

# International **IR** Rectifier

PD -94910A

## IRG4BC30KDPbF

INSULATED GATE BIPOLEAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

### Features

- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ , @360V  $V_{CE}$  (start),  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes
- Lead-Free

### Benefits

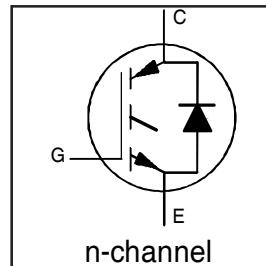
- Latest generation 4 IGBTs offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- This part replaces the IRGBC30KD2 and IRGBC30MD2 products
- For hints see design tip 97003

### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	28	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	16	
$I_{CM}$	Pulsed Collector Current ①	56	
$I_{LM}$	Clamped Inductive Load Current ②	56	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	12	
$I_{FM}$	Diode Maximum Forward Current	58	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu s$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	100	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	42	
$T_J$	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	Min.	Typ.	Max.	Units
$R_{0JC}$	Junction-to-Case - IGBT	—	—	1.2	$^\circ C/W$
$R_{0JC}$	Junction-to-Case - Diode	—	—	2.5	
$R_{0CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{0JA}$	Junction-to-Ambient, typical socket mount	—	—	80	
Wt	Weight	—	2 (0.07)	—	g (oz)



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 2.21V$ $@V_{GE} = 15V, I_C = 16A$



# IRG4BC30KDPbF

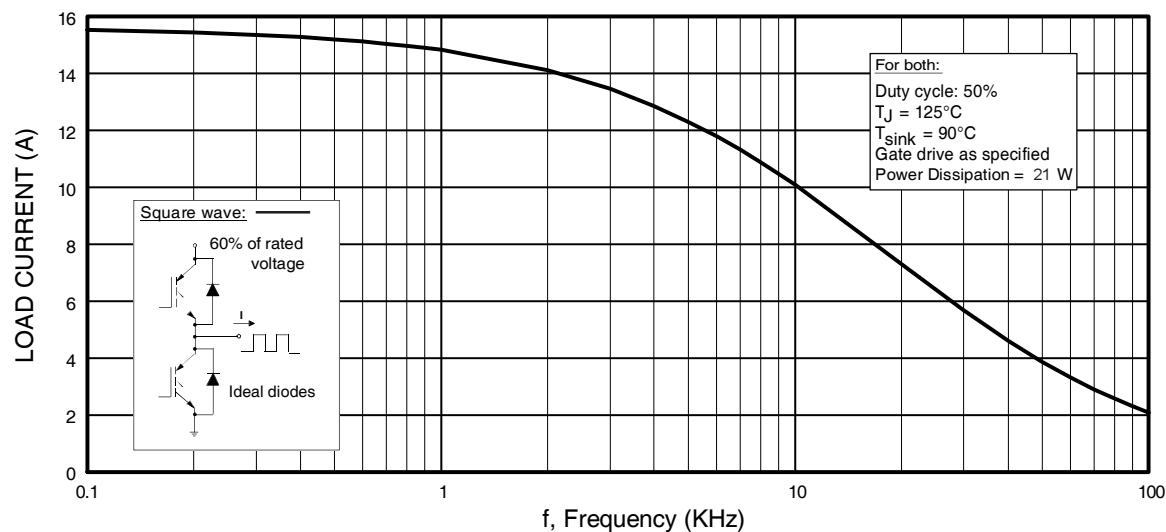
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## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

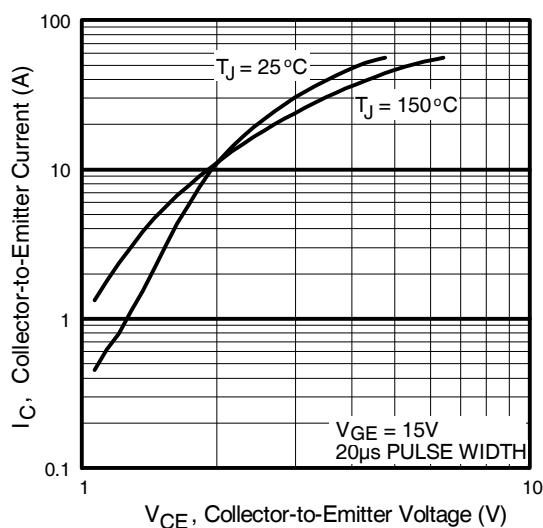
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{CES}}$	Collector-to-Emitter Breakdown Voltage③	600	—	—	V	$V_{\text{GE}} = 0\text{V}$ , $I_C = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{CES}/\Delta T_J}$	Temperature Coeff. of Breakdown Voltage	—	0.54	—	$\text{V}^\circ\text{C}$	$V_{\text{GE}} = 0\text{V}$ , $I_C = 1.0\text{mA}$
$V_{\text{CE}(\text{on})}$	Collector-to-Emitter Saturation Voltage	—	2.21	2.7	V	$I_C = 16\text{A}$ $V_{\text{GE}} = 15\text{V}$
		—	2.88	—		$I_C = 28\text{A}$ See Fig. 2, 5
		—	2.36	—		$I_C = 16\text{A}$ , $T_J = 150^\circ\text{C}$
$V_{\text{GE}(\text{th})}$	Gate Threshold Voltage	3.0	—	6.0		$V_{\text{CE}} = V_{\text{GE}}$ , $I_C = 250\mu\text{A}$
$\Delta V_{\text{GE}(\text{th})/\Delta T_J}$	Temperature Coeff. of Threshold Voltage	—	-12	—	$\text{mV}^\circ\text{C}$	$V_{\text{CE}} = V_{\text{GE}}$ , $I_C = 250\mu\text{A}$
$g_{\text{fe}}$	Forward Transconductance ④	5.4	8.1	—	S	$V_{\text{CE}} = 100\text{V}$ , $I_C = 16\text{A}$
$I_{\text{CES}}$	Zero Gate Voltage Collector Current	—	—	250	$\mu\text{A}$	$V_{\text{GE}} = 0\text{V}$ , $V_{\text{CE}} = 600\text{V}$
		—	—	2500		$V_{\text{GE}} = 0\text{V}$ , $V_{\text{CE}} = 600\text{V}$ , $T_J = 150^\circ\text{C}$
$V_{\text{FM}}$	Diode Forward Voltage Drop	—	1.4	1.7	V	$I_C = 12\text{A}$ See Fig. 13
		—	1.3	1.6		$I_C = 12\text{A}$ , $T_J = 150^\circ\text{C}$
$I_{\text{GES}}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{\text{GE}} = \pm 20\text{V}$

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

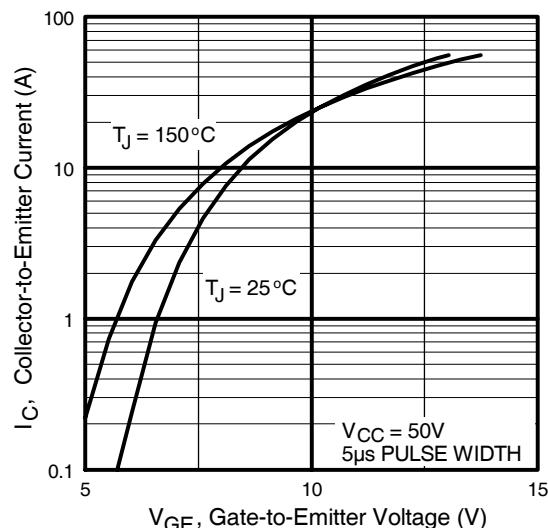
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	67	100	nC	$I_C = 16\text{A}$
$Q_{\text{ge}}$	Gate - Emitter Charge (turn-on)	—	11	16		$V_{\text{CC}} = 400\text{V}$ See Fig.8
$Q_{\text{gc}}$	Gate - Collector Charge (turn-on)	—	25	37		$V_{\text{GE}} = 15\text{V}$
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	60	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 16\text{A}$ , $V_{\text{CC}} = 480\text{V}$ $V_{\text{GE}} = 15\text{V}$ Energy losses include "tail" and diode reverse recovery See Fig. 9,10,14
$t_r$	Rise Time	—	42	—		
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	160	250		
$t_f$	Fall Time	—	80	120		
$E_{\text{on}}$	Turn-On Switching Loss	—	0.60	—	mJ	$V_{\text{CC}} = 360\text{V}$ , $T_J = 125^\circ\text{C}$ $V_{\text{GE}} = 15\text{V}$ , $R_G = 10\Omega$ , $V_{\text{CPK}} < 500\text{V}$
$E_{\text{off}}$	Turn-Off Switching Loss	—	0.58	—		
$E_{\text{ts}}$	Total Switching Loss	—	1.18	1.6		
$t_{\text{sc}}$	Short Circuit Withstand Time	10	—	—	$\mu\text{s}$	$T_J = 150^\circ\text{C}$ , See Fig. 11,14 $I_C = 16\text{A}$ , $V_{\text{CC}} = 480\text{V}$ $V_{\text{GE}} = 15\text{V}$ , $R_G = 23\Omega$ Energy losses include "tail" and diode reverse recovery
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	58	—		
$t_r$	Rise Time	—	42	—		
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	210	—		
$t_f$	Fall Time	—	160	—	mJ	Measured 5mm from package
$E_{\text{ts}}$	Total Switching Loss	—	1.69	—		
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	
$C_{\text{ies}}$	Input Capacitance	—	920	—	pF	$V_{\text{GE}} = 0\text{V}$ $V_{\text{CC}} = 30\text{V}$ See Fig. 7 $f = 1.0\text{MHz}$
$C_{\text{oes}}$	Output Capacitance	—	110	—		
$C_{\text{res}}$	Reverse Transfer Capacitance	—	27	—		
$t_{\text{rr}}$	Diode Reverse Recovery Time	—	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig.
		—	80	120		$T_J = 125^\circ\text{C}$ 14
$I_{\text{rr}}$	Diode Peak Reverse Recovery Current	—	3.5	6.0	A	$T_J = 25^\circ\text{C}$ See Fig.
		—	5.6	10		$T_J = 125^\circ\text{C}$ 15
$Q_{\text{rr}}$	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig.
		—	220	600		$T_J = 125^\circ\text{C}$ 16
$di_{(\text{rec})M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	180	—	A/ $\mu\text{s}$	$T_J = 25^\circ\text{C}$ See Fig.
		—	160	—		$T_J = 125^\circ\text{C}$ 17



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



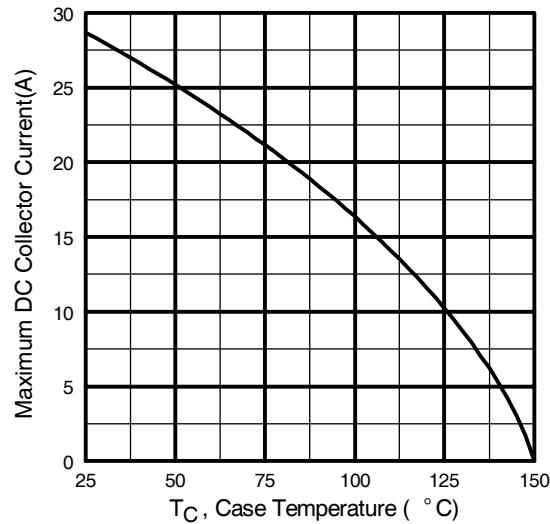
**Fig. 2 - Typical Output Characteristics**



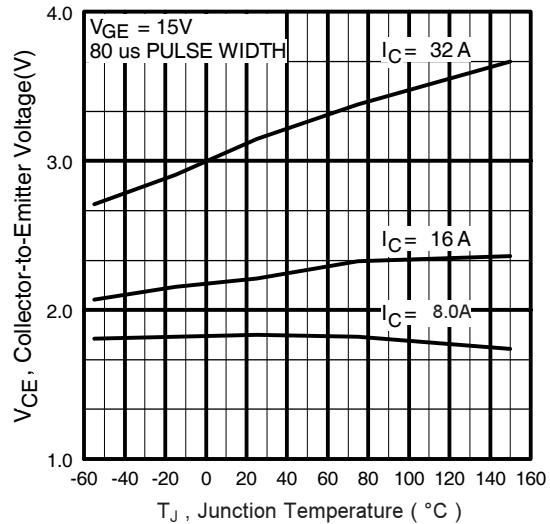
**Fig. 3 - Typical Transfer Characteristics**

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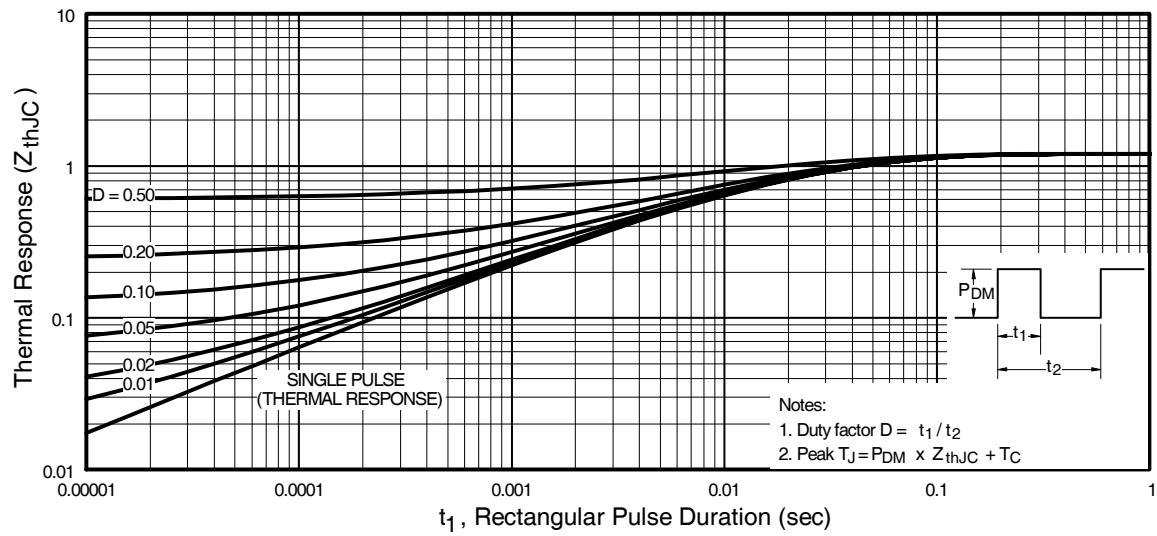
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**Fig. 4 - Maximum Collector Current vs. Case Temperature**

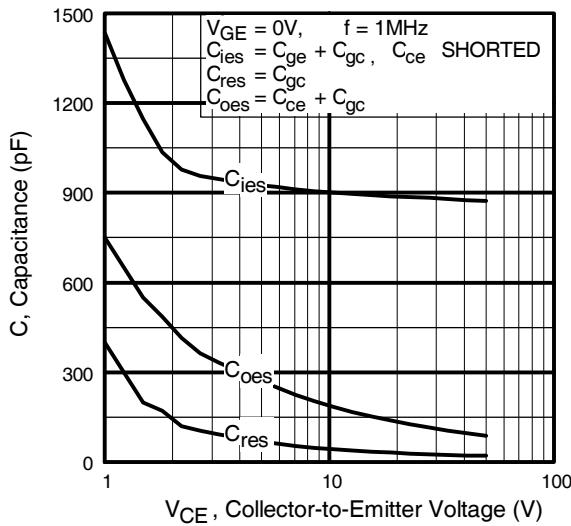


**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**

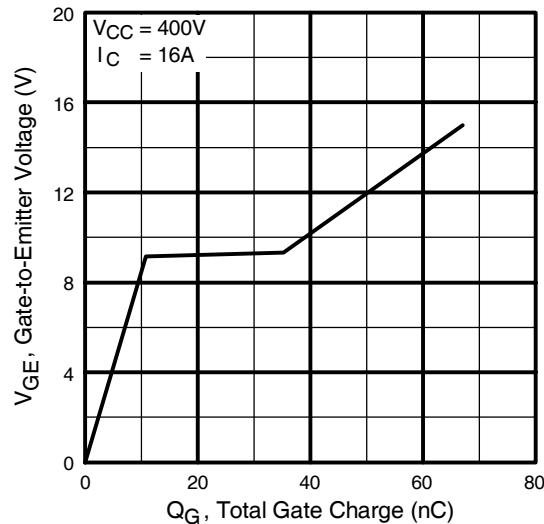


**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**

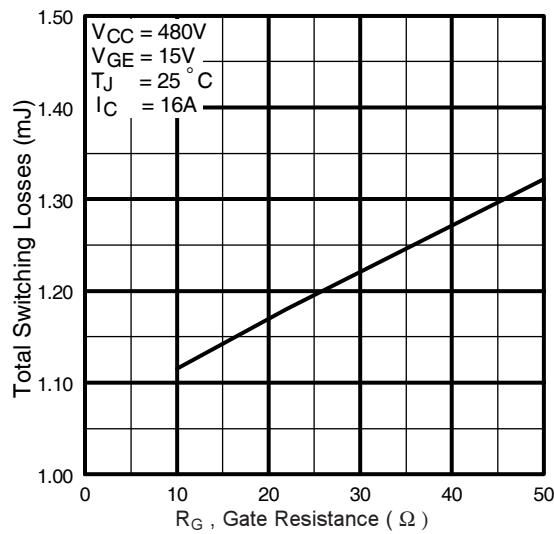
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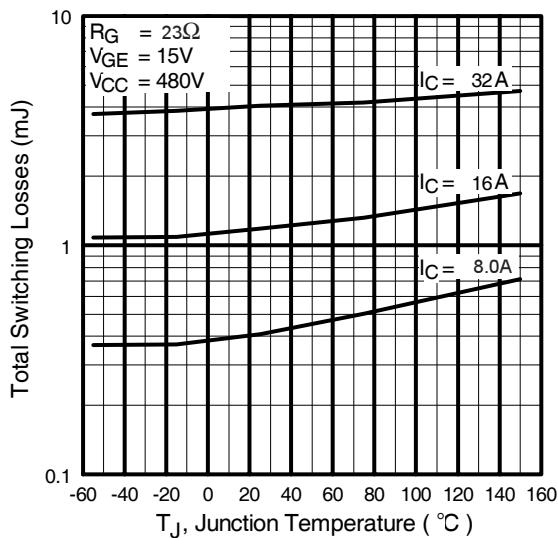
**Fig. 7 - Typical Capacitance vs.  
Collector-to-Emitter Voltage**



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



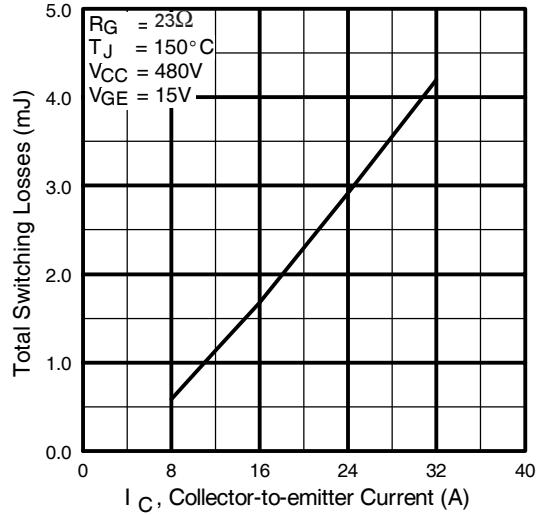
**Fig. 9 - Typical Switching Losses vs. Gate  
Resistance**



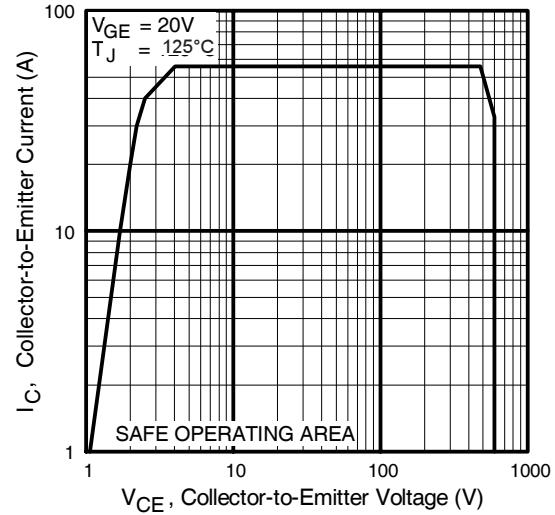
**Fig. 10 - Typical Switching Losses vs.  
Junction Temperature**

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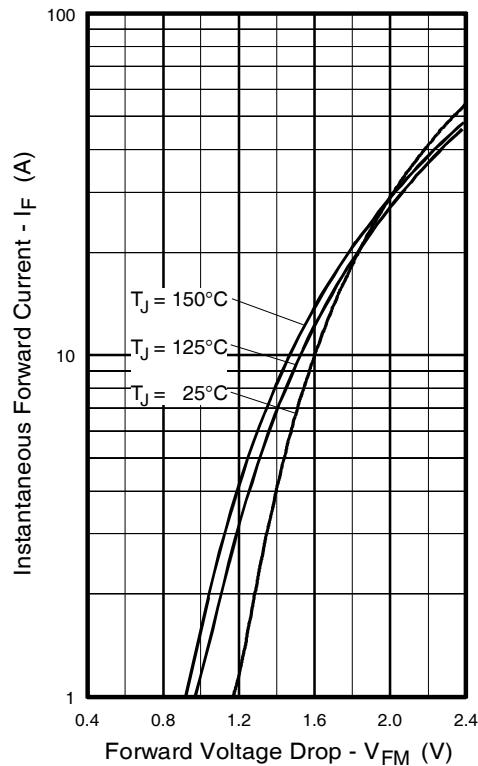
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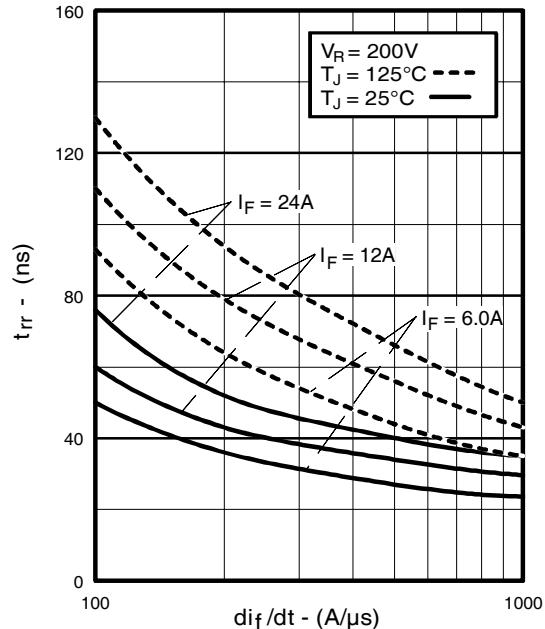
**Fig. 11 - Typical Switching Losses vs.  
Collector-to-Emitter Current**



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

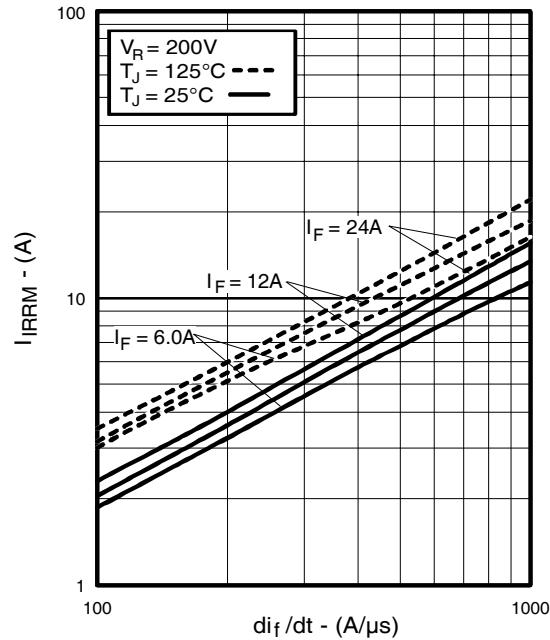


**Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current**

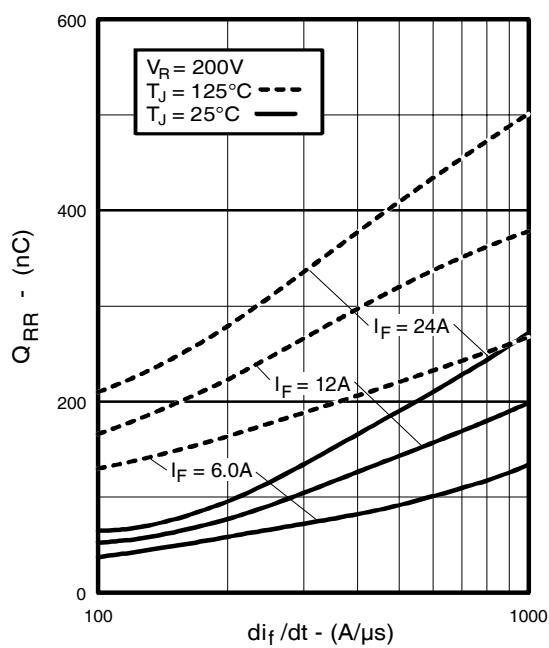


**Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$**

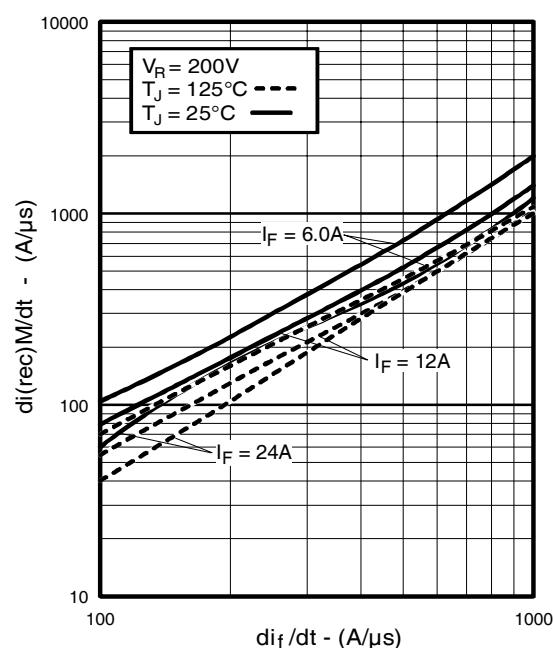
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**Fig. 15 - Typical Recovery Current vs.  $di_f/dt$**



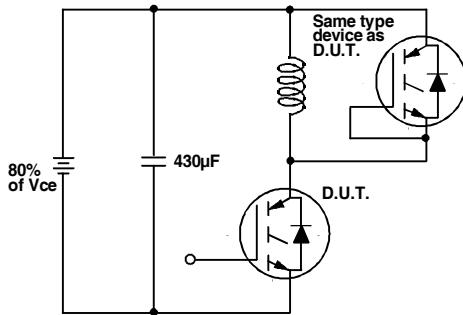
**Fig. 16 - Typical Stored Charge vs.  $di_f/dt$**



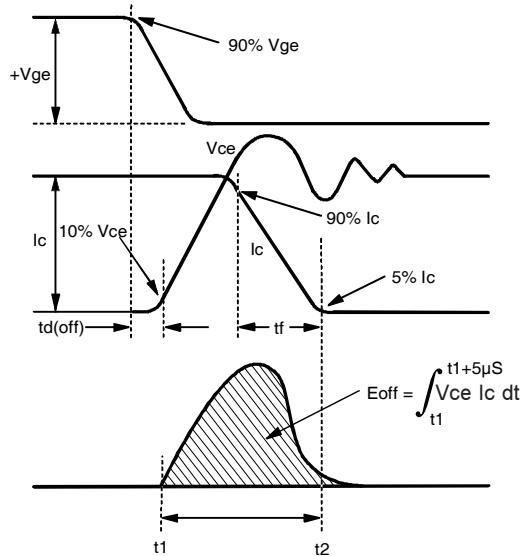
**Fig. 17 - Typical  $di_{(rec)}M/dt$  vs.  $di_f/dt$**

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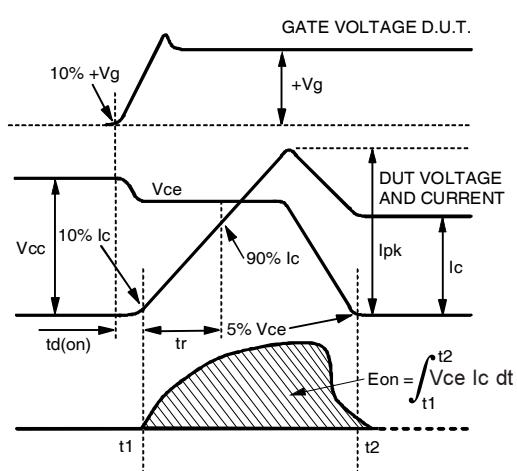
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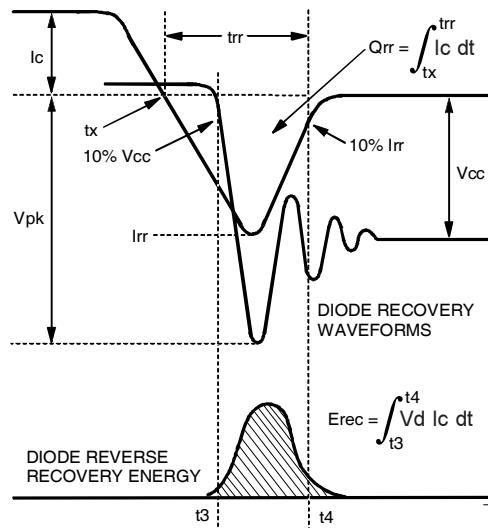
**Fig. 18a -** Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off(diode)}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

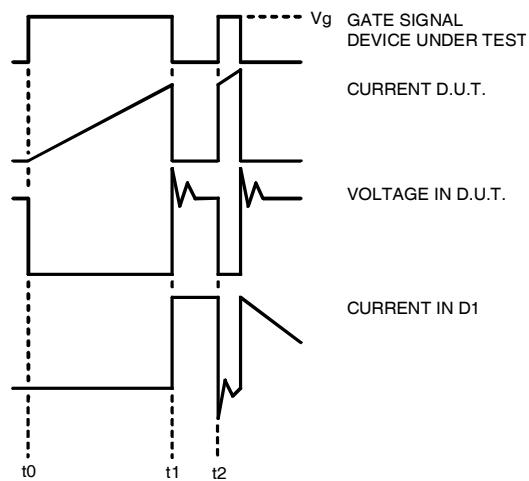


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

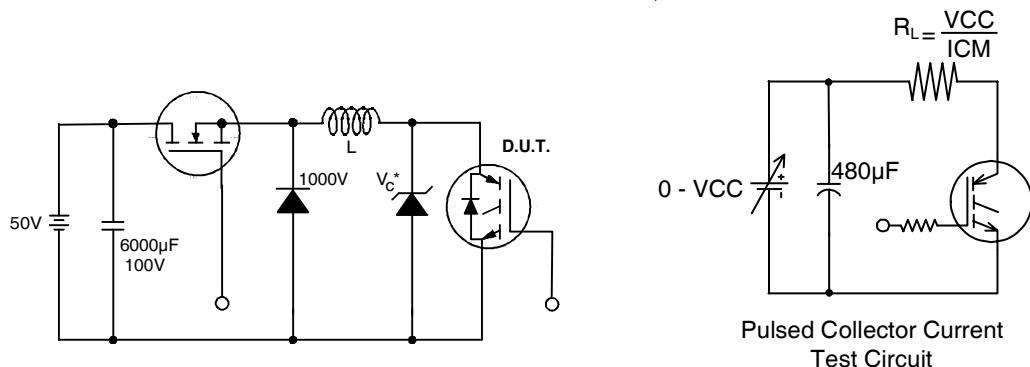


Figure 19. Clamped Inductive Load Test Circuit

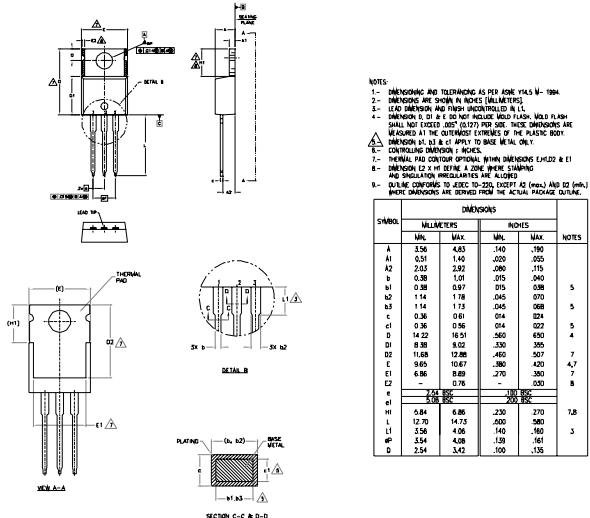
Figure 20. Pulsed Collector Current Test Circuit

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## Notes:

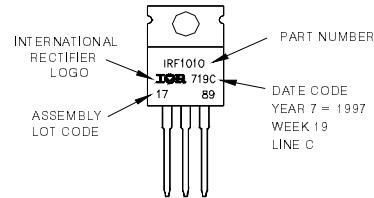
- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\% (V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=23\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

## TO-220AB Package Outline (Dimensions are shown in millimeters (inches))



## 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"



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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