

The documentation and process conversion measures necessary to comply shall with this document shall be completed by 3 March 2011.

* METRIC

MIL-PRF-19500/594B
 3 December 2010
 SUPERSEDING
 MIL-PRF-19500/594A
 3 July 1998

* PERFORMANCE SPECIFICATION SHEET

* SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, ULTRA FAST RECOVERY, LOW LEAKAGE, TYPES 1N6664 THROUGH 1N6666, AND 1N6664R THROUGH 1N6666R, 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, fast recovery power rectifier diodes. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (TO-257AA).

1.3 Maximum ratings (for each leg).

| Types | V_R and V_{RWM} | I_O (1) $T_C = +100^\circ C$ | I_{FSM} $T_C = +100^\circ C$ $t_p = 8.3$ ms | t_{rr} | T_{STG} and T_{OP} |
|--------------------|---------------------------|-----------------------------------|---|-----------|------------------------------|
| | <u>V dc</u> | <u>A dc</u> | <u>A dc</u> | <u>ns</u> | |
| 1N6664, 1N6664R | 100 | 10 | 50 | 35 | +200°C to -65°C |
| 1N6665, 1N6665R | 150 | 10 | 50 | 35 | |
| 1N6666, 1N6666R | 200 | 10 | 50 | 35 | |

(1) Derate linearly, 100 mA/°C from +100°C to +200°C.

Storage temperature: $T_{STG} = -65^\circ C$ to $+200^\circ C$.

Operating temperature: $T_J = -65^\circ C$ to $+200^\circ C$.

Barometric pressure reduced (altitude operation): 8 mm Hg.

$R_{\theta JC} = 2.5^\circ C/W$ maximum.

* 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@dsc.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.daps.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 listed 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.daps.dla.mil/quicksearch> or <https://assist.daps.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.

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.

* 3.4 Interface and physical dimensions. Interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 herein. Methods used for electrical isolation of the terminal feedthroughs shall employ materials that contain a minimum of 90 percent AL_2O_3 (ceramic).

* 3.4.1 Lead finish. Lead finish shall be solderable in accordance in 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).

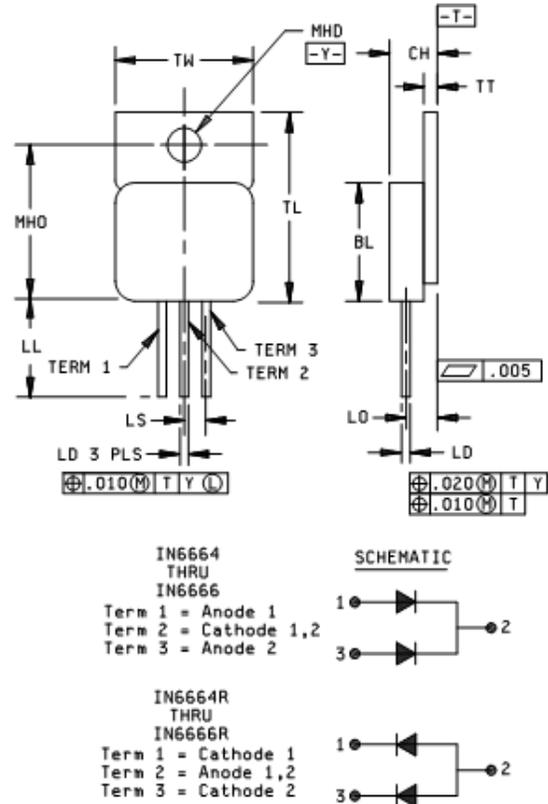
3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

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

* 3.7 Electrical test requirements. The electrical test requirements shall be as specified in table I herein.

* 3.8 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.

| Ltr | Dimensions | | | |
|--------|---------------|-------|----------|------|
| | Millimeters | | Inches | |
| | Min | Max | Min | Max |
| BL | 10.41 | 10.92 | .410 | .430 |
| CH | 4.83 | 5.08 | .190 | .200 |
| LD | 0.64 | 0.89 | .025 | .035 |
| LL | 12.82 | 15.11 | .505 | .595 |
| LO | 3.05 BSC | | .120 BSC | |
| LS | 2.54 BSC | | .100 BSC | |
| MHD | 3.56 | 3.81 | .140 | .150 |
| MHO | 13.39 | 13.64 | .527 | .537 |
| TL | 16.38 | 16.89 | .6450 | .665 |
| TT | 0.89 | 1.14 | .035 | .045 |
| TW | 10.41 | 10.67 | .410 | .420 |
| Term 1 | See schematic | | | |
| Term 2 | See schematic | | | |
| Term 3 | See schematic | | | |



NOTES:

1. Dimensions are in millimeters.
 2. Inch equivalents are given for general information only.
 3. Glass meniscus included in dimension TL and BL.
- * 4. In accordance with ASME Y14.5M, diameters are equivalent to ϕ x symbology.

* FIGURE 1. Dimensions and configuration (TO-257AA).

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.

4.2.1 Construction verification. Cross sectional photos from three devices shall be submitted in the qualification report.

* 4.2.2 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 (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 | JANTX and JANTXV levels |
| (1) 3c | Thermal impedance (see 4.3.2) | Thermal impedance (see 4.3.2) |
| 4 | Y_1 at 10,000 G | Not applicable |
| 9 | Not applicable | Not applicable |
| 11 | Subgroup 2 of table I herein; V_{F2} and I_{R1} | Subgroup 2 of table I herein; V_{F2} and I_{R1} |
| 12 | See 4.3.1, method 1038 of MIL-STD-750, test condition A, t = 96 hours | See 4.3.1, method 1038 of MIL-STD-750, test condition A, t = 48 hours |
| 13 | Subgroups 2 and 3 of table I herein; $\Delta V_{F2} = \pm .05$ V (pk); $\Delta I_{R1} = 150$ nA dc or 100 percent of the initial value, whichever is greater | Subgroup 2 of table I herein; $\Delta V_{F2} = \pm .05$ V (pk); $\Delta I_{R1} = 150$ nA dc or 100 percent of the initial value, whichever is greater |

- (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 impedance.

4.3.1 Burn-in conditions. Burn-in conditions are as follows: $T_A = +150^\circ\text{C}$; $V_R = 0.8$ to 0.85 rated V_R dc (see 1.3).

* 4.3.2 Thermal impedance $Z_{\theta JX}$ measurements for screening. The thermal impedance measurements shall be performed in accordance with method 3101 of MIL-STD 750 as applicable, using the guidelines in that method for determining I_M , I_H , t_H , and K factor where appropriate). Measurement delay time (t_{MD}) = $70 \mu\text{s}$ max. The thermal impedance limit used in screen 3c and table I, subgroup 2 shall be set statistically by the supplier.

4.3.2.1 Thermal impedance ($Z_{\theta JX}$ measurements) for initial qualification or requalification. The $Z_{\theta JX}$ measurements shall be performed in accordance with method 3101 of MIL-STD-750, (read and record date $Z_{\theta JX}$). $Z_{\theta JX}$ shall be supplied on one lot (500 pieces minimum and a thermal response curve shall be submitted. Twenty-two of these samples shall be serialized and provided to the qualifying activity for correlation prior to shipment of parts. Measurements conditions shall be in accordance with 4.4.1.

4.3.3 Surge current. Surge current, see method 4066 of MIL-STD-750. $I_{FSM} = 50$ A; 6 surges; $t_p = 8.3$ ms or rectangular pulse of equivalent I_{rms} ; 3 surges. $I_O = 0$ A; $V_{RMS} = 0$ V; duty factor 1 percent minimum $T_A = +25^\circ\text{C}$.

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. The following test conditions shall be used for $Z_{\theta JX}$, group A inspection: $Z_{\theta JX} \leq 2.5^\circ\text{C/W}$.

- a. $I_H = 5$ A minimum.
- b. $t_H \geq 100$ ms.
- c. $I_M = 10$ mA to 200 mA.
- d. $t_{MD} = 200 \mu\text{s}$ maximum.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIa (JANS) and table E-VIb (JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

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

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u> |
|-----------------|---------------|---|
| B3 | 4066 | $T_C = +100^\circ\text{C}$; $t_p \leq 8.3$ ms; $V_R =$ rated V_R (see 1.3); six 8.3 ms surges; 1 surge/minute maximum. I_F (surge) = 50 A dc; $I_O = 10$ A dc. |
| B3 | 2037 | Test condition D, all internal wires for each device shall be pulled separately. |
| B4 | 1037 | 2,000 cycles, 25 percent rated $I_O \leq I_O$ applied \leq rated I_O (see 4.5.2). |
| B5 | 1027 | $I_F \geq 0.5$ A dc at $T_A = +25^\circ\text{C}$, for 96 hours, or adjusted as required by the chosen T_A to give an average lot at $T_J = +275^\circ\text{C}$. |
| B6 | 3101 | See 4.4.1 except $t_H \geq 500$ ms. |

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

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u> |
|-----------------|---------------|---|
| B2 | 4066 | $T_C = +100^\circ\text{C}$; $t_p \leq 8.3 \text{ ms}$; $V_R = \text{rated } V_R$ (see 1.3); six 8.3 ms surges; 1 surge/minute maximum. I_F (surge) = 50 A dc; $I_O = 10 \text{ A dc}$. |
| B3 | 1037 | $I_F \geq 0.5 \text{ A dc}$, I_O (see 4.5.2); 2,000 cycles. |
| B4 | | Not applicable. |
| B5 | 3101 | See 4.4.1 except $t_H \geq 500 \text{ ms}$. |

* 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. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table III herein.

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

| <u>Subgroup</u> | <u>Method</u> | <u>Conditions</u> |
|-----------------|---------------|--|
| C2 | 2036 | Test condition A, weight = 10 pounds, $t = 15 \text{ seconds}$. |
| C2 | 1021 | Omit initial conditioning. |
| C6 | 1037 | $I_F \geq 0.5 \text{ A dc}$, I_O (see 4.5.2); 6,000 cycles. |

* 4.4.4 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. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps and footnotes of table III herein, except Z_{0JX} is not required.

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 DC intermittent operation life. A cycle shall consist of an "on" period, when forward current is applied suddenly, not gradually, to the device for the time necessary to achieve an increase (delta) case temperature of $+85^\circ\text{C} +15^\circ\text{C}$, -5°C followed by an "off" period, when the current is suddenly removed for cooling the case through a similar delta temperature. Auxiliary (forced) cooling is permitted during the "off" period only. Either forward current or "on" time, within specific limits, and "off" time may be adjusted to achieve the delta case temperature. Heat sinks shall only be used if, and to the degree necessary, to maintain test samples with the desired delta temperature tolerance. The heating time shall be such that $30 \text{ s} \leq t_{\text{heating}} \leq 180 \text{ s}$. The forward current may be steady-state dc, full-wave rectified dc, or the equivalent half-sine wave dc of the specified value. The test duration shall be the specified number of cycles. Within the time interval of 50 cycles before, and 500 cycles after, the termination of the test, the sample units shall be removed from the specified test conditions and allowed to reach room ambient conditions. Specified end-point measurements for qualification and quality conformance inspections shall be completed within 96 hours after removal of sample units from the specified test conditions. Additional readings may be taken at the discretion of the manufacturer.

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* TABLE I. Group A inspection.

| Inspection 1/ | MIL-STD-750 | | Symbol | Limits | | Unit |
|-----------------------------------|-------------|---|----------------------|--------|------------|--------------|
| | Method | Conditions | | Min | Max | |
| <u>Subgroup 1</u> | | | | | | |
| Visual and mechanical examination | 2071 | | | | | |
| <u>Subgroup 2</u> | | | | | | |
| Thermal impedance | 3101 | See 4.4.1 | $Z_{\theta JX}$ | | 2.5 | °C/W |
| Forward voltage | 4011 | $t_p \leq 400 \mu s$, duty cycle ≤ 2 percent pulse $I_F = 6 A$ $I_F = 12 A$ | V_{F1} V_{F2} | | 1.0 1.5 | V dc V dc |
| Reverse current leakage | 4016 | DC method; $V_R = \text{rated } V_R$ (see 1.3) | I_{R1} | | 250 | nA dc |
| Breakdown voltage | 4021 | $I_R = 1.0 \mu A$ dc | $V_{(BR)1}$ | | | |
| 1N6664, 1N6664R | | | | 100 | | V dc |
| 1N6665, 1N6665R | | | | 150 | | V dc |
| 1N6666, 1N6666R | | | | 200 | | V dc |
| <u>Subgroup 3</u> | | | | | | |
| High temperature operation: | | $T_A = +150^\circ C$ | | | | |
| Reverse current leakage | 4016 | DC method; $V_R = \text{rated } V_R$ (see 1.3) | I_{R2} | | 75 | μA dc |
| Forward voltage | 4011 | $I_{FM} = 6 A$, duty cycle ≤ 2 percent (pulsed); $t_p \leq 400 \mu s$ | V_{F3} | | 0.95 | V |
| Low temperature operation: | | $T_A = -55^\circ C$ | | | | |
| Forward voltage | 4011 | $I_{FM} = 6 A$, duty cycle ≤ 2 percent (pulsed); $t_p \leq 400 \mu s$ | V_{F4} | | 1.1 | V |
| Breakdown voltage | 4021 | $I_R = 1.0 \mu A$ dc | $V_{(BR)2}$ | | | |
| 1N6664, 1N6664R | | | | 100 | | V dc |
| 1N6665, 1N6665R | | | | 150 | | V dc |
| 1N6666, 1N6666R | | | | 200 | | 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 | | Unit |
|-----------------------|-------------|---|----------|--------|-----|------|
| | Method | Conditions | | Min | Max | |
| <u>Subgroup 4</u> | | | | | | |
| Reverse recovery time | 4031 | $I_F = 0.5 \text{ A}$; $I_R = 1 \text{ A}$; $I_{(REC)} = 0.25 \text{ A}$; $di/dt = 85 \text{ A}/\mu\text{s}$ minimum | t_{rr} | | 35 | ns |
| Junction capacitance | 4001 | $V_R = 10 \text{ V}$; $f = 1 \text{ MHz}$; $V_{SIG} = 50 \text{ mV}$ (p-p) maximum | C_J | | 100 | pF |
| <u>Subgroup 5</u> | | | | | | |
| Not applicable | | | | | | |
| <u>Subgroup 6</u> | | | | | | |
| Surge current | 4066 | | | 50 | | A |

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

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

| Inspection | MIL-STD-750 | | Sampling plan |
|-------------------------------------|-------------|--|---------------------|
| | Method | Conditions | |
| <u>Subgroup 1</u> | | | 45 devices c = 0 |
| Thermal shock (liquid to liquid) | 1056 | 20 cycles, except high temperature shall be 100°C and low temperature shall be 0°C. | |
| Temperature cycling (air to air) | 1051 | 500 cycles, condition C. -65°C to +200°C. | |
| Hermetic seal | 1071 | | |
| Electrical measurement | | See table I, group A, subgroup 2 and table III, steps 1 and 2. | |
| <u>Subgroup 2</u> | | | 22 devices c = 0 |
| Steady-state reverse bias | 1038 | Test condition A, t = 1,000 hours, T _C = +150°C, V _R = 0.8 of rated V _{RWM} (see 1.3). | |
| Electrical measurement | | See table I, group A, subgroup 2 and table III, steps 1 and 2. | |
| <u>Subgroup 3</u> | | | |
| Not applicable | | | |
| <u>Subgroup 4</u> | | | Sample size N/A |
| Thermal impedance curves | | See MIL-PRF-19500. | |

See footnotes at end of table

* TABLE III. Group B, C, and E delta requirements. 1/ 2/ 3/ 4/ 5/

| Step | Inspection | MIL-STD-750 | | Symbol | Limit | Unit |
|------|---------------------------------------|-------------|--|-----------------|--|------|
| | | Method | Conditions | | | |
| 1. | Forward voltage | 4011 | Duty cycle \leq 2 percent (pulsed see 4.5.1); $t_p = 8.3$ ms (max) | ΔV_{F1} | ± 50 mV dc change from initial value | |
| | 1N6664,R, 1N6665, R, 1N6666, R | | $I_F = 6$ A | | | |
| | 1N6664, R, 1N6665, R, 1N6666, R | | $I_F = 12$ A | ΔV_{F2} | ± 50 mV dc change from initial value | |
| 2. | Reverse current | 4016 | DC method | ΔI_{R1} | | |
| | 1N6664, R, 1N6665, R, 1N6666, R | | $V_R = 100$ V dc $V_R = 150$ V dc $V_R = 200$ V dc | | 100 percent or ± 150 nA dc change from initial reading, whichever is greater | |

- 1/ Devices which exceed the table I limits for this test shall not be accepted.
- 2/ The electrical measurements for group B inspections in table E-VIa (JANS) of MIL-PRF-19500 are as follows: Subgroups 4 and 5, see table III herein, steps 1 and 2.
- 3/ The electrical measurements for group B inspections in table E-VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows: Subgroup 3, see table III herein, steps 1 and 2.
- 4/ The electrical measurements for group C inspections in table E-VII (all quality levels) of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, steps 1 and 2.
- 5/ The electrical measurements for group E inspections in table E-IX of MIL-PRF-19500 are as follows: Subgroups 1 and 2, see table III herein, steps 1 and 2.

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 logistics 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.daps.dla.mil>.

6.4 Interchangeability information. MIL-PRF-19500/594 is a TO-257 package version of MIL-PRF-19500/477, which is an axial leaded diode version.

* 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 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 5961-2010-075)

Review activities:

Army - AR, MI, SM
Navy - AS,-MC
Air Force - 19, 99

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