

**RADIATION HARDENED  
 POWER MOSFET  
 SURFACE MOUNT (SMD-0.2)**

**IRHNM57110  
 JANSR2N7503U8  
 100V, N-CHANNEL  
 REF: MIL-PRF-19500/743**



**Product Summary**

Part Number	Radiation Level	R <sub>DS(on)</sub>	I <sub>D</sub>	QPL Part Number
IRHNM57110	100K Rads (Si)	0.22Ω	6.9A	JANSR2N7503U8
IRHNM53110	300K Rads (Si)	0.22Ω	6.9A	JANSF2N7503U8



**Refer to Page 10 for 1 Additional Part Number -  
 IRHNMC57110 (Ceramic Lid)**

International Rectifier's R5™ technology provides high performance power MOSFETs for space applications. These devices have been characterized for Single Event Effects (SEE) with useful performance up to an LET of 80 (MeV/(mg/cm<sup>2</sup>)). The combination of low R<sub>DS(on)</sub> and low gate charge reduces the power losses in switching applications such as DC to DC converters and motor control. These devices retain all of the well established advantages of MOSFETs such as voltage control, fast switching, ease of paralleling and temperature stability of electrical parameters.

**Features:**

- Single Event Effect (SEE) Hardened
- Low R<sub>DS(on)</sub>
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight
- Complimentary P-Channel Available - IRHNM597110, IRHNMC597110

**Absolute Maximum Ratings**

**Pre-Irradiation**

	Parameter		Units
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 25°C	Continuous Drain Current	6.9	A
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	4.4	
I <sub>DM</sub>	Pulsed Drain Current ①	27.6	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Max. Power Dissipation	23	W
	Linear Derating Factor	0.18	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	24	mJ
I <sub>AR</sub>	Avalanche Current ③	6.9	A
E <sub>AR</sub>	Repetitive Avalanche Energy ③	2.3	mJ
dv/dt	Peak Diode Recovery dv/dt ③	11.5	V/ns
T <sub>J</sub>	Operating Junction	-55 to 150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Lead Temperature	300 (for 5s)	
	Weight	0.25 (Typical)	

For footnotes refer to the last page

**Electrical Characteristics @ T<sub>j</sub> = 25°C (Unless Otherwise Specified)**

	Parameter	Min	Typ	Max	Units	Test Conditions
B <sub>V</sub> DSS	Drain-to-Source Breakdown Voltage	100	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔB <sub>V</sub> DSS/ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.13	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.22	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 4.4A ④
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	—	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1.0mA
ΔV <sub>GS(th)</sub> /ΔT <sub>J</sub>	Gate Threshold Voltage Coefficient	—	-7.5	—	mV/°C	
g <sub>fs</sub>	Forward Transconductance	3.6	—	—	S	V <sub>DS</sub> = 15V, I <sub>DS</sub> = 4.4A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	10	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V
		—	—	25		V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	—	100	nA	V <sub>GS</sub> = 20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	—	-100	nA	V <sub>GS</sub> = -20V
Q <sub>g</sub>	Total Gate Charge	—	—	15	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.9A V <sub>DS</sub> = 50V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	4.0		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	5.0		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	6.6		
t <sub>r</sub>	Rise Time	—	—	5.4	ns	V <sub>DD</sub> = 50V, I <sub>D</sub> = 6.9A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 7.5Ω
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	34		
t <sub>f</sub>	Fall Time	—	—	15		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	6.8	—	nH	Measured from the center of drain pad to center of source pad
C <sub>iss</sub>	Input Capacitance	—	378	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 100KHz
C <sub>oss</sub>	Output Capacitance	—	108	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	2.3	—		
R <sub>g</sub>	Gate Resistance	—	8.0	—	Ω	f = 1.0MHz, open drain

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	6.9	A	T <sub>j</sub> = 25°C, I <sub>S</sub> = 6.9A, V <sub>GS</sub> = 0V ⑥
I <sub>SM</sub>	Pulse Source Current (Body Diode)⑥	—	—	27.6		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.2	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 6.9A, V <sub>GS</sub> = 0V ⑥
t <sub>rr</sub>	Reverse Recovery Time	—	—	144	ns	T <sub>j</sub> = 25°C, I <sub>F</sub> = 6.9A, di/dt ≤ 100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	633	nC	V <sub>DD</sub> ≤ 50V ⑥
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> .				

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	5.4	°C/W	

Note: Corresponding Spice and Saber models are available on International Rectifier Web site.

For footnotes refer to the last page

## Radiation Characteristics

IRHNM57110, JANSR2N7503U8

International Rectifier Radiation Hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at International Rectifier is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 5 and 6) using the TO-3 package. 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.

**Table 1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥**

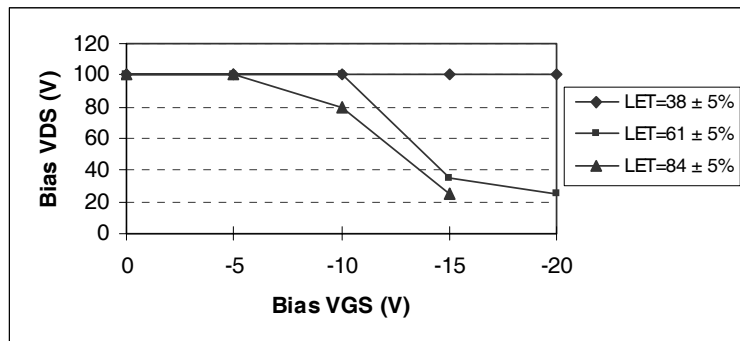
	Parameter	Up to 300K Rads (Si) <sup>1</sup>		Units	Test Conditions
		Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	100	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.0		V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0mA
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	100	nA	V <sub>GS</sub> = 20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	-100		V <sub>GS</sub> = -20V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	10	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source <sup>②</sup> On-State Resistance (TO-3)	—	0.226	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 4.4A
R <sub>DS(on)</sub>	Static Drain-to-Source On-state <sup>④</sup> Resistance (SMD-0.2)	—	0.22	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 4.4A
V <sub>SD</sub>	Diode Forward Voltage <sup>④</sup>	—	1.2	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 6.9A

1. Part Number IRHNM57110, IRHNM53110 and additional part numbers listed on page 10.

International Rectifier radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. a and Table 2.

**Table 2. Typical Single Event Effect Safe Operating Area**

LET (MeV/(mg/cm <sup>2</sup> ))	Energy (MeV)	Range (μm)	V <sub>DS</sub> (V)				
			@V <sub>GS</sub> = 0V	@V <sub>GS</sub> = -5V	@V <sub>GS</sub> = -10V	@V <sub>GS</sub> = -15V	@V <sub>GS</sub> = -20V
38 ± 5%	300 ± 7.5%	38 ± 7.5%	100	100	100	100	100
61 ± 5%	330 ± 7.5%	31 ± 10%	100	100	100	35	25
84 ± 5%	350 ± 10%	28 ± 7.5%	100	100	80	25	-



**Fig a. Typical Single Event Effect, Safe Operating Area**

For footnotes refer to the last page

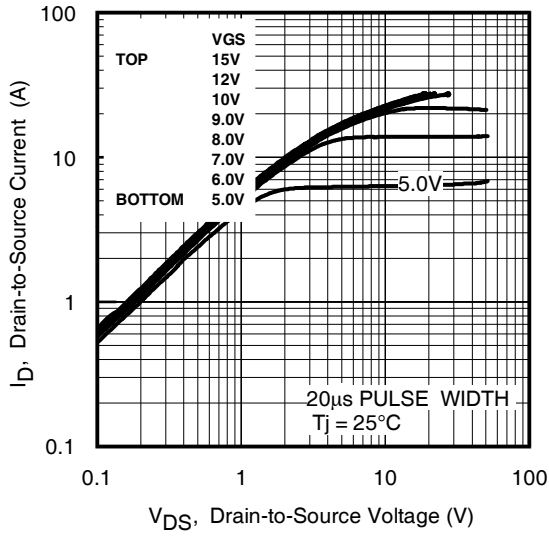


Fig 1. Typical Output Characteristics

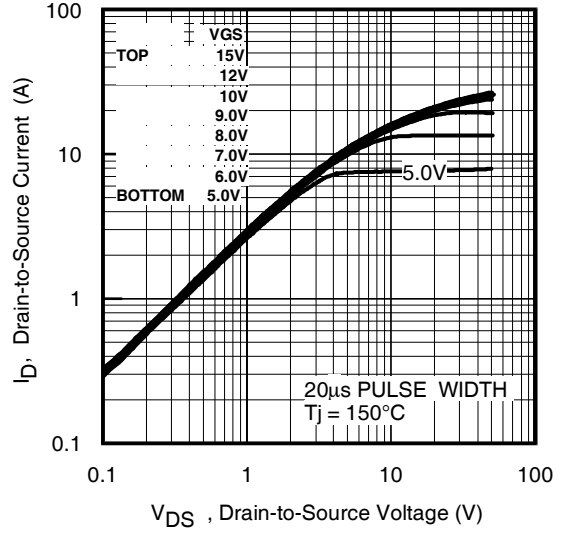


Fig 2. Typical Output Characteristics

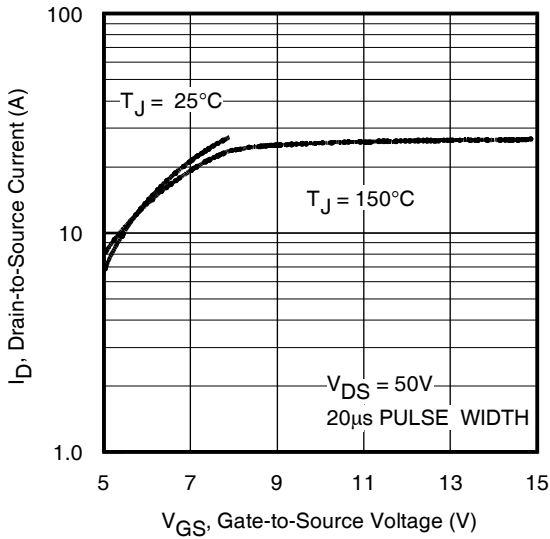


Fig 3. Typical Transfer Characteristics

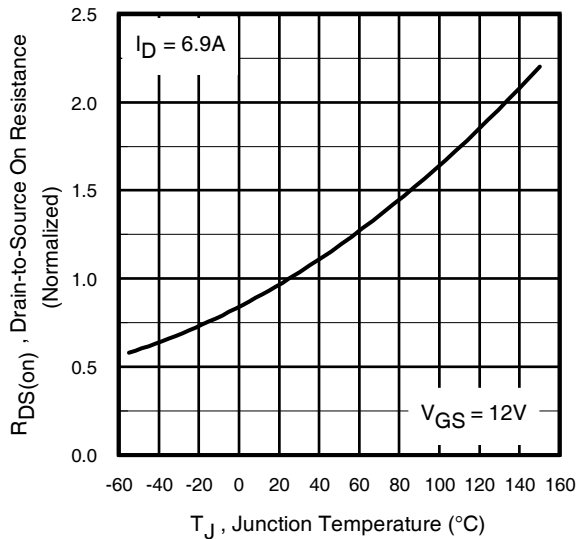
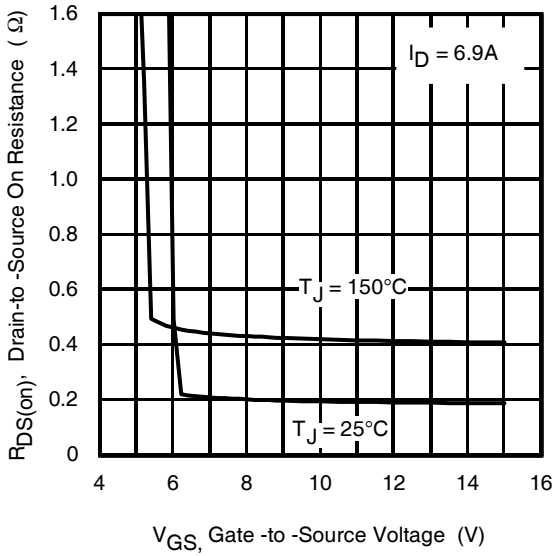
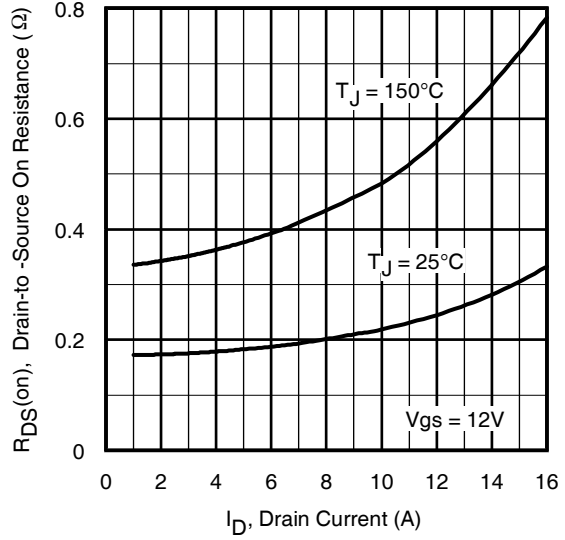


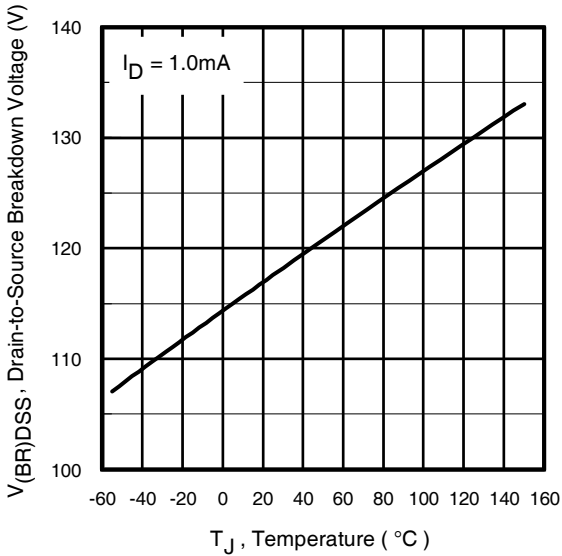
Fig 4. Normalized On-Resistance Vs. Temperature



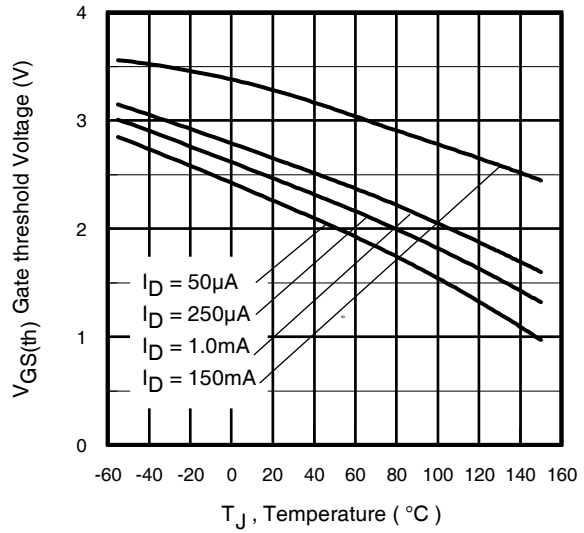
**Fig 5.** Typical On-Resistance Vs Gate Voltage



**Fig 6.** Typical On-Resistance Vs Drain Current



**Fig 7.** Typical Drain-to-Source Breakdown Voltage Vs Temperature



**Fig 8.** Typical Threshold Voltage Vs Temperature

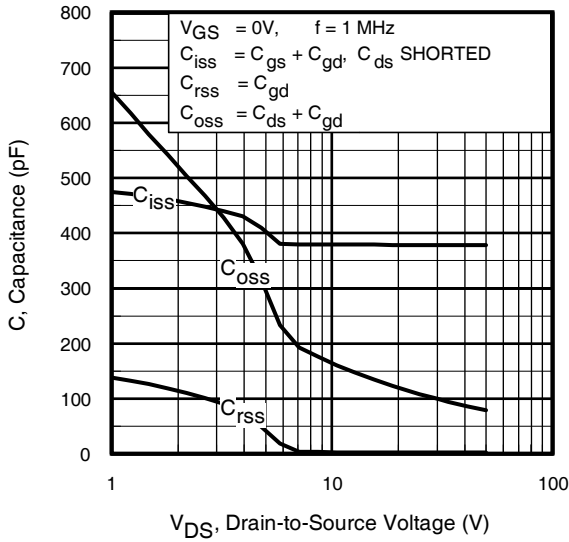


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

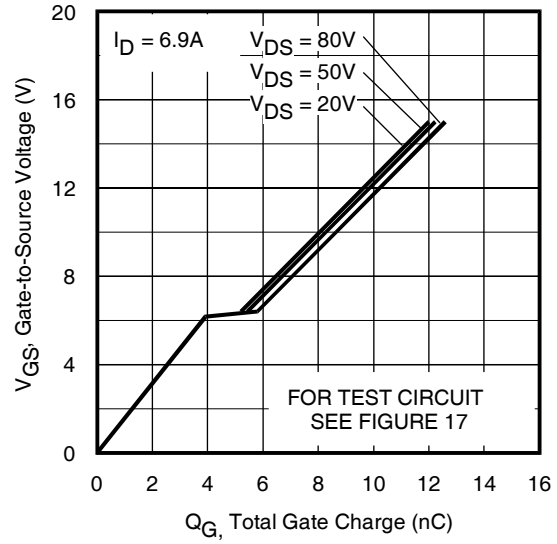


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

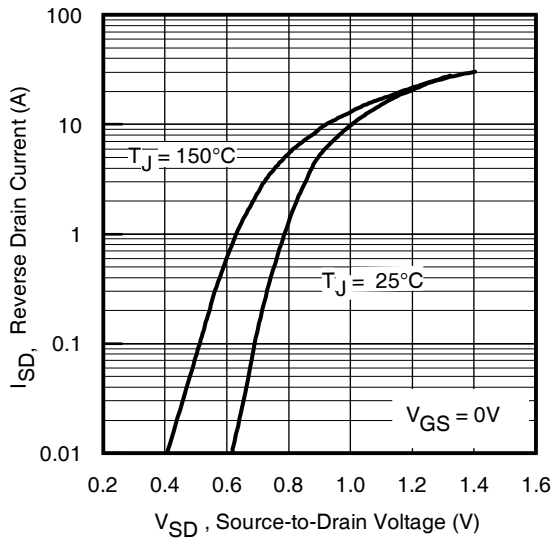


Fig 11. Typical Source-Drain Diode Forward Voltage

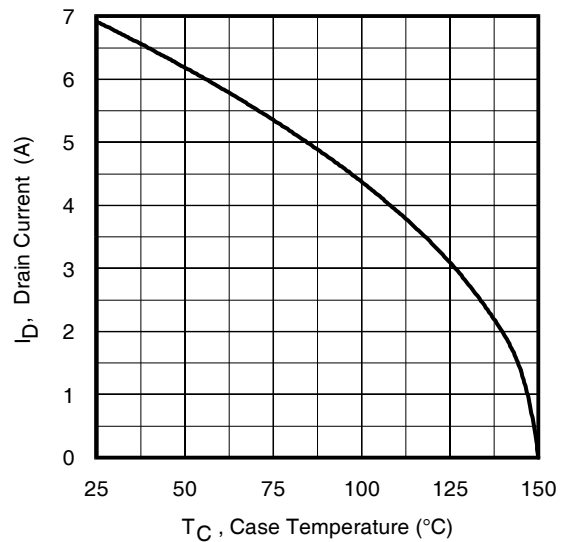


Fig 12. Maximum Drain Current Vs. Case Temperature

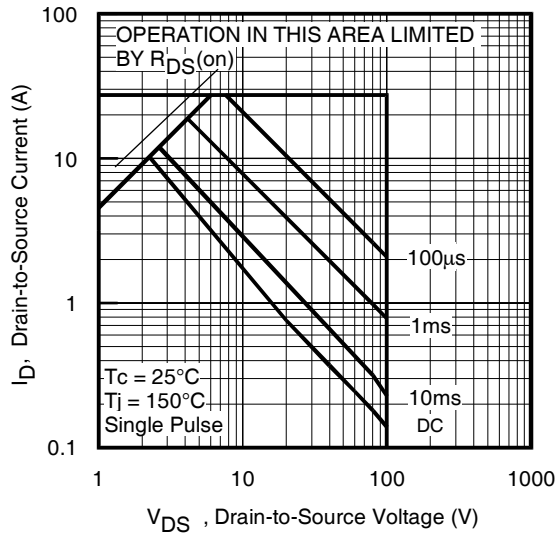


Fig 13. Maximum Safe Operating Area

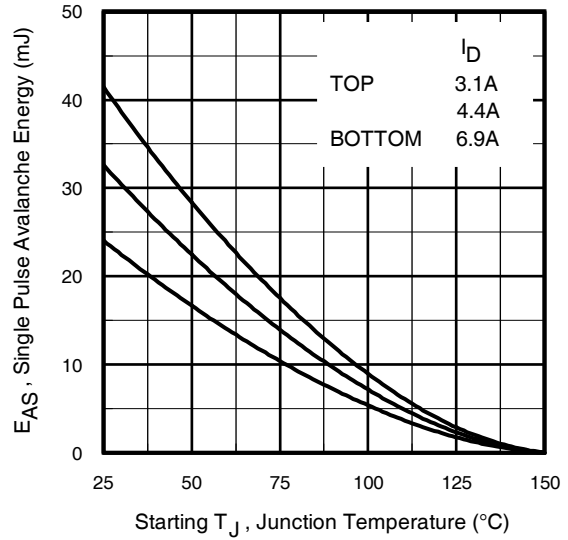


Fig 14. Maximum Avalanche Energy Vs. Drain Current

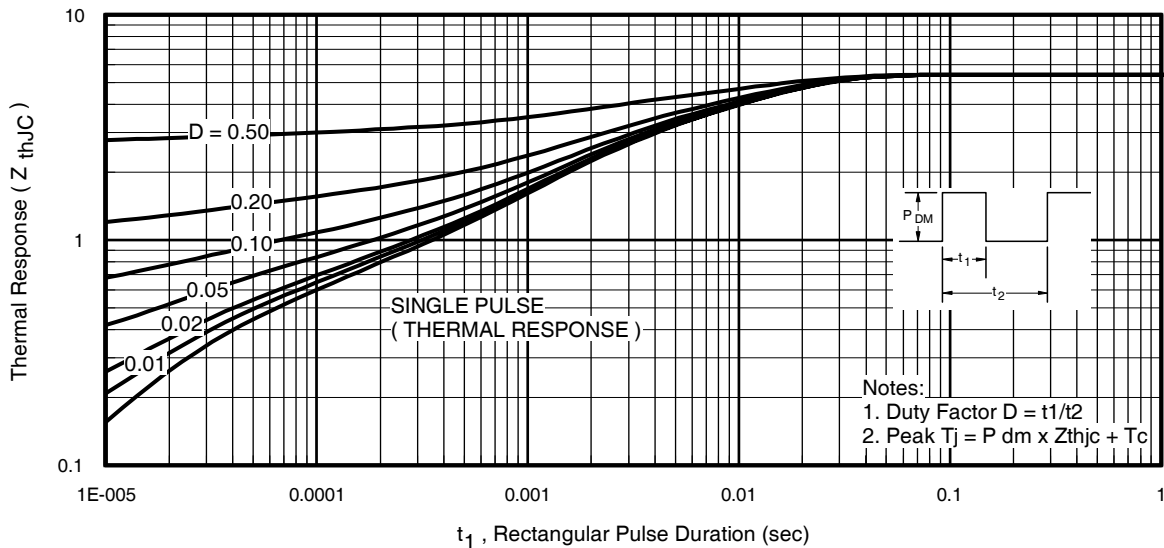


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

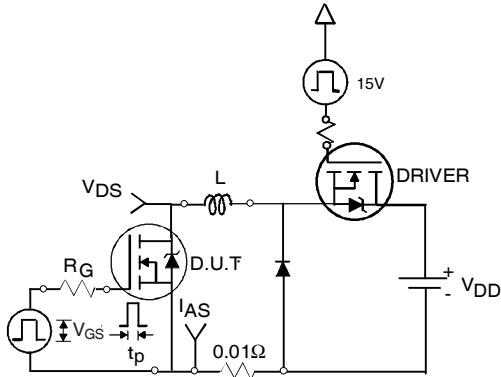


Fig 16a. Unclamped Inductive Test Circuit

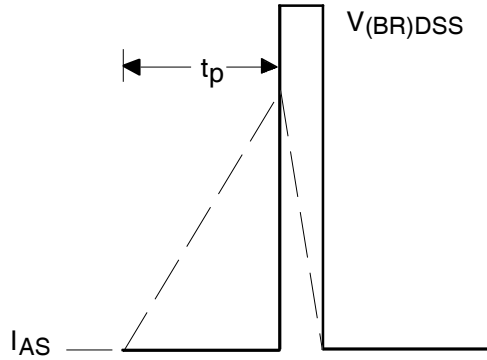


Fig 16b. Unclamped Inductive Waveforms

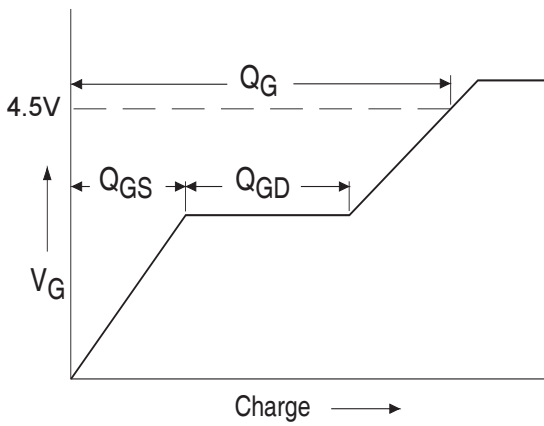


Fig 17a. Basic Gate Charge Waveform

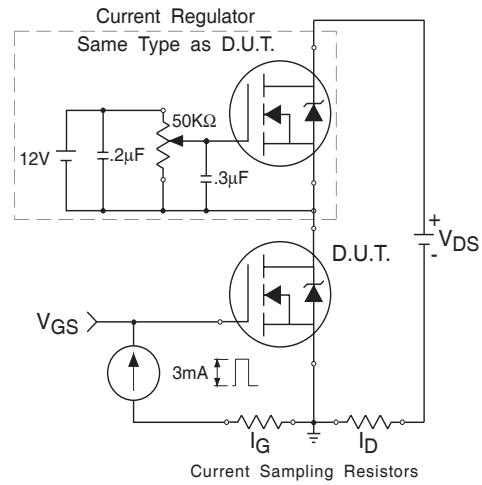


Fig 17b. Gate Charge Test Circuit

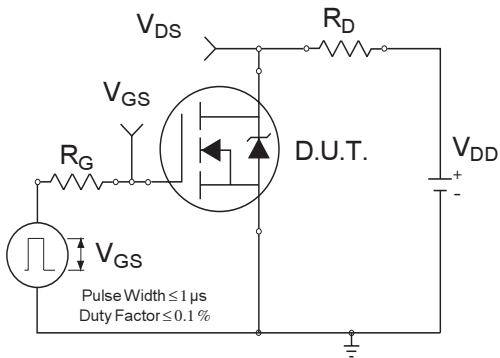


Fig 18a. Switching Time Test Circuit

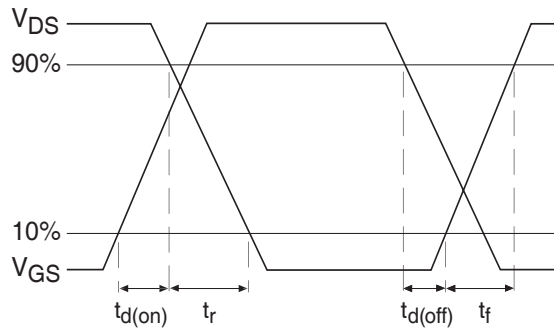
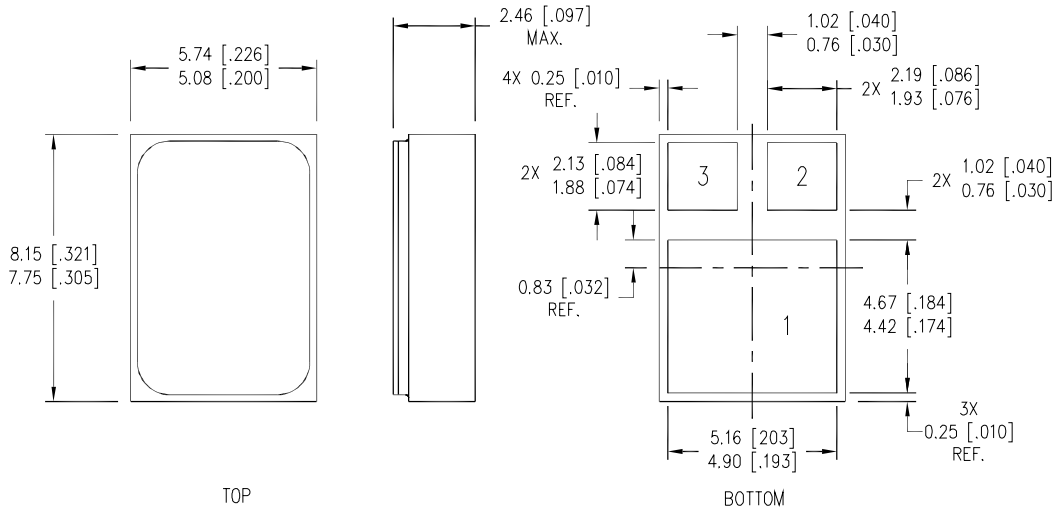


Fig 18b. Switching Time Waveforms



**Case Outline and Dimensions — SMD-0.2 (Metal Lid)**



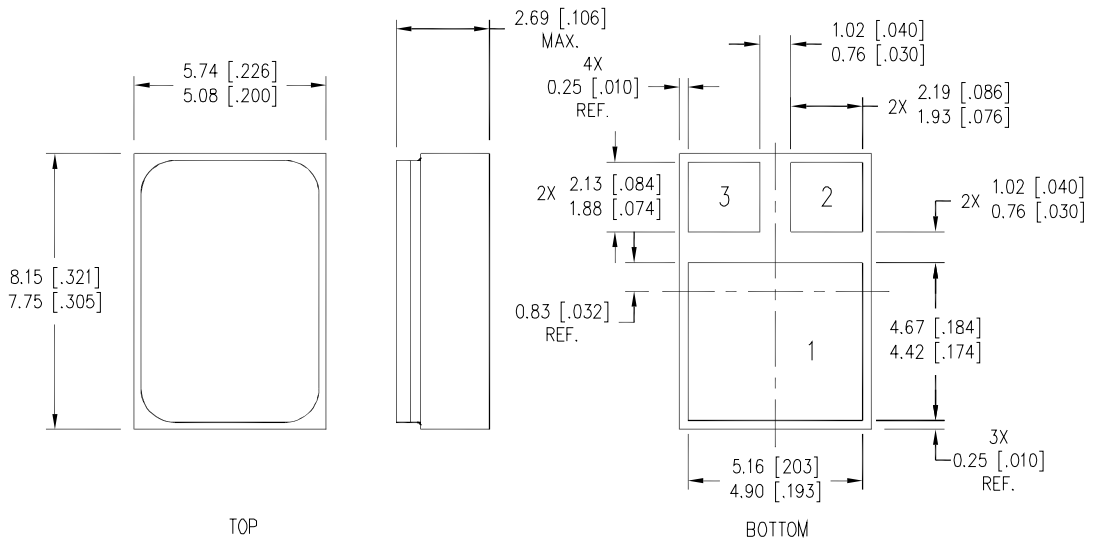
**NOTES:**

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

**PAD ASSIGNMENT**

- 1 = DRAIN
- 2 = GATE
- 3 = SOURCE

**Case Outline and Dimensions — SMD-0.2 (Ceramic Lid)**



**NOTES:**

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

**PAD ASSIGNMENT**


- 1 = DRAIN
- 2 = GATE
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**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^{\circ}C$ ,  $L=1.0\text{ mH}$   
Peak  $I_L = 6.9A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 6.9A$ ,  $di/dt \leq 560A/\mu s$ ,  
 $V_{DD} \leq 100V$ ,  $T_J \leq 150^{\circ}C$
- ④ Pulse width  $\leq 300\ \mu s$ ; Duty Cycle  $\leq 2\%$
- ⑤ **Total Dose Irradiation with VGS 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 VDS Bias.**  
80 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Additional Product Summary (continued from page 1 and 3)**

**Product Summary**

Part Number	Radiation Level	R <sub>DS(on)</sub>	I <sub>D</sub>	QPL Part Number	 <p><b>SMD-0.2 ( CERAMIC LID )</b></p>
IRHNMC57110	100K Rads (Si)	0.22Ω	6.9A	JANSR2N7503U8C	
IRHNMC53110	300K Rads (Si)	0.22Ω	6.9A	JANSF2N7503U8C	



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