

# IRGPS40B120UD

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFast SOFT RECOVERY DIODE

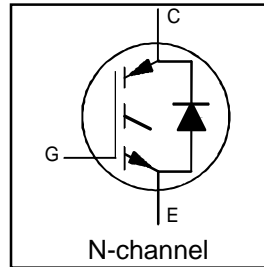
UltraFast Co-Pack IGBT

## Features

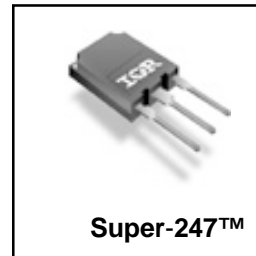
- Non Punch Through IGBT Technology.
- Low Diode VF.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive VCE (on) Temperature Coefficient.
- Super-247 Package.

## 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            | $\pm 20$                          | 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 | $^\circ C/W$ |
| $R_{\theta JC}$ | 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           |

# IRGPS40B120UD

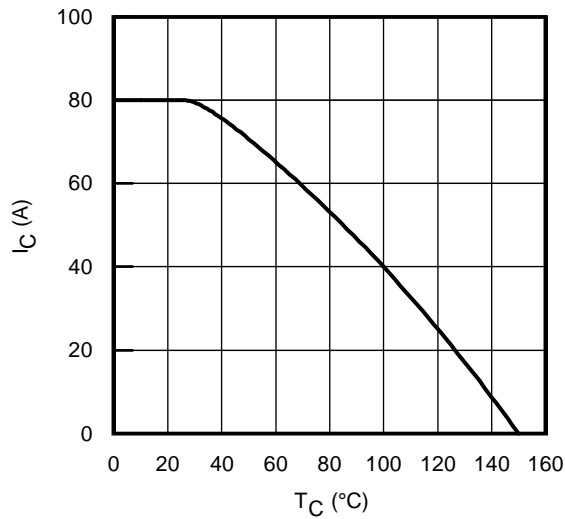
International  
**IR** Rectifier

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

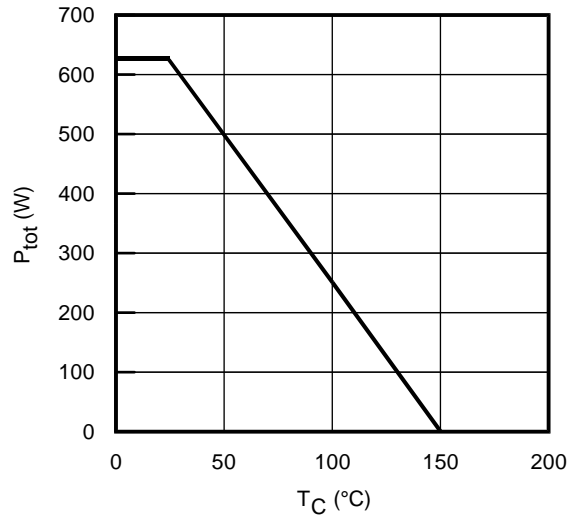
|  | Parameter                               | Min. | Typ. | Max. | Units | Conditions   | Ref.Fig. |
|--|---|------|------|------|-------|--|----------|
| V <sub>(BR)CES</sub>                   | Collector-to-Emitter Breakdown Voltage  | 1200 | —    | —    | V     | V <sub>GE</sub> = 0V, I <sub>C</sub> = 500μA   |          |
| ΔV <sub>(BR)CES</sub> /ΔT <sub>J</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<br>I <sub>C</sub> = 50A<br>I <sub>C</sub> = 40A, T <sub>J</sub> = 125°C<br>I <sub>C</sub> = 50A, T <sub>J</sub> = 125°C | 5, 6     |
|  |   | —    | 3.39 | 3.70 |       |  | 7, 9     |
|  |   | —    | 3.88 | 4.30 |       |  | 10       |
|  |   | —    | 4.24 | 4.70 |       |  | 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   | 9,10     |
| ΔV <sub>GE(th)</sub> /ΔT <sub>J</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)   | 11, 12   |
| 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  |          |
|  |   | —    | 420  | 1200 |       | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 125°C  |          |
| V <sub>FM</sub>                        | Diode Forward Voltage Drop              | —    | 2.03 | 2.40 | V     | I <sub>C</sub> = 40A   | 8        |
|  |   | —    | 2.17 | 2.60 |       | I <sub>C</sub> = 50A   |          |
|  |   | —    | 2.26 | 2.68 |       | I <sub>C</sub> = 40A, T <sub>J</sub> = 125°C   |          |
|  |   | —    | 2.46 | 2.95 |       | I <sub>C</sub> = 50A, 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)

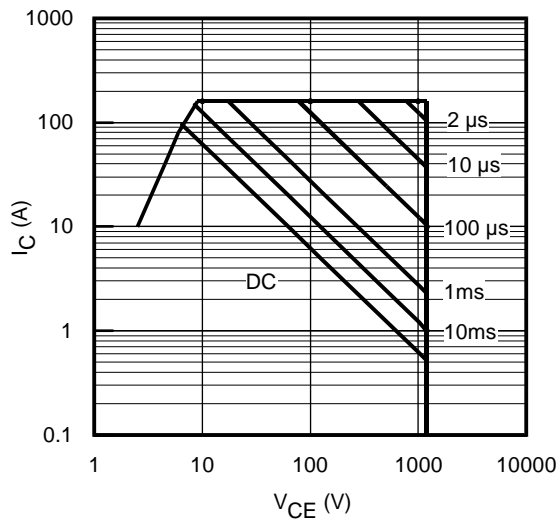
|                     | Parameter                            | Min.        | Typ. | Max. | Units | Conditions  | Ref.Fig.   |
|---------------------|--------------------------------------|-------------|------|------|-------|---|------------|
| Q <sub>g</sub>      | Total Gate Charge (turn-on)          | —           | 340  | 510  | nC    | I <sub>C</sub> = 40A  | 23         |
| Q <sub>ge</sub>     | Gate - Emitter Charge (turn-on)      | —           | 40   | 60   |       | V <sub>CC</sub> = 600V  | CT1        |
| Q <sub>gc</sub>     | Gate - Collector Charge (turn-on)    | —           | 165  | 248  |       | V <sub>GE</sub> = 15V   |            |
| E <sub>on</sub>     | Turn-On Switching Loss               | —           | 1400 | 1750 | μJ    | I <sub>C</sub> = 40A, V <sub>CC</sub> = 600V  | CT4        |
| E <sub>off</sub>    | Turn-Off Switching Loss              | —           | 1650 | 2050 |       | V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L = 200μH   | WF1        |
| E <sub>tot</sub>    | Total Switching Loss                 | —           | 3050 | 3800 | μJ    | L <sub>s</sub> = 150nH<br>T <sub>J</sub> = 25°C   | WF2        |
| E <sub>on</sub>     | Turn-On Switching Loss               | —           | 1950 | 2300 |       | T <sub>J</sub> = 125°C  | 13,15      |
| E <sub>off</sub>    | Turn-Off Switching Loss              | —           | 2200 | 2950 | μJ    | Energy losses include "tail" and diode reverse recovery.  |            |
| 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  | 14, 16     |
| t <sub>r</sub>      | Rise Time                            | —           | 39   | 55   |       | V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L = 200μH   | CT4        |
| t <sub>d(off)</sub> | Turn-Off Delay Time                  | —           | 332  | 365  |       | L <sub>s</sub> = 150nH, T <sub>J</sub> = 125°C  | WF1        |
| t <sub>f</sub>      | Fall Time                            | —           | 25   | 33   |       |   | WF2        |
| C <sub>ies</sub>    | Input Capacitance                    | —           | 4300 | —    | pF    | V <sub>GE</sub> = 0V  | 22         |
| C <sub>oes</sub>    | Output Capacitance                   | —           | 330  | —    |       | V <sub>CC</sub> = 30V   |            |
| C <sub>res</sub>    | Reverse Transfer Capacitance         | —           | 160  | —    |       | f = 1.0MHz  |            |
| RBSOA               | Reverse Bias Safe Operating Area     | FULL SQUARE |      |      |       | T <sub>J</sub> = 150°C, I <sub>C</sub> = 160A, V <sub>p</sub> = 1200V<br>V <sub>CC</sub> = 1000V, V <sub>GE</sub> = +15V to 0V<br>R <sub>G</sub> = 4.7Ω | 4<br>CT2   |
| SCSOA               | Short Circuit Safe Operating Area    | 10          | —    | —    | μs    | T <sub>J</sub> = 150°C, V <sub>p</sub> = 1200V<br>V <sub>CC</sub> = 900V, V <sub>GE</sub> = +15V to 0V,<br>R <sub>G</sub> = 4.7Ω                        | CT3<br>WF4 |
| E <sub>rec</sub>    | Reverse Recovery energy of the diode | —           | 3346 | —    | μJ    | T <sub>J</sub> = 125°C  | 17,18,19   |
| t <sub>rr</sub>     | Diode Reverse Recovery time          | —           | 180  | —    | ns    | V <sub>CC</sub> = 600V, I <sub>F</sub> = 60A, L = 200μH   | 20, 21     |
| I <sub>rr</sub>     | Diode Peak Reverse Recovery Current  | —           | 50   | —    | A     | V <sub>GE</sub> = 15V, R <sub>G</sub> = 4.7Ω, L <sub>s</sub> = 150nH  | CT4, WF3   |



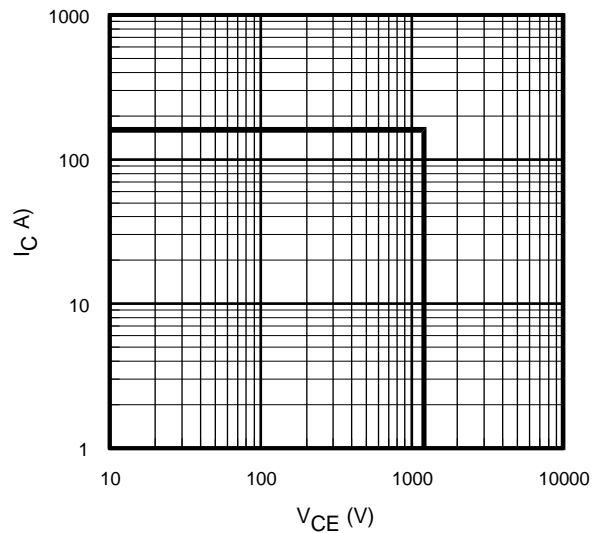
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



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

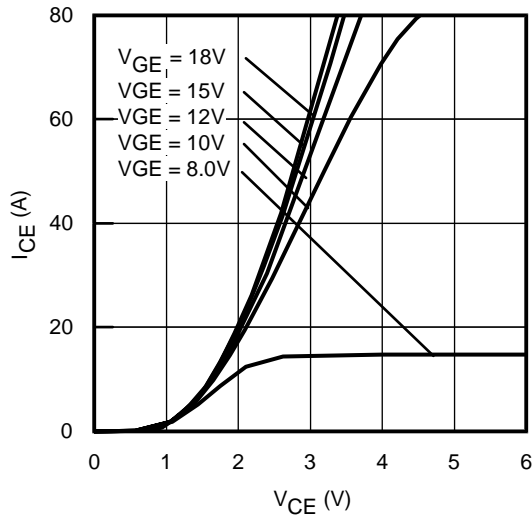


**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ;  $T_{JS} \leq 150^\circ\text{C}$

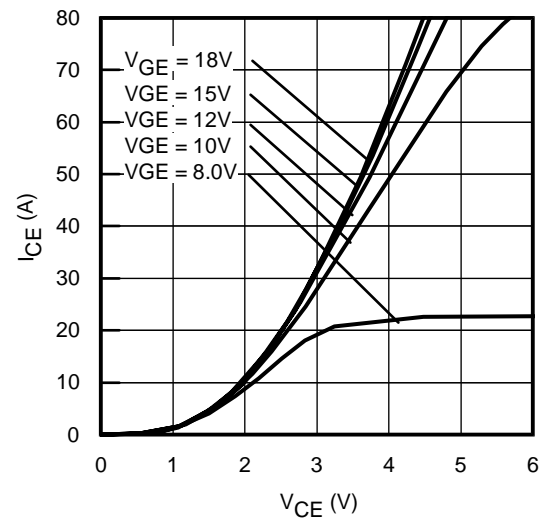


**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$

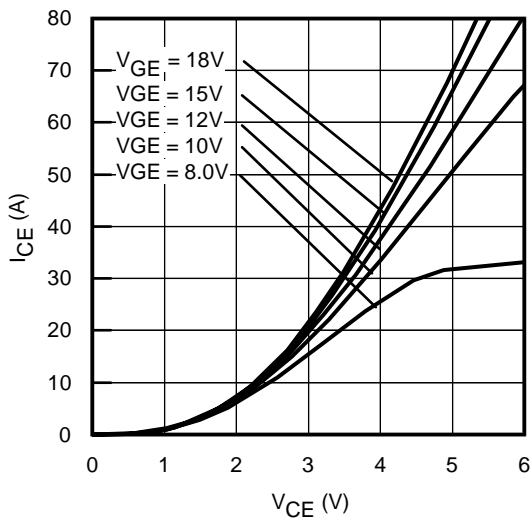
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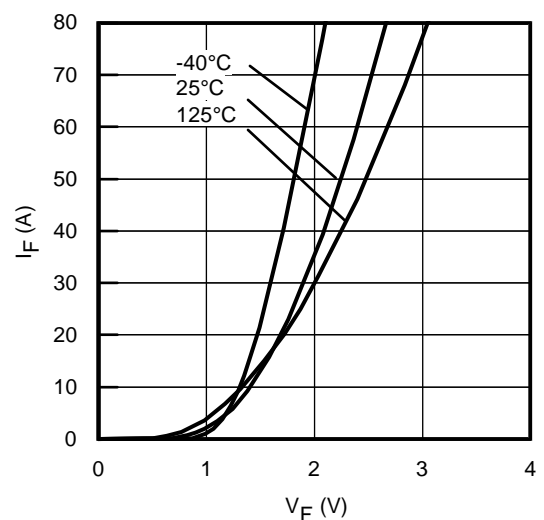
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



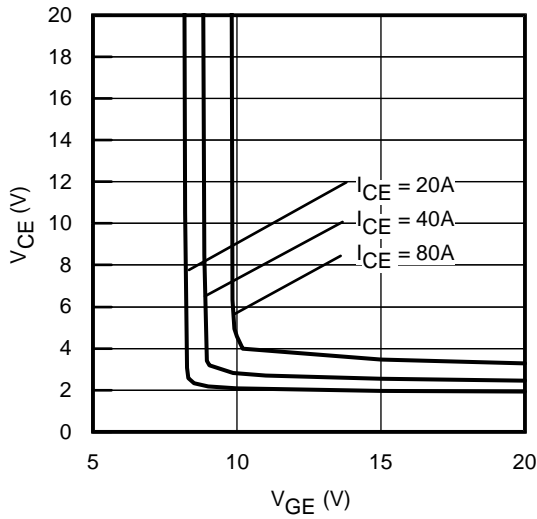
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



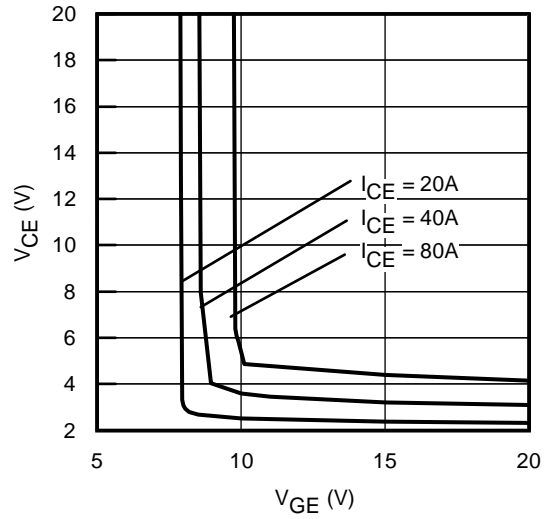
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 125^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



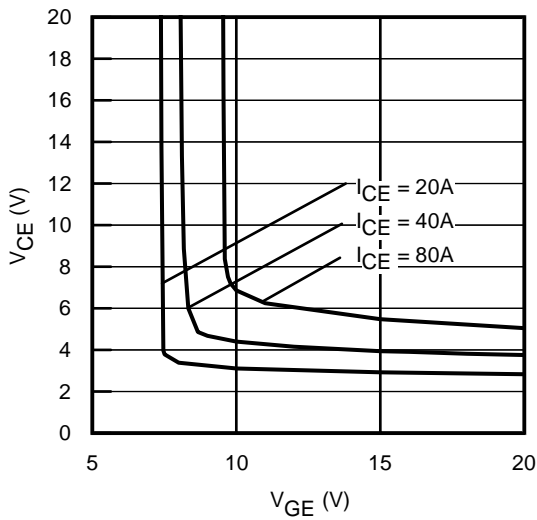
**Fig. 8** - Typ. Diode Forward Characteristics  
 $t_p = 80\mu\text{s}$



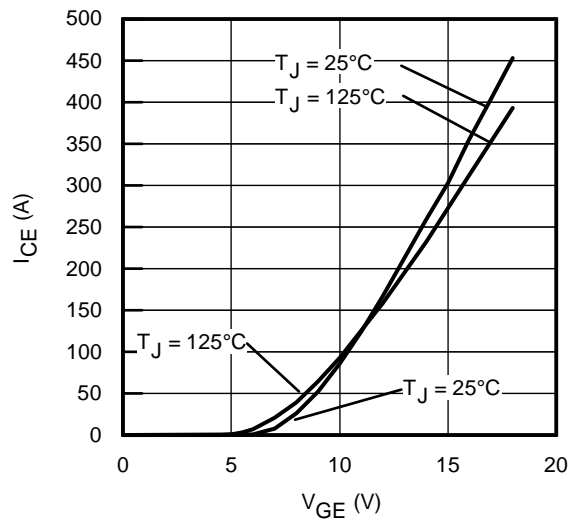
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



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

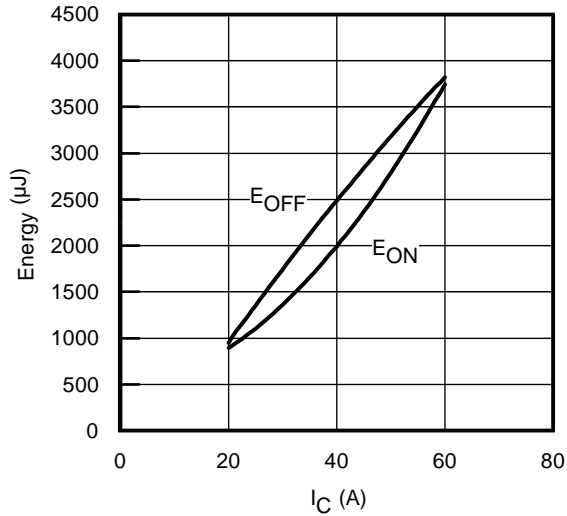


**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 125^\circ\text{C}$

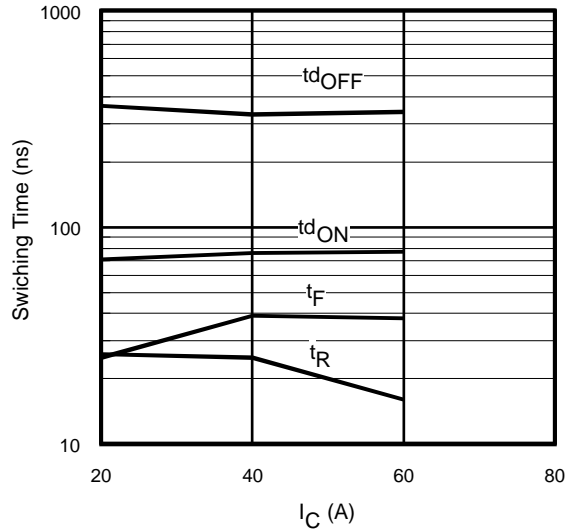


**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$

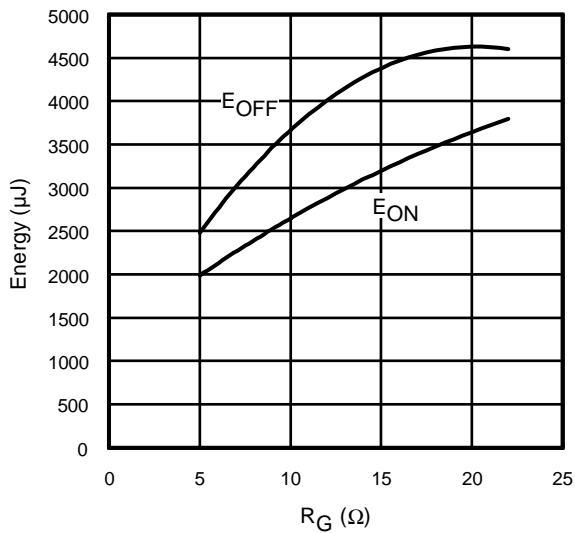
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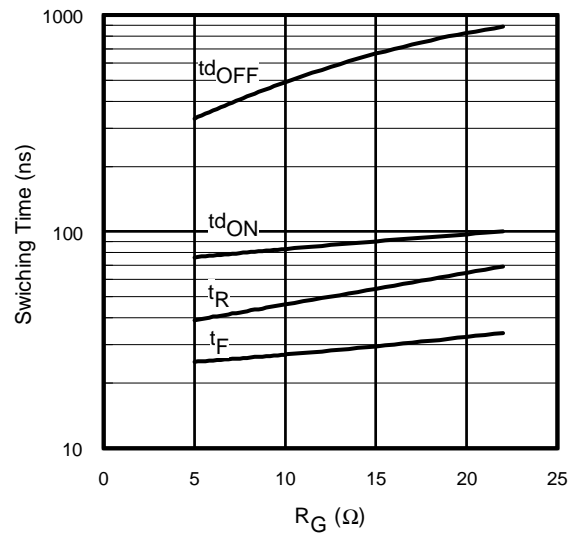
**Fig. 13** - Typ. Energy Loss vs. I<sub>C</sub>  
T<sub>J</sub> = 125°C; L=200μH; V<sub>CE</sub>= 600V  
R<sub>G</sub>= 4.7Ω; V<sub>GE</sub>= 15V



**Fig. 14** - Typ. Switching Time vs. I<sub>C</sub>  
T<sub>J</sub> = 125°C; L=200μH; V<sub>CE</sub>= 600V  
R<sub>G</sub>= 4.7Ω; V<sub>GE</sub>= 15V

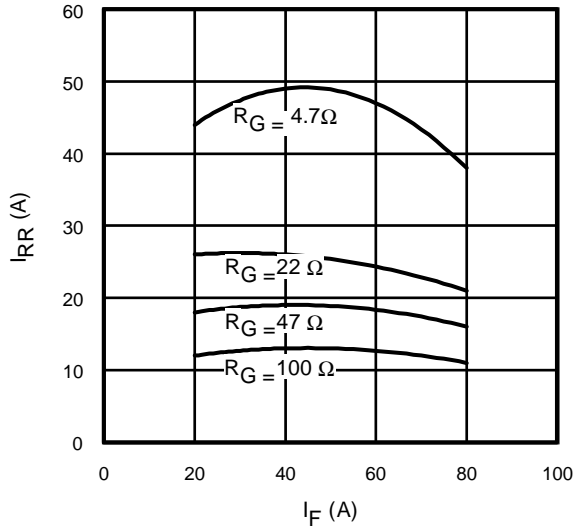


**Fig. 15** - Typ. Energy Loss vs. R<sub>G</sub>  
T<sub>J</sub> = 125°C; L=200μH; V<sub>CE</sub>= 600V  
I<sub>CE</sub>= 40A; V<sub>GE</sub>= 15V

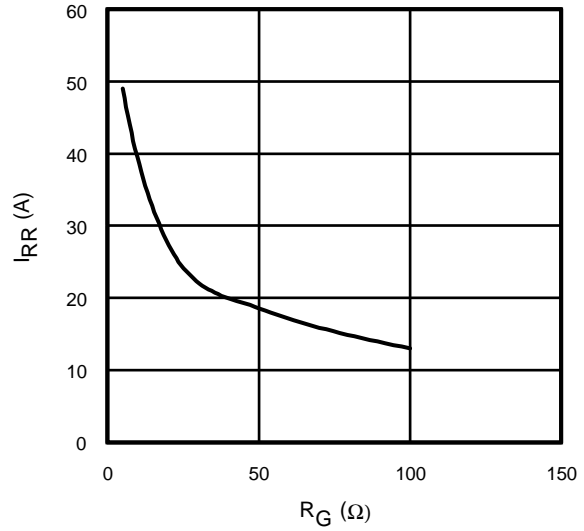


**Fig. 16** - Typ. Switching Time vs. R<sub>G</sub>  
T<sub>J</sub> = 125°C; L=200μH; V<sub>CE</sub>= 600V  
I<sub>CE</sub>= 40A; V<sub>GE</sub>= 15V

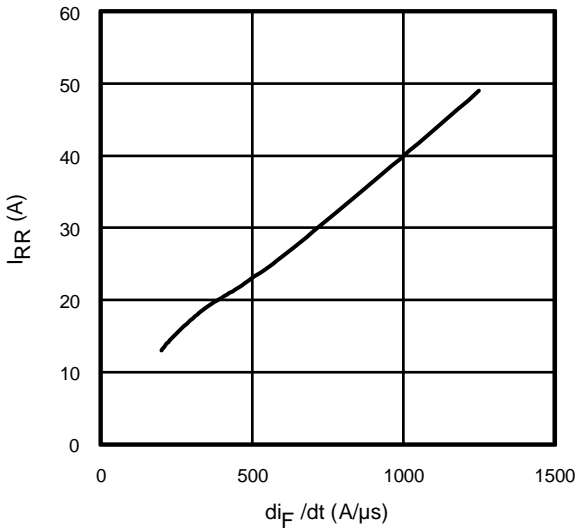
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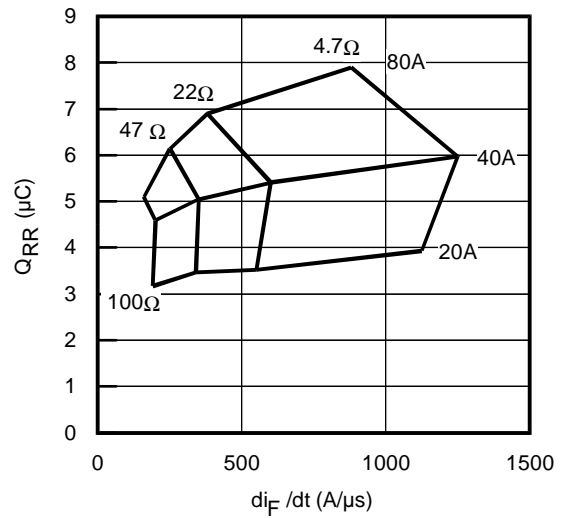
**Fig. 17** - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$



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

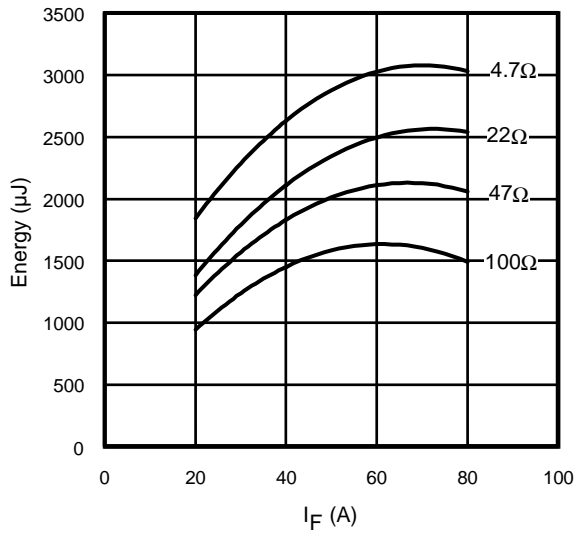


**Fig. 19**- Typical Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V};$   
 $I_{CE} = 40\text{A}; T_J = 125^\circ\text{C}$

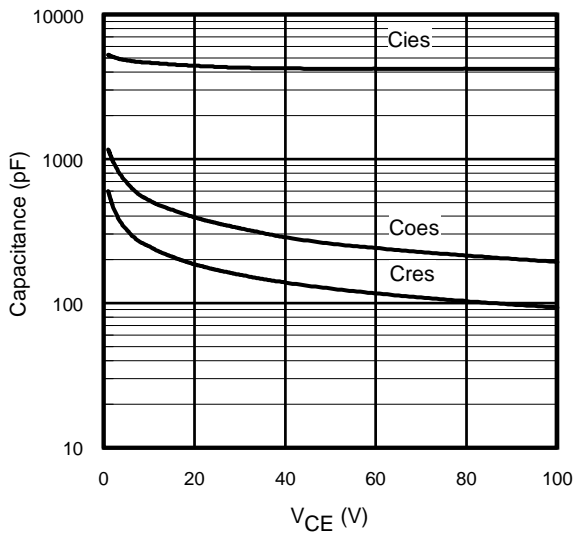


**Fig. 20** - Typical Diode  $Q_{RR}$   
 $V_{CC} = 600\text{V}; V_{GE} = 15\text{V}; T_J = 125^\circ\text{C}$

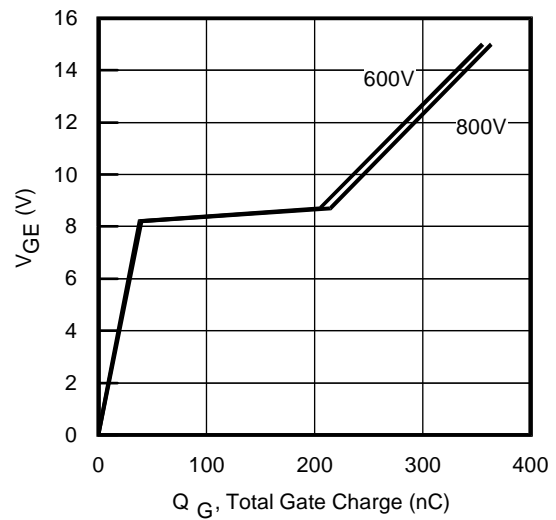
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**Fig. 21** - Typical Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 125^\circ\text{C}$



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



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



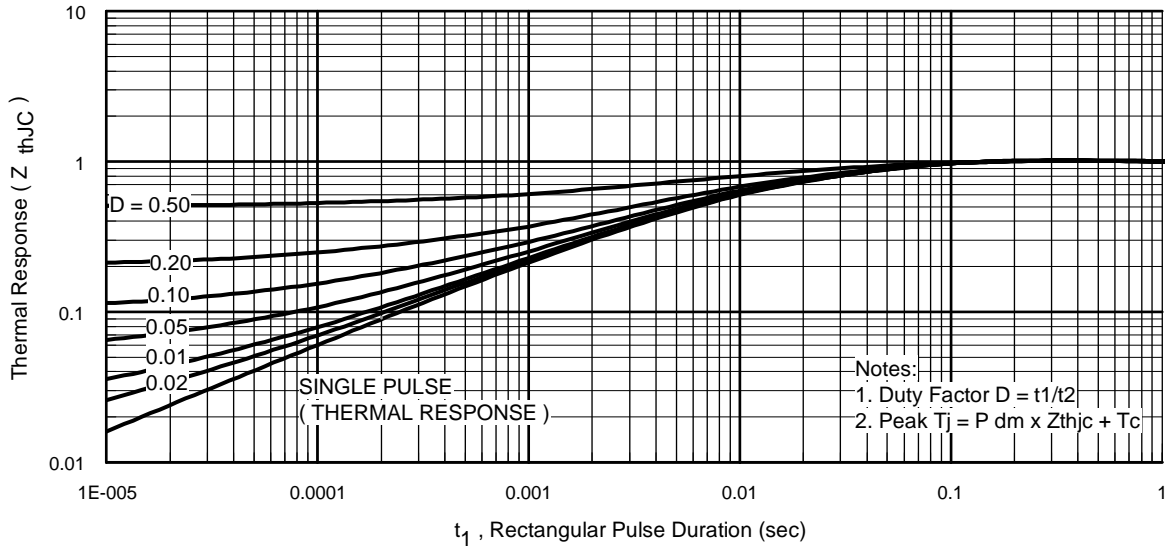


Fig 24. Normalized Transient Thermal Impedance, Junction-to-Case (IGBT)

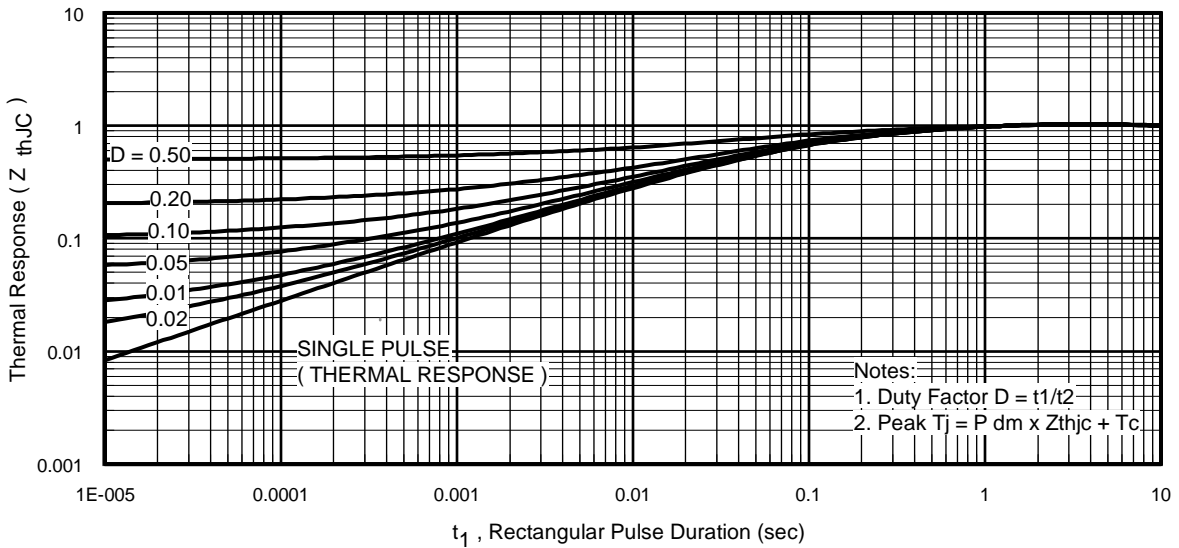
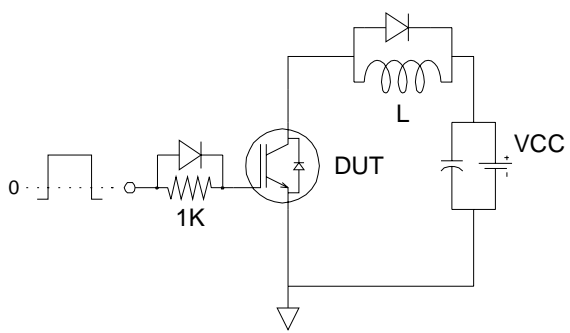


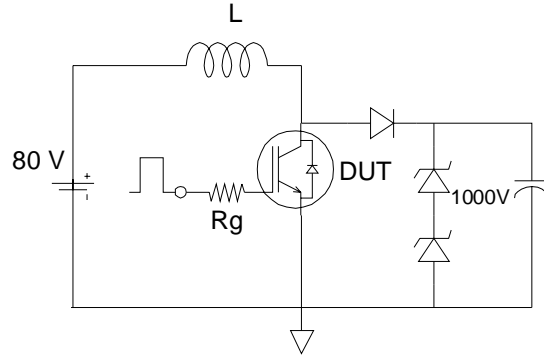
Fig 25. Normalized Transient Thermal Impedance, Junction-to-Case (DIODE)

# IRGPS40B120UD

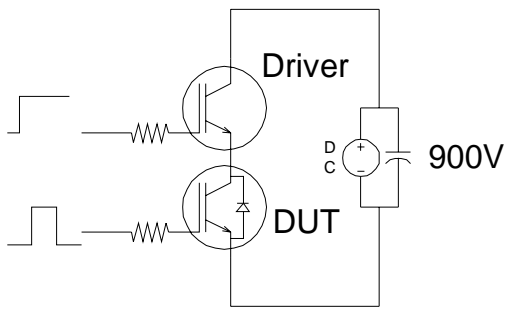
International  
**IR** Rectifier



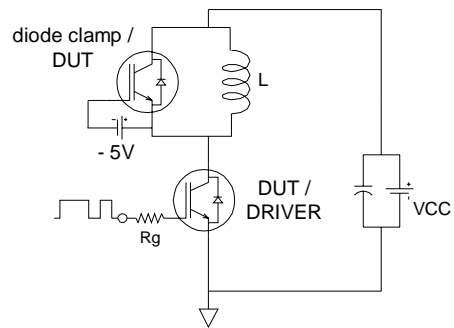
**Fig.C.T.1** - Gate Charge Circuit (turn-on)



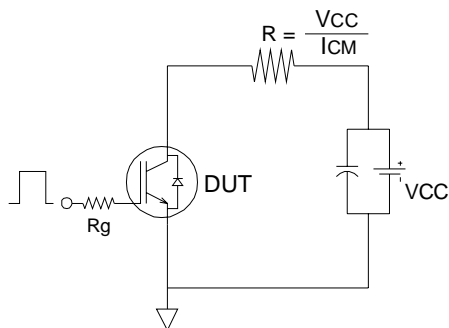
**Fig.C.T.2** - RBSOA Circuit



**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

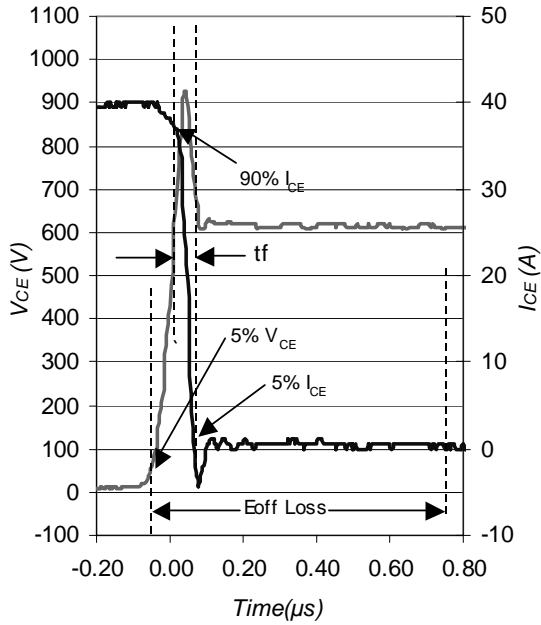


Fig. WF.2 - Typ. Turn-on Loss Waveform  
 @  $T_j=125^\circ\text{C}$  using Fig. CT.4

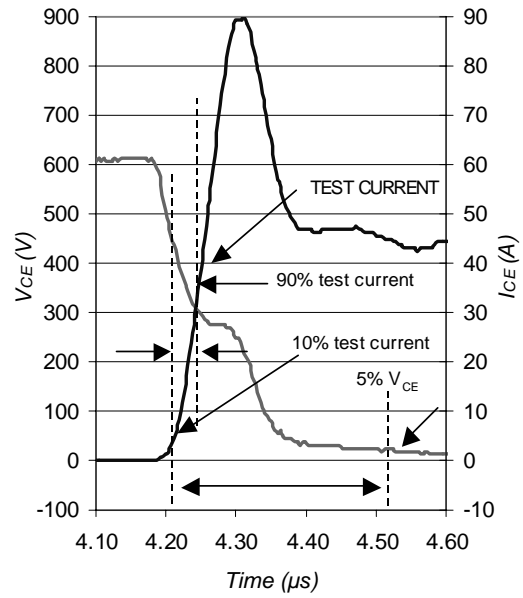


Fig. WF.3 - Typ. Diode Recovery Waveform  
 @  $T_j=125^\circ\text{C}$  using Fig. CT.4

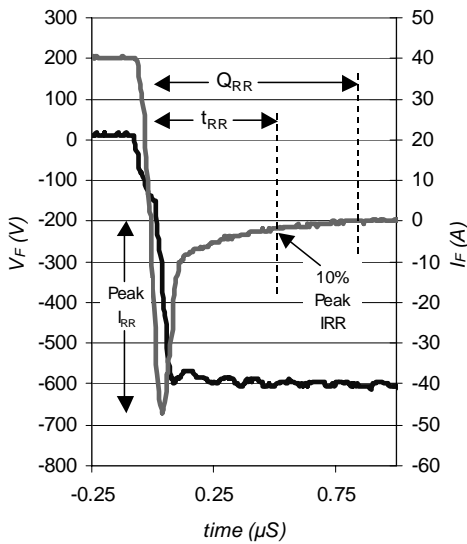
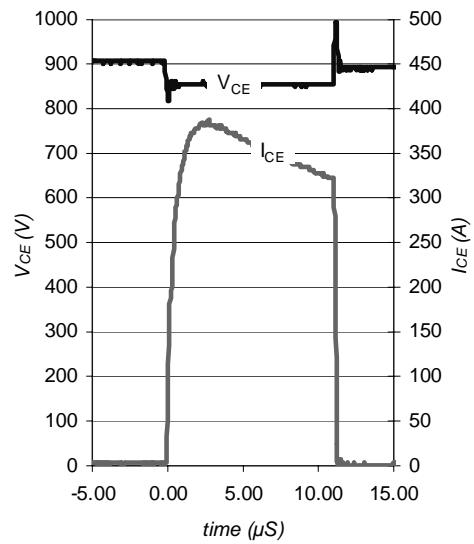


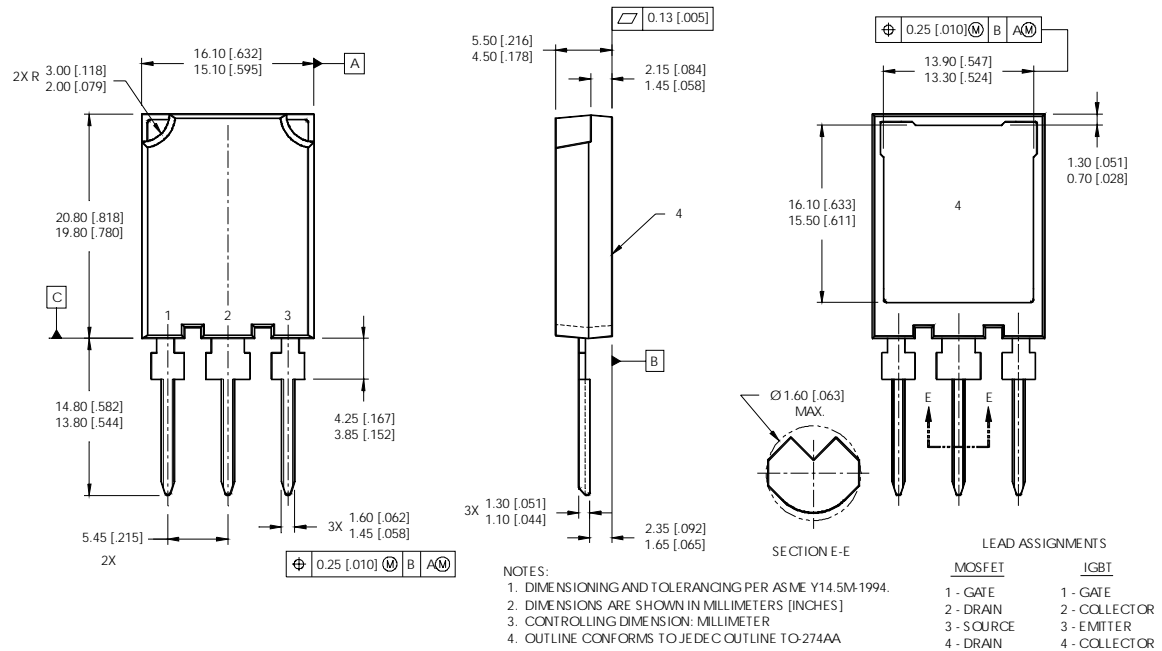
Fig. WF.4 - Typ. S.C. Waveform  
 @  $T_C=150^\circ\text{C}$  using Fig. CT.3



# IRGPS40B120UD

International  
**IR** Rectifier

## Super-247™ Package Outline



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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