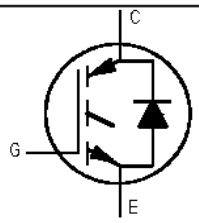
International
IOR Rectifier

PD - 95603

# IRG4IBC10UDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast Co-Pack IGBT




N-channel

$V_{CES}$ = 600V

$V_{CE(on)\,typ.}$ = 2.15V

@$V_{GE}$ = 15V, $I_C$ = 5.0A

$t_{f(typ.)}$ = 140ns

## Features

- UltraFast: Optimized for high operating up to 80 kHz in hard switching, > 200 kHz in resonant mode
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED® ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220 Full-Pak
- Lead-Free

TO-220 Full-Pak

## Benefits

- Generation 4 IGBTs offer highest efficiencies available
- IGBTs optimized for specific application conditions
- HEXFRED® diodes optimized for performance with IGBTs Minimized recovery characteristics require less/no snubbing

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 6.8 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 3.9 | |
| $I_{CM}$ | Pulsed Collector Current ① | 27 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 27 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 3.9 | |
| $I_{FM}$ | Diode Maximum Forward Current | 27 | |
| $V_{ISOL}$ | RMS Isolated Voltage, Terminal to case, t=1min | 2500 | V |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 25 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 10 | |
| $T_J$<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 (1.1 N•m) | |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | — | 5.0 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | — | 9.0 | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | — | 65 | |
| Wt | Weight | 2.1 (0.075) | — | g (oz) |

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage ③ | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 250µA |
| $DV_{(BR)CES}/DT_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.54 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.15 | 2.6 | V | $I_C$ = 5.0A $V_{GE}$ = 15V |
| | | — | 2.61 | — | | $I_C$ = 8.5A See Fig. 2, 5 |
| | | — | 2.30 | — | | $I_C$ = 5.0A, $T_J$ = 150°C |
| $V_{GE(th)}$ | Gate Threshold Voltage ④ | 3.0 | — | 6.0 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $DV_{GE(th)}/DT_J$ | Temperature Coeff. of Threshold Voltage | — | -8.7 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance | 2.8 | 4.2 | — | S | $V_{CE}$ = 100V, $I_C$ = 5.0A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | — | — | 1000 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.5 | 1.8 | V | $I_C$ = 4.0A See Fig. 13 |
| | | — | 1.4 | 1.7 | | $I_C$ = 4.0A, $T_J$ = 125°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) | — | 15 | 22 | nC | $I_C$ = 5.0A |
| Qge | Gate - Emitter Charge (turn-on) | — | 2.6 | 4.0 | | $V_{CC}$ = 400V See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 5.8 | 8.7 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | — | 40 | — | ns | $T_J$ = 25°C |
| $t_r$ | Rise Time | — | 16 | — | | $I_C$ = 5.0A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 87 | 130 | | $V_{GE}$ = 15V, $R_G$ = 100W |
| $t_f$ | Fall Time | — | 140 | 210 | | Energy losses include "tail" and |
| $E_{on}$ | Turn-On Switching Loss | — | 0.14 | — | mJ | diode reverse recovery. |
| $E_{off}$ | Turn-Off Switching Loss | — | 0.12 | — | | See Fig. 9, 10, 18 |
| $E_{ts}$ | Total Switching Loss | — | 0.26 | 0.33 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 38 | — | ns | $T_J$ = 150°C, See Fig. 11, 18 |
| $t_r$ | Rise Time | — | 18 | — | | $I_C$ = 5.0A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 95 | — | | $V_{GE}$ = 15V, $R_G$ = 100W |
| $t_f$ | Fall Time | — | 250 | — | | Energy losses include "tail" and |
| $E_{ts}$ | Total Switching Loss | — | 0.45 | — | mJ | diode reverse recovery. |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | — | 270 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 21 | — | | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 3.5 | — | | $f$ = 1.0MHz |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 28 | 42 | ns | $T_J$ = 25°C See Fig. |
| | | — | 38 | 57 | | $T_J$ = 125°C 14 $I_F$ = 4.0A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 2.9 | 5.2 | A | $T_J$ = 25°C See Fig. |
| | | — | 3.7 | 6.7 | | $T_J$ = 125°C 15 $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 40 | 60 | nC | $T_J$ = 25°C See Fig. |
| | | — | 70 | 105 | | $T_J$ = 125°C 16 di/dt = 200A/µs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery | — | 280 | — | A/µs | $T_J$ = 25°C See Fig. |
| | During $t_b$ | — | 235 | — | | $T_J$ = 125°C 17 |

Details of note ① through ④ are on the last page

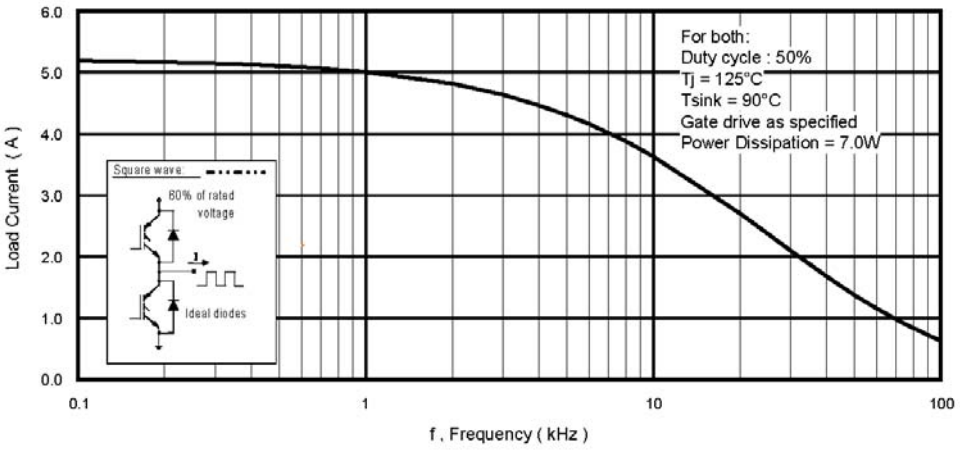



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

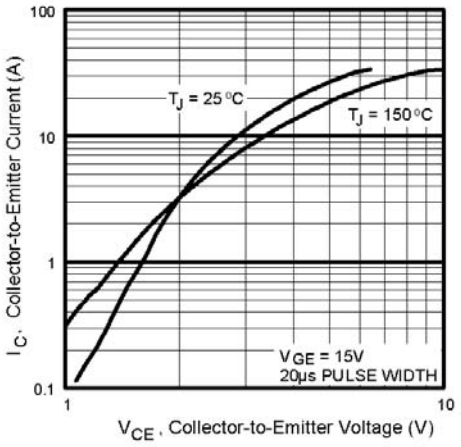



**Fig. 2** - Typical Output Characteristics

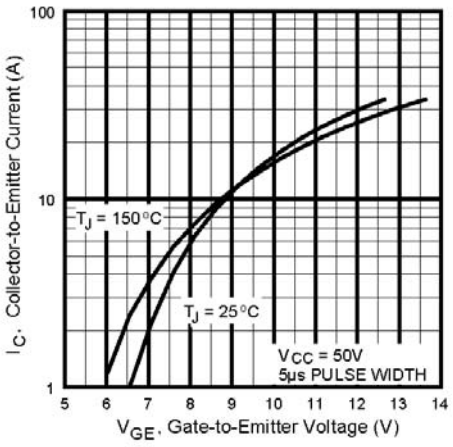



**Fig. 3** - Typical Transfer Characteristics

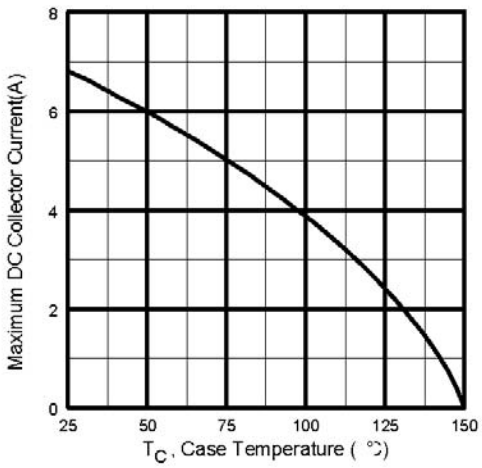



**Fig. 4** - Maximum Collector Current vs. Case Temperature

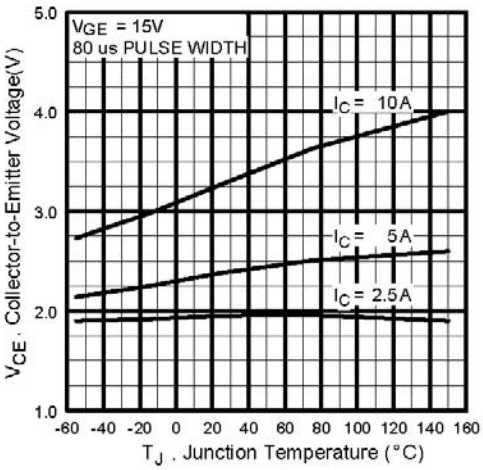



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

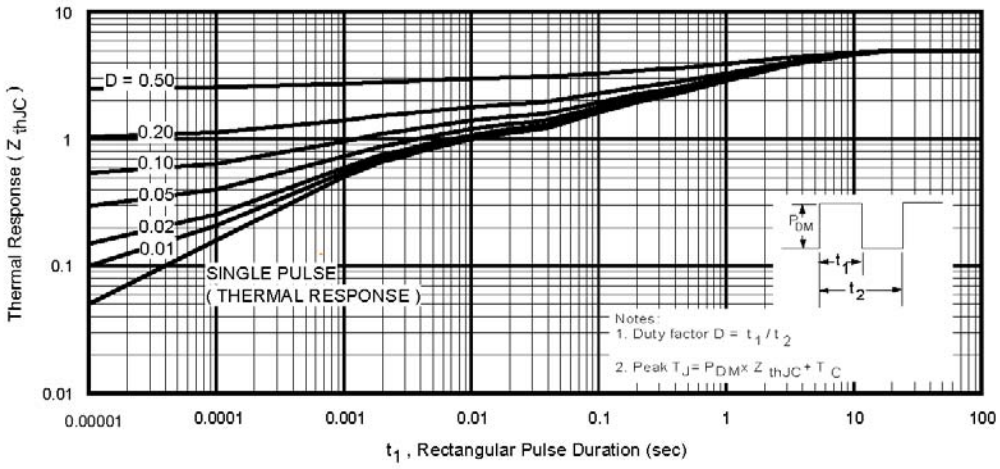



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

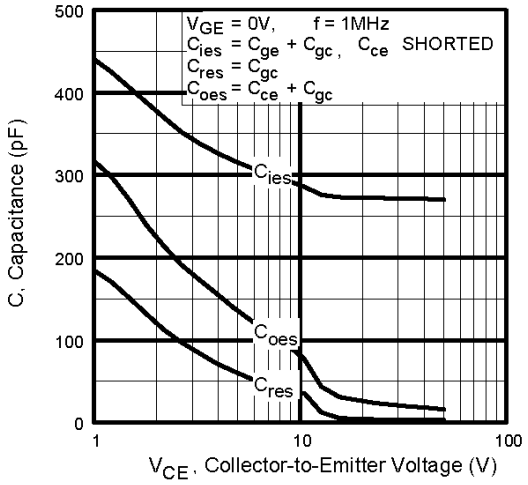



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

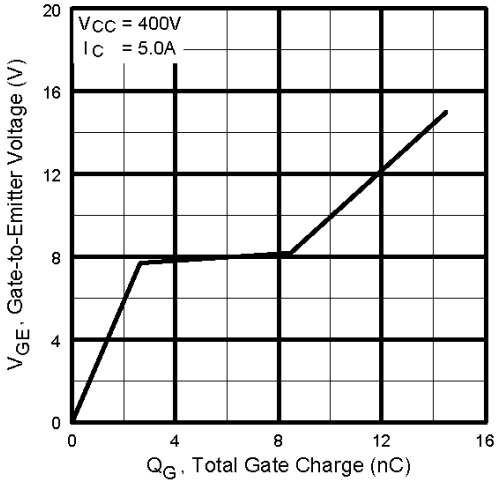



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

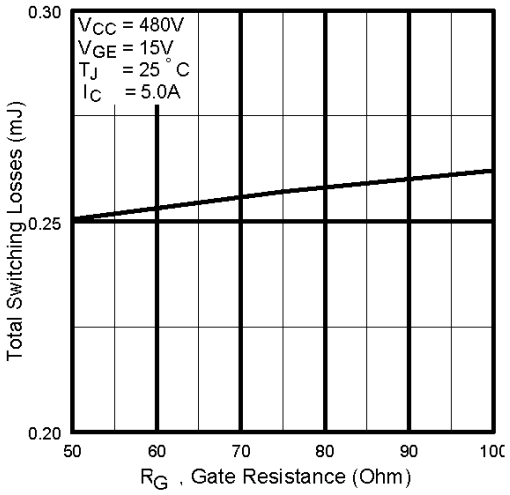



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

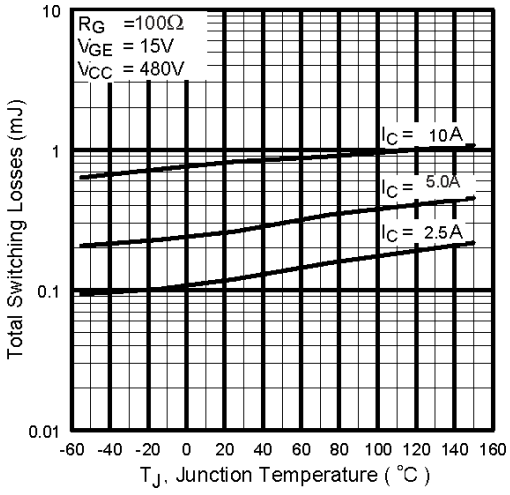



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

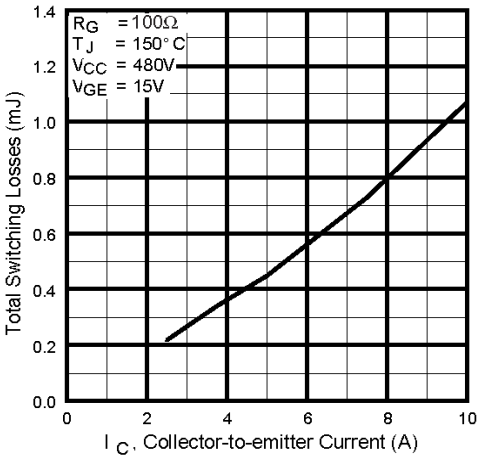



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

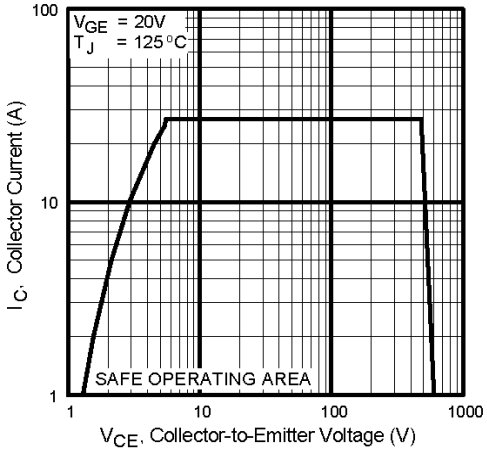



**Fig. 12** - Turn-Off SOA

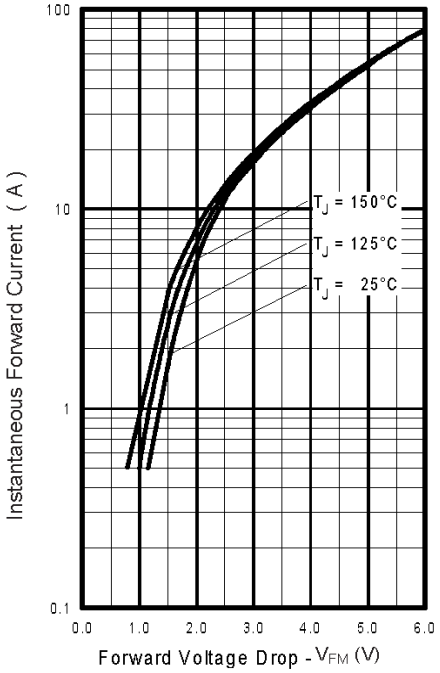



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

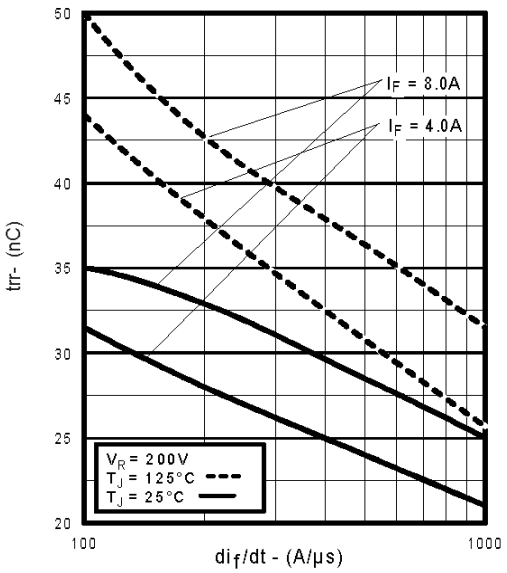



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

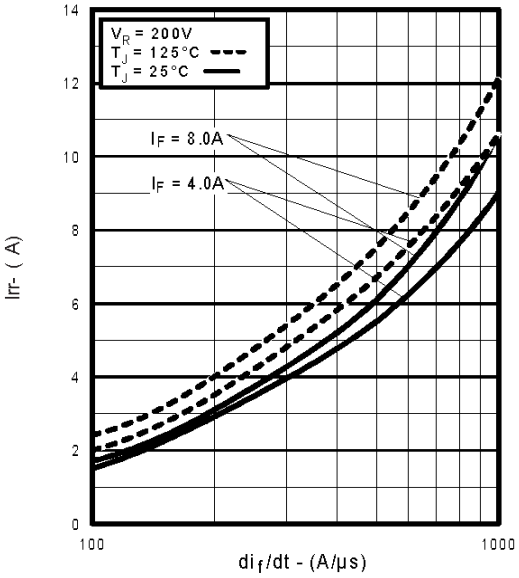



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

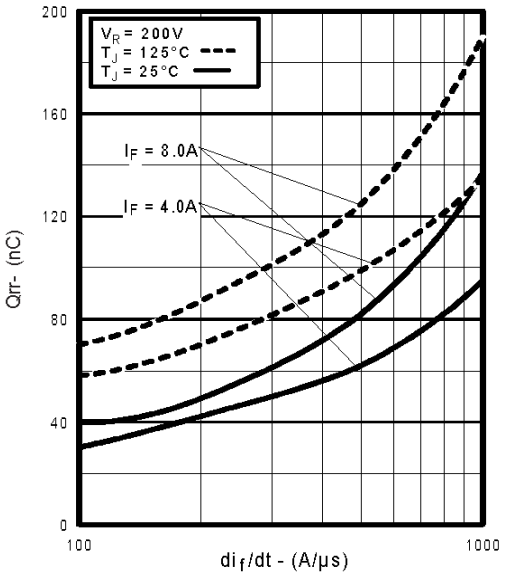



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

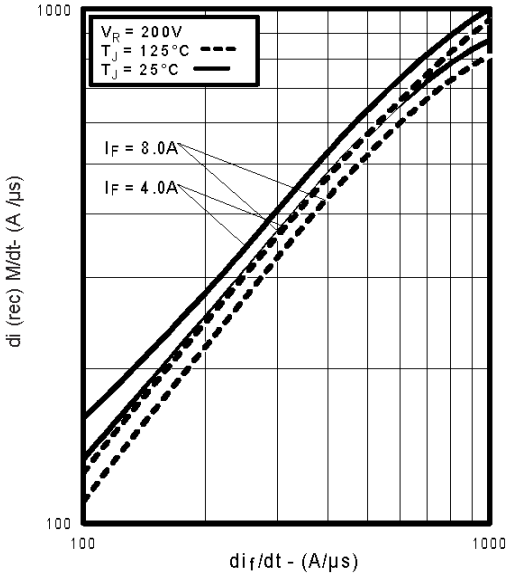



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

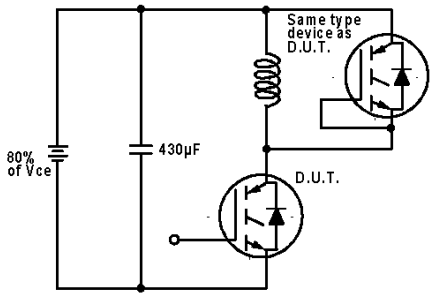



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

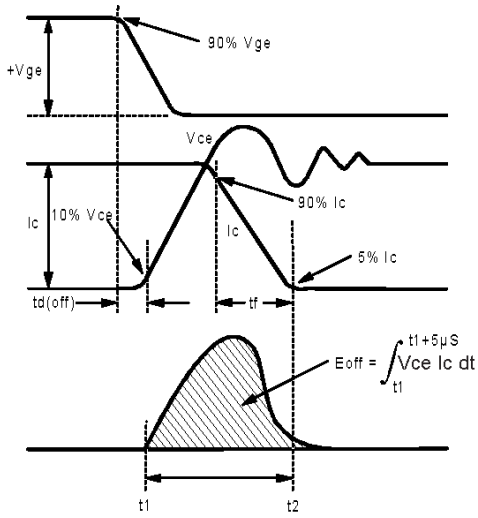



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

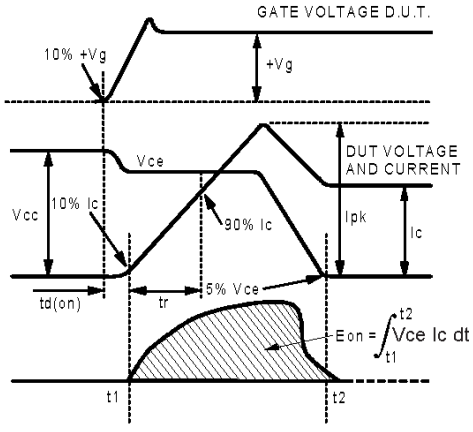



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

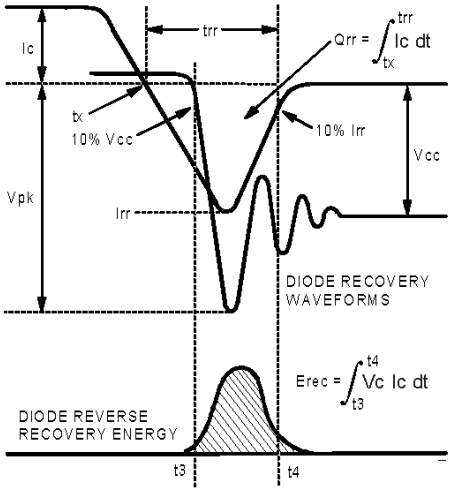



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

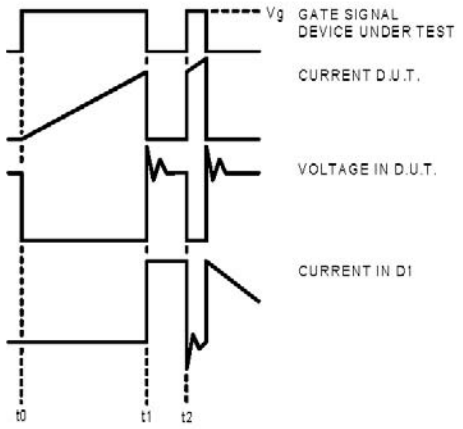



**Fig. 18e -** Macro Waveforms for Figure 18a's Test Circuit

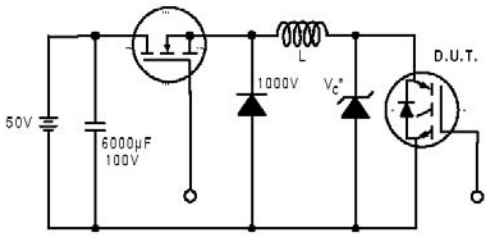



**Fig. 19 -** Clamped Inductive Load Test Circuit

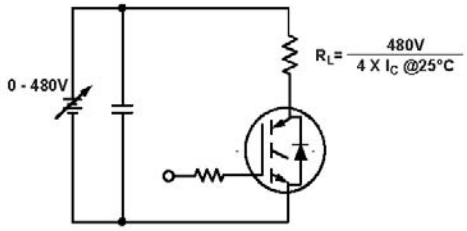
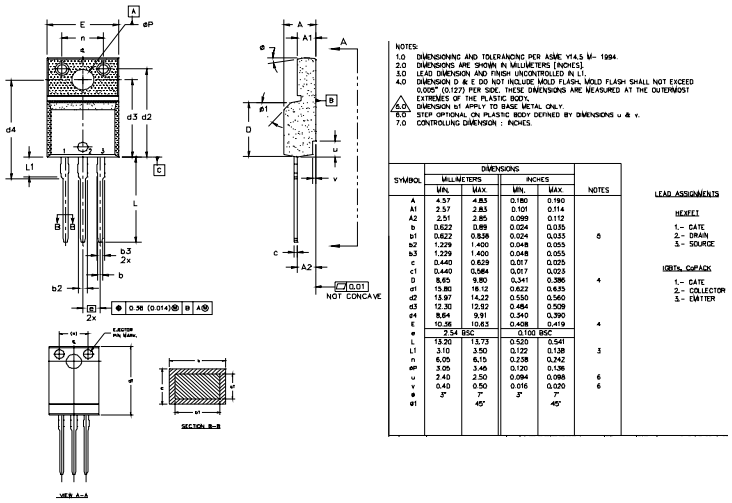



**Fig. 20 -** Pulsed Collector Current Test Circuit

## TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



NOTES:
1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
4.0 DIMENSION b1 APPLY TO BASE METAL ONLY.
5.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
7.0 CONTROLLING DIMENSION : INCHES.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.57 | 4.83 | 0.180 | 0.190 | |
| A1 | 2.57 | 2.83 | 0.101 | 0.114 | |
| A2 | 2.51 | 2.85 | 0.099 | 0.112 | |
| b | 0.622 | 0.89 | 0.024 | 0.035 | |
| b1 | 0.622 | 0.838 | 0.024 | 0.033 | 5 |
| b2 | 1.229 | 1.400 | 0.048 | 0.055 | |
| b3 | 1.229 | 1.400 | 0.048 | 0.055 | |
| c | 0.440 | 0.629 | 0.017 | 0.025 | |
| c1 | 0.440 | 0.584 | 0.017 | 0.023 | |
| D | 8.65 | 9.80 | 0.341 | 0.386 | 4 |
| d1 | 15.80 | 16.12 | 0.622 | 0.635 | |
| d2 | 13.97 | 14.22 | 0.550 | 0.560 | |
| d3 | 12.30 | 12.92 | 0.484 | 0.509 | |
| d4 | 8.64 | 9.91 | 0.340 | 0.390 | |
| E | 10.36 | 10.63 | 0.408 | 0.419 | 4 |
| e | 2.54 BSC | | 0.100 BSC | | |
| L | 15.20 | 15.73 | 0.520 | 0.541 | |
| L1 | 3.10 | 3.50 | 0.122 | 0.138 | 3 |
| n | 5.05 | 6.15 | 0.238 | 0.242 | |
| øP | 3.05 | 3.46 | 0.120 | 0.136 | |
| u | 2.40 | 2.50 | 0.094 | 0.098 | 6 |
| v | 0.40 | 0.50 | 0.016 | 0.020 | 6 |
| ø | 3° | 7° | 3° | 7° | |
| ø1 | | 45° | | 45° | |

LEAD ASSIGNMENTS

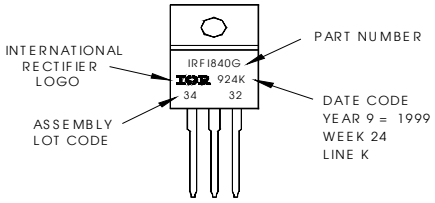
HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

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

## TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI840G
WITH ASSEMBLY
LOT CODE 3432
ASSEMBLED ON WW 24 1999
IN THE ASSEMBLY LINE "K"

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




## Notes

① Repetitive rating: $V_{GE}$=20V; Pulse width limited by maximum junction temperature (figure 20)

② $V_{CC}$=80%($V_{CES}$), $V_{GE}$=20V, L=10µH, $R_G$= 100Ω (figure 19)

③ Pulse width ≤ 80µs, duty factor ≤ 0.1%.

④ Pulse width 5.0µs, single shot.

Data and specifications subject to change without notice.



**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
Visit us at www.irf.com for sales contact information.07/04

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