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# IRG4BC15MDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST  
SOFT RECOVERY DIODE

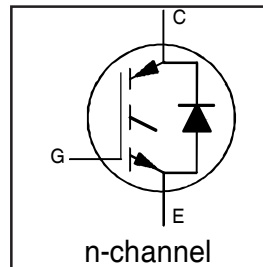
Short Circuit Rated  
Fast IGBT

## Features

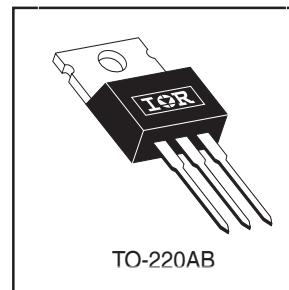
- Rugged: 10µsec short circuit capable at  $V_{GS} = 15V$
- Low  $V_{CE(on)}$  for 4 to 10kHz applications
- IGBT co-packaged with ultra-soft-recovery anti-parallel diodes
- Industry standard TO-220AB package

## Benefits

- Best Value for Appliance and Industrial applications
- Offers highest efficiency and short circuit capability for intermediate applications
- Provides best efficiency for the mid range frequency (4 to 10kHz)
- Optimized for Appliance and Industrial applications up to 1HP
- 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 Drive IC's
- Allows simpler gate drive



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 1.88V$
@ $V_{GE} = 15V, I_C = 8.6A$



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	14	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	8.6	
$I_{CM}$	Pulsed Collector Current ①	28	
$I_{LM}$	Clamped Inductive Load Current ②	28	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	4.0	
$t_{sc}$	Short Circuit Withstand Time	12	µs
$I_{FM}$	Diode Maximum Forward Current	16	A
$V_{GE}$	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	49	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	19	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	°C
	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	—	—	2.7	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	7.0	
$R_{\theta CS}$	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)

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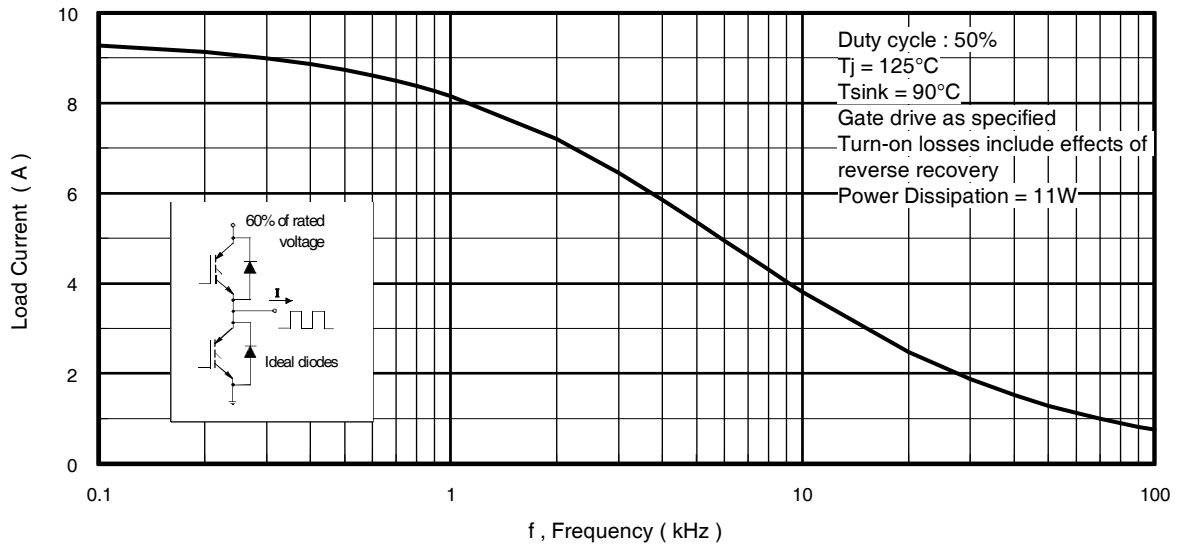
International  
 Rectifier

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

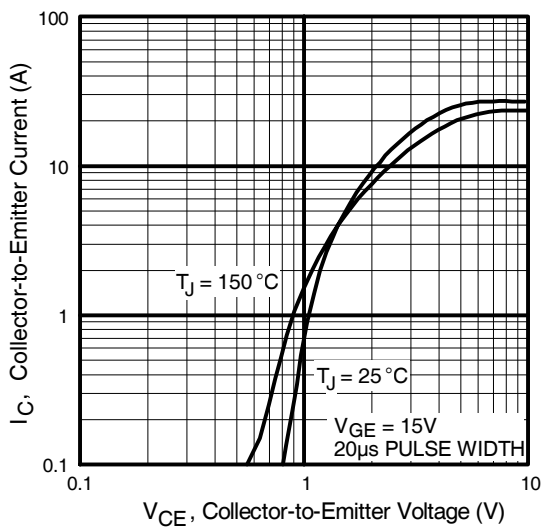
	Parameter	Min.	Typ.	Max.	Units	Conditions	
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.65	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.88	2.3	V	$V_{GE} = 15V$ $I_C = 8.6A$	
		—	2.6	—			$I_C = 14A$
		—	2.1	—			$I_C = 8.6A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5		$V_{CE} = V_{GE}, I_C = 250\mu A$	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$	
$g_{fe}$	Forward Transconductance <sup>④</sup>	2.3	3.4	—	S	$V_{CE} = 100V, I_C = 6.5A$	
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$	
		—	—	1400		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$	
$V_{FM}$	Diode Forward Voltage Drop	—	1.5	1.8	V	$I_C = 4.0A$	
		—	1.4	1.7		$I_C = 4.0A, T_J = 150^\circ\text{C}$	
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$	

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

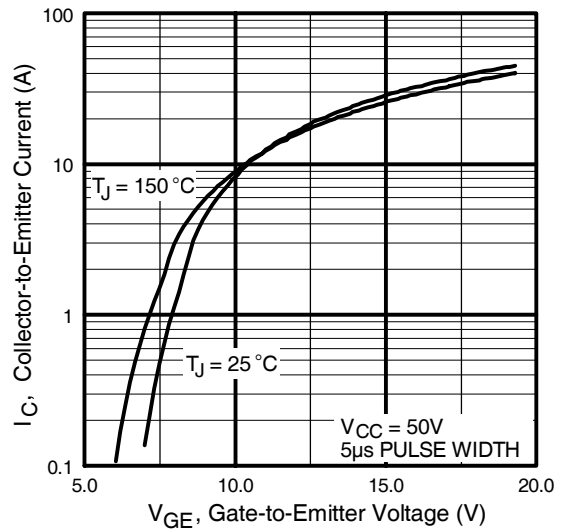
	Parameter	Min.	Typ.	Max.	Units	Conditions	
$Q_g$	Total Gate Charge (turn-on)	—	46	—	nC	$I_C = 8.6A$ $V_{CC} = 400V$ $V_{GE} = 15V$	
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	4.2	—			
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	15	—			
$t_{d(on)}$	Turn-On Delay Time	—	21	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 8.6A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 75\Omega$ Energy losses include "tail" and diode reverse recovery.	
$t_r$	Rise Time	—	38	—			
$t_{d(off)}$	Turn-Off Delay Time	—	540	810			
$t_f$	Fall Time	—	350	530			
$E_{on}$	Turn-On Switching Loss	—	0.32	—	mJ		
$E_{off}$	Turn-Off Switching Loss	—	1.93	—			
$E_{ts}$	Total Switching Loss	—	2.25	3.6			
$t_{d(on)}$	Turn-On Delay Time	—	20	—	ns	$T_J = 150^\circ\text{C}$ , $I_C = 8.6A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 75\Omega$ Energy losses include "tail" and diode reverse recovery.	
$t_r$	Rise Time	—	42	—			
$t_{d(off)}$	Turn-Off Delay Time	—	650	—			
$t_f$	Fall Time	—	590	—			
$E_{ts}$	Total Switching Loss	—	3.0	—	mJ		
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package	
$C_{ies}$	Input Capacitance	—	340	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$	
$C_{oes}$	Output Capacitance	—	35	—			
$C_{res}$	Reverse Transfer Capacitance	—	8.8	—			
$t_{rr}$	Diode Reverse Recovery Time	—	28	42	ns	$T_J = 25^\circ\text{C}$	$I_F = 4.0A$ $V_R = 200V$ $di/dt 200A/\mu s$
		—	38	57		$T_J = 125^\circ\text{C}$	
$I_{rr}$	Diode Peak Reverse Recovery Current	—	2.9	5.2	A	$T_J = 25^\circ\text{C}$	
		—	3.7	6.7		$T_J = 125^\circ\text{C}$	
$Q_{rr}$	Diode Reverse Recovery Charge	—	40	60	nC	$T_J = 25^\circ\text{C}$	
		—	70	110		$T_J = 125^\circ\text{C}$	
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	280	—	A/ $\mu s$	$T_J = 25^\circ\text{C}$	
		—	240	—		$T_J = 125^\circ\text{C}$	



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



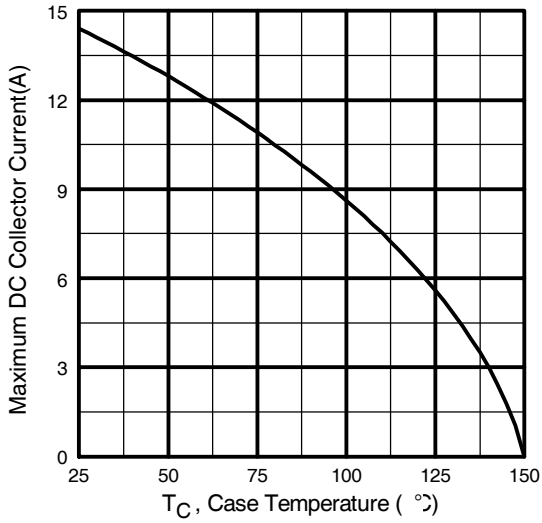
**Fig. 2 - Typical Output Characteristics**



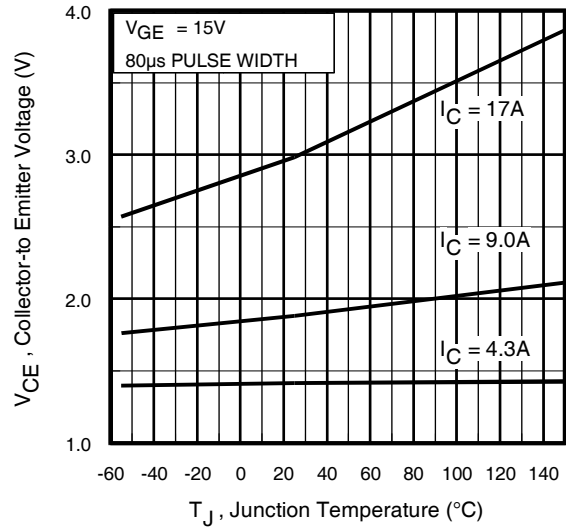
**Fig. 3 - Typical Transfer Characteristics**

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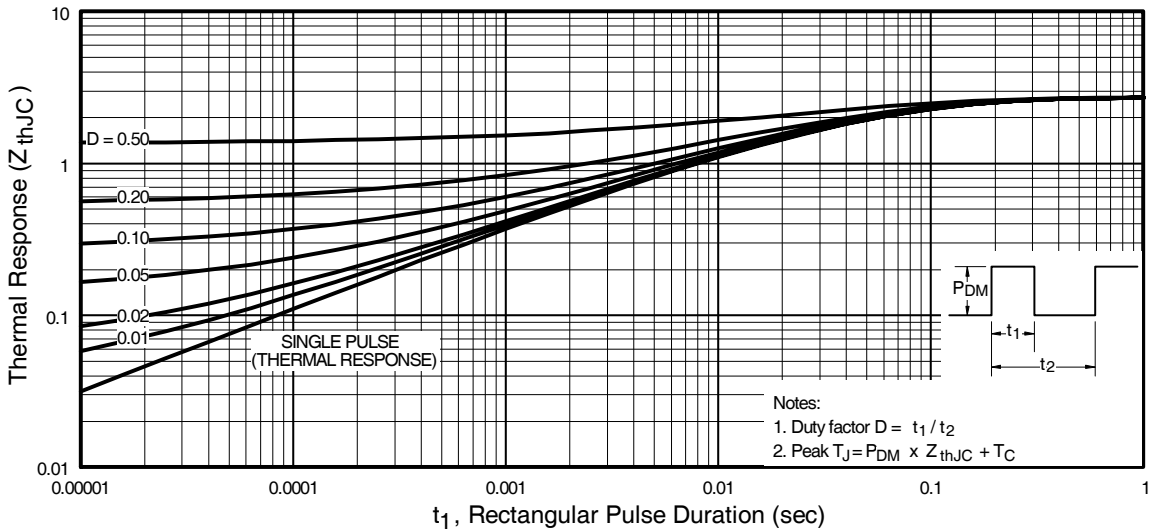
International  
**IR** Rectifier



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

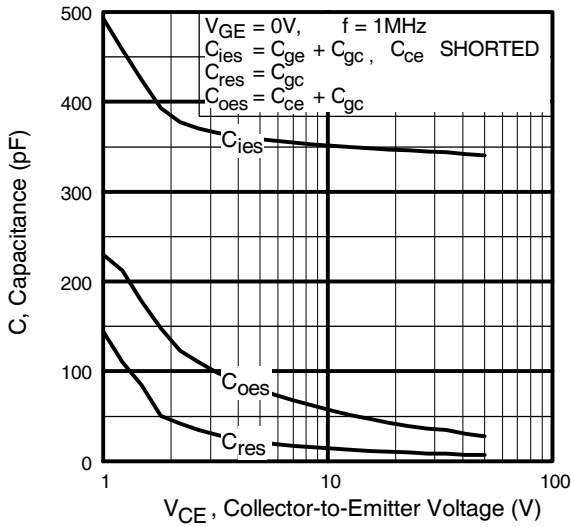


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

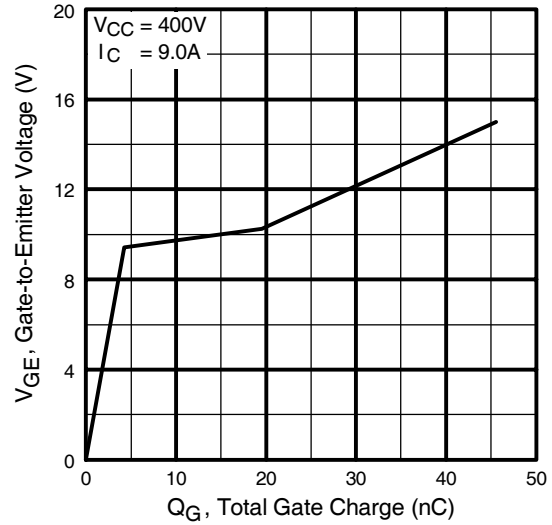


**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

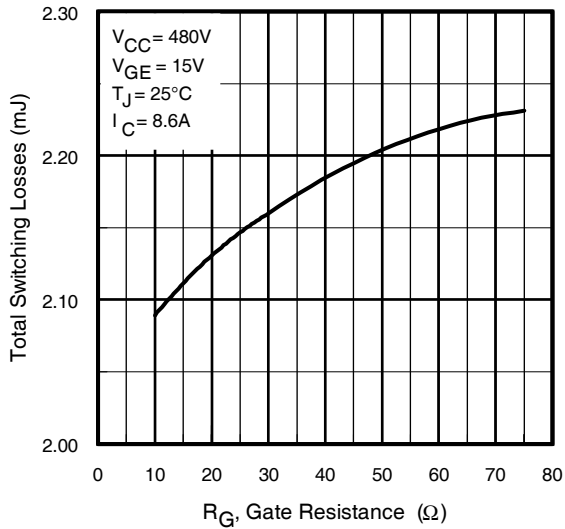
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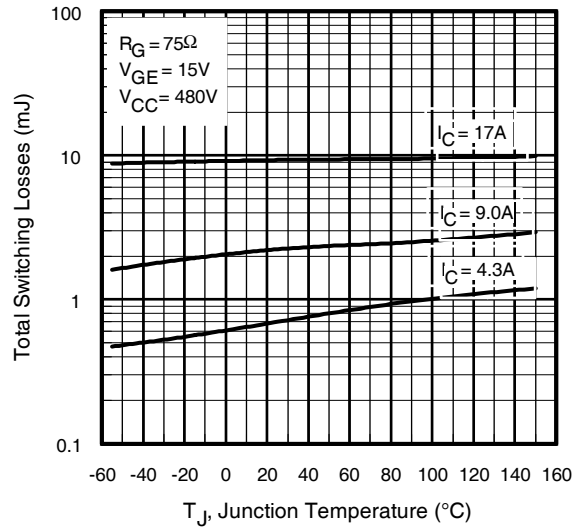
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

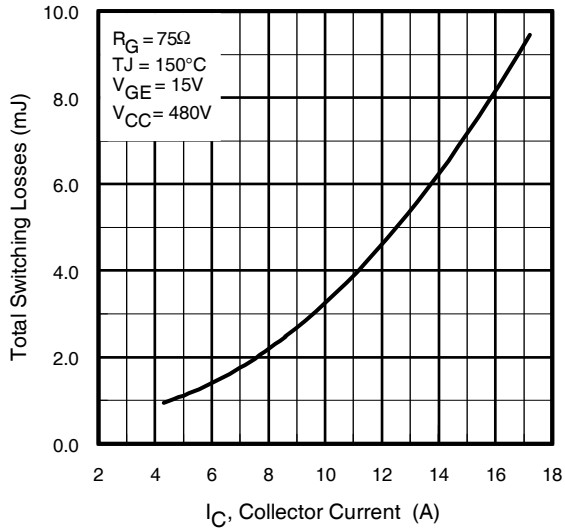


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

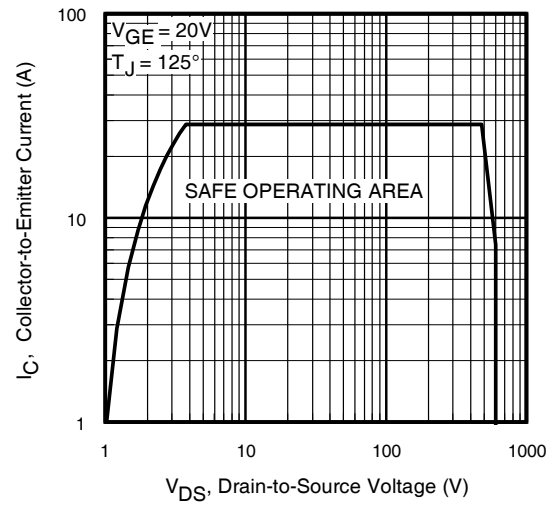


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

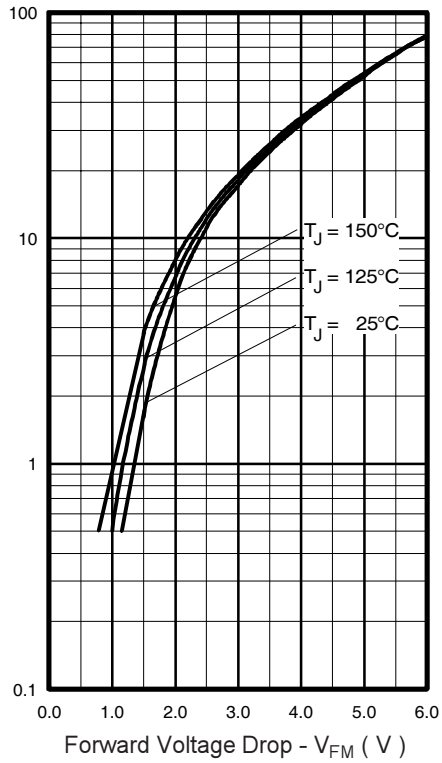
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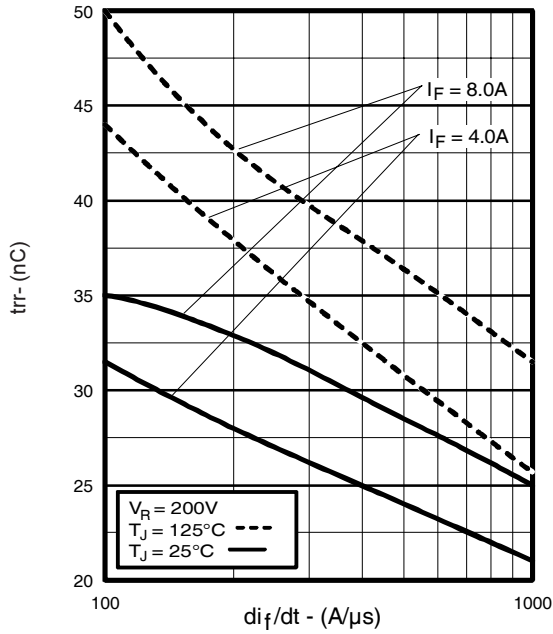


**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current

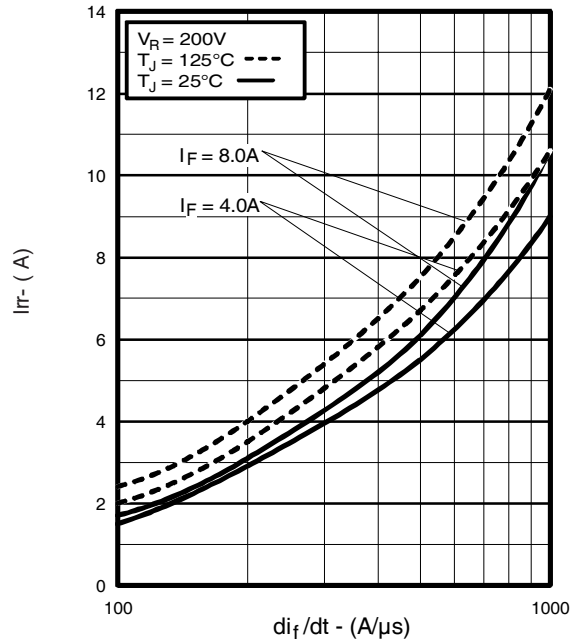


**Fig. 12** - Turn-Off SOA

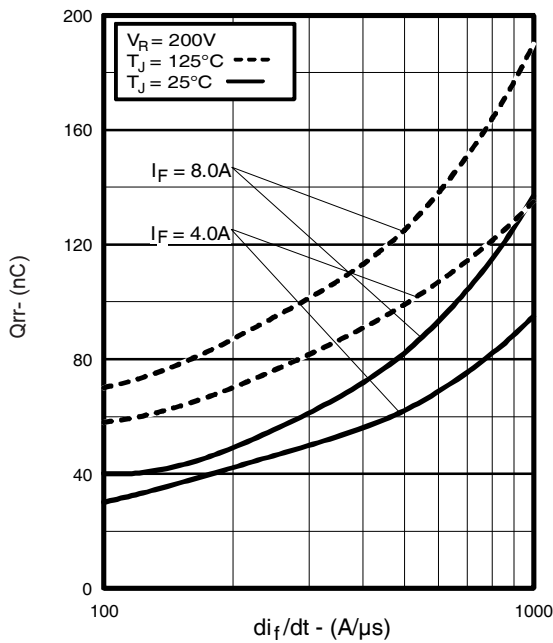




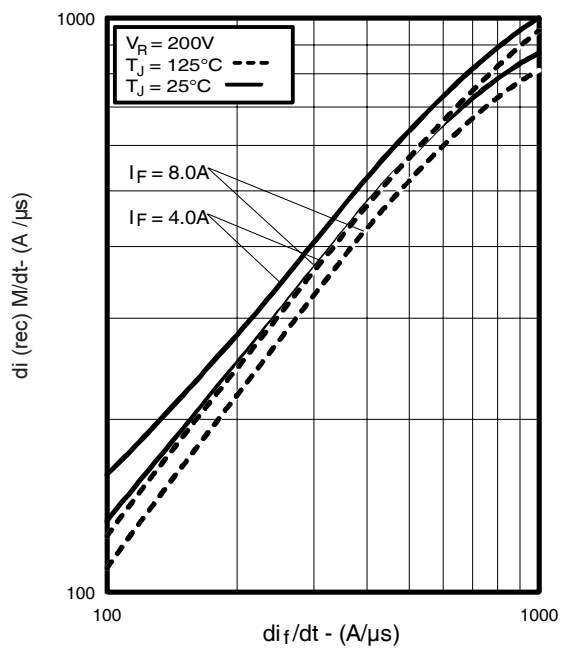
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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



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

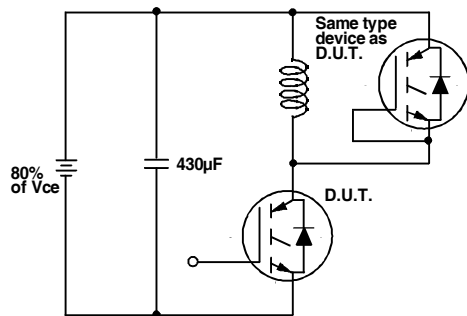


**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$ ,

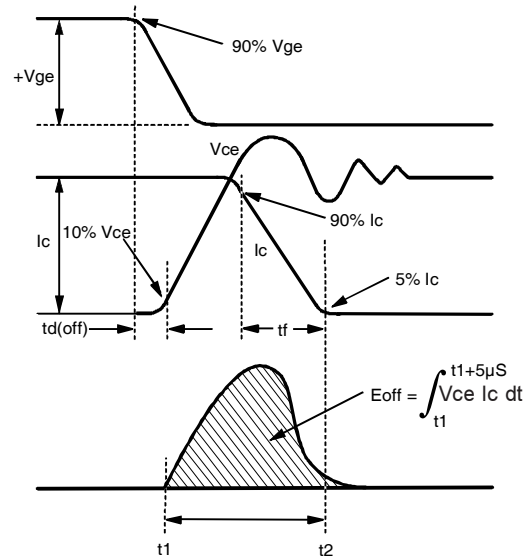


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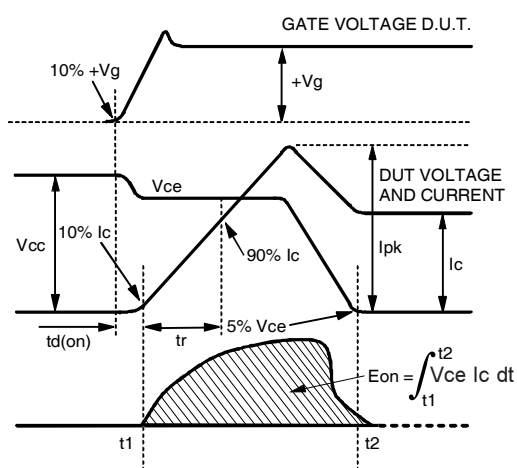
International  
**IR** Rectifier



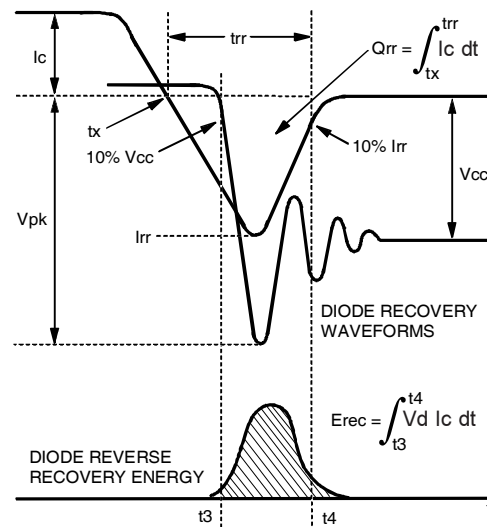
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

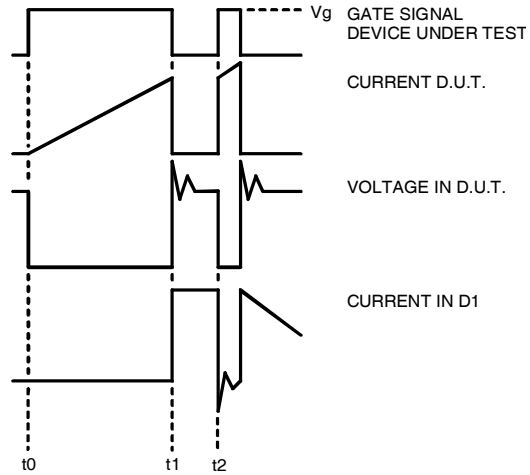


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

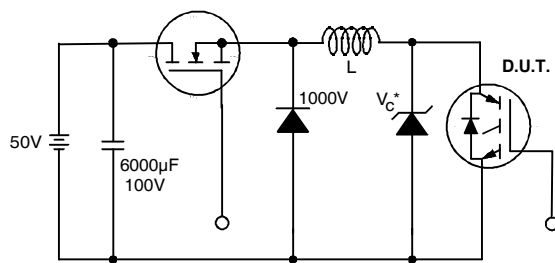


Figure 19. Clamped Inductive Load Test Circuit

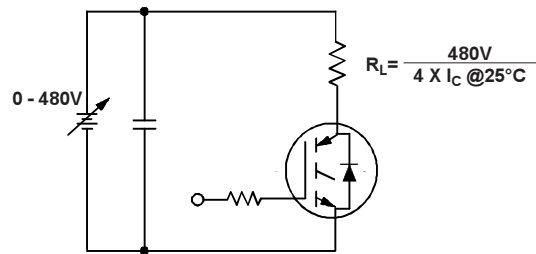


Figure 20. Pulsed Collector Current Test Circuit

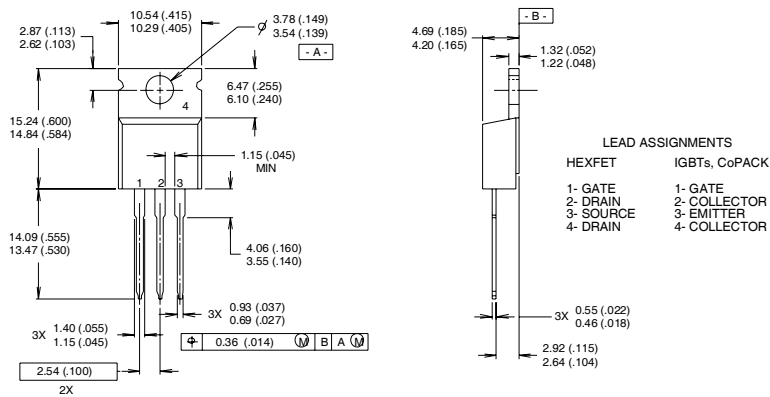
# IRG4BC15MDPbF



## Notes:

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G = 75\Omega$
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

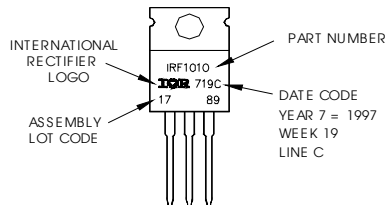
## TO-220AB Package Outline



- NOTES:
- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
  - 2 CONTROLLING DIMENSION : INCH
  - 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
  - 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"  
**Note:** "P" in assembly line  
 position indicates "Lead-Free"



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.



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