

International

IR Rectifier

RADIATION HARDENED

POWER MOSFET

SURFACE MOUNT (TO-254AA Tabless)

PD-96914

IRH MJ7250

200V, N-CHANNEL

RAD Hard™ HEXFET® TECHNOLOGY

Product Summary

Part Number	Radiation Level	RDS(on)	Id
IRH MJ7250	100K Rads (Si)	0.10Ω	26A
IRH MJ3250	300K Rads (Si)	0.10Ω	26A
IRH MJ4250	600K Rads (Si)	0.10Ω	26A
IRH MJ8250	1000K Rads (Si)	0.10Ω	26A



TO-254AA Tabless

International Rectifier's RADHard 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 Rdson 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
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Eyelets
- Light Weight

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
Id @ VGS = 12V, TC = 25°C	Continuous Drain Current	26	A
Id @ VGS = 12V, TC = 100°C	Continuous Drain Current	16	
IDM	Pulsed Drain Current ①	104	
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	26	A
EAR	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	5.0	V/ns
TJ	Operating Junction	-55 to 150	°C
TSTG	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	8.0 (Typical)	g

For footnotes refer to the last page

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

	Parameter	Min	Typ	Max	Units	Test Conditions
B _V D _{SS}	Drain-to-Source Breakdown Voltage	200	—	—	V	V _{GS} = 0 V, I _D = 1.0mA
ΔB _V D _{SS} /ΔT _J	Temperature Coefficient of Breakdown Voltage	—	0.27	—	V/°C	Reference to 25°C, I _D = 1.0mA
R _{DS(on)}	Static Drain-to-Source On-State Resistance	—	—	0.10 0.11	Ω	V _{GS} = 12V, I _D = 16A V _{GS} = 12V, I _D = 26A ④
V _{GS(th)}	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 1.0mA
g _{fs}	Forward Transconductance	8.0	—	—	S (r _S)	V _{DS} > 15V, I _{DS} = 16A ④
I _{DSS}	Zero Gate Voltage Drain Current	—	—	25 250	μA	V _{DS} = 160V, V _{GS} = 0V V _{DS} = 160V 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	nA	V _{GS} = -20V
Q _g	Total Gate Charge	—	—	170	nC	V _{GS} = 12V, I _D = 26A V _{DS} = 100V
Q _{gs}	Gate-to-Source Charge	—	—	30	nC	
Q _{gd}	Gate-to-Drain ('Miller') Charge	—	—	60	nC	
t _{d(on)}	Turn-On Delay Time	—	—	33	ns	V _{DD} = 100V, I _D = 26A, V _{GS} = 12V, R _G = 2.35Ω
t _r	Rise Time	—	—	140		
t _{d(off)}	Turn-Off Delay Time	—	—	140		
t _f	Fall Time	—	—	140		
L _S + L _D	Total Inductance	—	6.8	—	nH	Measured from drain lead (6mm/0.25in. from package) to source lead (6mm/0.25in. from package)
C _{iss}	Input Capacitance	—	4700	—	pF	V _{GS} = 0V, V _{DS} = 25V f = 1.0MHz
C _{oss}	Output Capacitance	—	850	—		
C _{rss}	Reverse Transfer Capacitance	—	210	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	26	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	104		
V _{SD}	Diode Forward Voltage	—	—	1.4	V	T _J = 25°C, I _S = 26A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	820	nS	T _J = 25°C, I _F = 26A, di/dt ≤100A/μs V _{DD} ≤ 25V ④
Q _{RR}	Reverse Recovery Charge	—	—	12	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	—	—	0.83	°C/W	Typical socket mount
R _{thCS}	Case-to-sink	—	0.21	—		
R _{thJA}	Junction-to-Ambient	—	—	48		

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

For footnotes refer to the last page

Radiation Characteristics

IRHMJ7250

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 @ $T_j = 25^\circ\text{C}$, Post Total Dose Irradiation ⑤⑥

	Parameter	Up to 600K Rads(Si) ¹		1000K Rads (Si) ²		Units	Test Conditions
		Min	Max	Min	Max		
BV_{DSS}	Drain-to-Source Breakdown Voltage	200	—	200	—	V	$V_{GS} = 0V, I_D = 1.0mA$
$V_{GS(th)}$	Gate Threshold Voltage ④	2.0	4.0	1.25	4.5		$V_{GS} = V_{DS}, I_D = 1.0mA$
I_{GSS}	Gate-to-Source Leakage Forward	—	100	—	100	nA	$V_{GS} = 20V$
I_{GSS}	Gate-to-Source Leakage Reverse	—	-100	—	-100		$V_{GS} = -20V$
I_{DSS}	Zero Gate Voltage Drain Current	—	25	—	50	μA	$V_{DS}=160V, V_{GS}=0V$
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.094	—	0.149	Ω	$V_{GS} = 12V, I_D = 16A$
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-254AA)	—	0.10	—	0.155	Ω	$V_{GS} = 12V, I_D = 16A$
V_{SD}	Diode Forward Voltage ④	—	1.4	—	1.4	V	$V_{GS} = 0V, I_S = 26A$

1. Part numbers IRHMJ7250, IRHMJ3250 and IRHMJ4250

2. Part number IRHMJ8250

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 ²)	Energy (MeV)	Range (μm)	$V_{DS}(V)$				
				@ $V_{GS}=0V$	@ $V_{GS}=-5V$	@ $V_{GS}=-10V$	@ $V_{GS}=-15V$	@ $V_{GS}=-20V$
Cu	28	285	43	190	180	170	125	—
Br	36.8	305	39	100	100	100	50	—

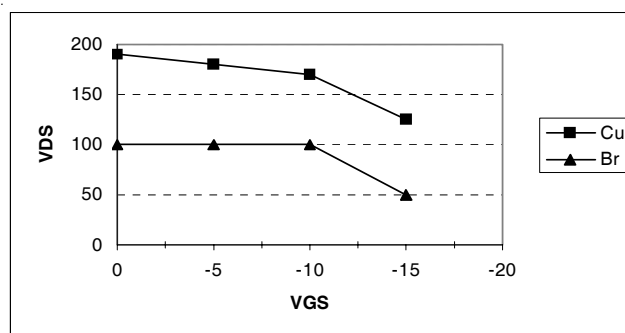


Fig a. Single Event Effect, Safe Operating Area

For footnotes refer to the last page

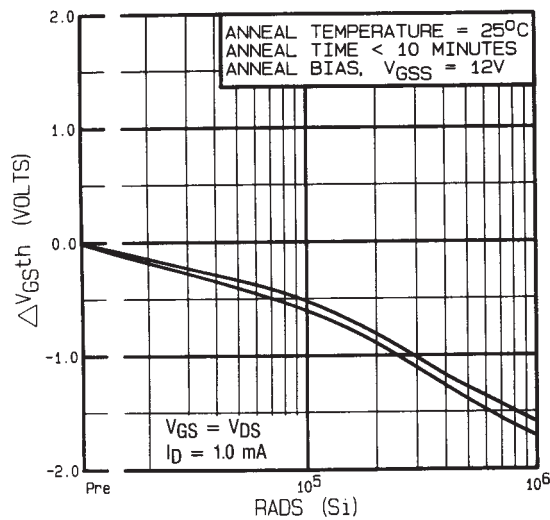


Fig 1. Typical Response of Gate Threshold Voltage Vs. Total Dose Exposure

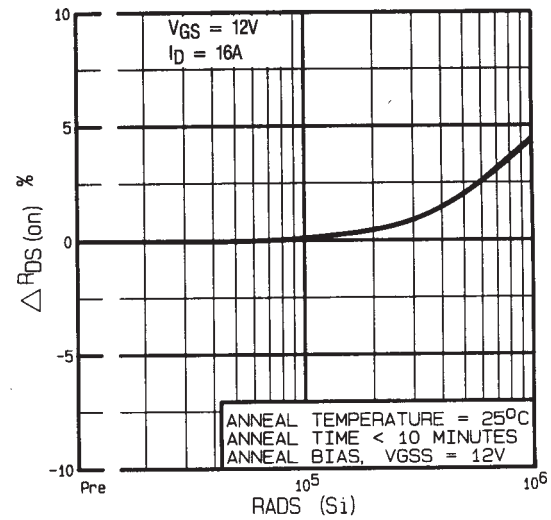


Fig 2. Typical Response of On-State Resistance Vs. Total Dose Exposure

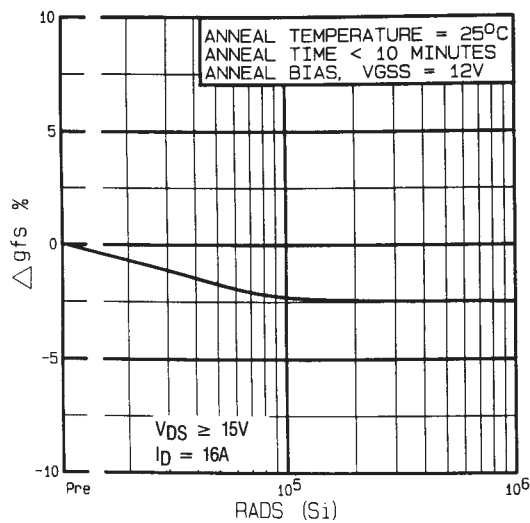


Fig 3. Typical Response of Transconductance Vs. Total Dose Exposure

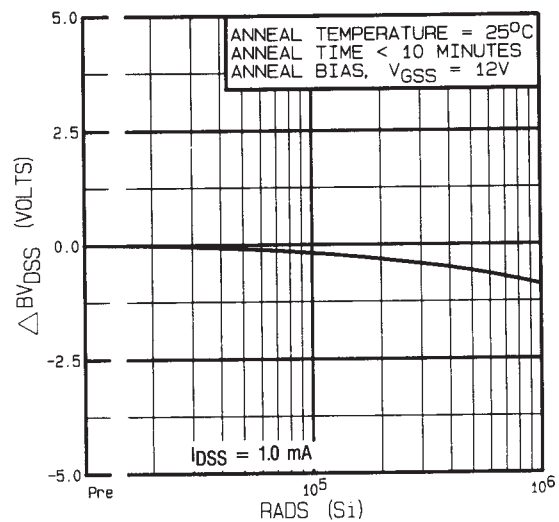


Fig 4. Typical Response of Drain to Source Breakdown Vs. Total Dose Exposure

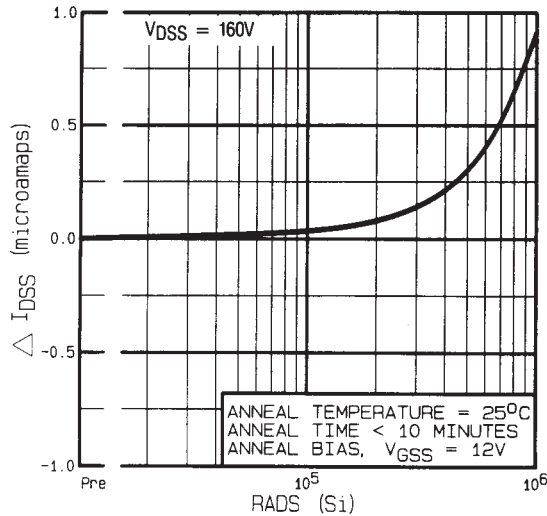


Fig 5. Typical Zero Gate Voltage Drain Current Vs. Total Dose Exposure

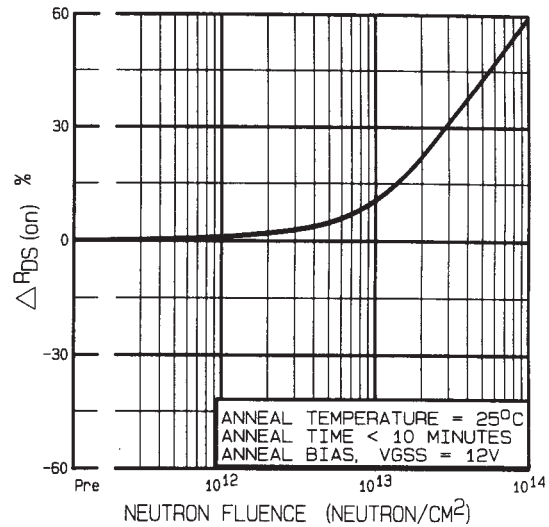


Fig 6. Typical On-State Resistance Vs. Neutron Fluence Level

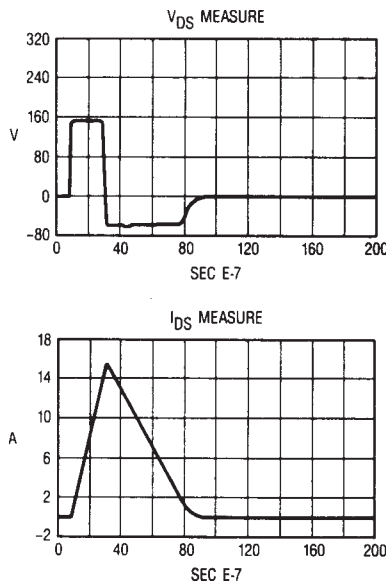


Fig 7. Typical Transient Response of Rad Hard HEXFET During 1×10^{12} Rad (Si)/Sec Exposure

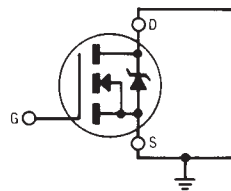


Fig 8a. Gate Stress of V_{GS} Equals 12 Volts During Radiation

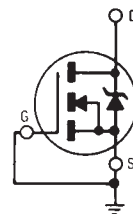


Fig 8b. V_{DS} Stress Equals 80% of B_{VDS} During Radiation

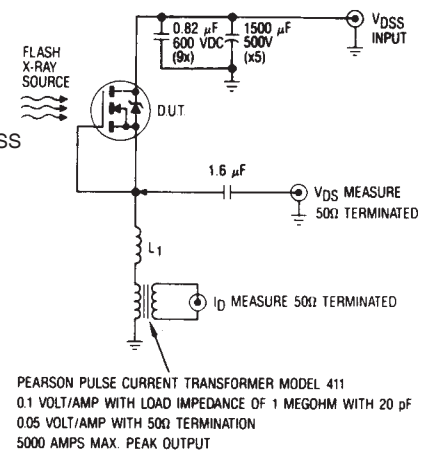


Fig 9. High Dose Rate (Gamma Dot) Test Circuit

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

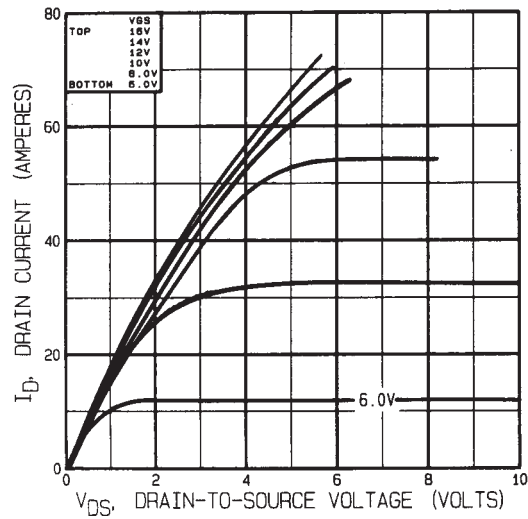


Fig 10. Typical Output Characteristics
Pre-Irradiation

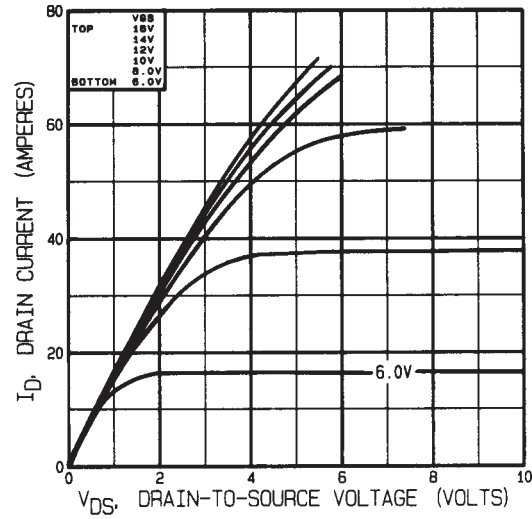


Fig 11. Typical Output Characteristics
Post-Irradiation 100K Rads (Si)

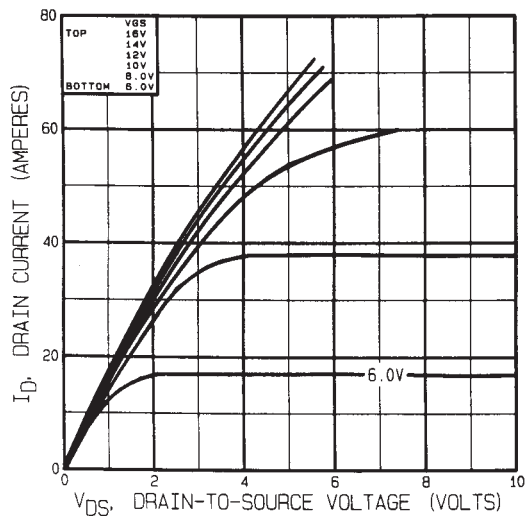


Fig 12. Typical Output Characteristics
Post-Irradiation 300K Rads (Si)

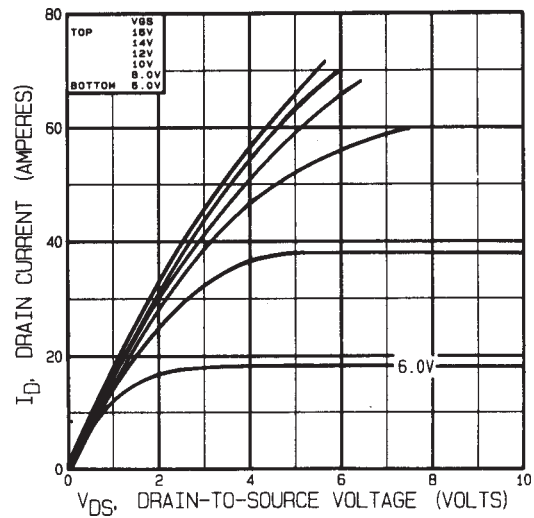


Fig 13. Typical Output Characteristics
Post-Irradiation 1 Mega Rads (Si)

Note: Bias Conditions during radiation: $V_{GS} = 0$ Vdc, $V_{DS} = 160$ Vdc

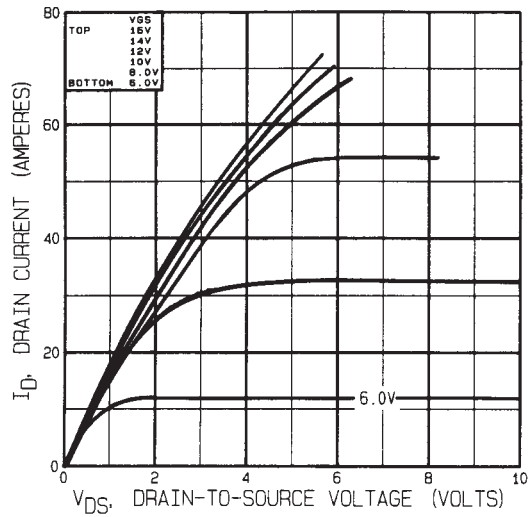


Fig 14. Typical Output Characteristics
Pre-Irradiation

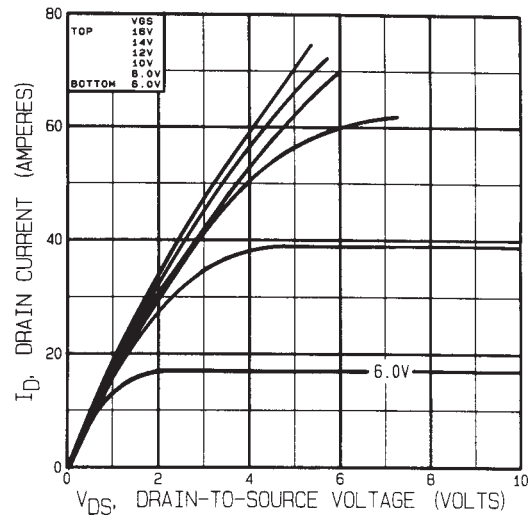


Fig 15. Typical Output Characteristics
Post-Irradiation 100K Rads (Si)

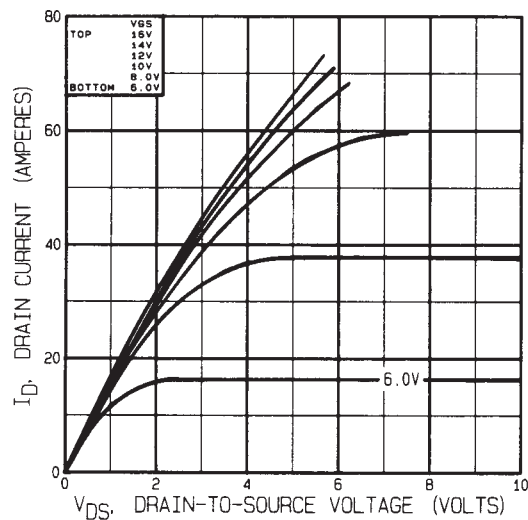


Fig 16. Typical Output Characteristics
Post-Irradiation 300K Rads (Si)

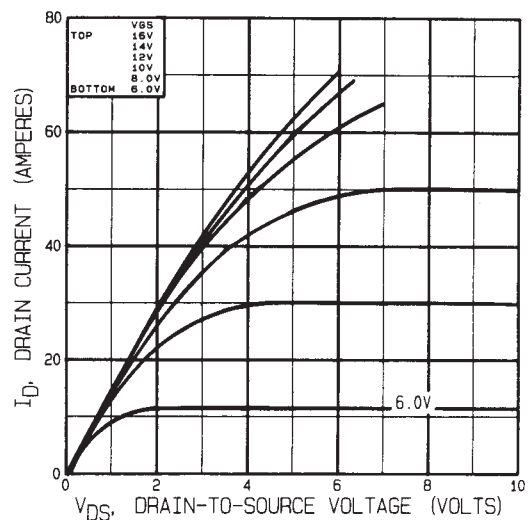


Fig 17. Typical Output Characteristics
Post-Irradiation 1 Mega Rads (Si)

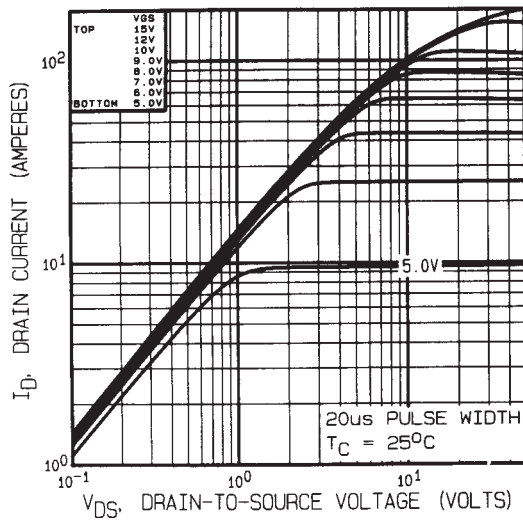


Fig 18. Typical Output Characteristics

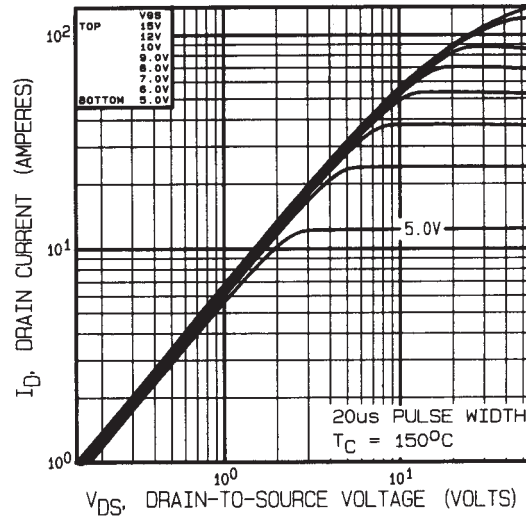


Fig 19. Typical Output Characteristics

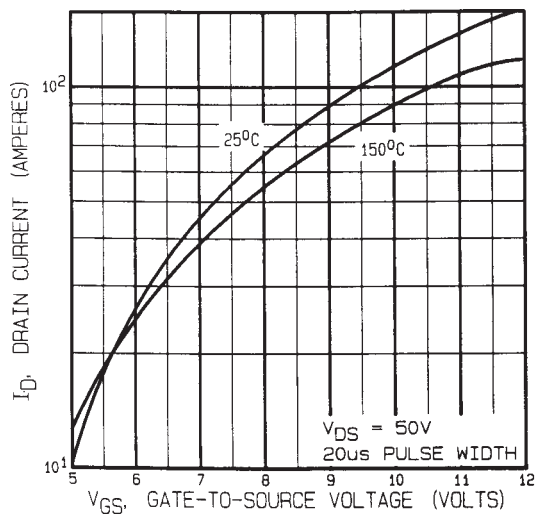
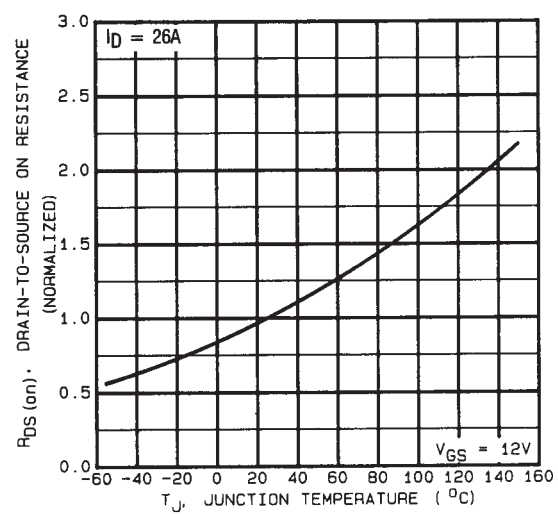


Fig 20. Typical Transfer Characteristics

Fig 21. Normalized On-Resistance
Vs. Temperature

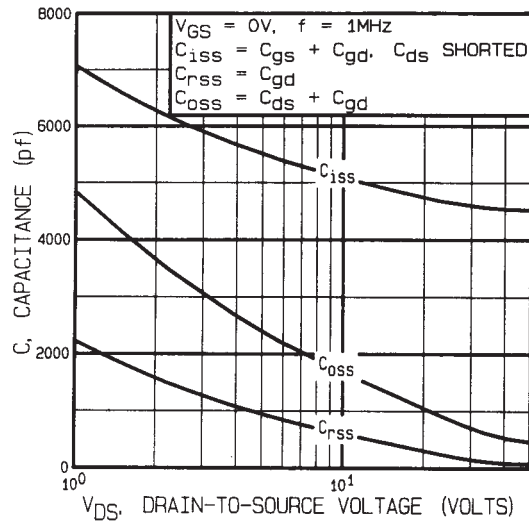


Fig 22. Typical Capacitance Vs. Drain-to-Source Voltage

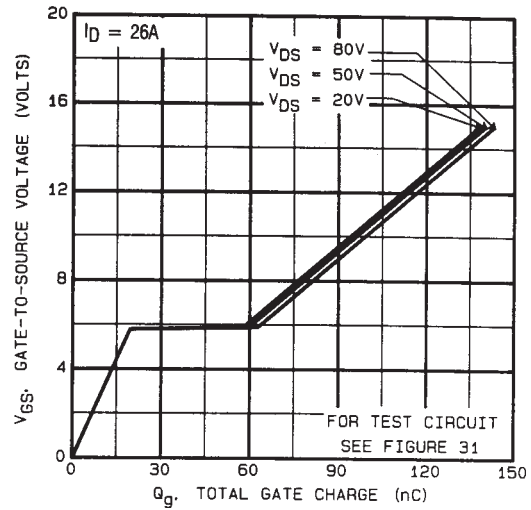


Fig 23. Typical Gate Charge Vs. Gate-to-Source Voltage

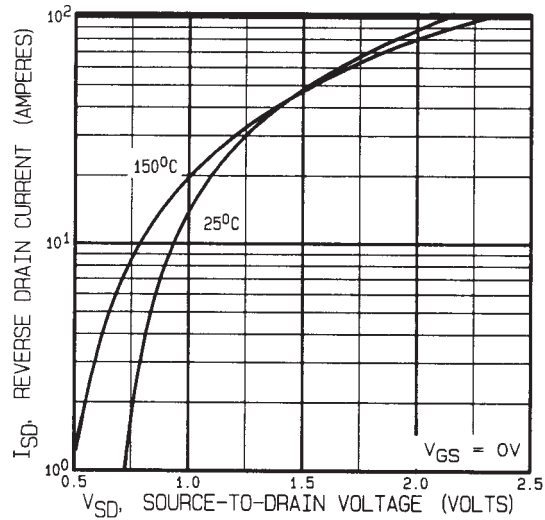


Fig 24. Typical Source-Drain Diode Forward Voltage

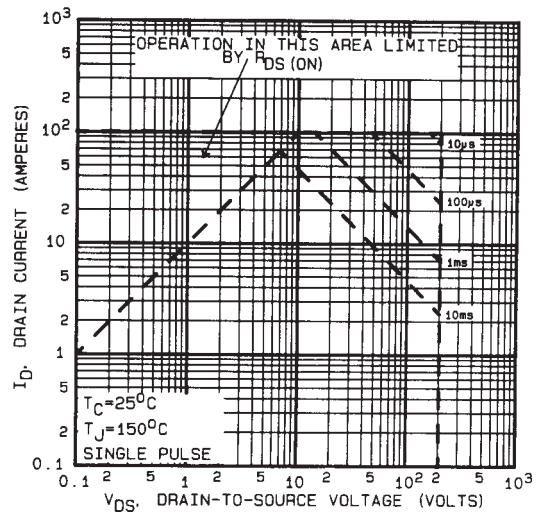


Fig 25. Maximum Safe Operating Area

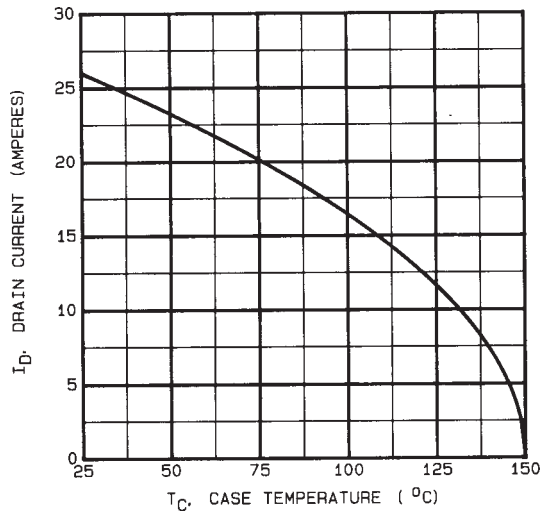


Fig 26. Maximum Drain Current Vs. Case Temperature

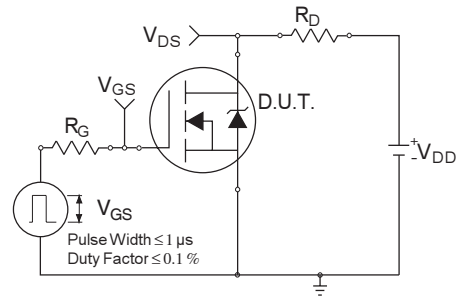


Fig 26a. Switching Time Test Circuit

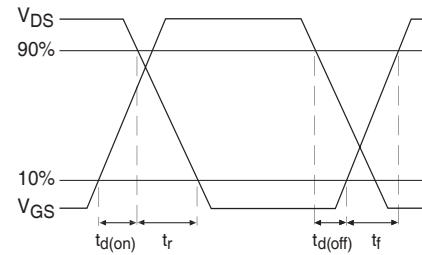


Fig 26b. Switching Time Waveforms

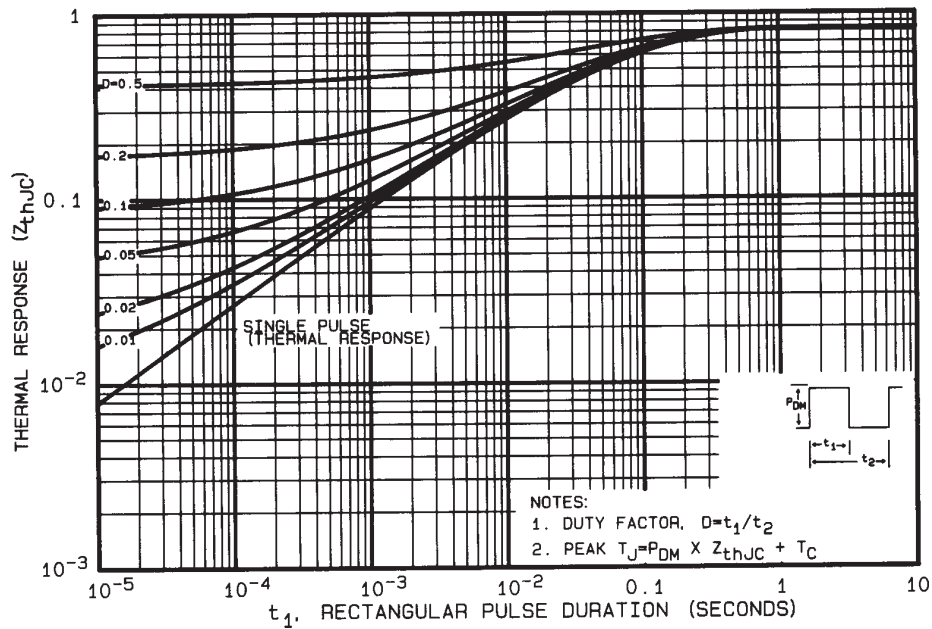


Fig 27. Maximum Effective Transient Thermal Impedance, Junction-to-Case

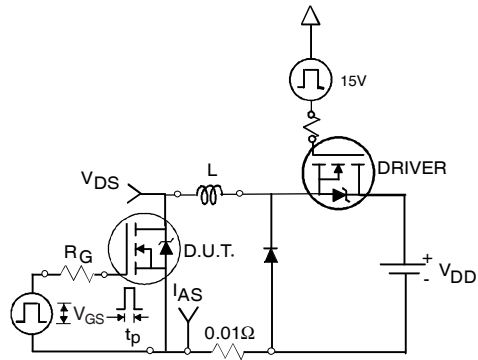


Fig 28a. Unclamped Inductive Test Circuit

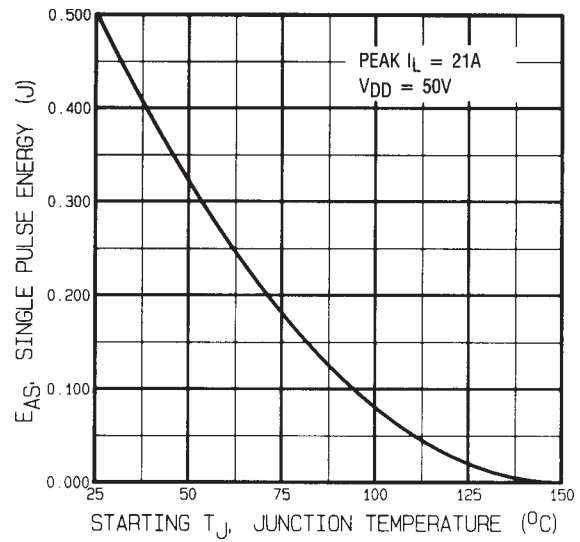


Fig 28c. Maximum Avalanche Energy Vs. Drain Current

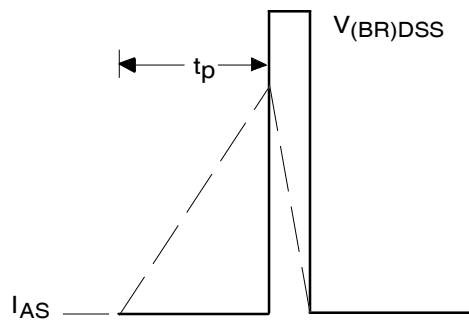


Fig 28b. Unclamped Inductive Waveforms

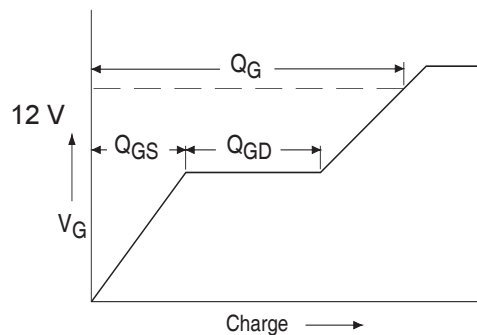


Fig 29a. Basic Gate Charge Waveform

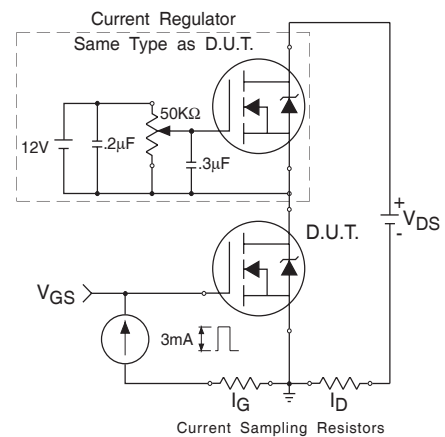


Fig 29b. Gate Charge Test Circuit

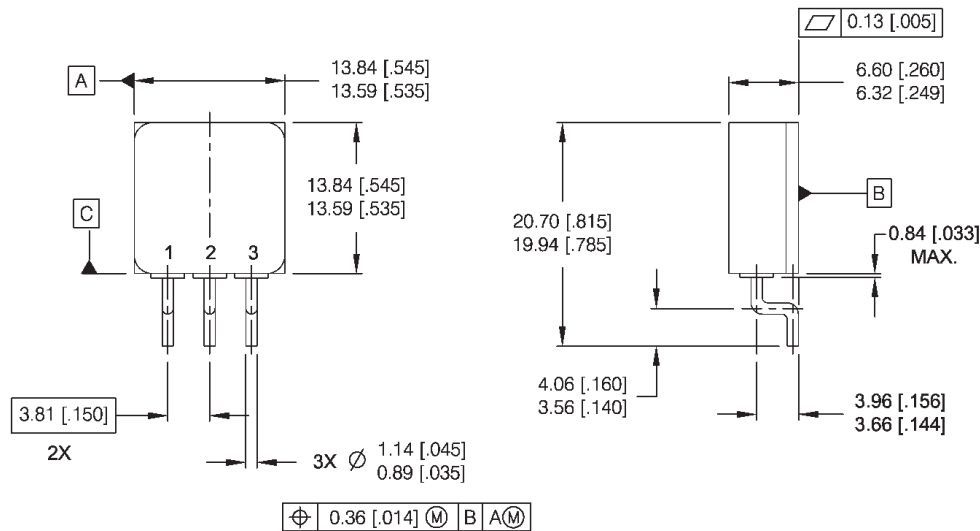
IRHMJ7250

Pre-Irradiation

Foot Notes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② $V_{DD} = 25V$, starting $T_J = 25^\circ C$, $L = 1.5mH$
Peak $I_L = 26A$, $V_{GS} = 12V$
- ③ $I_{SD} \leq 26A$, $di/dt \leq 190A/\mu s$,
 $V_{DD} \leq 200V$, $T_J \leq 150^\circ C$
- 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.**
160 volt V_{DS} applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions — TO-254AA Tabless



NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. CONTROLLING DIMENSION: INCH.
4. THIS OUTLINE IS A MODIFIED TO-254AA JEDEC OUTLINE.

PIN ASSIGNMENTS

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

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 oxide packages shall not be placed in acids that will produce fumes containing beryllium.

International
IOR Rectifier

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