

International IOR Rectifier

PD-94604B

RADIATION HARDENED POWER MOSFET SURFACE MOUNT (SMD-2)

IRHNA597064
60V, P-CHANNEL
R₅ TECHNOLOGY

Product Summary

Part Number	Radiation Level	R _{DS(on)}	I _D
IRHNA597064	100K Rads (Si)	0.016Ω	-56A*
IRHNA593064	300K Rads (Si)	0.016Ω	-56A*



SMD-2

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_{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
- Ultra Low R_{DS(on)}
- Low Total Gate Charge
- Proton Tolerant
- Simple Drive Requirements
- Ease of Paralleling
- 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	-56*	A
I _D @ V _{GS} = -12V, T _C = 100°C	Continuous Drain Current	-56	
I _{DM}	Pulsed Drain Current ①	-224	
P _D @ T _C = 25°C	Max. Power Dissipation	250	W
	Linear Derating Factor	2.0	W/°C
V _{GS}	Gate-to-Source Voltage	±20	V
E _{AS}	Single Pulse Avalanche Energy ②	725	mJ
I _{AR}	Avalanche Current ①	-56	A
E _{AR}	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	2.1	V/ns
T _J	Operating Junction	-55 to 150	°C
T _{STG}	Storage Temperature Range		
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	3.3 (Typical)	g

* Current is limited by package

For footnotes refer to the last page

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Pre-Irradiation

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

	Parameter	Min	Typ	Max	Units	Test Conditions
B _V DSS	Drain-to-Source Breakdown Voltage	-60	—	—	V	V _{GS} = 0V, I _D = -1.0mA
ΔB _V DSS/ΔT _J	Temperature Coefficient of Breakdown Voltage	—	-0.064	—	V/°C	Reference to 25°C, I _D = -1.0mA
R _{DS(on)}	Static Drain-to-Source On-State Resistance	—	—	0.016	Ω	V _{GS} = -12V, I _D = -56A ④
V _{GS(th)}	Gate Threshold Voltage	-2.0	—	-4.0	V	V _{DS} = V _{GS} , I _D = -1.0mA
g _{fs}	Forward Transconductance	40	—	—	S (Ω)	V _{DS} = -25V, I _{DS} = -56A ④
I _{DSS}	Zero Gate Voltage Drain Current	—	—	-10	μA	V _{DS} = -48V, V _{GS} = 0V
		—	—	-25		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 = -56A
Q _{gs}	Gate-to-Source Charge	—	—	65		V _{DS} = -30V
Q _{gd}	Gate-to-Drain ('Miller') Charge	—	—	60		
t _{d(on)}	Turn-On Delay Time	—	—	30	ns	V _{DD} = -30V, I _D = -56A, V _{GS} = -12V, R _G = 2.35Ω
t _r	Rise Time	—	—	100		
t _{d(off)}	Turn-Off Delay Time	—	—	100		
t _f	Fall Time	—	—	100		
L _S + L _D	Total Inductance	—	6.0	—	nH	Measured from the center of drain pad to center of source pad
C _{iss}	Input Capacitance	—	7022	—	pF	V _{GS} = 0V, V _{DS} = -25V
C _{oss}	Output Capacitance	—	2897	—		f = 1.0MHz
C _{rss}	Reverse Transfer Capacitance	—	267	—		

Source-Drain Diode Ratings and Characteristics

	Parameter	Min	Typ	Max	Units	Test Conditions
I _S	Continuous Source Current (Body Diode)	—	—	-56*	A	
I _{SM}	Pulse Source Current (Body Diode) ①	—	—	-224		
V _{SD}	Diode Forward Voltage	—	—	-5.0	V	T _j = 25°C, I _S = -56A, V _{GS} = 0V ④
t _{rr}	Reverse Recovery Time	—	—	200	ns	T _j = 25°C, I _F = -56A, di/dt ≤ -100A/μs
Q _{RR}	Reverse Recovery Charge	—	—	500	nC	V _{DD} ≤ -25V ④
t _{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by L _S + L _D .				

* Current is limited by package

Thermal Resistance

	Parameter	Min	Typ	Max	Units	Test Conditions
R _{thJC}	Junction-to-Case	—	—	0.5	°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 International Rectifier Website.

For footnotes refer to the last page

Radiation Characteristics

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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) ¹		300K 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	-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} = 20 V
I _{DSS}	Zero Gate Voltage Drain Current	—	-10	—	-10	μA	V _{DS} = -48V, V _{GS} = 0V
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.016	—	0.016	Ω	V _{GS} = -12V, I _D = -56A
R _{DS(on)}	Static Drain-to-Source ④ On-State Resistance (SMD-2)	—	0.016	—	0.016	Ω	V _{GS} = -12V, I _D = -56A
V _{SD}	Diode Forward Voltage ④	—	-5.0	—	-5.0	V	V _{GS} = 0V, I _S = -56A

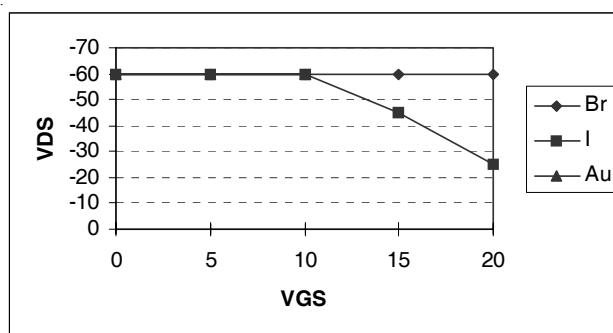
1. Part number IRHNA597064

2. Part number IRHNA593064

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	37.3	285	36.8	- 60	- 60	- 60	- 60	- 60
I	59.9	345	32.7	- 60	- 60	- 60	- 45	- 25
Au	82.3	357	28.5	- 60	- 60	- 60	—	—


Fig a. Single Event Effect, Safe Operating Area

For footnotes refer to the last page

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Pre-Irradiation

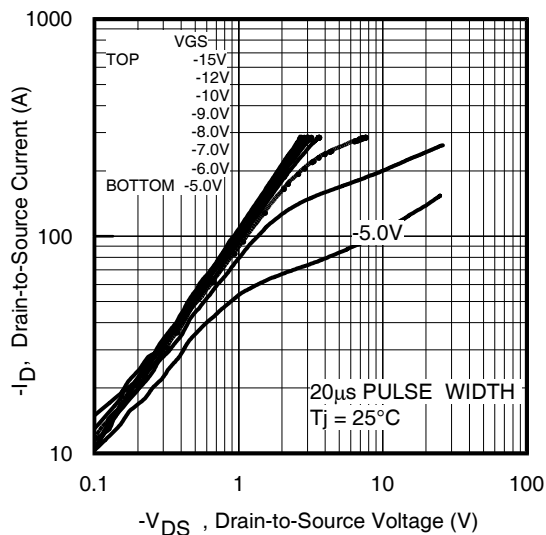


Fig 1. Typical Output Characteristics

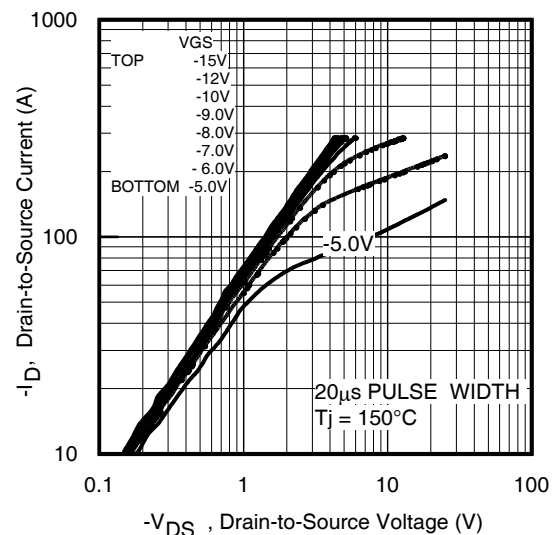


Fig 2. Typical Output Characteristics

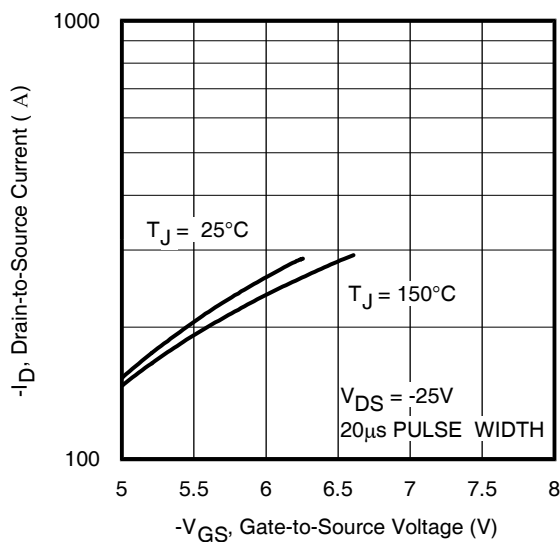


Fig 3. Typical Transfer Characteristics

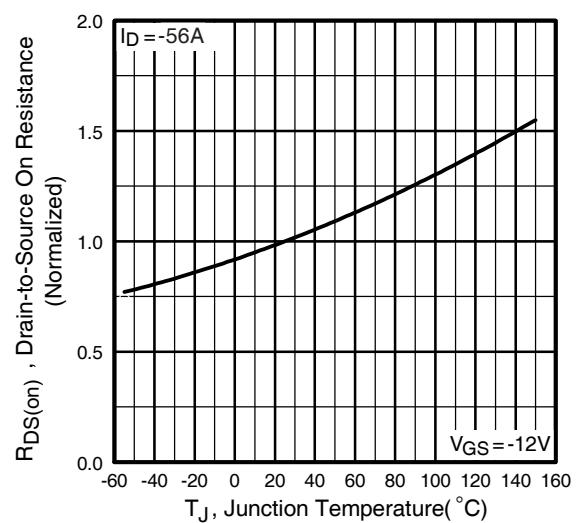


Fig 4. Normalized On-Resistance Vs. Temperature

Pre-Irradiation

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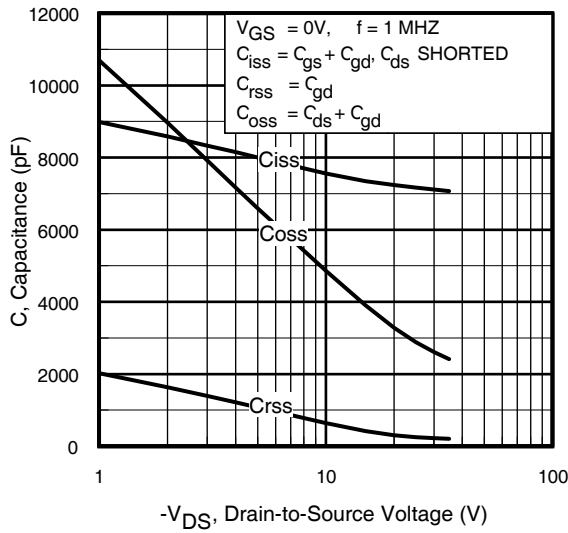


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

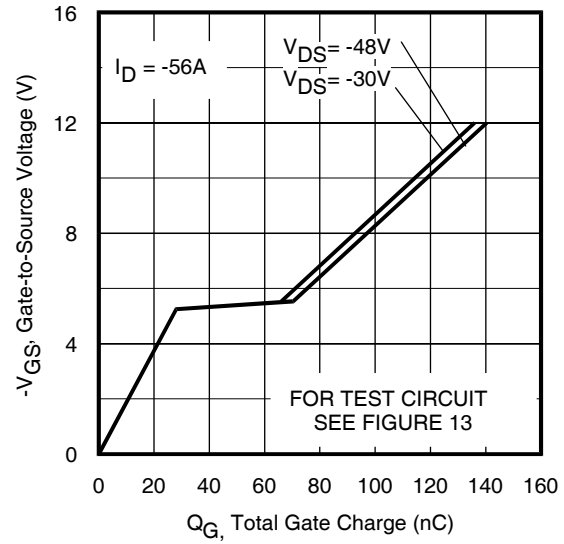


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

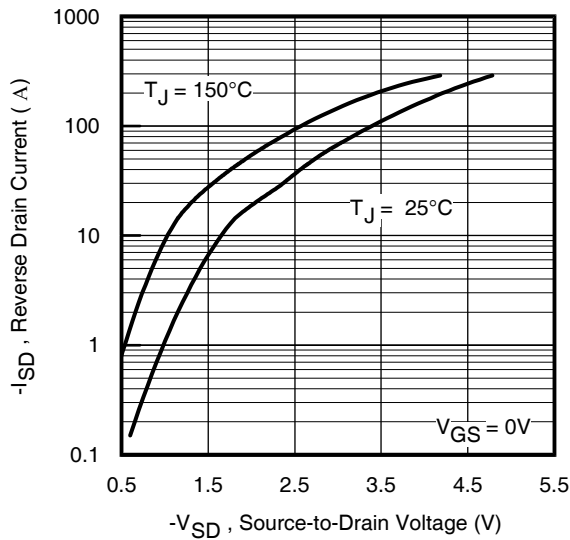


Fig 7. Typical Source-Drain Diode Forward Voltage

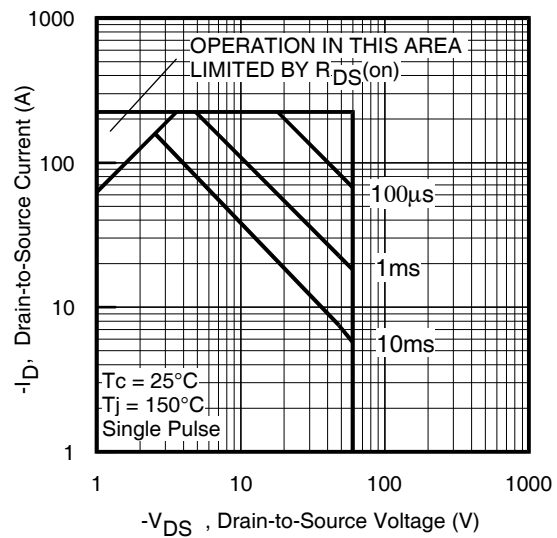


Fig 8. Maximum Safe Operating Area

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Pre-Irradiation

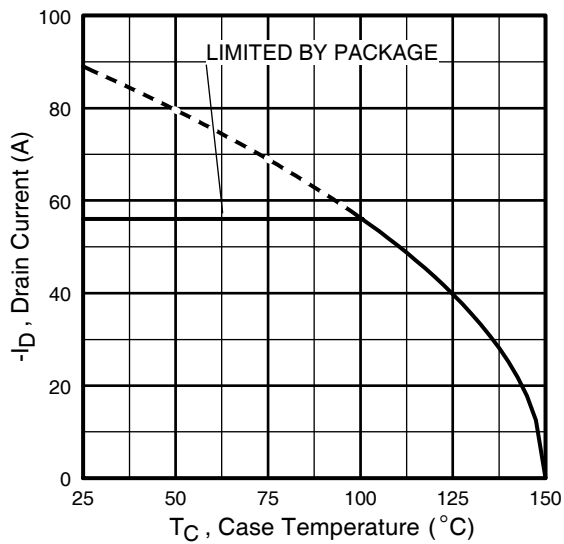


Fig 9. Maximum Drain Current Vs. Case Temperature

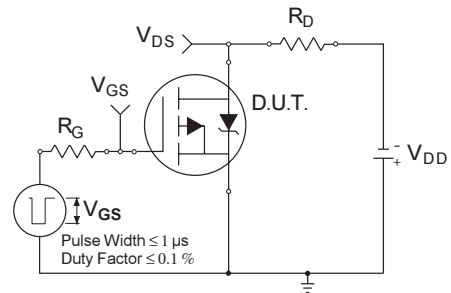


Fig 10a. Switching Time Test Circuit

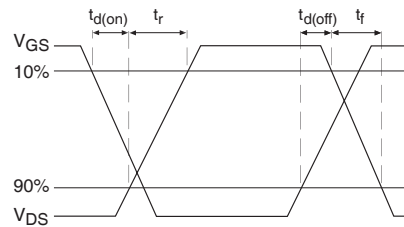


Fig 10b. Switching Time Waveforms

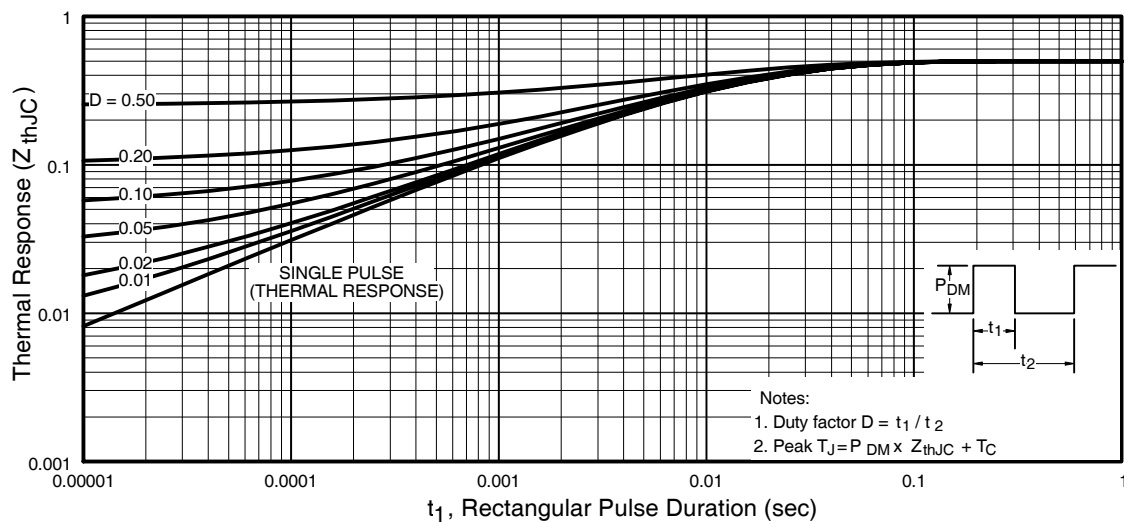


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

Pre-Irradiation

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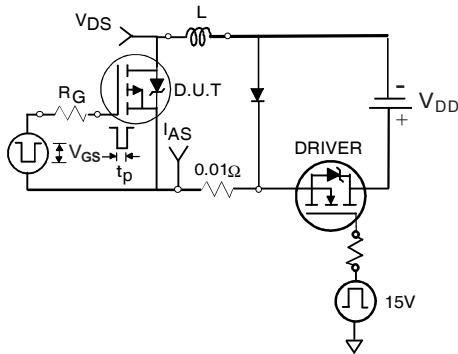


Fig 12a. Unclamped Inductive Test Circuit

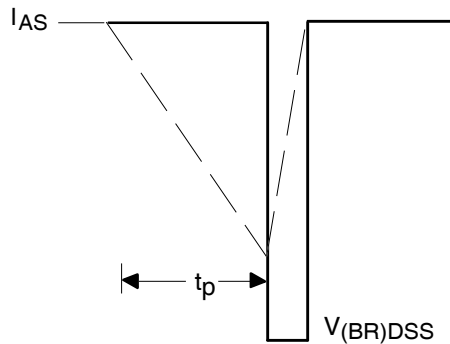


Fig 12b. Unclamped Inductive Waveforms

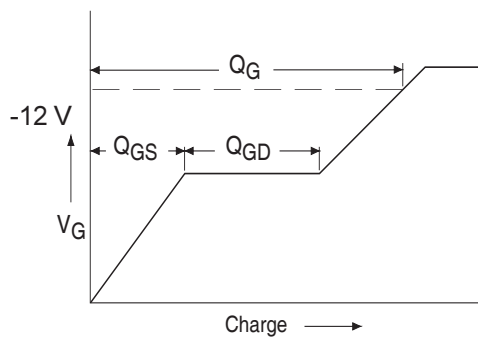


Fig 13a. Basic Gate Charge Waveform

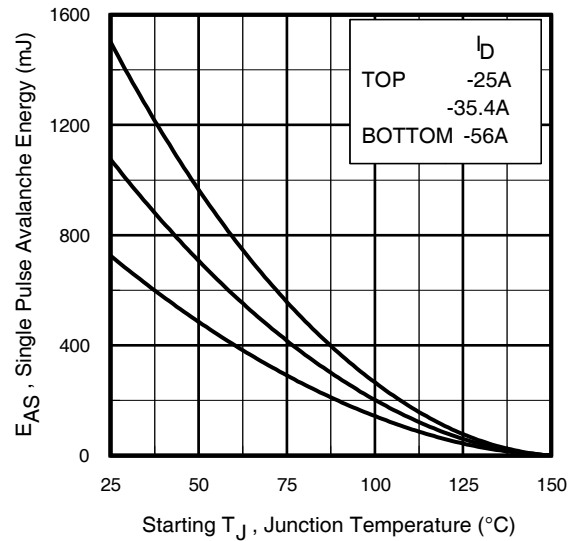


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

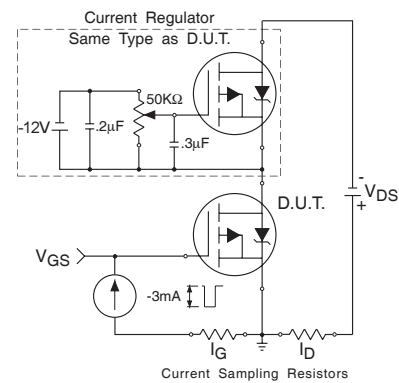


Fig 13b. Gate Charge Test Circuit

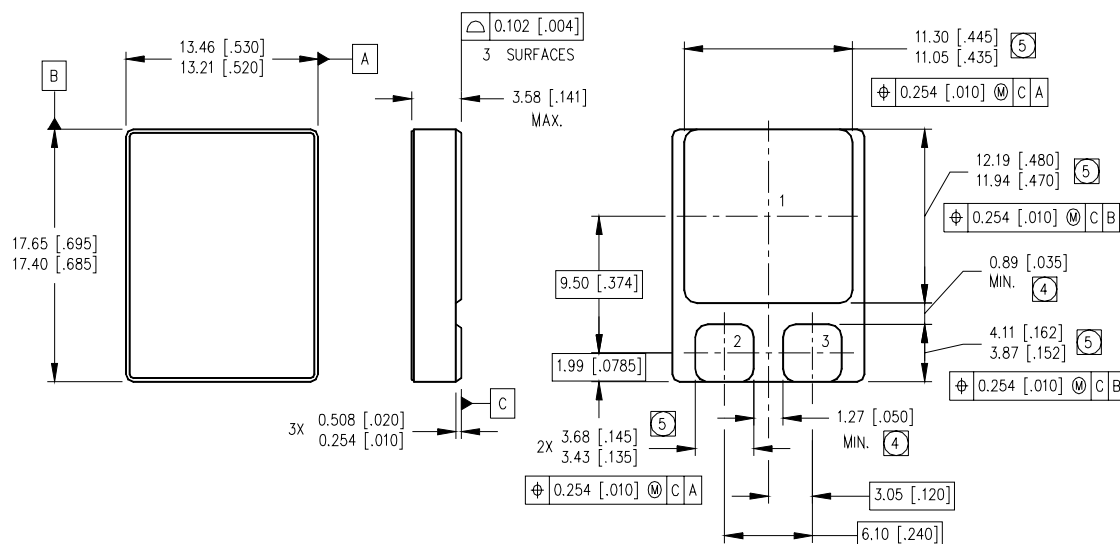
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Pre-Irradiation

Footnotes:

- ① Repetitive Rating; Pulse width limited by maximum junction temperature.
- ② $V_{DD} = -25V$, starting $T_J = 25^\circ C$, $L = 0.46mH$
Peak $I_L = -56A$, $V_{GS} = -12V$
- ③ $I_{SD} \leq -56A$, $di/dt \leq -360A/\mu s$,
 $V_{DD} \leq -60V$, $T_J \leq 150^\circ C$
- 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-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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Data and specifications subject to change without notice. 11/2004