

# IRGPS40B120UP

INSULATED GATE BIPOLAR TRANSISTOR

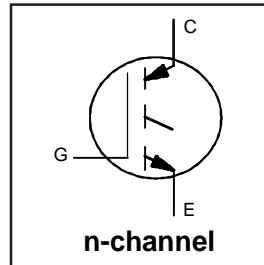
UltraFast IGBT

## Features

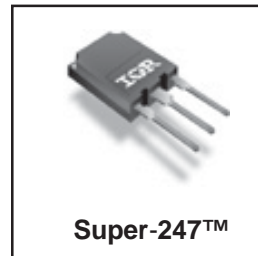
- Non Punch Through IGBT Technology.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.
- Super-247 Package.
- Lead-Free

## 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 $\text{\textcircled{D}}$	160	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	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	$^\circ C/W$
$R_{\theta CS}$	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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## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

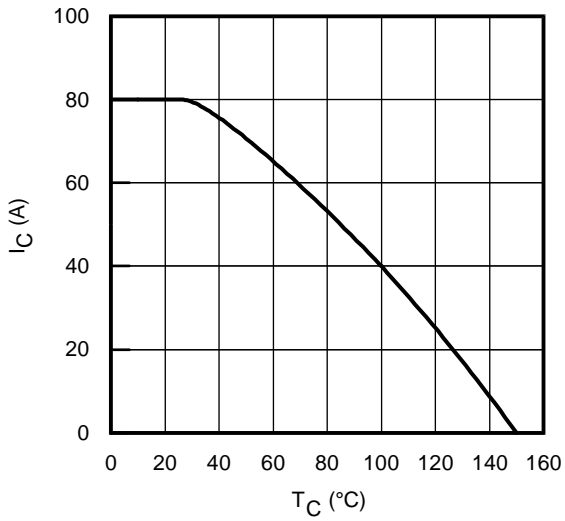
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 500μA	
ΔV <sub>(BR)CES/ΔT<sub>J</sub></sub>	Temperature Coeff. of Breakdown Voltage	—	0.40	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA, (25°C-125°C)	
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	3.12	3.40	V	I <sub>C</sub> = 40A I <sub>C</sub> = 50A I <sub>C</sub> = 40A, T <sub>J</sub> = 125°C I <sub>C</sub> = 50A, T <sub>J</sub> = 125°C	5, 6
		—	3.39	3.71			7, 9
		—	3.88	4.39			10
		—	4.24	4.79			11
V <sub>GE(th)</sub>	Gate Threshold Voltage	4.0	5.0	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA	8, 9
ΔV <sub>GE(th)/ΔT<sub>J</sub></sub>	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA, (25°C-125°C)	10, 11
g <sub>fe</sub>	Forward Transconductance	—	30.5	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 40A, PW=80μs	
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	500	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V	
		—	100	1200		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 125°C	
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V	

## Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

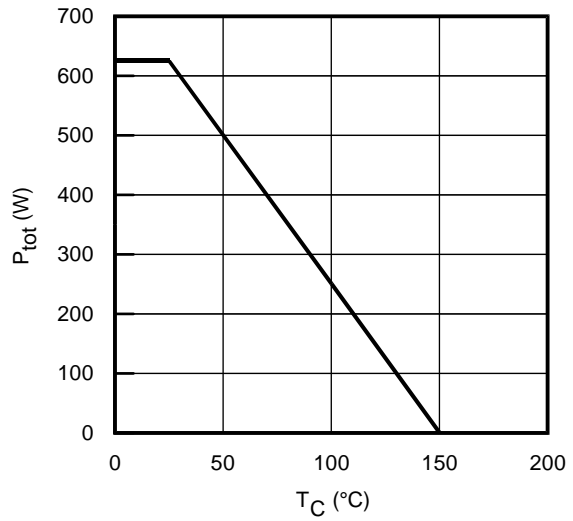
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	340	510	nC	I <sub>C</sub> = 40A V <sub>CC</sub> = 600V V <sub>GE</sub> = 15V	17
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	43	65			CT1
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	165	248			
E <sub>on</sub>	Turn-On Switching Loss	—	1400	1750	μJ	I <sub>C</sub> = 40A, V <sub>CC</sub> = 600V V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L = 200μH L <sub>s</sub> = 150nH	CT4
E <sub>off</sub>	Turn-Off Switching Loss	—	1650	2050			WF1
E <sub>tot</sub>	Total Switching Loss	—	3050	3800	μJ	T <sub>J</sub> = 25°C T <sub>J</sub> = 125°C Energy losses include "tail" and diode reverse recovery.	WF2
E <sub>on</sub>	Turn-On Switching Loss	—	1950	2300			12, 14
E <sub>off</sub>	Turn-Off Switching Loss	—	2200	2950			
E <sub>tot</sub>	Total Switching Loss	—	4150	5250			
t <sub>d(on)</sub>	Turn-On Delay Time	—	76	99	ns	I <sub>C</sub> = 40A, V <sub>CC</sub> = 600V V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L = 200μH L <sub>s</sub> = 150nH, T <sub>J</sub> = 125°C	13, 15
t <sub>r</sub>	Rise Time	—	39	55			CT4
t <sub>d(off)</sub>	Turn-Off Delay Time	—	332	365			WF1
t <sub>f</sub>	Fall Time	—	25	33			WF2
C <sub>ies</sub>	Input Capacitance	—	4300	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz	16
C <sub>oes</sub>	Output Capacitance	—	270	—			
C <sub>res</sub>	Reverse Transfer Capacitance	—	160	—			
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 150°C, I <sub>C</sub> = 160A, V <sub>p</sub> = 1200V V <sub>CC</sub> = 1000V, V <sub>GE</sub> = +15V to 0V R <sub>G</sub> = 4.7Ω	4
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T <sub>J</sub> = 150°C, V <sub>p</sub> = 1200V V <sub>CC</sub> = 900V, V <sub>GE</sub> = +15V to 0V, R <sub>G</sub> = 4.7Ω	CT3 WF4

### Note:

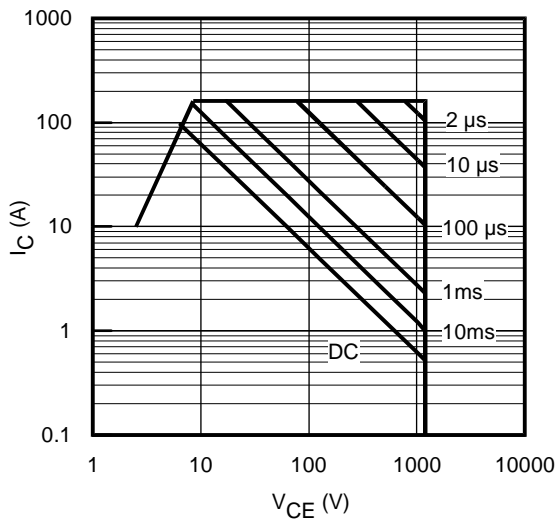
⊙ V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 100μH, R<sub>G</sub> = 4.7Ω.



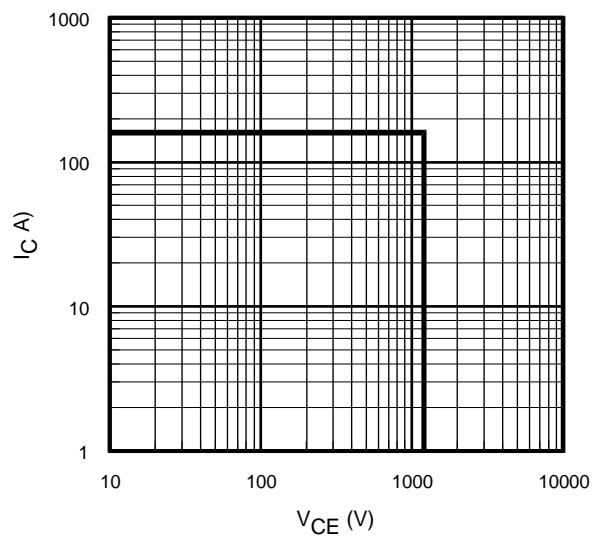
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



**Fig. 2** - Power Dissipation vs. Case Temperature

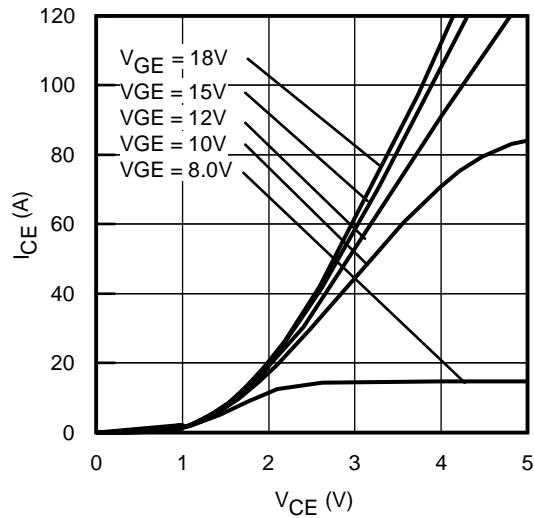


**Fig. 3** - Forward SOA  
 $T_C = 25^{\circ}C$ ;  $T_{JS} \leq 150^{\circ}C$

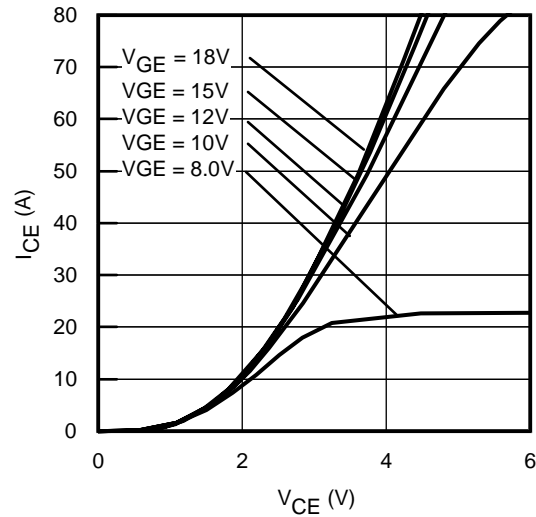


**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^{\circ}C$ ;  $V_{GE} = 15V$

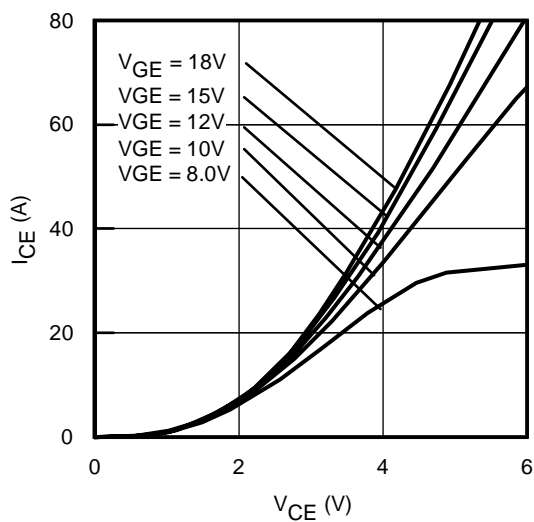
# IRGPS40B120UP



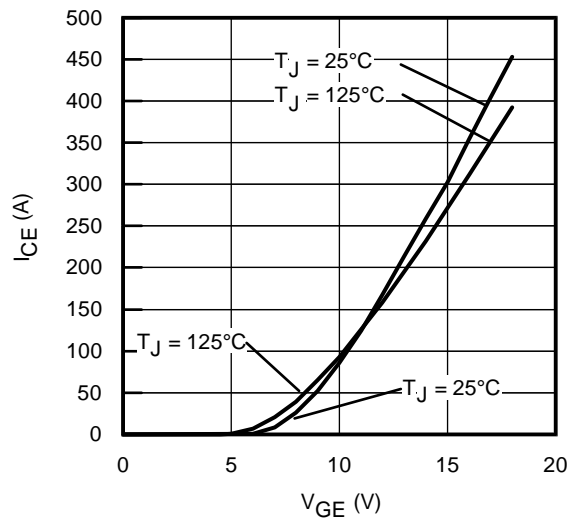
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



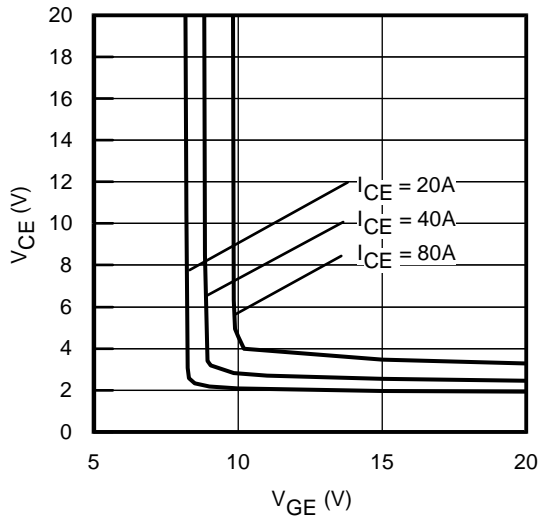
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



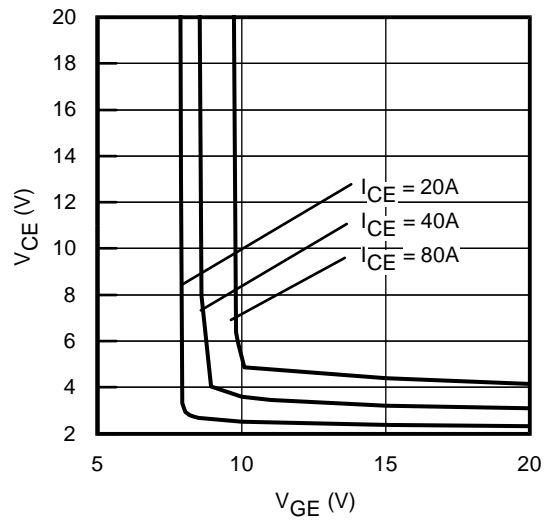
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 125^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



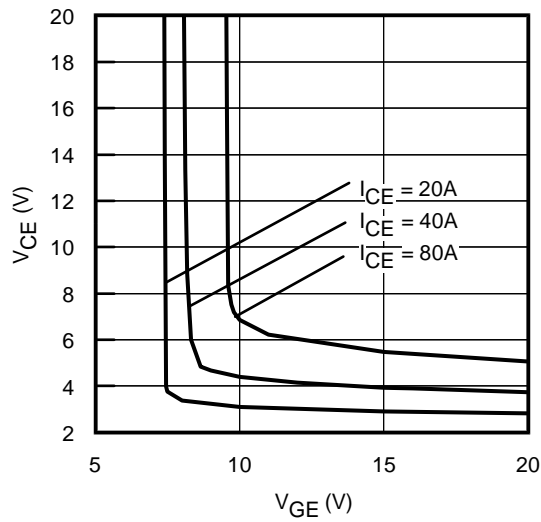
**Fig. 8** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



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

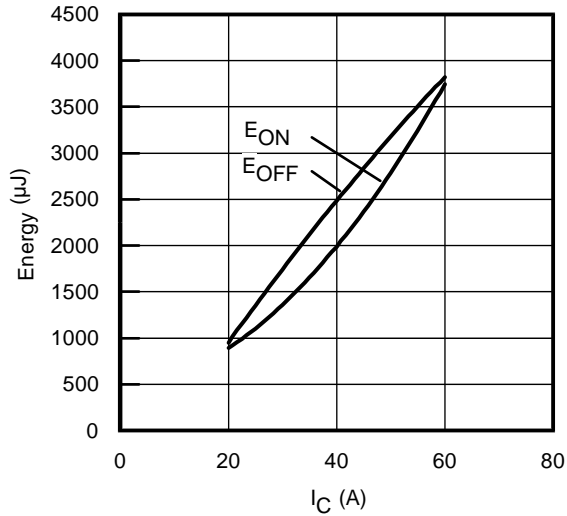


**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$

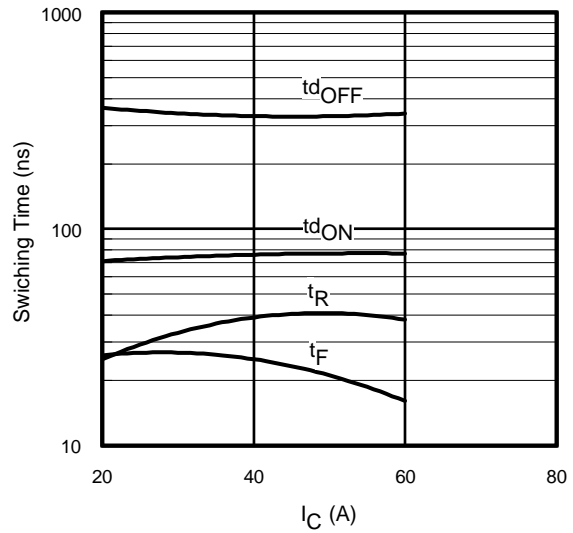


**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 125^\circ\text{C}$

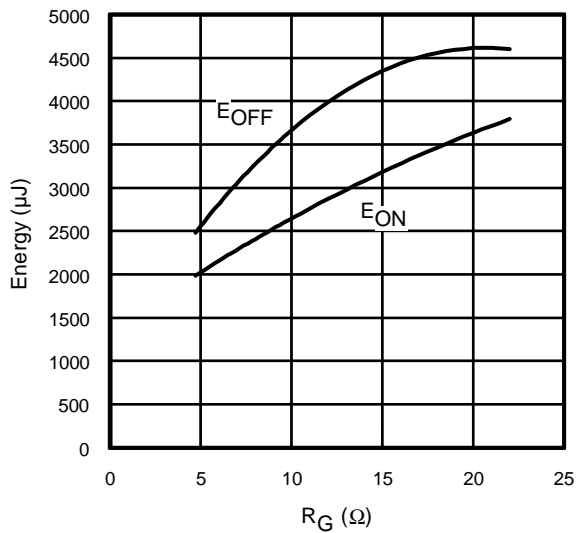
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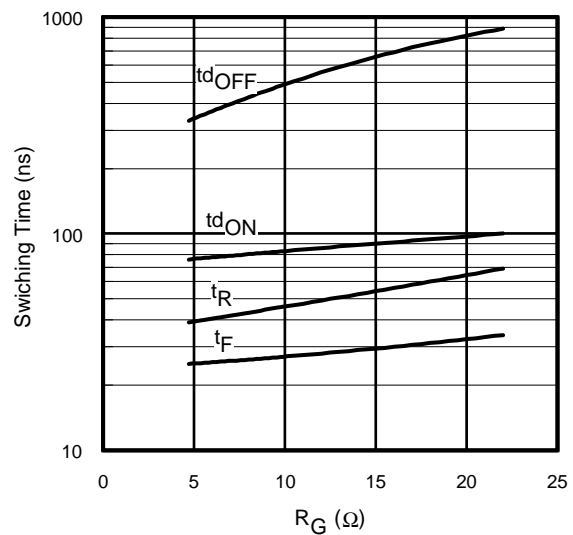
**Fig. 12** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $R_G= 4.7\Omega$ ;  $V_{GE}= 15\text{V}$



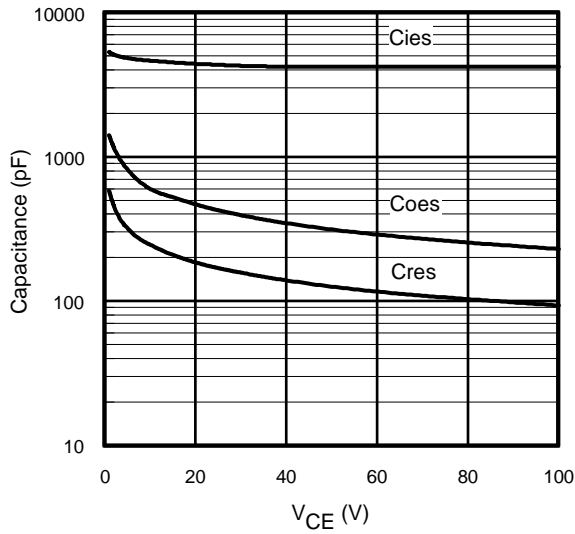
**Fig. 13** - Typ. Switching Time vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $R_G= 4.7\Omega$ ;  $V_{GE}= 15\text{V}$



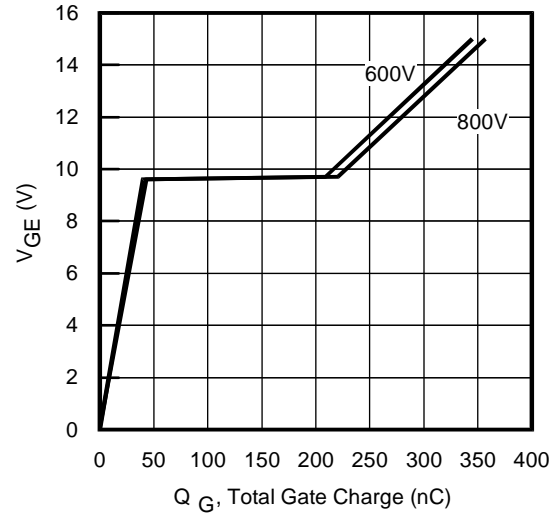
**Fig. 14** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $I_{CE}= 40\text{A}$ ;  $V_{GE}= 15\text{V}$



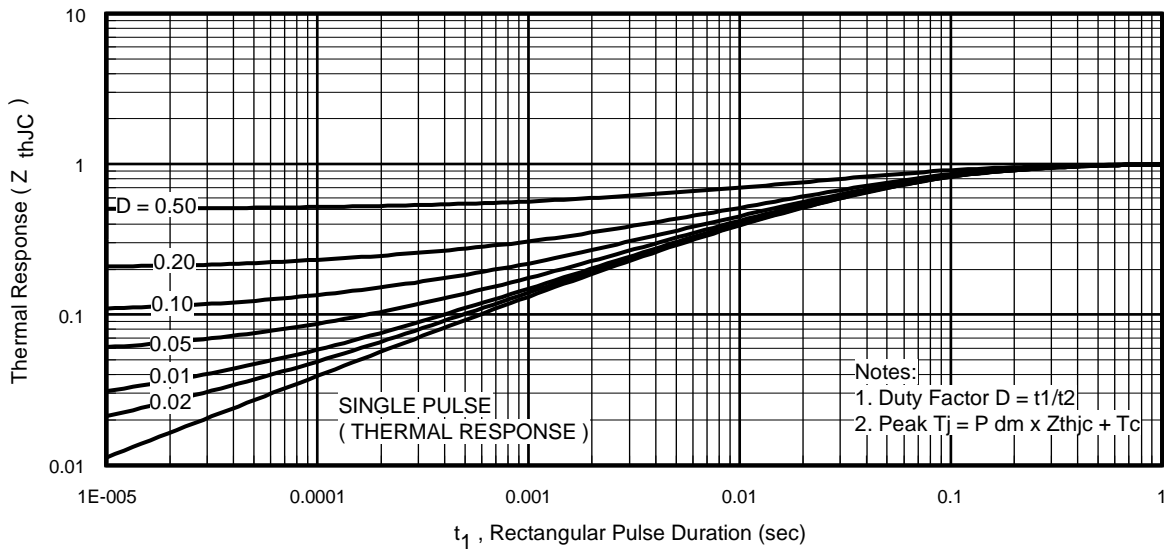
**Fig. 15** - Typ. Switching Time vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $I_{CE}= 40\text{A}$ ;  $V_{GE}= 15\text{V}$



**Fig. 16-** Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



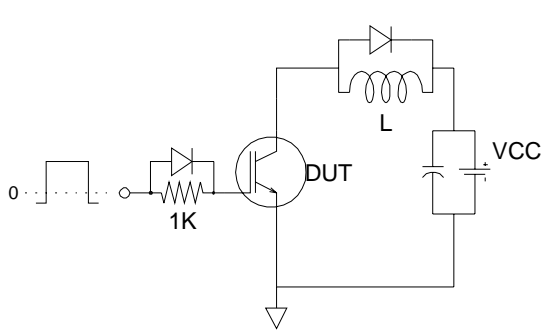
**Fig. 17 -** Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 40A$ ;  $L = 600\mu H$



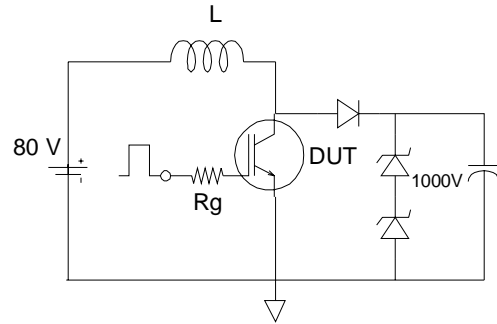
**Fig 18.** Normalized Transient Thermal Impedance, Junction-to-Case (IGBT)

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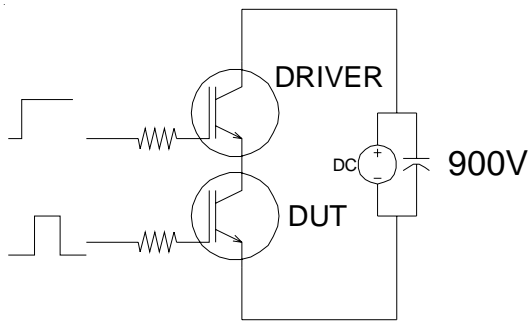
International  
**IR** Rectifier



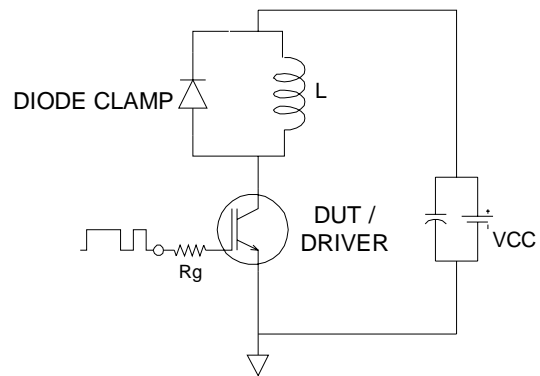
**Fig.C.T.1** - Gate Charge Circuit (turn-on)



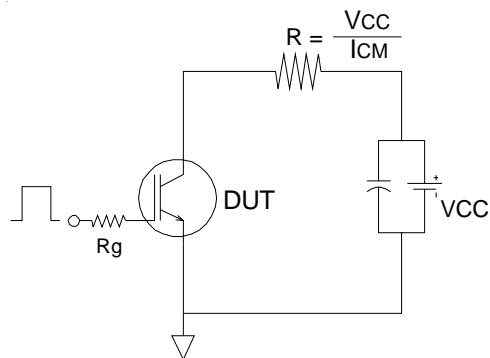
**Fig.C.T.2** - RBSOA Circuit



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



**Fig.C.T.4** - Switching Loss Circuit



**Fig.C.T.5** - Resistive Load Circuit



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

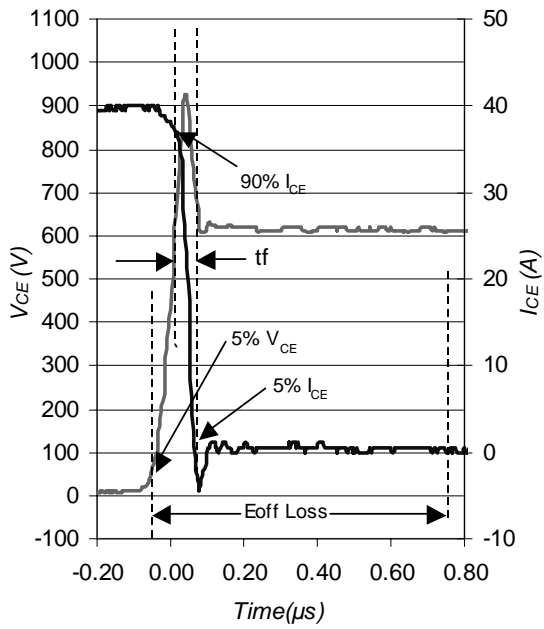


Fig. WF.2 - Typ. Turn-on Loss Waveform  
@  $T_j=125^\circ\text{C}$  using Fig. CT.4

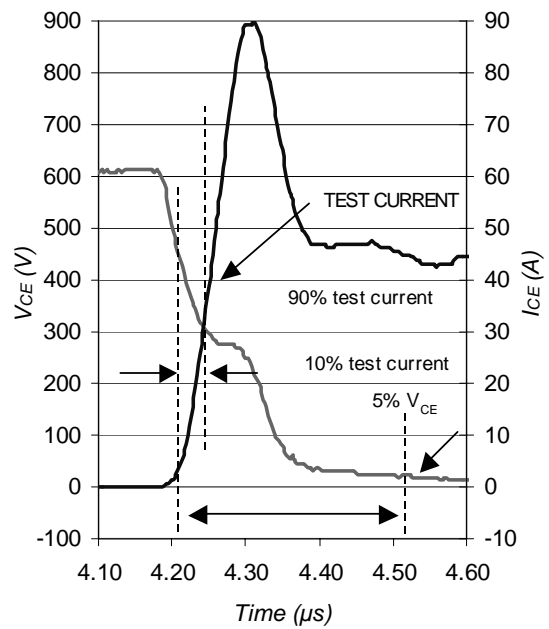
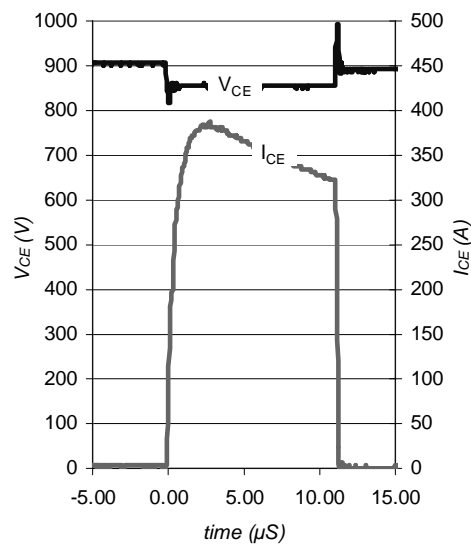


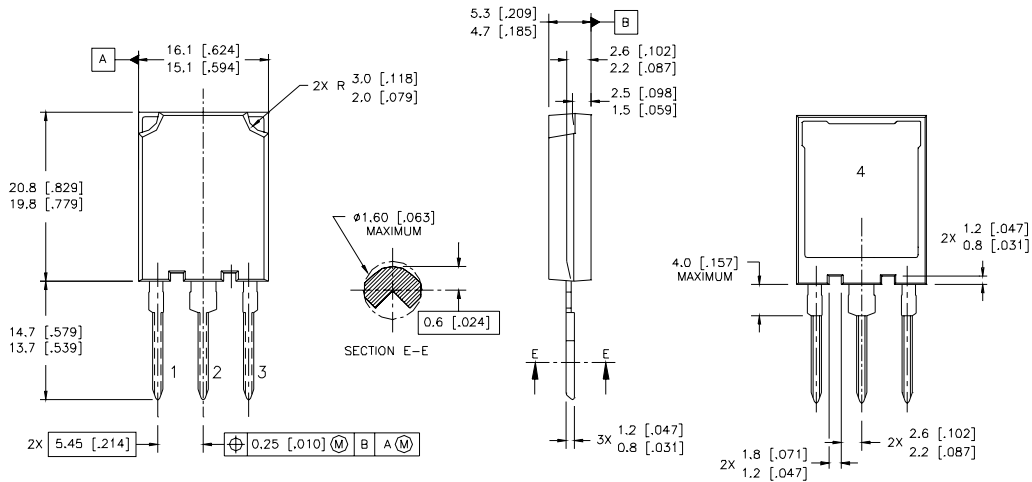
Fig. WF.3 - Typ. S.C. Waveform  
@  $T_C=150^\circ\text{C}$  using Fig. CT.3



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## Case Outline and Dimensions — Super-247

International  
**IR** Rectifier



**NOTES:**

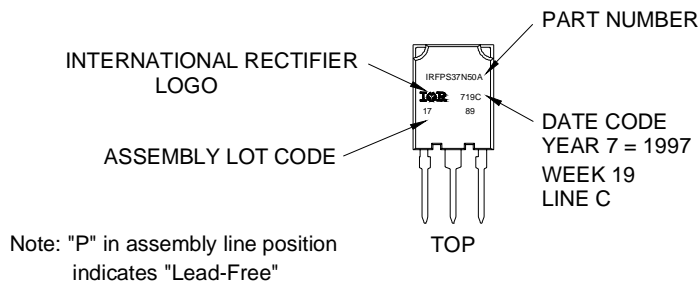
1. DIMENSIONS & TOLERANCING PER ASME Y14.5M-1994
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETRES [INCHES]

**LEAD ASSIGNMENTS**

MOSFET	IGBT
1 - GATE	1 - GATE
2 - DRAIN	2 - COLLECTOR
3 - SOURCE	3 - EMITTER
4 - DRAIN	4 - COLLECTOR

## Super-247 (TO-274AA) Part Marking Information

EXAMPLE: THIS IS AN IRFPS37N50A WITH  
ASSEMBLY LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"



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

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