PD - 94290

International
IOR Rectifier

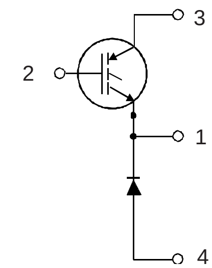
# GA100NA60U

INSULATED GATE BIPOLAR TRANSISTOR

Ultra-Fast™ Speed IGBT

## Features

- UltraFast™: Optimized for minimum saturation voltage and operating frequencies up to 40 kHz in hard switching, > 200 kHz in resonant mode
- Very low conduction and switching losses
- Fully isolated package (2,500 Volt AC/RMS)
- Very low internal inductance (≤ 5 nH typ.)
- Industry standard outline




$V_{CES}$ = 600V

$V_{CE(on)\ typ.}$ = 1.49V

@$V_{GE}$ = 15V, $I_C$ = 50A

## Benefits

- Designed for increased operating efficiency in power conversion: PFC, UPS, SMPS, Welding, Induction heating
- Lower overall losses available at frequencies ≥ 20kHz
- Easy to assemble and parallel
- Direct mounting to heatsink
- Lower EMI, requires less snubbing
- Plug-in compatible with other SOT-227 packages

SOT-227

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 100 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 50 | |
| $I_{CM}$ | Pulsed Collector Current | 200 | |
| $I_{LM}$ | Clamped Inductive Load Current② | 200 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $V_{ISOL}$ | RMS Isolation Voltage, Any Terminal to Case, t=1 min | 2500 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 250 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 100 | |
| $T_J$ | Operating Junction | -55 to + 150 | °C |
| $T_{STG}$ | Storage Temperature Range | -55 to + 150 | |
| | Mounting Torque, 6-32 or M3 Screw | 12 lbf •in(1.3N•m) | |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case, IGBT | —— | 0.50 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case , Diode | —— | 1.0 | |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.05 | —— | |
| Wt | Weight of Module | 30 | —— | gm |



7/27/01

## 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 | — | 0.36 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.49 | 2.1 | V | $I_C$ = 50A | $V_{GE}$ = 15V |
| | | — | 1.80 | — | | $I_C$ = 100A | See Fig. 1, 4 |
| | | — | 1.47 | — | | $I_C$ = 50A, $T_J$ = 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 | — | -7.6 | — | mV/°C | $V_{CE} = V_{GE}$, $I_C$ = 250µA | |
| $g_{fe}$ | Forward Transconductance ④ | 34 | 52 | — | S | $V_{CE}$ = 100V, $I_C$ = 50A | |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 250 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V | |
| | | — | — | 1.3 | mA | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°C | |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 1.3 | 1.6 | V | $I_C$ = 50A | See Fig. 12 |
| | | — | 1.16 | 1.3 | | $I_C$ = 50A, $T_J$ = 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) | — | 430 | 640 | nC | $I_C$ = 50A | | |
| Qge | Gate - Emitter Charge (turn-on) | — | 48 | 72 | | $V_{CC}$ = 400V | See Fig. 7 | |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 130 | 190 | | $V_{GE}$ = 15V | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 57 | — | ns | $T_J$ = 25°C | | |
| $t_r$ | Rise Time | — | 80 | — | | $I_C$ = 60A, $V_{CC}$ = 480V | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 240 | — | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω | | |
| $t_f$ | Fall Time | — | 120 | — | | Energy losses include "tail" and | | |
| $E_{on}$ | Turn-On Switching Loss | — | 0.41 | — | mJ | diode reverse recovery. | | |
| $E_{off}$ | Turn-Off Switching Loss | — | 2.51 | — | | | | |
| $E_{ts}$ | Total Switching Loss | — | 2.92 | 4.4 | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 57 | — | ns | $T_J$ = 150°C, | | |
| $t_r$ | Rise Time | — | 80 | — | | $I_C$ = 60A, $V_{CC}$ = 480V | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 380 | — | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω | | |
| $t_f$ | Fall Time | — | 170 | — | | Energy losses include "tail" and | | |
| $E_{ts}$ | Total Switching Loss | — | 4.78 | — | mJ | diode reverse recovery. | | |
| $L_E$ | Internal Emitter Inductance | — | 2.0 | — | nH | | | |
| $C_{ies}$ | Input Capacitance | — | 7400 | — | pF | $V_{GE}$ = 0V | | |
| $C_{oes}$ | Output Capacitance | — | 730 | — | | $V_{CC}$ = 30V | See Fig. 6 | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 90 | — | | $f$ = 1.0MHz | | |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 90 | 140 | ns | $T_J$ = 25°C | See Fig. | |
| | | — | 120 | 180 | | $T_J$ = 125°C | 13 | $I_F$ = 50A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 7.3 | 11 | A | $T_J$ = 25°C | See Fig. | |
| | | — | 11 | 16 | | $T_J$ = 125°C | 14 | $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 360 | 550 | nC | $T_J$ = 25°C | See Fig. | |
| | | — | 780 | 1200 | | $T_J$ = 125°C | 15 | di/dt = 200Aµs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery | — | 370 | — | A/µs | $T_J$ = 25°C | See Fig. | |
| | During $t_b$ | — | 220 | — | | $T_J$ = 125°C | 16 | |

Details of note ① through ④ are on the page 7

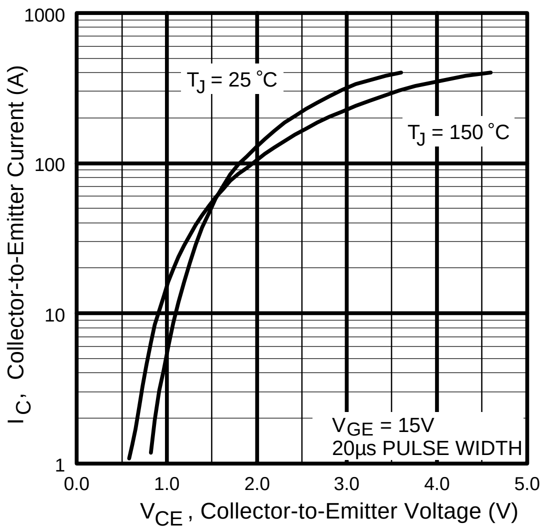



**Fig. 1** - Typical Output Characteristics

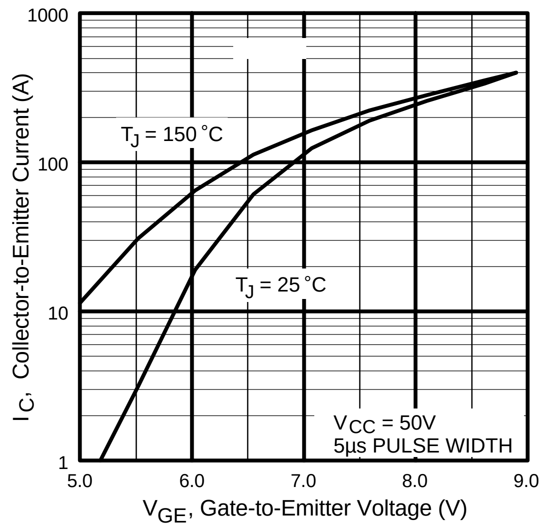



**Fig. 2** - Typical Transfer Characteristics

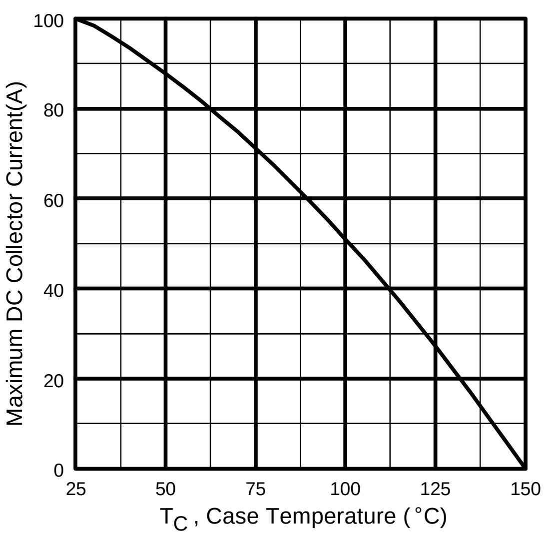



**Fig. 3** - Maximum Collector Current vs. Case Temperature

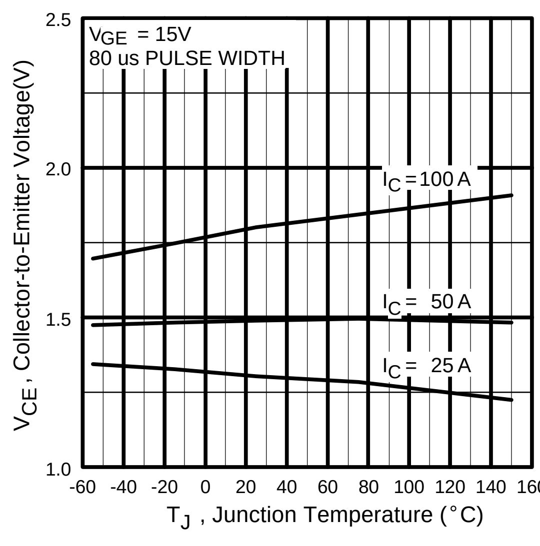



**Fig. 4 -** Typical Collector-to-Emitter Voltage vs. Junction Temperature

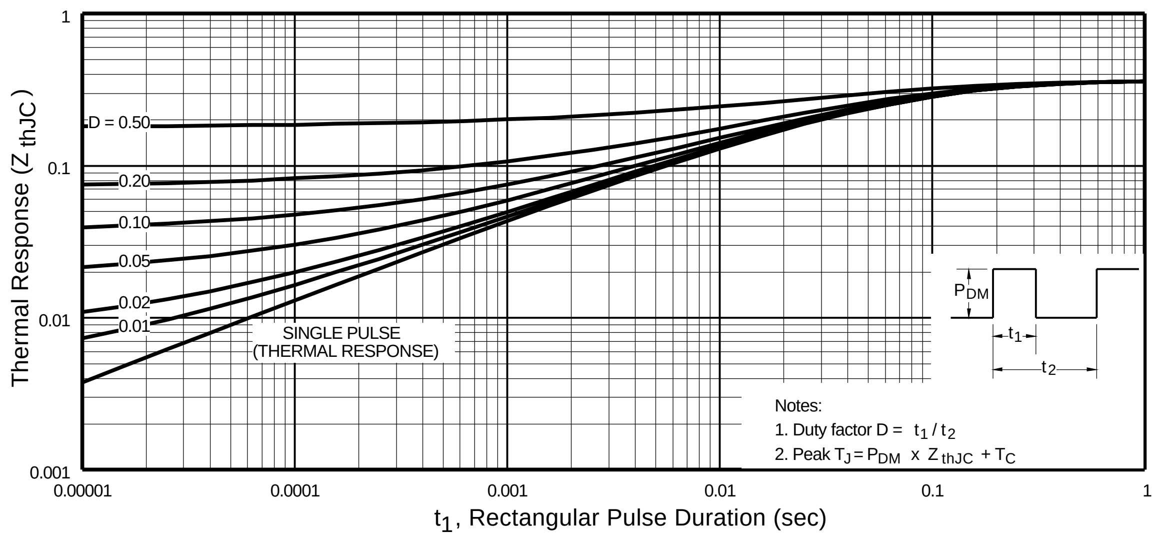



**Fig. 5** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

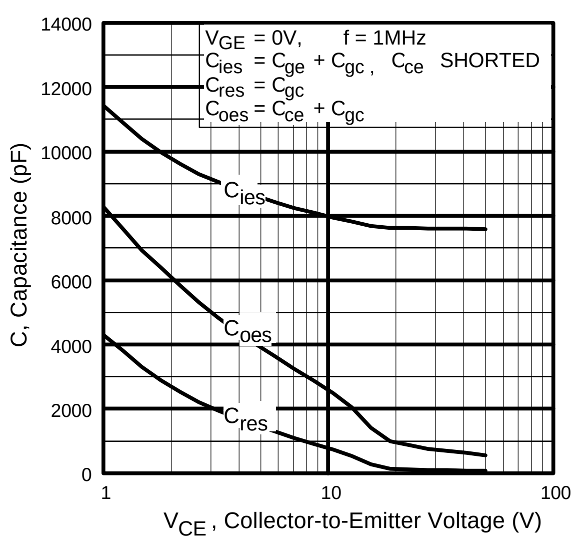



**Fig. 6 -** Typical Capacitance vs. Collector-to-Emitter Voltage

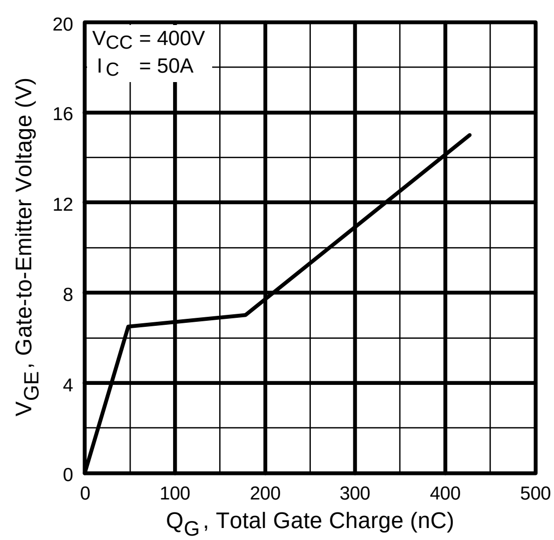



**Fig. 7 -** Typical Gate Charge vs. Gate-to-Emitter Voltage

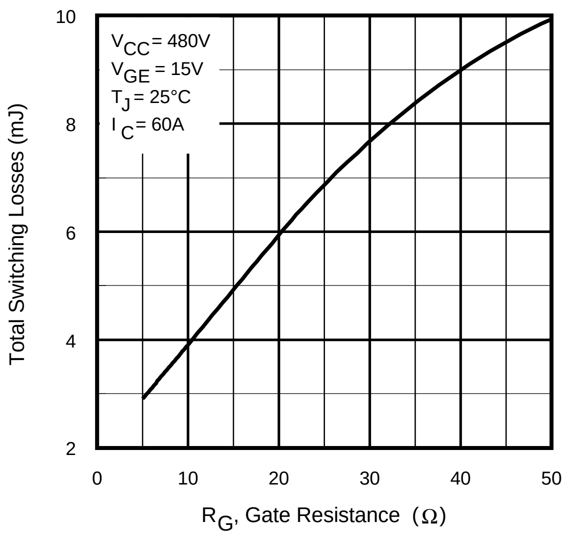



**Fig. 8 -** Typical Switching Losses vs. Gate Resistance

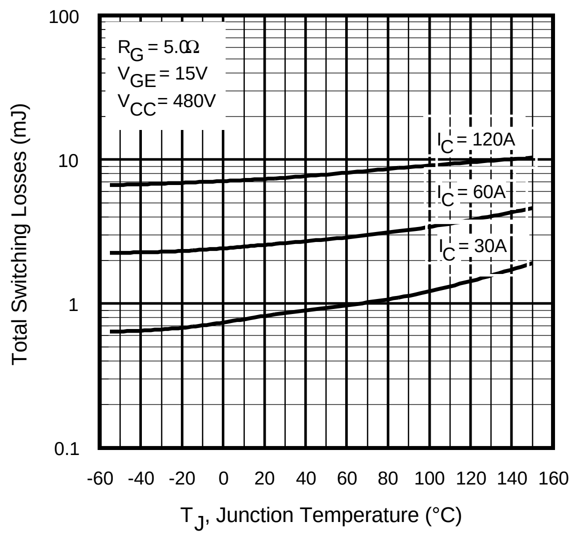



**Fig. 9 -** Typical Switching Losses vs. Junction Temperature

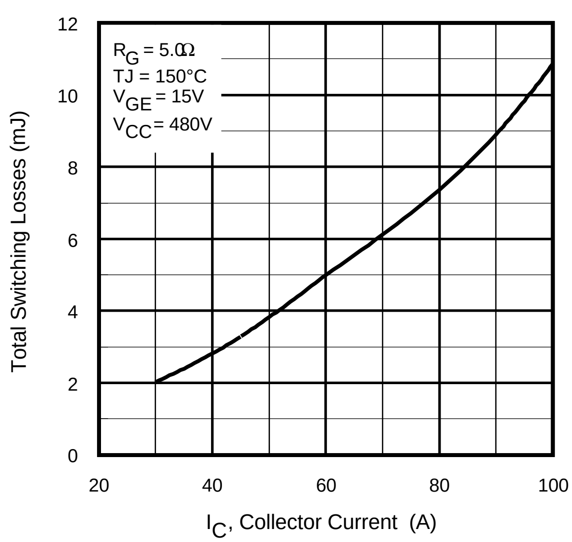



**Fig. 10 -** Typical Switching Losses vs. Collector-to-Emitter Current

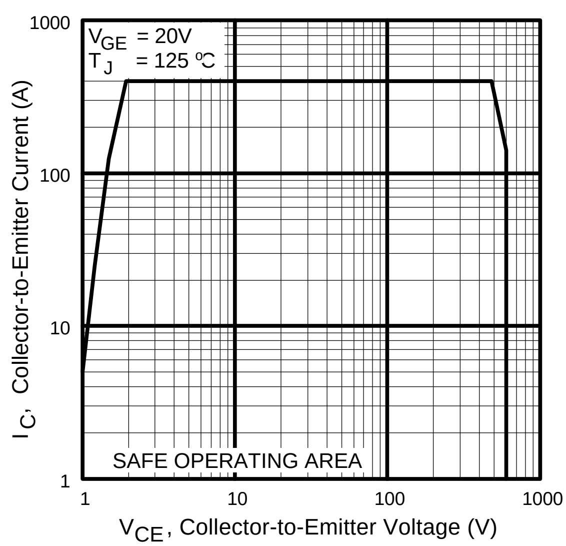



**Fig. 11** - Turn-Off SOA

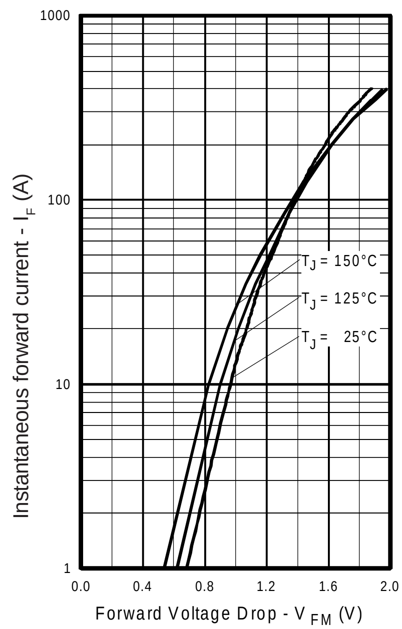



**Fig. 12** - Typical Forward Voltage Drop vs. Instantaneous Forward Current

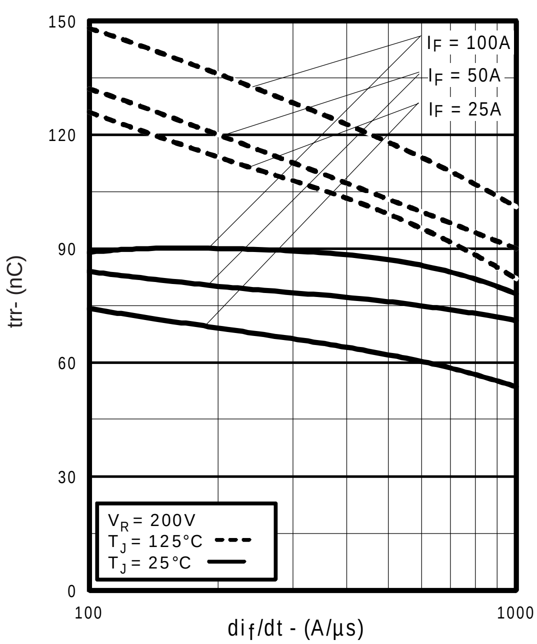



**Fig. 13** - Typical Reverse Recovery vs. $di_f/dt$

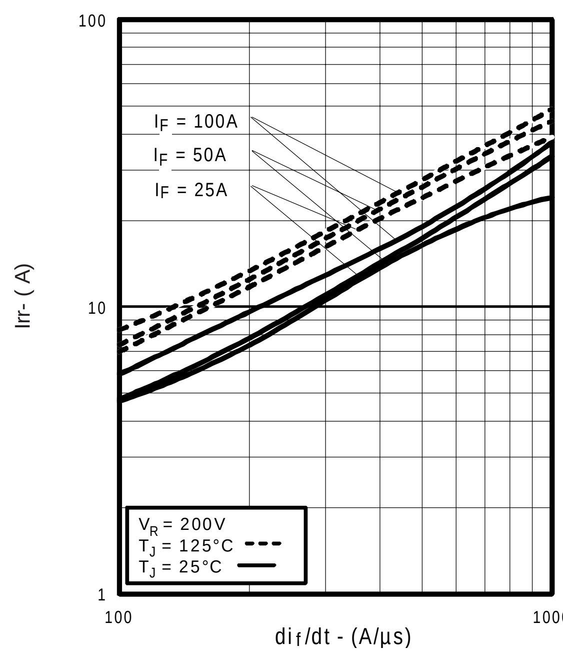



**Fig. 14** - Typical Recovery Current vs. $di_f/dt$

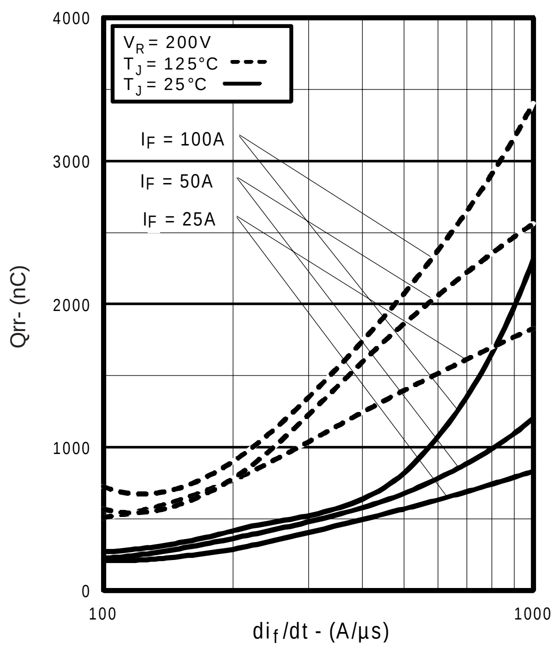



**Fig. 15 -** Typical Stored Charge vs. $di_f/dt$

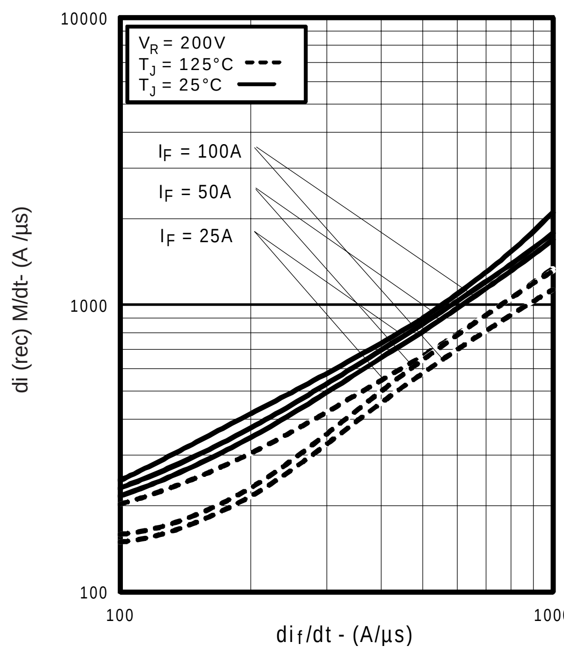



**Fig. 16 -** Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

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, $R_G$= 5.0Ω (figure 19)
③ Pulse width ≤ 80µs; duty factor ≤ 0.1%.
④ Pulse width 5.0µs, single shot.

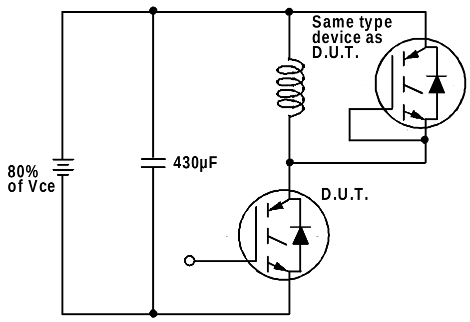



**Fig. 17a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

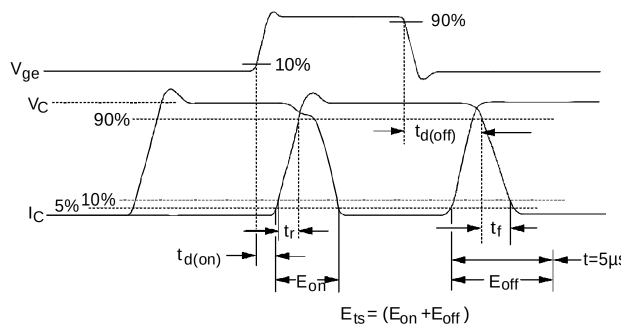



**Fig. 17b** - Test Waveforms for Circuit of Fig. 17a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

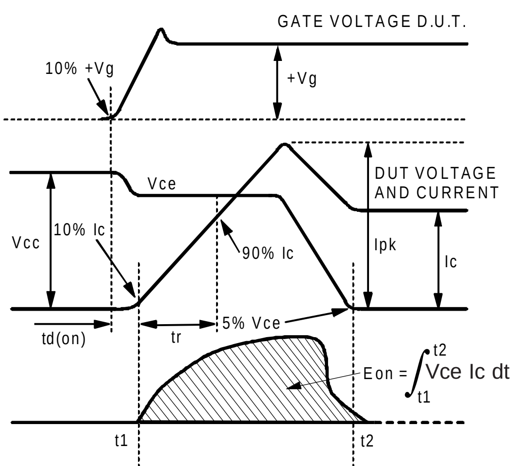



**Fig. 17c** - Test Waveforms for Circuit of Fig. 17a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

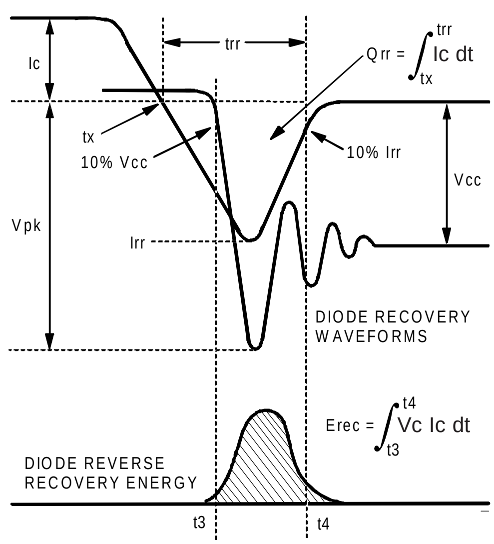



**Fig. 17d** - Test Waveforms for Circuit of Fig. 17a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

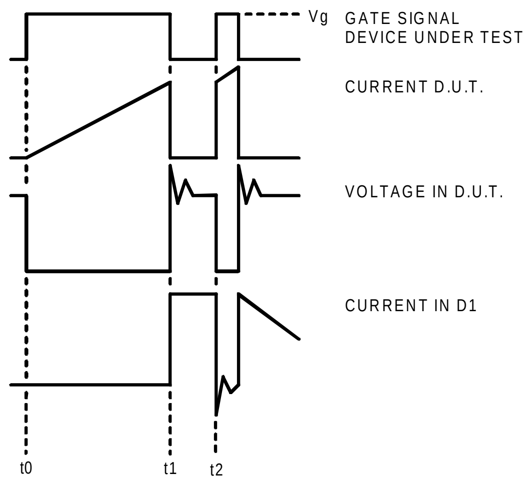



Figure 17e. Macro Waveforms for Figure 17a's Test Circuit

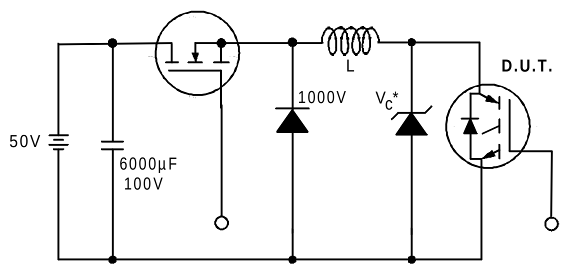



Figure 18. Clamped Inductive Load Test Circuit

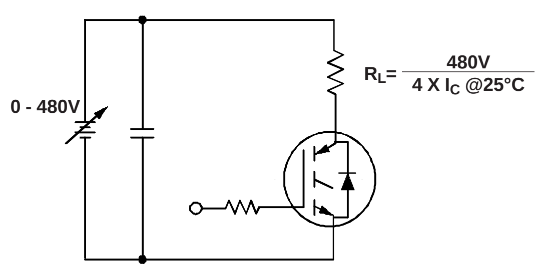
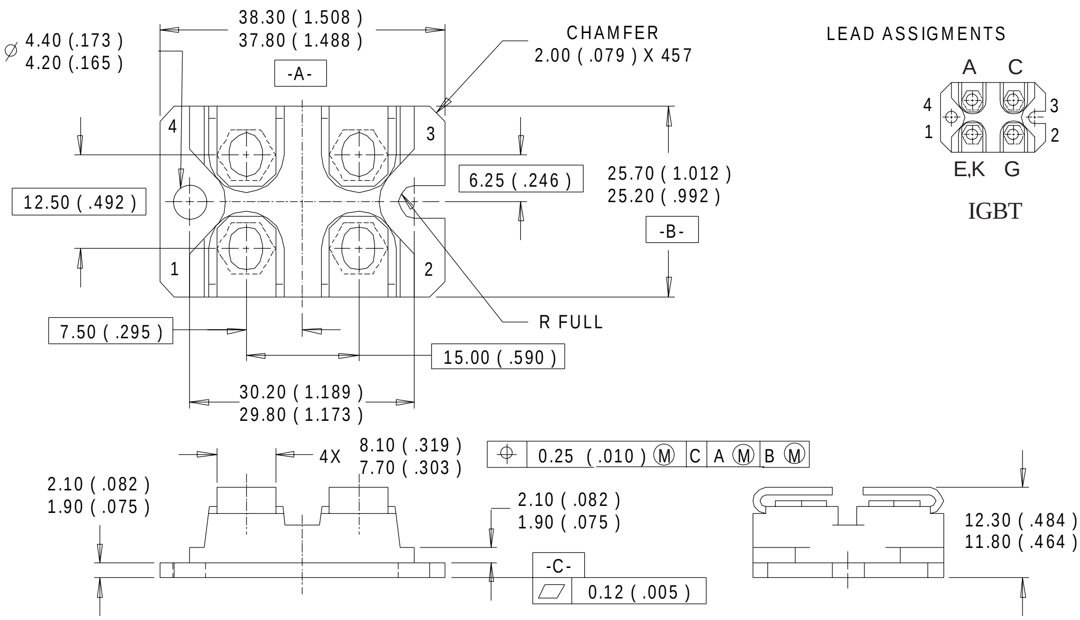



Figure 19. Pulsed Collector Current Test Circuit

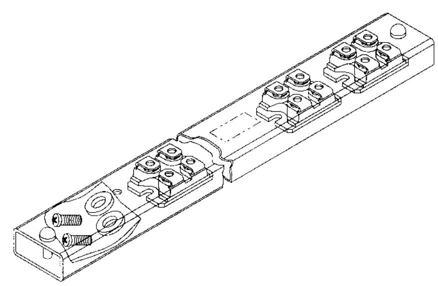
## SOT-227 Package Details

Dimensions are shown in millimeters ( inches )




## Tube

QUANTITIES PER TUBE IS 10
M4 SCREW AND WASHER INCLUDED



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 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.7/01