



# THE DATASHEET OF IRG4IBC20KDPBF



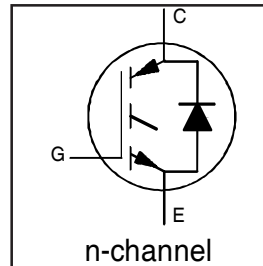
# IRG4IBC20KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
UltraFast IGBT

## Features

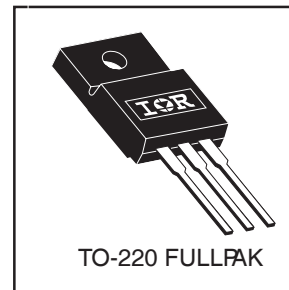
- High switching speed optimized for up to 25kHz with low  $V_{CE(on)}$
- Short Circuit Rating 10 $\mu$ s @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-220 FULLPAK
- Lead-Free



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 2.27V$
@ $V_{GE} = 15V, I_C = 6.3A$

## Benefits

- Generation 4 IGBTs offer highest efficiencies available maximizing the power density of the system
- IGBTs optimized for specific application conditions
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise EMI
- Designed to exceed the power handling capability of equivalent industry-standard IGBTs



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	11.5	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	6.3	
$I_{CM}$	Pulsed Collector Current ①	23	
$I_{LM}$	Clamped Inductive Load Current ②	23	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	6.3	
$I_{FM}$	Diode Maximum Forward Current	23	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu$ s
$V_{ISOL}$	RMS Isolation Voltage, Terminal to Case, $t = 1 \text{ min}$	2500	V
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	34	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	14	
$T_J$	Operating Junction and	-55 to +150	$^\circ C$
$T_{STG}$	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	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	---	3.7	$^\circ C/W$
$R_{\theta CS}$	Junction-to-Case - Diode	---	5.5	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	---	65	
Wt	Weight	2.0 (0.07)	---	g (oz)

# IRG4IBC20KDPbF

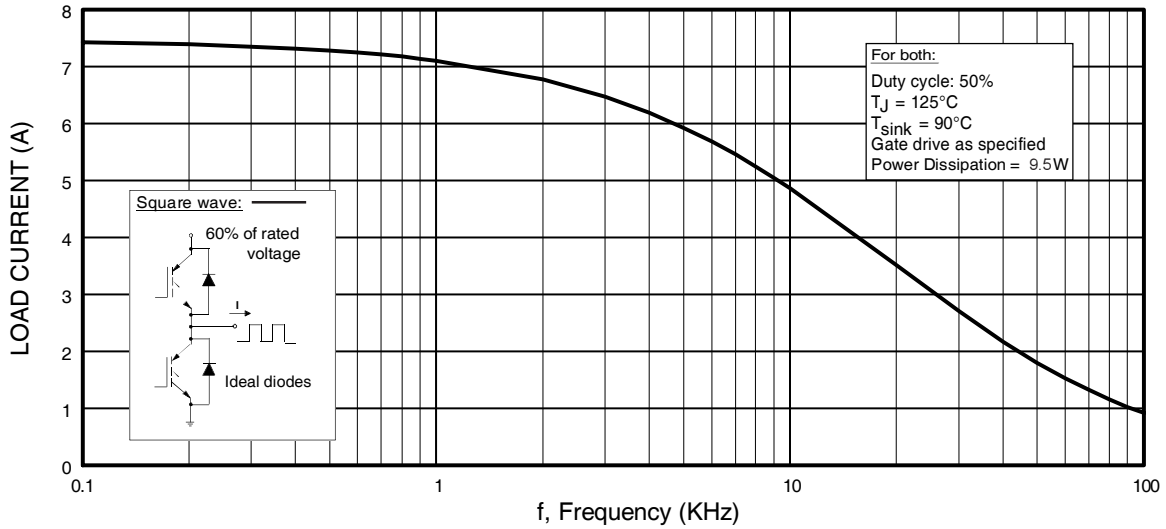
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IR Rectifier

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

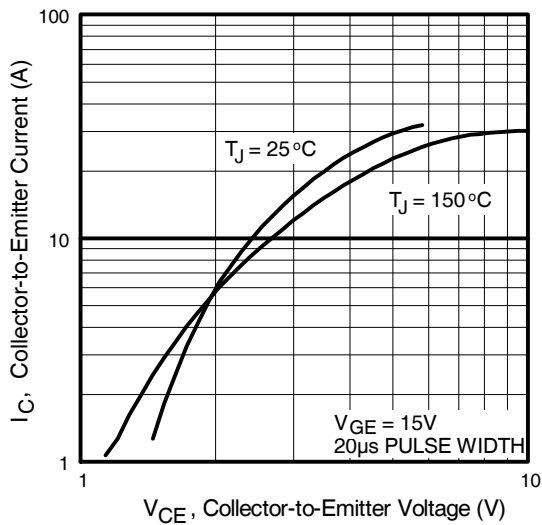
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.49	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.27	2.8	V	$I_C = 9.0A$ $I_C = 16A$ $I_C = 9.0A, T_J = 150^\circ\text{C}$
		—	3.01	—		
		—	2.43	—		
$V_{GE(th)}$	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	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$ $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
		—	—	1000		
$V_{FM}$	Diode Forward Voltage Drop	—	1.4	1.7	V	$I_C = 8.0A$ $I_C = 8.0A, T_J = 150^\circ\text{C}$
		—	1.3	1.6		
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

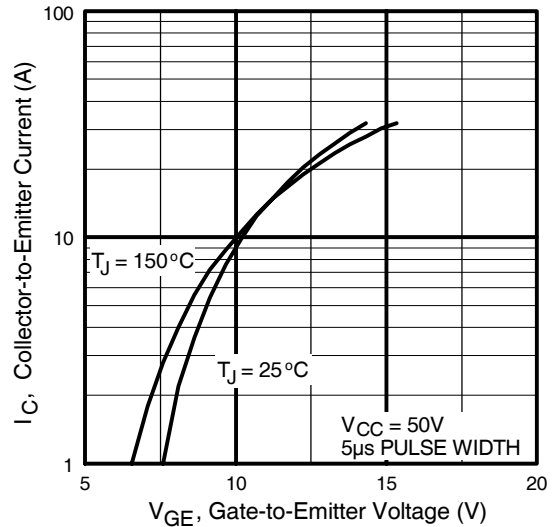
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	34	51	nC	$I_C = 9.0A$ $V_{CC} = 400V$ $V_{GE} = 15V$ See Fig.8
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	4.9	7.4		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	14	21		
$t_{d(on)}$	Turn-On Delay Time	—	54	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 9.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 50\Omega$
$t_r$	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" and diode reverse recovery 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	—	—	$\mu s$	$V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 50\Omega, V_{CPK} < 500V$
$t_{d(on)}$	Turn-On Delay Time	—	51	—	ns	$T_J = 150^\circ\text{C}$ , $I_C = 9.0A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 50\Omega$ See Fig. 10,11,14 Energy losses include "tail" and diode reverse recovery
$t_r$	Rise Time	—	37	—		
$t_{d(off)}$	Turn-Off Delay Time	—	220	—		
$t_f$	Fall Time	—	160	—		
$E_{ts}$	Total Switching Loss	—	0.85	—	mJ	
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	450	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ 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 $T_J = 125^\circ\text{C}$
		—	55	90		
$I_{rr}$	Diode Peak Reverse Recovery Current	—	3.5	5.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15 $T_J = 125^\circ\text{C}$
		—	4.5	8.0		
$Q_{rr}$	Diode Reverse Recovery Charge	—	65	138	nC	$T_J = 25^\circ\text{C}$ See Fig. 16 $T_J = 125^\circ\text{C}$
		—	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 $T_J = 125^\circ\text{C}$
		—	210	—		



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



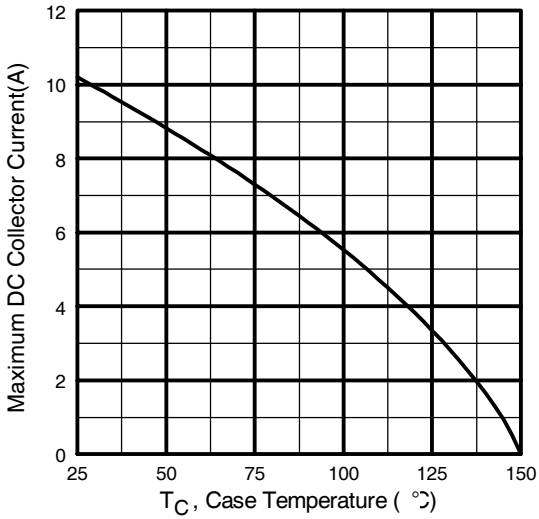
**Fig. 2 - Typical Output Characteristics**



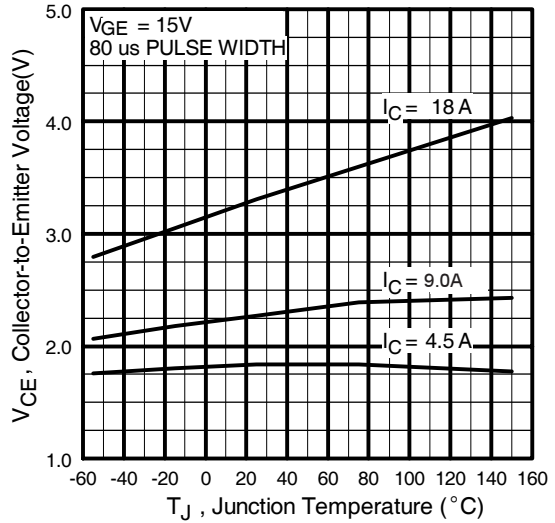
**Fig. 3 - Typical Transfer Characteristics**

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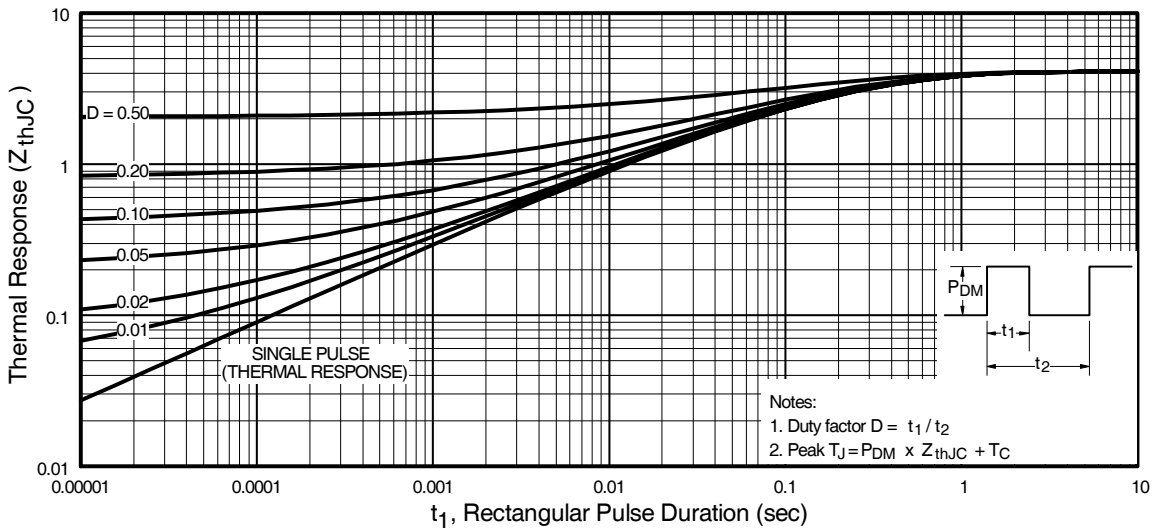
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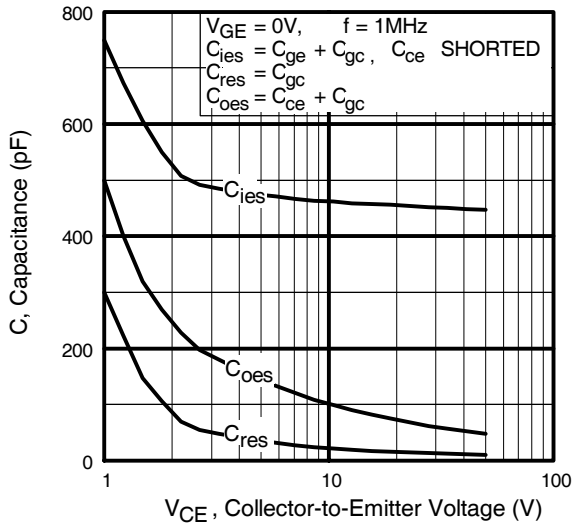
**Fig. 4** - Maximum Collector Current vs. Case Temperature



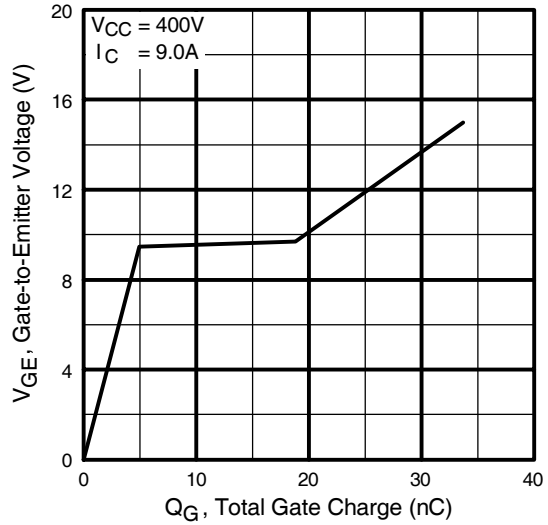
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



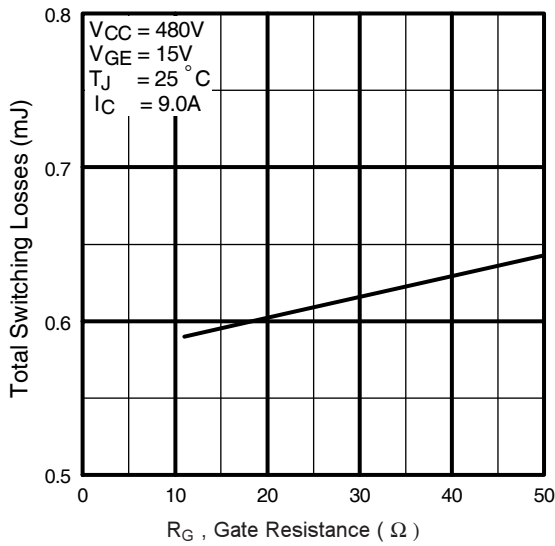
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



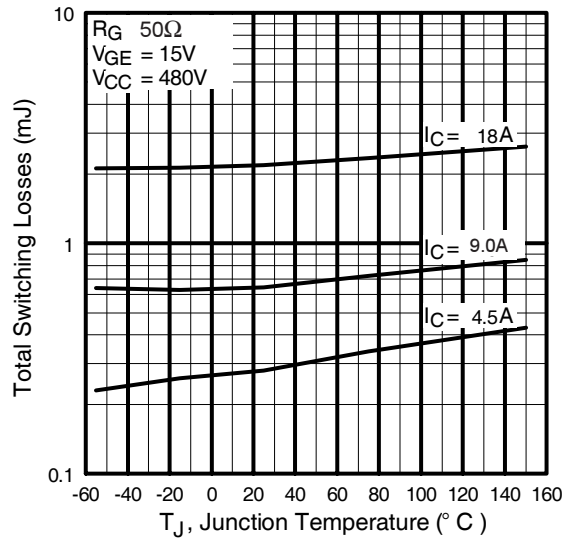
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



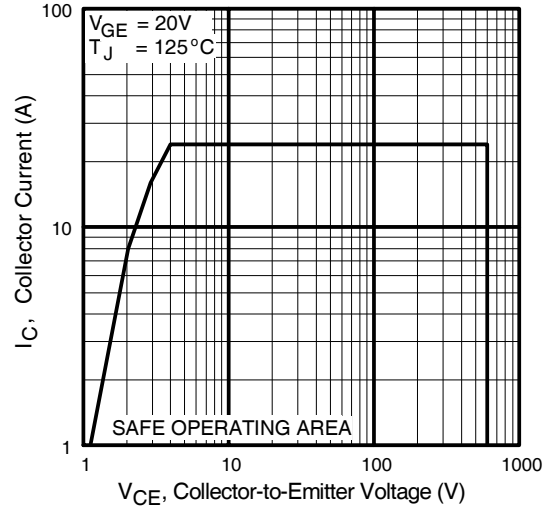
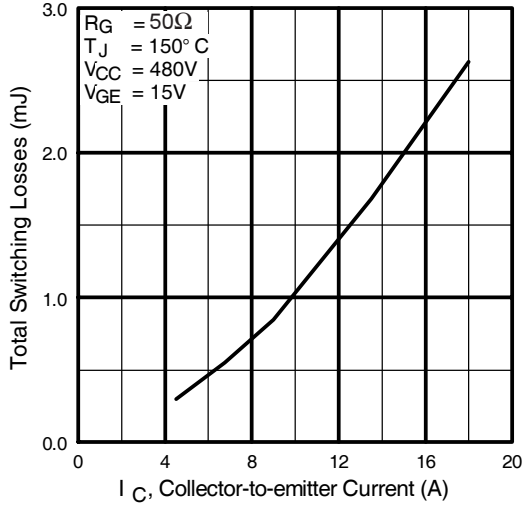
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



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

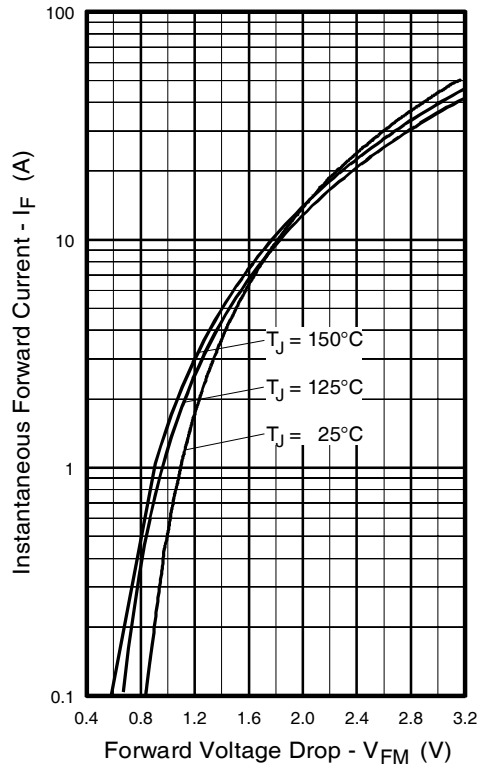
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**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current

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



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

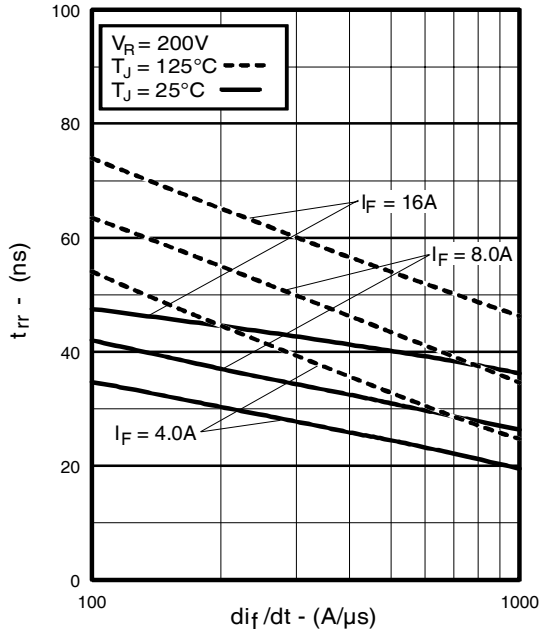


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

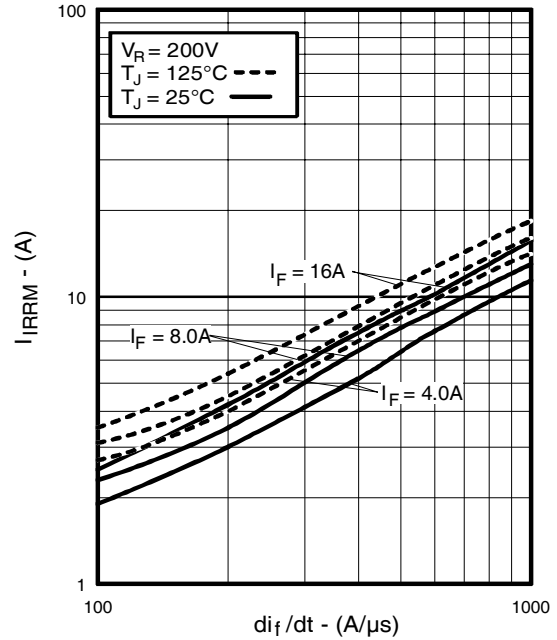


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

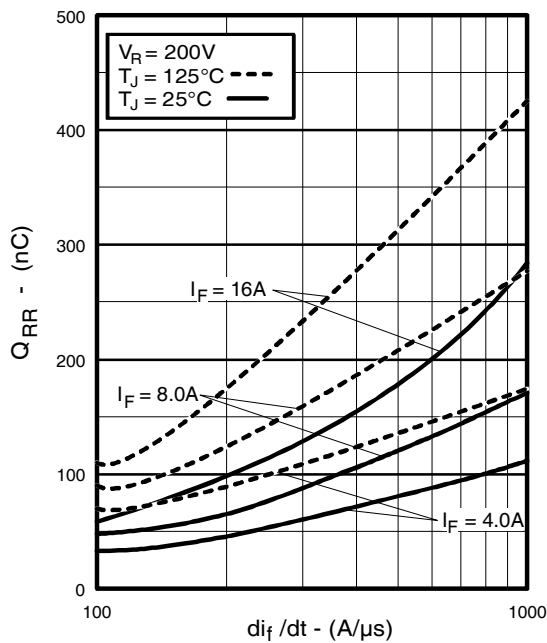


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

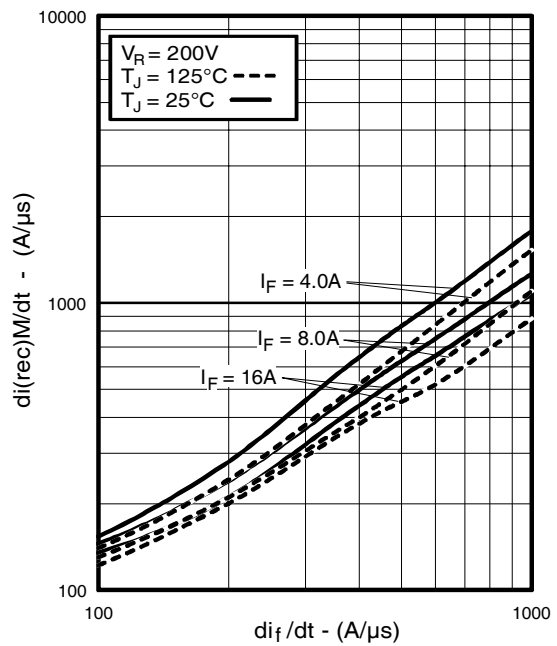
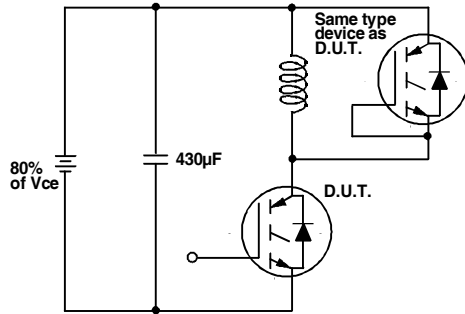
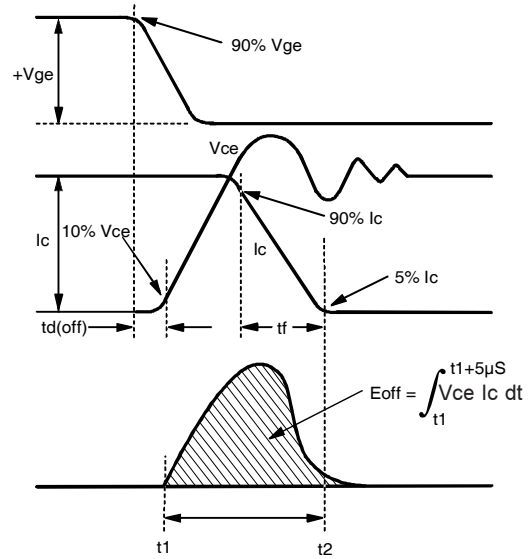


Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

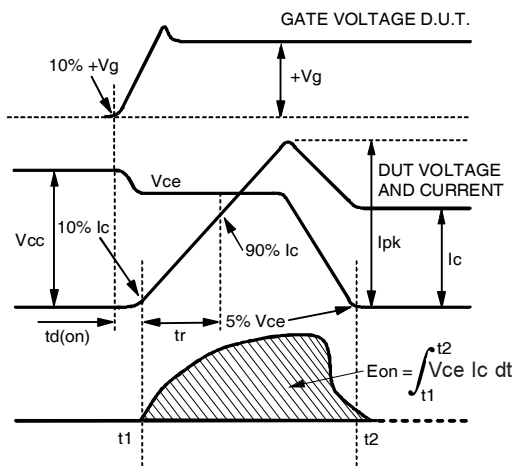
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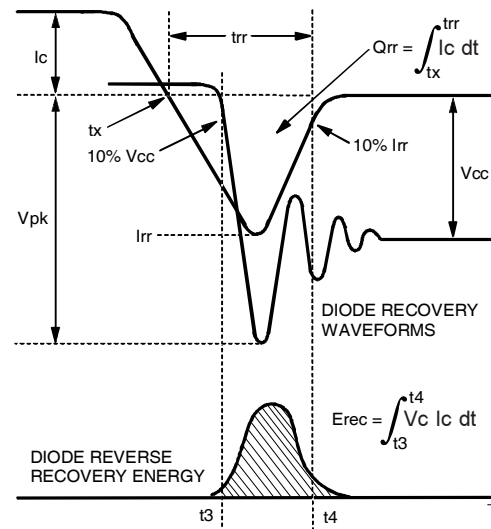
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

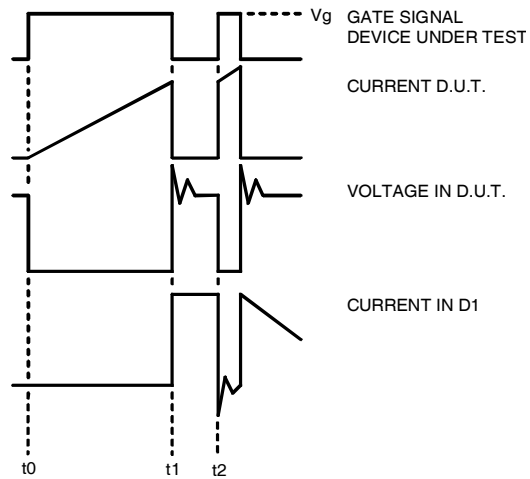


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

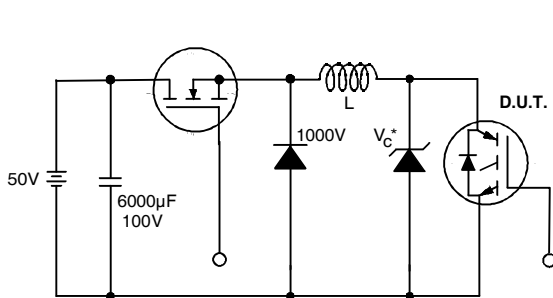


Figure 19. Clamped Inductive Load Test Circuit

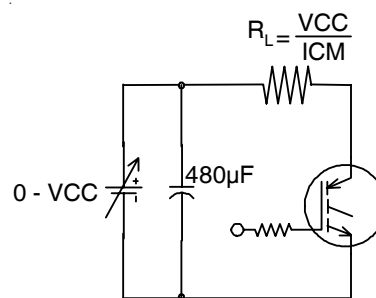


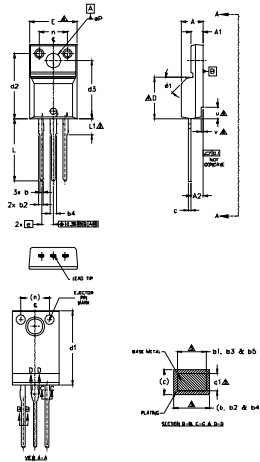
Figure 20. Pulsed Collector Current Test Circuit

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## TO-220AB Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



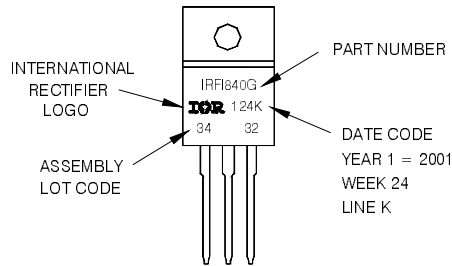
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.57	4.83	.180	.190	
A1	2.57	2.83	.101	.111	
A2	2.51	2.93	.099	.115	
b	0.61	0.94	.024	.037	
b1	0.61	0.89	.024	.035	5
b2	0.76	1.27	.030	.050	
b3	0.76	1.22	.030	.048	5
b4	1.02	1.52	.040	.060	
b5	1.02	1.47	.040	.058	5
c	0.33	0.63	.013	.025	
c1	0.33	0.38	.013	.023	5
D	8.66	9.80	.341	.386	4
d1	15.80	16.13	.622	.635	
d2	13.97	14.22	.550	.560	
d3	12.30	12.93	.484	.509	
E	9.63	10.76	.379	.423	4
e	2.54 BSC		100 BSC		
L	13.20	13.72	.520	.540	
L1	3.37	3.67	.122	.145	3
n	6.05	6.60	.238	.260	
øP	3.05	3.45	.120	.136	
u	2.40	2.60	.094	.098	6
v	0.40	0.50	.016	.020	6
ø1	-	45°	-	45°	

NOTES  
 1. DIMENSIONS AND TOLERANCING AS PER ASME Y14.5 M - 1994.  
 2. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).  
 3. LEAD DIMENSION AND FINISH UNCONTROLLED IN LT.  
 4. DIMENSION D & E DO NOT INCLUDE WELD FLASH; WELD FLASH SHALL NOT EXCEED .002 (0.075) PER SIDE; THESE DIMENSIONS ARE MEASURED AT THE OUTER MOST EXTREMES OF THE PLASTIC BODY.  
 5. DIMENSION H1, H2, H3 & H4 APPLY TO BAKE METAL ONLY.  
 6. STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS A & A1.  
 7. CONTROLLING DIMENSION - BONES.  
 LEAD ASSIGNMENTS  
 1. GATE  
 2. DRAIN  
 3. SOURCE  
 LABEL CODES  
 1. GATE  
 2. COLLECTOR  
 3. EMITTER

## TO-220AB Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRF1840G  
 WITH ASSEMBLY  
 LOT CODE 3432  
 ASSEMBLED ON WW 24, 2001  
 IN THE ASSEMBLY LINE 'K'

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



TO-220AB Full-Pak package is not recommended for Surface Mount Application.

### 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.

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

Data and specifications subject to change without notice.

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