

TB 9-4935-552-50-3

CHANGE 2

HEADQUARTERS, U. S. ARMY MISSILE COMMAND, REDSTONE ARSENAL, AL
20 July 1988

CALIBRATION PROCEDURE FOR GUIDED MISSILE SYSTEM TEST STATION AN/TSM-93 (LAND COMBAT SUPPORT SYSTEM)

TB 9-4935-552-50-3, dated 27 October 1978, is changed as follows:

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***TB 9-4935-552-50-3**

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR GUIDED MISSILE SYSTEM TEST STATION

AN/TSM-93

LAND COMBAT SUPPORT SYSTEM (LCSS)

Headquarters, Department of the Army, Washington, DC

27 October 1978

REPORTING OF ERRORS

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		Paragraph	Page
SECTION	I.	IDENTIFICATION AND DESCRIPTION	
		Test instrument identification.....	1 2
		Calibration data card (DA Form 2416).....	2 2
		Calibration description.....	3 2
	II.	EQUIPMENT REQUIREMENTS	
		Equipment required	4 3
		Accessories required	5 4
		Additional equipment required	6 4
	III.	PRELIMINARY OPERATIONS	
		Preliminary instructions	7 4
		Equipment setup	8 5
	IV.	CALIBRATION OF SELF-TEST REFERENCE	
		Dc standard	9 6
		Ac standard.....	10 7
		Resistance standard.....	11 9
		Frequency standard.....	12 9
		Final procedure.....	13 10

*This bulletin supersedes TB 9-4935-552-50-3, dated 15 November 1976.

SECTION		Paragraph	Page
	V. CALIBRATION OF PB106		
	Ac converter.....	14	10
	Stop band filter.....	15	13
	Voltage divider.....	16	14
	Resistance assembly.....	17	15
	Calibration of PB106 A1 and A2 troubleshooting devices circuit cards.....	17.1	16
	Final procedure.....	18	17

**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of guided missile system test station AN/TSM-93, 4935-00-930-7250. The item being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 8 hours, using the dc and low frequency technique.

2. Calibration Data Card (DA Form 2416)

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TM 38-750. DA Form 2416 must be annotated in accordance with TM 38-750 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) will follow the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. Test instrument parameters and performance specifications which pertain to this calibration are listed in tables 1 and 2.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
AC VOLTAGE	Range: 0-7 .007 V ac Accuracy: ±0.1% Frequency: 400 ±1 Hz Distortion: 0.1%
DC VOLTAGE	Range: 0-25 V dc Accuracy: ±0.015%
RESISTANCE	Range: 0-9,000Ω 1/2 wattmax Accuracy: ±0.01%
FREQUENCY	Range: 0-900,000 Hz Accuracy: 3 parts in 10 ⁻⁷ Amplitude: 0.4 V ac

Table 2. Calibration Description for PB106

Test instrument parameters	Performance specifications
AC/DC CONVERTER	Input: 0-10 V ac 20 Hz to 10 kHz Output: 0-10 V dc Accuracy: $\pm 0.046\%$
BANDSTOP FILTER	Ranges: 20 Hz, 400 Hz, and 1.2 kHz Accuracy: $\pm 0.046\%$
RESISTANCE DIVIDER	Range: 9Ω to $90\text{ k}\Omega \pm 0.1\%$ $9.09\text{ M}\Omega \pm 1\%$

**SECTION II
EQUIPMENT REQUIREMENTS**

4. Equipment Required

a. Table 3 identifies the specific equipment used in this calibration procedure. This equipment is issued with secondary transfer calibration standards set and is to be used in performing this procedure. Alternate items may be used by the calibrating activity when the equipment listed in table 3 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 3. The accuracies listed in table 3 provide a four-to-one accuracy ratio between the standard and TI. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

Table 3. Minimum Specifications of Equipment Required

Item	Common name	Minimum use specifications	Description and part number
A1	AC CALIBRATOR	Range: 20 to 50 Hz 7 V rms Accuracy: $\pm 0.068\%$ Range: 50 to 9900 Hz 7 V rms Accuracy: $\pm 0.032\%$	Hewlett-Packard, Model 745A (MIS-10342 Type 1)
A2	DC VOLTAGE STANDARD	Range: 10 to 100 V dc Accuracy: $\pm 0.003\%$	John Fluke, Model 332B1AF (7911393)
A3	DIFFERENTIAL VOLTMETER	Range: -7.51 to +25.1 V dc and 0 to 7.1 V rms Accuracy: $\pm 0.023\%$ dc $\pm 0.025\%$ ac	John Fluke, Model 887ABAN (p/o MIS-10216)
A4	FREQUENCY COUNTER	Range: 0 to 900 kHz Time interval: 249 to 100,100 μ S Accuracy: $\pm .33\%$	Systron Donner, Model 1037-M2 (7910628)
A5	OSCILLOSCOPE	Frequency: 900 kHz Amplitude: 2.4 Vpp	Tektronix, Model RM561A (791065502)
A6	RESISTANCE BRIDGE	Range: 8.973 to 9090,000 Ω Accuracy: $\pm 0.01\%$	ESI, Model 230B and 801 (p/o SP2280) (7912150 and 7912151)
A7	RESISTANCE DECADE	Range: 8.9982 k Ω to 1 M Ω Accuracy: $\pm 0.25\%$	Biddle-Gray, Model 601147-1 (7910328)
A8	SPECTRUM ANALYZER	Range: 400 Hz Capability: Measure distortion less than .05%	Hewlett-Packard, Model 334A (7911957)

TB 9-4935-552-50-3

5. Accessories Required. The accessories listed in table 4 are issued with secondary transfer calibration standards set and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

6. Additional Equipment Required. Table 5 identifies additional equipment used in this calibration procedure. This equipment is not issued with the secondary transfer calibration standards set and must be secured from user.

Table 4. Accessories Required

Item	Common name	Description and part number
B1	ADAPTER	Male BNC to female N (10519458)
B2	ADAPTER	BNC "T" type 2 jacks, 1 plug (MS35173)
B3	ADAPTER	Banana jack to phone tip plug (red) (7907517)
B4	ADAPTER	Banana jack to pin plug (black) (7907528)
B5	ADAPTER	BNC plug to double banana (7909401)
B6	ADAPTER	Jack tip (7907502-1)
B7	CABLE	60 in. RG-58/U BNC plug to BNC plug (7907406)
B8 ¹	CABLE	30 in. RG-58/U double banana plug termination (7907470)
B9 ²	LEAD	24 in. No. 18 (black) single banana plug termination (7907498)
B10 ²	LEAD	24 in. No. 18 (red) single banana plug termination (7907497)
B11	LEAD	36 in RG-58/U BNC plug to double banana plug termination (7907471)
B12	TERMINAL, COAXIAL	Bird 80 M (7907280)

¹Three required.

²Two required.

Table 5. Additional Equipment Required

Item	Common name	Part number	Manufacturer
C1	EXTENDER BOARD	11154849	RCA
C2 ¹	EXTENDER CABLE 57 PIN	11153750	RCA
C3 ²	EXTENDER CABLE 26 PIN	11153751	RCA

¹Two required.

²Three required.

**SECTION III
PRELIMINARY OPERATIONS**

7. Preliminary Instructions

a. The instructions outlined in this section are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 3, 4, and 5. For the identification of equipment referenced by item numbers prefixed with A, see table 3, for prefix B, see table 4, and for prefix C, see table 5.

c. Calibration personnel should obtain assistance from an experienced operator to operate and program the AN/TSM-93 system.

d. This calibration procedure must be performed in the following sequence:

- (1) Self-test reference – Section IV.
- (2) PB106 patchboard – Section V.

WARNING

HIGH VOLTAGE is used during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

8. Equipment Setup

a. On the monitor panel, set the TEST MODE switch to MANUAL and the UUT TEST NUMBER switches to 0000000.

b. Press the START TEST switch.

c. If an error is made during a keyboard entry or if reprogramming is required, press the RESET and the ADVANCE switches on the monitor panel and begin again.

d. If an assembly is out-of-tolerance, place it on extender cables C2 and C3 to provide access to the necessary adjustments. Once it becomes necessary to extend the assembly, it is more convenient and faster to leave it extended and complete the performance tests to detect any further out-of-tolerance conditions before making the final performance test. After completing any adjustments, remove the extender cables, replace the assembly in the system, and repeat the performance test. During the final performance tests, the TI must not be extended.

e. Use non-metallic alinement tools to perform all adjustments.

f. Ensure that the guided missile system test station AN/TSM-93 has been operating for at least 1 hour before beginning calibration.

g. Prior to calibrating the guided missile system test station AN/TSM-93, the C&M test program (9000) shall have been run with all-tests-go.

**SECTION IV
CALIBRATION OF SELF-TEST REFERENCE**

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met before continuing with the calibration.

9. Dc Standard

a. Performance Check

- (1) Connect the equipment as shown in figure 2.
- (2) Set resistance decade (A7) to 1.0 megohm.
- (3) If differential voltmeter (A3) does not indicate between -7.50113 and -7.49887 V dc, perform **b** below.

b. Adjustments

NOTE

Refer to figure 1 for all self-test reference adjustments unless otherwise specified.

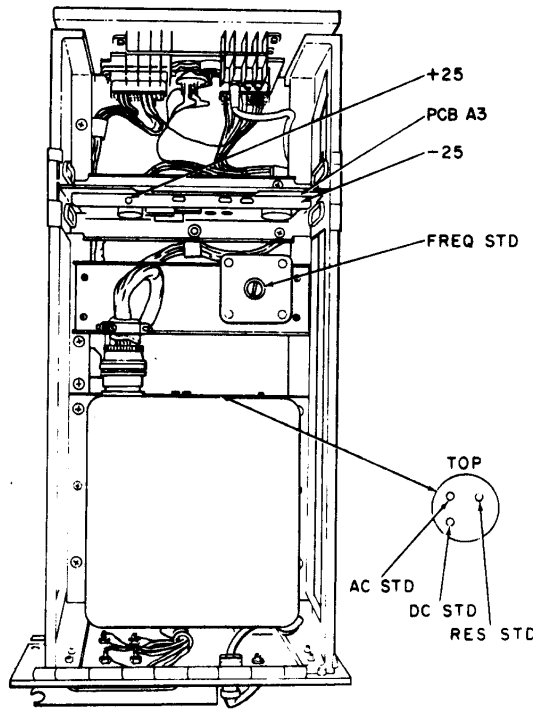


Figure 1. Self-test reference – adjustment locations.

(1) Press the POWER OFF switch on the monitor panel. Place the TI on extender cables, and extend PCB A3.

(2) Press the POWER ON switch on the monitor panel. Connect the differential voltmeter to pins 25 (+) and 23 (GND) of PCB A3. Adjust +25 (PCB A3 R16) for an indication of 25.00 ± 0.10 V dc.

(3) Connect the differential voltmeter to pins B (+) and 8 (GND) of PCB A3. Adjust -25 V (PCB A3 R32) for an indication of -25.00 ± 0.10 V dc.

(4) Press the POWER OFF switch on the monitor panel. Remove the extender board, and replace PCB A3 in its normal position.

(5) Remove the access cover from rear side of the electrical standards set of the TI.

(6) Connect the equipment as shown in figure 2. Press the POWER ON switch on the monitor panel. Adjust DC STD (R31) of the TI so that the differential voltmeter indication is -7.50000 ± 0.00113 V dc (R). A ccw rotation of R31 increases the dc standard voltage output.

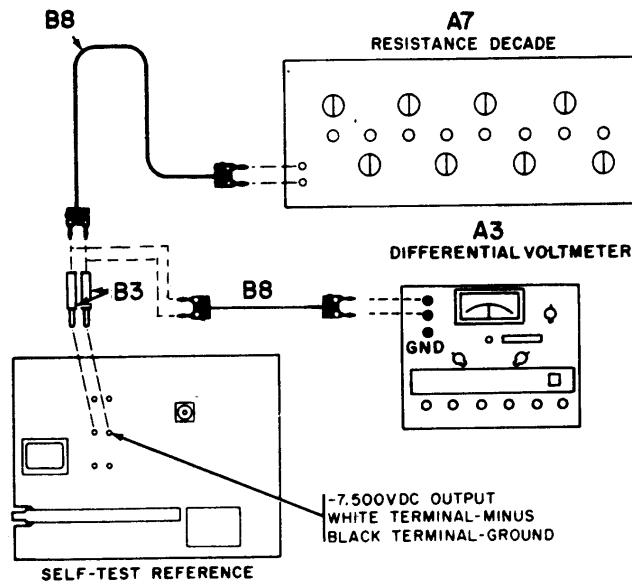
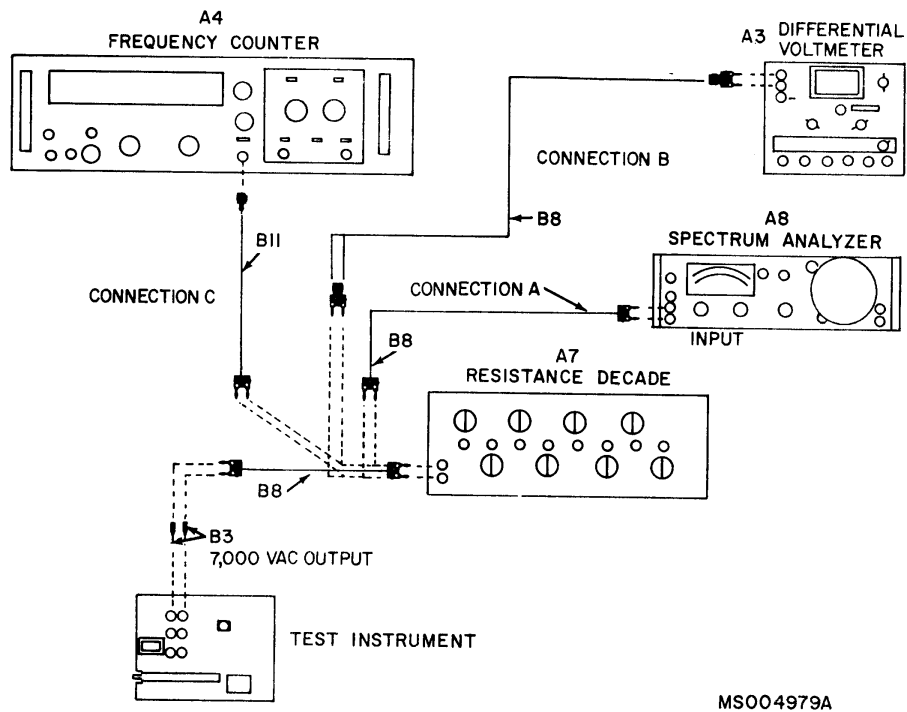


Figure 2. Dc standard check – equipment setup.

10. Ac Standard

a. Performance Check

(1) Refer to figure 3, and connect the differential voltmeter (A3) as in connection B. If the differential voltmeter does not indicate between 6.993 and 7.007 V ac, perform **b** below.



MS004979A

Figure 3. Ac standard check – equipment setup.

- (2) Set the resistance decade to 1.0 megohm.
- (3) Disconnect the differential voltmeter and connect frequency counter (A4) as in connection C. The indication should be between 2485.5 and 2514.5 microseconds.
- (4) Disconnect the frequency counter and connect spectrum analyzer (A8) to the TI as in connection A.
- (5) The spectrum analyzer indication should be less than 0.25 percent distortion at 400 Hz.

b. Adjustments

- (1) Press the POWER OFF switch on the monitor panel. With the TI extended, remove the access cover from rear side of electrical standards set.
- (2) Press the POWER ON switch on the monitor panel. Adjust AC STD (R73) of the TI so that the differential voltmeter indication is 7.000 ± 0.007 V ac (R). A cw rotation of R73 increases the ac standard voltage output.
- (3) No adjustment can be made for distortion or frequency.

11. Resistance Standard

a. Performance Check

(1) Connect resistance bridge (A6) to the TI 9000 OHMS test point, using two electrical leads (B10) and two connector adapters (B3).

(2) If the resistance bridge does not indicate between 8.9982 and 9.0018 k ohms, perform **b** below.

b. Adjustments

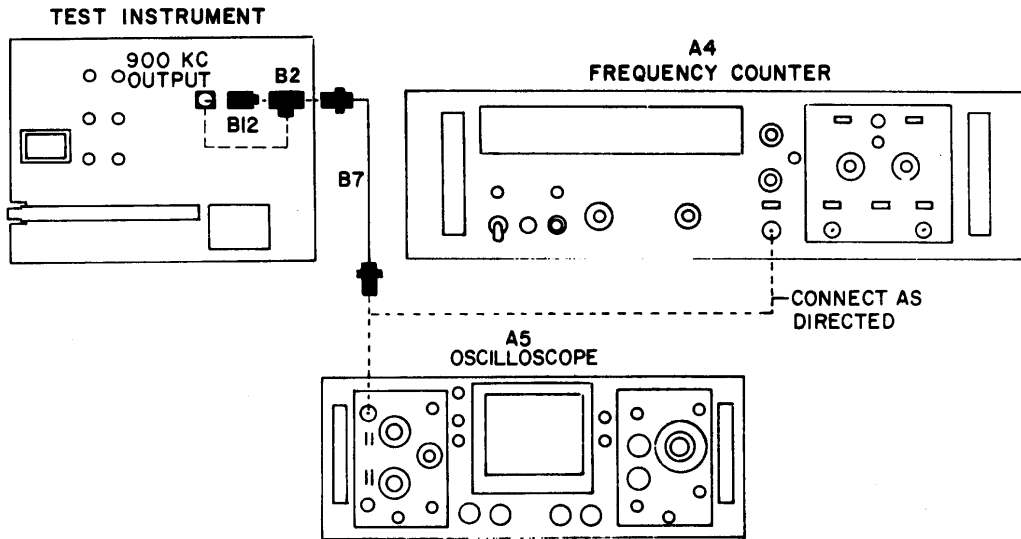
(1) Press the POWER OFF switch on the monitor panel. With the TI extended, remove the access cover from rear side of electrical standards set.

(2) Press the POWER ON switch on the monitor panel. Adjust the RES STD (R43) of the TI for an indication of 9.0000 ± 0.0018 k ohms on the resistance bridge (R).

12. Frequency Standard

a. Performance Check

(1) Refer to figure 4, and connect cable assembly (B7) to oscilloscope (A5).



MS004954A

Figure 4. Frequency standard check – equipment setup.

TB 9-4935-552-50-3

(2) If the TI is removed from the normal operating position by extender cables, connect B2 and B12 as shown in figure 4.

(3) Observe the oscilloscope, and measure the amplitude of the 900 kHz output to be 2.4 Vpp or greater.

(4) Disconnect the oscilloscope from the TI and connect the frequency counter (A4).

(5) Turn the DISPLAY TIME BASE switch to 10 SEC. If frequency counter indication is not between 899.9991 and 900.0009 kHz, perform **b** below.

b. Adjustments

(1) Press the POWER OFF switch on the monitor panel. With the TI extended, remove the access cover from top of frequency standard.

(2) Connect B2 and B12 as shown in figure 4.

NOTE

B1 may also be required depending upon configuration of accessory B12.

(3) Press the POWER ON switch on the monitor panel. Adjust FREQ variable resistor on the TI for an indication of 900.0000 ± 0.0009 kHz (R).

(4) No adjustment of the voltage amplitude of the frequency standard can be made.

13. Final Procedure

a. Deenergize and disconnect all equipment.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (U. S. Army Calibration System). When the test instrument cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable or Limited Use tag).

SECTION V CALIBRATION OF PB106

14. Ac Converter

a. Performance Check

(1) Install TI onto the patchboard receiver.

(2) Program: (Press START TEST) SPS2023PS3023RSA03@A.

(3) Allow 15 minutes for equipment warmup before proceeding with calibration of PB106.

- (4) Open the cover of the TI to gain access to the PC boards.
- (5) Refer to figure 5 and connect lead (B9) using adapters (B3) and (B4) between TI A2J1 and J44 (GND).

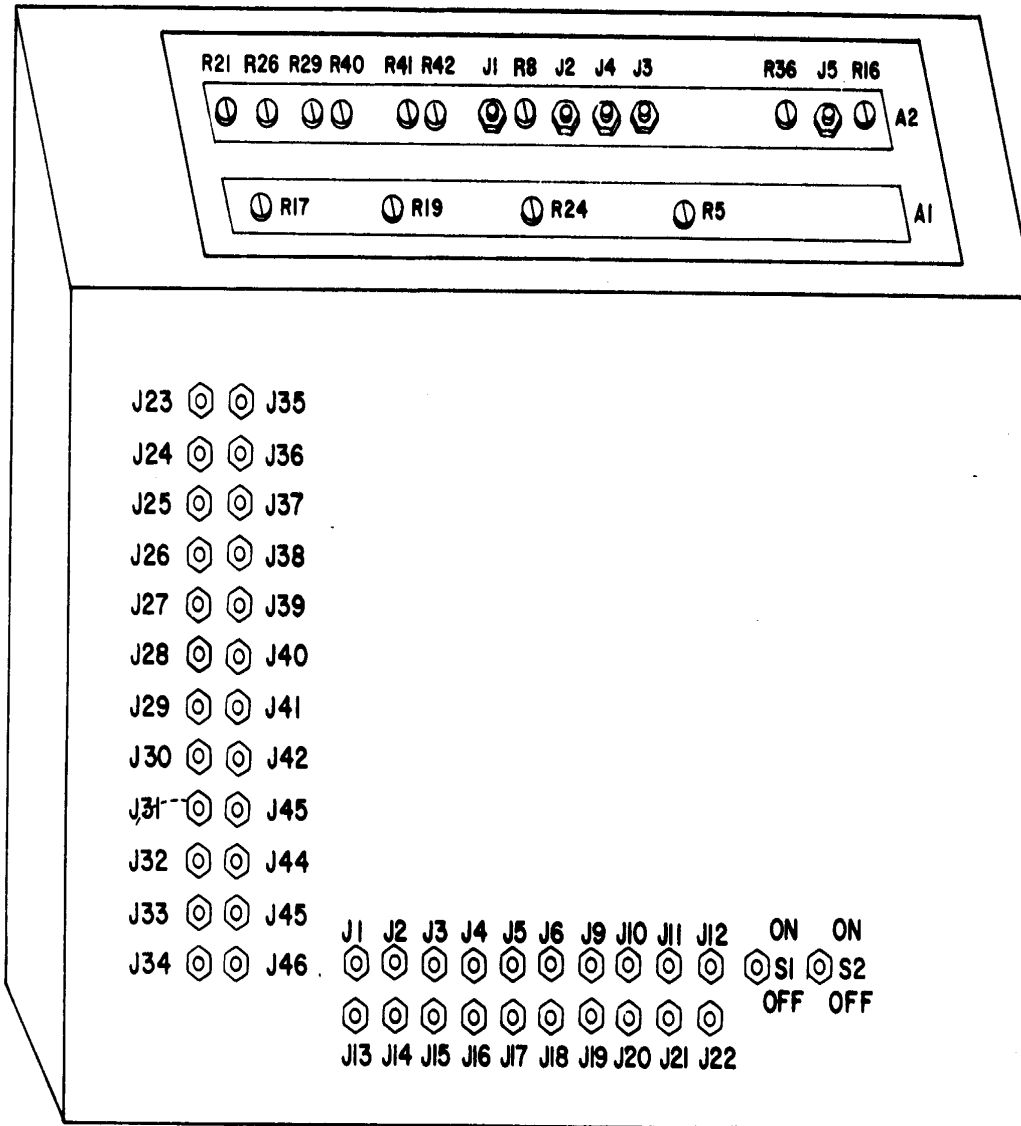


Figure 5. Patchboard PB106.

TB 9-4935-552-50-3

(6) Connect adapter (B6) and cable (B7) between E7 on the programmable signal conditioner and ground on differential voltmeter.

(7) Connect the differential voltmeter (A3) between A2J2 and J44 (GND) on the TI. If differential voltmeter does not indicate between -0.001 and +0.001 V dc, perform **b(1)** below.

(8) Connect the differential voltmeter between J36 and J44 (GND) on the TI. If differential voltmeter does not indicate between -0.001 and +0.001 V dc, perform **b(2)** below.

(9) Remove lead (B9) and adapters (B3) and (B4) from TI A2J1 and J44.

(10) Connect differential voltmeter to ac calibrator (A1).

(11) Set ac calibrator for 7.00000 V ac. Adjust differential voltmeter for a null at each frequency listed below, and record indications.

20 Hz	1000 Hz
50 Hz	4000 Hz
100 Hz	7000 Hz
500 Hz	9900 Hz

(12) Program: SRSC00001RSA032@A.

(13) Connect ac calibrator using leads (B9) and (B10) and adapters (B3) and (B4) between J21 and J44 (GND) on the TI.

(14) Connect differential voltmeter between J36 and J44 (GND) on the TI.

(15) Set ac calibrator for 500 Hz. Adjust the ac calibrator output voltage until the differential voltmeter indicates the ac voltage recorded in step (11) for 500 Hz.

(16) Program: SRSA03@.

(17) Adjust A2R36 (fig. 5) for a differential voltmeter indication of 7.0000 V dc.

(18) Program: SRSA032@A.

(19) Set the ac calibrator to 20 Hz. Adjust the ac calibrator output voltage until the differential voltmeter indicates the ac voltage recorded in step (11) for 20 Hz.

(20) Program: SRSA03@.

(21) Differential voltmeter will indicate $7.0000 \pm .0058$ V dc.

(22) Repeat technique of steps (18) through (21) above for frequencies listed below, except the differential voltmeter will indicate $7.0000 \pm .0033$ V dc.

50 Hz	4000 Hz
100 Hz	7000 Hz
1000 Hz	9900 Hz

(23) Press the HALT switch on the monitor panel.

b. Adjustments

(1) Adjust A2R8 (fig. 5) for a differential voltmeter (A3) indication of $0.000 \pm .001$ V dc (R).

(2) Adjust A2R16 (fig. 5) for a differential voltmeter indication of $0.000 \pm .001$ V dc (R).

15. Stop Band Filter

a. Performance Check

- (1) Program: (Press START TEST) SRSC00044@A.
- (2) Connect equipment as shown in figure 6.

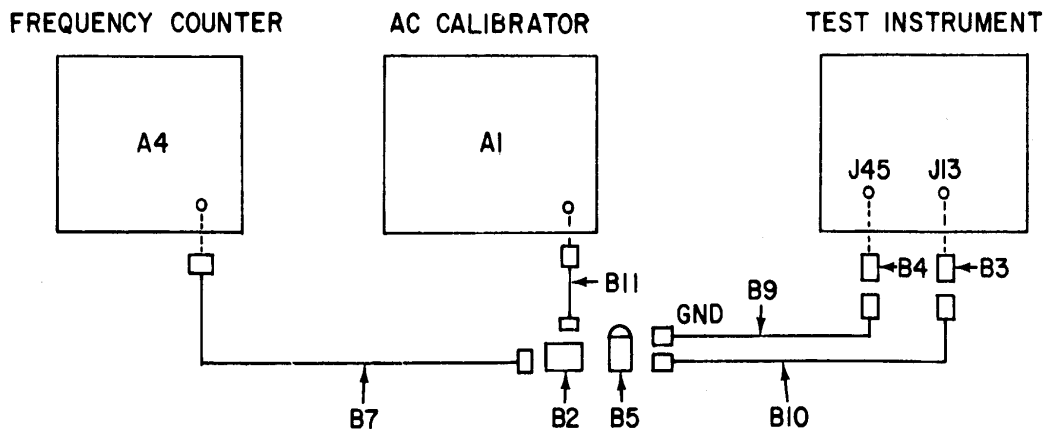


Figure 6. Stopband filter test – equipment setup.

TB 9-4935-552-50-3

- (3) Connect the differential voltmeter (A3) between J46 and J45 (GND) on the TI.
- (4) Connect chassis ground of differential voltmeter (A3) to system ground.
- (5) Adjust the ac calibrator (A1) for 3.5000 V ac at a period of 834.2 ± 0.5 μ sec. Alternately adjust A2R29 and A2R40 (fig. 5) for a differential voltmeter indication of less than .012 V ac.
- (6) Adjust the ac calibrator for a period of 832.5 ± 0.5 μ sec. Alternately adjust A2R29 and A2R40 (fig. 5) for a differential voltmeter indication of less than .012 V ac.
- (7) Program: SRSA004@A.
- (8) Adjust the ac calibrator for a period of 2502.5 ± 0.5 μ sec. Alternately adjust A2R26 and A2R41 (fig. 5) for a differential voltmeter indication of less than .012 V ac.
- (9) Adjust the ac calibrator for a period of 2497.5 ± 0.5 μ sec. Alternately adjust A2R26 and A2R41 (fig. 5) for a differential voltmeter indication of less than .012 V ac.
- (10) Program: SRSARRSA002@A.
- (11) Adjust the ac calibrator for a period of 50.050 ± 0.01 msec. Alternately adjust A2R21 and A2R42 (fig. 5) for a differential voltmeter indication of less than .012 V ac.
- (12) Adjust the ac calibrator for a period of 49.950 ± 0.01 msec. Alternately adjust A2R21 and A2R42 (fig. 5) for a differential voltmeter indication of less than .012.
- (13) Press the HALT switch on the monitor panel.

b. Adjustments. No further adjustments can be made.

16. Voltage Divider

a. Performance Check

- (1) Disengage the patchboard from the patchboard receiver.
- (2) Connect the resistance bridge (A6) between TI jacks listed in table 6. The resistance bridge will indicate within the limits specified.
- (3) Disconnect resistance bridge (A6). Connect resistance decade (A7) and the differential voltmeter (A3) between TI J19 and J20 (GND). Adjust the resistance decade for 1 megohm.

Table 6. Resistance Check

Test instrument jacks	Resistance bridge indications (Ω)	
	Minimum	Maximum
J38-J39	8.973	9.027 ¹
J41-J43	90.63	91.17 ¹
J34-J35	99.7	100.3 ¹
J33-J34	897.3	902.7
J19-J22	1,674.9	1,684.9
J20-J22	3,335	3,355
J32-J33	8,973	9,027
J19-J23	59,820	60,180
J32-J37	89,730	90,270
J41-J42	907,273	911,273
J39-J40	8,910,000	9,090,000

¹Measure the resistance of test leads and subtract from the indication on the resistance bridge.

(4) Connect the dc voltage standard (A2) between TI J23 and J20 (GND) using adapters (B3) and (B4) and leads (B9) and (B10).

(5) Adjust the dc voltage standard for a differential voltmeter indication of 7.5000 V dc. The dc voltage standard will indicate between 97.4500 and 97.5500 V dc.

(6) Connect the resistance decade and differential voltmeter between TI J22 and J20 (GND). The differential voltmeter will indicate between +4.999 and +5.001 V dc.

(7) Disconnect all leads from TI.

b. Adjustments. No further adjustments can be made.

17. Resistor Assembly

a. Performance Check

(1) Engage the patchboard on the patchboard receiver.

(2) Program: (Press START TEST) SRSA000002@A.

NOTE

No chassis ground connection should be made during this procedure. J5 and J6 are floating points.

(3) Connect resistance decade (A7) and differential voltmeter (A3) between TI J5 and J6. Adjust resistance decade for 1 megohm. If differential voltmeter does not indicate between 0.7480 and 0.7520 V dc, perform **b(1)** below.

TB 9-4935-552-50-3

(4) Program: SRSC000002@A.

(5) Connect resistance decade and differential voltmeter between TI J28 and J4. Adjust resistance decade for 1 megohm. If differential voltmeter does not indicate between 0.696 and 0.704 V ac, perform **b(2)** below.

(6) Press the START TEST switch on the monitor panel.

(7) Connect dc voltage standard (A2) between TI J24 and J20 (GND) using adapters (B3) and (B4) and leads (B9) and (B10). Adjust the dc voltage standard for 10.000 V dc.

(8) Program: SRSA2@A.

(9) Connect resistance decade and differential voltmeter between TI J30 and J20 (GND). Adjust resistance decade for 1 megohm. If differential voltmeter does not indicate between 0.996 and 1.004 V dc, perform **b(3)** below.

(10) Connect resistance decade and differential voltmeter between TI J29 and J20 (GND). Adjust resistance decade for 1 megohm. If differential voltmeter does not indicate between 0.098 and 0.102 V dc, perform **b(4)** below.

b. Adjustments

(1) Adjust A1R24 (fig. 5) for an indication of 0.750 V dc on differential voltmeter (A3) (R).

(2) Adjust A1R5 (fig. 5) for an indication of 0.700 V ac on differential voltmeter (R).

(3) Adjust A1R17 (fig. 5) for an indication of 1.000 V dc on differential voltmeter (R).

(4) Adjust A1R19 (fig. 5) for an indication of 0.100 V dc on differential voltmeter (R).

17.1 Calibration of PB106 A1 and A2 Troubleshooting Devices Circuit Card

a. Press HALT on monitor panel and disengage the patchboard PB106 from the patchboard receiver.

b. Remove circuit cards A1 and A2 from PB106 and install the A1 and A2 cards obtained from the LCSS troubleshooting devices.

c. With these cards installed, perform calibration of PB106 using paragraph **14** through **17**.

d. Upon completion of calibration, annotate and affix DA Label 80 to each card indicating the serial number of the PB106 in which the cards were calibrated. Return the cards to the troubleshooting devices storage and reinstall the original A1 and A2 cards.

18. Final Procedure

a. Deenergize and disconnect all equipment.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (U.S. Army Calibration System). When the TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable or Limited Use) tag.

c. Request the LCSS technician to run the maintenance calibration tap program (UUT 9007).

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