TB 11-6625-2713-50

CHANGE 2

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-296A (NSN 6625-00-115-9201)

Headquarters, Department of the Army, Washington, DC
12 December 1985

TB 11-6625-2713-50, 29 December 1978, is changed as follows:

Page 1, Reporting of Errors. Change address to read "Commander, U. S. Army TMDE Support Group, ATTN: AMXTM-LPE, Redstone Arsenal, AL 35898-5400."

Paragraph 2a. In lines 3 and 5, change "TM 38-750" to read "TB 750-25."

Page 4, paragraph 9a(5). Change "CH2" to read "CH1."

Paragraph 9a(6). Change "channel 2" to read "CH1."

Paragraph 9a(7) is superseded as follows:

(7) Set TI VERTICAL MODE switch to CH2 and connect digital voltmeter (A3) to junction of A2A3R9 and A2A3R20 (fig. 2) and chassis ground. If digital voltmeter does not indicate zero voltage ±50 mV, perform **b**(1) below.

Page 6, table 4. In line 5 u nder maximum column, change "0.22846" to read "0.28846."

Page 12, paragraph 22b is superseded as follows:

b. When all parameters are within tolerance, annotate and affix DA Label 80 (U.S. Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (U.S. Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (U.S. Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25.

PIN: 015255-002

By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff

Official:

MILDRED E. HEDBERG
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-34C, Block No. 319, requirements for calibration procedures publications.

US GOVERNMENT PRINTING OFFICE: 1985 - 631-027/20314

TB 11-6625-2713-50

CHANGE 1

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-296A (NSN 6625-00-115-9201)

Headquarters, Department of the Army, Washington, DC
17 June 1980

TB 11-6625-2713-50, 29 December 1978, is changed as follows:

Page 4, paragraph 7a(6), line 1. "CH 1" is changed to read: CH 2.

Paragraph 8a(6), line 2. "CH 1" is changed to read: CH 2.

Paragraph 8a(8), line 1. "CH 1" is changed to read: CH 2.

Paragraph 9a(2), line 2. "CH 1" is changed to read: CH 2

Paragraph 9a(3), line 1. "CH 1" is changed to read: CH 2.

Page 5, paragraph 9a(5) and (6) are superseded as follows:

(5) Set TI VERTICAL MODE to CH 2.

(6) Repeat steps (*3) and (4) above for channel 2.

(7) Connect digital voltmeter (A3) to junction of A2A3R9 and A2A3R20 (fig. 2) and chassis ground. If digital voltmeter does not indicate zero voltage ±50 mV, perform **b**(1) below.

(8) Set TI VERTICAL MODE to CH 1. If digital voltmeter does not indicate zero voltage ±50 mV, perform **b**(2) below.

(9) Set TI VERTICAL MODE to CH 1.

PIN: 015255-001

Paragraph 9b(1) and (2) are superseded as follows:

(1) Adjust A2A3R1 (fig. 2) for 0.0 volts.

(2) Adjust A2A6R56 (fig. 1) for 0.0 volts.

Page 6, table 4 is superseded as follows:

Test instrument VOLTS/DIV switch settings	Ac calibrator indications (rms)	
	Minimum	Maximum
.01	13.857 mV	14.423 mV
.02	27.714 mV	28.846 mV
.05	69.286 mV	72.120 mV
.1	0.13857 V	0.14423 V
.2	0.27714 V	0.22846 V
.5	0.69286 V	0.72120 V
1	1.3857 V	1.4423 V
2	2.7714 V	2.8846 V
5	6.9286 V	7.2120 V
10	13.857 V	14.423 V

Page 7, table 5, first column, line 5. ".5^{1}" is changed to read: 5^{1}.

Paragraph 13b, line 1. "A1A549" is changed to read: A1A5R49, and (R) is added at the end of the sentence.

Paragraph 14a(3), line 2. "10 MHz" is changed to read: 1MHz.

Page 8, paragraph 15a(4), line 2. "0.3" is changed to read: 0.5.

Paragraph 16a(3), line 2. "-0.01 and +0.01" is changed to read: +0.64 and +0.66.

Paragraph 16b(2), line 2. "0.00" is changed to read: +0.65.

Paragraph 16b(3), line 1. "+0.25" is changed to read: -0.25.

Page 9, paragraph 16B(4), line 1. "A1A1A2R12" is changed to read: A1A2R12.

Page 11, table 6, first column, lines 1 through 9. "SEC" is changed to read: µSEC.

Table 6, second column, lines 2 through 9. "pS" is changed to read: µS.

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-34A (block 75) requirements for calibration procedures publications.

US GOVERNMENT PRINTING OFFICE: 1980-665-119/282

*TB 11-6625-2713-50

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-296A (NSN 6625-00-115-9201)

Headquarters, Department of the Army, Washington, DC
29 December 1978

♦REPORTING OF ERRORS♦

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. FAX to DSN 788-2313 (commercial 256-842-2313). A reply will be furnished directly to you.

*This technical bulletin supersedes TB 11-6625-2713-50, 3 February 1977.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope AN/USM-296A and is to be used by calibration personnel. The manufacturer's manual was used as the prime data source in compiling these instructions. The above equipment will be referred to as the "TI" (test instrument) throughout the bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 6 hours, using the dc and low frequency technique.

2. Calibration Data Card, DA Form 2416

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25. DA Form 2416 (Calibration Data Card) must be annotated in accordance with TB 750-25 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear 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
Calibrator	
Square wave	Duty cycle 50% ±5%
Polarity	Positive going with baseline at zero volts
Output voltage	1 v or 0.3 peak to peak ±1%
Repetition rate	1 kHz ±20%
Risetime	Less than 1 microsecond
Z axis amplifier:	
Sensitivity	2 volts peak to peak
Risetime	70 nanoseconds
Input resistance	5 kohms, approximately

Table 1. Calibration Description - Continued.

Test instrument parameters	Performance specifications
Z axis amplifier:	
Input coupling	Dc
Polarity	Positive
Maximum input voltage	20 volts dc plus ac peak
External horizontal amplifier:	
Deflection factor:	
Unmagnified x1 horizontal gain	Variable 100 mV/cm to 1.0 V/cm
X10 horizontal gain	Variable 10 to 100 mV/cm
X10 external horizontal	Variable 1 to 10 V/cm
Frequency response	Dc to 4 MHz; not more than 30% down; trigger coupling in dc position.
Input	Approx. 1 megohm paralleled by 30 picofarads (pF)
Power supply	
Voltage	103.5 to 126.5 volts ac or 207 to 253 volts ac
Line frequency	47.5 Hz to 440 Hz.
Dual Trace Oscilloscope Plug-In Unit Am-6566/U	
Deflection factor	5 mV/div to 10 V/div in 11 calibrated steps for each channel. Within ±2% of indicated deflection with variable control fully clockwise.
Accuracy	Within ±2% of indicated deflection with variable control fully clockwise.
Variable factor	Uncalibrated deflection factor at least 2.5 times VOLTS/DIV switch indication, providing 25 V/div in 10 V position.
Frequency response	5 mV to 10 V/div, dc to 50 MHz.
Input	1 megohm ±2% paralleled by 24 pF ±1 pF.
Maximum input voltage	
Ac coupled	400 v (dc plus peak ac).
Dc coupled	400 v (dc plus peak ac).
Ac low frequency response	30% down at 2 Hz (ac-gnd-dc switch in ac position).
Vertical display modes	Channel 1 only; dual trace, chopping between channels. Channel 2 only: dual trace, chopping between channels.
Chopped repetition rate	500 kHz, approximately
Common mode rejection	Greater than 20:1 at 25 MHz, input signal less than 10 times V/div.
Position range	Approx. three screen diameters.
Polarity inversion	Channel 1 or channel 2 signal can be inverted.
Vertical drift	Not more than 1 cm per hours.
Mode	
Channel 1	Internal triggering from channel 1 only
Channel 2	Internal triggering from channel 2 only
Display	Trigger picked off channel being displayed.
Time Base Delay Oscilloscope Plug-In Unit Td-1086/U	
Triggering source	Internal as determined by TRIG MODE switch

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Trigger level:	
External	±3 volts minimum
External divided by 10	±30 volts minimum
Internal	From ac line
Time Base Delay Oscilloscope Plug-In Unit TD-1086/U	
Coupling	Ac low and high frequency reject
Triggering ac slope	From positive or negative going position of trigger signal.
Internal trigger sensitivity	
Ac	0.5 div of deflection, minimum 50 Hz or 50 MHz.
High frequency reject	0.5 div of deflection, minimum dc to 50 MHz.
External trigger sensitivity:	
Ac	50 mv peak to peak minimum 5 kHz to 50 MHz.
Low frequency reject	50 mv peak to peak minimum 5 kHz to 50 MHz.
High frequency reject	50 mv peak to peak minimum 50 Hz to 50 kHz.
Dc	50 mv peak to peak minimum dc to 50 MHz.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment used in this calibration 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 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 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. Minimum Specification of Equipment Required

Item	Common name and/or official nomenclature	Minimum use specifications	Manufacturer, model, and, part number Level A
A1	Autotransformer (Variable Power Transformer)	Range: 105 To 125 Vac Accuracy: ±1%	General Radio Model W10MT3AS3 (7910809)
A2	Ac Calibrator (Standard Ac Calibration (Precision)	Range: 10.61 mV To 21.21 V rms Accuracy: ±0.75%	Hewlett-Packard, Model 745A-C90 (MIS-10342, Type 1)
A3	Digital Voltmeter	Range: -1200 To +135 Vdc; 0 To 1 Vac Accuracy: ±0.05%	Dana, Model 5703-S-2127 (7912606) w/HV Probe (7911350)
A4	Oscillator (Audio-Radio Frequency	Range: 5 kHz To 4 MHz 15 mV To 12 V rms	Hewlett-Packard, Model 652A (MIS-10224)
A5	Square-Wave Generator	Range: 5 kHz To 1 MHz; 5 mV To 12 mV p-p.	Tektronix, Type 106 (MIS-10284-1)
A6	Time Mark Generator	Range: 1 To 50 MHz	Tektronix, Type 184 MOD146B (7912042-1)

Table 3. Accessories Required

Item	Common name and/or official nomenclature	Description and part number
B1	Adapter (Adapter, Connector)	UHF jack To BNC plug (10054847)
B2	Adapter (Adapter, Connector)	UHF plug To BNC jack (10519439)
B3	Adapter	BNC T type, 2 jacks, 1 plug (MS35173-274C)
B4	Cable (Cable Assembly, RF Frequency	30 inch RG-58/U; BNC plug to BNC plug terminations (7907467)
B5	Cable (Lead, Test)	36 inch RG-58/U; BNC plug to double banana plug terminations (7907471)
B6	Standardizer	5 to 47 picofarad, UHF plug to UHF jack (SKD 4850-44).

SECTION III
PRELIMINARY OPERATIONS

6. Preliminary Instructions

a. The instructions outlined in this section 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.

7. Equipment Setup

a. Position TI controls as listed in (1) through (9) below:

(1) Set MAIN TRIG switches as follows:

(a) SOURCE switch to INT.

(b) COUPLING switch to AC.

(c) SLOPE switch to + (positive).

(2) AUTO-TRIG-SINGLE switch to AUTO.

(3) Horizontal mode switch to EXT HOR.

(4) TIME/DIV switch to 1 MSEC and VARIABLE control to CAL.

(5) Repeat (1) above for DLY'D TRG.

(6) VERTICAL MODE switch to CH2 and TRIG MODE to DSPLY.

(7) CH1 and CH2 VOLTS/DIV VERNIER controls to CAL.

(8) CH1 and CH2 VOLTS/DIV switches to .05.

(9) CH1 and CH2 AC-DC-GND switches to DC.

b. Connect TI to autotransformer (A1) and connect autotransformer to a 115-volt ac source. Adjust controls for 115 volts output.

c. Adjust TI INTENSITY and FOCUS controls to midrange.

d. Set TI PWR switch to ON and allow 5 minutes for equipment to warm-up.

SECTION IV
CALIBRATION PROCESS

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. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in TM 11-6625-2713-14 for this TI.

8. Intensity Limit, Astigmatism, and Trace Alignment

a. Performance Check

(1) Center spot on crt (cathode ray tube) horizontal graticule centerline, using VERTICAL and HORIZONTAL POSITION controls.

(2) Adjust INTENSITY LIMIT on rear panel for optimum, suitable dim spot.

(3) Adjust rear panel ASTIG ADJ control and front panel FOCUS control for small spot with optimum roundness.

(4) Set horizontal mode switch to NORM.

(5) Align trace on crt graticule centerline, using CH1 POSITION control. If trace is not parallel to horizontal centerline, adjust TRACE ALIGN on rear panel until trace is parallel with graticule centerline.

(6) Align trace on top crt graticule line, using CH2 POSITION control. If trace does not align or indicates bowing, adjust rear panel PATTERN ADJ for proper alignment.

(7) Align trace on bottom crt graticule line and repeat (6) above.

(8) Connect TI CAL 300 MV output to CH2 input

(9) Set horizontal mode switch to EXT HOR and MAIN TRIG SOURCE switch to EXT.

(10) Adjust trace to right edge of crt graticule, using HORIZ POSITION control. If trace is not aligned and indicates bowing, readjust rear panel PATTERN ADJ for optimum alignment.

(11) Repeat (6) through (10) above for best compromise between horizontal and vertical pattern.

b. Adjustments. No further adjustments can be made.

9. Dc Balance

a. Performance Check

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

(a) Horizontal mode switch to NORM.

(b) MAIN TRIG SOURCE switch to INT.

(c) HORIZ POSITION VERNIER control pressed.

(2) Align trace on crt horizontal graticule centerline, using HORIZ and CH2 POSITION controls.

(3) Rotate CH2 VOLTS/DIV VERNIER control from CAL to fully counterclockwise while observing crt trace. If trace shifts from horizontal centerline, adjust front panel BAL control for no trace shift.

(4) Return VARIABLE control to CAL position.

(5) Set TI VERTICAL MODE to CH1.

(6) Repeat steps (3) and (4) above for CH1.

(7) Set TI VERTICAL MODE switch to CH2 and connect digital voltmeter (A3) to junction of A2A3R9 and A2A3R20 (fig. 2) and chassis ground. If digital voltmeter does not indicate zero voltage ±50 mV, perform **b**(1) below.

(8) Set TI VERTICAL MODE to CH1. If digital voltmeter does not indicate zero voltage ±50 mV, perform **b**(2) below.

(9) Set TI VERTICAL MODE to CH2.

b. Adjustments

(1) Adjust A2A3R1 (fig. 2) for 0.0 volts.

(2) Adjust A2A6R56 (fig. 1) for 0.0 volts.

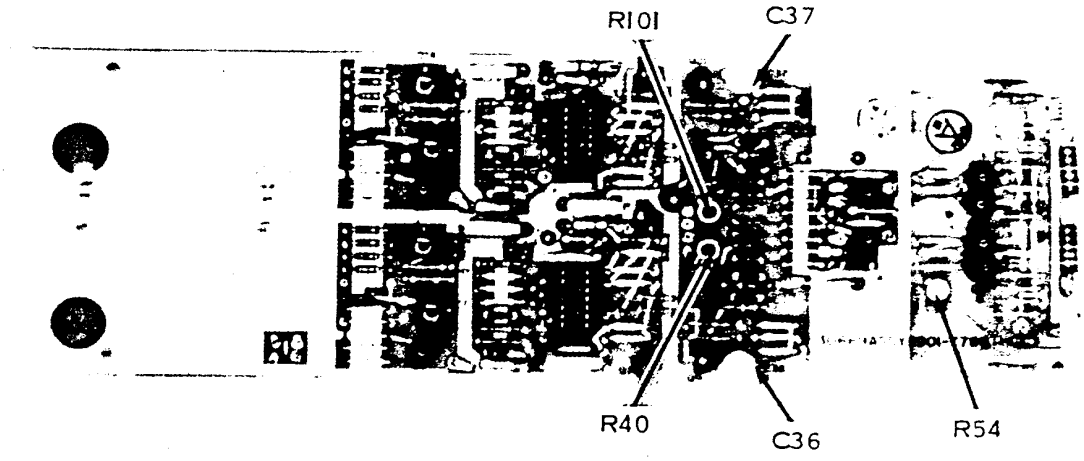

Figure 1. Vertical amplifier (subassembly 7788)

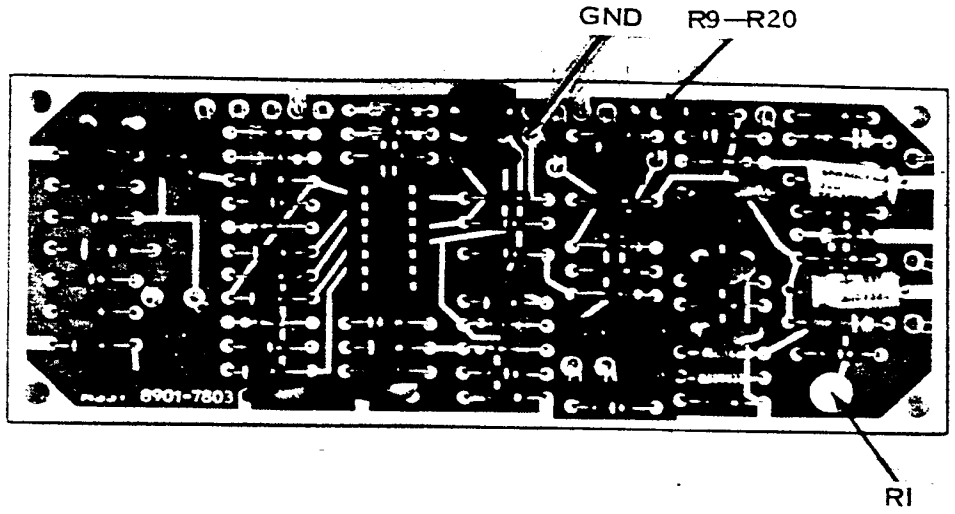

Figure 2. Vertical amplifier, test point and adjustment location.

10. Channel 1 and 2 Gain

a. Performance Check

(1) Connect ac (alternating current) calibrator (A2) to TI CH2 INPUT, using cable (B5).

(2) Set TI VOLTS/DIV switch to .005 and VERNIER control to CAL.

(3) Set ac calibrator frequency to 400 Hz (hertz) and output for 4 division of display on crt. If ac calibrator does not indicate between 6.928 and 7.212 mv rms (millivolts root mean square), perform **b** below.

(4) Set time base for convenient display on crt.

(5) Repeat technique of (3) above for TI VOLTS/DIV switch settings listed in table 4. Ac calibrator will indicate within limits specified.

Table 4. Gain and Deflection Factor Accuracy

Test instrument VOLTS/DIV switch settings	Ac calibrator indications (rms)	
	Min	Max
.01	13.857 mV	14.423 mV
.02	27.714 mV	28.846 mV
.05	69.286 mV	72.120 mV
.1	0.13857 V	0.14423 V
.2	0.27714 V	0.28846 V
.5	0.69286 V	0.72120 V
1	1.3857 V	1.4423 V
2	2.7714 V	2.8846 V
5	6.9286 V	7.2120 V
10	13.857 V	14.423 V

(6) Remove connection from CH2 and connect to CH1 INPUT.

(7) Set TI VERTICAL MODE to CH1 and repeat (2) through (5) above. If ac calibrator does not indicate within limits specified, perform **b** below.

b. Adjustments. Adjust ac calibrator amplitude for 7.070 mv rms and adjust TI front panel CAL control for exactly 4 divisions of display on crt.

11. Vertical Position

a. Performance Check

(1) Set TI CH1 VOLTS/DIV switch to 0.1 and adjust ac calibrator (A2) for 8 divisions of display on crt, and then set VOLTS/DIV switch to .05.

(2) Rotate CH1 POSITION control fully counterclockwise and then fully clockwise. If negative and positive portion of display is not equal distance above and below horizontal graticule centerline, perform **b** below.

b. Adjustments. Adjust A1A5R3 (fig. 3) until display is equal distance above and below horizontal graticule centerline.

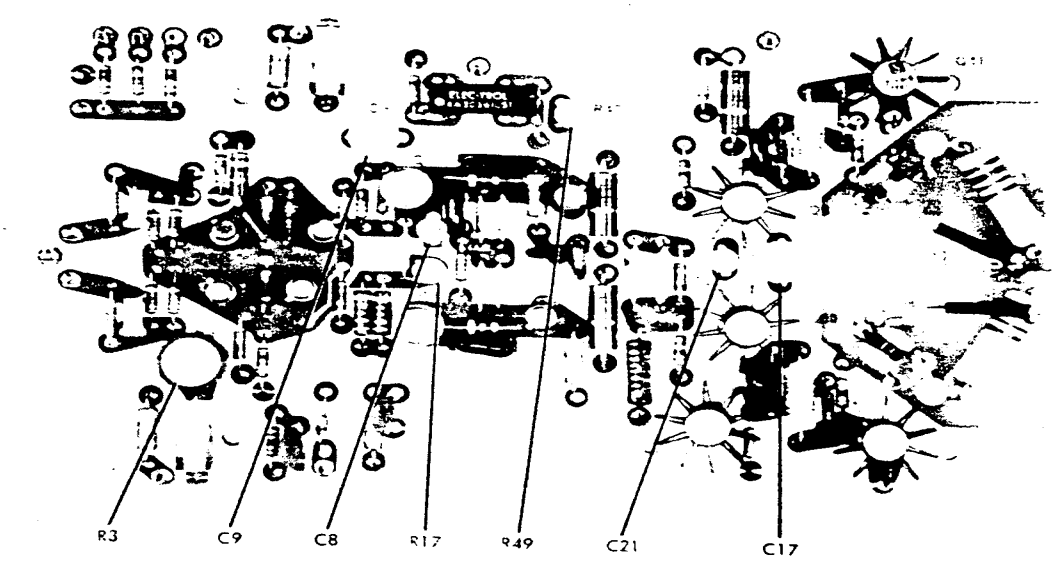

Figure 3. Vertical amplifier adjustments (subassembly 7963).

12. Attenuator and Input Capacitance

a. Performance Check

(1) Connect square-wave generator (A5) OUTPUT to TI CH1 INPUT, using cable and termination supplied with square-wave generator, standardizer, and adapters (B6, B1, and B2).

(2) Set TI CHI VOLTS/DIV switch to .005.

(3) Adjust square-wave generator frequency for 1 kHz (kilohertz) and amplitude for 4 divisions of vertical display on crt.

(4) Adjust time base for convenient display on crt.

(5) Adjust standardizer for optimum squarewave display.

(6) Repeat technique of (2) and (3) above for TI VOLTS/DIV switch settings listed in table 5. If crt does not display square-wave with square corners and flat top, perform appropriate adjustments listed.

Table 5. Attenuator Compensation

Test instrument Volts/Div switch settings	Adjustments (fig. 3)	
	Flat Top	Square Corner
.01	C2 (R)	C3 (R)
.02	C4 (R)	C1 (R)
.05	C6 (R)	C7 (R)
.5	C8 (R)	C9 (R)
5[1]	C10 (R)	C11 (R)

[1]Adjust square-wave generator for maximum amplitude.

(7) Set TI VERTICAL MODE switch to CH2 and repeat (1) through (3) and (6) above for CH2.

b. Adjustments. No further adjustments can be made.

13. X5 Gain

a. Performance Check

(1) Connect ac calibrator (A2) to TI CH1 INPUT, using cable (B5).

(2) Set TI VERTICAL MODE switch to CH1 and VOLTS/DIV switch to .01.

(3) Adjust ac calibrator frequency for 1 kHz and Output for 21.21 mv.

(4) Set TI VOLTS/DIV switch to .05 and VERT GAIN X1/X5 switch to X5. If crt does not display 6 divisions of deflection, perform **b** below.

b. Adjustments. Adjust A1A5R49 (fig. 3) for 6 divisions of display on crt. (R)

14. Risetime

a. Performance Check

(1) Connect square-wave generator (A5) to TI CH1 INPUT, using cable and termination supplied with square-wave generator.

(2) Set TI TIME/DIV switch to .1 μSEC and pull out HORIZ POSITION PULL X10 VERNIER control and set X1/X5 switch to X1.

(3) Adjust square-wave generator frequency for 1 MHz (megahertz) and amplitude for 8 divisions of vertical deflection.

(4) Measure risetime, using standard risetime technique. If risetime is not 7 ns (nanoseconds) or less, perform **b**(1) through (5) below.

(5) Move connection from CH1 to CH2.

(6) Set TI VERTICAL MODE switch to CH2 and VOLTS/DIV switch to .05 and repeat technique of (2) through (4) above. If risetime is not 7 ns or less, perform **b**(6) and (7) below.

b. Adjustments

(1) Adjust A2A6R40 (fig. 1) for fastest risetime.

(2) Adjust HF ADJUST A1A5C9, A1A5C8, and A1A5R17 (fig. 3) for optimum flat top square wave.

(3) Adjust A1A5C21 (fig. 3) for minimum peaking on square wave.

(4) Adjust A2A6C36 (fig. 1) for fastest risetime with minimum overshoot.

(5) Adjust A1A5C17 (fig. 3) for fastest risetime with minimum overshoot.

(6) Adjust A2A6C27 and A2A6R101 (fig. 1) for fastest risetime.

(7) Repeat (2), (3), and (5) above for best compromise between CH1 and CH2.

15. Triggering

a. Performance Check

(1) Connect ac calibrator (A2) to TI CH1 INPUT, using cable (B5).

(2) Set VERTICAL MODE switch to CH1 and time base to 1 MSEC, and press PULL X10 VERNIER control.

(3) Adjust TI LEVEL control to 0 (zero), set CH1 VOLTS/DIV switch to 2, and AUTO TRIG SINGLE switch to TRIG.

(4) Adjust ac calibrator frequency for 1 kHz and amplitude for 0.5 division of vertical deflection on crt. If display is not stable, perform **b** below.

b. Adjustment. Adjust A3A2R1 (fig. 4) for stable display on crt.

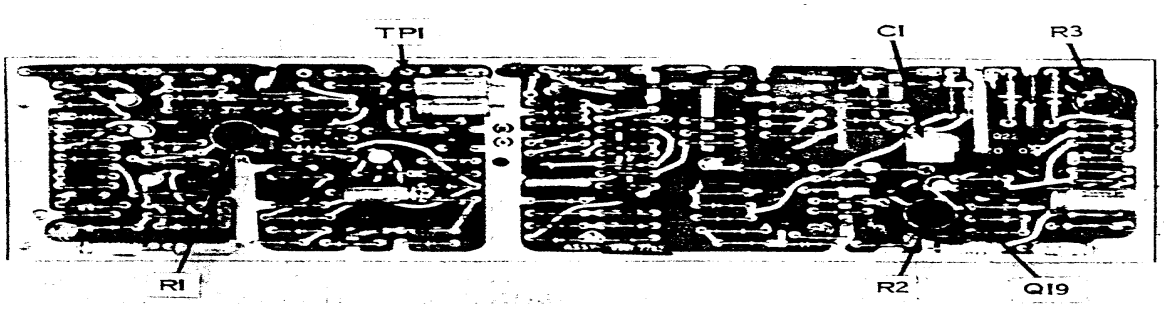

Figure 4. Horizontal sweep, test point location and adjustments.

16. Horizontal Sweep

a. Performance Check

(1) Connect digital voltmeter (A3) between case of A3A2Q19 (fig. 4) and chassis ground, using leads and adapter supplied with digital voltmeter. If digital voltmeter does not indicate between -0.24 and -0.26 volt, perform **b**(1) below.

(2) Move positive lead to A3A5TP1 (fig. 5). If voltage indication is not between +0.64 and +0.66, perform **b**(2) below.

(3) Move positive lead to case of A3A5Q17 (fig. 5). If digital voltmeter does not indicate between -0.24 and -0.26 volt, perform **b**(3) below.

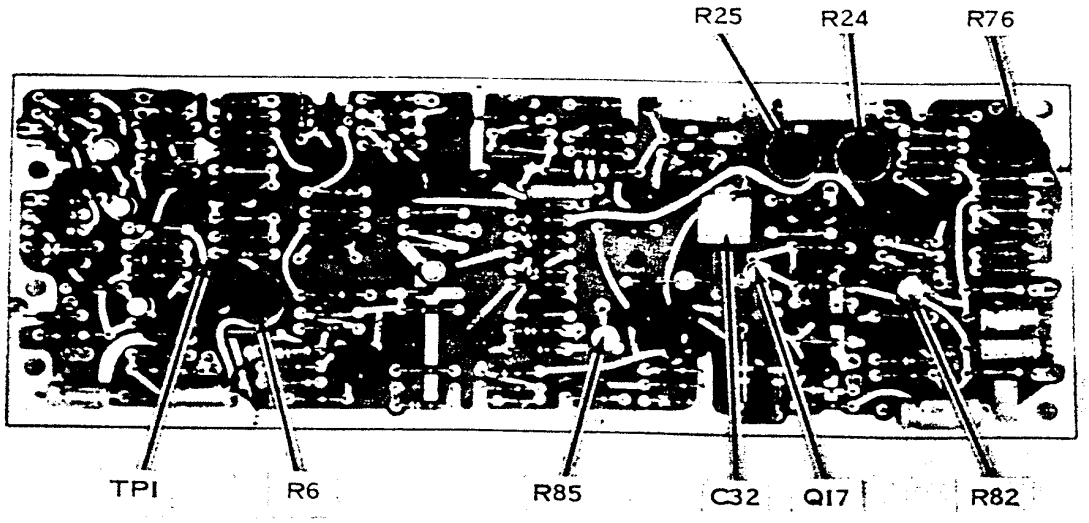

Figure 5. Delay trigger and sweep adjustments.

(4) Set TI horizontal mode switch to EXT-HOR and center spot on horizontal graticule centerline.

(5) Move positive lead and connect between A1A1A2Q7 collector and chassis ground. If digital voltmeter does not indicate between 48.8 and 50.2 volts, perform **b**(4) below.

(6) Disconnect positive lead and pull out PULL X10 VERNIER control. If spot shifts from graticule centerline, perform **b**(5) below.

b. Adjustments

(1) Adjust A3A2R2 (fig. 4) for -0-25 volt indication on digital voltmeter (R).

(2) Adjust TRIG LEVEL CENTERING ADJ A3A5R6 (fig. 5) for +0.65 volt indication on digital voltmeter (R).

(3) Adjust A3A5R82 (fig. 5) for -0.25 volt indication on digital voltmeter (R).

(4) Adjust CRT BIAS ADJ A1A2R12 (fig. 6) for 50 volts indication on digital voltmeter (R).

(5) Adjust A1A2R24 (fig. 6) for no shift of spot as X10 VERNIER control is pulled out and pressed in (R).

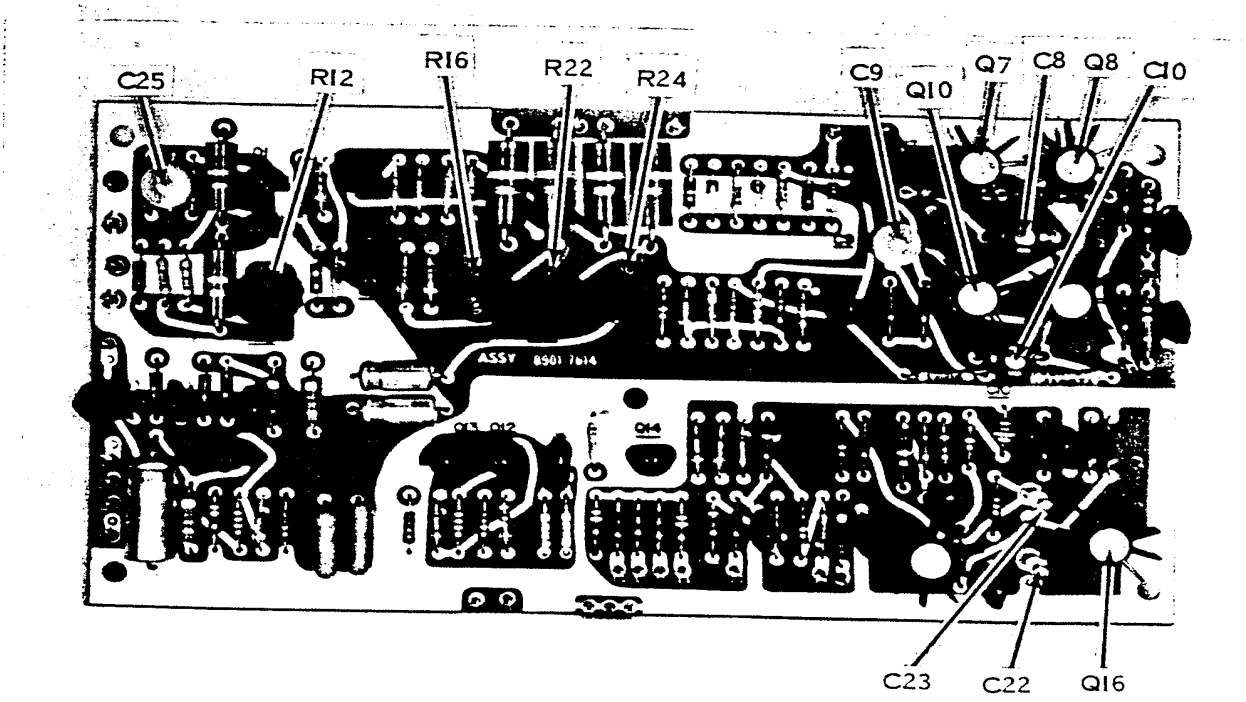

Figure 6. Horizontal amplifier, test point location.

17. Horizontal Bandwidth

a. Performance Check

(1) Connect oscillator (A4) to TI EXT HOR input, using cable (B4).

(2) Set both TI SOURCE switches to EXT.

(3) Adjust oscillator frequency for 50 kHz and amplitude for 6 divisions of deflection on crt.

(4) Adjust oscillator frequency until crt displays 4.25 divisions of deflection. If oscillator does not indicate 5 MHz or greater, perform **b** below.

b. Adjustments. Adjust C25 (fig. 7) until crt indicates at least 4.25 divisions of deflection (R).

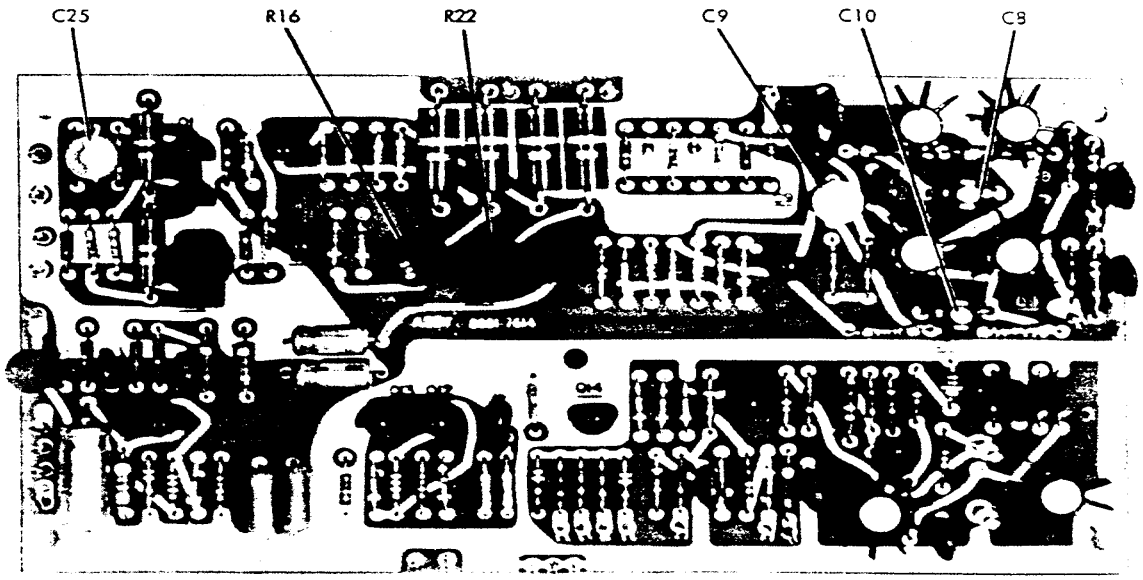

Figure 7. Horizontal sweep, adjustments and test point locations.

18. Sweep Length

a. Performance Check

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

(a) AUTO-TRIG SINGLE switch to AUTO.

(b) Horizontal mode switch to NORM.

(c) SOURCE switch to INT.

(2) Position trace to start of left vertical graticule line on crt. If sweep length is not 10.5 divisions, perform **b** below (R).

b. Adjustments. Adjust X1 GAIN CAL A1A2R22 (fig. 7) for sweep length of 10.5 divisions.

19. Sweep Calibration

a. Performance Check

(1) Connect time-mark generator (A6) to TI CH1 INPUT, using cable (b4).

(2) Set time-mark generator to 1 mS markers.

(3) Adjust TI LEVEL control for stable display and adjust HORIZ POSITION control to align second marker on second vertical graticule line on crt. If 10th marker is not displayed within ±1.5 minor divisions of 10th vertical graticule line, perform **b**(1) below.

(4) Repeat technique of (2) and (3) above for TI TIME/DIV switch settings listed in table 5. At each setting, align second (1/div) or third (2/div) marker behind second vertical graticule line. If either 10th (1/div) or 19th (2/div) marker is not within ±1.5 minor divisions of 10th vertical graticule line, perform appropriate adjustments listed in table 6.

Table 6. Normal and Delayed Sweep Rates

Test instrument TIME/DIV switch setting	Time-mark generator settings	Markers per division
.1 uSEC[1]	.50 nS	2
2. uSEC[2]	.1 uS	2
.5 uSEC	.5 uS	1
1 uSEC[2]	1 uS	1
2 uSEC	1 uS	2
5 uSEC	5 uS	1
10 uSEC	10 uS	1
20 uSEC	10 uS	2
50 uSEC	50 uS	1
.1 mSEC	.1 mS	1
.2 mSEC	.1 mS	2
.5 mSEC	.5 mS	1
1 mSEC[3]	.1 mS	1
1 mSEC	1 mS	1
2 mSEC	1 mS	2
5 mSEC	5 mS	1
10 mSEC	10 mS	1
20 mSEC	10 mS	2
50 mSEC	50 mS	1
.1 SEC	.1 s	1
.2 SEC	.1 s	2
.5 SEC	.5 s	1

[1]Alternately adjust A1A2C9, A1A2C8, and A1A2C10 (fig. 4) for two cycles per Division.
[2]Adjust A3A2C1 (fig. 4) to align each marker behind each major graticule line.
[3]Pull X10 Magnifier and adjust A1A2R1C (fig. 7) to align each marker behind each major graticule line.

(5) Set TI horizontal mode switch to DLY'D.

(6) Set TI TIME/DIV switch to 2 MSEC and DELAYED SWEEP to 1 MSEC.

(7) Set time-mark generator to 1 mS markers.

(8) Align second marker with second major vertical graticule line. If 10th marker is not displayed within ±1.5 minor divisions at 10th vertical line, perform **b**(2) below.

(9) Set TI TIME/DIV switch to 2 µSEC and DELAYED SWEEP to 1 µSEC and repeat technique of (8) above, except perform **b**(3) below.

b. Adjustments

(1) Adjust MAIN SWEEP CAL A3A2R3 (fig. 4) to align each marker behind each major vertical graticule line (R).

(2) Adjust A3A5R76 (fig. 12) to align each marker behind each major vertical graticule line (R).

(3) Adjust A3A5C32 (fig. 12) to align each marker behind each major graticule line (R).

20. Sweep Delay

a. Performance Check

(1) Set TI controls as listed in (a) through (f) below:

(a) VERTICAL MODE and TRIG MODE switches to CH1.

(b) AUTO-TRIG-SINGLE switch to AUTO.

(c) Horizontal mode switch to INTEN.

(d) TIME/DIV switch to 1 MSEC and DELAYED SWEEP to .1 μSEC.

(e) HORIZ POSITION control to start sweep to left edge of graticule.

(f) DELAY VERNIER control to 1.00.

(2) Set time-mark generator (A6) to 1 mS markers. If intensified portion of display does not start at second graticule line, perform **b**(1) below.

(3) Set TI DELAY VERNIER control to 9.00. If intensified portion of display does not start at 10th graticule line, perform **b**(2) below.

b. Adjustments

(1) Adjust A3A5R24 (fig. 5) until intensified portion of display starts on second graticule line.

(2) Set DELAY VERNIER control to 9.00 and adjust A3AR25 (fig. 5) until intensified portion of display starts on 10th graticule line.

NOTE

Interaction exists between A3A5R24 and A3A5R25 Repeat adjustments as necessary for best compromise.

21. Power Supply

a. Performance Check

NOTE

Do not perform power supply check if all other parameters are within tolerance.

(1) Connect digital voltmeter (A3) to TI TP2 (fig. 8) and chassis ground, using leads supplied with digital voltmeter. Digital voltmeter will indicate between -14.85 and -15.15 volts.

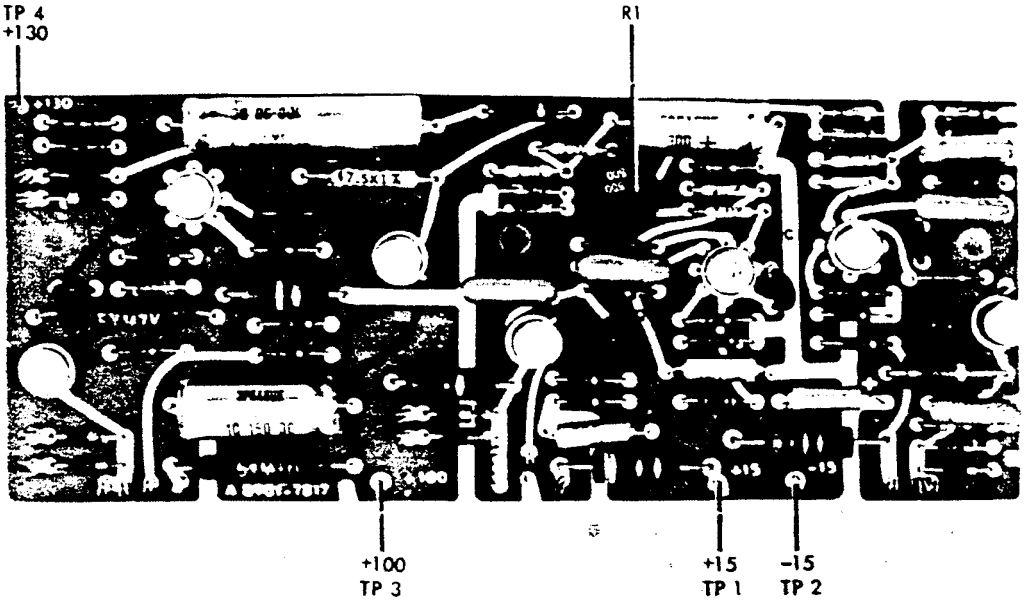

Figure 8. Oscilloscope, low voltage power supply board.

(2) Repeat technique of (1) above for TI test points and digital voltmeter indications listed in table 7. If digital voltmeter does not indicate within limits specified, perform appropriate adjustments listed in table 7.

Table 7. Power Supply Check

Test instrument test points	Digital voltmeter indications (V)		Adjustments
(fig. 8)	Min	Max	(fig. 8)
TP1	+14.85	+15.15	R1
TP3	+98	+102	---
TP4	+125	+135	---
PIN 7 of crt socket[1]	-920	-1350	A1A3R1

[1]Use high-voltage probe.

b. Adjustments. No further adjustments can be made.

22. Final Procedure

a. Deenergize equipment and replace TI protective covers.

b. When all parameters are within tolerance, annotate and affix DA Label 80 (U.S. Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (U.S. Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (U.S. Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25.

TB 11-6625-2713-50

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