

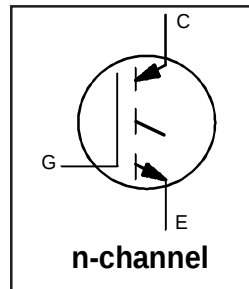
# IRG4PC40FPbF

INSULATED GATE BIPOLAR TRANSISTOR

Fast Speed IGBT

## Features

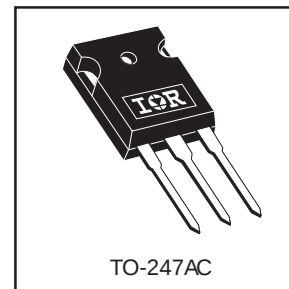
- Fast: Optimized for medium operating frequencies ( 1-5 kHz in hard switching, >20 kHz in resonant mode).
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- Industry standard TO-247AC package
- Lead-Free



|                                   |
|-----------------------------------|
| $V_{CES} = 600V$                  |
| $V_{CE(on)} \text{ typ.} = 1.50V$ |
| @ $V_{GE} = 15V, I_C = 27A$       |

## Benefits

- Generation 4 IGBT's offer highest efficiency available
- IGBT's optimized for specified application conditions
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBT's



## Absolute Maximum Ratings

|                           | Parameter                                           | Max.                              | Units      |
|---------------------------|-----------------------------------------------------|-----------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Breakdown Voltage              | 600                               | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current                        | 49                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current                        | 27                                |            |
| $I_{CM}$                  | Pulsed Collector Current ①                          | 200                               |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②                    | 200                               |            |
| $V_{GE}$                  | 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                                |            |
| $T_J$<br>$T_{STG}$        | Operating Junction and<br>Storage Temperature Range | -55 to + 150                      | $^\circ C$ |
|                           | Soldering Temperature, for 10 seconds               | 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  | —    | 0.70 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                            |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 1.50 | 1.7       | V                    | $I_C = 27A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 1.85 | —         |                      | $I_C = 49A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 1.56 | —         |                      | $I_C = 27A, T_J = 150^\circ\text{C}$                  |
| $V_{GE(th)}$                    | 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  | —    | -12  | —         | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |
| $g_{fe}$                        | Forward Transconductance ⑤               | 9.2  | 12   | —         | S                    | $V_{CE} = 100V, I_C = 27A$                            |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$                          |
|                                 |                                          | —    | —    | 2.0       |                      | $V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$   |
|                                 |                                          | —    | —    | 1000      |                      | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                    |

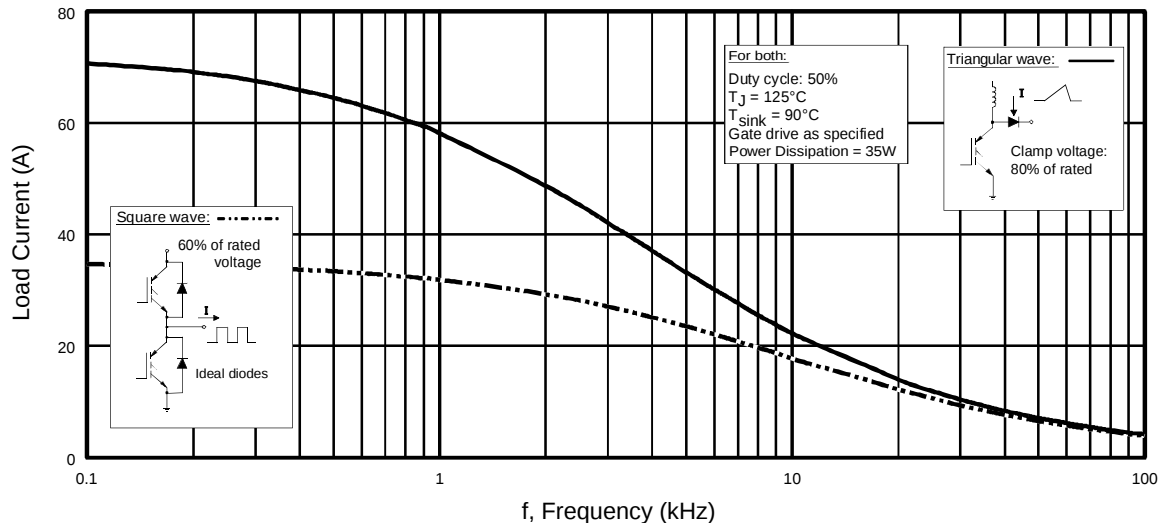
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|              | Parameter                         | Min. | Typ. | Max. | Units | Conditions                     |
|--------------|-----------------------------------|------|------|------|-------|--------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 100  | 150  | nC    | $I_C = 27A$                    |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 15   | 23   |       | $V_{CC} = 400V, V_{GE} = 15V$  |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 35   | 53   |       | See Fig. 8                     |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 26   | —    | ns    | $T_J = 25^\circ\text{C}$       |
| $t_r$        | Rise Time                         | —    | 18   | —    |       | $I_C = 27A, V_{CC} = 480V$     |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 240  | 360  |       | $V_{GE} = 15V, R_G = 10\Omega$ |
| $t_f$        | Fall Time                         | —    | 170  | 250  |       | Energy losses include "tail"   |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.37 | —    | mJ    | See Fig. 10, 11, 13, 14        |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 1.81 | —    |       |                                |
| $E_{ts}$     | Total Switching Loss              | —    | 2.18 | 2.8  |       |                                |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 25   | —    | ns    | $T_J = 150^\circ\text{C}$      |
| $t_r$        | Rise Time                         | —    | 21   | —    |       | $I_C = 27A, V_{CC} = 480V$     |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 380  | —    |       | $V_{GE} = 15V, R_G = 10\Omega$ |
| $t_f$        | Fall Time                         | —    | 310  | —    |       | Energy losses include "tail"   |
| $E_{ts}$     | Total Switching Loss              | —    | 3.9  | —    | mJ    | See Fig. 13, 14                |
| $L_E$        | Internal Emitter Inductance       | —    | 13   | —    | nH    | Measured 5mm from package      |
| $C_{ies}$    | Input Capacitance                 | —    | 2200 | —    | pF    | $V_{GE} = 0V$                  |
| $C_{oes}$    | Output Capacitance                | —    | 140  | —    |       | $V_{CC} = 30V$                 |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 29   | —    |       | $f = 1.0MHz$                   |

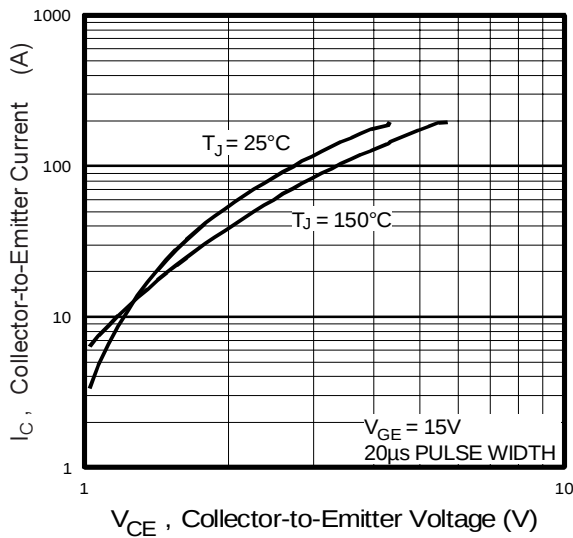
### Notes:

- 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.

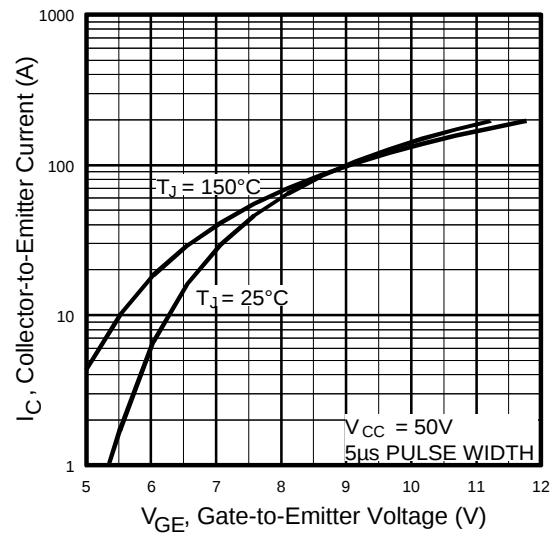
- ④ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ⑤ Pulse width  $5.0\mu s$ , single shot.



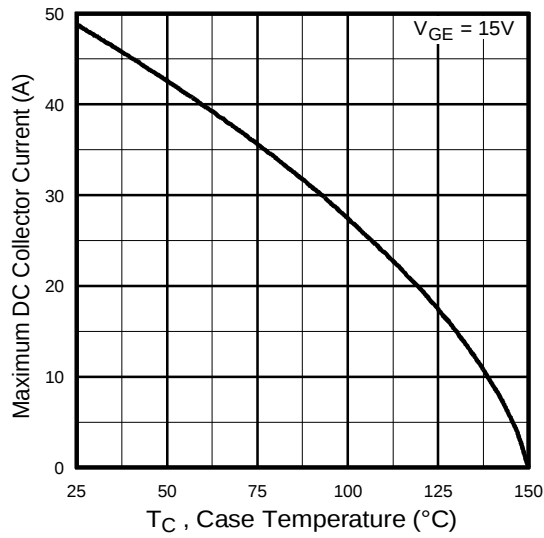
**Fig. 1 - Typical Load Current vs. Frequency**  
(For square wave,  $I = I_{\text{RMS}}$  of fundamental; for triangular wave,  $I = I_{\text{PK}}$ )



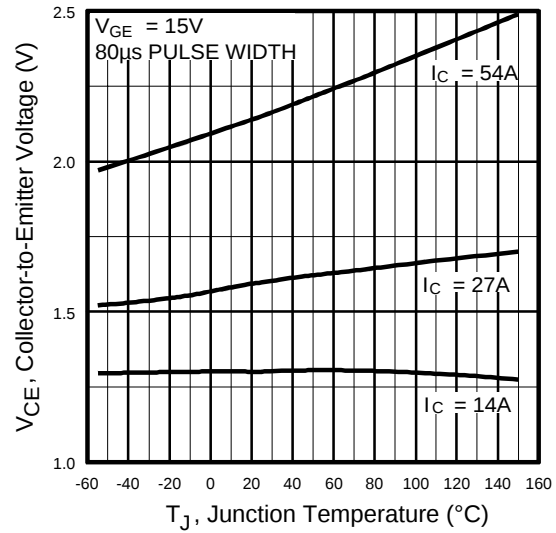
**Fig. 2 - Typical Output Characteristics**



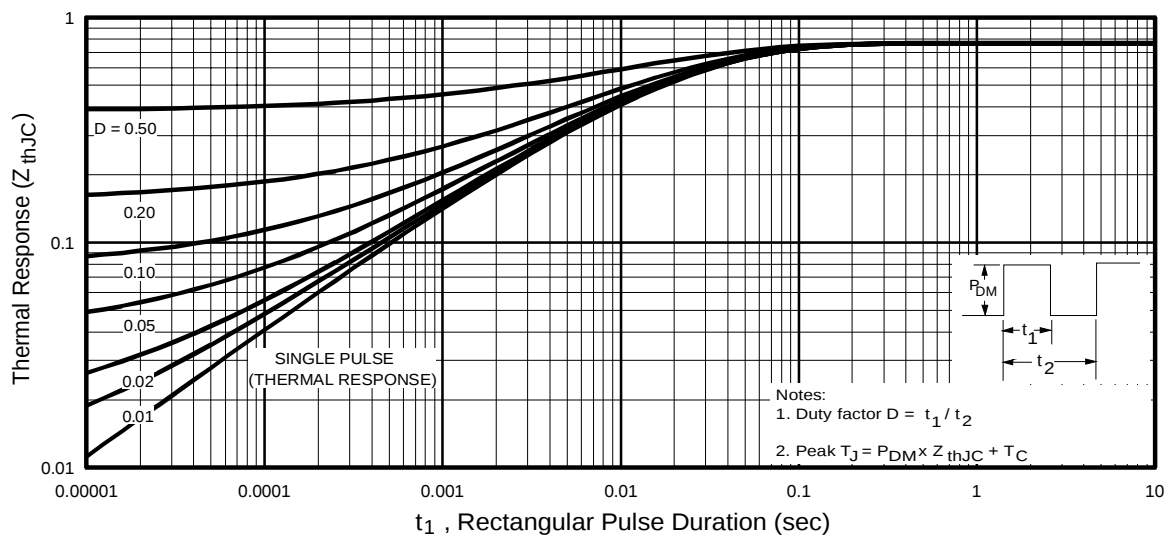
**Fig. 3 - Typical Transfer Characteristics**



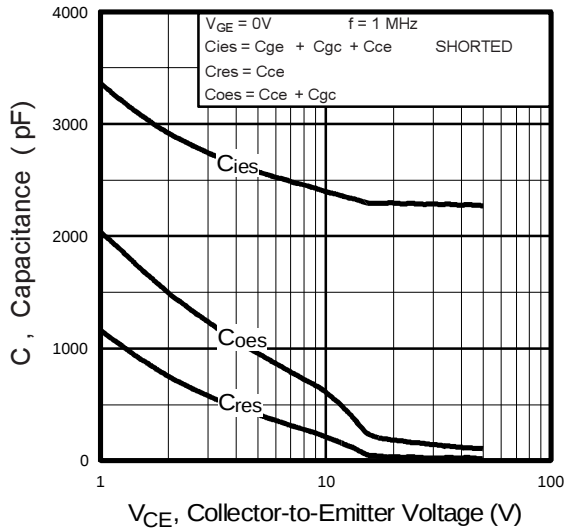
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



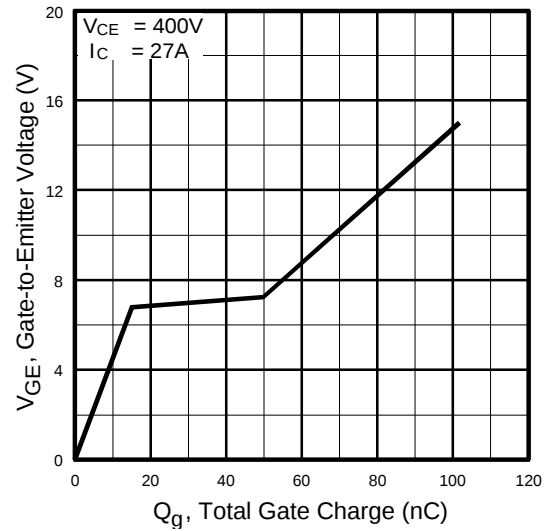
**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**



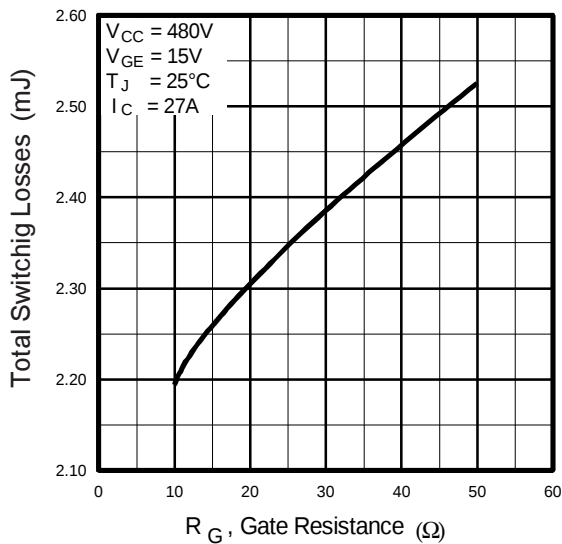
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



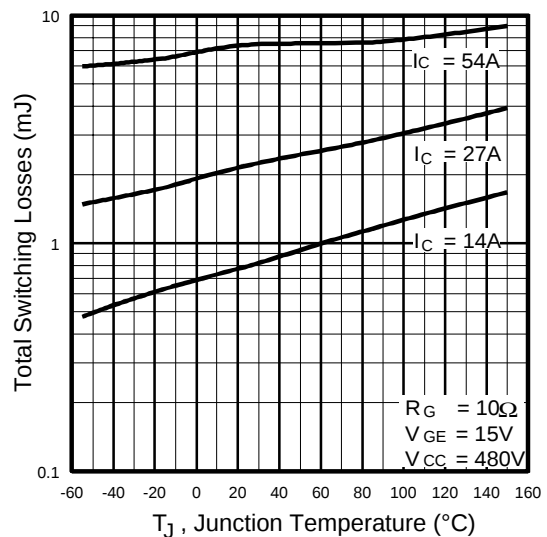
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



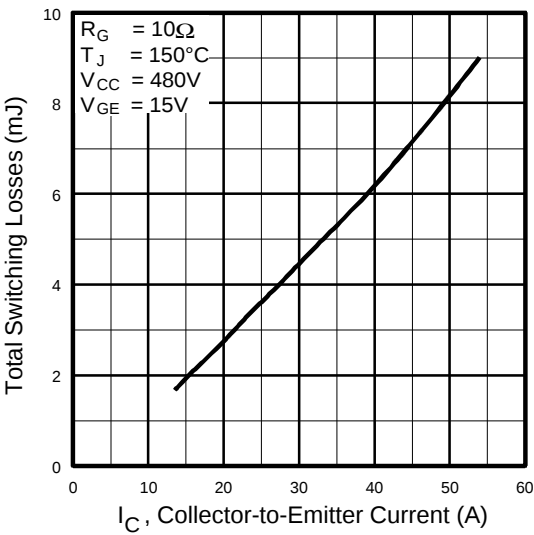
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



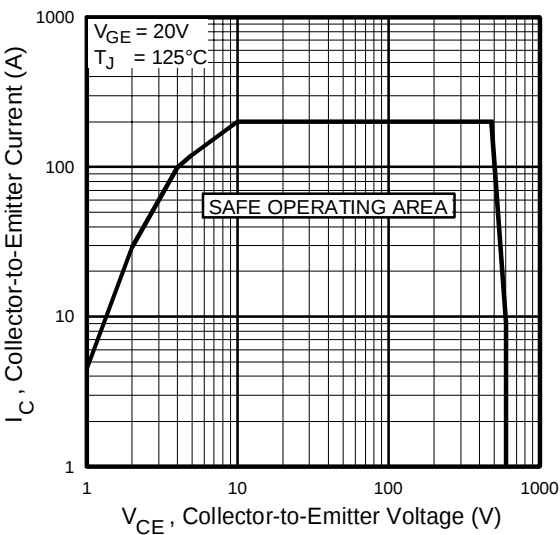
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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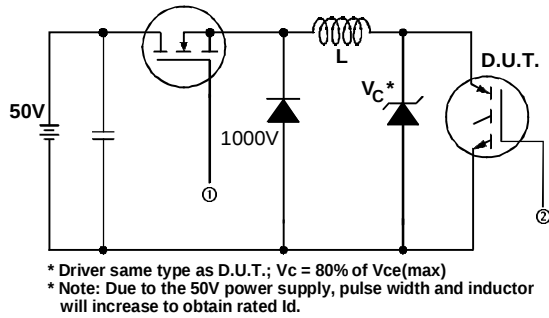
International  
**IR** Rectifier



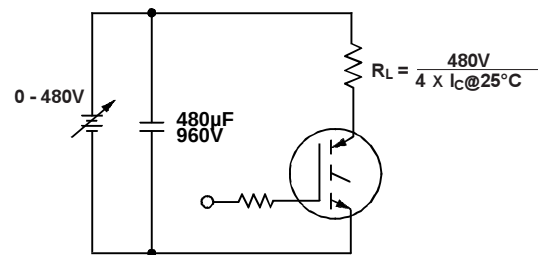
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



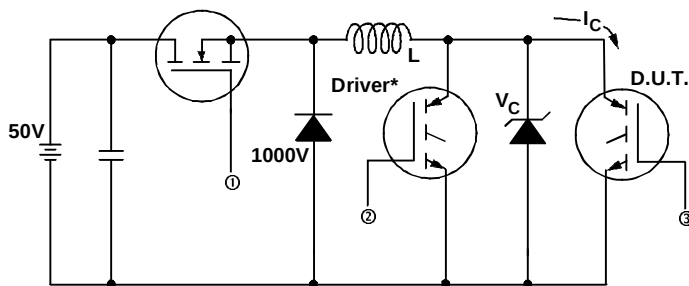
**Fig. 12** - Turn-Off SOA



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

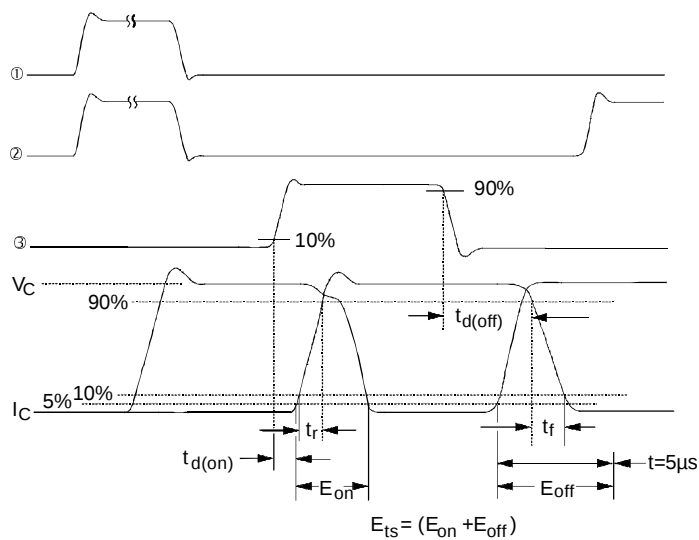


**Fig. 13b** - Pulsed Collector Current Test Circuit



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

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



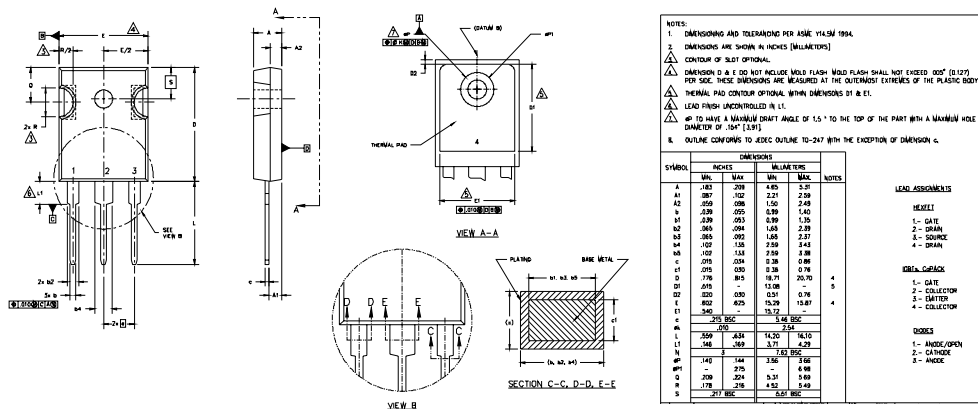
**Fig. 14b** - Switching Loss Waveforms

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## TO-247AC Package Outline

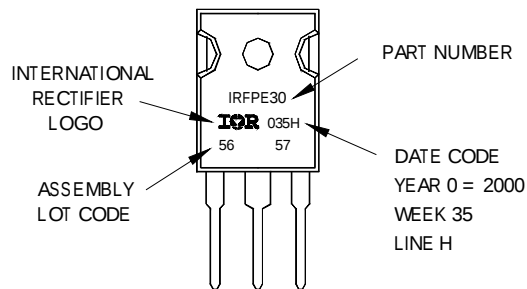
Dimensions are shown in millimeters (inches)



## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30  
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  
**IOR** Rectifier

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Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 06/04

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