

TB 9-6625-2364-35

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR POWER METER AGILENT, MODEL E4419B

Headquarters, Department of the Army, Washington, DC
21 June 2005

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, US Army Aviation and Missile Command, AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also provide DA Form 2028 information to AMCOM via e-mail, fax, or the World Wide Web. Our FAX number is: DSN 788-6546 or Commercial 256-842-6546. Our e-mail address is: 2028@redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual. For the World Wide Web, use: <https://amcom2028.redstone.army.mil>.

SECTION		Paragraph	Page
I.	IDENTIFICATION AND DESCRIPTION		
	Test instrument identification	1	2
	Forms, records, and reports	2	2
	Calibration description.....	3	2
II.	EQUIPMENT REQUIREMENTS		
	Equipment required.....	4	2
	Accessories required	5	3
III.	CALIBRATION PROCESS		
	Preliminary instructions	6	3
	Equipment setup.....	7	3
	Zero test.....	8	4
	Instrument accuracy test	9	5
	Power reference level.....	10	7
	Final procedure	11	9

**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Power Meter, Agilent, Model E4419B. 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 in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Zero set (digital settability of zero)	Accuracy: $\pm 0.5\%$ FS (most sensitive range. Decrease percentage by factor of 10 for each higher range ± 1 count)
Instrument accuracy	Range: -70dBm to $+44\text{dBm}$ (power sensor dependent) Accuracy: ± 0.02 dB (logarithmic) or 0.5% (linear)
Power reference	Range: 1 mW Accuracy: $\pm 0.9\%$ Frequency: 50 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, 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: Power Sensor Cable, Hewlett-Packard, Model 11730A.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
DIGITAL MULTIMETER	Voltage range: 0 to 20 V dc Accuracy: $\pm 0.08\%$ Ability to measure approximately 200Ω Ability to measure μV dc	Hewlett-Packard, Model 3458A (3458A)
FREQUENCY COUNTER	Frequency range: 10 Hz to 50 MHz Accuracy: $\pm 0.25\%$	Fluke, Model PM6681/656 (PM6681/656)
POWER METER	Power range: 1 mW Frequency range: 50 MHz Power accuracy: $\pm 0.2\%$ Must have V_{COMP} and V_{RF} Outputs	Hewlett-Packard, Model E12-432A (MIS-30525) w/thermistor mount Hewlett-Packard, Model H75-478A (7915907)
RANGE CALIBRATOR	Power range: $3.10 \mu W$ to 101.8 mW Accuracy: $\pm 0.25\%$	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. 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.

TB 9-6625-2364-35

- a. Connect TI to a 115 V ac source.
- b. Set TI **POWER** and range calibrator **LINE** switches to on position and allow 30 minutes for equipment to warm-up and stabilize.

NOTE

Throughout this procedure soft keys are identified by the use of brackets [] around the key.

8. Zero Test

a. Performance Check

- (1) Set TI **POWER** and range calibrator **LINE** switches to off position.
- (2) Connect equipment as shown in figure 1.

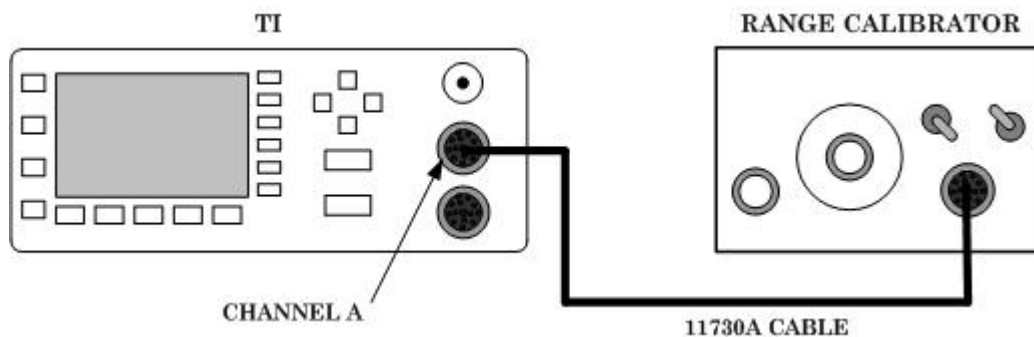


Figure 1. Zero test equipment connection.

- (3) Press TI keys as listed in (a) through (c) below:
 - (a) Press **POWER** switch to on position.
 - (b) Press **Preset Local**, [**Confirm**] keys.
 - (c) Press **dBm/W**, [**W**] keys.
- (4) Set range calibrator controls as listed in (a) through (d) below:
 - (a) **RANGE** to **3 μ W**.
 - (b) **POLARITY** to **NORMAL**.
 - (c) **FUNCTION** to **STANDBY**.
 - (d) **LINE** to **ON**.

NOTE

Allow enough time for the range calibrator to settle to its zero value before attempting to zero the TI. This settling would appear on the TI display as downward drift. When the drift has reached minimum, (typically less than 60 seconds), the range calibrator is settled.

- (5) Press TI keys as listed in (a) through (c) below:
 - (a) **System Inputs, [A Input Settings]**.
 - (b) **More, [ChA Filter], [Filter Off On] to On, [Mode Man Auto] to Man.**
 - (c) **[Length 128]**, using $\leftarrow, \rightarrow, \uparrow$ and \downarrow keys, set filter length to 0512 in pop up window then press **[Enter]**.
- (6) Press TI **Zero Cal, [Zero A]** keys and wait for **Please Wait** symbol to disappear.
- (7) Wait 30 seconds. TI reading will be $0 \pm 0.05 \mu\text{W}$.
- (8) Press TI **POWER** and range calibrator **LINE** switches to off position.
- (9) Move cable connection from TI **CHANNEL A** power sensor input to TI **CHANNEL B** power sensor input.
- (10) Set TI **POWER** switch to on position.
- (11) Press **Preset Local, [Confirm]** keys.
- (12) Press TI **DISPLAY** \uparrow key to activate B display.
- (13) Repeat technique of (3) (c) through (7) above for channel B.

b. Adjustments. None.

9. Instrument Accuracy Test

a. Performance Check

- (1) Press TI **POWER** and range calibrator **LINE** switches to off position.
- (2) Connect equipment as shown in figure 1.
- (3) Press TI keys as listed in (a) through (c) below:
 - (a) Press **POWER** switch to on position.
 - (b) Press **Preset Local, [Confirm]** keys.
 - (c) Press **dBm/W, [W]** keys.
- (4) Set range calibrator controls as listed in (a) through (d) below:
 - (a) **RANGE** to **3 μ W**.
 - (b) **POLARITY** to **NORMAL**.
 - (c) **FUNCTION** to **STANDBY**.
 - (d) **LINE** to **ON**.

NOTE

Allow enough time for the range calibrator to settle to its zero value before attempting to zero the TI. This settling would appear on the TI display as downward drift. When the drift has reached minimum, (typically less than 60 seconds), the range calibrator is settled.

- (5) Press TI keys as listed in (a) through (d) below:
 - (a) **System Inputs, [A Input Settings]**.
 - (b) **More, [ChA Filter], [Filter Off On] to On, [Mode Man Auto] to Man.**

TB 9-6625-2364-35

- (c) [**Length 128**], using $\leftarrow, \rightarrow, \uparrow$ and \downarrow keys set filter length to 512 in pop up window then press [**Enter**].
- (d) Press TI **Zero Cal**, [**Zero A**] keys and wait for **Please Wait** symbol to disappear.
- (6) TI reading will be $0 \pm 0.05 \mu\text{W}$.
- (7) Set range calibrator **FUNCTION** switch to **CALIBRATE** and **RANGE** switch to **1 mW**.
- (8) Press TI [**Cal▶**], [**Cal A**] keys.
- (9) Set range calibrator **RANGE** switch to settings listed in table 4. TI display will indicate within the limits in table 4.

Table 4. Power Meter Accuracy

Range calibrator RANGE switch settings	Test instrument display indications	
	Min	Max
3 μW	3.100 μW	3.230 μW
10 μW	9.900 μW	10.10 μW
30 μW	31.40 μW	31.80 μW
100 μW	99.50 μW	100.5 μW
300 μW	314.00 μW	318.00 μW
1 mW	0.995 mW	1.005 mW
3 mW	3.141 mW	3.171 mW
10 mW	9.984 mW	10.08 mW
30 mW	31.63 mW	31.94 mW
100 mW	100.9 mW	101.8 mW

- (10) Set range calibrator **FUNCTION** switch to **STANDBY** position.
- (11) Press TI **POWER** and range calibrator **LINE** switches to off position.
- (12) Move cable connection from channel **A** power sensor input to channel **B** power sensor input.
- (13) Set TI **POWER** and range calibrator **LINE** switches to on position.
- (14) Press **Preset Local**, [**Confirm**] keys.
- (15) Press TI **DISPLAY** \uparrow key to activate B display.
- (16) Repeat technique of (3) (c) through (10) above for channel B.
- (17) Set range calibrator **FUNCTION** switch to **STANDBY**.
- (18) Set TI **POWER** and range calibrator **LINE** switches to off and disconnect equipment setup.

b. Adjustments. None

10. Power Reference Level

a. Performance Check

- (1) Set power meter power **OFF ON** pushbutton to **OFF** position.
- (2) Disconnect thermistor mount from power meter interconnect cable.
- (3) Connect digital multimeter (resistance mode) between V_{RF} terminal center conductor on power meter (rear panel) and pin 1 of thermistor mount end of power meter interconnect cable.
- (4) Round off digital 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 2.

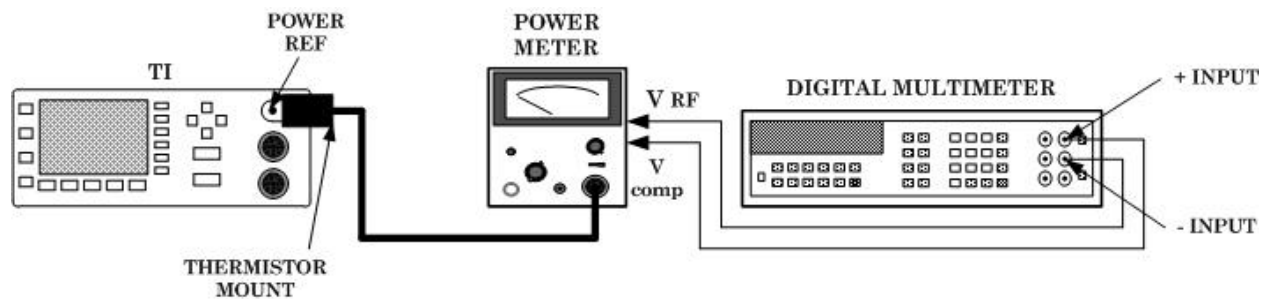


Figure 2. Power reference level - equipment setup.

- (7) Set power meter **OFF ON** pushbutton to **ON** position.
- (8) Set TI **POWER** switch to on and press **Preset Local**, [**Confirm**] keys.
- (9) Set power meter **RANGE** switch to **COARSE ZERO** and adjust front panel **COARSE 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 digital multimeter input terminals are isolated from chassis ground for (12) below.
- (12) Adjust digital multimeter (dc mode) controls to measure microvolts.
- (13) If digital multimeter indication is $400 \mu\text{V}$ or less, record digital multimeter indication and proceed to (15) below; if not, proceed to (14) below.
- (14) Hold power meter **FINE ZERO CONTROL** and adjust **COARSE ZERO** control for a digital multimeter indication $200 \mu\text{V}$ or less. Record digital multimeter indication.
- (15) Round off indications recorded in (13) or (14) above to two decimal places and record this value as V_0 .
- (16) Set power meter to highest range.

TB 9-6625-2364-35

(17) Press TI **Zero Cal**, [**Cal**], **More**, [**Power Ref On**] keys. Record digital multimeter indication, (rounded off to two decimal places), as V_1 .

(18) Disconnect digital multimeter negative lead from power meter V_{RF} (fig. 2) and connect digital multimeter negative lead to power meter chassis ground. Record digital multimeter indication as V_{COMP} .

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

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

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 (15) above

R = value recorded in (4) above

Calibration factor = value for thermistor mount at 50 MHz

(20) If calculated PRF is not between 0.999 and 1.001 mW, perform **b** below.

b. Adjustments

(1) Connect TI **POWER REF** output to frequency counter **A** input.

(2) Press TI **Zero Cal**, [**Cal**], **More**, [**Power Ref On**] keys.

(3) Adjust A2L9 (fig. 3) for 50.0 ± 0.5 MHz.

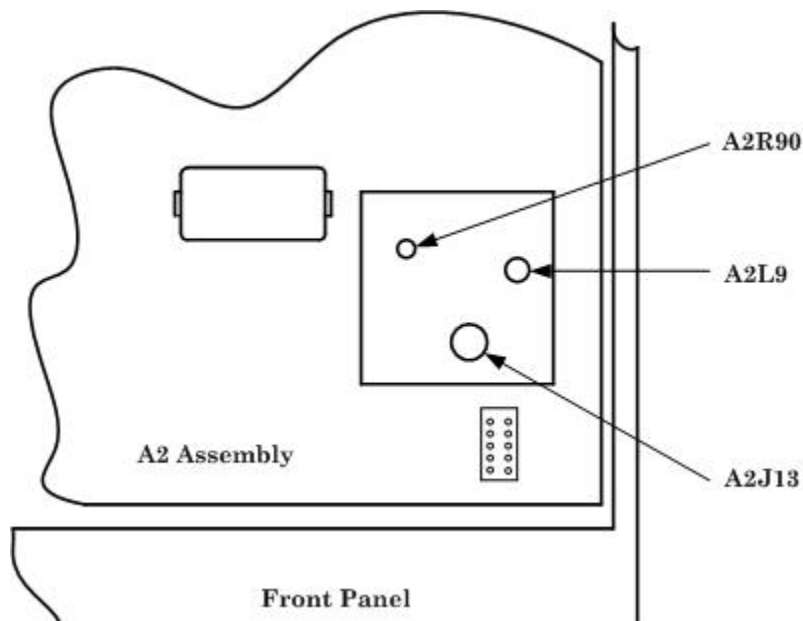


Figure 3. Adjustment locations.

TB 9-6625-2364-35

(4) Connect digital multimeter (resistance mode) between V_{RF} terminal center conductor on power meter (rear panel) and pin 1 of thermistor mount end of power meter interconnect cable.

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

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

(7) Connect equipment as shown in figure 2.

(8) Press **Preset Local**, [**Confirm**] keys.

(9) Set power meter **RANGE** switch to **COARSE ZERO** and adjust front panel **COARSE 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 digital multimeter input terminals are isolated from chassis ground for (12) below.

(12) Adjust digital multimeter (dc mode) controls to measure microvolts.

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

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

(15) Round off indications recorded in (13) or (14) above to two decimal places and record this value as V₀.

(16) Set power meter to highest range.

(17) Disconnect digital multimeter negative lead from power meter V_{RF} (fig. 2) and connect digital multimeter negative lead to power meter chassis ground.

(18) Press **TI Zero Cal**, [**Cal**], **More**, [**Power Ref On**] keys.

(19) Round off indications to two decimal places and record this value as V_{COMP}.

(20) Reconnect digital multimeter negative lead to power meter V_{RF} input.

(21) The multimeter is now set up to measure V₁.

(22) Calculate the required value of V₁ using the following formula:

$$V_1 = V_{\text{COMP}} + V_0 - \sqrt{V_{\text{COMP}}^2 - (10)^{-3} (4R)(\text{Calibration Factor})}$$

(23) Adjust A2R90 (fig. 3) until multimeter indicates value calculated in (22) above.


11. 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


SANDRA R. RILEY
*Administrative Assistant to the
Secretary of the Army*

0511601

PETER J. SCHOOMAKER
*General, United States Army
Chief of Staff*

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 344813,
requirements for calibration procedure TB 9-6625-2364-35.

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.

