International
IOR Rectifier

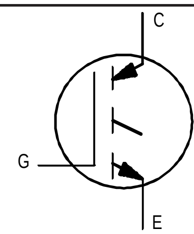


# IRG4PC60U-P

INSULATED GATE BIPOLAR TRANSISTOR

UltraFast Speed IGBT

### Features
- UltraFast: Optimized for high operating frequencies up to 50 kHz in hard switching and >200 kHz in resonant mode.
- Application in UPS, Welding and High Current power supply.
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency.
- Solder plated version of industry standard TO-247AC package.




n-channel

$V_{CES} = 600V$

$V_{CE(on)\ typ.} = 1.6V$

$@V_{GE} = 15V, I_C = 40A$

### Benefits
- Generation 4 IGBT's offer highest efficiency available.
- Solder plated version of the TO-247 allows the reflow soldering of the package heatsink to a substrate material.
- Designed for best performance when used with IR HEXFRED & IR FRED companion diodes.

TO-247AC

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 75 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 40 | |
| $I_{CM}$ | Pulsed Collector Current ① | 300 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 300 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $E_{ARV}$ | Reverse Voltage Avalanche Energy ③ | 200 | mJ |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 520 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 210 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 150 | °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) | |
| | Maximum Reflow Temperature⑦ | 230 (Time above 183°C should not exceed 100s) | °C |

### Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | ---- | 0.24 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.24 | ---- | |
| $R_{\theta JA}$ | Junction-to-Ambient (Typical Socket Mount) | ---- | 40 | |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, Steady State)⑥ | ---- | 20 | |
| Wt | Weight | 6 (0.21) | ---- | g (oz) |



04/26/02

## Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | ---- | ---- | V | $V_{GE}$ = 0V, $I_C$ = 250µA |
| $V_{(BR)ECS}$ | Emitter-to-Collector Breakdown Voltage ④ | 17 | ---- | ---- | V | $V_{GE}$ = 0V, $I_C$ = 1.0A |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | ---- | 0.28 | ---- | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(ON)}$ | Collector-to-Emitter Saturation Voltage | ---- | 1.7 | 2.0 | V | $I_C$ = 40A; $V_{GE}$ = 15V |
| | | ---- | 1.9 | ---- | | $I_C$ = 75A; See Fig.2, 5 |
| | | ---- | 1.6 | ---- | | $I_C$ = 40A , $T_J$ = 150°C |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | ---- | 6.0 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $\Delta V_{GE(th)}/\Delta T_J$ | Temperature Coeff. of Threshold Voltage | ---- | -12 | ---- | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance ⑤ | 44 | 59 | ---- | S | $V_{CE}$ ≥ 100V, $I_C$ = 40A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | ---- | ---- | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | ---- | ---- | 2.0 | | $V_{GE}$ = 0V, $V_{CE}$ = 10V, $T_J$ = 25°C |
| | | ---- | ---- | 5000 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | ---- | ---- | ±100 | nA | $V_{GE}$ = ±20V |

## Switching Characteristics @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | ---- | 310 | 320 | nC | $I_C$ = 40A |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | ---- | 41 | 46 | | $V_{CC}$ = 480V See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | ---- | 110 | 120 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 39 | ---- | ns | |
| $t_r$ | Rise Time | ---- | 42 | ---- | | $T_J$ = 25°C |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 200 | | | $I_C$ = 40A, $V_{CC}$ = 480V |
| $t_f$ | Fall Time | ---- | 100 | | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω |
| $E_{on}$ | Turn-On Switching Loss | ---- | 0.28 | ---- | mJ | Energy losses include "tail" |
| $E_{off}$ | Turn-Off Switching Loss | ---- | 1.1 | ---- | | See Fig. 10, 11, 13, 14 |
| $E_{ts}$ | Total Switching Loss | ---- | 1.3 | 1.8 | | |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 36 | ---- | ns | $T_J$ = 150°C, |
| $t_r$ | Rise Time | ---- | 42 | ---- | | $I_C$ = 40A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 300 | ---- | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω |
| $t_f$ | Fall Time | ---- | 160 | ---- | | Energy losses include "tail" |
| $E_{ts}$ | Total Switching Loss | ---- | 2.6 | ---- | mJ | See Fig. 13, 14 |
| $L_E$ | Internal Emitter Inductance | ---- | 13 | ---- | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | ---- | 5860 | ---- | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | ---- | 370 | ---- | | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | ---- | 75 | ---- | | ƒ = 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, Rg = 5.0W. (See fig. 13a)

③ Repetitive rating; pulse width limited by maximum junction temperature.

④ Pulse width ≤ 80µs; duty factor ≤ 0.1%.

⑤ Pulse width 5.0µs, single shot.

⑥ When mounted on 1" square PCB ( FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.

⑦ Refer to application note # 1023, "Surface Mounting of Larger Devices."

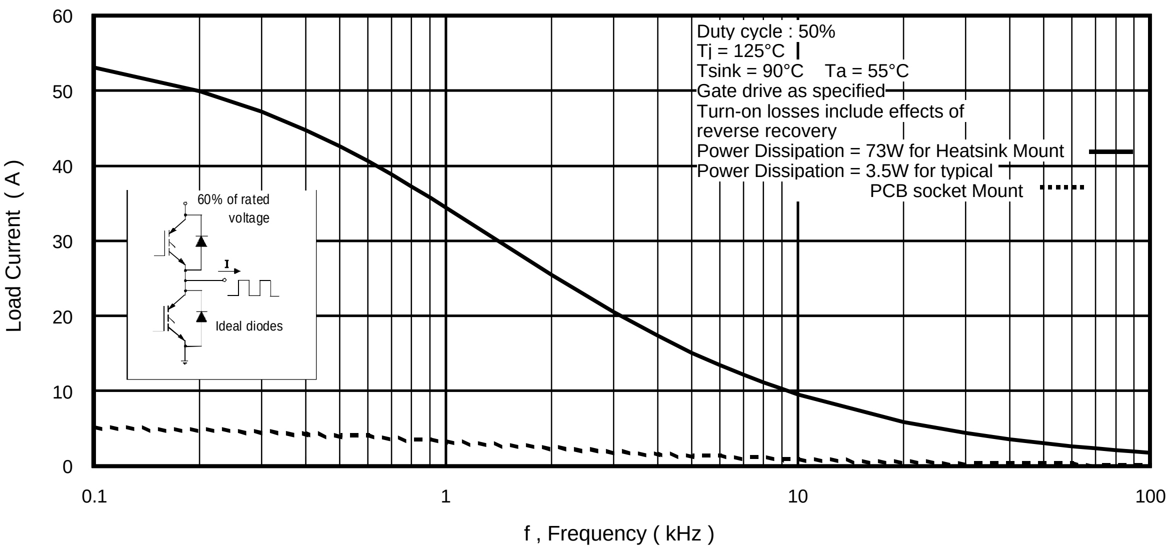



**Fig. 1** - Typical Load Current vs. Frequency
(For square wave, $I=I_{RMS}$ of fundamental; for triangular wave, $I=I_{PK}$)

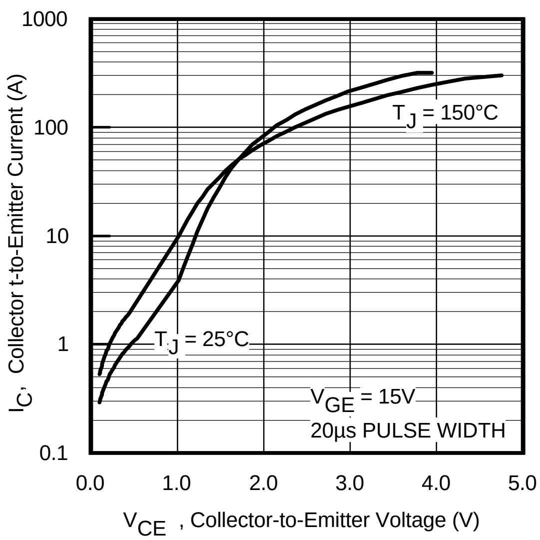



**Fig. 2** - Typical Output Characteristics

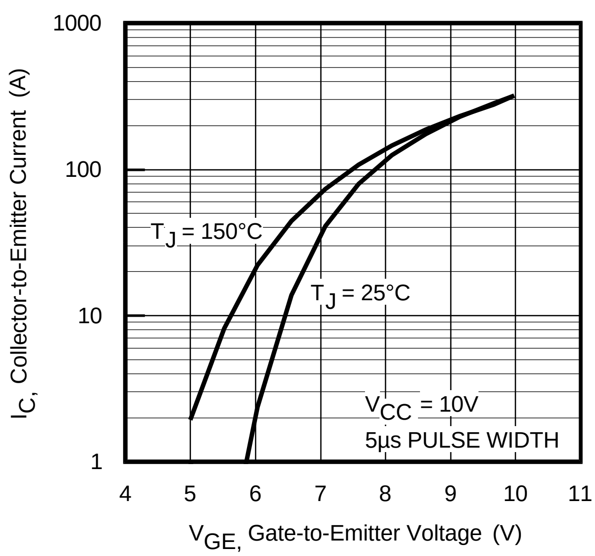



**Fig. 3** - Typical Transfer Characteristics

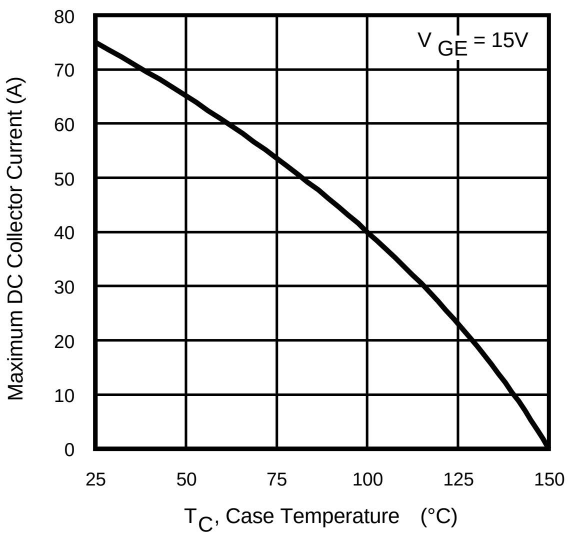



**Fig. 4 -** Maximum Collector Current vs. Case Temperature

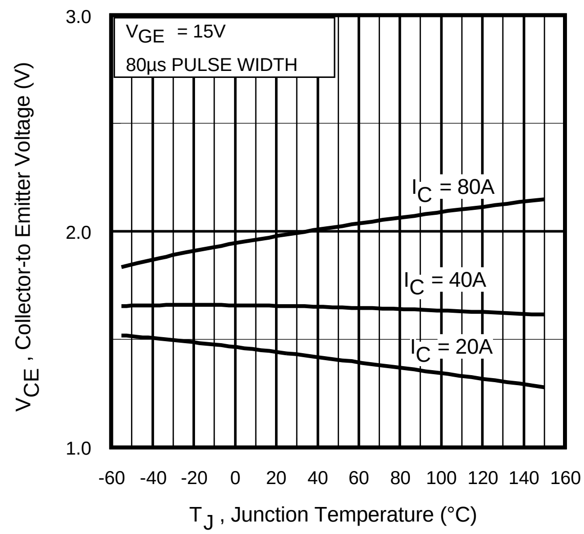



**Fig. 5 -** Collector-to-Emitter Voltage vs. Junction Temperature

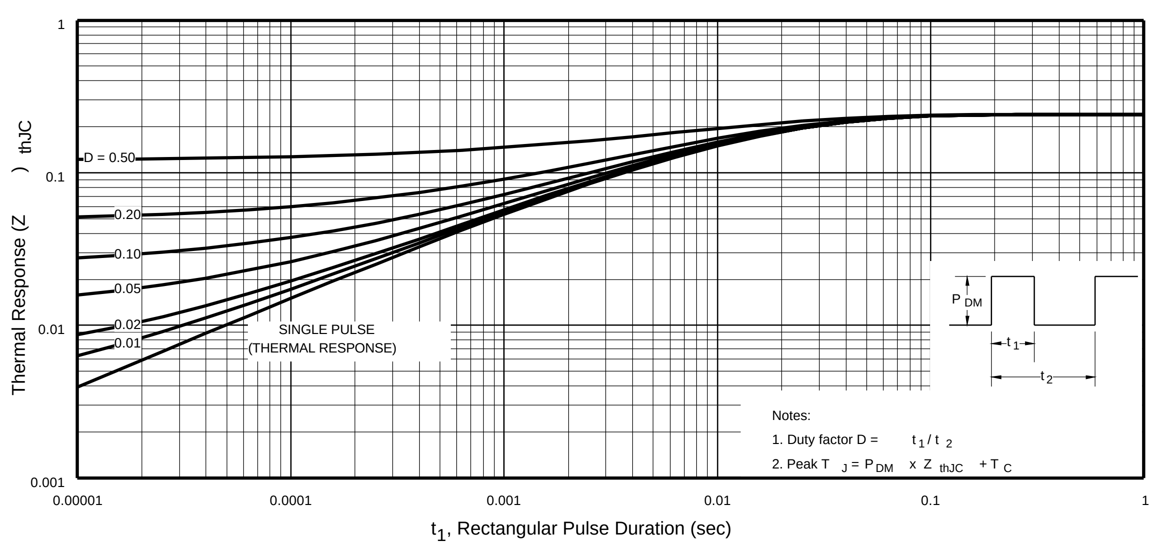



**Fig. 6 -** Maximum Effective Transient Thermal Impedance, Junction-to-Case

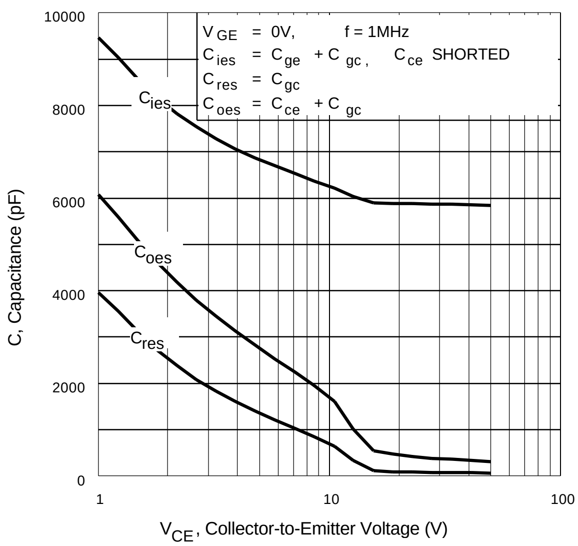



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

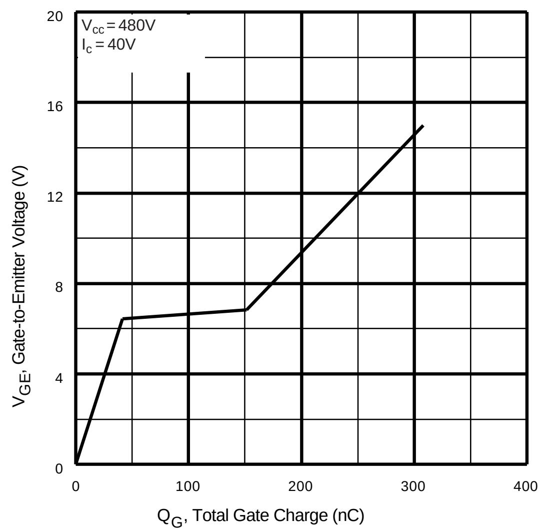



**Fig. 8 -** Typical Gate Charge vs. Gate-to-Emitter Voltage

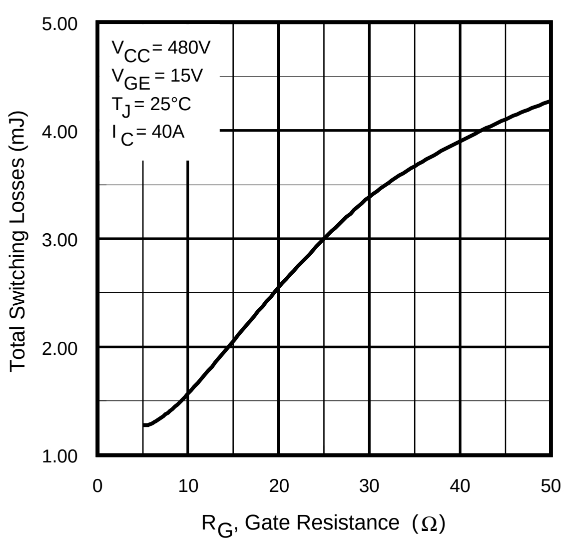



**Fig. 9 -** Typical Switching Losses vs. Gate Resistance

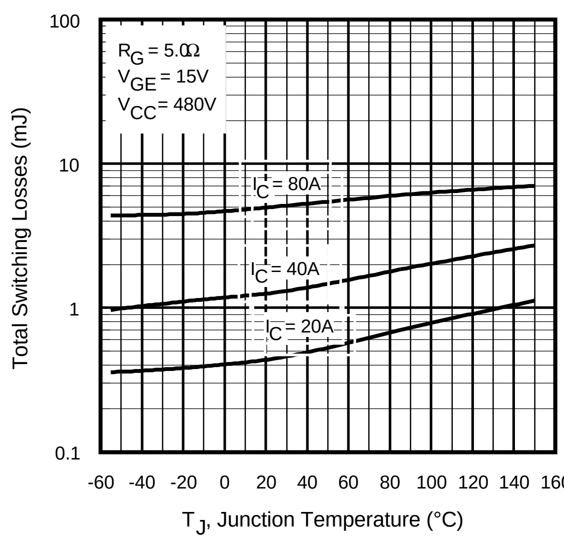



**Fig. 10 -** Typical Switching Losses vs. Junction Temperature

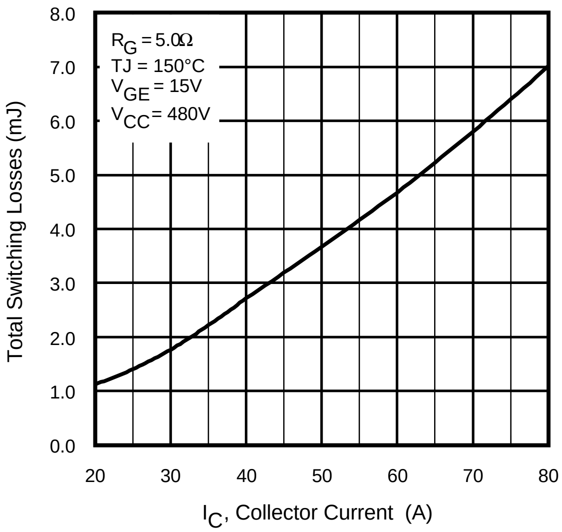



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

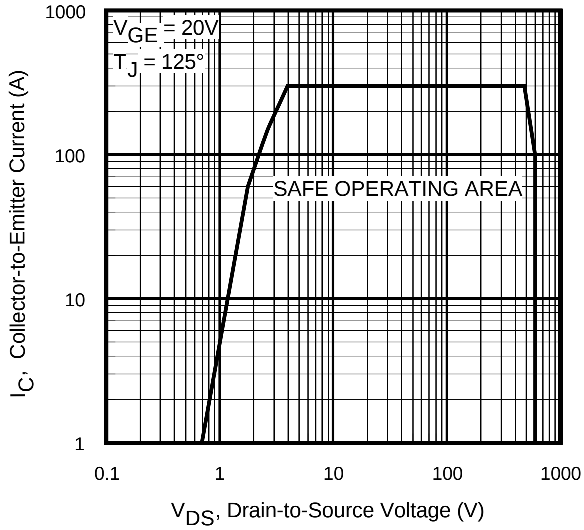
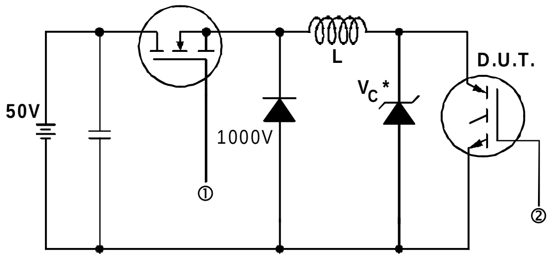



**Fig. 12** - Turn-Off SOA




* Driver same type as D.U.T.; Vc = 80% of Vce(max)
* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated Id.

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

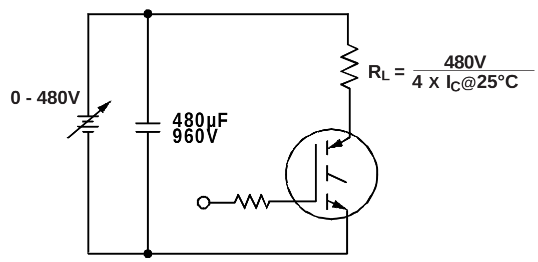



**Fig. 13b** - Pulsed Collector Current Test Circuit

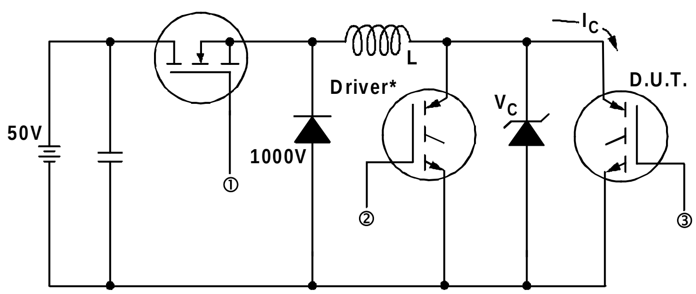



**Fig. 14a** - Switching Loss Test Circuit

* Driver same type as D.U.T., VC = 480V

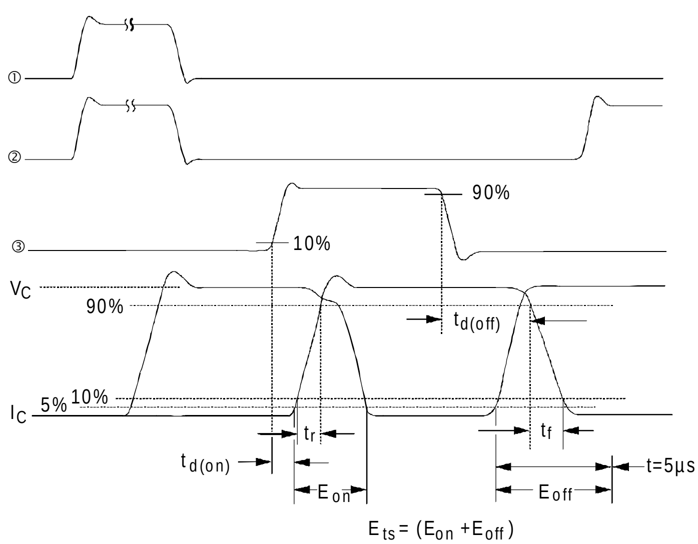
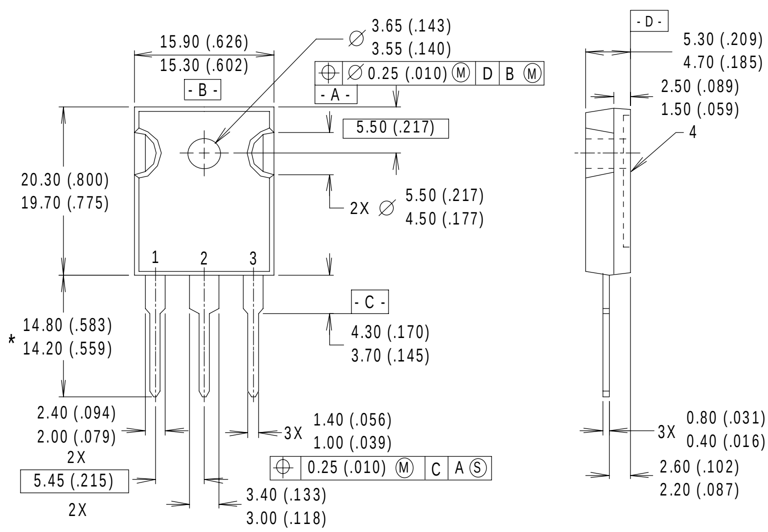



**Fig. 14b** - Switching Loss Waveforms

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



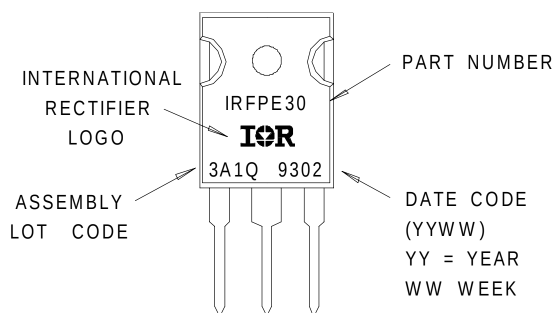

NOTES:
1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
4 CONFORMS TO JEDEC OUTLINE TO-247AC.

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

## Solderable TO-247AC Part Marking Information

EXAMPLE : THIS IS AN IRFPE30 WITH ASSEMBLY LOT CODE 3A1Q




Data and specifications subject to change without notice.
This product has been designed and qualified for the Industrial market.
Qualification Standards can be found on IR's Web site.

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