

The documentation and process conversion measures necessary to comply with this revision shall be completed by 25 June 2012.

INCH-POUND

MIL-PRF-19500/158T  
w/AMENDMENT 1  
6 April 2012  
SUPERSEDING  
MIL-PRF-19500/158T  
4 February 2009

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, DIODE, SILICON, TEMPERATURE COMPENSATED, VOLTAGE-REFERENCE, TYPES 1N3154-1, THROUGH 1N3157-1, AND 1N3154UR-1 THROUGH 1N3157UR-1, JAN, JANTX, JANTXV, AND JANS, RADIATION HARDENED (TOTAL DOSE ONLY) JANTXVM, D, L, R, F, G, H, AND JANSM, D, L, R, F, G, H

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 8.4 volts  $\pm$ 5 percent, silicon, temperature compensated, voltage-reference diodes. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500. Seven levels of radiation hardened (total dose only) product assurance are provided for each encapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See [figure 1](#) (similar to DO-7 and DO-35) and [figure 2](#) (DO-213AA).

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

$P_T$	$T_{STG}$ and $T_J$	$I_{ZM}$ (1)	Power derating above $T_A = +25^\circ\text{C}$
<u>mW</u>	<u>°C</u>	<u>mA dc</u>	<u>mW/°C</u>
500	-55 to +175	55	3.33

(1) To guarantee voltage temperature stability, it is necessary to maintain the proper  $I_Z = 10$  mA.

1.4 Primary electrical characteristics. Unless otherwise specified, primary electrical characteristics at  $T_A = +25^\circ\text{C}$ .

Type	$\Delta V_Z$ (voltage-temperature stability) (1)	$Z_Z$ (1)	$V_Z$ (1)		$I_R$ $V_R = 5.5$ V
			Min	Max	
	<u>mV dc</u>	<u>ohms</u>	<u>volts</u>	<u>volts</u>	<u><math>\mu\text{A}</math></u>
1N3154-1, 1N3154UR-1	130.0	15	7.98	8.82	10.0
1N3155-1, 1N3155UR-1	65.0	15	7.98	8.82	10.0
1N3156-1, 1N3156UR-1	26.0	15	7.98	8.82	10.0
1N3157-1, 1N3157UR-1	13.0	15	7.98	8.82	10.0

(1) To guarantee voltage temperature stability, it is necessary to maintain the proper  $I_Z = 10$  mA.

\* Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, 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 <https://assist.daps.dla.mil>.

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## 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.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 manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. The 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 figures 1 and 2 herein.

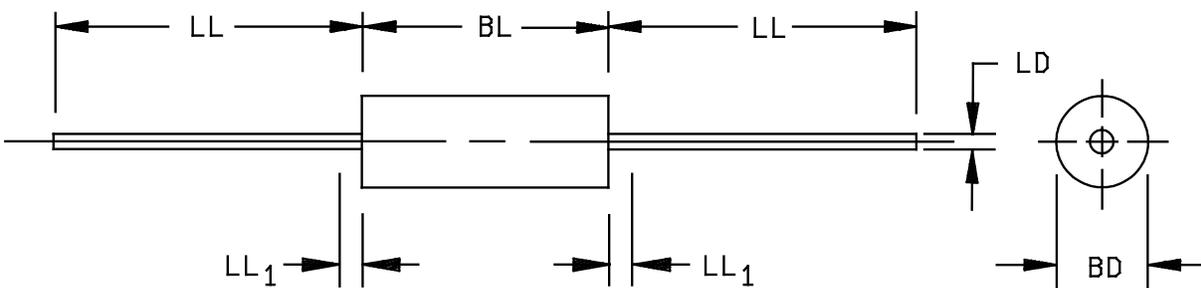
3.4.1 Lead finish. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Diode construction. These devices shall be constructed in a manner and using material which enable the diodes to meet the applicable requirements of MIL-PRF-19500 and this document.

3.5.1 Dash-one construction. Shall be as specified in MIL-PRF-19500.

3.5.2 JANS construction. Construction shall be dash-one, category I or II metallurgical bond in accordance with MIL-PRF-19500.

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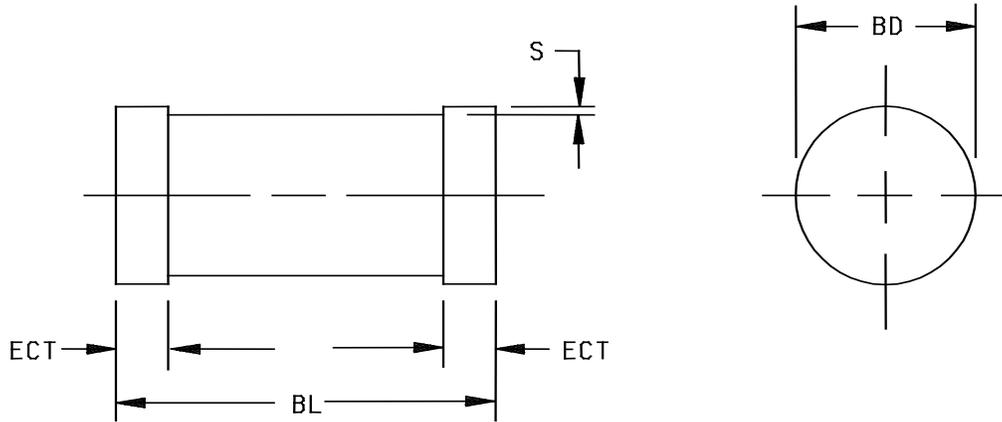
Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BD	.060	.107	1.52	2.72	3
BL	.120	.300	3.05	7.62	3
LD	.018	.023	0.46	0.58	
LL	1.000	1.500	25.40	38.10	
LL1		.050		1.27	4

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Package contour optional within BD and length BL. Heat slugs, if any, shall be included within this cylinder but shall not be subject to minimum limit of BD.
4. Within this zone, lead diameter may vary to allow for lead finishes and irregularities, other than heat slugs.
5. In accordance with ASME Y14.5M, diameters are equivalent to  $\Phi$ x symbology.

FIGURE 1. Physical dimensions, 1N3154-1 through 1N3157-1 (similar to DO-7 and DO-35).

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Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BD	.063	.067	1.60	1.70
BL	.130	.146	3.30	3.70
ECT	.016	.022	0.41	0.56
S	.001 Min		0.03 Min	

NOTES:

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. In accordance with ASME Y14.5M, diameters are equivalent to  $\Phi$ x symbology.

FIGURE 2. Physical dimensions, 1N3154-1 through 1N3157-1 (DO-213AA).

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

3.6.1 Marking of "UR" version devices. For "UR" version devices only, all marking (except polarity) may be omitted from the body, but shall be retained on the initial container.

3.7 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.8 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3.

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).

4.1.1 Sampling inspection. Sampling inspection shall be in accordance with MIL-PRF-19500 and as specified herein, except that lot accumulation period shall be 3 months in lieu of 6 weeks.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 Group E inspection. Group E inspection shall be conducted in accordance with MIL-PRF-19500 and 4.4.5 herein.

4.2.2 Radiation hardened devices. See MIL-PRF-19500 and 4.4.4 herein.

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\* 4.3 Screening (JANS, JANTXV, and JANTX levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500, and as specified herein. Specified electrical 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)	JANS level	JANTXV and JANTX level
3b	Not applicable	Not applicable
3c	Not applicable	Not applicable
4	Not applicable	Not applicable
5	Not applicable	Not applicable
6	Not applicable	Not applicable
10	Not applicable	Not applicable
11	Required $V_Z, Z_Z$	Required $V_Z, Z_Z$
12	Required see <a href="#">4.3.1</a>	Required see <a href="#">4.3.1</a>
13	Required Subgroups 2 and 3 of <a href="#">table I</a> herein; $\Delta Z_Z \leq \pm 15$ percent of initial reading. $T_A = +25^\circ\text{C} \pm 2^\circ\text{C}$ , $\Delta V_Z \leq \pm 0.004$ V dc from initial value for 1N3154-1, 1N3154UR-1, 1N3155-1, 1N3155UR-1. $\Delta V_Z \leq \pm 0.003$ V dc from initial value for 1N3156-1, 1N3156UR-1, 1N3157-1, 1N3157UR-1.	Required Subgroups 2 of <a href="#">table I</a> herein; $\Delta Z_Z \leq \pm 15$ percent of initial reading. $T_A = +25^\circ\text{C} \pm 2^\circ\text{C}$ , $\Delta V_Z \leq \pm 0.004$ V dc from initial value for 1N3154-1, 1N3154UR-1, 1N3155-1, 1N3155UR-1. $\Delta V_Z \leq \pm 0.003$ V dc from initial value for 1N3156-1, 1N3156UR-1, 1N3157-1, 1N3157UR-1.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:  $I_Z = 10$  mA dc min,  $\pm 0.75$  mA dc,  $T_A = +150^\circ\text{C}, +5^\circ\text{C}, -0^\circ\text{C}$ .

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 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 table E-VIa (JANS) and table E-VIb (JAN, JANTX, JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with the applicable steps of [table I](#), subgroup 2 herein.

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\* 4.4.2.1 Group B inspection, table E-VIa (JANS) of MIL-PRF-19500. For purposes of JANS inspection, a single device type shall be defined as devices from a single wafer lot (for each die type used in the construction). The conformance inspection sample shall be selected from the part category with the lowest  $\Delta V_Z$  rating in the inspection lot.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B3	1056	Test condition A, 25 cycles.
B3	4066	Not applicable.
B3	1071	Test condition E.
B4	1037	$I_Z = 27.5$ mA dc at $T_A =$ room ambient; $t_{on} = t_{off} = 30$ seconds minimum for 4,000 cycles. Forced air cooling allowed during off cycle.
B5	1027	$I_{ZM} = 55$ mA dc for 96 hours. $T_A = +75^\circ\text{C}$ , adjust $T_A$ to achieve $T_J = +200^\circ\text{C}$ minimum.
B6		Not applicable.

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

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B2	1056	Test condition A, 25 cycles.
B2	4066	Not applicable.
B2	1071	Test condition E.
B3	1027	See 4.3.1.
B5		Not applicable.

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) shall be in accordance with the applicable steps of [table I](#), subgroup 2 herein.

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

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
C2	1056	Test condition A, 25 cycles.
C2	2036	Lead tension: Test condition A; 10 pounds weight, $t = 15 \pm 3$ seconds. Lead fatigue: Test condition E (lead tension and fatigue tests are not applicable to surface mount "UR" version devices).
C2	1071	Condition E.
C2	1021	Omit initial conditioning.
C3		Not applicable.
C5		Not applicable.
C6	1026	$I_Z = 10.0$ mA dc, $T_A = +100^\circ\text{C}$ (see 4.5.2).
C7		Not applicable.

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. Submitted lots for group D sample inspection must be constructed using one homogeneous wafer lot for the Zener and one wafer lot for the compensating die (die), as also described in the submitted DSCC Design and Construction form 36D (see [table II](#) herein).

4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with table E-IX of MIL-PRF-19500 and [table III](#) herein.

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

4.5.1 Voltage-temperature stability. The breakdown voltage of each diode type shall be measured and recorded at each of the specified temperatures. The lowest measured voltage shall be subtracted from the highest measured voltage for each diode. The difference value obtained shall not exceed the specified  $\Delta V_Z$  per diode type.

4.5.2 Reference voltage time stability. The breakdown voltage shall be measured prior to life testing, at 340 hours, and at the conclusion of the life test. The 340-hour reading shall be compared with the 0-hour reading and the 1,000-hour reading compared with the 340-hour reading. The change in breakdown voltage shall not exceed the limits specified (see [table IV](#) herein).

4.5.3 Reference voltage. The test current shall be applied until thermal equilibrium is attained (15 seconds minimum) prior to reading the reference voltage. For this test, the diode shall be suspended by its leads with mounting clips whose inside edge is located between .375 inch (9.53 mm) and .500 inch (12.70 mm) from the body and the mounting clips shall be maintained at the specified temperature. This measurement may be performed after a shorter time following application of the test current than that which provides thermal equilibrium if correlation to stabilized readings can be established to the satisfaction of the Government.

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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> Reference voltage	4022	$I_Z = 10.0 \pm 0.01$ mA dc (see 4.5.3).	$V_Z$	7.98	8.82	V dc
Small signal breakdown impedance	4051	$I_Z = 10.0 + 0.1$ mA dc, $I_{sig} = 1.0$ mA ac.	$Z_Z$		15.0	ohms
<u>Subgroup 3</u> Voltage-temperature stability		$I_Z = 10.0 \pm 0.01$ mA dc, $T_A = -55^\circ\text{C}, 0^\circ\text{C}, +25^\circ\text{C}, +75^\circ\text{C},$ $+100^\circ\text{C} \pm 2^\circ\text{C}.$ (see 4.5.1 and 4.5.3)	$\Delta V_Z$			
1N3154-1, 1N3154UR-1 1N3155-1, 1N3155UR-1 1N3156-1, 1N3156UR-1 1N3157-1, 1N3157UR-1					130.0 65.0 26.0 13.0	mV dc mV dc mV dc mV dc
<u>Subgroups 4, 5, and 6</u> Not applicable						
<u>Subgroup 7</u> Reverse current leakage	4016	DC method; $V_R = 5.5$ V dc.	$I_R$		10.0	$\mu\text{A}$

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

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TABLE II. Group D inspection.

Inspection <u>1/</u> <u>2/</u>	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		$\Delta V_{Z1}$ pre-post irradiation change		Unit
	Method	Conditions		M, D, R, L, F, G and H		M, D, R, L, F, G and H		Min	Max	
				Min	Max	Min	Max			
<u>Subgroup 1</u> Not applicable										
<u>Subgroup 2</u> Steady-state total dose irradiation	1019	$T_C = +25^\circ\text{C}$ $I_Z = 10.0 \pm 0.01 \text{ mA dc}$ , condition A								
Reference voltage	4022	$I_Z = 10.0 \pm 0.01 \text{ mA dc}$ (see 4.5.3)	$V_Z$	7.98	8.82	7.98	8.82			V dc
Small-signal breakdown impedance	4051	$I_Z = 10.0 \pm 0.01 \text{ mA dc}$ $I_{sig} = 1.0 \text{ ac}$	$Z_Z$		15		15			ohms
Reverse current leakage	4016	DC method; $V_R = 5.5 \text{ V dc}$	$I_R$		10		10			$\mu\text{A}$
Voltage stability	4022	$I_Z = 10.0 \pm 0.01 \text{ mA dc}$ $T_A = +25^\circ\text{C} \pm 2^\circ\text{C}$ (see 4.5.1)	$\Delta V_Z$							
1N3154-1, 1N3154UR-1									$\pm 4.0$	mV
1N3155-1, 1N3155UR-1									$\pm 3.5$	mV
1N3156-1, 1N3156UR-1									$\pm 3.0$	mV
1N3157-1, 1N3157UR-1									$\pm 2.5$	mV

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

2/ Group D qualification may be performed any time prior to lot formation.

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\* TABLE III. Group E inspection qualification and requalification (all product assurance levels).

Inspection	MIL-STD-750		Qualification conformance inspection (sampling plan)
	Method	Conditions	
<u>Subgroup 1</u> Temperature cycling	1051	500 cycles.	45 devices, c = 0
Electrical measurements		See <a href="#">table I</a> , subgroup 2 herein.	
<u>Subgroup 2</u> Steady-state operation life	1038	Condition B, 1,000 hours. (see <a href="#">4.3.1</a> ).	45 devices, c = 0
Electrical measurements		See <a href="#">table I</a> , subgroup 2 herein.	
<u>Subgroups 4, 5, 6, and 7</u> Not applicable			
<u>Subgroup 9</u> Resistance to glass cracking	1057	Step stress to destruction by increasing cycles or up to a maximum of 25 cycles.	45 devices

TABLE IV. Reference voltage time stability.

Inspection	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Reference-voltage time stability		$T_A = +100^{\circ}\text{C} \pm 2^{\circ}\text{C}$ $I_Z = 10 \pm 0.01 \text{ mA dc}$ (see <a href="#">4.5.2</a> and <a href="#">4.5.3</a> )	$\Delta V_Z$			
1N3154-1, 1N3154UR-1		0 to 340 hours			7	mV dc
1N3155-1, 1N3155UR-1					7	mV dc
1N3156-1, 1N3156UR-1					6	mV dc
1N3157-1, 1N3157UR-1					5	mV dc
1N3154-1, 1N3154UR-1		340 to 1,000 hours			4	mV dc
1N3155-1, 1N3155UR-1					4	mV dc
1N3156-1, 1N3156UR-1					3	mV dc
1N3157-1, 1N3157UR-1					3	mV dc

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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, VQE, P.O. Box 3990, Columbus, OH 43218-3990 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.daps.dla.mil>.

6.4 Substitution of radiation hardened devices. See MIL-PRF-19500.

6.5 Substitutability of dash one parts. Non-dash-one devices have been deleted from this specification. Dash-one devices are a direct substitute for non dash-one devices and are preferred. The following table shows the direct substitutability.

Superseded PIN	Superseding PIN
1N3154	1N3154-1
1N3155	1N3155-1
1N3156	1N3156-1
1N3157	1N3157-1

6.6 Substitution of devices. Device types within this series with higher type numbers (lower  $\Delta V_Z$  voltage-temperature stability) are a direct one-way substitution for lower type numbers (higher  $\Delta V_Z$  voltage-temperature stability).

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\* 6.7 Amendment notations. The margins of this specification are marked with asterisks to indicate modifications generated by this amendment. 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.

Custodians:  
Army - CR  
Navy - EC  
Air Force - 85  
NASA - NA  
DLA - CC

Preparing activity:  
DLA - CC  
  
(Project 5961-2012-024)

Review activities:  
Army - AR, MI, SM  
Navy - AS, MC  
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.daps.dla.mil>.