International
IOR Rectifier

PRELIMINARY

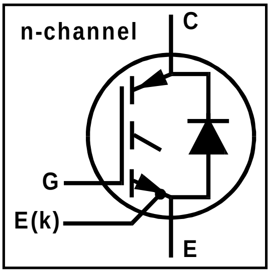
# IRG4ZH71KD

Surface Mountable
Short Circuit Rated
UltraFast IGBT

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

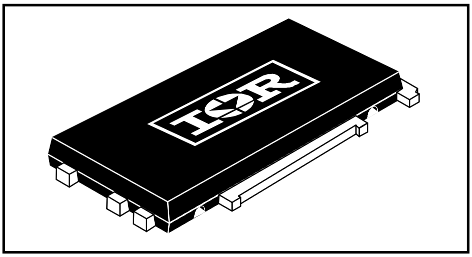
- High short circuit rating optimized for motor control, $t_{sc}$ =10µs, $V_{CC}$ = 720V , $T_J$ = 125°C, $V_{GE}$ = 15V
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery antiparallel diodes for use in bridge configurations
- Combines low conduction losses with high switching speed
- Low profile low inductance SMD-10 Package
- Separated control & Power-connections for easy paralleling
- Inherently Good coplanarity
- Easy solder inspection and cleaning




$V_{CES}$ = 1200V

$V_{CE(ON)typ}$ = 2.89V

@$V_{GE}$ = 15V, $I_C$ = 42A



### Benefits

- Highest power density and efficiency available
- HEXFRED Diodes optimized for performance with IGBTs. Minimized recovery characteristics
- IGBTs optimized for specific application conditions

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 1200 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 78 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 42 | |
| $I_{CM}$ | Pulsed Collector Current ① | 156 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 156 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 42 | |
| $I_{FM}$ | Diode Maximum Forward Current | 156 | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | µs |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 350 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 140 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +150 | °C |

### Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{θJC}$ | Junction-to-Case - IGBT | ––– | ––– | 0.36 | °C/W |
| $R_{θJC}$ | Junction-to-Case - Diode | ––– | ––– | 0.69 | |
| $R_{θCS}$ | SMD-10 Case-to-Heatsink (typical), * | ––– | 0.44 | ––– | |
| | Weight | ––– | 6.0(0.21) | ––– | g (oz) |

* Assumes device soldered to 3.0 oz. Cu on 3.0mm IMS/Aluminum board, mounted to flat, greased heatsink.

## Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage③ | 1200 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 250µA |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.26 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 4.0mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.89 | 3.9 | V | $I_C$ = 42A   $V_{GE}$ = 15V |
| | | — | 3.73 | — | | $I_C$ = 78A   See Fig. 2, 5 |
| | | — | 2.55 | — | | $I_C$ = 42A, $T_J$ = 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 | $V_{CE} = V_{GE}$, $I_C$ = 1.5mA |
| $g_{fe}$ | Forward Transconductance④ | 23 | 34 | — | S | $V_{CE}$ = 50V, $I_C$ = 42A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 500 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 1200V |
| | | — | — | 10 | mA | $V_{GE}$ = 0V, $V_{CE}$ = 1200V, $T_J$ = 150°C |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 2.45 | 3.7 | V | $I_C$ = 42A   See Fig. 13 |
| | | — | 2.40 | — | | $I_C$ = 42A, $T_J$ = 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) | — | 380 | 570 | nC | $I_C$ = 42A |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | — | 48 | 72 | | $V_{CC}$ = 400V   See Fig.8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | — | 120 | 180 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | — | 80 | — | ns | |
| $t_r$ | Rise Time | — | 45 | — | | $T_J$ = 25°C |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 215 | 320 | | $I_C$ = 42A, $V_{CC}$ = 800V |
| $t_f$ | Fall Time | — | 220 | 330 | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω |
| $E_{on}$ | Turn-On Switching Loss | — | 3.64 | — | mJ | Energy losses include "tail" |
| $E_{off}$ | Turn-Off Switching Loss | — | 3.17 | — | | and diode reverse recovery |
| $E_{ts}$ | Total Switching Loss | — | 6.81 | 9.8 | | See Fig. 9,10,18 |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | — | — | µs | $V_{CC}$ = 720V, $T_J$ = 125°C<br>$V_{GE}$ = 15V, $R_G$ = 5.0Ω |
| $t_{d(on)}$ | Turn-On Delay Time | — | 91 | — | ns | $T_J$ = 150°C,   See Fig. 10,11,18 |
| $t_r$ | Rise Time | — | 48 | — | | $I_C$ = 42A, $V_{CC}$ = 800V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 430 | — | | $V_{GE}$ = 15V, $R_G$ = 5.0Ω, |
| $t_f$ | Fall Time | — | 400 | — | | Energy losses include "tail" |
| $E_{ts}$ | Total Switching Loss | — | 14.6 | — | mJ | and diode reverse recovery |
| $L_E$ | Internal Emitter Inductance | — | 2.0 | — | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | — | 5620 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 400 | — | | $V_{CC}$ = 30V   See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 94 | — | | $f$ = 1.0MHz |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 107 | 160 | ns | $T_J$ = 25°C   See Fig. |
| | | — | 160 | 240 | | $T_J$ = 125°C   14   $I_F$ = 42A |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | — | 10 | 15 | A | $T_J$ = 25°C   See Fig. |
| | | — | 16 | 24 | | $T_J$ = 125°C   15   $V_R$ = 200V |
| $Q_{rr}$ | Diode Reverse Recovery Charge | — | 680 | 1020 | nC | $T_J$ = 25°C   See Fig. |
| | | — | 1400 | 2100 | | $T_J$ = 125°C   16   di/dt = 200A/µs |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During $t_b$ | — | 250 | — | A/µs | $T_J$ = 25°C   See Fig. |
| | | — | 320 | — | | $T_J$ = 125°C   17 |

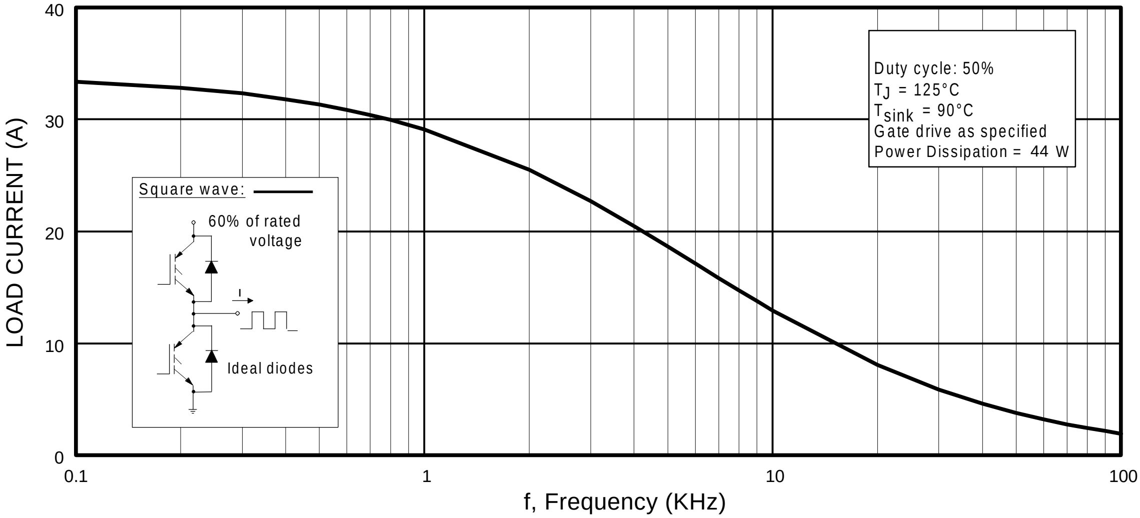



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

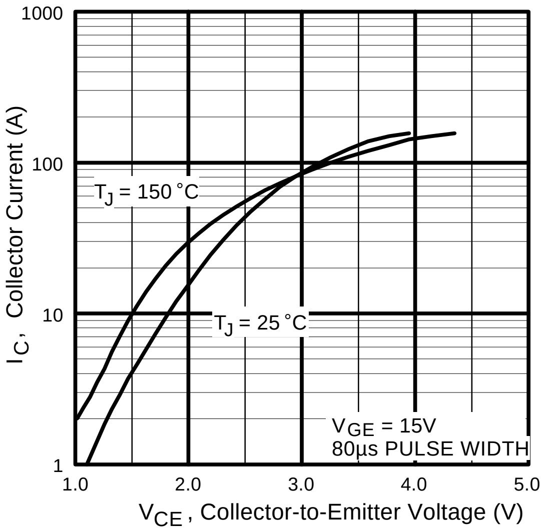



**Fig. 2** - Typical Output Characteristics

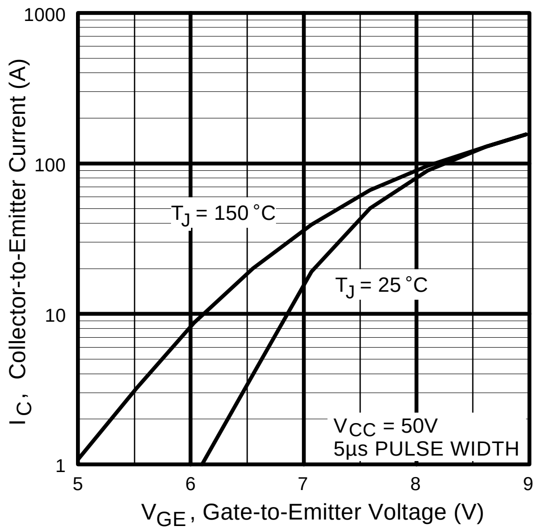



**Fig. 3** - Typical Transfer Characteristics

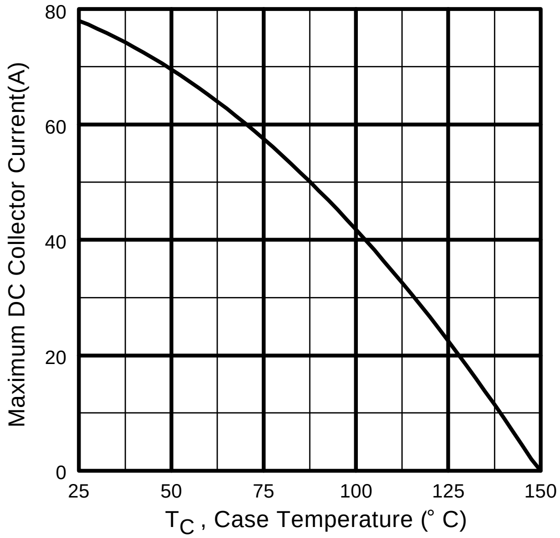



**Fig. 4** - Maximum Collector Current vs. Case Temperature

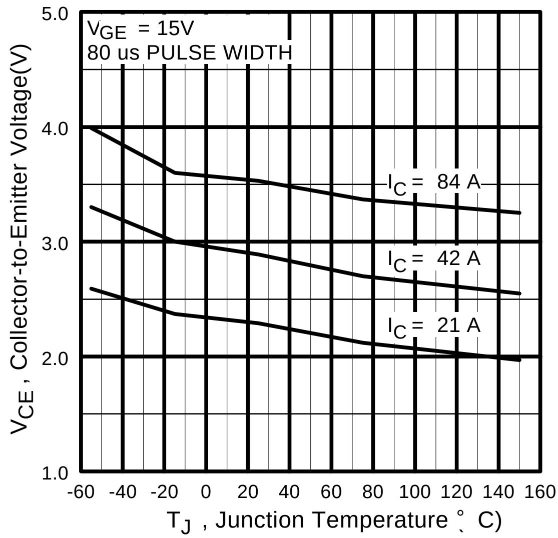



**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

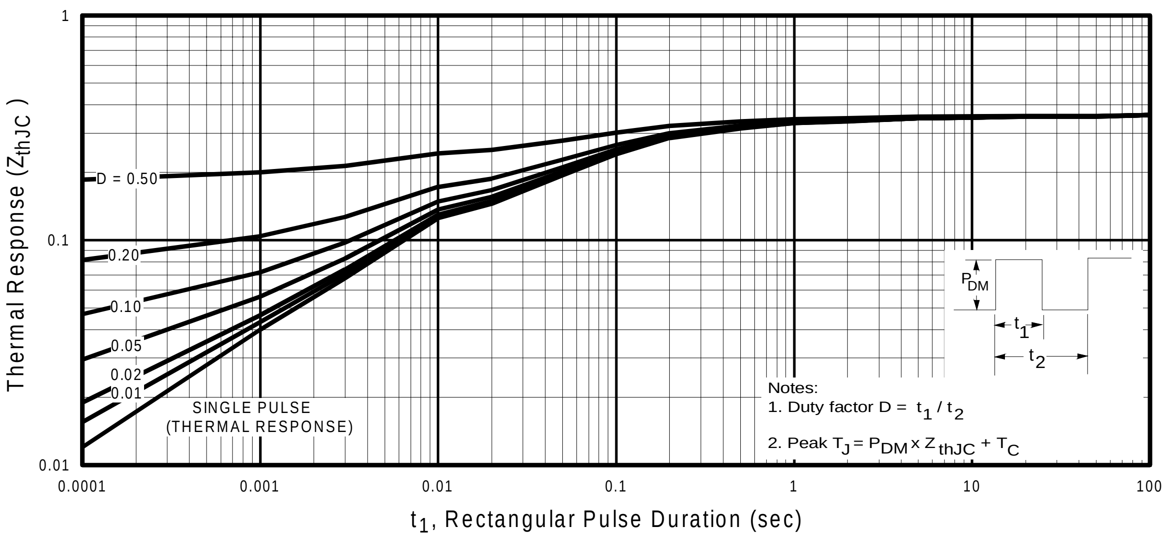



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

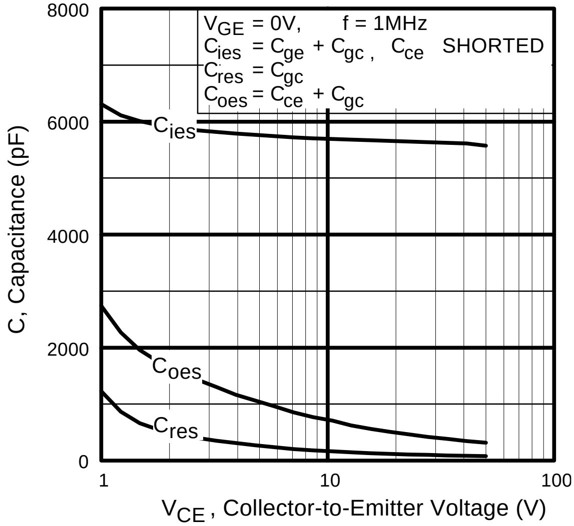



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

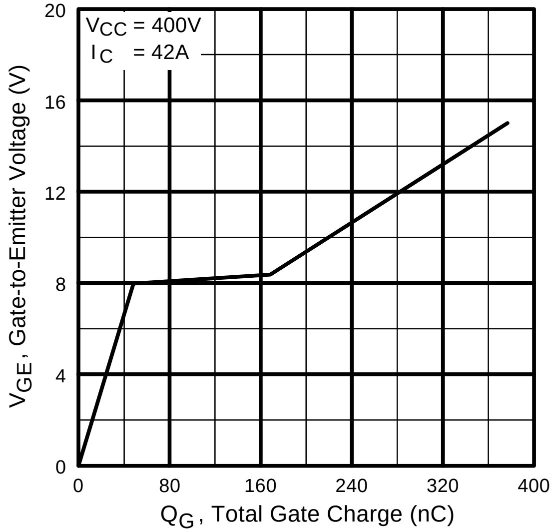



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

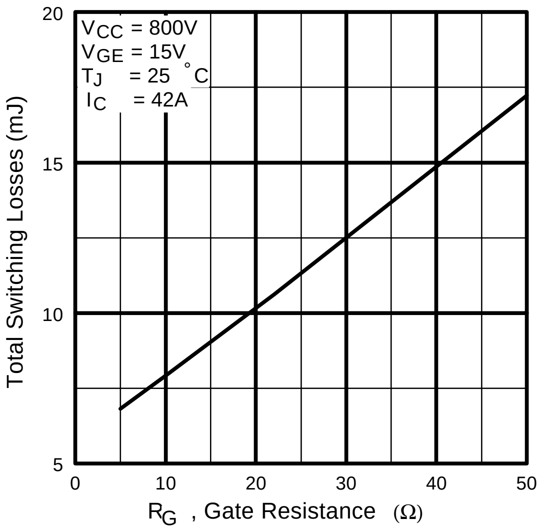



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

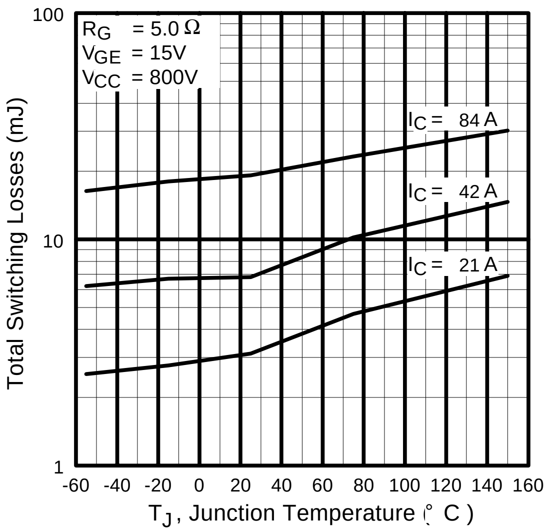



**Fig. 10 -** Typical Switching Losses vs. Junction Temperature

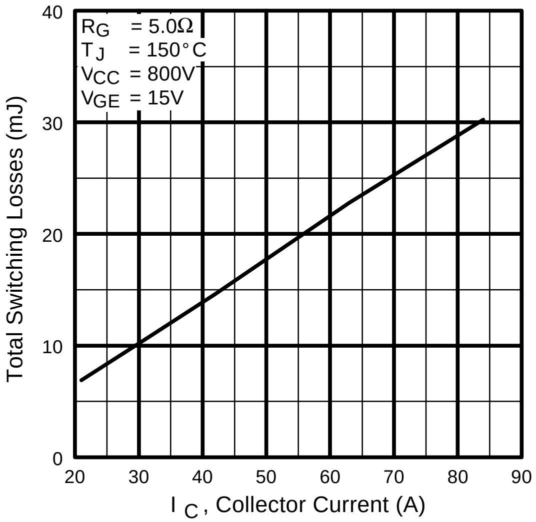



**Fig. 11 -** Typical Switching Losses vs. Collector Current

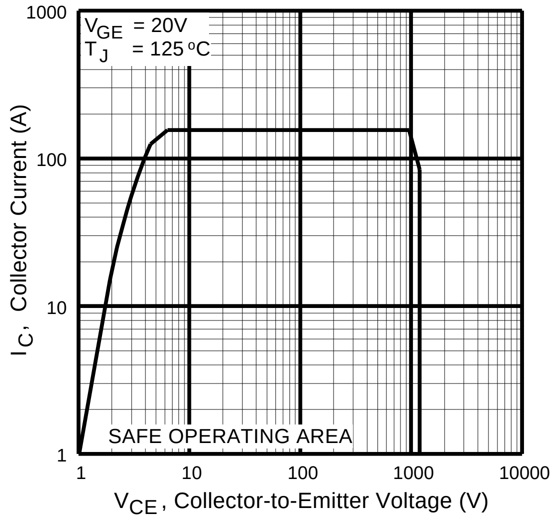



**Fig. 12** - Turn-Off SOA

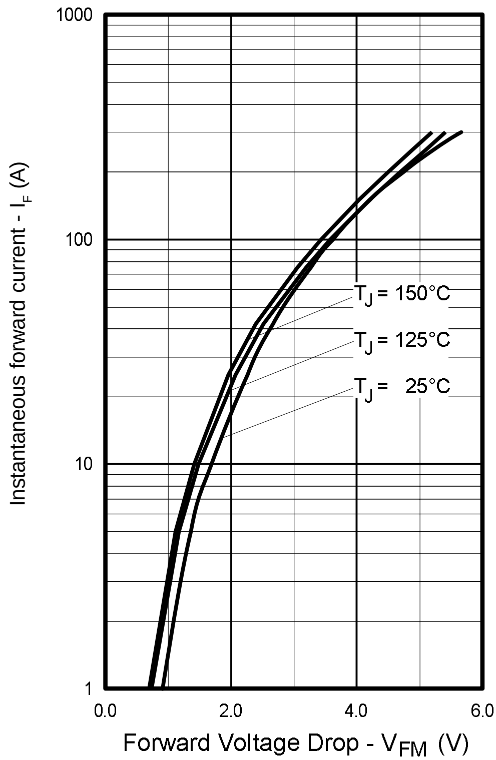



**Fig. 13** - Typical Forward Voltage Drop vs. Instantaneous Forward Current

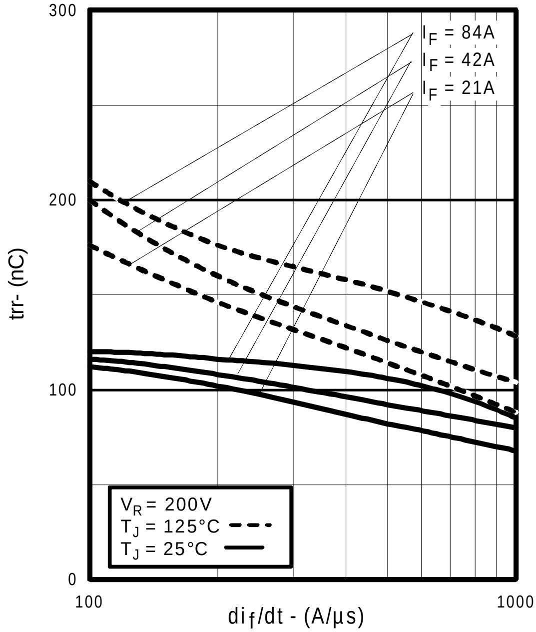



**Fig. 14** - Typical Reverse Recovery vs. $di_f/dt$

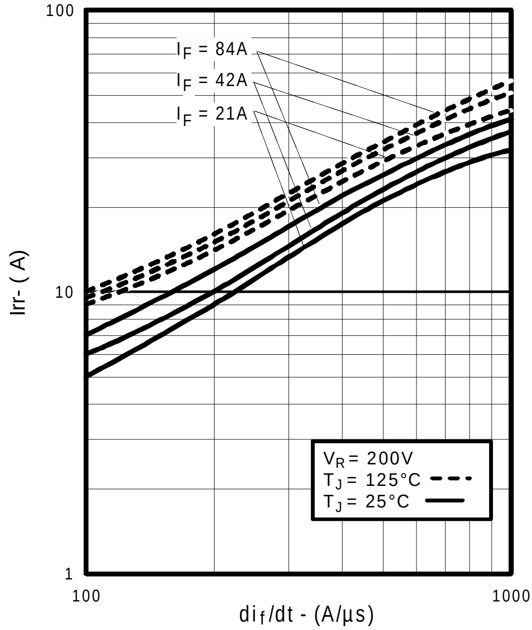



**Fig. 15** - Typical Recovery Current vs. $di_f/dt$

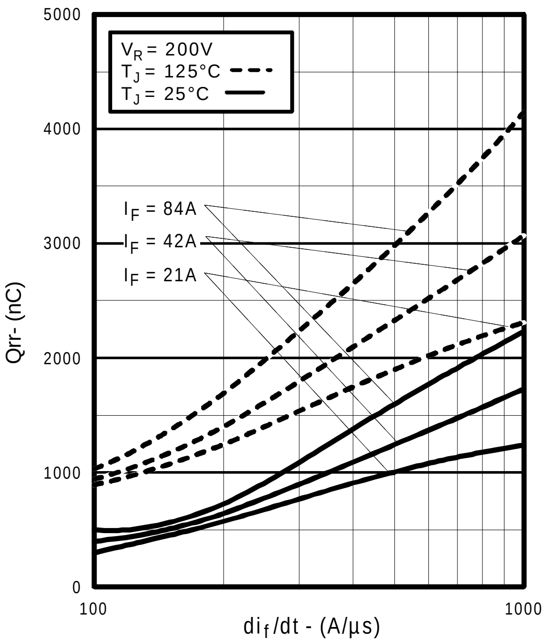



**Fig. 16** - Typical Stored Charge vs. $di_f/dt$

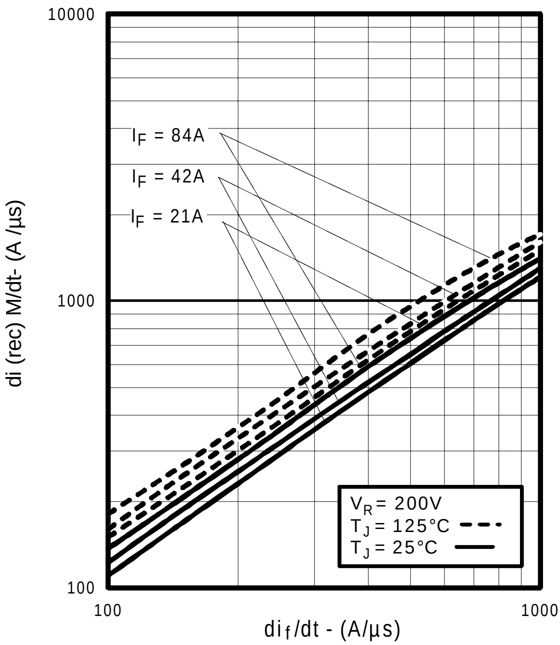



**Fig. 17** - Typical $di_{(rec)M}/dt$ vs. $di_f/dt$

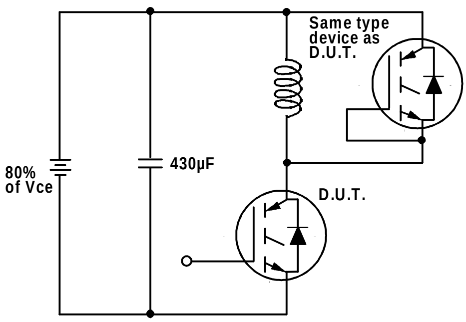



**Fig. 18a** - Test Circuit for Measurement of $I_{LM}$, $E_{on}$, $E_{off(diode)}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$, $t_{d(on)}$, $t_r$, $t_{d(off)}$, $t_f$

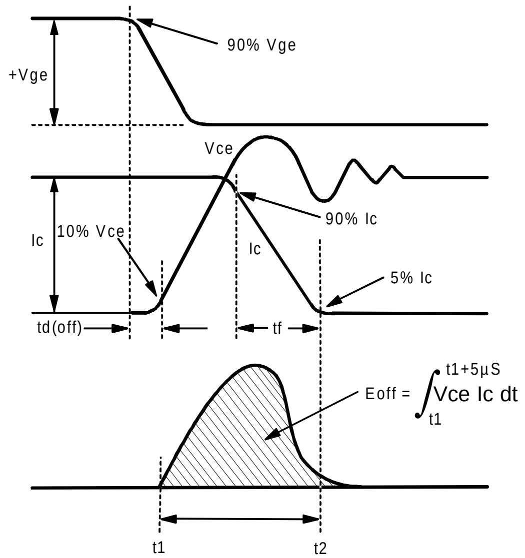



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{off}$, $t_{d(off)}$, $t_f$

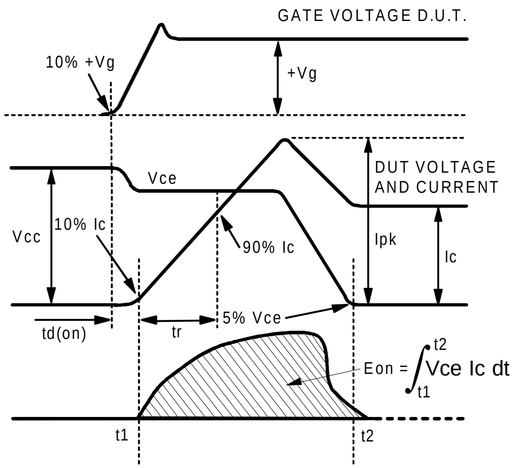



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{on}$, $t_{d(on)}$, $t_r$

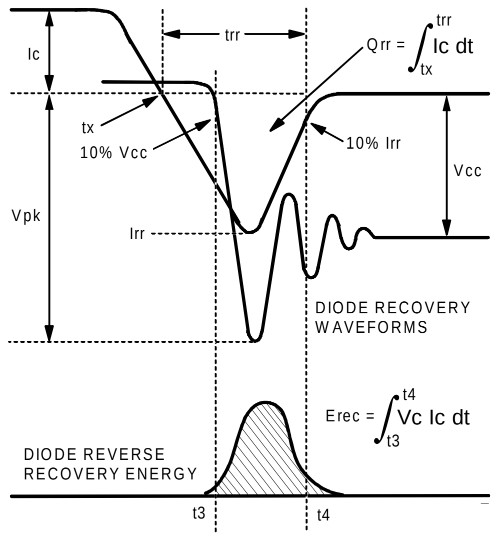



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining $E_{rec}$, $t_{rr}$, $Q_{rr}$, $I_{rr}$

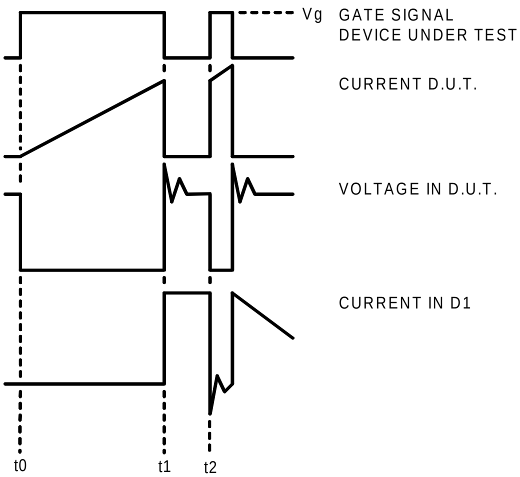



Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

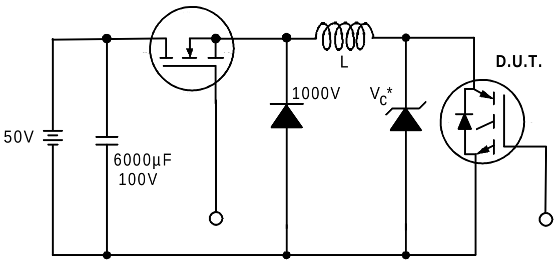



Figure 19. Clamped Inductive Load Test Circuit

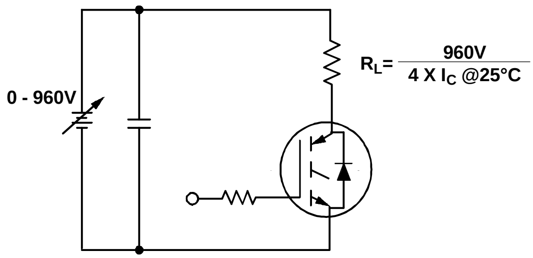



Figure 20. Pulsed Collector Current Test Circuit

Notes:

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

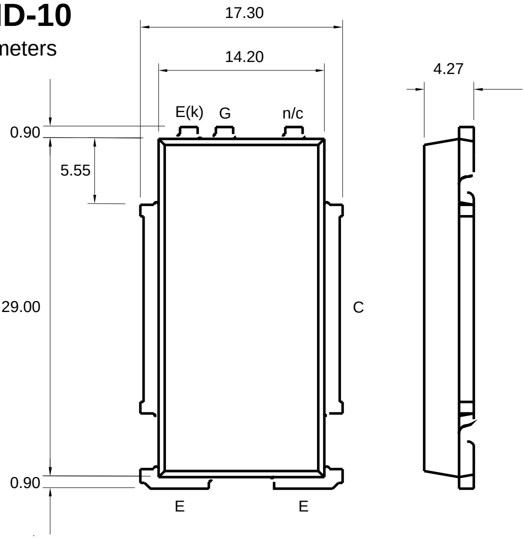
② $V_{CC}$=80%($V_{CES}$), $V_{GE}$=20V, L=10µH, $R_G$= 5.0Ω (figure 19)

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

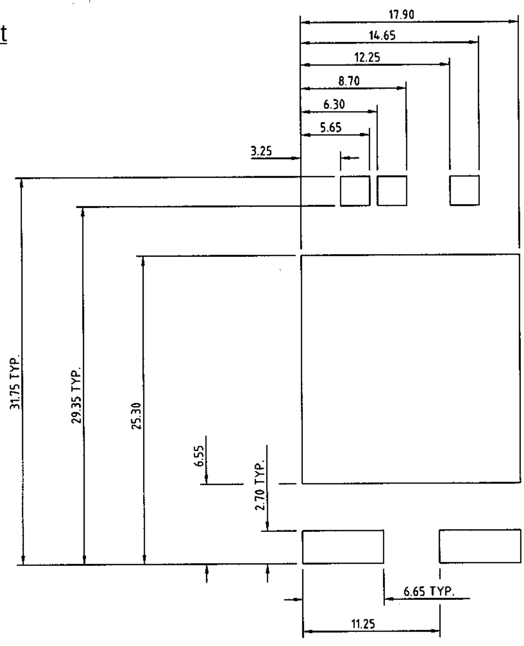
④ Pulse width 5.0µs, single shot

## Case Outline — SMD-10

Dimensions are shown in millimeters




Recommended footprint

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