200V, 45A N-Channel Radiation-Hardened MOSFET Qualified to MIL-PRF-19500/753 for Space Applications

JANSR2N7584T1 and JANSF2N7584T1

Product Overview

Developed on Microchip's new M6™ technology, the JANSR2N7584T1/MRH20N45T1 radiation hardened N-channel MOSFET provides high performance and radiation tolerance for space and defense applications. The proprietary M6 technology is designed to perform in extreme-environment applications and has been shown to remain within specification in radiation environments greater than 300 krad(Si) total ionizing dose (TID). Low $R_{DS(ON)}$, high current capability, and improved safe operating area (SOA) make this device ideal for DC-DC converters, power distribution and motor control.

Table 1. Ordering Options

Part Number	Screening Level	$R_{DS(ON)}$, max	I_{DS}, DC max	Q_G, max	Package	TID Level
MRH20N45T1	Commercial	0.029Ω	45A	240nC	TO-254AA	N/A
JANSR2N7584T1	JANS	0.029Ω	45A	240nC	TO-254AA	100 krad(Si)
JANSF2N7584T1	JANS	0.029Ω	45A	240nC	TO-254AA	300 krad(Si)
2C20N45-F5	Commercial	0.029Ω	45A	240nC	Die	N/A
JANKCBR2N7584	JANKC	0.029Ω	45A	240nC	Die	100 krad(Si)
JANKCBF2N7584	JANKC	0.029Ω	45A	240nC	Die	300 krad(Si)

Features

- Single Event Effect (SEE) Hardened to 90 MeV·cm²/mg per MIL-STD-750 TM 1080
- TID Measured Performance According to MIL-STD-750 TM 1019 Condition A
- ESD Rating: Class 3A MIL-STD-750, TM 1020
- PIND Tested per MIL-STD-750 TM 2052
- Isolated Lid from Rest of Package Frame
- Hermetically Sealed with Lid Brazed to Body
- Backside Metal Tab (Electrically Connected to Drain) Mountable to PCB to Aid Heat Transfer Away from Die
- Rugged Design with Measured SOA and Single Pulse Avalanche Characterization
- Simple Voltage Control Drive Requirements

Applications

- Satellites, Deep Space Probes
- Nuclear Facilities
- Isolated/Non-Isolated DC–DC Converters
- Motor Control
- Power Distribution/Protection

Figure 1. Package and Pin Description

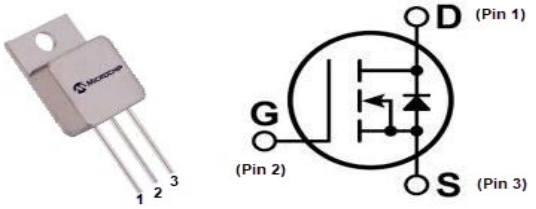


Table of Contents

1. Electrical Specifications

1.1. Absolute Maximum Ratings

Table 1-1. Absolute Maximum Ratings Pre-Irradiation

Symbol	Parameter	Ratings	Unit
I_{DS}	Continuous Drain Current at T_C = 25 °C	45	A
	Continuous Drain Current at T_C = 100 °C	35	
I_{DM}	Pulsed Drain Current [1]	180	
V_{GS}	Gate-Source Voltage	±20	V
P_D	Max Power Dissipation at T_C = 25 °C	208	W
	Linear Derating Factor	1.67	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	
W_T	Typical Package Mass	9.3	g
E_{AS}	Single Pulse Avalanche Energy[2]	344	mJ
I_{AR}	Avalanche Current[1]	45	A

Note:

1. Repetitive rating: pulse width and case temperature limited by maximum junction temperature.
2. V_{DD} = 25V, starting T_J = 25 °C, L = 302 µH, Peak I_L = 45A, V_{GS} = 12V

1.2. Electrical Performance

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

Symbol	Parameter	Test Conditions		Ratings			Unit
				Min	Typ	Max	
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_{DS} = 1.0 mA		200	—	—	V
$R_{DS(ON)}$	Drain-Source On Resistance [1]	V_{GS} = 12V, I_{DS} = 35A		—	—	0.029	Ω
$V_{GS(TH)}$	Gate-Source Threshold Voltage	$V_{GS} \leq V_{DS}$, I_{DS} = 1.0 mA		2.0	—	4.0	V
G_{FS}	Forward Transconductance[1]	V_{DD} = 15V, I_{DS} = 35A		40	—	—	S
I_{GSS}	Gate-Source Leakage Current	V_{GS} = ±20V		—	—	±100	nA
I_{DSS}	Zero-Gate Voltage Drain Current	V_{DS} = 160V	T_A = 25 °C	—	—	10	µA
		V_{GS} = 0V	T_A = 125 °C	—	—	25	

Note:

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

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

Symbol	Parameter	Test Conditions	Ratings			Unit
			Min	Typ	Max	
C_{ISS}	Input Capacitance	V_{GS} = 0V, V_{DS} = 25V, ƒ = 1 MHz	—	6199	—	pF
C_{RSS}	Reverse Transfer Capacitance		—	23	—	
C_{OSS}	Output Capacitance		—	951	—	

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

Symbol	Parameter	Test Conditions	Ratings			Unit
			Min	Typ	Max	
Q_G	Total Gate Charge	V_{GS} = 12V, I_{DS} = 45A, V_{DD} = 100V	—	—	240	nC
Q_{GS}	Gate-Source Charge		—	—	65	
Q_{GD}	Gate-Drain (“Miller”) Charge		—	—	60	
$t_{D(ON)}$	Turn-On Delay Time	V_{GS} = 12V, I_{DS} = 45A, V_{DD} = 100V, $R_{G(EXT)}$ = 7.5Ω	—	—	40	ns
t_R	Voltage Rise Time		—	—	125	
$t_{D(OFF)}$	Turn-Off Delay Time		—	—	85	
t_F	Voltage Fall Time		—	—	30	

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

Symbol	Parameter	Test Conditions	Ratings			Unit
			Min	Typ	Max	
I_S	Continuous Source Current (Body Diode)	—	—	—	45	A
I_{SM}	Pulsed Source Current (Body Diode)[1]	—	—	—	180	
V_{SD}	Diode Forward Voltage	I_{DS} = –45A, V_{GS} = 0V	—	—	1.2	V
t_{RR}	Reverse recovery time[2]	I_{DS} = –45A, di/dt ≤ –100A/µs, VDD ≤ 50V	—	—	640	ns

Notes:

1. Repetitive Rating: Pulse width and case temperature limited by maxing junction temperature.
2. Pulse Test: Pulse width < 300 µs, duty cycle <2%.

Table 1-5. Package Inductance

Symbol	Parameter	Test Conditions	Ratings			Unit
			Min	Typ	Max	
$L_S + L_D$	Total Inductance	Measured from the center of drain pad to center of source pad	—	6.8	—	nH

1.3. Typical Electrical Performance Curves Pre-Irradiation

Figure 1-1. Typical Output Characteristics

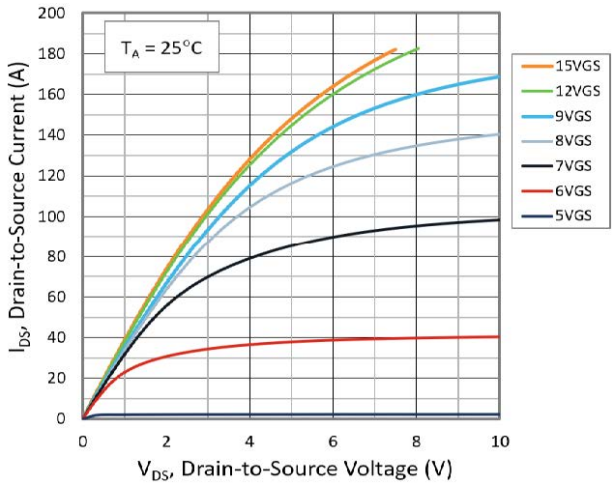


Figure 1-2. Typical Output Characteristics

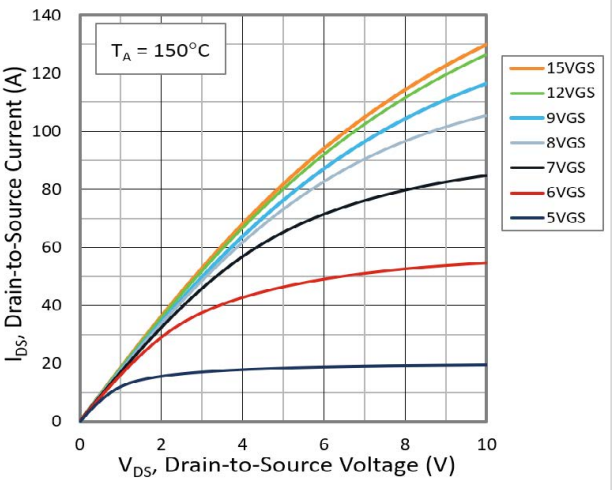


Figure 1-3. Typical Transfer Characteristics

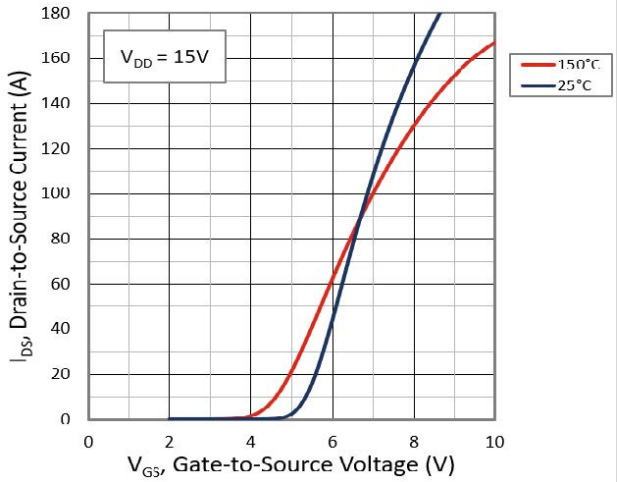


Figure 1-4. Typical $V_{GS(TH)}$ vs T_J

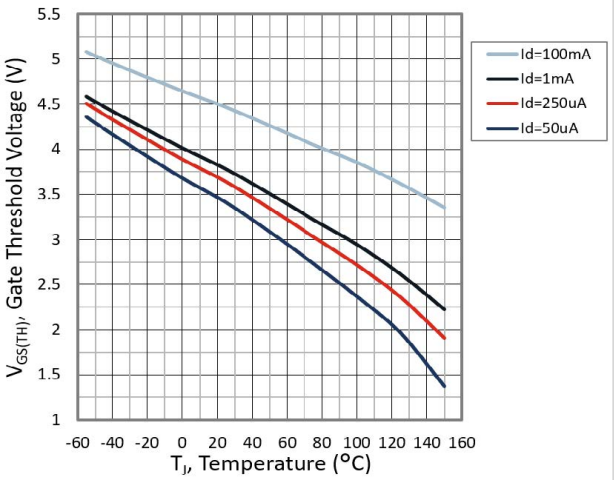


Figure 1-5. Typical $R_{DS(ON)}$ vs V_{GS}

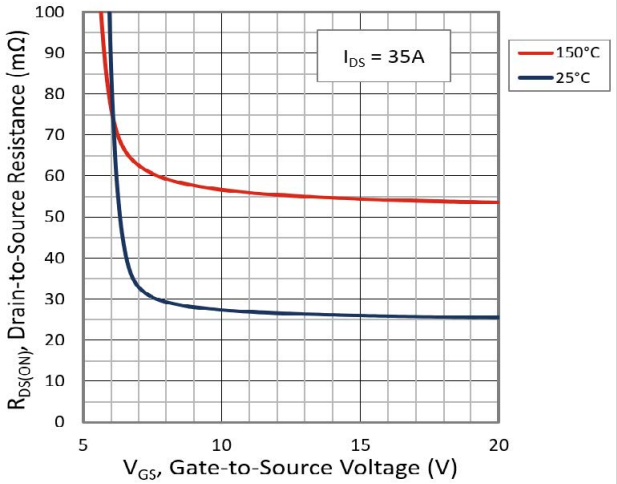


Figure 1-6. Typical $R_{DS(ON)}$ vs I_{DS}

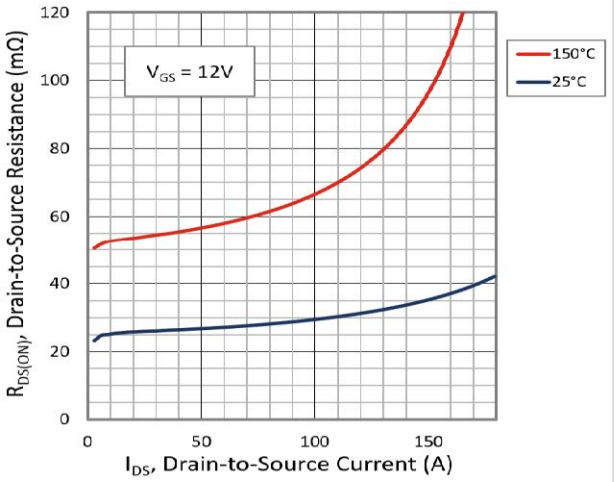


Figure 1-7. Normalized $R_{DS(ON)}$ vs T_J

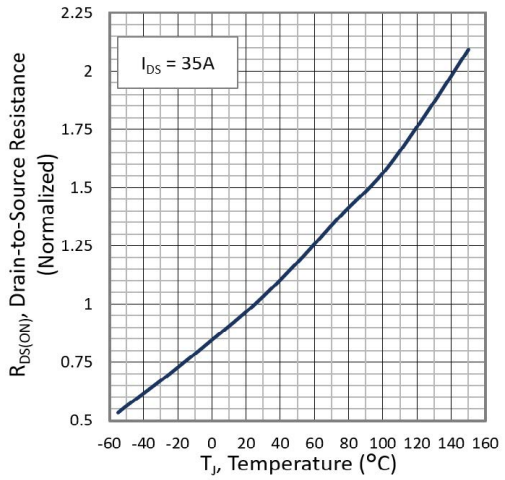


Figure 1-8. $V_{BR(DSS)}$ vs T_J

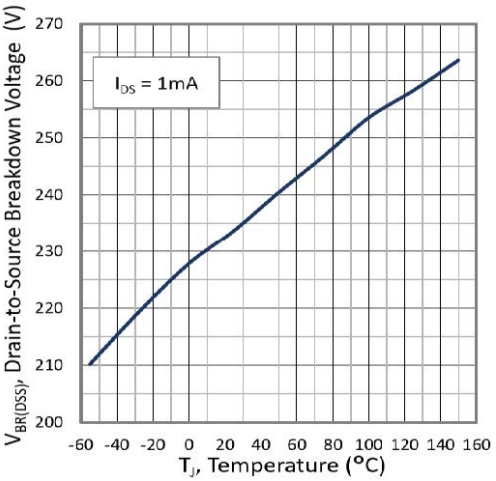


Figure 1-9. Typical Capacitance vs V_{DS}

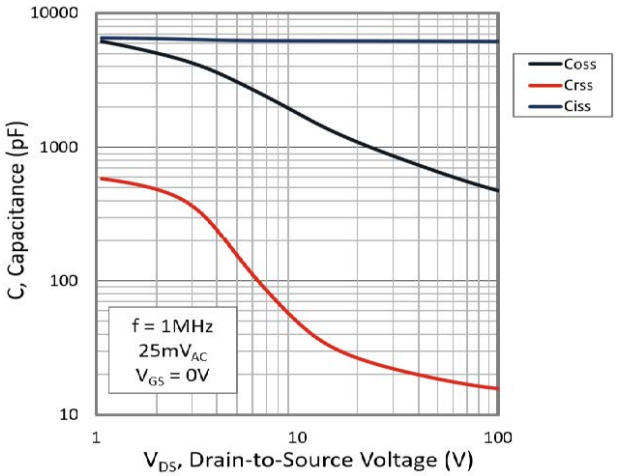


Figure 1-10. Typical V_{GS} vs Q_G

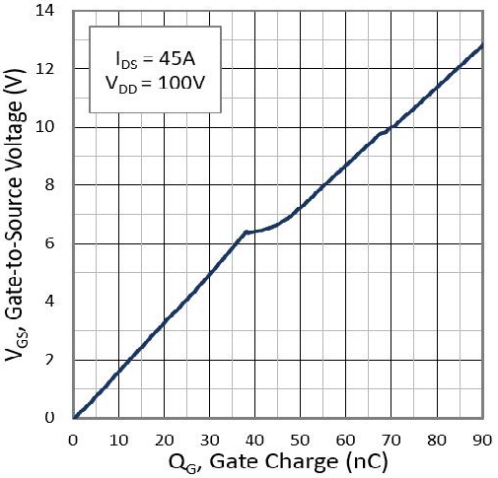


Figure 1-11. Typical Source-Drain Diode Conduction

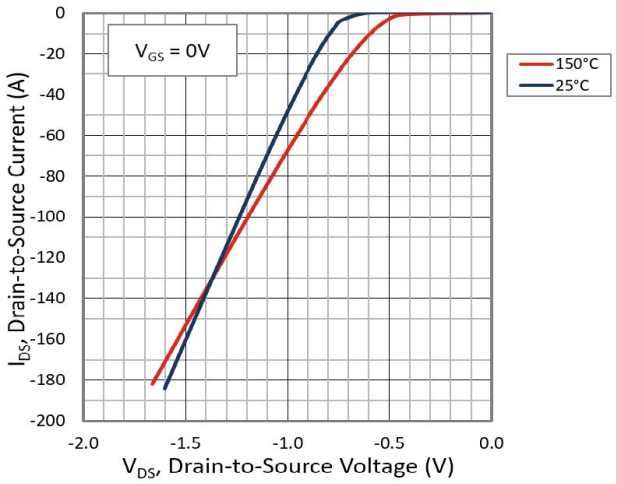


Figure 1-12. I_{DS} vs Case Temperature

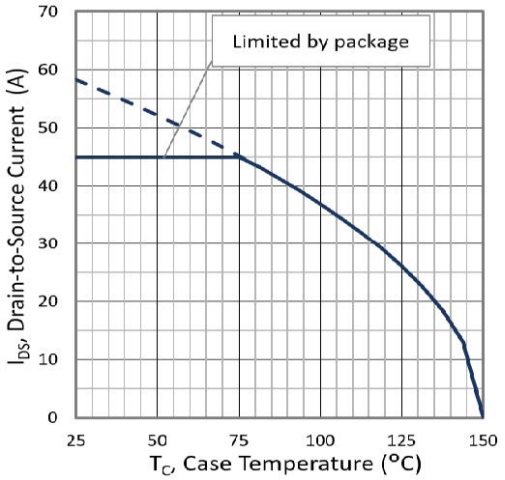
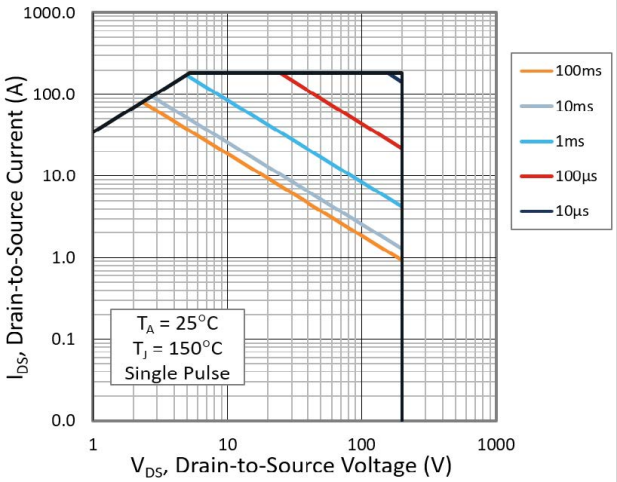


Figure 1-13. Maximum Safe Operating Area



2. Thermal Specifications

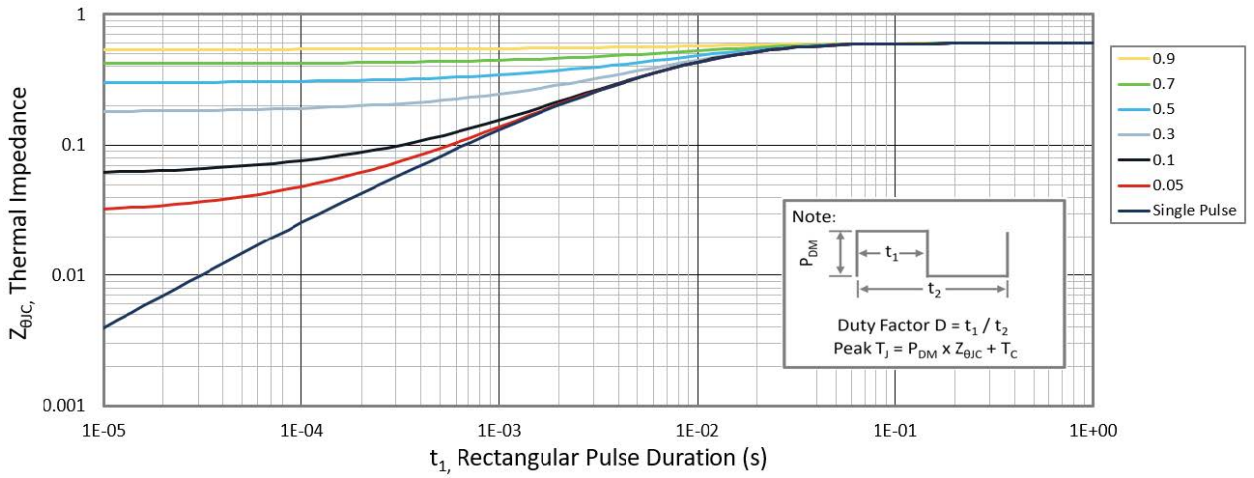
2.1. Thermal Performance

Table 2-1. Thermal Resistance

Symbol	Parameter	Test Conditions	Ratings			Unit
			Min	Typ	Max	
$R_{\theta JC}$	Junction-to-case thermal resistance	—	—	—	0.6	°C/W

2.2. Thermal Performance Curves

Figure 2-1. Maximum Transient Thermal Impedance



3. Radiation Performance

3.1. Post Total Dose Irradiation Electrical Performance

Table 3-1. Static Characteristics T_A = 25 °C, 300 krad(Si), 50–300 krad(Si)/s, unless otherwise noted

Symbol	Parameter	Test Conditions		Ratings			Unit
				Min	Typ	Max	
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_{DS} = 1.0 mA		200	—	—	V
$R_{DS(ON)}$	Drain-Source On Resistance[1] (SMD-0.5)	V_{GS} = 12V, I_{DS} = 35A		—	—	0.029	Ω
$V_{GS(TH)}$	Gate-Source Threshold Voltage	$V_{GS} \le V_{DS}$, I_{DS} = 1.0 mA		2.0	—	4.0	V
V_{SD}	Diode Forward Voltage	I_{DS} = –45A, V_{GS} = 0V		—	—	1.2	V
I_{GSS}	Gate-Source Leakage Current	V_{GS} = ±20V		—	—	±100	nA
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 160V, 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%

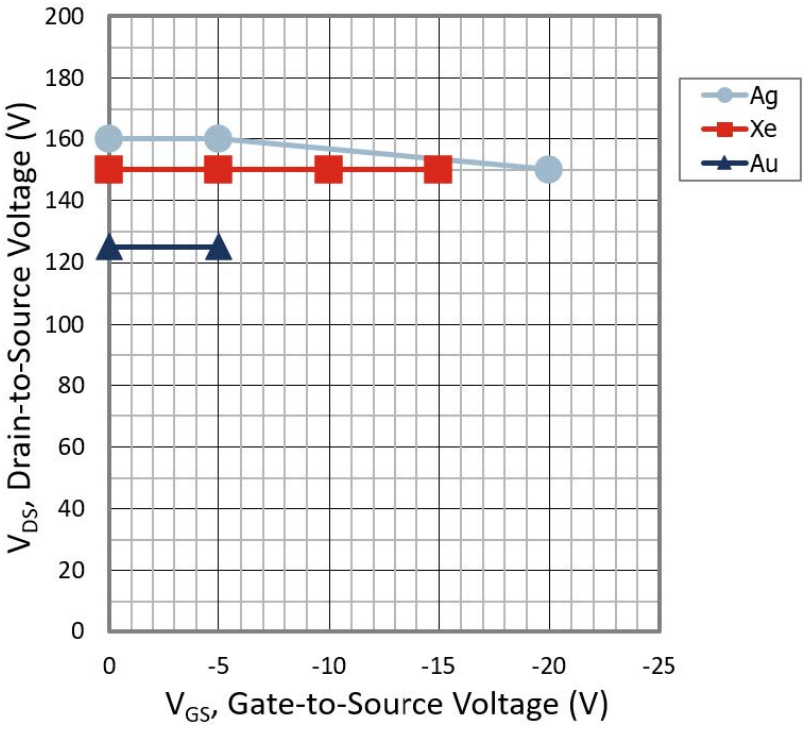
3.2. Single Event Effects (SEE) Performance

This device has been characterized for SEE with heavy ions. The following SEE safe-operating area profile has been established using the ions, linear energy transfer (LET), range and total energy conditions shown.

Table 3-2. SEE Safe-Operating Area

Ion Species	Eff. Surface LET (MeV·cm²/mg)	ION Energy (MeV)	Eff Range (µm)	VDS(V)				
				V_{GS} = 0V	V_{GS} = –5V	V_{GS} = –10V	V_{GS} = –15V	V_{GS} = –20V
Ag	44 (±5%)	1330 (±5%)	117 (±5%)	160	160	—	—	150
Xe	63.9 (±5%)	946 (±5%)	70 (±7.5%)	150	150	150	150	—
Au	90.0 (±5%)	1490 (±5%)	83 (±5%)	125	125	—	—	—

Figure 3-1. 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.

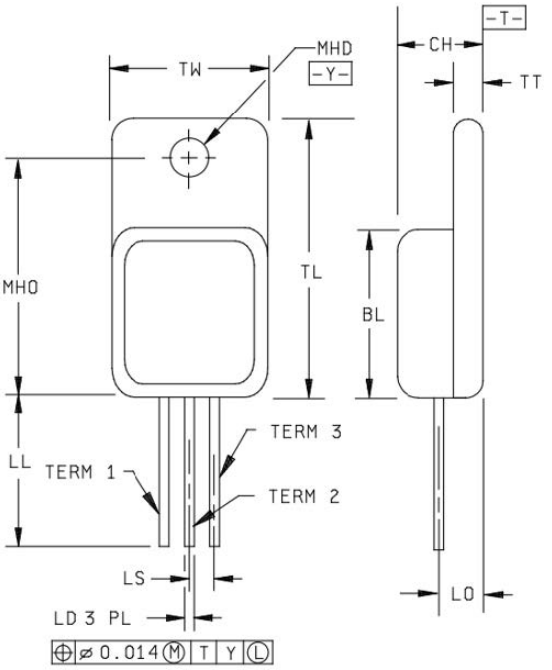
A V_{GS}/V_{DS} point is accepted on the prior plot if all of the following conditions are met:

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 I_{DSS} tests continue to pass specification.
5. Post-Exposure I_{GSS} tests continue to pass specification.

4. Package Details

4.1. Package Outline Drawing

Figure 4-1. Package Outline Drawing



Note:

1. All terminals are isolated from case

Table 4-1. Package Dimensions

Symbol	Dimensions			
	Inch		Millimeter	
	Min	Max	Min	Max
BL	0.535	0.545	13.59	13.84
CH	0.249	0.260	6.32	6.60
LL	0.510	0.570	12.95	14.48
LO	0.150 BSC		3.81 BSC	
LS	0.150 BSC		3.81 BSC	
MHD	0.139	0.149	3.53	3.78
MHO	0.665	0.685	16.89	17.40
TL	0.790	0.800	20.07	20.32
TT	0.040	0.050	1.02	1.27
TW	0.535	0.545	13.59	13.84
Term 1	Drain			
Term 2	Source			
Term 3	Gate			

5. Die Details

5.1. Die Drawing

Figure 5-1. Die Drawing

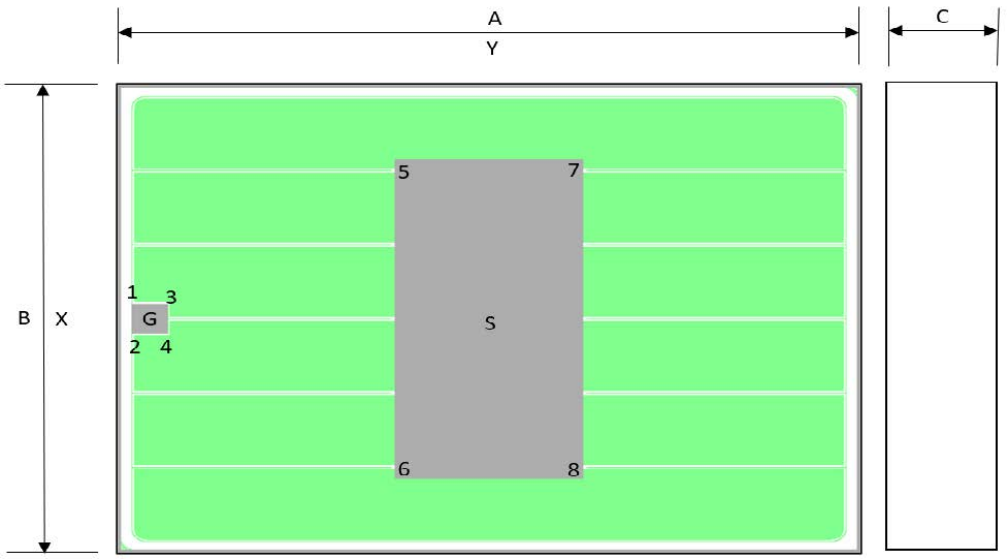


Table 5-1. Die Dimensions

Key	Dimensions					
	Inch	Inch	Micrometer	Micrometer	Tolerance	Tolerance
	X	Y	X	Y	Inch	Micrometer
1	0	0	0	0	±0.0002	±5
2	0.01622	0	412	0	±0.0002	±5
3	0	0.01606	0	408	±0.0002	±5
4	0.01622	0.01606	412	408	±0.0002	±5
5	0.08047	0.12012	2044	3051	±0.0002	±5
6	0.09669	0.12012	2456	3051	±0.0002	±5
7	0.08047	0.20673	2044	5251	±0.0002	±5
8	0.09669	0.20673	2456	5251	±0.0002	±5
A	0.3431		8714		±0.0079	±200
B	0.2631		6684		±0.0079	±200
C	0.0150		381		±0.0010	±25

Notes:

1. Dimensions are in inches. Micrometers are given for general information only.
2. All dimensions are valid for all radiation hardness levels specified.
3. For sawn die, outline dimensions (A and B) will be reduced by 0.001 inches (25 µm), due to saw kerf.
4. Die bond pad coordinates are provided for use in automate bonding equipment. Key locations 1 through 4 refer to adjacent gate (G) pad corners. Key locations 5 through 8 refer to adjacent source (S) pad corners.
5. Keys 2 through 8 are relative to Key 1.
6. Top metal: Titanium, Titanium Nitride, 1000 Å, Aluminum Copper (0.5%), 45,000 Å
7. Back metal: Titanium, Nickel, Silver 700 Å, 3200 Å, 7500 Å thick, respectively
8. Backside metal is the drain connection.

6. Part Nomenclature

6.1. Qualified Packaged Devices[1]

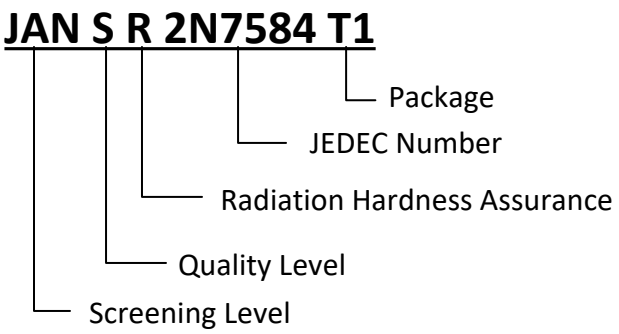


Table 6-1. Qualified Package Devices Description

Term	Initial	Option
Screening Level	JAN	Joint Army Navy
Quality Level	S	Space grade
Radiation Hardness Assurance	R	100 krad(Si)
	F	300 krad(Si)
JEDEC Number	2N8587	
Package	T1	TO-254AA

Example:

JANSF2N7584: Space grade 2N7584 MOSFET with 300 krad(Si) rating in a T1 package.

Note:

1. Cage Code: 43611

6.2. Qualified Unencapsulated Devices (Die Version)[1,2]

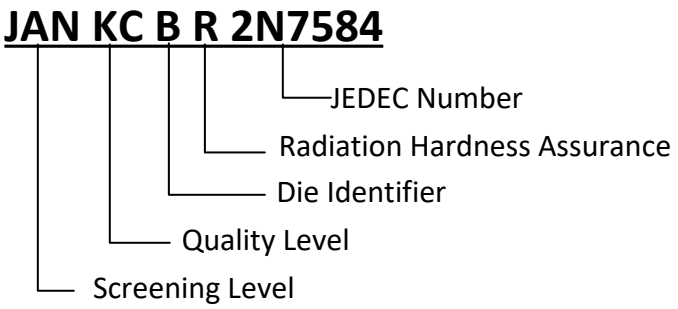


Table 6-2. Qualified Unencapsulated Devices Description

Term	Initial	Option
Screening Level	JAN	Joint Army Navy
Quality Level	KC	Screened per MIL-PRF-19500 Class K for space applications
Die Identifier	B	Microchip die
Radiation Hardeness Assurance	R	100 krad(Si)
	F	300 krad(Si)
JEDEC Number	2N7584	

Notes:

1. Please refer to slash sheet MIL-PRF-19500/753 for more die information.
2. Cage code: 43611

6.3. Commercial Packaged Devices[1, 2]

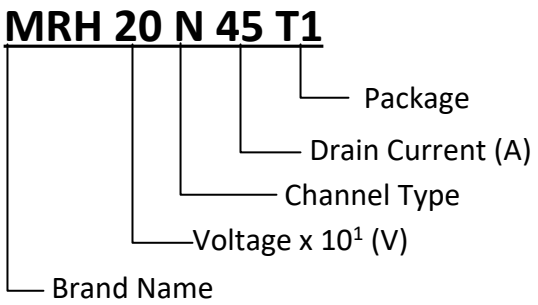


Table 6-3. Commercial Package Devices Description

Term	Initial	Option
Brand Name	MRH	Microchip Radiation Hardened
Voltage (V)	20	$20 \times 10^1 = 200V$
Channel Type	N	N-Channel
Drain Current	45	45A
Package	T1	TO-254AA

Notes:

1. Commercial screened devices are intended for engineering evaluation and are not available with any quality levels or radiation hardness assurance.
2. Commercial screened devices are only tested to meet static electrical specifications.

6.4. Commercial Unencapsulated Devices (Die Version)[1,2,3]

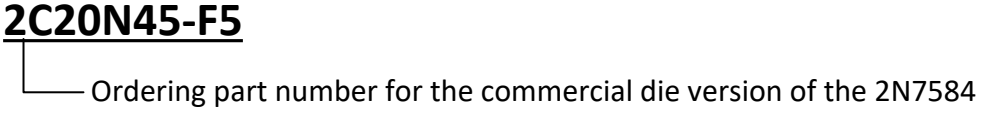


Table 6-4. Commercial Unencapsulated Devices Description

Term	Initial	Option
	2C	MOSFET Die
Voltage (V)	20	20×10^1 = 200V
Channel Type	N	N-Channel
Drain Current	45	45A
	F5	Internal Microchip Fabrication Site

Notes:

1. Commercial screened devices are intended for engineering evaluation and are not available with any quality levels or radiation hardness assurance.
2. Commercial screened devices are only tested to meet static electrical specifications.
3. Please refer to slash sheet MIL-PRF-19500/753 for more die information.

7. Additional Product Resources

7.1. Product Webpages

JANSR2N7584T1-MOSFET | Microchip Technology

Main webpage for this product

Radiation-Hardened Power MOSFETs | Micochip Technology

Main webpage for this product family

8. Revision History

Revision	Date	Description
B	06/2026	• Updated Table 1 Ordering Options • Updated Figure 1 Package and Pin Description • Updated Features • Added information to Applications • Updated Table 1-1 Absolute Maximum Ratings Pre-Irradiation • Updated Table 1-2 Static Characteristics (Pre-Irradiation, T_A = 25 °C unless otherwise noted • Updated Table 1-3 Dynamic Characteristics Pre-Irradiation (T_A = +25 °C) • Updated Table 1-4 Source-Drain Characteristics Pre-Irradiation (T_A = +25 °C) • Updated Table 1-5 Package Inductance • Updated figures in Section 1.3 Typical Electrical Performance Curves Pre-Irradiation • Updated Table 2-1 SEE Safe-Operating Area • Updated Figure 2-1 SEE Safe-Operating Area • Added Sections 3 through 8
A	01/2026	Initial Revision

Microchip Information

Trademarks

The “Microchip” name and logo, the “M” logo, and other names, logos, and brands are registered and unregistered trademarks of Microchip Technology Incorporated or its affiliates and/or subsidiaries in the United States and/or other countries (“Microchip Trademarks”). Information regarding Microchip Trademarks can be found at https://www.microchip.com/en-us/about/legal-information/microchip-trademarks.

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 products are 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.