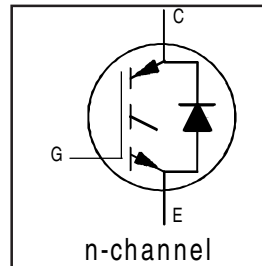


IRG4PH40UD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE UltraFast CoPack IGBT

Features

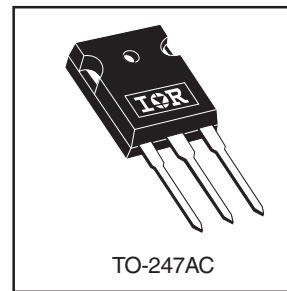
- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package



$V_{CES} = 1200V$
 $V_{CE(on) typ.} = 2.43V$
 @ $V_{GE} = 15V, I_C = 21A$

Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- 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 Breakdown Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	41	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	21	
I_{CM}	Pulsed Collector Current ①	82	
I_{LM}	Clamped Inductive Load Current ②	82	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	8.0	
I_{FM}	Diode Maximum Forward Current	130	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
T_J	Operating Junction and Storage Temperature Range	-55 to + 150	$^\circ C$
T_{STG}			
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.77	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	1.7	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	40	
Wt	Weight	—	6 (0.21)	—	g (oz)

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
V _{(BR)CES}	Collector-to-Emitter Breakdown Voltage ^③	1200	—	—	V	V _{GE} = 0V, I _C = 250μA
ΔV _{(BR)CES} /ΔT _J	Temperature Coeff. of Breakdown Voltage	—	0.43	—	V/°C	V _{GE} = 0V, I _C = 1.0mA
V _{CE(on)}	Collector-to-Emitter Saturation Voltage	—	2.43	3.1	V	I _C = 21A I _C = 41A I _C = 21A, T _J = 150°C V _{GE} = 15V See Fig. 2, 5
		—	2.97	—		
		—	2.47	—		
V _{GE(th)}	Gate Threshold Voltage	3.0	—	6.0		V _{CE} = V _{GE} , I _C = 250μA
ΔV _{GE(th)} /ΔT _J	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V _{CE} = V _{GE} , I _C = 250μA
g _{fe}	Forward Transconductance ^④	16	24	—	S	V _{CE} = 100V, I _C = 21A
I _{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	V _{GE} = 0V, V _{CE} = 600V
		—	—	5000		V _{GE} = 0V, V _{CE} = 600V, T _J = 150°C
V _{FM}	Diode Forward Voltage Drop	—	2.6	3.3	V	I _C = 8.0A I _C = 8.0A, T _J = 125°C See Fig. 13
		—	2.4	3.1		
I _{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V _{GE} = ±20V

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q _g	Total Gate Charge (turn-on)	—	86	130	nC	I _C = 21A V _{CC} = 400V V _{GE} = 15V See Fig. 8
Q _{ge}	Gate - Emitter Charge (turn-on)	—	13	20		
Q _{gc}	Gate - Collector Charge (turn-on)	—	29	44		
t _{d(on)}	Turn-On Delay Time	—	46	—	ns	T _J = 25°C I _C = 21A, V _{CC} = 800V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 18
t _r	Rise Time	—	35	—		
t _{d(off)}	Turn-Off Delay Time	—	97	150		
t _f	Fall Time	—	240	360	mJ	T _J = 150°C, See Fig. 11, 18 I _C = 21A, V _{CC} = 800V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery.
E _{on}	Turn-On Switching Loss	—	1.80	—		
E _{off}	Turn-Off Switching Loss	—	1.93	—		
E _{ts}	Total Switching Loss	—	3.73	4.6	mJ	T _J = 150°C, See Fig. 11, 18 I _C = 21A, V _{CC} = 800V V _{GE} = 15V, R _G = 10Ω Energy losses include "tail" and diode reverse recovery.
t _{d(on)}	Turn-On Delay Time	—	42	—		
t _r	Rise Time	—	32	—		
t _{d(off)}	Turn-Off Delay Time	—	240	—	ns	T _J = 25°C T _J = 125°C T _J = 125°C T _J = 125°C See Fig. 14 See Fig. 15
t _f	Fall Time	—	510	—		
E _{ts}	Total Switching Loss	—	7.04	—		
L _E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C _{ies}	Input Capacitance	—	1800	—	pF	V _{GE} = 0V V _{CC} = 30V f = 1.0MHz See Fig. 7
C _{oes}	Output Capacitance	—	120	—		
C _{res}	Reverse Transfer Capacitance	—	18	—		
t _{rr}	Diode Reverse Recovery Time	—	63	95	ns	T _J = 25°C T _J = 125°C See Fig. 14 See Fig. 15
		—	106	160		
I _{rr}	Diode Peak Reverse Recovery Current	—	4.5	8.0	A	T _J = 25°C T _J = 125°C See Fig. 15
		—	6.2	11		
Q _{rr}	Diode Reverse Recovery Charge	—	140	380	nC	T _J = 25°C T _J = 125°C See Fig. 16
		—	335	880		
di _(rec) /dt	Diode Peak Rate of Fall of Recovery During t _b	—	133	—	A/μs	T _J = 25°C T _J = 125°C See Fig. 17
		—	85	—		

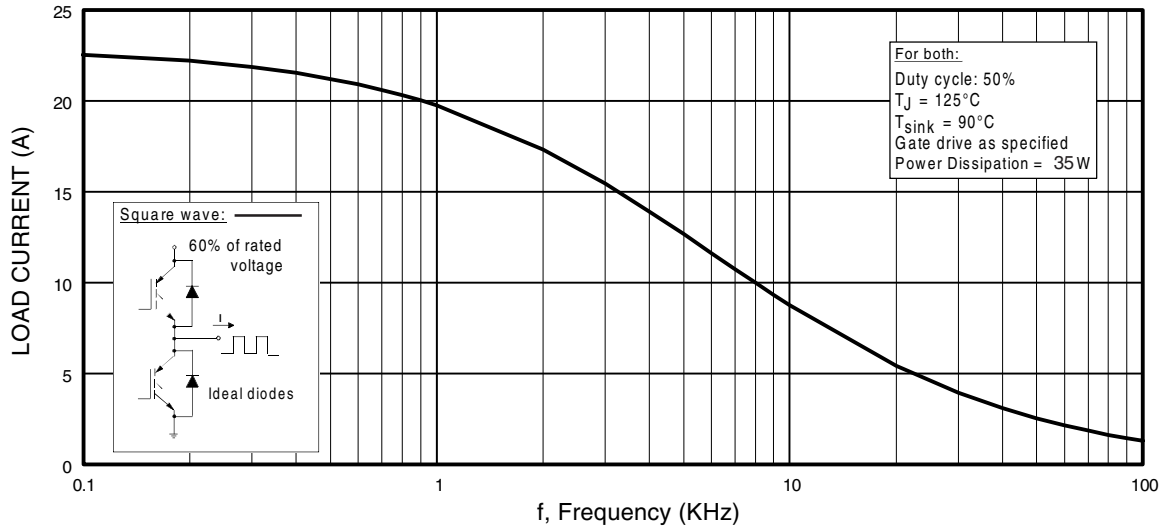


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

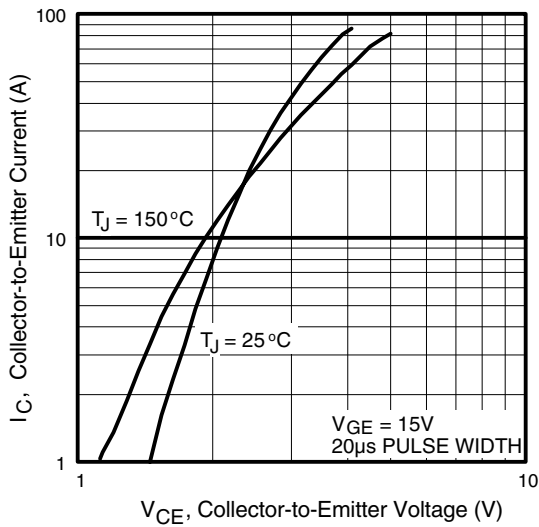


Fig. 2 - Typical Output Characteristics

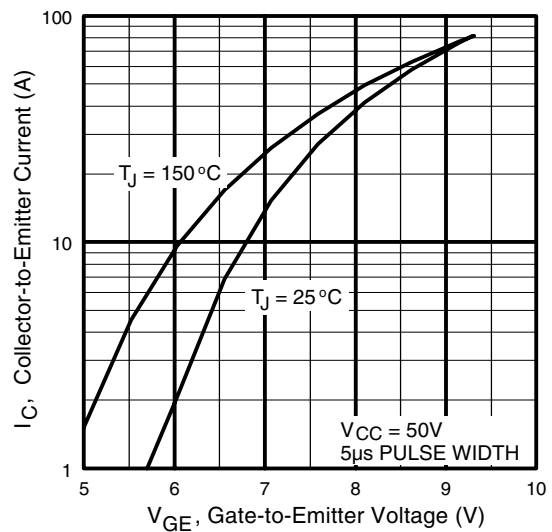


Fig. 3 - Typical Transfer Characteristics

IRG4PH40UD

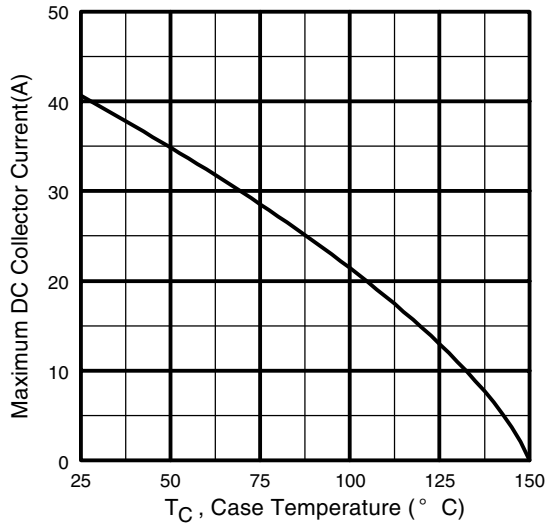


Fig. 4 - Maximum Collector Current vs. Case Temperature

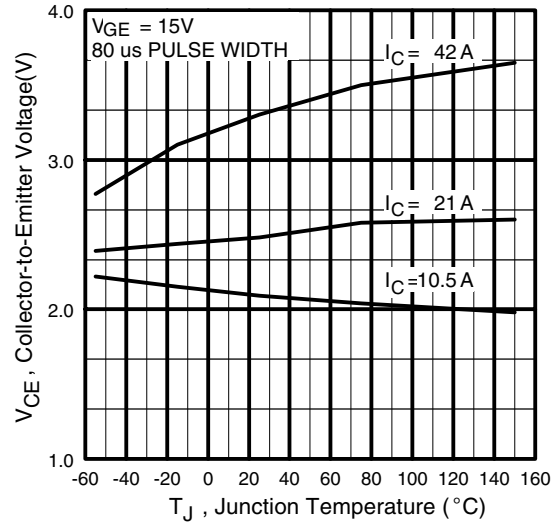


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

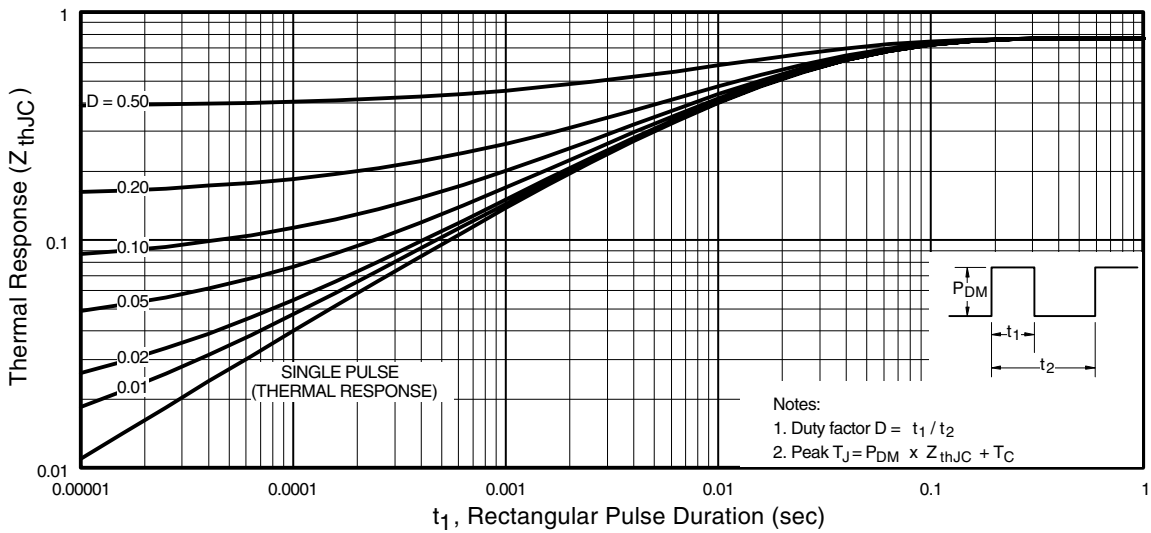


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

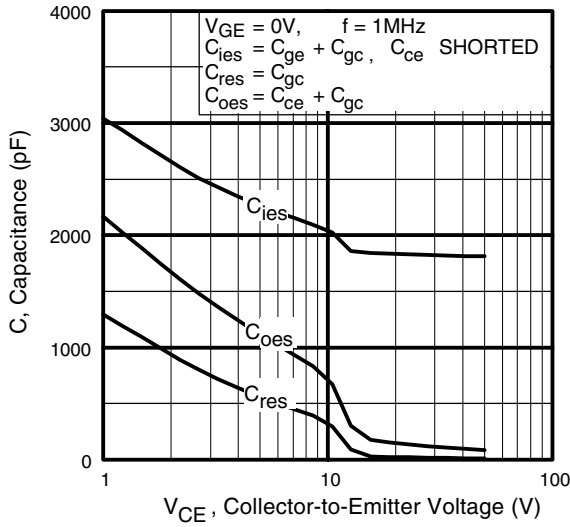


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

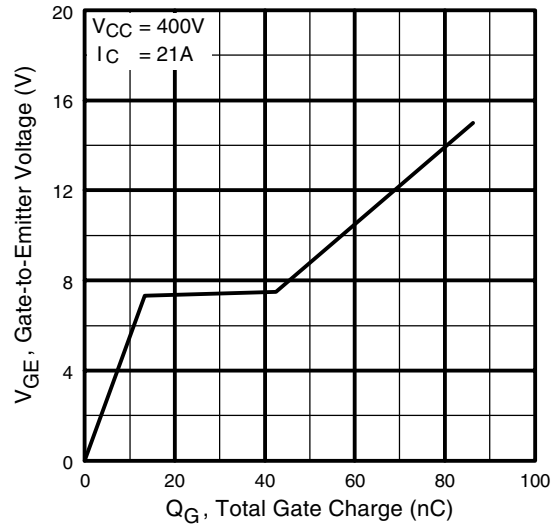


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

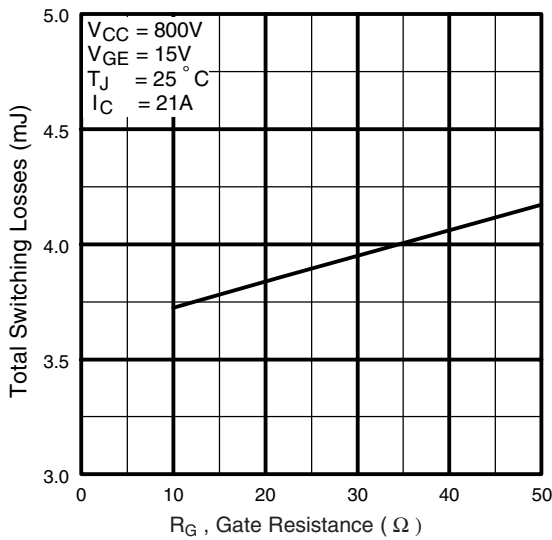


Fig. 9 - Typical Switching Losses vs. Gate Resistance

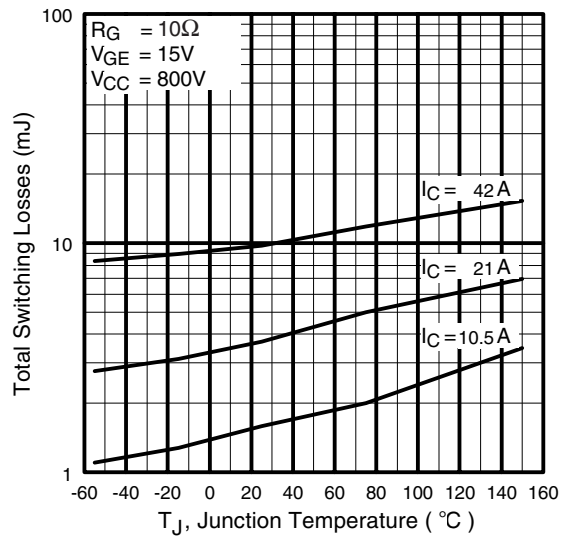


Fig. 10 - Typical Switching Losses vs. Junction Temperature

IRG4PH40UD

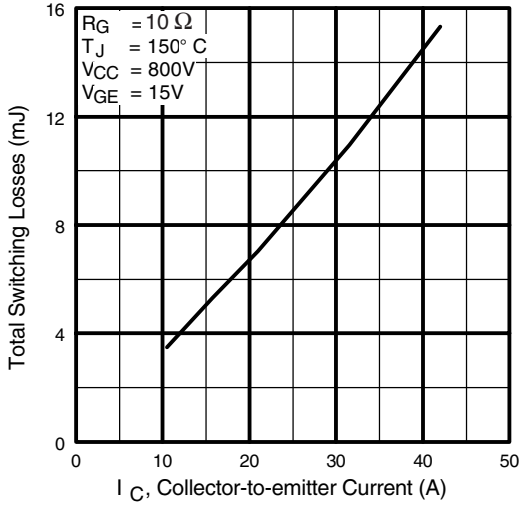


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

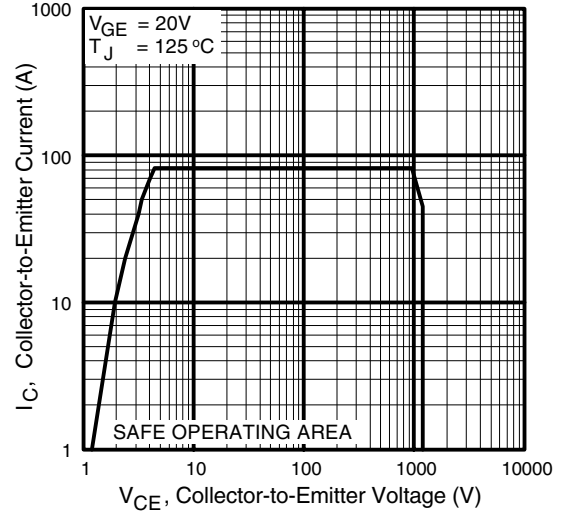


Fig. 12 - Turn-Off SOA

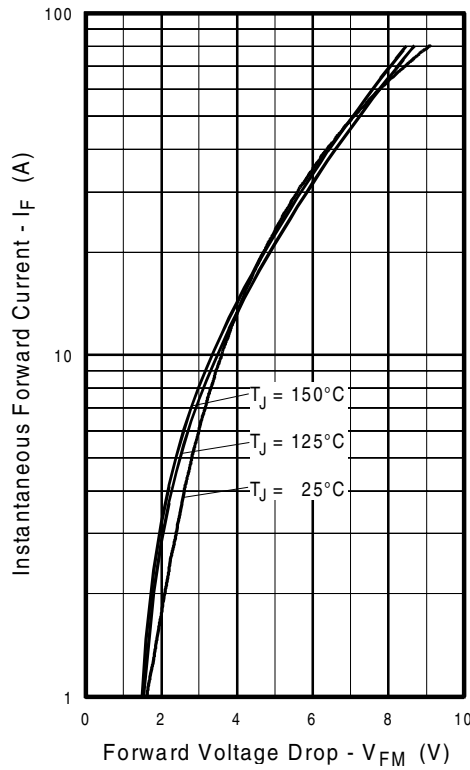


Fig. 13 - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

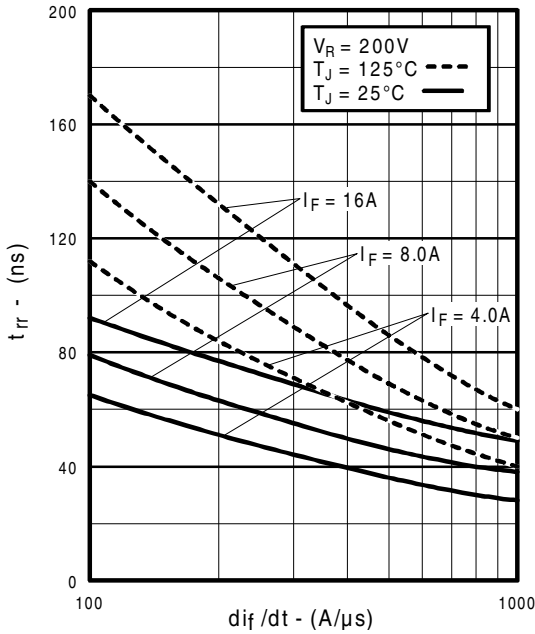


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

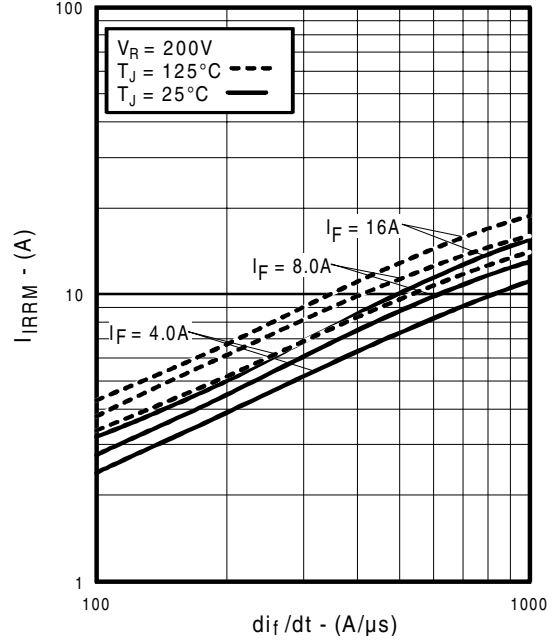


Fig. 15 - Typical Recovery Current vs. di_f/dt

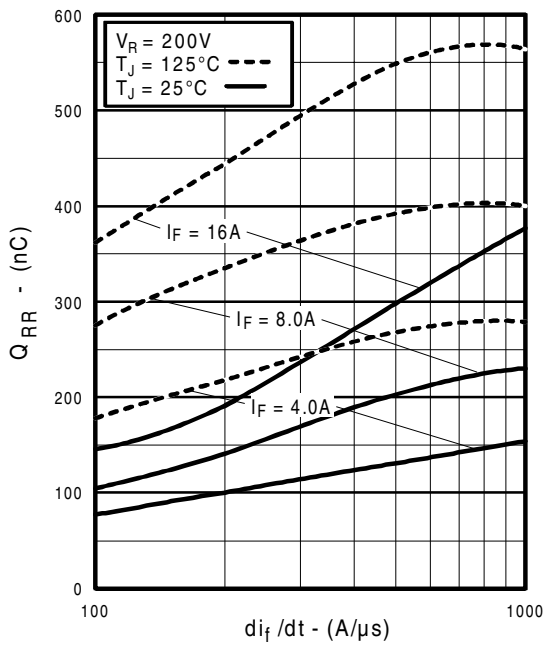


Fig. 16 - Typical Stored Charge vs. di_f/dt

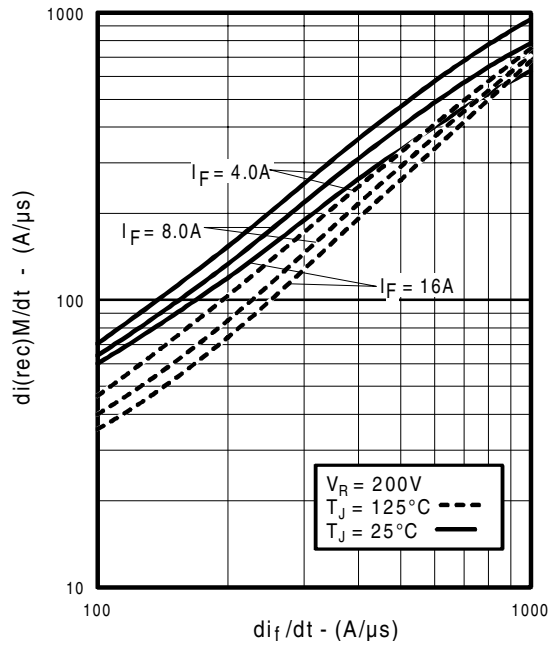


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

IRG4PH40UD

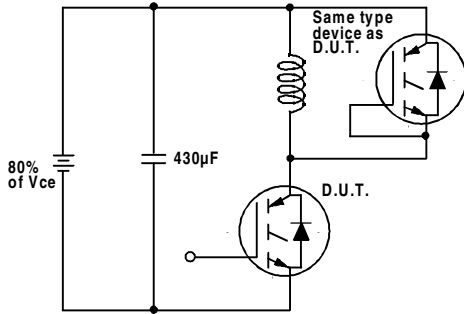


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

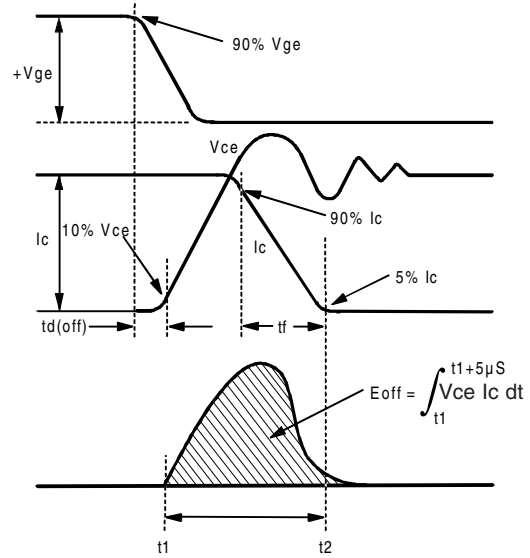


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

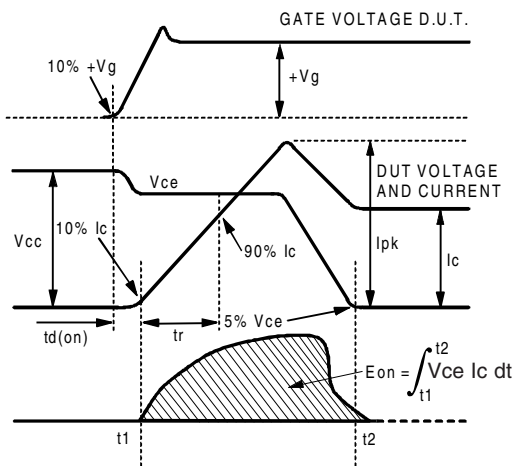


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

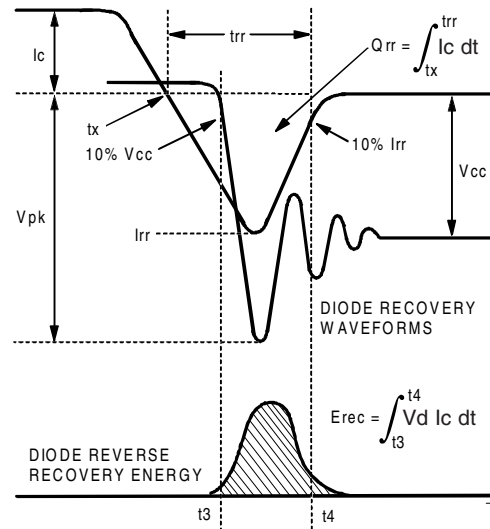


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

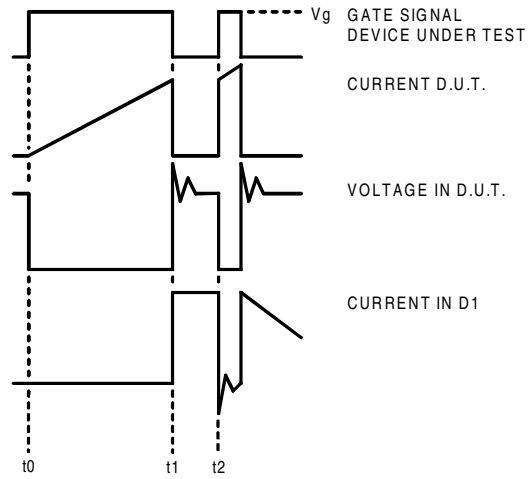


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

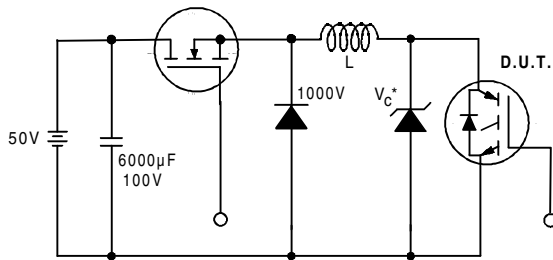


Figure 19. Clamped Inductive Load Test Circuit

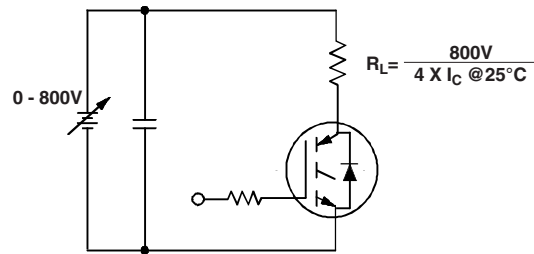


Figure 20. Pulsed Collector Current Test Circuit

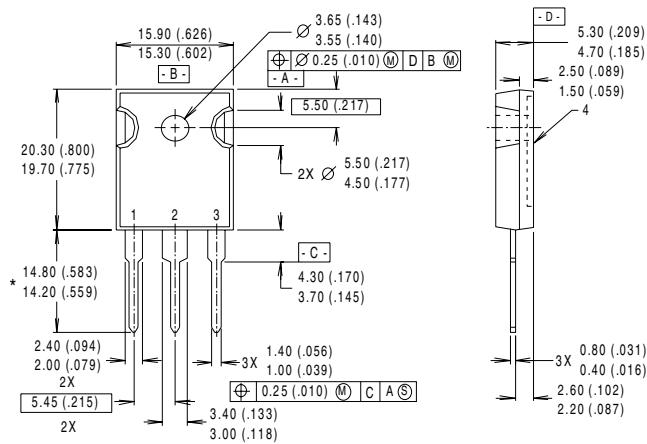
IRG4PH40UD

International
IR Rectifier

Notes:

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

Case Outline — TO-247AC



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-247AC.

LEAD ASSIGNMENTS

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

* LONGER LEADED (20mm) VERSION AVAILABLE (TO-247AD) TO ORDER ADD '-E' SUFFIX TO PART NUMBER

CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)

Dimensions in Millimeters and (Inches)

International
IR Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
IR EUROPEAN REGIONAL CENTRE: 439/445 Godstone Rd, Whyteleafe, Surrey CR3 OBL, UK Tel: ++ 44 (0)20 8645 8000

IR CANADA: 15 Lincoln Court, Brampton, Ontario L6T3Z2, Tel: (905) 453 2200

IR GERMANY: Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 (0) 6172 96590

IR ITALY: Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 011 451 0111

IR JAPAN: K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo 171 Tel: 81 (0)3 3983 0086

IR SOUTHEAST ASIA: 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: ++ 65 (0)838 4630

IR TAIWAN: 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673 Tel: 886-(0)2 2377 9936

Data and specifications subject to change without notice. 7/00