



# THE DATASHEET OF IRG4PC50KDPBF



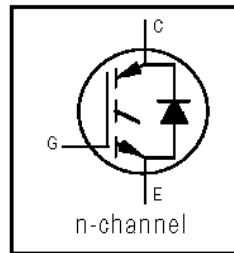
# IRG4PC50KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
 UltraFast IGBT

### Features

- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz, and Short Circuit Rated to 10µs @125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package

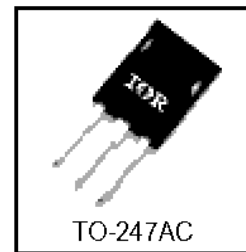


$V_{CES} = 600V$   
 $V_{CE(on) typ.} = 1.84V$   
 @ $V_{GE} = 15V, I_C = 30A$

- Lead-Free

### Benefits

- Generation 4 IGBTs offer highest efficiencies available
- HEXFRED diodes optimized for performance with IGBT. Minimized recovery characteristics require less/no snub
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBTs



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	52	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	30	
$I_{CM}$	Pulsed Collector Current ①	104	
$I_{LM}$	Clamped Inductive Load Current ②	104	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	25	
$I_{FM}$	Diode Maximum Forward Current	280	
$t_{sc}$	Short Circuit Withstand Time	10	µs
$V_{GE}$	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
$T_J$	Operating Junction and Storage Temperature Range	-55 to +150	°C
$T_{STG}$			
	Mounting Torque, 6-32 or M3 Screw.	10 lbf·in (1.1 N·m)	

### Thermal Resistance

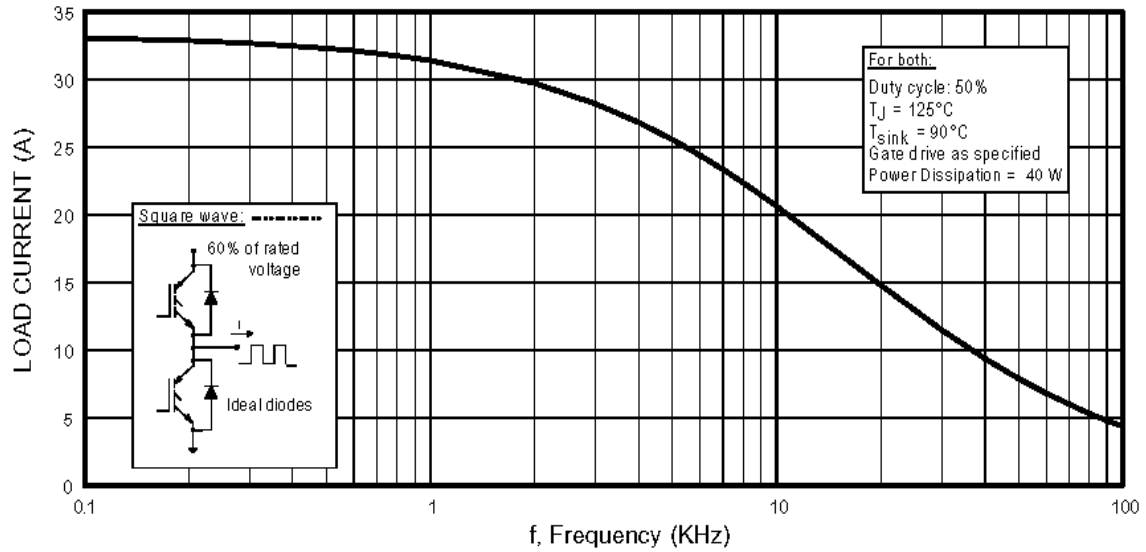
	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.64	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.83	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	40	
Wt	Weight	—	6 (0.21)	—	g (oz)

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

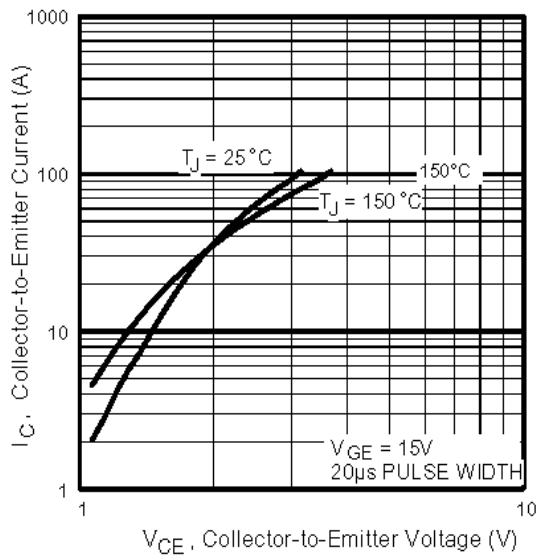
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage ③	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
DV <sub>(BR)CES</sub> /DT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.47	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.84	2.2	V	I <sub>C</sub> = 30A, V <sub>GE</sub> = 15V I <sub>C</sub> = 52A, see figures 2, 5 I <sub>C</sub> = 25A, T <sub>J</sub> = 150°C
		—	2.19	—		
		—	1.79	—		
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
DV <sub>GE(th)</sub> /DT <sub>J</sub>	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance ④	17	24	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 30A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
		—	—	6500		
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.3	1.7	V	I <sub>C</sub> = 25A, see figure 13 I <sub>C</sub> = 25A, T <sub>J</sub> = 150°C
		—	1.2	1.5		
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)

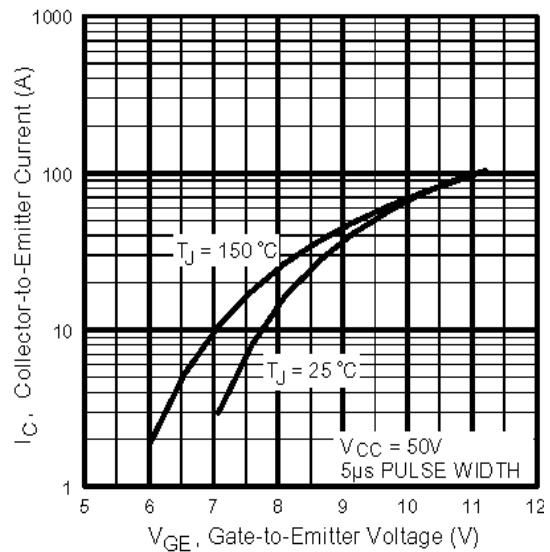
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	200	300	nC	I <sub>C</sub> = 30A V <sub>CC</sub> = 400V, see figure 8 V <sub>GE</sub> = 15V
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	25	38		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	85	127		
t <sub>d(on)</sub>	Turn-On Delay Time	—	63	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>r</sub>	Rise Time	—	49	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	150	220		
t <sub>f</sub>	Fall Time	—	95	140		
E <sub>on</sub>	Turn-On Switching Loss	—	1.61	—	mJ	Energy losses include "tail" and diode reverse recovery
E <sub>off</sub>	Turn-Off Switching Loss	—	0.84	—		
E <sub>ts</sub>	Total Switching Loss	—	2.45	3.0		
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—	μs	V <sub>CC</sub> = 360V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, V <sub>CPK</sub> < 500V
t <sub>d(on)</sub>	Turn-On Delay Time	—	61	—	ns	T <sub>J</sub> = 150°C, see figures 11, 18 I <sub>C</sub> = 30A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω Energy losses include "tail" and diode reverse recovery
t <sub>r</sub>	Rise Time	—	46	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	310	—		
t <sub>f</sub>	Fall Time	—	170	—		
E <sub>ts</sub>	Total Switching Loss	—	3.53	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	3200	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V, see figure 7 f = 1.0MHz
C <sub>oes</sub>	Output Capacitance	—	370	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	95	—		
t <sub>rr</sub>	Diode Reverse Recovery Time	—	50	75	ns	T <sub>J</sub> = 25°C, see figure 14 T <sub>J</sub> = 125°C, 14
		—	105	160		
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	4.5	10	A	T <sub>J</sub> = 25°C, see figure 15 T <sub>J</sub> = 125°C, 15
		—	8.0	15		
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	112	375	nC	T <sub>J</sub> = 25°C, see figure 16 T <sub>J</sub> = 125°C, 16
		—	420	1200		
di <sub>(rec)</sub> /dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	250	—	A/μs	T <sub>J</sub> = 25°C, see figure 17 T <sub>J</sub> = 125°C, 17
		—	160	—		



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



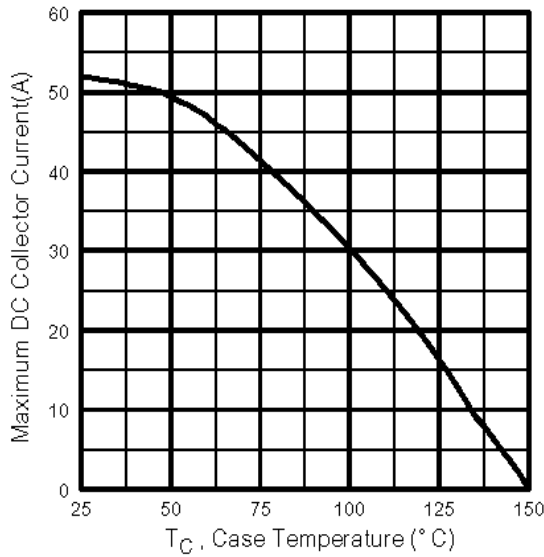
**Fig. 2 - Typical Output Characteristics**



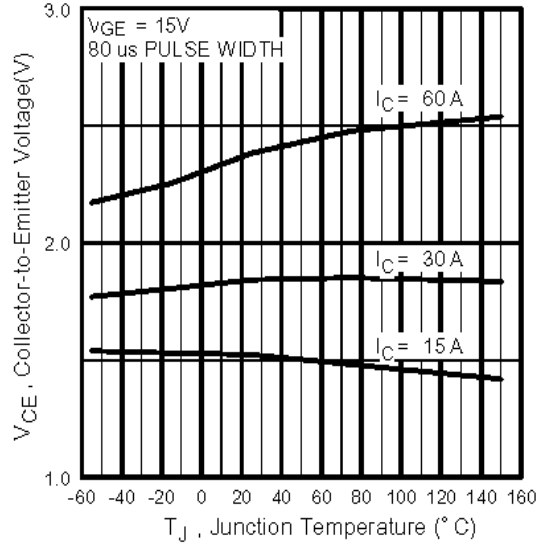
**Fig. 3 - Typical Transfer Characteristics**

# IRG4PC50KDPbF

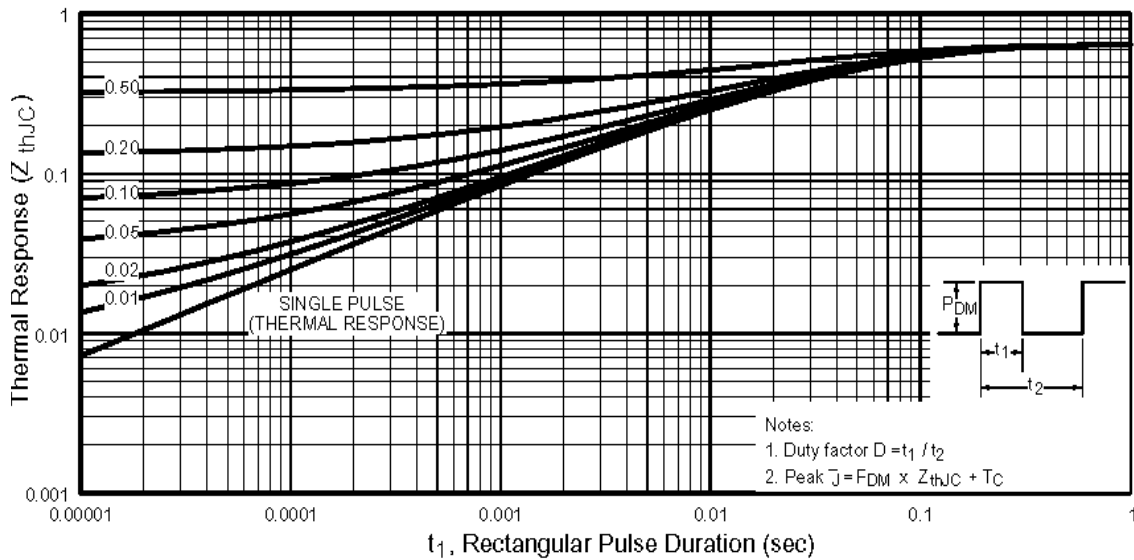
International  
**IR** Rectifier



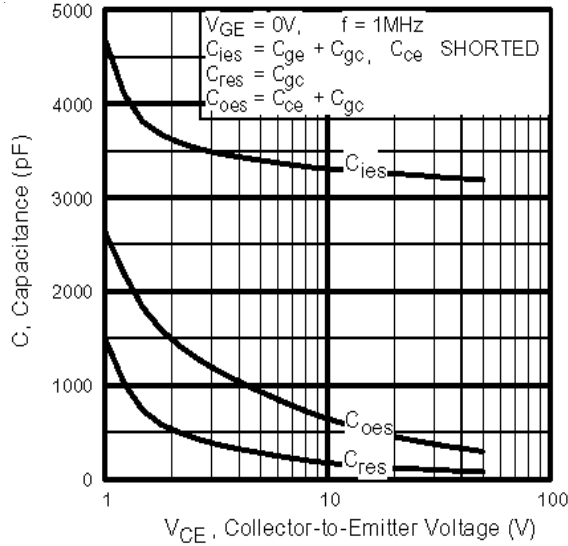
**Fig. 4** - Maximum Collector Current vs. Case Temperature



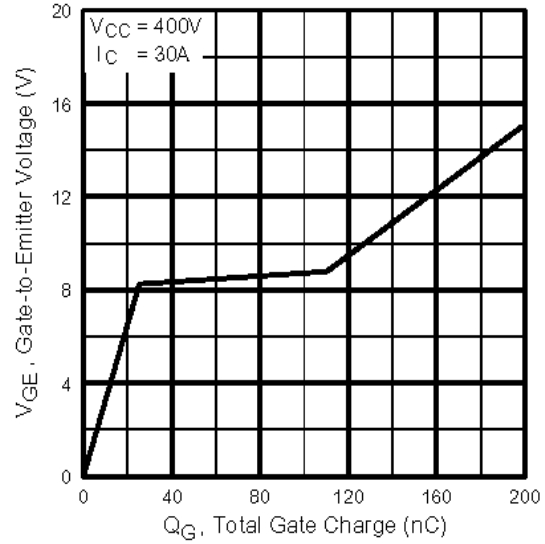
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



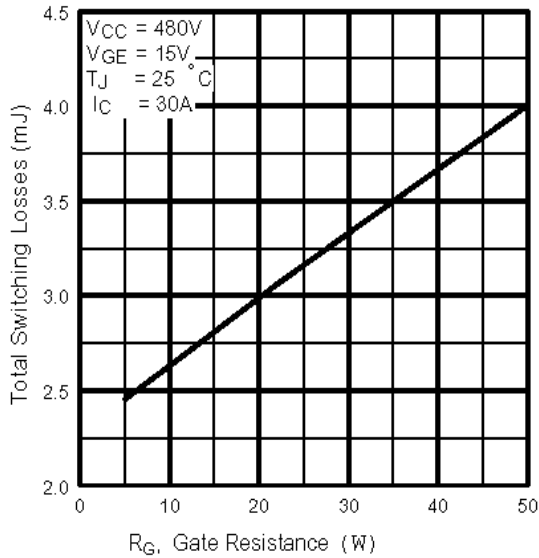
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



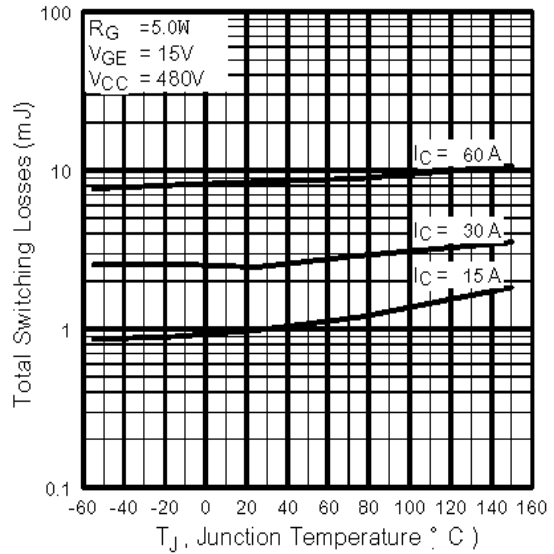
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



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



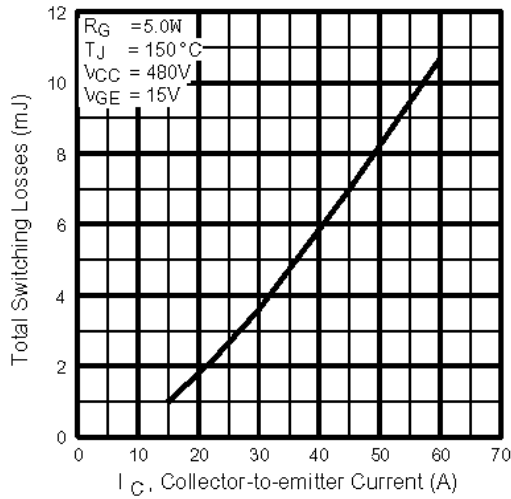
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



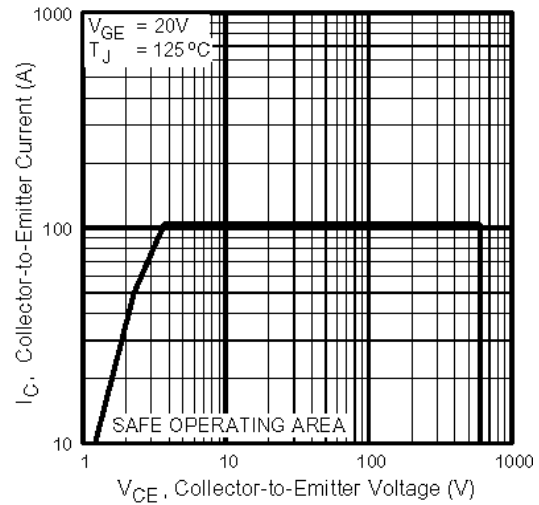
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

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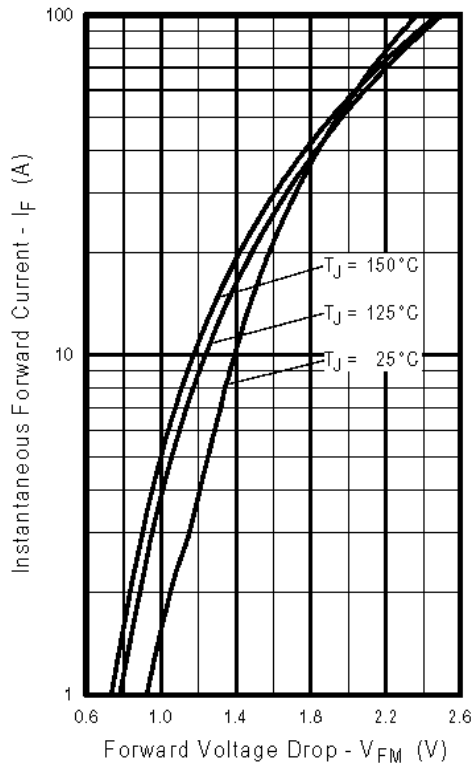
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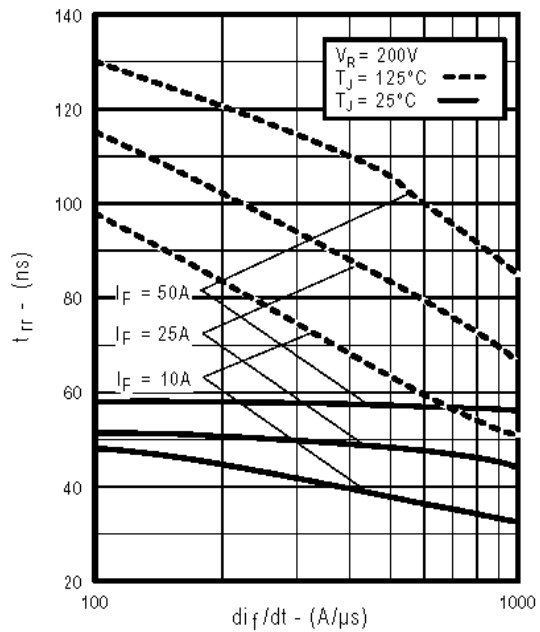
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



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



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



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

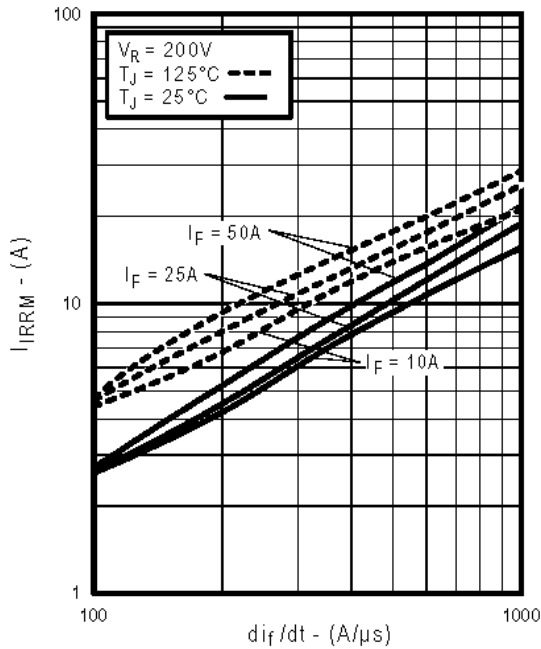


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

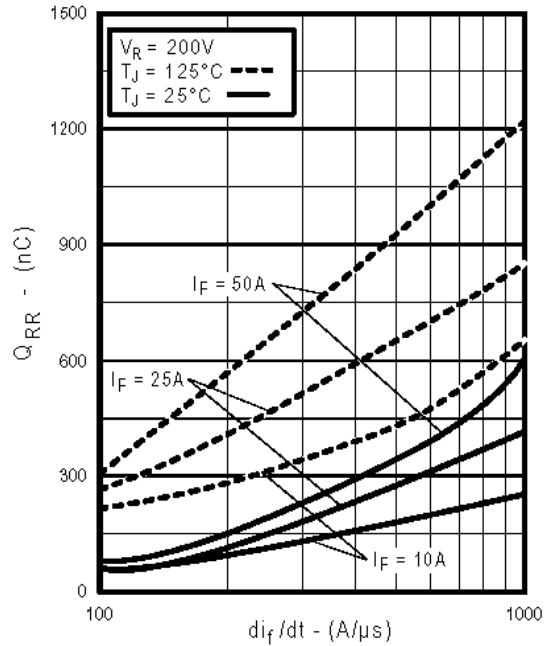


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

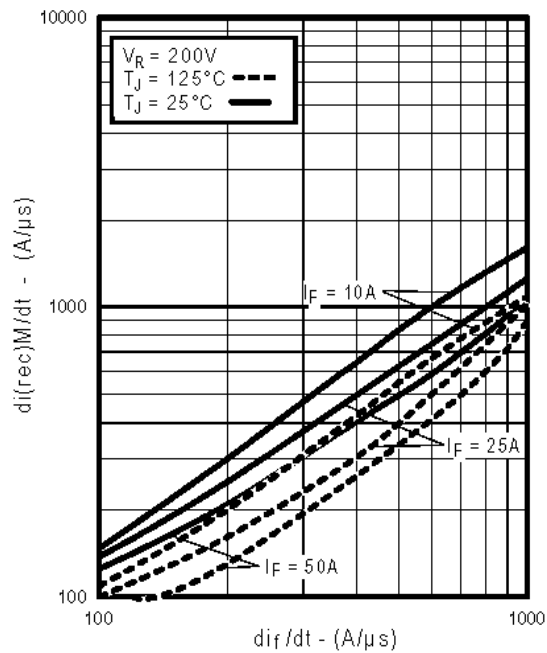
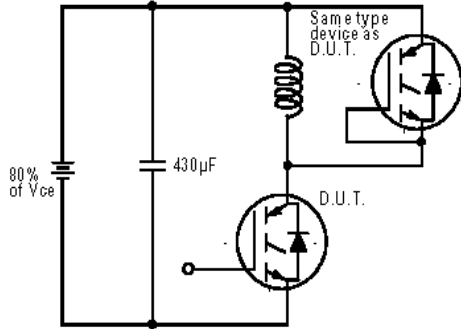


Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$

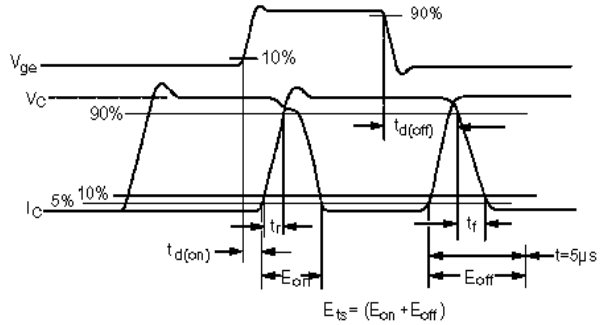
Mechanical drawings, Appendix A  
 Test Circuit diagrams, Appendix B  
 Switching Loss Waveforms, Appendix C

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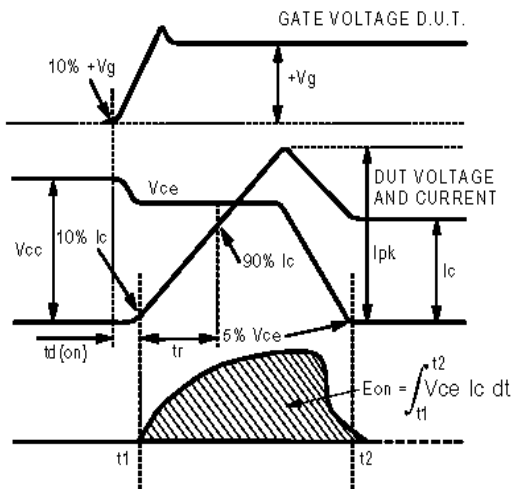
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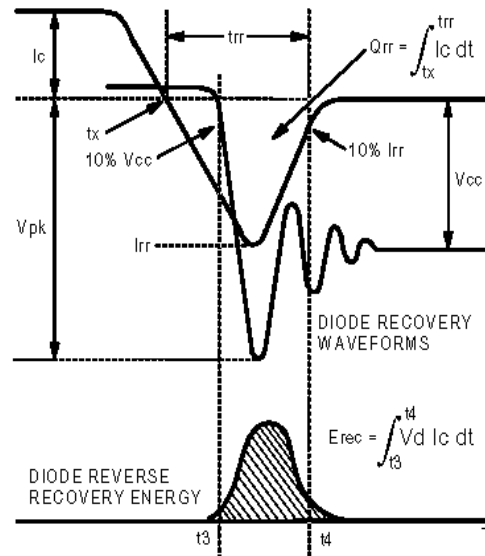
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

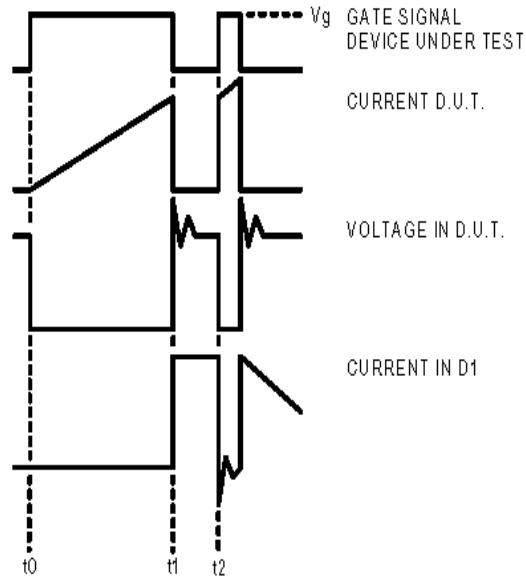


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

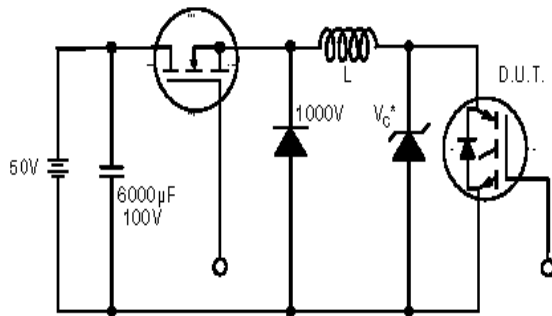


Figure 19. Clamped Inductive Load Test Circuit

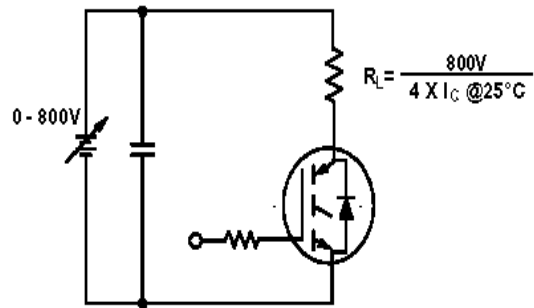


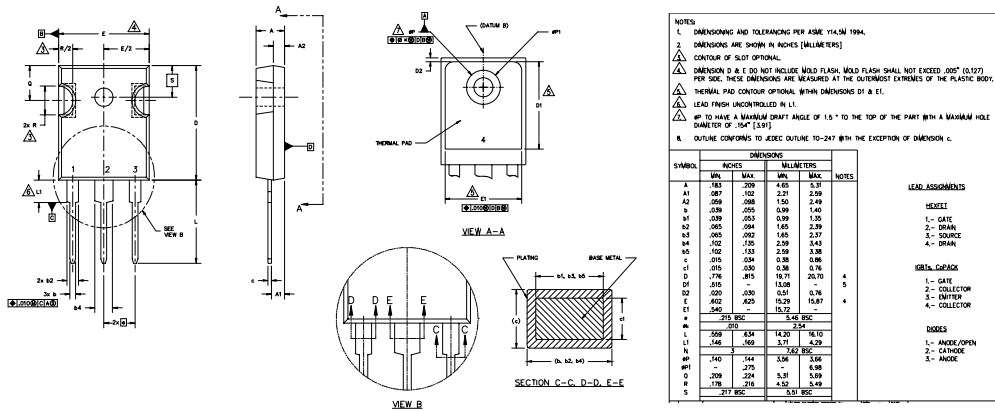
Figure 20. Pulsed Collector Current Test Circuit

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## TO-247AC Package Outline

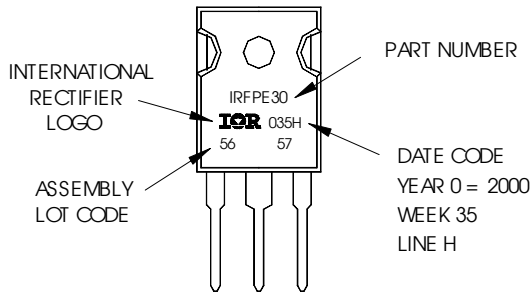
Dimensions are shown in millimeters (inches)



## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFP30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE "H"

**Note:** "P" in assembly line  
position indicates "Lead-Free"



Data and specifications subject to change without notice.

International  
**IR** Rectifier

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Note: For the most current drawings please refer to the IR website at:  
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