

**RADIATION HARDENED
POWER MOSFET
SURFACE MOUNT (SMD-1)**

**IRHN7054
JANSR2N7394U
60V, N-CHANNEL
REF: MIL-PRF-19500/603
RAD-Hard™ HEXFET® TECHNOLOGY**

Product Summary

Part Number	Radiation Level	R _{DS(on)}	I _D	QPL Part Number
IRHN7054	100K Rads (Si)	0.027Ω	35A	JANSR2N7394U
IRHN3054	300K Rads (Si)	0.027Ω	35A	JANSF2N7394U
IRHN4054	500K Rads (Si)	0.027Ω	35A	JANSG2N7394U
IRHN8054	1000K Rads (Si)	0.040Ω	35A	JANSH2N7394U



SMD-1

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 R_{DS(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 R_{DS(on)}
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Paralleling
- Hermetically Sealed
- Ceramic Package
- Light Weight
- Surface Mount

Absolute Maximum Ratings

Pre-Irradiation

	Parameter		Units
I _D @ V _{GS} = 12V, T _C = 25°C	Continuous Drain Current	35	A
I _D @ V _{GS} = 12V, T _C = 100°C	Continuous Drain Current	30	
I _{DM}	Pulsed Drain Current ①	283	
P _D @ T _C = 25°C	Max. Power Dissipation	150	W
	Linear Derating Factor	1.2	W/°C
V _{GS}	Gate-to-Source Voltage	±20	V
E _{AS}	Single Pulse Avalanche Energy ②	500	mJ
I _{AR}	Avalanche Current ①	35	A
E _{AR}	Repetitive Avalanche Energy ①	15	mJ
dv/dt	Peak Diode Recovery dv/dt ③	3.5	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Package Mounting Surface Temperature	300 (5sec)	
	Weight	2.6 (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
BV _{DSS}	Drain-to-Source Breakdown Voltage	60	—	—	V	V _{GS} = 0V, I _D = 1.0mA
ΔBV _{DSS} /ΔT _J	Temperature Coefficient of Breakdown Voltage	—	0.053	—	V/°C	Reference to 25°C, I _D = 1.0mA
R _{DS(on)}	Static Drain-to-Source On-State Resistance	—	—	0.027	Ω	V _{GS} = 12V, I _D = 30A ④
		—	—	0.030		V _{GS} = 12V, I _D = 35A
V _{GS(th)}	Gate Threshold Voltage	2.0	—	4.0	V	V _{DS} = V _{GS} , I _D = 1.0mA
g _{fs}	Forward Transconductance	12	—	—	S (℧)	V _{DS} > 15V, I _{DS} = 30A ④
I _{DSS}	Zero Gate Voltage Drain Current	—	—	25	μA	V _{DS} = 48V, V _{GS} = 0V
		—	—	250		V _{DS} = 48V, 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		V _{GS} = -20V
Q _g	Total Gate Charge	—	—	200	nC	V _{GS} = 12V, I _D = 35A
Q _{gs}	Gate-to-Source Charge	—	—	60		V _{DS} = 30V
Q _{gd}	Gate-to-Drain ('Miller') Charge	—	—	75		
t _{d(on)}	Turn-On Delay Time	—	—	27	ns	V _{DD} = 30V, I _D = 35A V _{GS} = 12V, R _G = 2.35Ω
t _r	Rise Time	—	—	100		
t _{d(off)}	Turn-Off Delay Time	—	—	75		
t _f	Fall Time	—	—	75		
L _S + L _D	Total Inductance	—	4.0	—	nH	Measured from the center of drain pad to center of source pad
C _{iss}	Input Capacitance	—	4100	—	pF	V _{GS} = 0V, V _{DS} = 25V f = 1.0MHz
C _{oss}	Output Capacitance	—	2000	—		
C _{rss}	Reverse Transfer Capacitance	—	560	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	35	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	283		
V _{SD}	Diode Forward Voltage	—	—	1.4	V	T _J = 25°C, I _S = 35A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	280	ns	T _J = 25°C, I _F = 35A, di/dt ≤ 100A/μs
Q _{RR}	Reverse Recovery Charge	—	—	2.2	μC	V _{DD} ≤ 50V ④
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	Soldered to a 1 inch square clad PC board
R _{thJ-PCB}	Junction-to-PC board	—	6.6	—		

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

For footnotes refer to the last page

Radiation Characteristics

IRHN7054, JANSR2N7394U

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	Up to 500K Rads(Si) ¹		1000K Rads (Si) ²		Units	Test Conditions
		Min	Max	Min	Max		
BV _{DSS}	Drain-to-Source Breakdown Voltage	60	—	60	—	V	V _{GS} = 0V, I _D = 1.0mA
V _{GS(th)}	Gate Threshold Voltage	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	—	50	μA	V _{DS} =48V, V _{GS} =0V
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.027	—	0.04	Ω	V _{GS} = 12V, I _D =30A
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (SMD-1)	—	0.027	—	0.04	Ω	V _{GS} = 12V, I _D =30A
V _{SD}	Diode Forward Voltage ④	—	1.4	—	1.4	V	V _{GS} = 0V, I _S = 35A

1. Part numbers IRHN7054 (JANSR2N7394U), IRHN3054 (JANSF2N7394U) and IRHN4054 (JANSR2N7394U)

2. Part number IRHN8054 (JANSR2N7394U)

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
Br	36.8	305	39	60	60	45	40	30
I	59.9	345	32.8	40	35	30	25	20

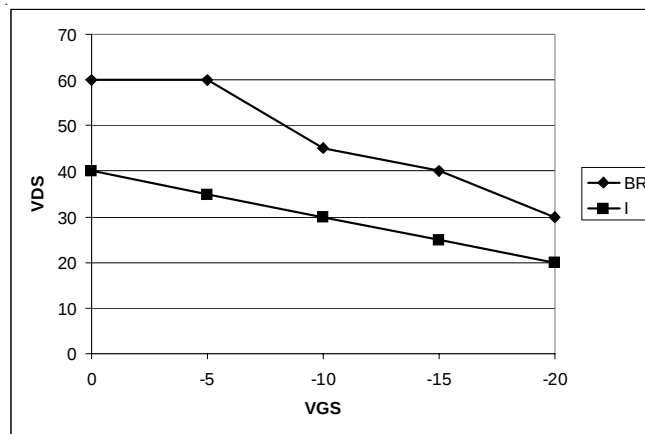


Fig a. Single Event Effect, Safe Operating Area

For footnotes refer to the last page

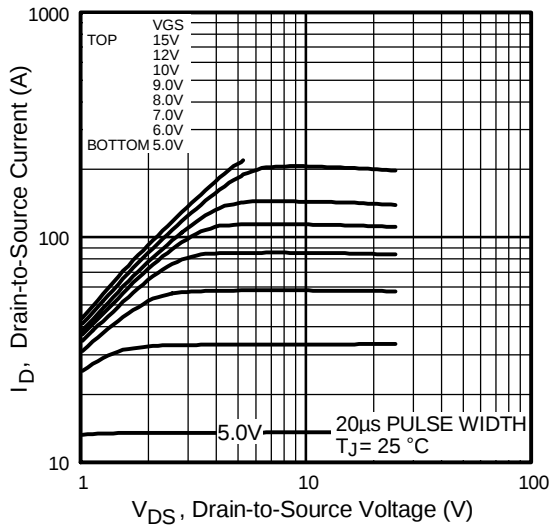


Fig 1. Typical Output Characteristics

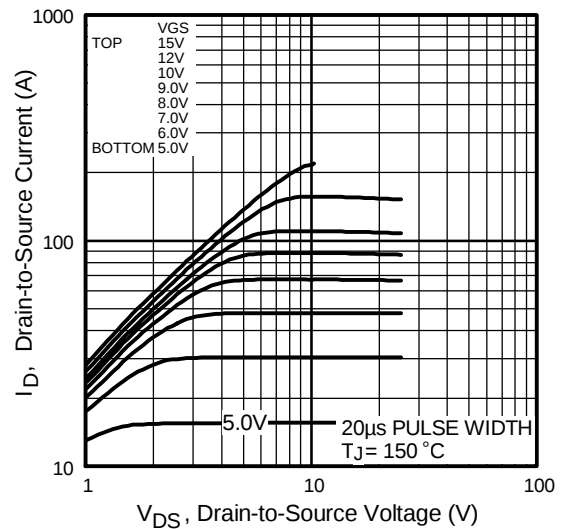


Fig 2. Typical Output Characteristics

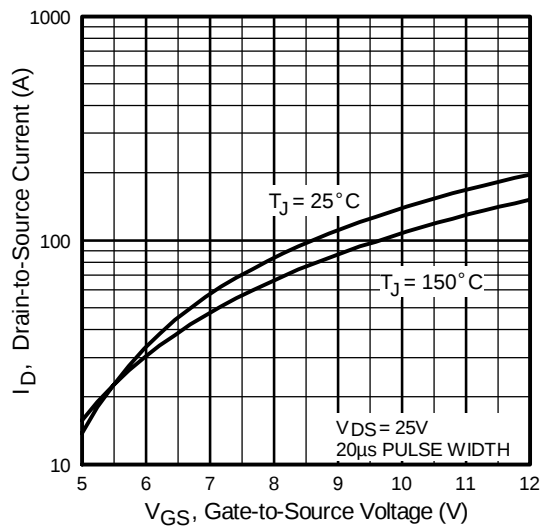


Fig 3. Typical Transfer Characteristics

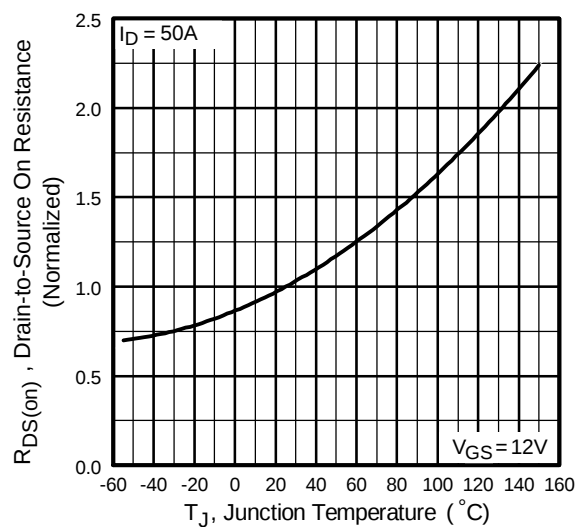


Fig 4. Normalized On-Resistance Vs. Temperature

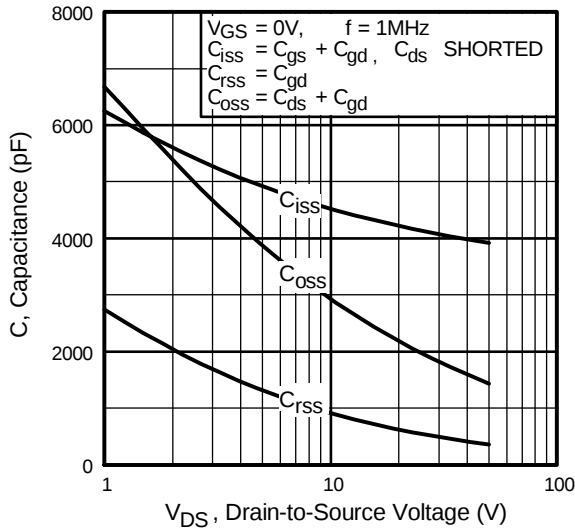


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

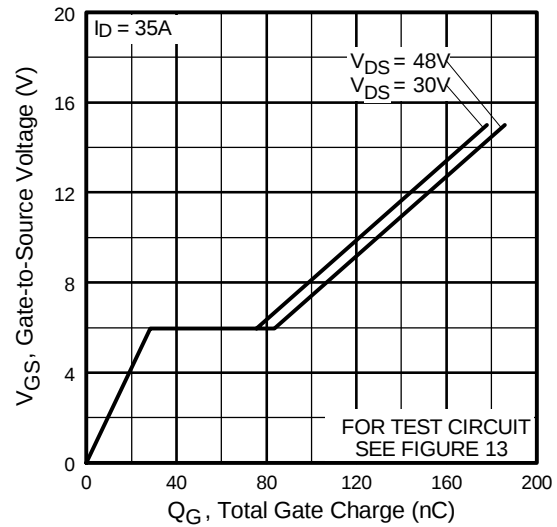


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

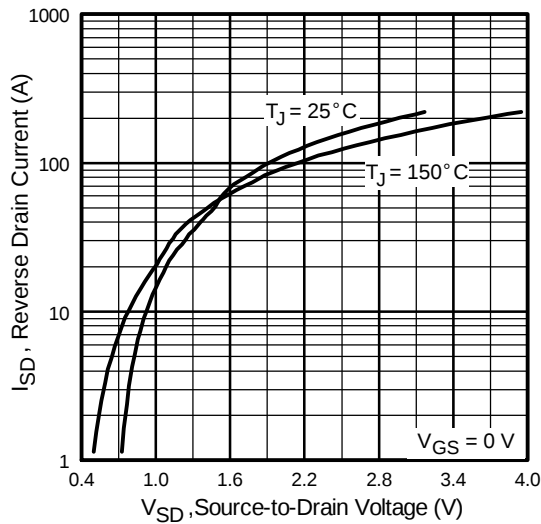


Fig 7. Typical Source-Drain Diode Forward Voltage

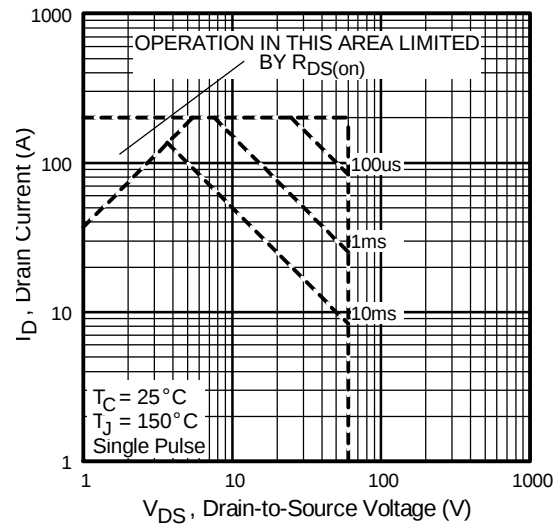


Fig 8. Maximum Safe Operating Area

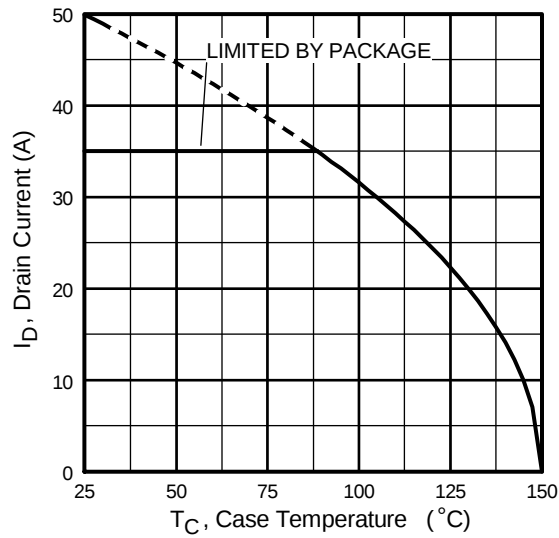


Fig 9. Maximum Drain Current Vs. Case Temperature

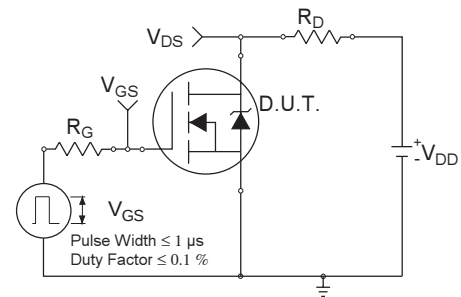


Fig 10a. Switching Time Test Circuit

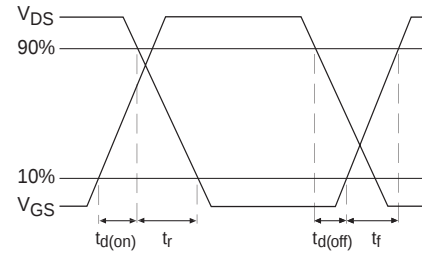


Fig 10b. Switching Time Waveforms

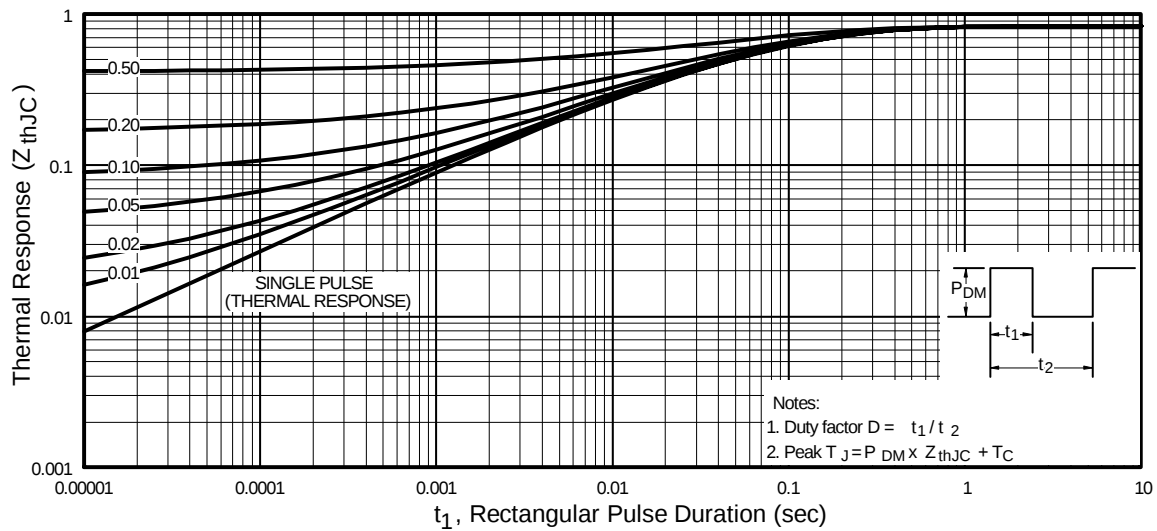


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

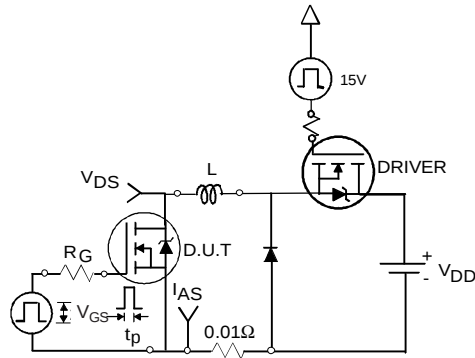


Fig 12a. Unclamped Inductive Test Circuit

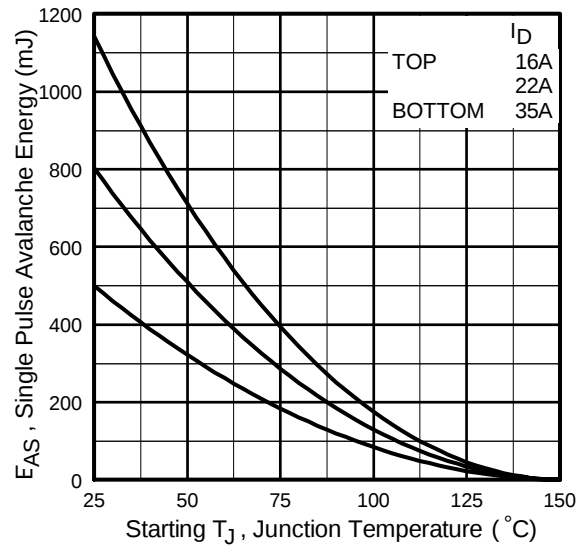


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

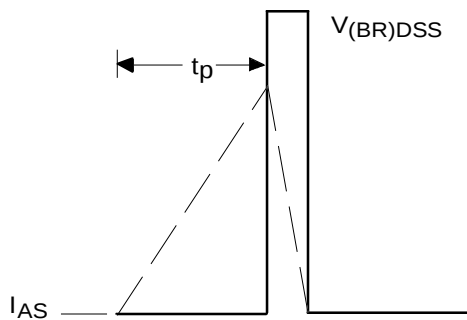


Fig 12b. Unclamped Inductive Waveforms

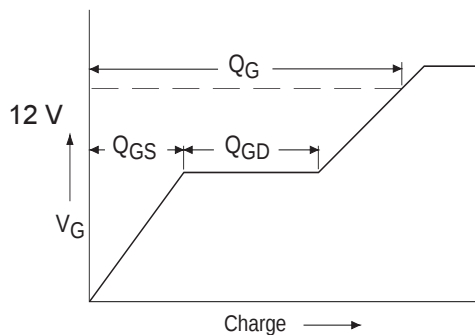


Fig 13a. Basic Gate Charge Waveform

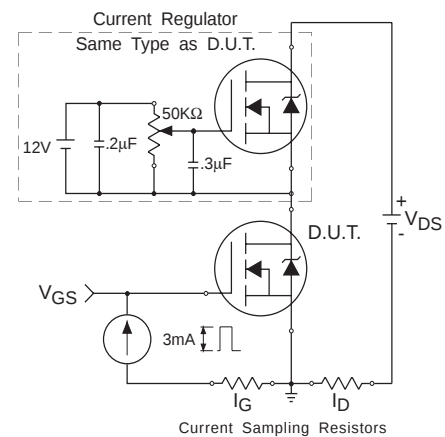
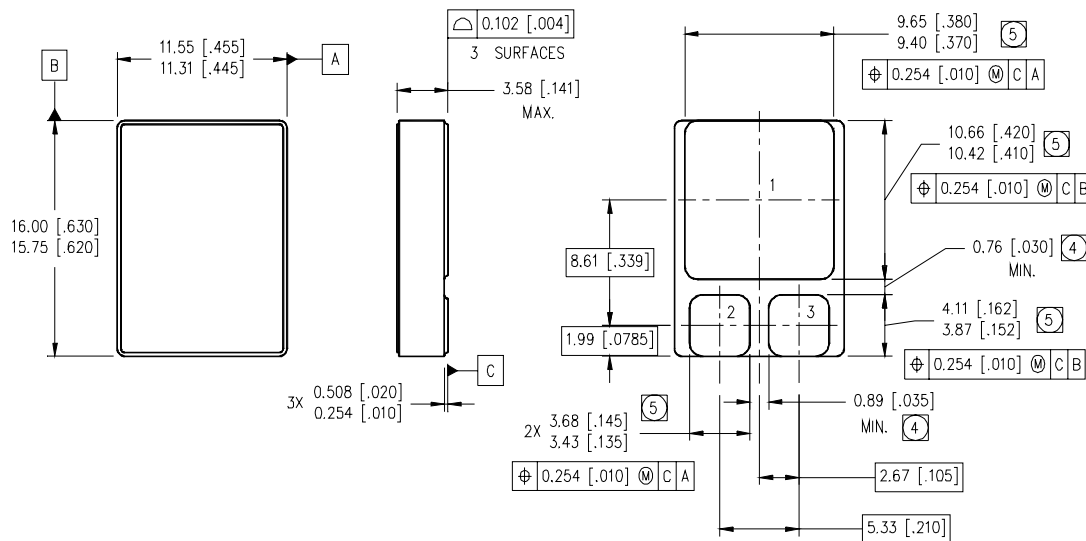


Fig 13b. Gate Charge Test Circuit

Foot Notes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② $V_{DD} = 25V$, starting $T_J = 25^\circ C$, $L = 0.82mH$
Peak $I_L = 35A$, $V_{GS} = 12V$
- ③ $I_{SD} \leq 35A$, $di/dt \leq 150A/\mu s$,
 $V_{DD} \leq 60V$, $T_J \leq 150^\circ C$
- 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.**
48 volt V_{DS} applied and $V_{GS} = 0$ during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions — SMD-1**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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Data and specifications subject to change without notice. 05/2006