

The documentation and process conversion measures necessary to comply with this revision shall be completed by 28 July 2016.

INCH-POUND

MIL-PRF-19500/687D
 28 April 2016
 SUPERSEDING
 MIL-PRF-19500/687C
 18 December 2013

PERFORMANCE SPECIFICATION SHEET

* TRANSISTOR, FIELD EFFECT, N-CHANNEL, RADIATION HARDENED, SILICON, ENCAPSULATED (THROUGH-HOLE MOUNT PACKAGE), TYPES 2N7509, 2N7510, AND 2N7511, JANTXVD, R AND JANS D, R

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 (total dose and single event effects (SEE) characterization), power transistor intended for use in high density power switching applications. Two levels of product assurance (JANTXV and JANS) are provided for each encapsulated device type as specified in [MIL-PRF-19500](#). Provisions for radiation hardness assurance (RHA) to two radiation levels ("D" and "R") are provided for JANTXV and JANS product assurance levels.

* 1.2 Package outlines. The device package outlines are as follows: TO-254AA 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) $T_C = +25^{\circ}\text{C}$	V_{DS}	V_{DG}	V_{GS}	$R_{\theta JC}$ max	I_{D1} (2) (3) $T_C = +25^{\circ}\text{C}$	I_{D2} (2) (3) $T_C = +100^{\circ}\text{C}$	I_S	I_{DM}	T_J and T_{STG}	V_{ISO} 70,000 ft. altitude
	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>$^{\circ}\text{C}/\text{W}$</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A (pk)</u>	<u>$^{\circ}\text{C}$</u>	<u>V dc</u>
2N7509	192	100	100	± 30	0.65	70	55	70	200	-55	N/A
2N7510	192	200	200	± 30		53	34	53	200	to	N/A
2N7511	192	250	250	± 30		42	27	42	160	+150	250

(1) Derate linearly $1.54 \text{ W}/^{\circ}\text{C}$ for $T_C > +25^{\circ}\text{C}$.

(2) The following formula derives the maximum theoretical I_D limit. I_D is limited by package and internal wires and may be limited by pin diameter:

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

(3) See [figure 2](#), maximum drain current graph.

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

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0 \text{ mA}$ dc	$V_{GS(TH)1}$ $V_{DS} = V_{GS}$ $I_D = 1.0 \text{ mA}$ dc		Max I_{DSS1} $V_{GS} = 0$ $V_{GS} = 80\%$ of rated V_{DS}	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{V}$		I_{AS}
					$T_J = 25^\circ\text{C}$ at I_{D2}	$T_J = 125^\circ\text{C}$ at I_{D2}	
	<u>V dc</u>	<u>V dc</u> Min Max		<u>μA dc</u>	<u>Ω</u>	<u>Ω</u>	<u>A (pk)</u>
2N7509	100	2.0	4.5	25	0.0115	0.021	170
2N7510	200				0.034	0.065	110
2N7511	250				0.049	0.096	85

(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 6.5 for a list of available PINs.

* 1.5.1 JAN certification mark and quality level for encapsulated devices. 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".

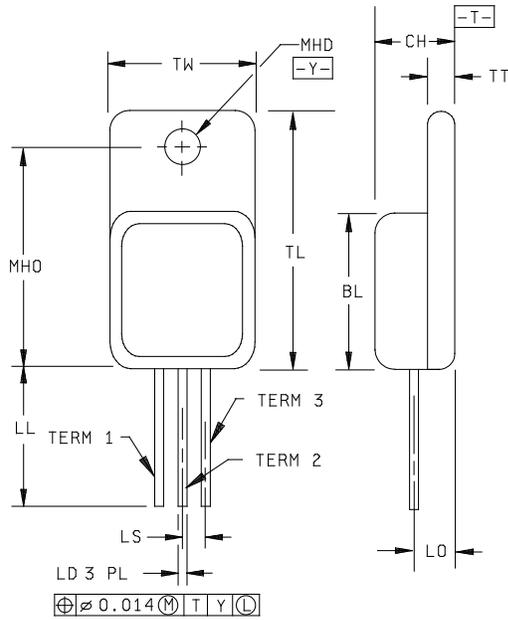
* 1.5.2 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest are as follows: "D" and "R".

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

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

* 1.5.3.2 Second number symbols. The second number symbol for the transistors covered by this specification sheet is as follows: "7509", "7510", and "7511".

* 1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on [QPDSIS-19500](#).



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.84
CH	.249	.260	6.32	6.60
LD	.035	.045	0.89	1.14
LL	.510	.570	12.95	14.48
LO	.150 BSC		3.81 BSC	
LS	.150 BSC		3.81 BSC	
MHD	.139	.149	3.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.84
Term 1	Drain			
Term 2	Source			
Term 3	Gate			

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. All terminals are isolated from case.
4. Die to base is BeO isolated, terminals to case ceramic (AL₂O₃) isolated.
5. In accordance with ASME Y14.5M, diameters are equivalent to φx symbology.

*

FIGURE 1. Physical dimensions for TO-254AA.

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.

* (Copies of these documents are available online at <http://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 manufacturers list 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](#) and as follows.

I_{AS}	Rated avalanche current, non-repetitive.
nC	nano coulomb.

* 3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in [MIL-PRF-19500](#), and [figure 1](#) (TO-254AA) herein. Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent Al_2O_3 (ceramic).

3.4.1 Lead finish. Unless otherwise specified, 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).

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

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in paragraph 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 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.8.1 Handling. MOS devices must be handled with certain precautions 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 ohms, whenever bias voltage is applied drain to source.

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](#) and as specified herein.

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 V](#)). 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.

* 4.3 Screening (JANS and JANTXV levels only). 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 (see table E-IV of MIL-PRF-19500) (1) (2)	Measurement	
	JANS	JANTXV
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, (see 4.3.2)	Method 3470 of MIL-STD-750, (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, (see 4.3.3)	Method 3161 of MIL-STD-750, (see 4.3.3)
7	Optional.	Optional.
9	I_{GSSF1} , I_{GSSR1} , I_{DSS1} subgroup 2 of table I herein	I_{GSSF1} , I_{GSSR1} , I_{DSS1} subgroup 2 of table I herein
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. $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A 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, 240 hours minimum.	Method 1042 of MIL-STD-750, test condition A, 160 hours minimum.
13	Subgroups 2 and 3 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value.	Subgroup 2 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or ± 100 percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ μ A dc or ± 100 percent of initial value, whichever is greater. $\Delta r_{DS(ON)1} = \pm 20$ percent of initial value. $\Delta V_{GS(TH)1} = \pm 20$ percent of initial value.
14	Required.	Required.
17	For TO-254 packages: Method 1081 of MIL-STD-750 (see 4.3.4), Endpoints: Subgroup 2 of table I herein.	For TO-254 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; JANTXV levels do not need to be repeated in screening requirement.

4.3.1 Gate stress test. Apply $V_{GS} = 45$ V minimum for $t = 250$ μ s minimum.

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

- a. I_{AS} shall be as specified in 1.4 herein.
- b. $L = 0.1$ mH.
- c. Gate to source resistor ($25 \text{ ohms} \leq R_{GS} \leq 200 \text{ ohms}$).
- d. $E_{AS} = 1/2 LI_{AS}^2$.
- e. $V_{DD} = 50$ V to 150 V dc.
- f. Initial junction temperature = +25°C, -5°C, +10°C.

4.3.3 Thermal impedance (V_{SD} measurement). The delta V_{SD} measurement shall be performed in accordance with method 3161 of MIL-STD-750. The delta V_{SD} conditions (I_H and V_H) and maximum limit shall be derived by each vendor from the thermal response curves (see figure 3) and shall be specified in the certificate of conformance prior to qualification. The following parameter measurements shall apply:

- a. Measuring current (I_M) 10 mA.
- b. Heating time (t_H) 100 ms.
- c. Measurement time delay (t_{MD}) 30 - 60 μ s.
- d. Sample window time (t_{SW}) 10 μ s maximum.

4.3.4 Dielectric withstanding voltage.

- a. Magnitude of test voltage 900 V dc.
- b. Duration of application of test voltage 15 seconds (min).
- c. Points of application of test voltage All leads to case (bunch connection).
- 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.

* 4.4 Conformance. 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 in table E-VIB (JANTXV) of MIL-PRF-19500, and 4.4.2.1 and 4.4.2.2 herein. Delta V_{SD} measurements shall be in accordance with table IV herein.

* 4.4.2.1 Quality level JANS, table E-VIA of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition F or G, 100 cycles.
B4	1042	Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle; $t_{on} = 30$ seconds minimum.
B5	1042	Accelerated steady-state reverse bias, condition A.
B5	1042	Accelerated steady-state gate bias, condition B.
B6	3161	Thermal resistance, see 4.5.2.

* 4.4.2.2 Quality level JANTXV, table E-VIB of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1042	Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ seconds minimum.
B5	3161	Thermal resistance, see 4.5.2.

* 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. Delta requirements shall be in accordance with the applicable steps of table IV herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
* C2	2036	Terminal strength, test condition A, weight = 10 pounds (4.5 kg), $t = 15$ seconds.
C5	3161	See 4.5.2.
C6	1042	Intermittent operation life, condition D. No heat sink or forced-air cooling on the device shall be permitted during the on cycle. $t_{on} = 30$ 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.

4.4.4.1 Design parameters. Not tested on a per lot basis. Design shall be such that the devices shall be capable of meeting the requirements in SEE safe operating area graphs.

* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III herein. Delta requirements shall be in accordance with the applicable steps of table IV 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](#).

4.5.2 Thermal resistance. Thermal resistance measurements shall be performed in accordance with method 3161 of [MIL-STD-750](#). The maximum limit of $R_{\theta JC} = 0.65^{\circ}\text{C/W}$. The following parameters shall apply:

- a. Measuring current (I_M) 10 mA.
- b. Drain heating current (I_H) 4 A.
- c. Heating time (t_H) Steady-state (see method 3161 of [MIL-STD-750](#)).
- d. Drain-source heating voltage (V_H) 25 V.
- e. Measurement time delay (t_{MD}) 30 to 60 μs .
- f. Sample window time (t_{SW}) 10 μs maximum.

*

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Units
	Method	Conditions		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	ΔV_{SD}			$^{\circ}\text{C/W}$
Breakdown voltage drain to source	3407	$V_{GS} = 0\text{V}$, $I_D = 1\text{ mA dc}$, bias condition C	$V_{(BR)DSS}$			
2N7509				100		V dc
2N7510				200		V dc
2N7511				250		V dc
Gate to source voltage (threshold)	3403	$V_{DS} = V_{GS}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)1}$	2.0	4.5	V dc
Gate current	3411	$V_{GS} = +30\text{V dc}$, bias condition C, $V_{DS} = 0\text{V}$	I_{GSSF1}		+100	nA dc
Gate current	3411	$V_{GS} = -30\text{V dc}$, bias condition C, $V_{DS} = 0\text{V}$	I_{GSSR1}		-100	nA dc
Drain current	3413	$V_{GS} = 0\text{V dc}$, bias condition C, $V_{DS} = 80\text{ percent of rated } V_{DS}$	I_{DSS1}		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), $I_D = I_{D2}$	$r_{DS(ON)1}$			
2N7509					0.0115	Ω
2N7510					0.034	Ω
2N7511					0.049	Ω
Static drain to source on-state voltage	3405	$V_{GS} = 12\text{V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{DS(ON)}$			
2N7509					0.84	V dc
2N7510					1.91	V dc
2N7511					2.18	V dc
Forward voltage	4011	$V_{GS} = 0\text{V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	V_{SD}		1.2	V dc

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Units
	Method	Conditions		Min	Max	
<u>Subgroup 3</u>						
High temperature operation		$T_C = T_J = +125^\circ\text{C}$				
Gate current	3411	$V_{GS} = \pm 30\text{V dc}$, 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, $V_{DS} = 80$ percent of rated V_{DS}	I_{DSS2}		0.250	mA dc
Static drain to source on-state resistance 2N7509 2N7510 2N7511	3421	$V_{GS} = 12\text{V dc}$, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)2}$		0.021 0.065 0.096	Ω Ω Ω
Gate to source voltage (threshold)	3403	$V_{DS} = V_{GS}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)2}$	1.0		V dc
Low temperature operation		$T_C = T_J = -55^\circ\text{C}$				
Gate to source voltage (threshold)	3403	$V_{DS} = V_{GS}$, $I_D = 1\text{ mA dc}$	$V_{GS(TH)3}$		5.5	V dc
<u>Subgroup 4</u>						
Switching time test	3472	$I_D = I_{D1}$, $V_{GS} = 12\text{ V dc}$, $R_G = 2.35\ \Omega$, $V_{DD} = 50$ percent of rated V_{DS}				
Turn-on delay time 2N7509 2N7510 2N7511			$t_{D(on)}$		35 35 35	ns ns ns
Rise time 2N7509 2N7510 2N7511			t_R		140 140 70	ns ns ns

See footnote at end of table.

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TABLE I. Group A inspection – Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Units
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued.						
Turn-off delay time			$t_{D(off)}$			
2N7509					60	ns
2N7510					65	ns
2N7511					70	s
Fall time			t_f			
2N7509					20	ns
2N7510					15	ns
2N7511					15	ns
<u>Subgroup 5</u>						
Safe operating area test (high voltage)	3474	See figure 4 , $t_p = 10$ ms min. $V_{DS} = 80$ percent of max. rated V_{DS} ($V_{DS} \leq 200$ V)				
Electrical measurements		See table I , subgroup 2				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition A or B				
On-state gate charge			$Q_{G(ON)}$			
2N7509					150	nC
2N7510					115	nC
2N7511					115	nC
Gate to source charge			Q_{GS}			
2N7509					45	nC
2N7510					60	nC
2N7511					45	nC

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Units
	Method	Conditions		Min	Max	
<u>Subgroup 7</u> - Continued.						
Gate to drain charge			Q_{GD}			
2N7509					55	nC
2N7510					30	nC
2N7511					45	nC
Reverse recovery time	3473	$di/dt = 100 \text{ A}/\mu\text{s}$, $V_{DD} \leq 50 \text{ V}$, $I_D = I_{D1}$	t_{rr}			
2N7509					290	ns
2N7510					375	ns
2N7511					590	ns

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

2/ This test required for the following end-point measurements only:

- Group B, subgroups 3 and 4 (JANS).
- Group B, subgroups 2 and 3 (JANTXV).
- Group C, subgroup 2 and 6.
- Group E, subgroup 1.

TABLE II. Group D inspection.

Inspection <u>1/ 2/ 3/ 4/ 5/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post irradiation limits		Units
	Method	Conditions		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)	1019	$V_{GS} = 12\text{V}, V_{DS} = 0\text{V}$						
Steady state total dose irradiation (V_{DS} bias)	1019	$V_{GS} = 0\text{V}, V_{DS} = 80$ percent of rated V_{DS}						
Breakdown voltage drain to source	3407	$V_{GS} = 0\text{V}, I_D = 1$ mA dc, bias condition C	$V_{(BR)DSS}$					
2N7509				100		100		V dc
2N7510				200		200		V dc
2N7511				250		250		V dc
Gate to source voltage (threshold)	3403	$V_{DS} = V_{GS}, I_D = 1$ mA dc	$V_{GS(TH)1}$	2.0	4.5	2.0	4.5	V dc
Gate current	3411	$V_{GS} = \pm 30\text{V}$ dc, $V_{DS} = 0\text{V}$, bias condition C	I_{GSS1}		± 100		± 100	nA dc
Drain current	3413	$V_{GS} = 0\text{V}, V_{DS} = 80$ percent of rated V_{DS} , bias condition C	I_{DSS1}		25		25	μA dc
Static drain to source on-state resistance	3421	$V_{GS} = 12\text{V}$ dc, condition A, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$					
2N7509					0.0115		0.0115	Ω
2N7510					0.034		0.034	Ω
2N7511					0.049		0.049	Ω
Static drain to source on-state voltage	3405	$V_{GS} = 12\text{V}$ dc, condition A, pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{DS(ON)}$					
2N7509					0.84		0.84	V dc
2N7510					1.91		1.91	V dc
2N7511					2.18		2.18	V dc

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

2/ Electrical specifications are for 'D' and 'R' rad levels.

3/ 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 sheet utilizing the same die design.

4/ Separate samples shall be pulled for each bias.

5/ At the manufacturer's option, group D samples need not be subjected to all the screening tests, but shall be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.

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

Inspection <u>1/ 2/ 3/ 4/ 5/</u>	MIL-STD-750		Qualification and large lot conformance inspection
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition F or G, 500 cycles	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See table I , subgroup 2 and table IV , step 1	
<u>Subgroup 2 1/</u>			45 devices c = 0
Steady-state gate bias	1042	Test condition B; 1,000 hours	
Electrical measurements		See table I , subgroup 2 and table IV , step 1	
Steady state reverse bias	1042	Test condition A; 1,000 hours	
Electrical measurements		See table I , subgroup 2 and table IV , step 1	
<u>Subgroup 4</u>			sample size N/A
Thermal impedance curves		Each supplier shall submit their qual-lot average and design maximum thermal impedance curves. In addition, the optimal test conditions and $Z_{\theta JX}$ limit shall be provided to the qualifying activity in the qualification report	
<u>Subgroup 5</u>			15 devices c = 0
Barometric pressure test (not required for $V_{BR(DSS)} \leq 200$ V)	1001	Test condition C	
2N7511		$V_{DS} = 250$ V; $I_{(ISO)} < 0.25$ mA	

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

2/ Group E qualification of single event effect testing may be performed prior to lot formation. Wafers qualified to these group E QCI requirements may be used for any other specification utilizing the same die design.

3/ As a minimum, gate to source leakages and drain to source leakage are to be examined to verify the electrical performance of the DUT prior to and after test. At the manufacturer's option, the remaining static tests in [table IV](#), with the exception of step 8, may be performed.

4/ This sampling plan applies to each bias condition specified.

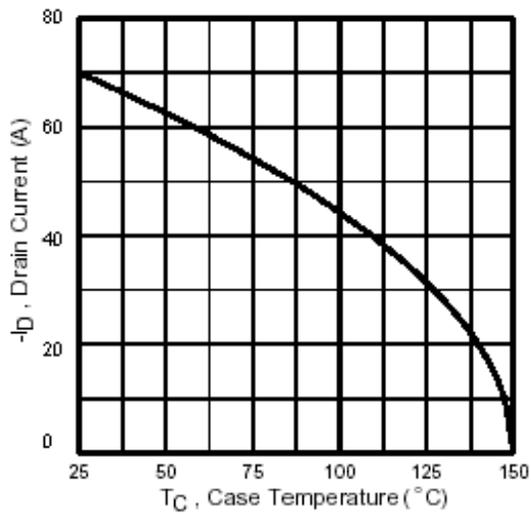
TABLE IV. Group A, B, C, and E delta measurements.

Step	Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Limits		Units
		Method	Conditions		Min	Max	
1.	Thermal response	3161	See 4.3.3	ΔV_{SD}		100	mV

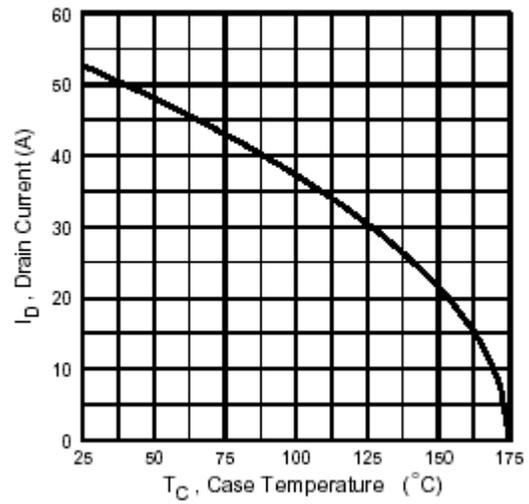
1/ The delta measurements for table VIA (JANS) of MIL-PRF-19500 are: Subgroup 4

2/ The delta measurements for table VII of MIL-PRF-19500 are: Subgroup 6.

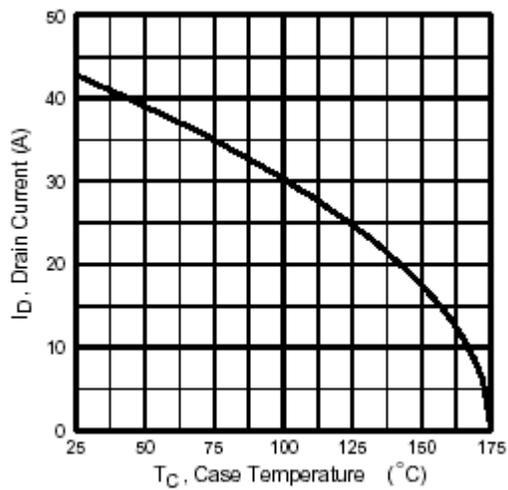
3/ The delta measurements for table IX of MIL-PRF-19500 are: Subgroups 1, 2, and 6.



2N7509



2N7510



2N7511

FIGURE 2. Maximum drain current vs case temperature graphs.

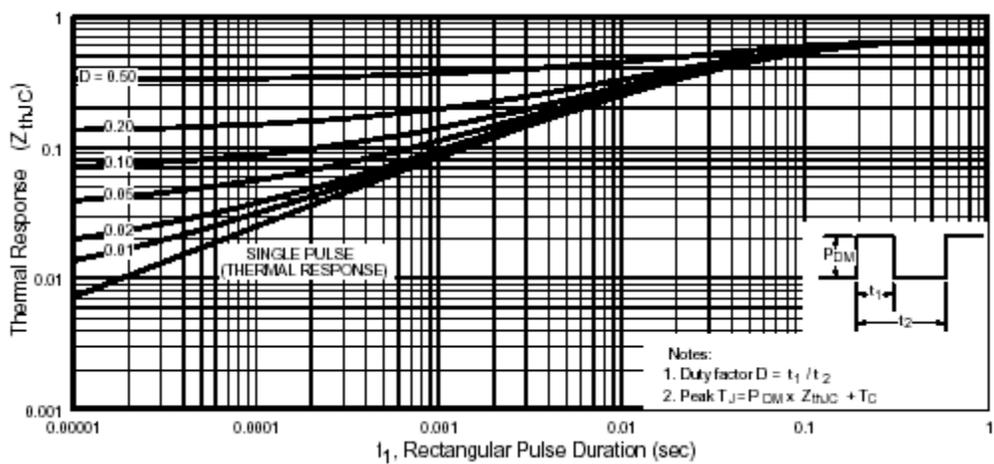


FIGURE 3. Thermal response curves.

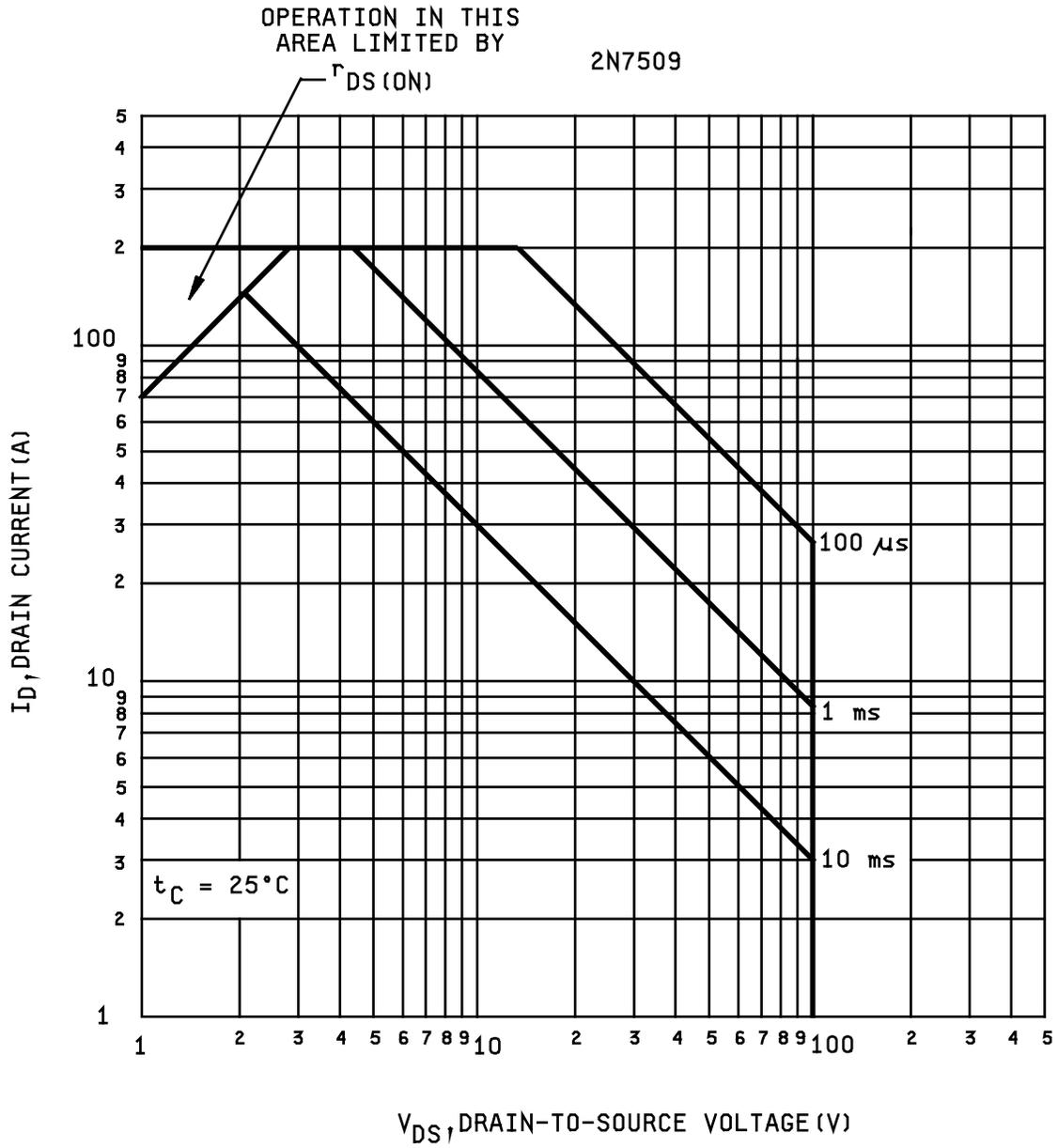


FIGURE 4. Safe operating area graphs.

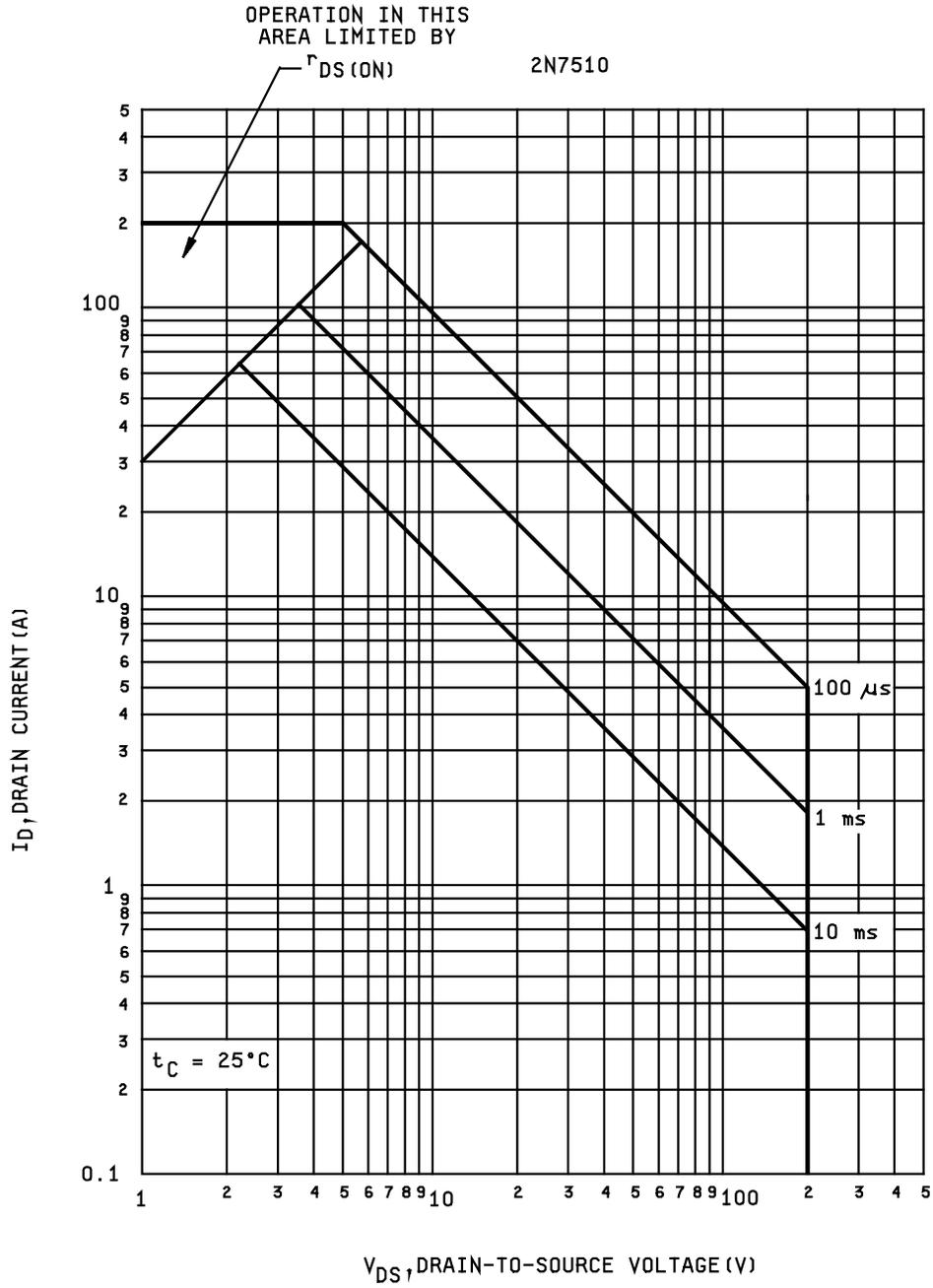


FIGURE 4. Safe operating area graphs -continued.

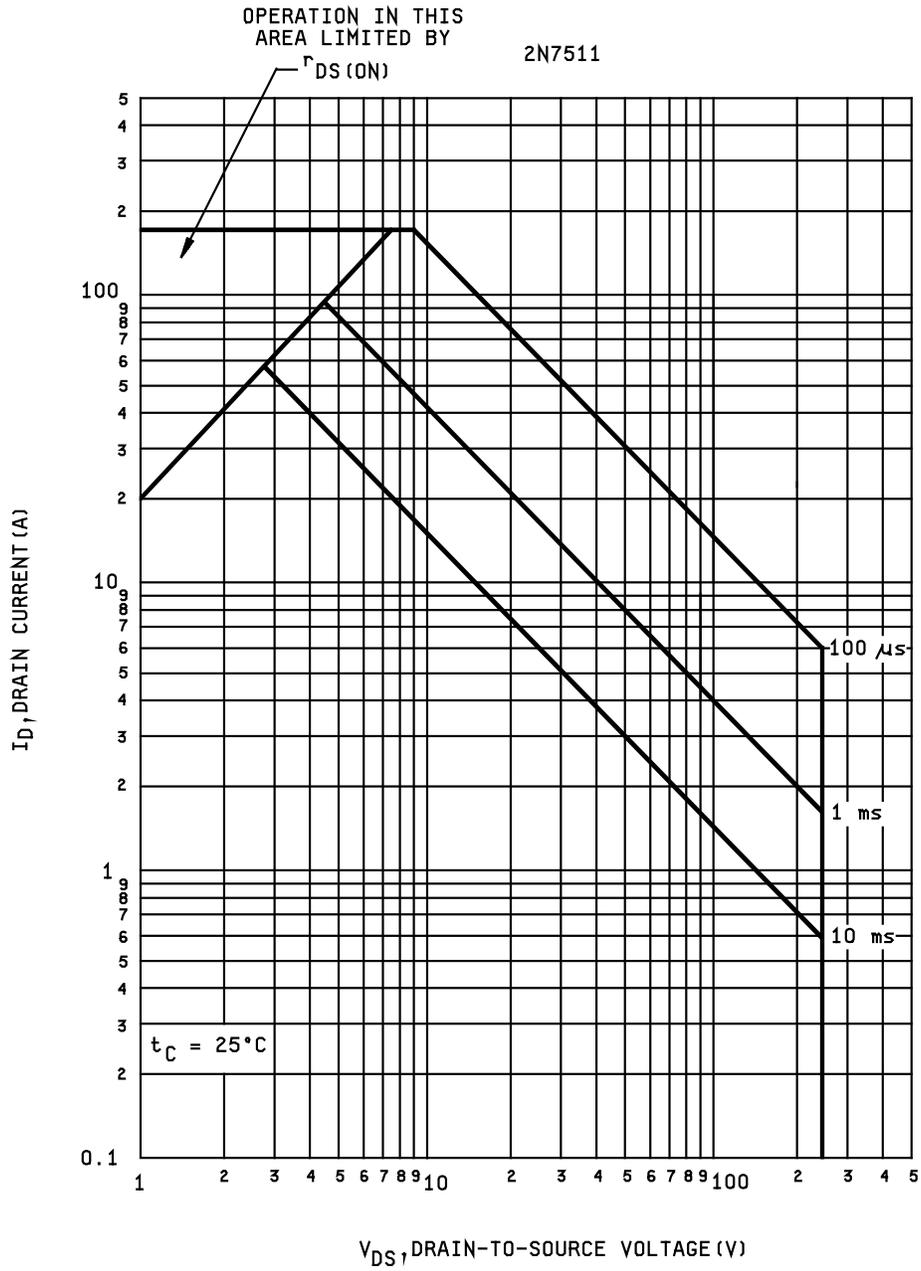


FIGURE 4. Safe operating area graphs - Continued.

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.)

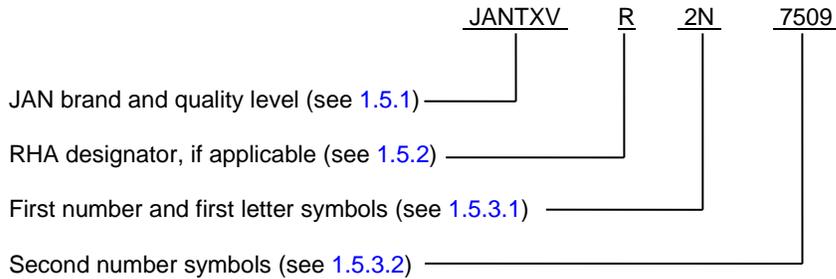
6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

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 6.5.
- * 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 or order.
- * f. If SEE testing data is desired, it should be specified in the contract or order.
- * g. If specific SEE characterization conditions are desired (see section 6.7 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://assist.dla.mil>.

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



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

PINs for devices of the "TXV" quality level	PINs for devices of the "TXV" quality level with RHA (1)	PINs for devices of the "S" quality level	PINs for devices of the "S" quality level with RHA (1)
JANTXV2N7509	JANTXV#2N7509	JANS2N7509	JANS#2N7509
JANTXV2N7510	JANTXV#2N7510	JANS2N7510	JANS#2N7510
JANTXV2N7511	JANTXV#2N7511	JANS2N7511	JANS#2N7511

(1) The number sign (#) represents one of two RHA designators available on this specification sheet ("D" or "R").

6.6 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PINs are substitutable for the military PIN.

Generic P/N	Military P/N
FSGJ160	2N7509
FSGJ260	2N7510
FSGJ264	2N7511

6.7 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.

TABLE V. Manufacturers characterization conditions.

Manufactures cage	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Upon qualification, all manufacturers should provide the verification test conditions to be added to this table. </div>				

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

* 6.8 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 693-1642 or DSN 850-6939.

6.9 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. 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 - EC
 Air Force - 85
 NASA - NA
 DLA - CC

Preparing activity:
 DLA - CC
 (Project 5961-2016-042)

Review activities:
 Army - MI
 Air Force - 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.dla.mil>.