PD-97192A

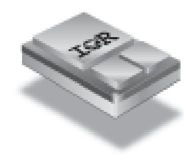
International Rectifier

RADIATION HARDENED POWER MOSFET SURFACE MOUNT (SMD-0.2)

IRHNM57110 100V, N-CHANNEL R5™ TECHNOLOGY

Product Summary

Part Number	Radiation Level	$R_{DS(on)}$	I_D
IRHNM57110	100K Rads (Si)	0.22Ω	6.9A
IRHNM53110	300K Rads (Si)	0.22Ω	6.9A
IRHNM54110	600K Rads (Si)	0.22Ω	6.9A
IRHNM58110	1000K Rads (Si)	0.22Ω	6.9A



SMD-0.2

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
- Low $R_{DS(on)}$
- 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	6.9	A
I_D @ V_{GS} = 12V, T_C = 100°C	Continuous Drain Current	4.4	
I_{DM}	Pulsed Drain Current ①	27.6	
P_D @ T_C = 25°C	Max. Power Dissipation	23	W
	Linear Derating Factor	0.18	W/°C
V_{GS}	Gate-to-Source Voltage	±20	V
E_{AS}	Single Pulse Avalanche Energy ②	24	mJ
I_{AR}	Avalanche Current ①	6.9	A
E_{AR}	Repetitive Avalanche Energy ①	2.3	mJ
dv/dt	Peak Diode Recovery dv/dt ③	11.5	V/ns
T_J T_{STG}	Operating Junction Storage Temperature Range	-55 to 150	°C
	Pckg. Mounting Surface Temp.	300 (for 5s)	
	Weight	0.25 (Typical)	g

For footnotes refer to the last page

12/19/07

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

	Parameter	Min	Typ	Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	—	—	V	V_{GS} = 0V, I_D = 1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Temperature Coefficient of Breakdown Voltage	—	0.13	—	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Resistance	—	—	0.22	Ω	V_{GS} = 12V, I_D = 4.4A 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	—	-7.5	—	mV/°C	
g_{fs}	Forward Transconductance	3.6	—	—	S	V_{DS} = 15V, I_{DS} = 4.4A ④
I_{DSS}	Zero Gate Voltage Drain Current	—	—	10	µA	V_{DS}= 80V ,V_{GS}=0V
		—	—	25		V_{DS} = 80V, 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	—	—	15	nC	V_{GS} = 12V, I_D = 6.9A
Q_{gs}	Gate-to-Source Charge	—	—	4.0		V_{DS} = 50V
Q_{gd}	Gate-to-Drain ('Miller') Charge	—	—	5.0		
$t_{d(on)}$	Turn-On Delay Time	—	—	6.6	ns	V_{DD} = 50V, I_D = 6.9A,
t_r	Rise Time	—	—	5.4		V_{GS} = 12V, R_G = 7.5Ω
$t_{d(off)}$	Turn-Off Delay Time	—	—	34		
t_f	Fall Time	—	—	15		
$L_S + L_D$	Total Inductance	—	6.8	—	nH	Measured from the center of drain pad to center of source pad
Ciss	Input Capacitance	—	378	—	pF	V_{GS} = 0V, V_{DS} = 25V
C_{oss}	Output Capacitance	—	108	—		f = 100KHz
C_{rss}	Reverse Transfer Capacitance	—	2.3	—		
R_g	Gate Resistance	—	2.3	—	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)	—	—	6.9	A	
I_{SM}	Pulse Source Current (Body Diode) ①	—	—	27.6		
V_{SD}	Diode Forward Voltage	—	—	1.2	V	T_j = 25°C, I_S = 6.9A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	—	—	144	ns	T_j = 25°C, I_F = 6.9A, di/dt ≤ 100A/µs
Q_{RR}	Reverse Recovery Charge	—	—	633	nC	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	—	—	5.4	°C/W	

Note: Corresponding Spice and Saber models are available on 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	Up to 600K Rads(Si)[1] Min	Up to 600K Rads(Si)[1] Max	1000K Rads(Si)[2] Min	1000K Rads(Si)[2] Max	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	100	—	100	—	V	V_{GS} = 0V, I_D = 1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	2.0	4.0	2.0	4.0	V	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	nA	V_{GS} = -20 V
I_{DSS}	Zero Gate Voltage Drain Current	—	10	—	10	µA	V_{DS}= 80V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	—	0.226	—	0.246	Ω	V_{GS} = 12V, I_D = 4.4A
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (SMD-0.2)	—	0.22	—	0.22	Ω	V_{GS} = 12V, I_D = 4.4A
V_{SD}	Diode Forward Voltage ④	—	1.2	—	1.2	V	V_{GS} = 0V, I_S = 6.9A

1. Part numbers IRHNM57110, IRHNM53110, IRHNM54110
2. Part number IRHNM58110

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/cm²))	Energy (MeV)	Range (µm)	VDS (V) @VGS= 0V	@VGS= -5V	@VGS= -10V	@VGS= -12.5V	@VGS= -15V	@VGS= -20V
Br	36.7	309	39.5	100	100	100	100	100	80
I	59.8	341	32.5	100	100	100	90	25	20

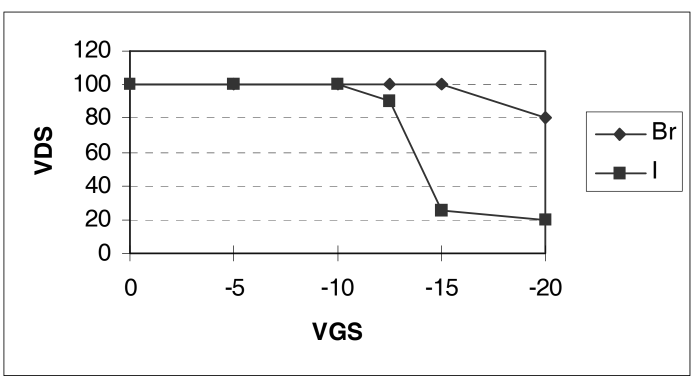


Fig a. Typical Single Event Effect, Safe Operating Area

For footnotes refer to the last page

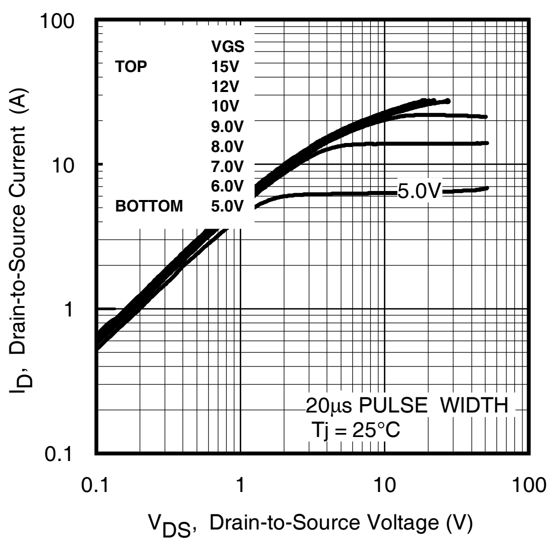


Fig 1. Typical Output Characteristics

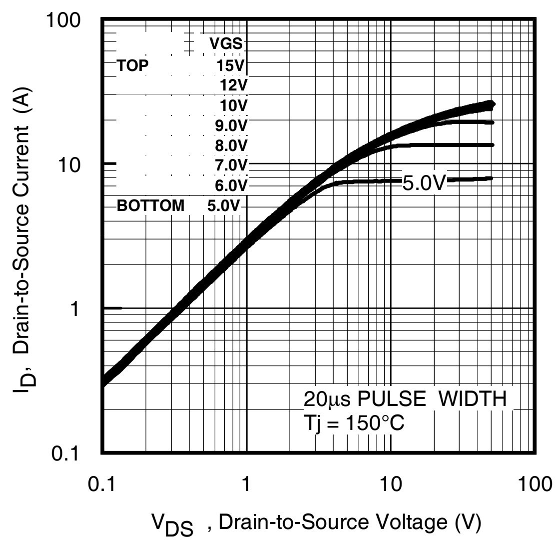


Fig 2. Typical Output Characteristics

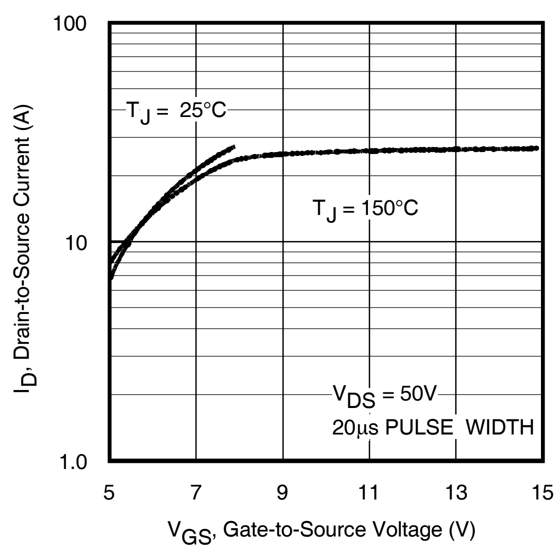


Fig 3. Typical Transfer Characteristics

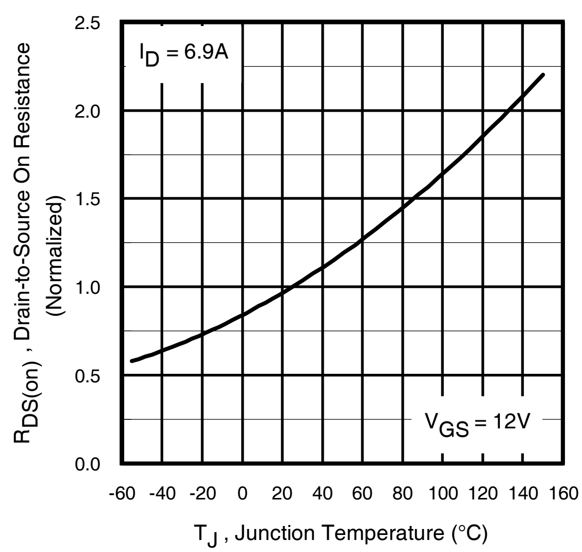


Fig 4. Normalized On-Resistance Vs. Temperature

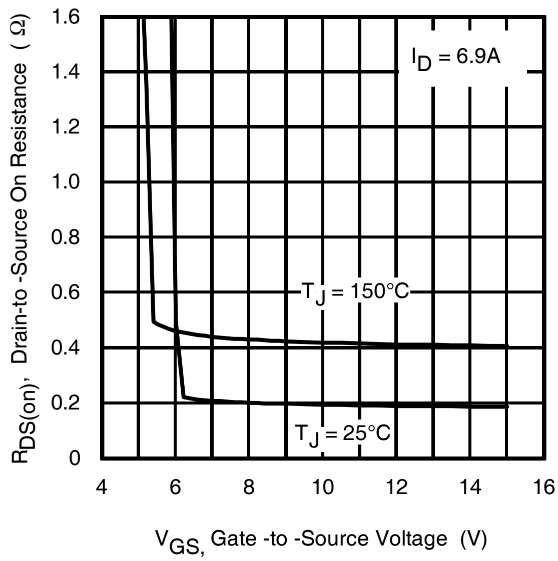


Fig 5. Typical On-Resistance Vs Gate Voltage

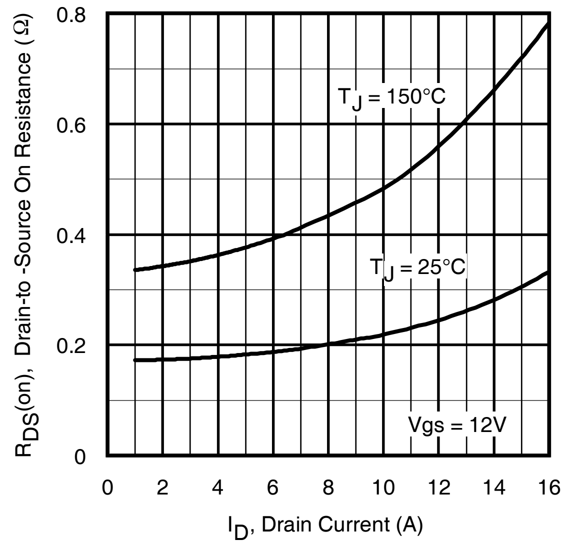


Fig 6. Typical On-Resistance Vs Drain Current

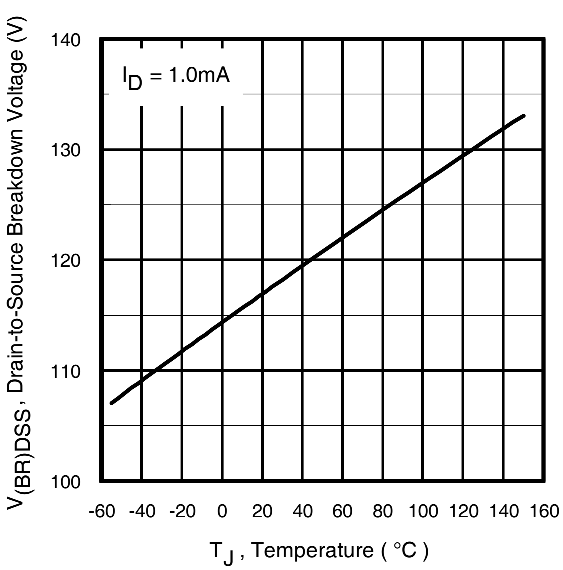


Fig 7. Typical Drain-to-Source Breakdown Voltage Vs Temperature

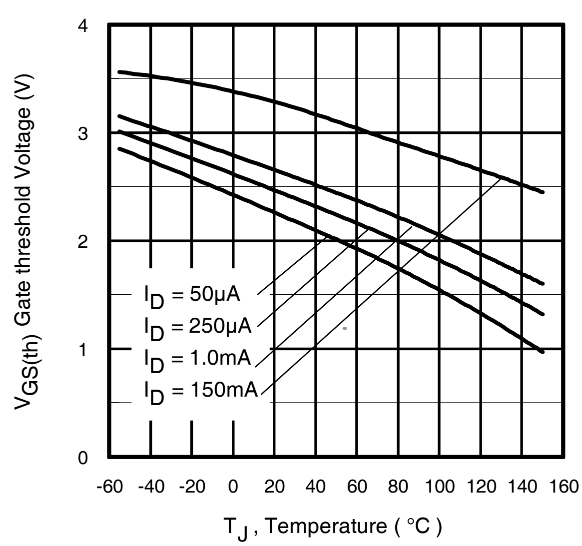


Fig 8. Typical Threshold Voltage Vs Temperature

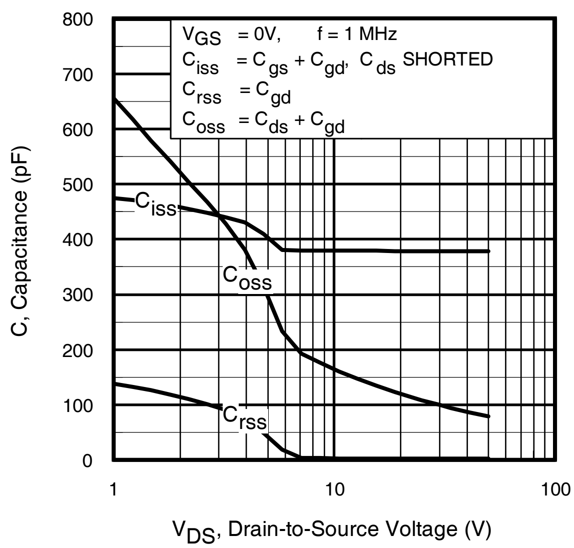


Fig 9. Typical Capacitance Vs. Drain-to-Source Voltage

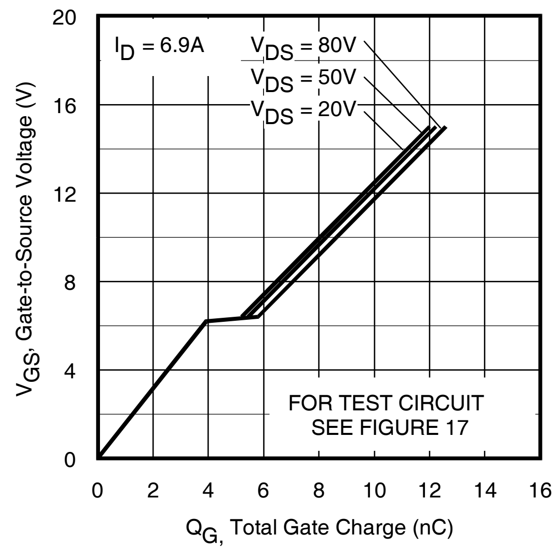


Fig 10. Typical Gate Charge Vs. Gate-to-Source Voltage

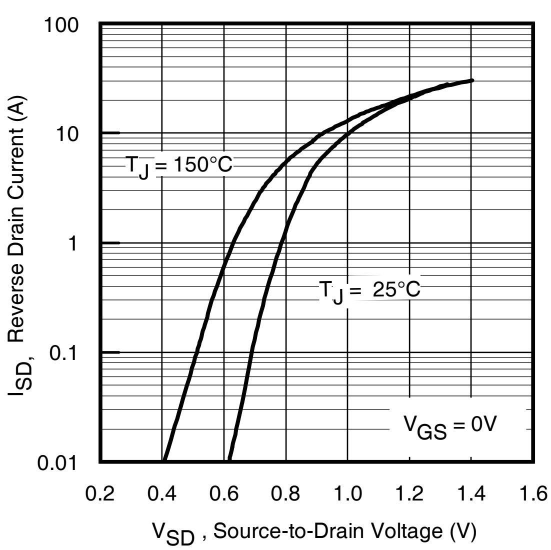


Fig 11. Typical Source-Drain Diode Forward Voltage

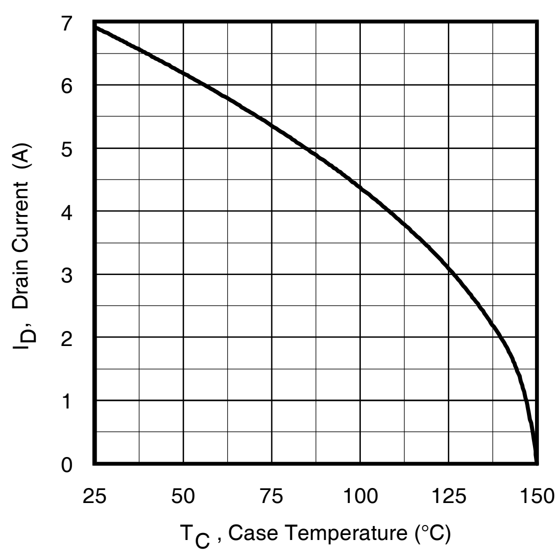


Fig 12. Maximum Drain Current Vs. Case Temperature

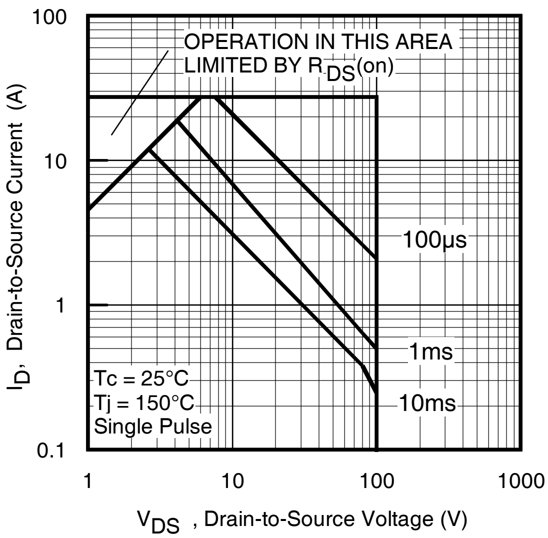


Fig 13. Maximum Safe Operating Area

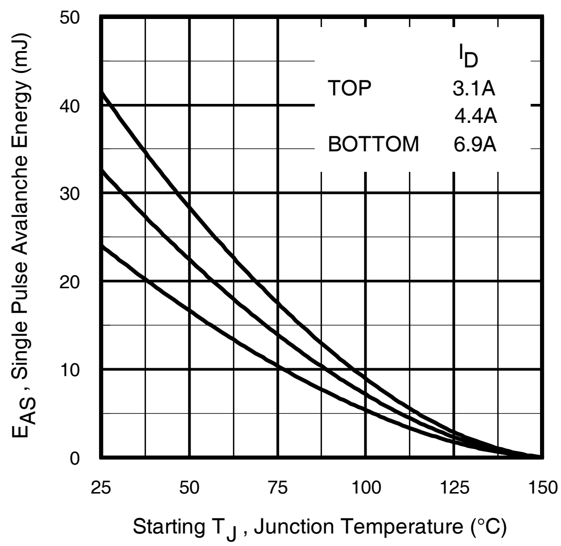


Fig 14. Maximum Avalanche Energy Vs. Drain Current

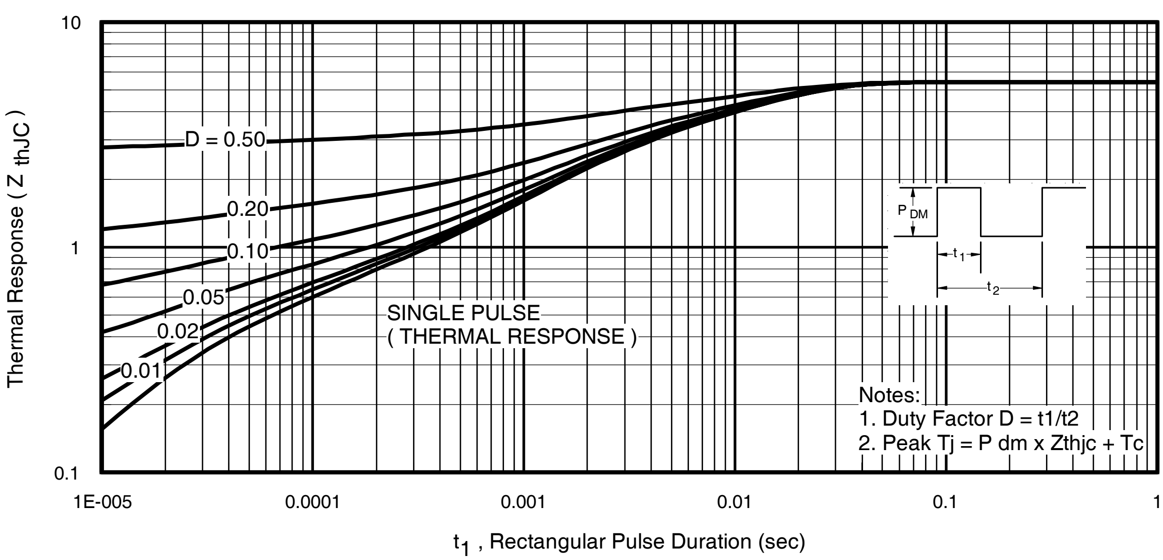


Fig 15. Maximum Effective Transient Thermal Impedance, Junction-to-Case

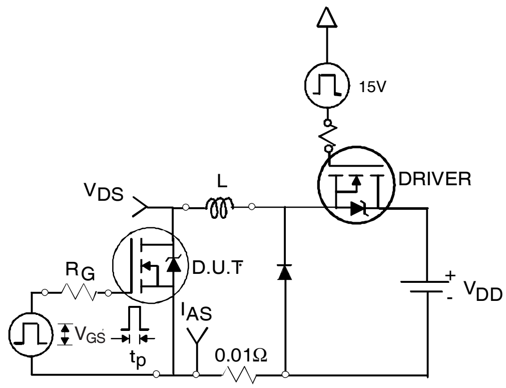


Fig 16a. Unclamped Inductive Test Circuit

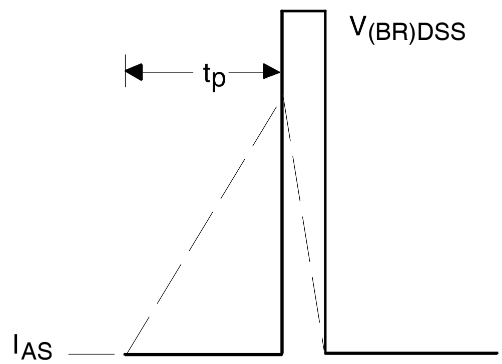


Fig 16b. Unclamped Inductive Waveforms

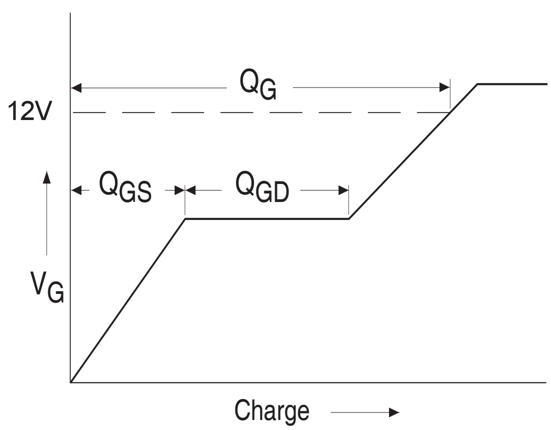


Fig 17a. Basic Gate Charge Waveform

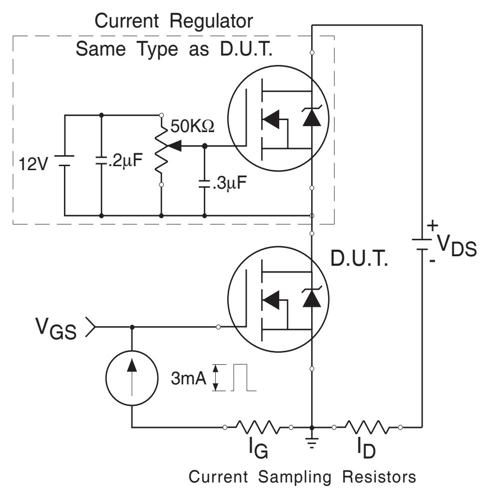


Fig 17b. Gate Charge Test Circuit

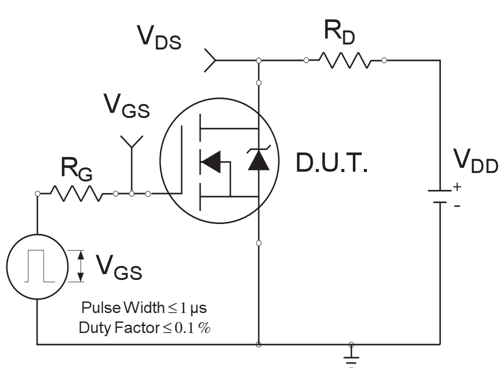


Fig 18a. Switching Time Test Circuit

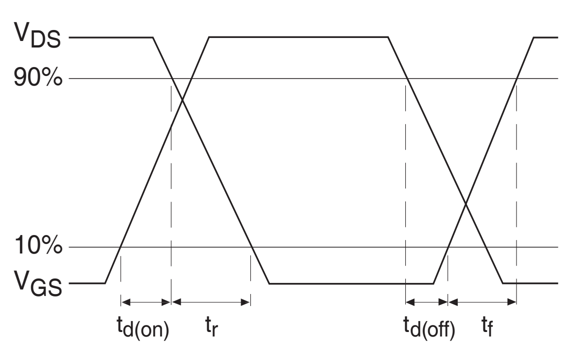
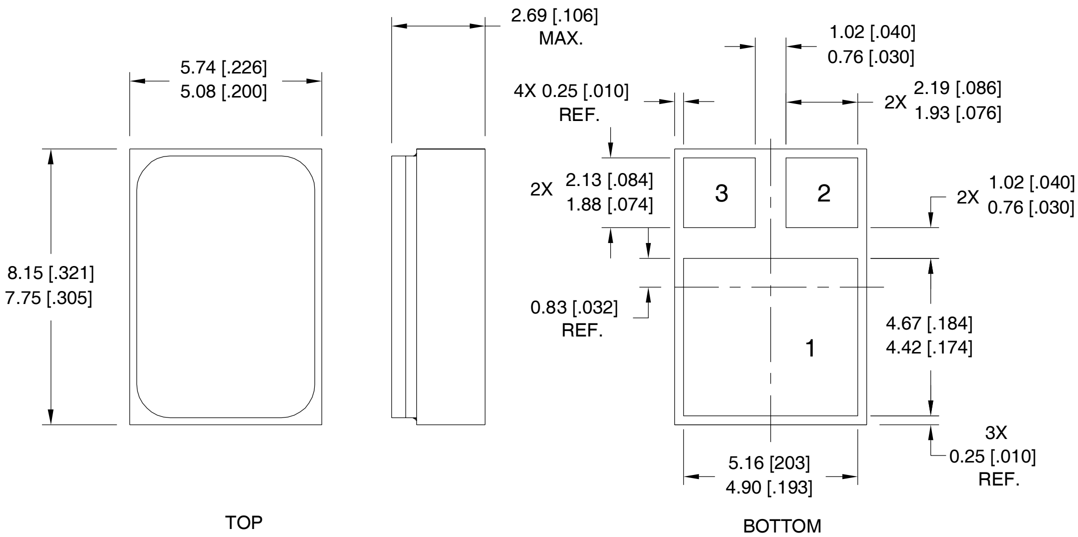


Fig 18b. Switching Time Waveforms

Footnotes:

① Repetitive Rating; Pulse width limited by maximum junction temperature.
② V_{DD} = 50V, starting T_J = 25°C, L=1.0 mH Peak I_L = 6.9A, V_{GS} =12V
③ $I_{SD} \leq$ 6.9A, di/dt ≤ 560A/µs, $V_{DD} \leq$ 100V, $T_J \leq$ 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.** 80 volt V_{DS} applied and V_{GS} = 0 during irradiation per MIL-STD-750, method 1019, condition A.

Case Outline and Dimensions — SMD-0.2



NOTES:
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

PAD ASSIGNMENT
1 = DRAIN
2 = GATE
3 = SOURCE

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