DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-254 AND OS-185/U (NSN 6625-00-069-5477) (HEWLETT-PACKARD MODELS 130C AND 130 CR)

Headquarters, Department of the Army, Washington, DC
5 September 1978

TB 11-6625-1615-35, 13 February 1975, is changed as follows:

The title of the bulletin is changed as shown above.

Page 1. Table of contents, Section IV, line 5. The following is added after line 5. Vertical amplifier response (C-level only) .....13.1 10.

Page 2. Paragraph 3, lines 7 and 8. Lines 7 and 8 are superseded as follows: US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-MA-Q, Fort Monmouth, NJ, 07703.

Page 3. Paragraph 5, line 4. "4931-621-7877" is changed to read: 6695-00-621-7877, and in line 7, "4940-454-8710" is changed to read: 4940-00-454-8710.

Paragraph 6*a*, line 3. "4931-621-7877" is changed to read: 6695-00-621-7877.

Subparagraph 6*b*, line 3. "4940-454-7810" is changed to read: 4940-00-454-8710.

Page 4. Table 2, item A7, line 1. "Range: 0 to 3000 kHz" is changed to read: Range: 0 to 3000 Volts.

Table 3, item B6, line 1 in the description column. "AEG" is changed to read: AWG.

Page 7. Figure 2, lower left corner. "C17" is changed to read: C11. "C11" is changed to read: C17.

Page 10. The following paragraph is added after paragraph 13.

13.1. Vertical Amplifier Response (C-Level Only).

a. Performance Check.

(1) Connect test instrument VERTICAL input to square wave generator (A10) output with cable assembly and termination provided, and adapter (B1).

(2) Position test instrument controls as follows:

(a) VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

(b) VERTICAL VERNIER control to CAL.

(c) SWEEP TIME switch to 5 u SECONDS/ CM.

(3) Adjust square wave generator for 50 kHz and test instrument CRT display of 8 cm p-p.

(4) Test instrument CRT displays square wave with minimum risetime and no overshoot.

(5) Set test instrument VERTICAL SENSITIVITY switch to .5 VOLTS/CM.

(6) Adjust square wave generator for 50 kHz and test instrument CRT display of 8 cm p-p.

(7) Test Instrument CRT displays square wave with minimum risetime and no overshoot.

(8) Set test instrument VERTICAL SENSITIVITY switch to 5 VOLTS/CM.

(9) Adjust square wave generator for 50 kHz and test instrument CRT display of 3 cm p-p.

(10) Test instrument displays square wave with minimum risetime and no overshoot.

b. Adjustments.

(1) Set test instrument VERTICAL SENSITIVITY switch to settings listed in table 5.1. At each setting adjust square wave generator for 50 kHz and test instrument CRT display listed. Adjust test instrument adjustments for minimum risetime and no overshoot.

(2) Reconnect test instrument ground strap at VERTICAL input terminal.

Table 5.1. Vertical Amplifier Response Adjustments

Test Instrument		
VERTICAL SENSITIVITY switch setting (VOLT/CM)	CRT Display cm p-p	Adjustment
.2	8	C 48 (Fig. 1) (R) C 49 (Fig. 1) (R)
.5	8	C 17 (Fig. 2) (R) *C 18 (Fig. 2) (R)
5	8	C 11 (Fig. 2) (R) *C 12 (Fig. 2) (R)

*Remove test instrument ground strap at VERTICAL input terminal and connect square wave generator between center terminal and ground.

Page 16. Table 10, lines 1 and 2, adjustment column. "R468" is changed to read: R468(R) and "R447" is changed to read: R447 (R).

Table 10, line 5. The -2850 volt check is deleted entirely.

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

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CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-254 AND OS-185/U (NSN 6625-00-069-5477) (HEWLETT-PACKARD MODELS 130C AND 130 CR)

Headquarters, Department of the Army, Washington, DC
13 February 1975

*This bulletin supersedes TB 9-6625-977-35, 7 April 1972.

SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification

This bulletin provides instructions for the A and C-level calibration of Oscilloscope AN/USM-254 and OS-185/U (Hewlett-Packard Models 130C and 130CR). The manufacturer's instruction manuals and TM 11-6625-1615-15 were used as the prime data source in compiling these instructions. The oscilloscope will be referred to as the "test instrument" throughout ,this bulletin.

a. Model Variations. There are no electrical differences among models. AN/USM-254 and 0S185/U are military designations for model l30C and differ only in that accessories are not furnished with the OS-185/U and are furnished with the AN/USM-254. Model 130CR is the rack-mounted version of model 130C.

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)

During the use of this bulletin, annotate DA Form 2416 in accordance with TM 38-750. Adjustments to be reported are designated (R) at the end of the sentence in which they appear.

3. Reporting of Errors

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forwarded direct to Commander, US Army Communications and Electronics Materiel Readiness Command, ATTN: DRSEL-MA-1, Fort Monmouth, NJ, 07703.

4. Calibration Description

Test instrument parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test Instrument Parameters.	Performance Specifications.
Vertical and horizontal amplifier bandwidth.	Dc coupled: dc to 500 kHz. Ac coupled (input) : 2 Hz to 500 kHz. Ac coupled (amplifier) : 25 Hz to 500 kHz at 0.2 mv/cm sensitivity.
Sensitivity	Range switch 0.2 mv/cm to 20 v/cm, in 16 balanced input ranges in 1, 2, 5, and 10 sequence with an attenuator accuracy of ±3%. Vernier: continuously variable between ranges and extends minimum sensitivity to at least 50 v/cm.
Internal calibrator [1]	Frequency 350 Hz square wave (approx), 5 my ±3%
Input impedance	1 megohm shunted by 45 pf; constant on all sensitivity ranges
Maximum input [1]	600 v peak (dc + ac)
Sweep generator: internal sweep.	Range switch 1 μsec/cm to 5 sec/cm, ±3%. Vernier: continuously variable between ranges and extends slowest sweep to at least 12.5 sec/cm.
Magnification	X2, X5, X10, X20, and X50 overall sweep accuracy within ±5% for sweep rates which do not exceed a maximum rate of 0.2 μsec/cm.

See footnote at end of table.

Table 1. Calibration Description-Continued

Test Instrument Parameters.	Performance Specifications.
Automatic triggering [2]	Internal, 50 Hz to 500 kHz signal 0.5 cm or more vertical deflection and also from line voltages. External, 60 Hz to 500 kHz, 0.5 volts peak to peak or more Trigger slope, positive or negative slope of external sync signals or internal vertical deflection signals.
Amplitude selection triggering.	Internal, 10 Hz to 50 kHz, 0.5 cm or more vertical deflection signal External, dc (do to 500 kHz) or ac (20 Hz to 500 kHz) coupled, 0.5 volts peak to peak or more. Trigger point and slope, internally from any point of the vertical waveform presented on screen, or continuously variable from +10 volts to -10 volts; or, either positive or negative slope of external signal. Single sweep, front panel switch permits single sweep operation.
Calibrator	Frequency 350 Hz square wave (approx.), 500 mv pp ± 2%.

[1] This specification is for information only and is not necessarily verified in this bulletin.
[2] Base line is displayed in the absence of an Input signal.

SECTION II

EQUIPMENT REQUIREMENTS

5. Equipment Required

Table 2 identifies the specific equipment used in this calibration procedure. This equipment is issued with secondary transfer calibration standards set 6695-00-621-7877 and is to be used in performing this procedure. The equipment used for the C-level calibration was selected from those known to be available in AN/TSM-55(V)5 4940-00-454-8710. 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 accuracy ratio between the standard and test instrument. Where the four-to-one accuracy ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

6. Accessories Required

a. The accessories listed in table 3 are issued with secondary transfer calibration standards set 6695-00-621-7877 and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

b. The accessories used for the C-level calibration was selected from those known to be available in AN/TSM-55(V)5 4940-00-454-8710. The listing by make or model number carries no implication of preference, recommendation, or approval by the Department of Defense for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in the procedure.

Table 2. Minimum Use Specifications of Equipment Required

Item	Common Name	Minimum Use Specifications.	Manufacturer, Model, and Part Number.
A1	AMPLIFIER CALIBRATOR [1]	Square-wave output: 2 my to 100 v pp. Accuracy: ±1%	Tektronix, Model 067-0502-01 (AN/USM-360)
A2	AUTO-TRANS-FORMER [3]	Range: 105 to 125 vac Accuracy: ± 1%	General Radio, Model W10MT3A (7910809) (TF-510/U).

See footnotes at end of tables

Table 2. Minimum Use Specifications of Equipment Required-Continued

Item	Common Name	Minimum Use Specifications.	Manufacturer, Model, and Part Number.
A3	AC VOLTAGE CALIBRATOR.	Range: 0.68579 mv to 72.821 v rms at 1 kHz. Accuracy: ± 0.75 %	Hewlett-Packard, Model 745A (MIS-10342).
A4	DC VOLTMETER	Range: -2750 to -2950 vdc Accuracy: ± 1%o	Electrical Instrument Service, Model ESV (MIS-10276).
A5	AC/DC VOLTMETER	Range: -100 to +250 vdc Accuracy: ±0.75%	John Fluke, Model 887AB (MIS-10216)
A6	L-C METER [1]	Range: 41 ,to 49 pf at 50 kHz Accuracy: ± 3%	Tektronix, Model 130 (AN/USM-357)
A7	MULTIMETER [1]	Range: 0 to 3000 Volts Accuracy: ± 3.5%7; 100,000 ohm/ v input impedance.	Simpson, Model 269-3 (AN/USM-319)
A8	SIGNAL GENERATOR.[1]	Range: 10 mv to 5 v pp at 50 kHz reference; 500 kHz.	AN/USM-272; Tektronix, Model 191.
A9	SIGNAL GENERATOR. [1]	Range: 10 Hz to 500 kHz	AN/USM-264, Hewlett-Packard, Model 652A.
A10	SQUARE-WAVE GENERATOR.	Range: 1 to 50 kHz Risetime: 0.175 µsec	Tektronix, Model 106 (MIS-10284).
A11	TEST OSCILLATOR	Range: 5 Hz to 500 kHz Accuracy: ± 1%o	Preston, Model 134A (MIS-10224).
A12	TIME-MARK GENERATOR.	Range: 1 µsec to 5 see Accuracy: -± 0.75%	Tektronix, Model 184 (7912042) (AN/USM-271).

[1] C-level only.
[2] A- and C-level

Table 3. Accessories Required

Item	Common Name	Description and Part Number.
B1	ADAPTER [1]	BNC jack to double banana plug (7907592) (UG-1887/U; Pomona Electronics, Model 1269).
B2	ADAPTER	BNC jack to UHF plug (10519439) (Amphenol, Model UG-273/U)
B3	ADAPTER [2]	BNC jack to test clips. (Pomona Electronics, Model 2630)
B4	CABLE	30-in, RG-58/U; rf; double banana plug terminations (7907470)
B5	CABLE [3]	36-in, RG-58/U; rf; BNC plug and double banana plug terminations (7907471).
B6	LEAD	18-in, No. 18 AWG; electrical; single banana plug terminations (red) (7907497).
B7	TEST LEAD'	24-in, single banana plug terminations (Pomona Electronics, Model B-24 (black)).

[1] Four required for C-level.
[2] C-level only. Two required.
[3] Two required for A- and C-level

SECTION III

PRELIMINARY OPERATIONS

7. 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. All performance checks pertain to both A and C-level calibration unless specified "A-level only" or "C-level only."

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.

8. Equipment Setup

a. Remove test instrument from case.

b. Connect autotransformer (A2) to ac power source and adjust for 115-volt output.

c. Connect test instrument to autotransformer.

d. Energize equipment and allow sufficient time for equipment to warm up and stabilize.

CAUTION

Turn test instrument INTENSITY control fully counterclockwise during warm-up.

e. Position test instrument controls as listed in (1) through (10) below.

(1) INTENSITY control fully counterclockwise.
(2) All VERNIER controls to CAL.
(3) All AC-DC switches to AC.
(4) VERTICAL SENSITIVITY switch to 20 VOLTS/CM.
(5) HORIZONTAL SENSITIVITY switch to INTERNAL SWEEP X1.
(6) SWEEP TIME switch to 1 MILLISECONDS/CM.
(7) TRIGGER SOURCE-SLOPE switch to INT + (positive).
(8) LEVEL control to FREE RUN.
(9) NORMAL-SINGLE switch to NORMAL.
(10) HORIZONTAL and VERTICAL POSITION controls to midrange.

f. Turn test instrument INTENSITY control clockwise until trace appears on crt and then adjust FOCUS control for sharp trace.

g. Adjust HORIZONTAL and VERTICAL POSITION controls to center trace on crt graticule centerline.

h. If necessary, adjust test instrument TRACE ALIGN adjustment R329 (Fig. 1, external rear) to align trace parallel to horizontal graticule line.

i. Set HORIZONTAL SENSITIVITY switch to 20 MV/CM.

j. Adjust test instrument INTENSITY, FOCUS, and POSITION controls for a low intensity, small round sharply focused dot centered on crt. If necessary, adjust R319 (Fig. 2) for smallest in-focus spot.

k. Turn test instrument FOCUS control fully clockwise.

I. Turn test instrument INTENSITY control to 10-o'clock position for a no-dot display on crt. If necessary, adjust R307 (Fig. 2) to extinguish dot.

m. Adjust INTENSITY, FOCUS, and POSITION controls for a suitable spot centered on crt.

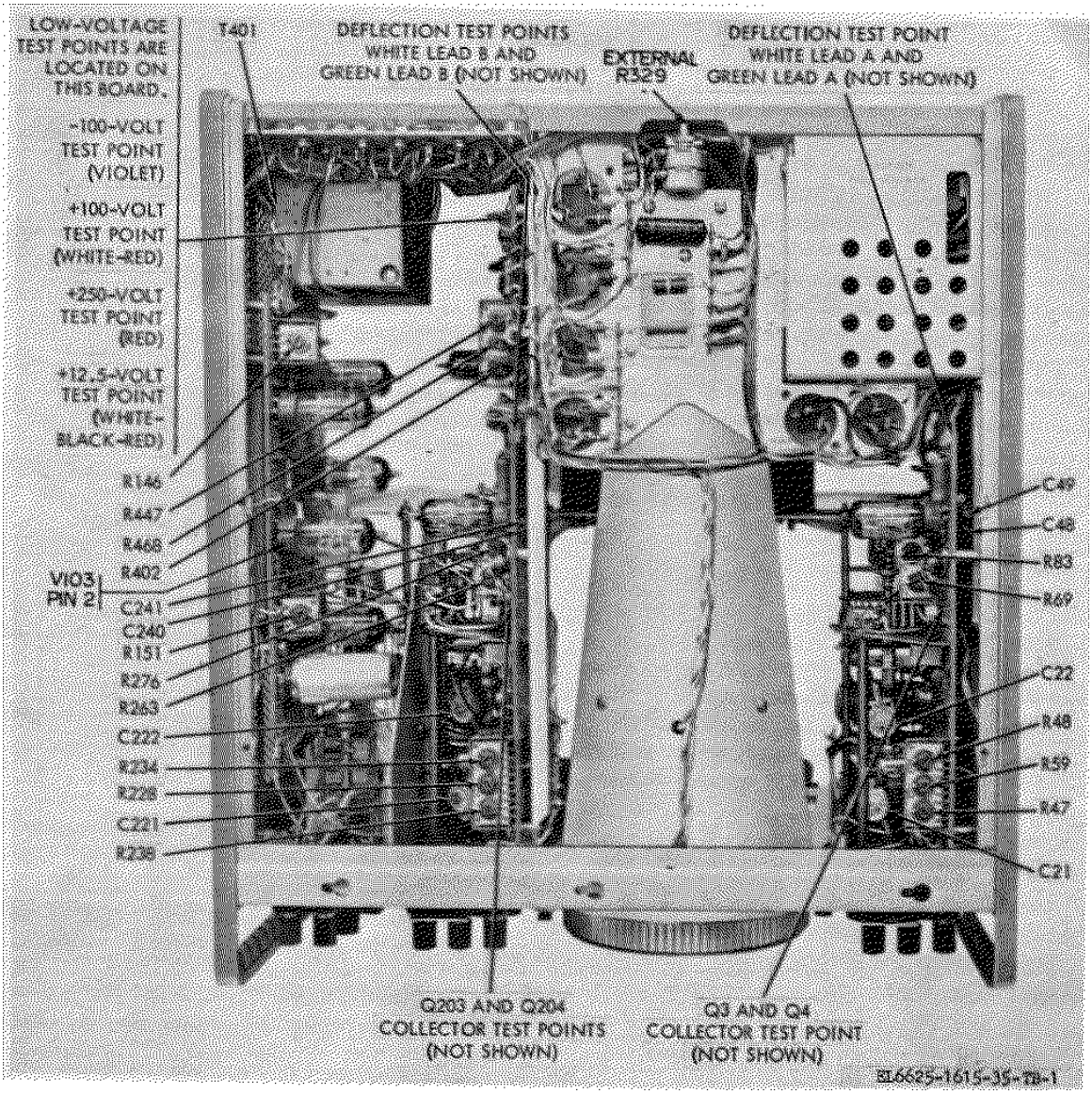

Figure 1. Oscilloscope-bottom view.

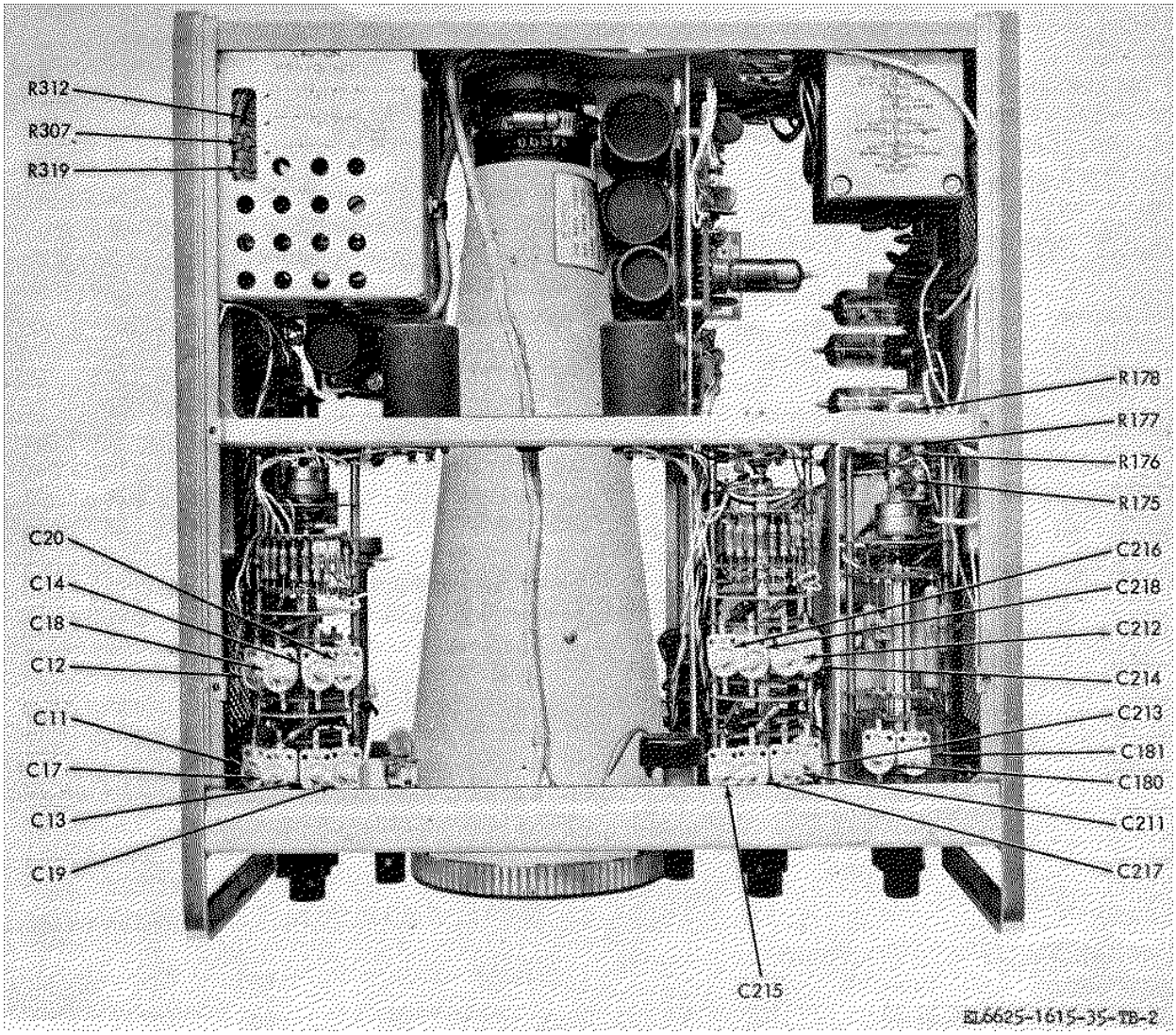

Figure 2. Oscilloscope-top interior view.

SECTION IV

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met before continuing with the calibration.

9. External Calibrator

a. Performance Check

(1) Connect test instrument 500 MV CALIBRATOR jack to left VERTICAL input terminal, using lead (B6).

(2) Position test instrument controls as listed in (*a*) through (*c*) below:

(a) SWEEP TIME switch to 2 MILLISECONDS.

(*b*) VERTICAL SENSITIVITY switch to 20 MV/CM.

(*c*) VERTICAL VERNIER control for 10 centimeters of vertical deflection on crt.

(3) Disconnect lead from 500 MV CALIBRATOR jack and VERTICAL input terminal.

(4) Connect output of ac voltage calibrator (A3) to VERTICAL input terminals, using cable (B4).

(5) Adjust ac voltage calibrator for 1 kHz and 10 centimeters of vertical deflection on crt.

Observe that ac voltage calibrator indicates between 171.448 and 182.053 millivolts rms. If not, perform b below.

b. Adjustments.

(1) Adjust ac voltage calibrated output to 176.75 millivolts rms.

(2) Adjust VERTICAL VERNIER control for 10 centimeters of vertical deflection on the test instrument crt.

(3) Disconnect lead from ac voltage calibrator and connect it to test instrument 500 MV CALIBRATOR jack.

(4) Adjust R402 (Fig. 1) for 10 centimeters of vertical deflection on the test instrument crt. (R)

10. Vertical and Horizontal Dc Balance

a. Performance Check

(1) Turn test instrument VERTICAL VERNIER control out of CAL position and vary throughout its range. Spot will remain stationary on crt graticule. If not, perform b(1) below.

(2) Position test instrument controls as listed in (*a*) through (*d*) below:

(*a*) VERTICAL DC BALANCE control to midrange.

(*b*) VERTICAL VERNIER control to CAL.

(*c*) VERTICAL SENSITIVITY switch to BAL.

(*d*) VERTICAL POSITION control to center the spot on crt graticule.

(3) Set VERTICAL AMPLIFIER switch to DC. Spot will remain centered. If not, perform b(2) below.

(4) Repeat (1) through (3) above, using HORIZONTAL controls. If necessary, perform b(3) and (4) below.

(5) Turn HORIZONTAL SENSITIVITY controls to INTERNAL SWEEP X1.

b. Adjustments

(1) Vary VERTICAL VERNIER control throughout its range and adjust R47 (Fig. 1) until minimum spot shift is observed.

(2) Adjust R48 (Fig. 1) to center the spot on crt graticule. (R)

(3) Vary HORIZONTAL VERNIER control throughout its range and adjust R238 (Fig. 1) until minimum spot shift is observed.

(4) Adjust R234 (Fig. 1) to center the spot on crt graticule. (R)

11. Vertical and Horizontal Sensitivity and Range (A-Level Only)

a. Performance Check

(1) Set SWEEP TIME switch to .5 MILLI-SECONDS / CM

(2) Connect output of ac voltage calibrator (A3) to center and left VERTICAL input terminals on test instrument, using cable (B4). Connect center and ground VERTICAL input terminals together with ground strap.

(3) Turn test instrument VERTICAL SENSITIVITY switch to .2 MV/CM.

(4) Adjust output controls of ac voltage calibrator for 1 kHz and a 10-cm display amplitude as indicated on test instrument. Ac voltage calibrator will indicate between 0.68579 and 0.7821 mv rms. If not, perform b(1) through (4) below.

(5) Repeat technique of (3) and (4) above, using settings listed in table 4. Ac voltage calibrator will indicate within limits specified. If not, perform b(1) through (4) below.

(6) Disconnect ac voltage calibrator from test instrument VERTICAL input terminals and connect to center and left HORIZONTAL input terminals, using cable (B4). Connect center and ground HORIZONTAL input terminals together with ground strap.

(7) Turn test instrument HORIZONTAL SENSITIVITY switch to .2 MV/CM.

(8) Repeat (4) and (5) above, using HORIZONTAL SENSITIVITY switch.

b. Adjustments

(1) Connect ac voltage calibrator to test instrument VERTICAL input terminals as in a(2) above.

(2) Turn VERTICAL SENSITIVITY switch to .A VOLTS/GW.

(3) Adjust ac voltage calibrator for a 0.3535-volt rms output.

(4) Adjust R69 (Fig. 1) for a 10-cm display amplitude on test instrument crt. (R)

(5) Connect ac voltage calibrator to test instrument HORIZONTAL input terminals as in *a*(6) above.

(6) Turn HORIZONTAL SENSITIVITY switch to .1 VOLTS/CM.

(7) Repeat (3) above.

(8) Adjust R263 (Fig. 1) for a 10-cm display amplitude on test instrument crt. (R)

Table 4. Vertical and Horizontal Sensitivity and Range

Test Instrument VERTICAL SENSITIVITY Switch Positions.	Ac Voltage Calibrator Indication (rms Voltage).	
	Min	Max
.5 MV/CM	1.7145 mv	1.8205 mv
1 MV/CM	3.429 mv	3.641 mv
2 MV/CM	6.8579 mv	7.2821 mv
5 MV/CM	17.1448 mv	18.2053 mv
10 MV/CM	34.2895 mv	36.4105 mv
20 MV/CM	68.579 mv	72.821 mv
50 MV/CM	171.448 mv	182.053 mv
.1 VOLTS/CM	0.342895 v	0.364105 v
.2 VOLTS/CM	0.68579 v	0.72821 v
.5 VOLTS/CM	1.71448 v	1.82053 v
1 VOLTS/CM	3.42895 v	3.64105 v
2 VOLTS/CM	6.8579 v	7.2821 v
5 VOLTS/CM	17.1448 v	18.2053 v
10 VOLTS/CM	34.2895 v	36.4105 v
20 VOLTS/CM	68.579 v	72.821 v

12. Vertical and Horizontal Linearity

a. Performance Check

(1) Connect ac voltage calibrator (AS) OUTPUT to center and left VERTICAL input terminals of test instrument, using cable (B4).

(2) Turn test instrument VERTICAL SENSITIVITY switch to .5 VOLTS/CM and HORIZONTAL SENSITIVITY to INTERNAL SWEEP X1.

(3) Adjust ac voltage calibrator for a 0.8536volt rms output.

(4) Adjust test instrument VERTICAL POSITION control until displayed trace is centered between two bottom horizontal graticule lines.

(5) Vary VERTICAL VERNIER control throughout its range. Position of trace will remain stationary while amplitude changes. If not, perform b(1) through (4) below.

(6) Adjust test instrument VERTICAL POSITION control until trace is centered between two top horizontal graticule lines.

(7) Repeat (5) above. If necessary, perform *b*(5) through (7) below.

(8) Repeat (1) through (7) above, using HORIZONTAL input terminals and controls. If necessary, perform b(8) through (16) below.

b. Adjustments

NOTE

Some models with S/N prefix 235 may not contain some of the adjustments below.

(1) Repeat *a*(1) through (4) above and adjust VERTICAL POSITION control to center the trace on crt graticule.

(2) Connect ac/dc voltmeter (A5) between Q3 (Fig. 1) collector and chassis ground and record indication.

(3) Connect ac/dc voltmeter between Q4 (Fig. 1) collector and chassis ground and record indication.

(4) Adjust R59 (Fig. 1) until average indication of (2) and (3) above is -15 volts. (R)

(5) Connect ac/dc voltmeter to deflection test point white lead A (Fig. 1) and record indication.

(6) Connect ac/dc voltmeter to deflection

test point green lead A (Fig. 1) and record indication.

(7) Adjust R83 (Fig. 1) until average indication of (5) and (6) above is +140 volts. (R)

(8) If an adjustment is necessary to obtain the average values in (4) and (7) above, repeat paragraph 10*a*(1) through (3) and *a*(1) through (7) above.

(9) Repeat a(1) through (3) above, using HORIZONTAL input terminals and controls. Adjust test instrument HORIZONTAL POSITION control to center the trace on crt graticule.

(10) Connect ac/dc voltmeter to Q203 collector test point (Fig. 1) and record indication.

(11) Connect ac/dc voltmeter to Q204 collector test point (Fig. 1) and record indication.

(12) Adjust R228 (Fig. 1) until average indication of (10) and (11) above is -15 volts. (R)

(13) Connect ac/dc voltmeter to deflection test point white lead B (Fig. 1) and record indication.

(14) Connect ac/dc voltmeter to deflection test point green lead B (Fig. 1) and record indication.

(15) Adjust R276 (Fig. 1) until average indication in (13) and (14) above is +140 volts.(R)

(16) If an adjustment is necessary to obtain the average values in (12) and (15) above, repeat paragraph 10*a*(15) and *a*(8) above.

13. Vertical Amplifier Response

a. Performance Check

(1) Position test instrument controls as listed in (*a*) through (*a*) below:

(*a*) HORIZONTAL and VERTICAL VERNIER controls to CAL.

(*b*) VERTICAL SENSITIVITY control to .2 V/CM.

(*c*) HORIZONTAL SENSITIVITY control to INTERNAL SWEEP X1.

(*d*) SWEEP TIME switch to 5 MICROSECONDS/CM.

(2) Connect square-wave generator (A10) output to VERTICAL input, using cable and load supplied with square-wave generator and adapter (B1).

(3) Adjust square-wave generator for a 50kHz output and a 6-cm height as indicated on test instrument crt. Adjust SWEEP TIME and VERNIER controls as necessary for a 2-cycle display. Crt will indicate a square wave with minimum overshoot and rounding. If not, perform b(1) below.

(4) Repeat (3) above with VERTICAL SENSITIVITY control in 2 V/CM and 5 V/CM positions and square-wave generator output at 1 kHz. It may not be possible to obtain 6 cm at the 5 V/CM setting. If necessary, perform *b*(2) through (5) below.

(5) Remove ground strap from center and right (GROUND) VERTICAL input terminals of test instrument. Connect left and right (GROUND) terminals, using lead (B6).

(6) Reverse adapter connector at VERTICAL input terminals.

(7) Repeat (1), (3), (4), and (6) above.

Table 5. Vertical Amplifier Frequency Response Check

Test Instrument VOLTS/CM Position.	Test Instrument Adjustments.
5	C13 and C11 (Fig. 2)
.2[1]	C22 (Fig. 1)
2 [1]	C18 and C20 (Fig. 2)
5 [1]	C12 and C14 (Fig. 2)

[1] Connect left- and right-hand (GROUND) VERTICAL input terminals together, using lead (11E). Do not disconnect from square-ways generator, but reverse the adapter (B1).

(8) Connect center and right (GROUND) terminals, using ground strap. Remove lead (B6).

b. Adjustments

(1) Alternately adjust C48 and C49 (Fig. 1) for optimum square-wave display on test instrument crt.

(2) Adjust C21 (Fig. 1) for an optimum square-wave display on test instrument crt.

(3) Turn test instrument VERTICAL SENSITIVITY switch to 2 V/CM.

(4) Alternately adjust C17 and C19 (Fig. 2) for an optimum square-wave display on test instrument crt.

(5) Repeat technique of (4) and (5) above, using settings listed in table 5. Perform adjustments as specified for optimum square-wave display. (R)

13.1. Vertical Amplifier response (C-Level Only)

a. Performance Check.

(1) Connect test instrument VERTICAL input to square wave generator (A10) output with cable assembly and termination provided, and adapter (B1).

(2) Position test instrument controls as follows:

(a) VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

(b) VERTICAL VERNIER control to CAL.

(c) SWEEP TIME switch to 5 u SECONDS/ CM.

(3) Adjust square wave generator for 50 kHz and test instrument CRT display of 8 cm p-p.

(4) Test instrument CRT displays square wave with minimum risetime and no overshoot.

(5) Set test instrument VERTICAL SENSITIVITY switch to .5 VOLTS/CM.

(6) Adjust square wave generator for 50 kHz and test instrument CRT display of 8 cm p-p.

(7) Test Instrument CRT displays square wave with minimum risetime and no overshoot.

(8) Set test instrument VERTICAL SENSITIVITY switch to 5 VOLTS/CM.

(9) Adjust square wave generator for 50 kHz and test instrument CRT display of 3 cm p-p.

(10) Test instrument displays square wave with minimum risetime and no overshoot.

b. Adjustments.

(1) Set test instrument VERTICAL SENSITIVITY switch to settings listed in table 5.1. At each setting adjust square wave generator for 50 kHz and test instrument CRT display listed. Adjust test instrument adjustments for minimum risetime and no overshoot.

(2) Reconnect test instrument ground strap at VERTICAL input terminal.

Table 5.1. Vertical Amplifier Response Adjustments

Test Instrument		
VERTICAL SENSITIVITY switch setting (VOLT/CM)	CRT Display cm p-p	Adjustment
.2	8	C 48 (Fig. 1) (R) C 49 (Fig. 1) (R)
.5	8	C 17 (Fig. 2) (R) *C 18 (Fig. 2) (R)
5	8	C 11 (Fig. 2) (R) *C 12 (Fig. 2) (R)

*Remove test instrument ground strap at VERTICAL input terminal and connect square wave generator between center terminal and ground.

14. Vertical Calibrator (C-Level Only)

a. Performance Check

(1) Connect test instrument VERTICAL input to amplifier calibrator (A1), using cable and adapter (B5 and B1).

(2) Set test instrument VERTICAL SENSITIVITY switch to 1 MV/CM.

(3) Set amplitude calibrator AMPLITUDE switch to 5 m VOLTS.

(4) Adjust test instrument VERTICAL VERNIER control for a 4-cm crt display.

(5) Set test instrument VERTICAL SENSITIVITY switch to CAL. Test instrument art will display square wave between 3.88 and 4.12 cm.

b. Adjustments. No adjustments can be made.

15. Vertical Input Capacitance (C-Level Only).

a. Performance Check

(1) Disconnect test instrument VERTICAL input connector grounding strap.

(2) Connect L-C meter (A6) to test instrument VERTICAL input connectors listed in table 6, using cable and two adapters (B5, B2, and B3). Set test instrument VERTICAL SENSITIVITY switch to setting listed in table 6. L-C meter will indicate within specified limits. If not, perform b below.

b. Adjustments

(1) Connect L-C meter to test instrument VERTICAL input connectors listed in table 6, using cable and adapters (B5, 2, and B3). Set VERTICAL SENSITIVITY switch to settings listed in table 6. At each setting, perform the test instrument adjustment for an L-C meter indication of 45 pf. (R)

(2) Repeat performance check.

Table 6. Vertical Input Capacitance

Test Instrument		L-C Meter Indication (pf)	Test Instrument Adjustments.
Vertical Input Connectors.	Vertical Sensitivity Switch Setting.		
Left and right	.2 VOLTS/CM	41 to 49	C21 (Fig. 1)
Center and right	.2 VOLTS/CM	41 to 49	C22 (Fig. 1)
Center and right	2 VOLTS/CM	41 to 49	C20 (Fig. 2)
Left and right	2 VOLTS/CM	41 to 49	C19 (Fig. 2)
Left and right	5 VOLTS/CM	41 to 49	C13 (Fig. 2)
Center and right	5 VOLTS/CM	41 to 49	C14 (Fig. 2)

16. Horizontal Amplifier Response

a. Performance Check

(1) Connect equipment as shown in figure 3.

(2) Position test instrument controls as indicated in (a) through (d) below:

(*a*) VERTICAL VERNIER control to CAL.

(*b*) VERTICAL SENSITIVITY switch to 2 V/CM.

(*c*) HORIZONTAL SENSITIVITY switch to .2 V/CM.

(*d*) VERTICAL and HORIZONTAL POSITION controls for centered display.

(3) Adjust frequency controls of squarewave generator (A10) for 50-kHz output and test oscillator (All) for a 25-kHz output.

(4) Adjust amplitude controls of squarewave generator and test oscillator for a 6-cm height and width display on test instrument crt.

(5) Adjust fine frequency control on test oscillator for a 2-cycle display. Test instrument will indicate square waves, with minimum overshoot and rounding. If not, perform b below.

(6) Adjust square-wave generator for a 10kHz output and test oscillator for a 5-kHz output.

(7) Repeat (4) and (5) above, with HORIZONTAL SENSITIVITY switch in 2 V/CM and 5 V/CM positions.

(8) Remove ground strap from center and right (GROUND) HORIZONTAL input terminals of test instrument and connect left and right (GROUND) terminals, using lead (B6).

(9) Reverse the adapter at HORIZONTAL input terminals.

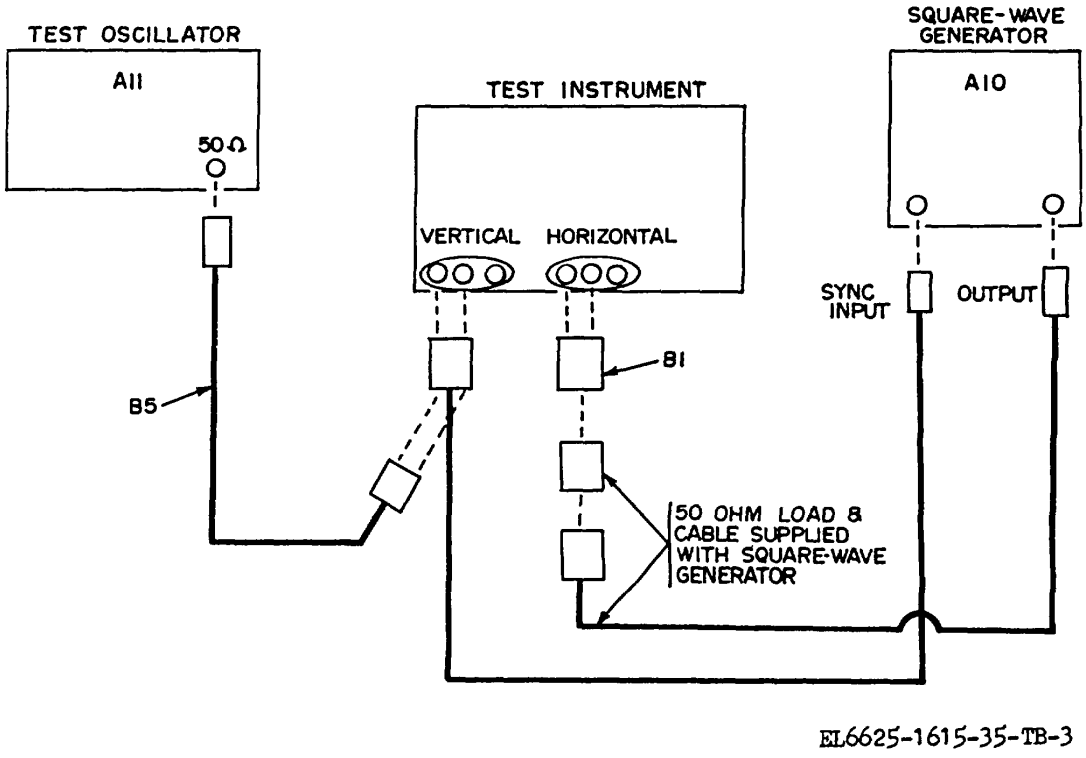

Figure 3. Horizontal amplifier response-equipment setup.

Table 7. Horizontal Frequency Response Adjustment.

Test Instrument VOLTS/CM Switch Setting.	**Adjustment (Fig. 2).**
2	C213 and C217
5	C211 and C215
.2 [1] [2]	C222 (Fig. 1)
2 [3]	C214 and C218
5	C212 and C216

[1] Remove ground strap between center and right (GROUND) HORIZONTAL Input terminal of test instrument Connect left- and right-hand (GROUND) HORIZONTAL input terminals together, using lead (B6).
[1] Repeat b(3).
[2] Repeat s(6).

(10) Repeat (2) through (7) above.

(11) Connect center and right (GROUND) terminals, using ground strap. Remove lead (B6).

b. Adjustment

(1) Repeat a(2) through (5) above.

(2) Alternately adjust C240 and C241 (Fig. 1) for optimum square-wave display on test instrument crt.

(3) Adjust square-wave generator for 1-kHz output and test oscillator for a 500-Hz output. Adjust test oscillator fine frequency control for a 2-cycle display.

(4) Adjust C221 (Fig. 1) for optimum square-wave display. (R)

(5) Repeat technique of a(6) and (7) above, using settings listed in table 7. Perform adjustments as specified for optimum square-wave display.

17. Phase Shift (C-Level Only)

a. Performance Check

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

(*a*) HORIZONTAL and VERTICAL SENSITIVITY switches to .5 VOLTS/CM.

(*b*) HORIZONTAL and VERTICAL VERNIER controls to CAL.

(*c*) HORIZONTAL and VERTICAL AMPLIFIER switches to DC.

(*d*) HORIZONTAL and VERTICAL INPUT switches to DC.

(2) Connect signal generator (AS) 50 a output to test instrument HORIZONTAL and VERTICAL input connectors, using two cables and three adapters (B5 and B1).

(3) Adjust signal generator for 100 kHz and a 5-cm vertical and horizontal display on test instrument. Crt will display diagonal line with center opening less than 0.1 cm.

(4) Disconnect equipment.

b. Adjustments. No adjustments can be made.

18. Triggering Range and Level

a. Performance Check

(1) Position test instrument controls as listed in (*a*) through (*e*) below:

(*a*) VERTICAL SENSITIVITY switch to 20 VOLTS/CM.

(*b*) HORIZONTAL SENSITIVITY switch to INTERNAL SWEEP X1.

(*c*) SWEEP TIME switch to 1 MILLISECONDS/CM.

(*d*) TRIGGER SOURCE-SLOPE switch -to EXT + (positive).

(*e*) LEVEL control to AUTO (defended position). A trace will be displayed on test instrument crt. If not, perform b below.

(2) Turn TRIGGER SOURCE-SLOPE switch to INT + (positive).

(3) Connect output .of test oscillator (All) to VERTICAL input terminals of test instrument, using cable (B5).

(4) Adjust test oscillator frequency controls for 500-kHz output and adjust controls for a 0.6-cm crt display on test instrument.

NOTE

Adjust SWEEP TIME switch as necessary to maintain a suitable display throughout the remainder of this performance check.

(5) Vary test oscillator frequency from 500 kHz to 50 Hz, while maintaining a 0.5-cm display on test instrument crt. Triggering will remain stable.

(6) Turn test instrument LEVEL control to + (POSITIVE).

(7) Vary test oscillator frequency from 10 Hz to 500 kHz, while maintaining a 0.5-cm display on test instrument crt. Stable triggering will occur over entire range.

NOTE

At high frequencies, adjustment of LEVEL CONTROL may be necessary.

(8) Connect test instrument positive VERTICAL input terminal to positive trigger input terminal, using lead (B6).

(9) Position test instrument controls as listed in (*a*) through (*e*) below:

(*a*) LEVEL control to AUTO (defended position).

(*b*) TRIGGER input AC-DC switch to DC.

(*c*) TRIGGER SOURCE-SLOPE switch to EXT + (positive).

(*d*) VERTICAL SENSITIVITY switch to 1 VOLTS/CM.

(*e*) VERTICAL VERNIER control to CAL.

(10) Vary test oscillator frequency from 500 kHz to 50 Hz, while maintaining a display amplitude of 0.5 cm. Triggering will remain stable.

(11) Set TRIGGER LEVEL to + (positive).

NOTE

It may be necessary to fine-adjust LEVEL control.

(12) Vary test oscillator frequency from 10 Hz to 500 kHz, while maintaining a display amplitude to 0.5 cm. Stable triggering will occur over entire range.

(13) Set TRIGGER input AC-DC switch to AC.

(14) Vary test oscillator frequency from 500 kHz to 20 Hz, while maintaining a constant output of 0.5 cm. Triggering will remain stable.

(15) Adjust test oscillator frequency control for 60 Hz output.

(16) Turn TRIGGER SOURCE-SLOPE switch to LINE + (positive).

(17) Turn LEVEL control to AUTO (detended position).

(18) Vary test oscillator frequency control and observe that display is synchronized at power-line frequency.

(19) Position, instrument controls as listed in (*a*) and (*b*) below:

(*a*) VERTICAL SENSITIVITY switch to 2 VOLTS/CM.

(*b*) TRIGGER SOURCE-SLOPE switch to INT + (positive).

(20) Adjust test oscillator for an output frequency of 100 Hz and an amplitude of 10 cm on test instrument crt. Sweep will trigger on positive-going part of displayed waveform.

(21) Turn TRIGGER SOURCE-SLOPE switch to INT (negative). Sweep will trigger on negative-going part of displayed waveform.

(22) Turn TRIGGER SOURCE-SLOPE switch to EXT + (positive). Sweep will trigger on positive-going part of displayed waveform.

(23) Turn TRIGGER SOURCE-SLOPE switch to EXT (negative). Sweep will trigger on negative-going part of displayed waveform.

(24) Vary LEVEL control and observe that starting point of sweep varies along all points on 10-cm displayed waveform.

b. Adjustments

(1) Connect ac/dc voltmeter (A5) between pin 2 of V103 (Fig. 1) and chassis ground.

(2) If no trace display is present on test instrument, perform (*a*) and (*b*) below.

(*a*) Adjust R151 (Fig. 1) clockwise until trace appears.

(*b*) Turn R151 counterclockwise until trace just disappears.

(3) If trace display appears on test instrument crt, adjust R151 counterclockwise until trace just disappears. Ac/dc voltmeter will indicate -55 volts (normal condition).

(4) Turn R151 slightly counterclockwise until ac/dc voltmeter indicates approximately 2 volts less negative than observed in (3) above. (R)

19. Sweep Timing

a. Performance Check

(1) Position test instrument controls as listed in (*a*) through (*e*) below:

(*a*) VERTICAL SENSITIVITY switch to .1 VOLTS/CM.

(*b*) HORIZONTAL SENSITIVITY switch to INTERNAL SWEEP X1.

(*c*) LEVEL control to FREE RUN (detented position).

(*d*) TRIGGER SOURCE-SLOPE switch to INT + (positive).

(*e*) SWEEP VERNIER control to CAL. Sweep length of trace will be 10.75 cm. If not,

Table 8. Sweep Calibration

Teat Instrument SWEEP TIME Switch Positions.	Time Mark Generator Output.	Time Markers Per cm.	Adjustments (Fig. 2).
2 µSECONDS/CM	1 µsec	2	---
5 µSECONDS/CM	5 µsec	1	---
10 µSECONDS/CM	10 µsec	1	C180
20 µSECONDS/CM	10 µsec	2	---
50 µSECONDS/CM	50 µsec	1	---
.1 MILLISECONDS/CM	1 msec	,1	R178
.2 MILLISECONDS/CM	1 msec	2	---
.5 MILLISECONDS/CM	5 msec	1	---
1 MILLISECONDS/CGM	1 msec	1	R177
2 MILLISECONDS/CM	1 msec	2	
5 MILLISECONDS/CM	5 msec	1	---
10 MILLISECONDS/CM	10 msec	1	R176
20 MILLISECONDS/CM	10 msec	2	---
50 MILLISECONDS/CM	50 msec	1	---
.1 SECONDS/CM	1 sec	1	R175

perform *b*(1) and (2) below.

(2) Connect time-mark generator (A12) MARKER OUTPUT connector to test instrument VERTICAL input terminals, using cable (B5).

(3) Press 1 μS pushbutton on time-mark generator.

(4) Adjust LEVEL control to + (POSITIVE) area to obtain suitable display.

(5) Turn test instrument SWEEP TIME switch to 1 MICROSECONDS/CM.

(6) Adjust test instrument HORIZONTAL POSITION control to align second marker with second vertical graticule line. Crt will display 10th marker within plus or minus two minor divisions of 10th vertical graticule line. If not, perform b(3) below.

(7) Repeat technique of (2) through (6) above, using settings listed in table 8. Test instrument will display time markers per cm as specified. If not, perform b(4) below.

b. Adjustments

(1) Repeat a(1) above.

(2) Adjust R146 (Fig. 1) for sweep length of 10.75 cm.

(3) Adjust C181 (Fig. 2) to position 10th marker behind 10th graticule line.

(4) Repeat a(3) through (6) above and perform adjustments as specified in table 8 at the settings shown. (R)

20. Sweep Magnifier

a. Performance Check

(1) Position test instrument controls as listed in (*a*) through (*e*) below:

(*a*) SWEEP TIME switch to 1 MILLI-SECONDS/CM.

(*b*) SWEEP VERNIER control to CAL.

(*c*) HORIZONTAL SENSITIVITY switch to INTERNAL SWEEP X2.

(*d*) TRIGGER SOURCE-SLOPE switch to INT + (positive).

(*e*) LEVEL control to + (POSITIVE).

(2) Connect time-mark generator (A12) MARKER OUTPUT to VERTICAL input terminals of test instrument, using cable (B5).

(3) Press 1 msec pushbutton on time-mark generator.

(4) Adjust test instrument HORIZONTAL POSITION control to align first marker with left graticule edge. Sixth marker will be displayed within .6 cm of right-hand graticule edge.

(5) Check all remaining SWEEP MAGNIFIER ranges, using values shown in table 9.

b. Adjustments. No adjustments can be made.

Table 9. Sweep Magnifier Calibration (Sweep Time at 1 msec/em)

Time-Mark Generator Output.	Test Instrument Sweep Magnifier Positions.	Time Marks/ 10 cm.
.1 msec	X5	21
.1 msec	X10	11
.1 msec	X20	6
10 μsec	X50	21

21. Single Sweep Mode

a. Performance Check. Position controls as listed in (1) through (3) below:

(1) SWEEP TIME switch to 10 MILLISECONDS/CM.

(2) LEVEL control to midrange.

(3) NORMAL-SINGLE switch to SINGLE. ARMED light of test instrument will glow.

b. Adjustments. No adjustments can be made.

22. Sweep Vernier (C-Level Only)

a. Performance Check

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

(*a*) SWEEP TIME switch to 5 SECONDS/CGM.

(*b*) SWEEP VERNIER control fully counterclockwise.

(*c*) LEVEL control to FREE RUN.

(2) Adjust time-mark generator (A12) output for 5-second markers. Test instrument will display more than 5 markers for each 2 cm.

b. Adjustments. No adjustments can be made.

23. Sweep Length (C-Level Only)

a. Performance Check

(1) Connect signal generator (A9) 600 Ω output to test instrument VERTICAL input, using cable (B4).

(2) Position test instrument controls as

listed in (*a*) through (*d*) below:

(*a*) LEVEL control to midrange.

(*b*) SWEEP TIME switch to .1 MILLISECONDS/CM.

(*c*) HORIZONTAL SENSITIVITY switch to INTERNAL SWEEP X1.

(*d*) VERTICAL SENSITIVITY switch to 1 VOLTS/CM.

(3) Adjust signal generator for 500 kHz and test instrument crt display of 4-cm vertical deflection.

(4) Adjust test instrument LEVEL control for shortest sweep length. Sweep length will be between 10.5 and 11.0 cm. If not, perform b below.

(5) Disconnect equipment.

b. Adjustments. Adjust test instrument SWEEP LENGTH adjustment R146 (Fig. 1) for Sweep length of 10.75 cm. (R)

24. Intensity Modulation (C-Level Only)

a. Performance Check

(1) Set test instrument VERTICAL SENSITIVITY switch to 20 VOLTS/CM and SWEEP TIME switch to 10 SECONDS/CM.

(2) Connect test oscillator (A11) to test instrument VERTICAL input, using cable and two adapters (B5 and B1).

(3) Adjust test oscillator output for 100 kHz and a 2-cm vertical deflection on test instrument crt.

(4) Disconnect test instrument Z AXIS INPUT (rear panel) grounding strap.

(5) Connect test instrument VERTICAL input red terminal to Z AXIS INPUT red terminal with test lead (B7). Test instrument will display sine wave with top portion extinguished at normal display intensity.

(6) Disconnect equipment.

(7) Connect test instrument Z AXIS INPUT (rear panel) grounding strap.

b. Adjustments. No adjustments can be made.

25. Power Supply

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

a. Performance Check. Connect multimeter (A7) or ac/dc voltmeter (A5) -between test instrument test points listed in table 10 and chassis ground. Adjust autotransformer (A2) output voltage control for a meter indication of 105, 125, and 115 volts ac. Multimeter will indicate within limits specified. Perform adjustments listed in table 10 for the test-point indications shown.

Table 10. Power Supply Check

Test Instrument		Multimeter Indication (vdc)	Test Instrument Adjustment (Fig. 1).
Test Point.	Connection (Fig. 1).		
-100	Violet wire	-99 to-101	R468(R)
+100	White/red wire	+99 to +101	R447(R)
+250	Red wire	+243 to +257	---
+12.5	White/black/red wire	+11.5 to +13.5	---

b. Adjustments. No further adjustments can be made.

26. High-Voltage Power Supply (A-Level Only)

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

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

a. Performance Check. Connect dc voltmeter (A4) to pin 8 of T401 (Fig. 1) and chassis ground.

Dc voltmeter will indicate between -2750 and -2950 volts. If not, perform b below.

b. Adjustments. Adjust R812 (Fig. 2) for -2850 volts as indicated on dc voltmeter. (R)

27. Final Procedure

a. Deenergize and disconnect all equipment and replace test instrument within protective cover.

b. in accordance with TM 38-750, annotate and affix DA Label 80 (U.S. Army Calibration System). When the test instrument cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable or Limited Use tag).

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