

*TB 9-6625-1138-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR WAVE ANALYZER, HEWLETT-PACKARD MODELS 302A AND 302AR (TS-1830D/U)

Headquarters, Department of the Army, Washington, DC
8 April 2008

Distribution Statement A: Approved for public release; distribution is unlimited.

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. 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 by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: <https://amcom2028.redstone.army.mil>. Instructions for sending an electronic 2028 can be found at the back of this manual.

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*This bulletin supersedes TB 9-6625-1138-35, dated 29 September 1982, including all changes.

**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Wave Analyzer, Hewlett-Packard Models 302A and 302AR (TS-1830D/U). The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are described in text.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports.

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. Adjustments to be reported 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
Frequency	Range: 20 Hz to 50 kHz Dial accuracy: $\pm(1\% + 5 \text{ Hz})$ Graduations: Linear, 1 div per 10 Hz
Voltage	Range: 30 μV to 300 V in 15 ranges in a 30, 100, and 300 sequence Accuracy: $\pm 5\%$ FS
IF rejection	At least 75 dB down
Residual modulation and hum voltage	Greater than 75 dB down
Automatic frequency control	$\pm 100 \text{ Hz min}$
Selectivity	$\pm \text{ Hz bandwidth less than } 1\% \text{ down}$ $\pm 3.5 \text{ Hz bandwidth at least } 3 \text{ dB down}$ $\pm 25 \text{ Hz bandwidth at least } 50 \text{ dB down}$ $\pm 70 \text{ Hz bandwidth at least } 80 \text{ dB down}$

SECTION II EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286; AN/GSM-287; or AN/GSM-705. Alternate items may be used by the calibrating activity. 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. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories required for this calibration are common usage accessories, issued as indicated in paragraph 4 above, and are not listed in this calibration procedure. The following peculiar accessory is also required for this calibration: Voltage Divider, 600 Ω , double banana plug to triple banana jack, Agilent, model 11047A (7911560).

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: $\pm 1\%$	Ridge, Model 9020A (9020A)
CALIBRATOR	DC Range: 285 mV to 315 V Accuracy: $\pm 1\%$ AC Range: 20 Hz to 50 KHz Flatness: $\pm 1.25\%$	Fluke, Model 5720A (5720A) (p/o MIS-35947); w amplifier, Fluke 5725A/AR (5725A/AR)
FREQUENCY COUNTER	Range: 14 to 51,000 Hz Accuracy: $\pm 1\%$	Agilent, Model 5345A (MIS-28754/1 Type 1) w/converter, frequency, plug-in, model 5355A (5355A)
MULTIMETER	DC Range: -1 to -15.2 V Accuracy: $\pm 0.33\%$ AC Range: 1 to 315 V Accuracy: $\pm 1\%$	Fluke, Model 8840A/AF05 (AN/GSM-64D)
OSCILLOSCOPE	Range: 6.3 to 7.7 V p-p Accuracy: $\pm 3\%$	Agilent, OS-303/G (OS-303/G)
RATIO TRANSFORMER	Range: 0.0001 Accuracy: $\pm 0.1\%$	ESI, Model DT72A (7915908)

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 as listed in table 2.

c. Unless otherwise specified, verify the result 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.

d. When indications specified in paragraphs 8 through 12 are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs 8 through 12. Do not perform power supply check if all other parameters are within tolerance.

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

7. Equipment Setup

WARNING

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

a. Remove protective cover from TI as required to gain access to test points and adjustments.

b. If TI **R.M.S. VOLTS** meter does not indicate 0 (zero) on 0 to 1.0 scale, adjust meter adjustment screw (located below meter face) until pointer indicates 0 (zero).

c. Set **BATTERY-AC (DC-AC** on some TI's) switch on rear of TI to **AC**.

d. Connect TI to autotransformer.

e. Position controls as listed in (1) through (9) below:

(1) **POWER** switch to **ON** (up).

(2) **MODE SELECTOR** switch to **NORMAL**.

(3) **SCALE VALUE** switch to **ABSOLUTE**.

(4) **MAX INPUT VOLTAGE** switch to **1**.

(5) **RANGE (VOLTS)** switch to **30 mV**.

(6) **FREQUENCY** dial to **0.0 kHz**.

(7) **OUTPUT AMPLITUDE** control fully cw.

(8) **ZERO SET** control for maximum indication on TI **R.M.S. VOLTS** meter.

(9) **CARRIER BAL RES** and **CAP** adjustment screws for minimum indication (-40 dB or less) on TI **R.M.S. VOLTS** meter.

NOTE

RES and **CAP** adjustments interact. Repeat (9) above as necessary for best results.

8. Frequency Accuracy and Stability

a. Performance Check

- (1) Connect frequency counter to TI **OUTPUT** using voltage divider.
- (2) Position controls as listed in (a) through (c) below:
 - (a) **MODE SELECTOR** switch to **BFO**.
 - (b) **RANGE (VOLTS)** switch to **1 V**.
 - (c) **FREQUENCY** dial to **20 Hz**. If frequency counter does not indicate between 39 and 67 ms, perform **b** (1) below.
- (3) Vary autotransformer output between 105 and 125 V ac. Frequency counter will remain between 39 and 67 ms.
- (4) Adjust autotransformer output for 115 V ac.
- (5) Adjust **FREQUENCY** dial to settings listed in table 3. If frequency counter does not indicate within limits specified, perform **b** (2) below.

Table 3. Frequency Accuracy

Test instrument FREQUENCY dial setting (Hz)	Frequency counter indications	
	Min	Max
30	28.329 ms	40.486 ms
40	22.026 ms	28.902 ms
50	18.018 ms	22.472 ms
60	15.244 ms	18.382 ms
60	13.210 ms	15.552 ms
80	11.655 ms	13.477 ms
90	10.428 ms	11.891 ms
100	9.4340 ms	10.638 ms
400	2.4450 ms	2.5575 ms
700	1.4045 ms	1.4535 ms
1,000	0.98522 ms	1.01523 ms
4,000	3,955 Hz	4,045 Hz
7,000	6,925 Hz	7,075 Hz
10,000	9,895 Hz	10,105 Hz
20,000	19,795 Hz	20,205 Hz
30,000	29,695 Hz	30,305 Hz
40,000	39,595 Hz	40,405 Hz
50,000	49,495 Hz	50,505 Hz

- (6) Substitute frequency counter with multimeter.
- (7) Vary **FREQUENCY** dial from 20 Hz to 50 kHz. If multimeter does not indicate at least 1 V, perform **b** (3) below.

b. Adjustments (fig. 2)

- (1) Adjust L6 for out-of-tolerance indications on low end of **FREQUENCY** dial (R).
- (2) Adjust C37 (fig.1) and C38 (fig. 1) for overall in-tolerance indication (R).

NOTE

Because of interaction, repeat (1) and (2) above until no further adjustment is required.

(3) Adjust R116 (fig. 1) for an indication of at least 1 V rms on multimeter (R).

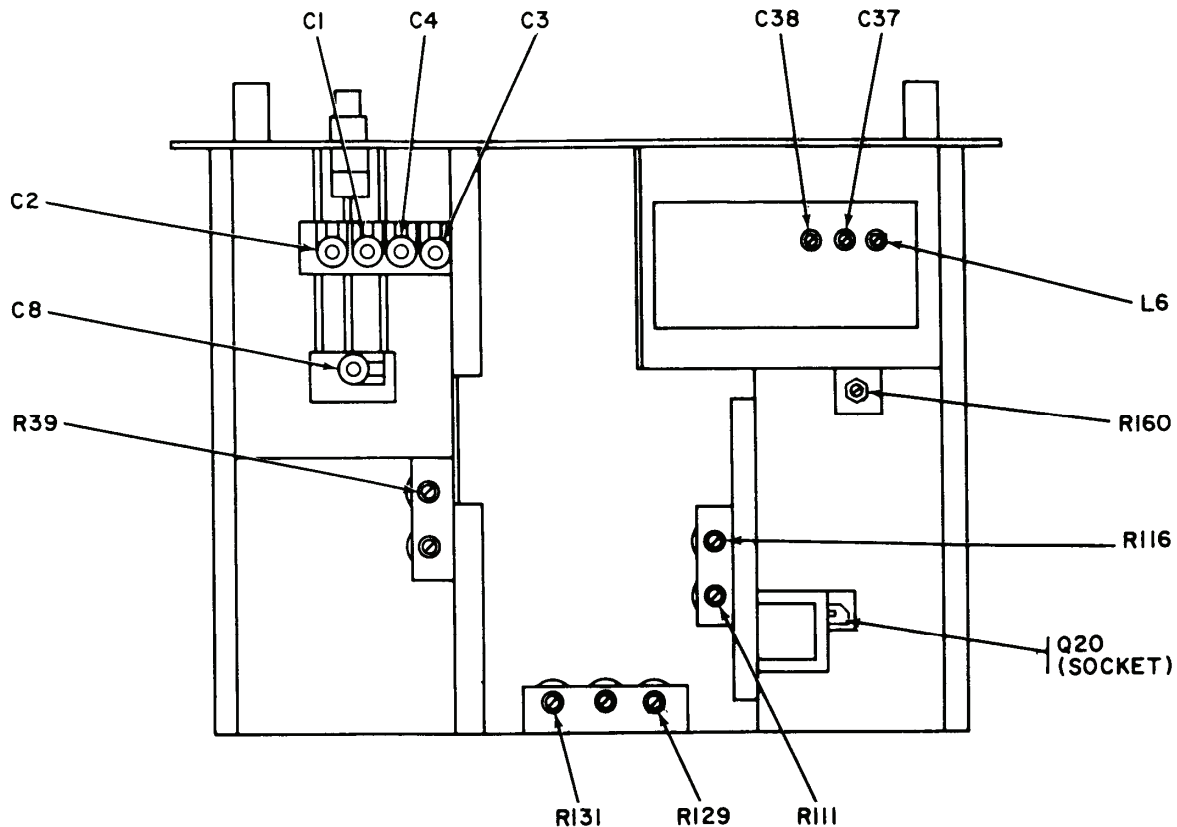


Figure 1. Wave analyzer - adjustment locations.

9. Calibrator and Voltage Accuracy

a. Performance Check

- (1) Position controls as listed in (a) through (c) below:
 - (a) **MODE SELECTOR** switch to **NORMAL**.
 - (b) **RANGE** switch to **METER CAL**.
 - (c) **FREQUENCY** dial adjusted for maximum **TI R.M.S. VOLTS** meter indication (approx. 4 to 5 kHz).
- (2) Adjust **METER CAL** adjustment screw (front panel) until **TI R.M.S. VOLTS** meter indicates 1.0 on 0 to 1.0 scale. If 1.0 cannot be obtained, perform **b** (1) through (5) below.
- (3) Connect calibrator to **TI INPUT** terminal.
- (4) Set **RANGE (VOLTS)** switch to 1 V.

- (5) Adjust calibrator output to 0.95 V at 1 kHz.
- (6) Adjust **FREQUENCY** dial for maximum indication on TI **R.M.S. VOLTS** meter (peaks at approx. 1 kHz).
- (7) Set **MODE SELECTOR** switch to **AFC**.
- (8) Adjust calibrator output until TI **R.M.S. VOLTS** meter indicates 1.0 on 0 to 1.0 scale. If calibrator output is not between 0.95 and 1.05 V, perform **b** (1) through (5) below.
- (9) Connect oscilloscope to TI **OUTPUT** connector. If oscilloscope does not display an undistorted waveform with an amplitude between 6.3 and 7.7 V p-p, perform **b**(6) below.
- (10) Disconnect oscilloscope from TI and repeat technique of (8) above for TI switch settings listed in table 4. Calibrator will indicate within limits specified.

Table 4. Voltage Accuracy

Test instrument				Calibrator indications (rms)	
MAX INPUT VOLTAGE switch positions	RANGE (VOLTS) switch positions	R.M.S. VOLTS meter indications		Min	Max
		0 to 1.0 scale	0 to 3 scale		
0.03	300 μ V	---	3	285 μ V	315 μ V
0.03	1 MV	1.0	---	0.95 mV	1.05 mV
0.03	3 MV	---	3	2.85 mV	3.15 mV
0.03	10 MV	1.0	---	9.5 mV	10.5 mV
0.1	30 MV	---	3	28.5 mV	31.5 mV
0.1	100 MV	1.0	---	95 mV	105 mV
0.3	300 MV	---	3	285 mV	315 mV
1	1 V	1.0	---	0.95 V	1.05 V
1	1 V	.8	---	0.75 V	0.85 V
1	1 V	.6	---	0.55 V	0.65 V
1	1 V	.4	---	0.35 V	0.45 V
1	1 V	.2	---	0.15 V	0.25 V
3	3 V	---	3	2.85 V	3.15 V
10	10 V	1.0	---	9.5 V	10.5 V
30	30 V	---	3	28.5 V	31.5 V
100	100 V	1.0	---	95 V	105 V
300	300 V	---	3	285 V	315 V

- (13) Connect equipment as shown in figure2.

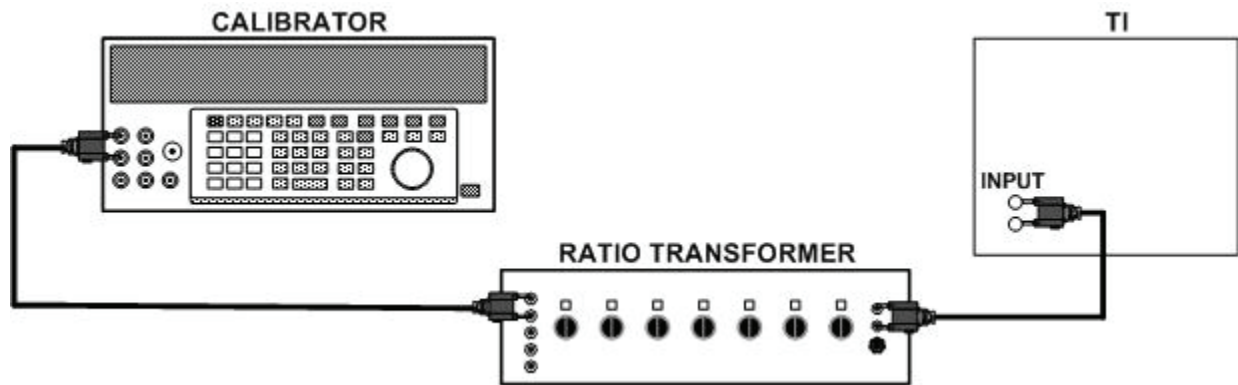


Figure 2. Calibrator and voltage accuracy - equipment setup.

(12) Set **MAX INPUT VOLTAGE** switch to .03 and **RANGE (VOLTS)** switch to 30 μV .

(13) Adjust ratio transformer to indicate 0.0001.

(14) Adjust calibrator output until TI **R.M.S. VOLTS** meter indicates 3 on 0 to 3 scale. Calibrator will indicate between 0.285 to 0.315 V_{rms} .

(15) Set **RANGE** switch to **100 μV** .

(16) Adjust calibrator output until TI **R.M.S. VOLTS** meter indicates 1.0 on 0 to 1.0 scale. Calibrator will indicate between 0.95 and 1.05 Vac.

b. Adjustments

(1) Adjust calibrator for an output of 1.0 Vac.

(2) Set **RANGE (VOLTS)** switch to **METER CAL**.

(3) Adjust **METER CAL** adjustment screw until TI **R.M.S. VOLTS** meter indicates 1.0 to 1.0 scale.

(4) Adjust **FREQUENCY** dial for maximum indication on TI **R.M.S. VOLTS** meter (approx. 4 to 5 kHz).

(5) Adjust R39 (fig. 1) until TI **R.M.S. VOLTS** meter indicates 1.0 on 0 to 1.0 scale (R).

(6) Adjust R111 (fig. 1) until oscilloscope indicates 7 V p-p (R).

10. Frequency Response

a. Performance Check

(1) Connect calibrator wideband output to TI **INPUT** terminal.

(2) Position controls as listed in (a) through (d) below:

(a) **MAX INPUT VOLTAGE** switch to 1.

(b) **RANGE (VOLTS)** switch to 100 mV.

(c) **SCALE VALUE** switch to **RELATIVE**.

(d) **REF ADJUST** control fully cw.

(3) Adjust calibrator output frequency for 400 Hz at an amplitude of 90 mV.

(4) Adjust TI **FREQUENCY** dial to 400 Hz and fine tune for a peak indication on **R.M.S. VOLTS** meter.

NOTE

If necessary, increase calibrator output amplitude for at least three-quarter scale indication on TI **R.M.S. VOLTS** meter.

(5) Record TI **R.M.S. VOLTS** meter indication and calibrator output indication.

(6) Adjust calibrator output frequency to 50 kHz and fine tune TI for a peak indication on **R.M.S. VOLTS** meter.

(7) Adjust calibrator output until TI **R.M.S. VOLTS** meter indicates value recorded in (5) above. If calibrator does not indicate within ± 5 percent of value recorded in (5) above, perform **b** (1) and (2) below.

(8) Repeat technique of (3) through (7) above for TI switch setting listed in table 5. If calibrator does not indicate within limits specified in (7) above, perform adjustments listed in table 5.

Table 5. Frequency Response

Test instrument		Calibrator output amplitude	Adjustments (fig. 1) (R)
MAX INPUT VOLTAGE switch position	RANGE (VOLTS) switch position		
0.3	300 MV	280 mV	C4
1	1 V	0.9 V	C1
3	3 V	2.8 V	C8
10	3 V	2.8 V	C2

b. Adjustments

(1) Adjust calibrator output amplitude for indication as established in **a** (5) above.

(2) Adjust C3 (fig. 1) until TI **R.M.S. VOLTS** meter indicates value recorded in **a** (5) above (R).

11. Selectivity

a. Performance Check

(1) Connect frequency counter and calibrator to TI **INPUT** terminal using 600 Ω load.

(2) Position controls as listed in (a) through (e) below:

- (a) **MAX INPUT VOLTAGE** switch to 3.
- (b) **MODE SELECTOR** switch to **NORMAL**.
- (c) **SCALE VALUE** switch to **RELATIVE**.
- (d) **RANGE (VOLTS)** switch to **3 V**.
- (e) **FREQUENCY** dial to **25 Hz**.

(3) Adjust calibrator output for a 40-ms indication on frequency counter.

(4) Adjust **FREQUENCY** dial for a peak indication on TI **R.M.S. VOLTS** meter.

(5) Adjust calibrator amplitude for a 3 V indication on TI **R.M.S. VOLTS** meter.

(6) Adjust **REF ADJUST** control for a 0 (zero) dB indication on TI **R.M.S. VOLTS** meter.

(7) Slowly decrease calibrator frequency until TI **R.M.S. VOLTS** meter indicates -3 dB. Record frequency counter indication.

(8) Slowly increase calibrator frequency until TI **R.M.S. VOLTS** meter passes through reference established in (6) above and decreases on other side to -3 dB. Record frequency counter indication.

(9) Determine difference between value recorded in (7) and (8) above. Difference will not exceed 15 ms.

(10) Compute center frequency by adding values recorded in (7) and (8) above and dividing by 2.

(11) Adjust calibrator frequency to indicate center frequency value calculated in (10) above, then adjust frequency dial for peak TI meter indication.

(12) Adjust **REF ADJ** control for 1.0 V indication on TI **R.M.S. VOLTS** meter (100 percent).

NOTE

It may be necessary to increase calibrator output for desired indication.

(13) Increase calibrator frequency until TI **R.M.S. VOLTS** meter decreases one-half of one division (one percentage point). Record frequency counter indication.

(14) Decrease calibrator frequency until TI **R.M.S. VOLTS** meter passes through reference established in (12) above and decreases on other side by one-half of one division (one percentage point). Record frequency counter indication.

(15) Determine difference between values recorded in (13) and (14) above. Difference will be 3 ms or greater.

NOTE

The one percentage points are critical. If difference in (15) above is less than 3 ms, repeat (11) through (15) above.

(16) Adjust calibrator frequency for a 3.85 ms indication on frequency counter.

(17) Adjust **TI FREQUENCY** dial (approximately 260 Hz) for peak TI meter indication.

(18) Repeat (12) above. Record dB value of **RANGE (VOLTS)** switch indicator. (1 V used for 0 (zero) dB reference.)

(19) Decrease calibrator frequency until counter indicates 5.26 ms. Maintain a constant output.

(20) Decrease **RANGE (DECIBELS)** switch setting by 60 dB. TI meter will indicate 0.1 V or less.

(21) Set **RANGE (VOLTS)** switch to 3 V.

(22) Repeat (16) through (20) above, except in (18) above, increase calibrator frequency to 3.03 ms.

b. Adjustments. No adjustments can be made.

12. AFC Discriminator

a. Performance Check

- (1) Connect equipment as shown in figure 3.

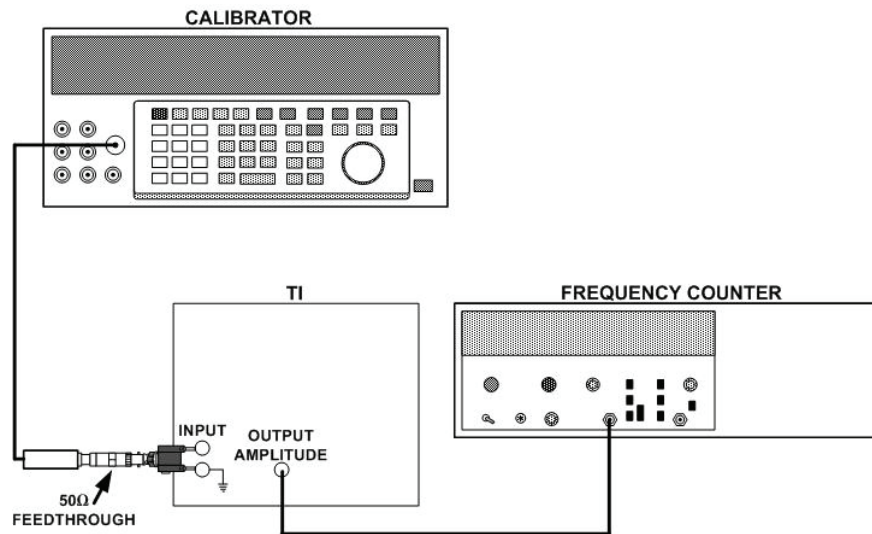


Figure 3. AFC discriminator - equipment setup.

- (2) Position controls as listed in (a) through (e) below:
- RANGE (VOLTS)** switch to 3 V.
 - MAX INPUT VOLTAGE** switch to 3.
 - MODE SELECTOR** switch to **NORMAL**.
 - SCALE VALUE** switch to **ABSOLUTE**.
 - FREQUENCY** dial to **400 Hz**.
- (3) Adjust calibrator output for 1 V and a 2.5 ms indication on counter.
- (4) Position controls as listed in (a) through (e) below:
- RANGE (VOLTS)** switch to 1 V.
 - SCALE VALUE** switch to **RELATIVE**.
 - FREQUENCY** dial to same frequency as calibrator. Fine-tune peak indication.
 - REF ADJUST** control for 1 V.
 - MODE SELECTOR** switch to **AFC**.

NOTE

AFC circuit loss of control in (5) and (7) below is determined by a sudden drop on TI **R.M.S. VOLTS** meter.

- (5) Slowly increase calibrator frequency (AFC circuit will automatically track changing frequency) until AFC circuit loses control. If counter indication is more than 2.0 ms, perform **b** below.

(6) Repeat (3) above.

(7) Slowly decrease calibrator frequency until **AFC** circuit loses control. If counter indication is less than 3.3 ms, perform **b** below.

b. Adjustments (fig. 1)

(1) Set **MODE SELECTOR** switch to **NORMAL**.

(2) Connect multimeter positive lead to center tap (wiper arm) of R129 and negative lead to chassis ground.

(3) Adjust R129 for a -1 V dc indication on multimeter (R).

(4) Remove positive lead from R129 and reconnect to center tap of R131.

(5) Adjust R131 for a -1 V dc indication on multimeter (R).

(6) Repeat **a** (4) through (7) above.

13. Power Supply

NOTE

Do not perform power supply check if all other parameters are within tolerance.

a. Performance Check. Connect multimeter positive lead to emitter of Q20 (SOCKET) (fig. 1) and negative lead to chassis ground. If multimeter does not indicate between -14.8 and -15.2 V dc, perform **b** below.

b. Adjustments. Adjust R160 (ADJ -15 V) (fig. 1) for a -15 V dc indication on multimeter (R).

14. Final Procedure

a. Deenergize and disconnect all equipment.

b. Annotate and affix DA label/form in accordance with TB 750-25.

By Order of the Secretary of the Army:

Official:



JOYCE E. MORROW
*Administrative Assistant to the
Secretary of the Army*

GEORGE W. CASEY, JR.
*General, United States Army
Chief of Staff*

0803808

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342119, requirements for calibration procedure TB 9-6625-1138-24.

Instructions for Submitting an Electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" whomever@redstone.army.mil

To: <2028@redstone.army.mil

Subject: DA Form 2028

1. **From:** Joe Smith
2. **Unit:** home
3. **Address:** 4300 Park
4. **City:** Hometown
5. **St:** MO
6. **Zip:** 77777
7. **Date Sent:** 19-OCT-93
8. **Pub no:** 55-2840-229-23
9. **Pub Title:** TM
10. **Publication Date:** 04-JUL-85
11. **Change Number:** 7
12. **Submitter Rank:** MSG
13. **Submitter FName:** Joe
14. **Submitter MName:** T
15. **Submitter LName:** Smith
16. **Submitter Phone:** 123-123-1234
17. **Problem:** 1
18. **Page:** 2
19. **Paragraph:** 3
20. **Line:** 4
21. **NSN:** 5
22. **Reference:** 6
23. **Figure:** 7
24. **Table:** 8
25. **Item:** 9
26. **Total:** 123
27. **Text**

This is the text for the problem below line 27.

