*TB 9-4931-491-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR SWEEP/SIGNAL GENERATOR WAVETEK, MODEL 2001 AND SG-677A/U

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

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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 9-4931-491-35, dated 14 July 2004.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Sweep/Signal Generator, Wavetek, Model 2001 and SG-677A/U. The manufacturer's manual and TM 11-6625-2955-14&P were used as the prime data sources 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 2 1/2 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 3 overlapping bands	1 to 1400 MHz Band 1: 1 to 500 MHz[1] Band 2: 450 to 950 MHz Band 3: 900 to 1400 MHz
Operating modes	Start/stop, Δf, and cw
Frequency dial calibration accuracy	10 MHz intervals Band 1: 10 MHz Band 2: 2% of selected frequency Band 3: 2% of selected frequency

Footnote at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Sweep width accuracy	200 kHz to 500 MHz, calibrated in 10 MHz intervals Band 1: ±10 MHz Band 2: ±20 MHz Band 3: ±20 MHz
RF output accuracy	+10 to -80 dBm ±0.5 dB to 500 MHz
Flatness at 10 dBm	±0.75 dB from 1 to 500 MHz (when read with measuring receiver)

[1]This procedure covers only band 1 performance specifications check.

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: Semiconductor Device (Coaxial Crystal Detector), Hewlett-Packard, Model 423A003 (7923182).

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
MEASURING RECEIVER	Flatness measurement: Frequency: 50 to 500 MHz Accuracy: ±0.188 dB Frequency measurement: Range: 50 to 500 MHz Accuracy: ±0.5% Power measurement: Frequency: 250 and 300 MHz Range: +10 dB to -80 dB Accuracy: ±0.125 dB	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. 504 (504)
MULTIMETER	Range: 1 to 50 V dc Accuracy: ±0.1%	Fluke, Model 8840A/AF05 (AN/GSM-64D)
OSCILLOSCOPE	Range: 1 mV/cm sensitivity Accuracy: ±3%	(OS-303/G)
SIGNAL GENERATOR	Range: 10 to 110 MHz Display Accuracy: ±0.00125%	Aeroflex, Model 2023B (2023B) or SG-1207/U (SG-1207/U)

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 TM 11-6625-2955-14&P for this TI.

d. When indications specified in paragraphs **8** through **13** are not within tolerance, perform the power supply checks (paragraphs **14** through **17**) prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **13**. Do not perform power supply checks 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 top cover from TI as necessary for access to adjustments. Reinstall top cover after completing check or adjustments.

b. Connect TI to a 115 V ac source.

c. Position controls as listed in (1) through (11) below:

(1) **BAND** switch to **1**.

(2) **SWEEP TIME SEC** switch to **LINE**.

(3) ● **VAR/MANUAL** control cw.

(4) **OUTPUT** switch to **+10 dBm**.

(5) **MARKERS ○ WIDTH • SIZE** switch to **WIDE**.

(6) **MODE** switch to **ΔF**.

(7) The four paddle switches to their extreme down position.

(8) **MARKERS MHz 50 Har** pushbutton pressed in (all other pushbuttons out).

(9) Set **CENT FREQ** to **250 MHz**.

(10) Set **SWEEP WIDTH** to **520 MHz**.

(11) **POWER** switch to on.

d. Allow 15 minutes for TI to warm up and stabilize.

8. Marker System

a. Performance Check

(1) Connect equipment as shown in figure 1.

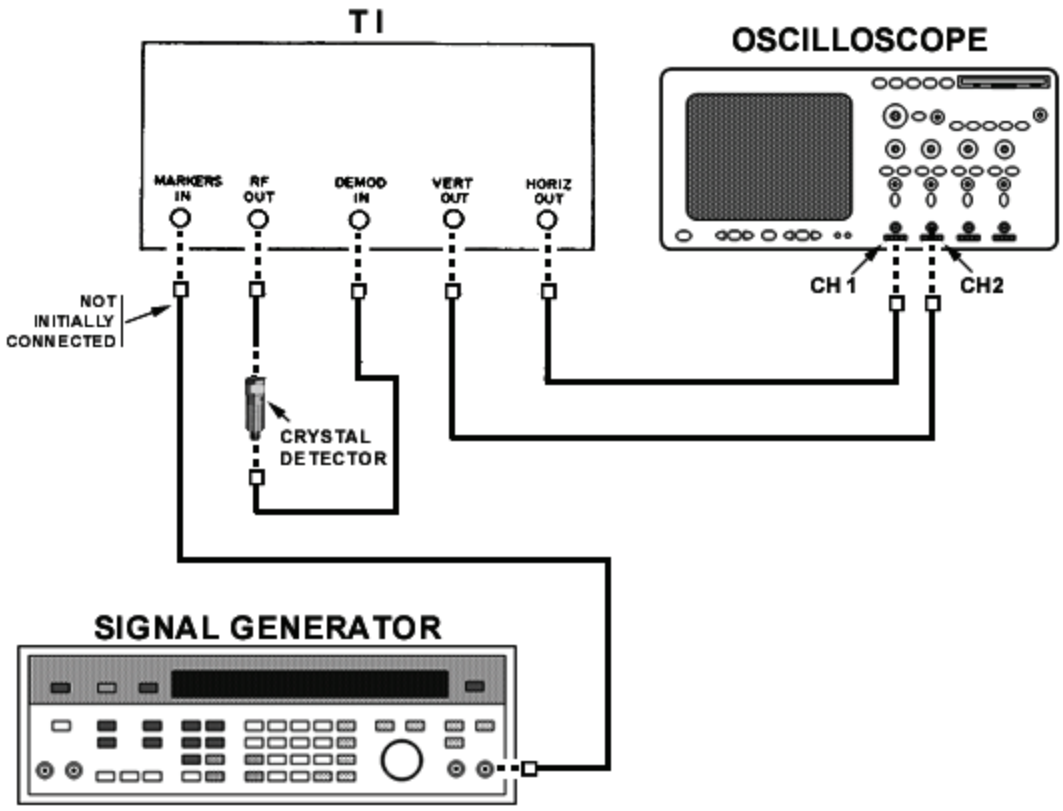

Figure 1. Test equipment – Marker System setup.

(2) Set oscilloscope for an X verses Y function operation.

(3) Adjust TI **MARKER SIZE** and oscilloscope vertical and horizontal controls to obtain a pattern as shown in figure 2.

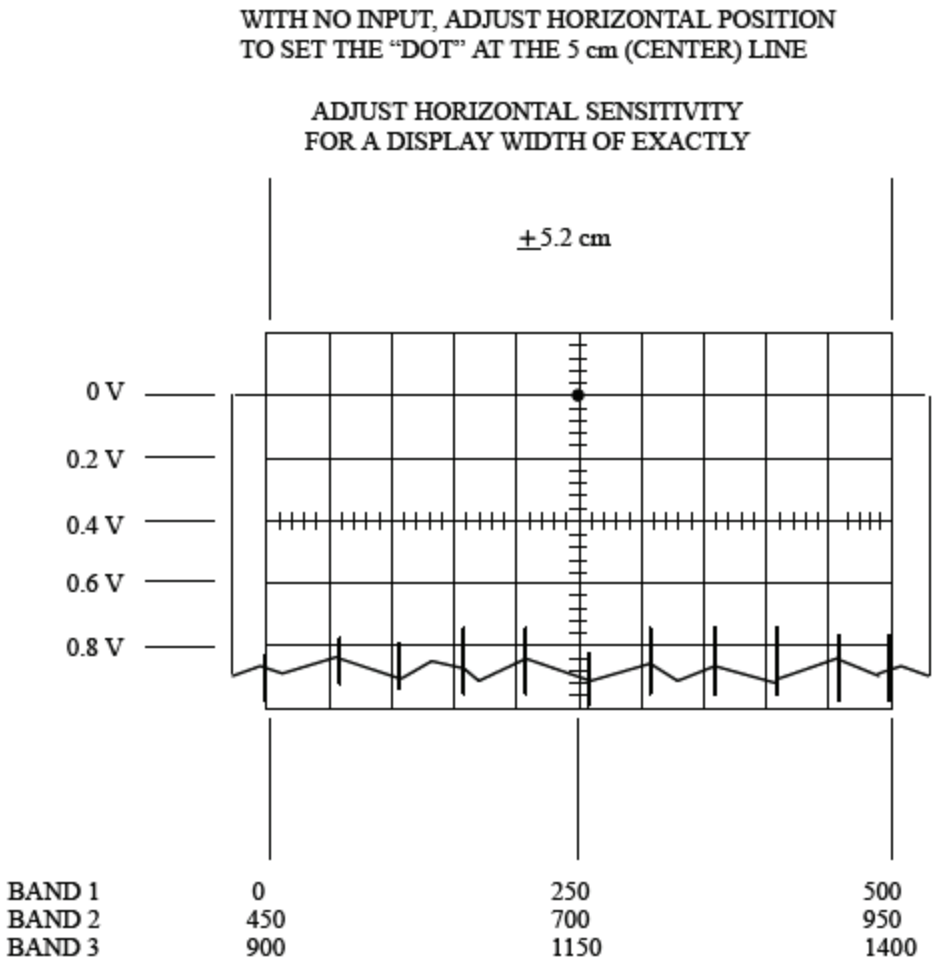

Figure 2. RF detector display.

(4) Connect signal generator output to TI **MARKER** in.

(5) Adjust **CENT FREQ** and **SWEEP WIDTH** until second 50 MHz harmonic marker is centered on oscilloscope and marker expanded sufficiently to observe zero beat.

(6) Adjust signal generator for a 50 MHz zero beat (when signal generator marker is aligned with second 50 MHz marker) with the internally (TI) generated marker on oscilloscope.

(7) At zero beat, the signal generator display will indicate between 49.9975 and 50.0025 MHz.

(8) Repeat (5) through (7) above for **1**, **5, 10,** and **100 MARKERS MHz** settings, decreasing the **SWEEP WIDTH** as required (example: 40-65 MHz) to obtain a zero beat with the **1**, **5,** and **10 MHz** markers. The allowable error is ±0.005% of the internal marker frequency.

(9) Note that single frequency markers should have no spurious markers throughout the sweep range. Harmonic type markers may have small spurious markers at one-half or one-third the specified marker interval.

(10) Readjust TI and oscilloscope controls to obtain display shown in figure 2.

(11) Set **MARKER SIZE** switch to the down position.

(12) Set **MARKER TILT** switch to the up position.

(13) If markers are not at least 12 V p-p, perform **b** below.

(14) Note that the birdy (notch) marker is adjustable from 12 V p-p vertical marker to a horizontal marker equal to 10 percent of the horizontal deflection.

b. Adjustments

CAUTION

Use extreme care when probing M5H connector. If too much pressure is applied, damage to connector may result.

(1) Readjust TI and oscilloscope controls to obtain display shown in figure 2.

(2) Disconnect **SWEEP SAMPLE OUT** connector from M5H (fig. 3) module and remove input to RF out.

(3) Connect cable assembly to **SWEEP SAMPLE OUT** on M5H.

(4) Adjust **M5H SWEEP SAMPLE ADJ** (fig. 3) for a detected output of 0.035 V (R).

(5) Remove bottom cover.

(6) Locate the size control for each marker module.

(7) Adjust the size control on each marker module until the amplitude of the markers does not increase.

NOTE

Increasing the size adjustment beyond this point will cause spurious markers to appear on the display.

(8) Repeat **a** (10) through (14) above.

9. Frequency Band

a. Performance Check

(1) Reconnect equipment as shown in figure 1 with signal generator disconnected.

(2) Reset controls as specified in **7 c** above.

(3) Readjust oscilloscope controls to obtain display shown in figure 2.

NOTE

Adjust oscilloscope controls for exactly 10.4 divisions.

(4) If each 50 MHz marker does not fall within ±0.2 cm of each cm line on oscilloscope graticule line, perform **b** below.

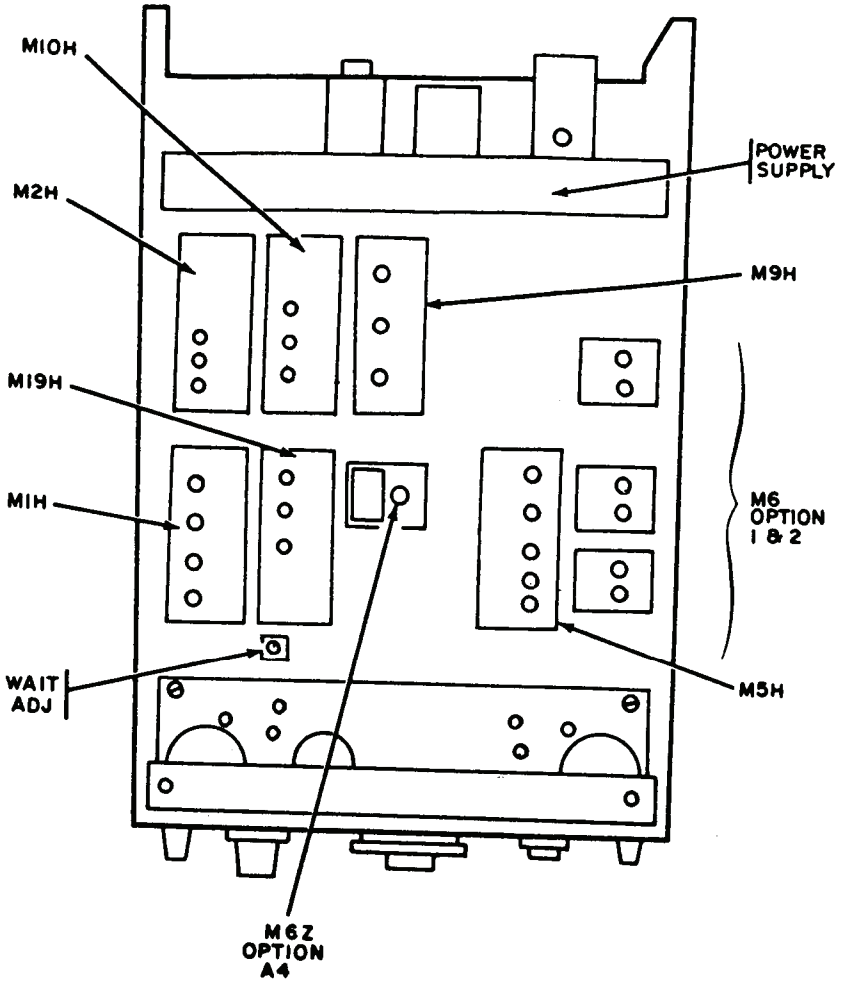

Figure 3. Test instrument - top view.

b. Adjustments

NOTE

TI should be thoroughly stabilized by operating 1 hour before the following adjustments are made. See figure 3 for location of adjustments.

(1) Adjust M9H **CENT BAND 1** control to position the 250 MHz marker at the exact center of oscilloscope display (fig. 2) (R).

(2) Adjust M2H **SWEEP WIDTH 1** to position the 0 frequency and the 500 MHz marker as shown in figure 2. Compromise between 0 and 500 if necessary (R).

(3) Note the extreme left side of the oscilloscope display.

(4) Set **SWEEP TIME SEC** to **LINE.**

(5) Adjust M1H **CLAMP (**fig. 3) to extend the sweep 0.2 cm beyond the first graticule line (R).

10. Dial Accuracy

a. Performance Check

(1) Repeat **7 c** (1) through (8) above.

(2) Set **SWEEP WIDTH** between 1 and 2 MHz.

(3) Adjust **CENT FREQ** control until the zero frequency lock-in point is exactly centered on oscilloscope No. 2 display.

(4) Read the error on the frequency scale.

(5) Repeat (1) through (4) above at each 50 MHz interval across the band. The allowable error is ±10 MHz.

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

(a) **MODE** switch to **S/S**.
(b) **BAND** switch to **1**.
(c) **CENT FREQ** control to **10 MHz**.
(d) **SWEEP WIDTH** control to **510 MHz**.

(7) A pattern similar to figure 2 should be present on oscilloscope.

(8) Reduce **SWEEP WIDTH** control until the 500 MHz marker just disappears from the right side of the oscilloscope display.

(9) Read the error on the **STOP** frequency indication (red).

(10) Repeat (6) through (9) above at each 50 MHz interval. Allowable error is ±10 MHz.

(11) Set TI **MODE** switch to **CW** and **OUTPUT** switch to **0 dBm**.

(12) Remove the crystal detector from **RF OUT** jack.

(13) Connect measuring receiver sensor module to the power reference output. Perform sensor zero and calibration.

(14) Disconnect measuring receiver sensor module from power reference output and connect to TI **RF OUTPUT**.

(15) Configure measuring receiver for frequency measurement.

(16) Adjust **CENT FREQ** control to **50 MHz**.

(17) Observe measuring receiver frequency reading. Allowable error is ±10 MHz.

(18) Repeat technique of (14) and (15) above at each 50 MHz interval across the band. The allowable error is ±10 MHz.

b. Adjustments. No adjustments can be made.

11. RF Output Level and Vernier Accuracy

a. Performance Check

(1) Position controls as listed in (a) through (h) below:

(a) **BAND** switch to **1**.
(b) **SWEEP TIME SEC** switch to **LINE**.
(c) **OUTPUT** switch to **+10 dBm**.
(d) **MARKERS ○ WIDTH • SIZE** switch to **WIDE**.
(e) **MODE** switch to **CW**.
(f) The four paddle switches to their extreme down positions.
(g) **MARKERS MHz 50 Har** pushbutton pressed in (all other pushbuttons out).
(h) Set **CENT FREQ** to **300 MHz**.

NOTE

TI should be stabilized with ac power applied for 15 minutes before making the following measurements.

(2) Connect sensor module to the power reference output. Zero and calibrate sensor.

(3) Disconnect sensor module from power reference output and connect to TI **RF OUTPUT**.

(4) Configure measuring receiver for RF power measurement.

(5) Using measuring receiver and RF power measurement techniques, measured power will indicate between +9.5 and +10.5 dBm, if not, perform **b** below.

(6) Set **OUTPUT** vernier to 0 dBm.

(7) Measuring receiver will indicate between -0.5 and +0.5 dBm.

(8) Set **OUTPUT** vernier to -10 dBm.

(9) Measuring receiver will indicate between -9.5 and -10.5 dBm.

b. Adjustments. (See figure 3 for location of adjustments.)

(1) Set **OUTPUT** to +10 dBm.

(2) Adjust M10H **LEVEL MAX** until measuring receiver indicates +10 dBm (R).

(3) Adjust **OUTPUT** vernier to -10 dBm (fully ccw).

(4) Adjust M10H **LEVEL MIN** until measuring receiver indicates -10 dBm (R).

NOTE

Some interaction exists between **LEVEL MIN** and **LEVEL MAX** controls, so repeat the adjustment until both the +10 and the -10 dBm readings are obtained.

12. RF Output Flatness

a. Performance Check

(1) Set **MODE** switch to **CW**.

(2) Connect sensor module to the power reference output. Zero and calibrate sensor.

(3) Disconnect sensor module from power reference output and connect to TI **RF OUTPUT**.

(4) Configure measuring receiver for Tuned RF level measurement.

(5) Set **OUTPUT** switch to **+10 dBm**.

(6) Adjust **CENT FREQ** controls slowly across the entire band (10-500 MHz).

(7) Using measuring receiver and tuned level techniques, note frequency where maximum output is obtained.

(8) Adjust **CENT FREQ** to frequency noted in (6) above.

(9) Adjust **OUTPUT** vernier control until measuring receiver indicates +10 dBm.

(10) Adjust **CENT FREQ** controls slowly across entire band and note the minimum output indication.

(11) Measuring receiver will indicate at least +8.5 dBm across entire band.

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

13. Attenuator Accuracy

a. Performance Check

(1) Connect measuring receiver sensor module to the power reference output. Zero and calibrate sensor.

(2) Disconnect sensor module from power reference output and connect to TI **RF OUTPUT**.

(3) Configure measuring receiver for Tuned RF level measurement.

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

(a) **MODE** switch to **CW**.
(b) **CENT FREQ** control to **250 MHz**.
(c) **OUTPUT** control to **0 dBm**.

(5) Tune measuring receiver to 250 MHz (.250 GHz) with a 0.000 reference.

(6) Set **OUTPUT** control to **-10 dBm**.

(7) Using standard tuned level measurement techniques, verify the measuring receiver indicates within minimum and maximum limits for TI **OUTPUT** control settings as listed in table 3 below.

Table 3. 250 MHz Attenuator Test

Test instrument **OUTPUT** control (dBm)	Min	Max
-10	-10.5	-9.5
-20	-20.5	-19.5
-30	-30.5	-29.5
-40	-40.5	-39.5
-50	-50.5	-49.5
-60	-60.5	-59.5
-70	-70.5	-69.5

b. Adjustments. No adjustments can be made.

14. Power Supply

NOTE

Do not perform power supply checks (paragraphs **14** through **17**) if all other parameters are within tolerance.

NOTE

Remove TI top cover, left side panel, and M2H module cover before starting performance checks. (See figure 5 for location of monitoring points and adjustments.)

a. Performance Check

(1) Connect multimeter to pin 6 on power plug and chassis ground (fig. 4).

(2) If multimeter does not indicate between +17.90 and +18.10 V dc, perform **b** (1) below.

(3) Connect multimeter to pin 4 on power plug and chassis ground (fig. 4).

(4) Multimeter will indicate between -17.50 and -18.50 V dc.

(5) Connect multimeter to pin 5 on power plug and chassis ground (fig. 4).

(6) Multimeter will indicate between -19.70 and -20.3 V dc.

(7) Connect multimeter to pin 3 on the remote jack and chassis ground (fig. 4).

(8) Multimeter will indicate between -15-90 and -16.10 V dc. Record indication.

(9) Connect multimeter to pin 2 on the remote jack and chassis ground (fig. 4).

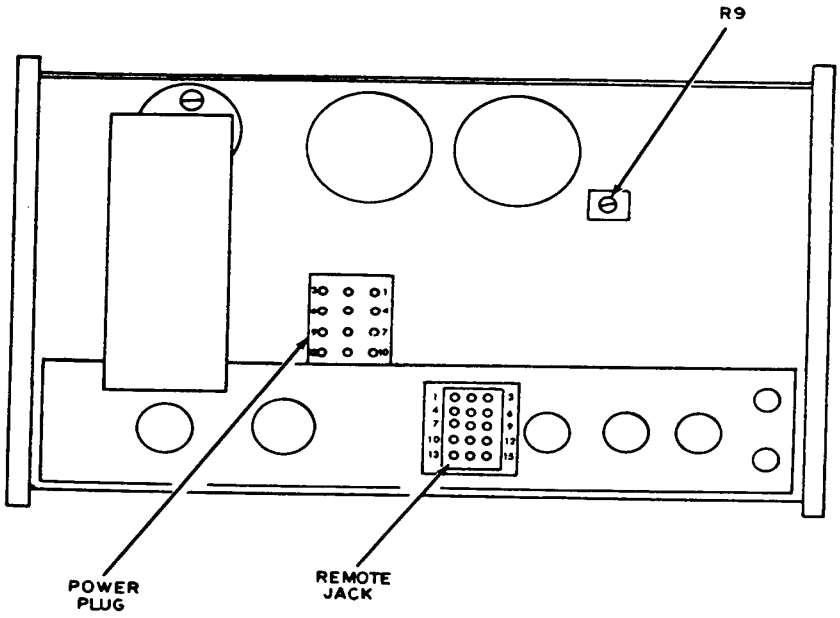

Figure 4. Power supply - (rear view).

(10) If multimeter does not indicate the same voltage, but of opposite polarity as recorded in (8) above, perform **b** (2) below.

b. Adjustments

(1) Adjust R9 (fig. 4) until multimeter indicates +18 V dc (R).

(2) Adjust R95 (fig. 5) until multimeter indicates the same voltage, but of opposite polarity as recorded in (8) above (R).

15. Sweep Rate Voltage

NOTE

The following performance check is for module M1H. See figure 3 for location of M1H module and adjustments.

a. Performance Check

(1) Position controls as listed in (a) through (c) below:

(a) **TRIG RECUR** switch to **RECUR**.
(b) **SWEEP TIME SEC** control to **.1 - .01**.
(c) •**VAR/MANUAL** control cw.

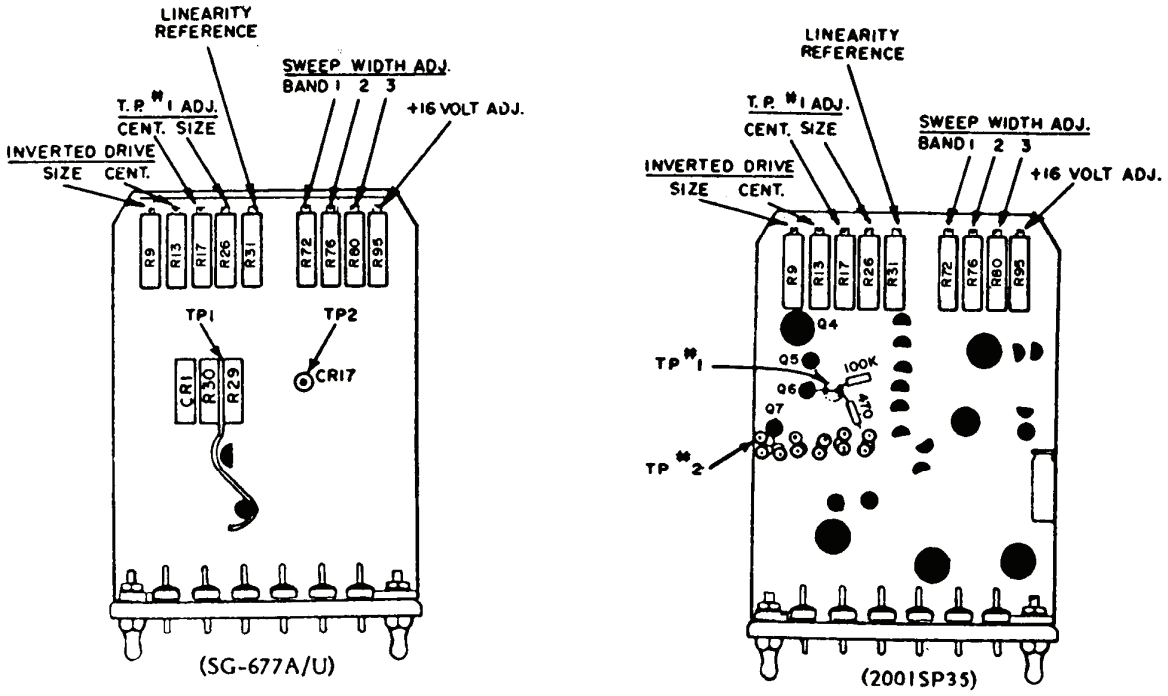

Figure 5. M2H module.

(2) Connect oscilloscope to pin 10 of the remote jack and chassis ground.

(3) Adjust oscilloscope controls to produce a stable display similar to figure 6.

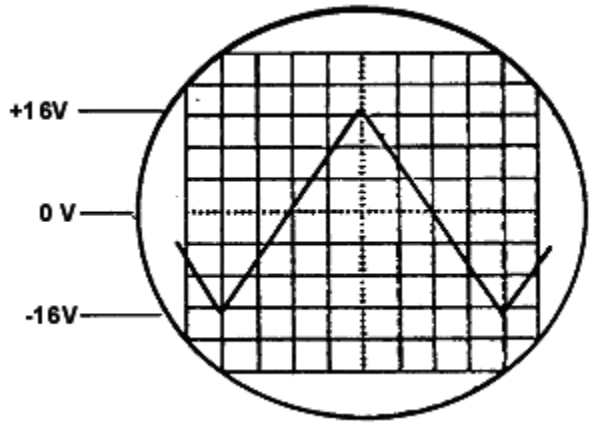

Figure 6. Sweep ramp (M1H output).

(4) If oscilloscope does not indicate a waveshape symmetrical about 0 V and 32 V p-p, perform **b** below.

b. Adjustments

(1) Adjust M1H **CENT** control until waveshape is symmetrical about 0 V (fig. 3) (R).

(2) Adjust M1H **SIZE** control until amplitude is 32 V p-p (fig. 3) (R).

NOTE

These are preliminary adjustments only. Final adjustments will be made in paragraph **16** below.

(3) Adjust •**VAR/MANUAL** control fully ccw.

(4) If sweep time as displayed on oscilloscope is not 0.12 seconds (fig. 7), adjust M1H **INT BAL** (fig. 3) (R).

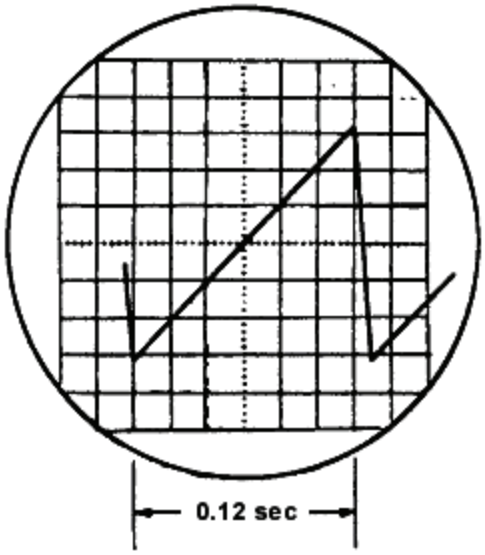

Figure 7. M1H balance adjustment.

(5) Set **SWEEP TIME SEC** to **LINE.**

(6) If signal is not clamped at -16 V (fig. 8), adjust M1H **CLAMP** (fig. 3) (R).

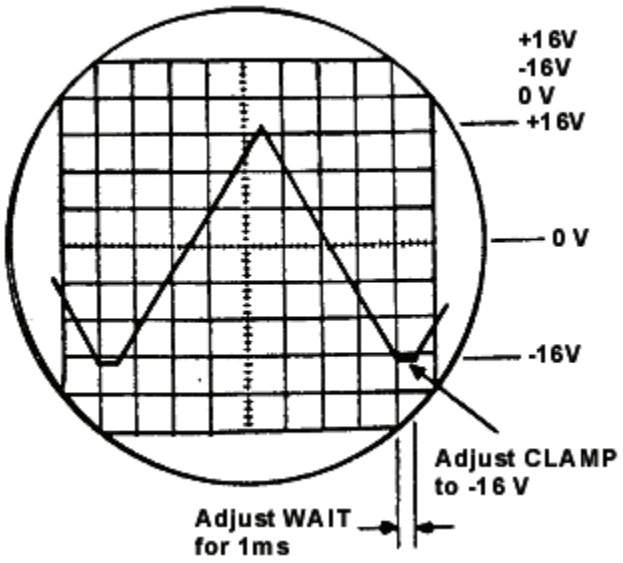

Figure 8. Sweep ramp.

(7) While observing waveshape in figure 8, adjust **WAIT ADJ** (fig. 3) for a wait time of 1 ms (R).

16. Source Relationship

NOTE

The frequency accuracy of the TI is dependent on the +16 V reference supply, the -16 V reference supply, the 32 V p-p ramp, and the inverted 32 V sweep ramp. These four voltages must be precisely adjusted in relation to each other to maintain dial and display accuracy. (See figure 9.)

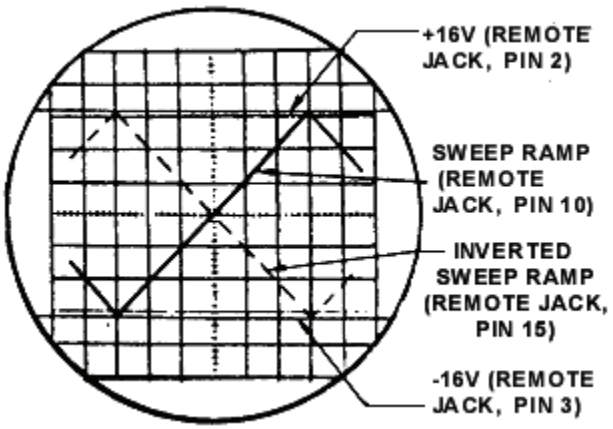

Figure 9. Relationship between sources.

a. Performance Check

NOTE

In (1) and (2) below, switching positive and negative offset voltage is required to obtain the reference mark on the 50/mV per division range.

(1) Connect oscilloscope to pin 2 of remote jack and chassis ground (fig. 4). Record exact amplitude.

(2) Connect oscilloscope to pin 3 of remote jack and chassis ground (fig. 4). Record exact amplitude.

(3) Connect oscilloscope to pin 10 of remote jack and chassis ground (fig. 4).

(4) If the positive and negative peaks do not agree precisely with recordings in (2) and (3) above, perform **b** below.

(5) Connect oscilloscope to pin 15 of remote jack and chassis ground (fig. 4).

(6) If the positive and negative inverted peaks do not agree precisely with recordings in (2) and (3) above, perform **b** below.

b. Adjustments

(1) Connect oscilloscope to pin 10 of remote jack and chassis ground (fig. 4).

(2) Adjust M1H **CENT** and **SIZE** (fig. 3) until the positive and negative peaks agree precisely with recordings in **a** (2) and (3) above (R).

(3) Connect oscilloscope to pin 15 of remote jack and chassis ground (fig. 4).

(4) Adjust M2H R9 and M2H R13 (fig. 5) until the positive and negative peaks agree precisely with recordings in (2) and (3) above (R).

(5) Repeat **a** (1) through (6) above to check for oscilloscope drift while adjustments were being made.

17. Sweep Drive Voltage

a. Performance Check

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

(a) **MODE** switch to **AF**.
(b) **SWEEP WIDTH** to min.
(c) **CENT FREQ** to **250 MHz**.
(d) **BAND** switch to **1**.

(2) Connect oscilloscope to M2H TP1 (fig. 5) and chassis ground.

(3) If indication on oscilloscope is not 0 V, perform **b** (1) below.

(4) Increase **SWEEP WIDTH** to max.

(5) If indication on oscilloscope is not 28 V p-p, perform **b** (2) below.

(6) Connect **HORIZ** output to oscilloscope **CH 2** (set oscilloscope for an X verses Y function operation).

(7) Set **SWEEP TIME SEC** to **.1-.01**.

(8) Adjust oscilloscope width to 10.4 cm (.2 cm overlap on each end) (fig. 10a).

(9) Connect oscilloscope to M2H TP2 (fig. 5) and chassis ground.

(10) If oscilloscope sweep does not “knee” (fig. 10b) approximately 2/3 cm to the left of the 10 cm mark, perform **b** (3) below.

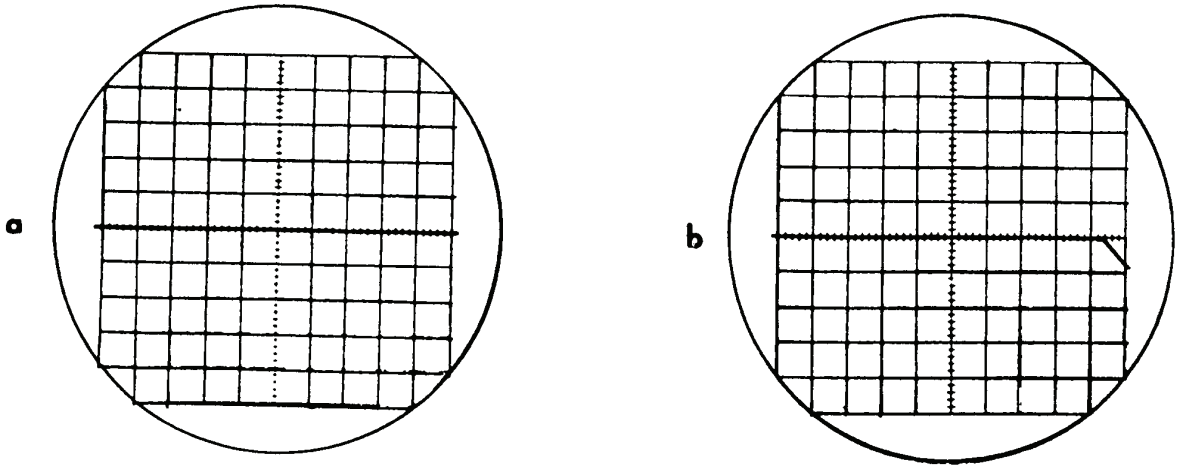

Figure 10. M2H linearity reference adjustment.

b. Adjustments

(1) Adjust R17 (fig. 5) for 0 V indication on oscilloscope (R).

(2) Adjust R26 (fig. 5) for 28 V pp indication on oscilloscope (R).

(3) Adjust R31 (fig. 5) until oscilloscope sweep "knees" approximately 2/3 cm to the left of the 10 cm mark (R).

(4) Repeat paragraphs **9** through **13** above.

18. 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

0719046

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342065, requirements for calibration procedure TB 9-4931-491-24.

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.