

# IRG4PH50U

International  
**IR** Rectifier

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

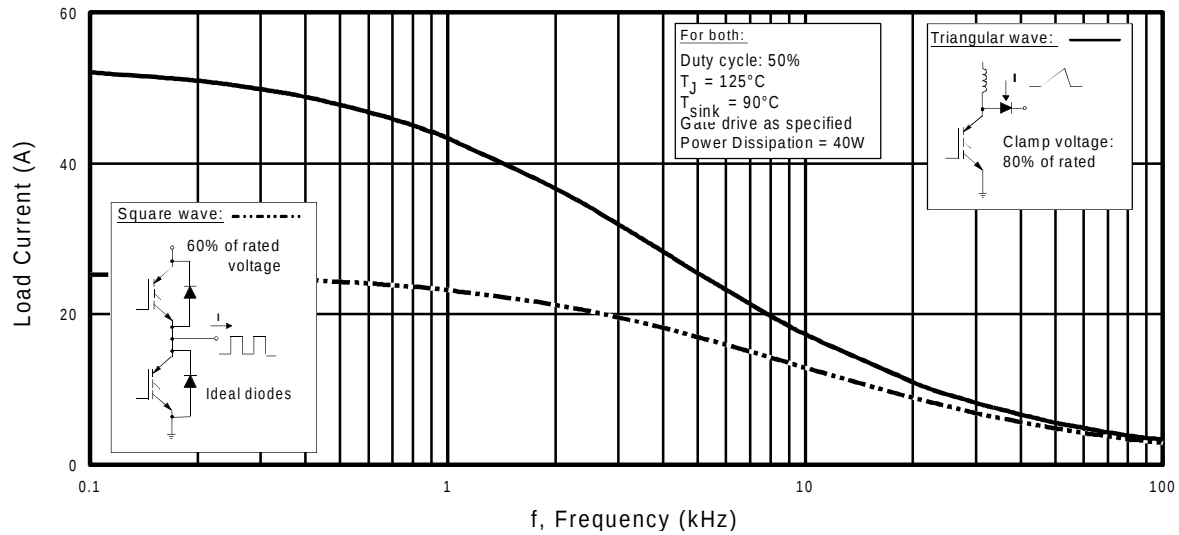
|                                 | Parameter                                | Min. | Typ. | Max.      | Units                | Conditions                                             |
|---------------------------------|------------------------------------------|------|------|-----------|----------------------|--------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 1200 | —    | —         | V                    | $V_{GE} = 0V, I_C = 250\mu A$                          |
| $V_{(BR)ECS}$                   | Emitter-to-Collector Breakdown Voltage ④ | 18   | —    | —         | V                    | $V_{GE} = 0V, I_C = 1.0A$                              |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage  | —    | 1.20 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                             |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 2.56 | 3.5       | V                    | $I_C = 20A$                                            |
|                                 |                                          | —    | 2.78 | 3.7       |                      | $I_C = 24A$                                            |
|                                 |                                          | —    | 3.20 | —         |                      | $I_C = 45A$                                            |
|                                 |                                          | —    | 2.54 | —         |                      | $I_C = 24A, T_J = 150^\circ\text{C}$                   |
| $V_{GE(th)}$                    | 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  | —    | -13  | —         | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$                      |
| $g_{fe}$                        | Forward Transconductance ⑤               | 23   | 35   | —         | S                    | $V_{CE} = 100V, I_C = 24A$                             |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 1200V$                          |
|                                 |                                          | —    | —    | 2.0       |                      | $V_{GE} = 0V, V_{CE} = 24V, T_J = 25^\circ\text{C}$    |
|                                 |                                          | —    | —    | 5000      |                      | $V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                     |

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

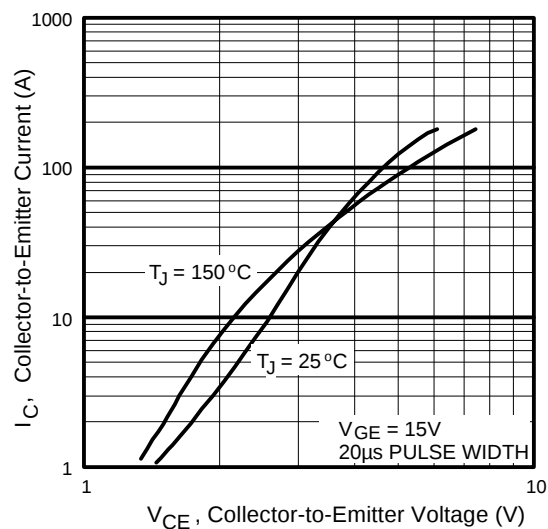
|              | Parameter                         | Min. | Typ. | Max. | Units | Conditions                                                                                                                                                                 |
|--------------|-----------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 160  | 250  | nC    | $I_C = 24A$                                                                                                                                                                |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 27   | 40   |       | $V_{CC} = 400V$ See Fig. 8                                                                                                                                                 |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 53   | 83   |       | $V_{GE} = 15V$                                                                                                                                                             |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 35   | —    | ns    | $T_J = 25^\circ\text{C}$<br>$I_C = 24A, V_{CC} = 960V$<br>$V_{GE} = 15V, R_G = 5.0\Omega$<br>Energy losses include "tail"<br>See Fig. 9, 10, 14                            |
| $t_r$        | Rise Time                         | —    | 15   | —    |       |                                                                                                                                                                            |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 200  | 350  |       |                                                                                                                                                                            |
| $t_f$        | Fall Time                         | —    | 290  | 500  |       |                                                                                                                                                                            |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.53 | —    | mJ    | $T_J = 150^\circ\text{C}$<br>$I_C = 24A, V_{CC} = 960V$<br>$V_{GE} = 15V, R_G = 5.0\Omega$<br>Energy losses include "tail"<br>See Fig. 11, 14                              |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 1.41 | —    |       |                                                                                                                                                                            |
| $E_{ts}$     | Total Switching Loss              | —    | 1.94 | 2.6  |       |                                                                                                                                                                            |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 31   | —    | ns    | $T_J = 25^\circ\text{C}, V_{GE} = 15V, R_G = 5.0\Omega$<br>$I_C = 20A, V_{CC} = 960V$<br>Energy losses include "tail"<br>See Fig. 9, 10, 11, 14, $T_J = 150^\circ\text{C}$ |
| $t_r$        | Rise Time                         | —    | 18   | —    |       |                                                                                                                                                                            |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 320  | —    |       |                                                                                                                                                                            |
| $t_f$        | Fall Time                         | —    | 280  | —    |       |                                                                                                                                                                            |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.35 | —    | mJ    | $T_J = 25^\circ\text{C}, V_{GE} = 15V, R_G = 5.0\Omega$<br>$I_C = 20A, V_{CC} = 960V$<br>Energy losses include "tail"<br>See Fig. 9, 10, 11, 14, $T_J = 150^\circ\text{C}$ |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 1.43 | —    |       |                                                                                                                                                                            |
| $E_{ts}$     | Total Switching Loss              | —    | 1.78 | 2.9  |       |                                                                                                                                                                            |
| $L_E$        | Internal Emitter Inductance       | —    | 13   | —    | nH    | Measured 5mm from package                                                                                                                                                  |
| $C_{ies}$    | Input Capacitance                 | —    | 3600 | —    | pF    | $V_{GE} = 0V$                                                                                                                                                              |
| $C_{oes}$    | Output Capacitance                | —    | 160  | —    |       | $V_{CC} = 30V$ See Fig. 7                                                                                                                                                  |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 31   | —    |       | $f = 1.0MHz$                                                                                                                                                               |

### Notes:

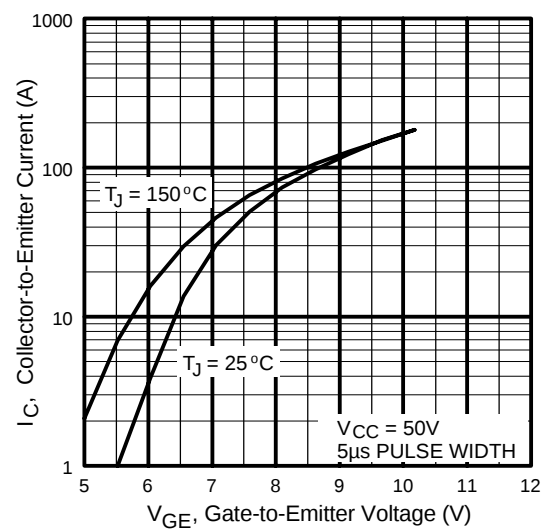
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 5.0\Omega$ , (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ⑤ Pulse width  $5.0\mu s$ , single shot.



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



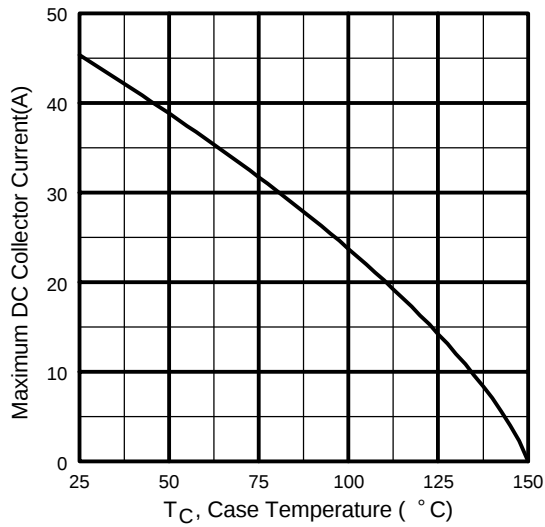
**Fig. 2** - Typical Output Characteristics



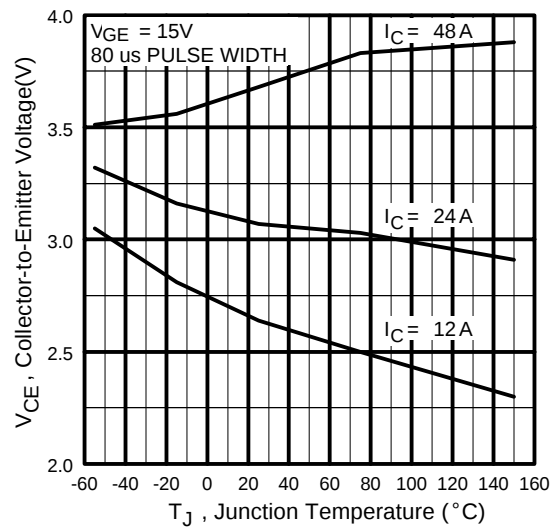
**Fig. 3** - Typical Transfer Characteristics

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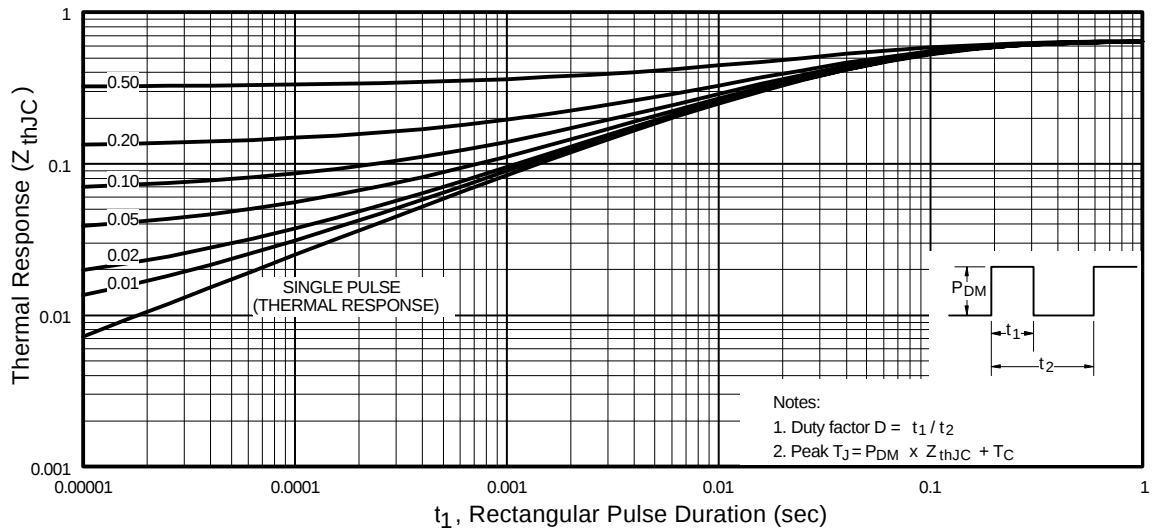
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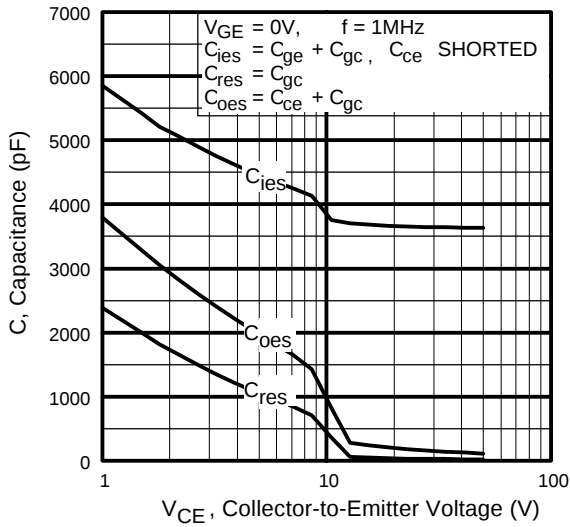
**Fig. 4** - Maximum Collector Current vs. Case Temperature



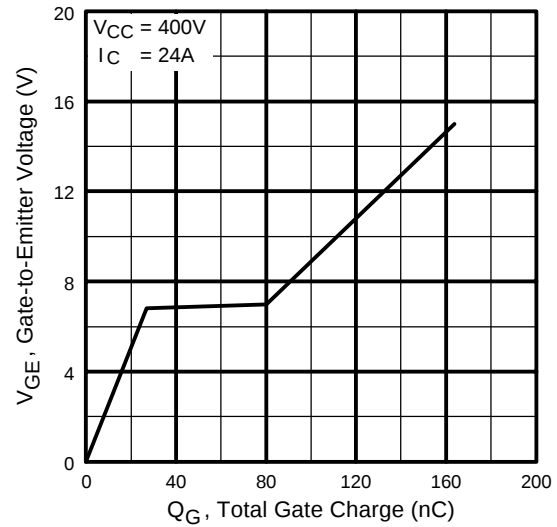
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



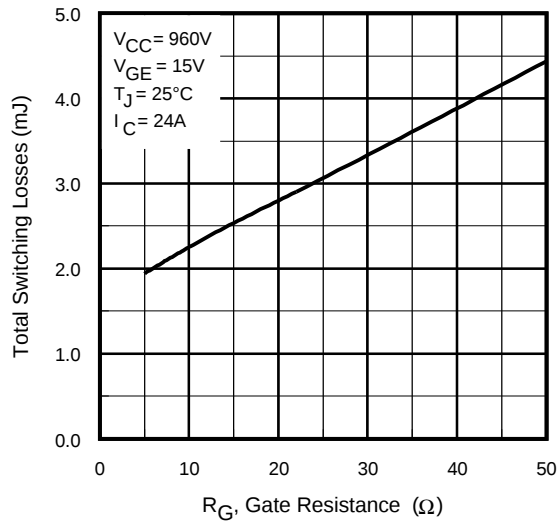
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



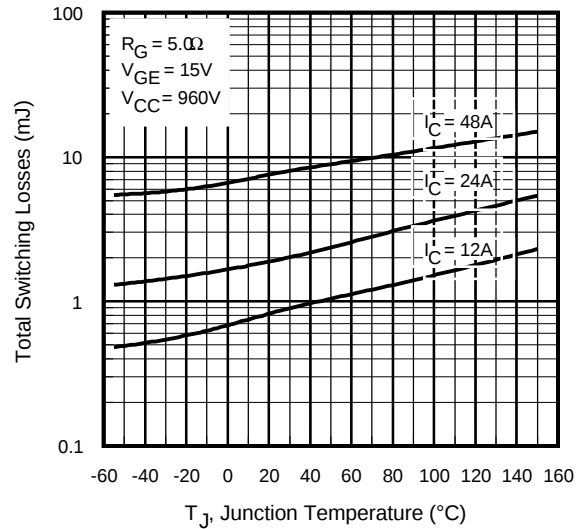
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



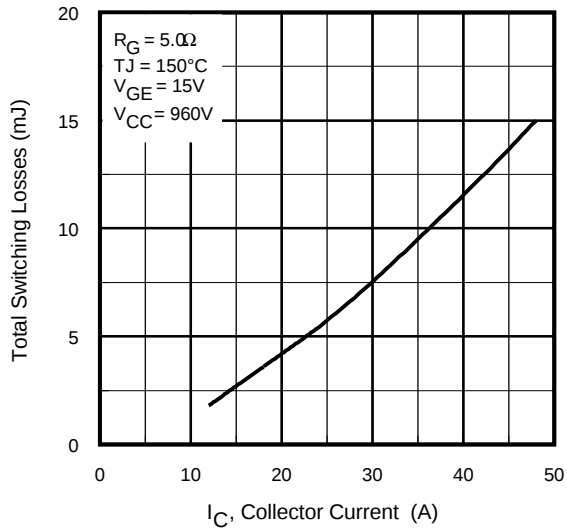
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



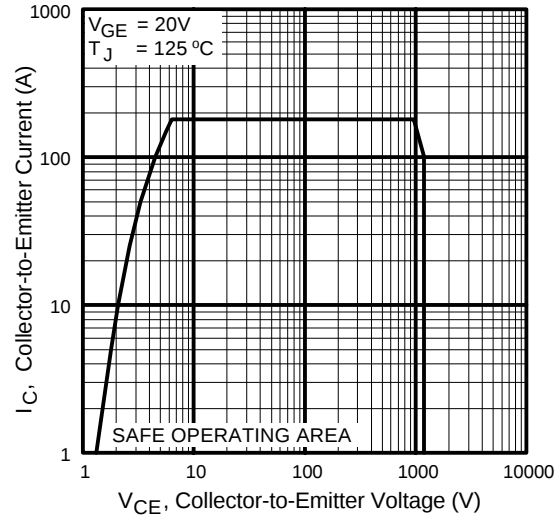
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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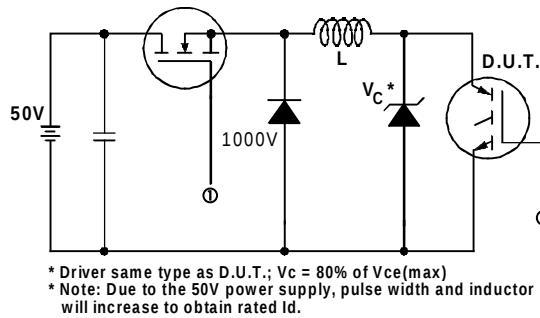
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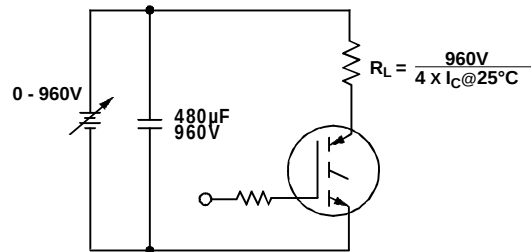
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



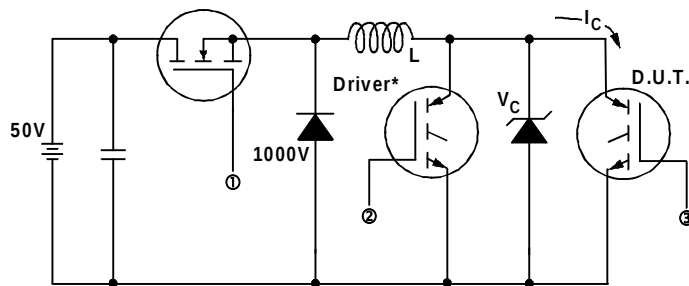
**Fig. 12** - Turn-Off SOA



**Fig. 13a** - Clamped Inductive Load Test Circuit

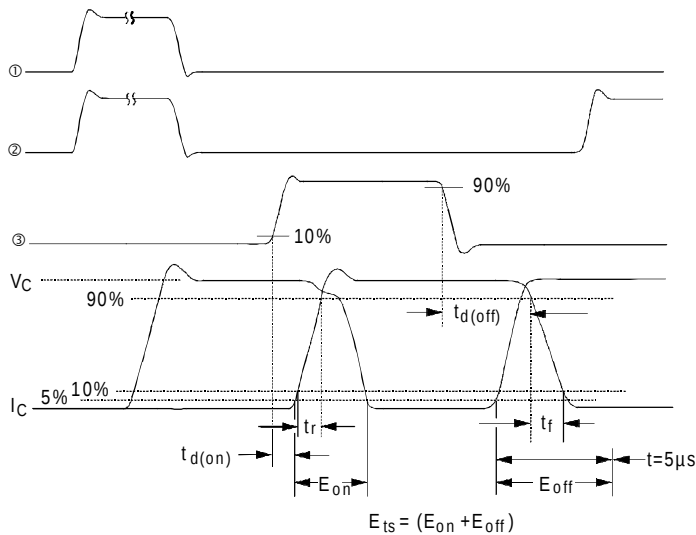


**Fig. 13b** - Pulsed Collector Current Test Circuit



**Fig. 14a** - Switching Loss Test Circuit

\* Driver same type as D.U.T.,  $V_C = 960V$

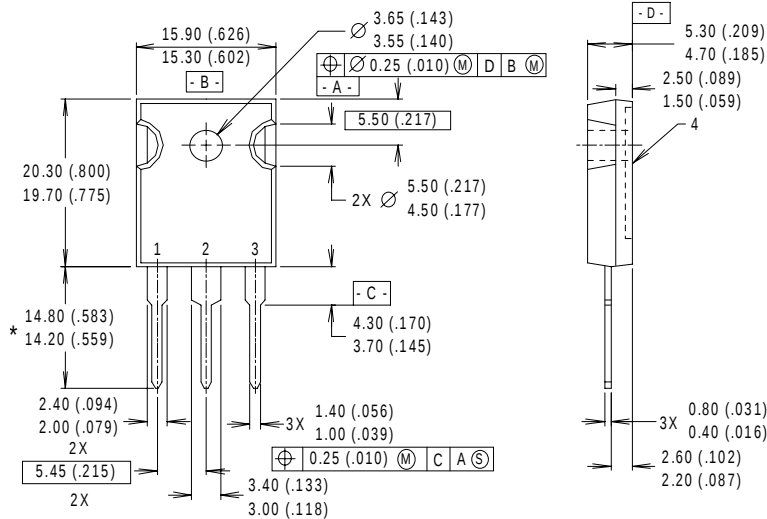


**Fig. 14b** - Switching Loss Waveforms

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## Case Outline and Dimensions — TO-247AC



### 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-247AC.

### LEAD ASSIGNMENTS

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

\* LONGER LEADED (20mm)  
VERSION AVAILABLE (TO-247AD)  
TO ORDER ADD "-E" SUFFIX  
TO PART NUMBER

### CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)

Dimensions in Millimeters and (Inches)

International  
**IR** Rectifier

**WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, Tel: (310) 322 3331

**IR GREAT BRITAIN:** Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: ++ 44 1883 732020

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

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

**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111

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

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

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

<http://www.irf.com/>

Data and specifications subject to change without notice. 01/02

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