International
IOR Rectifier

PD-91738

REPETITIVE AVALANCHE AND dv/dt RATED
HEXFET® TRANSISTOR

IRHNB7264SE

N-CHANNEL
SINGLE EVENT EFFECT (SEE) RAD HARD

250Volt, 0.11W, (SEE) RAD HARD HEXFET

International Rectifier's (SEE) RAD HARD technology HEXFETs demonstrate immunity to SEE failure. 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
IRHNB7264SE	250V	0.11W	34A

Features:

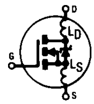
- Radiation Hardened up to 1 x 10^5 Rads (Si)
- Single Event Burnout (SEB) Hardened
- Single Event Gate Rupture (SEGR) Hardened
- Gamma Dot (Flash X-Ray) Hardened
- Neutron Tolerant
- Identical Pre- and Post-Electrical Test Conditions
- Repetitive Avalanche Rating
- Dynamic dv/dt Rating
- Simple Drive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

Absolute Maximum Ratings

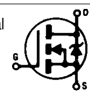
Pre-Irradiation

	Parameter	IRHNB7264SE	Units
I_D @ V_{GS} = 12V, T_C = 25°C	Continuous Drain Current	34	A
I_D @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	21	
I_{DM}	Pulsed Drain Current ①	136	
P_D @ T_C = 25°C	Max. Power Dissipation	300	W
	Linear Derating Factor	2.4	W/°C
V_{GS}	Gate-to-Source Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	500	mJ
I_{AR}	Avalanche Current ①	34	A
E_{AR}	Repetitive Avalanche Energy ①	30	mJ
dv/dt	Peak Diode Recovery dv/dt ③	2.5	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Package Mounting Surface Temperature	300 (for 5 sec.)	
	Weight	3.5 (typical)	g

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

	Parameter	Min	Typ	Max	Units	Test Conditions	
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	—	V	V_{GS} = 0V, I_D = 1.0mA	
DBV_{DSS}/DT_J	Temperature Coefficient of Breakdown Voltage	—	0.32	—	V/°C	Reference to 25°C, I_D = 1.0mA	
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.110	W	V_{GS} = 12V, I_D = 21A ④	
		—	—	0.123		V_{GS} = 12V, I_D = 34A	
$V_{GS(th)}$	Gate Threshold Voltage	2.5	—	4.5	V	V_{DS} = V_{GS}, I_D = 1.0mA	
g_{fs}	Forward Transconductance	10	—	—	S (W)	V_{DS} > 15V, I_{DS} = 21A ④	
I_{DSS}	Zero Gate Voltage Drain Current	—	—	50	mA	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	—	—	220	nC	V_{GS} = 12V, I_D = 34A	
Q_{gs}	Gate-to-Source Charge	—	—	50		V_{DS} = Max Rating x 0.5	
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	110			
$t_{d(on)}$	Turn-On Delay Time	—	—	35	ns	V_{DD} = 125V, I_D = 34A,	
t_r	Rise Time	—	—	180		R_G = 2.35W	
$t_{d(off)}$	Turn-Off Delay Time	—	—	100			
t_f	Fall Time	—	—	120			
L_D	Internal Drain Inductance	—	0.8	—	nH	Measured from drain lead, 6mm (0.25 in) from package to center of die.	Modified MOSFET symbol showing the internal inductances. 
L_S	Internal Source Inductance	—	2.8	—		Measured from source lead, 6mm (0.25 in) from package to source bonding pad.	
C_{iss}	Input Capacitance	—	4000	—	pF	V_{GS} = 0V, V_{DS} = 25V	
C_{oss}	Output Capacitance	—	1300	—		f = 1.0MHz	
C_{rss}	Reverse Transfer Capacitance	—	480	—			

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	34	A	Modified MOSFET symbol showing the integral reverse p-n junction rectifier. 
I_{SM}	Pulse Source Current (Body Diode) ①	—	—	136		
V_{SD}	Diode Forward Voltage	—	—	1.4	V	T_j = 25°C, I_S = 34A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	700	ns	T_j = 25°C, I_F = 34A, di/dt £ 100A/ms
Q_{RR}	Reverse Recovery Charge	—	—	16	mC	V_{DD} £ 50V ④
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	—	—	0.42	°C/W	
$R_{thJ-PCB}$	Junction-to PC board	—	1.6	—		Soldered to a 1" sp. copper-clad board

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 comprises 3 radiation environments.

Every manufacturing lot is tested in a low dose rate (total dose) environment per MIL-STD-750, test method 1019 condition A. International Rectifier has imposed a standard gate condition of 12 volts per note 5 and a V_{DS} bias condition equal to 80% of the device rated voltage per note 6. Post-irradiation limits of the devices irradiated to 1 x 10^5 Rads (Si) are presented in Table 1, column 1, IRHNB7264SE. 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-irradiation 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) the only parameter limit change is V_{GSTh} minimum.

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. (See Table 2)

International Rectifier 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 ⑤ ⑥

	Parameter	IRHNB7264SE 100K Rads (Si) Min	Max	Units	Test Conditions ⑧
BV_{DSS}	Drain-to-Source Breakdown Voltage	250	—	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage ④	2.0	4.5		V_{GS} = V_{DS}, I_D = 1.0mA
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 x Max Rating, V_{GS}=0V
$R_{DS(on)1}$	Static Drain-to-Source ④ On-State Resistance One	—	0.110	W	V_{GS} = 12V, I_D =21A
V_{SD}	Diode Forward Voltage ④	—	1.4	V	T_C = 25°C, I_S = 34A,V_{GS} = 0V

Table 2. High Dose Rate ⑦

		10^{11} Rads (Si)/sec			10^{12} Rads (Si)/sec				
	Parameter	Min	Typ	Max	Min	Typ	Max	Units	Test Conditions
V_{DSS}	Drain-to-Source Voltage	—	—	200	—	—	200	V	Applied drain-to-source voltage during gamma-dot
I_{PP}		—	10	—	—	10	—	A	Peak radiation induced photo-current
di/dt		—	16	—	—	2.3	—	A/µsec	Rate of rise of photo-current
L_1		—	1.0	—	—	120	—	µH	Circuit inductance required to limit di/dt

Table 3. Single Event Effects

Ion	LET (Si) (MeV/mg/cm²)	Fluence (ions/cm²)	Range (µm)	V_{DS}Bias (V)	V_{GS} Bias (V)
Cu	28	3x 10^5	43	250	-5

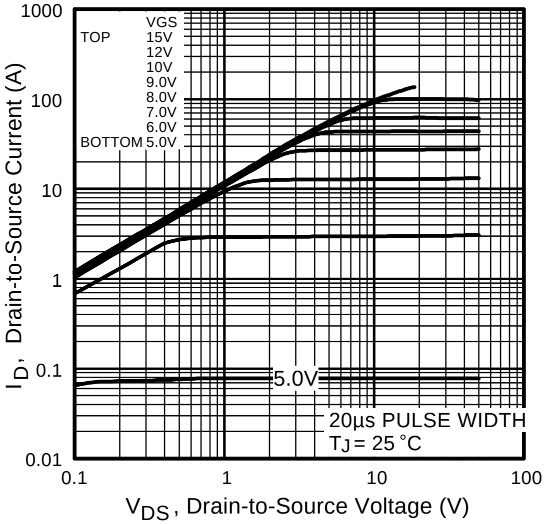


Fig 1. Typical Output Characteristics

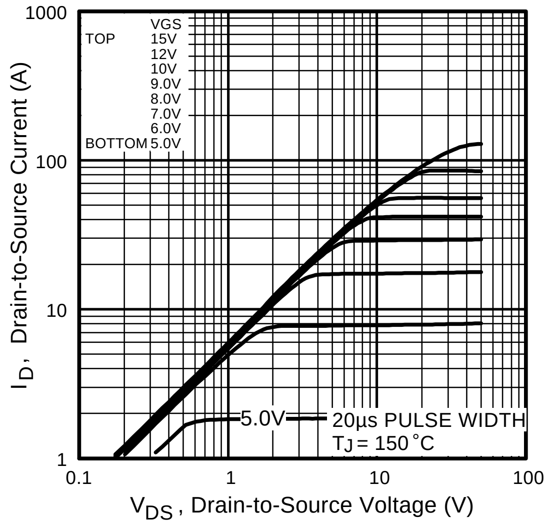


Fig 2. Typical Output Characteristics

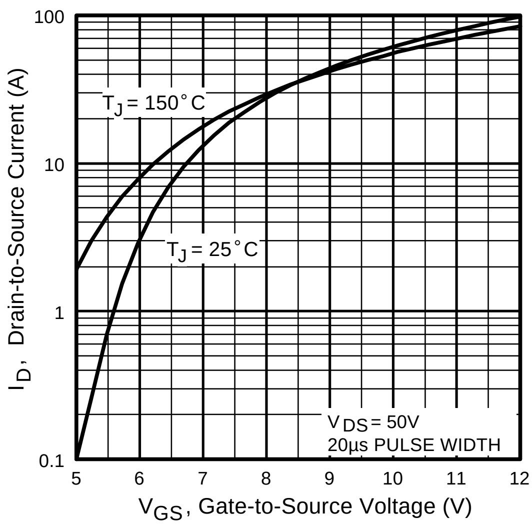


Fig 3. Typical Transfer Characteristics

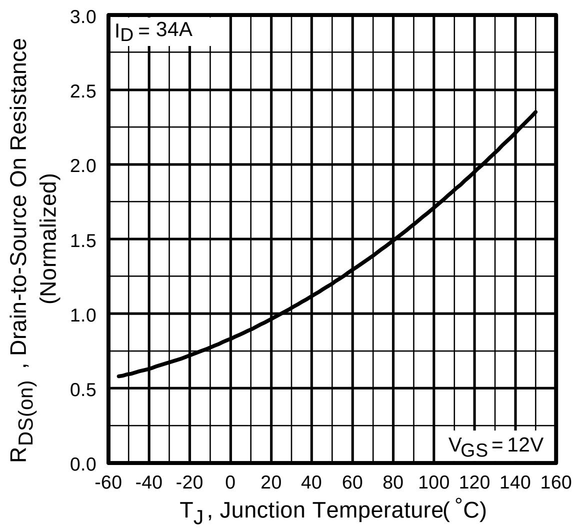


Fig 4. Normalized On-Resistance Vs. Temperature

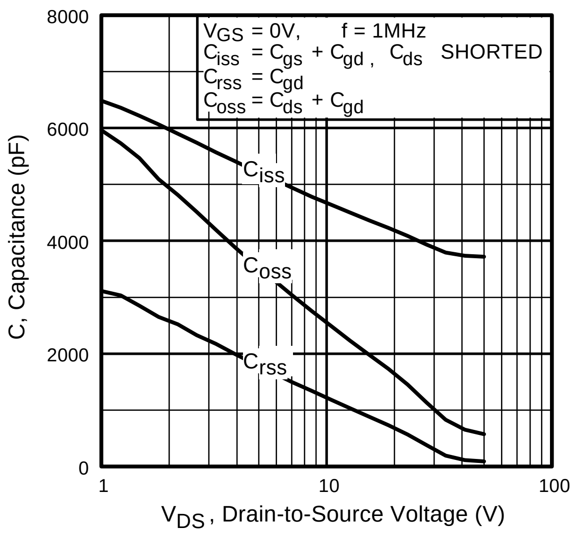


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

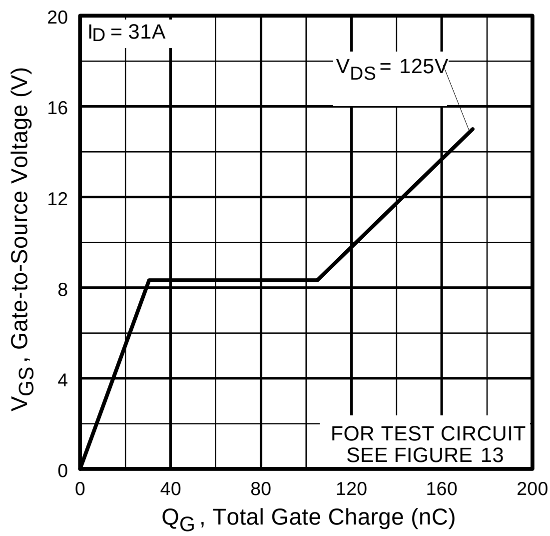


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

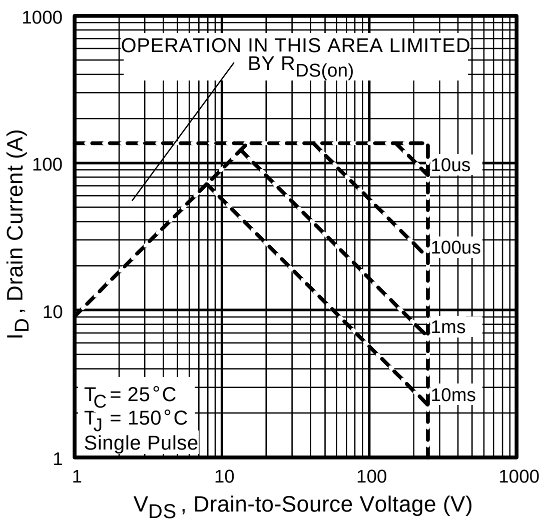


Fig 7. Maximum Safe Operating Area

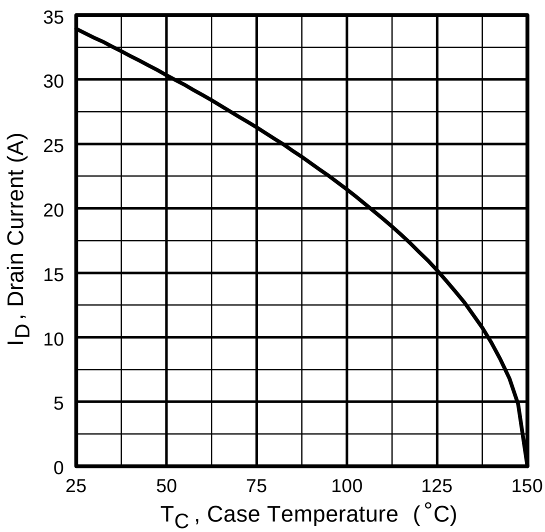


Fig 8. Maximum Drain Current Vs. Case Temperature

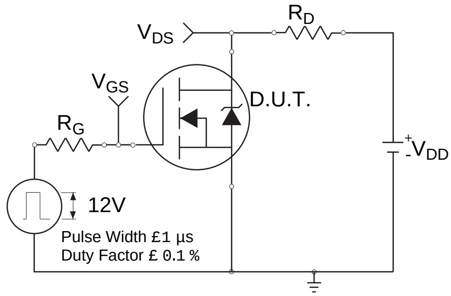


Fig 9a. Switching Time Test Circuit

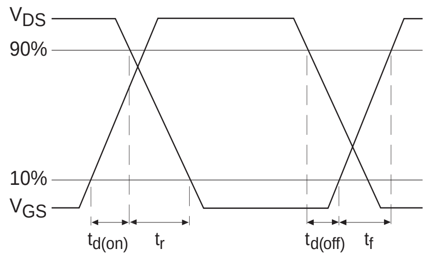


Fig 9b. Switching Time Waveforms

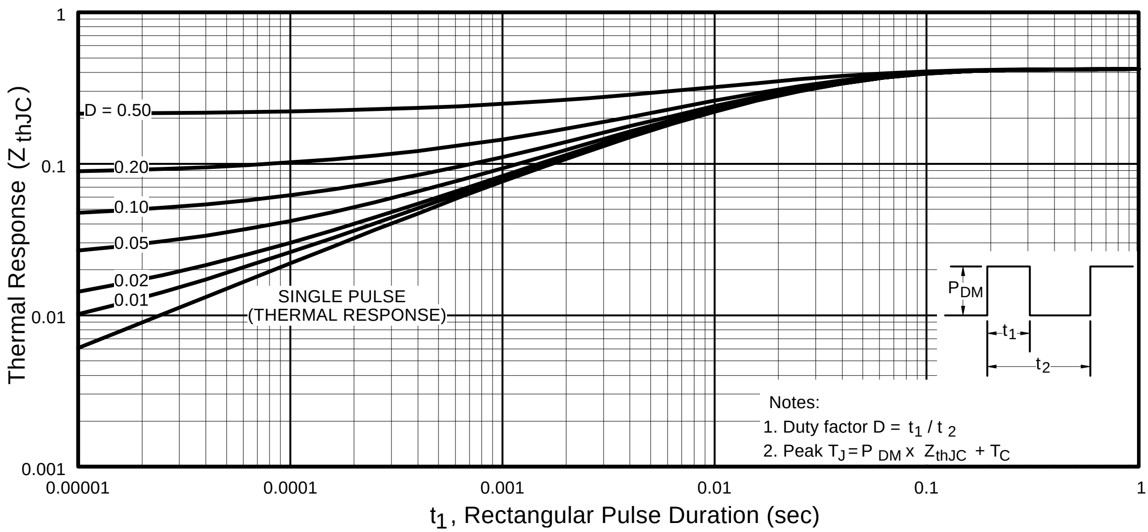


Fig 10. Maximum Effective Transient Thermal Impedance, Junction-to-Case

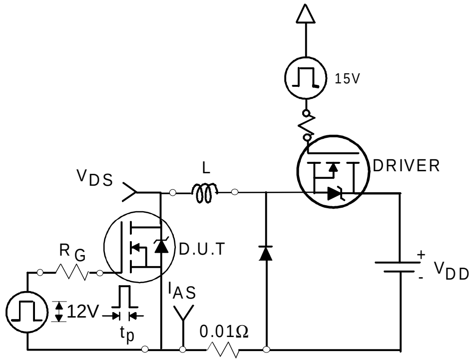


Fig 11a. Unclamped Inductive Test Circuit

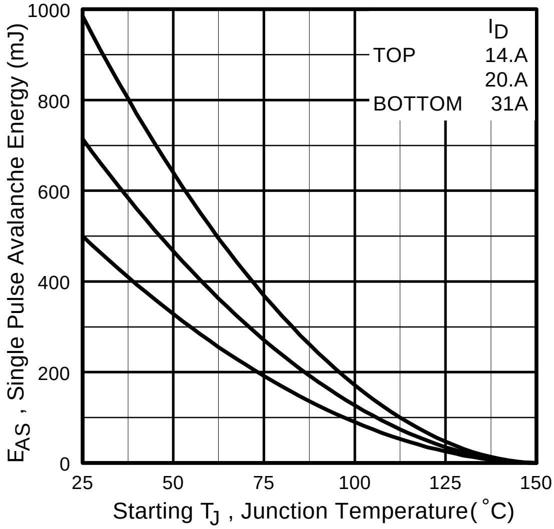


Fig 11c. Maximum Avalanche Energy Vs. Drain Current

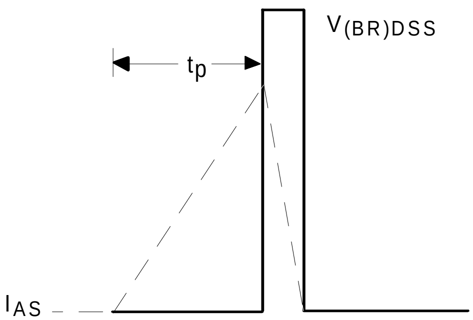


Fig 11b. Unclamped Inductive Waveforms

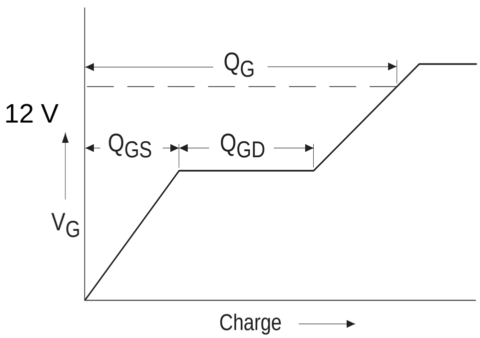


Fig 12a. Basic Gate Charge Waveform

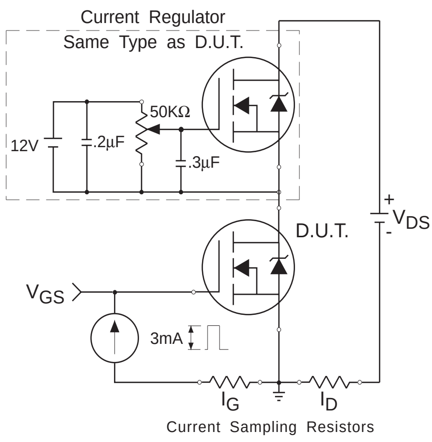


Fig 12b. Gate Charge Test Circuit

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)]
Peak I_L = 34A, V_{GS} = 12V, 25 £ R_G £ 200W

③ I_{SD} £ 34A, di/dt £ 300A/ms,
V_{DD} £ BV_{DSS}, T_J £ 150°C
Suggested RG = 2.35W

④ Pulse width £ 300 ms; Duty Cycle £ 2%

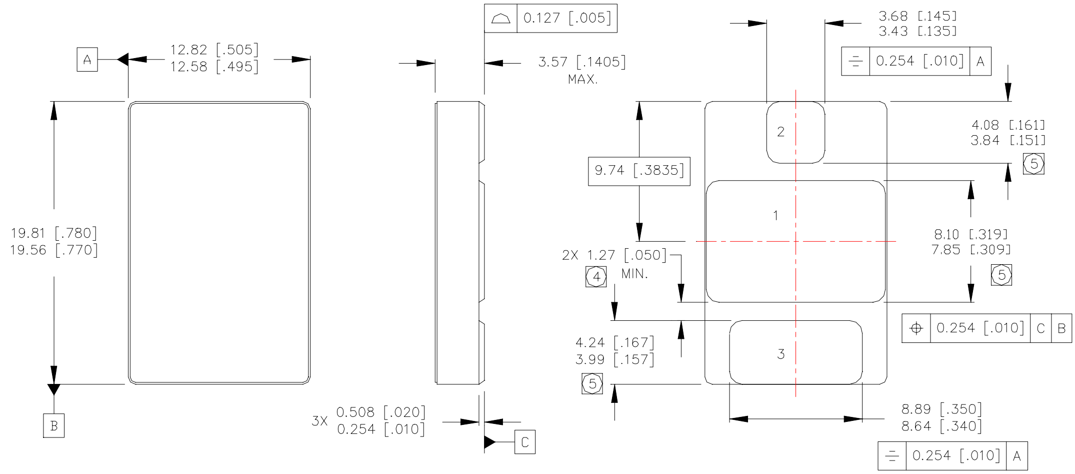
⑤ **Total Dose Irradiation with V_{GS} Bias.**
12 volt V_{GS} applied and V_{DS} = 0 during irradiation per MIL-STD-750, method 1019, condition A.

⑥ **Total Dose Irradiation with V_{DS} Bias.**
V_{DS} = 0.8 rated BV_{DSS} (pre-irradiation) applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019, condition A.

⑦ This test is performed using a flash x-ray source operated in the e-beam mode (energy ~2.5 MeV), 30 nsec pulse.

⑧ All Pre-Irradiation and Post-Irradiation test conditions are **identical** to facilitate direct comparison for circuit applications.

Case Outline and Dimensions — SMD-3



NOTES:
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
④ DIMENSION INCLUDES METALLIZATION FLASH.
⑤ DIMENSION DOES NOT INCLUDE METALLIZATION FLASH.

LEAD ASSIGNMENTS
1 = DRAIN
2 = GATE
3 = SOURCE

SMD-3

International
IOR Rectifier

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