

8 May 1969

SUPERSEDING

MIL-S-19500/170(SigC)

15 February 1961

## MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, GERMANIUM  
TYPE 2N1499A

## 1. SCOPE

1.1 Scope.- This specification covers the detail requirements for germanium, PNP, transistors for use particularly as high-speed switching devices in compatible electronic-equipment circuits.

1.2 Outline and dimensions.- See Figure 1A and 1B, and 3.3.1 herein.

1.3 Maximum ratings.-

$P_T$ <sup>1/</sup>	$V_{CBO}$	$V_{EBO}$	$V_{CES}$	$I_C$	$T_J$	$T_{stg}$
$\frac{mW}{60}$	$\frac{Vdc}{-20}$	$\frac{Vdc}{-2}$	$\frac{Vdc}{-20}$	$\frac{mAadc}{-100}$	$\frac{^{\circ}C}{+100}$	$\frac{^{\circ}C}{-65 \text{ to } +100}$

<sup>1/</sup> For  $T_A > +25^{\circ}C$ , derate linearly at 0.8 mW/ $^{\circ}C$ .

1.4 Particular electrical characteristics.- (At  $T_A = +25^{\circ}C$ , unless otherwise specified):

	$h_{FE}$ at: $V_{CE} = -0.3 Vdc$ $I_C = -10 mAadc$	$ h_{fe} $ at: $V_{CE} = -3 Vdc$ $I_C = -5 mAadc$	$V_{BE}$ at: $I_C = -10 mAadc$ $I_B = -1 mAadc$	$V_{CE(sat)}$ at: $I_C = -10 mAadc$ $I_B = -1 mAadc$	$C_{obo}$ at: $f = 1/$ $I_E = 0$ $V_{CB} = -6Vdc$	$t_r$ (See Fig. 3 herein)
	---	---	$Vdc$	$Vdc$	pf	nsec
Min	30	1	-0.25	---	---	---
Max	300	4	-0.40	-0.20	3	60

<sup>1/</sup>  $0.1 \text{ MHz} \leq f \leq 1.0 \text{ MHz}$ .

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 this specification to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-S-19500 Semiconductor Devices, General Specification For

STANDARDS

MILITARY

MIL-STD-750 Test Methods For Semiconductor Devices

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Both the title and number or symbol should be stipulated when requesting copies.)

3. REQUIREMENTS

3.1 Requirements.- Requirements for the transistors shall be in accordance with Specification MIL-S-19500, and as otherwise specified herein.

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

$K'_s$  . . . . . hole storage constant

3.3 Design and construction.- The transistor shall be of the design, construction, and physical dimensions specified on Figure 1A or 1B herein.

3.3.1 Terminal arrangement.- The terminal arrangement on the transistor shall be as indicated in Figure 1A or 1B for the applicable transistor design.

3.3.2 Terminal-lead length.- Terminal-lead length(s) other than that specified in Figure 1A or 1B may be furnished when specified in the contract or order (see 6.2 herein) where the devices covered herein are required directly for particular equipment-circuit installation. Where such other lead lengths are required and provided, it shall not be construed as affecting adversely the Qualified-product status of the device, or applicable "JAN" marking.

3.3.3 Operating position. - The transistor shall be capable of proper operation in any position.

3.4 Performance characteristics. - The transistor performance characteristics shall be as specified in Tables I, II, and III herein.

3.5 Marking. - Except as otherwise specified herein, marking shall be in accordance with Specification MIL-S-19500. The "manufacturer's identification" may, at option of the manufacturer, be omitted from being marked directly on the semiconductor device covered herein.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 General. - Except as otherwise specified herein, the responsibility for inspection, general procedures for acceptance, classification of inspection, and inspection conditions and methods of test shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions.

4.2 Qualification and Quality Conformance Inspection. - Qualification and Quality Conformance inspection shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions, and as otherwise specified herein, Groups A, B, and C inspection shall consist of the examinations and tests specified in Tables I, II and III, respectively, herein. Quality Conformance inspection shall include inspection of Preparation for Delivery (see 5.1 herein).

4.2.1 Special Group A criteria for Qualification inspection. - For Qualification inspection, only 10 failures will be permitted for all Group A tests combined. Hereto, where the manufacturer deems that the data in paragraph 4.4.2 of Specification MIL-S-19500 are invokable, notification shall be made to the Chief, Components and Material Standardization Branch, Procurement and Production Directorate, Fort Monmouth, New Jersey 07703, Attention: AMSEL-PP-EM-2.

4.2.2 Group B-Group C life test samples. - Samples that have been subjected to Group B, 340-hour life test may be continued on test for 1000 hours in order to satisfy Group C life test requirements. These samples shall be predesignated, and shall remain subjected to the Group C 1000-hour 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 1000 hours on these samples shall be computed for 1000-hour acceptance criteria.

4.2.3 Group C testing. - Group C tests shall be performed on a lot every 6 months. (See Table III herein.) 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.

4.2.4 Disposition of sample units.- Sample units that have been subjected to Group B, Subgroup 2, 4 and 5 tests shall not be delivered on the contract or order. Sample units that have been subjected to and have passed Group B, Subgroups 1, 3, 6, 7 and 8 tests and Group C, Subgroup 1 and 2 tests, (these tests to be considered non-destructive), may be delivered on the contract or order provided that, after Group B and Group C inspection is terminated, those sample units are subjected to and pass Group A inspection. Defective units from any sample group that may have passed group inspection shall not be delivered on the contract or order until the defect(s) has been remedied to the satisfaction of the Government.

4.3 Particular examination and test requirements.-

4.3.1 "Pulsed" - conditions measurements.- Measurements required herein to be effected under pulsed conditions, shall be made in accordance with "Pulse Measurements" requirements in Section 4 of Standard MIL-STD-750.

4.3.2 Mechanical damage resulting from tests.- Except for intentionally deforming, mutilating, or dismembering mechanical-stress tests to which samples are subjected, there shall be no evidence of mechanical damage to any sample unit as a result of any of the Group A, B, or C tests.

4.3.3 Seal (leak-rate) test.- The transistors shall be subjected to hermetic-seal test(s) in accordance with requirements of Method 1071 in Standard MIL-STD-750 except that the following test conditions therein shall apply hereto.

- a. Fine-leak test: per Test Condition G or H. Where Condition H is employed, a maximum leakage rate of  $1 \times 10^{-7}$  atm/cc/sec shall be effective for acceptance.
- b. Gross-leak test: per Test Condition A, C, D, or F.

Table 1. Group A inspection.

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
	<u>Subgroup 1</u>		10				
2071	Visual and mechanical examination	---		---	---	---	---
	<u>Subgroup 2</u>		7				
3001	Collector-to-base breakdown voltage	Bias Cond.D $I_C = -100 \mu\text{A dc}$		$BV_{VBO}$	-20	---	Vdc
3026	Emitter-to-base breakdown voltage	Bias Cond.D $I_C = -100 \mu\text{A dc}$		$BV_{EBO}$	-2	---	Vdc
3036	Collector-to-base cutoff current	Bias Cond.D $V_{CB} = -5 \text{ Vdc}$		$I_{CBO}$	---	-3	$\mu\text{A dc}$
3036	Collector-to-base cutoff current	Bias Cond.D $V_{CB} = -15 \text{ Vdc}$		$I_{CBO}$	---	-10	$\mu\text{A dc}$
3041	Collector-to-emitter cutoff current	Bias Cond.C $V_{CE} = -20 \text{ Vdc}$ $V_{BE} = 0$		$I_{CES}$	---	-10	$\mu\text{A dc}$
	<u>Subgroup 3</u>		7				
3076	Forward-current transfer ratio	$V_{CE} = -0.3 \text{ Vdc}$ $I_C = -10 \text{ mA dc}$		$h_{FE}$	30	300	---
3076	Forward-current transfer ratio	$V_{CE} = -0.5 \text{ Vdc}$ $I_C = -40 \text{ mA dc}$ Pulsed; $1/$		$h_{FE}$	20	250	---
3071	Collector-to-emitter saturation voltage	$I_C = -10 \text{ mA dc}$ $I_B = -1 \text{ mA dc}$		$V_{CE(sat)}$	---	-0.20	Vdc
3071	Collector-to-emitter saturation voltage	$I_C = -10 \text{ mA dc}$ $I_B = -0.5 \text{ mA dc}$		$V_{CE(sat)}$	---	-0.25	Vdc

Table I. Group A inspection.-(Cont'd).

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
<u>Subgroup 3-(Cont'd)</u>							
3066	Base-to-emitter voltage(non-sat.)	$I_C = -10 \text{ mA dc}$ $I_B = -1 \text{ mA dc}$		$V_{BE}$	-0.25	-0.40	Vdc
3066	Base-to-emitter voltage(non-sat.)	$I_C = -10 \text{ mA dc}$ $I_B = -0.5 \text{ mA dc}$		$V_{BE}$	---	0.34	Vdc
<u>Subgroup 4</u>							
			10				
3306	Magnitude of small- signal short-circuit forward-current transfer ratio	$V_{CE} = -3 \text{ Vdc}$ $I_C = -5 \text{ mA dc}$ $f = 100 \text{ MHz}$		$ h_{fe} $	1	4	---
---	Hole storage factor	Test circuit and procedural formula per Fig.2 herein.		$K'_s$	---	120	nsec
3236	Output capacitance	$V_{CB} = -6 \text{ Vdc}$ $I_E = 0$ $0.1 \text{ MHz} \leq f \leq 1.0 \text{ MHz}$		$C_{obo}$	---	3	pf
---	Rise time (Pulse response)	See Fig. 3		$t_r$	---	60	nsec

<sup>1/</sup>  
See 4.3.1 herein.

Table II. Group B Inspection.

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD Symbol	Limits		Unit
				Min	Max	
	<u>Subgroup 1</u>		10			
2066	Physical dimensions	See Fig.1	---	---	---	---
	<u>Subgroup 2</u>		15			
2026	Solderability	---	---	---	---	---
1051	Temperature cycling	Test Cond.B except $T_{(high)} = +100^{\circ}\text{C}$	---	---	---	---
1056	Thermal shock (glass strain)	Test Cond.A	---	---	---	---
<u>1/</u>	Seal (leak rate)	---	---	---	---	---
1021	Moisture resistance	---	---	---	---	---
	<u>End-Point tests:</u>					
3036	Collector-to-base cutoff current	Bias Cond.D $V_{CE} = -15 \text{ Vdc}$	$I_{CBO}$	---	-10	$\mu\text{A dc}$
3071	Collector-to-emitter saturation voltage	$I_C = -10 \text{ mA dc}$ $I_B = -1 \text{ mA dc}$	$V_{CE(sat)}$	---	-0.20	$\text{V dc}$
3076	Forward current transfer ratio	$V_{CE} = -0.3 \text{ V dc}$ $I_C = -10 \text{ mA dc}$	$h_{FE}$	30	300	---

Table II.- Group B Inspection-(Cont'd).

Test Method per MIL-STD-750	Examination or Test	Conditions	LTPD Symbol	Limits		Unit
				Min	Max	
	<u>Subgroup 3</u>		15			
2016	Shock	Non-operating 1500 G 5 blows of 0.5 msec ea. in ea. orientation X1, Y1, Y2, Z1 (total=20 blows)	---	---	---	---
2056	Vibration, variable frequency	10 G	---	---	---	---
2006	Constant acceleration (centrifugal)	20,000G Orientations X1, Y1, Y2, Z1	---	---	---	---
	<u>End-point tests:</u> Same as for Subgroup 2 above					
	<u>Subgroup 4</u>		15			
2036	Terminal strength: Lead fatigue	2/ Test Cond.E	---	---	---	---
	<u>Subgroup 5</u>		20			
1041	Salt-atmosphere corrosion	2/	---	---	---	---

Table II.- Group B inspection-(Cont'd).

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD Symbol	Limits		Unit
				Min	Max	
	<u>Subgroup 6</u>		15			
<u>3/</u>	High-temperature operation:	$T_A = +55^\circ\text{C}$ <u>4/</u>	---	---	---	---
3036	Collector-to-base cutoff current	Bias Cond.D $V_{CB} = -5 \text{ Vdc}$	$I_{CBO}$	---	-18	$\mu\text{Adc}$
---	Low-temperature operation:	$T_A = -55^\circ\text{C}$ <u>4/</u>	---	---	---	---
3076	Forward-current transfer ratio	$V_{CE} = -0.3 \text{ Vdc}$ $I_C = -10 \text{ mAdc}$	$h_{FE}$	16	---	---
	<u>Subgroup 7</u>		7			
1032	High-temperature life (non-operating)	$T_{stg} = +100^\circ\text{C}$ $t = 340 \text{ hrs.}$ <u>5/</u>	---	---	---	---
	<u>End-point tests:</u>					
3036	Collector-to-base cutoff current	Bias Cond.D $V_{CE} = -15 \text{ Vdc}$	$I_{CBO}$	---	-20	$\mu\text{Adc}$
3076	Forward-current transfer ratio	$V_{CE} = -0.3 \text{ Vdc}$ $I_C = -10 \text{ mAdc}$	$h_{FE}$	25	330	---

Table II. Group B Inspection.-(Cont'd).

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD Symbol	Limits		Unit
				Min	Max	
	<u>Subgroup 8</u>		7			
1027	Steady-state operation life	$V_{CB} = -6 \text{ Vdc}$ $P_T = 60 \text{ mW}$ $t = 340 \text{ hrs}$ <u>5/</u>	---	---	---	---
	<u>End-Point tests:</u> Same as for Subgroup 7 above					

1/ See 4.3.3 herein.

2/ Electrical rejects from the same lot under evaluation may be used for this test.

3/ In this Subgroup, the sample units subjected to the High-Temperature Operation test shall be permitted to return to and be stabilized at room ambient temperature prior to their being subjected to the Low-Temperature Operation test.

4/ Measurement(s) shall be made after thermal equilibrium has been reached at the temperature specified.

5/ See 4.2.2 herein.

Table III. Group C inspection.<sup>1/</sup>

Test Method per MIL-STD-750	Examination or test	Conditions	LTPD Symbol	Limits		Unit
				Min	Max	
	<u>Subgroup 1</u>		$\lambda=10$			
1031	High-temperature life (non-operating)	$T_{ctg} = +100^{\circ}\text{C}$ <u>2/</u>	---	---	---	---
	<u>End-point tests:</u>					
3036	Collector-to-base cutoff current	Bias Cond. D $V_{CE} = -15 \text{ Vdc}$	$I_{CBO}$	---	-20	$\mu\text{A dc}$
3076	Forward-current transfer ratio	$V_{CE} = -0.3 \text{ Vdc}$ $I_C = -10 \text{ mA dc}$	$h_{FE}$	25	330	---
	<u>Subgroup 2</u>		$\lambda=10$			
1026	Steady-state operation life	$V_{CB} = -6 \text{ Vdc}$ $P_T = 60 \text{ mW}$ <u>2/</u>	---	---	---	---
	<u>End-Point tests:</u> Same as for Subgroup 1 above					

<sup>1/</sup> See 4.2.3 herein.<sup>2/</sup> See 4.2.2 herein.

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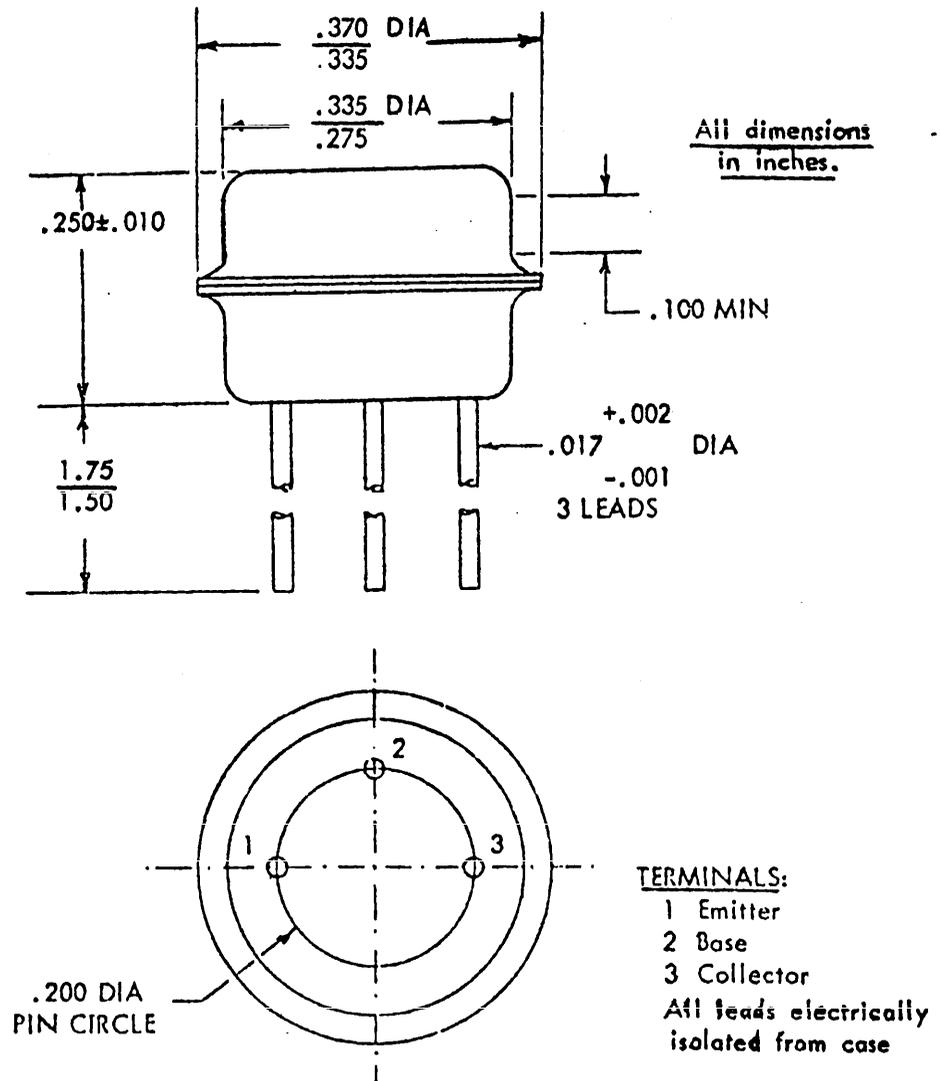
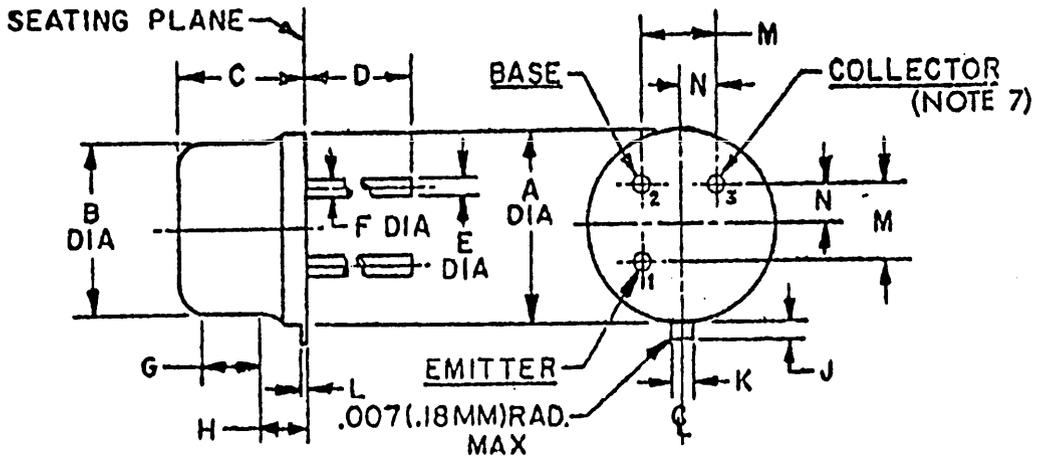


Figure 1A. Outline and dimensions.

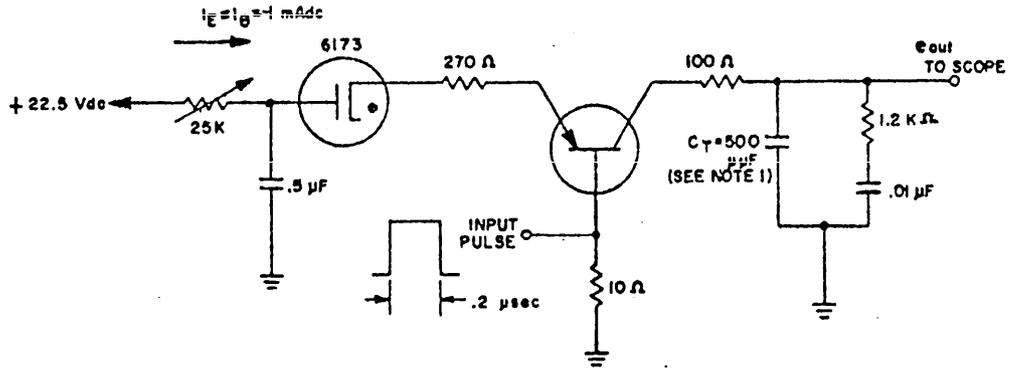


**NOTES:**

1. Metric equivalents (to the nearest .01 mm) are given for general information only and are based upon 1 inch = 25.4mm.
2. Measured in the zone beyond .250 (6.35mm) from the seating plane.
3. Measured in the zone .050 (1.27mm) and .250 (6.35mm) from the seating plane.
4. Variations on Dim.B in this zone shall not exceed .010 (.25mm).
5. Outline in this zone is not controlled.
6. When measured in a gaging plane .054 +.001 (1.37mm +.03mm) below the seating plane of the transistor, max dia leads shall be within .007 (.18mm) of their true location relative to a maximum width tab. Smaller dia leads shall fall within the outline of the max dia lead tolerance.
7. All leads electrically isolated from case.
8. Measured from the maximum diameter of the actual device.
9. All 3 leads.

LTR	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
A	.335	.370	8.51	9.40	
B	.305	.335	7.75	8.51	
C	.240	.260	6.10	6.60	
D	1.500	1.750	38.10	44.45	7,9
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
K	.028	.034	.71	.86	
L	.009	.125	.23	3.18	
M	.1414 Nom		3.59 Nom		6
N	.0707 Nom		1.80 Nom		6

Figure 1B. Outline and dimensions.



**NOTES:**

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

Figure 2. Hole Storage Factor test circuit.

(Type R Tektronix Plug-In Unit, or equal,  
normally constituent in circuit)

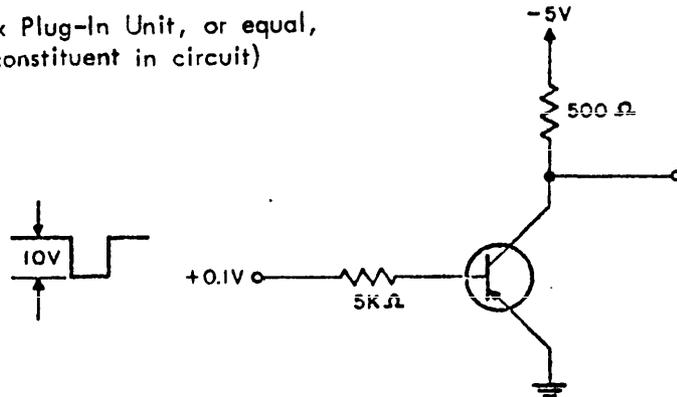


Figure 3. Rise Time test circuit.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery.- Preparation for delivery and the inspection of Preparation For Delivery shall be in accordance with Specification MIL-S-19500.

6. NOTES

6.1 Notes.- The notes included in Specification MIL-S-19500, with the following additions or exceptions, are applicable to this specification.

6.2 Ordering data:

a. Terminal-lead length: See 3.3.2 herein.

6.3 Qualification.- With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List (QPL)-19500, whether or not such products have actually been so listed by that date. Information pertaining to qualification of products covered by this specification should be requested from the Commanding General, US Army Electronics Command, Fort Monmouth, New Jersey 07703, Attention: AMSEL-PP-EM-2.

6.4 Revision (document) changes.- Revision-letter symbols are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodian:  
Army-EL

Preparing activity:  
Army-EL

Project No. 5961-A244