

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, LOW-POWER
 TYPE 2N398A

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 a PNP, germanium, low-power transistor.

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

1.3 Maximum ratings.

P_T 1/	V_{CB0}	V_{CES}	V_{EBO}	I_C	T_{stg}
<u>mW</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>mAdc</u>	<u>°C</u>
150	-105	-105	-75	-200	-65 to +100

1/ Derate linearly 2.0 mW/°C for $T_A > 25^\circ\text{C}$.

1.4 Primary electrical characteristics.

Limits	f_{hfb} $V_{CB} = -8 \text{ Vdc}$ $I_C = +1 \text{ mAdc}$	h_{FE} $V_{CE} = -0.35 \text{ Vdc}$ $I_C = -5 \text{ mAdc}$	C_{obo} $V_{CB} = -8 \text{ Vdc}$ $I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$	$V_{CE}(\text{sat})$ $I_C = -100 \text{ mAdc}$ $I_B = -20 \text{ mAdc}$
	<u>MHz</u>		<u>pF</u>	<u>Vdc</u>
Min	0.6	20	---	---
Max	---	100	25	-0.5

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

MILITARY

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:

RBE - - - - - External base to emitter resistance

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)).

* 3.3.1.1 Selectivity of lead material. Where choice of lead material (see 3.3.1 above) is desired, it shall be specified in the contract or order (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.

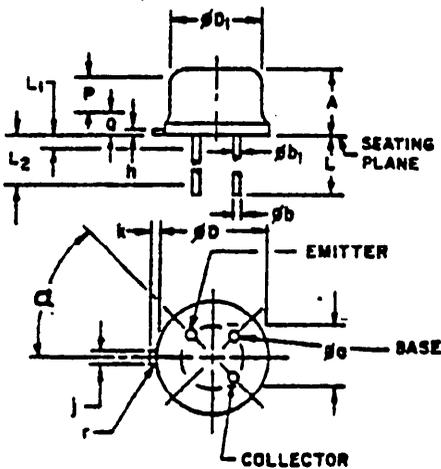
4.3 Quality conformance inspection. Quality conformance inspection shall consist of group A, B, and C inspections.

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-hour 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.

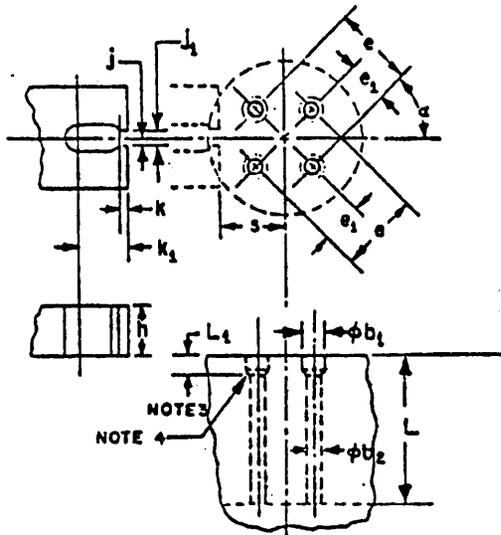


SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.240	.260	6.10	6.60	
Øa	.200 TP		5.080 TP		6
Øb	.016	.021	.407	.533	7, 8
Øb1	.016	.019	.407	.482	7, 8
ØD	.335	.370	8.51	9.40	
ØD1	.305	.335	7.75	8.51	
h	.009	.041	.23	1.04	
j	.028	.034	.712	.863	2
k	.029	.045	.74	1.14	3
L	1.500	1.750	38.10	44.45	7, 8
L1	---	.050	---	1.27	7, 8
L2	.250	---	6.35	---	7, 8
P	.100	---	2.54	---	5
Q	---	.050	---	1.27	4
r	---	.010	---	.254	10
α	45° TP		45° TP		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. Beyond r(radius) maximum, j must be held for a minimum length of .011 (.28 mm).
3. k measured from maximum ØD.
4. Outline in this zone is not controlled.
5. ØD1 shall not vary more than .010 (.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gage plane .054 +.001 -.000 (1.37 +.03 -.00 mm) below seating plane shall be within .007 (.18 mm) radius of True Position at maximum material condition relative to tab at MMC. The device may be measured by direct methods or by the gage and gaging procedure shown in Figure 2.
7. Øb1 applies between L1 and L2. Øb applies between L2 and L minimum. Diameter is uncontrolled in L1 and beyond L minimum.
8. All three leads.
9. All leads electrically insulated from the case.
10. r(radius) applies to both inside corners of tab.

FIGURE 1. Physical dimensions of transistor type 2N398A (TO-5).



SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
ϕb_1	.0595	.0605	1.511	1.537	
ϕb_2	.0325	.0335	.8255	.8509	
e	.1995	.2005	5.067	5.093	
e_1	.0995	.1005	2.527	2.552	
h	.150 NOM		3.81 NOM		
j	.0175	.0180	.4445	.4572	
j_1	.0350	.0355	.8890	.9017	
k	.009	.011	.23	.28	
k_1	.125 NOM		3.18 NOM		
L	.372	.378	9.45	9.60	
L_1	.054	.055	1.37	1.40	
s	.182	.199	4.62	5.05	1
α	44.90°	45.10°	44.90°	45.10°	

NOTES:

1. The location of the tab locator within the limits indicated will be determined by the tab and flange dimensions of the device being checked.
2. The following gaging procedure shall be used:

The device being measured shall be inserted until its seating plane is $.125(3.18 \text{ mm}) \pm .010(.25 \text{ mm})$ from the seating surface of the gage. A force of $8 \pm .5 \text{ oz.}$ 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.

The use of a pin straightener prior to insertion in the gage is permissible.

3. Gaging plane.
4. Drill angle.

FIGURE 2. Gage for lead and tab location for transistor type 2N398A.

TABLE I. Group A Inspection.

MIL-S-19500/174B

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
* Subgroup 1							
Visual and mechanical examination	2071		10	---	---	---	---
Subgroup 2							
Breakdown voltage, collector to base	3001	Bias condition D $I_C = -50 \mu\text{A}_{dc}$	5	BV_{CBO}	-105	---	V _{dc}
Breakdown voltage, emitter to base	3026	Bias condition D $I_E = -100 \mu\text{A}_{dc}$		BV_{EBO}	-75	---	V _{dc}
Collector to base cutoff current	3036	Bias condition D $V_{CB} = -60 \text{V}_{dc}$		I_{CBO}	---	-14	μA_{dc}
Collector to emitter cutoff current	3041	Bias condition C $V_{CE} = -105 \text{V}_{dc}$		I_{CES}	---	-600	μA_{dc}
Collector to emitter cutoff current	3041	Bias condition B $V_{CE} = -55 \text{V}_{dc}$ $R_{BE} = 10 \text{ kilohms}$		I_{CER}	---	-600	μA_{dc}
Emitter to base cutoff current	3061	Bias condition D $V_{EB} = -50 \text{V}_{dc}$		I_{EBO}	---	-14	μA_{dc}
Floating potential	3020	$V_{CB} = -105 \text{V}_{dc}$ Voltmeter input resistance $\geq 10 \text{ megohms}$		$VEBF$	---	-1	V _{dc}
Subgroup 3							
Forward-current transfer ratio	3076	$V_{CE} = -0.35 \text{V}_{dc}$ $I_C = -5 \text{ mA}_{dc}$	5	h_{FE}	20	100	---
Base emitter voltage (saturated)	3066	Test condition A $I_C = -5 \text{ mA}_{dc}$ $I_B = -0.25 \text{ mA}_{dc}$		$V_{BE(sat)}$	---	-0.35	V _{dc}
Collector to emitter voltage (saturated)	3071	$I_C = -5 \text{ mA}_{dc}$ $I_B = -0.25 \text{ mA}_{dc}$		$V_{CE(sat)}$	---	-0.35	V _{dc}
Collector to emitter voltage (saturated)	3071	$I_C = -100 \text{ mA}_{dc}$ $I_B = -20 \text{ mA}_{dc}$		$V_{CE(sat)}$	---	-0.5	V _{dc}
Subgroup 4							
Small-signal short-circuit forward-current transfer ratio	3206	$V_{CE} = -6 \text{V}_{dc}$ $I_C = -1 \text{ mA}_{dc}$	5	h_{fe}	20	---	---
Small-signal short-circuit forward-current transfer ratio cutoff frequency	3301	$V_{CB} = -6 \text{V}_{dc}$ $I_E = +1 \text{ mA}_{dc}$		f_{hfb}	0.6	---	MHz
Open-circuit output capacitance	3236	$V_{CB} = -6 \text{V}_{dc}$; $I_E = 0$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$		C_{obo}	---	25	pF

TABLE I. Group A inspection - Continued.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
Subgroup 5							
High-temperature operation: Collector to base cutoff current	3036	T _A = +71°C Bias condition D V _{CB} = -60 Vdc	10	ICBO	---	-200	μA _{dc}
Low-temperature operation: Forward-current transfer ratio	3076	T _A = -55°C V _{CE} = -0.35 Vdc I _C = -5 mA _{dc}		h _{FE}	10	---	---

TABLE II. Group B inspection.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit	
	Method	Details			Min	Max		
* Subgroup 1								
Physical dimensions	2066	See figure 1	20	---	---	---	---	
* Subgroup 2								
Solderability	2026		15	---	---	---	---	
Thermal shock (temperature cycling)	1051	Test condition B except in step 3, T _A = +100 ±5°C		---	---	---	---	
Thermal shock (glass strain)	1056	Test condition A		---	---	---	---	
Hermetic seal	1071	Test condition G or H for fine leaks; test condition A, C, D or F for gross leaks		---	---	1x10 ⁻⁷	atm cc/s	
Moisture resistance	1021			---	---	---	---	
End points:								
Collector to base cutoff current	3036	Bias condition D V _{CB} = -60 Vdc			ICBO	---	-14	μA _{dc}
Forward-current transfer ratio	3076	V _{CE} = -0.35 Vdc I _C = -5 mA _{dc}		h _{FE}	20	100	---	
* Subgroup 3								
Shock	2016	Nonoperating; 500 G 1 ms, 5 blows in each orientation: X ₁ , Y ₁ , Y ₂ and Z ₁	15	---	---	---	---	
Vibration, variable frequency	2056			---	---	---	---	
Constant acceleration	2006	10,000 G; in each orienta- tion: X ₁ , Y ₁ , Y ₂ and Z ₁		---	---	---	---	
End points: (Same as subgroup 2)								

TABLE II. Group B inspection - Continued.

ML-S-19500/174B

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
* <u>Subgroup 4</u>			20				
Terminal strength (lead fatigue)	2036	Test condition E		---	---	---	---
End points:							
Hermetic seal	1071	Test condition G or H for fine leaks; test condition A, C, D or F for gross leaks		---	---	1x10 ⁻⁷	atm cc/s
* <u>Subgroup 5</u>			20				
Salt atmosphere (corrosion)	1041			---	---	---	---
* <u>Subgroup 6</u>			7				
High-temperature life (nonoperating)	1032	Tstg = +100°C time = 340 hours (see 4.3.4)		---	---	---	---
End points;							
Collector to base cutoff current	3036	Bias condition D VCB = -60 Vdc		ICBO	---	-25	μAdc
Forward-current transfer ratio	3076	VCE = -0.35 Vdc IC = -5 mAdc		hFE	15	---	---
* <u>Subgroup 7</u>			7				
Steady-state operation life	1027	PT = 150 mW VCB = -20 Vdc time = 340 hours (see 4.3.4)		---	---	---	---
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	
<u>Subgroup 1</u>			20				
Barometric pressure, reduced (altitude operation)	1001	Normal mounting; pressure = 8 mm Hg for 60 s min.		---	---	---	---
Measurement during test:							
Collector to base cutoff current	3036	Bias condition D VCB = -105 Vdc		ICBO	---	-50	μAdc

TABLE III. Group C inspection - Continued.

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 2</u>			20				
Burnout by pulsing	3005	V _{CB} = 0; I _C = -200 mAdc t _p = 60 s for 1 cycle		---	---	---	---
End points:							
Forward-current transfer ratio	3076	V _{CE} = -0.35 Vdc I _C = -5 mAdc (see 4.4.2)		hFE	20	100	---
* <u>Subgroup 3</u>			10				
Resistance to solvents	---	MIL-STD-202, method 215 (see 4.4.1)		---	---	---	---
* <u>Subgroup 4</u>			λ = 10				
High-temperature life (nonoperating)	1031	T _{stg} = +100°C (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6 of group B)							
* <u>Subgroup 5</u>			λ = 10				
Steady-state operation life	1026	P _T = 150 mW V _{CB} = -20 Vdc (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 6 of group B)							

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 markings shall have remained legible.

4.4.2 Stabilization time. End-point measurements, after the burnout by pulsing test (group C inspection), shall be performed within the time period between 24 hours and 96 hours to allow for stabilization of units.

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).
- (b) Selectivity of lead material (see 3.3.1.1).

6.3 Changes from previous issue. The margins of this specification are marked with an asterisk to indicate where changes (additions, modification, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:

Army - EL
Navy - EC
Air Force - 17

Review activities:

Army - MU
Air Force - 11, 80, 70
DSA - ES

User activities:

Army - AV, SM
Navy - AS, CG, MC, SH
Air Force - 13, 15, 19

Preparing activity:

Navy - EC

Agent:

DSA - ES

(Project 5961-0261)

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

MIL-S-19500/174B (EC)

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