

The documentation and process conversion measures necessary to comply with this revision shall be completed by 15 Jan 93.

INCH-POUND

MIL-S-19500/124G  
 15 October 1992  
 SUPERSEDING  
 MIL-S-19500/124F  
 1 August 1980

### MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, VOLTAGE REGULATOR B AND RB  
 TYPES 1N2970 THROUGH 1N2977, 1N2979, 1N2980, 1N2982, 1N2984  
 THROUGH 1N2986, 1N2988 THROUGH 1N2993, 1N2995, 1N2997, 1N2999  
 THROUGH 1N3005, 1N3007, 1N3008, 1N3009, 1N3011, 1N3012, 1N3014, 1N3015,  
 A AND RA TYPES 1N3993 THROUGH 1N3998, JAN, JANTX, JANTXV, AND JANS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

#### 1. SCOPE

1.1 Scope. This specification covers the detail requirements for 10 watt, silicon, voltage regulator diodes: A or B type (standard polarity); RA or RB type (reverse polarity). Four levels of product assurance are provided for each device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1 (DO-4).

1.3 Maximum ratings. (maximum ratings are as shown in columns 4, 8, and 10 of table V herein and as follows:

$$\begin{aligned} -65^{\circ}\text{C} \leq T_J \leq +175^{\circ}\text{C}; P_T &= 10 \text{ W at } T_C = +55^{\circ}\text{C}; \text{ derate at } .083 \text{ W}/^{\circ}\text{C} \text{ above } +55^{\circ}\text{C}. \\ -65^{\circ}\text{C} \leq T_{STG} \leq +200^{\circ}\text{C}. \end{aligned}$$

1.4 Primary electrical characteristics. Primary electrical characteristics are as shown in columns 2, 9, 12, and 14 of table V herein, and as follows:

$$\text{Thermal resistance } (R_{\theta JC}) = 12^{\circ}\text{C}/\text{W maximum.}$$

#### 2. APPLICABLE DOCUMENTS

##### 2.1 Government documents.

2.1.1 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 issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to U.S. Army Laboratory Command Electronics Technology and Devices Laboratory ATTN: SLCET-RS Fort Monmouth, NJ 07703-5601 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or letter

AHSC N/A

FSC 5961

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MIL-S-19500/124G

## SPECIFICATIONS

## MILITARY

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

## STANDARDS

## MILITARY

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

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 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 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500, and as specified herein.

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

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and on figure 1 herein.

- a. Device types 1N2970B through 1N3015B and 1N3993RA through 1N3998RA shall have the anode connected to the stud.
- b. Device types 1N2970RB through 1N3015RB and 1N3993A through 1N3998A shall have the cathode connected to the stud.

3.3.1 Lead finish. Lead finish shall be gold, silver, or tin-lead plated. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 Marking. Devices shall be marked in accordance with MIL-S-19500. At the option of the manufacturer, the marking of the country of origin may be omitted from the body of the diodes, but shall be retained on the initial container.

3.4.1 Reverse polarity types. Reverse polarity units (see 3.3a and b) shall be marked with an "R" preceding the "A" or "B" in the type designation, as applicable.

## 4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein.

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

## MIL-S-19500/124G

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table II of MIL-S-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 II of MIL-S-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
7(b)	MIL-STD-750, test method 1071, condition C, step 2.	MIL-STD-750, test method 1071, condition C, step 2.
9	$I_R$ and $V_Z$ (for devices with $V_{Z(nom)} \geq 10$ V dc; see column 2 of table V).	Not applicable
11	$I_R$ and $V_Z$ ; $\Delta I_R = 100\%$ of initial value or 1 of column 12 of table V, whichever is greater; $\Delta V_Z = \pm 2.5\%$ of initial value (for devices with $V_{Z(nom)} \geq 10$ V dc; see column 2 of table V).	$I_R$ and $V_Z$
12	See 4.3.1	See 4.3.1
13	Subgroups 2, 3, and 4 of table I herein; $\Delta I_R = 100\%$ of initial value or 1 of column 12 of table V, whichever is greater; $\Delta V_Z = \pm 2.5\%$ of initial value.	Subgroup 2 of table I herein; $\Delta I_R = 100\%$ of initial value or 1 of column 12 of table V, whichever is greater; $\Delta V_Z = \pm 2.5\%$ of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

$$I_Z = \text{Column 15 of table V}; V_Z = \text{Column 2 of table V}; T_C = 150 \pm 5^\circ\text{C}.$$

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500 and as specified herein. Group A inspection shall be performed on each subplot.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500 and table I herein. End point electrical measurements shall be in accordance with the applicable steps of table IV herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVa (JANS) and table IVb (JAN, JANTX, and JANTXV), of MIL-S-19500, and tables IIa and IIb herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV herein.

MIL-S-19500/124G

TABLE I. Group A inspection.

Inspection <sup>1/</sup>	MIL-STD-750		Symbol	Limits <sup>2/</sup>		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical inspection	2071					
<u>Subgroup 2</u>						
Forward voltage	4011	$I_F = 2 \text{ A dc}$	$V_F$		1.5	V dc
Reverse current	4016	$V_R = \text{column 11 of table V, dc method}$	$I_{R1}$		Column 12	A dc
Regulator voltage (see 4.5.3)	4022	$I_Z = \text{column 5 of table V}$	$V_Z$	Column 3	Column 4	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = 150^\circ\text{C}$				
Reverse current	4016	dc method $V_R = \text{column 11 of table V}$	$I_{R2}$		500	$\mu\text{A dc}$
<u>Subgroup 4</u>						
Small-signal break-down impedance	4051	$I_Z = \text{column 5 of table V; } I_{\text{sig}} = 10\% I_{Z\text{rms}}$	$Z_Z$		Column 6	ohms
Knee impedance	4051	$I_{ZK} = 1 \text{ mA dc, } I_{\text{sig}} = 10\% I_{ZK\text{rms}}$	$Z_{ZK}$		Column 7	ohms
<u>Subgroup 5</u>						
Not applicable						
<u>Subgroup 6</u>						
Surge current (see 4.5.1)	4066	$T_C = 25^\circ\text{C; } I_{ZSM} = \text{column 10 of table V}$				
End point electrical measurements		See table IV, steps 1, 3, and 4				
<u>Subgroup 7</u>						
Voltage regulation (see 4.5.2)			$V_{Z(\text{reg})}$		Column 9	V dc
Temperature coefficient of breakdown voltage (see 4.5.4)	4071	$I_Z = \text{column 5 of table V; } T_1 = 30^\circ\text{C; } T_2 = T_1 + 100^\circ\text{C}$	$\alpha V_Z$		Column 14	$^\circ\text{C}$

<sup>1/</sup> For sampling plan, see MIL-S-19500.<sup>2/</sup> Column references are to table V herein.

## MIL-S-19500/124G

TABLE IIa. Group B inspection for JANS devices.

Inspection <sup>1/</sup>	MIL-STD-750	
	Method	Conditions
<u>Subgroup 1</u>		
Physical dimensions	2066	See figure 1
<u>Subgroup 2</u>		
Solderability	2026	Dwell time = 10 ±1 s; immersion to cover flat portion of terminal only
Resistance to solvents	1022	
<u>Subgroup 3</u>		
Thermal shock (temperature cycling)	1051	
Hermetic seal	1071	
a. Fine		
b. Gross		
Electrical measurements		See table IV, steps 1, 3, 4, 5, and 6
Die shear	2017	
<u>Subgroup 4</u>		
Intermittent operating life	1037	$I_Z$ = column 8 of table V, $t_{on} = t_{off}$ = 3 minutes minimum for 2,000 cycles. $T_C = 30 \pm 3^\circ\text{C}$
Electrical measurements		See table IV, steps 1, 3, 4, 5, and 6
<u>Subgroup 5</u>		
Accelerated steady - state operation life	1027	$I_Z$ = column 15 of table V for 96 hours, $T_A = 125^\circ\text{C}$ or adjusted, as required, to give an average lot $T_J = 225^\circ\text{C}$
Electrical measurements		See table IV, steps 2, 3, 4, 5, and 6
<u>Subgroup 6</u>		
Thermal resistance	4081	$R_{\theta JC} = 12^\circ\text{C/W}$ maximum, $T_C = 30 \pm 3^\circ\text{C}$ . For purposes of this test "junction to case" shall be used in lieu of "junction to lead" and " $R_{\theta JC}$ " shall be used in lieu of " $R_{\theta JL}$ ". The case shall be the reference point for calculation of junction to case thermal resistance ( $R_{\theta JC}$ ). The mounting arrangement shall be with heat sink to case.

<sup>1/</sup> For sampling plan, see MIL-S-19500.

## MIL-S-19500/124G

TABLE IIb. Group B inspection for JAN, JANTX, and JANTXV devices.

Inspection <sup>1/</sup>	MIL-STD-750	
	Method	Conditions
<u>Subgroup 1</u>		
Solderability	2026	Dwell time = 10 ±1 s; immersion to cover flat portion of terminal only
Resistance to solvents	1022	
<u>Subgroup 2</u>		
Thermal shock (temperature cycling)	1051	
Surge current (see 4.5.1)		$I_{ZSM}$ = column 10 of table V
Hermetic seal	1071	
a. Fine leak b. Gross leak		
Electrical measurements		See table IV, steps 1, 3, and 4
<u>Subgroup 3</u>		
Steady-state operation life	1027	$I_Z$ = column 15 of table V $T_C$ = 150 ±5°C
Electrical measurements		See table IV, steps 2, 3, and 4
<u>Subgroup 4</u>		
Decap internal visual (design verification)	2075	
<u>Subgroup 5</u>		
Thermal resistance	4081	$R_{\theta JC}$ = 12°C/W maximum; $T_C$ = 30 ±3°C. For purposes of this test "junction to case" shall be used in lieu of "junction to lead" and " $R_{\theta JC}$ " shall be used in lieu of " $R_{\theta JL}$ ". The case shall be the reference point for calculation of junction to case thermal resistance ( $R_{\theta JC}$ ). The mounting arrangement shall be with heatsink to case.
<u>Subgroup 6</u>		
High temperature (non- operating life)	1032	$T_A$ = 200°C
Electrical measurements		See table IV, steps 2, 3, and 4

<sup>1/</sup> For sampling plan, see MIL-S-19500.

MIL-S-19500/124G

TABLE III. Group C inspection for all quality levels.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Physical dimensions	2066	See figure 1				
<u>Subgroup 2</u>						
Thermal shock (glass strain)	1056					
Terminal strength	2036					
Tension		Test condition A; 20 pounds; t = 15 ±3 s				
Torque (terminal)		Test condition D <sub>1</sub> ; 10 ounce-inches; t = 15 ±3 s				
Torque (stud)		Test condition D <sub>2</sub> ; 15 pound-inches; t = 30 ±3 s				
Bending stress		Test condition F; 3 pounds; t = 15 ±3 s, method B.				
Hermetic seal	1071					
a. Fine leak						
b. Gross leak						
Moisture resistance	1021					
Electrical measurements		See table IV, steps 1, 3, 4, 5, and 6 (JANS) and steps 1, 3, and 4 (JAN, JANTX, and JANTXV)				
<u>Subgroup 3</u>						
Shock	2016					
Vibration, variable frequency	2056					
Constant acceleration	2006					
Electrical measurements		See table IV, steps 1, 3, 4, 5, and 6 (JANS) and steps 1, 3, and 4 (JAN, JANTX and JANTXV)				
<u>Subgroup 4</u>						
Salt atmosphere (corrosion)	1041					

See footnotes at end of table.

MIL-S-19500/124G

TABLE III. Group C inspection for all quality levels) - Continued.

Inspection <sup>1/</sup>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5</u> <sup>2/</sup> Barometric pressure reduced (altitude operation)	1001	8 mm Hg				
<u>Subgroup 6</u> Steady-state operation life Electrical measurements	1026	$I_Z$ = column 15 of table IV $T_C$ = +150 ±5°C  See table IV, steps 2, 3, 4, 5, and 6 (JANS) and steps 2, 3, and 4 (JAN, JANTX, and JANTXV)				
<u>Subgroup 7</u> <sup>3/</sup> Temperature coefficient of breakdown voltage (see 4.5.3)	4071	JAN, JANTX, and JANTXV levels only  $I_Z$ = column 5 of table V $T_1$ = 30 ±3°C; $T_2$ = $T_1$ +100°C each subplot	$\alpha V_Z$		Column 14 of table IV	/°C
Voltage regulation (see 4.5.2)		Each subplot	$V_{Z(\text{reg})}$		Column 9 of table V	V dc

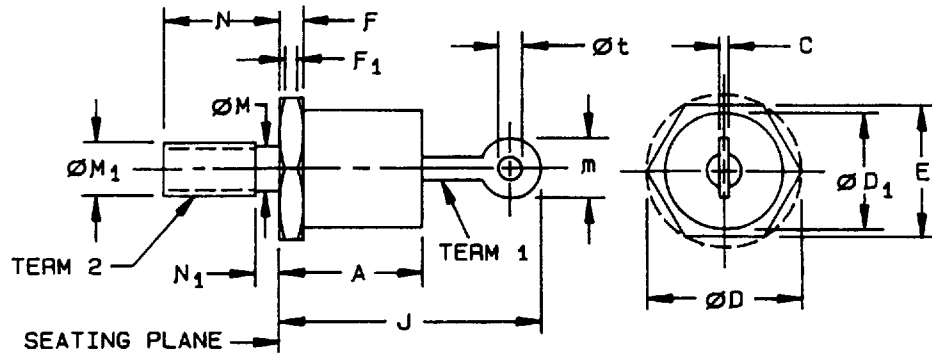
<sup>1/</sup> For sampling plan, see MIL-S-19500.<sup>2/</sup> LTPD = 15, small lot = 6 devices, c = 0.<sup>3/</sup> LTPD = 10, small lot = 12 devices, c = 0.



Page(s) 9 + 10 of this document was (were)  
missing upon receipt. The document has been reordered  
and will be refilmed when received.

INFORMATION HANDLING SERVICES

MIL-S-19500/124G



Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.300	.405	7.62	10.29	
C	.012	.065	.30	1.65	
$\phi D$	----	.505	----	12.83	
$\phi D_1$	.255	.424	6.48	10.77	
E	.423	.438	10.74	11.13	
F	.075	.175	1.90	4.44	
F <sub>1</sub>	.060	.175	1.52	4.44	2
J	.600	.800	15.24	20.32	
$\phi M$	.163	.189	4.14	4.80	1
$\phi M_1$	----	----	----	----	5
m	----	.250	----	6.35	3
N	.422	.453	10.72	11.51	
N <sub>1</sub>	----	.078	----	1.98	4
$\phi t$	.060	.095	1.52	2.41	
W	----	----	----	----	

## NOTES:

1. Complete threads to extend to within 2-1/2 threads of seating plane.
2. Chamfer on undercut on one or both ends of hexagonal base is optional.
3. Angular orientation of this terminal is undefined.
4. Length of incomplete or undercut threads of  $\phi M$ .
5. 10-32 UNF-2A maximum pitch diameter of plated threads shall be basic pitch diameter (.1697 inch (4.310 mm)) reference. (Screw thread standards for Federal Services 1957) Handbook H28 P1.
6. Metric equivalents are given for general information only.

FIGURE 1. Physical dimensions.

## MIL-S-19500/124G

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500 and table III herein. Electrical measurements (end points) and delta requirements shall be in accordance with the applicable steps of table IV herein.

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

4.5.1 Surge current  $I_{ZSM}$ . The currents specified in column 10 of table V shall be applied in the reverse direction and shall be superimposed on the current ( $I_Z$  = column 5 of table V) a total of five surges at 1-minute intervals. Each individual surge shall be a 1/2 square wave pulse of 1/120-second duration or an equivalent 1/2 sine wave with the same effective (rms) current.

4.5.2 Voltage regulation  $V_Z(\text{reg})$ . A current at 10 percent of  $I_{ZM}$  (column 8) shall be maintained until thermal equilibrium is obtained, and the  $I_Z$  shall then be increased to a level of 50 percent of  $I_{ZM}$  (column 8) and maintained at this level for a period of time until thermal equilibrium is obtained at which time the voltage change shall not exceed column 9 of table V. During this test, the case temperature ( $T_C$ ) of the diode shall be equal to  $30 \pm 3^\circ\text{C}$ .

4.5.3 Regulator voltage. The  $I_Z$  test current (column 5 of table V) shall be applied until thermal equilibrium is obtained prior to reading the regulator voltage. During this test, the case temperature ( $T_C$ ) of the diode shall be equal to  $30 \pm 3^\circ\text{C}$ .

4.5.4 Temperature coefficient of regulator voltage ( $\alpha V_Z$ ). The device shall be temperature stabilized with current applied prior to reading regulator voltage at the specified case temperatures.

4.5.5 Inspection condition. Unless otherwise specified in MIL-S-19500 or herein, all inspections shall be made at case temperature ( $T_C$ ) of  $30 \pm 3^\circ\text{C}$ .

## 5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

## 6. NOTES

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Ordering data. Procurement documents should specify the following:

- a. Lead material and finish (see 3.2.1).
- b. Type designation, polarity type, and product assurance level.

6.3 Part number information. Part numbers 1N3993A, RA through 1N3998A, and RA from MIL-S-19500/272 have been incorporated into MIL-S-19500/124.

6.4 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

MIL-S-19500/124G

## Custodians:

Army - ER  
Navy - EC  
Air Force - 17  
NASA - NA

## Review activities:

Army - AR, MI  
Navy - SH  
Air Force - 11, 19, 85  
DLA - ES  
NASA - LRC, MSF

## User activities:

Army - SM  
Navy - AS, CG, MC, OS  
Air Force - 13

## Preparing activity:

Army - ER

## Agent:

DLA - ES

(Project 5961-1365)