

IRHN7450 (JANSR2N7270U)

PD-90819E

Radiation Hardened Power MOSFET

Surface Mount (SMD-1)

500V, 11A, N-channel, Rad Hard HEXFET™ Technology

Features

- Single event effect (SEE) hardened
- Low $R_{DS(on)}$
- Low total gate charge
- Simple drive requirements
- Hermetically sealed
- Electrically isolated
- Ceramic package
- Light weight
- Surface mount
- ESD rating: Class 3A per MIL-STD-750, Method 1020

Potential Applications

- DC-DC converter
- Motor drives
- Electric propulsion

Product Validation

Qualified to JANS screening flow according to MIL-PRF-19500 for space applications

Description

IR HiRel rad hard HEXFET technology provides high performance power MOSFETs for space applications. This technology has over a decade of proven performance and reliability in satellite applications. These devices have been characterized for both Total Dose and Single Event Effects (SEE). The combination of low $R_{DS(on)}$ 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 and temperature stability of electrical parameters.

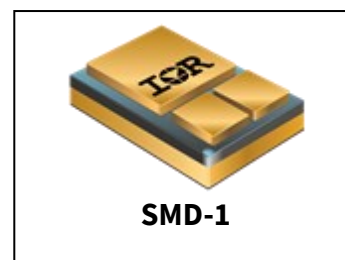
Ordering Information

Table 1 **Ordering options**

Part number	Package	Screening Level	TID Level
IRHN7450	SMD-1	COTS	100 krad(Si)
JANSR2N7270U	SMD-1	JANS	100 krad(Si)
IRHN3450	SMD-1	COTS	300 krad(Si)
JANSF2N7270U	SMD-1	JANS	300 krad(Si)
IRHN4450	SMD-1	COTS	500 krad(Si)
JANSR2N7270U	SMD-1	JANS	500 krad(Si)

Product Summary

- **BV_{DSS} :** 500V
- **I_D :** 11A
- **$R_{DS(on),max}$:** 0.45Ω
- **$Q_{G,max}$:** 150nC
- **REF:** MIL-PRF-19500/603



IRHN7450 (JANSR2N7270U)

Radiation Hardened Power MOSFET (SMD-1)

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Absolute Maximum Ratings

1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings (Pre-Irradiation)

Symbol	Parameter	Value	Unit
$I_{D1} @ V_{GS} = 12V, T_C = 25^{\circ}C$	Continuous Drain Current	11	A
$I_{D2} @ V_{GS} = 12V, T_C = 100^{\circ}C$	Continuous Drain Current	7.0	A
$I_{DM} @ T_C = 25^{\circ}C$	Pulsed Drain Current ¹	44	A
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	150	W
	Linear Derating Factor	1.2	W/ $^{\circ}C$
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy ²	500	mJ
I_{AR}	Avalanche Current ¹	11	A
E_{AR}	Repetitive Avalanche Energy ¹	15	mJ
dv/dt	Peak Diode Reverse Recovery ³	3.5	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	$^{\circ}C$
	Lead Temperature	300 (for 5 sec)	
	Weight	2.6 (Typical)	

¹ Repetitive Rating; Pulse width limited by maximum junction temperature.² $V_{DD} = 50V$, starting $T_J = 25^{\circ}C$, $L = 7.4mH$, Peak $I_L = 11A$, $V_{GS} = 12V$ ³ $I_{SD} \leq 11A$, $di/dt \leq 140A/\mu s$, $V_{DD} \leq 500V$, $T_J \leq 150^{\circ}C$

Device Characteristics

2 Device Characteristics

2.1 Electrical Characteristics (Pre-Irradiation)

Table 3 Static and Dynamic Electrical Characteristics @ $T_j = 25^\circ\text{C}$ (Unless Otherwise Specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	500	—	—	V	$V_{GS} = 0V, I_D = 1.0mA$
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.6	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1.0mA$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.45	Ω	$V_{GS} = 12V, I_{D2} = 7.0A^1$
		—	—	0.50		$V_{GS} = 12V, I_{D1} = 11A^1$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}, I_D = 1mA$
G_{fs}	Forward Transconductance	4.0	—	—	S	$V_{DS} = 15V, I_{D2} = 7.0A^1$
I_{DSS}	Zero Gate Voltage Drain Current	—	—	50	μA	$V_{DS} = 400V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 400V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
I_{GSS}	Gate-to-Source Leakage Forward	—	—	100	nA	$V_{GS} = 20V$
	Gate-to-Source Leakage Reverse	—	—	-100		$V_{GS} = -20V$
Q_G	Total Gate Charge	—	—	150	nC	$I_{D1} = 11A$
Q_{GS}	Gate-to-Source Charge	—	—	30		$V_{DS} = 250V$
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	75		$V_{GS} = 12V$
$t_{d(on)}$	Turn-On Delay Time	—	—	45	ns	$I_{D1} = 11A^{**}$ $V_{DD} = 250V$ $R_G = 2.35\Omega$ $V_{GS} = 12V$
t_r	Rise Time	—	—	190		
$t_{d(off)}$	Turn-Off Delay Time	—	—	190		
t_f	Fall Time	—	—	130		
$L_s + L_D$	Total Inductance	—	4.0	—	nH	Measured from center of Drain pad to center of Source pad
C_{iss}	Input Capacitance	—	4000	—	pF	$V_{GS} = 0V$ $V_{DS} = 25V$ $f = 1.0MHz$
C_{oss}	Output Capacitance	—	330	—		
C_{rss}	Reverse Transfer Capacitance	—	52	—		

** Switching speed maximum limits are based on manufacturing test equipment and capability.

¹ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$

Device Characteristics

2.2 Source-Drain Diode Ratings and Characteristics (Pre-Irradiation)

Table 4 Source-Drain Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	11	A	
I_{SM}	Pulsed Source Current (Body Diode) ¹	—	—	44	A	
V_{SD}	Diode Forward Voltage	—	—	1.6	V	$T_J = 25^\circ\text{C}$, $I_S = 11\text{A}$, $V_{GS} = 0\text{V}$ ²
t_{rr}	Reverse Recovery Time	—	—	1100	ns	$T_J = 25^\circ\text{C}$, $I_F = 11\text{A}$, $V_{DD} \leq 50\text{V}$
Q_{rr}	Reverse Recovery Charge	—	10.7	—	μC	$di/dt = 100\text{A}/\mu\text{s}$ ²
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$)				

2.3 Thermal Characteristics

Table 5 Thermal Resistance

Symbol	Parameter	Min.	Typ.	Max.	Unit
$R_{\theta JC}$	Junction-to-Case	—	—	0.83	$^\circ\text{C}/\text{W}$
$R_{\theta PCB}$	Junction-to-PC Board (soldered to 1inch square cu clad board)	—	6.6	—	

2.4 Radiation Characteristics

IR HiRel radiation hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at IR HiRel is comprised of two radiation environments. Every manufacturing lot is tested for total ionizing dose (per notes 3 and 4) 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.

2.4.1 Electrical Characteristics — Post Total Dose Irradiation

Table 6 Electrical Characteristics @ $T_J = 25^\circ\text{C}$, Post Total Dose Irradiation ^{3, 4}

Symbol	Parameter	100krad (Si) ⁵		Up to 500krad (Si) ⁶		Unit	Test Conditions
		Min.	Max.	Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	500	—	500	—	V	$V_{GS} = 0\text{V}$, $I_D = 1.0\text{mA}$
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	1.25	4.5	V	$V_{DS} = V_{GS}$, $I_D = 1.0\text{mA}$
I_{GSS}	Gate-to-Source Leakage Forward	—	100	—	100	nA	$V_{GS} = 20\text{V}$
	Gate-to-Source Leakage Reverse	—	-100	—	-100		$V_{GS} = -20\text{V}$
I_{DSS}	Zero Gate Voltage Drain Current	—	50	—	100	μA	$V_{DS} = 400\text{V}$, $V_{GS} = 0\text{V}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (TO-3) ²	—	0.45	—	0.60	Ω	$V_{GS} = 12\text{V}$, $I_{D2} = 7.0\text{A}$
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance (SMD-1) ²	—	0.45	—	0.60	Ω	$V_{GS} = 12\text{V}$, $I_{D2} = 7.0\text{A}$

¹ Repetitive Rating; Pulse width limited by maximum junction temperature.

² Pulse width $\leq 300 \mu\text{s}$; Duty Cycle $\leq 2\%$

³ Total Dose Irradiation with V_{GS} Bias. $V_{GS} = 12\text{V}$ applied and $V_{DS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

⁴ Total Dose Irradiation with V_{DS} Bias. $V_{DS} = 400\text{V}$ applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, Method 1019, condition A.

⁵ Part numbers IRHN7450 (JANSR2N7270U)

⁶ Part numbers IRHN3450 (JANSF2N7270U) and IRHN4450 (JANS2N7270U)

IRHN7450 (JANSR2N7270U)
Radiation Hardened Power MOSFET (SMD-1)

Device Characteristics

Symbol	Parameter	100krad (Si) ¹		Up to 500krad (Si) ²		Unit	Test Conditions
		Min.	Max.	Min.	Max.		
V _{SD}	Diode Forward Voltage	—	1.6	—	1.6	V	V _{GS} = 0V, I _F = 11A

2.4.2 Single Event Effects — Safe Operating Area

IR HiRel radiation hardened MOSFETs have been characterized in heavy ion environment for Single Event Effects (SEE). Single Event Effects characterization is illustrated in Fig. 1 and Table 7.

Table 7 Typical Single Event Effects Safe Operating Area

Ion	LET (MeV·cm ² /mg)	Energy (MeV)	Range (μm)	V _{DS} (V)				
				V _{GS} = 0V	V _{GS} = -5V	V _{GS} = -10V	V _{GS} = -15V	V _{GS} = -20V
Ni	28	265	41	275	275	—	—	—

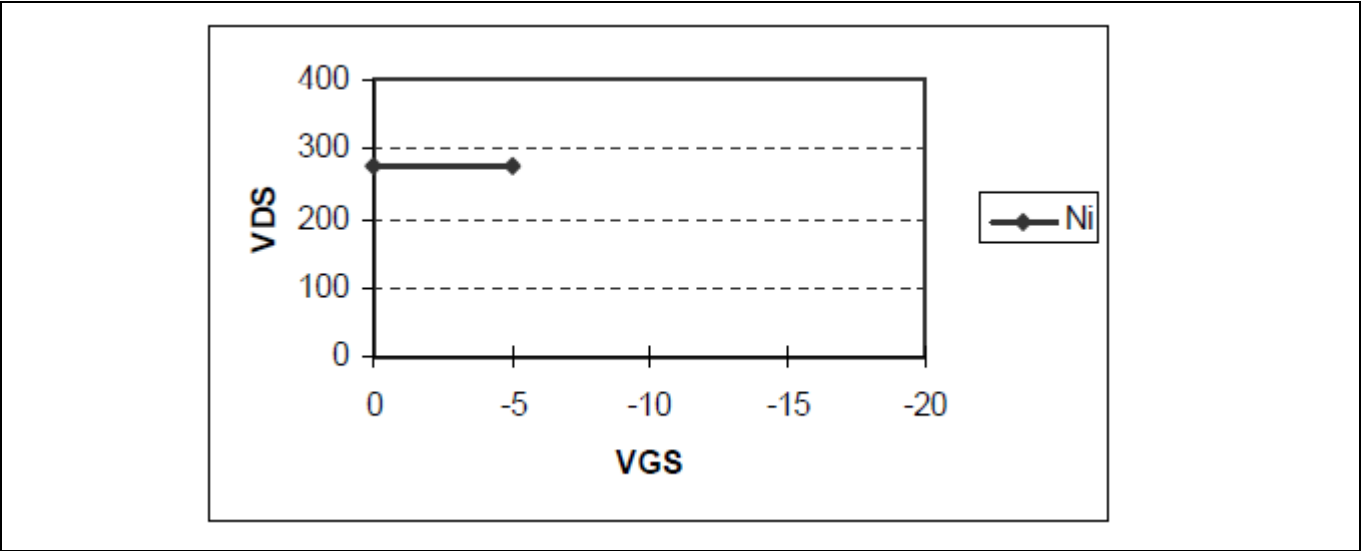


Figure 1 Typical Single Event Effect, Safe Operating Area

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Radiation Hardened Power MOSFET (SMD-1)

Electrical Characteristics Curves (Pre-irradiation)

3 Electrical Characteristics Curves (Pre-irradiation)

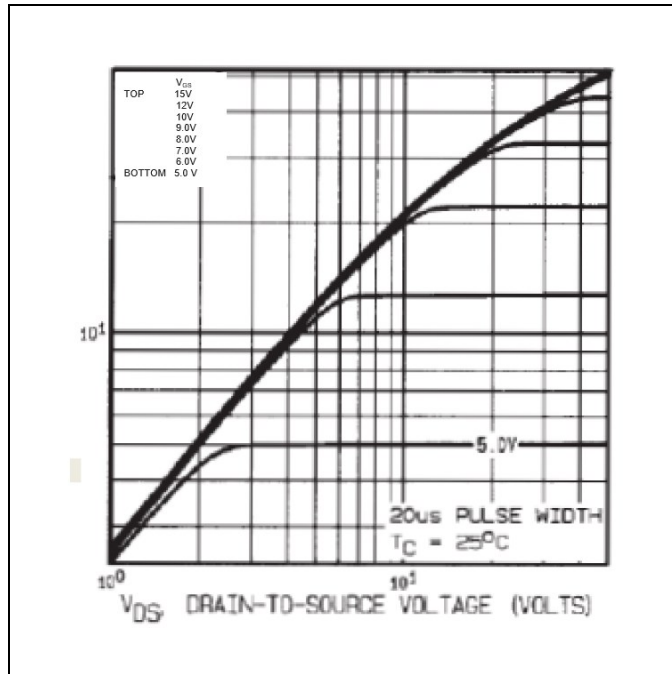


Figure 2 Typical Output Characteristics

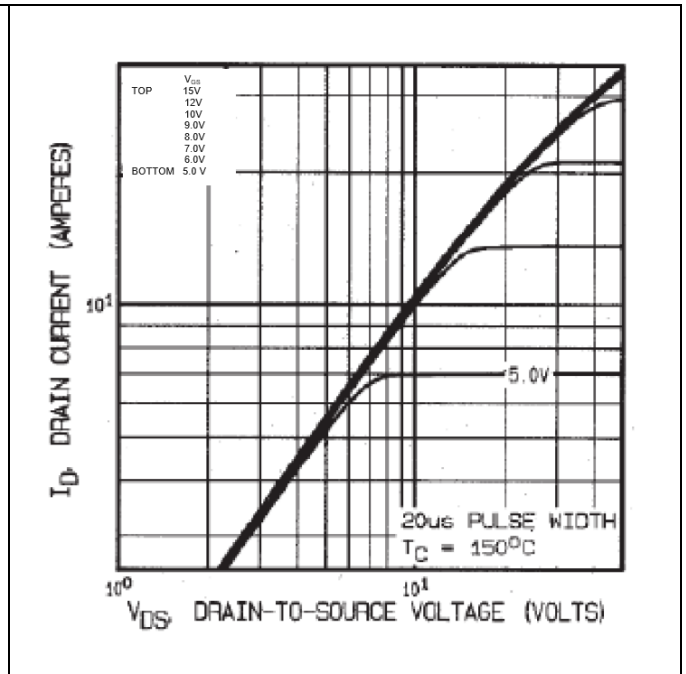


Figure 3 Typical Output Characteristics

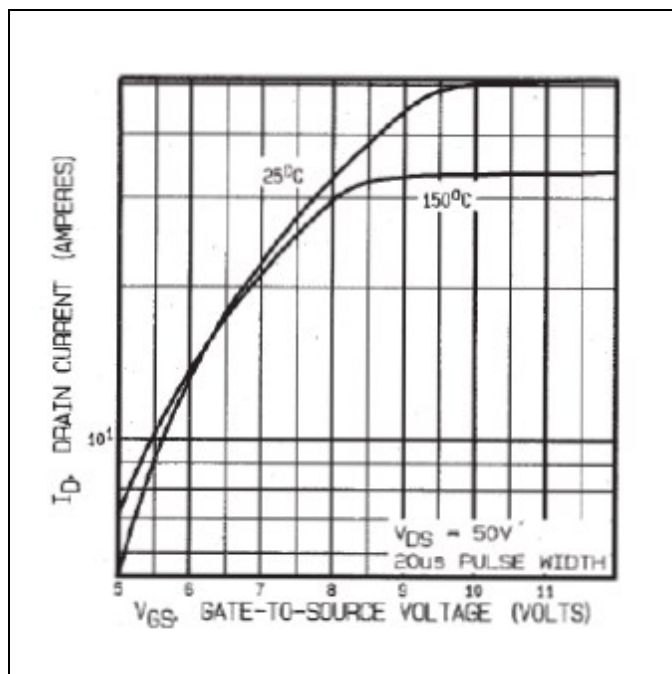


Figure 4 Typical Transfer Characteristics

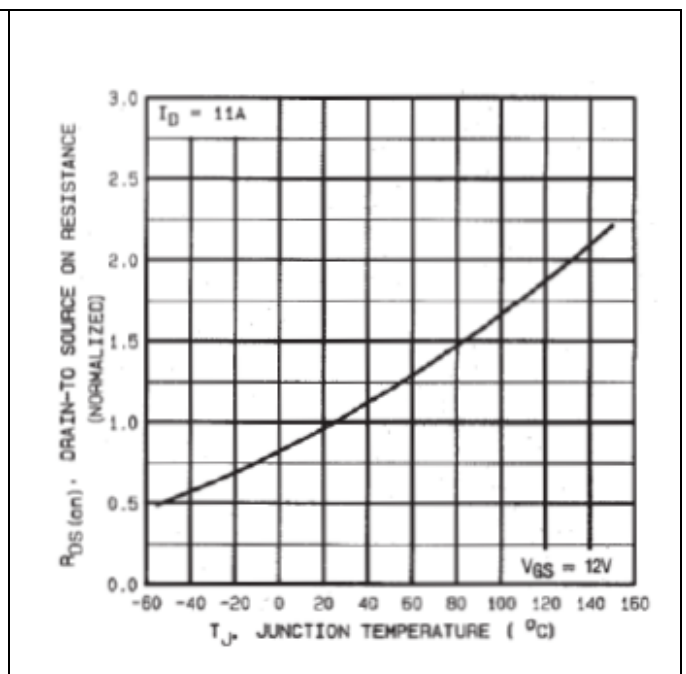


Figure 5 Normalized On-Resistance Vs. Temperature

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Radiation Hardened Power MOSFET (SMD-1)

Electrical Characteristics Curves (Pre-irradiation)

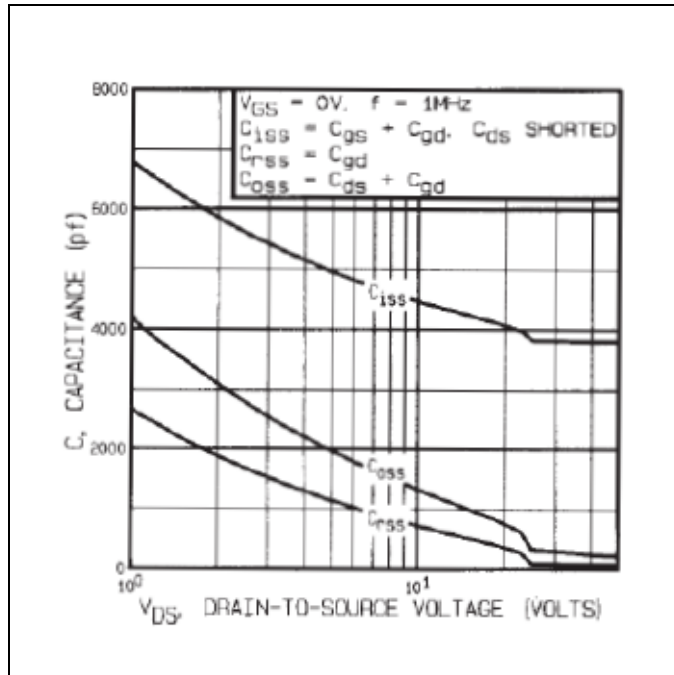


Figure 6 Typical Capacitance Vs. Drain-to-Source Voltage

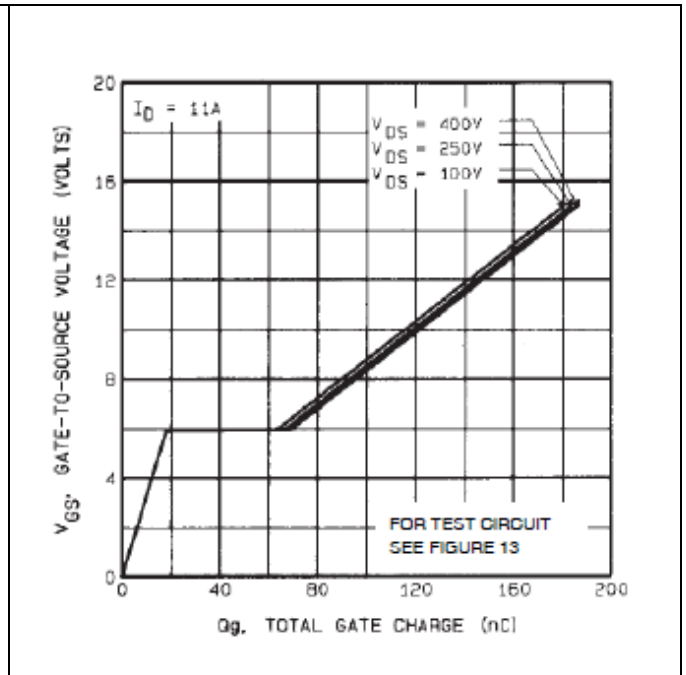


Figure 7 Typical Gate-to-Source Voltage Vs. Typical Gate Charge

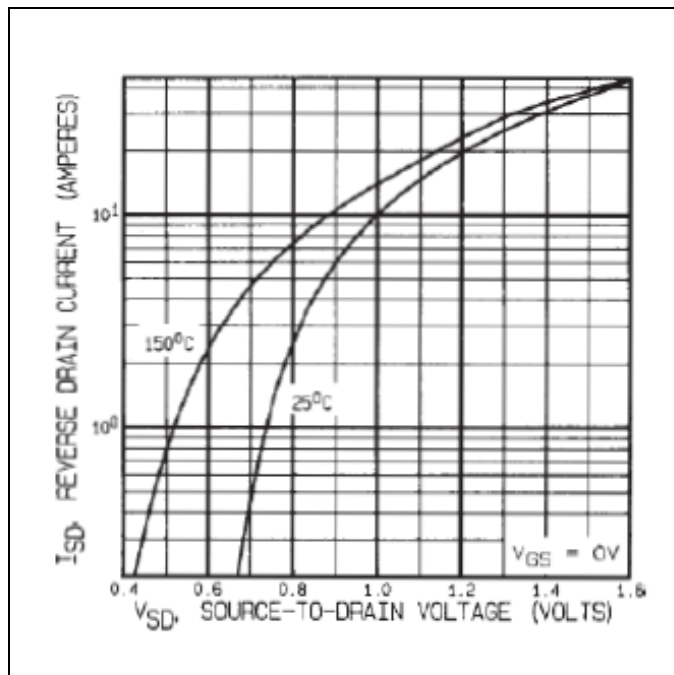


Figure 8 Typical Source-Drain Current Vs. Diode Forward Voltage

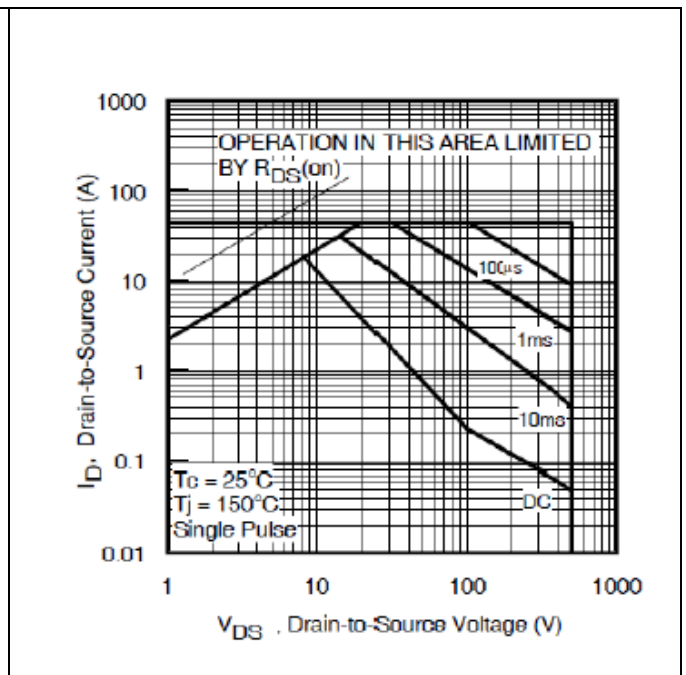


Figure 9 Maximum Safe Operating Area

IRHN7450 (JANSR2N7270U)

Radiation Hardened Power MOSFET (SMD-1)

Electrical Characteristics Curves (Pre-irradiation)

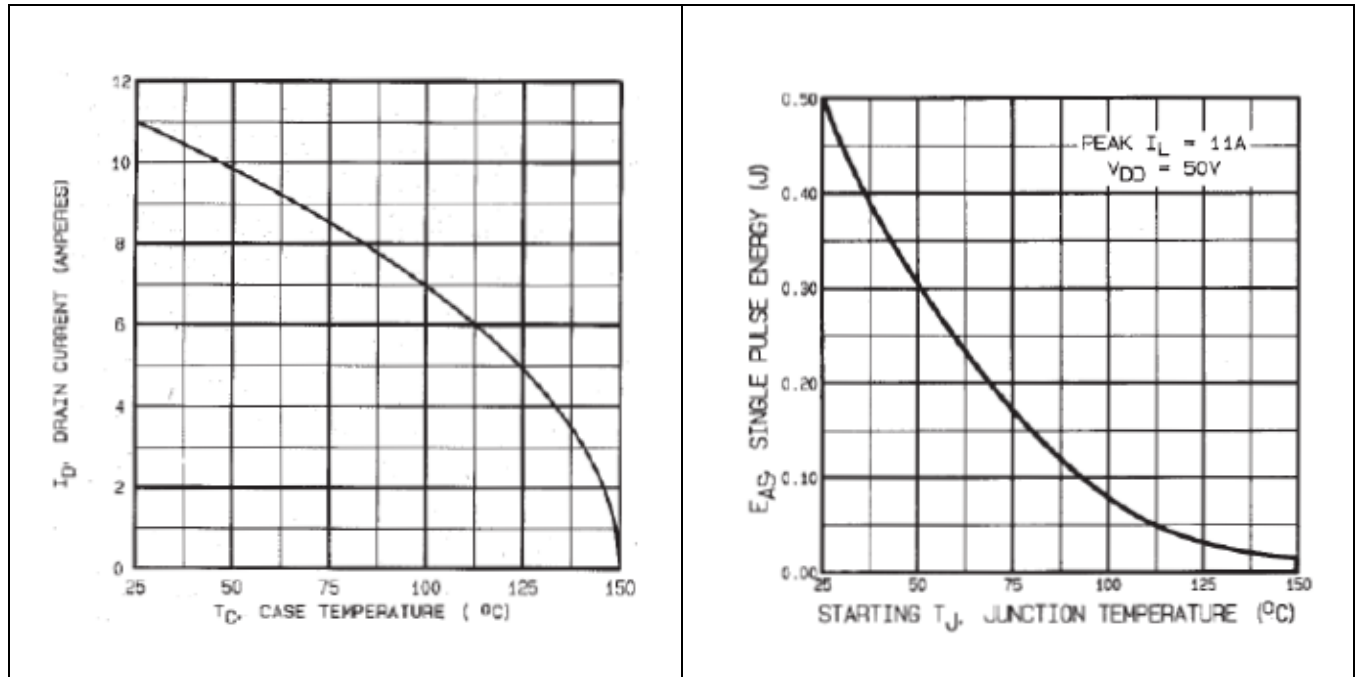


Figure 10 Maximum Drain Current Vs. Case Temperature

Figure 11 Maximum Avalanche Energy Vs. Junction Temperature

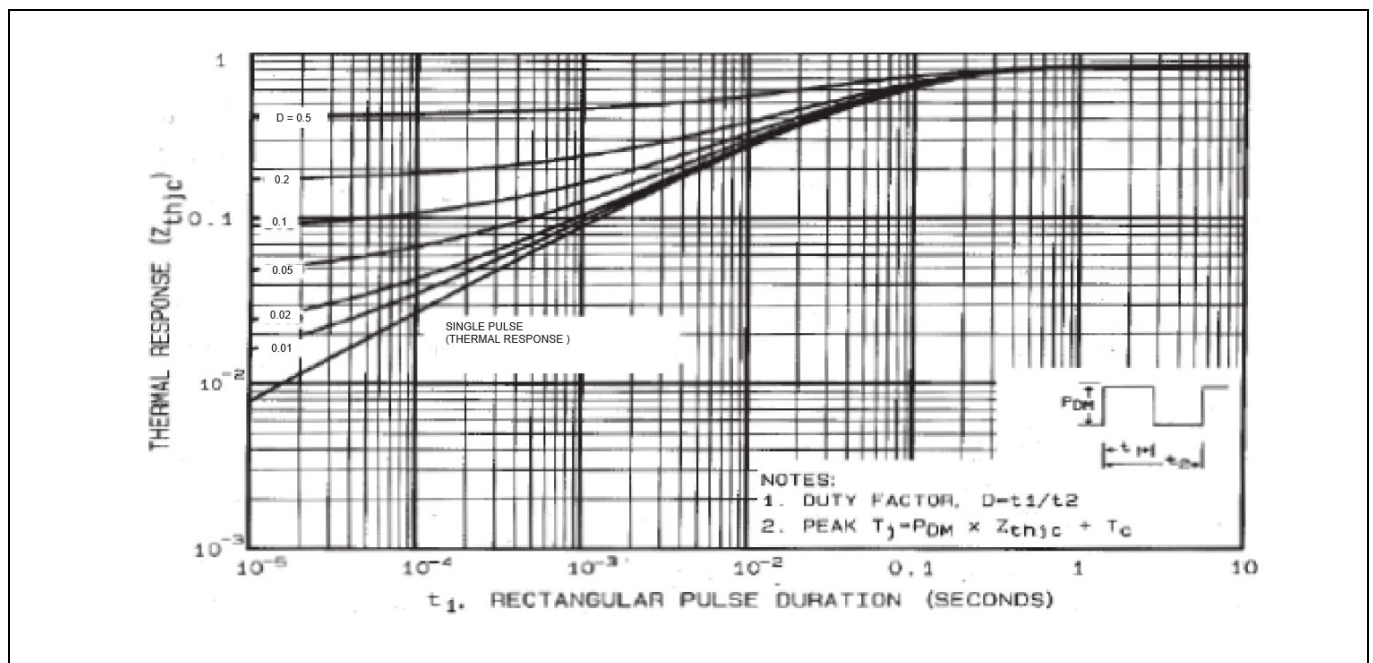


Figure 12 Maximum Effective Transient Thermal Impedance, Junction-to-Case

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Radiation Hardened Power MOSFET (SMD-1)

Test Circuits (Pre-irradiation)

4 Test Circuits (Pre-irradiation)

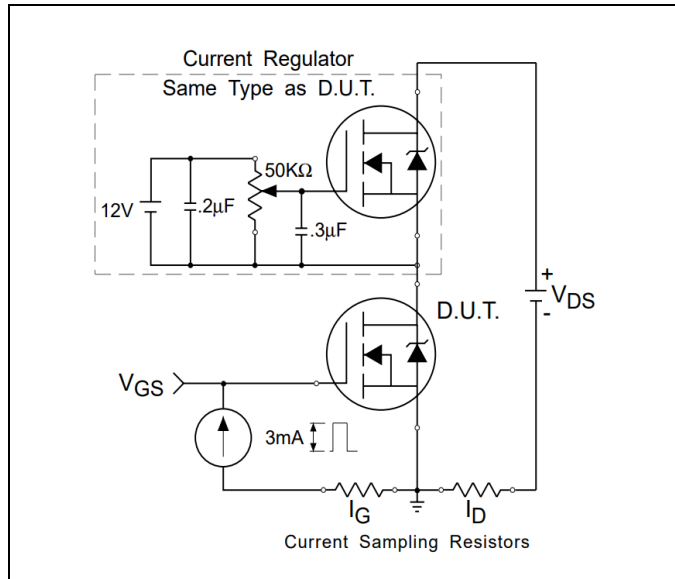


Figure 13 Gate Charge Test Circuit

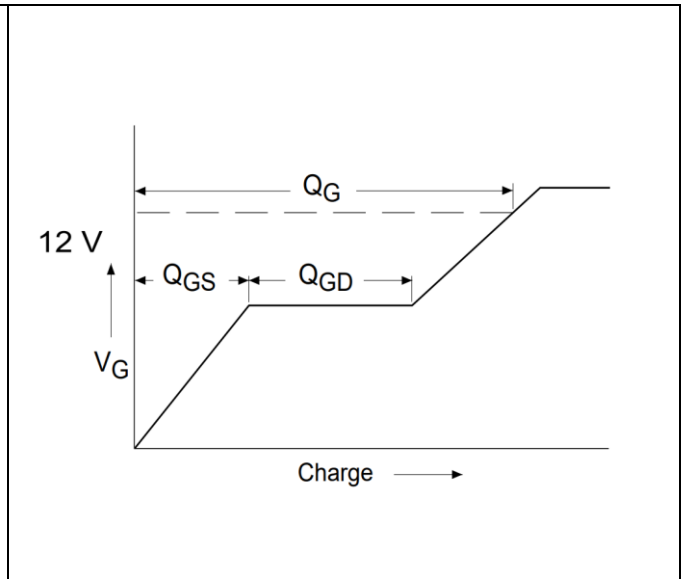


Figure 14 Gate Charge Waveform

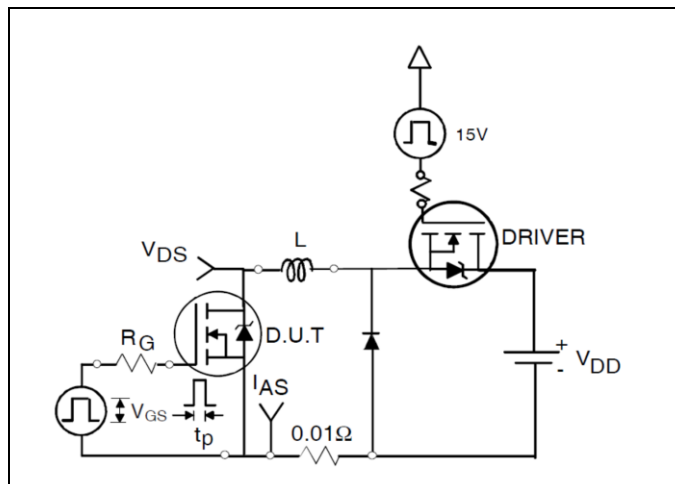


Figure 15 Unclamped Inductive Test Circuit

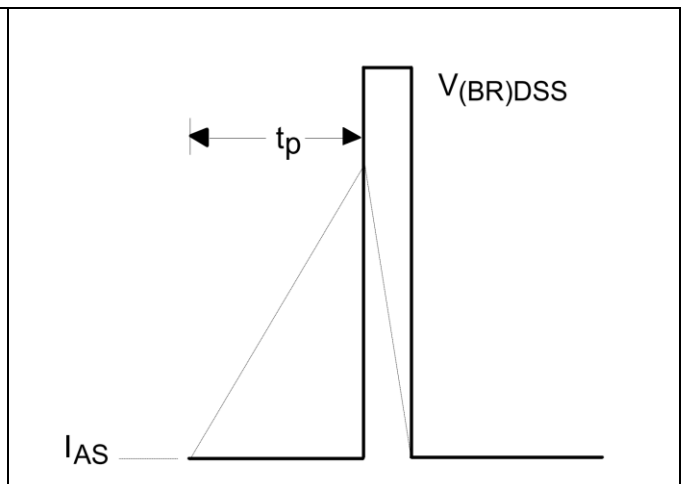


Figure 16 Unclamped Inductive Waveform

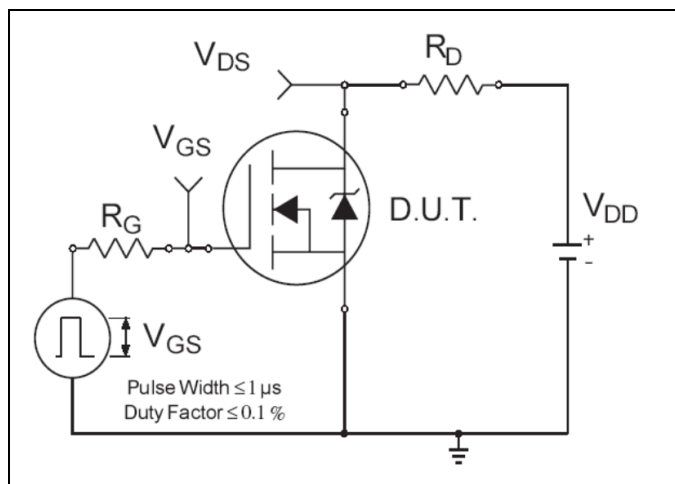


Figure 17 Switching Time Test Circuit

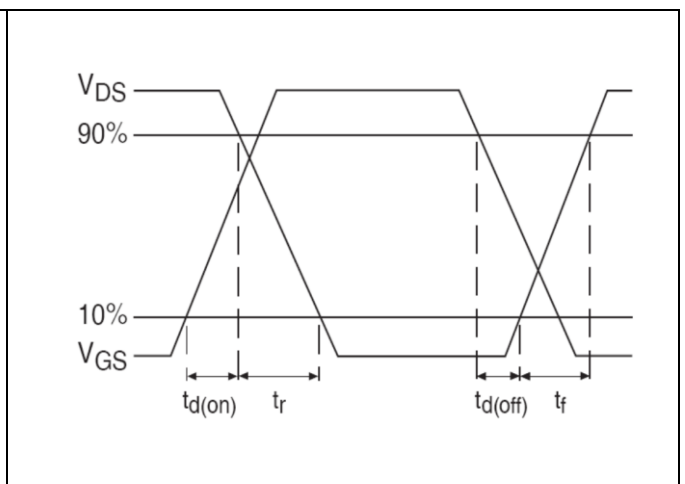


Figure 18 Switching Time Waveforms

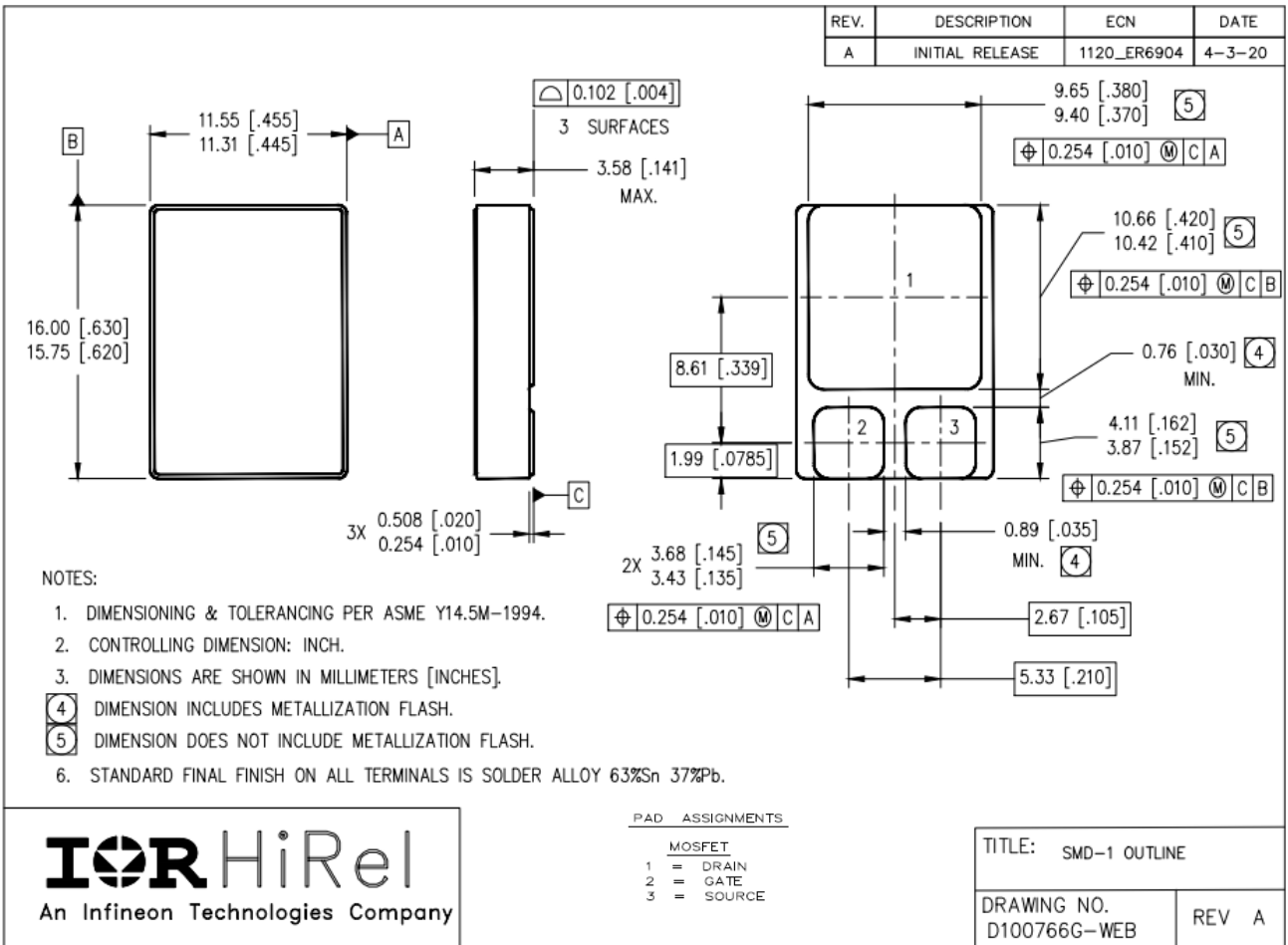
IRHN7450 (JANSR2N7270U)

Radiation Hardened Power MOSFET (SMD-1)

Package Outline

5 Package Outline

Note: For the most updated package outline, please see the website: [SMD-1](#)



IRHN7450 (JANSR2N7270U)**Radiation Hardened Power MOSFET (SMD-1)****Revision history****Revision history**

Document version	Date of release	Description of changes
	10/06/1998	Datasheet (PD-90819A)
Rev B	05/18/2006	Updated 600kRad(si) to 500kRad(si)
Rev C	06/30/2016	Updated based on ECN-1120_04308
Rev D	08/02/2022	Updated based on ECN-1120_09044
Rev E	12/09/2024	Updated based on ECN-1120_10128

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