

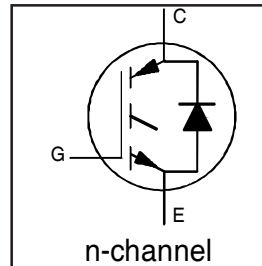
# IRG4BC20KD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
 UltraFast IGBT

### Features

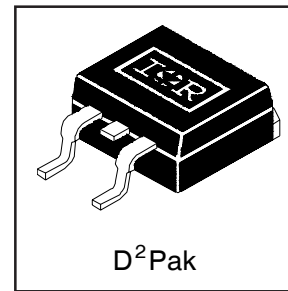
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10μs @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard D<sup>2</sup>Pak package
- Lead-Free



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

### Benefits

- Latest generation 4 IGBT's 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-S and IRGBC20MD2-S 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                                | μs    |
| $t_{sc}$                  | Short Circuit Withstand Time                     | 10                                |       |
| $V_{GE}$                  | 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    |
| $T_{STG}$                 |  |                                   |       |
|                           | 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   | 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               | 0.5  | ---  |       |
| $R_{\theta JA}$ | Junction-to-Ambient ( PCB Mounted, steady-state)③ | ---  | 40   |       |
| Wt              | Weight  | 1.44 | ---  | g     |

# IRG4BC20KD-SPbF

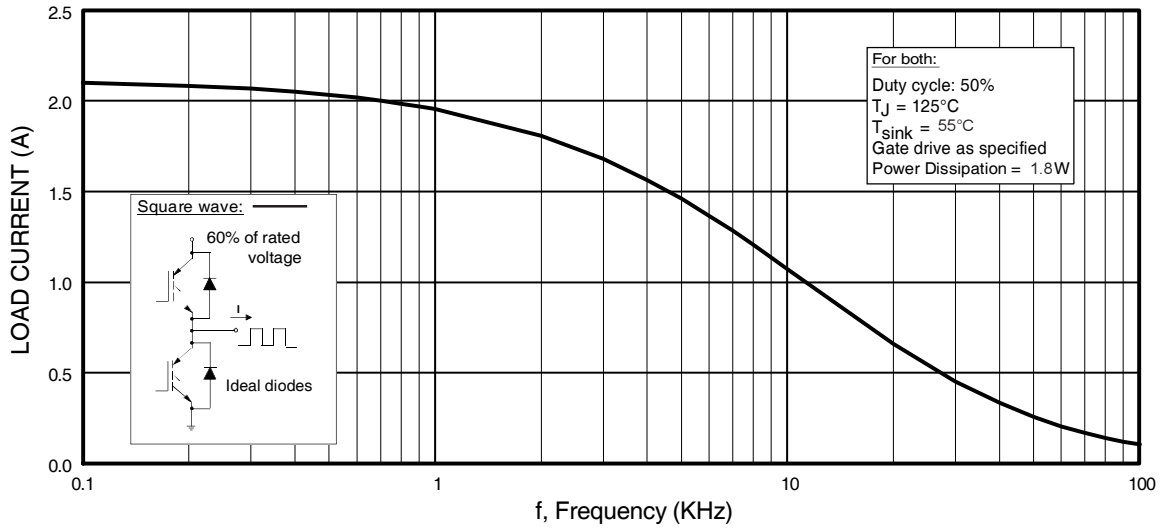
International  
 Rectifier

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

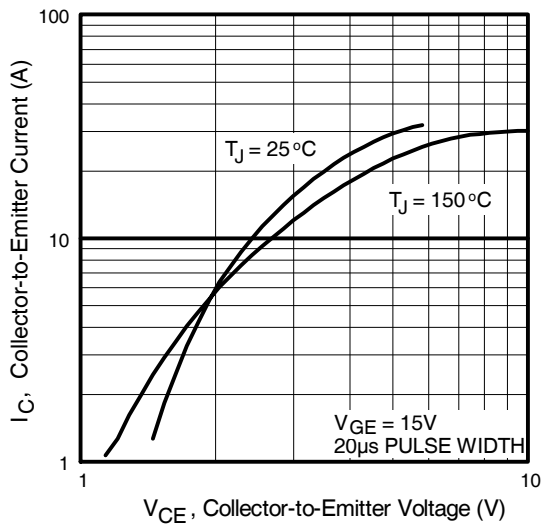
|                                 | Parameter   | Min. | Typ. | Max.      | Units                | Conditions  |                |
|---------------------------------|---|------|------|-----------|----------------------|---|----------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown 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             | —    | 0.49 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$  |                |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage             | —    | 2.27 | 2.8       | V                    | $I_C = 9.0A$<br>$I_C = 16A$<br>$I_C = 9.0A, T_J = 150^\circ\text{C}$                  |                |
|                                 |   | —    | 3.01 | —         |                      |   | $V_{GE} = 15V$ |
|                                 |   | —    | 2.43 | —         |                      |   | See Fig. 2, 5  |
| $V_{GE(th)}$                    | 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 <sup>④</sup>               | 2.9  | 4.3  | —         | S                    | $V_{CE} = 100V, I_C = 9.0A$   |                |
| $I_{CES}$                       | Zero Gate Voltage Collector Current                 | —    | —    | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$<br>$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |                |
|                                 |   | —    | —    | 1000      |                      |   |                |
| $V_{FM}$                        | Diode Forward Voltage Drop                          | —    | 1.4  | 1.7       | V                    | $I_C = 8.0A$<br>$I_C = 8.0A, T_J = 150^\circ\text{C}$                                 |                |
|                                 |   | —    | 1.3  | 1.6       |                      |   | See Fig. 13    |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current                     | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$  |                |

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

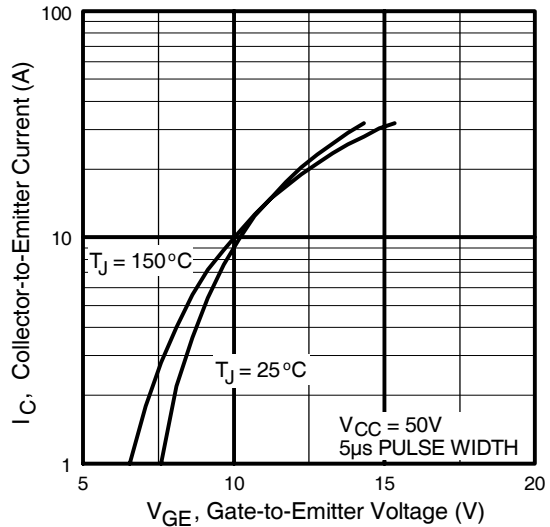
|                  | Parameter  | Min. | Typ. | Max. | Units      | Conditions  |
|------------------|--|------|------|------|------------|---|
| $Q_g$            | Total Gate Charge (turn-on)                      | —    | 34   | 51   | nC         | $I_C = 9.0A$<br>$V_{CC} = 400V$<br>$V_{GE} = 15V$<br>See Fig. 8   |
| $Q_{ge}$         | 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         | $T_J = 25^\circ\text{C}$<br>$I_C = 9.0A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 50\Omega$                   |
| $t_r$            | 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"<br>and diode reverse recovery<br>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   | —    | —    | $\mu s$    | $V_{CC} = 360V, T_J = 125^\circ\text{C}$<br>$V_{GE} = 15V, R_G = 50\Omega, V_{CPK} < 500V$                  |
| $t_{d(on)}$      | Turn-On Delay Time                               | —    | 51   | —    | ns         | $T_J = 150^\circ\text{C}$ , See Fig. 11,14<br>$I_C = 9.0A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 50\Omega$ |
| $t_r$            | 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"<br>and diode reverse recovery  |
| $L_E$            | Internal Emitter Inductance                      | —    | 7.5  | —    | nH         | Measured 5mm from package   |
| $C_{ies}$        | Input Capacitance                                | —    | 450  | —    | pF         | $V_{GE} = 0V$<br>$V_{CC} = 30V$<br>$f = 1.0MHz$<br>See Fig. 7   |
| $C_{oes}$        | 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<br>$T_J = 125^\circ\text{C}$ 14  |
|                  |  | —    | 55   | 90   |            |   |
| $I_{rr}$         | Diode Peak Reverse Recovery Current              | —    | 3.5  | 5.0  | A          | $T_J = 25^\circ\text{C}$ See Fig. 15<br>$T_J = 125^\circ\text{C}$ 15  |
|                  |  | —    | 4.5  | 8.0  |            |   |
| $Q_{rr}$         | Diode Reverse Recovery Charge                    | —    | 65   | 138  | nC         | $T_J = 25^\circ\text{C}$ See Fig. 16<br>$T_J = 125^\circ\text{C}$ 16  |
|                  |  | —    | 124  | 360  |            |   |
| $di_{(rec)M}/dt$ | Diode Peak Rate of Fall of Recovery During $t_b$ | —    | 240  | —    | A/ $\mu s$ | $T_J = 25^\circ\text{C}$ See Fig. 17<br>$T_J = 125^\circ\text{C}$ 17  |
|                  |  | —    | 210  | —    |            |   |



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



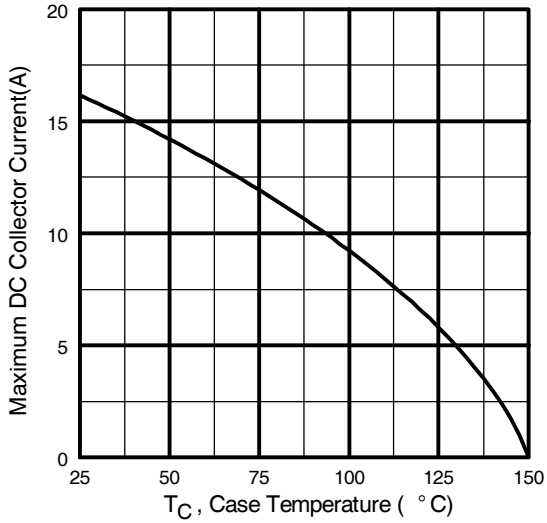
**Fig. 2 - Typical Output Characteristics**



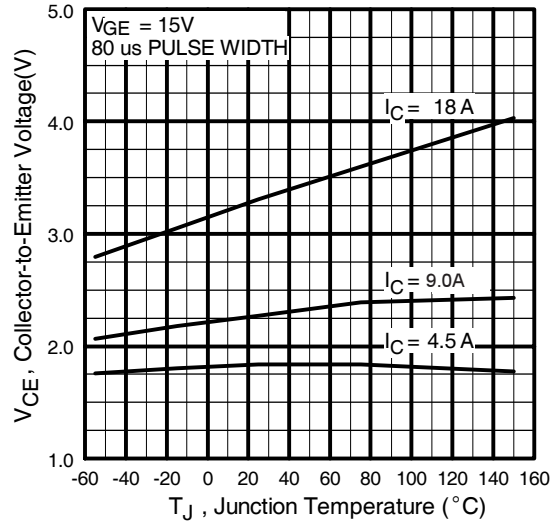
**Fig. 3 - Typical Transfer Characteristics**

# IRG4BC20KD-SPbF

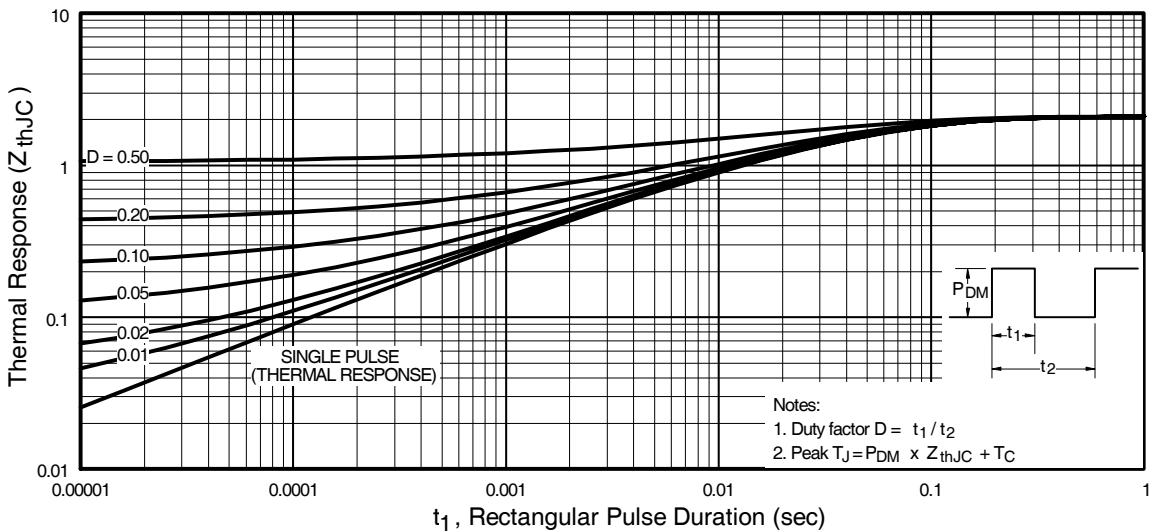
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**Fig. 4** - Maximum Collector Current vs. Case Temperature

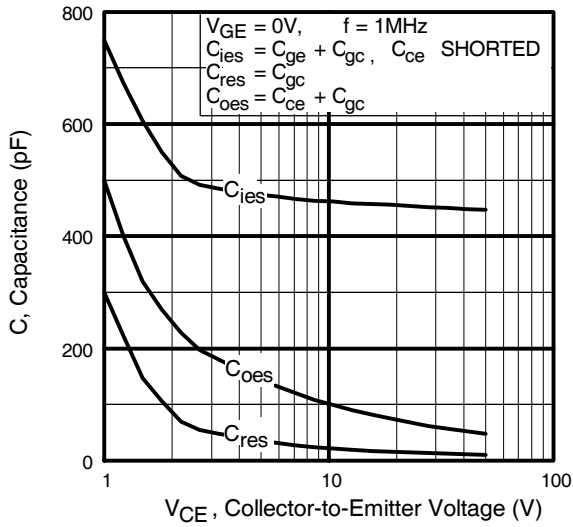


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

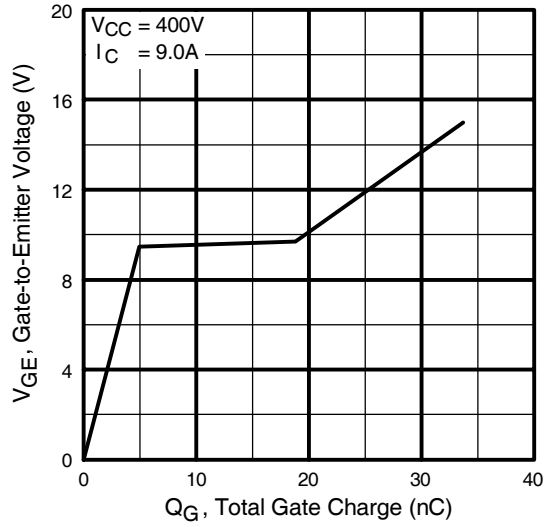


**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

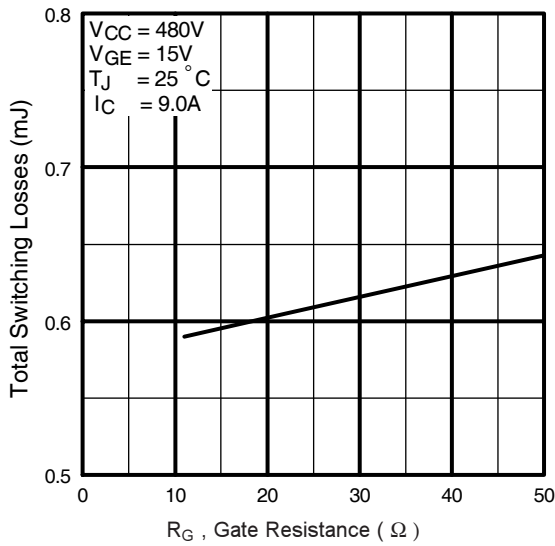
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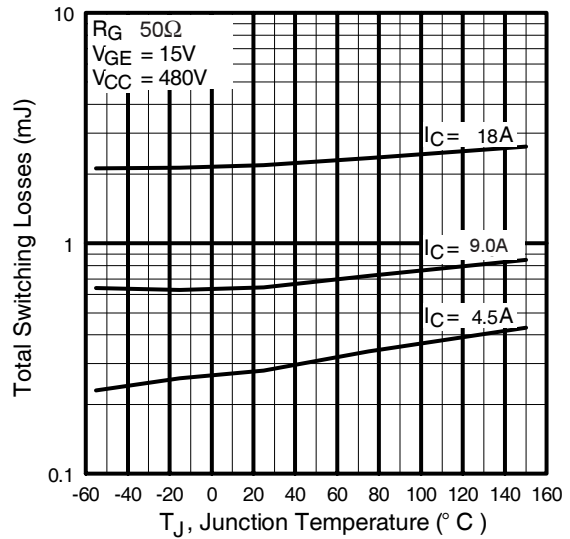
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



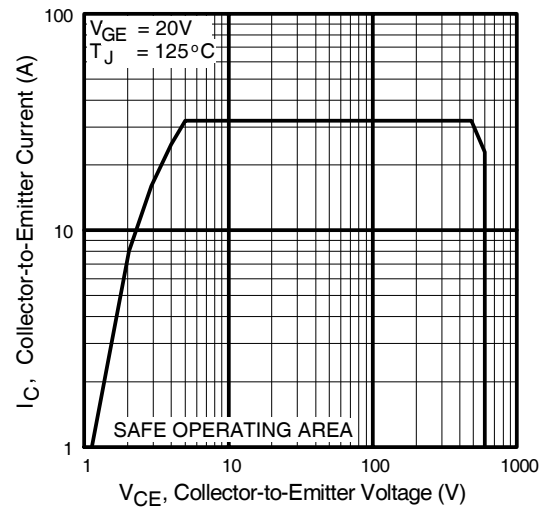
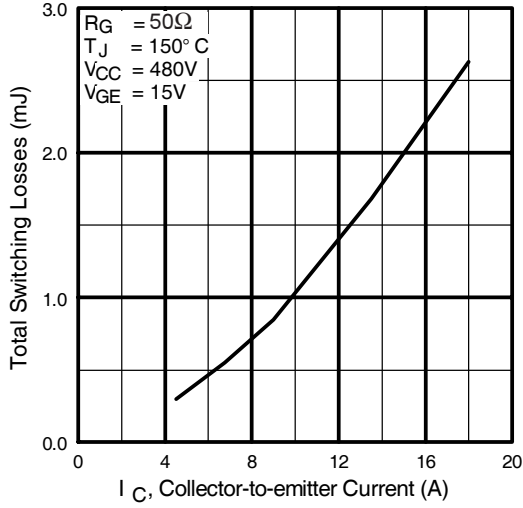
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



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

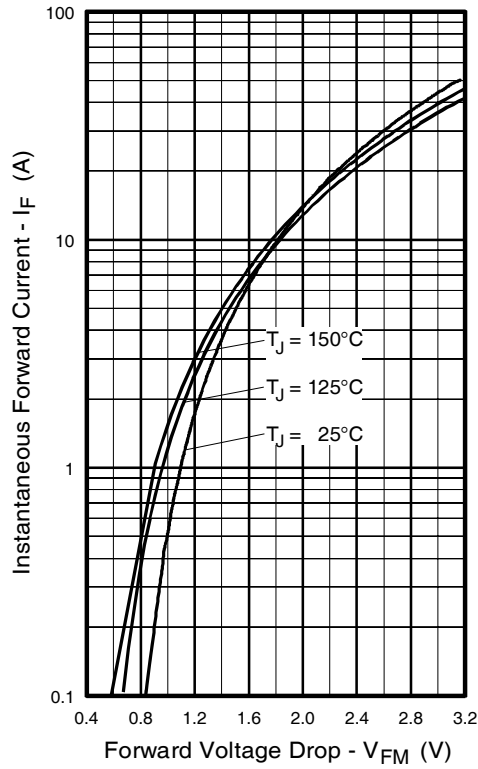
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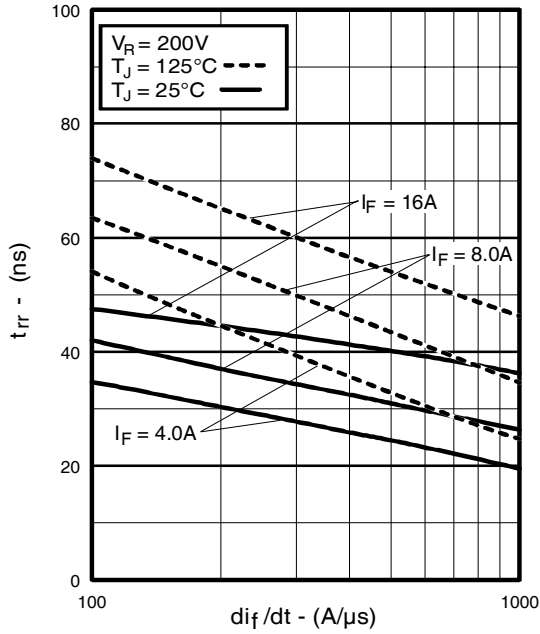


**Fig. 11** - Typical Switching Losses vs. Collector-to-emitter Current

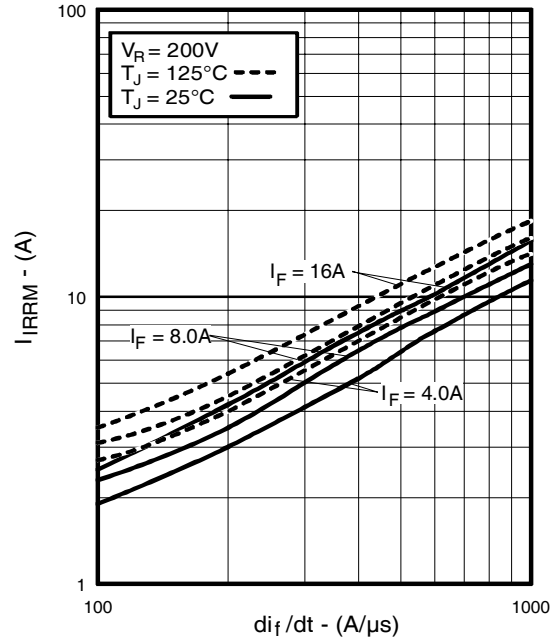
**Fig. 12** - Turn-Off SOA



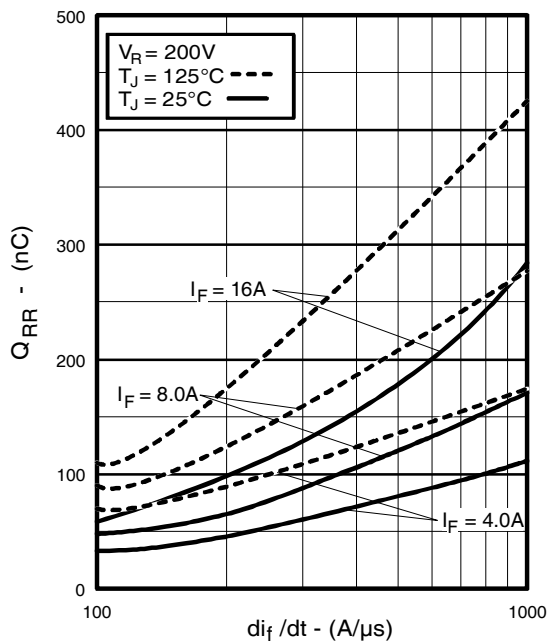
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



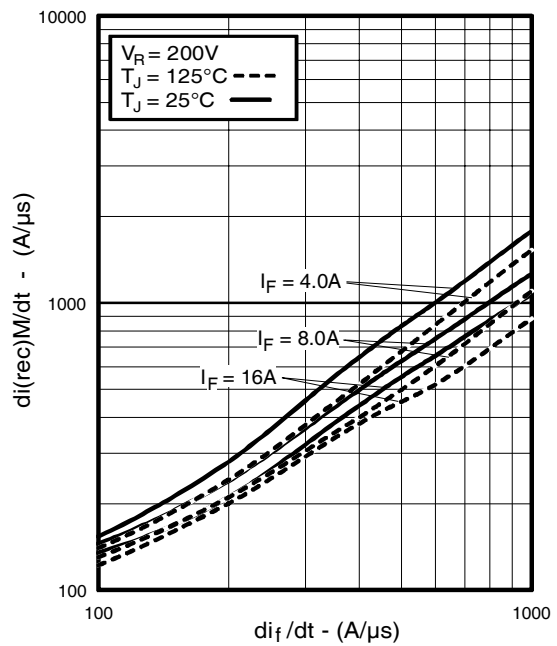
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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

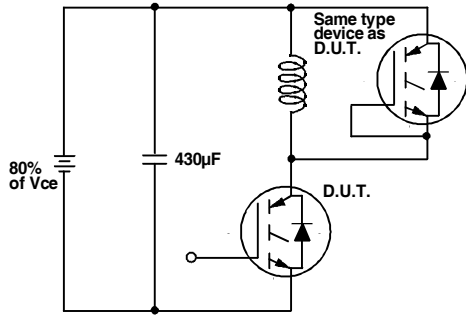


**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$

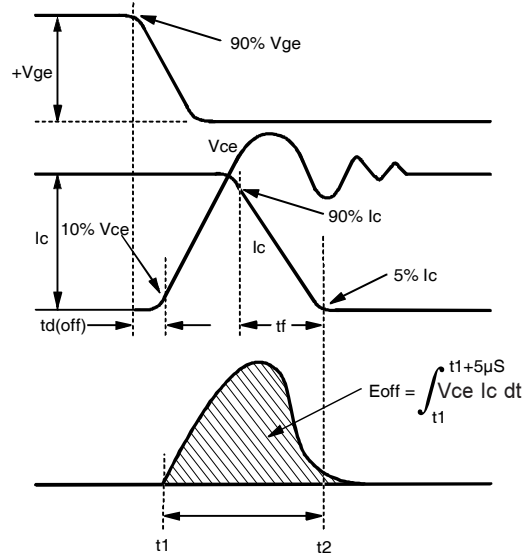


**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

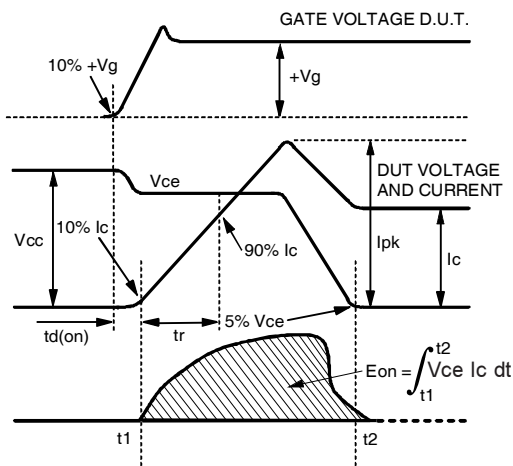
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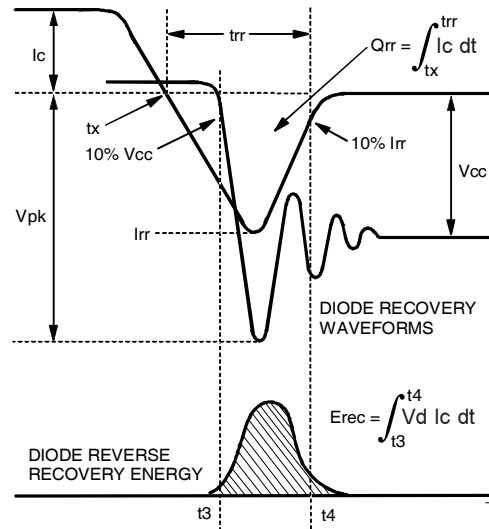
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$

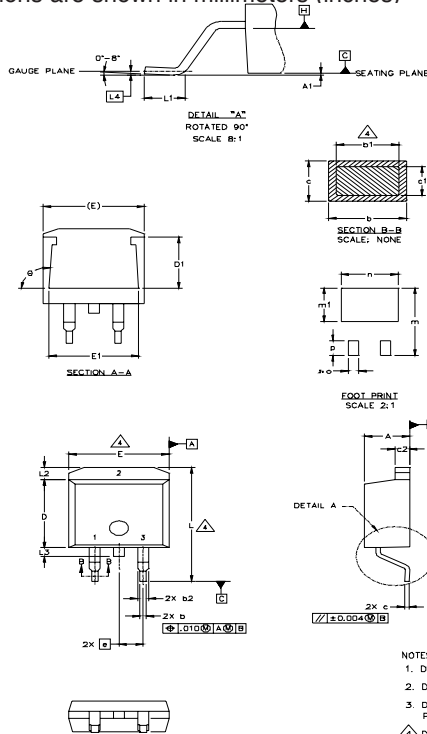


**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



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

Dimensions are shown in millimeters (inches)



| 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 | 3     |
| 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   |

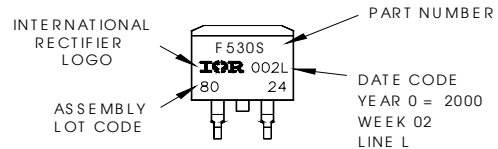
\* PART DEPENDENT.

- NOTES:
- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  - DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
  - 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.
  - △ DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
  - CONTROLLING DIMENSION: INCH.

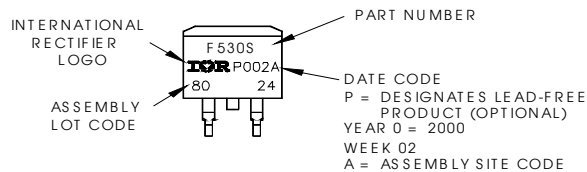
## D<sup>2</sup>Pak Part Marking Information (Lead-Free)

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**



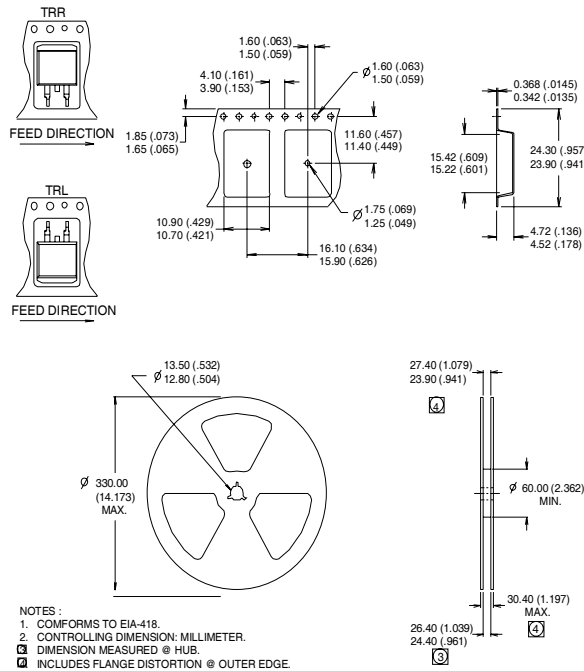
# IRG4BC20KD-SPbF

International  
**IR** Rectifier

## 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.
- ⑤ When mounted on 1" square PCB (FR-4 or G-10 Material ).  
For recommended footprint and soldering techniques refer to application note #AN-994.

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



Data and specifications subject to change without notice.

International  
**IR** Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

Visit us at [www.irf.com](http://www.irf.com) for sales contact information.08/04

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

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