

IRGPS40B120UD

INSULATED GATE BIPOLAR TRANSISTOR WITH
 ULTRAFast SOFT RECOVERY DIODE

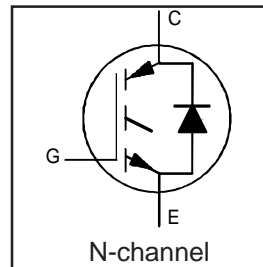
UltraFast Co-Pack IGBT

Features

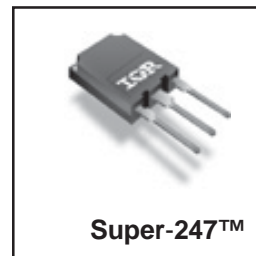
- Non Punch Through IGBT Technology.
- Low Diode VF.
- 10 μ s Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- Super-247 Package.

Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Significantly Less Snubber Required
- Excellent Current Sharing in Parallel Operation.



$V_{CES} = 1200V$
$V_{CE(on)} \text{ typ.} = 3.12V$
@ $V_{GE} = 15V,$
$I_{CE} = 40A, T_j = 25^\circ C$



Absolute Maximum Ratings

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	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	80	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	40	
I_{CM}	Pulsed Collector Current	160	
I_{LM}	Clamped Inductive Load Current $\text{\textcircled{D}}$	160	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	80	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	40	
I_{FM}	Diode Maximum Forward Current	160	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	595	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	238	
T_J	Operating Junction and	-55 to +150	$^\circ C$
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.20	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.83	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	40	
	Recommended Clip Force	20 (2)	—	—	N(kgf)
Wt	Weight	—	6.0 (0.21)	—	g (oz)
Le	Internal Emitter Inductance (5mm from package)	—	13	—	nH

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IR RectifierElectrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	$V_{GE} = 0V, I_C = 500\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.40	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	3.12	3.40	V	$I_C = 40A, V_{GE} = 15V$ $I_C = 50A$ $I_C = 40A, T_J = 125^\circ\text{C}$ $I_C = 50A, T_J = 125^\circ\text{C}$	5, 6
		—	3.39	3.70			7, 9
		—	3.88	4.30			10
		—	4.24	4.70			11
$V_{GE(th)}$	Gate Threshold Voltage	4.0	5.0	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$	9,10
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	11, 12
g_{fe}	Forward Transconductance	—	30.5	—	S	$V_{CE} = 50V, I_C = 40A, PW=80\mu s$	
I_{CES}	Zero Gate Voltage Collector Current	—	—	500	μA	$V_{GE} = 0V, V_{CE} = 1200V$	
		—	420	1200		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 125^\circ\text{C}$	
V_{FM}	Diode Forward Voltage Drop	—	2.03	2.40	V	$I_C = 40A$	8
		—	2.17	2.60		$I_C = 50A$	
		—	2.26	2.68		$I_C = 40A, T_J = 125^\circ\text{C}$	
		—	2.46	2.95		$I_C = 50A, T_J = 125^\circ\text{C}$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$	

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)	—	340	510	nC	$I_C = 40A$	23
Q_{ge}	Gate - Emitter Charge (turn-on)	—	40	60		$V_{CC} = 600V$	CT1
Q_{gc}	Gate - Collector Charge (turn-on)	—	165	248		$V_{GE} = 15V$	
E_{on}	Turn-On Switching Loss	—	1400	1750	μJ	$I_C = 40A, V_{CC} = 600V$	CT4
E_{off}	Turn-Off Switching Loss	—	1650	2050		$V_{GE} = 15V, R_G = 4.7\Omega, L = 200\mu H$	WF1
E_{tot}	Total Switching Loss	—	3050	3800	μJ	$L_s = 150nH, T_J = 25^\circ\text{C}$	WF2
E_{on}	Turn-On Switching Loss	—	1950	2300		$T_J = 125^\circ\text{C}$	13,15
E_{off}	Turn-Off Switching Loss	—	2200	2950		Energy losses include "tail" and diode reverse recovery.	
E_{tot}	Total Switching Loss	—	4150	5250			
$t_{d(on)}$	Turn-On Delay Time	—	76	99	ns	$I_C = 40A, V_{CC} = 600V$	14, 16
t_r	Rise Time	—	39	55		$V_{GE} = 15V, R_G = 4.7\Omega, L = 200\mu H$	CT4
$t_{d(off)}$	Turn-Off Delay Time	—	332	365		$L_s = 150nH, T_J = 125^\circ\text{C}$	WF1
t_f	Fall Time	—	25	33			WF2
C_{ies}	Input Capacitance	—	4300	—	pF	$V_{GE} = 0V$	22
C_{oes}	Output Capacitance	—	330	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	160	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 160A, V_p = 1200V$ $V_{CC} = 1000V, V_{GE} = +15V \text{ to } 0V$ $R_G = 4.7\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_p = 1200V$ $V_{CC} = 900V, V_{GE} = +15V \text{ to } 0V,$ $R_G = 4.7\Omega$	CT3 WF4
E_{rec}	Reverse Recovery energy of the diode	—	3346	—	μJ	$T_J = 125^\circ\text{C}$	17,18,19
t_{rr}	Diode Reverse Recovery time	—	180	—	ns	$V_{CC} = 600V, I_F = 60A, L = 200\mu H$	20, 21
I_{rr}	Diode Peak Reverse Recovery Current	—	50	—	A	$V_{GE} = 15V, R_G = 4.7\Omega, L_s = 150nH$	CT4, WF3

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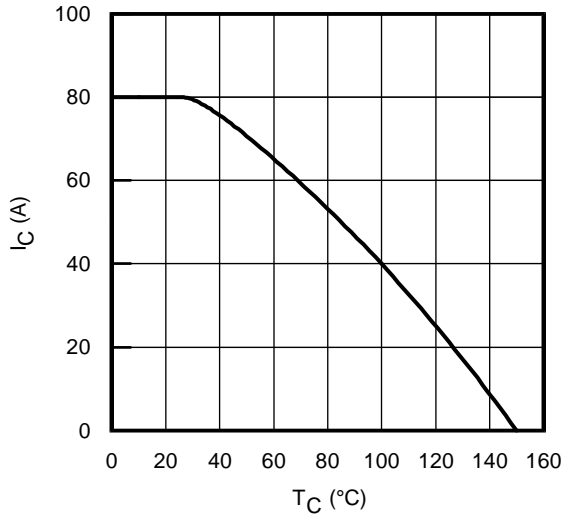


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

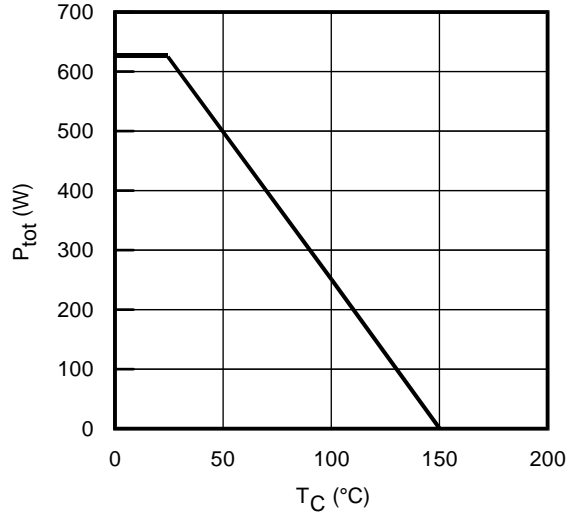


Fig. 2 - Power Dissipation vs. Case Temperature

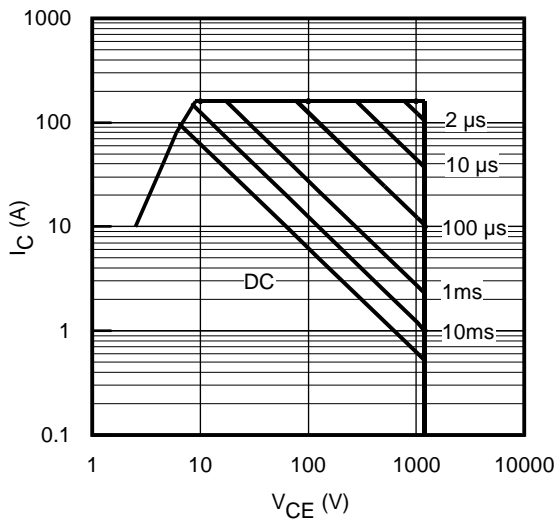


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}C$; $T_{JS} \leq 150^{\circ}C$

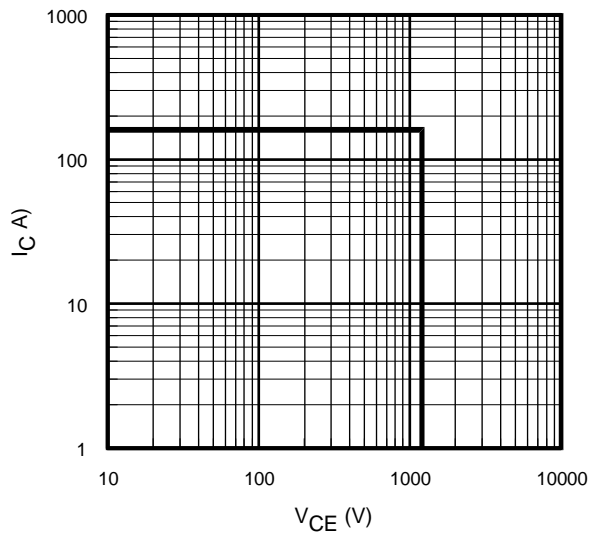


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}C$; $V_{GE} = 15V$

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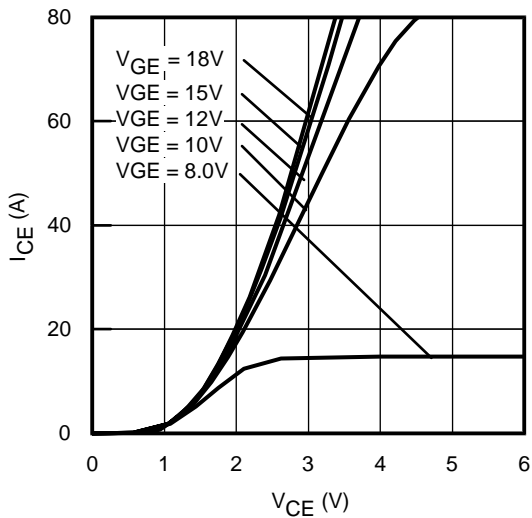


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

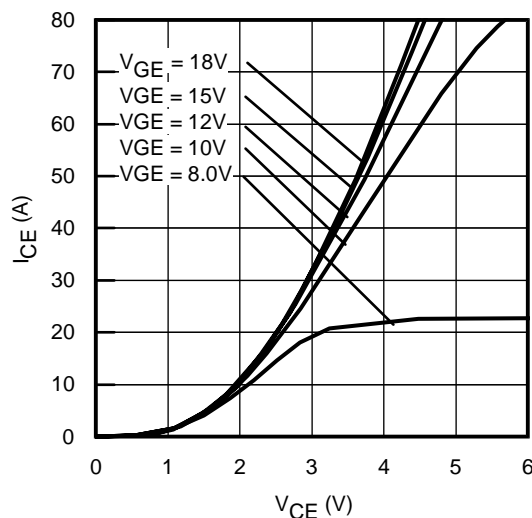


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

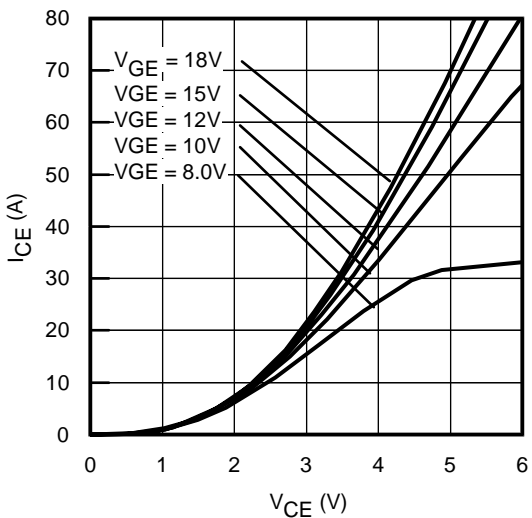


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 125^\circ\text{C}$; $t_p = 80\mu\text{s}$

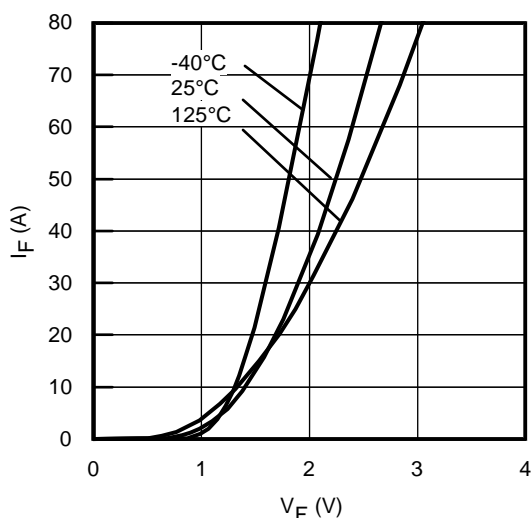


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

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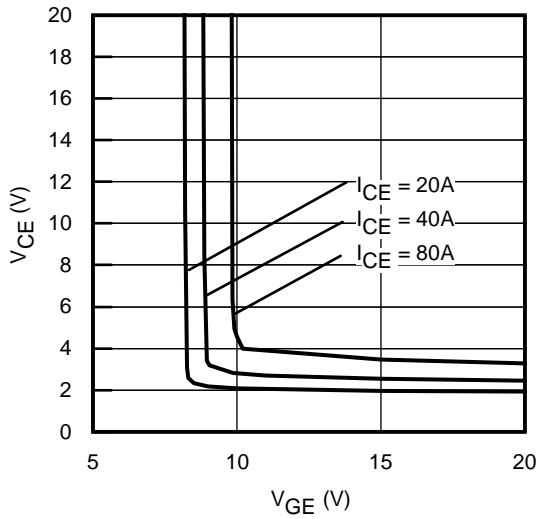


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

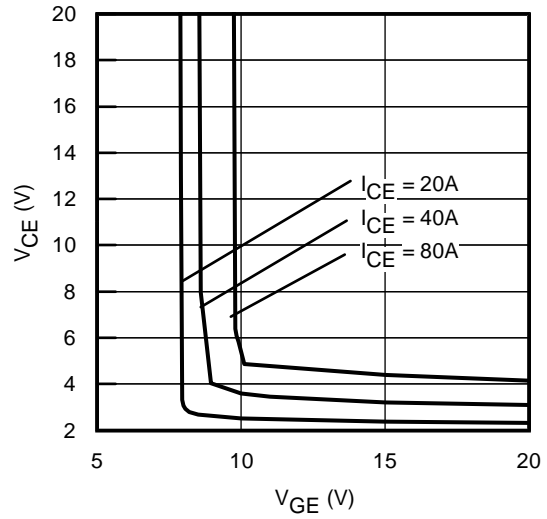


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

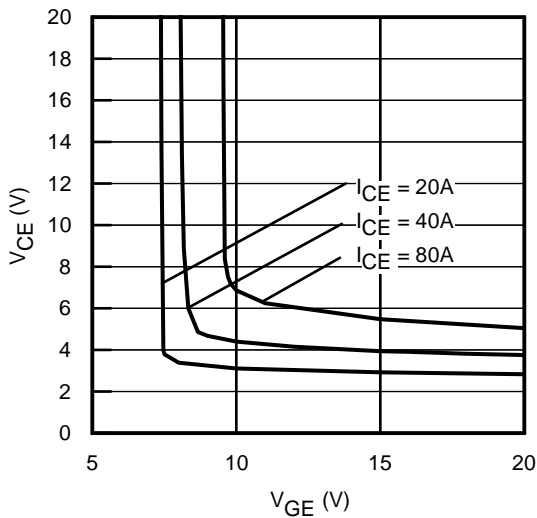


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 125^\circ\text{C}$

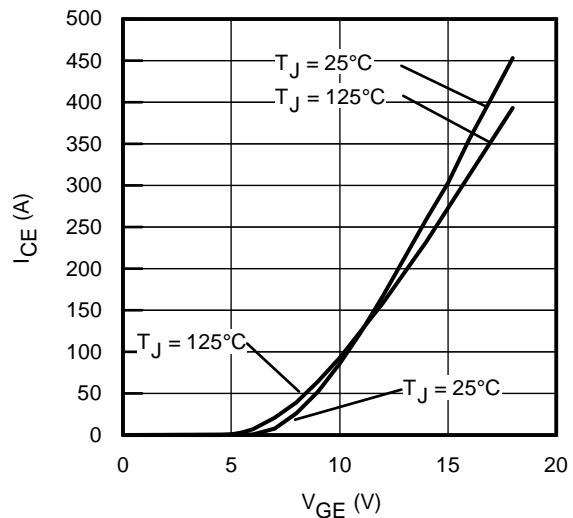


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

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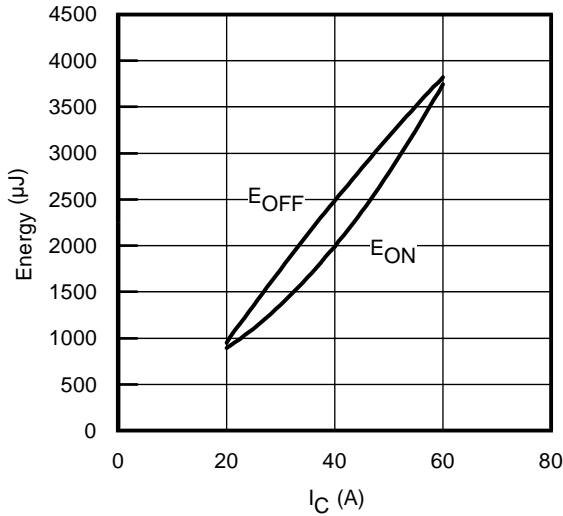


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE}= 600\text{V}$
 $R_G= 4.7\Omega$; $V_{GE}= 15\text{V}$

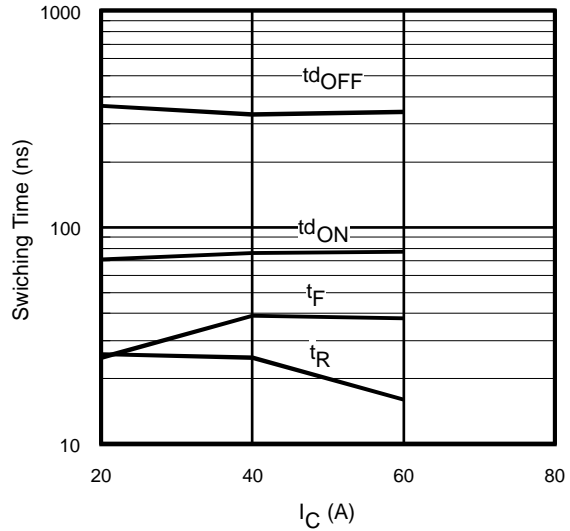


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE}= 600\text{V}$
 $R_G= 4.7\Omega$; $V_{GE}= 15\text{V}$

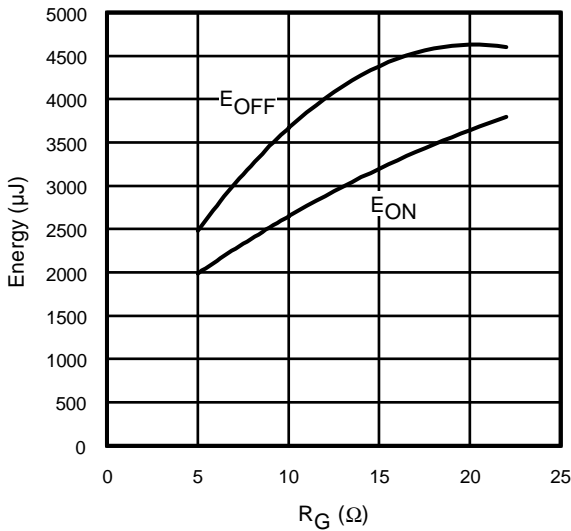


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE}= 600\text{V}$
 $I_{CE}= 40\text{A}$; $V_{GE}= 15\text{V}$

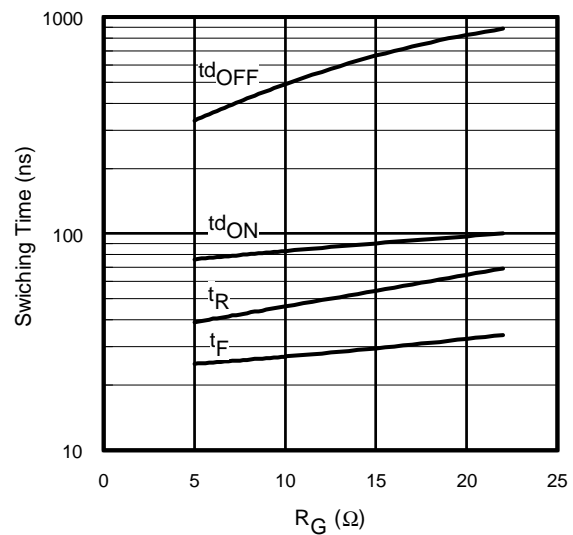


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE}= 600\text{V}$
 $I_{CE}= 40\text{A}$; $V_{GE}= 15\text{V}$

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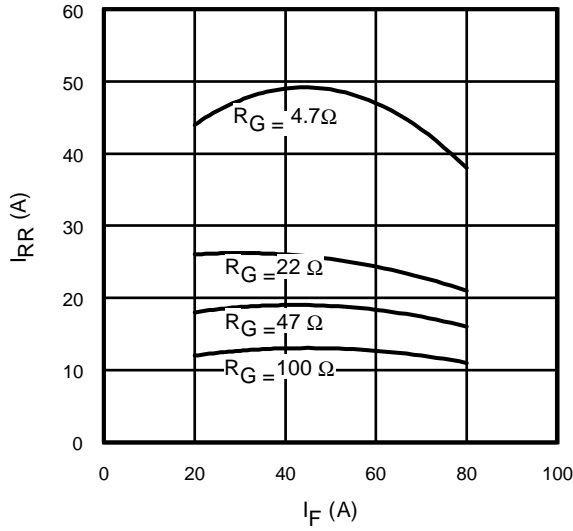


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

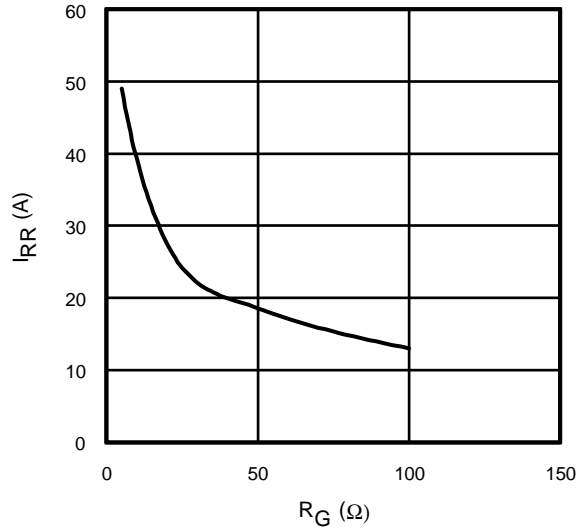


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}; I_F = 40\text{A}$

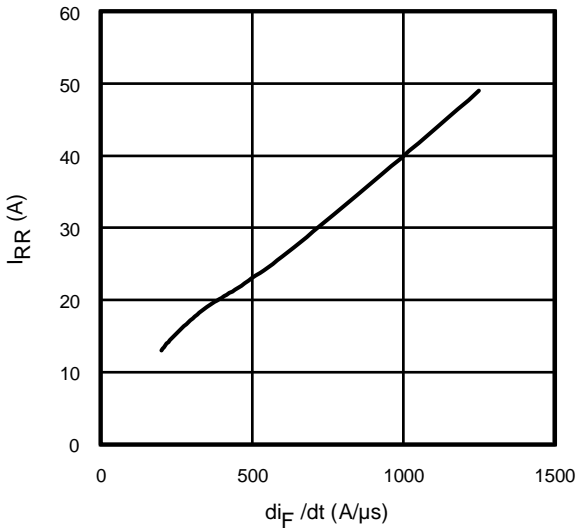


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V};$
 $I_{CE} = 40\text{A}; T_J = 125^\circ\text{C}$

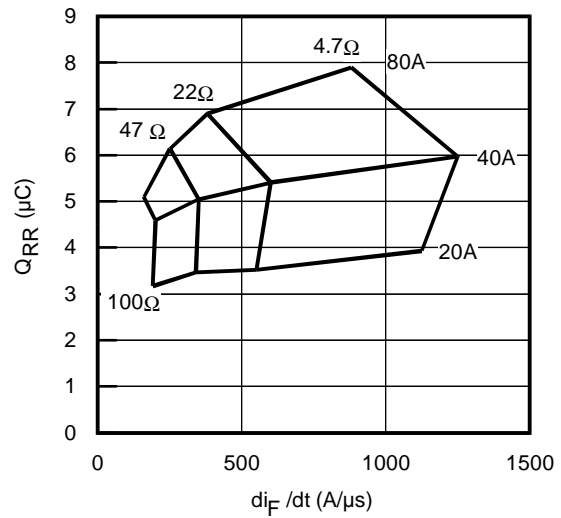


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V}; T_J = 125^\circ\text{C}$

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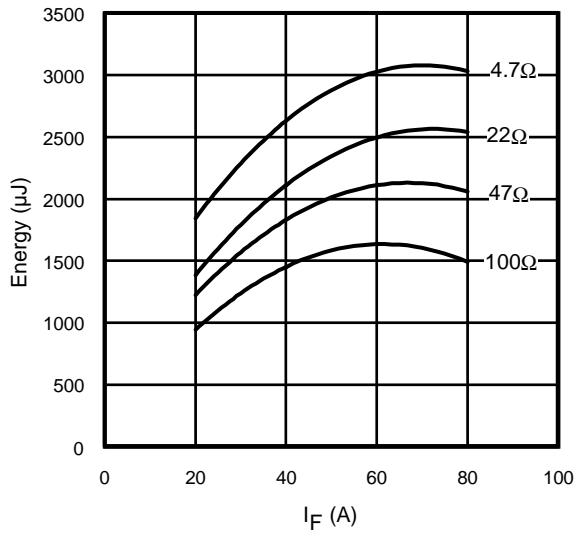


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

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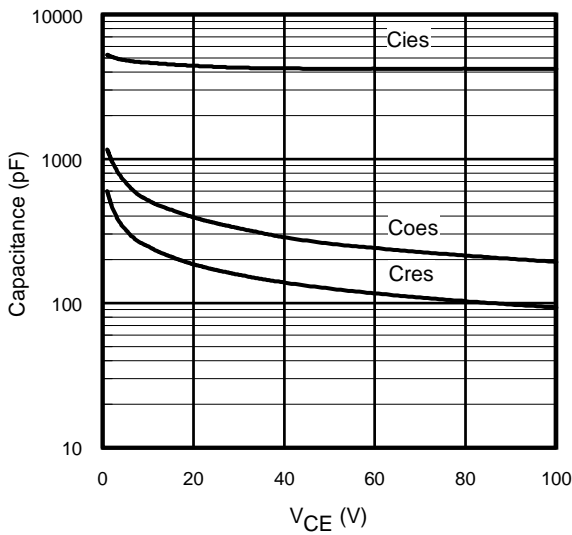


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1\text{MHz}$

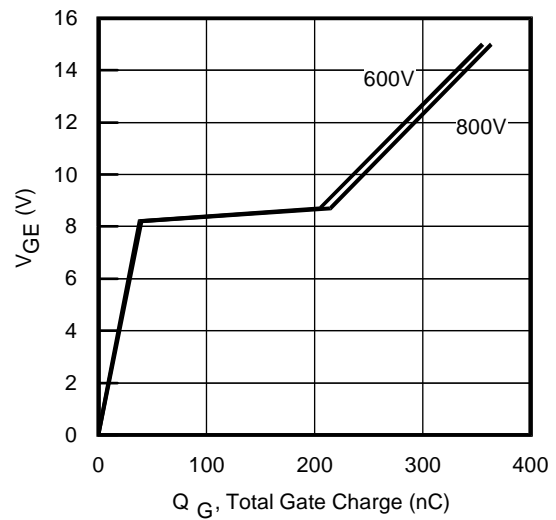


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 40A$; $L = 600\mu\text{H}$

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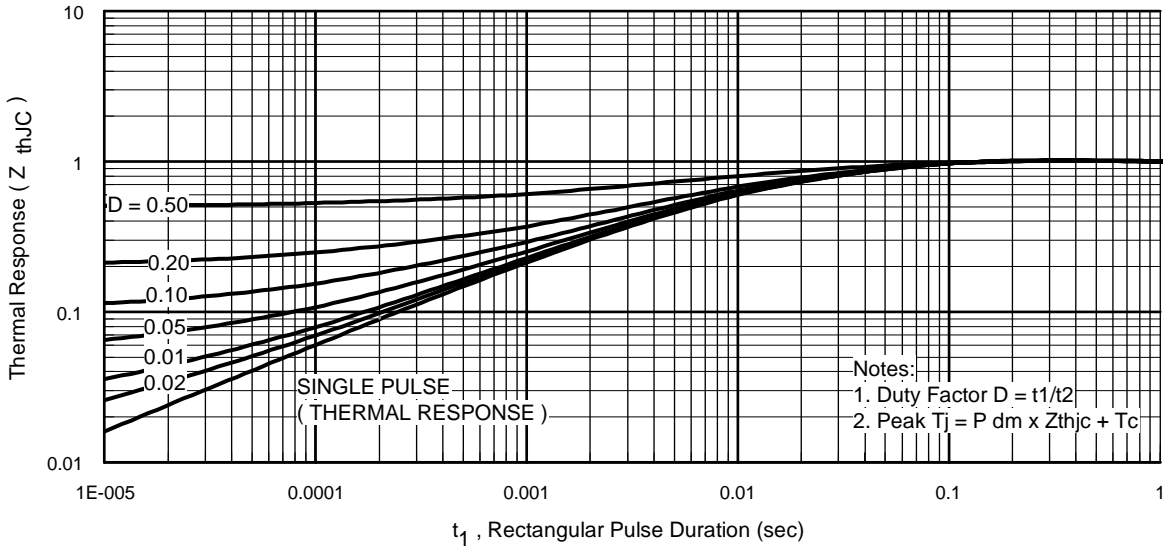


Fig 24. Normalized Transient Thermal Impedance, Junction-to-Case (IGBT)

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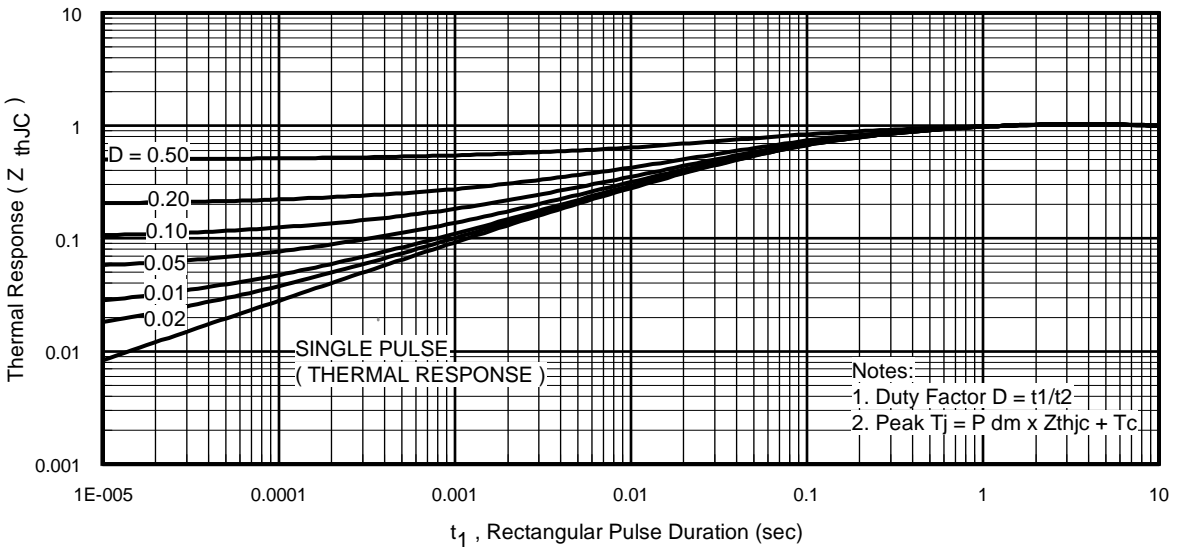


Fig 25. Normalized Transient Thermal Impedance, Junction-to-Case (DIODE)

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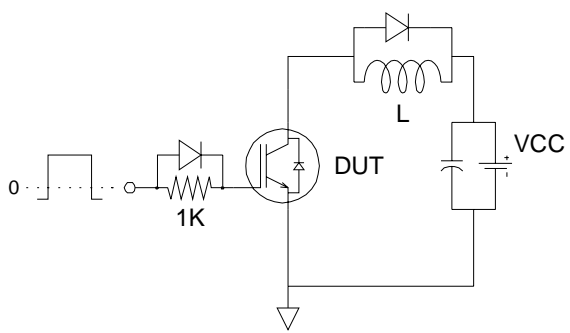


Fig.C.T.1 - Gate Charge Circuit (turn-on)

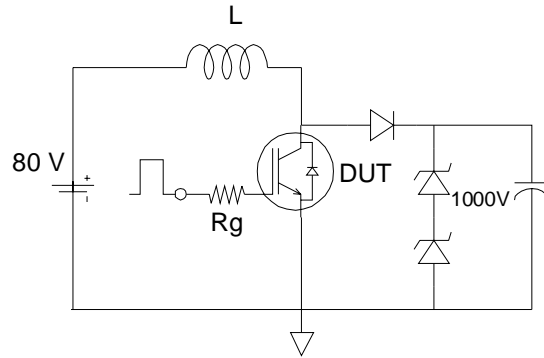


Fig.C.T.2 - RBSOA Circuit

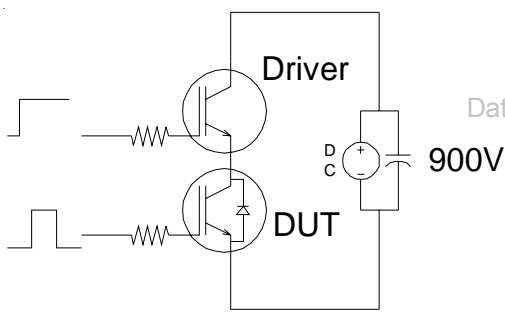


Fig.C.T.3 - RBSOA Circuit

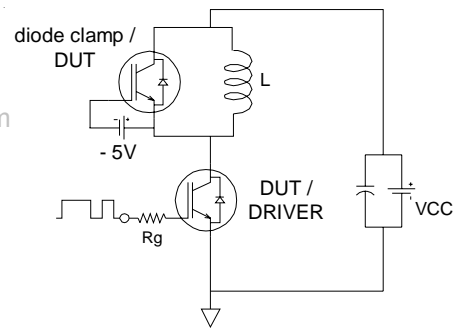


Fig.C.T.4 - RBSOA Circuit

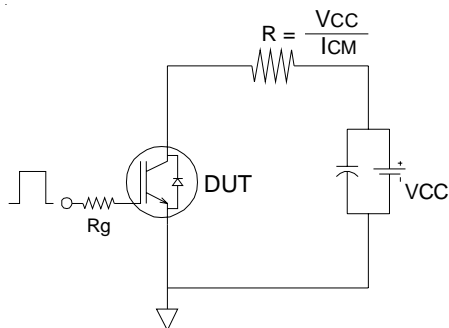


Fig.C.T.5 - RBSOA Circuit

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Fig. WF.1 - Typ. Turn-off Loss Waveform
 @ $T_j=125^\circ\text{C}$ using Fig. CT.4

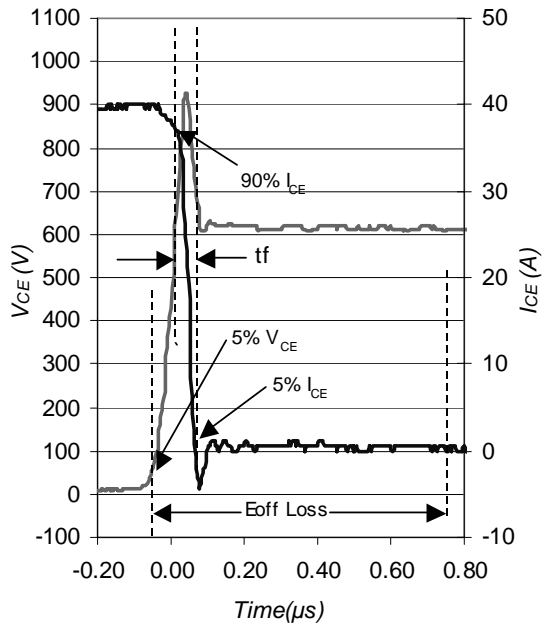


Fig. WF.2 - Typ. Turn-on Loss Waveform
 @ $T_j=125^\circ\text{C}$ using Fig. CT.4

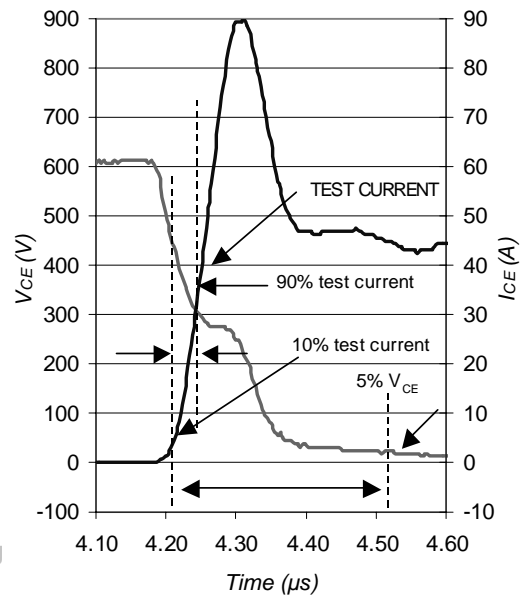


Fig. WF.3 - Typ. Diode Recovery Waveform
 @ $T_j=125^\circ\text{C}$ using Fig. CT.4

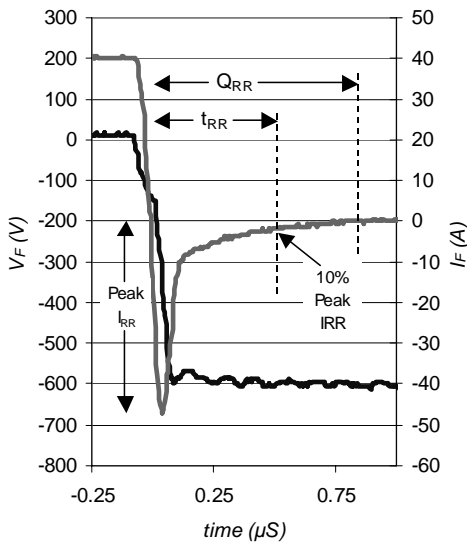
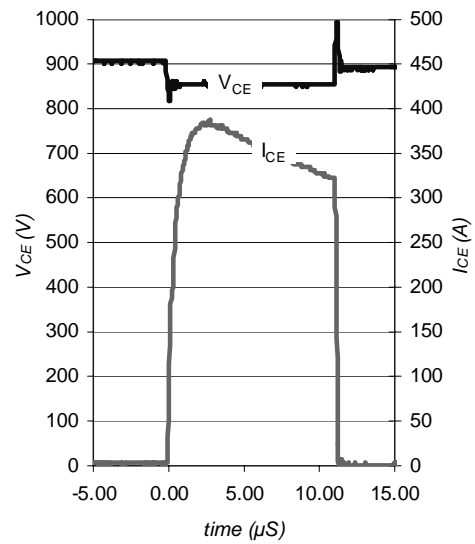


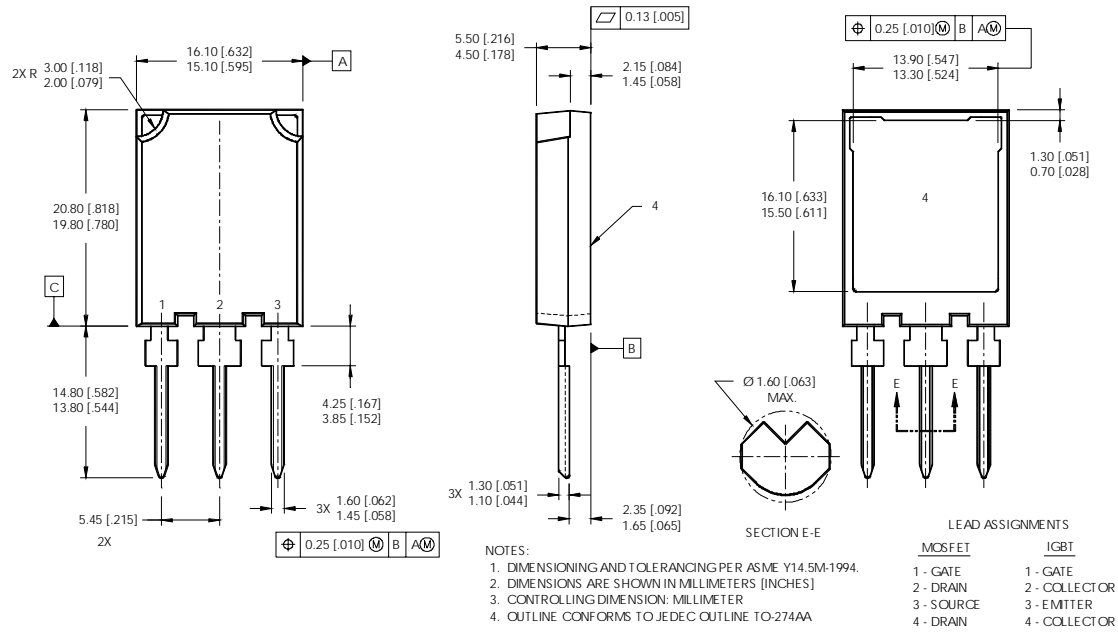
Fig. WF.4 - Typ. S.C. Waveform
 @ $T_C=150^\circ\text{C}$ using Fig. CT.3



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Super-247™ Package Outline



Super-247™ Part Marking Information

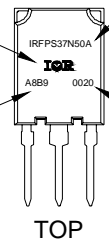
EXAMPLE: THIS IS AN IRFPS37N50A WITH ASSEMBLY LOT CODE A8B9

INTERNATIONAL RECTIFIER
LOGO

ASSEMBLY LOT CODE

PART NUMBER

DATE CODE
(YYWW)
YY = YEAR
WW = WEEK



① $V_{CC} = 80\% (V_{CES})$, $V_{GE} = 20V$, $L = 100 \mu H$, $R_G = 4.7\Omega$.

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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