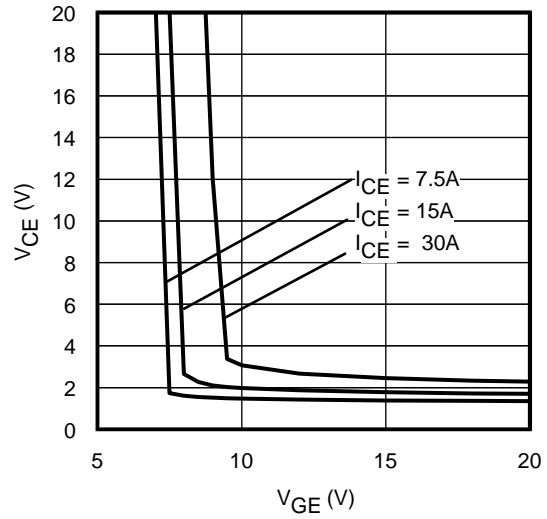


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

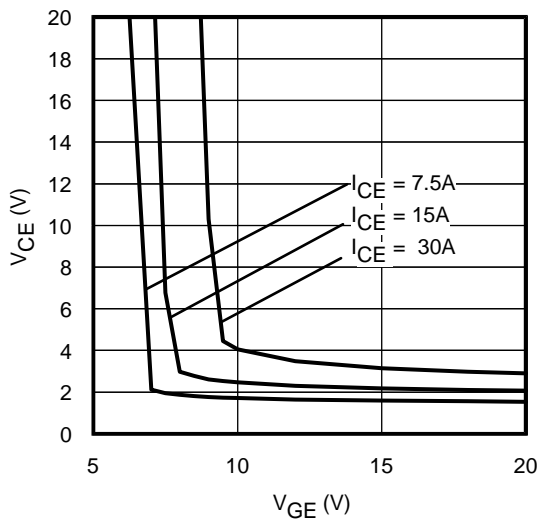


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

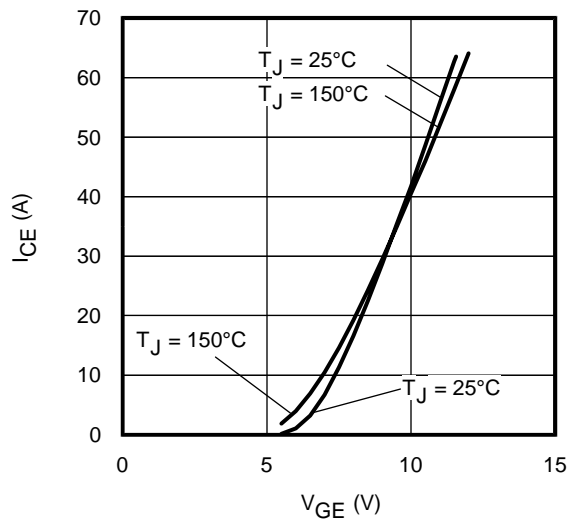


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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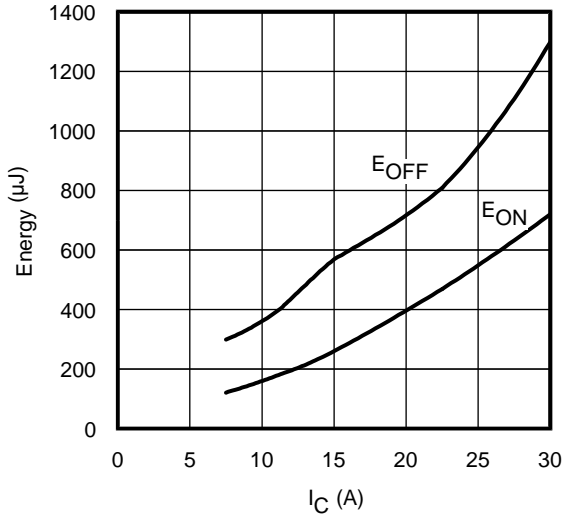


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 22Ω; V_{GE}= 15V

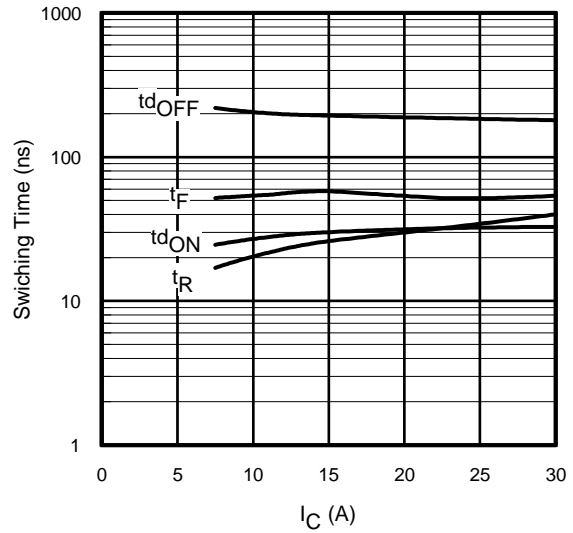


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=1.07mH; V_{CE}= 400V
R_G= 22Ω; V_{GE}= 15V

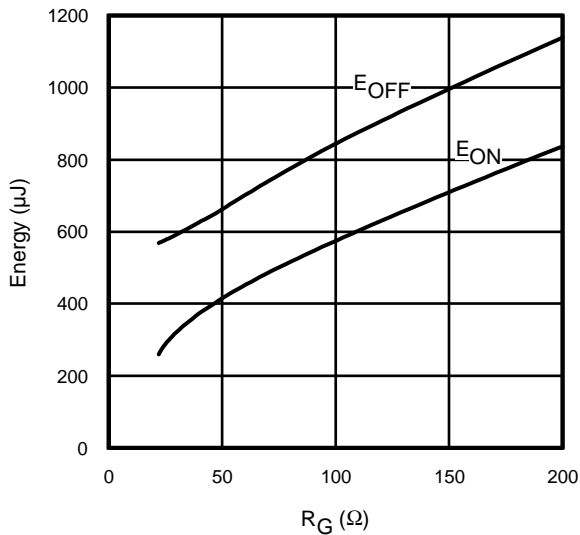


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 15A; V_{GE}= 15V

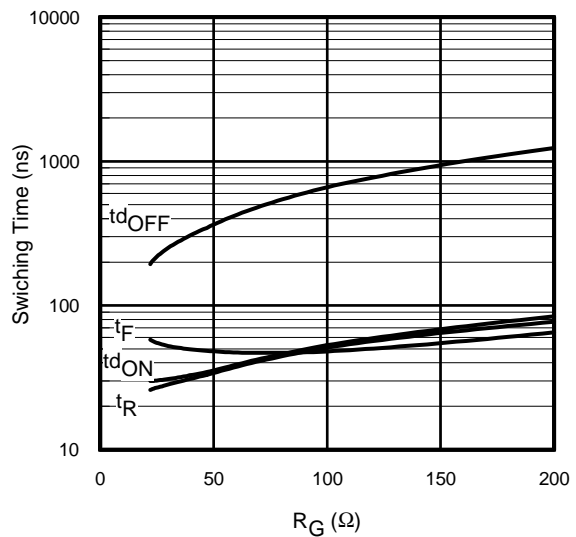


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=1.07mH; V_{CE}= 400V
I_{CE}= 15A; V_{GE}= 15V

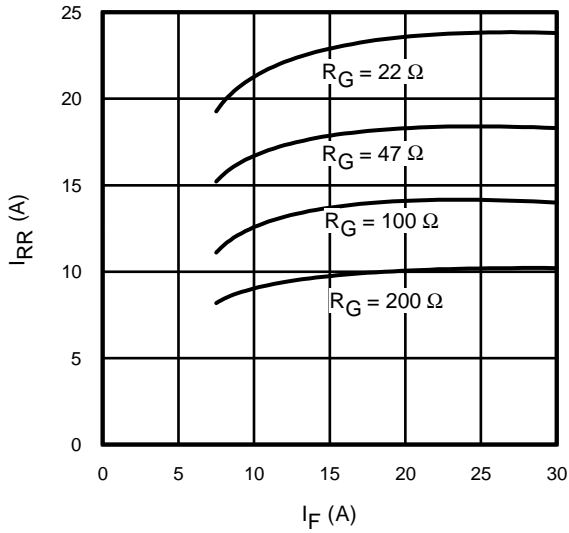


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

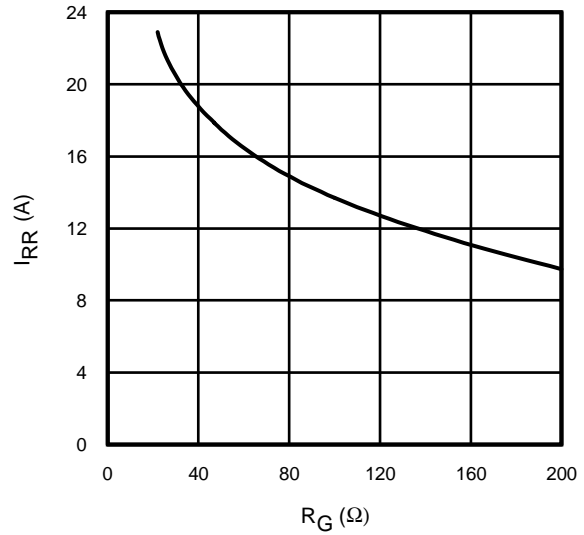


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150^\circ\text{C}$; $I_F = 15\text{A}$

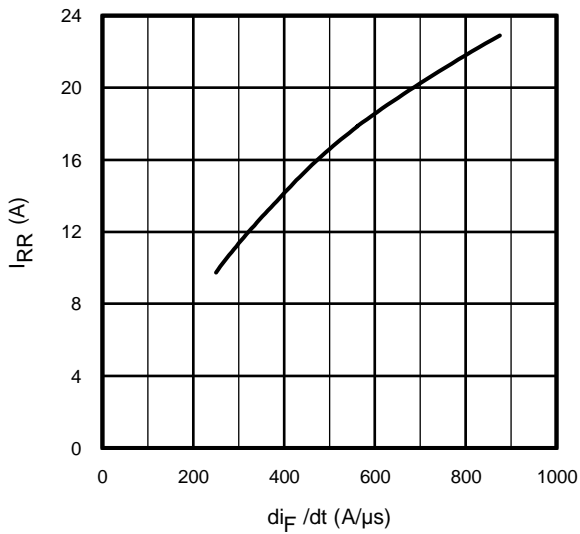


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$;
 $I_{CE} = 15\text{A}$; $T_J = 150^\circ\text{C}$

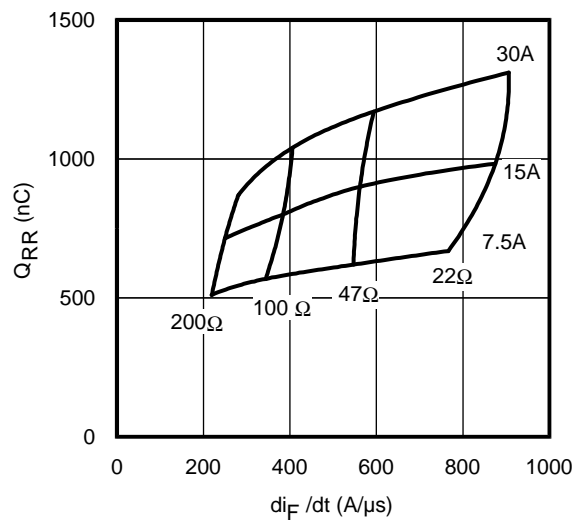


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 150^\circ\text{C}$

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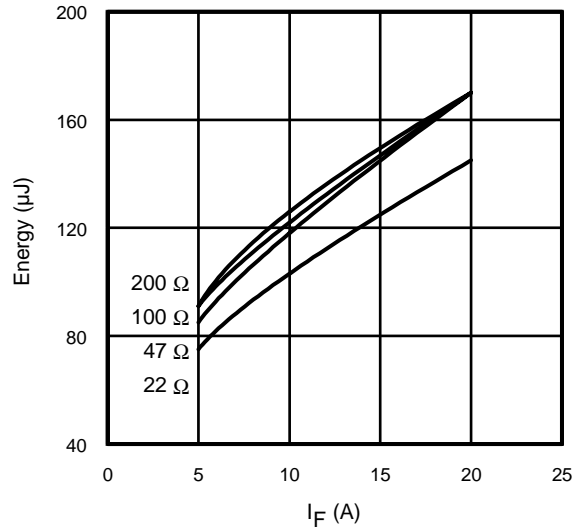


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

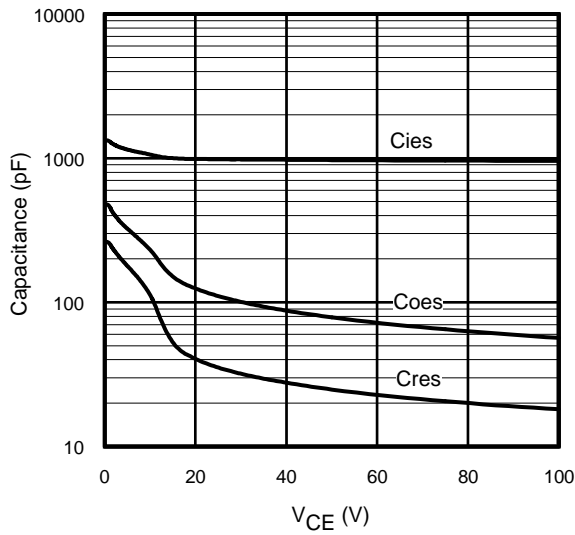


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

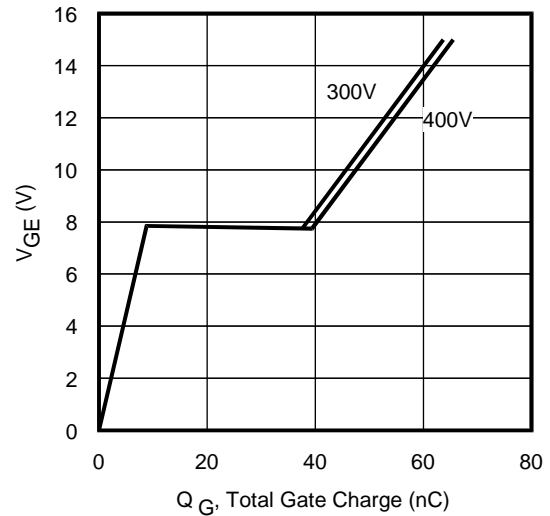


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 15\text{A}$; $L = 2500\ \mu\text{H}$

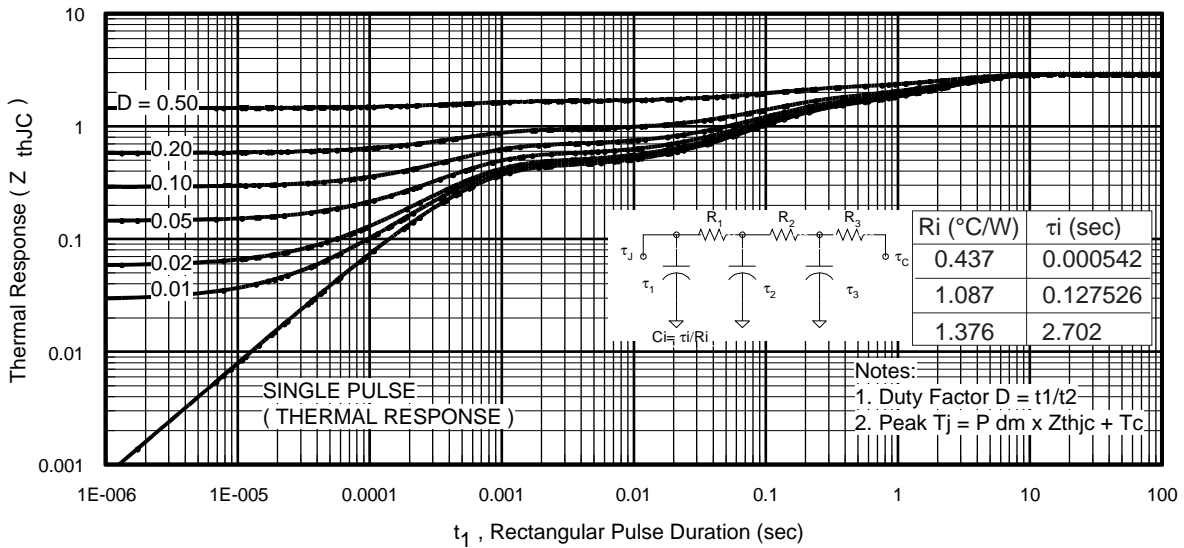


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

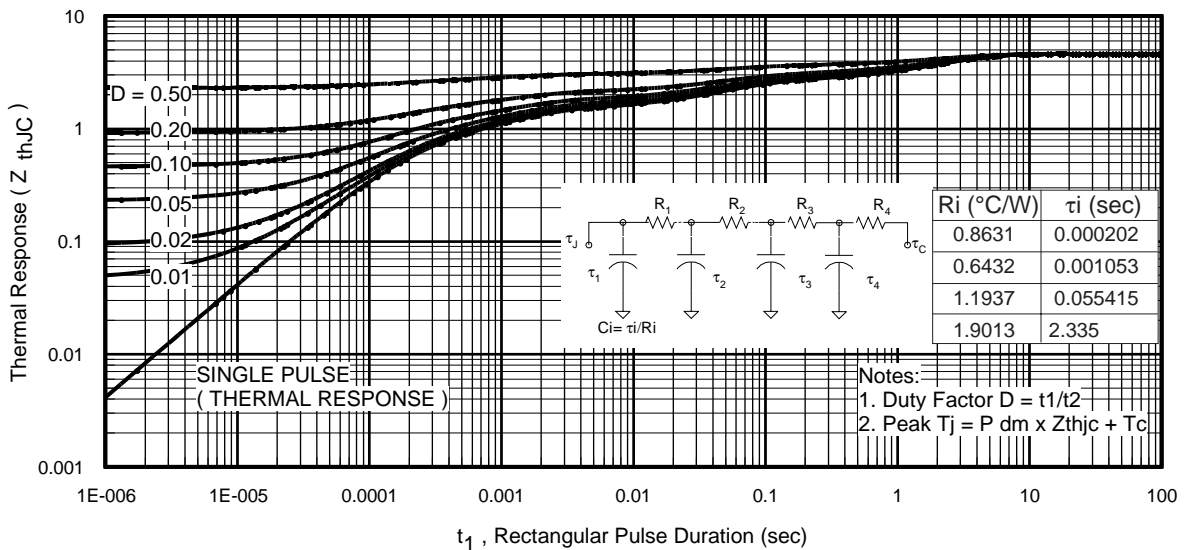


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

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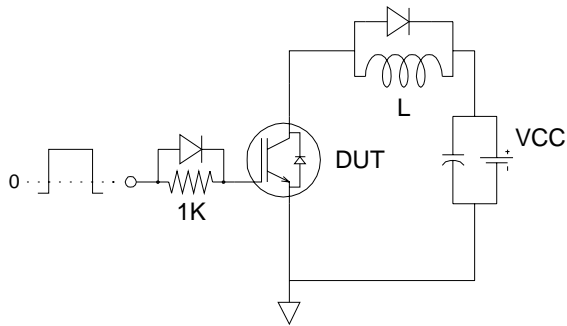


Fig.C.T.1 - Gate Charge Circuit (turn-off)

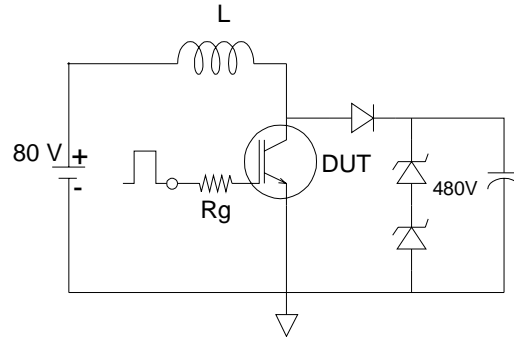


Fig.C.T.2 - RBSOA Circuit

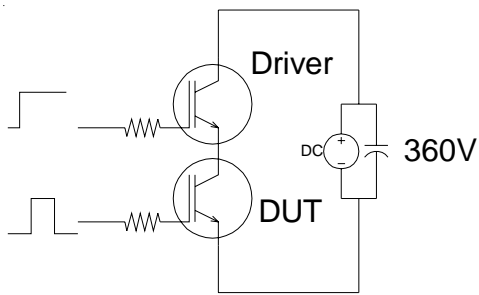


Fig.C.T.3 - S.C.SOA Circuit

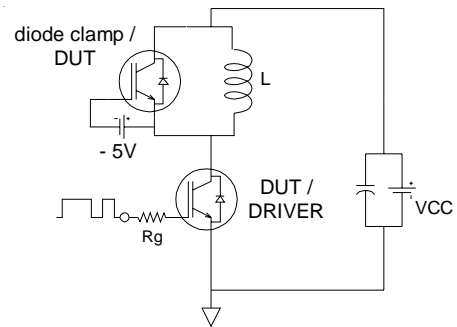


Fig.C.T.4 - Switching Loss Circuit

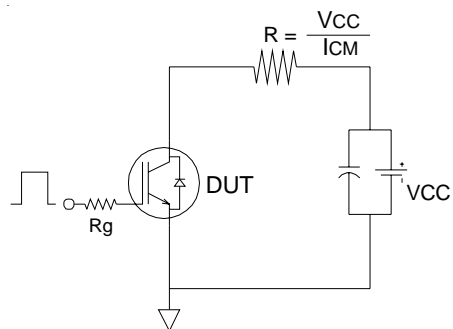


Fig.C.T.5 - Resistive Load Circuit

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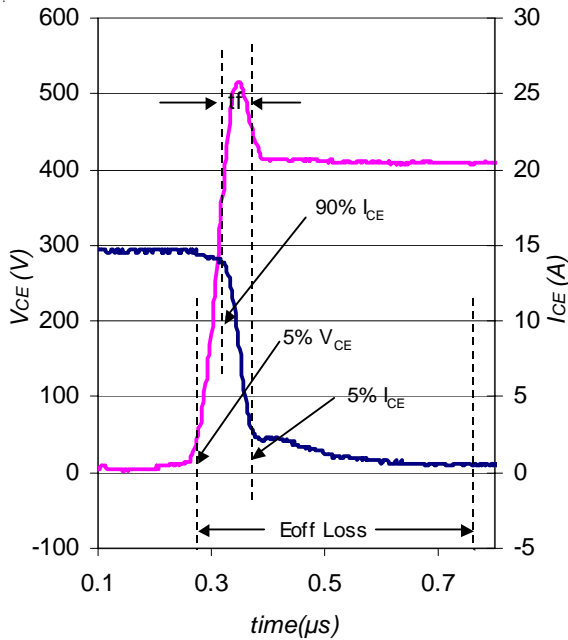


Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

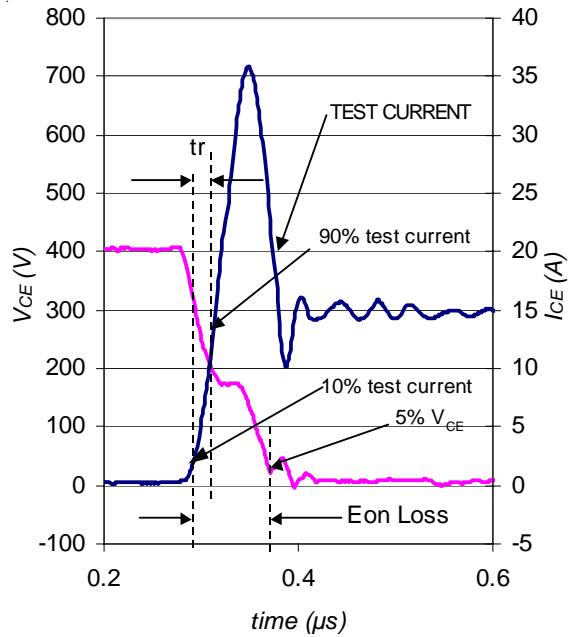


Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

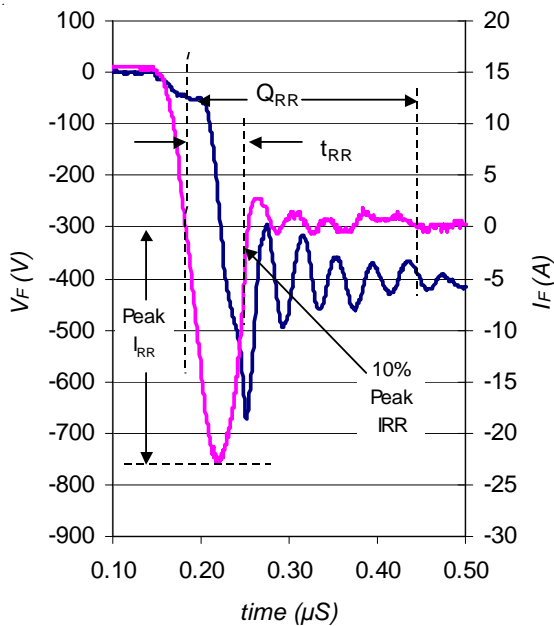


Fig. WF3- Typ. Diode Recovery Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

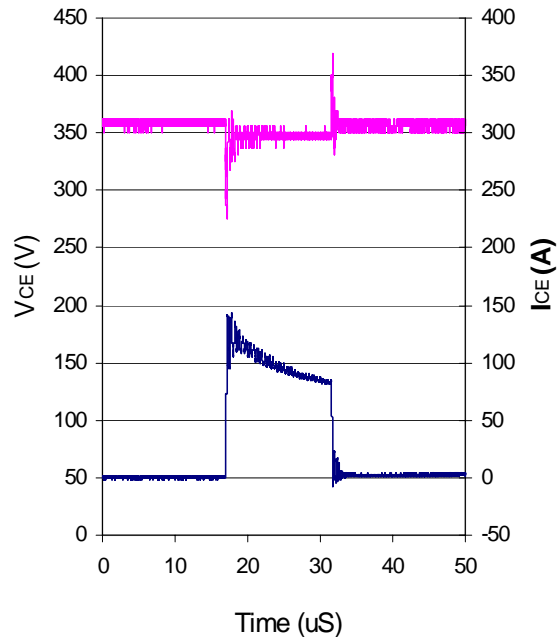


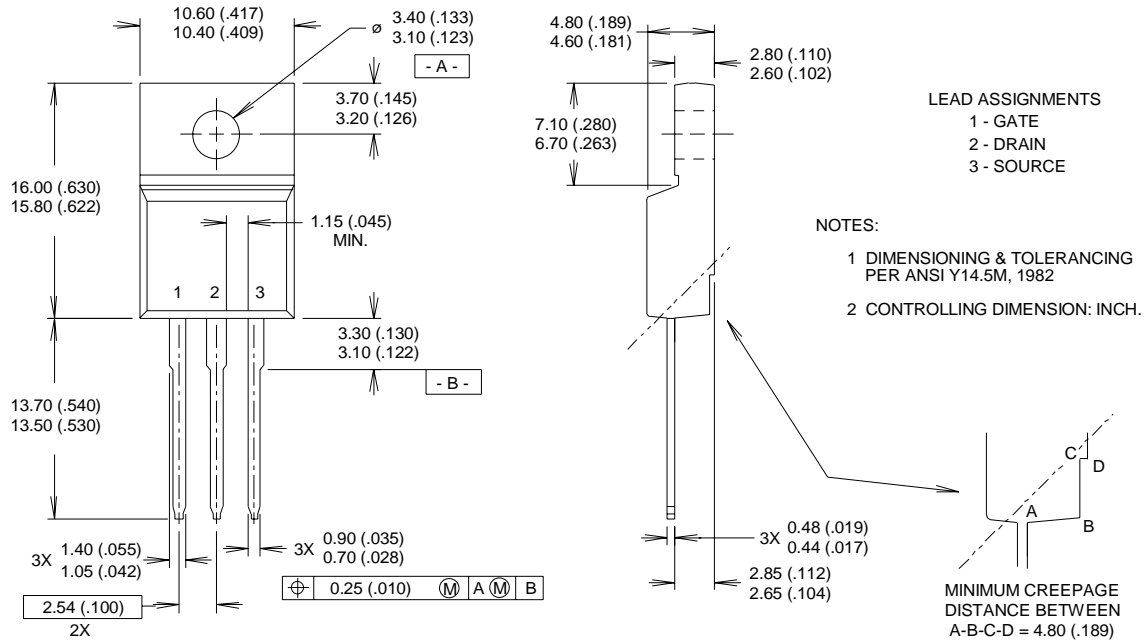
Fig. WF4- Typ. S.C. Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT.3

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TO-220 Full-Pak Package Outline

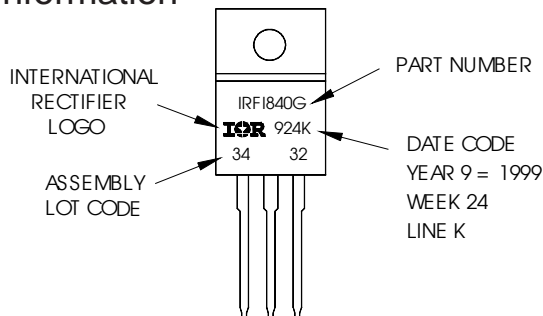
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Dimensions are shown in millimeters (inches)



TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRF1840G
 WITH ASSEMBLY
 LOT CODE 3432
 ASSEMBLED ON WW 24 1999
 IN THE ASSEMBLY LINE "K"



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.

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 TAC Fax: (310) 252-7903

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www.irf.com

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

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