

# International IOR Rectifier

INSULATED GATE BIPOLAR TRANSISTOR

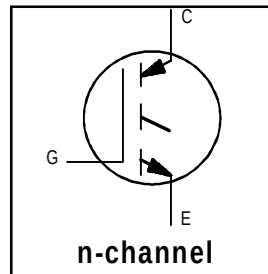
PD - 9.1585B

## IRG4PC40K

Short Circuit Rated  
UltraFast IGBT

### Features

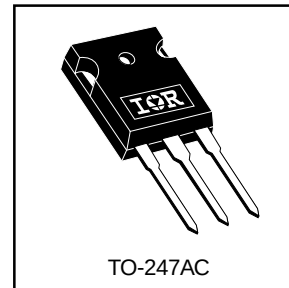
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10 $\mu$ s @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides higher efficiency than Generation 3
- Industry standard TO-247AC package



|                                  |
|----------------------------------|
| $V_{CES} = 600V$                 |
| $V_{CE(on)} \text{ typ.} = 2.1V$ |
| @ $V_{GE} = 15V, I_C = 25A$      |

### Benefits

- Generation 4 IGBTs offer highest efficiency available
- IGBTs optimized for specified application conditions



### Absolute Maximum Ratings

|                           | Parameter                          | Max.                              | Units      |
|---------------------------|------------------------------------|-----------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage       | 600                               | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 42                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 25                                |            |
| $I_{CM}$                  | Pulsed Collector Current ①         | 84                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②   | 84                                |            |
| $t_{sc}$                  | Short Circuit Withstand Time       | 10                                | $\mu s$    |
| $V_{GE}$                  | Gate-to-Emitter Voltage            | $\pm 20$                          | V          |
| $E_{ARV}$                 | Reverse Voltage Avalanche Energy ③ | 15                                | 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. | 300 (0.063 in. (1.6mm) from case) |            |
|                           | Mounting torque, 6-32 or M3 screw. | 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)       |

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

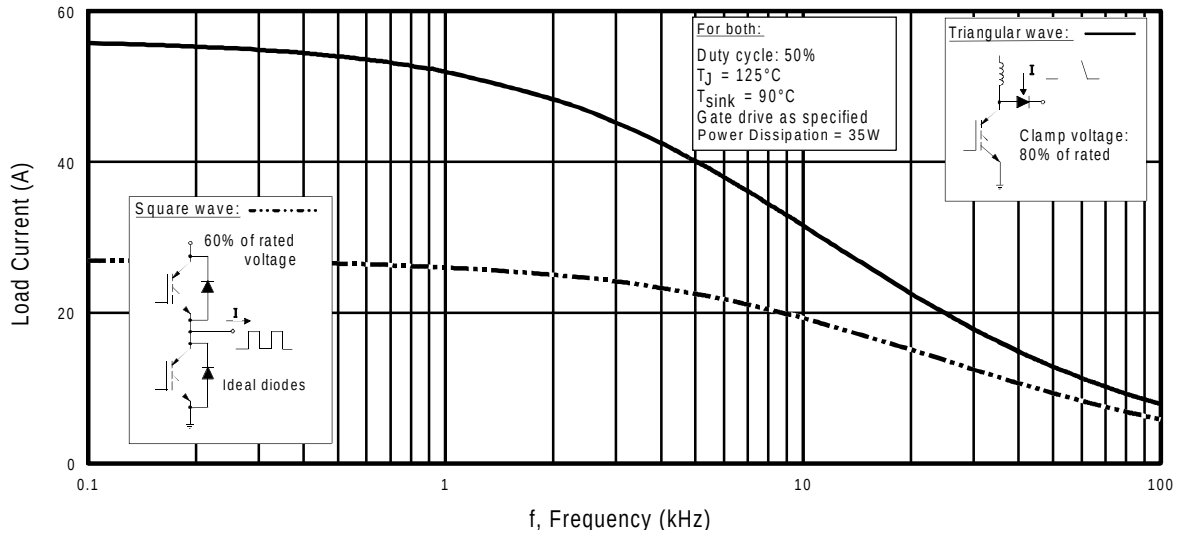
|                                 | Parameter                                | Min. | Typ. | Max.      | Units                | Conditions                                            |
|---------------------------------|------------------------------------------|------|------|-----------|----------------------|-------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 600  | —    | —         | 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  | —    | 0.46 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                            |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 2.10 | 2.6       | V                    | $I_C = 25A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 2.70 | —         |                      | $I_C = 42A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 2.14 | —         |                      | $I_C = 25A, T_J = 150^\circ\text{C}$                  |
| $V_{GE(th)}$                    | 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               | 7.0  | 14   | —         | S                    | $V_{CE} = 100V, I_C = 25A$                            |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$                          |
|                                 |                                          | —    | —    | 2.0       |                      | $V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$   |
|                                 |                                          | —    | —    | 2000      |                      | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                    |

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

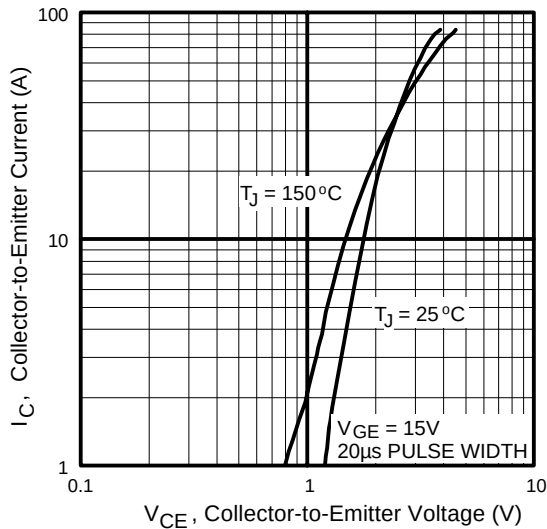
|              | Parameter                         | Min. | Typ. | Max. | Units   | Conditions                                                                                 |
|--------------|-----------------------------------|------|------|------|---------|--------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 120  | 180  | nC      | $I_C = 25A$                                                                                |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 16   | 24   |         | $V_{CC} = 400V$                                                                            |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 51   | 77   |         | $V_{GE} = 15V$                                                                             |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 30   | —    | ns      | $T_J = 25^\circ\text{C}$                                                                   |
| $t_r$        | Rise Time                         | —    | 15   | —    |         | $I_C = 25A, V_{CC} = 480V$                                                                 |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 140  | 210  |         | $V_{GE} = 15V, R_G = 10\Omega$                                                             |
| $t_f$        | Fall Time                         | —    | 140  | 210  |         | Energy losses include "tail"                                                               |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.62 | —    | mJ      | See Fig. 9,10,14                                                                           |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 0.33 | —    |         |                                                                                            |
| $E_{ts}$     | Total Switching Loss              | —    | 0.95 | 1.4  |         |                                                                                            |
| $t_{sc}$     | Short Circuit Withstand Time      | 10   | —    | —    | $\mu s$ | $V_{CC} = 400V, T_J = 125^\circ\text{C}$<br>$V_{GE} = 15V, R_G = 10\Omega, V_{CPK} < 500V$ |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 30   | —    | ns      | $T_J = 150^\circ\text{C}$                                                                  |
| $t_r$        | Rise Time                         | —    | 18   | —    |         | $I_C = 25A, V_{CC} = 480V$                                                                 |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 190  | —    |         | $V_{GE} = 15V, R_G = 10\Omega$                                                             |
| $t_f$        | Fall Time                         | —    | 150  | —    |         | Energy losses include "tail"                                                               |
| $E_{ts}$     | Total Switching Loss              | —    | 1.9  | —    | mJ      | See Fig. 11,14                                                                             |
| $L_E$        | Internal Emitter Inductance       | —    | 13   | —    | nH      | Measured 5mm from package                                                                  |
| $C_{ies}$    | Input Capacitance                 | —    | 1600 | —    | pF      | $V_{GE} = 0V$                                                                              |
| $C_{oes}$    | Output Capacitance                | —    | 130  | —    |         | $V_{CC} = 30V$                                                                             |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 55   | —    |         | $f = 1.0MHz$                                                                               |

### Notes:

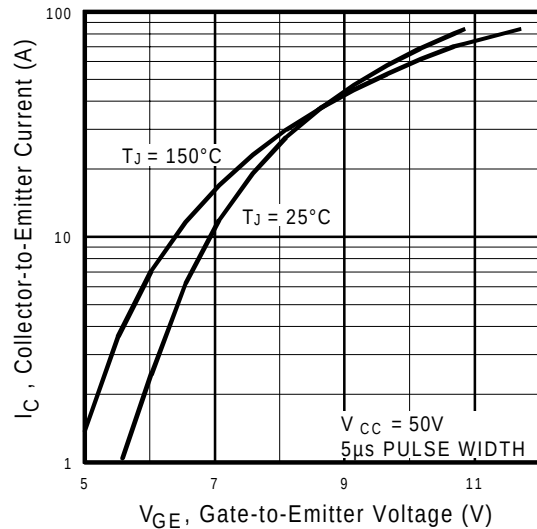
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 10\Omega$ , (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width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



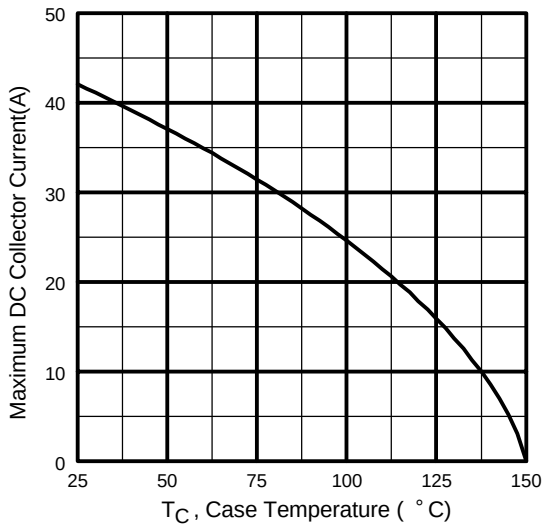
**Fig. 1** - Typical Load Current vs. Frequency  
(Load Current =  $I_{\text{RMS}}$  of fundamental)



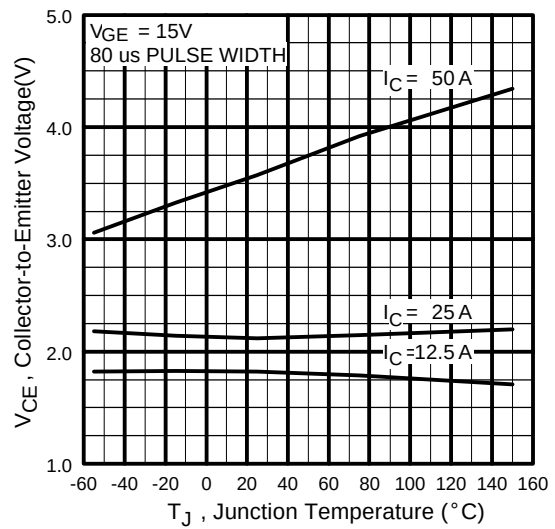
**Fig. 2** - Typical Output Characteristics



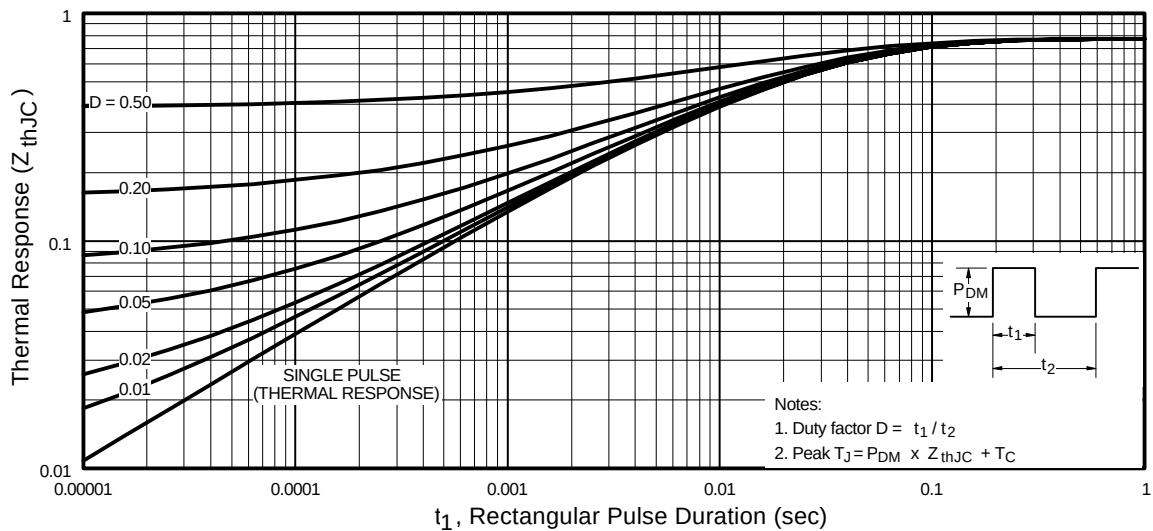
**Fig. 3** - Typical Transfer Characteristics



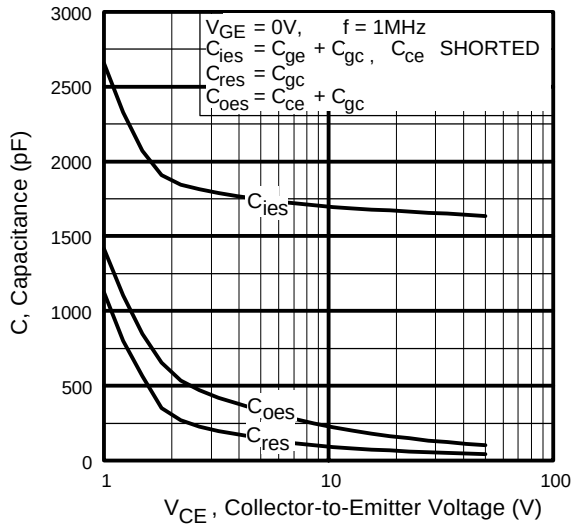
**Fig. 4** - Maximum Collector Current vs. Case Temperature



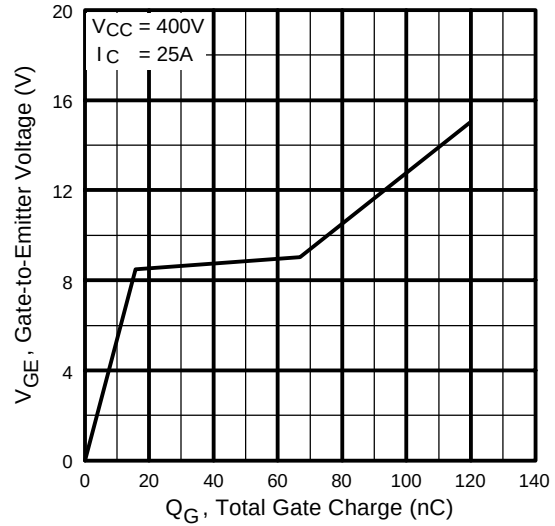
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



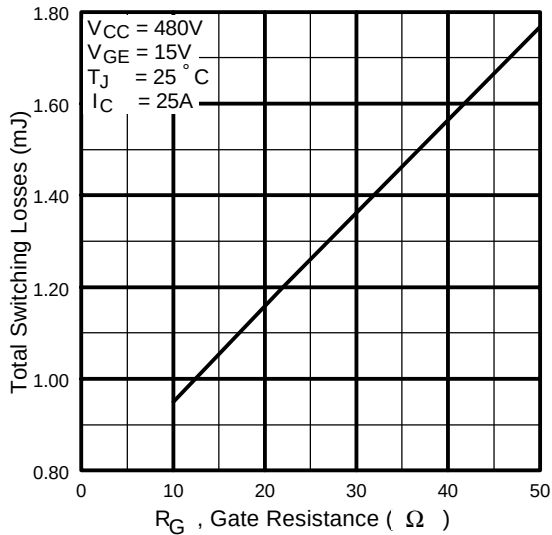
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



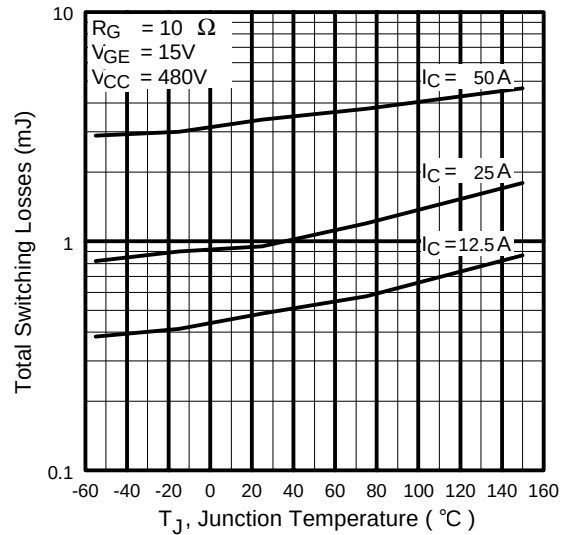
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



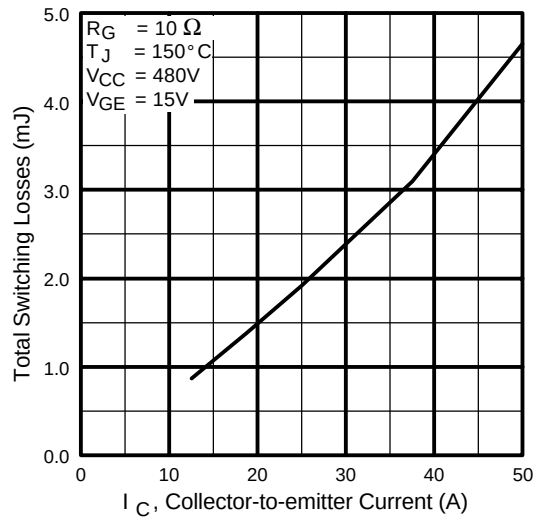
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



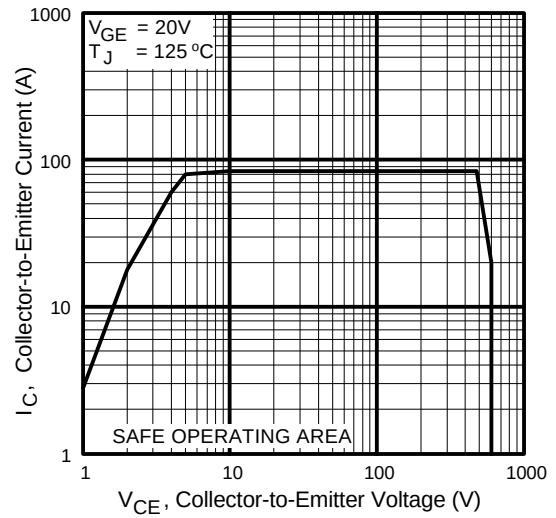
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

# IRG4PC40K

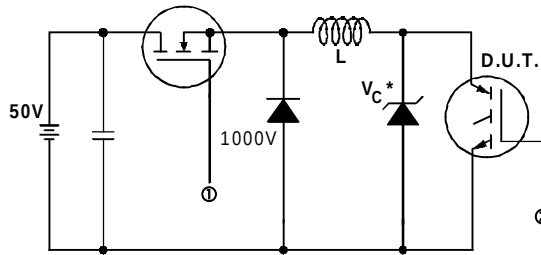
International  
**IR** Rectifier



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

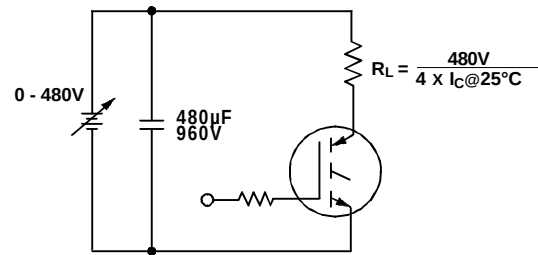


**Fig. 12** - Turn-Off SOA

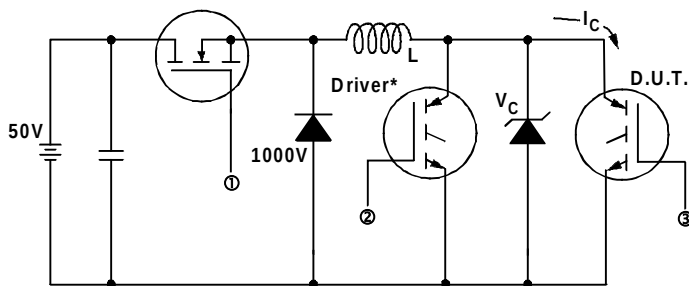


\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

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

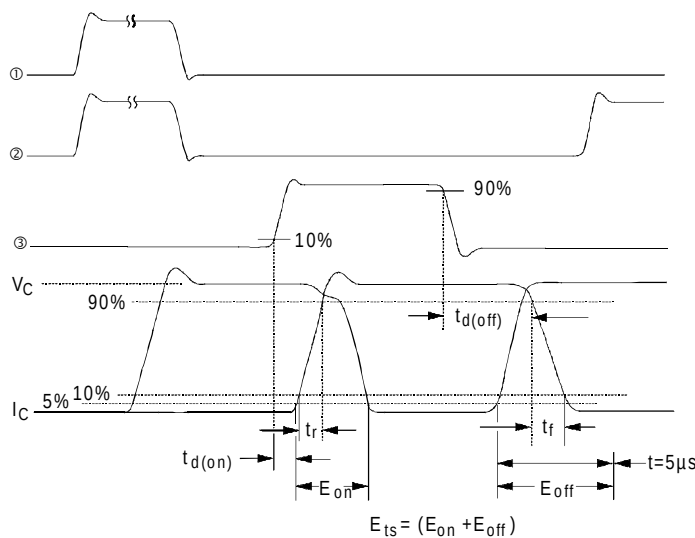


**Fig. 13b** - Pulsed Collector Current Test Circuit



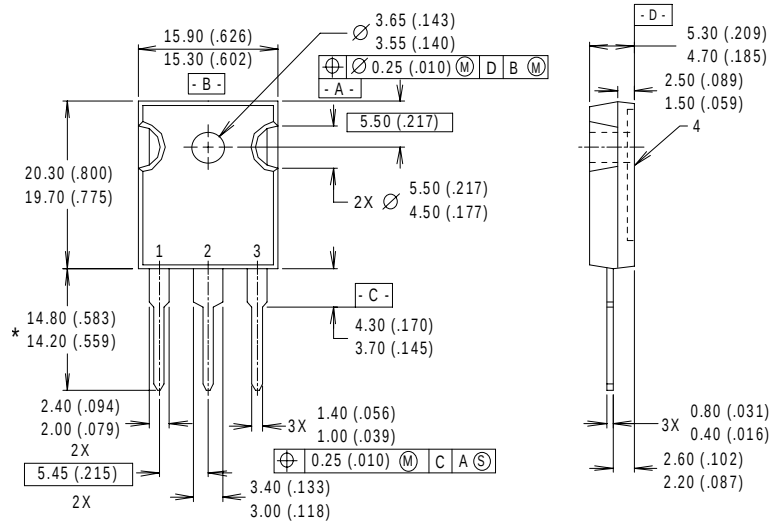
**Fig. 14a** - Switching Loss Test Circuit

\* Driver same type as D.U.T.,  $V_C = 480V$



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

## 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  
**IOR** Rectifier

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**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

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