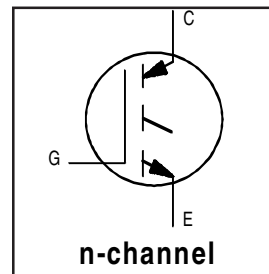


# IRG4PH40K

Short Circuit Rated  
UltraFast IGBT

## Features

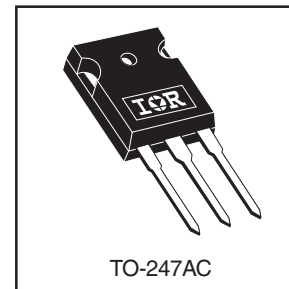
- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ ,  $V_{CC} = 720V$ ,  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Latest generation design provides tighter parameter distribution and higher efficiency than previous generations



$V_{CES} = 1200V$   
 $V_{CE(on)} \text{ typ.} = 2.74V$   
@  $V_{GE} = 15V$ ,  $I_C = 15A$

## Benefits

- As a Freewheeling Diode we recommend our HEXFRED™ ultrafast, ultrasoft recovery diodes for minimum EMI / Noise and switching losses in the Diode and IGBT
- Latest generation 4 IGBT's offer highest power density motor controls possible
- This part replaces the IRGPH40K and IRGPH40M devices



## Absolute Maximum Ratings

|                           | Parameter                          | Max.                                                    | Units      |
|---------------------------|------------------------------------|---------------------------------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage       | 1200                                                    | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 30                                                      | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 15                                                      |            |
| $I_{CM}$                  | Pulsed Collector Current ①         | 60                                                      |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②   | 60                                                      |            |
| $t_{sc}$                  | Short Circuit Withstand Time       | 10                                                      | $\mu s$    |
| $V_{GE}$                  | Gate-to-Emitter Voltage            | $\pm 20$                                                | V          |
| $E_{ARV}$                 | Reverse Voltage Avalanche Energy ③ | 180                                                     | mJ         |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation          | 160                                                     | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation          | 65                                                      |            |
| $T_J$                     | Operating Junction and             | -55 to +150                                             | $^\circ C$ |
| $T_{STG}$                 | Storage Temperature Range          |                                                         |            |
|                           | Soldering Temperature, for 10 sec. |                                                         |            |
|                           | Mounting torque, 6-32 or M3 screw. | 300 (0.063 in. (1.6mm) from case)<br>10 lbf•in (1.1N•m) |            |

## Thermal Resistance

|                 | Parameter                                 | Typ.     | Max. | Units        |
|-----------------|-------------------------------------------|----------|------|--------------|
| $R_{\theta JC}$ | Junction-to-Case                          | —        | 0.77 | $^\circ C/W$ |
| $R_{\theta CS}$ | 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)       |

# IRG4PH40K

International  
**IR** Rectifier

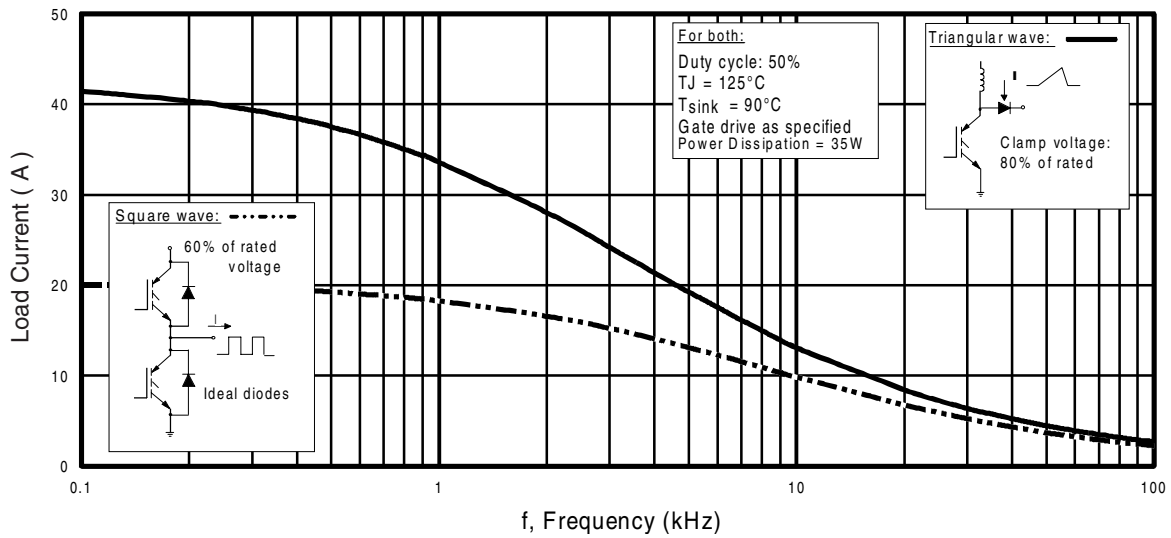
## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|                                 | Parameter                                | Min. | Typ. | Max.      | Units                      | Conditions                                                                 |
|---------------------------------|------------------------------------------|------|------|-----------|----------------------------|----------------------------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 1200 | —    | —         | V                          | $V_{GE} = 0\text{V}$ , $I_C = 250\mu\text{A}$                              |
| $V_{(BR)ECS}$                   | Emitter-to-Collector Breakdown Voltage ④ | 18   | —    | —         | V                          | $V_{GE} = 0\text{V}$ , $I_C = 1.0\text{A}$                                 |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage  | —    | 0.37 | —         | $^\circ\text{C}$           | $V_{GE} = 0\text{V}$ , $I_C = 1.0\text{mA}$                                |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 2.54 | —         | V                          | $I_C = 10\text{A}$                                                         |
|                                 |                                          | —    | 2.74 | 3.4       |                            | $I_C = 15\text{A}$                                                         |
|                                 |                                          | —    | 3.29 | —         |                            | $I_C = 30\text{A}$                                                         |
|                                 |                                          | —    | 2.53 | —         |                            | $I_C = 15\text{A}$ , $T_J = 150^\circ\text{C}$                             |
| $V_{GE(th)}$                    | Gate Threshold Voltage                   | 3.0  | —    | 6.0       |                            | $V_{CE} = V_{GE}$ , $I_C = 250\mu\text{A}$                                 |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage  | —    | -3.3 | —         | $\text{mV}/^\circ\text{C}$ | $V_{CE} = V_{GE}$ , $I_C = 250\mu\text{A}$                                 |
| $g_{fe}$                        | Forward Transconductance ⑤               | 8.0  | 12   | —         | S                          | $V_{CE} = 100\text{V}$ , $I_C = 15\text{A}$                                |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu\text{A}$              | $V_{GE} = 0\text{V}$ , $V_{CE} = 1200\text{V}$                             |
|                                 |                                          | —    | —    | 2.0       |                            | $V_{GE} = 0\text{V}$ , $V_{CE} = 10\text{V}$ , $T_J = 25^\circ\text{C}$    |
|                                 |                                          | —    | —    | 3000      |                            | $V_{GE} = 0\text{V}$ , $V_{CE} = 1200\text{V}$ , $T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA                         | $V_{GE} = \pm 20\text{V}$                                                  |

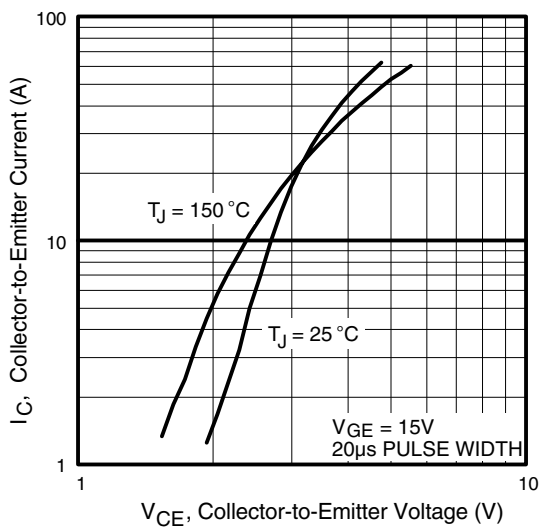
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|              | Parameter                         | Min. | Typ. | Max. | Units         | Conditions                                                                                                                                                                  |
|--------------|-----------------------------------|------|------|------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 94   | 140  | nC            | $I_C = 15\text{A}$                                                                                                                                                          |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 14   | 22   |               | $V_{CC} = 400\text{V}$                                                                                                                                                      |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 37   | 55   |               | $V_{GE} = 15\text{V}$                                                                                                                                                       |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 30   | —    | ns            | $T_J = 25^\circ\text{C}$<br>$I_C = 15\text{A}$ , $V_{CC} = 960\text{V}$<br>$V_{GE} = 15\text{V}$ , $R_G = 10\Omega$<br>Energy losses include "tail"<br>See Fig. 9,10,14     |
| $t_r$        | Rise Time                         | —    | 22   | —    |               |                                                                                                                                                                             |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 200  | 300  |               |                                                                                                                                                                             |
| $t_f$        | Fall Time                         | —    | 150  | 230  |               |                                                                                                                                                                             |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.73 | —    | mJ            | See Fig. 9,10,14                                                                                                                                                            |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 1.66 | —    |               |                                                                                                                                                                             |
| $E_{ts}$     | Total Switching Loss              | —    | 2.39 | 2.9  |               |                                                                                                                                                                             |
| $t_{sc}$     | Short Circuit Withstand Time      | 10   | —    | —    | $\mu\text{s}$ | $V_{CC} = 720\text{V}$ , $T_J = 125^\circ\text{C}$<br>$V_{GE} = 15\text{V}$ , $R_G = 10\Omega$                                                                              |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 29   | —    | ns            | $T_J = 150^\circ\text{C}$ ,<br>$I_C = 15\text{A}$ , $V_{CC} = 960\text{V}$<br>$V_{GE} = 15\text{V}$ , $R_G = 10\Omega$<br>Energy losses include "tail"<br>See Fig. 10,11,14 |
| $t_r$        | Rise Time                         | —    | 24   | —    |               |                                                                                                                                                                             |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 870  | —    |               |                                                                                                                                                                             |
| $t_f$        | Fall Time                         | —    | 330  | —    |               |                                                                                                                                                                             |
| $E_{ts}$     | Total Switching Loss              | —    | 4.93 | —    | mJ            | $T_J = 25^\circ\text{C}$ , $V_{GE} = 15\text{V}$ , $R_G = 10\Omega$<br>$I_C = 10\text{A}$ , $V_{CC} = 960\text{V}$<br>Energy losses include "tail"                          |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.37 | —    |               |                                                                                                                                                                             |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 0.89 | —    |               |                                                                                                                                                                             |
| $E_{ts}$     | Total Switching Loss              | —    | 1.26 | —    | mJ            | Measured 5mm from package                                                                                                                                                   |
| $L_E$        | Internal Emitter Inductance       | —    | 13   | —    |               |                                                                                                                                                                             |
| $C_{ies}$    | Input Capacitance                 | —    | 1600 | —    |               |                                                                                                                                                                             |
| $C_{oes}$    | Output Capacitance                | —    | 77   | —    |               |                                                                                                                                                                             |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 26   | —    | pF            | $V_{GE} = 0\text{V}$<br>$V_{CC} = 30\text{V}$<br>$f = 1.0\text{MHz}$                                                                                                        |

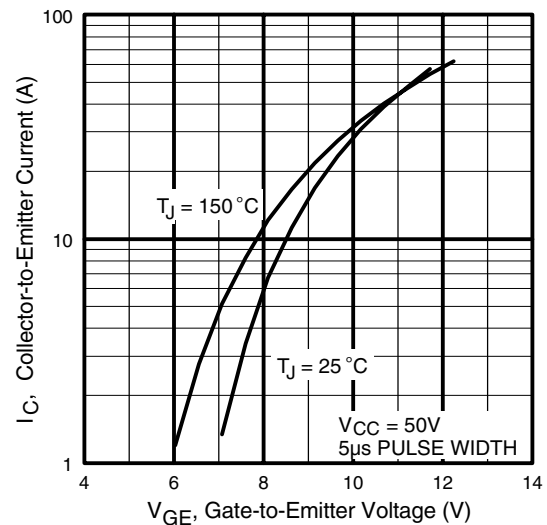
Details of note ① through ⑤ are on the last page



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



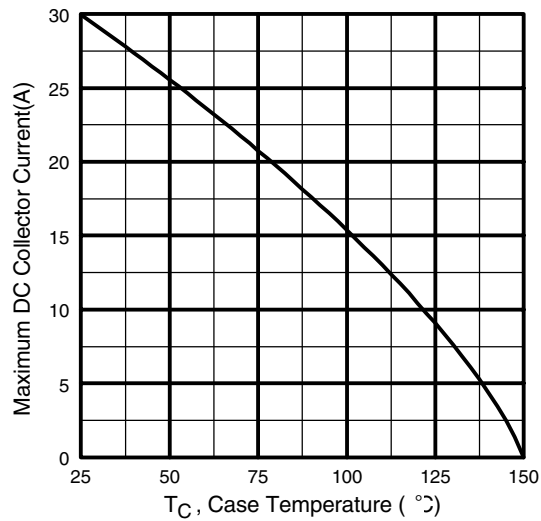
**Fig. 2** - Typical Output Characteristics



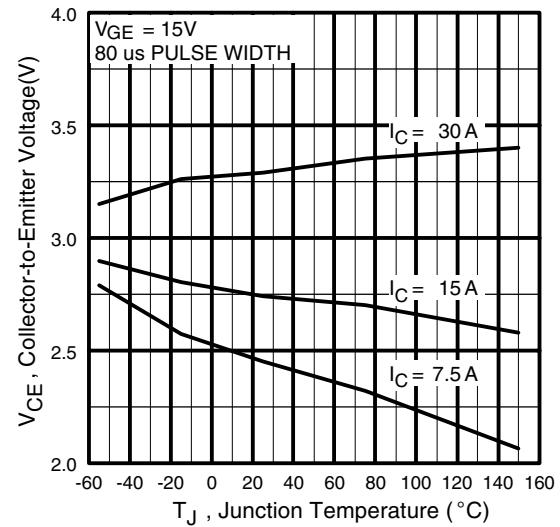
**Fig. 3** - Typical Transfer Characteristics

# IRG4PH40K

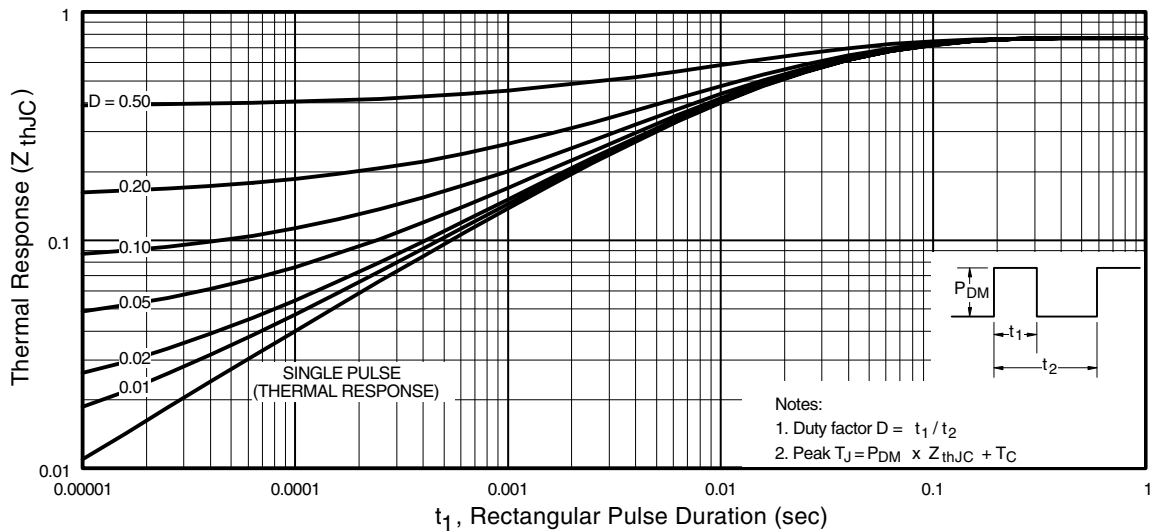
International  
**IR** Rectifier



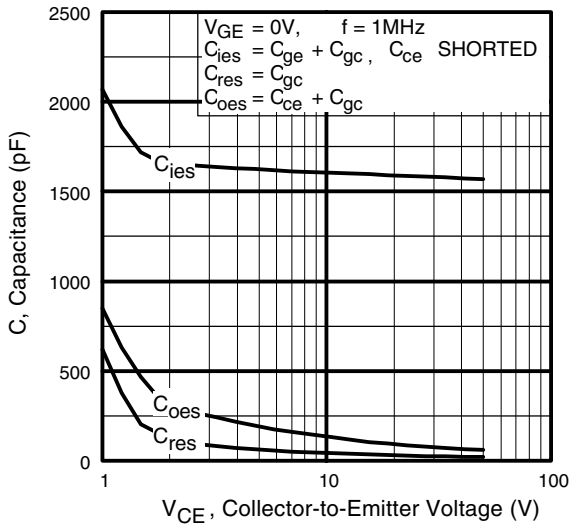
**Fig. 4** - Maximum Collector Current vs. Case Temperature



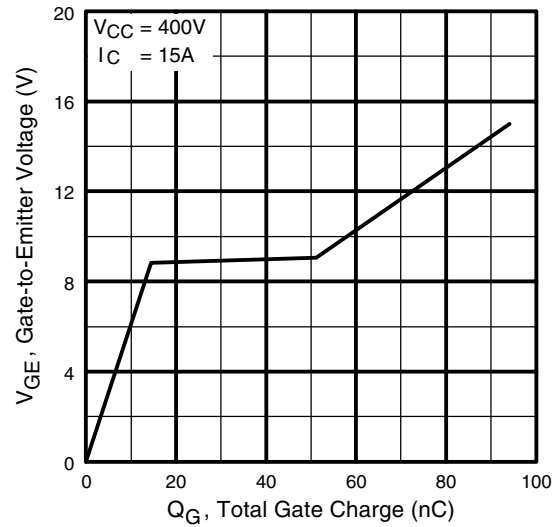
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



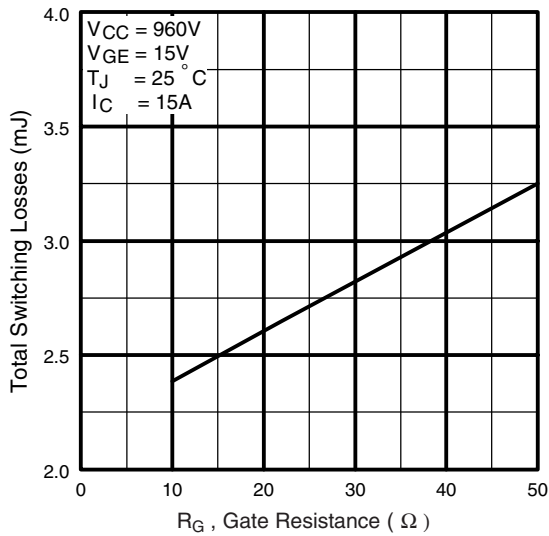
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



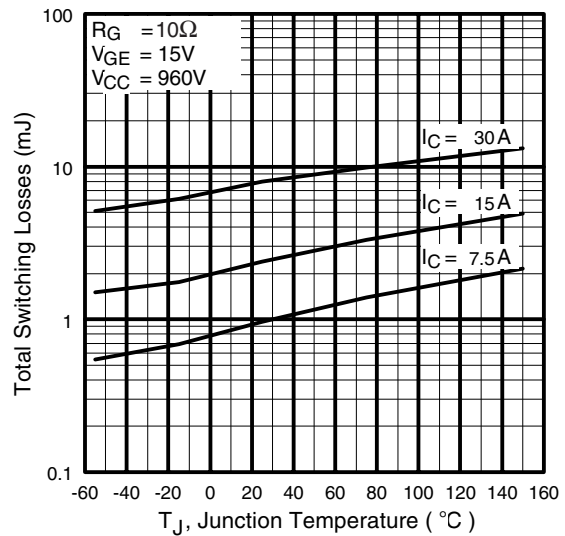
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



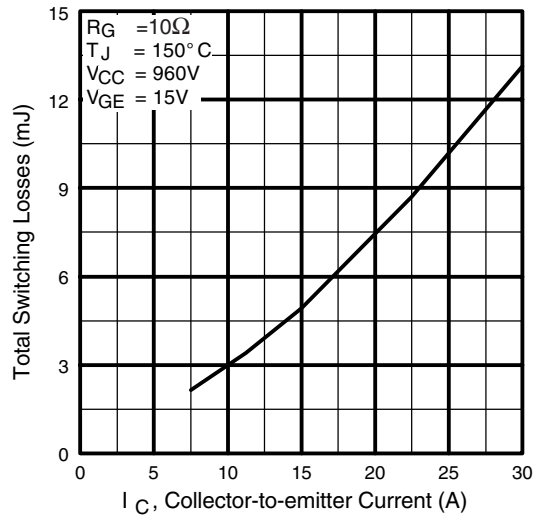
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



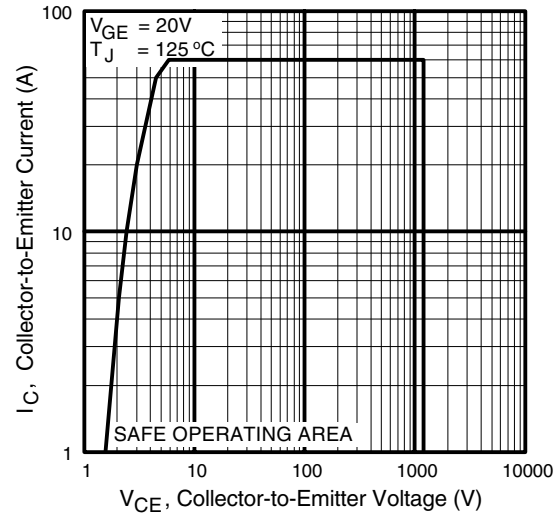
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

# IRG4PH40K

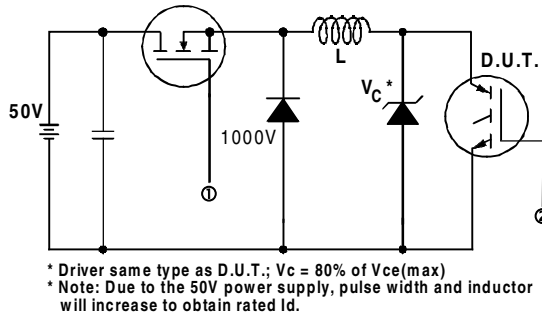
International  
**IR** Rectifier



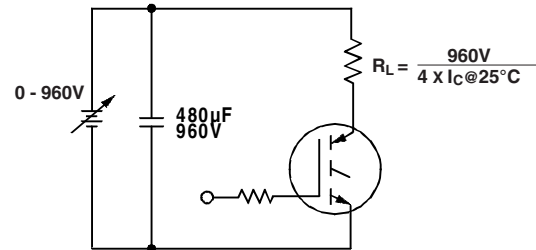
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



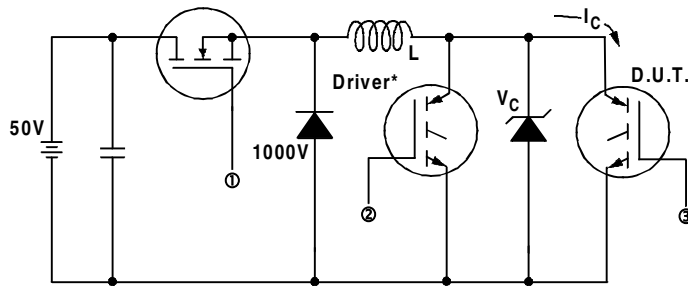
**Fig. 12** - Turn-Off SOA



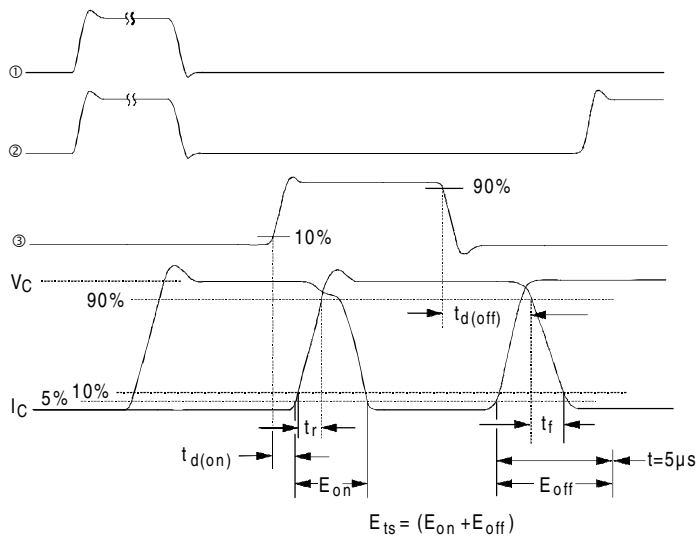
**Fig. 13a** - Clamped Inductive Load Test Circuit



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



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



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

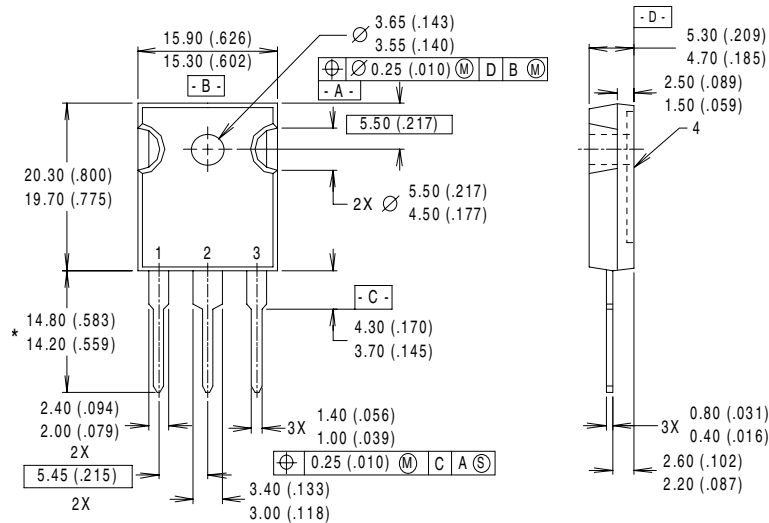
# IRG4PH40K

International  
**IR** Rectifier

## Notes:

- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 10\Omega$ , (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.

## 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

**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 0BL, 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. 6/00*



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