



# THE DATASHEET OF IRG4BC15UD-STRL

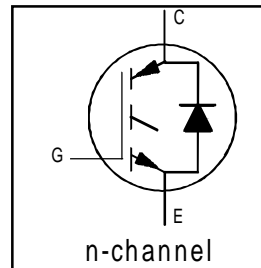


**IRG4BC15UD-S**  
**IRG4BC15UD-L**  
UltraFast CoPack IGBT

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFast SOFT RECOVERY DIODE

**Features**

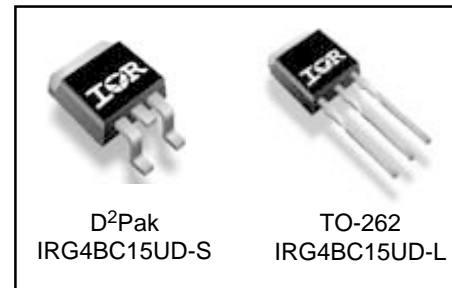
- UltraFast: Optimized for high frequencies from 10 to 30 kHz in hard switching
- IGBT Co-packaged with ultra-soft-recovery antiparallel diode
- Industry standard D<sup>2</sup>Pak & TO-262 packages



$V_{CES} = 600V$   
 $V_{CE(on) typ.} = 2.02V$   
@  $V_{GE} = 15V, I_C = 7.8A$

**Benefits**

- Best Value for Appliance and Industrial Applications
- High noise immune "Positive Only" gate drive- Negative bias gate drive not necessary
- For Low EMI designs- requires little or no snubbing
- Single Package switch for bridge circuit applications
- Compatible with high voltage Gate Driver IC's
- Allows simpler gate drive



**Absolute Maximum Ratings**

|                           | Parameter                          | Max.                              | Units      |
|---------------------------|------------------------------------|-----------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage       | 600                               | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 14                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 7.8                               |            |
| $I_{CM}$                  | Pulsed Collector Current ①         | 42                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②   | 42                                |            |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current   | 4.0                               |            |
| $I_{FM}$                  | Diode Maximum Forward Current      | 16                                |            |
| $V_{GE}$                  | Gate-to-Emitter Voltage            | $\pm 20$                          | V          |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation          | 49                                | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation          | 19                                |            |
| $T_J$                     | 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                         | —    | —        | 2.7  | $^\circ C/W$ |
| $R_{\theta JC}$ | Junction-to-Case - Diode                        | —    | —        | 7.0  |              |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface             | —    | 0.50     | —    |              |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount ⑤     | —    | —        | 80   |              |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state) ⑥ | —    | —        | 40   |              |
| Wt              | Weight  | —    | 2 (0.07) | —    | g (oz)       |

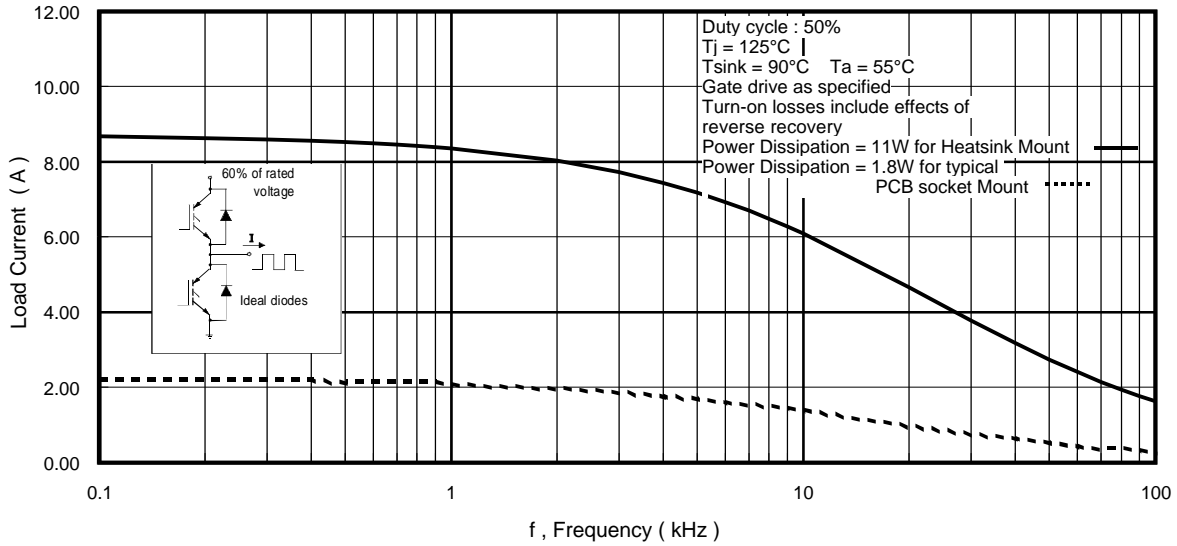
# IRG4BC15UD-S/L

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

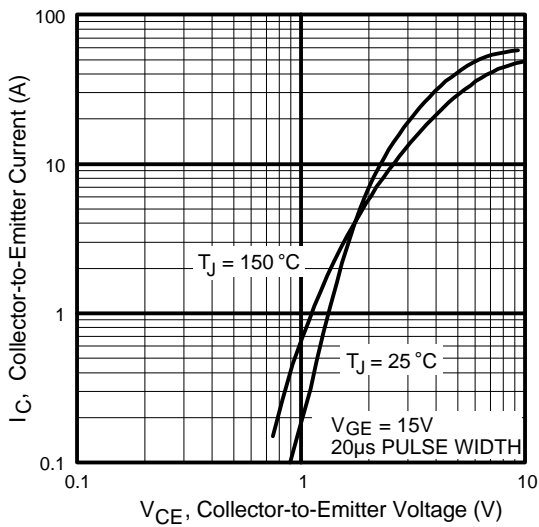
|                                 | Parameter   | Min. | Typ. | Max.      | Units   | Conditions  |                                       |
|---------------------------------|---|------|------|-----------|---------|---|---------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter 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             | —    | 0.63 | —         | V/°C    | $V_{GE} = 0V, I_C = 1.0mA$                            |                                       |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage             | —    | 2.02 | 2.4       | V       | $V_{GE} = 15V$<br>$I_C = 7.8A$                        |                                       |
|                                 |   | —    | 2.56 | —         |         |   | $I_C = 14A$                           |
|                                 |   | —    | 2.21 | —         |         |   | $I_C = 7.8A, T_J = 150^\circ\text{C}$ |
| $V_{GE(th)}$                    | 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             | —    | -10  | —         | mV/°C   | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |                                       |
| $g_{fe}$                        | Forward Transconductance <sup>④</sup>               | 4.1  | 6.2  | —         | S       | $V_{CE} = 100V, I_C = 7.8A$                           |                                       |
| $I_{CES}$                       | Zero Gate Voltage Collector Current                 | —    | —    | 250       | $\mu A$ | $V_{GE} = 0V, V_{CE} = 600V$                          |                                       |
|                                 |   | —    | —    | 1400      |         | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |                                       |
| $V_{FM}$                        | Diode Forward Voltage Drop                          | —    | 1.5  | 1.8       | V       | $I_C = 4.0A$  |                                       |
|                                 |   | —    | 1.4  | 1.7       |         | $I_C = 4.0A, T_J = 150^\circ\text{C}$                 |                                       |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current                     | —    | —    | $\pm 100$ | nA      | $V_{GE} = \pm 20V$                                    |                                       |

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

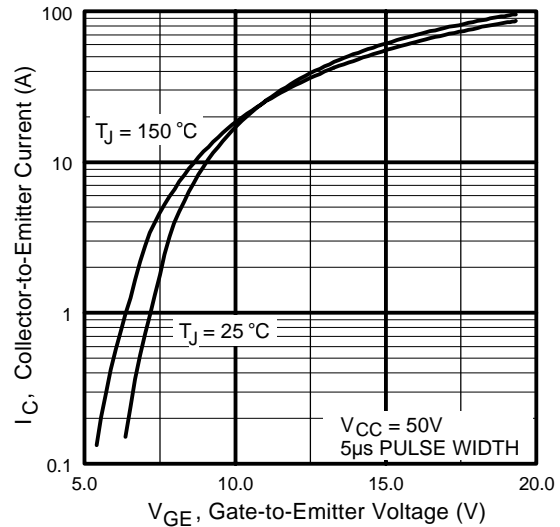
|                  | Parameter  | Min. | Typ. | Max. | Units      | Conditions   |                     |
|------------------|--|------|------|------|------------|--|---------------------|
| $Q_g$            | Total Gate Charge (turn-on)                      | —    | 23   | 35   | nC         | $I_C = 7.8A$<br>$V_{CC} = 400V$<br>$V_{GE} = 15V$  |                     |
| $Q_{ge}$         | Gate - Emitter Charge (turn-on)                  | —    | 4.0  | 6.0  |            |  |                     |
| $Q_{gc}$         | Gate - Collector Charge (turn-on)                | —    | 9.6  | 14   |            |  |                     |
| $t_{d(on)}$      | Turn-On Delay Time                               | —    | 17   | —    | ns         | $T_J = 25^\circ\text{C}$<br>$I_C = 7.8A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 75\Omega$<br>Energy losses include "tail" and diode reverse recovery.    |                     |
| $t_r$            | Rise Time  | —    | 20   | —    |            |  |                     |
| $t_{d(off)}$     | Turn-Off Delay Time                              | —    | 160  | 240  |            |  |                     |
| $t_f$            | Fall Time  | —    | 83   | 120  |            |  |                     |
| $E_{on}$         | Turn-On Switching Loss                           | —    | 0.24 | —    | mJ         | $T_J = 150^\circ\text{C}$ ,<br>$I_C = 7.8A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 75\Omega$<br>Energy losses include "tail" and diode reverse recovery. |                     |
| $E_{off}$        | Turn-Off Switching Loss                          | —    | 0.26 | —    |            |  |                     |
| $E_{ts}$         | Total Switching Loss                             | —    | 0.50 | 0.63 |            |  |                     |
| $t_{d(on)}$      | Turn-On Delay Time                               | —    | 16   | —    | ns         | $T_J = 150^\circ\text{C}$ ,<br>$I_C = 7.8A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 75\Omega$<br>Energy losses include "tail" and diode reverse recovery. |                     |
| $t_r$            | Rise Time  | —    | 21   | —    |            |  |                     |
| $t_{d(off)}$     | Turn-Off Delay Time                              | —    | 180  | —    |            |  |                     |
| $t_f$            | Fall Time  | —    | 220  | —    |            |  |                     |
| $E_{ts}$         | Total Switching Loss                             | —    | 0.76 | —    | mJ         |  |                     |
| $L_E$            | Internal Emitter Inductance                      | —    | 7.5  | —    | nH         | Measured 5mm from package  |                     |
| $C_{ies}$        | Input Capacitance                                | —    | 410  | —    | pF         | $V_{GE} = 0V$<br>$V_{CC} = 30V$<br>$f = 1.0MHz$  |                     |
| $C_{oes}$        | Output Capacitance                               | —    | 37   | —    |            |  |                     |
| $C_{res}$        | Reverse Transfer Capacitance                     | —    | 5.3  | —    |            |  |                     |
| $t_{rr}$         | Diode Reverse Recovery Time                      | —    | 28   | 42   | ns         | $T_J = 25^\circ\text{C}$<br>$T_J = 125^\circ\text{C}$  | $I_F = 4.0A$        |
|                  |  | —    | 38   | 57   |            |  |                     |
| $I_{rr}$         | Diode Peak Reverse Recovery Current              | —    | 2.9  | 5.2  | A          | $T_J = 25^\circ\text{C}$<br>$T_J = 125^\circ\text{C}$  | $V_R = 200V$        |
|                  |  | —    | 3.7  | 6.7  |            |  |                     |
| $Q_{rr}$         | Diode Reverse Recovery Charge                    | —    | 40   | 60   | nC         | $T_J = 25^\circ\text{C}$<br>$T_J = 125^\circ\text{C}$  | di/dt 200A/ $\mu s$ |
|                  |  | —    | 70   | 110  |            |  |                     |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During $t_b$ | —    | 280  | —    | A/ $\mu s$ | $T_J = 25^\circ\text{C}$<br>$T_J = 125^\circ\text{C}$  |                     |
|                  |  | —    | 240  | —    |            |  |                     |



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



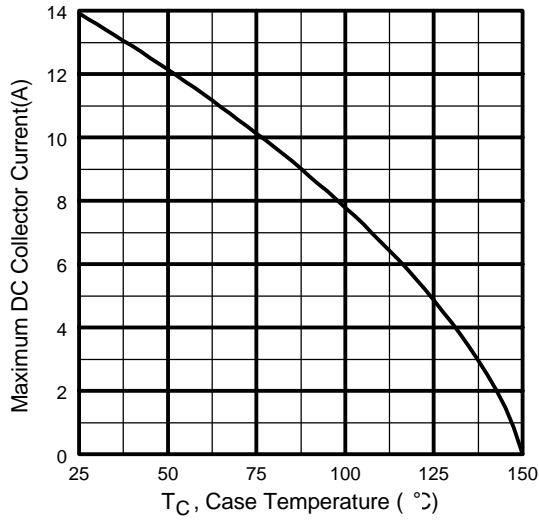
**Fig. 2** - Typical Output Characteristics



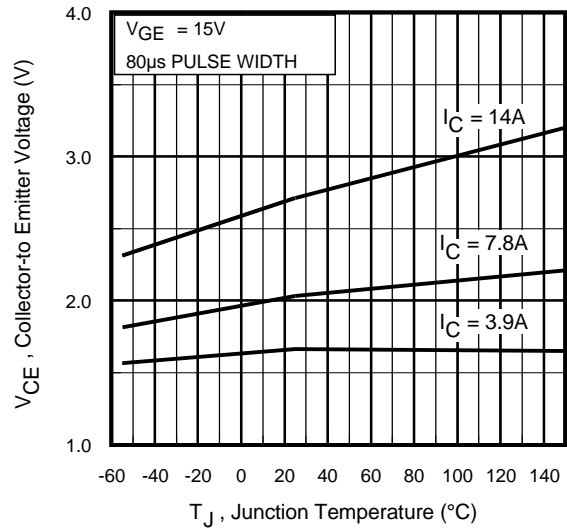
**Fig. 3** - Typical Transfer Characteristics

# IRG4BC15UD-S/L

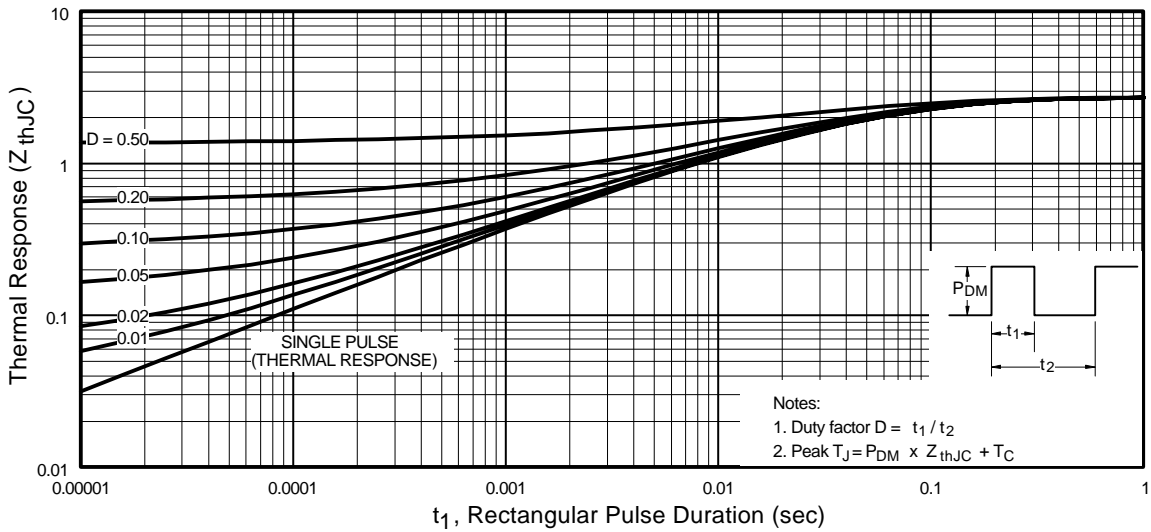
International  
**IR** Rectifier



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

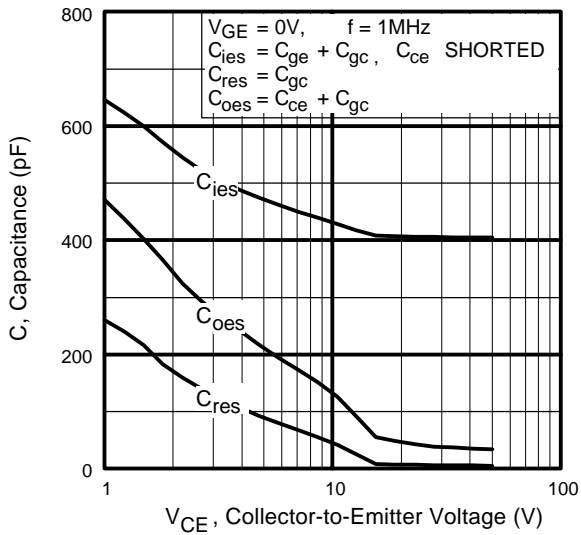


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

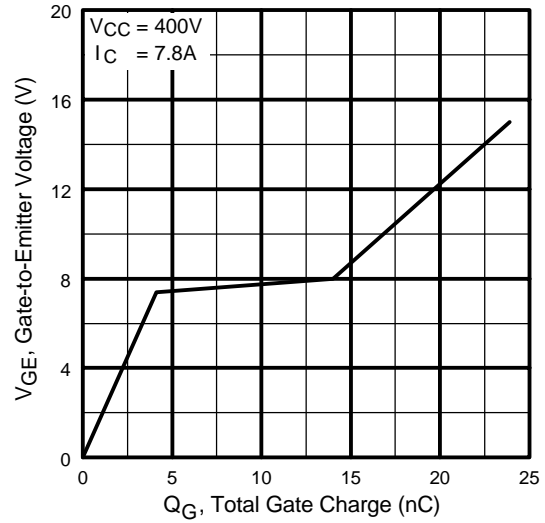


**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

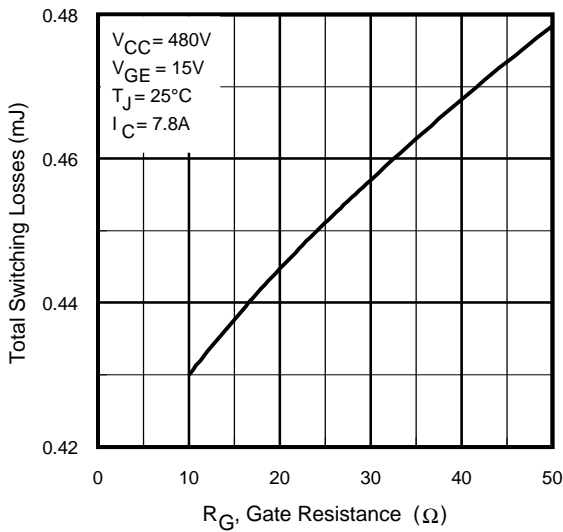
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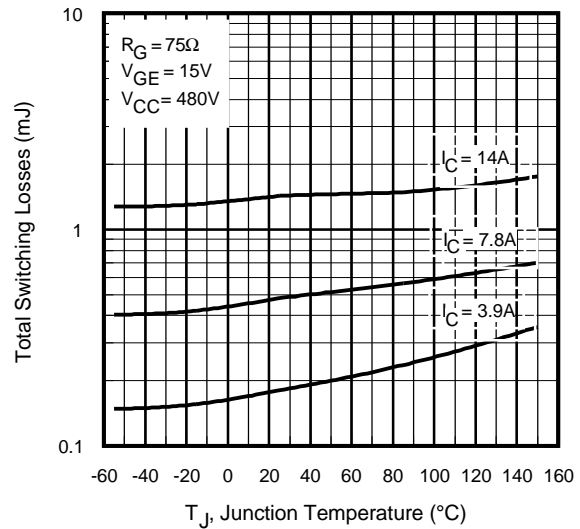
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



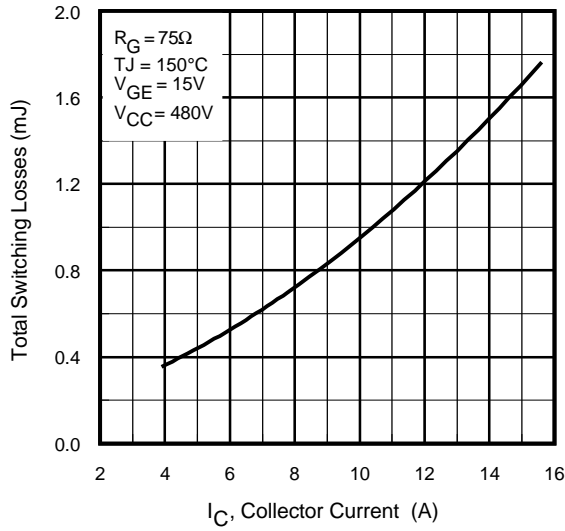
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



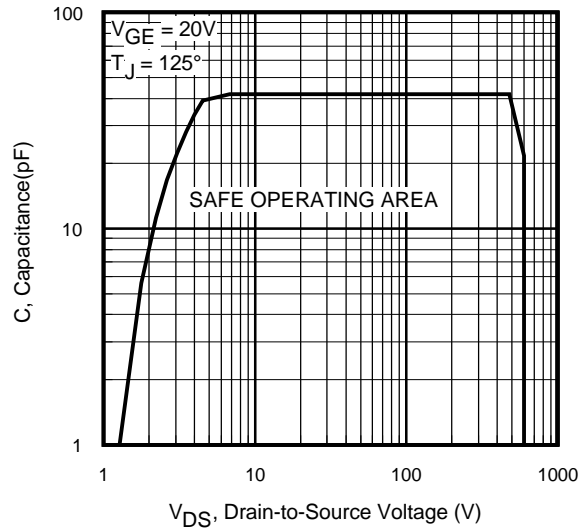
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

# IRG4BC15UD-S/L

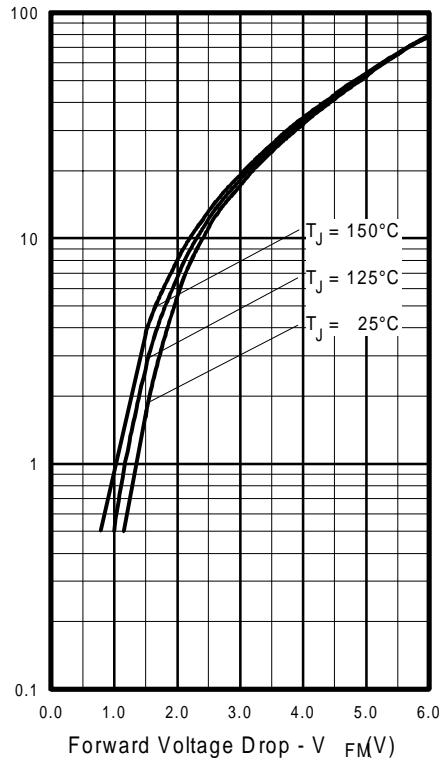
International  
**IR** Rectifier



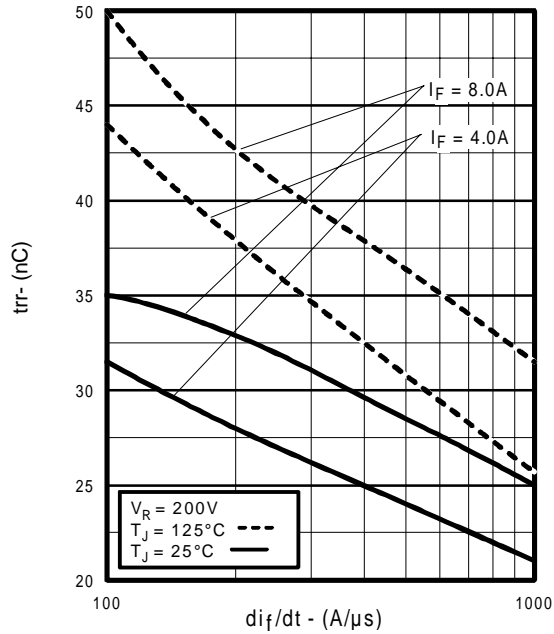
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



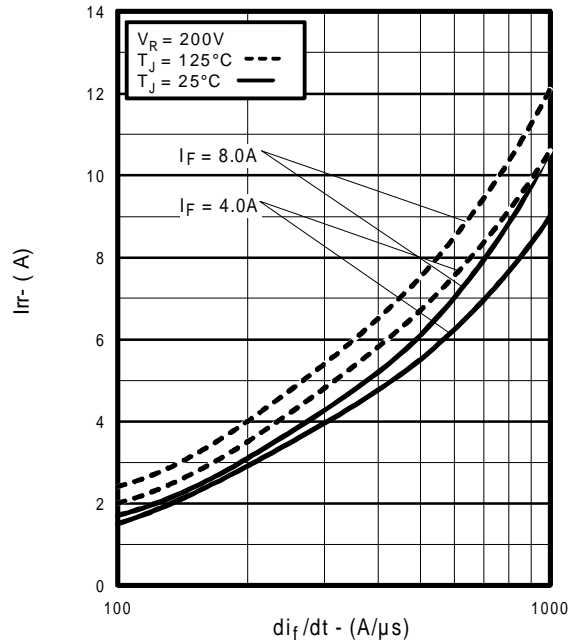
**Fig. 12** - Turn-Off SOA



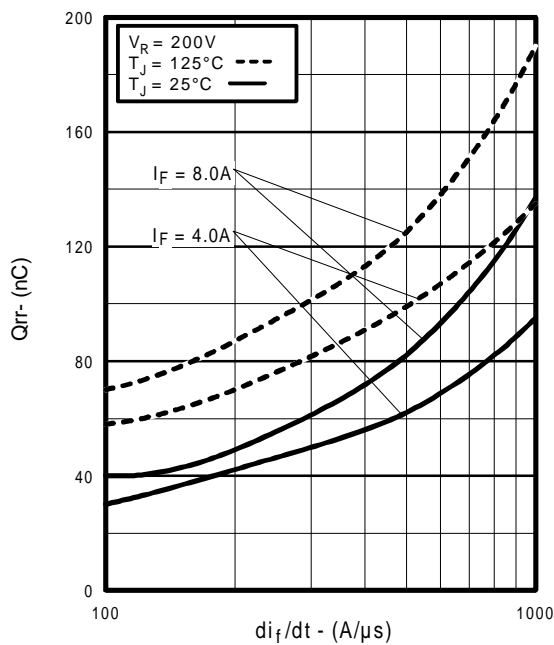
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



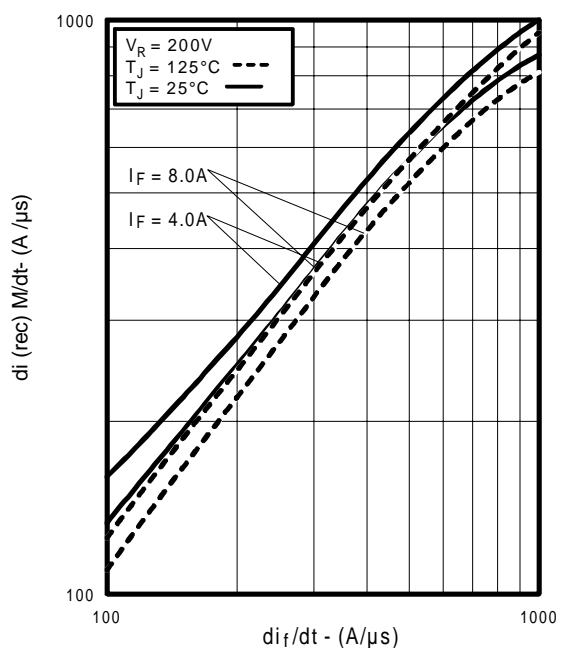
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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



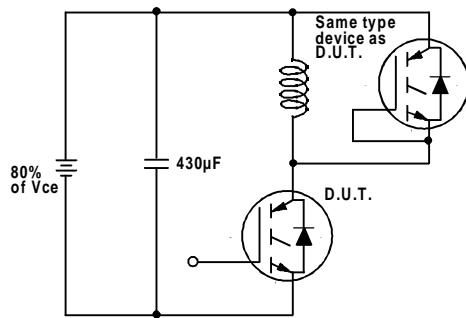
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



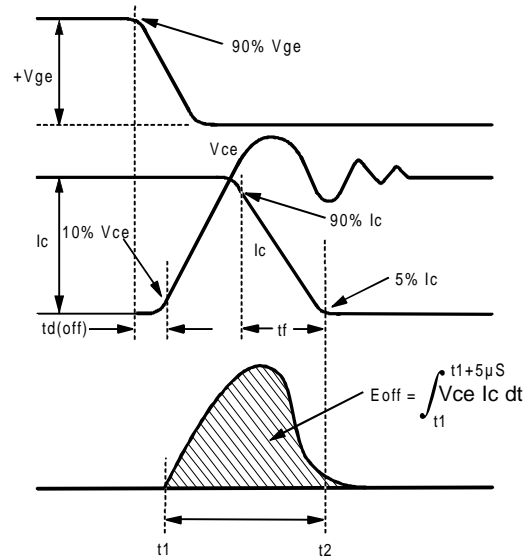
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$ ,

# IRG4BC15UD-S/L

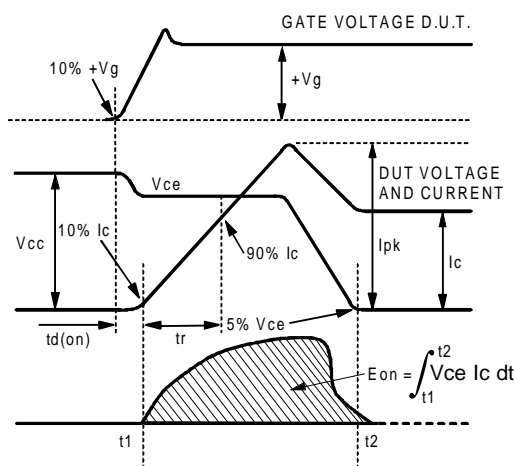
International  
**IR** Rectifier



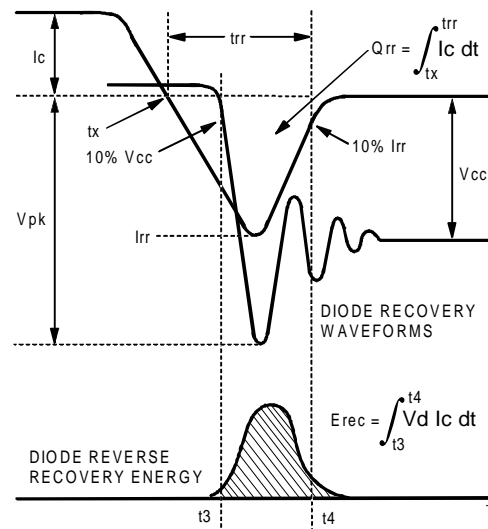
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

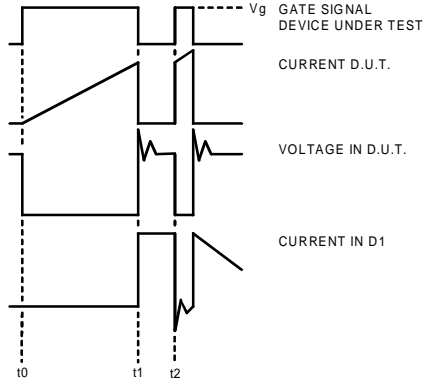


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

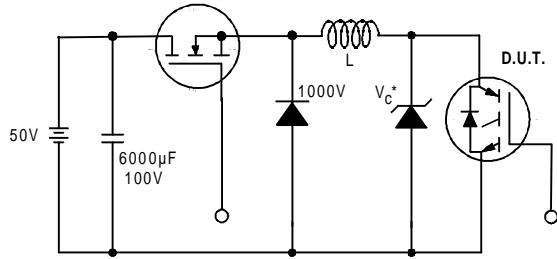


Figure 19. Clamped Inductive Load Test Circuit

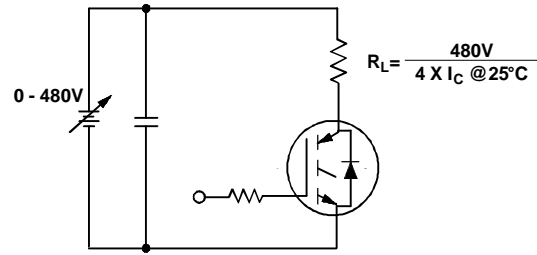
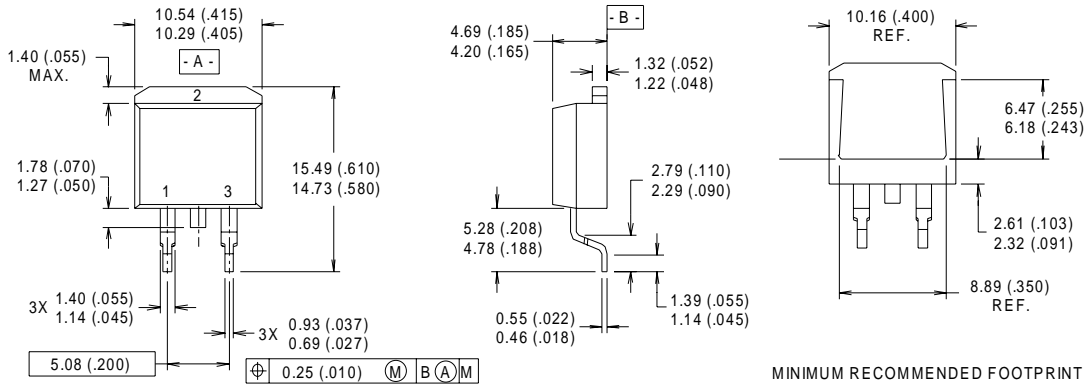


Figure 20. Pulsed Collector Current Test Circuit

# IRG4BC15UD-S/L



## D<sup>2</sup>Pak Package Outline



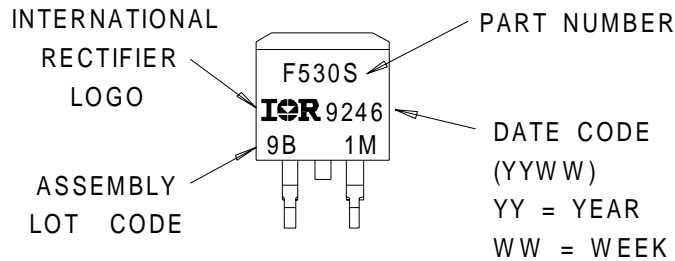
**NOTES:**

- 1 DIMENSIONS AFTER SOLDER DIP.
- 2 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 3 CONTROLLING DIMENSION : INCH.
- 4 HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

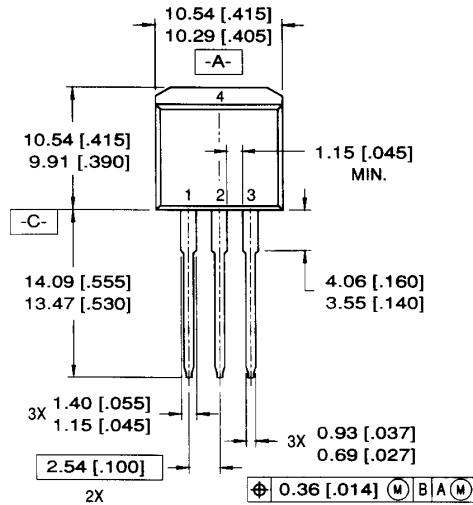
**LEAD ASSIGNMENTS**

- 1 - GATE
- 2 - DRAIN
- 3 - SOURCE

## D<sup>2</sup>Pak Part Marking Information

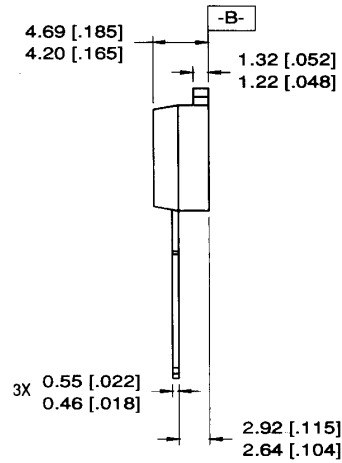


## TO-262 Package Outline



**LEAD ASSIGNMENTS**

- |           |            |
|-----------|------------|
| 1 = GATE  | 3 = SOURCE |
| 2 = DRAIN | 4 = DRAIN  |

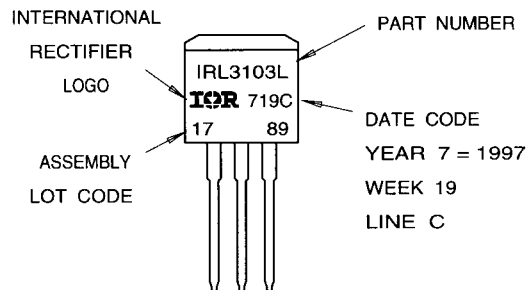


**NOTES:**

1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

## TO-262 Part Marking Information

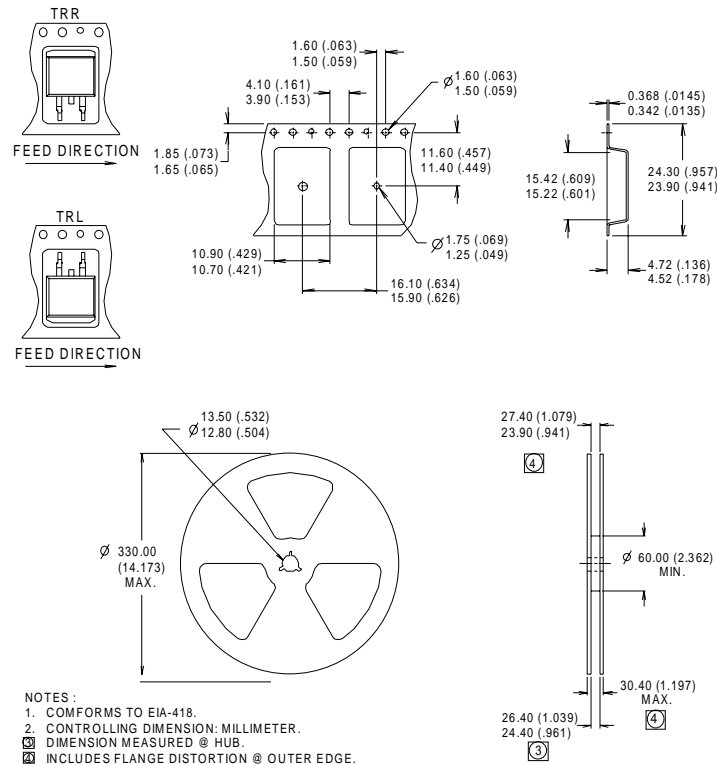
EXAMPLE: THIS IS AN IRL3103L  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"



# IRG4BC15UD-S/L

International  
**IR** Rectifier

## D<sup>2</sup>Pak Tape & Reel Information



### Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature.
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G = 75\Omega$
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.
- ⑤ This only applies to TO-262 package.

⑥ This applies to D<sup>2</sup>Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

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



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TAC Fax: (310) 252-7903

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Note: For the most current drawings please refer to the IR website at:  
<http://www.irf.com/package/>

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