PD -94903

International
IOR Rectifier

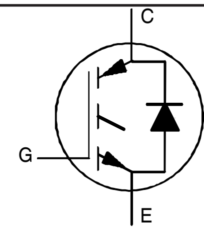
# IRG4BC10KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast IGBT

## Features

- High short circuit rating optimized for motor control, $t_{sc}$ =10µs, @360V $V_{CE}$ (start), $T_J$ = 125°C, $V_{GE}$ = 15V
- Combines low conduction losses with high switching speed
- Tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes
- Lead-Free




n-channel

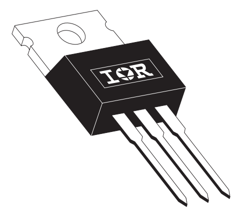
$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 2.39V

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

## Benefits

- Latest generation 4 IGBTs offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses



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 | 9.0 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 5.0 | |
| $I_{CM}$ | Pulsed Collector Current ① | 18 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 18 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 4.0 | |
| $I_{FM}$ | Diode Maximum Forward Current | 16 | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | µs |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 38 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 15 | |
| $T_J$<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 | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | ---- | ---- | 3.3 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | ---- | ---- | 7.0 | |
| $R_{\theta CS}$ | 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) |



12/23/03

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions | |
|---|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltageƒ | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 250µA | |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.58 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.39 | 2.62 | V | $I_C$ = 5.0A | $V_{GE}$ = 15V |
| | | — | 3.25 | — | | $I_C$ = 9.0A | See Fig. 2, 5 |
| | | — | 2.63 | — | | $I_C$ = 5.0A, $T_J$ = 150°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | — | 6.5 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 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 „ | 1.2 | 1.8 | — | S | $V_{CE}$ = 50V, $I_C$ = 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, $T_J$ = 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) | — | 19 | 29 | nC | $I_C$ = 5.0A | | |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | — | 2.9 | 4.3 | | $V_{CC}$ = 400V | See Fig.8 | |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 9.8 | 15 | | $V_{GE}$ = 15V | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 49 | — | ns | | | |
| $t_r$ | Rise Time | — | 28 | — | | $T_J$ = 25°C | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 97 | 150 | | $I_C$ = 5.0A, $V_{CC}$ = 480V | | |
| $t_f$ | Fall Time | — | 140 | 210 | | $V_{GE}$ = 15V, $R_G$ = 100Ω | | |
| $E_{on}$ | Turn-On Switching Loss | — | 0.25 | — | mJ | Energy losses include "tail" | | |
| $E_{off}$ | Turn-Off Switching Loss | — | 0.14 | — | | and diode reverse recovery | | |
| $E_{ts}$ | Total Switching Loss | — | 0.39 | 0.48 | | See Fig. 9,10,14 | | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | — | — | µs | $V_{CC}$ = 360V, $T_J$ = 125°C | | |
| | | | | | | $V_{GE}$ = 15V, $R_G$ = 100Ω , $V_{CPK}$ < 500V | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 46 | — | ns | $T_J$ = 150°C, | See Fig. 10,11,14 | |
| $t_r$ | Rise Time | — | 32 | — | | $I_C$ = 5.0A, $V_{CC}$ = 480V | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 100 | — | | $V_{GE}$ = 15V, $R_G$ = 100Ω | | |
| $t_f$ | Fall Time | — | 310 | — | | Energy losses include "tail" | | |
| $E_{ts}$ | Total Switching Loss | — | 0.56 | — | mJ | and diode reverse recovery | | |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package | | |
| $C_{ies}$ | Input Capacitance | — | 220 | — | pF | $V_{GE}$ = 0V | | |
| $C_{oes}$ | Output Capacitance | — | 29 | — | | $V_{CC}$ = 30V | See Fig. 7 | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 7.5 | — | | ƒ = 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 | |

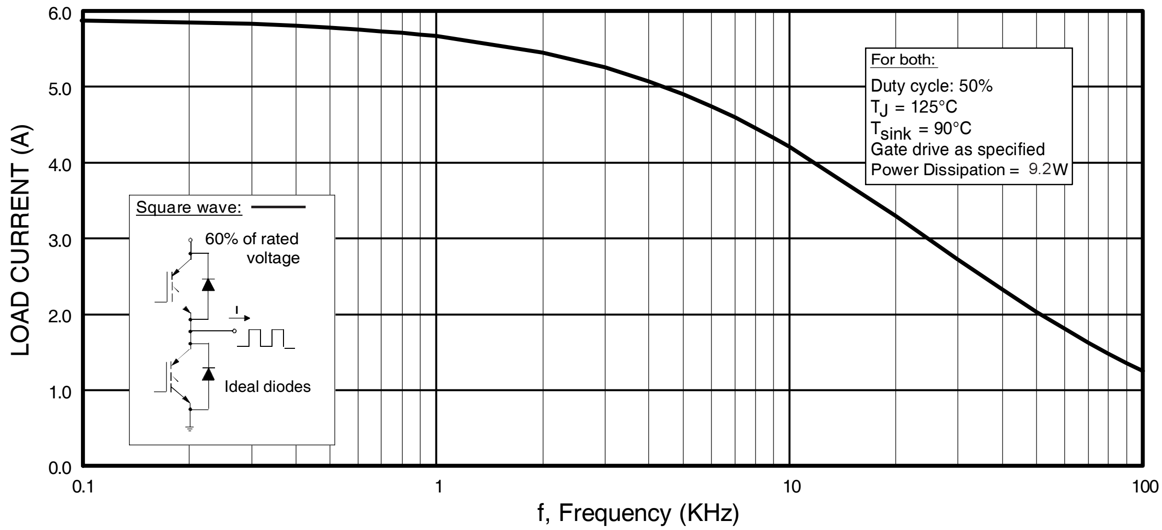



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

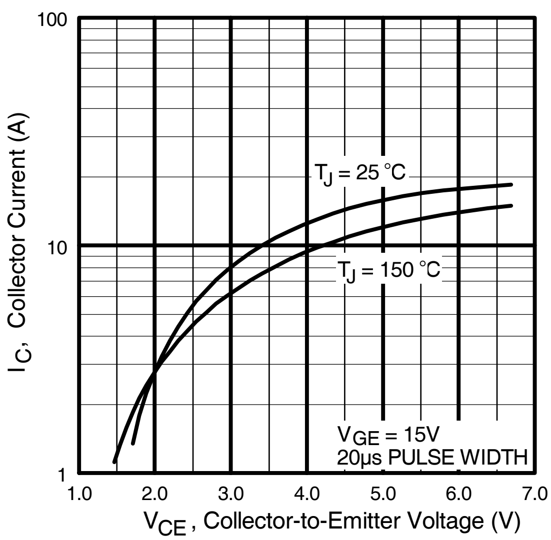



**Fig. 2** - Typical Output Characteristics

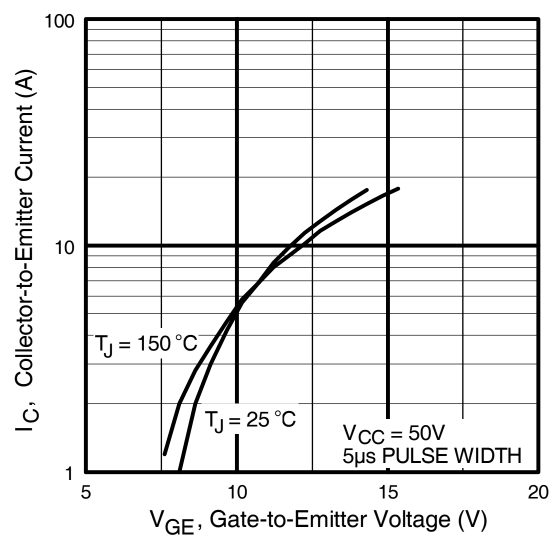



**Fig. 3** - Typical Transfer Characteristics

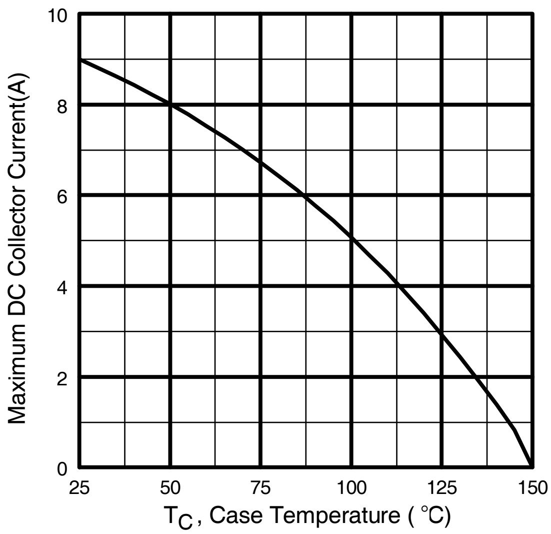



**Fig. 4** - Maximum Collector Current vs. Case Temperature

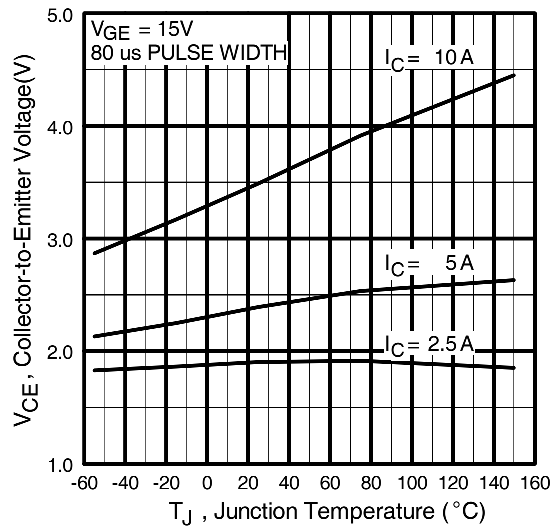



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

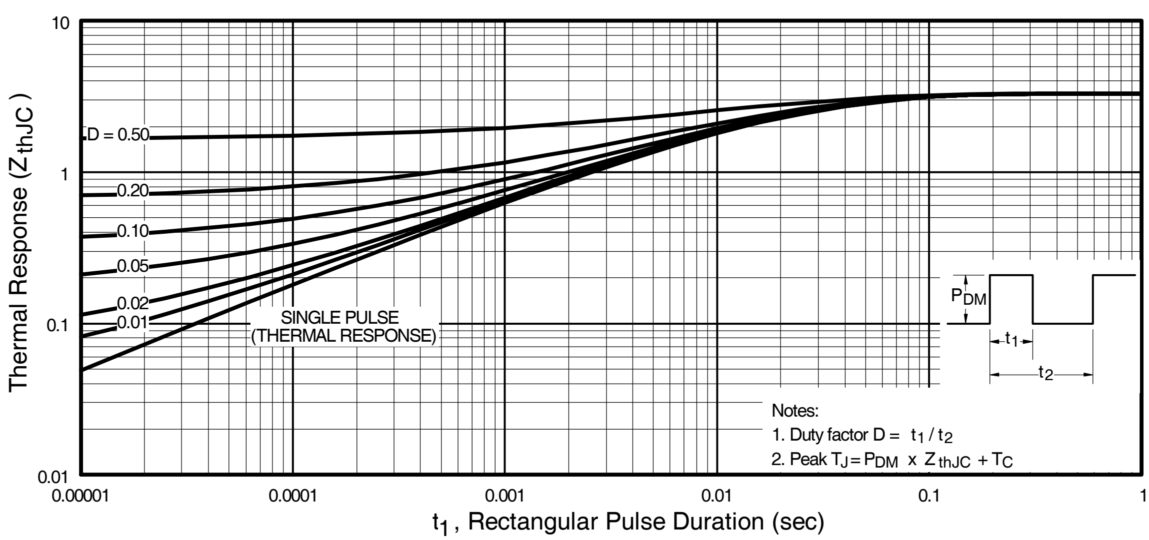



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

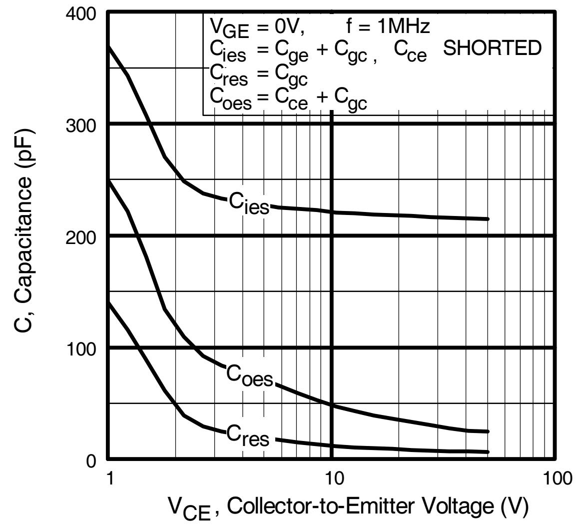



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

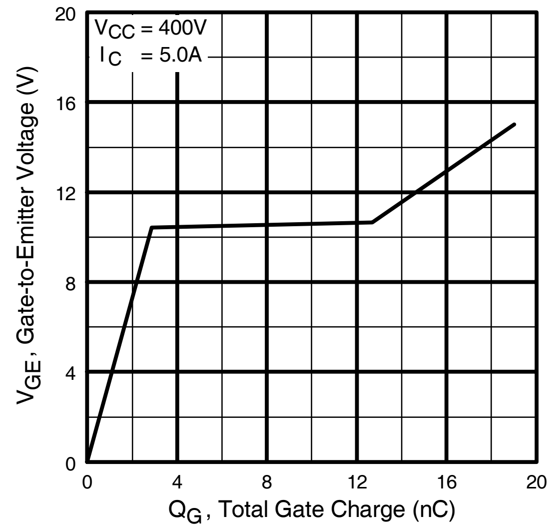



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

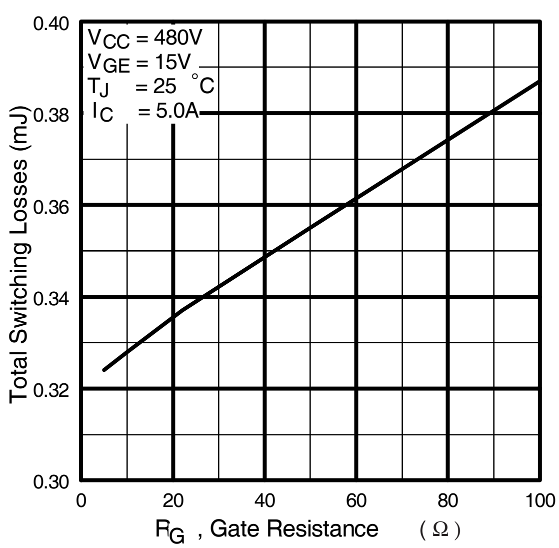



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

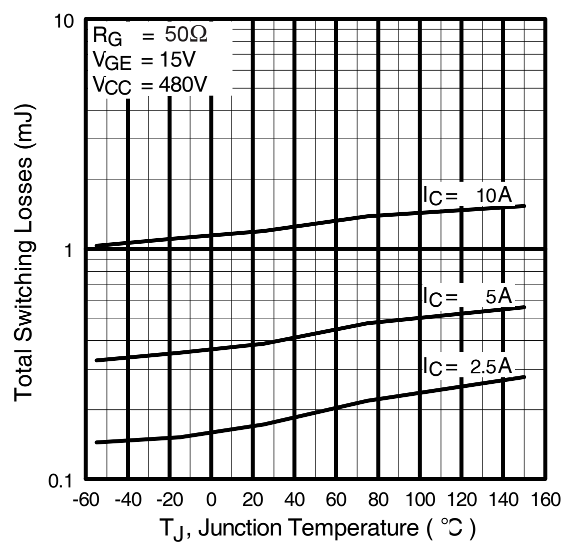



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

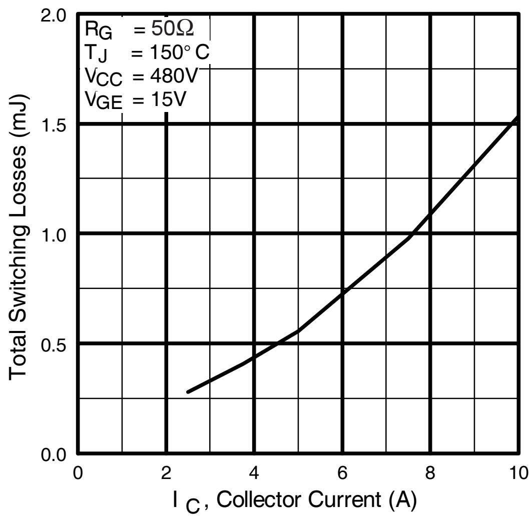



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

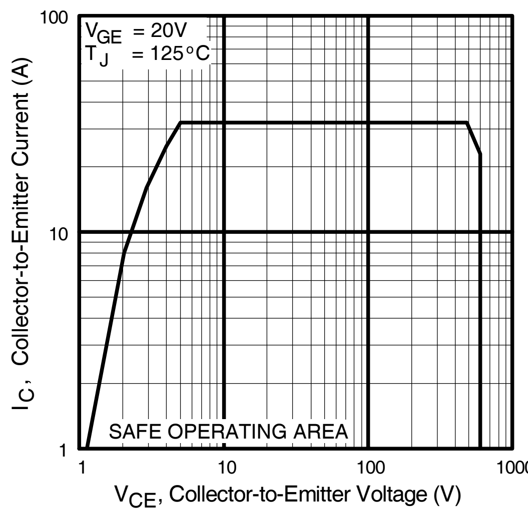



**Fig. 12** - Turn-Off SOA

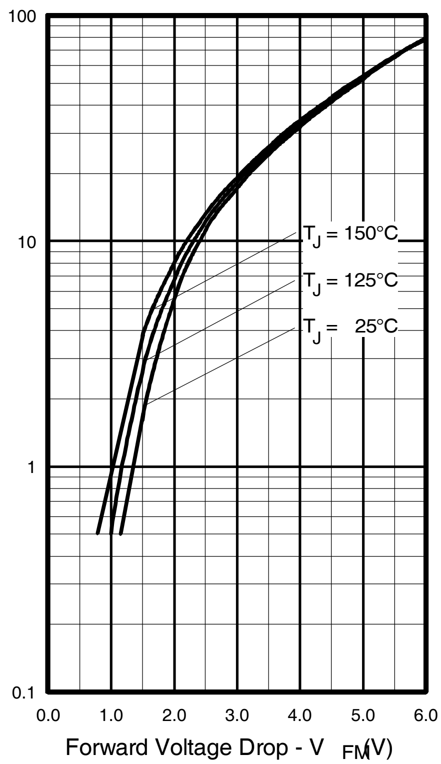



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

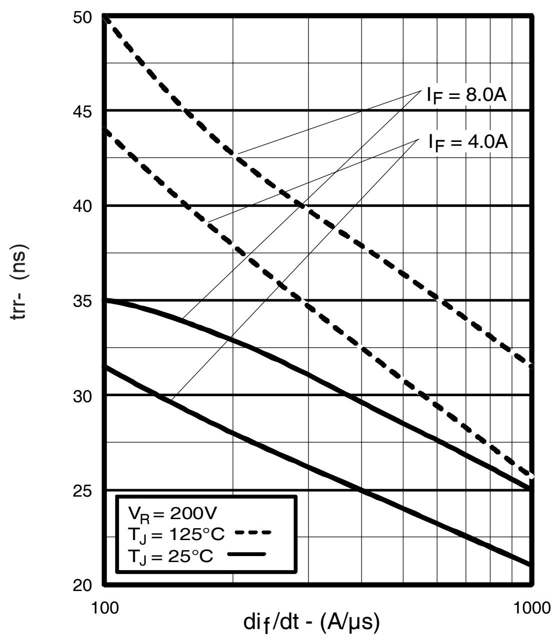



**Fig. 14 -** Typical Reverse Recovery vs. $di_f/dt$

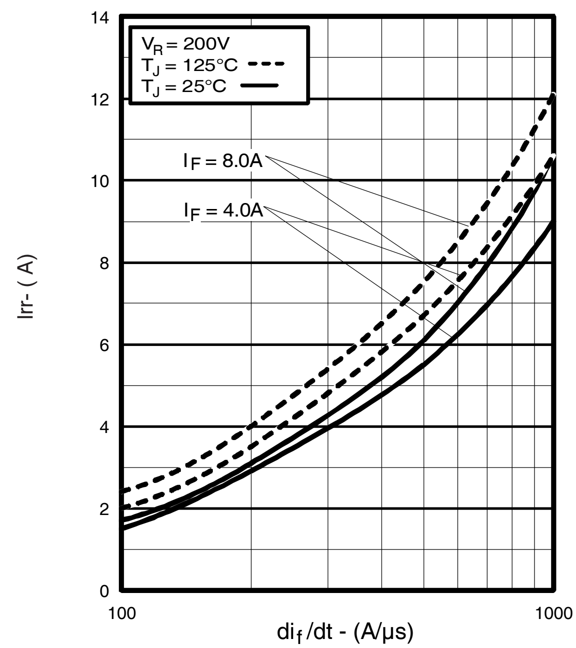



**Fig. 15 -** Typical Recovery Current vs. $di_f/dt$

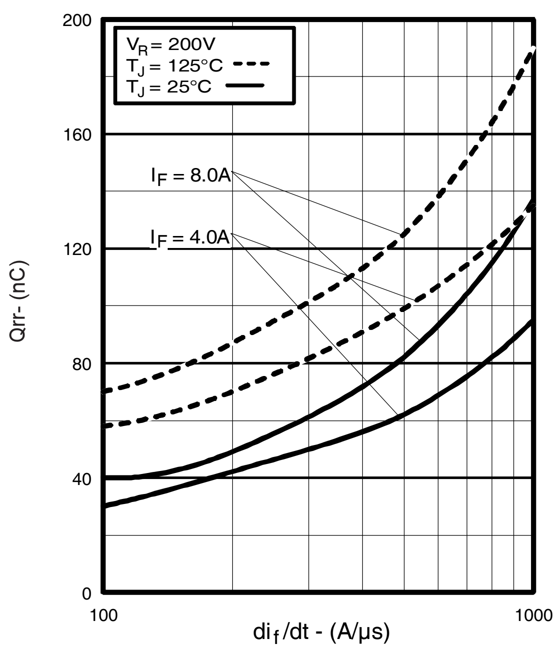



**Fig. 16 -** Typical Stored Charge vs. $di_f/dt$

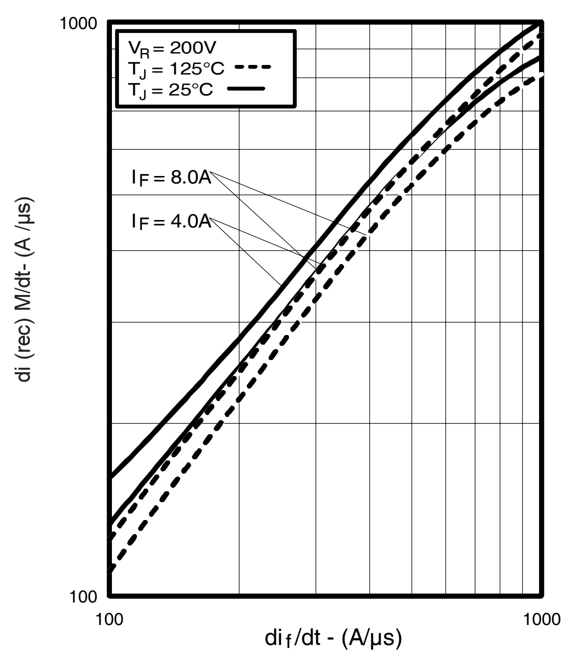



**Fig. 17 -** Typical $di_{(rec)M}/dt$ vs. $di_f/dt$,

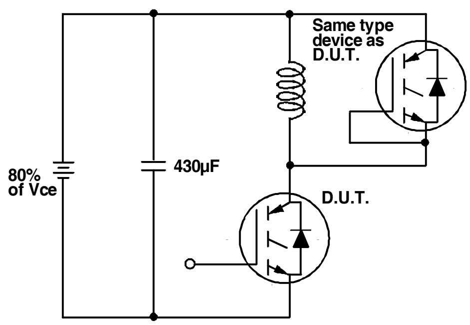



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

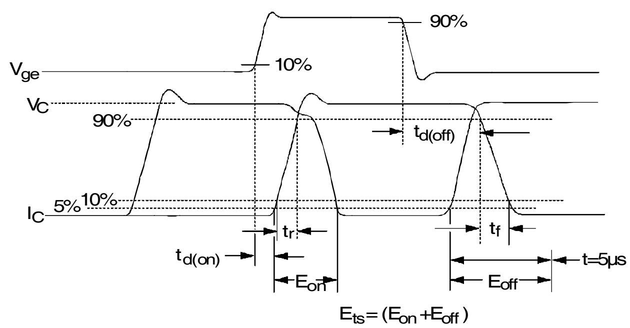



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

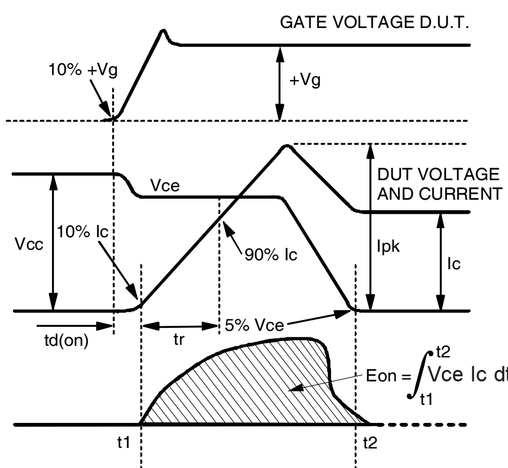



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

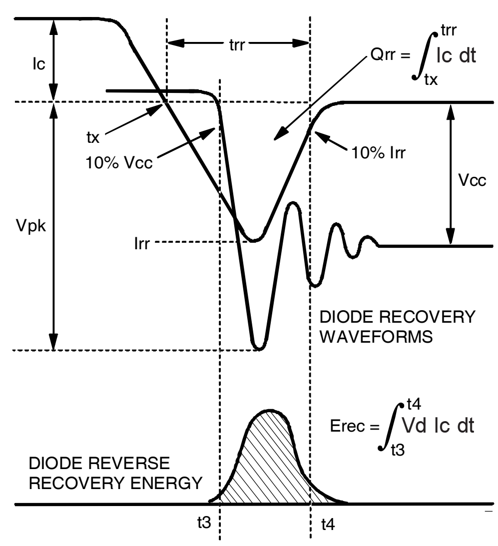



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

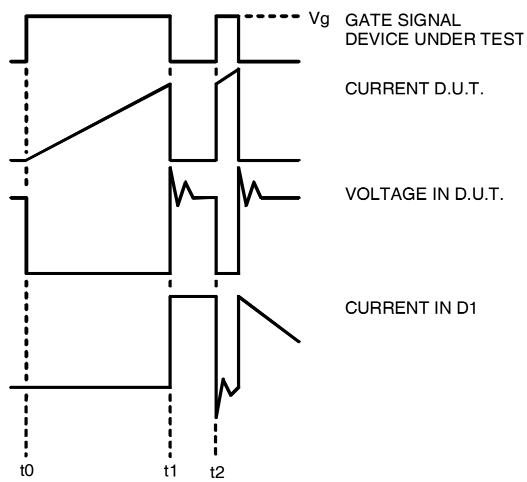



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

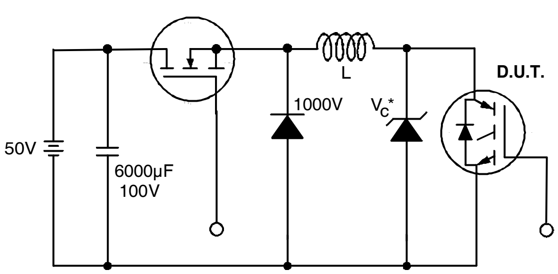



Figure 19. Clamped Inductive Load Test Circuit

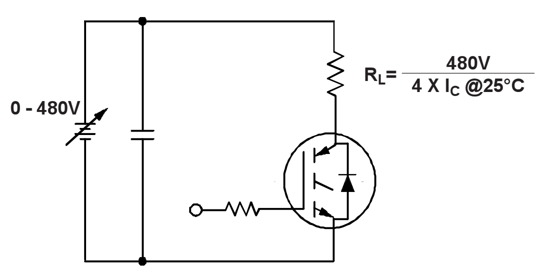



Figure 20. Pulsed Collector Current Test Circuit

Notes:

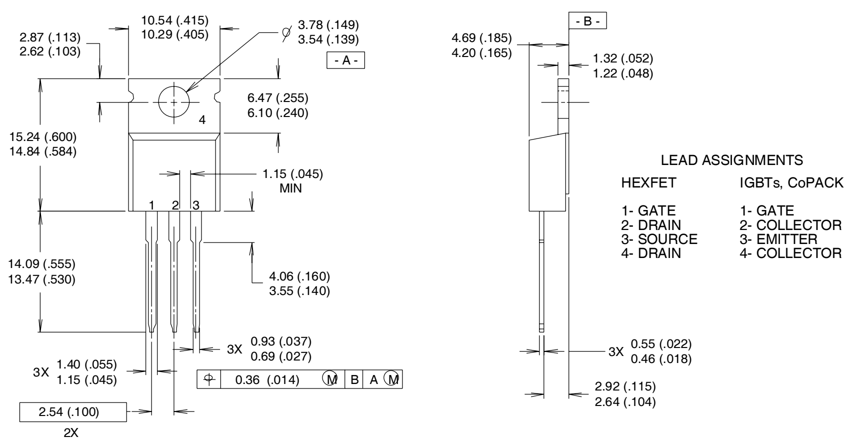
① Repetitive rating: $V_{GE}$=20V; pulse width limited by maximum junction temperature (figure 20)

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

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

④ Pulse width 5.0µs, single shot.

## TO-220AB Package Outline




NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.

2 CONTROLLING DIMENSION : INCH

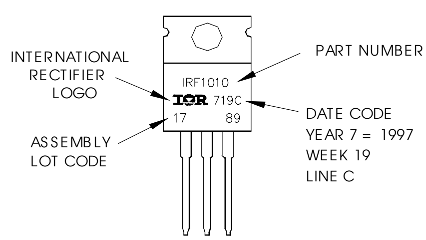
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## 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"




Data and specifications subject to change without notice.

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