

International IR Rectifier

PD- 94599A

IRGIB15B60KD1

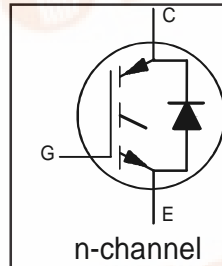
INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

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.



$V_{CES} = 600V$

$I_C = 12A, T_C = 100^\circ C$

$t_{sc} > 10\mu s, T_J = 150^\circ C$

$V_{CE(on)} \text{ typ.} = 1.80V$



TO-220
Full-Pak

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	$^\circ C$
T_J	Operating Junction and Storage Temperature Range	-55 to +175	
T_{STG}	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	$^\circ C/W$
$R_{\theta JC}$	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/°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/°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	$I_C = 15A$ $V_{CC} = 400V$ $V_{GE} = 15V$	23	
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	7.0	10			CT1	
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	26	39				
E_{on}	Turn-On Switching Loss	—	127	140	μJ	$I_C = 15A, V_{CC} = 400V$ $V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$ $L_s = 150nH, T_J = 25^\circ\text{C} \textcircled{2}$	CT4	
E_{off}	Turn-Off Switching Loss	—	334	422				
E_{tot}	Total Switching Loss	—	461	556				
$t_{d(on)}$	Turn-On delay time	—	30	39	ns	$I_C = 15A, V_{CC} = 400V$ $V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$ $L_s = 150nH, T_J = 25^\circ\text{C}$	CT4	
t_r	Rise time	—	25	35				
$t_{d(off)}$	Turn-Off delay time	—	173	188				
t_f	Fall time	—	41	53				
E_{on}	Turn-On Switching Loss	—	258	282				CT4
E_{off}	Turn-Off Switching Loss	—	570	646	μJ	13,15		
E_{tot}	Total Switching Loss	—	829	915		WF1,WF2		
$t_{d(on)}$	Turn-On delay time	—	30	39	ns	$I_C = 15A, V_{CC} = 400V$ $V_{GE} = 15V, R_G = 22\Omega, L = 1.07mH$ $L_s = 150nH, T_J = 150^\circ\text{C}$	14,16	
t_r	Rise time	—	25	35				CT4
$t_{d(off)}$	Turn-Off delay time	—	194	207				WF1
t_f	Fall time	—	56	73				WF2
L_E	Internal Emitter Inductance	—	7.5	—				nH
C_{ies}	Input Capacitance	—	850	1275	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$	22	
C_{oes}	Output Capacitance	—	100	150				
C_{res}	Reverse Transfer Capacitance	—	32	48				
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	$di/dt = 875A/\mu s$		

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

$\textcircled{2}$ Energy losses include "tail" and diode reverse recovery.

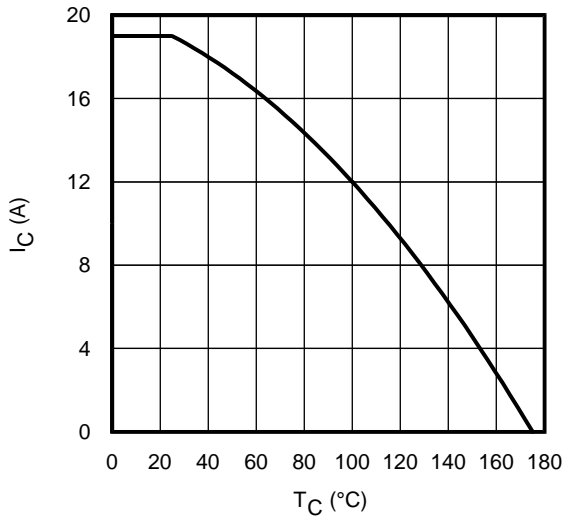


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

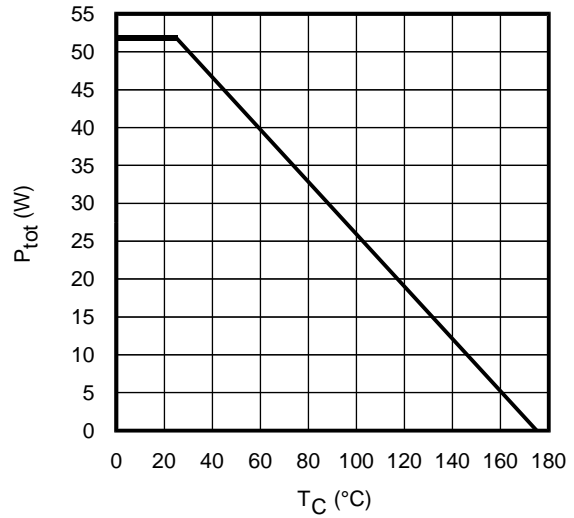


Fig. 2 - Power Dissipation vs. Case Temperature

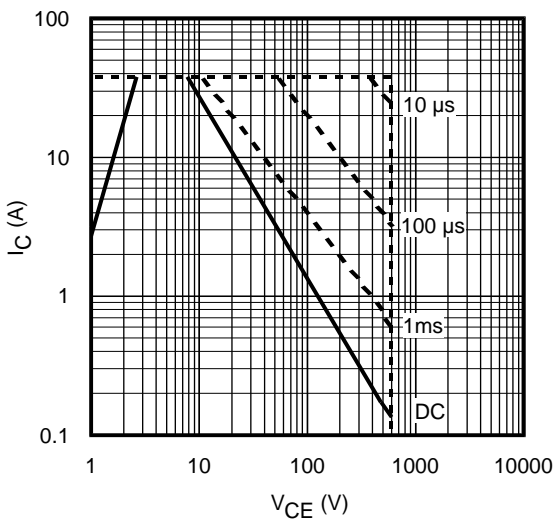


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}C$; $T_J \leq 150^{\circ}C$

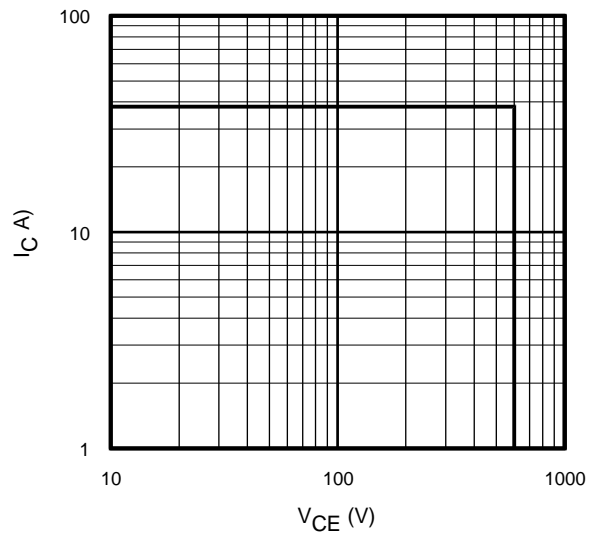


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}C$; $V_{GE} = 15V$

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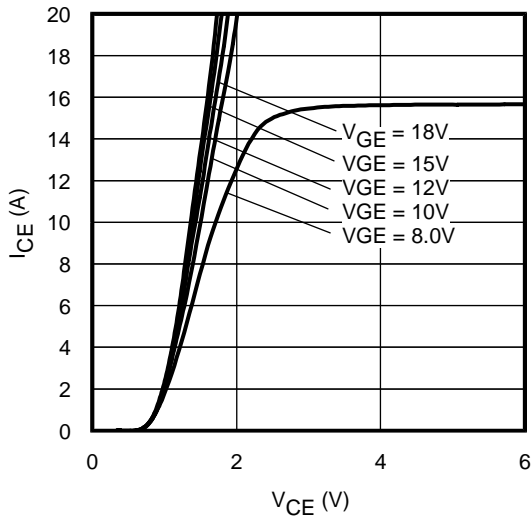


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 60\mu\text{s}$

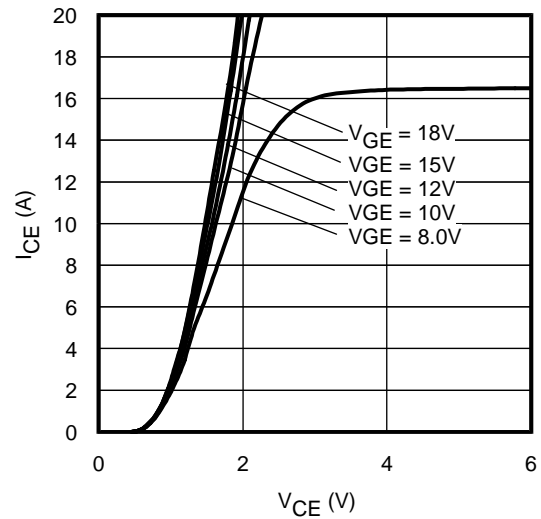


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 60\mu\text{s}$

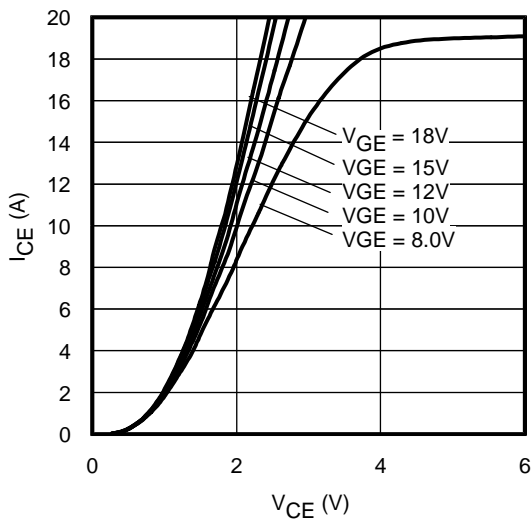


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 60\mu\text{s}$

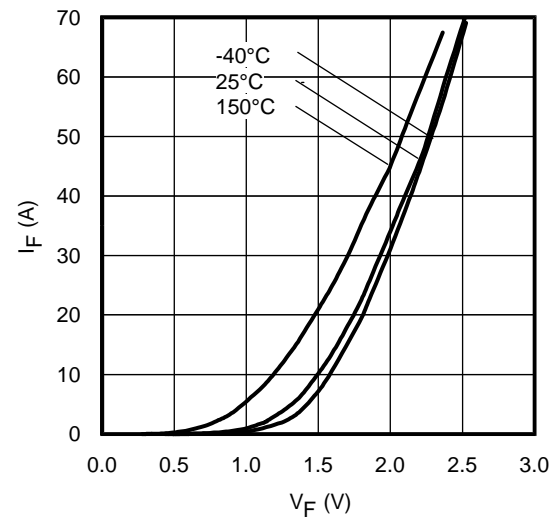


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 60\mu\text{s}$

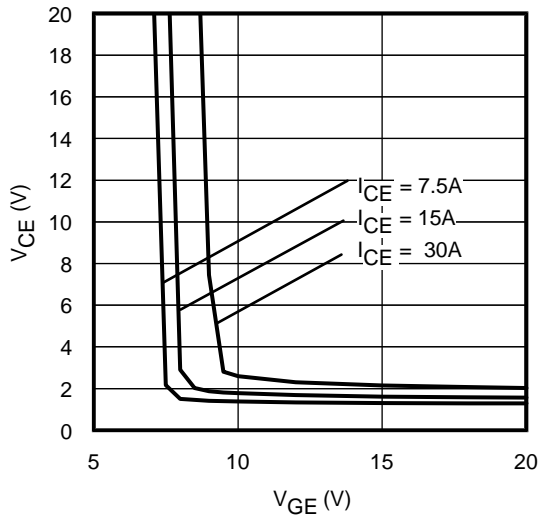


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

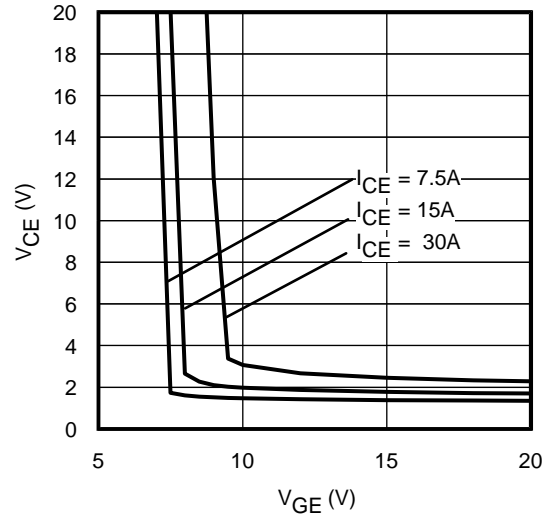


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

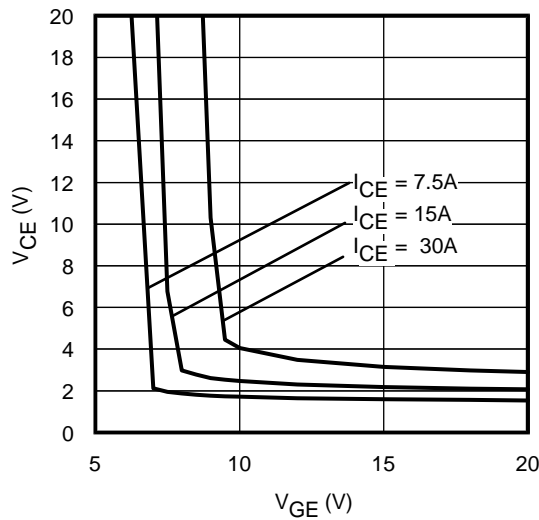


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

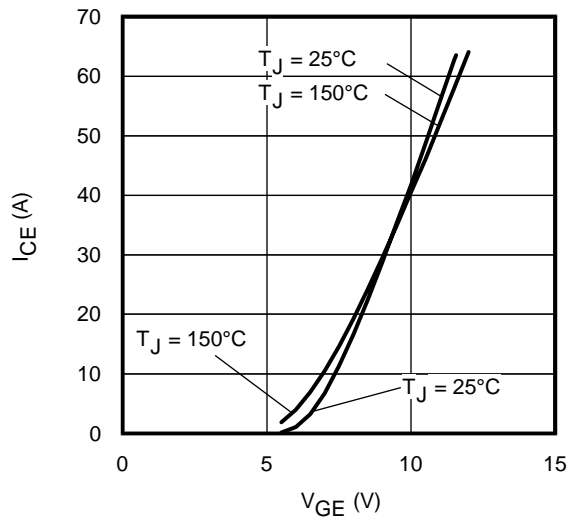


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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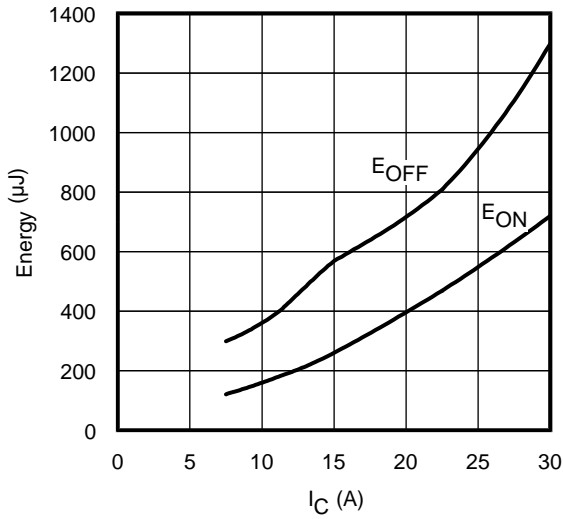


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 22\Omega$; $V_{GE}= 15\text{V}$

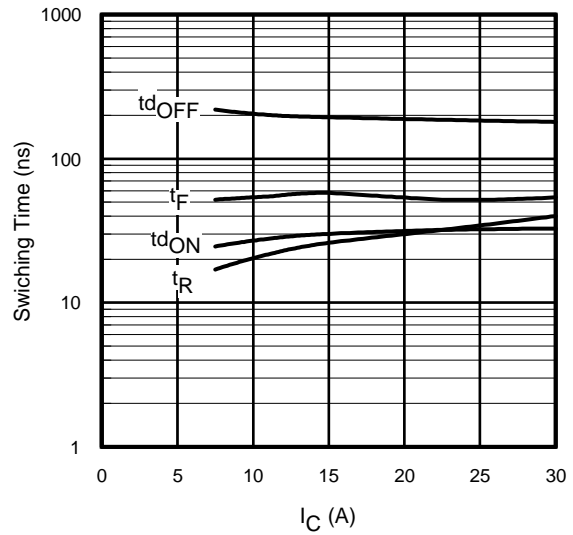


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 22\Omega$; $V_{GE}= 15\text{V}$

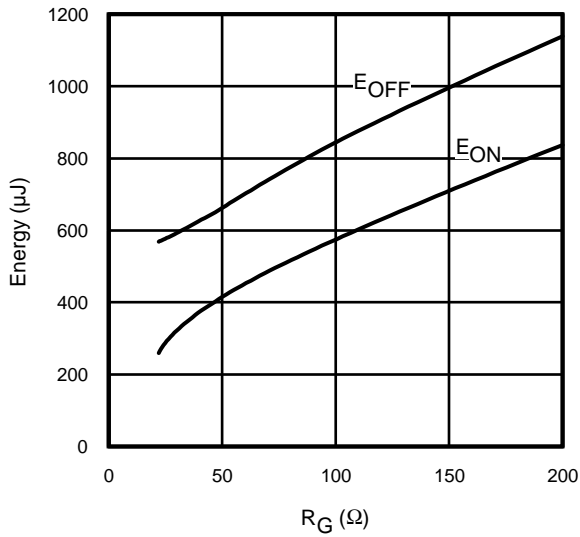


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 15\text{A}$; $V_{GE}= 15\text{V}$

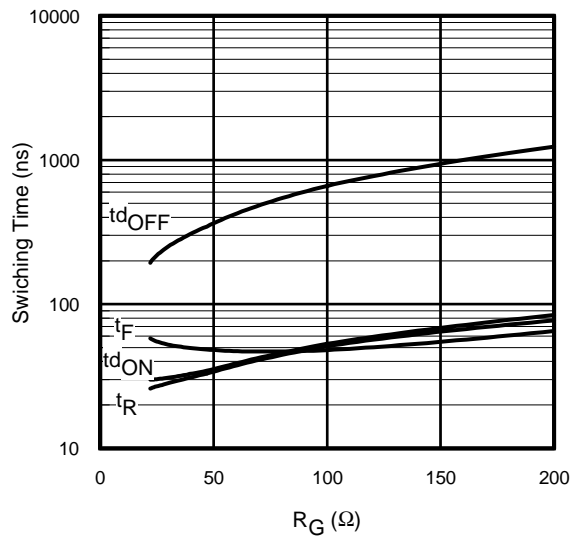


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.07\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 15\text{A}$; $V_{GE}= 15\text{V}$

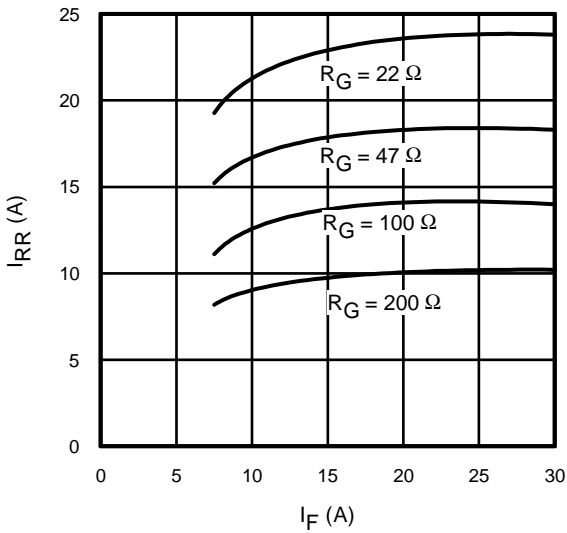


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

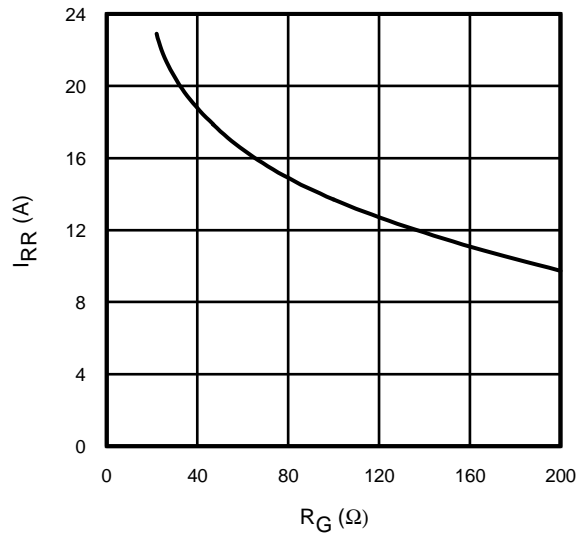


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 150^\circ\text{C}$; $I_F = 15\text{A}$

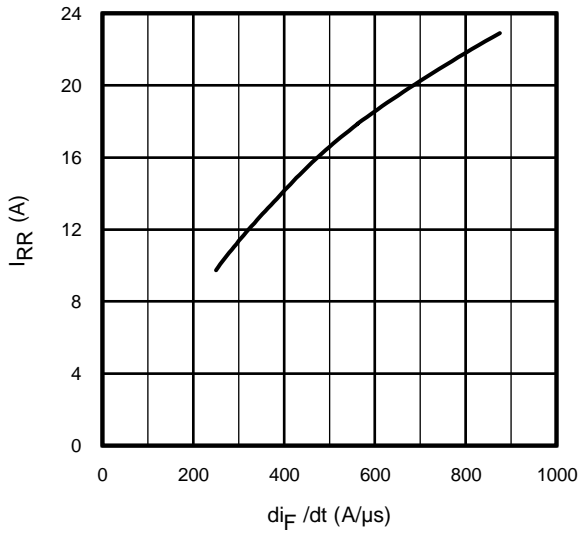


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$;
 $I_{CE} = 15\text{A}$; $T_J = 150^\circ\text{C}$

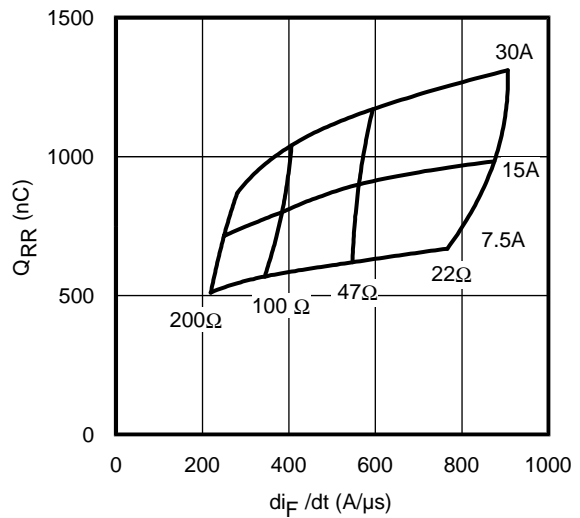


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 150^\circ\text{C}$

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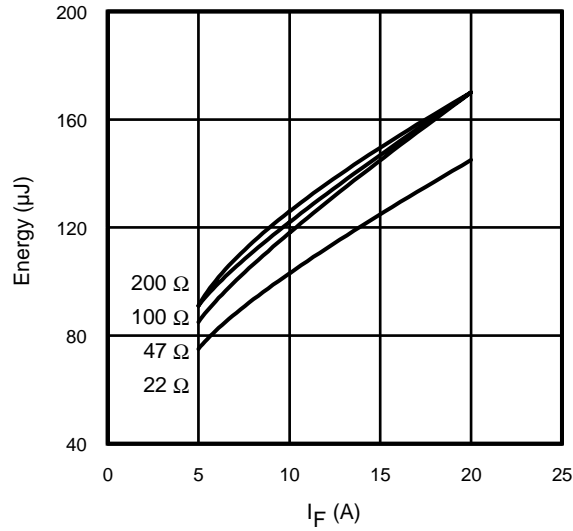


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 150^\circ\text{C}$

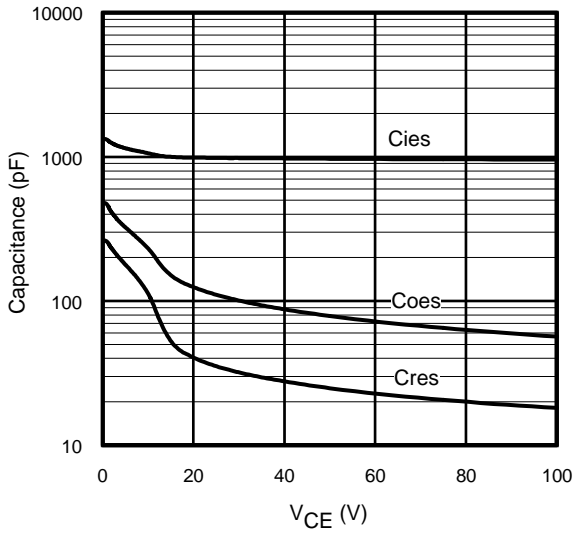


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

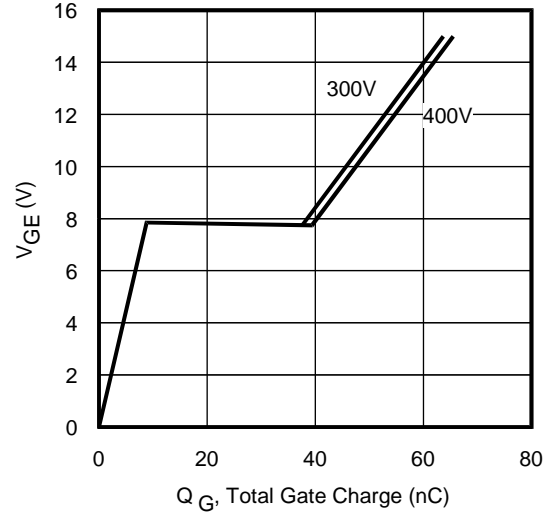


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 15\text{A}$; $L = 2500\ \mu\text{H}$

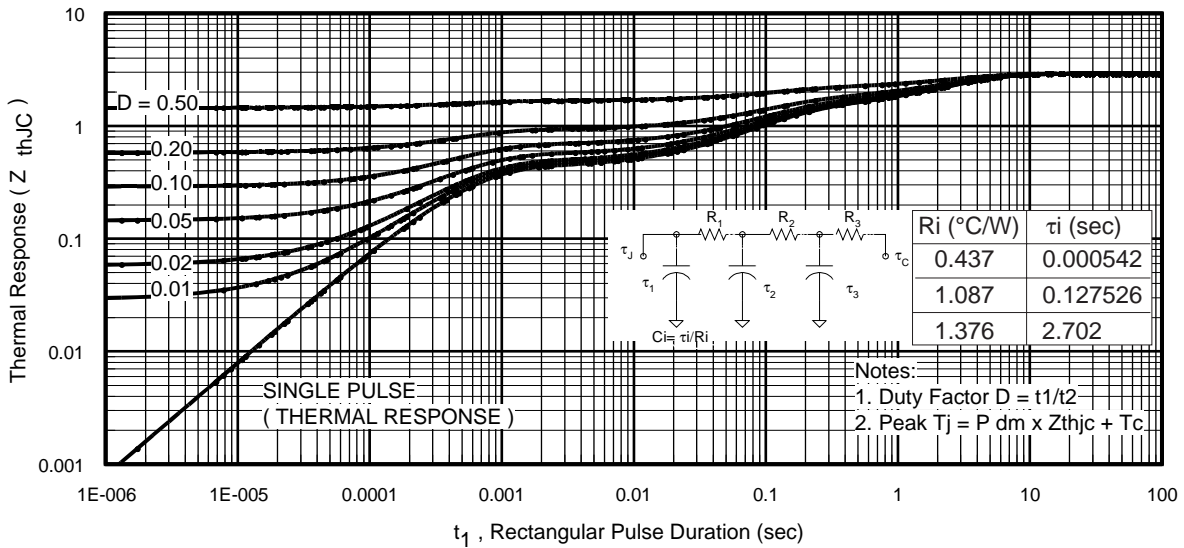


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

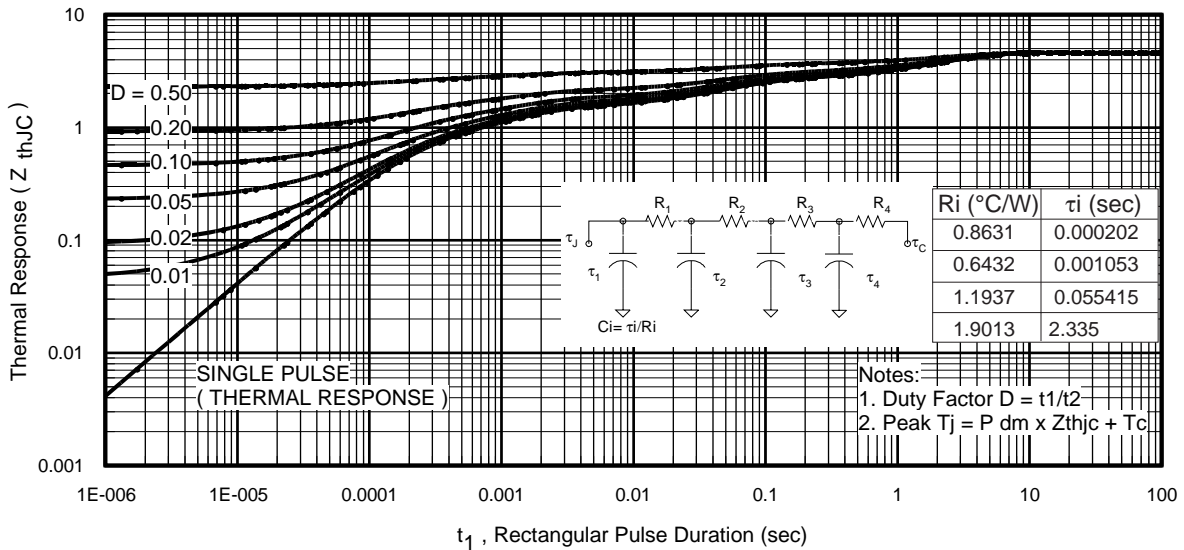


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

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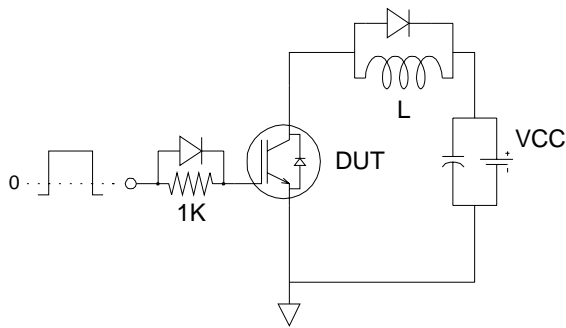


Fig.C.T.1 - Gate Charge Circuit (turn-off)

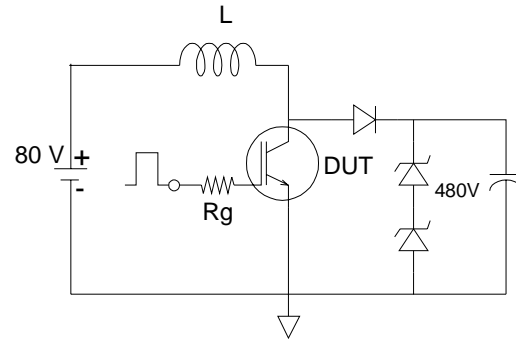


Fig.C.T.2 - RBSOA Circuit

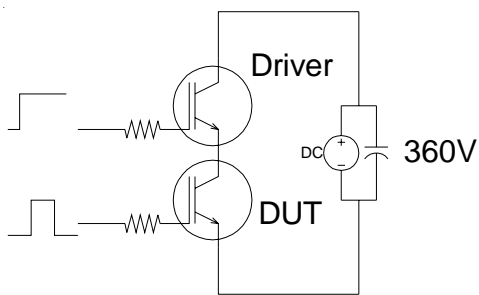


Fig.C.T.3 - S.C.SOA Circuit

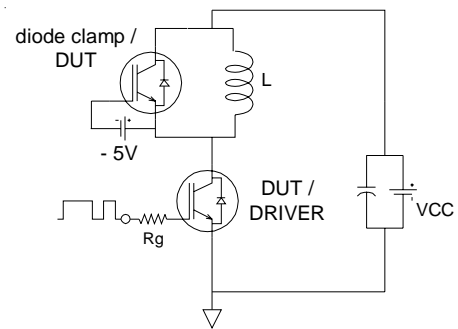


Fig.C.T.4 - Switching Loss Circuit

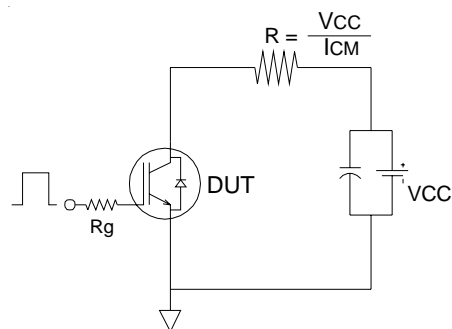


Fig.C.T.5 - Resistive Load Circuit

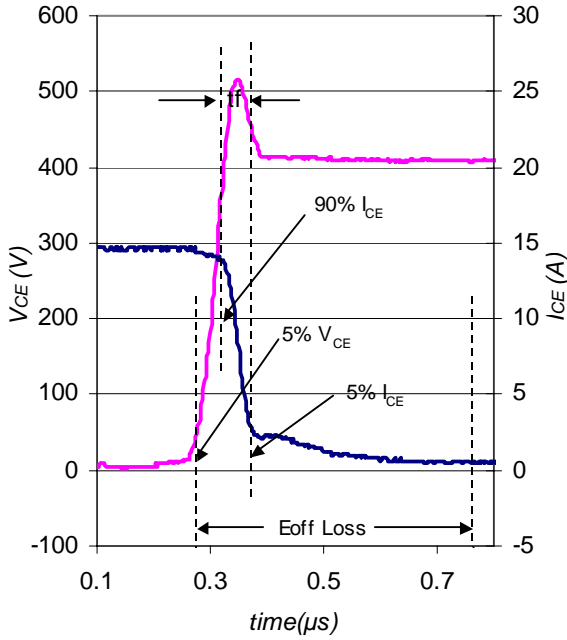


Fig. WF1- Typ. Turn-off Loss Waveform
 @ T_J = 150°C using Fig. CT.4

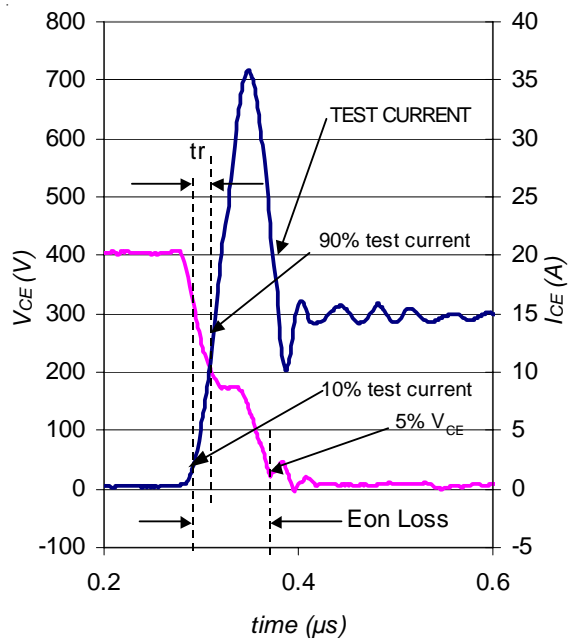


Fig. WF2- Typ. Turn-on Loss Waveform
 @ T_J = 150°C using Fig. CT.4

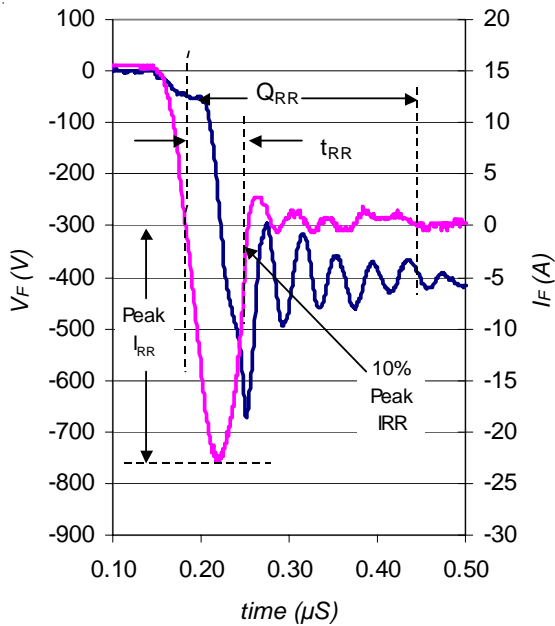


Fig. WF3- Typ. Diode Recovery Waveform
 @ T_J = 150°C using Fig. CT.4

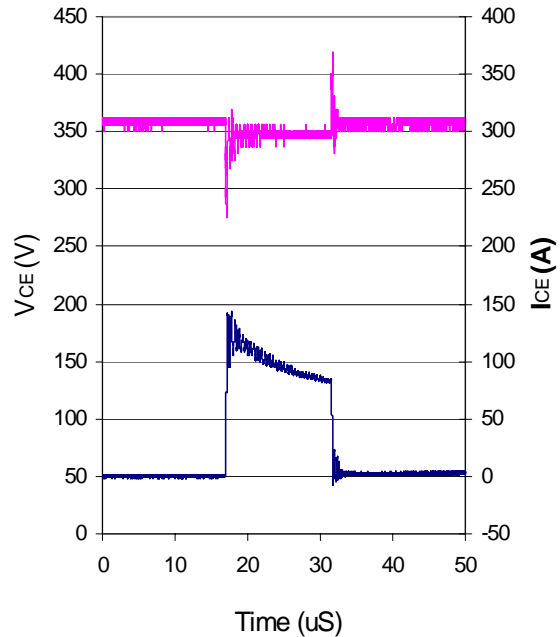


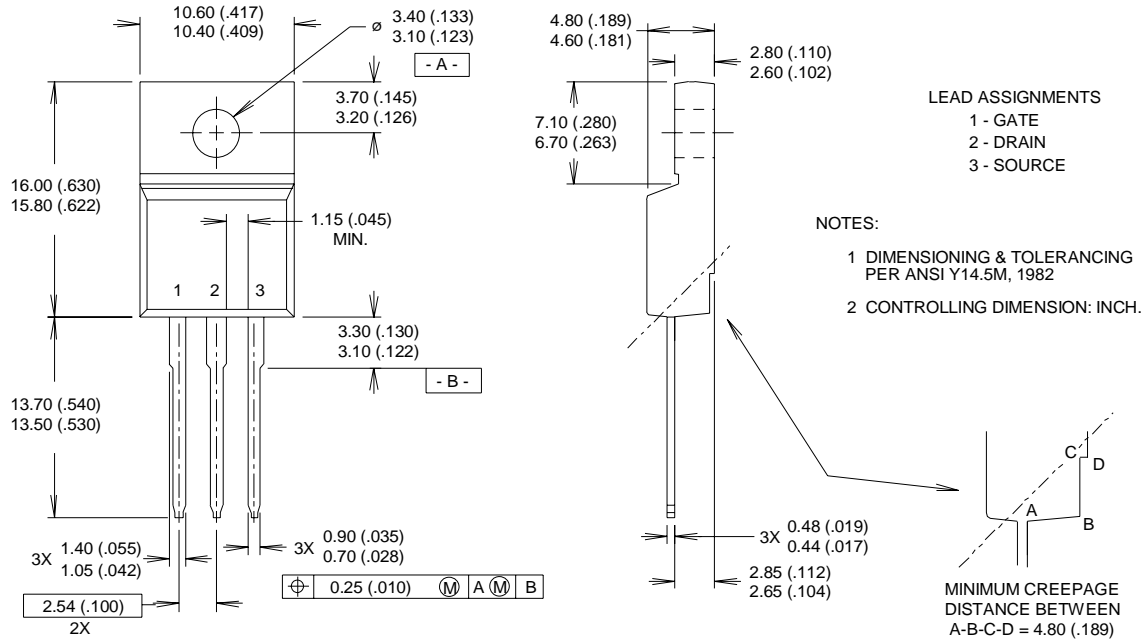
Fig. WF4- Typ. S.C. Waveform
 @ T_C = 150°C using Fig. CT.3

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TO-220 Full-Pak Package Outline

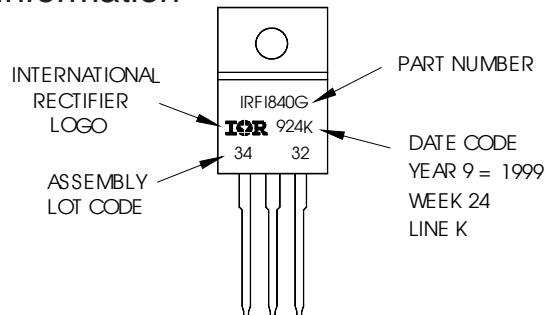
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Dimensions are shown in millimeters (inches)



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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