NAVAIR 17-20AW-08

Technical Manual

Instrument Calibration Procedure

AW-08

c.1

OSCILLOSCOPES

535, 545, 945

RM-35, RM-45, AN/USM-120

(Tektronix)

DEPARTMENT OF THE NAVY CALIBRATION PROGRAM

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TABLE OF CONTENTS

ILLUSTRATIONS

TABLES

SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of the Tektronix 535, 545, 945, RM-35, RM-45, or AN/USM-120 oscilloscope which is a broadband laboratory oscilloscope with calibrated main sweeps, calibrated delaying sweeps, sweep magnification, a square-wave calibrator, provisions for automatic or adjustable triggering from either internal or external sources, and the necessary power supplies. The instrument being calibrated will be referred to herein as the Test Instrument.

1.2 This procedure was prepared by the Metrology Engineering Center, BWR Pomona, California. All comments concerning this procedure should be directed to the Metrology Engineering Center.

Table 1. Calibration Description

Test Instrument Characteristics	Performance Specifications	Test Method
Operational characteristics	None	Functional (see step 1.3)
Line voltage regulation	Satisfactory operation is implied within all stated tolerances with line voltages of 105 and 125 volts	The calibrator signal is connected to the vertical input and displayed. The display is observed for variations when the line voltage is changed to 105 and 125 volts.
Sawtooth output	Tektronix 535, 545, RM-35, and RM-45: Same duration as the main sweep, positive going, approximately 150 volts Tektronix 945 and AN/USM-120: Same duration as the main sweep, positive going, 165 volts ±20%	Measured with an auxiliary oscilloscope
+ Gate output	Tektronix 535, 545, RM-35, and RM-45: Same duration as the main sweep, approximately 20 volts Tektronix 945 and AN/USM-120: Same duration as the main sweep, 25 volts ±50%	Measured with an auxiliary oscilloscope

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Test Instrument Characteristics	Performance Specifications	Test Method
Voltage calibrator	Square-wave output at approximately 1 kHz Eighteen fixed voltages from 0.2 mv peak-to-peak to 100v peak-to-peak Accuracy, ±2% (Tektronix 945 and AN/USM-120) or ±3% (Tektronix 535, 545, RM-35, and RM-45)	The wave shape is observed on an auxiliary oscilloscope. Voltage accuracy is tested by comparing the calibrator waveform amplitude to the amplitude of an accurate alternating voltage, using an auxiliary oscilloscope to compare the two signals.
Vertical gain	0.1v p-p/cm	Tested by applying a signal of known amplitude to the main vertical amplifier, and adjusting the Test Instrument gain control as necessary
Triggering signal requirements	Internal, 2 mm or less External, 0.2 to 10v p-p (Tektronix 535, 545, RM-35, and RM-45) or 0.5 to 100v p-p (Tektronix 945 and AN/USM-120) Frequency range, dc to 30 kHz	See step 1.4
Horizontal balance	None	It is verified that the CRT display does not shift horizontally as the DELAYING SWEEP STABILITY OR EXT. SWEEP ATTEN. control is adjusted throughout its range.
Horizontal gain test	Tektronix 535, 545, RM-35 and RM-45: Approximately 0.2 to 15 volts/cm, continuously variable Tektronix 945 and AN/USM-120: Approximately 0.2 to 10 volts/cm, continuously variable	Tested using the Test Instrument calibrator as an accurate signal source, and noting the amount of horizontal deflection

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Test Instrument Characteristics	Performance Specifications	Test Method
Horizontal bandwidth	Tektronix 535, 545, RM-35, and RM-45: dc to 800 kHz Tektronix 945 and AN/USM-120: dc to 1 MHz.	Constant amplitude signals are provided from 50 kHz to the frequency at which the horizontal deflection decreases 3 db.
CRT geometry	Not greater than 1 mm of tilt or bowing	A time-mark generator is used to display 1.0-millisecond markers with a height greater than the graticule. These markers are then observed for correct geometry.
Sweep length	Approximately 10.5 cm	Observed on the CRT for proper length
Magnifier registration	None	It is verified that a spot displayed at horizontal center does not shift more than 1/2 minor division when the magnifier is turned on and off.
Magnifier	Provides a 5-times magnification of the center 2-centimeter portion of the display and increases the sweep to 0.02 μsec/cm.	Tested with a time-mark generator
Sweep time	Range, 0.1 μsec/cm to 5 sec/cm in 24 calibrated steps Accuracy, ±3% Continuously variable sweep rate control will slow the calibrated sweep rates down by a factor of approximately 2.5x.	Tested with a time-mark generator at each switch setting The operation of the variable control is verified by measuring the time of displayed markers from the time-mark generator.

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Test Instrument Characteristics	Performance Specifications	Test Method
Delayed sweep	Continuously variable from 2 μsec to 100 msec Accuracy, ±1% (Tektronix 945 and AN/USM-120) or ±2% (Tektronix 535, 545 RM-35 and RM-45)	Tested with a time-mark generator
Vertical bandwidth for 535 and RM-35	Main vertical amplifier rise time is 32 nsec (bandwidth equals 11 MHz)	The output of a pulse generator is displayed and observed for flatness and overshoot, and the rise time is measured.
for 545, RM-45, 945, and AN/USM-120	Main vertical amplifier rise time is 10 nsec (bandwidth equals 35 MHz)	

1.3 The SCALE ILLUM., FOCUS, ASTIGMATISM, INTENSITY, and HORIZONTAL POSITION controls are functionally tested to determine proper operation. CRT alignment is verified by observing the relationship of a displayed trace to the center graticule line. The indicating lamps used in conjunction with the main sweep and positioning are tested for proper indications as the applicable controls are varied.

1.4 The ability of the Test Instrument to trigger on either the positive- or negative-going slope of an internally or externally derived signal is tested by utilizing the calibrator output as the input signal. High frequency synchronization is tested by inference during the sweep time and vertical bandwidth tests when high frequency signals are applied to the vertical input.

SECTION 2

EQUIPMENT REQUIREMENTS[1]

NOTE

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. The selection of equipment other than that designated is the reponsibility of the supervisor of the calibrating activity. Correct performance of alternate items should be verified by operational tests. All applicable equipment must bear evidence of current calibration.

[1]The instruments utilized in this procedure were selected from those known to be available at Department of Defense facilities, and 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.

Item	Minimum Use Specifications	Calibration Equipment
2.1 Oscilloscope	Input sensitivity, 4 mv/cm to 20v/cm Calibrated sensitivities of 5v/cm, 10v/cm, and 20v/cm, ±5% with a vertical graticule of 10 cm Sweep speed, 0.1 ms/cm to 2 ms/cm Bandwidth, 10 Hz to 300 kHz	Hewlett-Packard 130C, B, or A
2.2 Autotransformer	Input voltage, 105 to 125 volts, 60 Hz, 1ϕ Output voltage, 105 to 125 volts adjustable Metered output	General Radio W10MT3A
2.3 Alternating voltage source	Range, 1.0 to 50 volts Accuracy, ±0.5% Frequency, 1000 Hz ±2% Distortion, 1% max.	Rotek 146A, or 146AG5; Holt AVS-321 driven by a Hewlett-Packard 200 CD; or Altec 1569 AN driven by a Hewlett-Packard 200 CD and monitored with an RFL 1605
2.4 Time-mark generator	Markers from 5 seconds to 1 μsec in a 1, 5, 10 sequence, and 5 and 10 MHz signals Accuracy, ±0.75% Trigger outputs, 1, 10, 100 Hz and 1, 10, 100 kHz	Tektronix 180A
2.5 Voltage divider	Voltage ratio, 0.0001 to 1.0000 in steps of 0.0001 Accuracy, ±0.04% of indicated ratio Linearity, ±0.02% of full-scale setting Input resistance, 10 kΩ Minimum input voltage, 100 volts peak-to-peak	General Radio 1454-A, Electro Measurements DV412, or Gray Instruments E2553
2.6 Signal generator	Frequency range, 50 kHz to 1.5 MHz Accuracy, ±2% Output voltage, 0 to 1 volt Accuracy, ±2%	Hewlett-Packard 651A, 651B, 652A, or 606A loaded with a 50Ω ±5%, 1 watt resistor

Item	Minimum Use Specifications	Calibration Equipment
2.7 Preamplifier	No	Tektronix 53/54K or K*
2.8 Gain adjust adapter	Test Instrument calibration accessory	Tektronix 013-005
2.9 Pulse generator	Output amplitude: 175 mv min. into 50Ω Polarity: + or - Rise time: 2.5 nsec max. Repetition rate: 100 kHz Width: 1 μsec min.	Hewlett-Packard 213B
2.10 Rise time adapter	No substitute	MET D-150
2.11 Interconnecting leads	As required	

SECTION 3

PRELIMINARY OPERATIONS

NOTE

Throughout this procedure, alternate names of switches, controls, and connectors are included within parentheses.

3.1 Verify that all power switches are off, then connect all applicable auxiliary equipment to the appropriate power source.

3.2 Verify that the autotransformer meter indicates approximately 115 volts output, then connect the Test Instrument power cord to the autotransformer output.

3.3 Set all auxiliary equipment controls as necessary to avoid damage to the equipment, and so that dangerous voltages will not be present on output terminals when power switches are turned on.

3.4 Adjust the Test Instrument INTENSITY control fully ccw, and set the AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to OFF.

CAUTION

A BRIGHT SPOT OR TRACE MAY DAMAGE THE TI CRT. DURING THIS PROCEDURE, THE INTENSITY CONTROL SHOULD BE ADJUSTED FOR A DIM SPOT OR TRACE UNLESS OTHERWISE INSTRUCTED.

*Any general purpose Tektronix plug-in preamplifier such as the L,C-A, B, H, etc., may be used; however the instructions in this procedure apply to the Tektronix 53/54K or K preamplifier.

3.5 Install the preamplifier in the Test Instrument.

3.6 Turn all power switches on, and adjust the autotransformer for 115 volts output.

3.7 Verify that the Test Instrument power indicator is illuminated, and that the fan motor is operating. If not, take corrective action.

3.8 Allow sufficient time for the equipment to warm up and stabilize (the Test Instrument requires approximately 20 minutes to warm up).

SECTION 4

CALIBRATION PROCESS

NOTE

Unless otherwise specified, verify the results of each test and take corrective action before proceeding.

4.1 OPERATIONAL AND FUNCTIONAL TESTS

4.1.1 Intial Conditions

4.1.1.1 Set the Test Instrument controls as follows:

TRIGGERING LEVEL control to	0
STABILITY control	fully cw
TIME/CM switch to	.1 μSEC (or .1 MICROSEC)
MULTIPLIER switch to	5
HORIZONTAL POSITION control to	midrange
HORIZONTAL POSITION VERNIER control to	midrange
TRIGGER SLOPE switch to	+ INT
TRIGGERING MODE switch to	AC LF REJECT (or AC FAST)
HORIZONTAL DISPLAY switch to	MAIN SWEEP NORMAL
5X MAGNIFIER switch to	OFF

4.1.1.2 Set the preamplifier controls as follows:

VOLTS/CM switch to	.5
VERTICAL POSITION control to	midrange
AC-DC switch to	AC

4.1.1.3 Adjust the Test Instrument INTENSITY, FOCUS, ASTIGMATISM, and positioning controls for a dim, centered trace.

4.1.2 Scale Illumination Test

4.1.2.1 Adjust the Test Instrument SCALE ILLUM. control fully cw, and verify that the graticule illuminates.

4.1.3 Focus Control Test

4.1.3.1 Adjust the FOCUS control, and verify that it is performing satisfactorily.

4.1.4 Intensity Control Test

4.1.4.1 Adjust the INTENSITY control fully cw, and verify that adequate intensity is obtainable.

4.1.4.2 Adjust the INTENSITY control for a dim trace.

4.1.5 Vertical Positioning Test

4.1.5.1 Adjust the preamplifier VERTICAL POSITION control ccw, then cw, and verify that sufficient range is available to place the trace well beyond the upper and lower graticule limits, and that the vertical positioning indicating lamps indicate properly.

4.1.5.2 Adjust the preamplifier VERTICAL POSITION control to center the trace vertically.

4.1.6 CRT Alignment Test

4.1.6.1 Adjust the INTENSITY, FOCUS ASTIGMATISM, and positioning controls as necessary, and verify that the trace and the center graticule line coincide.

4.1.7 Horizontal Positioning Test

4.1.7.1 Adjust the HORIZONTAL POSITION control fully cw, and verify that the start of the trace is to the right of the center of the CRT.

4.1.7.2 Adjust the HORIZONTAL POSITION control fully ccw, and verify that the start of the trace can be adjusted well beyond the left-hand graticule limit.

4.1.7.3 Adjust the HORIZONTAL POSITION control to center the trace.

4.2 LINE VOLTAGE REGULATION TEST

4.2.1 Set the Test Instrument controls as follows:

TRIGGER MODE switch to	AUTO (or AC AUTO)
TIME/CM switch to	10 μSEC (or 10 MICROSEC)
MULTIPLIER switch to	12-5
MULTIPLIER variable control to	midrange

4.2.2 Connect a lead from the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector to the preamplifier INPUT connector.

4.2.3 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to 5 VOLTS.

4.2.4 Adjust the preamplifier VOLTS/CM VARIABLE and VERTICAL POSITION controls for a display exactly 4 cm high centered on the CRT. Adjust the Test Instrument STABILITY control as necessary for a stable display.

4.2.5 Adjust the Test Instrument MULTIPLIER variable control for a square-wave display exactly 4 cm wide.

4.2.6 Adjust the autotransformer for 105 volts output, and wait one minute.

4.2.7 Both the height and width of the square-wave display must be from 3.9 to 4.1 cm.

4.2.8 Adjust the autotransformer for 125 volts output, and wait one minute.

4.2.9 Both the height and width of the square-wave display must be from 3.9 to 4.1 cm.

4.2.10 Adjust the autotransformer for 115 volts output.

4.2.11 Disconnect the lead from the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector and the preamplifier INPUT connector.

4.3 OUTPUT SIGNAL TESTS

4.3.1 Sawtooth Output Test

4.3.1.1 Set the auxiliary oscilloscope controls for a sweep time of 1 millisecond/cm, and a calibrated vertical sensitivity of 20 volts/cm.

4.3.1.2 Connect the Test Instrument SAWTOOTH MAIN SWEEP output and a ground terminal to the auxiliary oscilloscope vertical input.

4.3.1.3 Adjust the Test Instrument STABILITY control fully cw.

4.3.1.4 Adjust the auxiliary oscilloscope controls to obtain a sawtooth display.

4.3.1.5 The amplitude of the sawtooth display must be from 120 to 180 volts (Tektronix 535, 545, RM-35, and RM-45) or from 132 to 198 volts (Tektronix 945 and AN/USM-120).

4.3.2 + Gate Output Test

4.3.2.1 Disconnect the lead from the Test Instrument SAWTOOTH MAIN SWEEP output, and reconnect it to the +GATE MAIN SWEEP output.

4.3.2.2 Set the auxiliary oscilloscope controls for a calibrated vertical sensitivity of 10 volts/cm and to display the gated waveform.

4.3.2.3 The amplitude of the gated waveform display should be 15 volts minimum (Tektronix 535, 545, RM-35, and RM-45) or 12 volts minimum (Tektronix 945 and AN/USM-120).

4.3.2.4 Disconnect the auxiliary oscilloscope from the Test Instrument.

4.4 CALIBRATOR TEST

4.4.1 Initial Conditions

4.4.1.1 Set the voltage divider dials to 0.

4.4.1.2 Set the alternating voltage source controls for 1 kHz and minimum output voltage.

4.4.1.3 Connect the alternating voltage source to the voltage divider input.

4.4.1.4 Set the auxiliary oscilloscope controls for a sweep time of 0.2 milliseconds/cm and a vertical sensitivity of 20 volts/cm.

4.4.1.5 Connect the auxiliary oscilloscope to the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector.

4.4.1.6 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to 100 VOLTS.

4.4.2 Waveform Test

4.4.2.1 Set the auxiliary oscilloscope controls, as necessary, to display the square waves.

4.4.2.2 Examine the square-wave display for correct symmetry, minimum overshoot, and rounding.

4.4.3 Accuracy Test

4.4.3.1 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to the first setting listed in step 4.4.3.7, and adjust the alternating voltage source controls for the corresponding output voltage.

4.4.3.2 Set the auxiliary oscilloscope controls for a display exactly 10 cm high.

NOTE

The display should be dim and properly focused to obtain maximum resolution.

4.4.3.3 Disconnect the auxiliary oscilloscope from the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector, and reconnect it to the voltage divider output.

4.4.3.4 Set the voltage divider dials to obtain a display exactly 10 cm high on the auxiliary oscilloscope CRT.

4.4.3.5 The corresponding voltage divider indication must not exceed that which is listed in step 4.4.3.7.

4.4.3.6 Disconnect the auxiliary oscilloscope from the voltage divider output, and reconnect it to the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector.

4.4.3.7 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to each remaining setting listed below, adjust the alternating voltage source controls for the corresponding output voltage, and repeat steps 4.4.3.2 through 4.4.3.6 at each setting.

Test Instrument AMPLITUDE CALIBRATOR (or SQUARE WAVE CALIBRATOR) Switch	Alternating Voltage Source Output	Voltage Divider Indication	
		Tektronix 535, 545, RM-35, and RM-45	Tektronix 945 and AN/USM-120
100 VOLTS	50 volts	.6860 to .7284	.6931 to .7213
20 "	"	.1373 to .1457	.1387 to .1443
5 "	10 volts	.1715 to .1821	.1733 to .1803
1 "	1 volt	.3430 to .3642	.3465 to .3607
.2 "	"	.0686 to .0728	.0693 to .0721

4.4.3.8 Disconnect the auxiliary oscilloscope from the Test Instrument.

4.5 VERTICAL GAIN ADJUSTMENT

4.5.1 Turn the Test Instrument POWER switch off.

4.5.2 Remove the Test Instrument from its case.

4.5.3 Remove the preamplifier, and reinstall it using the gain adjust adapter (item 2.8).

4.5.4 Turn the Test Instrument POWER switch on, and allow 5 minutes for warm up.

4.5.5 Adjust the alternating voltage source controls for exactly 1 volt output and the voltage divider dials to .1414.

4.5.6 Connect the voltage divider output to the gain adjust adapter and ground.

4.5.7 Set the Test Instrument TIME/CM and MULTIPLIER switches to 1 mSEC (or 1 MILLISEC) and 1, respectively, and adjust the STABILITY control for a stable display.

4.5.8 Adjust the Test Instrument INTENSITY, FOCUS, and ASTIGMATISM controls for a dim sharp display, and the preamplifier VERTICAL POSITION control to position the display.

4.5.9 Verify that the display is exactly 4 cm high. If not, adjust the Test Instrument gain potentiometer.

4.5.10 Disconnect the voltage divider from the Test Instrument.

4.5.11 Turn the Test Instrument POWER switch off, remove the gain adjust adapter, and reinstall the preamplifier.

4.5.12 Slide the Test Instrument into its cabinet, turn the POWER switch on, and allow 5 minutes for warm up.

4.6 TRIGGERING TESTS

4.6.1 Internal Triggering Tests

4.6.1.1 Set the Test Instrument controls as follows:

TRIGGERING MODE switch to	AUTO (or AC AUTO)
TRIGGER SLOPE switch to	+INT
STABILITY control	fully cw
TRIGGERING LEVEL control to	0
TIME/CM switch to	100 μSEC (or 100 MICROSEC)
MULTIPLIER switch to	2
5X MAGNIFIER switch to	OFF
AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to	.5 VOLTS

4.6.1.2 Set the preamplifier VOLTS/CM switch to .2, and adjust the VOLTS/CM VARIABLE control fully cw.

4.6.1.3 Connect a lead from the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector to the preamplifier INPUT connector.

4.6.1.4 Adjust the Test Instrument INTENSITY, FOCUS, ASTIGMATISM, positioning, and STABILITY controls for a stable square-wave display.

4.6.1.5 Adjust the preamplifier sensitivity controls to reduce the display amplitude to minimum, while adjusting the STABILITY control as necessary to maintain a stable display, and verify that a stable display is obtained when the amplitude is 1 minor division (2 mm) or less.

4.6.1.6 Verify that with a vertical amplitude of 1 minor division maximum, the square waves appear to invert when the TRIGGER SLOPE switch is set to +INT and -INT, and that the TRIGGER LEVEL control indicates at or near 0, and does not require adjustment to maintain a stable display when changing the TRIGGER SLOPE from +INT to -INT.

4.6.1.7 Set the TRIGGERING MODE switch to AC LF REJECT (or AC FAST) and AC (or AC SLOW). At each setting, adjust the STABILITY control for a stable display and repeat step 4.6.1.6.

4.6.1.8 Adjust the preamplifier sensitivity until the display amplitude is 2 minor divisions (4 mm), and vertically center the presentation.

4.6.1.9 Set the TRIGGERING MODE switch to DC, and verify that a stable triggering can be obtained with the TRIGGER SLOPE switch at both +INT and -INT. Slight adjustments of the TRIGGERING LEVEL and the preamplifier VERTICAL POSITION controls may be necessary.

4.6.1.10 Set the TRIGGERING MODE switch to AC (or AC SLOW), and adjust the TRIGGERING LEVEL and STABILITY controls for a stable display.

4.6.1.11 Disconnect the lead from the preamplifier INPUT connector. The display should disappear; if not, adjust the STABILITY control slowly ccw until the trace disappears.

4.6.1.12 Set the TRIGGER SLOPE switch to +LINE and -LINE. Verify that a trace is present at both settings.

4.6.2 External Triggering Tests

4.6.2.1 Connect the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector to the TRIGGER INPUT and the preamplifier INPUT connectors.

4.6.2.2 Set the Test Instrument TRIGGER MODE switch to AC (or AC SLOW) and the TRIGGER SLOPE switch to +EXT.

4.6.2.3 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to .2 VOLTS (Tektronix 535, 545, RM-35, and RM-45) or .5 VOLTS (Tektronix 945 and AN/USM-120), and the preamplifier controls for a sensitivity of 0.5 volts/cm.

4.6.2.4 Adjust the STABILITY control for a stable display.

4.6.2.5 Disconnect the lead from the TRIGGER INPUT connector, and verify that the display disappears or becomes unstable. Reconnect the lead to the TRIGGER INPUT connector, and a stable display should reappear.

4.6.2.6 Verify that the display inverts when the TRIGGER SLOPE switch is set to +EXT. and -EXT. Slight readjustments of the TRIGGERING LEVEL control may be necessary.

4.6.2.7 Disconnect the leads from the Test Instrument.

4.7 HORIZONTAL BALANCE, GAIN, AND BANDWIDTH TESTS

4.7.1 Balance Test

4.7.1.1 Set the preamplifier VOLTS/CM switch to 20, and adjust the VOLTS/CM VARIABLE control fully ccw.

4.7.1.2 Connect the Test Instrument SAWTOOTH MAIN SWEEP connector to the preamplifier INPUT connector.

4.7.1.3 Set the Test Instrument HORIZONTAL DISPLAY switch to EXT MAIN SWEEP, the 5X MAGNIFIER switch to ON, adjust the STABILITY control fully cw, and adjust the INTENSITY and positioning controls to display the trace at the left graticule line.

4.7.1.4 Adjust the Test Instrument DELAYING SWEEP STABILITY OR EXT SWEEP ATTEN. control throughout its range, and verify that the trace does not shift horizontally.

4.7.2 Gain Test

4.7.2.1 Connect a lead from the Test Instrument CALIBRATOR OUT (or CAL. OUT) connector to the TRIGGER IN OR EXT. SWEEP IN connector.

4.7.2.2 Set the Test Instrument controls as follows:

ATTEN switch to	X1
DELAYING SWEEP STABILITY OR EXT. SWEEP ATTEN. control	fully cw
AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to	1 VOLTS

4.7.2.3 Adjust the Test Instrument HORIZONTAL POSITION control as necessary, and verify that the horizontal deflection is at least 5 cm.

4.7.2.4 Set the Test Instrument AMPLITUDE CALIBRATOR (or SQUARE-WAVE CALIBRATOR) switch to 2 volts, and adjust the DELAYING SWEEP STABILITY OR EXT. SWEEP ATTEN. and HORIZONTAL POSITION controls for a display exactly 10 cm wide.

4.7.2.5 Set the Test Instrument ATTEN switch to X10, and verify that the display is approximately 1 cm.

4.7.2.6 Disconnect the leads from the Test Instrument.

4.7.3 Bandwidth Tests

4.7.3.1 Set the signal generator controls for 50 kHz and minimum output voltage

4.7.3.2 Connect the signal generator to the Test Instrument TRIGGER OR EXT SWEEP IN connector and ground.

4.7.3.3 Set the Test Instrument ATTEN switch to X1, and adjust the DELAYING SWEEP STABILITY OR EXT. SWEEP ATTEN. control fully cw.

4.7.3.4 Adjust the signal generator output voltage to obtain a trace exactly 4.0 cm wide.

4.7.3.5 Note the exact signal generator output voltage.

4.7.3.6 While maintaining the exact signal generator output voltage noted in step 4.7.3.5, increase the signal generator frequency until the Test Instrument display is 2.8 cm wide. Verify that while increasing the frequency, the display does not exceed 4.2 cm, and that the signal generator output frequency conforms to the following requirements when the display is 2.8 cm wide.

Test Instrument	Frequency
Tektronix 535, 545, RM-35, and RM-45	240 kHz min.
Tektronix 945 and AN/USM-120	1 MHz min.

4.7.3.7 Set the Test Instrument ATTEN switch to X10.

4.7.3.8 Set the signal generator controls for 50 kHz and minimum output voltage, and repeat steps 4.7.3.4 through 4.7.3.6.

4.7.3.9 Adjust the signal generator output voltage to minimum, and disconnect it from the Test Instrument.

4.8 GEOMETRY TEST

4.8.1 Set the Test Instrument controls as follows:

HORIZONTAL DISPLAY switch to	MAIN SWEEP NORMAL
TRIGGER SLOPE switch to	+INT.
TRIGGERING MODE switch to	AC LF REJECT (or AC FAST)
TIME/CM switch to	1 mSEC (or 1 MILLISEC)
MULTIPLIER switch to	1
5X MAGNIFIER switch to	OFF

4.8.2 Set the preamplifier controls for a vertical sensitivity of 0.2 volts/cm.

4.8.3 Set the time-mark generator controls for 1.0 millisecond, and connect the marker output to the preamplifier INPUT connector.

4.8.4 Adjust the Test Instrument TRIGGERING LEVEL, STABILITY, INTENSITY, FOCUS, and ASTIGMATISM controls for a sharp display, and the preamplifier VERTICAL POSITION control to place the base of the timing comb below the bottom edge of the CRT so that it is not visible.

4.8.5 Verify that the displayed vertical lines are parallel and approximately coincident with the graticule lines. See figure 1.

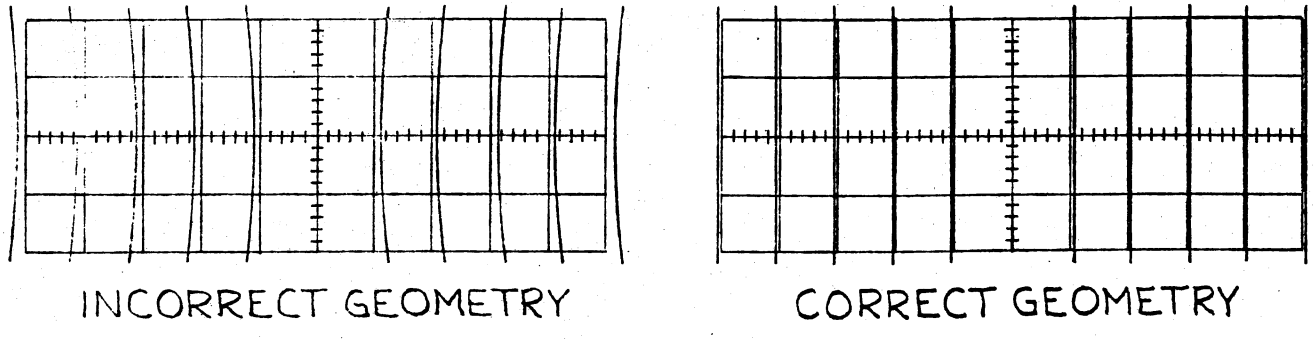

Figure 1. Geometry Displays

4.8.6 Disconnect the time-mark generator.

4.9 SWEEP CIRCUIT TEST

4.9.1 Sweep Length Test

4.9.1.1 Adjust the Test Instrument STABILITY control fully cw, and the INTENSITY, FOCUS, and positioning controls for a dim, sharply focused, centered trace.

4.9.1.2 Verify that the trace length is approximately 10.5 cm.

4.9.2 Magnifier Registration Test

4.9.2.1 Adjust the Test Instrument STABILITY control fully ccw but not to PRESET, and the INTENSITY, FOCUS, and positioning controls for a dim, centered spot.

4.9.2.2 Set the Test Instrument 5X MAGNIFIER switch to ON, and adjust the HORIZONTAL POSITION control to center the spot.

4.9.2.3 Set the Test Instrument 5X MAGNIFIER switch to OFF, and verify that the spot does not shift more than 1/2 minor division.

4.9.2.4 Adjust the Test Instrument STABILITY control fully cw, and reduce the intensity.

4.9.3 Magnifier Gain Test

4.9.3.1 Connect the time-mark generator marker output to the preamplifier INPUT connector.

4.9.3.2 Obtain 100-μsec markers from the time-mark generator.

4.9.3.3 Set the Test Instrument 5X MAGNIFIER switch to ON, and adjust the preamplifier sensitivity and positioning controls for a display 2 to 3 cm high.

4.9.3.4 Adjust the Test Instrument HORIZONTAL POSITION control to place a marker on the left-hand graticule line.

4.9.3.5 The distance occupied by 21 markers must be from 9.7 to 10.3 cm.

4.9.3.6 Set the Test Instrument 5X MAGNIFIER switch to OFF.

4.9.4 Sweep Time Test

4.9.4.1 Connect the time-mark generator trigger output to the Test Instrument TRIGGER INPUT connector.

4.9.4.2 Set the Test Instrument TRIGGER SLOPE switch to +EXT.

4.9.4.3 Set the Test Instrument TIME/CM and MULTIPLIER switches to the positions listed below. At each setting, obtain the corresponding marker and trigger signals, and verify that the distance between the specified markers is from 9.7 to 10.3 cm. Adjust the preamplifier sensitivity controls

to maintain a display 2 to 3 cm high, and the Test Instrument TRIGGERING LEVEL, STABILITY, and positioning controls as necessary to maintain stable, properly positioned displays.

NOTE

At slower sweep speeds, it may be desirable to increase the vertical sensitivity and intensity, and position the bottom of the timing comb down so that only the tops of the markers are visible.

Test Instrument		Time-Mark Generator		
TIME/CM Switch	MULTIPLIER Switch	Markers	Triggers	Specified Markers
1 SEC	5	5 Seconds	1~/1sec	1st and 11th
"	2	1 "	"	1st and 21st
"	1	"	"	1st and 11th
100 mSEC[1]	5	500 Millisecond	"	" "
" "	"	" "	"	Verify correct linearity[2]
" "	2	" "	"	1st and 5th
" "	1	100 "	10~/100 ms	1st and 11th
10 "	5	50 "	"	" "
" "	2	" "	"	1st and 5th
" "	1	10 "	100~/10 ms	1st and 11th
1 "	5	5 "	"	" "
" "	2	" "	"	1st and 5th
" "	1	1 "	1 kc/1 ms	1st and 11th
" "	"	" "	"	Verify correct linearity[2]
100 μSEC[3]	5	500 Microsecond	"	1st and 11th
" "	2	" "	"	1st and 5th
" "	1	100 "	10 kc/100μs	1st and 11th
10 "	5	50 "	"	" "
" "	2	" "	"	1st and 5th
" "	1	10 "	100 kc/10μs	1st and 11th
1 μSEC[3]	5	5 Microsecond	100 kc/10μs	1st and 11th
" "	"	" "	"	Verify correct linearity[2]
" "	2	" "	"	1st and 5th
" "	1	1 "	"	1st and 11th
.1 "	5	" "	"	1st and 6th
" "	2	5 Mc Sine Wave	"	1st and 11th
" "	1	10 " " "	"	" "
" "	"	" " " "	"	Verify correct linearity[2]

[1] Or MILLISEC

[2] Satisfactory linearity is indiated by equal spacing of the markers

[3] Or MICROSEC

4.9.4.4 Set the Test Instrument 5X MAGNIFIER switch to ON.

4.9.4.5 Adjust the preamplifier sensitivity and vertical position controls for a display exactly 4 cm high.

4.9.4.6 Adjust the Test Instrument HORIZONTAL POSITION control as necessary, and verify that the distance occupied by two complete sine waves is from 9.7 to 10.3 cm.

4.9.4.7 Set the Test Instrument 5X MAGNIFIER switch to OFF, the TIME/CM switch to 1 mSEC (or 1 MILLISEC), and adjust the MULTIPLIER variable control fully cw.

4.9.4.8 Set the Test Instrument MULTIPLIER switch to the first setting listed in step 4.9.4.12.

4.9.4.9 Obtain the corresponding markers and trigger signals from the time-mark generator.

4.9.4.10 Adjust the Test Instrument triggering and positioning controls as necessary for a stable, centered display.

4.9.4.11 Slowly adjust the Test Instrument MULTIPLIER variable control fully ccw, and verify that the control operates smoothly and that the sweep time is within the tolerance specified in step 4.9.4.12.

4.9.4.12 Set the Test Instrument MULTIPLIER switch to each remaining setting listed below, and repeat steps 4.9.4.9 through 4.9.4.11 at each setting, except it is not necessary to verify smooth operation of the MULTIPLIER variable control.

Test Instrument MULTIPLIER Switch	Time-Mark Generator		Sweep Time
	Markers	Trigger	
2.5-1	1 and 5 Milliseconds	100~/10 ms	25 Milliseconds min.
5-2	5 and 10 "	"	60 " "
12-5	10 and 50 "	10~/100 ms	120 " "

4.10 DELAYING SWEEP TESTS

4.10.1 Time/cm Test

4.10.1.1 Disconnect the lead from the Test Instrument TRIGGER connector, and reconnect it to the TRIGGER OR EXT. SWEEP IN connector.

4.10.1.2 Set the Test Instrument HORIZONTAL DISPLAY switch to DEL'G SWEEP (or DELAYING SWEEP), and adjust the TIME/CM OR DELAY TIME LENGTH control fully cw.

4.10.1.3 Set the Test Instrument TIME/CM OR DELAY TIME LENGTH switch to the positions listed below. At each setting, obtain the corresponding markers and trigger signals, and verify that the distance between the specified markers is from 9.7 to 10.3 cm. Adjust the preamplifier sensitivity controls to maintain a display 2 to 3 cm high, and the Test Instrument positioning, DELAYING SWEEP TRIGGERING LEVEL, and STABILITY OR EXT. SWEEP ATTEN. controls as necessary to maintain stable, properly positioned displays.

(NOTE follows)

NOTE

At slower sweep speeds, it may be desirable to increase the vertical sensitivity and intensity, and position the bottom of the timing comb down so that only the tops of the markers are visible.

Test Instrument TIME/CM or DELAY TIME Switch	Time-Mark Generator		Specified Markers
	Markers	Triggers	
10 mSEC[1]	10 Millisecond	100~/10 ms	1st and 11th
" "	" "	"	Verify correct linearity[2]
5 "	5 "	"	1st and 11th
2 "	" "	"	1st and 5th
1 "	1 "	1 kc/1 ms	1st and 11th
500 μSEC[3]	500 Microsecond	"	" "
200 "	" "	"	1st and 5th
100 "	100 "	10 kc/100 μs	1st and 11th
" "	" "	"	Verify correct linearity[2]
50 "	50 "	"	1st and 11th
20 "	" "	"	1st and 5th
10 "	10 "	100 kc/10 μs	1st and 11th
5 "	5 "	"	" "
2 "	1 "	"	1st and 21st

[1] Or MILLISEC
[2] Satisfactory linearity is indicated by equal spacing of the markers
[3] Or MICROSEC

4.10.2 Delay Time Multiplier Test

4.10.2.1 Obtain 500-microsecond markers and a 1 kc/1 ms trigger signal from the time-mark generator.

4.10.2.2 Set the Test Instrument controls as follows:

MAIN SWEEP:
TIME/CM switch to — 10 μSEC (or 10 MICROSEC)

MULTIPLIER switch to — 2
STABILITY control — fully cw

DELAYING SWEEP:
TIME/CM OR DELAY TIME switch to — 500 μSEC (or 500 MICROSEC)

LENGTH Control — fully cw
DELAY-TIME MULTIPLIER control to — 1.00

4.10.2.3 Adjust the Test Instrument INTENSITY, DELAYING SWEEP STABILITY and TRIGGERING LEVEL, HORIZONTAL POSITION, and the preamplifier sensitivity and positioning controls for a stable, centered display.

4.10.2.4 Reduce the intensity so that only the intensified 0.4 cm portion of the display is visible.

4.10.2.5 Adjust the Test Instrument DELAY-TIME MULTIPLIER control until the brightened portion starts at the second marker (1 cm from the start of the trace).

4.10.2.6 Set the Test Instrument HORIZONTAL DISPLAY switch to MAIN SWEEP DELAYED, and slightly adjust the DELAY-TIME MULTIPLIER control until the leading edge of the second marker occurs at the very start of the trace.

4.10.2.7 The Test Instrument DELAY-TIME MULTIPLIER control must indicate from 0.98 to 1.02.

4.10.2.8 Adjust the Test Instrument DELAY TIME MULTIPLIER control near each setting listed below, until the leading edge of the corresponding marker occurs at the start of the sweep, and verify that the control indication is within the listed tolerance.

DELAY-TIME MULTIPLIER Control	Marker	Tolerance (DELAY-TIME MULTIPLIER Indication)	
		Tektronix 535, 545, RM-35 and RM-45	Tektronix 945 and AN/USM-120
2.00	3rd	1.98 to 2.02	1.99 to 2.01
3.00	4th	2.98 to 3.02	2.99 to 3.01
4.00	5th	3.98 to 4.02	3.99 to 4.01
5.00	6th	4.98 to 5.02	4.99 to 5.01
6.00	7th	5.98 to 6.02	5.99 to 6.01
7.00	8th	6.98 to 7.02	6.99 to 7.01
8.00	9th	7.98 to 8.02	7.99 to 8.01
9.00	10th	8.98 to 9.02	8.99 to 9.01

4.10.2.9 Disconnect the time-mark generator from the Test Instrument.

4.11 VERTICAL RISE TIME AND DELAY LINE TESTS

NOTE

This section is written for the use of a Hewlett-Packard 213B pulse generator. It is recognized that other fast rise-time pulse or square-wave generators will give equally satisfactory results. The exact wave shape and rise time of any pulse generator should be known. This can be accomplished by connecting the pulse directly to the vertical deflection plates of a good CRT and observing the wave shape. Some pulse generators have overshoot on the leading edge of the output pulse. Unless the wave shape is known, the TI could be misadjusted. Low level signals can be observed on a CRT by magnifying the image with a telescope or a magnifying glass.

4.11.1 Delay Line Tests

4.11.1.1 Turn the Test Instrument POWER switch off.

4.11.1.2 Remove the Test Instrument from its case.

4.11.1.3 Remove the plug-in preamplifier, reinstall the plug-in preamplifier using the rise time adapter (item 2.10), turn the POWER switch to ON, and allow 5 minutes for warm up.

4.11.1.4 Set the TI controls as follows:

HORIZONTAL DISPLAY switch to	MAIN SWEEP NORMAL
TRIGGERING MODE switch to	AC LF REJECT (or AC FAST)
TRIGGER SLOPE switch to	+INT
TRIGGERING LEVEL control to	0
STABILITY control to	PRESET
A TIME/CM switch to	0.1 μSEC (or MICROSEC)
A TIME/CM VARIABLE control to	CALIBRATED
5X MAGNIFIER switch to	OFF

4.11.1.5 Connect the pulse generator to the rise time adapter input.

4.11.1.6 Set the pulse generator output switch for a negative pulse.

NOTE

The negative pulse will be displayed on the TI as a positive pulse.

4.11.1.7 Adjust the pulse generator sensitivity control, and the TI TRIGGERING LEVEL and POSITIONING controls to display the pulse.

4.11.1.8 Adjust the TI for a dim, sharply focused presentation, and adjust the pulse generator sensitivity control to the point where the pulse just comes on or the display is stable.

4.11.1.9 Observe the pulse presentation. It should have a square corner with less than 5% overshoot at the leading edge, the amplitude should remain level for 0.4 microseconds (4 cm), and the waveform should be free from major wrinkles. The peak-to-peak value of any wrinkles should not exceed 1 mm (0.1 cm).

NOTE

The Hewlett-Packard 213B specifications state less than 2% droop for the first 100 nsec (0.1 μsec). Most units will stay flat for 500 nsec. If an appreciable droop is noticed, it should be verified whether this is a TI or pulse generator shortcoming. This can be done by using a Tektronix type P or 1M1 plug-in unit, or a Hewlett-Packard 212A, or E-H Laboratories 132A pulse generator in place of the Hewlett-Packard 213B. If this is done, ignore the first 20 nsec of the presentation, and observe the overall amplitude for 400 nsec.

4.11.2 Rise Time Test

4.11.2.1 Vertically position the display with the bottom on the CRT bottom graticule line, and note the amplitude of the pulse disregarding any overshoot or rounding at the leading corner.

4.11.2.2 Set the TI 5X MAGNIFIER switch on, and adjust the Positioning controls to position the presentation to measure the rise time.

4.11.2.3 Measure the rise time between the 10% and 90% amplitude points. Establish the 10% and 90% points from the total amplitude noted in step 4.7.2.1.

4.11.2.4 The rise time must be 32 nsec or less for a 535 or RM-35, and 10 nsec or less for a 945, AN/USM-120, 545, or RM-45. If not, take corrective action.

4.11.2.5 Adjust the TI INTENSITY control fully ccw.

4.11.2.6 Unless other measurements are to be performed, turn all power switches off and disconnect the TI.

4.11.2.7 Replace the TI bottom cover.

TEST INST (S): TEA 545 or RM-45 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
3.7	Power ind. & fan	--	ck( )			
4.1.2.1	Scale illum.	--	ck( )			
4.1.3.1	Focus	--	ck( )			
4.1.4.1	Intensity	--	ck( )			
4.1.5.1	Vertical positioning	--	ck( )			
4.1.6.1	CRT alignment	--	ck( )			
4.1.7.1	Horiz. positioning	--	ck( )			
4.1.7.2	Horiz. positioning	--	ck( )			
4.2	Line Regulation					
4.2.7	Height (105v)	4.0 cm				3.9 to 4.1 cm(3.75 to 4.1cm)[a]
"	Width (")	"				"
4.2.9	Height (125v)	"				" (3.75 to 4.1cm)[a]
"	Width (")	"				"
4.3.1.5	Sawtooth output	150v				120 to 180v
4.3.2.3	+Gate output	--				15v min.
4.4	Calibrator Test					
4.4.2.2	Waveform	--	ck( )			
4.4.3.5	Calibrator at 100v	.7072				.6860 to .7284
4.4.3.7	" " " 20v	.1415				.1373 to .1457
"	" " " 5v	.1768				.1715 to .1821
"	" " " 1v	.3536				.3430 to .3642
"	" " " .2v	.0707				.0686 to .0728
4.5.9	Vert. gain adjust	4.0 cm				Adj. to 4.0 cm
4.6	Triggering Tests					
4.6.1	Internal Triggering Tests					
4.6.1.5	Sensitivity	--	ck( )			2 mm max.
4.6.1.6	Slope +INT & -INT	--	ck( )			display inverts
"	Triggering level	--	ck( )			at or near 0
4.6.1.7	AC LF REJECT	--	ck( )			
"	AC	--	ck( )			

[a] "If the instrument fails the first listed tolerance, but meets the second listed tolerance, it is acceptable. However, a limited use label must be affixed stating: 'This instrument will measure voltages to an accuracy of ±3% only when the line voltage is 115v or more.'"

TEST INST (S): TEA 545 or RM-45 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.6.1.9	DC	--	ck( )			
4.6.1.12	Slope + LINE & -LINE	--	ck( )			
4.6.2	External Triggering	Tests				
4.6.2.5	Sensitivity	--	ck( )			0.2 volt p-p min.
4.6.2.6	Slope + EXT & - EXT					display inverts
4.7.1.4	Horiz. balance	--	ck( )			
4.7.2.3	Horiz. gain X1	--				5.0 cm min.
4.7.2.5	" " X10	--				approx. 1 cm
4.7.3.6	" B.W. X1	--	ck( )			4.2 cm max.
"	" " "	--	ck( )			240 kHz min.
4.7.3.8	" " X10	--	ck( )			4.2 cm max.
"	" " "	--				240 kHz min.
4.8.5	Geometry test	--	ck( )			
4.9.1.2	Sweep length	--	ck( )			approx. 10.5 cm
4.9.2.3	Mag. registration	--	ck( )			1 mm max. shift
4.9.3.5	Mag. gain test	10 cm				9.7 to 10.3 cm
4.9.4	Sweep Time Tests					
4.9.4.3	5 sec	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MILLISEC	"				"
"	" "	--	ck( )			linearity
"	200 "	10 cm				9.7 to 10.3 cm
"	100 "	"				"
"	50 "	"				"
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
"	1 "	"				"
"	" "	--	ck( )			linearity
"	500 MICROSEC	10 cm				9.7 to 10.3 cm
"	200 "	"				"
"	100 "	"				"
"	50 "	"				"
"	20 "	"				"

TEST INST (S): TEA 545 or RM-45 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.9.4.3	10 MICROSEC	10 cm				9.7 to 10.3 cm
"	5 "	"				"
"	" "	--	ck ( )			linearity
"	2 "	10 cm				9.7 to 10.3 cm
"	1 "	"				"
4.9.4.3	.5 MICROSEC	10 cm				9.7 to 10.3 cm
"	.2 "	"				"
"	.1 "	"				"
"	" "	--	ck ( )			linearity
4.9.4.6	5X MAG ON	10 cm				9.7 to 10.3 cm
4.9.4.11	Mult. to 2.5-1	--				25 msec min.
4.9.4.12	" " 5-2	--				60 " "
"	" " 12-5	--				120 " "
4.10	Delaying Sweep Tests					
4.10.1.3	10 MILLISEC	10 cm				9.7 to 10.3 cm
"	" "	--	ck ( )			linearity
"	5 "	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MICROSEC	"				"
"	200 "	"				"
"	100 "	"				"
"	" "	--	ck ( )			linearity
"	50 "	"				9.7 to 10.3 cm
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
4.10.2.7	Delay multiplier	1.00				0.98 to 1.02
4.10.2.8	" "	2.00				1.98 to 2.02
"	" "	3.00				2.98 to 3.02
"	" "	4.00				3.98 to 4.02
"	" "	5.00				4.98 to 5.02
"	" "	6.00				5.98 to 6.02

NAVY CALIBRATION CHECKLIST-CONTINUATION

SECTION D

TEST INST (S): TEA 545 or RM-45 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.10.2.8	Delay Multiplier	7.00				6.98 to 7.02
"	" "	8.00				7.98 to 8.02
"	" "	9.00				8.98 to 9.02
4.11.1.9	Delay line test	--	ck ( )			No wrinkles >1 mm p-p
4.11.2.4	Rise time test	--	ck ( )			10 nsec max.

TEST INST (S): TEA 535 or RM-35 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
3.7	Power ind. & fan	--	ck( )			
4.1.2.1	Scale illum.	--	ck( )			
4.1.3.1	Focus	--	ck( )			
4.1.4.1	Intensity	--	ck( )			
4.1.5.1	Vertical positioning	--	ck( )			
4.1.6.1	CRT alignment	--	ck( )			
4.1.7.1	Horiz. positioning	--	ck( )			
4.1.7.2	Horiz. positioning	--	ck( )			
4.2	Line Regulation					
4.2.7	Height (105v)	4.0 cm				3.9 to 4.1cm(3.75 to 4.1cm)[a]
"	Width (")	"				"
4.2.9	Height (125v)	"				" (3.75 to 4.1cm)[a]
"	Width (")	"				"
4.3.1.5	Sawtooth output	150v				120 to 180v
4.3.2.3	+Gate output	--				15v min.
4.4	Calibrator Test					
4.4.2.2	Waveform	--	ck( )			
4.4.3.5	Calibrator at 100v	.7072				.6860 to .7284
4.4.3.7	" " 20v	.1415				.1373 to .1457
"	" " 5v	.1768				.1715 to .1821
"	" " 1v	.3536				.3430 to .3642
"	" " .2v	.0707				.0686 to .0728
4.5.9	Vert. gain adjust	4.0 cm				Adj. to 4.0 cm
4.6	Triggering Tests					
4.6.1	Internal Triggering	Tests				
4.6.1.5	Sensitivity	--	ck( )			2 mm max.
4.6.1.6	Slope +INT & -INT	--	ck( )			display inverts
"	Triggering level	--	ck( )			at or near 0
4.6.1.7	AC FAST	--	ck( )			
"	AC SLOW	--	ck( )			

[a] "If the instrument fails the first listed tolerance, but meets the second listed tolerance, it is acceptable. However, a limited use label must be affixed stating: 'This instrument will measure voltages to an accuracy of ±3% only when the line voltage is 115v or more.'"

TEST INST (S): TEA 535 or RM-35 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.6.1.9	DC	--				
4.6.1.12	Slope +LINE & -LINE	--	ck( )			
4.6.2	External Triggering	Tests				
4.6.2.5	Sensitivity	--	ck( )			0.2 volt p-p min.
4.6.2.6	Slope +EXT & -EXT					display inverts
4.7.1.4	Horiz. balance	--	ck( )			
4.7.2.3	Horiz. gain X1	--				5.0 cm min.
4.7.2.5	" " X10	--				approx. 1 cm
4.7.3.6	" B.W. X1	--	ck( )			4.2 cm max.
"	" " "	--				240 kHz min.
4.7.3.8	" " X10	--	ck( )			4.2 cm max.
"	" " "	--				240 kHz min.
4.8.5	Geometry test	--	ck( )			
4.9.1.2	Sweep length	--	ck( )			approx. 10.5 cm
4.9.2.3	Mag. registration	--	ck( )			1 mm max. shift
4.9.3.5	Mag. gain test	10 cm				9.7 to 10.3 cm
4.9.4	Sweep Time Tests					
4.9.4.3	5 sec	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MILLISEC	"				"
"	" "	--	ck( )			linearity
"	200 "	10 cm				9.7 to 10.3 cm
"	100 "	"				"
"	50 "	"				"
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
"	1 "	"				"
"	" "	--	ck( )			linearity
"	500 MICROSEC	10 cm				9.7 to 10.3 cm
"	200 "	"				"
"	100 "	"				"
"	50 "	"				"

NAVY CALIBRATION CHECKLIST-CONTINUATION

SECTION D

TEST INST (S): TEA 535 or RM-35 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.9.4.3	20 MICROSEC	10 cm				9.7 to 10.3 cm
"	10 "	"				"
"	5 "	"				"
"	" "	--	ck ( )			linearity
"	2 "	10 cm				9.7 to 10.3 cm
"	1 "	"				"
4.9.4.3	.5 MICROSEC	10 cm				9.7 to 10.3 cm
"	.2 "	"				"
"	.1 "	"				"
"	" "	--	ck ( )			linearity
4.9.4.6	5X MAG ON	10 cm				9.7 to 10.3 cm
4.9.4.11	Mult. to 2.5-1	--				25 msec min.
4.9.4.12	" " 5-2	--				60 " "
"	" " 12-5	--				120 " "
4.10	Delaying Sweep Tests					
4.10.1.3	10 MILLISEC	10 cm				9.7 to 10.3 cm
"	" "	--	ck ( )			linearity
"	5 "	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MICROSEC	"				"
"	200 "	"				"
"	100 "	"				"
"	" "	--	ck ( )			linearity
"	50 "	"				9.7 to 10.3 cm
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
4.10.2.7	Delay multiplier	1.00				0.98 to 1.02
4.10.2.8	" "	2.00				1.98 to 2.02
"	" "	3.00				2.98 to 3.02
"	" "	4.00				3.98 to 4.02
"	" "	5.00				4.98 to 5.02

TEST INST (S): TEA 535 or RM-35 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.10.2.8	Delay multiplier	6.00				5.98 to 6.02
"	" "	7.00				6.98 to 7.02
"	" "	8.00				7.98 to 8.02
"	" "	9.00				8.98 to 9.02
4.11.1.9	Delay line test	--	ck ( )			No wrinkles >1 mm p-p
4.11.2.4	Rise time test	--	ck ( )			32 nsec max.

TEST INST (S): TEA 945 or AN/USM-120 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
3.7	Power ind. & fan	--	ck( )			
4.1.2.1	Scale illum.	--	ck( )			
4.1.3.1	Focus	--	ck( )			
4.1.4.1	Intensity	--	ck( )			
4.1.5.1	Vertical positioning	--	ck( )			
4.1.6.1	CRT alignment	--	ck( )			
4.1.7.1	Horiz. positioning	--	ck( )			
4.1.7.2	Horiz. positioning	--	ck( )			
4.2	Line Regulation					
4.2.7	Height (105v)	4.0 cm				3.9 to 4.1 cm
"	Width (")	"				"
4.2.9	Height (125v)	"				
"	Width (")	"				"
4.3.1.5	Sawtooth output	165v				132 to 198v
4.3.2.3	+Gate output	--				12v min.
4.4	Calibrator Test					
4.4.2.2	Waveform	--	ck( )			
4.4.3.5	Calibrator at 100v	.7072				.6931 to .7213
4.4.3.7	" " " 20v	.1415				.1387 to .1443
"	" " " 5v	.1768				.1733 to .1803
"	" " " 1v	.3536				.3465 to .3607
"	" " " .2v	.0707				.0693 to .0721
4.5.9	Vert. gain adjust	4.0 cm				adj to 4.0 cm
4.6	Triggering Tests					
4.6.1	Internal Triggering	Tests				
4.6.1.5	Sensitivity	--	ck( )			2 mm max.
4.6.1.6	Slope +INT & -INT	--	ck( )			display inverts
"	Triggering level	--	ck( )			at or near 0
4.6.1.7	AC LF REJECT	--	ck( )			
"	AC	--	ck( )			
4.6.1.9	DC	--	ck( )			
4.6.1.12	Slope +LINE & -LINE	--	ck( )			
4.6.2	External Triggering	Tests				
4.6.2.5	Sensitivity	--	ck( )			0.2 volt p-p min.
4.6.2.6	Slope +EXT & -EXT					display inverts

TEST INST (S): TEA 945 or AN/USM-120 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
4.7.1.4	Horiz. Balance	--	ck( )			
4.7.2.3	Horiz. gain X1	--	ck( )			5.0 cm min.
4.7.2.5	" " X10	--				approx. 1 cm
4.7.3.6	" B.W. X1	--	ck( )			4.2 cm max.
"	" " "	--				1 MHz min.
4.7.3.8	" " X10	--	ck( )			4.2 cm max.
"	" " "	--				1 MHz min.
4.8.5	Geometry test	--	ck( )			
4.9.1.2	Sweep length	--	ck( )			approx. 10.5 cm.
4.9.2.3	Mag. registration	--	ck( )			1 mm max. shift
4.9.3.5	Mag. gain test	10 cm				9.7 to 10.3 cm
4.9.4	Sweep Time Tests					
4.9.4.3	5 sec	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MILLISEC	"				"
"	" "	--	ck( )			linearity
"	200 "	10 cm				9.7 to 10.3 cm
"	100 "	"				"
"	50 "	"				"
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
"	1 "	"				"
"	" "	--	ck( )			linearity
"	500 MICROSEC	10 cm				9.7 to 10.3 cm
"	200 "	"				"
"	100 "	"				"
"	50 "	"				"
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	" "	--	ck( )			linearity
"	2 "	10 cm				9.7 to 10.3 cm
"	1 "	"				"

TEST INST (S): TEA 945 or AN/USM-120 Oscilloscope

PROC NO. NW 17-20AW-08 MFR MODEL SER NO.

PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL ✓ (6)	CALIBRATION TOLERANCES (7)
	Sweep Time Test (Cont)					
4.9.4.3	.5 MICROSEC	10 cm				9.7 to 10.3 cm
"	.2 "	"				"
"	.1 "	"				"
"	" "	--	ck ( )			linearity
4.9.4.6	5X MAG ON	10 cm				9.7 to 10.3 cm
4.9.4.11	Mult. to 2.5-1	--				25 msec min.
4.9.4.12	" " 5-2	--				60 " "
"	" " 12-5	--				120 " "
4.10	Delaying Sweep Tests					
4.10.1.3	10 MILLISEC	10 cm				9.7 to 10.3 cm
"	" "	--	ck ( )			linearity
"	5 "	10 cm				9.7 to 10.3 cm
"	2 "	"				"
"	1 "	"				"
"	500 MICROSEC	"				"
"	200 "	"				"
"	100 "	"				"
"	" "	--	ck ( )			linearity
"	50 "	10 cm				9.7 to 10.3 cm
"	20 "	"				"
"	10 "	"				"
"	5 "	"				"
"	2 "	"				"
4.10.2.7	Delay multiplier	1.00				0.99 to 1.01
4.10.2.8	" "	2.00				1.99 to 2.01
"	" "	3.00				2.99 to 3.01
"	" "	4.00				3.99 to 4.01
"	" "	5.00				4.99 to 5.01
"	" "	6.00				5.99 to 6.01
"	" "	7.00				6.99 to 7.01
"	" "	8.00				7.99 to 8.01
"	" "	9.00				8.99 to 9.01
4.11.1.9	Delay line test	--	ck ( )			No wrinkles >1 mm p-p
4.11.2.4	Rise time test	--	ck ( )			10 nsec max.