

The documentation and process conversion measures necessary to comply with this revision shall be completed by 29 October 2014.

INCH-POUND

MIL-PRF-19500/628C
 29 July 2014
 SUPERSEDING
 MIL-PRF-19500/628B
 24 August 2012

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, ULTRA-FAST RECOVERY, POWER RECTIFIER,
 1N6690 THROUGH 1N6693, 1N6690US THROUGH 1N6693US
 JAN, JANTX, JANTXV, AND JANS

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 silicon, ultra-fast recovery, semiconductor power rectifier diode. Three levels of product assurance are provided for each device type as specified in [MIL-PRF-19500](#).

1.2 Physical dimensions. See figures 1 (similar to DO-41) and 2 (surface mount).

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

1.3.1 Ratings applicable to all types. Ratings applicable to all Part or Identifying Numbers (PIN). T_{STG} and $T_J = -65^\circ\text{C}$ to $+175^\circ\text{C}$.

1.3.2 Ratings applicable to individual types.

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Device type	V_{RWM}	I_O (1)	I_{FSM} at $t_p = 8.3 \text{ ms}$	t_{rr}	$R_{\theta JL}$ at L = .375 inch (9.52 mm)	$R_{\theta JEC}$ (2)
	<u>V dc</u>	<u>A</u>	<u>A pk</u>	<u>ns</u>	<u>°C/W</u>	<u>°C/W</u>
1N6690, US	600	20	375	40	4	3.5
1N6691, US	800	20	375	40	4	3.5
1N6692, US	1,000	20	375	40	4	3.5
1N6693, US	1,200	20	375	40	4	3.5

- (1) Derate linearly at 267 mA/°C from +100°C to +175°C.
- (2) US devices only.

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. 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>.

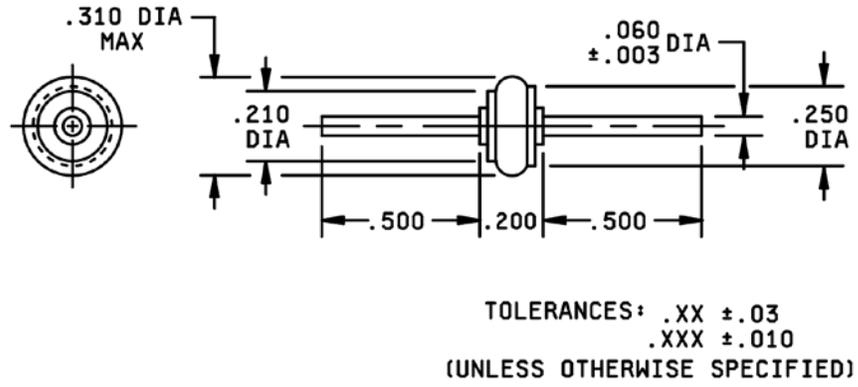
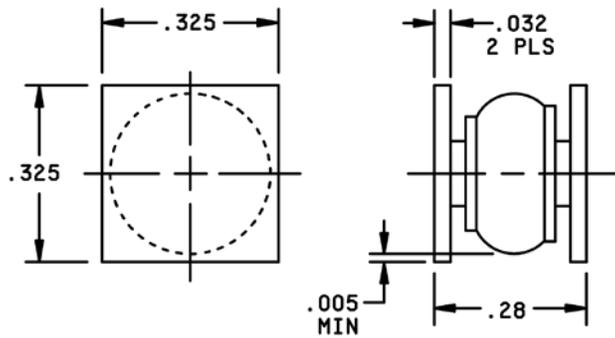


FIGURE 1. Physical dimensions and configuration for 1N6690 through 1N6693.



* FIGURE 2. Physical dimensions and configuration for 1N6690US through 1N6693US (surface mount devices).

2. APPLICABLE DOCUMENTS

* 2.1 General. The documents listed in this section are specified in sections 3 or 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 or 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 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](#) and as follows:

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in [MIL-PRF-19500](#) and [figures 1](#) and [2](#) herein.

3.4.1 Lead finish. Unless otherwise specified, lead or end-cap finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. When solder alloy is used for finish, the maximum lead temperature is limited to +175°C maximum. Where a choice of finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4.2 Diode construction. These devices shall be constructed utilizing non-cavity double plug construction with high temperature metallurgical bonding between both sides of the silicon die and terminal pins (see MIL-PRF-19500). Metallurgical bond shall be in accordance with the requirements of category I in MIL-PRF-19500. US version devices shall be structurally identical to the non-surface mount devices except for lead terminations.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3 and table I herein.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 Marking. Devices shall be marked as specified in MIL-PRF-19500.

3.7.1 Marking for US devices. For US version devices only, all marking may be omitted from the device except for the cathode marking. All marking which is omitted from the body of the device shall appear on the label of the initial container.

3.8 Polarity. The polarity of all types shall be indicated with a contrasting color band to denote the cathode end.

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 table I).

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 qualification 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 II tests, the tests specified in table II herein that were not performed in the prior revision shall be performed by the first inspection lot to this revision to maintain qualification.

4.3 Screening (JANS, JANTX, 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)	Measurement	
	JANS level	JANTXV and JANTX level
(1) 3c	Thermal impedance (see 4.3.1)	Thermal impedance (see 4.3.1)
5	Not applicable	Not applicable
9	Required I_{R1} and V_{FM1}	Not required
10	Method 1038 of MIL-STD-750, condition A	Method 1038 of MIL-STD-750, condition A
11	I_{R1} and V_{FM1} , $\Delta I_{R1} \leq 100$ percent of initial reading or ± 100 nA dc (± 200 nA dc for 1N6625), whichever is greater. $\Delta V_{FM1} \leq \pm 0.05$ V dc	I_{R1} and V_{FM1}
12	Required, see 4.3.2	Required, see 4.3.2
(2) 13	Subgroups 2 and 3 of table I herein: $\Delta I_{R1} \leq 100$ percent of initial reading or ± 100 nA dc (± 200 nA dc for 1N6625), whichever is greater. $\Delta V_{FM1} \leq \pm 0.05$ V dc. Scope display evaluation (see 4.5.4)	Subgroup 2 of table I herein: $\Delta I_{R1} \leq 100$ percent of initial reading or ± 100 nA dc (± 200 nA dc for 1N6625), whichever is greater. $\Delta V_{FM1} \leq \pm 0.05$ V dc. Scope display evaluation (see 4.5.4)

(1) Thermal impedance shall be performed any time after sealing provided temperature cycling is performed in accordance with MIL-PRF-19500, screen 3 prior to this thermal test.

(2) $Z_{\theta JX}$ is not required in screen 13, if already previously performed.

4.3.1 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3101, as applicable, of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , t_H , and K factor. See table II, group E, subgroup 4 herein.

4.3.2 Power burn-in conditions. Power burn-in conditions are as follows (see 4.5.3 and 4.5.3.1 herein), $T_A = +55^\circ\text{C}$ maximum. Test conditions shall be in accordance with method 1038 of MIL-STD-750, condition B. Adjust I_O to achieve the required T_J . Use method 3100 of MIL-STD-750 to measure T_J . $T_J = +115^\circ\text{C}$ minimum and $+150^\circ\text{C}$ maximum.

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

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with [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 E-VIB (JAN, JANTX and JANTXV) of [MIL-PRF-19500](#) and [4.4.2.1](#) and [4.4.2.2](#) herein. Delta measurements shall be in accordance with [table III](#) herein.

* 4.4.2.1 Group B inspection, table E-VIA (JANS) of [MIL-PRF-19500](#). For B5, if a failure occurs, resubmission shall be at the test conditions of the original sample.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1056	-0°C to +100°C, 25 cycles.
B3	1051	-55°C to +175°C, 100 cycles.
* B3	4066	Condition A, I_{FSM} = rated I_{FSM} (see 1.3 , col. 4); ten surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 0$, $V_{RWM} = 0$.
B4	1037	$I_O = I_O$ rated minimum (see 1.3 , col. 3); V_R = rated V_{RWM} (see col. 2 of 1.3 , and 4.5.3); 2,000 cycles.
B5	1027	$I_O = I_O$ rated minimum (see 1.3 , col. 3 and 4.5.3); adjust T_A and or I_O to achieve $T_J = +150^\circ\text{C}$ minimum. $t = 1,000$ hours. Temporary leads may be added for surface mount devices. $n = 45$, $c = 0$. Delta shall not exceed 60 percent of initial reading.
B6	4081	See 4.5.5 , $+25^\circ\text{C} \leq T_A \leq +35^\circ\text{C}$ (recorded before test is performed); $R_{\theta JL}$ (maximum) $\leq 4^\circ\text{C/W}$; $L = .375$ inch (9.53 mm). For surface mount devices (US version), $R_{\theta JEC} = 3.5^\circ\text{C/W}$ maximum.
B8	4065	Peak reverse power, $P_{RM} \geq 318$ W for square wave in accordance with method 4065 of MIL-STD-750 ($P_{RM} \geq 500$ W for half-sine wave). Test shall be performed on each subplot; sampling plan $n = 10$, $c = 0$, end-points, see 4.4.2 .

4.4.2.2 Group B inspection, table E-VIB (JAN, JANTX and JANTXV) of [MIL-PRF-19500](#).

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B2	1056	-0°C to +100°C, 10 cycles.
B2	1051	-55°C to +175°C, 25 cycles.
B3	1027	$I_O = I_O$ (rated, see col. 3 of 1.3) minimum; adjust I_O to achieve required T_J of $+125^\circ\text{C}$ minimum; apply $V_R =$ rated V_{RWM} (see col. 2 of 1.3), $f = 50 - 60$ Hz (see 4.5.3.1). Delta shall not exceed 25 percent of initial reading.

* 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. See table III for delta limits when applicable.

4.4.3.1 Group C inspection, table E-VII of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	1056	-0°C to +100°C, 10 cycles.
C2	1051	-55°C to +175°C, 25 cycles.
C2	2036	Axial devices – Tension: Test condition A; weight = 12 pounds; t = 30 seconds. Lead fatigue: Test condition E; weight 2 pounds, t = 15 s. NOTE: Lead fatigue is not applicable for US devices.
* C2	2038	US devices - Condition B, 12 pounds, t = 30s.
C5	4081	See 4.5.5, $+25^{\circ}\text{C} \leq T_A \leq +35^{\circ}\text{C}$ (recorded before test is performed); $R_{\theta JL}$ (maximum) $\leq 4^{\circ}\text{C/W}$; L = .375 inch (9.53 mm). For surface mount devices (US version), $R_{\theta JEC} \leq 3.5^{\circ}\text{C/W}$.
C6	1027	$I_O = I_O$ (rated see col. 3 of 1.3) minimum; adjust I_O to achieve T_J of $+125^{\circ}\text{C}$ minimum; apply $V_R =$ rated V_{RWM} (see col. 2 of 1.3), $f = 50 - 60$ Hz (see 4.5.3.1). Delta shall not exceed 25 percent of initial reading.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table E-IX of MIL-PRF-19500 and as specified herein. See table III for delta limits when applicable.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables 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 Inspection conditions. Unless otherwise specified, all inspections shall be conducted at $T_A =$ room ambient as defined in the general requirements of MIL-STD-750 (see 4.5).

4.5.3 Burn-in and life tests. These tests shall be conducted with a half-sine waveform of the specified peak voltage impressed across the diode in the reverse direction followed by a half-sine waveform of the specified average rectified current. The forward conduction angle of the rectified current shall be neither greater than 180 degrees, nor less than 150 degrees.

4.5.3.1 Free air burn-in. The use of a current limiting or ballast resistor is permitted provided that each DUT still sees the full P_t (minimum) and that the minimum applied voltage, where applicable, is maintained through-out the burn-in period. $T_J = +115^\circ\text{C}$ minimum and $+150^\circ\text{C}$ maximum for screening, and $T_J = +125^\circ\text{C}$ minimum for 4.4.2.2 and 4.4.3.1 life tests. Accelerated life test in 4.4.2.1 shall be $T_J = +150^\circ\text{C}$ minimum.

4.5.4 Scope display evaluation. Scope display evaluation shall be stable in accordance with method 4023 of MIL-STD-750. Scope display may be performed on ATE (automatic test equipment) for screening only with the approval of the qualifying activity. Scope display in table I, subgroup 4 shall be performed on a scope. Reverse current (I_{BR}) over the knee shall be 500 μA peak.

4.5.5 Thermal resistance. Thermal resistance measurement shall be performed in accordance with method 4081 of MIL-STD-750 using the guidelines in that method for determining I_M , I_H , and t_H . Measurement delay time $t_{MD} = 100$ μs max. See table E-IX of MIL-PRF-19500.

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TABLE I. Group A inspection.

Inspection ^{1/}	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance	3101	See 4.3.1	Z _{θJX}			°C/W
Breakdown voltage	4022	I _R = 100 A dc; pulsed (see 4.5.1) 1N6690, 1N6690US 1N6691, 1N6691US 1N6692, 1N6692US 1N6693, 1N6693US	V _{BR}	600 800 1,000 1,200		V
Forward voltage	4011	Duty cycle ≤ 2 percent (pulsed) (see 4.5.1); t _p = 8.3 ms (max). I _F = 5 A I _F = 20 A I _F = 70 A	V _{F1} V _{F2} V _{F3}		1.25 1.9 2.4	V
Reverse current leakage	4016	V _{RM} = column 2 (peak) of 1.3; pulsed (see 4.5.1)	I _{R1}		10	μA
<u>Subgroup 3</u>						
High temperature operation:		T _C = +100°C				
Reverse current leakage	4016	V _{RM} = column 2 (peak) of 1.3; pulsed (see 4.5.1)	I _{R2}		250	mA
Low temperature operation:		T _A = -65°C				
Forward voltage	4011	I _F = 5 A (pk); pulsed (see 4.5.1)	V _{F4}		1.5	V
<u>Subgroup 4</u>						
Scope display	4023	Stable only. See 4.5.4, n = 116, c = 0				
Reverse recovery time	4031	Condition B; I _F = .5 A, I _R = 1 A; I _{RR} = .25 A	t _{rr}		75	ns
Junction capacitance	4001	V _R = 10 V dc; f = 1 MHz; V _{SIG} = 50 mV (p-p) (maximum)	C _J		250	pF
<u>Subgroup 5</u>						
Not applicable						

See footnote at end of table.

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TABLE I. Group A inspection. - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 6</u> Forward surge Electrical measurement <u>Subgroup 7</u> Not applicable	4066	Condition A. $I_{FSM} = \text{rated } I_{FSM}$ (see 1.3 , col. 5); ten surges of 8.3 ms each at 1 minute intervals, superimposed on $I_O = 0$, $V_{RWM} = 0$. $T_A = +25^\circ\text{C}$ See table I , subgroup 2.				

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

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TABLE II. Group E inspection (all quality levels) for qualification and requalification only.

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Thermal shock (glass strain)	1056	20 cycles, condition D except low temperature shall be achieved using liquid nitrogen (-195°C). Visual for cracked glass.	
Temperature cycling	1051	500 cycles, -65°C to +175°C.	
Hermetic seal gross leak	1071		
Electrical measurement		See table I , subgroup 2 and table III herein, steps 1 and 2.	
<u>Subgroup 2</u>			22 devices c = 0
Blocking life	1048	T _A = +150°C; t = 1,000 hours +65, -0 hours; dc = 80 - 85 percent rated V _R .	
Electrical measurement		See table I , subgroup 2.	
<u>Subgroup 4</u>			
Thermal impedance curves		See MIL-PRF-19500 .	
<u>Subgroup 5</u>			
Insulation resistance	1016	V _R = rated V _{RWM} (see 1.3 , col. 2); pressure = 33 mmHg; t = 1 minute (minimum), R _{ISO} = 2.0 x 10 ⁶ Ω maximum.	5 devices c = 0
<u>Subgroup 8 1/</u>			n = 45
Peak reverse power	4065	Peak reverse power (P _{RM}) = shall be characterized by the supplier and this data shall be available to the Government. Test shall be performed on each subplot.	
<u>Subgroup 9 2/</u>			n = 45
Resistance to glass cracking	1057	Test condition B. Step stress to destruction by increasing cycles or up to a maximum of 25 cycles.	
<u>Subgroup 10</u>			22 devices c = 0
Forward surge	4066	Condition A, I _{FSM} = rated I _{FSM} (see 1.3 , col. 5); ten surges of 8.3 ms each at 1 minute intervals, I _O = 0, V _{RWM} = 0.	
Electrical measurement		See table I , subgroup 2.	

1/ The sample size for this step stress requirement shall be determined by the supplier. A statistically significant sample size is required.

2/ Also applies US suffix versions.

TABLE III. Groups B, C, and E delta measurements. 1/ 2/ 3/ 4/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward voltage change	4011	$I_F = 5$ A, pulsed (see 4.5.1)	ΔV_{F1}	± 100 mV change from previous measured value		
2.	Reverse current change	4016	$V_R =$ rated V_{RWM} (see 1.3, col. 2)	ΔI_{R1}		± 5	μA

1/ Devices which exceed table I, subgroup 2 (group A) limits for this test shall not be accepted.

2/ The delta measurements for group B inspection, table E-VIA (JANS) of MIL-PRF-19500 are as follows:
Subgroup 5, see table III herein, steps 1 and 2.

3/ The delta measurements for group E inspection, table E-IX of MIL-PRF-19500 are as follows: Subgroup 1, see table III herein, steps 1 and 2.

4/ Also applies to US suffix versions.

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 Part or Identifying Number (PIN), see title and section 1.

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 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 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 5961-2014-096)

Review Activities:
Army - AR, MI, SM
Navy - AS
Air Force - 19, 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 <https://assist.dla.mil>.