

IRGPS40B120UD

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

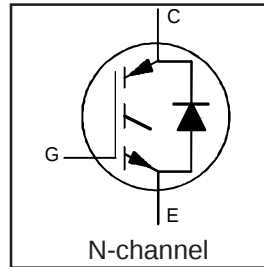
UltraFast Co-Pack IGBT

Features

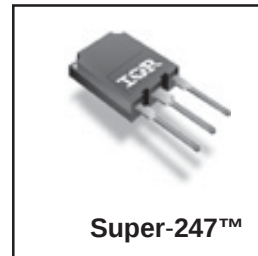
- Non Punch Through IGBT Technology.
- Low Diode VF.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- Super-247 Package.

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

	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®	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

Electrical 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/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	3.12	3.40	V	$I_C = 40A, V_{GE} = 15V$	5, 6
		—	3.39	3.70		$I_C = 50A$	7, 9
		—	3.88	4.30		$I_C = 40A, T_J = 125^\circ\text{C}$	10
		—	4.24	4.70		$I_C = 50A, T_J = 125^\circ\text{C}$	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/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA, (25^\circ\text{C}-125^\circ\text{C})$	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		$L_S = 150nH, T_J = 25^\circ\text{C}$	WF2
E_{on}	Turn-On Switching Loss	—	1950	2300	μJ	$T_J = 125^\circ\text{C}$	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

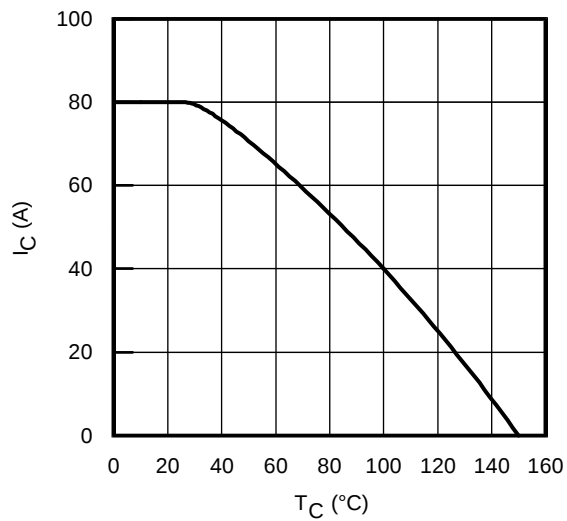


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

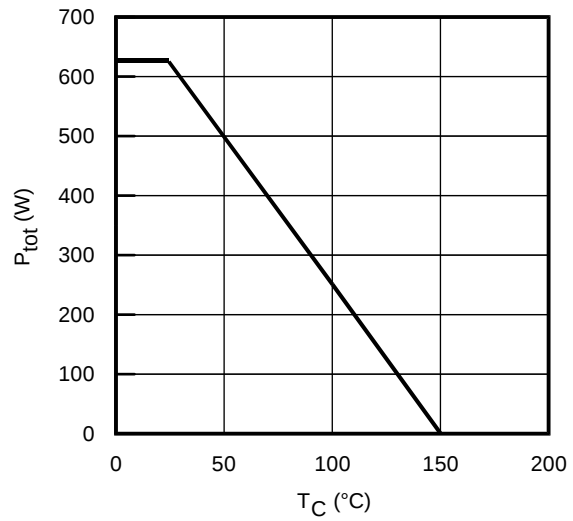


Fig. 2 - Power Dissipation vs. Case Temperature

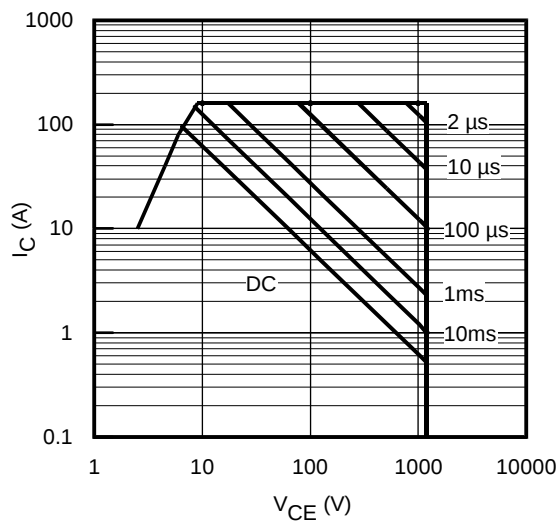


Fig. 3 - Forward SOA
 $T_C = 25^\circ\text{C}$; $T_{JS} \leq 150^\circ\text{C}$

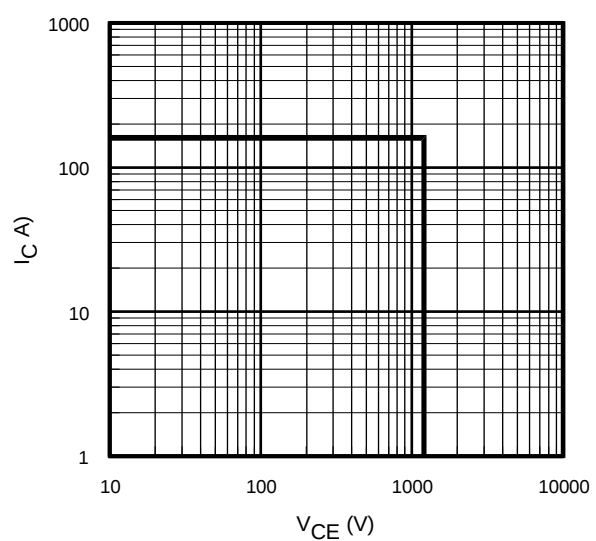


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 15\text{V}$

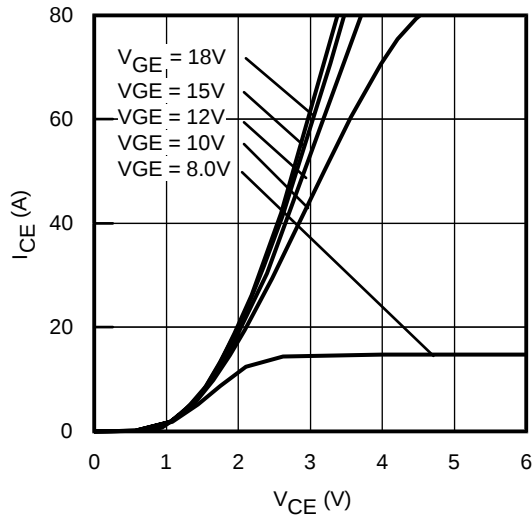


Fig. 5 - Typ. IGBT Output Characteristics
 $T_j = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

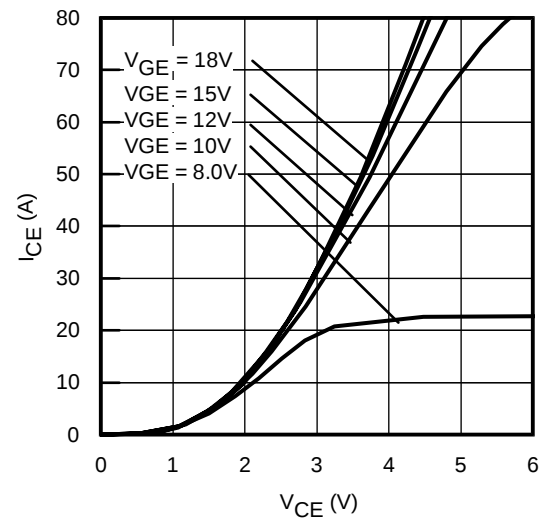


Fig. 6 - Typ. IGBT Output Characteristics
 $T_j = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

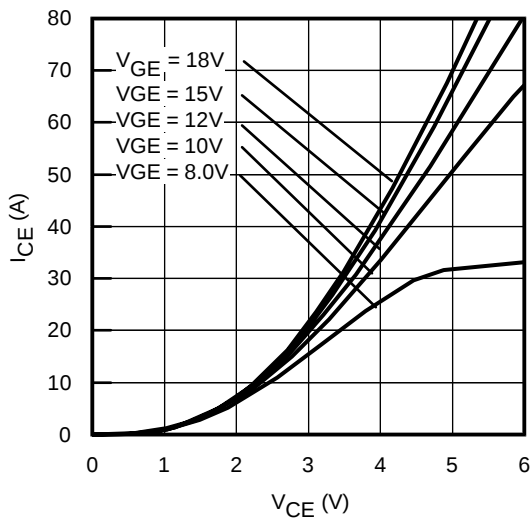


Fig. 7 - Typ. IGBT Output Characteristics
 $T_j = 125^\circ\text{C}$; $t_p = 80\mu\text{s}$

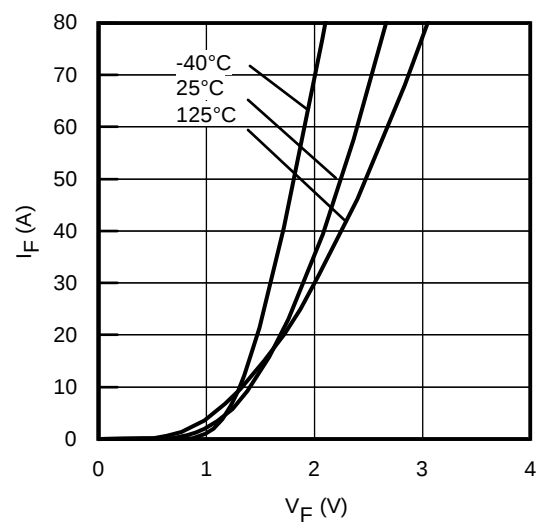


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

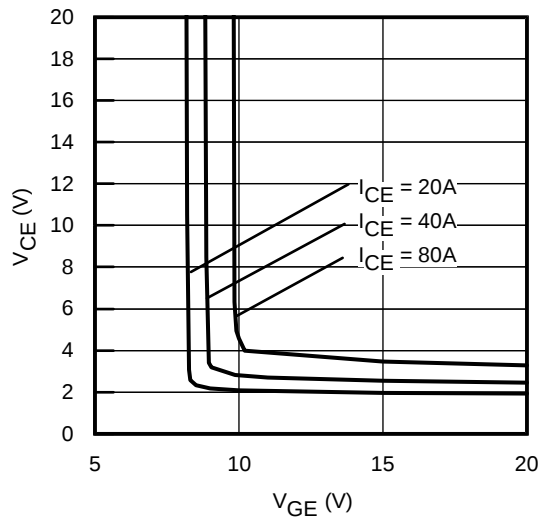


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

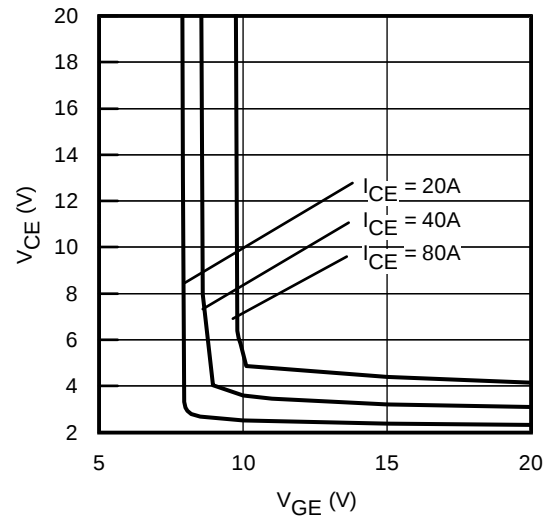


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

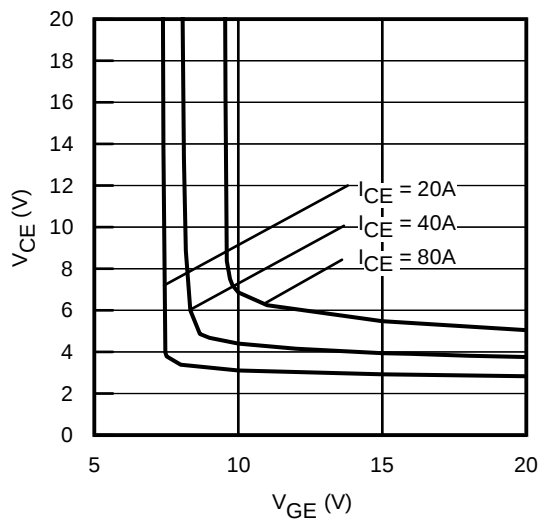


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 125^\circ\text{C}$

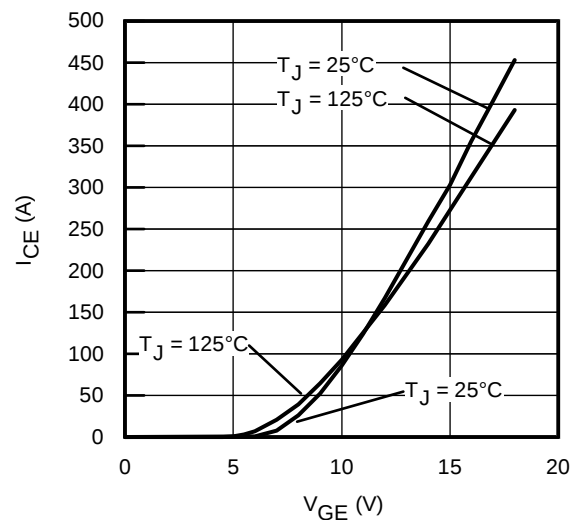


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

IRGPS40B120UD

International
IR Rectifier

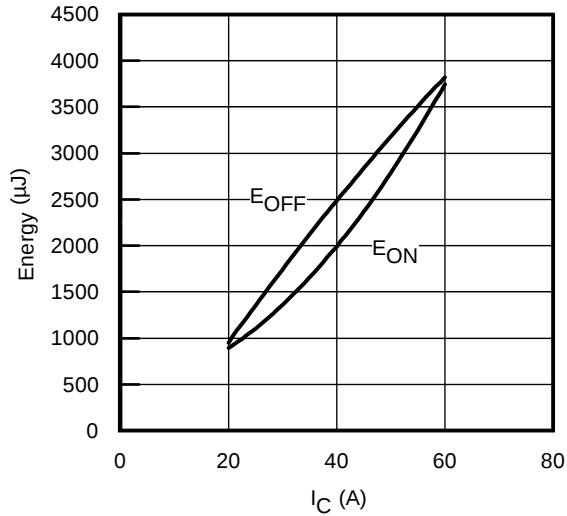


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE} = 600\text{V}$
 $R_G = 4.7\Omega$; $V_{GE} = 15\text{V}$

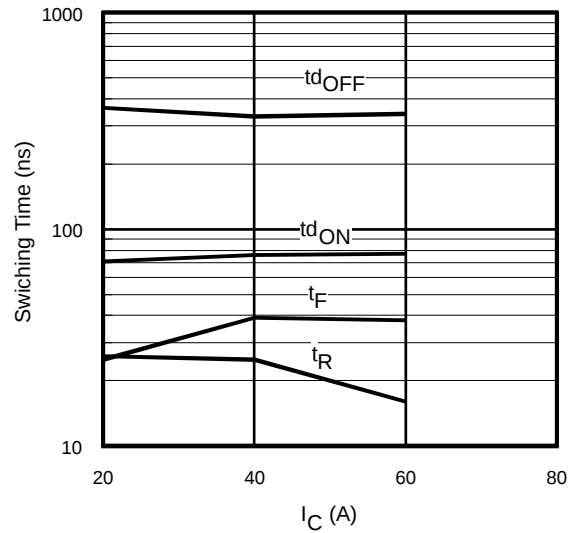


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE} = 600\text{V}$
 $R_G = 4.7\Omega$; $V_{GE} = 15\text{V}$

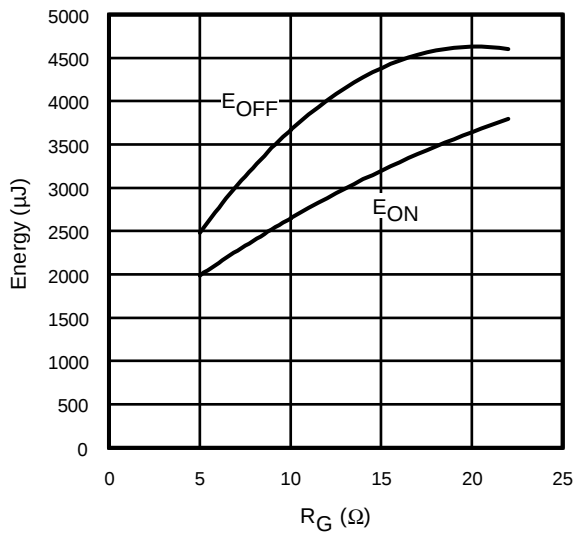


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE} = 600\text{V}$
 $I_{CE} = 40\text{A}$; $V_{GE} = 15\text{V}$

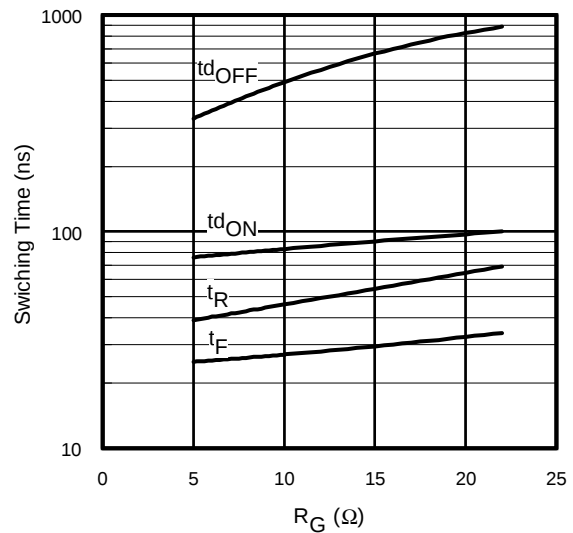


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 125^\circ\text{C}$; $L=200\mu\text{H}$; $V_{CE} = 600\text{V}$
 $I_{CE} = 40\text{A}$; $V_{GE} = 15\text{V}$

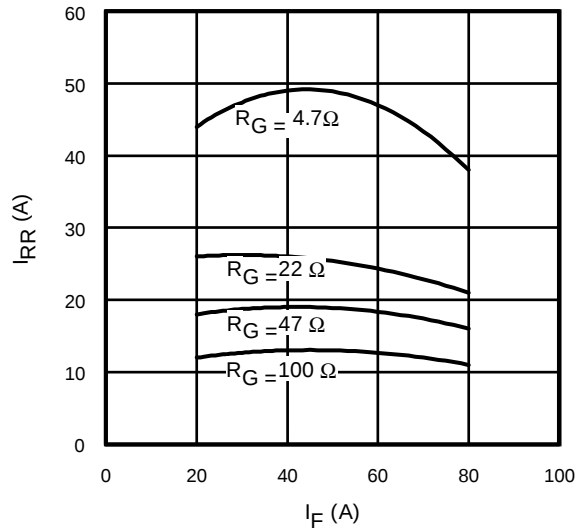


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

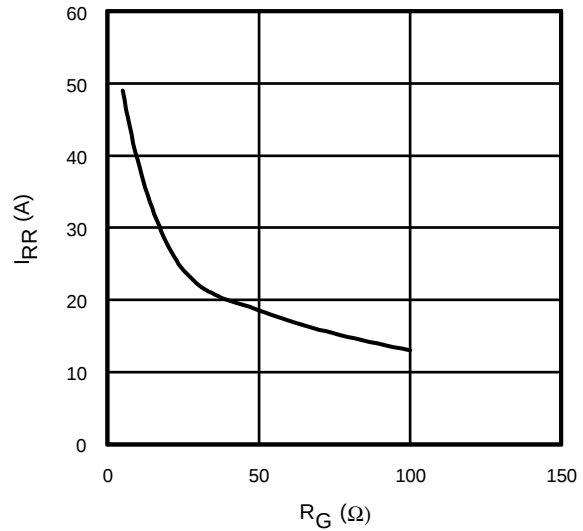


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 125^\circ\text{C}; I_F = 40\text{A}$

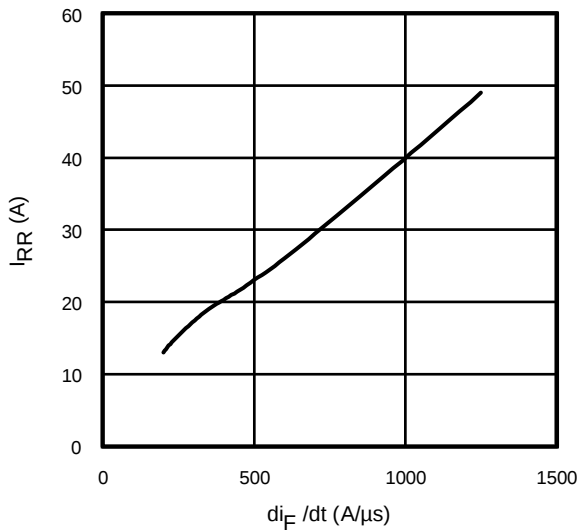


Fig. 19 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V};$
 $I_{CE} = 40\text{A}; T_J = 125^\circ\text{C}$

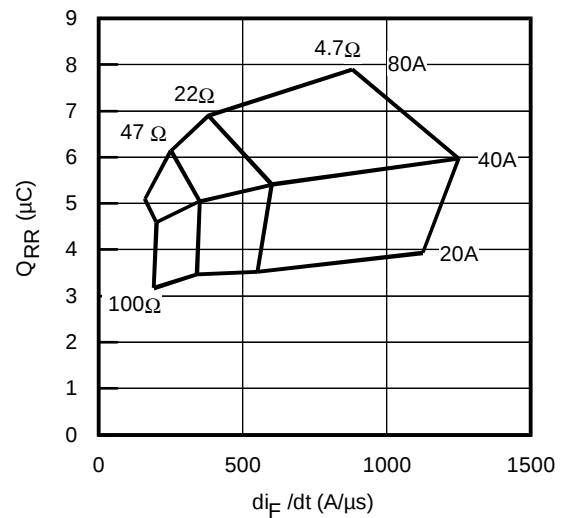


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V}; T_J = 125^\circ\text{C}$

IRGPS40B120UD

International
IR Rectifier

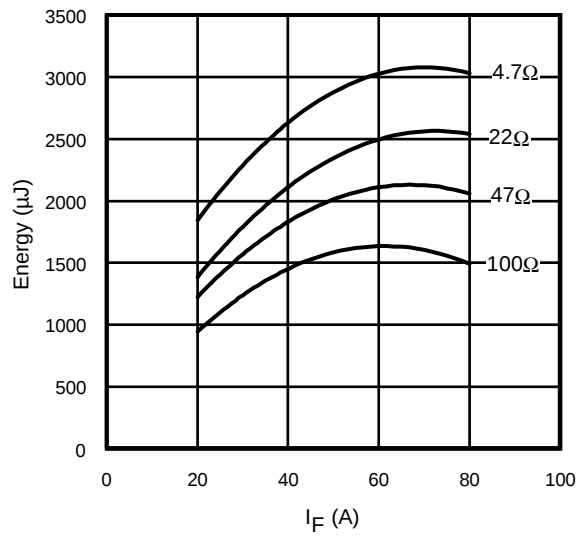


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J = 125^\circ\text{C}$

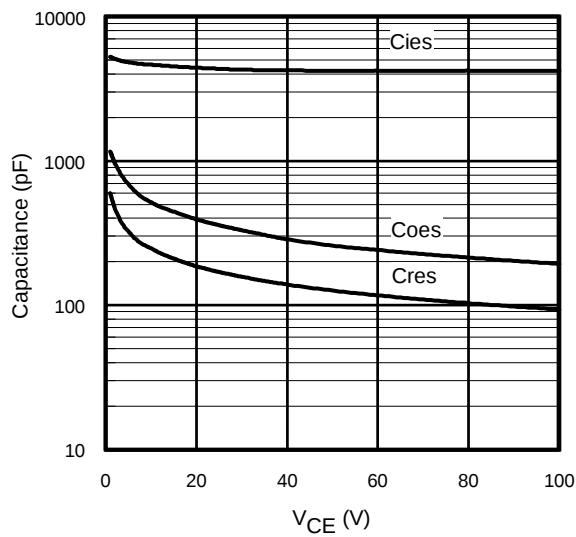


Fig. 22- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0\text{V}$; $f = 1\text{MHz}$

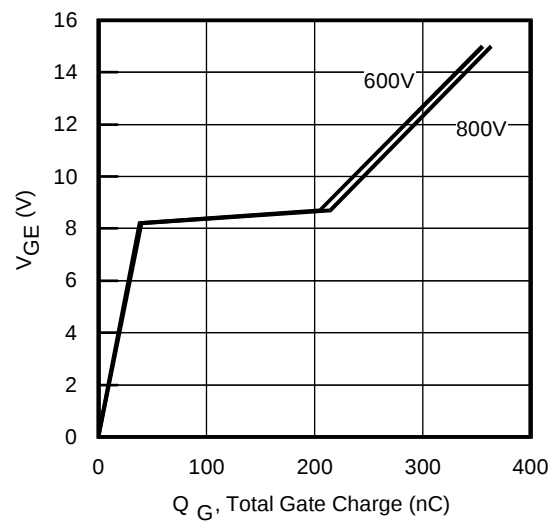


Fig. 23 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 40\text{A}$; $L = 600\mu\text{H}$

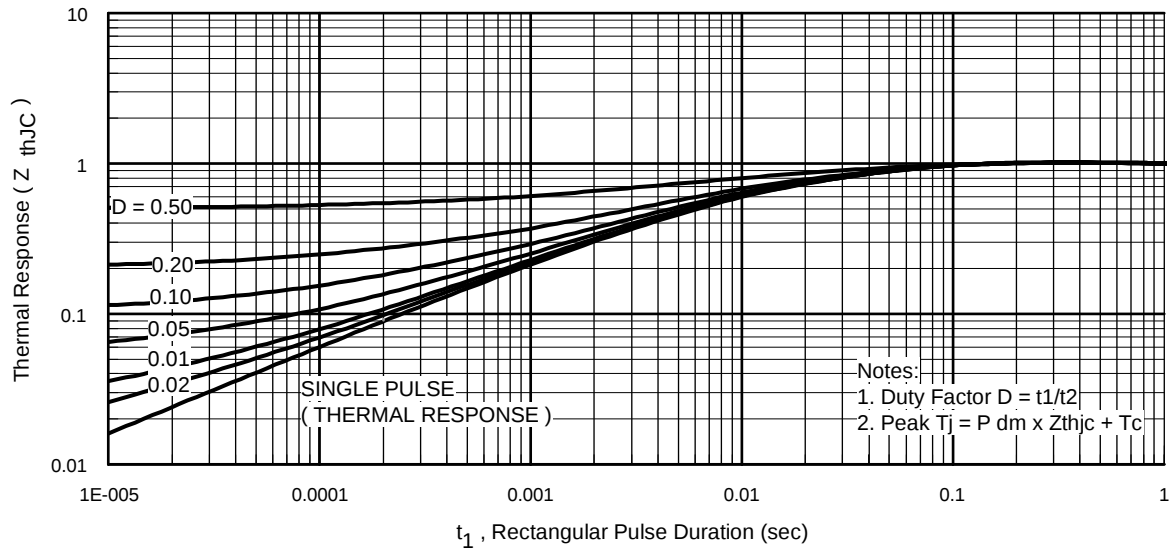


Fig 24. Normalized Transient Thermal Impedance, Junction-to-Case (IGBT)

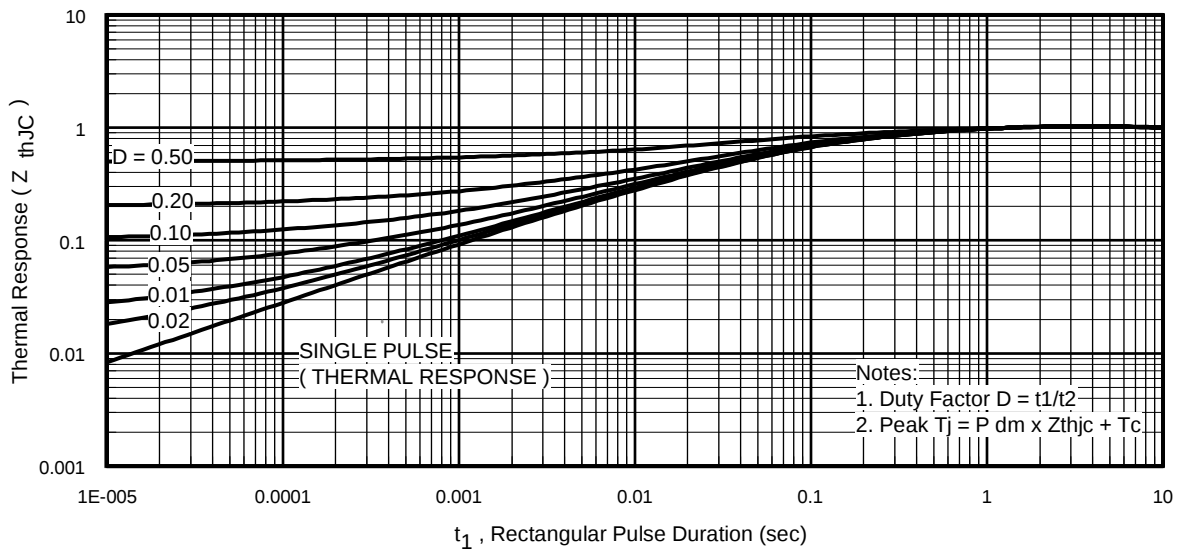


Fig 25. Normalized Transient Thermal Impedance, Junction-to-Case (DIODE)

IRGPS40B120UD

International
IR Rectifier

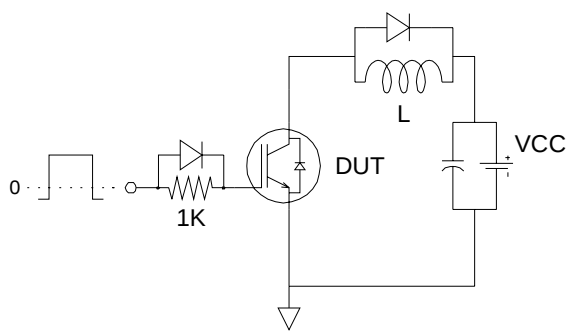


Fig.C.T.1 - Gate Charge Circuit (turn-on)

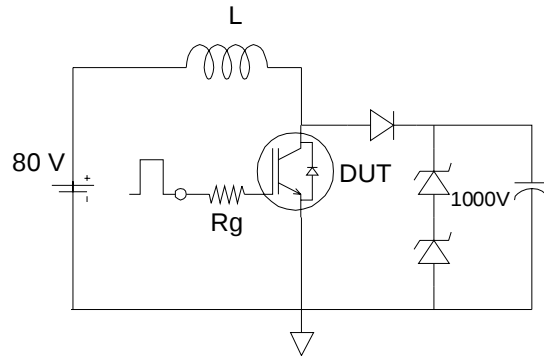


Fig.C.T.2 - RBSOA Circuit

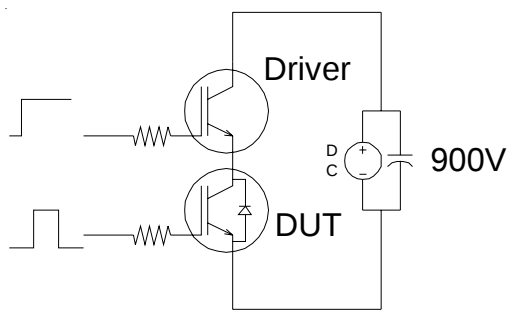


Fig.C.T.3 - RBSOA Circuit

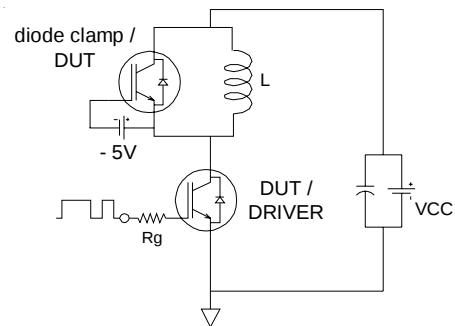


Fig.C.T.4 - RBSOA Circuit

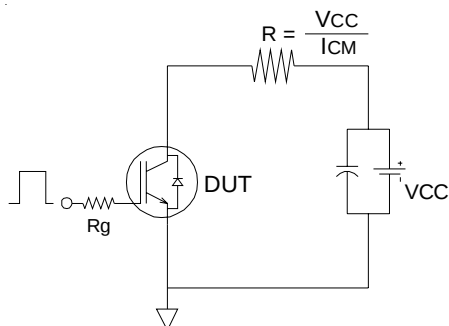


Fig.C.T.5 - RBSOA Circuit

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

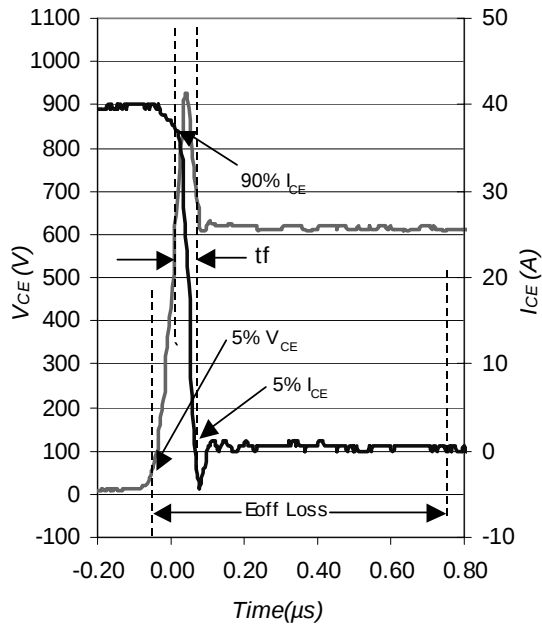


Fig. WF.2 - Typ. Turn-on Loss Waveform
@ $T_j=125^\circ\text{C}$ using Fig. CT.4

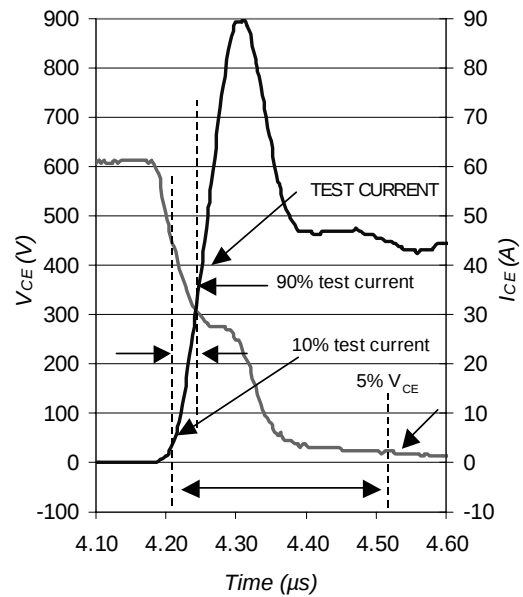


Fig. WF.3 - Typ. Diode Recovery Waveform
@ $T_j=125^\circ\text{C}$ using Fig. CT.4

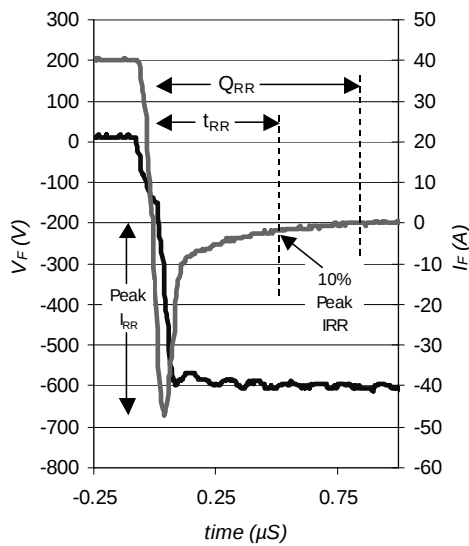
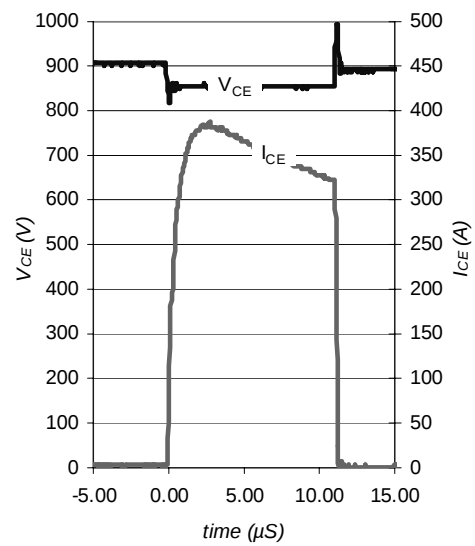


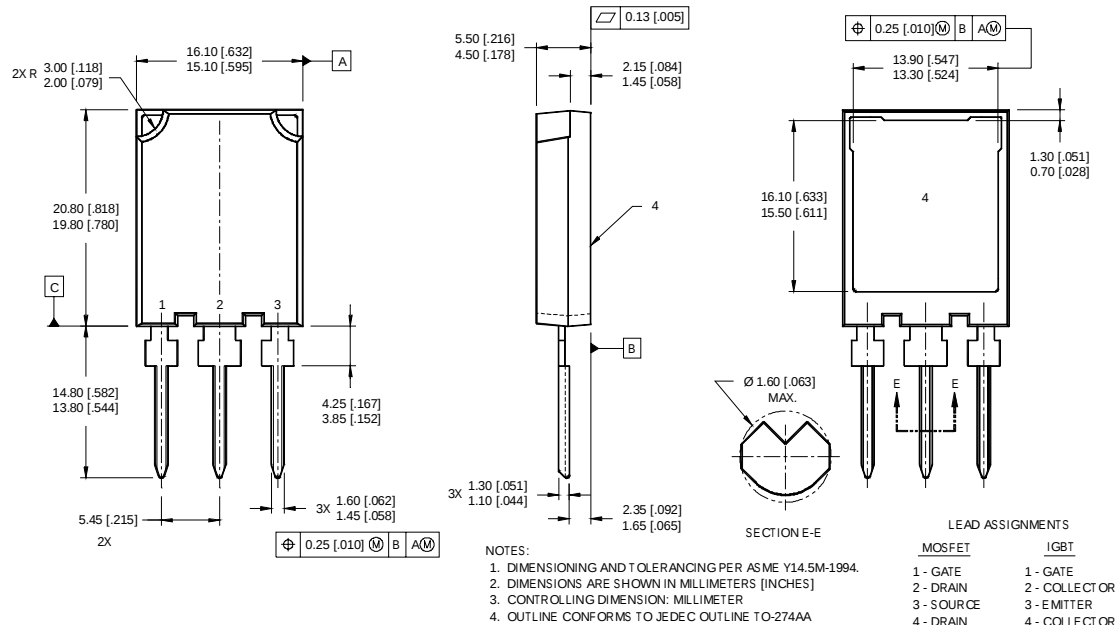
Fig. WF.4 - Typ. S.C. Waveform
@ $T_C=150^\circ\text{C}$ using Fig. CT.3



IRGPS40B120UD

International
IR Rectifier

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

TOP

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.

International
IR 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.08/04

www.irf.com