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# IRG4BC20MD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

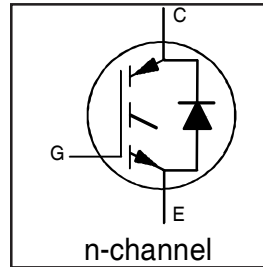
Short Circuit Rated  
Fast IGBT

## 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



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



## 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

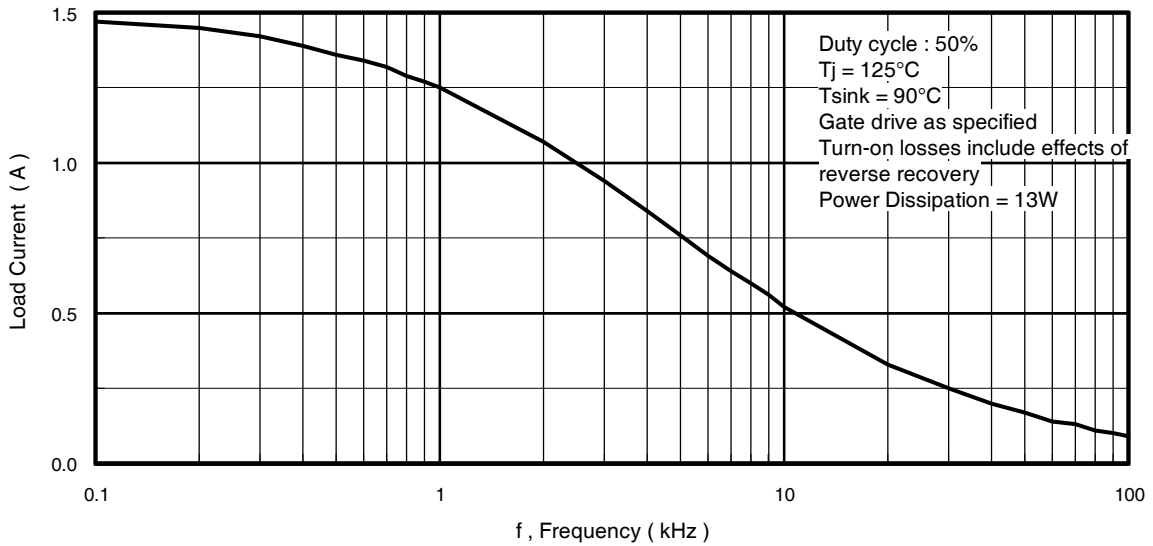
	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	-----	-----	2.1	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	-----	-----	2.5	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	-----	0.50	-----	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	-----	-----	80	
$Wt$	Weight	-----	2 (0.07)	-----	g (oz)

## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

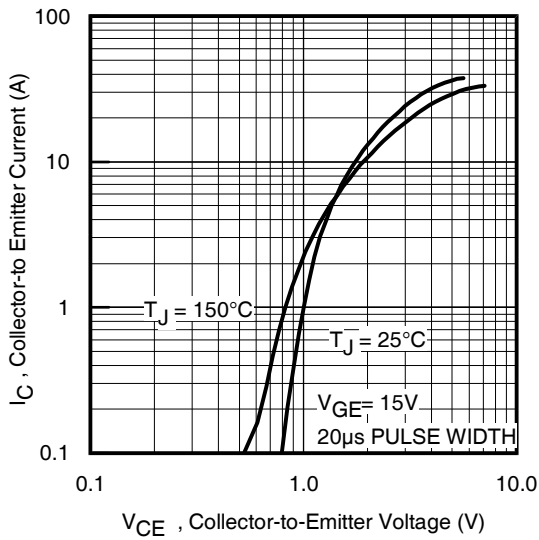
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	----	----	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	----	0.67	----	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	----	1.85	2.1	V	I <sub>C</sub> = 11A V <sub>GE</sub> = 15V
		----	2.46	----		I <sub>C</sub> = 18A See Fig. 2, 5
		----	2.07	----		I <sub>C</sub> = 11A, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	4.0	----	6.5		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Threshold Voltage	----	-11	----	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance <sup>④</sup>	3.0	3.6	----	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 11A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	----	----	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		----	----	2500		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	----	1.4	1.7	V	I <sub>C</sub> = 8.0A See Fig. 13
		----	1.3	1.6		I <sub>C</sub> = 8.0A, T <sub>J</sub> = 150°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	----	----	±100	nA	V <sub>GE</sub> = ±20V

## Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

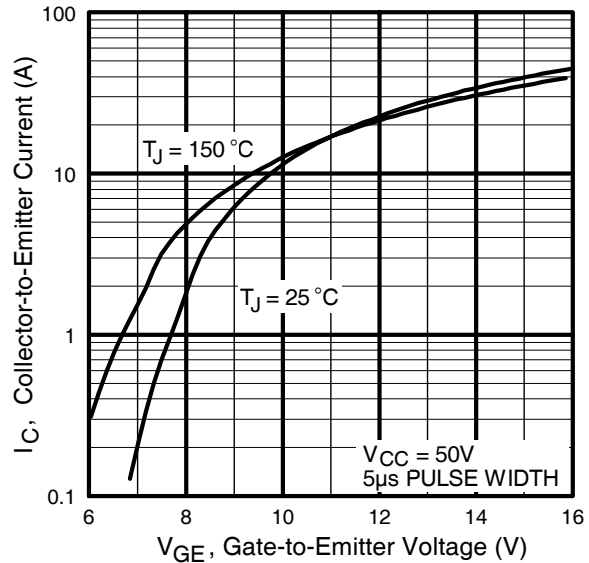
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	----	39	59	nC	I <sub>C</sub> = 11A
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	----	5.3	8.0		V <sub>CC</sub> = 400V See Fig. 8
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	----	20	30		V <sub>GE</sub> = 15V
t <sub>d(on)</sub>	Turn-On Delay Time	----	21	----	ns	T <sub>J</sub> = 25°C
t <sub>r</sub>	Rise Time	----	37	----		I <sub>C</sub> = 11A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	----	463	690		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω
t <sub>f</sub>	Fall Time	----	340	510		Energy losses include "tail" and diode reverse recovery.
E <sub>on</sub>	Turn-On Switching Loss	----	0.41	----	mJ	See Fig. 9, 10, 11, 18
E <sub>off</sub>	Turn-Off Switching Loss	----	2.03	----		
E <sub>ts</sub>	Total Switching Loss	----	2.44	3.7		
t <sub>d(on)</sub>	Turn-On Delay Time	----	19	----	ns	T <sub>J</sub> = 150°C, See Fig. 9, 10, 11, 18
t <sub>r</sub>	Rise Time	----	41	----		I <sub>C</sub> = 6.5A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	----	590	----		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω
t <sub>f</sub>	Fall Time	----	600	----		Energy losses include "tail" and diode reverse recovery.
E <sub>ts</sub>	Total Switching Loss	----	3.49	----	mJ	Measured 5mm from package
L <sub>E</sub>	Internal Emitter Inductance	----	7.5	----	nH	
C <sub>ies</sub>	Input Capacitance	----	460	----	pF	V <sub>GE</sub> = 0V
C <sub>oes</sub>	Output Capacitance	----	54	----		V <sub>CC</sub> = 30V See Fig. 7
C <sub>res</sub>	Reverse Transfer Capacitance	----	14	----		f = 1.0MHz
t <sub>rr</sub>	Diode Reverse Recovery Time	----	37	55	ns	T <sub>J</sub> = 25°C See Fig. 14
		----	55	90		T <sub>J</sub> = 125°C
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	----	3.5	5.0	A	T <sub>J</sub> = 25°C See Fig. 15
		----	4.5	8.0		T <sub>J</sub> = 125°C
Q <sub>rr</sub>	Diode Reverse Recovery Charge	----	65	138	nC	T <sub>J</sub> = 25°C See Fig. 16
		----	124	360		T <sub>J</sub> = 125°C
di <sub>(rec)M</sub> /dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	----	240	----	A/μs	T <sub>J</sub> = 25°C See Fig. 17
		----	210	----		T <sub>J</sub> = 125°C



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

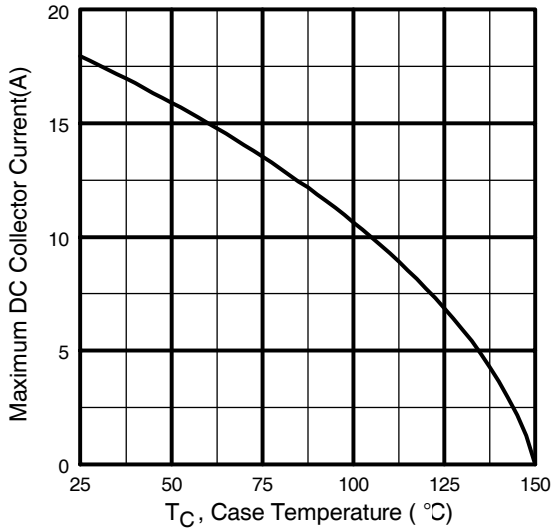


**Fig. 2 - Typical Output Characteristics**

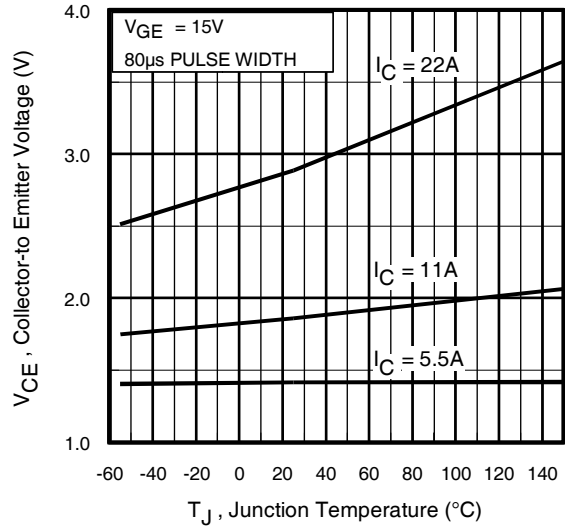


**Fig. 3 - Typical Transfer Characteristics**

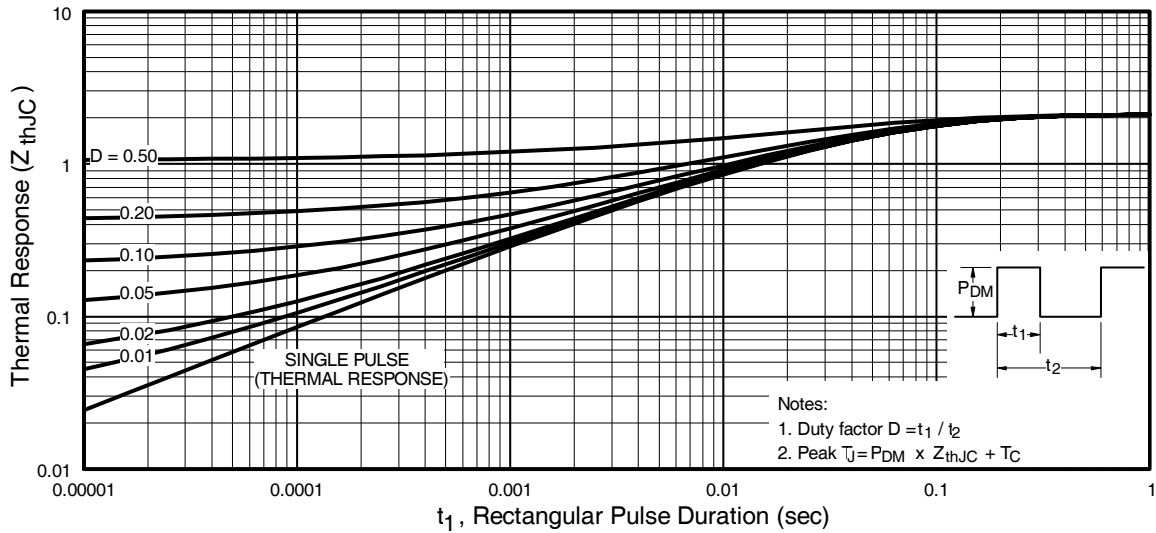
# IRG4BC20MD-SPbF



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

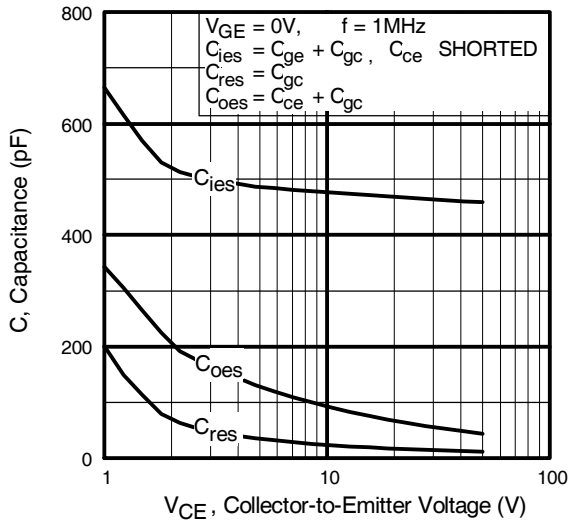


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

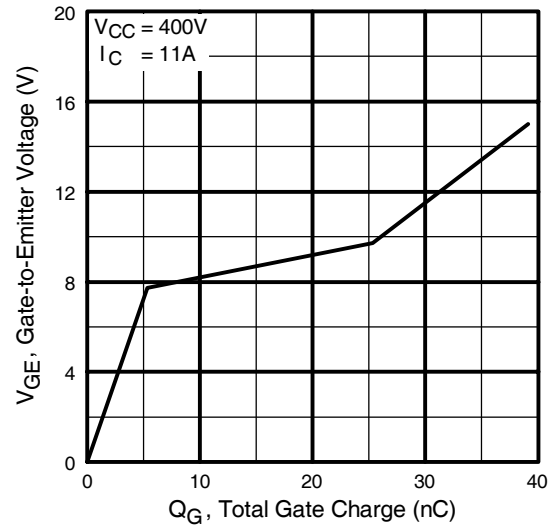


**Fig. 6** - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case

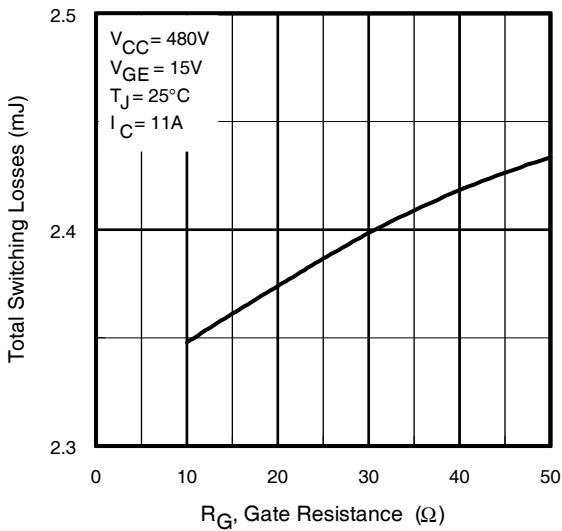
# IRG4BC20MD-SPbF



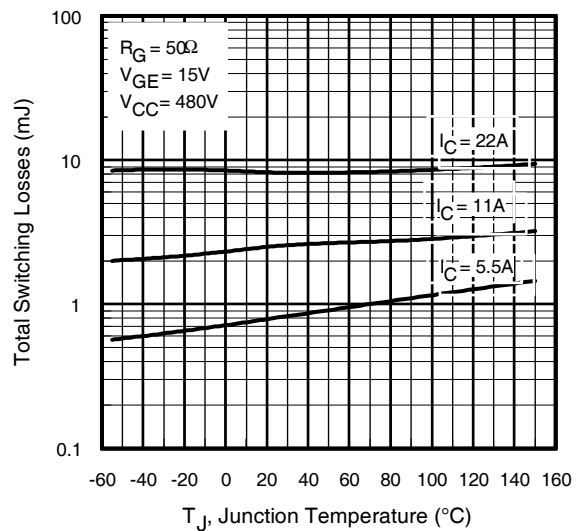
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

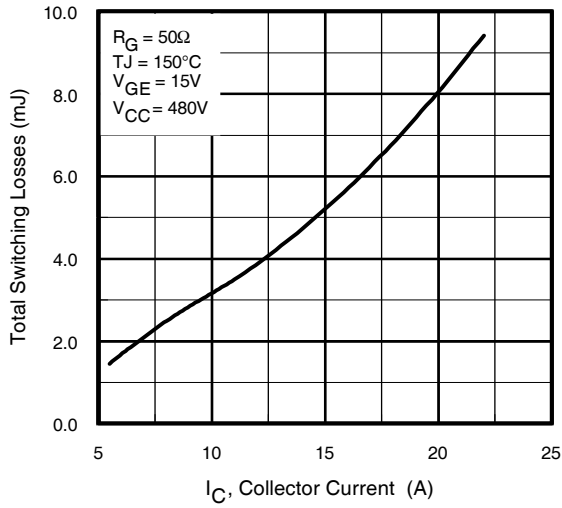


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

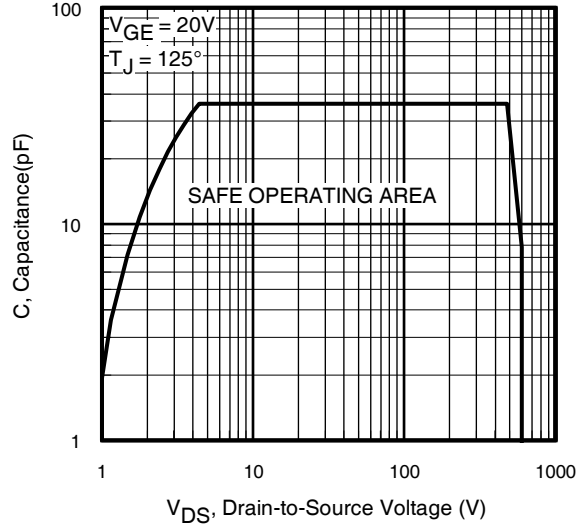


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

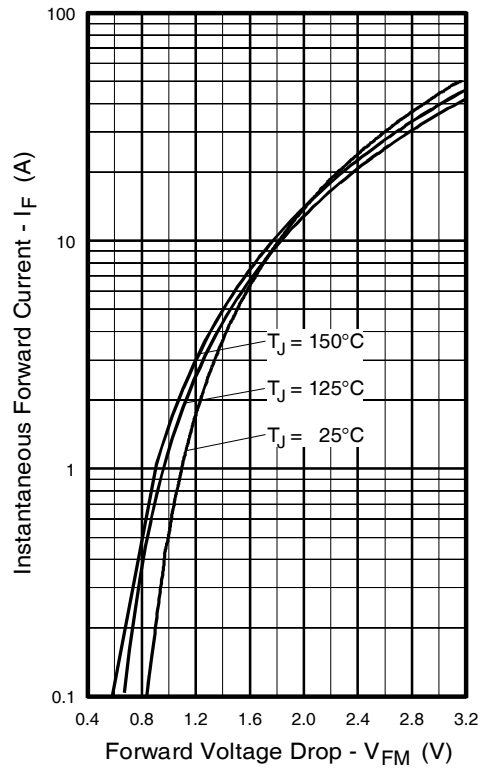
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**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



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



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

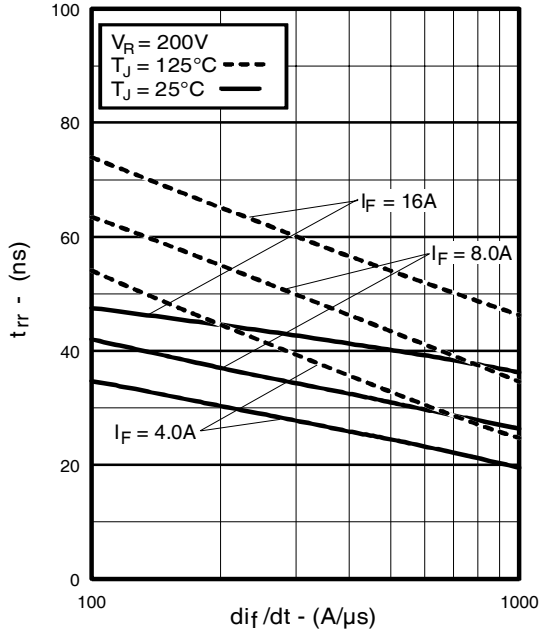


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

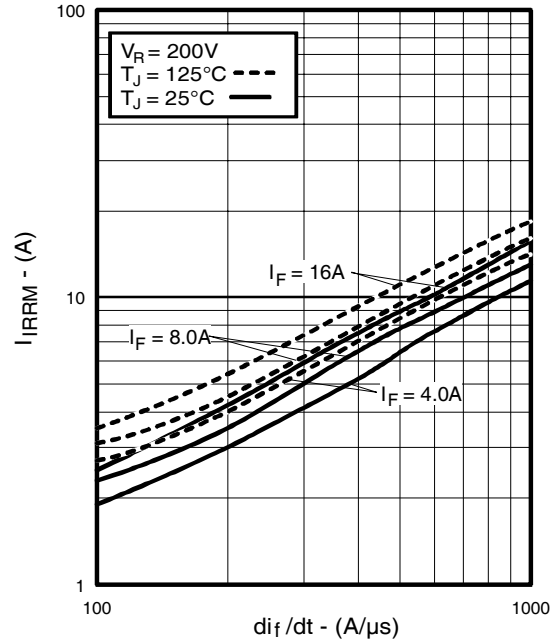


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

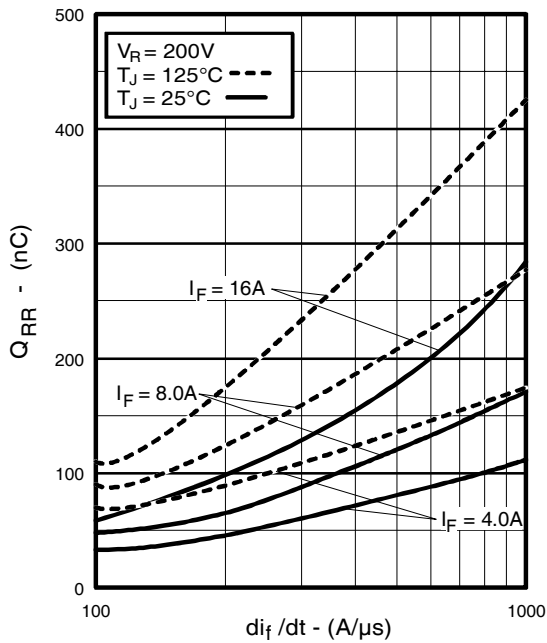


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

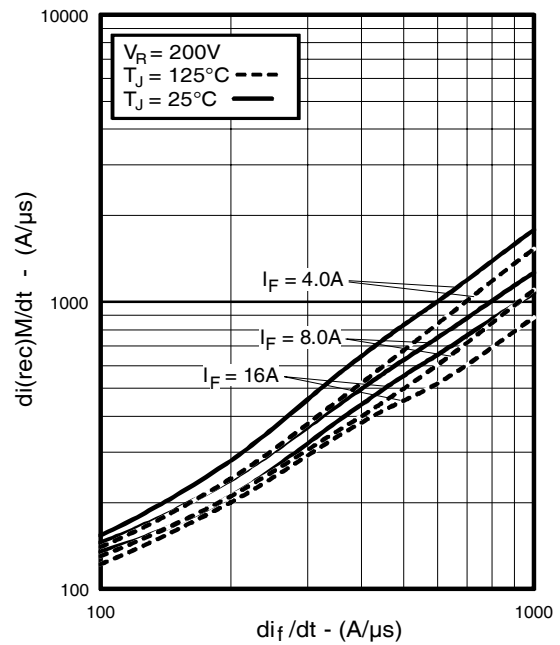
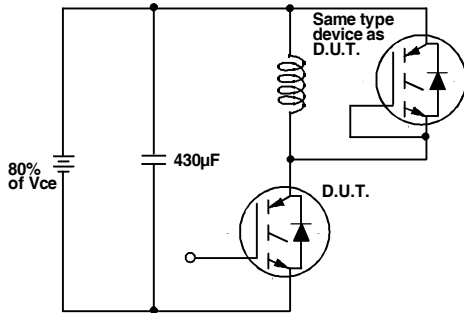


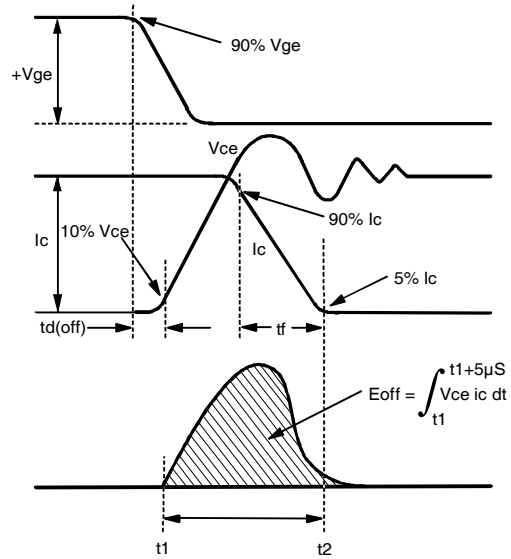
Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$



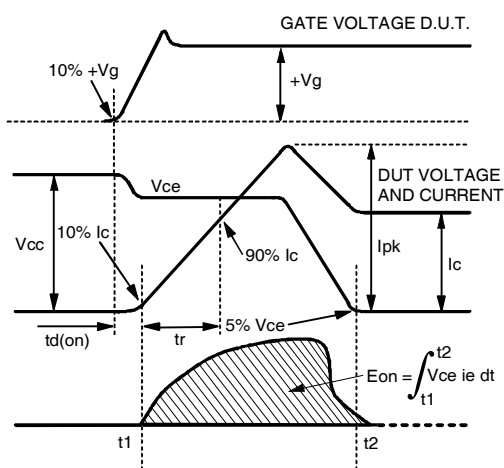
# IRG4BC20MD-SPbF



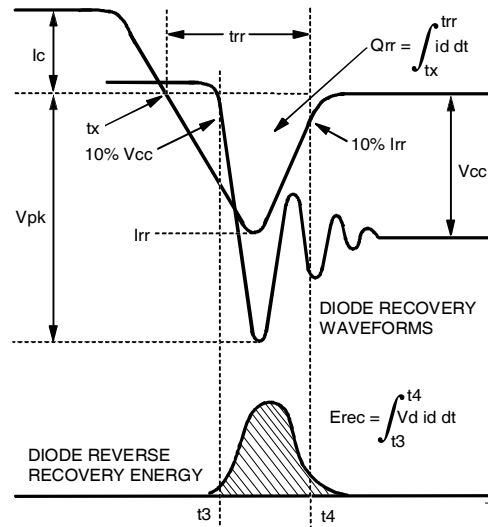
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

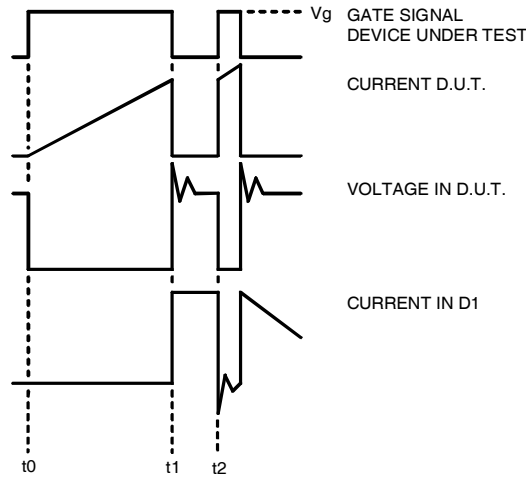


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

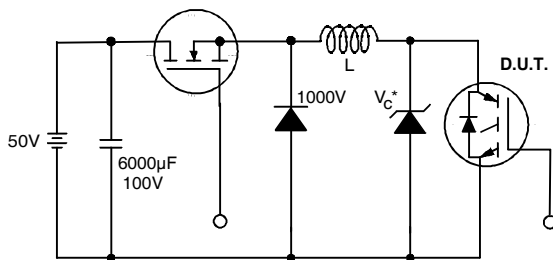
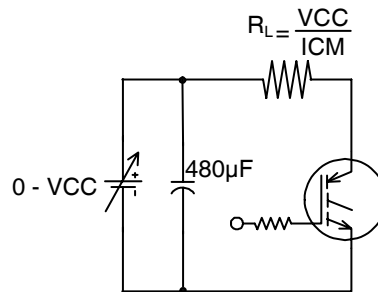


Figure 19. Clamped Inductive Load Test Circuit



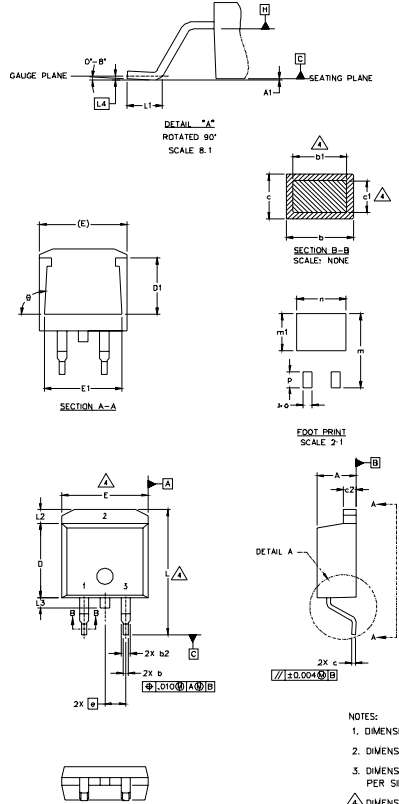
Pulsed Collector Current Test Circuit

Figure 20. Pulsed Collector Current Test Circuit

# IRG4BC20MD-SPbF

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

Dimensions are shown in millimeters (inches)



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	3
D	8.51	9.65	.335	.380	
D1	5.33		.210		3
E	9.65	10.67	.380	.420	
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

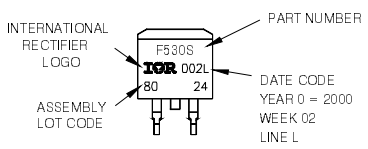
\* PART DEPENDENT.

- 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.

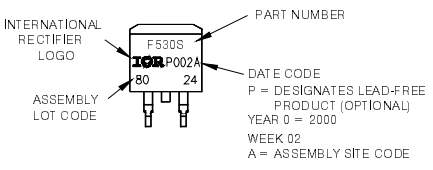
## D<sup>2</sup>Pak Part Marking Information

**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**



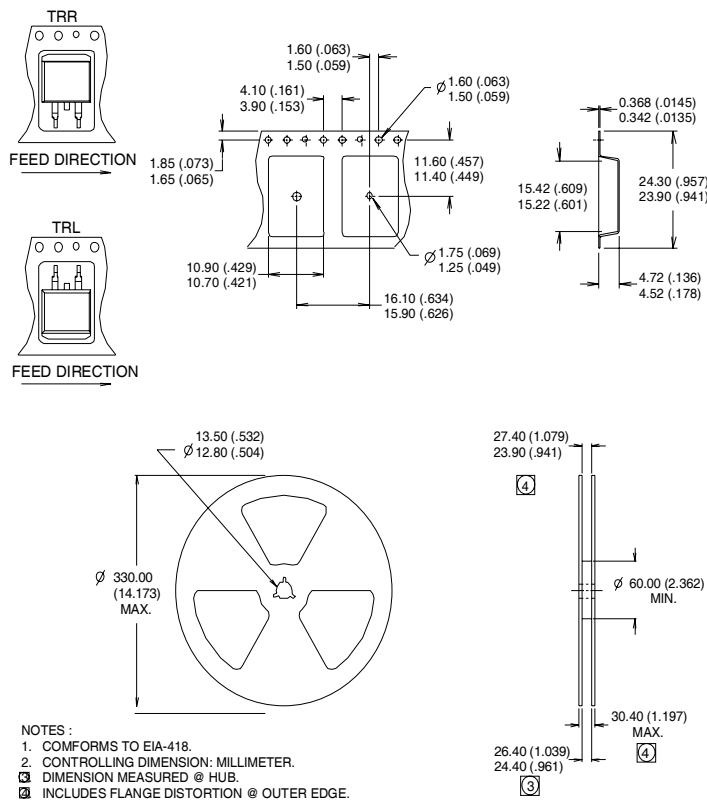
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## 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.