The documentation and process conversion measures necessary to comply with this revision shall be completed by 16 November 1994

INCH-POUND

MIL-S-19500/159H
16 May 1994
SUPERSEDING
MIL-S-19500/159G
22 January 1993

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, DIODE, SILICON, VOLTAGE-REFERENCE,
TYPES 1N821, 1N823, 1N825, 1N827, 1N829, AND 1N821-1, 1N823-1, 1N825-1, 1N827-1,
AND 1N829-1, 1N821UR-1, 1N823UR-1, 1N825UR-1, 1N827UR-1, AND 1N829UR-1,
JAN, JANTX, JANTXV, JANS, JANHC AND JANKC; RADIATION HARDENED (TOTAL DOSE ONLY) TYPES
JANTXVM, D, L, R, F, G, H; JANSM, D, L, R, F, G, H; JANHCM, D, L, R, F, G, H; AND JANKCM, D, L, R, F, G, H

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 6.2 volts ±5 percent, silicon, voltage-reference diodes. Four levels of product assurance are provided for each encapsulated device type as specified in MIL-S-19500, and two levels of product assurance for each unencapsulated device type die. Seven levels of radiation hardened (total dose only) product assurance are provided for each encapsulated device type as specified in MIL-S-19500, and two levels of product assurance for each unencapsulated device type die.

1.2 Physical dimensions. See figure 1 (DO-7 and DO-35), figure 2 (DO-213AA), figure 3 (JANHCA and JANKCA), and figure 4 (JANHCB and JANKCB).

1.3 Maximum ratings (T_A = +25°C, unless otherwise specified).

P_T	T_{STG} and T_{op}	I_{ZM}	Power derating above T_A = 25°C
mW 500	°C -65 to +175	mA dc 70	mW/°C 3.33

1.4 Primary electrical characteristics. Primary electrical characteristics at T_A = +25°C unless otherwise specified.

Type	ΔV_Z (voltage - temperature stability	Z_Z I_Z = 7.5 mA dc	V_Z I_Z = 7.5 mA dc		I_R V_R = 3.0 V
			Min	Max	
	mV dc	ohms	volts	volts	µA
1N821, 1N821-1, 1N821UR-1	96	15	5.89	6.51	2.0
1N823, 1N823-1, 1N823UR-1	48	15	5.89	6.51	2.0
1N825, 1N825-1, 1N825UR-1	19	15	5.89	6.51	2.0
1N827, 1N827-1, 1N827UR-1	9	15	5.89	6.51	2.0
1N829, 1N829-1, 1N829UR-1	5	15	5.89	6.51	2.0

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ELDT, 1507 Wilmington Pike, Dayton, OH 45444-5765 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 5961

AMSC N/A
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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).

SPECIFICATION

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 Defense Printing Service Detachment Office, Building 4D (Customer Service), 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 and as follows:

UR	Unleaded or surface mounted devices (round end caps).
JANH	High reliability product assurance level for unencapsulated devices.
JANK	Space reliability product assurance level for unencapsulated devices.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and on figures 1, 2, 3, and 4 herein.

3.3.1 Lead finish. Lead finish shall be solderable as defined in MIL-S-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).

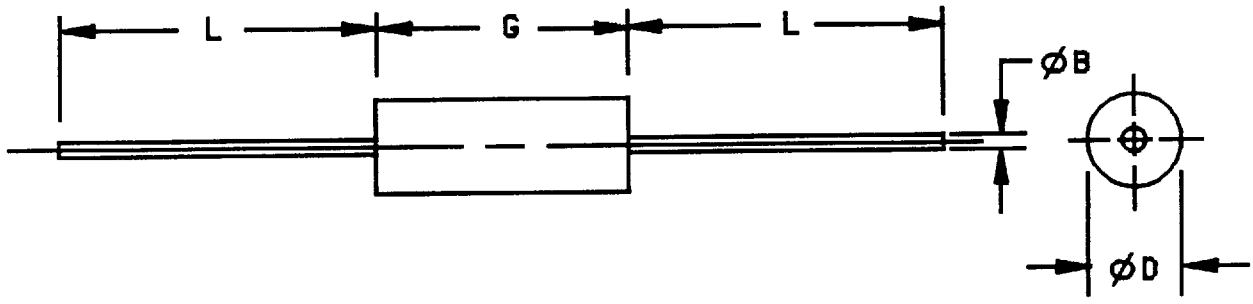
3.3.2 Dash-one construction. These devices shall be category I or II metallurgical bonding in accordance with MIL-S-19500.

3.3.3 JANS construction. Construction shall be dash-one, category I or II metallurgical bond in accordance with MIL-S-19500, appendix A, 30.14.2 and 30.14.4.

3.3.4 JANC construction. JANC construction may differ in die size and bonding pad layout provided the manufacturing technology is identical (example: diffused junction, alloy junction).

3.4 Marking. Marking shall be in accordance with MIL-S-19500.

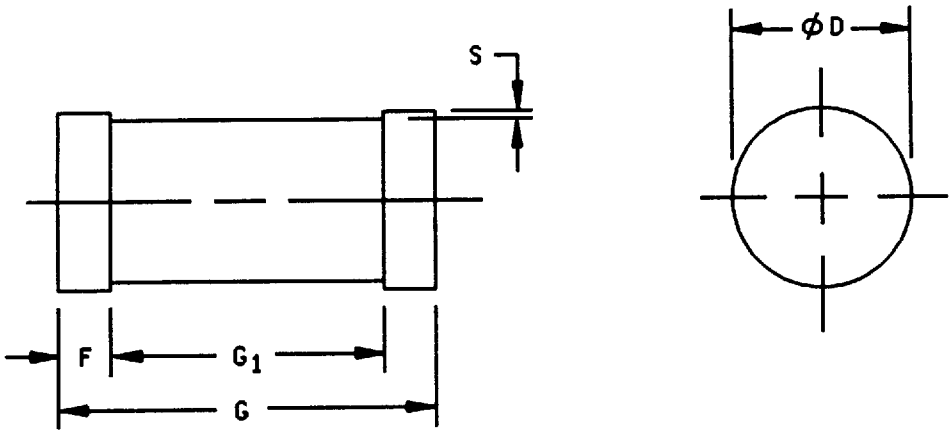
3.4.1 Marking of "UR" version devices. For "UR" version devices only, all marking (except polarity) may be omitted from the body, but shall be retained on the initial container.



Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
ϕB	.018	.023	0.46	0.58	3,4
ϕD	.060	.107	1.52	2.72	5
G	.120	.300	3.05	7.62	
L	1.000	1.500	25.40	38.10	

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The specified lead diameter applied in the zone between .050 inch (1.27 mm) and 1.0 inches (25.40 mm) from the diode body. Outside of this zone the lead diameter is not controlled.
4. Both leads shall be within the specified dimension.
5. The minimum body diameter shall be maintained over .15 inch (3.8 mm) of body length.

FIGURE 1. Physical dimensions, 1N821, 1N823, 1N825, 1N827, 1N829, 1N821-1, 1N823-1, 1N825-1, 1N827-1, 1N829-1 (DO-35 and DO-7).

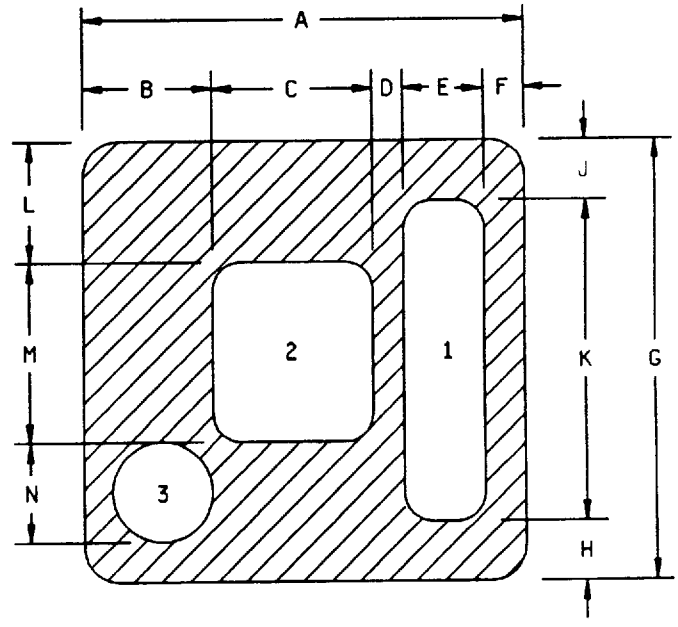


Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
ϕD	.063	.067	1.60	1.70
F	.016	.022	0.41	0.56
G	.130	.146	3.30	3.71
G_1	.100 Ref		2.54 Ref	
S	.001 Min		0.03 Min	

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

FIGURE 2. Physical dimensions, 1N821UR-1, 1N823UR-1, 1N825UR-1, 1N827UR-1 and 1N829UR-1 (DO-213AA).

Dimensions				
Symbol	Inches		Millimeters	
	Min	Max	Min	Max
A	.0280	.0320	.711	.813
B	.0080	.0100	.203	.254
C	.0104	.0106	.264	.269
D	.0019	.0021	.048	.053
E	.0054	.0056	.137	.142
F	.0020	.0040	.050	.102
G	.0280	.0320	.711	.813
H	.0030	.0050	.076	.127
J	.0030	.0050	.076	.127
K	.0209	.0211	.531	.536
L	.0080	.0100	.203	.254
M	.0104	.0106	.264	.269
N	.0059	.0061	.150	.155



BACKSIDE MUST BE ELECTRICALLY ISOLATED

DESIGN DATA

Metallization:

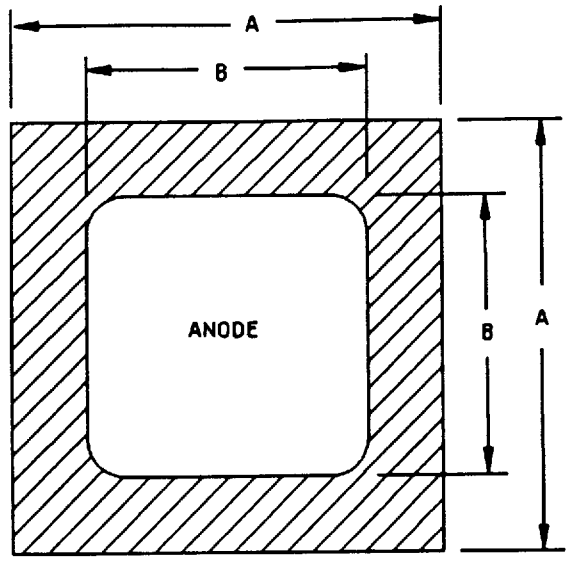
Top: 1 (Cathode) . . . . Al
2 (Anode) . . . . . Al
3 (Test pad) . . . . Al
Back . . . . . Au

Circuit layout data:
For zener operation, cathode must be operated positive with respect anode.

Al thickness . . . . . 25,000Å minimum
Gold thickness . . . . . 4,000Å minimum
Chip thickness . . . . . 0.010 inch (0.254 mm) ±0.002 inch (0.051 mm).

NOTES:
1. Dimensions are in inches unless otherwise indicated.
2. Metric equivalents are given for general information only.

FIGURE 3. JANHC and JANKC (A-version) die dimensions.



BACKSIDE IS CATHODE

Dimensions				
Symbol	Inches		Millimeters	
	Min	Max	Min	Max
A	.024	.028	.61	.71
B	.014	.018	.36	.46

DESIGN DATA

Metallization:

Top: (Anode) . . . . . Al

Back . . . . . Au

Al thickness . . . . . 40,000Å minimum
Gold thickness . . . . . 5,000Å minimum
Chip thickness . . . . . 0.010 inch (0.254 mm) ±0.002 inch (0.051 mm).

Circuit layout data:
For zener operation, cathode must be operated positive with respect anode.

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information.
3. Requirements in accordance with MIL-S-19500 (appendix H) are performed in a TO-5 package (see 6.5).

FIGURE 4. JANHC and JANKC (B-version) die dimensions.

3.4.2 Designation of JANHC and JANKC die. For JANHC and JANKC die, the following designations shall be used (example):

JANHCAM1N821
↑↑↑↑
|||└ RHA level (see MIL-S-19500).
||└ Source of manufacturer (see figure 3).
|└ Unencapsulated.
└ Product assurance level 1/.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500, and as specified herein except lot accumulation requirement shall be six months in lieu of six weeks.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

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

4.2.2 JANHC and JANKC devices. Qualification for JANHC and JANKC devices shall be in accordance with appendix H of MIL-S-19500.

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
11	V_Z, Z_Z, and I_R	V_Z, Z_Z, and I_R
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; $\Delta Z_Z \leq \pm 2.25$ ohms of initial reading. at T_A = +25°C ±2°C $\Delta V_Z \leq \pm 4$ mV dc from initial value for 1N821, 1N821-1, 1N821UR-1, 1N823, 1N823-1, 1N823UR-1, 1N825, 1N825-1, and 1N825UR-1. $\Delta V_Z \leq \pm 3$ mV dc from initial value for 1N827, 1N827-1, 1N827UR-1, 1N829, 1N829-1, and 1N829UR-1.	Subgroup 2 of table I herein; $\Delta Z_Z \leq \pm 2.25$ ohms of initial reading. at T_A = +25°C ±2°C $\Delta V_Z \leq \pm 4$ mV dc from initial value for 1N821, 1N821-1, 1N821UR-1, 1N823, 1N823-1, 1N823UR-1, 1N825, 1N825-1, and 1N825UR-1. $\Delta V_Z \leq \pm 3$ mV dc from initial value for 1N827, 1N827-1, 1N827UR-1, 1N829, 1N829-1, and 1N829UR-1.

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

I_Z = 7.5 mA dc, +0.75 mA dc, -0 mA dc, T_A = 150 +5°C, -0°C.

4.3.2 Screening (JANHC and JANKC). Screening of JANHC and JANKC die shall be in accordance with appendix H of MIL-S-19500.

1/ Two levels of product assurance levels are provided for unencapsulated devices, H and K (see MIL-S-19500.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-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 IVa (JANS) and table IVb (JAN, JANTX and JANTXV) of MIL-S-19500. Electrical measurements (end-points) shall be in accordance with the applicable steps of table I, subgroup 2 herein.

4.4.2.1 Group B inspection, table IVa (JANS) of MIL-S-19500.

Subgroup	Method	Conditions
B3	1071	Test condition E.
B4	1037	I_Z = 7.5 mA dc at T_A = +150°C; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No forced air cooling on the device shall be permitted. Paragraph 3, delta case temperature does not apply.
B5	1027	I_Z = 7.5 mA dc for 1,000 hours. T_A = +150°C.

4.4.2.2 Group B inspection, table IVb (JAN, JANTX and JANTXV) of MIL-S-19500.

Subgroup	Method	Conditions
B2	1071	Test condition E.
B3	1027	T_A = +150°C and I_Z = 7.5 mA dc. NOTE: When group C (subgroup 6) is required, group B (subgroup 3) is not required for that lot.

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. Electrical measurements (end-points) requirements shall be in accordance with the applicable steps of table I, subgroup 2 herein.

4.4.3.1 Group C inspection, table V of MIL-S-19500.

Subgroup	Method	Conditions
C2	2036	Lead tension: 4 pounds weight, t = 15 ±3 seconds; test condition A. Not applicable to "UR" version devices. Lead fatigue: Test condition E, not applicable to "UR" version devices.
C2	1071	Test condition E.
C6	1026	T_A = +100°C and I_Z = 7.5 mA dc (see 4.5.2).

4.4.4 Group D inspection. Group D inspection shall be conducted in accordance with MIL-S-19500 and table II herein. MIL-S-19500, appendix G is not required when homogeneous product of radiation hard assembly (per applicable 36D form) is submitted and successfully passes group D sampling of total dose at an outside facility compliant to MIL-STD-750, method 1019. 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 36D forms.

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 ΔV_Z per diode type.

4.5.2 Reference voltage time stability. The breakdown voltage shall be measured prior to life testing at 500 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.

Inspection	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Reference-voltage time stability		T_A = +100°C ±2°C (see 4.5.2 and 4.5.3) I_Z = 7.5 ±0.01 mA dc	ΔV_Z			
1N821, 1N821-1, 1N821UR-1		(0 to 340 hours)			7	mV dc
1N823, 1N823-1, 1N823UR-1					7	mV dc
1N825, 1N825-1, 1N825UR-1					7	mV dc
1N827, 1N827-1, 1N827UR-1					6	mV dc
1N829, 1N829-1, 1N829UR-1					5	mV dc
1N821, 1N821-1, 1N821UR-1		(340 to 1,000 hours)			4	mV dc
1N823, 1N823-1, 1N823UR-1					4	mV dc
1N825, 1N825-1, 1N825UR-1					4	mV dc
1N827, 1N827-1, 1N827UR-1					3	mV dc
1N829, 1N829-1, 1N829UR-1					3	mV dc

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 0.375 inch (9.53 mm) and 0.500 inch (12.70 mm) inch 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.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Reference voltage (see 4.5.3)	4022	I_Z = 7.5 ±0.01 mA dc	V_Z	5.89	6.51	V dc
Small-signal breakdown impedance	4051	I_Z = 7.5 ±0.01 mA dc I_{sig} = 0.75 mA ac	Z_Z		15	Ω
Reverse current leakage	4016	DC method; V_R = 3.0 V dc	I_R		2.0	µA
Subgroup 3						
Voltage-temperature stability (see 4.5.1 and 4.5.3)		I_Z = 7.5 ±0.01 mA dc T_A = -55°C, 0°C. +25°C, +75°C, +100°C ±2°C	ΔV_Z			
1N821, 1N821-1, 1N821UR-1					96	mV dc
1N823, 1N823-1, 1N823UR-1					48	mV dc
1N825, 1N825-1, 1N825UR-1					19	mV dc
1N827, 1N827-1, 1N827UR-1					9	mV dc
1N829, 1N829-1, 1N829UR-1					5	mV dc
Subgroups 4, 5, and 6						
Not applicable						

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

TABLE II. Group D inspection.

Inspection 1/	MIL-STD-750		Symbol	Pre-irradiation limits		Post-irradiation limits		ΔV_{ze} Pre-Post I_{RRAD} change		Unit
	Method	Conditions		M, D, R and H		M, D, R and H				
				Min	Max	Min	Max	Min	Max	
Subgroup 1										
Not applicable										
Subgroup 2		T_C = +25°C								
Steady-state total dose irradiation	1019	I_Z = 7.5 ±0.01 mA dc Condition A								
Reference voltage (see 4.5.3)	4022	I_Z = 7.5 ±0.01 mA dc	V_Z	5.89	6.51	5.89	6.51			V dc
Small-signal breakdown impedance	4051	I_Z = 7.5 ±0.01 mA dc I_{sig} = 0.75 ac	Z_Z		15		15			ohms
Reverse current leakage	4016	DC method; V_R = 3.0 V dc	I_R		2.0		2.0			µA
Voltage stability (see 4.5.3)	4022	I_Z = 7.5 ±0.01 mA dc T_A = 25°C ±2°C	ΔV_Z							
1N821, 1N821-1 1N821UR-1									±3.0	mV
1N823, 1N823-1 1N823UR-1									±3.0	mV
1N825, 1N825-1 1N825UR-1									±2.0	mV
1N827, 1N827-1 1N827UR-1									±1.5	mV
1N829, 1N829-1 1N829UR-1									±1.0	mV

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

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

Inspection	MIL-STD-750		Sampling plan 1/
	Method	Conditions	
Subgroup 1			22 devices c = 0
Thermal shock temperature cycling	1051	500 cycles	
Electrical measurement		See table I, subgroup 2	
Subgroup 2			22 devices c = 0
Steady-state dc life	1038	Condition B; 1,000 hours I_Z = 7.5 mA dc T_A = +150°C	
Electrical measurement		See table I, subgroup 2	
Subgroup 3			
Not applicable			
Subgroups 4, 5 and 6			
Not applicable			

1/ For sampling plans not specified, see MIL-S-19500.

5. PACKAGING

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

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-S-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 and for die acquisition, the JANHC or JANKC letter version shall be specified (see figures 3 and 4).

6.3 Suppliers of JANC die. The qualified JANC suppliers with the applicable letter version (example JANHCAM1N821) will be identified on the QPL.

JANC ordering information				
PIN	Manufacturer			
	55801	55801 Radiation designators M,D,L,R,F,G,H	12954	12954 Radiation designators M,D,L,R,F,G,H
1N821	JANHCA1N821 JANKCA1N821	JANHCA1N821 JANKCA1N821	JANHCB1N821 JANKCB1N821	JANHCB1N821 JANKCB1N821
1N823	JANHCA1N823 JANKCA1N823	JANHCA1N823 JANKCA1N823	JANHCB1N823 JANKCB1N823	JANHCB1N823 JANKCB1N823
1N825	JANHCA1N825 JANKCA1N825	JANHCA1N825 JANKCA1N825	JANHCB1N825 JANKCB1N825	JANHCB1N825 JANKCB1N825
1N827	JANHCA1N827 JANKCA1N827	JANHCA1N827 JANKCA1N827	JANHCB1N827 JANKCB1N827	JANHCB1N827 JANKCB1N827
1N829	JANHCA1N829 JANKCA1N829	JANHCA1N829 JANKCA1N829	JANHCB1N829 JANKCB1N829	JANHCB1N829 JANKCB1N829

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

6.5 Substitution of ΔV_z devices. Device types within this series with higher type numbers (lower ΔV_z) are a direct oneway substitution for lower type numbers (higher ΔV_z).

6.6 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.

CONCLUDING MATERIAL

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

Review activities:
Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 19, 85, 99
DLA - ES

Preparing activity:
DLA - ES

Agent:
DLA - ES

(Project 5961-1577)