# *TB 9-6625-2249-24

## DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

# CALIBRATION PROCEDURE FOR MICROWAVE AMPLIFIER HEWLETT-PACKARD, MODEL 8349B

Headquarters, Department of the Army, Washington, DC
30 September 2008



**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 9-6625-2249-35, dated 13 August 1991.

## SECTION I
## IDENTIFICATION AND DESCRIPTION

**1. Test Instrument Identification.** This bulletin provides instructions for the calibration of Microwave Amplifier, Hewlett-Packard, Model 8349B. The manufacturer's manual was used as the prime date 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 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

<table>
<tr><th>Test instrument parameters</th><th colspan="3">Performance specifications[1]</th></tr>
<tr><td rowspan="11">Input and output 25° C ±5° C)</td><td colspan="3">Input: +5 dBm</td></tr>
<tr><td rowspan="2">Frequency range (GHz)</td><td colspan="2">Minimum output power</td></tr>
<tr><td>Leveled</td><td>Unleveled</td></tr>
<tr><td>2.0 to 18.6</td><td>19 dBm</td><td>20 dBm</td></tr>
<tr><td>18.6 to 20.0</td><td>16 dBm</td><td>17 dBm</td></tr>
<tr><td colspan="3">Input: -5 dBm</td></tr>
<tr><td>Frequency range (GHz)</td><td colspan="2">Minimum gain</td></tr>
<tr><td>2.0 to 18.6</td><td colspan="2">15 dB</td></tr>
<tr><td>18.6 to 20.0</td><td colspan="2">12 dB</td></tr>
<tr><td colspan="3">Power flatness (leveled): ±1.25 dB</td></tr>
<tr><td>LED display accuracy (25° C ±5° C)</td><td colspan="3">Range: 0 to +20 dBm<br>Accuracy: ±1.5 dB</td></tr>
<tr><td>Spectral purity (25° C ±5° C)</td><td colspan="3">Harmonics:[2] 2.0 to 11.0 GHz < -20 dBc<br>Non-harmonic spurious:[2] < -55 dBc</td></tr>
</table>

[1]Calibration limited to 18 GHz due to USATA Engineering Division evaluation.
[2]dB below the fundamental at maximum specified output power.

## 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 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. 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.

Table 2. Minimum Specification of Equipment Required

| Common name | Minimum use specifications | Manufacturer and model (part number) |
|---|---|---|
| ATTENUATOR (FIXED) | 20 dB:<br>Frequency range: 2 to 18 GHz<br>Accuracy: ±0.5 dB or test report value<br>60 dB:<br>Frequency: 2 to 18 GHz<br>Accuracy: ±1.5 dB | Weinschel, Model 9918, 9918-20dB, and 9918-60dB (9918)* |
| MEASURING RECEIVER | Frequency range: 2 to 18 GHz<br>dB range: From 0.00 to 20.5<br>Accuracy: ±0.02 dB/10 dB step | Measuring receiver system N5530S consisting of: Spectrum Analyzer Agilent, Model E4440A (E4440A), Power Meter Agilent, Model E4419B (E4419B), and Sensor module, Agilent Model N5532A opt. 518 (518) |
| MICROWAVE FREQUENCY COUNTER | Range: 2000 MHz<br>Accuracy: ±2.5 MHz | Anritsu, Model MF2414B (MF2414B) |
| MULTIMETER | Range: -15.001 to ±15.001 V dc<br>Accuracy: ±0.002%<br><br>Range: 70 mV rms<br>Accuracy: ±3% | Hewlett-Packard, Model 3458A (3458A) |
| POWER METER | Frequency range: 2 to 18 GHz<br>Power range: -25 to +5 dBm<br>Accuracy: ±0.7 dB | Hewlett-Packard, Model E12-432A (MIS-30525) w/thermistor mount, Hewlett-Packard, Model 8478B (8478B) |
| POWER SPLITTER | Frequency range: 2 to 18 GHz<br>Accuracy:<br>Output tracking between ports:<br>2 to 8 GHz ±0.2 dB<br>8 to 18 GHz ±0.25 dB | Weinschel, Model 1870A (7916839) |

Table 2. Minimum Specification of Equipment Required - Continued

| | | |
|---|---|---|
| SPECTRUM ANALYZER | Frequency range: 2 to 22 GHz<br>Flatness: 2 to 12.4 GHz: ±1.5 dB<br>12.4 to 22 GHz: ±3 dB | (AN/USM-677) |
| SYNTHESIZED SIGNAL GENERATOR | Frequency range: 2 to 18 GHz<br>Power range: from -25 to +5 dBm<br>V/GHz output: 0.99 to 9.09 V dc<br>Accuracy: ±1% | Anritsu, Model 68369NV (68369NV) |

## 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. Additional maintenance information is contained in the manufacturer's manual for this TI.

**d.** When indications specified in paragraphs **8** through **10** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **10**. 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

**a.** Set synthesized signal generator output for a 2 GHz signal at +6dBm.

**b.** Connect measuring receiver sensor module to the power reference output. Perform sensor zero and calibration.

**c.** Set power meter **MW-RANGE-DBM** switch to 0.

**d.** Allow equipment to warm up for 1 hour.

**e.** Connect equipment as shown in figure 1.

**f.** Adjust synthesized signal generator level controls for a 0 dBm indication on power meter.

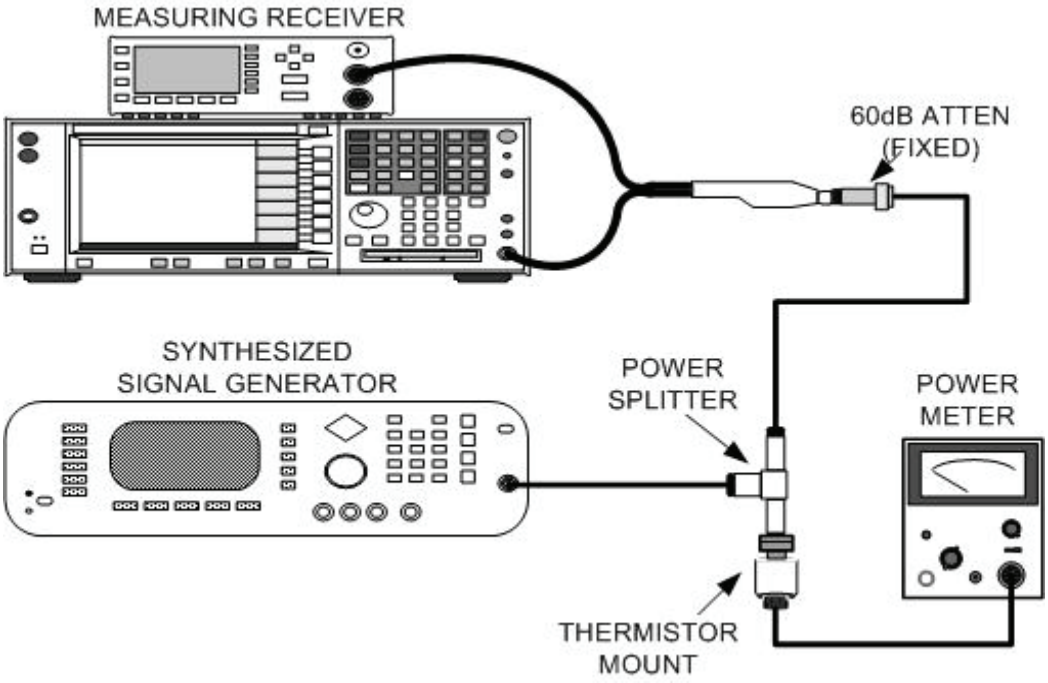


Figure 1. Receiver system reference – equipment setup.

**g.** Configure measuring receiver to measure frequency at 2 GHz.

**h.** Configure measuring receiver to measure power and establish a 0.00 dB reference.

**NOTE**

Verify the proper cal factors are loaded for the power sensor module being utilized.

**8. Unlevel Output Power Gain**

**a. Performance Check**

**NOTE**

Ensure measuring receiver indicates between 0.00 and 0.01 dB in power measurement mode before proceeding to (1) below.

(1) Connect equipment as shown in figure 2.

(2) Adjust synthesized signal generator level controls for a -5 dBm indication on power meter.

(3) Configure measuring receiver to measure power. Indication will be equal to or greater than 15 dB.

(4) Adjust synthesized signal generator frequency controls for a display of first test frequency listed in table 3.

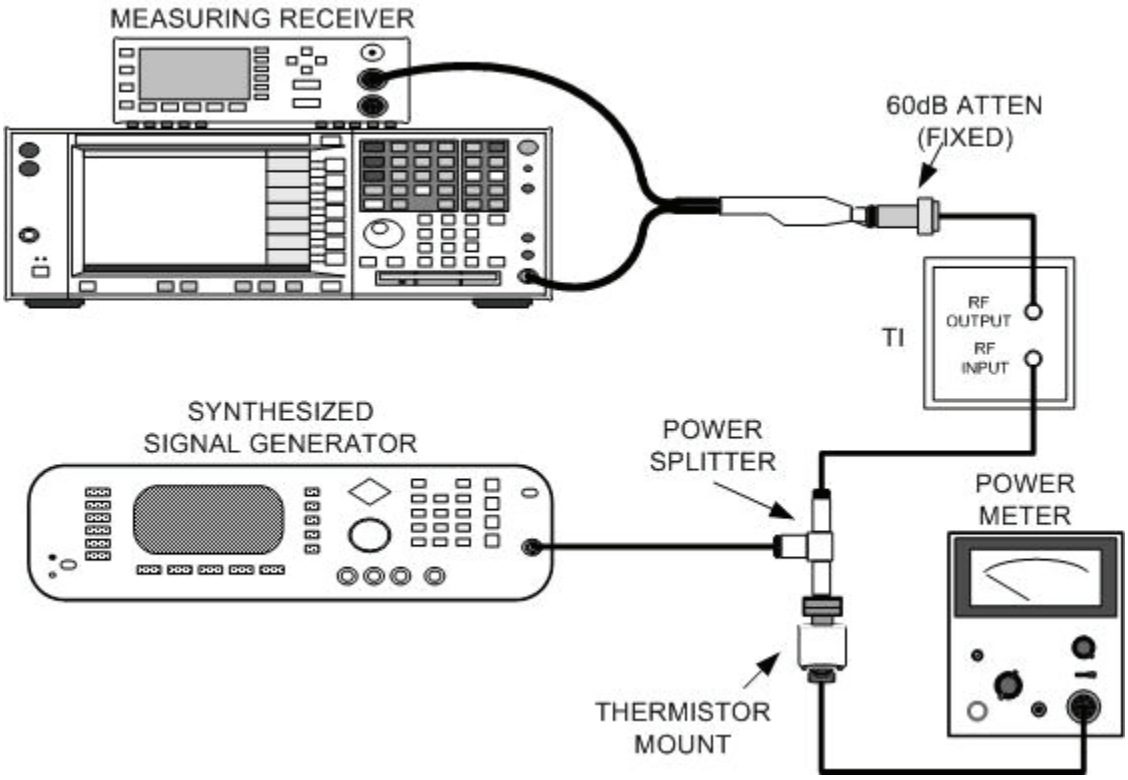


Figure 2. UnIeveled output power gain - equipment setup.

Table 3. Unleveled Gain Test Frequencies

| Test frequencies (GHz) |
|---|
| 3.0 |
| 5.6 |
| 9.7 |
| 11.0 |
| 15.0 |
| 17.0 |
| 18.0 |

(5) Configure measuring receiver to measure frequency. Indication will be the same as synthesized signal generator frequency in (4) above.

(6) Configure measuring receiver to measure power. Indication will be equal to or greater than 15 dB.

(7) Repeat technique of (2) through (6) above for remaining test frequencies listed in table 3.

(8) Adjust synthesized signal generator frequency controls for a display of 2 GHz.

(9) Adjust synthesized signal generator level output controls for a +5 dBm indication on power meter.

(10) Configure measuring receiver to measure frequency at 2 GHz.

(11) Configure measuring receiver to measure power. Indication will be equal to or greater than 20 dB.

(12) Adjust synthesized signal generator frequency controls for a display of the first test frequency listed in table 3.

(13) Configure measuring receiver to measure frequency. Indication will be the same as frequency of the synthesized signal generator.

(14) Configure measuring receiver to measure power. Indication will be equal to or greater than 20 dB.

(15) Repeat technique of (9) through (14) above for remaining test frequencies listed in table 3.

**b. Adjustments.** No adjustments can be made.

**9. Leveled Output Power Gain and flatness**

**a. Performance Check**

(1) Connect equipment as shown in figure 3.

(2) Set synthesized signal generator for a 2 GHz output signal at +5dBm.

(3) Adjust synthesized signal generator level output for a +19 dBm indication on TI **POWER LEVEL** meter.

(4) Connect microwave frequency counter to point A in figure 3.

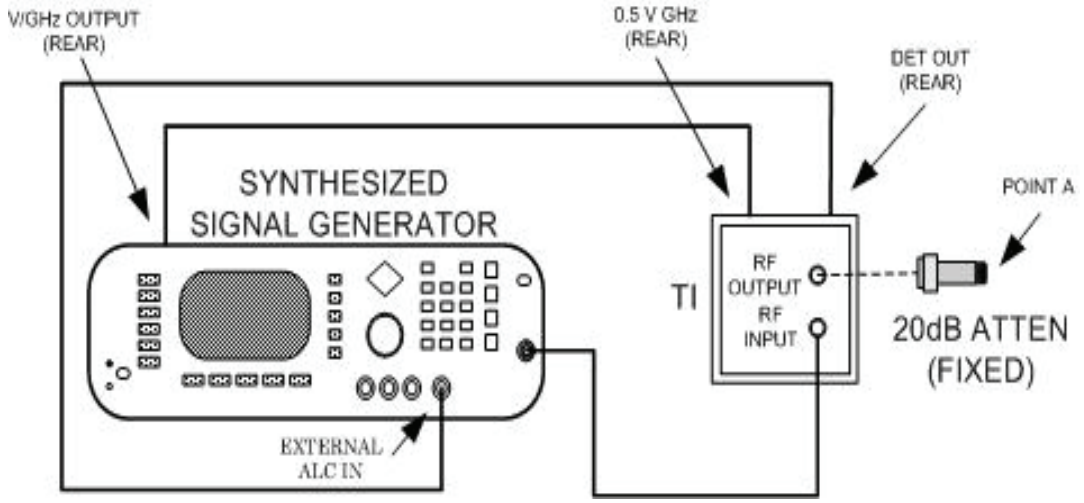


Figure 3. Leveled out output power gain and flatness - equipment setup.

(5) Adjust synthesized signal generator for a 2.0 GHz indication on microwave frequency counter.

(6) Disconnect microwave frequency counter from point A of figure 3.

(7) Connect power meter to point A of figure 3.

(8) Adjust synthesized signal generator level control for a TI **POWER LEVEL** meter indication of +19.0 dBm. Record power meter indication in table 4.

(9) Disconnect power meter from point A of figure 3.

(10) Repeat technique of (4) through (9) above for remaining frequencies listed in table 4.

Table 4. Leveled Output Power and Flatness

| Synthesized signal generator frequency settings (GHz) | Power meter indications | 20 dB attenuator (Fixed) test report value[1] (dB) | Corrected power indications (dBm) |
|---|---|---|---|
| 2.0 | | | |
| 3.0 | | | |
| 5.6 | | | |
| 9.7 | | | |
| 11.0 | | | |
| 15.0 | | | |
| 17.0 | | | |
| 18.0 | | | |

[1]Round to nearest tenths.

(11) Record 20 dB attenuator (fixed) test report values for frequencies listed in table 4.

**NOTE**

Treat test report values as negative numbers.

**NOTE**

Average 20 dB attenuator (fixed) test report values for 1.5 and 3.0 GHz and use results as test report value for 2 GHz.

**NOTE**

Use same 20 dB attenuator (fixed) test report value for 17 and 18 GHz in table 4.

(12) Algebraically subtract each 20 dB attenuator (fixed) value recorded in table 4 from power meter indication of same row. Record difference in table 4, corrected power indication column. If corrected power indications are not between 17.5 and 20.5 dBm, perform **b** below.

EXAMPLE:

| | |
|---|---|
| + 0.1 power meter indication | + 0.1 |
| --20.1 test report value | + ±20.1 |
| | 20.2 corrected power indication |

(13) Subtract the smallest value from the largest value recorded in table 4, Corrected power indication column; if the difference is not 2.5 dB or less, perform **b** below.

**b. Adjustments**

(1) Connect thermistor mount to point A of figure 4.

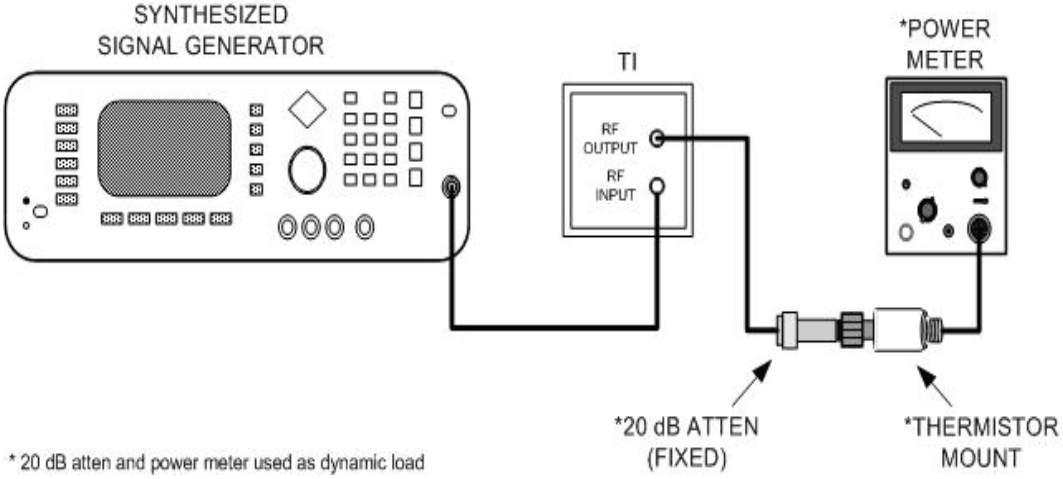


Figure 4. Compensation zero adjustments - equipment setup.

(2) Adjust synthesized signal generator frequency controls to 11 GHz and adjust level output controls for -25 dBm indication on power meter. Record synthesized signal generator level indication.

(3) Connect equipment as shown in figure 1.

(4) Center A4R60 through A4R67 (fig. 5).

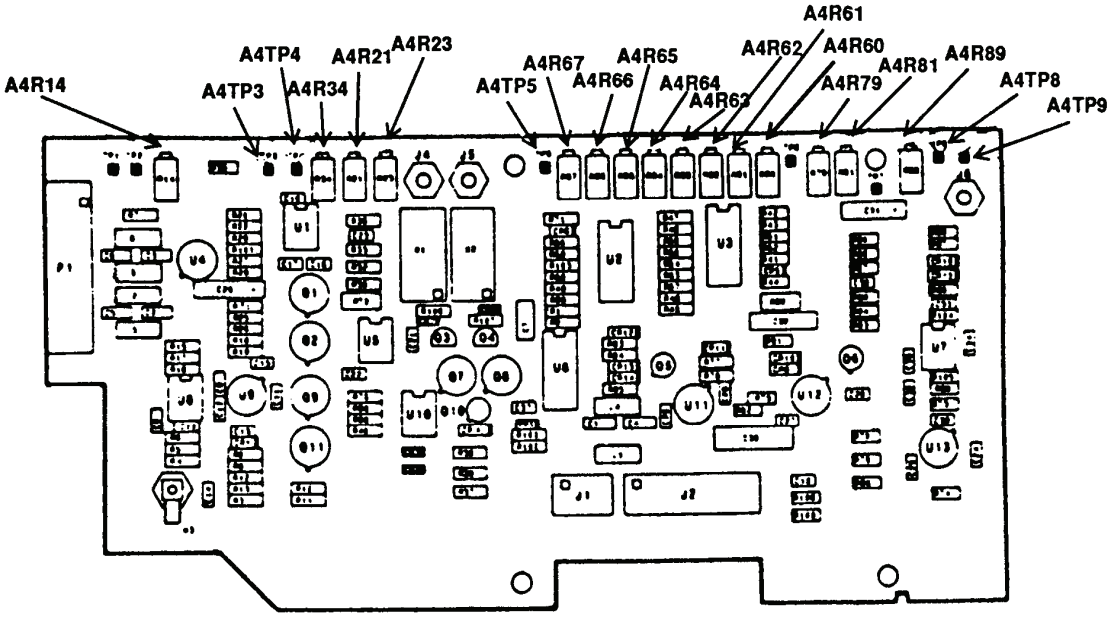


Figure 5. Signal conditioning board - adjustments location.

(5) Connect multimeter negative lead to A4TP4 (fig. 5) and positive lead to A4TP5 (fig. 5).

(6) Adjust A4R67 (fig. 5) for a multimeter indication between -0.001 and +0.001 V dc.

(7) Connect multimeter positive lead to A4TP3 (fig. 5).

(8) Center A4R14, A4R23, and A4R34 (fig. 5).

(9) Adjust synthesized signal generator level output controls for a multimeter indication between -0.001 and +0.001 V dc.

**NOTE**

Maintain multimeter indication of (9) above with synthesized signal generator level output controls while performing the adjustment in (10) below.

(10) Adjust A4R81 (fig. 5) for a 0.0 dBm indication with a blinking minus sign on TI display (R).

(11) Adjust synthesized signal generator level output controls for multimeter indication between 1.197 and 1.203 V dc.

**NOTE**

Maintain multimeter indication of (11) above with synthesized signal generator level output controls while performing the adjustment in (12) below.

(12) Adjust A4R79 (fig. 5) for a TI display indication between 19.9 and 20.1 dBm (R).

(13) Adjust synthesized signal generator level output controls for a TI display indication of 20.0 dBm.

(14) Connect multimeter negative lead to A4TP9 (fig. 5) and positive lead to A4TP8 (fig. 5).

(15) Adjust A4R89 (fig. 5) for a multimeter indication between -0.305 and 0.325 V dc.

(16) Turn synthesized signal generator RF output off.

(17) Connect multimeter (ac mode) negative lead to A4TP4 (fig. 5) and positive lead to A4TP3 (fig. 5).

(18) Adjust A4R34 (fig. 5) fully cw.

(19) Adjust A4R14 (fig. 5) for a maximum indication on digital voltmeter (typically 70 mV rms).

(20) Turn synthesized signal generator RF output on.

(21) Disconnect 20 dB attenuator (fixed) from figure 4 equipment setup.

(22) Connect TI **RF OUTPUT** to power meter (fig. 4).

(23) Adjust synthesized signal generator level output controls for a 0 dBm indication on power meter.

(24) Adjust A4R21 (fig. 5) for a TI 0.0 dBm indication on TI display (R).

(25) Adjust synthesized signal generator level output controls for a -10 dBm indication on power meter.

(26) Adjust A4R34 (fig. 5) for a -10.0 dBm indication on TI display (R).

(27) Install 20 dB attenuator (fixed) between power meter and TI **RF OUTPUT** (fig. 4).

(28) Determine 20 dB attenuator (fixed) correction factor at 11 GHz from test report. Record correction factor.

**NOTE**

Treat 20 dB attenuator (fixed) test report value as negative number.

EXAMPLE:

- 20.1 test report value -20.1
--20.0 nominal attenuator value ++20.0
00.1 correction factor

(29) Algebraically subtract correction factor determined in (28) above from 0 dBm. Record difference.

EXAMPLE:

0.00 dBm (29) above -10.1
--10.0 nominal attenuator value ++0.10 dBm difference

(30) Adjust synthesized signal generator level output controls to value recorded in (29) above on power meter.

(31) Adjust A4R23 (fig. 5) for a +20.0 dBm indication on TI display (R).

**NOTE**

A4R23 (fig. 5) will be adjusted for best compromise between +10 and +20, indications on TI display.

EXAMPLE:

Ideal compromise is the equal but opposite offset from nominal values with the +10 dBm power level at the lower tolerance level and the +20 dBm power level at the upper tolerance level. If +10 power level is +9.7 then the +20 power range should be +20.3 dBm.

(32) Algebraically subtract correction factor determined in (28) above from -10 dBm. Record difference.

(33) Adjust synthesized signal generator level output controls for a power meter indication equal to the value determined in (32) above.

(34) If TI display does not indicate between +9.7 and 10.3 dBm, adjust A4R23 (fig. 5) for TI display lower intolerance indication.

(35) Repeat (30) above. If TI display does not indicate between +19.7 and +20.3 dBm, adjust A4R23 (fig. 5) for a TI display higher intolerance indication.

(36) Repeat (30) through (35) until TI indications for both the +10 and +20 dBm power levels are within tolerance.

(37) Confirm TI display indications are still in tolerance by performing (a) through (e) below. If TI display indications listed in (d) and (e) below are not within the specified limits, perform (24) through (37) above.

(a) Disconnect 20 dB attenuator (fixed) from figure 4 equipment setup.

(b) Connect power meter to TI **RF OUTPUT**.
(c) Adjust synthesized signal generator level display to value recorded in (2) above.
(d) Repeat (23) above, TI display will Indicate between -0.3 and +0.3 dBm.
(e) Repeat (25) above, TI display will Indicate between -9.7 and -10.3 dBm.

(38) Connect equipment as shown in figure 3 with the following exception. Do not connect 20 dB attenuator (fixed) in figure 3 equipment setup.

(39) Connect power meter to TI **RF OUTPUT**.

(40) Adjust synthesized signal generator frequency setting to 2 GHz.

(41) Adjust synthesized signal generator level controls for a TI **POWER LEVEL** meter indication of 0.0 dBm.

(42) Record power meter indication in table 5.

Table 5. Flatness Level

| Synthesized signal generator frequency settings (GHz) | Power meter indications (dBm) |
|---|---|
| 2.0 | |
| 3.8 | |
| 5.6 | |
| 7.4 | |
| 9.2 | |
| 11.0 | |
| 12.8 | |
| 14.6 | |
| 16.4 | |
| 18.0 | |

(43) Repeat technique of (40) through (42) above for remaining frequency settings listed in table 5.

(44) Subtract smallest value recorded in table 5 from the largest value recorded in table 5. If the difference is not 2.5 dB or less, repeat (40) through (44) above while adjusting A4R60 through A4R67 (fig. 5) for best intolerance indications.

## 10. Harmonic Distortion and Spurious Noise Test

### a. Performance Check

(1) Connect equipment as shown in figure 3 except connect spectrum analyzer to point A.

(2) Adjust synthesized signal generator frequency setting to 2.0 GHz.

(3) Adjust synthesized signal generator level controls for a +19 dBm indication on TI **POWER LEVEL** dBm display.

(4) Measure and record second harmonic frequency amplitude in table 6.

Table 6. Harmonic Distortion

| Synthesized signal generator frequency settings (GHz) | Spectrum analyzer harmonic amplitude indications | | | |
|---|---|---|---|---|
| | Second harmonic | | Third harmonic | |
| | Frequency (GHz) | Amplitude (dBc) | Frequency (GHz) | Amplitude (dBc) |
| 2.0 | 4.0 | | 6.0 | |
| 3.0 | 6.0 | | 9.0 | |
| 4.0 | 8.0 | | 12.0 | |
| 5.0 | 10.0 | | 15.0 | |
| 6.0 | 12.0 | | 18.0 | |
| 7.0 | 14.0 | | 21.0 | |
| 8.0 | 16.0 | | --- | --- |
| 9.0 | 18.0 | | --- | --- |
| 10.0 | 20.0 | | --- | --- |
| 11.0 | 22.0 | | --- | --- |

(5) Measure and record third harmonic frequency amplitude in table 6.

(6) Adjust synthesized signal generator frequency to remaining frequencies listed in table 6 and repeat (3) through (5) above.

(7) Search table 6 spectrum analyzer harmonic indications for highest second or third harmonic amplitude indication. Record amplitude level.

(8) Add -20 to highest second or third harmonic amplitude value recorded in (7) above. SUM will be equal to or less than -20 dBc.

EXAMPLE:

Highest harmonic indication recorded in (7) above is -10 dBc at 6 GHz.
-10.0 (7) above
-20.0 (8) above
-30.0 dBc

(9) Repeat (2) and (3) above.

(10) Tune spectrum analyzer frequency controls from 2 to 18 GHz and record amplitude of any spurious responses.

(11) Add -20 to spurious response amplitude value recorded in (10) above. Sum will be equal to or less than -.55 dBc.

EXAMPLE:

Spurious response indication recorded is -40 dBc above is -40 dBc at 6 GHz.
-40.0 (10) above
-20.0 (11) above
-60.0 dBc

(12) Repeat (11) above for remaining spurious responses recorded in (10) above.

**b. Adjustments.** No adjustments can be made.

## 11. 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.

(2) Perform (a) through (c) below to remove top cover case from TI.

(a) Remove screw from rear cover-strip of carrying handle.
(b) Slide top cover back to expose the cover's front edge.
(c) Lift top cover off TI.

(3) Press **LINE** switch to on position and allow TI to warm-up for 30 minutes.

(4) Connect multimeter (dc mode) negative lead to A5TP1 (fig. 6) and positive lead to A5TP5 (fig. 6). If multimeter does not indicate between 4.999 and 5.001 V dc, perform **b** (1) below.

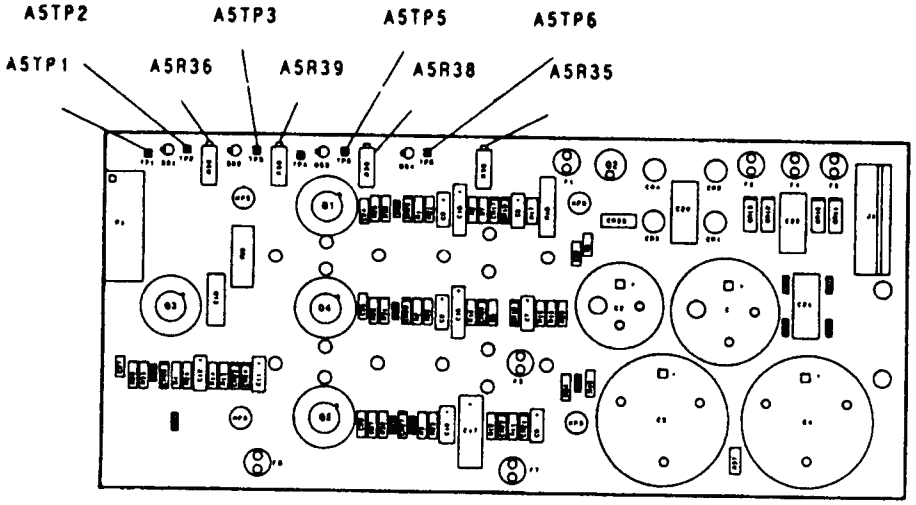


Figure 6. Power supply - adjustment locations.

(5) Connect multimeter positive lead to A5TP6 (fig. 6). If multimeter does not indicate between 7.999 and 8.001 V dc, perform **b** (2) below.

(6) Connect multimeter positive lead to A5TP3 (fig. 6). If multimeter does not indicate between 14.999 and 15.001 V dc, perform **b** (3) below.

(7) Connect multimeter positive lead to A5TP2 (fig. 6). If multimeter does not indicate between -14.999 and -15.001 V dc, perform **b** (4) below.

**b. Adjustments**

(1) Adjust A5R38 (fig. 6) for a multimeter indication between 4.999 and 5.001 V dc (R).

(2) Adjust A5R35 (fig. 6) for a multimeter indication between 7.999 and 8.001 V dc (R).

(3) Adjust A5R39 (fig. 6) for a multimeter indication between 14.999 and 15.001 V dc (R).

(4) Adjust A5R36 (fig. 6) for a multimeter indication between -14.999 and -15.001 V dc (R).

## 12. 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*

0719025

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 344390 requirements for calibration procedure TB 9-6625-2249-24.

## 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.