

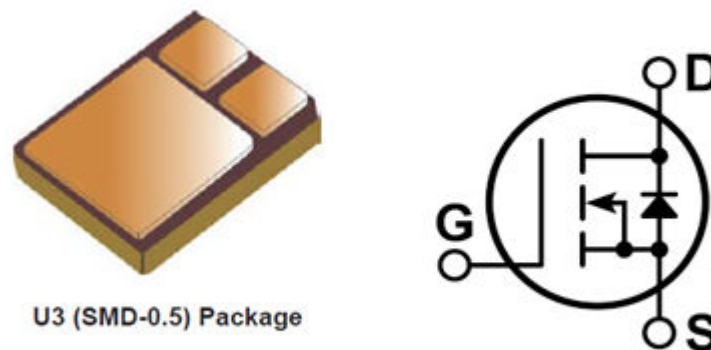
Product Overview

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. 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

- Product Overview..... 1
 - Features..... 1
 - Applications..... 2
- 1. Electrical Specifications..... 4
 - 1.1. Absolute Maximum Ratings..... 4
 - 1.2. Electrical Performance..... 4
 - 1.3. Typical Performance Curves..... 5
- 2. Single-Event Effects..... 9
- 3. Part Nomenclature..... 10
- 4. Package Outline Drawing..... 11
- 5. Revision History..... 12
- Microchip Information..... 13
 - Trademarks..... 13
 - Legal Notice..... 13
 - Microchip Devices Code Protection Feature..... 14

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 $T_C = 25\text{ }^\circ\text{C}$	19	A
	Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$	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 $T_C = 25\text{ }^\circ\text{C}$	75	W
	Linear derating factor	0.60	W/ $^\circ\text{C}$
T_J, T_{STG}	Operating junction and storage temperature range	-55 to 150	$^\circ\text{C}$
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. $T_A = +25\text{ }^\circ\text{C}$ unless otherwise specified.

Table 1-2. Static Characteristics

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

Table 1-3. Dynamic Characteristics

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	$V_{GS} = 0\text{ V}$	—	2140	—	pF
C_{rSS}	Reverse transfer capacitance	$V_{DS} = 25\text{ V}$	—	20	—	
C_{oss}	Output capacitance	$f = 1\text{ MHz}$	—	325	—	
Q_g	Total gate charge	$V_{GS} = 12\text{ V}$	—	32	50	nC
Q_{gs}	Gate-source charge	$I_D = 19\text{ A}$	—	13	15	
Q_{gd}	Gate-drain ("Miller") charge	$V_{DS} = 75\text{ V}$	—	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	$V_{GS} = 12\text{ V}$	—	15	25	ns
t_r	Voltage rise time	$I_D = 19\text{ A}$	—	4	30	
$t_{d(off)}$	Time-off delay time	$V_{DS} = 75\text{ V}$	—	18	60	
t_f	Voltage fall time	$R_{G(ext)} = 7.5\ \Omega^1$	—	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. $T_A = +25\text{ °C}$ 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	$I_{SD} = 19\text{ A}$ $T_A = 25\text{ °C}$ $V_{GS} = 0\text{ V}$	—	—	1.2	V
ESR	Gate equivalent source resistance	$f = 1\text{ MHz}$ Level = 25 mV drain short	—	1.67	—	Ω
t_{rr}	Reverse recovery time	$I_F = 19\text{ A}$ $di/dt \leq 100\text{ A}/\mu\text{s}$ $V_{DD} \leq 50\text{ V}$	—	—	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	$^{\circ}\text{C}/\text{W}$

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

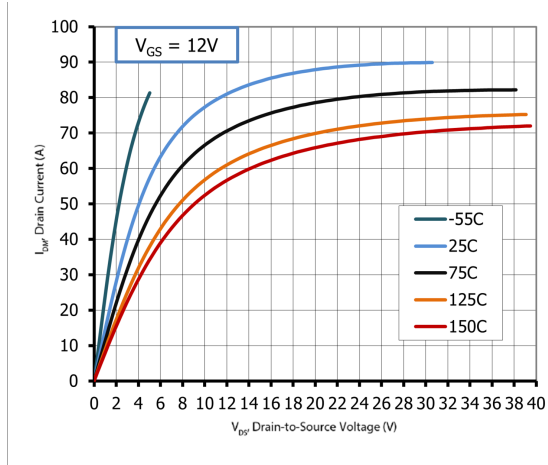


Figure 1-2. Output Characteristics at 150 °C

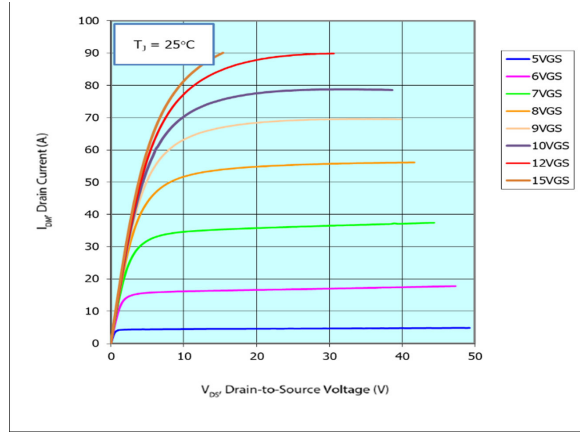


Figure 1-3. I_{DM} vs. V_{GS} at 25 °C and 150 °C

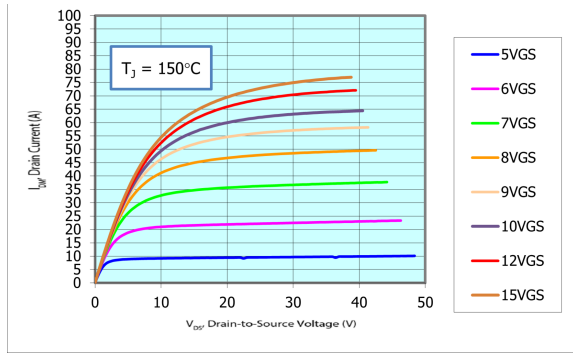


Figure 1-4. $R_{DS(on)}$ vs. Junction Temperature

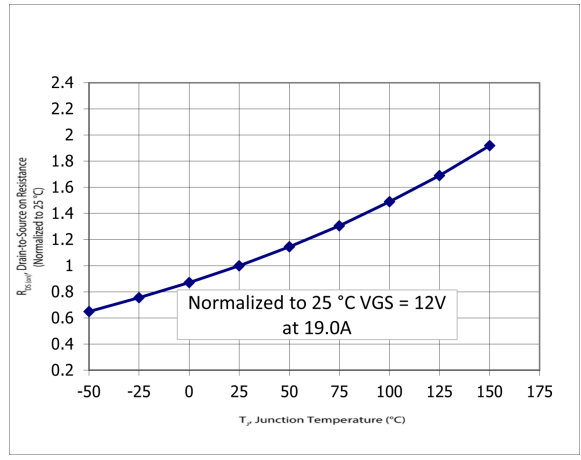


Figure 1-5. Q_C vs. V_{GS}

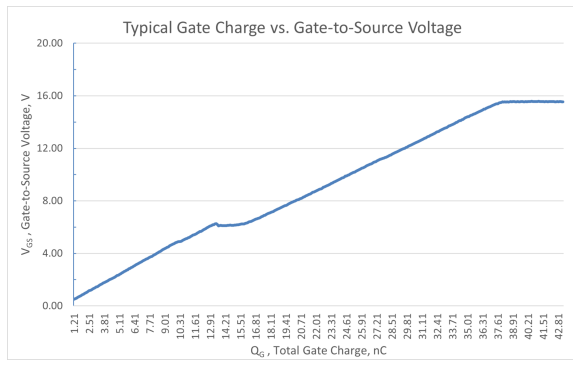


Figure 1-6. Capacitance vs. V_{DS}

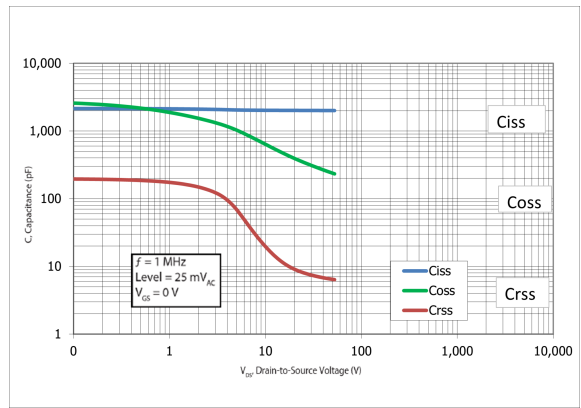


Figure 1-13. $R_{DS(on)}$ vs. Gate Voltage

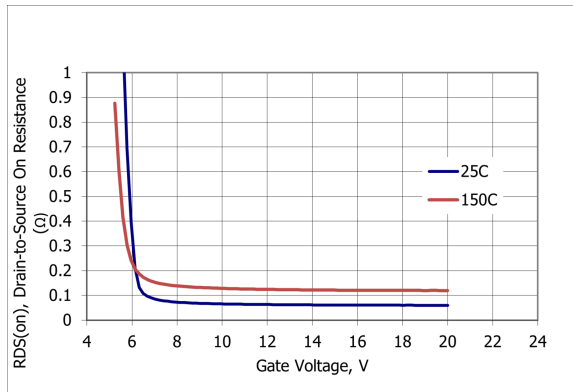


Figure 1-14. $R_{DS(on)}$ vs. Drain Current

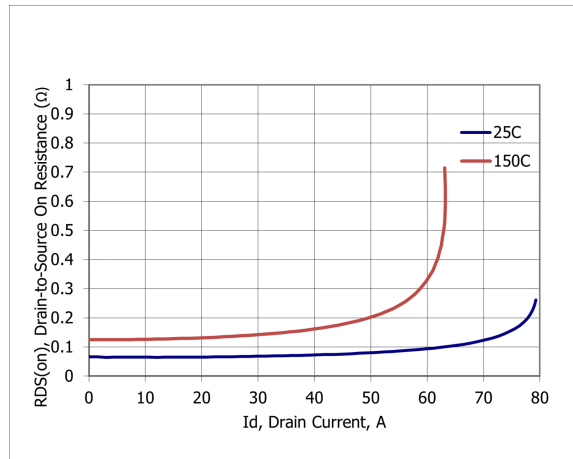
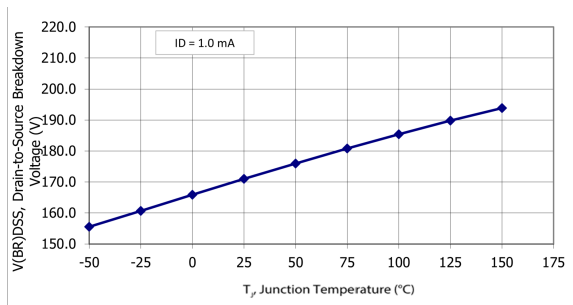


Figure 1-15. $V_{(BR)dss}$ vs. Junction Temperature



2. Single-Event Effects

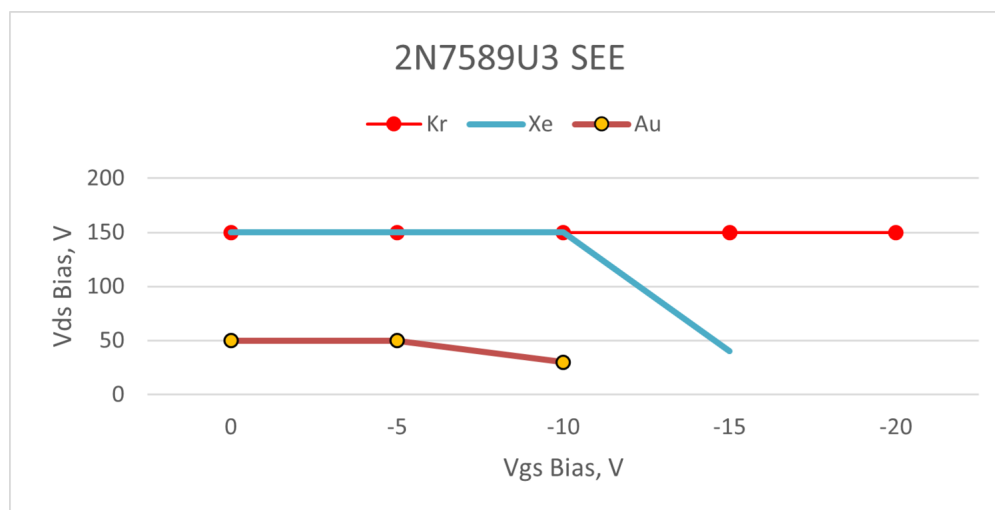
The Microchip JANSR2N7589U3/MRH15N19U3SR device has been characterized for heavy ion responses at the Texas A&M cyclotron. Devices have been characterized up to $V_{DS} = 150$ V and $V_{GS} = -20$ V. The following single-event effects (SEE) safe-operating area profile has been established using the ions,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

Table 2-1. Safe-Operating Area Profile

Parameter	Description	Environment		V_{DS} (V)				
				$V_{GS} = 0$ V	$V_{GS} = 5$ V	$V_{GS} = 10$ V	$V_{GS} = 15$ V	$V_{GS} = 20$ V
Ion species	Typical LET (MeV/(mg/cm ²))	Ion Energy (MeV)	Eff Range (μm)					
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.

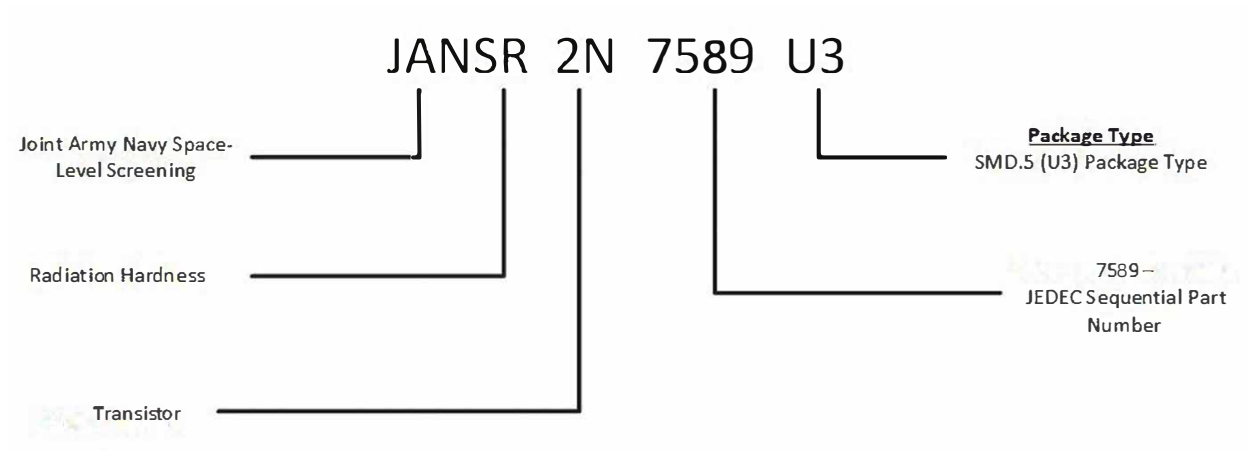
A V_{GS}/V_{DS} point is accepted on the prior plot if all of the following conditions are met:

1. A fluence of $3 \times 10^5 \pm 20\%$ 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.

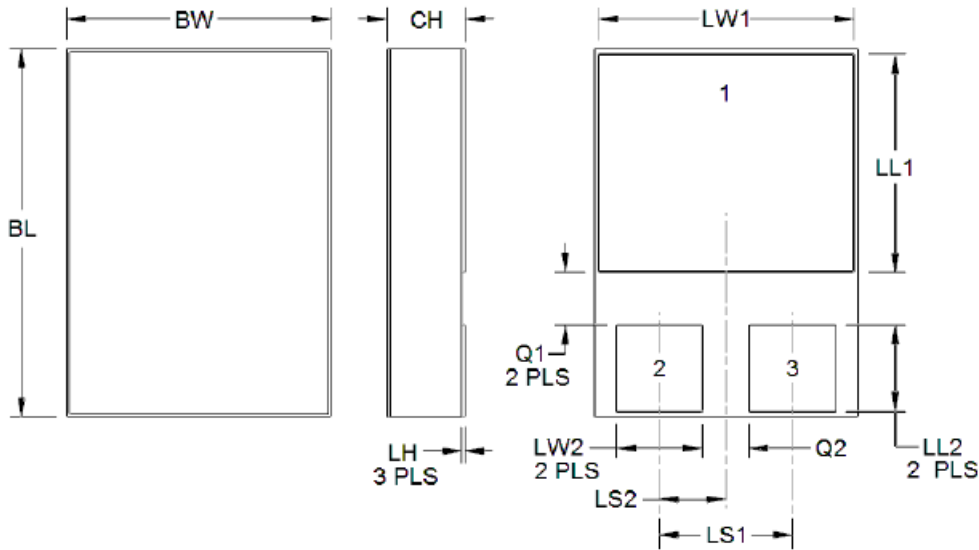
3. Part Nomenclature

The following image shows the part nomenclature for the 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	<ul style="list-style-type: none">Updated Product Overview for environments greater than 300 Krad TIDAdded Table 1 JANSR2N7587U3/MRH10N22U3SRUpdated Figure 1 JANSR2N7587U3/MRH10N22U3SRUpdated Figure 1-11 Forward Safe Operating AreaAdded Section 3 Package Outline Drawing
B	8/2023	Updated Figure 1-11 Forward Safe Operating Area.
A	11/2022	Document created.

Microchip Information

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, KoD, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2024, Microchip Technology Incorporated and its subsidiaries. All Rights Reserved.

ISBN: 979-8-3371-0040-1

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.