

International  
**IR** Rectifier  
**RADIATION HARDENED  
 POWER MOSFET  
 SURFACE MOUNT (SMD-2)**

PD-91396F

**IRHNA7160  
 JANSR2N7432U  
 100V, N-CHANNEL  
 REF: MIL-PRF-19500/664**

**RAD-Hard™ HEXFET® TECHNOLOGY**

**Product Summary**

Part Number	Radiation Level	RDS(on)	Id	QPL Part Number
IRHNA7160	100K Rads (Si)	0.04Ω	51A	JANSR2N7432U
IRHNA3160	300K Rads (Si)	0.04Ω	51A	JANSF2N7432U
IRHNA4160	500K Rads (Si)	0.04Ω	51A	JANSG2N7432U
IRHNA8160	1000K Rads (Si)	0.04Ω	51A	JANSH2N7432U



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
- Light Weight
- ESD Class: 3B per MIL-STD-750, Method 1020

**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	51	A
I <sub>D</sub> @ V <sub>GS</sub> = 12V, T <sub>C</sub> = 100°C	Continuous Drain Current	32.5	
I <sub>DM</sub>	Pulsed Drain Current ①	204	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Max. Power Dissipation	300	W
	Linear Derating Factor	2.4	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±20	V
EAS	Single Pulse Avalanche Energy ②	500	mJ
I <sub>AR</sub>	Avalanche Current ①	51	A
EAR	Repetitive Avalanche Energy ①	30	mJ
dv/dt	Peak Diode Recovery dv/dt ③	7.3	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	3.3 (Typical)	g

For footnotes refer to the last page

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**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	100	—	—	V	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1.0mA
ΔBV <sub>DSS</sub> /ΔT <sub>J</sub>	Temperature Coefficient of Breakdown Voltage	—	0.11	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1.0mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-State Resistance	—	—	0.040 0.045	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 32.5A ④ V <sub>GS</sub> = 12V, I <sub>D</sub> = 51A
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	16	—	—	S	V <sub>DS</sub> ≥ 15V, I <sub>DS</sub> = 32.5A ④
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	—	25 250	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V V <sub>DS</sub> = 80V 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	nA	V <sub>GS</sub> = -20V
Q <sub>g</sub>	Total Gate Charge	—	—	310	nC	V <sub>GS</sub> = 12V, I <sub>D</sub> = 51A V <sub>DS</sub> = 50V
Q <sub>gs</sub>	Gate-to-Source Charge	—	—	53	nC	
Q <sub>gd</sub>	Gate-to-Drain ('Miller') Charge	—	—	110	nC	
t <sub>d(on)</sub>	Turn-On Delay Time	—	—	35	ns	V <sub>DD</sub> = 50V, I <sub>D</sub> = 51A, V <sub>GS</sub> = 12V, R <sub>G</sub> = 2.35Ω
t <sub>r</sub>	Rise Time	—	—	150		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	—	150		
t <sub>f</sub>	Fall Time	—	—	130		
L <sub>S</sub> + L <sub>D</sub>	Total Inductance	—	4.0	—	nH	Measured from center of drain pad to center of source pad
C <sub>iss</sub>	Input Capacitance	—	5300	—	pF	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	1600	—		
C <sub>rss</sub>	Reverse Transfer Capacitance	—	350	—		

**Source-Drain Diode Ratings and Characteristics**

	Parameter	Min	Typ	Max	Units	Test Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	51	A	
I <sub>SM</sub>	Pulse Source Current (Body Diode) ①	—	—	204		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.8	V	T <sub>j</sub> = 25°C, I <sub>S</sub> = 51A, V <sub>GS</sub> = 0V ④
t <sub>rr</sub>	Reverse Recovery Time	—	—	520	ns	T <sub>j</sub> = 25°C, I <sub>F</sub> = 51A, di/dt ≥ 100A/μs V <sub>DD</sub> ≤ 50V ④
Q <sub>RR</sub>	Reverse Recovery Charge	—	—	6.5	μC	
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	—	—	0.42	°C/W	Solder to a 1" sq. copper clad PC Board
R <sub>thJPCB</sub>	Junction-to-PC Board	—	1.6	—		

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

For footnotes refer to the last page

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**

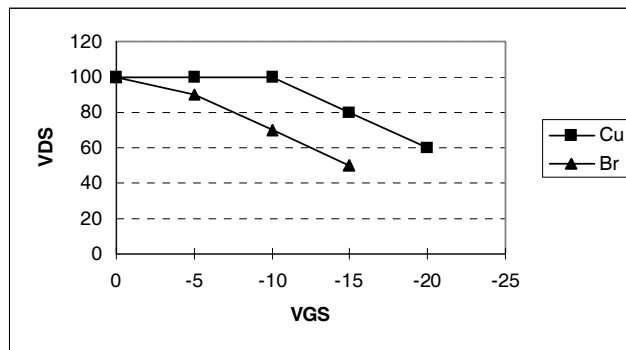
	Parameter	100K Rads(Si) <sup>1</sup>		300K-1000KRads(Si) <sup>2</sup>		Units	Test Conditions
		Min	Max	Min	Max		
BV <sub>DSS</sub>	Drain-to-Source Breakdown Voltage	100	—	100	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1.0mA
V <sub>GS(th)</sub>	Gate Threshold Voltage ④	2.0	4.0	1.25	4.5		V <sub>GS</sub> = 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> = -20 V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	—	25	—	50	μA	V <sub>DS</sub> = 80V, V <sub>GS</sub> = 0V
R <sub>DS(on)</sub>	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.045	—	0.062	Ω	V <sub>GS</sub> = 12V, I <sub>D</sub> = 32.5A
V <sub>SD</sub>	Diode Forward Voltage ④	—	1.8	—	1.8	V	V <sub>GS</sub> = 0V, I <sub>S</sub> = 51A

1. Part number IRHNA7160 (JANSR2N7432U)
2. Part numbers IRHNA3160 (JANSF2N7432U), IRHNA4160 (JANSR2N7432U) and IRHNA8160 (JANSR2N7432U)

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. Typical 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	285	43	100	100	100	80	60
Br	36.8	305	39	100	90	70	50	—



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

For footnotes refer to the last page

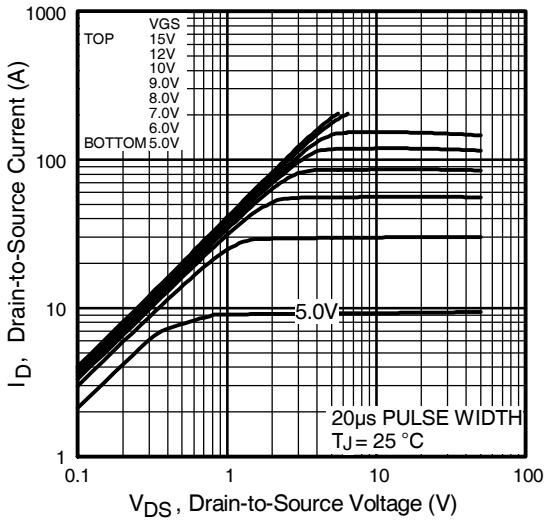


Fig 1. Typical Output Characteristics

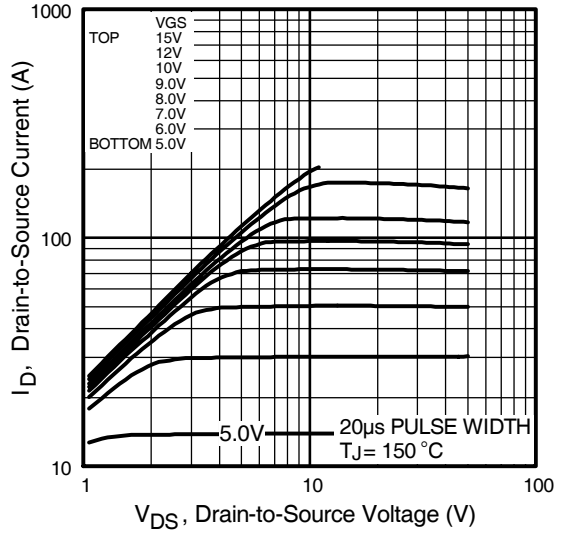


Fig 2. Typical Output Characteristics

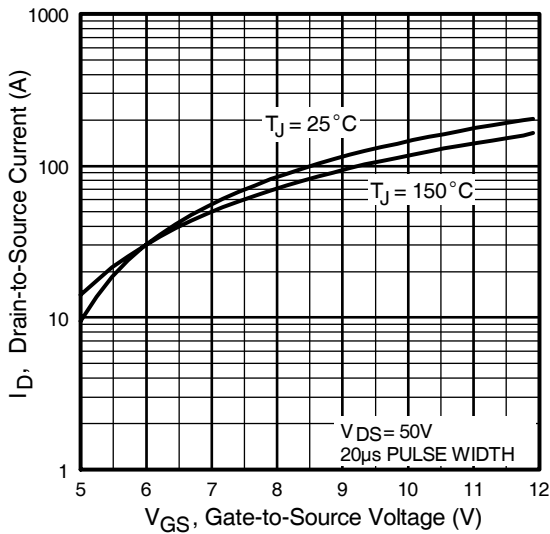


Fig 3. Typical Transfer Characteristics

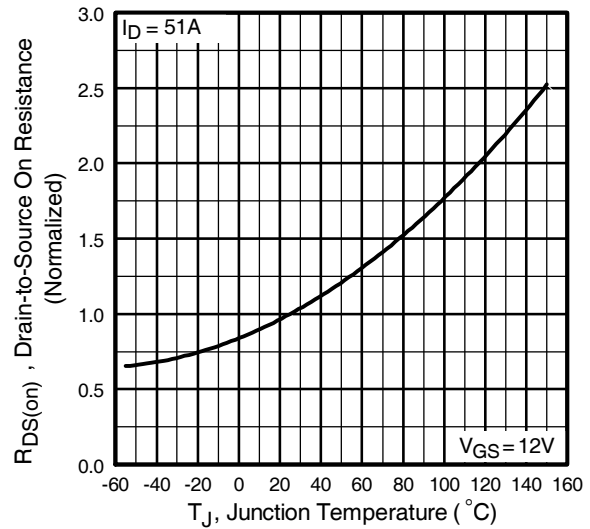


Fig 4. Normalized On-Resistance Vs. Temperature

Pre-Irradiation

IRHNA7160, JANSR2N7432U

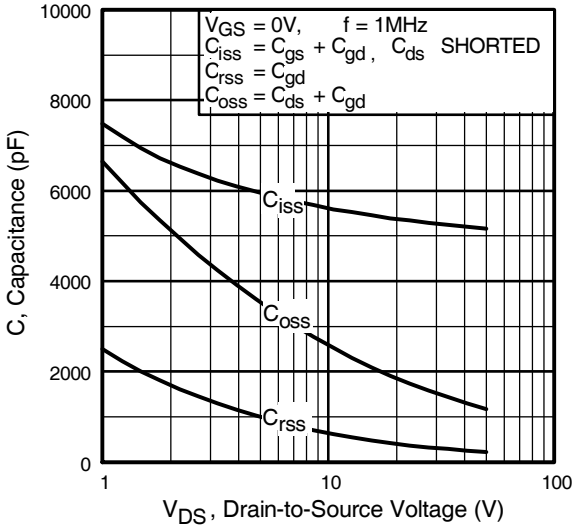


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

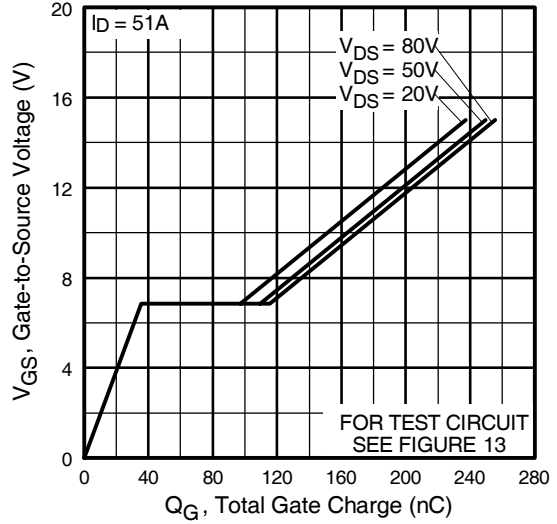


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

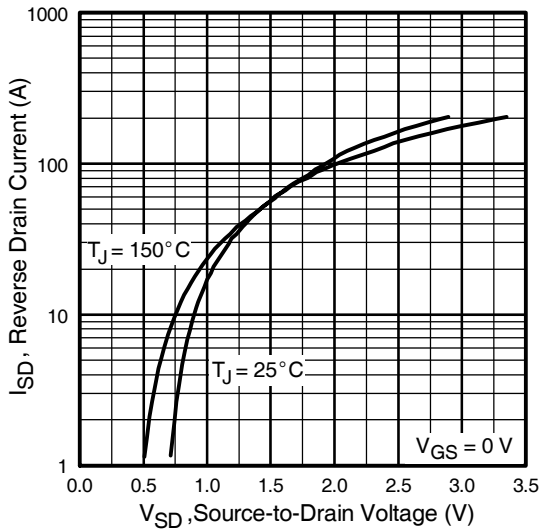


Fig 7. Typical Source-Drain Diode Forward Voltage

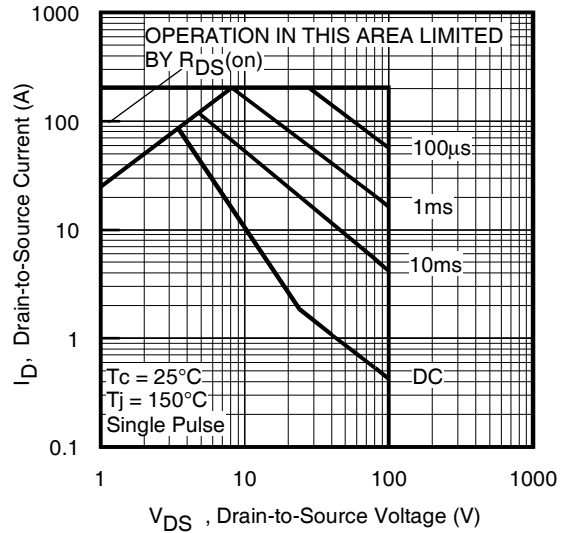


Fig 8. Maximum Safe Operating Area

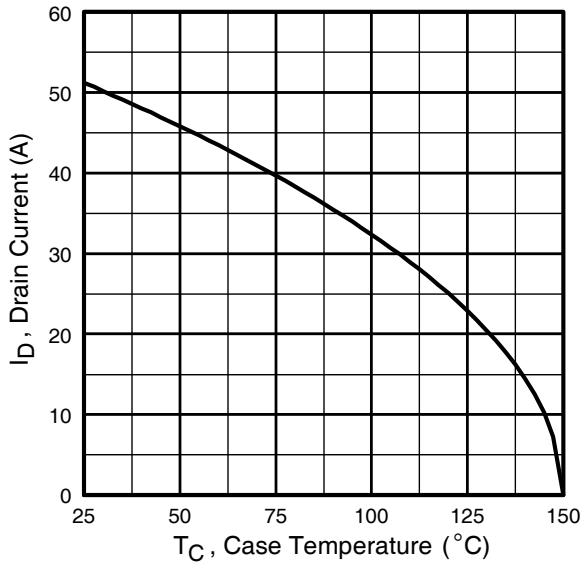


Fig 9. Maximum Drain Current Vs. Case Temperature

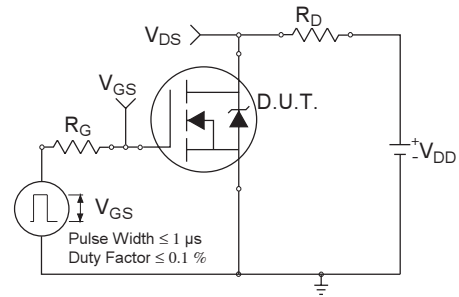


Fig 10a. Switching Time Test Circuit

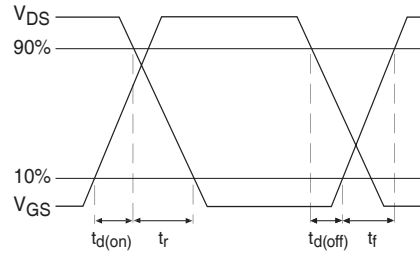


Fig 10b. Switching Time Waveforms

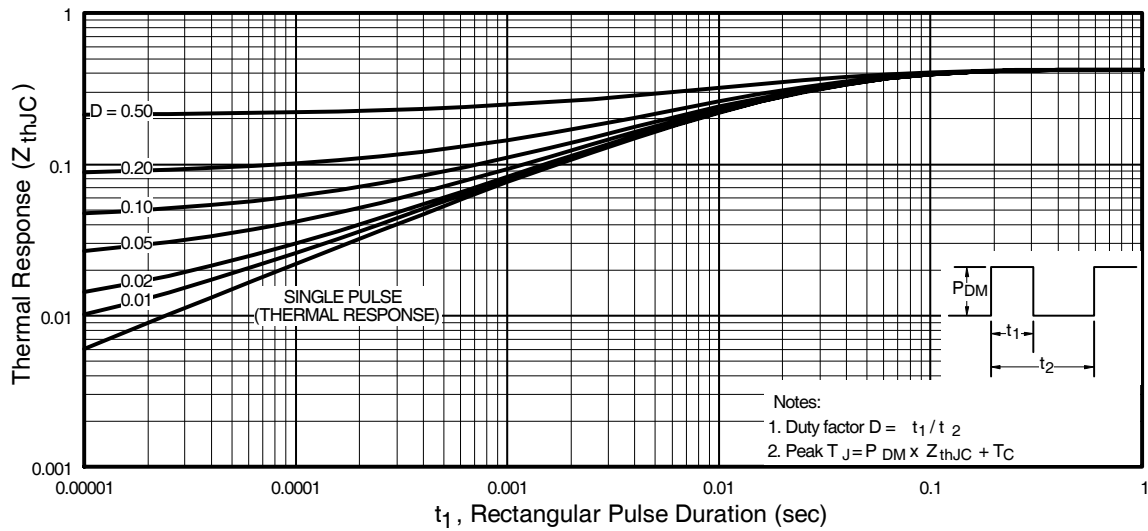


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

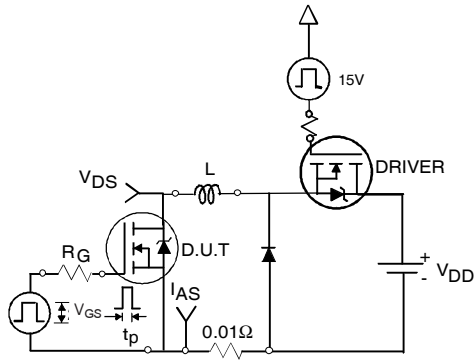


Fig 12a. Unclamped Inductive Test Circuit

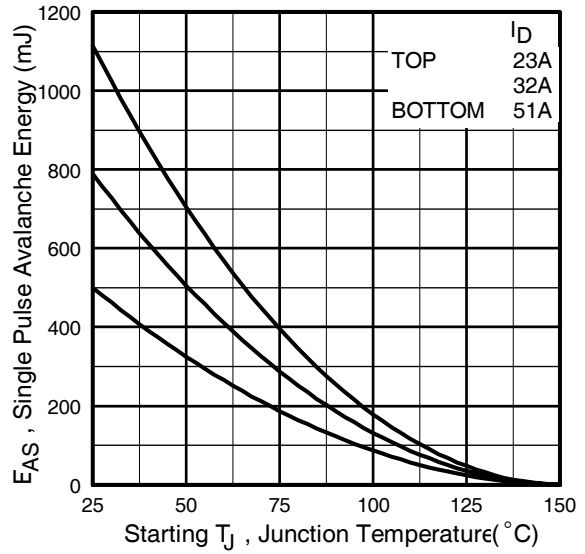


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

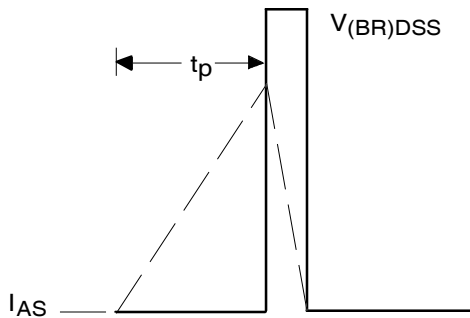


Fig 12b. Unclamped Inductive Waveforms

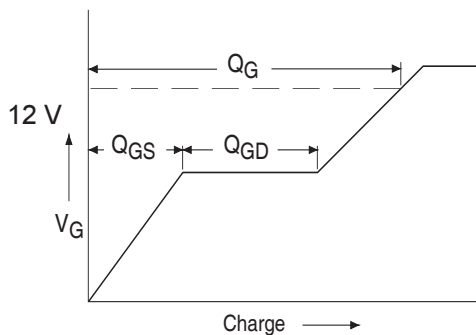


Fig 13a. Basic Gate Charge Waveform

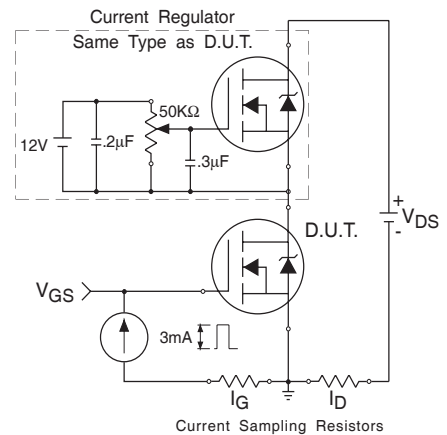
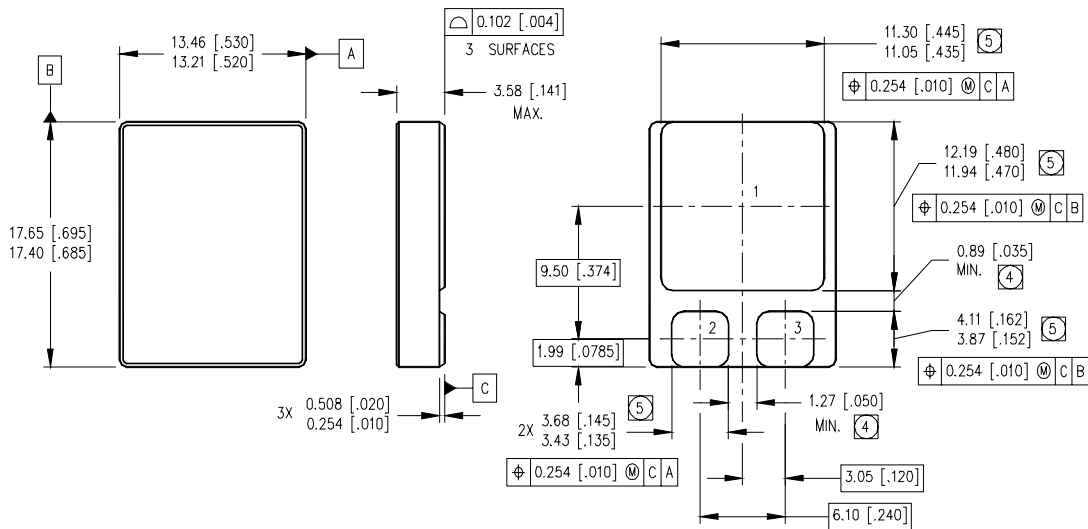


Fig 13b. Gate Charge Test Circuit

**Footnotes:**

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 25V$ , starting  $T_J = 25^\circ C$ ,  $L = 0.38mH$   
Peak  $I_L = 51A$ ,  $V_{GS} = 12V$
- ③  $I_{SD} \leq 51A$ ,  $di/dt \leq 410A/\mu s$ ,  
 $V_{DD} \leq 100V$ ,  $T_J \leq 150^\circ C$
- 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.**  
80 volt  $V_{DS}$  applied and  $V_{GS} = 0$  during irradiation per MIL-STD-750, method 1019, condition A.

**Case Outline and Dimensions — SMD-2**



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

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