TB 9-4931-491-35

Change 2

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR SWEEP/SIGNAL GENERATOR WAVETEK, MODEL 2001SP35 AND SG-677A/U

Headquarters, Department of the Army, Washington, DC
8 August 1989

TB 9-4931-491-35, 8 July 1988, is changed as follows:

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11 and 12	11 and 12

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Change 1

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Headquarters, Department of the Army, Washington, DC
6 February 1989

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CALIBRATION PROCEDURE FOR SWEEP/SIGNAL GENERATOR WAVETEK, MODEL 2001SP35 AND SG-677A/U

Headquarters, Department of the Army, Washington, DC
8 July 1988

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You can help improve this publication by calling attention to errors and by recommending improvements and stating your reasons for the recommendations. Your letter or DA Form 2028, Recommended Changes to Publications, should be mailed directly to Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-TMD-EP, Redstone Arsenal, AL 35898-5000. You may also contact this office electronically. A reply will be furnished directly to you.

*This bulletin supersedes TB 9-4931-491-50, 30 June 1976, including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Sweep/Signal Generator, Wavetek, Model 2001SP35 and SG-677A/U 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 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
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 a power meter)

[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-287. 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.

5. Accessories Required. The accessories used in this calibration procedure are issued with Secondary Transfer Calibration Standards Set AN/GSM-287.

Table 2. Minimum Specifications of Equipment Required

Common Name (Official Nomenclature)	Minimum Use Specifications	Manufacturer and Model (Part Number)
ATTENUATOR No. 1	Range: 0 to 70 dB Accuracy: ±0.125 dB (±0.25 dB/10 dB)	RLC Electronics, Model A2648 (MIS-10263)
ATTENUATOR No. 2	Range: 0 to 10 dB Accuracy: ±0.125 dB	Hewlett-Packard, Model 355C (7910807)
AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: ±2.5%	General Radio, Model W10MT3AS3 or Ridge, Model 9020F (7910809)
SEMICONDUCTOR DEVICE (CRYSTAL DETECTOR WAVEGUIDE)	Frequency range: 1 to 1500 MHz	Hewlett-Packard, Model 423AOPT03 (423AOPT03)
DIGITAL VOLTMETER	Range: 1 to 50 V dc Accuracy: ±0.1%	Hewlett-Packard, Model 3490AOPT060 (3490AOPT060) Dana, Model 5000, or Dana, Model 5000, w/641
FREQUENCY COUNTER	Range: 1 to 1500 MHz Accuracy: ±0.5%	Hewlett-Packard, Model 5345A (MIS-28754/1 Type 1) w/5355A
OSCILLOSCOPE No. 1	Range: 1 mV/cm sensitivity Accuracy: ±3%	Tektronix, Type R5440 (MIS-28706/1 Type 1) w/5A48 (MIS-28706/3) and B42 (MIS-28706/4) and 5S14 (MIS-28706/5)
OSCILLOSCOPE No. 2	Range: 1 mV/cm sensitivity Accuracy: ±3%	Tektronix, Type SC504
POWER METER	Range: 10 to 1500 MHz Accuracy: ±3%	Hewlett-Packard, Model E12-432A (MIS-30525) w/thermistor mount, Hewlett-Packard, Model H75-478A (7915907) or 8478B (8478B)
SIGNAL GENERATOR	Range: 10 to 110 MHz with 0.1 V output	Hewlett-Packard, Model 8640B-OPTH66 (MIS-28707 Type 1)
SPECTRUM ANALYZER	Frequency range: 10 to 500 MHz	Tektronix, Type 492

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.

a. Remove top cover from TI as necessary for access to adjustments. Reinstall top cover after completing check or adjustments.

b. Connect TI to autotransformer.

c. Connect autotransformer to a 115 V ac source and adjust for a 115 V output.

d. Connect equipment as shown in figure 1.

e. 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.

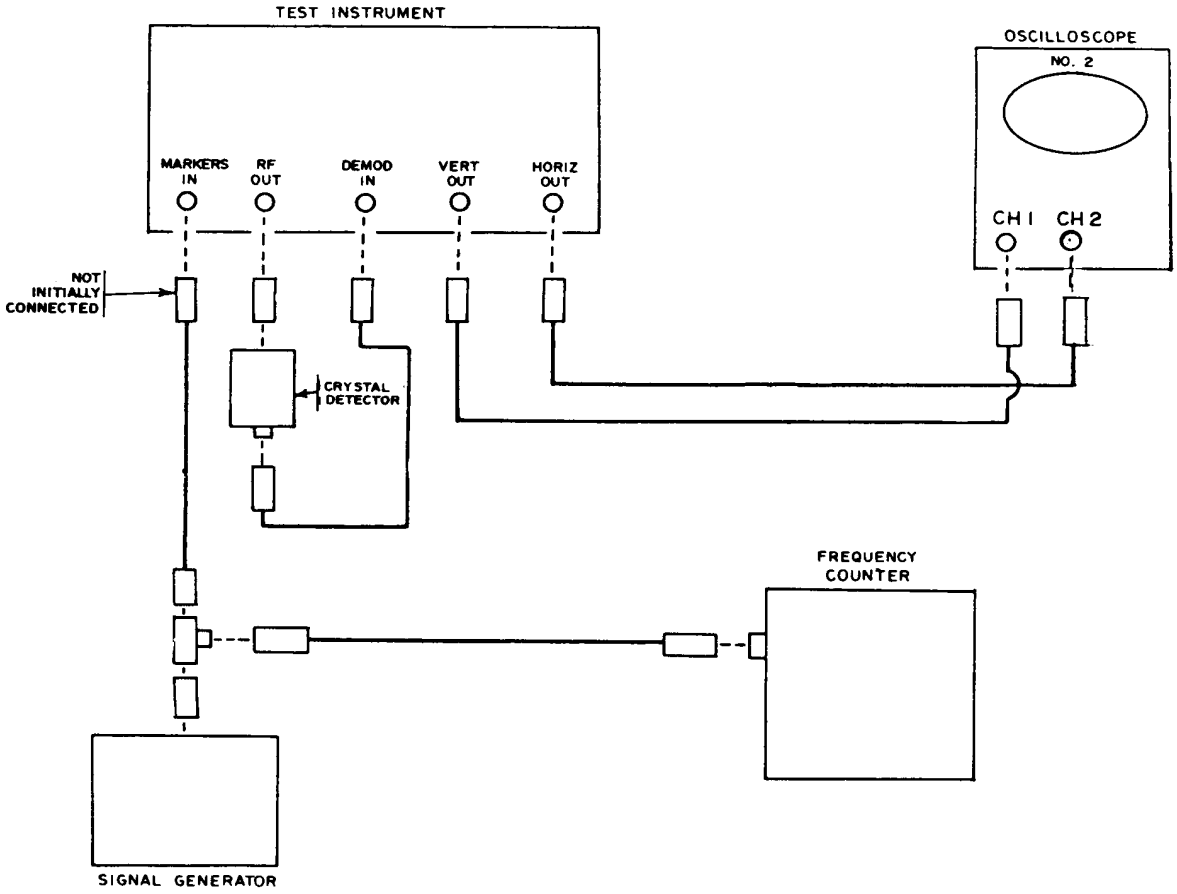

Figure 1. Test equipment - overall equipment setup.

(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.

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

8. Marker System

a. Performance Check

(1) Adjust **MARKER SIZE** and oscilloscope No. 2 vertical and horizontal controls to obtain a pattern as shown in figure 2. (Set oscilloscope for xy.)

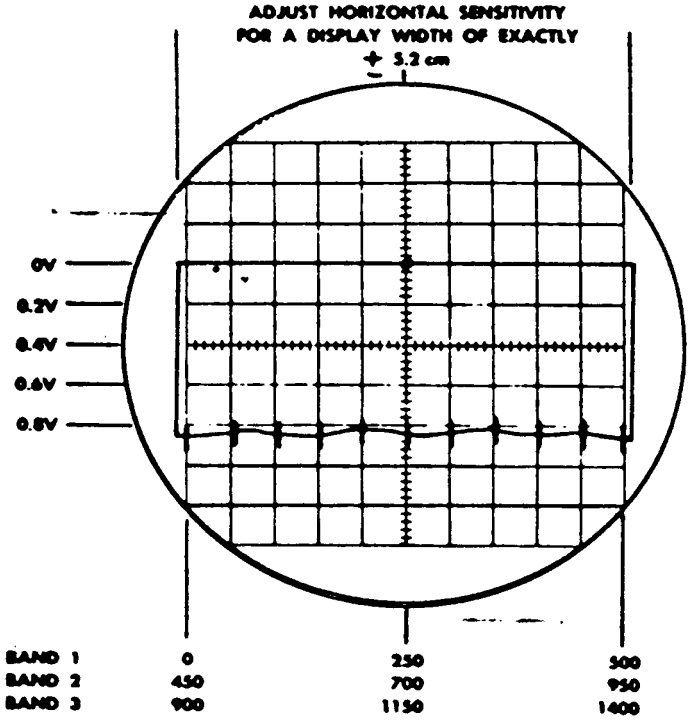

Figure 2. RF detector display.

(2) Connect signal generator output to **MARKER** in and frequency counter.

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

(4) 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.

(5) At zero beat, the frequency counter will indicate between 49.9975 and 50.0025 MHz.

(6) Repeat (3) through (5) 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.

(7) 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.

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

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

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

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

(12) Note that the birdy marker is adjustable from 12 V p-p vertical marker to a horizontal marker equal to 10% of the horizontal deflection (1 cm on a 10 CM 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 **SWEEP SAMPLE ADJ** (fig. 3) for a detected output of .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**(8) through (12) above.

9. Frequency Band

a. Performance Check

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

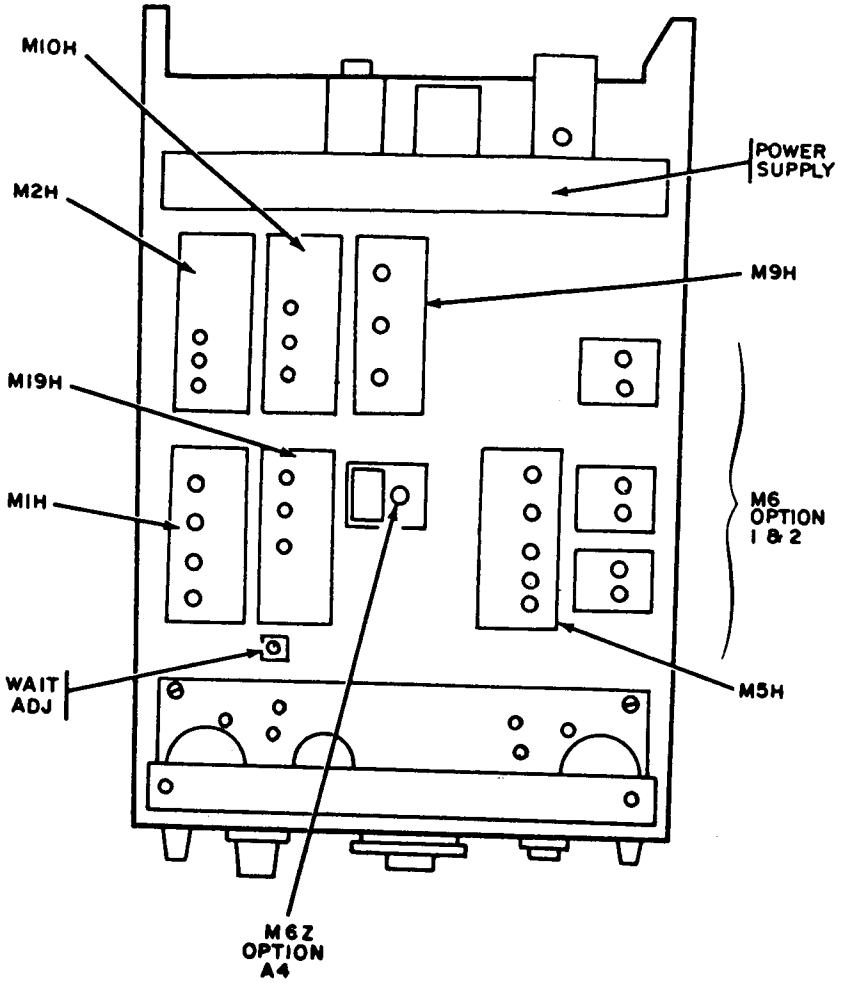

Figure 3. Test instrument - top view.

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

(3) Readjust oscilloscope No. 2 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.

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** to extend the sweep 0.2 cm beyond the first graticule line (R).

10. Dial Accuracy

a. Performance Check

(1) Repeat **7e**(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 **MODE** switch to **CW.**

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

(13) Connect **RF OUT** to frequency counter.

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

(15) Observe frequency counter reading. Allowable error is ±10 MHz.

(16) 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 **+9 dBm**.

(d) **MARKERS** o **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**.

(2) Set power meter to read +10 dBm and connect to **RF** out using thermistor mount.

NOTE

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

(3) If power meter does not indicate between +8.5 and +9.5 dBm, perform **b** below.

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

(5) Power meter will indicate between -0.5 and +0.5 dBm.

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

(7) Power meter 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 power meter indicates **+10 dBm** (R).

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

(4) Adjust M10H **LEVEL MIN** until power meter 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) Set **OUTPUT** switch to **+10 dBm.**

(3) Set power meter to read +10 dBm and connect to RF out using thermistor mount.

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

(5) Note frequency where maximum output is obtained.

(6) Adjust **CENT FREQ** to frequency noted in (5) above.

(7) Adjust **OUTPUT** vernier control until power meter indicates **+10 dBm.**

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

(9) Power meter 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 equipment as shown in figure 4.

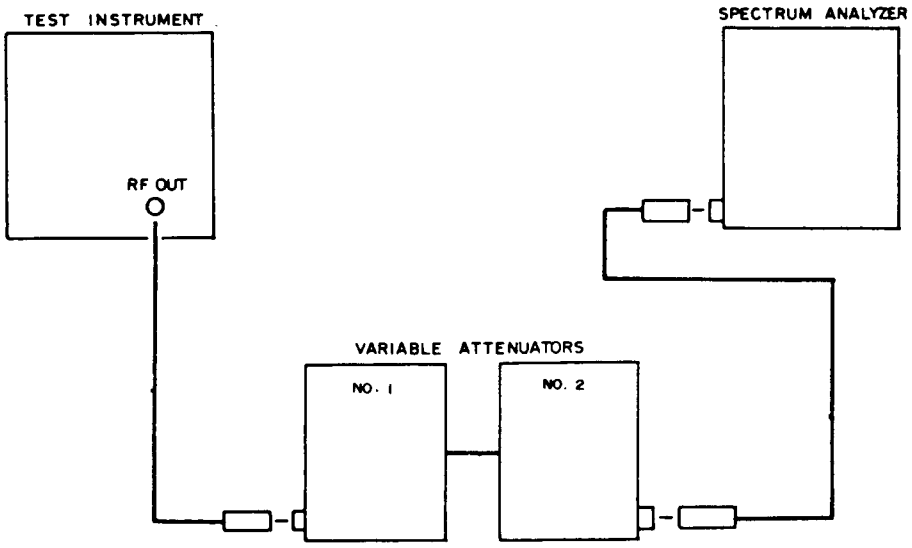

Figure 4. Attenuator accuracy - equipment setup.

(2) Set attenuators No. 1 and No. 2 to 72 dB.

(3) 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**.

(4) Adjust spectrum analyzer controls to establish a reference point.

(5) Set variable attenuators No. 1 and No. 2 to 62 dB.

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

(7) Spectrum analyzer will indicate within ±0.5 dB of reference point established in (4) above.

NOTE

Increasing or decreasing variable attenuators 1 dB may be required to interpolate the ±0.5 dB deviation from the reference point.

(8) Repeat (5) through (7) above, decreasing attenuators No. 1 and No. 2 and increasing **OUTPUT** in 10 dB steps throughout **OUTPUT** range.

(9) Spectrum analyzer will indicate within ±0.5 dB of reference point established in (4) above.

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 digital voltmeter to pin 6 on power plug and chassis ground (fig. 5).

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

(3) Connect digital voltmeter to pin 4 on power plug and chassis ground (fig. 5).

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

(5) Connect digital voltmeter to pin 5 on power plug and chassis ground (fig. 5).

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

(7) Connect digital voltmeter to pin 3 on the remote jack and chassis ground (fig. 5).

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

(9) Connect digital voltmeter to pin 2 on the remote jack and chassis ground (fig. 5).

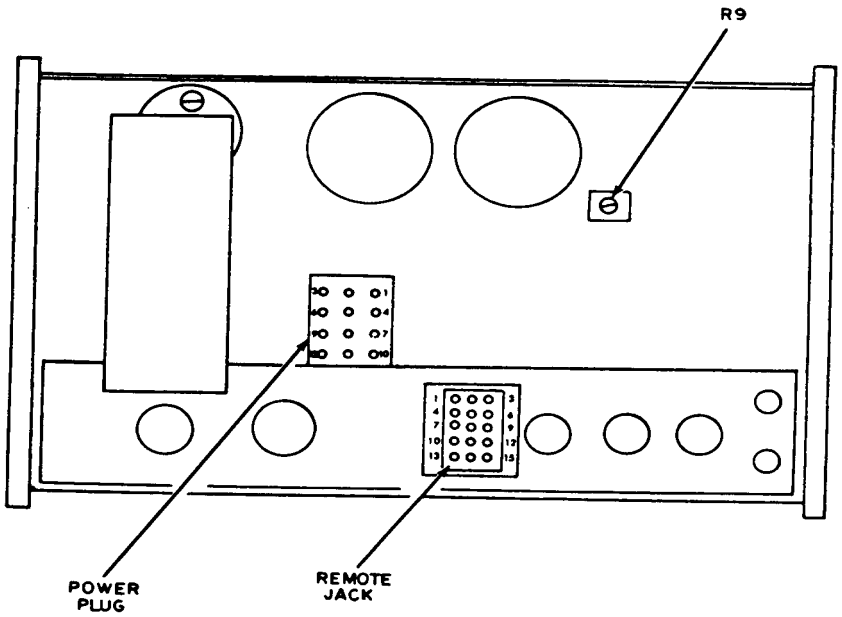

Figure 5. Power supply - (rear view).

(10) If digital voltmeter 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. 5) until digital voltmeter indicates +18 V dc (R).

(2) Adjust R95 (fig. 6) until digital voltmeter 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.

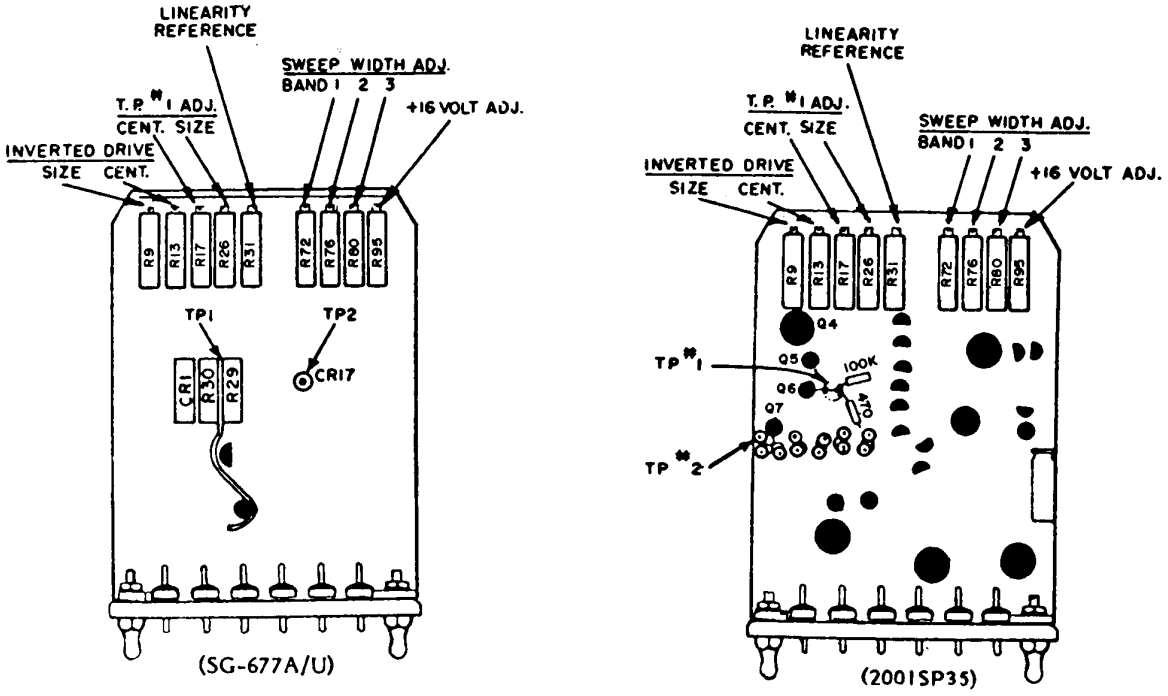

Figure 6. M2H module.

(2) Connect oscilloscope No. 1 differential comparator to pin 10 of the remote jack and chassis ground.

(3) Adjust oscilloscope controls to produce a stable display similar to figure 7.

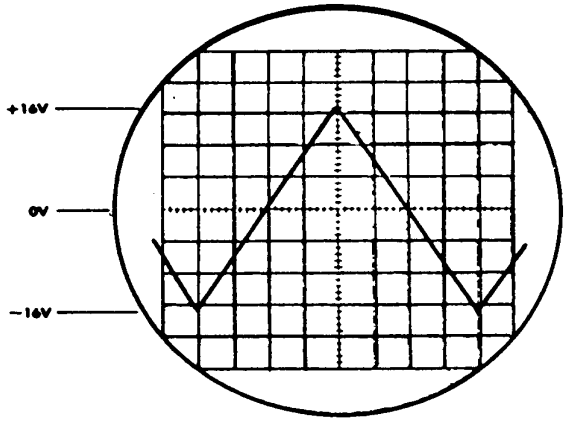

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Figure 7. Sweep ramp (M1H output).

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

b. Adjustments

(1) Adjust M1H **CENT** control until waveshape is symmetrical about zero 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. 8), adjust M1H **INT BAL** (fig. 3) (R).

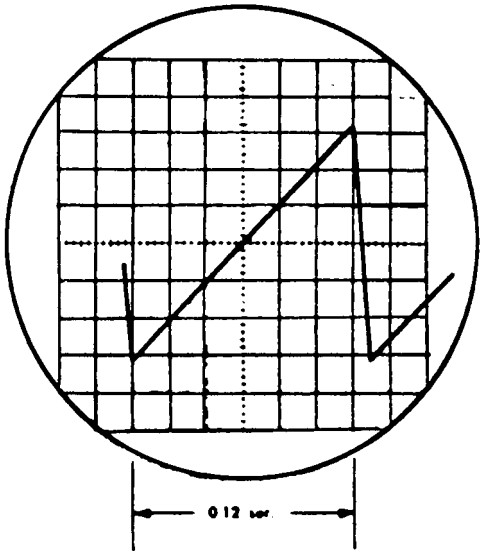

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Figure 8. M1H balance adjustment.

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

(6) If signal is not clamped at-16 V (fig. 9), adjust M1H **CLAMP** (fig. 3) (R).

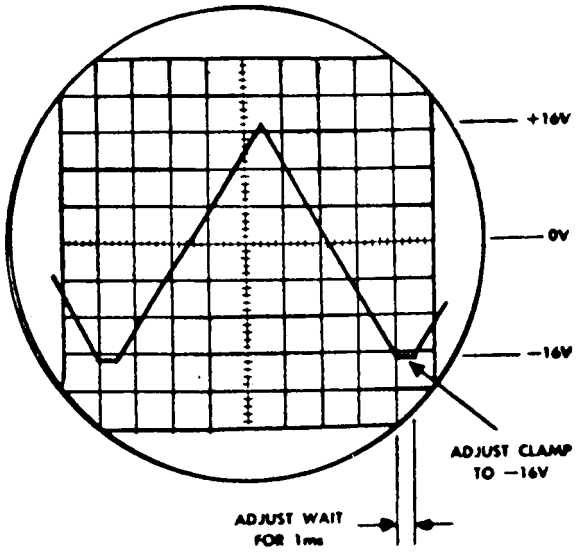

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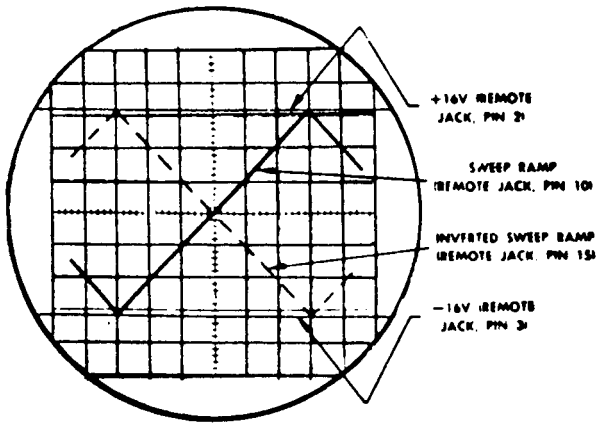
Figure 9. Sweep ramp.

(7) While observing waveshape in figure 9, 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 10.)



MSC00998

Figure 10. Relationship between sources

a. Performance Check

NOTE

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

(1) Connect oscilloscope No. 1 to pin 2 of remote jack and chassis ground. Record exact amplitude (fig. 5).

(2) Connect oscilloscope to pin 3 of remote jack and chassis ground. Record exact amplitude (fig. 5).

(3) Connect oscilloscope to pin 10 of remote jack and chassis ground (fig. 5).

(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. 5).

(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. 5).

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

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

(4) Adjust M2HR9 and M2HR13 (fig. 6) until the positive and negative peaks agree precisely with recordings in (2) and (3) above (R).

(5) Repeat (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 No. 2 to M2H TP1 (fig. 6) 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 xy).

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

(8) Adjust oscilloscope width to 10.4 cm (.2 cm overlap on each end) (fig. 11a).

(9) Connect oscilloscope **CH1** to M2H TP2 and chassis ground.

(10) If oscilloscope sweep does not "knee"(fig. 11b) approximately 2/3 cm to the left of the 10 cm mark, perform **b**(3) below.

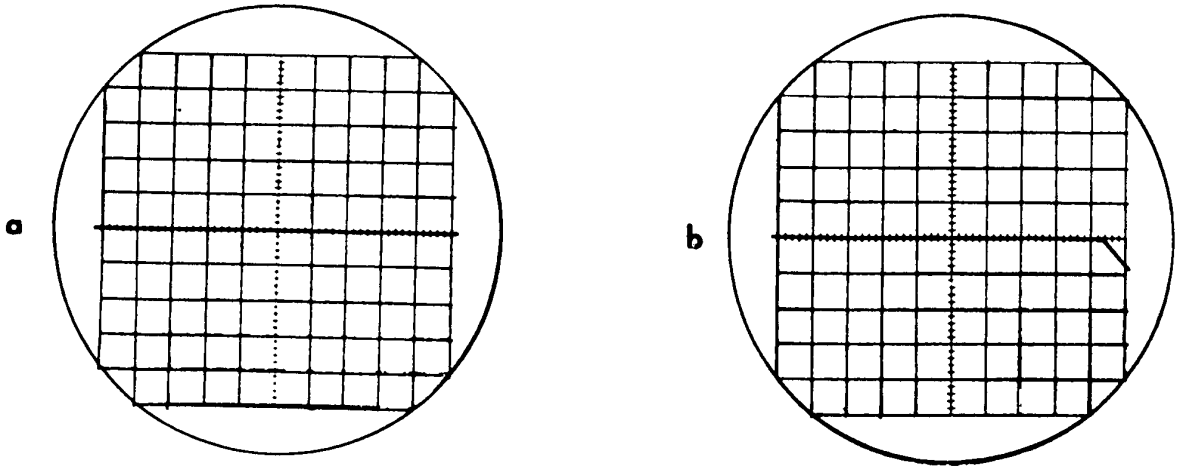


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Figure 11. M2H linearity reference adjustment.

b. Adjustments

(1) Adjust R17 (fig. 6) for 0 V indication on oscilloscope (R).

(2) Adjust R26 (fig. 6) for 28 V p-p indication on oscilloscope (R).

(3) Adjust R31 (fig. 6) 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:

CARL E. VUONO
General, United States Army
Chief Of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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