

MIL-S-19500/38C  
 10 January 1969  
 SUPERSEDING  
 MIL-S-19500/38B  
 31 January 1962  
 (See 6.3.)

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, POWER  
 TYPES 2N539 AND 2N539A

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

\* 1.2 Physical dimensions. See figure 1.

\* 1.3 Maximum ratings.

$P_T \frac{1}{T_C = 75^\circ C}$	$I_E$	$V_{CBO}$	$V_{EBO}$	$V_{CEO}$	$T_{stg}$	$T_J$
<u>W</u>	<u>Adc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>Vdc</u>	<u>°C</u>	<u>°C</u>
11	3.5	-80	-28	-55	-65 to +100	+100

1/ Derate linearly 0.44 W/°C for  $T_C > 75^\circ C$ .

\* 1.4 Primary electrical characteristics.

Limits	$h_{FE}$	$h_{fe}$	$V_{CE} (sat)$	$h_{IE}$
	$V_{CE} = -2.0 Vdc$ $I_C = -2.0 Adc$	$V_{CE} = -4.0 Vdc$ $I_C = -0.5 Adc$ $f = 100 kHz$	$I_C = -2.0 Adc$ $I_B = -0.2 Adc$	$V_{CE} = -2.0 Vdc$ $I_C = -2.0 Adc$
			<u>Vdc</u>	<u>ohm</u>
Min	30	3.0	---	27
Max	75	---	-0.6	54

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.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL BUREAU OF STANDARDS

Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.)

3. REQUIREMENTS

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

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

$G_p$  ----- Power conductance  
 $\tau_t$  ----- Thermal time constant

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

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.

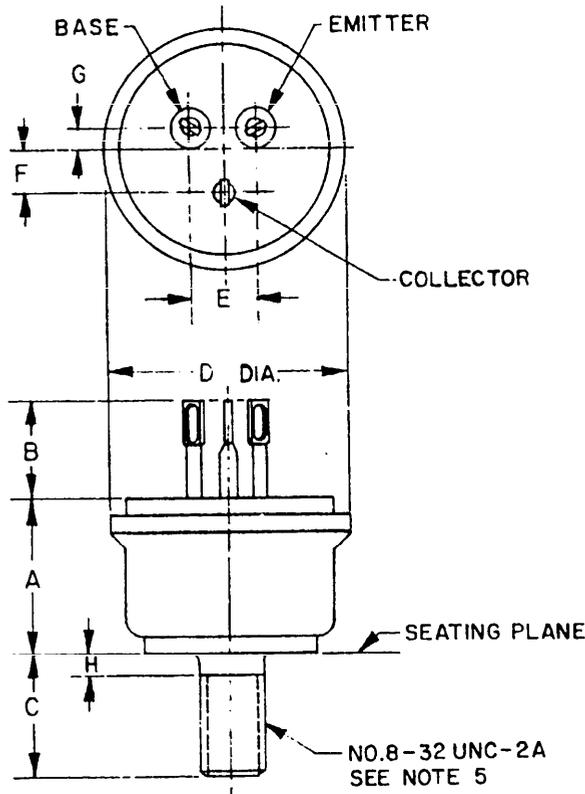
4. QUALITY ASSURANCE PROVISIONS

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 groups 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.

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



LTR	INCHES		MILLIMETERS		Notes
	MIN	MAX	MIN	MAX	
A	.330	.380	8.38	9.65	
B	.230	.270	5.94	6.96	4
C	.335	.375	8.51	9.53	
D	.525	.645	13.34	16.38	
E	.132	.172	3.35	4.37	3
F	.087	.127	2.21	3.23	
G	.034	.074	.86	1.88	
H	.040	.080	1.02	2.03	

**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. The collector shall be electrically connected to the case.
3. The angular orientation of the terminal flats is not controlled.
4. The size and shape of all three terminals are identical.
5. Threads in accordance with Handbook H-28.

FIGURE 1. Physical dimensions of transistor types 2N539 and 2N539A.

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

4.4.2 Power conductance (G<sub>p</sub>). Power conductance is a transfer function equal to the product of the forward-current transfer ratio and the dc transconductance.

$$G_p = \frac{I_C^2}{V_{BE}I_B}$$

The values of V<sub>BE</sub> and its corresponding I<sub>B</sub> shall be as measured during the base emitter voltage test in subgroup 3 of table I.

4.4.3 Vibration, variable frequency (monitored). The collector current shall not exceed 10 ma during the 8-minute vibration (a 10 ma fast-acting instrument-type fuse may be used to indicate compliance or failure of a transistor in the test procedure). A transistor which is indicated as a failure by a blown fuse may be subjected to retest, consisting of an additional 10-minute vibration (in each orientation). If a failure indication does not recur, the transistor shall not be considered as a failure. This retest shall be performed one time only for each transistor.

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>			7				
Breakdown voltage, collector to emitter	3011	Bias cond. D; I <sub>C</sub> = -100 mA dc; pulsed (see 4.4.1)		BV <sub>CEO</sub>	-55	---	Vdc

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>							
Collector to base cutoff current	3036	Bias cond. D;		$I_{CBO}$	---	-0.1	mAdc
		$V_{CB} = -2.0$ Vdc			---	-1.0	mAdc
		$V_{CB} = -28$ Vdc			---	-2.0	mAdc
Emitter to base cutoff current	3061	Bias cond. D;		$I_{EBO}$	---	-0.15	mAdc
		$V_{EB} = -2.0$ Vdc			---	-2.0	mAdc
		$V_{EB} = -28$ Vdc					
<u>Subgroup 3</u>							
Forward-current transfer ratio	3076	$V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc; pulsed (see 4.4.1)	7	$h_{FE}$	30	75	---
Collector to emitter voltage (saturated)	3071	$I_C = -2.0$ Adc; $I_B = -200$ mAdc		$V_{CE}(\text{sat})$	---	-0.6	Vdc
Base emitter voltage (nonsaturated)	3066	Test cond. B; $V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc		$V_{BE}$	-1.0	-2.5	Vdc
Floating potential	3020	$V_{CB} = -80$ Vdc; $R_{EB} = 10$ K ohms		$V_{EBF}$	---	-0.5	Vdc
<u>Subgroup 4</u>							
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = -4.0$ Vdc; $I_C = -500$ mAdc; $f = 100$ kHz	10	$ h_{te} $	3.0	---	---
Static input resistance (2N539A only)	3086	$V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc		$h_{IE}$	27	54	ohms
Power conductance (2N539A only)	---	$V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc (see 4.4.2)		$G_p$	35	105	mhos
<u>Subgroup 5</u>							
High-temperature operation:		$T_C = +85^\circ$ C					
Collector to base cutoff current	3036	$V_{CB} = -80$ Vdc; $I_E = 0$		$I_{CBO}$	---	-20.0	mAdc
Low-temperature operation:		$T_C = -55^\circ$ C					
Forward current transfer ratio	3076	$V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc; pulsed (see 4.4.1)	15	$h_{FE}$	25	---	---

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 $T_{high} = +100^{\circ}C$		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. B		---	---	---	---
Terminal strength (tension)	2036	Test cond. A; weight = 5 lb; time = 15 sec. each terminal		---	---	---	---
Terminal strength (terminal torque)	2036	Test cond. D1; torque = 10 oz. -in. to be applied to flat of each terminal for $t = 15$ sec.		---	---	---	---
Terminal strength (stud torque)	2036	Test cond. D2; torque = 100 oz. -in.; time = 15 sec.		---	---	---	---
Seal (leak-rate)	---	MIL-STD-202, method 112, test cond. C, procedure III; test cond. B for gross leaks		---	---	$1 \times 10^{-7}$	atm cc/sec
Moisture resistance	1021	Omit initial conditioning		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -80$ Vdc		$I_{CBO}$	---	-2.0	mAdc
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -28$ Vdc		$I_{EBO}$	---	-2.0	mAdc
Forward current transfer ratio	3076	$V_{CE} = -2.0$ Vdc; $I_C = -2.0$ Adc; pulsed (see 4.4.1)		$h_{FE}$	30	75	---
<u>Subgroup 3</u>			15				
Shock	2016	Nonoperating; 500 G, 1.0 msec, 5 blows in each orientation: $X_1$ , $Y_1$ , $Y_2$ , and $Z_1$		---	---	---	---
Vibration fatigue	2046	Nonoperating		---	---	---	---
Vibration, variable frequency	2056			---	---	---	---
Vibration, variable frequency (monitored)	2057	(See 4.4.3 and fig. 2)		---	---	---	---
Constant acceleration	2006	5,000 G; in each orientation: $X_1$ , $Y_1$ , $Y_2$ , and $Z_1$		---	---	---	---
End points: (Same as subgroup 2)							

TABLE II. Group B inspection - Continued

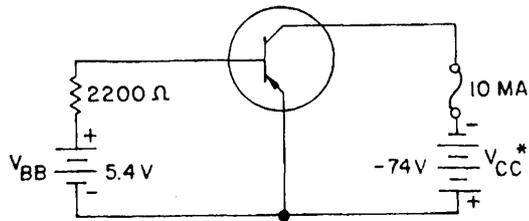
Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 4</u>			20				
Salt atmosphere (corrosion)	1041			---	---	---	---
End points: (Same as subgroup 2)							
<u>Subgroup 5</u>			5				
High-temperature life (nonoperating)	1031	$T_{stg} = +100^{\circ} \text{C}$ ; $t = 340$ hours (see 4.3.4)		---	---	---	---
End points: Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -80 \text{ Vdc}$		$I_{CBO}$	---	-4.0	mAdc
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -28 \text{ Vdc}$		$I_{EBO}$	---	-4.0	mAdc
Forward current transfer ratio	3076	$V_{CE} = -2.0 \text{ Vdc}$ ; $I_C = -2.0 \text{ Adc}$ ; pulsed (see 4.4.1)		$h_{FE}$	22	88	---
<u>Subgroup 6</u>			7				
Steady-state operation life	1026	$T_C = +55^{\circ} \text{C}$ ; $V_{CB} = -12 \text{ Vdc}$ ; $P_T = 20 \text{ watts}$ ; $t = 340$ hours (see 4.3.4)		---	---	---	---
End points: (Same as subgroup 5)							

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 pressure = 15 mm Hg for 60 sec min		---	---	---	---
Measurement during test:							
Collector to base cutoff current	3036	$V_{CB} = -80 \text{ Vdc}$		$I_{CBO}$	---	-2.0	mAdc
Thermal resistance	3151			$\theta_{J-C}$	---	2.2	$^{\circ}\text{C/W}$
Thermal time constant	3146			$\tau_t$	10	---	msec
<u>Subgroup 2</u>			$\lambda = 7$				
High-temperature life (nonoperating)	1031	$T_{stg} = +100^{\circ} \text{C}$ (see 4.3.4)		---	---	---	---

TABLE III. Group C inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		Unit
	Method	Details			Min	Max	
<u>Subgroup 2 - Continued</u> End points: (Same as subgroup 5 of group B) <u>Subgroup 3</u> Steady-state operation life End points: (Same as subgroup 5 of group B)	1026	$T_C = +55^\circ \text{ C};$ $V_{CB} = -12 \text{ Vdc};$ $P_T = 20 \text{ watts (see 4.3.4)}$	$\lambda = 10$	---	---	---	---



\*  $V_{CC}$  SHALL BE APPLIED, AT THE APPROXIMATE RATE OF 20 VOLTS PER SECONDS, AFTER APPLICATION OF  $V_{BB}$

FIGURE 2. Test circuit for active vibration.

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) Inspection data (see 4.3).

6.3 Changes from previous issue. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, 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 - 11

Preparing activity:  
Navy - EC

(Project 5961-0008-32)

Review activities:

Army - EL, MU, MI  
Navy - SH  
Air Force - 11, 17, 85  
DSA - ES

User activities:

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