MIL-S-19500/77C
6 March 1968
SUPERSEDING
MIL-T-19500/77B
5 July 1961
(See 6.3.)

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM, LOW-POWER
TYPE 2N393

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 low-power, PNP, germanium, transistor.

* 1.2 Physical dimensions. See figure 1.

* 1.3 Maximum ratings.

P_T 1/ T_A = 25° C	I_C	V_{CBO}	V_{EBO}	V_{CEO}	T_{stg}	T_J
mW	mAdc	Vdc	Vdc	Vdc	°C	°C
35	-50	-10	-10	-6.0	-65 to +100	+100

1/ Derate linearly 0.46 mW/°C for $T_A > 25°$ C.

* 1.4 Primary electrical characteristics.

Limits	h_{FE} V_{CE} = -0.5 Vdc I_C = -50 mAdc 1/	h_{fe} V_{CE} = -3.0 Vdc I_C = -0.5 mAdc f = 10 MHz	V_{CE}(sat) I_C = -8.0 mAdc I_B = -1.0 mAdc	C_{obo} V_{CB} = -3.0 Vdc I_E = 0 f = 1 MHz
			Vdc	pf
Min	20	3	---	---
Max	150	18	-0.07	4

1/ Pulsed (see 4.4.1).

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:

K'_s - - - - - Hole-storage constant

$r_b'C_c$ - - - Collector-base time constant

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

* 3.3.1 Terminal-lead length. Terminal-lead length(s) other than that specified in figure 1 may be furnished under contract or order (see 6.2) where the devices covered herein are required directly for particular equipment-circuit installation or for automatic-assembly-technique programs. 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.

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.

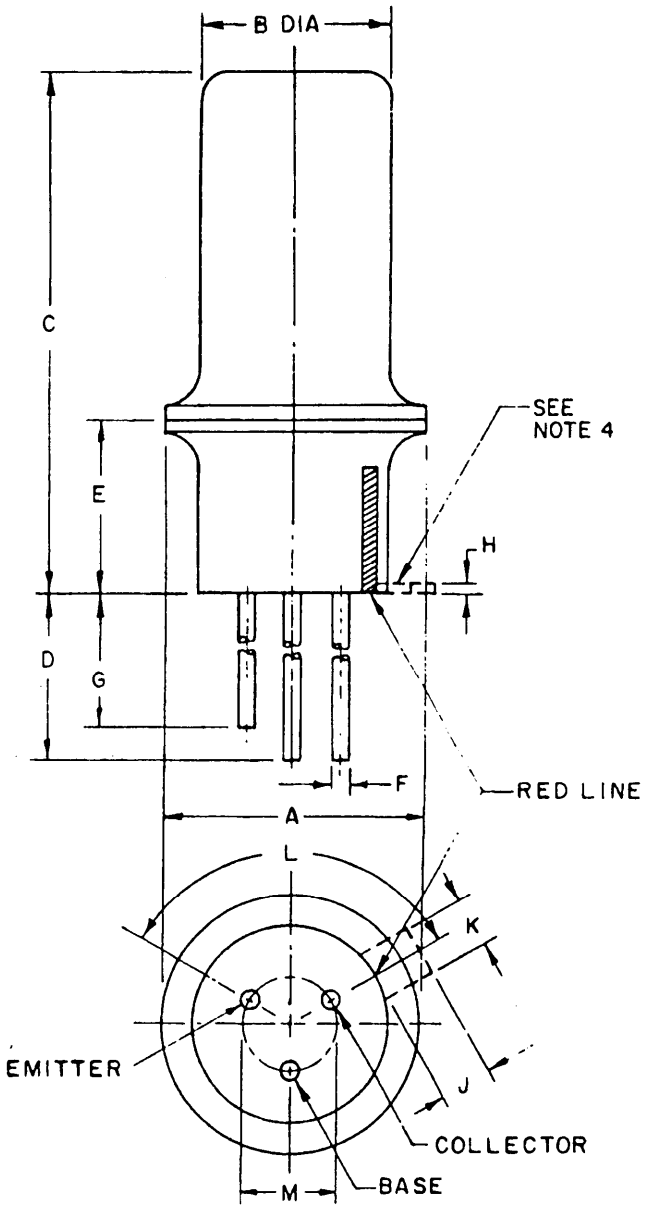
4.2 Qualification inspection. Qualification inspection shall consist of the examinations and tests specified in tables I, II, and III.

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.



LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.195	.230	4.95	5.84	
B	.155	.180	3.94	4.57	
C	.375	.475	9.53	12.07	
D	1.500	1.750	38.10	44.45	
E	---	.160	---	4.06	2
F	.016	.019	.41	.48	3,5
G	1.450	1.638	36.83	41.61	4
H	.007	.025	.18	.64	4
J	.028	.048	.71	1.22	4
K	.028	.042	.71	1.07	4
L	120° Nom				
M	.070 Nom		1.78 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. Flange position not controlled within this range.
3. All leads electrically isolated from case.
4. Tab optional. When tab is included, the red line indicator is not applicable and the lead lengths may be of equal length. (Per D dimensions).
5. All three leads.

* FIGURE 1. Physical dimensions of transistor type 2N393.

* 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 Time limit for end point test measurements. 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		Limits		
	Method	Details		Symbol	Min	Max	Unit
Subgroup 1			10				
Visual and mechanical examination	2071			---	---	---	---
* Subgroup 2			7				
Breakdown voltage, collector to base	3001	Bias cond. D; I_C = -100 μAdc		BV_{CBO}	-10	---	Vdc
Breakdown voltage, collector to emitter	3011	Bias cond. D; I_C = -1.0 mAdc		BV_{CEO}	-6	---	Vdc
Breakdown voltage, emitter to base	3026	Bias cond. D; I_C = -100 μAdc		BV_{EBO}	-10	---	Vdc
Collector to base cutoff current	3036	Bias cond. D; V_{CB} = -6.0 Vdc		I_{CBO}	---	-5.0	μAdc
Emitter to base cutoff current	3061	Bias cond. D; V_{EB} = -6.0 Vdc		I_{EBO}	---	-5.0	μAdc
* Subgroup 3			7				
Forward-current transfer ratio	3076	V_{CE} = -0.5 Vdc; I_C = -50 mAdc; pulsed (see 4.4.1)		h_{FE}	20	150	---
Collector to emitter voltage (saturated)	3071	I_C = -8.0 mAdc; I_B = -1.0 mAdc		$V_{CE}(sat)$	---	-0.07	Vdc
Base emitter voltage (nonsaturated)	3066	Test cond. B; I_C = -8.0 mAdc; I_B = -1.0 mAdc		V_{BE}	---	-0.50	Vdc

TABLE I. Group A inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		
	Method	Details			Min	Max	Unit
* Subgroup 4			10				
Small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = -3.0 Vdc; I_C = -0.5 mAdc; f = 10 MHz		h_{fe}	3	18	---
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = -3.0 Vdc; I_C = -0.5 mAdc		h_{fe}	40	250	---
Open circuit output capacitance	3236	V_{CB} = -3.0 Vdc; I_E = 0; f = 1 MHz		C_{obo}	---	4	pf
* Subgroup 5			15				
Reach through voltage	---	V_{EB} = -1 Vdc		V_{RT}	-6	---	Vdc
Hole-storage factor	---	I_B = -1 mAdc (see figure 2)		K'_s	---	100	nsec
Collector-base time constant	---	V_{CB} = -3.0 Vdc; I_E = -0.5 mAdc; f = 10 MHz (see figure 3)		$r_b'C_c$	250	750	psec
* Subgroup 6			15				
High-temperature operation:		T_A = +55° C					
Collector to base cutoff current	3036	Bias cond. D; V_{CB} = -6.0 Vdc		I_{CBO}	---	-35	μAdc
Low-temperature operation:		T_A = -55° C					
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = -0.5 Vdc; I_C = -50 mAdc; pulsed (see 4.4.1)		h_{fe}	10	---	---

TABLE II. Group B inspection

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		
	Method	Details			Min	Max	Unit
* Subgroup 1			20				
Physical dimensions	2066	(See figure 1)		---	---	---	---
* Subgroup 2			15				
Solderability	2026			---	---	---	---
Thermal shock (temperature cycling)	1051	Test cond. B except T = +100° C		---	---	---	---
Thermal shock (glass strain)	1056	Test cond. A		---	---	---	---
Seal (leak-rate)	---	MIL-STD-202, method 112, test cond. C, procedure III; test cond. B for gross leaks		---	---	$1x10^{-7}$	atm cc/sec

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		
	Method	Details			Min	Max	Unit
Subgroup 2 - Continued							
Moisture resistance	1021			---	---	---	---
End points: (See 4.4.2.)							
Collector to base cutoff current	3036	Bias cond. D; V_{CB} = -6.0 Vdc		I_{CBO}	---	-5.0	μAdc
Collector to emitter voltage (saturated)	3071	I_C = -8.0 mAdc I_B = -1.0 mAdc		V_{CE}(sat)	---	-0.07	Vdc
Forward-current transfer ratio	3076	V_{CE} = -0.5 Vdc; I_C = -50 mAdc; pulsed (see 4.4.1)		h_{FE}	20	150	---
Subgroup 3			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; 10 G		---	---	---	---
Vibration, variable frequency	2056	10 G		---	---	---	---
Constant acceleration	2006	10, 00 G; in each orientation: X_1, Y_1, Y_2 and Z_1		---	---	---	---
End points:							
(Same as subgroup 2)							
* Subgroup 4			15				
Terminal strength (lead fatigue)	2036	Test cond. E		---	---	---	---
Subgroup 5			15				
Salt atmosphere (corrosion)	1041			---	---	---	---
End points:							
(Same as subgroup 2)							
* Subgroup 6			5				
High-temperature life (nonoperating)	1031	T_{stg} = 100° C; t = 340 hours (see 4.3.4)		---	---	---	---
End points: (See 4.4.2.)							
Collector to base cutoff current	3036	Bias cond. D; V_{CB} = -6.0 Vdc		I_{CBO}	---	-10	μAdc
Forward-current transfer ratio	3076	V_{CE} = -0.5 Vdc; I_C = -50 mAdc; pulsed (see 4.4.1)		h_{FE}	15	185	---

TABLE II. Group B inspection - Continued

Examination or test	MIL-STD-750		LTPD	Symbol	Limits		
	Method	Details			Min	Max	Unit
* Subgroup 7			7				
Steady-state operation life	1026	T_A = 25° C; P_T = 35 mW; V_{CB} = -2.5 Vdc; t = 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		
	Method	Details			Min	Max	Unit
* Subgroup 1			λ = 7				
High-temperature life (nonoperating)	1031	T_{stg} = +100° C (see 4.3.4)		---	---	---	---
End points: (See 4.4.2.)							
Collector to base cutoff current	3036	Bias cond. D; V_{CB} = -6.0 Vdc		I_{CBO}	---	-10	μAdc
Forward-current transfer ratio	3076	V_{CE} = -0.5 Vdc; I_C = -50 mAdc; pulsed (see 4.4.1)		h_{FE}	15	185	---
* Subgroup 2							
Steady-state operation life	1026	T_A = 25° C; P_T = 35 mW; V_{CB} = -2.5 Vdc (see 4.3.4)	λ = 10	---	---	---	---
End points:							
(Same as subgroup 1)							

5. PREPARATION FOR DELIVERY

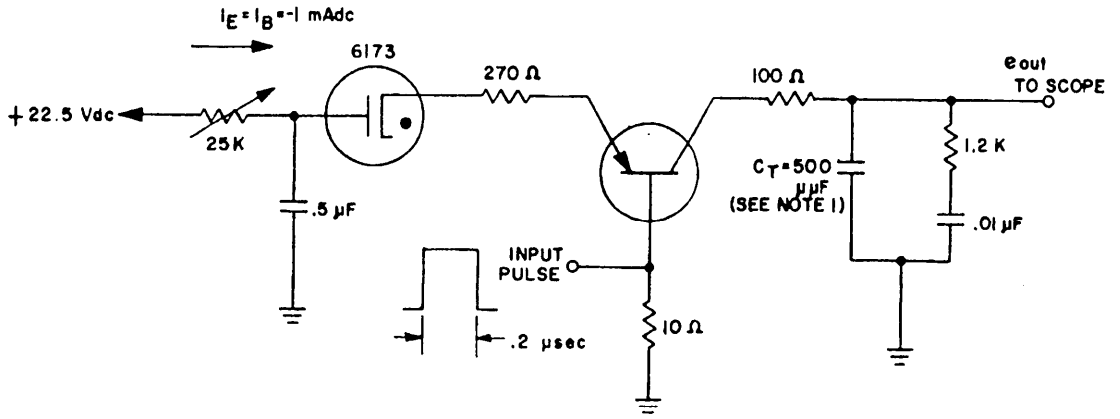
5.1 See MIL-S-19500, section 5.

6. NOTES

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

6.2 Ordering data.

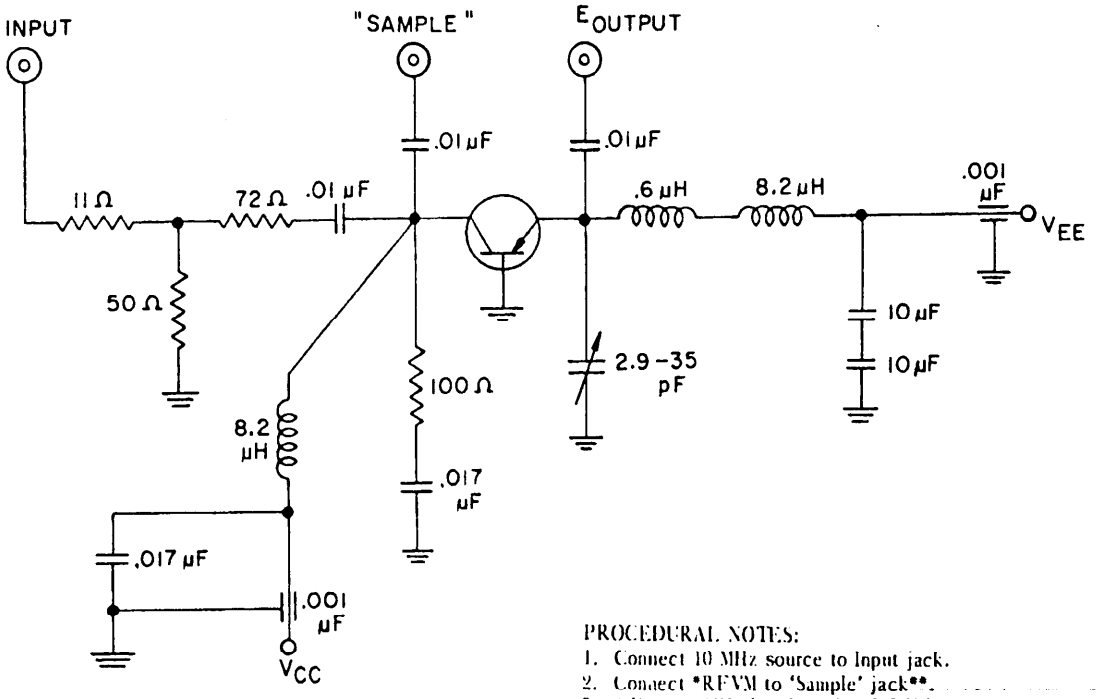
(a) Terminal-lead length if other than specified in figure 1 (see 3.3.1).
(b) Inspection data (see 4.3).



NOTES:

1. C_T includes probe or scope capacitance. This value should be measured with the differentiating network disconnected.
2. $K's = \frac{C_T}{I_E} \frac{e\ out}{I} = 500\ \frac{e\ out}{mAdc}$ microcoulombs (these units are the equivalent of musec).
3. An equivalent circuit may be used.

FIGURE 2. Typical circuit for K's test.



PROCEDURAL NOTES:

1. Connect 10 MHz source to Input jack.
2. Connect *RFVM to 'Sample' jack**.
3. Adjust 10 MHz level so that 1.6 V is read on RFVM.
4. Connect RFVM to Output jack; peak the emitter tuning-capacitor on fixture.
5. Return RFVM to 'Sample' jack.
6. Insert transistor into socket, apply bias, and set 10 MHz level for a 1.59 V reading on RFVM.
7. Connect RFVM to 'Output' jack. $r_{b'}C_c$ is read with 1 mV = 10 psec, 3 mV = 30 psec, etc, (the 1.59 Vin should be checked regularly during successive test measurements).

*RFVM = Boonton type 91CA or equiv; (high impedance); unterminated probe, Boonton type 91-6C adapter or equiv, to be used.

**Adapter BNC UG-491A/U, or equiv, to be used for connections to Input, 'Sample', and Output jacks.

FIGURE 3. $r_{b'}C_c$ test circuit.

6.3 Interchangeability criteria. The device covered herein is interchangeable with the device covered by the superseded MIL-S-19500/77B.

6.4 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

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

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

Preparing activity:
Army - EL

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