

TB 9-4931-321-35

CHANGE 1

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR STANDING WAVE RATIO METER AN/USM 261 AND ME-339/U HEWLETT-PACKARD MODELS 415E AND Y10-415E AND PRD MODEL 277D

Headquarters, Department of the Army, Washington, DC

13 June 2001

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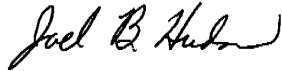
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***TB 9-4931-321-35**

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29 May 1979

REPORTING OF ERRORS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedure, please let us know. Mail your letter or DA Form 2028 to: Commander, U. S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. A reply will be furnished to you. You may also send in your comments electronically to our e-mail address: 2028@redstone.army.mil or FAX 256-842-6546/DSN 788-6546.

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CHANGE 1

*This bulletin supersedes TB 9-4931-321-35, 16 October, 1973, including all changes.

**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Standing Wave Ratio Meter, AN/USM-261 and ME-339/U, Hewlett-Packard Models 415E and Y10-415E, and PRD Model 277D. The manufacturer's manuals were used as prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. AN/USM-261 and ME-339/U are military designations for Hewlett-Packard Model 415E. Hewlett-Packard Models 415E and Y10-415E are electrically and mechanically identical. PRD Model 277D differs from other models in this bulletin by front panel nomenclature and component designation. Where these differences occur, the PRD Model 277D information is shown in parenthesis. Other variations among models are described in text.

b. Time and Technique. The time required for this calibration is approximately 2 hours, using the dc (direct current) 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) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Power input	Satisfactory performance w/line voltage between 105 and 125 V ac
Noise level	7.5 dB below FS at rated sensitivity with input terminated in optimum source impedance.
Bolometer current: Range Accuracy	8.7 or 4.5 mA ±3% into 200 Ω
Attenuator: Range Accuracy	0 to 70 dB in 10 dB steps 0 to 8 dB in 2 dB steps ±0.05 dB per 10 dB step ±0.02 dB per 2 dB step ±0.02 dB on expanded scale

**SECTION II
EQUIPMENT REQUIREMENTS**

4. Equipment Required. Table 2 identifies the specific equipment used in this calibration procedure. This equipment is issued with Secondary Transfer Standards Calibration Sets NSN 6695-00-621-7877, NSN 6695-00-525-8175 (AN/GSM-256), and NSN 4931-01-019-1829 (AN/GSM-259), and Transportable Maintenance Calibration Facility AN/TSM-55(), and is to be used in performing this procedure. Alternate items may be used by the calibrating activity when the equipment listed in table 2 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 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

Table 2. Minimum Specifications of Equipment Required

Item	Common name and/or (official nomenclature)	Minimum use specifications	Manufacturer, model, and part number			
			Level A	AN/GSM-256	AN/GSM-259	AN-TSM-55
A1	ATTENUATOR (VARIABLE ATTENUATOR)	Range: 0 to 10 dB	N/A	Hewlett-Packard, Model 355C (7910807)	Hewlett-Packard, Model 355C (7910807)	N/A
A2	ATTENUATOR (VARIABLE ATTENUATOR)	Range: 0 to 100 dB	N/A	Hewlett-Packard, Model 355D (H-P355D)	Hewlett-Packard, Model 355D (H-P355D)	N/A
A3	AUTOTRANSFORMER (VARIABLE POWER TRANSFORMER)	Range: 105 to 125 V ac Accuracy: ±1%	General Radio, Model W10MT3-AS3 (7910809)	General Radio, Model W10MT3-AS3 (7910809)	General Radio, Model W10MT3-AS3 (7910809)	General Radio, Model W10MT3A TF-510/U
A4	DC VOLTMETER (DIGITAL VOLT-METER)	Range: 0.87 to 1.8 V dc Accuracy: ±1%	Dana, Model 5000S2351 (5000S2351)	Hewlett-Packard, Model 3490A w/Option 060 (3490A Option 060)	Hewlett-Packard, Model 3490A w/Option 060 (3490A Option 060)	J-Omega, Model 217A, ME-333/U

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Table 2. Minimum Specifications of Equipment Required - Continued.

Item	Common name and/or (official nomenclature)	Minimum use specifications	Manufacturer, model, and part number			
			Level A	AN/GSM-256	AN/GSM-259	AN-TSM-55
A5	FREQUENCY COUNTER (ELECTRONIC DIGITAL COUNTER)	Range: 890 to 1,020 Hz Accuracy: $\pm 1\%$	Systron-Donner Model 1037M (7910823) w/1926A (7910824)	Hewlett-Packard, Model 5245L (H-P 5425L)	Hewlett-Packard, Model 5245L (H-P 5425L)	Systron-Donner Model 1037B4-F-H, AN/USM-257A w/1926A, CV2349A
A6	RATIO TRANSFORMER	Range: 0.098850 to 1.000000 Accuracy: $\pm 0.06\%$	North Atlantic Research, Model RB503-C-S1702 (MIS-10232) or Gertsch, Model 1000 (7907060-1)	N/A	N/A	Gertsch, Model RT-60, TF-515/U
A7	RESISTANCE STANDARD (DECADE RESISTOR)	Range: 100 to 5,000 Ω Accuracy: $+0.75\%$	Biddle-Gray, Model 6011471 (7910328)	Biddle-Gray, Model 6011471 (7910328)	Biddle-Gray, Model 6011471 (7910328)	General Radio, Model 1434-N XM-57/U
A8	SIGNAL GENERATOR (AUDIO-RADIO FREQUENCY OSCILLATOR)	Range: .015 to 1 V rms at 1 kHz Accuracy: Amplitude $\pm 2\%$	Preston Scientific, Model 134A or Hewlett-Packard, Model 652A (MIS-10244)	Hewlett-Packard, Model 652A (MIS-10244)	Hewlett-Packard, Model 652A (MIS-10244)	Hewlett-Packard, Model 652A, AN/USM-264
A9	SWR METER STANDARD (STANDING WAVE RATIO METER)	Calibrated standard to be used for comparison	N/A	Hewlett-Packard, Model 415E (7910160)	Hewlett-Packard, Model 415E (7910160)	N/A

Table 3. Accessories Required

Item	Common name (official nomenclature)	Description (part number)
B1	ADAPTER (ADAPTER CONNECTOR)	BNC T, two jacks and one plug-in (MS35173-274C)
B2	CABLE ¹ (RF CABLE ASSEMBLY)	30-in., RG-58/U; BNC plug terminations (7907467)
B3	CABLE ² (TEST LEAD)	36-in., RG-58/U; BNC plug and double banana plug terminations (7907471)
B4	ISOLATION PLUG (ADAPTER CONNECTOR)	Three-wire to two wire adapter (7912356)
B5	TERMINATION (ELECTRICAL DUMMY LOAD)	50-ohm feed-through, BNC plug and BNC jack terminations (11048C)

¹Four required.

²Two required.

**SECTION III
CALIBRATION PROCESS**

6. Preliminary Instructions

a. The instructions outlined in paragraphs 6 and 7 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 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

WARNING

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

NOTE

Unless otherwise specified, verify the results of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.

NOTE

Remove TI from protective cover only when required to make adjustments.

NOTE

Unless otherwise specified, all controls, control settings, and connectors refer to the TI.

7. Equipment Setup

a. Connect TI to autotransformer (A3).

b. Connect autotransformer to a 115-V ac (volt alternating current) source and adjust for a 115-V output.

c. Position controls as listed in (1) through (7) below:

(1) RANGE-DB switch to 0.

(2) EXPAND switch to NORM.

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- (3) INPUT (INPUT SELECTOR) switch to 8.7 MA.
- (4) GAIN (COARSE GAIN) control fully clockwise.
- (5) VERNIER (FINE GAIN) control fully clockwise.
- (6) BANDWIDTH control fully clockwise.
- (7) POWER switch to LINE ON.

d. Allow at least 30 minutes for equipment to warm up and stabilize

e. Set POWER switch to OFF and verify that meter pointer aligns with 2 on 0 (zero) to 2 dB (decibel) scale. If necessary, rotate mechanical zero-adjustment screw clockwise until pointer is to the left of 2, moving upscale. Stop clockwise adjustment when pointer is aligned with 2.

f. Set POWER switch to LINE ON.

8. Bolometer Bias

a. Performance Check

(1) Connect resistance standard (A7) to INPUT, using cable (B3) and connect dc voltmeter (A4) across resistance standard, using leads furnished with dc voltmeter.

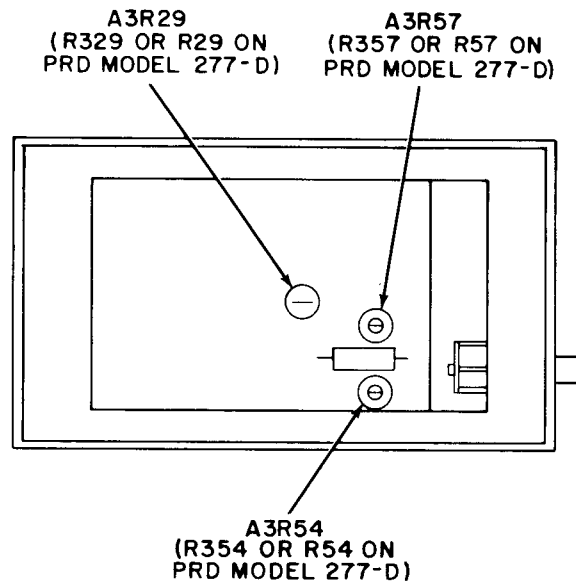
(2) Set resistance standard and INPUT (INPUT SELECTOR) switch to settings listed in table 4. If dc voltmeter does not indicate within specified limits, perform **b** below.

Table 4 . Bolometer Bias

Resistance standard setting (Ω)	Test instrument INPUT (INPUT SELECTOR) switch setting	Dc voltmeter indication (V dc)	
		Min	Max
200	8.7 MA	1.688	1.792
200	4.5 MA	0.873	0.927
1000	BIASED	0.97	1.03

(3) Set INPUT (INPUT SELECTOR) switch to LOW.

b. Adjustments. Adjust A3R54 (R354 or R54) (fig. 1) until all dc voltmeter indications listed in table 4 are within specified limits.



NOTE: COMPONENTS WITH A3 PREFIX ARE FOR HEWLETT-PACKARD MODELS, COMPONENTS FOR PRD ARE IDENTIFIED WITH EITHER 2 OR 3 DIGIT NUMBERS.

Figure 1. Standing wave ratio meter - left view.

9. Sensitivity, Stability and Noise

a. Performance Check

(1) Connect signal generator (A8) (50-ohm output) to INPUT, using cable (B2) and termination (B5).

(2) Adjust signal generator frequency to 1000 Hz (hertz) and amplitude for up-scale indication on TI meter.

(3) Adjust FREQ control for maximum meter indication. If necessary, reduce amplitude of signal generator output.

(4) Adjust amplitude of signal generator output for a 0 (zero) dB indication on TI meter 0 (zero) to 10 dB scale.

(5) Signal generator output will not exceed 0.15 V (volt).

(6) Adjust autotransformer (A3) from 105 to 125 V, while maintaining 0 (zero) dB indication on TI meter with amplitude control of signal generator.

(7) Signal generator output amplitude will not exceed 0.15 V.

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- (8) Adjust autotransformer for a 115-V output
- (9) Set INPUT (INPUT SELECTOR) switch to HIGH.
- (10) Adjust amplitude of signal generator for a 0 (zero) dB indication on TI meter.
- (11) Signal generator output amplitude will not exceed 1 V.
- (12) Adjust FREQ control fully clockwise and signal generator frequency for peak indication on TI meter. Adjust signal generator amplitude as necessary.
- (13) Adjust signal generator output amplitude to 1.0 V and adjust GAIN controls for a 0 (zero) dB indication on TI meter.

NOTE

Strap LOW and GRD terminals on resistance standard.

- (14) Disconnect signal generator. Set resistance standard (A7) to 5000 ohms and connect to INPUT, using cable (B3).
- (15) Set RANGE-DB switch to 60.
- (16) Average noise level will be at least 7.5 dB down from 0 (zero) on TI meter 0 (zero) to 10 dB scale.

NOTE

If resistance standard induces too much noise, fabricate termination, using stock resistor and BNC to terminal adapter.

- (17) Set RANGE-DB switch to 0 (zero) and INPUT (INPUT SELECTOR) switch to LOW
- (18) Adjust signal generator output amplitude for 0.15 V
- (19) Disconnect resistance standard and reconnect signal generator to INPUT. Adjust GAIN control as required.
- (20) Adjust signal generator frequency for peak TI meter indication and GAIN control for a 0 (zero) dB indication on TI meter.
- (21) Disconnect signal generator. Set resistance standard to 100 ohms and connect to INPUT.
- (22) Set RANGE-DB switch to 60 and repeat (16) above.
- (23) Set RANGE-DB switch to 0 (zero).

b. Adjustments. No adjustments can be made.

10. Input Frequency

a. Performance Check

(1) Connect equipment as shown in figure 2.

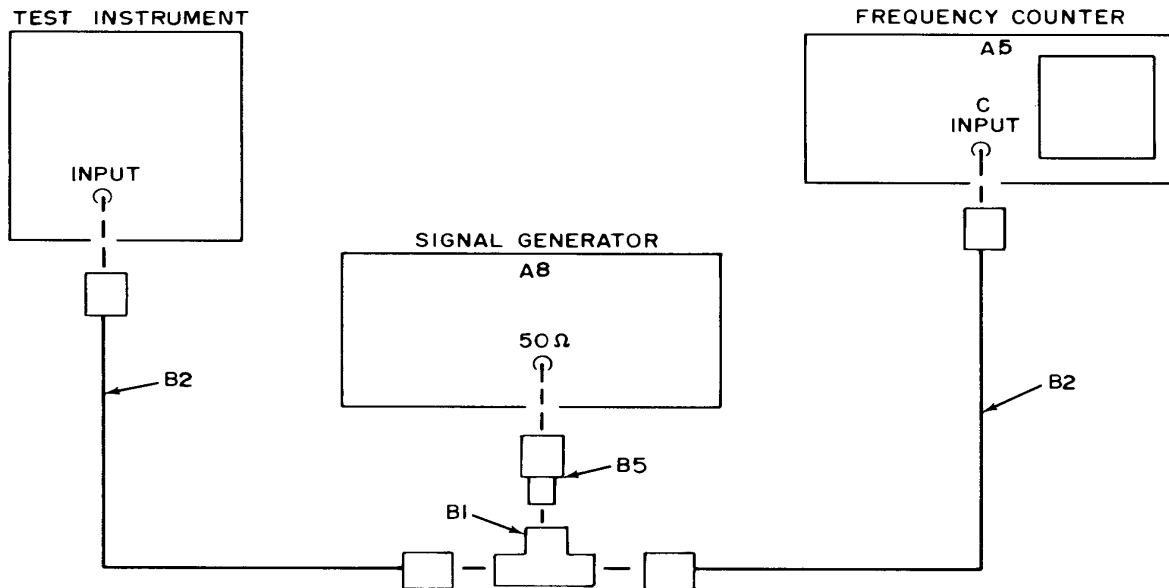


Figure 2. Frequency and bandwidth - equipment setup.

(2) Set EXPAND switch to 0 (zero) and turn GAIN and FREQ controls fully clockwise.

(3) Adjust signal generator (A8) output amplitude for on-scale indication on TI meter. Adjust signal generator frequency to obtain peak indication on TI meter. Readjust signal generator output amplitude to obtain a 0 (zero) dB indication on TI meter 0 (zero) to 2 dB scale. Frequency counter (A5) will indicate 1020 Hz or more. Record frequency counter indication.

NOTE

When practical, make frequency measurements in period for better accuracy.

(4) Turn FREQ control fully counterclockwise.

(5) Adjust signal generator frequency to obtain peak indication on TI meter. If necessary, adjust signal generator output amplitude to maintain on-scale indication on TI meter. Frequency counter will indicate 980 Hz or less. Difference between this indication and indication recorded in (3) above will be 70 Hz or more.

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b. Adjustments. No adjustments can be made.

11. Bandwidth

a. Performance Check

(1) Adjust signal generator (A8) frequency to obtain indication of 1000 Hz on frequency counter (A5).

(2) Adjust FREQ control to obtain peak indication on TI meter

(3) Adjust signal generator output amplitude to obtain a 0 (zero) dB indication on TI meter 0 (zero) to 2 dB scale

(4) While maintaining signal generator output amplitude constant, reduce signal generator frequency until TI meter indicates 1.5 dB on 0 (zero) to 2 dB scale. Record frequency counter indication.

(5) While continuing to maintain signal generator output amplitude constant, increase signal generator frequency until TI meter indication returns to 0 (zero) dB and again drops to 1.5 dB. The difference in this frequency counter indication and indication recorded in (4) above will be 130 Hz or more.

(6) Turn BANDWIDTH control fully counterclockwise and repeat (1) through (4) above.

(7) Repeat technique of (5) above. The difference in frequencies will be 15 Hz or less.

(8) Set INPUT (INPUT SELECTOR) switch to HIGH. Adjust signal generator output amplitude to obtain on-scale indication on TI meter.

(9) Adjust signal generator frequency and FREQ control to obtain peak indication on TI meter.

(10) Adjust signal generator output amplitude to obtain a 1-dB indication on TI meter 0 (zero) to 2 dB scale.

(11) Turn BANDWIDTH control fully clockwise. Adjust FREQ control to obtain peak TI meter indication.

(12) If TI meter does not indicate between 0.5 and 1.5 dB on 0 (zero) to 2 dB scale (between 0.9 and 1.1 dB), perform **b** below.

b. Adjustments

- (1) Adjust signal generator frequency to obtain indication of 1000 Hz on frequency counter.
- (2) Adjust **FREQ** control to obtain peak indication on TI meter.
- (3) Adjust signal generator output amplitude to obtain 1 dB indication on TI meter 0 (zero) to 2 dB scale.
- (4) Turn **BANDWIDTH** control fully counterclockwise.
- (5) Adjust **FREQ** control to obtain peak indication on TI meter.
- (6) Adjust A3R29 (R329 or R29) (fig. 1) to obtain indication of 1 dB on TI meter 0 (zero) to 2 dB scale (R).
- (7) Turn **BANDWIDTH** control fully clockwise and repeat (2) through (6) above until TI meter indication remains between 0.5 and 1.5 dB throughout range of **BANDWIDTH** control.

12. Range Accuracy

a. Performance Check

NOTE

When using AN/GSM-256 or AN/GSM-259 set, perform paragraph 14.

- (1) Set **EXPAND** switch to **NORM** and **BANDWIDTH** control fully clockwise.
- (2) Connect equipment as shown in figure 3.

NOTE

Isolate TI from power line ground for remainder of procedure.

- (3) Adjust ratio transformer (A6) to 1.000000 and adjust signal generator (A8) output amplitude to obtain on-scale indication on TI meter.
- (4) Adjust signal generator frequency to obtain peak indication on TI meter. Adjust signal generator output to 1 V.
- (5) Adjust **GAIN** controls to obtain a 0 (zero) dB indication on TI meter. Readjust signal generator output amplitude if necessary.
- (6) Adjust ratio transformer to .100000 and set **RANGE-DB** switch to 10.

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(7) Adjust ratio transformer to obtain a 0 (zero) dB indication on TI meter. Ratio transformer will indicate between .098850 and .101160.

(8) Reduce signal generator output amplitude and adjust ratio transformer to 1.000000.

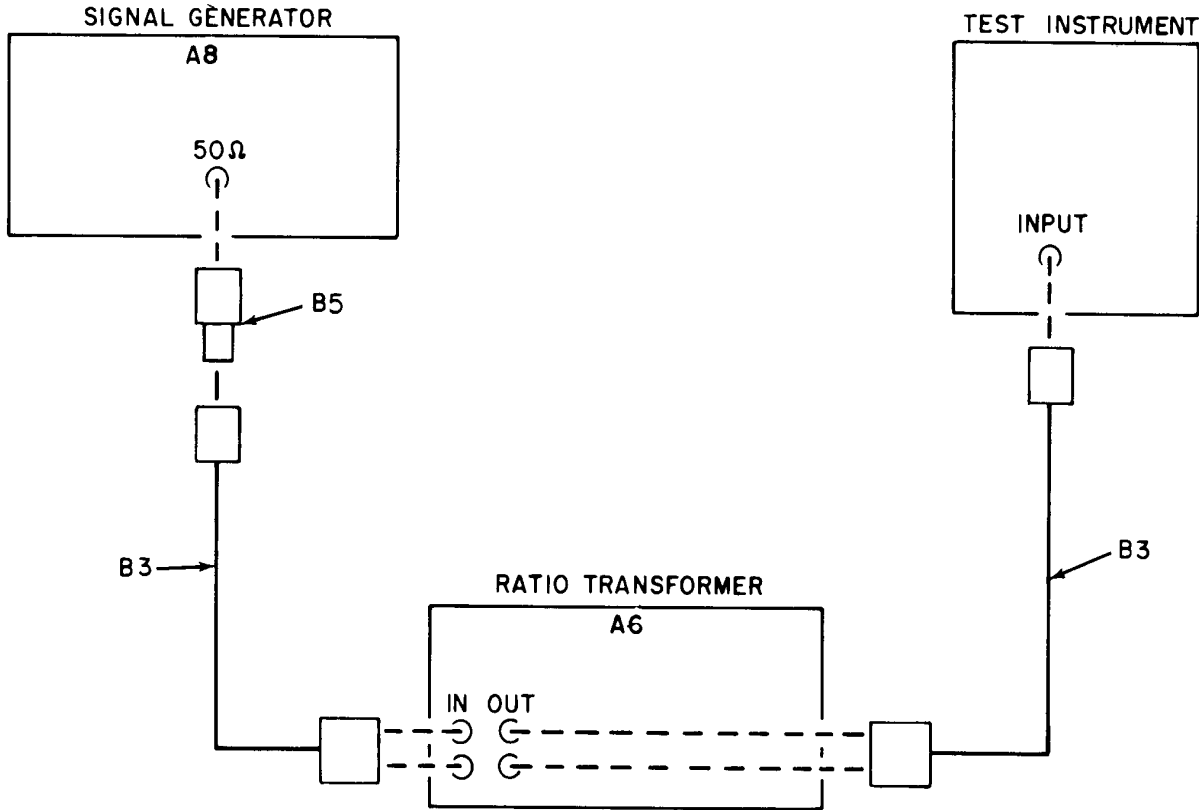


Figure 3. Range accuracy - equipment setup.

(9) Adjust signal generator output amplitude to obtain a 0 (zero) dB indication on TI meter.

(10) Adjust ratio transformer to .100000 and set RANGE-DB switch to 20.

(11) Adjust ratio transformer to obtain a 0 (zero) dB indication on TI meter. Ratio transformer will indicate between .098850 and .101160.

(12) Repeat technique of (8) through (11) above for remaining RANGE-DB switch positions.

NOTE

Before performing (8) above for 50-dB switch position, rotate GAIN control counterclockwise. Return GAIN control to clockwise position when checks are complete.

b. Adjustments. No adjustments can be made.

13. Expanded Range Linearity and Accuracy

NOTE

When using AN/GSM-256 or AN/GSM-259 set, perform paragraph 14.

a. Performance Check

- (1) Reduce signal generator (A8) output amplitude and adjust ratio transformer (A6) to 1.000000.
- (2) Set RANGE-DB switch to 0 and EXPAND 0.
- (3) Adjust signal generator output amplitude to obtain an on-scale indication on TI meter. Adjust signal generator frequency to obtain peak indication on TI meter
- (4) Adjust signal generator output amplitude and GAIN controls to obtain a 0 (zero) dB indication on TI meter 0 (zero) to 2 dB scale.
- (5) Adjust ratio transformer to obtain 0.5 dB indication on TI meter 0 (zero) to 2 dB scale.
- (6) If ratio transformer does not indicate between .887160 and .895360, perform **b**(1) through (3) below.
- (7) Adjust ratio transformer to obtain TI meter indications listed in table 5. If ratio transformer does not indicate within specified limits, perform **b**(4) and (5) below.

Table 5. Expanded Range Linearity

Test instrument indication (0 to 2 dB scale)	Ratio transformer indication		
	Min	Optimum	Max
1	.790684	.794328	.798001
1.5	.704700	.707946	.711212
2	.628063	.630957	.633870

- (8) Repeat (1), (3), and (4) above
- (9) Adjust ratio transformer to .630957 and set EXPAND switch to 2.
- (10) Adjust ratio transformer to obtain a 0 (zero) dB indication on TI meter 0 (zero) to 2 dB scale. Ratio transformer will indicate between .623735 and .638266.
- (11) Repeat technique of (9) and (10) above, using settings listed in table 6. Ratio transformer indications will be within specified limits.

Table 6. Expanded Range Accuracy

Initial ratio transformer setting	Test instrument EXPAND switch position	Ratio transformer indication	
		Min	Max
.398107	4	.393551	.402712
.251189	6	.248313	.254097
.158489	8	.156675	.160325

b. Adjustments

- (1) Adjust ratio transformer to .891251.
- (2) Adjust A3R57 (R357 or R57) (fig. 1) to obtain 0.5 dB indication on TI meter 0 (zero) to 2 dB scale (R).
- (3) Repeat a(2) through (6) above.
- (4) Adjust ratio transformer for optimum values listed in table 5. Adjust A3R57 (R357 or R57) (fig. 1) for corresponding TI meter indication or best in-tolerance compromise of error across 0 (zero) to 2 dB scale (R).
- (5) Repeat a(2) through (7) above.

14. Attenuator Accuracy Using AN/GSM-256 or AN/GSM-259

a. Performance Check

- (1) Connect equipment as shown in figure 4.

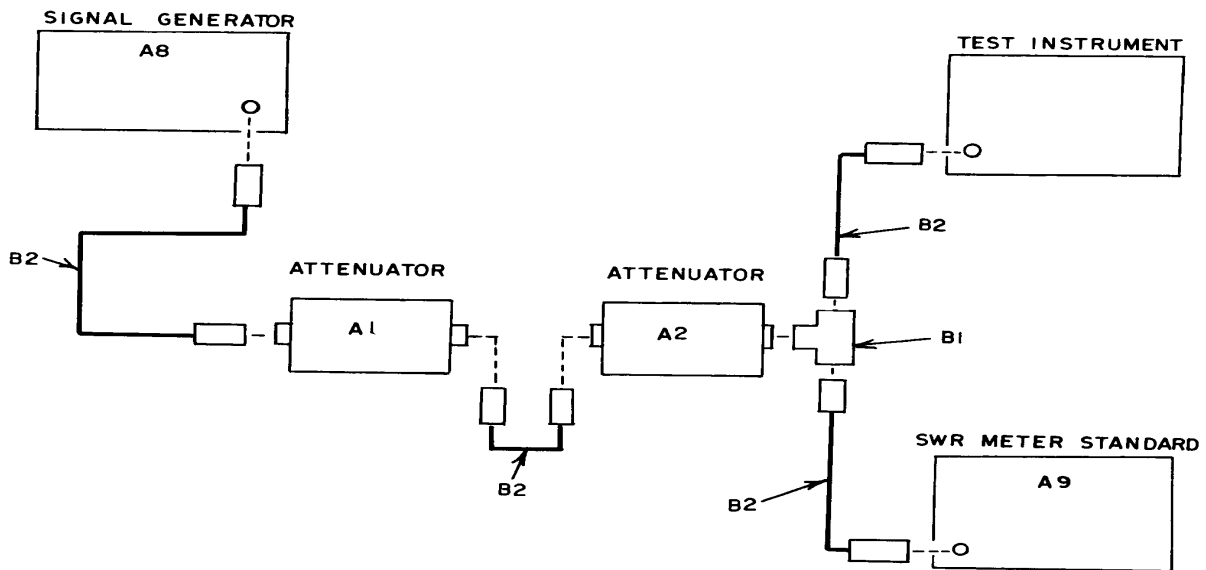


Figure 4. Attenuator accuracy - equipment setup.

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- (2) Set attenuator (A1) and attenuator (A2) to 0 (zero) dB.
- (3) Adjust signal generator (A8) frequency to 1000 Hz. Adjust signal generator output amplitude to obtain up-scale indication on TI meter.
- (4) Adjust both TI and SWR meter standard (A9) FREQ and BANDWIDTH controls to obtain peak indication on TI meter.
- (5) Set INPUT switch to HIGH, RANGE-DB 0 (zero) and EXPAND switch to NORM on TI and SWR meter standard.
- (6) Set signal generator output attenuator to +20 DBM and adjust its output amplitude to obtain convenient meter indication on SWR meter standard. Record meter indication.
- (7) Adjust GAIN control to obtain same indication on TI meter as recorded in (6) above.
- (8) Set signal generator output attenuator to 0 (zero) DBM.
- (9) Set RANGE-DB switches to 10 dB on TI and SWR meter standard.
- (10) Adjust signal generator output amplitude to obtain same SWR meter standard meter indication recorded in (5) above.
- (11) TI meter will indicate within ± 0.05 dB of SWR meter standard indication.
- (12) Set signal generator output attenuator to -20 DBM.
- (13) Set RANGE-DB switches to 20 dB on TI and SWR meter standard.
- (14) Adjust signal generator output amplitude to obtain same SWR meter standard meter indication recorded in (5) above.
- (15) TI meter will indicate within ± 0.05 dB of SWR meter standard indication.
- (16) Repeat the above technique, using signal generator output attenuator and attenuator (A2) to compare each 10-dB step of TI with corresponding step of SWR meter standard.
- (17) Set RANGE-DB switches to 0 (zero) and EXPAND switches to 0 (zero) on TI and SWR meter standard.
- (18) Using above technique, compare each 2-dB step (EXPAND switch) of TI with corresponding step of SWR meter standard. If TI does not indicate within ± 0.02 dB, perform **b** below.

b. Adjustments. Adjust A3R57 (R357 or R57) (fig. 1) for best overall in-tolerance indication on TI meter 0 (zero) to 2 dB scale (R).

15. Final Procedure

a. Deenergize and disconnect equipment and reinstall protective cover.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument).

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