

The documentation and process conversion measures necessary to comply with this revision shall be completed by 12 June 2007.

INCH-POUND

MIL-PRF-19500/616E  
 12 March 2007  
 SUPERSEDING  
 MIL-PRF-19500/616D  
 3 April 2006

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, POWER RECTIFIER, DUAL,  
 COMMON CATHODE OR ANODE CENTER TAP, ULTRAFAST, TYPES 1N6657 THROUGH 1N6659  
 AND 1N6657R THROUGH 1N6659R, 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, dual high voltage, ultrafast power rectifier diodes. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

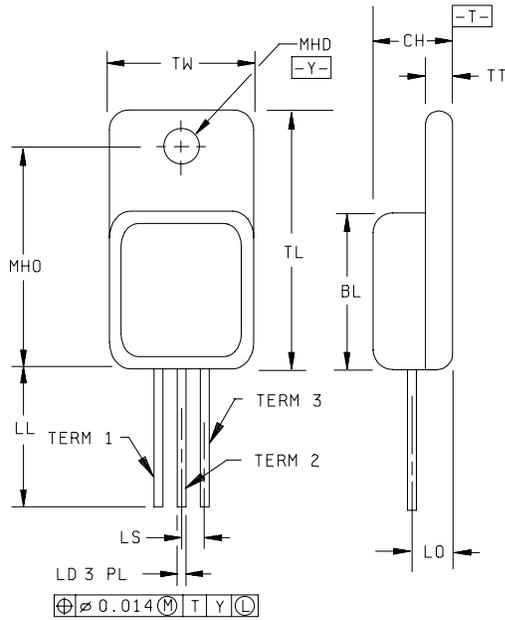
1.2 Physical dimensions. See figure 1 (TO-254AA isolated).

1.3 Maximum ratings. (per leg)

Types	$V_{RWM}$	$I_{FSM}$ (1) $t_p = 8.3$ ms	$I_F$ $T_C = 100^\circ\text{C}$ (1) (2) (3)	$t_{rr}$ (1)	$R_{\theta JC}$ (1)	$R_{\theta JA}$ (1)	$T_{STG}$ and $T_J$
	<u>V dc</u>	<u>A (pk)</u>	<u>A dc</u>	<u>ns</u>	<u>°C/W</u>	<u>°C/W</u>	<u>°C</u>
1N6657, 1N6657R	100						
1N6658, 1N6658R	150	150	15	35	2.3	40	-65 to +200
1N6659, 1N6659R	200						

- (1) Each individual diode.
- (2) Derate linearly at 300 mA/°C from +100°C to +150°C.
- (3) Total package current is limited to 30A dc.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center, Columbus, ATTN: DSCC-VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to [Semiconductor@dsc.dla.mil](mailto: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 <http://assist.daps.dla.mil>.

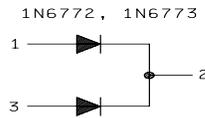


Ltr	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.535	.545	13.59	13.84
CH	.249	.260	6.32	6.60
LD	.035	.045	0.89	1.14
LL	.530	.550	13.46	13.97
LO	.150 BSC		3.81 BSC	
LS	.150 BSC		3.81 BSC	
MHD	.139	.149	3.53	3.78
MHO	.665	.685	16.89	17.40
TL	.790	.800	20.07	20.32
TT	.040	.050	1.02	1.27
TW	.535	.545	13.59	13.84

**SCHEMATIC**

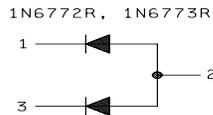
1N6657, 1N6658, 1N6659

TERM 1 = ANODE 1  
 TERM 2 = CATHODE  
 TERM 3 = ANODE 2



1N6657R, 1N6658R, 1N6659R

TERM 1 = CATHODE 1  
 TERM 2 = ANODE  
 TERM 3 = CATHODE 2



**NOTES:**

1. Dimensions are in inches.
2. Millimeter equivalents are given for general information only.
3. All terminals are isolated from case.
4. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi$ x symbology.

FIGURE 1. Dimensions and configuration (TO-254AA).

## 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://assist.daps.dla.mil/quicksearch/> or <http://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. 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.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500, and on figure 1 (TO-254AA) herein. Methods used for electrical isolation of the terminal feed throughs shall employ materials that contain a minimum of 90 percent  $AL_2O_3$  (ceramic). Examples of such construction techniques are metallized ceramic eyelets or ceramic walled packages. The US Government's preferred system of measurement is the metric SI system. However, since this item was originally designed using inch-pound units of measurement, in the event of conflict between the metric and inch-pound units, the inch-pound units shall take precedence.

3.4.1 Lead formation and finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish or formation is desired, it shall be specified in the acquisition document (see 6.2). When lead formation is performed, as a minimum, the vendor shall perform 100 percent hermetic seal in accordance with screen 14 of MIL-PRF-19500.

3.4.2 Polarity. Polarity and terminal configuration shall be in accordance with figure 1 herein.

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 the subgroups 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.

#### 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 ( JANS, JANTX, and JANTXV levels 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	
	JANS level	JANTX and JANTXV levels
1a	Required	Not required
1b	Required	Required (JANTXV only)
2	Not required	Not required
3a	Required	Required
3b	Surge (see 4.3.1)	Surge (see 4.3.1)
(1) 3c	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
4, 5, 6	Not applicable	Not applicable
8	Required	Not applicable
9	$V_{F1}$ and $I_{R1}$	Not applicable
10	Method 1038 of MIL-STD-750, test condition A; $t = 48$ hours; $V_R = 80$ percent of rated $V_R$ .	Not applicable
11	$V_{F1}$ and $I_{R1}$ ; $\Delta V_{F1} = \pm 0.1$ V (pk); $\Delta I_{R1} = \pm 2$ $\mu$ A dc or 100 percent from the initial value; whichever is greater.	$V_{F1}$ and $I_{R1}$
12	Method 1038 of MIL-STD-750, test condition B; $t = 240$ hours; (see 4.3.3)	Method 1038 of MIL-STD-750, test condition A; $t = 48$ hours; $V_R = 80$ percent of rated $V_R$ .
13	Subgroup 2 and 3 of table I herein; $V_{F1}$ and $I_{R1}$ ; $\Delta V_{F1} = \pm 0.1$ V (pk); $\Delta I_{R1} = \pm 2$ $\mu$ A dc or 100 percent from the initial value; whichever is greater.	Subgroup 2 of table I herein; $V_{F1}$ and $I_{R1}$ ; $\Delta V_{F1} = \pm 0.1$ V (pk); $\Delta I_{R1} = \pm 2$ $\mu$ A dc or 100 percent from the initial value; whichever is greater.
15	Required	Not required
16	Required	Not required

(1) Shall be performed anytime after temperature cycling, screen 3a; and does not need to be repeated in screening requirements.

4.3.1 Surge current. Surge current, method 4066 of MIL-STD-750.  $I_O = 0$ ;  $V_{RM}(w) = 0$ ;  $I_{FSM} =$  see 1.3; six surges;  $T_A = 25^\circ\text{C}$ ,  $t_p = 8.3$  ms, one minute minimum time between surges.

4.3.2 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3101 or 4081, as applicable, of MIL-STD-750 using the guidelines in that method for determining  $I_M$ ,  $I_H$ ,  $t_H$ ,  $t_{SW}$  ( $V_C$  and  $V_H$  where appropriate). Measurement delay time ( $t_{MD}$ ) = 70  $\mu$ s max. See table II, group E, subgroup 4 herein.

\* 4.3.3 Burn-in conditions. Burn-in conditions are as follows:  $T_A =$  room ambient as defined in the general requirements of 4.5 of MIL-STD-750.  $V_R =$  rated. Adjust  $I_O$  or  $I_F$  to achieve  $T_J = 150^\circ\text{C}$  minimum.

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 of appendix E, tables E-VIa (JANS) and E-VIb (JANTX and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. See table III herein for delta limits when applicable.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B4	1037	$T_A$ = room ambient as defined in the general requirements of 4.5 of MIL-STD-750. $I_F$ or $I_O$ = 1.25 to 10 A. Minimum for 2,000 cycles.

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
B3	1037	$T_A$ = room ambient as defined in the general requirements of 4.5 of MIL-STD-750. $I_F$ or $I_O$ = 1.25 to 10 A. Minimum for 2,000 cycles.

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

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

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition A, weight = 10 pounds, t = 15 seconds.
C5	3101 or 4081	$R_{\theta JC} = 2.3^\circ\text{C/W}$ .
C6	1037	$T_A$ = room ambient as defined in the general requirements of 4.5 of MIL-STD-750. $I_F$ or $I_O$ = 1.25 to 10 A for 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 appendix E, table E-IX of MIL-PRF-19500 and table II herein. Electrical measurements (end-points) shall be in accordance with 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 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 Burn-in and steady-state operation 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 rectifier current. The forward conduction angle of the rectified current shall not be greater than 180 degrees nor less than 150 degrees.

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\* TABLE I. Group A inspection.

Inspection <u>1/</u>	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 4.3.2	Z <sub>θJX</sub>			°C/W
Breakdown voltage	4022	I <sub>R</sub> = 500 μA dc; pulsed (see 4.5.1)	V <sub>BR</sub>			V dc
1N6657, 1N6657R 1N6658, 1N6658R 1N6659, 1N6659R				100 150 200		
Forward voltage	4011	I <sub>F</sub> = 10 A (pk); pulsed (see 4.5.1)	V <sub>F1</sub>		1.0	V dc
		I <sub>F</sub> = 20 A (pk); pulsed (see 4.5.1)	V <sub>F2</sub>		1.2	V dc
Reverse current leakage	4016	DC method; V <sub>R</sub> = rated V <sub>R</sub> , (see 1.3); pulsed (see 4.5.1)	I <sub>R1</sub>		10	μA dc
<u>Subgroup 3</u>						
High temperature operation		T <sub>C</sub> = +100°C				
Reverse current leakage	4016	DC method; V <sub>R</sub> = rated V <sub>R</sub> (see 1.3); pulsed (see 4.5.1)	I <sub>R2</sub>		1.0	mA dc
Low temperature operation:		T <sub>A</sub> = -65°C				
Forward voltage	4011	I <sub>F</sub> = 10 A (pk); pulsed (see 4.5.1)	V <sub>F3</sub>		1.15	V dc
<u>Subgroup 4</u>						
Scope display evaluation <u>2/</u>						
Reverse recovery time	4031	Condition B; I <sub>F</sub> = 1A dc, I <sub>R</sub> = 1 A, I <sub>RR</sub> = 100 mA	t <sub>rr</sub>		35	ns
Junction capacitance	4001	V <sub>R</sub> = 10 V dc, f = 1 mHz, V <sub>SIG</sub> = 50 mV (p-p) (max)	C <sub>J</sub>		150	
<u>Subgroup 5</u>						
Not applicable						

See footnotes at end of table.

\* TABLE I. Group A inspection - Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 6</u> Surge  Electrical measurements  <u>Subgroup 7</u> Not applicable	4066	Mounting conditions in accordance with test method 1026 of MIL-STD-750, $T_A = +25^\circ\text{C}$ , $I_{FSM} =$ (see 1.3), $I_O = 0$ ; $V_{RM}(w) = 0$ ; six surges; $T_A = 25^\circ\text{C}$ , $t_p = 8.3$ ms, one minute minimum time between surges.  See table I, subgroup 2 herein.				

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

2/ The reverse breakdown characteristics shall be viewed on an oscilloscope with display calibration factors of 50 to 100  $\mu\text{A}/\text{division}$  and 20 to 50  $\text{V}/\text{division}$ . Reverse current over the knee shall be at least 500  $\mu\text{A}$ . Each device may exhibit a slightly rounded characteristic and any discontinuity or dynamic instability of the trace shall be cause for rejection.

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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>			22 devices c = 0
Temperature cycling	1051	500 cycles, condition C, - 55°C to +175°C.	
Hermetic seal	1071		
Electrical measurements		See table I, subgroup 2 and table III, steps 1 and 2.	
<u>Subgroup 2</u>			22 devices c = 0
Blocking life	1048	1,000 hours, $V_R = 80$ percent of $V_{Rated}$ .	
Electrical measurements		See table I, subgroup 2 herein, except for thermal impedance and table III, steps 1 and 2.	
<u>Subgroup 4</u>			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
<u>Subgroup 5</u>			22 devices c = 0
Barometric pressure, reduced (altitude operation)	1001	$V_R = \text{rated } V_R$ (see 1.3); pressure = 33 mmHg; t = 1 minute (minimum), $R_{ISO} = 2.0 \times 10^6$ ohm max.	
<u>Subgroup 6</u>			
Not applicable			
<u>Subgroup 8</u>			22 devices c = 0
Forward surge	4066		
Electrical measurements		See table I, subgroup 2 herein.	

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

Step	Inspection	MIL-STD-750		Symbol	Limits <u>3/</u>		Unit
		Method	Conditions		Min	Max	
1.	Forward voltage change	4011	$I_{FM} = 10A$ , pulsed (see 4.5.1)	$\Delta V_{F1}$	$\pm 0.1$ V (pk) from previous measured value		
2.	Reverse current change	4016	$V_R = 80$ percent of $V_{RWM}$ (see 1.3)	$\Delta I_{R1}$	$\pm 10$ $\mu A$ dc or 100 percent from initial value, whichever is greater.		

- 1/ The electrical measurements for table E-VIa (JANS) of MIL-PRF-19500 are as follows:
  - a. Subgroup 4, see table III herein, steps 1 and 2.
  - b. Subgroup 5, see table III herein, steps 1 and 2.
- 2/ The electrical measurements for table E-VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows:
  - a. Subgroup 3, see table III herein, steps 1 and 2.
  - b. Subgroup 6, see table III herein, steps 1 and 2.
- 3/ The electrical measurements for table E-VII (all quality levels) of MIL-PRF-19500 are as follows: Subgroup 6, see table III herein, steps 1 and 2.
- 4/ The electrical measurements for table E-IX (all quality levels) of MIL-PRF-19500 are as follows: Subgroup 1, 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.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

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 Defense Supply Center, Columbus, ATTN: DSCC/VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail [vqe.chief@dla.mil](mailto:vqe.chief@dla.mil).

6.4 Interchangeability information. MIL-PRF-19500/616 is a dual TO-254 package version of MIL-PRF-19500/478, which is a stud package 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 the marginal notations and relationship to the last previous issue.

Custodians:

Army - CR  
Navy - EC  
Air Force - 11  
NASA - NA  
DLA – CC

Preparing activity:

DLA - CC

(Project 5961-2006-072)

Review activities:

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

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