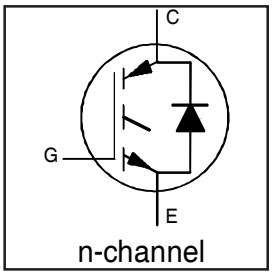
International
IOR Rectifier

# IRG4IBC20KDPbF

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

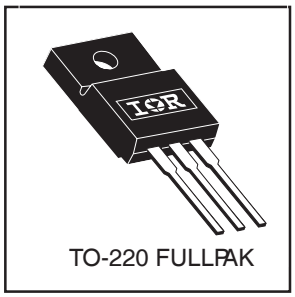
Short Circuit Rated
UltraFast IGBT




$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 2.27V

@$V_{GE}$ = 15V, $I_C$ = 6.3A




TO-220 FULLPAK

### Features

- High switching speed optimized for up to 25kHz with low $V_{CE(on)}$
- Short Circuit Rating 10µs @ 125°C, $V_{GE}$ = 15V
- 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 FULLPAK
- Lead-Free

### Benefits

- Generation 4 IGBTs offer highest efficiencies available maximizing the power density of the system
- IGBTs optimized for specific application conditions
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise EMI
- Designed to exceed the power handling capability of equivalent industry-standard IGBTs

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 11.5 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 6.3 | |
| $I_{CM}$ | Pulsed Collector Current ① | 23 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 23 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 6.3 | |
| $I_{FM}$ | Diode Maximum Forward Current | 23 | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | µs |
| $V_{ISOL}$ | RMS Isolation Voltage, Terminal to Case, t = 1 min | 2500 | V |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 34 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 14 | |
| $T_J$<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 | ––– | 3.7 | °C/W |
| $R_{\theta CS}$ | Junction-to-Case - Diode | ––– | 5.5 | |
| $R_{\theta JA}$ | 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 | — | 0.49 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.27 | 2.8 | V | $I_C$ = 9.0A $V_{GE}$ = 15V |
| | | — | 3.01 | — | | $I_C$ = 16A See Fig. 2, 5 |
| | | — | 2.43 | — | | $I_C$ = 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 | — | -10 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance ④ | 2.9 | 4.3 | — | S | $V_{CE}$ = 100V, $I_C$ = 9.0A |
| $I_{CES}$ | 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 | — | 1.4 | 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) | — | 34 | 51 | nC | $I_C$ = 9.0A |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | — | 4.9 | 7.4 | | $V_{CC}$ = 400V See Fig.8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 14 | 21 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | — | 54 | — | ns | |
| $t_r$ | Rise Time | — | 34 | — | | $T_J$ = 25°C |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 180 | 270 | | $I_C$ = 9.0A, $V_{CC}$ = 480V |
| $t_f$ | Fall Time | — | 72 | 110 | | $V_{GE}$ = 15V, $R_G$ = 50Ω |
| $E_{on}$ | Turn-On Switching Loss | — | 0.34 | — | mJ | Energy losses include "tail" |
| $E_{off}$ | Turn-Off Switching Loss | — | 0.30 | — | | and diode reverse recovery |
| $E_{ts}$ | Total Switching Loss | — | 0.64 | 0.96 | | See Fig. 9,10,14 |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | — | — | µs | $V_{CC}$ = 360V, $T_J$ = 125°C |
| | | | | | | $V_{GE}$ = 15V, $R_G$ = 50Ω , $V_{CPK}$ < 500V |
| $t_{d(on)}$ | Turn-On Delay Time | — | 51 | — | ns | $T_J$ = 150°C, See Fig. 10,11,14 |
| $t_r$ | Rise Time | — | 37 | — | | $I_C$ = 9.0A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 220 | — | | $V_{GE}$ = 15V, $R_G$ = 50Ω |
| $t_f$ | Fall Time | — | 160 | — | | Energy losses include "tail" |
| $E_{ts}$ | Total Switching Loss | — | 0.85 | — | mJ | and diode reverse recovery |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | — | 450 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 61 | — | | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 14 | — | | $f$ = 1.0MHz |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 37 | 55 | ns | $T_J$ = 25°C See Fig. 14 $I_F$ = 8.0A |
| | | — | 55 | 90 | | $T_J$ = 125°C |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 3.5 | 5.0 | A | $T_J$ = 25°C See Fig. 15 $V_R$ = 200V |
| | | — | 4.5 | 8.0 | | $T_J$ = 125°C |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 65 | 138 | nC | $T_J$ = 25°C See Fig. 16 di/dt = 200Aµs |
| | | — | 124 | 360 | | $T_J$ = 125°C |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery | — | 240 | — | A/µs | $T_J$ = 25°C See Fig. 17 |
| | During $t_b$ | — | 210 | — | | $T_J$ = 125°C |

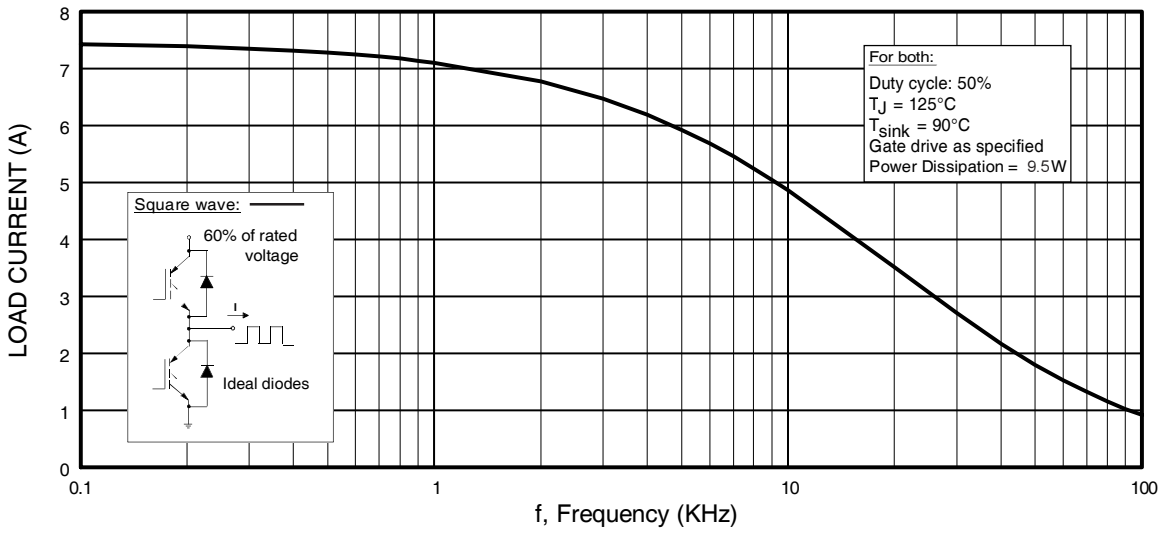



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

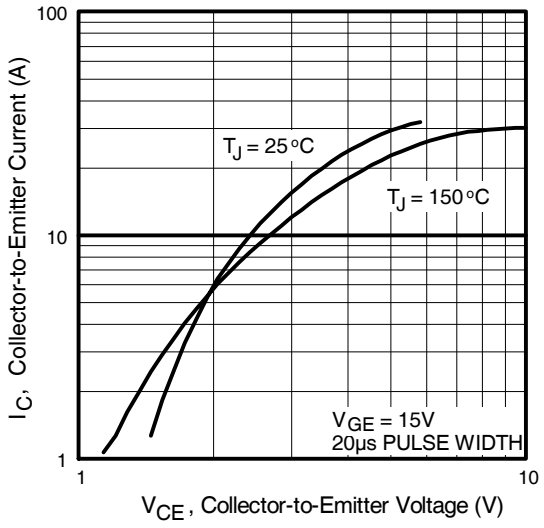



**Fig. 2** - Typical Output Characteristics

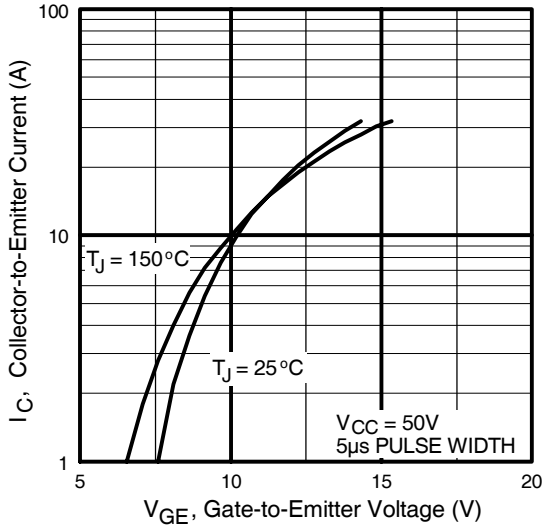



**Fig. 3** - Typical Transfer Characteristics

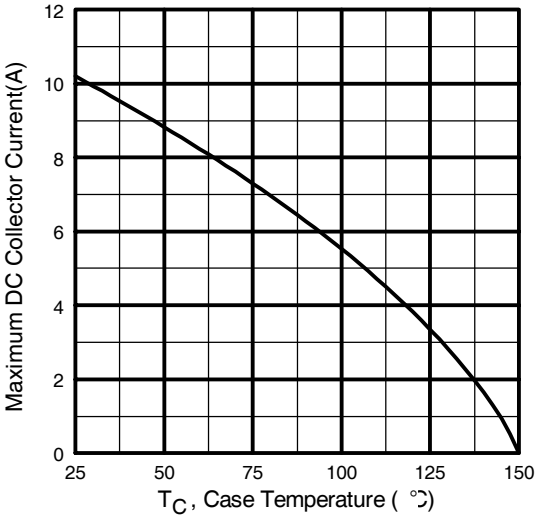



**Fig. 4** - Maximum Collector Current vs. Case Temperature

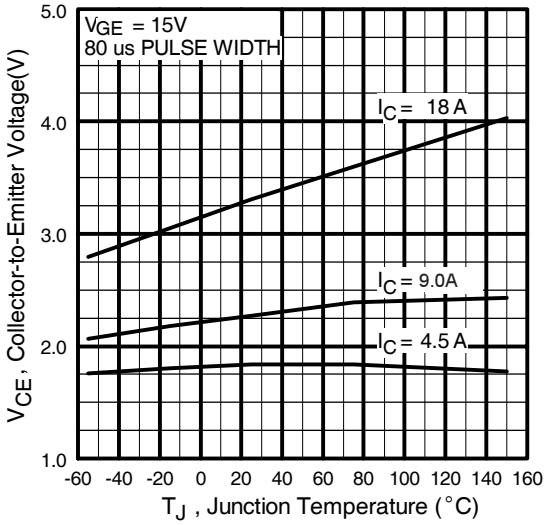



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

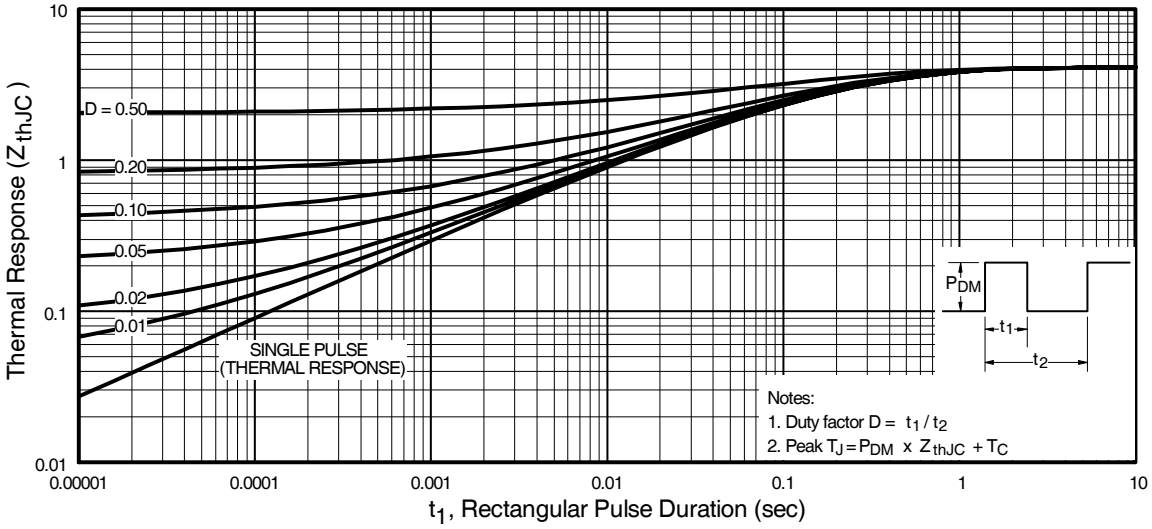



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

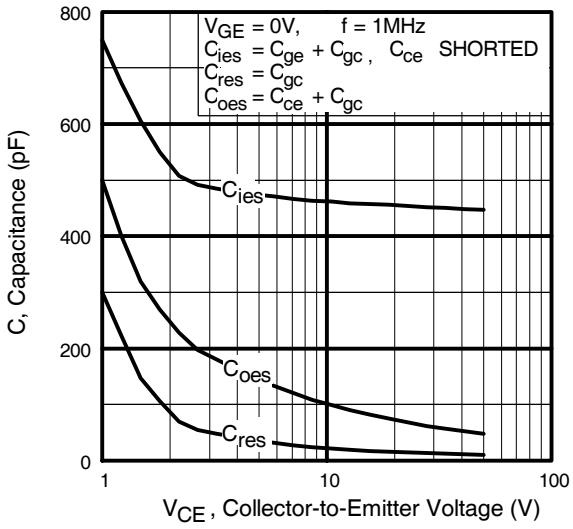



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

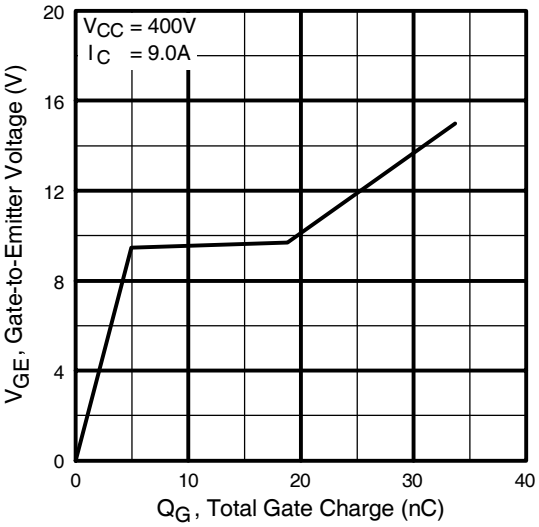



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

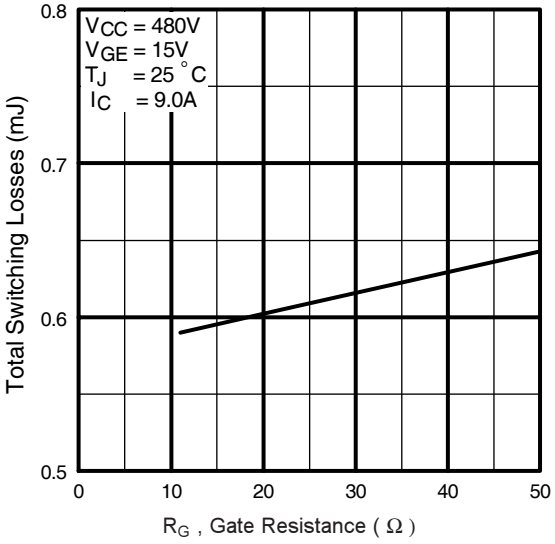



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

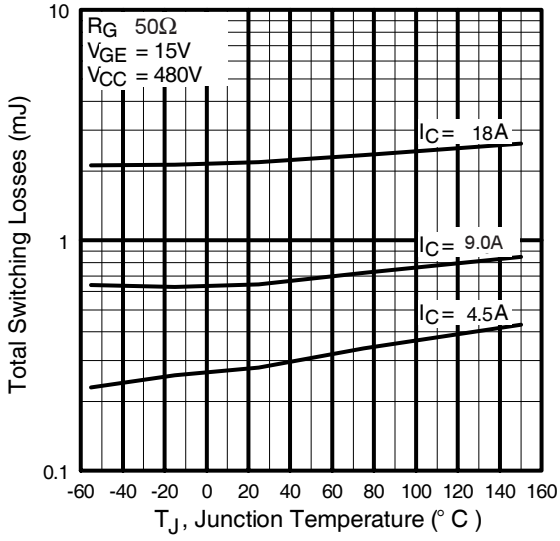



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

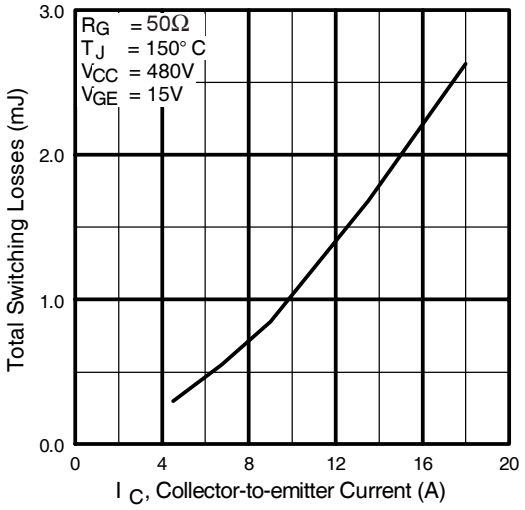



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

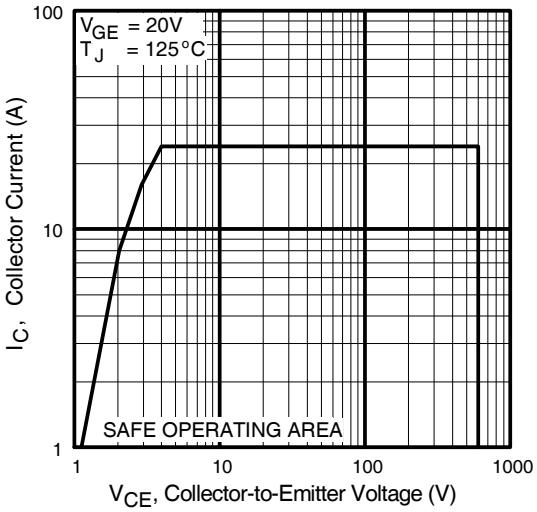



**Fig. 12** - Turn-Off SOA

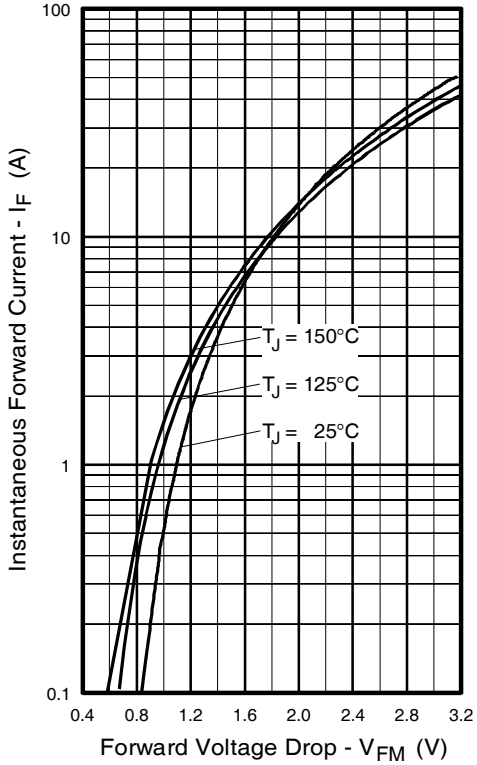



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

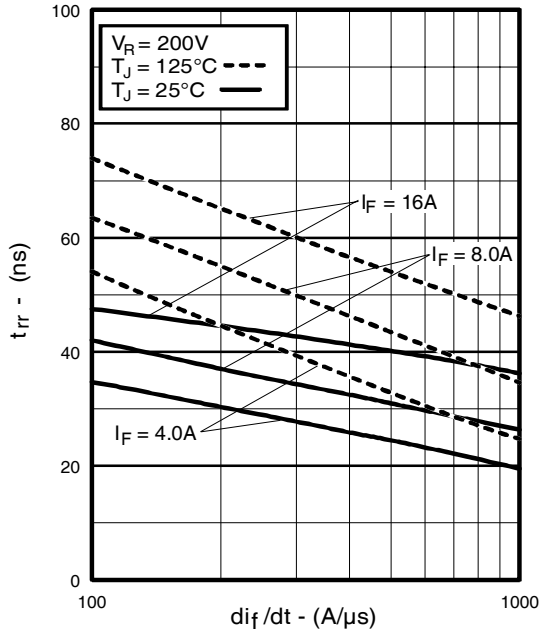



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

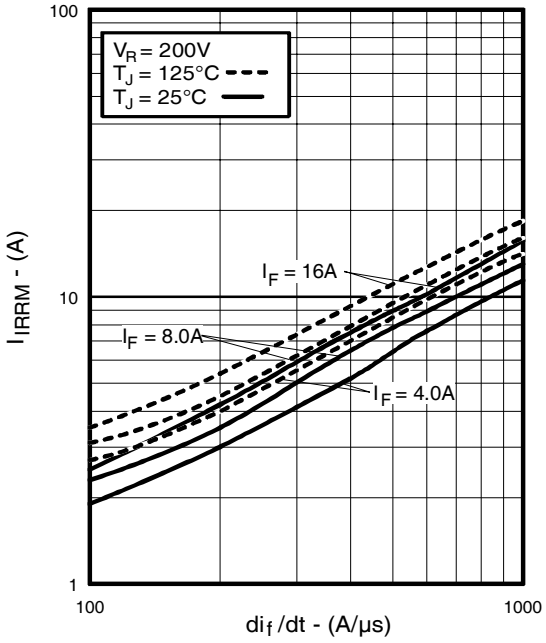



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

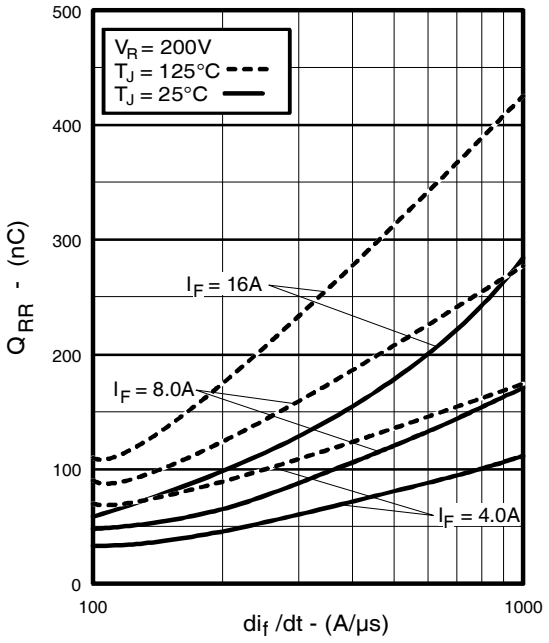



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

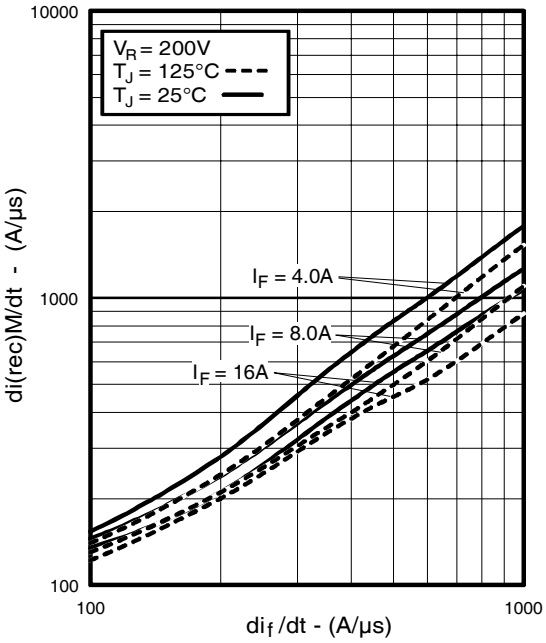



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

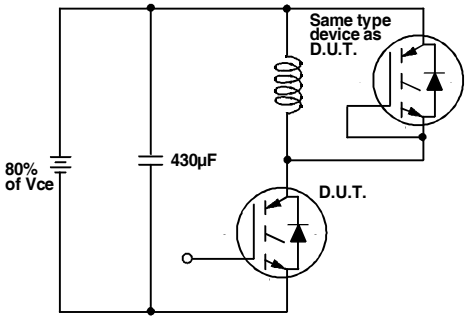



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

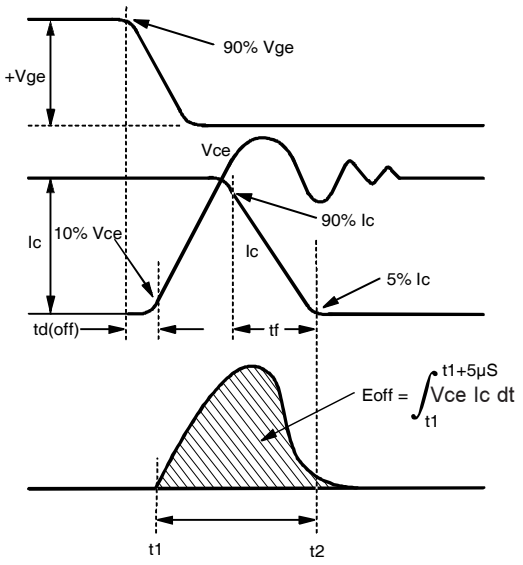



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

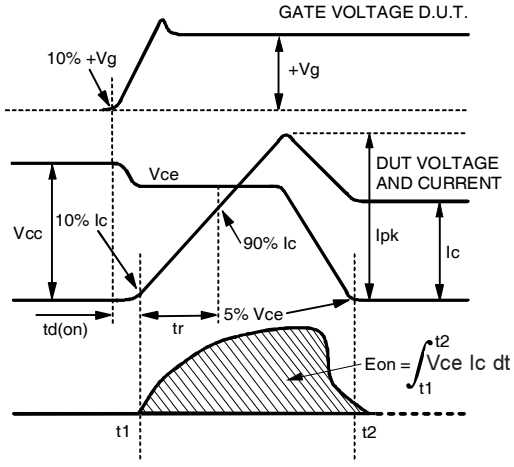



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

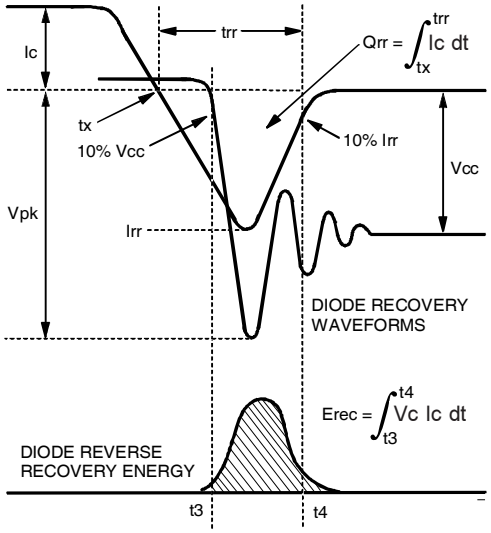



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

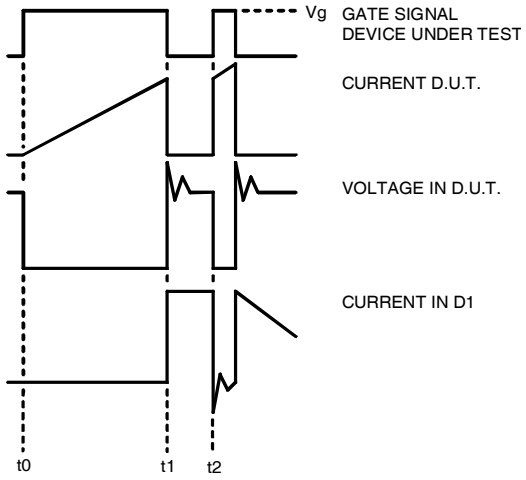



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

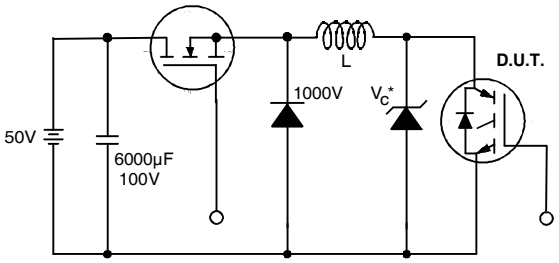



Figure 19. Clamped Inductive Load Test Circuit

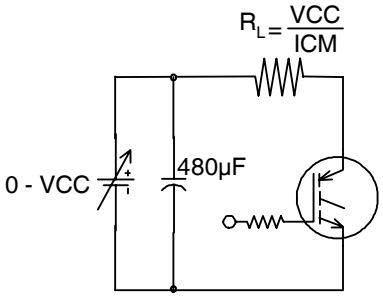



Figure 20. Pulsed Collector Current Test Circuit

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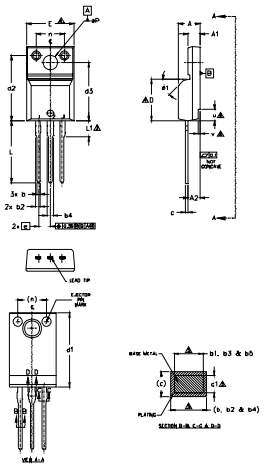
## TO-220AB Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.57 | 4.83 | .180 | .190 | |
| A1 | 2.57 | 2.83 | .101 | .111 | |
| A2 | 2.51 | 2.93 | .099 | .115 | |
| b | 0.61 | 0.94 | .024 | .037 | |
| b1 | 0.61 | 0.89 | .024 | .035 | 5 |
| b2 | 0.76 | 1.27 | .030 | .050 | |
| b3 | 0.76 | 1.22 | .030 | .048 | 5 |
| b4 | 1.02 | 1.52 | .040 | .060 | |
| b5 | 1.02 | 1.47 | .040 | .058 | 5 |
| c | 0.33 | 0.63 | .013 | .025 | |
| c1 | 0.33 | 0.58 | .013 | .023 | 5 |
| D | 8.66 | 9.80 | .341 | .386 | 4 |
| d1 | 15.80 | 16.13 | .622 | .635 | |
| d2 | 13.97 | 14.22 | .550 | .560 | |
| d3 | 12.30 | 12.93 | .484 | .509 | |
| E | 9.63 | 10.75 | .379 | .423 | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| L | 13.20 | 13.72 | .520 | .540 | |
| L1 | 3.37 | 3.67 | .122 | .146 | 3 |
| n | 6.05 | 6.60 | .238 | .260 | |
| øP | 3.05 | 3.45 | .120 | .136 | |
| u | 2.40 | 2.50 | .094 | .098 | 6 |
| v | 0.40 | 0.50 | .016 | .020 | 6 |
| ø1 | – | 45° | – | 45° | |

NOTES
1.0 DIMENSIONING AND TOLERANCING AS 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 .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTER MOST EXTREMES OF THE PLASTIC BODY.
5.0 DIMENSION b1, b3, b5 & c1 APPLY TO BASE METAL ONLY.
6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
7.0 CONTROLLING DIMENSION : INCHES.

LEAD ASSIGNMENTS

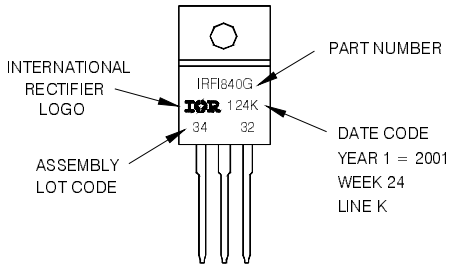
HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

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

## TO-220AB Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRFI840G
WITH ASSEMBLY
LOT CODE 3432
ASSEMBLED ON WW 24, 2001
IN THE ASSEMBLY LINE 'K'

Note: 'P' in assembly line position
indicates 'Lead-Free'




TO-220AB Full-Pak package is not recommended for Surface Mount Application.

## 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.

**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.

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**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
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