

# IRG4PC40UDPbF

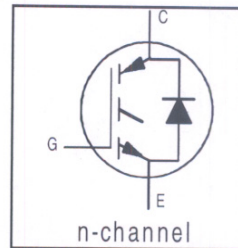
INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

## Features

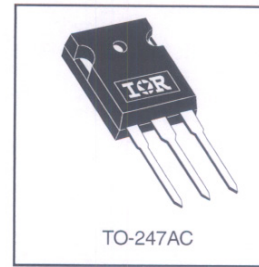
- UltraFast: Optimized for high operating frequencies 8-40 kHz in hard switching, >200 kHz in resonant mode
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package
- 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
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBT's



$V_{CES} = 600V$   
 $V_{CE(on) typ.} = 1.72V$   
@  $V_{GE} = 15V, I_C = 20A$



## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	40	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	20	
$I_{CM}$	Pulsed Collector Current ①	160	
$I_{LM}$	Clamped Inductive Load Current ②	160	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
$I_{FM}$	Diode Maximum Forward Current	160	W
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
$T_J$	Operating Junction and	-55 to +150	$^\circ C$
$T_{STG}$	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

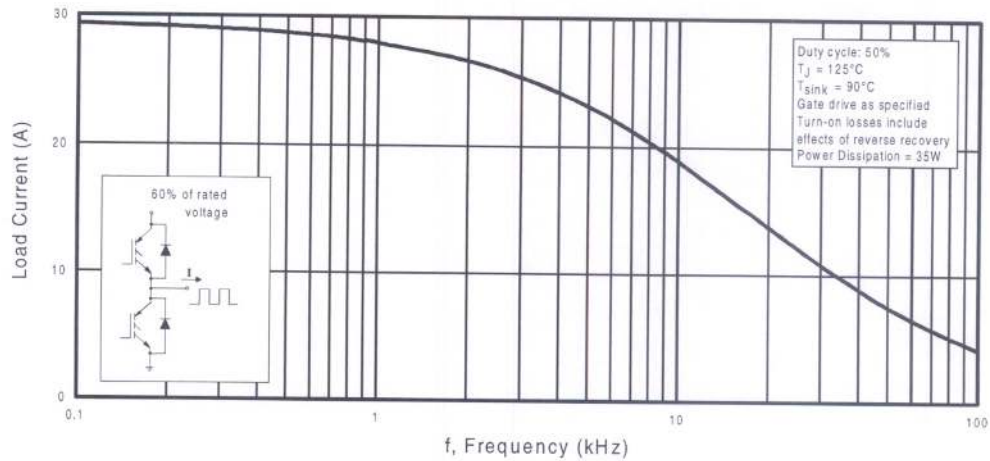
	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	-----	-----	0.77	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	-----	-----	1.7	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	-----	0.24	-----	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	-----	-----	40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

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

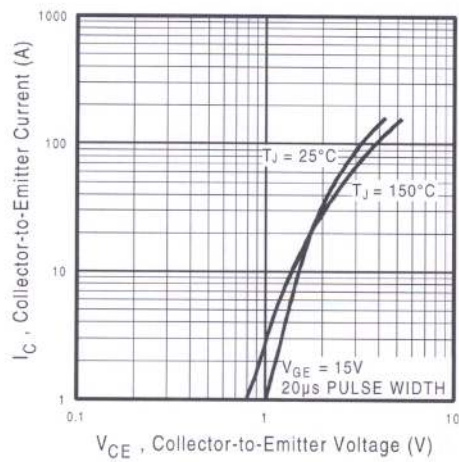
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	600	----	----	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.63	----	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	1.72	2.1	V	$I_C = 20A$ $V_{GE} = 15V$
		----	2.15	----		$I_C = 40A$ See Fig. 2, 5
		----	1.7	----		$I_C = 20A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	----	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	----	-13	----	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance <sup>④</sup>	11	18	----	S	$V_{CE} = 100V, I_C = 20A$
$I_{CES}$	Zero Gate Voltage Collector Current	----	----	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		----	----	3500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	----	1.3	1.7	V	$I_C = 15A$ See Fig. 13
		----	1.2	1.6		$I_C = 15A, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	----	----	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

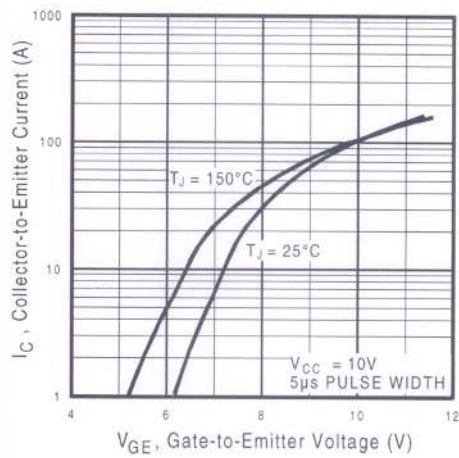
	Parameter	Min.	Typ.	Max.	Units	Conditions	
$Q_g$	Total Gate Charge (turn-on)	----	100	150	nC	$I_C = 20A$	
$Q_{ge}$	Gate - Emitter Charge (turn-on)	----	16	25		$V_{CC} = 400V$ See Fig. 8	
$Q_{gc}$	Gate - Collector Charge (turn-on)	----	40	60		$V_{GE} = 15V$	
$t_{d(on)}$	Turn-On Delay Time	----	54	----	ns	$T_J = 25^\circ\text{C}$	
$t_r$	Rise Time	----	57	----		$I_C = 20A, V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	110	165		$V_{GE} = 15V, R_G = 10\Omega$	
$t_f$	Fall Time	----	80	120		Energy losses include "tail" and diode reverse recovery.	
$E_{on}$	Turn-On Switching Loss	----	0.71	----		mJ	See Fig. 9, 10, 11, 18
$E_{off}$	Turn-Off Switching Loss	----	0.35	----			
$E_{ts}$	Total Switching Loss	----	1.10	1.5			
$t_{d(on)}$	Turn-On Delay Time	----	40	----	ns	$T_J = 150^\circ\text{C}$ , See Fig. 9, 10, 11, 18	
$t_r$	Rise Time	----	52	----		$I_C = 20A, V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	200	----		$V_{GE} = 15V, R_G = 10\Omega$	
$t_f$	Fall Time	----	130	----		Energy losses include "tail" and diode reverse recovery.	
$E_{ts}$	Total Switching Loss	----	1.6	----	mJ		
$L_E$	Internal Emitter Inductance	----	13	----	nH	Measured 5mm from package	
$C_{ies}$	Input Capacitance	----	2100	----	pF	$V_{GE} = 0V$	
$C_{oes}$	Output Capacitance	----	140	----		$V_{CC} = 30V$ See Fig. 7	
$C_{res}$	Reverse Transfer Capacitance	----	34	----		$f = 1.0MHz$	
$t_{rr}$	Diode Reverse Recovery Time	----	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig.	
		----	74	120		$T_J = 125^\circ\text{C}$ 14	
$I_{rr}$	Diode Peak Reverse Recovery Current	----	4.0	6.0	A	$T_J = 25^\circ\text{C}$ See Fig.	
		----	6.5	10		$T_J = 125^\circ\text{C}$ 15	
$Q_{rr}$	Diode Reverse Recovery Charge	----	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig.	
		----	220	600		$T_J = 125^\circ\text{C}$ 16	
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	----	190	----	A/ $\mu s$	$T_J = 25^\circ\text{C}$	
		----	160	----		$T_J = 125^\circ\text{C}$	



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

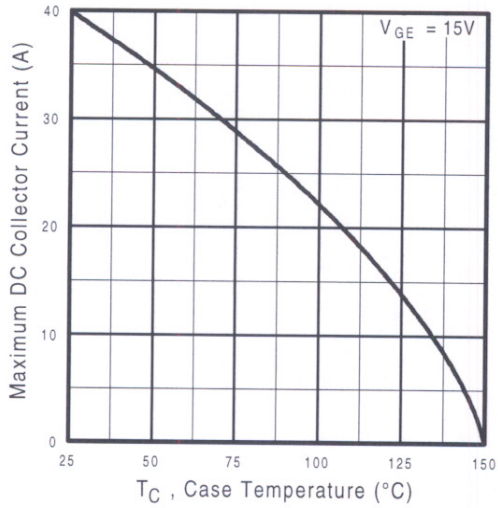


**Fig. 2 - Typical Output Characteristics**

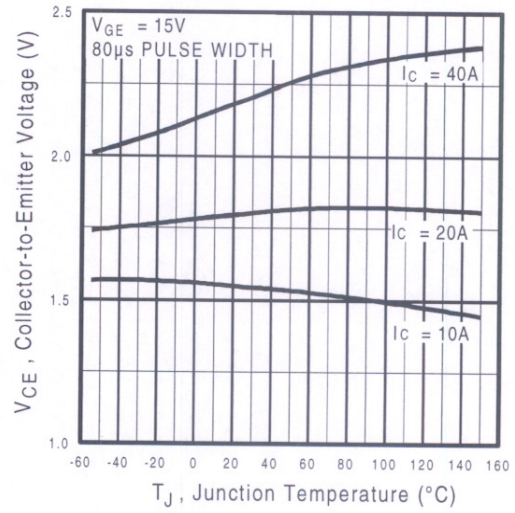


**Fig. 3 - Typical Transfer Characteristics**

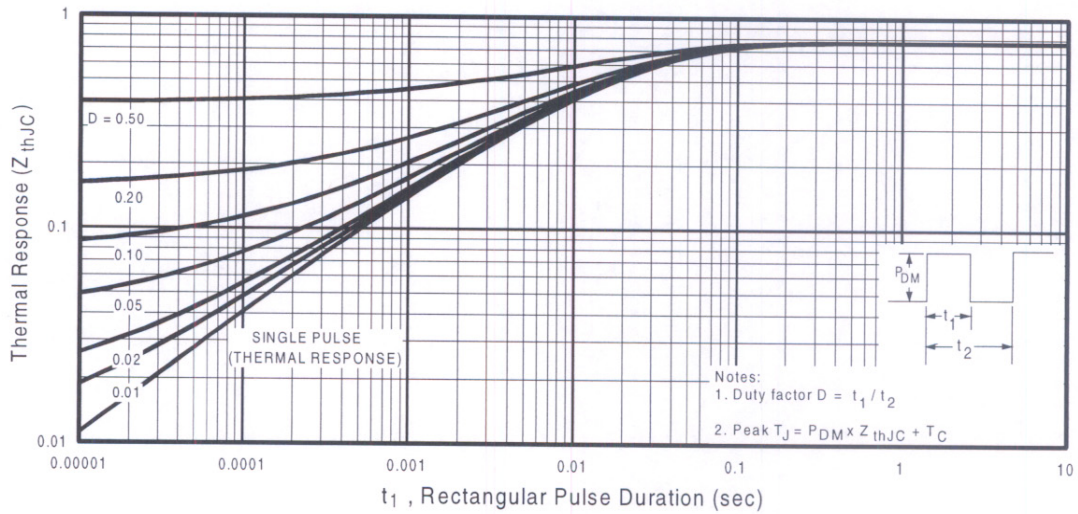




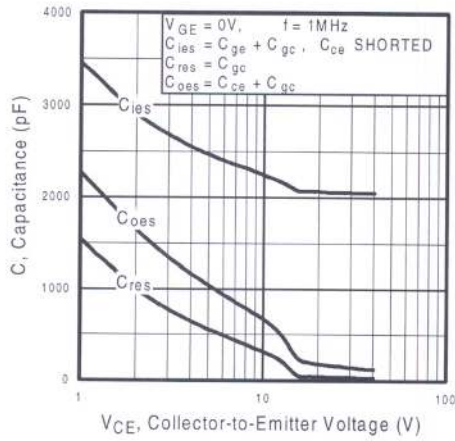
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



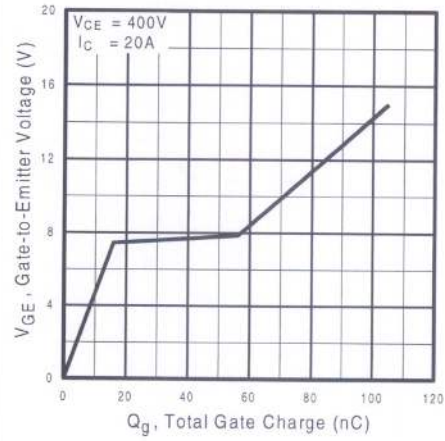
**Fig. 5 - Collector-to-Emitter Voltage vs. Junction Temperature**



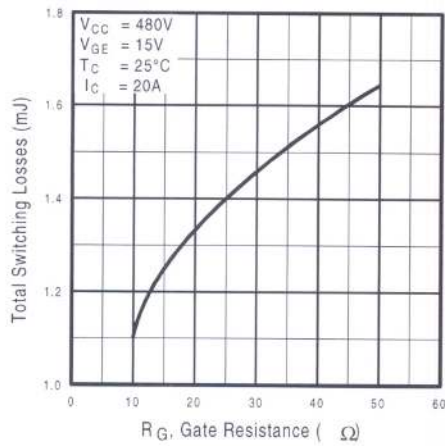
**Fig. 6 - Maximum IGBT Effective Transient Thermal Impedance, Junction-to-Case**



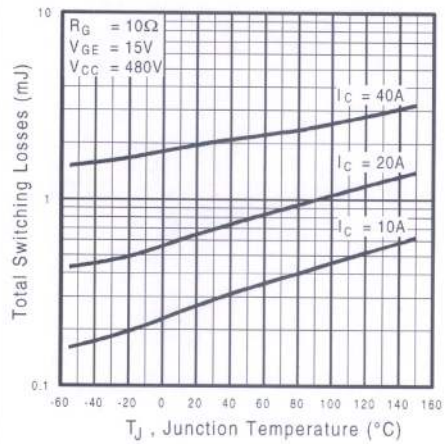
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



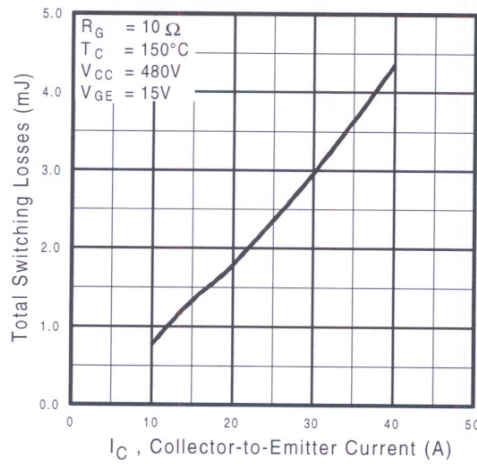
**Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage**



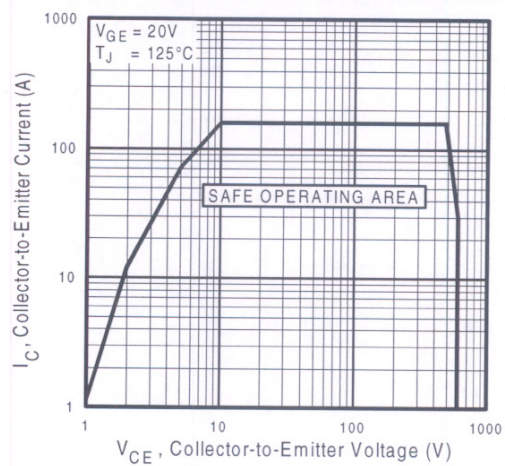
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



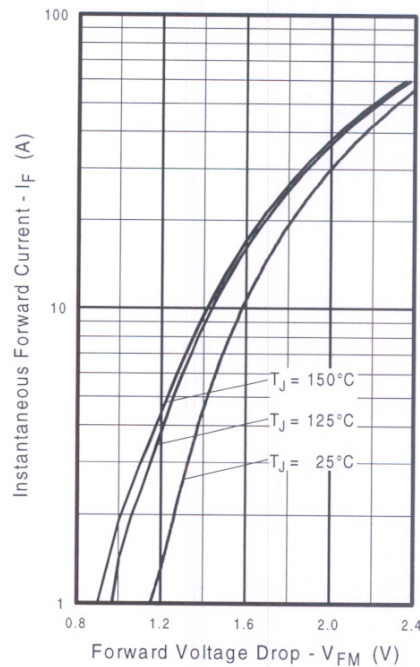
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**



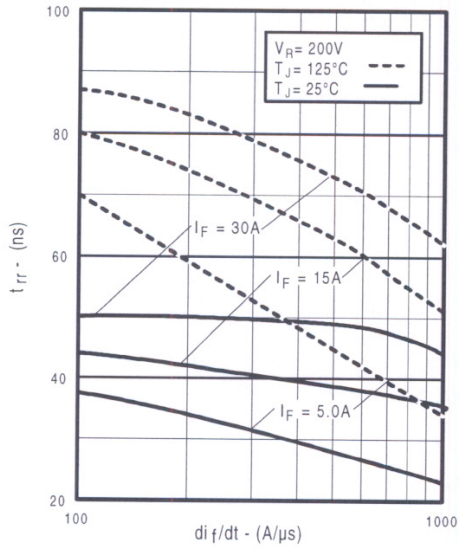
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



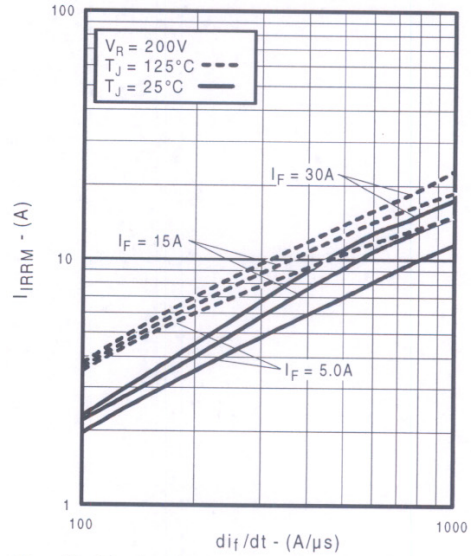
**Fig. 12** - Turn-Off SOA



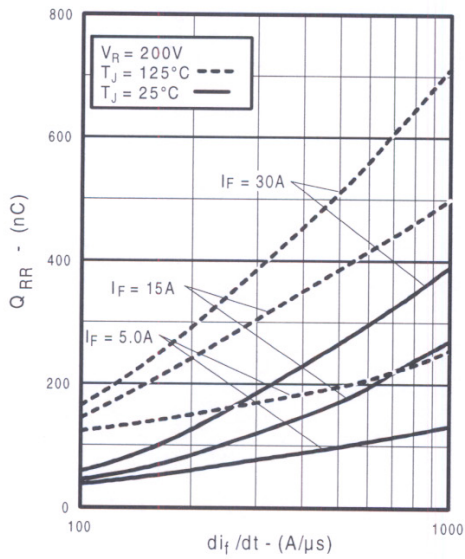
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



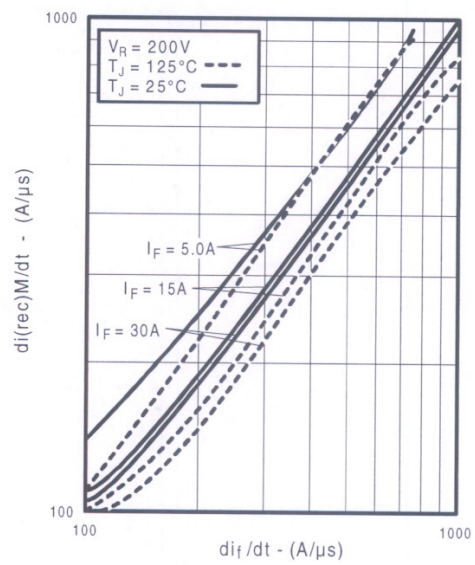
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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



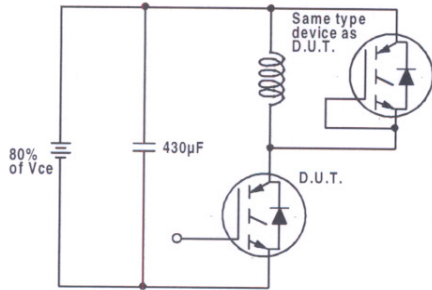
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



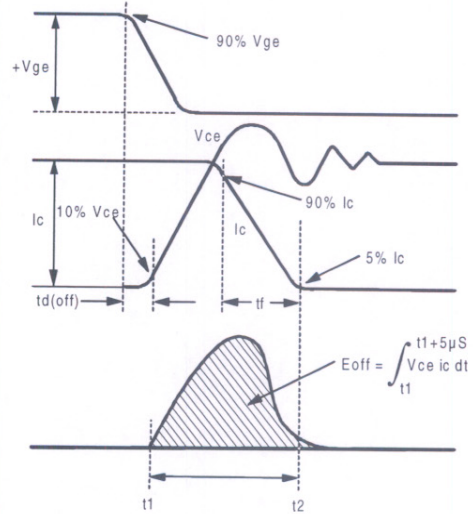
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$



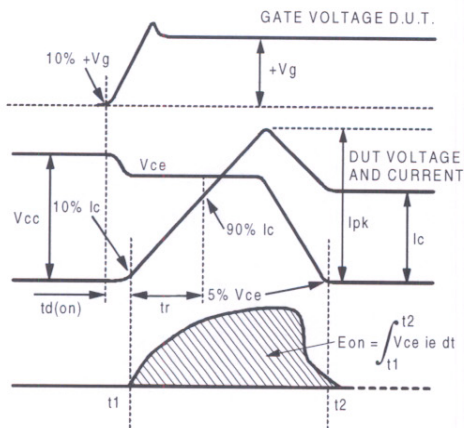
# IRG4PC40UDPbF



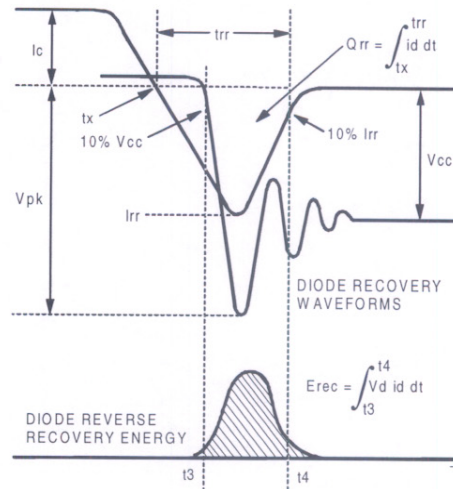
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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



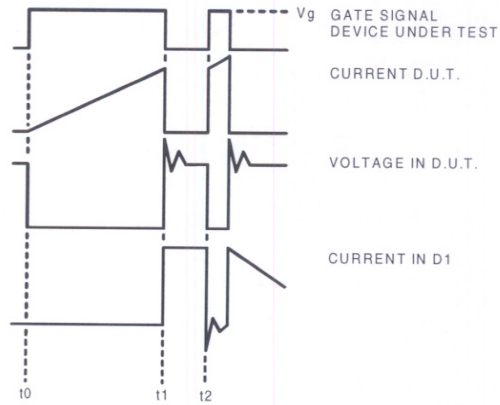


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

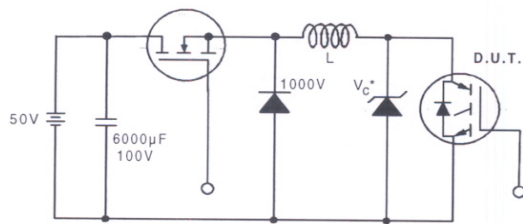


Figure 19. Clamped Inductive Load Test Circuit

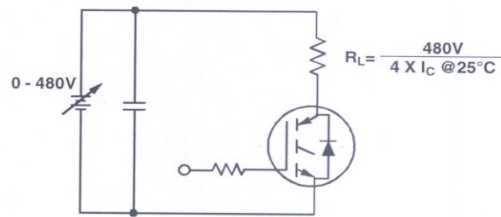


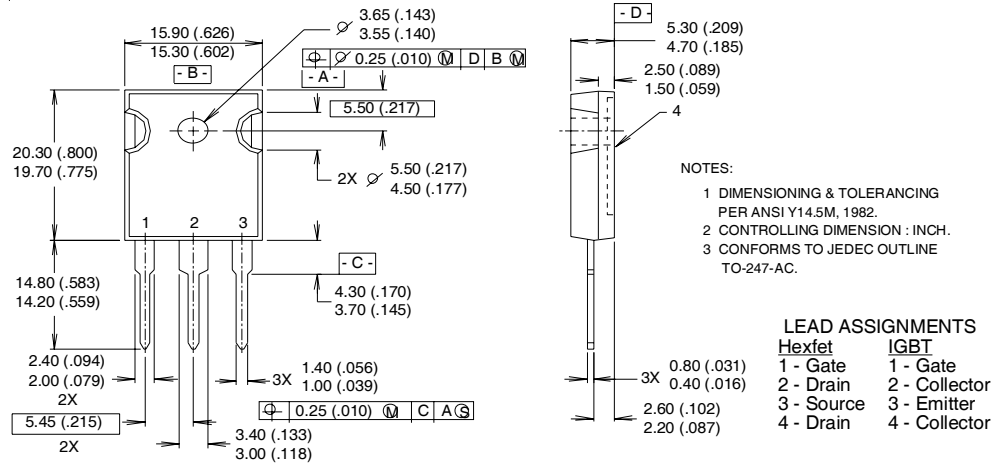
Figure 20. Pulsed Collector Current Test Circuit

# IRG4PC40UDPbF

International  
**IR** Rectifier

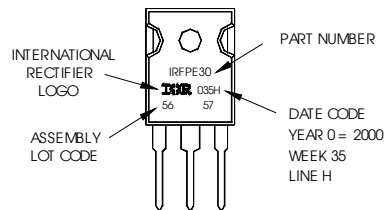
## TO-247AC Package Outline

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"



### 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.

Data and specifications subject to change without notice.

International  
**IR** Rectifier

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TAC Fax: (310) 252-7903

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