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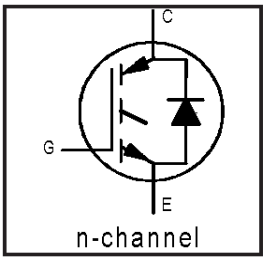
International
IOR Rectifier

PD - 95604

# IRG4IBC30FDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT




$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 1.59V

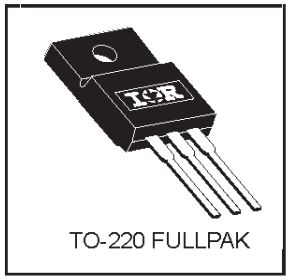
@$V_{GE}$ = 15V, $I_C$ = 17A

## Features

- Very Low 1.59V votage drop
- 2.5kV, 60s insulation voltage ⑤
- 4.8 mm creapage distance to heatsink
- Fast: Optimized for medium operating frequencies ( 1-5 kHz in hard switching, >20 kHz in resonant mode).
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes
- Tighter parameter distribution
- Industry standard Isolated TO-220 Fullpak™ outline

## Benefits

- Simplified assembly
- Highest efficiency and power density
- HEXFRED™ antiparallel Diode minimizes switching losses and EMI
- Lead-Free




TO-220 FULLPAK

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 20.3 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 11 | |
| $I_{CM}$ | Pulsed Collector Current ① | 120 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 120 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 8.5 | |
| $I_{FM}$ | Diode Maximum Forward Current | 120 | |
| Visol | RMS Isolation Voltage, Terminal to Case⑤ | 2500 | V |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 45 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 18 | |
| $T_J$ | Operating Junction and | -55 to +150 | °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 (1.1 N•m) | |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | —– | 2.8 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | —– | 4.1 | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | —– | 65 | |
| Wt | Weight | 2.0 (0.07) | —– | g (oz) |

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage③ | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 250µA |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.69 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.59 | 1.8 | V | $I_C$ = 17A $V_{GE}$ = 15V |
| | | — | 1.99 | — | | $I_C$ = 31A See Fig. 2, 5 |
| | | — | 1.70 | — | | $I_C$ = 17A, $T_J$ = 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 | — | -11 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance ④ | 6.1 | 10 | — | S | $V_{CE}$ = 100V, $I_C$ = 17A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | — | — | 2500 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.4 | 1.7 | V | $I_C$ = 12A See Fig. 13 |
| | | — | 1.3 | 1.6 | | $I_C$ = 12A, $T_J$ = 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) | — | 51 | 77 | nC | $I_C$ = 17A |
| Qge | Gate - Emitter Charge (turn-on) | — | 7.9 | 12 | | $V_{CC}$ = 400V See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 19 | 28 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | — | 42 | — | ns | $T_J$ = 25°C |
| $t_r$ | Rise Time | — | 26 | — | | $I_C$ = 17A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 230 | 350 | | $V_{GE}$ = 15V, $R_G$ = 23Ω |
| $t_f$ | Fall Time | — | 160 | 230 | | Energy losses include "tail" and |
| $E_{on}$ | Turn-On Switching Loss | — | 0.63 | — | mJ | diode reverse recovery. |
| $E_{off}$ | Turn-Off Switching Loss | — | 1.39 | — | | See Fig. 9, 10, 11, 18 |
| $E_{ts}$ | Total Switching Loss | — | 2.02 | 3.9 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 42 | — | ns | $T_J$ = 150°C, See Fig. 9, 10, 11, 18 |
| $t_r$ | Rise Time | — | 27 | — | | $I_C$ = 17A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 310 | — | | $V_{GE}$ = 15V, $R_G$ = 23Ω |
| $t_f$ | Fall Time | — | 310 | — | | Energy losses include "tail" and |
| $E_{ts}$ | Total Switching Loss | — | 3.2 | — | mJ | diode reverse recovery. |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | — | 1100 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 74 | — | | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 14 | — | | $f$ = 1.0MHz |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 42 | 60 | ns | $T_J$ = 25°C See Fig. |
| | | — | 80 | 120 | | $T_J$ = 125°C 14 $I_F$ = 12A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 3.5 | 6.0 | A | $T_J$ = 25°C See Fig. |
| | | — | 5.6 | 10 | | $T_J$ = 125°C 15 $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 80 | 180 | nC | $T_J$ = 25°C See Fig. |
| | | — | 220 | 600 | | $T_J$ = 125°C 16 di/dt 200A/µs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery | — | 180 | — | A/µs | $T_J$ = 25°C See Fig. |
| | During $t_b$ | — | 120 | — | | $T_J$ = 125°C 17 |

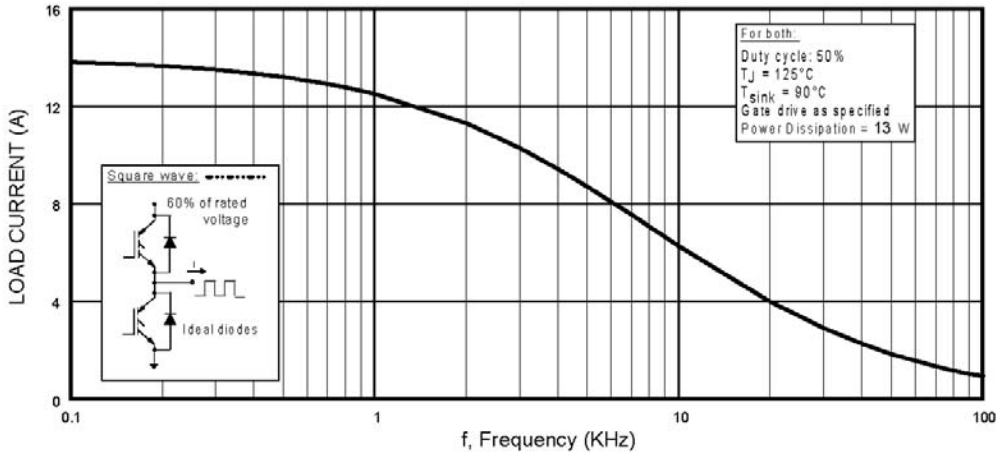



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

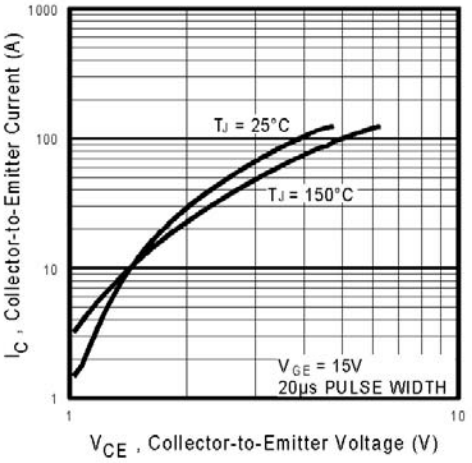



**Fig. 2** - Typical Output Characteristics

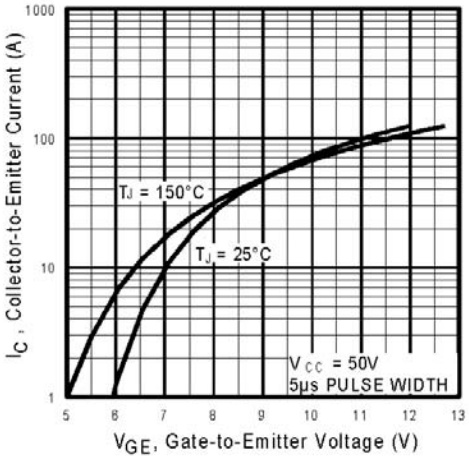



**Fig. 3** - Typical Transfer Characteristics

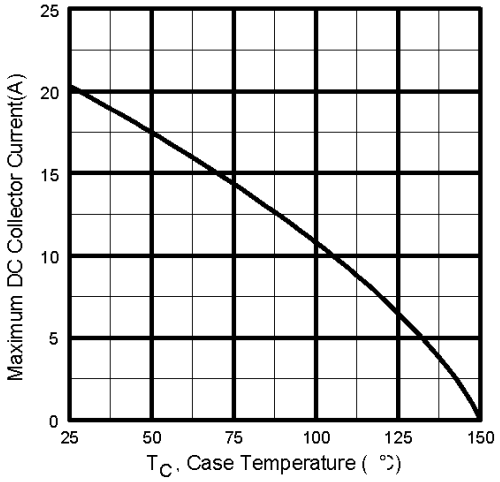



**Fig. 4** - Maximum Collector Current vs. Case Temperature

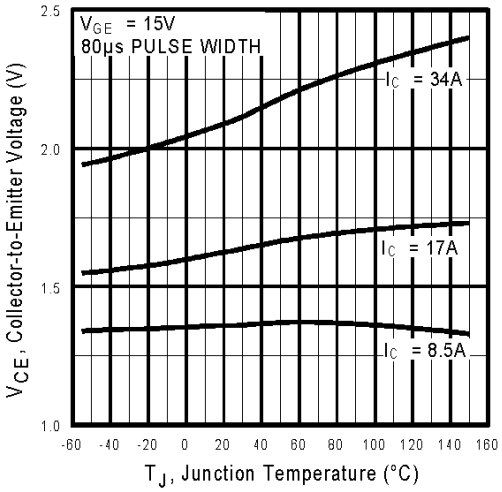



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

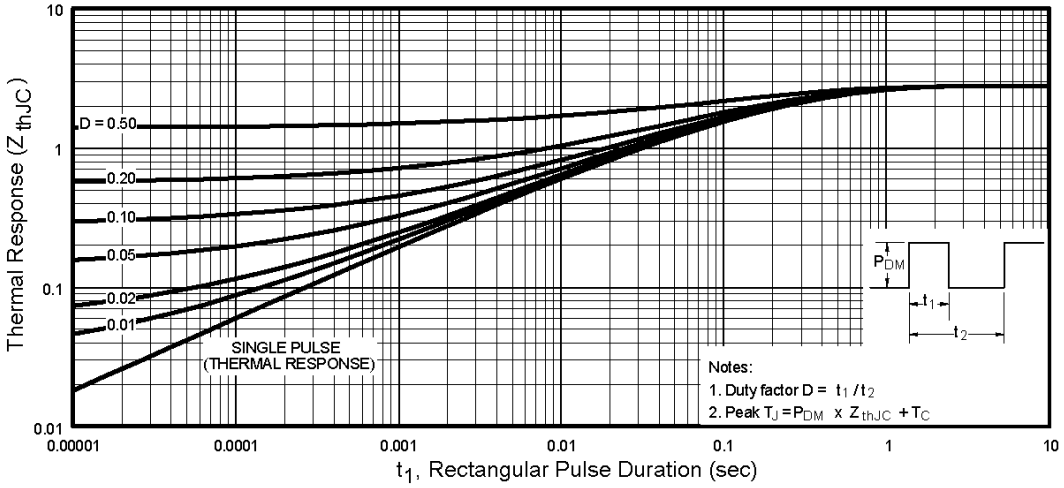



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

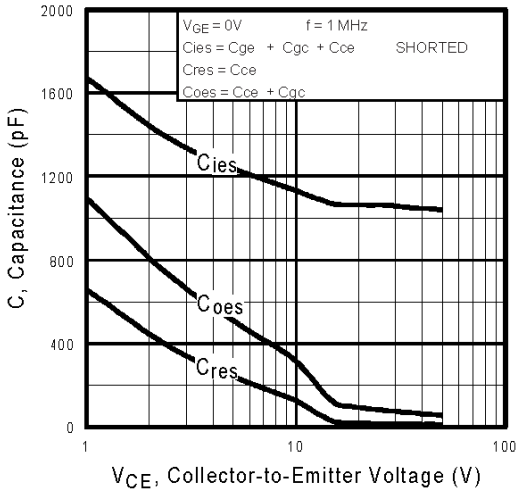



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

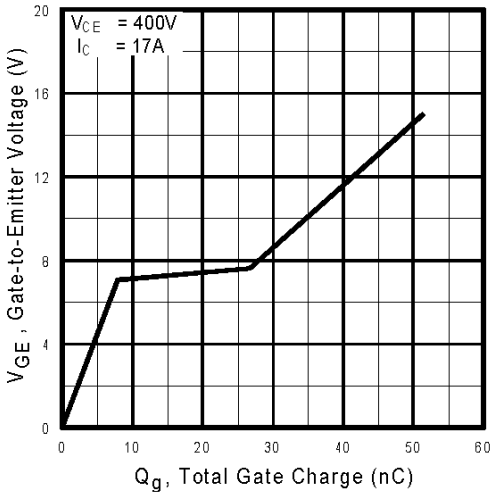



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

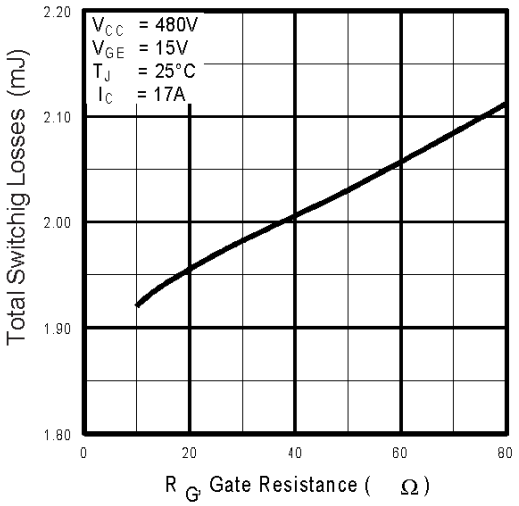



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

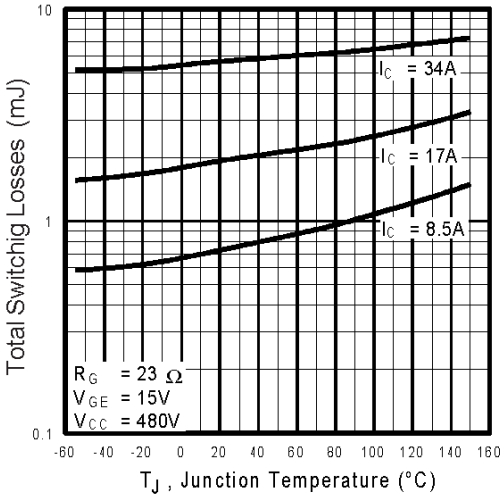



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

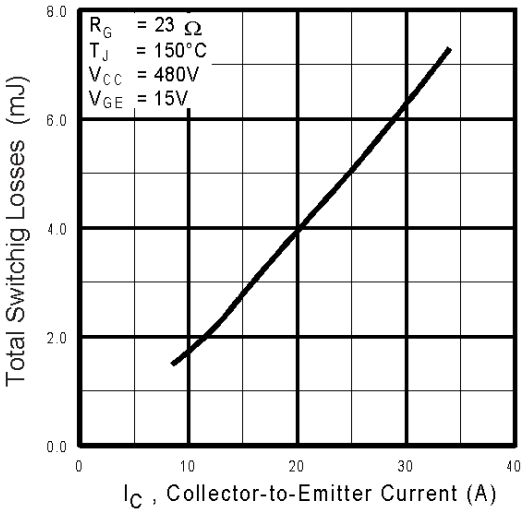



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

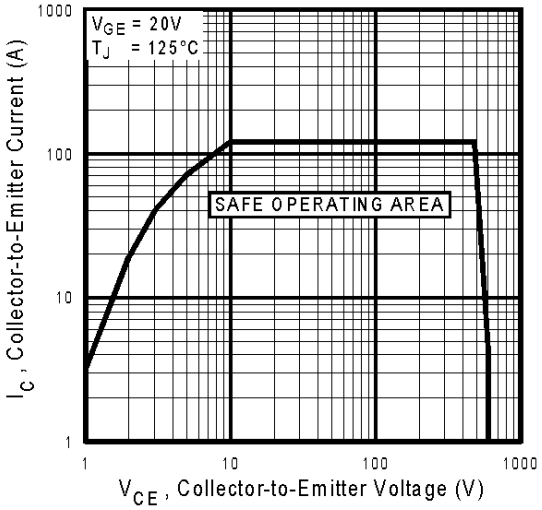



**Fig. 12** - Turn-Off SOA

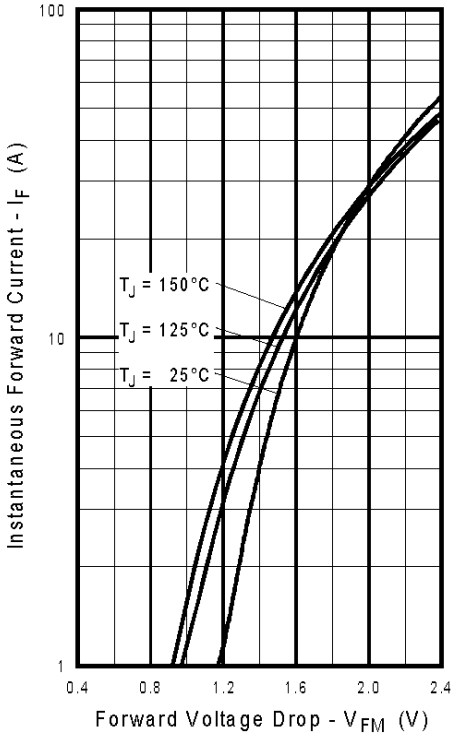



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

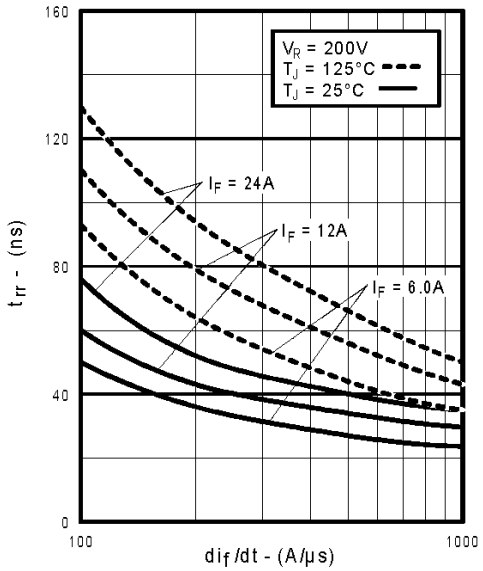



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

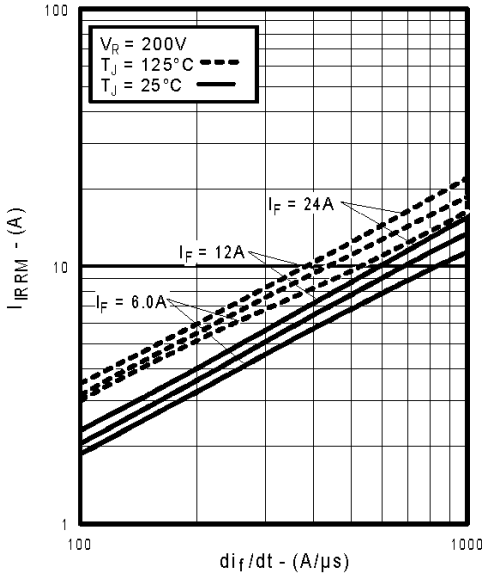



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

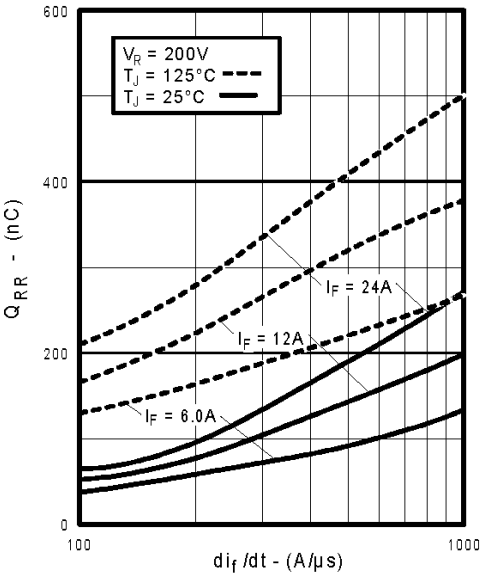



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

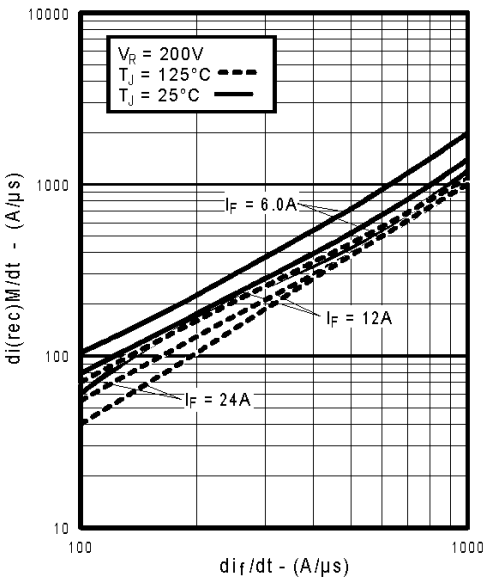



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

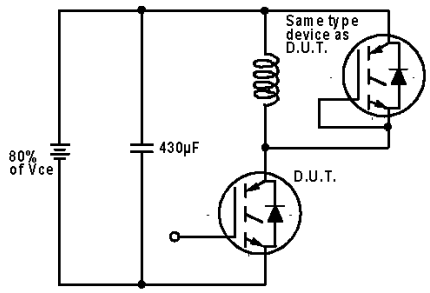



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

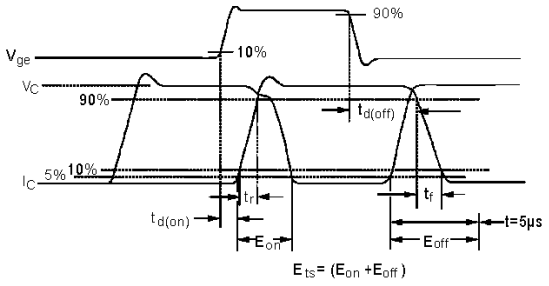



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

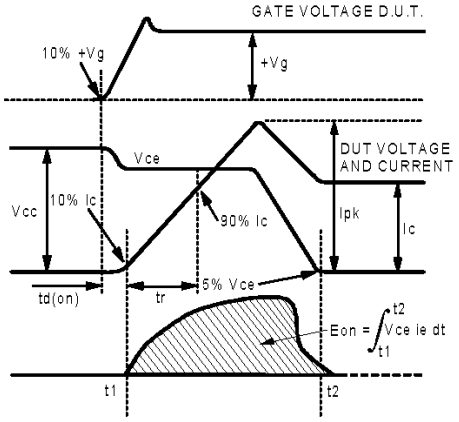



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

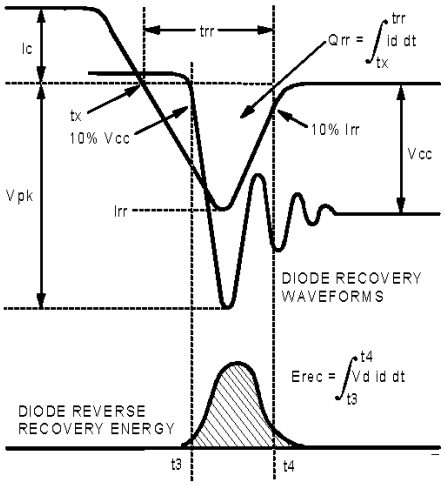



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

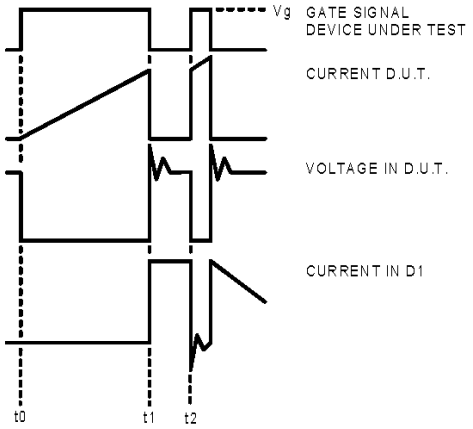



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

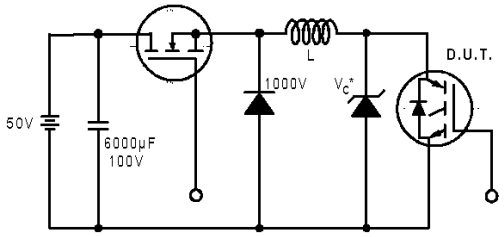



Figure 19. Clamped Inductive Load Test Circuit

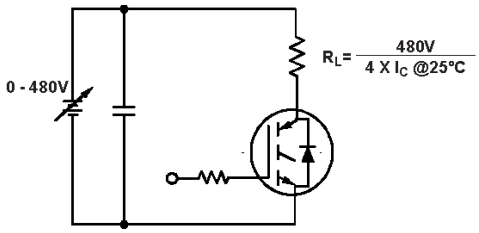



Figure 20. Pulsed Collector Current Test Circuit

## 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, $R_G$ = 23Ω (figure 19)

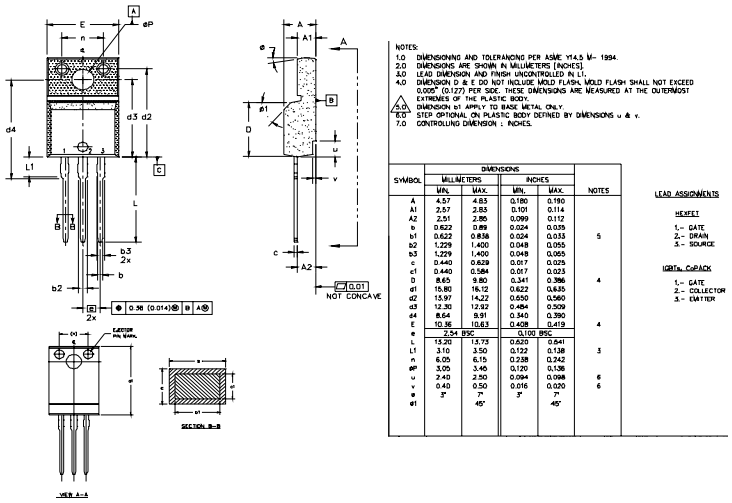
③ Pulse width ≤ 80µs; duty factor ≤ 0.1%.

④ Pulse width 5.0µs, single shot.

⑤ t = 60s, f = 60Hz

## TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)

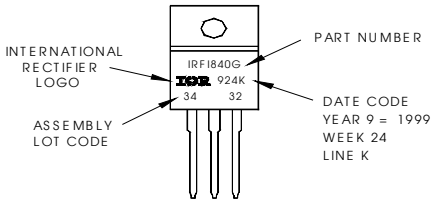



| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.57 | 4.83 | 0.180 | 0.190 | |
| A1 | 2.57 | 2.83 | 0.101 | 0.114 | |
| A2 | 2.51 | 2.86 | 0.099 | 0.112 | |
| b | 0.622 | 0.89 | 0.024 | 0.035 | |
| b1 | 0.622 | 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 | 15.97 | 14.22 | 0.650 | 0.560 | |
| d3 | 12.30 | 12.92 | 0.484 | 0.509 | |
| d4 | 8.64 | 9.91 | 0.340 | 0.390 | |
| E | 10.35 | 10.63 | 0.408 | 0.419 | 4 |
| e | 2.54 BSC | | 0.100 BSC | | |
| L | 13.20 | 13.75 | 0.520 | 0.541 | |
| L1 | 3.10 | 3.50 | 0.122 | 0.138 | 3 |
| n | 6.05 | 6.15 | 0.238 | 0.242 | |
| øP | 3.05 | 3.45 | 0.120 | 0.136 | |
| u | 2.40 | 2.50 | 0.094 | 0.098 | 6 |
| v | 0.40 | 0.50 | 0.016 | 0.020 | 6 |
| α | 3° | 7° | 3° | 7° | |
| α1 | | 45° | | 45° | |

## 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"




Data and specifications subject to change without notice.

International
IOR Rectifier

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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/