

# IRG4BC20UD

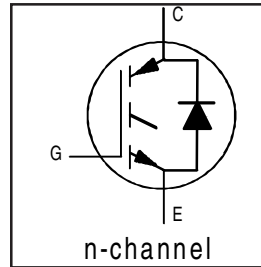
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE UltraFast CoPack IGBT

## Features

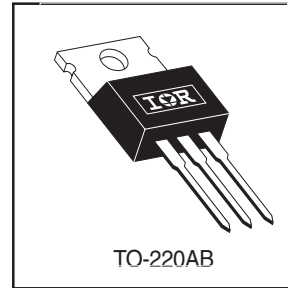
- UltraFast: optimized for high operating frequencies 8-40 kHz in hard switching, >200 kHz in resonant mode
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED® ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220AB package

## Benefits

- Generation -4 IGBTs offer highest efficiencies available
- IGBTs optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBTs. Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBTs



|                                   |
|-----------------------------------|
| $V_{CES} = 600V$                  |
| $V_{CE(on)} \text{ typ.} = 1.85V$ |
| @ $V_{GE} = 15V, I_C = 6.5A$      |



## Absolute Maximum Ratings

|                           | Parameter                                        | Max.                              | Units      |
|---------------------------|--------------------------------------------------|-----------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage                     | 600                               | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current                     | 13                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current                     | 6.5                               |            |
| $I_{CM}$                  | Pulsed Collector Current ①                       | 52                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②                 | 52                                |            |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current                 | 7.0                               |            |
| $I_{FM}$                  | Diode Maximum Forward Current                    | 52                                |            |
| $V_{GE}$                  | Gate-to-Emitter Voltage                          | $\pm 20$                          | V          |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                        | 60                                | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                        | 24                                |            |
| $T_J$                     | Operating Junction and Storage Temperature Range | -55 to +150                       | $^\circ C$ |
| $T_{STG}$                 |                                                  |                                   |            |
|                           | Soldering Temperature, for 10 sec.               | 300 (0.063 in. (1.6mm) from case) |            |
|                           | Mounting Torque, 6-32 or M3 Screw.               | 10 lbf•in (1.1 N•m)               |            |

## Thermal Resistance

|                 | Parameter                                 | Min.  | Typ.     | Max.  | Units        |
|-----------------|-------------------------------------------|-------|----------|-------|--------------|
| $R_{\theta JC}$ | Junction-to-Case - IGBT                   | ----- | -----    | 2.1   | $^\circ C/W$ |
| $R_{\theta JC}$ | Junction-to-Case - Diode                  | ----- | -----    | 3.5   |              |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface       | ----- | 0.50     | ----- |              |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ----- | -----    | 80    |              |
| Wt              | Weight                                    | ----- | 2 (0.07) | ----- | g (oz)       |

# IRG4BC20UD

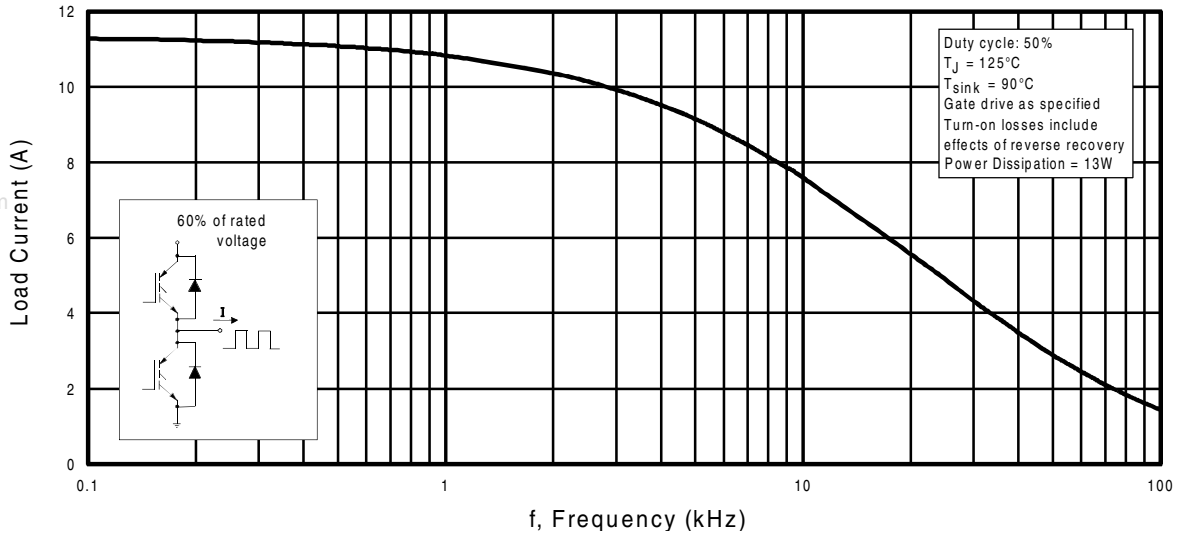
International  
IR Rectifier

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

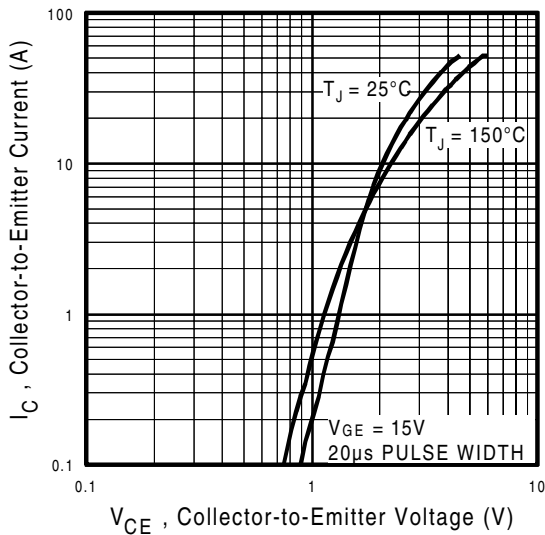
|                                 | Parameter                                           | Min. | Typ. | Max.      | Units                | Conditions                                                                                          |
|---------------------------------|-----------------------------------------------------|------|------|-----------|----------------------|-----------------------------------------------------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage <sup>③</sup> | 600  | ---- | ----      | V                    | $V_{GE} = 0V, I_C = 250\mu A$                                                                       |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage             | ---- | 0.69 | ----      | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                                                                          |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage             | ---- | 1.85 | 2.1       | V                    | $I_C = 6.5A, V_{GE} = 15V$<br>$I_C = 13A$<br>$I_C = 6.5A, T_J = 150^\circ\text{C}$<br>See Fig. 2, 5 |
|                                 |                                                     | ---- | 2.27 | ----      |                      |                                                                                                     |
|                                 |                                                     | ---- | 1.87 | ----      |                      |                                                                                                     |
| $V_{GE(th)}$                    | Gate Threshold Voltage                              | 3.0  | ---- | 6.0       |                      | $V_{CE} = V_{GE}, I_C = 250\mu A$                                                                   |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage             | ---- | -11  | ----      | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$                                                                   |
| $g_{fe}$                        | Forward Transconductance <sup>④</sup>               | 1.4  | 4.3  | ----      | S                    | $V_{CE} = 100V, I_C = 6.5A$                                                                         |
| $I_{CES}$                       | Zero Gate Voltage Collector Current                 | ---- | ---- | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$<br>$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$               |
|                                 |                                                     | ---- | ---- | 1700      |                      |                                                                                                     |
| $V_{FM}$                        | Diode Forward Voltage Drop                          | ---- | 1.4  | 1.7       | V                    | $I_C = 8.0A$<br>$I_C = 8.0A, T_J = 150^\circ\text{C}$<br>See Fig. 13                                |
|                                 |                                                     | ---- | 1.3  | 1.6       |                      |                                                                                                     |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current                     | ---- | ---- | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                                                                  |

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

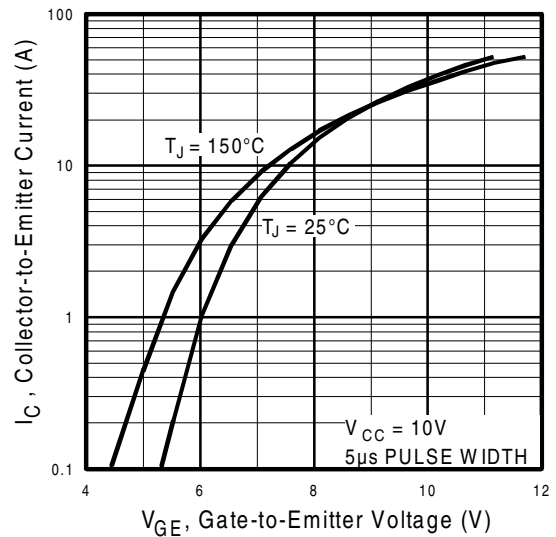
|                  | Parameter                                        | Min. | Typ. | Max. | Units      | Conditions                                                                                                                                                                      |
|------------------|--------------------------------------------------|------|------|------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $Q_g$            | Total Gate Charge (turn-on)                      | ---- | 27   | 41   | nC         | $I_C = 6.5A$<br>$V_{CC} = 400V$<br>$V_{GE} = 15V$<br>See Fig. 8                                                                                                                 |
| $Q_{ge}$         | Gate - Emitter Charge (turn-on)                  | ---- | 4.5  | 6.8  |            |                                                                                                                                                                                 |
| $Q_{gc}$         | Gate - Collector Charge (turn-on)                | ---- | 10   | 16   |            |                                                                                                                                                                                 |
| $t_{d(on)}$      | Turn-On Delay Time                               | ---- | 39   | ---- | ns         | $T_J = 25^\circ\text{C}$<br>$I_C = 6.5A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 50\Omega$<br>Energy losses include "tail" and diode reverse recovery.<br>See Fig. 9, 10, 11, 18 |
| $t_r$            | Rise Time                                        | ---- | 15   | ---- |            |                                                                                                                                                                                 |
| $t_{d(off)}$     | Turn-Off Delay Time                              | ---- | 93   | 140  |            |                                                                                                                                                                                 |
| $t_f$            | Fall Time                                        | ---- | 110  | 170  |            |                                                                                                                                                                                 |
| $E_{on}$         | Turn-On Switching Loss                           | ---- | 0.16 | ---- | mJ         | See Fig. 9, 10, 11, 18                                                                                                                                                          |
| $E_{off}$        | Turn-Off Switching Loss                          | ---- | 0.13 | ---- |            |                                                                                                                                                                                 |
| $E_{ts}$         | Total Switching Loss                             | ---- | 0.29 | 0.3  |            |                                                                                                                                                                                 |
| $t_{d(on)}$      | Turn-On Delay Time                               | ---- | 38   | ---- | ns         | $T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18<br>$I_C = 6.5A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 50\Omega$<br>Energy losses include "tail" and diode reverse recovery. |
| $t_r$            | Rise Time                                        | ---- | 17   | ---- |            |                                                                                                                                                                                 |
| $t_{d(off)}$     | Turn-Off Delay Time                              | ---- | 100  | ---- |            |                                                                                                                                                                                 |
| $t_f$            | Fall Time                                        | ---- | 220  | ---- |            |                                                                                                                                                                                 |
| $E_{ts}$         | Total Switching Loss                             | ---- | 0.49 | ---- | mJ         |                                                                                                                                                                                 |
| $L_E$            | Internal Emitter Inductance                      | ---- | 7.5  | ---- | nH         | Measured 5mm from package                                                                                                                                                       |
| $C_{ies}$        | Input Capacitance                                | ---- | 530  | ---- | pF         | $V_{GE} = 0V$<br>$V_{CC} = 30V$<br>$f = 1.0MHz$<br>See Fig. 7                                                                                                                   |
| $C_{oes}$        | Output Capacitance                               | ---- | 39   | ---- |            |                                                                                                                                                                                 |
| $C_{res}$        | Reverse Transfer Capacitance                     | ---- | 7.4  | ---- |            |                                                                                                                                                                                 |
| $t_{rr}$         | Diode Reverse Recovery Time                      | ---- | 37   | 55   |            |                                                                                                                                                                                 |
| $I_{rr}$         | Diode Peak Reverse Recovery Current              | ---- | 55   | 90   | A          | $T_J = 25^\circ\text{C}$ See Fig. 14<br>$T_J = 125^\circ\text{C}$ 15<br>$I_F = 8.0A$<br>$V_R = 200V$                                                                            |
|                  |                                                  | ---- | 3.5  | 5.0  |            |                                                                                                                                                                                 |
| $Q_{rr}$         | Diode Reverse Recovery Charge                    | ---- | 4.5  | 8.0  | nC         | $T_J = 25^\circ\text{C}$ See Fig. 16<br>$T_J = 125^\circ\text{C}$ 16<br>$di/dt 200A/\mu s$                                                                                      |
|                  |                                                  | ---- | 65   | 138  |            |                                                                                                                                                                                 |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During $t_b$ | ---- | 124  | 360  | A/ $\mu s$ | $T_J = 25^\circ\text{C}$ See Fig. 17<br>$T_J = 125^\circ\text{C}$ 17                                                                                                            |
|                  |                                                  | ---- | 240  | ---- |            |                                                                                                                                                                                 |



**Fig. 1** - Typical Load Current vs. Frequency  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)

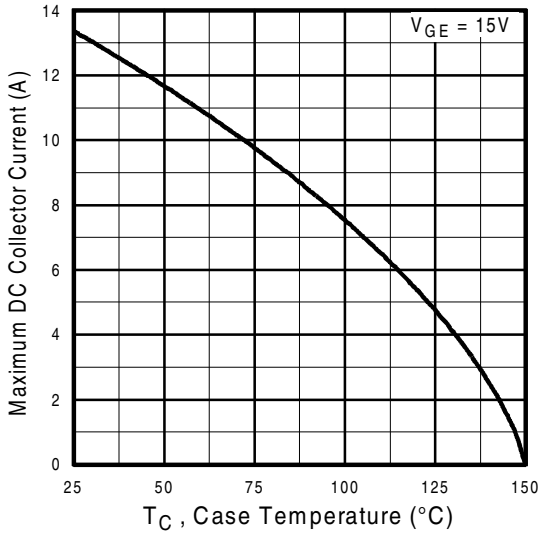


**Fig. 2** - Typical Output Characteristics

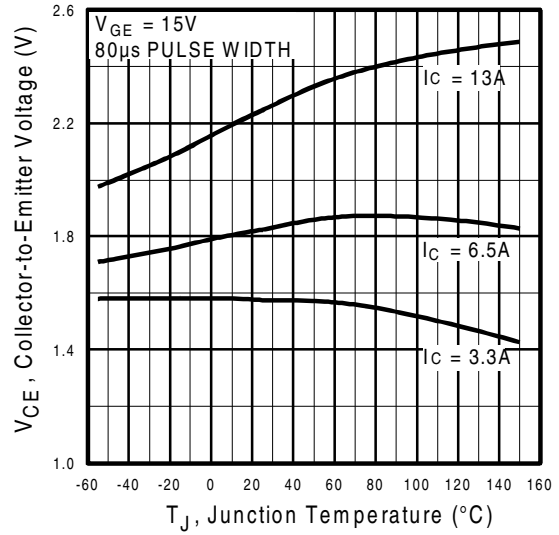


**Fig. 3** - Typical Transfer Characteristics

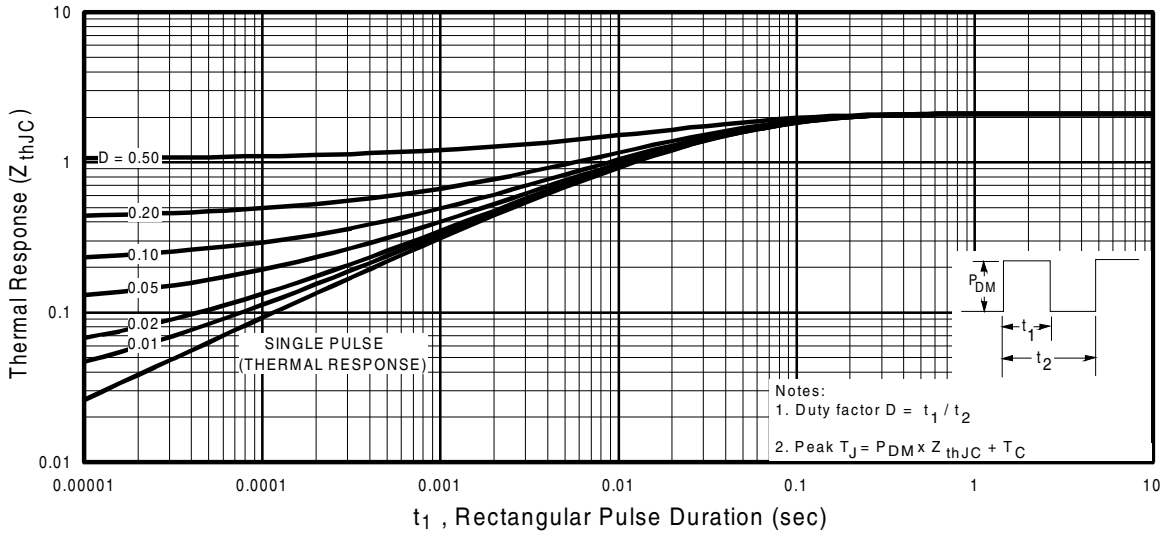
# IRG4BC20UD



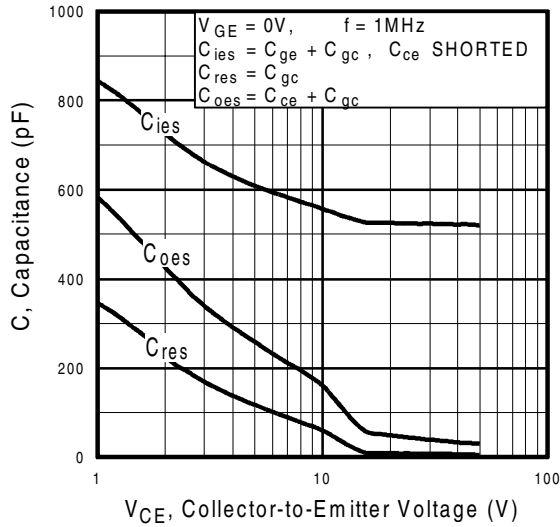
**Fig. 4** - Maximum Collector Current vs. Case Temperature



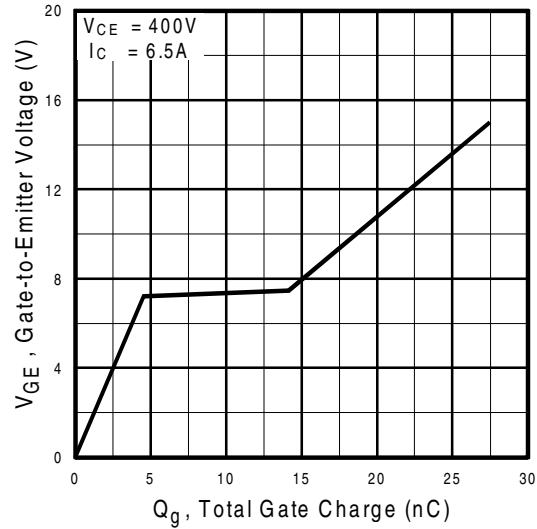
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



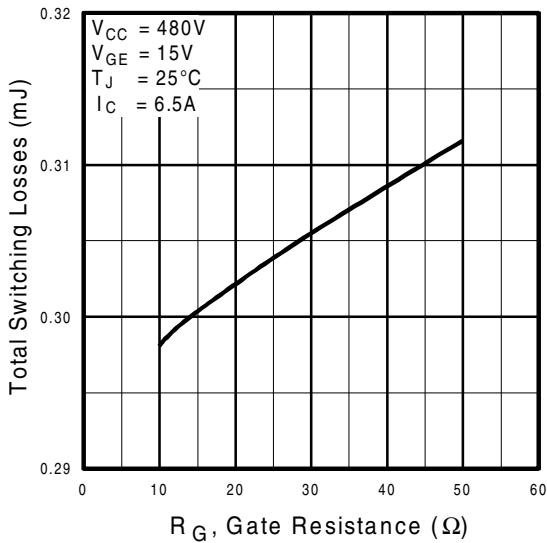
**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case



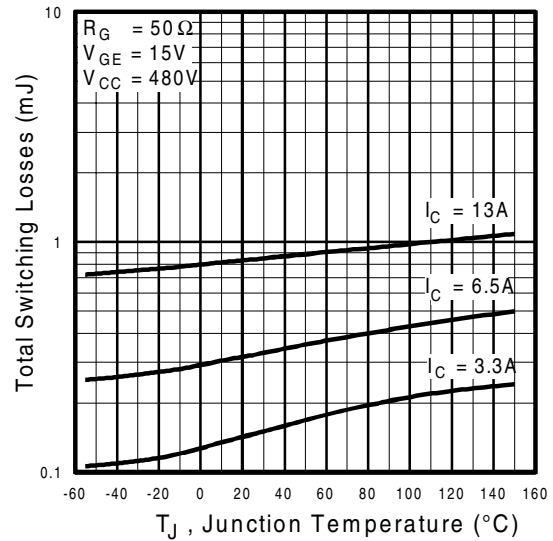
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

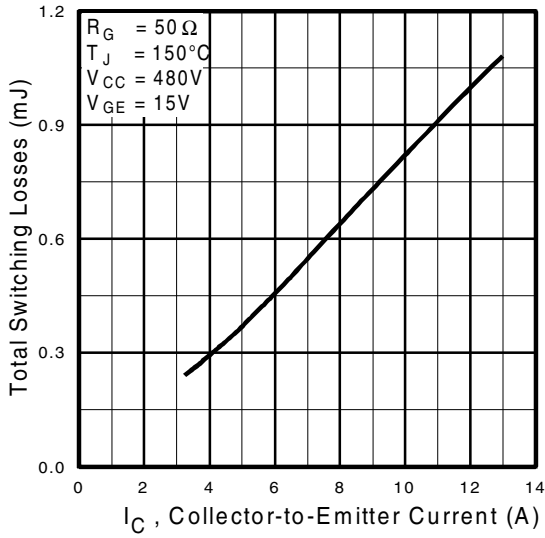


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

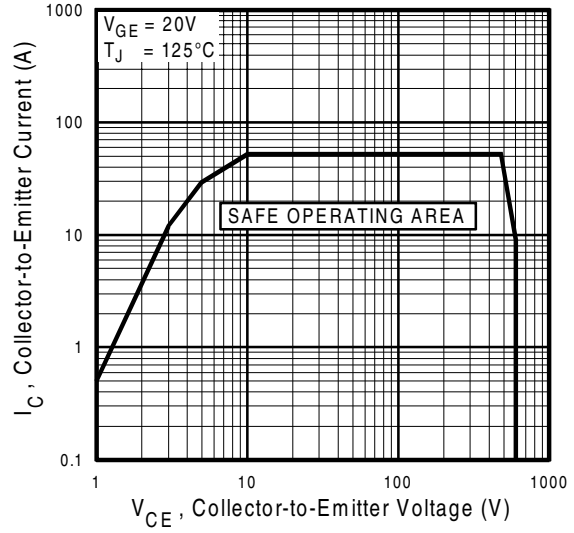


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

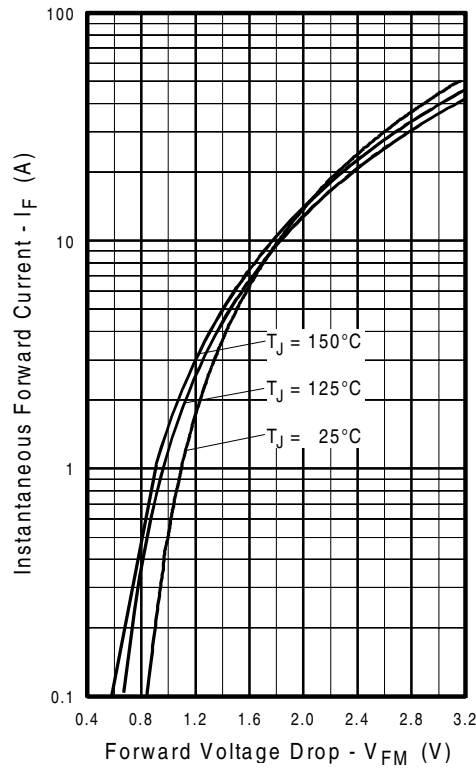
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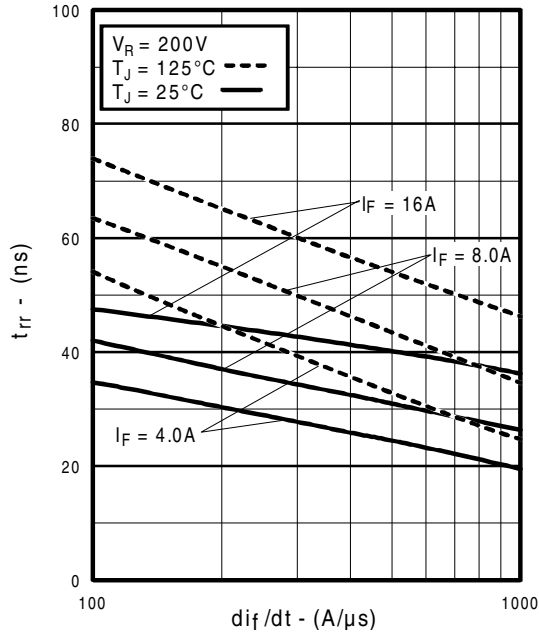
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



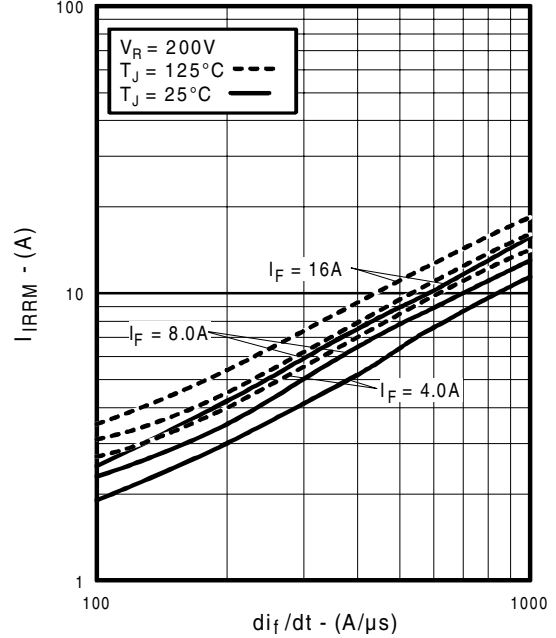
**Fig. 12** - Turn-Off SOA



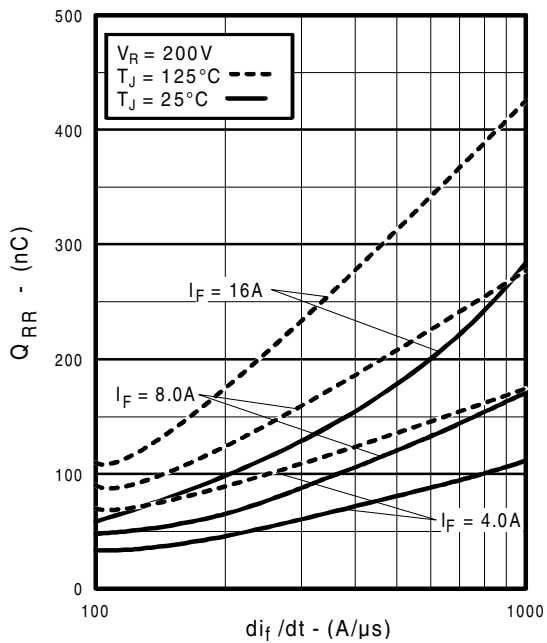
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



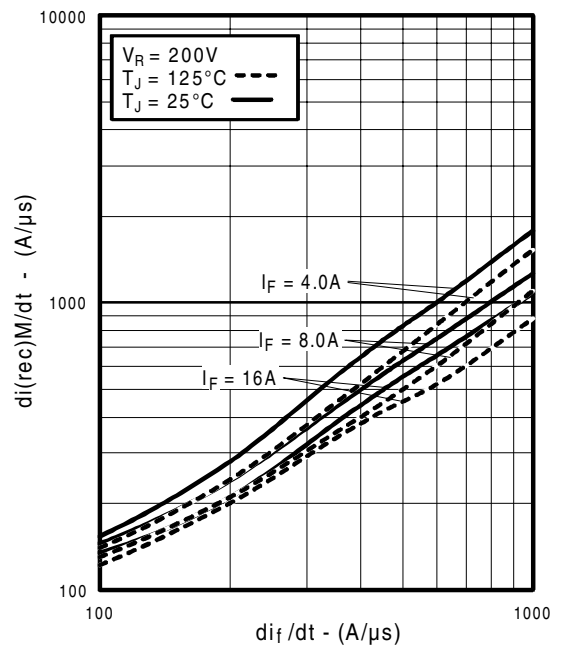
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



**Fig. 15** - Typical Recovery Current vs.  $di_f/dt$



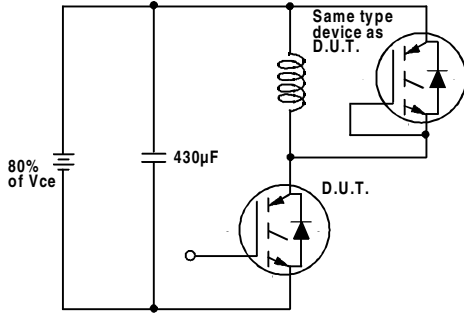
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$   
[www.irf.com](http://www.irf.com)



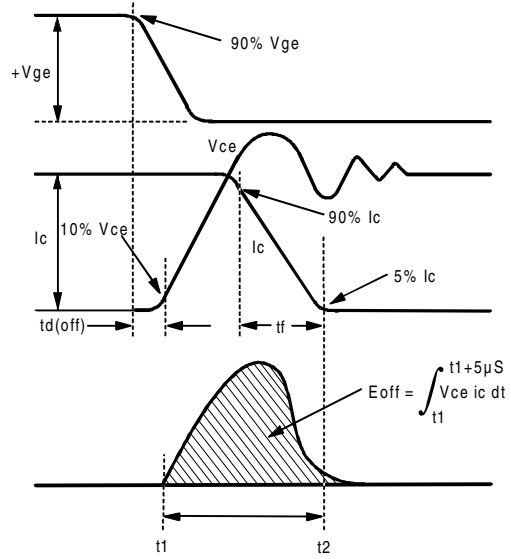
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

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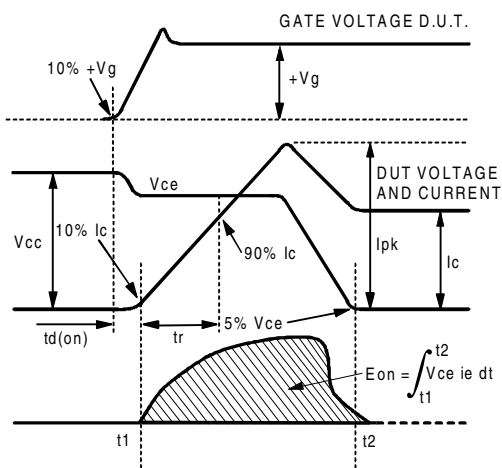
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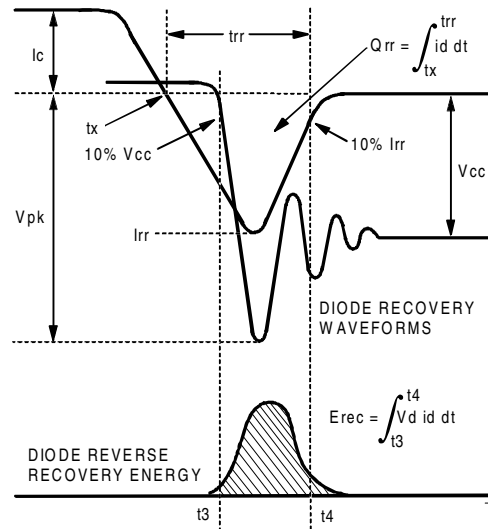
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



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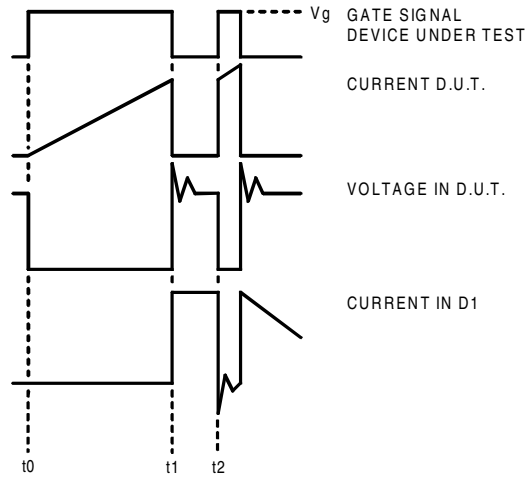


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

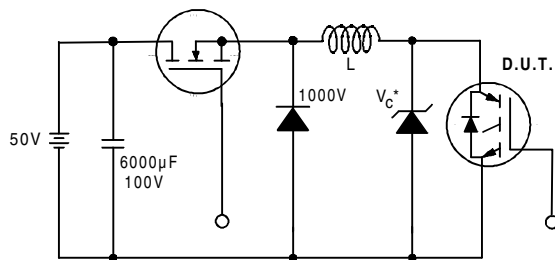


Figure 19. Clamped Inductive Load Test Circuit

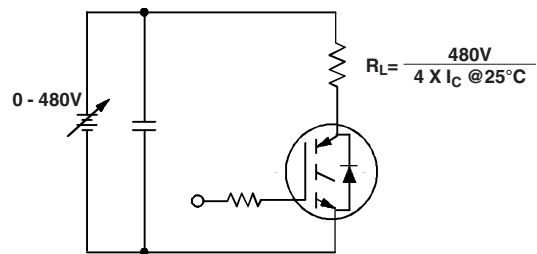


Figure 20. Pulsed Collector Current Test Circuit

# IRG4BC20UD

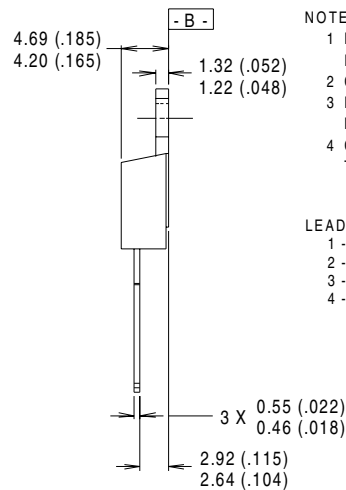
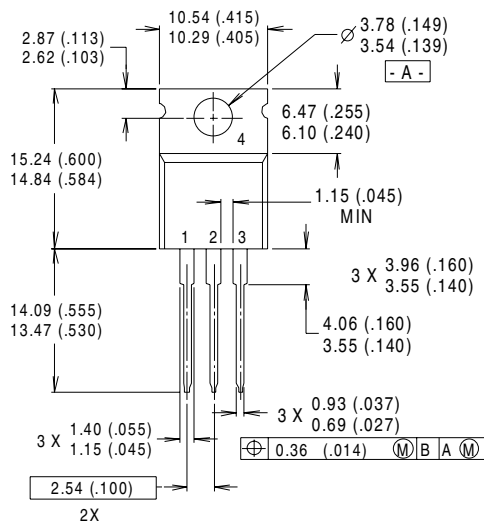
International  
**IR** Rectifier

## Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=50\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

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## Case Outline — TO-220AB



### NOTES:

- 1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
- 2 CONTROLLING DIMENSION : INCH.
- 3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
- 4 CONFORMS TO JEDEC OUTLINE TO-220AB.

### LEAD ASSIGNMENTS

- 1 - GATE
- 2 - COLLECTOR
- 3 - EMITTER
- 4 - COLLECTOR

### CONFORMS TO JEDEC OUTLINE TO-220AB

Dimensions in Millimeters and (Inches)

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105

**IR EUROPEAN REGIONAL CENTRE:** 439/445 Godstone Rd, Whyteleafe, Surrey CR3 OBL, UK Tel: ++ 44 (0)20 8645 8000

**IR CANADA:** 15 Lincoln Court, Brampton, Ontario L6T3Z2, Tel: (905) 453 2200

**IR GERMANY:** Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 (0) 6172 96590

**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 011 451 0111

**IR JAPAN:** K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo 171 Tel: 81 (0)3 3983 0086

**IR SOUTHEAST ASIA:** 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: ++ 65 (0)838 4630

**IR TAIWAN:** 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673 Tel: 886-(0)2 2377 9936

*Data and specifications subject to change without notice. 4/00*