

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR
SHF SIGNAL GENERATOR
AN/USM-47 (HEWLETT-PACKARD MODEL 626A)
(NSN 6625-00-455-6917)

Headquarters, Department of the Army, Washington, DC
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REPORTING OF ERRORS

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*This bulletin supersedes TB 9-6625-776-50, 31 August 1966.

SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides information for the periodic calibration of SHF Signal Generator AN/USM-47 (Hewlett Packard model 626A) and is to be used by calibration personnel at all levels. Signal Generator AN/USM-47 (HP 626A) will be referred to as the TI (test instrument) throughout this bulletin.

a. *Model variations.* None

b. *Time and Technique.* The time required for calibration is approximately 4 hours using the Microwave Technique.

2. Calibration Data Card (DA Form 2416). a. Forms,

records, and reports required for calibration personnel at all levels are prescribed by TM 38-750 DA Form 2416 must be annotated in accordance with TM 38-750 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 an designated (R) at the end of the sentence in which they appear. 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
Power input requirements Frequency range Frequency accuracy Output range Output monitor accuracy Attenuator Internal pulse modulation Modulation Internal square wave modulation Internal frequency modulation ¹ External pulse modulation: Amplitude requirement ¹ Width requirement ¹ External frequency modulation ¹ Sync out signal ¹ External sync ¹	115 or 230 V $\pm 10\%$, 50 to 60 Hz, 200 W. 10 to 15.5 GHz. $\pm 1.0\%$ of dial indication. 10 mW to 1 pW (+ 10 dBm to - 90 dBm). ± 1.0 dB. $\pm 2.0\%$ Variable from 40 to 4,000 pps. Pulse width variable from 0.5 to 10 μ sec. Internal or external pulsed, FM or square wave. Variable from 40 to 4,000 Hz. Power line frequency, deviation up to ± 5 MHz. 15 to 70 volt peak (positive or negative). 1.0 to 2,500 μ sec. Provides capacitive coupling to repeller of klystron. Max deviation ± 5 MHz. 20 to 50 v into 1,000 ohm load. Better than μ sec rise time. (1) Simultaneous with RF pulse-positive. (2) In advance of RF pulse-positive, variable 3 to 300 μ sec. Pulse or sine wave; 5 to 50 V, 0.5 to 5 μ sec wide.

¹These specifications are for information only and are not necessarily verified in this procedure.

SECTION II.

EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment used in this calibration procedure. This equipment is issued with the secondary transfer calibration standards set, NSN 6695-00-621-7877, and is to be used in performing this procedure. 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 of specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one accuracy ratio between the standard and the TI.

5. Accessories Required. The accessories listed in

table 3 are issued as indicated in paragraph 4 above, and are to be used in this calibration procedure. When

necessary, these items may be substituted by equivalent items unless specifically prohibited.

Table 2. Equipment Required.

Item	Common name	Minimum use specifications	Calibration equipment
A1	Frequency Counter*	Range: 40 Hz to 15.2 GHz Accuracy: ± 3 parts in 10^{10}	Hewlett-Packard 5345A
A2	Frequency Converter	(used with A1)	Hewlett-Packard 5257A
A3	Power Meter, with Waveguide Thermister Mount	Range 0 to - 2 dB; to mW Accuracy: 3%	Systron-Donner 1292A (7910462-2) Hewlett-Packard 431C (7910462-2) Hewlett-Packard P486A (7910709) and X486A (7910460)
A4	Oscilloscope	Range: 0.5 μ sec to 300 μ sec to 30 MHZ	Tektronix RM561A (7910655-2)
A5	Amplifier, Dual trace plug-in		Tektronix 3A6 (7911441-2)
A6	Time Base plug in	Range: 0.5 μ sec to 300 μ sec	Tektronix 3B4 (7912040-2)
A7	Receiver		PRD Electronics 915-S10 (7923103)
A8	Signal Source	Range: 4 to 15.2 GHz	
	RF Head Assembly		PRD Electronics U7006(7923024)
	RF Head Assembly		PRD Electronics X7006(7923023)
	Power Supply Sweeping Tunable Synchronizer		PRD Electronics 816-S10 (7923105) Sage 243A (7923102)

*Use a 10:1 probe or a suitable attenuator. TI output may reach 40 volts. A1 input is limited to 5 volts.

Table 3. Accessories Required

Item	Common name	Description and or identification number
B1	Adapter	Waveguide to coax, PRD 354C (10519423)
B2	Attenuator (2 required)	Set Level, PRD 158A (7909014)
B3	Attenuator	Video, ARI HFA-50 (7923143)
B4	Cable assembly, rf*	72-in. RG-58A/U BNC plug to BNC plug (10519139)
B5	Cable assembly, rf	48-in. RG-58A/U BNC plug to BNC plug (10519140)
B6	Cable assembly, rf	36-in. RG-214/U, N plug to N plug (10519061)
B7	Cable assembly, rf	Microdot to TNC plug (7923236)
B8	Cable assembly, rf	TNC plug to TNC plug (7923237)
B9	Cable assembly, rf	BNC plug to TNC plug (7923244)
B10	Coupler	Waveguide directional, PRD 413-S1 (7923187)
B11	Crystal detector	HP P424A (7923241)
B12	Isolator	Waveguide, PRD 1208B (7923168)
B13	Mixer	Waveguide balanced. Microwave Associates 1119A - 1BE (7923178)
B14	Matching network	PRD 915-1 (7923189)
B15	Bend (2 required)*	Waveguide, PRD 467 (7923242)
B16	Flexible waveguide (2 required)	Airtron AF-2B-062-1800 (10519041)
B17	Twist waveguide	5-in. PRD U3414 (7923229) 12.4 to 18 GHz
B18	Waveguide	Transition waveguide MP292B (supplied with some TI)
B19	Adapter	MX-29213
B20	Adapter	BNC to double banana plug terminations
B21	Probe	10:1 probe HP 1001A or 10003A; use only if frequency counter model HP 5345A is used.
B22	Termination	51 ohm load termination (7622743) BNC connector
B23	Adapter connector	BNC "T" connector

*Required only if working surface is limited.

SECTION III

PRELIMINARY 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 and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

WARNING

HIGH VOLTAGE is used during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

NOTE

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. Additional maintenance information is contained in the manufacturer's manual.

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

7. Equipment Setup.**NOTE**

BEFORE APPLYING POWER verify that the power transformer primary is matched to the available line voltage,

the correct fuse is installed, and Safety Precautions are taken.

WARNING

BEFORE SWITCHING ON THE INSTRUMENT, the protective earth terminal must be connected to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two conductor outlet is not sufficient protection.

IF THIS INSTRUMENT is to be energized via an autotransformer, make sure the common terminal is connected to the earth terminal of the power source.

CAPACITORS INSIDE THE INSTRUMENT may still be charged even if the instrument has been disconnected from its source of supply.

a. Turn TI PWR SET and OUTPUT ATTEN DBM controls fully counterclockwise.

b. Energize TI and allow approximately 20 minutes for warmup and stabilization. Do not connect the TI to the calibration equipment at this time.

SECTION IV

CALIBRATION PROCESS

8. Zero Set. a. *Performance Check.*

(1) Turn TI MOD SELECTOR switch to OFF.

(2) Adjust TI ZERO SET control for ZERO SET as indicated on TI power monitor meter.

b. *Adjustments.*

(1) Remove TI from case.

(2) Turn ZERO SET control to midrange.

(3) Adjust R98 (figure 1) for ZERO SET as indicated on power monitor meter. (R)

9. Power Monitor. a. *Performance Check.*

(1) Connect TI RF OUTPUT connector to power meter (A3) using waveguide thermister mount P486A and adaptor (B18)

(2) Position TI controls as indicated in (a) through (g) below.

(a) SIGNAL FREQUENCY control to 15 GHz as indicated on TI frequency dial.

(b) MOD SELECTOR switch to OFF.

(c) ZERO SET control for ZERO SET as indicated on TI power monitor meter.

(d) MOD SELECTOR switch to CW.

(e) PWR SET control for POWER SET as indicated on TI power monitor meter.

(f) MOD SELECTOR switch to OFF.

(g) OUTPUT ATTEN DBM control to 1 (-1) DBM as indicated on dial.

(3) Zero-set power meter (A3) and recheck ZERO SET on TI power monitor meter.

(4) Turn TI MOD SELECTOR switch to CW.

(5) Power meter (A3) will indicate between 0 dB and - 2 dB. If not, perform *b*, below.

(6) Turn OUTPUT ATTEN DBM control fully counterclockwise.

(7) Repeat the technique in (1) through (6) above at frequencies of 12 and 10 GHz changing thermister mount to X486A and adapter (B19).

b. Adjustments.

WARNING

HIGH VOLTAGE is used during the performance of this procedure. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

(1) Remove TI from case.

(2) Adjust PWR SET control for -1 dBm as indicated on power meter (A3).

(3) Adjust R108 (fig. 1) for 0 dBm (POWER SET) as indicated on TI power monitor meter. (R)

10. Frequency Dial. a. Performance Check.

(1) Connect frequency counter (A1) with frequency converter (A2) to TI using cable assembly, rf (B6) and adapter (B1).

(2) Position TI controls as indicated in (a) through (e) below.

(a) SIGNAL FREQUENCY control to 10 GHz as indicated on TI frequency dial.

(b) MOD SELECTOR switch to OFF.

(c) ZERO SET control for ZERO SET as indicated on TI power monitor meter.

(d) Set MOD SELECTOR switch to CW and PWR SET control for POWER SET as indicated on TI power monitor meter.

(e) OUTPUT ATTEN DBM control to 0 DBM as indicated on dial.

(3) Frequency counter will indicate between 9.9 and 10.1 GHz.

(4) Repeat (2) and (3) above utilizing settings listed in table 4. Frequency counter indications will be within limits specified in table 4. If not, perform *b*, below.

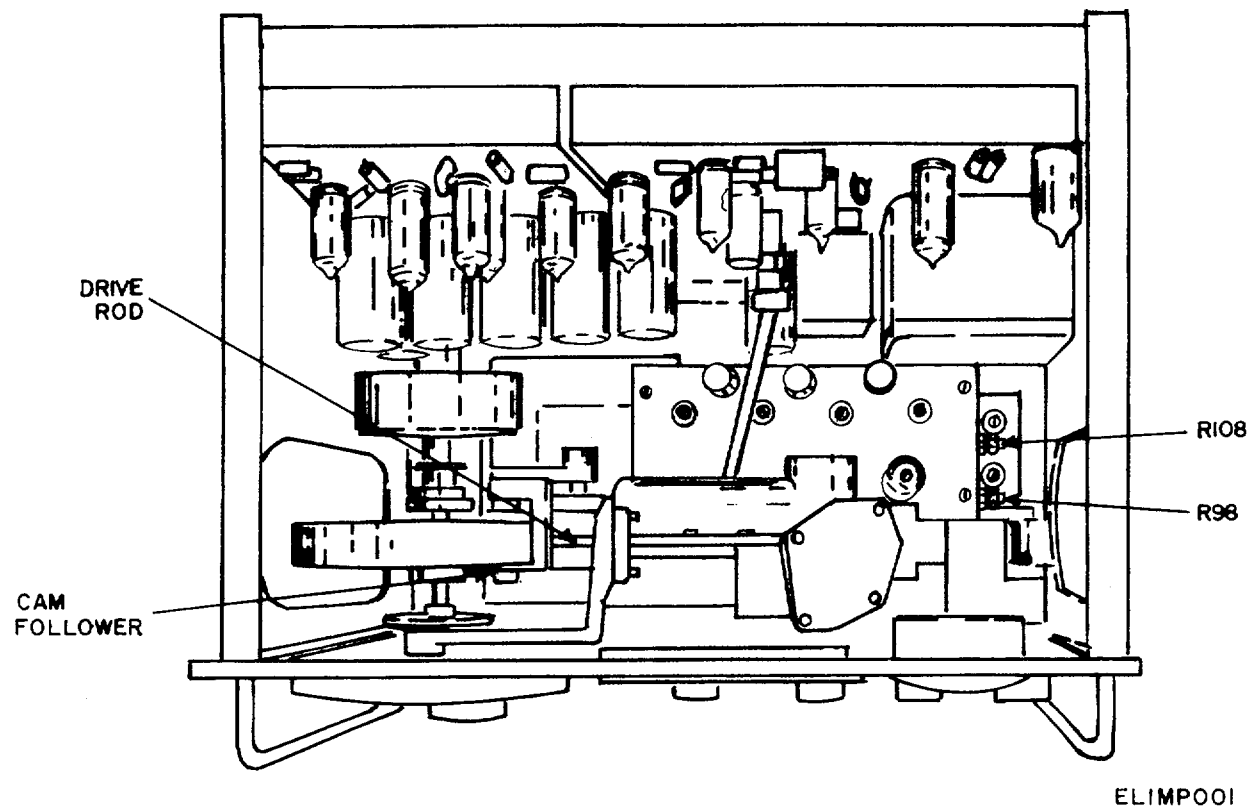


Figure 1. Top interior view.

Table 4. Frequency Dial Performance Check

Test instrument frequency dial setting (GHz)	Frequency counter indication (GHz)	
	Minimum	Maximum
11.0	10.890	11.110
12.0	11.880	12.120
13.0	12.870	13.130
14.0	13.860	14.140
15.0	14.850	15.150

b. Adjustments.

- (1) Turn TI SIGNAL FREQUENCY control to 10 GHz as indicated on the frequency dial.

CAUTION

The stops for the frequency drive mechanism are inoperative when the frequency dial is not in place. Rotating the shaft for the frequency dial and frequency drive cam to one extreme or the other without these stops may result in serious and permanent damage to plunger on inner end of frequency drive rod. Handle with care.

- (2) Loosen setscrews holding drive rod (fig. 1) to cam follower.

(3) With frequency dial at 10 GHz, manually move drive rod in increments of approximately 1/32 inch until output frequency of TI is 10 GHz as indicated on the frequency counter.

- (4) Tighten setscrews.

(5) Repeat a(1) through (4) and refine the adjustment as necessary to ensure that TI indications are within tolerance. (R)

11. Pulse Rate. *a. Performance Check.*

CAUTION

Be extremely careful that TI SYNC OUT is not connected directly to the frequency counter. Damage will occur if the 5 V/ +24 dbm max limitation is not observed.

- (1) Connect frequency counter (A1) to TI SYNC OUT connector using probe (B21) and adapter (B20).

(2) Position TI controls as indicated in (a) through (c) below.

- (a) MOD SELECTOR switch to INT.
 (b) SYNC SELECTOR switch to X1.
 (c) PULSE RATE control to 40.

(3) Frequency counter will indicate 40 Hz or less.

- (4) Turn SYNC SELECTOR switch to TI to X10.

- (5) Turn PULSE RATE control of TI to 400.

(6) Frequency counter will indicate at least 4,000 Hz.

b. Adjustments.

- (1) Adjust TI PULSE RATE control for 1,000 Hz as indicated on the frequency counter.

(2) Without changing PULSE RATE position, loosen knob screws and slip, control so that 100 is located under panel index marker. Tighten knob screws. (R)

(3) Check PULSE RATE control calibration at 40 and 400.

(4) If necessary, again loosen knob screws and slip control to average error across range. Tighten screws. (R) Repeat the performance check.

12. Pulse Delay. *a. Performance Check.*

(1) Connect TI RF output through crystal detector (B11), adapter (B18), and cable assembly, rf (B5) to channel 1 input of oscilloscope (A4).

(2) Connect TI SYNC OUT connector to EXT TRIG IN connector of oscilloscope using cable assembly, rf (B5).

(3) Turn TI PULSE DELAY control fully counterclockwise, SYNC SELECTOR control to X10, and PULSE RATE control to 100.

(4) Minimum delay from start of trace to leading edge of pulse will be less than 5 microseconds as indicated on the oscilloscope. If not, perform *b*, below.

- (5) Turn TI PULSE DELAY control to 300.

(6) Delay from start of trace to leading edge of pulse will be at least 300 microseconds as indicated on the oscilloscope.

b. Adjustments.

- (1) Remove TI from case.

(2) Adjust R78 (fig. 2) for a delay less than 5 microseconds as indicated on the oscilloscope. (R)

(3) Turn PULSE DELAY control to 50 microseconds as indicated on the oscilloscope.

(4) Loosen setscrews and slip PULSE DELAY control so that 50 is located under panel index marker. Tighten setscrews. (R) Repeat the performance check.

13. Pulse Width. *a. Performance Check.*

(1) Turn TI PULSE WIDTH control fully counterclockwise and PULSE DELAY control fully counterclockwise.

(2) Connect a 50 ohm load (B22) to the oscilloscope connection with adapter connector "T" (B23).

(3) Minimum pulse width as indicated on the oscilloscope will be less than 0.5 microseconds. If not, perform *b*, below.

- (4) Turn TI PULSE WIDTH control to 10.

(5) Pulse width as indicated on the oscilloscope will be at least 10 microseconds.

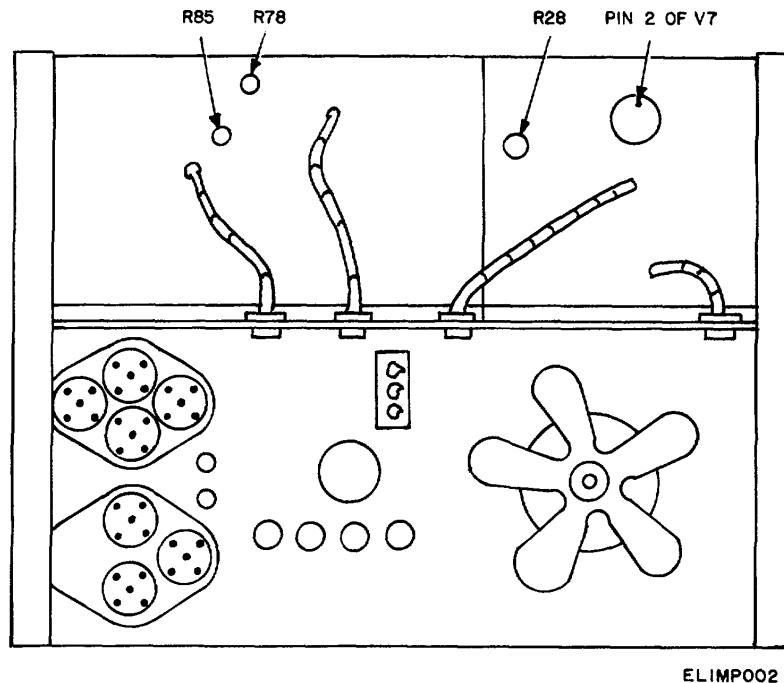


Figure 2. Rear interior view.

b. Adjustments.

- (1) Remove TI from case.
- (2) Adjust R85 (fig. 2) for a pulse width less than 0.5 microseconds wide as indicated on the oscilloscope.(R)
- (3) Adjust PULSE WIDTH control of TI for a 10 microsecond wide pulse as indicated on the oscilloscope.
- (4) Loosen knob setscrews and slip PULSE WIDTH control so that 10 is located under panel index marker. Tighten setscrews. (R) Repeat the performance check.

14. Attenuator. a. Performance Check.

- (1) Connect equipment as shown in figure 3.

CAUTION

Since ferrous materials may permanently damage magnetic fields of the BWO tubes used in the RF head assembly, keep ferrous materials away from BWO tubes and use only nonferrous tools when working near BWO tubes.

- (2) Adjust TI controls for a CW output frequency of 12.75 kmc.
- (3) Adjust TI OUTPUT ATTEN DBM control to 0 db.
- (4) Adjust controls of signal source (A) for a CW output frequency of approximately 12.75 kmc. Coarse

tune output frequency and matching network (B14) for maximum deflection on receiver (A7) NULL meter.

(5) Phase lock and level signal source and fine tune for an oscilloscope display of 30 mHz \pm 25 kHz (difference of local and reference oscillator frequencies).

(6) Adjust RF power output of signal source utilizing level set attenuator (B2) number 2 for 0.9 ma as indicated on CRYSTAL CURRENT meter of receiver.

(7) Adjust REFERENCE ATTENUATOR control of receiver for 0 db as indicated by ATTENUATION-DB digital readout of receiver.

(8) Turn TI MOD SELECTOR switch to OFF.

(9) Turn POWER LEVEL-OSC. OFF control of receiver counterclockwise to OSC. OFF.

(10) Adjust NOISE BALANCE control of receiver for zero as indicated on NULL meter.

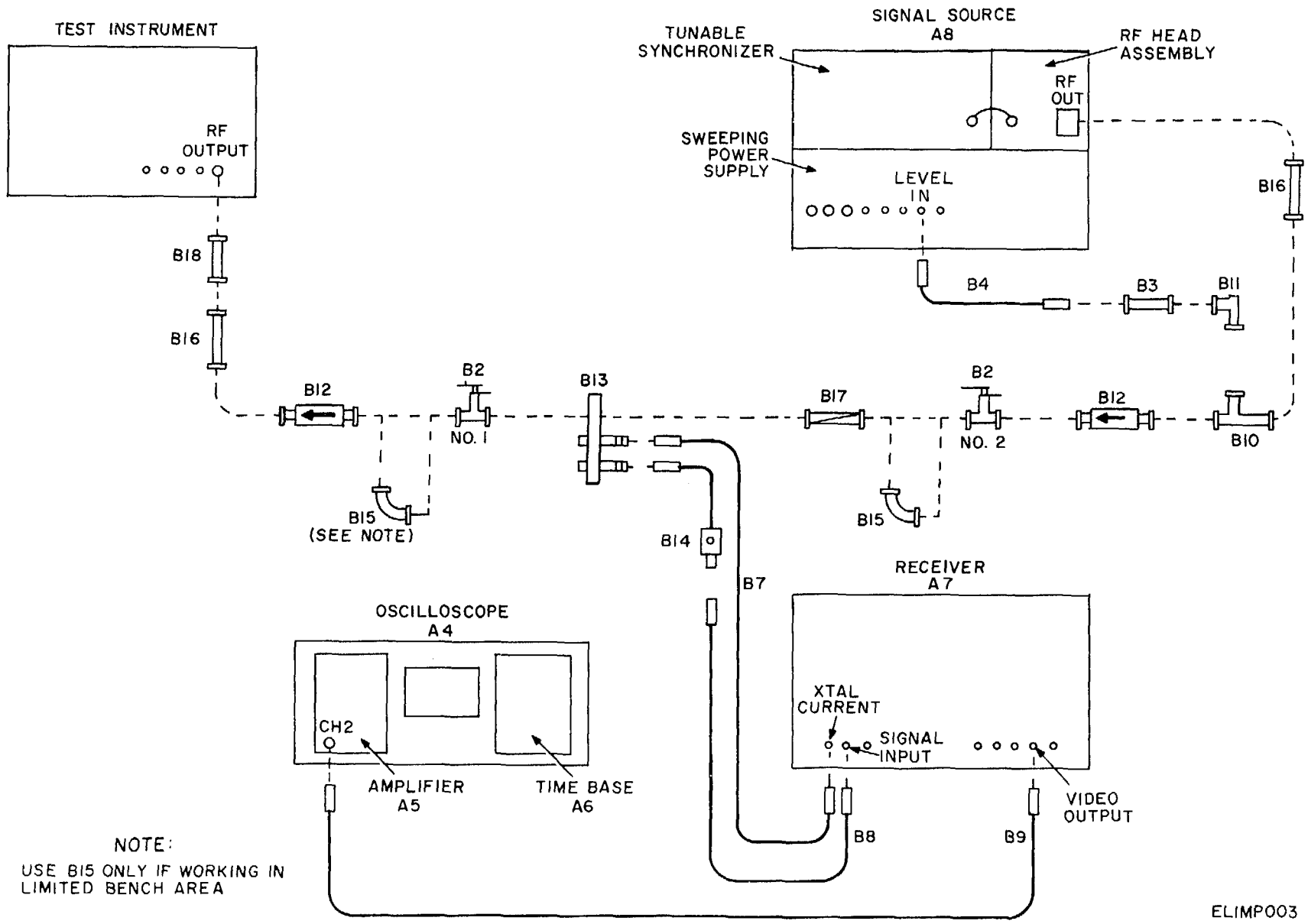
NOTE

Do not readjust NOISE BALANCE control for the remainder of this procedure.

(11) Turn TI MOD SELECTOR to CW and stabilize at frequency and power output as in (2) and (3) above.

(12) Turn POWER LEVEL-OSC OFF control of receiver to POWER LEVEL.

(13) Adjust level set attenuator number 1 for null (zero reference) as indicated on NULL meter of receiver.



NOTE:
USE B15 ONLY IF WORKING IN
LIMITED BENCH AREA

ELIMPO03

Figure 3. Attenuation check, equipment setup.

(14) Adjust OUTPUT ATTENUATOR control of TI to - 10 db.

(15) Adjust REFERENCE ATTENUATOR control of receiver for a null as indicated on NULL meter of receiver.

(16) ATTENUATION-DB digital readout of receiver will indicate between 9.8 and 10.2 db.

(17) Repeat (14) through (16) above for each setting listed in table 5. ATTENUATION-DB digital readout of receiver will be within limits specified in table 5. Repeat signal source as necessary for each TI setting.

b. Adjustments. No adjustments can be made.

15. Final Procedure. *a.* Deenergize and disconnect all test equipment and reinsert TI in case if removed for adjustments.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument).

Table 5. Attenuator performance check.

Test instrument OUTPUT ATTEN settings (DBM)	ATTENUATION-DB digital readout of receiver (db)	
	Minimum	Maximum
-20	19.6	20.4
-30	29.4	30.6
-40	39.2	40.8
-50	49.0	51.0
-60	58.8	61.2
-70	68.6	71.4
-80	78A*	81.6*

*Excessive noise may make this reading and readings beyond this amount difficult to read. For the purpose of periodic calibration terminate the test at this reading

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