PD- 95565A

International
IOR Rectifier

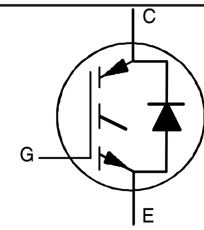
# IRG4BC20UD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

UltraFast CoPack IGBT

## Features

- UltraFast: Optimized for high operating frequencies 8-40 kHz in hard switching, >200kHz 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
- Lead-Free




N-channel

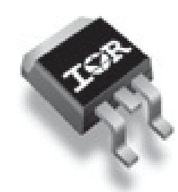
$V_{CES}$ = 600V

$V_{CE(on)}$ typ. = 1.85V

@$V_{GE}$ = 15V, $I_C$ = 6.5A

## Benefits

- Generation 4 IGBTs offers highest efficiencies available
- 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 | 13 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 6.5 | |
| $I_{CM}$ | Pulsed Collector Current ① | 52 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 52 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 7.0 | |
| $I_{FM}$ | Diode Maximum Forward Current | 52 | |
| $V_{GE}$ | 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 |
| | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | —— | 2.1 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.5 | —— | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | —— | 40 | |
| Wt | Weight | 1.44 | —— | g (oz) |



01/22/10

## 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 | — | 1.85 | 2.1 | V | $I_C$ = 6.5A | $V_{GE}$ = 15V |
| | | — | 2.27 | — | | $I_C$ = 13A | See Fig. 2, 5 |
| | | — | 1.87 | — | | $I_C$ = 6.5A, $T_J$ = 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 | 1.4 | 4.3 | — | S | $V_{CE}$ = 100V, $I_C$ = 6.5A | |
| $I_{CES}$ | 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 | 41 | nC | $I_C$ = 6.5A | |
| Qge | Gate - Emitter Charge (turn-on) | — | 4.5 | 6.8 | | $V_{CC}$ = 400V See Fig. 8 | |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 10 | 16 | | $V_{GE}$ = 15V | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 39 | — | ns | $T_J$ = 25°C | |
| $t_r$ | Rise Time | — | 15 | — | | $I_C$ = 6.5A, $V_{CC}$ = 480V | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 93 | 140 | | $V_{GE}$ = 15V, $R_G$ = 50Ω | |
| $t_f$ | Fall Time | — | 110 | 170 | | Energy losses include "tail" and | |
| $E_{on}$ | Turn-On Switching Loss | — | 0.16 | — | mJ | diode reverse recovery. | |
| $E_{off}$ | Turn-Off Switching Loss | — | 0.13 | — | | See Fig. 9, 10, 11, 18 | |
| $E_{ts}$ | Total Switching Loss | — | 0.29 | 0.3 | | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 38 | — | ns | $T_J$ = 150°C, See Fig. 9, 10, 11, 18 | |
| $t_r$ | Rise Time | — | 17 | — | | $I_C$ = 6.5A, $V_{CC}$ = 480V | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 100 | — | | $V_{GE}$ = 15V, $R_G$ = 50Ω | |
| $t_f$ | Fall Time | — | 220 | — | | Energy losses include "tail" and | |
| $E_{ts}$ | Total Switching Loss | — | 0.49 | — | mJ | diode reverse recovery. | |
| $L_E$ | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package | |
| $C_{ies}$ | Input Capacitance | — | 530 | — | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | — | 39 | — | | $V_{CC}$ = 30V See Fig. 7 | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 7.4 | — | | ƒ = 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 | |

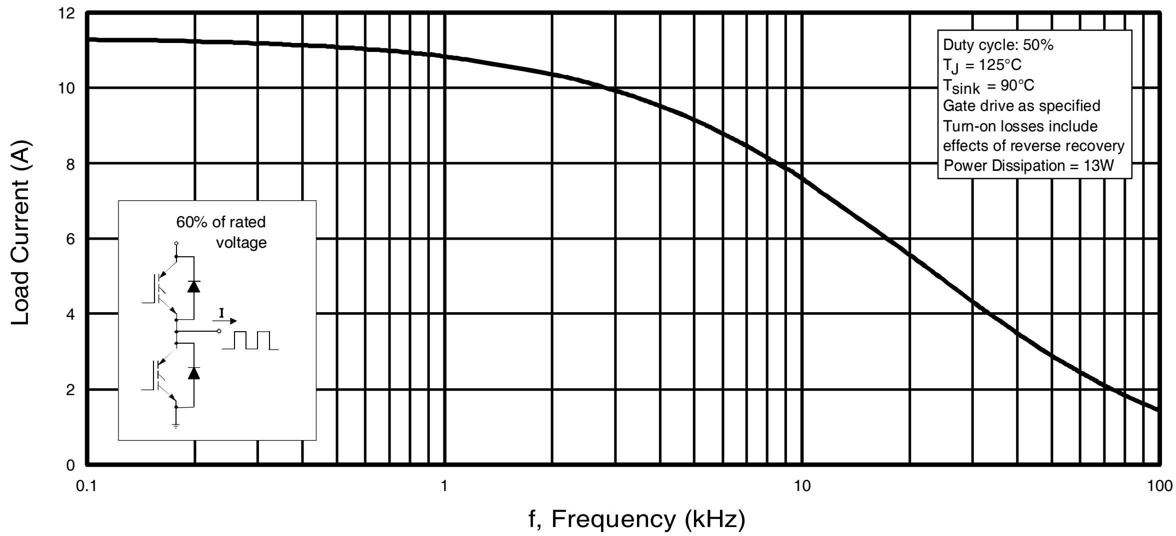



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

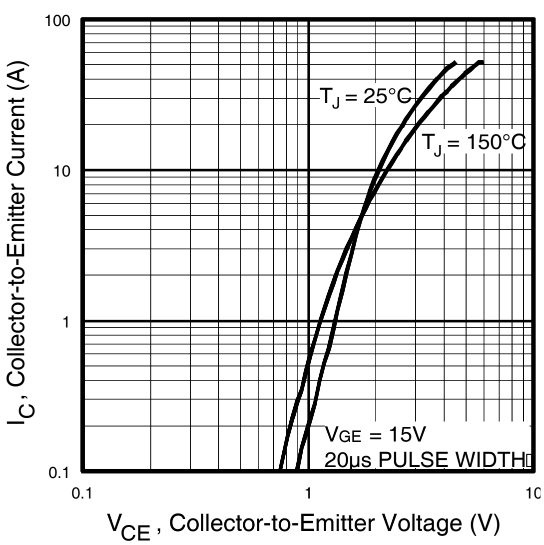



**Fig. 2** - Typical Output Characteristics

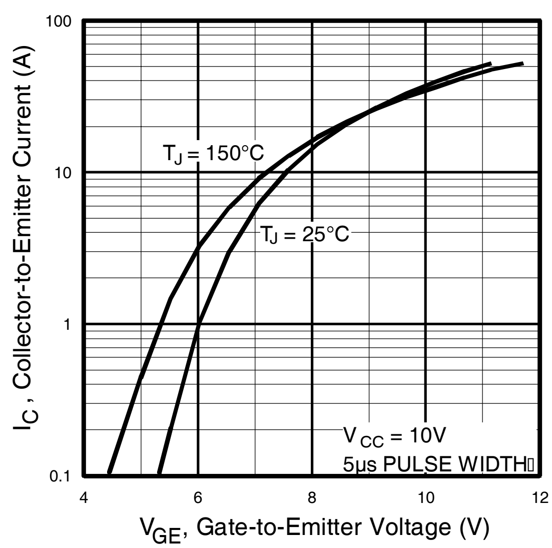



**Fig. 3** - Typical Transfer Characteristics

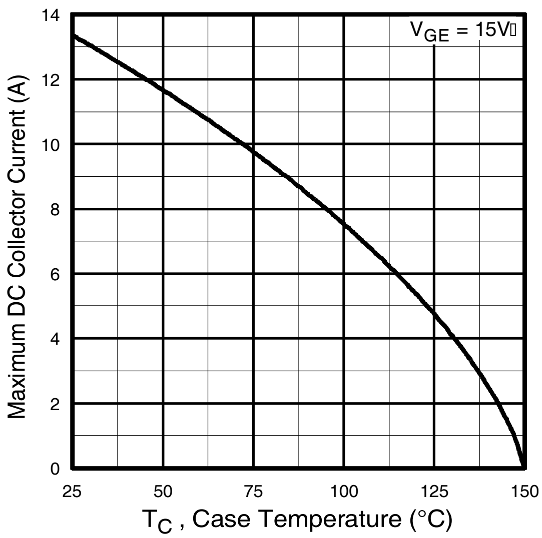



**Fig. 4** - Maximum Collector Current vs. Case Temperature

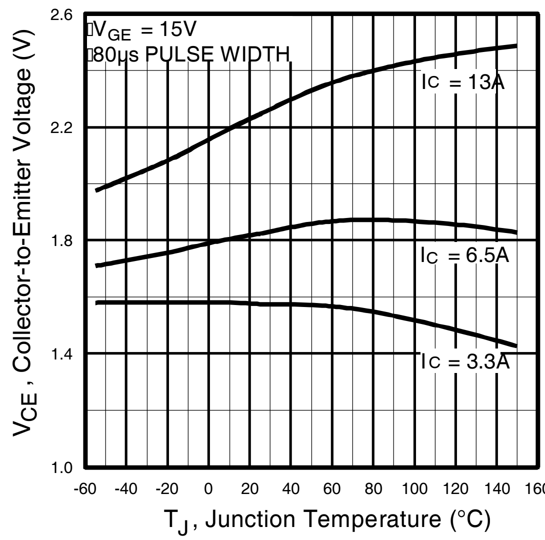



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

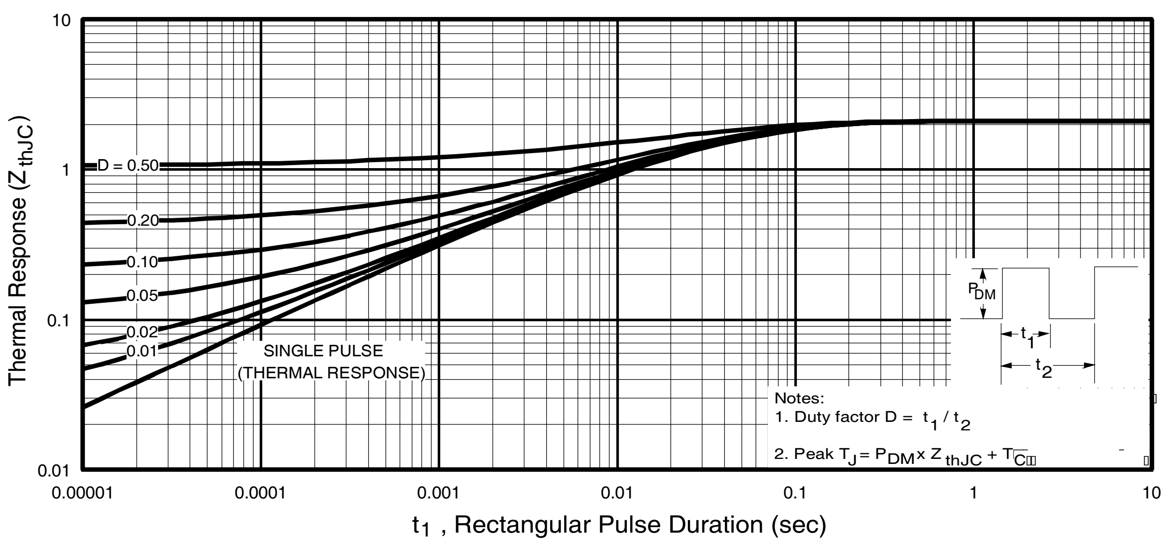



**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

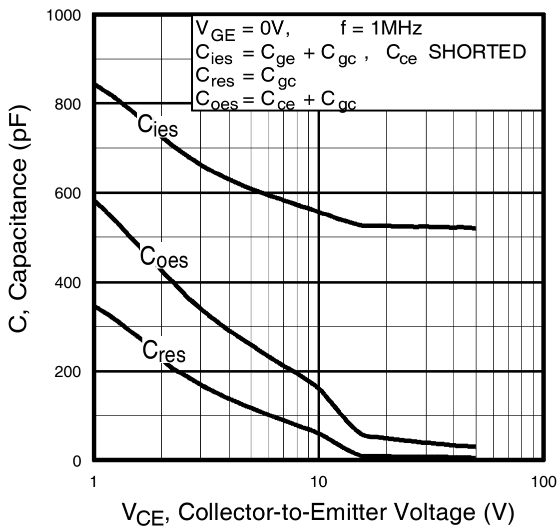



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

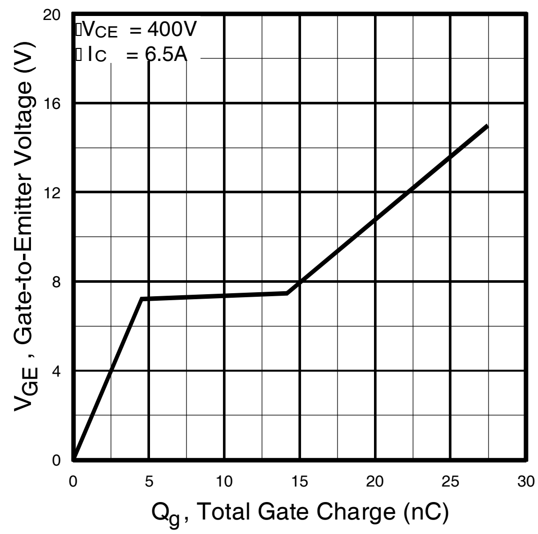



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

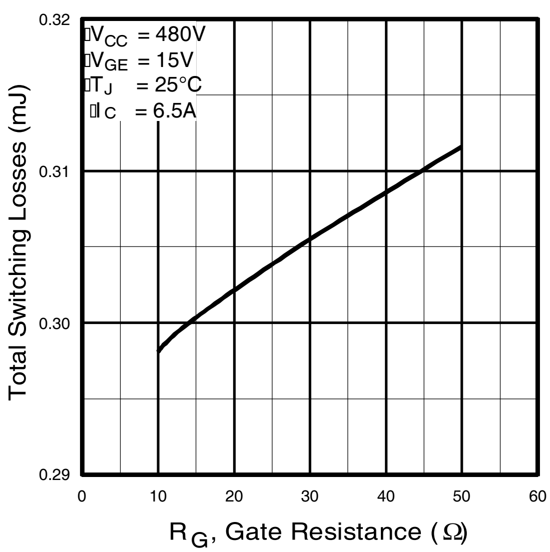



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

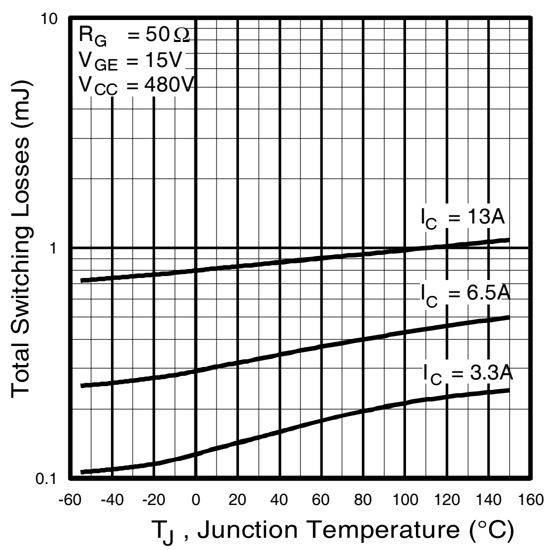



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

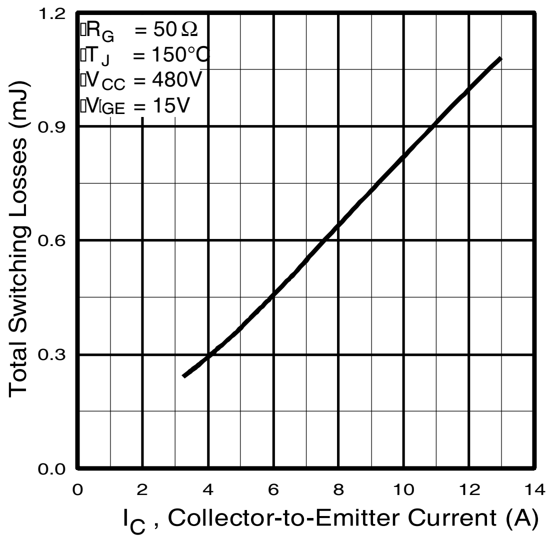



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

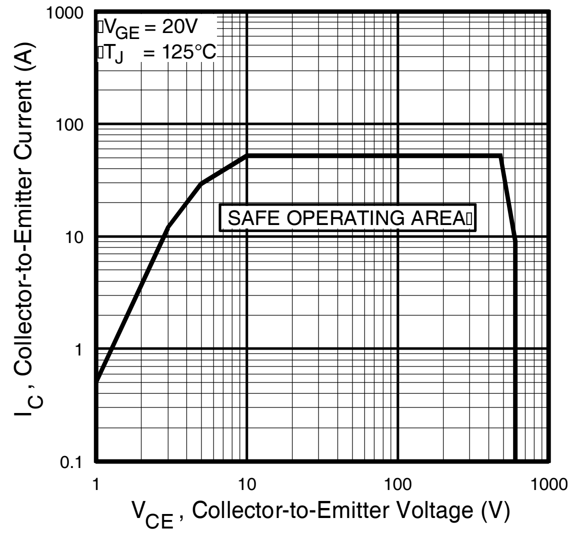



**Fig. 12** - Turn-Off SOA

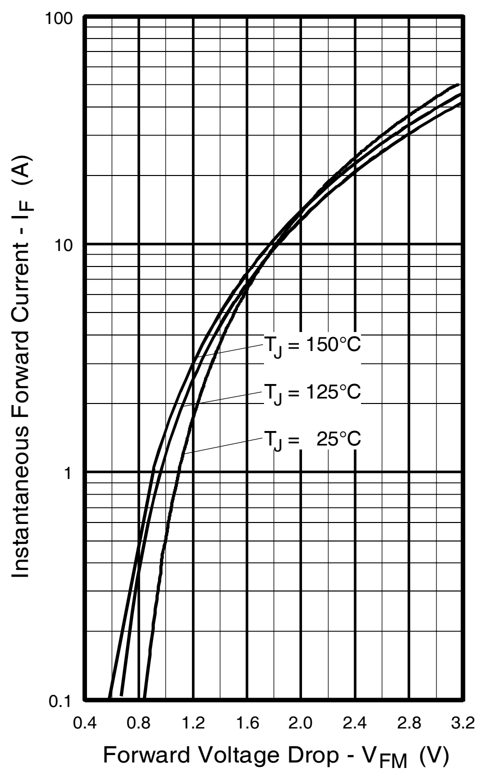



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

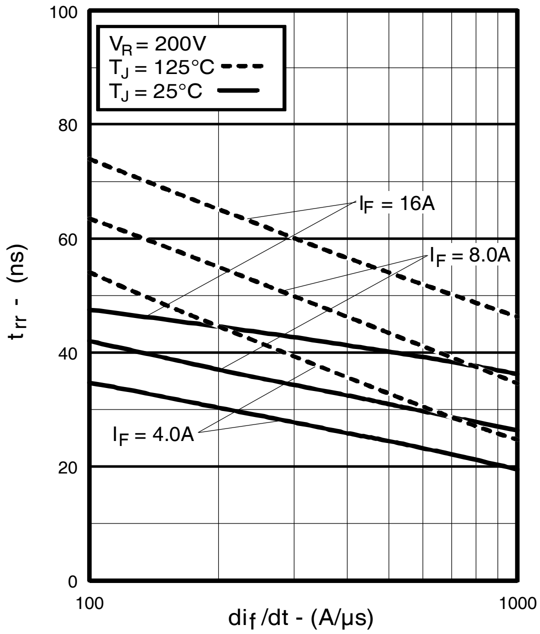



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

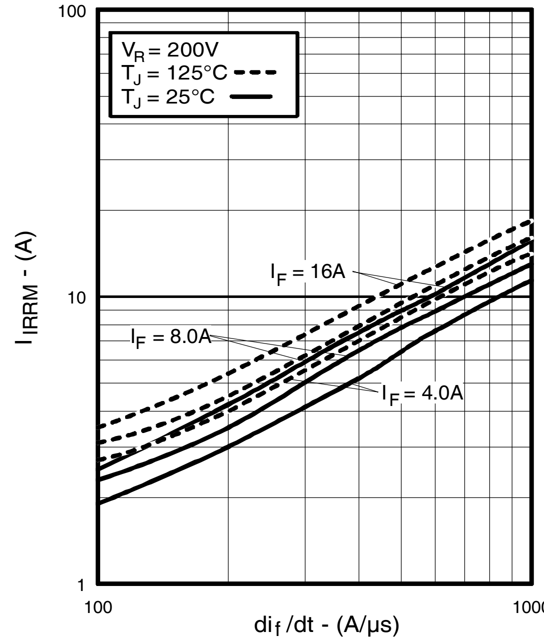



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

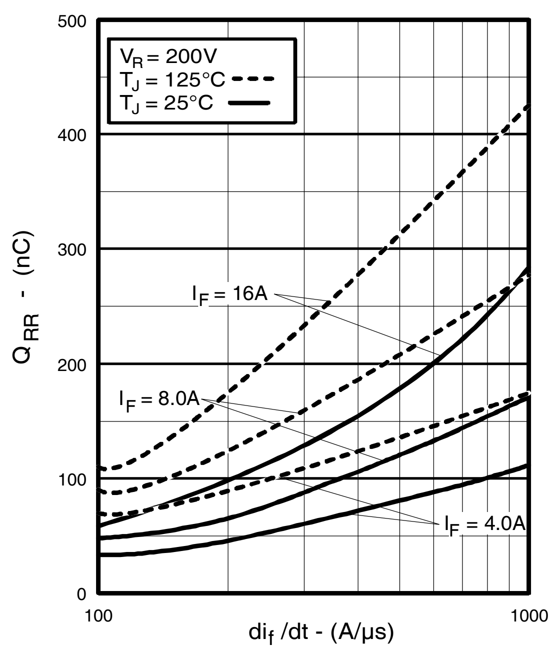



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

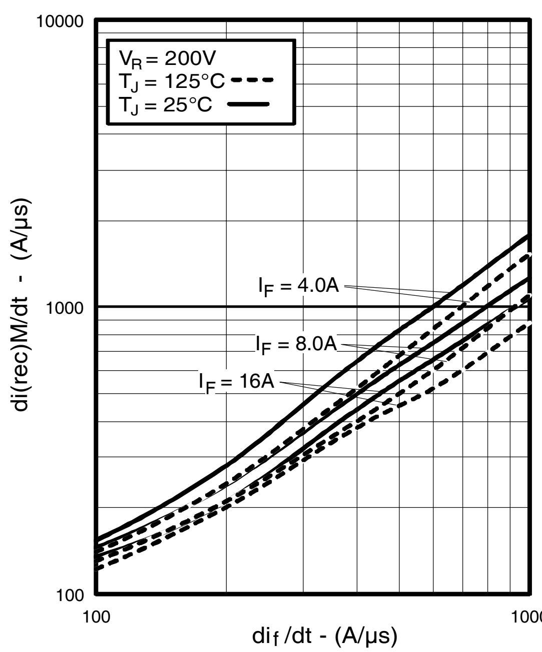



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

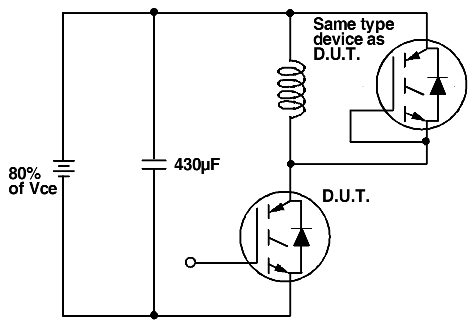



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

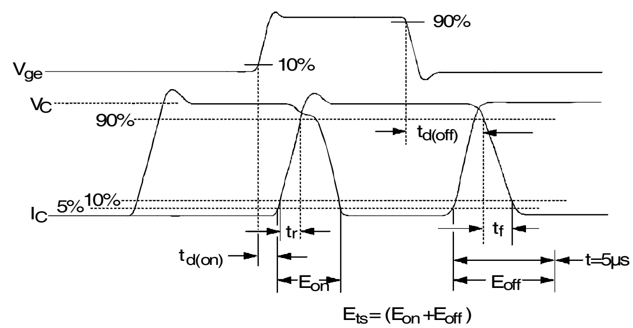



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

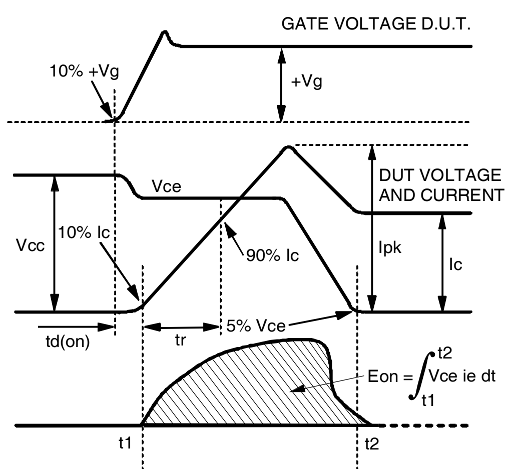



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

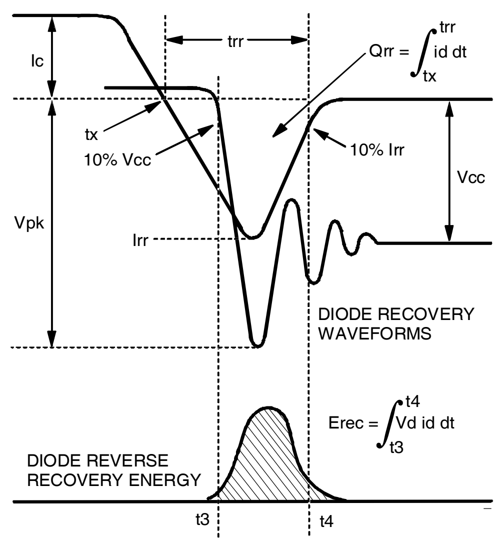



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

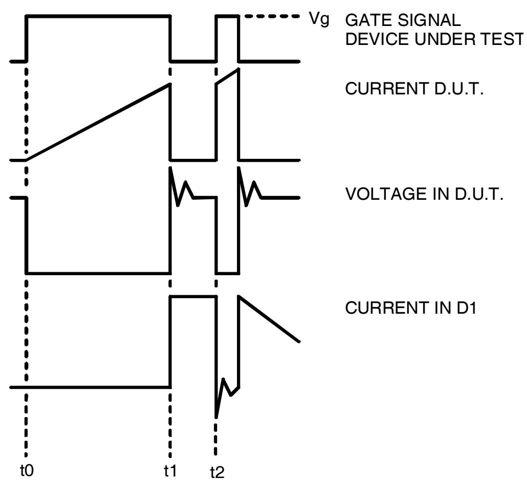



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

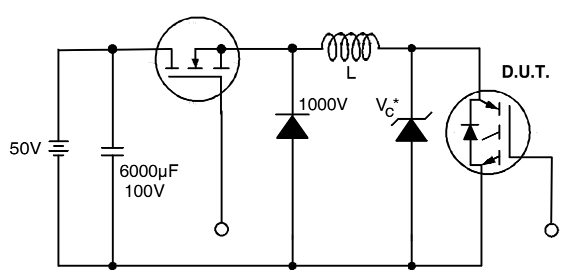



Figure 19. Clamped Inductive Load Test Circuit

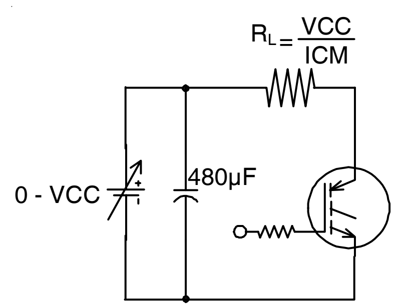
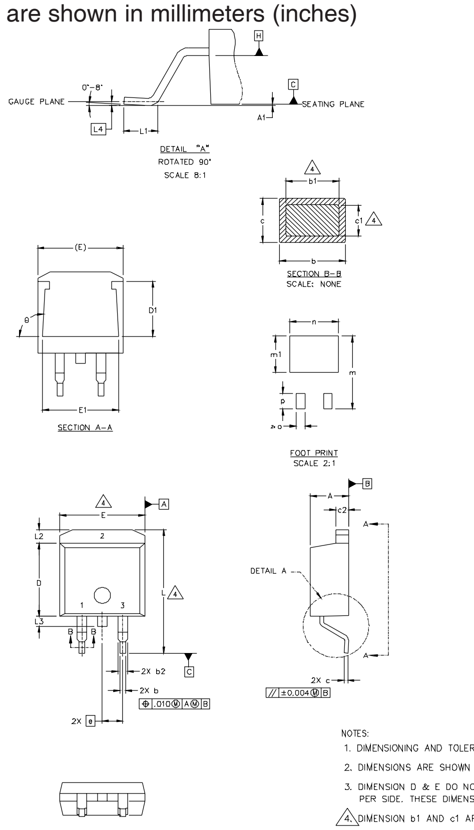



Figure 20. Pulsed Collector Current Test Circuit

## D2Pak Package Outline

Dimensions are shown in millimeters (inches)




| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | | 0.127 | | .005 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 4 |
| b2 | 1.14 | 1.40 | .045 | .055 | |
| c | 0.43 | 0.63 | .017 | .025 | |
| c1 | 0.38 | 0.74 | .015 | .029 | 4 |
| c2 | 1.14 | 1.40 | .045 | .055 | |
| D | 8.51 | 9.65 | .335 | .380 | 3 |
| D1 | 5.33 | | .210 | | |
| E | 9.65 | 10.67 | .380 | .420 | 3 |
| E1 | 6.22 | | .245 | | |
| e | 2.54 BSC | | .100 BSC | | |
| L | 14.61 | 15.88 | .575 | .625 | |
| L1 | 1.78 | 2.79 | .070 | .110 | |
| L2 | | 1.65 | | .065 | |
| L3 | 1.27 | 1.78 | .050 | .070 | |
| L4 | 0.25 BSC | | .010 BSC | | |
| m | 17.78 | | .700 | | |
| m1 | 8.89 | | .350 | | |
| n | 11.43 | | .450 | | |
| o | 2.08 | | .082 | | |
| p | 3.81 | | .150 | | |
| θ | 90° | 93° | 90° | 93° | |

LEAD ASSIGNMENTS

| HEXFET | IGBTs, CoPACK | DIODES |
|---|---|---|
| 1.– GATE | 1.– GATE | 1.– ANODE * |
| 2.– DRAIN | 2.– COLLECTOR | 2.– CATHODE |
| 3.– SOURCE | 3.– EMITTER | 3.– ANODE |

* PART DEPENDENT.

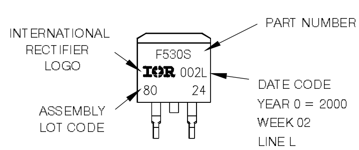
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

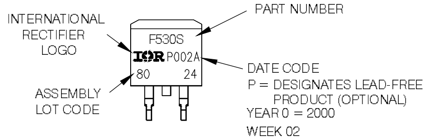
## D2Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH LOT CODE 8024
ASSEMBLED ON WW 02, 2000
IN THE ASSEMBLY LINE "L"

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



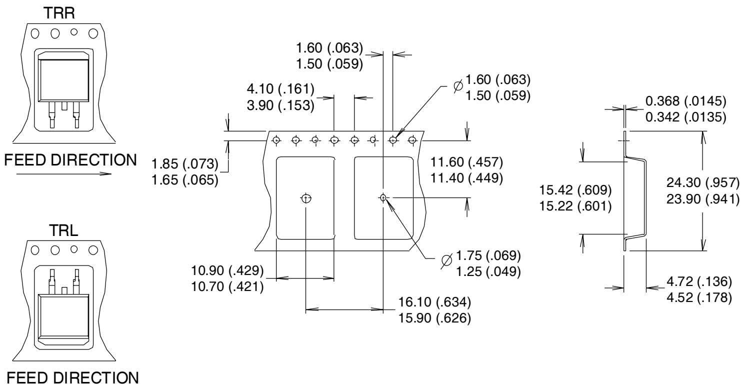

OR

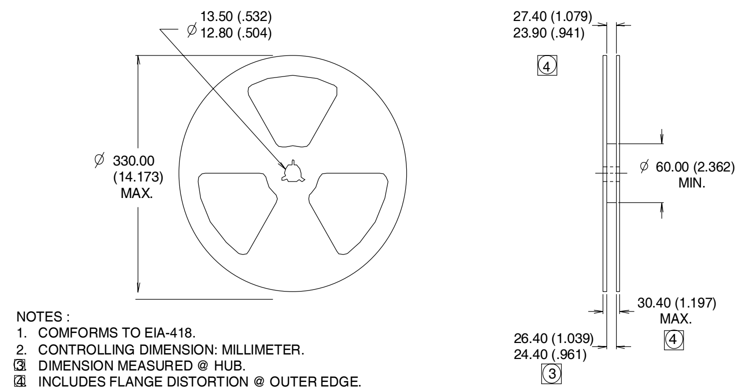



Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

# $D^2$Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)




## 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.

Data and specifications subject to change without notice.
This product has been designed and qualified for the Industrial market.
Qualification Standards can be found on IR's Web site.

International
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