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International Rectifier

Provisional Data Sheet No. PD-9.1224A

REPETITIVE AVALANCHE AND dv/dt RATED

HEXFET® TRANSISTOR

IRHM7360SE
JANSR2N7391

[REF:MIL-PRF-195000/TBD]

N-CHANNEL

SINGLE EVENT EFFECT (SEE) RAD HARD

400 Volt, 0.20Ω, (SEE) RAD HARD HEXFET

International Rectifier's (SEE) RAD HARD technology HEXFETs demonstrate virtual immunity to SEE failure. Additionally, under **identical** pre- and post-radiation test conditions, International Rectifier's 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. Since the SEE process utilizes International Rectifier's patented HEXFET technology, the user can expect the highest quality and reliability in the industry.

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
IRHM7360SE	400V	0.20Ω	22A

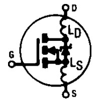
Features:

- 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
- Electrically Isolated
- Ceramic Eyelets

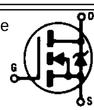
Absolute Maximum Ratings — Pre-Radiation

	Parameter	IRHM7360SE	Units
I_D @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	22	A
I_D @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	14	
I_{DM}	Pulsed Drain Current ①	88	
P_D @ T_C = 25°C	Max. Power Dissipation	250	W
	Linear Derating Factor	2.0	W/K ⑤
V_{GS}	Gate-to-Source Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	500	mJ
I_{AR}	Avalanche Current ①	22	A
E_{AR}	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.0	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10 sec.)	
	Weight	9.3 (typical)	g

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	400	—	—	V	V_{GS} = 0V, I_D = 1.0 mA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.45	—	V/°C	Reference to 25°C, I_D = 1.0 mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.20	Ω	V_{GS} = 12V, I_D =14A ④
		—	—	0.21		V_{GS} = 12V, I_D = 22A
$V_{GS(th)}$	Gate Threshold Voltage	2.5	—	4.5	V	V_{DS} = V_{GS}, I_D = 1.0 mA
g_{fs}	Forward Transconductance	4.0	—	—	S (℧)	V_{DS} > 15V, I_{DS} = 14A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	50	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	—	—	180	nC	V_{GS} =12V, I_D = 22A V_{DS} = Max. Rating x 0.5
Q_{gs}	Gate-to-Source Charge	—	—	75		
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	—	100		
$t_{d(on)}$	Turn-On Delay Time	—	—	35	ns	V_{DD} = 200V, I_D =22A, R_G = 2.35Ω
t_r	Rise Time	—	—	100		
$t_{d(off)}$	Turn-Off Delay Time	—	—	100		
t_f	Fall Time	—	—	100		
L_D	Internal Drain Inductance	—	8.7	—	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	—	8.7	—		Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.
C_{iss}	Input Capacitance	—	7500	—	pF	V_{GS} = 0V, V_{DS} = 25V f = 1.0 MHz
C_{oss}	Output Capacitance	—	1200	—		
C_{rss}	Reverse Transfer Capacitance	—	500	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	22	A	Modified MOSFET symbol showing the integral reverse p-n junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ①	—	—	88		
V_{SD}	Diode Forward Voltage	—	—	1.4	V	T_j = 25°C, I_S = 22A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	750	ns	T_j = 25°C, I_F = 22A, di/dt ≤ 100A/μs V_{DD} ≤ 50V ④
Q_{RR}	Reverse Recovery Charge	—	—	16	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	—	—	0.50	K/W⑤	
R_{thJA}	Junction-to-Ambient	—	—	48		
RthCS	Case-to-Sink	—	0.21	—		Typical socket mount

Radiation Performance of 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 1×10^5 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 HEXFETs have been characterized in neutron and heavy ion Single Event Effects (SEE) environments. Single Event Effects characterization is shown in Table 3.

Table 1. Low Dose Rate ⑥ ⑦

Parameter		IRHM7360SE 100K Rads (Si) min.	IRHM7360SE 100K Rads (Si) max.	Units	Test Conditions ⑩
BV_{DSS}	Drain-to-Source Breakdown Voltage	400	—	V	$V_{GS} = 0V$, $I_D = 1.0$ mA
$V_{GS(th)}$	Gate Threshold Voltage ④	2.5	4.5		$V_{GS} = V_{DS}$, $I_D = 1.0$ 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	—	50	µA	$V_{DS} = 0.8 \times$ Max Rating, $V_{GS} = 0V$
$R_{DS(on)1}$	Static Drain-to-Source ④ On-State Resistance One	—	0.20	Ω	$V_{GS} = 12V$, $I_D = 14A$
V_{SD}	Diode Forward Voltage ④	—	1.35	V	$T_C = 25°C$, $I_S = 22A$, $V_{GS} = 0V$

Table 2. High Dose Rate ⑧

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	—	—	320	—	—	320	V	Applied drain-to-source voltage during gamma-dot
I_{PP}		—	6.4	—	—	6.4	—	A	Peak radiation induced photo-current
di/dt		—	—	16	—	—	2.3	A/µsec	Rate of rise of photo-current
L_1		20	—	—	137	—	—	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}	400	V	Ni	28	1×10^5	~35	320	-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, $E_{AS} = [0.5 * L * (I_L^2) * [BV_{DSS}/(BV_{DSS}-V_{DD})]$ Peak I_L = 22A, V_{GS} = 12V, 25 ≤ R_G ≤ 200Ω

③ I_{SD} ≤ 22A, di/dt ≤ 170 A/µs, $V_{DD} \le BV_{DSS}$, T_J ≤ 150°C
Suggested RG = 2.35Ω

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.

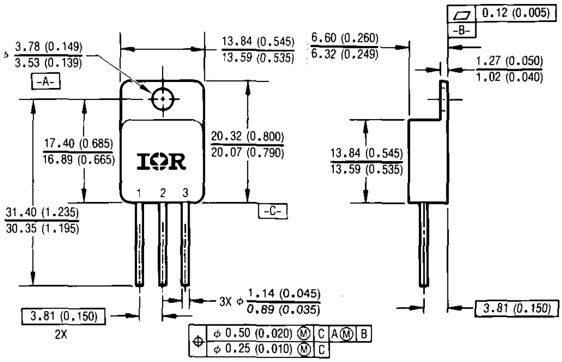
⑦ **Total Dose Irradiation with V_{DS} Bias.** V_{DS} = 0.8 rated BV_{DSS} (pre-radiation) applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019.

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

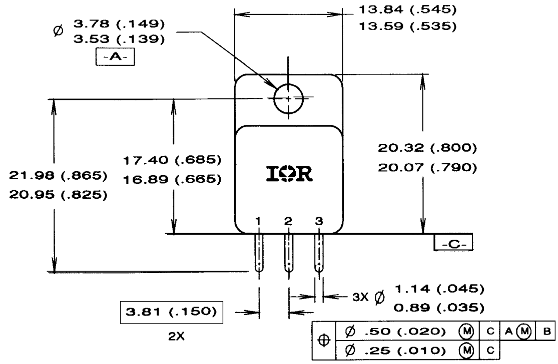


Legend
1 - Drain
2 - Source
3 - Gate

Notes:
1. Dimensioning and Tolerancing per ANSI Y14.5M-1982
2. All dimensions are show in millimeters (inches).

Conforms to JEDEC Outline TO-254AA
Dimensions in Millimeters and (Inches)

Optional leadforms for outline TO-254



Legend
1 - Drain
2 - Source
3 - Gate

Notes:
1. Dimensioning and Tolerancing per ANSI Y14.5M-1982
2. All dimensions are show in millimeters (inches).
3. Leadform is available in either orientation.

Dimensions in Millimeters and (Inches)

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.

International IOR Rectifier

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