

# 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<sub>GE</sub> = 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

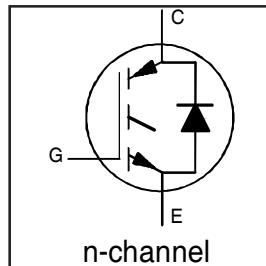
	Parameter	Max.	Units
V <sub>CES</sub>	Collector-to-Emitter Voltage	600	V
I <sub>C</sub> @ T <sub>C</sub> = 25°C	Continuous Collector Current	9.0	
I <sub>C</sub> @ T <sub>C</sub> = 100°C	Continuous Collector Current	5.0	
I <sub>CM</sub>	Pulsed Collector Current ①	18	A
I <sub>LM</sub>	Clamped Inductive Load Current ②	18	
I <sub>F</sub> @ T <sub>C</sub> = 100°C	Diode Continuous Forward Current	4.0	
I <sub>FM</sub>	Diode Maximum Forward Current	16	
t <sub>sc</sub>	Short Circuit Withstand Time	10	$\mu$ s
V <sub>GE</sub>	Gate-to-Emitter Voltage	$\pm$ 20	V
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Maximum Power Dissipation	38	
P <sub>D</sub> @ T <sub>C</sub> = 100°C	Maximum Power Dissipation	15	W
T <sub>J</sub> T <sub>STG</sub>	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	g (oz)

## Thermal Resistance

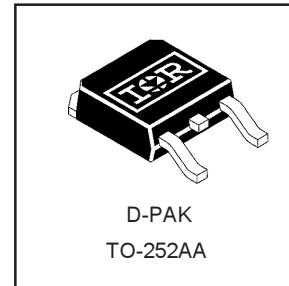
	Parameter	Typ.	Max.	Units
R <sub>0JC</sub>	Junction-to-Case - IGBT	—	3.3	°C/W
R <sub>0JC</sub>	Junction-to-Case - Diode	—	7.0	
R <sub>0JA</sub>	Junction-to-Ambient (PCB mount)*	—	50	
Wt	Weight	0.3 (0.01)	—	g (oz)

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

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



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



# IRG4RC10KDPbF

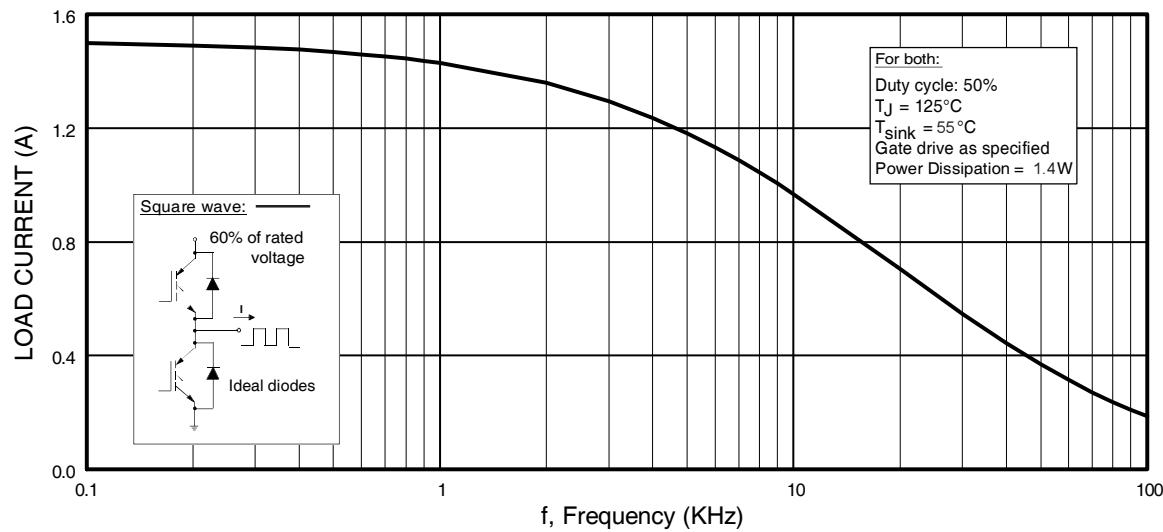
International  
Rectifier

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

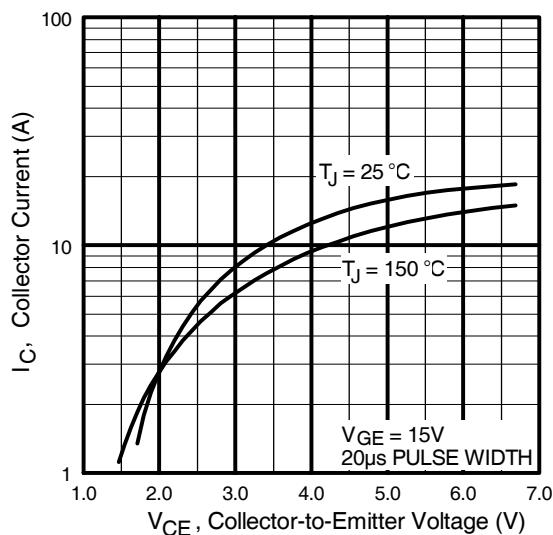
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{CES}}$	Collector-to-Emitter Breakdown Voltage <sup>f</sup>	600	—	—	V	$V_{\text{GE}} = 0\text{V}$ , $I_C = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{CES}/\Delta T_J}$	Temperature Coeff. of Breakdown Voltage	—	0.58	—	V/ $^\circ\text{C}$	$V_{\text{GE}} = 0\text{V}$ , $I_C = 1.0\text{mA}$
$V_{\text{CE}(\text{on})}$	Collector-to-Emitter Saturation Voltage	—	2.39	2.62	V	$I_C = 5.0\text{A}$ $V_{\text{GE}} = 15\text{V}$
		—	3.25	—		$I_C = 9.0\text{A}$ See Fig. 2, 5
		—	2.63	—		$I_C = 5.0\text{A}$ , $T_J = 150^\circ\text{C}$
$V_{\text{GE}(\text{th})}$	Gate Threshold Voltage	3.0	—	6.5		$V_{\text{CE}} = V_{\text{GE}}$ , $I_C = 250\mu\text{A}$
$\Delta V_{\text{GE}(\text{th})/\Delta T_J}$	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/ $^\circ\text{C}$	$V_{\text{CE}} = V_{\text{GE}}$ , $I_C = 250\mu\text{A}$
$g_{\text{fe}}$	Forward Transconductance „	1.2	1.8	—	S	$V_{\text{CE}} = 50\text{V}$ , $I_C = 5.0\text{A}$
$I_{\text{CES}}$	Zero Gate Voltage Collector Current	—	—	250	$\mu\text{A}$	$V_{\text{GE}} = 0\text{V}$ , $V_{\text{CE}} = 600\text{V}$
		—	—	1000		$V_{\text{GE}} = 0\text{V}$ , $V_{\text{CE}} = 600\text{V}$ , $T_J = 150^\circ\text{C}$
$V_{\text{FM}}$	Diode Forward Voltage Drop	—	1.5	1.8	V	$I_C = 4.0\text{A}$ See Fig. 13
		—	1.4	1.7		$I_C = 4.0\text{A}$ , $T_J = 150^\circ\text{C}$
$I_{\text{GES}}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{\text{GE}} = \pm 20\text{V}$

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

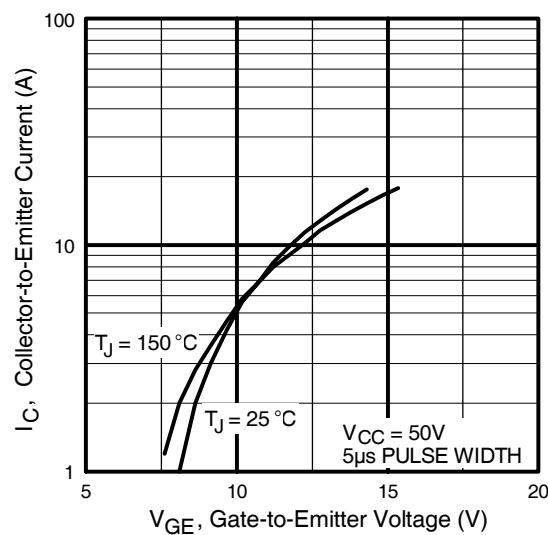
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	19	29	nC	$I_C = 5.0\text{A}$
$Q_{\text{ge}}$	Gate - Emitter Charge (turn-on)	—	2.9	4.3		$V_{\text{CC}} = 400\text{V}$ See Fig.8
$Q_{\text{gc}}$	Gate - Collector Charge (turn-on)	—	9.8	15		$V_{\text{GE}} = 15\text{V}$
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	49	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 5.0\text{A}$ , $V_{\text{CC}} = 480\text{V}$ $V_{\text{GE}} = 15\text{V}$ , $R_G = 100\Omega$ Energy losses include "tail" and diode reverse recovery See Fig. 9,10,14
$t_r$	Rise Time	—	28	—		
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	97	150		
$t_f$	Fall Time	—	140	210		
$E_{\text{on}}$	Turn-On Switching Loss	—	0.25	—	mJ	See Fig. 9,10,14
$E_{\text{off}}$	Turn-Off Switching Loss	—	0.14	—		
$E_{\text{ts}}$	Total Switching Loss	—	0.39	0.48		
$t_{\text{sc}}$	Short Circuit Withstand Time	10	—	—	$\mu\text{s}$	$V_{\text{CC}} = 360\text{V}$ , $T_J = 125^\circ\text{C}$ $V_{\text{GE}} = 15\text{V}$ , $R_G = 100\Omega$ , $V_{\text{CPK}} < 500\text{V}$
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	46	—	ns	$T_J = 150^\circ\text{C}$ , See Fig. 10,11,14 $I_C = 5.0\text{A}$ , $V_{\text{CC}} = 480\text{V}$ $V_{\text{GE}} = 15\text{V}$ , $R_G = 100\Omega$ Energy losses include "tail" and diode reverse recovery
$t_r$	Rise Time	—	32	—		
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	100	—		
$t_f$	Fall Time	—	310	—		
$E_{\text{ts}}$	Total Switching Loss	—	0.56	—	mJ	Measured 5mm from package
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	
$C_{\text{ies}}$	Input Capacitance	—	220	—	pF	$V_{\text{GE}} = 0\text{V}$
$C_{\text{oes}}$	Output Capacitance	—	29	—		$V_{\text{CC}} = 30\text{V}$ See Fig. 7
$C_{\text{res}}$	Reverse Transfer Capacitance	—	7.5	—		$f = 1.0\text{MHz}$
$t_{\text{rr}}$	Diode Reverse Recovery Time	—	28	42	ns	$T_J = 25^\circ\text{C}$ See Fig.
		—	38	57		$T_J = 125^\circ\text{C}$ 14
$I_{\text{rr}}$	Diode Peak Reverse Recovery Current	—	2.9	5.2	A	$T_J = 25^\circ\text{C}$ See Fig.
		—	3.7	6.7		$T_J = 125^\circ\text{C}$ 15
$Q_{\text{rr}}$	Diode Reverse Recovery Charge	—	40	60	nC	$T_J = 25^\circ\text{C}$ See Fig.
		—	70	105		$T_J = 125^\circ\text{C}$ 16
$dI_{(\text{rec})M}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	280	—	A/ $\mu\text{s}$	$T_J = 25^\circ\text{C}$ See Fig.
		—	235	—		$T_J = 125^\circ\text{C}$ 17



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



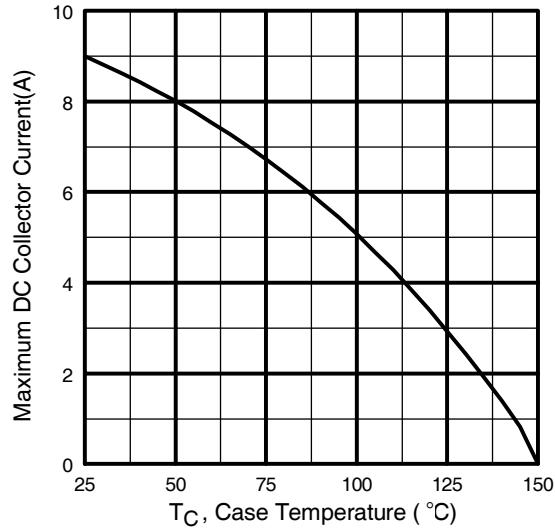
**Fig. 2 - Typical Output Characteristics**  
[www.irf.com](http://www.irf.com)



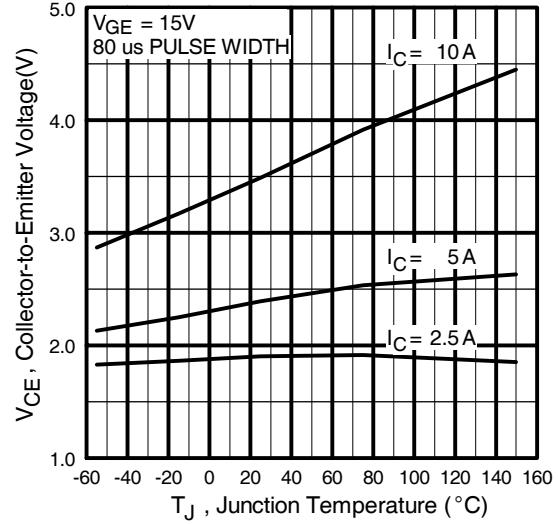
**Fig. 3 - Typical Transfer Characteristics**

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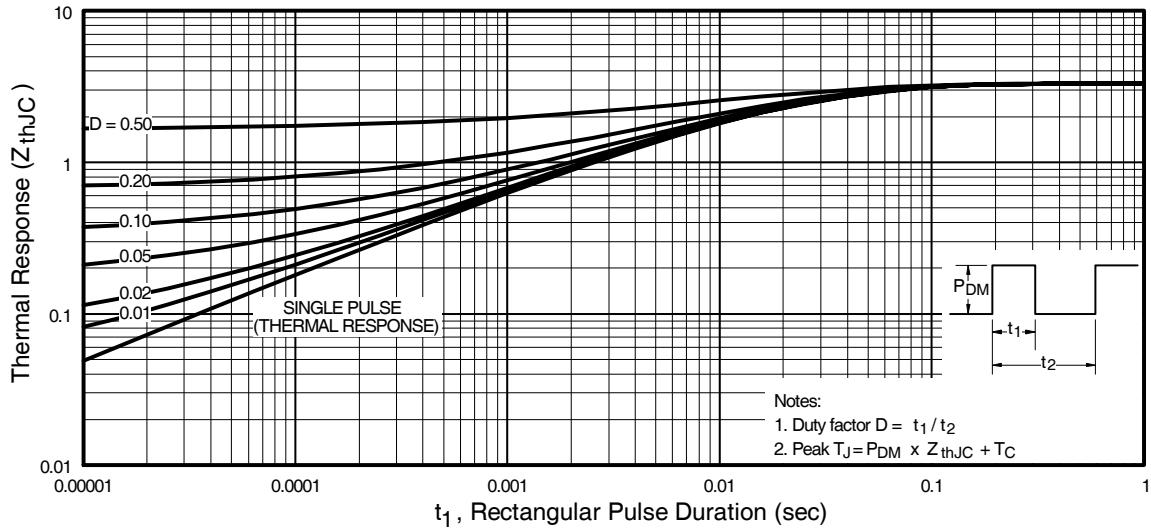
International  
**IR** Rectifier



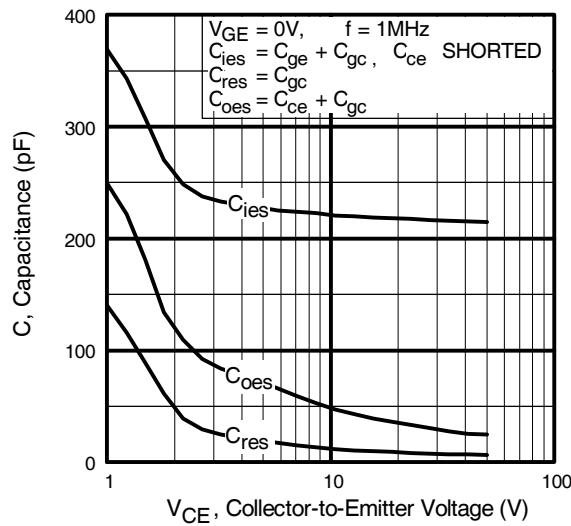
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



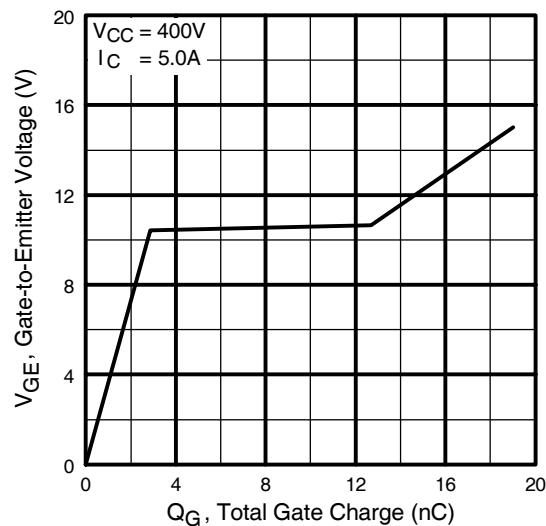
**Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature**



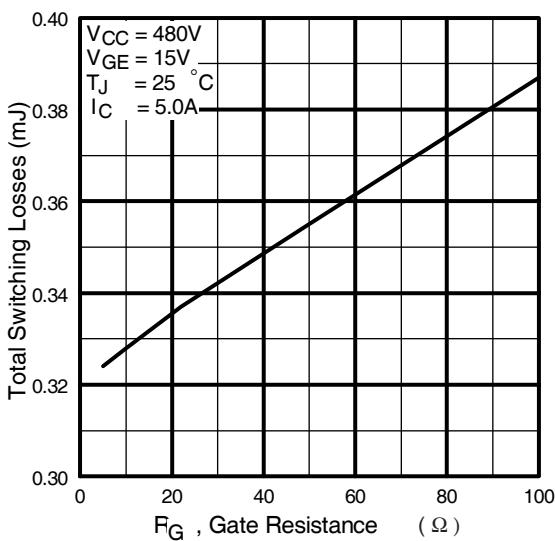
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



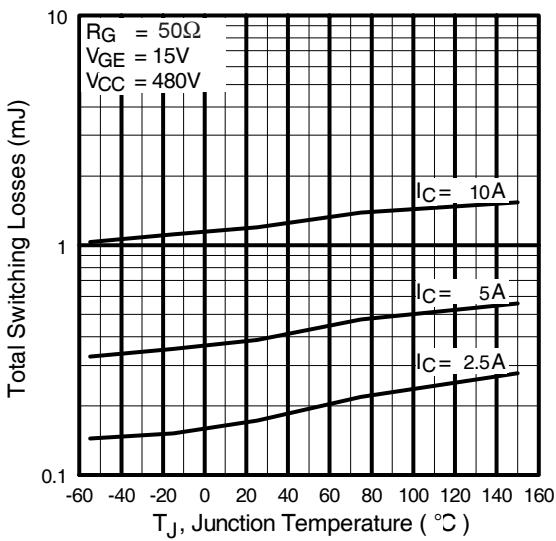
**Fig. 7** - Typical Capacitance vs.  
Collector-to-Emitter Voltage



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



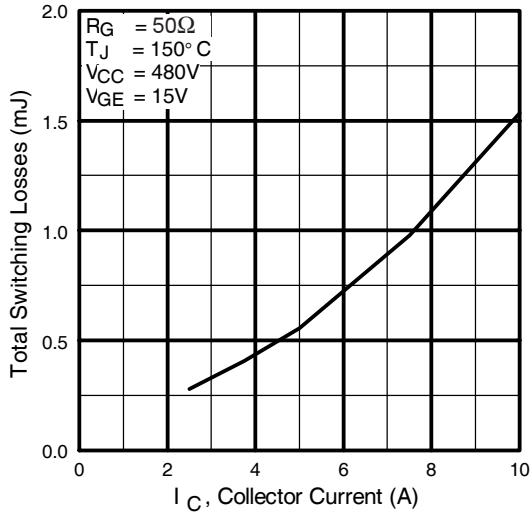
**Fig. 9** - Typical Switching Losses vs. Gate  
Resistance



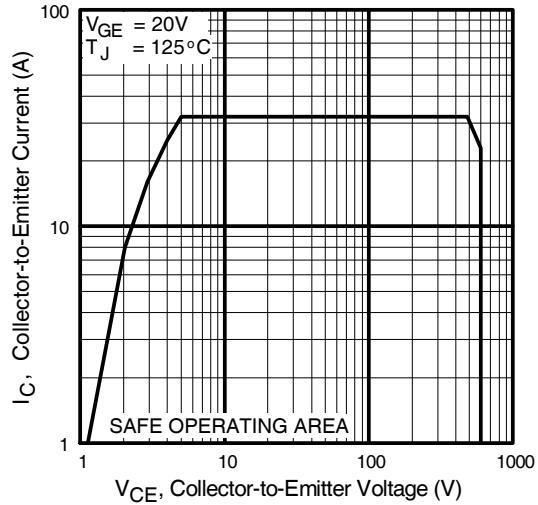
**Fig. 10** - Typical Switching Losses vs.  
Junction Temperature

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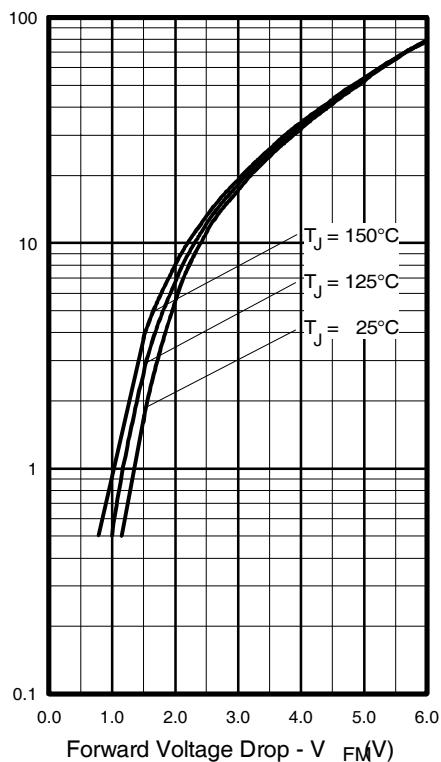
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**Fig. 11** - Typical Switching Losses vs.  
Collector-to-Emitter Current

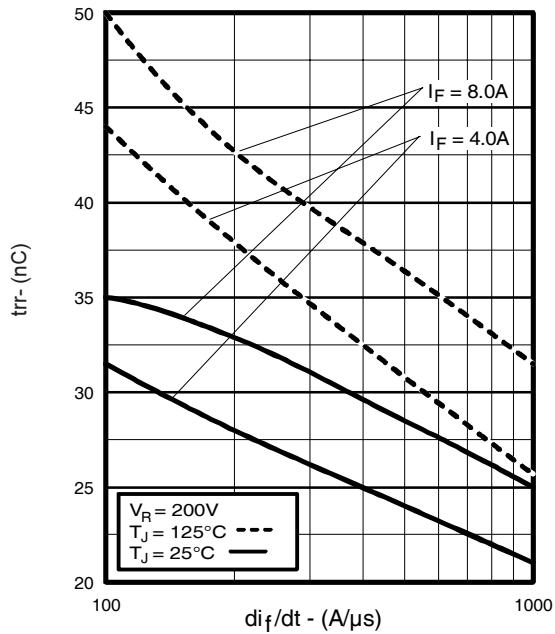


**Fig. 12** - Turn-Off SOA

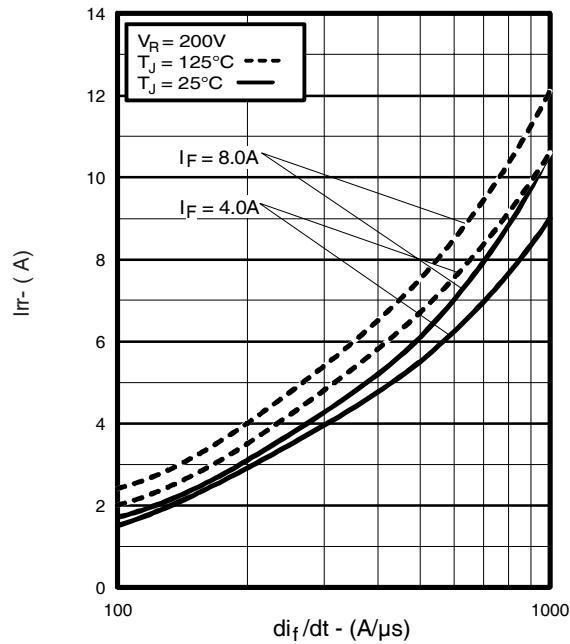


**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current

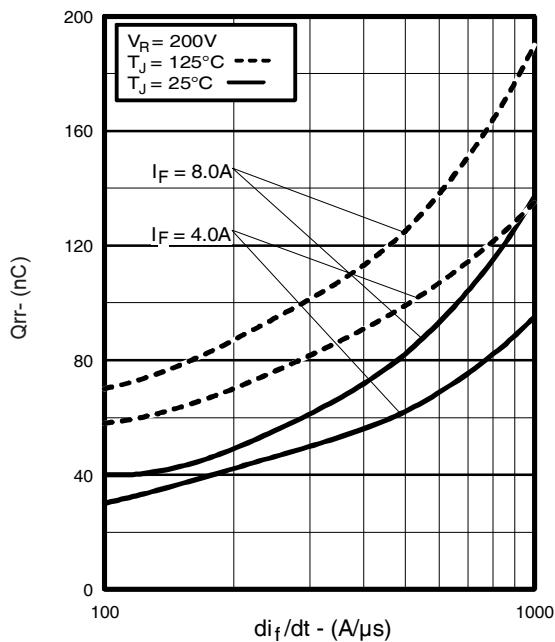
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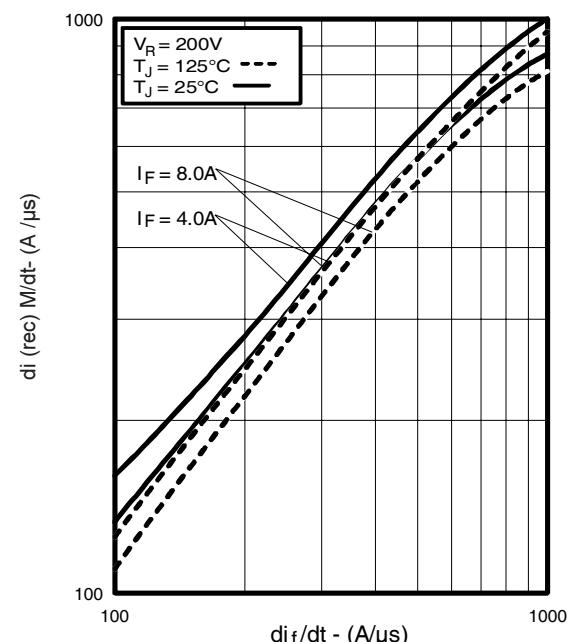
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



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



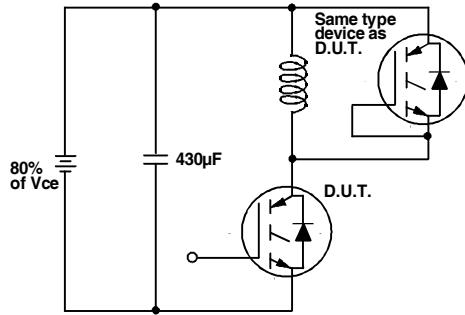
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$



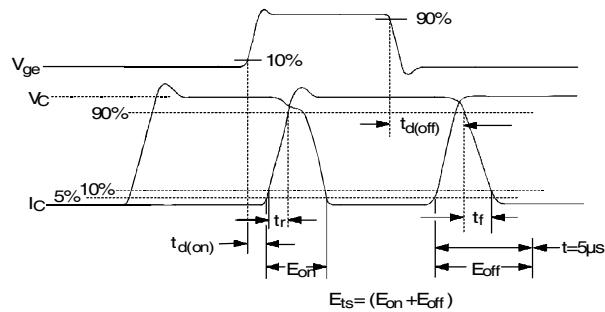
**Fig. 17** - Typical  $di_{(rec)M}/dt$  vs.  $di_f/dt$ ,

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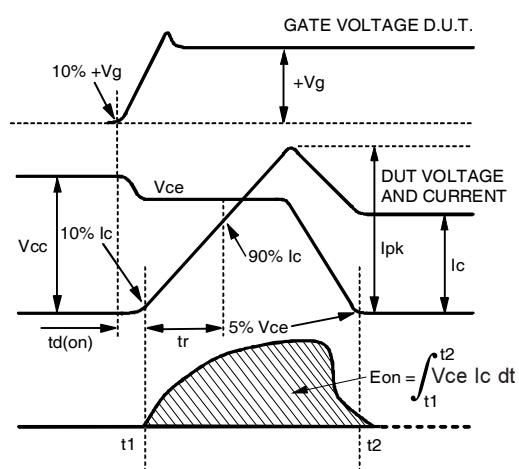
International  
**IR** Rectifier



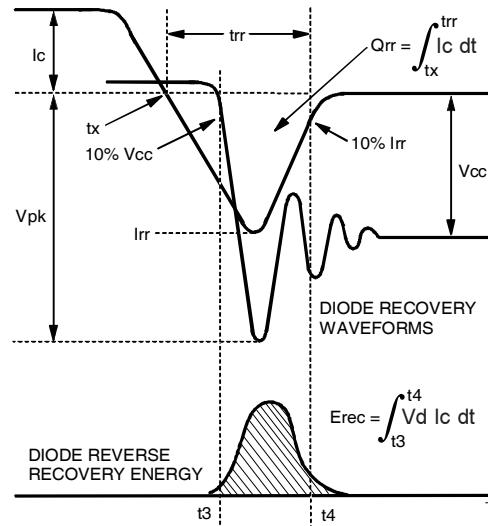
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off(diode)}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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

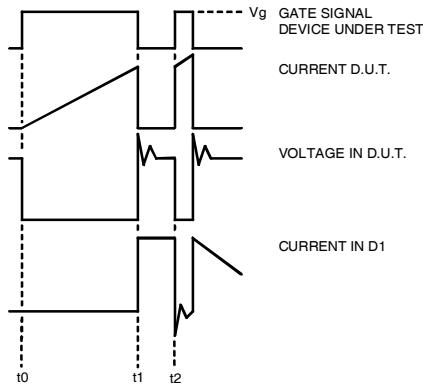


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

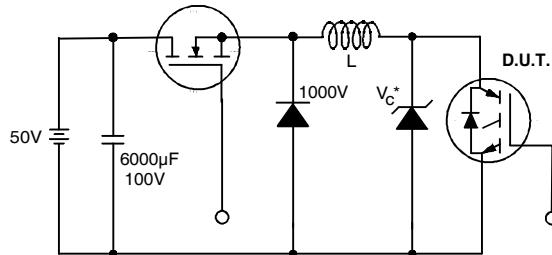


Figure 19. Clamped Inductive Load Test Circuit

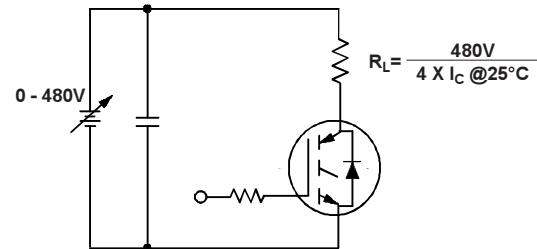


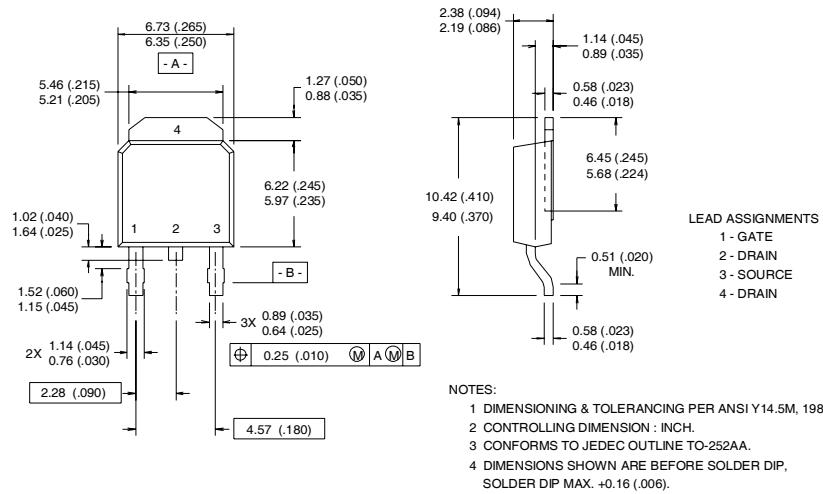
Figure 20. Pulsed Collector Current Test Circuit

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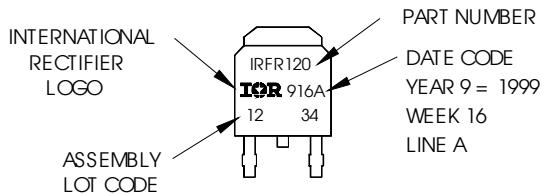
## D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)

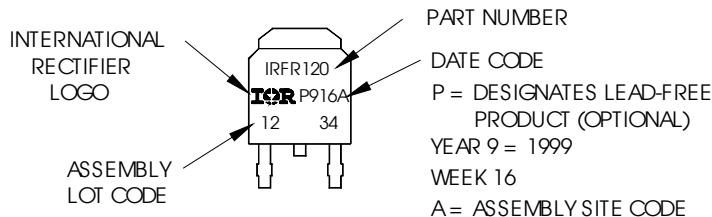


## D-Pak (TO-252AA) Part Marking Information (Lead-Free)

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

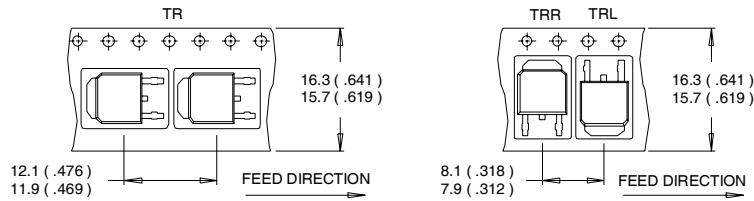


### Notes:

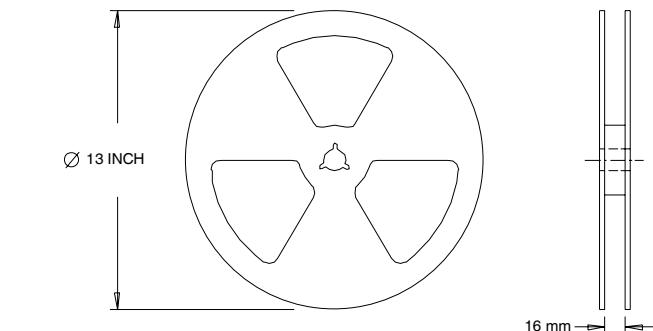
- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\% (V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G= 100\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

### 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.

International  
**IR** Rectifier

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