

The documentation and process conversion measures necessary to comply with this document shall be completed by 6 February 2014.

INCH-POUND

MIL-PRF-19500/634D  
6 December 2013  
SUPERSEDING  
MIL-PRF-19500/634C  
12 September 2008

PERFORMANCE SPECIFICATION SHEET

\* SEMICONDUCTOR DEVICE, FIELD EFFECT RADIATION HARDENED TRANSISTORS, N-CHANNEL SILICON, TYPES 2N7405, 2N7406, 2N7407, AND 2N7408, JANSR 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 intended for use in high density power switching applications. One level of product assurance is provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1, (TO-254).

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

Type	$P_T$ $T_C = +25^\circ\text{C}$	$P_T$ $T_A = +25^\circ\text{C}$	$V_{DS}$	$V_{DG}$	$V_{GS}$	$R_{\theta JC}$ Max	$I_{D1}$ (2) (3) $T_C = +25^\circ\text{C}$	$I_{D2}$ $T_C = +100^\circ\text{C}$	$I_S$	$I_{DM}$	$T_J$ and $T_{STG}$	$V_{ISO}$ 70,000 ft. altitude
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>°C/W</u>	<u>A dc</u>	<u>A dc</u>	<u>A dc</u>	<u>A (pk)</u>	<u>°C</u>	<u>V dc</u>
2N7405	125	50	100	100	$\pm 20$	1.00	25	20	25	75	-55	N/A
2N7406			200	200		1.00	24	15	24	72	to	N/A
2N7407			250	250		1.00	18	12	18	54	+150	250
2N7408			500	500		1.00	9	6	9	27		500

(1) Derate linearly 1 W/°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 graphs.

\* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dla.mil](mailto:Semiconductor@dla.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.

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

Type	Min $V_{(BR)DSS}$ $V_{GS} = 0$ $I_D = 1.0 \text{ mA dc}$	$V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$ $I_D = 1.0 \text{ mA dc}$	Max $I_{DSS1}$ $V_{GS} = 0$ $V_{GS} = 80 \text{ percent of}$ rated $V_{DS}$	Max $r_{DS(on)}$ (1) $V_{GS} = 12\text{V}$		$I_{AS} = I_{DM}$
				$T_J = +25^\circ\text{C}$ at $I_{D2}$	$T_J = +125^\circ\text{C}$ at $I_{D2}$	
	<u>V dc</u>	<u>V dc</u> Min    Max	<u><math>\mu\text{A dc}</math></u>	<u><math>\Omega</math></u>	<u><math>\Omega</math></u>	<u>A (pk)</u>
2N7405	100	1.5    4.0	25	0.07	0.105	75
2N7406	200			0.11	0.189	72
2N7407	250			0.17	0.306	54
2N7408	500			0.60	1.20	27

(1) Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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, 4, or 5 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

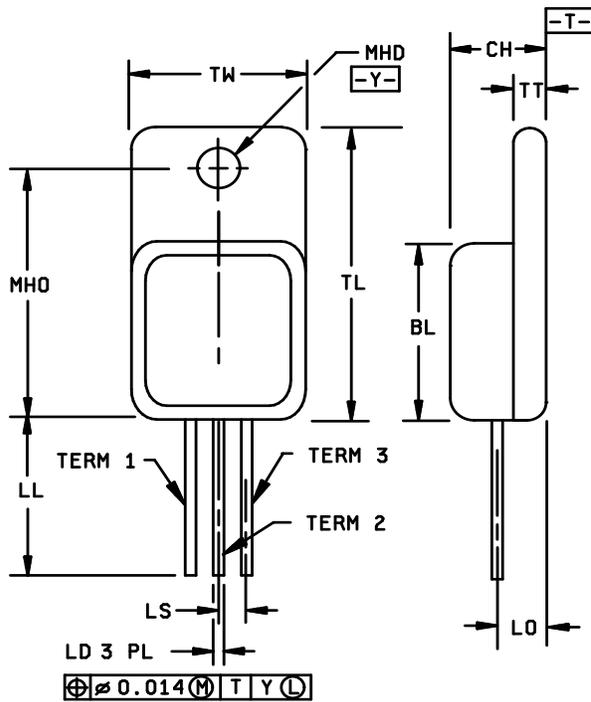
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices.

\* (Copies of these documents are available online at <http://quicksearch.dla.mil> or <https://assist.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

\* 2.3 Order of precedence. 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.



Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.530	.550	13.46	13.97
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 TYP		3.81 TYP	
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 (AL<sub>2</sub>O<sub>3</sub>) isolated.
5. In accordance with ASME Y14.5M, diameters are equivalent to φx symbology.

FIGURE 1. Physical dimensions (similar to TO-254).

### 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. Interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (similar to TO-254) herein.

3.4.1 Lead finish and material. 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). Lead material shall be Kovar or Alloy 52; a copper core or plated core is permitted.

3.4.2 Internal construction. Multiple chip construction shall not be permitted.

3.5 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.5.1 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 (see 3.5).

- 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 $\Omega$ , 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 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 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. Alternate flow is allowed for qualification inspection 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 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.

\* 4.3 Screening (JANS 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
(3)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, (see 4.3.3)
9	$I_{GSSF1}$ , $I_{GSSR1}$ , $I_{DSS1}$ , subgroup 2 of table I herein.
10	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 $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ $\mu$ A dc or $\pm 100$ percent of initial value, whichever is greater.
12	Method 1042 of MIL-STD-750, test condition A
13	Subgroups 2 and 3 of table I herein $\Delta I_{GSSF1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{GSSR1} = \pm 20$ nA dc or $\pm 100$ percent of initial value, whichever is greater. $\Delta I_{DSS1} = \pm 25$ $\mu$ A dc or $\pm 100$ 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.
17	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  $I_{GSSF1}$ ,  $I_{GSSR1}$ ,  $I_{DSS1}$ , and  $V_{GS(th)1}$  shall be invoked.
- (3) Shall be performed anytime before screen 9.

4.3.1 Gate stress test. Apply  $V_{GS} = 30$  V minimum for  $t = 250$   $\mu$ s minimum.

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

- a.  $I_{AS} = I_{DM}$ .
- b.  $L = 0.1$  mH.
- c.  $E_{AS} = 1/2 LI_{AS}^2$ .
- d.  $V_{DD} = 50$  V to 150 V dc.
- e. Initial junction temperature = +25°C, -5°C, +10°C.

4.3.3 Thermal response ( $\Delta V_{SD}$  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. Drain heating current ( $I_H$ ) .....4 A.
- c. Heating time ( $t_H$ ).....100 ms.
- d. Drain-source heating voltage ( $V_H$ )....25 V.
- e. Measurement time delay ( $t_{MD}$ ) .....30 - 60  $\mu$ s.
- f. Sample window time ( $t_{SW}$ ).....10  $\mu$ 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 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.

MIL-PRF-19500/634D

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) of MIL-PRF-19500, and as follows. End-point electrical measurements shall be in accordance with the applicable steps of table IV herein.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1051	Test condition G, 100 cycles.
B3	2077	SEM.
B4	1042	Intermittent operation life, condition D. No heat sink nor 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, $V_{DS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ ; $t = 120$ hours, minimum.
B5	1042	Accelerated steady-state gate bias, condition B, $V_{GS} = \text{rated}$ ; $T_A = +175^\circ\text{C}$ ; $t = 24$ hours.
B5	2037	Bond strength, test condition A.
B6	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. Electrical measurements (end-points) and 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 lbs., $t = 15$ sec.
C5	3161	See 4.5.2.
C6	1042	Test condition D; 1 cycle = 30 sec. min.

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 herein.

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. Electrical measurements (end-points) and 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  $R_{\theta JC} = 1.0^{\circ}\text{C/W}$ . 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  $\mu\text{s}$ .
- f. Sample window time ( $t_{SW}$ )..... 10  $\mu\text{s}$  maximum.

MIL-PRF-19500/634D

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>						
Breakdown voltage, drain to source	3407	Bias condition C, $V_{GS} = 0$ V, $I_D = 1.0$ mA dc	$V_{(BR)DSS}$			
2N7405				100		V dc
2N7406				200		V dc
2N7407				250		V dc
2N7408				500		V dc
Gate to source voltage (threshold)	3403	$V_{DG} \geq V_{GS}$ , $I_D = 1.0$ mA dc	$V_{GS(th)1}$	1.5	4.0	V dc
Gate current	3411	Bias condition C, $V_{GS} = +20$ V dc, $V_{DS} = 0$	$I_{GSSF1}$		+100	nA dc
Gate current	3411	Bias condition C, $V_{GS} = -20$ V dc, $V_{DS} = 0$	$I_{GSSR1}$		-100	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0$ V dc, $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS1}$		25	$\mu$ A dc
Static drain to source on-state resistance	3421	Bias condition A, $V_{GS} = 12$ V dc, $I_D = I_{D2}$ , pulsed (see 4.5.1)	$r_{DS(ON)1}$			
2N7405					0.07	$\Omega$
2N7406					0.11	$\Omega$
2N7407					0.17	$\Omega$
2N7408					0.60	$\Omega$
Static drain to source on-state voltage	3405	Bias condition A, $V_{GS} = 12$ V dc, $I_D = I_{D1}$ , pulsed (see 4.5.1)	$V_{DS(ON)1}$			
2N7405					1.84	V dc
2N7406					2.77	V dc
2N7407					3.21	V dc
2N7408					5.67	V dc
Forward voltage	4011	Pulsed (see 4.5.1), $I_D = I_{D1}$ , $V_{GS} = 0$ V dc	$V_{SD}$		1.8	V dc

See footnote at end of table.

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:						
Gate current	3411	Bias condition C, $V_{GS} = \pm 20$ V dc, $V_{DS} = 0$ V dc,	$I_{GSS2}$		$\pm 200$	nA dc
Drain current	3413	Bias condition C, $V_{GS} = 0$ V dc, $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS2}$		0.25	mA dc
Static drain to source on-state resistance	3421	Condition A. $V_{GS} = 12$ V dc, pulsed (see 4.5.1), $I_D = \text{rated } I_{D2}$	$r_{DS(on)2}$			
2N7405					0.07	$\Omega$
2N7406					0.11	$\Omega$
2N7407					0.17	$\Omega$
2N7408					0.60	$\Omega$
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ , $I_D = 1$ mA	$V_{GS(th)2}$	0.5		V dc
Low temperature operation:						
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ , $I_D = 1$ mA	$V_{GS(th)3}$		5.0	V dc
<u>Subgroup 4</u>						
Switching time test	3472	$I_D = \text{rated } I_{D1}$ ; $V_{GS} = 12$ V dc; $R_G = 2.35 \Omega$ ; $V_{DD} = 50$ percent of rated $V_{DS}$				
Turn-on delay time			$t_{d(on)}$			
2N7405					140	ns
2N7406					130	ns
2N7407					130	ns
2N7408					150	ns
Rise time			$t_r$			
2N7405					310	ns
2N7406					160	ns
2N7407					160	ns
2N7408					140	ns

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 4</u> - continued						
Turn-off delay time			$t_{d(off)}$			
2N7405					170	ns
2N7406					160	ns
2N7407					160	ns
2N7408					180	ns
Rise time			$t_r$			
2N7405					70	ns
2N7406					65	ns
2N7407					65	ns
2N7408					70	ns
<u>Subgroup 5</u>						
Safe operating area test (high voltage)	3474	See figure 4, $t_p = 10$ ms, $V_{DS} = 80$ percent of rated $V_{DS}$ , $V_{DS} \leq 200$ V dc max.				
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, and 7				
<u>Subgroup 6</u>						
Not applicable						
<u>Subgroup 7</u>						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{g(on)}$			
2N7405					160	nC
2N7406					160	nC
2N7407					150	nC
2N7408					150	nC
Gate to source charge			$Q_{gs}$			
2N7405					31	nC
2N7406					36	nC
2N7407					28	nC
2N7408					28	nC

See footnote at end of table.

TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Condition		Min	Max	
<u>Subgroup 7</u> - continued						
Gate to drain charge			$Q_{gd}$		88	nC
2N7405					84	nC
2N7406					71	nC
2N7407					62	nC
2N7408						
Reverse recovery time	3473	Condition A. $d/d_t \leq 100 \text{ A}/\mu\text{s}$ , $V_{DD} \leq 30 \text{ V}$ , $I_D = I_{D1}$	$t_{rr}$			
2N7405					400	ns
2N7406					540	ns
2N7407					690	ns
2N7408					810	ns

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

MIL-PRF-19500/634D

TABLE II. Group D inspection.

Inspection <u>1/</u> <u>2/</u> <u>3/</u> <u>4/</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 <sub>C</sub> = +25°C						
Steady-state total dose irradiation (V <sub>GS</sub> bias) <u>4/</u>	1019	V <sub>GS</sub> = 12V, V <sub>DS</sub> = 0V						
Steady-state total dose irradiation (V <sub>DS</sub> bias)	1019	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 80 percent of rated V <sub>DS</sub>						
Breakdown voltage drain to source	3407	V <sub>GS</sub> = 0V, I <sub>D</sub> = 1 mA dc, Bias condition C	V <sub>(BR)DSS</sub>					
2N7405				100		100		V dc
2N7406				200		200		V dc
2N7407				250		250		V dc
2N7408				500		500		V dc
Gate to source voltage (threshold)	3403	V <sub>DS</sub> ≥ V <sub>GS</sub> , I <sub>D</sub> = 1 mA dc	V <sub>GS(TH)1</sub>	1.5	4.0	1.5	4.0	V dc
Gate current	3411	Bias condition C, V <sub>GS</sub> = ±20V dc, V <sub>DS</sub> = 0V	I <sub>GSS1</sub>		±100		±100	nA dc
Drain current	3413	Bias condition C, V <sub>GS</sub> = 0V, V <sub>DS</sub> = 80 percent of rated V <sub>DS</sub>	I <sub>DSS1</sub>		25		25	μA dc
Static drain to source on-state resistance	3421	V <sub>GS</sub> = 12V dc, condition A, pulsed (see 4.5.1), I <sub>D</sub> = I <sub>D2</sub>	r <sub>DS(ON)1</sub>					
2N7405				0.07		0.07		Ω
2N7406				0.11		0.11		Ω
2N7407				0.17		0.17		Ω
2N7408				0.60		0.60		Ω
Static drain to source on-state voltage	3405	V <sub>GS</sub> = 12V dc, condition A, pulsed (see 4.5.1), I <sub>D</sub> = I <sub>D1</sub>	V <sub>DS(ON)</sub>					
2N7405				1.84		1.84		V dc
2N7406				2.77		2.77		V dc
2N7407				3.21		3.21		V dc
2N7408				5.67		5.67		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 utilizing the same die design.

4/ At the manufacturers 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.

MIL-PRF-19500/634D

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

Inspection 1/ 2/ 3/ 4/	MIL-STD-750		Qualification inspection
	Method	Conditions	
<u>Subgroup 1</u>			12 devices c = 0
Temperature cycle	1051	Condition G, 500 cycles	
Hermetic seal Fine leak Gross leak	1071		
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8	
<u>Subgroup 2 1/</u>			12 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours	
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8	
Steady-state gate bias	1042	Condition B, 1,000 hours	
Electrical measurements		See table IV, steps 1, 2, 3, 4, 5, 6, 7, and 8	
<u>Subgroup 4</u>			
Thermal impedance curves		See MIL-PRF-19500.	
<u>Subgroup 5</u>			12 devices c = 0
Barometric pressure test (not required for $V_{BR(DSS)} \leq 200V$ ) 2N7407 2N7408		Test condition C  $V_{DS} = 250 V; I_{(ISO)} < 0.25 mA$ $V_{DS} = 500 V; I_{(ISO)} < 0.25 mA$	
<u>Subgroup 6</u>			
ESD	1020		
<u>Subgroup 8</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		

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.

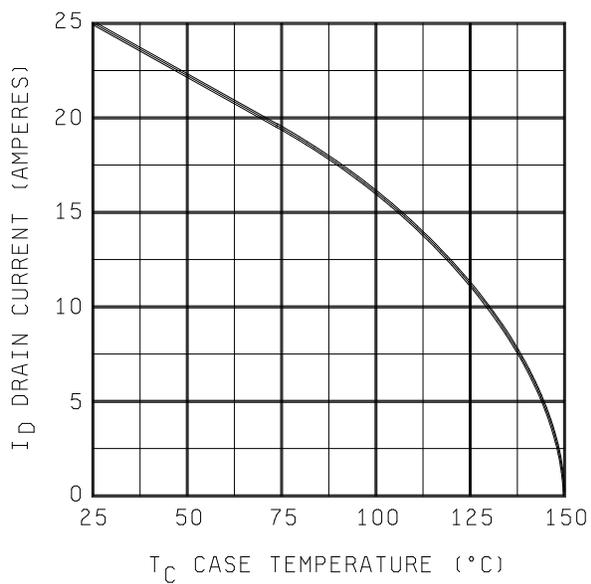
3/ As a minimum, gate to source leakage and drain to source leakage are to be examined to verify the electrical performance of the DUT prior to and after test. At the manufacturer's option, the remaining static tests in table IV, with the exception of step 8, may be performed.

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

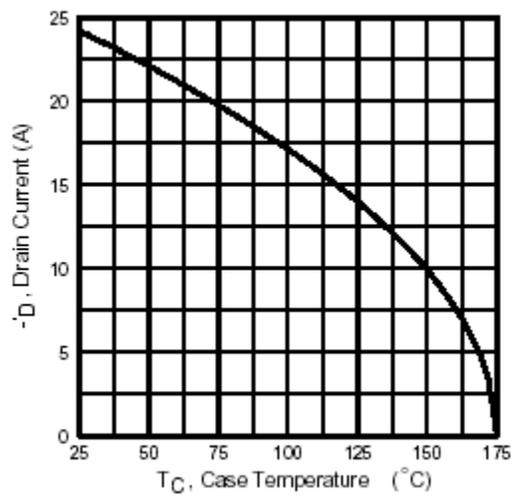
TABLE IV. Group A, B, C, and E electrical and delta measurements.

Step	Inspection <u>1/</u> <u>2/</u> <u>3/</u>	MIL-STD-750		Symbol	Limits		Units
		Method	Conditions		Min	Max	
1.	Breakdown voltage drain to source 2N7405 2N7406 2N7407 2N7408	3407	$V_{GS} = 0V$ , $I_D = 1 \text{ mA dc}$ , Bias condition C	$V_{(BR)DSS}$			
					100		V dc
					200		V dc
					250		V dc
					500		V dc
2.	Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$ , $I_D = 1 \text{ mA dc}$	$V_{GS(TH)1}$	1.5	4.0	V dc
3.	Gate current	3411	$V_{GS} = +20V$ and $-20V$ dc, Bias condition C, $V_{DS} = 0V$	$I_{GSS1}$		$\pm 100$	nA dc
4.	Drain current	3413	$V_{GS} = 0V$ dc, Bias condition C, $V_{DS} = 80$ percent of rated $V_{DS}$	$I_{DSS1}$		25	$\mu A$ dc
5.	Static drain to source on-state resistance 2N7405 2N7406 2N7407 2N7408	3421	$V_{GS} = 12V$ dc, condition A, Pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(ON)1}$			
						0.07	$\Omega$
						0.11	$\Omega$
						0.17	$\Omega$
					0.60	$\Omega$	
6.	Static drain to source on-state voltage 2N7405 2N7406 2N7407 2N7408	3405	$V_{GS} = 12V$ dc, condition A, Pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{DS(ON)}$			
						1.84	V dc
						2.77	V dc
						3.21	V dc
					5.67	V dc	
7.	Forward voltage	4011	$V_{GS} = 0V$ dc, condition A, Pulsed (see 4.5.1), $I_D = I_{D1}$	$V_{SD}$		1.8	V dc
8.	Thermal response	3161	See 4.3.3	$\Delta V_{SD}$		136	mV

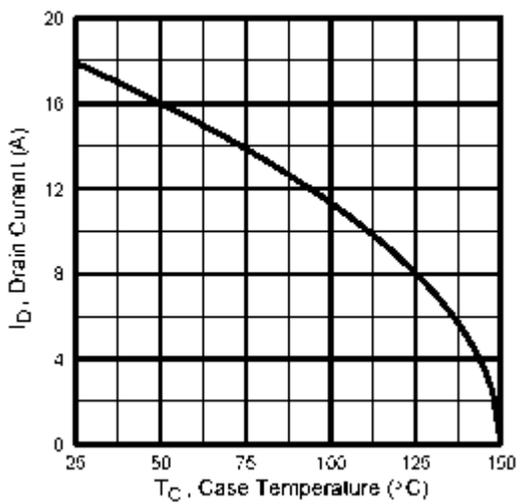
- 1/ The electrical measurements for table VIa (JANS) of MIL-PRF-19500 are as follows:
  - a. Subgroup 3, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
  - b. Subgroup 4, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.
  - c. Subgroup 5, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
- 2/ The electrical measurements for table VII of MIL-PRF-19500 are as follows:
  - a. Subgroup 2 and 3, see table IV herein, steps 1, 2, 3, 4, 5, 6, and 7.
  - b. Subgroup 6, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.
- 3/ The electrical measurements for table IX of MIL-PRF-19500 are as follows:
  - a. Subgroup 1 and 2, see table IV herein, steps 1, 2, 3, 4, 5, 6, 7, and 8.
  - b. Subgroup 6, see table IV herein, steps 3 and 4.



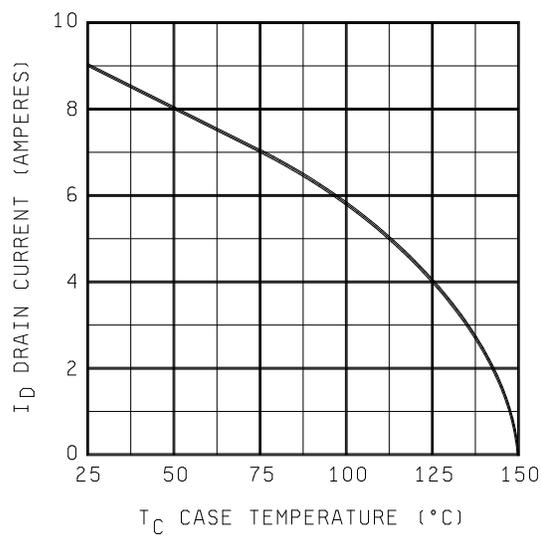
2N7405



2N7406



2N7407



2N7408

FIGURE 2. Maximum drain current vs case temperature graphs.

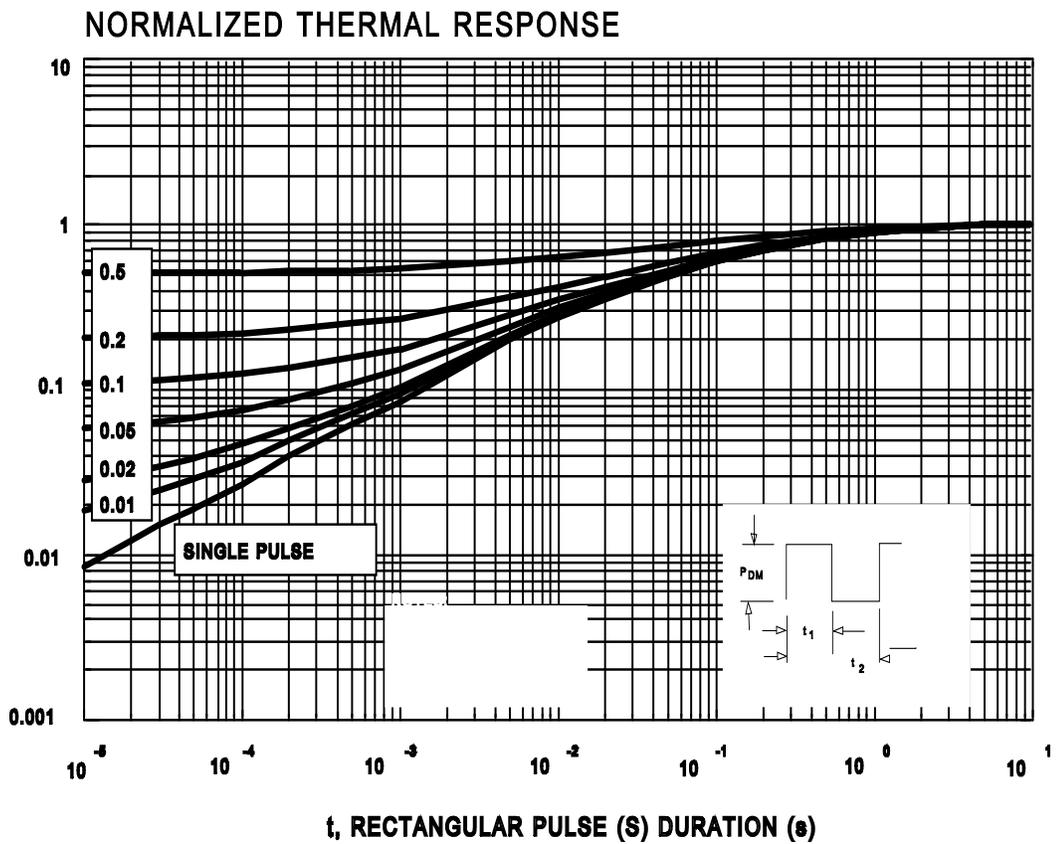


FIGURE 3. Thermal response curves.

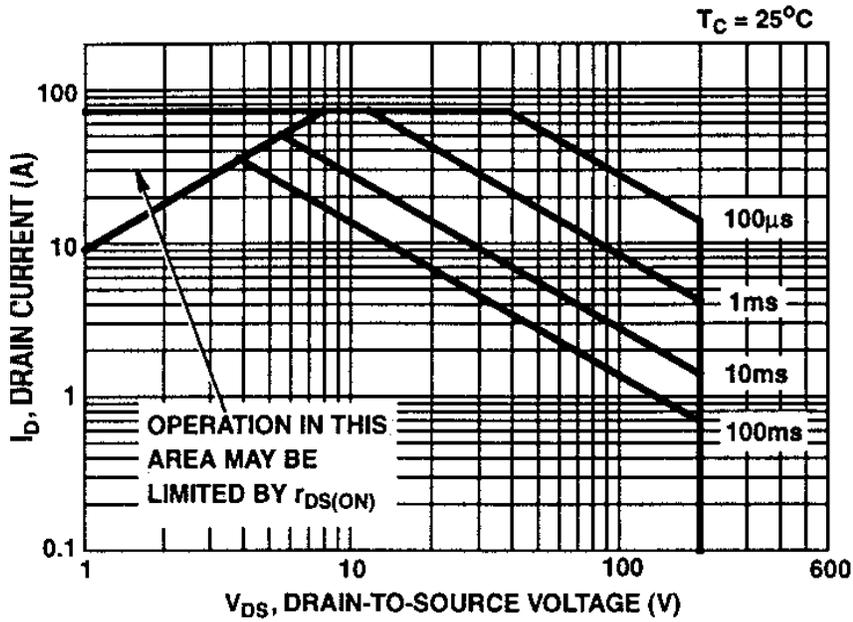
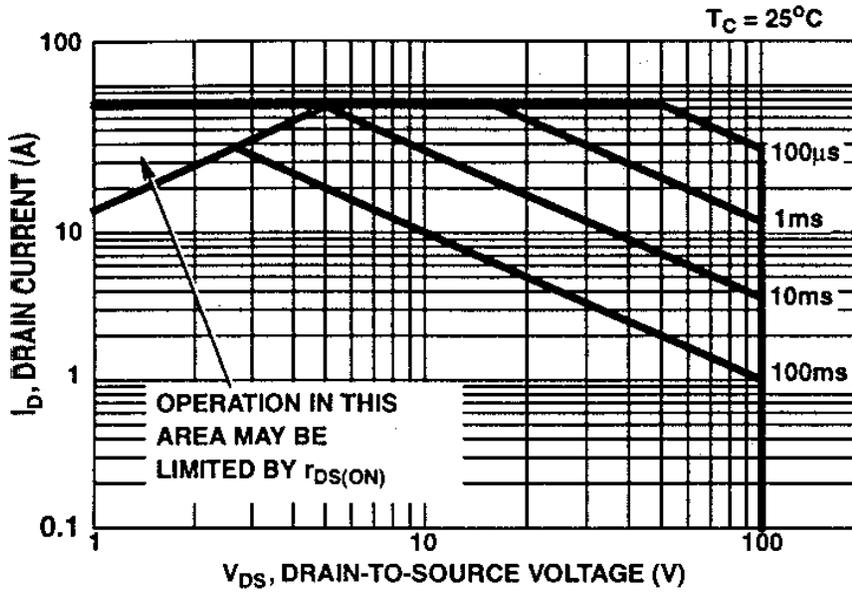


FIGURE 4. Safe operating area graphs.

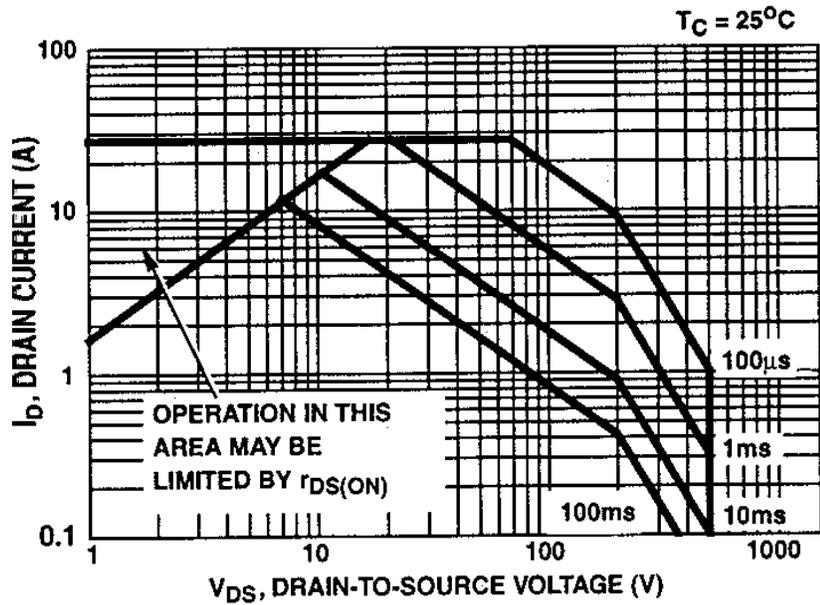
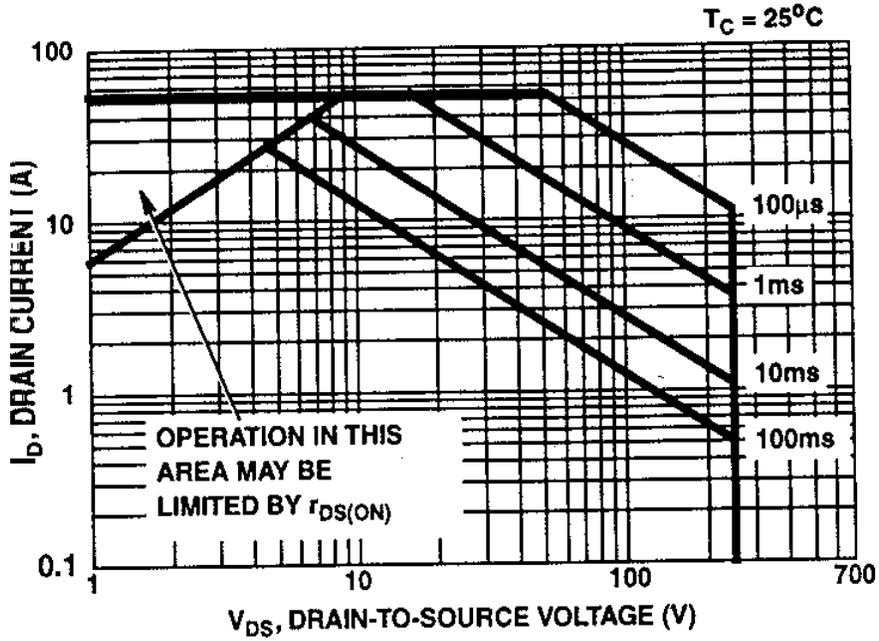


FIGURE 4. Safe operating area graphs - Continued.

## 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 material and finish (see 3.4.1).
- d. Product assurance level and type designator.
- \* 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 6.4 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 43216-5000 or e-mail [vqe.chief@dla.mil](mailto: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 Application data.

\* 6.4.1 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.

\* TABLE V. Manufacturers characterization conditions - Continued.

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>				

6.5 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 5961-2013-109)

Review activities:  
 Army - AV, MI

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 <https://assist.dla.mil>.