

International  
**IR** Rectifier

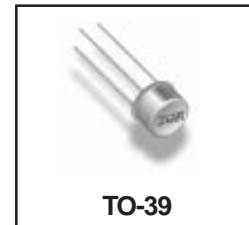
PD - 90882F

**RADIATION HARDENED  
 POWER MOSFET  
 THRU-HOLE (TO-39)**

**IRHF9130  
 JANSR2N7389  
 100V, P-CHANNEL  
 REF: MIL-PRF-19500/630  
 RAD-Hard™ HEXFET® TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	RDS(on)	ID	QPL Part Number
IRHF9130	100K Rads (Si)	0.30Ω	-6.5A	JANSR2N7389
IRHF93130	300K Rads (Si)	0.30Ω	-6.5A	JANSF2N7389



International Rectifier's RAD-Hard HEXFET™ technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). The combination of low Rds(on) and low gate charge reduces the power losses in switching applications such as DC to DC converters and motor control. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching, ease of paralleling and temperature stability of electrical parameters.

**Features:**

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Package
- Light Weight

**Absolute Maximum Ratings**

**Pre-Irradiation**

	Parameter		Units
ID @ VGS = -12V, TC = 25°C	Continuous Drain Current	-6.5	A
ID @ VGS = -12V, TC = 100°C	Continuous Drain Current	-4.1	
IDM	Pulsed Drain Current ①	-26	
PD @ TC = 25°C	Max. Power Dissipation	25	W
	Linear Derating Factor	0.2	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	165	mJ
IAR	Avalanche Current ①	-6.5	A
EAR	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-22	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Lead Temperature	300 ( 0.063 in. (1.6mm) from case for 10s)	
	Weight	0.98 (typical)	g

For footnotes refer to the last page

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## IRHF9130

## Pre-Irradiation

Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)

	Parameter	Min	Typ	Max	Units	Test Conditions
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	-100	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = -1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	-0.112	—	V/°C	Reference to 25°C, I <sub>D</sub> = -1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.30	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -4.1A <sup>④</sup>
		—	—	0.35		V <sub>GS</sub> = -12V, I <sub>D</sub> = -6.5A <sup>④</sup>
V <sub>GS(th)</sub>	Gate Threshold Voltage	-2.0	—	-4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -1.0mA
g <sub>fs</sub>	Forward Transconductance	2.5	—	—	S (r)	V <sub>DS</sub> > -15V, I <sub>DS</sub> = -4.1A <sup>④</sup>
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	-25	μA	V <sub>DS</sub> = -80V, V <sub>GS</sub> = 0V
		—	—	-250		V <sub>DS</sub> = -80V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	—	-100	nA	V <sub>GS</sub> = -20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	—	100		V <sub>GS</sub> = 20V
Q <sub>g</sub>	Total Gate Charge	—	—	45	nC	V <sub>GS</sub> = -12V, I <sub>D</sub> = -6.5A V <sub>DS</sub> = -50V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	10		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	25		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	30	ns	V <sub>DD</sub> = -50V, I <sub>D</sub> = -6.5A, V <sub>GS</sub> = -12V, R <sub>G</sub> = 7.5Ω
t <sub>r</sub>	Rise Time	—	—	50		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	70		
t <sub>f</sub>	Fall Time	—	—	70		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	7.0	—	nH	Measured from drain lead (6mm/0.25in. from package) to source lead (6mm/0.25in. from package)
C <sub>iss</sub>	Input Capacitance	—	1200	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = -25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	290	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	76	—		

## Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	-6.5	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) <sup>①</sup>	—	—	-26		
V <sub>SD</sub>	Diode Forward Voltage	—	—	-3.0	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = -6.5A, V <sub>GS</sub> = 0V <sup>④</sup>
t <sub>rr</sub>	Reverse Recovery Time	—	—	250	nS	T <sub>J</sub> = 25°C, I <sub>F</sub> = -6.5A, di/dt ≤ -100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	0.74	μC	V <sub>DD</sub> ≤ -50V <sup>④</sup>
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> .				

## Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	5.0	°C/W	Typical socket mount
R <sub>thJA</sub>	Junction-to-Ambient	—	—	175		

Note: Corresponding Spice and Saber models are available on the G&S Website.

For footnotes refer to the last page

## Radiation Characteristics

**IRHF9130**

International Rectifier Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at International Rectifier is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 5 and 6) using the TO-3 package. Both pre- and post-irradiation performance are tested and specified using the same drive circuitry and test conditions in order to provide a direct comparison.

**Table 1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥**

	Parameter	100K Rads(Si) <sup>1</sup>		300K Rads (Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	-100	—	-100	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = -1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	-2.0	-4.0	-2.0	-5.0		V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = -1.0mA
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	-100	—	-100	nA	V <sub>GS</sub> = -20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	100	—	100		V <sub>GS</sub> = 20 V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	-25	—	-25	μA	V <sub>DS</sub> = -80V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.30	—	0.30	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -4.1A
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-39)	—	0.30	—	0.30	Ω	V <sub>GS</sub> = -12V, I <sub>D</sub> = -4.1A
V <sub>SD</sub>	Diode Forward Voltage ④	—	-3.0	—	-3.0	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = -6.5A

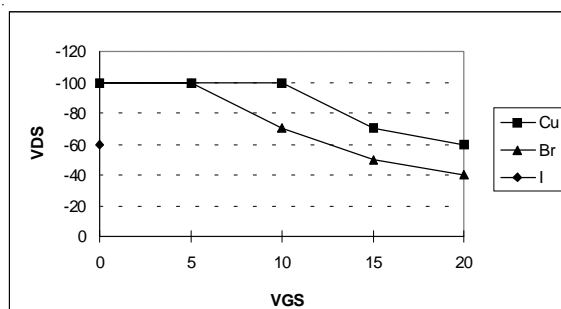
1. Part number IRHF9130 (JANSR2N7389)

2. Part number IRHF9130 (JANSF2N7389)

International Rectifier radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. a and Table 2.

**Table 2. Single Event Effect Safe Operating Area**

Ion	LET MeV/(mg/cm <sup>2</sup> )	Energy (MeV)	Range (μm)	V <sub>DS</sub> (V)				
				@V <sub>GS</sub> =0V	@V <sub>GS</sub> =5V	@V <sub>GS</sub> =10V	@V <sub>GS</sub> =15V	@V <sub>GS</sub> =20V
Cu	28	285	43	-100	-100	-100	-70	-60
Br	36.8	305	39	-100	-100	-70	-50	-40
I	59.9	345	32.8	-60	—	—	—	—


**Fig a. Single Event Effect, Safe Operating Area**

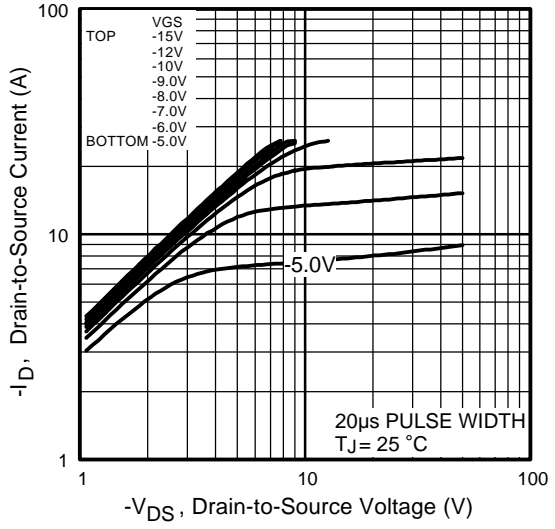
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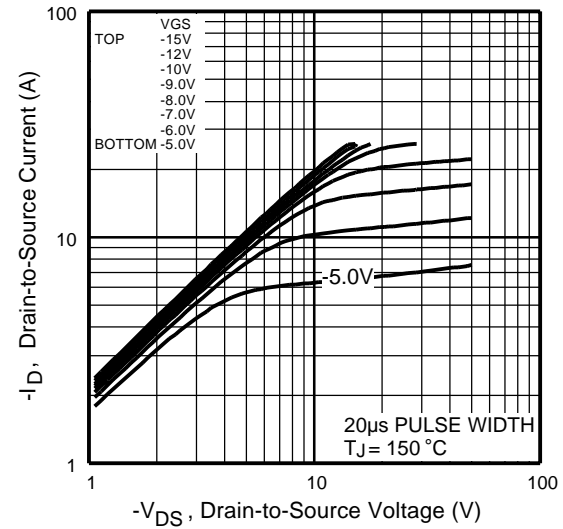
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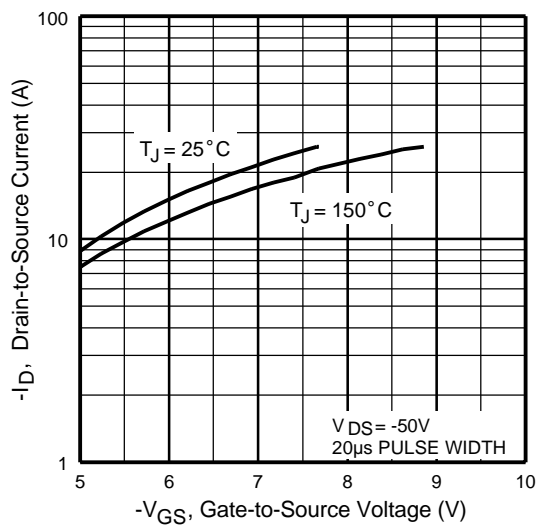
**Pre-Irradiation**



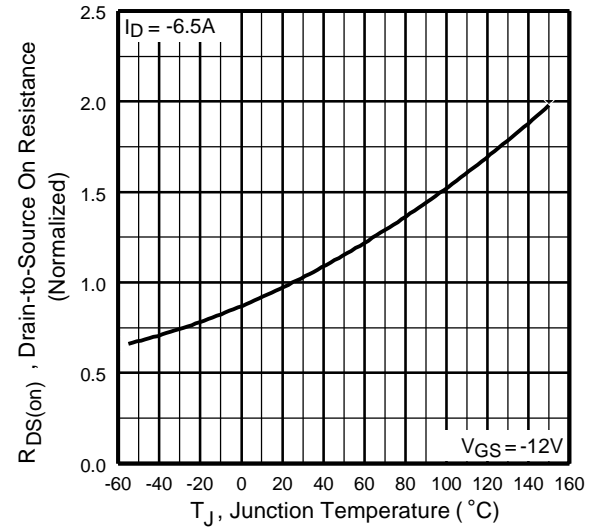
**Fig1.** Typical Output Characteristics



**Fig2.** Typical Output Characteristics



**Fig3.** Typical Transfer Characteristics



**Fig4.** Normalized On-Resistance Vs. Temperature

Pre-Irradiation

IRHF9130

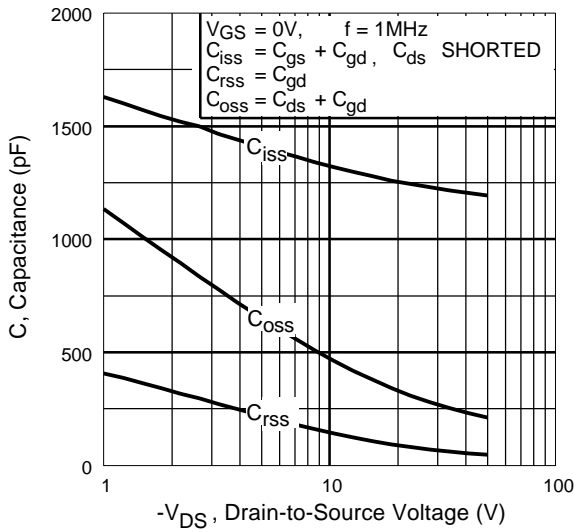


Fig5. Typical Capacitance Vs. Drain-to-Source Voltage

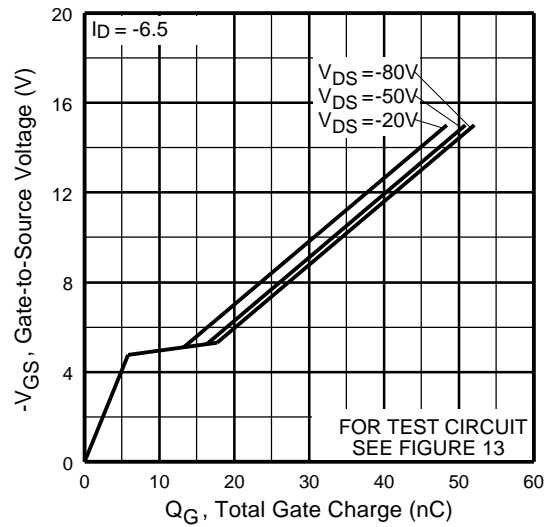


Fig6. Typical Gate Charge Vs. Gate-to-Source Voltage

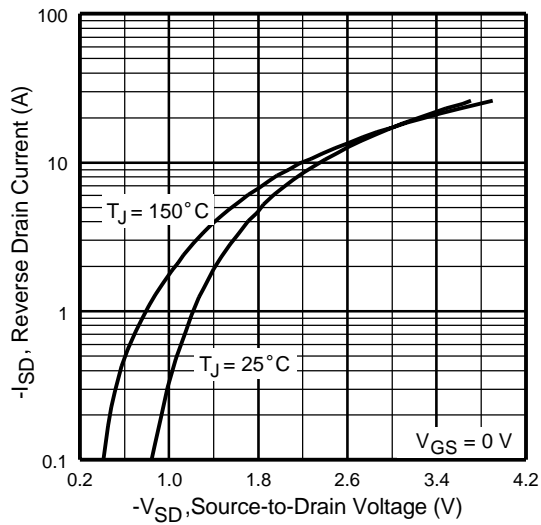


Fig7. Typical Source-Drain Diode Forward Voltage

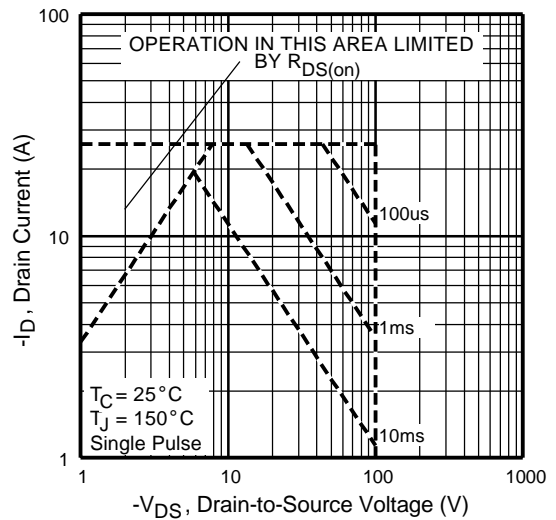


Fig8. Maximum Safe Operating Area

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Pre-Irradiation

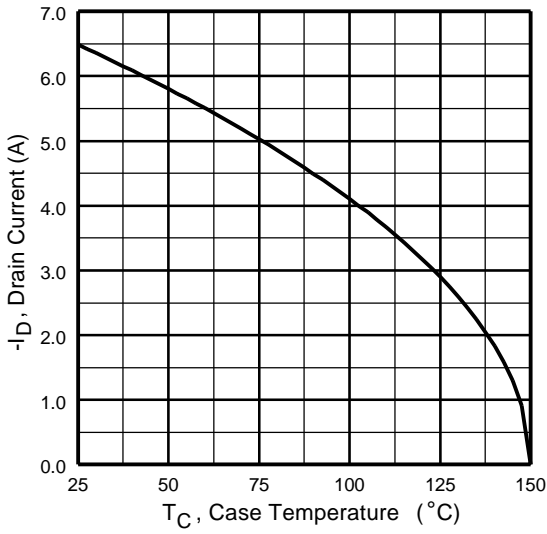


Fig9. Maximum Drain Current Vs. Case Temperature

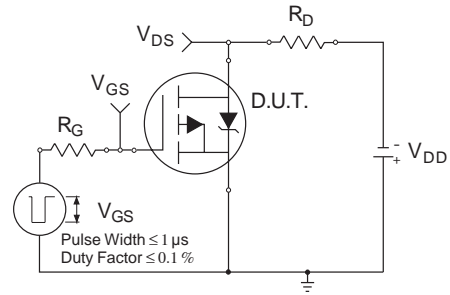


Fig 10a. Switching Time Test Circuit

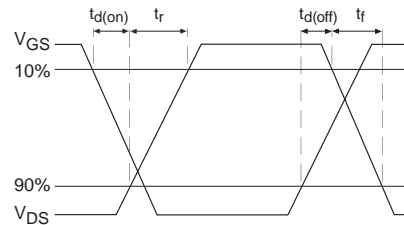


Fig 10b. Switching Time Waveforms

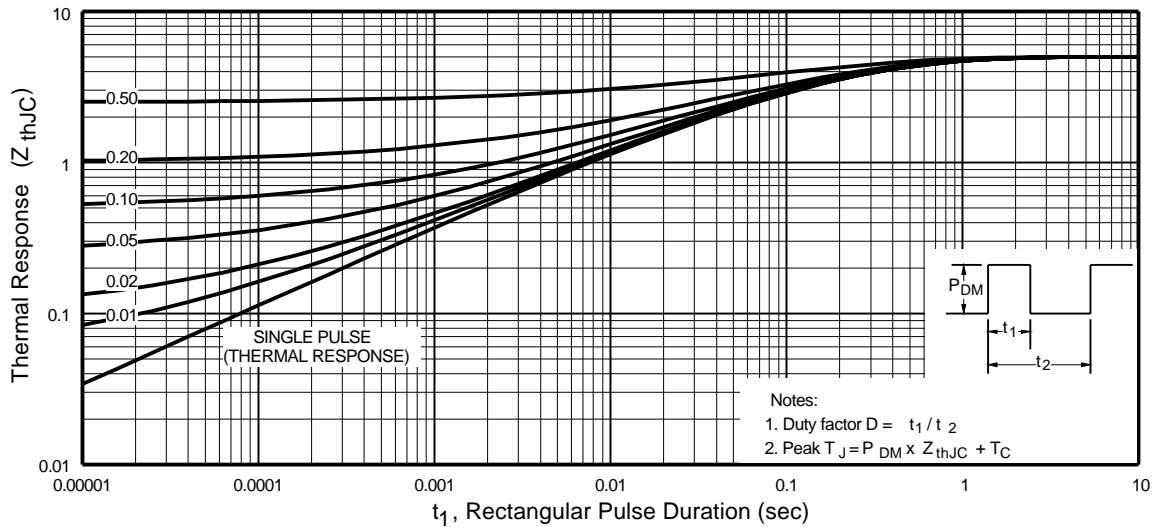


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Pre-Irradiation

IRHF9130

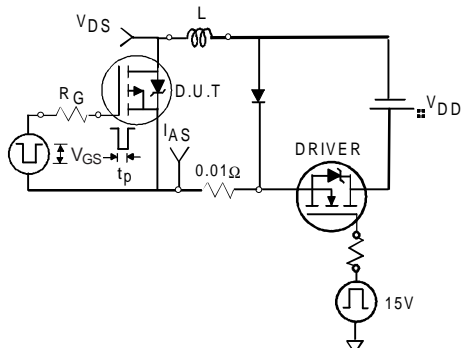


Fig12a. Unclamped Inductive Test Circuit

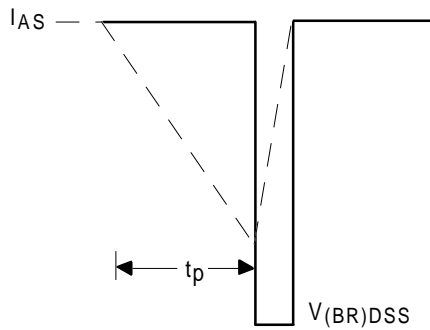


Fig12b. Unclamped Inductive Waveforms

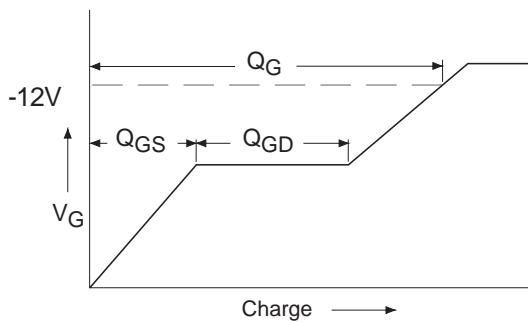


Fig13a. Basic Gate Charge Waveform

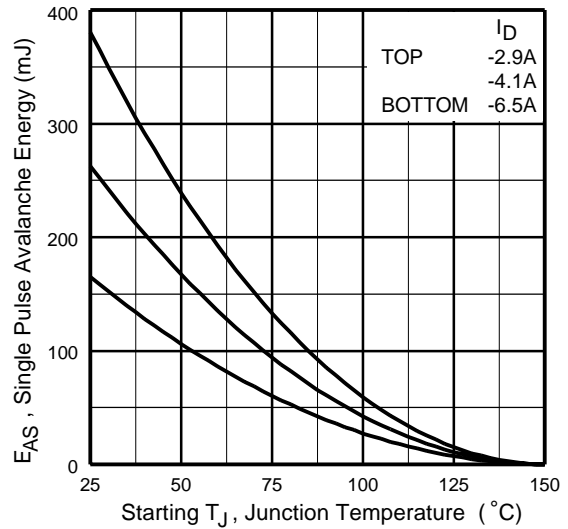


Fig12c. Maximum Avalanche Energy Vs. Drain Current

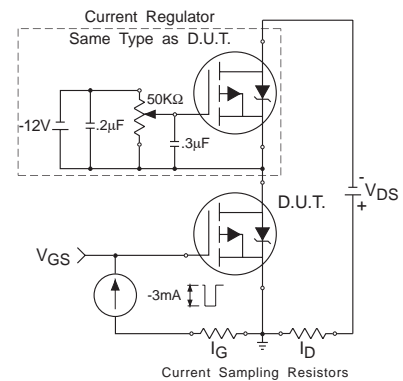
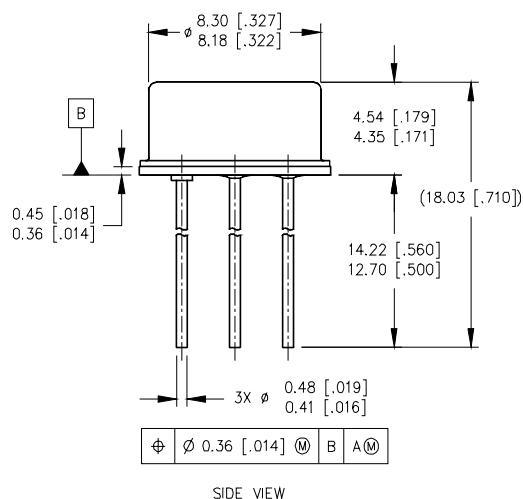


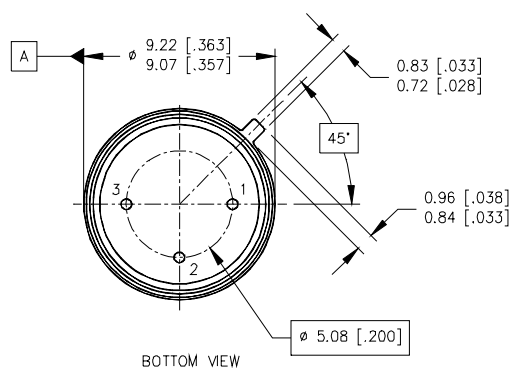
Fig13b. Gate Charge Test Circuit

**IRHF9130****Pre-Irradiation****Foot Notes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = -25V$ , starting  $T_J = 25^\circ C$ ,  $L=7.8mH$   
Peak  $I_L = -6.5A$ ,  $V_{GS} = -12V$
- ③  $I_{SD} \leq -6.5A$ ,  $di/dt \leq -430A/\mu s$ ,  
 $V_{DD} \leq -100V$ ,  $T_J \leq 150^\circ C$
- ④ Pulse width  $\leq 300 \mu s$ ; Duty Cycle  $\leq 2\%$
- ⑤ **Total Dose Irradiation with  $V_{GS}$  Bias.**  
-12 volt  $V_{GS}$  applied and  $V_{DS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.
- ⑥ **Total Dose Irradiation with  $V_{DS}$  Bias.**  
-80 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — TO-205AF(Modified TO-39)****NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME 14.5M-1994.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO-205AF (TO-39).

**LEGEND**

- 1- SOURCE
- 2- GATE
- 3- DRAIN

International  
**IR Rectifier**

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