

# IRGPS40B120UDP

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFast SOFT RECOVERY DIODE

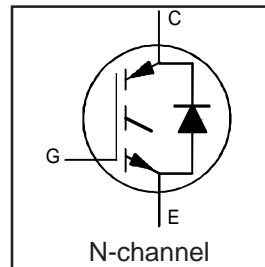
UltraFast Co-Pack IGBT

## Features

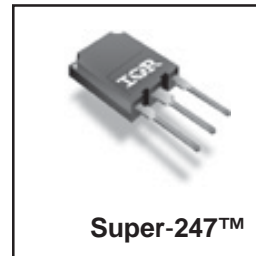
- Non Punch Through IGBT Technology.
- Low Diode VF.
- 10 $\mu$ s Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- Super-247 Package.
- Lead-Free

## 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

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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	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	595	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	238	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$
	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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## IRGPS40B120UDP

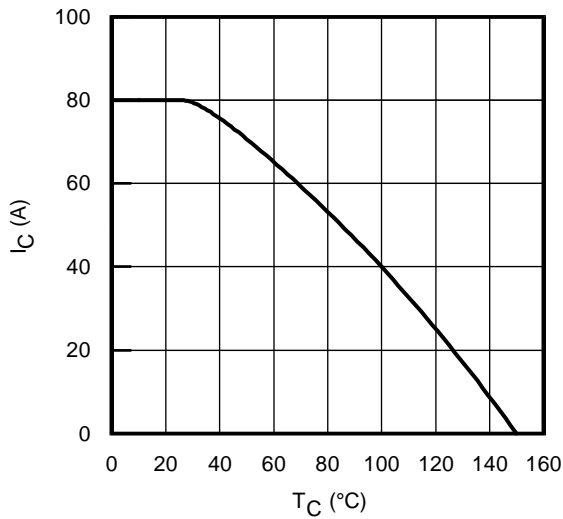
International  
IR RectifierElectrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

	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	$\mu A$	$V_{GE} = 0V, V_{CE} = 1200V$	
		—	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	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$	

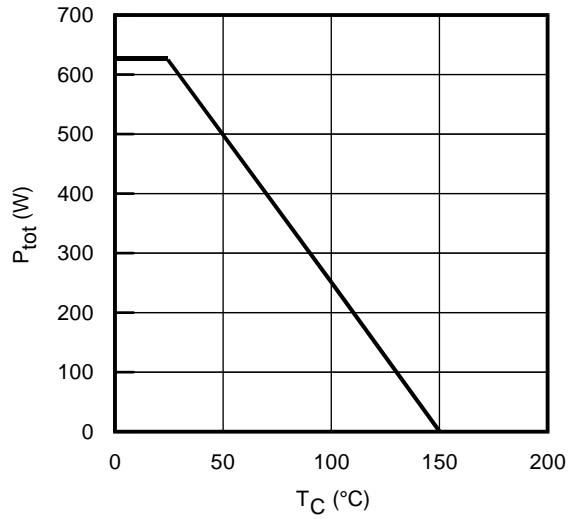
Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

	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	$\mu J$	$I_C = 40A, V_{CC} = 600V$	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	$\mu J$	$L_s = 150nH, T_J = 25^\circ\text{C}$	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	$\mu J$	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	—	—	$\mu s$	$T_J = 150^\circ\text{C}, V_p = 1200V$ $V_{CC} = 900V, V_{GE} = +15V \text{ to } 0V,$ $R_G = 4.7\Omega$	CT3 WF4
$E_{rec}$	Reverse Recovery energy of the diode	—	3346	—	$\mu J$	$T_J = 125^\circ\text{C}$	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

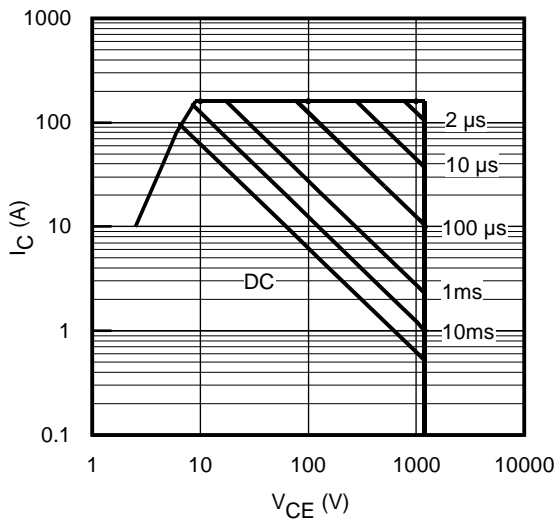
# IRGPS40B120UDP



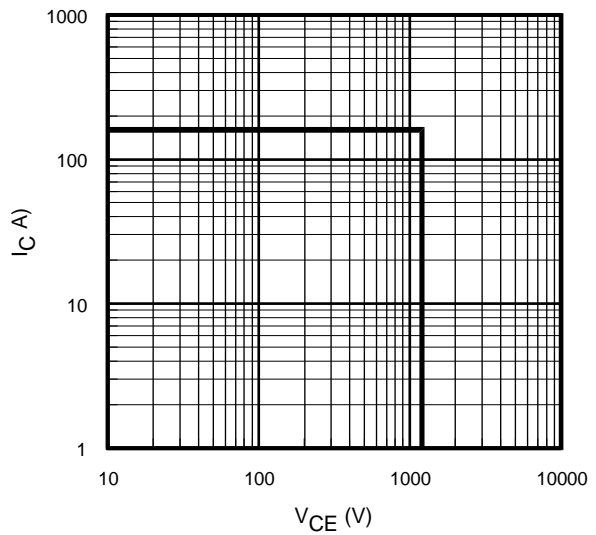
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



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



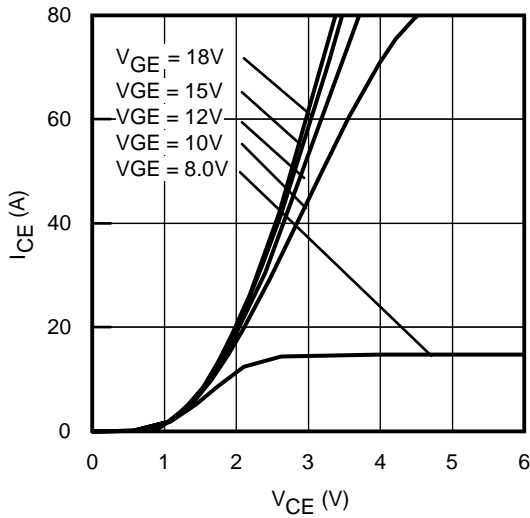
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}; T_{JS} \leq 150^\circ\text{C}$



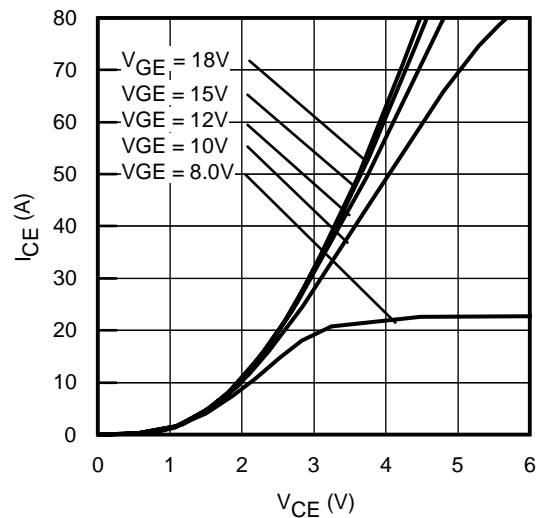
**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}; V_{GE} = 15\text{V}$

# IRGPS40B120UDP

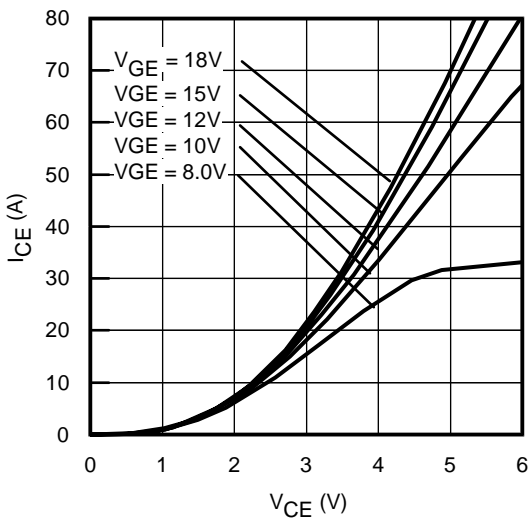
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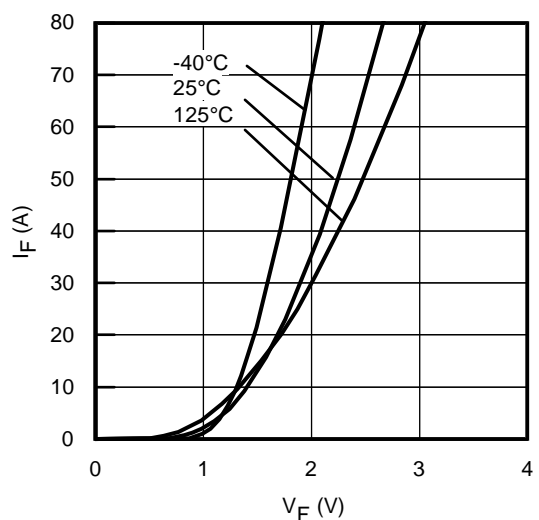
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



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

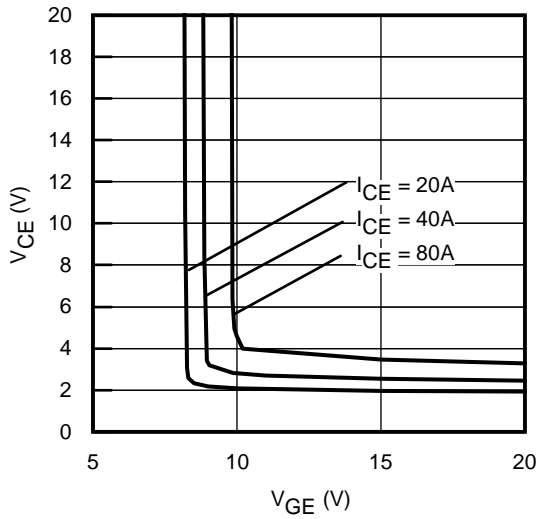


**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 125^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$

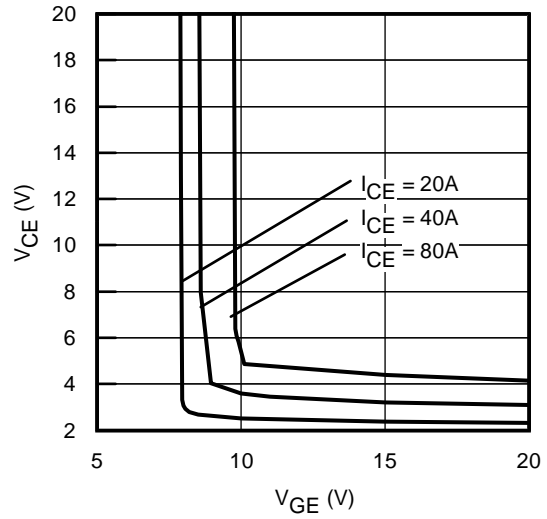


**Fig. 8** - Typ. Diode Forward Characteristics  
 $t_p = 80\mu\text{s}$

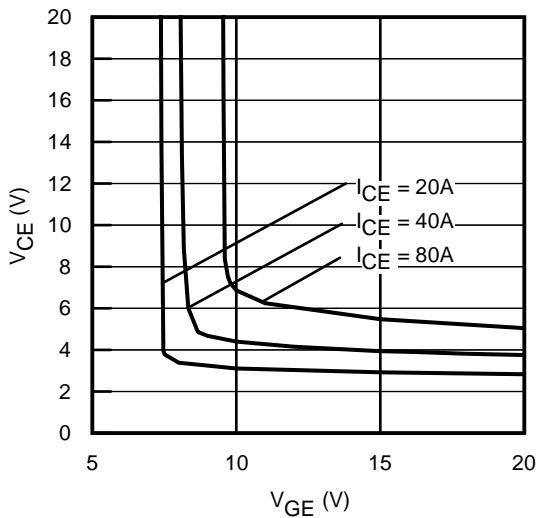
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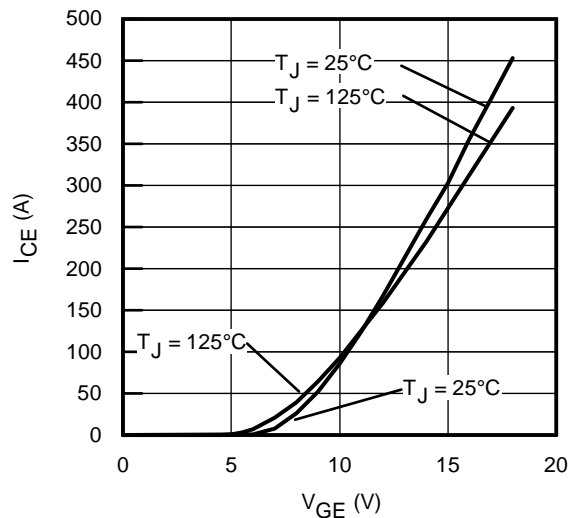
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



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



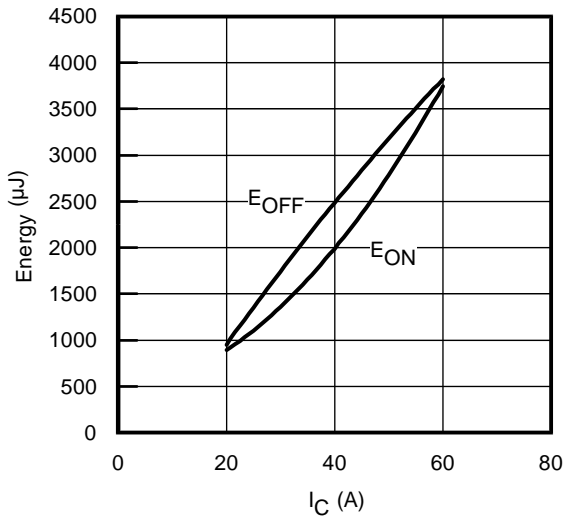
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 125^\circ\text{C}$



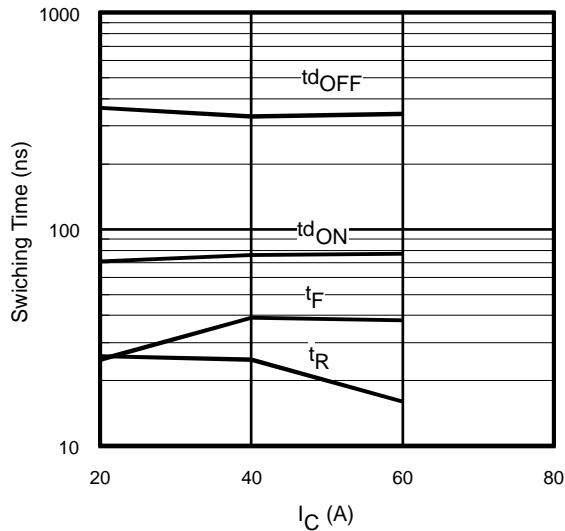
**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$

# IRGPS40B120UDP

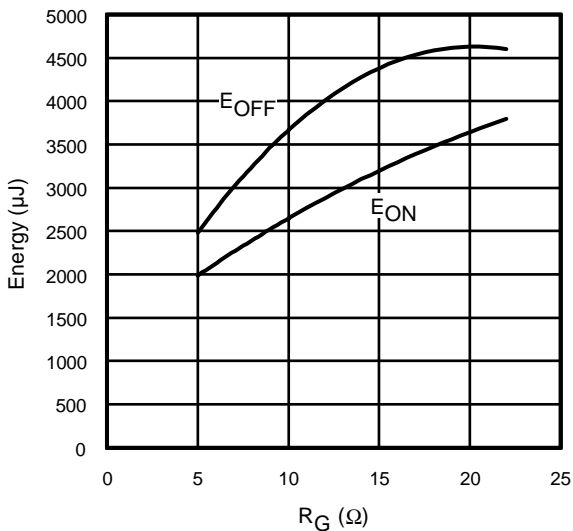
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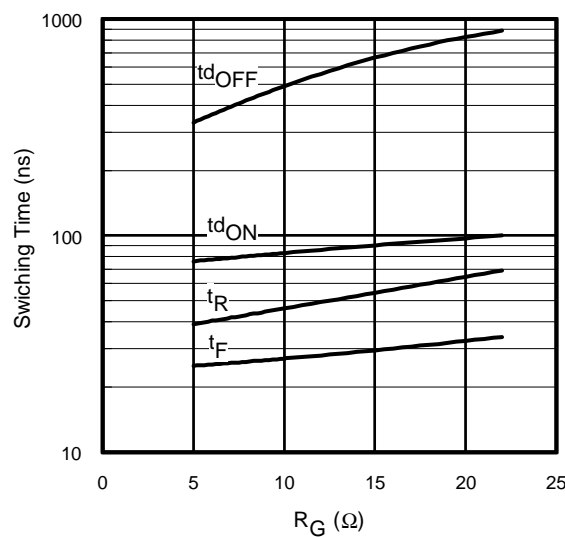
**Fig. 13** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $R_G= 4.7\Omega$ ;  $V_{GE}= 15\text{V}$



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

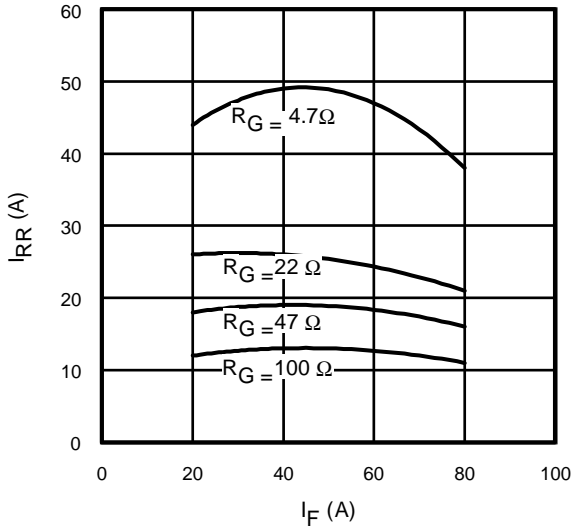


**Fig. 15** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $I_{CE}= 40\text{A}$ ;  $V_{GE}= 15\text{V}$

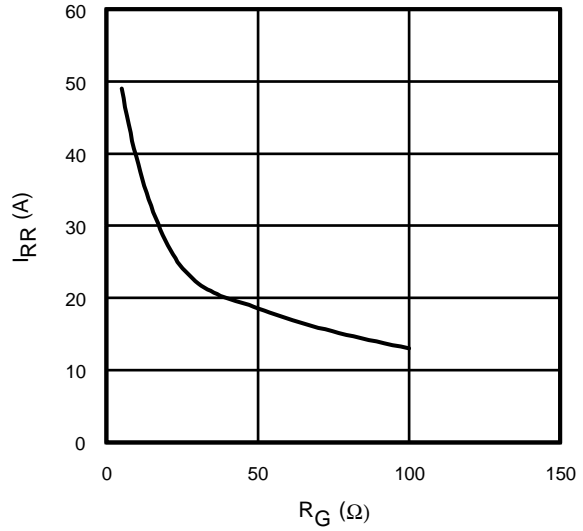


**Fig. 16** - Typ. Switching Time vs.  $R_G$   
 $T_J = 125^\circ\text{C}$ ;  $L=200\mu\text{H}$ ;  $V_{CE}= 600\text{V}$   
 $I_{CE}= 40\text{A}$ ;  $V_{GE}= 15\text{V}$

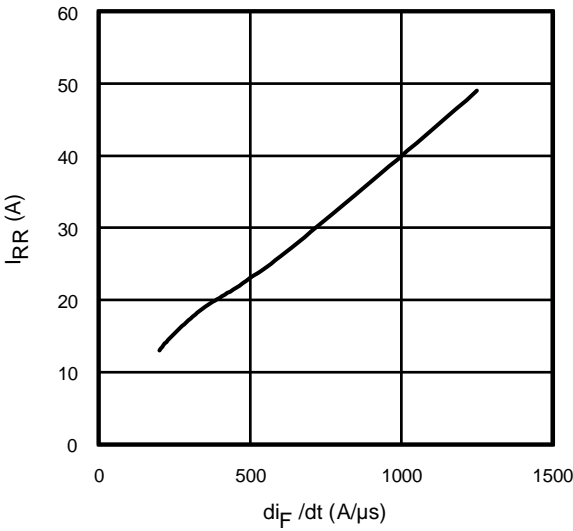
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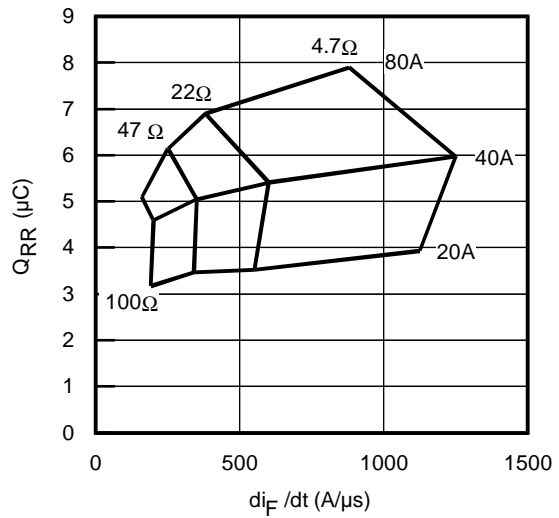
**Fig. 17** - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$



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



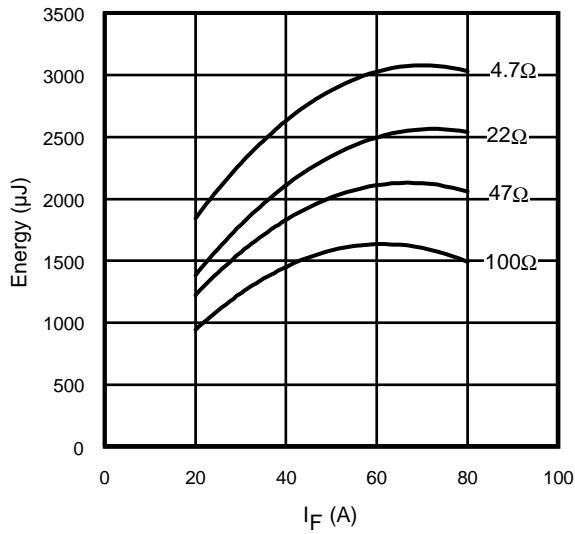
**Fig. 19**- Typical Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V};$   
 $I_{CE} = 40\text{A}; T_J = 125^\circ\text{C}$



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

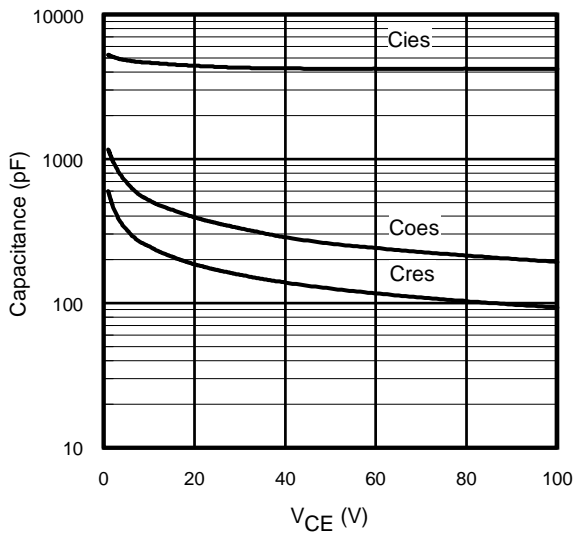
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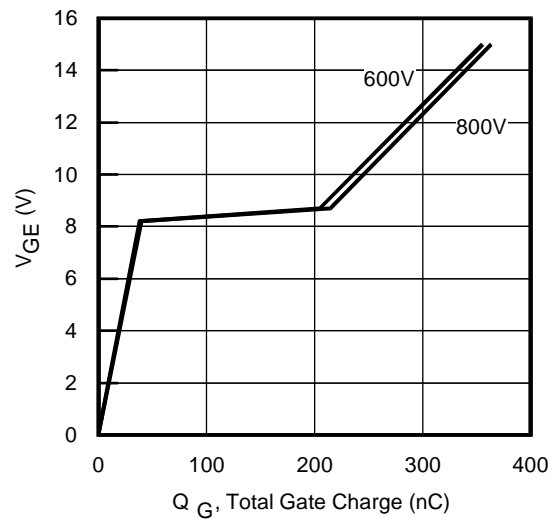


**Fig. 21** - Typical Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$

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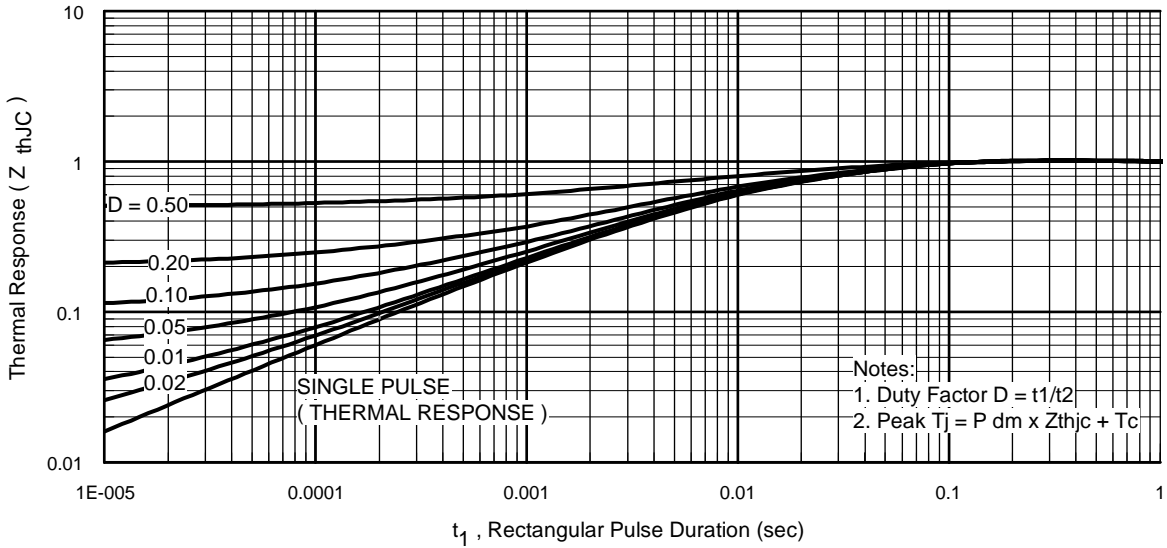
**Fig. 22**- Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0\text{V}$ ;  $f = 1\text{MHz}$



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

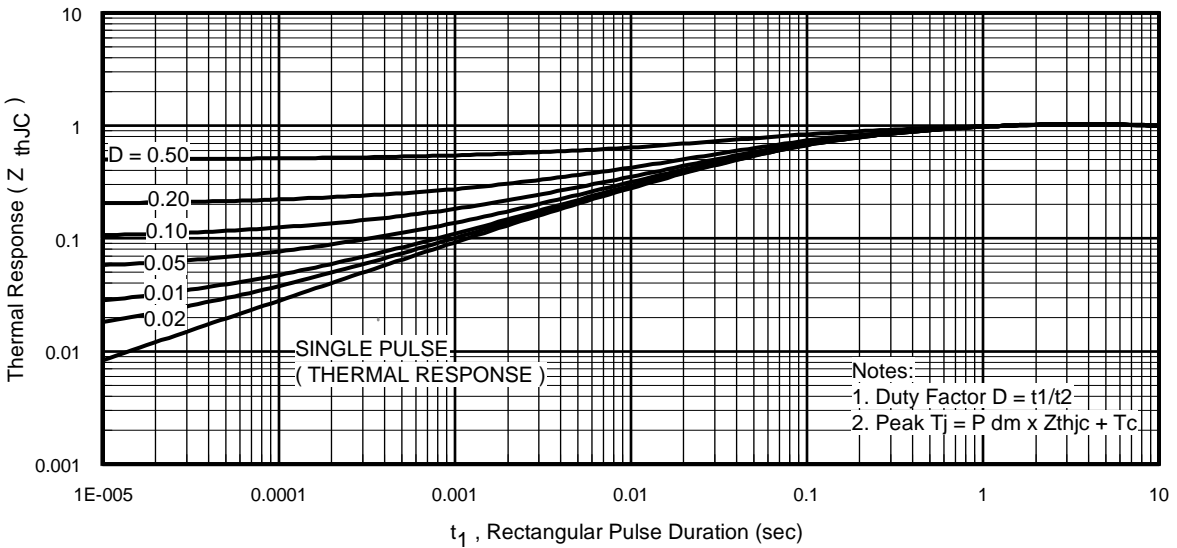
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**Fig 24.** Normalized Transient Thermal Impedance, Junction-to-Case (IGBT)

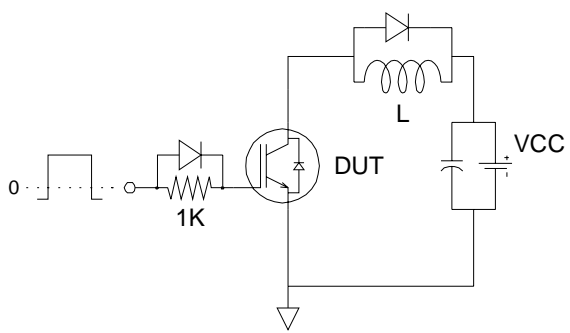
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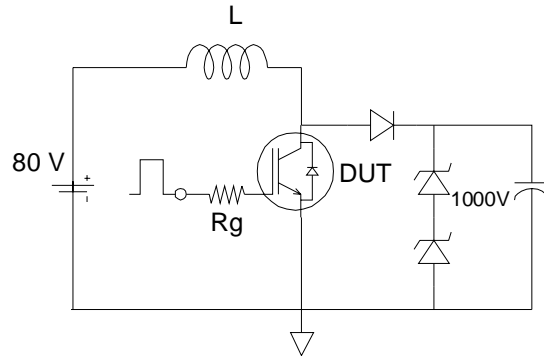
**Fig 25.** Normalized Transient Thermal Impedance, Junction-to-Case (DIODE)

# IRGPS40B120UDP

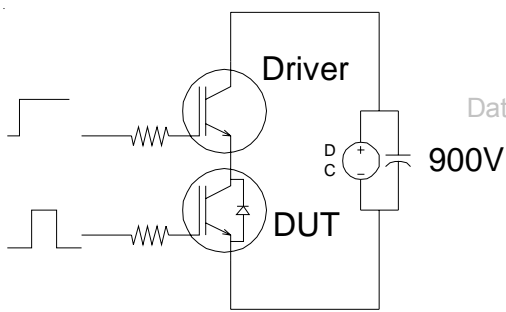
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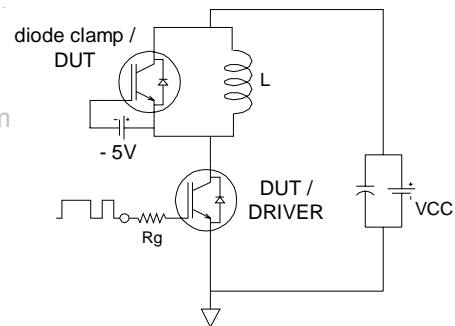
**Fig.C.T.1** - Gate Charge Circuit (turn-on)



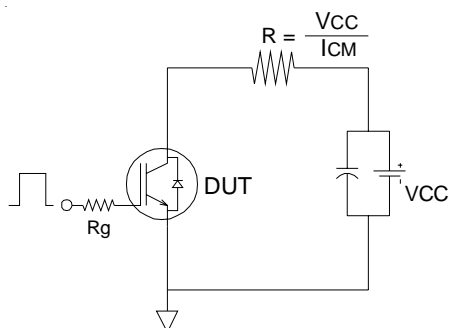
**Fig.C.T.2** - RBSOA Circuit



**Fig.C.T.3** - RBSOA Circuit



**Fig.C.T.4** - RBSOA Circuit



**Fig.C.T.5** - RBSOA Circuit

# IRGPS40B120UDP

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

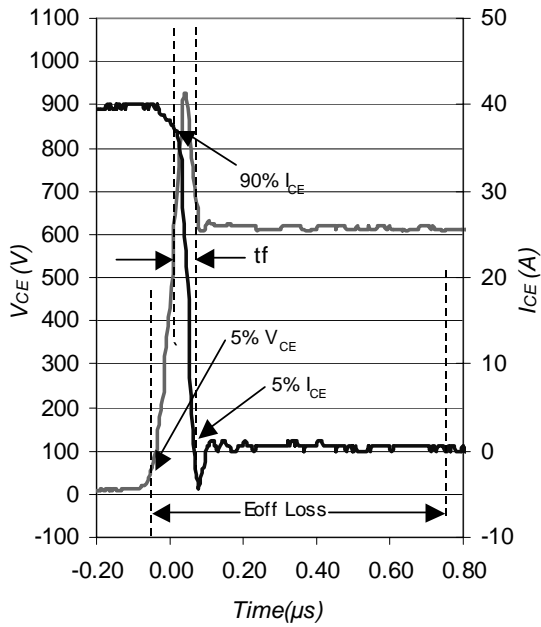


Fig. WF.2 - Typ. Turn-on Loss Waveform  
 @  $T_j=125^\circ\text{C}$  using Fig. CT.4

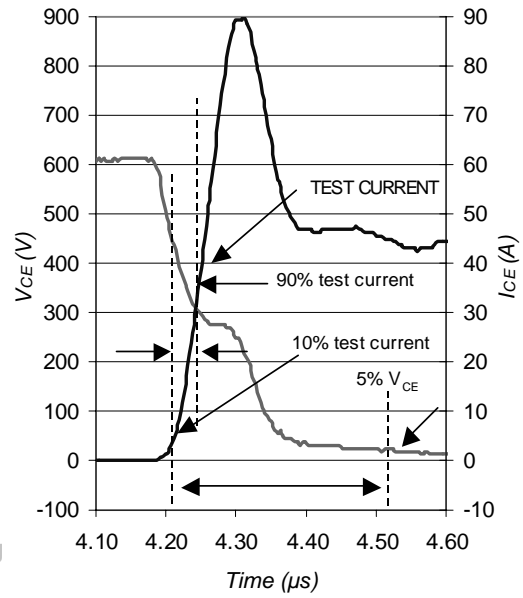


Fig. WF.3 - Typ. Diode Recovery Waveform  
 @  $T_j=125^\circ\text{C}$  using Fig. CT.4

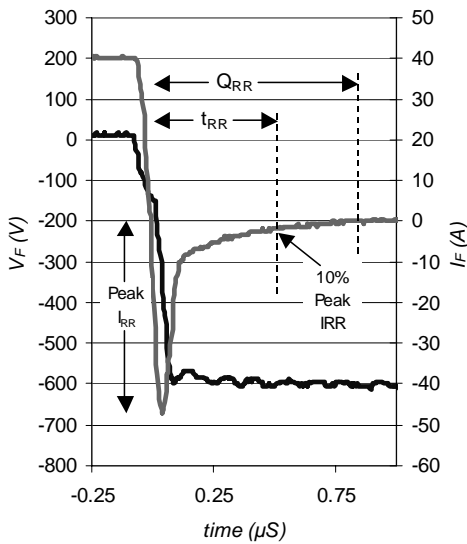
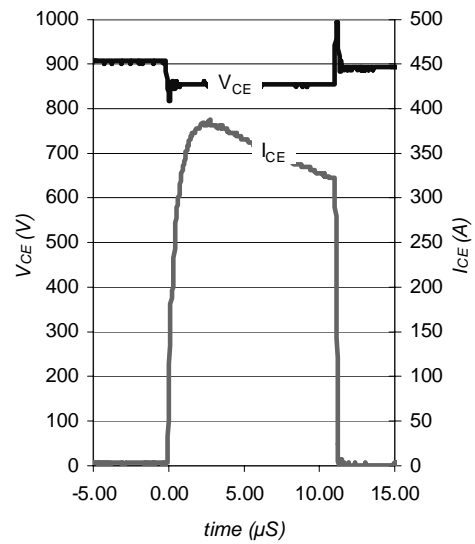


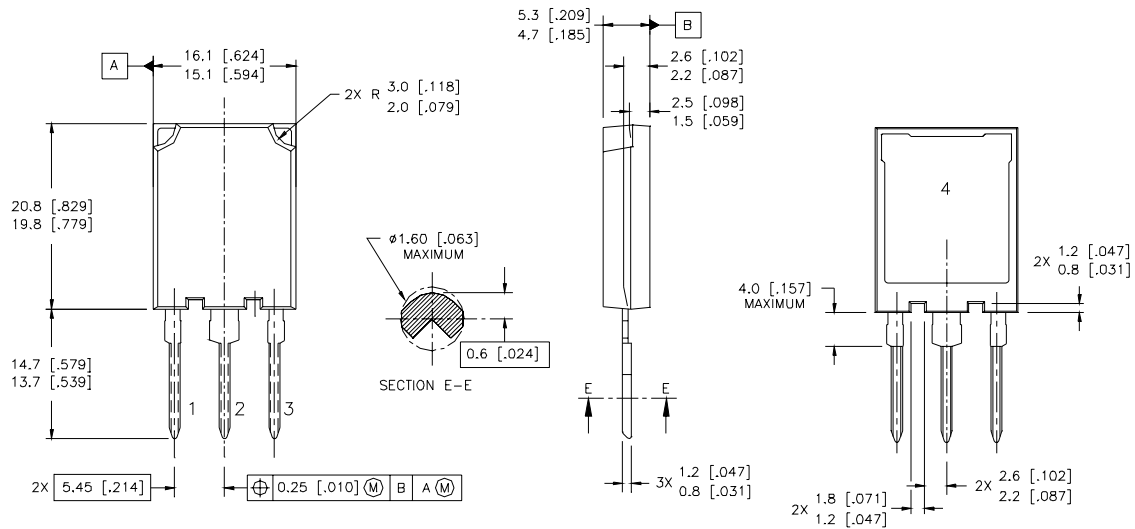
Fig. WF.4 - Typ. S.C. Waveform  
 @  $T_C=150^\circ\text{C}$  using Fig. CT.3



# IRGPS40B120UDP

## Case Outline and Dimensions — Super-247

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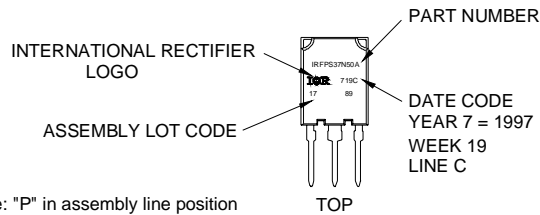
- NOTES:
1. DIMENSIONS & TOLERANCING PER ASME Y14.5M-1994
  2. CONTROLLING DIMENSION: MILLIMETER
  3. DIMENSIONS ARE SHOWN IN MILLIMETRES [INCHES]

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"



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  
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