

The documentation and process conversion measures necessary to comply with this revision shall be completed by 3 February 2023.

INCH-POUND

MIL-PRF-19500/704F
w/AMENDMENT 2
3 November 2022
SUPERSEDING
MIL-PRF-19500/704F
w/AMENDMENT 1
17 July 2019

PERFORMANCE SPECIFICATION SHEET

TRANSISTOR, FIELD EFFECT RADIATION HARDENED
N-CHANNEL, SILICON, TYPES 2N7485U3, 2N7486U3, 2N7487U3, AND 2N7555U3
JANTXVR AND JANSR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and [MIL-PRF-19500](#).

1. SCOPE

1.1 Scope. This specification covers the performance requirements for a N-channel, enhancement-mode, MOSFET, radiation hardened, power transistor. Two levels of product assurance are provided for each device type as specified in [MIL-PRF-19500](#), with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}). See 6.5 for JANHC and JANKC die versions.

1.2 Package outlines. The device package outline for this specification sheet is a surface mount, TO-276AA, SMD-0.5. in accordance with [figure 1](#) for all encapsulated device types.

1.3 Maximum ratings. $T_A = +25^\circ\text{C}$, unless otherwise specified.

Type	P_T (1) $T_C = +25^\circ\text{C}$	P_T $T_A = +25^\circ\text{C}$	$R_{\theta JC}$ (2)	V_{DS}	V_{DG}	V_{GS}	I_{D1} (3) (4) $T_C = +25^\circ\text{C}$	I_{D2} $T_C = +100^\circ\text{C}$	I_S	I_{DM} (5)	T_J and T_{STG}	V_{ISO} 70,000 ft. altitude
	<u>W</u>	<u>W</u>	<u>°C/W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A (pk)</u>	<u>°C</u>	<u>V dc</u>
2N7485U3	75	2.5	1.67	130	130	±20	20	12.5	20	80	-55	N/A
2N7486U3	75	2.5	1.67	200	200	±20	12	7.8	12	48	to	N/A
2N7487U3	75	2.5	1.67	250	250	±20	10	6.4	10	40	+150	250
2N7555U3	75	2.5	1.67	250	250	±20	10	6.4	10	40		250

(1) Derate linearly by 0.6 W/°C for $T_C > +25^\circ\text{C}$.

(2) See [figure 2](#), thermal impedance curves.

(3) The following formula derives the maximum theoretical I_D limit. I_D is limited by package and internal construction.

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta JC}) \times (R_{DS(on)} \text{ at } T_{JM})}}$$

(4) See [figure 3](#), maximum drain current graph.

(5) $I_{DM} = 4 \times I_{D1}$ as calculated in note (3).

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AMSC N/A

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1.4 Primary electrical characteristics at $T_C = +25^\circ\text{C}$.

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$	$V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$	Max I_{DSS1} $V_{GS} = 0$	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{V}$, $I_D = I_{D2}$	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{V}$, $I_D = I_{D2}$	E_{AS}
	$I_D = 1.0\text{mA}$ dc	$I_D = 1.0\text{mA}$ dc	$V_{DS} = 80\%$ of rated V_{DS}	$T_J = +25^\circ\text{C}$	$T_J = +150^\circ\text{C}$	
	<u>V dc</u>	<u>V dc</u> Min Max		<u>μA dc</u>	<u>Ω</u>	<u>mJ</u>
2N7485U3	130	2.5	4.5	10	0.080	65
2N7486U3	200	2.5	4.5	10	0.220	60
2N7487U3	250	2.5	4.5	10	0.400	58
2N7555U3	250	2.5	4.5	10	0.400	58

(1) Pulsed (see 4.5.1).

1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.4.1 for a list of available PINs.

1.5.1 JAN certification mark and quality level. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: "JANTXV" and "JANS".

1.5.2 Radiation hardness assurance (RHA) designator. The RHA level that is applicable for this specification sheet is "R".

1.5.3 Device type. The designation system for the device types of semiconductors covered by this specification sheet are as follows.

1.5.3.1 First number and first letter symbols. The semiconductors of this specification sheet use the first number and letter symbols "2N".

1.5.3.2 Second number symbols. The second number symbols for the semiconductors covered by this specification sheet are as follows: "7485", "7486", "7487", and "7555".

1.5.4 Suffix symbols. The suffix "U3" is used on devices to indicate a 3 pad surface mount package (see figure 1).

1.5.5 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.

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* 1.6 Radiation features. The following radiation features are applicable for RHA devices supplied to this specification sheet.

* 1.6.1 Maximum total ionizing dose (TID). The maximum TID that RHA devices were tested to in accordance with condition A (dose rate = 50 to 300 rad(Si)/s) of method 1019 of [MIL-STD-750](#) are as follows:

For device type 2N7485U3, 2N7486U3, 2N7487U3, and 2N7555U3: 100 krads(Si) 1/

* 1.6.2 Heavy ion irradiation SEE. SEE testing includes Single-Event Burnout (SEB) and Single-Event Gate Rupture (SEGR) tests at the specified linear energy transfer (LET) units. See 6.6 for the specific RHA SEE characterization testing details. The following characterization conditions were used for the testing to the requirements herein:

For device type 2N7485U3:

No SEB and SEGR were observed at surface LET (see [table IV](#)) $\leq 84 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 130 \text{ V}$ and $V_{GS} = -0 \text{ V}$)
(In-situ Bias $V_{DS} = 120 \text{ V}$ and $V_{GS} = -5 \text{ V}$)
(In-situ Bias $V_{DS} = 30 \text{ V}$ and $V_{GS} = -10 \text{ V}$)

For device type 2N7486U3:

No SEB and SEGR were observed at surface LET (see [table IV](#)) $\leq 84 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 200 \text{ V}$ and $V_{GS} = -5 \text{ V}$)
(In-situ Bias $V_{DS} = 150 \text{ V}$ and $V_{GS} = -10 \text{ V}$)
(In-situ Bias $V_{DS} = 50 \text{ V}$ and $V_{GS} = -15 \text{ V}$)
(In-situ Bias $V_{DS} = 25 \text{ V}$ and $V_{GS} = -20 \text{ V}$)

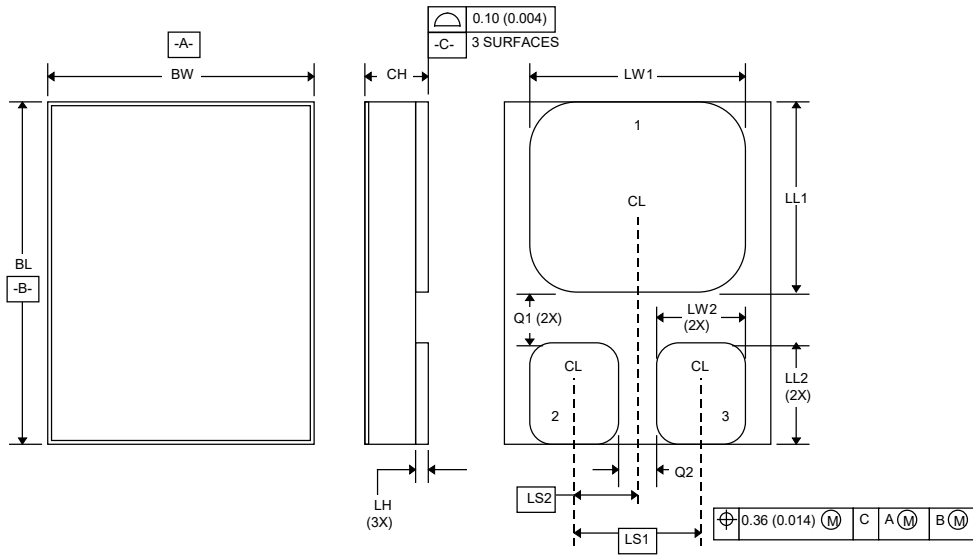
For device type 2N7487U3, and 2N7555U3:

No SEB and SEGR were observed at surface LET (see [table IV](#)) $\leq 84 \text{ MeV}\cdot\text{cm}^2/\text{mg}$ 2/
(In-situ Bias $V_{DS} = 250 \text{ V}$ and $V_{GS} = -5 \text{ V}$)
(In-situ Bias $V_{DS} = 225 \text{ V}$ and $V_{GS} = -10 \text{ V}$)
(In-situ Bias $V_{DS} = 175 \text{ V}$ and $V_{GS} = -15 \text{ V}$)
(In-situ Bias $V_{DS} = 50 \text{ V}$ and $V_{GS} = -20 \text{ V}$)

* 1/ The manufacturers supplying these device types have performed characterization testing in accordance with condition A (dose rate = 50 to 300 rad(Si)/s) of method 1019 of [MIL-STD-750](#). The radiation end point limits are guaranteed only to a maximum TID level of 100 krads(Si).

* 2/ The manufacturers have performed SEE tests at Texas A&M University (TAMU) Radiation Effects Facility and Brookhaven National Lab in accordance with method 1080 of [MIL-STD-750](#). For more information on SEE testing and results, customers should contact the qualified manufacturer.

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Symbol	Dimensions			
	Inches	Inches	Millimeters	Millimeters
	Min	Max	Min	Max
BL	.395	.405	10.03	10.29
BW	.291	.301	7.39	7.65
CH		.124		3.15
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.39
LW2	.090	.100	2.29	2.54
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	
Q1	.030		0.762	
Q2	.030		0.762	
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:

1. Dimension are in inches.
2. Millimeters are given for information only.
3. The lid shall be electrically isolated from the drain, gate and source.

FIGURE 1. Dimensions and configuration (TO-276AA, SMD-0.5).

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-19500](#) - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-750](#) - Test Methods for Semiconductor Devices.
[MIL-STD-883](#) - Test Method Standard Microcircuits

(Copies of these documents are available online at <https://quicksearch.dla.mil>.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in [MIL-PRF-19500](#) and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see [4.2](#) and [6.3](#)).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in [MIL-PRF-19500](#).

3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and on [figure 1](#) (TO-276AA, SMD-0.5) herein.

3.4.1 Lead finish. Lead finish shall be solderable in accordance with [MIL-PRF-19500](#), [MIL-STD-750](#), and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see [6.2](#)).

3.4.2 Multiple chip construction. Multiple chip construction is not permitted to meet the requirements of this specification.

3.4.3 Silicone die coat. The use of a silicone die coat requires a successful completion of [MIL-STD-883, method 5011](#) on each silicone lot for its intended applications, and as part of the full [MIL-PRF-19500](#) qualification process.

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3.5 Electrostatic discharge sensitive (ESDS). The devices covered by this specification sheet have been classified as ESDS. The Metal oxide semiconductor (MOS) devices shall be handled in accordance with the ESD program established to comply with the requirements of [MIL-PRF-19500](#) to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended.

- a. Devices should be handled on benches with conductive handling devices.
- b. Ground test equipment, tools, and personnel handling devices.
- c. Do not handle devices by the leads.
- d. Store devices in conductive foam or carriers.
- e. Avoid use of plastic, rubber or silk in MOS areas.
- f. Maintain relative humidity above 50 percent if practical.
- g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.
- h. Gate must be terminated to source, $R \leq$ or 100 k Ω , whenever bias voltage is applied drain to source.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in [1.3](#), [1.4](#), and [table I](#).

3.7 Electrical test requirements. The electrical test requirements shall be as specified in [table I](#).

3.8 Marking. Marking shall be in accordance with [MIL-PRF-19500](#).

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see [4.2](#)).
- b. Screening (see [4.3](#)).
- c. Conformance inspection (see [4.4](#) and [tables I and II](#)).

4.2 Qualification inspection. Qualification inspection shall be in accordance with [MIL-PRF-19500](#).

4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of [table III](#) tests, the tests specified in [table III](#) herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.1.1 Single event effects SEE. SEE shall be performed at initial qualification and after process or design changes which may affect radiation hardness (see [table III](#) and [table IV](#)). Upon qualification, manufacturers shall provide the verification test conditions from section 5 of method 1080 of [MIL-STD-750](#) that were used to qualify the device for inclusion into section 6 of the slash sheet. End-point measurements shall be in accordance with [table II](#). SEE characterization data shall be made available upon request of the qualifying or acquiring activity.

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4.3 Screening (JANS and JANTXV). Screening shall be in accordance with table E-IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (1) (2)	Measurements for JANS	Measurements for JANTXV
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E _{AS} (see 4.3.2)	Method 3470 of MIL-STD-750, E _{AS} (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, thermal impedance, (see 4.3.3)	Method 3161 of MIL-STD-750, thermal impedance, (see 4.3.3)
5	Method 2052 of MIL-STD-750, PIND (see MIL-PRF-19500 and 4.3.5)	Not applicable
9	Subgroup 2 of table I herein I _{GSSF1} , I _{GSSR1} , I _{DSS1} as a minimum	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	I _{GSSF1} , I _{GSSR1} , I _{DSS1} , r _{DS(ON)1} , V _{GS(TH)1} Subgroup 2 of table I herein. ΔI _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater.	I _{GSSF1} , I _{GSSR1} , I _{DSS1} , r _{DS(ON)1} , V _{GS(TH)1} Subgroup 2 of table I herein.
12	Method 1042 of MIL-STD-750, test condition A	Method 1042 of MIL-STD-750, test condition A
13	Subgroups 2 and 3 of table I herein ΔI _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. Δr _{DS(ON)1} = ±20 percent of initial value. ΔV _{GS(TH)1} = ±20 percent of initial value.	Subgroup 2 of table I herein ΔI _{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI _{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. Δr _{DS(ON)1} = ±20 percent of initial value. ΔV _{GS(TH)1} = ±20 percent of initial value.
17	For U3 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.	For U3 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein

- (1) At the end of the test program, I_{GSSF1}, I_{GSSR1}, and I_{DSS1} are measured.
- (2) An out-of-family program to characterize I_{GSSF1}, I_{GSSR1}, I_{DSS1}, V_{GS(TH)1} and r_{DS(ON)1} shall be invoked.
- (3) Shall be performed anytime after temperature cycling, screen 3a. JANTX and JANTXV levels do not need to be repeated in screening requirements.

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4.3.1 Gate stress test. Apply $V_{GS} = 24$ V minimum for $t = 250$ μ s minimum.

4.3.2 Single pulse avalanche energy (E_{AS}).

- a. Peak current $I_{AS} = I_{D1}$.
- b. Inductance: $\left[\frac{2E_{AS}}{(I_{D1})^2} \right] \left[\frac{V_{BR} - V_{DD}}{V_{BR}} \right]$ mH minimum.
- c. Gate to source resistor (R_{GS})..... $25 \leq R_{GS} \leq 200 \Omega$.
- d. Supply voltage (V_{DD})..... $V_{DD} = 25$ V dc, except $V_{DD} = 50$ V dc for 2N7487U3 and 2N7555U3.
- e. Peak gate voltage (V_{GS}).....12 V.
- f. Initial case temperature $T_C = +25^\circ\text{C} +10^\circ\text{C}, -5^\circ\text{C}$.
- g. Number of pulses to be applied1 pulse minimum.

4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of [MIL-STD-750](#) using the guidelines in that method for determining I_M , I_H , t_H , t_{sw} , (and V_H where appropriate). Measurement delay time (t_{MD}) = 70 μ s max. See [table III](#), group E, subgroup 4 herein.

4.3.4 Dielectric withstanding voltage.

- a. Magnitude of test voltage.....600 V dc.
- b. Duration of application of test voltage.....15 seconds (min).
- c. Points of application of test voltage.....All terminals to case.
- d. Method of connection.....Mechanical.
- e. Kilovolt-ampere rating of high voltage source.....1,200 V/1.0 mA (min).
- f. Maximum leakage current.....1.0 mA.
- g. Voltage ramp up time.....500 V/second

4.3.5 PIND. Not applicable in screening when devices are processed using alternative method and flow requirements approved by the qualifying activity, that includes incorporating the use of certified clean processing and silicone die coat. Instead, the PIND test performance shall be performed in group B3 and group C3, on a lot sample basis. PIND failures detected in group B or C will represent lot jeopardy and shall be evaluated for root cause and lot integrity.

4.4 Conformance inspection. Conformance inspection shall be in accordance with [MIL-PRF-19500](#).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of [MIL-PRF-19500](#) and [table I](#) herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIA (JANS) and table E-VIB (JANTXV) of [MIL-PRF-19500](#), and as follows. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

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4.4.2.1 Group B inspection, table E-VIA (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles.
B3	2077	Scanning electron microscope (SEM).
B3	2052	PIND, required if not performed in screening. (22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
B4	1042	Intermittent operation life, condition D, $t_{on} = 30$ seconds minimum.
B5	1042	Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$; $T_A = +175^\circ\text{C}$, $t = 24$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 48$ hours minimum.
B5	1042	Accelerated steady-state reverse bias, condition A, $V_{DS} = \text{rated}$; $T_A = +175^\circ\text{C}$, $t = 120$ hours minimum; or $T_A = +150^\circ\text{C}$, $t = 240$ hours minimum.
B5	2037	Bond strength, test condition D.

4.4.2.2 Group B inspection, table E-VIB (JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1051	Test condition G, 25 cycles.
B3	1042	Intermittent operation life, condition D, $t_{on} = 30$ seconds minimum.
B5 and B6		Not applicable.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Terminal strength is not applicable.
C3	2052	PIND, required if not performed in screening. (JANS only, 22 devices, c = 0 for large lots, 12 devices, c = 0 for small lots).
C5	3161	See 4.3.3 .
C6	1042	Intermittent operation life, condition D, $t_{on} = 30$ seconds minimum.

4.4.4 Group D inspection. Group D inspection shall be conducted in accordance with table E-VIII of MIL-PRF-19500 and [table II](#) herein.

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with MIL-PRF-19500, and [table III](#) herein. Electrical measurements (end-points) shall be in accordance with [table I](#), subgroup 2 herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

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TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Thermal impedance <u>2/</u>	3161	See 4.3.3	$Z_{\theta JC}$			°C/W
Breakdown voltage drain to source	3407	Bias condition C, $V_{GS} = 0$ V, $I_D = 1$ mA dc	$V_{(BR)DSS}$			
2N7485U3				130		V dc
2N7486U3				200		V dc
2N7487U3				250		V dc
2N7555U3				250		V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1$ mA dc	$V_{GS(TH)1}$	2.5	4.5	V dc
Gate current	3411	$V_{GS} = +20$ V dc, bias condition C, $V_{DS} = 0$ V	I_{GSSF1}		+100	nA dc
Gate current	3411	$V_{GS} = -20$ V dc, bias condition C, $V_{DS} = 0$ V	I_{GSSR1}		-100	nA dc
Drain current	3413	$V_{GS} = 0$ V dc, bias condition C, $V_{DS} = 80$ percent of rated V_{DS} ,	I_{DSS1}		10	μA dc
Static drain to source on-state resistance	3421	$V_{GS} = 12$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$			
2N7485U3					0.080	Ω
2N7486U3					0.220	Ω
2N7487U3					0.400	Ω
2N7555U3					0.400	Ω
Forward voltage	4011	$V_{GS} = 0$ V dc, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	V_{SD}		1.2	V dc

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 3</u>						
High temperature operation		$T_C = T_J = +125^\circ\text{C}$				
Gate current	3411	$V_{GS} = \pm 20\text{ V dc}$, bias condition C, $V_{DS} = 0\text{ V}$	I_{GSS2}		± 200	nA dc
Drain current	3413	$V_{GS} = 0\text{ V dc}$, bias condition C, $V_{DS} = 80\text{ percent of rated } V_{DS}$	I_{DSS2}		25	$\mu\text{A dc}$
Static drain to source on-state resistance	3421	$V_{GS} = 12\text{ V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)3}$			
2N7485U3					0.160	Ω
2N7486U3					0.462	Ω
2N7487U3					0.750	Ω
2N7555U3					0.750	Ω
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)2}$	1.5		V dc
Low temperature operation		$T_C = T_J = -55^\circ\text{C}$				
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS(TH)3}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)3}$		5.5	V dc
<u>Subgroup 4</u>						
Forward transconductance	3475	$I_D = I_{D2}$, $V_{DD} = 15\text{ V dc}$ (see 4.5.1)	g_{FS}			
2N7485U3				5		S
2N7486U3				6		S
2N7487U3				6		S
2N7555U3				3		S
Switching time test	3472	$I_D = I_{D1}$, $V_{GS} = 12\text{ V dc}$, $R_G = 7.5\ \Omega$, $V_{DD} = 50\text{ percent of rated } V_{DS}$				
Turn-on delay time			$t_{D(on)}$			
2N7485U3					20	ns
2N7486U3					25	ns
2N7487U3					25	ns
2N7555U3					25	ns
Rise time			t_r		100	ns
Turn-off delay time			$t_{D(off)}$		35	ns
Fall time			t_f			
2N7485U3					40	ns
2N7486U3					30	ns
2N7487U3					30	ns
2N7555U3					30	ns

See footnotes at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits	Limits	Unit
	Method	Condition		Min	Max	
<u>Subgroup 5</u>						
Safe operating area test	3474	See figure 4 ; $t_p = 10$ ms min $V_{DS} = 80$ percent of max. rated V_{DS}				
Electrical measurements		See table I , subgroup 2				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B, $I_D = I_{D1}$, $V_{GS} = 12$ V dc $V_{DD} = 50$ percent of rated V_{DS}				
On-state gate charge			$Q_{G(ON)}$			
2N7485U3				48		nC
2N7486U3				35		nC
2N7487U3				28		nC
2N7555U3				32		nC
Gate to source charge			Q_{GS}			
2N7485U3				16		nC
2N7486U3				9		nC
2N7487U3				7.4		nC
2N7555U3				11		nC
Gate to drain charge			Q_{GD}			
2N7485U3				18		nC
2N7486U3				15		nC
2N7487U3				12		nC
2N7555U3				16		nC
Reverse recovery time	3473	$di/dt = -100$ A/ μ s, $V_{DD} \leq 50$ V $I_D = I_{D1}$	t_{rr}			
2N7485U3				250		ns
2N7486U3				300		ns
2N7487U3				300		ns
2N7555U3				300		ns

1/ For sampling plan, see [MIL-PRF-19500](#).

2/ For end-point measurements, this test is required for the following subgroups (not intended for [4.3](#), screen 9 or 11): JANS table E-VIA of [MIL-PRF-19500](#), group B, subgroups 3 and 4; JANTXV, table E-VIB of [MIL-PRF-19500](#), group B, subgroups 2 and 3; and table E-VII of [MIL-PRF-19500](#), group C, subgroups 2 and 6, and table E-IX of [MIL-PRF-19500](#), group E, subgroup 1.

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TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		Unit
	Method	Conditions		R		R		
				Min	Max	Min	Max	
<u>Subgroup 1</u>								
Not applicable								
<u>Subgroup 2</u>		$T_C = + 25^\circ\text{C}$						
* Steady-state total dose irradiation (V_{GS} bias) <u>4/</u>	1019	Condition A, $V_{GS} = 12\text{ V}$; $V_{DS} = 0$						
* Steady-state total dose irradiation (V_{DS} bias) <u>4/</u>	1019	Condition A, $V_{GS} = 0$; $V_{DS} = 80$ percent of rated V_{DS} (preirradiation)						
End-point electricals:								
Breakdown voltage, drain to source	3407	Bias condition C, $V_{GS} = 0$; $I_D = 1\text{ mA}$	$V_{(BR)DSS}$					
2N7485U3				130		130		V dc
2N7486U3				200		200		V dc
2N7487U3				250		250		V dc
2N7555U3				250		250		V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ $I_D = 1\text{ mA}$	$V_{GS(th)1}$	2.5	4.5	2.0	4.5	V dc
Gate current	3411	Bias condition C, $V_{GS} = +20\text{ V}$; $V_{DS} = 0$	I_{GSSF1}		100		100	nA dc
Gate current	3411	Bias condition C, $V_{GS} = -20\text{ V}$; $V_{DS} = 0$	I_{GSSR1}		-100		-100	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0$ $V_{DS} = 80$ percent of rated V_{DS} (preirradiation)	I_{DSS}		10		10	μA dc
Static drain to source on-state voltage <u>5/</u>	3405	$V_{GS} = 12\text{ V}$; $I_D = I_{D2}$ condition A, pulsed (see 4.5.1)	$V_{DS(on)}$					
2N7485U3					1.000		1.000	V dc
2N7486U3					1.716		1.716	V dc
2N7487U3					2.560		2.560	V dc
2N7555U3					2.560		2.560	V dc
Forward voltage source drain diode	4011	Bias condition C, $V_{GS} = 0$; $I_D = I_{D1}$	V_{SD}		1.2		1.2	V dc

1/ For sampling plan see MIL-PRF-19500.

2/ Group D qualification may be performed prior to lot formation. Wafers qualified to these group D QCI requirements may be used for any other specification sheets utilizing the same die design.

3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in it's qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

4/ Separate samples shall be pulled for each bias.

*5/ Group D samples are built and tested in TO-3 packages. The equivalent pre-radiation and post radiation limit for $V_{DS(on)}$ in the TO-3 package is 1.025 Vdc for the 2N7485U3 device, 1.732 Vdc for the 2N7486U3 device, and 2.586 Vdc for the 2N7487U3 and 2N7555U3 devices.

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TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Qualification and large lot quality conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling	1051	-55°C to +150°C, 500 cycles	
Hermetic seal Fine leak Gross leak	1071	As applicable	
Electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 2 1/</u>			45 devices c = 0
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I , subgroup 2 herein.	
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I , subgroup 2 herein.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			15 devices c = 0
Barometric pressure 2N7487U3 and 2N7555U3	1001	Test condition C.	
<u>Subgroup 10</u>			22 devices c = 0
Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors	3476	Test conditions shall be derived by the manufacturer	
<u>Subgroup 11</u>			3 devices
SEE 2/ 3/	1080	See MIL-STD-750 method 1080 and 6.2 .	

1/ A separate sample for each test shall be pulled.

2/ Group E qualification of SEE testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.

3/ Device qualification to a higher level linear energy transfer (LET) is sufficient to qualify all lower level LETs.

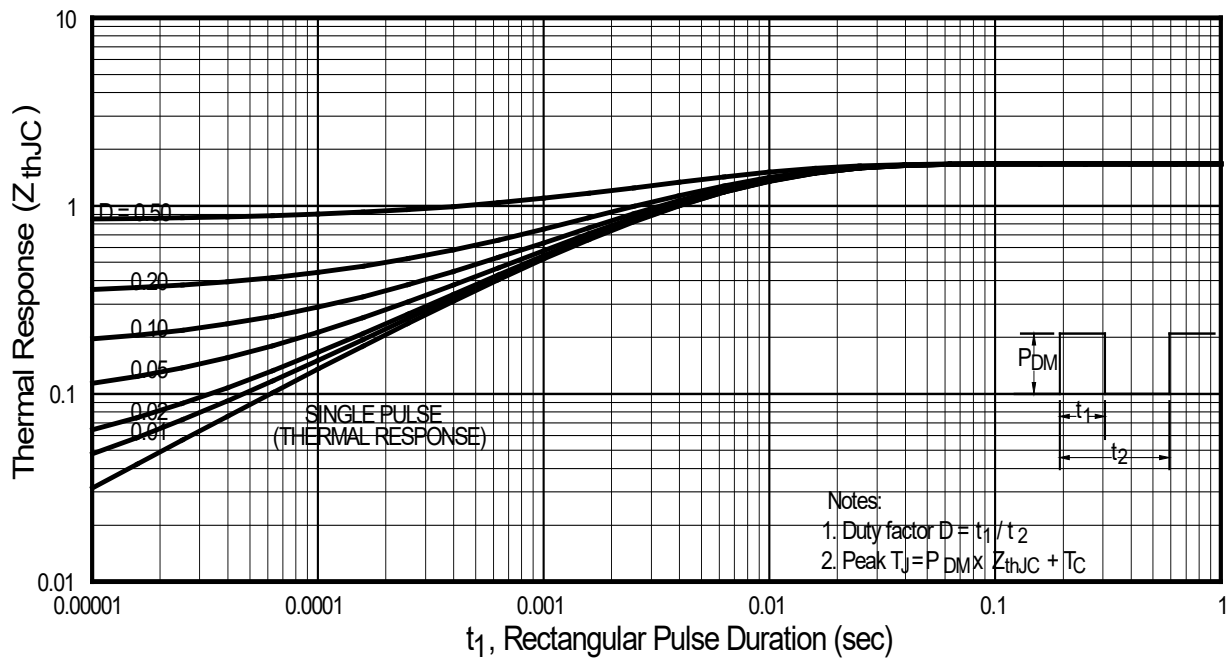
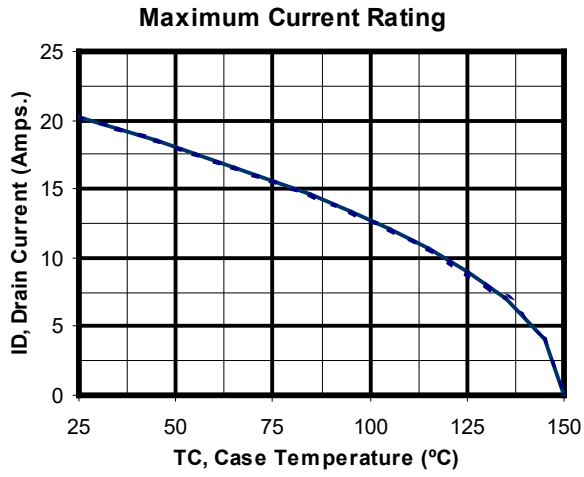
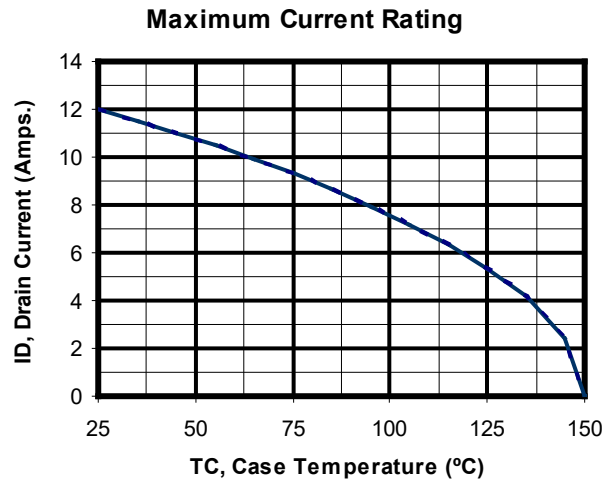


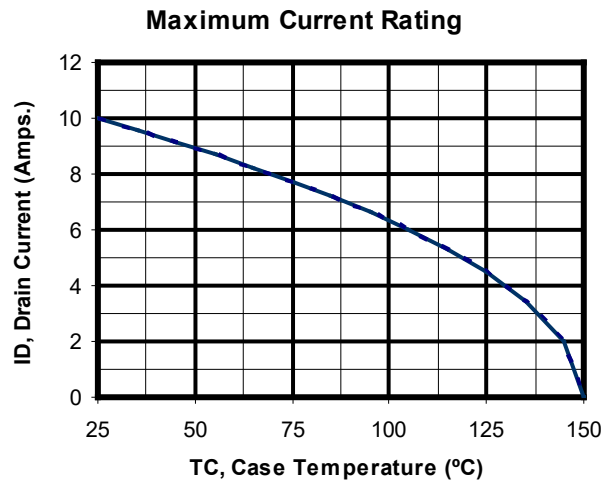
FIGURE 2. Thermal response curve.



2N7485U3



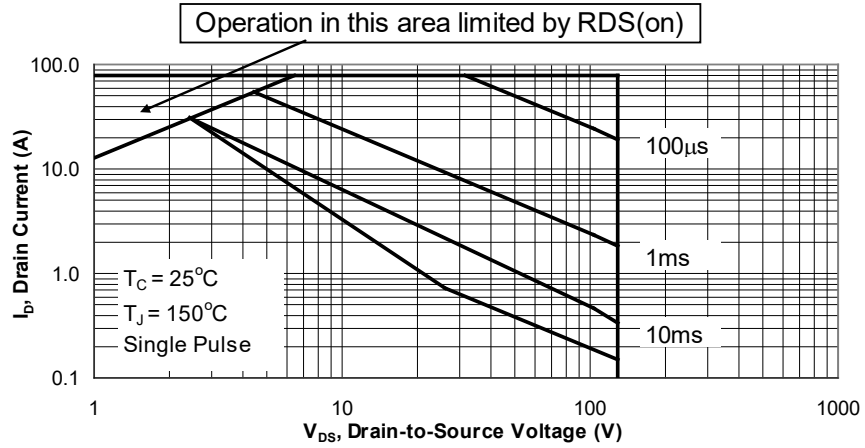
2N7486U3



2N7487U3 and 2N7555U3

FIGURE 3. Maximum drain current versus case temperature graphs.

2N7485U3



2N7486U3

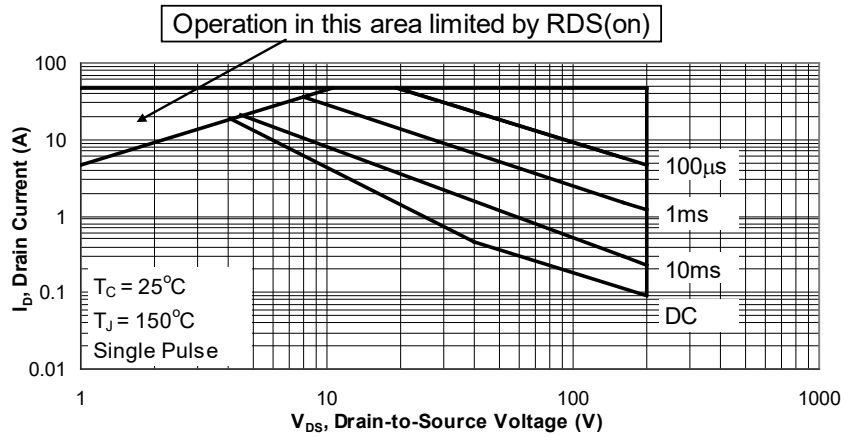
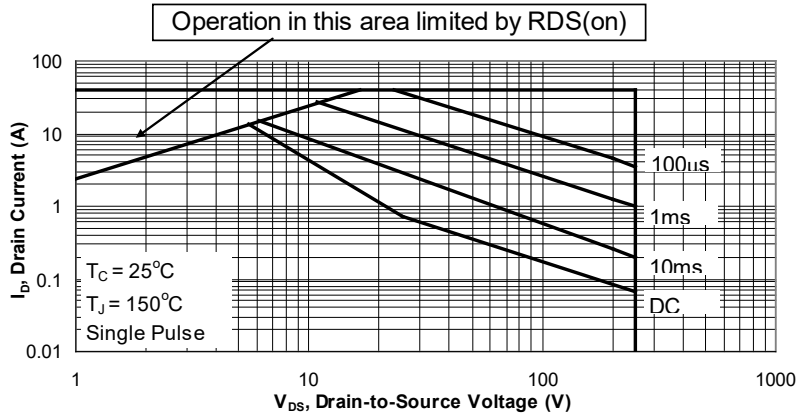


FIGURE 4. Safe operating area graph.

2N7487U3



2N7555U3

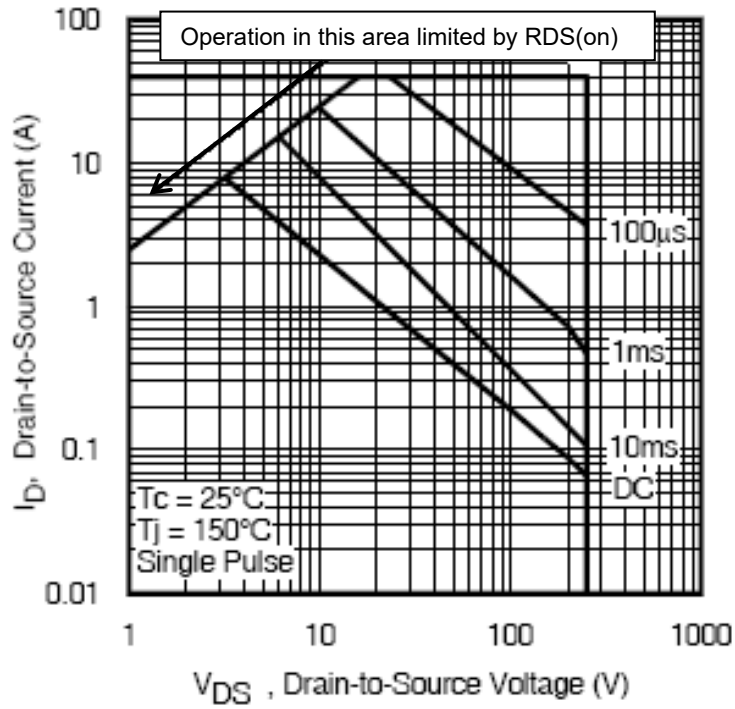


FIGURE 4. Safe operating area graph - Continued.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

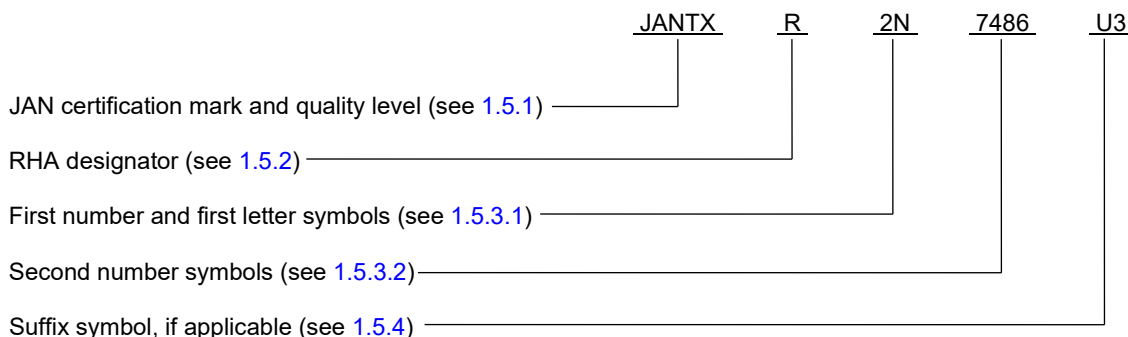
6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Packaging requirements (see 5.1).
- c. Lead finish (see 3.4.1).
- d. The complete PIN, see 1.5 and 6.4.
- e. For acquisition of RHA designated devices, table II, subgroup 1 testing of group D herein is optional. If subgroup 1 is desired, it should be specified in the contract.
- f. If specific SEE characterization conditions are desired (see 6.6 and table IV), manufacturer's cage code should be specified in the contract or order.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at <https://qpldocs.dla.mil>.

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6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



6.4.1 List of PINs. The following is a list of possible PINs available on this specification sheet.

Quality level TXV	Quality level S
JANTXVR2N7485U3	JANSR2N7485U3
JANTXVR2N7486U3	JANSR2N7486U3
JANTXVR2N7487U3	JANSR2N7487U3
JANTXVR2N7555U3	JANSR2N7555U3

6.4.2 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN) (without JAN and RHA prefix). This information in no way implies that manufacturer's PINs are substitutable for the military PIN.

Preferred types military PIN	Commercial PIN
2N7485U3 2N7486U3 2N7487U3 (obsolete) 2N7555U3 (2N7487U3 replacement)	IRHNJ57133SE IRHNJ57230SE IRHNJ57234SE IRHNJ57234SE

6.5 JANC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet [MIL-PRF-19500/741](#).

6.6 Application data.

6.6.1 Manufacturer specific irradiation data. Each manufacturer qualified to this slash sheet has characterized its devices to the requirements of [MIL-STD-750](#) method 1080 and as specified herein. Since each manufacturer's characterization conditions can be different and can vary by the version of method 1080 qualified to, the [MIL-STD-750](#) method 1080 revision version date and conditions used by each manufacturer for characterization have been listed here (see [table IV](#)) for information only. SEE conditions and figures listed in section 6 are current as of the date of this specification sheet, please contact the manufacturer for the most recent conditions.

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* TABLE IV. Manufacturers characterization conditions.

Manufactures CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
69210 (Applicable to devices with a date code of 2 February 1998 and older)	SEE <u>1</u> /	1080.0	See MIL-STD-750 method 1080. See figure 5.	3 devices
	Electrical measurements		I_{GSSR1} , I_{GSSR1} , and I_{DSS1} in accordance with table I, subgroup 2	
	SEE Irradiation:		Fluence = $3E5 \pm 20$ percent ions/cm ² Flux = $2E3$ to $2E4$ ions/cm ² /sec, temperature = $25 \pm 5^\circ C$	
	2N7485U3		Surface LET = 38 MeV-cm ² /mg $\pm 5\%$, range = 38 $\mu m \pm 7.5\%$, Kr ion energy = 300 MeV $\pm 7.5\%$	
			In situ bias conditions: $V_{DS} = 130$ V and $V_{GS} = -20$ V (typical 3.58 MeV/Nucleon at Texas A&M Cyclotron)	
	2N7486U3		Surface LET = 38 MeV-cm ² /mg $\pm 5\%$, range = 38 $\mu m \pm 7.5\%$, Br ion energy = 300 MeV $\pm 7.5\%$	
			In situ bias conditions: $V_{DS} = 200$ V and $V_{GS} = -20$ V (nominal 3.80 MeV/Nucleon at Brookhaven National Lab Accelerator)	
	2N7487U3 and 2N7555U3		Surface LET = 38 MeV-cm ² /mg $\pm 5\%$, range = 38 $\mu m \pm 7.5\%$, Br ion energy = 300 MeV $\pm 7.5\%$	
			In situ bias conditions: $V_{DS} = 250$ V and $V_{GS} = -20$ V nominal 3.80 MeV/Nucleon at Brookhaven National Lab Accelerator)	
	2N7485U3		Surface LET = 61 MeV-cm ² /mg ± 5 percent, Range = 31 $\mu m \pm 10\%$, energy = Xe ion 330 MeV $\pm 7.5\%$,	
			In situ bias conditions: $V_{DS} = 130$ V and $V_{GS} = -10$ V $V_{DS} = 100$ V and $V_{GS} = -15$ V $V_{DS} = 50$ V and $V_{GS} = -20$ V (typical 2.56 MeV/Nucleon at Texas A&M Cyclotron)	
	2N7486U3		Surface LET = 61 MeV-cm ² /mg $\pm 5\%$, range = 31 $\mu m \pm 10\%$, I ion energy = 330 MeV $\pm 7.5\%$	
	In situ bias conditions: $V_{DS} = 200$ V and $V_{GS} = -10$ V $V_{DS} = 185$ V and $V_{GS} = -15$ V $V_{DS} = 120$ V and $V_{GS} = -20$ V (nominal 2.92 MeV/Nucleon at Brookhaven National Lab Accelerator)			
2N7487U3 and 2N7555U3	Surface LET = 61 MeV-cm ² /mg $\pm 5\%$, range = 31 $\mu m \pm 10\%$, I ion energy = 330 MeV $\pm 7.5\%$			
	In-situ bias conditions: $V_{DS} = 250$ V and $V_{GS} = -15$ V $V_{DS} = 240$ V and $V_{GS} = -20$ V (nominal 2.60 MeV/nucleon at Brookhaven National Lab Accelerator)			

See footnotes at end of table.

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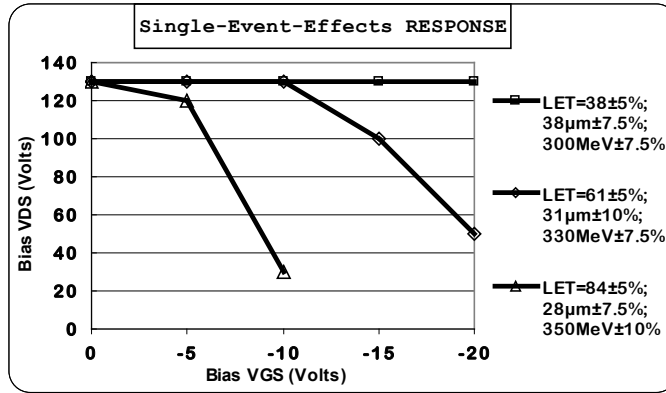
* TABLE IV. Manufacturers characterization conditions – Continued.

Manufactures CAGE	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
*	2N7485U3		Surface LET = 84 MeV-cm ² /mg ±5%, range = 28 μm ±7.5%, Au ion energy = 350 MeV ±10% In-situ bias conditions: V _{DS} = 130 V and V _{GS} = 0 V V _{DS} = 120 V and V _{GS} = -5 V V _{DS} = 30 V and V _{GS} = -10 V (typical 1.78 MeV/nucleon at Texas A & M Cyclotron)	
*	2N7486U3		In-situ bias conditions: V _{DS} = 200 V and V _{GS} = -5V V _{DS} = 150 V and V _{GS} = -10 V V _{DS} = 50 V and V _{GS} = -15 V V _{DS} = 25 V and V _{GS} = -20 V (nominal 1.78 MeV/nucleon at Brookhaven National Lab Accelerator)	
*	2N7487U3 and 2N7555U3		In-situ bias conditions: V _{DS} = 250 V and V _{GS} = -5 V V _{DS} = 225 V and V _{GS} = -10 V V _{DS} = 175 V and V _{GS} = -15 V V _{DS} = 50 V and V _{GS} = -20 V (nominal 1.78 MeV/nucleon at Brookhaven National Lab Accelerator)	
	Electrical measurements		I _{GSSF1} , I _{GSSR1} , and I _{DSS1} in accordance with table I , subgroup 2	

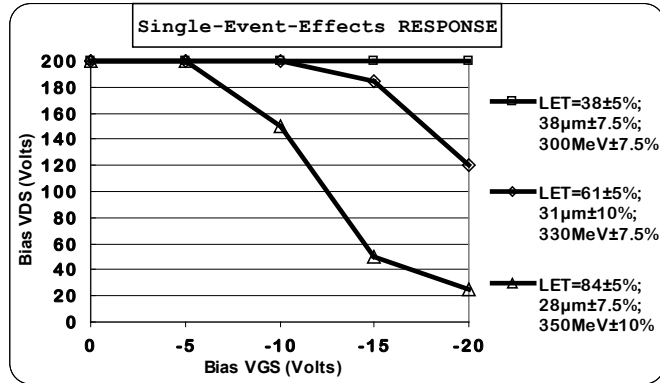
1/ I_{GSSF1}, I_{GSSR1}, and I_{DSS1} was examined before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with [table I](#), subgroup 2, may be performed at the manufacturer's option.

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2N7485U3



2N7486U3



2N7487U3 and 2N7555U3

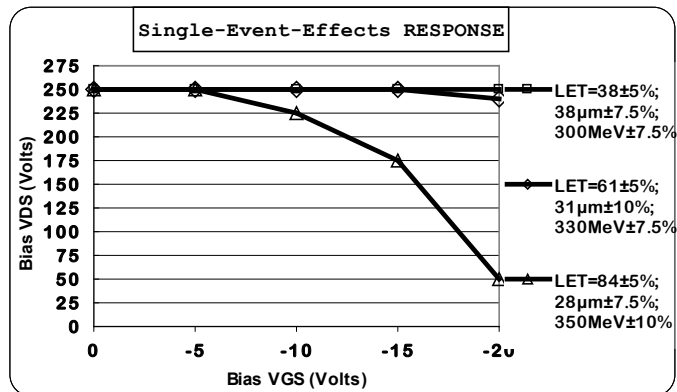


FIGURE 5. Typical SEE safe operating area graph.

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6.7 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - CR
* Navy - SH
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2022-088)

Review activity:
Air Force - 19

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