

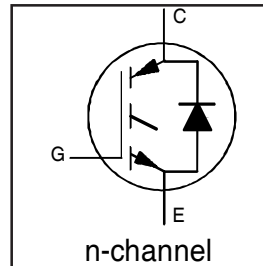
IRG4BC20KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated
UltraFast IGBT

Features

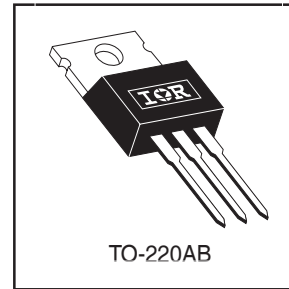
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz, and Short Circuit Rated to 10μs @ 125°C, $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220AB package
- Lead-Free



| |
|-----------------------------------|
| $V_{CES} = 600V$ |
| $V_{CE(on)} \text{ typ.} = 2.27V$ |
| @ $V_{GE} = 15V, I_C = 9.0A$ |

Benefits

- Latest generation 4 IGBTs offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- This part replaces the IRGBC20KD2 and IRGBC20MD2 products
- For hints see design tip 97003



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|--|---------------------|-------|
| V_{CES} | Collector-to-Emitter Voltage | 600 | V |
| $I_C @ T_C = 25^\circ C$ | Continuous Collector Current | 16 | A |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current | 9.0 | |
| I_{CM} | Pulsed Collector Current ① | 32 | |
| I_{LM} | Clamped Inductive Load Current ② | 32 | |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current | 7.0 | |
| I_{FM} | Diode Maximum Forward Current | 32 | |
| t_{sc} | Short Circuit Withstand Time | 10 | μs |
| V_{GE} | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D @ T_C = 25^\circ C$ | Maximum Power Dissipation | 60 | W |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation | 24 | |
| T_J | Operating Junction and Storage Temperature Range | -55 to +150 | °C |
| T_{STG} | | | |
| | | | |
| | 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 | --- | --- | 2.1 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | --- | --- | 3.5 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | --- | 0.50 | --- | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | --- | --- | 80 | |
| Wt | Weight | --- | 2 (0.07) | --- | g (oz) |

IRG4BC20KDPbF

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 | $V_{GE} = 0V, I_C = 250\mu A$ |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.49 | — | V/ $^\circ\text{C}$ | $V_{GE} = 0V, I_C = 1.0mA$ |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.27 | 2.8 | V | $I_C = 9.0A$ $V_{GE} = 15V$ |
| | | — | 3.01 | — | | $I_C = 16A$ See Fig. 2, 5 |
| | | — | 2.43 | — | | $I_C = 9.0A, T_J = 150^\circ\text{C}$ |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | — | 6.0 | | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| $\Delta V_{GE(th)}/\Delta T_J$ | Temperature Coeff. of Threshold Voltage | — | -10 | — | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| g_{fe} | Forward Transconductance ^④ | 2.9 | 4.3 | — | S | $V_{CE} = 100V, I_C = 9.0A$ |
| I_{CES} | Zero Gate Voltage Collector Current | — | — | 250 | μA | $V_{GE} = 0V, V_{CE} = 600V$ |
| | | — | — | 1000 | | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| V_{FM} | Diode Forward Voltage Drop | — | 1.4 | 1.7 | V | $I_C = 8.0A$ See Fig. 13 |
| | | — | 1.3 | 1.6 | | $I_C = 8.0A, T_J = 150^\circ\text{C}$ |
| 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) | — | 34 | 51 | nC | $I_C = 9.0A$ $V_{CC} = 400V$ See Fig. 8 $V_{GE} = 15V$ |
| Q_{ge} | Gate - Emitter Charge (turn-on) | — | 4.9 | 7.4 | | |
| Q_{gc} | Gate - Collector Charge (turn-on) | — | 14 | 21 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 54 | — | ns | $T_J = 25^\circ\text{C}$ $I_C = 9.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 50\Omega$ |
| t_r | Rise Time | — | 34 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 180 | 270 | | |
| t_f | Fall Time | — | 72 | 110 | | |
| E_{on} | Turn-On Switching Loss | — | 0.34 | — | mJ | Energy losses include "tail" and diode reverse recovery See Fig. 9,10,14 |
| E_{off} | Turn-Off Switching Loss | — | 0.30 | — | | |
| E_{ts} | Total Switching Loss | — | 0.64 | 0.96 | | |
| t_{sc} | Short Circuit Withstand Time | 10 | — | — | μs | $V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 50\Omega, V_{CPK} < 500V$ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 51 | — | ns | $T_J = 150^\circ\text{C}$, See Fig. 11,14 $I_C = 9.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 50\Omega$ |
| t_r | Rise Time | — | 37 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 220 | — | | |
| t_f | Fall Time | — | 160 | — | | |
| E_{ts} | Total Switching Loss | — | 0.85 | — | mJ | Energy losses include "tail" and diode reverse recovery |
| L_E | Internal Emitter Inductance | — | 7.5 | — | nH | Measured 5mm from package |
| C_{ies} | Input Capacitance | — | 450 | — | pF | $V_{GE} = 0V$ $V_{CC} = 30V$ See Fig. 7 $f = 1.0MHz$ |
| C_{oes} | Output Capacitance | — | 61 | — | | |
| C_{res} | Reverse Transfer Capacitance | — | 14 | — | | |
| t_{rr} | Diode Reverse Recovery Time | — | 37 | 55 | ns | $T_J = 25^\circ\text{C}$ See Fig. 14 |
| | | — | 55 | 90 | | $T_J = 125^\circ\text{C}$ |
| I_{rr} | Diode Peak Reverse Recovery Current | — | 3.5 | 5.0 | A | $T_J = 25^\circ\text{C}$ See Fig. 15 |
| | | — | 4.5 | 8.0 | | $T_J = 125^\circ\text{C}$ |
| Q_{rr} | Diode Reverse Recovery Charge | — | 65 | 138 | nC | $T_J = 25^\circ\text{C}$ See Fig. 16 |
| | | — | 124 | 360 | | $T_J = 125^\circ\text{C}$ |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During t_b | — | 240 | — | A/ μs | $T_J = 25^\circ\text{C}$ See Fig. 17 |
| | | — | 210 | — | | $T_J = 125^\circ\text{C}$ |

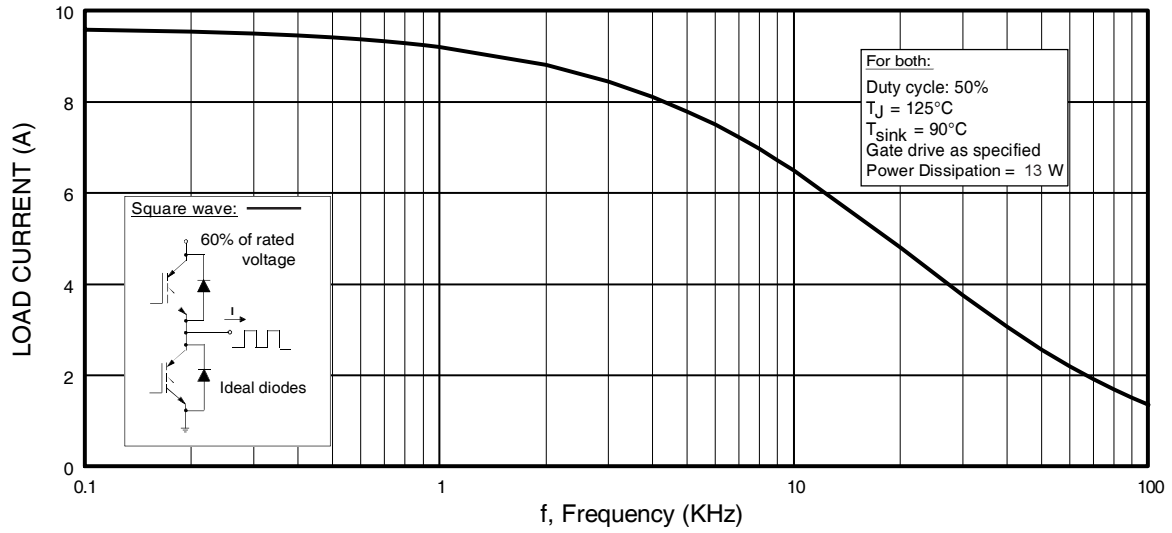


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

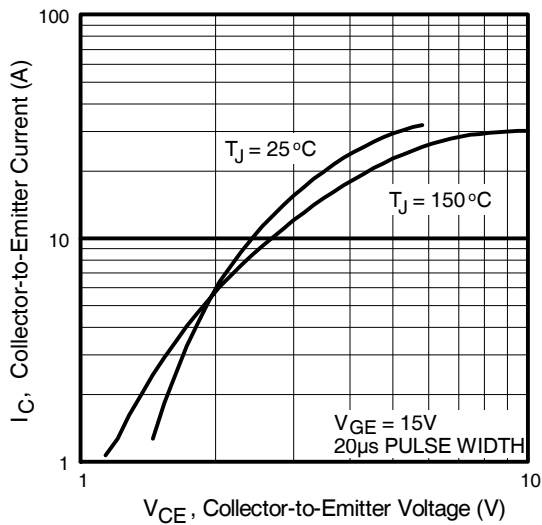


Fig. 2 - Typical Output Characteristics

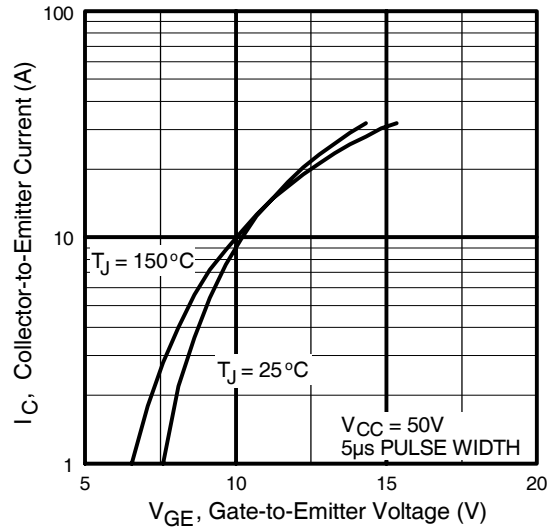


Fig. 3 - Typical Transfer Characteristics

IRG4BC20KDPbF

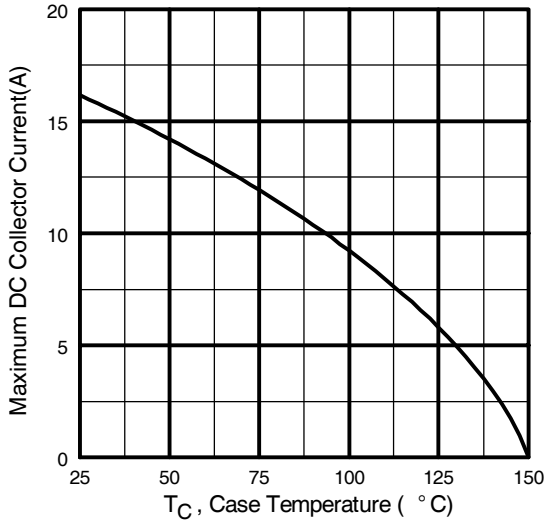


Fig. 4 - Maximum Collector Current vs. Case Temperature

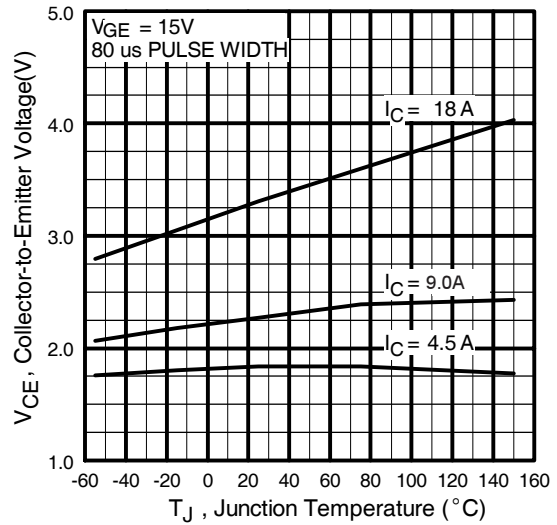


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

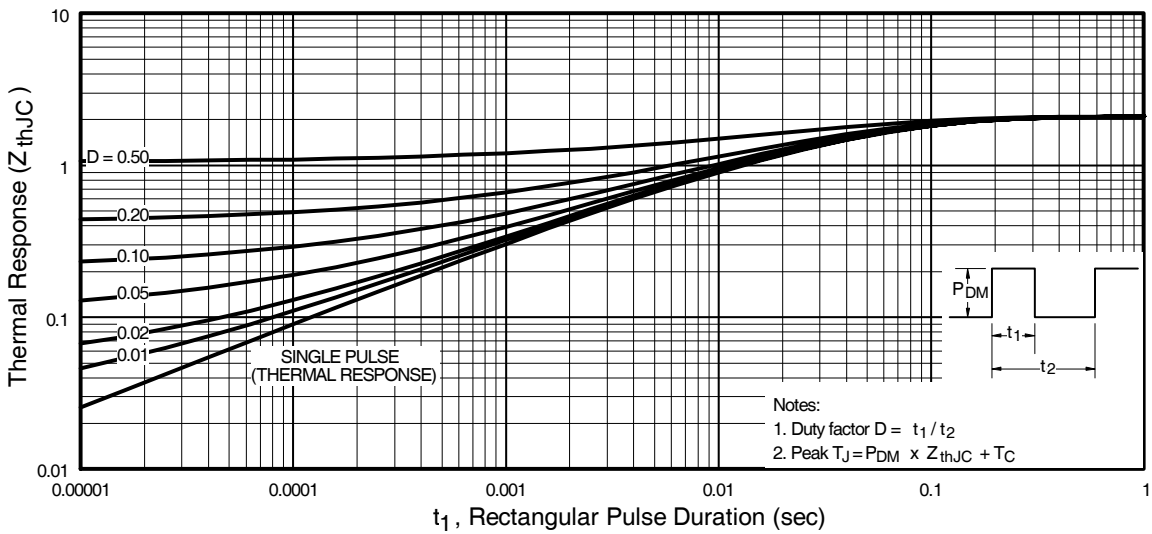


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRG4BC20KDPbF

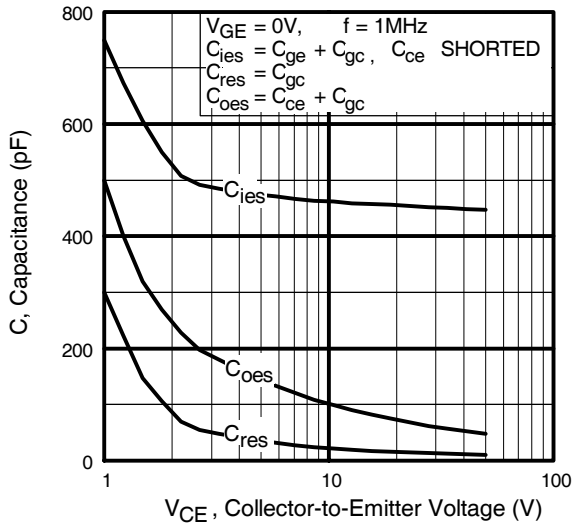


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

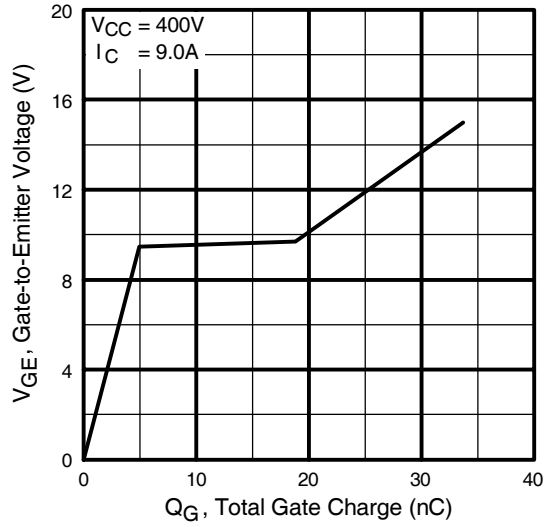


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

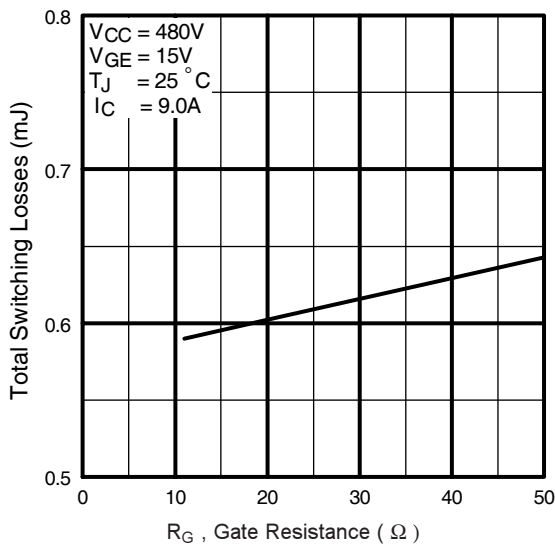


Fig. 9 - Typical Switching Losses vs. Gate Resistance

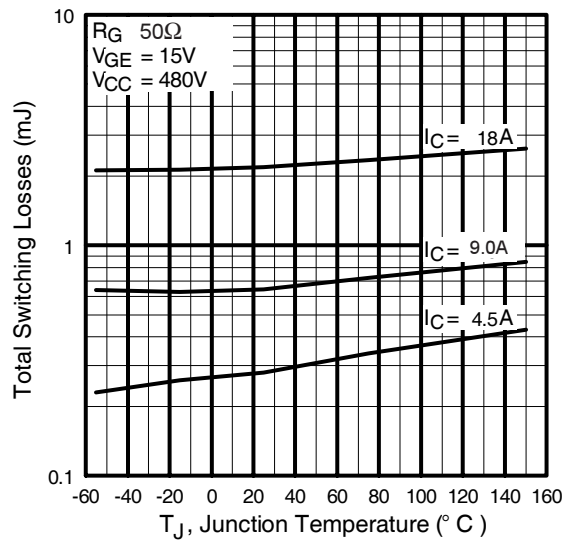


Fig. 10 - Typical Switching Losses vs. Junction Temperature

IRG4BC20KDPbF

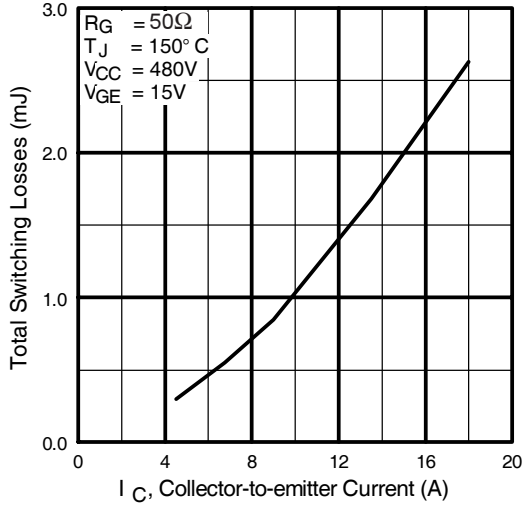


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

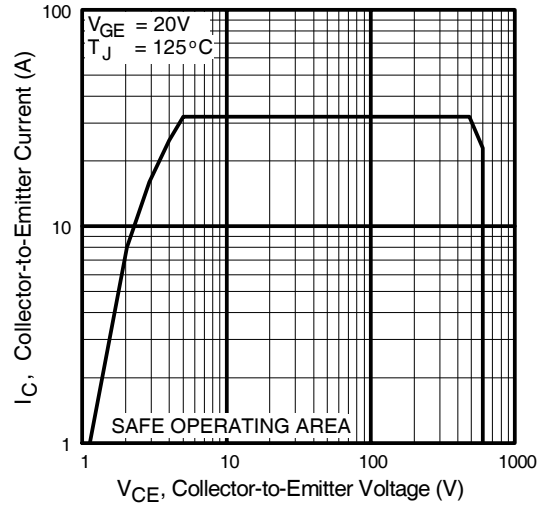


Fig. 12 - Turn-Off SOA

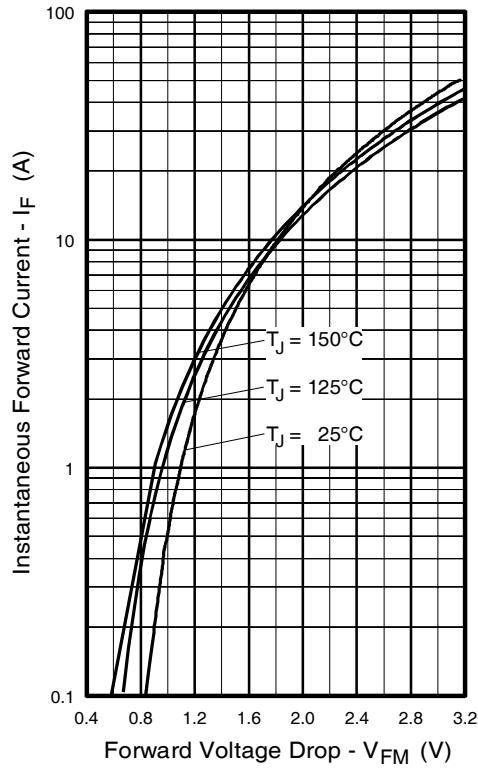


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

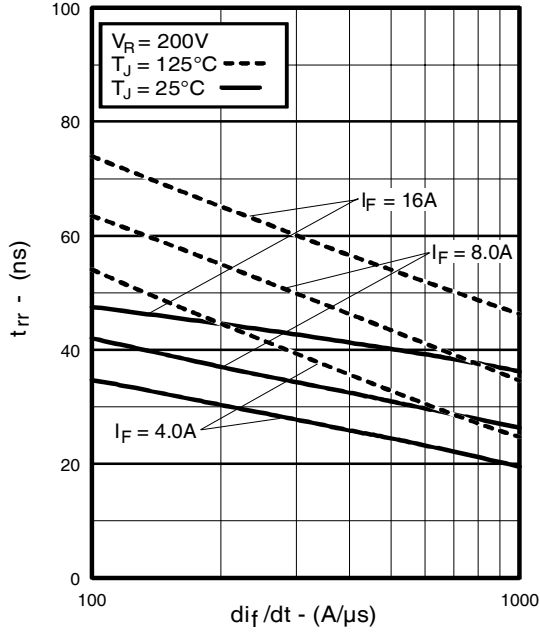


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

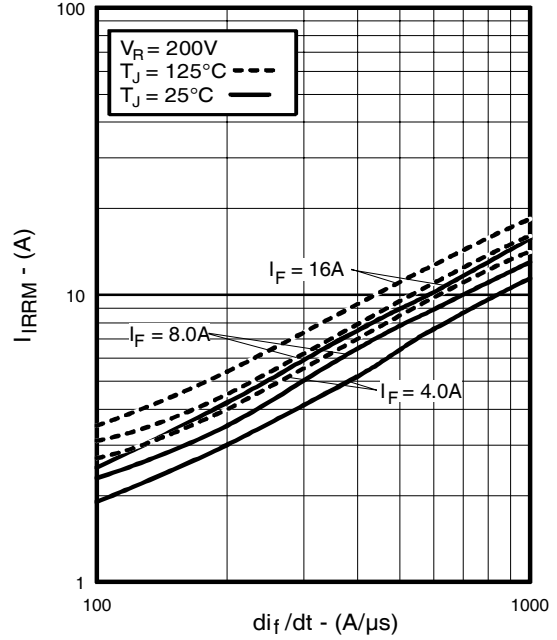


Fig. 15 - Typical Recovery Current vs. di_f/dt

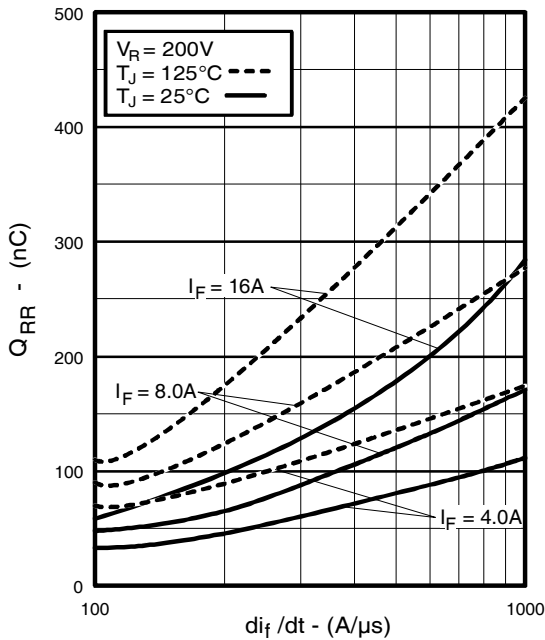


Fig. 16 - Typical Stored Charge vs. di_f/dt

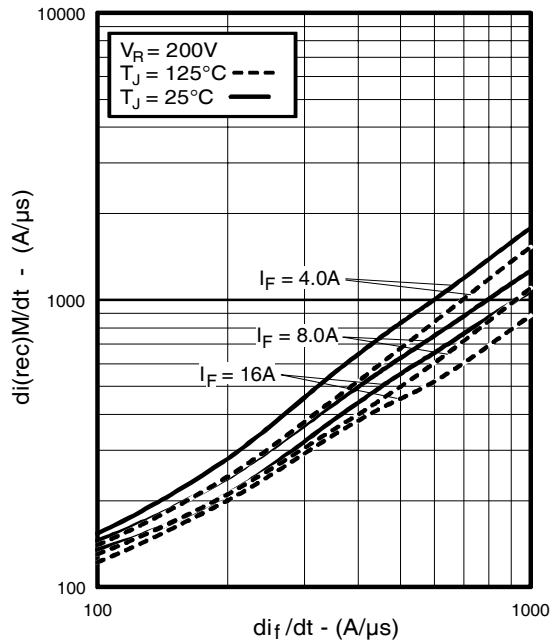


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

IRG4BC20KDPbF

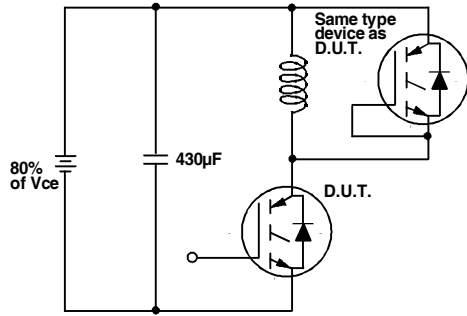


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

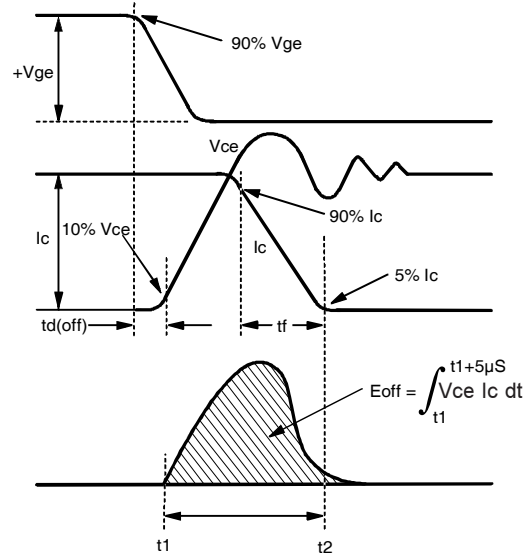


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

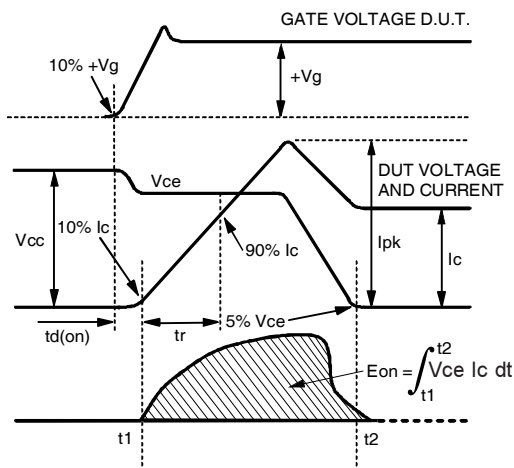


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

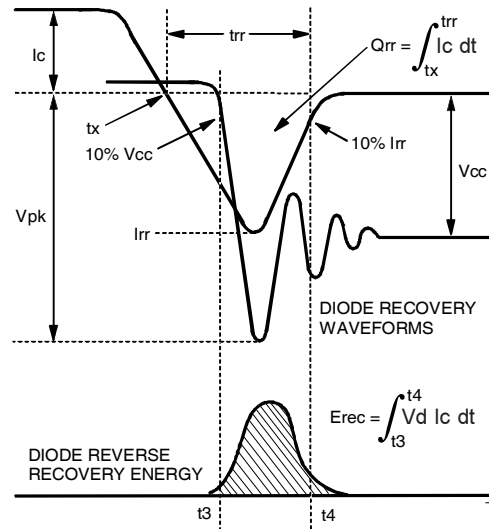


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

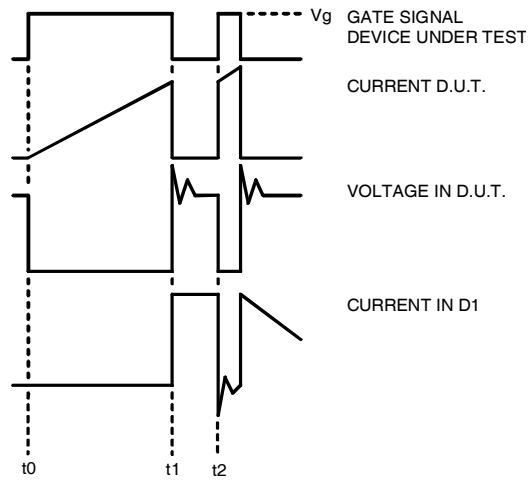


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit



Figure 19. Clamped Inductive Load Test Circuit

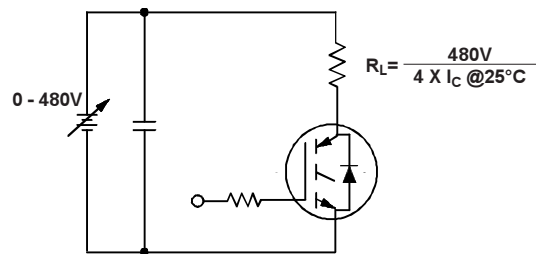


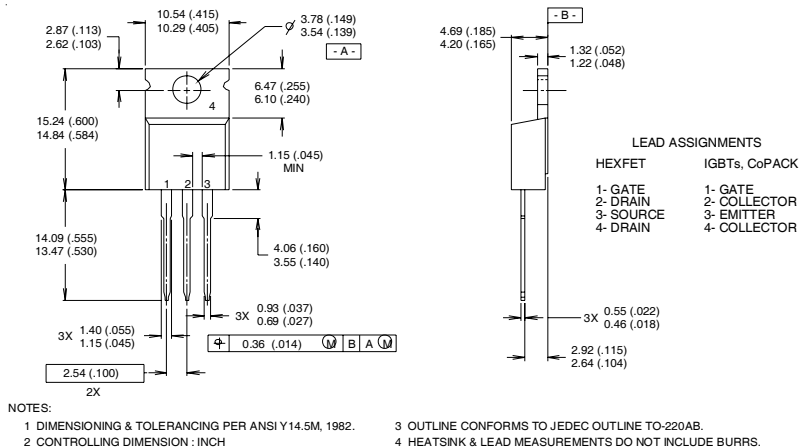
Figure 20. Pulsed Collector Current Test Circuit

IRG4BC20KDPbF

Notes:

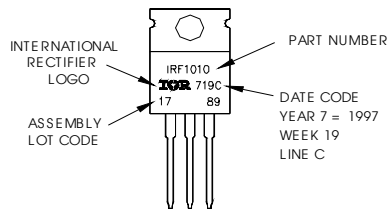
- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\%(V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G=50\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

TO-220AB Package Outline



TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010
 LOT CODE 1789
 ASSEMBLED ON WW 19, 1997
 IN THE ASSEMBLY LINE "C"
Note: "P" in assembly line
 position indicates "Lead-Free"



Data and specifications subject to change without notice.

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