

REPETITIVE AVALANCHE AND dv/dt RATED HEXFET® TRANSISTOR

IRHF9130 JANSR2N7389 [REF: MIL-PRF-19500/630] P-CHANNEL RAD HARD

-100 Volt, 0.30 Ω , RAD HARD HEXFET

International Rectifier's P-Channel RAD HARD technology HEXFETs demonstrate excellent threshold voltage stability and breakdown voltage stability at total radiation doses as high as 10^5 Rads (Si). Under **identical** pre- and post-radiation test conditions, International Rectifier's P-Channel RAD HARD HEXFETs retain **identical** electrical specifications up to 1×10^5 Rads (Si) total dose. No compensation in gate drive circuitry is required. These devices are also capable of surviving transient ionization pulses as high as 1×10^{12} Rads (Si)/Sec, and return to normal operation within a few microseconds. Single Event Effect (SEE) testing of International Rectifier P-Channel RAD HARD HEXFETs has demonstrated virtual immunity to SEE failure. Since the RAD HARD process utilizes International Rectifier's patented HEXFET technology, the user can expect the highest quality and reliability in the industry.

P-Channel RAD HARD HEXFET transistors also feature all of the well-established advantages of MOSFETs, such as voltage control, very fast switching, ease of paralleling and temperature stability of the electrical parameters.

They are well-suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers and high-energy pulse circuits in space and weapons environments.

Product Summary

Part Number	BV _{DSS}	R _{DS(on)}	I _D
IRHF9130	-100V	0.30 Ω	-6.5A

Features:

- Radiation Hardened up to 1×10^5 Rads (Si)
- Single Event Burnout (SEB) Hardened
- Single Event Gate Rupture (SEGR) Hardened
- Gamma Dot (Flash X-Ray) Hardened
- Neutron Tolerant
- Identical Pre- and Post-Electrical Test Conditions
- Avalanche Energy Rating
- Dynamic dv/dt Rating
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed

Absolute Maximum Ratings

Pre-Radiation

	Parameter	IRHF9130	Units
I _D @ V _{GS} = -12V, T _C = 25°C	Continuous Drain Current	-6.5	A
I _D @ V _{GS} = -12V, T _C = 100°C	Continuous Drain Current	-4.1	
I _{DM}	Pulsed Drain Current ①	-26	
P _D @ T _C = 25°C	Max. Power Dissipation	25	W
	Linear Derating Factor	0.2	W/K ⑤
V _{GS}	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	165	mJ
I _{AR}	Avalanche Current ①	-6.5	A
E _{AR}	Repetitive Avalanche Energy ①	2.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Lead Temperature	300 (0.063 in (1.6 mm) from case for 10 sec.)	
	Weight	0.98 (typical)	

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV _{DSS}	Drain-to-Source Breakdown Voltage	-100	—	—	V	V _{GS} = 0V, I _D = -1.0 mA
ΔBV _{DSS} /ΔT _J	Temperature Coefficient of Breakdown Voltage	—	-0.087	—	V/°C	Reference to 25°C, I _D = -1.0 mA
RDS(on)	Static Drain-to-Source	—	—	0.30	Ω	V _{GS} = 12V, I _D = -4.1A
	On-State Resistance	—	—	0.325		V _{GS} = 12V, I _D = -6.5A ④
VGS(th)	Gate Threshold Voltage	-2.0	—	-4.0	V	V _{DS} = V _{GS} , I _D = -1.0 mA
g _{fs}	Forward Transconductance	2.5	—	—	S (r)	V _{DS} ≥ -15V, I _{DS} = -4.1A ④
IDSS	Zero Gate Voltage Drain Current	—	—	-25	μA	V _{DS} = 0.8 x Max Rating, V _{GS} = 0V
		—	—	-250		V _{DS} = 0.8 x Max Rating V _{GS} = 0V, T _J = 125°C
IGSS	Gate-to-Source Leakage Forward	—	—	-100	nA	V _{GS} = -20V
IGSS	Gate-to-Source Leakage Reverse	—	—	100	nA	V _{GS} = 20V
Q _g	Total Gate Charge	—	—	35	nC	V _{GS} = -12V, I _D = -6.5A
Q _{gs}	Gate-to-Source Charge	—	—	10		V _{DS} = Max. Rating x 0.5
Q _{gd}	Gate-to-Drain ("Miller") Charge	—	—	25		
t _{d(on)}	Turn-On Delay Time	—	—	30	ns	V _{DD} = -50V, I _D = -6.5A, R _G = 7.5Ω
t _r	Rise Time	—	—	70		
t _{d(off)}	Turn-Off Delay Time	—	—	70		
t _f	Fall Time	—	—	70		
LD	Internal Drain Inductance	—	5.0	—	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
LS	Internal Source Inductance	—	13	—		Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.
C _{iss}	Input Capacitance	—	1100	—	pF	V _{GS} = 0V, V _{DS} = -25V f = 1.0 MHz
C _{oss}	Output Capacitance	—	310	—		
C _{rss}	Reverse Transfer Capacitance	—	55	—		

Modified MOSFET symbol showing the internal inductances.



Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	-6.5	A	Modified MOSFET symbol showing the integral reverse p-n junction rectifier.
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	-26		
V _{SD}	Diode Forward Voltage	—	—	-3.0	V	T _j = 25°C, I _S = -6.5A, V _{GS} = 0V ②
t _{rr}	Reverse Recovery Time	—	—	250	ns	T _j = 25°C, I _F = -6.5A, di/dt ≤ -100A/μs
Q _{RR}	Reverse Recovery Charge	—	—	2.6	μC	V _{DD} ≤ -50V ②
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _S + L _D .				

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R _{thJC}	Junction-to-Case	—	—	5.0	K/W ③	Typical socket mount
R _{thJA}	Junction-to-Ambient	—	—	175		

Radiation Performance of P-Channel Rad Hard HEXFETs

International Rectifier Radiation Hardened HEX-FETs are tested to verify their hardness capability. The hardness assurance program at International Rectifier uses two radiation environments.

Every manufacturing lot is tested in a low dose rate (total dose) environment per MIL-STD-750, test method 1019. International Rectifier has imposed a standard gate voltage of -12 volts per note 6 and a V_{DSS} bias condition equal to 80% of the device rated voltage per note 7. Pre- and post-radiation limits of the devices irradiated to 1×10^5 Rads (Si) are identical and are presented in Table 1. The values in Table 1 will be met for either of the two low dose rate test circuits that are used. Both pre- and

post-radiation performance are tested and specified using the same drive circuitry and test conditions in order to provide a direct comparison. It should be noted that at a radiation level of 1×10^5 Rads (Si), no change in limits are specified in DC parameters.

High dose rate testing may be done on a special request basis, using a dose rate up to 1×10^{12} Rads (Si)/Sec.

International Rectifier radiation hardened P-Channel HEXFETs are considered to be neutron-tolerant, as stated in MIL-PRF-19500 Group D. International Rectifier P-Channel radiation hardened HEXFETs have been characterized in heavy ion Single Event Effects (SEE) environments. Single Event Effects characterization is shown in Table 3.

Table 1. Low Dose Rate ⑥ ⑦

Parameter		IRHF9130		Units	Test Conditions ⑩
		100K Rads (Si)			
		min.	max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	—	V	$V_{GS} = 0V, I_D = -1.0 \text{ mA}$
$V_{GS(th)}$	Gate Threshold Voltage ④	-2.0	-4.0		$V_{GS} = V_{DS}, I_D = -1.0 \text{ mA}$
I_{GSS}	Gate-to-Source Leakage Forward	—	-100	nA	$V_{GS} = -20V$
I_{GSS}	Gate-to-Source Leakage Reverse	—	100		$V_{GS} = 20V$
I_{DSS}	Zero Gate Voltage Drain Current	—	-25	μA	$V_{DS} = 0.8 \times \text{Max Rating}, V_{GS} = 0V$
$R_{DS(on)1}$	Static Drain-to-Source ④ On-State Resistance One	—	0.30	Ω	$V_{GS} = -12V, I_D = -4.1A$
V_{SD}	Diode Forward Voltage ④	—	-3.0	V	$T_C = 25^\circ C, I_S = -6.5A, V_{GS} = 0V$

Table 2. High Dose Rate ⑧

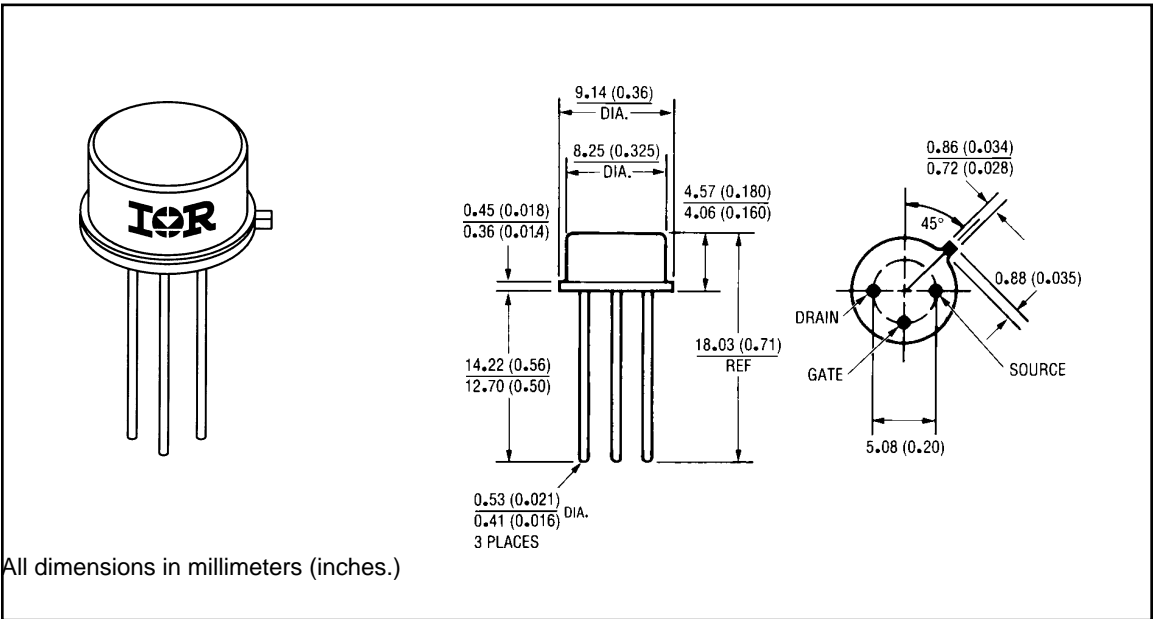
Parameter	10 ¹¹ Rads (Si)/sec			10 ¹² Rads (Si)/sec			Units	Test Conditions
	Min.	Typ	Max.	Min.	Typ.	Max.		
V_{DSS}	—	—	-80	—	—	-80	V	Applied drain-to-source voltage during gamma-dot
I_{PP}	—	-60	—	—	-60	—	A	Peak radiation induced photo-current
di/dt	—	—	-800	—	—	-160	A/ μ sec	Rate of rise of photo-current
L_1	0.1	—	—	0.5	—	—	μH	Circuit inductance required to limit di/dt

Table 3. Single Event Effects ⑨

Parameter	Typ.	Units	Ion	LET (Si) (MeV/mg/cm ²)	Fluence (ions/cm ²)	Range (μm)	V_{DS} Bias (V)	V_{GS} Bias (V)
BV_{DSS}	-100	V	Ni	28	1×10^6	~41	-100	5

- ① Repetitive Rating; Pulse width limited by maximum junction temperature. Refer to current HEXFET reliability report.
- ② @ $V_{DD} = -25V$, Starting $T_J = 25^\circ C$,
 $E_{AS} = [0.5 * L * (I_L^2) * [BV_{DSS}/(BV_{DSS}-V_{DD})]$
 Peak $I_L = -6.5A$, $V_{GS} = -12V$, $25 \leq R_G \leq 200\Omega$
- ③ $I_{SD} \leq -6.5A$, $di/dt \leq -140 A/\mu s$,
 $V_{DD} \leq BV_{DSS}$, $T_J \leq 150^\circ C$
 Suggested $R_G = 7.5\Omega$
- ④ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$
- ⑤ $K/W = ^\circ C/W$
 $W/K = W/^\circ C$
- ⑥ **Total Dose Irradiation with V_{GS} Bias.**
 -12 volt V_{GS} applied and $V_{DS} = 0$ during irradiation per MIL-STD-750, method 1019.
- ⑦ **Total Dose Irradiation with V_{DS} Bias.**
 $V_{DS} = 0.8$ rated BV_{DSS} (pre-radiation) applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, method 1019.
- ⑧ This test is performed using a flash x-ray source operated in the e-beam mode (energy ~ 2.5 MeV), 30 nsec pulse.
- ⑨ Process characterized by independent laboratory.
- ⑩ All Pre-Radiation and Post-Radiation test conditions are **identical** to facilitate direct comparison for circuit applications.

Case Outline and Dimensions — TO-204AF (TO-39)



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