International
IOR Rectifier

PD-96959B

2N7581U2
IRHNA67164
150V, N-CHANNEL
R6 TECHNOLOGY

RADIATION HARDENED POWER MOSFET SURFACE MOUNT (SMD-2)

Product Summary

Part Number	Radiation Level	$R_{DS(on)}$	I_D
IRHNA67164	100K Rads (Si)	0.018Ω	56A*
IRHNA63164	300K Rads (Si)	0.018Ω	56A*

SMD-2

International Rectifier's R6™ technology provides superior power MOSFETs for space applications. These devices have improved immunity to Single Event Effect (SEE) and have been characterized for useful performance with Linear Energy Transfer (LET) up to 90MeV/(mg/cm^2). Their combination of very low $R_{DS(on)}$ and faster switching times reduces power loss and increases power density in today's high speed switching applications such as DC-DC converters and motor controllers. These devices retain all of the well established advantages of MOSFETs such as voltage control, ease of paralleling and temperature stability of electrical parameters.

Features:

- Low $R_{DS(on)}$
- Fast Switching
- Single Event Effect (SEE) Hardened
- Low Total Gate Charge
- 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	49	
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	283	mJ
I_{AR}	Avalanche Current ①	56	A
E_{AR}	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	7.5	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	3.3 (Typical)	g

* Current is limited by package

For footnotes refer to the last page

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

	Parameter	Min	Typ	Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	150	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.17	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.018	Ω	V_{GS} = 12V, I_D = 49A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{DS} = V_{GS}$, I_D = 1.0mA
$\Delta V_{GS(th)}/\Delta T_J$	Gate Threshold Voltage Coefficient	—	-9.83	—	mV/°C	
g_{fs}	Forward Transconductance	50	—	—	S	V_{DS} = 15V, I_{DS} = 49A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	10	µA	V_{DS}= 120V ,V_{GS}=0V
		—	—	25		V_{DS} = 120V, 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	—	—	230	nC	V_{GS} = 12V, I_D = 56A V_{DS} = 75V
Q_{gs}	Gate-to-Source Charge	—	—	70		
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	90		
$t_{d(on)}$	Turn-On Delay Time	—	—	35	ns	V_{DD} = 75V, I_D = 56A, V_{GS} = 12V, R_G = 2.35Ω
t_r	Rise Time	—	—	170		
$t_{d(off)}$	Turn-Off Delay Time	—	—	85		
t_f	Fall Time	—	—	35		
$L_S + L_D$	Total Inductance	—	2.8	—	nH	Measured from the center of drain pad to center of source pad
Ciss	Input Capacitance	—	7390	—	pF	V_{GS} = 0V, V_{DS} = 25V f = 100KHz
C_{oss}	Output Capacitance	—	1144	—		
C_{rss}	Reverse Transfer Capacitance	—	28	—		
R_g	Gate Resistance	—	0.52	—	Ω	f = 1.0MHz, open drain

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	—	—	1.2	V	T_j = 25°C, I_S = 56A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	370	ns	T_j = 25°C, I_F = 56A, di/dt ≤ 100A/µs V_{DD} ≤ 25V ④
Q_{RR}	Reverse Recovery Charge	—	—	4.5	µC	
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	

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

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	Upto 300K Rads (Si)[1] Min	Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	150	—	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0		V_{GS} = V_{DS}, I_D = 1.0mA
I_{GSS}	Gate-to-Source Leakage Forward	—	100	nA	V_{GS} = 20V
I_{GSS}	Gate-to-Source Leakage Reverse	—	-100		V_{GS} = -20V
I_{DSS}	Zero Gate Voltage Drain Current	—	10	µA	V_{DS}= 120V, V_{GS}= 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.019	Ω	V_{GS} = 12V, I_D = 49A
$R_{DS(on)}$	Static Drain-to-Source On-state ④ Resistance (SMD-2)	—	0.018	Ω	V_{GS} = 12V, I_D = 49A
V_{SD}	Diode Forward Voltage④	—	1.2	V	V_{GS} = 0V, I_D = 56A

1. Part numbers IRHNA67164, IRHNA63164

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

LET (MeV/(mg/cm^2))	Energy (MeV)	Range (µm)	VDS (V) @VGS= 0V	@VGS= -5V	@VGS= -10V	@VGS= -15V	@VGS= -20V
39 ± 5%	410 ± 5%	50 ± 5%	150	150	150	150	150
61 ± 5%	825 ± 5%	66 ± 7.5%	150	150	150	40	-
90 ± 5%	1470 ± 5%	80 ± 5%	50	50	30	-	-

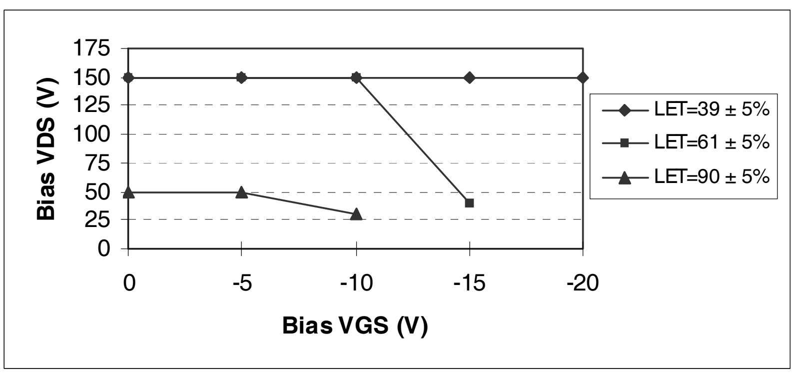


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

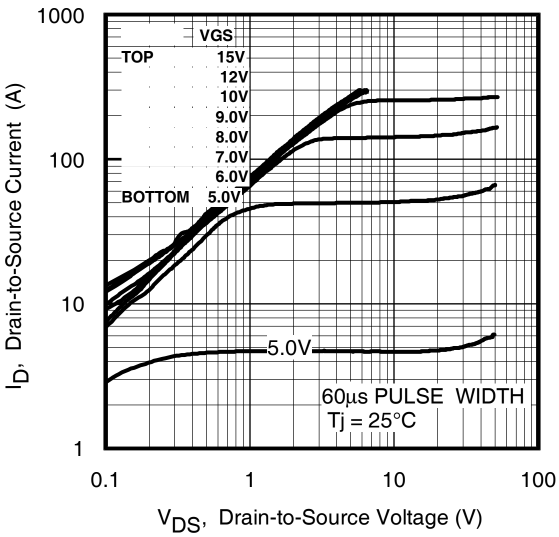


Fig 1. Typical Output Characteristics

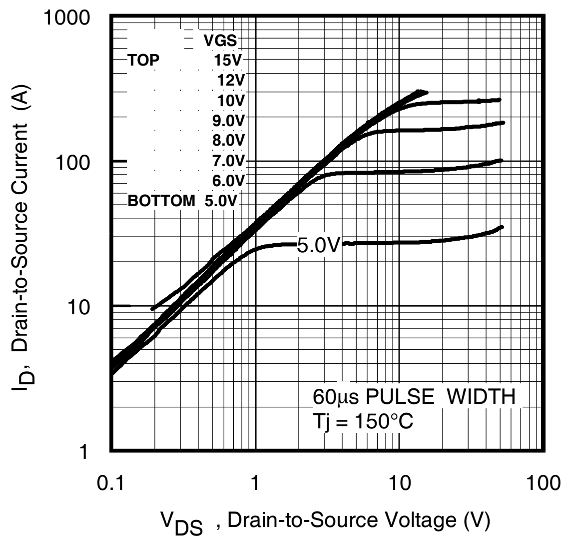


Fig 2. Typical Output Characteristics

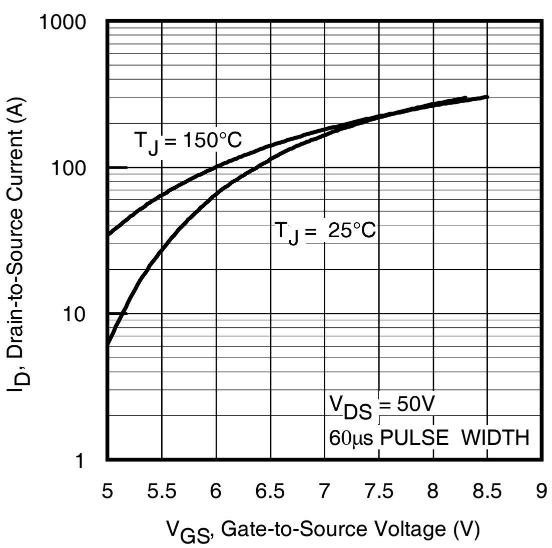


Fig 3. Typical Transfer Characteristics

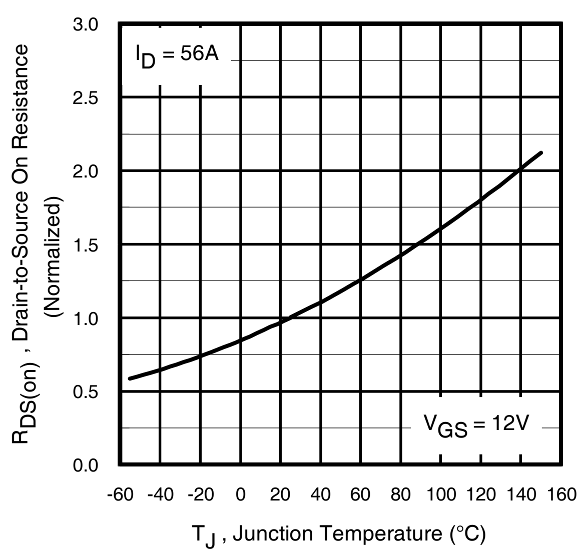


Fig 4. Normalized On-Resistance Vs. Temperature

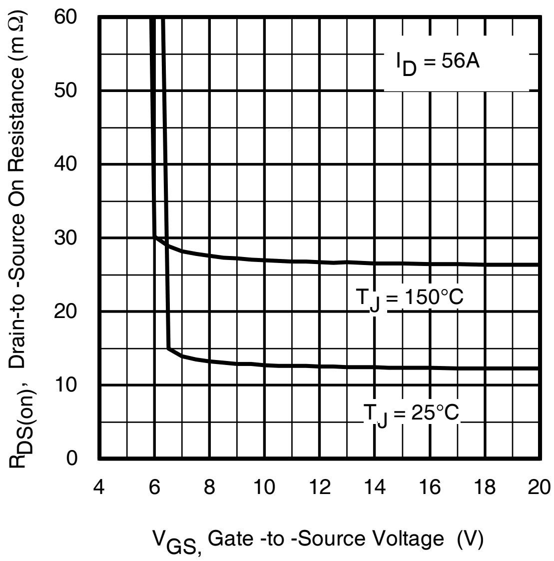


Fig 5. Typical On-Resistance Vs Gate Voltage

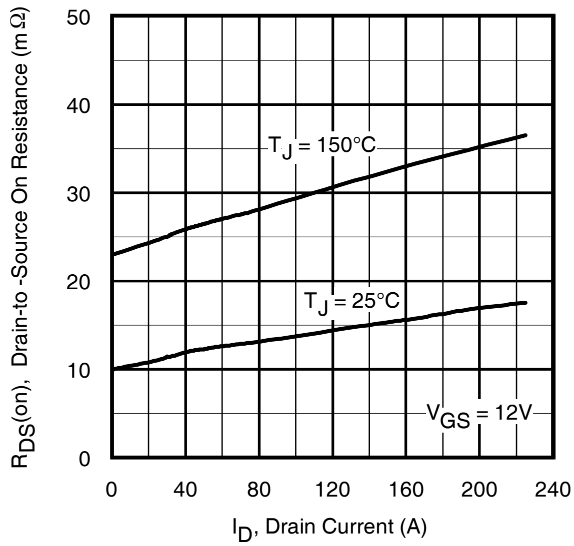


Fig 6. Typical On-Resistance Vs Drain Current

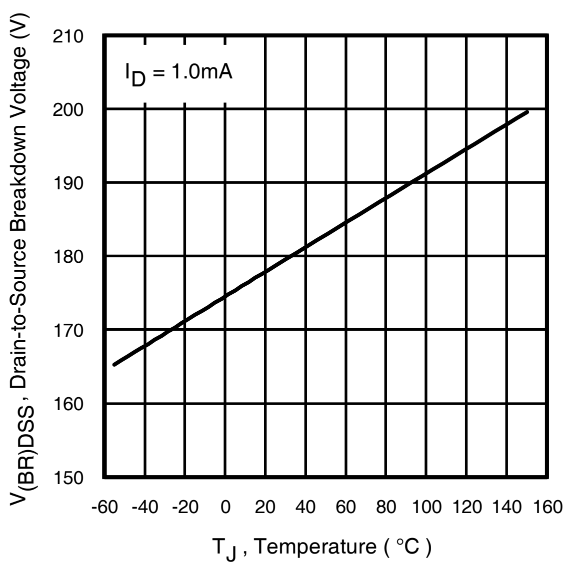


Fig 7. Typical Drain-to-Source Breakdown Voltage Vs Temperature

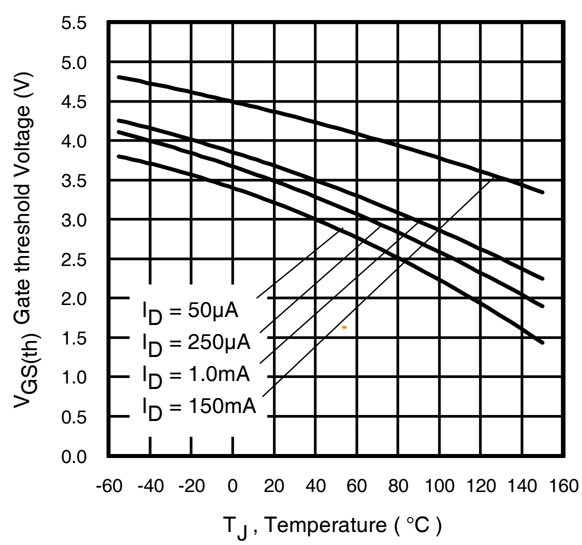


Fig 8. Typical Threshold Voltage Vs Temperature

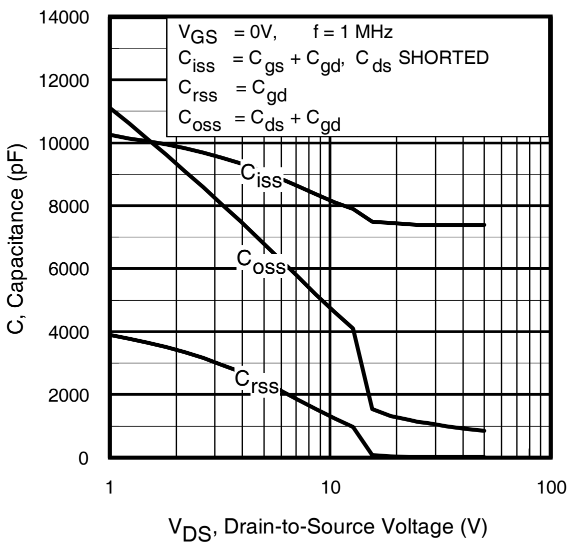


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

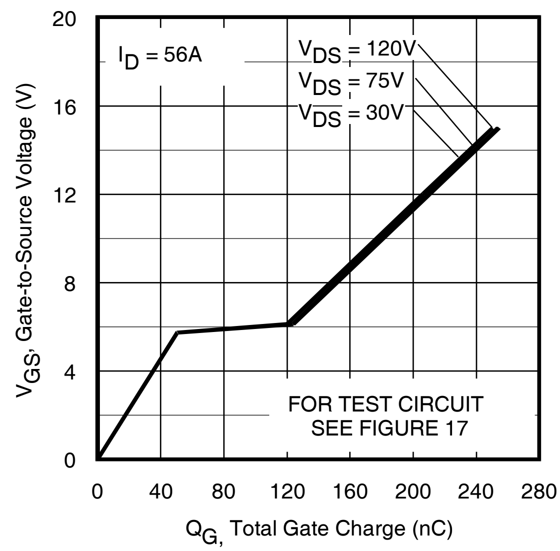


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

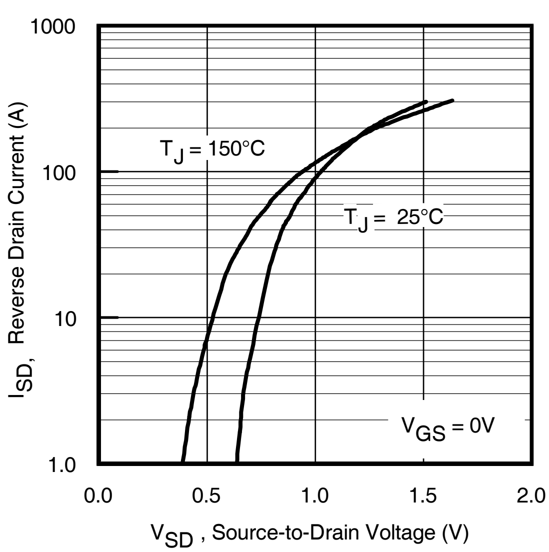


Fig 11. Typical Source-to-Drain Diode Forward Voltage

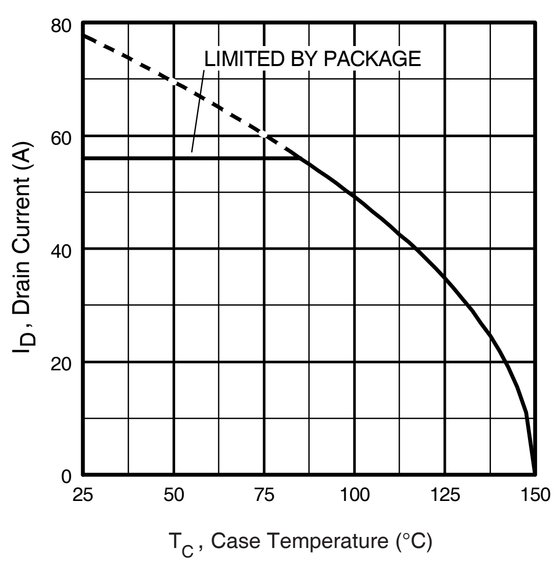


Fig 12. Maximum Drain Current Vs. Case Temperature

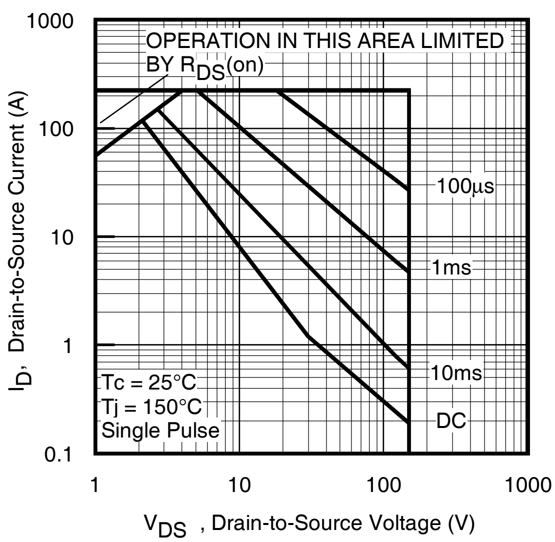


Fig 13. Maximum Safe Operating Area

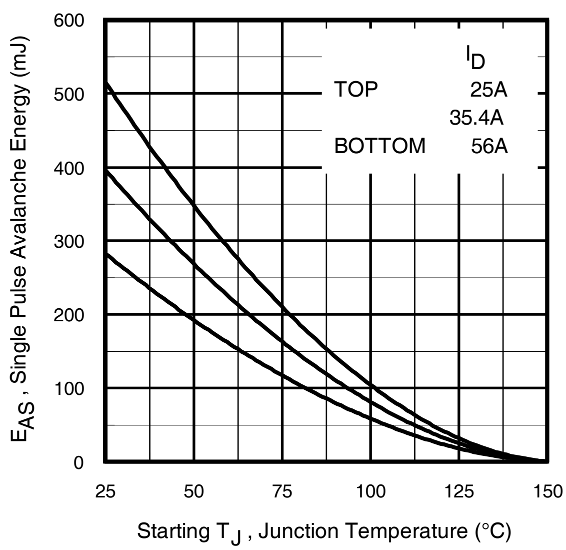


Fig 14. Maximum Avalanche Energy Vs. Drain Current

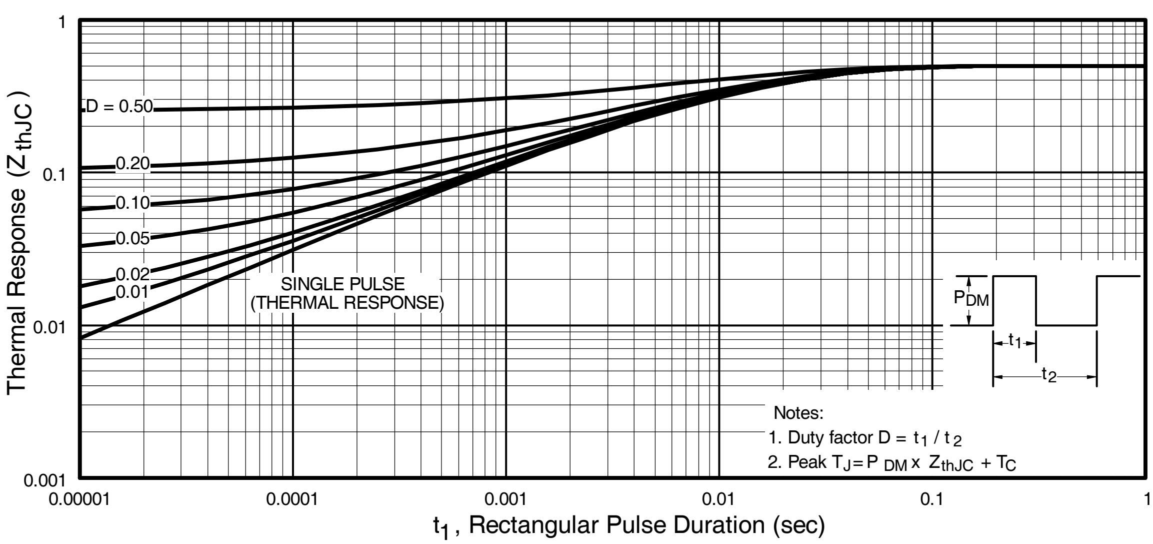


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

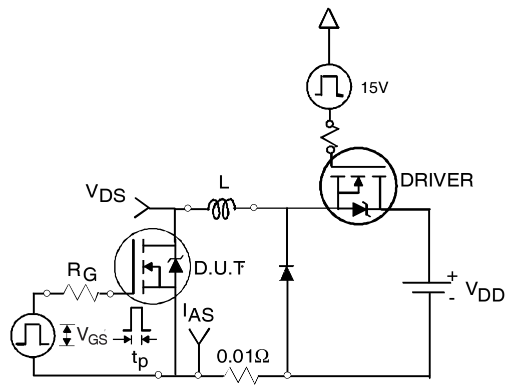


Fig 16a. Unclamped Inductive Test Circuit

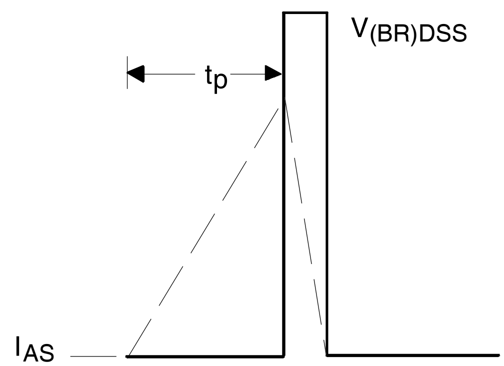


Fig 16b. Unclamped Inductive Waveforms

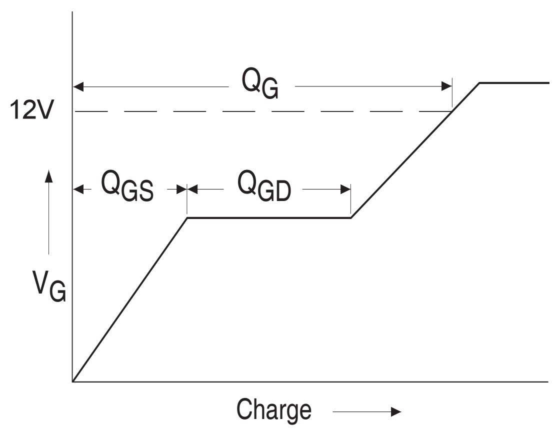


Fig 17a. Basic Gate Charge Waveform

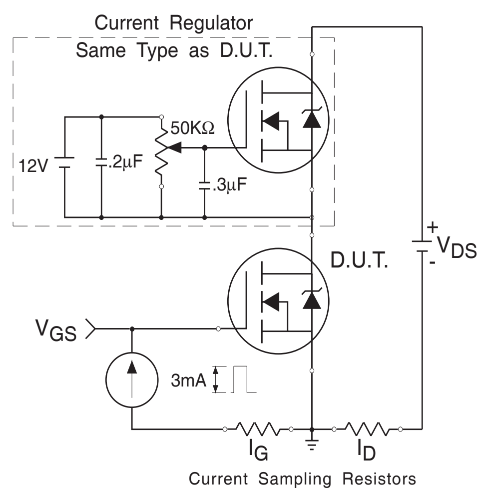


Fig 17b. Gate Charge Test Circuit

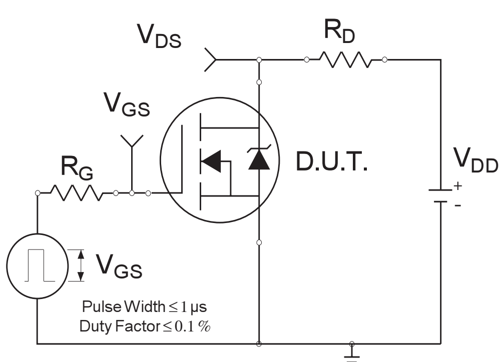


Fig 18a. Switching Time Test Circuit

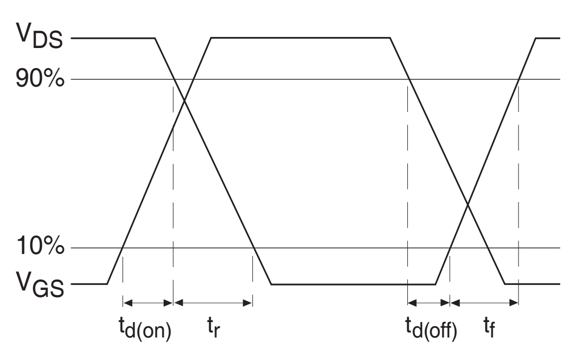


Fig 18b. Switching Time Waveforms

Footnotes:

① Repetitive Rating; Pulse width limited by maximum junction temperature.

② V_{DD} = 50V, starting T_J = 25°C, L= 0.18mH Peak I_L = 56A, V_{GS} = 12V

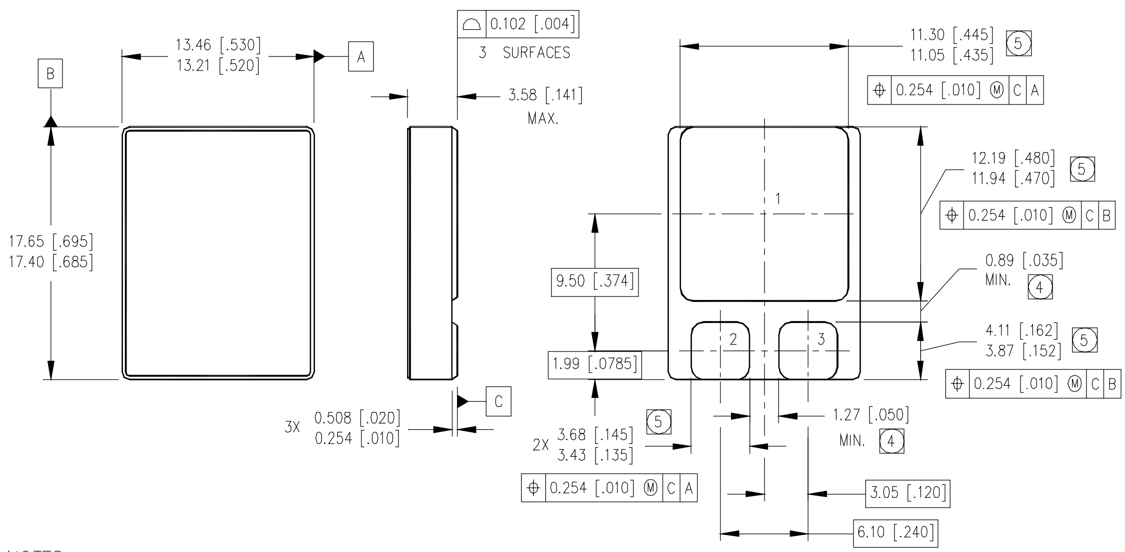
③ I_{SD} ≤ 56A, di/dt ≤ 860A/µs, V_{DD} ≤ 150V, T_J ≤ 150°C

④ Pulse width ≤ 300 µs; 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.** 120 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

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