

**RADIATION HARDENED  
 POWER MOSFET  
 SURFACE MOUNT (SMD-1)**

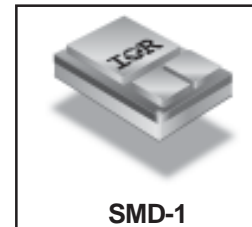
**IRHN7450  
 JANSR2N7270U  
 500V, N-CHANNEL**

REF: MIL-PRF-19500/603

**RAD-Hard™ HEXFET® TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	RDS(on)	Id	QPL Part Number
IRHN7450	100K Rads (Si)	0.45Ω	11A	JANSR2N7270U
IRHN3450	300K Rads (Si)	0.45Ω	11A	JANSF2N7270U
IRHN4450	500K Rads (Si)	0.45Ω	11A	JANSG2N7270U
IRHN8450	1000K Rads (Si)	0.45Ω	11A	JANSH2N7270U



International Rectifier's 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 Rds(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, ease of paralleling and temperature stability of electrical parameters.

**Features:**

- Single Event Effect (SEE) Hardened
- Low RDS(on)
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight

**Absolute Maximum Ratings**

**Pre-Irradiation**

	Parameter		Units
Id @ VGS = 12V, TC = 25°C	Continuous Drain Current	11	A
Id @ VGS = 12V, TC = 100°C	Continuous Drain Current	7.0	
IdM	Pulsed Drain Current ①	44	
PD @ TC = 25°C	Max. Power Dissipation	150	W
	Linear Derating Factor	1.2	W/°C
VGS	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	500	mJ
IAR	Avalanche Current ①	11	A
EAR	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.5	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	PCKG. Mounting Surface Temp.	300 (for 5s)	
	Weight	2.6 (Typical)	g

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
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	500	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.6	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.45	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A ④
		—	—	0.50		V <sub>GS</sub> = 12V, I <sub>D</sub> = 11A
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
g <sub>fs</sub>	Forward Transconductance	4.0	—	—	S (r̄)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 7.0A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	50	μA	V <sub>DS</sub> = 400V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 400V 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		V <sub>GS</sub> = -20V
Q <sub>g</sub>	Total Gate Charge	—	—	150	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 11A V <sub>DS</sub> = 250V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	30		
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	75		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	45	ns	V <sub>DD</sub> = 250V, I <sub>D</sub> = 11A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω
t <sub>r</sub>	Rise Time	—	—	190		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	190		
t <sub>f</sub>	Fall Time	—	—	130		
LS + LD	Total Inductance	—	4.0	—	nH	Measured from the center of drain pad to center of source pad
C <sub>iss</sub>	Input Capacitance	—	4000	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	330	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	52	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	11	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	44		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.6	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 11A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	1100	ns	T <sub>j</sub> = 25°C, I <sub>F</sub> = 11A, di/dt ≥ 100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	16	μC	V <sub>DD</sub> ≤ 50V ④
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by LS + LD.				

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	0.83	°C/W	soldered to a 1"sq. copper-clad board
R <sub>thJ-PCB</sub>	Junction-to-PC board	—	6.6	—		

**Note:** Corresponding Spice and Saber models are available on the International Rectifier Website.

For footnotes refer to the last page

## Radiation Characteristics

## IRHN7450, JANSR2N7270U

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** <sup>⑤⑥</sup>

	Parameter	100K Rads(Si) <sup>1</sup>		300K- 1000K Rads (Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	500	—	500	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	4.0	1.25	4.5		V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 1.0mA
I <sub>GSS</sub>	Gate-to-Source Leakage Forward	—	100	—	100	nA	V <sub>GS</sub> = 20V
I <sub>GSS</sub>	Gate-to-Source Leakage Reverse	—	-100	—	-100		V <sub>GS</sub> = -20 V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	50	—	50	μA	V <sub>DS</sub> =400V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source <sup>④</sup> On-State Resistance (TO-3)	—	0.45	—	0.6	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A
R <sub>DS(on)</sub>	Static Drain-to-Source <sup>④</sup> On-State Resistance (SMD-1)	—	0.45	—	0.6	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 7.0A
V <sub>SD</sub>	Diode Forward Voltage <sup>④</sup>	—	1.6	—	1.6	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 11A

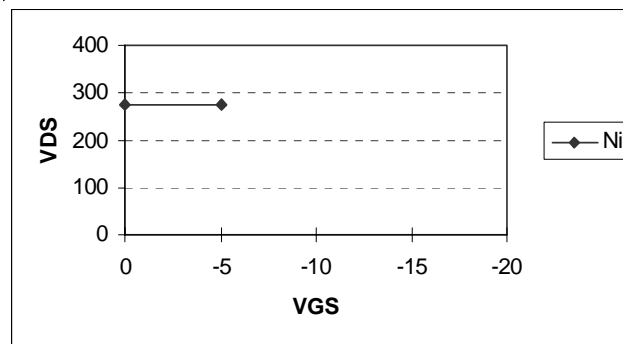
1. Part number IRHN7450 (JANSR2N7270U)

2. Part numbers IRHN3450 (JANSF2N7270U), IRHN4450 (JANSR2N7270U) and IRHN8450 (JANSH2N7270U)

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. Single Event Effect Safe Operating Area**

Ion	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
Ni	28	265	41	275	275	-	-	-



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

For footnotes refer to the last page

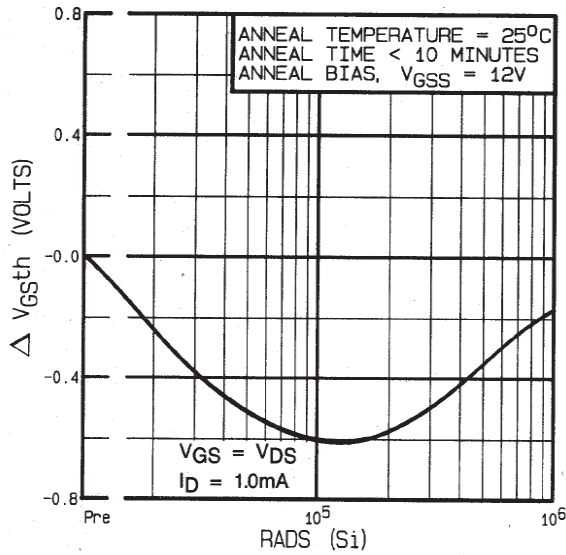


Fig 1. Typical Response of Gate Threshold Voltage Vs. Total Dose Exposure

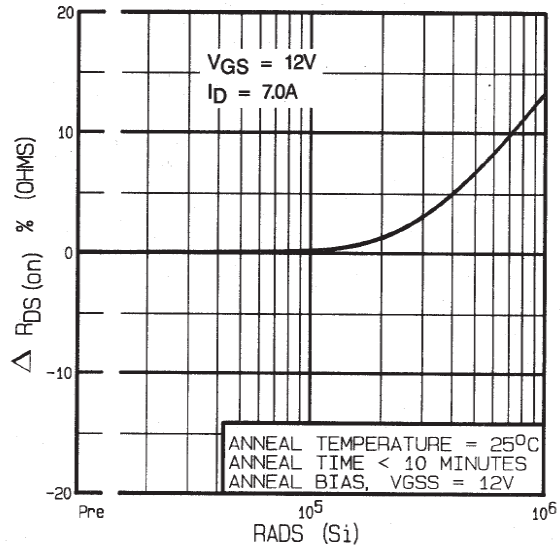


Fig 2. Typical Response of On-State Resistance Vs. Total Dose Exposure

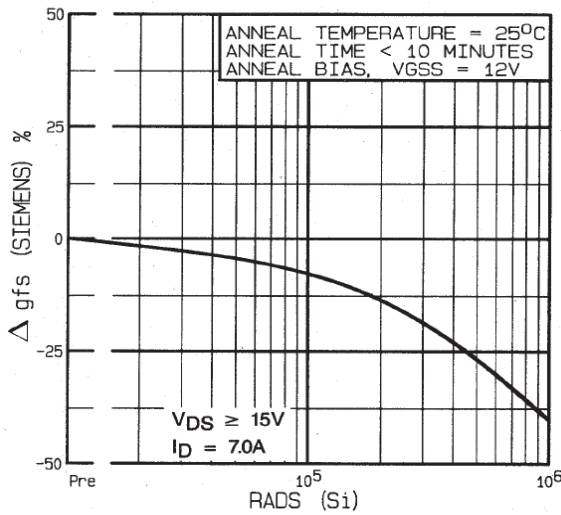


Fig 3. Typical Response of Transconductance Vs. Total Dose Exposure

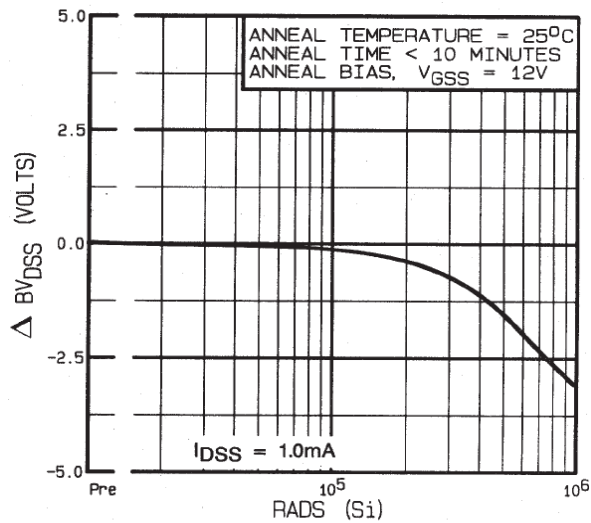


Fig 4. Typical Response of Drain to Source Breakdown Vs. Total Dose Exposure

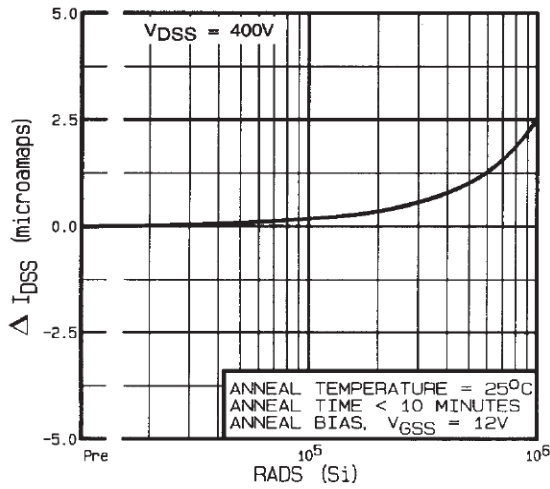


Fig 5. Typical Zero Gate Voltage Drain Current Vs. Total Dose Exposure

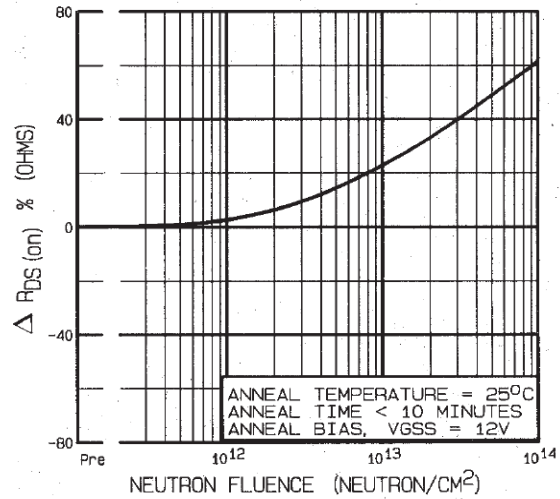


Fig 6. Typical On-State Resistance Vs. Neutron Fluence Level

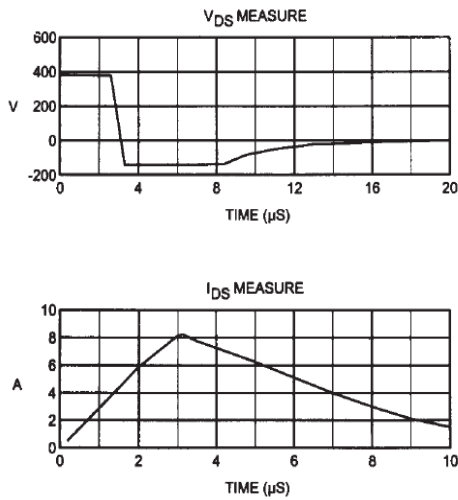


Fig 7. Typical Transient Response of Rad Hard HEXFET During  $1 \times 10^{12}$  Rad (Si)/Sec Exposure

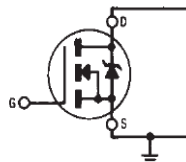


Fig 8a. Gate Stress of  $V_{GSS}$  Equals 12 Volts During Radiation

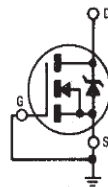


Fig 8b.  $V_{DSS}$  Stress Equals 80% of  $B_{V_{DSS}}$  During Radiation

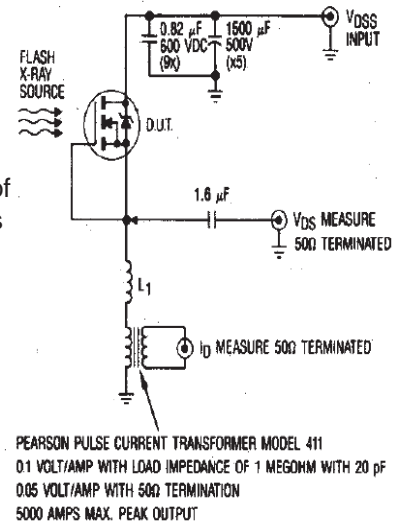


Fig 9. High Dose Rate (Gamma Dot) Test Circuit

Note: Bias Conditions during radiation:  $V_{GS} = 12\text{ Vdc}$ ,  $V_{DS} = 0\text{ Vdc}$

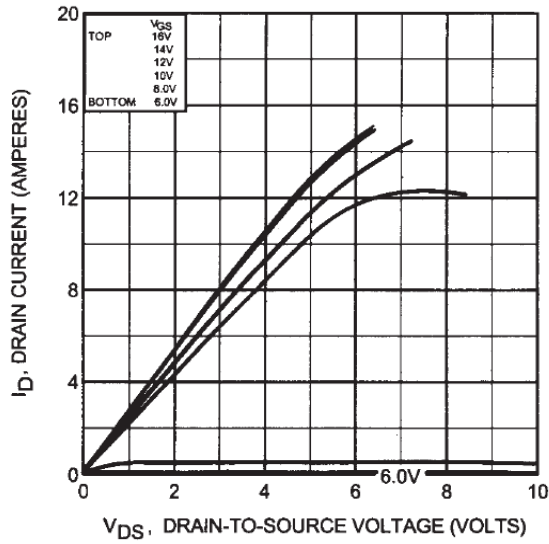


Fig 10. Typical Output Characteristics Pre-Irradiation

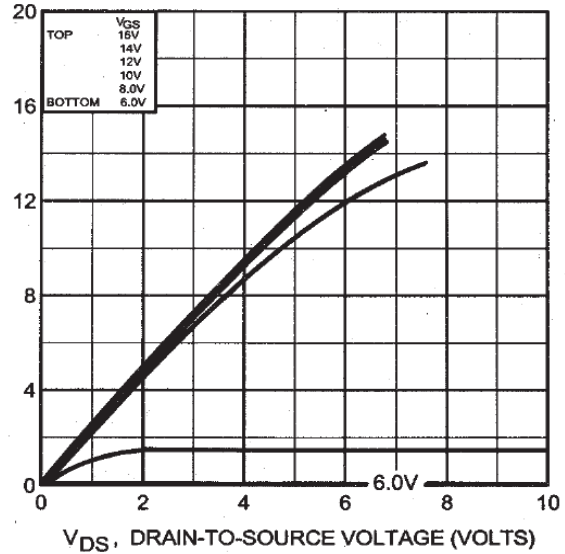


Fig 11. Typical Output Characteristics Post-Irradiation 100K Rads (Si)

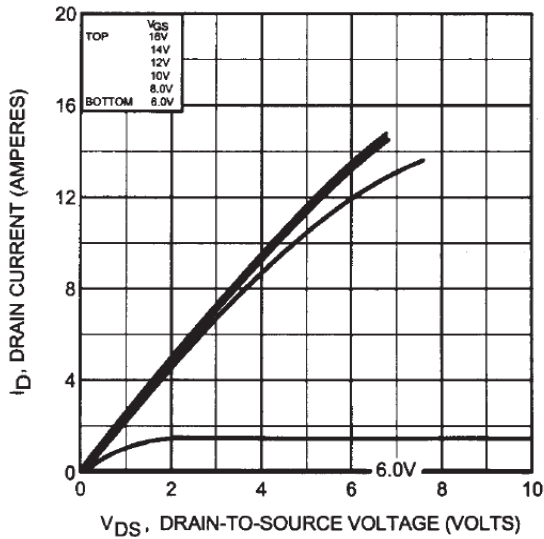


Fig 12. Typical Output Characteristics Post-Irradiation 300K Rads (Si)

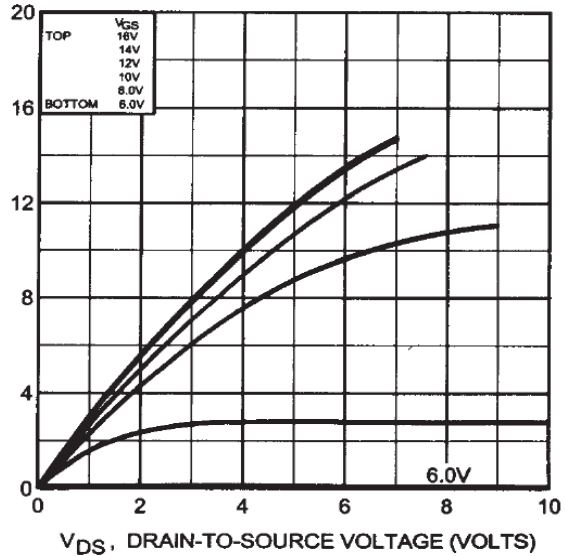


Fig 13. Typical Output Characteristics Post-Irradiation 1 Mega Rads (Si)

## Radiation Characteristics

IRHN7450, JANSR2N7270U

Note: Bias Conditions during radiation:  $V_{GS} = 0$  Vdc,  $V_{DS} = 400$  Vdc

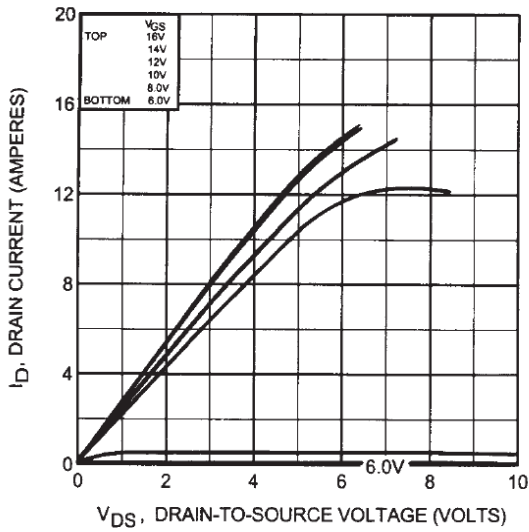


Fig 14. Typical Output Characteristics Pre-Irradiation

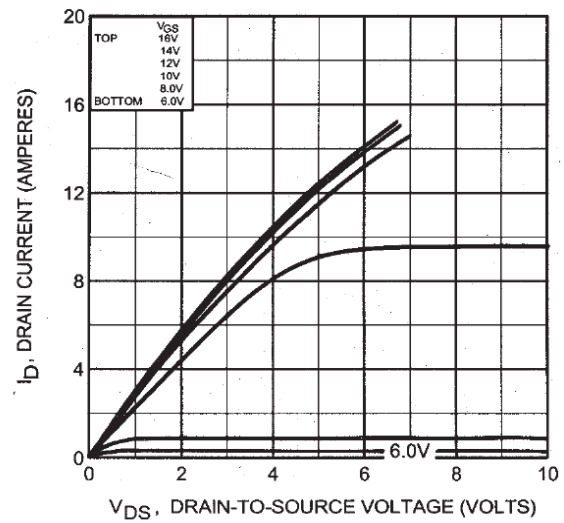


Fig 15. Typical Output Characteristics Post-Irradiation 100K Rads (Si)

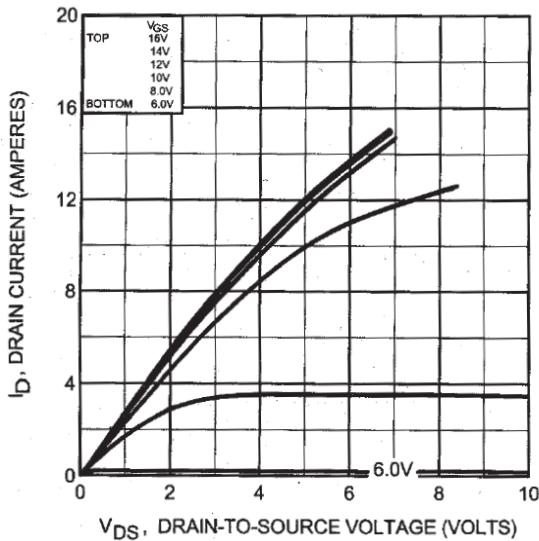


Fig 16. Typical Output Characteristics Post-Irradiation 300K Rads (Si)

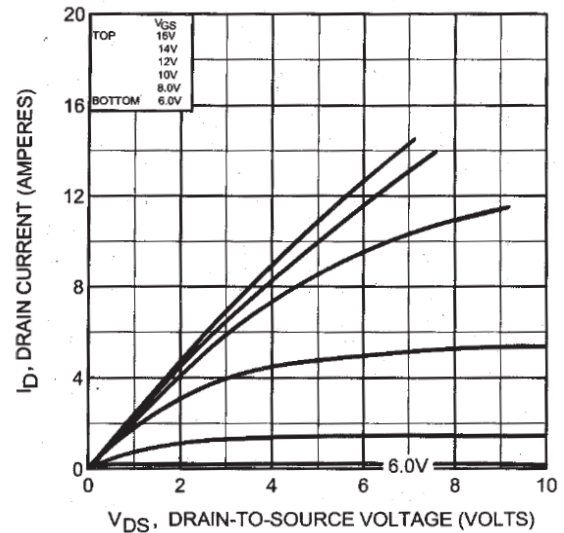


Fig 17. Typical Output Characteristics Post-Irradiation 1 Mega Rads (Si)

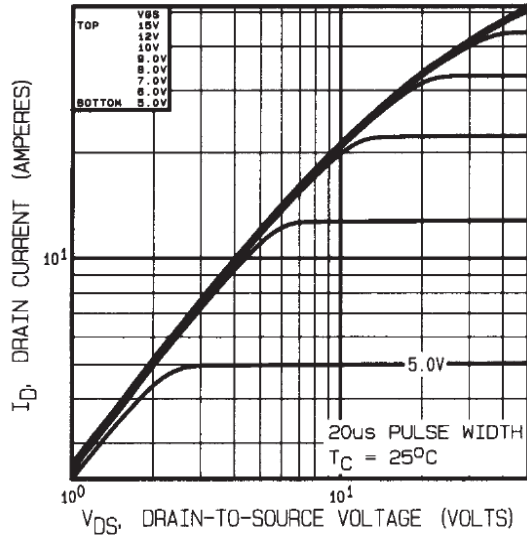


Fig 18. Typical Output Characteristics

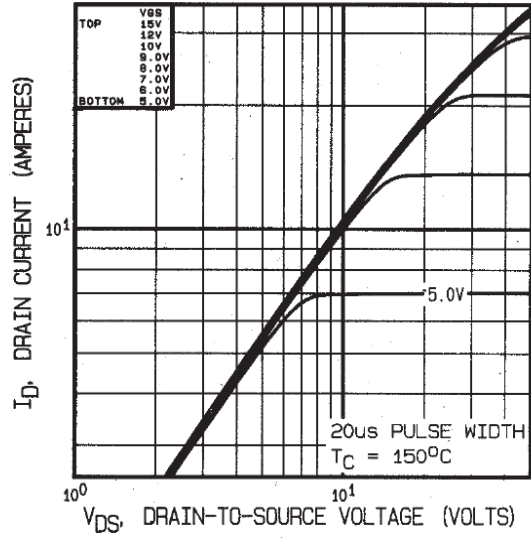


Fig 19. Typical Output Characteristics

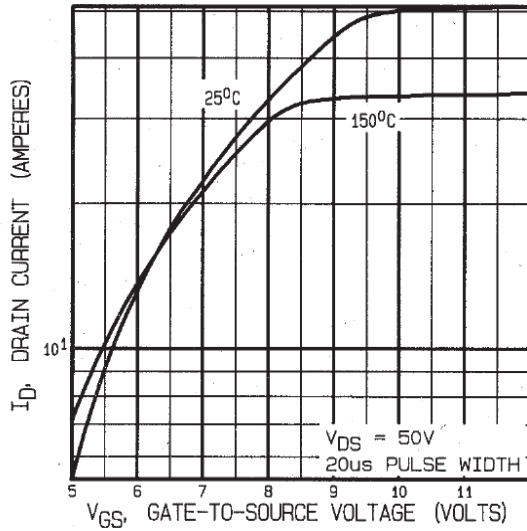


Fig 20. Typical Transfer Characteristics

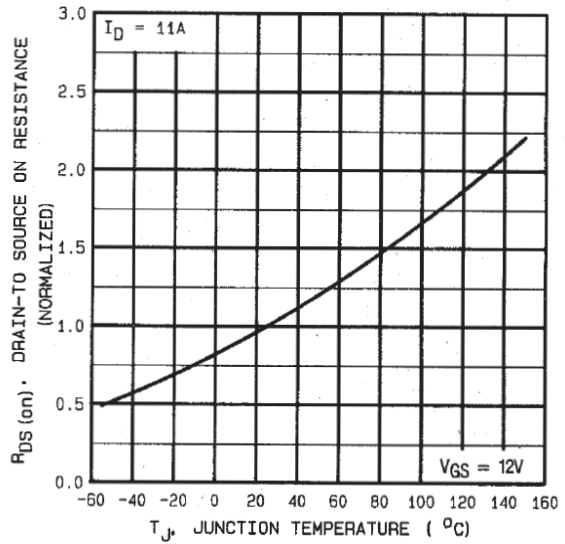


Fig 21. Normalized On-Resistance Vs. Temperature



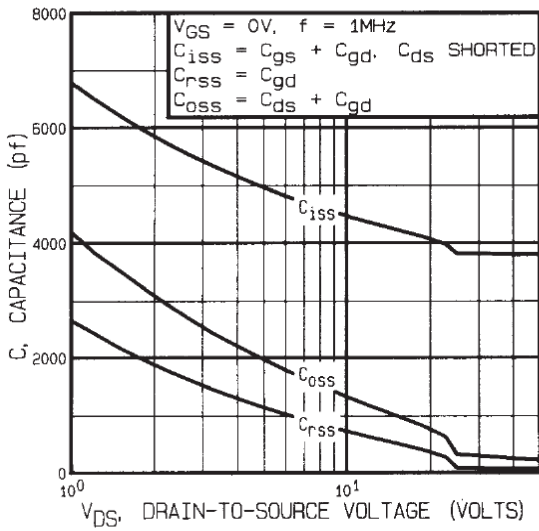


Fig 22. Typical Capacitance Vs. Drain-to-Source Voltage

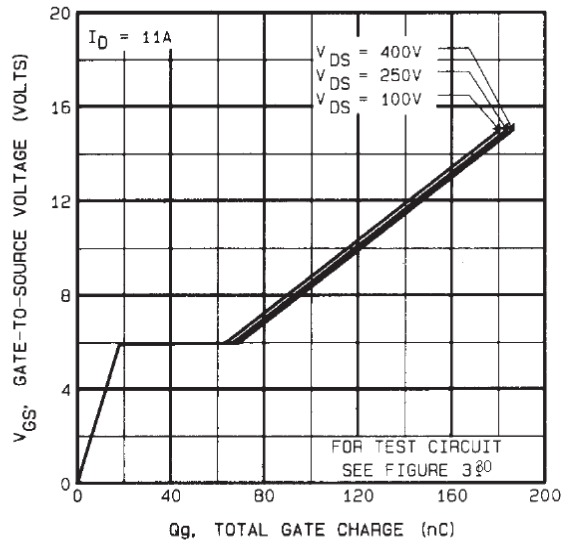


Fig 23. Typical Gate Charge Vs. Gate-to-Source Voltage

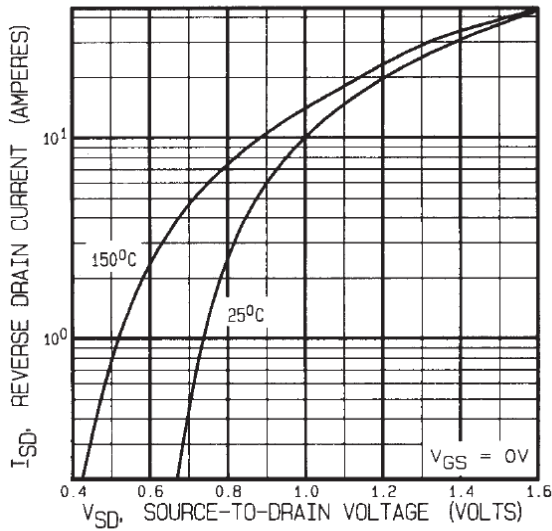


Fig 24. Typical Source-Drain Diode Forward Voltage

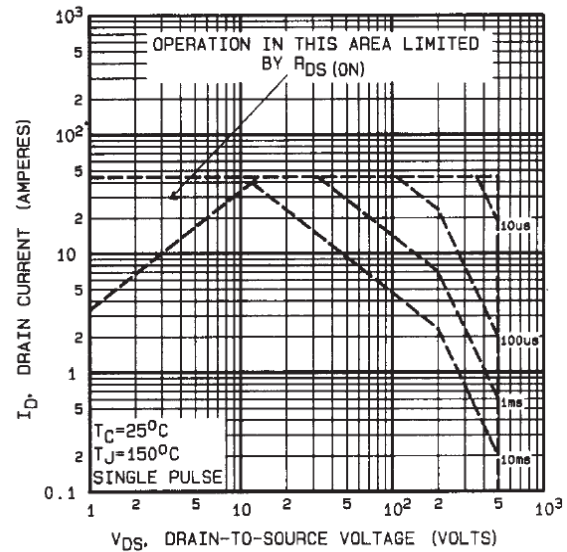


Fig 25. Maximum Safe Operating Area

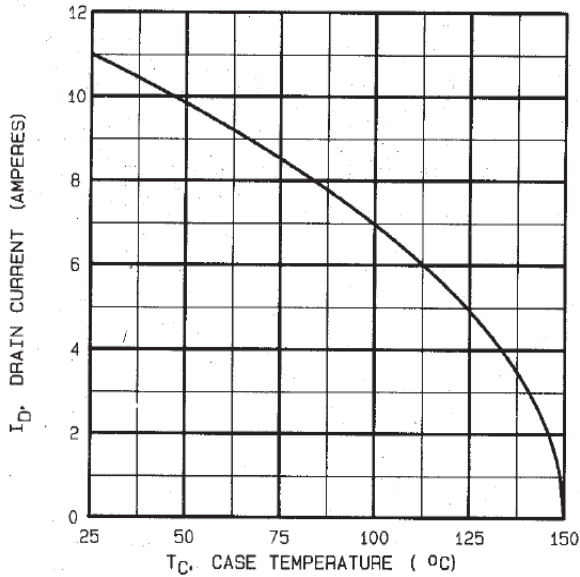


Fig 26. Maximum Drain Current Vs. Case Temperature

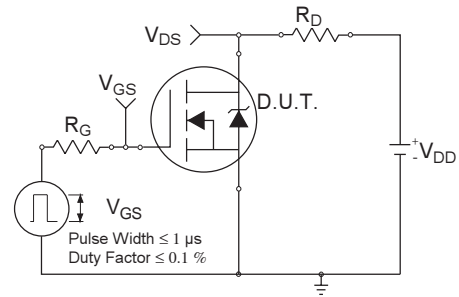


Fig 27a. Switching Time Test Circuit

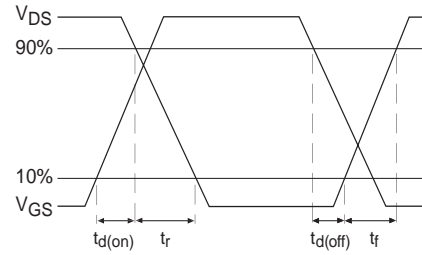


Fig 27b. Switching Time Waveforms

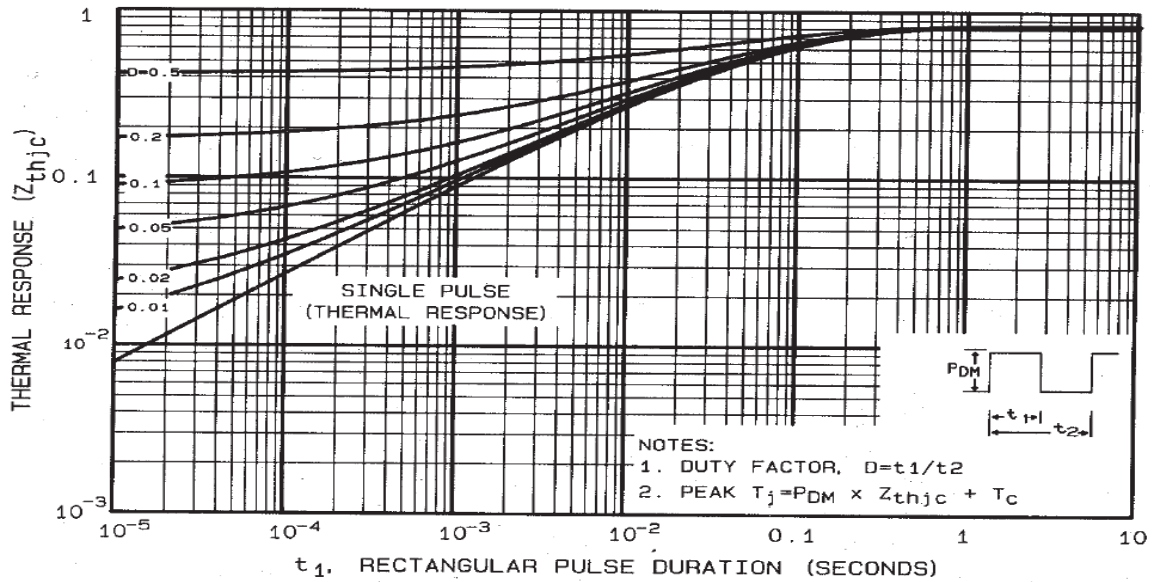


Fig 28. Maximum Effective Transient Thermal Impedance, Junction-to-Case

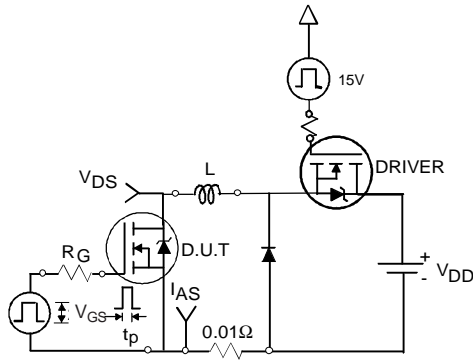


Fig 29a. Unclamped Inductive Test Circuit

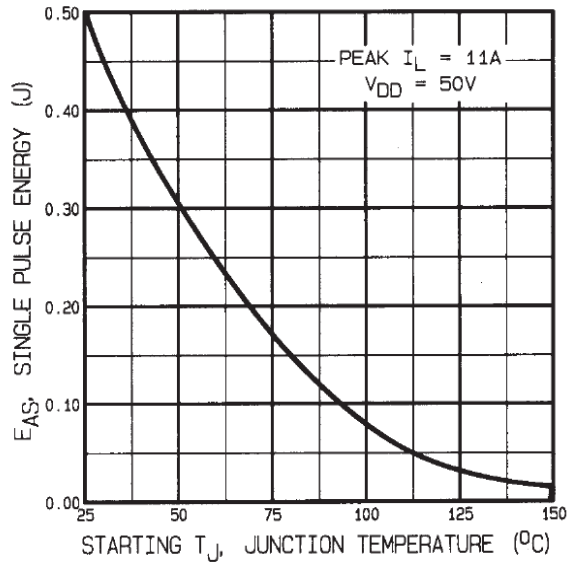


Fig 29c. Maximum Avalanche Energy Vs. Drain Current

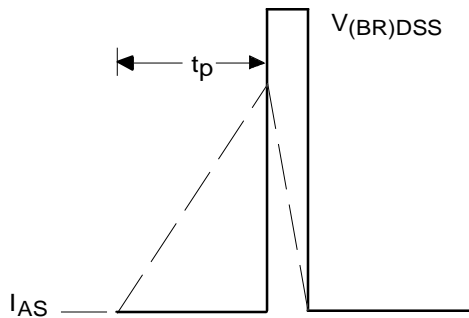


Fig 29b. Unclamped Inductive Waveforms

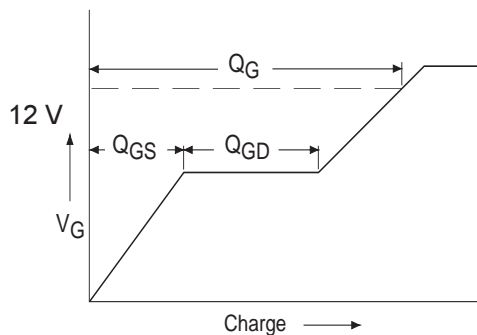


Fig 30a. Basic Gate Charge Waveform

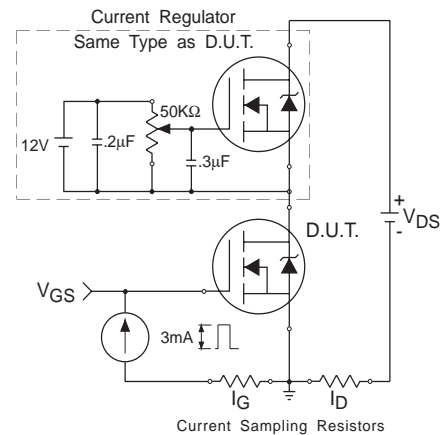
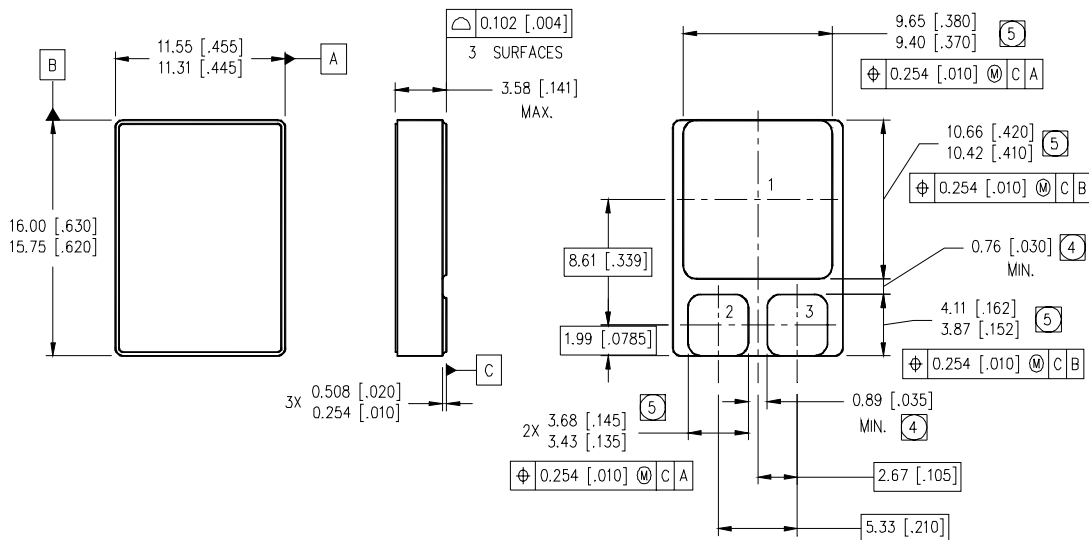


Fig 30b. Gate Charge Test Circuit

**Foot Notes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L \geq 7.4mH$   
Peak  $I_L = 11A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 11A$ ,  $di/dt \leq 140A/\mu s$ ,  
 $V_{DD} \leq 500V$ ,  $T_J \leq 150^\circ C$
- ④ Pulse width  $\leq 300 \mu s$ ; Duty Cycle  $\leq 2\%$
- 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.**  
400 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — SMD-1**



**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.

**PAD ASSIGNMENTS**

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

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
**IR LEOMINSTER :** 205 Crawford St., Leominster, Massachusetts 01453, USA Tel: (978) 534-5776  
TAC Fax: (310) 252-7903

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[>>Infineon Technologies\(英飞凌\)](#)