

# IRG4BC20MD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

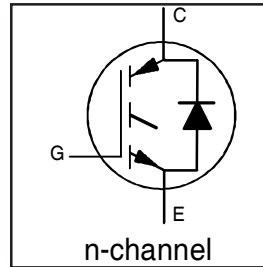
Short Circuit Rated  
Fast IGBT

## Features

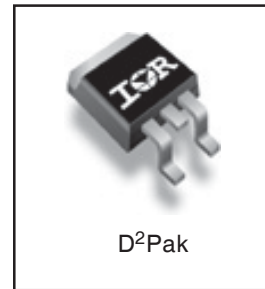
- Rugged: 10μsec short circuit capable at  $V_{GS}=15V$
- Low  $V_{CE(on)}$  for 4 to 10kHz applications
- IGBT Co-packaged with ultra-soft-recovery antiparallel diode
- Industry standard D<sup>2</sup>Pak package
- Lead-Free

## Benefits

- Offers highest efficiency and short circuit capability for intermediate applications
- Provides best efficiency for the mid range frequency (4 to 10kHz)
- Optimized for Appliance Motor Drives, Industrial (Short Circuit Proof) Drives and Intermediate Frequency Range Drives
- High noise immune "Positive Only" gate drive- Negative bias gate drive not necessary
- For Low EMI designs- requires little or no snubbing
- Single Package switch for bridge circuit applications
- Compatible with high voltage Gate Driver IC's
- Allows simpler gate drive



|                                   |
|-----------------------------------|
| $V_{CES} = 600V$                  |
| $V_{CE(on)} \text{ typ.} = 1.85V$ |
| @ $V_{GE} = 15V, I_C = 11A$       |



## Absolute Maximum Ratings

|                           | Parameter                          | Max.                              | Units |
|---------------------------|------------------------------------|-----------------------------------|-------|
| $V_{CES}$                 | Collector-to-Emitter Voltage       | 600                               | V     |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 18                                | A     |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 11                                |       |
| $I_{CM}$                  | Pulsed Collector Current ①         | 36                                |       |
| $I_{LM}$                  | Clamped Inductive Load Current ②   | 36                                |       |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current   | 7.0                               |       |
| $t_{sc}$                  | Short Circuit Withstand Time       | 10                                | μs    |
| $I_{FM}$                  | Diode Maximum Forward Current      | 36                                | A     |
| $V_{GE}$                  | 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             | -55 to +150                       | °C    |
| $T_{STG}$                 | Storage Temperature Range          |                                   |       |
|                           | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) |       |
|                           | Mounting Torque, 6-32 or M3 Screw. | 10 lbf•in (1.1 N•m)               |       |

## Thermal Resistance

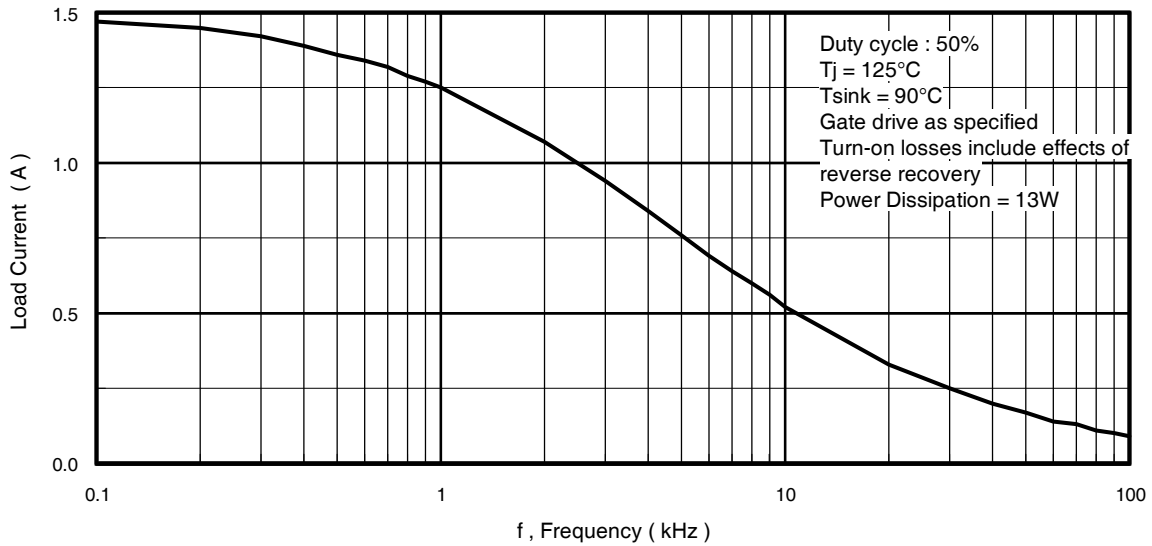
|                 | Parameter                                 | Min.  | Typ.     | Max.  | Units  |
|-----------------|-------------------------------------------|-------|----------|-------|--------|
| $R_{\theta JC}$ | Junction-to-Case - IGBT                   | ----- | -----    | 2.1   | °C/W   |
| $R_{\theta JC}$ | Junction-to-Case - Diode                  | ----- | -----    | 2.5   |        |
| $R_{\theta CS}$ | 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) |

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

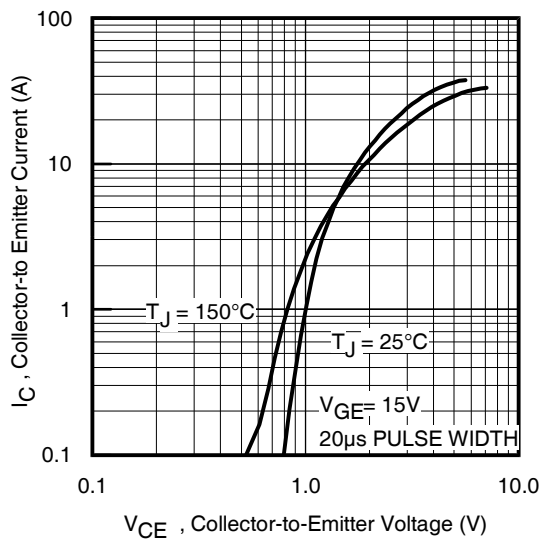
|                                 | Parameter                                           | Min. | Typ. | Max.      | Units                | Conditions                                            |
|---------------------------------|-----------------------------------------------------|------|------|-----------|----------------------|-------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage <sup>③</sup> | 600  | ---- | ----      | V                    | $V_{GE} = 0V, I_C = 250\mu A$                         |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage             | ---- | 0.67 | ----      | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                            |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage             | ---- | 1.85 | 2.1       | V                    | $I_C = 11A, V_{GE} = 15V$                             |
|                                 |                                                     | ---- | 2.46 | ----      |                      | $I_C = 18A$                                           |
|                                 |                                                     | ---- | 2.07 | ----      |                      | $I_C = 11A, T_J = 150^\circ\text{C}$                  |
| $V_{GE(th)}$                    | Gate Threshold Voltage                              | 4.0  | ---- | 6.5       |                      | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage             | ---- | -11  | ----      | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |
| $g_{fe}$                        | Forward Transconductance <sup>④</sup>               | 3.0  | 3.6  | ----      | S                    | $V_{CE} = 100V, I_C = 11A$                            |
| $I_{CES}$                       | Zero Gate Voltage Collector Current                 | ---- | ---- | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$                          |
|                                 |                                                     | ---- | ---- | 2500      |                      | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| $V_{FM}$                        | Diode Forward Voltage Drop                          | ---- | 1.4  | 1.7       | V                    | $I_C = 8.0A$                                          |
|                                 |                                                     | ---- | 1.3  | 1.6       |                      | $I_C = 8.0A, T_J = 150^\circ\text{C}$                 |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current                     | ---- | ---- | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                    |

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

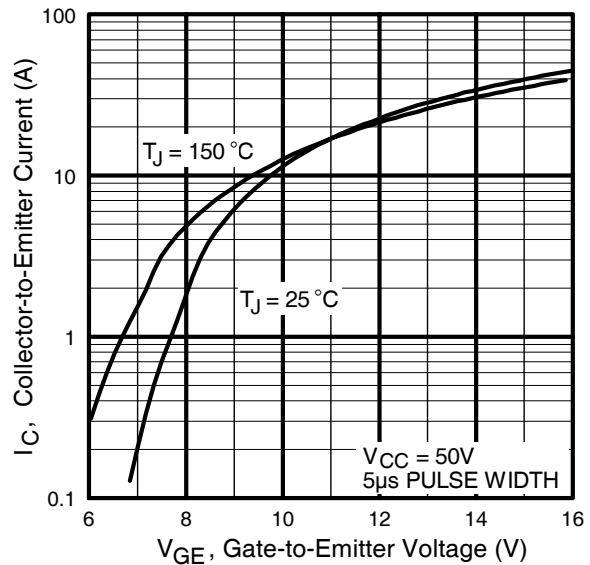
|                  | Parameter                                        | Min. | Typ. | Max. | Units      | Conditions                                               |
|------------------|--------------------------------------------------|------|------|------|------------|----------------------------------------------------------|
| $Q_g$            | Total Gate Charge (turn-on)                      | ---- | 39   | 59   | nC         | $I_C = 11A$                                              |
| $Q_{ge}$         | Gate - Emitter Charge (turn-on)                  | ---- | 5.3  | 8.0  |            | $V_{CC} = 400V$                                          |
| $Q_{gc}$         | Gate - Collector Charge (turn-on)                | ---- | 20   | 30   |            | $V_{GE} = 15V$                                           |
| $t_{d(on)}$      | Turn-On Delay Time                               | ---- | 21   | ---- | ns         | $T_J = 25^\circ\text{C}$                                 |
| $t_r$            | Rise Time                                        | ---- | 37   | ---- |            | $I_C = 11A, V_{CC} = 480V$                               |
| $t_{d(off)}$     | Turn-Off Delay Time                              | ---- | 463  | 690  |            | $V_{GE} = 15V, R_G = 50\Omega$                           |
| $t_f$            | Fall Time                                        | ---- | 340  | 510  |            | Energy losses include "tail" and diode reverse recovery. |
| $E_{on}$         | Turn-On Switching Loss                           | ---- | 0.41 | ---- | mJ         | See Fig. 9, 10, 11, 18                                   |
| $E_{off}$        | Turn-Off Switching Loss                          | ---- | 2.03 | ---- |            |                                                          |
| $E_{ts}$         | Total Switching Loss                             | ---- | 2.44 | 3.7  |            |                                                          |
| $t_{d(on)}$      | Turn-On Delay Time                               | ---- | 19   | ---- | ns         | $T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18       |
| $t_r$            | Rise Time                                        | ---- | 41   | ---- |            | $I_C = 6.5A, V_{CC} = 480V$                              |
| $t_{d(off)}$     | Turn-Off Delay Time                              | ---- | 590  | ---- |            | $V_{GE} = 15V, R_G = 50\Omega$                           |
| $t_f$            | Fall Time                                        | ---- | 600  | ---- |            | Energy losses include "tail" and diode reverse recovery. |
| $E_{ts}$         | Total Switching Loss                             | ---- | 3.49 | ---- | mJ         |                                                          |
| $L_E$            | Internal Emitter Inductance                      | ---- | 7.5  | ---- | nH         | Measured 5mm from package                                |
| $C_{ies}$        | Input Capacitance                                | ---- | 460  | ---- | pF         | $V_{GE} = 0V$                                            |
| $C_{oes}$        | Output Capacitance                               | ---- | 54   | ---- |            | $V_{CC} = 30V$                                           |
| $C_{res}$        | Reverse Transfer Capacitance                     | ---- | 14   | ---- |            | $f = 1.0MHz$                                             |
| $t_{rr}$         | 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/ $\mu s$ | $T_J = 25^\circ\text{C}$ See Fig. 17                     |
|                  |                                                  | ---- | 210  | ---- |            | $T_J = 125^\circ\text{C}$                                |



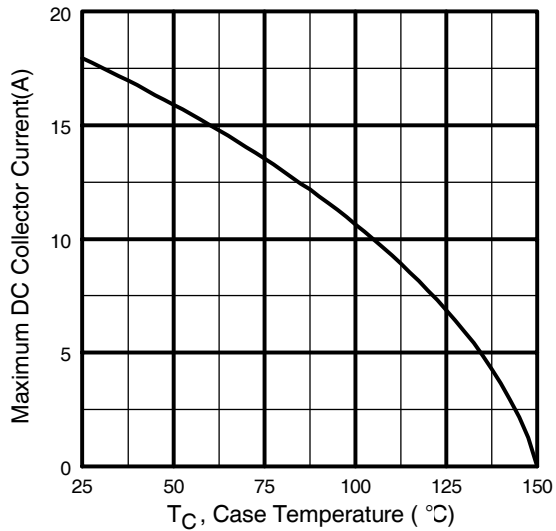
**Fig. 1 - Typical Load Current vs. Frequency**  
(Load Current =  $I_{\text{RMS}}$  of fundamental)



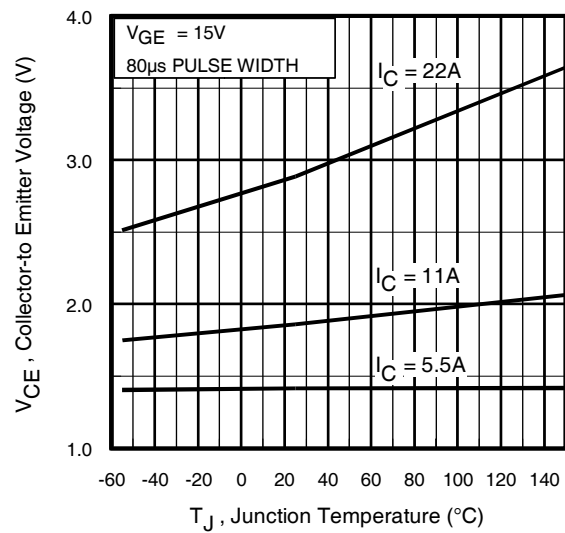
**Fig. 2 - Typical Output Characteristics**



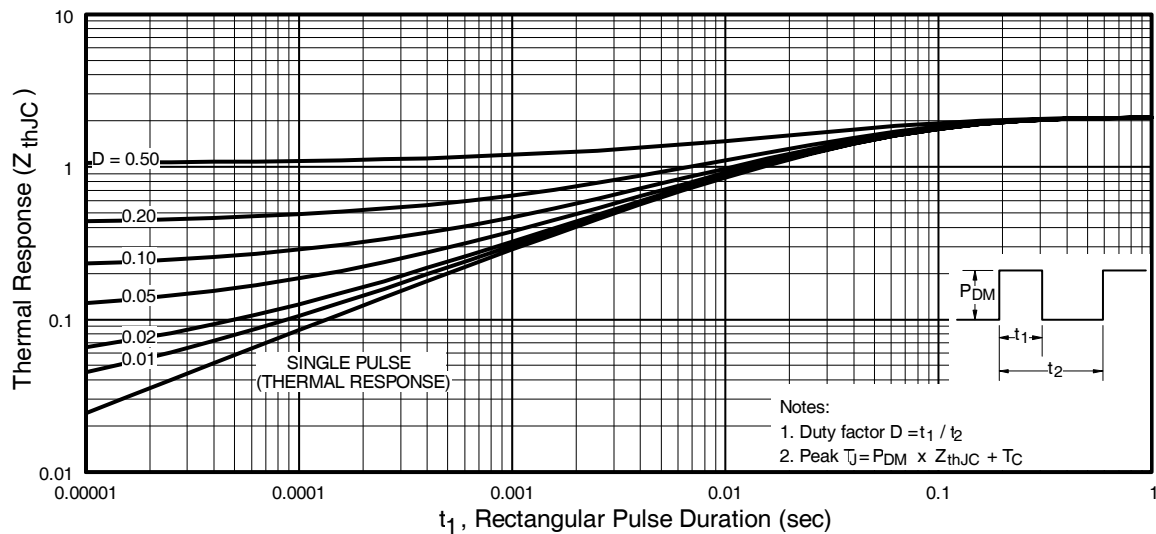
**Fig. 3 - Typical Transfer Characteristics**



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

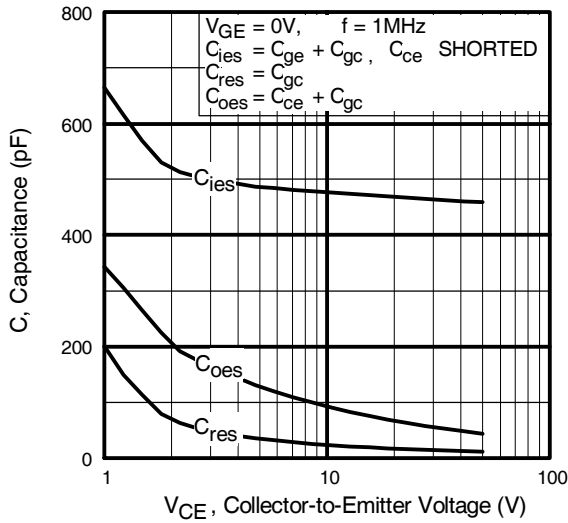


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

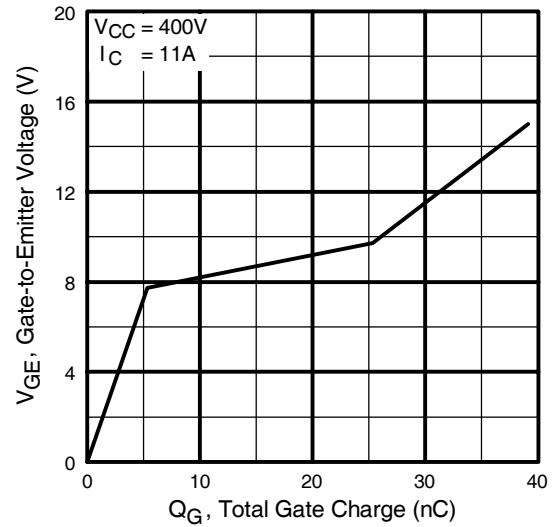


**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

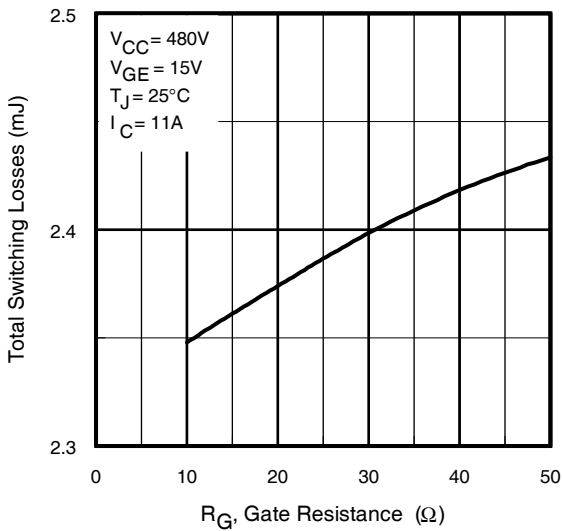
# IRG4BC20MD-SPbF



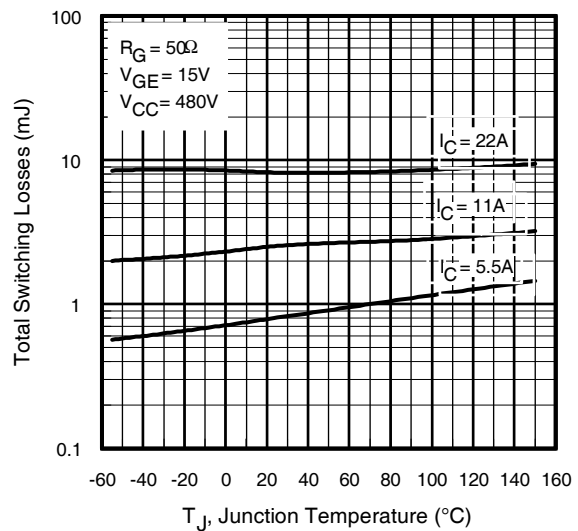
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



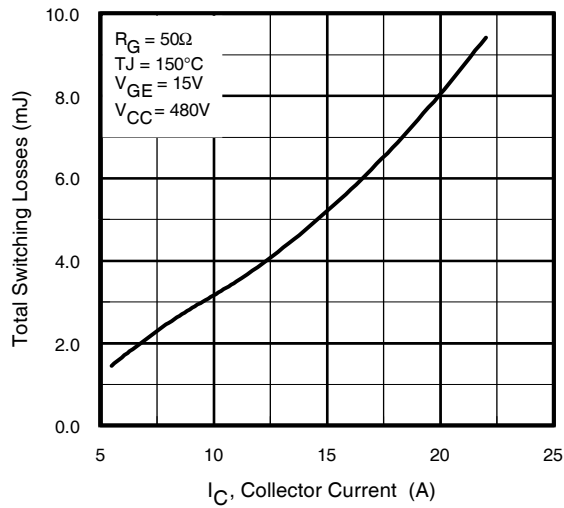
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



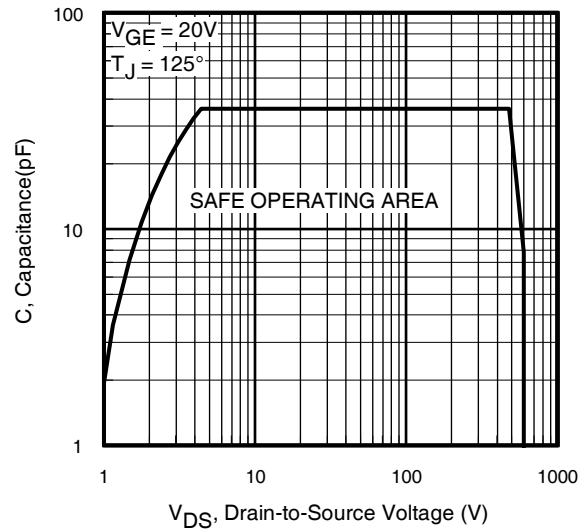
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

# IRG4BC20MD-SPbF

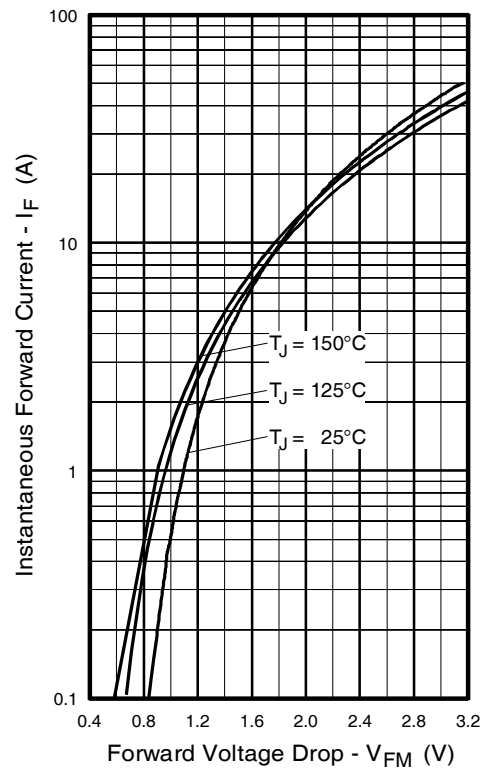
International  
**IR** Rectifier



**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

# IRG4BC20MD-SPbF

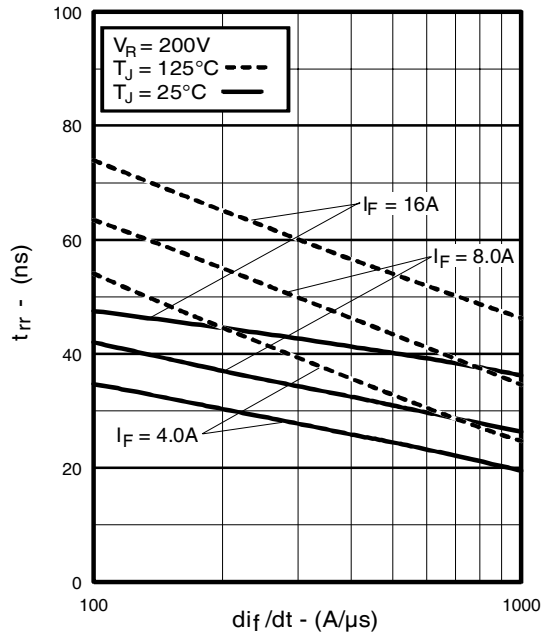


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

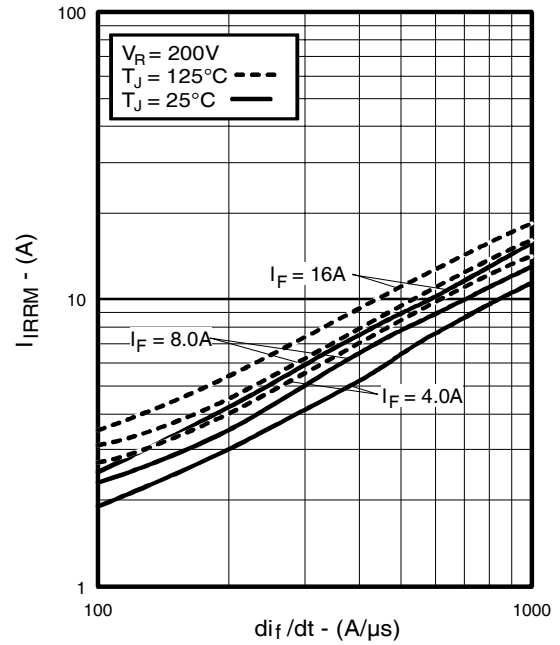


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

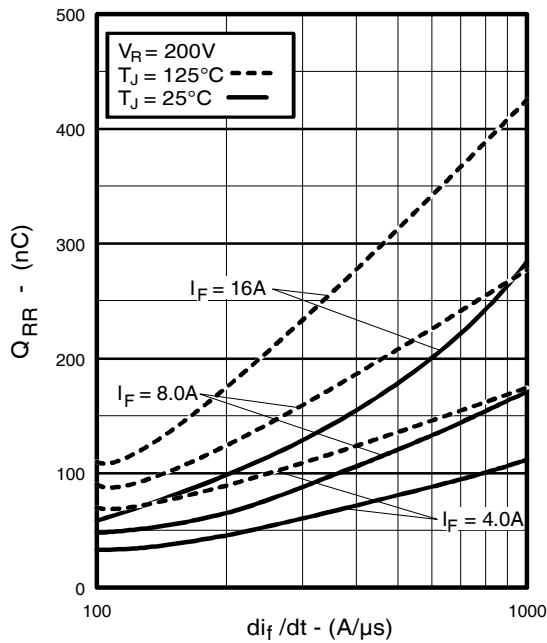


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

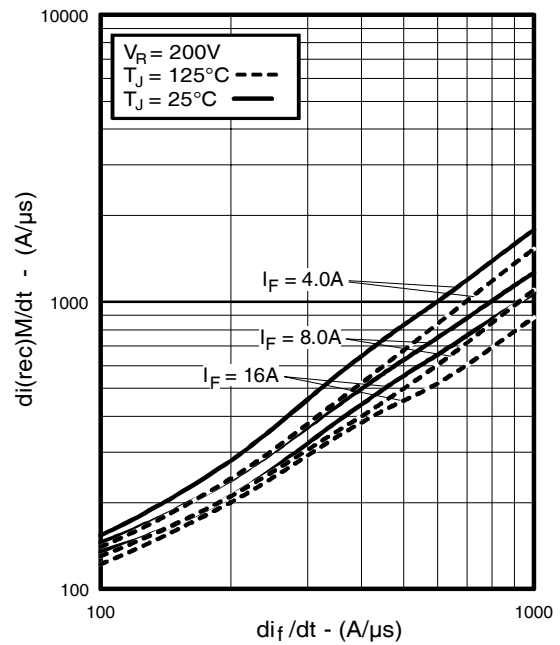
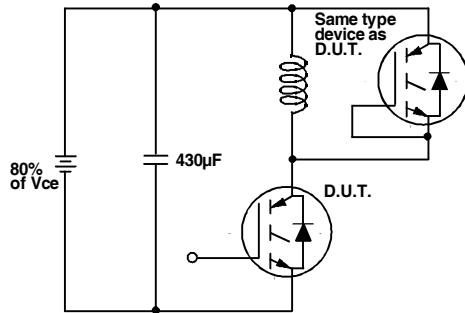


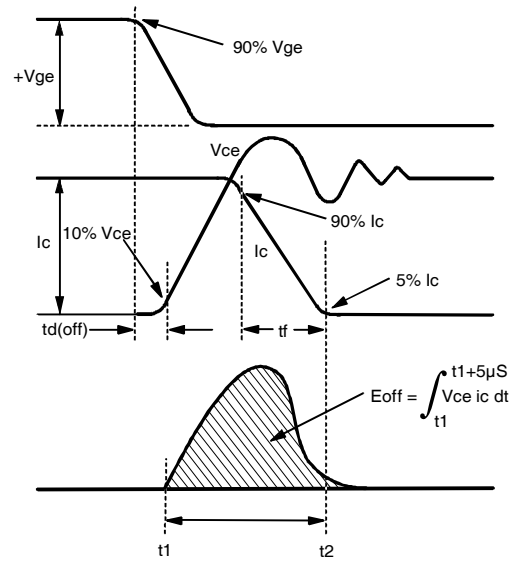
Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

# IRG4BC20MD-SPbF

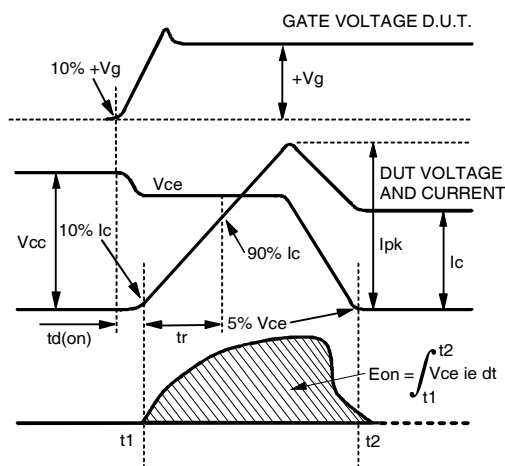
International  
**IRF** Rectifier



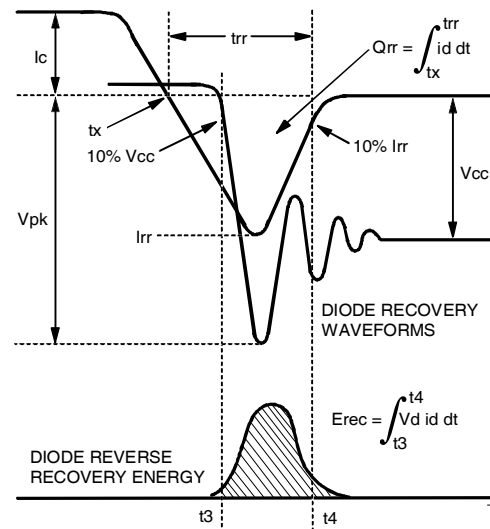
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$

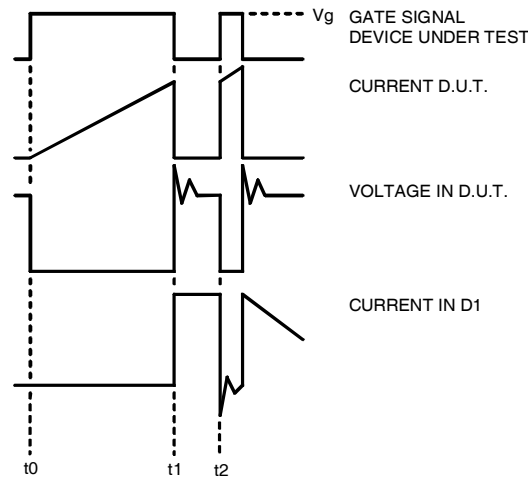


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

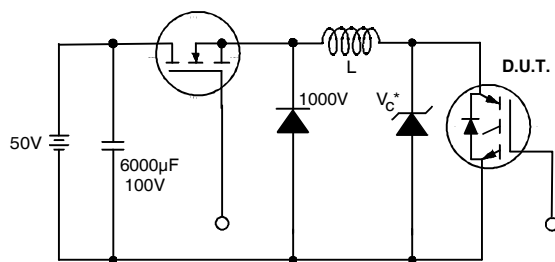
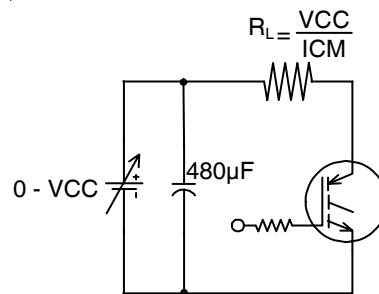


Figure 19. Clamped Inductive Load Test Circuit



Pulsed Collector Current  
Test Circuit

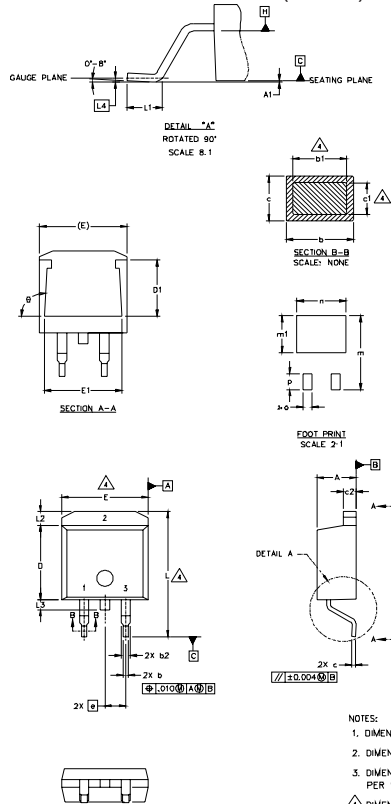
Figure 20. Pulsed Collector Current  
Test Circuit

# IRG4BC20MD-SPbF

## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)

International  
**IR** Rectifier



| SYMBOL | DIMENSIONS  |          |        |      | NOTES |
|--------|-------------|----------|--------|------|-------|
|        | MILLIMETERS |          | INCHES |      |       |
|        | MIN.        | MAX.     | MIN.   | MAX. |       |
| A      | 4.06        | 4.83     | .160   | .190 | 4     |
| A1     |             | 0.127    |        | .005 |       |
| b      | 0.51        | 0.99     | .020   | .039 |       |
| b1     | 0.51        | 0.89     | .020   | .035 |       |
| b2     | 1.14        | 1.40     | .045   | .055 | 4     |
| c      | 0.43        | 0.63     | .017   | .025 |       |
| c1     | 0.38        | 0.74     | .015   | .029 |       |
| c2     | 1.14        | 1.40     | .045   | .055 |       |
| D      | 8.51        | 9.65     | .335   | .380 | 3     |
| D1     | 5.33        |          | .210   |      |       |
| E      | 9.65        | 10.67    | .380   | .420 | 3     |
| E1     | 6.22        |          | .245   |      |       |
| e      | 2.54        | BSC      | .100   | BSC  |       |
| L      | 14.61       | 15.88    | .575   | .625 |       |
| L1     | 1.78        | 2.79     | .070   | .110 |       |
| L2     |             | 1.65     |        | .065 |       |
| L3     | 1.27        | 1.78     | .050   | .070 |       |
| L4     |             | 0.25 BSC | .010   | BSC  |       |
| m      | 17.78       |          | .700   |      |       |
| m1     | 8.89        |          | .350   |      |       |
| n      | 11.43       |          | .450   |      |       |
| o      | 2.08        |          | .082   |      |       |
| p      | 3.81        |          | .150   |      |       |
| θ      | 90°         | 93°      | 90°    | 93°  |       |

### LEAD ASSIGNMENTS

| HEXFET     | IGBTs, CoPACK | DIODES      |
|------------|---------------|-------------|
| 1 - GATE   | 1 - GATE      | 1 - ANODE * |
| 2 - DRAIN  | 2 - COLLECTOR | 2 - CATHODE |
| 3 - SOURCE | 3 - EMITTER   | 3 - ANODE   |

\* PART DEPENDENT.

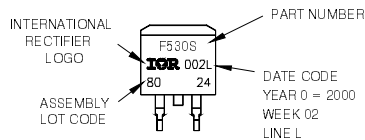
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

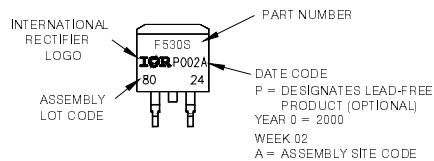
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE 'L'

Note: 'P' in assembly line  
position indicates 'Lead-Free'



**OR**



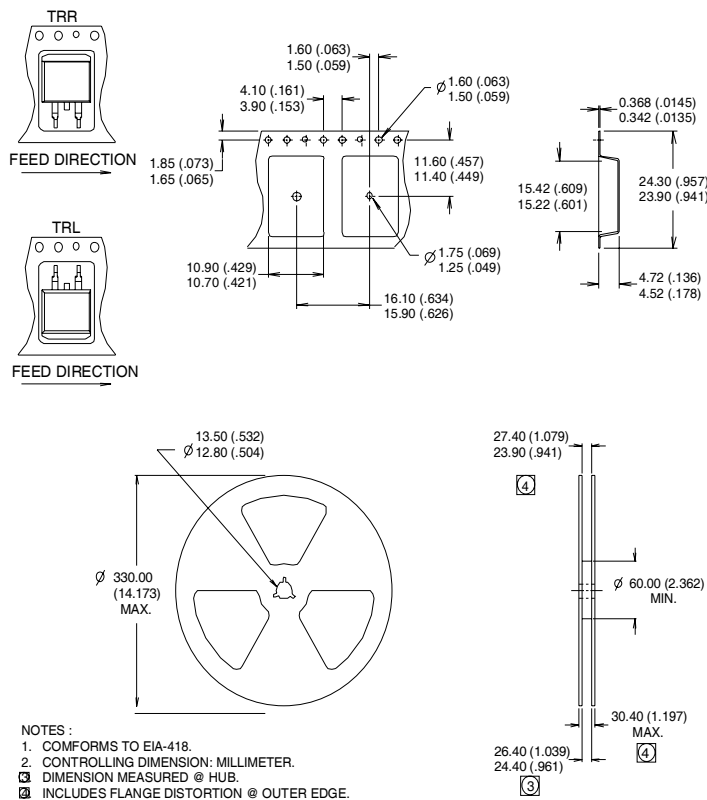
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## 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.

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



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.