

# IRG4RC10KDPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH  
ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
UltraFast IGBT

## Features

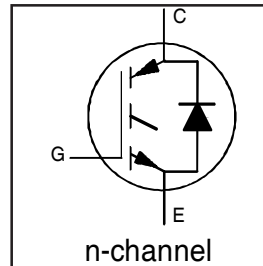
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10 $\mu$ s @ 125°C,  $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than previous generation
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-252AA package
- Lead-Free

## Benefits

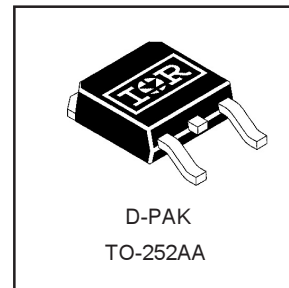
- Latest generation 4 IGBT's offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- For hints see design tip 97003

## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	9.0	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	5.0	
$I_{CM}$	Pulsed Collector Current ①	18	
$I_{LM}$	Clamped Inductive Load Current ②	18	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	4.0	
$I_{FM}$	Diode Maximum Forward Current	16	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu$ s
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	38	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	15	
$T_J$	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)	



$V_{CES} = 600V$
$V_{CE(on) typ.} = 2.39V$
@ $V_{GE} = 15V, I_C = 5.0A$



## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	3.3	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	7.0	
$R_{\theta JA}$	Junction-to-Ambient (PCB mount)*	—	50	
Wt	Weight	0.3 (0.01)	—	g (oz)

\* When mounted on 1" square PCB (FR-4 or G-10 Material).

For recommended footprint and soldering techniques refer to application note #AN-994

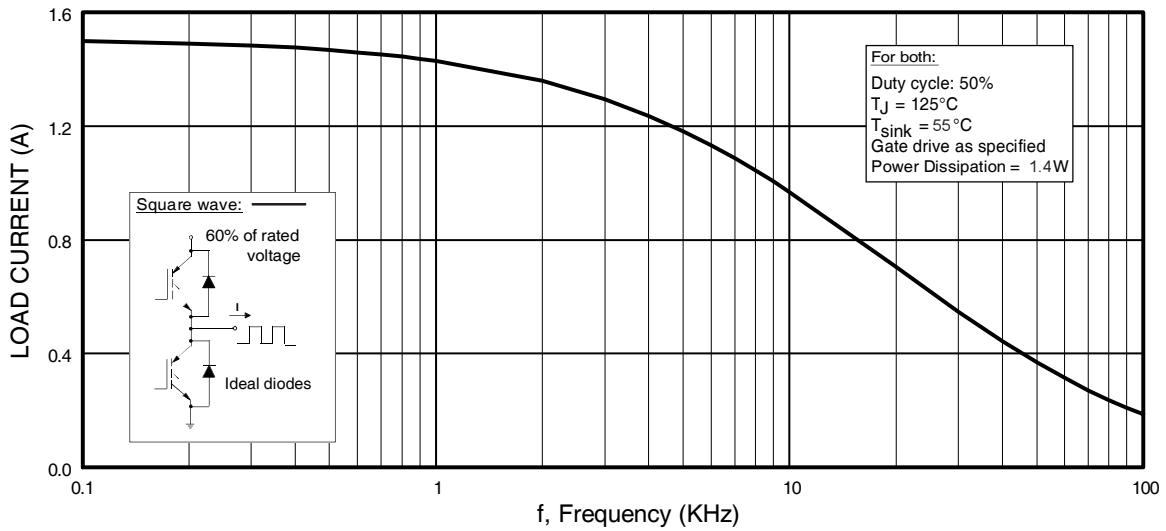
# IRG4RC10KDPbF

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

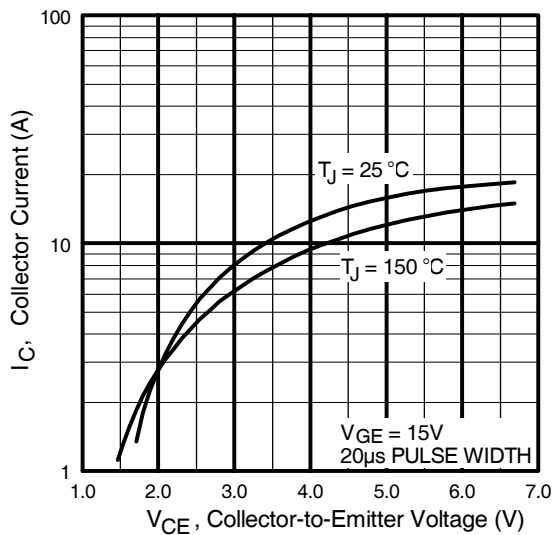
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sub>f</sub>	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.58	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.39	2.62	V	I <sub>C</sub> = 5.0A V <sub>GE</sub> = 15V
		—	3.25	—		I <sub>C</sub> = 9.0A See Fig. 2, 5
		—	2.63	—		I <sub>C</sub> = 5.0A, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.5		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance „	1.2	1.8	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 5.0A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	1000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.5	1.8	V	I <sub>C</sub> = 4.0A See Fig. 13
		—	1.4	1.7		I <sub>C</sub> = 4.0A, T <sub>J</sub> = 150°C
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)

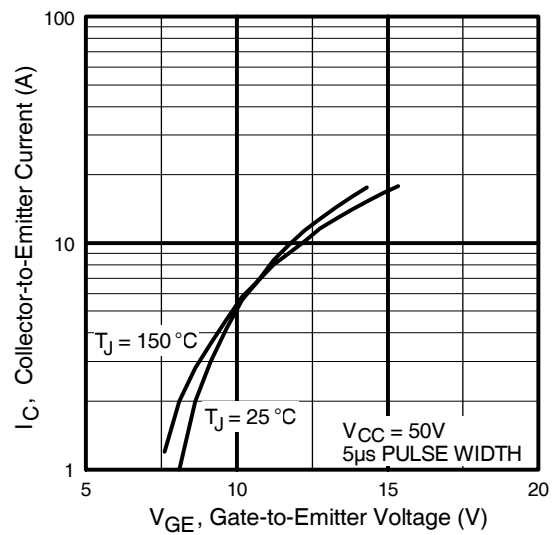
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	19	29	nC	I <sub>C</sub> = 5.0A
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	2.9	4.3		V <sub>CC</sub> = 400V See Fig.8
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	9.8	15		V <sub>GE</sub> = 15V
t <sub>d(on)</sub>	Turn-On Delay Time	—	49	—	ns	T <sub>J</sub> = 25°C
t <sub>r</sub>	Rise Time	—	28	—		I <sub>C</sub> = 5.0A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	97	150		V <sub>GE</sub> = 15V, R <sub>G</sub> = 100Ω
t <sub>f</sub>	Fall Time	—	140	210		Energy losses include "tail" and diode reverse recovery See Fig. 9,10,14
E <sub>on</sub>	Turn-On Switching Loss	—	0.25	—	mJ	V <sub>CC</sub> = 360V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 100Ω, V <sub>CPK</sub> < 500V
E <sub>off</sub>	Turn-Off Switching Loss	—	0.14	—		
E <sub>ts</sub>	Total Switching Loss	—	0.39	0.48		
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—	μs	
t <sub>d(on)</sub>	Turn-On Delay Time	—	46	—	ns	T <sub>J</sub> = 150°C, See Fig. 10,11,14
t <sub>r</sub>	Rise Time	—	32	—		I <sub>C</sub> = 5.0A, V <sub>CC</sub> = 480V
t <sub>d(off)</sub>	Turn-Off Delay Time	—	100	—		V <sub>GE</sub> = 15V, R <sub>G</sub> = 100Ω
t <sub>f</sub>	Fall Time	—	310	—		Energy losses include "tail" and diode reverse recovery
E <sub>ts</sub>	Total Switching Loss	—	0.56	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	220	—	pF	V <sub>GE</sub> = 0V
C <sub>oes</sub>	Output Capacitance	—	29	—		V <sub>CC</sub> = 30V See Fig. 7
C <sub>res</sub>	Reverse Transfer Capacitance	—	7.5	—		f = 1.0MHz
t <sub>rr</sub>	Diode Reverse Recovery Time	—	28	42	ns	T <sub>J</sub> = 25°C See Fig. 14
		—	38	57		T <sub>J</sub> = 125°C
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	2.9	5.2	A	T <sub>J</sub> = 25°C See Fig. 15
		—	3.7	6.7		T <sub>J</sub> = 125°C
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	40	60	nC	T <sub>J</sub> = 25°C See Fig. 16
		—	70	105		T <sub>J</sub> = 125°C
di <sub>(rec)M</sub> /dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	280	—	A/μs	T <sub>J</sub> = 25°C See Fig. 17
		—	235	—		T <sub>J</sub> = 125°C



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

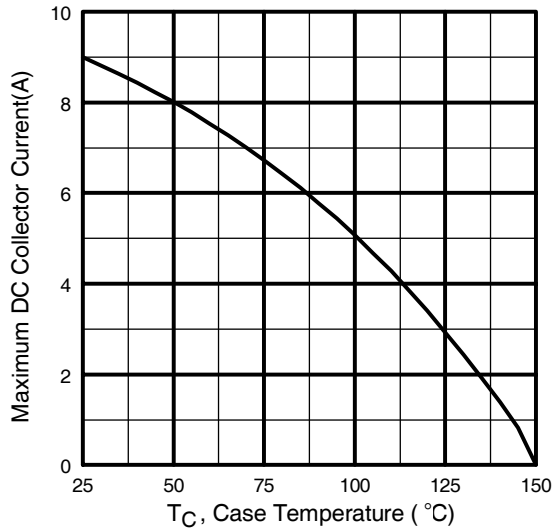


**Fig. 2** - Typical Output Characteristics  
[www.irf.com](http://www.irf.com)

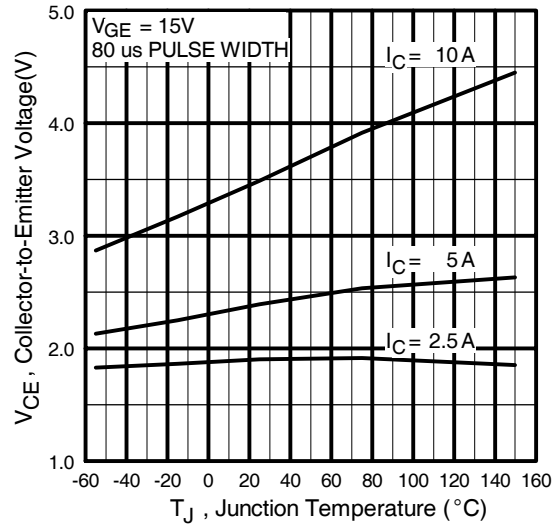


**Fig. 3** - Typical Transfer Characteristics

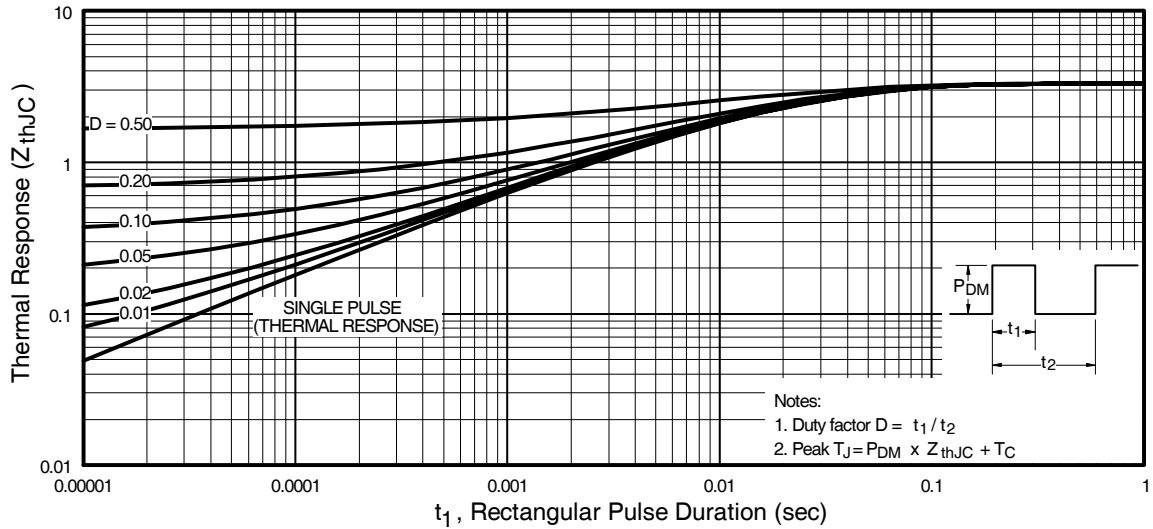
# IRG4RC10KDPbF



**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

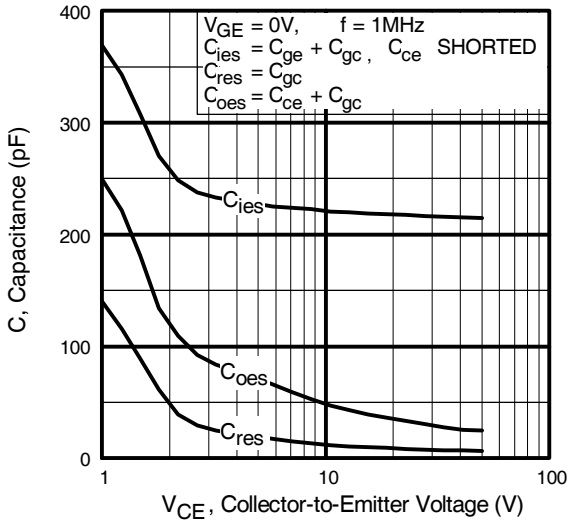


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

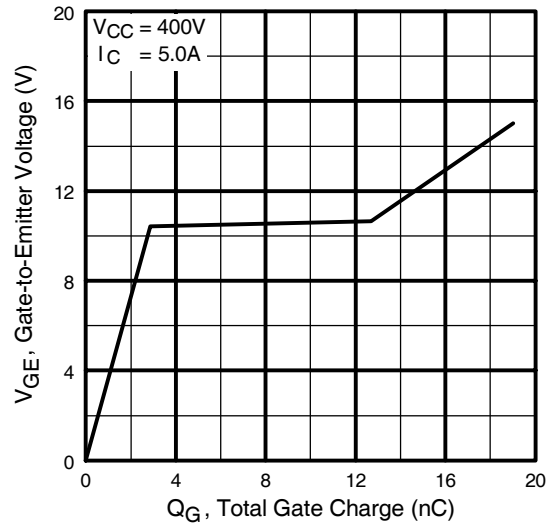


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

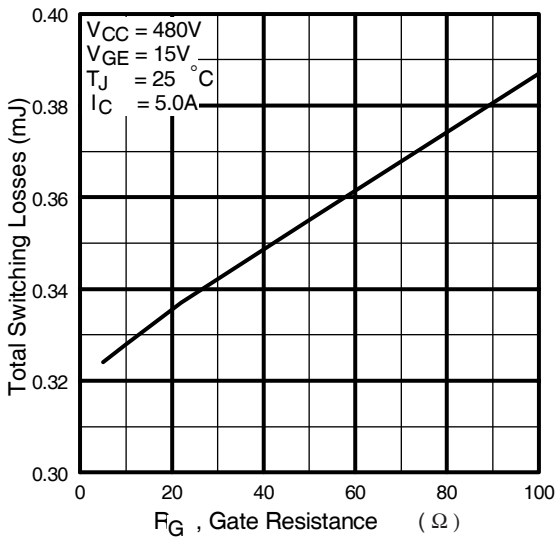


Fig. 9 - Typical Switching Losses vs. Gate Resistance

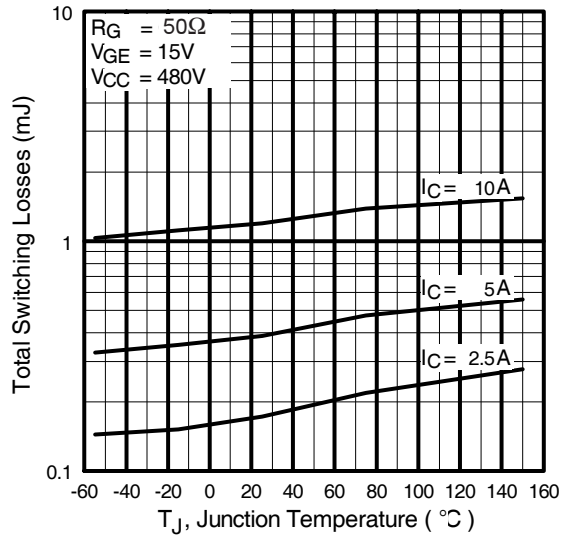
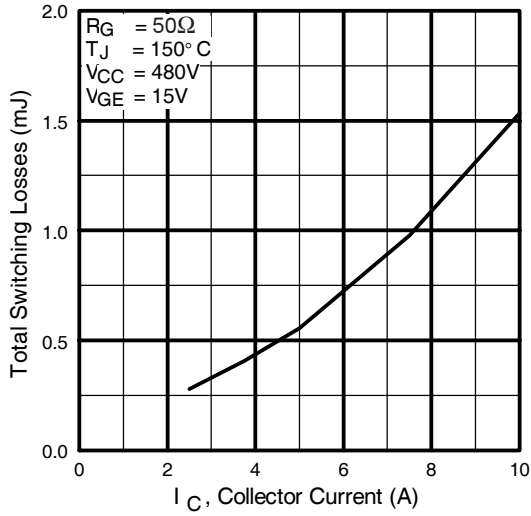
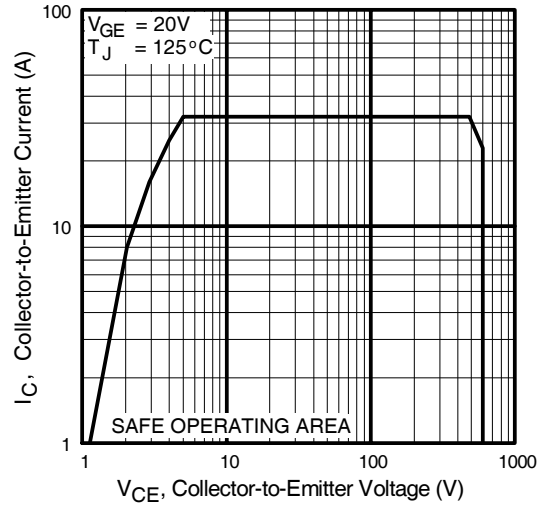


Fig. 10 - Typical Switching Losses vs. Junction Temperature

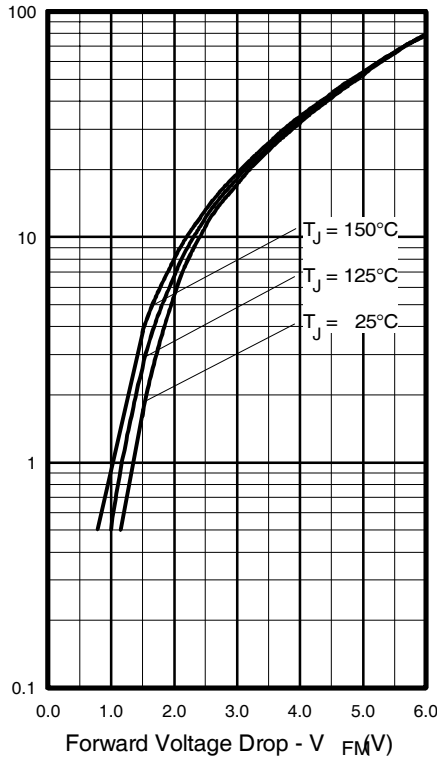
# IRG4RC10KDPbF



**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

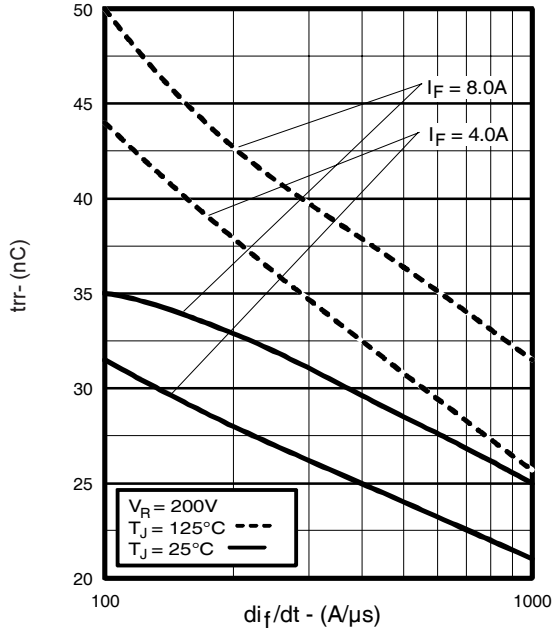


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

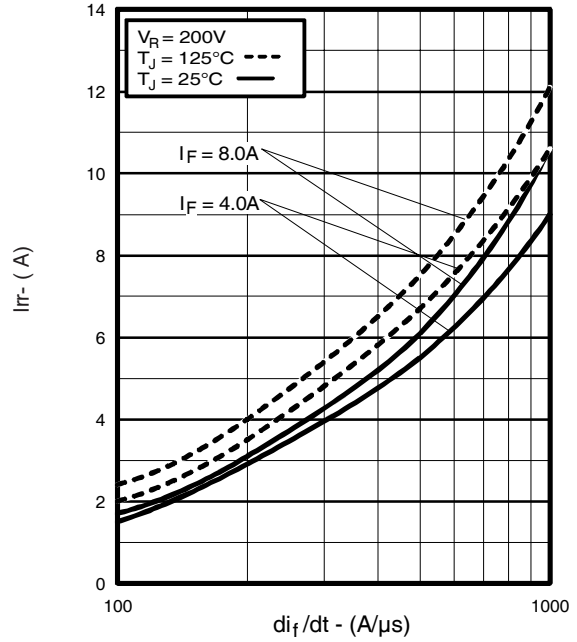


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

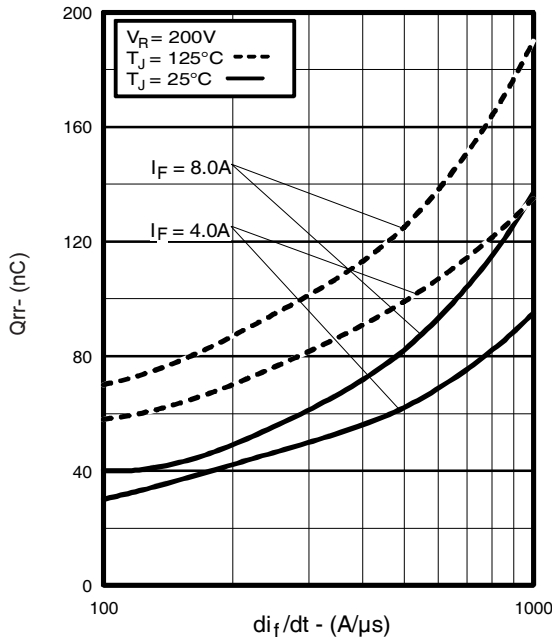


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

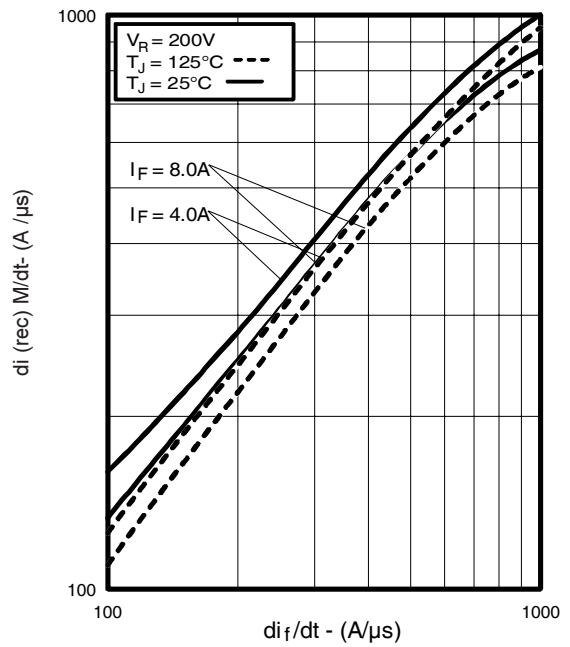
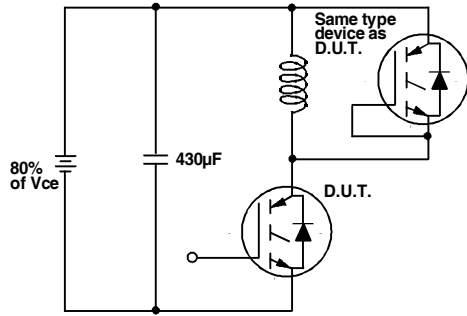
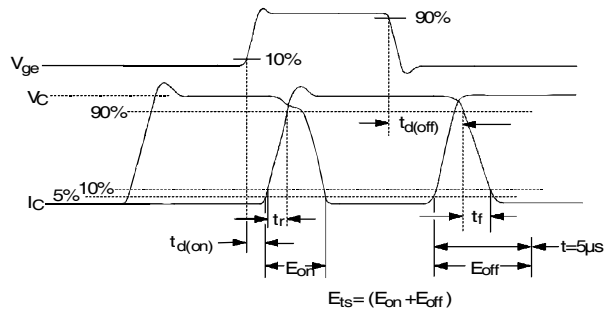


Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$ ,

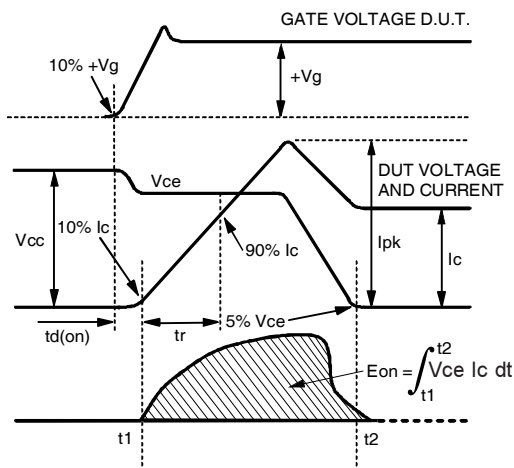
# IRG4RC10KDPbF



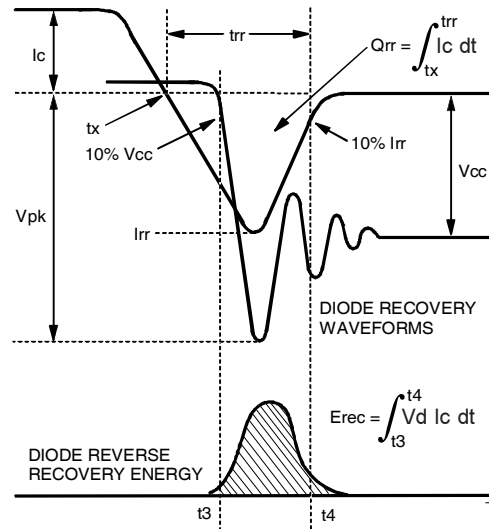
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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



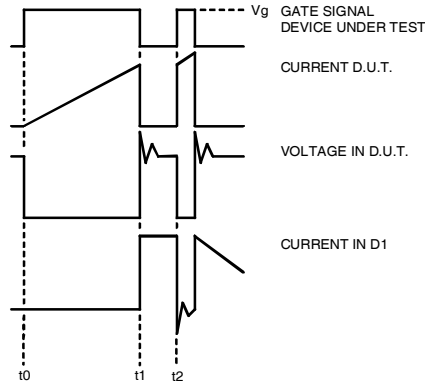


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

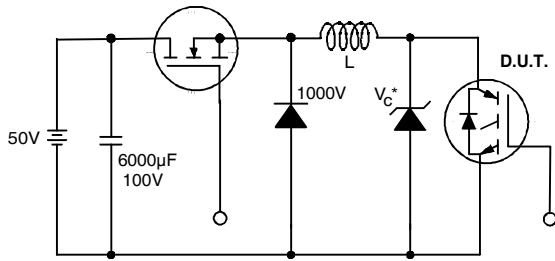


Figure 19. Clamped Inductive Load Test Circuit

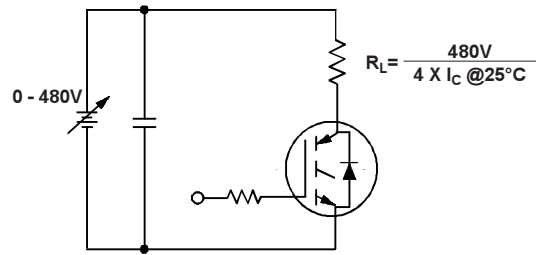
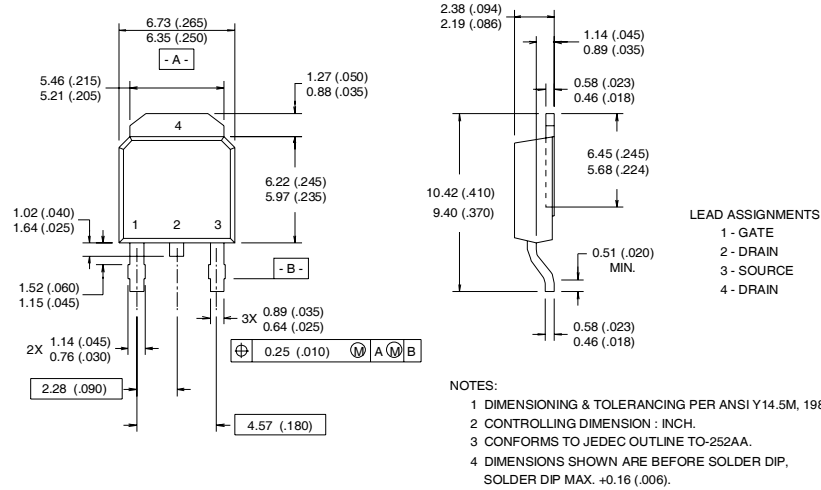


Figure 20. Pulsed Collector Current Test Circuit

# IRG4RC10KDPbF

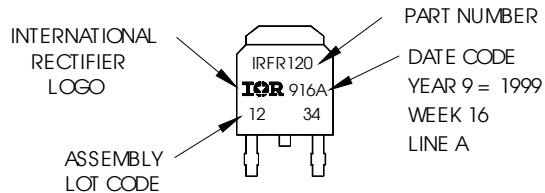
## D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)

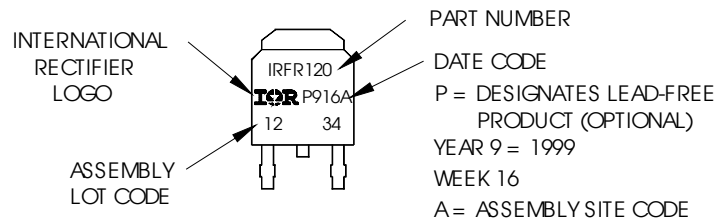


## D-Pak (TO-252AA) Part Marking Information (Lead-Free)

EXAMPLE: THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON WW 16, 1999  
IN THE ASSEMBLY LINE "A"  
Note: "P" in assembly line  
position indicates "Lead-Free"



OR

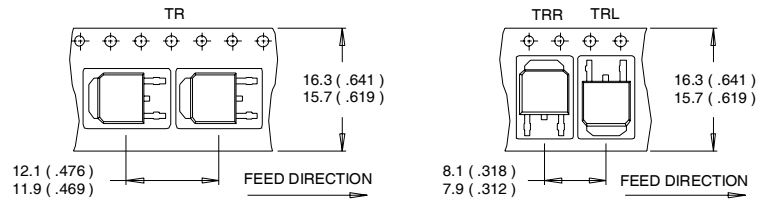


**Notes:**

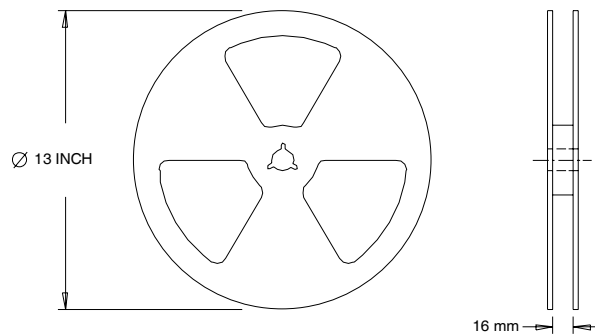
- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=100\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

## D-Pak (TO-252AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



- NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
  2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
  3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



- NOTES :
1. OUTLINE CONFORMS TO EIA-481.

Data and specifications subject to change without notice.

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