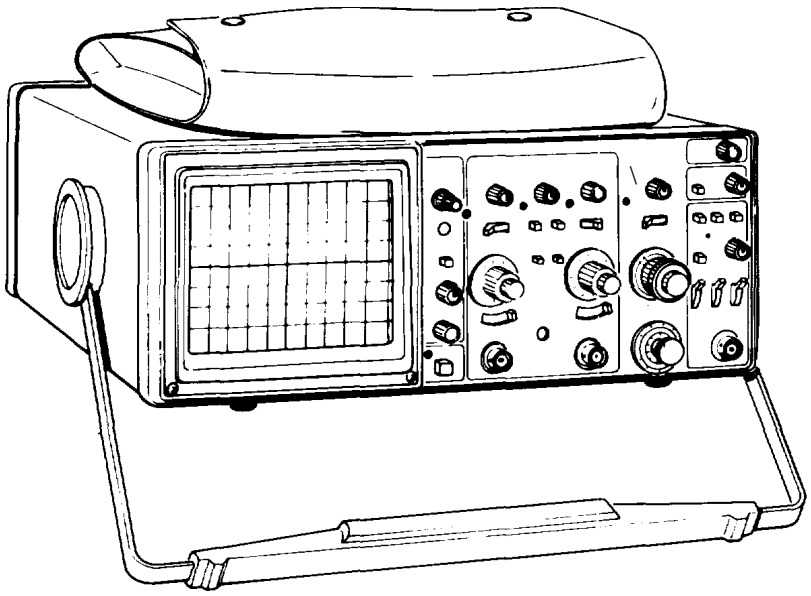
TECHNICAL MANUAL

GENERAL SUPPORT MAINTENANCE MANUAL



OSCILLOSCOPE
AN/USM-488
(NSN 6625-01-187-7847) (EIC: KNQ)

HEADQUARTERS, DEPARTMENT OF THE ARMY
15 OCTOBER 1986

5 **SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK:**

1 **DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL.**

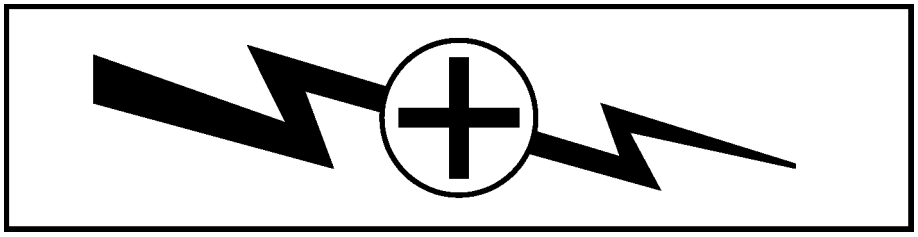
2 **IF POSSIBLE, TURN OFF THE ELECTRICAL POWER.**

3 **IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A DRY WOODEN POLE OR A DRY ROPE OR SOME OTHER INSULATING MATERIAL.**

4 **SEND FOR HELP AS SOON AS POSSIBLE.**

5 **AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION.**

WARNING



HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When technicians are aided by operators, they must warn them about dangerous areas.

A periodic review of safety precautions in TB 385-4, Safety Requirements for Maintenance of Electrical and Electronic Equipment, is recommended. When the equipment is operated with covers removed, DO NOT TOUCH exposed connections or components. MAKE CERTAIN you are not grounded when making connections or adjusting components inside the test instrument.

Be careful not to contact high-voltage connections of 115-Volt ac input when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through vital organs of the body.

WARNING

Do not be misled by the terms "LOW VOLTAGE." potentials as low as 50 volts can cause death under certain conditions.

For First Aid, refer to FM 4-25.11.

WARNING

Use care when handling a CRT. Breaking it may cause high-velocity scattering of glass fragments (implosion). Protective clothing and safety glasses should be worn. Avoid striking the CRT on any object which may cause it to crack or implode. When storing a CRT, either place it in a protective carton or set it face down on a smooth surface in a protected location with a soft mat under the face plate.

WARNING

The CRT anode lead and the high-voltage multiplier output leads retain a high-voltage charge after the oscilloscope is turned off. To avoid electric shock, disconnect the high-voltage multiplier lead from the CRT anode lead and ground both leads to the main chassis.

WARNING

With cover removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

WARNING

Use approved personal protective equipment (goggles/face shield) when using compressed air. Provide protection from flying particles. Do not direct airstream toward self or other personnel, as injury may result.

WARNING

Isopropyl alcohol is flammable and harmful to eyes, skin, and breathing passages. Provide adequate ventilation. Keep ignition sources away and wear protective clothing.

CAUTION

THIS EQUIPMENT CONTAINS PARTS
AND ASSEMBLIES SENSITIVE TO
DAMAGE BY ELECTROSTATIC DISCHARGE (ESD).
USE ESD PRECAUTIONARY PROCEDURES WHEN TOUCHING,
REMOVING OR INSERTING PRINTED CIRCUIT BOARDS.

ESD
CLASS 1

NOTE

The symbol for static sensitive devices in military inventory is as depicted in the caution block above.

GENERAL HANDLING PROCEDURES FOR ESD ITEMS

- USE WRIST GROUND STRAPS OR MANUAL GROUNDING PROCEDURES.
- KEEP ESD ITEMS IN PROTECTIVE COVERING WHEN NOT IN USE.
- GROUND ALL ELECTRICAL TOOLS AND TEST EQUIPMENT.
- PERIODICALLY CHECK CONTINUITY AND RESISTANCE OF GROUNDING SYSTEM.
- USE ONLY METALIZED SOLDER SUCKERS.
- HANDLE ESD ITEMS ONLY IN PROTECTED AREAS.

MANUAL GROUNDING PROCEDURE

- MAKE CERTAIN EQUIPMENT IS POWERED DOWN.
- TOUCH GROUND PRIOR TO REMOVING ESD ITEMS.
- TOUCH PACKAGE OF REPLACEMENT ESD ITEM TO GROUND BEFORE OPENING.
- TOUCH GROUND PRIOR TO INSERTING REPLACEMENT ESD ITEMS.

ESD PROTECTIVE PACKAGING AND LABELING

- INNER COVERING OF ANTI-STATIC MATERIAL WITH AN OUTER WRAP OF EITHER TYPE 1 ALUMINIZED MATERIAL OR CONDUCTIVE PLASTIC FILM OR HYBRID LAMINATED BAGS HAVING AN INTERIOR OF ANTISTATIC MATERIAL WITH AN OUTER METALIZED LAYER.
- LABEL WITH SENSITIVE ELECTRONIC SYMBOL AND CAUTION NOTE.

CAUTION

Devices such as CMOS, NMOS, VMOS, HMOS, thin-film resistors PMOS, and MOSFET used in many equipments can be damaged by static voltages present in most repair facilities. Most of the components contain internal gate protection circuits that are partially effective, but sound maintenance practice and the cost of equipment failure in time and money dictate careful handling of all electrostatic sensitive components.

The following precautions should be observed when handling all electrostatic sensitive components and units containing such components.

CAUTION

Failure to observe all of these precautions can cause permanent damage to the electrostatic sensitive device. This damage can cause the device to fail immediately or at a later date when exposed to an adverse environment.

STEP 1. Turn off and/or disconnect all power and signal sources and loads used with the unit.

STEP 2. Place the unit on grounded conductive work surfaces.

STEP 3. Ground the repair operator using a conductive wrist strap or other device using a 1 M series resistor to protect the operator.

STEP 4. Ground any tools (including soldering equipment) that will contact the unit. Contact with the operator's hand provides a sufficient ground for tools that are otherwise electrically isolated.

STEP 5. All electrostatic sensitive replacement components are shipped in conductive foam or tubes and must be stored in the original shipping container until installed.

STEP 6. When these devices and assemblies are removed from the unit, they should be placed on the conductive work surface or in conductive containers.

STEP 7. When not being worked on, wrap disconnected circuit boards in aluminum foil or in plastic bags that have been coated or impregnated with a conductive material.

STEP 8. Do not handle these devices unnecessarily or remove them from their packages until actually used or tested.

CHANGE
No. 2

Headquarters
Department of the Army
Washington, D.C., 18 June 2008

GENERAL SUPPORT MAINTENANCE MANUAL FOR OSCILLOSCOPE AN/USM-488 (NSN 6625-01-187-7847) (EIC: KNQ)

HAZARDOUS MATERIAL INFORMATION – This document has been reviewed for the presence of solvents containing hazardous materials as defined by the EPCRA 302 and 313 lists by the Engineering, Environment, and Logistics Oversight Office. As of the base document through Change 1, dated 5 January 1992, all references to solvents containing hazardous materials have been removed from this document by substitution with non-hazardous or less-hazardous materials where possible.

OZONE DEPLETING CHEMICAL INFORMATION – This document has been reviewed for the presence of Class I ozone depleting chemicals by the Engineering, Environment, and Logistics Oversight Office. As of the base document through Change 1, dated 15 January 1992, all references to Class I ozone depleting chemicals have been removed from this document by substitution with chemicals that do not cause atmospheric ozone depletion.

DISTRIBUTION STATEMENT A – Approved for public release; distribution is unlimited.

TM 11-6625-3135-40, dated 15 October 1986, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the outer margin of the page.

Remove Pages	Insert Pages
A through E/(F Blank)	a through e/(f Blank)
None	A/(B Blank)
i and 1-0	i and ii
None	iii and iv
1-1 and 1-2	1-1 and 1-2
2-1 and 2-2	2-1 and 2-2
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Remove Pages	**Insert Pages**
B-1 and B-2	B-1 and B-2
DA-Form 2028-2	DA Form 2028
Cover	Cover

2. File this change sheet in front of the publication for reference purposes.

By Order of the Secretary of the Army

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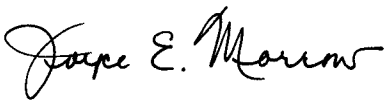
General, United States Army
Chief of Staff

Official:



JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army
0811916

DISTRIBUTION:

To be distributed in accordance with the initial distribution number (IDN) 511715, requirements for TM 11-6625-3135-40.

Change
No. 1

HEADQUARTERS,
DEPARTMENT OF THE ARMY
Washington, DC, 15 January 1992

General Support Maintenance Manual
OSCILLOSCOPE AN/USM-488
(NSN 6625-01-187-7847) (EIC: KNQ)

TM 11–6625-31 35-40, 15 October 1986, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page. Added or revised illustrations are indicated by a vertical bar adjacent to the illustration identification number or by a miniature pointing hand on the illustration page.

Remove pages	*Insert pages*
2–11 and 2–12	2–11 and 2–12
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By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, *United* States *Army*
Chief of Staff

Official:

MILTON H. HAMILTON
Administrative Assistant to *the*
Secretary of the Army
00271

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LIST OF EFFECTIVE PAGES

NOTE

ON CHANGED PAGES, THE PORTION OF THE TEXT AFFECTED BY THE LATEST CHANGE IS INDICATED BY A VERTICAL LINE OR OTHER CHANGE SYMBOL IN THE OUTER MARGIN OF THE PAGE.

Date of issue for original and changed pages are:

Original	0	15 October 1986
Change	1	15 January 1992
Change	2	18 June 2008

Total number of pages in this publication is 179 consisting of the following:

Page No.	* Change No.	Page No.	*Change No.
Cover	2	A-2 Blank	2
a through e	2	B-1 and B-2	2
f Blank	0	Index-1 through Index-4	0
A	2	Figure FO-1	0
B Blank	2	Figure FO-2	0
i and ii	2	Figure FO-3 (Sheet 1 through 3)	0
iii	2	Figure FO-4 (Sheet 1 through 2)	0
iv	2	Figure FO-5	0
1-1 and 1-2	2	Figure FO-6	0
1-3 through 1-9	0	Figure FO-7	0
1-10 Blank	0	Figure FO-8	0
2-1	0	Figure FO-9	0
2-2	2	Figure FO-10	0
2-3 through 2-10	0	Figure FO-11 (Sheet 1 through 2)	1
2-11	1	Figure FO-12	1
2-12 through 2-112	0	Figure FO-13 (Sheet 1 of 2)	0
A-1	2	Figure FO-13 (Sheet 2 of 2)	0

*Zero in this column indicates an original page.

TECHNICAL MANUAL
NO. 11-6625-3135-40

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 15 October 1986

GENERAL SUPPORT MAINTENANCE MANUAL FOR OSCILLOSCOPE, AN/USM-488 (NSN 6625-01-187-7847) (EIC: KNQ)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), located in the back of this manual directly to: Commander, U.S. Army Aviation and Missile Command, AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: https://amcom2028.redstone.army.mil. Instructions for sending an electronic 2028 may be found in the back of this manual immediately preceding the hard copy 2028.

HAZARDOUS MATERIAL INFORMATION

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TABLE OF CONTENTS

TABLE OF CONTENTS – CONTINUED

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HOW TO USE THIS MANUAL

This manual tells you about your Oscilloscope, AN-USM-488, and provides instructions for general support maintenance personnel. This manual also includes instructions on how to troubleshoot problems you may encounter during operation.

When you first receive the oscilloscope, start at the front of the manual and go all the way through to the back. Become familiar with every part of the manual and the Oscilloscope, AN-USM-488.

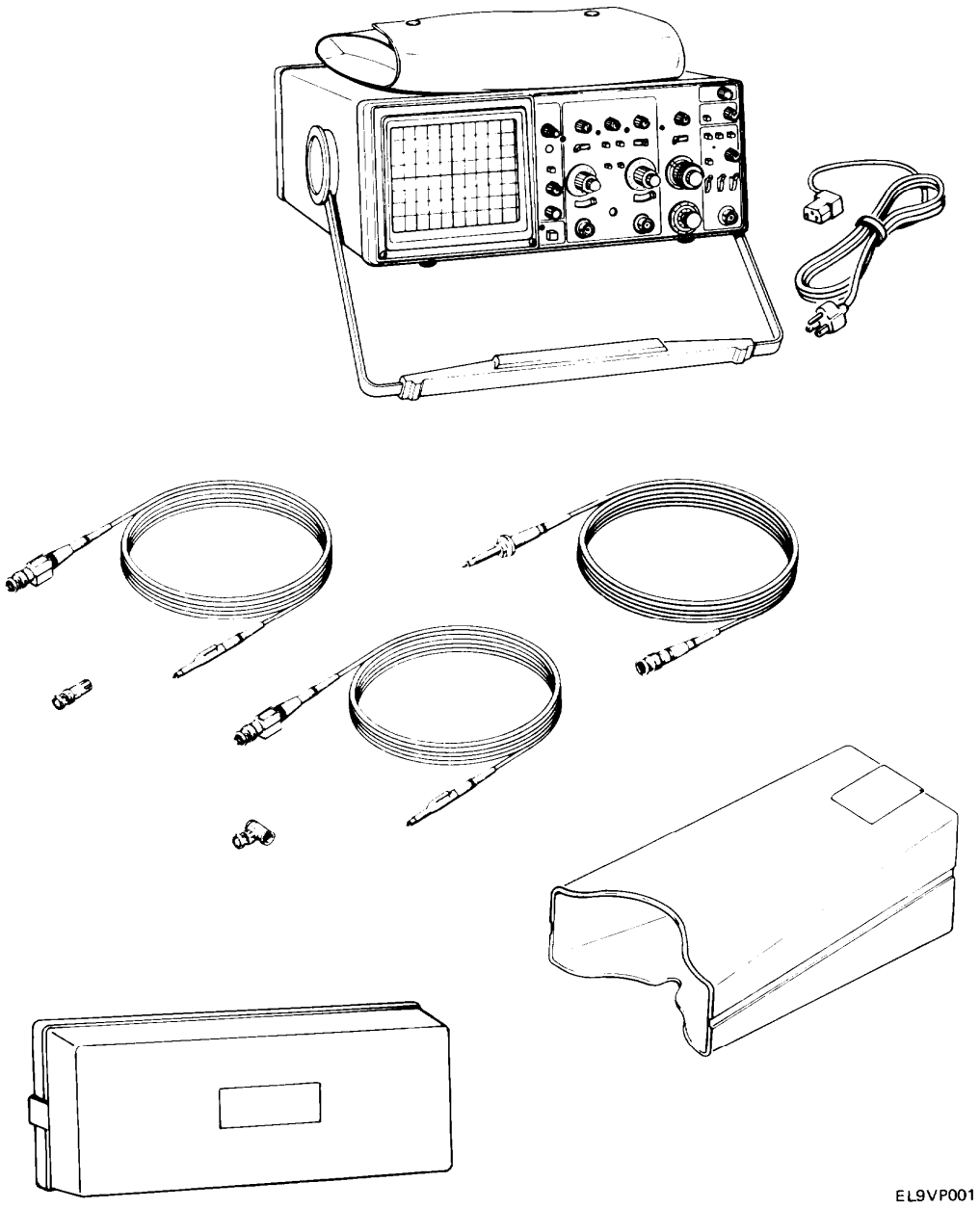


Figure 1-1. Oscilloscope AN/USM-488

CHAPTER 1
INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

This manual describes the Oscilloscope, AN/USM-488, and provides instructions for general support maintenance personnel. The oscilloscope (fig. 1-1) is used to visually evaluate electronic circuitry.

1-2. CONSOLIDATED ARMY PUBLICATIONS AND FORMS INDEX

Refer to the latest issue of DA Pam 25-30 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

1-3. MAINTENANCE FORMS, RECORDS, AND REPORTS

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 750-8, as contained in The Army Maintenance Management System (TAMMS) Users Manual.

b. Report of Packaging and Handling Discrepancies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAI 4140.55/SECNAVINST 4355.18A/AFJMAN 23-215.

c. Transportation Discrepancy Report (TDR) (DD Form 361). Fill out and forward Transportation Discrepancy Report (TDR) (DD Form 361) as prescribed in DA Pam 25-30.

1-4. CALIBRATION

Procedures for calibrating Oscilloscope, AN/USM-488, are found in TB 43-180.

1-5. DESTRUCTION OF ARMY ELECTRONICS MATERIEL TO PREVENT ENEMY USE

Demolition and destruction of electronic equipment will be under the direction of the Commander and in accordance with TM 750-244-2.

1-6. PREPARATION FOR STORAGE OR SHIPMENT

Storage and shipment procedures are in Chapter 2, Section V.

1-7. SAFETY, CARE, AND HANDLING

Observe all WARNINGS, CAUTIONS, AND NOTES in this manual. This equipment can be extremely dangerous if these instructions are not followed.

1-8 NOMENCLATURE CROSS-REFERENCE LIST

This listing identifies approved nomenclature usage that is different from the official nomenclature:

Common Name	Official Nomenclature
Oscilloscope	Oscilloscope, AN/USM-488

1-9. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your oscilloscope needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: Commander, US Army Aviation and Missile Command, AMSAM-MMC-MA-NM, Redstone Arsenal, AL 35898-5000. We'll send you a reply.

1-10. WARRANTY INFORMATION

Oscilloscope, AN/USM-488, is warranted by Tektronix Inc. for 1 year. The warranty starts on the date of purchase by the original owner. Report all defects in material or workmanship to your supervisor who will take appropriate action through your organizational maintenance shop.

1-11. LIST OF ABBREVIATIONS

This list identifies abbreviations, and descriptions that are used in this manual.

Abbreviation	Term
AN/ US M	Army-Navy/ General utility-special-maintenance
AR	Army Regulation
cm	Centimeter
CMOS	Complementary metal-oxide-semiconductor
DA	Department of the Army
DISREP	Discrepancy in shipment report
DOD	Department of Defense
ECL	Emitter-coupled level
EIR	Equipment improvement recommendation
EMI	Electromagnetic interference
FET	Field effect transistor
H	General support maintenance
Hz	Hertz (formerly cps)
lc	Integrated circuit
kg	Kilogram
kHz	Kilohertz
mA	Milliampere
MAC	Maintenance allocation chart
MHz	Megahertz
mm	Millimeter
mV	Millivolt
mW	Milliwatt
NSN	National/ NATO stock number
P-P	Peak-to-peak
pF	Picofarad
S.S	Static sensitive
TTL	Transistor-transistor logic
U/ M	Unit of measure

Section II. EQUIPMENT DESCRIPTION

1-12. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

Equipment characteristics, capabilities, and features are described in TM-11-6625-3135-12.

1-13. LOCATION AND DESCRIPTION OF MAJOR INTERNAL COMPONENTS

A2 ATTENUATOR CIRCUIT BOARD ASSEMBLY (A) — Attenuates vertical channel input signals.

CRT (CATHODE-RAY TUBE) (B) — Provides visual presentation of input signals.

Al MAIN CIRCUIT BOARD ASSEMBLY (C) — Provides instrument working voltages and processes vertical and horizontal signals.

A5 ALTERNATE SWEEP CIRCUIT BOARD ASSEMBLY (D) — Processes Alternate B Sweep horizontal signals.

A6 EM I FILTER CIRCUIT BOARD ASSEMBLY (E) — Provides electromagnetic interference filtering of input ac line power.

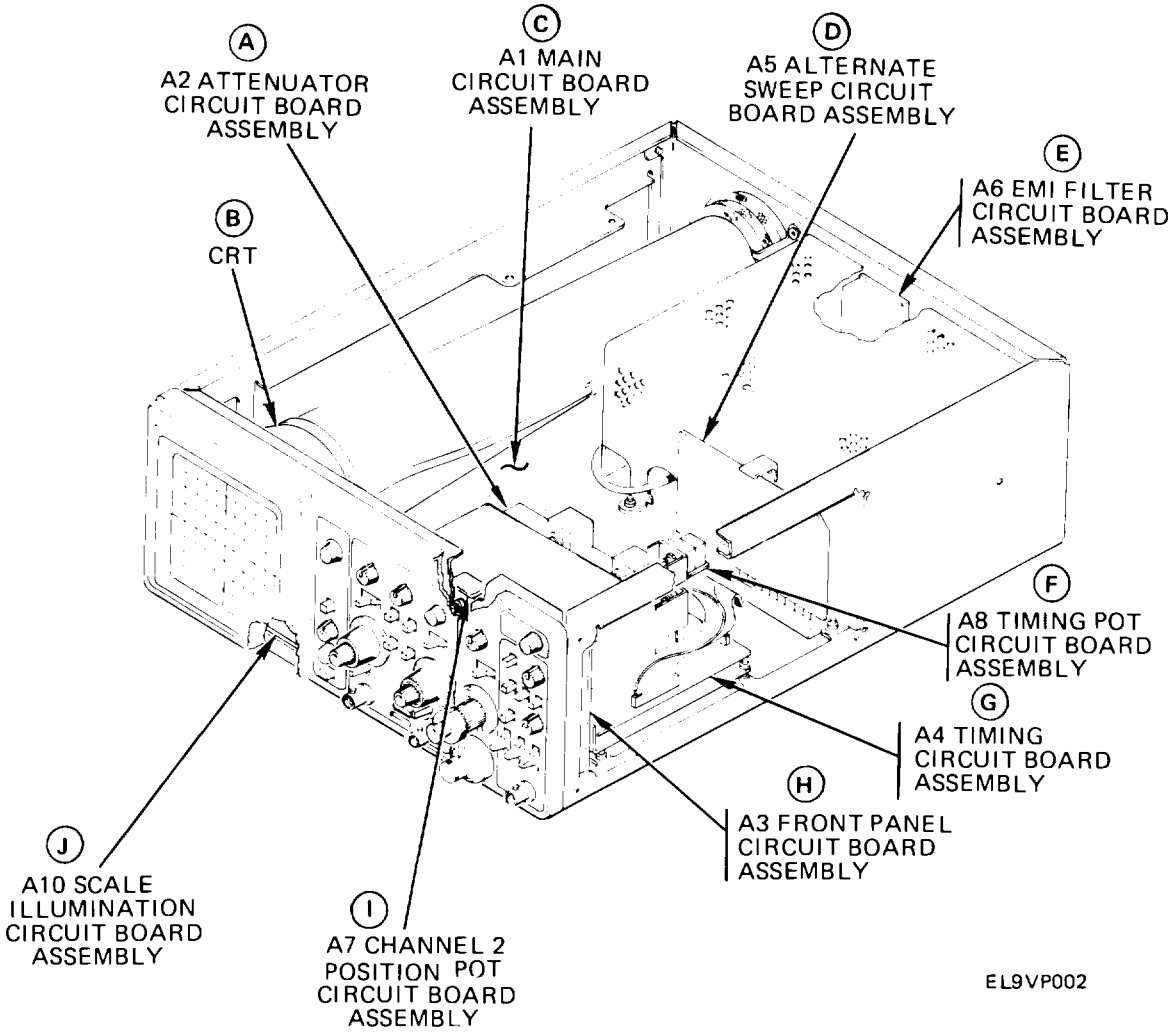
A8 TIMING POT CIRCUIT BOARD ASSEMBLY (F) — Provides sweep timing adjustment.

A4 TIMING CIRCUIT BOARD ASSEMBLY (G) — Generates horizontal timing signals.

A3 FRONT PANEL CIRCUIT BOARD ASSEMBLY (H) — Provides mounting for front panel controls.

A7 CHANNEL 2 POSITION POT CIRCUIT BOARD ASSEMBLY (I) — Provides Channel 2 vertical position adjustment.

A10 SCALE ILLUMINATION CIRCUIT BOARD ASSEMBLY(J) — Provides crt graticule scale lighting.



1-14. EQUIPMENT DATA

Refer to TM 11-6625-3135-12 for oscilloscope equipment data.

Section III. PRINCIPLES OF OPERATION

1-15. GENERAL FUNCTIONAL DESCRIPTION

Oscilloscope AN/ USM-488 is a self-contained multi-range measuring instrument that allows visual evaluation of electrical circuits. Figure 1-2 shows the major operating sections of the oscilloscope.

(1) The front panel contains all controls for selecting the desired crt display. It also contains five indicators to show power on, uncalibrated, and triggered ready conditions. Three input connectors are provided; channel 1 or X input signal, channel 2 or Y input signal, and external trigger input. An output connector provides the amplitude calibrate signal.

(2) The internal circuitry amplifies the input signals, generates an internal sync signal, and processes input signals for display on the crt. Setting the front panel controls establishes the amplitude, polarity, and type of display. An internal power supply provides all voltages needed by the other internal circuits and the crt.

(3) The rear panel contains the input connector for input power, a fuse, and an input connector for the external Z-axis input.

(4) The crt provides a visual display of the signal being examined.

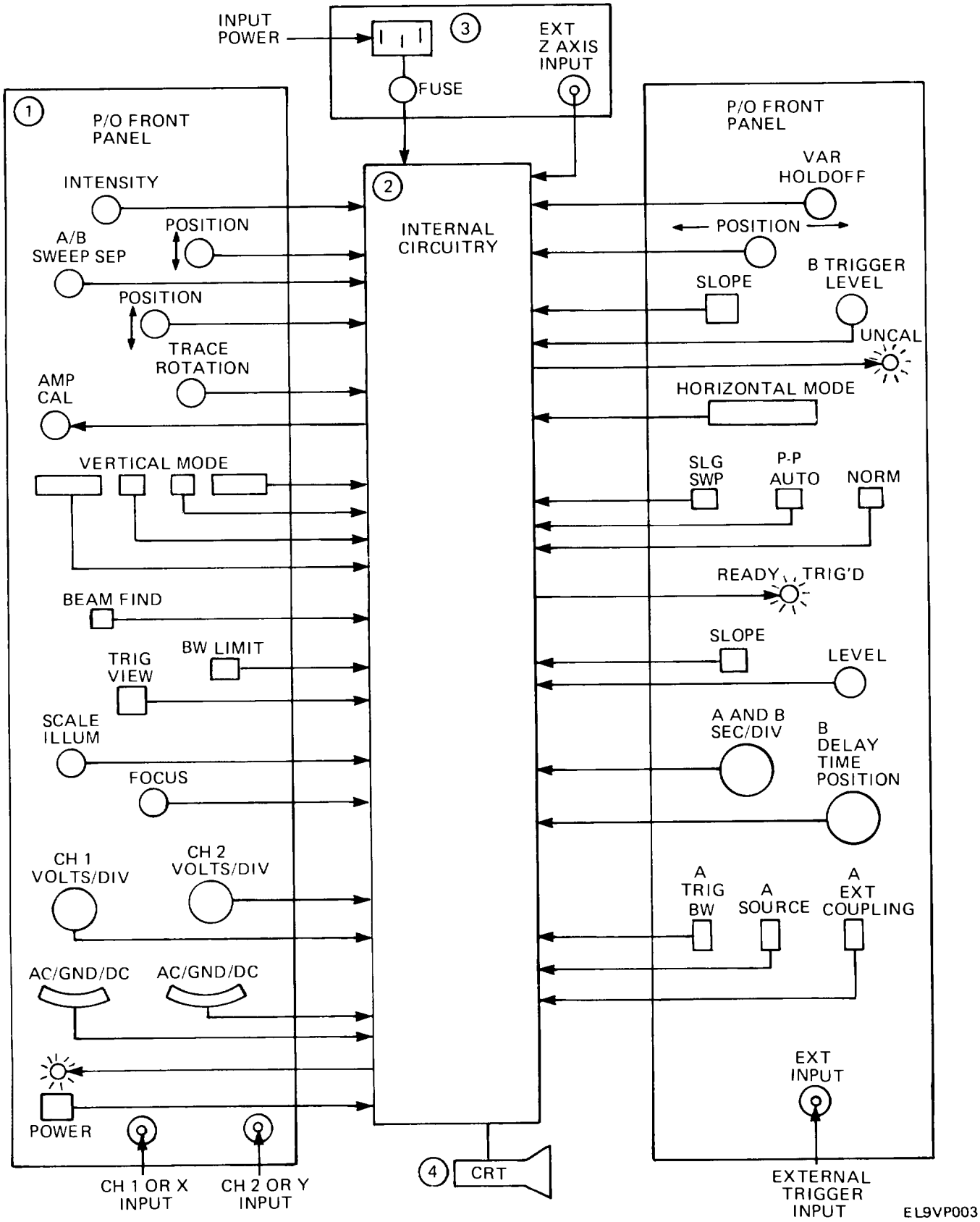


FIGURE 1-2. OSCILLOSCOPE GENERAL BLOCK DIAGRAM

1-16. DETAILED FUNCTIONAL DESCRIPTION

This functional description covers the major circuits of the oscilloscope, and is keyed to the block diagram (fig. FO-1) and the functional blocks of A1 (fig. FO-2). These circuits are also shown in detail on the schematic diagrams (figs. FO-5 through FO-11). The following circuits are covered in this functional description:

1. Vertical Attenuator Circuit (fig. FO-5).
2. Vertical Preamplifier and Output Amplifier Circuit (fig. FO-6).
3. Triggering-Circuit (fig. FO-7).
4. A Sweep Generator and Logic Circuit (fig. FO-8).
5. Alternate Sweep Logic Circuit (fig. FO-9).
6. Amplitude Calibrator and Horizontal Output Amplifier Circuits (fig. FO-10).
7. Power Supply, Z-Axis and CRT Circuits (fig. FO-I1).

(1) VERTICAL ATTENUATOR CIRCUIT. Input signals are applied to either CH 1 OR X or CH 2 OR Y input connectors. They may be directly (DC) coupled to the attenuator circuit, (AC) coupled through an input-coupling capacitor, or electrically disconnected (GND). The channel 2 attenuator can invert the channel 2 crt display. The output signal is applied to the vertical preamplifier for amplification.

(2) VERTICAL PREAMPLIFIER AND OUTPUT AMPLIFIER CIRCUIT. Each channel can supply an internal trigger signal to the internal trigger amplifier. Front panel VERTICAL MODE switches and the channel switching circuit select input signals for display. The delay line produces approximately 90 ns of delay in the vertical signal. This gives the horizontal circuitry time to start the sweep so that the operator can see the signal that triggered the sweep. It also provides the vertical position control of crt display. The vertical output amplifier provides final amplification of vertical signals. Bandwidth limit (BW) circuitry reduces amplifier upper frequency response. To help locate the position of off-screen displays, amplifier dynamic range can be limited with the beam find circuitry. This circuitry also brightens the trace and limits horizontal deflection. The A/B sweep separation circuit vertically positions the B trace with respect to the A trace when ALT horizontal mode is selected.

(3) TRIGGERING CIRCUIT. The triggering circuit uses either an internal, external, or line trigger signal to develop the input for the A sweep generator. The B trigger circuitry uses only an internal trigger. A P-P auto trigger circuit allows triggering on most signals without A TRIGGER LEVEL adjustment. In NORM mode, A TRIGGER LEVEL control is adjusted for correct trigger signal level before a sweep can be generated. When the TRIG VIEW switch is pressed, the A trigger circuit input signal is displayed.

(4) A SWEEP GENERATOR AND LOGIC CIRCUIT. The A sweep generator logic circuit controls A Sweep generation and Z-Axis unblinking. When the A TRIGGER mode switches are set to either P-P AUTO or TV FIELD (with no trigger signal present), a reference sweep is produced. In the NORM setting, sweeps are inhibited until a trigger input is present. This is useful for low-repetition-rate triggering. The SGL SWP setting allows only one sweep at a time to be generated. The sweep signal is applied to the horizontal amplifier.

5 ALTERNATE SWEEP LOGIC CIRCUIT. The alternate sweep logic circuit controls the alternate and B horizontal mode displays, intensity, Z-Axis amplifier drive level, and includes the B Miller sweep generator and B sweep logic circuitry. It also provides the B sweep sawtooth waveform and generates signals to control switching between the A and B displays.

6 AMPLITUDE CALIBRATOR AND HORIZONTAL OUTPUT AMPLIFIER C1RCU1TS. The X 10 magnifier can increase horizontal preamplifier gain by a factor of 10. The preamplifier also controls horizontal positioning of the display. In the X-Y mode (A AND B SEC/DIV switch), the channel 1 internal trigger signal passes to the horizontal preamplifier to supply the horizontal deflection to the crt. A front-panel AMP CAL output provides probe compensation adjustment. Voltage at the AMP CAL connector is a negative-going square wave about 0.5 V peak-to-peak in amplitude and a I kHz repetition rate.

7 POWER SUPPLY, Z-AXIS AND CRT CIRCUITS. The A sweep logic and alternate B sweep circuits and chop oscillator drive the Z-Axis amplifier. The chop oscillator provides a crt display blanking signal while switching between the vertical channels. The Z-Axis amplifier circuit output signal sets the crt intensity. The power supply provides necessary operating voltages. The power supply consists of a preregulator, inverter and transformer, and rectifiers and filters. The preregulator produces approximately 43 vdc from the ac power line to drive the 20 kHz inverter stage. The transformer secondary windings provide various ac levels that are rectified and filtered to produce the operating voltages. A high-voltage multiplier circuit supplies the crt accelerating, focus, and cathode potentials. The DC restorer applies the Z-Axis amplifier output voltage between the crt cathode and grid. There are high dc potentials on these elements that prohibit direct coupling to the crt.

CHAPTER 2
MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

2-1. COMMON TOOLS AND EQUIPMENT

Common tools and equipment required for general support maintenance of Oscilloscope, AN/USM-488, are listed in the Maintenance Allocation Chart (MAC), TM 11-6625-3135-12, Appendix B.

2-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

No special tools or support equipment are required

2-3. REPAIR PARTS

Repair parts are listed and illustrated in the Repair Parts and Special Tools List (TM 11-6625-3135-24P).

Section II. SERVICE UPON RECEIPT

2-4. UNPACKING

The oscilloscope is shipped assembled in its original packing container. Unpack carefully and do not damage the container while unpacking. Save the container for use in reshipment.

2-5. CHECKING UNPACKED EQUIPMENT

a. Inspect for damage incurred during shipment. If oscilloscope has been damaged, report the damage on Form SF 364, Report of Discrepancy.

b. Check the oscilloscope against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 750-8.

c. Check to see whether the oscilloscope has been modified.

2-6. PRELIMINARY SERVICING AND ADJUSTMENTS OF EQUIPMENT

Run the performance test, (para 2-24).

Section III. TROUBLESHOOTING

SYMPTOM INDEX

2-7. INTRODUCTION.

Troubleshooting at general support maintenance level requires that all troubles be located as quickly as possible. The amount of troubleshooting permitted is based on the Maintenance Allocation Chart (MAC) allowance for your activity. Because of this, the only trouble symptoms contained here are those that could be caused by defects you can repair.

NOTE

Before using this troubleshooting section, check equipment work order and talk to organizational maintenance, if possible, for description of symptoms and steps taken to correct them. Check all forms and tags attached to, or accompanying equipment to determine reason for removal from service.

2-8. CIRCUIT BOARD INSPECTION.

a. Inspect for loose or damaged parts. If circuit board is not damaged, tighten loose parts. Replace all damaged parts. Check that problem still exists and troubleshoot.

b. Inspect for loose or damaged wires. If circuit board is not damaged, fix loose or damaged wires. Check that problem still exists and troubleshoot.

2-9. USING THE TROUBLESHOOTING SECTION.

The troubleshooting section has been divided into three main parts. These main parts are explained in the following text and referenced to the troubleshooting table example shown below.

Malfunction	Test or Inspection	Corrective Action
2. NO BASELINE TRACE APPEARS ON CRT.		
	Step 1. Check for +100Y±3 vdc at W955 (37, FO-1).	
		• If voltage is correct, go to step 2.
		. If voltage is incorrect, check T948 (116) and C954 (92).

2-10. TROUBLESHOOTING TABLE

General Support Maintenance troubleshooting initial setup of controls is in table 2-1, and the troubleshooting procedures are in table 2-2. Location of troubleshooting test points are shown on fig. FO-1. A performance test (para 2-27) can be used to determine what part of the instrument has a malfunction. If any indication is out of tolerance during the performance test, go to the comparable part of the adjustment procedure (para 2-28) and perform adjustment. The symptom index lists troubleshooting symptoms and the page where the appropriate troubleshooting procedure is located. If the exact symptom is not known when you receive the oscilloscope, run the performance test (para 2-27) first. After troubleshooting has been completed and the instrument repaired, run both the performance test and adjustment procedure.

NOTE

After replacing defective component, recheck voltage or resistance readings. If problem remains, continue troubleshooting procedures as appropriate.

2-11. TROUBLESHOOTING PROCEDURES.

Each troubleshooting procedure referenced to is to be followed in order until told to do another step or paragraph, or to replace a part. After replacing part, return to the original malfunction and verify that the problem has been corrected.

WARNING

With cover removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

CAUTION

The oscilloscope power source must be connected through an isolation transformer or damage to equipment could result.

NOTES

. All measurements and waveforms are to chassis ground unless otherwise noted.

. All reference designations are on Al unless otherwise noted.

. All test point locations in ( ) are located on fig. FO-3.

Table 2-1. Troubleshooting Initial Setup

Control	Setting
. Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/ DIV	2 mV
VOLTS/ DIV Variable	CAL detent
AC/GND/DC	AC
. Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	0.2 ms
SEC/ DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
. A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	AC

Table 2-2. Troubleshooting

Malfunction	Test or Inspection	Corrective Action

1. POWER INDICATOR DOES NOT COME ON.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Check continuity of fuse F9001.

. Replace if open (TM 11-6625 -3135-1 2).

Step 2. Check rectifier output.

Connect oscilloscope to power source through an isolation transformer.

Measure for +170 ±10 vdc between C906 (100) and TP950 (ground).

. If voltage is incorrect, go to step 3,

. If voltage is correct, troubleshoot power supply (para 2-1 2).

Step 3. Measure for 120 ±5 vac between A6W9041 (165) and chassis ground.

. If voltage is correct, go to step 4.

. If voltage is incorrect, replace A6 (para 2-14).

Step 4. Measure for 120 ±5 vac between POWER switch S901-1 (35) and ground.

. If voltage is correct, check and replace defective rectifiers CR901 through CR904 (101 through 104).

. If voltage is incorrect, replace POWER switch S901.

2. NO BASELINE TRACE APPEARS ON CRT.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Perform power supply troubleshooting (para 2-12).

. Replace defective part,

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 2. Measure for +100 ±3 vdc at W955 (37).

- If voltage is correct, go to step 3.
- If voltage is incorrect, check T948 (116) and C954 (92).

Step 3. Measure for +30 ±0.9 vdc at W964 (38).

- If voltage is correct, go to step 4.
- If voltage is incorrect, check T948 (116) and C956 (95)

Step 4. Measure for +8.6 ±0.17 vdc at W960 (125).

- If voltage is correct, go to step 5.
- If voltage is incorrect, check T948 (116), rectifiers CR960 (93), CR961 (94), CR962 (122), CR963 (96), C960 (121), and C962 (120).

Step 5. Measure for -8.6 ±0.04 vdc at W961 (123).

- If voltage is correct, go to step 6.
- If voltage is incorrect, check T948 (116), C961 (118), and C963 (119).

Step 6. Measure for +5.2 ±0.56 vdc at W968 (124).

- If voltage is correct, go to step 7.
- If voltage is incorrect, check T948 (116), CR970 (115), C968 (114), and C970 (117).

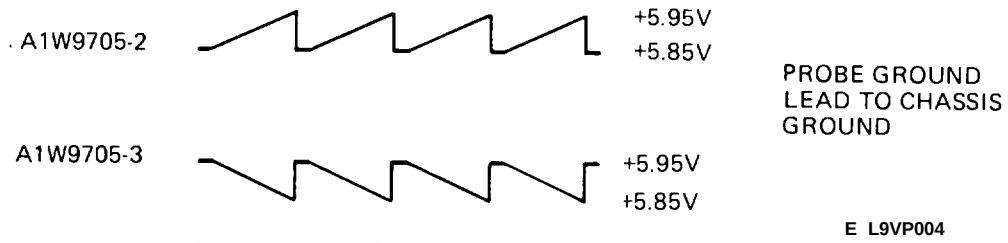
Step 7. Depress BEAM FIND control.

- If a dot is present on crt, go to step 8.
- If a short, compressed sweep is present on center of crt, go to step 19.
- If a short, compressed sweep is present near top or bottom of crt, go to step 25.

Table 2-2. Troubleshooting (Cont)

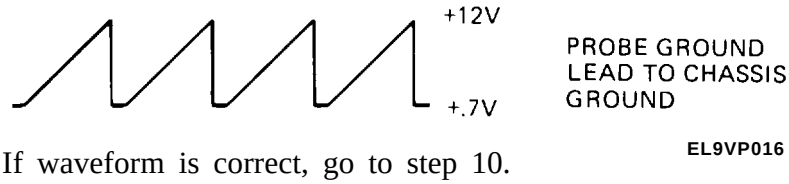
Malfunction	Test or Inspection	Corrective Action

Step **8.** Check for the following waveforms at W9705 (84) pin 2 and W9705 (84) pin 3.



- If either waveform is incorrect, go to step 9.
- If both waveforms are correct, go to step 11.

Step 9. Check for the following waveform at A4R707 (159).

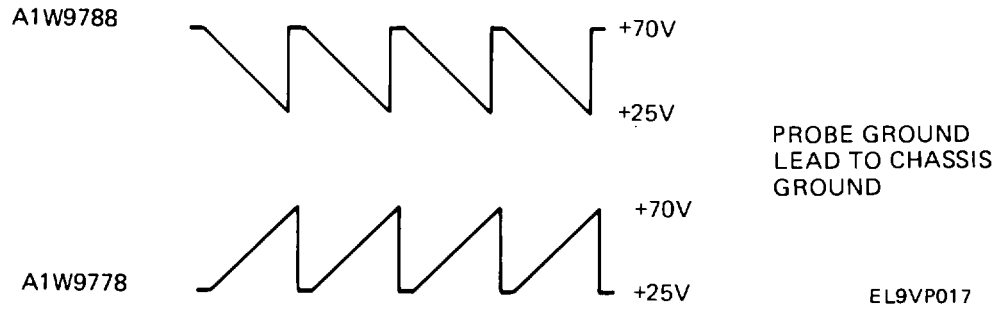


- If waveform is correct, go to step 10.
- If waveform is incorrect, go to step 12.

Step 10. Measure a DISP voltage (+5 vdc) at A4P9700 (160) pin 1.

- If correct, replace A4 (para 2-20),
- If incorrect, go to step 16.

Step 11. Check for the following waveforms at W9788 (48) and W9778 (47).



- If both waveforms are correct, check crt wiring.
- If either waveform is incorrect, check horizontal output amplifier Q770 (24), Q775 (44), Q779 (43), Q780 (23), Q785 (20), Q789 (42), and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 12. Check A GATE at A4P9700 (160) pin 8 and A SWP at A4P9700 pin 7 for high or low (pin 7 high is+ 12 vdc, low is +0.7 vdc; pin 8 high is + 1.5 vdc, low is zero).

- If both are either high or low, replace A4 (para 2-20).
- If one is high and the other low, go to step 13.

Step 13. Check W9001 (145) pin 25 for high or low.

- If high, go to step 14.
- If low. check A TRIGGER MODE switch S401 on A3 at pins 2 and 3 for open, C505 (136) for short, and R505 (77) for open. If S401 is defective, replace A3 (para 2-23); if not, replace defective component.

Step 14. Measure W9001 (146) pin 24 for approximately -8.3 •0.3 vdc.

- If voltage is not correct, replace A3 (para 2-23).
- If voltage is correct, go to step 15.

Step 15. Measure W9001 (145) pin 30 for approximately +8.6 ±0.3 vdc.

- If voltage is not correct, replace A3 (para 2-23).
- If voltage is correct, check A Sweep Generator Logic Circuit components U502 (138), U504 (78), U506 (135), U532 (132), and associated components.

Step 16. Check for high at J9400 pin 15 (88) (high is +5 vdc).

- If high is present, check R566 (83).
- If high is not present, check resistor R676 (82). If resistor is good, go to step 17.

Step 17. Check J9400 (28) pin 13 for low (low is zero).

- If low, replace A5 (para 2-18).
- If high, go to step 18.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

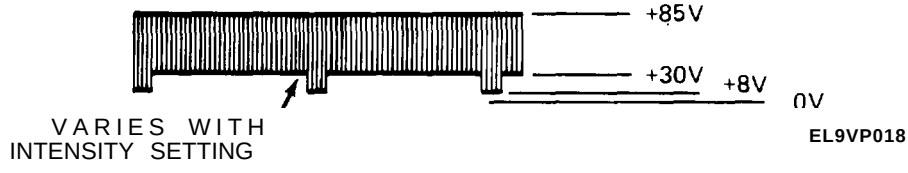
Step 18. Check W9001 (148) pin 16 for low(low is zero).

- If low, check A1 printed circuit between A1W9001 pin 15 and A1J9400 pin 13.
- If high, replace A3 (para 2-23).

Step 19. Check TP842 (33) for a pulse with an amplitude of 40-60V.

- If present, go to step 20.
- If not present, go to step 23.

Step 20. Check for the following waveform at junction of R854 (98' and CR853 (99



- If incorrect, check GRID BIAS pot R851 (34) and associated components.

Step 21. Measure for approximately -2 kv at W9870 pins 1, 2, 3, and 14 (39).

- If present, go to step 22.
- If not present, check U975 (91) and associated components.

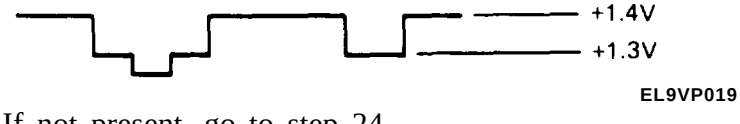
Step 22. Measure for approximately -1500 vdc at W9870 pin 4 (40).

- If present, replace crt (para 2-14).
- If not present, go to step 22a.

Step 22a. Check R888, R889, R890, R891, R892, and R894.

- If faulty, replace all 6 resistors.
- If not faulty, check FOCUS pot R893 (41) and associated components.

Step 23. Check for the following waveform at Q825 (28) emitter.



- If not present, go to step 24.
- If present, check Z-Axis circuit components Q829 (29), Q835 (31), Q840 (32), Q845 (30), and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection Corrective Action
	Step 24. Measure voltage at Q804 (69) emitter. Voltage should be +3 to -8 vdc, depending on position of intensity control. • If voltage is correct, replace A5 (para 2-18). • If not, check Q804 (69), Q586 (130), and associated components.
	Step 25. Disconnect A3P9103. • If trace centers, replace A3 (para 2-23). • If trace does not center, reconnect A3P9103 and go to step 26.
	Step 26. Measure for +0.7 vdc at U130 (63), pin 14. • If voltage is present, go to step 29. • If voltage is not present, go to step 27.
	Step 27. Check for low at U540 pin 4 (26) (low is +0.7 vdc). • If pin 4 is low, check U540 (26), U537 (27), and associated components. • If pin 4 is not low, go to step 28.
	Step 28. Check for low at A4P9250 pin 3 (162) (low is zero). • If pin 3 is low, replace A3 (para 2-23). • If pin 3 is not low, replace A4 (para 2-20).
	Step 29. Measure for 0 volts at DL9210 (both + and - sides). • If no voltage is present, go to step 36. • If voltage is present, go to step 30.
	Step 30. Measure for +2.7 ±0.1 vdc at base of Q202 (3) and Q203 (4). • If voltage is correct, check Q202 (3), Q203 (4), Q206 (2), Q207 (5), U225 (l), and associated components. • If voltage is not correct, go to step 31.

Table 2-2. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

Step 31. Check that CR202 (66) and CR203 (67) are off.

. If they are off, go to step 32.

. If they are not off, go to step 35.

Step 32. Measure for -0.7 ±0. 1 vdc at U 180 pin 14 (49).

• If present, go to step 33.

. If not present, go to step 34.

Step 33. Measure for -5.2 vdc at U 130(63) pins 2 and 3 and -4.5 vdc at U 130(63) pins 4 and 5.

• If all voltages are correct, replace U130.

. If any voltages are not correct, check Q102 (59), Q103 (58), Q114(57), Q 115 (56), and associated components.

Step 34. Measure for high (+5 vdc) at U540 pin 1 (26).

. If high, check U540 and associated components.

. If not high, replace A3 (para 2-23).

Step 35. Measure for O vdc at P9001 pin 6 (148).

• If O vdc, check Q440 (75), Q441 (76), and associated components.

. If not O vdc, replace A3 (para 2-23).

Step 36. Check Q283 (19) base for high (+7 vdc).

. If high, go to step 38.

. If not high, go to step 37.

Step 37. Check for low (zero) at J9400 pin 10 (88).

. If low, replace A5 (para 2-18).

. If not low, replace A3 (para 2-23).

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 38. Check for low (zero) at Q284 (16) base.

- If low, go to step 39.
- If not low, check Q283 (19) and associated components.

Step 39. Disconnect one end of R288 (15) and R289 (14).

- If trace centers, check Q284 (16), Q285 (11), and associated components. Reconnect R288 and R289.
- If trace does not center, go to step 40.

Step 40. Measure for +8.8 vdc at Q256 (22) and Q257 (21) collectors.

- If correct, check crt wiring.
- If not correct, check Q230 (12), Q231 (13), Q254 (18), Q255 (17), Q256 (22), Q257 (21), Q283 (19), Q284 (16), Q285 (1 1), and associated components.

3. NO VERTICAL DEFLECTION ON CHANNEL 1.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Measure for +8.6 ±0.2 vdc at A2P9991 (155) pin 1 and for -8.6 ±0.2 vdc at A2P9991 pin 3.

- If voltage is correct, go to step 2.
- If voltage is not correct, check wiring between A2P9991 (155) and A1 W9991.

Step 2. Apply 10 mv, 50 kHz signal to CH 1 OR X INPUT and check for signal at A2U30 pin 4 (154).

- If signal is present, go to step 3.
- If signal is not present, replace A2 (para 2-19).

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action
	Step 3. Measure for +4.8 ±0.1 vdc at A2P9103 (153) pins 2 and 3.	• If voltage is correct, go to Malfunction 2 (steps 25-40). • If voltage is not correct, replace A2 (para 2-19).
4. NO VERTICAL DEFLECTION ON CHANNEL 2.		
	NOTE Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.	
	Step 1. Measure for +8.6 ±0.2 vdc at A2P9991 (155) pin 1 and for -8.6 ±0.2 vdc at A2P9991 pin 3.	• If voltage is correct, go to step 2. • If voltage is not correct, check wiring between A2P9991 (155) and A1W9991.
	Step 2. Apply 10 mv, 50 kHz signal to CH 2 OR Y INPUT and check for signal at A2U80 pin 4 (158).	• If signal is present, go to step 3. • If signal is not present, replace A2 (para 2-19).
	Step 3. Measure for +4.8 ±0.1 vdc at A2P9108 (153) pins 2 and 3.	• If voltage is correct, go to Malfunction 2 (steps 25-40). • If voltage is not correct, replace A2 (para 2-19).

Table 2-2. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

5. INVERT FUNCTION FAULTY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Measure for +2.5 ±0.1 vdc at A7P9200 pin 2 (151) and +3.4 ±0.2 vdc at A7W9200 pin 1 (150).

- If voltage is correct, replace A2 (para 2-19).
- If voltage is not correct, go to step 2.

Step 2. Check for +8.6 vdc at W9161-5 (149).

- If present, replace A7 (para 2-24).
- If not present, replace A3 (para 2-23).

6. CHANNEL 1 OR 2 DOES NOT CENTER VERTICALLY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Perform Malfunction 2 Troubleshooting, steps 25-40.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

7. TRIG VIEW FUNCTION FAULTY.

NOTES

- Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.
- All measurements and checks must be done with TRIG VIEW switch held in.

Step 1. Set Trig source to CH 1.
Apply 10 mv, 50 kHz signal to CH 1 OR X INPUT.
Measure for -8.6 ±0.2 vdc at W9001 pin 6 (148).

- If present, go to step 2.
- If not, replace A3 (para 2-23).

Step 2. Measure for -0.7 ±0.l vdc at U130 pin 14 (63) and U180 pin 14 (49) (U130 and U 180 should be off).

- If correct, go to step 3.
- If not, check R138 (62) and R188 (61).

Step 3. Check that CR202 (66) and CR203 (67) are turned on.

- If they are, go to step 4.
- If not, check VR200 (60), CR200 (64), CR201 (65), CR202 (66), and CR203 (67).

Step 4. Measure for 100 mV or less at base of Q440 (75).

- If correct, go to step 12.
- If not correct, go to step 5.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 5. Check for low (-0.7 ±0.1 vdc) at W9001 (142) pin 37 and high (+8.6 ±0.2 vdc) at pins 35 and 36.

- If correct, go to step 6.
- If incorrect, replace A3 (para 2-23).

Step 6. Measure for -2.8 ±0.1 vdc at U310 pin 8 (50).

- If correct, go to step 7.
- If not correct, check R321 and R322 (52).

Step 7. Measure for -3.3 ±0.1 vdc at U310 pin 11.

- If correct, go to step 9.
- If incorrect, go to step 8.

Step 8. Check W9001 (142) pin 32 for low (zero), pin 33 for high (+5 ±0.1 vdc), and pin 34 for high (+5 ±0.1 vdc).

- If correct, check U555 (46), U565 (25), and associated components.
- If incorrect, replace A3 (para 2-23).

Step 9. Check U310 (50), pins 2 and 10 for trigger signal.

- If present, go to step 11.
- If not present, go to step 10.

Step 10. Move input signal to CH 2 OR Y INPUT, set trigger source switch to CH 2, and set VERTICAL MODE switch to BOTH ALT.

- If trigger view works, check U310 (50), Q302 (51), Q303 (53), and associated components.
- If trigger view does not work, check U350 (74) and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 11. Check base of Q441 (76) for zero (±O.1 vdc).

- If correct, check Q440 (75), Q441 (76), and associated components.
- If not, go to step 12.

Step 12. Measure for -8.3 ±0.3 vdc at W9001 pin 24 (146).

- If correct, go to step 13.
- If voltage is correct and S401 is pressed in, replace A3 (para 2-23).
- If voltage is incorrect, check R414 (144) and R416 (68).

Step 13. Measure for -0.6 ±0.1 vdc at U426A pin 2 (147).

- If correct, go to step 14.
- If incorrect, check Q420 (72), Q422 (70), and associated components.

Step 14. Measure for +0.6 ±0.1 vdc at U426 pin 5 (147).

- If correct, go to step 15.
- If incorrect, check Q421 (73), Q423 (71), and associated components.

Step 15. Measure for zero ±0.1 vdc at U426 (147) pin 1 and at pin 7.

- If correct, replace A3 (para 2-23).
- If not, check U426 (147) and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

8. VERTICAL BANDWIDTH FUNCTION FAULTY.

NOTES

- Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.
- This procedure is for channel 1. Channel 2 is the same except for reference designators.

Set up oscilloscope for band pass measurement.
Apply signal to CH 1 OR X INPUT.
Reverse A2P9103 (153) and A2P9108 (157). Set VERTICAL MODE to CH 2.

. If band pass is still faulty, replace A2 (para 2-19).

. If band pass is not still faulty, check Cl 30, C180, C210, C237, C250, and C251.

9. **VERTICAL BANDWIDTH LIMIT FUNCTION FAULTY.**

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Press in BW LIMIT switch.
Measure for +8.6 ±0.2 vdc at W9OO1-10 (148).

. If not correct, replace A3 (para 2-23).

. If correct, check CR226 (6), CR227 (7), CR228 (9), CR229 (8), C228, C229, and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

10. HORIZONTAL TIMING INACCURATE.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Monitor A4R701 (161) pin 1 for approximately -8 vdc ±50 mv, as switch is turned through all TIMING ranges.

- If voltage varies more than 5 mV, replace A4 (para 2-20).

11. POOR HORIZONTAL LINEARITY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Check horizontal linearity of both A and B sweeps.

- If both are bad, replace crt (para 2-14).
- If one is bad, replace A4 (para 2-20).

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

12. SWEEP SEPARATION FAULTY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Set HORIZ mode to ALT.
Set B trigger level to RUNS AFTER DELAY.

Step 2. Check for the following waveform at W282 (45).

- If correct, go to step 3.
- If not correct, go to step 6.

Step 3. Check that W9001 (55), pin 4 goes from +8.6 to 0 to 8.6 vdc when A/ BSWP SEP control is turned from clockwise to counter-clockwise.

- If correct, go to step 4.
- If not correct, - A/B SWP SEP control is defective; replace A3 (para 2-23).

Step 4. Set A/B SWP SEP control to clockwise position.
Check Q284 (16) base for +0.3 vdc when waveform in step 2 is low and 0 when waveform in step 2 is high.

- If correct, go to step 5.
- If not correct, check Q283 (11), Q284 (16), and associated components.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 5. Check base of Q285 (11) for low.

- If correct, check Q285 (11) and associated components.
- If not correct, replace R285 (10).

Step 6. Check J9400 pin 10 (88) for high.

- If correct, replace A5 (paragraph 2-18).
- If not correct, go to step 7.

Step 7. Disconnect one end of C647 (87) and check W9001 pin 27 (145) for high.

- If correct, check C647 (87) and R649 (133).
- If not correct, replace A3 (para 2-23) and reconnect C647.

13. B TIME DELAY RANGE FAULTY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Set HORIZ MODE to ALT.
Set B trigger level to RUNS AFTER DELAY.

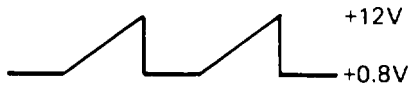
Step 2. Check J9400 (88) pin 14 for +6.2 to less than +1.0 vdc as B DELAY TIME POSITION control is rotated from stop to stop.

- If correct, go to step 3.
- If incorrect, check B DELAY TIME POSITION control, R646 (131), C646 (126), and R647 (127).

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 3. Check for following waveform at J9400-20 (88).



EL9VP035

- If incorrect, go to Malfunction 2, steps 9-18.

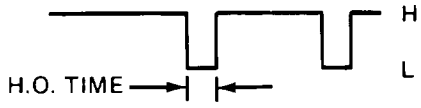
Step 4. Measure J9400 pin 13 (88) for +5 vdc.

- If correct, go to step 6.
- If incorrect, go to step 5.

Step 5. Check continuity from W9100 pin 15 (148) to ground.

- If continuity is there, replace A3 (para 2-23).
- If no continuity, check R648 (134) and C648 (128).

Step 6. Check for following waveform at J9400 pin 21 (88).



EL9VP036

- If correct, go to step 7.
- If not correct, go to Malfunction 2, steps 9-18.

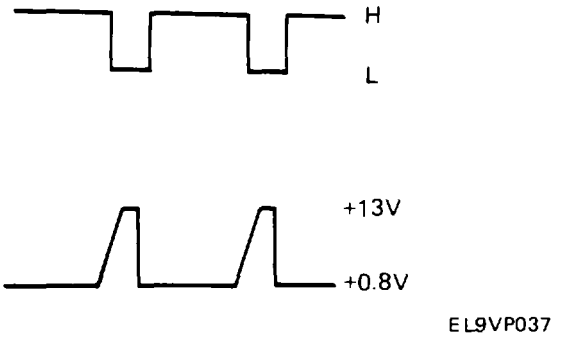
Step 7. Check J9400 pin 4 (88) for +8.6 ±0.2 vdc.

- If correct, go to step 8.
- If not correct, replace A3 (para 2-23).

Table 2-2. Troubleshooting (Cont)

Malfunction Test or Inspection Corrective Action

Step 8. Check for following waveforms at J9400 pin 22 (88) and J9400 pin 22 (88).



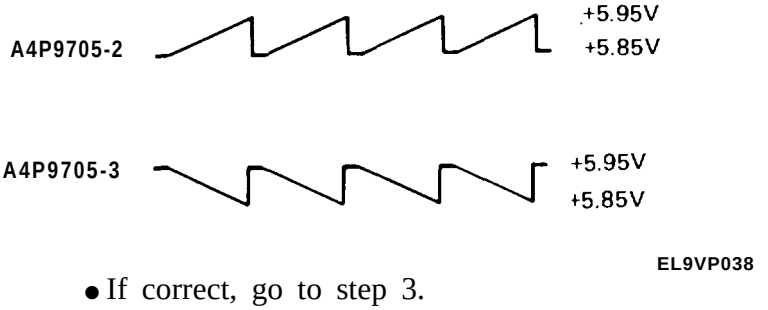
- If correct, replace A5 (para 2-18).
- If not correct (both high or low at the same time), replace A4 (para 2-20).

14. TRACE DOES NOT ENTER HORIZONTALLY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Check for following waveforms at A4P9705 (164) pins 2 and 3.



- If correct, go to step 3.
- If not correct, go to step 2.

Table 2-2. Troubleshooting (Cont)

Malfunction	Test or Inspection	Corrective Action

Step 2. Check W9001 pin 21 (146) for +8.6 to --8.6 vdc as POSITION control is turned through its entire range.

- If correct, replace A4 (para 2-20).
- If not, replace A3 (para 2-23).

Step 3. Check Q770 (24) emitter for +6.7 vdc and Q780 (23) emitter for +5.4 vdc.

- If correct, go to step 4.
- If not correct, check Q770 (24), Q780 (23), and associated components.

Step 4. Check for following waveforms at W9778 (47) and W9788 (48).

- If correct, check crt wiring.
- If not correct, check Q775 (44), Q779 (43), Q785 (20), Q789 (42) and associated components.

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Table 2-2. Troubleshooting (Cent)

Malfunction
Test or Inspection
Corrective Action

15. LOW X GAIN.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Set A AND B SEC/ DIV switch to X-Y.
Connect 10 mv square wave signal to CH 1 OR X.

Step 2. Check A4U760 pin 11 (163) for approximately 200 mv square wave.

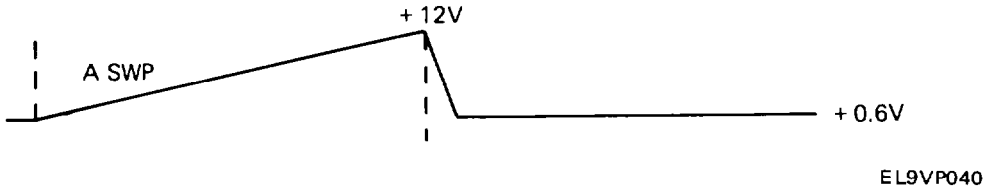
- If correct, replace A4 (para 2-20).
- If not correct, check U758 (81), Q756 (79), and associated components.

16. IMPROPER SWEEP LENGTH.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Check for following waveform at A4R707 (159).

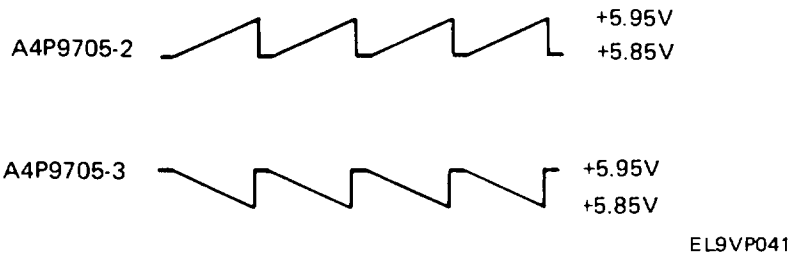


- If correct, go to step 2.
- If not correct, go to step 3.

Table 2-2. Troubleshooting (Cent)

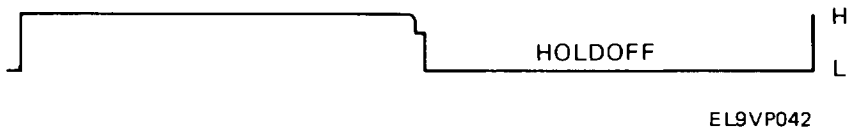
Malfunction	Test or Inspection	Corrective Action

Step 2. Check for following waveforms at A4P9705 pins 2 and 3 (164),



- If correct, go to Malfunction 14.
- If incorrect, replace A4 (para 2-20).

Step 3. Check for following waveform at U504-9 (78).



- If correct, check R525 (85), C525 (129), Q525 (80), R524 (86), and associated components.
- If not correct, check U504 (78) and associated components.

Table 2-2. Troubleshooting (Cent)

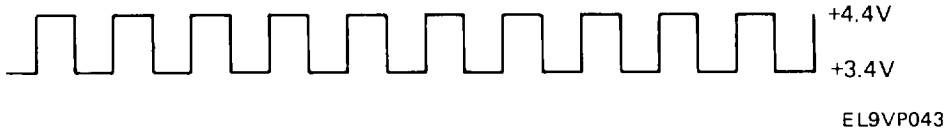
Malfunction	Test or Inspection	Corrective Action

17. A INTERNAL TRIGGER FUNCTION FAULTY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Trigger oscilloscope and check for following waveform at U506 pin 6 (135).



- If correct, check U502 (138), U506 (135), and associated components.
- If not correct, go to step 2.

Step 2. Check that TV TRIG ENABLE signal at W9001 pin 17 (148) is low.

- If low, go to step 3.
- If not, replace A3 (para 2-23).

Step 3. Check the following U460 (141) pins:
Pin 2 should be O ±1OO mv
Pin 4 should be O ±1OO mv
Pin 7 should be +1.9 vdc ±50 mv
Pin 8 should be +1 .65 vdc ±50 mv with SLOPE switch in and +2. 15 vdc ±50 mv with SLOPE switch out.

- If voltages are correct, check U460 (141), R479 (143), Q473 (140), Q474 (139), and Q487 (137).
- If not correct, check resistors in inputs to U460 (141).

Table 2-2. Troubleshooting (Cent)

Malfunction	Test or Inspection	Corrective Action

18. B INTERNAL TRIGGER FUNCTION FAULTY.

NOTE

Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.

Step 1. Check A trigger function.

- If it is correct, go to step 2.
- If not, go to malfunction 17.

Step 2. Check that J9400-4 (88) voltage is +8.6 ±0.2 vdc to -8.6 ±O.2 vdc when B TRIGGER LEVEL control is rotated through its range.

- If correct, go to step 3.
- If not, replace A3 (para 2-23).

Step 3. Check voltage at A5U605 pin 8 (152). It should be +1.65 vdc ±50 mv with SLOPE switch in, and +2.15 vdc ±5O mv with SLOPE switch out.

- If correct, replace A5 (para 2-18).
- If not, replace A3 (para 2-23).

19. FOCUS DOES NOT WORK.

Go to Malfunction 2 (steps 21 and 22).

Table 2-2. Troubleshooting (Cent)

Malfunction	Test or Inspection	Corrective Action

20. TRACE DRIFTS.

NOTES

- Before performing troubleshooting, make sure all controls are set to positions listed in table 2-1.
- This procedure is for channel 1. Channel 2 is the same except for reference designators.

Reverse A2P9103 (153) and A2P9108 (157).

- If trace still drifts, check U130 (63), Q102 (59), Q102 (59), Q103 (58), Q114 (57), Q115 (56), and associated components.
- If trace does not drift, replace A2 (para 2-19).

21. X10 MAGNIFIER DOES NOT WORK.

CAUTION

Make sure power to oscilloscope is off to prevent damage to multimeter.

With power off and X 10 magnifier switch closed (pulled out), check for continuity between A8W9726 (166) and A8W9724 (167).

- If continuity exists, replace A4 (para 2-20).
- If continuity does not exist, replace A8 (para 2-21).

2-12. POWER SUPPLY FAULT ISOLATION TEST

DESCRIPTION

This test locates the faulty power supply component.

INITIAL SETUP

WARNING

With cover removed, several dangerous voltage points may be exposed. Contact with these points could cause serious injury or death.

CAUTION

The oscilloscope power source must be connected through an isolation transformer or damage to equipment could result.

NOTES

- All measurements and waveforms are to chassis ground unless otherwise noted.
- All reference designations are on A 1 unless otherwise noted.
- All test point locations in ( ) are located on fig. FO-1.

NOTE

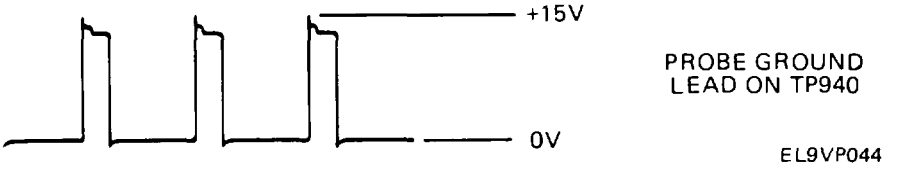
After replacing failed part, do functional check to verify original fault has been corrected.

1. Set all controls to positions listed in table 2-1.
2. Check for +43 ±1 vdc between TP940 (109) and TP950 (105) (ground).

- If voltage is incorrect, go to step 3.
- If voltage is correct, go to step 4.

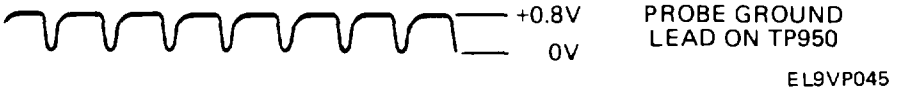
2-12. POWER SUPPLY FAULT ISOLATION TEST (CONT)

3. Check for the following waveform at U930, pin IO (106).



- If waveform is correct, check Q928, Q930, Q908, Q907, and assorted components.
- If waveform is incorrect, go to step 5.

4. Check for the following waveform at R949 (111).



- If waveform is incorrect, go to step 5.
- If waveform is correct, go to step 6.

5. Disconnect one end of R949 (111) and check for +43 ±1 vdc between TP940 (109) and TP950 (105) (ground).

- If voltage is correct, reconnect R949 and go to step 6.
- If voltage is incorrect, check Q938 (110), Q939 (108), Q944 (107), Q946 (113), Q947 (112), and their associated components. Replace defective component and reconnect R949.

6. Disconnect wire between T948 (116) and U975 (91), and check if POWER indicator DS901 comes on.

- If POWER indicator comes on, check U975 or associated components. Replace defective component and reconnect wire.
- If POWER indicator does not come on, reconnect wire and go to step 7.

7. Disconnect jumpers W955 (37) and W954 (90) (+100 vdc supply) and check if POWER indicator comes on.

- If POWER indicator comes on, trace +100 vdc distribution (fig. FO-12), replace defective component, and reconnect jumpers.
- If POWER indicator does not come on, go to step 11.

2-12. POWER SUPPLY FAULT ISOLATION TEST (CONT)

8. Check C954 (92) for short.

- If shorted, replace C954 and reconnect jumpers.
- If C954 is not shorted, reconnect jumpers and go to step 9.

9. Disconnect jumpers W956 (89) and W964 (38) (+30 vdc supply) and check if POWER indicator comes on.

- If POWER indicator comes on, trace +30 vdc distribution (fig. FO-12), replace defective component, and reconnect jumpers.
- If POWER indicator does not come on, go to step 10.

10, Check C956 (95) for short.

- If shorted, replace C956 and reconnect jumpers,
- If C956 is not shorted, reconnect jumpers and go to step 11.

11. Disconnect jumper W960 (125) (+8.6 vdc supply) and check if POWER indicator comes on.

- If POWER indicator comes on, trace +8.6 vdc distribution (fig. FO-12), replace defective component and reconnect jumper.
- If POWER indicator does not come on, go to step 12.

12. Check C960 (125) and C962 (120) for short.

- If shorted, replace defective capacitor and reconnect jumper.
- If neither capacitor is shorted, reconnect jumper and go to step 13.

13. Disconnect jumper W961 (123) (8.6 vdc supply) and check if POWER indicator comes on.

- If POWER indicator comes on, trace -8.6 vdc distribution (fig. FO-12), replace defective component and reconnect jumper.
- If POWER indicator does not come on, go to step 14.

14. Check C961 (118) and C963 (119) for short.

- If shorted, replace defective component and reconnect jumper.
- If neither capacitor is shorted, reconnect jumper and go to step 15.

2-12. POWER SUPPLY FAULT ISOLATION TEST (CONT)

15. Disconnect jumper W968 (124) and resistor R964 (36) (+5.2 vdc supply) and check for +5.2±O.l6 vdc between C970 (117) and chassis ground.

- If voltage is correct, trace +5.2 vdc distribution (fig. FO-12), replace defective component, and reconnect jumper and resistor.
- If POWER voltage is correct, check capacitors C968 (114) and C970 (117) for short. Reconnect jumper and resistor.

END OF TASK

Section IV. MAINTENANCE PROCEDURES

2-13. CABINET REMOVAL

DESCRIPTION

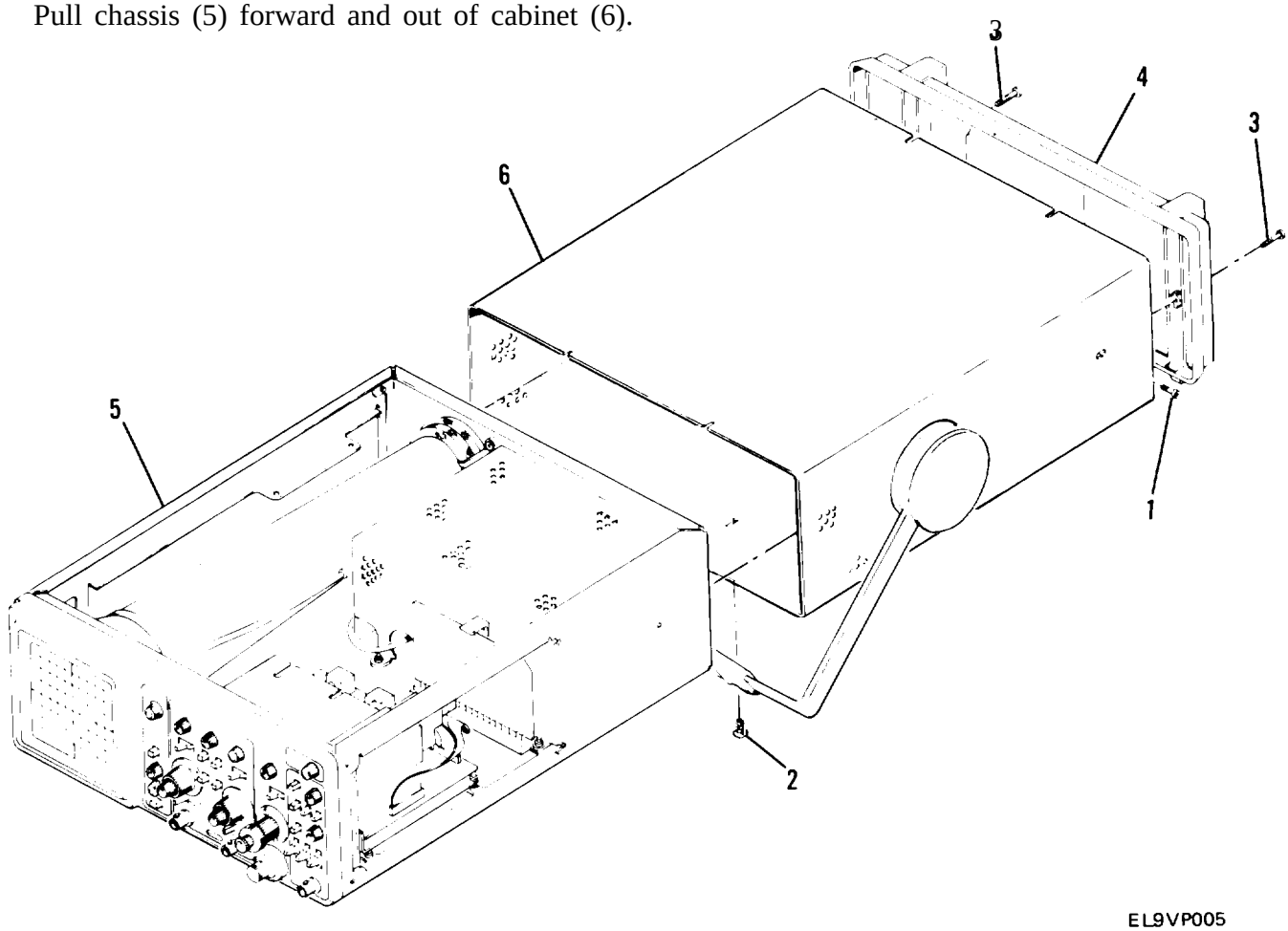
This procedure covers: Remove and Install

WARNING

To avoid electrical shock, disconnect oscilloscope from ac power source before removing or replacing any component or assembly.

REMOVE

1. Disconnect power cord and accessories from oscilloscope.
2. Remove screws at right rear side (1), bottom front (2), and rear panel (3). Remove rear panel (4).
3. Pull chassis (5) forward and out of cabinet (6).



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2-13. CABINET REMOVAL (CONT)

INSTALL

1. Slide chassis (5) into cabinet (6).
2. Install rear panel (4) with two screws (3).
3. Secure cabinet (6) to chassis (5) with screws at right rear side (1) and at bottom front (2).
4. Attach power cord and any accessories.

END OF TASK

2-14. CRT REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

WARNING

Crt anode and high-voltage multiplier output leads retain a high-voltage charge after oscilloscope is turned off. Disconnect high-voltage multiplier lead from crt anode lead and ground both leads to chassis, or death or injury could occur.

REMOVE

1. Remove cabinet (para 2-1 3).
2. Identify and remove four deflection plate wires (1) at crt neck.
3. Disconnect trace rotation P9006 (2) from A3 (3).
4. Disconnect crt anode lead (4) from high-voltage multiplier lead (5).
5. Discharge anode lead (4) to chassis.
6. Remove two screws (6) and frame (7), mesh (8), and shield (9) together.
7. With rear of oscilloscope facing you, place fingers of both hands over from subpanel (10) front edge.
8. Using thumbs, press forward gently on crt funnel near front of crt (11).

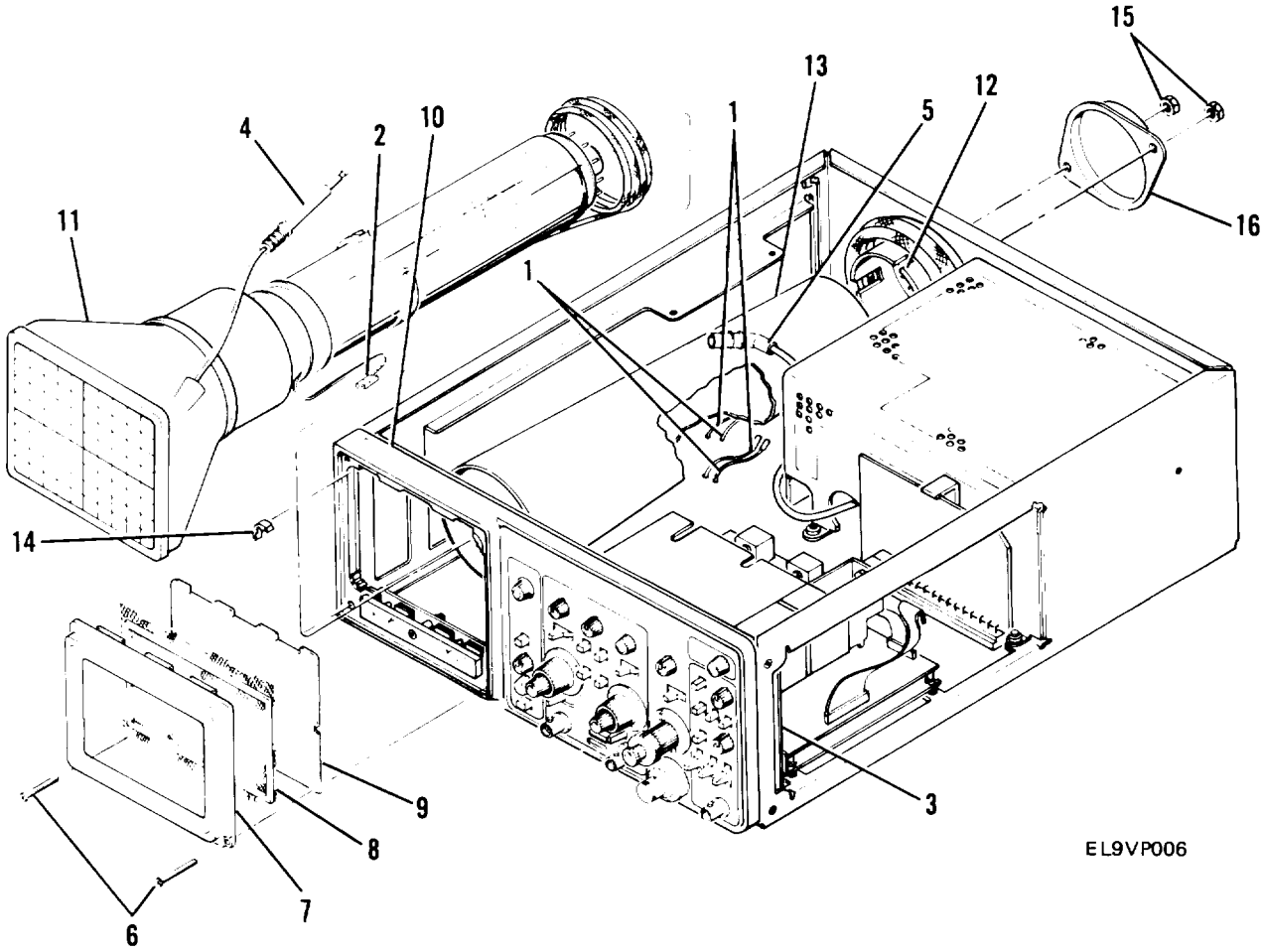
2-14. CRT REPLACEMENT (CONT)

9. When crt base pins disengage from socket (12), remove crt (11) and crt shield (13) through front subpanel (10).

10. Place crt (11) in safe place for installation.

11. If corner pads (14) fall out, save them for installation.

12. Remove two nuts (15) and crt cover (16).



2-14. CRT REPLACEMENT (CONT)

INSTALL

1. Install corner pads (14).
2. Ensure crt (11) pins are straight.
3. Insert crt shield (13) and crt (11) through front subpanel (10).
4. Ensure crt shield (13) and base socket (12) index keys are aligned.
5. Carefully align and seat crt (11) pins with socket (12).
6. Install crt cover (16) and two nuts (1 5).
7. Assemble shield (9), mesh (8), and crt frame (7), then install and secure with two screws (6).
8. Connect crt anode lead (4) to high-voltage multiplier lead (5).
9. Connect P9006 (2) to A3 (3).
10. Connect four deflection plate wires (1) to crt neck.
11. Install cabinet (para 2-1 3).

END OF TASK

2-15. A10 SCALE ILLUMINATION CIRCUIT BOARD ASSEMBLY REPLACEMENT

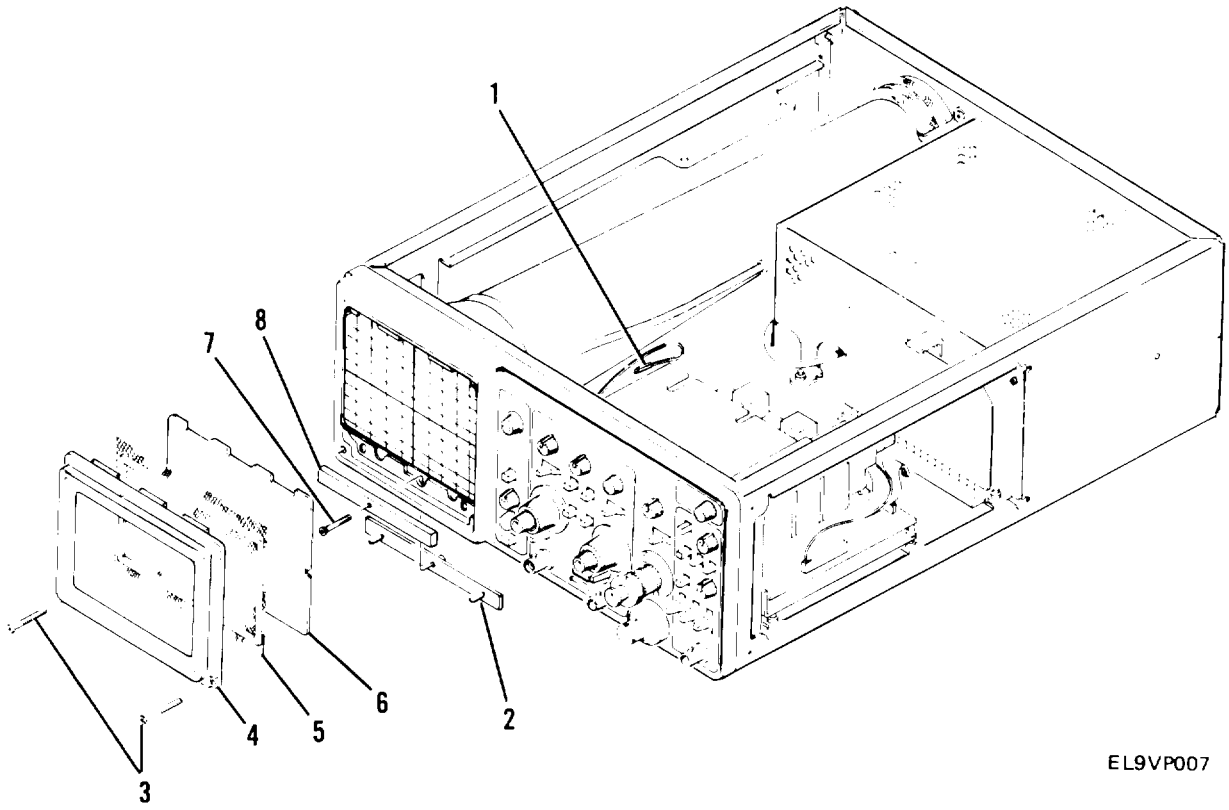
DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Disconnect P9882 (1) from A1O (2).
3. Remove two screws (3), frame (4), mesh (5), and shield (6) together.
4. Remove screw (7), eyelet, A 10 (2), and light reflector (8).

2-15. A10 SCALE ILLUMINATION CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



INSTALL

1. Install light reflector (8), eyelet, and A10 (2) with screw (7).
2. Assemble shield (6), mesh (5), and frame (4). Secure with two screws (3),
3. Attach P9882 (1) to A10 (2).
4. Install cabinet (paragraph 2-13).

END OF TASK

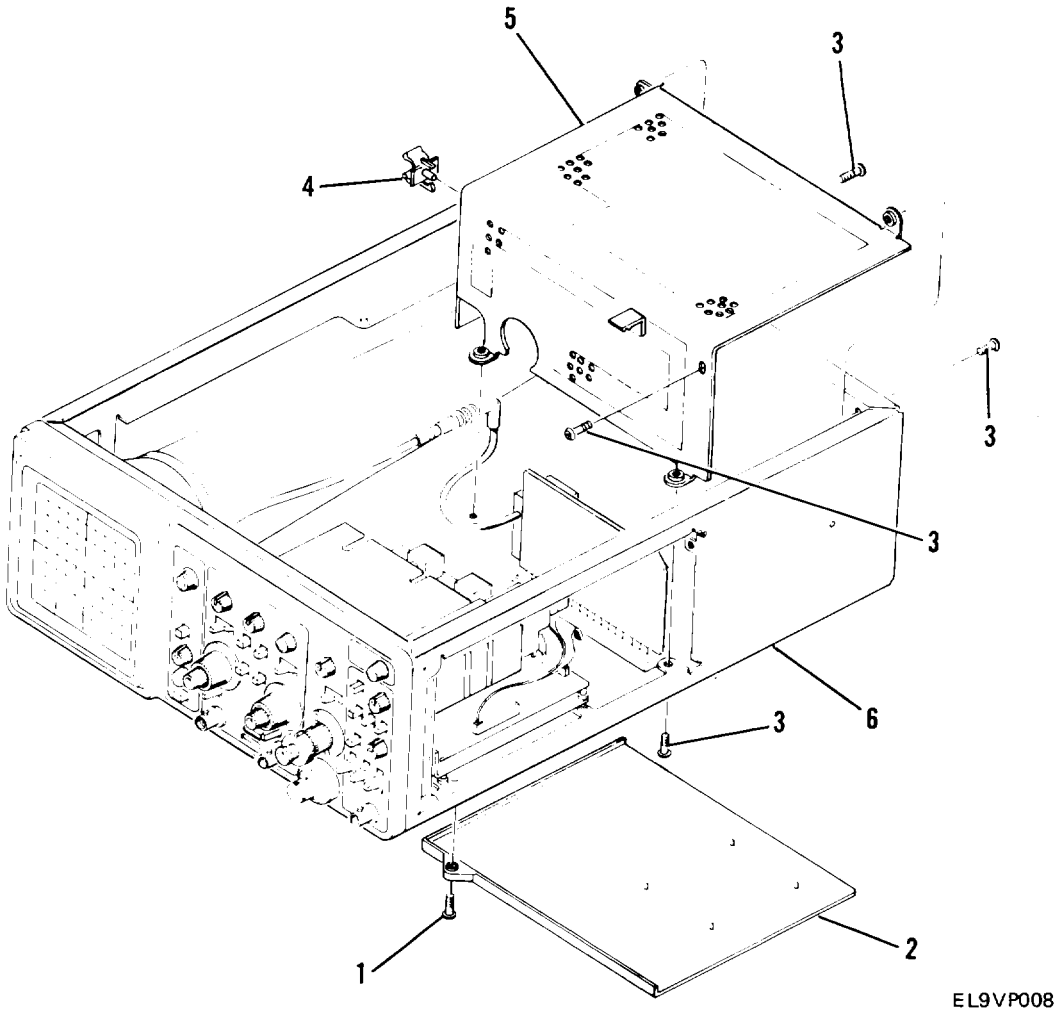
2-16. POWER SUPPLY SHIELD REMOVAL

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Remove screw (1). Press gently on rear of cover (2) and slide it forward.
3. Remove A5 (para 2-18).
4. Remove five screws (3). Remove crt anode lead from clip (4).
5. Lift shield (5) out of chassis (6) by tilting right rear corner up.



2-16. POWER SUPPLY SHIELD REMOVAL (CONT)

INSTALL

1. Set shield (5) down and into chassis (6).
2. Install crt anode lead to clip (4). Install all five screws (3) loosely, then tighten.
3. Install A5 (para 2-18).
4. Press on front of cover (2) and slide it rearward. Install screw (1).
5. Install cabinet (para 2-1 3).

END OF TASK

2-17. A6 EMI FILTER CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

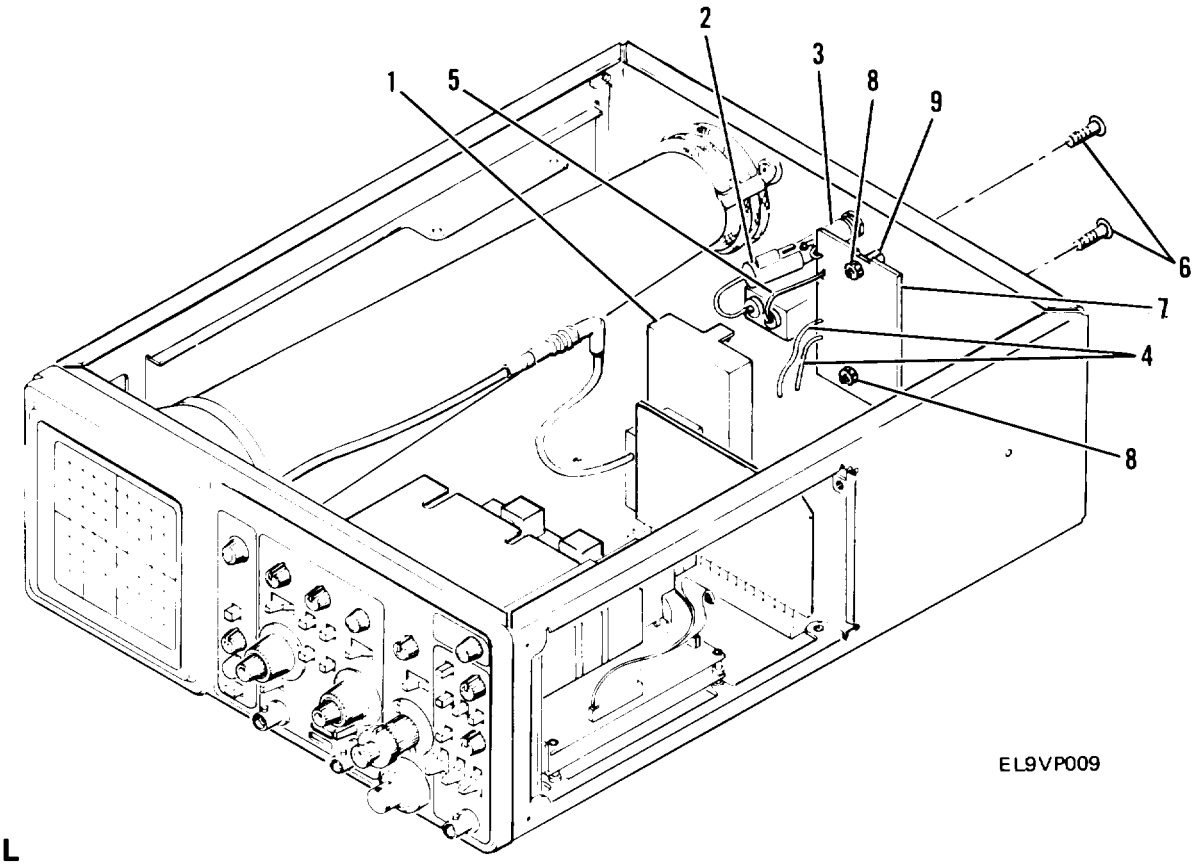
1. Remove cabinet (para 2-13) and power supply shield (para 2-16).
2. Pull off cover (l).

CAUTION

Cap (2) must be slid off fuseholder (3) before wires are unsoldered, or damage to the cap could occur.

3. Slide cap (2) off fuseholder (3) and unsolder two wires from A1 (4), one from line filter (5), and one from fuseholder (3).
4. Remove two screws (6) and lift off A6 (7), with two nuts (8) and spacers (9) attached.

2-17. A6 EMI FILTER CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



INSTALL

1. Install A6 (7) with two nuts (8), spacers (9), and screws (6).
2. Solder two wires from A 1 (4), one from line filter (5), and one from fuseholder (3). Slide cap (2) on fuseholder after soldering.
3. Install cover (1).
4. Install power supply shield (para 2-16) and cabinet (para 2-13),

END OF TASK

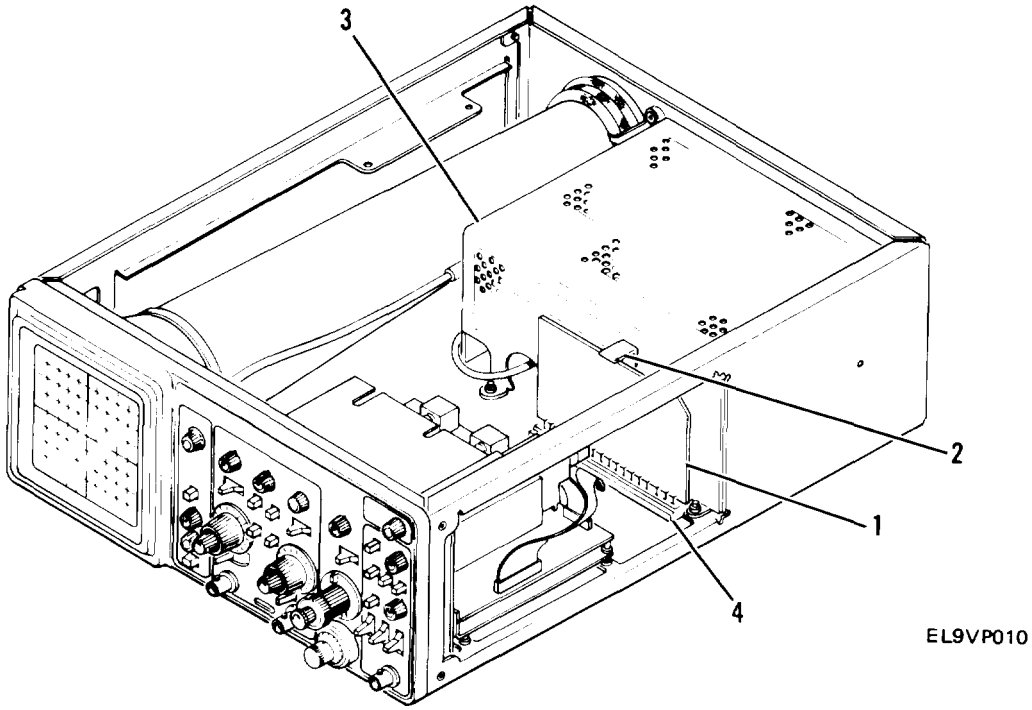
2-18. A5 ALTERNATE SWEEP CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Unclip A5 (1) from holder (2) on shield (3).
3. Pull A5 (1) up and from Al connector (4).



INSTALL

1. Align A5 (1) with Al connector (4) and seat firmly.
2. Clip A5 (1) into holder (2) on shield (3).
3. Install cabinet (para 2-1 3).

END OF TASK

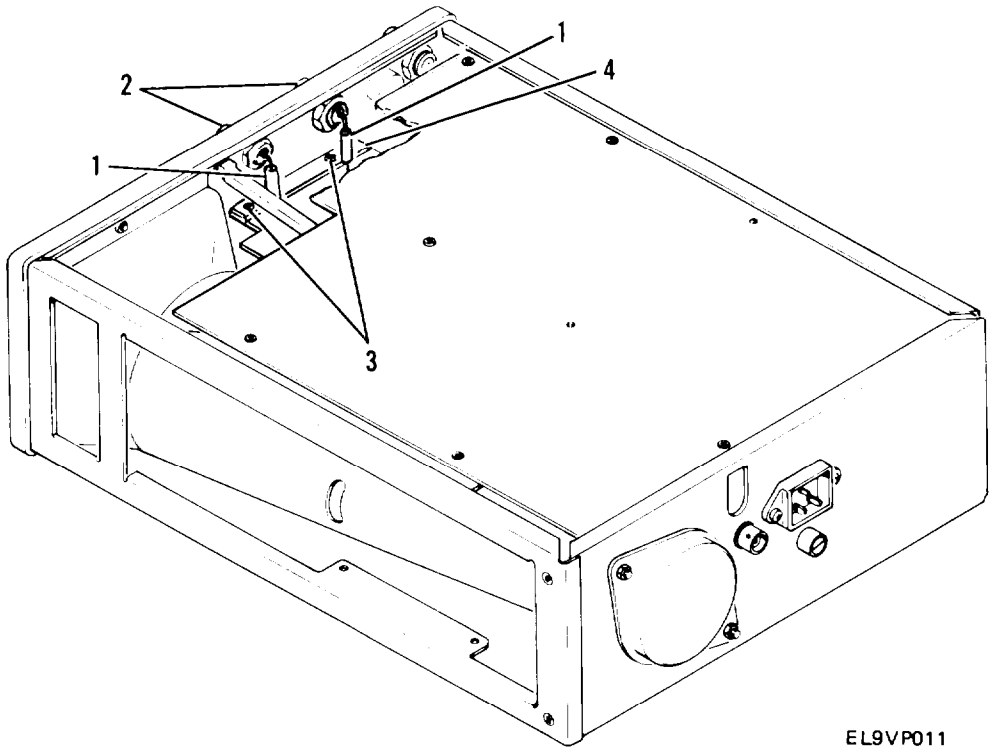
2-19. A2 ATTENUATOR CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Place oscilloscope on side and unsolder resistors (1) from CH 1 OR X and CH 2 OR Y input connectors (2).
3. Remove two screws (3) from bracket (4).
4. Loosen CH 1 and CH 2 VOLTS/ DIV variable knob setscrews (5) and remove knobs (6).
5. Set CH 1 and CH 2 VOLTS/ DIV switches to same setting and note for installation. Remove knobs (7) by pulling them straight from front panel.
6. Disconnect P9103 (8), P9108 (9), P9091 (10), P9405 (11), and P9200 (12).
7. Remove two screws (13), screw (14), screw (15), and shield (16).
8. Remove screw (17) and ground strap (18).
9. Remove screw (19) and pull A2 (20) straight back until switch shafts are clear.



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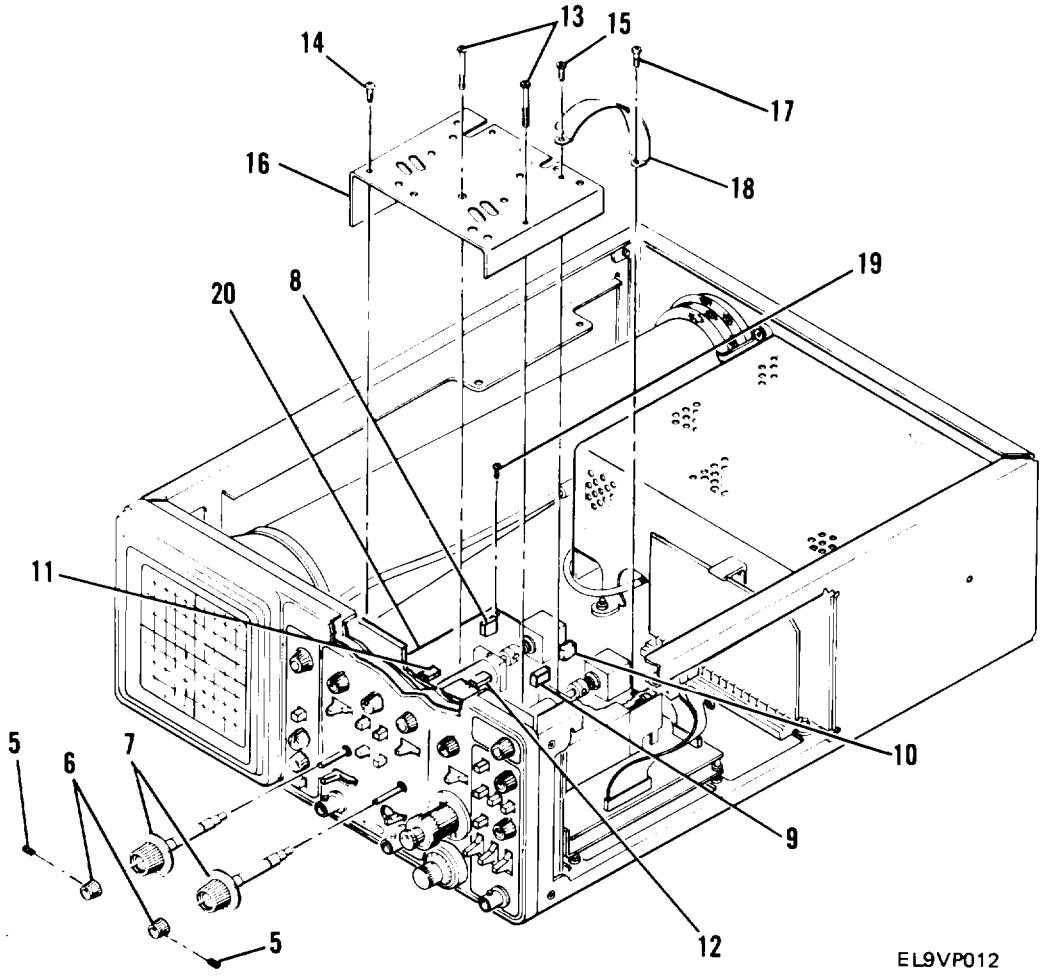
2-19. A2 ATTENUATOR CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



INSTALL

1. Position resistors (1) so leads will be accessible from bottom of oscilloscope after A2 (20) is installed.
2. Insert A2 (20).
3. Install screw (19), ground strap (18), and screw (17).
4. Install shield (16) and four screws (13, 14, and 15).
5. Install P9200 (12), P9405 (11), P9091 (10), P9108 (9) and P9103 (8).
6. Install switch knobs (7).
7. Install knobs (6) and tighten setscrews (5).

2-19. A2 ATTENUATOR CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

8. Install two screws (3) in bracket (4). Tighten securely.

9. Solder resistors (1) to CH 1 OR X and CH 2 OR Y input connectors (2).

10. Install cabinet (para 2-13).

END OF TASK

2-20. A4 TIMING CIRCUIT BOARD ASSEMBLY REPLACEMENT

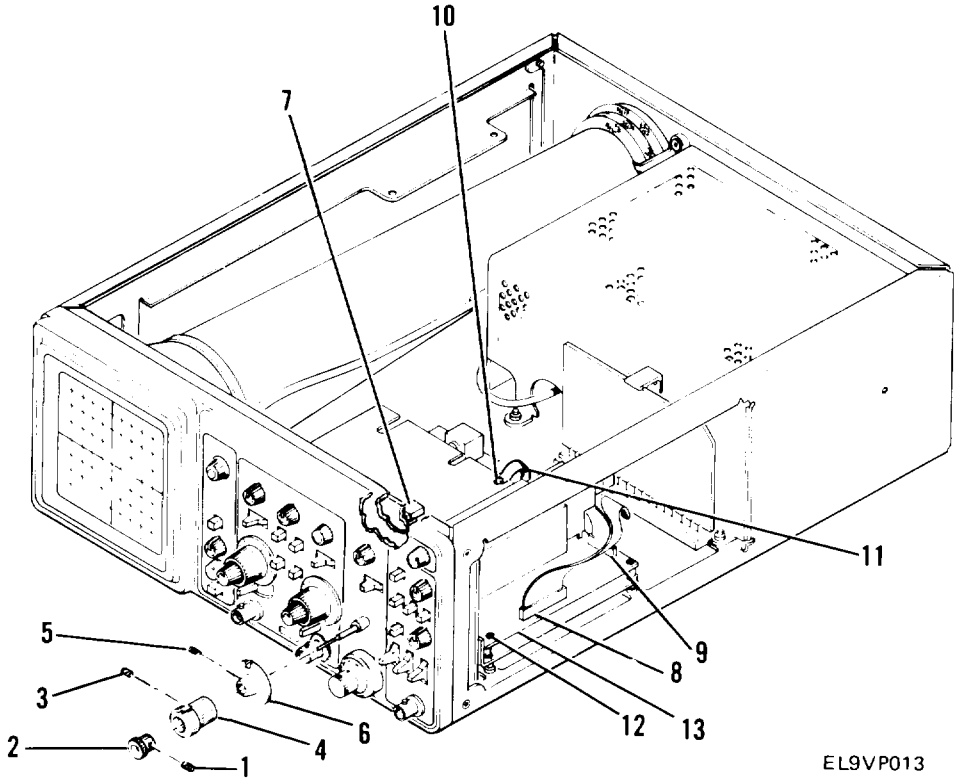
DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Loosen setscrew (1) and remove knob (2).
3. Lock A and B SEC/ DIV knobs (4 and 6) together in XY position.
4. Loosen two setscrews (3) and remove knob (4).
5. Loosen two setscrews (5) and remove knob (6).
6. Remove P9705 (7), P9700 (8), and P9723 (9).
7. Remove screw (10) securing ground strap.
8. Remove three screws (12) and pull A4 (13) back until pins disengage and switch shaft is clear of front panel.

2-20. A4 TIMING CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



INSTALL

1. Insert A4 (13) by aligning switch shaft through front panel and engaging interconnecting pins.
2. Secure A4 (13) with three screws (12).
3. Install ground strap (11) and secure with screw (10).
4. Connect P9723 (9), P9700 (8) and P9705 (7).
5. Install knob (6) in XY position and tighten two setscrews (5).
6. Install knob (4) in XY position and tighten two setscrews (3).
7. Install knob (2) and tighten setscrew (1).
8. Install cabinet (para 2-13).

END OF TASK

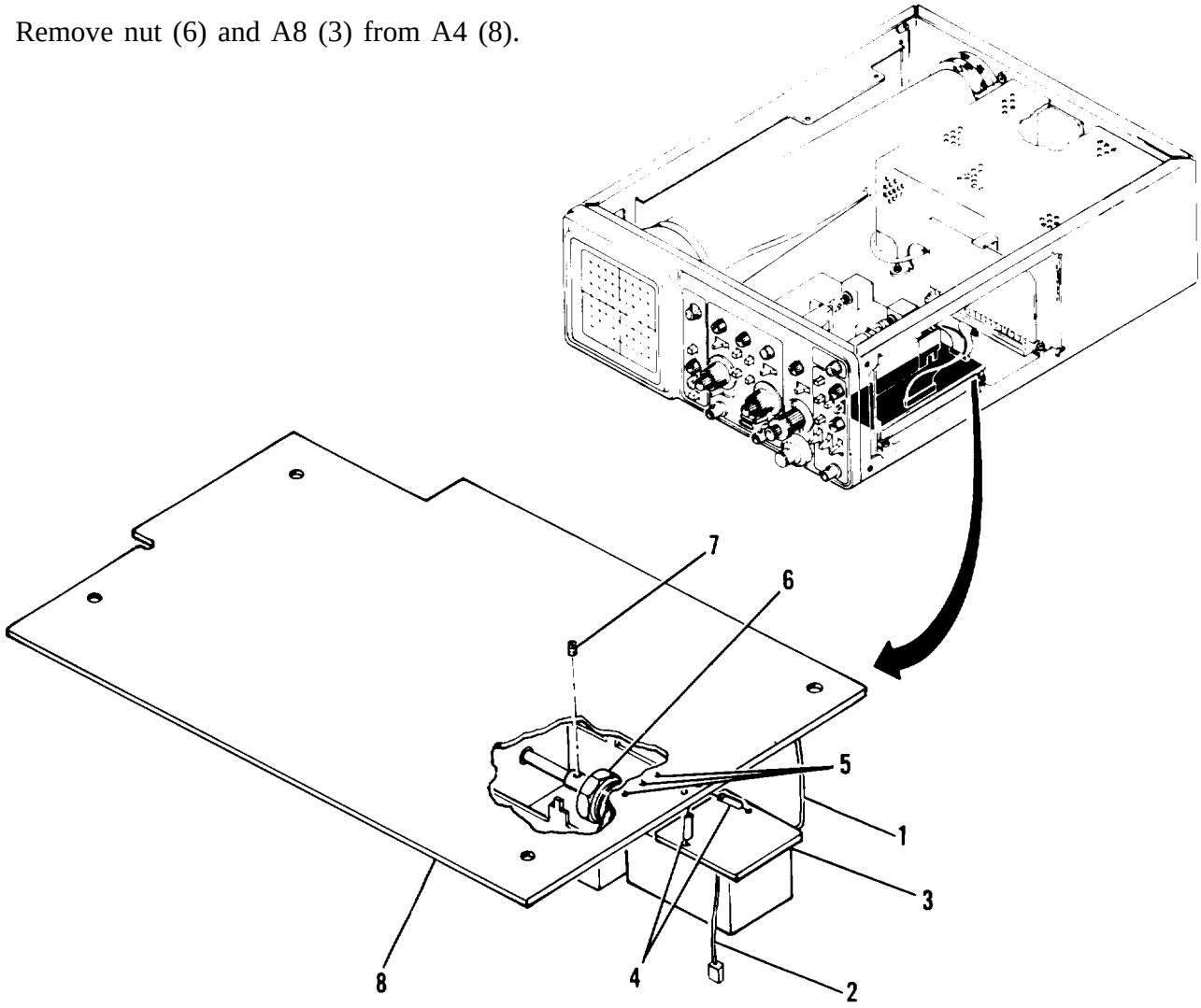
2-21. A8 TIMING POT CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13) and A4 (para 2-20).
2. Unsolder wire W9722 (1) and wire (2) on A8 (3).
3. Unsolder two bus conductors (4) and leads (5).
4. Loosen setscrew (7).
5. Remove nut (6) and A8 (3) from A4 (8).



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2-21. A8 TIMING POT CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

INSTALL

1. Properly position A8 (3) on A4 (8) and secure with nut (6).
2. Slide shaft into A8 and tighten setscrew (7).
3. Solder leads (5), two bus conductors (4), wire W9722 (1), and wire (2).
4. Install A4 (para 2-20) and cabinet (para 2-13).

END OF TASK

2-22. BOTTOM SHIELD MODULE REMOVAL

DESCRIPTION

This procedures covers: Remove and Install

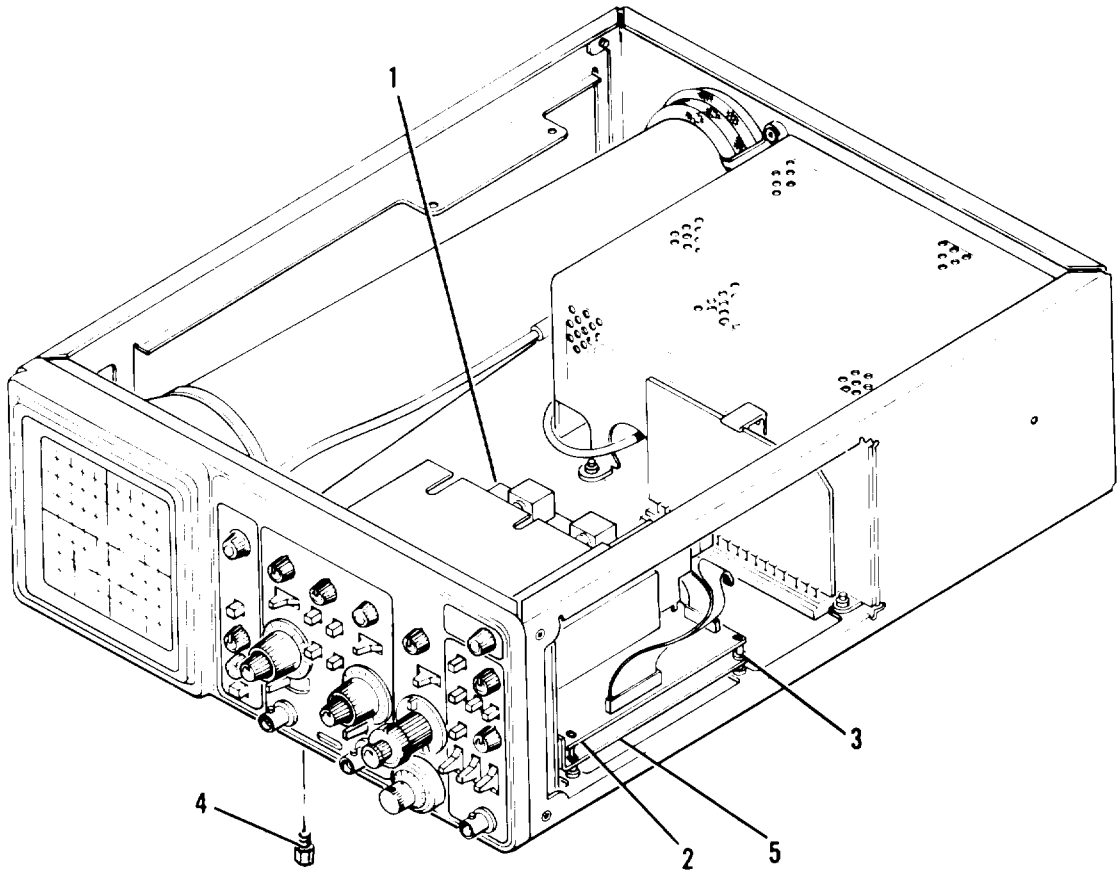
NOTE

The bottom shield module consists of bottom shield, A2, and A4.

REMOVE

1. Perform A2 (1) removal procedures (para 2-19, 1 through 6).
2. Perform A4 (2) removal procedures (para 2-20, 2 through 6).
3. Place oscilloscope on side and remove three screws (3) and spacer (4).
4. Pull shield (5) along with A2 (1) and A4 (2) back until pins are disengaged and switch shafts clear front panel.

2-22. BOTTOM SHIELD MODULE REMOVAL (CONT)



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INSTALL

1. Position module in oscilloscope by inserting switch shafts through front panel and seating interconnecting pins.
2. Place oscilloscope on side and secure module with three screws (3) and spacer (4).
3. Install A4 (2) (para 2-20, 4 through 7).
4. Install A2 (1) (para 2-19, 5 through 9).
5. Install cabinet (para 2-13).

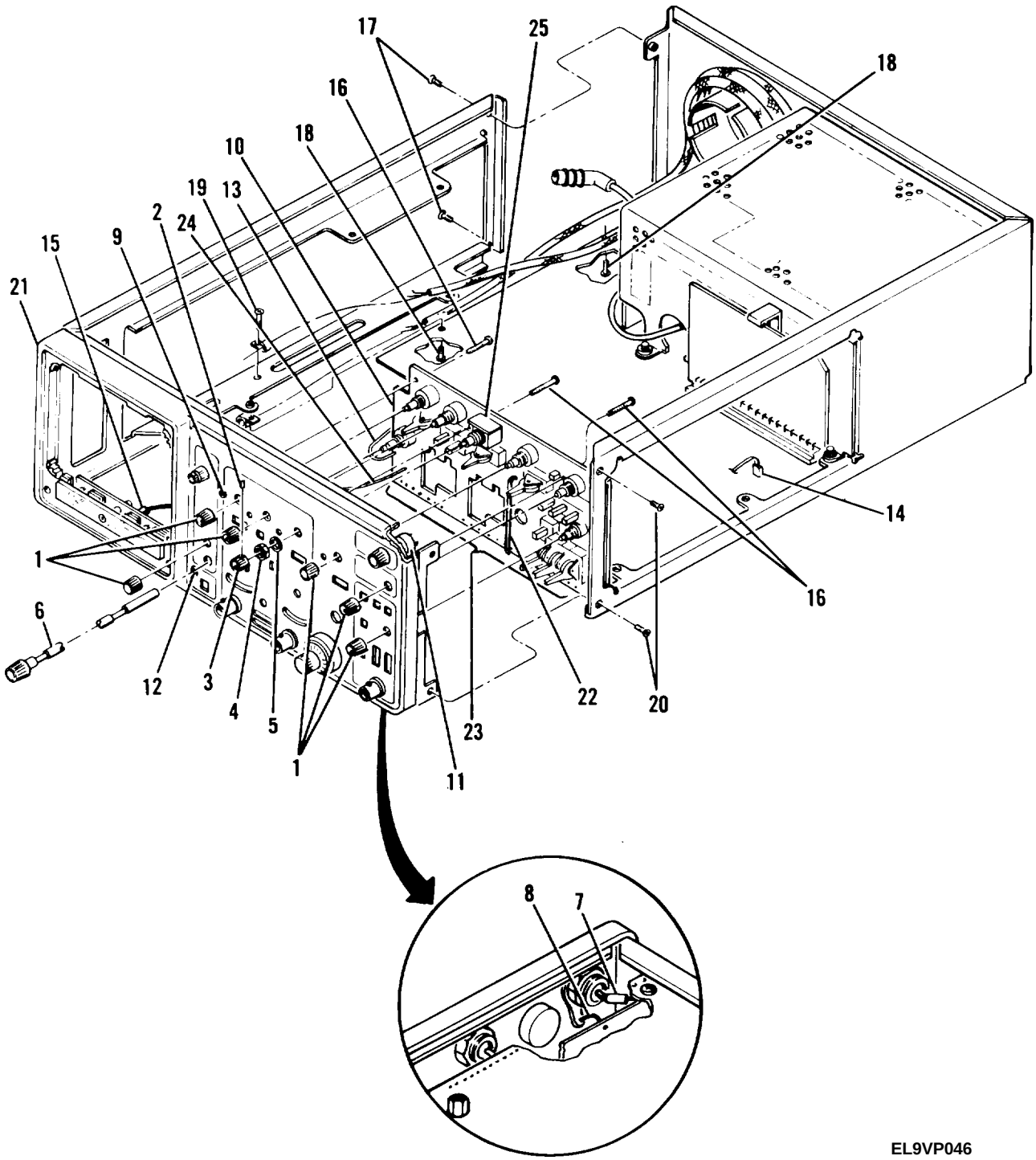
END OF TASK

2-23. A3 FRONT PANEL CIRCUIT BOARD ASSEMBLY REPLACEMENT

REMOVE

1. Remove cabinet (para 2-13), crt (para 2-14), and bottom shield module (para 2-22).
2. Pull six knobs (1).
3. Loosen setscrew (2) and remove knob (3), nut (4), and washer (5).
4. Pull FOCUS pot shaft (6) and remove from front panel.
5 Unsolder resistor (7), wire strap (8), AMP CAL lead (9) at A3 (10) (located between front panel and A3), and VAR HOLDOFF wires (11) at potentiometer.
6. Disengage POWER indicator DS9150 (12) from front panel.
7. Disconnect P9802 (13) and W9644 (14) from A1.
8. Disconnect P9882 (15) from A10.
9. Set front panel switches to center position.
10. Remove three screws (16) from A3, two screws (17) from chassis, two screws (18) from Al, one screw (19) from delay line, and two screws (20) at right front corner.
11. Pull front-left frame (21) from chassis.
12. Unsolder leads (22) from W9409 (located on back of A3).
13. Unsolder 39 wire straps (23) (located between A1 and A3).
14. Unsolder W9881 (24) (located on front of A3).
15. Remove A3 (10). Clean wire strap holes in Al.
16. Remove A7 (25) (para 2-24).

2-23. A3 FRONT PANEL CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



2-23. A3 FRONT PANEL CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

INSTALL

1. Install A7 (25) on A3 (10) (para 2-24).
2. Position A3 (10) on Al and solder 39 wire straps (23).
3. Solder W9881 (24) to front of A3 (10).
4. Solder W9409 to back of A3.
5. Position front-left assembly (18) with chassis.
6. Install two screws (20) at right front corner, screw (19) at delay line, two screws (18) at A 1, two screws (17) at left rear corner, and three screws (16) at front panel.
7. Connect P9882 (15) to A1O.
8. Connect P9802 (13) and W9644 (14) to Al.
9. Insert POWER indicator DS9150 (12) in front panel.
10. Solder resistor (7), wire strap (8), and AMP CAL lead (9) to A3 (between A3 and front panel.
11. Solder wires (11) to VAR HOLDOFF pot.
12. Insert FOCUS pot shaft (6) through front panel and connect to pot.
13. Install washer (5), nut (4), and knob (3). Tighten setscrew (2).
14. Install six knobs (l).
15. Install bottom shield module (para 2-22), crt (para 2-14), and cabinet (para 2-13).

END OF TASK

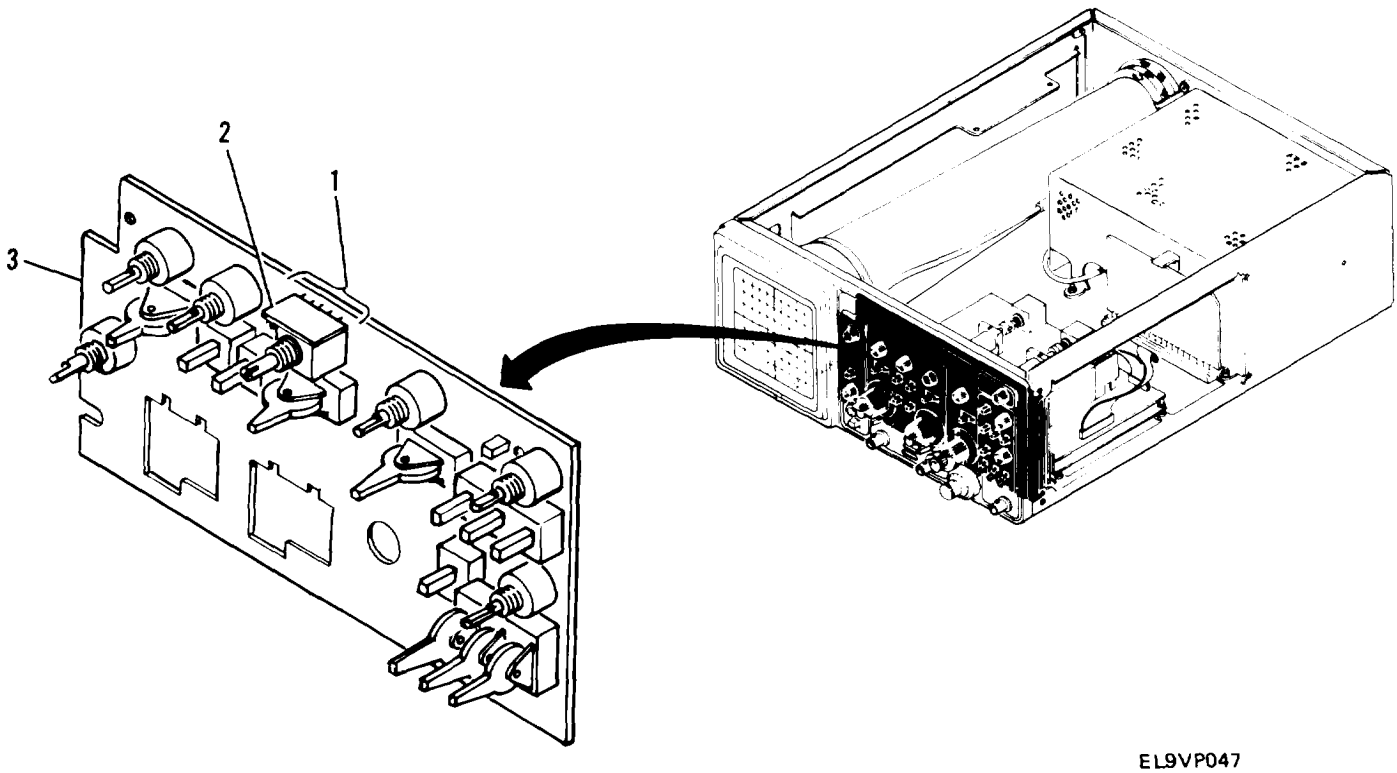
2-24. A7 CHANNEL 2 POSITION POT CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Perform A3 removal procedure (para 2-23, steps 1 through 11).
2. Unsolder five wire straps (1) at A3.
3. Remove A7 (2) from A3 (3) and clean wire strap holes of any solder.



INSTALL

1. Solder five wire straps (1) from A7 (2) to A3 (3).
2. Perform A3 (3) installation procedure (para 2-23, steps 1 through 11)
3. Install cabinet (para 2-13).

END OF TASK

2-25. Al MAIN CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install

REMOVE

1. Remove cabinet (para 2-13).
2. Disconnect P9644 (1) from Al (2).
3. Remove pcb A5 (para 2-18) and power supply shield (para 2-16).
4. Unsolder two wires from A6 at W9190 (3) and W9040 (4).
5. Disconnect cables that go between A1 and A2, and between A1 and A4. Note locations.
6. Disconect P9802 (5).
7. Pull focus shaft (6) straight out from front panel.
8. Disengage POWER LED (7) from front panel.
9. Press POWER switch (8) to ON. Insert a scribe or similar tool into notch between end of switch shaft (9) and extension (10) and gently pry apart. Push extension (10) forward, then sideways to clear shaft (9), then pull extension back and out.
10. Unsolder wire W9800 (11) from EXT Z AXIS INPUT BNC connector located on rear panel.
11. Remove two screws (12).

WARNING

Crt anode and high-voltage multiplier output leads retain a high-voltage charge after oscilloscope is turned off. Disconnect high-voltage multiplier lead from crt anode lead and ground both leads.

12. Carefully disconnect crt anode lead (13) and ground to chassis.
13. Disconnect horizontal and vertical deflection wires (14) from crt.
14. Unsolder two sets of socket wires (15). Note location for installation.
15. Unsolder two sets of delay line wires (16). Note location for installation.

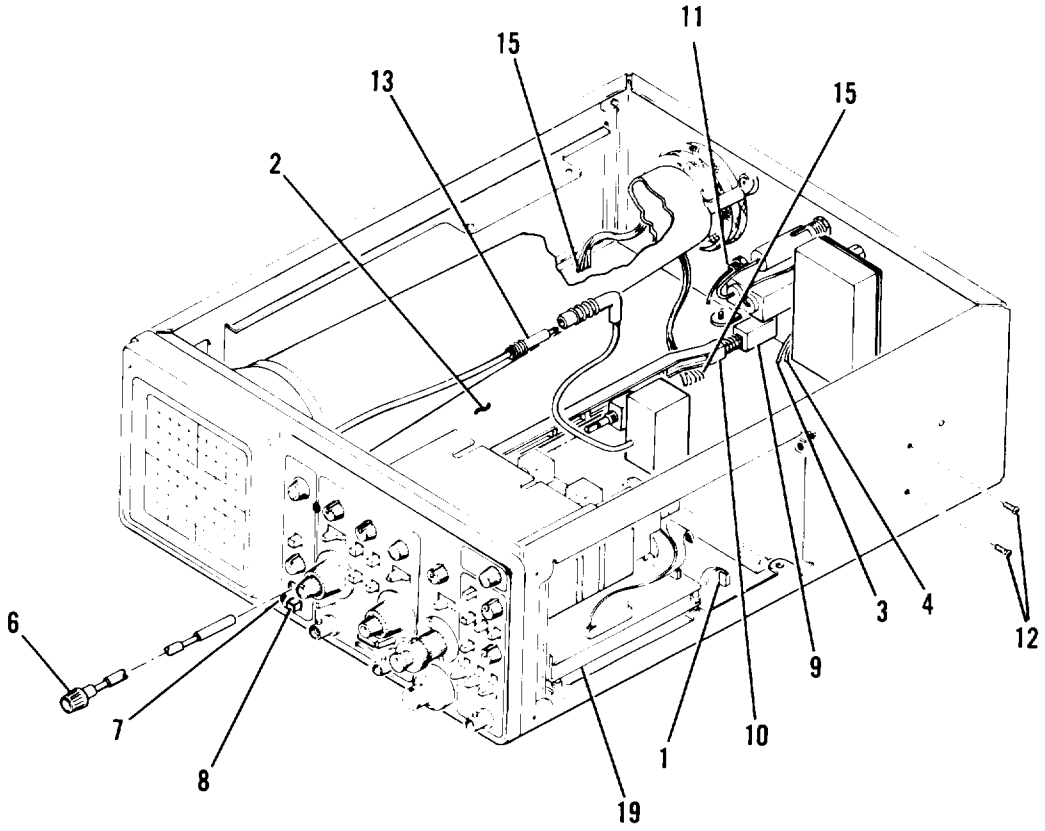
2-25. Al MAIN CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

16. Remove three screws (17) and spacer (18) at bottom shield (19) and three screws (20) at chassis.

17. Identify and unsolder two leads (21) at W941O and one lead (22) at W9880 on A1.

18. Unsolder 39 wire straps (23) (located between A1 and A3).

19. Push wire-strap connection end of A1 (2) down until clear of all strap ends. Remove A1 (2) through bottom of chassis.



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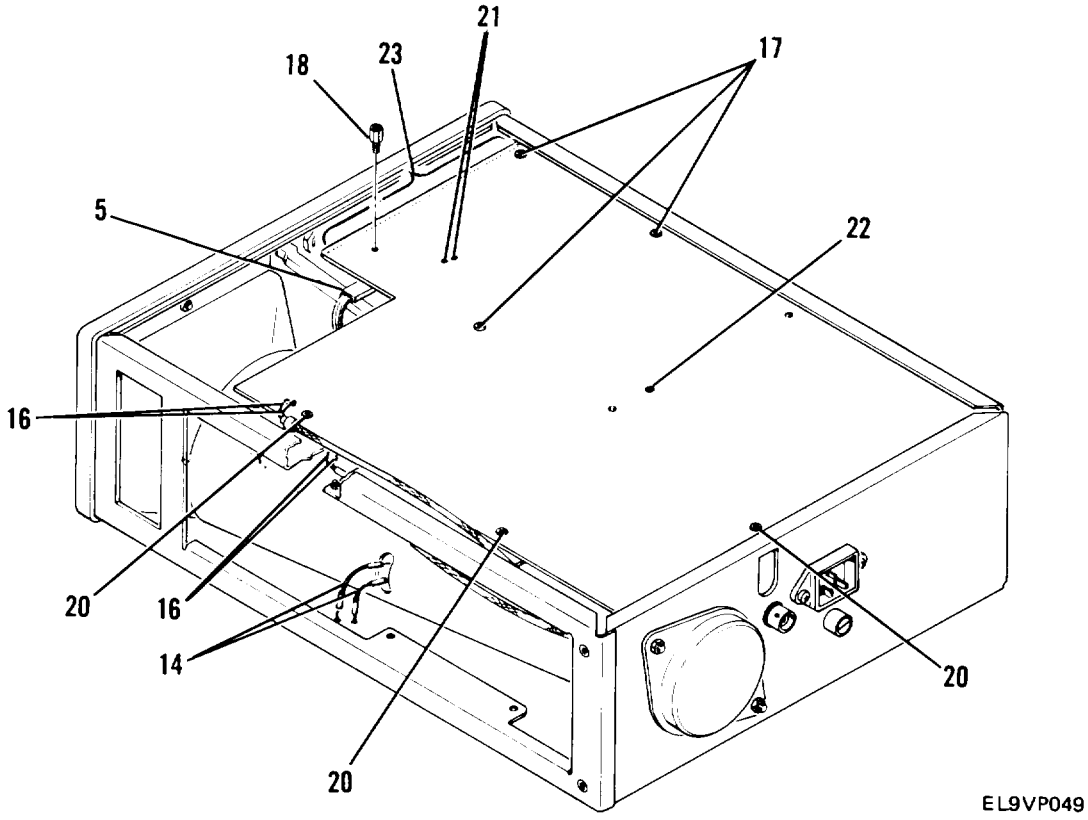
2-25. Al MAIN CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)



INSTALL

1. Position Al (2) into bottom of chassis.
2. Solder 39 wire straps (23) to A1 (2) (located between Al and A3).
3. Solder two leads (22) at W9880 and one lead (21) at W941O.
4. Secure A 1 with three screws (20).
5. Secure shield (19) to Al with three screws (17) and spacer (18).
6. Solder two sets of wires (16) from delay line to Al.
7. Solder two sets of wires (15) from crt socket to Al.
8. Connect horizontal and vertical deflection wires (14) to crt.
9. Connect crt anode lead (13) to high-voltage multiplier lead.

2-25. Al MAIN CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

10. Secure heatsink assembly to chassis with two screws (12).
11. Solder wire W9800 (11) to EXT Z AXIS BNC connector located on rear panel.
12. Position extension (10) into front panel. Push extension forward, then sideways to line up with shaft (9). Snap extension and shaft together.
13. Insert POWER LED (7) into front panel.
14. Insert focus shaft (6) into front panel.
15. Connect cables that go from Al to A2 and from Al to A4.
16. Connect P9802 (5).
17. Solder two wires from A6 to A1 at W9190 (3) and W9040 (4).
18. Install power supply shield (para 2-16) and A5 (para 2-18).
19. Connect P9644 (1) to Al (2).
20. Install cabinet (para 2-13).

END OF TASK

2-26. CLEANING

DESCRIPTION

This procedure covers: Cleaning

1. Unplug power cord and remove cabinet (para 2-13).

WARNING

Use approved personal protective equipment (goggles/ face shield) when using compressed air. Provide protection from flying particles. Do not direct airstream toward self or other personnel, as injury may result.

2. Use dry, low-pressure air (approximately 9 psi) to blow off dirt.

3. Remove any remaining dirt with soft-bristle brush or soft cloth dampened in a mild detergent and water solution. Use cotton-tipped applicator for cleaning in narrow spaces and on pcb's.

WARNING

Isopropyl alcohol is flammable and harmful to eyes, skin, and breathing passages. Provide adequate ventilation. Keep ignition sources away, and wear protective clothing.

CAUTION

Use only isopropyl alcohol as a cleaning solution, especially around attenuator A2. Carbon-based solvents damage board material.

4. Clean the switch contacts by applying alcohol with a small camel hair brush. Do not use cotton-tip applicators for cleaning contacts.

END OF TASK

2-27. PERFORMANCE TESTS

The performance tests are broken into five parts:

Initial Setup

Vertical Circuits Tests

Horizontal Circuits Tests

Trigger Circuits Tests

External Z-Axis and Amplitude Calibrator Circuits Tests

NOTES

- Each section of the performance tests must be done in order and in their entirety to ensure correct control settings.
- Allow an inital 20 minute warm up period when performing the first test to ensure the equipment stabilizes.

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 V ac source.

2. Press POWER ON/OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.

3. Set oscilloscope controls as follows:

Control	Setting
l Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	On (switch in)
VOLTS/DIV	2 mV
VOLTS/DIV Variable	CAL detent
AC/ GND/DC	AC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	0.2 ms
SEC/ DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	AC

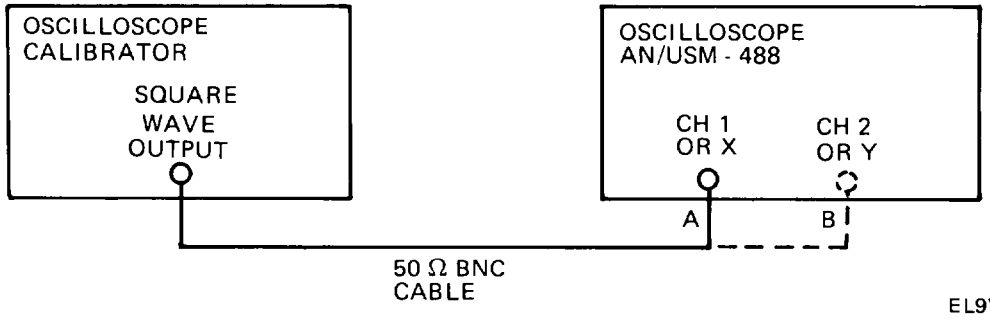
a. **Vertical Circuits Tests.** perform vertical circuit tests in their entirety and in the following order:

- Vertical Deflection and Variable Range Test
- Vertical Position Range Test
- Trigger View Gain Test
- Vertical Aberration Test
- Vertical Bandwidth Test
- Vertical Bandwidth Limit Test
- Vertical Common-Mode Rejection Ratio Test
- Vertical Channel Isolation Test

VERTICAL DEFLECTION AND VARIABLE RANGE TEST

1. Perform Initial Setup Procedure.

2. Connect test equipment as shown, connection A.



3. Select each oscilloscope channel 1 and oscilloscope calibrator setting combination listed below and verify that oscilloscope vertical deflection and accuracy is within the limits shown.

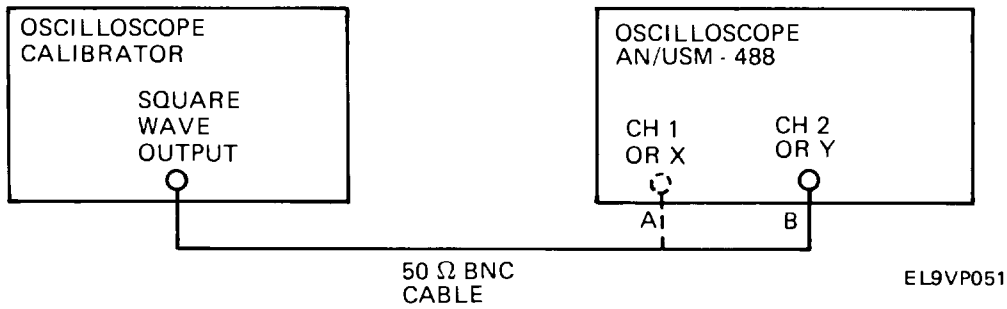
VOLTS/DIV Switch Setting	VOLTS/DIV Variable Setting	Oscilloscope Calibrator Signal	Vertical Defelection (Divisions)	Accuracy Limits (Divisions)
2 mV	Detent	10 mV	5	4.90 - 5.10
5 mV	Detent	20 mV	4	3.92 - 4.08
10 mV	Detent	50 mV	5	4.90 - 5.10
20 mV	Detent	0.1 V	5	4.90 - 5.10
20 mV	Fully CCW	0.1 V	2	1.50 - 2.00
50 mV	Detent	0.2 V	4	3.92 - 4.08
0.1 V	Detent	0.5 V	5	4.90 - 5.10
0.2 V	Detent	1 V	5	4.90 - 5.10
0.5 V	Detent	2 V	4	3.92 - 4.08
1 V	Detent	5 V	5	4.90 - 5.10
2 V	Detent	10 V	5	4.90 - 5.10
5 V	Detent	20 V	4	3.92 - 4.08

4. Move cable to connection 2.

5. Set oscilloscope VERTICAL MODE switch to CH 2. Repeat step 3 using channel 2 controls.

VERTICAL POSITION RANGE TEST

1. Connect test equipment as shown, connection B.



2. Set oscilloscope controls as follows:

   - CH 1 and CH 2 VOLTS /DIV to 10 mV
   - CH 1 and CH 2 AC/ GND/DC to AC

3. Set oscilloscope calibrator for 0.1 V output signal.

4. Adjust oscilloscope CH 2 VOLTS/ DIV variable control for a 7-division display. Channel 2 UNCAL LED comes on. Set calibration generator for 0.2 V output.

5. Rotate Channel 2 POSITION control fully clockwise. Check that bottom of trace is at top graticule or above.

6. Rotate Channel 2 POSITION control fully counterclockwise. Check that top of trace is at bottom graticule or below.

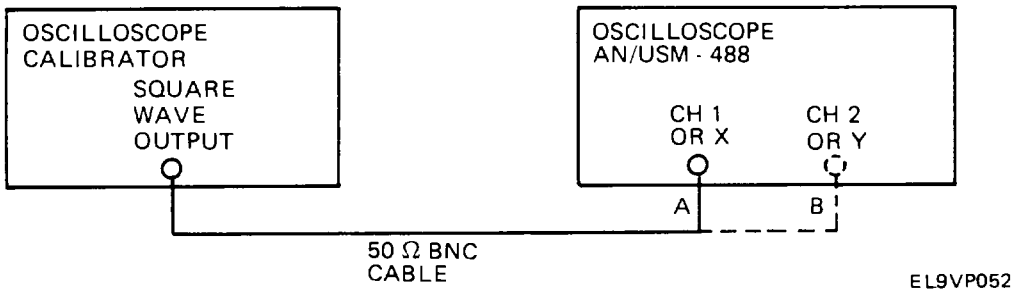
7. Reconnect test equipment to oscilloscope as shown above.

8. Move cable to connection A.

9. Repeat steps 3 through 5 using channel 1 controls.

TRIGGER VIEW GAIN TEST

1. Connect test equipment as shown below, connection A.



2. Set oscilloscope controls as follows:

   - Channel 1 and Channel 2 POSITION to midrange
   - CH 1 and CH 2 VOLTS /DIV to 0.1 V
   - CH I and CH 2 VOLTS/ DIV variable control to CAL detent

3. Set oscilloscope calibrator for an 0.5 V output.

4. While holding oscilloscope TRIG VIEW switch in, vertically center display with A TRIGGER LEVEL control.

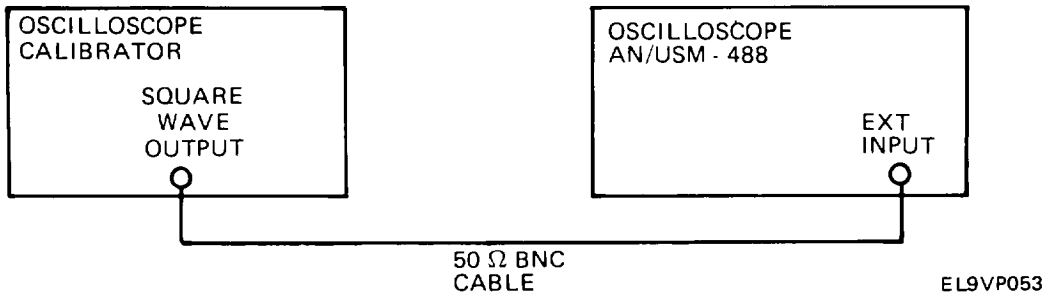
5. Check that display amplitude is 4 to 6 divisions high while holding TRIG VIEW switch in.

6. Move cable to connection B.

7. Set VERTICAL MODE to CH 2.

8. Repeat steps 3 through 5 using channel 2 controls.

9. Connect test equipment as shown below.



TRIGGER VIEW GAIN TEST (CONT)

10. Set A SOURCE switch to EXT and repeat steps 3 through 5.

11. Set A EXT COUPLING switch to DC and repeat steps 3 through 5.

12. Set A EXT COUPLING switch to DC÷10, oscilloscope calibrator for a 5 V output, and repeat steps 3 through 5.

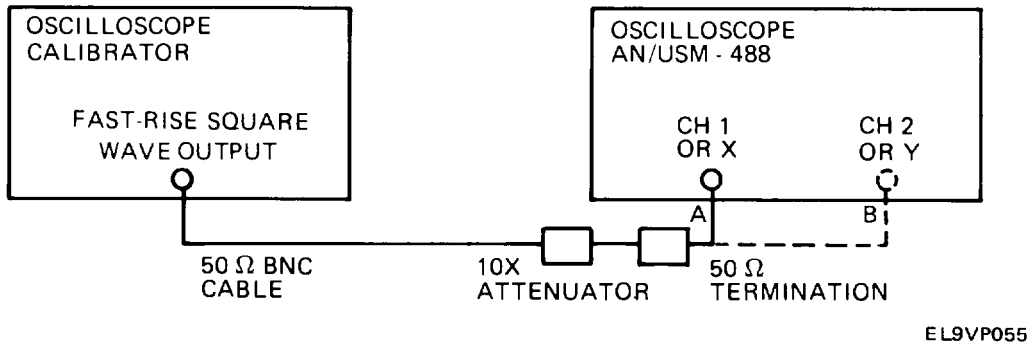
13. Disconnect test equipment.

VERTICAL ABERRATION TEST

1. Set oscilloscope controls as follows:

   - VERTICAL MODE to CH 1
   - BW LIMIT to Off
   - CH 1 and CH 2 VOLTS/DIV to 2 mV
   - CH 1 and CH 2 AC/GND/DC to DC
   - A SOURCE to INT
   - A SEC/ DIV switch to 0.05 us

2. Connect test equipment as shown below, connection A.



3. Set oscilloscope calibrator for 1 MHz, 5-division display.

4. Use vertical POSITION control to set display at center graticule.

5. Check that display aberrations are within 4% (0.2 division or less).

6. Repeat step 4 for all VOLTS/DIV switch settings from 5 mV position to 0.2 V position. Adjust calibration generator and attach or remove 10X Attenuator to maintain 5-division display at each VOLTS/DIV switch setting.

7. Set oscilloscope calibrator for minimum output.

VERTICAL ABERRATION TEST (CONT)

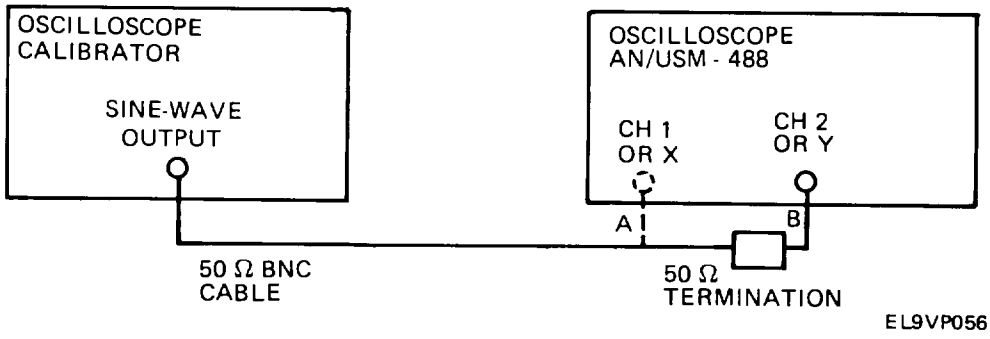
8. Move cable to connection B.
9. Set oscilloscope VERTICAL MODE to CH 2.
10. Set calibration generator for l-MHz, 5 division display.
11. Use vertical POSITION control to set display top at center graticule.
12. Repeat steps 5 and 6 using channel 2 controls.
13. Disconnect test equipment.

VERTICAL BANDWIDTH TEST

1. Set oscilloscope controls as follows:

   - CH 1 and CH 2 VOLTS/DIV to 2 mV
   - A SEC/DIV to 20 US

2. Connect test equipment as shown below, connection B.



3. Set oscilloscope calibrator for 50 kHz, 6-division display.

VERTICAL BANDWIDTH TEST (CONT)

4. Check that oscilloscope display amplitude is 4.2 divisions or greater as oscilloscope calibrator output frequency is increased up to values shown below for each corresponding VOLTS/DIV switch setting.

VOLTS/DIV Switch Setting	Oscilloscope Calibrator Output Frequency
2 mV	90 MHz
5 mV - 1 V	100 MHz

5. Repeat steps 3 and 4 for all VOLTS/DIV settings from 5 mV to 1 V.

6. Move cable to connection A.

7. Set oscilloscope VERTICAL MODE switch to CH 1.

8. Repeat steps 3 and 4 using channel 1 controls.

VERTICAL BANDWIDTH LIMIT TEST

1. Set oscilloscope controls as follows:

   - BW LIMIT switch to On (switch in)
   - CH 1 VOLTS/DIV switch to 10 mV
   - A SEC/DIV switch to 20 us

2. Set oscilloscope calibrator output for 50 kHz, 6-division display.

3. Increase oscilloscope calibrator output frequency until display amplitude decreases to 4.2 divisions.

4. Check that oscilloscope calibrator output frequency is between 18 and 22 MHz.

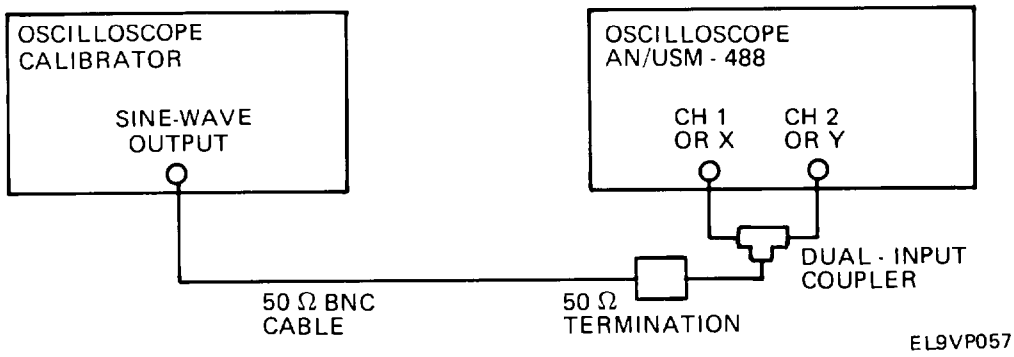
5. Disconnect test equipment.

VERTICAL COMMON-MODE REJECTION RATIO TEST

1. Set oscilloscope controls as follows:

   - BW LIMIT switch to Off (switch out)
   - CH 2 VOLTS/DIV switch to 10 mV
   - INVERT switch to On

2. Connect test equipment as shown below.



3. Set oscilloscope calibrator for 80 MHz, 6-division display.

4. Adjust Channel 1 POSITION control to vertically center display.

5. Set VERTICAL MODE switch to CH 2 and use Channel 2 POSITION control to vertically center display.

6. Set VERTICAL MODE switches to BOTH and ADD.

7. Check that display amplitude is 0.6 division or less.

8. If display amplitude is 0.6 division or less, go to step 17. If display amplitude is more than 0.6 division, go to step 9.

9. Set VERTICAL MODE switch to CH 1.

10. Set oscilloscope calibrator for 50 kHz, 6-division display.

11. Set VERTICAL MODE switch to BOTH.

12. Adjust CH 1 or CH 2 VOLTS/DIV variable control for minimum display amplitude.

13. Set VERTICAL MODE switch to CH 1.

VERTICAL COMMON-MODE REJECTION RATIO TEST (CONT)

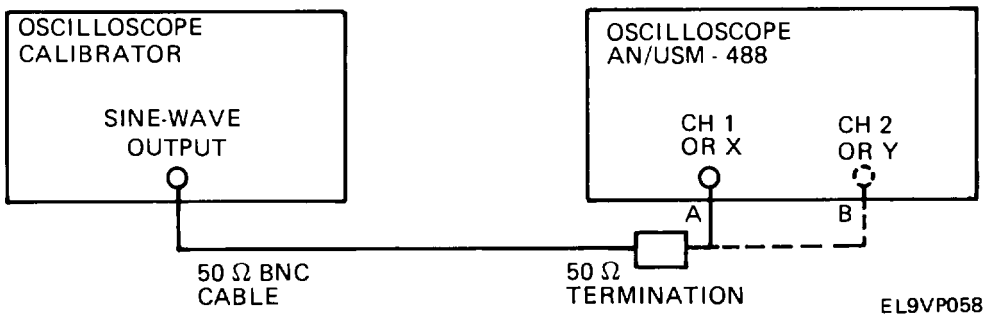
14. Set oscilloscope calibrator for 80 MHz, 6-division display,
15. Set VERTICAL MODE switch to BOTH.
16. Check that display amplitude is 0.6 division or less.
17. Disconnect test equipment from oscilloscope.

VERTICAL CHANNEL ISOLATION TEST

1. Set oscilloscope controls as follows:

   - VERTICAL MODE to CH 1
   - CH 1 and CH 2 VOLTS/DIV to 0.5 V
   - CH 1 and CH 2 VOLTS/DIV variable control to CAL detent
   - INVERT to Off
   - Channel 2 AC/GND/DC to GND
   - A SEC/DIV to 0.1 us

2. Connect test equipment as shown below. connection A.



3. Set oscilloscope calibrator for 50 MHz, 5 V p-p output.
4. Set VERTICAL MODE switch to CH 2.
5. Check that display amplitude is 0.10 division or less.
6. Move cable to connection B.

VERTICAL CHANNEL ISOLATION TEST (CONT)

7. Set oscilloscope controls as follows:

   - VERTICAL MODE to CH 1
   - Channel 1 AC/GND/DC to GND
   - Channel 2 AC/GND/DC to DC

8. Check that display amplitude is 0.10 division or less.

9. Disconnect test equipment.

END OF TASK

b. Horizontal Circuits Tests. Horizontal circuit tests are structured as one task, and should be performed in their entirety and in the order presented to ensure correct control settings for each test.

- Initial Setup
- Horizontal Timing Accuracy and Linearity Test
- Horizontal Variable Range and Sweep Separation Test
- Horizontal Delay Time Dial Range and Accuracy Test
- Horizontal Delay Jitter Test
- Horizontal Position Range Test
- Horizontal X Gain Test
- Horizontal X Bandwidth Test
- Horizontal Sweep Length Test

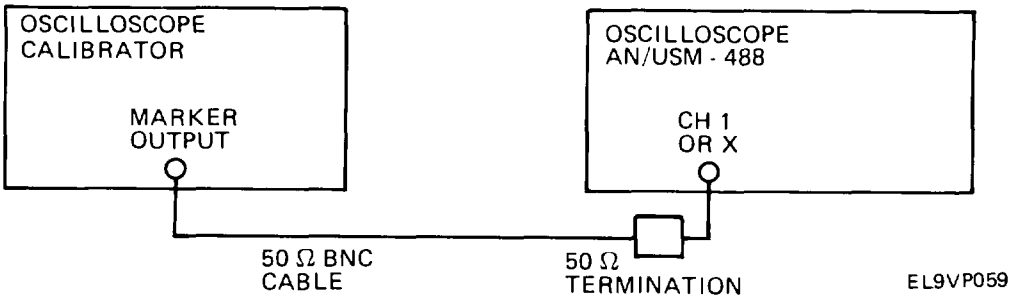
INITIAL SETUP

Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/DIV	0.5 **v**
VOLTS/DIV Variable	CAL detent
AC/GND/DC	DC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	**0.05** us
SEC/DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
B DELAY TIME POSITION	Fully counterclockwise
• A Trigger	
VAR HOLDOFF	NORM
Mode	NORM
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	DC÷10
• B Trigger	
SLOPE	OUT
LEVEL	Fully clockwise

HORIZONTAL TIMING ACCURACY AND LINEARITY TEST

1. Connect test equipment as shown below.



2. Set oscilloscope calibrator for 50 ns time marker output.

3. Adjust A TRIGGER LEVEL for stable, triggered display.

4. Adjust horizontal POSITION control to align second time marker with second vertical graticule line.

5. Check that timing accuracy is within 2% (0. 16 division at tenth vertical graticule line) and linearity is within 57% (0. 1 division over any two of center eight divisions).

NOTE

For A SEC/DIV timing accuracy, check switch settings from 50 ns to 0.5 s, only watch time marker tips at the second and tenth vertical graticules while adjusting horizontal POSITION control.

6. Repeat steps 3 through 5 for each remaining oscilloscope and oscilloscope calibrator setting combination as given below.

HORIZONTAL TIMING ACCURACY AND LINEARITY TEST (CONT)

A SEC/DIV Switch Setting	Oscilloscope Calibrator Setting
0.05 us	50 ns
0.1 us	0.1 us
0.2 us	0.2 us
0.5 us	0.5 us
1 us	1 us
2 us	2 us
5 us	5 us
10 US	10 us
20 us	20 us
50 us	50 us
0.1 ms	0.1 ms
0.2 ms	0.2 ms
0.5 ms	0.5 ms
1 ms	1 ms
2 ms	2 ms
5 ms	5 ms
10 ms	10 ms
20 ms	20 ms
50 ms	50 ms
0.1 s	0.1s
0.2 s	0.2 s
0.5 s	0.5 s

7. Set oscilloscope controls as follows:

   l A SEC/DIV to 0.05 US
   l X 10 Magnifier to On

8. Set oscilloscope calibrator for a 10 ns time marker output.

9. Adjust horizontal POSITION control to align first time marker that is 25 ns beyond sweep start with second vertical graticule.

10. Check that timing accuracy is within 3% (0.24 division at tenth vertical graticule) and linearity is within 5% (0.1 division over any two of center eight divisions). Exclude any portion of sweep past one-hundredth magnified division.

HORIZONTAL TIMING ACCURACY AND LINEARITY TEST (CONT)

11. Repeat steps 9 and 10 for each remaining A SEC/ DIV and oscilloscope calibrator setting combination given below.

A SEC/DIV Switch Setting	Oscilloscope Calibrator Setting
0.05 us	10 ns
0.1 us	10 ns
0.2 us	20 ns
0.5 us	50 ns
1 us	0.1 us
2 us	0.2 us
5 us	0.5 us
10 us	1 us
20 us	2 us
50 us	5 us
0.1 ms	10 US
0.2 ms	20 us
0.5 ms	50 us
1 ms	0.1 ms
2 ms	0.2 ms
5 ms	0.5 ms
10 ms	1 ms
20 ms	2 ms
50 ms	5 ms
0.1 s	10 ms
0.2 s	20 ms
0.5 s	50 ms

12. Set oscilloscope controls as follows:

- HORIZONTAL MODE to B
- A SEC/DIV to 0.1 US
- B SEC/DIV to 0.05 US
- X 10 Magnifier to Off

13. Repeat steps 2 through 6 using each B SEC/DIV and oscilloscope calibrator setting combination given below. Keep A SEC/DIV switch at one setting slower than B SEC/ DIV switch for the 0.05 us and 0.1 us steps.

HORIZONTAL TIMING ACCURACY AND LINEARITY TEST (CONT)

B SEC/DIV Switch Setting	Oscilloscope Calibrator Setting
0.05 us	50 ns
0.1 us	0.1 us
0.2 us	0.2 us
0.5 us	0.5 us
1 us	1 us
2 us	2 us
5 us	5 us
10 us	10 us
20 us	20 us
50 us	50 us
0.1 ms	0.1 ms
0.2 ms	0.2 ms
0.5 ms	0.5 ms
1 ms	1 ms
2 ms	2 ms
5 ms	5 ms
10 ms	10 ms
20 ms	20 ms
50 ms	50 ms

14. Set oscilloscope controls as follows:

    l B SEC/DIV to 0.05 US
    l X 10 Magnifier to On

15. Set oscilloscope calibrator for 10 ns time marker output.

16. Adjust horizontal POSITION control to align first time marker that is 25 ns beyond sweep start with second vertical graticule.

17. Check that timing accuracy is within 3% (0.24 division at tenth vertical graticule) and linearity is within 5% (O. 1 division over any two of center eight divisions). Exclude any portion of sweep past one-hundredth magnified division.

18. Repeat steps 16 and 17 for each remaining B SEC/DIV and oscilloscope calibrator setting combination given below.

HORIZONTAL TIMING ACCURACY AND LINEARITY TEST (CONT)

B SEC/DIV Switch Setting	Oscilloscope Calibrator Setting
0.05 us	10 ns
0.1 us	10 ns
0.2 us	20 ns
0.5 us	50 ns
1 us	0.1 us
2 us	0.2 us
5 us	0.5 us
10 us	1 us
20 us	2 us
50 us	5 us
0.1 ms	10 us
0.2 ms	20 us
0.5 ms	50 us
1 ms	0.1 ms
2 ms	0.2 ms
5 ms	0.5 ms
10 ms	1 ms
20 ms	2 ms
50 ms	5 ms

HORIZONTAL VARIABLE RANGE AND SWEEP SEPARATION TEST

1. Set oscilloscope controls as follows:

   - HORIZONTAL MODE to A
   - A AND B SEC/DIV to 0.2 ms
   - SEC/ DIV variable control to fully counterclockwise
   - X 10 Magnifier to Off
   - A TRIGGER mode to P-P AUTO

2. Set oscilloscope calibrator for 0.5 ms time marker output.

3. Check that time markers in display are 1 division or less apart.

4. Set oscilloscope controls as follows:

   - CH 1 AC/GND/DC to GND
   - SEC/DIV variable control to CAL detent
   - HORIZONTAL MODE to ALT

HORIZONTAL VARIABLE RANGE AND SWEEP SEPARATION TEST (CONT)

5. Adjust Channel 1 POSITION control to set A Sweep at center horizontal graticule.

6. Check that B Sweep can be positioned more than 3.5 divisions both above and below A Sweep when A/B SWP SE-P control is rotated fully clockwise and counterclockwise, respectively.

HORIZONTAL DELAY TIME DIAL RANGE AND ACCURACY TEST

1. Set oscilloscope B DELAY TIME POSITION fully counterclockwise.

2. Align A Sweep start with first vertical graticule using horizontal POSITION control.

3. Check that intensified portion of trace starts within 0.5 division of sweep start.

4. Rotate B DELAY TIME POSITION dial fully clockwise.

5. Check that intensified portion of trace is to right of eleventh vertical graticule.

6. Set oscilloscope controls as follows:

   - A AND B SEC/DIV to 0.5 US
   - B DELAY TIME POSITION to fully counterclockwise

7. Adjust horizontal POSITION control to align A Sweep start with first vertical graticule.

8. Check that intensified portion of trace starts within 1.1 divisions of sweep start.

9. Repeat steps 4 and 5.

10. Set oscilloscope controls as follows:

    - CH 1 AC/GND/DC to DC
    - HORIZONTAL MODE to B
    - A SEC/DIV to 0.5 US
    - B SEC/DIV to 0.05 US
    - B DELAY TIME POSITION to 1.00

11. Set oscilloscope calibrator for 0.5 us time marker output.

12. Adjust horizontal POSITION control to align top of first fully displayed time marker with center vertical graticule.

13. Set B DELAY TIME POSITION dial to 9.00, then readjust as necessary to align top of time marker with center vertical graticule.

14. Check that B DELAY TIME POSITION is between 8.910 and 9.090.

HORIZONTAL DELAY TIME DIAL RANGE AND ACCURACY TEST (CONT)

15. Repeat steps 12 through 14 for each remaining A AND B SEC/DIV and oscilloscope calibrator setting combination given below.

A SEC/DIV Switch Setting	B SEC/DIV Switch Setting	Marker Output Setting
0.5 us	0.05 us	0.5 us
5 us	0.5 us	5 us
0.5 ms	50 us	0.5 ms
5 ms	0.5 ms	5 ms

16. Set oscilloscope controls as follows:

- A SEC/DIV to 0.5 ms
- B SEC/DIV to 50 US
- B DELAY TIME POSITION to 1.00

17. Set oscilloscope calibrator for 0.5 ms time marker output.

18. Adjust horizontal POSITION control to align time marker rising edge with center vertical graticule.

19. Turn B DELAY TIME POSITION dial to position the next time marker leading edge on center vertical graticule.

20. Check that B DELAY TIME POSITION dial setting is 0.980 to 1.020 greater than previous setting.

21. Set B DELAY TIME POSITION dial to the exact integer setting.

22. Repeat steps 18 through 21 for each successive time marker up to marker corresponding to B DELAY TIME POSITION setting of 10.00.

HORIZONTAL DELAY JITTER TEST

1. Set oscilloscope controls as follows:

   - A SEC/DIV to 0.5 ms
   - B SEC/DIV to 0.5 US
   - B DELAY TIME POSITION to 10.00

2. Set oscilloscope calibrator for 50 us time marker output.

3. Rotate B DELAY TIME POSITION dial counterclockwise to position a time marker within graticule area for each major dial division.

4. Check that time marker leading edge jitter does not exceed 0.5 division. Disregard slow drift.

HORIZONTAL POSITION RANGE TEST

1. Set oscilloscope controls as follows:

   - HORIZONTAL MODE to A
   - A SEC/DIV to 10 US

2. Set oscilloscope calibrator for 10 us time marker output.

3. Set horizontal POSITION control fully clockwise. Check that sweep start is to right of center vertical graticule.

4. Set horizontal POSITION control fully counterclockwise. Check that eleventh time marker is to left of center vertical graticule.

5. Set oscilloscope calibrator for 50 us time marker output.

6. Adjust horizontal POSITION control to align third time marker with center vertical graticule.

7. Set X1O Magnifier to On.

8. Set horizontal POSITION control fully counterclockwise. Check that magnified time marker is left of center vertical graticule.

9. Set horizontal POSITION control fully clockwise. Check that sweep start is to right of center vertical graticule.

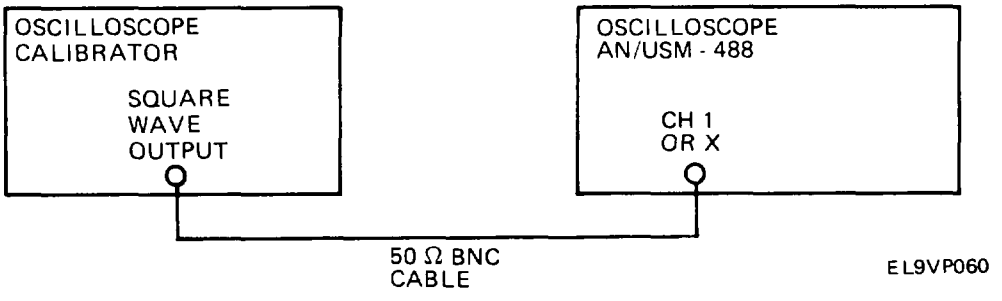
10. Disconnect test equipment.

HORIZONTAL X GAIN TEST

1. Set oscilloscope controls as follows:

   - CH 1 VOLTS/DIV to 10 mV
   - Horizontal POSITION to Midrange
   - A SEC/DIV to X-Y
   - X 10 Magnifier to Off

2. Connect test equipment as shown below.



3. Set oscilloscope calibrator for 50 mV output signal.

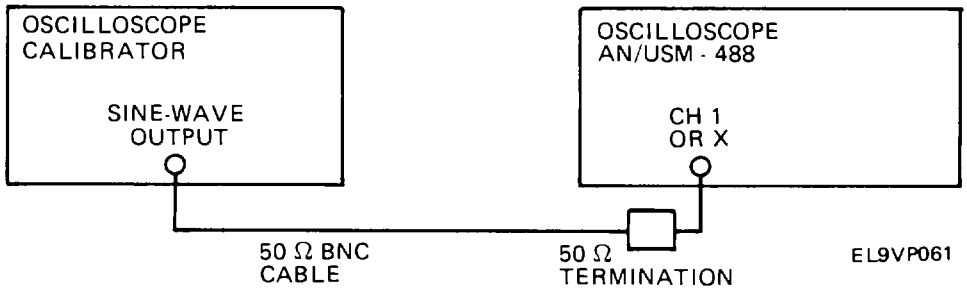
4. Use Channel 2 POSITION control to vertically center trace.

5. Check that X display is 4.85 to 5.15 horizontal divisions.

6. Disconnect test equipment.

HORIZONTAL X BANDWIDTH TEST

1. Connect test equipment as shown below.



2. Set oscilloscope calibrator for 50 kHz, 5-division horizontal display.
3. Increase oscilloscope calibrator output frequency to 2.5 MHz.
4. Check that display is at least 3.5 horizontal divisions.

HORIZONTAL SWEEP LENGTH TEST

1. Set A SEC/DIV to 0.l ms and use horizontal POSITION control to set sweep start at first vertical graticule.
2. Check that sweep end is to right of eleventh vertical graticule.
3. Disconnect test equipment.

END OF TASK

c. **Trigger Circuits Tests.** Trigger circuit tests are structured as one task, and should be performed in their entirety and in the order presented to ensure correct control settings for each test.

- Initial Setup
- Internal A and B Triggering Test
- H F and LF Reject A Triggering Test
- External Triggering Test
- External Triggering Ranges Test
- Single Sweep Operation Test

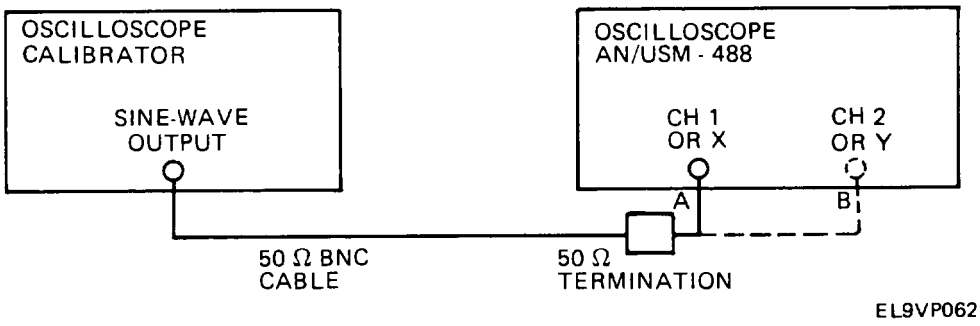
INITIAL SETUP

Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/DIV	5 mV
VOLTS/DIV Variable	CAL detent
AC/GND/DC	DC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	0.2 us
SEC/DIV Variable	CAL detent
X10 Magnifier	Off (knob in)
B DELAY TIME POSITION	Fully counterclockwise
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	DC
• B Trigger	
SLOPE	OUT
LEVEL	Midrange

INTERNAL A AND B TRIGGERING TEST

1. Connect test equipment as shown below, connection A.



2. Set oscilloscope calibrator for 10 M Hz, 3.5-division amplitude display.

3. Set CH 1 VOLTS/DIV switch to 50 mV.

4. Check that stable display can be obtained by adjusting A TRIGGER LEVEL for each setting combination given below.

A TRIGGER Mode	A TRIGGER SLOPE
NORM	OUT
NORM	IN
P-P AUTO	IN
P-P AUTO	OUT

5. Set A TRIGGER mode to P-P AUTO.

6. Set HORIZONTAL MODE switch to B.

7. Check that B TRIGGER LEVEL can be adjusted for stable display in other than B RUNS AFTER DLY position.

8. Set B SLOPE to IN.

9. Check that B TRIGGER LEVEL can readjusted for stable display in other than B RUNS AFTER DLY position.

10. Set oscilloscope controls as follows:

- VERTICAL MODE to CH 2
- TRIGGER SOURCE to CH 2
- HORIZONTAL MODE to A

INTERNAL A AND B TRIGGERING TEST (CONT)

11. Move cable to connection B.

12. Repeat steps 3 through 9 using channel 2 controls.

13. Set oscilloscope controls as follows:

    - HORIZONTAL MODE to A
    - A SEC/DIV to 0.1 US
    - X 10 Magnifier to On.

14. Set oscilloscope calibrator for 60 MHz, l-division amplitude display.

15. Repeat steps 4 through 9 using channel 2 controls.

16. Set oscilloscope controls as follows:

    - VERTICAL MODE to CH 1
    - TRIGGER SOURCE to COMPOSITE
    - HORIZONTAL MODE to A

17. Move cable to conection A.

18. Repeat steps 4 through 9 using channel 1 controls.

19. Set oscilloscope controls as follows:

    - HORIZONTAL MODE to A
    - A SEC/DIV to 0.05 US

20. Set oscilloscope calibrator for 100 MHz, 1.5-division display.

21. Repeat steps 4 through 9 using channel 1 controls.

22. Set oscilloscope controls as follows:

    - VERTICAL MODE to CH 2
    - HORIZONTAL MODE to A

23. Move cable to connection B.

24. Repeat steps 4 through 9 using channel 2 controls.

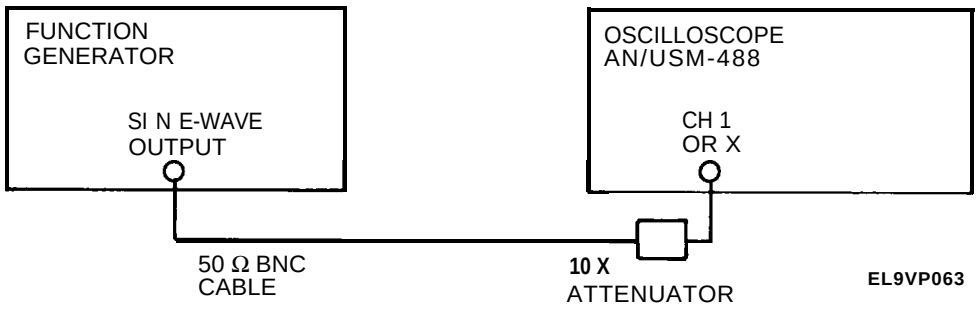
25. Disconnect test equipment.

HF AND LF REJECT A TRIGGERING TEST

1. Set oscilloscope controls as follows:

   - VERTICAL MODE to CH 1
   - HORIZONTAL MODE to A
   - A TRIG BW to HF REJ
   - A SEC/DIV to 0.5 ms
   - X 10 Magnifier to Off (knob in)

2. Connect test equipment as shown below.



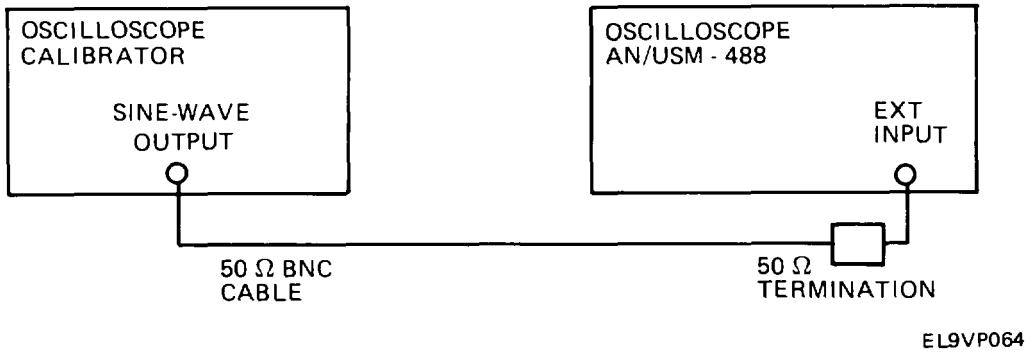
3. Push in and hold TRIG VIEW switch.
4. Set function generator for 1 kHz, 6-division display.
5. Increase function generator frequency for a 4.2-division display.
6. Check that function generator reads between 30 and 50 kHz.
7. Set A TRIG BW switch to LF REJ.
8. Push in and hold TRIG VIEW switch.
9. Set function generator for 500 kHz, 6-division display.
10. Decrease function generator frequency for 4.2-division display.
11. Check that function generator reads between 30 and 50 kHz.
12. Disconnect test equipment.

EXTERNAL TRIGGERING TEST

1. Set oscilloscope controls as follows:

   - VERTICAL MODE to CH 1
   - HORIZONTAL MODE to A
   - A SOURCE to EXT
   - A SEC/DIV to 0.05 US
   - A TRIG BW to FULL

2. Connect test equipment as shown below.



3. Set oscilloscope calibrator for 10 MHz, 35 mV output.

4. Push and hold TRIG VIEW switch.

5. Check that adjusting A TRIGGER LEVEL produces stable display for each setting combination given below.

A TRIGGER Mode	A TRIGGER SLOPE
NORM	OUT
NORM	IN
P-P AUTO	IN
P-P AUTO	OUT

6. Set oscillosocpe calibrator for 60 MHz, 120 mV output and X 10 Magnifier to On,

7. Repeat steps 4 and 5.

8. Set oscilloscope calibrator for 100 MHz, 150 mV output.

9. Repeat steps 4 and 5.

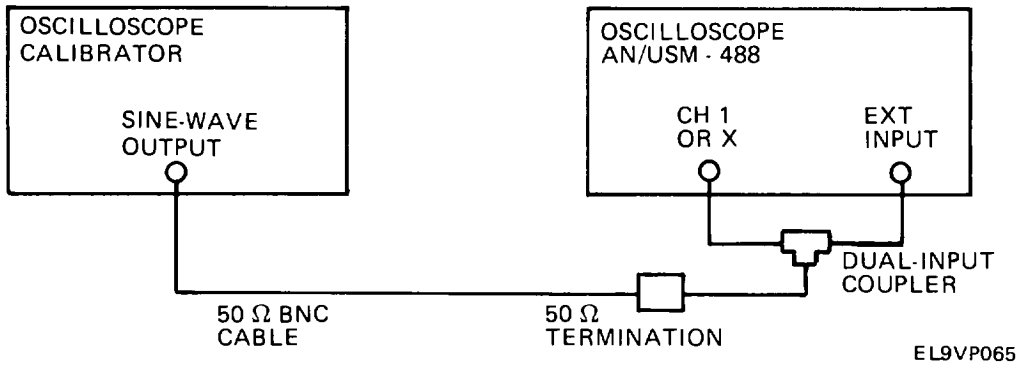
10. Disconnect test equipment.

EXTERNAL TRIGGER RANGES TEST

1. Set oscilloscope controls as follows:

   - CH 1 VOLTS/DIV to 0.5 V
   - A SEC/DIV to 20 US
   - X 10 Magnifier to Off
   - A TRIGGER Mode to NORM

2. Connect test equipment as shown below.



3. Set oscilloscope calibrator for 50 kHz, 6.4-division display.

4. Check that display is triggered along entire positive slope throughout A TRIGGER LEVEL range, except not triggered (no trace) for fully clockwise and fully counter-clockwise.

5. Set A TRIGGER SLOPE to IN.

6. Check that display is triggered along entire negative slope throughout A TRIGGER LEVEL range, except not triggered (no trace) for fully clockwise and fully counter-clockwise.

SINGLE SWEEP OPERATION TEST

1. Set A SOURCE to INT.
2. Adjust A TRIGGER LEVEL for stable display.
3. Set oscilloscope controls as follows:
   - A SEC/DIV to 50 ms
   - Channel 1 AC/GND/DC to GND
4. Press SGL SWP switch in. Check that READY LED comes on.
5. Set channel 1 AC/GND/DC switch to DC.
6. Check that READY LED goes out and single sweep occurs.

NOTE

The A INTENSITY control may require adjustment to observe single-sweep trace.

7. Press SGL SWP RESET switch several times.
8. Check that single-sweep trace occurs, and READY LED comes on briefly each time SGL SWP RESET switch is pressed in and released.
9. Disconnect test equipment.

END OF TASK

d. **External Z-Axis and Amplitude Calibrator Circuits Tests.** External Z-Axis and amplitude calibrator circuit tests are structured as one task, and should be performed in their entirety and in the order presented to ensure correct control settings for each test.

- Initial Setup
- External Z-Axis Test
- Amplitude Calibrator Test

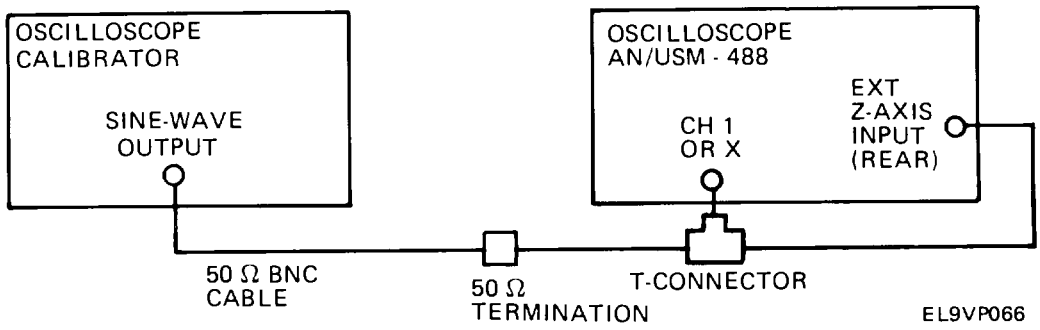
INITIAL SETUP

Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/DIV	1V
VOLTS/DIV Variable	CAL detent
AC/GND/DC	DC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	20 us
SEC/DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A SOURCE	INT
A TRIG BW	FULL

EXTERNAL Z-AXIS TEST

1. Connect test equipment as shown below.



2. Set oscilloscope calibrator for 50 kHz, 5 V output.

3. Adjust A INTENSITY control as necessary.

4. Check for noticeable intensity modulation; positive part of sine wave has lower intensity than negative part.

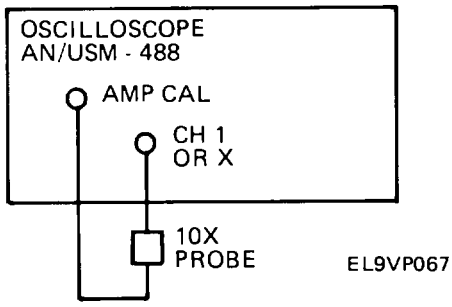
5. Disconnect test equipment.

AMPLITUDE CALIBRATOR TEST

1. Set oscilloscope controls as follows:

   - CH 1 VOLTS/DIV to 10 mV
   - A SEC/DIV to 0.5 ms

2. Connect X10 probe to oscilloscope as shown below.



3. Adjust probe compensation for a flat-topped square-wave display.
4. Check that display amplitude is 4.90 to 5.10 divisions.
5. Disconnect probe from instrument.
6. Set POWER switch to OFF.
7. Remove power cord plug from line source socket.

END OF TASK

2-28. ADJUSTMENT PROCEDURE

This section contains adjustment procedures that make sure the oscilloscope meets performance specifications after replacement of parts. The adjustment procedures are divided into five major sections, each of which can be performed individually. For example, if only the vertical section has been repaired, it can be adjusted without effect on other sections. After completion of the adjustment procedure, do the performance test in para 2-27. The five sections are:

Power Supply and CRT Display Adjustment

Vertical Circuits Adjustments

Horizontal Circuits Adjustments

Trigger Circuits Adjustments

Amplitude Calibrator Adjustment

NOTES

- Each section of an adjustment procedure must be done in order and in their entirety to ensure correct control settings.
- All reference designations are on A1 main printed circuit board unless otherwise noted.
- All adjustment points listed in these procedures are located on fig F0-4.

INDEX TO ADJUSTMENT PROCEDURE

a. Power Supply and CRT Display Adjustments. Perform the power supply and crt display adjustments in the following order:

- Initial Setup
- Power Supply DC Level Adjustment
- CRT Grid Bias Adjustment
- Astigmatism Adjustment
- Trace Alignment Adjustment
- Geometry Adjustment

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 vac source.

2. Press POWER ON/ OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.

3. Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/DIV	5 mV
VOLTS/DIV Variable	CAL detent
AC/GND/DC	GND
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A AND B SEC/DIV	x-Y
SEC/DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT

POWER SUPPLY DC LEVEL ADJUSTMENT

1. Connect digital multimeter low lead to chassis ground and connect volts lead to TP961.
2. Check that voltage is -8.6 ±0.04 vdc. If it is, go to step 3. If it is not, adjust R938.
3. Check all other power supply voltages listed below:

Power Supply	Test Point	Indication
+5.2 vdc	Al W968	+5.1 ±0.16 vdc
+8.6 vdc	A1 W960	+8.6 ±0.17 vdc
+30 vdc	Al W956	+30 ±0.9 vdc
+100 vdc	Al W954	+100 ±3.0 vdc

CRT GRID BIAS ADJUSTMENT

1. Connect 50-ohm termination to EXT Z AXIS INPUT connector on the oscilloscope rear panel,
2. Adjust FOCUS control until well-defined dot is on crt.
3. Rotate A INTENSITY control fully counterclockwise.
4. Adjust R851 for visible dot, then back off until dot just disappears,
5. Disconnect 50-ohm termination.

ASTIGMATISM ADJUSTMENT

1. Set controls to following positions:

   A INTENSITY to provide a visible display on crt
   CH 1 VOLTS/DIV to 5 mV
   Channel 1 Input Coupling to DC
   A SEC/DIV to 5 US

2. Connect oscilloscope calibrator sine-wave output to oscilloscope CH 1 OR X input connector through 50-ohm cable and 50-ohm termination.
3. Set oscilloscope calibrator for a 50-kHz, 4-division display on oscilloscope crt.
4. Adjust R874 and FOCUS control for best defined waveform.
5. Disconnect termination, cable, and oscilloscope calibrator.

TRACE ALIGNMENT ADJUSTMENT

1. Position trace on center horizontal graticule line.

2. Adjust TRACE ROTATION control for optimum alignment of trace with center horizontal graticule line.

GEOMETRY ADJUSTMENT

1. Set oscilloscope controls to following positions:

   CH 1 VOLTS/DIV to 50 mV
   A SEC/DIV to 0.1 ms

2. Connect oscilloscope calibrator l-volt, 10-KHz square-wave signal to oscilloscope CH 1 OR X connector through 50-ohm cable.

3. Adjust channel 1 POSITION control to position baseline part of display below the bottom horizontal graticule line.

4. Adjust SEC/DIV control for 5 markers per division.

5. Adjust R870 for minimum curvature of the time markers at the left and right edges of graticule.

6. Turn off and disconnect all equipment.

END OF TASK

b. **Vertical Circuits Adjustments.** Perform the vertical circuits adjustments in the following order:

- Initial Setup
- Attenuator Step Balance Adjustment
- 2/5 mV DC Balance Adjustment
- Channel 1 Variable Balance and CH 1 UNCAL LED Adjustment
- Channel 2 Invert Balance and CH 2 UNCAL LED Adjustment
- MF/LF Compensation and Gain Balance Adjustment
- Vertical Gain Adjustment
- Attenuator Compensation Adjustment
- High-Frequency Compensation, Delay Line Compensation, and Channel 2 High-Frequency Compensation Adjustment
- 2-mV Peaking Compensation Adjustment

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 vac source.
2. Press POWER ON/ OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.
3. Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
VOLTS/DIV	50 mV
VOLTS/DIV Variable	CAL detent
AC/GND/DC	GND
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A SEC/DIV	0.5 ms
SEC/DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
EXT COUPLING	AC

ATTENUATOR STEP BALANCE ADJUSTMENT

1. Position trace on center horizontal graticule line using channel 1 POSITION control.
2. Set CH 1 VOLTS/DIV switch to 5 mV.
3. Adjust A2R 10 to set trace on center horizontal graticule line.
4. Set CH 1 VOLTS/DIV switch to 50 mV.
5. Set VERTICAL MODE switch to CH 2.
6. Repeat steps 1 through 4 for channnel 2, adjusting A2R60 instead of A2R10.

2/5 MV DC BALANCE ADJUSTMENT

1. Set CH 2 VOLTS/DIV switch to 5 mV.
2. Position trace on center horizontal graticule line using channel 2 POSITION control.
3. Set CH 2 VOLTS/DIV switch to 2 mV.
4. Adjust A2R83 to set trace on center horizontal graticule line.
5. Set VERTICAL MODE switch to CH 1.
6. Repeat steps 1 through 4 for channnel 1, adjusting A2R33 instead of A2R83.

CHANNEL 1 VARIABLE BALANCE AND CH 1 UNCAL LED ADJUSTMENT

1. Set both VOLTS/DIV switches to 10 mV.
2. Rotate CH 1 VOLTS/DIV variable control fully counterclockwise.
3. Check that CH 1 UNCAL LED is on.
4. Position trace on center horizontal graticule line using channel 1 POSITION control.
5. Rotate CH 1 VOLTS/DIV variable control clockwise to CAL detent.
6. Adjust A2R25 to set trace to center horizontal graticule line.

CHANNEL 2 INVERT BALANCE AND CH 2 UNCAL LED ADJUSTMENT

1. Set VERTICAL MODE switch to CH 2.
2. Position trace on center horizontal graticule line using channel 2 POSITION control.

NOTE

Once trace is aligned with center horizontal graticule line, do not touch channel 2 POSITION control when switching INVERT control between on and off positions. When pulling INVERT control out (on position), apply pressure around the end of the control. When pushing control in (off position), apply pressure at the end of the control.

3. Set INVERT control to on position (out).
4. Adjust A2R75 to position trace on center graticule line.
5. Set INVERT control to off position (in).
6. Rotate CH 2 VOLTS/DIV variable control fully counterclockwise.
7. Check that CH 2 UNCAL LED is on.
8. Rotate CH 2 VOLTS/DIV variable control clockwise to CAL detent.

MF/LF COMPENSATION AND GAIN BALANCE ADJUSTMENT

1. Set controls to following positions:

   INVERT to off (in) position
   VERTICAL MODE to CH 2
   VOLTS/DIV (both) to 10 mV
   Input Coupling (both) to DC
   A SEC/DIV to 20 US

2. Connect oscilloscope calibrator high-amplitude square wave output to oscilloscope CH 2 OR Y connector through 50-ohm cable, X 10 attenuator, and a 50-ohm termination.
3. Set oscilloscope calibrator output to produce a 10-kHz, 5-division display on oscilloscope.
4. Set top of display on center horizontal graticule line using channel 2 POSITION control.
5. Adjust A2C53 and A2R97 for best front corner and flat top of display.

MF/LF COMPENSATION AND GAIN BALANCE ADJUSTMENT (CONT)

6. Move cable to CH 1 or X and set VERTICAL MODE switch to CH 1.
7. Set top of display on center horizontal graticule line using channel 1 POSITION control.
8. Adjust A2C3 and A2R47 for best front corner and flat top of display.

VERTICAL GAIN ADJUSTMENT

1. Connect 50-mv standard-amplitude signal from oscilloscope calibrator to oscilloscope CH 1 OR X connector through 50-ohm cable.
2. Set A SEC/DIV switch to 0.2 ms.
3. Adjust R 145 for an exact 5-division display.
4. Move cable to CH 2 or Y and set VERTICAL MODE switch to CH 2.
5. Adjust R 195 for an exact 5-division display.
6. Change oscilloscope calibrator output to IO millivolts and set both oscilloscope VOLTS/DIV switches to 2 mV.
7. Adjust A2R76 for an exact 5-division display.
8. Move cable to CH 1 or X and set VERTICAL MODE switch to CH 1.
9. Adjust A2R26 for an exact 5-division display.

ATTENUATOR COMPENSATION ADJUSTMENT

1. Set both input coupling switches to DC and both oscilloscope VOLTS/DIV switches to 10 mV.
2. Connect oscilloscope calibrator high-amplitude square wave output to oscilloscope CH 1 OR X connector through a 10X attenuator and a X 10 probe. Ground probe to oscilloscope calibrator output connector.
3. Set oscilloscope calibrator output to produce a 1-kHz, 5-division display on oscilloscope and compensate the probe (TM 11-6625-3 135-12).
4. Set CH 1 VOLTS/DIV switch to 0.1 V.
5. Replace probe with a 50-ohm cable.
6. Set oscilloscope calibrator to produce a 5-division display.

ATTENUATOR COMPENSATION ADJUSTMENT (CONT)

NOTE

Use the capacitors listed below, for adjustments in this procedure. See fig. FO-2 for location of capacitors.

Adjustment	Channel 1	Channel 2
10X LF Comp	A2C12	A2C62
10X Input C	A2C11	A2C61
100X LF Comp	A2C5	A2C55
100X Input C	A2C4	A2C54

7. Adjust 10X LF Comp capacitor for best front corner of display.
8. Replace 50-ohm cable and 10X attenuator with probe.
9. Set oscilloscope calibrator to produce a 5-division display.
10. Adjust 10X Input C capacitor for best flat top of display.
11. Set CH 1 VOLTS/DIV switch to 1 V.
12. Replace probe with 50-ohm cable.
13. Set oscilloscope calibrator to produce a 5-division display.
14. Adjust 100X LF Comp capacitor for best front corner.
15. Replace 50-ohm cable with probe.
16. Set oscilloscope calibrator to produce a 5-division display.
17. Adjust 100X Input C capacitor for best flat top of display.
18. Set VERTICAL MODE s-witch to CH 2.
19. Repeat steps 2 through 17 for channel 2.

HIGH-FREQUENCY COMPENSATION, DELAY LINE COMPENSATION, AND CHANNEL 2 HIGH-FREQUENCY COMPENSATION ADJUSTMENT

1. Set controls to following positions:

   VERTICAL MODE to CH 1
   BW LIMIT to off position (out)
   VOLTS/DIV (both) to 10 mV
   Input Coupling (both) to DC
   A SEC/DIV to 0,05 US
   A SOURCE to INT

2. Connect oscilloscope calibrator positive-going fast-rise square wave output to oscilloscope CH 1 OR X connector through 50-ohm cable, X10 attenuator, and a 50-ohm termination.
3. Set oscilloscope calibrator output to produce a l-MHz, 5-division display on oscilloscope.
4. Set top of display on center horizontal graticule line using channel 1 POSITION control.
5. Adjust R240 and R241 for best flat top on the front corner.
6. Adjust C237 for 2 percent overshoot (0.1 major division) on displayed signal.
7. Move cable to CH 2 OR Y connector and set VERTICAL MODE switch to CH 2.
8. Adjust oscilloscope calibrator output for an exact 5-division display.
9. Set top of display on center horizontal graticule line using channel 2 POSITION control.
10. Adjust C180 for 2 percent overshoot (0.1 major division) on displayed signal.

2-MV PEAKING COMPENSATION ADJUSTMENT

1. Set both VOLTS/DIV switches to 2 mV.
2. Set oscilloscope calibrator output to produce a 5-division display.
3. Set top of display on center horizontal graticule line using channel 2 POSITION control.
4. Adjust A2C76 for 2 percent overshoot (0.1 major division) on displayed signal.
5. Move cable to CH 1 OR X connector and set VERTICAL MODE switch to CH 1.
6. Repeat steps 2 through 4 for channel 1, adjusting A2C26 in step 4.
7. Turn off all power and disconnect all equipment.

END OF TASK

c. **Horizontal Circuits Adjustments.** Perform the horizontal circuits adjustments in the following order:

- Initial Setup
- Horizontal Amplifier Gain Adjustment
- X 10 Horiontal Amplifier Gain Adjustment
- Magnifier Resgistration Adjustment
- Delay Dial Time Adjustment
- High-Speed Timing Adjustment
- 5-ns Timing and Linearity Adjustment
- X Gain Adjustment

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 vac source.

2. Press POWER ON/OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.

3. Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
CH 1 VOLTS/DIV	0.5 v
VOLTS/DIV Variable	CAL detent
AC/GND/DC	DC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A SEC/DIV	0.1 ms
SEC/DIV Variable	CAL detent
X10 Magnifier	Off (knob in)
B DELAY TIME POSITION	Fully Counterclockwise
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT

HORIZONTAL AMPLIFIER GAIN ADJUSTMENT

1. Connect oscilloscope calibrator time-mark generator 0.1-ms time markers to oscilloscope CH 1 OR X connector through 50-ohm cable and 50-ohm termination.
2. Align first time marker with the first (extreme left) vertical graticule line using horizontal POSITION control.
3. Adjust A4R740 for 1 time marker per division over the center 8 divisions,

NOTE

When making timing measurements, use as a reference the tips of the time markers positioned at the center horizontal graticule line.

4. Set HORIZONTAL MODE switch to B.
5. Adjust A4R730 for 1 time marker per division.

X1O HORIZONTAL AMPLIFIER GAIN ADJUSTMENT

1. Set controls to following positions:

   HORIZONTAL MODE to A
   X10 Magnifier to on position (out)

2. Select 10-US time markers from the oscilloscope calibrator.
3. Align the nearest time marker to the first vertical graticule line with the horizontal POSITION control.
4. Adjust A4R754 for 1 time marker per division.

MAGNIFIER REGISTRATION ADJUSTMENT

1. Set A SEC/DIV switch to 0.2 ms.
2. Select 1 ms time markers from the oscilloscope calibrator.
3. Position the middle time marker rising edge to the center vertical graticule line using the horizontal POSITION control.
4. Set X10 Magnifier to off position (in).
5. Adjust A4R749 to position the middle time marker to the center vertical graticule line.
6. Set X10 Magnifier to on position (out) and check for no horizontal shift in the time marker.

DELAY DIAL TIME ADJUSTMENT

1. Set controls to following positions:

   HORIZONTAL MODE to ALT
   A SEC/DIV to 0.1 ms
   B SEC/DIV to 1 US
   SEC/DIV variable to CAL detent
   B DELAY TIME POSITION to 1.00

2. Select 0.l-ms time markers from the oscilloscope calibrator.

3. Adjust the A/B SWP SEP control to separate A and B sweeps.

4. Adjust R646 to that the 2nd A-sweep time marker is intensified and the B-sweep time marker's rising edge starts at the beginning of the B sweep.

5. Set B DELAY TIME POSITION dial to 9.00.

6. Adjust A5R652 to that the 10th A-sweep time marker is intensified and the B-sweep time marker's rising edge starts at the beginning of the B sweep.

7. Set B DELAY TIME POSITION dial to 1.00.

HIGH-SPEED TIMING ADJUSTMENT

1. Set controls to following positions:

   HORIZONTAL MODE to A
   A SEC/DIV to 1 US

2. Select l-us time markers from the oscilloscope calibrator.

3. Adjust A4C703 for 1 time marker per division over the center 8 divisions.

4. Set HORIZONTAL MODE to B.

5. Adjust A4C713 for 1 time marker per division over the center 8 divisions.

5-NS TIMING AND LINEARITY ADJUSTMENT

1. Set controls to following positions:

   CH 1 VOLTS/DIV to 0.2 V
   HORIZONTAL MODE to A
   A SEC/DIV to 0.05 US
   X10 Magnifier to on position (out)

2. Select 10-ns time markers from the oscilloscope calibrator.

3. Align the time markers with the vertical graticule lines using the horizontal POSITION control.

4. Adjust C775 and C785 alternately for one time marker every 2 divisions over the center 8 divisions of the magnified sweep.

X GAIN ADJUSTMENT

1. Set controls to following positions:

   X10 Magnifier to off position (in)
   CH 1 VOLTS/DIV to 10 mV
   A SEC/DIV to X-Y

2. Connect a 50-mV standard-amplitude square-wave signal from the oscilloscope calibrator to the oscilloscope CH 1 OR X input connector through a 50-ohm cable.

3. Adjust R760 for exactly 5-divisions of horizontal deflection.

4. Turn off all power and disconnect all equipment.

END OF TASK

d. **Trigger Circuits Adjustments.** Perform the trigger circuits adjustments in the following order:

- Initial Setup
- Trigger Offset Adjustment
- A Trigger Sensitivity Adjustment
- P-P Auto Trigger Centering Adjustment
- B Trigger Sensitivity Adjustment

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 vac source.

2. Press POWER ON/OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.

3. Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
INVERT	Off (knob in)
VERTICAL MODE	BOTH-ALT
TRIGGER SOURCE	CH 2
BW LIMIT	Off (switch out)
VOLTS/DIV	0.5 v
VOLTS/DIV Variable	CAL detent
AC/GND/DC	GND
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A SEC/DIV	1 ms
SEC/DIV Variable	CAL detent
X 10 Magnifier	Off (knob in)
B DELAY TIME POSITION	Fully Counterclockwise
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	DC
• B Trigger	
SLOPE	OUT
LEVEL	Midrange

TRIGGER OFFSET ADJUSTMENT

1. Set both traces to center horizontal graticule using POSITION controls.
2. Connect digital multimeter low lead to chassis ground and high (volts) lead to A5J9400-1.
3. Check offset voltage reading. It should be less than 100 millivolts. Record reading for use in step 5.
4. Set TRIGGER SOURCE switch to CH 1.
5. Adjust R309 so that voltage reading is the same as in step 3.

A TRIGGER SENSITIVITY ADJUSTMENT

1. Set controls to following positions:

   VERTICAL MODE to CH 1
   CH 1 VOLTS/DIV to 0.1 V
   Input Coupling (both) to AC
   A SEC/DIV to 10 US

2. Connect oscilloscope calibrator sine-wave signal through a 50-ohm cable and 50-ohm termination to the CH 1 OR X input connector.
3. Set oscilloscope calibrator output to produce a 50-kHz, 2.4-division display.
4. Set CH 1 VOLTS/DIV switch to 1 V.
5. Adjust R479 while rotating A TRIGGER LEVEL control slowly, so that A trigger is just able to be maintained.

P-P AUTO TRIGGER CENTERING ADJUSTMENT

1. Set controls to following positions:

   CH 1 VOLTS/DIV to 50 mV
   A TRIGGER SLOPE to out
   A TRIGGER LEVEL to fully clockwise

2. Set oscilloscope calibrator output to produce a 50-kHz, 5-division display.
3. Set CH 1 VOLTS/DIV switch to 0.5 V.
4. Adjust R434 so that vertical display just solidly triggers on the positive peak of the signal.

P-P AUTO TRIGGER CENTERING ADJUSTMENT (CONT)

5. Set controls to following positions:

   A TRIGGER SLOPE to in
   A TRIGGER LEVEL to fully counterclockwise

6. Adjust R435 so that vertical display just solidly triggers on the negative peak of the signal.

B TRIGGER SENSITIVITY ADJUSTMENT

1. Set CH 1 VOLTS/DIV control to 10 mV.

2. Connect oscilloscope calibrator sine-wave signal through a 50-ohm cable and and 50-ohm termination to the CH 1 OR X input connector.

3. Set oscilloscope calibrator output to produce a 50-kHz, 2.4-division display.

4. Adjust A TRIGGER LEVEL control for a stable display.

5. Set HORIZONTAL MODE switch to B.

6. Adjust B TRIGGER LEVEL control for a stable display.

7. Set CH 1 VOLTS/DIV switch to 0.1 V.

8. Adjust A5R627 so the display can just be maintained with B TRIGGER LEVEL control.

9. Turn off all power and disconnect all equipment.

END OF TASK

e. **External Z-Axis and Amplitude Calibrator Adjustment.**

INITIAL SETUP

1. Plug oscilloscope ac power cord into 115 vac source.
2. Press POWER ON/OFF switch to ON and allow at least 20 minutes for oscilloscope to warm up and stabilize before first test.
3. Set oscilloscope controls as follows:

Control	Setting
• Vertical (Both Channels)	
POSITION	Midrange
VERTICAL MODE	CH 1
TRIGGER SOURCE	COMPOSITE
BW LIMIT	Off (switch out)
CH 1 VOLTS/DIV	10 mV
CH 1 VOLTS/DIV Variable	CAL detent
AC/GND/DC	AC
• Horizontal	
POSITION	Midrange
HORIZONTAL MODE	A
A SEC/DIV	0.5 ms
SEC/DIV Variable	CAL detent
X10 Magnifier	Off (knob in)
• A Trigger	
VAR HOLDOFF	NORM
Mode	P-P AUTO
SLOPE	OUT
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT

EXTERNAL Z-AXIS AND AMPLITUDE CALIBRATOR ADJUSTMENT

Connect 10X probe to CH 1 OR X input connector and insert probe tip in AMP CAL output jack.

Adjust A3R984 for 5-division display.

Turn off all power and disconnect all equipment.

END OF TASK

Section V. PREPARATION FOR STORAGE OR SHIPMENT

2-26. PREPARATION FOR STORAGE OR SHIPMENT

If original packing material was saved, pack oscilloscope in the same manner as it was received. When using packing materials other than the original, use the following guidelines:

a. Wrap oscilloscope in polyethylene sheeting before placing in container.

b. Select corrugated cardboard container having inside dimensions at least 6 inches greater than oscilloscope dimensions and having a carton test strength of at least 75 pounds.

c. Use plenty of shock-absorbing material all around oscilloscope to protect against damage insert into a suitable size container.

d. Seal the carton with shipping tape or an industrial stapler.

e. Mark container “FRAGILE-DELICATE INSTRUMENT” to ensure proper handling.

2-27. TYPES OF STORAGE

a. **Short-term (administrative)** = 1 to 45 days. All equipment in this type must be made ready within 24 hours for use on a mission. Make sure the next scheduled PMCS is done and all deficiencies corrected before placing in storage. The storage site should provide protection from extreme weather conditions and allow you to reach it for inspections or exercises if needed.

b. **Intermediate** = 46 to 180 days.

c. **Long-term** = over 180 days.

APPENDIX A
REFERENCES

A-1. SCOPE

This appendix lists all forms, field manuals, technical manuals, and miscellaneous publication references in this manual.

A-2. FORMS

Equipment Control Record ..... DA Form 2408-9

Product Quality Deficiency Report ..... Form SF 368

Recommended Changes to Publications and Blank Forms ..... DA Form 2028

Report of Discrepancy (ROD) ..... Form SF 364

Transportation Discrepancy Report (TDR) ..... DD Form 361

A-3. TECHNICAL MANUALS

Operators and Organizational Maintenance Manual for Oscilloscope, AN/USM-488, (NSN 6625-01-187-7847) ..... TM 11-6625-3135-12

Organizational, Direct Support and General Support Maintenance Repair Parts and Special Tools List for Oscilloscope, AN/USM-488, (NSN 6625-01-187-7847) ..... TM 11-6625-3135-24P

Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command) ..... TM 750-244-2

A-4. MISCELLANEOUS PUBLICATIONS

Common Table of Allowance, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items) ..... CTA 50-970

Consolidated Army Publications and Forms Index ..... DA Pam 25-30

First Aid ..... FM 4-25.11

Interactive Electronic Technical Manual (IETM) for Calibration and Repair Requirements for the Maintenance of Army Materiel ..... TB 43-180

Reporting of Supply Discrepancies ..... AR 735-11-2

Safety Requirements for Maintenance of Electrical and Electronic Equipment ..... TB 385-4

The Army Maintenance Management System (TAMMS) Users Manual ..... DA Pam 750-8

The American Society of Mechanical Engineers, Abbreviations and Acronyms ..... ASME Y14.38

APPENDIX B
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

B-1. SCOPE

This appendix lists expendable supplies and materials you will need to operate and maintain the Oscilloscope, AN/USM-488. These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

B-2. EXPLANATION OF COLUMNS

a. Column (1) - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material.

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the listed item. Enter as applicable:

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column (3) - National Stock Number. This is the national stock number assigned to the item. Use it to request or requisition the item.

d. Column (4) - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Commercial and Government Entity Code (CAGEC) (in parentheses) followed by the part number.

e. Column (5) - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	H	8305-00-267-3015	Cloth, Cheesecloth, Cotton, Type II, Class 2 (81348) CCC-C-440	YD
2	H	7930-00-279-7089	Detergent, Liquid, General Purpose (59728), 2902N10	QT
3	H	6810-01-382-2904	Isopropyl Alcohol, Technical 1.01 Fluid Oz, Bottle (81346) ASTM D 770	BX
4	H	6515-00-905-1473	Applicator, Disposable Cotton-Tipped, (5L934) 36802	PK

INDEX

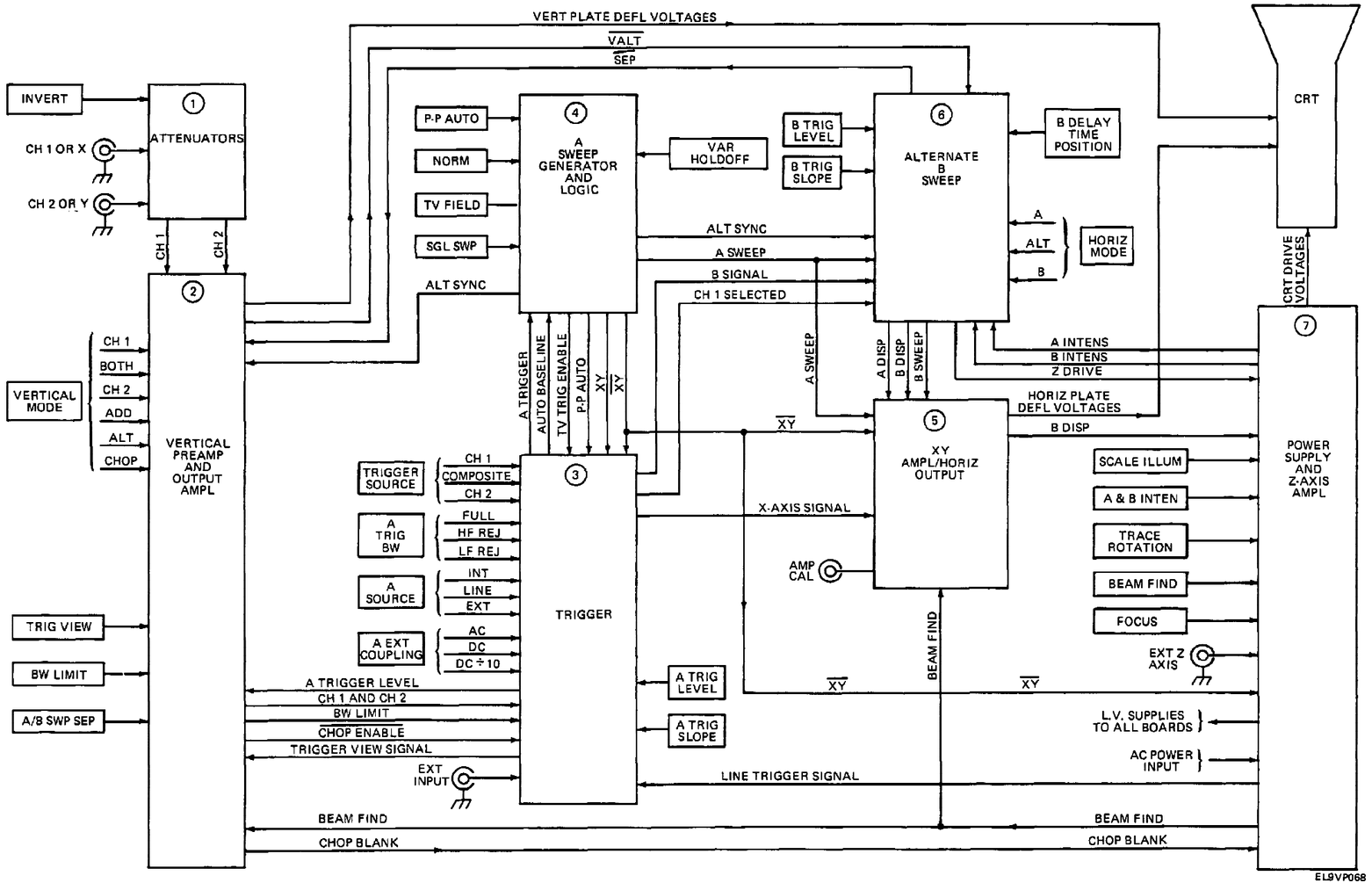


Figure FO-1. Simplified Block Diagram.

NOTE

FUNCTIONAL BLOCKS OF A1 REPRESENT MAJOR PART OF CIRCUIT. SOME CIRCUITS HAVE COMPONENTS ON OTHER BOARDS.

1. VERTICAL PREAMPLIFIER AND OUTPUT AMPLIFIER (FO-6)
2. TRIGGERING (FO-7)
3. A SWEEP GENERATOR AND LOGIC CIRCUIT (FO-8)
4. HORIZONTAL OUTPUT AMP (FO-10)
5. POWER SUPPLY (FO-11)
6. Z-AXIS CIRCUITS (FO-11)

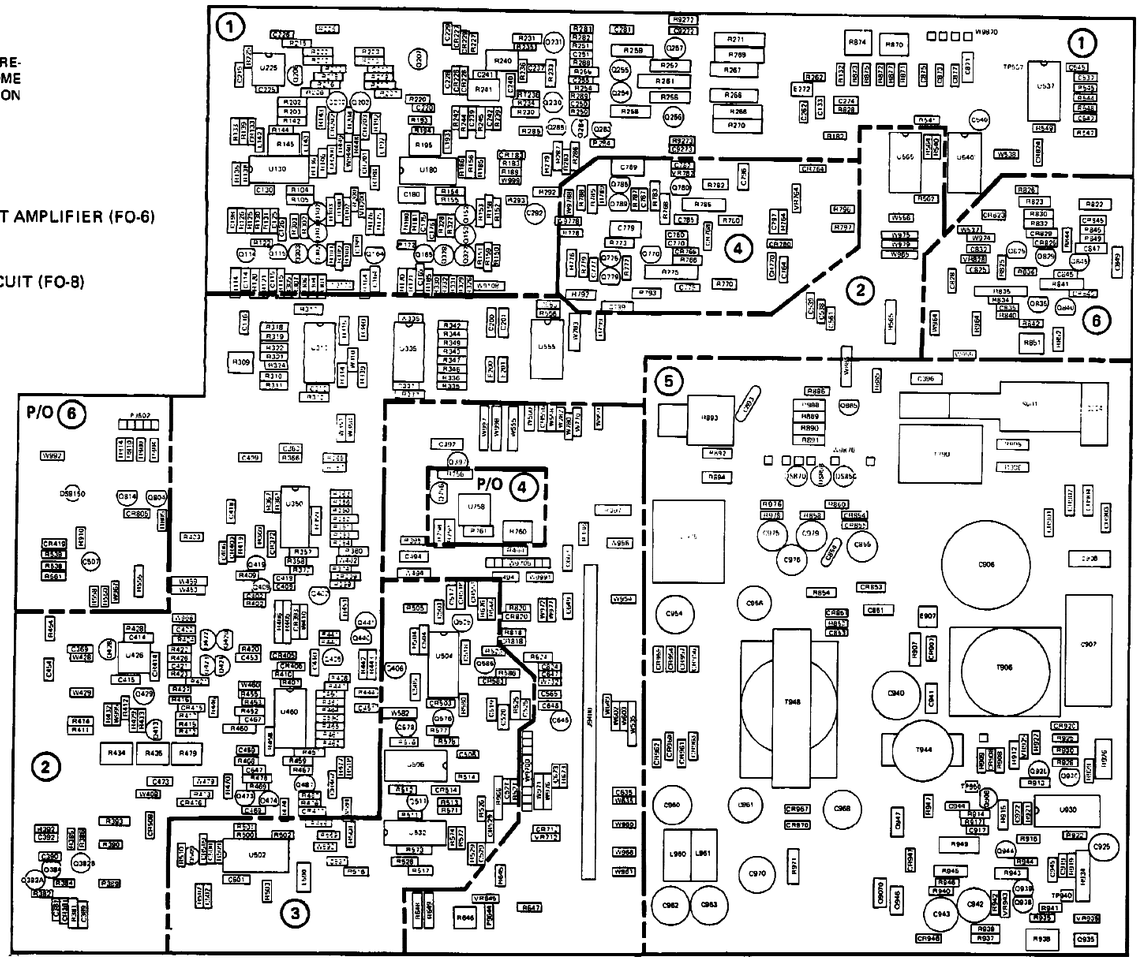


Figure FO-2. A1 Main Board Functional Blocks.

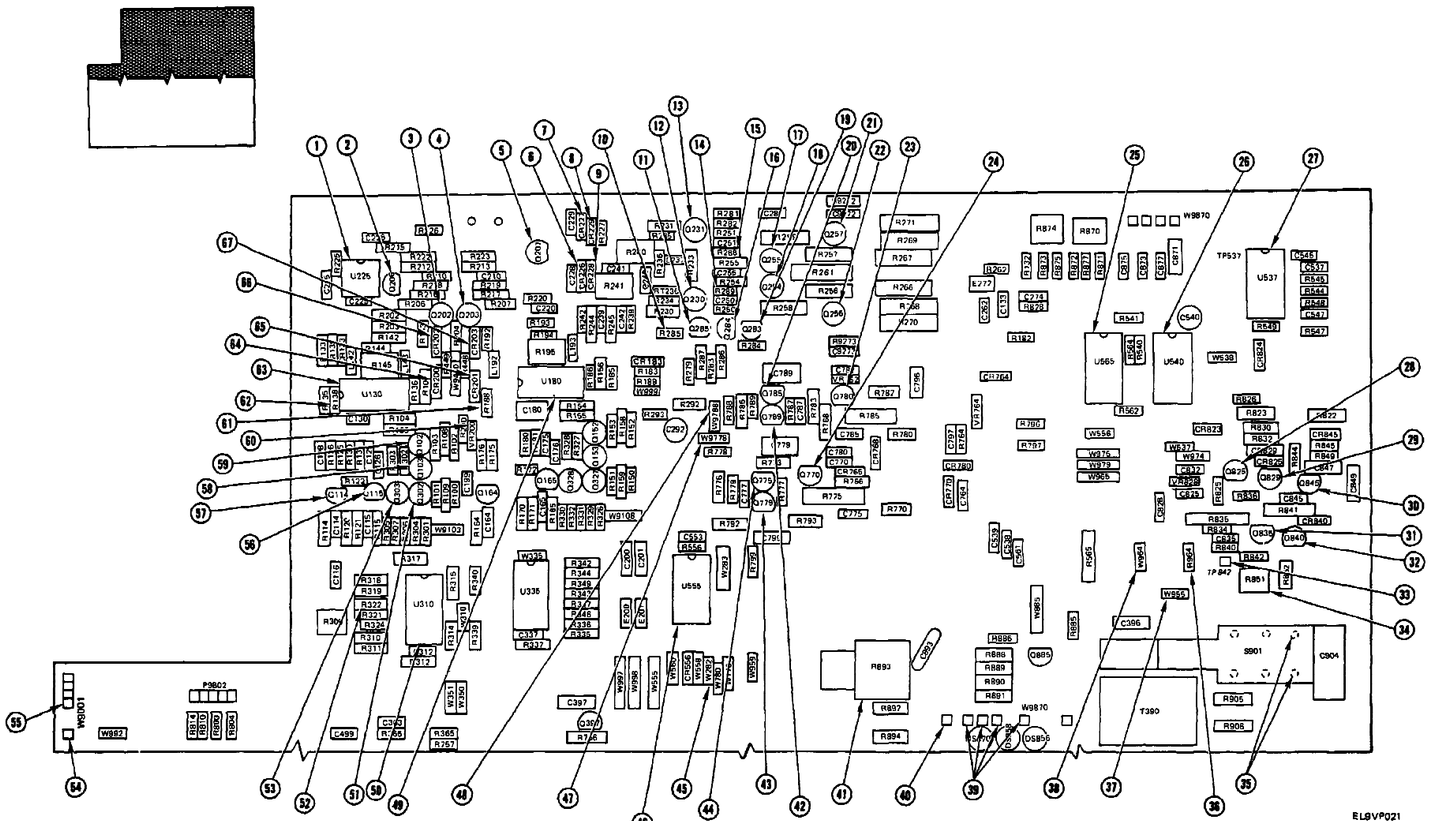


Figure FO-3. Troubleshooting Test Points
(Sheet 1 of 3)

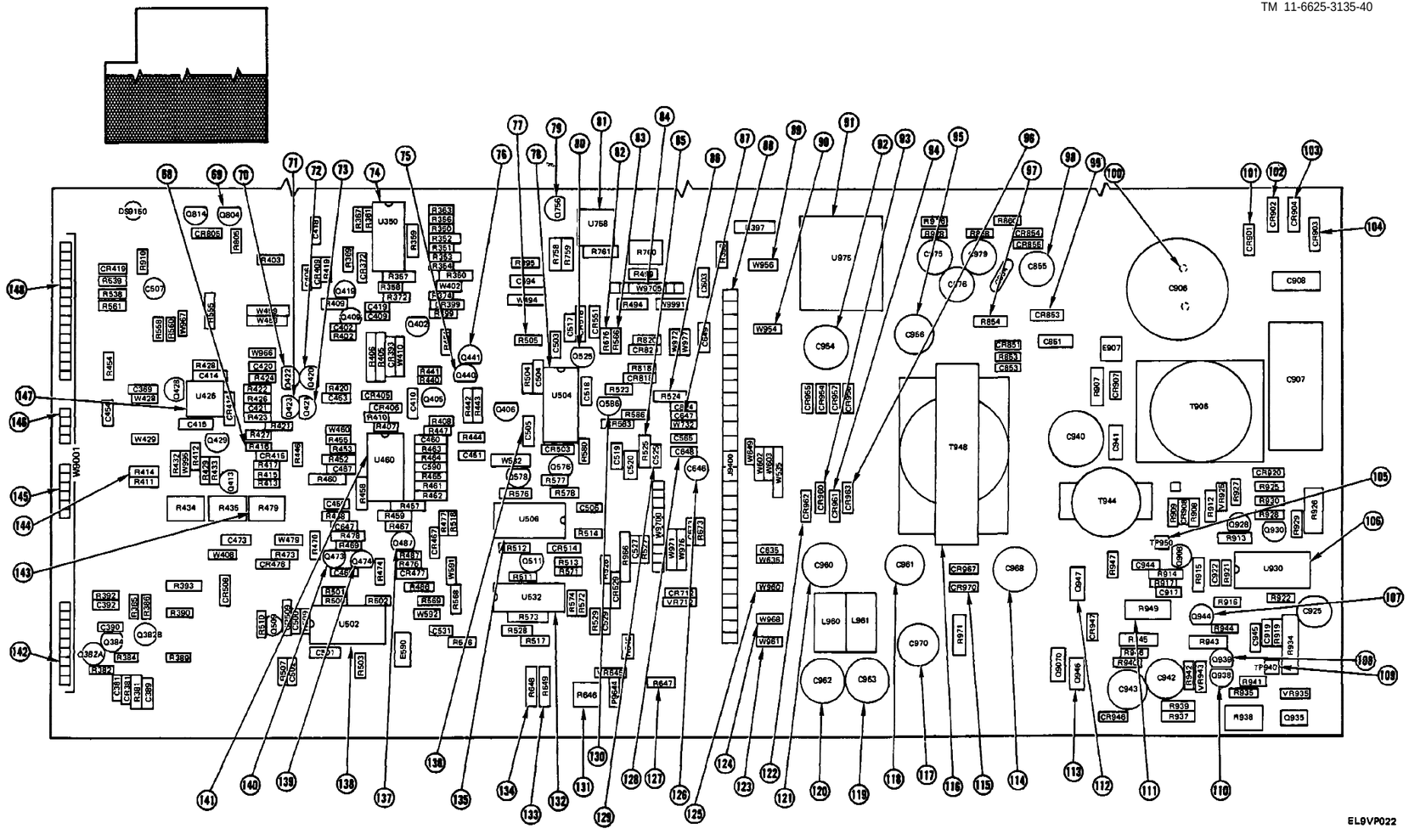


Figure FO-3. Troubleshooting Test Points
(Sheet 2 of 3).

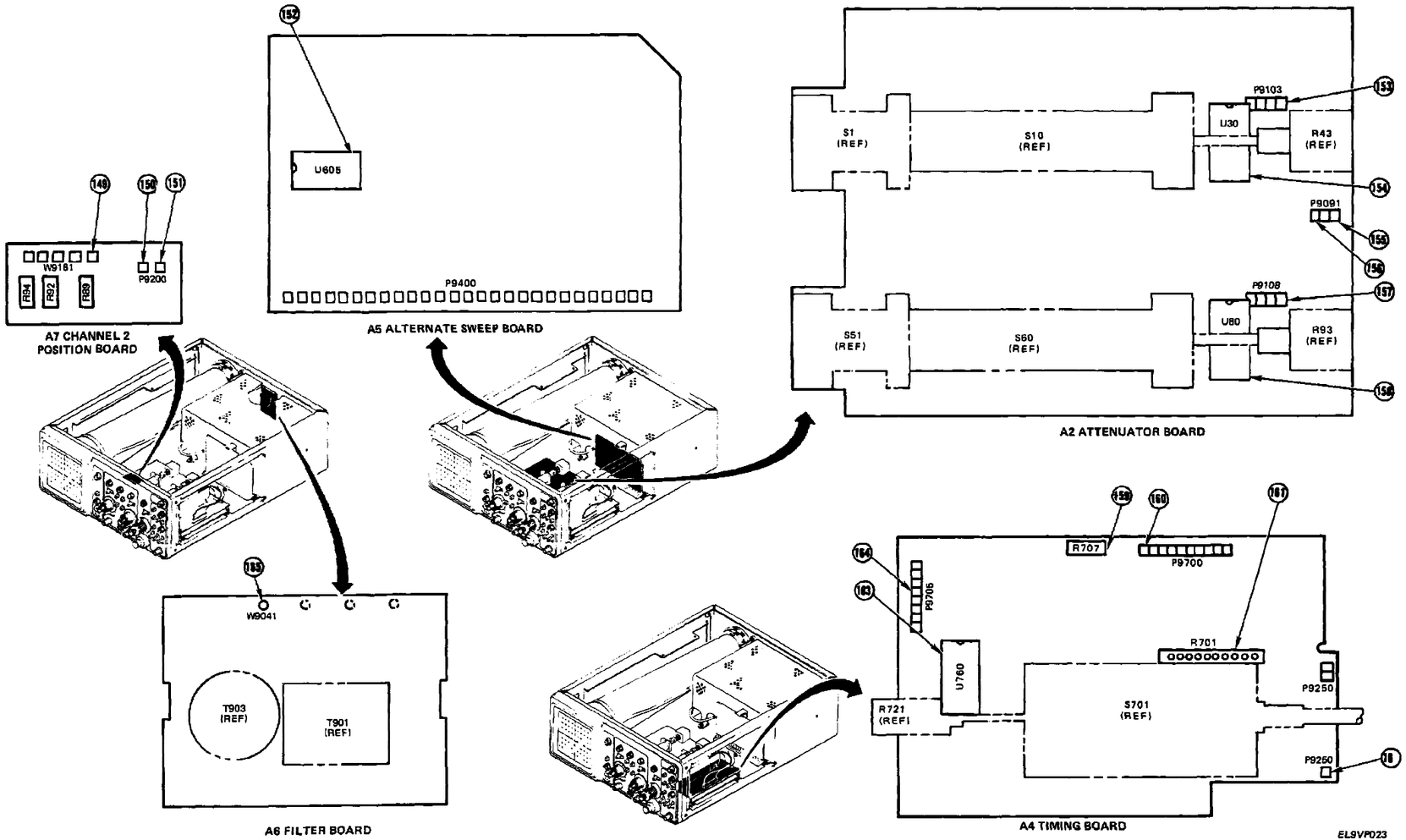


Figure FO-3. Troubleshooting Test Points
(Sheet 3 of 3).

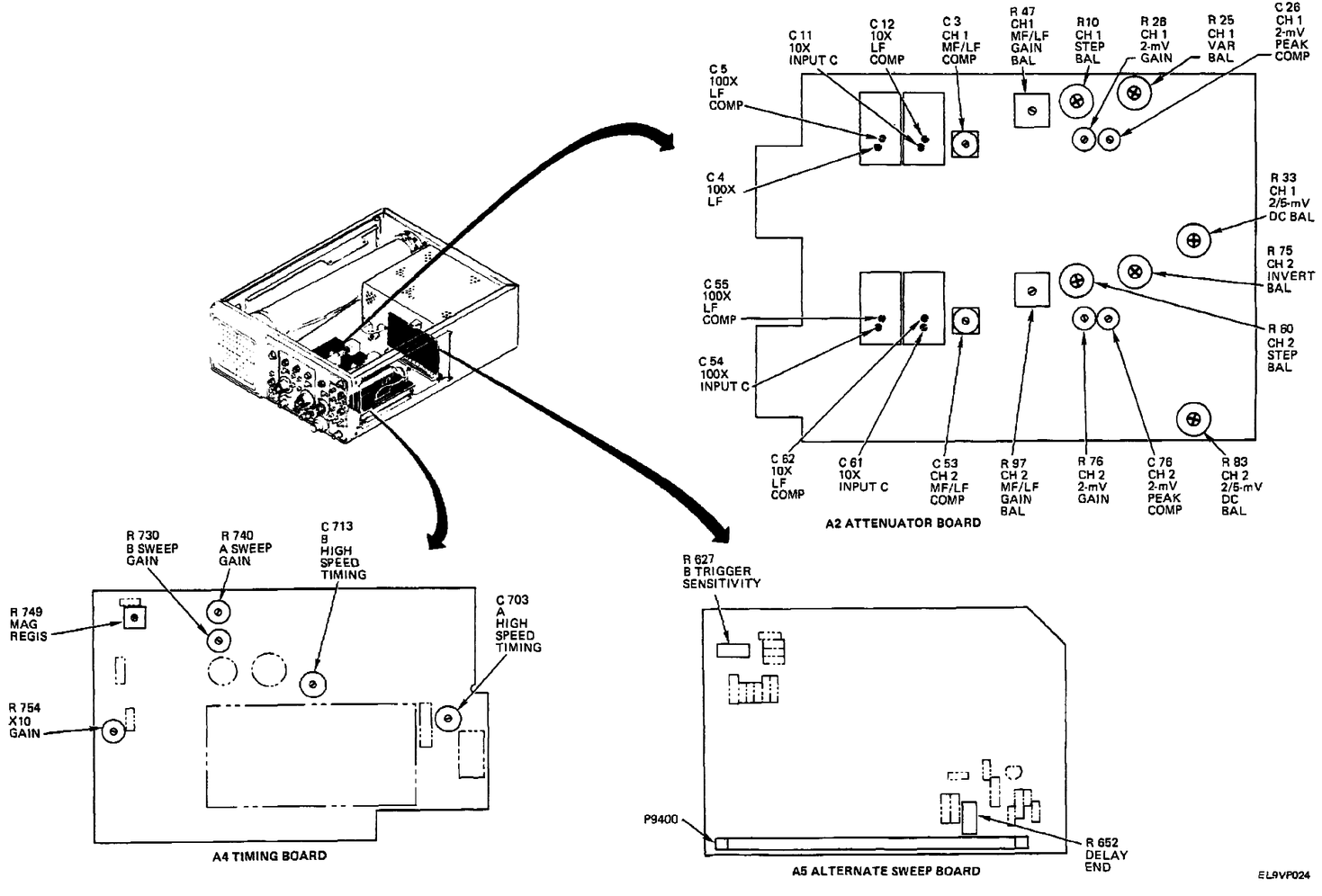


Figure FO-4. Adjustment Points (Sheet 1 of 2).

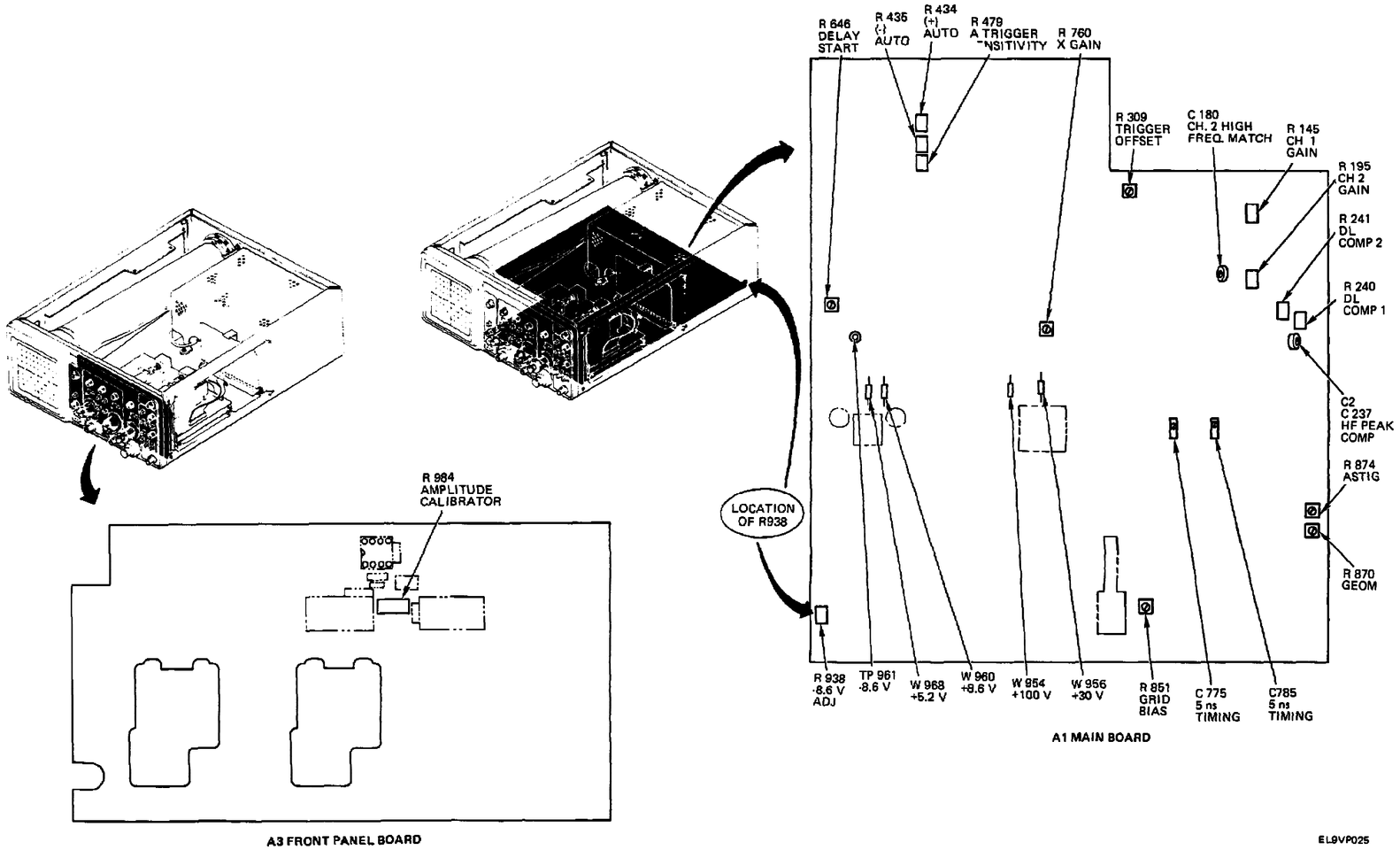


Figure FO-4. Adjustment Points (Sheet 2 of 2)

NOTES

1. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN PICOFARADS (pF); VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF) UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

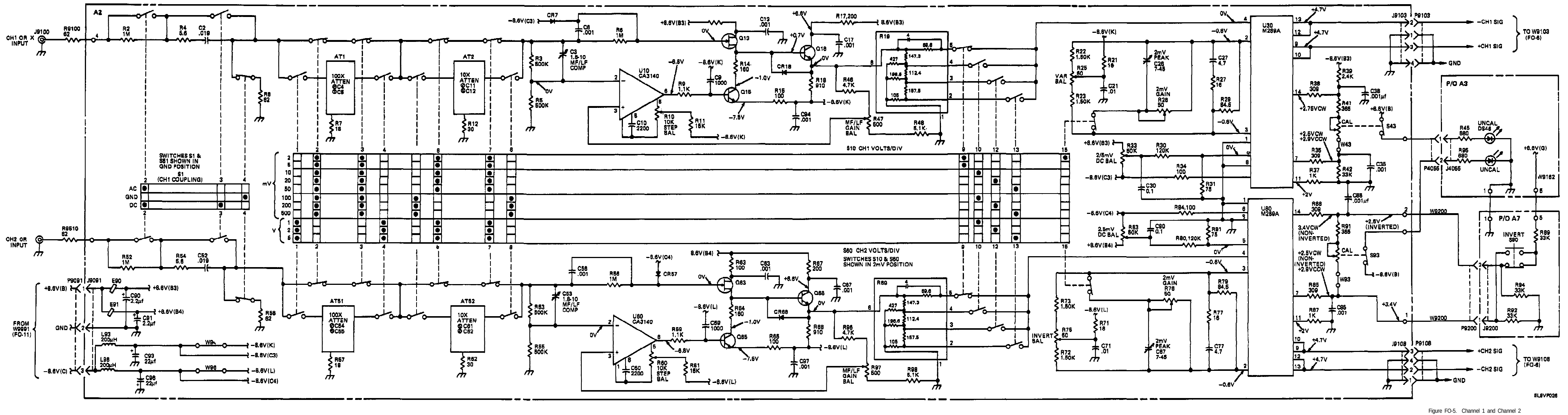


Figure FO-5. Channel 1 and Channel 2 Attenuators Schematic Diagram.

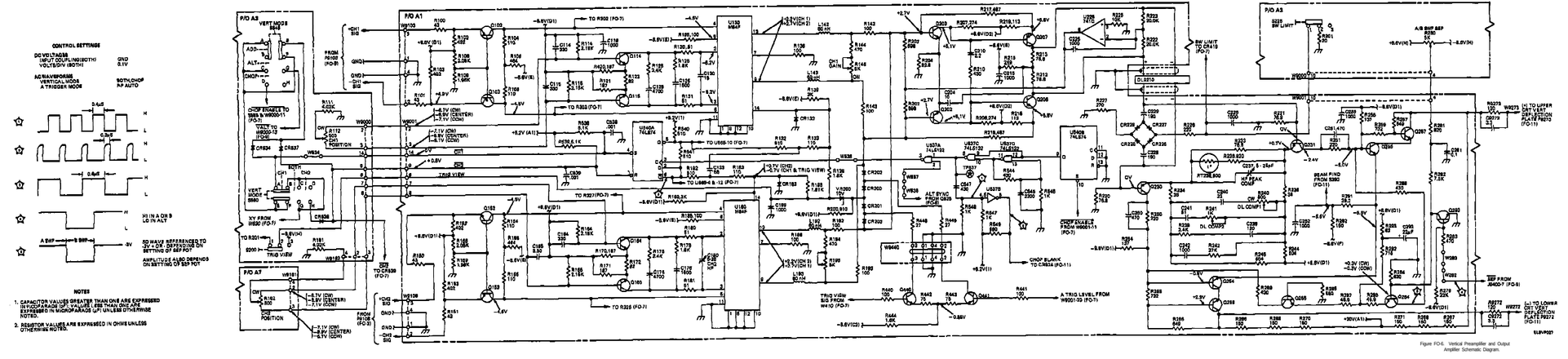


Figure FO-6. Vertical Preamplifier and Output Amplifier Schematic Diagram.

NOTES

1. WITH SLOPE SWITCH S602 IN (⌄), LEVEL IS 1.65V. WITH S602 OUT(⌃), LEVEL IS 2.15V.
2. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN PICOFARADS (pF); VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF), UNLESS OTHER WISE NOTED.
3. RESISTOR VALUES ARE EXPRESSED IN OHMS, UNLESS OTHERWISE NOTED.

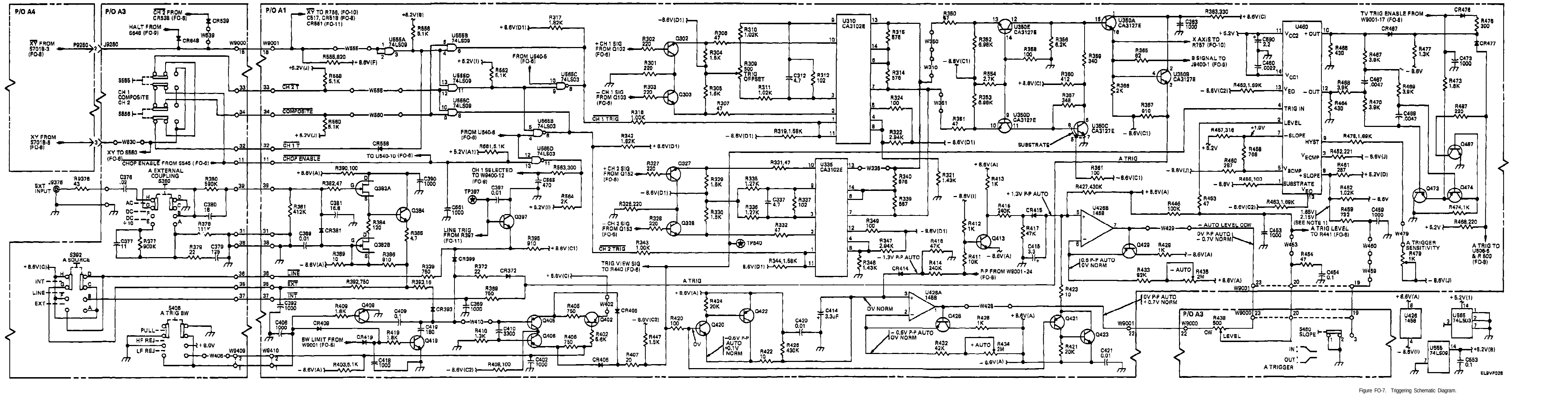
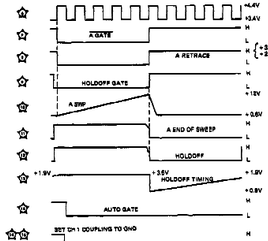


Figure FO-7. Triggering Schematic Diagram.

CONTROL SETTINGS

AC WAVEFORMS		DC VOLTAGES		MULTIRANGE
VERTICAL MODE	CH 1	A INTENSITY	A	
TRIGGER SOURCE	CH 1	HORIZONTAL MODE	0.1 mS	
CH 1 VOLTS/DIV	1V	A SEC/DIV	P – P AUTO	
CH 1 INPUT COUPLING	DC	A TRIGGER MODE		
HORIZONTAL MODE	A			
A TRIGGER LEVEL	MIDRANGE			
A TRIGGER MODE	P-P AUTO			
A SLOPE	INT			
A TRIG SW	PULL			
CH 1 INPUT SIGNAL	1 mA 1 kHz SINE WAVE, 4V P – P			



NOTES

1. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN FCOPARADS (pF). VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF) UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

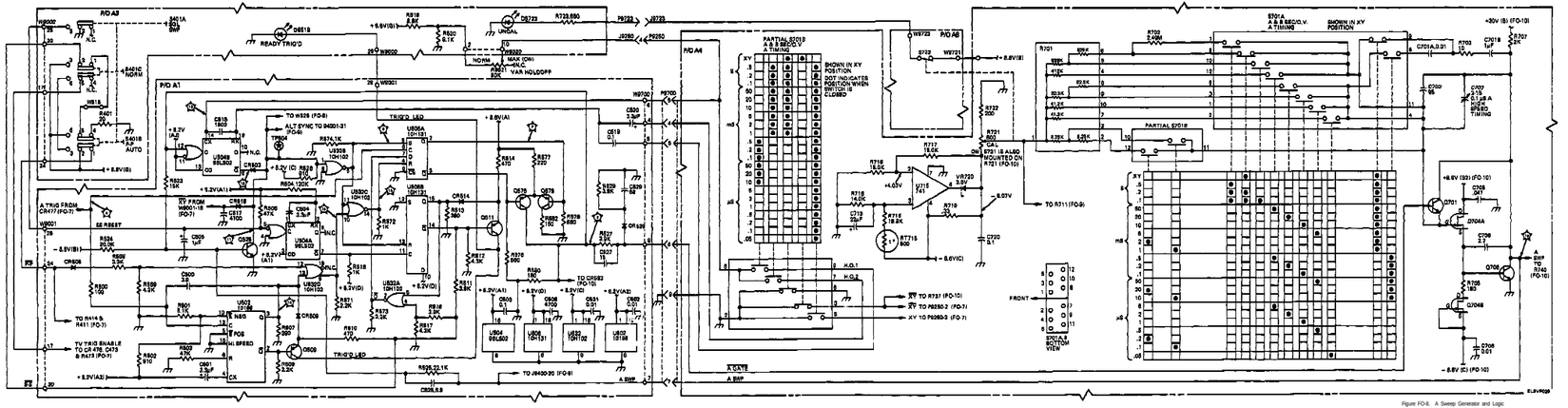


Figure FO-6. A Sweep Generator and Logic Circuit Schematic Diagram.

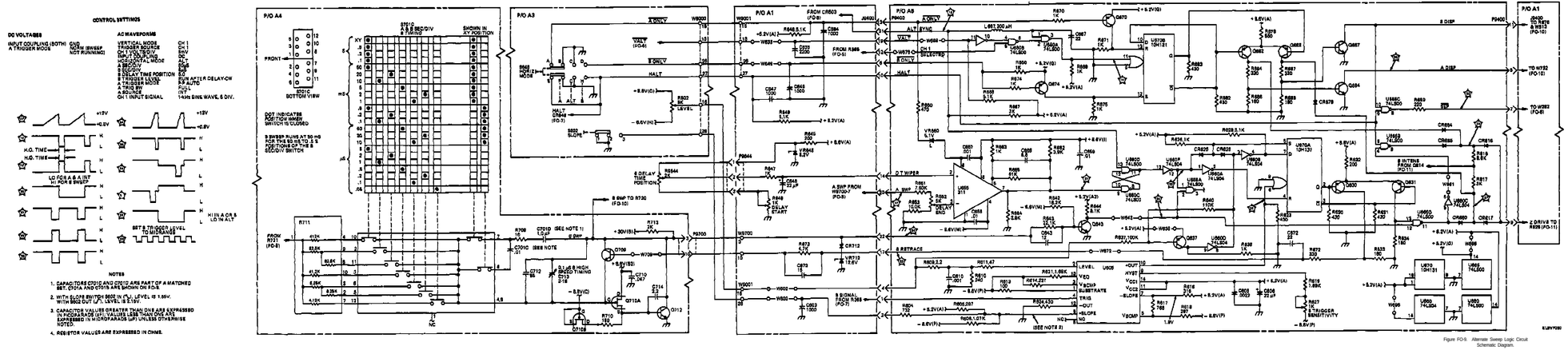
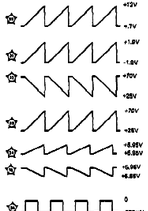


Figure FO-5. Alternate Sweep Logic Circuit Schematic Diagram.

CONTROL SETTINGS

DC VOLTAGES	
INPUT COUPLING (BOTH)	GND
HORIZONTAL MODE	A
A TRIGGER MODE	P-P AUTO
AC WAVEFORMS	
INPUT COUPLING (BOTH)	GND
HORIZONTAL MODE	A
X10 MAGNIFIER	OFF(KNOB IN)
VAR HOLDOFF	MIN(FULLY CCW)
A TRIGGER MODE	P-P AUTO



NOTES

1. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN PICOFARADS (pF). VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF), UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

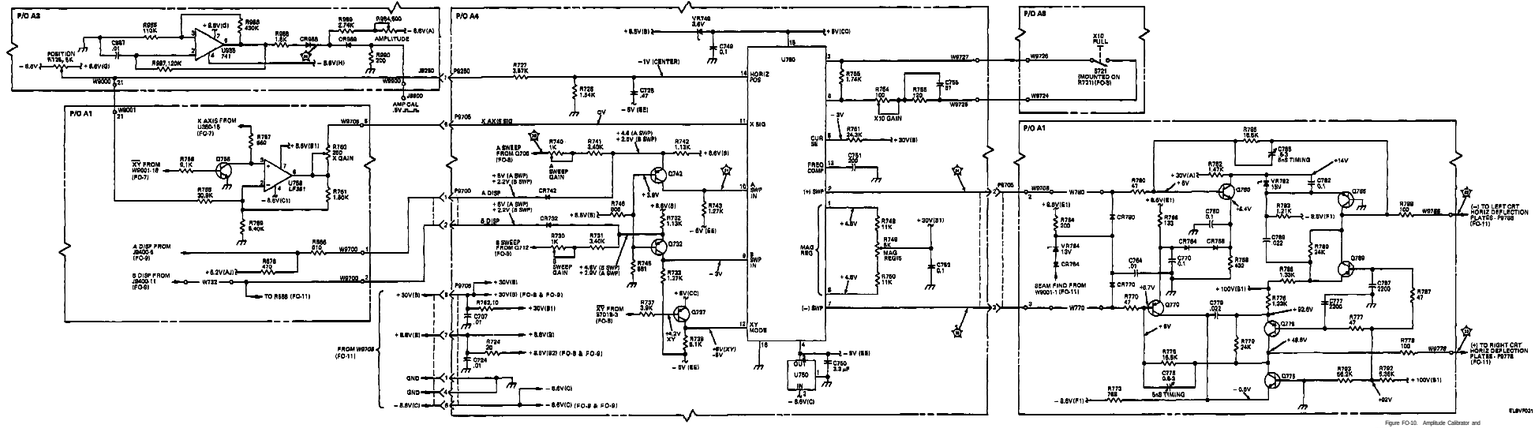


Figure FO-10. Amplitude Calibrator and Horizontal Output Amplifier Schematic Diagram.

WARNING

SOURCE AC POTENTIAL IS PRESENT ON THE POWER SUPPLY UNIVERSE CIRCUIT. DISCONNECT POWER CORD FROM AC POWER SUPPLY BEFORE ATTEMPTING REPAIRS OR RESISTANCE MEASUREMENTS.

NOTES

1. PRIMARY VOLTAGES ARE NOT REFERENCED TO GROUND. AN ISOLATION TRANSFORMER MUST BE USED WHEN PROBING PRIMARY CIRCUIT.
2. SYMBOL ⏚ IS USED FOR PRIMARY CIRCUIT COMMON. SYMBOL ⏚ IS USED FOR CHASSIS GROUND.
3. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN MICROFARADS (µF). VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (µF) UNLESS OTHERWISE NOTED.
4. RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

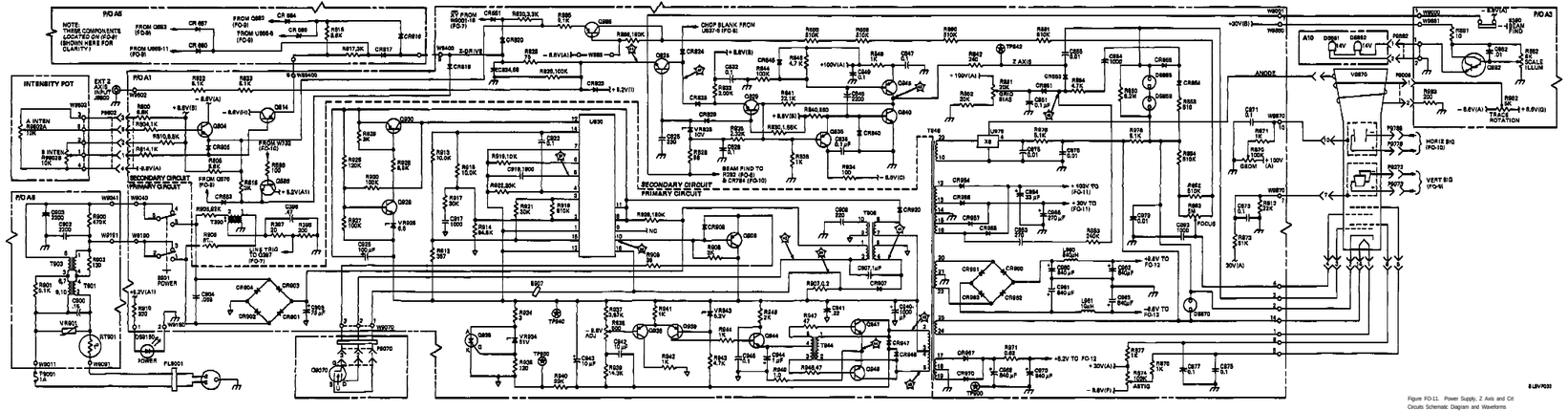
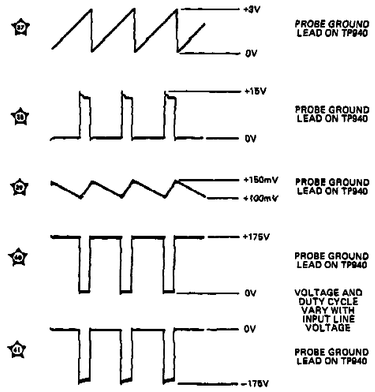


Figure FO-11. Power Supply, Z Axis and Crt Circuits Schematic Diagram and Waveforms (Sheet 1 of 2).

CONTROL SETTINGS



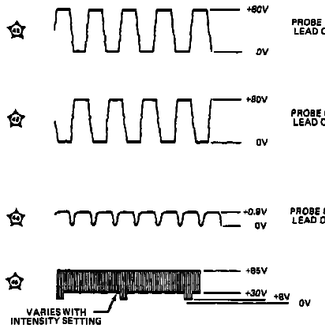
AC WAVEFORMS

WARNING

INSTRUMENT MUST BE CONNECTED TO THE AC POWER SOURCE USING A 1:1 ISOLATION TRANSFORMER. DO NOT CONNECT THE TEST OSCILLOSCOPE GROUND LEAD TO THE INVERTER CIRCUIT TEST POINTS IF THE INSTRUMENT IS NOT ISOLATED. AC SOURCE VOLTAGE EXISTS ON REFERENCE POINTS TP 940 AND TP 950.

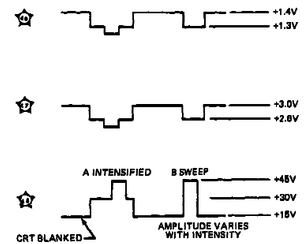
DC VOLTAGES

PREREGULATOR AND INVERTER VOLTAGES ARE REFERENCED TO TEST POINT NOTED ADJACENT TO THE VOLTAGE. POWER SUPPLY OUTPUT VOLTAGES ARE REFERENCED TO CHASSIS GROUND.



AC WAVEFORMS

VERTICAL MODE	CH 1
TRIGGER SOURCE	CH 1
CH 1 VOLTS/DIV	5mV
INPUT COUPLING	DC
HORIZONTAL MODE	ALT
A SEC/DIV	50µS
B SEC/DIV	5µS
B DELAY TIME POSITION	5.0
B TRIGGER LEVEL	RUN AFTER DELAY-CW
A TRIGGER MODE	P-P AUTO
A TRIG SW	FULL
A SOURCE	INT
CH 1 INPUT SIGNAL	1-kHz SINE WAVE, 5 DIV.



EL8VP032

Figure FO-11. Power Supply, Z Axis and Crt Circuit Schematic Diagram and Waveforms (Sheet 2 of 2).

NOTES

1. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN PICOFARADS (pF). VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF) UNLESS OTHERWISE NOTED.
2. RESISTOR VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

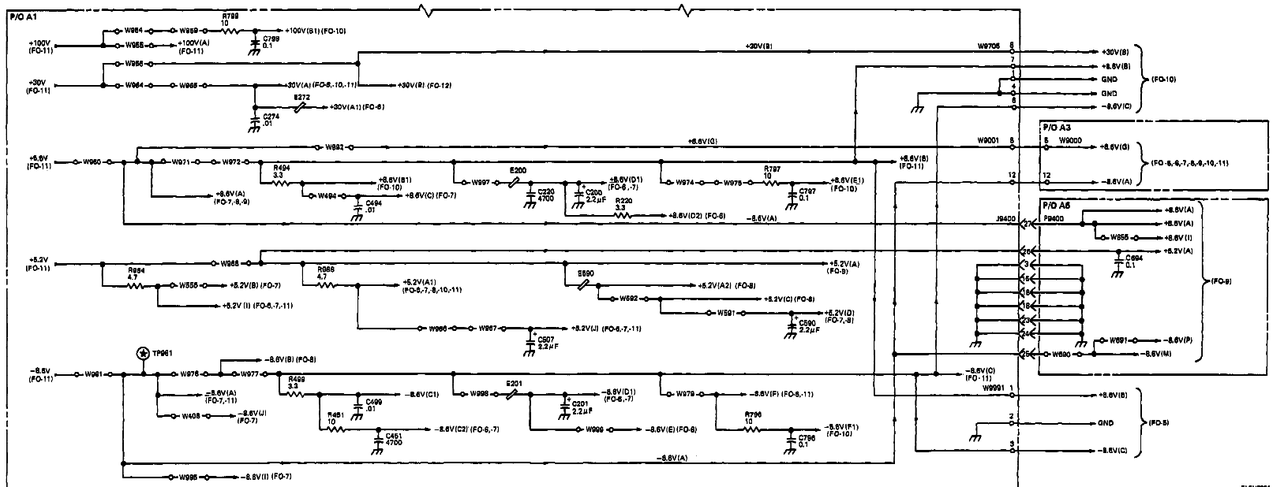


Figure FO-12. Power Supply Distribution Schematic Diagram.

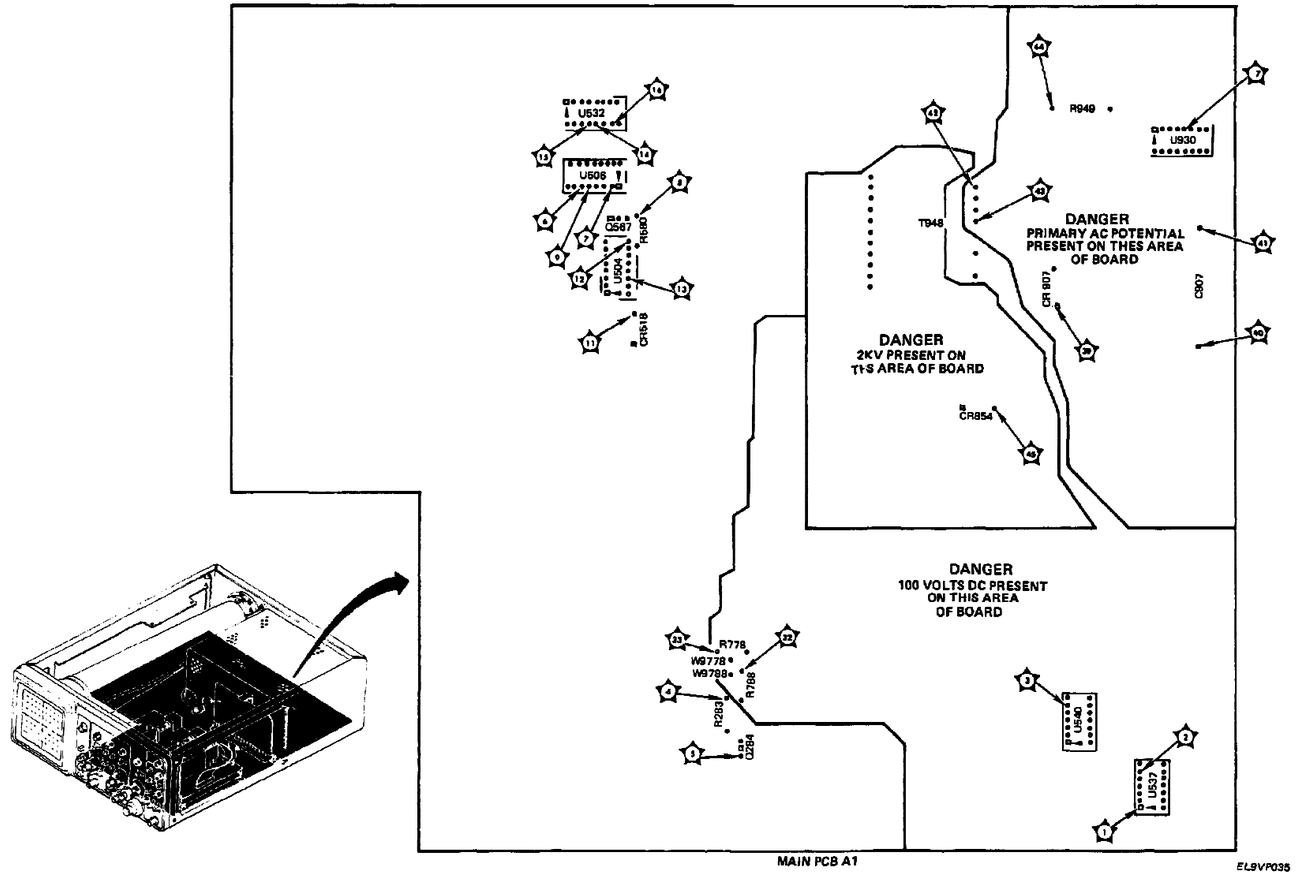


Figure FO-13. Waveform Test Point Locations
(Sheet 1 of 2).

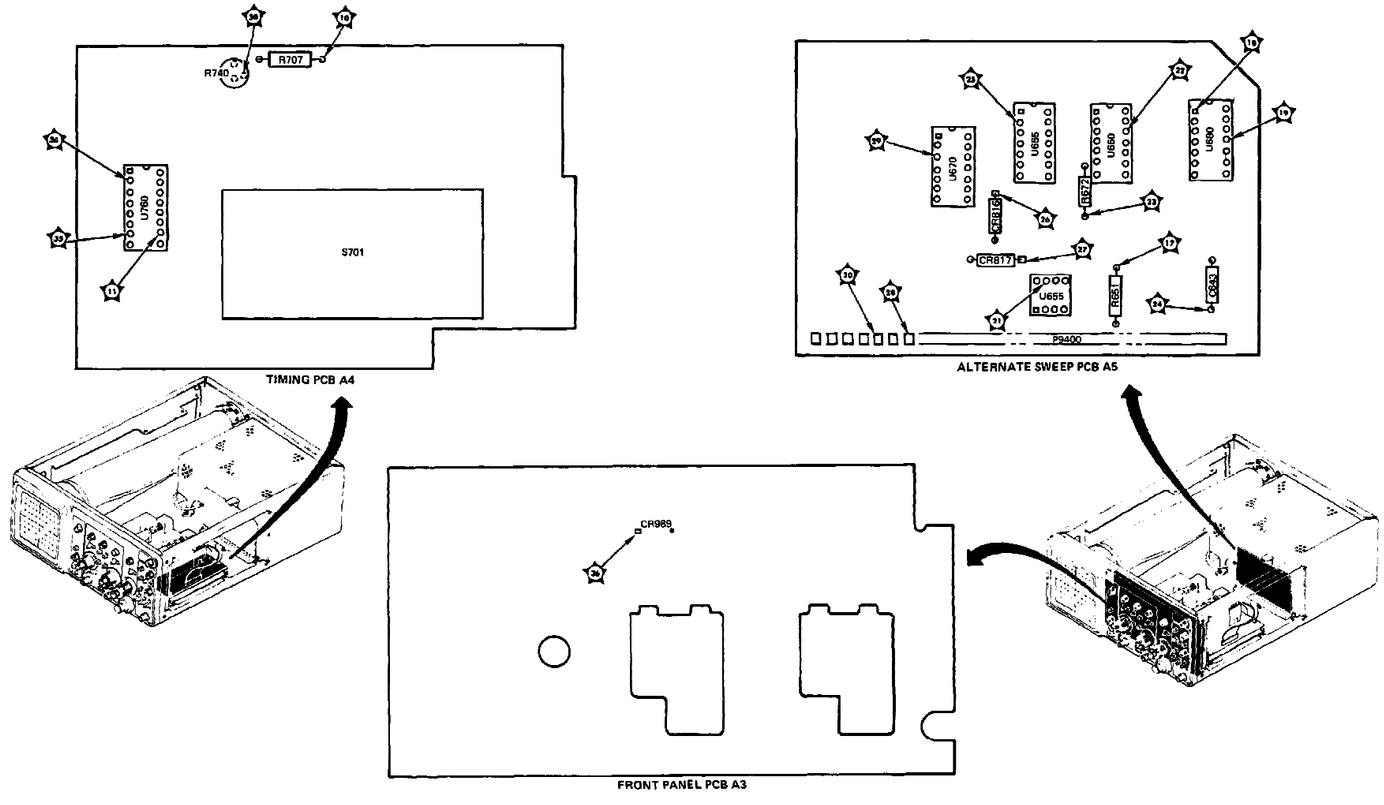


Figure FO-13. Waveform Test Point Locations
(Sheet 2 of 2)

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

Official:

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Subject: DA Form 2028

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2 *Unit: home*
3 ***Address: 4300 Park***
4 ***City***: Hometown
5 ***St: MO***
6 ***Zip: 77777***
7 ***Date Sent***: 19--OCT--93
8 ***Pub no***: 55--2840--229--23
9 ***Pub Title: TM***
10 ***Publication Date***: 04--JUL--85
11 *Change Number*: 7
12 *Submitter Rank*: MSG
13 ***Submitter FName***: Joe
14 *Submitter MName*: T
15 ***Submitter LName***: Smith
16 ***Submitter Phone***: 123--123--1234
17 ***Problem: 1***
18 *Page: 2*
19 *Paragraph: 3*
20 *Line: 4*
21 *NSN: 5*
22 *Reference: 6*
23 *Figure: 7*
24 *Table: 8*
25 *Item: 9*
26 *Total: 123*

27 ***Text***:
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PUBLICATION/FORM NUMBER	DATE	TITLE
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* *Reference to line numbers within the paragraph or subparagraph.*

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PUBLICATION NUMBER	DATE	TITLE

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

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