

International IR Rectifier

REPETITIVE AVALANCHE AND dv/dt RATED HEXFET® TRANSISTOR

IRHN9150 IRHN93150 P-CHANNEL RAD HARD

-100Volt, 0.075Ω, RAD HARD HEXFET

International Rectifier's P-Channel RAD HARD technology HEXFETs demonstrate excellent threshold voltage stability at total radiation doses as high as 3×10^5 Rads (Si). Under **identical** pre- and post-radiation test conditions, International Rectifier's P-Channel 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 SEE 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.

Absolute Maximum Ratings

	Parameter	IRHN9150, IRHN93150	Units
I_D @ $V_{GS} = -12V, T_C = 25^\circ C$	Continuous Drain Current	-22	A
I_D @ $V_{GS} = -12V, T_C = 100^\circ C$	Continuous Drain Current	-14	
I_{DM}	Pulsed Drain Current ①	-88	
P_D @ $T_C = 25^\circ C$	Max. Power Dissipation	150	W
	Linear Derating Factor	1.2	W/K ⑤
V_{GS}	Gate-to-Source Voltage	± 20	V
EAS	Single Pulse Avalanche Energy ②	500	mJ
I_{AR}	Avalanche Current ①	-22	A
EAR	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-23	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 10 sec.)	
	Weight	2.6 (typical)	g

Product Summary

Part Number	BV _{DSS}	R _{DS(on)}	I _D
IRHN9150	-100V	0.075Ω	-22A
IRHN93150	-100V	0.075Ω	-22A

Features:

- Radiation Hardened up to 3×10^5 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
- Lightweight

Pre-Radiation

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

	Parameter	Min	Typ	Max	Units	Test Conditions
BVDSS	Drain-to-Source Breakdown Voltage	-100	—	—	V	VGS = 0V, ID = -1.0mA
ΔBVDSS/ΔTj	Temperature Coefficient of Breakdown Voltage	—	-0.093	—	V/°C	Reference to 25°C, ID = -1.0mA
RDS(on)	Static Drain-to-Source On-State Resistance	—	—	0.075	Ω	VGS = -12V, ID = -14A ④
		—	—	0.080		VGS = -12V, ID = -22A
VGS(th)	Gate Threshold Voltage	-2.0	—	-4.0	V	VDS = VGS, ID = -1.0mA
gfs	Forward Transconductance	11	—	—	S (τ)	VDS > -15V, IDS = -14A ④
IDSS	Zero Gate Voltage Drain Current	—	—	-25	μA	VDS = 0.8 x Max Rating, VGS = 0V
		—	—	-250		VDS = 0.8 x Max Rating, VGS = 0V, Tj = 125°C
IGSS	Gate-to-Source Leakage Forward	—	—	-100	nA	VGS = -20V
IGSS	Gate-to-Source Leakage Reverse	—	—	100		VGS = 20V
Qg	Total Gate Charge	—	—	200	nC	VGS = -12V, ID = -22A VDS = Max Rating x 0.5
Qgs	Gate-to-Source Charge	—	—	35		
Qgd	Gate-to-Drain ('Miller') Charge	—	—	48		
td(on)	Turn-On Delay Time	—	—	40	ns	VDD = -50V, ID = -22A, RG = 2.35Ω
tr	Rise Time	—	—	150		
td(off)	Turn-Off Delay Time	—	—	100		
tf	Fall Time	—	—	190		
LD	Internal Drain Inductance	—	0.8	—	nH	Measured from center of drain pad to die.
LS	Internal Source Inductance	—	2.8	—		Measured from center of source pad to the end of source bonding wire
Ciss	Input Capacitance	—	4300	—	pF	VGS = 0V, VDS = -25V f = 1.0MHz
Coss	Output Capacitance	—	1100	—		
Crss	Reverse Transfer Capacitance	—	310	—		



Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
IS	Continuous Source Current (Body Diode)	—	—	-22	A	Modified MOSFET symbol showing the integrated reverse-pn junction rectifier.
ISM	Pulse Source Current (Body Diode) ①	—	—	-88		
VSD	Diode Forward Voltage	—	—	-3.0	V	Tj = 25°C, IS = -22A, VGS = 0V ④
trr	Reverse Recovery Time	—	—	250	ns	Tj = 25°C, IF = -22A, di/dt ≤ -100A/μs
QRR	Reverse Recovery Charge	—	—	1.5	μC	VDD ≤ -50V ④
ton	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
RthJC	Junction-to-Case	—	—	0.83	K/W ⑤	Soldered to a 1 inch square clad PC board
RthJ-PCB	Junction-to-PC board	—	6.6	—		

Radiation Performance of P-Channel Rad Hard HEXFETs

International Rectifier Radiation Hardened HEXFETs are tested to verify their hardness capability. The hardness assurance program at International Rectifier uses two radiation environments.

Every manufacturing lot is tested in a low dose rate (total dose) environment per MIL-STD-750, test method 1019. International Rectifier has imposed a standard gate voltage of 12 volts per note 6 and a V_{DSS} bias condition equal to 80% of the device rated voltage per note 7. Pre- and post-radiation limits of the devices irradiated to 1×10^5 Rads (Si) are identical and are presented in Table 1, column 1, IRHN9150. 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-radiation performance are tested and speci-

fied using the same drive circuitry and test conditions in order to provide a direct comparison. It should be noted that at a radiation level of 3×10^5 Rads (Si) no changes in limits are specified in DC parameters.

High dose rate testing may be done on a special request basis using a dose rate up to 1×10^{12} Rads (Si)/Sec.

International Rectifier radiation hardened P-Channel HEXFETs are considered to be neutron-tolerant, as stated in MIL-PRF-19500 Group D. International Rectifier radiation hardened P-Channel HEXFETs have been characterized in heavy ion Single Event Effects (SEE) environments and the results are shown in Table 3.

Table 1. Low Dose Rate ⑥ ⑦

	Parameter	IRHN9150		IRHN93150		Units	Test Conditions ⑩
		100K Rads (Si)		300K 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 ④	-2.0	-4.0	-2.0	-5.0		$V_{GS} = V_{DS}, I_D = -1.0mA$
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	—	-25	μA	$V_{DS}=0.8 \times \text{Max Rating}, V_{GS}=0V$
$R_{DS(on)1}$	Static Drain-to-Source ④ On-State Resistance One	—	0.075	—	0.085	Ω	$V_{GS} = -12V, I_D = -14A$
V_{SD}	Diode Forward Voltage ④	—	-3.0	—	-3.0	V	$T_C = 25^\circ C, I_S = -22A, V_{GS} = 0V$

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}		—	-100	—	—	-100	—	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 ⑨

Parameter	Typical	Units	Ion	LET (Si) (MeV/mg/cm ²)	Fluence (ions/cm ²)	Range (μm)	V_{DS} Bias (V)	V_{GS} Bias (V)
BV_{DSS}	-100	V	Ni	28	1×10^5	~41	-100	+5

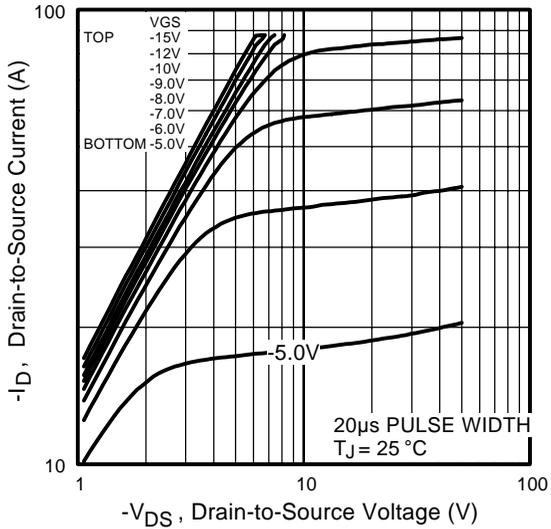


Fig 1. Typical Output Characteristics

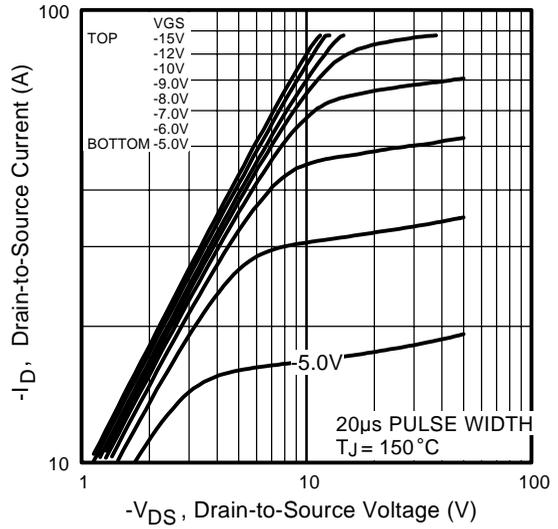


Fig 2. Typical Output Characteristics

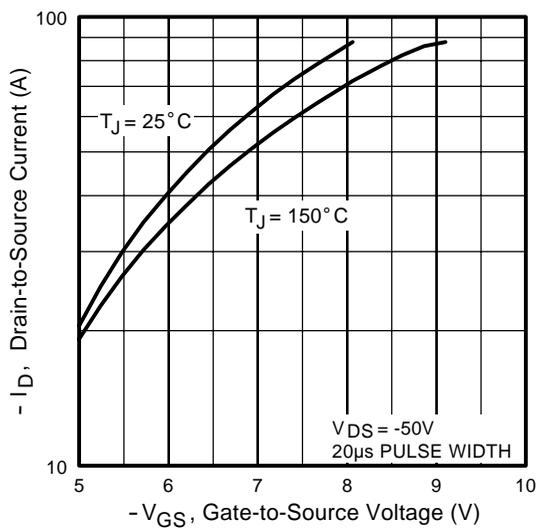


Fig 3. Typical Transfer Characteristics

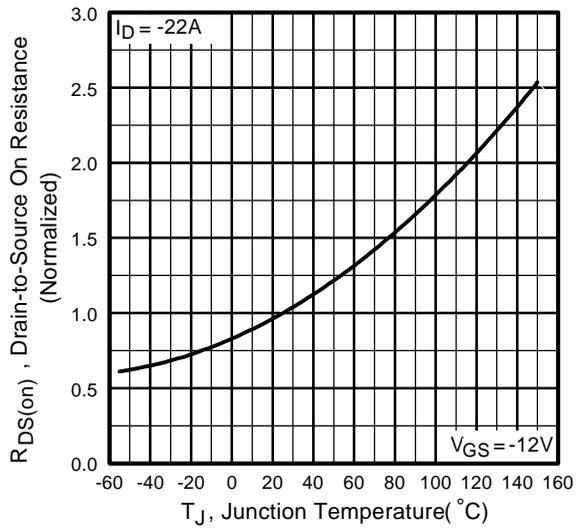


Fig 4. Normalized On-Resistance Vs. Temperature

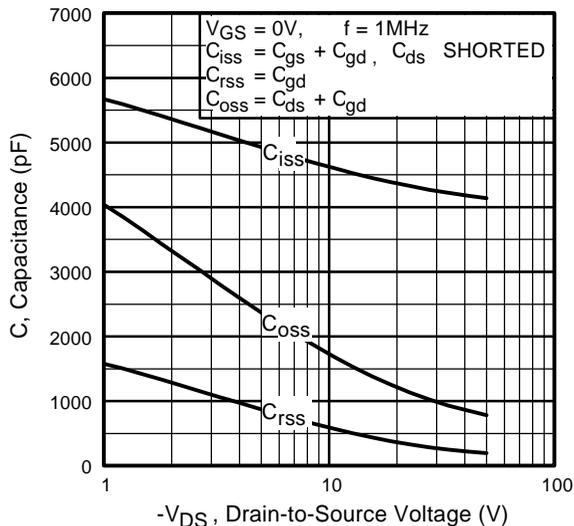


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

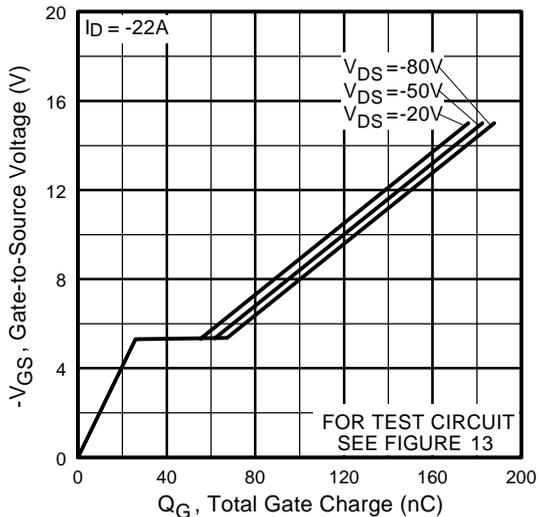


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

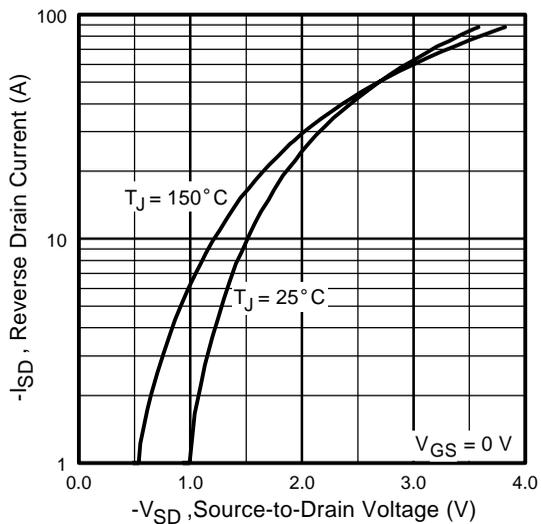


Fig 7. Typical Source-Drain Diode Forward Voltage

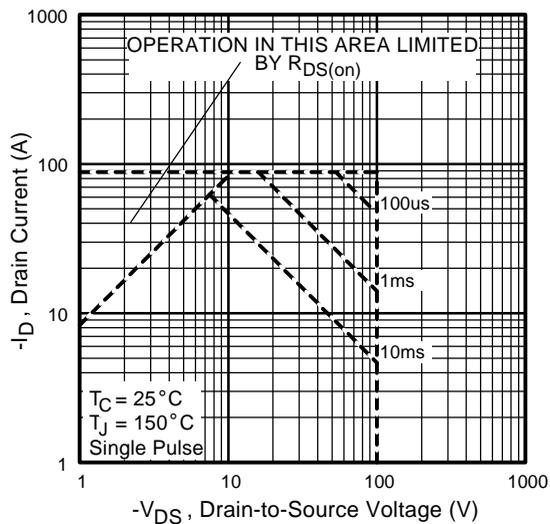


Fig 8. Maximum Safe Operating Area

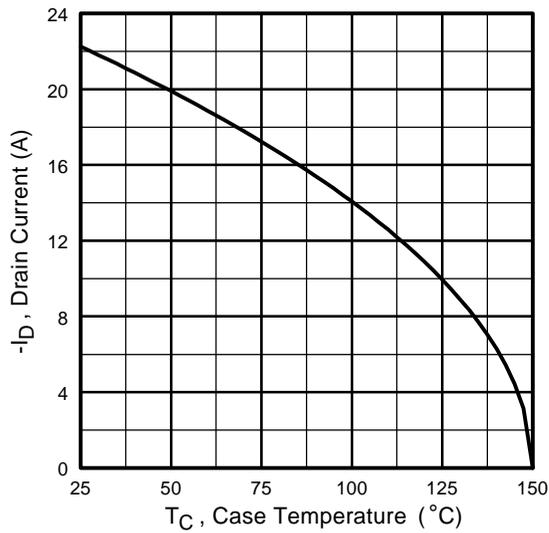


Fig 9. Maximum Drain Current Vs. Case Temperature

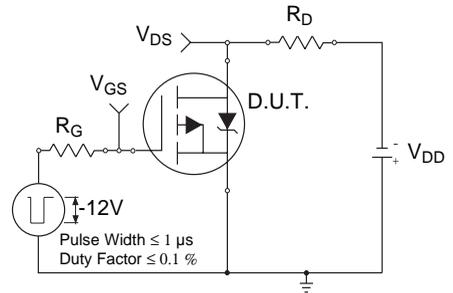


Fig 10a. Switching Time Test Circuit

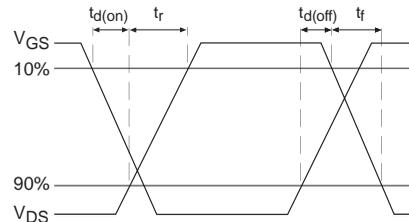


Fig 10b. Switching Time Waveforms

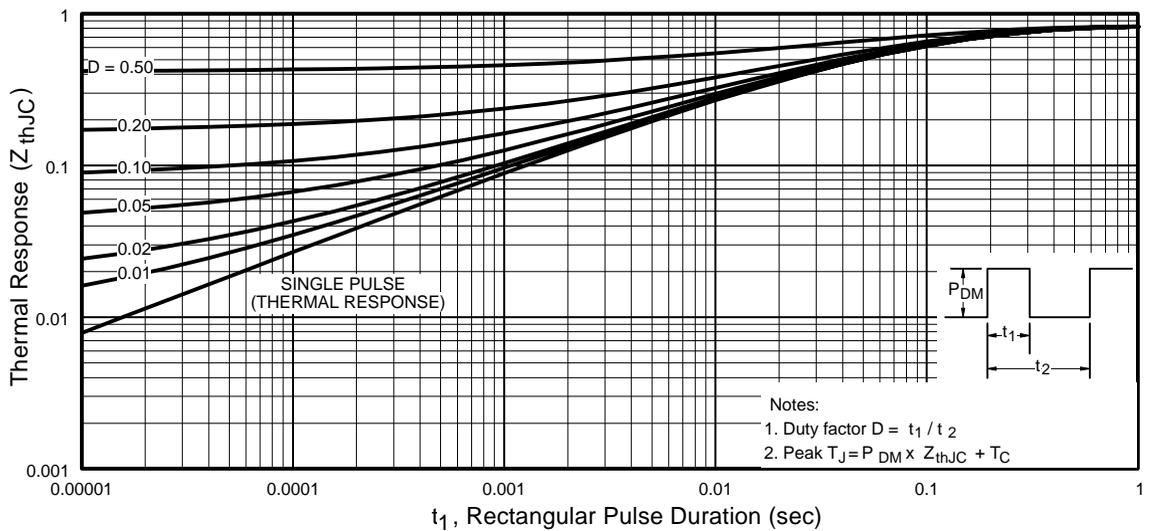


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

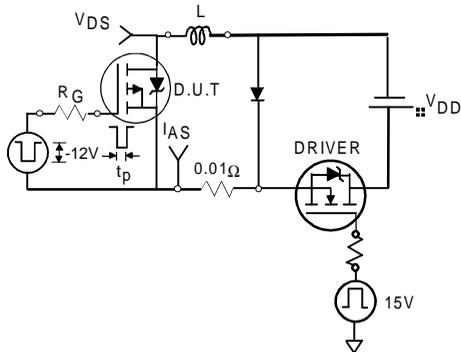


Fig 12a. Unclamped Inductive Test Circuit

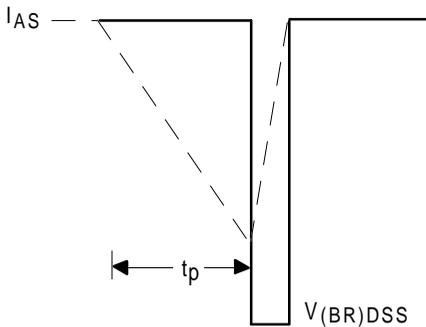


Fig 12b. Unclamped Inductive Waveforms

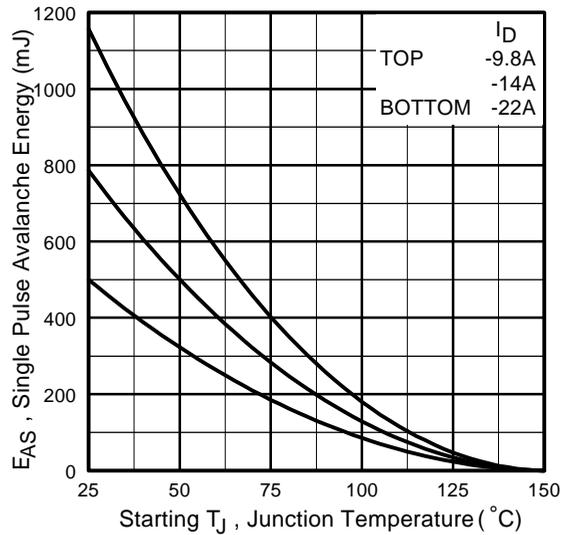


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

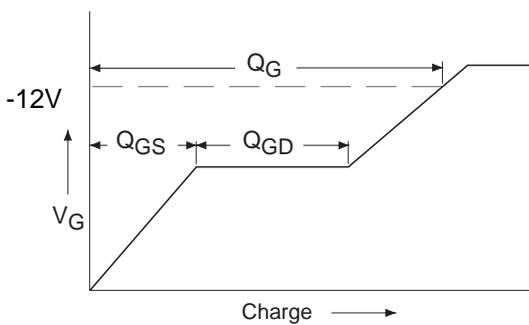


Fig 13a. Basic Gate Charge Waveform

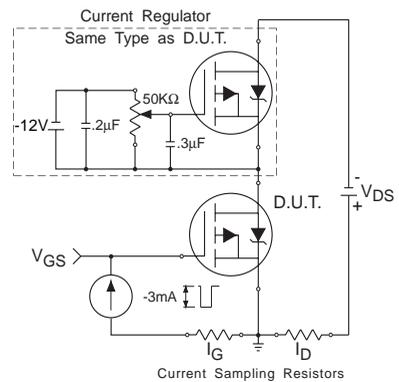
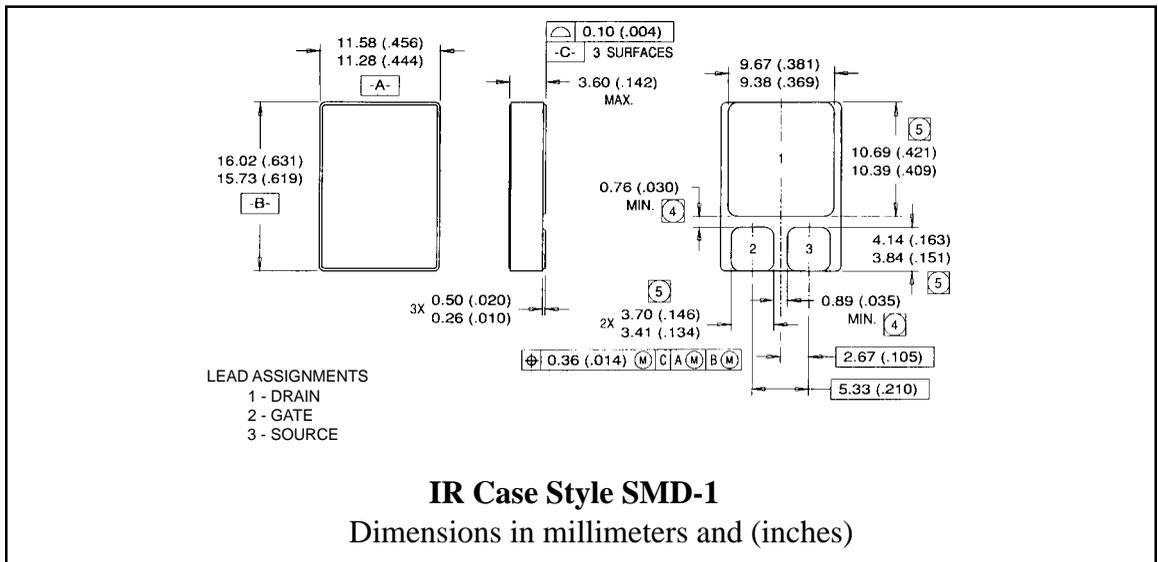


Fig 13b. Gate Charge Test Circuit

- ① Repetitive Rating; Pulse width limited by maximum junction temperature. Refer to current HEXFET reliability report.
- ② @ $V_{DD} = -25V$, Starting $T_J = 25^\circ C$, $EAS = [0.5 * L * (I_L^2)]$
Peak $I_L = -22A$, $V_{GS} = -12V$, $25 \leq R_G \leq 200\Omega$
- ③ $ISD \leq -22A$, $di/dt \leq -450A/\mu s$,
 $V_{DD} \leq BV_{DSS}$, $T_J \leq 150^\circ C$
Suggested $R_G = 2.35\Omega$
- ④ Pulse width $\leq 300 \mu s$; Duty Cycle $\leq 2\%$
- ⑤ $K/W = ^\circ C/W$
 $W/K = W/^\circ C$
- 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.
- 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.
- 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 Process characterized by independent laboratory.
- ⑩ All Pre-Radiation and Post-Radiation test conditions are **identical** to facilitate direct comparison for circuit applications.

Case Outline and Dimensions — SMD-1



International
IR Rectifier

WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, Tel: (310) 322 3331

EUROPEAN HEADQUARTERS: Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: ++ 44 1883 732020

IR CANADA: 7321 Victoria Park Ave., Suite 201, Markham, Ontario L3R 2Z8, Tel: (905) 475 1897

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: 315 Outram Road, #10-02 Tan Boon Liat Building, Singapore 0316 Tel: 65 221 8371

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