100V N-Channel Radiation-Hardened MOSFET

JANSR2N7587U3/MRH10N22U3SR

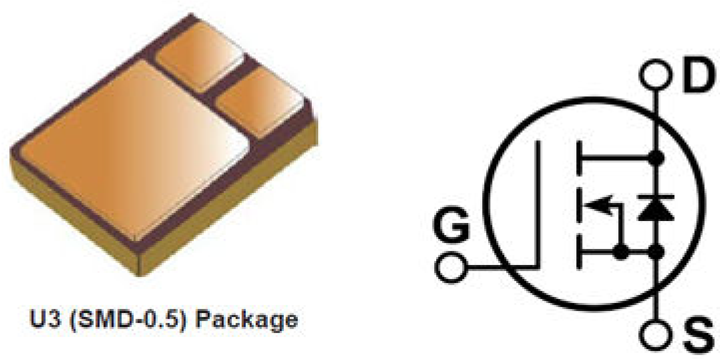
Product Overview

Microchip's new M6™ technology has been developed to provide extreme reliability and enhanced radiation hardness for hermetic power MOSFETs targeted for space and military applications. Microchip Rad-Hard MOSFETs feature low $R_{DS(on)}$ and low total gate charge. The devices have been developed for total dose and Single-Event Environments (SEE). M6 will perform in extreme-environment applications and will remain within specification in radiation environments greater than 300Krad Total Ionizing Dose (TID).

Table 1. JANSR2N7587U3/MRH10N22U3SR Ordering Options

Part Number	Radiation Level	$R_{DS(on)}$	I_D	QPL Part Number
MRH10N22U3SR	100 KRad (Si)	0.042Ω	22A	JANSR2N7587U3
MRH10N22U3SF	300 KRad (Si)	0.042Ω	22A	JANSF2N7587U3

Figure 1. JANSR2N7587U3/MRH10N22U3SR Package and Pin Description



Features

The following are key features of the JANSR2N7587U3/MRH10N22U3SR device:

- Low $R_{DS(on)}$
- Fast Switching
- Single-Event Hardened
- Low Gate Charge
- Simple Drive
- Ease Of Paralleling
- Hermetically Sealed

- Surface-Mount Design
- Ceramic Package
- ESD Rating: Class 3B MIL-STD-750, TM 1020

Applications

The JANSR2N7587U3/MRH10N22U3SR device is designed for the following applications:

- DC–DC Converters
- Motor Control
- Switch Mode Power Supplies

Table of Contents

1. Electrical Specifications

This section shows the electrical specifications of the JANSR2N7587U3/MRH10N22U3SR device.

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings for the JANSR2N7587U3/MRH10N22U3SR device.

Table 1-1. Absolute Maximum Ratings Pre-Irradiation

Symbol	Parameter	Ratings	Unit
I_D	Continuous Drain Current @ T_c = 25° C	22	A
	Continuous Drain Current @ T_c = 100° C	19	
I_{DM}	Pulsed Drain Current [1]	88	
V_{GS}	Gate-Source Voltage	±20	V
dv/dt	Peak Diode Recovery	5.0	V/ns
P_D	Total Power Dissipation @ T_C = 25° C	75	W
	Linear Derating Factor	0.6	W/°C
T_J,T_{STG}	Operating and Storage Junction Temperature Range	-55 to 150	°C
T_L	Soldering Temperature for 5 Seconds (1.6mm from case)	300	
W_T	Package Weight	1.0	g
Torque	Mounting Torque (TO-254 Package), 4-40 or M3 screw	1.1	N-m

1.2 Electrical Performance

The following table shows the static characteristics of the JANSR2N7587U3/MRH10N22U3SR device

Table 1-2. Static Characteristics T_A = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(DSS)}$	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_D = 1.0mA		100	—	—	V
$R_{DS(on)}$	Drain-Source On Resistance [1]	V_{GS} = 12V, I_D = 19A		—	—	0.042	Ω
$V_{GS(th)}$	Gate-Source Threshold Voltage	V_{GS} = V_{DS}, I_D = 1.0mA		2.0	—	4.0	V
g_{fs}	Forward Transconductance	V_{DS}= 15V, I_{DS}= 19 A		14	—	—	S
I_{GSS}	Gate-Source Leakage Current	V_{GS} = ±20V		—	—	±100	nA
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 80V V_{GS} = 0V	T_A=25°C	—	—	10	µA
			T_A=125°C	—	—	25	

Note:

1. Pulse test: pulse width < 300 µs, duty cycle < 2%

The following table shows the dynamic characteristics of the JANSR2N7587U3/MRH10N22U3SR device.

Table 1-3. Dynamic Characteristics (T_A = +25° C)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input Capacitance	V_{GS} = 0V, V_{DS} = 25V ƒ = 1MHz	—	1948	—	pF
C_{rss}	Reverse Transfer Capacitance		—	20	—	
Co_{ss}	Output Capacitance		—	465	—	

Table 1-3. Dynamic Characteristics (T_A = +25° C) (continued)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Q_g	Total Gate Charge	V_{GS} = 12V, I_D = 22A V_{DD} = 50V	—	29	50	nC
Q_{gs}	Gate-Source Charge		—	12	15	
Q_{gd}	Gate-Drain ("Miller") Charge		—	2	20	

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
td(on)	Turn-On Delay Time	—	—	14	25	nS
tr	Voltage Rise Time	V_{GS}= 12 V, I_D= 22 A, V_{DD}= 50 V R_G(ext) = 7.5Ω (1)	—	3	30	nS
td(off)	Turn-Off Delay Time		—	21	60	nS
tf	Voltage Fall Time		—	5	30	nS

The following table shows the source-drain characteristics of the JANSR2N7587U3/MRH10N22U3SR device.

Table 1-4. Source-Drain Characteristics (T_A = +25 °C)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_S	Continuous Source Current (Body Diode)	Integral Reverse P-N Junction Diode	—	—	22	A
I_{SM}	Pulsed Source Current (Body Diode)[1]		—	—	88	
V_{SD}	Diode Forward Voltage	I_{SD} = 22A, T_A=25°C V_{GS} = 0V	—	0.9	1.2	V
ESR	Gate Equivalent Source Resistance	*F*=1MHZ Level=25mV Drain short	—	1.55	—	Ω
trr	Reverse recovery time	IF = 22.0A, di/dt ≤ 100A/μS, VDD ≤ 50V	—	145	350	nS

Note:

1. Pulse test: pulse width < 300 μs, duty cycle < 2%.

Table 1-5. Thermal Resistance

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$R_{ΘJC}$	Junction-to-case thermal resistance	—	—	0.56	1.67	°C/W

Figure 1-1. Output Characteristics at 25 °C

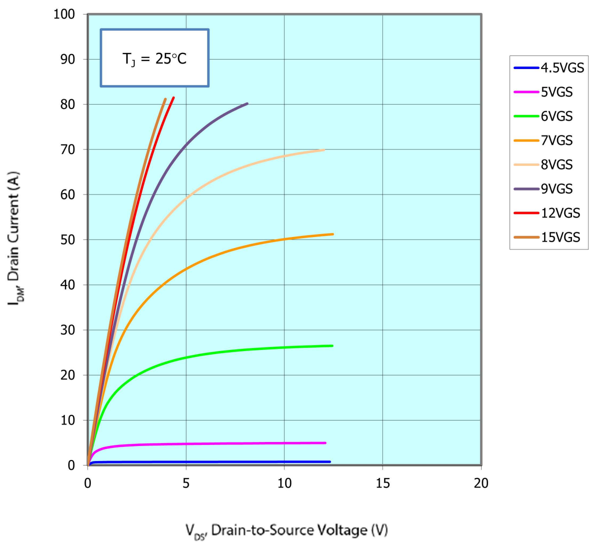


Figure 1-2. Output Characteristics at 150 °C

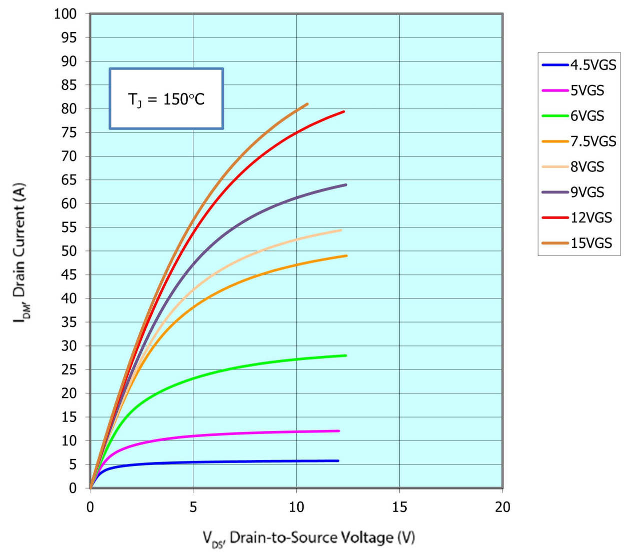


Figure 1-3. Rds(on) vs. Junction Temperature

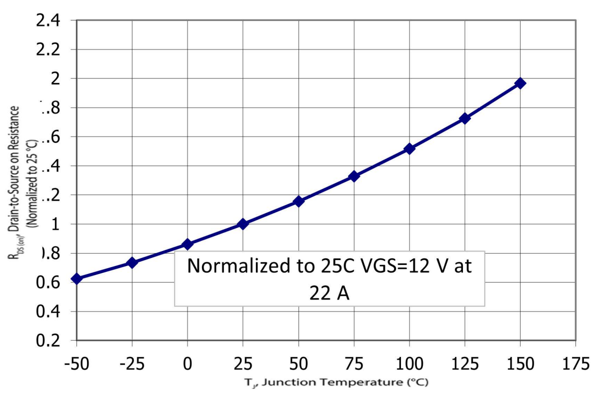


Figure 1-4. Typical Gate Charge vs. Gate-to-Source Voltage

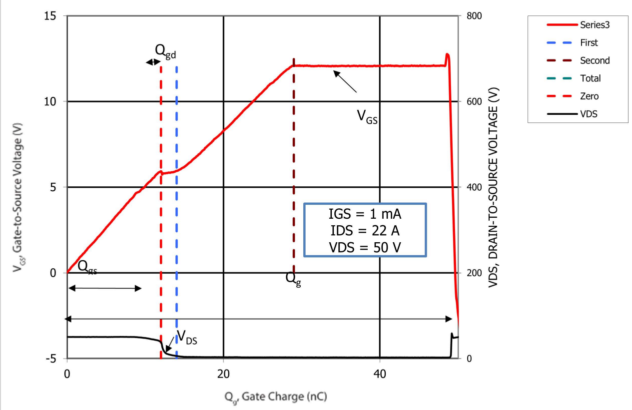


Figure 1-5. Capacitance vs. Drain-to-Source Voltage

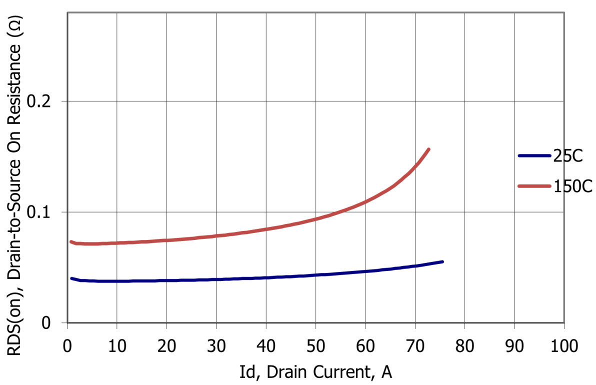


Figure 1-6. IDM vs. Gate-to-Source Voltage

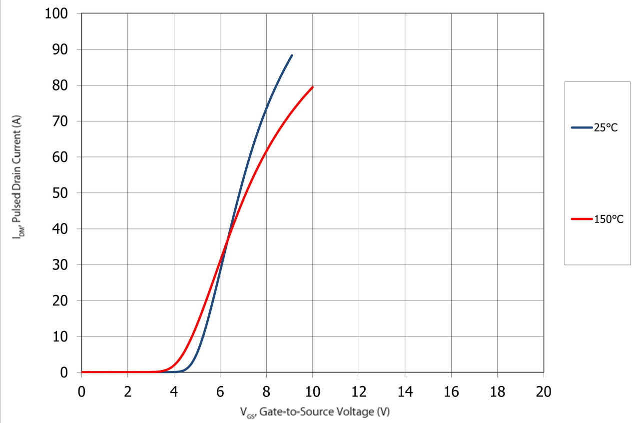


Figure 1-7. IDM vs. VDS Third Quadrant Conduction

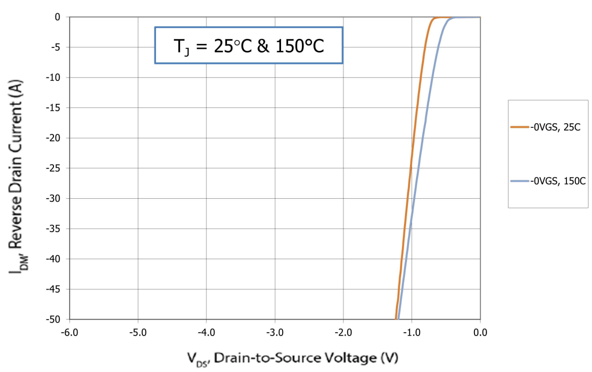


Figure 1-8. VGS (th) vs. Junction Temperature (2N7587U3)

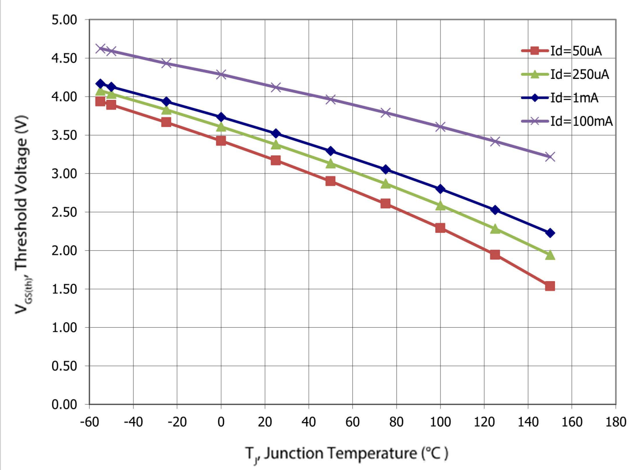


Figure 1-9. Forward Safe Operating Area (2N7587U3)

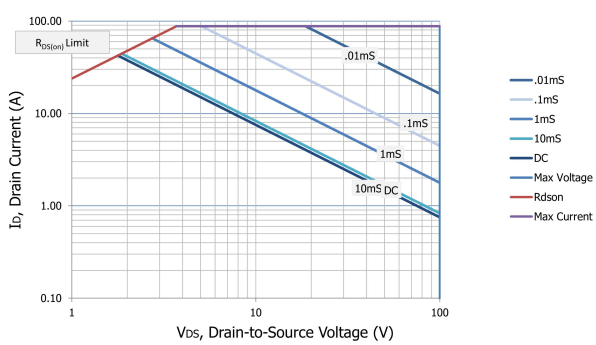


Figure 1-10. Maximum Transient Thermal Impedance (2N7587U3)

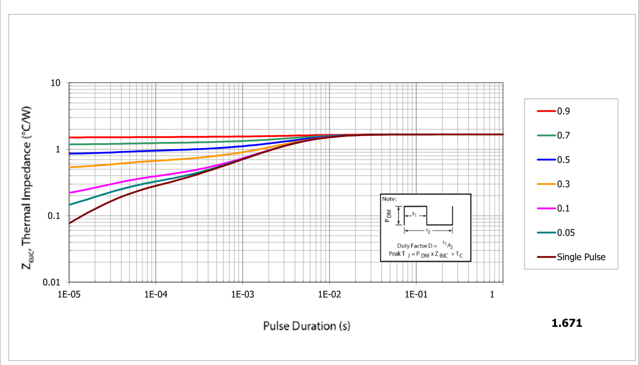


Figure 1-11. On-Resistance vs. Gate Voltage

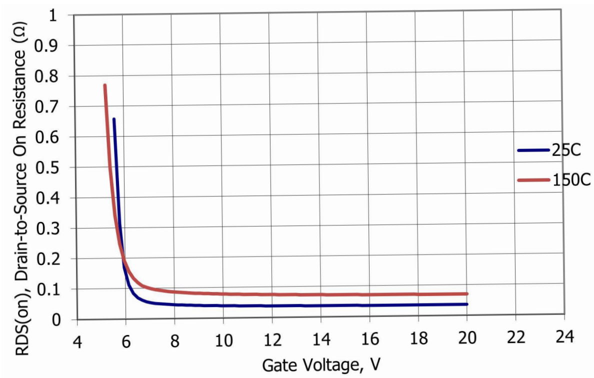


Figure 1-12. On-Resistance vs. Drain Current

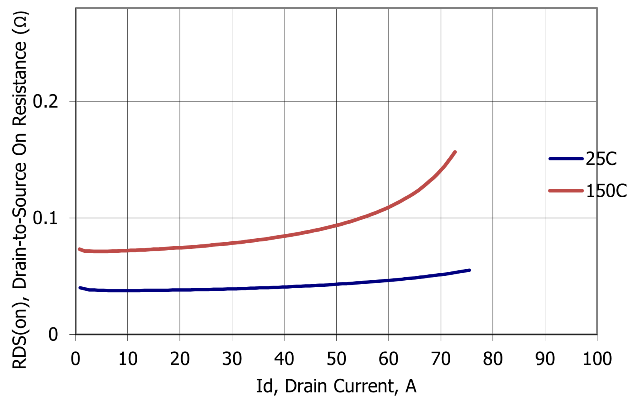


Figure 1-13. V(BR)dss vs. Junction Temperature

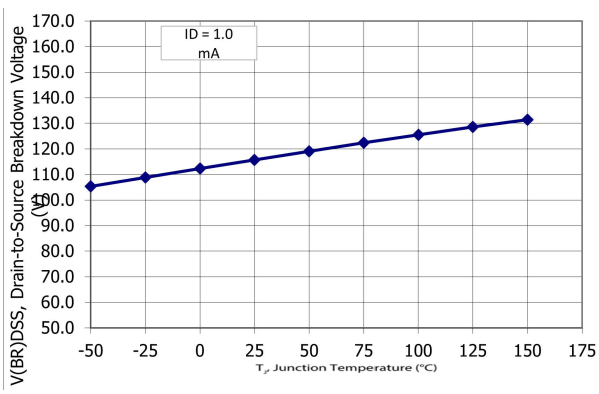
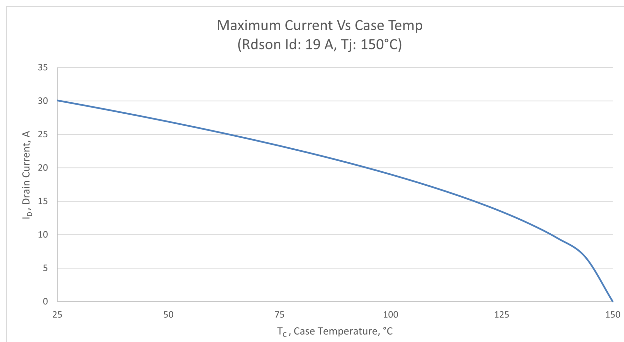


Figure 1-14. Maximum Current vs. Case Temperature



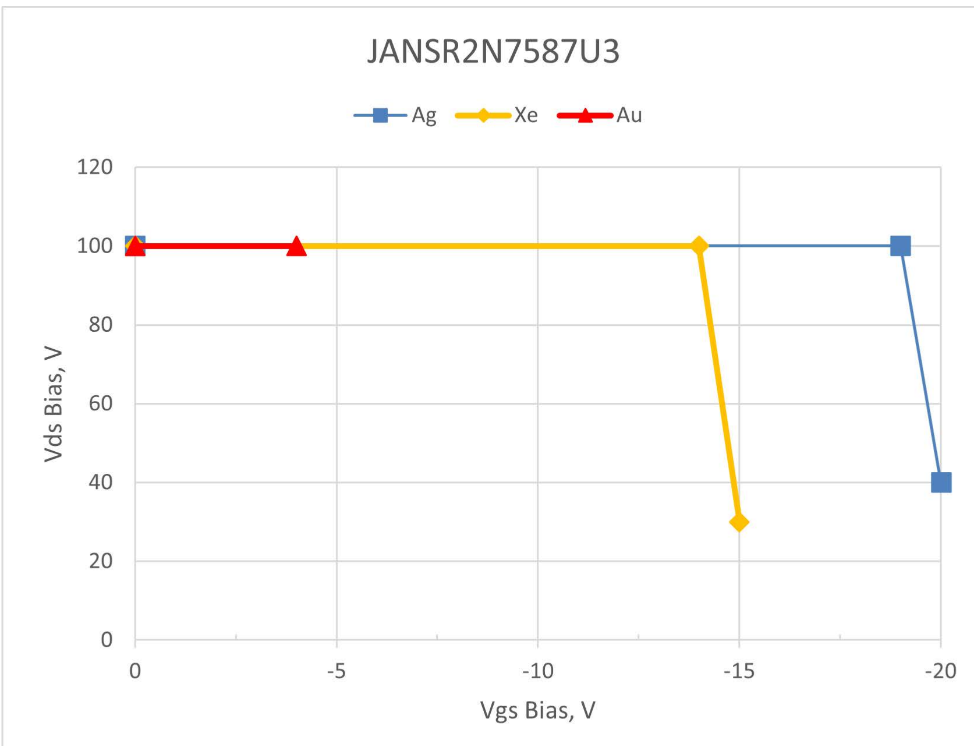
2. Single Event Effects

The Microchip JANSR2N7587U3/MRH10N22U3SR device has been characterized for heavy ion responses at the Texas A&M cyclotron. Devices have been characterized up to V_{DS}=150V and V_{GS}= –20V. The following single-event effects (SEE) safe-operating area profile has been established using the ions, linear energy transfer (LET), range, and total energy conditions shown.

Table 2-1. SEE Safe-Operating Area

Parameter	Description	Environment				VDS(V)				
Ion Species	Typical LET (MeV/(mg/c m^2))	ION Energy (MeV)	Eff Range (µm)	VGS = 0V	VGS = –4	VGS = –5V	VGS = –10V	VGS = –15V	VGS = –19	VGS = –20V
Ag	43.9 (43.9±5%)	1330(1330±5%)	117.3 (50±5%)	100	100	100	100	100	100	40
Xe	62 (61±5%)	1071 (345±5%)	78.7 (32±5%)	100	100	100	100	30	—	—
Au	90 (90±5%)	1489 (375±7.5%)	83.2 (29±7.5%)	100	100	—	—	—	—	—

Figure 2-1. SEE Safe-Operating Area



Microchip Radiation-Hardened MOSFETs are tested in a manner to provide maximum observability during heavy ion exposure. The filtering circuits of MIL-STD-750F Method 1080 are not used.

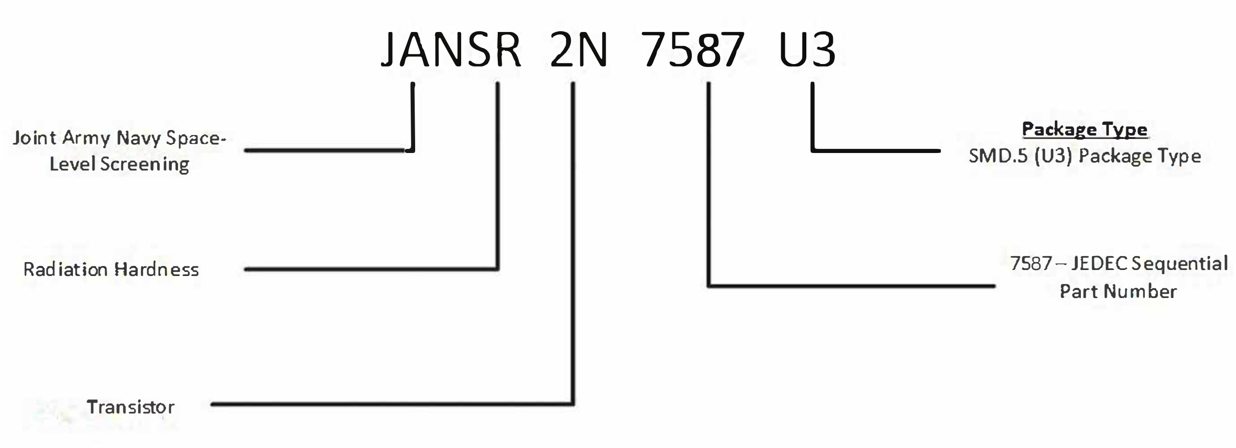
A V_{GS}/V_{DS} point is accepted on the prior plot if all of the following conditions are met:

1. A fluence of $3x10^5$ ± 20% ions/cm2 is delivered to each sample.
2. No Single Event Burnout is detected via continuous monitoring of the drain current.
3. No Single Event Gate Rupture is detected via continuous monitoring of the gate current.
4. Post-Exposure IDSS tests continue to pass specification.
5. Post-Exposure IGSS tests continue to pass specification.
6. Three randomly selected samples from different production lots are used for observation.

It should be noted that total energy levels are considered to be a factor in SEE characterization. Comparisons to other data sets should not be based on LET alone.

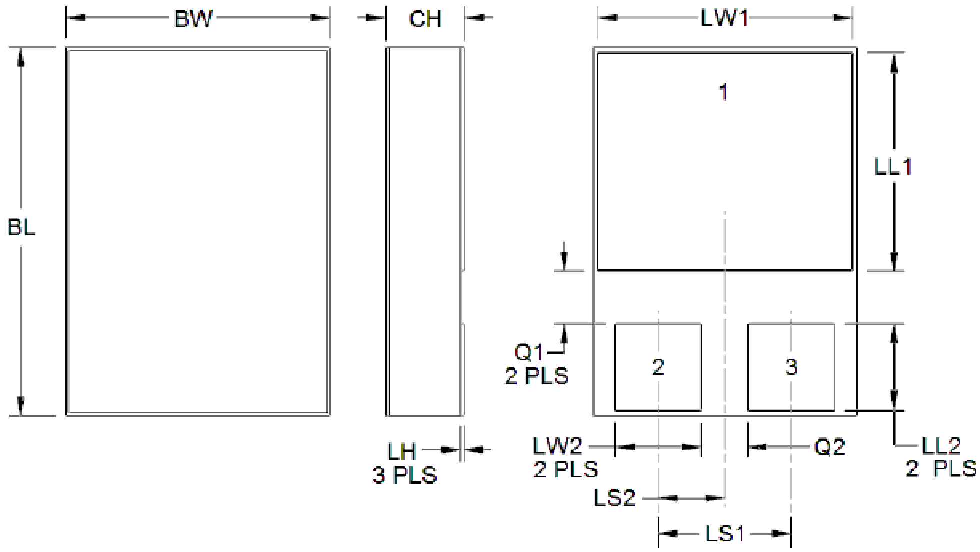
3. Part Nomenclature

The following image shows the part nomenclature for the JANSR2N7587U3 device. MRH10N22U3 is the internal part number.



JAN	Joint Army Navy
S	Space-level screening
R	Total ionizing dose 1x10 5 (RAD(Si))
F	Total ionizing dose 3x10 5 (RAD(Si))
2N	Transistor
7587	JEDEC sequential part number
U3	SMD.5 (U3) package type

4. Package Outline Drawing



Notes:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. In accordance with ASME Y 14.5M, diameters are equivalent to ϕx symbology.

Symbol	DIMENSIONS			
	INCH		MILLIMETERS	
	Min	Max	Min	Max
BL	.395	.405	10.03	10.29
BW	.291	.301	7.39	7.65
CH	.112	.124	2.84	3.15
LH	.010	.020	0.25	0.51
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.92	3.18
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
LW1	.281	.291	.714	.739
LW2	.090	.100	2.29	2.54
Q1	.030		0.76	
Q2	.030		0.76	
Term 1	Drain			
Term 2	Gate			
Term 3	Source			

5. Revision History

Revision	Date	Description
C	3/2025	• Added APL Part Number to Table 1
B	11/2024	• Updated Product Overview for environments greater than 300 Krad TID • Added Table 1 JANSR2N7587U3/ MRH10N22U3SR • Updated Figure 1 JANSR2N7587U3/ MRH10N22U3SR • Added images to Electrical Performance • Updated Image 2-1 SEE Safe-Operating Area • Added Image 2-2 SMD0.5 Case Outline and Dimensions • Added Section 3 Package Outline Drawing
A	9/2023	Initial Revision

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