MIL-S-19500/126C
24 March 1971
SUPERSEDING
MIL-S-19500/126B
20 March 1964

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, GERMANIUM, HIGH-FREQUENCY NPN TYPES 2N1302, 2N1304, 2N1306, 2N1308 AND PNP TYPES 2N1303, 2N1305, 2N1307, 2N1309

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

1. SCOPE

1.1 Scope. This specification covers the detail requirements for NPN and PNP, complementary germanium, high-frequency transistors.

1.2 Physical dimensions. See figure 1 (TO-5).

1.3 Maximum ratings.

P_T 1/	V_{CB}		V_{EB}		I_C		T_{stg}
	NPN	PNP	NPN	PNP	NPN	PNP	
mw	Vdc	Vdc	Vdc	Vdc	mAdc	mAdc	°C
150	25	-30	25	-25	300	-300	-65 to +100

1/ Derate linearly 2.5 mW/° C for T_A between 25° C and 85° C.

1.4 Primary electrical characteristics.

	h_{FE} V_{CE} = 1 Vdc, I_C = 10 mAdc 1/ V_{CE} = -1 Vdc, I_C = -10 mAdc 2/				f_{hfb} V_{CB} = 5 Vdc, I_E = -1 mAdc 1/ V_{CB} = -5 Vdc, I_E = 1 mAdc 2/			
	2N1302 2N1303	2N1304 2N1305	2N1306 2N1307	2N1308 2N1309	2N1302 2N1303	2N1304 2N1305	2N1306 2N1307	2N1308 2N1309
	---	---	---	---	MHz	MHz	MHz	MHz
Minimum	20	40	60	80	3	5	10	15
Maximum	---	200	300	400	---	---	---	---

1/ Test conditions for types 2N1302, 2N1304, 2N1306 and 2N1308.

2/ Test conditions for types 2N1303, 2N1305, 2N1307 and 2N1309.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

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

STANDARDS

MILITARY

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-750 - Test Methods for Semiconductor Devices.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 General. Requirements shall be in accordance with MIL-S-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. The abbreviations, symbols, and definitions used herein are defined in MIL-S-19500, and as follows:

Qsb - - - - - - - - - Stored base charge
pC - - - - - - - - - Pico-coulombs

3.3 Design, construction, and physical dimensions. Transistors shall be of the design, construction, and physical dimensions shown on figure 1.

3.3.1 Lead material and finish. Lead material shall be Kovar or alloy 52. Lead finish shall be gold-plated. (Leads may be tin-coated if specified in the contract or order, and this requirement shall not be construed as adversely affecting the qualified-product status of the device, or applicable JAN marking, see 6.2.)

3.4 Performance characteristics. Performance characteristics shall be as specified in tables I, II, and III.

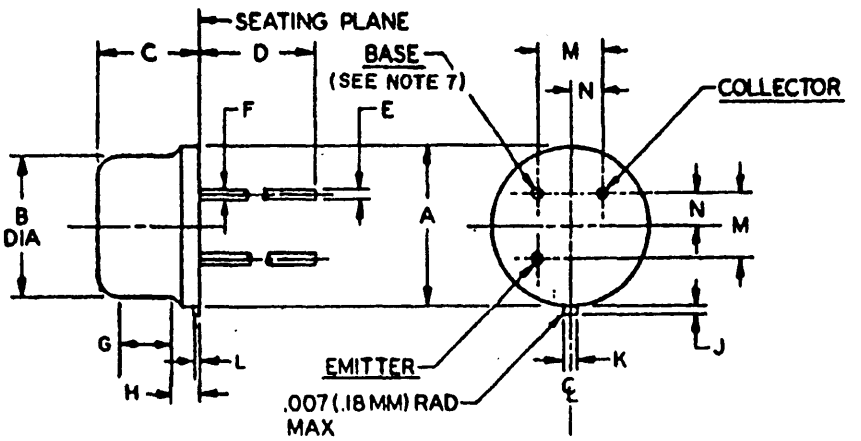
3.5 Marking. The following marking specified in MIL-S-19500 may be omitted from the body of the transistor at the option of the manufacturer:

(a) Country of origin.
(b) Manufacturer's identification.

4. QUALITY ASSURANCE PROVISIONS

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

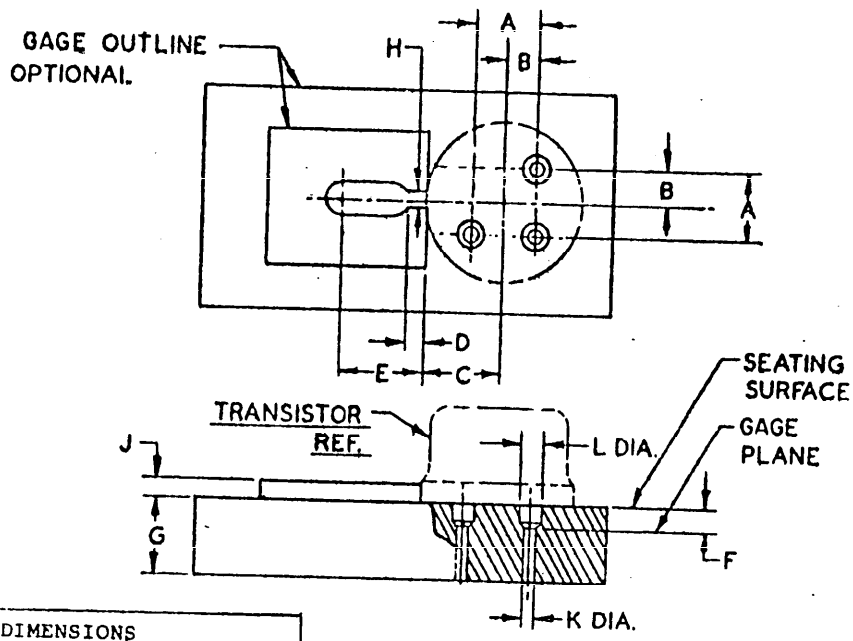
4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.



LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	
B	.305	.335	7.75	8.51	
C	.240	.260	6.10	6.60	
D	1.500	1.750	38.10	44.45	9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100	---	2.54	---	4
H	---	---	---	---	5
J	.029	.045	.74	1.14	8
K	.028	.034	.71	.86	
L	.009	.041	.23	1.04	
M	.1414 Nom		3.59 Nom		6
N	.0707 Nom		1.80 Nom		6

NOTES:
1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.
2. Measured in the zone beyond .250 (6.35 mm) from the seating plane.
3. Measured in the zone .050 (1.27 mm) and .250 (6.35 mm) from the seating plane.
4. Variations on dimension B in this zone shall not exceed .010 (.25 mm).
5. Outline in this zone is not controlled.
6. When measured in a gaging plane .054+.001, -.000 (1.37+.03, -.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 shows the preferred measured method.
7. The base shall be electrically connected to the case.
8. Measured from the maximum diameter of the actual device.
9. All 3 leads.

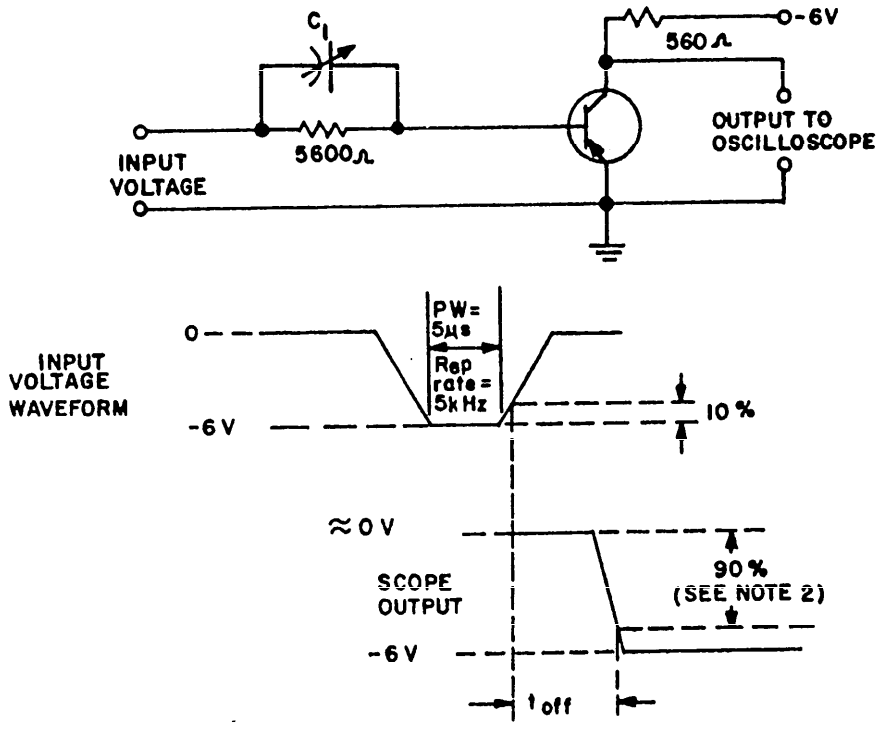
FIGURE 1. Physical dimensions of transistor types 2N1302 through 2N1309 (TO-5).



DIMENSIONS				
LTR	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.1409	.1419	3.58	3.60
B	.0702	.0712	1.78	1.81
C	.182	.199	4.62	5.05
D	.009	.011	.23	.28
E	.125 Nom		3.18 Nom	
F	.054	.055	1.37	1.40
G	.372	.378	9.45	9.60
H	.0350	.0355	.89	.90
J	.150 Nom		3.81 Nom	
K	.0325	.0335	.83	.85
L	.0595	.0605	1.51	1.54

NOTES:
1. The following gaging procedure shall be used: The use of a pin straightener prior to insertion in the gage is permissible. The device being measured shall be inserted until its seating plane is .125±.010 (3.18±.25 mm) from the seating surface of the gage. A spacer may be used to obtain the .125 (3.18 mm) distance from the gage seat prior to force application. A force of 8 oz ±.05 oz shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed) the seating plane of the device shall be seated against the gage.
2. The location of the tab locator, within the limits of dim C, will be determined by the tab and flange dimension of the device being checked.
3. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4 mm.

FIGURE 2. Gage for lead and tab location for transistor types 2N1302 through 2N1309.



NOTES:
1. The capacitance of C_1 shall be increased until the t off time of the output waveform is decreased to .2 usec. Q_{sb} in pC is then calculated by $Q_{sb} = C_1 X E_{in}$ where C_1 is in pF and E_{in} is 6 volts.
2. Any unit that turns on above the 90-percent point, once it starts to turn off, fails the test.

FIGURE 3. Circuit for determining value of stored base charge.
(Polarities shown apply to PNP)

TABLE I. Group A inspection.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1			10				
Visual and mechanical examination	2071			---	---	---	---
Subgroup 2			5				
Breakdown voltage, collector to base	3001						
All NPN devices		Bias cond. D; I_C = 100 μAdc		BV_{CBO}	25	---	Vdc
All PNP devices		Bias cond. D; I_C = -100 μAdc		BV_{CBO}	-30	---	Vdc
Breakdown voltage, emitter to base	3026						
All NPN devices		Bias cond. D; I_E = 100 μAdc		BV_{EBO}	25	---	Vdc
All PNP devices		Bias cond. D; I_E = -100 μAdc		BV_{EBO}	-25	---	Vdc
Collector to base cutoff current	3036						
All NPN devices		Bias cond. D; V_{CB} = 25 Vdc		I_{CBO}	---	6	μAdc
All PNP devices		Bias cond. D; V_{CB} = -25 Vdc		I_{CBO}	---	-6	μAdc
Emitter to base cutoff current	3061						
All NPN devices		Bias cond. D; V_{EB} = 25 Vdc		I_{EBO}	---	6	μAdc
All PNP devices		Bias cond. D; V_{EB} = -25 Vdc		I_{EBO}	---	-6	μAdc
Floating potential	3020	R_{BE} = 1 megohm ±5% including voltmeter input resistance					
NPN devices - 2N1302		V_{CB} = 25 Vdc		V_{EBF}	---	1	Vdc
2N1304		V_{CB} = 20 Vdc			---	1	Vdc
2N1306		V_{CB} = 15 Vdc			---	1	Vdc
2N1308		V_{CB} = 15 Vdc			---	1	Vdc
PNP devices - 2N1303		V_{CB} = -25 Vdc		V_{EBF}	---	-1	Vdc
2N1305		V_{CB} = -20 Vdc			---	-1	Vdc
2N1307		V_{CB} = -15 Vdc			---	-1	Vdc
2N1309		V_{CB} = -15 Vdc			---	-1	Vdc

TABLE I. Group A inspection. -Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 3			5				
Forward-current transfer ratio	3076						
NPN devices - 2N1302		V_{CE} = 1 Vdc; I_C = 10 mAdc		h_{FE}	20	---	---
2N1304					40	200	---
2N1306					60	300	---
2N1308					80	400	---
PNP devices - 2N1303		V_{CE} = -1 Vdc; I_C = -10 mAdc		h_{FE}	20	---	---
2N1305					40	200	---
2N1307					60	300	---
2N1309					80	400	---
NPN devices - 2N1302		V_{CE} = 0.35 Vdc; I_C = 200 mAdc		h_{FE}	10	---	---
2N1304					15	---	---
2N1306					20	---	---
2N1308					20	---	---
PNP devices - 2N1303		V_{CE} = -0.35 Vdc; I_C = -200 mAdc		h_{FE}	10	---	---
2N1305					15	---	---
2N1307					20	---	---
2N1309					20	---	---
Collector to emitter voltage (saturated)	3071						
NPN devices - 2N1302		I_B = 0.5 mAdc; I_C = 10 mAdc		V_{CE} (sat)	---	0.20	Vdc
2N1304		I_B = 0.25 mAdc; I_C = 10 mAdc			---	0.20	Vdc
2N1306		I_B = 0.17 mAdc; I_C = 10 mAdc			---	0.20	Vdc
2N1308		I_B = 0.13 mAdc; I_C = 10 mAdc			---	0.20	Vdc

TABLE I. Group A inspection. -Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 3 -Continued							
PNP devices - 2N1303		I_B = -0.5 mAdc; I_C = -10 mAdc		V_{CE} (sat)	---	-0.20	Vdc
2N1305		I_B = -0.25 mAdc; I_C = -10 mAdc			---	-0.20	Vdc
2N1307		I_B = -0.17 mAdc; I_C = -10 mAdc			---	-0.20	Vdc
2N1309		I_B = -0.13 mAdc; I_C = -10 mAdc			---	-0.20	Vdc
Base emitter voltage (saturated)	3066	Test cond. A					
NPN devices - 2N1302		I_B = 0.5 mAdc; I_C = 10 mAdc		V_{BE} (sat)	0.15	0.40	Vdc
2N1304					0.15	0.35	Vdc
2N1306					0.15	0.35	Vdc
2N1308					0.15	0.35	Vdc
PNP devices - 2N1303		I_B = -0.5 mAdc; I_C = -10 mAdc		V_{BE} (sat)	-0.15	-0.40	Vdc
2N1305					-0.15	-0.35	Vdc
2N1307					-0.15	-0.35	Vdc
2N1309					-0.15	-0.35	Vdc
Subgroup 4			5				
Open circuit output capacitance	3236						
All NPN devices		V_{CB} = 5 Vdc; I_E = 0 100 kHz $\leq$ f $\leq$ 1 MHz		C_{obo}	---	20	pF
All PNP devices		V_{CB} = -5 Vdc; I_E = 0 100 kHz $\leq$ f $\leq$ 1 MHz		C_{obo}	---	20	pF
Small-signal short-circuit forward-current transfer-ratio cutoff frequency	3301						
NPN devices - 2N1302		V_{CB} = 5 Vdc; I_E = -1 mAdc		f_{hfb}	3	---	MHz
2N1304					5	---	MHz
2N1306					10	---	MHz
2N1308					15	---	MHz

TABLE I. Group A inspection, -Continued

Examination or test	MIL-STD-750			Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 4 -Continued							
PNP devices - 2N1303		V_{CB} = -5 Vdc; I_E = 1 mAdc		f_{hfb}	3	---	MHz
2N1305					5	---	MHz
2N1307					10	---	MHz
2N1309					15	---	MHz
Stored base charge	---	(See figure 3)					
NPN devices - 2N1302				Q_{sb}	---	1400	pC
2N1304					---	1200	pC
2N1306					---	1000	pC
2N1308					---	1000	pC
PNP devices - 2N1303				Q_{sb}	---	1600	pC
2N1305					---	1400	pC
2N1307					---	1200	pC
2N1309					---	1200	pC
Subgroup 5			10				
High-temperature operation:		T_A = +55° C					
Collector to emitter cutoff current	3041	Bias cond. A					
NPN devices		V_{CE} = 15 Vdc V_{BE} = -0.2 Vdc		I_{CEX}	---	50	µAdc
PNP devices		V_{CE} = -15 Vdc V_{BE} = 0.2 Vdc		I_{CEX}	---	-50	µAdc
Low-temperature operation:		T_A = -65° C					
Forward-current transfer ratio	3076						
NPN devices 2N1302		V_{CE} = 1 Vdc I_C = 10 mAdc		h_{FE}	10	---	---
2N1304					20	200	---
2N1306					30	300	---
2N1308					40	---	---
PNP devices 2N1303		V_{CE} = -1 Vdc I_C = -10 mAdc		h_{FE}	10	---	---
2N1305					20	200	---
2N1307					30	300	---
2N1309					40	---	---

TABLE II. Group B inspection.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---
Subgroup 2			15				
Solderability	2026			---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. C, except in step 3, T_A = +85 ±5° C		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Moisture resistance	1021			---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D					
All NPN devices		V_{CB} = 25 Vdc; I_E = 0		I_{CBO}	---	6	µAdc
All PNP devices		V_{CB} = -25 Vdc; I_E = 0		I_{CBO}	---	-6	µAdc
Forward-current transfer ratio	3076						
NPN devices - 2N1302		V_{CE} = 1 Vdc I_C = 10 mAdc		h_{FE}	20	---	---
2N1304					40	200	---
2N1306					60	300	---
2N1308					80	400	---
PNP devices - 2N1303		V_{CE} = -1 Vdc I_C = -10 mAdc		h_{FE}	20	---	---
2N1305					40	200	---
2N1307					60	300	---
2N1309					80	400	---
Subgroup 3			15				
Shock	2016	Nonoperating; 1,500 G; 0.5 ms; 5 blows in each orientation: X_1, Y_1, Y_2 and Z_1		---	---	---	---
Vibration, variable frequency	2056			---	---	---	---
Constant acceleration	2006	10,000 G in each orientation: X_1, Y_1, Y_2, and Z_1		---	---	---	---
End points: (Same as subgroup 2)							
Subgroup 4			20				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---

TABLE II. Group B inspection, -Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 4 -Continued							
End points:							
Hermetic seal	1071	Test cond. G or H for fine leaks; test cond. A, C, D, or F for gross leaks		---	---	$1x10^{-7}$	atm cc/s
Subgroup 5			20				
Salt atmosphere (corrosion)	1041			---	---	---	---
Subgroup 6			7				
High-temperature life (nonoperating)	1032	T_{stg} = +100° C time = 340 hours (see 4.3.4)		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D					
All NPN devices		V_{CB} = 25 Vdc; I_E = 0		I_{CBO}	---	12	μAdc
All PNP devices		V_{CB} = -25 Vdc; I_E = 0		I_{CBO}	---	-12	μAdc
Forward-current transfer ratio	3076						
NPN devices - 2N1302		V_{CE} = 1 Vdc I_C = 10 mAdc		h_{FE}	16	---	---
2N1304					32	---	---
2N1306					48	---	---
2N1308					64	---	---
PNP devices 2N1303		V_{CE} = -1 Vdc I_C = -10 mAdc		h_{FE}	16	---	---
2N1305					32	---	---
2N1307					48	---	---
2N1309					64	---	---
Subgroup 7			7				
Steady-state operation life	1027	P_T = 150 mW time = 340 hours (see 4.3.4)					
All NPN devices		V_{CB} = 10 Vdc		---	---	---	---
All PNP devices		V_{CB} = -10 Vdc		---	---	---	---
End points: (Same as subgroup 6)							

TABLE III. Group C inspection.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 1			10				
Resistance to solvents	---	MIL-STD-202, Method 215 (see 4.4.1)		---	---	---	---
Subgroup 2			λ = 10				
High-temperature life (nonoperating)	1031	T_{stg} = +100° C (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6 of Group B)							
Subgroup 3			λ = 10				
Steady-state operation life	1026	P_T = 150 mW (see 4.3.4)					
All NPN devices		V_{CB} = 10 Vdc		---	---	---	---
All PNP devices		V_{CB} = -10 Vdc		---	---	---	---
End points: (Same as subgroup 6 of Group B)							

4.3 Quality conformance inspection. Quality conformance inspection shall consist of group A, B, and C inspections. A lot shall consist of transistors of only one family (NPN or PNP). For subgroups 1 through 5 of group B tests and subgroup 1 of group C, where a lot consists of more than one type, only one type need be tested as a representative of the lot for all types in the lot. For subgroups 6 and 7 of group B tests and subgroups 2 and 3 of group C tests, the samples for each subgroup shall consist of all types within the lot to be tested and the number of devices of each type shall be proportional to the distribution of the types within the lot.

4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table I.

4.3.2 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table II.

4.3.3 Group C inspection. Group C inspection shall consist of the tests specified in table III. This inspection shall be conducted on the initial lot and thereafter every six months during production.

4.3.4 Group B and group C life-test samples. Samples that have been subjected to group B, 340-hours life-test, may be continued on test to 1,000 hours in order to satisfy group C life-test requirements. These samples shall be predesignated, and shall remain subjected to the group C 1,000-hour acceptance evaluation after they have passed the group B, 340-hour acceptance criteria. The cumulative total of failures found during 340-hour test and during the subsequent interval up to 1,000 hours shall be computed for 1,000-hour acceptance criteria, see 4.3.3.

4.4 Methods of examination and test. Methods of examination and test shall be as specified in tables I, II, and III, and as follows:

4.4.1 Resistance to solvents. Transistors shall be subjected to tests in accordance with method 215 of MIL-STD-202. The following details shall apply:

(a) All areas of the transistor body where marking has been applied shall be brushed.
(b) After subjection to the tests there shall be no evidence of mechanical damage to the device and and markings shall have remained legible.

5. PREPARATION FOR DELIVERY

5.1 See MIL-S-19500, section 5.

6. NOTES

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

6.2 Ordering data.

(a) Lead finish if other than gold-plated (see 3.3.1).

Custodians:
Army - EL
Navy - EC
Air Force - 17

Review activities:
Army - MU, MI
Air Force - 11, 70, 80
DSA - ES

User activities:
Army - SM
Navy - AS, CG, MC, OS, SH
Air Force - 13, 15, 19

Preparing activity:
Navy - EC

Agent:
DSA - ES

(Project 5961-0214)

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

DD FORM 1 JAN 66 1426

REPLACES EDITION OF 1 OCT 64 WHICH MAY BE USED.

S/N-0102-014-1801 C-25254