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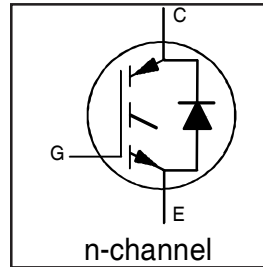


# IRG4BC20SD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE Standard Speed IGBT

## Features

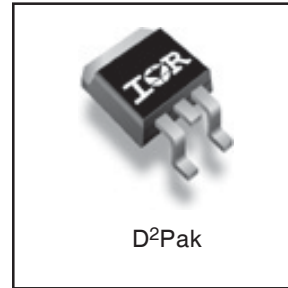
- Extremely low voltage drop 1.4Vtyp. @ 10A
- S-Series: Minimizes power dissipation at up to 3 KHz PWM frequency in inverter drives, up to 4 KHz in brushless DC drives.
- Very Tight Vce(on) distribution
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard D<sup>2</sup>Pak package
- Lead-Free



$V_{CES} = 600V$
$V_{CE(on) typ.} = 1.4V$
@ $V_{GE} = 15V, I_C = 10A$

## Benefits

- Generation 4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing
- Lower losses than MOSFET's conduction and Diode losses



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	19	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	10	
$I_{CM}$	Pulsed Collector Current ①	38	
$I_{LM}$	Clamped Inductive Load Current ②	38	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	7.0	
$I_{FM}$	Diode Maximum Forward Current	38	V
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	24	
$T_J$	Operating Junction and	-55 to +150	$^\circ C$
$T_{STG}$	Storage Temperature Range		

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	2.1	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	3.5	
$R_{\theta JA}$	Junction-to-Ambient ( PCB Mounted, steady-state)*	—	80	
Wt	Weight	1.44	—	g (oz)

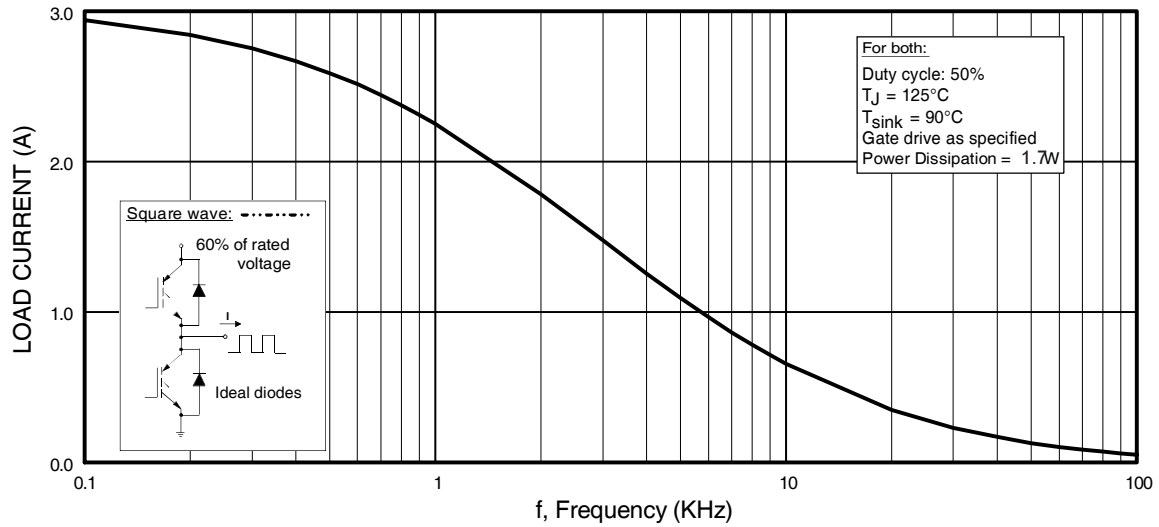
\* When mounted on 1" square PCB (FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.

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

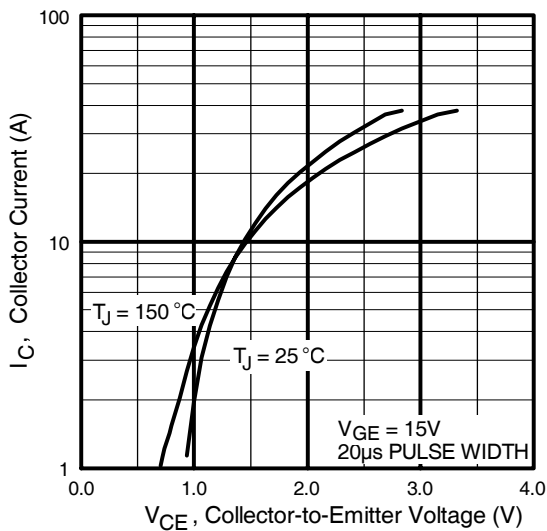
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sub>f</sub>	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.75	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.40	1.6	V	I <sub>C</sub> = 10A I <sub>C</sub> = 19A I <sub>C</sub> = 10A, T <sub>J</sub> = 150°C
		—	1.85	—		
		—	1.44	—		
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0		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 ④	2.0	5.8	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 10A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
		—	—	1700		
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.4	1.7	V	I <sub>C</sub> = 8.0A I <sub>C</sub> = 8.0A, T <sub>J</sub> = 150°C
		—	1.3	1.6		
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)

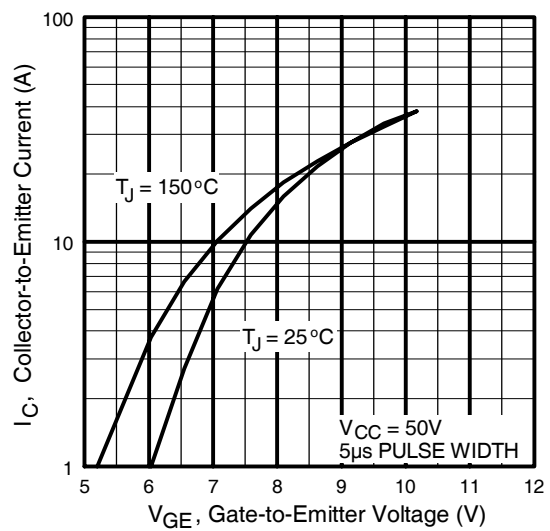
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	27	40	nC	I <sub>C</sub> = 10A V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V See Fig. 8
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	4.3	6.5		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	10	15		
t <sub>d(on)</sub>	Turn-On Delay Time	—	62	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 10A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
t <sub>r</sub>	Rise Time	—	32	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	690	1040		
t <sub>f</sub>	Fall Time	—	480	730		
E <sub>on</sub>	Turn-On Switching Loss	—	0.32	—	mJ	T <sub>J</sub> = 150°C, See Fig. 10, 11, 18 I <sub>C</sub> = 10A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω Energy losses include "tail" and diode reverse recovery.
E <sub>off</sub>	Turn-Off Switching Loss	—	2.58	—		
E <sub>ts</sub>	Total Switching Loss	—	2.90	4.5		
t <sub>d(on)</sub>	Turn-On Delay Time	—	64	—	ns	T <sub>J</sub> = 150°C, See Fig. 10, 11, 18 I <sub>C</sub> = 10A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω Energy losses include "tail" and diode reverse recovery.
t <sub>r</sub>	Rise Time	—	35	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	980	—		
t <sub>f</sub>	Fall Time	—	800	—		
E <sub>ts</sub>	Total Switching Loss	—	4.33	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	550	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz See Fig. 7
C <sub>oes</sub>	Output Capacitance	—	39	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	7.1	—		
t <sub>rr</sub>	Diode Reverse Recovery Time	—	37	55	ns	T <sub>J</sub> = 25°C See Fig. 14 T <sub>J</sub> = 125°C
		—	55	90		
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	3.5	5.0	A	T <sub>J</sub> = 25°C See Fig. 15 T <sub>J</sub> = 125°C
		—	4.5	8.0		
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	65	138	nC	T <sub>J</sub> = 25°C See Fig. 16 T <sub>J</sub> = 125°C
		—	124	360		
di <sub>(rec)</sub> M/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 T <sub>J</sub> = 125°C
		—	210	—		



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

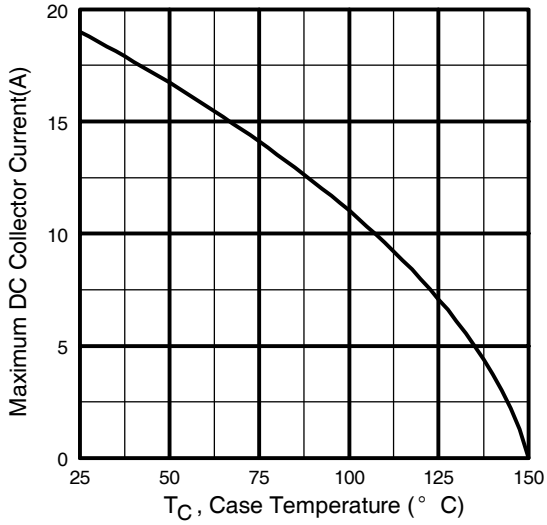


**Fig. 2 - Typical Output Characteristics**  
[www.irf.com](http://www.irf.com)

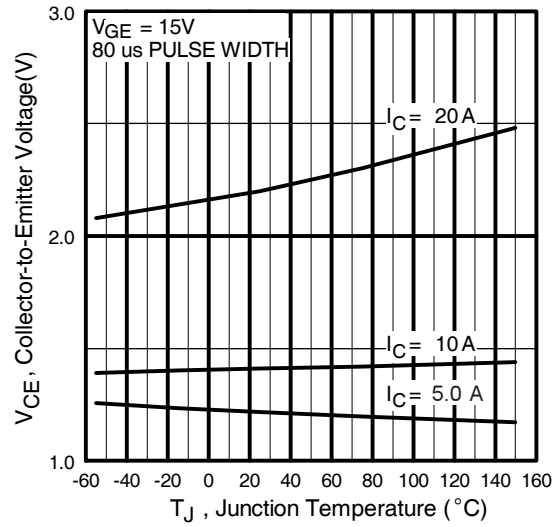


**Fig. 3 - Typical Transfer Characteristics**

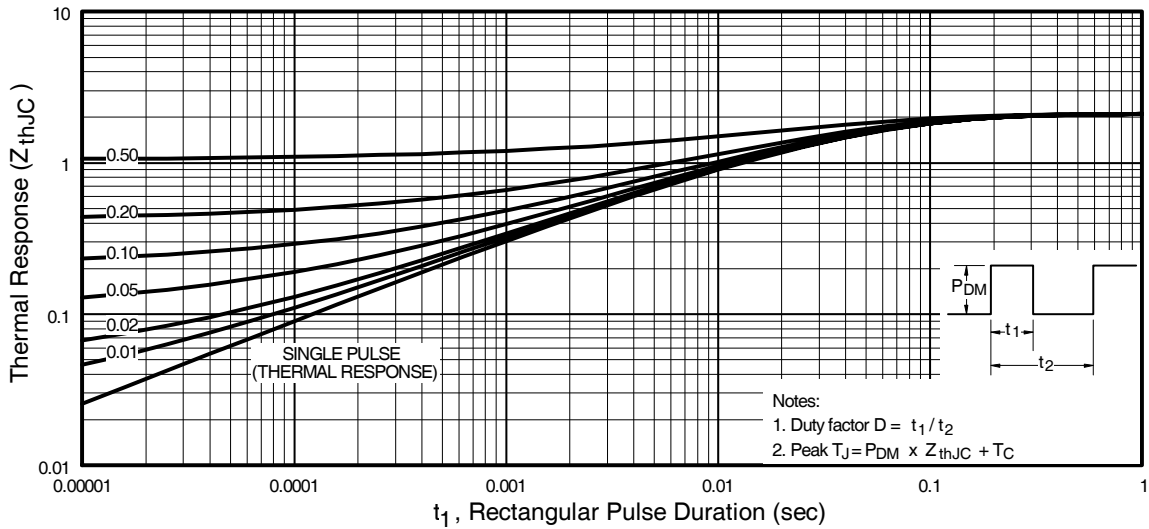
# IRG4BC20SD-SPbF



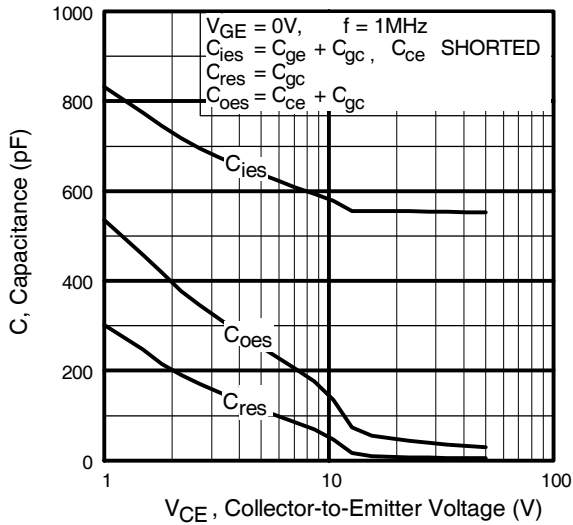
**Fig. 4** - Maximum Collector Current vs. Case Temperature



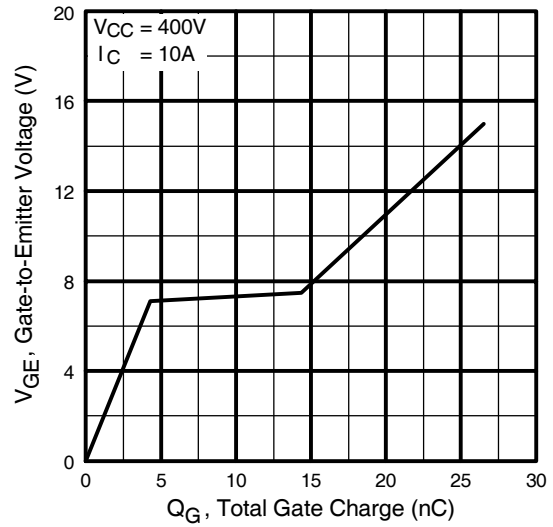
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



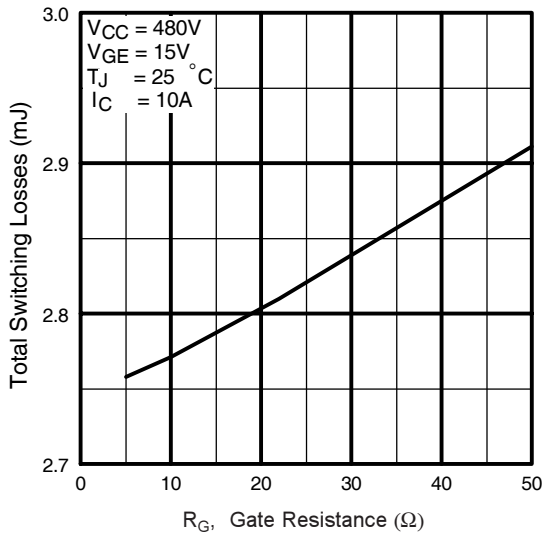
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



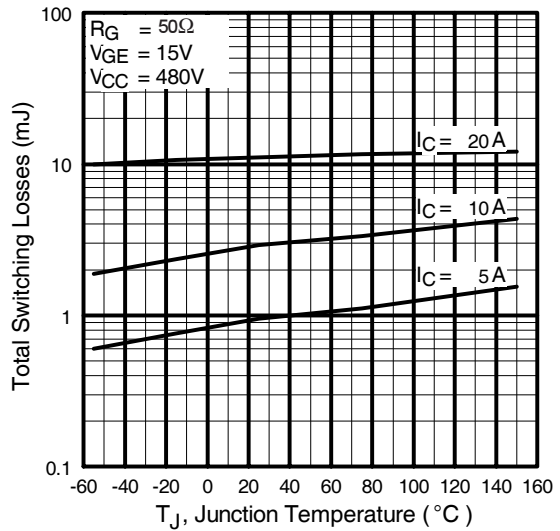
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



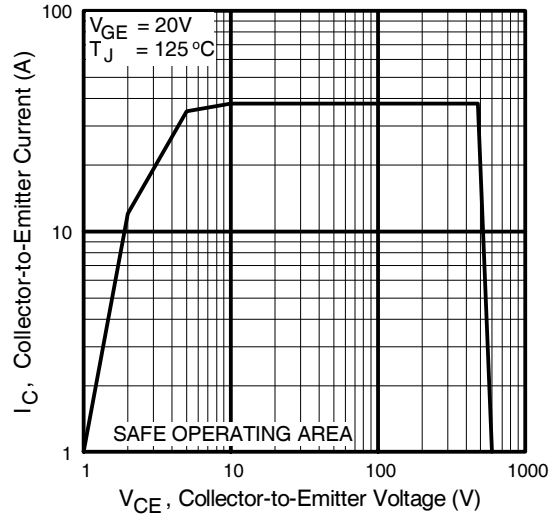
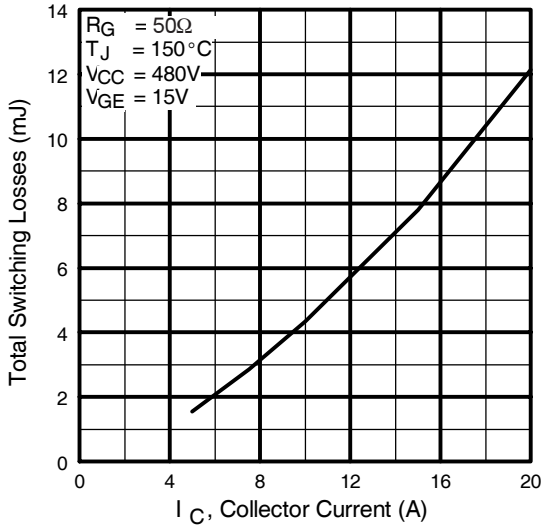
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



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

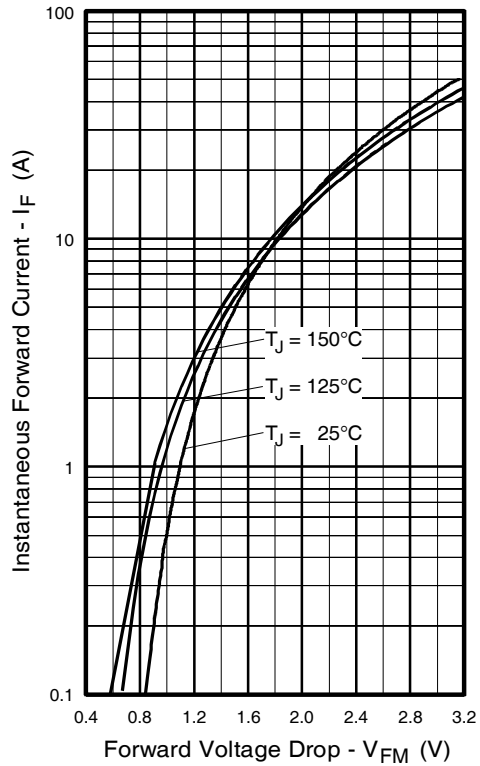
# IRG4BC20SD-SPbF

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

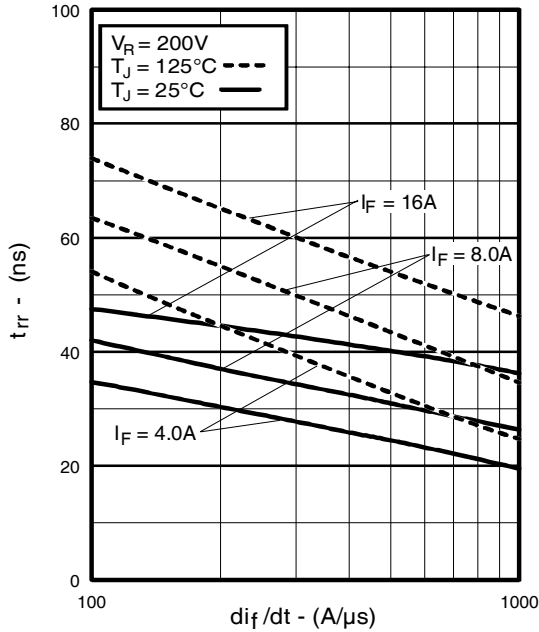


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

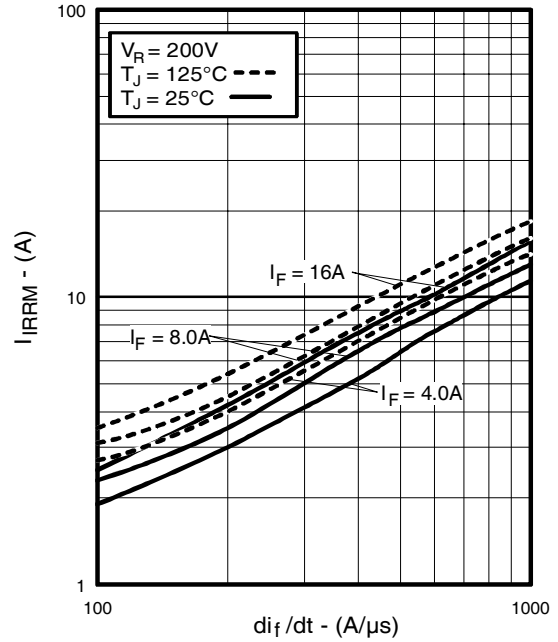


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

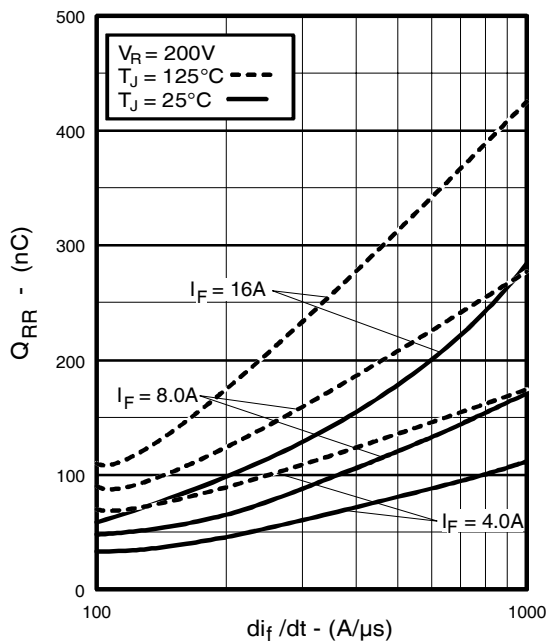


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$   
www.irf.com

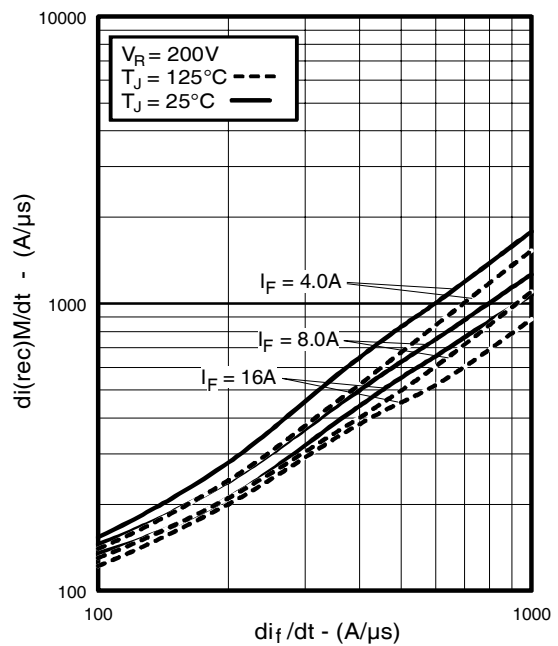
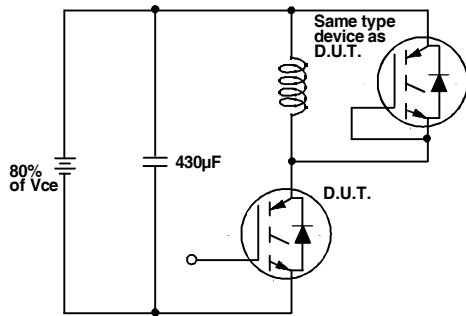


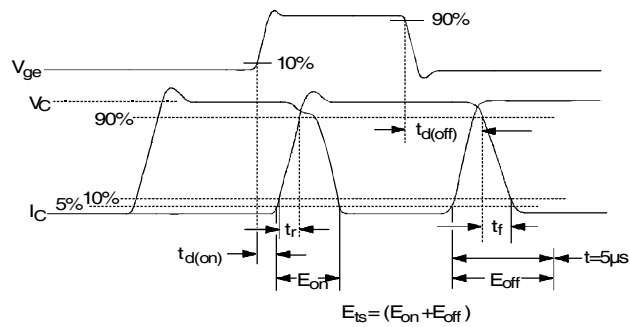
Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$



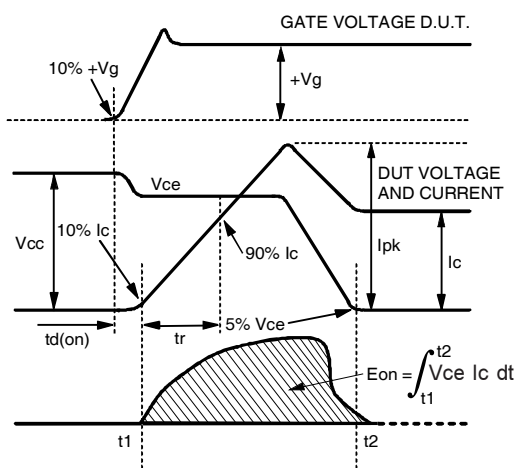
# IRG4BC20SD-SPbF



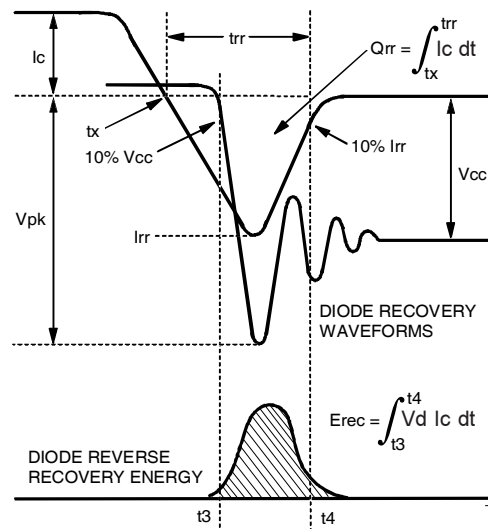
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

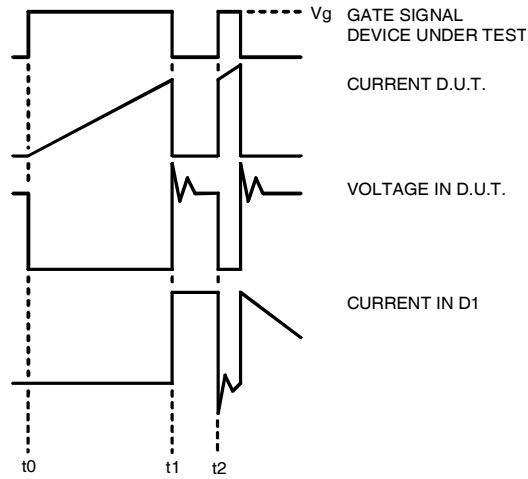


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

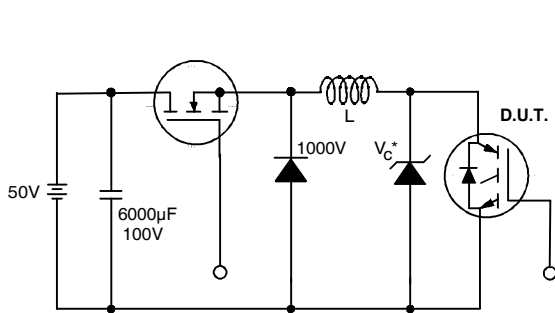


Figure 19. Clamped Inductive Load Test Circuit

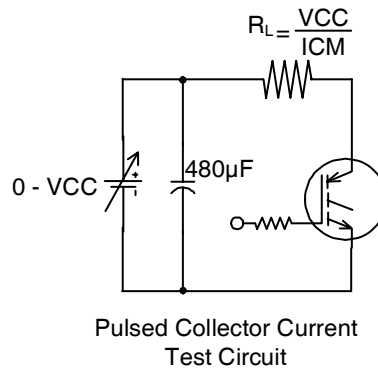


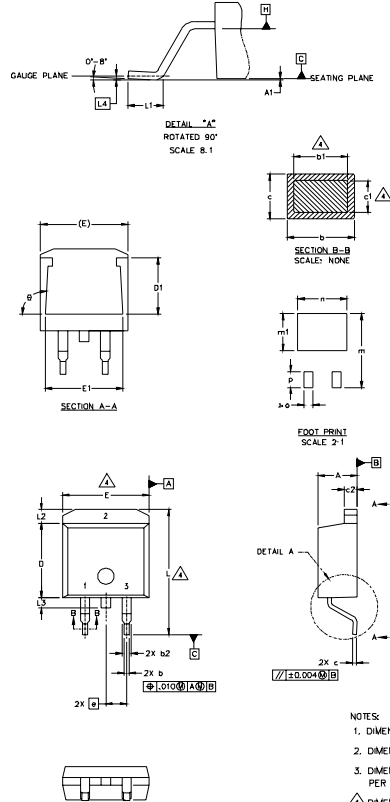
Figure 20. Pulsed Collector Current Test Circuit

# IRG4BC20SD-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	0.51	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.

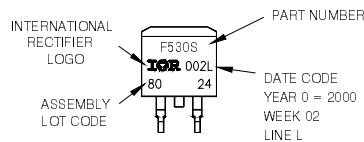
### NOTES:

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.

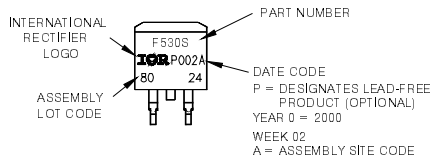
## D<sup>2</sup>Pak Part Marking Information

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**



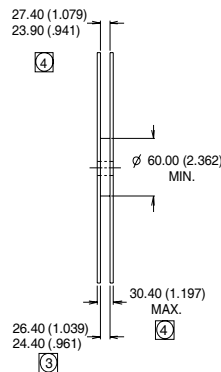
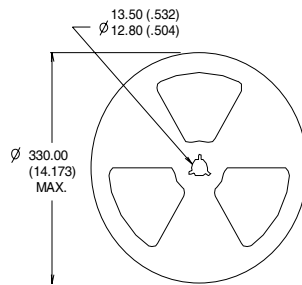
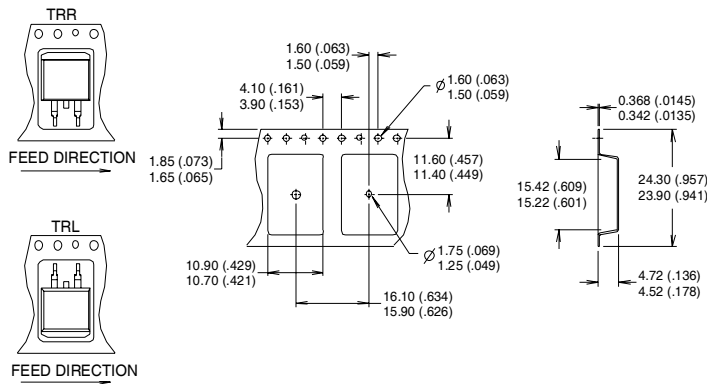
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## 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)



- NOTES:
1. CONFORMS TO EIA-418.
  2. CONTROLLING DIMENSION: MILLIMETER.
  - ③ DIMENSION MEASURED @ HUB.
  - ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Data and specifications subject to change without notice.