IRHNA5S97160

RADIATION HARDENED POWER MOSFET SURFACE MOUNT (SMD-2)

100V, P-CHANNEL
R5 TECHNOLOGY

Product Summary

Part Number	Radiation Level	RDS(on)	I_D
IRHNA5S97160	100 kRads(Si)	0.049Ω	-47A

SMD-2

Description

IR HiRel 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/cm^2)). The combination of low RDS(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 and temperature stability of electrical parameters.
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Features

- Single Event Effect (SEE) Hardened
- Ultra Low RDS(on)
- Low Total Gate Charge
- Simple Drive Requirements
- Hermetically Sealed
- Surface Mount
- Ceramic Package
- Light Weight
- ESD Rating: Class 3A per MIL-STD-750, Method 1020

Absolute Maximum Ratings

Pre-Irradiation

Symbol	Parameter	Value	Units
I_{D1} @ V_{GS} = -9.6V, T_C = 25°C	Continuous Drain Current	-47	A
I_{D2} @ V_{GS} = -9.6V, T_C = 100°C	Continuous Drain Current	-30	
I_{DM} @ T_C = 25°C	Pulsed Drain Current ①	-188	
P_D @T_C = 25°C	Maximum Power Dissipation	250	W
	Linear Derating Factor	2.0	W/°C
V_{GS}	Gate-to-Source Voltage	± 12	V
E_{AS}	Single Pulse Avalanche Energy ②	400	mJ
I_{AR}	Avalanche Current ①	-47	A
E_{AR}	Repetitive Avalanche Energy ①	25	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-10	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C
	Lead Temperature	300 (for 5sec)	
	Weight	3.3 (Typical)	g

For Footnotes, refer to the page 2.

Pre-Irradiation

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

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	—	—	V	V_{GS} = 0V, I_D = -1.0mA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	-0.1	—	V/°C	Reference to 25°C, I_D = -1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-State Rsistance	—	—	0.049	Ω	V_{GS} = -9.6V, I_{D2} = -30A ④
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	—	-4.0	V	V_{DS} = V_{GS}, I_D = -1.0mA
Gfs	Forward Transconductance	24	—	—	S	V_{DS} = -15V, I_{D2} = -30A 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} = -12V
	Gate-to-Source Leakage Reverse	—	—	100		V_{GS} = 12V
Q_G	Total Gate Charge	—	—	170	nC	I_{D1} = -47A
Q_{GS}	Gate-to-Source Charge	—	—	65		V_{DS} = -50V
Q_{GD}	Gate-to-Drain ('Miller') Charge	—	—	55		V_{GS} = -9.6V
$t_{d(on)}$	Turn-On Delay Time	—	—	40	ns	V_{DD} = -50V
tr	Rise Time	—	—	110		I_{D1} = -47A
$t_{d(off)}$	Turn-Off Delay Time	—	—	110		R_G = 2.35Ω
t_f	Fall Time	—	—	120		V_{GS} = -9.6V
Ls +L_D	Total Inductance	—	4.0	—	nH	Measured from center of Drain pad to center of Source pad
C_{iss}	Input Capacitance	—	6240	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	1570	—		V_{DS} = -25V
C_{rss}	Reverse Transfer Capacitance	—	115	—		f = 1.0MHz

Source-Drain Diode Ratings and Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I_S	Continuous Source Current (Body Diode)	—	—	-47	A	
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	-188		
V_{SD}	Diode Forward Voltage	—	—	-5.0	V	T_J = 25°C, I_S = -47A, V_{GS} = 0V④
t_{rr}	Reverse Recovery Time	—	—	230	ns	T_J = 25°C, I_F = -47A, V_{DD} ≤ –50V
Q_{rr}	Reverse Recovery Charge	—	—	1.6	μC	di/dt = 100A/μs ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Thermal Resistance

Symbol	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	0.50	°C/W
$R_{\theta\text{-}PCB}$	Junction-to-PC Board (soldered to 1 inch square cu clad board)	—	1.6	—	

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} = -9.6V

③ I_{SD} ≤ -47A, di/dt ≤ -450A/μs, V_{DD} ≤ -100V, 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. -80 volt V_{DS} applied and V_{GS} = 0 during irradiation per MIL-STD-750, Method 1019, condition A.

Radiation Characteristics

IR HiRel radiation hardened MOSFETs are tested to verify their radiation hardness capability. The hardness assurance program at IR Hirel 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.

Table1. Electrical Characteristics @ Tj = 25°C, Post Total Dose Irradiation ⑤⑥

Symbol	Parameter	100 kRads (Si)[1]		Units	Test Conditions
		Min.	Max.		
BV_{DSS}	Drain-to-Source Breakdown Voltage	-100	——	V	V_{GS} = 0V, I_D = -1.0mA
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	-4.0	V	V_{DS} = V_{GS}, I_D = -1.0mA
I_{GSS}	Gate-to-Source Leakage Forward	——	-100	nA	V_{GS} = -12V
I_{GSS}	Gate-to-Source Leakage Reverse	——	100	nA	V_{GS} = 12V
I_{DSS}	Zero Gate Voltage Drain Current	——	-10	µA	V_{DS} = -80V, V_{GS} = 0V
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (TO-3)	——	0.05	Ω	V_{GS} = -9.6V, I_{D2} = -30A
$R_{DS(on)}$	Static Drain-to-Source ④ On-State Resistance (SMD-2)	——	0.049	Ω	V_{GS} = -9.6V, I_{D2} = -30A
V_{SD}	Diode Forward Voltage	——	-5.0	V	V_{GS} = 0V, I_S = -47A

IR HiRel 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/cm^2))	Energy (MeV)	Range (µm)	VDS (V)					
				@ VGS = 0V	@ VGS = 1V	@ VGS = 2V	@ VGS = 3V	@ VGS = 4V	@ VGS = 5V
Kr	38.3	347	42.6	-100	-100	-100	-100	-100	-100
Xe	61.1	640	52.7	-100	-100	-100	——	——	——

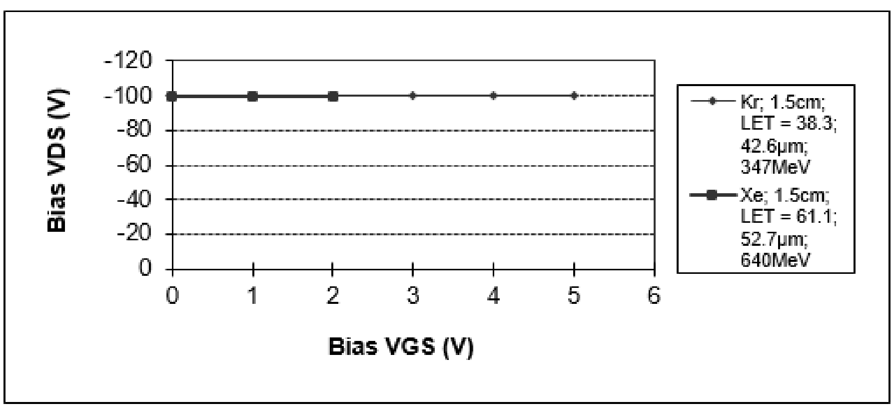


Fig a. Typical Single Event Effect, Safe Operating Area

For Footnotes, refer to the page 2.

Pre-Irradiation

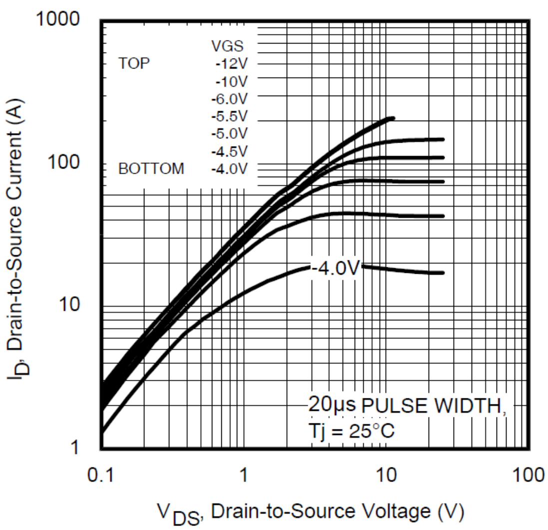


Fig 1. Typical Output Characteristics

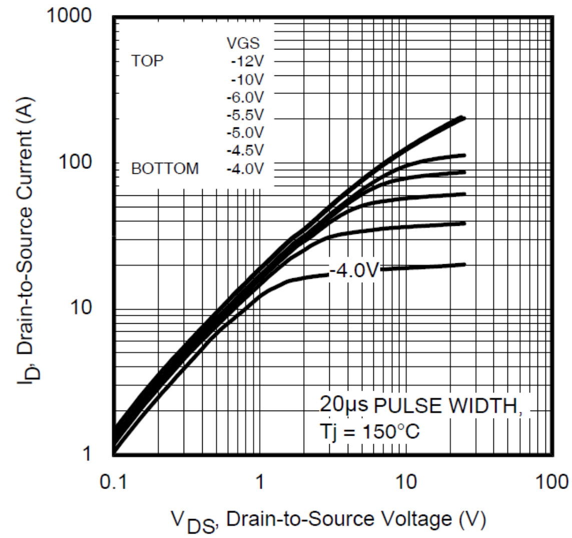


Fig 2. Typical Output Characteristics

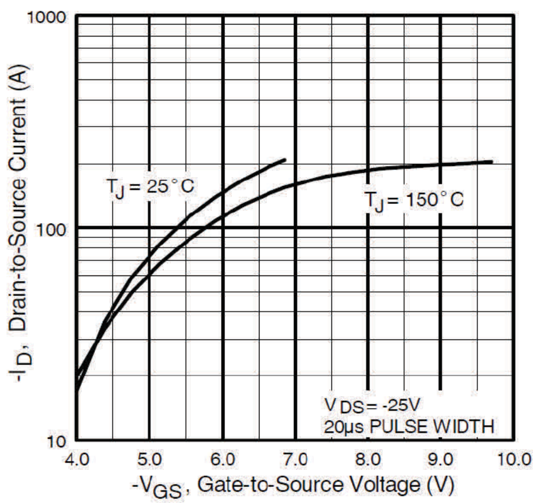


Fig 3. Typical Transfer Characteristics

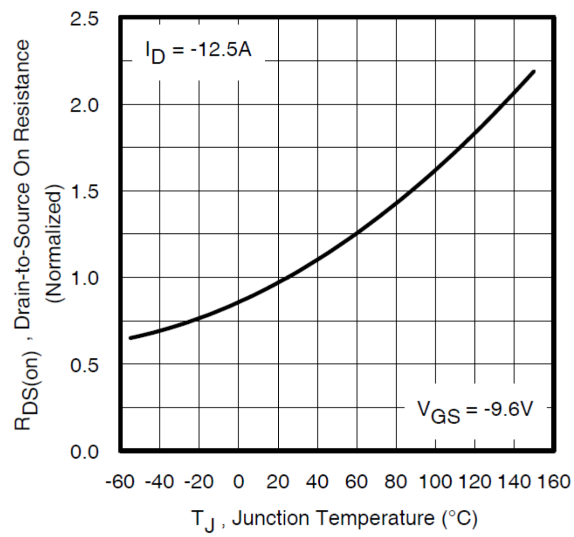


Fig 4. Normalized On-Resistance Vs. Temperature

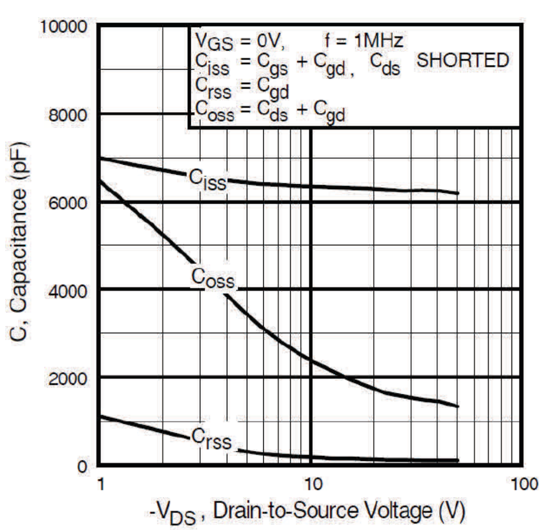


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

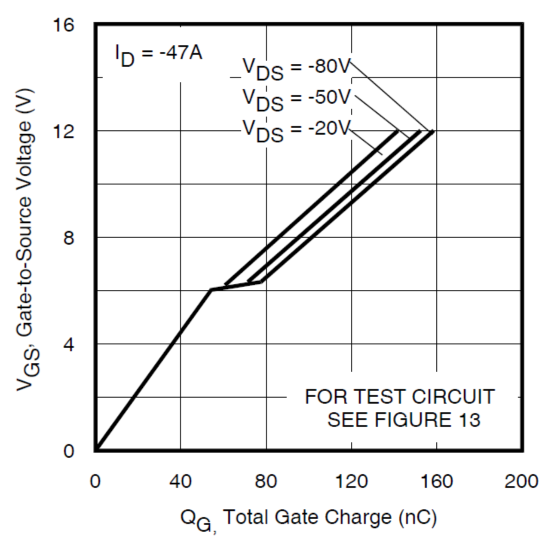


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

Pre-Irradiation

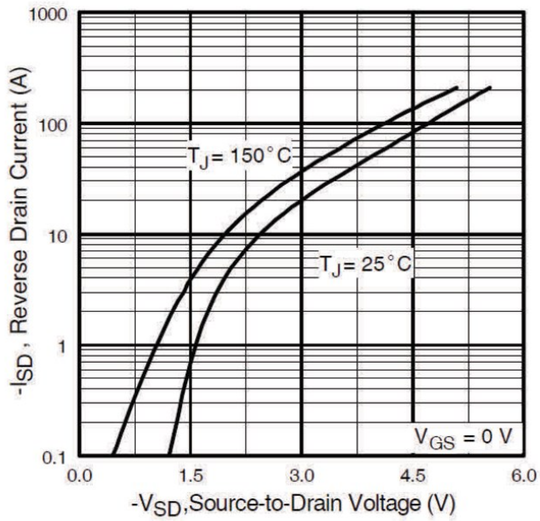


Fig 7. Typical Source-Drain Diode Forward Voltage

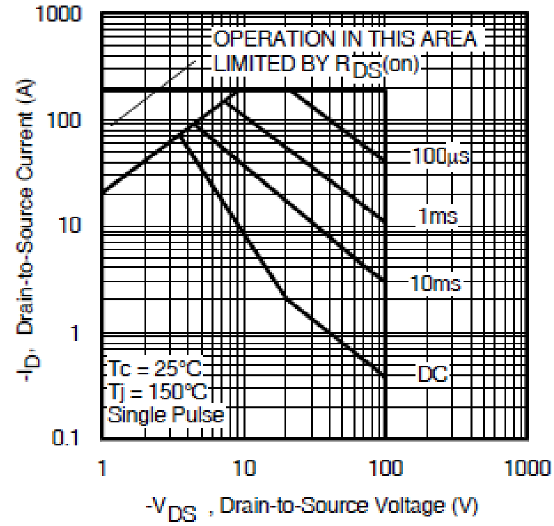


Fig 8. Maximum Safe Operating Area

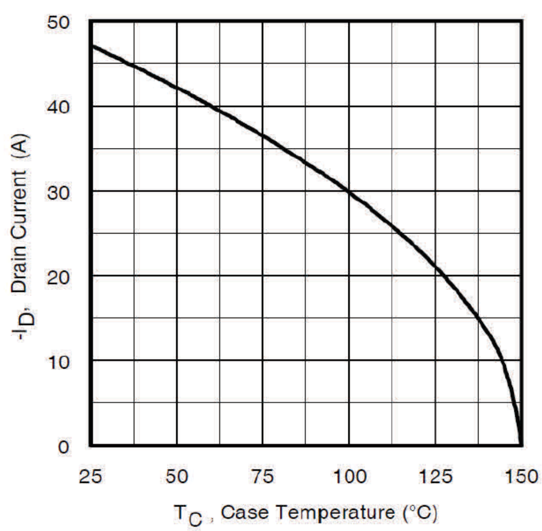


Fig 9. Maximum Drain Current Vs. Case Temperature

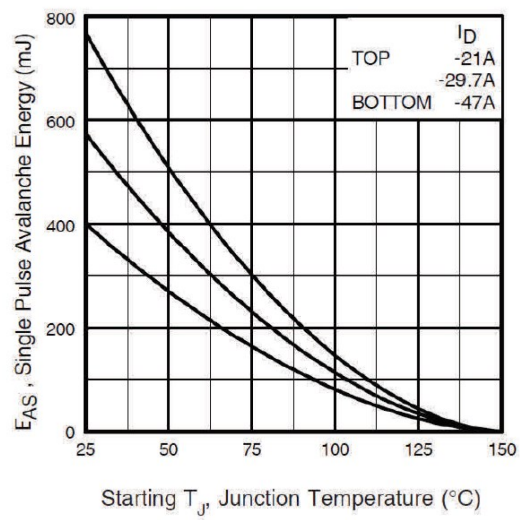


Fig 10. Maximum Avalanche Energy Vs. Drain Current

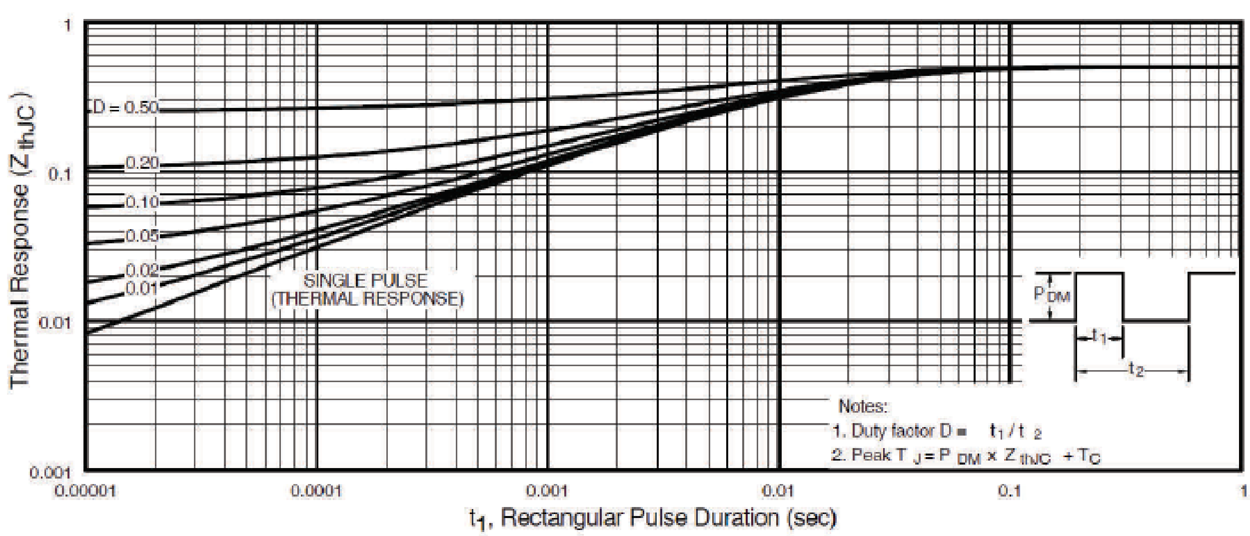


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

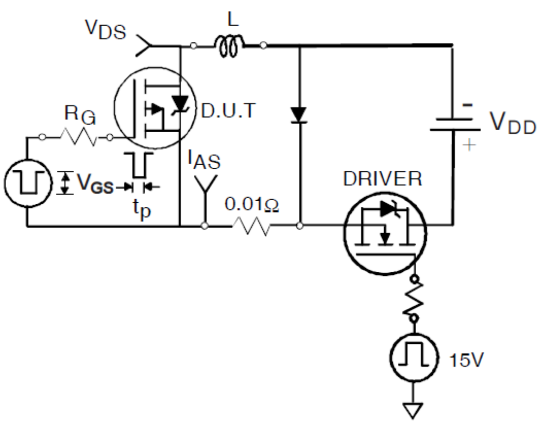


Fig 12a. Unclamped Inductive Test Circuit

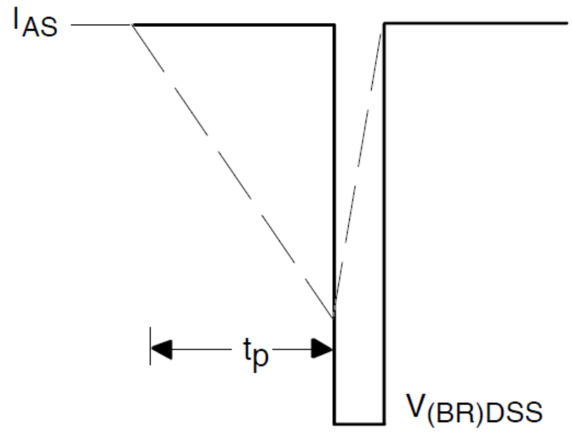


Fig 12b. Unclamped Inductive Wave-

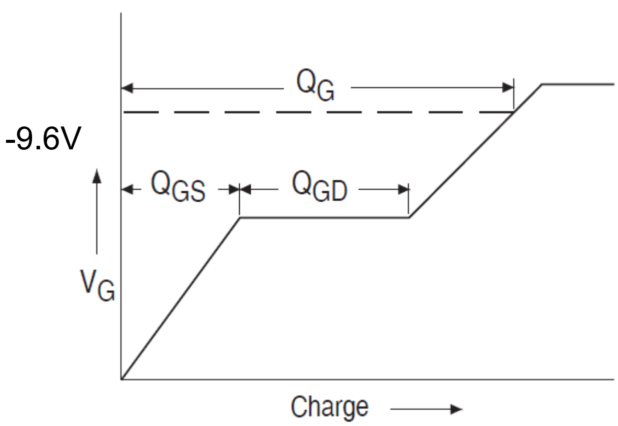


Fig 13a. Gate Charge Waveform

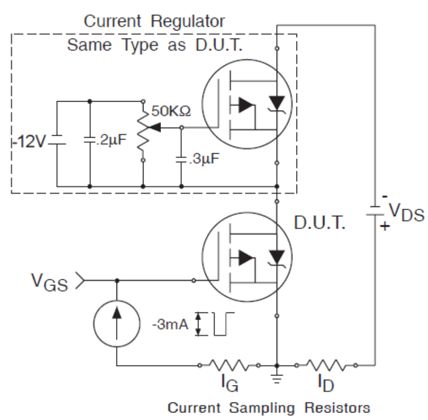


Fig 13b. Gate Charge Test Circuit

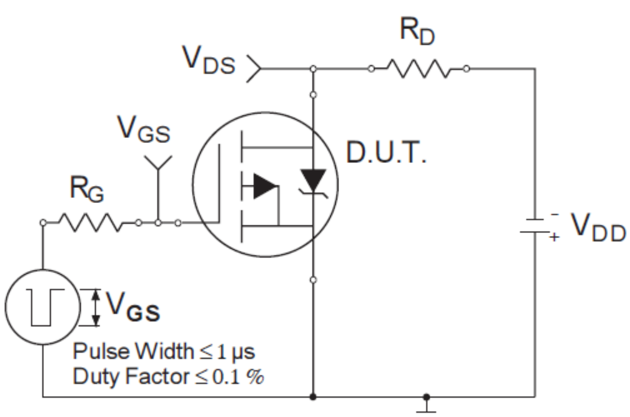


Fig 14a. Switching Time Test Circuit

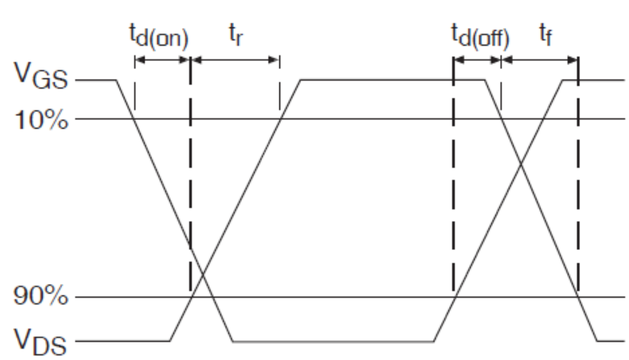
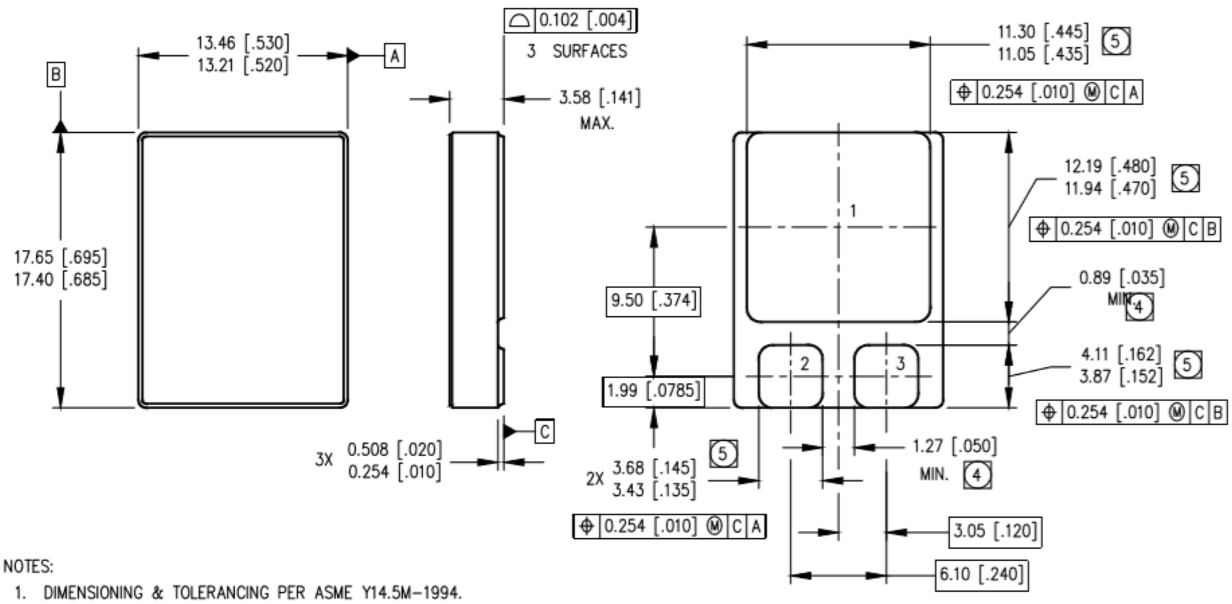


Fig 14b. Switching Time Waveforms

Note: For the most updated package outline, please see the website: [SMD-2](SMD-2)

Case Outline and Dimensions — SMD-2

REV.	DESCRIPTION	ECN	DATE
A	INITIAL RELEASE	1120_ER6904	4-3-20



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.
6. STANDARD FINAL FINISH ON ALL TERMINALS IS SOLDER ALLOY 63%Sn 37%Pb.

PAD ASSIGNMENTS

MOSFET
1 = DRAIN
2 = GATE
3 = SOURCE

IR HiRel
An Infineon Technologies Company

TITLE: SMD-2 OUTLINE	
DRAWING NO. D100721G-WEB	REV A

IR HiRel
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Data and specifications subject to change without notice.

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