International Rectifier

Provisional Data Sheet No. PD-9.1445

REPETITIVE AVALANCHE AND dv/dt RATED

HEXFET® TRANSISTOR

IRHN9230

P-CHANNEL

RAD HARD

-200 Volt, 0.8Ω, 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 **identica**l pre- and post-radiation test conditions, International Rectifier's P-Channel RAD HARD HEXFETs retain **identical** electrical specifications up to 1 x 10^5 Rads (Si) total dose. No compensation in gate drive circuitry is required. In addition these devices are also capable of surviving transient ionization pulses as high as 1 x 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 P-Channel 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
IRHN9230	-200V	0.8Ω	-6.5A

Features:

- Radiation Hardened up to 1 x 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
- Repetitive Avalanche Rating
- Dynamic dv/dt Rating
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- Light-weight

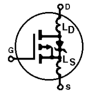
Absolute Maximum Ratings

Pre-Radiation

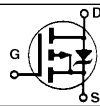
	Parameter	IRHN9230	Units
I_D @ V_{GS} = -12V, T_C = 25°C	Continuous Drain Current	-6.5	A
I_D @ V_{GS} = -12V, T_C = 100°C	Continuous Drain Current	-4.0	
I_{DM}	Pulsed Drain Current ①	-26	
P_D @ T_C = 25°C	Max. Power Dissipation	75	W
	Linear Derating Factor	0.6	W/K ⑤
V_{GS}	Gate-to-Source Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	150	mJ
I_{AR}	Avalanche Current ①	-6.5	A
E_{AR}	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.0	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Package Mounting Surface Temperature	300 (for 5 seconds)	
	Weight	2.6 (typical)	g

Notes: See page 4

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	—	—	V	V_{GS} = 0V, I_D = -1.0 mA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	-0.22	—	V/°C	Reference to 25°C, I_D = -1.0 mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.8	Ω	V_{GS} = -12V, I_D = -4.0A ④
		—	—	0.92		V_{GS} = -12V, I_D = -6.5A
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	—	-4.0	V	V_{DS} = V_{GS}, I_D = -1.0 mA
g_{fs}	Forward Transconductance	2.5	—	—	S (℧)	V_{DS} > -15V, I_{DS} = -4.0 A ④
I_{DSS}	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
I_{GSS}	Gate-to-Source Leakage Forward	—	—	-100	nA	V_{GS} = -20V
I_{GSS}	Gate-to-Source Leakage Reverse	—	—	100		V_{GS} = 20V
Q_g	Total Gate Charge	—	—	45	nC	V_{GS} = -12V, I_D = -6.5A V_{DS} = Max. Rating x 0.5
Q_{gs}	Gate-to-Source Charge	—	—	10		
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	—	25		
$t_{d(on)}$	Turn-On Delay Time	—	—	50	ns	V_{DD} = 100V, I_D = -6.5A, R_G = 7.5Ω
t_r	Rise Time	—	—	90		
$t_{d(off)}$	Turn-Off Delay Time	—	—	90		
t_f	Fall Time	—	—	90		
L_D	Internal Drain Inductance	—	TBD	—	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die. Modified MOSFET symbol showing the internal inductances. 
L_S	Internal Source Inductance	—	TBD	—		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	—		

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 ① (Body Diode)	—	—	-26		
V_{SD}	Diode Forward Voltage	—	—	-5.0	V	T_j = 25°C, I_S = -6.5A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	400	ns	T_j = 25°C, I_F = -6.5A, di/dt ≤ -100 A/μs V_{DD} ≤ -50V ④
Q_{RR}	Reverse Recovery Charge	—	—	3.0	μC	
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	—	—	1.67	K/W ⑤	
$R_{thJ-PCB}$	Junction-to-PC board	—	TBD	—		Soldered to a copper-clad PC board

Notes: See page 4

Radiation Performance of P-Channel Rad Hard HEXFETs

International Rectifier Radiation Hardened HEXFETs 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 x 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 x 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 x 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 environment the results are shown in Table 3.

Table 1. Low Dose Rate ⑥ ⑦

Parameter		IRHN9230 100K Rads (Si) min.	IRHN9230 100K Rads (Si) max.	Units	Test Conditions ⑩
BV_{DSS}	Drain-to-Source Breakdown Voltage	-200	—	V	V_{GS} = 0V, I_D = -1.0 mA
$V_{GS(th)}$	Gate Threshold Voltage④	-2.0	-4.0		V_{GS} = V_{DS}, I_D = -1.0 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 x Max Rating, V_{GS} = 0V
$R_{DS(on)1}$	Static Drain-to-Source④ On-State Resistance One	—	0.8	Ω	V_{GS} = -12V, I_D = -4.0A
V_{SD}	Diode Forward Voltage④	—	-5.0	V	T_C = 25°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}	Drain-to-Source Voltage	—	—	-160	—	—	-160	V	Applied drain-to-source voltage during gamma-dot
I_{PP}		—	-60	—	—	-60	—	A	Peak radiation induced photo-current
di/dt		—	-800	—	—	-160	—	A/µsec	Rate of rise of photo-current
L_1		27	—	—	0.5	—	—	µH	Circuit inductance required to limit di/dt

Table 3. Single Event Effects ⑨

Parameter	Typ.	Units	Ion	LET (Si) (MeV/mg/cm²)	Fluence (ions/cm²)	Range (µm)	V_{DS} Bias (V)	V_{GS} Bias (V)
BV_{DSS}	-200	V	Ni	28	1 x 10^5	~41	-200	+5

① Repetitive Rating; Pulse width limited by maximum junction temperature. Refer to current HEXFET reliability report.

② @ V_{DD} = -50V, Starting T_J = 25°C, E_{AS} = [0.5 * L * ($I_L{}^2$) * [BV_{DSS}/(BV_{DSS}-V_{DD})] 25 ≤ R_G ≤ 200Ω, I_L = -6.5A, V_{GS} = -12V

③ I_{SD} ≤ -6.5A, di/dt ≤ -140 A/µs, V_{DD} ≤ BV_{DSS}, T_J ≤ 150°C

④ Pulse width ≤ 300 µs; Duty Cycle ≤ 2%

⑤ K/W = °C/W
W/K = W/°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.

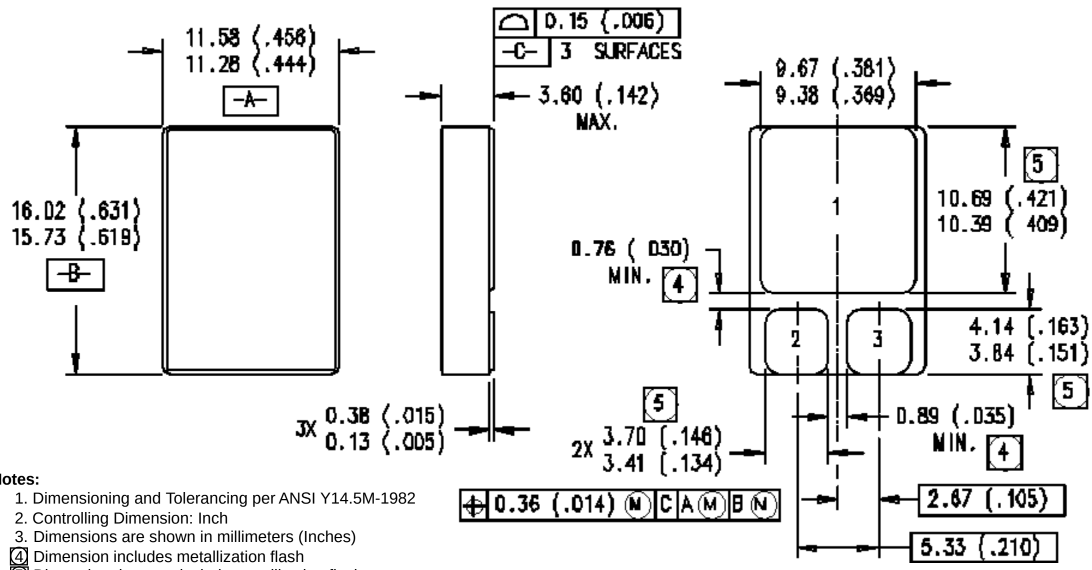
⑦ **Total Dose Irradiation with V_{DS} Bias.** V_{DS} = 0.8 rated BV_{DSS} (pre-radiation) applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019.

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 — SMD-1



Notes:
1. Dimensioning and Tolerancing per ANSI Y14.5M-1982
2. Controlling Dimension: Inch
3. Dimensions are shown in millimeters (Inches)
4 Dimension includes metallization flash
5 Dimension does not include metallization flash

International IOR Rectifier

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