International
IOR Rectifier

Provisional Data Sheet No. PD-9.886

REPETITIVE AVALANCHE AND dv/dt RATED
# HEXFET® TRANSISTOR

# IRHN9130
P-CHANNEL
RAD HARD

## -100 Volt, 0.30Ω, 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 x $10^5$ 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 x $10^{12}$ Rads (Si)/Sec, and return to normal operation within a few microseconds. Single Event Effect, (SEE), testing of International Rectifier's 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 | $BV_{DSS}$ | $R_{DS(on)}$ | $I_D$ |
|---|---|---|---|
| IRHN9130 | -100V | 0.30Ω | -11A |

## 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
- Lightweight

## Absolute Maximum Ratings

**Pre-Radiation**

| | Parameter | IRHN9130 | Units |
|---|---|---|---|
| $I_D$ @ $V_{GS}$ = -12V, $T_C$ = 25°C | Continuous Drain Current | -11 | A |
| $I_D$ @ $V_{GS}$ = -12V, $T_C$ = 100°C | Continuous Drain Current | -7.0 | |
| $I_{DM}$ | Pulsed Drain Current ① | -44 | |
| $P_D$ @ $T_C$ = 25°C | Max. Power Dissipation | 75 | W |
| | Linear Derating Factor | 0.60 | W/K ② |
| $V_{GS}$ | Gate-to-Source Voltage | ±20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy ③ | 500 | mJ |
| $I_{AR}$ | Avalanche Current ① | -11 | A |
| $E_{AR}$ | Repetitive Avalanche Energy ① | 7.5 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ④ | -5.5 | V/ns |
| $T_J$ | Operating Junction | -55 to 150 | °C |
| $T_{STG}$ | Storage Temperature Range | | |
| | Package Mount Surface Temperature | 300 (for 5 seconds) | |
| | Weight | 2.6 (typical) | g |

## Electrical Characteristics @ Tj = 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 |
| $\Delta BV_{DSS}/\Delta T_J$ | Temperature Coefficient of Breakdown Voltage | — | -0.087 | — | V/°C | Reference to 25°C, $I_D$ = -1.0 mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-State Resistance | — | — | 0.30 | Ω | $V_{GS}$ = -12V, $I_D$ = -7.0A ⇩ |
| | | — | — | 0.35 | | $V_{GS}$ = -12V, $I_D$ = -11A ⇩ |
| $V_{GS(th)}$ | 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, $I_{DS}$ = -7.0A ⇩ |
| $I_{DSS}$ | 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, $I_D$ = -11A |
| $Q_{gs}$ | 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, $I_D$ = -11A, $R_G$ = 7.5Ω |
| $t_r$ | Rise Time | — | — | 70 | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | — | 70 | | |
| $t_f$ | Fall Time | — | — | 70 | | |
| $L_D$ | 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 |
| $C_{oss}$ | Output Capacitance | — | 310 | — | | f = 1.0 MHz |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 55 | — | | |

## Source-Drain Diode Ratings and Characteristics

| | Parameter | | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | | — | — | -11 | A | Modified MOSFET symbol showing the integral reverse p-n junction rectifier. |
| $I_{SM}$ | Pulse Source Current (Body Diode) ⏲ | | — | — | -44 | | |
| $V_{SD}$ | Diode Forward Voltage | | — | — | -3.0 | V | $T_j$ = 25°C, $I_S$ = -11A, $V_{GS}$ = 0V ⇩ |
| $t_{rr}$ | Reverse Recovery Time | | — | — | 250 | ns | $T_j$ = 25°C, $I_F$ = -11A, di/dt ≤ -100A/µs |
| $Q_{RR}$ | Reverse Recovery Charge | | — | — | 2.6 | µC | $V_{DD}$ ≤ -50V ⇩ |
| $t_{on}$ | 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 ⇨ | |
| $R_{thJ\text{-}PCB}$ | Junction-to-PC Board | — | TBD | — | | Soldered to a copper clad PC board |

## 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 (SEE) environment and results are shown in Table 3.

**Table 1. Low Dose Rate**

| Parameter | | IRHN9130 100K Rads (Si) min. | IRHN9130 100K Rads (Si) max. | Units | Test Conditions |
|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | -100 | — | V | $V_{GS}$ = 0V, $I_D$ = -1.0 mA |
| $V_{GS(th)}$ | Gate Threshold Voltage | -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-Source On-State Resistance One | — | 0.30 | Ω | $V_{GS}$ = -12V, $I_D$ = -7A |
| $V_{SD}$ | Diode Forward Voltage | — | -3.0 | V | $T_C$ = 25°C, $I_S$ = -11 $V_{GS}$ = 0V |

**Table 2. High Dose Rate**

| Parameter | | $10^{11}$ Rads (Si)/sec Min. | Typ | Max. | $10^{12}$ Rads (Si)/sec Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|---|---|---|
| $V_{DSS}$ | Drain-to-Source Voltage | — | — | -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/µsec | 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**

| Parameter | Typ. | Units | Ion | LET (Si) (MeV/mg/cm²) | Fluence (ions/cm²) | Range (µm) | $V_{DS}$ Bias (V) | $V_{GS}$ Bias (V) |
|---|---|---|---|---|---|---|---|---|
| $BV_{DSS}$ | -100 | V | Ni | 28 | 1 x $10^5$ | ~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°C,
$E_{AS}$ = [0.5 * L * ($I_L^2$) * [$BV_{DSS}$/($BV_{DSS}$-$V_{DD}$)]
Peak $I_L$ = -11A, $V_{GS}$ = -12V, 25 ≤ $R_G$ ≤ 200Ω

③ $I_{SD}$ ≤ -11A, di/dt ≤ -140A/µs,
$V_{DD}$ ≤ $BV_{DSS}$, $T_J$ ≤ 150°C
Suggested RG = 7.5Ω

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.

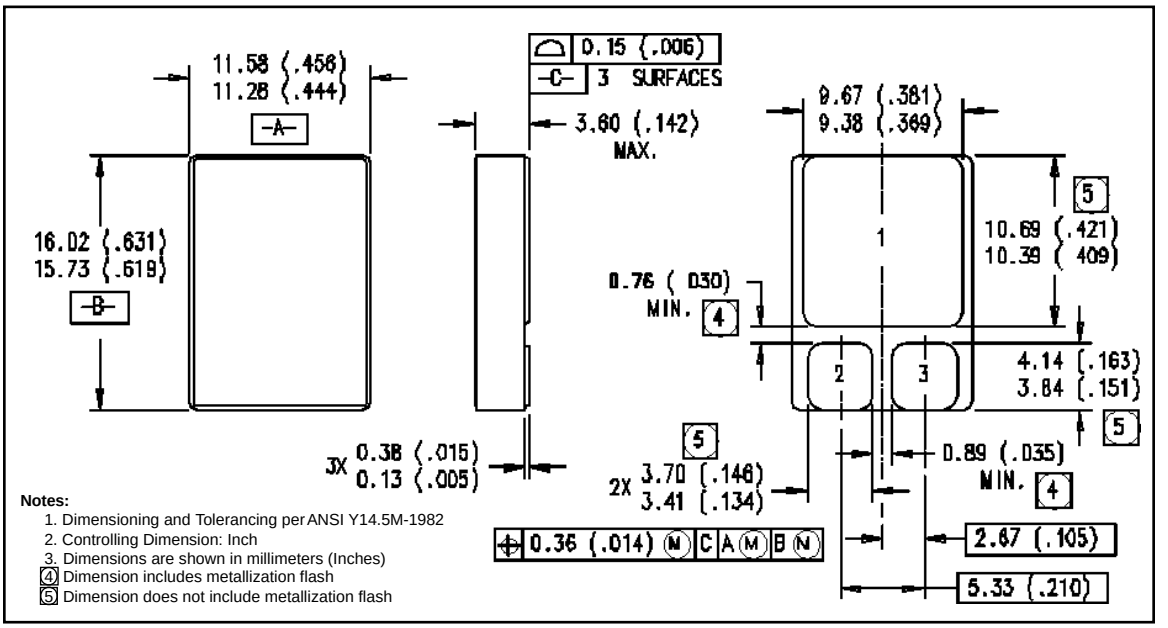
⑦ **Total Dose Irradiation with $V_{DS}$ Bias.**
$V_{DS}$ = 0.8 rated $BV_{DSS}$ (pre-radiation) applied and $V_{GS}$ = 0 during irradiation per MIL-STD-750, method 1019.

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 Study sponsored by NASA. Evaluation performed at Brookhaven National Labs.

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

**CAUTION**

**BERYLLIA WARNING PER MIL-PRF-19500**

Packages containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxides packages shall not be placed in acids that will produce fumes containing beryllium.

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