



RADIATION HARDENED POWER MOSFET THRU-HOLE TO-205AF (TO-39)

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

Product Summary

Part Number	Radiation Level	RDS(on)	I _D	QPL Part Number
IRHF9130	100 kRads(Si)	0.30Ω	-6.5A	JANSR2N7389
IRHF93130	300 kRads(Si)	0.30Ω	-6.5A	JANSF2N7389



Description

IR HiRel RADHard™ HEXFET® MOSFET technology provides high performance power MOSFETs for space applications. This technology has long history 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 and temperature stability of electrical parameters.

Features

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Proton Tolerant
- · Simple Drive Requirements
- · Hermetically Sealed
- Ceramic Package
- Light Weight
- ESD Rating: Class 1B per MIL-STD-750, Method 1020

Absolute Maximum Ratings

Pre-Irradiation

Symbol	Parameter	Value	Units	
I_{D1} @ V_{GS} = -12V, T_{C} = 25°C	Continuous Drain Current	-6.5		
I _{D2} @ V _{GS} = -12V, T _C = 100°C	Continuous Drain Current	-4.1	Α	
I _{DM} @ T _C = 25°C	Pulsed Drain Current ①	-26		
P _D @ T _C = 25°C	Maximum Power Dissipation	25	W	
	Linear Derating Factor	0.2	W/°C	
V_{GS}	Gate-to-Source Voltage	ge ± 20		
E _{AS}	Single Pulse Avalanche Energy ②	165	mJ	
I _{AR}	Avalanche Current ①	-6.5	Α	
E _{AR}	Repetitive Avalanche Energy ①	2.5	mJ	
dv/dt	Peak Diode Recovery dv/dt ③	-22	V/ns	
T _J	Operating Junction and	-55 to + 150		
T _{STG}	Storage Temperature Range	-55 to + 150	°C	
	Lead Temperature	300 (0.063 in. /1.6 mm from case for 10s)		
	Weight	0.98 (Typical)	g	

For Footnotes, refer to the page 2.



Electrical Characteristics @ Tj = 25°C (Unless Otherwise Specified)

Symbol	Parameter	Min.	Тур.	Max.	Units	Test Conditions
BV _{DSS}	Drain-to-Source Breakdown Voltage	-100			V	$V_{GS} = 0V, I_{D} = -1.0mA$
$\Delta BV_{DSS}/\Delta T_{J}$	Breakdown Voltage Temp. Coefficient		-0.112		V/°C	Reference to 25°C, I _D = -1.0mA
В	Static Drain-to-Source On-Resistance			0.30	0	V _{GS} = -12V, I _{D2} = -4.1A ④
R _{DS(on)}	Static Drain-to-Source On-Resistance			0.35	Ω	V _{GS} = -12V, I _{D1} = -6.5A ④
V _{GS(th)}	Gate Threshold Voltage	-2.0		-4.0	V	$V_{DS} = V_{GS}$, $I_D = -1.0$ mA
Gfs	Forward Transconductance	2.5			S	V _{DS} = -15V, I _{D2} = -4.1A ④
I _{DSS}	Zero Gate Voltage Drain Current			-25		$V_{DS} = -80V$, $V_{GS} = 0V$
	Zelo Gate Voltage Dialii Current			-250	μA	$V_{DS} = -80V, V_{GS} = 0V, T_{J} = 125^{\circ}C$
I _{GSS}	Gate-to-Source Leakage Forward			-100	nA	$V_{GS} = -20V$
	Gate-to-Source Leakage Reverse			100	Π	$V_{GS} = 20V$
Q_{G}	Total Gate Charge			45		$I_{D1} = -6.5A$
Q_{GS}	Gate-to-Source Charge			10	nC	$V_{DS} = -50V$
Q_{GD}	Gate-to-Drain ('Miller') Charge			25		V _{GS} = -12V
t _{d(on)}	Turn-On Delay Time			30		$V_{DD} = -50V$
tr	Rise Time			50		$I_{D1} = -6.5A$
t _{d(off)}	Turn-Off Delay Time			70	ns	$R_G = 7.5\Omega$
t _f	Fall Time			70		V _{GS} = -12V
Ls +L _D	Total Inductance		7.0		nH	Measured from Drain lead (6mm / 0.25 in from package) to Source lead (6mm/ 0.25 in from package) with Source wire internally bonded from Source pin to Drain pin
C _{iss}	Input Capacitance		1200			V _{GS} = 0V
Coss	Output Capacitance		290		pF	$V_{DS} = -25V$
C _{rss}	Reverse Transfer Capacitance		76			f = 1.0 MHz

Source-Drain Diode Ratings and Characteristics

Symbol	Parameter	Min.	Тур.	Max.	Units	Test Conditions
Is	Continuous Source Current (Body Diode)			-6.5	^	
I _{SM}	Pulsed Source Current (Body Diode) ①			-26	A	
V_{SD}	Diode Forward Voltage			-3.0	V	$T_J = 25^{\circ}C, I_S = -6.5A, V_{GS} = 0V$
t _{rr}	Reverse Recovery Time			250	ns	$T_J = 25^{\circ}C, I_F = -6.5A, V_{DD} \le -50V$
Q _{rr}	Reverse Recovery Charge			0.74	μC	di/dt = -100A/µs ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L _S +L _D)				

Thermal Resistance

Symbol	Parameter	Min.	Тур.	Max.	Units
$R_{ heta JC}$	Junction-to-Case			5.0	°C 111
$R_{\theta JA}$	Junction-to-Ambient (Typical Socket Mount)			175	°C/W

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- \odot V_{DD} = -25V, starting T_J = 25°C, L = 7.8mH, Peak I_L = -6.5A, V_{GS} = -12V
- $\label{eq:local_spin_spin} \text{\mathbb{S}} \quad I_{SD} \leq \text{-6.5A, di/dt} \leq \text{-430A/}\mu\text{s, } V_{DD} \leq \text{-100V, } T_J \leq 150^{\circ}\text{C}$
- \odot 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.
- © 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.



Radiation Characteristics

IR HiRel Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at IR HiRel 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.

Table1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation \$6

Symbol	Parameter	100 kRads (Si) ¹		300 kRads (Si) ²		Units	Test Conditions	
		Min.	Max.	Min.	Max.			
BV _{DSS}	Drain-to-Source Breakdown Voltage	-100		-100		V	$V_{GS} = 0V, I_{D} = -1.0 \text{mA}$	
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	-4.0	-2.0	-5.0	V	$V_{DS} = V_{GS}$, $I_D = -1.0$ mA	
I _{GSS}	Gate-to-Source Leakage Forward		-100		-100	nA	V _{GS} = -20V	
I _{GSS}	Gate-to-Source Leakage Reverse		100		100	nA	V _{GS} = 20V	
I _{DSS}	Zero Gate Voltage Drain Current		-25		-25	μA	$V_{DS} = -80V, V_{GS} = 0V$	
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (TO-3)		0.30		0.30	Ω	V _{GS} = -12V, I _{D2} = -4.1A	
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (TO-39)		0.30		0.30	Ω	$V_{GS} = -12V$, $I_{D2} = -4.1A$	
V _{SD}	Diode Forward Voltage 4		-3.0		-3.0	V	$V_{GS} = 0V, I_{S} = -6.5A$	

- Part numbers IRHF9130 (JANSR2N7389)
- 2. Part numbers IRHF91230 (JANSF2N7389)

IR HiRel 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. Typical Single Event Effect Safe Operating Area

					VDS (V)					
lon	LET (MeV/(mg/cm²))	Energy (MeV)	Range (µm)	@ VGS = 0V	@ VGS = 5V	@ VGS = 10V	@ VGS = 15V	@ VGS = 20V		
Cu	28	285	43	-100	-100	-100	-70	-50		
Kr	38.8	320	39.6	-100	-100	-75	-50			
Xe	63.4	348	32.5	-50						

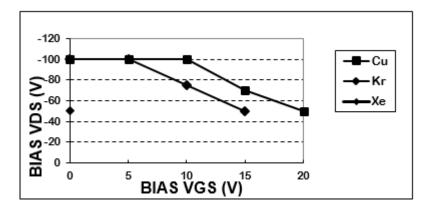


Fig a. Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

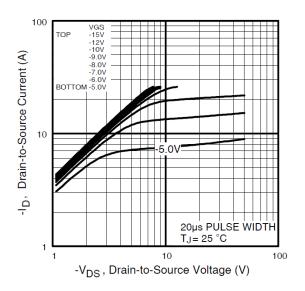


Fig 1. Typical Output Characteristics

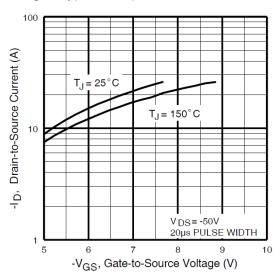


Fig 3. Typical Transfer Characteristics

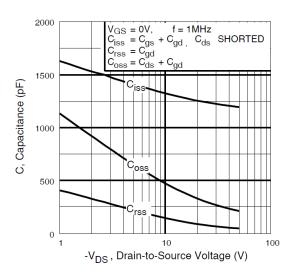


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

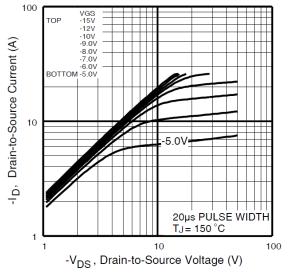


Fig 2. Typical Output Characteristics

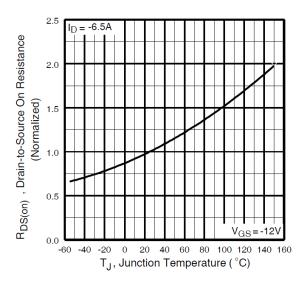


Fig 4. Normalized On-Resistance Vs. Temperature

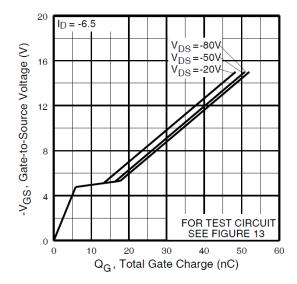


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

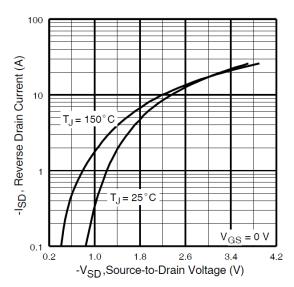


Fig 7. Typical Source-Drain Diode Forward Voltage

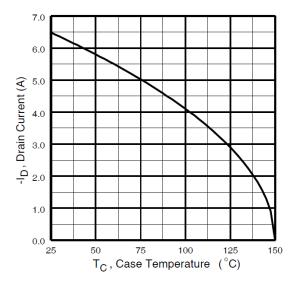


Fig 9. Maximum Drain Current Vs.
Case Temperature

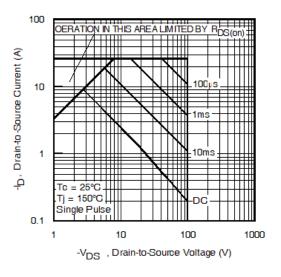


Fig 8. Maximum Safe Operating Area

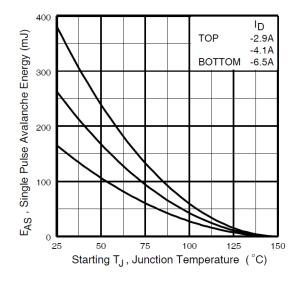


Fig 10. Maximum Avalanche Energy Vs. Drain Current

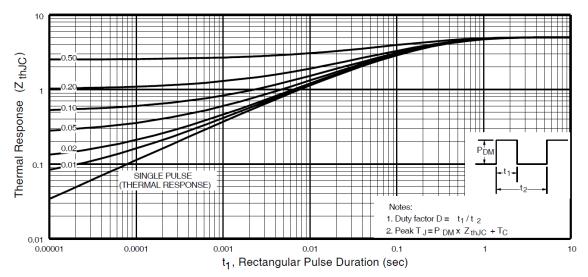


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

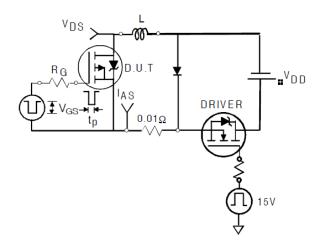


Fig 12a. Unclamped Inductive Test Circuit

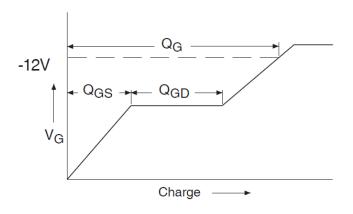


Fig 13a. Gate Charge Waveform

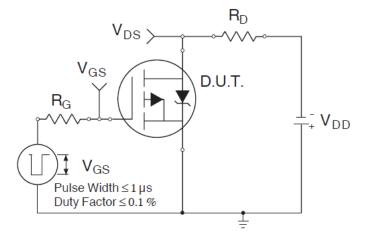


Fig 14a. Switching Time Test Circuit

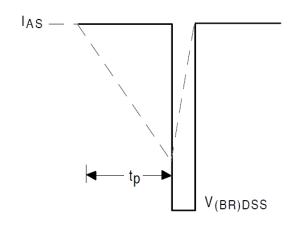


Fig 12b. Unclamped Inductive Wave-

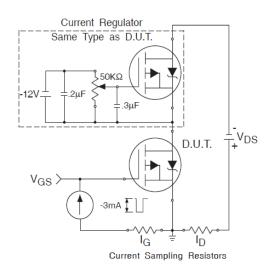


Fig 13b. Gate Charge Test Circuit

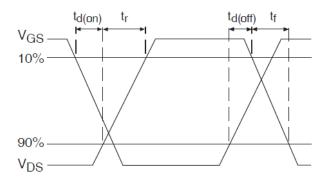
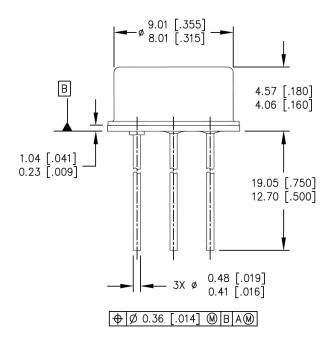


Fig 14b. Switching Time Waveforms

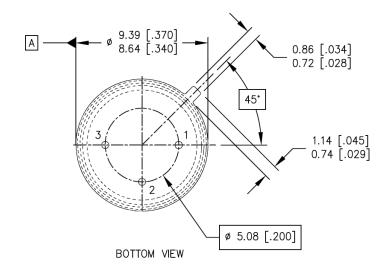


Case Outline and Dimensions - TO-205AF (TO-39)



NOTES: SIDE VIEW

- 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 (CONNECTED TO THE CASE)



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