PD - 95428A

International
IOR Rectifier

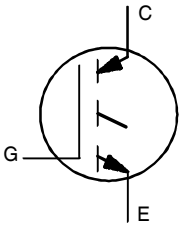
# IRG4BC40UPbF

INSULATED GATE BIPOLAR TRANSISTOR

UltraFast Speed IGBT

## Features

- UltraFast: optimized for high operating frequencies 8-40 KHz in hard switching, >200 kHz in resonant mode
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- Industry standard TO-220AB package
- Lead-Free




n-channel

$V_{CES} = 600V$

$V_{CE(on)\ typ.} = 1.72V$

$@V_{GE} = 15V, I_C = 20A$

## Benefits

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

TO-220AB

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 40 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 20 | |
| $I_{CM}$ | Pulsed Collector Current ① | 160 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 160 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ±20 | V |
| $E_{ARV}$ | Reverse Voltage Avalanche Energy ③ | 15 | mJ |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 160 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 65 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +150 | °C |
| | 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 | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | ------ | ------ | 0.77 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ------ | 0.50 | ------ | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ------ | ------ | 80 | |
| Wt | Weight | ------ | 2 (0.07) | ------ | g (oz) |



02/18/10

## 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 | 18 | ---- | ---- | V | $V_{GE}$ = 0V, $I_C$ = 1.0A See Fig. 2, 5 |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | ---- | 0.63 | ---- | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | ---- | 1.72 | 2.1 | V | $I_C$ = 20A $V_{GE}$ = 15V |
| | | ---- | 2.15 | ---- | | $I_C$ = 40A |
| | | ---- | 1.7 | ---- | | $I_C$ = 20A, $T_J$ = 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 | ---- | -13 | ---- | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance ⑤ | 11 | 18 | ---- | S | $V_{CE}$ = 100V, $I_C$ = 20A |
| $I_{CES}$ | 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 |
| | | ---- | ---- | 2500 | | $V_{GE}$ = 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) | ---- | 100 | 150 | nC | $I_C$ = 20A |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | ---- | 16 | 25 | | $V_{CC}$ = 400V See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | ---- | 40 | 60 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 34 | ---- | ns | $T_J$ = 25°C |
| $t_r$ | Rise Time | ---- | 19 | ---- | | $I_C$ = 20A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 110 | 175 | | $V_{GE}$ = 15V, $R_G$ = 10Ω |
| $t_f$ | Fall Time | ---- | 120 | 180 | | Energy losses include "tail" |
| $E_{on}$ | Turn-On Switching Loss | ---- | 0.32 | ---- | mJ | See Fig. 10, 11, 13, 14 |
| $E_{off}$ | Turn-Off Switching Loss | ---- | 0.35 | ---- | | |
| $E_{ts}$ | Total Switching Loss | ---- | 0.67 | 1.0 | | |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 30 | ---- | ns | $T_J$ = 150°C, |
| $t_r$ | Rise Time | ---- | 19 | ---- | | $I_C$ = 20A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 220 | ---- | | $V_{GE}$ = 15V, $R_G$ = 10Ω |
| $t_f$ | Fall Time | ---- | 160 | ---- | | Energy losses include "tail" |
| $E_{ts}$ | Total Switching Loss | ---- | 1.4 | ---- | mJ | See Fig. 13, 14 |
| $L_E$ | Internal Emitter Inductance | ---- | 7.5 | ---- | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | ---- | 2100 | ---- | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | ---- | 140 | ---- | | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | ---- | 34 | ---- | | $f$ = 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 = 10µH, $R_G$ = 10Ω, (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.

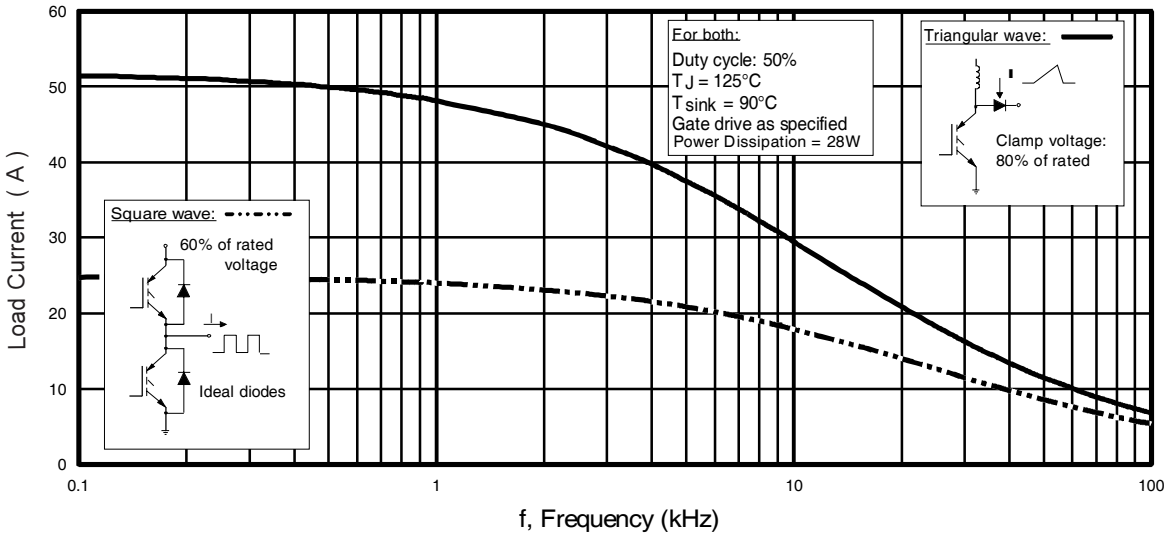



**Fig. 1** - Typical Load Current vs. Frequency
(For square wave, $I=I_{RMS}$ of fundamental; for triangular wave, $I=I_{PK}$)

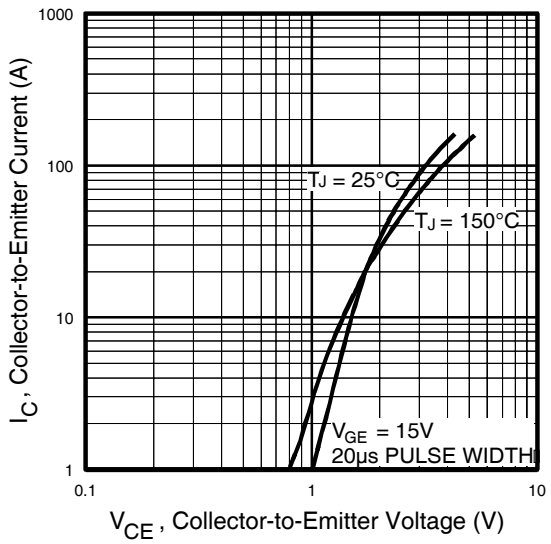



**Fig. 2** - Typical Output Characteristics
$T_C = 25°C$

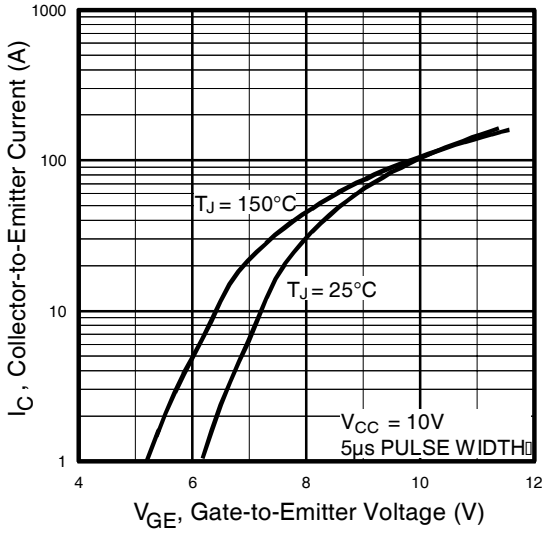



**Fig. 3** - Typical Transfer Characteristics

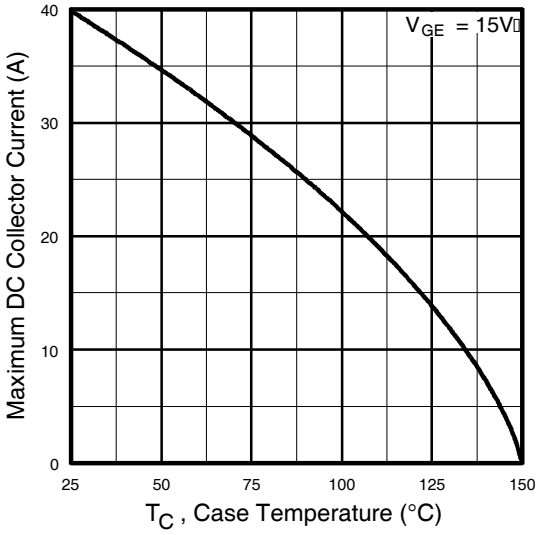



**Fig. 4** - Maximum Collector Current vs. Case Temperature

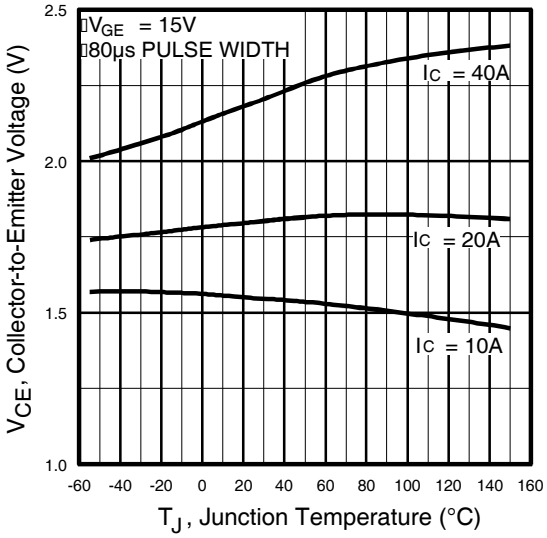



**Fig. 5** - Collector-to-Emitter Voltage vs. Junction Temperature

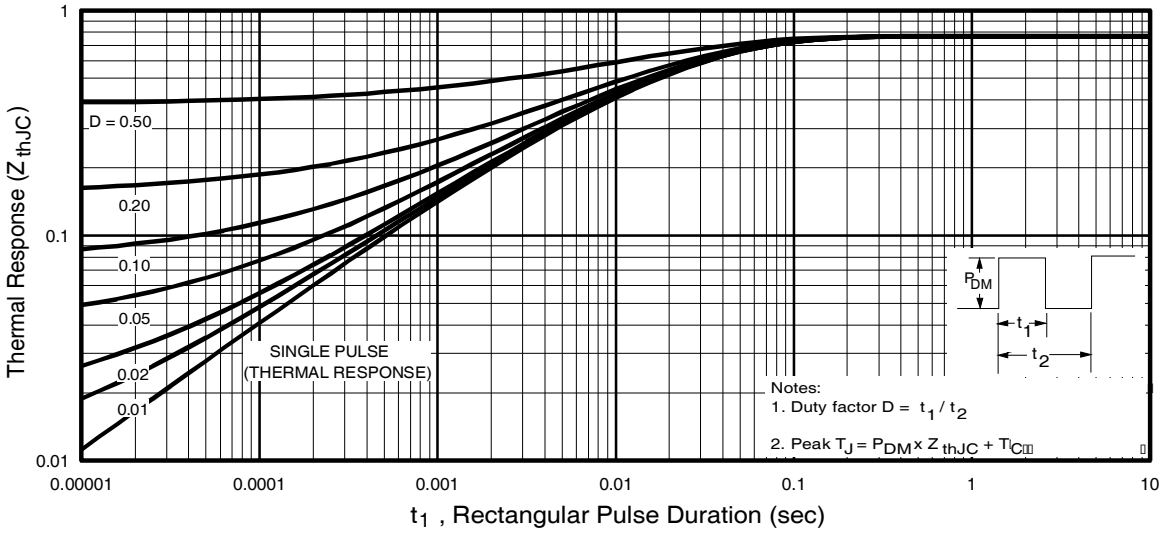



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

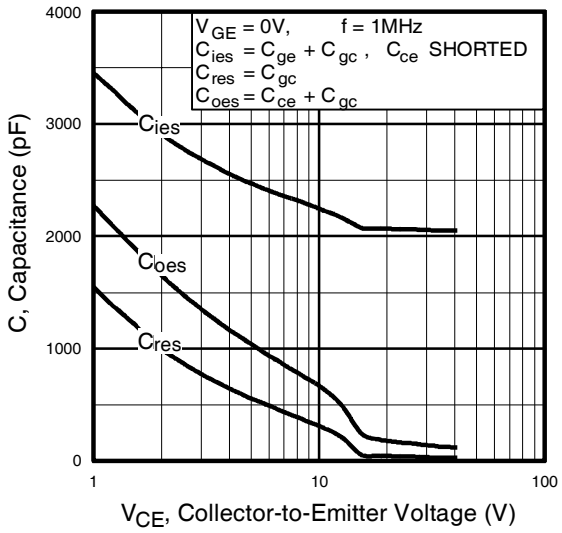



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

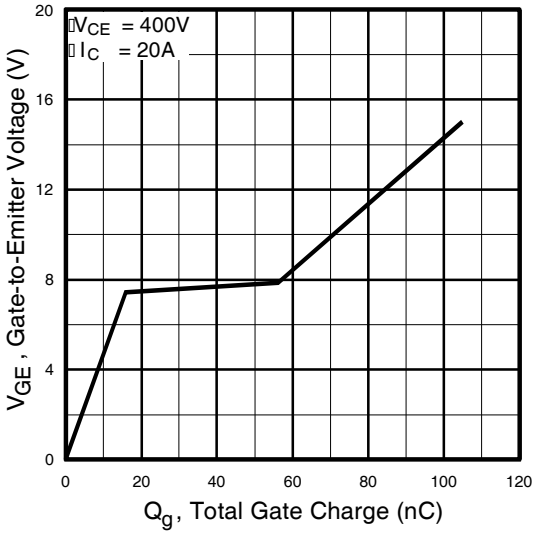



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

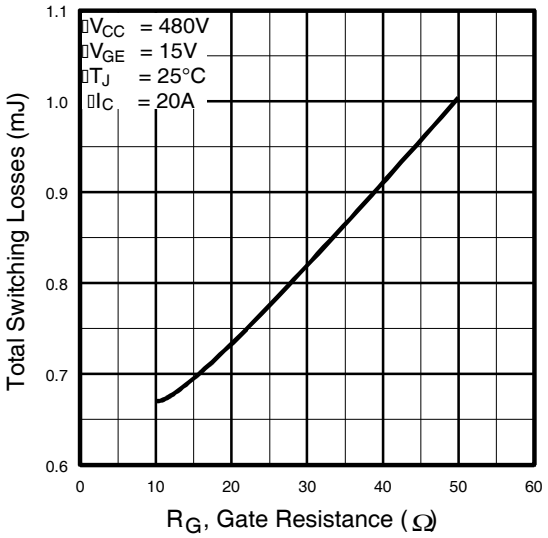



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

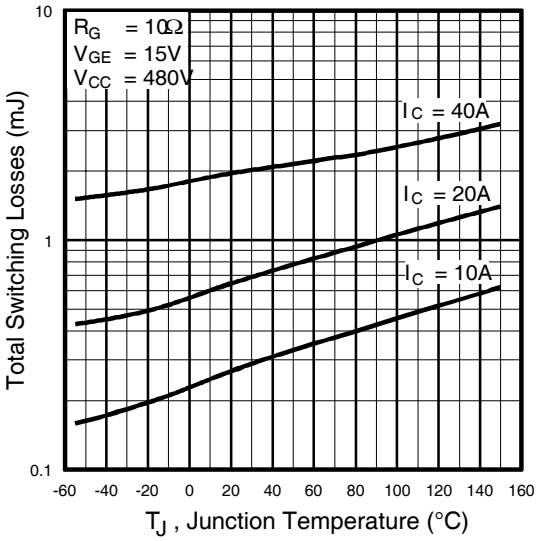



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

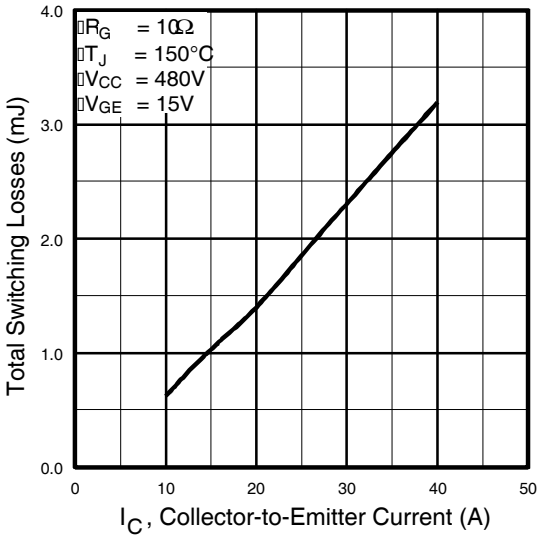



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

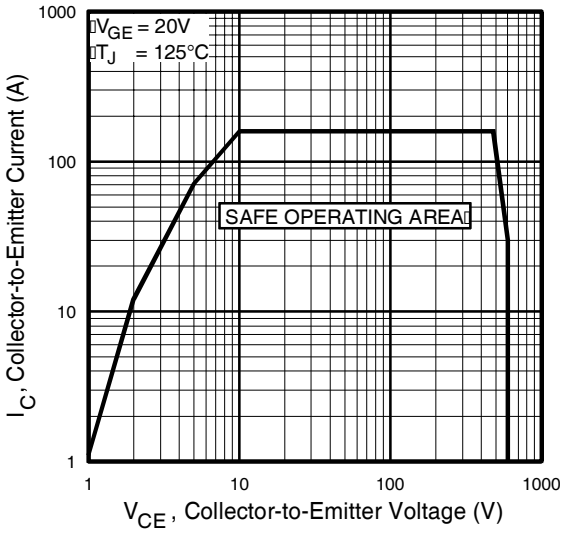



**Fig. 12** - Turn-Off SOA

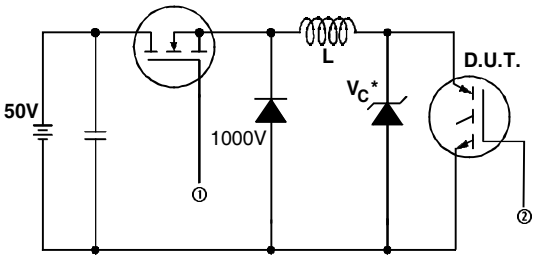
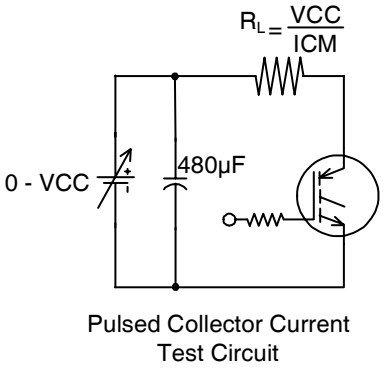



**Fig. 13a** - Clamped Inductive Load Test Circuit




Pulsed Collector Current Test Circuit

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

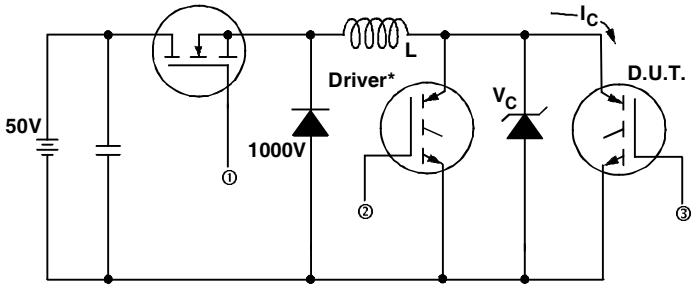



**Fig. 14a** - Switching Loss Test Circuit

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

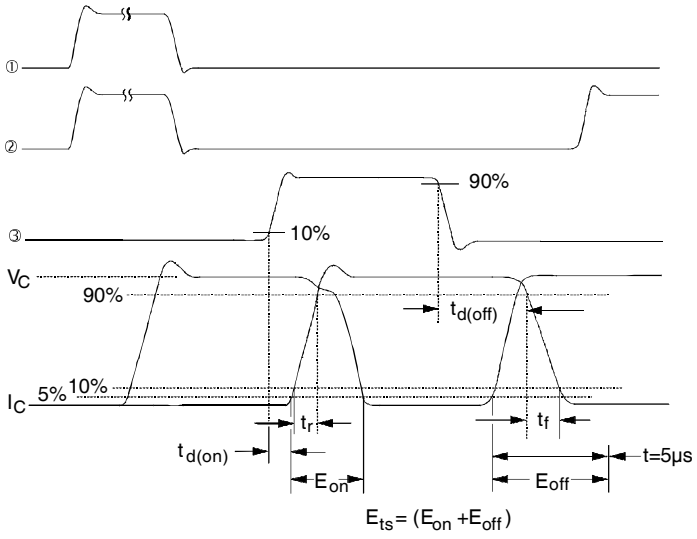
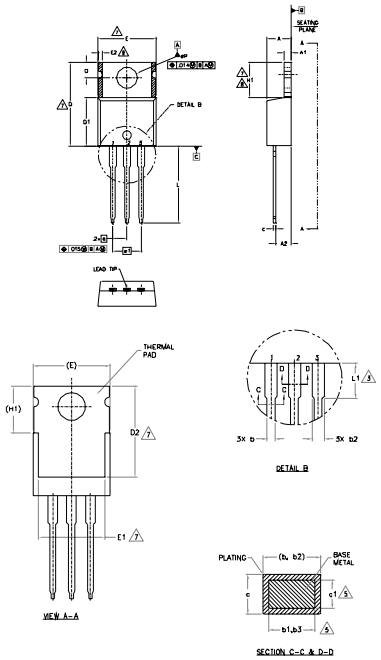



**Fig. 14b** - Switching Loss Waveforms

## TO-220AB Package Outline (Dimensions are shown in millimeters (inches))




NOTES:
1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5 DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.- CONTROLLING DIMENSION : INCHES.
7.- THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.83 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.38 | 1.01 | .015 | .040 | |
| b1 | 0.38 | 0.97 | .015 | .038 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.36 | 0.61 | .014 | .024 | |
| c1 | 0.36 | 0.56 | .014 | .022 | 5 |
| D | 14.22 | 16.51 | .560 | .650 | 4 |
| D1 | 8.38 | 9.02 | .330 | .355 | |
| D2 | 11.68 | 12.88 | .460 | .507 | 7 |
| E | 9.65 | 10.67 | .380 | .420 | 4,7 |
| E1 | 6.86 | 8.89 | .270 | .350 | 7 |
| E2 | – | 0.76 | – | .030 | 8 |
| e | 2.54 BSC | | .100 BSC | | |
| e1 | 5.08 BSC | | .200 BSC | | |
| H1 | 5.84 | 6.86 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| L1 | 3.56 | 4.06 | .140 | .160 | 3 |
| øP | 3.54 | 4.08 | .139 | .161 | |
| Q | 2.54 | 3.42 | .100 | .135 | |

LEAD ASSIGNMENTS

HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

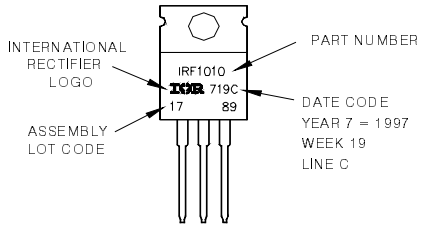
IGBTs, CoPACK
1.- GATE
2.- COLLECTOR
3.- EMITTER

DIODES
1.- ANODE
2.- CATHODE
3.- ANODE

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE 'C'

**Note:** "P" in assembly line position indicates "Lead-Free"




**Note: For the most current drawing please refer to IR website at http://www.irf.com/package/**

Data and specifications subject to change without notice.

International
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