

REPETITIVE AVALANCHE AND dv/dt RATED HEXFET® TRANSISTOR

IRHE7110 IRHE8110 N CHANNEL MEGA HARD RAD

100Volt, 0.60Ω, MEGA RAD HARD HEXFET

International Rectifier's RAD HARD technology HEXFETs demonstrate excellent threshold voltage stability and breakdown voltage stability at total radiation doses as high as 1×10^6 Rads(Si). Under **identical** pre- and post-irradiation test conditions, International Rectifier's RAD HARD HEXFETs retain **identical** electrical specifications up to 1×10^5 Rads (Si) total dose. No compensation in gate drive circuitry is required. These devices are also capable of surviving transient ionization pulses as high as 1×10^{12} Rads (Si)/Sec, and return to normal operation within a few microseconds. Since the RAD HARD 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
IRHE7110	100V	0.60Ω	3.5A
IRHE8110	100V	0.60Ω	3.5A

Features:

- Radiation Hardened up to 1×10^6 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
- Light Weight

Absolute Maximum Ratings

Pre-Irradiation

	Parameter	IRHE7130, IRHE8130	Units
I _D @ V _{GS} = 12V, T _C = 25°C	Continuous Drain Current	3.5	A
I _D @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	2.2	
I _{DM}	Pulsed Drain Current ②	14	
P _D @ T _C = 25°C	Max. Power Dissipation	15	W
	Linear Derating Factor	0.12	W/°C
V _{GS}	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ③	68	mJ
dv/dt	Peak Diode Recovery dv/dt ④	5.5	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)	
	Weight	0.42 (typical)	g

Electrical Characteristics @ $T_j = 25^\circ\text{C}$ (Unless Otherwise Specified)

	Parameter	Min	Typ	Max	Units	Test Conditions
BVDSS	Drain-to-Source Breakdown Voltage	100	—	—	V	$V_{GS} = 0\text{V}$, $I_D = 1.0\text{mA}$
$\Delta BVDSS/\Delta T_j$	Temperature Coefficient of Breakdown Voltage	—	0.10	—	$^\circ\text{V}/^\circ\text{C}$	Reference to 25°C , $I_D = 1.0\text{mA}$
RDS(on)	Static Drain-to-Source On-State Resistance	—	—	0.60	Ω	$V_{GS} = 12\text{V}$, $I_D = 2.2\text{A}$ ⑤
		—	—	0.69		$V_{GS} = 12\text{V}$, $I_D = 3.5\text{A}$ ⑤
VGS(th)	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}$, $I_D = 1.0\text{mA}$
gfs	Forward Transconductance	0.8	—	—	S (τ)	$V_{DS} > 15\text{V}$, $I_{DS} = 2.2\text{A}$ ⑤
IDSS	Zero Gate Voltage Drain Current	—	—	25	μA	$V_{DS} = 0.8 \times \text{Max Rating}$, $V_{GS} = 0\text{V}$
		—	—	250		$V_{DS} = 0.8 \times \text{Max Rating}$, $V_{GS} = 0\text{V}$, $T_j = 125^\circ\text{C}$
IGSS	Gate-to-Source Leakage Forward	—	—	100	nA	$V_{GS} = 20\text{V}$
IGSS	Gate-to-Source Leakage Reverse	—	—	-100		$V_{GS} = -20\text{V}$
Qg	Total Gate Charge	—	—	11	nC	$V_{GS} = 12\text{V}$, $I_D = 3.5\text{A}$ $V_{DS} = \text{Max Rating} \times 0.5$
Qgs	Gate-to-Source Charge	—	—	3.0		
Qgd	Gate-to-Drain ('Miller') Charge	—	—	3.3		
td(on)	Turn-On Delay Time	—	—	20	ns	$V_{DD} = 50\text{V}$, $I_D = 3.5\text{A}$, $R_G = 7.5\Omega$
tr	Rise Time	—	—	25		
td(off)	Turn-Off Delay Time	—	—	40		
tf	Fall Time	—	—	40		
LD	Internal Drain Inductance	—	1.8	—	nH	Measured from drain lead, 6mm (0.25 in) from package to center of die.
LS	Internal Source Inductance	—	4.3	—		Measured from source lead, 6mm (0.25 in) from package to source bonding pad.
Ciss	Input Capacitance	—	290	—	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$ $f = 1.0\text{MHz}$
Coss	Output Capacitance	—	100	—		
Crss	Reverse Transfer Capacitance	—	15	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
IS	Continuous Source Current (Body Diode)	—	—	26	A	Modified MOSFET symbol showing the integral reverse p-n junction rectifier.
ISM	Pulse Source Current (Body Diode) ②	—	—	104		
VSD	Diode Forward Voltage	—	—	1.4	V	$T_j = 25^\circ\text{C}$, $I_S = 26\text{A}$, $V_{GS} = 0\text{V}$ ⑤
trr	Reverse Recovery Time	—	—	820	ns	$T_j = 25^\circ\text{C}$, $I_F = 26\text{A}$, $di/dt \leq 100\text{A}/\mu\text{s}$
QRR	Reverse Recovery Charge	—	—	12	μC	$V_{DD} \leq 50\text{V}$ ⑤
ton	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
RthJC	Junction-to-Case	—	—	8.3	$^\circ\text{C}/\text{W}$	
Rth-PCB	Junction-to-PCBoard	—	27	—		Solder to a copper clad PC 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 three 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. Pre- and post- irradiation limits of the devices irradiated to 1×10^5 Rads (Si) are identical and are presented in Table 1, column 1, IRHE7130. Post-irradiation limits of the devices irradiated to 1×10^6 Rads (Si) are presented in

Table 1, column 2, IRHE8130. 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.

High dose rate testing may be done on a special request basis using a dose rate up to 1×10^{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 ⑥ ⑦

Table 1. Low Dose Rate ⑥ ⑦		IRHE7110		IRHE8110		Units	Test Conditions ⑨
	Parameter	100K Rads (Si)		1000K Rads (Si)			
		Min	Max	Min	Max		
BV _{DSS}	Drain-to-Source Breakdown Voltage	100	—	100	—	V	V _{GS} = 0V, I _D = 1.0mA
V _{GS(th)}	Gate Threshold Voltage ⑤	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} = -20 V
I _{DSS}	Zero Gate Voltage Drain Current	—	25	—	25	μA	V _{DS} =0.8 x Max Rating, V _{GS} =0V
R _{DS(on)1}	Static Drain-to-Source ⑤ On-State Resistance One	—	0.60	—	0.80	Ω	V _{GS} = 12V, I _D = 2.2A
V _{SD}	Diode Forward Voltage ⑤	—	1.5	—	1.5	V	T _C = 25°C, I _S =3.5A, V _{GS} = 0V

Table 2. High Dose Rate ⑧

	Parameter	10 ¹¹ Rads (Si)/sec			10 ¹² Rads (Si)/sec			Units	Test Conditions
		Min	Typ	Max	Min	Typ	Max		
V_{DSS}	Drain-to-Source Voltage	—	—	80	—	—	80	V	Applied drain-to-source voltage during gamma-dot
I_{pp}		—	20	—	—	20	—	A	Peak radiation induced photo-current
di/dt		—	—	800	—	—	160	A/ μ sec	Rate of rise of photo-current
L_1		0.1	—	—	0.5	—	—	μH	Circuit inductance required to limit di/dt

Table 3. Single Event Effects

Ion	LET (Si) (MeV/mg/cm ²)	Fluence (ions/cm ²)	Range (μ m)	V_{DS} Bias (V)	V_{GS} Bias (V)
Ni	28	3×10^5	~43	100	-5

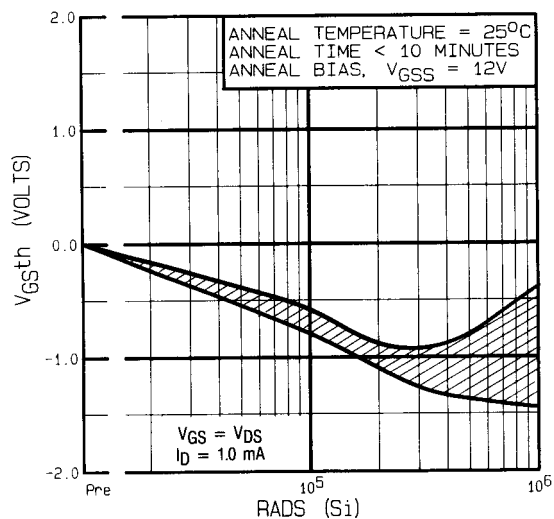


Fig 1. Typical Response of Gate Threshold Voltage Vs. Total Dose Exposure

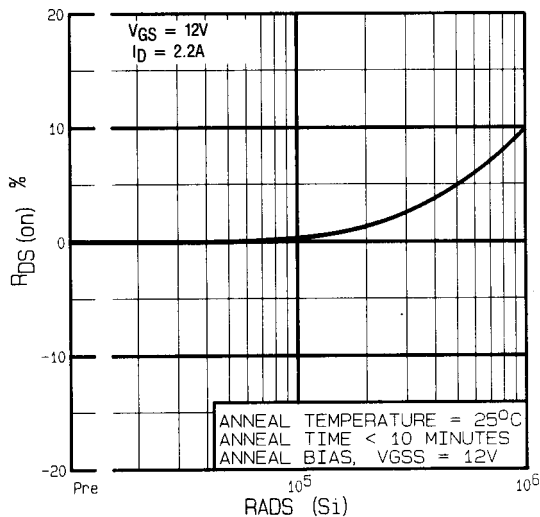


Fig 2. Typical Response of On-State Resistance Vs. Total Dose Exposure

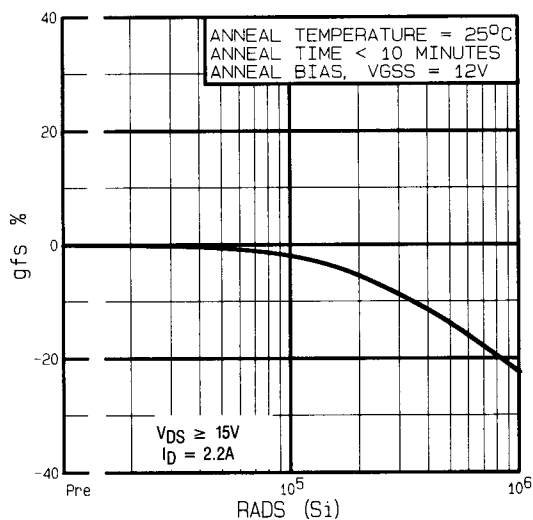


Fig 3. Typical Response of Transconductance Vs. Total Dose Exposure

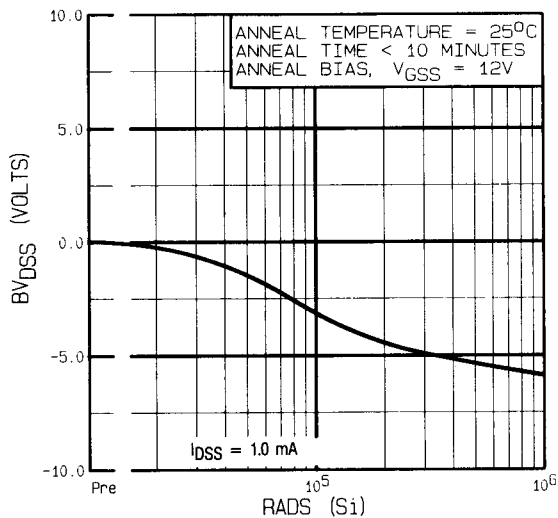


Fig 4. Typical Response of Drain to Source Breakdown Vs. Total Dose Exposure

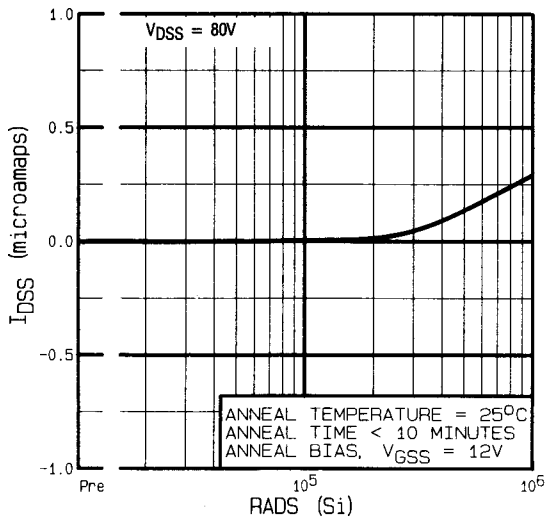


Fig 5. Typical Zero Gate Voltage Drain Current Vs. Total Dose Exposure

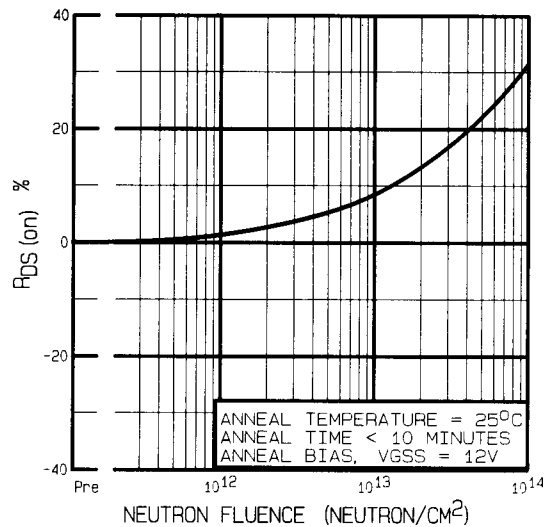


Fig 6. Typical On-State Resistance Vs. Neutron Fluence Level

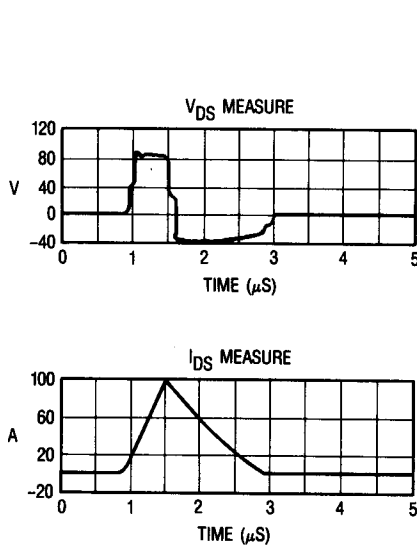


Fig 7. Typical Transient Response of Rad Hard HEXFET During 1×10^{12} Rad (Si)/Sec Exposure

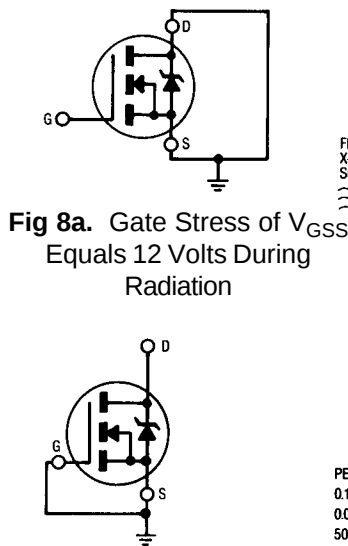


Fig 8a. Gate Stress of V_{GSS} Equals 12 Volts During Radiation

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

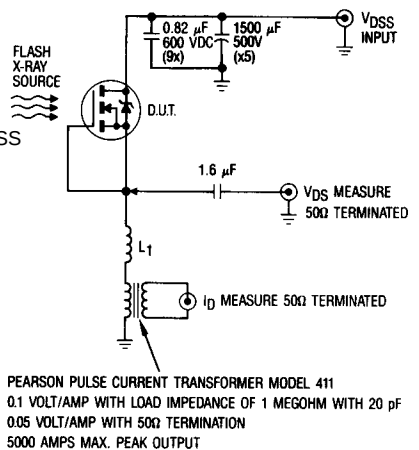


Fig 9. High Dose Rate (Gamma Dot) Test Circuit

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

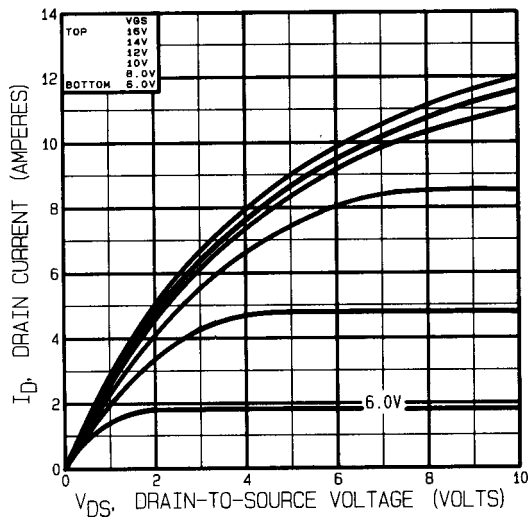


Fig 10. Typical Output Characteristics
Pre-Irradiation

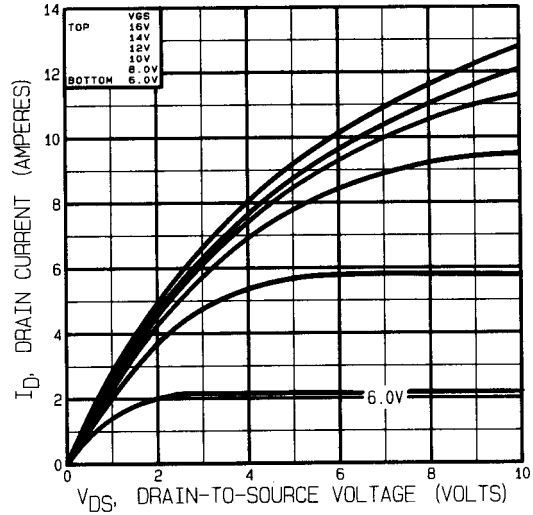


Fig 11. Typical Output Characteristics
Post-Irradiation 100K Rads (Si)

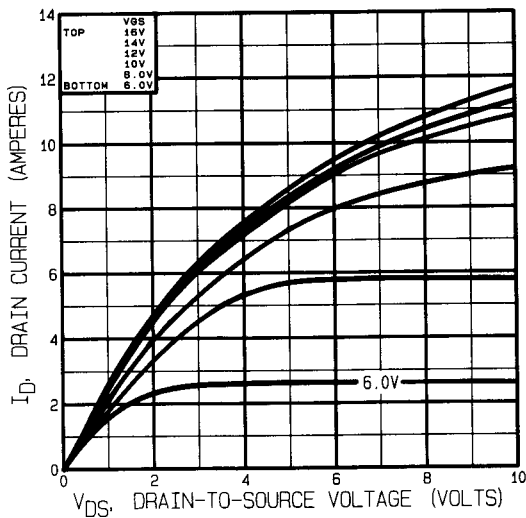


Fig 12. Typical Output Characteristics
Post-Irradiation 300K Rads (Si)

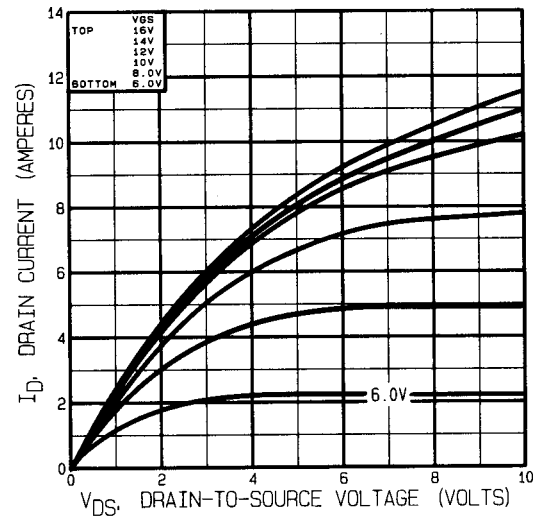


Fig 13. Typical Output Characteristics
Post-Irradiation 1 Mega Rads (Si)

Note: Bias Conditions during radiation: $V_{GS} = 0$ Vdc, $V_{BS} = 80$ Vdc

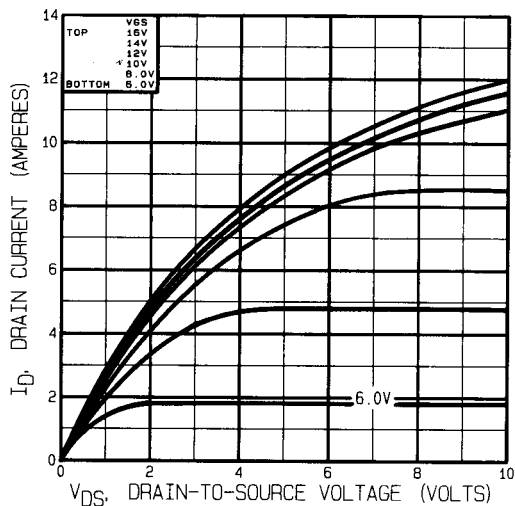


Fig 14. Typical Output Characteristics
Pre-Irradiation

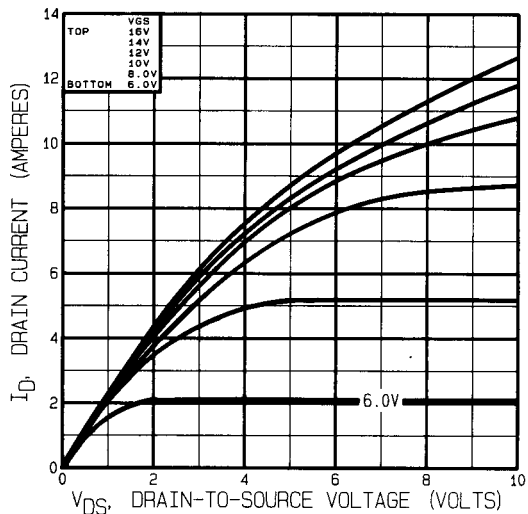


Fig 15. Typical Output Characteristics
Post-Irradiation 100K Rads (Si)

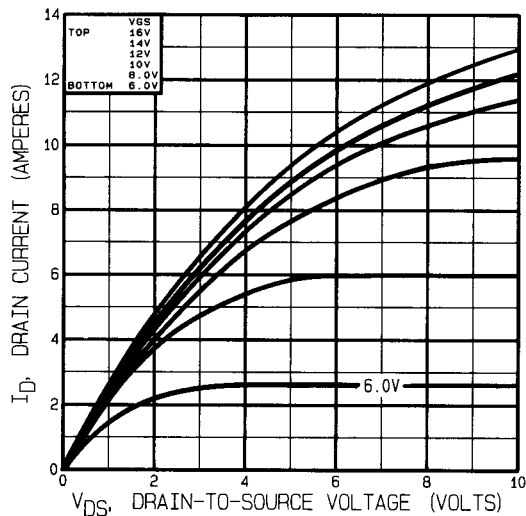


Fig 16. Typical Output Characteristics
Post-Irradiation 300K Rads (Si)

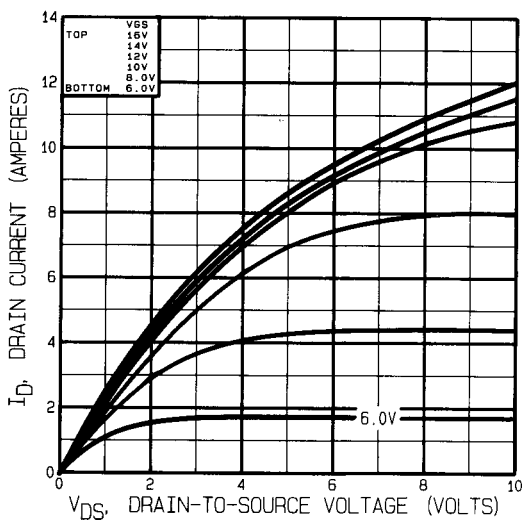


Fig 17. Typical Output Characteristics
Post-Irradiation 1 Mega Rads (Si)

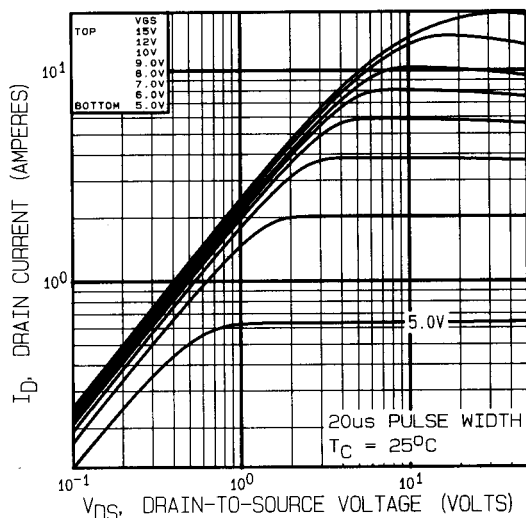


Fig 18. Typical Output Characteristics

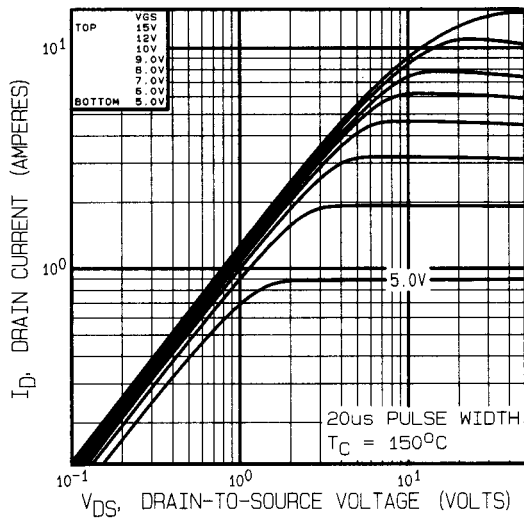


Fig 19. Typical Output Characteristics

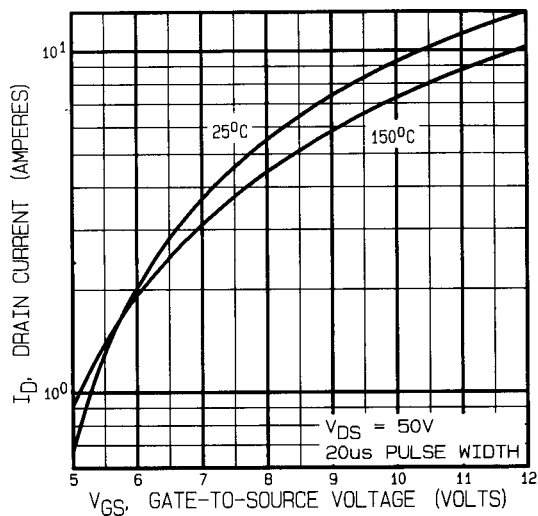


Fig 20. Typical Transfer Characteristics

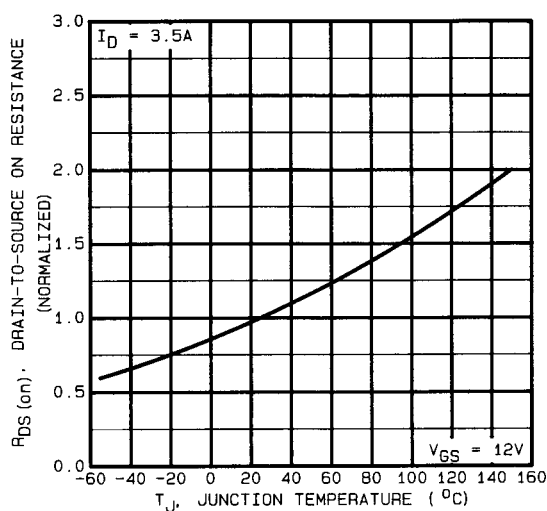


Fig 21. Normalized On-Resistance Vs. Temperature

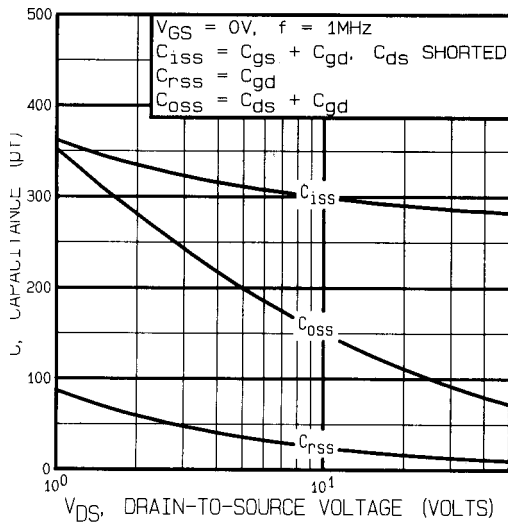


Fig 22. Typical Capacitance Vs. Drain-to-Source Voltage

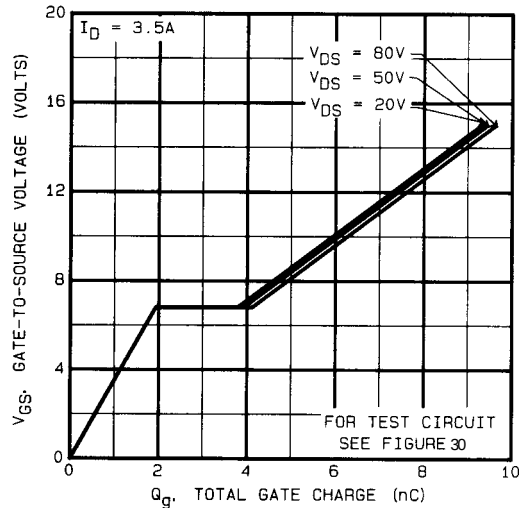


Fig 23. Typical Gate Charge Vs. Gate-to-Source Voltage

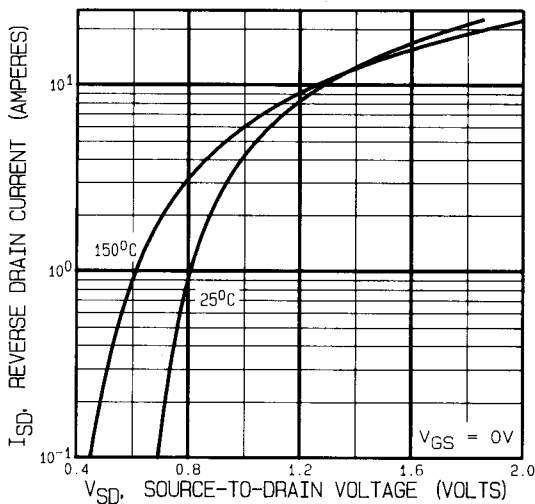


Fig 24. Typical Source-Drain Diode Forward Voltage

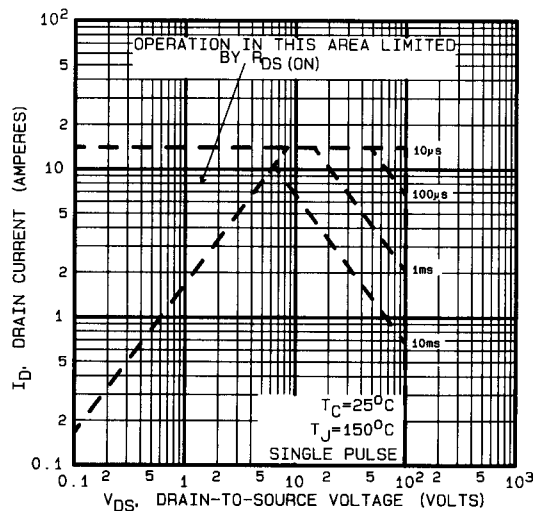


Fig 25. Maximum Safe Operating Area

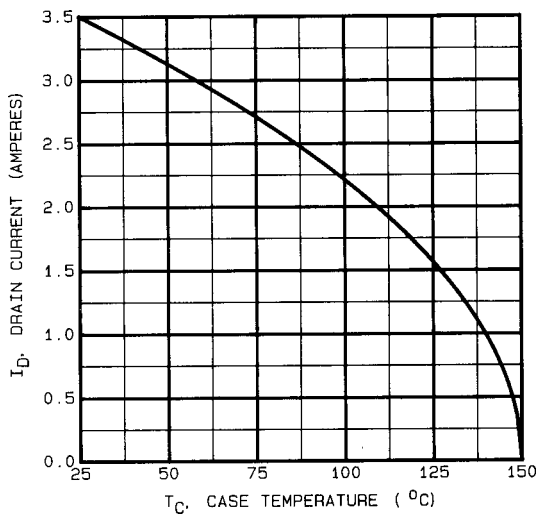


Fig 26. Maximum Drain Current Vs. Case Temperature

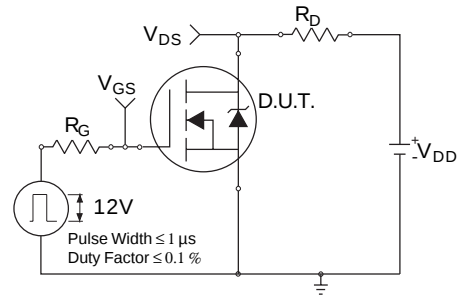


Fig 27a. Switching Time Test Circuit

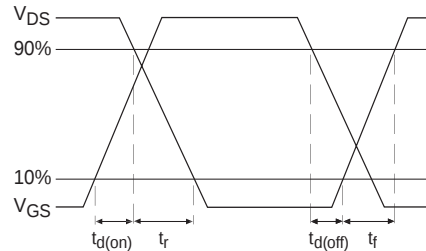


Fig 27b. Switching Time Waveforms

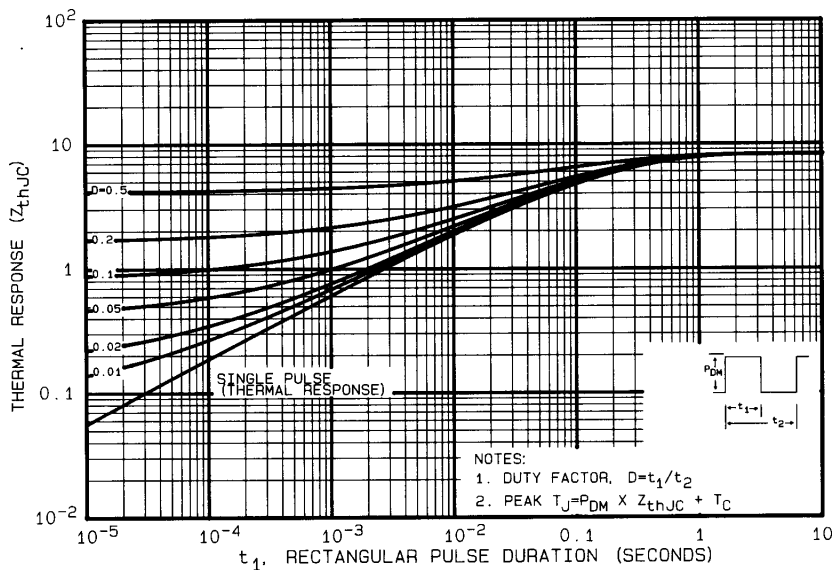


Fig 28. Maximum Effective Transient Thermal Impedance, Junction-to-Case

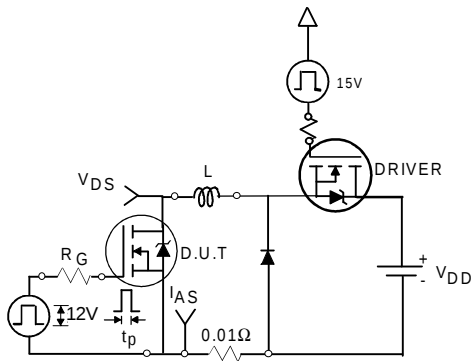


Fig 29a. Unclamped Inductive Test Circuit

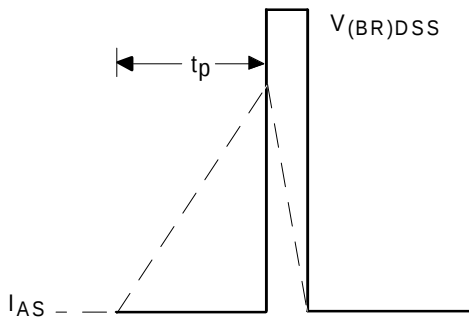


Fig 29b. Unclamped Inductive Waveforms

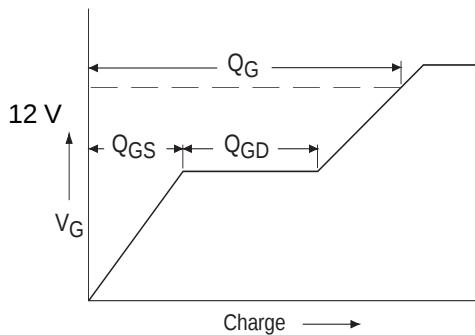


Fig 30a. Basic Gate Charge Waveform

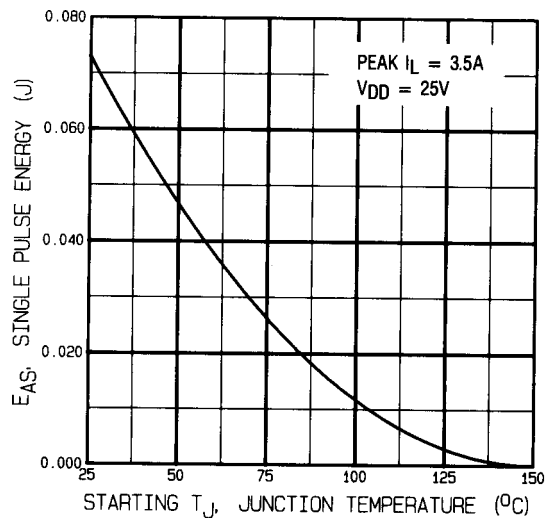


Fig 29c. Maximum Avalanche Energy Vs. Drain Current

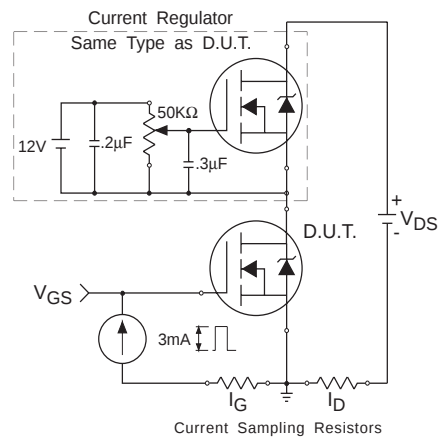
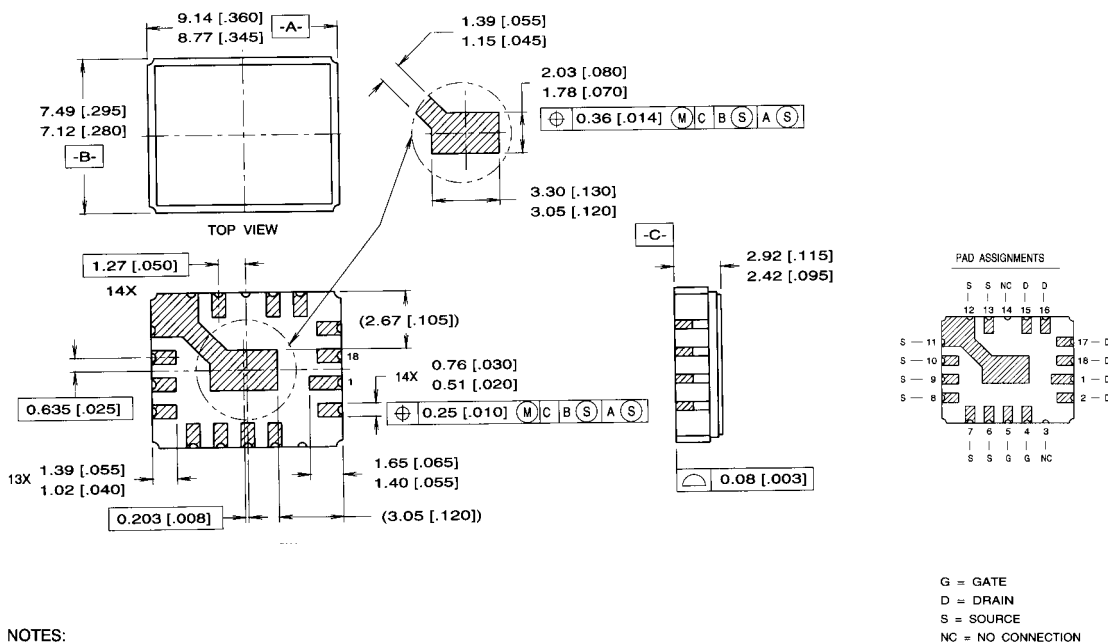


Fig 30b. Gate Charge Test Circuit

- ① See Figures 18 through 30 for pre-radiation curves
- ② Repetitive Rating; Pulse width limited by maximum junction temperature.
Refer to current HEXFET reliability report.
- ③ $V_{DD} = 25V$, Starting $T_J = 25^\circ C$,
Peak $I_L = 3.5A$, $L > 3.0mH$ $R_G = 25\Omega$
- ④ $I_{SD} \leq 3.5A$, $di/dt \leq 140A/\mu s$,
 $V_{DD} \leq BV_{DSS}$, $T_J \leq 150^\circ C$
Suggested $R_G = 7.5\Omega$
- ⑤ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$
- ⑥ **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.
- ⑦ **Total Dose Irradiation with V_{DS} Bias.**
 $V_{DS} = 0.8$ rated BV_{DSS} (pre-radiation) applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, method 1019, condition A.
- ⑧ This test is performed using a flash x-ray source operated in the e-beam mode (energy ~ 2.5 MeV), 30 nsec pulse.
- ⑨ All Pre-Irradiation and Post-Irradiation test conditions are **identical** to facilitate direct comparison for circuit applications.

Case Outline and Dimensions — Leadless Chip Carrier (LCC) Package



IR Case Style Leadless Chip Carrier (LCC)

International
IOR Rectifier

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IR CANADA: 15 Lincoln Court, Brampton, Ontario L6T3Z2, Tel: (905) 453 2200

IR GERMANY: Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 6172 96590

IR ITALY: Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111

IR FAR EAST: K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo Japan 171 Tel: 81 3 3983 0086

IR SOUTHEAST ASIA: 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: ++ 65 838 4630

IR TAIWAN: 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673, Taiwan Tel: 886-2-2377-9936

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