

MILITARY SPECIFICATION

TRANSISTOR, PNP, GERMANIUM
 TYPES 2N499 and 2N499A

1. SCOPE

1.1 Scope.-- This specification covers the detail requirements for germanium, PNP, transistors for particular use in high-frequency, equipment-circuit applications. (See 3.4 and 6.2 herein.)

1.2 Outline and dimensions.-- See Fig.1 herein.

1.3 Maximum ratings.--

	P_T 1/	V_{CBO}	V_{CEO}	V_{EBO}	I_C	T_{stg}
	mW	Vdc	Vdc	Vdc	mA	°C
2N499	50	-30	-18	0.5	-50	-65 to +100
2N499A	60	-30	-18	0.5	-50	-65 to +100

1/

This power dissipation is for 1000 hours expected life at $T_A = +25^\circ\text{C}$. For $T_A > +25^\circ\text{C}$, derate:
 for 2N499, at 0.67 mW/°C
 for 2N499A, at 0.80 mW/°C

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

	h_{fe}	$ h_{fe} $	P_g	$r_b' C_c$	C_{ob}
	at: f=1 KHz $V_{CE} = -9$ Vdc $I_E = 1$ mAdc	at: f=100 MHz $V_{CE} = -10$ Vdc $I_E = 2$ mAdc	at: f=100 MHz $V_{CE} = -10$ Vdc $I_E = 2$ mAdc	at: f=46 MHz $V_{CE} = -10$ Vdc $I_E = 2$ mAdc	at: f=1 MHz $V_{CE} = -10$ Vdc $I_E = 0$
	--- Min Max	--- Min Max	db Min Max	psec Min Max	pf Min Max
2N499	10 250	1.2 6.5	7.5 ---	5 50	--- 2.5
2N499A	20 50	1.2 6.5	7.5 ---	5 50	--- 2.5

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-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 contractors in connection with specific procurement functions should be obtained from the procuring agency 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:

$r_b C_c$ extrinsic base-resistance collector-capacitance product

R_e real part of the small-signal (characteristic) parameter

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

3.3.1 Terminal arrangement.- The terminal arrangement on the transistor shall be as indicated in Figure 1.

3.3.2 Terminal-lead length.- Terminal-lead length(s) other than that specified in Figure 1 may be furnished under contract or order (see 6.3 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. Except where specifically differentiated for respective transistor types (see 1.3, 1.4 and Tables I, II, and III herein), the performance requirements including characteristics, ratings, and test conditions, apply equally to both transistor types covered herein.

3.5 Marking.- Except as otherwise specified herein, marking shall be in accordance with Specification MIL-S-19500. If any specification-requirements waiver has been granted, the product-identification marking shall consist of the "classification" type designation only. The "manufacturer's identification" and "country of origin" 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 Acceptance inspection.- Qualification and Quality Conformance inspection shall be in accordance with Specification MIL-S-19500, Quality Assurance Provisions, and as otherwise specified herein (see 4.2.2 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 Specified LTPD for subgroups.- The LTPD specified for a subgroup in Tables I, II, and III herein shall apply for all of the tests, combined, in the subgroup.

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; hence, 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.- Unless otherwise specified, Group C tests shall be performed on the initial lot and thereafter 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 to Group C, Subgroup 1, 2 and 3 tests, (these tests to be considered non-destructive), may be delivered on the contract or order provided that, after Group B and 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 Interval for End-Point test measurements.- All applicable End-Point Test measurements shall be performed, after sample units have been subjected to required physical-mechanical or environmental test(s), in accordance with the following time-delay limitations:

- (a) For Qualification inspection: within 24 hours.
- (b) For Quality Conformance inspection: within 96 hours.

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.

Table I. Group A inspection.

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
<u>Subgroup 1</u>			10				
2071	Visual and mechanical examination	---		---	---	---	---
<u>Subgroup 2</u>			5				
3036	Collector-base cut-off current	Bias Cond. D $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-10	μAdc
3036	Collector-base cut-off current	Bias Cond. D $V_{CB} = -5 \text{ Vdc}$		I_{CBO}	---	-5	μAdc
3041	Collector-emitter cutoff current	Bias Cond. C $V_{CE} = -30 \text{ Vdc}$		I_{CES}	---	-100	μAdc
3061	Emitter-base cutoff current	Bias Cond. D $V_{EB} = -0.5 \text{ Vdc}$		I_{EBO}	---	-500	μAdc
3011	Collector-emitter breakdown voltage	Bias Cond. D $I_C = -1 \text{ mAdc}$		BV_{CEO}	-18	---	Vdc
<u>Subgroup 3</u>			10				
3206	Small-signal short-circuit forward-current transfer ratio:	$V_{CE} = -9 \text{ Vdc}$ $I_E = 1 \text{ mAdc}$ $f = 1 \text{ kHz}$					
	2N499			h_{fe}	10	250	---
	2N499A			h_{fe}	20	80	---
3306	Magnitude of small-signal short-circuit forward-current transfer ratio	$V_{CE} = -10 \text{ Vdc}$ $I_E = 2 \text{ mAdc}$ $f = 100 \text{ MHz}$		$ h_{fe} $	1.2	6.5	---
3256	Small-signal power gain	$V_{CE} = -10 \text{ Vdc}$ $I_E = 2 \text{ mAdc}$ $f = 100 \text{ MHz}$ Test circuit per Fig. 2 herein		P_g	7.5	---	db

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

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
<u>Subgroup 4</u>			10				
3236	Output capacitance	$V_{CB} = -10 \text{ Vdc}$ $I_E = 0$ $f = 1 \text{ MHz}$		C_{obo}	---	2.5	pf
---	Extrinsic base-re- sistance collec- tor-capacitance product	$V_{CB} = -10 \text{ Vdc}$ $I_E = 2 \text{ mAdc}$ $f = 46 \text{ MHz}$ Test circuit per Fig. 3 herein		$r_b' C_c$	5	50	psec

1/
See 3.4 herein.

Table II. Group B inspection.

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
	<u>Subgroup 1</u>		20				
2066	Physical dimensions	---		---	---	---	---
	<u>Subgroup 2</u>		15				
2026	Solderability	Omit aging		---	---	---	---
1051	Temperature cycling	Test Cond. B except T(high) = +100°C		---	---	---	---
1056	Thermal shock (glass strain)	Test Cond. A		---	---	---	---
2/	Seal (leak rate)	Test Cond. C procedure III; Test Cond. A or B for gross leaks		---	---	10 ⁻⁷ atm cc/sec	
1021	Moisture resistance	---		---	---	---	---
	<u>End-Point tests:</u>						
3036	Collector-base cutoff current:	Bias Cond. D V _{CB} = -15 Vdc		ICBO	---	-10	uA _{dc}
3206	Small-signal short-circuit transfer ratio:	V _{CE} = -9 Vdc I _E = 1 mA _{dc} f = 1 kHz					
	2N499			h _{fe}	10	250	---
	2N499A			h _{fe}	20	80	---
	<u>Subgroup 3</u>		15				
2016	Shock	Non-operating 500 G 5 blows of 1.0 msec ea. in orientations X1, Y1, Y2, Z1 (total=20 blows)		---	---	---	---
2046	Vibration fatigue	Non-operating 10 G		---	---	---	---
2056	Vibration, variable frequency	10 G		---	---	---	---
2006	Constant acceleration	10,000G Orientations X1, Y1, Y2, Z1		---	---	---	---
	<u>End-Point Tests:</u>						
	Same as for sub- group 2 above						

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

Test Method per MIL-STD-750	Examination or test 1/	Conditions	LTPD	Symbol	Limits		Unit
					Min	Max	
	<u>Subgroup 4</u>		15				
2036	Terminal strength (lead fatigue)	Test Cond. E		---	---	---	---
	<u>Subgroup 5</u>		15				
1041	Salt atmosphere (corrosion)	---		---	---	---	---
	End-point tests: Same as for Subgroup 2, above						
	<u>Subgroup 6 3/</u>		15				
1/	High-temperature operation:	$T_A = +55^\circ\text{C}$					
3036	Collector-base cutoff current	Bias Cond. D $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-80	μAdc
1/	Low-temperature operation:	$T_A = -55^\circ\text{C}$					
3206	Small-signal short- circuit forward- current transfer ratio:	$V_{CE} = -9 \text{ Vdc}$ $I_E = 1 \text{ mAdc}$ $f = 1 \text{ kHz}$					
	2N499			h_{fe}	5	---	---
	2N499A			h_{fe}	10	---	---
	<u>Subgroup 7</u>		7				
1031	High-temperature life (non-operating)	$T_{stg} = +100^\circ\text{C}$ $t = 340 \text{ hours}$ 5/		---	---	---	---
	End-Point tests:						
3036	Collector-base cutoff current	Bias Cond. D $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-20	μAdc
3206	Small-signal short- circuit forward- current transfer ratio:	$V_{CE} = -9 \text{ Vdc}$ $I_E = 1 \text{ mAdc}$ $f = 1 \text{ kHz}$					
	2N499			h_{fe}	8	300	---
	2N499A			h_{fe}	15	96	---

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

Test Method per MIL-STD-750	Examination or test 1/	Conditions	MTPD	Symbol	Limits		Unit
					Min	Max	
<u>Subgroup 8</u>			7				
1026	Steady state operation life:	$T_A = +25^\circ\text{C}$ $t = 340$ hours 5/		---	---	---	---
	2N499	$V_{CE} = -5$ Vdc $P_T = 50$ mW					
	2N499A	$V_{CE} = -6$ Vdc $P_T = 60$ mW					
<u>End-Point tests:</u>							
Same as for Subgroup 7, above							

1/ See 3.4 and 4.3.1 herein.

2/ Per Method 112 in Standard MIL-STD-202.

3/ For 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.^{1/}

Test Method per MIL-STD-750	Examination or test 2/	Conditions	LTPD	Symbol	Limits		Unit
					Min.	Max.	
Subgroup 1		10					
3221	Real part of input admittance	$V_{CB} = -10 \text{ Vdc}$ $I_E = 2 \text{ mA dc}$ $f = 200 \text{ MHz}$		$\text{Re}(Y_{ie})$	7	35	mmhos
3231	Real part of output admittance	$V_{CB} = -10 \text{ Vdc}$ $I_E = 2 \text{ mA dc}$ $f = 200 \text{ MHz}$		$\text{Re}(Y_{oe})$	150	450	umhos
Subgroup 2		$\lambda = 10$					
1031	High-temperature life (non-operating)	$T_{stg} = +100^\circ\text{C}$ $t = 1000 \text{ hrs.}$ 3/		---	---	---	---
3036	End-Point tests: Collector-base cut-off current	Bias Cond. D $V_{CB} = -15 \text{ Vdc}$		I_{CBO}	---	-20	uA dc
3206	Small-signal short-circuit forward-current transfer ratio:	$V_{CE} = -9 \text{ Vdc}$ $I_E = 1 \text{ mA dc}$ $f = 1 \text{ kHz}$					
	2N499			h_{fe}	8	300	---
	2N499A			h_{fe}	15	96	---
Subgroup 3		$\lambda = 10$					
1026	Steady state operation life:	$T_A = +25^\circ\text{C}$ $t = 1000 \text{ hrs.}$ 3/		---	---	---	---
	2N499	$V_{CE} = -5 \text{ Vdc}$ $P_T = 50 \text{ mW}$					
	2N499A	$V_{CE} = -6 \text{ Vdc}$ $P_T = 60 \text{ mW}$					
End-Point tests: Same as for Subgroup 2 above							

^{1/} Periodicity: See 4.2.3 herein.^{2/} See 3.4 and 4.3.1 herein.^{3/} See 4.2.2 herein.

NOTES:

1. All dimensions in inches, unless otherwise specified.
2. Flange position not controlled within this range.
3. All leads electrically isolated from case.

TERMINALS:

1. Emitter
2. Base
3. Collector

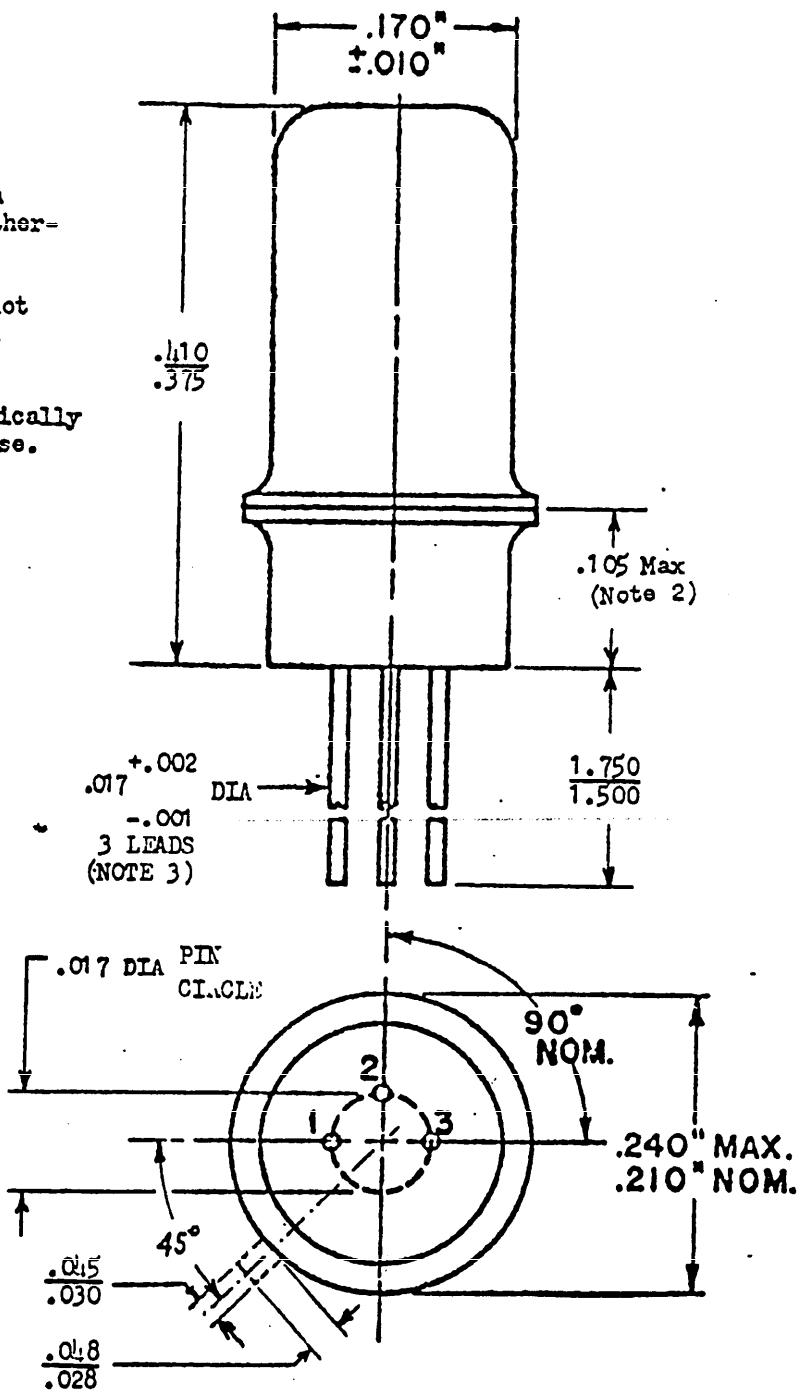
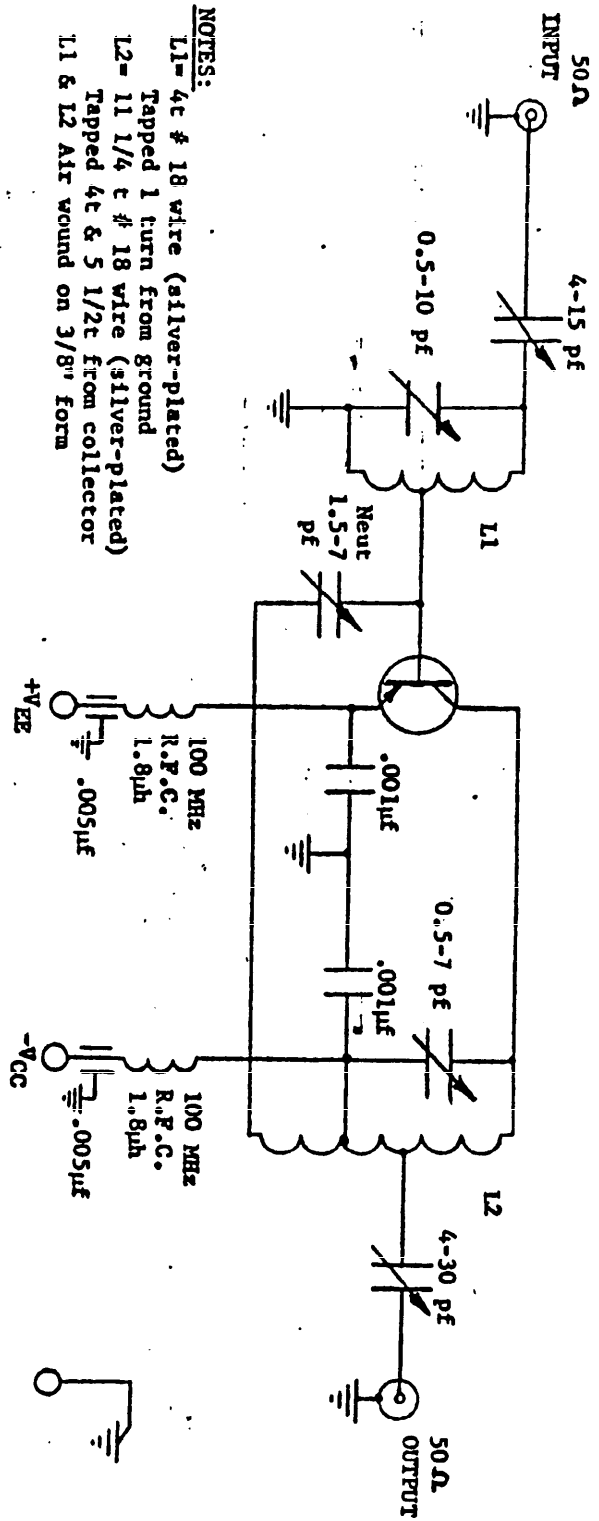


Figure 1. Outline and dimensions.



NOTES:

L1- 4c # 18 wire (silver-plated)
Tapped 1 turn from ground

L2- 11 1/4 c # 18 wire (silver-plated)
Tapped 4c & 5 1/2c from collector

L1 & L2 Air wound on 3/8" form

Figure 2. 100-mc Power Amplifier test circuit.

1. Connect 46-mHz source to Input Jack.
2. Connect *RFVM to "Sample" Jack **.
3. Adjust 46-mHz level so that 0.35 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 T.U.T. into socket, apply bias, and set 46-mHz level for a 0.346-volt reading on RFVM.
7. Connect RFVM to "Output" Jack. r_{pC} is read with 1 mV = 10 psec, 3 mV = 30 psec, etc.; (the 0.346 V_{in} should be checked regularly during successive test measurements).

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

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

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5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery.- 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 Application guidance.-

- a. The transistors conforming to requirements in this document issue are recommended as ready replacements (having superior-controlled operational characteristics) for the transistors covered by previous issue(s) of this document.
- b. To insure proper equipment-circuit application, particular attention should be given to the differential voltage-and-current (power) ratings, and performance (gain characteristics) pertinent to the individual transistor types covered herein.

6.3 Ordering data.-

- a. Terminal-lead length.- See 3.3.2 herein.

6.4 Qualification.- With respect to products requiring qualification, awards will be made 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, U. S. Army Electronics Command, Fort Monmouth, New Jersey 07703, Attention: AMSEL-PP-EM-2.

6.5 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.

Custodian:
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Preparing activity:
Army-EL

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