

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, LOW-POWER

TYPE 2N501A

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 transistor, PNP, germanium, low-power, switching, and is in accordance with MIL-S-19500 except as otherwise specified herein.

1.2 Physical dimensions. See figure 1.

1.3 Maximum ratings.

P_C 1/	V_{CB0}	V_{EBO}	V_{CES}	T_{stg}
<u>mW</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>°C</u>
60	-15	-2.0	-12	-65 to +100

1/ Derate linearly at 0.8 mW/°C for $T_A > 25^\circ C$.

1.4 Primary electrical characteristics.

	h_{FE}	C_{obo}	$V_{CE}^{(sat)}$
	$V_{CE} = -0.5 V_{dc}$ $I_C = -10 mA_{dc}$	$V_{CB} = -3.0 V_{dc}$ $I_E = 0$ $f = 4 MHz$	$I_C = -50 mA_{dc}$ $I_B = -5 mA_{dc}$
Min. Max.	30 ---	<u>pf</u> --- 3	<u>Vdc</u> --- -0.25

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.

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

3.3.1 Terminal-lead length. Terminal-lead length(s) will be as specified in figure 1 unless otherwise specified in contract or order. (Where other lead lengths are required and provided, it 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:

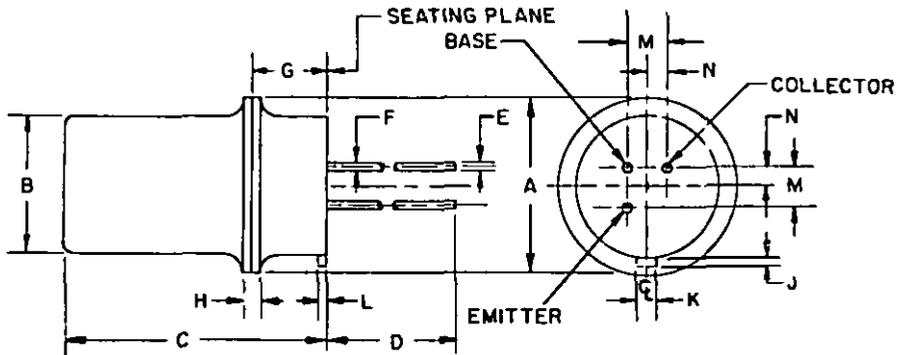
- (a) Country of origin.
- (b) Manufacturer's identification.

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.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of group A, B, and C inspections. When specified in the contract or order, one copy of the quality conformance inspection data, pertinent to the device inspection lot, shall be supplied with each shipment by the device manufacturer.



LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.200	.230	5.08	5.84	
B	.155	.180	3.94	4.57	
C	.375	.410	9.53	10.41	
D	1.500	1.750	38.10	44.45	4
E	.016	.021	.41	.53	2,4
F	.016	.019	.41	.48	3,4
G		.105		2.67	6
H					7
J	.028	.048	.71	1.22	8
K	.028	.042	.71	1.07	8
L	.007	.025	.18	.64	8
M	.0500 Nom		1.27 Nom		
N	.0250 Nom		.64 Nom		

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. All three leads.
5. All leads shall be electrically isolated from the case.
6. Flange position not controlled within this range.
7. This dimension not controlled.
8. Tab optional.

FIGURE 1. Physical dimensions of transistor type 2N501A.

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 examinations and tests specified in table III and shall be conducted on the initial lot and thereafter every 6 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 for 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.

4.3.5 Group C testing. The contractor shall, throughout the course of a contract or order, permit the Government representative to scrutinize all test data and findings covering manufacturer's test program on group C characteristics and parameters for the product concerned. Upon determination by the Government inspector (in advance of group C, 6-month, test results) that group C parameters are not being adequately met, the Government inspector may require lot-by-lot inspection, normally for a minimum of 3-consecutive lots, to be performed for required group C tests.

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 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.4.2 Time limit for end points. End-point tests for qualification and quality conformance inspection shall be completed within 96 hours after completion of the last test in the subgroup.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1</u>			10				
Visual and mechanical examination	2071			---	---	---	---
<u>Subgroup 2</u>			5				
Collector to emitter cutoff current	3041	Bias cond. C; $V_{CE} = -12 \text{ Vdc}$		I_{CES}	---	-100	μAdc
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -5 \text{ Vdc}$		I_{CBO}	---	-5.0	μAdc
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-25	μAdc
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -2 \text{ Vdc}$		I_{EBO}	---	-1.0	mAdc

TABLE I. Group A inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 2 - Continued</u>							
Forward current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc};$ $I_C = -10 \text{ mAdc}$		h_{FE}	30	225	---
Forward current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc};$ $I_C = -50 \text{ mAdc}$		h_{FE}	30	---	---
<u>Subgroup 3</u>							
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$	5	$V_{CE}^{(sat)}$	---	-0.20	Vdc
Collector to emitter voltage (saturated)	3071	$I_C = -50 \text{ mAdc};$ $I_B = -5 \text{ mAdc}$		$V_{CE}^{(sat)}$	---	-0.25	Vdc
<u>Subgroup 4</u>							
Open circuit output capacitance	3238	$V_{CB} = -3.0 \text{ Vdc}; I_E = 0;$ $f = 4 \text{ MHz}$	5	C_{obo}	---	3.0	pf
Base to emitter voltage (nonsaturated)	3066	Test cond. B; $I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		V_{BE}	---	-0.45	Vdc
<u>Subgroup 5</u>							
High-temperature operation:		$T_A = +55^\circ \text{ C}$					
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -5 \text{ Vdc}$		I_{CBO}	---	-40	μAdc
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		$V_{CE}^{(sat)}$	---	-0.25	Vdc
Low-temperature operation:		$T_A = -55^\circ \text{ C}$					
Forward current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc};$ $I_C = -50 \text{ mAdc}$	10	h_{FE}	15	---	---
<u>Subgroup 6</u>							
Pulse rise time		(See figure 2.)		t_r	---	18	nsec
Pulse storage time		(See figure 3.)		t_s	---	12	nsec
Pulse fall time		(See figure 3.)		t_f	---	10	nsec

TABLE II. Group B inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1</u>							
Physical dimensions	2066	(See figure 1.)	20	---	---	---	---

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 2</u>			15				
Solderability	2026			---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. B except $T(\text{high}) = +100 \pm \frac{3}{0}^{\circ}\text{C}$		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Seal (leak-rate) $\frac{1}{2}$	---	MIL-STD-202, method 112, test cond. C, procedure III; test cond. A or B for gross leaks		---	---	1×10^{-7}	atm cc/sec
Moisture resistance	1021			---	---	---	---
End points: (See 4. 4. 2.)							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-25	μAdc
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		$V_{CE}^{(\text{sat})}$	---	-0.20	Vdc
Base to emitter voltage (nonsaturated)	3066	Test cond. B; $I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		V_{BE}	---	-0.45	Vdc
<u>Subgroup 3</u>			15				
Shock	2016	Nonoperating; 1,500 G, 0.5 msec, 5 blows in each orientation: $X_1, Y_1, Y_2,$ and Z_1		---	---	---	---
Vibration fatigue	2046	Nonoperating		---	---	---	---
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 for subgroup 2)							
<u>Subgroup 4</u>			15				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---
<u>Subgroup 5</u>			15				
Salt atmosphere (corrosion)	1041			---	---	---	---
End points: (Same as for subgroup 2)							

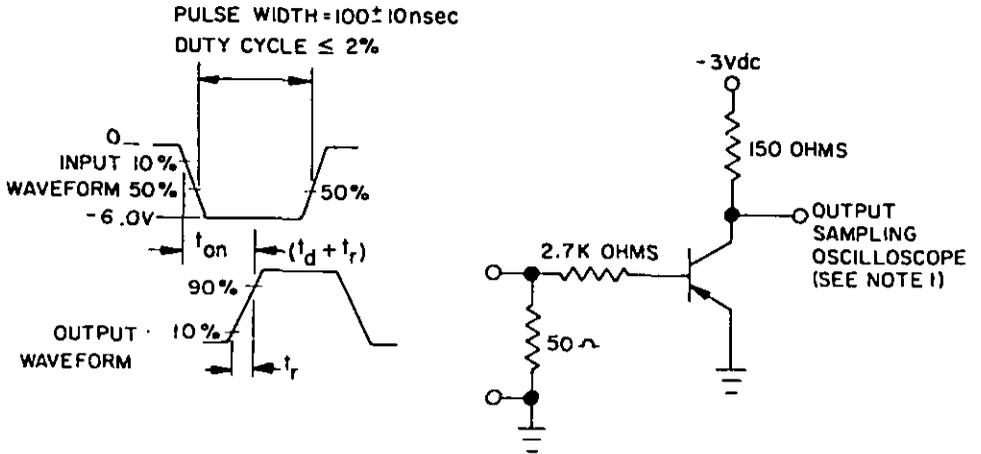
TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 6</u>							
High-temperature life (nonoperating)	1031	$T_{stg} = +100^{\circ} \text{C};$ $t = 340 \text{ hrs.}$	5	---	---	---	---
End points: (See 4. 4. 2.)							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-50	μAdc
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		$V_{CE}^{(sat)}$	---	-0.23	Vdc
Base to emitter voltage (nonsaturated)	3066	Test cond. B; $I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		V_{BE}	---	-0.55	Vdc
<u>Subgroup 7</u>							
Steady-state operation life	1026	$P_T = 60 \text{ mW};$ $V_{CB} = -10 \text{ Vdc};$ $t = 340 \text{ hrs.}$	7	---	---	---	---
End points: (Same as for subgroup 6)							

✓ This test need not be performed where any chemical has been introduced as a filler.

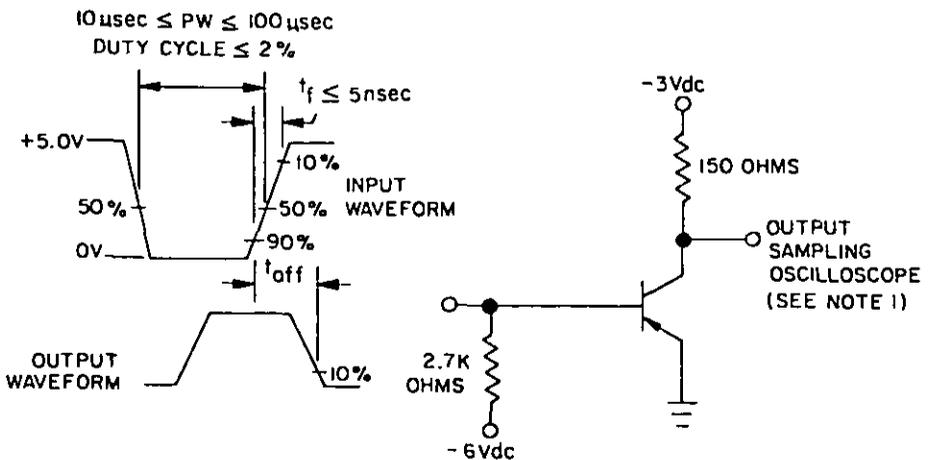
TABLE III. Group C inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 1</u>							
High-temperature life (nonoperating)	1031	$T_{stg} = 100^{\circ} \text{C}$	$\lambda = 7$	---	---	---	---
End points: (See 4. 4. 2)							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-50	μAdc
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		$V_{CE}^{(sat)}$	---	-0.23	Vdc
Base to emitter voltage (nonsaturated)	3066	Test cond. B; $I_C = -10 \text{ mAdc};$ $I_B = -1.0 \text{ mAdc}$		V_{BE}	---	-0.55	Vdc
<u>Subgroup 2</u>							
Steady-state operation life	1026	$P_T = 60 \text{ mW};$ $V_{CB} = -10 \text{ Vdc}$	$\lambda = 10$	---	---	---	---
End points: (Same as for subgroup 1)							



- NOTES:
1. Oscilloscope: $Z_{in} \geq 100 \text{ K}$; $C_{in} \leq 12 \text{ pf}$; $t_r \leq 15 \text{ nsec}$.
 2. Equivalent circuits may be used.

FIGURE 2. Rise switching-time (t_r) test circuit.



- NOTES:
1. Oscilloscope: $Z_{in} \geq 100 \text{ K}$; $C_{in} \leq 12 \text{ pf}$; $t_r \leq 15 \text{ nsec}$.
 2. Equivalent circuits may be used.

FIGURE 3. Turn-off switching-time (t_s and t_f) test circuit.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery and the quality assurance provisions for preparation for delivery shall conform to MIL-S-19500.

6. NOTES

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

6.2 Ordering data.

- (a) Terminal-lead length if other than specified in figure 1 (see 3.3.1).
- (b) Inspection data (see 4.3).

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

Custodians:
Army - EL
Navy - EC
Air Force - 11

Preparing activity:
Army - EL
(Project 5961-0009-15)

Review activities:
Army - EL, MI
Navy - SH, EC
Air Force - 11, 17, 85
DSA - ES

User activities:
Army - EL, SM
Navy - CG, MC, AS, OS
Air Force - 19