

This documentation process conversion measures necessary to comply with this revision shall be completed by 29 December 1999

~~INCH-POUND~~
MIL-PRF-19500/406D
29 September 1999
SUPERSEDING
MIL-S-19500/406C
16 May 1994

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICES, DIODE, SILICON, VOLTAGE REGULATOR
TYPES 1N4460, THROUGH 1N4496, AND 1N6485, THROUGH 1N6491 1N4460US, THROUGH
1N4496US, AND 1N6485US, 1N6485CUS, 1N6485DUS THROUGH 1N6491US,
PLUS C AND D TOLERANCE SUFFIXES; JAN, JANTX, JANTXV, JANJ, JANS, JANHC, AND JANKC

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 performance requirements for microminiature 1.5 watt silicon, low leakage, voltage regulator diodes with tolerances of 5 percent, 2 percent, and 1 percent. Five levels of product assurance are provided for each device type as specified in MIL-PRF-19500, and two levels of product assurance for die.

1.2 Physical dimensions. See figures 1 (similar to DO-41), 2 (surface mount), 3, 4 and 5 (die).

1.3 Maximum ratings. Maximum ratings are as shown in columns 8 and 10 of table III herein and as follows:

$$P_T = 1.5 \text{ W (derate at } 10 \text{ mW/}^\circ\text{C above } T_A = +25^\circ\text{C); } -55^\circ\text{C} < T_{op} < +175^\circ\text{C; } -65^\circ\text{C} < T_{STG} < +175^\circ\text{C}$$

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

$$3.3 \text{ V dc} \leq V_z \leq 200 \text{ V dc (nominal)}$$

1N4460D through 1N4496D and 1N6485D through 1N6491D are 1 percent voltage tolerance.
1N4460C through 1N4496C and 1N6485C through 1N6491C are 2 percent voltage tolerance.
1N4460 through 1N4496 and 1N6485 through 1N6491 are 5 percent voltage tolerance.

$$R_{\theta JL} = 42^\circ\text{C/W (max) at } L = 0.375 \text{ inch (9.52 mm) (nonsurface mount) (See figure 4)}$$

$$R_{\theta JEC} = 20^\circ\text{C/W (max) (surface mount) (See figure 4)}$$

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FSC 5961

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 documents cited in sections 3 and 4 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 issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

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

STANDARD

DEPARTMENT OF DEFENSE

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, 700 Robbins Avenue, Building 4D (DPM-DODSSP), Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, (except for related associated specifications or specification sheets), 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 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable products list before contract award (see 4.2 and 6.5).

3.2 Associated specification. The individual item performance requirements shall be in accordance with MIL-PRF-19500, and herein.

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

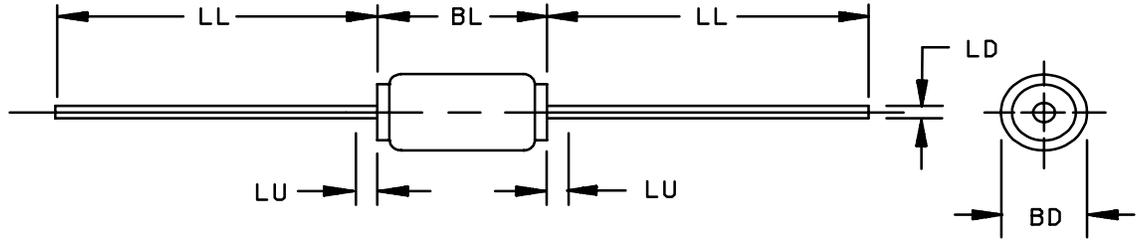
EC Endcap.
US Surface mount case outline, square endcap.

3.4 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, and on figures 1, 2, 3, 4, and 5 herein.

3.4.1 Construction except for JANHC and JANKC. Devices shall be metallurgically bonded, thermally matched, noncavity-double plug construction in accordance with MIL-PRF-19500, and herein. The "US" version shall be structurally identical to the axial lead type except for lead configuration.

3.4.1.1 Metallurgical bond for diodes with V_z greater than 6.8 V dc. Category I metallurgical bonds as defined in MIL-PRF-19500 shall be utilized.

3.4.1.2 Metallurgical bond for diodes with V_z less than or equal to 6.8 V dc. category I, or category III metallurgical bonds (see MIL-PRF-19500).

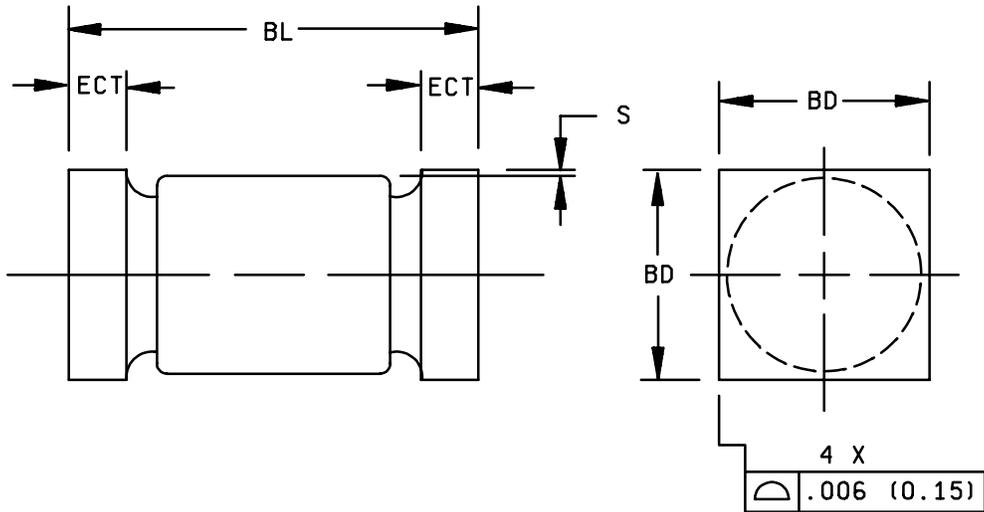


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BL	.106	.160	2.69	4.06	3
BD	.060	.085	1.52	2.16	3
LL	.800	1.300	20.32	33.02	
LD	.028	.032	0.71	0.81	
LU		.050		1.27	4

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Package contour optional with 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. The specified lead diameters apply in the zone between .050 inch (1.27 mm) from the diode body and the end of the lead.

FIGURE 1. Physical dimensions of nonsurface mount device (similar to DO-41).

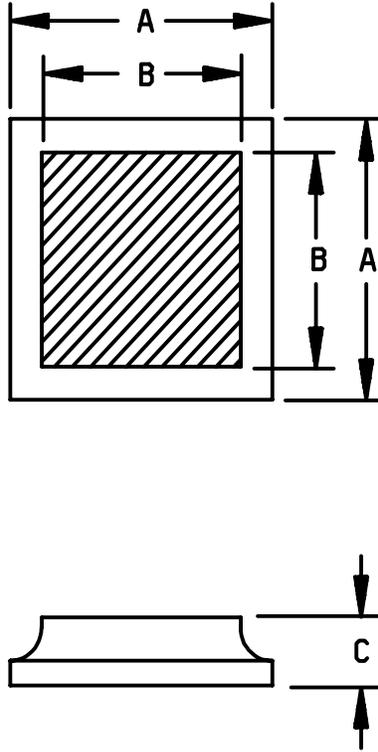


Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
BL	.168	.200	4.28	5.08	
ECT	.019	.028	0.48	0.71	
S	.003		0.08		
BD	.091	.103	2.31	2.62	

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 2. Physical dimensions of surface mount device, "US".



Symbol	Dimensions			
	Inches		Millimeter	
	Min	Max	Min	Max
A	.030	.036	0.813	0.914
B	.022	.027	0.584	0.686
C	.006	.012	0.152	0.305

DESIGN DATA

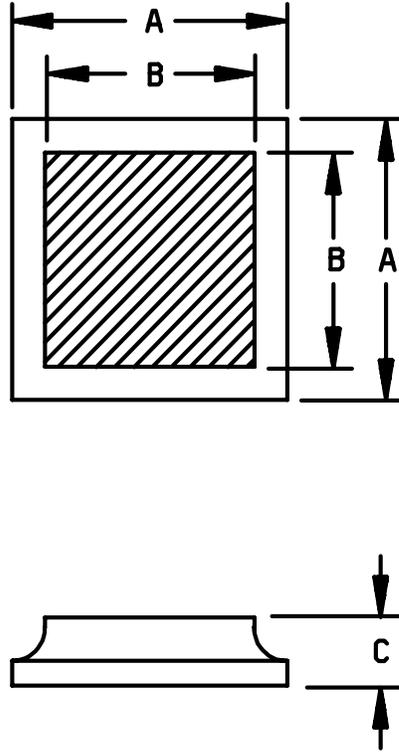
Metallization:

Top: (Cathode) Aluminum
 Back: (Anode) Gold

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 3. Physical dimensions for JANHCA and JANKCA (die).



Symbol	Dimensions			
	Inches		Millimeter	
	Min	Max	Min	Max
A	.030	.036	0.813	0.914
B	.022	.027	0.584	0.686
C	.006	.012	0.152	0.305

DESIGN DATA

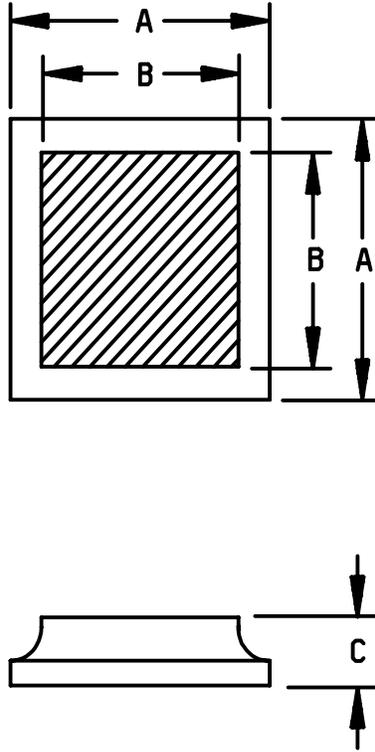
Metallization:

Top: (Cathode) Aluminum
 Back: (Anode) Silver

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 4. Physical dimensions for JANHCB and JANKCB (die).



Symbol	Dimensions			
	Inches		Millimeter	
	Min	Max	Min	Max
A	.030	.036	0.813	0.914
B	.022	.027	0.584	0.686
C	.006	.012	0.152	0.305

DESIGN DATA

Metallization:

Top: (Cathode) Silver
 Back: (Anode) Silver

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.

FIGURE 5. Physical dimensions for JANHCC and JANKCC (die).

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

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

3.5.2 Marking for JANHC and JANKC die. Marking of JANHC and JANKC die shall be in accordance with MIL-PRF-19500.

3.6 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).

3.7 Polarity. The polarity of all types shall be indicated with a contrasting color band to denote the cathode end. Alternatively, for US suffix devices, a minimum of three contrasting color dots spaced around the periphery on the cathode end may be used.

3.7.1 Polarity of JANHC and JANKC devices. Polarity marking is not required on JANHC or JANKC devices. All marking shall be retained on the initial container.

3.8 Selection of tighter tolerance devices. The C and D suffix devices shall be selected from JAN, JANTX, JANTXV, JANJ or JANS devices, which have successfully completed all applicable screening, and groups A, B, and C testing as ± 5 percent tolerance devices. All sublots of C and D suffix devices shall pass group A, subgroup 2, at tightened tolerances. Tighter tolerances for mounting clip temperature shall be maintained for reference purposes to establish correlation. For C and D tolerance levels, $T_L = 25^\circ\text{C} + 1^\circ\text{C}, -3^\circ\text{C}$ at 0.375" from body or equivalent.

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

3.9 Electrical test requirements. The electrical test requirements shall be as specified in table I, group A herein.

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 Lot accumulation. 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. Supplier imposed requirements shall be document in the QM plan and must be submitted to the Qualifying Activity for approval. Radiation characterization may be submitted in the QM plan at the option of the manufacturer.

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

4.2.2 JANJ devices. For JANJ level, 3.3.1 through 3.3.1.3 of MIL-PRF-19500 shall apply, except as modified herein. Supplier imposed requirements as well as alternate screens, procedures, and/or controls shall be documented in the QM plan and must be submitted to the Qualifying Activity for approval. When alternate screens procedures, and/or controls are used in lieu of the JANJ screens herein equivalency shall be proven and documented in the QM Plan. Radiation characterization may be submitted in the QM plan at the option of the manufacturer, however, paragraph 3.3.1.1 of MIL-PRF-19500 is not required. Die lot controls and rework requirements shall be in accordance with MIL-PRF-19500 paragraphs 3.13 and D.3.13.2.1 for JANS level. Lot formation and conformance inspection requirements for JANJ shall be those used for JANTXV devices as a minimum.

4.2.3 JANHC and JANKC devices. Qualification for JANC devices shall be as specified in appendix H of MIL-PRF-19500.

4.3 Screening (all levels). Screening shall be in accordance with appendix E table 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 IV of MIL-PRF-19500)	Measurements		
	JANS Level	JANJ	JANTX and JANTXV Levels
1a	Required	Not Required	Not Required
1b	Required	Required	Required (JANTXV only)
2	Not Required	Not Required	Not Required
3a	Required	Required	Required
3b	Not Applicable	Not Applicable	Not Applicable
3c 1/	Thermal impedance, see 4.5.4	Thermal impedance, see 4.5.4	Thermal impedance, see 4.5.4
4	Not Applicable	Not Applicable	Not Applicable
5	Not Applicable	Not Applicable	Not Applicable
6	Not Applicable	Not Applicable	Not Applicable
7	Hermetic seal, gross leak	Hermetic seal, gross leak	Hermetic seal, gross leak
8	Required	Not Required	Not Required
9	I _{R1} and V _Z (1N4466 thru 1N4496 only)	I _{R1} and V _Z (1N4466 thru 1N4496 only)	Not applicable
10	Required for device > 10 V dc	Required for device > 10 V dc	Not Applicable
11	I _{R1} and V _Z $\Delta I_{R1} \leq \pm 100$ percent of initial reading or 50 nA dc, whichever is greater. $\Delta V_Z \leq \pm 2$ percent of initial reading. 3/	I _{R1} and V _Z $\Delta I_{R1} \leq \pm 100$ percent of initial reading or 50 nA dc, whichever is greater. $\Delta V_Z \leq \pm 2$ percent of initial reading. 3/	I _{R1} and V _Z
12	Required See 4.3.2	Required T = 240 hours See 4.3.2	Required See 4.3.2
13 2/ 3/	Required Subgroups 2 and 3 of table I herein; $\Delta I_{R1} (\text{max}) \leq \pm 100$ percent of initial reading or 50 nA, whichever is greater; $\Delta V_Z \leq \pm 2$ percent of initial reading.	Required Subgroups 2 and 3 of table I herein; $\Delta I_{R1} (\text{max}) \leq \pm 100$ percent of initial reading or 50 nA, whichever is greater; $\Delta V_Z \leq \pm 2$ percent of initial reading.	Required Subgroup 2 of table I herein; $\Delta I_{R1} (\text{max}) \leq \pm 100$ percent of initial reading or 50 nA, whichever is greater; $\Delta V_Z \leq \pm 2$ percent of initial reading.
14a	Not Applicable	Not Applicable	Not Applicable
14b	Optional	Optional	Optional
15	Required	Not Required	Not Required
16	Required	Required	Not Required

1/ This test shall be performed anytime after screen 3.

2/ Thermal impedance not applicable, if already performed 100%.

3/ Delta limits applicable to 1N4466 thru 1N4496 only.

4.3.1 Screening (JANHC and JANKC). Screening of die shall be in accordance with MIL-PRF-19500, appendix G.

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

The test current I_Z shall be adjusted to produce a junction temperature of +125°C minimum and I_Z minimum shall be equal to 50 percent of column 8 of table III.

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 in accordance with MIL-PRF-19500 and table I herein. Thermal impedance conditions are as follows:

- a. I_M measurement current 1 mA to 10 mA.
- b. I_H forward heating current 3A to 10 A.
- c. t_H heating time 10 ms.
- d. t_{MD} measurement delay time 100 μ s maximum.

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 VIa (JANS) and VIb (JAN, JANJ, JANTX, and JANTXV) of MIL-PRF-19500. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein except $Z_{\theta JX}$ need not to be performed. See subgroup conditions for delta limits when applicable.

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

Subgroup	Method	Condition
B4	1037	I_Z = column 8 of table III at T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750; for 2,000 cycles. Mounting conditions in accordance with 4.5.2.
B5	1027	I_Z = column 8 of table III for 96 hours; $P_T = 1.5$ W; $T_A = +125^\circ\text{C}$ C (frequency is per inspection lot) or adjusted as required to give an average lot $T_J = +275^\circ\text{C}$ per wafer lot. Leaded samples from this lot may be used in lieu of surface mount devices. OR I_Z = column 8 of table III for 1000 hours $T_J = 175^\circ\text{C}$ (min). T_A = room ambient (frequency is per inspection lot). Leaded samples from the same lot may be used in lieu of the U suffix sample life test.
B6	3101 or 4081	$R_{\theta JL} = 42^\circ\text{C/W}$ maximum; $R_{\theta JEC} = 20^\circ\text{C/W}$ maximum; $+25^\circ\text{C} < T_A < +35^\circ\text{C}$; reference temperature measuring point is the inside of mounting clip on lead or endcap (see 4.5.7).

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

Subgroup	Method	Condition
B2	1071	Test condition E only NOTE: For non-transparent devices, hermetic seal may be performed after electrical measurements.
B3	1027	$I_Z(\text{min}) = 50$ percent of column 8 of table III minimum. Adjust I_Z or T_A to achieve $T_J = 150^\circ\text{C}$ min.

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 VII of MIL-PRF-19500 and herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein except $Z_{\theta JX}$ need not to be performed. See subgroup conditions for delta limits when applicable.

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

Subgroup	Method	Condition
C2	2036	Tension - test condition A; 10 lbs; $t = 15$ s ± 3 s. Lead fatigue - Test condition E. NOTE: Not applicable to US versions.
	1071	Test condition E only NOTE: For non-transparent devices, hermetic seal may be performed after electrical measurements.
C6	1027	$I_Z(\text{min}) = 50$ percent of column 8 of table III (conditions in accordance with 4.3.2); T_A = room ambient as defined in the general requirements of paragraph 4.5 of MIL-STD-750 except $T_J = +150^\circ\text{C}$ (min).
C7	4071	Temperature coefficient for JAN, JANJ, JANTX and JANTXV only; I_Z = column 5 of table III; $T_{A1} = +25^\circ\text{C} \pm 5^\circ\text{C}$; $T_{A2} = +125^\circ\text{C} \pm 5^\circ\text{C}$; limit = column 14 of table III (see paragraph 4.5.3).

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

4.5.1 Surge current (I_{ZSM}). The peak currents specified in column 10 of table III shall be applied in the reverse direction and shall be superimposed on the current (I_Z = column 5 of table III) a total of five surges at 1 minute intervals. Each individual surge shall be at one-half square wave pulse of 8.3 millisecond duration or an equivalent sine wave with the same effective (rms) current.

4.5.2 Voltage regulation ($V_{Z(reg)}$). A current of 10 percent of I_Z (column 8) shall be maintained until thermal equilibrium is attained and the V_Z shall be noted. The current shall then be increased to a level of 50 percent of I_Z (column 8) and maintained at this level until thermal equilibrium is attained at which time the voltage change shall not exceed column 9 of table III. For this test, the diode shall be suspended by its leads (nonsurface mount) with mounting clips whose inside edge is located at 0.375 ± 0.010 inch (9.52 ± 0.25 mm) from the body and the lead temperature at inside edge of the mounting clips shall be maintained at a temperature between $+23^\circ\text{C}$ and $+33^\circ\text{C}$. For surface mount packages, the diode shall be suspended by the endcaps with the temperature of the endcaps being maintained between $+23^\circ\text{C}$ and $+33^\circ\text{C}$. For JANC, the die shall be stabilized at $+25^\circ\text{C}$ and the test shall be performed utilizing pulse condition. This measurement may be performed after a shorter time interval following application of the test current than that which provides thermal equilibrium if correlation can be established to the satisfaction of the qualifying activity.

4.5.3 Temperature coefficient of regulator voltage (α_{VZ}). The device shall be temperature stabilized with current applied prior to reading regulator voltage at the specified ambient temperature.

4.5.4 Thermal impedance ($Z_{\theta JX}$ measurements) The $Z_{\theta JX}$ measurements shall be performed in accordance with MIL-STD-750, method 3101. The maximum screen limit shall be developed by the supplier using statistical methods and it shall not to exceed the Group A, Subgroup 2 herein.

4.5.5 Regulator voltage. The test current (column 5 of table III) shall be applied until thermal equilibrium is attained prior to reading the regulator voltage. For this test, the diode shall be suspended by its leads (nonsurface mount) with mounting clips whose inside edge is located at 0.375 ± 0.010 inch (9.52 ± 0.25 mm) from the body and the lead temperature at inside edge of the mounting clips shall be maintained at a temperature of $+23^\circ\text{C}$ to $+33^\circ\text{C}$. For surface mount diodes, the diode shall be suspended by the endcaps with the temperature of the endcaps being maintained at $+23^\circ\text{C}$ to $+33^\circ\text{C}$. 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 qualifying activity. The breakdown voltage or JANHC and JANKC shall be read with a pulse measurement of 10 msec (max)

4.5.6 Pulse measurements. Conditions for pulse measurements shall be as specified in of MIL-STD-750.

TABLE I. Group A inspection.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits <u>2/</u>		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 1</u>						
Visual and mechanical examination	2071					
<u>Subgroup 2</u>						
Thermal impedance <u>4/</u>	3101	Category I bond Category III bond (See 4.4.1)	$Z_{\theta JX}$		4.5 7.5	$^{\circ}\text{C/W}$ $^{\circ}\text{C/W}$
Forward voltage	4011	$I_F = 200 \text{ mA dc}$	V_{F1}		1.0	V dc
Forward voltage	4011	$I_F = 1 \text{ A dc}$	V_{F2}		1.5	V dc
Reverse current Leakage	4016	DC method; $V_R =$ column 11 of table III	I_{R1}		Column 12	$\mu\text{A dc}$
Regulator voltage <u>3/</u>	4022	$I_Z =$ column 5 of table III (see 4.5.5)	V_Z	Column 3 -5, -2, -1 percent	Column 4 +5, +2, +1 percent	V dc
<u>Subgroup 3</u>						
High temperature operation		$T_A = +150^{\circ}\text{C}$				
Reverse current Leakage	4016	DC method; $V_R =$ column 11 of table III	I_{R2}		Column 15	$\mu\text{A dc}$
<u>Subgroup 4</u>						
Small-signal reverse breakdown impedance	4051	$I_Z =$ column 5 of table III $I_{\text{sig}} = 10 \text{ percent } I_Z$	Z_Z		Column 6	Ω
Knee impedance	4051	$I_{ZK} =$ column 15 of table III $I_{\text{sig}} = 10 \text{ percent } I_{ZK}$	Z_{ZK}		Column 7	Ω
<u>Subgroup 5</u>						
Not applicable						
<u>Subgroup 6</u>						
Surge current	4066	$I_{ZSM} =$ column 10 of table III at $T_A + 25^{\circ}\text{C}$ (see 4.5.1).	I_{ZSM}			
End-point electrical measurements		See table I, group A; subgroup 2 except $Z_{\theta JX}$				

See footnotes at end of table.

TABLE I. Group A inspection. -Continued.

Inspection <u>1/</u>	MIL-STD-750		Symbol	Limits <u>2/</u>		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 7</u>						
Voltage regulation <u>3/</u>		See 4.5.2	$V_{Z(\text{reg})}$		Column 9	V dc
Temperature coefficient of regulator voltage	4071	JANS Level only $I_Z = \text{column 5 of table III}$ $T_{A1} = +25^\circ\text{C} \pm 5^\circ\text{C}$, $T_{A2} = 120^\circ\text{C} \leq T_2 \leq 130^\circ\text{C}$	$\alpha_V Z$		Column 13	%/°C

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

2/ Column references are to table III.

3/ For JANC, test using pulse conditions.

4/ Not required for JANHC and JANKC

TABLE II. Group E inspection (all quality levels).

Inspection	MIL-STD-750		Sampling plan
	Method	Conditions	
<u>Subgroup 1</u>			22 devices c = 0
Temperature cycling	1056	Liquid N ₂ (-195°C) to +150°C fluoro bath. The DUT shall be stabilized at the temperature extremes for 20 s minimum, transfer time ≤ 5 s, continuously monitor for discontinuities during the last five cycles, $V_f = 200$ mA dc; 20 cycles for group C. Visual inspection - cracks in package shall be cause for rejection.	
	Delta	ΔV_f at 200 mA = ± 20 mV or 2 percent of initial readings, whichever is greater. See table I, group A, subgroup 2	
Electrical measurements		See table I, group A, subgroup 2	
<u>Subgroup 2</u>			22 devices c = 0
Steady-state intermittent operating life	1037	$I_Z = I_{Z2}$ (column 8 of table III) at $T_A = \text{room ambient}$ for 10,000 cycles. No forced air cooling on the device shall be permitted. (Mounting conditions in accordance with 4.5.2.)	
Electrical measurements		See table I, group A, subgroup 2	
<u>Subgroup 3</u>			
Not applicable			
<u>Subgroup 4</u>			
Thermal resistance (see 4.5.7)	3101 or 4081	$R_{\theta JL} = 42^\circ\text{C/W}$ (max) at $L = 3/8"$; $R_{\theta JEC} = 20^\circ\text{C/W}$ max for US types,	22 devices c = 0
<u>Subgroups 5, 6, and 7</u>			
Not applicable			

TABLE III. Electrical characteristics and test conditions (all case outlines).

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 14	Col 15
Device type	V _Z Nom	V _Z Min	V _Z Max	I _Z test current T _A = +25°C	Z _Z Impedance	Z _K Knee impedance	I _Z Max dc current T _A = +25°C	V _Z (reg) voltage regulation 3/	I _{ZSM} T _A = +25°C 4/	V _R Reverse voltage	I _R Reverse current I _{R1}	α _{VZ} Temperature coefficient 5/	I _{ZK} Test current	I _R Reverse current dc T _A = +150°C I _{R2}
	V	V	V	mA	Ω	Ω	mA	V	A	V	μA	%/°C	mA	μA
1N6485	3.3	3.14	3.46	76	10	400	433	0.9	4.2	1.0	50.00	-0.75	1.00	500
1N6486	3.6	3.42	3.78	69	10	400	397	0.8	3.9	1.0	50.00	-0.70	1.00	200
1N6487	3.9	3.71	4.09	64	9	400	366	.75	3.6	1.0	35.00	-0.60	1.00	100
1N6488	4.3	4.09	4.51	58	9	400	332	.70	3.3	1.0	5.00	+0.050	1.00	100
1N6489	4.7	4.47	4.93	53	8	500	304	.60	3.0	1.0	4.00	±.025	1.00	100
1N6490	5.1	4.85	5.35	49	7	500	280	.5	2.7	1.0	1.00	±.030	1.00	100
1N6491	5.6	5.32	5.88	45	5	600	255	.40	2.5	2.0	0.50	±.040	1.00	100
1N4460	6.2	5.89	6.51	40	4	200	230	.35	2.3	3.72	10.00	+0.050	1.00	50
1N4461	6.8	6.46	7.14	37	2.5	200	210	.30	2.1	4.08	5.00	+0.057	1.00	20
1N4462	7.5	7.13	7.87	34	2.5	400	191	.35	1.9	4.50	1.00	+0.061	0.50	10
1N4463	8.2	7.79	8.61	31	3.0	400	174	.40	1.7	4.92	0.50	+0.065	0.50	5
1N4464	9.1	8.65	9.55	28	4.0	500	157	.45	1.6	5.46	0.30	+0.068	0.50	3
1N4465	10	9.50	10.50	25	5.0	500	143	.50	1.4	8.0	0.30	+0.071	0.25	3
1N4466	11	10.45	11.55	23	6.0	550	130	.55	1.3	8.8	0.30	+0.073	0.25	2
1N4467	12	11.40	12.60	21	7.0	550	119	.60	1.2	9.6	0.20	+0.076	0.25	2
1N4468	13	12.35	13.65	19	8.0	550	110	.65	1.1	10.4	0.05	+0.079	0.25	2
1N4469	15	14.25	15.75	17	9.0	600	95	.75	.95	12.0	0.05	+0.082	0.25	2
1N4470	16	15.20	16.80	15.5	10.0	600	90	.80	.90	12.8	0.05	+0.083	0.25	2
1N4471	18	17.10	18.90	14	11.0	650	79	.83	.79	14.4	0.05	+0.085	0.25	2
1N4472	20	19.00	21.00	12.5	12.0	650	71	.95	.71	16.0	0.05	+0.086	0.25	2
1N4473	22	20.90	23.10	11.5	14	650	65	1.0	.65	17.6	0.05	+0.087	0.25	2
1N4474	24	22.80	25.20	10.5	16	700	60	1.1	.60	19.2	0.05	+0.088	0.25	2
1N4475	27	25.70	28.30	9.5	18	700	53	1.3	.53	21.6	0.05	+0.090	0.25	2
1N4476	30	28.50	31.50	8.5	20	750	48	1.4	.48	24.0	0.05	+0.091	0.25	2
1N4477	33	31.40	34.60	7.5	25	800	43	1.5	.43	26.4	0.05	+0.092	0.25	2

See footnotes at end of table.

TABLE III. Electrical characteristics and test conditions (all case outlines) - Continued.

Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10	Col 11	Col 12	Col 13	Col 14	Col 15
Device type	V _Z Nom	V _Z Min	V _Z Max	I _Z test current T _A = +25°C	Z _Z Impedance	Z _K Knee impedance	I _Z Max dc current T _A = +25°C	V _Z (reg) voltage regulation 3/	I _{ZSM} T _A = +25°C 4/	V _R Reverse voltage	I _R Reverse dc current I _{R1}	α _{VZ} Temperature coefficient 5/	I _{ZK} Test current	I _R Reverse dc current T _A = +150°C I _{R2}
	V	V	V	mA	Ω	Ω	mA	V	A	V	μA	%/°C	mA	μA
1N4478	36	34.2	37.8	7.0	27	850	40	1.7	.40	28.8	.05	+0.93	0.25	2
1N4479	39	37.1	40.9	6.5	30	900	37	1.8	.37	31.2	.05	+0.94	0.25	2
1N4480	43	40.9	45.1	6.0	40	950	33	1.9	.33	34.4	.05	+0.95	0.25	2
1N4481	47	44.7	49.3	5.5	50	1000	30	2.1	.30	37.6	.05	+0.95	0.25	2
1N4482	51	48.5	53.5	5.0	60	1100	28	2.3	.28	40.8	.05	+0.96	0.25	2
1N4483	56	53.2	58.8	4.5	70	1300	26	2.5	.26	44.8	.25	+0.96	0.25	10
1N4484	62	58.9	65.1	4.0	80	1500	23	2.7	.23	49.6	.25	+0.97	0.25	10
1N4485	68	64.6	71.4	3.7	100	1700	21	3.0	.21	54.4	.25	+0.97	0.25	10
1N4486	75	71.3	78.7	3.3	130	2000	19	3.3	.19	60.0	.25	+0.98	0.25	10
1N4487	82	77.9	86.1	3.0	160	2500	17	3.6	.17	65.6	.25	+0.98	0.25	10
1N4488	91	86.5	95.5	2.8	200	3000	16	4.0	.16	72.8	.25	+0.99	0.25	10
1N4489	100	95.0	105.0	2.5	250	3100	14	4.4	.14	80.0	.25	+1.00	0.25	10
1N4490	110	104.5	115.5	2.3	300	4000	13	5.0	.13	88.0	.25	+1.00	0.25	10
1N4491	120	114.0	126.0	2.0	400	4500	12	5.5	.12	96.0	.25	+1.00	0.25	10
1N4492	130	123.5	136.5	1.9	500	5000	11	6.0	.11	104	.25	+1.00	0.25	10
1N4493	150	142.5	157.5	1.7	700	6000	9.5	7.0	.095	120	.25	+1.00	0.25	10
1N4494	160	152	168	1.6	1000	6500	8.9	8.0	.089	128	.25	+1.00	0.25	10
1N4495	180	171	189	1.4	1300	7000	7.9	10.0	.079	144	.25	+1.00	0.25	10
1N4496	200	190	210	1.2	1500	8000	7.2	12.0	.072	160	.25	+1.00	0.25	10

1/ See 4.5.5. Voltages shown are for 5 percent tolerance devices. Voltages for 2 and 1 percent tolerances devices shall be calculated accordingly.

2/ 1N4460D through 1N4496D and 1N6485D through 1N6491D are 1 percent voltage tolerance.
1N4460C through 1N4496C and 1N6485C through 1N6491C are 2 percent voltage tolerance.
1N4460 through 1N4496 and 1N6485 through 1N6491 are 5 percent voltage tolerance.

3/ See 4.5.2.

4/ See 4.5.1.

5/ See 4.5.3.

4.5.7 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with test method 3101 of MIL-STD-750. The following details shall apply:

$I_H = 2.0$ A dc minimum
 $I_M = 1$ to 10 mA
 $t_{MD} = 100$ μ s maximum
 $t_H =$ thermal equilibrium

The device shall be allowed to reach thermal equilibrium at current I_H before the measurement shall be made.

Lead spacing: $LS = 3/8$ inches for leaded devices.
 $LS = 0$ (endcap mount) for US devices.

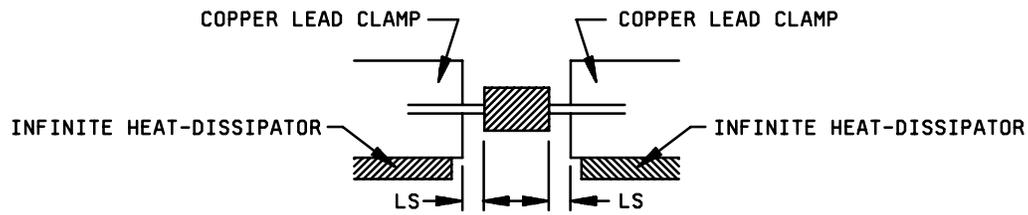


FIGURE 4. Mounting arrangement for thermal resistance measurements.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' 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 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Issue of DODISS to be cited in the solicitation.
- b. Lead finish as specified (see 3.3.1).
- c. Product assurance level, type designator.
- d. Packing requirements (see 5.1).

6.3 Suppliers of die. The qualified die suppliers with the applicable letter version (example JANHCA1N4461) will be identified on the QPL.

JANC ordering information ^{1/}	
PIN	Manufacturer
1N4461 thru 1N4496	JANHCA1N4461 thru JANHCA1N4496
1N4461 thru 1N4496	JANHCB1N4461 thru JANHCB1N4496
1N4461 thru 1N4496	JANHCC1N4461 thru JANHCC1N4496

^{1/} For JANS level replace JANHC (prefix) with JANKC (prefix)

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

6.5 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 No.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 purchase 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, 3990 East Broad Street, Columbus OH 43216-5000.

CONCLUDING MATERIAL

Custodians:

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

Preparing activity:
DLA - CC

(Project 5961-2039)

Review activities:

Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 13, 19,

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-PRF-19500/406D	2. DOCUMENT DATE (YYMMDD)
3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, DIODE, SILICON, VOLTAGE REGULATOR TYPES 1N4460, THROUGH 1N4496, AND 1N6485, THROUGH 1N6491, 1N4460US, 1N4460CUS, 1N4460DUS THROUGH 1N4496US, 1N4496CUS, 1N4496DUS AND 1N6485US, 1N6485CUS, 1N6485DUS THROUGH 1N6491US, 1N6491CUS, 1N6491DUS, PLUS C AND D TOLERANCE SUFFIX; JAN, JANTX, JANTXV, JANJ, JANS; JANHC, AND JANKC			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (Last, First, Middle initial)		b. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code) (1) Commercial (2) DSN (If applicable) (3) E-Mail	7. DATE SUBMITTED (YYMMDD)
8. PREPARING ACTIVITY			
a. NAME Alan Barone		b. TELEPHONE (Include Area Code) (Commercial DSN FAX EMAIL 614-692-0510 850-0510 614-692-6939 alan_barone@dscclia.mil	
b. ADDRESS (Include Zip Code) Defense Supply Center Columbus, ATTN: DSCC-VAC, 3990 East Broad Street, Columbus, OH 43216-5000		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533, Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888	