

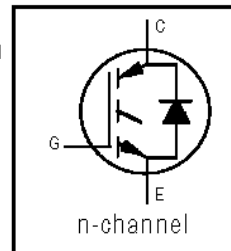
# IRG4PC50KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
 UltraFast IGBT

### Features

- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz, and Short Circuit Rated to 10µs @125°C,  $V_{GE} = 15V$
- 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-247AC package

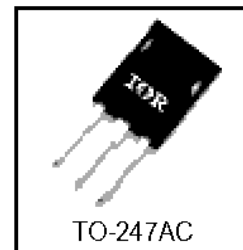


$V_{CES} = 600V$   
 $V_{CE(on) typ.} = 1.84V$   
 @ $V_{GE} = 15V, I_C = 30A$

- Lead-Free

### Benefits

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



### Absolute Maximum Ratings

|                           | Parameter  | Max.                | Units |
|---------------------------|--|---------------------|-------|
| $V_{CES}$                 | Collector-to-Emitter Voltage                     | 600                 | V     |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current                     | 52                  | A     |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current                     | 30                  |       |
| $I_{CM}$                  | Pulsed Collector Current ①                       | 104                 |       |
| $I_{LM}$                  | Clamped Inductive Load Current ②                 | 104                 |       |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current                 | 25                  |       |
| $I_{FM}$                  | Diode Maximum Forward Current                    | 280                 |       |
| $t_{sc}$                  | Short Circuit Withstand Time                     | 10                  | µs    |
| $V_{GE}$                  | Gate-to-Emitter Voltage                          | ± 20                | V     |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                        | 200                 | W     |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                        | 78                  |       |
| $T_J$                     | Operating Junction and Storage Temperature Range | -55 to +150         | °C    |
| $T_{STG}$                 |  |                     |       |
|                           |  |                     |       |
|                           | 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                   | —    | —        | 0.64 | °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   |        |
| Wt              | Weight                                    | —    | 6 (0.21) | —    | g (oz) |

# IRG4PC50KDPbF

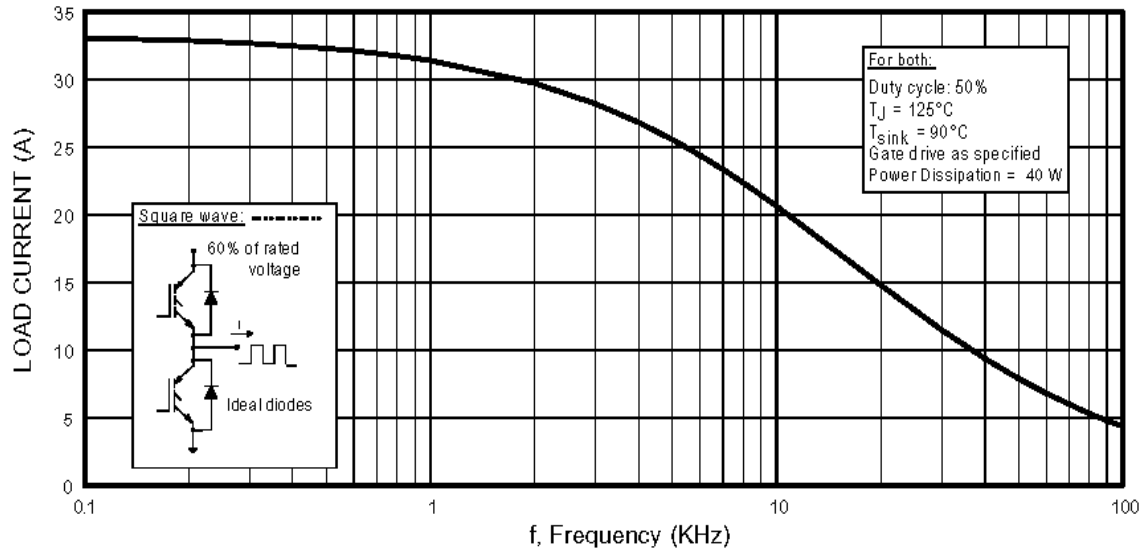
International  
 Rectifier

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

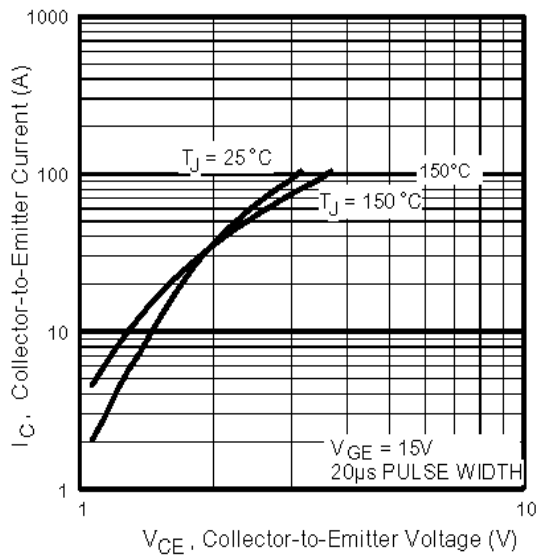
|  | Parameter                                | Min. | Typ. | Max. | Units | Conditions  |
|--|--|------|------|------|-------|---|
| V <sub>(BR)CES</sub>                   | Collector-to-Emitter Breakdown Voltage ③ | 600  | —    | —    | V     | V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA  |
| DV <sub>(BR)CES</sub> /DT <sub>J</sub> | Temperature Coeff. of Breakdown Voltage  | —    | 0.47 | —    | V/°C  | V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA  |
| V <sub>CE(on)</sub>                    | Collector-to-Emitter Saturation Voltage  | —    | 1.84 | 2.2  | V     | I <sub>C</sub> = 30A, V <sub>GE</sub> = 15V<br>I <sub>C</sub> = 52A, see figures 2, 5<br>I <sub>C</sub> = 25A, T <sub>J</sub> = 150°C |
|  |  | —    | 2.19 | —    |       |   |
|  |  | —    | 1.79 | —    |       |   |
| V <sub>GE(th)</sub>                    | Gate Threshold Voltage                   | 3.0  | —    | 6.0  |       | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA  |
| DV <sub>GE(th)</sub> /DT <sub>J</sub>  | Temperature Coeff. of Threshold Voltage  | —    | -12  | —    | mV/°C | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA  |
| g <sub>fe</sub>                        | Forward Transconductance ④               | 17   | 24   | —    | S     | V <sub>CE</sub> = 100V, I <sub>C</sub> = 30A  |
| I <sub>CES</sub>                       | Zero Gate Voltage Collector Current      | —    | —    | 250  | μA    | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V<br>V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C                  |
|  |  | —    | —    | 6500 |       |   |
| V <sub>FM</sub>                        | Diode Forward Voltage Drop               | —    | 1.3  | 1.7  | V     | I <sub>C</sub> = 25A, see figure 13<br>I <sub>C</sub> = 25A, T <sub>J</sub> = 150°C   |
|  |  | —    | 1.2  | 1.5  |       |   |
| 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)

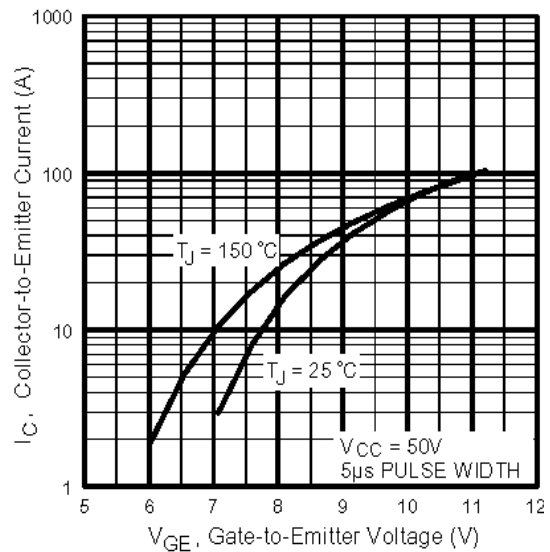
|                         | Parameter   | Min. | Typ. | Max. | Units | Conditions  |
|-------------------------|---|------|------|------|-------|---|
| Q <sub>g</sub>          | Total Gate Charge (turn-on)                               | —    | 200  | 300  | nC    | I <sub>C</sub> = 30A<br>V <sub>CC</sub> = 400V, see figure 8<br>V <sub>GE</sub> = 15V   |
| Q <sub>ge</sub>         | Gate - Emitter Charge (turn-on)                           | —    | 25   | 38   |       |   |
| Q <sub>gc</sub>         | Gate - Collector Charge (turn-on)                         | —    | 85   | 127  |       |   |
| t <sub>d(on)</sub>      | Turn-On Delay Time  | —    | 63   | —    | ns    | T <sub>J</sub> = 25°C<br>I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω                     |
| t <sub>r</sub>          | Rise Time   | —    | 49   | —    |       |   |
| t <sub>d(off)</sub>     | Turn-Off Delay Time                                       | —    | 150  | 220  |       |   |
| t <sub>f</sub>          | Fall Time   | —    | 95   | 140  |       |   |
| E <sub>on</sub>         | Turn-On Switching Loss                                    | —    | 1.61 | —    | mJ    | Energy losses include "tail"<br>and diode reverse recovery  |
| E <sub>off</sub>        | Turn-Off Switching Loss                                   | —    | 0.84 | —    |       |   |
| E <sub>ts</sub>         | Total Switching Loss                                      | —    | 2.45 | 3.0  |       |   |
| t <sub>sc</sub>         | Short Circuit Withstand Time                              | 10   | —    | —    | μs    | V <sub>CC</sub> = 360V, T <sub>J</sub> = 125°C<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, V <sub>CPK</sub> < 500V                    |
| t <sub>d(on)</sub>      | Turn-On Delay Time  | —    | 61   | —    | ns    | T <sub>J</sub> = 150°C, see figures 11,18<br>I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω |
| t <sub>r</sub>          | Rise Time   | —    | 46   | —    |       |   |
| t <sub>d(off)</sub>     | Turn-Off Delay Time                                       | —    | 310  | —    |       |   |
| t <sub>f</sub>          | Fall Time   | —    | 170  | —    |       |   |
| E <sub>ts</sub>         | Total Switching Loss                                      | —    | 3.53 | —    | mJ    | Energy losses include "tail"<br>and diode reverse recovery  |
| L <sub>E</sub>          | Internal Emitter Inductance                               | —    | 13   | —    | nH    | Measured 5mm from package   |
| C <sub>ies</sub>        | Input Capacitance   | —    | 3200 | —    | pF    | V <sub>GE</sub> = 0V<br>V <sub>CC</sub> = 30V, see figure 7<br>f = 1.0MHz   |
| C <sub>oes</sub>        | Output Capacitance  | —    | 370  | —    |       |   |
| C <sub>res</sub>        | Reverse Transfer Capacitance                              | —    | 95   | —    |       |   |
| t <sub>rr</sub>         | Diode Reverse Recovery Time                               | —    | 50   | 75   | ns    | T <sub>J</sub> = 25°C, see figure 14<br>T <sub>J</sub> = 125°C, 14  |
|                         |   | —    | 105  | 160  |       |   |
| I <sub>rr</sub>         | Diode Peak Reverse Recovery Current                       | —    | 4.5  | 10   | A     | T <sub>J</sub> = 25°C, see figure 15<br>T <sub>J</sub> = 125°C, 15  |
|                         |   | —    | 8.0  | 15   |       |   |
| Q <sub>rr</sub>         | Diode Reverse Recovery Charge                             | —    | 112  | 375  | nC    | T <sub>J</sub> = 25°C, see figure 16<br>T <sub>J</sub> = 125°C, 16  |
|                         |   | —    | 420  | 1200 |       |   |
| di <sub>(rec)</sub> /dt | Diode Peak Rate of Fall of Recovery During t <sub>b</sub> | —    | 250  | —    | A/μs  | T <sub>J</sub> = 25°C, see figure 17<br>T <sub>J</sub> = 125°C, 17  |
|                         |   | —    | 160  | —    |       |   |



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



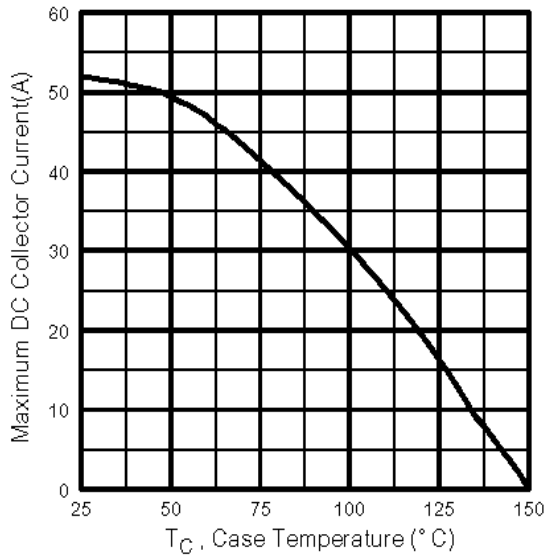
**Fig. 2 - Typical Output Characteristics**



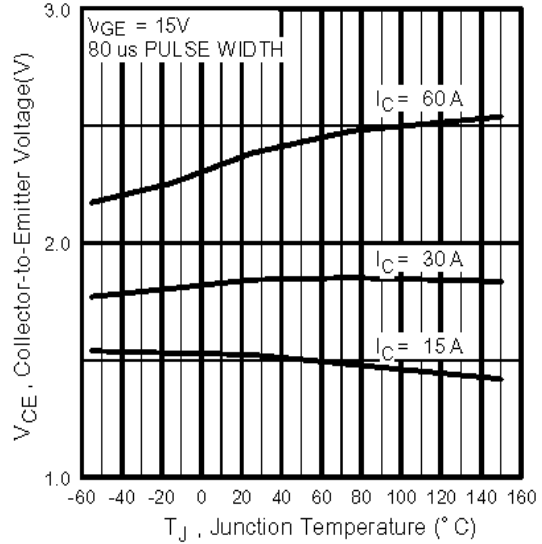
**Fig. 3 - Typical Transfer Characteristics**

# IRG4PC50KDPbF

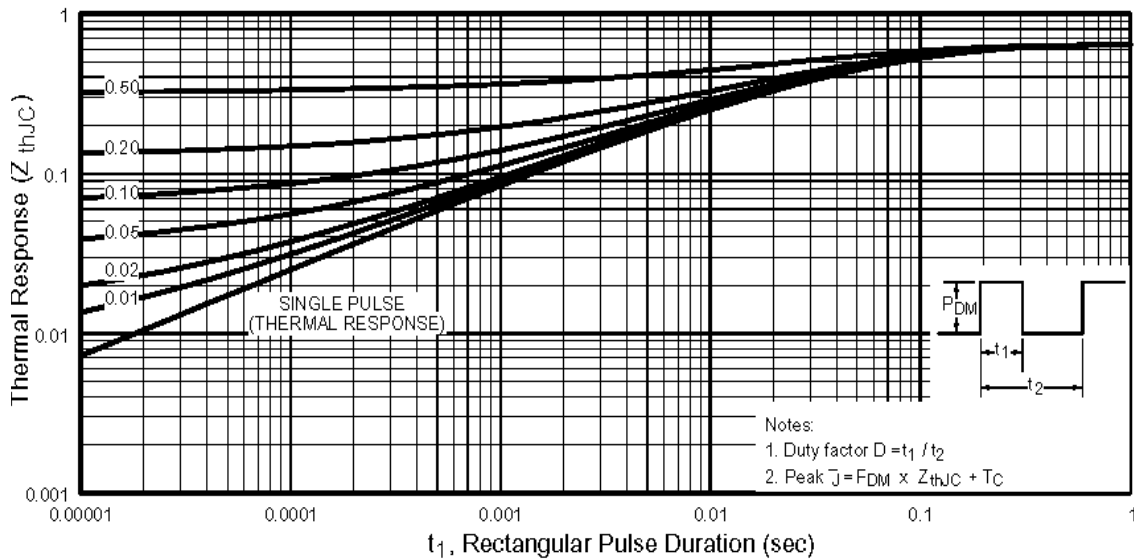
International  
**IR** Rectifier



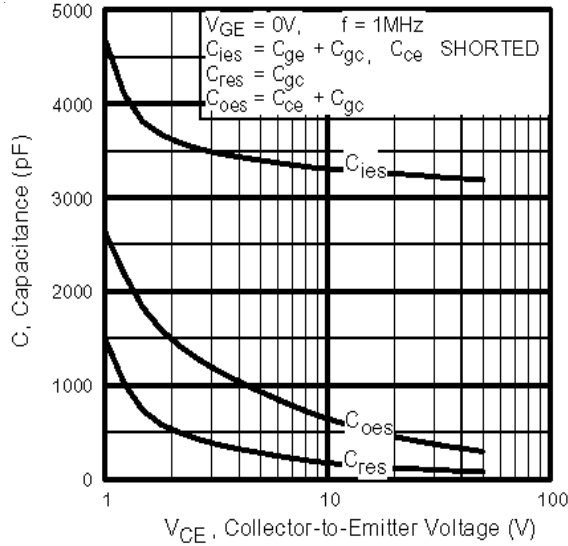
**Fig. 4** - Maximum Collector Current vs. Case Temperature



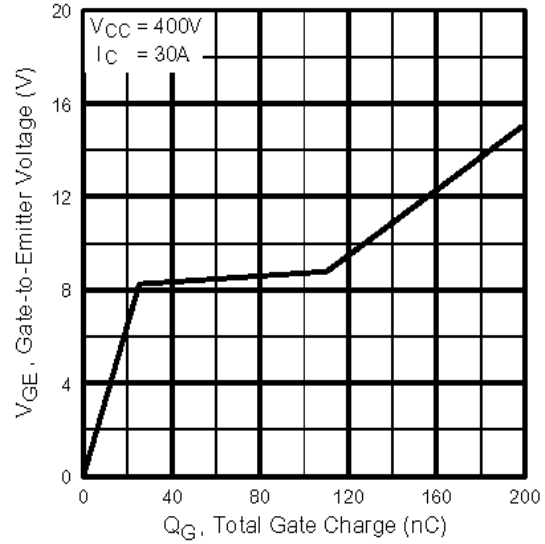
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



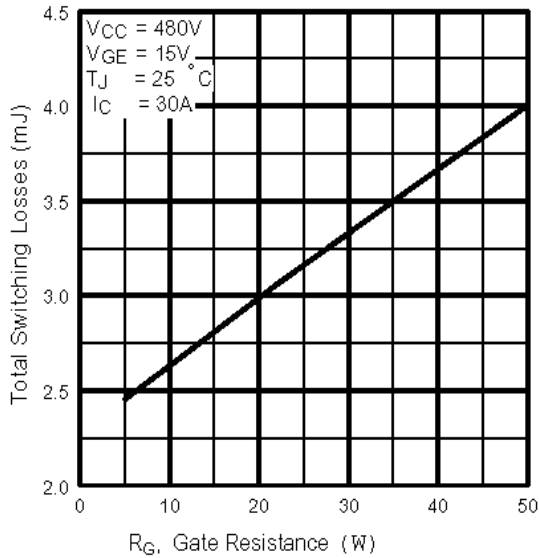
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



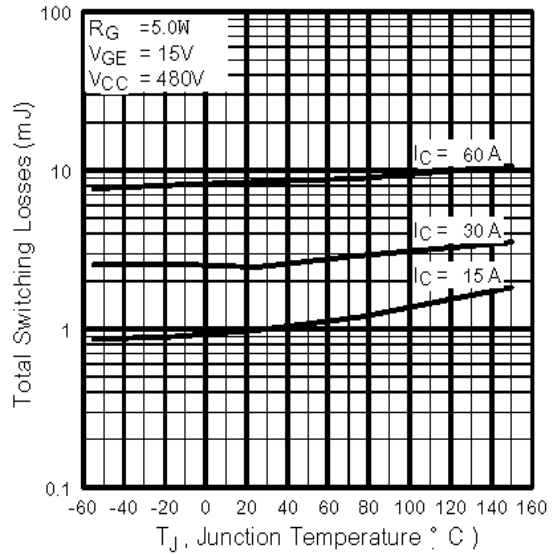
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



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



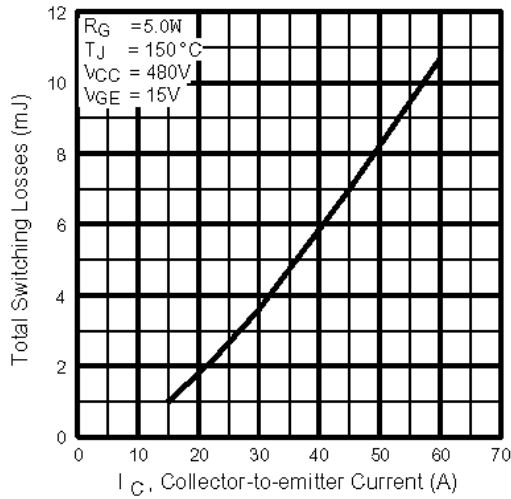
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



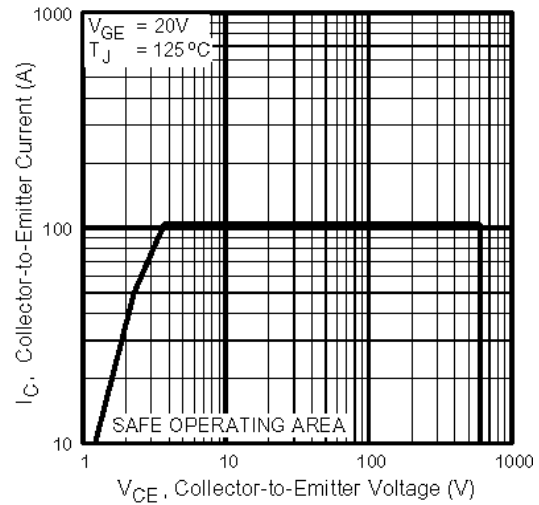
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

# IRG4PC50KDPbF

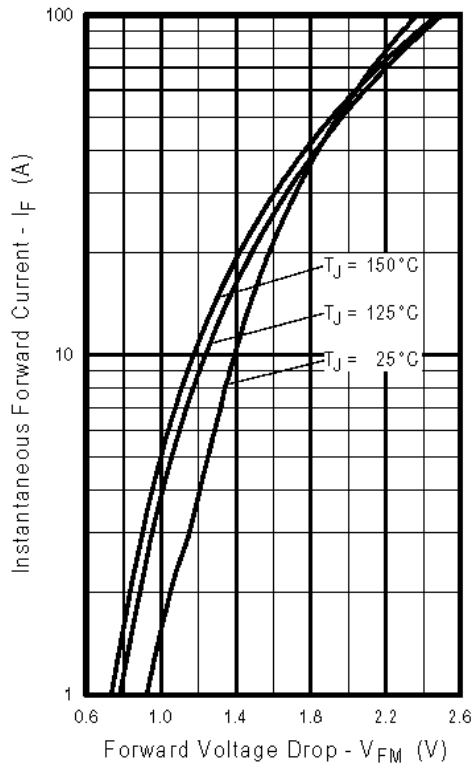
International  
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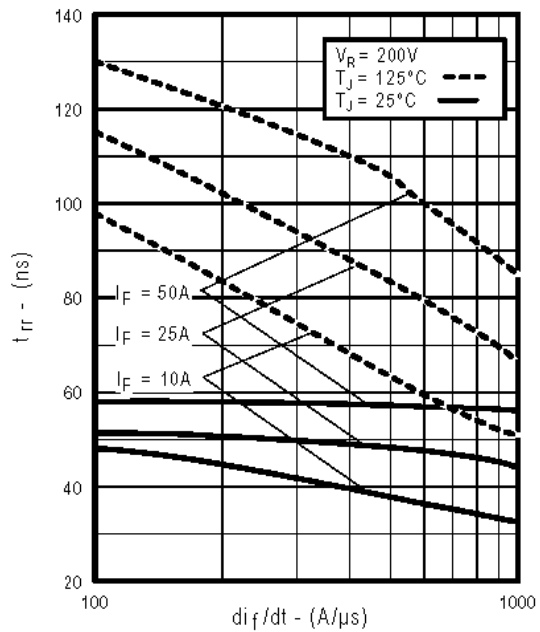
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



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



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



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

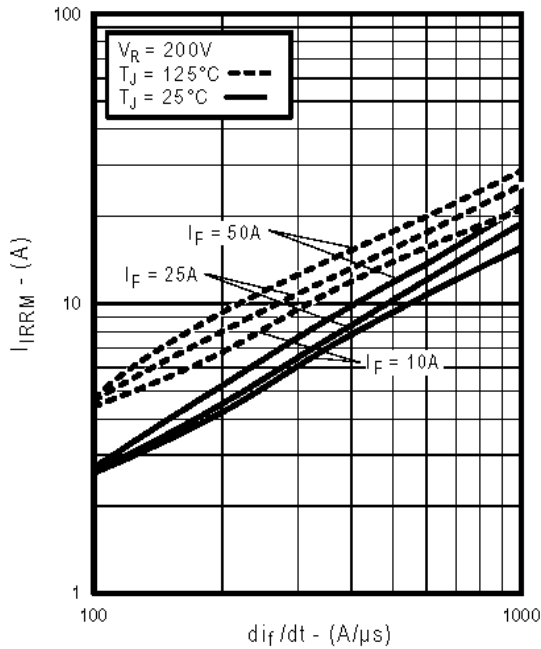


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

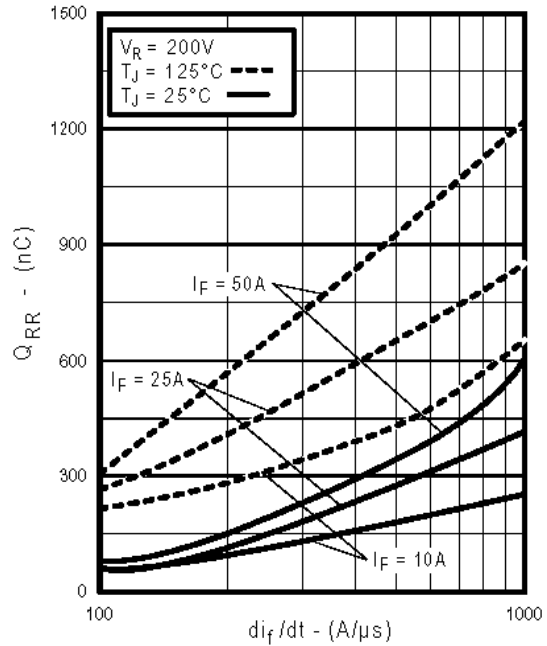


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

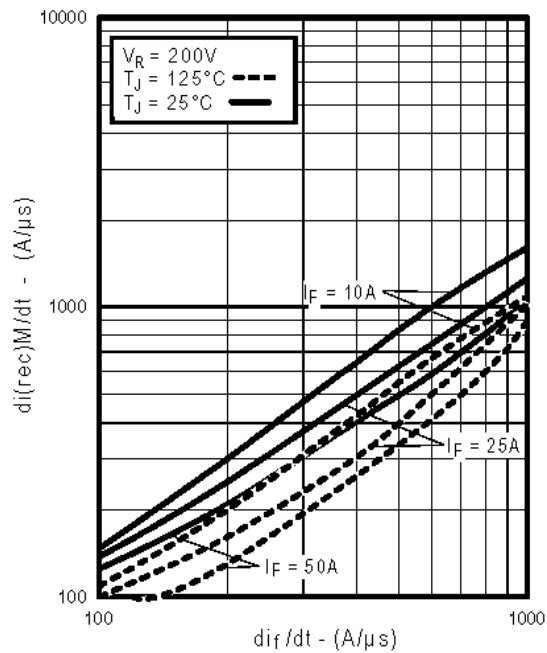
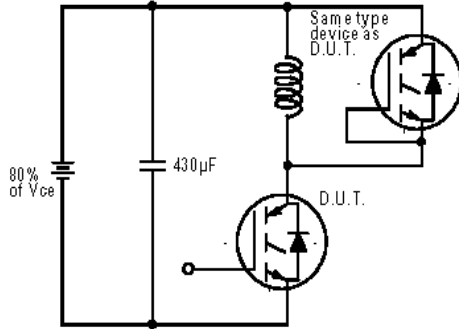


Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

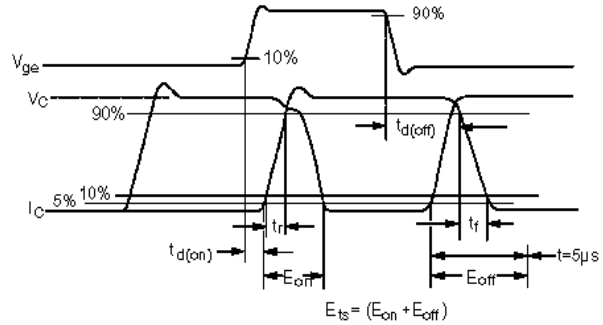
Mechanical drawings, Appendix A  
 Test Circuit diagrams, Appendix B  
 Switching Loss Waveforms, Appendix C

# IRG4PC50KDPbF

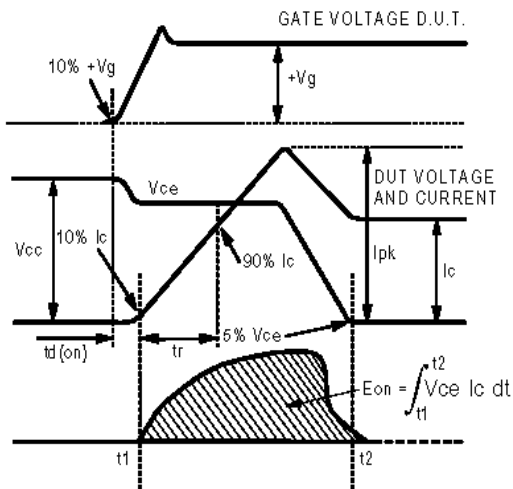
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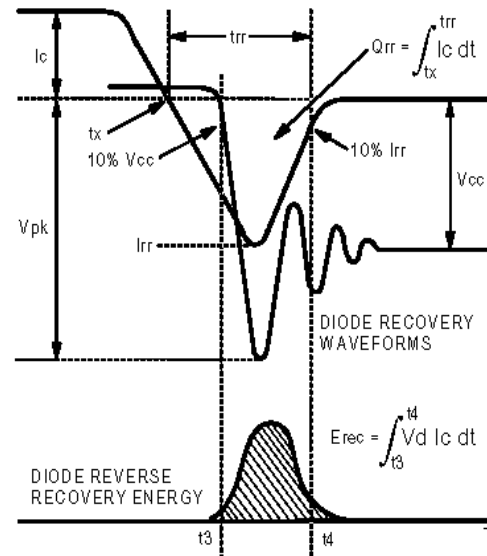
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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



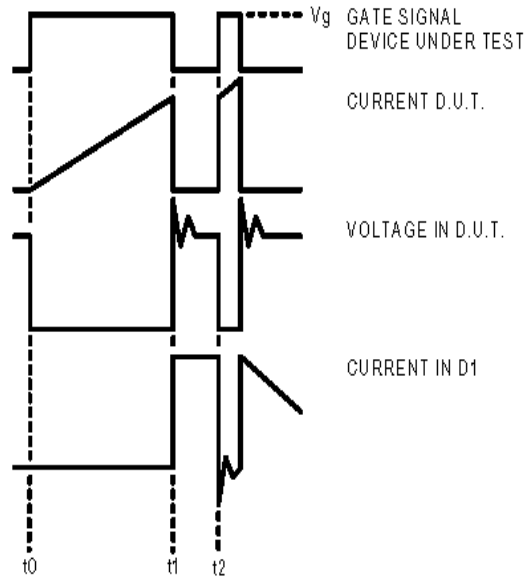


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

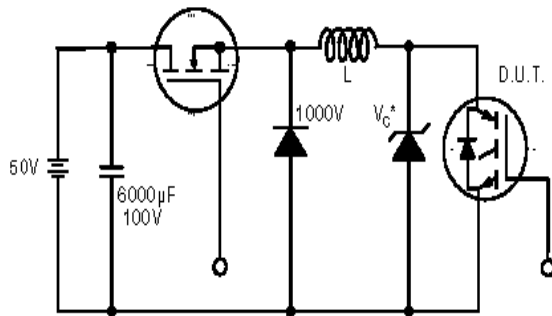


Figure 19. Clamped Inductive Load Test Circuit

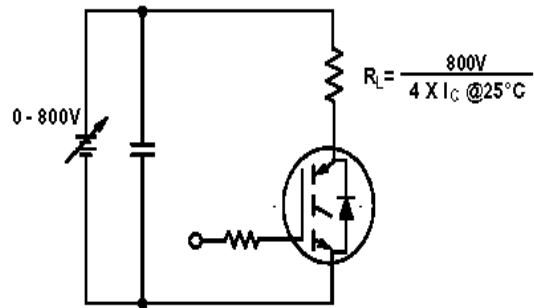


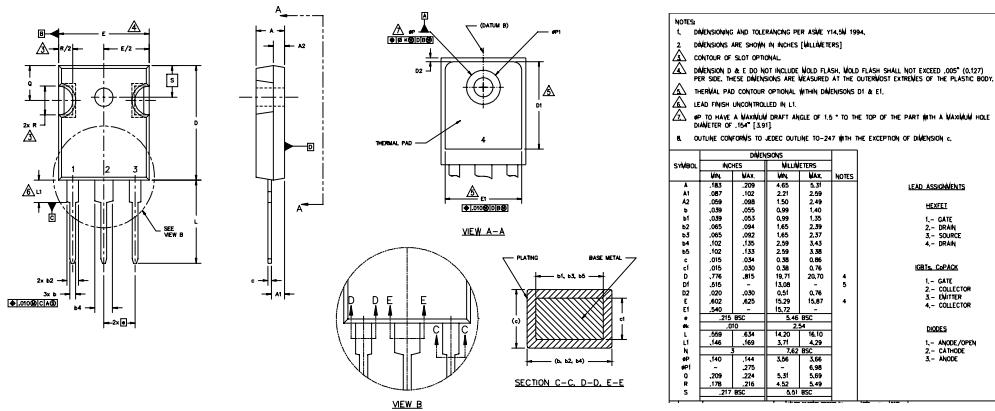
Figure 20. Pulsed Collector Current Test Circuit

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## TO-247AC Package Outline

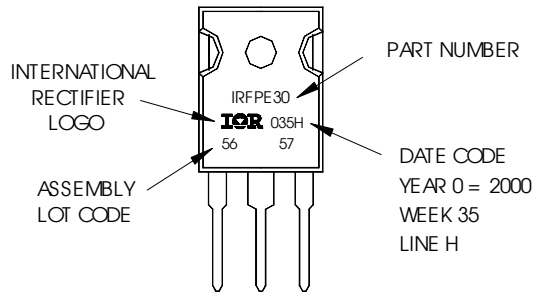
Dimensions are shown in millimeters (inches)



## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFP30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE "H"

**Note:** "P" in assembly line  
position indicates "Lead-Free"



Data and specifications subject to change without notice.

International  
**IR** Rectifier

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

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