

International **IR** Rectifier

PD-94493C

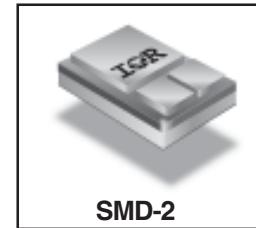
RADIATION HARDENED POWER MOSFET SURFACE MOUNT (SMD-2)

IRHNA597160
JANSR2N7550U2
100V, P-CHANNEL
REF: MIL-PRF-19500/713

 **TECHNOLOGY**

Product Summary

Part Number	Radiation Level	R _{d(on)}	I _D	QPL Part Number
IRHNA597160	100K Rads (Si)	0.049Ω	-47A	JANSR2N7550U2
IRHNA593160	300K Rads (Si)	0.049Ω	-47A	JANSF2N7550U2



International Rectifier's R5™ technology provides high performance power MOSFETs for space applications. These devices have been characterized for Single Event Effects (SEE) with useful performance up to an LET of 80 (MeV/(mg/cm²)). The combination of low R_{d(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
- Ultra Low R_{d(on)}
- Low Total Gate Charge
- Simple Drive Requirements
- Ease of Parallelizing
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight

Absolute Maximum Ratings

Pre-Irradiation

	Parameter	Units
I _D @ V _{GS} = -12V, T _C = 25°C	Continuous Drain Current	-47
I _D @ V _{GS} = -12V, T _C = 100°C	Continuous Drain Current	-30
I _{DM}	Pulsed Drain Current ①	-188
P _D @ T _C = 25°C	Max. Power Dissipation	250
	Linear Derating Factor	2.0
V _{GS}	Gate-to-Source Voltage	±20
E _{AS}	Single Pulse Avalanche Energy ②	400
I _{AR}	Avalanche Current ①	-47
E _{AR}	Repetitive Avalanche Energy ①	25
dv/dt	Peak Diode Recovery dv/dt ③	-10
T _J	Operating Junction	-55 to 150
T _{STG}	Storage Temperature Range	°C
	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 @ $T_j = 25^\circ\text{C}$ (Unless Otherwise Specified)

	Parameter	Min	Typ	Max	Units	Test Conditions
BVDSS	Drain-to-Source Breakdown Voltage	-100	—	—	V	$V_{GS} = 0V, I_D = -1.0\text{mA}$
$\Delta BVDSS/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	-0.1	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = -1.0\text{mA}$
RDS(on)	Static Drain-to-Source On-State Resistance	—	—	0.049	Ω	$V_{GS} = -12V, I_D = -30\text{A}$ ④
VGS(th)	Gate Threshold Voltage	-2.0	—	-4.0	V	$V_{DS} = V_{GS}, I_D = -1.0\text{mA}$
gfs	Forward Transconductance	24	—	—	S	$V_{DS} > -15V, I_{DS} = -30\text{A}$ ④
IDSS	Zero Gate Voltage Drain Current	—	—	-10	μA	$V_{DS} = -80V, V_{GS}=0V$
		—	—	-25		$V_{DS} = -80V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
IGSS	Gate-to-Source Leakage Forward	—	—	-100	nA	$V_{GS} = -20V$
IGSS	Gate-to-Source Leakage Reverse	—	—	100		$V_{GS} = 20V$
Qg	Total Gate Charge	—	—	170	nC	$V_{GS} = -12V, I_D = -47\text{A}$
Qgs	Gate-to-Source Charge	—	—	65		$V_{DS} = -50V$
Qgd	Gate-to-Drain ('Miller') Charge	—	—	30	ns	$V_{DD} = -50V, I_D = -47\text{A}, V_{GS} = -12V, R_G = 2.35\Omega$
t _{d(on)}	Turn-On Delay Time	—	—	30		
t _r	Rise Time	—	—	100		
t _{d(off)}	Turn-Off Delay Time	—	—	100		
t _f	Fall Time	—	—	100	pF	$V_{GS} = 0V, V_{DS} = -25V, f = 1.0\text{MHz}$
L _{S + LD}	Total Inductance	—	4.0	—	nH	
Ciss	Input Capacitance	—	6240	—		
Coss	Output Capacitance	—	1570	—		
Crss	Reverse Transfer Capacitance	—	115	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	-47	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	-188		
V _{SD}	Diode Forward Voltage	—	—	-5.0	V	$T_j = 25^\circ\text{C}, I_S = -47\text{A}, V_{GS} = 0V$ ④
t _{rr}	Reverse Recovery Time	—	—	230	ns	$T_j = 25^\circ\text{C}, I_F = -47\text{A}, dI/dt \leq -100\text{A}/\mu\text{s}$
QRR	Reverse Recovery Charge	—	—	1.6	μC	$V_{DD} \leq -50V$ ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _{S + LD} .				

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R _{thJC}	Junction-to-Case	—	—	0.50	$^\circ\text{C/W}$	
R _{thJ-PCB}	Junction-to-PC board	—	1.6	—		soldered to a 2" square copper-clad board

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

For footnotes refer to the last page

Radiation Characteristics

IRHNA597160, JANSR2N7550U2

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 @ $T_j = 25^\circ\text{C}$, Post Total Dose Irradiation ^{⑤⑥}

	Parameter	100K Rads(Si) ¹		300KRads(Si) ²		Units	Test Conditions
		Min	Max	Min	Max		
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	—	-100	—	V	$\text{V}_{\text{GS}} = 0\text{V}, \text{I}_D = -1.0\text{mA}$
$\text{V}_{\text{GS(th)}}$	Gate Threshold Voltage	-2.0	-4.0	-2.0	-5.0		$\text{V}_{\text{GS}} = \text{V}_{\text{DS}}, \text{I}_D = -1.0\text{mA}$
I_{GSS}	Gate-to-Source Leakage Forward	—	-100	—	-100	nA	$\text{V}_{\text{GS}} = -20\text{V}$
I_{GSS}	Gate-to-Source Leakage Reverse	—	100	—	100		$\text{V}_{\text{GS}} = 20\text{ V}$
I_{DSS}	Zero Gate Voltage Drain Current	—	-10	—	-10	μA	$\text{V}_{\text{DS}} = -80\text{V}, \text{V}_{\text{GS}} = 0\text{V}$
$\text{R}_{\text{DS(on)}}$	Static Drain-to-Source ^④ On-State Resistance (TO-3)	—	0.05	—	0.05	Ω	$\text{V}_{\text{GS}} = -12\text{V}, \text{I}_D = -30\text{A}$
V_{SD}	Diode Forward Voltage ^④	—	-5.0	—	-5.0	V	$\text{V}_{\text{GS}} = 0\text{V}, \text{I}_S = -47\text{A}$

1. Part number IRHNA597160 (JANSR2N7550U2)

2. Part number IRHNA593160 (JANSF2N7550U2)

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)	$\text{V}_{\text{DS}} (\text{V})$					
				@ $\text{V}_{\text{GS}}=0\text{V}$	@ $\text{V}_{\text{GS}}=5\text{V}$	@ $\text{V}_{\text{GS}}=10\text{V}$	@ $\text{V}_{\text{GS}}=15\text{V}$	@ $\text{V}_{\text{GS}}=17.5\text{V}$	@ $\text{V}_{\text{GS}}=20\text{V}$
Br	37.9	252.6	33.1	-100	-100	-100	-100	-100	-100
I	59.7	314	30.5	-100	-100	-100	-100	-100	-75
Au	82.3	350	28.4	-100	-100	-100	-100	-30	—

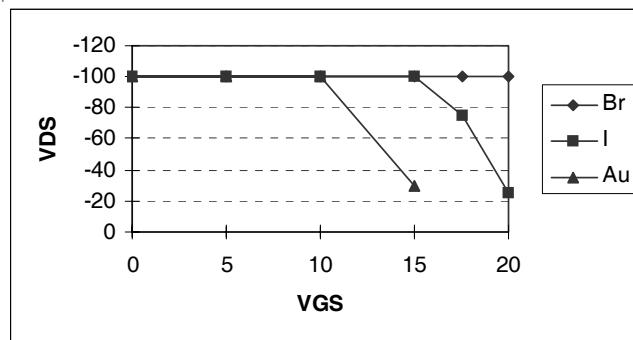


Fig a. Single Event Effect, Safe Operating Area

For footnotes refer to the last page

IRHNA597160, JANSR2N7550U2

Pre-Irradiation

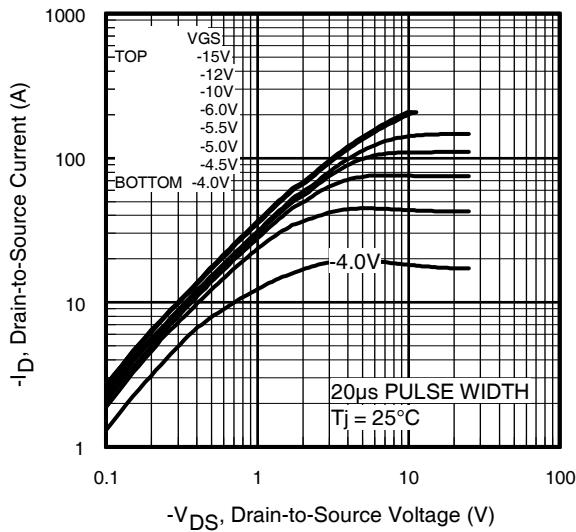


Fig 1. Typical Output Characteristics

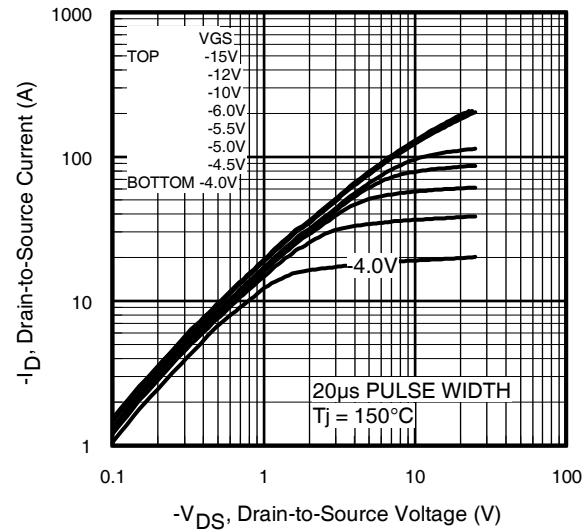


Fig 2. Typical Output Characteristics

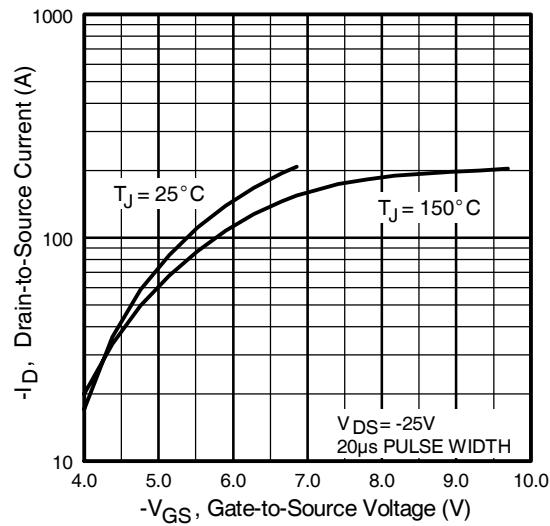


Fig 3. Typical Transfer Characteristics

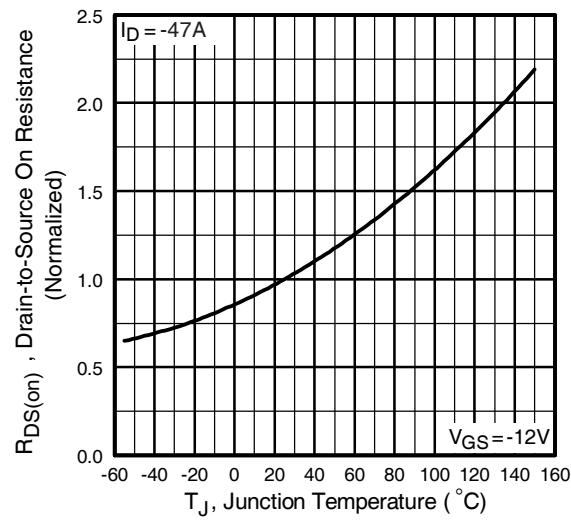


Fig 4. Normalized On-Resistance
Vs. Temperature

Pre-Irradiation

IRHNA597160, JANSR2N7550U2

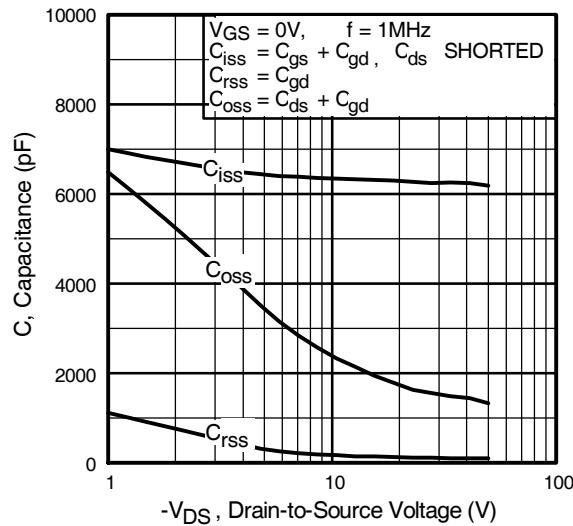


Fig 5. Typical Capacitance Vs.
Drain-to-Source Voltage

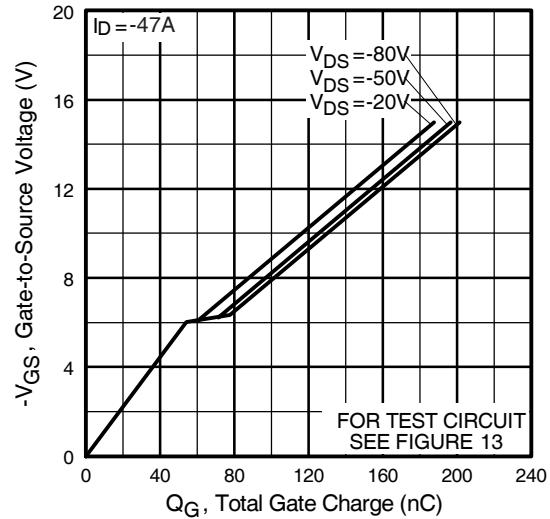


Fig 6. Typical Gate Charge Vs.
Gate-to-Source Voltage

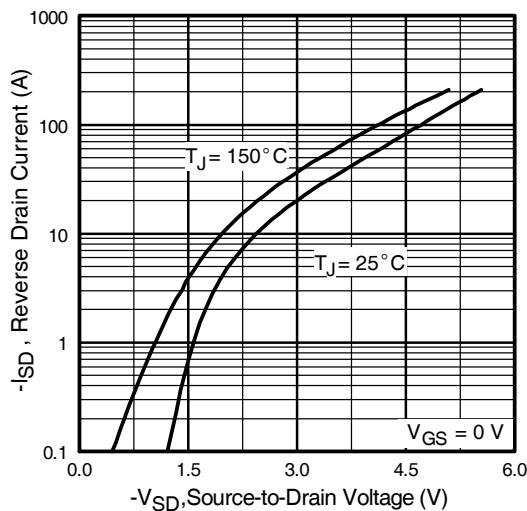


Fig 7. Typical Source-Drain Diode
Forward Voltage

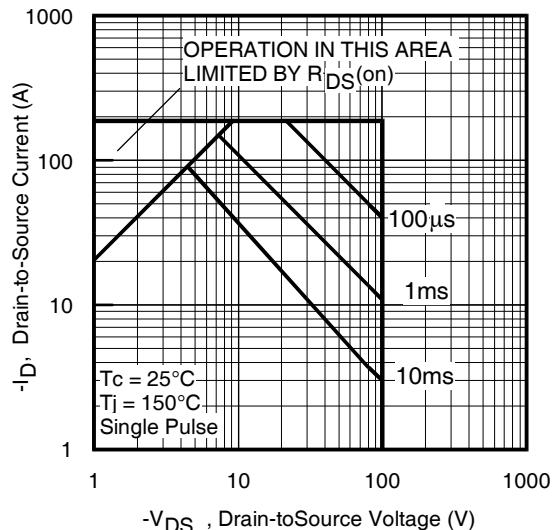


Fig 8. Maximum Safe Operating Area

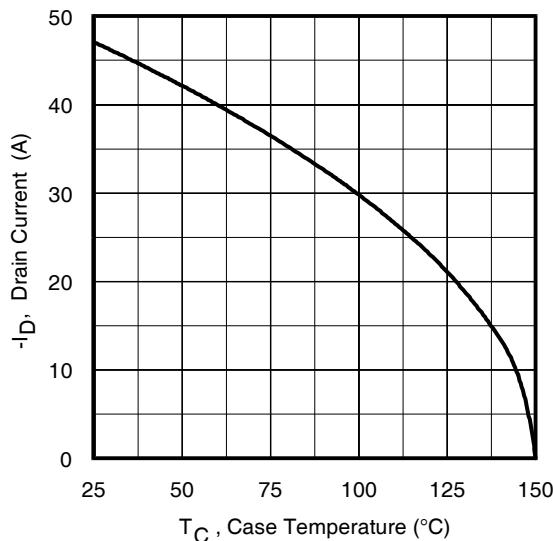


Fig 9. Maximum Drain Current Vs.
Case Temperature

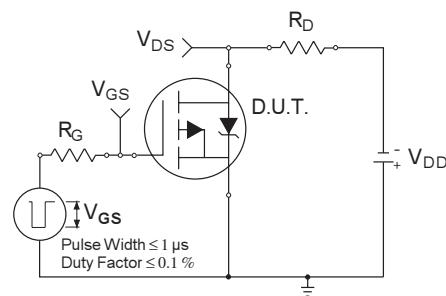


Fig 10a. Switching Time Test Circuit

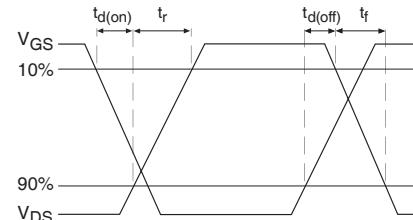


Fig 10b. Switching Time Waveforms

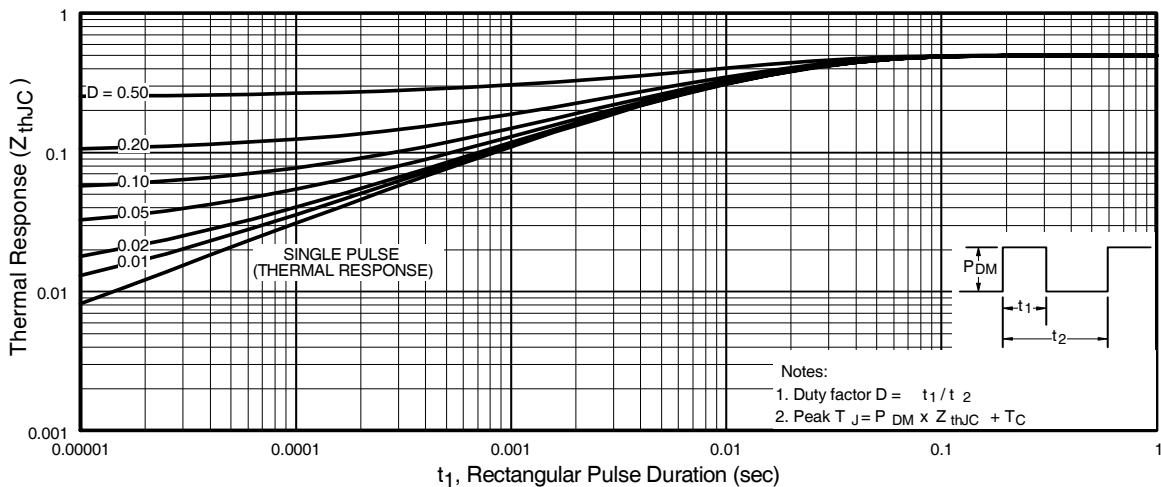


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Pre-Irradiation

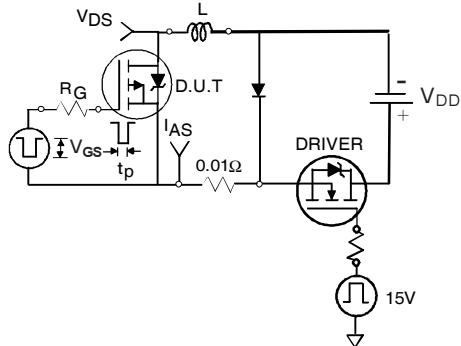


Fig 12a. Unclamped Inductive Test Circuit

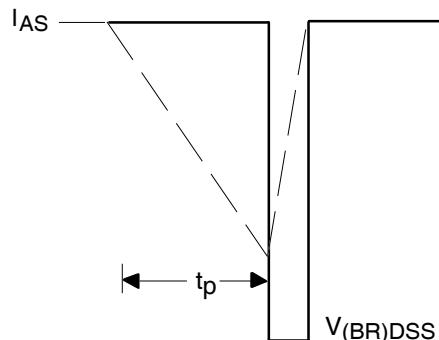


Fig 12b. Unclamped Inductive Waveforms

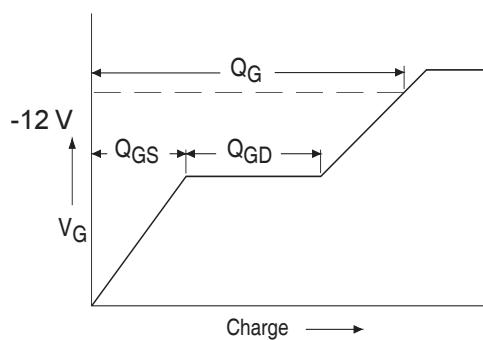


Fig 13a. Basic Gate Charge Waveform

IRHNA597160, JANSR2N7550U2

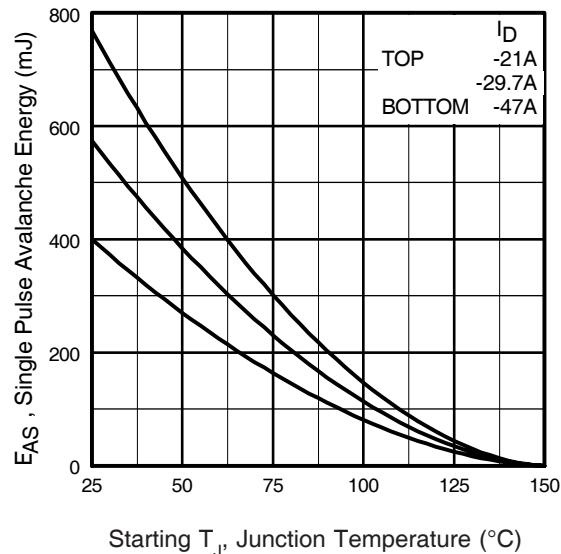


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

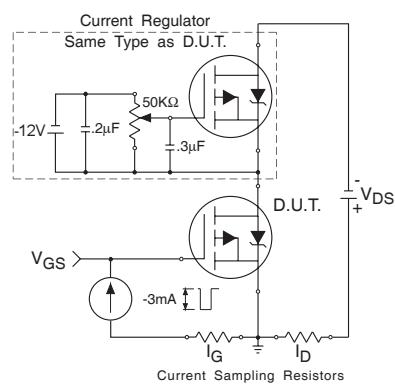
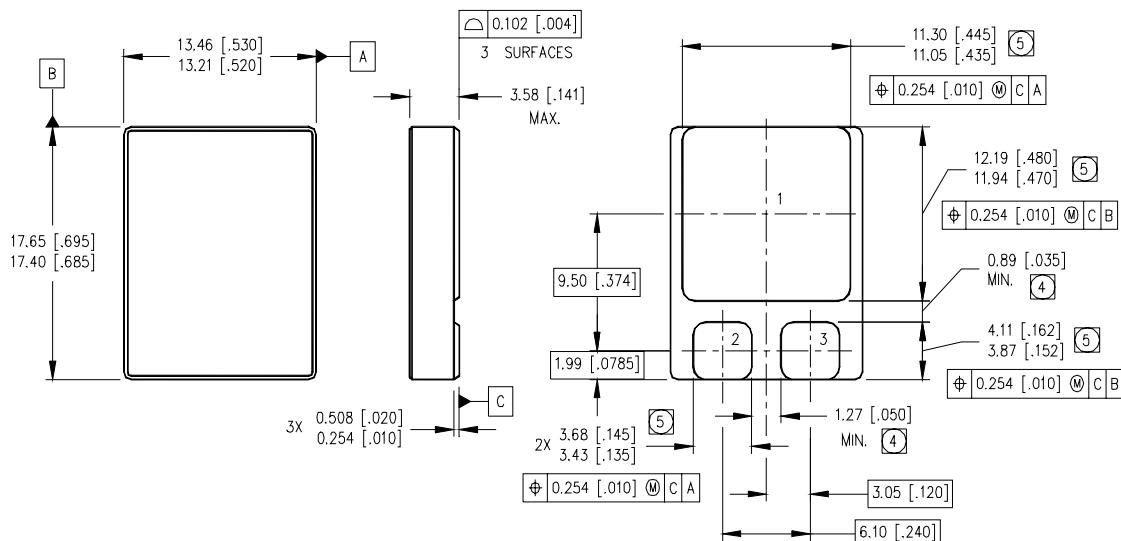


Fig 13b. Gate Charge Test Circuit

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② V_{DD} = -50V, starting T_J = 25°C, L=0.36mH
Peak I_L = -47A, V_{GS} = -12V
- ③ I_{SD} ≤ -47A, dI/dt ≤ -450A/μs,
V_{DD} ≤ -100V, T_J ≤ 150°C
- ④ Pulse width ≤ 300μs; Duty Cycle ≤ 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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