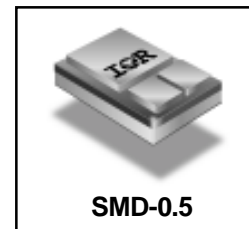


**RADIATION HARDENED  
POWER MOSFET  
SURFACE MOUNT (SMD-0.5)**

**IRH NJ7230  
200V, N-CHANNEL  
RAD-Hard™ HEXFET®  
MOSFET TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	R <sub>DS(on)</sub>	I <sub>D</sub>
IRH NJ7230	100K Rads (Si)	0.40Ω	9.4A
IRH NJ3230	300K Rads (Si)	0.40Ω	9.4A
IRH NJ4230	600K Rads (Si)	0.40Ω	9.4A
IRH NJ8230	1000K Rads (Si)	0.53Ω	9.4A



International Rectifier's RAD-Hard™ HEXFET® MOSFET 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<sub>DS(on)</sub> 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 R<sub>DS(on)</sub>
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Package
- Surface Mount
- Light Weight

**Absolute Maximum Ratings**

**Pre-Irradiation**

	Parameter		Units
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 25°C	Continuous Drain Current	9.4	A
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	6.0	
I <sub>DM</sub>	Pulsed Drain Current ①	37	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Max. Power Dissipation	75	W
	Linear Derating Factor	0.6	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
E <sub>AS</sub>	Single Pulse Avalanche Energy	150 ②	mJ
I <sub>AR</sub>	Avalanche Current ①	5.5	A
E <sub>AR</sub>	Repetitive Avalanche Energy ①	7.5	mJ
dv/dt	Peak Diode Recovery dv/dt	16 ③	V/ns
T <sub>J</sub>	Operating Junction	-55 to 150	°C
T <sub>STG</sub>	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	1.0 (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
B <sub>V</sub> DSS	Drain-to-Source Breakdown Voltage	200	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
ΔB <sub>V</sub> DSS/ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.23	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.40	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A ④
		—	—	0.49		V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.4A
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	2.5	—	—	S (r)	V <sub>DS</sub> > 15V, I <sub>DS</sub> = 6.0A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	25	μA	V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 160V, 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	—	—	50	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 9.4A
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	10		V <sub>DS</sub> = 100V
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	25		
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	35	ns	V <sub>DD</sub> = 100V, I <sub>D</sub> = 9.4A, R <sub>G</sub> = 7.5Ω
t <sub>r</sub>	Rise Time	—	—	75		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	70		
t <sub>f</sub>	Fall Time	—	—	60		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	4.0	—	nH	Measured from the center of drain pad to center of source pad
C <sub>iss</sub>	Input Capacitance	—	1200	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	250	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	63	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	9.4	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	37		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.4	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 9.4A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	460	nS	T <sub>j</sub> = 25°C, I <sub>F</sub> = 9.4A, di/dt ≥ 100A/μs
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	2.4	μC	V <sub>DD</sub> ≤ 25V ④
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L <sub>S</sub> + L <sub>D</sub> .				

**Thermal Resistance**

	Parameter	Min	Typ	Max	Units	Test Conditions
R <sub>thJC</sub>	Junction-to-Case	—	—	1.67	°C/W	

For footnotes refer to the last page

## Radiation Characteristics

IRHNJ7230

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** ⑤⑥

	Parameter	100K Rads(Si) <sup>1</sup>		300K to 1000K Rads (Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	200	—	200	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage ④	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> = -20V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	25	—	25	μA	V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-39)	—	0.41	—	0.54	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (SMD-0.5)	—	0.40	—	0.53	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 6.0A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.4	—	1.4	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 9.4A

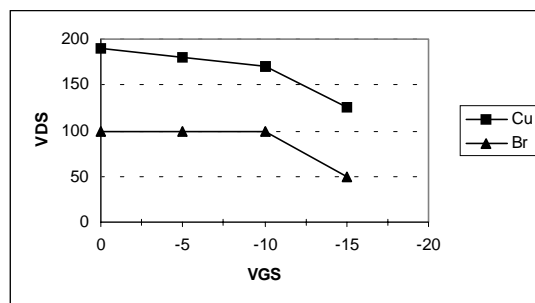
1. Part numbers IRHNJ7230, IRHNJ3230, IRHNJ4230

2. Part number IRHNJ8230

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
Cu	28.0	285	43.0	190	180	170	125	—
Br	36.8	305	39.0	100	100	100	50	—



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

For footnotes refer to the last page

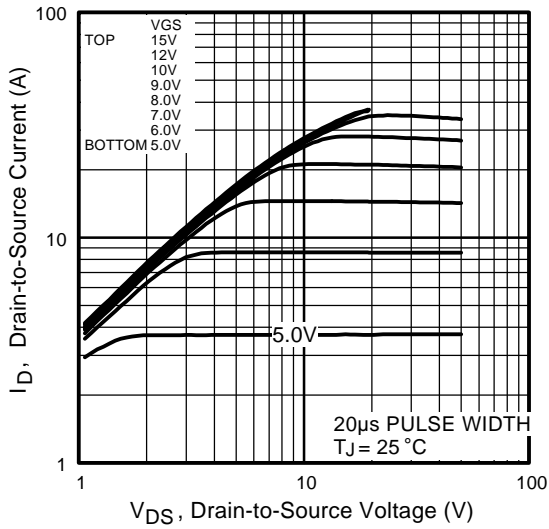


Fig 1. Typical Output Characteristics

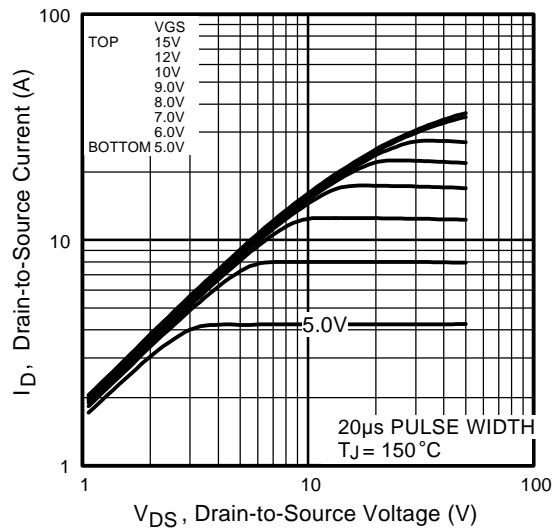


Fig 2. Typical Output Characteristics

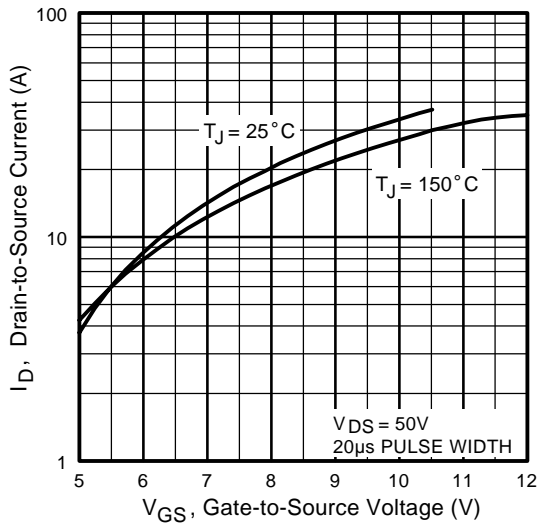


Fig 3. Typical Transfer Characteristics

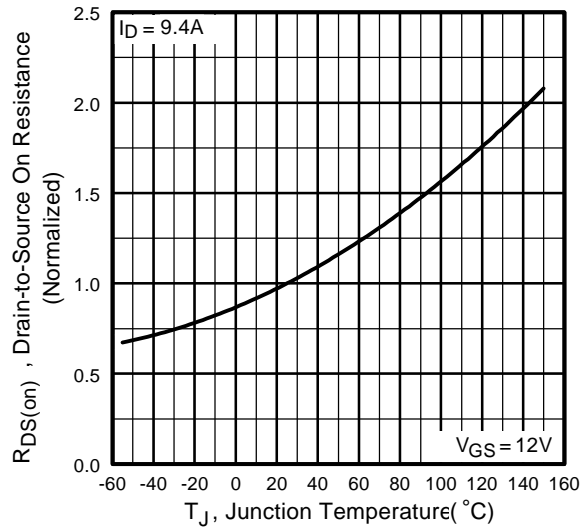


Fig 4. Normalized On-Resistance Vs. Temperature

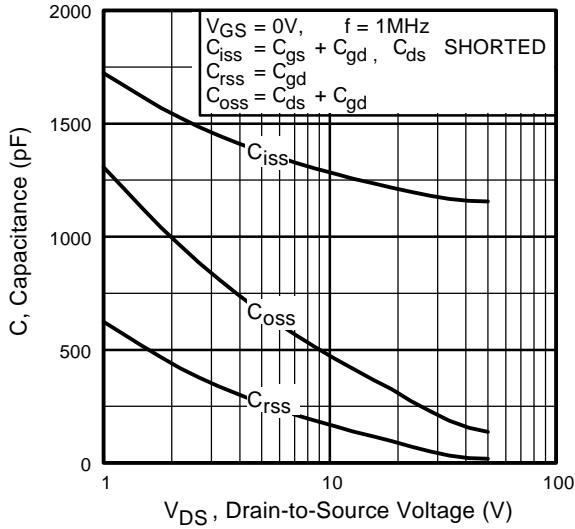


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

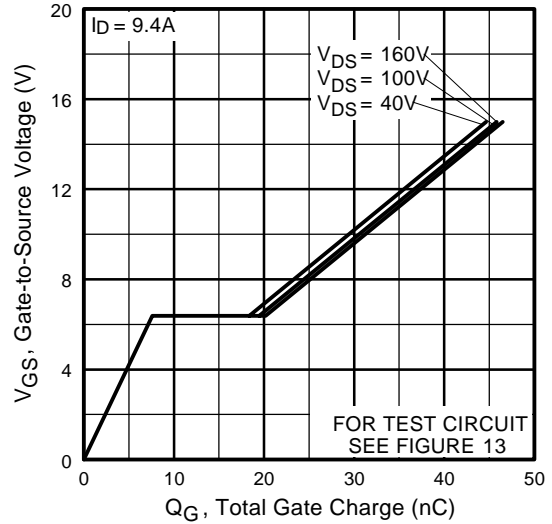


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

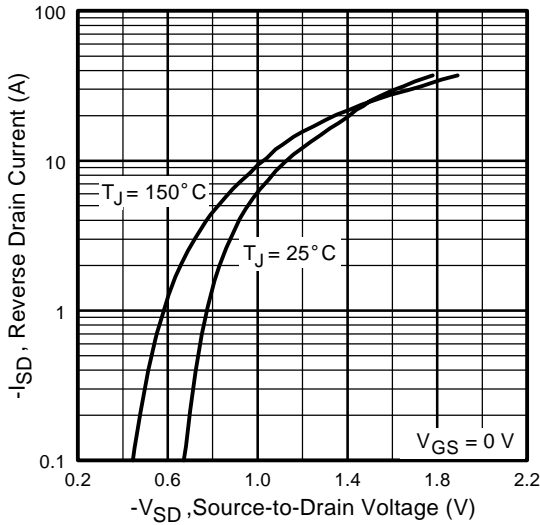


Fig 7. Typical Source-Drain Diode Forward Voltage

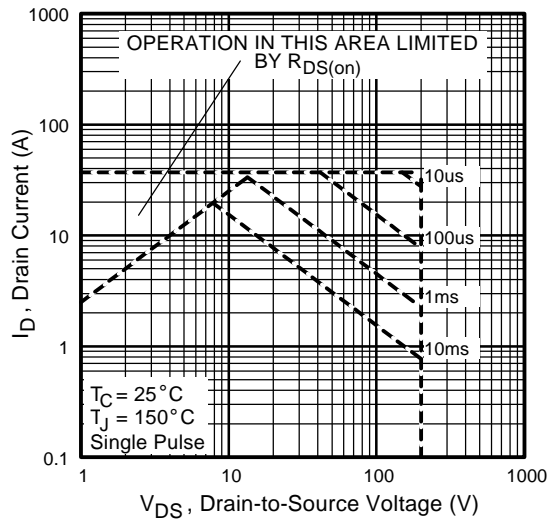
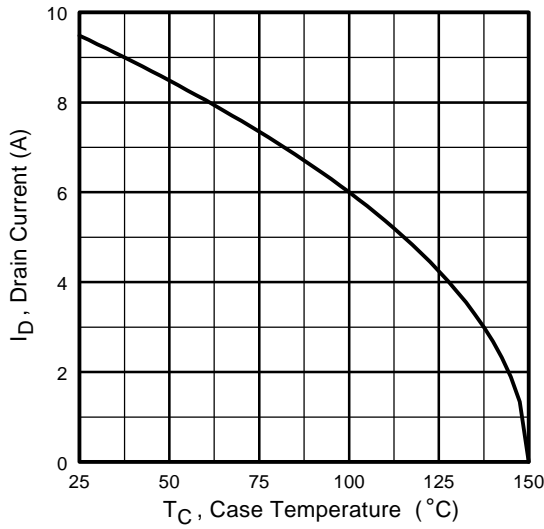
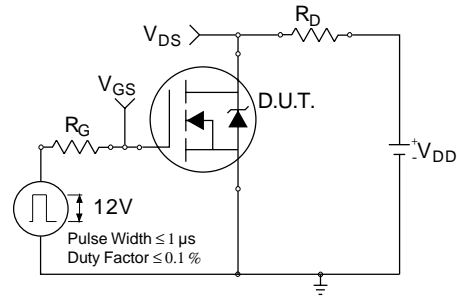


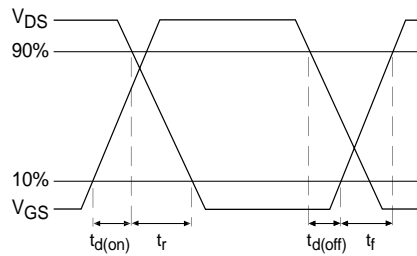
Fig 8. Maximum Safe Operating Area



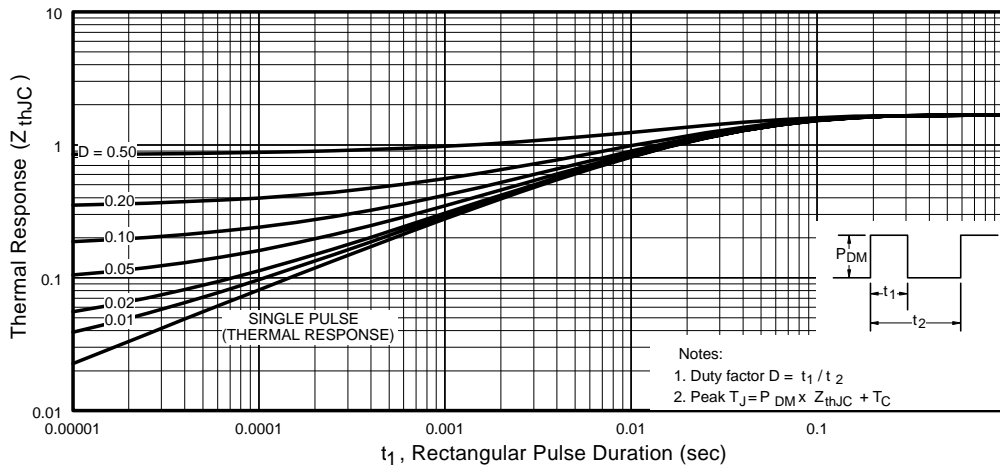
**Fig 9.** Maximum Drain Current Vs. Case Temperature



**Fig 10a.** Switching Time Test Circuit



**Fig 10b.** Switching Time Waveforms



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

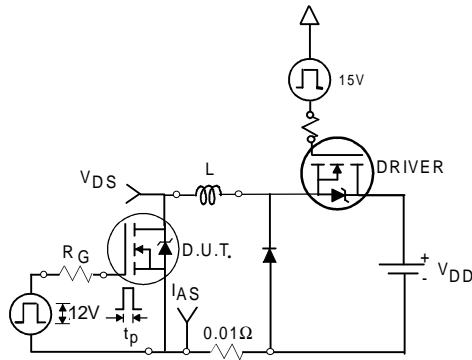


Fig 12a. Unclamped Inductive Test Circuit

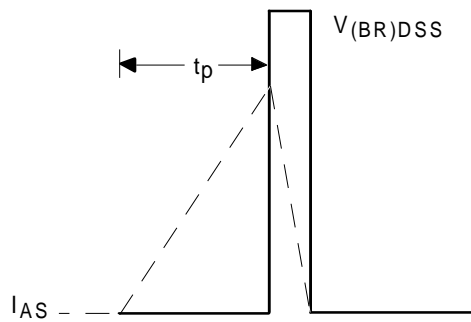


Fig 12b. Unclamped Inductive Waveforms

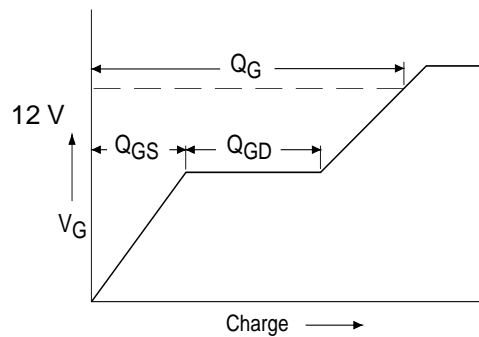


Fig 13a. Basic Gate Charge Waveform

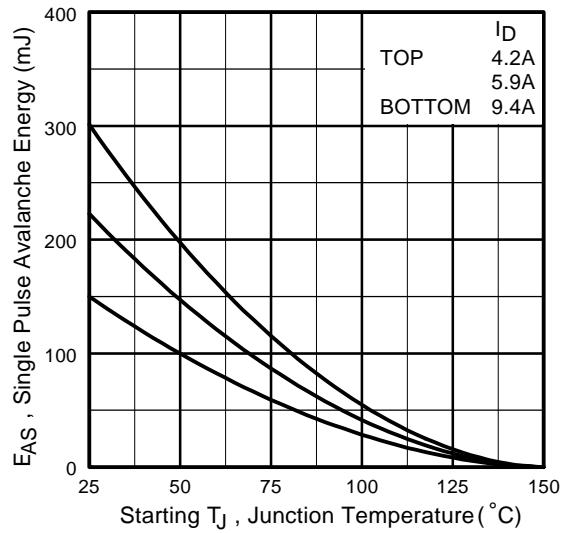


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

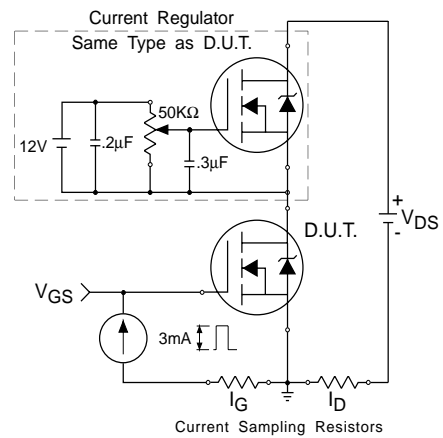
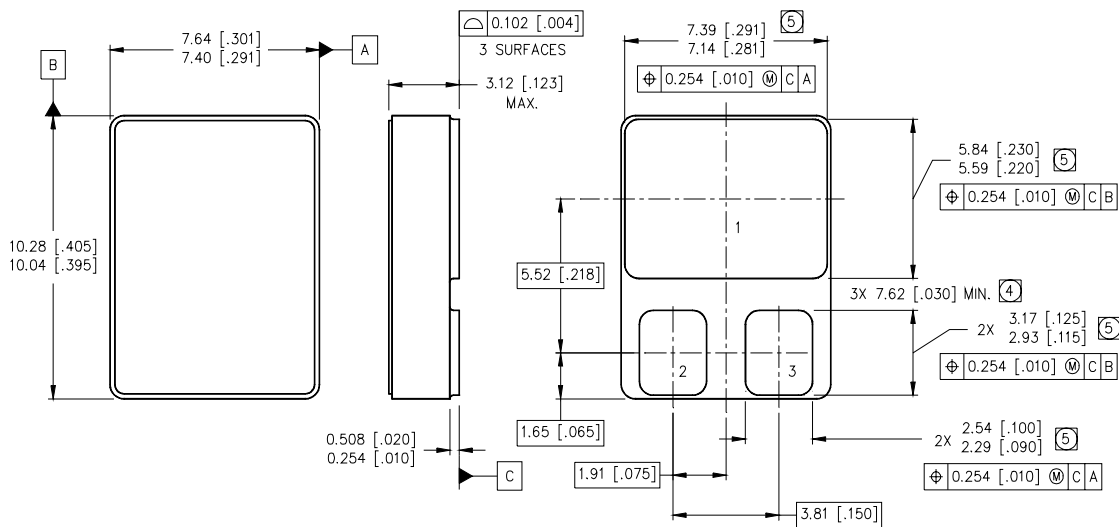


Fig 13b. Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^{\circ}C$ ,  $L = 3.4mH$ , Peak  $I_L = 9.4A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 9.4A$ ,  $di/dt \leq 660A/\mu s$ ,  $V_{DD} \leq 200V$ ,  $T_J \leq 150^{\circ}C$
- ④ Pulse width  $\leq 300 \mu s$ ; Duty Cycle  $\leq 2\%$
- ⑤ **Total Dose Irradiation with VGS 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 VDS Bias.**  
160 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A

**Case Outline and Dimensions — SMD-0.5**



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



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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 (0) 6172 96590  
**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 011 451 0111  
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*Data and specifications subject to change without notice. 7/00*