

IRG4PH50UDPbF

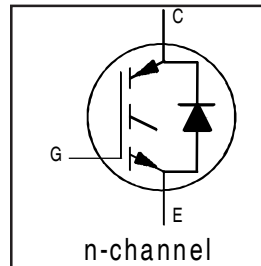
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE UltraFast CoPack IGBT

Features

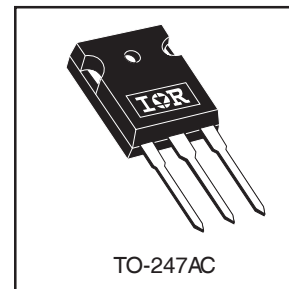
- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package
- Lead-Free

Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- HEXFRED diodes optimized for performance with IGBT's. Minimized recovery characteristics require less/no snubbing



| |
|-----------------------------------|
| $V_{CES} = 1200V$ |
| $V_{CE(on)} \text{ typ.} = 2.78V$ |
| @ $V_{GE} = 15V, I_C = 24A$ |



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|--|--------------------|------------|
| V_{CES} | Collector-to-Emitter Breakdown Voltage | 1200 | V |
| $I_C @ T_C = 25^\circ C$ | Continuous Collector Current | 45 | A |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current | 24 | |
| I_{CM} | Pulsed Collector Current ① | 180 | |
| I_{LM} | Clamped Inductive Load Current ② | 180 | |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current | 16 | |
| I_{FM} | Diode Maximum Forward Current | 180 | |
| V_{GE} | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D @ T_C = 25^\circ C$ | Maximum Power Dissipation | 200 | W |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation | 78 | |
| T_J | Operating Junction and Storage Temperature Range | -55 to + 150 | $^\circ C$ |
| T_{STG} | | | |
| | | | |
| | Mounting torque, 6-32 or M3 screw. | 10 lbf•in (1.1N•m) | |

Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|-----------------|---|------|----------|------|--------------|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | — | — | 0.64 | $^\circ C/W$ |
| $R_{\theta JC}$ | Junction-to-Case - Diode | — | — | 0.83 | |
| $R_{\theta CS}$ | 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) |

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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 | 1200 | — | — | V | $V_{GE} = 0V, I_C = 250\mu A$ |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 1.20 | — | V/°C | $V_{GE} = 0V, I_C = 1.0mA$ |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 2.56 | 3.5 | V | $I_C = 20A, V_{GE} = 15V$ |
| | | — | 2.78 | 3.7 | | $I_C = 24A$ |
| | | — | 3.20 | — | | $I_C = 45A$ |
| | | — | 2.54 | — | | $I_C = 24A, T_J = 150^\circ\text{C}$ |
| $V_{GE(th)}$ | 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 | — | -13 | — | mV/°C | $V_{CE} = V_{GE}, I_C = 250\mu A$ |
| g_{fe} | Forward Transconductance ^④ | 23 | 35 | — | S | $V_{CE} = 100V, I_C = 24A$ |
| I_{CES} | Zero Gate Voltage Collector Current | — | — | 250 | μA | $V_{GE} = 0V, V_{CE} = 1200V$ |
| | | — | — | 6500 | | $V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$ |
| V_{FM} | Diode Forward Voltage Drop | — | 2.5 | 3.5 | V | $I_C = 16A$ |
| | | — | 2.1 | 3.0 | | $I_C = 16A, T_J = 150^\circ\text{C}$ |
| 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) | — | 160 | 250 | nC | $I_C = 24A$ |
| Q_{ge} | Gate - Emitter Charge (turn-on) | — | 27 | 40 | | $V_{CC} = 400V$ |
| Q_{gc} | Gate - Collector Charge (turn-on) | — | 53 | 80 | | $V_{GE} = 15V$ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 47 | — | ns | $T_J = 25^\circ\text{C}$ |
| t_r | Rise Time | — | 24 | — | | $I_C = 24A, V_{CC} = 800V$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 110 | 170 | | $V_{GE} = 15V, R_G = 5.0\Omega$ |
| t_f | Fall Time | — | 180 | 260 | | Energy losses include "tail" and diode reverse recovery. |
| E_{on} | Turn-On Switching Loss | — | 2.10 | — | mJ | See Fig. 9, 10, 18 |
| E_{off} | Turn-Off Switching Loss | — | 1.50 | — | | |
| E_{ts} | Total Switching Loss | — | 3.60 | 4.6 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 46 | — | ns | $T_J = 150^\circ\text{C}$, See Fig. 11, 18 |
| t_r | Rise Time | — | 27 | — | | $I_C = 24A, V_{CC} = 800V$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 240 | — | | $V_{GE} = 15V, R_G = 5.0\Omega$ |
| t_f | Fall Time | — | 330 | — | | Energy losses include "tail" and diode reverse recovery. |
| E_{ts} | Total Switching Loss | — | 6.38 | — | mJ | |
| L_E | Internal Emitter Inductance | — | 13 | — | nH | Measured 5mm from package |
| C_{ies} | Input Capacitance | — | 3600 | — | pF | $V_{GE} = 0V$ |
| C_{oes} | Output Capacitance | — | 160 | — | | $V_{CC} = 30V$ |
| C_{res} | Reverse Transfer Capacitance | — | 31 | — | | $f = 1.0MHz$ |
| t_{rr} | Diode Reverse Recovery Time | — | 90 | 135 | ns | $T_J = 25^\circ\text{C}$ See Fig. 14 |
| | | — | 164 | 245 | | $T_J = 125^\circ\text{C}$ |
| I_{rr} | Diode Peak Reverse Recovery Current | — | 5.8 | 10 | A | $T_J = 25^\circ\text{C}$ See Fig. 15 |
| | | — | 8.3 | 15 | | $T_J = 125^\circ\text{C}$ |
| Q_{rr} | Diode Reverse Recovery Charge | — | 260 | 675 | nC | $T_J = 25^\circ\text{C}$ See Fig. 16 |
| | | — | 680 | 1838 | | $T_J = 125^\circ\text{C}$ |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During t_b | — | 120 | — | A/ μs | $T_J = 25^\circ\text{C}$ See Fig. 17 |
| | | — | 76 | — | | $T_J = 125^\circ\text{C}$ |

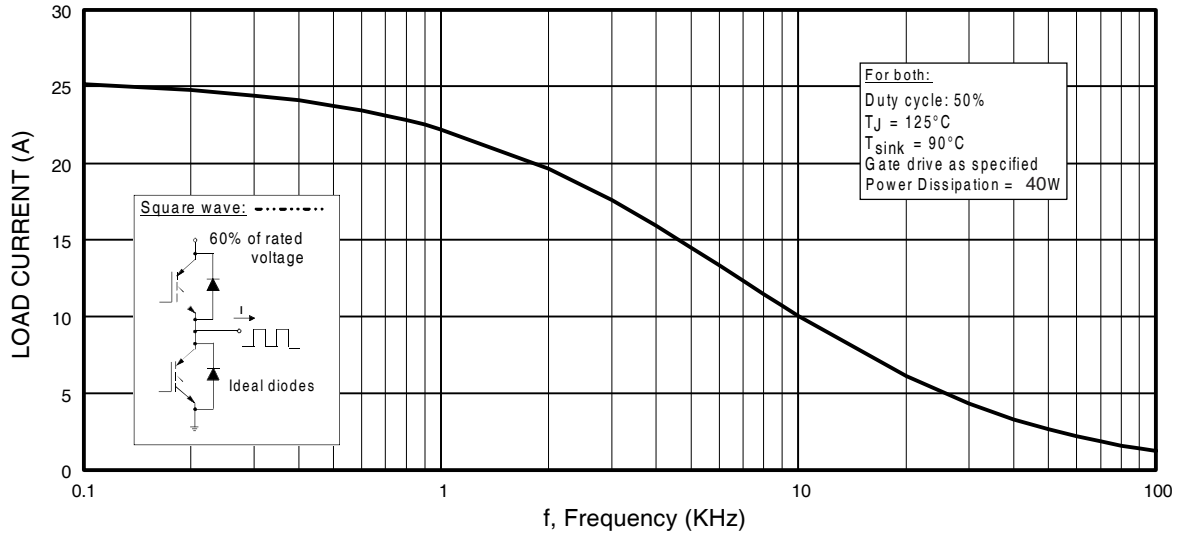


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

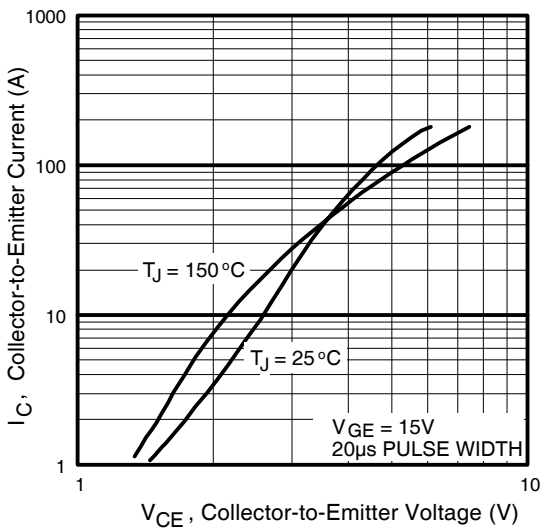


Fig. 2 - Typical Output Characteristics
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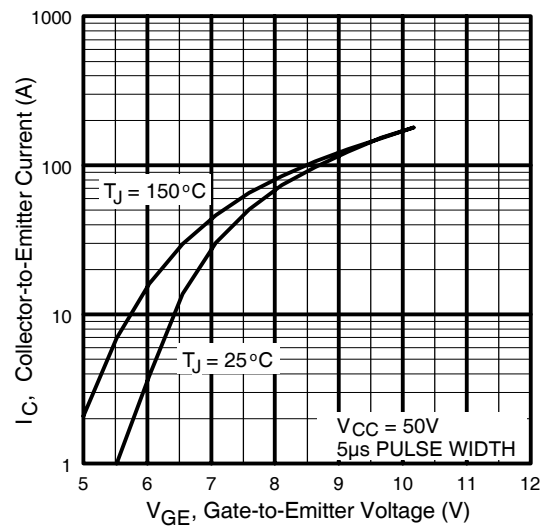


Fig. 3 - Typical Transfer Characteristics

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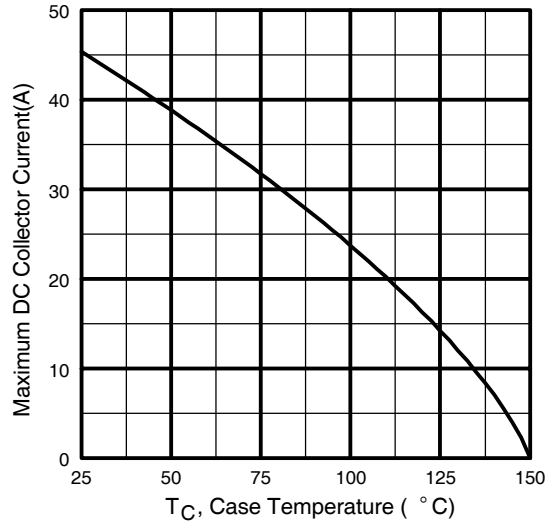


Fig. 4 - Maximum Collector Current vs. Case Temperature

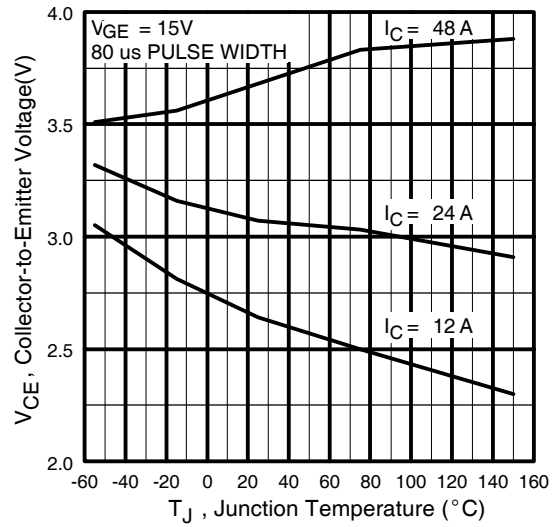


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

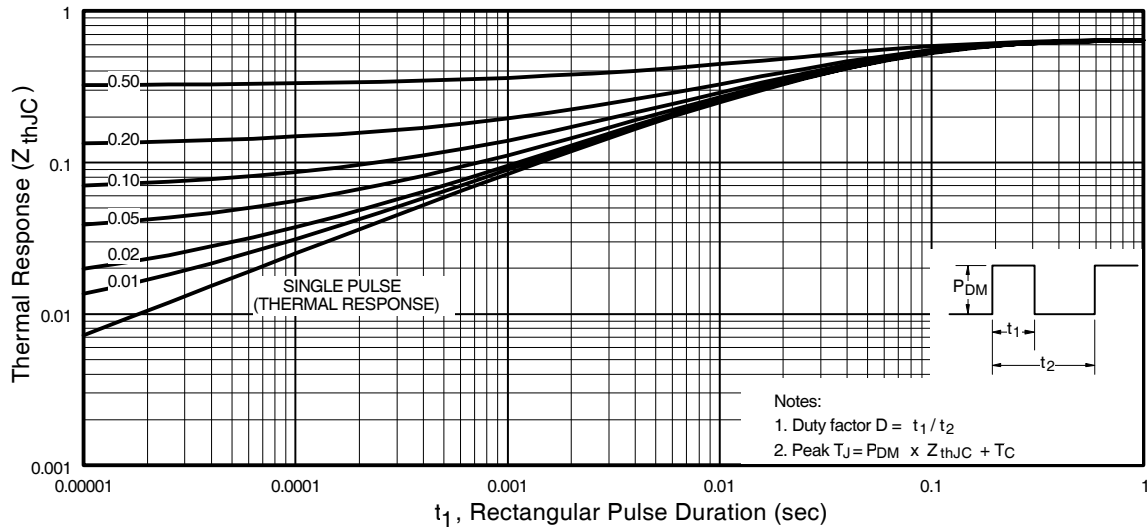


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

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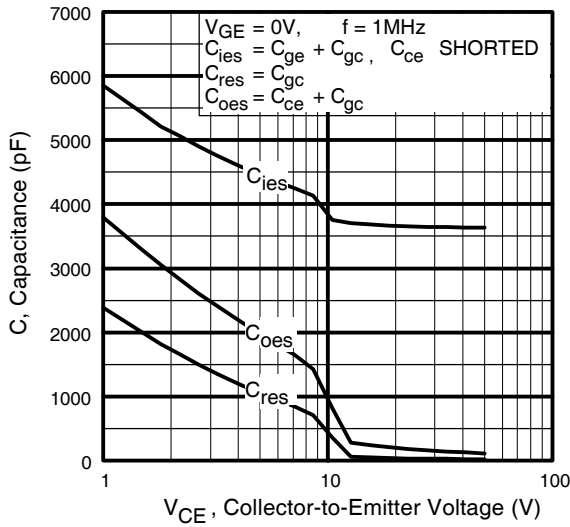


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

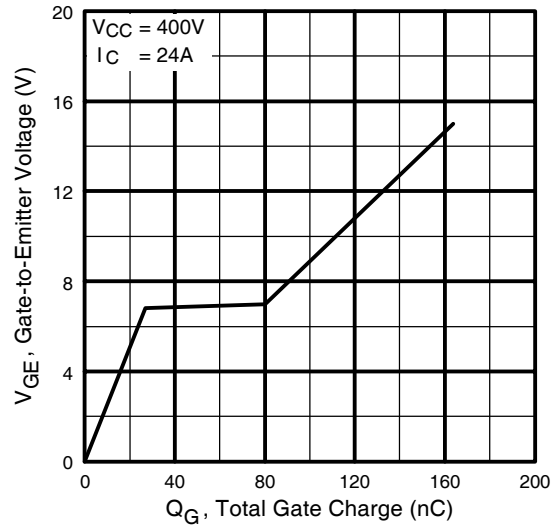


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

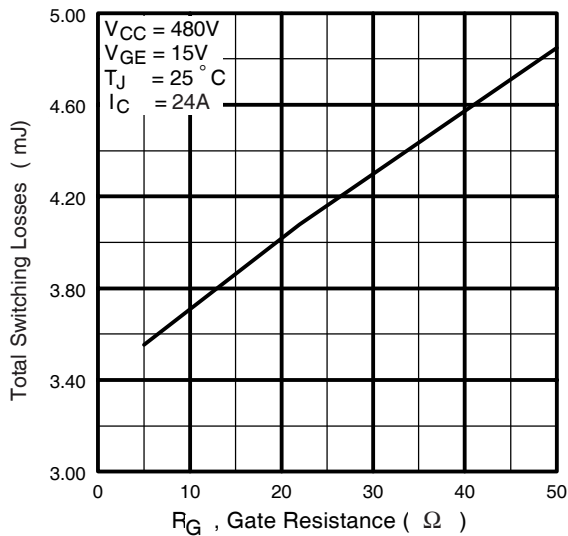


Fig. 9 - Typical Switching Losses vs. Gate Resistance

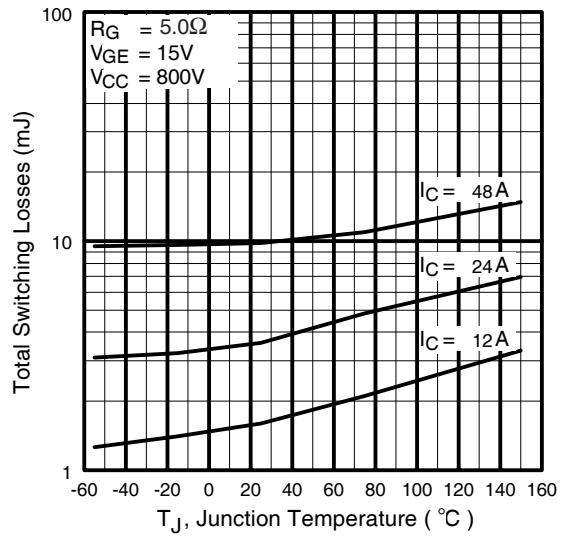


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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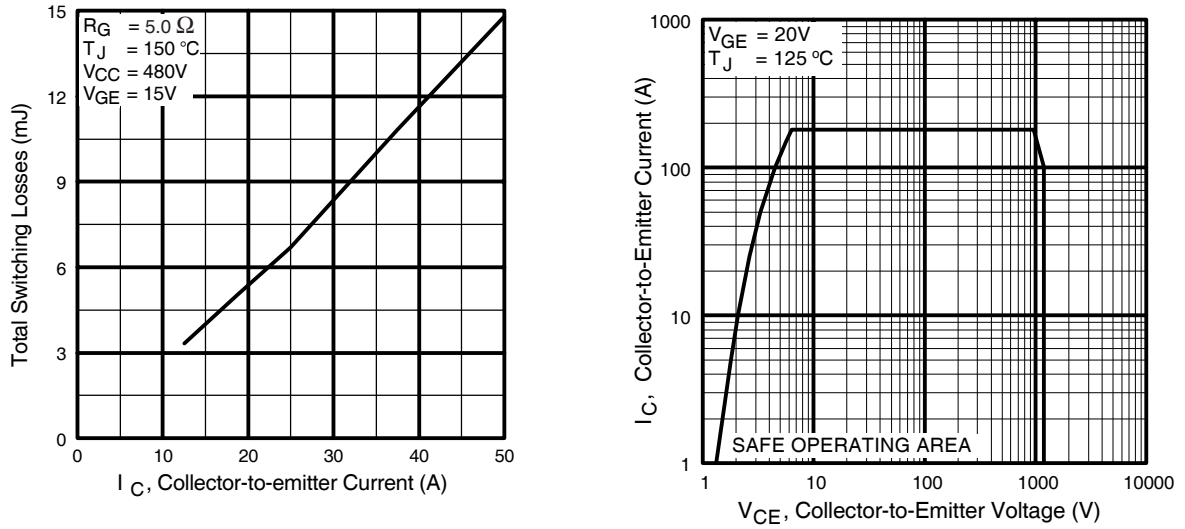


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

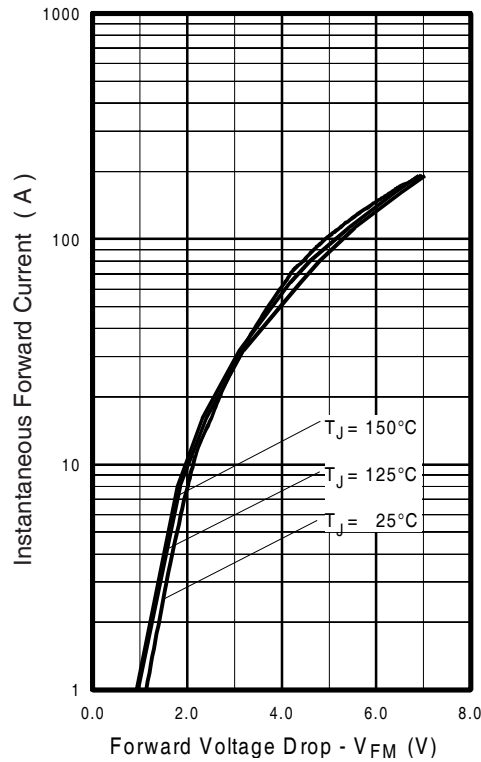


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

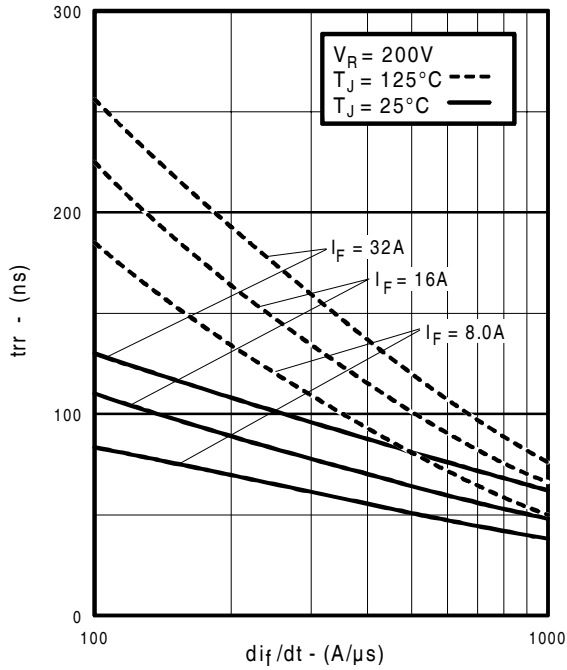


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

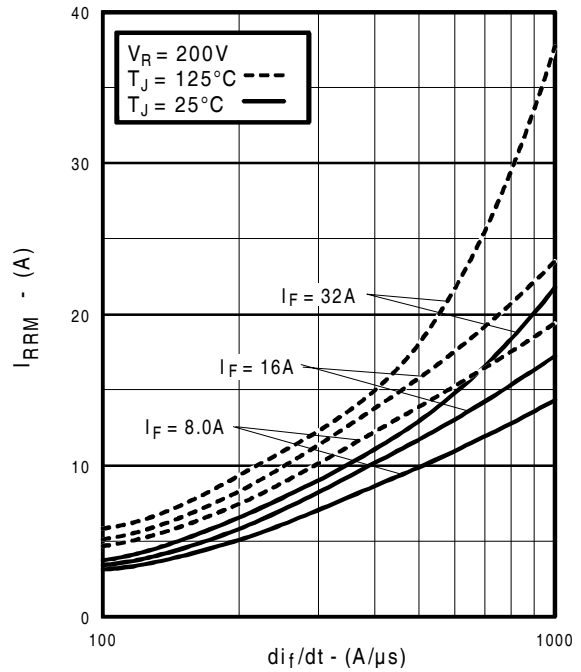


Fig. 15 - Typical Recovery Current vs. di_f/dt

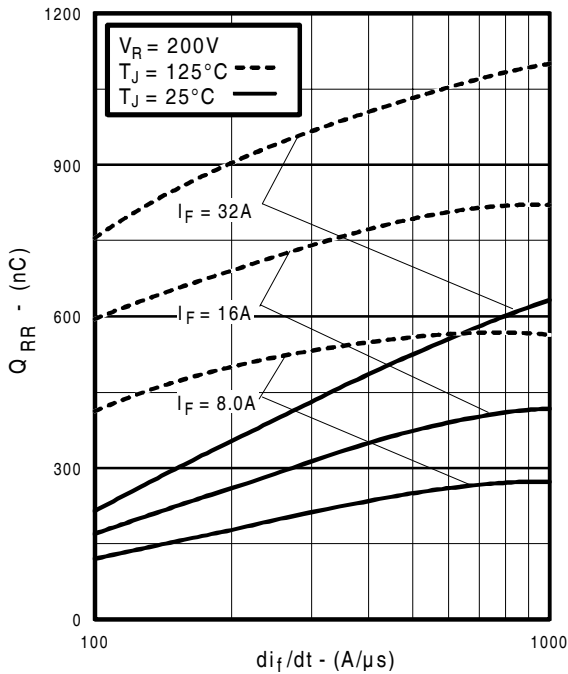


Fig. 16 - Typical Stored Charge vs. di_f/dt
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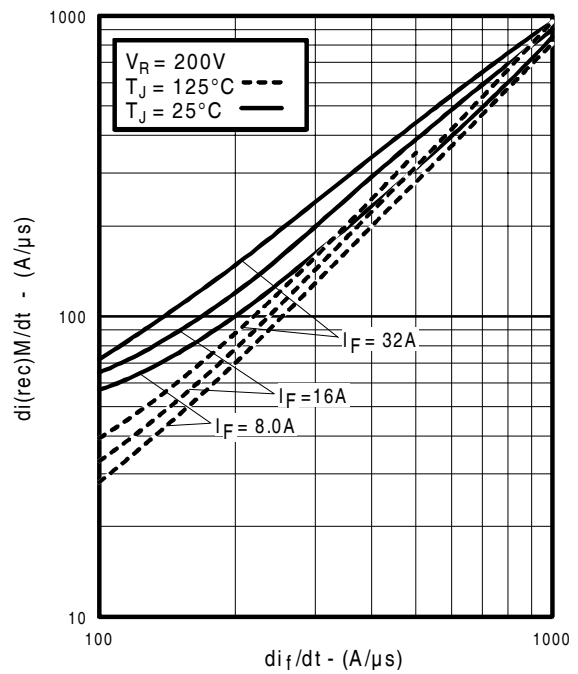


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

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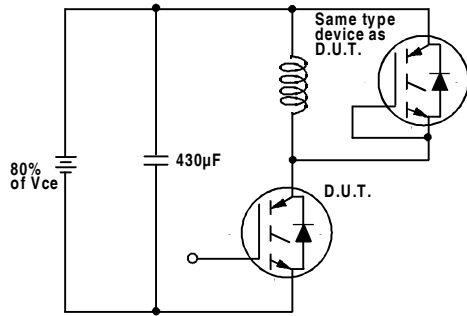


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

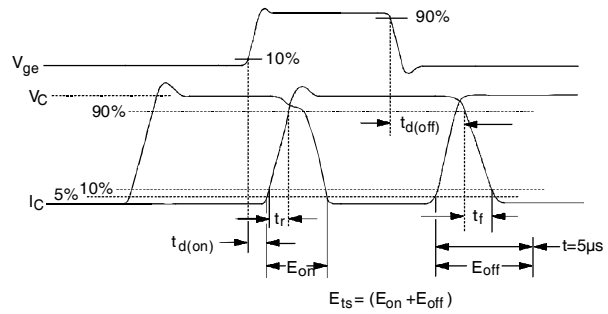


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

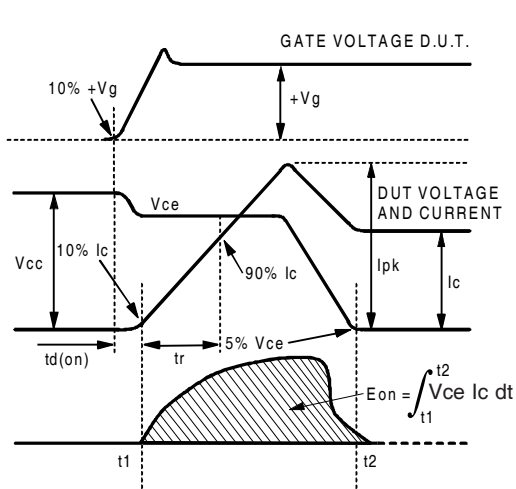


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

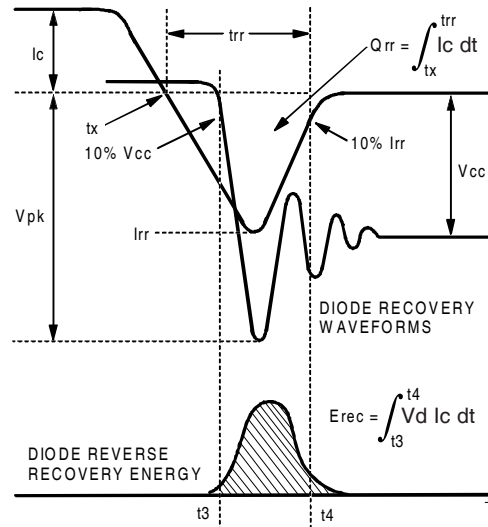


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

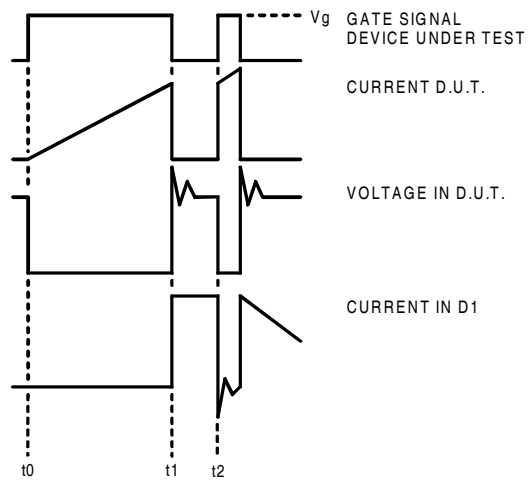


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

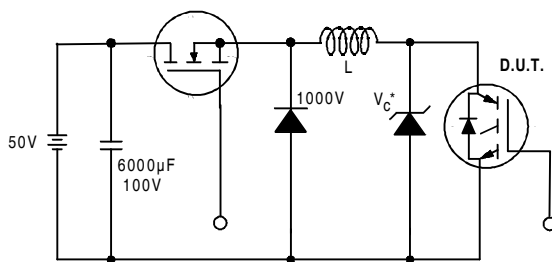


Figure 19. Clamped Inductive Load Test Circuit

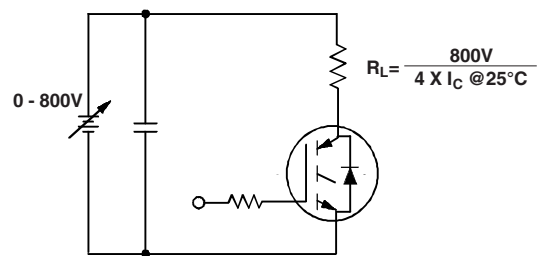


Figure 20. Pulsed Collector Current Test Circuit

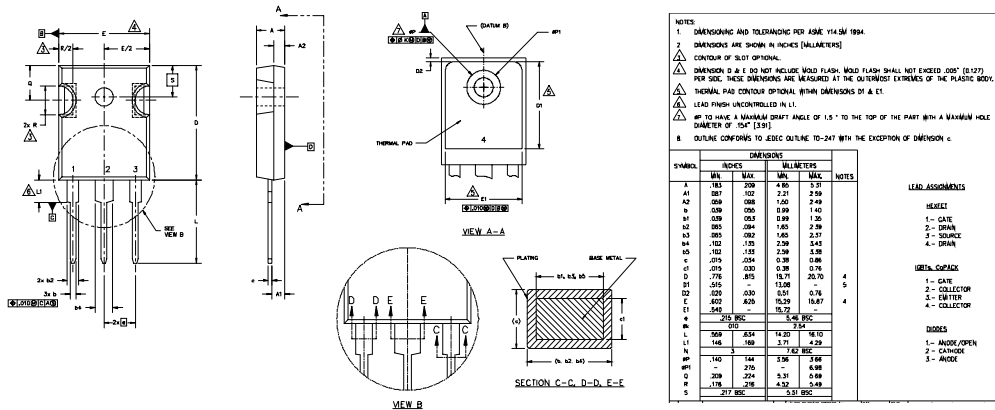
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Notes:

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

TO-247AC Package Outline

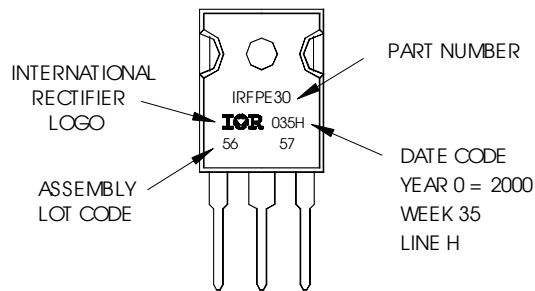
Dimensions are shown in millimeters (inches)



TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFP30
 WITH ASSEMBLY
 LOT CODE 5657
 ASSEMBLED ON WW 35, 2000
 IN THE ASSEMBLY LINE "H"

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/>