

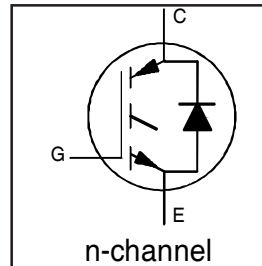
# IRG4BC20KD-SPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
 UltraFast IGBT

### Features

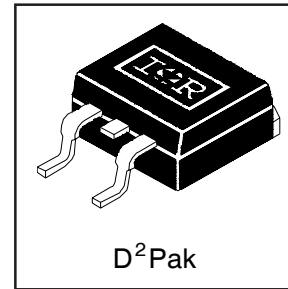
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10μs @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery 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
$T_{STG}$			
	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

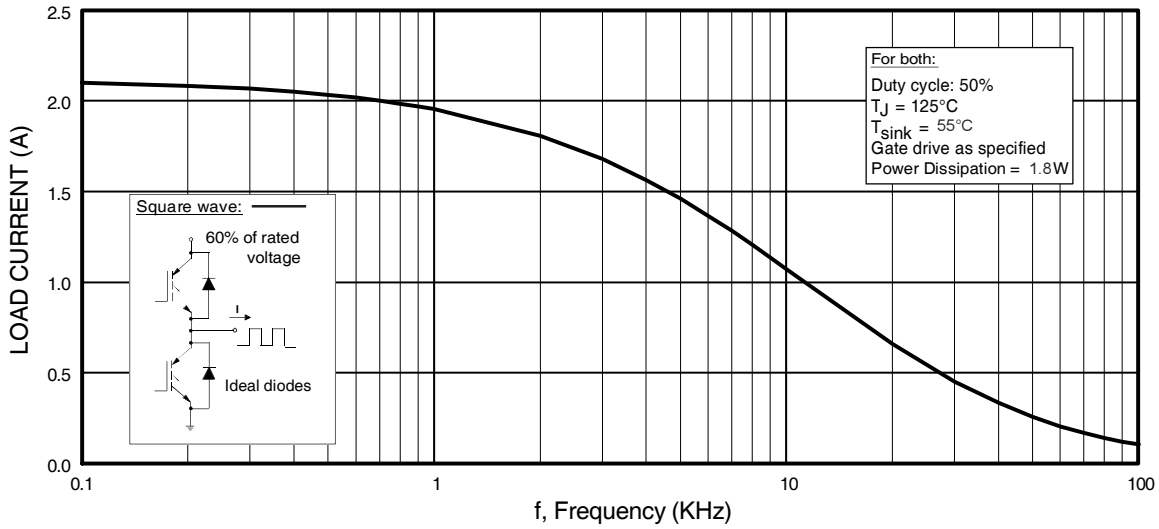
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IR Rectifier

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

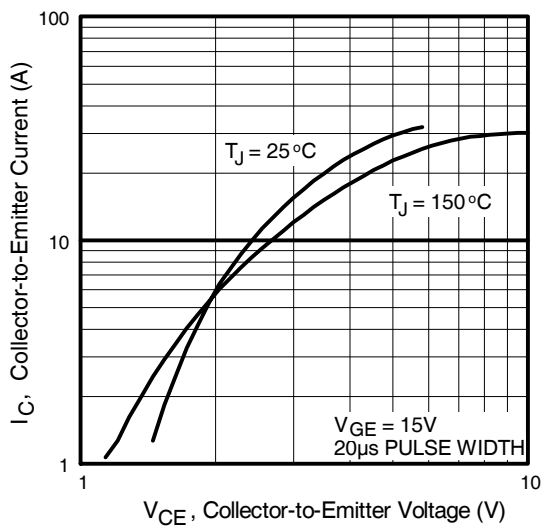
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.49	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.27	2.8	V	I <sub>C</sub> = 9.0A V <sub>GE</sub> = 15V
		—	3.01	—		I <sub>C</sub> = 16A See Fig. 2, 5
		—	2.43	—		I <sub>C</sub> = 9.0A, T <sub>J</sub> = 150°C
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	—	-10	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance <sup>④</sup>	2.9	4.3	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 9.0A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	1000		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)

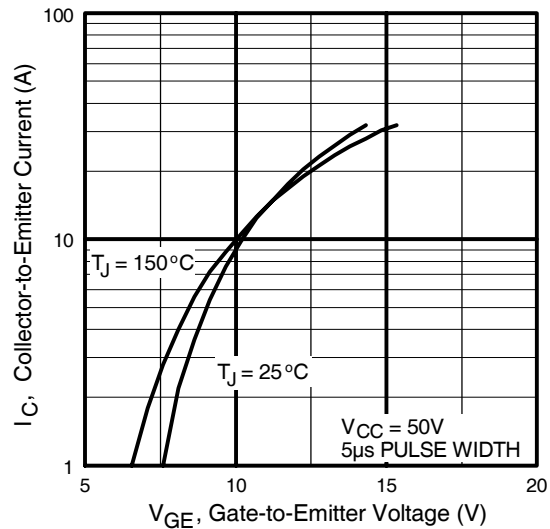
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	34	51	nC	I <sub>C</sub> = 9.0A
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	4.9	7.4		V <sub>CC</sub> = 400V See Fig. 8
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	14	21		V <sub>GE</sub> = 15V
t <sub>d(on)</sub>	Turn-On Delay Time	—	54	—	ns	T <sub>J</sub> = 25°C
t <sub>r</sub>	Rise Time	—	34	—		I <sub>C</sub> = 9.0A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	180	270		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω
t <sub>f</sub>	Fall Time	—	72	110		Energy losses include "tail" and diode reverse recovery
E <sub>on</sub>	Turn-On Switching Loss	—	0.34	—	mJ	See Fig. 9,10,14
E <sub>off</sub>	Turn-Off Switching Loss	—	0.30	—		
E <sub>ts</sub>	Total Switching Loss	—	0.64	0.96	μs	V <sub>CC</sub> = 360V, T <sub>J</sub> = 125°C
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω, V <sub>CPK</sub> < 500V
t <sub>d(on)</sub>	Turn-On Delay Time	—	51	—	ns	T <sub>J</sub> = 150°C, See Fig. 11,14
t <sub>r</sub>	Rise Time	—	37	—		I <sub>C</sub> = 9.0A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	220	—		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω
t <sub>f</sub>	Fall Time	—	160	—		Energy losses include "tail" and diode reverse recovery
E <sub>ts</sub>	Total Switching Loss	—	0.85	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	450	—	pF	V <sub>GE</sub> = 0V
C <sub>oes</sub>	Output Capacitance	—	61	—		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)</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
		—	210	—		T <sub>J</sub> = 125°C



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



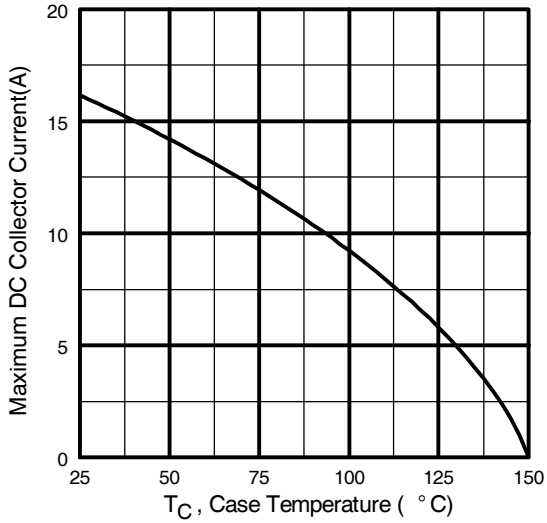
**Fig. 2 - Typical Output Characteristics**



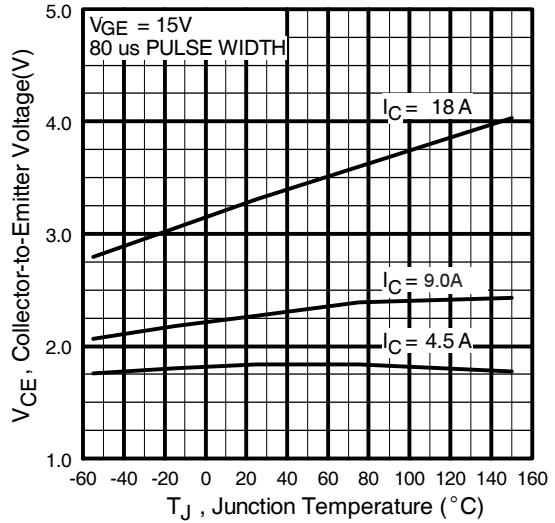
**Fig. 3 - Typical Transfer Characteristics**

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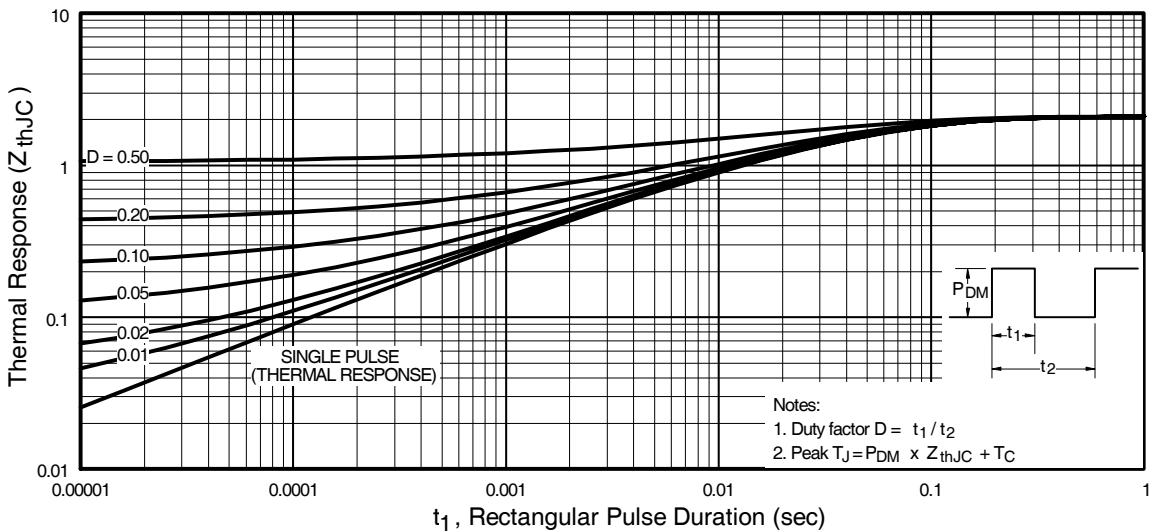
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**Fig. 4** - Maximum Collector Current vs. Case Temperature

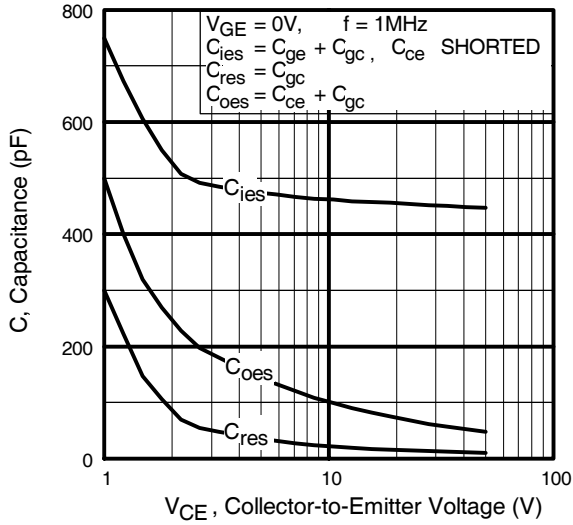


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

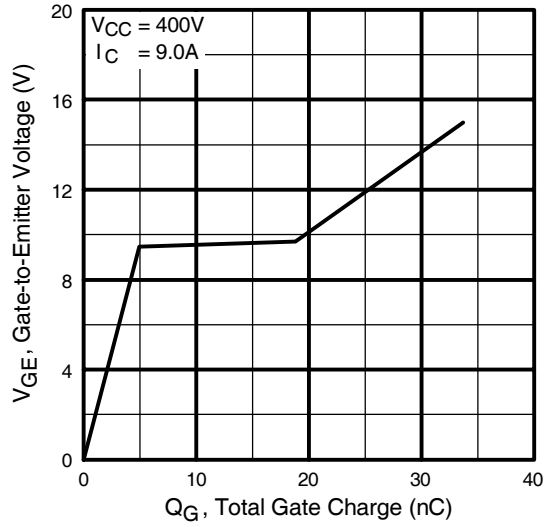


**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

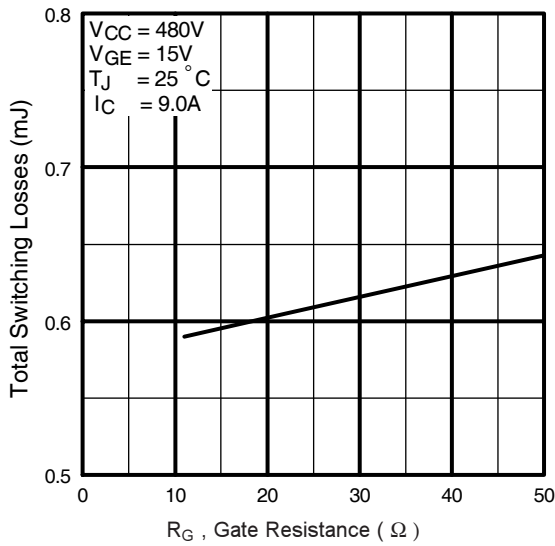
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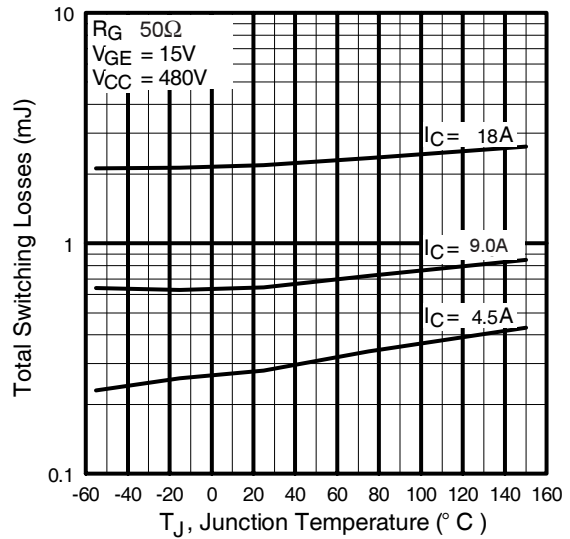
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



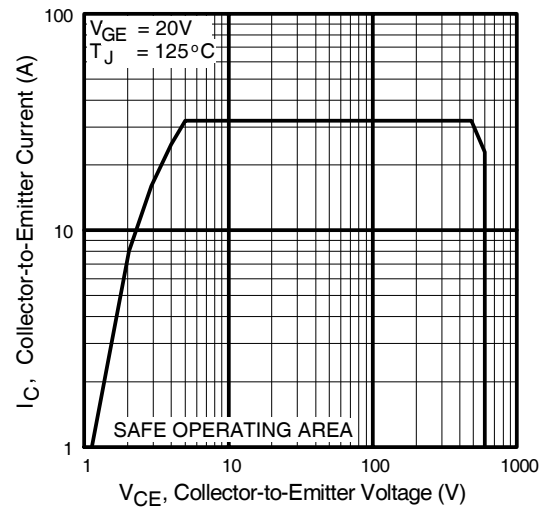
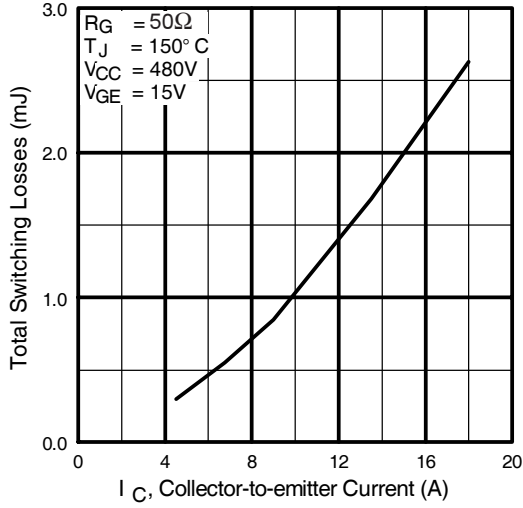
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



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

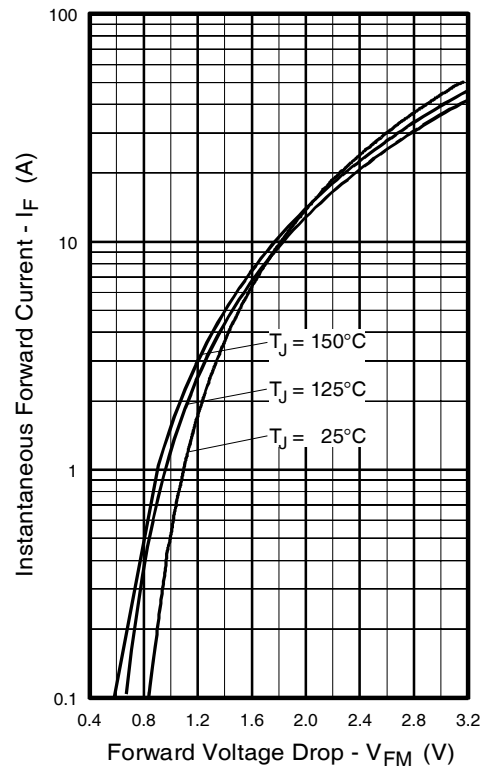
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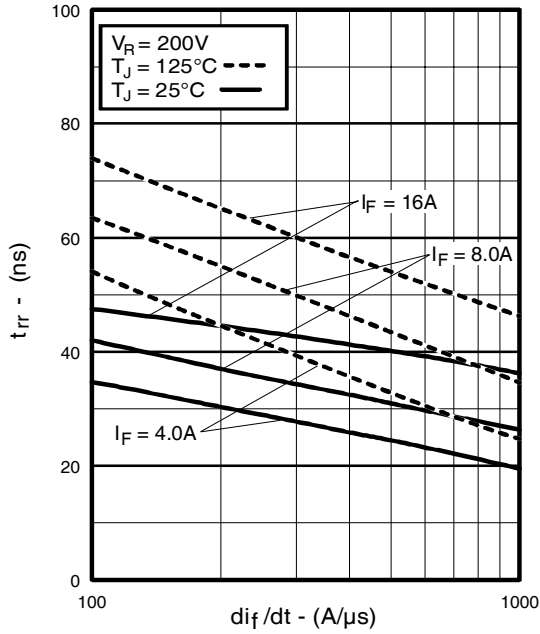


**Fig. 11** - Typical Switching Losses vs. Collector-to-emitter Current

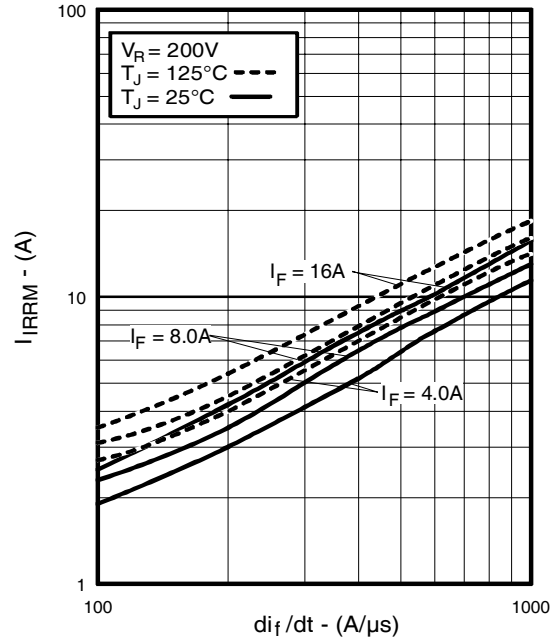
**Fig. 12** - Turn-Off SOA



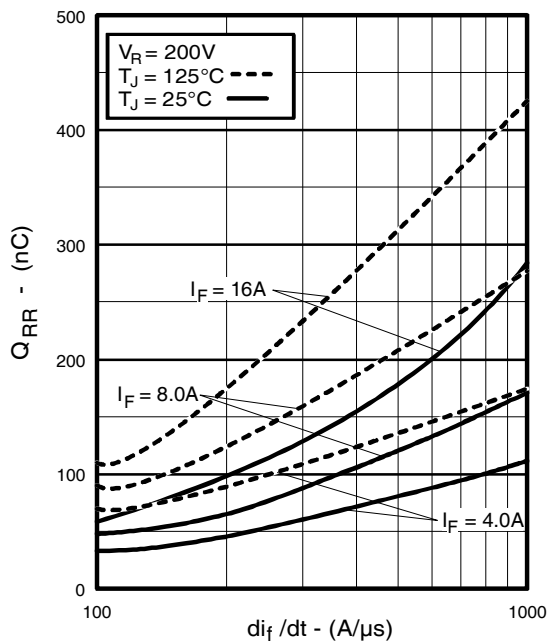
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



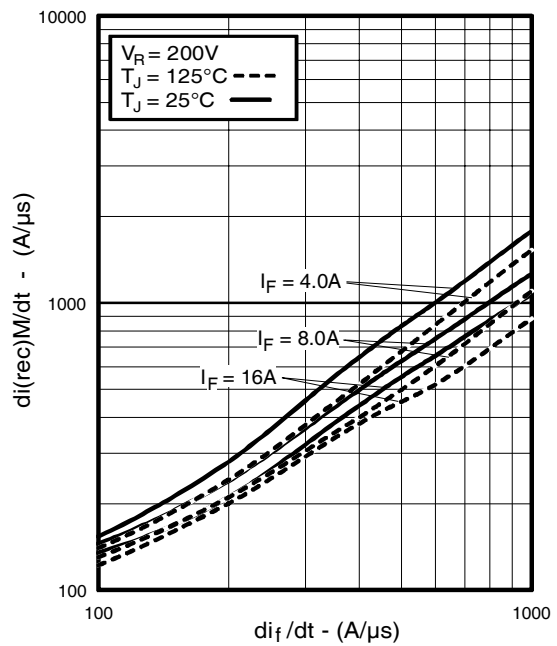
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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

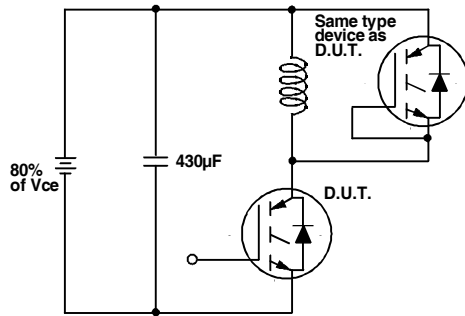


**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$

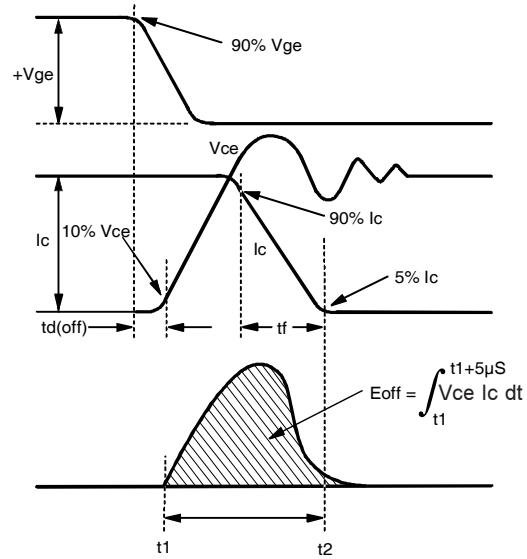


**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

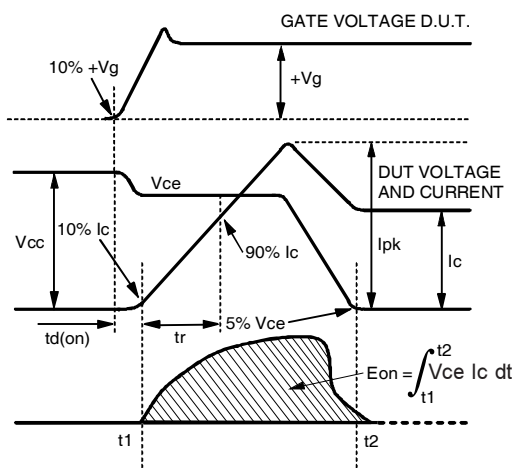
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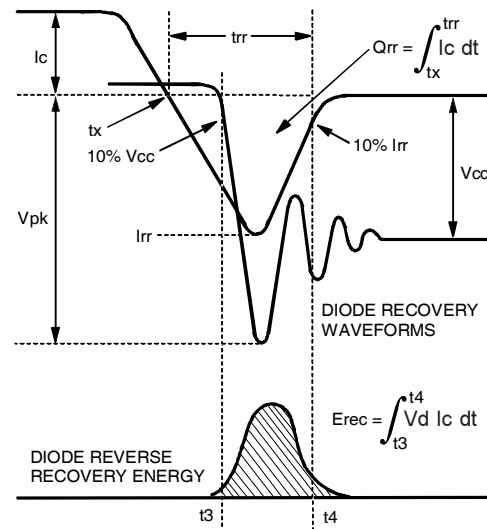
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

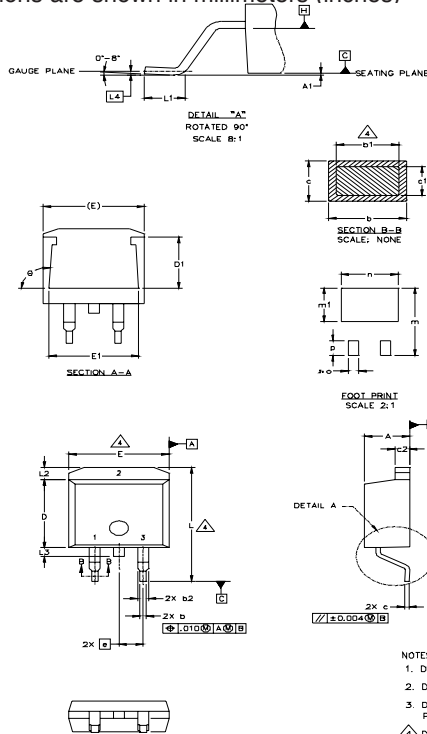


**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



## 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

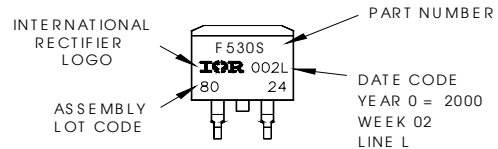
\* PART DEPENDENT.

- 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.

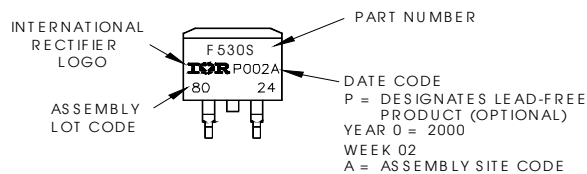
## D<sup>2</sup>Pak Part Marking Information (Lead-Free)

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**



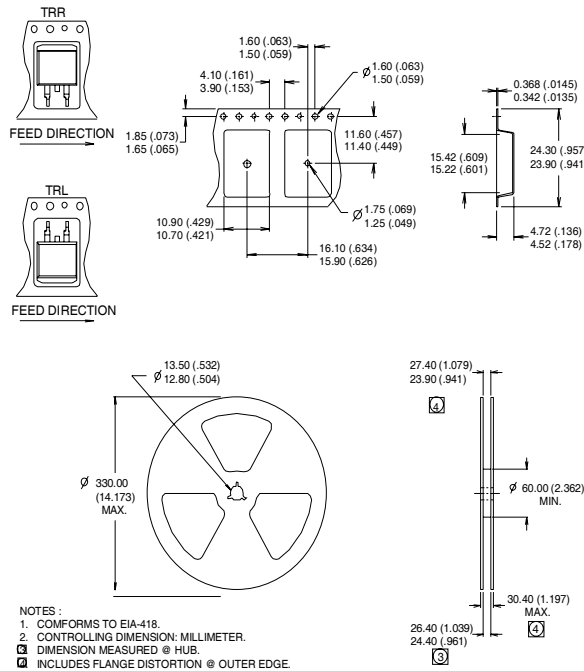
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## Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=50\Omega$  (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/>