150V N-Channel Radiation-Hardened MOSFET

JANSR2N7589U3/MRH15N19U3SR

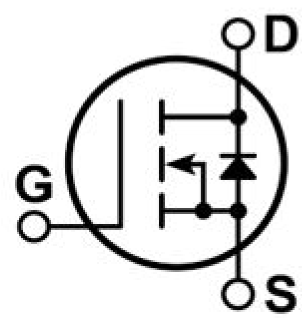
Product Overview

Microchip's new M6[TM] 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. JANSR2N7589U3/MRH15N19U3SR Ordering Options

Part Number	Radiation Level	$R_{DS(on)}$	I_D	QPL Part Number
MRH15N19U3SR	100KRad (Si)	0.088Ω	19A	JANSR2N7589U3
MRH15N19U3SF	300KRad (Si)	0.088Ω	19A	—

Figure 1. JANSR2N7589U3/MRH15N19U3SR Package and Pin Description



Features

The following are key features of the JANSR2N7589U3/MRH15N19U3SR 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 JANSR2N7589U3/MRH15N19U3SR 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 JANSR2N7589U3/MRH15N19U3SR device.

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the JANSR2N7589U3/MRH15N19U3SR device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DSS}	Drain-source voltage	150	V
I_D	Continuous drain current at T_C = 25 °C	19	A
	Continuous drain current at T_C = 100 °C	12.7	
I_{DM}	Pulsed drain current[1]	76	
V_{GS}	Gate-source voltage	±20	V
dv/dt	Peak diode recovery	5.0	V/ns
P_D	Max. power dissipation at T_C = 25 °C	75	W
	Linear derating factor	0.60	W/°C
T_J, T_{STG}	Operating junction and storage temperature range	–55 to 150	°C
T_L	Soldering temperature for 5 seconds (1.6 mm from case)	300	
Wt	Package weight	1.0 (typical)	g

Note:

1. Repetitive rating: pulse width and case temperature limited by maximum junction temperature.

1.2 Electrical Performance

The following table shows the static characteristics of the JANSR2N7589U3/MRH15N19U3SR device. T_A = +25 °C unless otherwise specified.

Table 1-2. Static Characteristics

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{BR(DSS)}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1.0 mA		150	—	—	V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 12 V, I_D = 12 A		—	0.07	0.088	Ω
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} =V_{DS}, I_D = 1.0 mA		2.0	—	4.0	V
g_{fs}	Forward transconductance	V_{DS} =15 V, I_{DS} = 12 A		13	—	—	S
I_{DSS}	Zero-gate voltage drain current	V_{DS} = 120 V V_{GS} = 0 V	T_A = 25 °C	—	—	10	µA
			T_A = 125 °C	—	—	25	
I_{GSS}	Gate-source leakage current	V_{GS} = ±20 V		—	—	±100	nA

Note:

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

The following table shows the dynamic characteristics of the JANSR2N7589U3/MRH15N19U3SR device. T_A = +25 °C unless otherwise specified.

Table 1-3. Dynamic Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V V_{DS} = 25 V f = 1 MHz	—	2140	—	pF
C_{rss}	Reverse transfer capacitance		—	20	—	
C_{oss}	Output capacitance		—	325	—	
Q_g	Total gate charge	V_{GS} = 12 V I_D = 19 A V_{DS} = 75 V	—	32	50	nC
Q_{gs}	Gate-source charge		—	13	15	
Q_{gd}	Gate-drain ("Miller") charge		—	5	20	

The following table shows the switching characteristics of the JANSR2N7589U3/MRH15N19U3SR device.

Table 1-4. Switching Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Time-on delay time	V_{GS} = 12 V I_D = 19 A V_{DS} = 75 V $R_{G(ext)}$ = 7.5 Ω[1]	—	15	25	ns
t_r	Voltage rise time		—	4	30	
$t_{d(off)}$	Time-off delay time		—	18	60	
t_f	Voltage fall time		—	6	30	

Note:

1. R_G is the external gate resistance excluding internal gate driver impedance.

The following table shows the source-drain characteristics of the JANSR2N7589U3/MRH15N19U3SR device. T_A = +25 °C unless otherwise specified.

Table 1-5. Source-Drain Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
I_S	Continuous source current (body diode)	Integral reverse P-N junction diode	—	—	19	A
I_{SM}	Pulsed source current (body diode)[1]		—	—	76	
V_{SD}	Diode forward voltage[2]	I_{SD} = 19 A T_A = 25 °C V_{GS} = 0 V	—	—	1.2	V
ESR	Gate equivalent source resistance	*F*=1 MHZ Level = 25 mV drain short	—	1.67	—	Ω
trr	Reverse recovery time	IF = 19 A di/dt ≤ 100 A/µs V_{DD} ≤ 50 V	—	—	350	ns

Notes:

1. Repetitive rating: pulse width and case temperature limited by maximum junction temperature.
2. Pulse test: pulse width < 300 µs, duty cycle < 2%.

The following table shows the thermal resistance of the JANSR2N7589U3/MRH15N19U3SR device.

Table 1-6. Thermal Resistance

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

1.3 Typical Performance Curves

This section shows the typical performance curves of the JANSR2N7589U3/MRH15N19U3SR device.

Figure 1-1. Output Characteristics at 25 °C

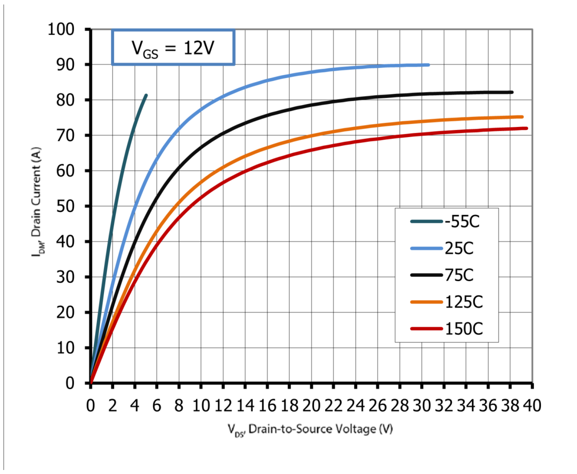


Figure 1-2. Output Characteristics at 150 °C

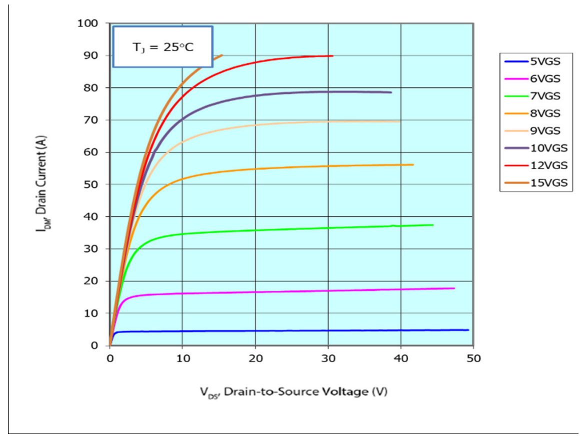


Figure 1-3. I_{DM} vs. V_{GS} at 25 °C and 150 °C

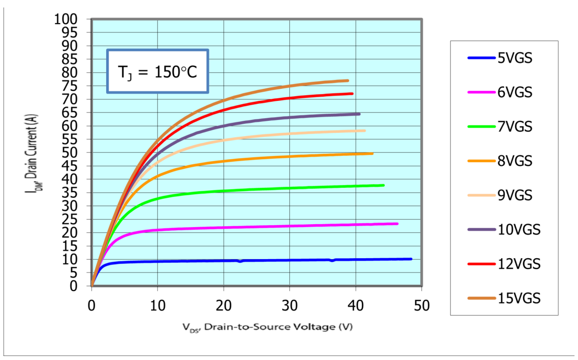


Figure 1-4. $R_{DS(on)}$ vs. Junction Temperature

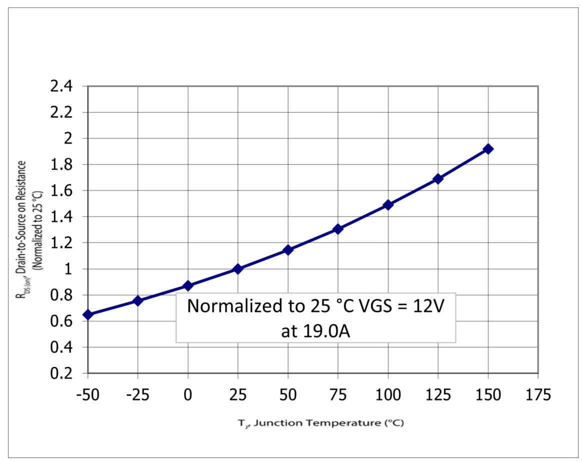


Figure 1-5. Q_C vs. V_{GS}

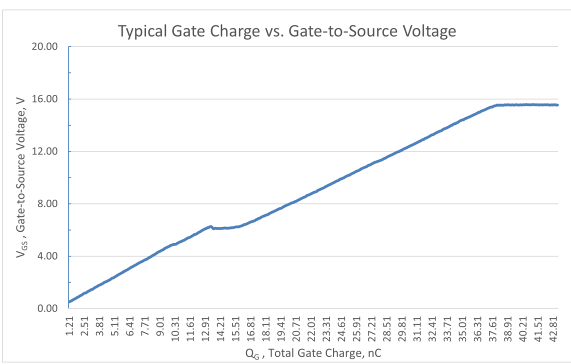


Figure 1-6. Capacitance vs. V_{DS}

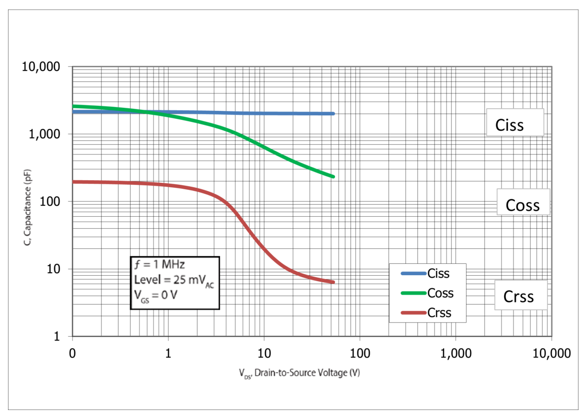


Figure 1-7. I_{DM} vs. V_{GS}

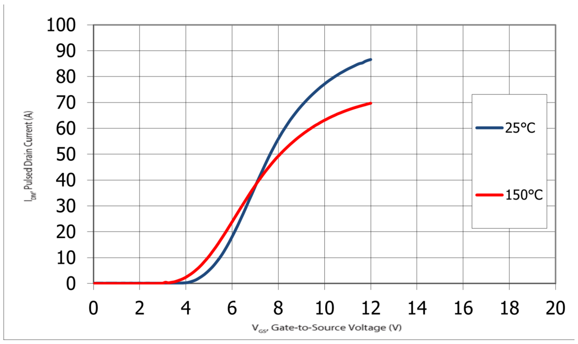


Figure 1-8. I_{DM} vs. V_{DS} 3rd Quadrant Conduction

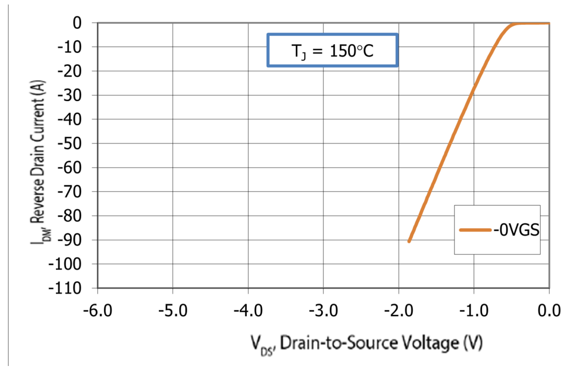


Figure 1-9. I_{DM} vs. V_{DS} 3rd Quadrant Conduction

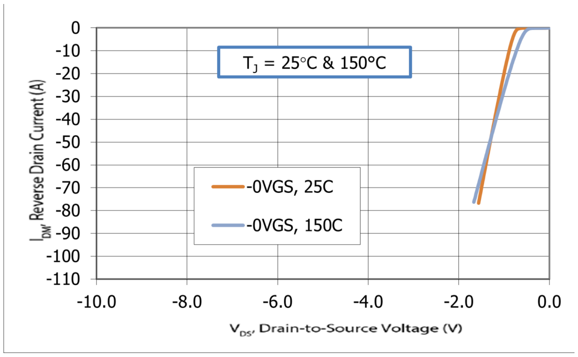


Figure 1-10. $V_{GS(th)}$ vs. Junction Temperature

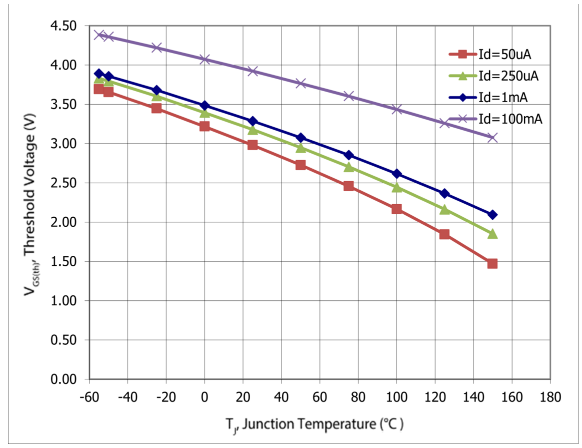


Figure 1-11. Forward Safe Operating Area

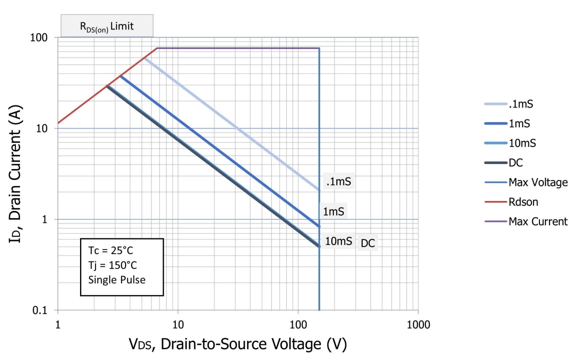


Figure 1-12. Maximum Transient Thermal Impedance

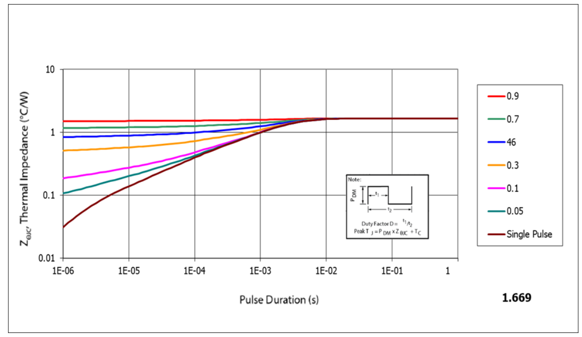


Figure 1-13. $R_{DS(on)}$ vs. Gate Voltage

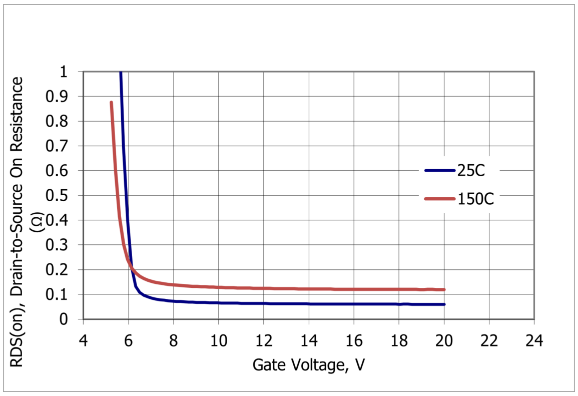


Figure 1-14. $R_{DS(on)}$ vs. Drain Current

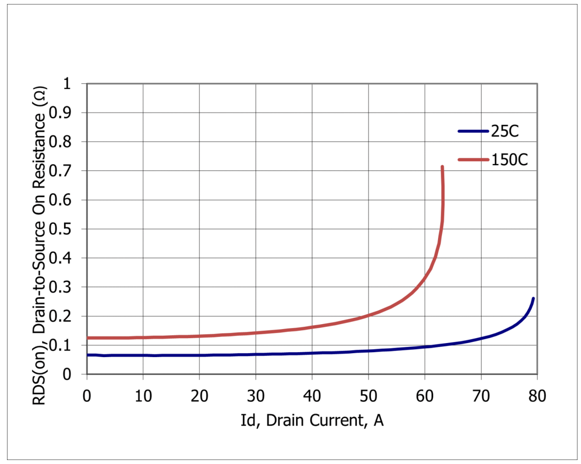
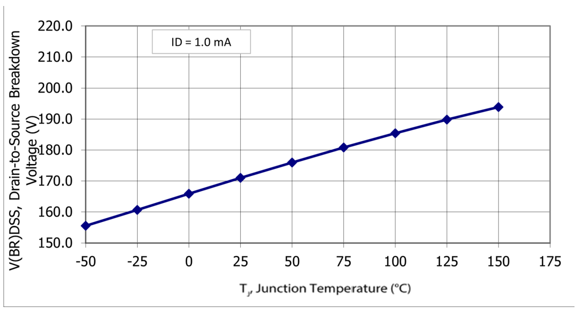


Figure 1-15. $V_{(BR)dss}$ vs. Junction Temperature



2. Single-Event Effects

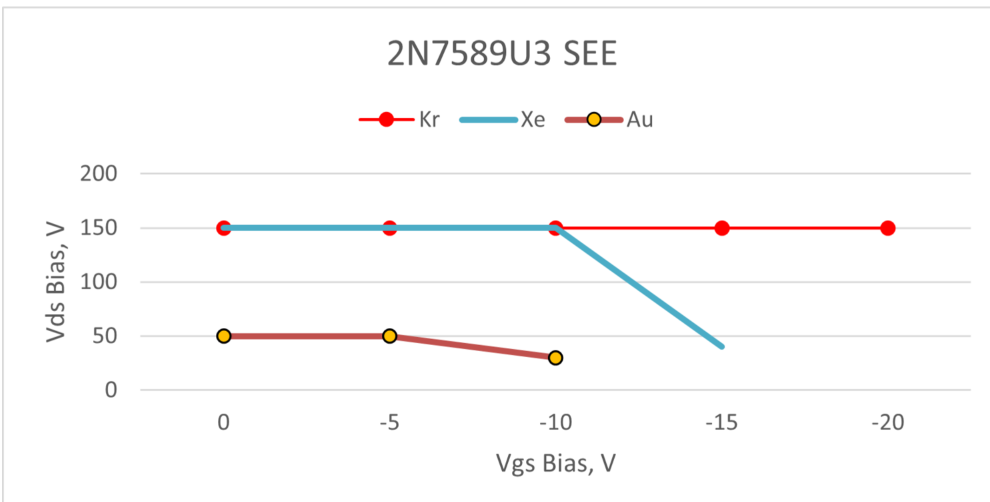
The Microchip JANSR2N7589U3/MRH15N19U3SR device has been characterized for heavy ion responses at the Texas A&M cyclotron. Devices have been characterized up to V_{DS} = 150 V and V_{GS} = –20 V. The following single-event effects (SEE) safe-operating area profile has been established using the ions, linear energy transfer (LET), range, and total energy conditions shown.

Table 2-1. Safe-Operating Area Profile

Parameter	Description	Environment		V_{DS} (V)				
Ion species	**Typical LET (MeV/(mg/cm²))**	**Ion Energy (MeV)**	**Eff Range (µm)**	V_{GS} = 0 V	V_{GS} = 5 V	V_{GS} = 10 V	V_{GS} = 15 V	V_{GS} = 20 V
Kr	38.6 (39 ±5%)	410 (410 ±5%)	50.8 (50 ±5%)	150	150	150	150	150
Xe	64 (61 ±5%)	942 (825 ±5%)	69.6 (66 ±7.5%)	150	150	150	40	—
Au	90 (90 ±5%)	1489 (1470 ±5%)	83.2 (80 ±5%)	50	50	30	—	—

The following figure shows the safe-operating area of the JANSR2N7589U3/MRH15N19U3SR device.

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.

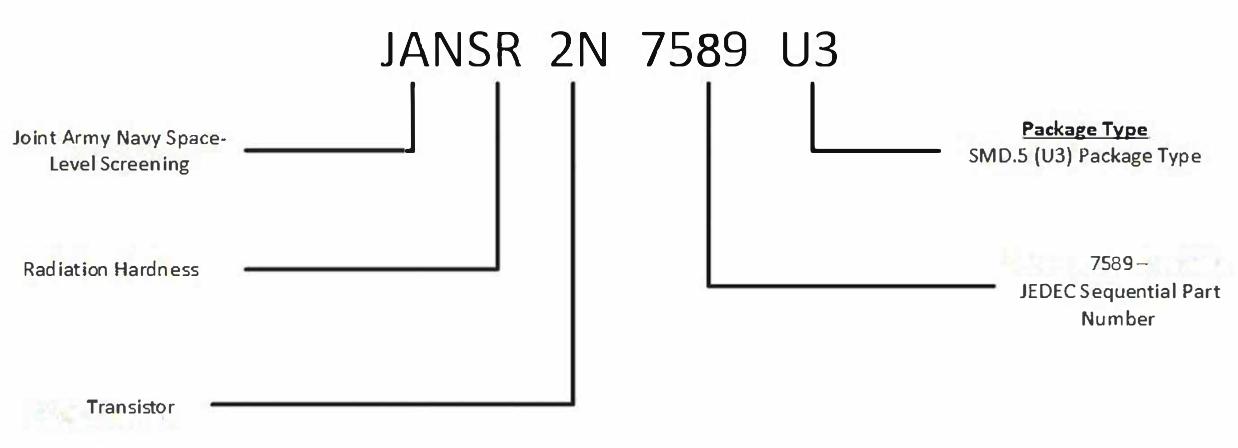
A V_{GS}/V_{DS} point is accepted on the prior plot if all of the following conditions are met:

1. A fluence of $3x10^5$ ±20% ions/cm^2 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.

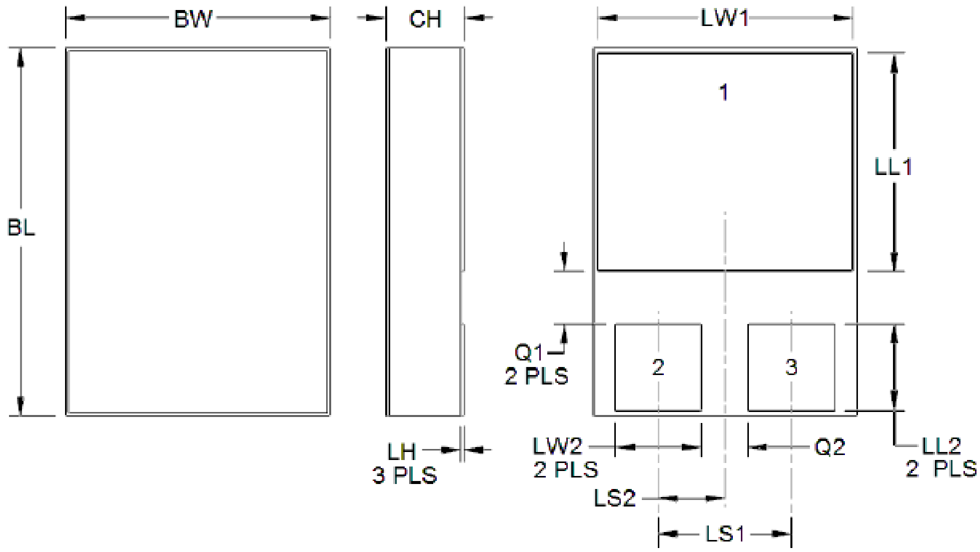
3. Part Nomenclature

The following image shows the part nomenclature for the JANSR2N7589U3 device. MRH15N19U3 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 Level	Date	Description
C	11/2024	• Updated Product Overview for environments greater than 300 Krad TID • Added Table 1 JANSR2N7587U3/MRH10N22U3SR • Updated Figure 1 JANSR2N7587U3/MRH10N22U3SR • Updated Figure 1-11 Forward Safe Operating Area • Added Section 3 Package Outline Drawing
B	8/2023	Updated Figure 1-11 Forward Safe Operating Area.
A	11/2022	Document created.

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