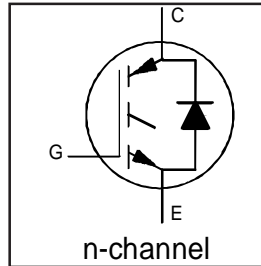


# IRG4PH40UD2-E

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

## Features

- UltraFast IGBT optimized for high operating frequencies up to 200kHz in resonant mode
- IGBT co-packaged with HEXFRED™ ultrafast ultra-soft-recovery anti-parallel diode for use in resonant circuits
- Industry standard TO-247AD package with extended leads



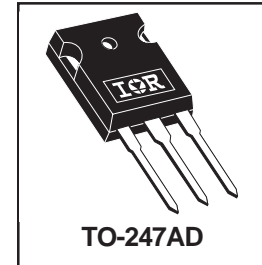
$V_{CES} = 1200V$
$V_{CE(on) typ.} = 2.43V$
@ $V_{GE} = 15V, I_C = 21A$

## Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- HEXFRED diodes optimized for performance with IGBTs. Minimized recovery characteristics require less / no snubbing

## Applications

- Induction cooking systems
- Microwave Ovens
- Resonant Circuits



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter 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	
$I_{CM}$	Pulse Collector Current ①	82	
$I_{LM}$	Clamped Inductive Load current ②	82	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	10	
$I_{FM}$	Diode Maximum Forward Current	40	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	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	-55 to +150	°C
$T_{STG}$	Storage Temperature Range		
	Storage Temperature Range, for 10 sec.		
	Mounting Torque, 6-32 or M3 screw	10 lbf•in (1.1N•m)	

## Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	—	—	0.77	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	—	—	2.5	
$R_{\theta CS}$	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.)

# IRG4PH40UD2-E

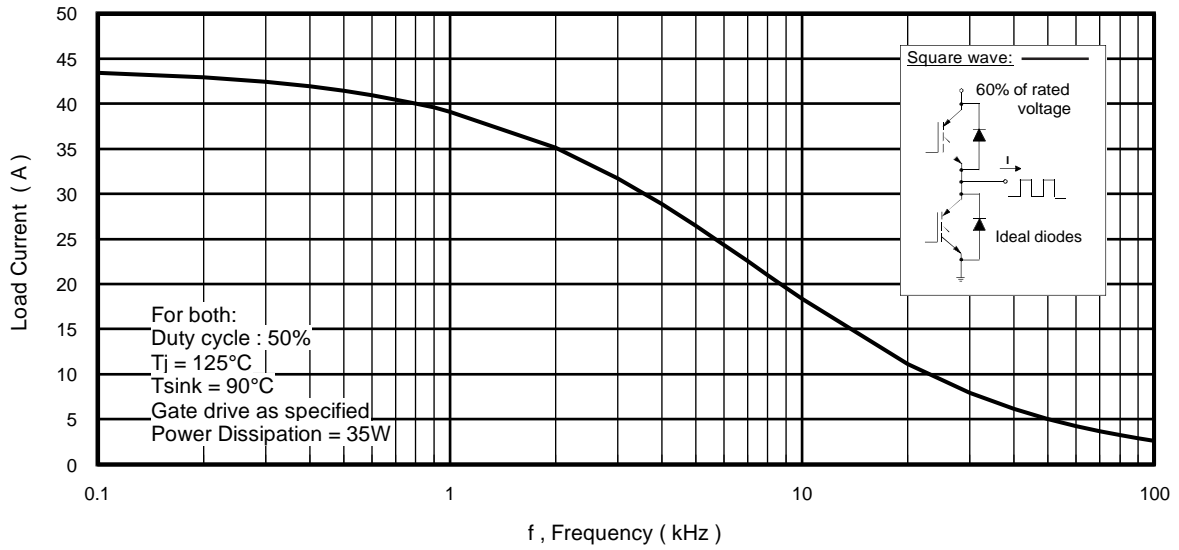
International  
**IRF** Rectifier

## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

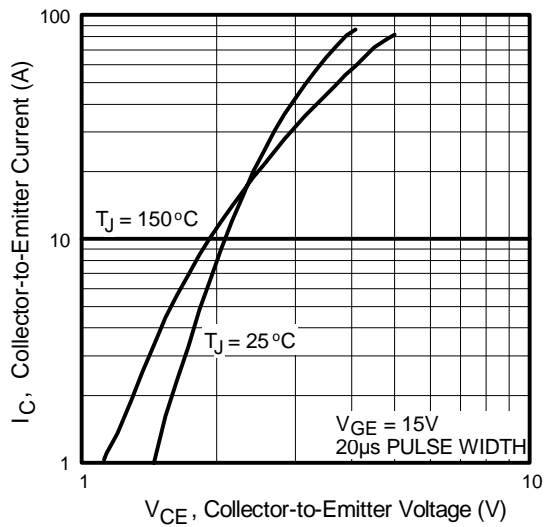
Parameter	Min.	Typ.	Max.	Units	Conditions	
V <sub>(BR)CES</sub>	1200	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA	
V <sub>(BR)ECS</sub>	18	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0A	
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	—	0.43	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA	
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.43	3.1	V	I <sub>C</sub> = 21A, V <sub>GE</sub> = 15V See Fig.2, 5
		—	2.97	—		
		—	2.47	—		
V <sub>GE(th)</sub>	3.0	—	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA	
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA	
g <sub>f</sub>	16	24	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 21A	
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 150°C
		—	—	5000		
V <sub>FM</sub>	Diode Forward Voltage Drop	—	3.4	3.8	V	I <sub>F</sub> = 10A, See Fig.13 I <sub>F</sub> = 10A, T <sub>J</sub> = 150°C
		—	3.3	3.7		
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V

## Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

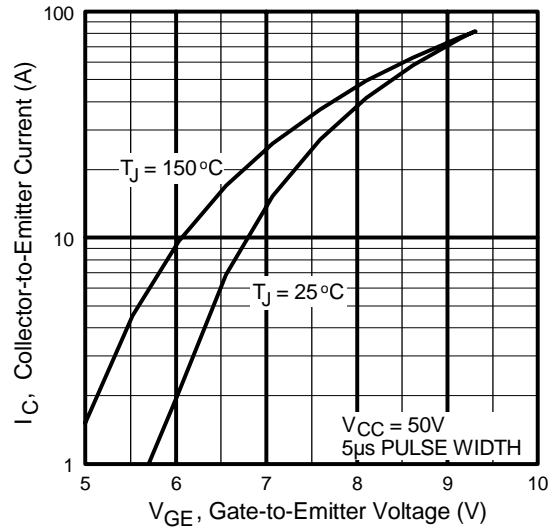
Parameter	Min.	Typ.	Max.	Units	Conditions	
Q <sub>g</sub>	—	100	150		I <sub>C</sub> = 21A	
Q <sub>ge</sub>	—	18	24	nC	V <sub>CC</sub> = 400V, See Fig.8 V <sub>GE</sub> = 15V	
Q <sub>gc</sub>	—	34	50			
t <sub>d(on)</sub>	—	22	—	ns	I <sub>C</sub> = 21A, V <sub>CC</sub> = 800V V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18	
t <sub>r</sub>	—	26	—			
t <sub>d(off)</sub>	—	100	140			
t <sub>f</sub>	—	200	300			
E <sub>on</sub>	—	1950	—	μJ	T <sub>J</sub> = 150°C, See Fig. 9, 10, 11, 18 I <sub>C</sub> = 21A, V <sub>CC</sub> = 800V V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18	
E <sub>off</sub>	—	1710	—			
E <sub>tot</sub>	—	3660	4490			
t <sub>d(on)</sub>	—	21	—	ns	T <sub>J</sub> = 150°C, See Fig. 9, 10, 11, 18 I <sub>C</sub> = 21A, V <sub>CC</sub> = 800V V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω Energy losses include "tail" and diode reverse recovery.	
t <sub>r</sub>	—	25	—			
t <sub>d(off)</sub>	—	220	—			
t <sub>f</sub>	—	380	—			
E <sub>TS</sub>	—	6220	—	μJ	Measured 5mm from package	
L <sub>E</sub>	—	13	—	nH		
C <sub>ies</sub>	—	2100	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V, See Fig.7 f = 1.0MHz	
C <sub>oes</sub>	—	99	—			
C <sub>res</sub>	—	12	—			
t <sub>rr</sub>	Diode Reverse Recovery Time	—	50	76	ns	T <sub>J</sub> =25°C, See Fig. 14 T <sub>J</sub> =125°C, 14
		—	72	110		
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	4.4	7.0	A	T <sub>J</sub> =25°C, See Fig. 15 T <sub>J</sub> =125°C, 15
		—	5.9	8.8		
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	130	200	nC	T <sub>J</sub> =25°C, See Fig. 16 T <sub>J</sub> =125°C, 16
		—	250	380		
di <sub>(rec)</sub> /dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	210	—	A/μs	T <sub>J</sub> =25°C, See Fig. 17 T <sub>J</sub> =125°C, 17
		—	180	—		



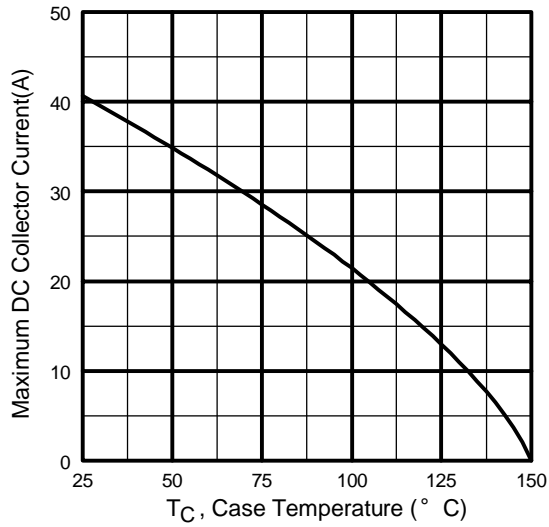
**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)



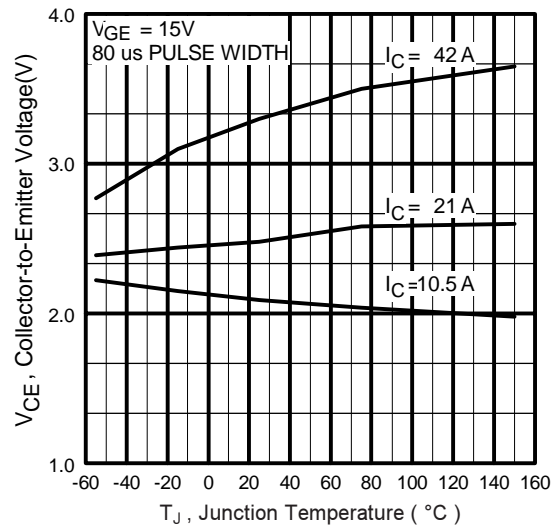
**Fig. 2 - Typical Output Characteristics**  
[www.irf.com](http://www.irf.com)



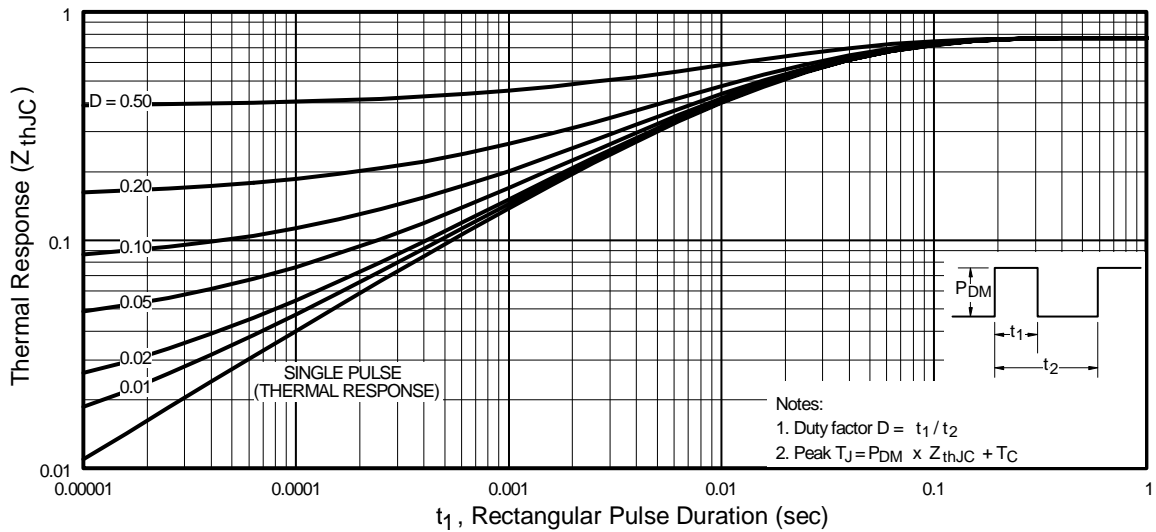
**Fig. 3 - Typical Transfer Characteristics**



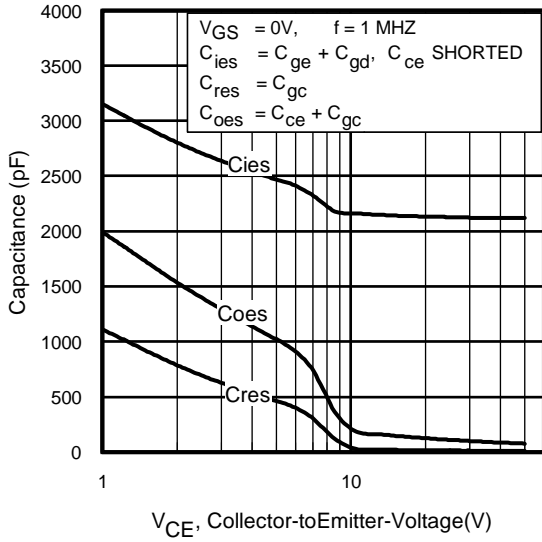
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



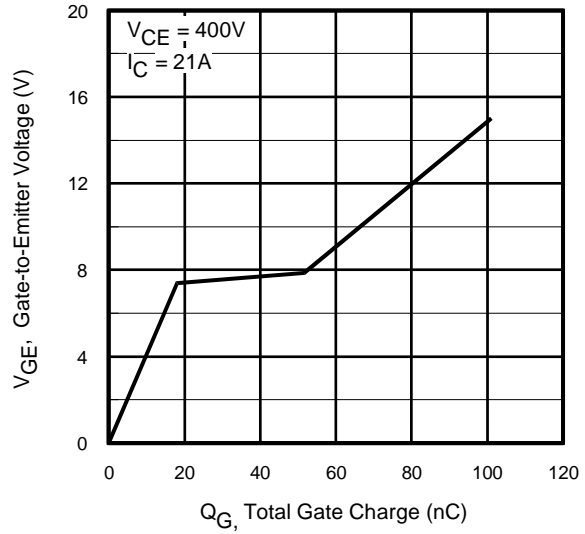
**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**



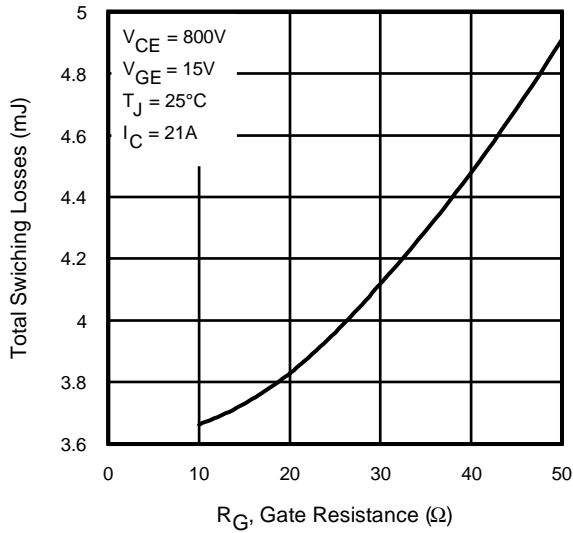
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



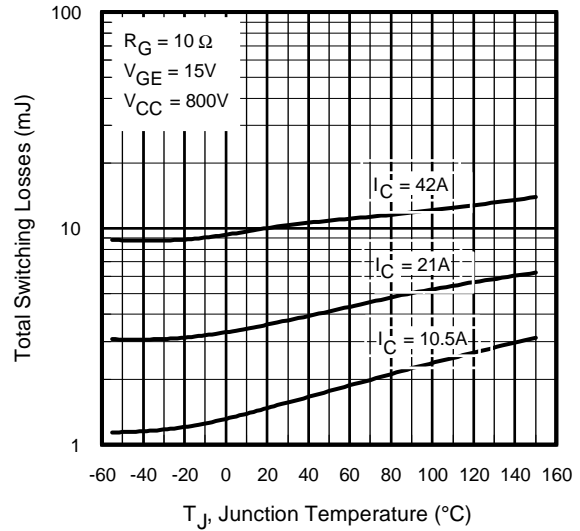
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



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

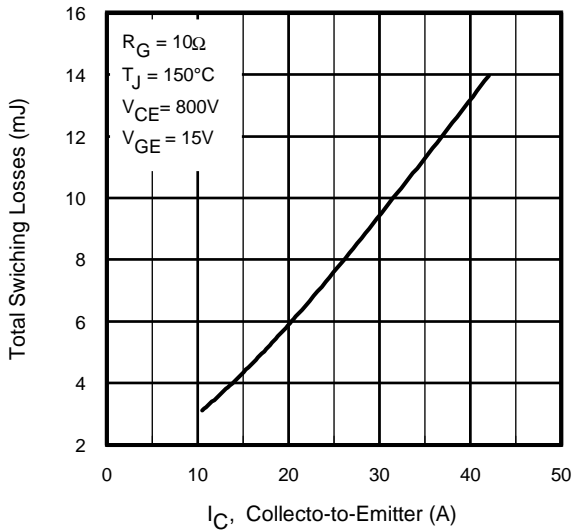


**Fig. 9 - Typical Switching Losses vs. Gate Resistance**

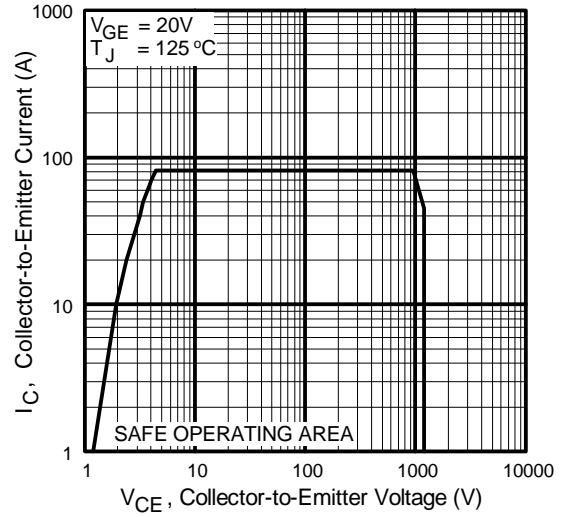


**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

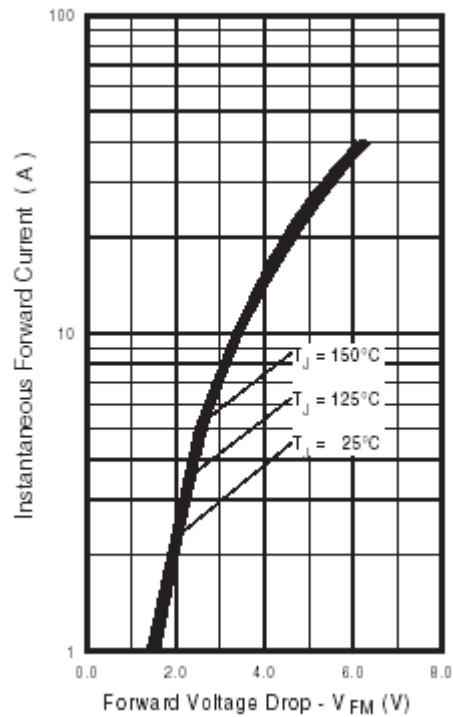
# IRG4PH40UD2-E



**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

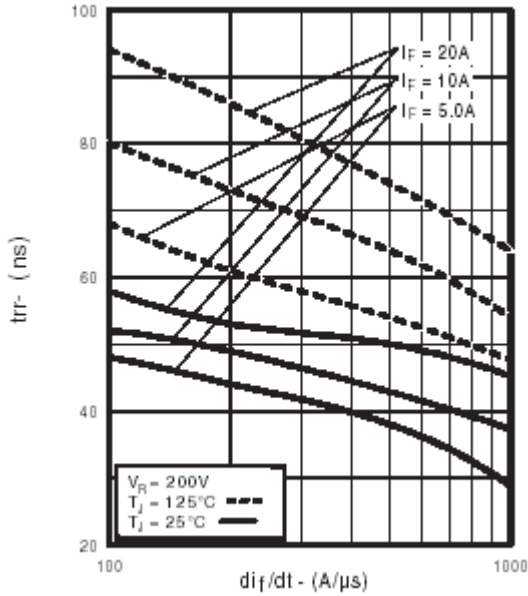


Fig. 14 - Typical Reverse Recovery vs.  $dI_F/dt$

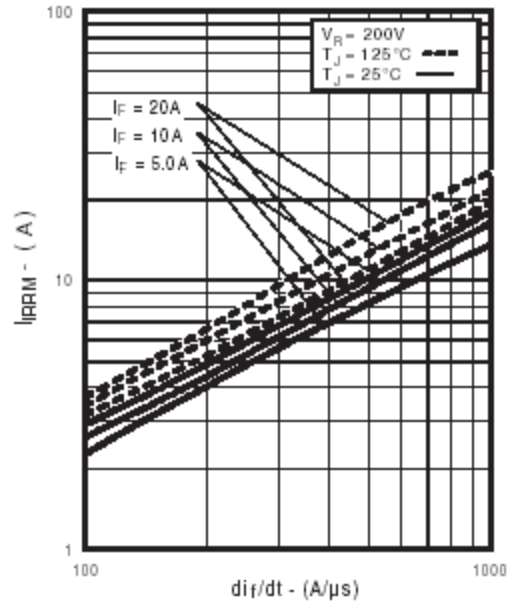


Fig. 15 - Typical Recovery Current vs.  $dI_F/dt$

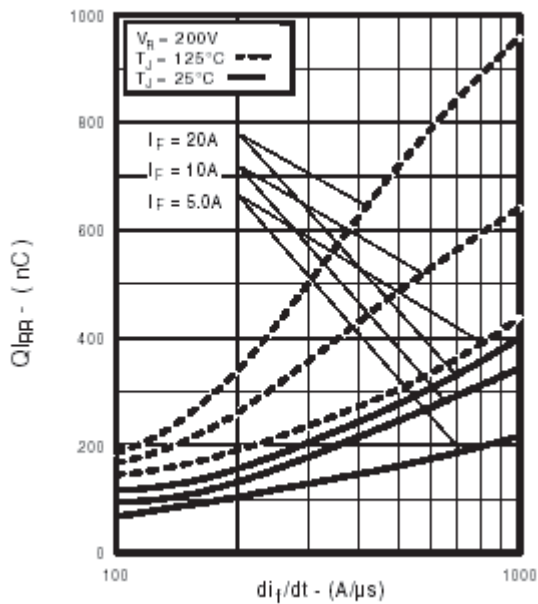


Fig. 16 - Typical Stored Charge vs.  $dI_F/dt$   
www.irf.com

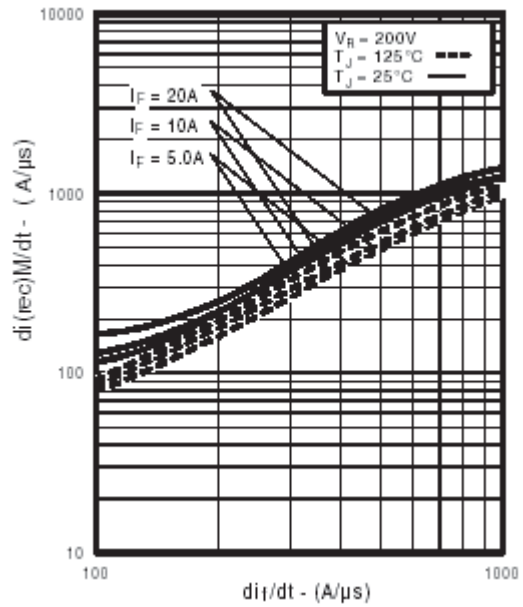
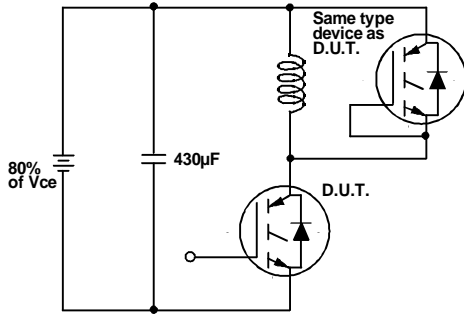
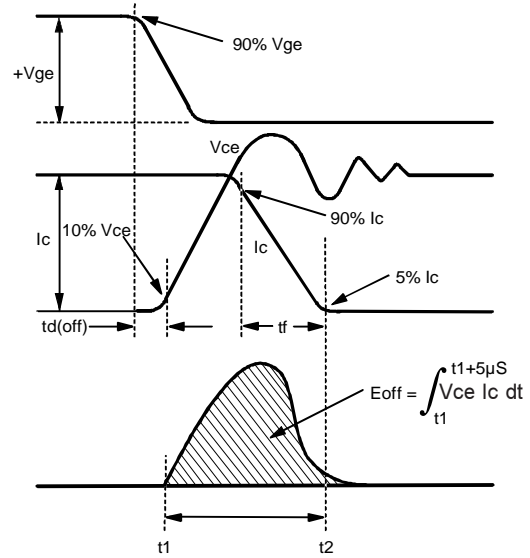


Fig. 17 - Typical  $dI_{(rec)M}/dt$  vs.  $dI_F/dt$

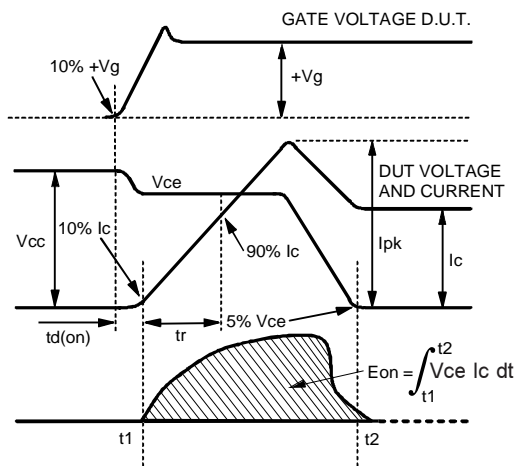
# IRG4PH40UD2-E



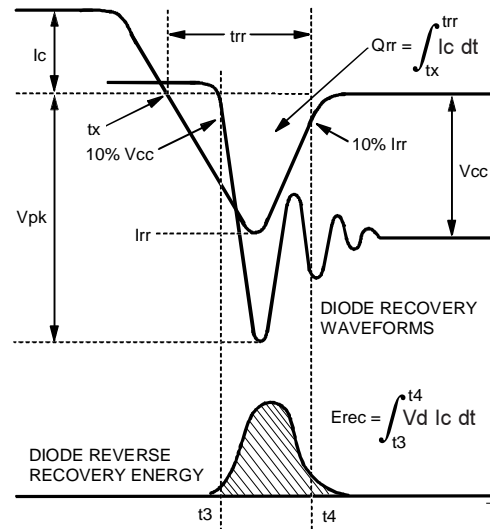
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off(diode)}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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



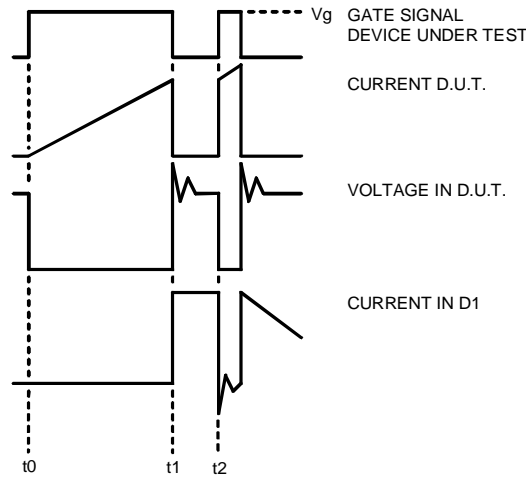


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

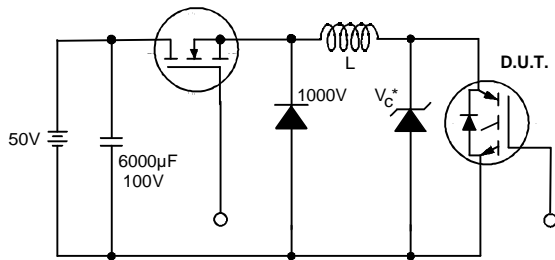


Figure 19. Clamped Inductive Load Test Circuit

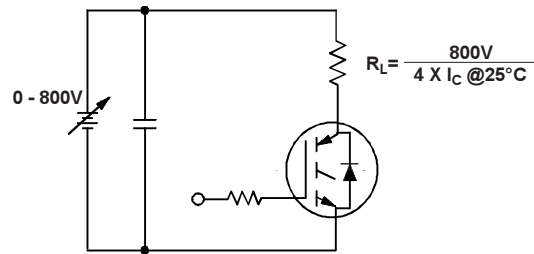


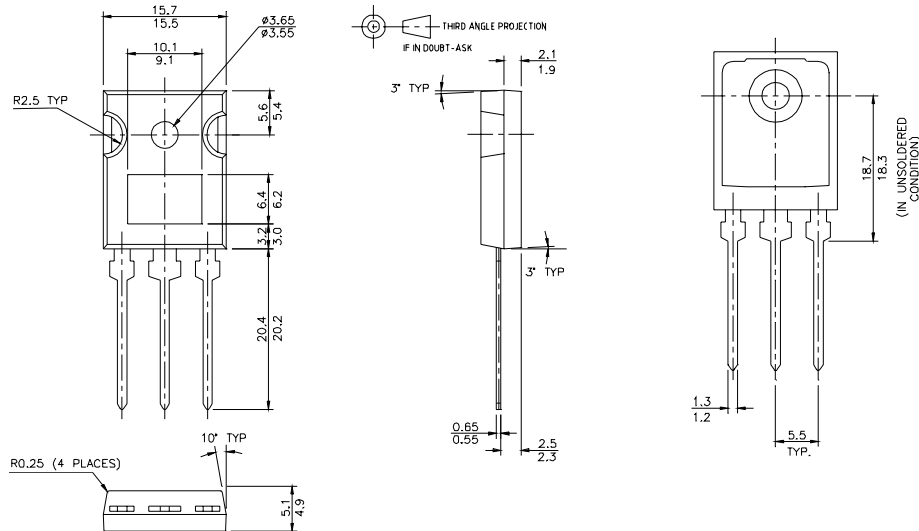
Figure 20. Pulsed Collector Current Test Circuit

# IRG4PH40UD2-E

## TO-247AD Package Outline

Dimensions are shown in millimeters (inches)

International  
**IR** Rectifier

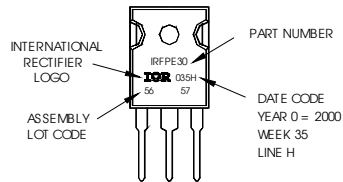


## TO-247AD Part Marking Information

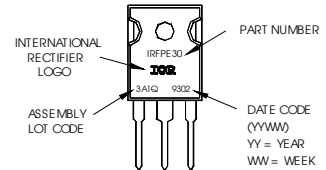
Notes: This part marking information applies to devices produced after 02/26/2001

Notes: This part marking information applies to devices produced before 02/26/2001 or for parts manufactured in GB.

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5667  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE "H"



EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 3A1Q



### 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.

**TO-247AD package is not recommended for Surface Mount Application.**

Data and specifications subject to change without notice.  
This product has been designed and qualified for Industrial market.  
Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

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TAC Fax: (310) 252-7903

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