

# International IR Rectifier

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

PD- 94151A

## IRG4BC15MD

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

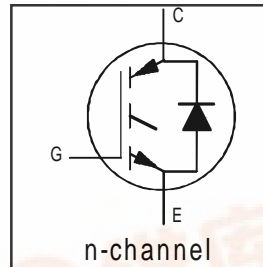
- Best Value for Appliance and Industrial applications
- Offers highest efficiency and short circuit capability for intermediate applications
- Provides best efficiency for the mid range frequency (4 to 10kHz)
- Optimized for Appliance and Industrial applications up to 1HP
- High noise immune "Positive 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

### 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	A
$t_{sc}$	Short Circuit Withstand Time	12	
$I_{FM}$	Diode Maximum Forward Current	16	A
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	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	$^\circ C$
	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	$^\circ C/W$
$R_{\theta JC}$	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)

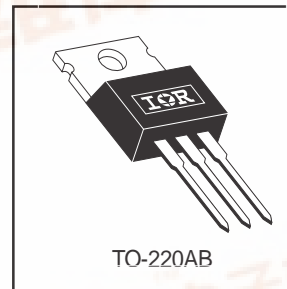


n-channel

$$V_{CES} = 600V$$

$$V_{CE(on)} \text{ typ.} = 1.88V$$

$$@V_{GE} = 15V, I_C = 8.6A$$



TO-220AB



# IRG4BC15MD

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## 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/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.88	2.3	V	$I_C = 8.6A$
		—	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/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	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	$V_{GE} = \pm 20V$

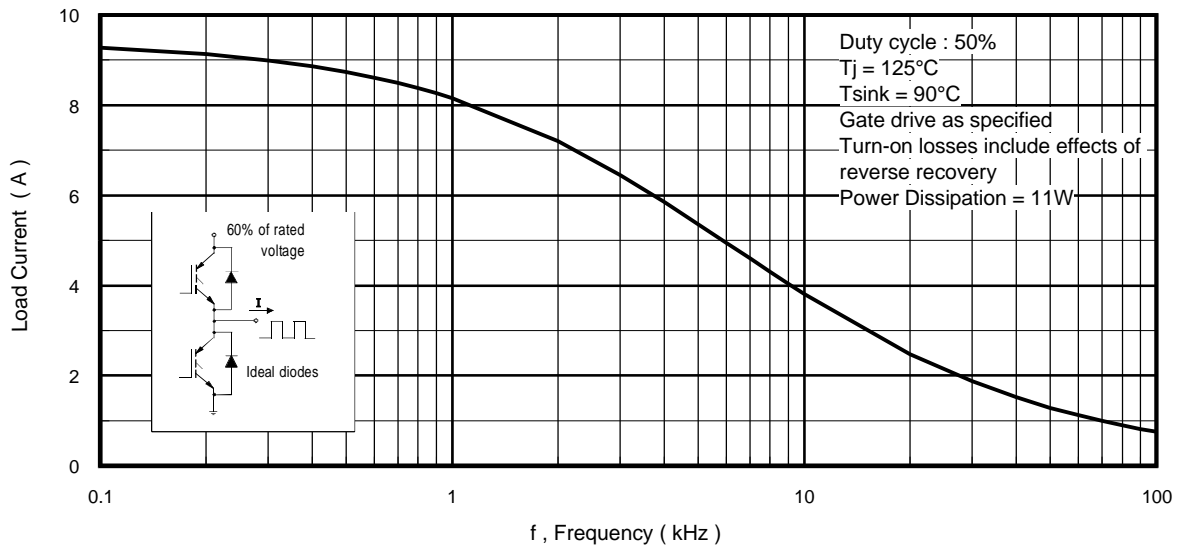
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	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	$T_J = 25^\circ\text{C}$
		—	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	—		$T_J = 125^\circ\text{C}$

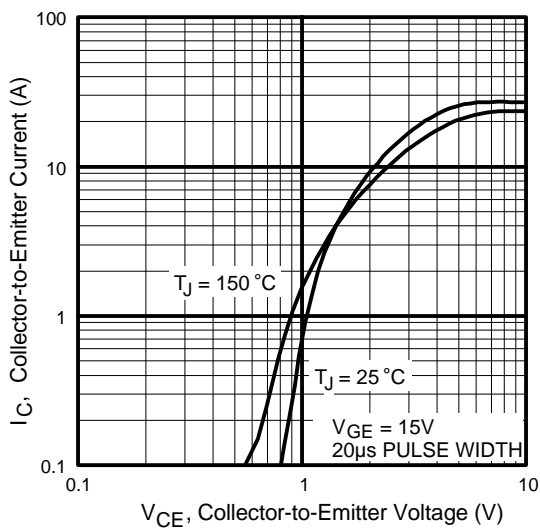
$I_F = 4.0A$

$V_R = 200V$

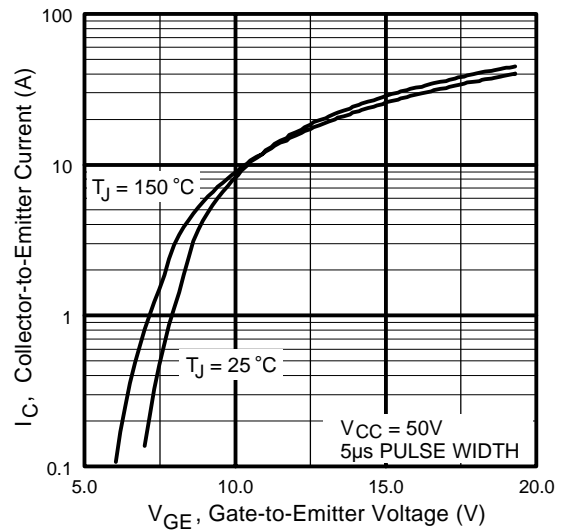
$di/dt 200A/\mu s$



**Fig. 1** - Typical Load Current vs. Frequency  
(Load Current = I<sub>RMS</sub> of fundamental)



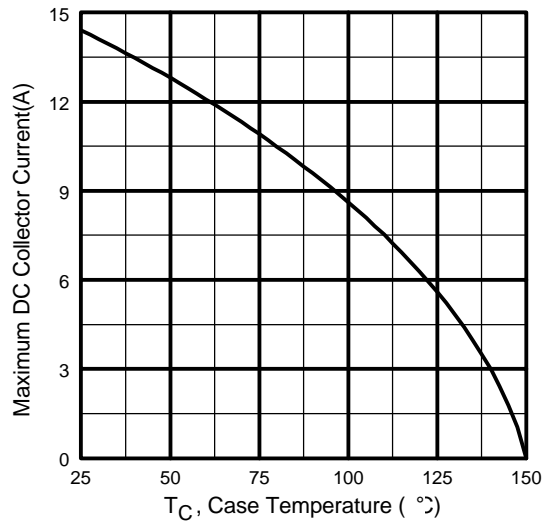
**Fig. 2** - Typical Output Characteristics



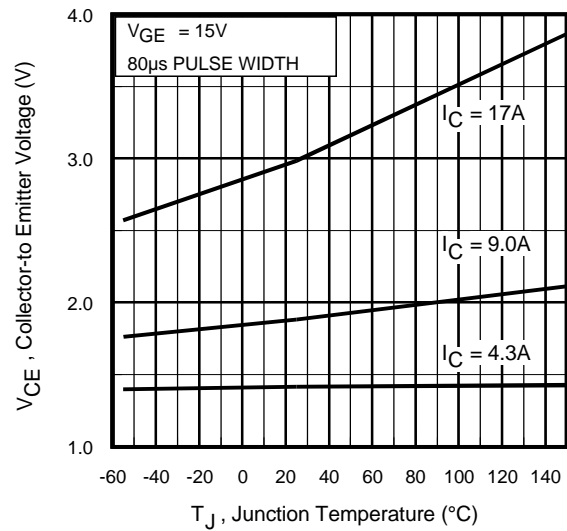
**Fig. 3** - Typical Transfer Characteristics

# IRG4BC15MD

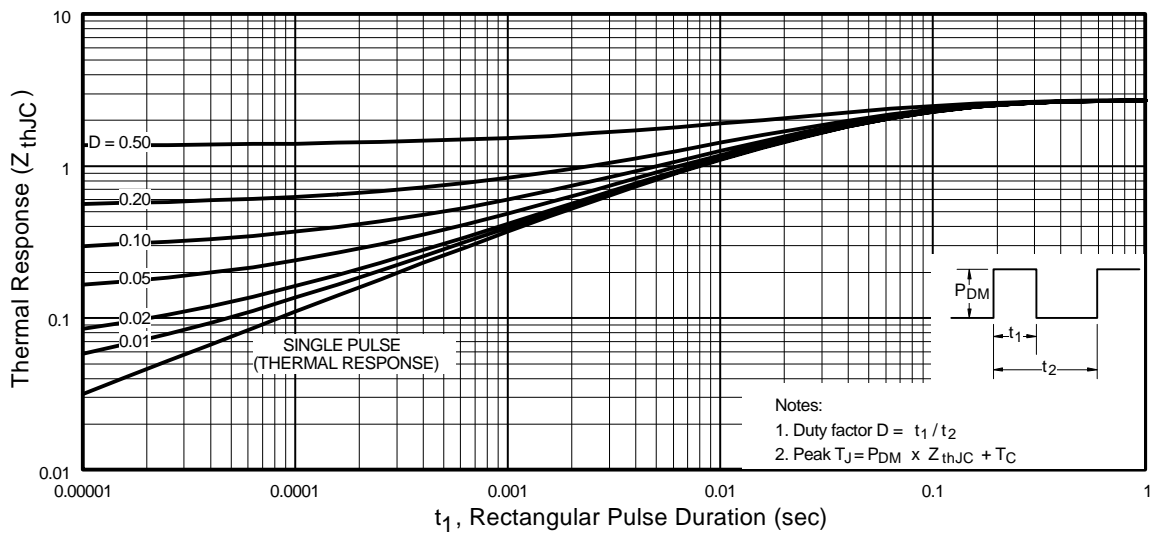
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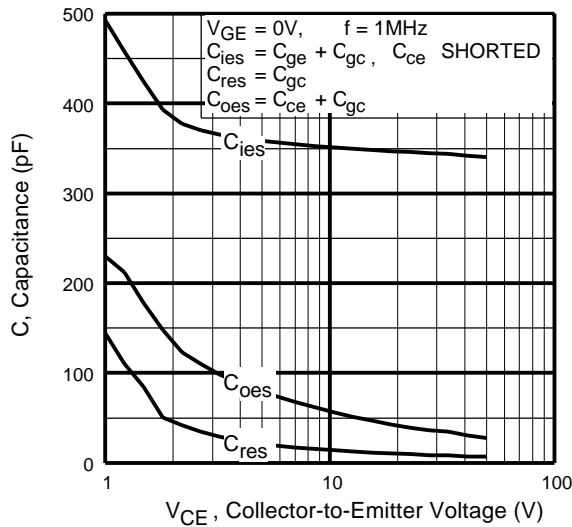
**Fig. 4** - Maximum Collector Current vs. Case Temperature



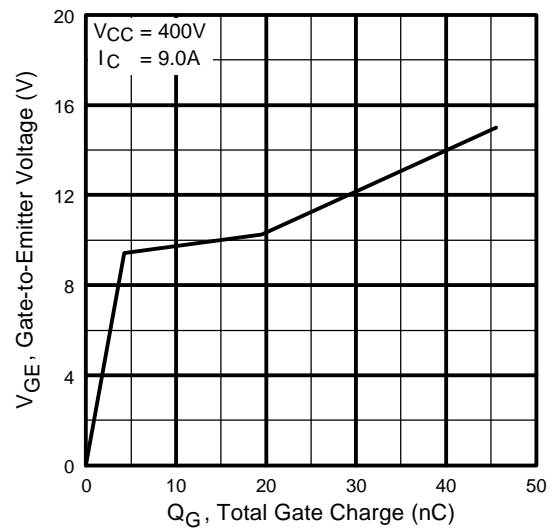
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



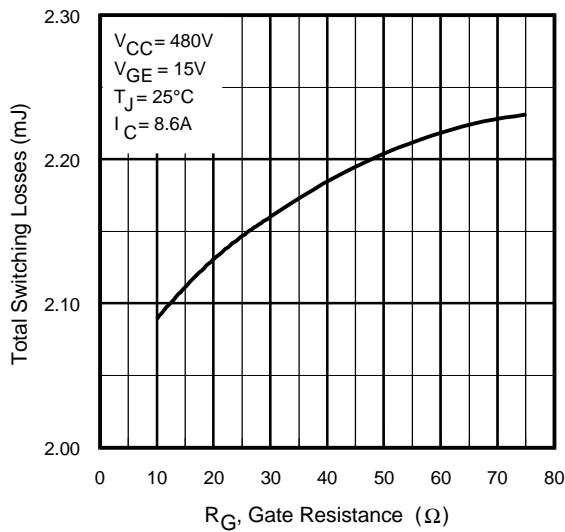
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



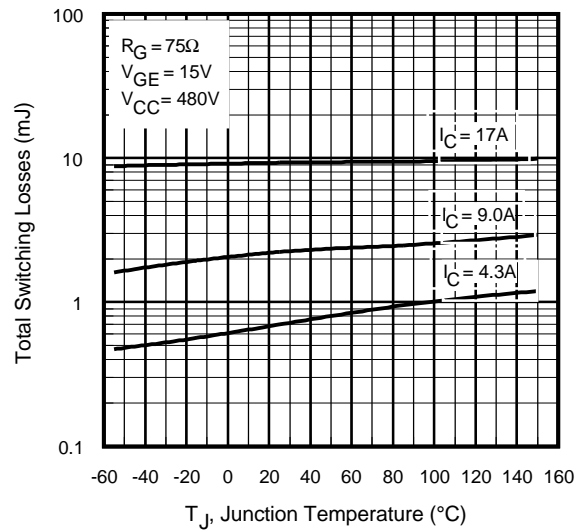
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



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



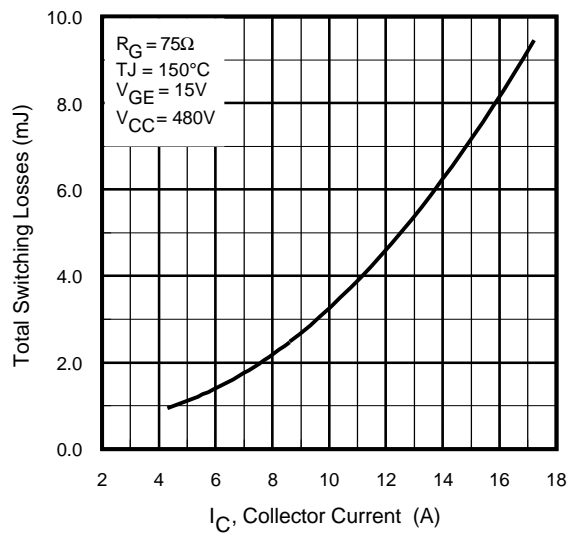
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



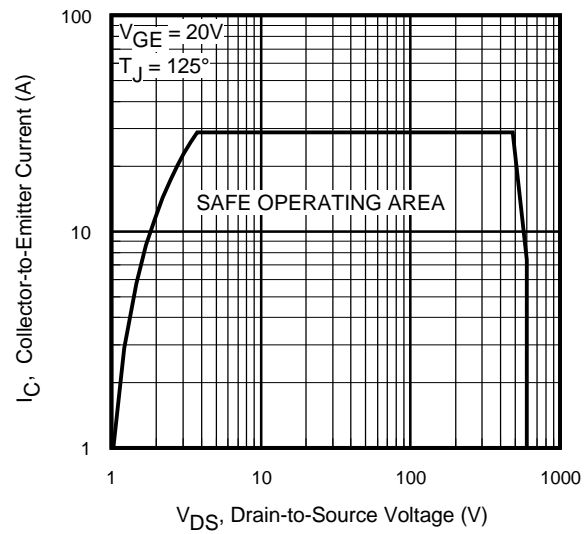
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

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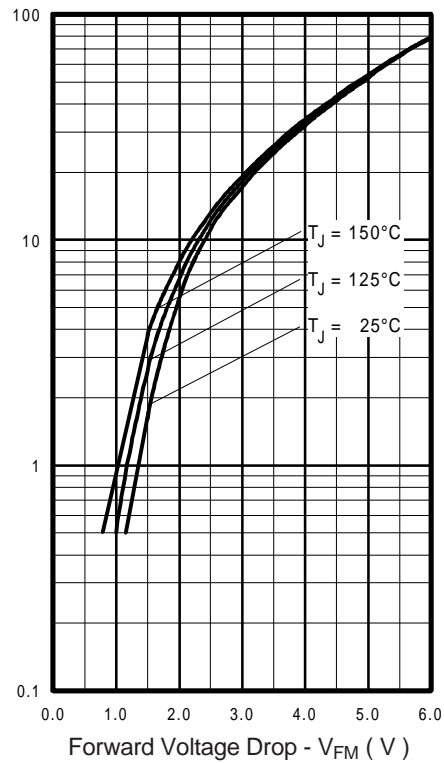
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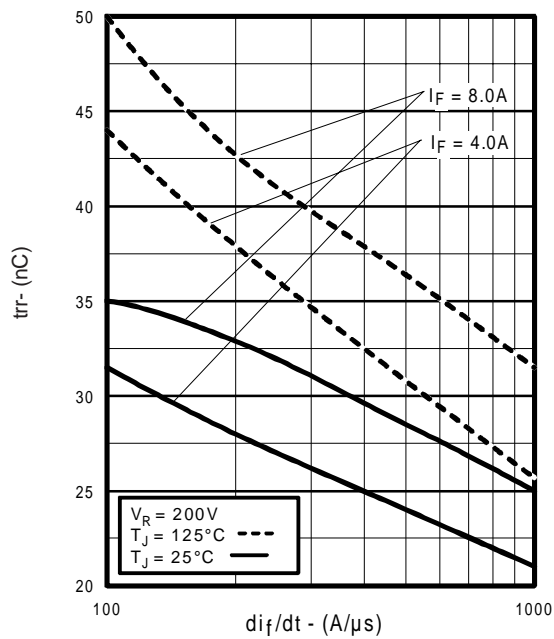


**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current

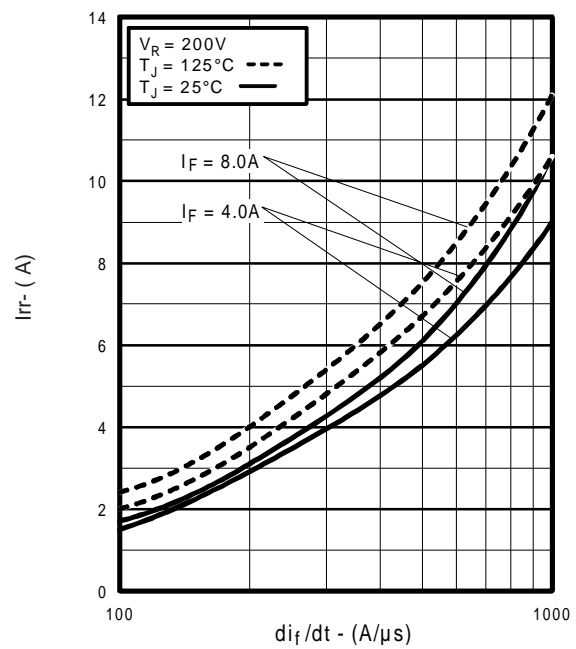


**Fig. 12** - Turn-Off SOA

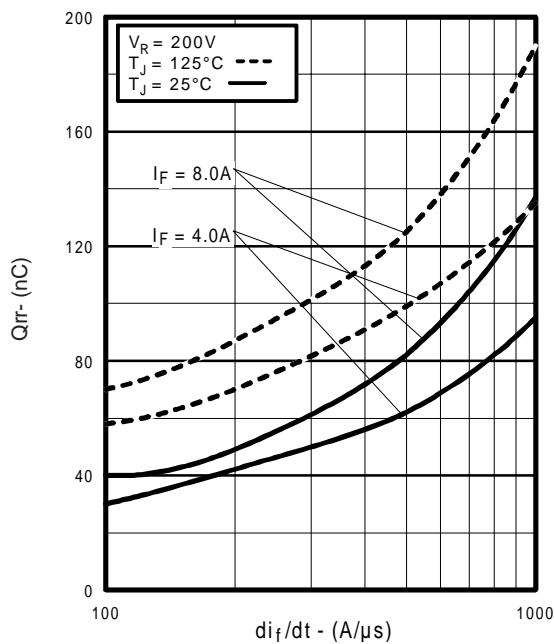




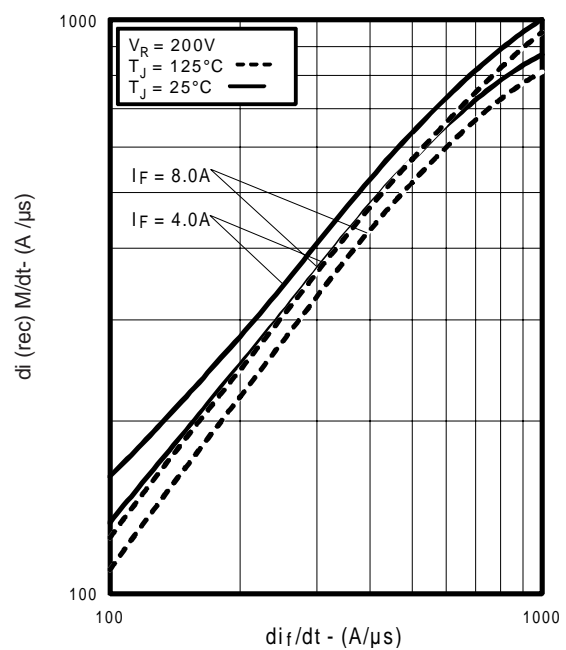
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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



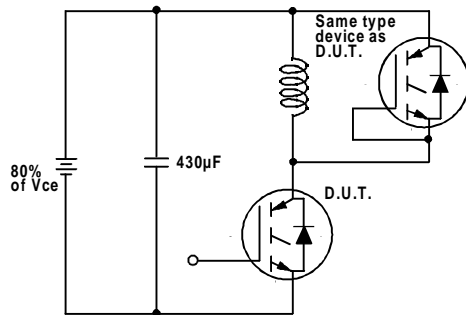
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



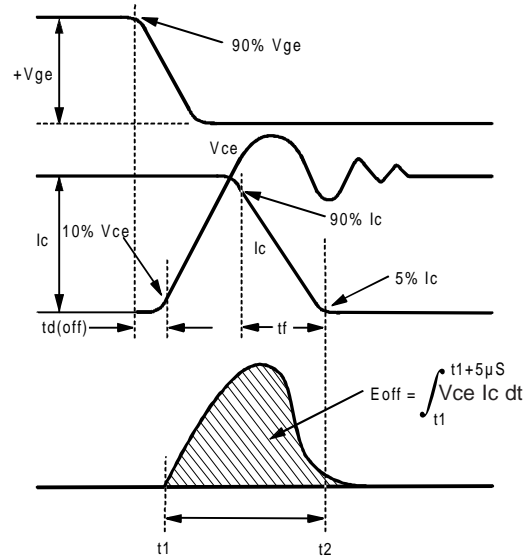
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$ ,

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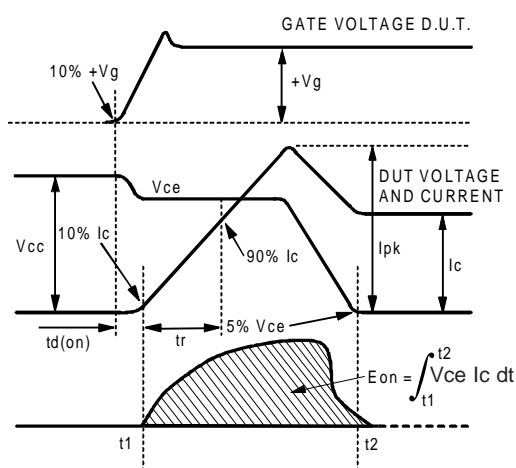
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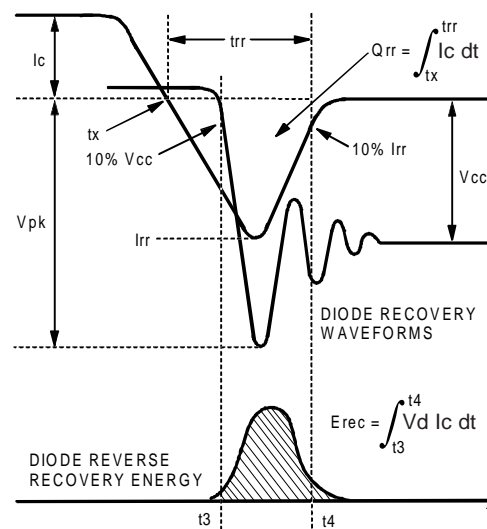
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

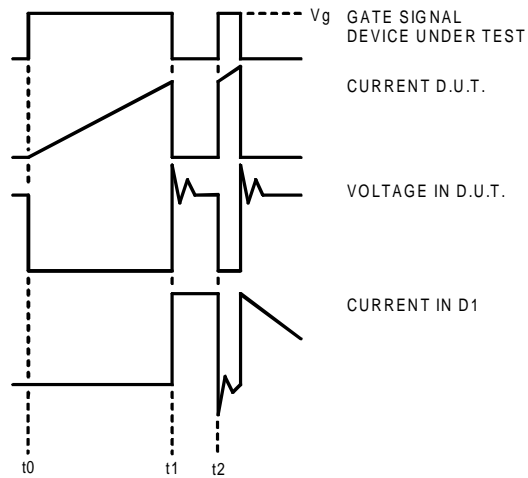


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

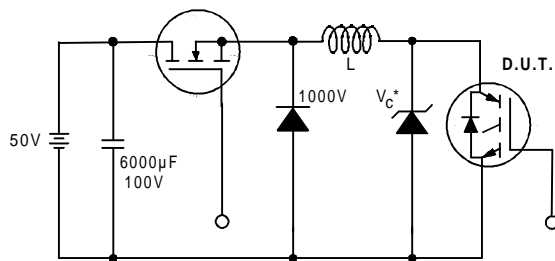


Figure 19. Clamped Inductive Load Test Circuit

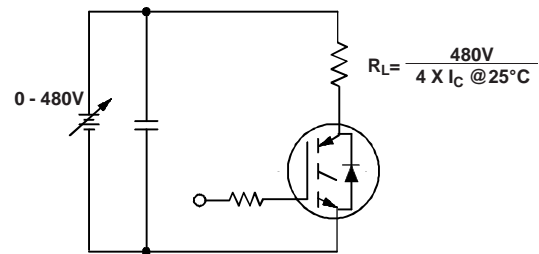


Figure 20. Pulsed Collector Current Test Circuit

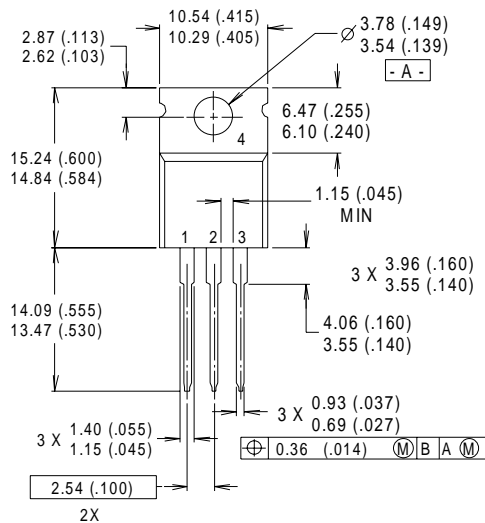
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## Notes:

- 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.

## Case Outline — TO-220AB



- NOTES:
- 1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
  - 2 CONTROLLING DIMENSION : INCH.
  - 3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
  - 4 CONFORMS TO JEDEC OUTLINE TO-220AB.

- LEAD ASSIGNMENTS
- 1 - GATE
  - 2 - COLLECTOR
  - 3 - EMITTER
  - 4 - COLLECTOR

## CONFORMS TO JEDEC OUTLINE TO-220AB

Dimensions in Millimeters and (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.

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**IR** Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

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