

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, SWITCHING

TYPE 2N1500

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 high-speed switching, PNP, germanium transistor.

1.2 Physical dimensions. See figure 1 (TO-9).

1.3 Maximum ratings.

$P_T$ <sup>1/</sup> $T_A = 25^\circ C$	VCBO	VEBO	VCES	IC	T <sub>stg</sub>	T <sub>J</sub>
mW	Vdc	Vdc	Vdc	mAdc	° C	° C
60	-15	-2	-12	-50	-65 to +100	+100

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

1.4 Primary electrical characteristics.

	h <sub>FE</sub> V <sub>CE</sub> = -0.5 Vdc I <sub>C</sub> = -50 mAdc	h <sub>fe</sub> V <sub>CE</sub> = -0.5 Vdc I <sub>E</sub> = -2 mAdc f = 20 MHz	V <sub>CE(sat)</sub> I <sub>C</sub> = -50 mAdc I <sub>B</sub> = -5 mAdc	C <sub>obo</sub> V <sub>CB</sub> = -3 Vdc I <sub>E</sub> = 0 100kHz ≤ f ≤ 1 MHz	t <sub>r</sub>	t <sub>s</sub>	t <sub>f</sub>
			Vdc	pf	nsec	nsec	nsec
Minimum	20	5	---	---	---	---	---
Maximum	---	---	-0.20	3	18	12	10

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 as defined in MIL-S-19500, and as follows:

V<sub>CES</sub> - - - - - Collector-to-emitter voltage, with base short-circuited to emitter.

\* 3.3 Design, construction, and physical dimensions. The transistor shall be of the design, construction, and physical dimensions specified in 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.

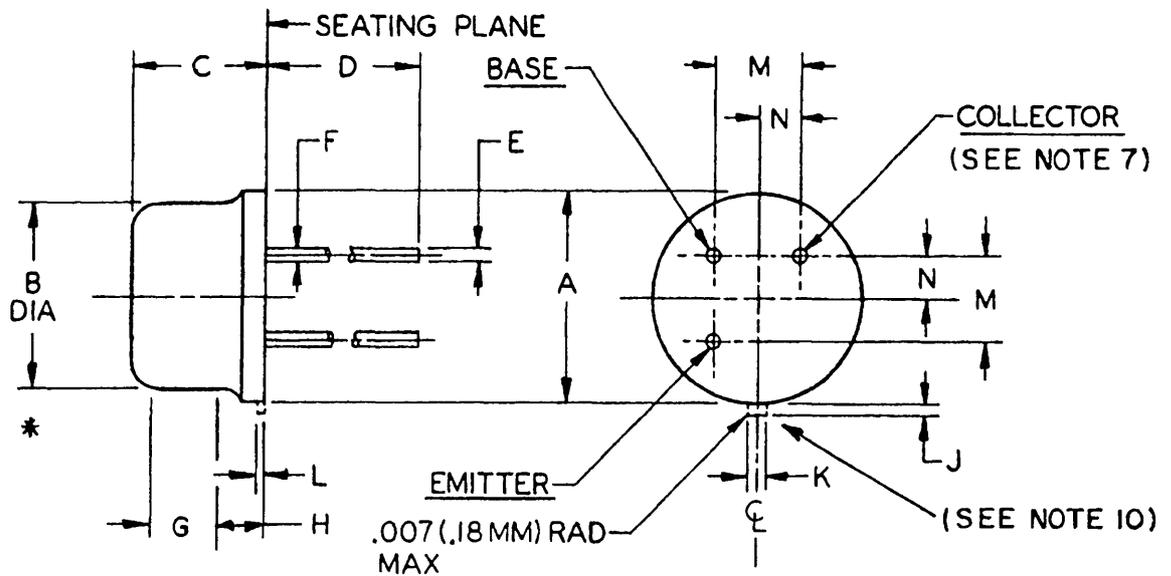
4.3.1 Group A inspection. Group A inspection shall consist of the examinations and tests specified, in table I.

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. 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 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.

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

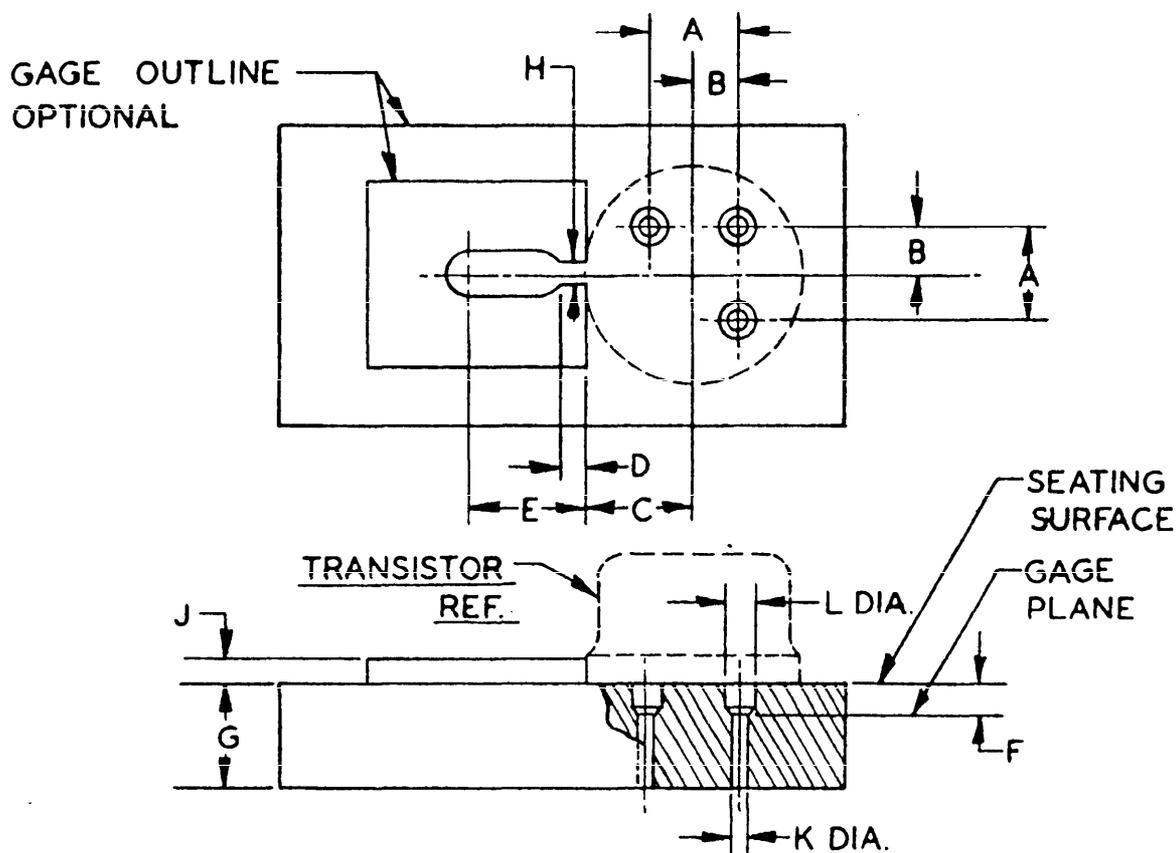


LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.290	.370	7.37	9.40	
B	.275	.335	6.99	8.51	
C	.200	.260	5.08	6.60	
D	1.500	1.750	38.10	44.45	9
E	.016	.021	.41	.53	2,9
F	.016	.019	.41	.48	3,9
G	.100	---	2.54	---	4
H	---	---	---	---	5
J	.029	.045	.74	1.14	8,10
K	.028	.034	.71	.86	10
L	.009	.125	.23	3.18	10
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 Dim 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 max dia leads shall be within .007 (.18 mm) of their true location relative to a maximum width tab. Smaller dia leads shall fall within the outline of the max dia lead tolerance. Figure 2 shows the preferred measured method.
7. All leads shall be insulated from the case.
8. Measured from the maximum diameter of the actual device.
9. All 3 leads.
- \* 10. Tab optional.

FIGURE 1. Physical dimensions of transistor type 2N1500 (TO-9).



LTR	DIMENSIONS		DIMENSIONS	
	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  $.125 \pm .010$  (3.18  $\pm$  .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  $\pm$  .5 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 type 2N1500.

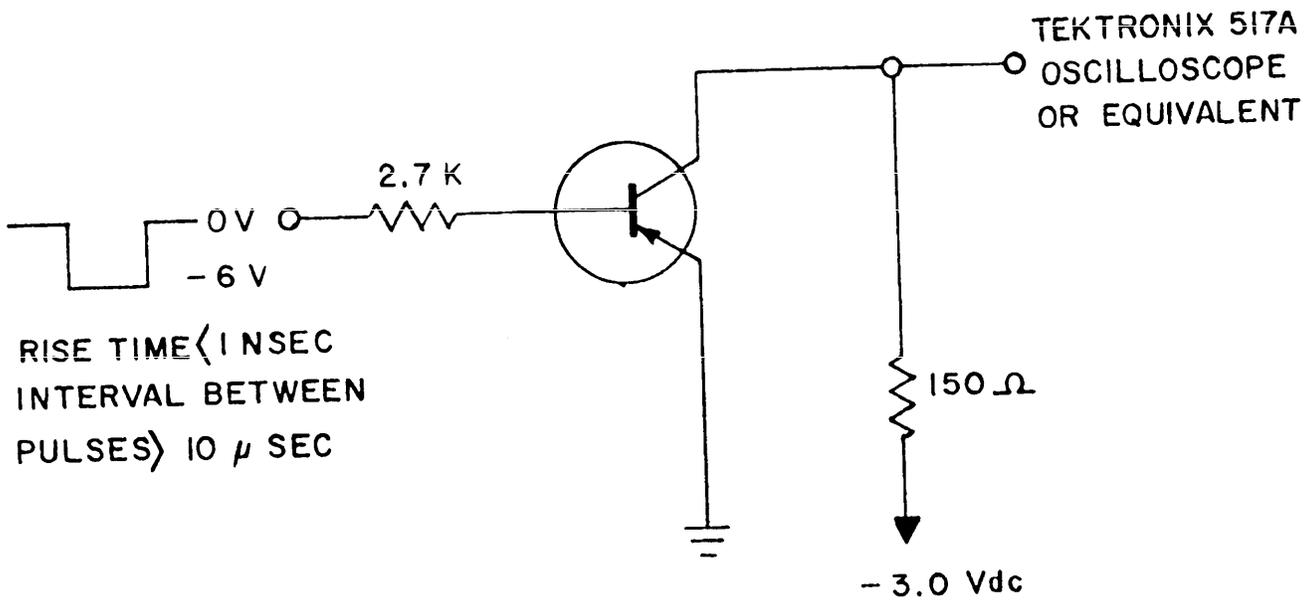


FIGURE 3. Pulse rise-time test circuit.

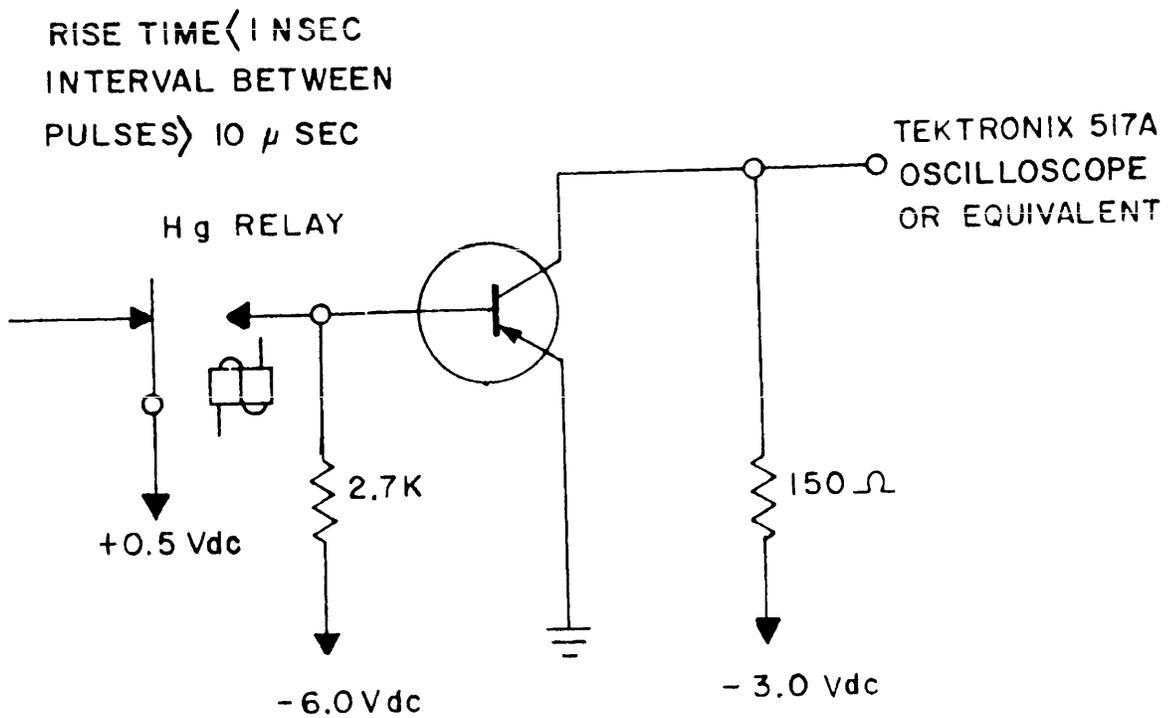


FIGURE 4. Pulse storage and fall-time test circuit.

TABLE I. Group A inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u>			10				
Visual and mechanical examination	2071			---	---	---	---
<u>Subgroup 2</u>			5				
Breakdown voltage, collector to emitter	3011	Bias cond. C; $I_C = -10 \mu\text{A dc}$		$BV_{CES}$	-12	---	Vdc
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -5 \text{ Vdc}$		$I_{CBO}$	---	-2.5	$\mu\text{A dc}$
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		$I_{CBO}$	---	-10	$\mu\text{A dc}$
Emitter to base cutoff current	3061	Bias cond. D; $V_{EB} = -2 \text{ Vdc}$		$I_{EBO}$	---	-100	$\mu\text{A dc}$
<u>Subgroup 3</u>			5				
Forward-current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc}$ ; $I_C = -10 \text{ mA dc}$		$h_{FE}$	20	---	---
Forward-current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc}$ ; $I_C = -50 \text{ mA dc}$		$h_{FE}$	20	---	---
Collector to emitter voltage (saturated)	3071	$I_C = -50 \text{ mA dc}$ ; $I_B = -5 \text{ mA dc}$		$V_{CE(sat)}$	---	-0.20	Vdc
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mA dc}$ ; $I_B = -1 \text{ mA dc}$		$V_{CE(sat)}$	---	-0.15	Vdc
* Base emitter voltage (saturated)	3066	Test cond. A; $I_C = -10 \text{ mA dc}$ ; $I_B = -1 \text{ mA dc}$		$V_{BE(sat)}$	---	-0.40	Vdc
<u>Subgroup 4</u>			10				
Small-signal short-circuit forward-current transfer ratio	3306	$V_{CE} = -0.5 \text{ Vdc}$ ; $I_E = -2 \text{ mA dc}$ ; $f = 20 \text{ MHz}$		$h_{fe}$	5	---	---
* Open-circuit output capacitance	3236	$V_{CB} = -3 \text{ Vdc}$ ; $I_E = 0$ ; $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$		$C_{obo}$	---	3	pf
Rise time	---	See figure 3		$t_r$	---	18	nsec
Storage time	---	See figure 4		$t_s$	---	12	nsec
Fall time	---	See figure 4		$t_f$	---	10	nsec
<u>Subgroup 5</u>			10				
High-temperature operation:	---	$T_A = +55^\circ \text{ C}$		---	---	---	---
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -5 \text{ Vdc}$		$I_{CBO}$	---	-20	$\mu\text{A dc}$
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mA dc}$ ; $I_B = -1.0 \text{ mA dc}$		$V_{CE(sat)}$	---	-0.18	Vdc

TABLE I. Group A inspection - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 5 - Continued</u>							
Low-temperature operation:	---	$T_A = -40^\circ \text{C}$		---	---	---	---
Forward-current transfer ratio	3076	$V_{CE} = -0.5 \text{ Vdc};$ $I_C = -50 \text{ mAdc}$		$h_{FE}$	14	---	---

TABLE II. Group B inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u>							
* Physical dimensions	2066	See figure 1	10	---	---	---	---
<u>Subgroup 2</u>							
Solderability	2026	Omit aging	15	---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. B; $T = +100^\circ \text{C}$		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Seal (leak-rate)	---	Method 112, MIL-STD-202, test cond. C, procedure III; test cond. B for gross leaks		---	---	$5 \times 10^{-7}$	atm cc/sec
Moisture resistance	1021			---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D; $V_{CB} = -15 \text{ Vdc}$		$I_{CBO}$	---	-10	$\mu\text{Adc}$
Collector to emitter voltage (saturated)	3071	$I_C = -10 \text{ mAdc};$ $I_B = -1 \text{ mAdc}$		$V_{CE}(\text{sat})$	---	-0.15	Vdc
* Base emitter voltage (saturated)	3066	Test cond. A; $I_C = -10 \text{ mAdc};$ $I_B = -1 \text{ mAdc}$		$V_{BE}(\text{sat})$	---	-0.40	Vdc
<u>Subgroup 3</u>							
Shock	2016	Nonoperating; 500 G; 1.0 msec; 5 blows in each orientation: $X_1, Y_1, Y_2$ and $Z_1$	15	---	---	---	---
Vibration fatigue	2046	Nonoperating		---	---	---	---
Vibration, variable frequency	2056			---	---	---	---

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 3 - Continued</u>							
Constant acceleration	2006	20,000 G; in each orientation: X <sub>1</sub> , Y <sub>1</sub> , Y <sub>2</sub> , and Z <sub>1</sub>		---	---	---	---
End points: (Same as subgroup 2)							
<u>Subgroup 4</u>							
Terminal strength (lead fatigue)	2036	Test cond. E	15	---	---	---	---
<u>Subgroup 5</u>							
Salt atmosphere (corrosion)	1041			---	---	---	---
End points: (Same as subgroup 2)							
* <u>Subgroup 6</u>							
High-temperature life (nonoperating)	1031	T <sub>stg</sub> = 100° C; time = 340 hours		---	---	---	---
End points:							
Collector to base cutoff current	3036	Bias cond. D; V <sub>CB</sub> = -15 Vdc		I <sub>CBO</sub>	---	-20	μAdc
Collector to emitter voltage (saturated)	3071	I <sub>C</sub> = -10 mAdc; I <sub>B</sub> = -1.0 mAdc		V <sub>CE(sat)</sub>	---	-0.18	Vdc
* Base emitter voltage (saturated)	3066	Test cond. A; I <sub>C</sub> = -10 mAdc; I <sub>B</sub> = -1.0 mAdc		V <sub>BE(sat)</sub>	---	-0.45	Vdc
* <u>Subgroup 7</u>							
Steady state operation life	1026	P <sub>T</sub> = 60 mW; V <sub>CB</sub> = -6 Vdc; time = 340 hours		---	---	---	---
End points: (Same as subgroup 6)							

TABLE III. Group C inspection

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
* <u>Subgroup 1</u>							
High-temperature life (nonoperating)	1031	T <sub>stg</sub> = 100° C	λ = 5	---	---	---	---

TABLE III. Group C inspection - Continued

Examination or test	MIL-STD-750		L T P D	Symbol	Limits		
	Method	Details			Min	Max	Unit
<u>Subgroup 1</u> - Continued							
End points							
Collector to base cutoff current	3006	Bias cond. D, V <sub>CB</sub> = -15 Vdc		I <sub>CBO</sub>	---	-20	μA <sub>dc</sub>
Collector to emitter voltage (saturated)	3001	I <sub>C</sub> = -10 mA <sub>dc</sub> ; I <sub>B</sub> = -1.0 mA <sub>dc</sub>		V <sub>CE(sat)</sub>	---	-0.18	V <sub>dc</sub>
* Base emitter voltage (saturated)	3006	Test cond. A; I <sub>C</sub> = -10 mA <sub>dc</sub> ; I <sub>B</sub> = -1.0 mA <sub>dc</sub>		V <sub>BE(sat)</sub>	---	-0.45	V <sub>dc</sub>
* <u>Subgroup 2</u>							
Steady state operation life	1006	P <sub>T</sub> = 60 mW; V <sub>CB</sub> = -6 Vdc	λ = 10	---	---	---	---
End points: (Same as subgroup 1)							

## 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 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.

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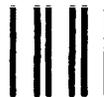
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