The documentation and process conversion measures necessary to comply with this revision shall be completed by 26 July 2013.

INCH-POUND

MIL-PRF-19500/228R
26 April 2013
SUPERSEDING
MIL-PRF-19500/228P
26 October 2011

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, RECTIFIER,
TYPES 1N3611, 1N3612, 1N3613, 1N3614, 1N3957, JAN AND JANTX

These devices are inactive for new design, preferred devices are - 1N5614, 1N5616, 1N5618, 1N5620, 1N5622 on MIL-PRF-19500/427.

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 1.0 ampere silicon rectifier diodes. Two levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1, axial package.

1.3 Maximum ratings. Unless otherwise specified, T_A = 25°C.

Types	V_{RWM}	I_O		I_{FSM}	Barometric pressure (reduced)	T_{STG} and T_J	$R_{\theta JL}$ L = .375 inch (9.53 mm)
		At: T_A = +55°C (1) (2)	At: T_A = +150°C (1) (2)	T_A = +55°C I_O = 1 A dc t_p = 8.0 ms			
	V(pk)	A dc	mA dc	A(pk)	mmHg	°C	°C/W
1N3611	200	1	200	30	8	-65 to +175	36
1N3612	400	1	200	30	8	-65 to +175	36
1N3613	600	1	200	30	8	-65 to +175	36
1N3614	800	1	200	30	33	-65 to +175	36
1N3957	1,000	1	200	30	33	-65 to +175	36

(1) From I_O rating is independent of heat sinking, special mounting, or leads of the device.
(2) Derate linearly at 8.3 mA between T_A = +55°C and T_A = +175°C.

* 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.

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

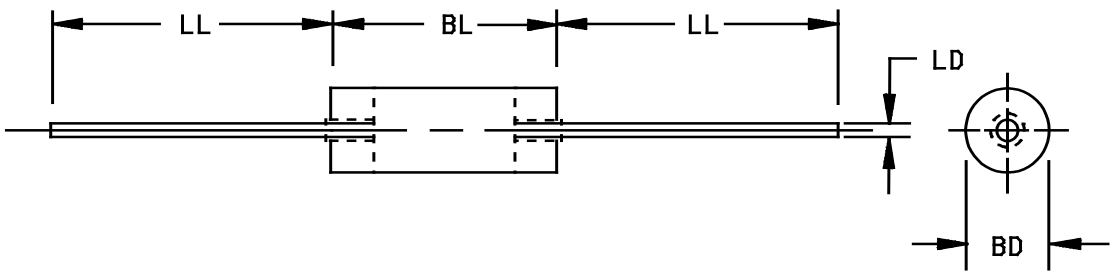
MIL-PRF-19500 - Semiconductor Devices, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

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

* (Copies of these documents are available online at https://assist.dla.mil/quicksearch/ 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. 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.



Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BD	.060	.110	1.52	2.79	4
BL	.125	.205	3.18	5.21	3
LD	.025	.034	0.64	0.86	3
LL	.600	1.500	15.24	38.10	

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimension BL shall include the entire body including slugs and sections of the lead over which the diameter is uncontrolled. This uncontrolled area is defined as the zone between the edge of the diode body and extending .050 inch (1.27 mm) onto the leads.
4. Dimension BD shall be measured at the largest diameter.
5. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

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

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 herein. No lead (Pb) shall be used in the construction of the die bonds.

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

3.4.2 Diode construction. These devices shall be constructed utilizing non-cavity double plug construction with high temperature bonding between both sides of the silicon die and terminal pins compliant to category 1 as defined in MIL-PRF-19500.

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.

3.7 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking may be omitted from the body, but shall be retained on the initial container.

3.8 Polarity. The polarity shall be indicated with a contrasting color band to denote the cathode end or the use of other techniques considered commercial practice.

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).

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

4.3 Screening (JANTX level only). Screening shall be in accordance with appendix E, 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 appendix E, table E-IV of MIL-PRF-19500)	Measurement JANTX level
(1) 3c	See 4.3.2.
9	Not applicable.
10	Method 1038 of MIL-STD-750, condition A
11	I_{R1} and V_{F2}.
12	See 4.3.1.
(2) 13	Subgroup 2 of table I herein. ΔI_{R1} ≤100 percent of initial reading or ±50 nA dc, whichever is greater. ΔV_{F2} ≤ ±0.1 V dc. Scope display evaluation (see 4.5.3).

(1) Shall be performed anytime after temperature cycling, screen 3a, and does not need to be repeated in screening requirements.
(2) For clear glass diodes, the hermetic seal (gross leak) may be performed at anytime after temperature cycling.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows (see 4.5.1): $I_{O(min)}$ = 1A, V_{RWM} as specified (see 1.3 herein). T_A = 55°C maximum. Test conditions in accordance with method 1038 of MIL-STD-750, condition B. Adjust I_O or T_A to achieve the required T_J. T_J = 135°C minimum, 175°C maximum. With approval of the qualifying activity and preparing activity, alternate burn-in criteria (hours, bias conditions, T_J, mounting conditions) may be used for JANTX quality level. A justification demonstrating equivalence is required. In addition, the manufacturing site's burn-in data and performance history will be essential criteria for burn-in modification approval.

* 4.3.2 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, and t_H. Measurement delay time (t_{MD}) = 70 μs max. The thermal impedance limit used in screen 3c and table I, subgroup 2 shall be set statistically by the supplier. See table II, subgroup 4 herein. Thermal impedance limit used by supplier shall not exceed the thermal impedance graph, see figure 2 herein.

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 appendix E, 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 appendix E, table E-VIB (JAN and JANTX) of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with the applicable steps of table I, subgroup 2 herein. Delta requirements shall be in accordance with the applicable steps of table III herein.

4.4.2.1 Group B inspection, appendix E, table E-VIB of MIL-PRF-19500.

	Subgroup	Method	Conditions
	B2	4066	I_{FSM} = 30 A(pk), 10 surges of 8.3 ms each at 1 minute intervals, I_O = 1 A dc, V_{RWM} = rated (see 1.3), T_A = +55°C. n = 22, c = 0.
*	B3	1027	T_A = +55°C (max), I_O = 1A, V_R = rated V_{RWM} (see 1.3), t = 340 hours, f = 60 Hz. Adjust I_O to achieve a T_J = +150°C minimum.
	B6	1032	T_A = +175°C, t = 340 hours.

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

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

Subgroup	Method	Conditions
C2	2036	Tension: Test condition A, weight = 12 pounds, t = 15 s. Lead fatigue: Test condition E, weight = 2 pounds.
C5	4081	+25°C ≤ T_L ≤ +35°C (recorded before test is performed), $R_{\theta JL}$ ≤ maximum rated $R_{\theta JL}$ (see 1.3 and 4.5.4).
C6	1026	T_A = +55°C (max), I_O = 1A, V_{RWM} = rated V_{RWM} (see 1.3), f = 60 Hz. t = 1,000 hrs Adjust I_O to achieve a T_J = +150°C minimum.
C8	2031	n = 22, c = 0, one cycle.

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 table II herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, subgroup 2 herein. See table III herein for delta limits when applicable.

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

4.5.1 Burn-in and life tests The use of a current limiting or ballast resistor is permitted provided that each DUT still sees the required T_J and full rated Io and that the minimum required voltage V_{RWM} is maintained throughout the burn-in period. Use method 3100 of MIL-STD-750 to measure T_J.

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

4.5.3 Scope display evaluation. Scope display evaluation shall be sharp and 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 curve tracer. The reverse current (I_{BR}) over the knee shall be 500 μA peak.

4.5.4 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} = 70 μs max. Forced moving air or draft shall not be permitted across the devices during test.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Thermal impedance	3101	See 4.3.2.	$Z_{\theta JX}$			°C/W
Forward voltage	4011	I_F = 1 A dc (pulsed, see 4.5.2); duty cycle = 2 percent maximum.	V_{F1}	.6	1.1	V pk
Forward voltage	4011	I_F = 3 A dc (pulsed, see 4.5.2); $t_p \leq$ 8.3 ms, 2 percent maximum duty cycle.	V_{F2}	.8	1.3	V pk
Reverse current leakage	4016	V_R = rated V_{RWM} (see 1.3), dc method or equivalent pulse.	I_{R1}		1.0	µA
Breakdown voltage	4022	I_{BR} = 50 uA.	V_{BR}			V
1N3611				220		
1N3612				440		
1N3613				660		
1N3614				880		
1N3957				1100		
Subgroup 3						
		T_A = +125°C.				
High temperature operation:						
Reverse current leakage	4016	V_R = rated V_{RWM} (see 1.3), dc method or equivalent pulse.	I_{R2}		300	µa
1N3611		V_R = 200				
1N3612		V_R = 400				
1N3613		V_R = 600				
1N3614		V_R = 800				
1N3957		V_R = 1,000				
Low temperature operation:		T_A = -55°C.				
Forward voltage	4011	I_F = 3.0 A dc (pulsed, see 4.5.2).	V_{F3}	0.6	1.5	V
Subgroup 4						
Reverse recovery time	4031	Condition B1	t_{rr}		2	µs
Scope display evaluation	4023	See 4.5.3, n = 116, c = 0.				

See footnote at end of table.

TABLE I. Group A inspection – Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 6						
Forward surge inspection	4066	I_{FSM} = 30 A (pk); ten surges of 8.3 ms each at 1 minute intervals, superimposed on I_O = 1 A V_{RWM} = rated (see col. 4 of 1.3.2); T_A = +55°C.				
Electrical measurements		See table 1, subgroup 2.				

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

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

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
Subgroup 1A			45 devices c = 0
Temperature cycling (air to air)	1/ 1051	20 cycles, except high temperature shall be 150°C and low temperature shall be -195°C.	
Hermetic seal 2/	1071		
Electrical measurements		See table I, subgroup 2 and table III, steps 1 and 2.	
Subgroup 1B			45 devices c = 0
Temperature cycling (air to air)	1051	500 cycles, condition C, -65°C to +175°C.	
Hermetic seal 2/	1071		
Electrical measurement		See table I, subgroup 2 and table III, steps 1 and 2.	
Subgroup 2			22 devices c = 0
Steady-state dc blocking life	1048	T_A = +150°C; t = 1,000 hours +65, -0 hours; dc = 80 - 85 percent rated V_{RWM} (see 1.3).	
Electrical measurement		See table I, subgroup 2.	
Subgroup 4			
Thermal impedance curves		See MIL-PRF-19500.	
Subgroup 5			22 devices c = 0
Barometric pressure (reduced)	1001	1N3611, 1N3612, and 1N3613 at 8 mm Hg; 1N3614 and 1N3957 at 33 mm Hg. 7	

See footnotes at end of table.

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

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
Subgroup 8			
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 sublot.	45 devices c = 0
Electrical measurement		During the P_{RM} test, the voltage (V_{BR}) shall be monitored to verify it has not collapsed. Any collapse in V_{BR} during or after the P_{RM} test, or rise in leakage current (I_R) after the test, that exceeds I_{R1} in table I herein shall be considered a failure to that level of applied P_{RM}. Progressively higher levels of P_{RM} shall be applied until failure occurs on all devices within the chosen sample size.	
Subgroup 9			45 devices c = 0
Resistance to glass cracking	1057	Test condition B. Step stress to destruction by increasing cycles or up to a maximum of 25 cycles.	
Subgroup 10			22 devices c = 0
Forward surge	4066	I_{FSM} = rated (see 1.3); ten surges of 8.3 ms each at 1 minute intervals superimposed on I_O = 1.0 A (see 1.3); V_{RWM} = rated (see 1.3); T_A = + 55°C.	
Electrical measurement		See table I, subgroup 2.	

1/ Test method 1056 of MIL-STD-750, condition D, using liquid nitrogen may be used in lieu of test method 1051.
2/ For opaque glass diodes use test method 2068 of MIL-STD-750.

TABLE III. Groups A, 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	4011	I_F = 3.0 A dc pulse width = 8.3 ms maximum; duty cycle = 2 percent maximum.	ΔV_{F2}	±0.1 V dc maximum		
2.	Reverse current	4016	DC method; V_R = rated (see 1.3).	ΔI_{R1}	±50 nA dc or ±100 percent of initial value, whichever is greater.		

1/ Devices that exceed the table I, subgroup 2 limits for this test shall not be accepted.
2/ The electrical measurements for group B inspection in appendix E, table E-VIB (JAN and JANTX) of MIL-PRF-19500 are as follows: Subgroups 3 and 6, see table III herein, steps 1 and 2.
3/ The electrical measurements for group C inspection in appendix E, table E-VII of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, steps 1 and 2.
4/ The electrical measurements for group E inspection in table E-IX of MIL-PRF-19500 are as follows:
a. Subgroup 1, see table III herein, steps 1 and 2.
b. Subgroup 2, see table III herein, steps 1 and 2.

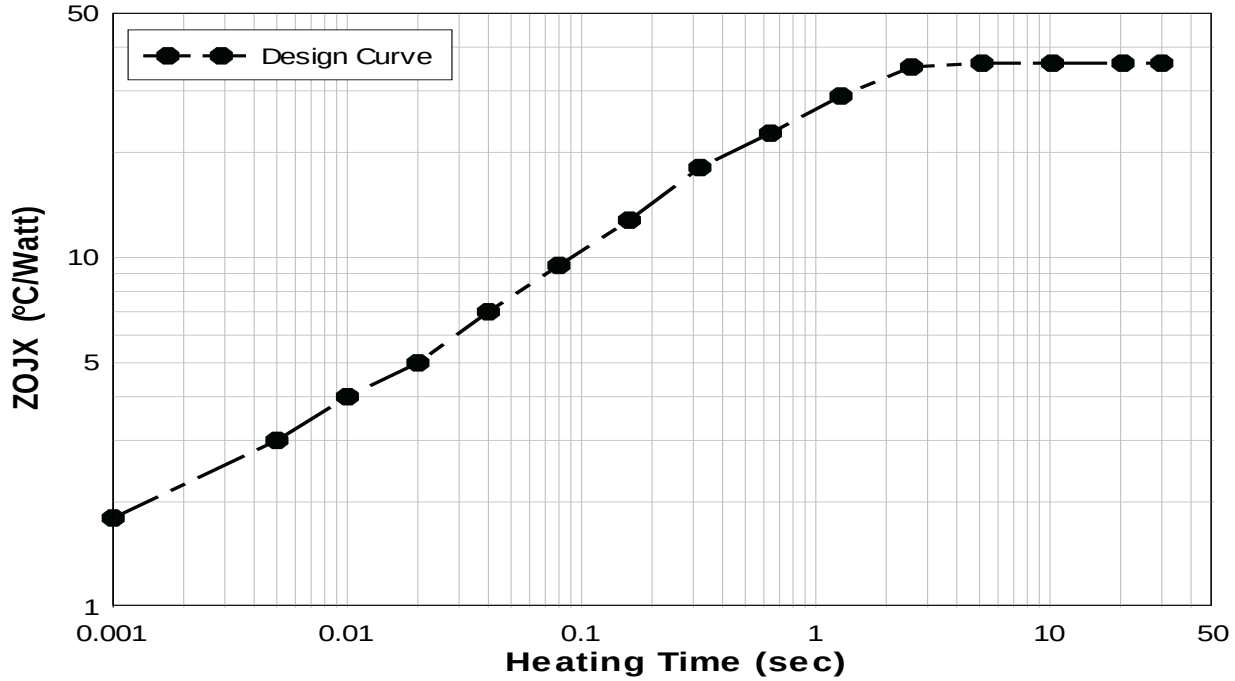


FIGURE 2. Thermal impedance graph $R_{\theta JL}$ 36°C/W.

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. Product assurance level and type designator.

* 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 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
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2012-095)

Review activities:
Army - AR, AV, MI, SM
Navy - AS, MC
Air Force - 19, 70, 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/.