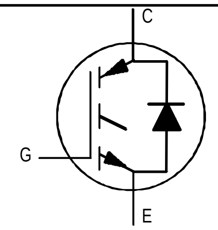
PD -91783A

International
IOR Rectifier

# IRG4BC20FD-S

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Fast CoPack IGBT



n-channel

$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 1.66V

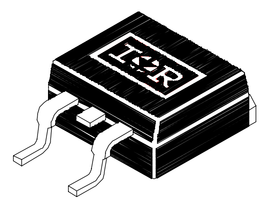
@$V_{GE}$ = 15V, $I_C$ = 9.0A

## Features

- Fast: Optimized for medium operating frequencies ( 1-5 kHz in hard switching, >20 kHz in resonant mode).
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard $D^2$Pak package

## 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
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBTs


$D^2$Pak

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 16 | |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 9.0 | |
| $I_{CM}$ | Pulsed Collector Current ① | 64 | A |
| $I_{LM}$ | Clamped Inductive Load Current ② | 64 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 8.0 | |
| $I_{FM}$ | Diode Maximum Forward Current | 60 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 60 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 24 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +150 | °C |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | —— | 2.1 | |
| $R_{\theta JC}$ | Junction-to-Case - Diode | —— | 3.5 | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient ( PCB Mounted,steady-state)* | —— | 80 | |
| Wt | Weight | 1.44 | —— | g (oz) |

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



4/24/2000

## 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 | — | 0.72 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.66 | 2.0 | V | $I_C$ = 9.0A | $V_{GE}$ = 15V |
| | | — | 2.06 | — | | $I_C$ = 16A | See Fig. 2, 5 |
| | | — | 1.76 | — | | $I_C$ = 9.0A, $T_J$ = 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 | 2.9 | 5.1 | — | S | $V_{CE}$ = 100V, $I_C$ = 9.0A | |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V | |
| | | — | — | 1700 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C | |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.4 | 1.7 | V | $I_C$ = 8.0A | See Fig. 13 |
| | | — | 1.3 | 1.6 | | $I_C$ = 8.0A, $T_J$ = 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) | — | 27 | 40 | nC | $I_C$ = 9.0A | |
| Qge | Gate - Emitter Charge (turn-on) | — | 4.2 | 6.2 | | $V_{CC}$ = 400V See Fig. 8 | |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 9.9 | 15 | | $V_{GE}$ = 15V | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 43 | — | ns | $T_J$ = 25°C | |
| $t_r$ | Rise Time | — | 20 | — | | $I_C$ = 9.0A, $V_{CC}$ = 480V | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 240 | 360 | | $V_{GE}$ = 15V, $R_G$ = 50Ω | |
| $t_f$ | Fall Time | — | 150 | 220 | | Energy losses include "tail" and | |
| $E_{on}$ | Turn-On Switching Loss | — | 0.25 | — | mJ | diode reverse recovery. | |
| $E_{off}$ | Turn-Off Switching Loss | — | 0.64 | — | | See Fig. 9, 10, 18 | |
| $E_{ts}$ | Total Switching Loss | — | 0.89 | 1.3 | | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 41 | — | ns | $T_J$ = 150°C, See Fig. 10, 11, 18 | |
| $t_r$ | Rise Time | — | 22 | — | | $I_C$ = 9.0A, $V_{CC}$ = 480V | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 320 | — | | $V_{GE}$ = 15V, $R_G$ = 50Ω | |
| $t_f$ | Fall Time | — | 290 | — | | Energy losses include "tail" and | |
| $E_{ts}$ | Total Switching Loss | — | 1.35 | — | mJ | diode reverse recovery. | |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package | |
| $C_{ies}$ | Input Capacitance | — | 540 | — | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | — | 37 | — | | $V_{CC}$ = 30V See Fig. 7 | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 7.0 | — | | $f$ = 1.0MHz | |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 37 | 55 | ns | $T_J$ = 25°C See Fig. | |
| | | — | 55 | 90 | | $T_J$ = 125°C 14 | $I_F$ = 8.0A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 3.5 | 5.0 | A | $T_J$ = 25°C See Fig. | |
| | | — | 4.5 | 8.0 | | $T_J$ = 125°C 15 | $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 65 | 138 | nC | $T_J$ = 25°C See Fig. | |
| | | — | 124 | 360 | | $T_J$ = 125°C 16 | di/dt = 200A/µs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery | — | 240 | — | A/µs | $T_J$ = 25°C See Fig. | |
| | During $t_b$ | — | 210 | — | | $T_J$ = 125°C 17 | |

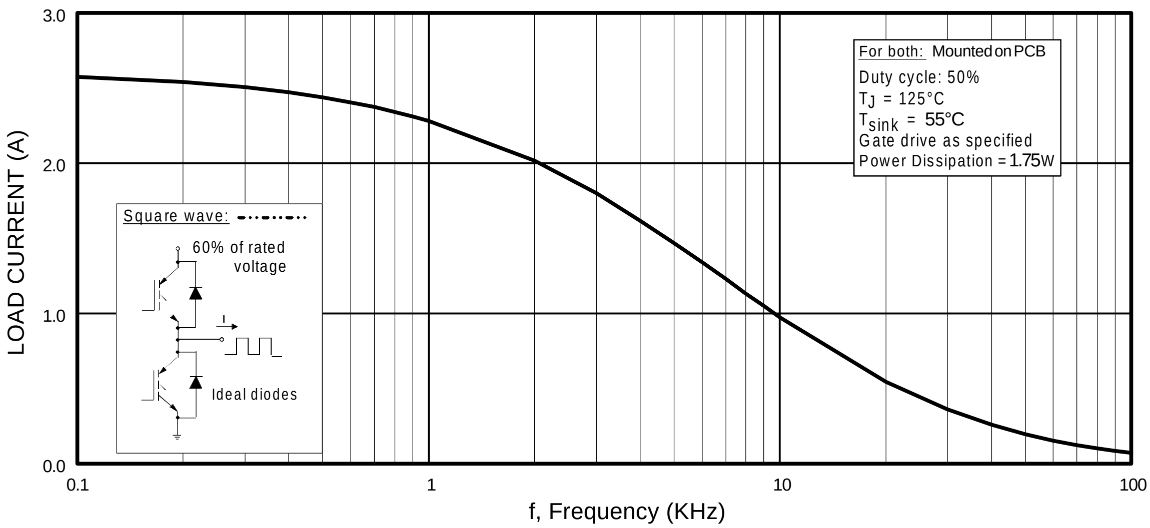



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

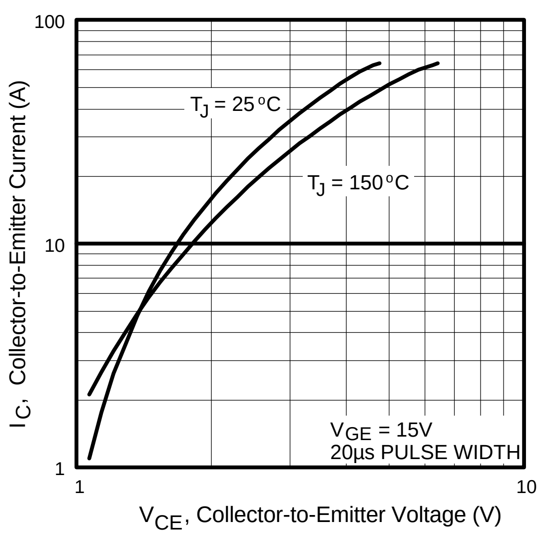



**Fig. 2** - Typical Output Characteristics

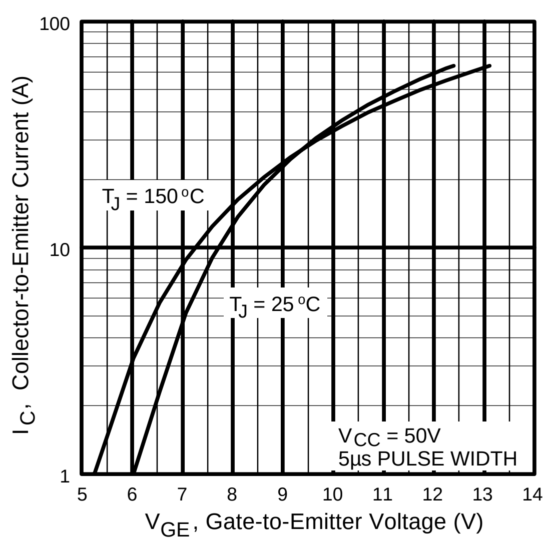



**Fig. 3** - Typical Transfer Characteristics

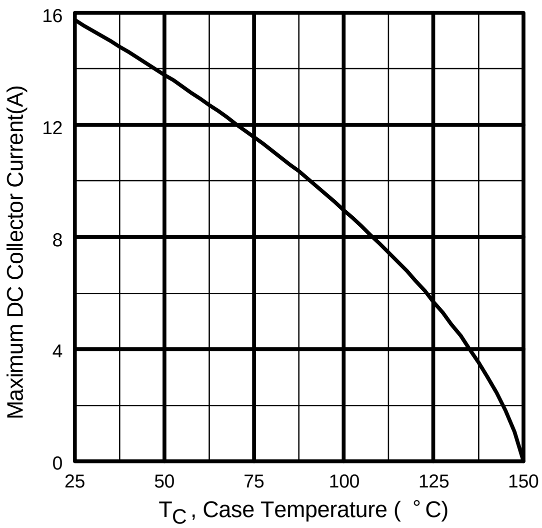



**Fig. 4** - Maximum Collector Current vs. Case Temperature

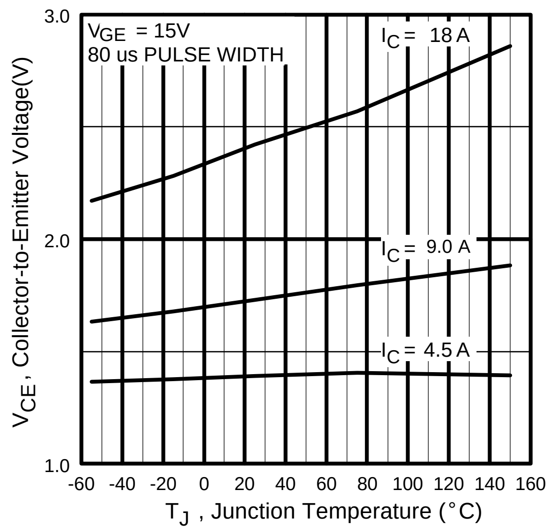



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

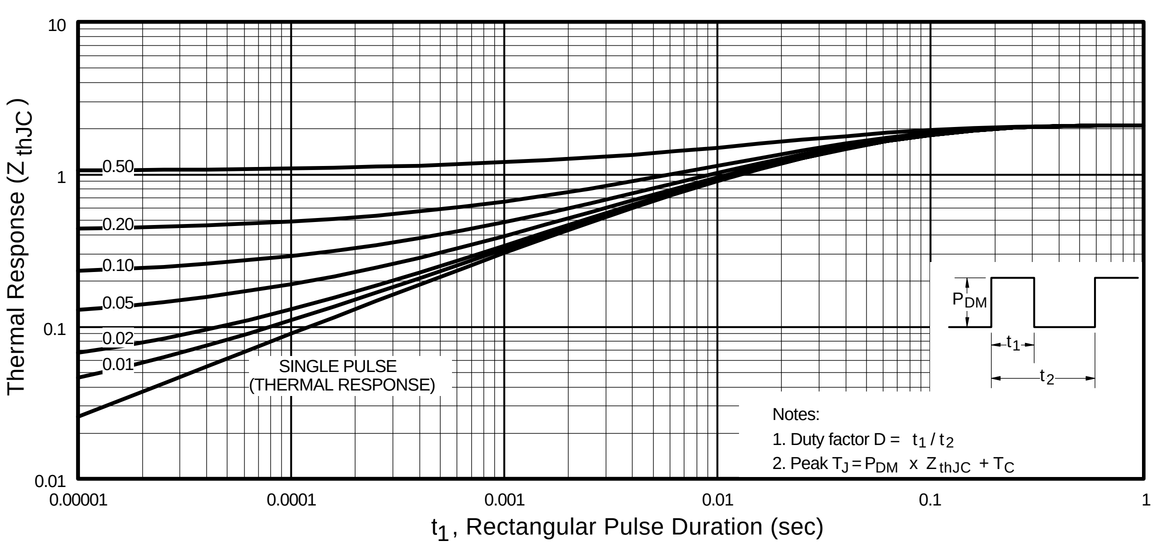



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

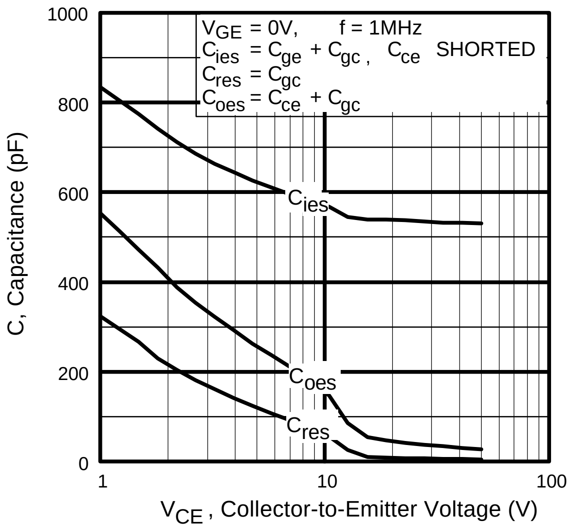



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

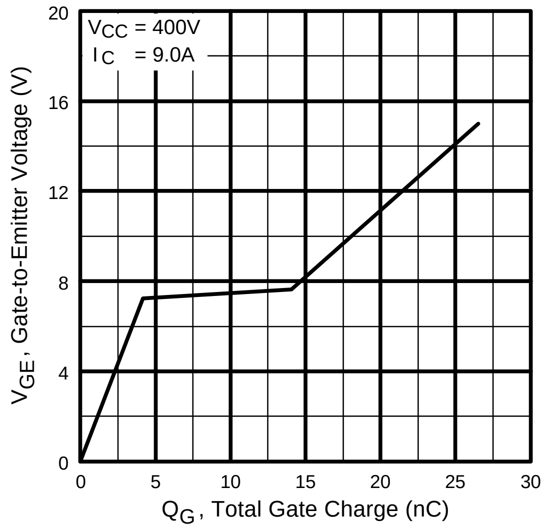



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

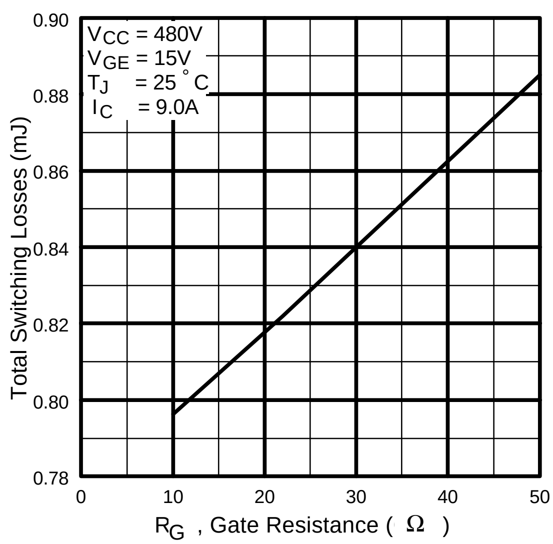



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

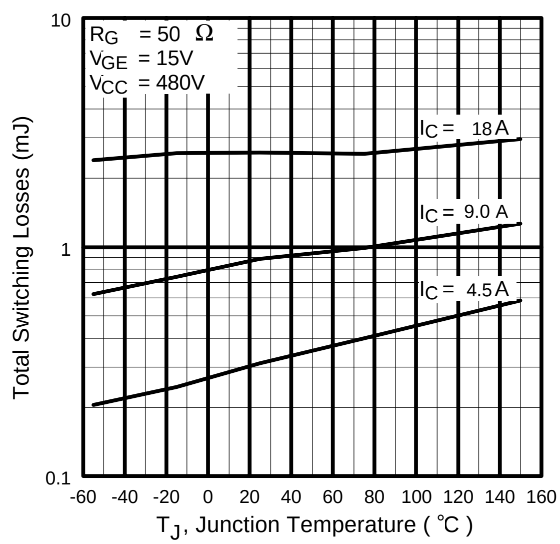



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

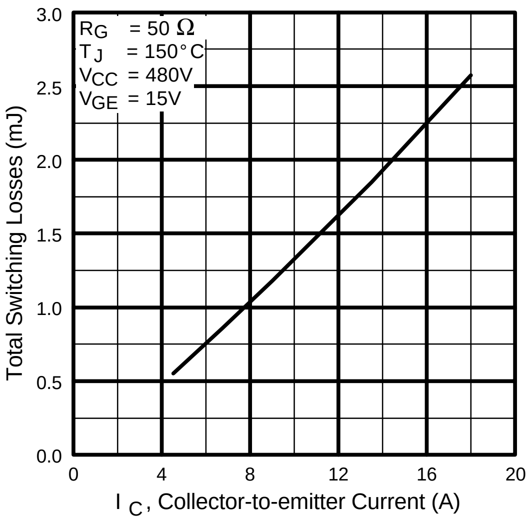



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

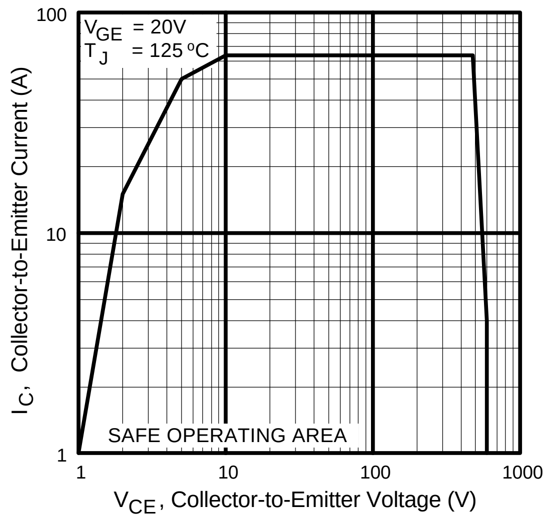



**Fig. 12** - Turn-Off SOA

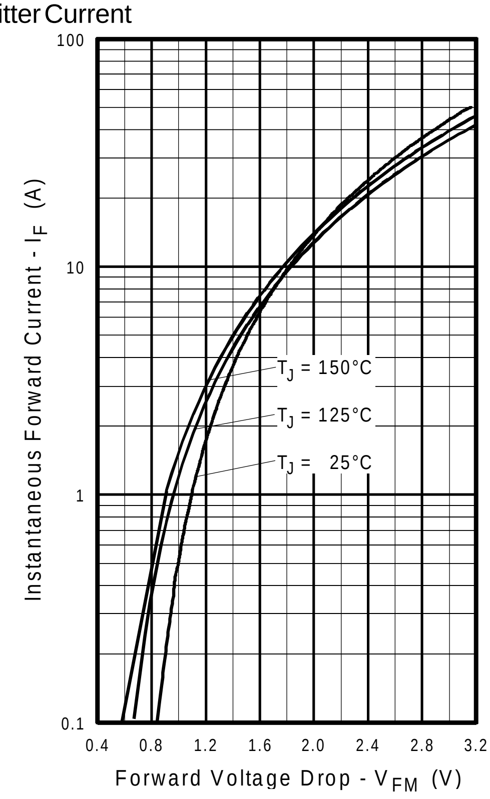



**Fig. 13 -** Maximum Forward Voltage Drop vs. Instantaneous Forward Current

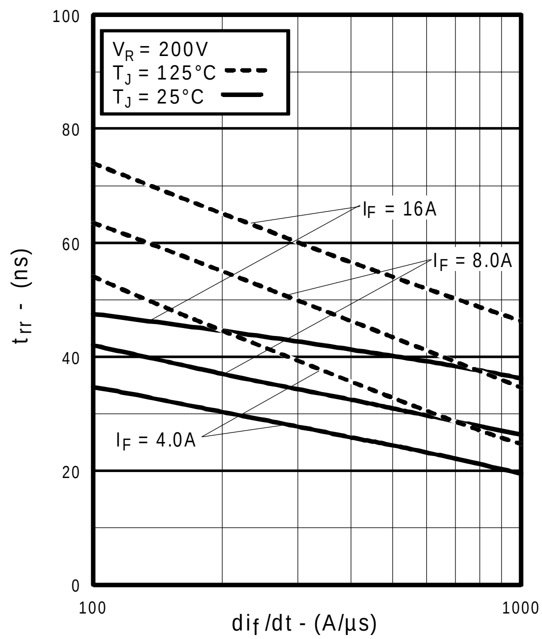



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

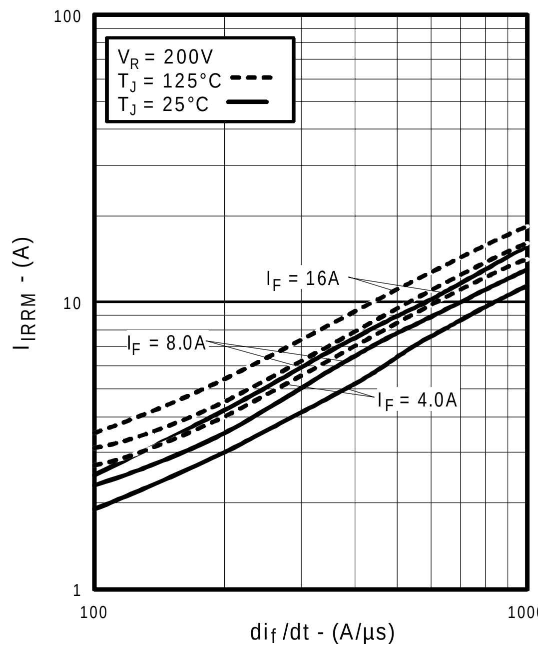



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

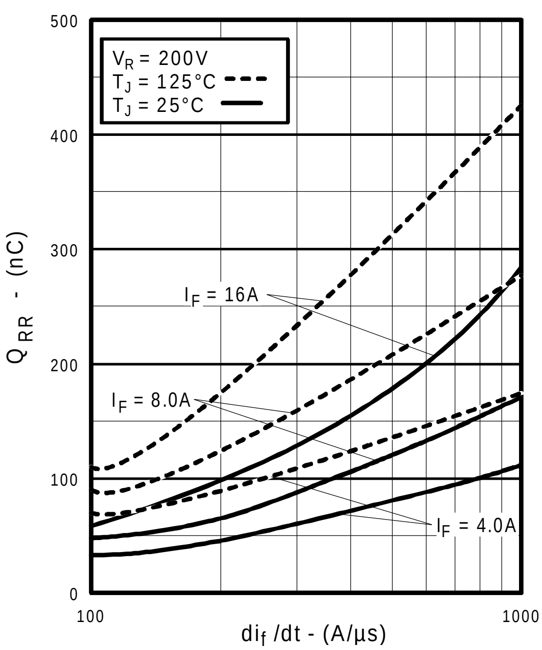



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

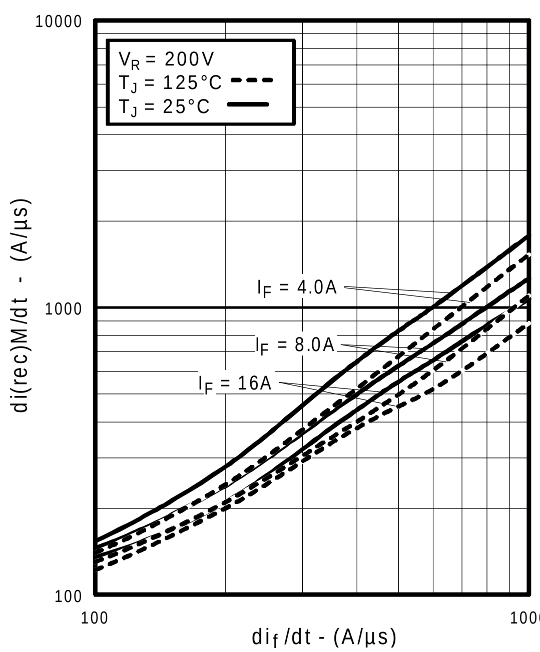



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

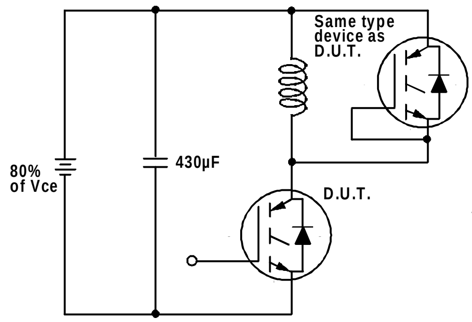



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

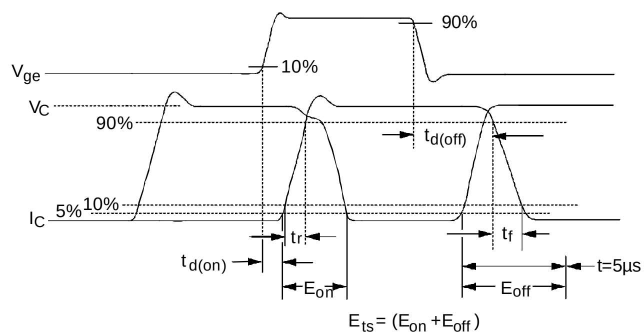



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

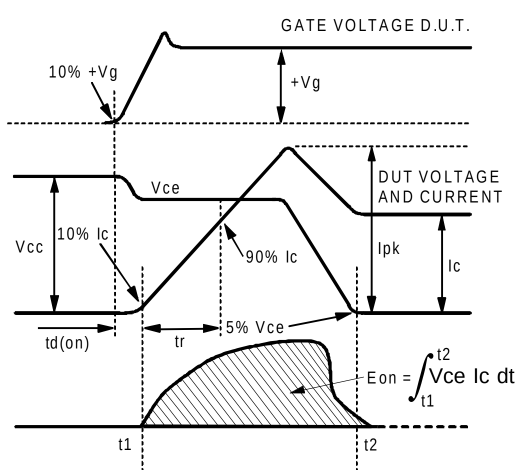



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

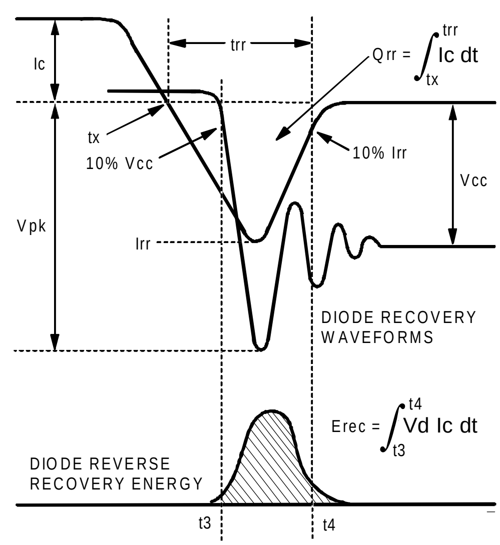



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

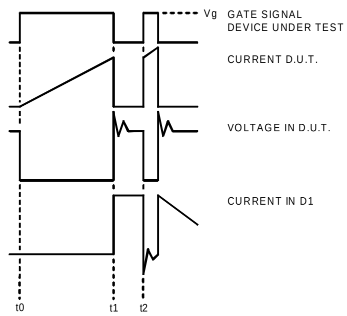



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

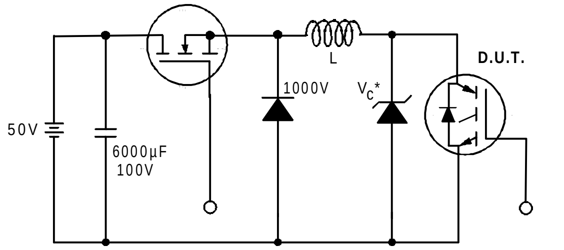



Figure 19. Clamped Inductive Load Test Circuit

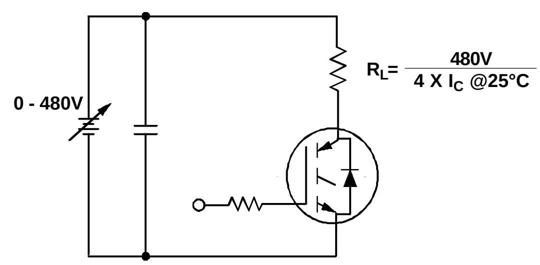
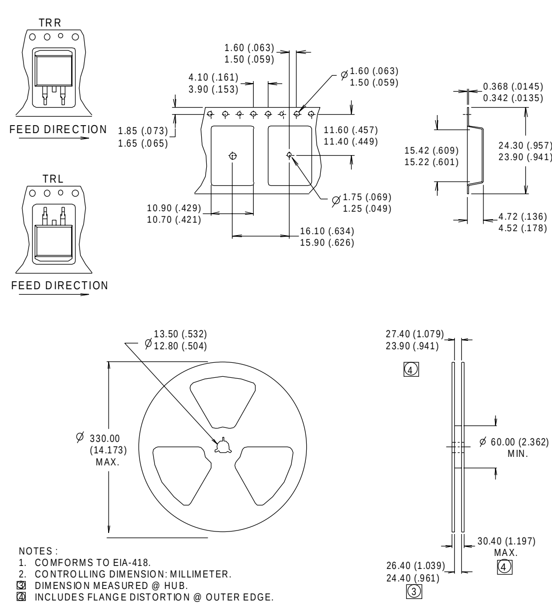



Figure 20. Pulsed Collector Current Test Circuit

# Tape & Reel Information

**$D^2$Pak**



## Notes:

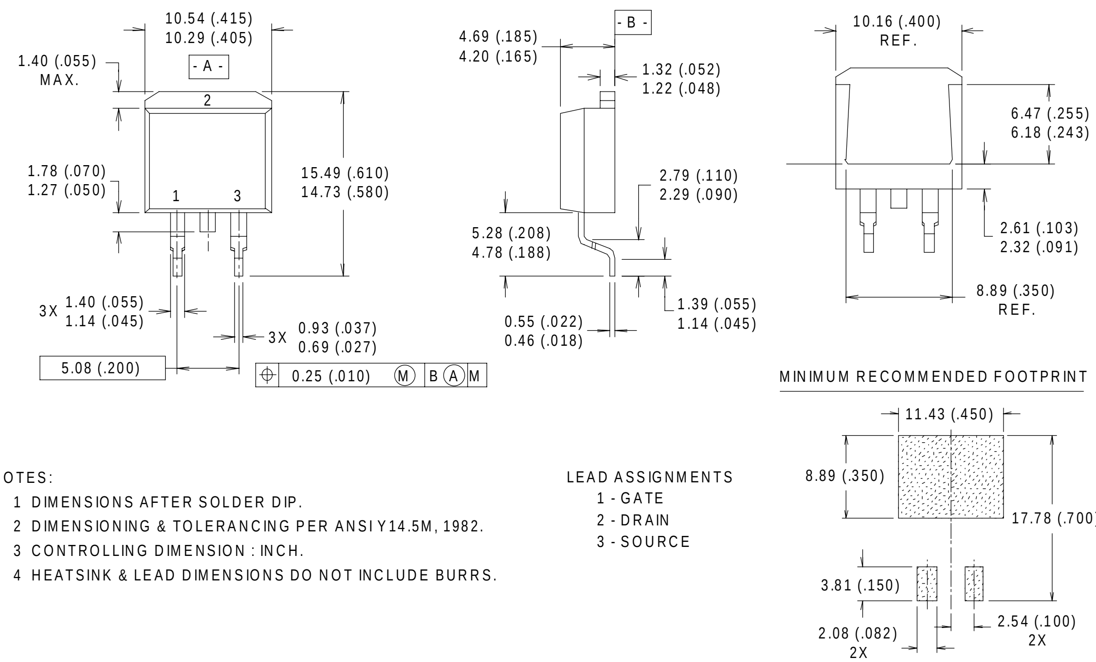
① Repetitive rating: $V_{GE}$=20V; pulse width limited by maximum junction temperature (figure 20)

② $V_{CC}$=80%($V_{CES}$), $V_{GE}$=20V, L=10µH, $R_G$ = 50Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

## $D^2$Pak Package Outline




International
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*Data and specifications subject to change without notice. 4/00*

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