*TB 9-6625-2364-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR POWER METER AGILENT, MODEL E4419B

Headquarters, Department of the Army, Washington, DC
5 December 2006

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, ATTN: 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.

*This bulletin supersedes TB 9-6625-2364-35, dated 21 June 2005, including all changes.

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 setability of zero)	Accuracy: ± 0.5% FS (Most sensitive range. Decrease percentage by factor of 10 for each higher range ±l count.)
Instrument accuracy	Range: −70 dBm to +44 dBm (power sensor dependent) Accuracy: ±0.02 dB (logarithmic) or 0.5% (linear)
Power reference	Range: 1 mW Accuracy: ±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)
CALIBRATOR	Voltage range: 0 to 22 V dc Accuracy: ± .115 percent of reading	Fluke 5720A (5700 A/EP) (p/o MIS-35947
FREQUENCY COUNTER	Frequency range: 10 Hz to 50 MHz Accuracy: ±0.25%	Fluke, Model PM6681/656 (PM6681/656)
MULTIMETER	Voltage range: 0 to 20 V dc Accuracy: ±0.08% Ability to measure approximately 200 Ω Ability to measure μV dc	Hewlett-Packard, Model 3458A (3458A)
POWER METER	Power range: 1 mW Frequency range: 50 MHz Power accuracy: ±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) or 8478B (8478B)
RANGE CALIBRATOR	Power range: 3.10 μW to 101.8 mW Accuracy: ±0.25%	Hewlett-Packard, Model 11683A (11683A) with Option H01

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 manufacturer's 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.

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.

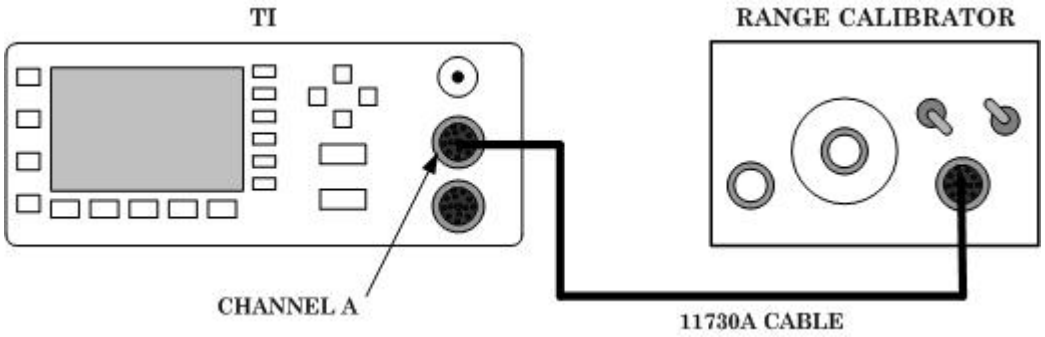

Figure 1. Zero test equipment connection.

(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 **3µW**.
(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 ⇐,⇒,⇑ and ⇓ 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 ±0.05 μW.

(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** ↕ 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 2.

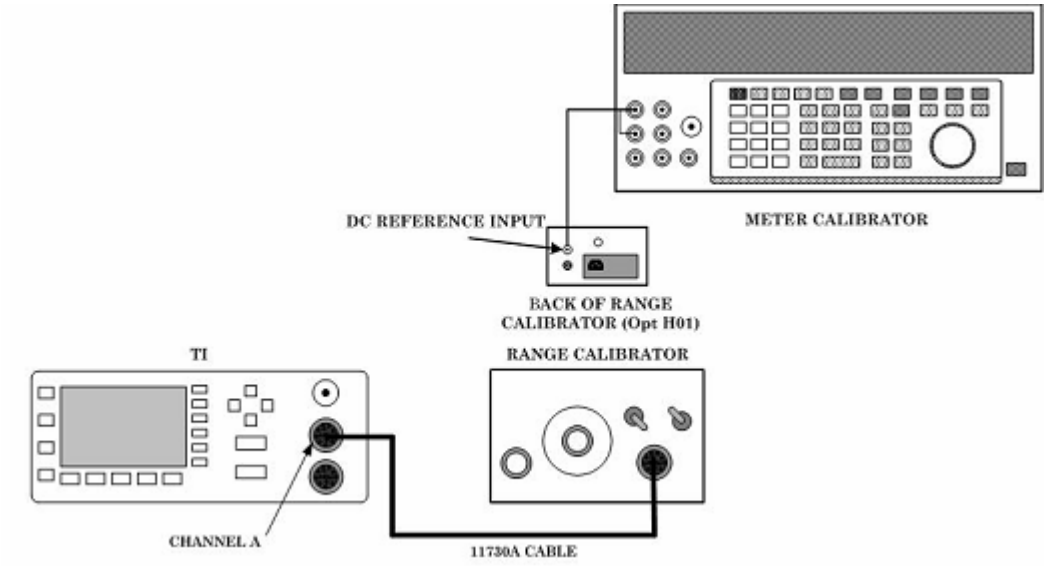

Figure 2. Instrument accuracy test.

(3) Unplug power cord from range calibrator.

NOTE

Due to a ground loop design problem with the 11683A option H01 range calibrator, it will not operate properly unless ground loops are eliminated. The instrument will continue to operate with no power applied, and disconnecting the power cord eliminates the problem.

WARNING

There is a small risk of mild electrical shock from the chassis of the 11683A option H01 range calibrator unless the power meter is connected.

NOTE

Figure 2 shows the **HI/LO** outputs of the DC calibrator connected to the DC reference input of the range calibrator. Ensure that the **Guard** and **LO** output of the voltage calibrator are floating; **EX GRD** is on; **EX SNS** is off; and the **V-GUARD** terminal is disconnected from the **GROUND** terminal.

(4) Press TI keys as listed in (a) through (d) below:
   (a) Press **POWER** switch to on position.
   (b) Press **Preset Local**, **[Confirm]** keys.
   (c) Press **dBm/W**, **[W]** keys.
   (d) Press **Meas Setup**, **[Resolution]** to 4.

(5) Set range calibrator controls as listed in (a) through (d) below:
   (a) **RANGE** to **100 mW**.
   (b) **POLARITY** to **NORMAL**.
   (c) **FUNCTION** to **STANDBY**.
   (d) **INT/EXT** switch to **EXT**.

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.

(6) Set the meter calibrator for a 0 VDC and output to **STANDBY**.

(7) 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**.

(c) **[Length]** use ⇐,⇒,⇑ and ⇓ 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.

(8) TI reading will be 0 ±0.05 μW.

(9) Set meter calibrator output to 144.93 mV and press **OPR/STDBY** to **OPERATE**

(10) Press TI **[Cal►]**, **[Cal A]** keys.

(11) Set TI filter settings to values listed in table 3 using technique of (7) (a) through (c) above.

(12) Set meter calibrator levels as listed in table 3. TI display will indicate within the limits in table 3.

Table 3. Power Meter Accuracy

Meter calibrator output (+DCV)	Test instrument filter settings	Test instrument display indications	
		Min	Max
458.31 μV	256	3.0977 μW	3.2269 μW
1.4493 mV	256	9.904 μW	10.096 μW
4.5831 mV	256	31.428 μW	31.819 μW
14.493 mV	64	99.49 μW	100.51 μW
45.831 mV	64	314.72 μW	317.74 μW
144.93 mV	16	0.9954 mW	1.0047 mW
459.12 mV	16	3.1477 mW	3.1769 mW
1.4588 mV	16	9.954 mW	10.046 mW
4.6872 V	16	31.477 mW	31.769 mW
15.588 V	16	99.54 mW	100.46 mW

(13) Set meter calibrator output to **STANDBY**.

(14) Press TI **POWER** switch to off.

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

(16) Set TI **POWER** switch to on position.

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

(18) Press TI **DISPLAY** ↕ key to activate B display.

(19) Repeat technique of (4) (c) through (12) above for channel B.

(20) Set meter calibrator output to **STANDBY**.

(21) Set TI **POWER** switch 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 multimeter (resistance mode) between VRF terminal center conductor 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 200 Ω).

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

(6) Connect equipment as shown in figure 3.

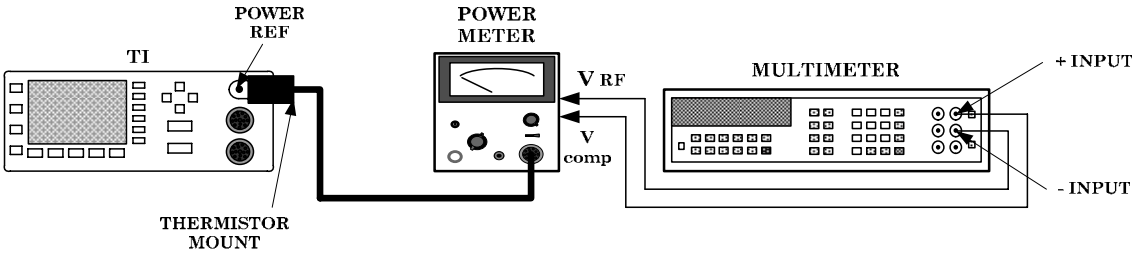

Figure 3. Power reference level - equipment setup.

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

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

(13) If multimeter indication is 400 μV or less, record 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 multimeter indication 200 μV or less. Record 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.

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

(18) Disconnect multimeter negative lead from power meter V_{RF} (fig. 3) and connect multimeter negative lead to power meter chassis ground. Record 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 0.991 and 1.009 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. 4) for 50.0 ±0.5 MHz.

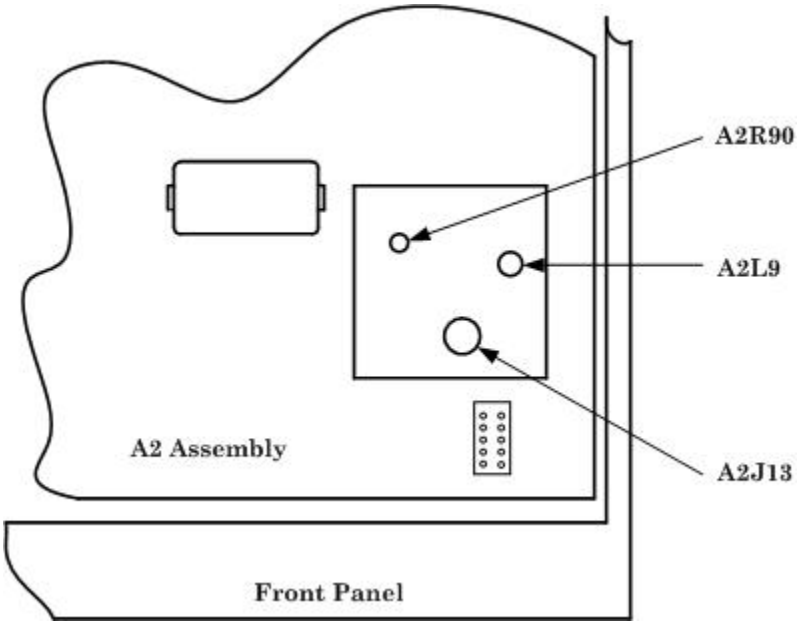

Figure 4. Adjustment locations.

(4) Connect digital multimeter (resistance mode) between VRF 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 3.

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

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

(13) If 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 multimeter indication 200 μV or less. Record 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.

(17) Disconnect multimeter negative lead from power meter V_{RF} (fig. 3) and connect 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 multimeter negative lead to power meter V_{RF} input.

(21) The multimeter is now set up to measure V_1.

(22) Calculate the required value of V_1 using the following formula:

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

(23) Adjust A2R90 (fig. 4) 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:

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

Official

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

0627701

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 344813, requirements for calibration procedure TB 9-6625-2364-24.

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.