# *TB 9-6625-2278-24

**DEPARTMENT OF THE ARMY TECHNICAL BULLETIN**

# CALIBRATION PROCEDURE FOR POWER METER HEWLETT-PACKARD, MODEL 438A AND 438AOPT002

Headquarters, Department of the Army, Washington, DC
17 June 2009



**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.



*This bulletin supersedes TB 9-6625-2278-35, dated 13 May 1992.

## SECTION I
## IDENTIFICATION AND DESCRIPTION

**1. Test Instrument Identification.** This bulletin provides instructions for the calibration of Power Meter, Hewlett-Packard, Model 438A and 438AOPT002. 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**. None

**b. Time and Technique**. The time required for this calibration is approximately 4 hours, using the dc and low frequency and microwave 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 |
|---|---|
| Zero set (digital settability of zero) | ±0.5% FS (most sensitive range) Decrease percentage by factor of 10 for each higher range ±l count) |
| Instrument accuracy single channel mode | Range: 3 μW to 100 mW<br>Accuracy: ±0.02 dB (within same calibration range)<br>Plus: ±0.02 dB (outside calibration range) |
| Power reference | Range: 1 mW<br>Accuracy: ±1.2%<br><br>Frequency: 50 MHz<br>Accuracy: ±0.5 MHz |

## 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-287, and 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 four-to-one accuracy will be listed, and 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: Power Sensor Cable, Hewlett-Packard, Model 11730A (supplied with TI).

Table 2. Minimum specifications of Equipment Required

| Common name (official nomenclature) | Minimum use specifications | Manufacturer and model (part number) |
|---|---|---|
| MICROWAVE FREQUENCY COUNTER | Frequency range: 49.5 to 50.5 MHz<br>Accuracy: ±0.25% | Anritsu, Model MF2414B003 (MF2414B003) |
| MULTIMETER | Voltage range: -15.05 to 15.75 V dc<br>Accuracy: ±0.08%<br>Ability to measure approximates 200 Ω<br>Ability to measure μV dc | Hewlett-Packard, Model 3458A (3458A) |
| POWER METER | Power range: 0.988 to 1.012 mW<br>Frequency range: 50 MHz<br>Power accuracy: ±0.3% (±0.7%)<br><br>Must have $V_{COMP}$ and $V_{RF}$ Outputs | Hewlett-Packard, Model E12-432A (MIS-30525) w/thermistor mount Hewlett-Packard, Model 478A-H75 (7915907) or 8478B (8478B) |
| RANGE CALIBRATOR | Power range: 3.13 μW to 101.0 mW<br>Accuracy: ±0.125% (± 0.25%) | Hewlett-Packard, Model 11683A (11683A) |

## 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 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 manufacturers manual for this TI.

**d**. When indications specified in paragraphs **8** through **11** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **11**. 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 the safety precautions. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

**a**. Connect TI to a 115V ac source.

**b**. Set TI and range calibrator **LINE** switches to **ON** position and allow 30 minutes for equipment to warm up and stabilize.

**NOTE**

If an out-of-tolerance indication is obtained during any performance check, re-zero TI as follows: Set range calibrator **FUNCTION** switch to **STANDBY,** then press TI **ZERO** key and wait for display to stabilize.

## 8. Zero Carryover

### a. Performance Check

(1) Set TI and range calibrator **LINE** switches to **OFF** position.

(2) Connect channel **A** power sensor input to range calibrator using cable supplied with TI.

**NOTE**

Press **SENSOR B** key in (3) (c) below only if instructed to do so by text.

(3) Set TI controls as listed in (a) through (c) below:

(a) Press **LINE** switch to **ON** position.
(b) Press **PRESET** key.
(c) Press **SENSOR A** key.

(4) Set range calibrator **FUNCTION** switch to **STANDBY** and **LINE** switch to **ON** position.

(5) Press **ZERO** key and wait approximately 15 to 17 seconds for display to reappear and stabilize. If TI display does not indicate between -0.06 and +0.06 μW, perform **b** below.

**NOTE**

TI is now zeroed on range 1 (most sensitive).

**NOTE**

Value in (6) (b) below will reflect table 3 **MNL RANGE** settings.

(6) Press TI keys as listed in (a) through (c) below. TI display will indicate within the limits specified in table 3; if not, perform **b** below.

(a) **MNL RANGE**.
(b) **2**.
(c) **ENTER**.

(7) Repeat technique of (6) above for remaining **MNL RANGE** settings listed in table 3.

(8) Press TI **LINE** and range calibrator **LINE** switches to **OFF** position.

(9) Move cable connection from channel **A** power sensor input to channel **B** power sensor input.

**NOTE**

For (10) below, press **SENSOR B** key when repeating (3)(c) above.

Table 3. Power Meter Zero Carryover

| **MNL RANGE** key settings | Test instrument display indications | |
|---|---|---|
| | Min | Max |
| 2 | -0.1 μW | +0.1 μW |
| 3 | -0.001 mW | +0.001 mW |
| 4 | -0.01 mW | +0.01 mW |
| 5 | -0.1 mW | +0.1 mW |

(10) Repeat (3) through (7) above for channel **B** sensor input.

**NOTE**

Perform (11) through (15) below only if TI has option 002.

(11) Repeat (8) above.

(12) Move channel **B** power sensor connection (front panel) to channel **A** power sensor input (rear panel).

(13) Repeat (3) through (8) above.

(14) Move cable connection from channel **A** power sensor input (rear panel) to channel **B** power sensor input (rear panel).

**NOTE**

For (15) below, press **SENSOR B** key when repeating (3)(c) above.

(15) Repeat (3) through (7) above for channel **B** sensor input.

**b. Adjustments**

(1) Press TI and range calibrator **LINE** switches to **OFF** position.

(2) Disconnect TI from range calibrator.

(3) Remove TI top cover.

(4) Locate service switch A3S1 (fig. 1) (located on A3 board).

**NOTE**

Service switch will be either located on TI in POSITION A or POSITION B (fig. 1).

(5) Note position of all four switches of service switch A3S1 (fig. 1).

(6) Place all four switches of service switch A3S1(fig. 1) into test position.

**NOTE**

Test position will be opposite to switch positions now displayed on A3S1 (fig. 1) service switch.

(7) Press **LINE** switch to **ON** position.

**NOTE**

TI display will indicate _ _ _ _ _.

(8) Connect multimeter (dc mode) negative lead to A5TP2 (fig. 2) and then connect digital multimeter positive lead to A5TP8 (fig. 2)

(9) Record multimeter indication.

(10) Enter multimeter indication recorded in (9) above into power meter by pressing five digits (four decimal places) with TI keyboard and then by pressing **ENTER** key.

(11) Adjust A5R61 (fig. 2) for a TI display indication centered as close as possible to zero (R).

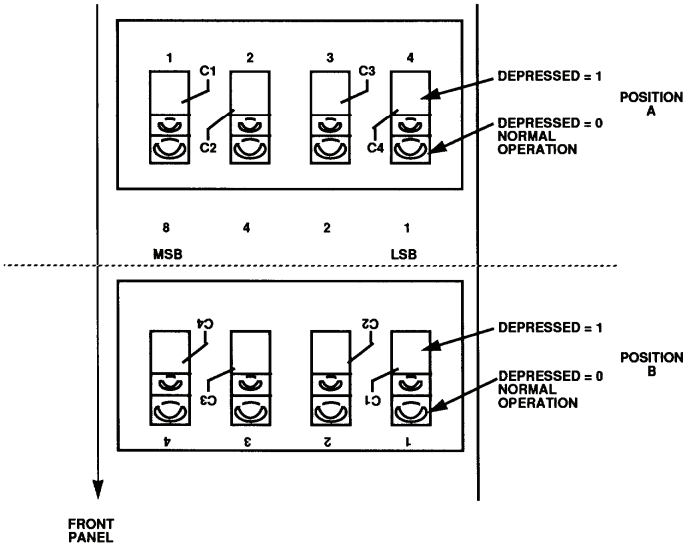


Figure 1. A3S1 service switch.

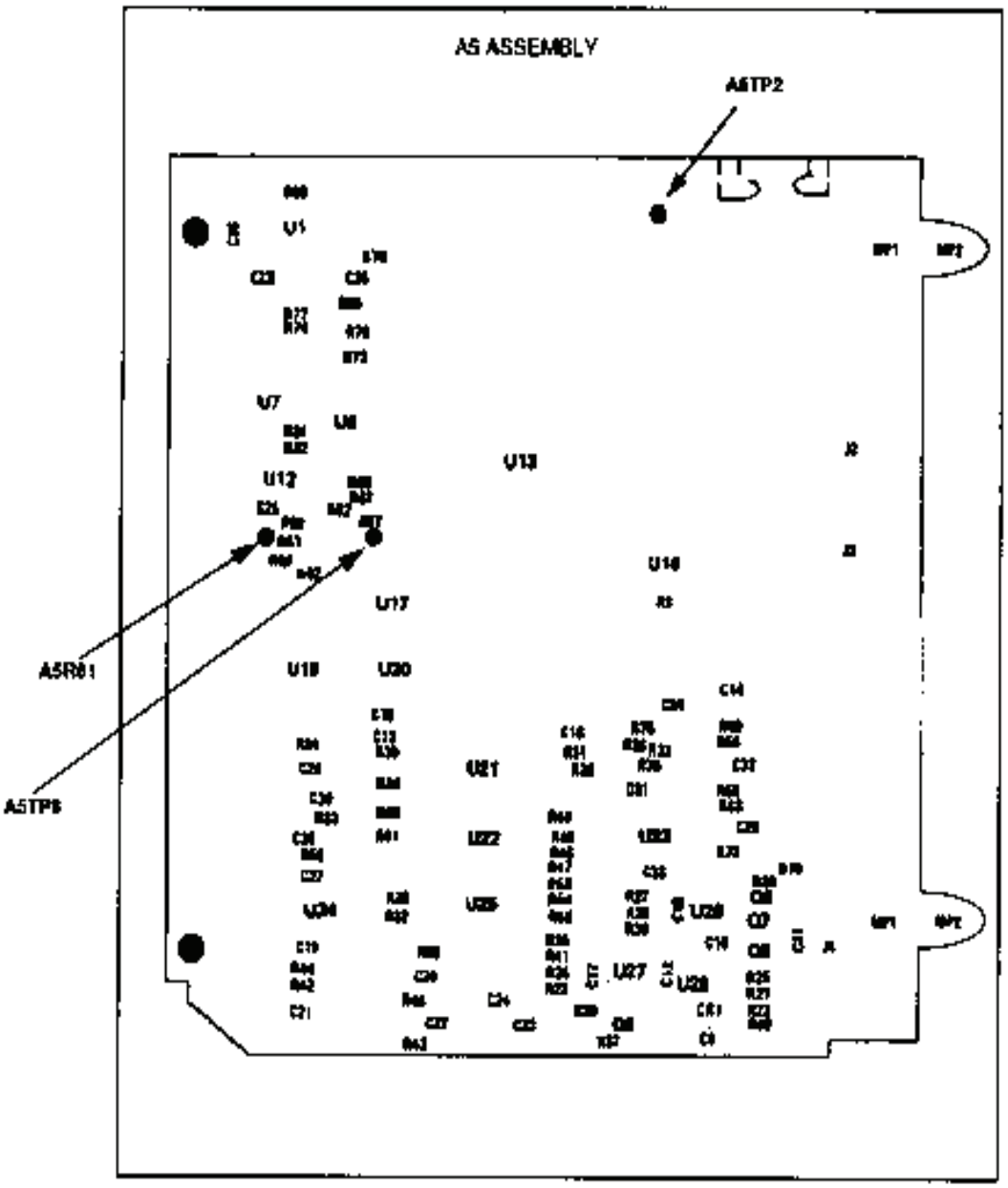


Figure 2. A5 component location.

(12) Disconnect multimeter from TI.

(13) Press **LINE** switch to **OFF** position.

(14) Place all four switches of service switch A3S1 (fig. 1) into NORMAL position.

(15) Replace TI top cover.

(16) Press **LINE** switch to **ON** position.

**9. Instrument Accuracy Test**

**a. Performance Check**

(1) Press TI and range calibrator **LINE** switches to **OFF** position.

(2) Connect channel **A** power sensor input to range calibrator using cable supplied with TI.

(3) Set TI controls as listed in (a) through (c) below.

(a) Press **LINE** switch to **ON** position.

(b) Press **PRESET** key.

(c) Press **SENSOR A** key.

(4) Set range calibrator switches as listed in (a) through (d) below:

(a) **FUNCTION** switch to **STANDBY**.

(b) **POLARITY** switch to **NORMAL**.

(c) **RANGE** switch to **1 mW**.

(d) **LINE** switch to **ON** position.

(5) Press **ZERO** key and wait approximately 15 to 17 seconds for display to reappear and stablilize. TI display will indicate between -0.06 and +0.06 μW.

(6) Set range calibrator **FUNCTION** switch to **CALIBRATE.**

(7) Press TI keys as listed in (a) through (f) below. TI display will indicated between 0.995 and 1.005 mW; if not, perform **b** below.

(a) **CAL ADJ** key.

(b) **±** key (**SET A** key location).

(c) **1** key.

(d) **0** key.

(e) **0** key.

(f) **ENTER** key.

**NOTE**

The minus sign in (7) (b) above indicates the use of an external reference source.

**NOTE**

If **NO REF** error is displayed, repeat (7) above.

(8) Set range calibrator **RANGE** switch to settings listed in table 4. If TI display does not indicate within the limits in table 4, perform **b** below.

(9) Set range calibrator **FUNCTION** switch to **STANDBY** position.

Table 4. Power Meter Accuracy

| Range calibrator **RANGE** switch settings | Test instrument display indications | |
|---|---|---|
| | Min | Max |
| 3 μW | 3.13 μW | 3.19 μW |
| 10 μW | 9.90 μW | 10.10 μW |
| 30 μW | 31.3 μW | 31.9 μW |
| 100 μW | 99 μW | 101.0 μW |
| 300 μW | 0.314 mW | 0.318 mW |
| 3 mW | 3.13 mW | 3.19 mW |
| 10 mW | 9.90 mW | 10.10 mW |
| 30 mW | 31.3 mW | 31.9 mW |
| 100 mW | 99.0 mW | 101.0 mW |

(10) Move cable connection from channel **A** power sensor input to channel **B** power sensor input.

(11) Press **SENSOR B** key.

(12) Repeat (4) (c) and (5) through (8) above for channel **B** sensor input.

(13) Set **dBm/WATT** switch to **dBm** position. If TI display does not indicate between 19.96 and 20.04 dBm, perform **b** below.

(14) Set range calibrator **RANGE** switch to **-10 dBm.** If TI display does not indicate between 9.96 and -10.04 dBm, perform **b** below.

(15) Press **REL** key. If TI display does not indicate between -0.01 and +0.01 dB, perform **b** below.

**b. Adjustments**

(1) Press TI and range calibrator **LINE** switches to **OFF** position.

(2) Connect channel **A** power sensor input to range calibrator using cable supplied with TI.

(3) Set range calibrator switches as listed in (a) through (d) below:

(a) **LINE** switch to **ON** position.
(b) **RANGE** switch to **1 mW**.
(c) **FUNCTION** switch to **STANDBY**.
(d) **POLARITY** switch to **NORMAL**.

(4) Press TI controls as listed in (a) through (c) below:

(a) **LINE** switch to **ON** position.
(b) **SENSOR A** key.

(c) **PRESET** key.

(5) Press **ZERO** key and wait approximately 15 to 17 seconds for display to reappear and stabilize.

(6) Set range calibrator **FUNCTION** switch to **CALIBRATE**.

(7) Press TI keys as listed in (a) through (f) below:

(a) **CAL ADJ** key.

(b) ± key (**SET A** key location).

(c) **1** key.

(d) **0** key.

(e) **0** key.

(f) **ENTER** key.

**NOTE**

The minus sign in (7) (b) above indicates the use of an external reference source.

**NOTE**

If **NO REF** error is displaced, repeat (7) above.

(8) Adjust A4R43 (fig. 3) for a maximum TI display indication (R).

(9) Set range calibration **RANGE** switch to and adjust A4R26 (fig. 3) for a TI display indication between 9.99 and 10.01 mW (R).

(10) Set range calibrator **RANGE** switch to **100 mW** and adjust A4R34 (fig. 3) for a TI display indication between 99.9 and 100.1 mW (R).

(11) Repeat (9) and (10) above until both indications are within the limits specified.

(12) Press TI and range calibrator **LINE** switches to **OFF** position.

(13) Move cable connection from channel **A** power sensor input to channel **B** power sensor input.

(14) Press TI controls as listed in (a) through (c) below:

(a) **LINE** switch to **ON** position.
(b) **PRESET** key.
(c) **SENSOR B** key.

(15) Set range calibrator switches as listed in (a) through (d) below:

(a) **LINE** switch to **ON** position.
(b) **RANGE** switch to **1 mW**.
(c) **FUNCTION** switch to **STANDBY**.
(d) **POLARITY** switch to **NORMAL**.

(16) Press **ZERO** key and wait approximately 15 to 17 seconds for display to reappear and stabilize.

(17) Set range calibrator **FUNCTION** switch to **CALIBRATE**.

(18) Set range calibrator **RANGE** switch to **10 mW** and adjust A4R27 (fig. 3) for a TI display indication between 9.99 and 10.01 mW (R)

(19) Set range calibrator **RANGE** switch to **100 mW** and adjust A4R35 (fig. 3) for a TI display indication between 99.9 and 100.1 mW (R).

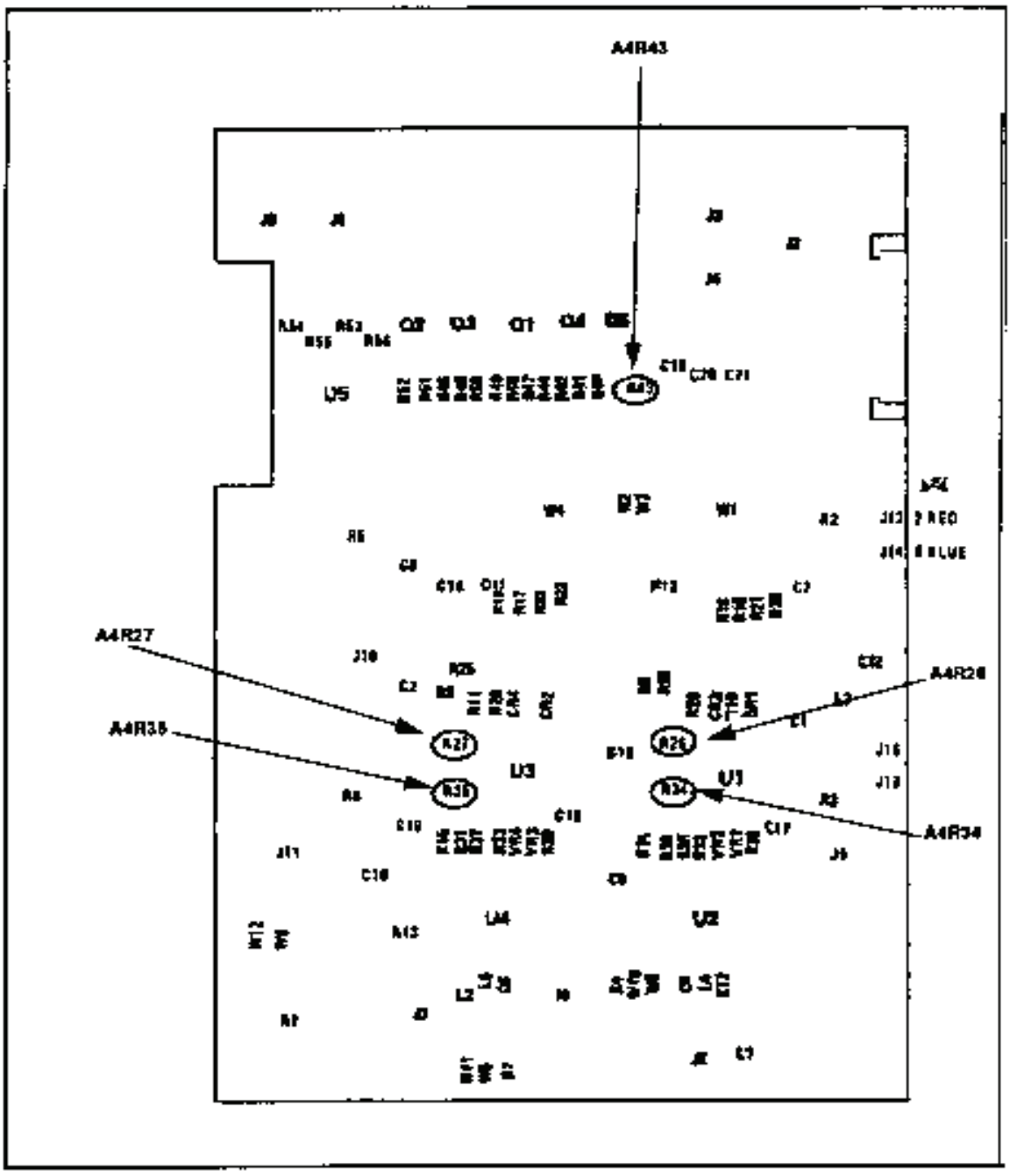


Figure 3. A4 board - component location.

(20) Repeat (18) and (19) above until both indications are within the limits specified.

(21) Press TI and range calibrator **LINE** switches to **OFF** position.

(22) Disconnect range from TI calibrator.

(23) Press TI **LINE** switch to **ON** position.

**10. Power Reference Oscillator Frequency Accuracy Test**

**a. Performance Check**

(1) Press **POWER REF OSC** switch to off position (LED off).

(2) Connect **POWER REF** to **INPUT 2** of microwave frequency counter.

(3) Press **POWER REF OSC** switch to on position (LED on). If microwave frequency counter indication is not between 49.5 and 50.5 MHz, perform **b** below.

**b. Adjustments**

(1) Press TI **LINE** switch to **OFF.**

(2) Remove TI top cover and loosen screws holding the A3 CPU assembly. Swing out assembly.

**NOTE**

Screwdriver adjustment is accessible through a hole in the deck.

(3) Press TI **LINE** switch to **ON** position.

(4) Adjust G1A1L1 for a microwave frequency counter indication between 49.5 and 50.5 MHz (R).

(5) Press TI **LINE** switch to **OFF** position.

(6) Swing in assembly and tighten screws holding the A3 CPU assembly. Replace TI top cover.

(7) Press TI **LINE** switch to **ON** position.

**11. Power Reference Level**

**a. Performance Check**

(1) Set power meter power pushbutton to **OFF** position.

(2) Disconnect thermistor mount from power meter interconnect cable.

(3) Connect multimeter (resistance mode) between vrf terminal on power meter (rear panel) and pin 1 of thermistor mount end of power meter interconnect cable.

(4) Round off multimeter indication to two decimal places and record this value as power meter internal bridge resistance R (value will be approximately 200Ω).

(5) Connect thermistor mount to power meter interconnect cable.

(6) Connect equipment as shown in figure 4.

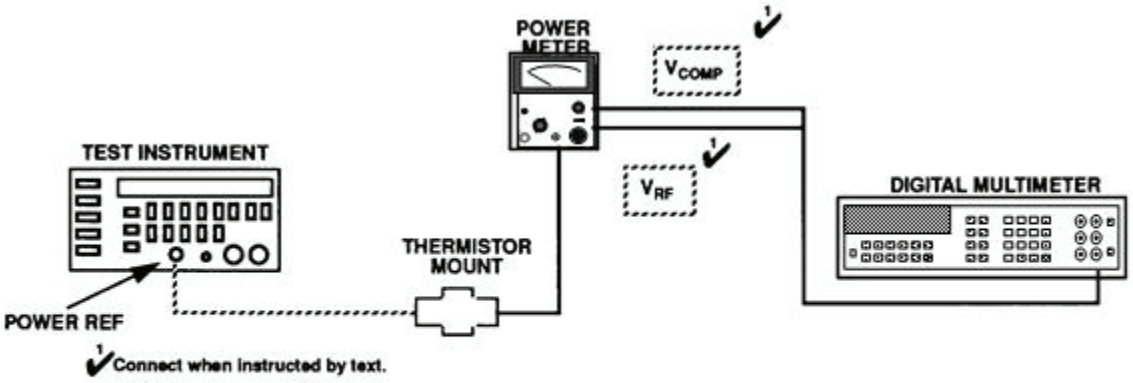


Figure 4. Power reference level - equipment setup.

(7) Set power meter power pushbutton to **ON** position.

(8) Set TI **LINE** switch to **ON** position and **POWER REF OSC** switch to off (LED off).

**NOTE**

Allow equipment and thermistor mount to warm-up for 30 minutes before proceeding to (9) below.

(9) Set power meter **RANGE** switch to **COURSE ZERO** and adjust front panel **COURSE ZERO** control for a zero meter indication.

(10) Fine zero power meter on most sensitive range then set power meter **RANGE** switch to **1 mW.**

(11) Ensure multimeter input terminals are isolated from chassis ground for (12) below.

(12) Adjust multimeter to measure microvolts dc.

(13) Connect multimeter positive lead to power meter $V_{comp}$ (fig. 4) and connect multimeter negative lead to power meter $V_{RF}$ (fig. 4).

(14) If multimeter indication is 400 μV or less, record multimeter indication and proceed to (16) below; if not, proceed to (15) below.

(15) Hold power meter **FINE ZERO CONTROL** and adjust **COURSE ZERO** control for a multimeter indication 200 μV or less. Record multimeter indication.

(16) Round off indications recorded in (14) or (15) above to the nearest microvolts and record this value as $V_0$ .

(17) Press **POWER REF OSC** switch to on position (LED on). Record ultimeter indication as $V_1$.

(18) Disconnect multimeter negative lead from power meter $V_{RF}$ (fig. 4) and connect multimeter negative lead to power meter chassis ground. Record ultimeter indication as $V_{COMP}$.

(19) Calculate the **POWER REF OSC** output level PRF from the below listed formula:

$$PRF \quad \frac{2\, V_{COMP}\,(V_1 - V_0) + V_0^2 - V_1^2}{4\,R\ (\text{calibration factor})}$$

Where:

PRF = power reference oscillator output power level

$V_{COMP}$ = value recorded in (18) above

$V_1$ = value recorded in (17) above

$V_0$ = value recorded in (16) above

R = value recorded in (4) above

Calibration factor = value for thermistor mount at 50 MHz

(20) If calculated PRF is not between 0.988 and 1.012 mW, perform **b** below.

**b. Adjustments**. Remove TI top cover and set **POWER REF OSC** switch to on position (LED on) and adjust LEVEL ADJUST G1A1R4 so that calculated PRF in (19) above is between 0.993 and 1.007 mW (R).

**12. Power Supply**

**NOTE**

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

**a. Performance Check**

(1) Press TI **LINE** switch to **OFF** position and remove TI top and bottom covers.

(2) Loosen screws that secure A3 CPU assembly.

(3) Press **LINE** switch to **ON** position and allow TI to warm-up for 30 minutes before proceeding to (4) below.

(4) Connect multimeter negative lead to chassis ground and then connect multimeter positive lead to A9TP8 (fig. 5). Multimeter will indicate between 14.25 and 15.75 V dc. Record multimeter indication.

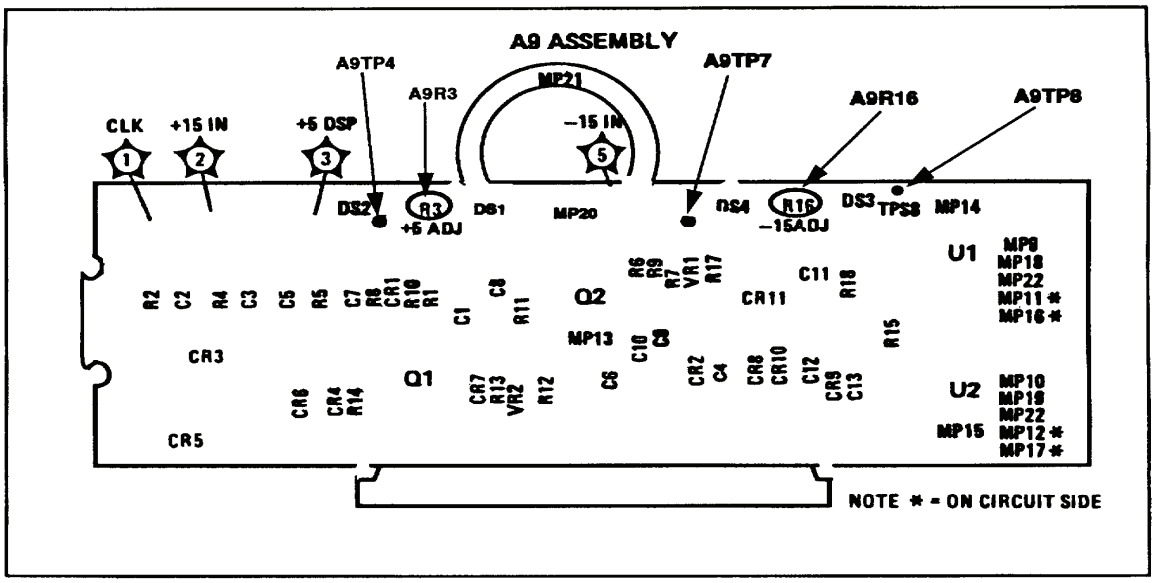


Figure 5. Power supply component location.

**NOTE**

Disregard sign of value measured in (5) below.

(5) Connect multimeter positive lead to A9TP7 (fig. 5). If multimeter does not indicate within ±0.05 V dc of value recorded in (4) above, perform **b** (l) below.

(6) Connect multimeter positive lead to A9TP4 (fig. 5). If multimeter does not indicate between 4.95 and 5.05 V dc, perform **b** (2) below.

(7) Press **LINE** switch to **OFF** position.

(8) Tighten screws that secure A3 CPU assembly.

(9) Replace TI top and bottom covers.

(10) Press **LINE** switch to **ON** position.

**b. Adjustments**

**NOTE**

Disregard sign of value measured in (1) below.

(1) Adjust A9Rl6 (fig. 5) for a digital multimeter indication within ±0.05 V dc of value recorded in (4) above (R).

(2) Adjust A9R3 (fig. 5) for a digital multimeter indication between 4.95 and 5.05 V dc (R).

## 13. 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:

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

Official:

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

0910502

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 343452, requirements for calibration procedure TB 9-6625-2278-24.

## 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.