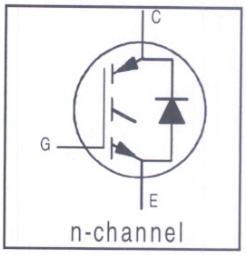
International
IOR Rectifier

PD - 94937

# IRG4PC40UDPbF

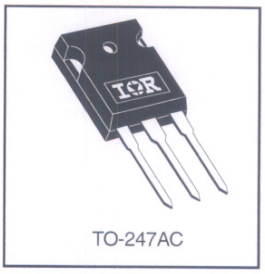
INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE




$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 1.72V

@$V_{GE}$ = 15V, $I_C$ = 20A




## Features

- UltraFast: Optimized for high operating frequencies 8-40 kHz in hard switching, >200 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 TO-247AC package
- Lead-Free

## Benefits

- Generation -4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's. Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBT's

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 40 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 20 | |
| $I_{CM}$ | Pulsed Collector Current ① | 160 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 160 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 15 | |
| $I_{FM}$ | Diode Maximum Forward Current | 160 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 160 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 65 | |
| $T_J$<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 | ------ | ------ | 0.77 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | ------ | ------ | 1.7 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ------ | 0.24 | ------ | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ----- | ----- | 40 | |
| Wt | Weight | ------ | 6 (0.21) | ------ | 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 | ---- | 0.63 | ---- | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | ---- | 1.72 | 2.1 | V | $I_C$ = 20A, $V_{GE}$ = 15V |
| | | ---- | 2.15 | ---- | | $I_C$ = 40A, See Fig. 2, 5 |
| | | ---- | 1.7 | ---- | | $I_C$ = 20A, $T_J$ = 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 | ---- | -13 | ---- | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA |
| $g_{fe}$ | Forward Transconductance ④ | 11 | 18 | ---- | S | $V_{CE}$ = 100V, $I_C$ = 20A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | ---- | ---- | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | ---- | ---- | 3500 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C |
| $V_{FM}$ | Diode Forward Voltage Drop | ---- | 1.3 | 1.7 | V | $I_C$ = 15A, See Fig. 13 |
| | | ---- | 1.2 | 1.6 | | $I_C$ = 15A, $T_J$ = 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) | ---- | 100 | 150 | nC | $I_C$ = 20A |
| Qge | Gate - Emitter Charge (turn-on) | ---- | 16 | 25 | | $V_{CC}$ = 400V, See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | ---- | 40 | 60 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 54 | ---- | ns | $T_J$ = 25°C |
| $t_r$ | Rise Time | ---- | 57 | ---- | | $I_C$ = 20A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 110 | 165 | | $V_{GE}$ = 15V, $R_G$ = 10Ω |
| $t_f$ | Fall Time | ---- | 80 | 120 | | Energy losses include "tail" and |
| $E_{on}$ | Turn-On Switching Loss | ---- | 0.71 | ---- | mJ | diode reverse recovery. |
| $E_{off}$ | Turn-Off Switching Loss | ---- | 0.35 | ---- | | See Fig. 9, 10, 11, 18 |
| $E_{ts}$ | Total Switching Loss | ---- | 1.10 | 1.5 | | |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 40 | ---- | ns | $T_J$ = 150°C, See Fig. 9, 10, 11, 18 |
| $t_r$ | Rise Time | ---- | 52 | ---- | | $I_C$ = 20A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 200 | ---- | | $V_{GE}$ = 15V, $R_G$ = 10Ω |
| $t_f$ | Fall Time | ---- | 130 | ---- | | Energy losses include "tail" and |
| $E_{ts}$ | Total Switching Loss | ---- | 1.6 | ---- | mJ | diode reverse recovery. |
| $L_E$ | Internal Emitter Inductance | ---- | 13 | ---- | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | ---- | 2100 | ---- | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | ---- | 140 | ---- | | $V_{CC}$ = 30V, See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | ---- | 34 | ---- | | $f$ = 1.0MHz |
| $t_{rr}$ | Diode Reverse Recovery Time | ---- | 42 | 60 | ns | $T_J$ = 25°C, See Fig. 14, $I_F$ = 15A |
| | | ---- | 74 | 120 | | $T_J$ = 125°C, $I_F$ = 15A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | ---- | 4.0 | 6.0 | A | $T_J$ = 25°C, See Fig. 15, $V_R$ = 200V |
| | | ---- | 6.5 | 10 | | $T_J$ = 125°C, $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | ---- | 80 | 180 | nC | $T_J$ = 25°C, See Fig. 16, di/dt 200A/µs |
| | | ---- | 220 | 600 | | $T_J$ = 125°C, di/dt 200A/µs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During $t_b$ | ---- | 190 | ---- | A/µs | $T_J$ = 25°C |
| | | ---- | 160 | ---- | | $T_J$ = 125°C |

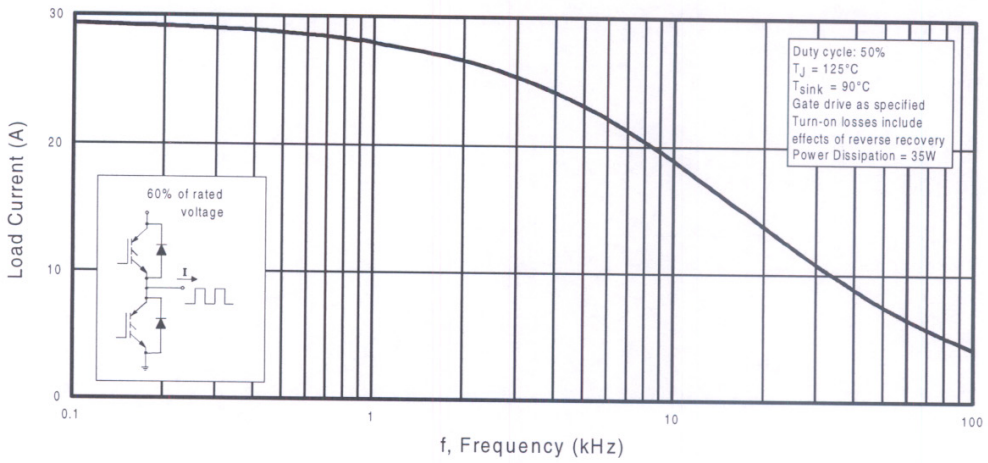



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

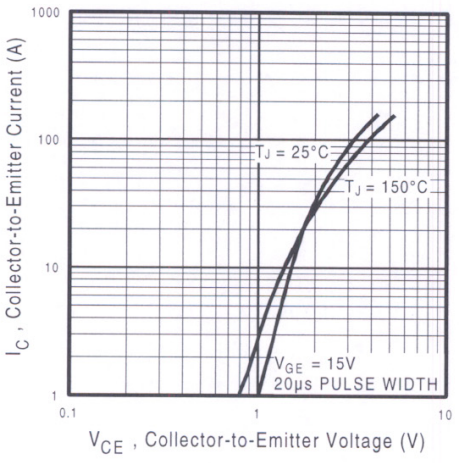



**Fig. 2** - Typical Output Characteristics

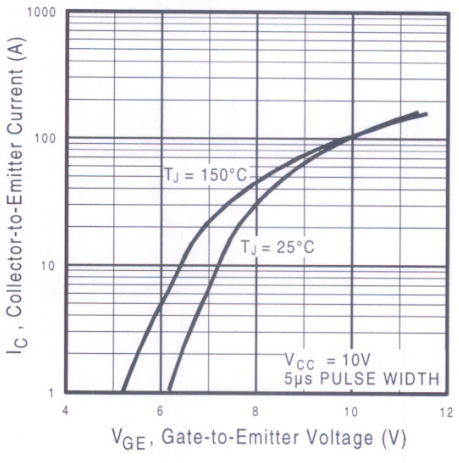



**Fig. 3** - Typical Transfer Characteristics

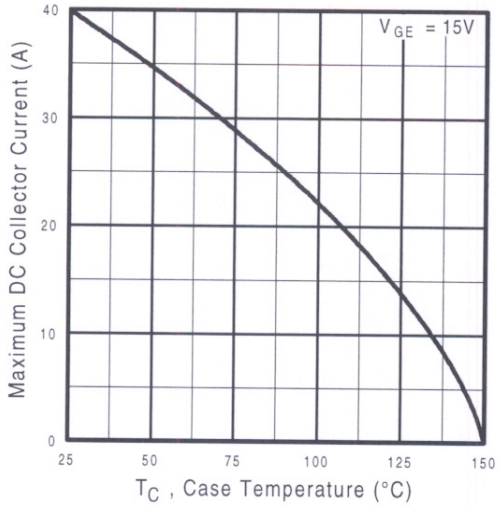



**Fig. 4** - Maximum Collector Current vs. Case Temperature

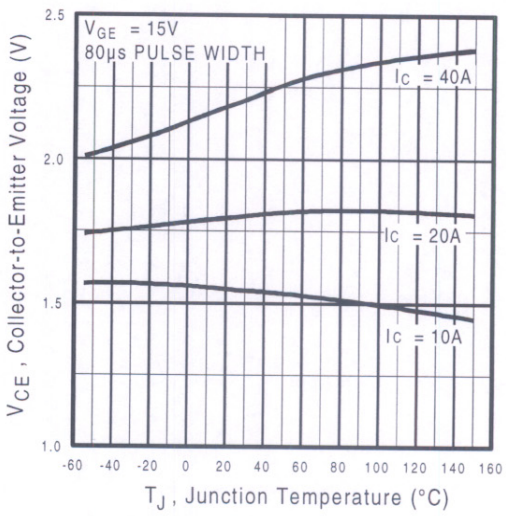



**Fig. 5** - Collector-to-Emitter Voltage vs. Junction Temperature

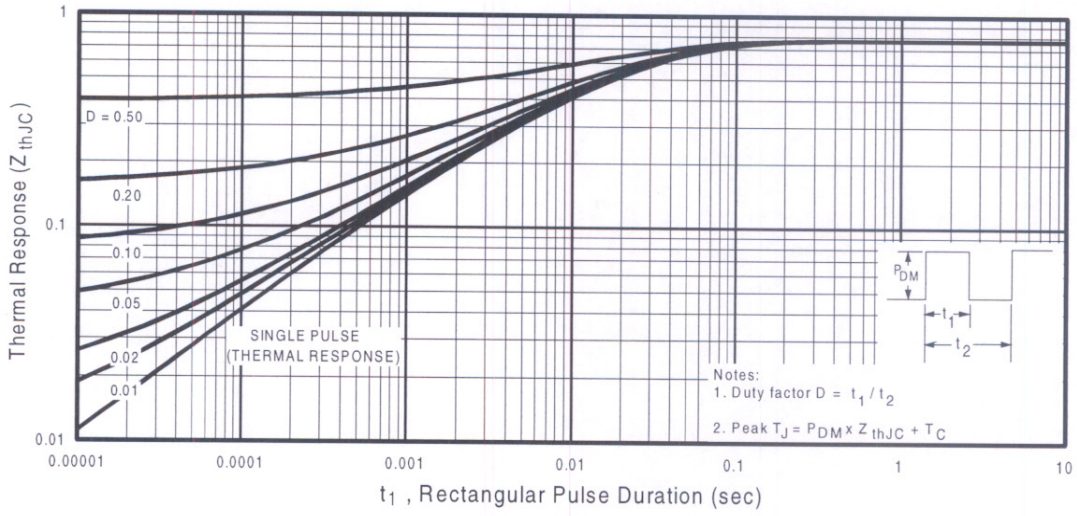



**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

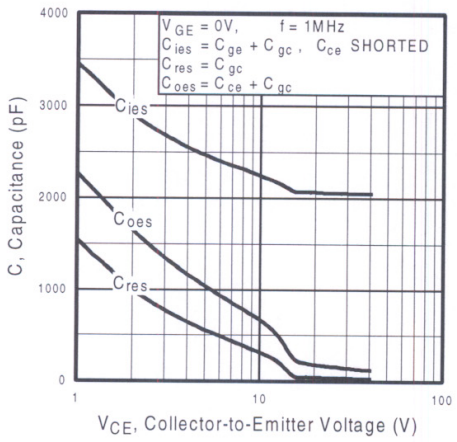



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

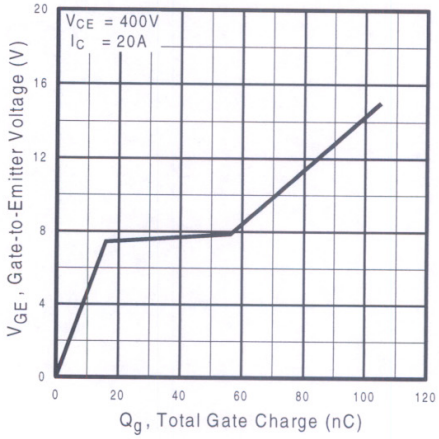



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

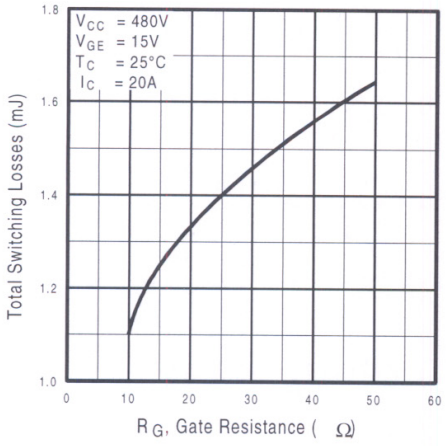



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

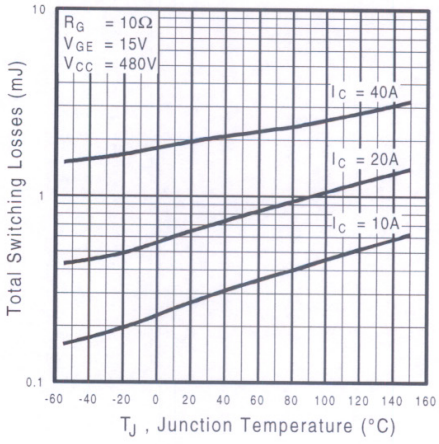



**Fig. 10** - Typical Switching Losses vs. Junction Temperature

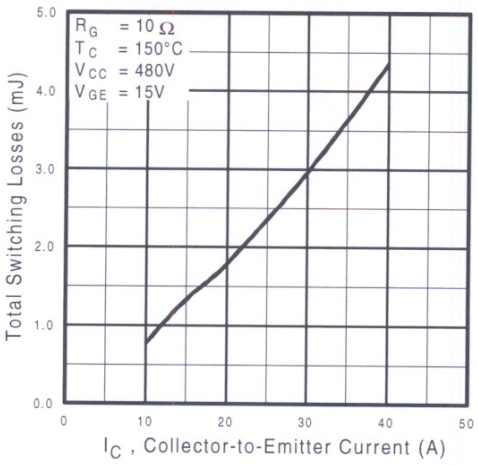



**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current

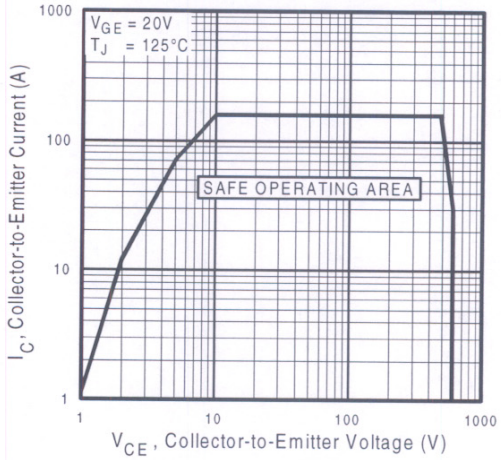



**Fig. 12** - Turn-Off SOA

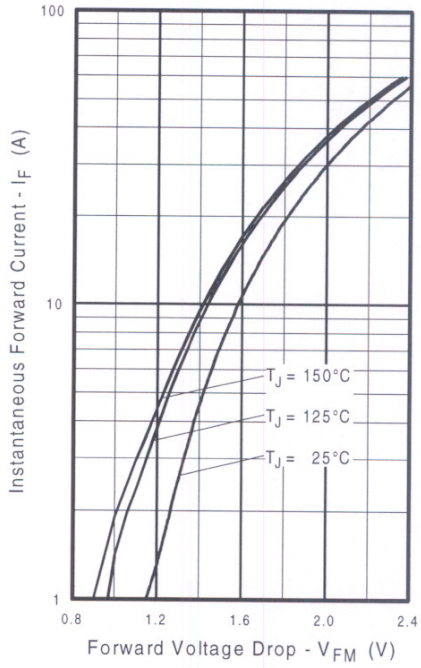



**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

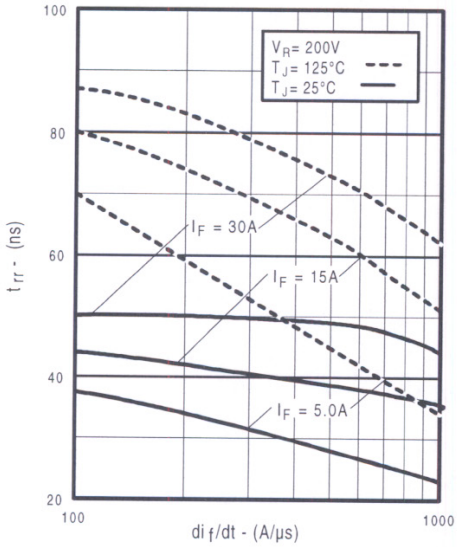



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

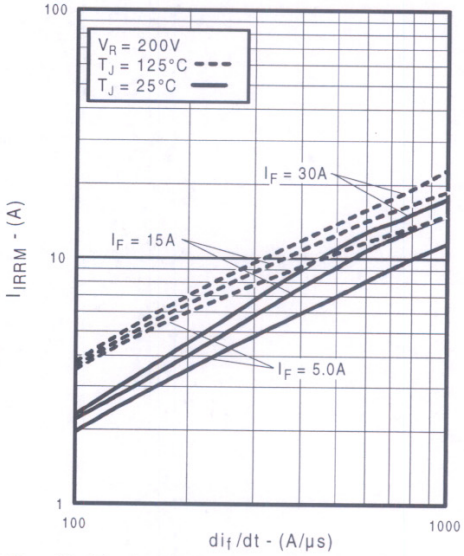



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

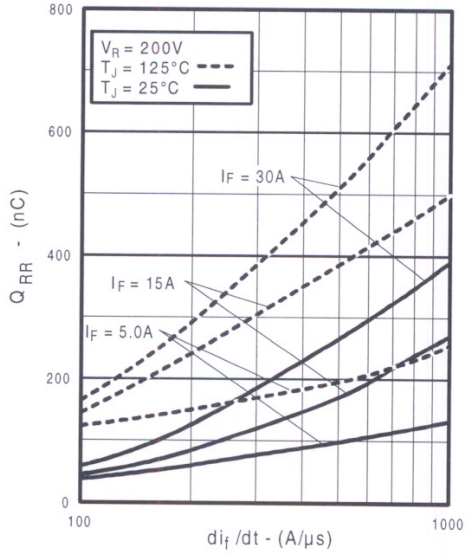



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

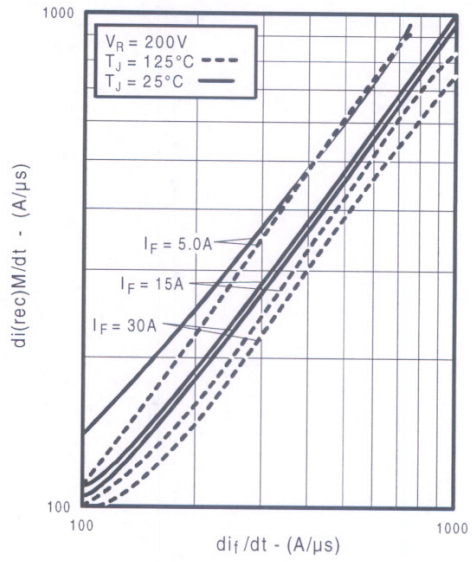



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

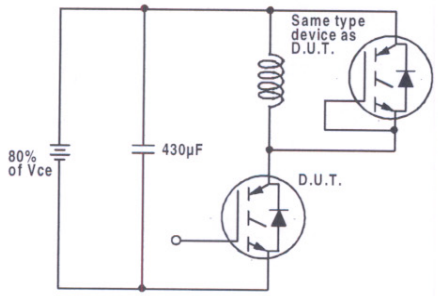



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

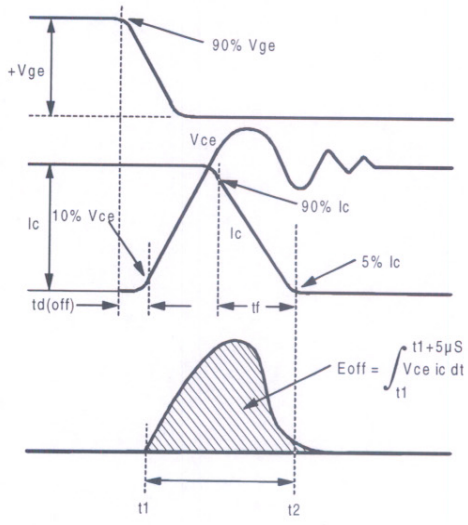



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

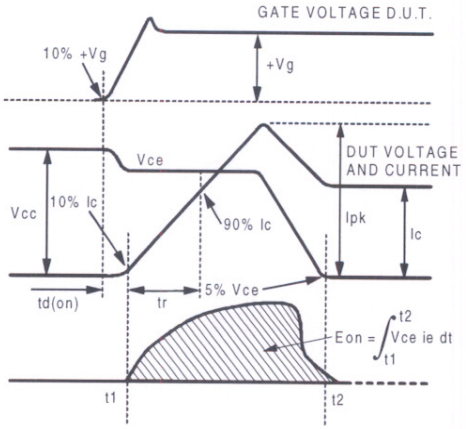



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

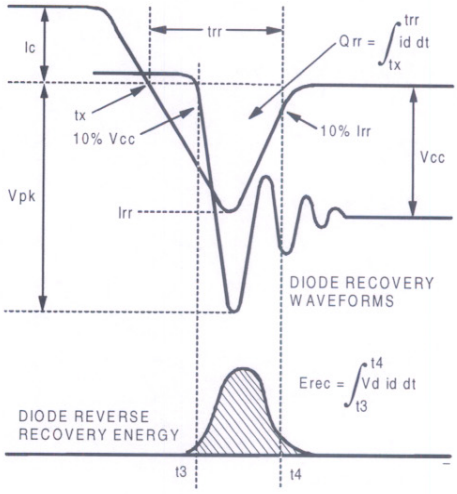



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

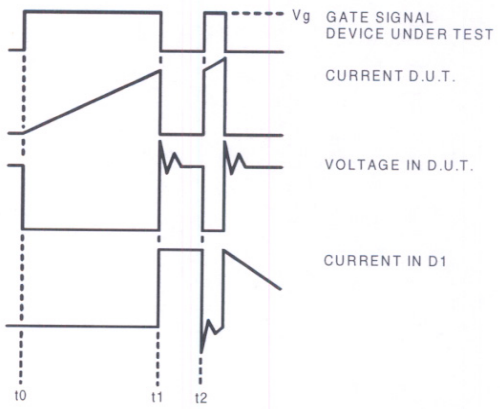



**Figure 18e.** Macro Waveforms for Figure 18a's Test Circuit

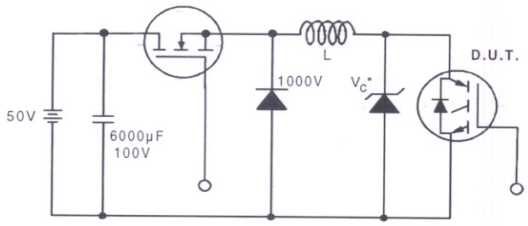



**Figure 19.** Clamped Inductive Load Test Circuit

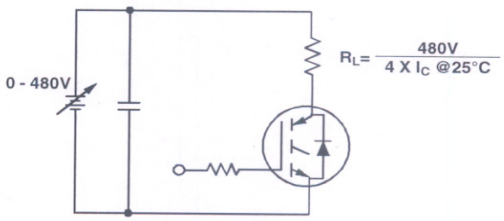
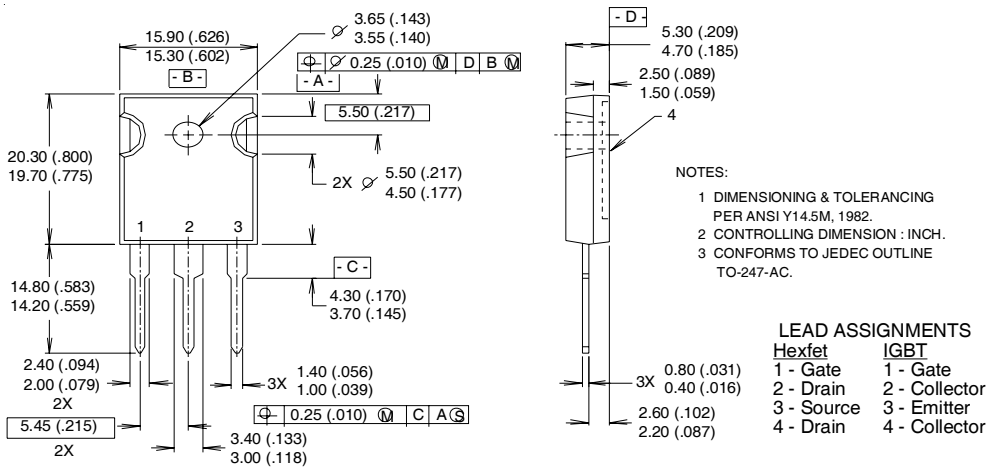



**Figure 20.** Pulsed Collector Current Test Circuit

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)




NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 CONFORMS TO JEDEC OUTLINE TO-247-AC.

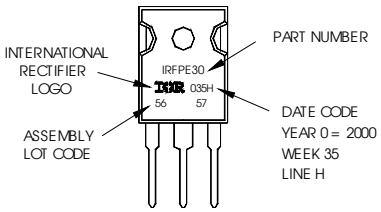
LEAD ASSIGNMENTS

| Hexfet | IGBT |
|---|---|
| 1 - Gate | 1 - Gate |
| 2 - Drain | 2 - Collector |
| 3 - Source | 3 - Emitter |
| 4 - Drain | 4 - Collector |

## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30
WITH ASSEMBLY
LOT CODE 5657
ASSEMBLED ON WW 35, 2000
IN THE ASSEMBLY LINE "H"

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




## 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, $R_G$= 10Ω (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.

International
IOR Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
Visit us at www.irf.com for sales contact information.01/04

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

Стандарт Электрон Связь

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**Телефон:** +7 812 627 14 35

**Электронная почта:** sales@st-electron.ru

**Адрес:** 198099, Санкт-Петербург,
Промышленная ул, дом № 19, литера Н,
помещение 100-Н Офис 331