

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

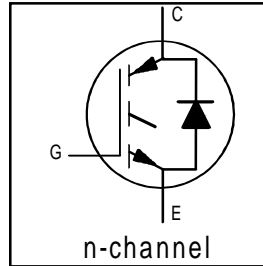
Fast CoPack IGBT

Features

- Fast: Optimized for medium operating frequencies (1-5 kHz in hard switching, >20 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-220AB package

Benefits

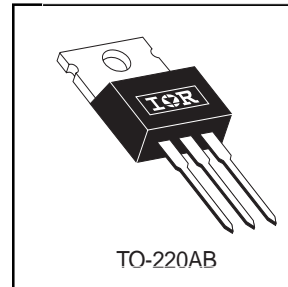
- Generation -4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard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



$$V_{CES} = 600V$$

$$V_{CE(on) \text{ typ.}} = 1.59V$$

$$@V_{GE} = 15V, I_C = 17A$$



TO-220AB

Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|------------------------------------|---------------------|------------|
| V_{CES} | Collector-to-Emitter Voltage | 600 | V |
| $I_C @ T_C = 25^\circ C$ | Continuous Collector Current | 31 | A |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current | 17 | |
| I_{CM} | Pulsed Collector Current ① | 120 | |
| I_{LM} | Clamped Inductive Load Current ② | 120 | |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current | 12 | |
| I_{FM} | Diode Maximum Forward Current | 120 | |
| V_{GE} | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D @ T_C = 25^\circ C$ | Maximum Power Dissipation | 100 | W |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation | 42 | |
| T_J | Operating Junction and | -55 to +150 | $^\circ C$ |
| T_{STG} | Storage Temperature Range | | |
| | Soldering Temperature, for 10 sec. | | |
| | 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 | ----- | ----- | 1.2 | $^\circ C/W$ |
| $R_{\theta JC}$ | Junction-to-Case - Diode | ----- | ----- | 2.5 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ----- | 0.50 | ----- | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ----- | ----- | 80 | |
| W_t | Weight | ----- | 2 (0.07) | ----- | g (oz) |

Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---------------------|---|------|------|-----------|----------------------|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage ^③ | 600 | ---- | ---- | V | $V_{GE} = 0V, I_C = 250\mu A$ |
| $DV_{(BR)CES}/DT_J$ | Temperature Coeff. of Breakdown Voltage | ---- | 0.69 | ---- | V/ $^\circ\text{C}$ | $V_{GE} = 0V, I_C = 1.0mA$ |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | ---- | 1.59 | 1.8 | V | $I_C = 17A, V_{GE} = 15V$ |
| | | ---- | 1.99 | ---- | | $I_C = 31A$ |
| | | ---- | 1.70 | ---- | | $I_C = 17A, T_J = 150^\circ\text{C}$ |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | ---- | 6.0 | | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| $DV_{GE(th)}/DT_J$ | Temperature Coeff. of Threshold Voltage | ---- | -11 | ---- | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| g_{fe} | Forward Transconductance ^④ | 6.1 | 10 | ---- | S | $V_{CE} = 100V, I_C = 17A$ |
| I_{CES} | Zero Gate Voltage Collector Current | ---- | ---- | 250 | μA | $V_{GE} = 0V, V_{CE} = 600V$ |
| | | ---- | ---- | 2500 | | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| V_{FM} | Diode Forward Voltage Drop | ---- | 1.4 | 1.7 | V | $I_C = 12A$ |
| | | ---- | 1.3 | 1.6 | | $I_C = 12A, T_J = 150^\circ\text{C}$ |
| I_{GES} | Gate-to-Emitter Leakage Current | ---- | ---- | ± 100 | nA | $V_{GE} = \pm 20V$ |

Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|------------------|--|------|------|------|------------|--|
| Q_g | Total Gate Charge (turn-on) | ---- | 51 | 77 | nC | $I_C = 17A$ |
| Q_{ge} | Gate - Emitter Charge (turn-on) | ---- | 7.9 | 12 | | $V_{CC} = 400V$ |
| Q_{gc} | Gate - Collector Charge (turn-on) | ---- | 19 | 28 | | $V_{GE} = 15V$ |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 42 | ---- | ns | $T_J = 25^\circ\text{C}$ |
| t_r | Rise Time | ---- | 26 | ---- | | $I_C = 17A, V_{CC} = 480V$ |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 230 | 350 | | $V_{GE} = 15V, R_G = 23\Omega$ |
| t_f | Fall Time | ---- | 160 | 230 | mJ | Energy losses include "tail" and diode reverse recovery. |
| E_{on} | Turn-On Switching Loss | ---- | 0.63 | ---- | | See Fig. 9, 10, 11, 18 |
| E_{off} | Turn-Off Switching Loss | ---- | 1.39 | ---- | | |
| E_{ts} | Total Switching Loss | ---- | 2.02 | 3.9 | mJ | $T_J = 150^\circ\text{C}$, See Fig. 9, 10, 11, 18 |
| $t_{d(on)}$ | Turn-On Delay Time | ---- | 42 | ---- | | $I_C = 17A, V_{CC} = 480V$ |
| t_r | Rise Time | ---- | 27 | ---- | | $V_{GE} = 15V, R_G = 23\Omega$ |
| $t_{d(off)}$ | Turn-Off Delay Time | ---- | 310 | ---- | mJ | Energy losses include "tail" and diode reverse recovery. |
| t_f | Fall Time | ---- | 310 | ---- | | |
| E_{ts} | Total Switching Loss | ---- | 3.2 | ---- | | |
| L_E | Internal Emitter Inductance | ---- | 7.5 | ---- | nH | Measured 5mm from package |
| C_{ies} | Input Capacitance | ---- | 1100 | ---- | pF | $V_{GE} = 0V$ |
| C_{oes} | Output Capacitance | ---- | 74 | ---- | | $V_{CC} = 30V$ |
| C_{res} | Reverse Transfer Capacitance | ---- | 14 | ---- | | $f = 1.0MHz$ |
| t_{rr} | Diode Reverse Recovery Time | ---- | 42 | 60 | ns | $T_J = 25^\circ\text{C}$ See Fig. 14 |
| | | ---- | 80 | 120 | | $T_J = 125^\circ\text{C}$ |
| I_{rr} | Diode Peak Reverse Recovery Current | ---- | 3.5 | 6.0 | A | $T_J = 25^\circ\text{C}$ See Fig. 15 |
| | | ---- | 5.6 | 10 | | $T_J = 125^\circ\text{C}$ |
| Q_{rr} | Diode Reverse Recovery Charge | ---- | 80 | 180 | nC | $T_J = 25^\circ\text{C}$ See Fig. 16 |
| | | ---- | 220 | 600 | | $T_J = 125^\circ\text{C}$ |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During t_b | ---- | 180 | ---- | A/ μs | $T_J = 25^\circ\text{C}$ See Fig. 17 |
| | | ---- | 120 | ---- | | $T_J = 125^\circ\text{C}$ |

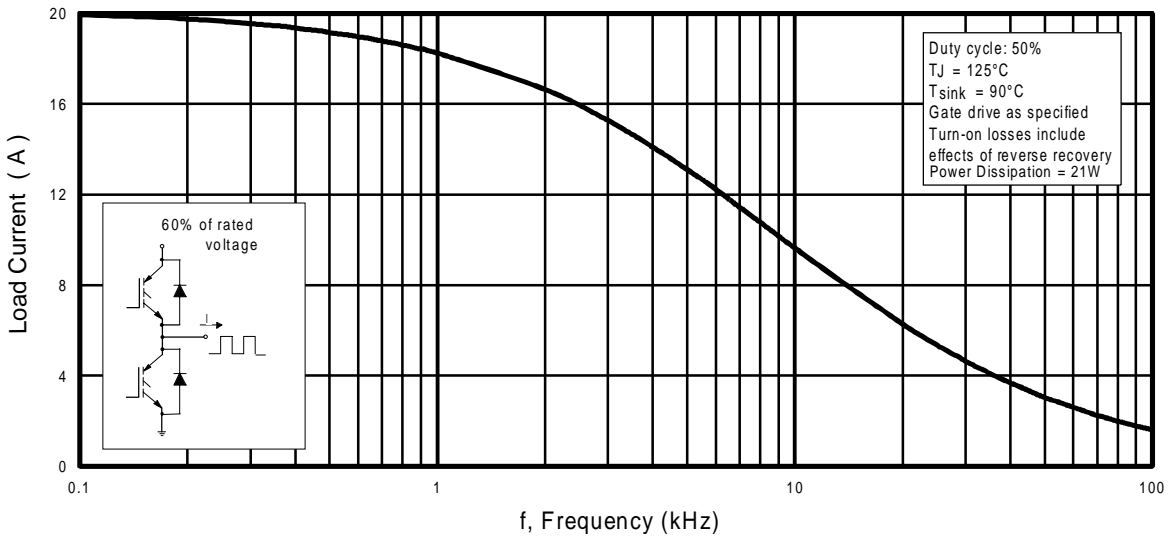


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

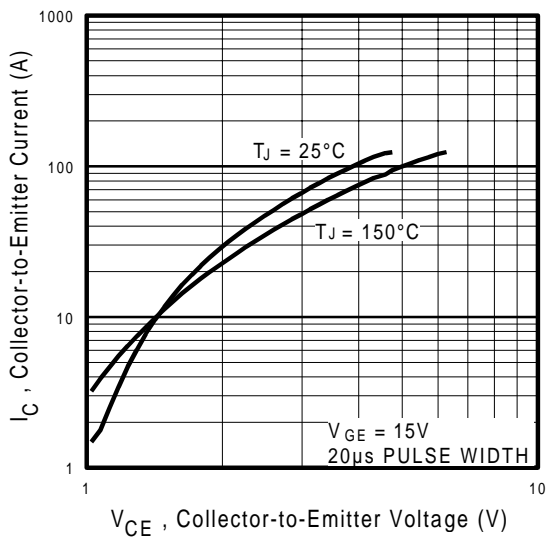


Fig. 2 - Typical Output Characteristics

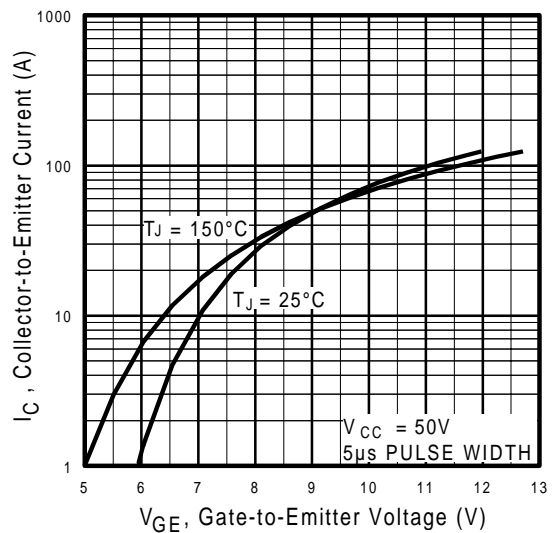


Fig. 3 - Typical Transfer Characteristics

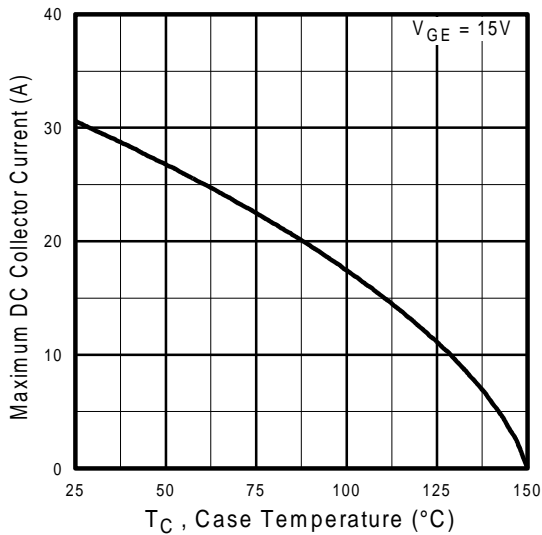


Fig. 4 - Maximum Collector Current vs. Case Temperature

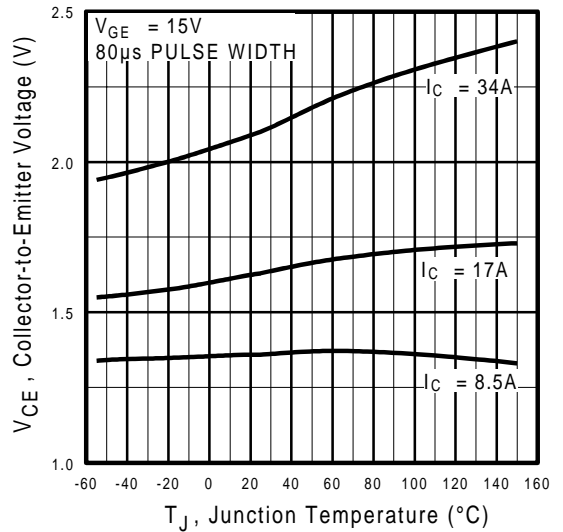


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

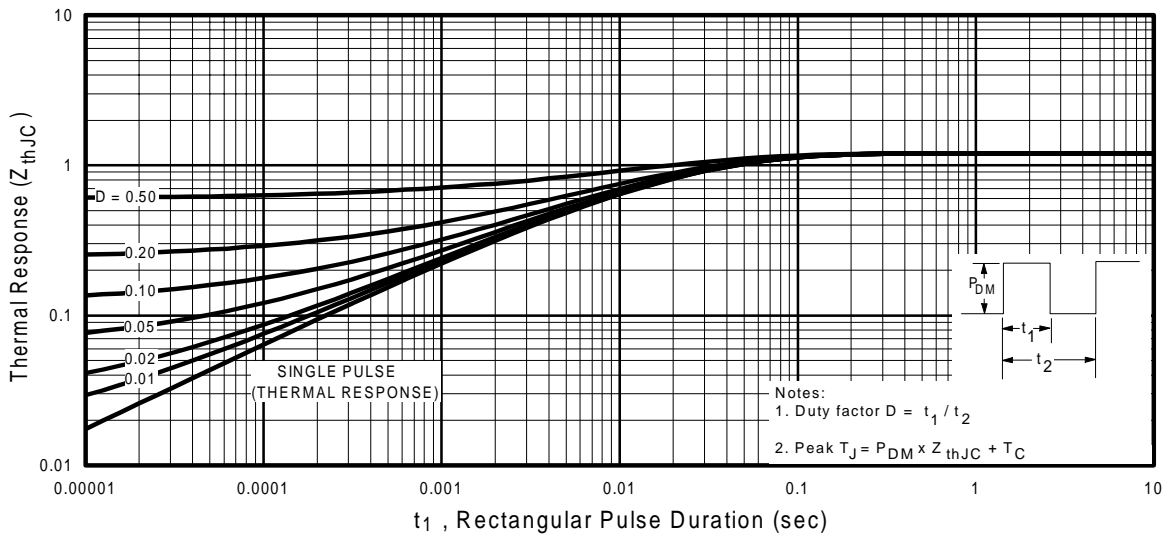


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

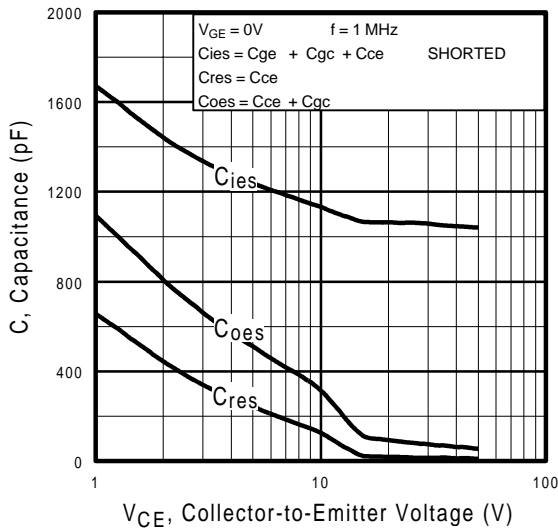


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

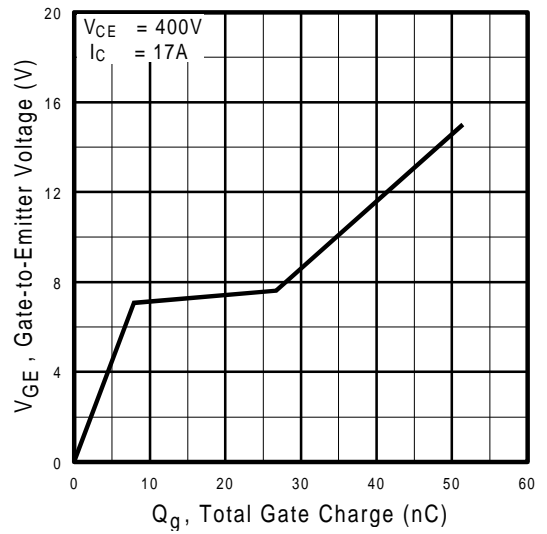


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

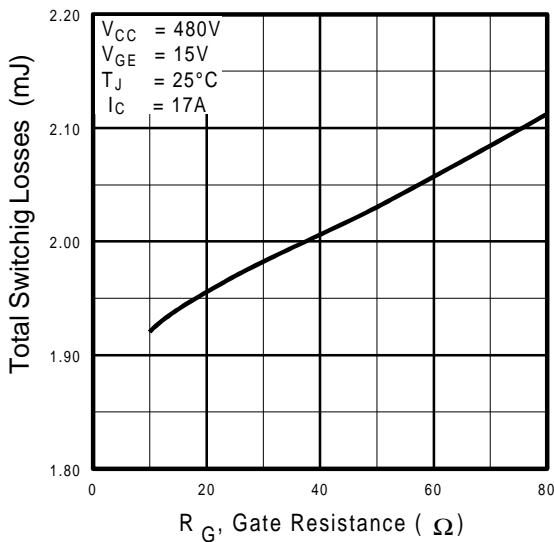


Fig. 9 - Typical Switching Losses vs. Gate Resistance

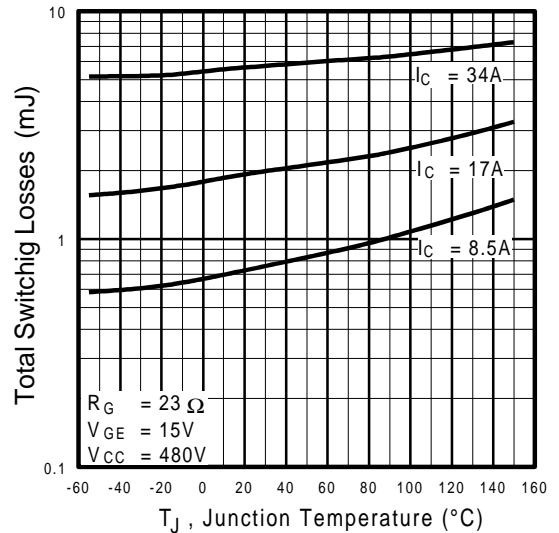


Fig. 10 - Typical Switching Losses vs. Junction Temperature

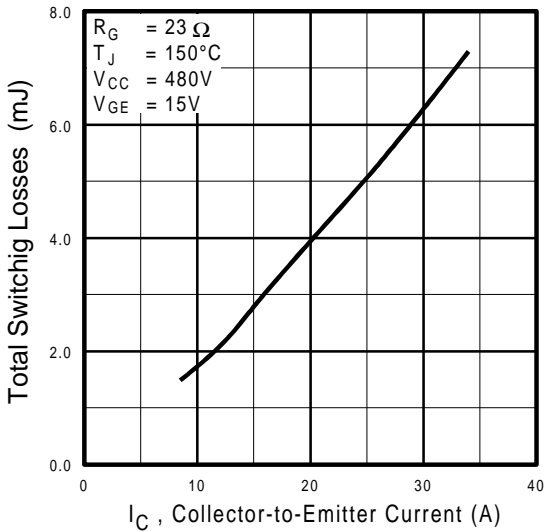


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

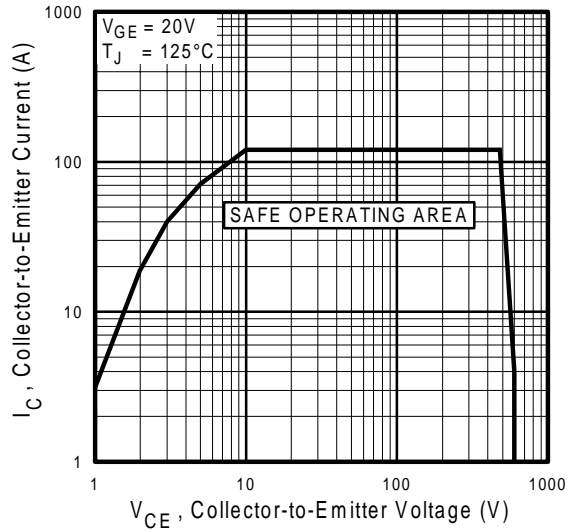


Fig. 12 - Turn-Off SOA

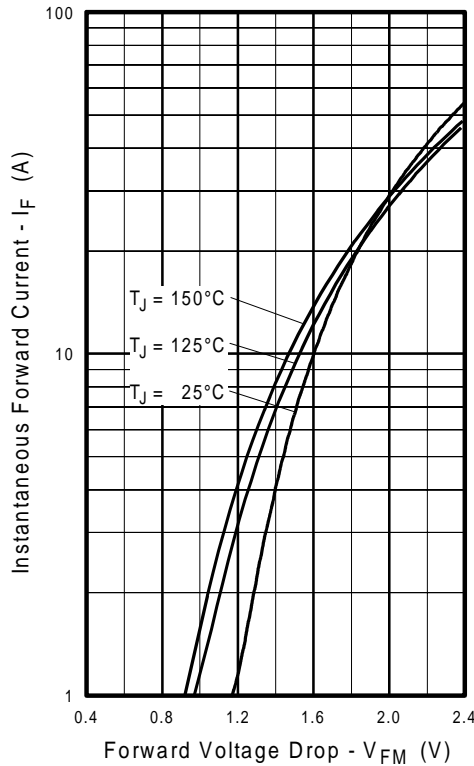


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

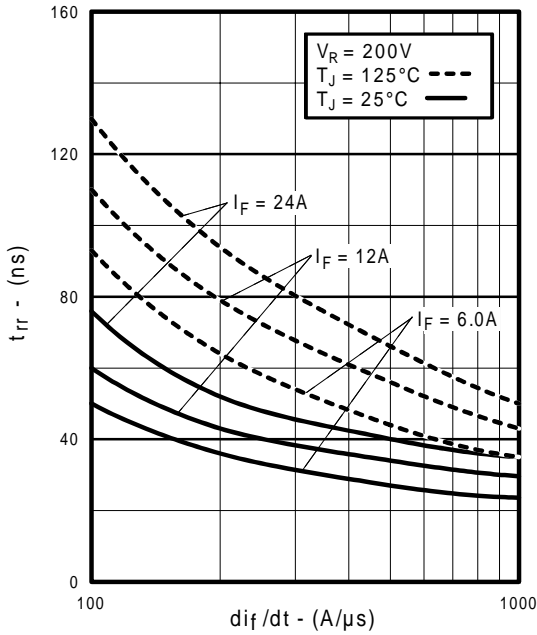


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

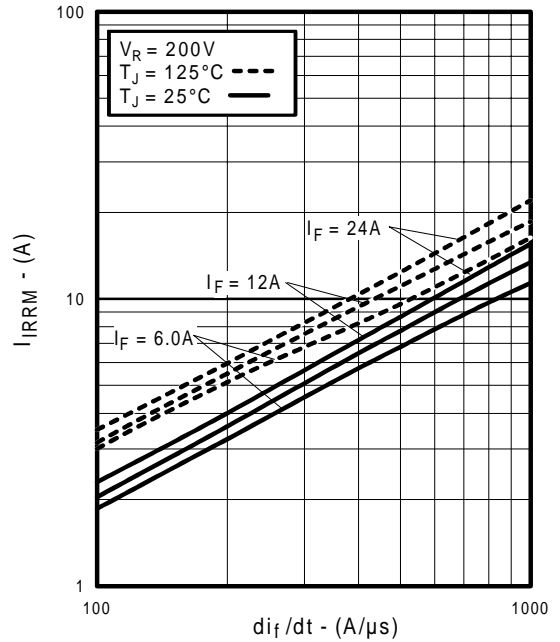


Fig. 15 - Typical Recovery Current vs. di_f/dt

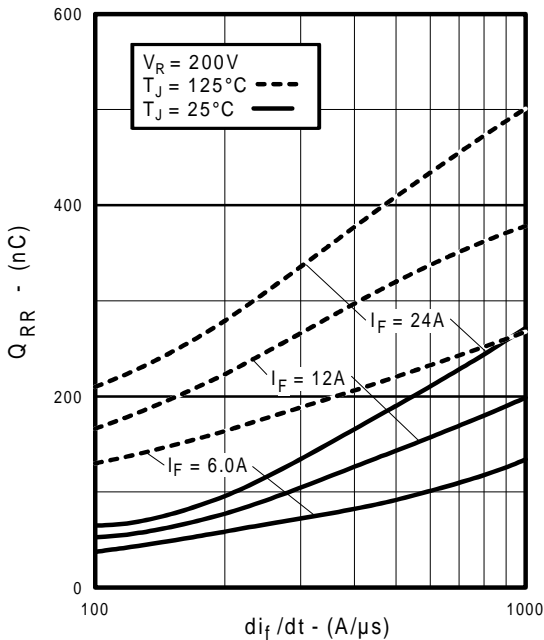


Fig. 16 - Typical Stored Charge vs. di_f/dt

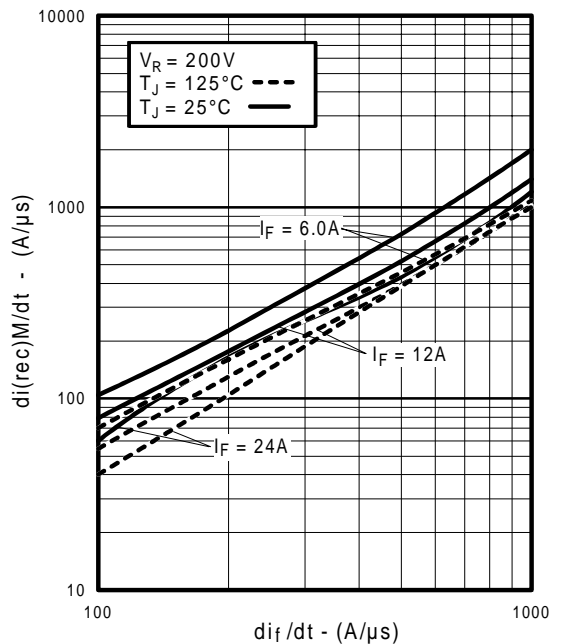


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

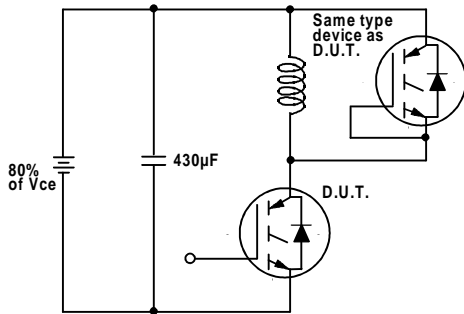


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

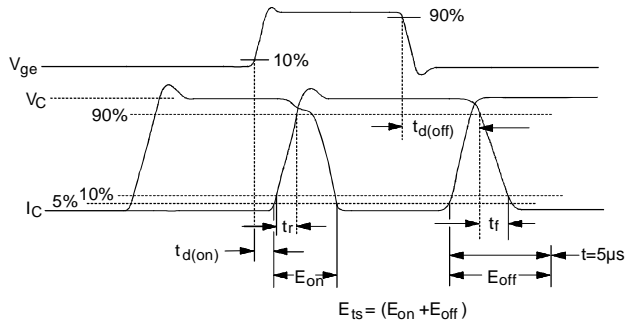


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

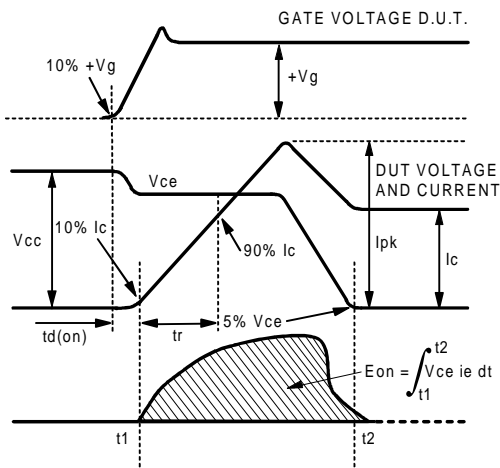


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

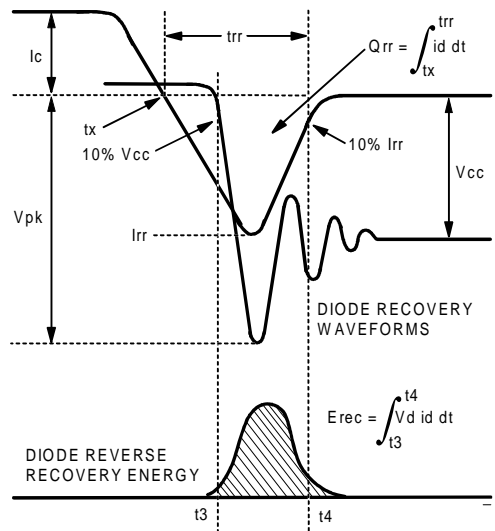


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

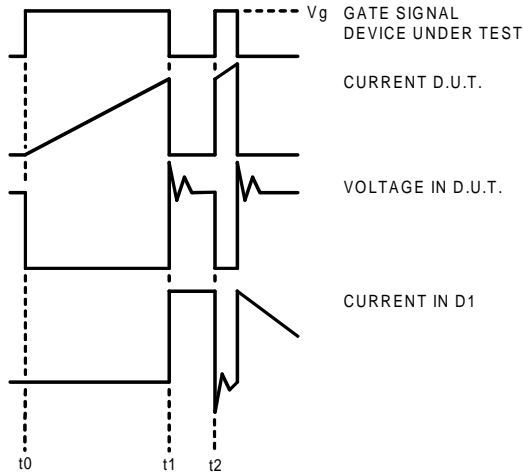


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

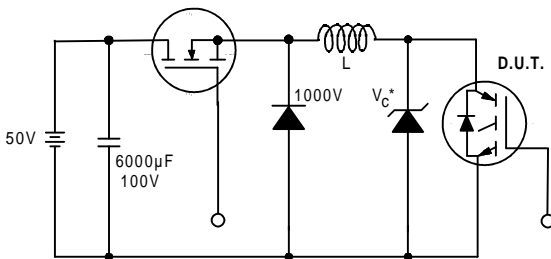


Figure 19. Clamped Inductive Load Test Circuit

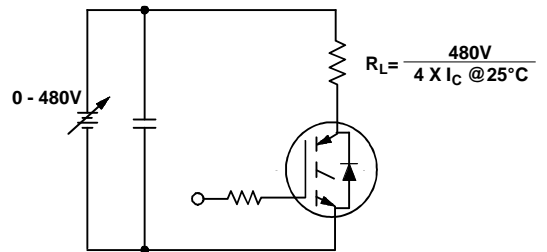


Figure 20. Pulsed Collector Current Test Circuit

Notes:

- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\% (V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G = 23\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

Case Outline — TO-220AB

