

International **IR** Rectifier

INSULATED GATE BIPOLEAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

PD - 94905

IRG4BC10UDPbF

UltraFast CoPack IGBT

Features

- UltraFast: Optimized for high operating up to 80 kHz in hard switching, >200 kHz in resonant mode
- 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-220AB package
- Lead-Free

Benefits

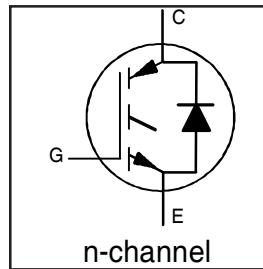
- Generation 4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's. Minimized recovery characteristics require less/no snubbing

Absolute Maximum Ratings

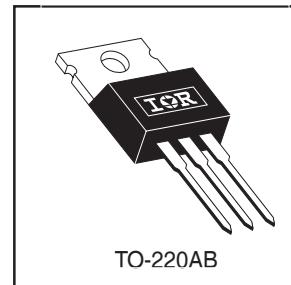
	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	8.5	
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	5.0	
I_{CM}	Pulsed Collector Current ①	34	A
I_{LM}	Clamped Inductive Load Current ②	34	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	4.0	
I_{FM}	Diode Maximum Forward Current	16	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	38	
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	15	W
T_J	Operating Junction and	-55 to +150	
T_{STG}	Storage Temperature Range		$^\circ C$
	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	—	—	3.3	
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	7.0	$^\circ C/W$
$R_{\theta CS}$	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)



$V_{CES} = 600V$
 $V_{CE(on)\text{ typ.}} = 2.15V$
 $@V_{GE} = 15V, I_C = 5.0A$
 $t_f(\text{typ.}) = 140ns$



IRG4BC10UDPbF

International
IR Rectifier

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 Voltage ^③	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	—	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	—	2.15	2.6	V	$I_C = 5.0\text{A}$ $V_{\text{GE}} = 15\text{V}$
		—	2.61	—		$I_C = 8.5\text{A}$ See Fig. 2, 5
		—	2.30	—		$I_C = 5.0\text{A}$, $T_J = 150^\circ\text{C}$
$V_{\text{GE}(\text{th})}$	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	—	-8.7	—	mV/ $^\circ\text{C}$	$V_{\text{CE}} = V_{\text{GE}}$, $I_C = 250\mu\text{A}$
g_{fe}	Forward Transconductance ^④	2.8	4.2	—	S	$V_{\text{CE}} = 100\text{V}$, $I_C = 5.0\text{A}$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{\text{GE}} = 0\text{V}$, $V_{\text{CE}} = 600\text{V}$
		—	—	1000		$V_{\text{GE}} = 0\text{V}$, $V_{\text{CE}} = 600\text{V}$, $T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.5	1.8	V	$I_C = 4.0\text{A}$ See Fig. 13
		—	1.4	1.7		$I_C = 4.0\text{A}$, $T_J = 125^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 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)	—	15	22	nC	$I_C = 5.0\text{A}$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	2.6	4.0		$V_{\text{CC}} = 400\text{V}$ See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	5.8	8.7		$V_{\text{GE}} = 15\text{V}$
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	40	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	16	—		$I_C = 5.0\text{A}$, $V_{\text{CC}} = 480\text{V}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	87	130		$V_{\text{GE}} = 15\text{V}$, $R_G = 100\Omega$
t_f	Fall Time	—	140	210		Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 18
E_{on}	Turn-On Switching Loss	—	0.14	—	mJ	
E_{off}	Turn-Off Switching Loss	—	0.12	—		
E_{ts}	Total Switching Loss	—	0.26	0.33		
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	38	—	ns	$T_J = 150^\circ\text{C}$, See Fig. 11, 18
t_r	Rise Time	—	18	—		$I_C = 5.0\text{A}$, $V_{\text{CC}} = 480\text{V}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	95	—		$V_{\text{GE}} = 15\text{V}$, $R_G = 100\Omega$
t_f	Fall Time	—	250	—		Energy losses include "tail" and diode reverse recovery.
E_{ts}	Total Switching Loss	—	0.45	—	mJ	
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	270	—	pF	$V_{\text{GE}} = 0\text{V}$
C_{oes}	Output Capacitance	—	21	—		$V_{\text{CC}} = 30\text{V}$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	3.5	—		$f = 1.0\text{MHz}$
t_{rr}	Diode Reverse Recovery Time	—	28	42	ns	$T_J = 25^\circ\text{C}$ See Fig.
		—	38	57		$T_J = 125^\circ\text{C}$ 14
I_{rr}	Diode Peak Reverse Recovery Current	—	2.9	5.2	A	$T_J = 25^\circ\text{C}$ See Fig.
		—	3.7	6.7		$T_J = 125^\circ\text{C}$ 15
Q_{rr}	Diode Reverse Recovery Charge	—	40	60	nC	$T_J = 25^\circ\text{C}$ See Fig.
		—	70	105		$T_J = 125^\circ\text{C}$ 16
$di_{(\text{rec})M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	280	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig.
		—	235	—		$T_J = 125^\circ\text{C}$ 17

Details of note ① through ④ are on the last page

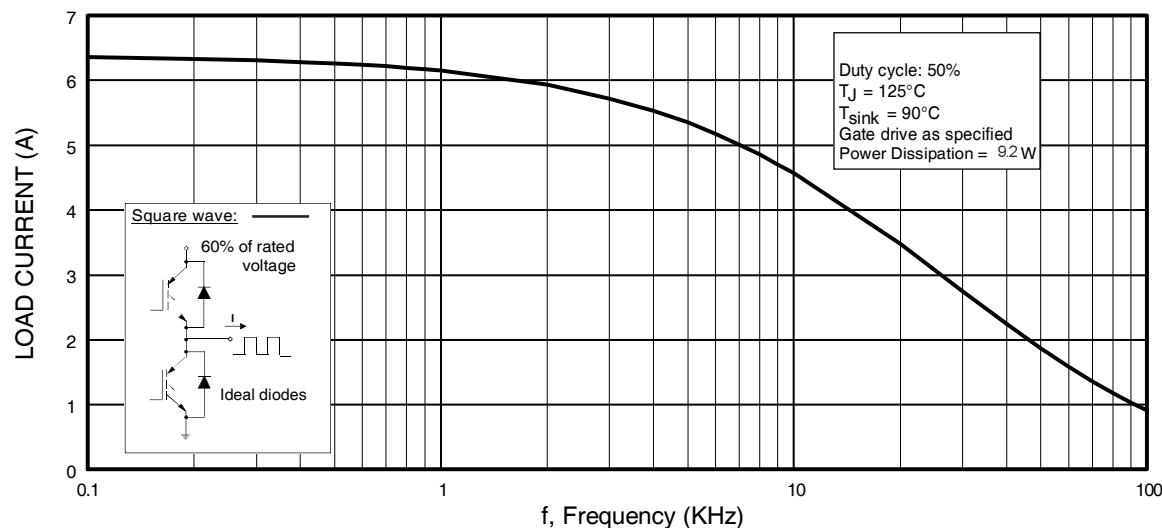


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

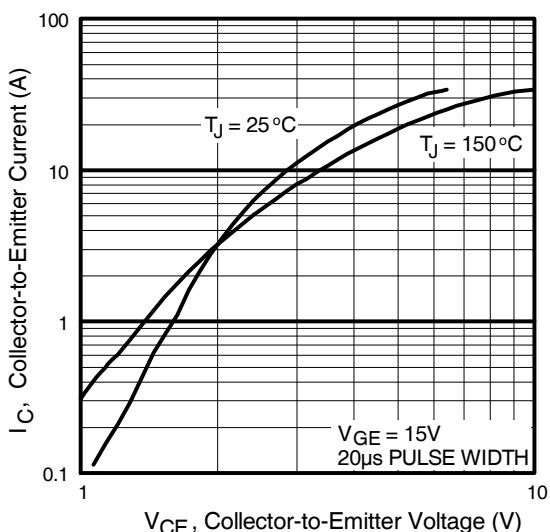


Fig. 2 - Typical Output Characteristics
www.irf.com

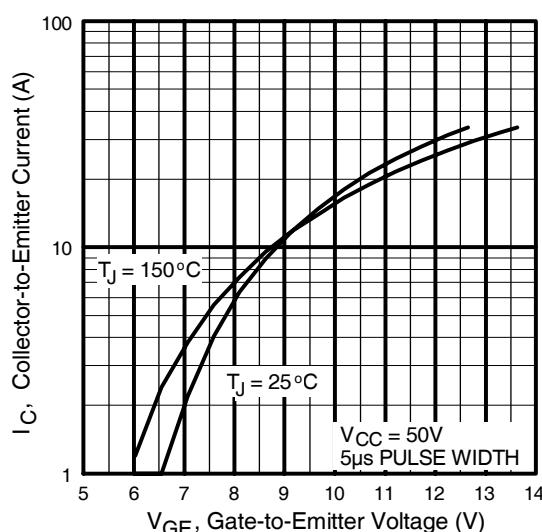


Fig. 3 - Typical Transfer Characteristics

IRG4BC10UDPbF

International
IR Rectifier

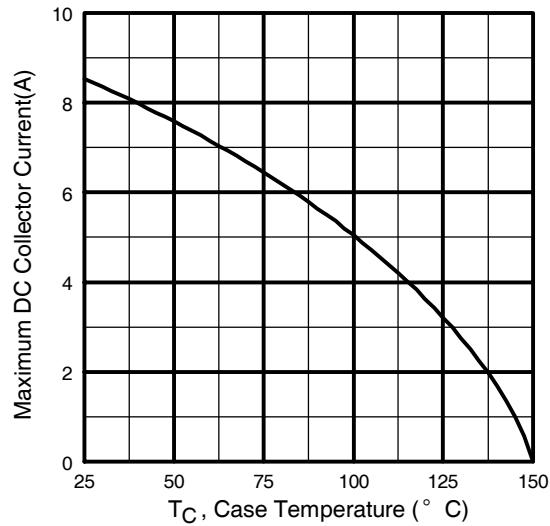


Fig. 4 - Maximum Collector Current vs. Case Temperature

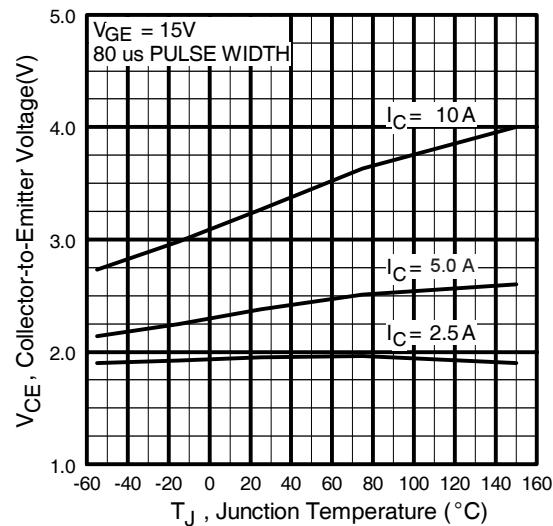


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

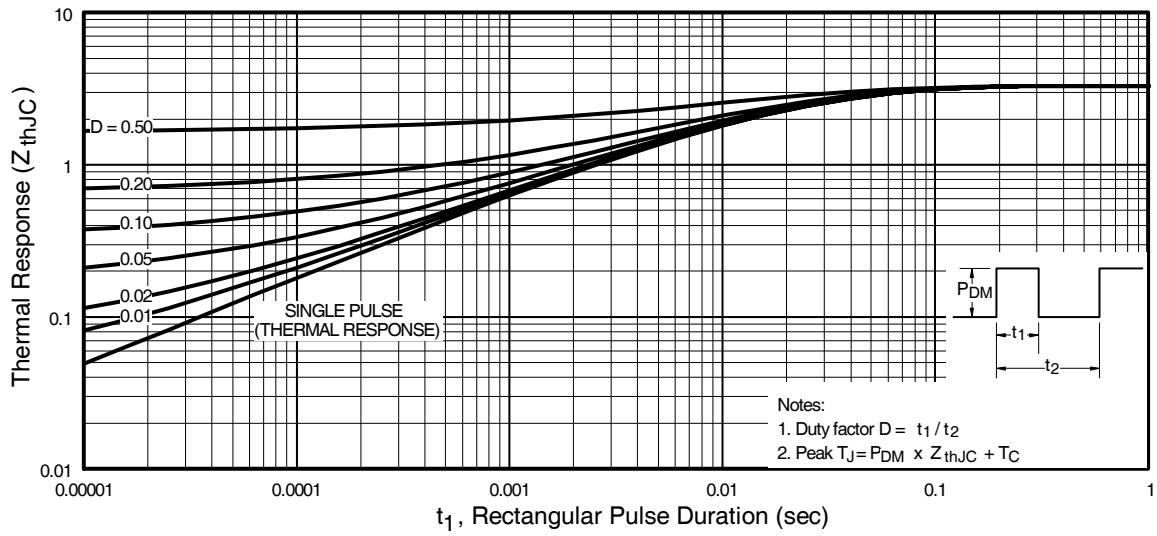


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRG4BC10UDPbF

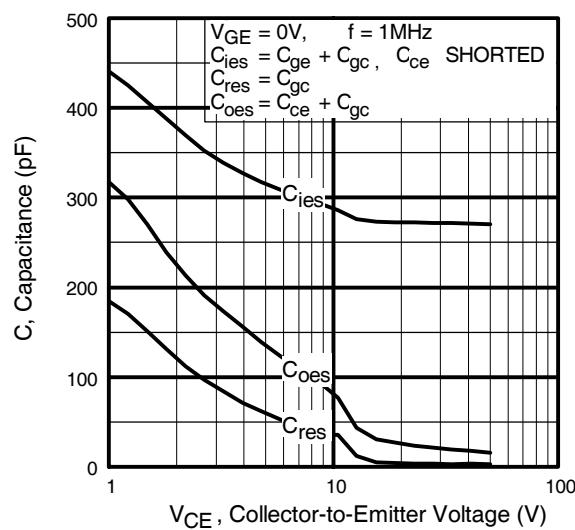


Fig. 7 - Typical Capacitance vs.
Collector-to-Emitter Voltage

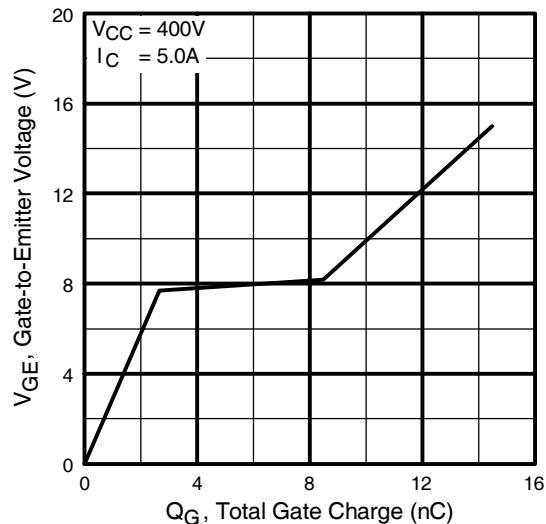


Fig. 8 - Typical Gate Charge vs.
Gate-to-Emitter Voltage

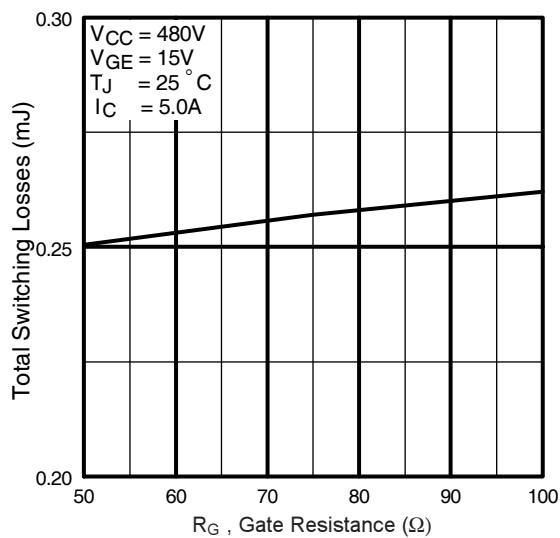


Fig. 9 - Typical Switching Losses vs. Gate
Resistance

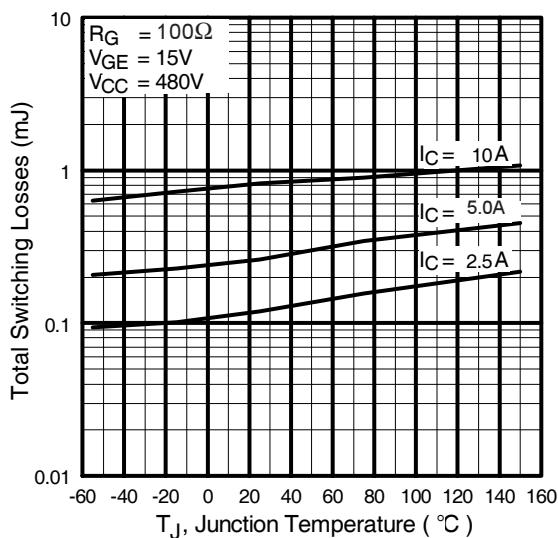


Fig. 10 - Typical Switching Losses vs.
Junction Temperature

IRG4BC10UDPbF

International
IR Rectifier

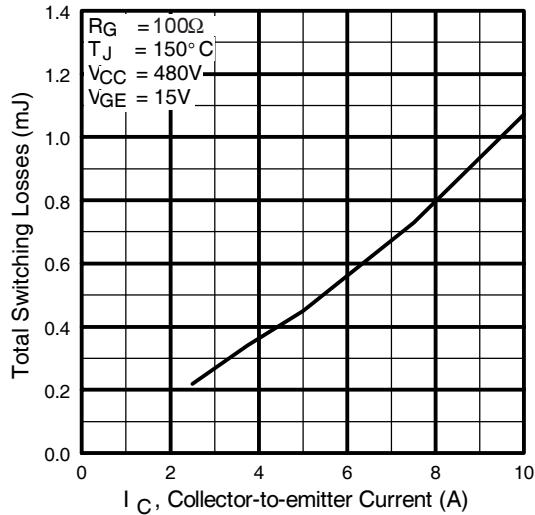


Fig. 11 - Typical Switching Losses vs.
Collector-to-Emitter Current

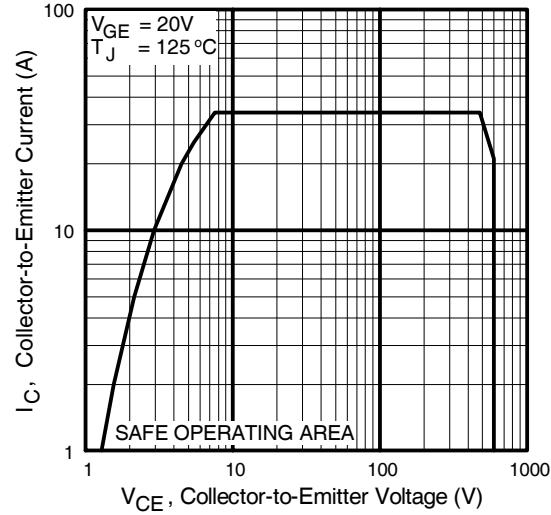


Fig. 12 - Turn-Off SOA

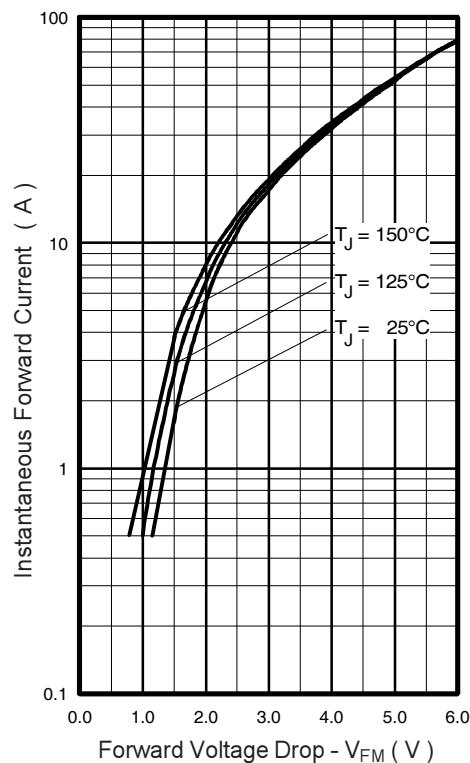


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

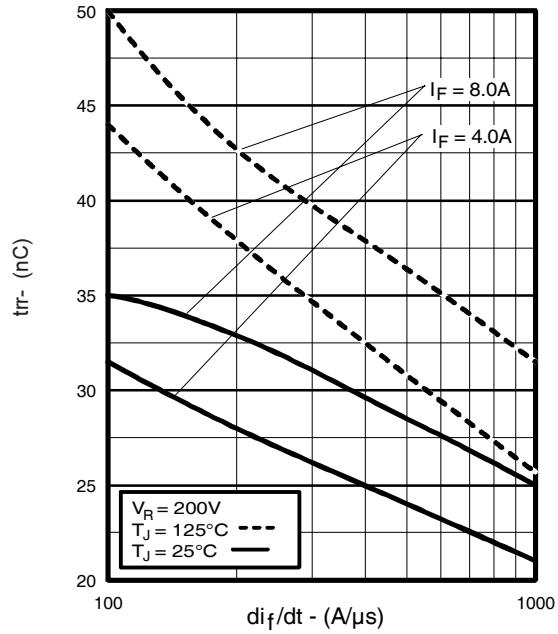


Fig. 14 - Typical Reverse Recovery vs. $\frac{di_f}{dt}$

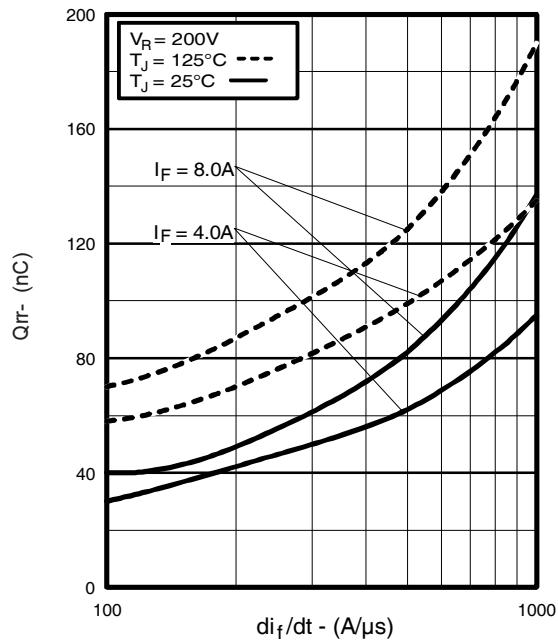


Fig. 16 - Typical Stored Charge vs. $\frac{di_f}{dt}$

IRG4BC10UDPbF

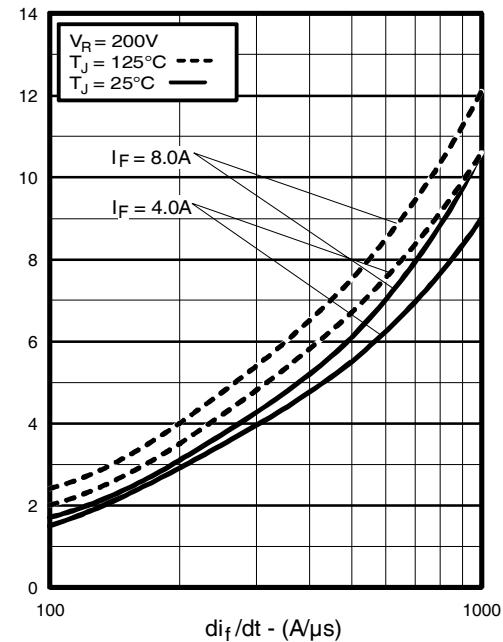


Fig. 15 - Typical Recovery Current vs. $\frac{di_f}{dt}$

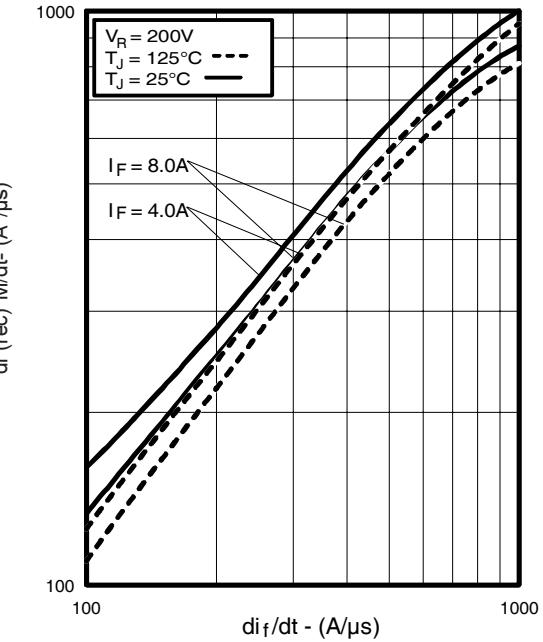


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. $\frac{di_f}{dt}$,

IRG4BC10UDPbF

International
IR Rectifier

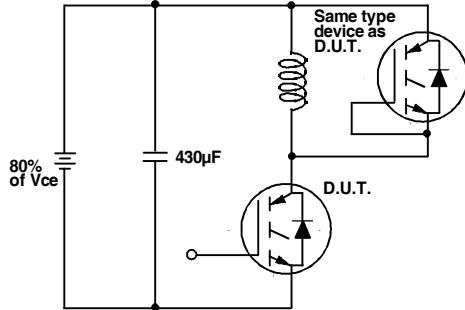


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off(diode)}$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, $t_{d(off)}$, t_f

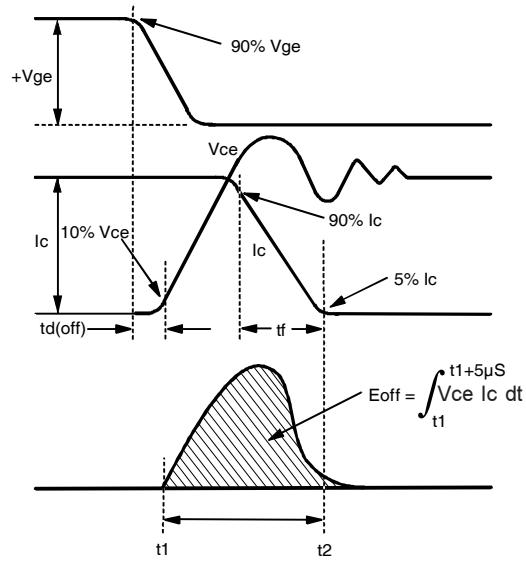


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

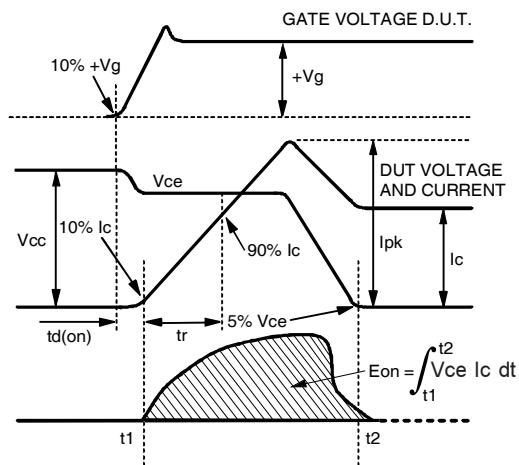


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

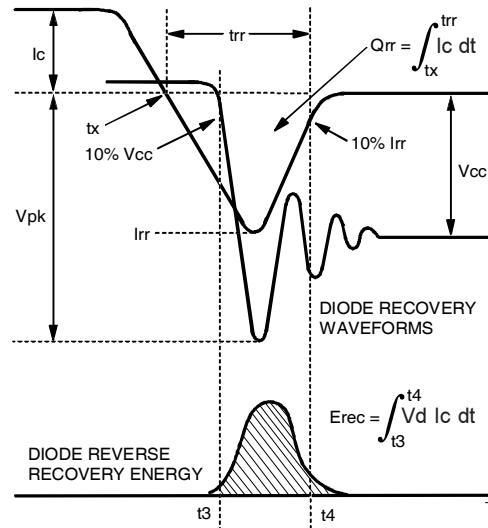


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

IRG4BC10UDPbF

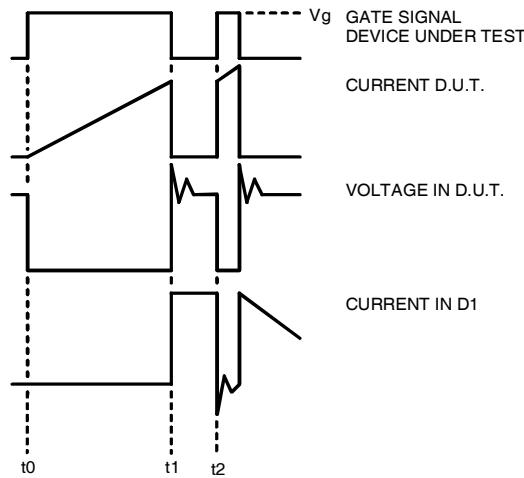


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

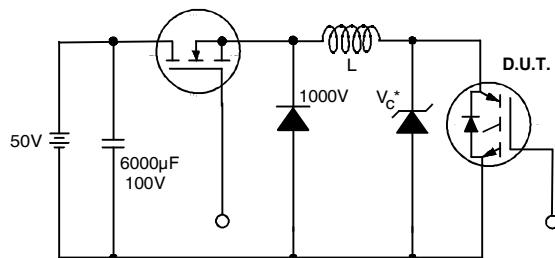


Figure 19. Clamped Inductive Load Test Circuit

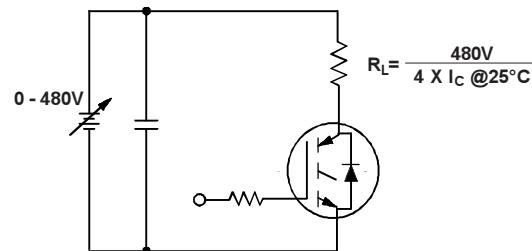


Figure 20. Pulsed Collector Current Test Circuit

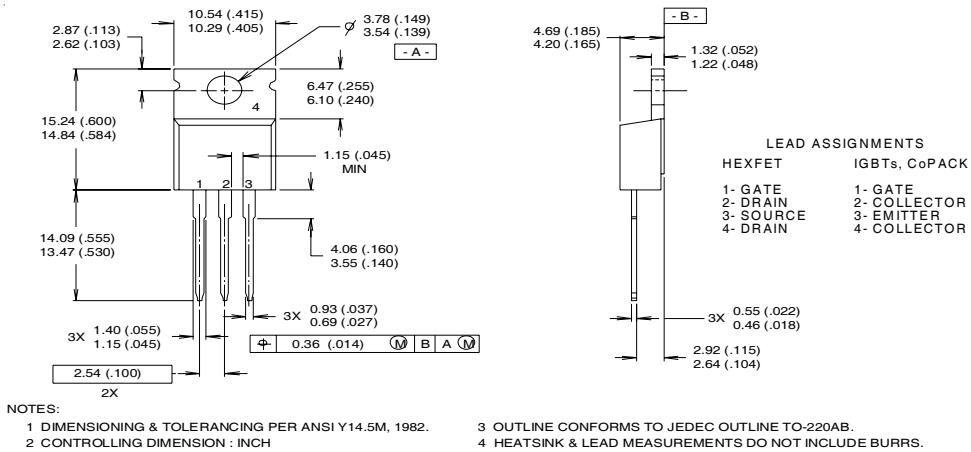
IRG4BC10UDPbF

International
IR Rectifier

Notes:

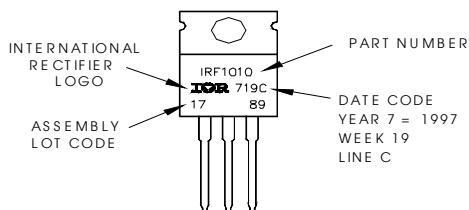
- ① Repetitive rating: $V_{GE}=20V$; pulse width limited by maximum junction temperature (figure 20)
- ② $V_{CC}=80\% (V_{CES})$, $V_{GE}=20V$, $L=10\mu H$, $R_G = 100\Omega$ (figure 19)
- ③ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ④ Pulse width $5.0\mu s$, single shot.

TO-220AB Package Outline



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"



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 for sales contact information.
Data and specifications subject to change without notice. 12/03

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