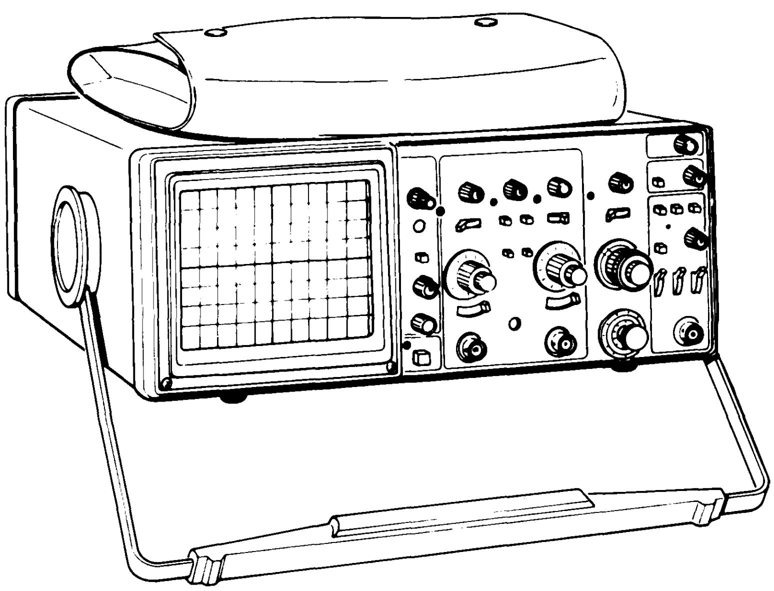
TM 11-6625-3135-12

TECHNICAL MANUAL

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE MANUAL



OSCILLOSCOPE AN/USM-488

(NSN 6625 -01-1 87-7847)

This copy is a reprint which includes current pages from Change 1.

EQUIPMENT DESCRIPTION PAGE 1-4

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HEADQUARTERS, DEPARTMENT OF THE ARMY

1 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

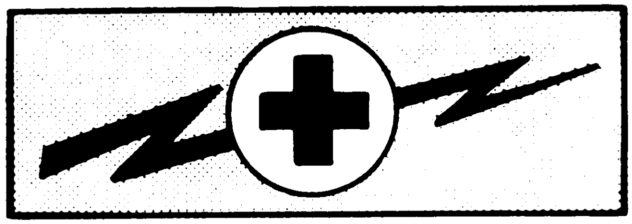
2. IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3. IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A 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 PERSONA 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 opera! ion and hazards of the equipment and who is competent in administering first aid. When the technician is aided by operators, they must be warned about dangerous areas.

A periodic review of safety precautions in TB 385-4, Safety Precautions for Maintenance of Electrical/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 or 115 volt ac input connections 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 the body.

WARNING Do not be misled by the term “low voltage”. Potentials as low as 50 volts may cause death under adverse conditions.

For Artficial Respiration. refer to FM 21-11.

Technical Manual

No. 11-6625-3135-12

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 1 October 1986

OPERATOR'S AND ORGANIZATIONAL MAINTENANCE MANUAL FOR OSCILLOSCOPE AN/USM-488 (NSN 6625-01-187-7847)

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), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-LC-LM-LT, Fort Monmouth, New Jersey 07703-5000. In either case, a reply will be furnished direct to you.

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HOW TO USE THIS MANUAL

This manual tells you about your Oscilloscope AN/USM-488 and contains instructions about how to use it while testing and maintaining other equipment.

The technical manual for the equipment you are maintaining will give you some guidance in the correct method to make certain connections when testing and troubleshooting with the oscilloscope.

When you first receive your oscilloscope, start at the front of the manual and go all the way through to the back, and become familiar with every part of the manual and the oscilloscope.

This manual has an edge index which will help you find specific information in a hurry. Simply spread the pages on the right edge of the manual until the printed blocks can be seen. Open the manual where the block on the edge of the page lines up with your selected topic printed in the front cover block.

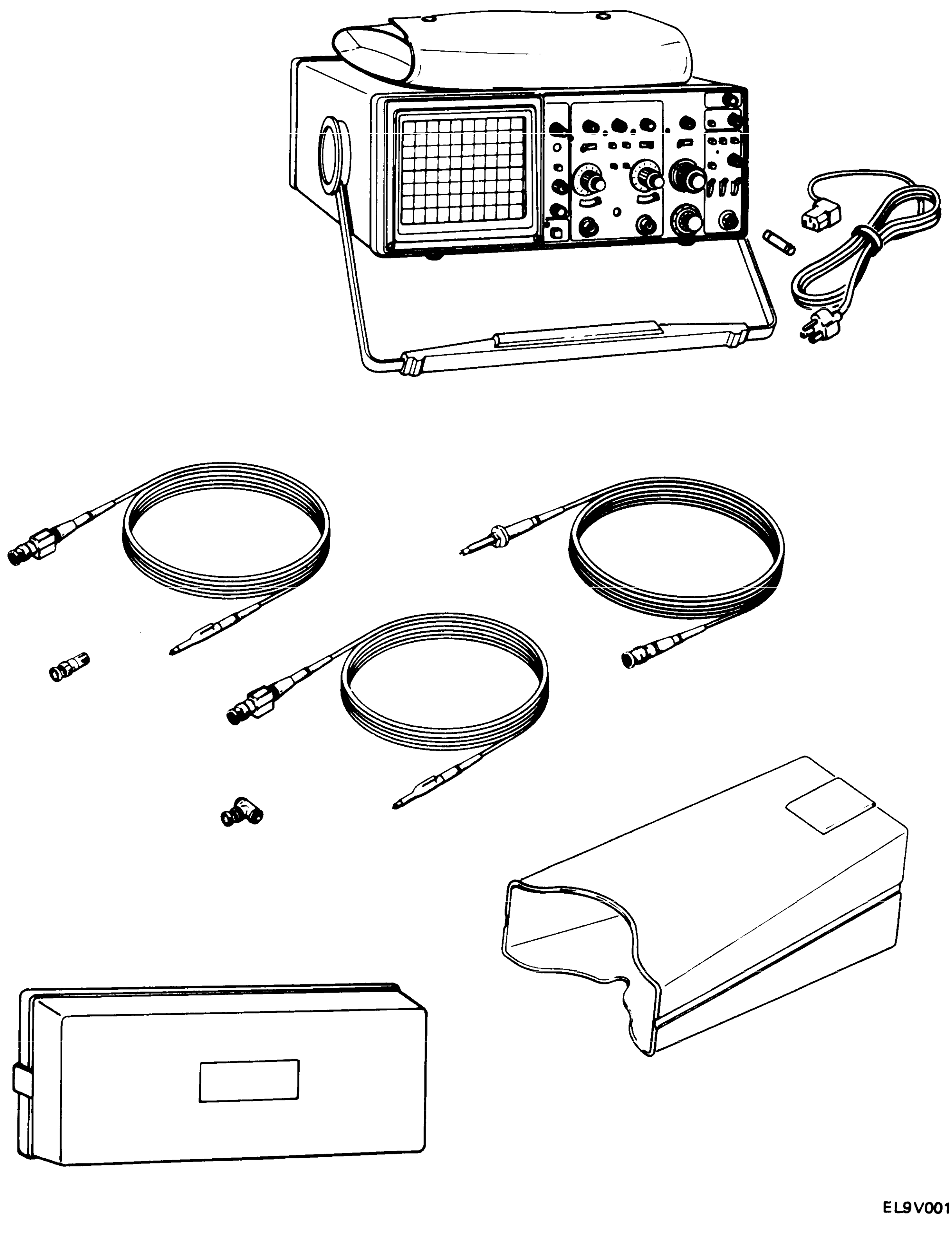

Figure 1-1. Oscilloscope AN/USM-488

CHAPTER 1
INTRODUCTION

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Consolidated Index of Army Publications and Blank Forms	1-2	1-1
Destruction of Army Materiel to Prevent Enemy Use	1-4	1-1
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Section I. GENERAL INFORMATION

1-1.SCOPE

This manual describes the Oscilloscope AN/USM-488 (oscilloscope) and provides instructions for operation, cleaning, inspection, and maintenance. Testing, troubleshooting, and repair procedures are provided for organizational maintenance personnel. The oscilloscope (fig. 1-1) is a portable, bench-type oscilloscope designed for general purpose waveform measurements using single-or dual-trace displays with normal or delayed sweep.

1-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS

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 Pam738-750, as contained in Maintenance Management Update.

b. Reporting of ltem and Packaging Discrepancies. Fill out and forward SF 364 (Report of Discrepancy (ROD)) as prescribed in AR 735-11-2/DLAR 4140.55/SECNAVINST 4355.18/AFR 400-54/MCO 4430.3J.

c. Transportation Discrepancy Report (TDR) (SF 361). Fill out and forward Transportation Discrepancy Report (TDR) (SF 361) as prescribed in AR 55–38/NAVSUPINST 4610.33C/AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1-4. DESTRUCTION OF ARMY ELECTRONICS MATERIEL TO PREVENT ENEMY USE

Destruction of Army electronics materiel to prevent enemy use shall be in accordance with TM 750-244-2.

1-5. PREPARATION FOR STORAGE OR SHIPMENT

Storage and shipment procedures are in Chapter 3, Section V.

1-6. 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.

1-7. NOMENCLATURE CROSS-REFERENCE LIST

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

Common Name	Official Nomenclature
Osccilloscope	Oscilloscope AN/USM-488

1-8. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)

If your oscillscope 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 your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ED-PH, Fort Monmouth, New Jersey 07703-5000. We'll send you a reply.

1-9. WARRANTY INFORMATION

Oscilloscope AN/USM488 is warranted by Tektronix Inc. for 1 year. The warranty starts on the date of purchase by the original owner. Report all defects immaterial or workmanship to your supervisor who will take appropriate action through your organizational maintenance shop.

1-10. LIST OF ABBREVIATIONS

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

Abbreviation	Term
AN/USM	Army-Navy/General utility-special-maintenance
AR	Army Regulation
BII	basic issue item
BW	Bandwidth
C	operator/crew
cm	centimeter
crt	cathode ray tube
DA	Department of the Army
DOD	Department of Defense
DISREP	discrepancy in shipment report
div	division
EAR	equipment improvement recommendation
Hz	hertz (formerly cps)
kHz	kilohertz
MAC	maintenance allocation chart
MHz	megahertz
mV	millivolt
ns	nanosecond
NON	National/NATO stock number
o	organizational maintenance
pF	picofarad
P-P	peak-to-peak
PMCS	preventive maintenance checks and services
rqr	required
s	second
sec/div	seconds per division
SIR	source, maintainability, and recoverability
TAMES	The Army Maintenance Management System
TIDE	test, measurement, and diagnostic equipment
U/M	unit of measure
us	microsecond
uV	microvolt
VITS	vertical interval test signal

Section II. EQUIPMENT DESCRIPTION

1-11. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

The oscilloscope is a rugged, lightweight, dual-channel instrument allowing visual evaluation of electrical circuits.

a. Characteristics.

- Measures ac voltage and dc voltage
- Measures frequency
- Measures nondelayed time
- Measures rise and fall times
- Algebraically adds signals applied to channels 1 and 2

b. Capabilities and Features.

- Vertical system provides calibrated deflection factors from 2 inV per division to 5 V per division
- Trigger circuits enable stable triggering over full bandwidth of vertical system
- Horizontal system provides calibrated sweep speeds from 0.5s per division to 50 ns per division
- Horizontal system provides delayed sweep feature
- Magnifier circuit extends maximum sweep speed to 5 ns per division

1-12. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

OSCILLOSCOPE (1) — A self-contained, multi-range measuring instrument that allows visual evaluation of electrical circuits. It measures and indicates various electrical characteristics needed to test and troubleshoot electrical equipment. The handle can be adjusted as a stand.

POUCH (2) — Provides storage for probes and small components.

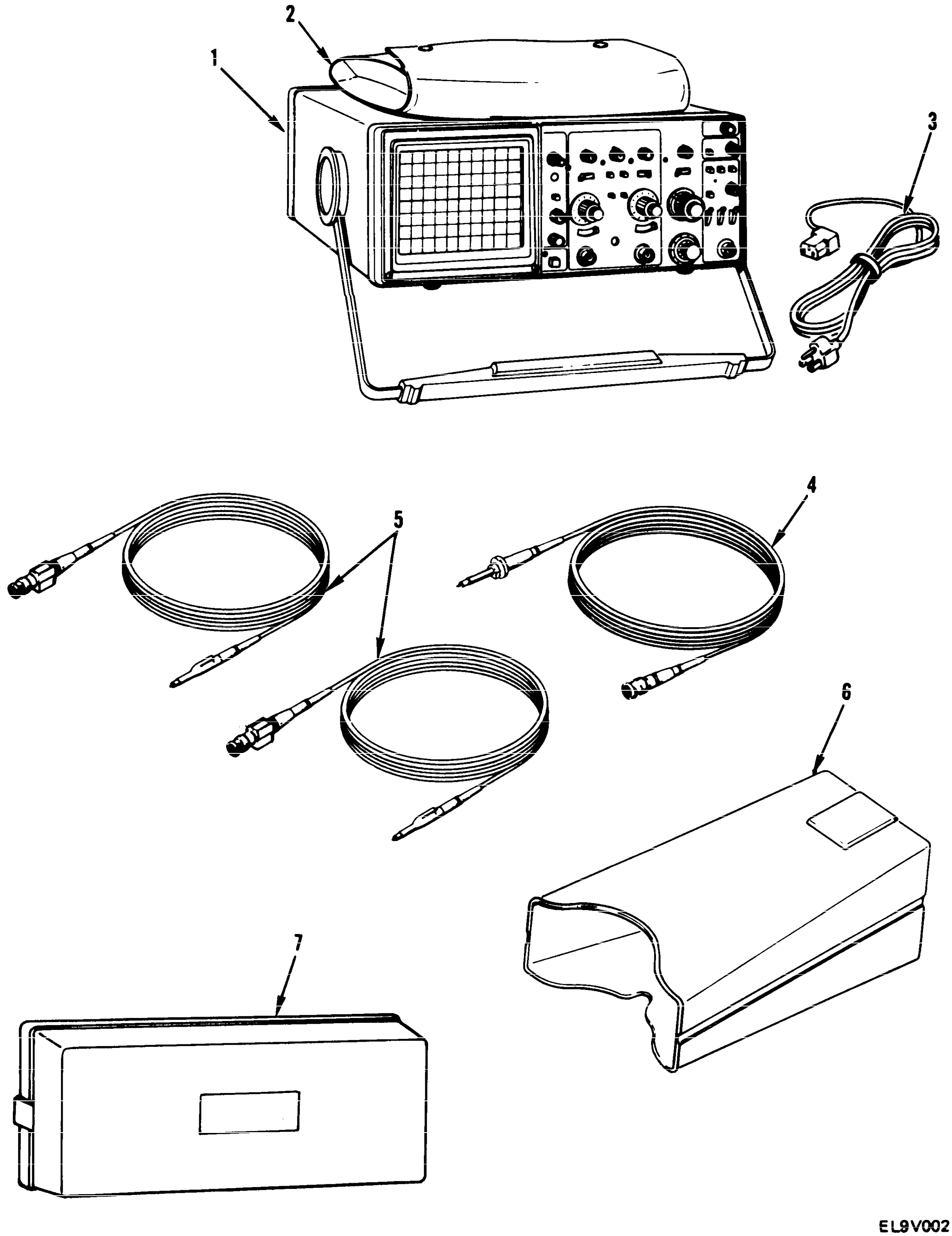
AC POWER CORD (3) — Provides for operation from the ac power line.

1X PROBE PACKAGE (4) — Provides nonattenuated input to oscilloscope.

10X PROBE PACKAGE (5) – Attenuates input signal by factor of 10.

VIEWING HOOD (6) — Allows operator to view crt display in bright light.

COVER (7) — Protects crt screen and front panel controls.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EL9V002

1-13. EQUIPMENT DATA

VERTICAL DEFLECTION SYSTEM:

Deflection Factor
- Range . . . . 2 m V to 5 V per division
- Accuracy at 52-95°F(15-350C) ±2%
- Accuracy at 32-122°F(0-50°C). . . . . ±3%
- Range of VOLTS/DIV Control . . . . Continuously variable between settings, Increases deflection factor by at least 2.5 to 1

Step Response (Rise Time)
- 32-95° F (0-35° C)
  - 5 mV to 5 V per Division . . . . 3.5 ns or less
  - 2 m V per Division . . . . 3.9 ns or less
- 52-122° F (35-50° C)
  - 5 mV to 5 V per Division . . . . 3.9 ns or less
  - 2 m V per Division, ... 4.4 ns or less

Aberrations (Positive-going Step)
- 2 m V to 0.5 V per Division . . . . 4% peak-to-peak
- 1 V to 5 V per Division . . . . 12% peak-to-peak

Bandwidth (-3 dB Point)
- 32-95° F (0-35° C)
  - 5 m V to5 V per Division .... dc to at least 100 MHz
  - 2 m V per Division . . . . dc to at least 90 MHz
- 95-122° F (35-50°C)
  - 5 m V to 5 V per Division . . . . dc to at least 90 MHz
  - 2 m V per Division . . . . dc to at least 80 MHz
- AC Coupled Lower Limit . . . . 10 Hz or less at -3 dB

Bandwidth Limiter .... Upper limits (-3 dB bandpass at 20 MHz, ± 10%)

Chop Mode Switching Rate . . . . 500 kHz ±30%

Input Characteristics
- Resistance .. . . 1 Megohm ±2%
- Capacitance . . . . 20 pF ±2 pF

Maximum Safe Input Voltage
- DC Coupled . . . . 400 V (dc + peak ac) or 800 V peak-to-peak to 10 kHz or less
- AC Coupled . . . . 400 V (dc + peak ac) or 800 V peak-to-peak to 10 kHz or less

Common Mode Rejection Ratio . . . . At least 20 to 1 at 80 MHz

Input Current . .. . 1.0 nA or less (0.5 division trace shift at 2 m V per division)

Trace Shift with VOLTS/DIV Switch
- Rotation . . . . 0.75 division or less

Trace Shift as VOLTS/DIV Variable Control
- is Rotated . . .. 1.0 division or less

Trace Shift With Invert. . . . . 1.5 divisions or less

Channel Isolation . . . . Greater than 100 to 1 at 50 MHz

POSITION Control Range .... At least ±11 divisions from graticule center

TRIGGER SYSTEM:

A Trigger Sensitivity	
P-P AUTO/TV LINE and NORM Modes	
Internal	0.35 division at 10 MHz, 1.0 division at 60 MHz, 1.5 divisions at 100 MHz
External	35 m V at 10 MHz, 120 m V at 60 MHz, 150 m V at 100 MHz
High-Frequency Rejection	Attenuates signals above 40 kHz (-3 dB point at 40 kHz ±25%)
Low-Frequency Rejection	Attenuates signals below 40 kHz (--3 dB point at 40 kHz ±25%)
Lowest Useable Frequency in P-P AUTO Mode	20 Hz with 1.0 division internal or 100 m V external
TV FIELD Mode	1.0 division of composite sync
External Trigger Input	
Maximum Input Voltage	400 V (dc + peak ac) or 800 V ac peak-to-peak
Input Resistance	1 Megohm ±2%
Input Capacitance	20 pF ±2.5 pF
AC Coupled	10 Hz or less at lower -3 dB point
Level Control Range	
A TRIGGER (Normal)	
INT	Can be set to any point of the trace that can be displayed
EXT. DC	At least+ 1.6 V (3.2 V peak-to-peak)
EXT. DC÷10	At least ±16 V (32 V peak-to-peak)
B TRIGGER (Internal)	Can be set to any point of trace that can be displayed
VAR HOLDOFF Control	Increases A sweep holdoff time by at least a factor of 10

TRIGGER VIEW SYSTEM:

Deflection Factor	
Internal	Same as vertical
External	
AC and DC	100 m V per division
DC ÷ 10	1 V per division
Accuracy	±20%
Delay Difference Between EXT INPUT and Either Vertical Channel	Less than 2.0 ns

HORIZONTAL DEFLECTION SYSTEM:

Sweep Rate Calibrated Range

A sleep . . . . 0.5 second to 0.05 us per division. X10 magnifier extends maximum sweep speed to 5 ns per division

B Sweep . . . . 50 ms to0.05us per division. X10 magnifier extends maximum sweep speed to 5 ns per division

Sweep Rate Accuracy at 59-95° F (15-35° C)... ±2% unmagnified, ±3% magnified

Sweep Rate Accuracy at 32-122° F (0-50° C)... ±3% unmagnified, ±4% magnified

POSITION Control Range . . . . Start of sweep to 10th division will position past center vertical graticule line in X1 or 100th division in X10

Sweep Linearity . . . . ±5%

Variable Control Range . . . . Continuously variable between calibrated settings. Reduces A and B sweep speeds by at least a factor of 2.5

Sweep Length . . . . Greater than 10 divisions

A/B SWP SEP Range . . . . ±3.5 divisions or greater

Delay Time . . . . Applies to 0.5 us per division and slower

Dial Control Range . . . . <0.5 + 300 ns to >10 divisions

Jitter . . . . 0.005% of the maximum delay time

Time Measurement Accuracy

59-95° F (15-35°C) . . . . ±1%+ 0.01 major dial division

32-122° F (0-50°C) . . . . ±2%+ 0.01 major dial division

X-Y OPERATION:

Deflection Factors . . . . Same as vertical deflection system (with VOLTS/DIV variable controls in CAL detent)

Accuracy

X-Axis at 59-95° F (15-35°C) . . . . ±3%

X-Axis at 32-122° F (0-50°C) . . . . ±4%

Y-Axis . . . . Same as vertical deflection system

Bandwidth (--3 dB Point)

X-Axis . . . . dc to at least 2.5 MHz

Y-Axis . . . . Same as vertical deflection system

Phase Difference Between X- and Y-Axis

Amplifiers, ... ±3%from dcto150kHz

AMPLITUDE CALIBRATOR:

Output Voltage of AMP CAL Connector . . . . . 0.5V ±2%

Repetition Rate................ . . . . 1 kHz ±20%

Z-AXIS INPUT:

Sensitivity . . . . 5 V causes noticeable modulation. Positive-going input decreases intensity. Useable frequency range is dc to 20 MHz.

Maximum Safe Input Voltage . . . . 30 V (dc + peak) or 30 V ac peak-to-peak at 1 kHz or less

Input Resistance . . . . 10 kilo hms ±10%

POWER SOURCE:

Line Voltage Ranges	90 V ac to 250 V ac
Line Frequency	48 to 440 Hz
Maximum Power Consumption	40 W (70 VA)
Line Fuse	1.0 A, 250 V, Slow-blow

CATHODE RAY TUBE:

Display Area	80mmx100mm
Standard Phosphor	P31
Nominal Accelerating Voltage	14 kV

ENVIRONMENTAL CHARACTERISTICS:

Operating Temperature	32-122° F (0-50° C)
Nonoperating Temperature	-67 to +167°F (--55 to + 75°C)
Operating Altitude	Up to 15,000 ft (4,500m). Maximum temperature decreased 1° C per 1,000 ft above 5,000 ft
Nonoperating Altitude	To 50,000 ft (15,000 m)
Operating Humidity	95% at 86-122° F (30-50° C)
Nonoperating Humidity	95% at 86-140° F (30-60° C)
Vibration (Operating)	Can withstand total displacement of 0.01 5 inch p-p (2.4 g's at 55 Hz) along all three axes, with frequency varied from 10 Hz to 55 Hz, for period of 15 minutes
Electromagnetic Interference	Meets requirements of MIL STD-461B Pt 4

PHYSICAL CHARACTERISTICS:

Weight with Accessories	20.0 lb (9.1 kg)
Weight without Accessories	13.5 lb (6.1 kg)
Domestic Shipping Weight	24.1 lb (10.9 kg)
Height with Empty Pouch	5.9 in. (150 mm)
Height without Pouch	5.4 in. (137 mm)
Width with Handle	14.2 in. (360 mm)
Width without Handle	12.9 in. (328 mm)
Length with Front Cover	17.5 in. (445 mm)
Length without Front Cover	17.3 in. (440 mm)
Length with Handle Extended	20.1 in. (511 mm)

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-14. FUNCTIONAL DESCRIPTION

The following is a basic functional description of the oscilloscope. Refer to fig. 1-2 for a block diagram.

1. There are two vertical attenuators (one for each channel). The attenuator circuits provide control of input coupling, vertical deflection factor, and variable volts-per-division gain. An invert circuit in the channel 2 attenuator allows you to invert the channel 2 input signal.

2. The vertical preamp and output circuit amplifies the input signals. This makes the signal level high enough for vertical deflection of the electron beam in the crt. The dynamic range of the amplifier can be limited with the beam find switch. The amplifier also intensifies the trace and limits horizontal deflection.

3. The A sweep generator and logic circuit produces a linear voltage ramp for horizontal deflection of the crt beam. The sweep generator also produces signals that generate correct timing of the crt unblinking and intensity levels.

4. The A trigger circuitry uses either an internal signal, external trigger, or ac line trigger signal to develop a gate signal for the A sweep generator. The B trigger circuitry uses only the internal trigger signal to gate the B signal generator.

5. The alternate B sweep circuitry produces a linear voltage ramp that is amplified by the horizontal amplifier. This provides the B sweep horizontal deflection on the crt. The alternate B sweep circuitry also produces sweep-switching signals that control the display of the A and B sweeps, and gate signals used to establish the crt unblinking and intensity levels for the A intensified and B sweep displays.

6. The X-Y amplifier amplifies the channel 1 signal from the internal circuit and applies it to the horizontal amplifier. The horizontal amplifier provides output signals to drive the crt horizontal deflection plates.

7. The power supply converts ac power-line voltage into voltages needed for oscilloscope operation. The Z-axis amplifier uses several input signal sources to control the crt intensity level.

8. The crt provides a visual display of the electrical properties of the circuit or signal under examination.

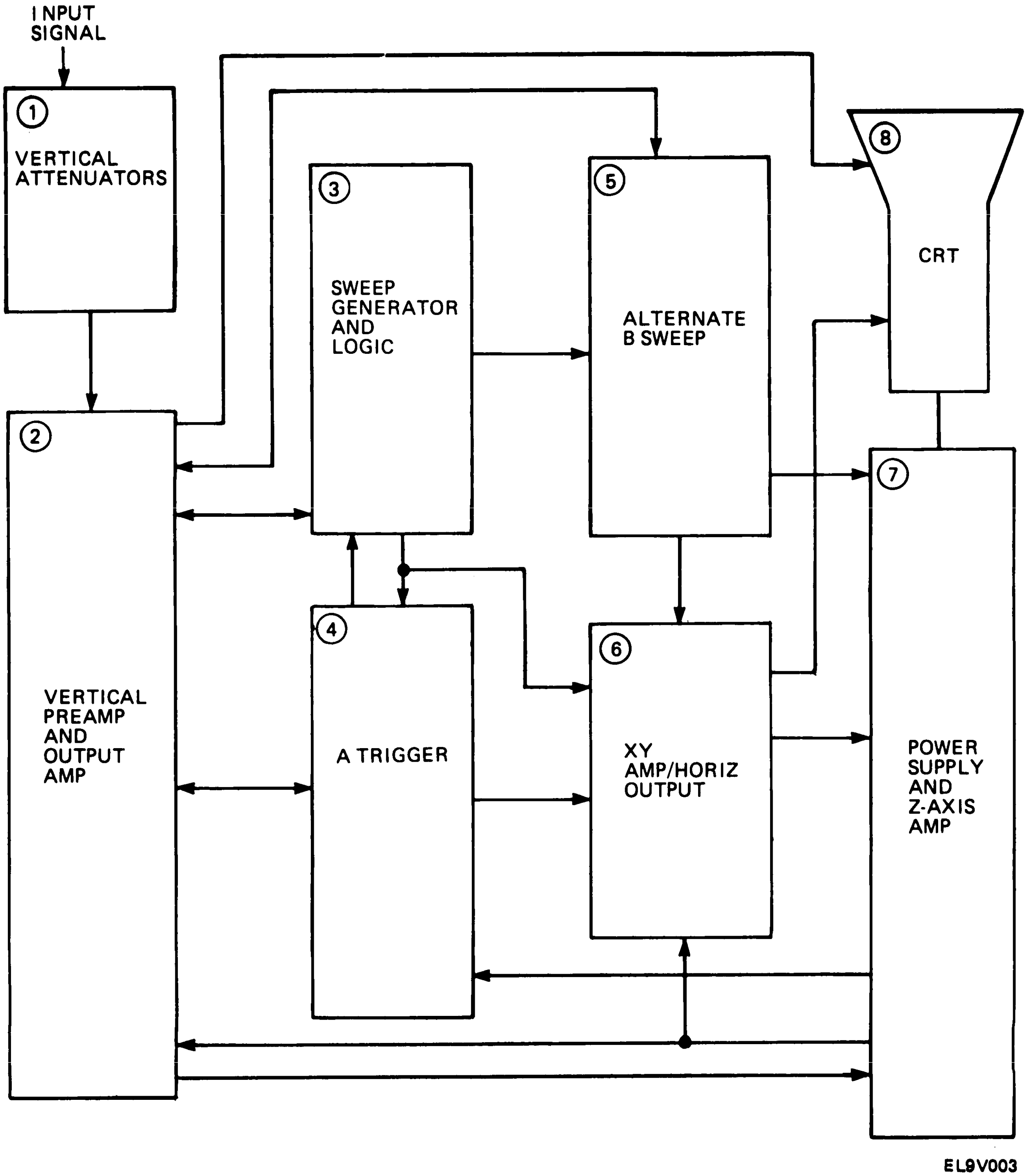

Figure 1-2. AN/USM-488 Oscilloscope Block Diagram

CHAPTER 2
OPERATING INSTRUCTIONS

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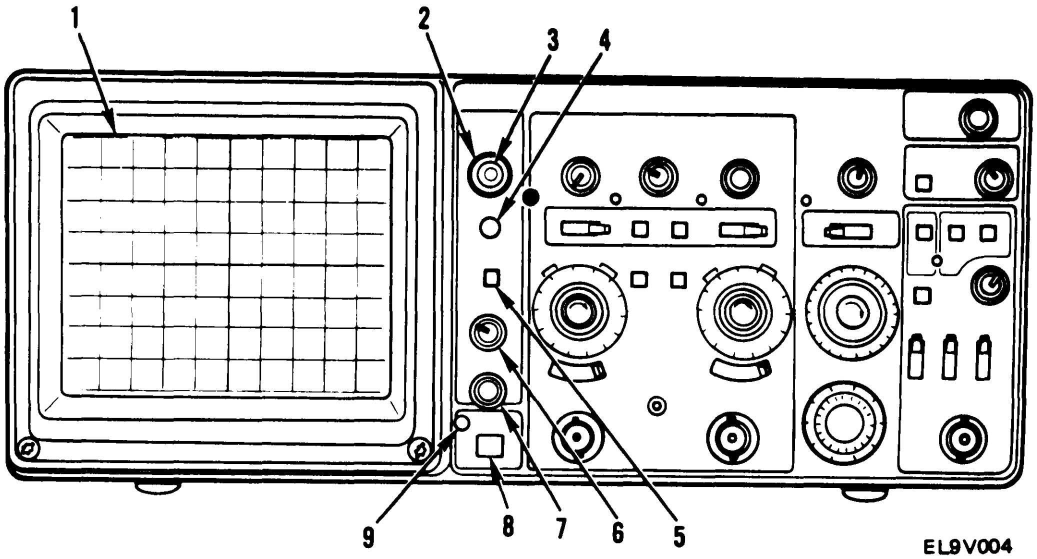
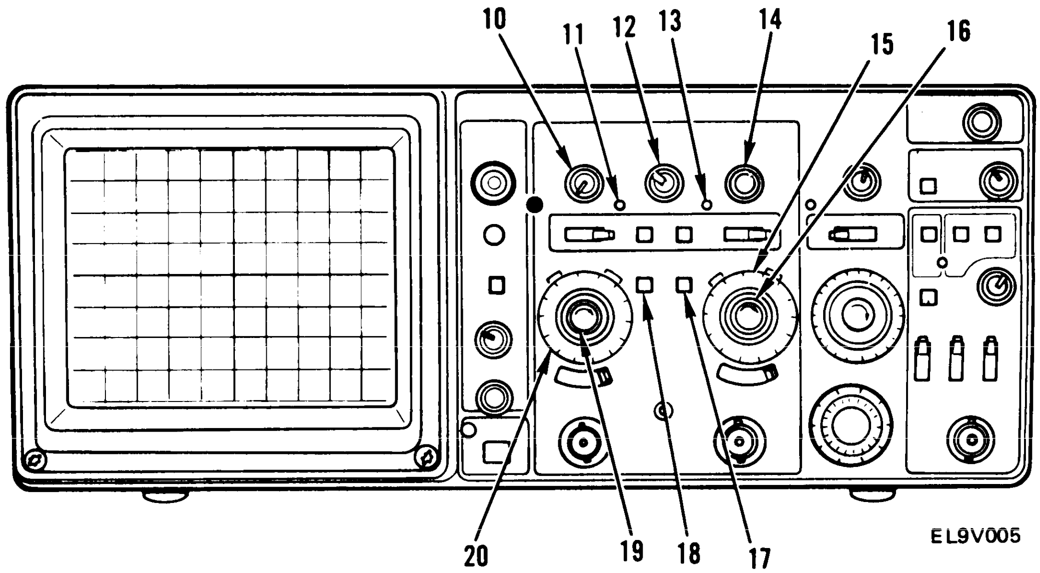
Operating Procedures	2-3	2-11
Operation in Unusual Weather	2-4	2-44
PMCS Table	2-2	2-8

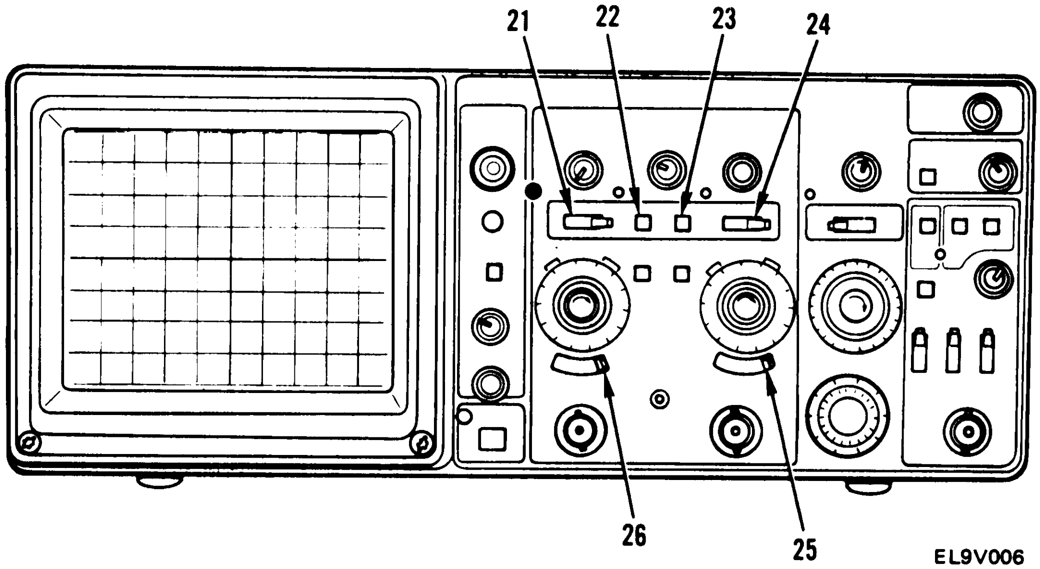
Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS



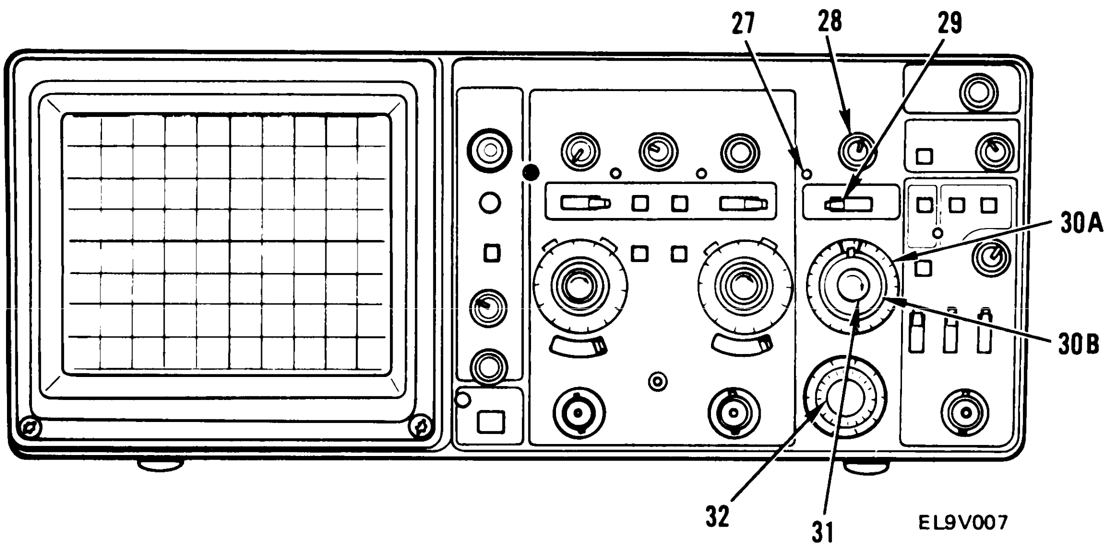
Key	Control Or Indicator	Function
1	Cathode Ray Tube	Provides visual display of electrical properties of circuit under examination
2	A INTENSITY Control	Controls brightness of A sweep trace
3	B INTENSITY Control	Controls brightness of B sweep trace
4	TRACE ROTATION Control	Screwdriver adjustment used to align trace with horizontal graticule line
5	BEAM FIND Switch	When held depressed, compresses display to within graticule area to aid in locating off-screen displays
6	SCALE ILLUM Control	Adjusts brightness of graticule illumination
7	FOCUS Control	Adjusts for optimum display definition
8	POWER Switch	Turns oscilloscope power on and off
9	POWER Indicator	When illuminated, indicates power applied to oscilloscope



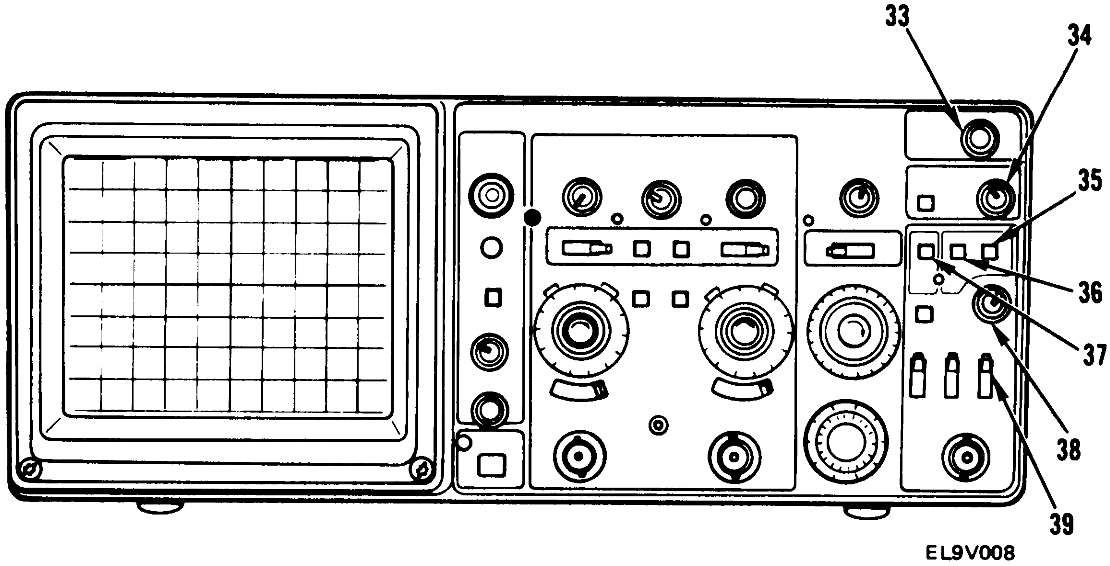
Key	Control Or Indicator	Function
10	POSITION Control	Controls vertical position of channel 1 display
11	UNCAL Indicator	When illuminated, indicates channel 1 VOLTS/DIV control not in calibrated position
12	A/B SWP SEP Control	Vertically positions B sweep trace with respect to A sweep trace when HORIZONTAL ALT mode is selected
13	UNCAL Indicator	When illuminated, indicates channel 2 VOLTS/DIV control not in calibrated position
14	POSITION Control	Controls vertical position of channel 2 display
15	CH 2 VOLTS/DIV Switch	Used to select channel 2 vertical deflection factor
16	CH 2 VOLTS/DIV Variable Control	When rotated out of detent, provides variable, uncalibrated deflection factors between calibrated settings of channel 2 VOLTS/DIV switch
17	BW LIMIT Switch	When depressed, limits bandwidth of vertical amplifier and A trigger system to approximately 20 MHz
18	TRIG VIEW Switch	While held in, sample of signal present in A trigger amplifier displayed on crt
19	CH 1 VOLTS/DIV Variable Control	When rotated out of detent, provides variable, uncalibrated deflection factors between calibrated settings of channel 1 VOLTS/DIV switch
20	CH 1 VOLTS/DIV Switch	Used to select channel 1 vertical deflection factor



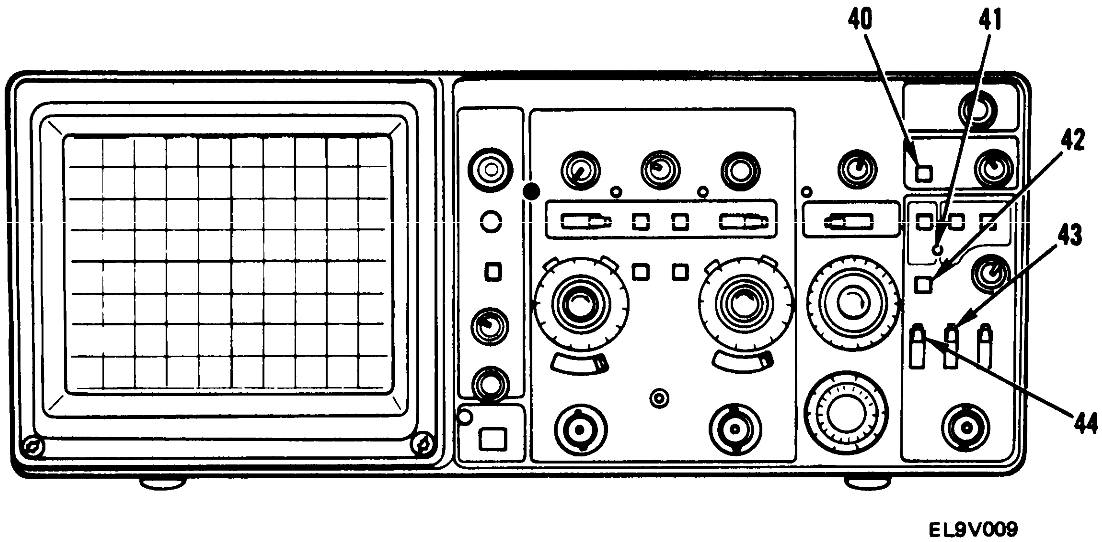
Key	Control Or Indicator	Function
21	VERTICAL MODE CH 1/BOTH/CH 2 Switch	When set to CH 1, selects only channel 1 input signal for display. When set to BOTH, selects both channel 1 and channel 2 input signals for display. When set to CH 2, selects only channel 2 input signal for display
22	CH 1 TRIGGER SOURCE Switch	When depressed, selects signal applied to CH 1 OR X INPUT connector as trigger source
22-23	COMPOSITE	When CH 1 and CH 2 switches are either both depressed or both released, composite trigger source is selected, Trigger source is then determined by signals selected for display by the VERTICAL MODE switches
23	CH 2 TRIGGER SOURCE Switch	When depressed, selects signal applied to CH 2 OR Y INPUT connector as trigger source
24	VERTICAL MODE ADD/ALT/CHOP Switch	When set to ADD, displays algebraic sum of channel 1 and channel 2 input signals. When set to ALT, displays channel 1 and channel 2 input signals alternately at end of each trace. When set to CHOP, displays channel 1 and channel 2 input signals alternately during sweep time
25	AC/GND/DC Switch	Three-position switch to select method of coupling input signal to channel 2 deflection system. It also establishes DC ground reference line on crt.
26	AC/GND/DC Switch	Three-position switch to select method of coupling input signal to channel 1 deflection system. It also establishes DC ground reference line on crt.



Key	Control Or Indicator	Function
27	UNCAL Indicator	When illuminated, indicates SEC/DIV variable control is not in calibrated position
28	POSITION Control	Moves A sweep and B sweep displays horizontally and horizontally positions X-axis in X-Y mode of operation
29	HORIZONTAL MODE A/ALT/B Switch	Determines mode of operation for horizontal deflection system. When set to A, horizontal deflection is provided by A sweep generator. When set to ALT, display alternates between A sweep and B delayed sweep. When set to B, horizontal deflection is provided by B sweep generator
30A	A SEC/DIV Switch	Used to select sweep speeds for A and B sweep generators in a 1, 2, 5 sequence. To lock A and B sweeps together, pull the B SEC/DIV switch out and align the pointer on the B SEC/DIV switch between the two markers on the A SEC/DIV switch, then release the switch. If the two switches are not locked together, B sweep can be delayed. Setting A SEC/DIV switch to X-Y locks the A sweep in horizontal mode.
30B	B SEC/DIV Switch	
31	SEC/DIV Variable Control and X10 Multiplier Switch	Provides continuously variable, uncalibrated sweep speeds. Pulling control out actuates X 10 magnifier switch, which expands crt display by a factor of 10
32	B DELAY TIME POSITION Control	Selects amount of delay time between start of A sweep and start of B sweep. Delay time is variable from 0.5 to 10 times A SEC/DIV switch setting



Key	Control Or Indicator	Function
33	VAR HOLDOFF Control	Provides continuous control of hold off time between sweeps and increases hold off time by at least a factor of 10
34	B TRIGGER LEVEL Control	Selects amplitude point on trigger signal at which B sweep is triggered
35	A TRIGGER NORM Switch	When depressed, sweep is initiated when adequate trigger signal is applied
35-36	TV FIELD	Depressing both P-P AUTO and NORM pushbuttons permits triggering on television field signals
36	A TRIGGER P-P AUTO/TV LINE Switch	Permits triggering on waveforms and television lines having repetition rate of at least 20 Hz. Sweep free-runs in absence of adequate trigger signal
37	A TRIGGER SGL SWP RESET Switch	When momentarily depressed, arms A trigger circuit for single-sweep display
38	A TRIGGER LEVEL Control	Selects amplitude point on trigger signal at which A sweep is triggered
39	A EXT COUPLING Switch	Three-position switch that determines method used to couple external signals from EXT INPUT connector to A trigger circuit



Key	Control Or Indicator	Function
40	B TRIGGER SLOPE Switch	Selects slope of signal that triggers B channel sweep
41	TRIG'D/READY Indicator	Illuminates when either P-P AUTO or NORM trigger mode is selected
42	A TRIGGER SLOPE Switch	Selects slope of signal that triggers A channel sweep
43	A SOURCE Switch	Three-position switch that determines source of trigger signal coupled to input of A trigger circuit. When set to INT, permits triggering on signal applied to CH 1 OR X connector or CH 2 OR Y connector. When set to LINE, selects ac line voltage as trigger signal. When set to EXT, permits triggering on signals applied to EXT INPUT connector
44	A TRIG BW Switch	Three-position switch that selects trigger bandpass frequencies for A trigger circuit. When set to FULL, allows all frequency components to pass. When set to HF REJ, attenuates all trigger signals above approximately 40 kHz. When set to LF REJ, attenuates all trigger signals below approximately 40 kHz

Section II. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-1. GENERAL

Operator Preventive Maintenance Checks and Services (PMCS) is the required inspection and care of your equipment necessary to keep it in good operating condition.

a. **Before You Operate.** Always keep in mind the CAUTIONS and WARNINGS. Perform your before - PMCS.

b. **While You Operate.** Always keep in mind the CAUTIONS and WARNINGS. Perform your during - PMCS.

c. **After You Operate.** Be sure to perform your after-operation PMCS.

d. **If Your Equipment Falls to Operate.** Troubleshoot with proper equipment. Report any deficiencies using the proper forms. See DA PAM 738-750.

2-2. PMCS TABLE

The PMCS are shown in table 2-1.

a. **Item Number Column.** The numbers appearing in this column are in the order the work should be performed. The numbers are keyed to fig. 2-1 to identify work locations. This column shall also be used as a source of item numbers for the TM Number Column on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) in recording results of PMCS.

b. **Interval Column.** This column indicates whether PMCS are performed before operation (B), during operation (D), after operation (A), or weekly (W).

c. **Item to be Inspected Column.** This column identifies the item to be inspected.

d. **Procedures Column.** This column contains a brief description of the check or service to be performed and step-by-step procedures.

e. **Equipment is Not Ready If Column.** This column identifies the condition that prevents the equipment from being ready for operation.

Table 2-1. Operator Preventive Maintenance Checks and Services

WARNING

High voltage is used in the operation of this equipment. Death on contact may result if you fail to observe safety precautions. Learn where there may be dangerous voltages present.

B = Before D = During A = After W = Weekly

Item No.	Interval B	D	A	W	Item to be Inspected	Procedure	Equipment is Not Ready if:
1	•			•	Cabinet Front Panel, and Viewing 'Hood	Inspect case, viewing hood, cover, and front panel for cracks, scratches, deformation, loose or missing hardware or gaskets.	Cabinet or front panel is badly damaged.
2	•	•	•	•	Front Panel Controls	Inspect for missing, loose, or damaged knobs, buttons, and controls.	Knobs, buttons, or controls missing or damaged.
3	•		•	•	Connectors	Inspect for broken shells, cracked insulation, deformed contacts, and dirt in connector.	Connector shell is broken, insulation is cracked, or contacts deformed.
4	•	•	•	•	Carrying Handle	Inspect for correct operation.	
5	•			•	AC Power Cord	Inspect for frayed, broken, or abraded insulation, broken wires, or damaged connectors. Replace if damaged.	Cord shows any signs of damage.
6	•			•	Probe Package	Inspect for missing items, bent pins, broken or frayed cables, and damaged connectors. Replace if damaged.	Cables frayed or broken, pins broken, or connectors damaged.

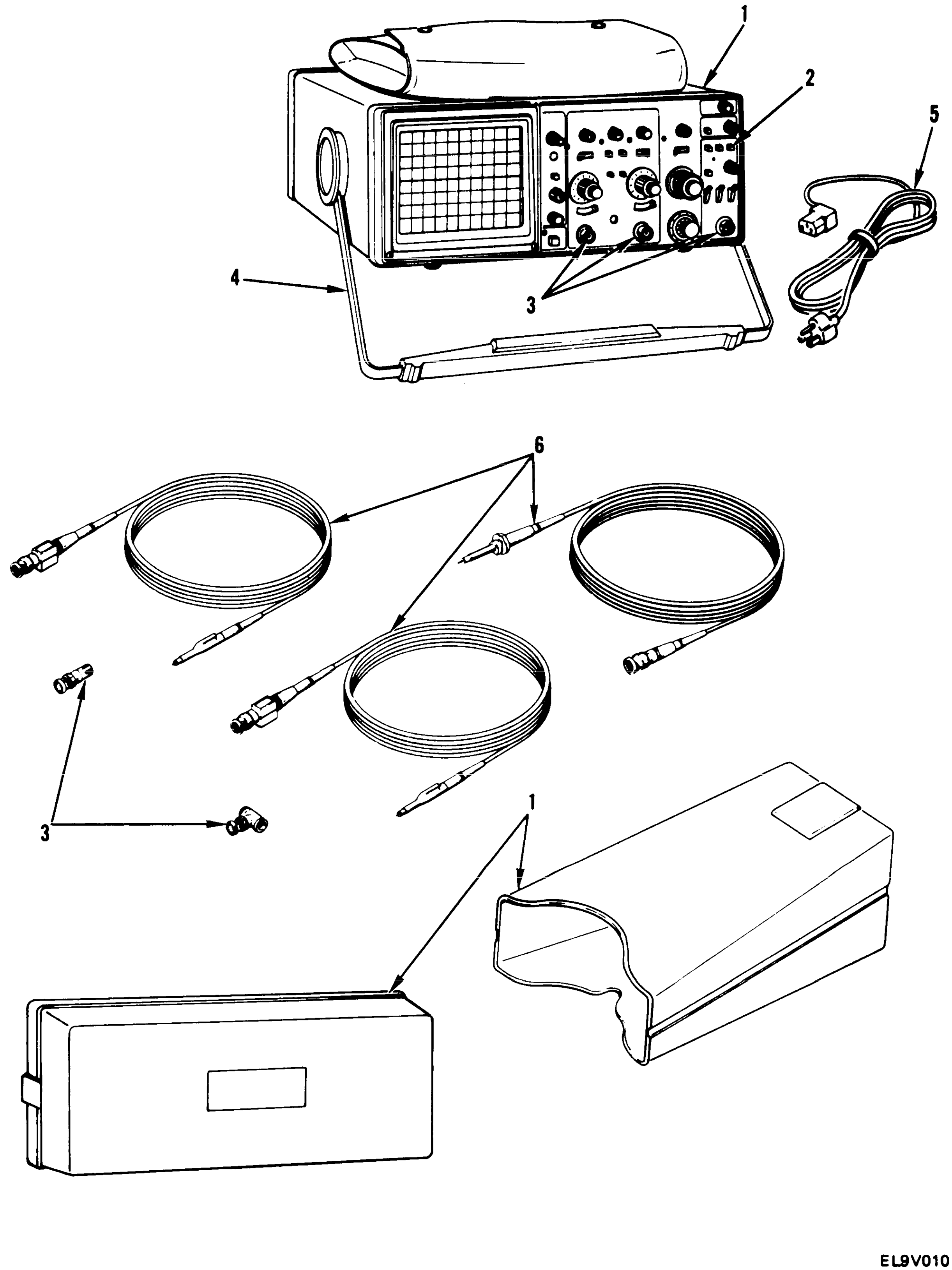


Figure 2-1. Oscilloscope PMCS Location Diagram

Section III. OPERATION UNDER USUAL CONDITIONS

2-3. OPERATING PROCEDURES

After becoming familiar with the capabilities of the oscilloscope, an operator can easily develop convenient methods for making measurements. The following paragraphs provide recommended methods for making basic measurements, such as probe compensation, voltage measurement, non-delayed time measurement, obtaining television displays, delayed sweep magnification, and delayed sweep time measurements.

a. Obtaining Baseline Trace.

1. Set POWER ON/ OFF switch (1) to OFF and plug power cord into ac source.
2. Preset front panel controls as shown in table 2-2.
3. Depress POWER ON/ OFF switch (1) to ON.
4. Adjust A INTENSITY control (2) to desired brightness of display.
5. Adjust channel 1 vertical POSITION control (3) to center trace vertically on screen.
6. Adjust horizontal POSITION control (4) to center trace horizontally on screen.

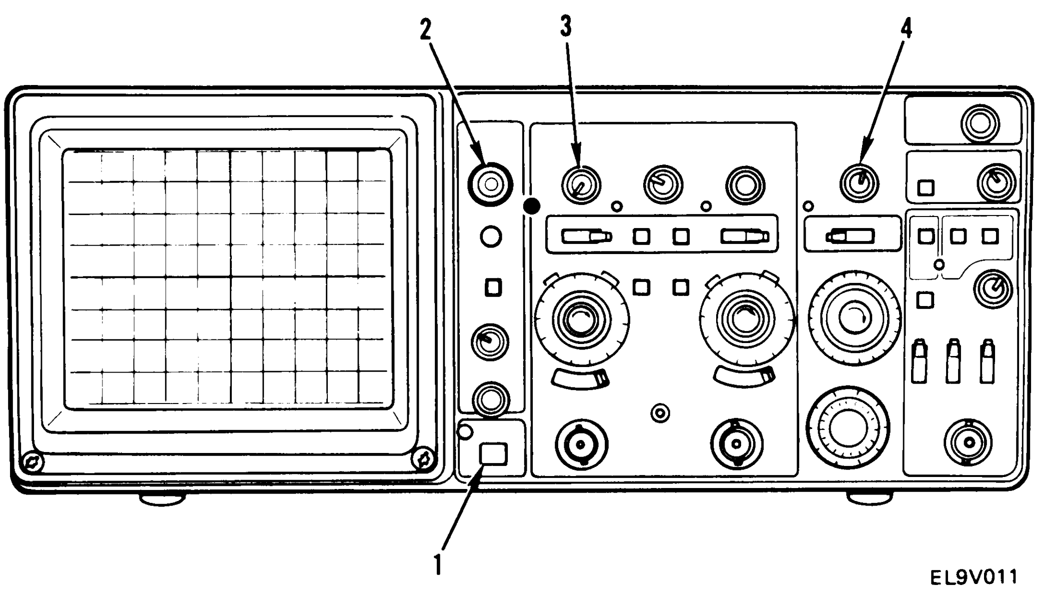


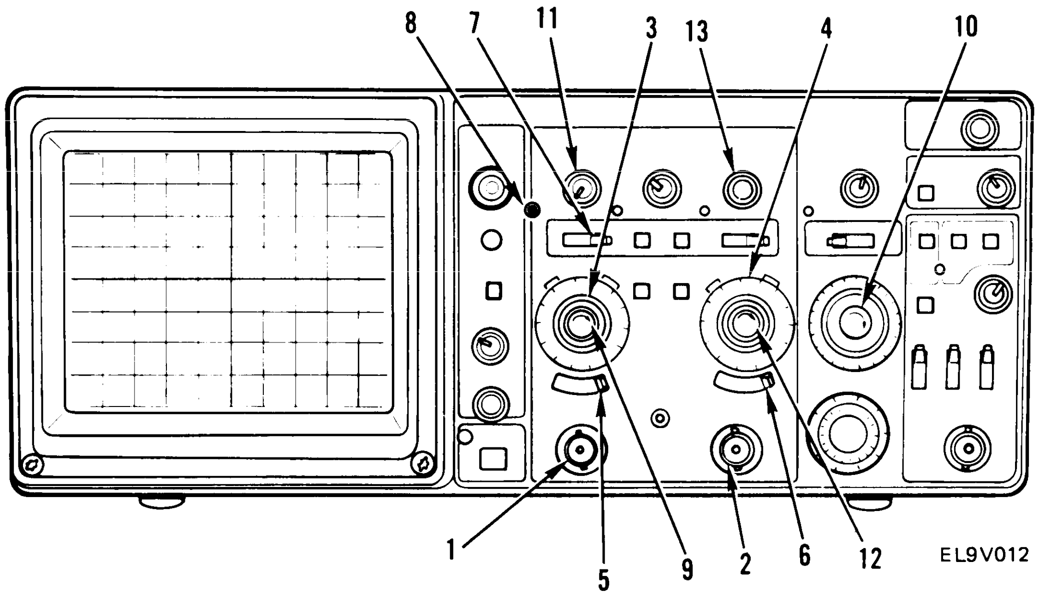
Table 2-2. Controls, Preset Positions

Control	Position
Display	
A AND B INTENSITY	Fully counterclockwise
FOCUS	Midrange
Vertical (Both Channels)	
POSITION	Midrange
POSITION and INVERT (Channel 2 only)	Midrange and pushed in
VERTICAL MODE CH 1/BOTH/CH 2	CH 1
TRIGGER SOURCE	COMPOSITE (both in or both out)
BW LIMIT	Off (button out)
VOLTS/DIV Switch	50 mV
VOLTS/DIV Variable Control	CAL detent
AC/GND/DC	AC
Horizontal	
A/B SWP SEP	Midrange
POSITION	Midrange
MODE	A
A AND B SEC/DIV Switch	0.5 ms
SEC/DIV Variable Control	CAL detent
X10 Multiplier	Off (knob in)
B DELAY TIME POSITION	Fully counterclockwise
B Trigger	
SLOPE	out
LEVEL	Fully clockwise
A Trigger	
VAR HOLDOFF	NORM
TRIGGER MODE P-P AUTO/TV LINE	In
SLOPE	out
LEVEL	Midrange
A TRIG BW	FULL
A SOURCE	INT
A EXT COUPLING	AC

b. **Probe Compensation.**

NOTE

Misadjustment of probe compensation is a common source of measurement error. To ensure optimum measurement accuracy, always compensate the oscilloscope probes before making measurements.



1. Obtain baseline trace as described in para 2-3a.

2. Connect one 10X probe to CH 1 OR X connector (1) and one 10X probe to CH 2 OR Y connector (2).

3. Set both CH 1 and CH 2 VOLTS/DIV switches (3 and 4) to 0.1 10X PROBE.

4. Set both AC/GND/DC switches (5 and 6) to DC.

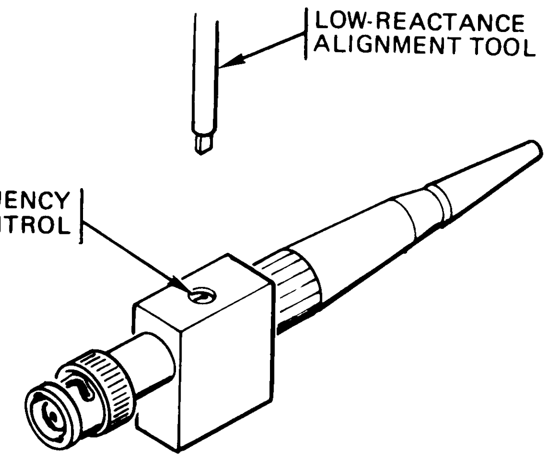
5. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (7) to CH 1.

6. Insert tip of channel 1 probe into AMP CAL connector (8) and adjust CH 1 VOLTS/DIV variable control (9) to obtain display amplitude of five vertical divisions.

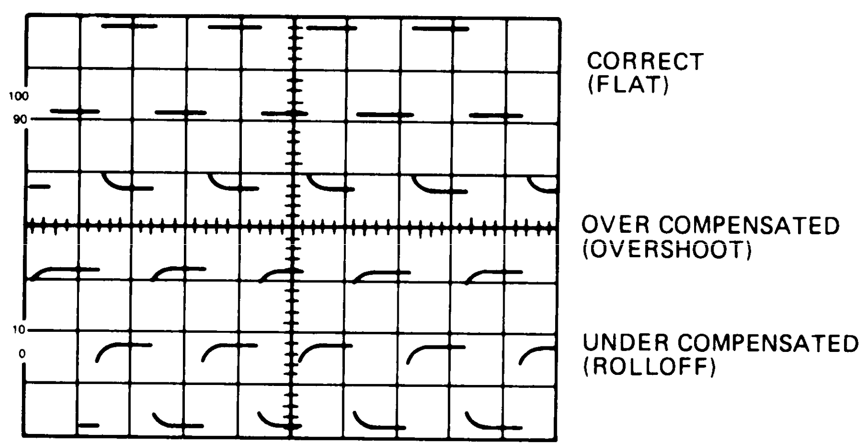
7. Set A SEC/DIV switch (10) to display 5 cycles of AMP CAL signal.

8. Using channel 1 vertical POSITION control (11), vertically center display on crt screen.

9. Using low-reactance alignment tool, adjust low-frequency compensation control on probe compensation box to obtain best wave orm with flattest top.



EL9V013



EL9V014

10. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (7) to CH2.

11. Insert tip of channel 2 probe into AMP CAL connector and adjust CH 2 VOLTS/DIV variable control (12) to obtain display amplitude of five vertical divisions.

12. Set A SEC/DIV switch (10) to display five cycles of AMP CAL signal.

13. Using channel 2 vertical POSITION control (13), vertically center display on crt screen.

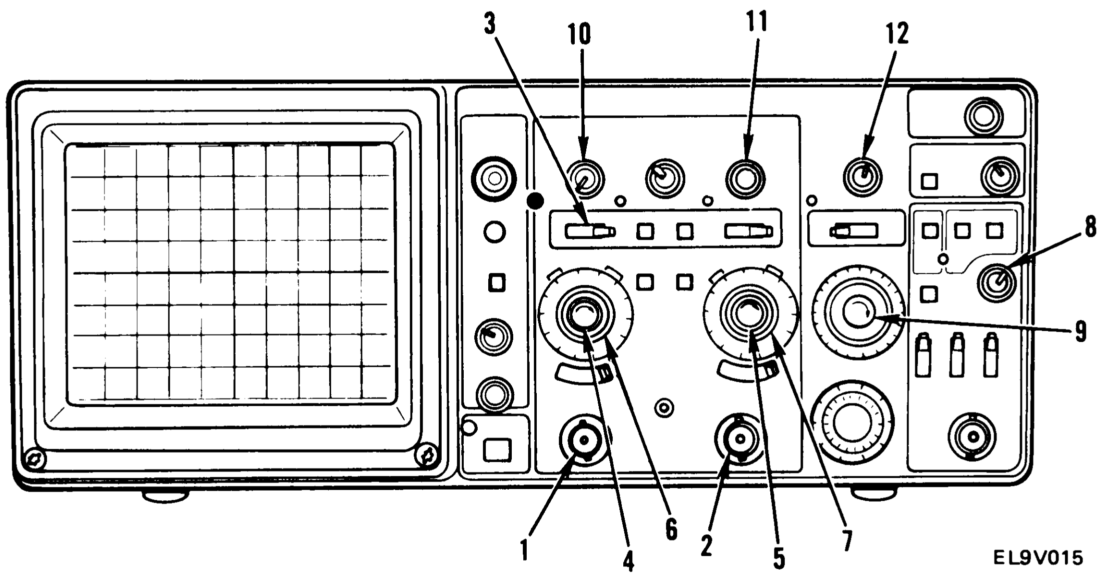
14. Using low-reactance alignment tool, adjust low-frequency compensation control on probe compensation box to obtain best waveform with flattest top.

15. Probes are now properly compensated.

c. Peak-To-Peak Voltage Measurements.

1. Obtain baseline trace as described in para 2-3a.

2. Apply ac signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2) and set VERTICAL MODE CH 1/BOTH/CH 2 switch (3) to display channel used.



3. Set CH 1 or CH 2 VOLTS/DIV variable control (4 or 5) for appropriate channel to CAL detent position, and set appropriate VOLTS/DIV switch (6 or 7) to display about five vertical divisions of waveform.

4. Adjust A TRIGGER LEVEL control (8) to obtain stable display.

5. Set A SEC/DIV switch (9) to position that allows several cycles of waveform to be displayed.

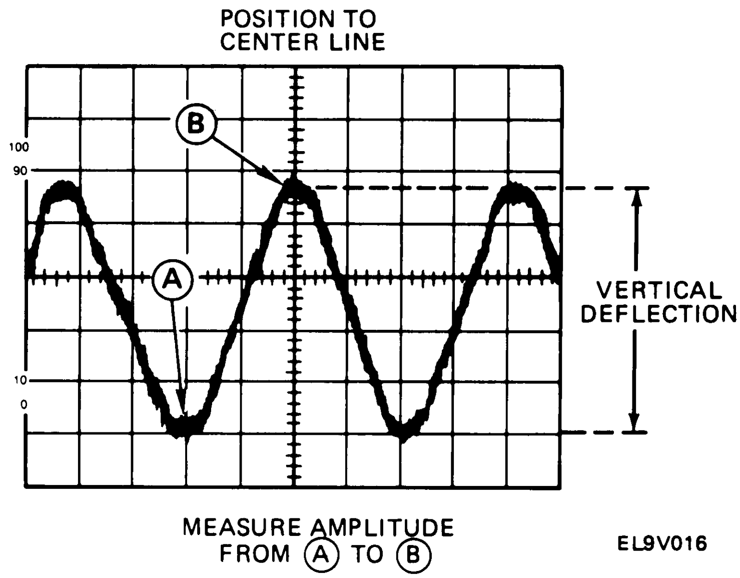
6. Rotate appropriate vertical POSITION control (10 or 11) until waveform negative peak coincides with one horizontal graticule line.

7. Rotate horizontal POSITION control (12) until one positive peak coincides with center vertical graticule line.

8. Measure deflection from negative point A to positive point B.

NOTE

If amplitude measurement is critical or trace is thick because of noise or hum on the signal, a more accurate value can be obtained by measuring from the top of the peak to the top of the valley. This eliminates trace thickness from the measurement.



9. Calculate the voltage, using the following formula:

$$\text{volts (p-p)} = \begin{matrix}\text{vertical}\\ \text{deflection}\\ \text{(divisions)}\end{matrix} \times \begin{matrix}\text{VOLTS/DIV switch setting indicated}\\ \text{1X (or 10X PROBE when 10X probe is}\\ \text{used)}\end{matrix}$$

EXAMPLE: Measured peak-to-peak vertical deflection is 4.6 divisions, a 10X attenuator probe is used and VOLTS/DIV switch is set to 5 at the 10X PROBE setting. Substituting the given values:

volts (p-p) = 4.6 div x 5 volts/div = 23 volts

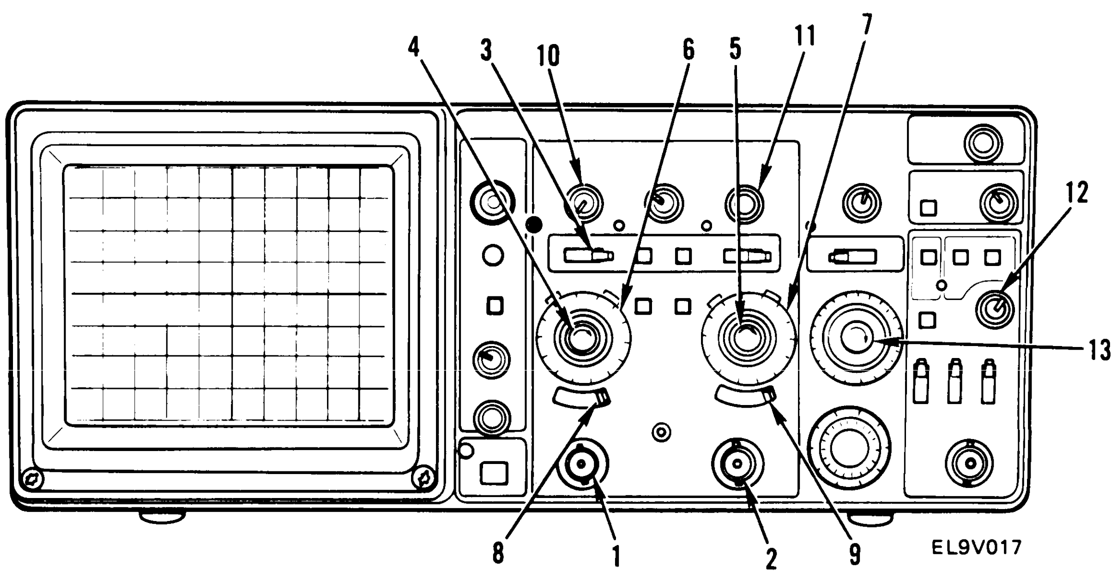
d. **Instantaneous Voltage Measurement.**

1. Obtain baseline trace as described in para 2-3a.

NOTE

This procedure can be used to measure instantaneous voltage for any input waveform. The example shown here is for a square wave.

2. Apply signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2) and set VERTICAL MODE CH 1 /BOTH/CH 2 switch (3) to display channel used.



3. Set CH 1 or CH 2 VOLTS/DIV variable control (4 or 5) to CAL detent position, and set appropriate VOLTS/DIV switch (6 or 7) for desired deflection.

4. Set AC/GND/DC switch (8 or 9) to GND.

5. Rotate channel 1 or channel 2 vertical POSITION control (10 or 11) until baseline trace falls on center horizontal graticule line. This establishes ground reference location.

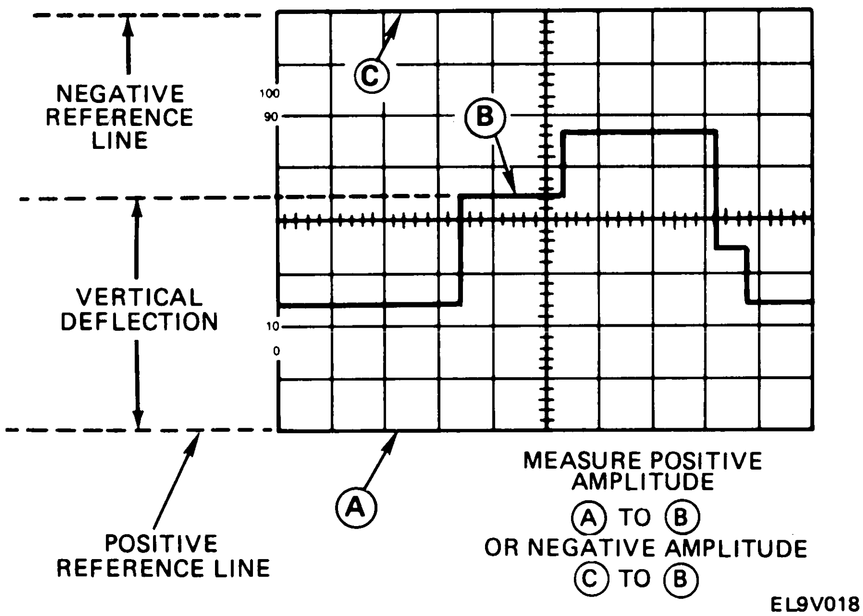
6. Set AC/GND/DC switch (8 or 9) to DC. Points on waveform above ground reference are positive; those below are negative.

7. If necessary, repeat step 5 using different reference line which allows waveform obtained in step 6 to be displayed on crt screen.

8. If using channel 2, ensure that channel 2 vertical POSITION control (11) is pushed in.

9. Adjust A TRIGGER LEVEL control (12) to obtain stable display.

10. Set A SEC/DIV switch (13) to position that allows several cycles of waveform to be displayed.



11. Count number of divisions of vertical deflection between ground reference line and point on waveform at which voltage level is to be determined.

12. Calculate voltage using formula:

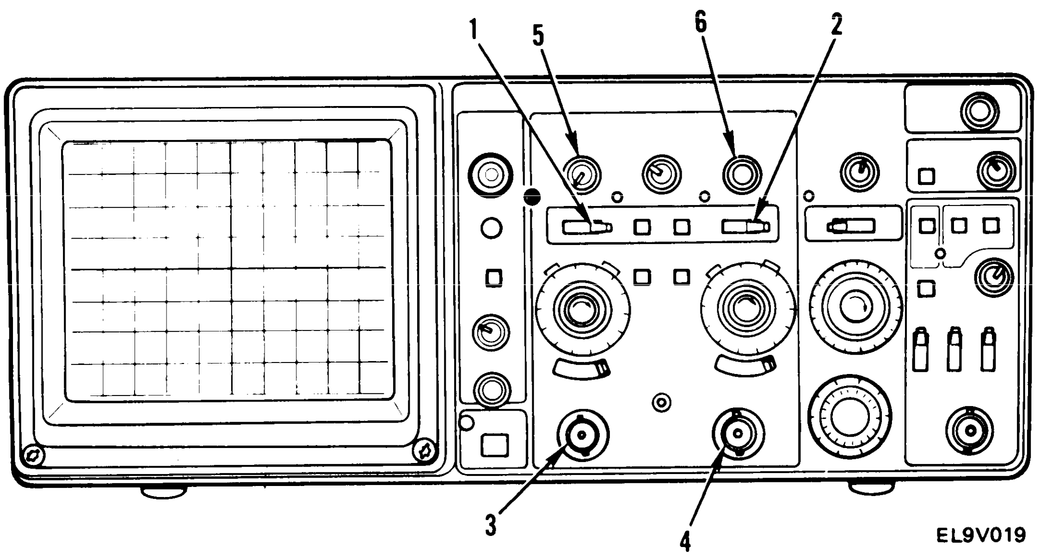
$$\text{instantaneous voltage} = \text{Vertical deflection (divisions)} \times \text{polarity } (+ \text{ or } -) \times \text{VOLTS/DIV switch setting indicated by 1X (or 10X PROBE when 10X probe is used)}$$

EXAMPLE: Vertical deflection from reference line is 4.6 divisions. The waveform point is above the reference line, a 10X attenuator probe is used, and VOLTS/ DIV switch is set to 2 at the 10X PROBE position. Substituting given values:

instantaneous voltage = 4.6 div x (+1) x 2 volts/div = +9.2 volts

e. Algebraic Addition.

1. Obtain baseline trace as described in para 2-3a.
2. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (1) to BOTH.
3. Set VERTICAL MODE ALT/ADD/CHOP switch (2) to ADD.



CAUTION

Do not exceed maximum safe input voltage rating (para 1-13).

NOTES

- Signals that exceed about eight times the VOLTS/DIV switch settings may distort the display.
- To obtain sim lar response from each , both AC/GND/DC switches must be set to the same position.

4. Connect one signal to CH 1 OR X connector (3) and one signal to CH 2 OR Y connector (4).

5. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (1) to CH 1 and adjust channel 1 vertical POSITION control (5) to center display vertically on crt screen.

6. Set VERTICAL MODE CH 1/BOTH CH 2 switch (1) to CH 2 and adjust channel 2 vertical POSITION control (6) to center display vertically on crt screen.

7. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (1) to BOTH.

NOTES

- If the channel 2 vertical POSITION control is pushed in, the resultant waveform is the sum of the two applied signals.

- If the channel 2 vertical POSITION control is pulled out, the resultant waveform is the difference between the two signals.

f. **Common-Mode Rejection.**

1. Obtain baseline trace as described in para 2-3a.

NOTE

This procedure can be used to measure instantaneous voltage for any input waveform. The example shown here is for a square wave.

2. Connect signal containing unwanted line-frequency components to CH 1 OR X connector (1).

3. Connect line-frequency signal to CH 2 OR Y connector (2).

NOTE

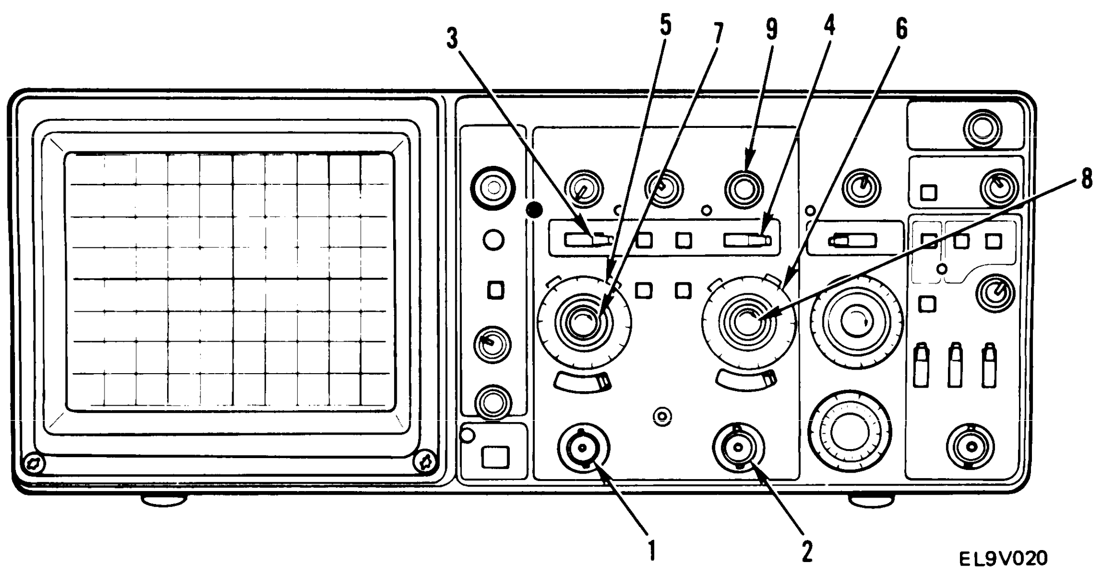
For maximum cancellation, the signal connected to channel 2 must be in phase with the unwanted line-frequency component connected to channel 1.

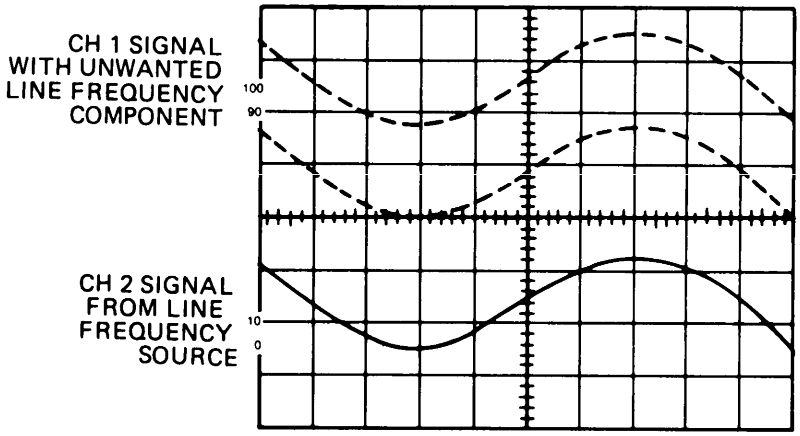
4. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (3) to BOTH.

5. Set VERTICAL MODE ADD/ALT/CHOP switch (4) to ALT.

6. Set both CH 1 and CH 2 VOLTS/DIV switches (5 and 6) to produce displays four or five divisions in amplitude.

7. Adjust either CH 1 or CH 2 VOLTS/DIV switch (5 or 6) and appropriate VOLTS/DIV variable control (7 or 8) so that both displays are of equal amplitude.





(A) CH 1 AND CH 2 SIGNALS

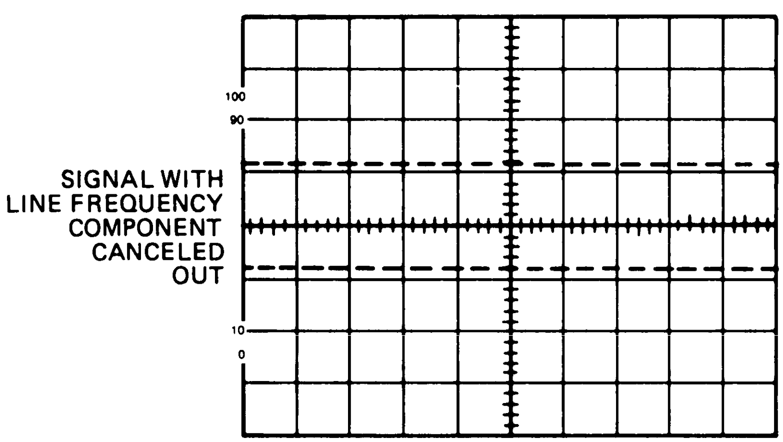
EL9V021

8. Adjust CH 2 VOLTS/DIV switch (6) and CH 2 VOLTS/DIV variable control (8) so that channel 2 display amplitude is approximately same amplitude as undesired portion of channel 1 display.

9. Set VERTICAL MODE ADD/ALT/CHOP switch (4) to ADD.

10. Pull out channel 2 vertical POSITION control (9) to invert signal.

11. Slightly readjust CH 2 VOLTS/DIV variable control (8) for maximum cancellation of unwanted signal.



RESULTANT SIGNAL

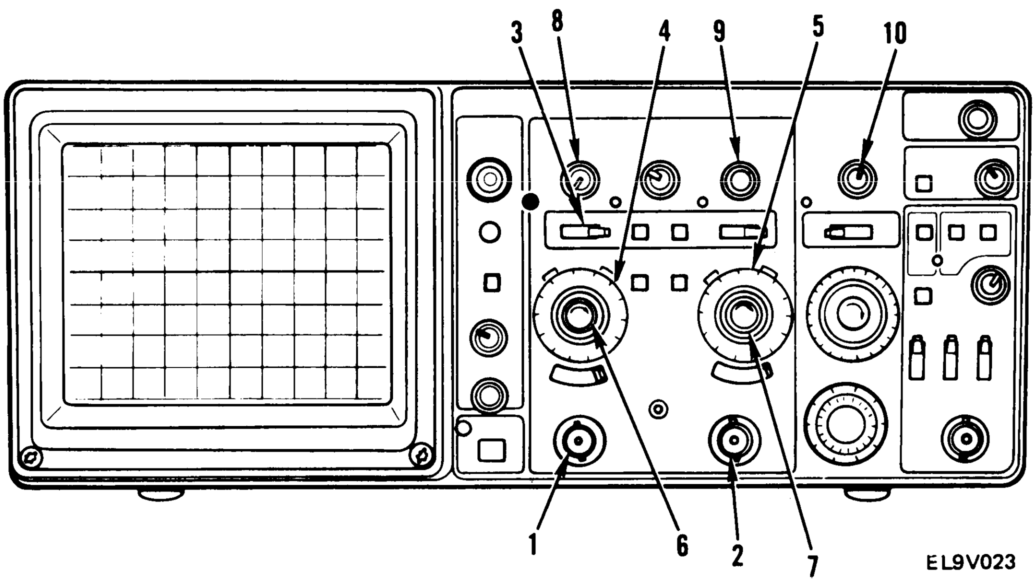
EL9V022

g. Amplitude Comparison (Ratio).

1. Obtain baseline trace as described in para 2-3a.

2. Connect known reference signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2).

3. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (3) to channel to which reference signal is connected.



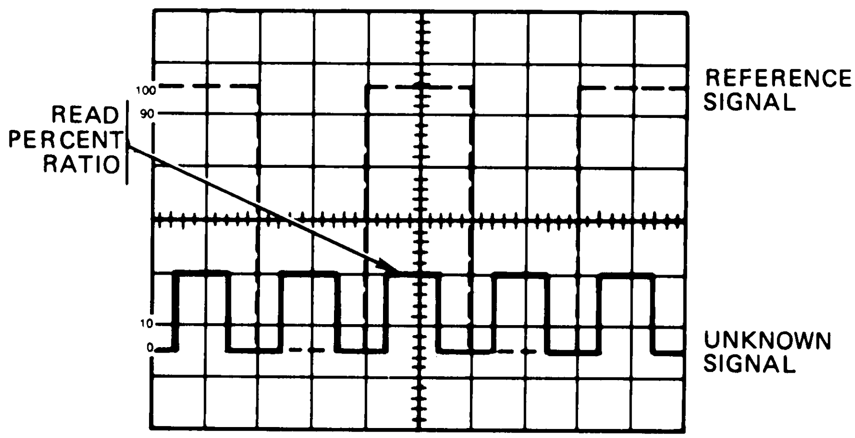
4. Adjust CH 1 or CH 2 VOLTS/DIV switch (4 or 5) and appropriate VOLTS/DIV variable control (6 or 7) for display amplitude of five vertical divisions.

5. Disconnect reference signal connected in step 2 and connect unknown signal to same connector.

6. Rotate channel 1 or 2 vertical POSITION control (8 or 9) until bottom edge of waveform just touches 0% line on crt.

7. Rotate horizontal POSITION control (10) until topmost feature of waveform crosses center vertical graticule line.

8. Read percent ratio directly from graduations of center vertical graticule line, referring to 0% and 100% marks on left edge of graticule. (One minor division equals 4% for five-division display.)



EL9V024

h. **Time Duration Measurement.**

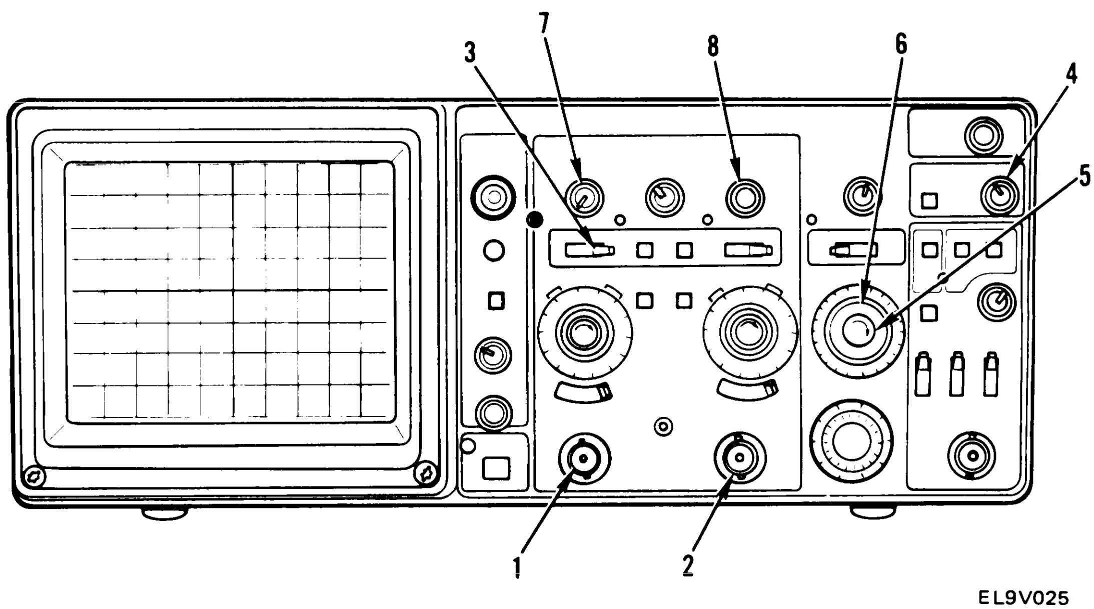
1. Obtain baseline trace as described in para 2-3a.

NOTE

This procedure can be used to measure instantaneous voltage for any input waveform. The example shown here is for a square wave.

2. Connect signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2).

3. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (3) to appropriate channel.

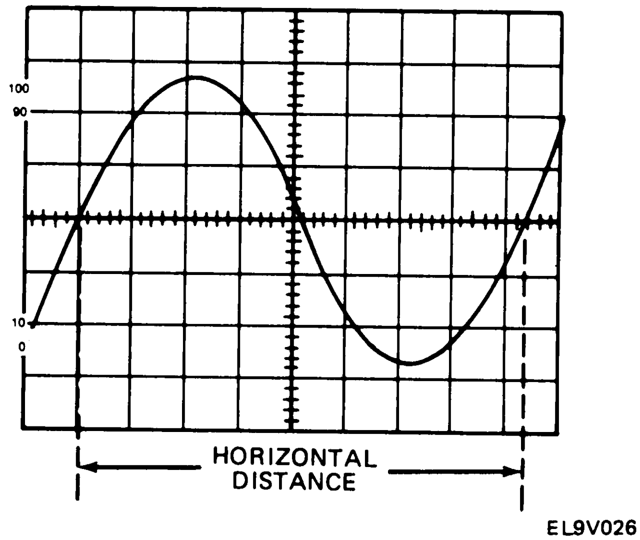


4. Adjust A TRIGGER LEVEL control (4) to obtain stable display.

5. Set A and B SEC/DIV variable control (5) to CAL detent, and set A SEC/DIV switch (6) to display one complete cycle of waveform.

6. Rotate channel 1 or channel 2 vertical POSITION control (7 or 8) until time measurement points fall on center horizontal graticule.

7. Count horizontal divisions between time measurement points.



8. Calculate time duration using formula:

$$\text{time duration} = \frac{\text{horizontal distance (division)} \times \text{A SEC/DIV switch setting}}{\text{magnification factor}}$$

EXAMPLE: The distance between time measurement points is 8.3 divisions. The A SEC/DIV switch is set to 2 ms per division, and the X 10 multiplier is off. Substituting given values:

$$\text{time duration} = \frac{8.3 \text{ div} \times 2 \text{ ms/div}}{1} = 16.6 \text{ ms}$$

i. **Frequency Measurement.**

1. Measure time duration of one cycle of waveform as described in paragraph 2-3h.

2. Calculate reciprocal of time duration determined in step 2-3h(8) to determine frequency of waveform.

   EXAMPLE: The signal obtained has a time duration of 16.6 ms. Substituting given values:

$$\text{frequency} = \frac{1}{\text{time duration}} = \frac{1}{16.6\ \text{ms}} \approx 60\ \text{Hz}$$

j. Rise **Time Measurement.**

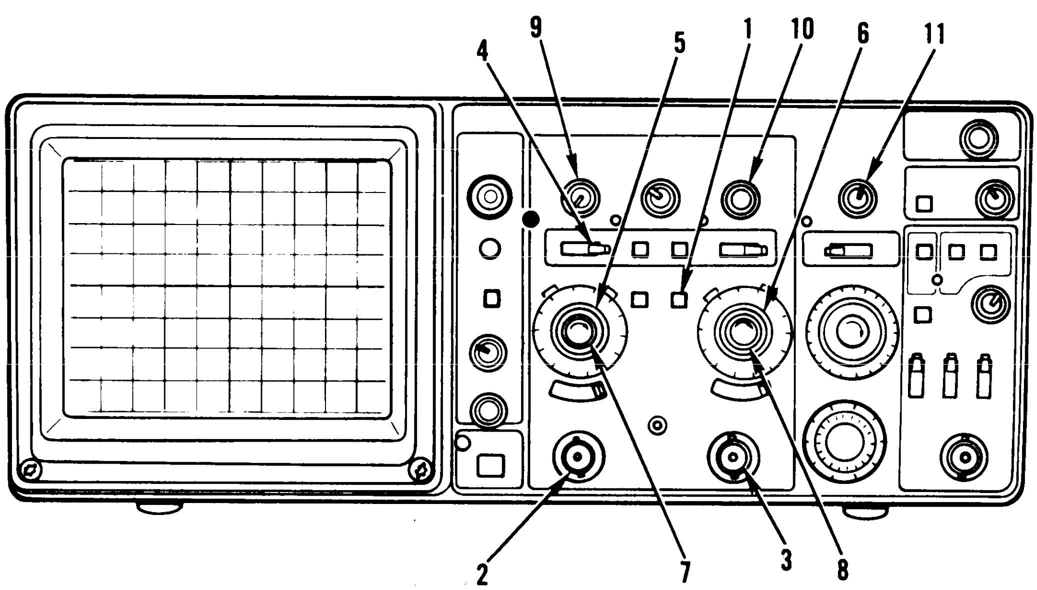
1. Obtain baseline trace as described in paragraph 2-3a.

2. Set BW LIMIT switch (1) to off (pushbutton out).

3. Connect signal to either CH 1 OR X connector (2) or CH 2 OR Y connector (3).

4. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (4) to appropriate channel.

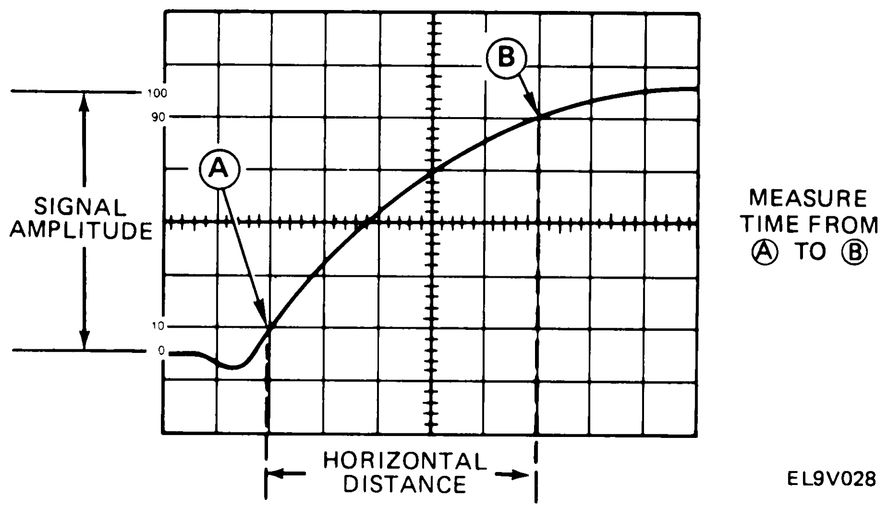
5. Set appropriate CH 1 or CH 2 VOLTS/DIV switch (5 or 6) and VOLTS/DIV variable control (7 or 8) for an exact five-division display.



EL9V027

6. Rotate channel 1 or channel 2 vertical POSITION control (9 or 10) until zero reference of waveform touches 0% graticule and top of waveform touches 100% graticule,

7. Rotate horizontal POSITION control (11) until 10% point on waveform intersects second vertical graticule line.



8. Determine horizontal distance between 10% and 90% points (points A and B) and calculate time duration using formula:

$$\text{rise time} = \frac{\text{horizontal distance (division)} \times \text{A SEC/DIV switch setting}}{\text{magnification factor}}$$

EXAMPLE: The horizontal distance between the 10% and 90% points is five divisions, The A SEC/DIV switch setting is 1 us and the magnification factor is 1. Substituting the given values:

$$\text{rise time} = \frac{\text{5 div x 1 us/div}}{1} = \text{5 us}$$

k. **Rise Time Measurement in Delayed-Sweep Mode.**

1. Obtain baseline trace as described in para 2-3a.

2. Connect signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2).

3. Set VERTICAL MODE CH 1 /BOTH/CH 2 switch (3) to selected channel.

4. Set appropriate CH 1 or CH 2 VOLTS/DIV switch (4 or 5) and VOLTS, DIV variable control (6 or 7) to provide display amplitude of exactly five divisions.

5. Rotate appropriate channel 1 or 2 vertical POSITION control (8 or 9) until zero reference line of waveform touches 0% graticule line and top of waveform touches 100% graticule line.

6. Set SEC/DIV variable control (10) to CAL detent position and set A SEC/DIV switch (11) so one rise time of interest is displayed.

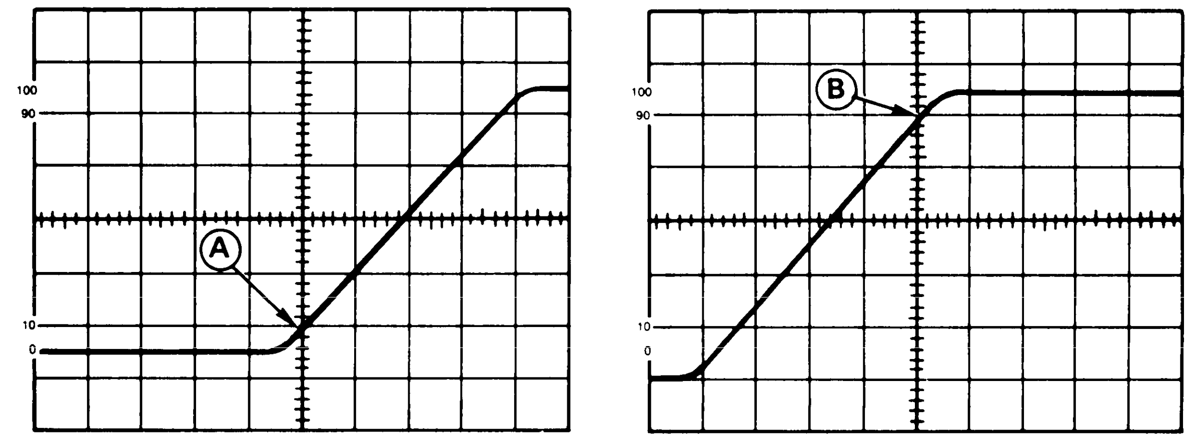
7. Set HORIZONTAL MODE switch (12) to ALT.

8. Adjust B DELAY TIME POSITION control (13) to intensify rise time of interest on A trace.

9. Set B SEC/DIV switch (11) so portion of A trace being measured is spread as much as possible on B sweep.

10. Set HORIZONTAL MODE switch (12) to B.

11. Adjust B DELAY TIME POSITION control (13) until display intersects 10% point at center vertical graticule line. Record B DELAY TIME POSITION control dial reading.



THE 10% POINT ON THE WAVEFORM INTERSECTS THE CENTER VERTICAL GRATICULE LINE.

THE 90% POINT ON THE WAVEFORM INTERSECTS THE CENTER VERTICAL GRATICULE LINE.

EL9V043

12. Adjust B DELAY TIME POSITION control (13) until display intersects the 90% point at center vertical graticule line. Record B DELAY TIME POSITION control dial reading.

13. Calculate rise time using the formula:

$$\begin{array}{c} \text{time} \\ \text{difference} \\ \text{(duration)} \end{array} = \left(\begin{array}{c} \text{second} \\ \text{dial} \\ \text{setting} \end{array} - \begin{array}{c} \text{first} \\ \text{dial} \\ \text{setting} \end{array} \right) \times \begin{array}{c} \text{A SEC/DIV} \\ \text{switch} \\ \text{setting} \end{array}$$

EXAMPLE: A SEC/ DIV switch is set to 1 us per division, first B DELAY TIME POSITION control is set to 2.50, and second B DELAY TIME POSITION control is set to 7.50. Substituting given values:

$$\text{rise time} = (7.03 - 2.50)(1\ \text{us/div}) = 5\ \text{us}$$

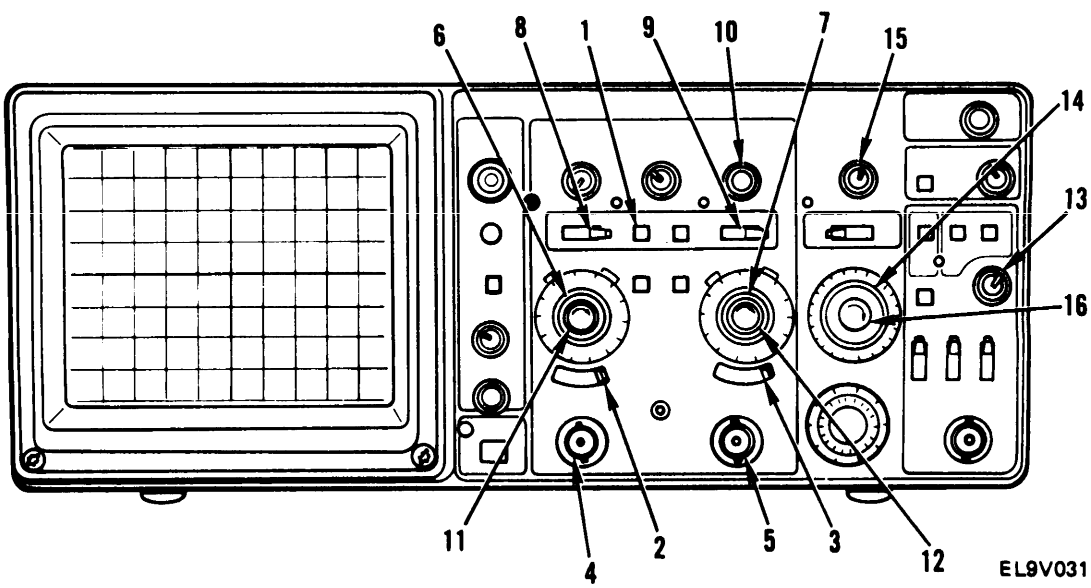
1. **Phase Difference Measurement.**

1. Obtain baseline trace as described in para 2-3a.
2. Depress CH 1 TRIGGER SOURCE switch (1).
3. Set both AC/GND/DC switches (2 and 3) to desired positions and ensure that both are set to same position.
4. Using either probes or cables with equal time delays, connect known reference signal to CH 1 OR X connector (4) and comparison signal to CH 2 OR Y connector (5).
5. Set both CH 1 and CH 2 VOLTS/DIV switches (6 and 7) for four- or five-division display.
6. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (8) to BOTH.
7. Set VERTICAL MODE ADD/ALT/CHOP switch (9) to either ALT or CHOP, depending on frequency of input signals.

NOTE

The reference signal should precede the comparison signal in time.

8. If two signals are opposite polarities, pull out channel 2 vertical POSITION control (10) to invert channel 2 display.



EL9V031

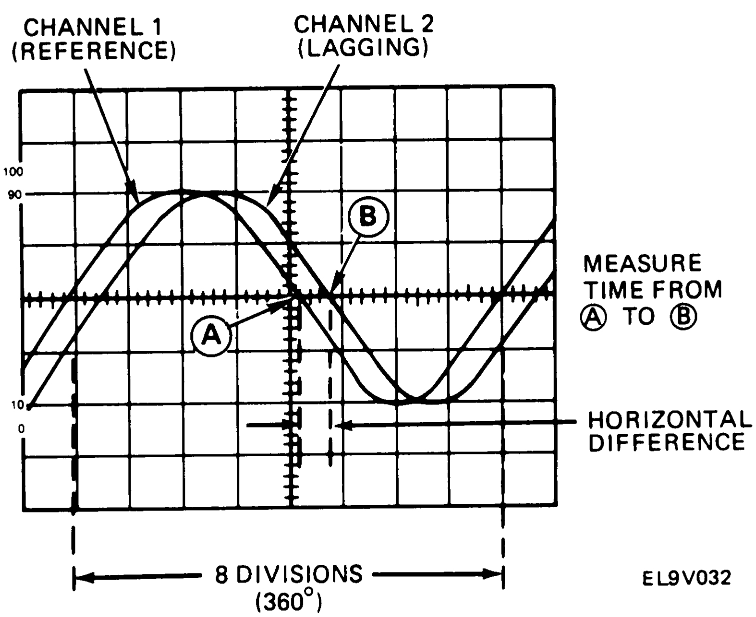
9. Adjust both CH 1 and CH 2 VOLTS/DIV variable controls (1 1 and 12) until two displays are equal in amplitude.

10. Adjust A TRIGGER LEVEL control (13) for stable display.

11. Set A SEC/DIV switch (14) to sweep speed setting which provides display of one full cycle of reference signal.

12. Using horizontal POSITION control (15), center display.

13. Adjust SEC/DIV variable control (16) until one reference signal cycle occupies exactly eight horizontal graticule divisions at 50% rise-time points. Each graticule division now represents 45° and graticule calibration can be stated as 45° per division.



14. Determine horizontal difference between corresponding points on waveforms at common horizontal graticule line and calculate phase difference using formula:

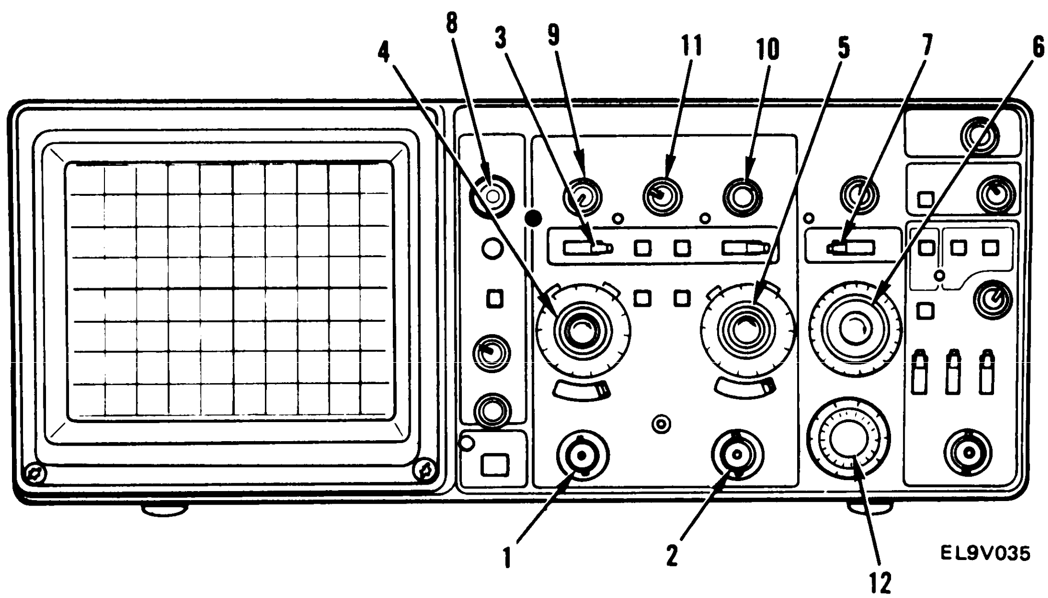
$$\text{phase difference} = \begin{array}{c}\text{horizontal}\\\text{difference}\\\text{(divisions)}\end{array} \times \begin{array}{c}\text{horizontal}\\\text{calibration}\\\text{(deg/div)}\end{array}$$

EXAMPLE: The horizontal difference is 0.6 division with a graticule calibration of 45° per division. Substituting given values:

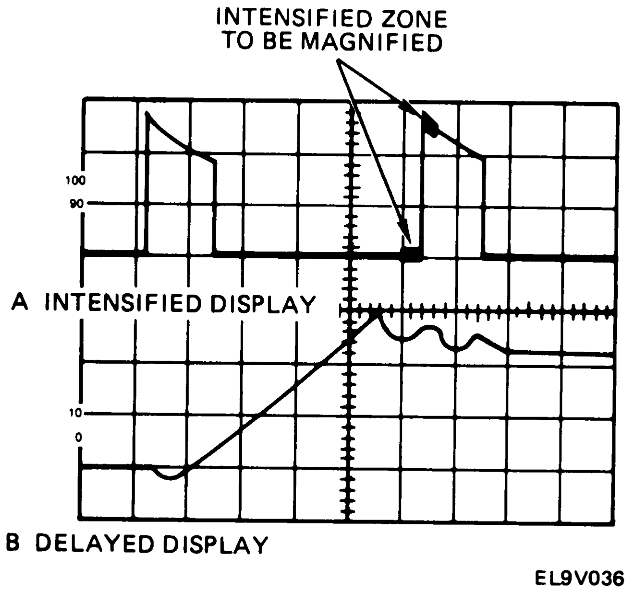
Phase difference = 0.6 div x 45° / div = 27°

m. **Magnified B Sweep Runs After Delay.**

1. Obtain baseline trace as described in para 2-3a.
2. Connect signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2).
3. Set VERTICAL MODE CH 1/BOTH/ CH 2 switch (3) to selected channel.



4. Set appropriate CH 1 or CH 2 VOLTS/DIV switch (4 or 5) to provide display amplitude of two or three divisions.
5. Set A SEC/DIV switch (6) to sweep speed setting which provides display of at least one complete waveform cycle.
6. Set HORIZONTAL MODE switch (7) to ALT.
7.- Adjust B INTENSITY control (8) to display B trace.
8. Adjust appropriate vertical POSITION control (9 or 10) and A/BSWP SEP control (11) to display A trace above B trace.
9. Adjust B DELAY TIME POSITION control (12) to position start of intensified zone to portion of display to be magnified.
10. Set B SEC/DIV switch (6) to setting which intensifies full portion of A trace to be magnified. Intensified zone is displayed as B trace.



11. Calculate apparent sweep magnification using formula:

$$\text{apparent delayed sweep magnification} = \frac{\text{A SEC/DIV switch setting}}{\text{B SEC/DIV switch setting}}$$

EXAMPLE: Determine the apparent delayed sweep magnification of a display with an A SEC/DIV switch setting of 0.1 ms per division and a B SEC/DIV switch setting of 1 us per division. Substituting the given values:

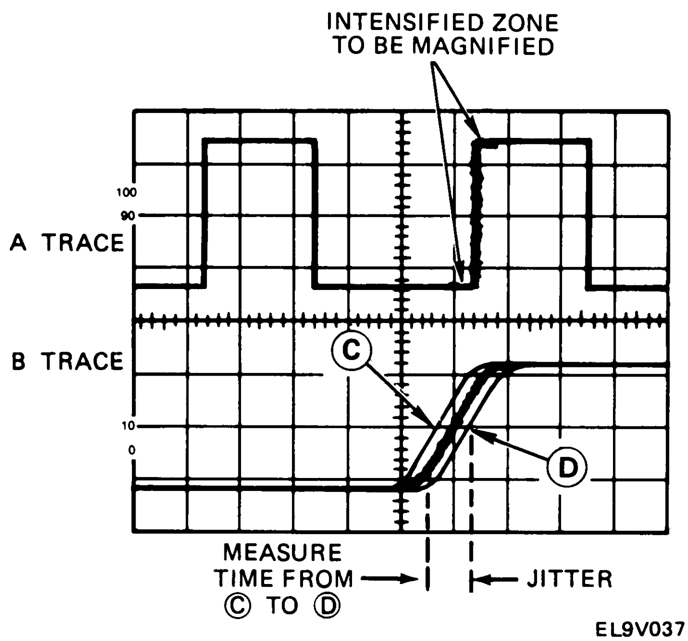
$$\text{apparent delayed sweep magnification} = \frac{1 \times 10^{-4}}{1 \times 10^{-6}} = 10^{2} = 100$$

n. **Pulse Jitter Time Measurement.**

1. Perform Magnified Sweep Runs After Delay, para 2-3m, steps 1 through 10.

2. Determine number of divisions difference between points C and D and calculate pulse jitter time using formula:

pulse jitter time = horizontal difference (divisions) x B SEC/ DIV switch setting



p. **Triggered Magnified Sweep Measurement.**

1. Perform Magnified Sweep Runs After Delay, para 2-3m, steps 1 through 10.

NOTE

The intensified zone seen in the ALT HORIZONTAL MODE display will move from trigger point to trigger point as B DELAY TIME POSITION CONTROL is rotated.

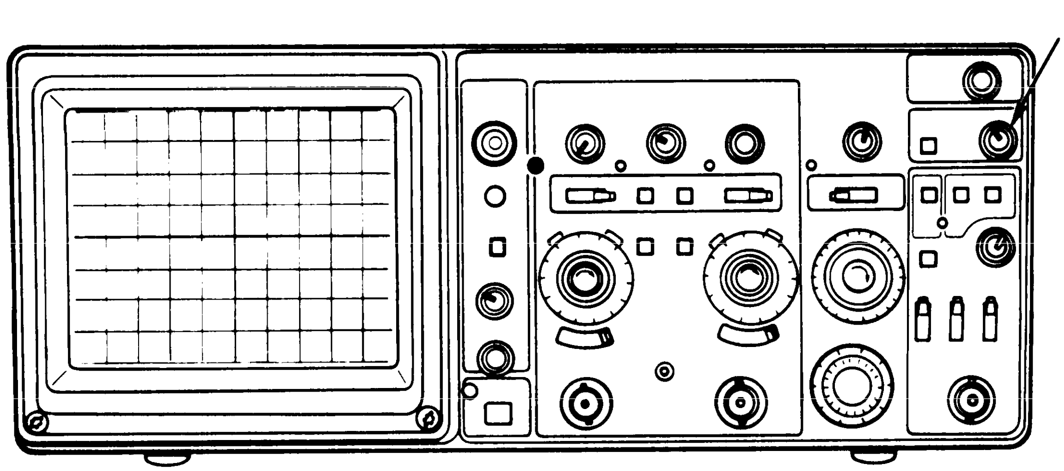
2. Adjust B TRIGGER LEVEL control (1) to stabilize intensified portion of A trace.

3. Calculate apparent magnification factor using formula:

$$\text{apparent magnification factor} = \frac{\text{A SEC/DIV switch setting}}{\text{B SEC/DIV switch setting}}$$

EXAMPLE: Determine apparent magnification factor of a display with an A SEC/DIV switch setting of 0.1 ms per division and a B SEC/DIV switch setting of 1 us per division. Substituting given values:

$$\text{apparent magnification factor} = \frac{1 \times 10^{-4}}{1 \times 10^{-6}} = 10^{2} = 100$$



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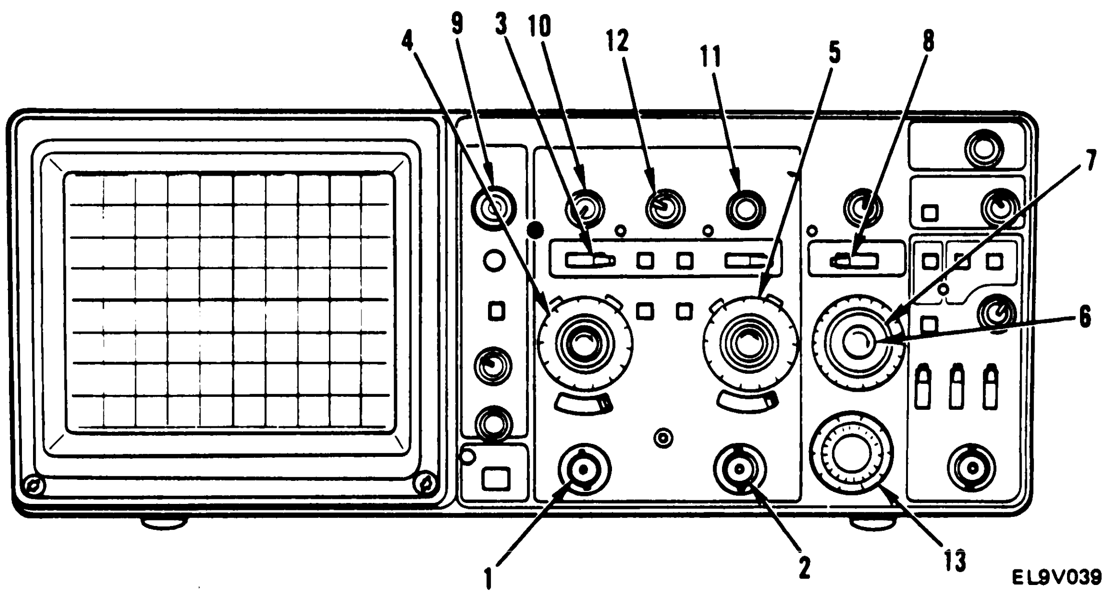
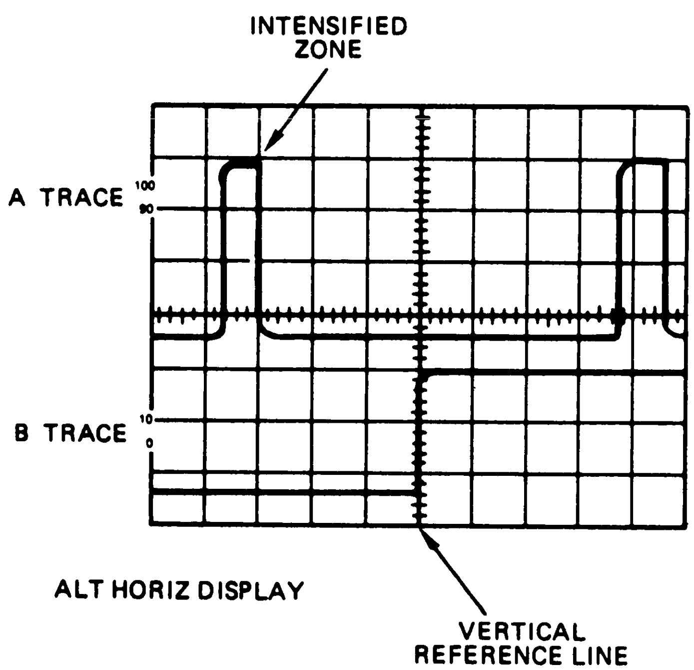
q. **Time Difference Measurement on**

1. Obtain baseline trace as described in para 2-3a.
2. Connect signal to either CH 1 OR X connector (1) or CH 2 OR Y connector (2).
3. Set VERTICAL MODE CH 1/ BOTH/ CH 2 switch (3) to selected channel.
4. Set appropriate CH 1 or CH 2 VOLTS/ DIV switch (4 or 5) to provide display amplitude of two or three divisions.



EL9V039



EL9V040

5. Ensure that SEC/DIV variable control (6) is in CAL detent position and set A SEC/DIV Switch (7) to sweep speed setting that displays measurement points on waveform.

6. Set HORIZONTAL MODE switch (8) to ALT.

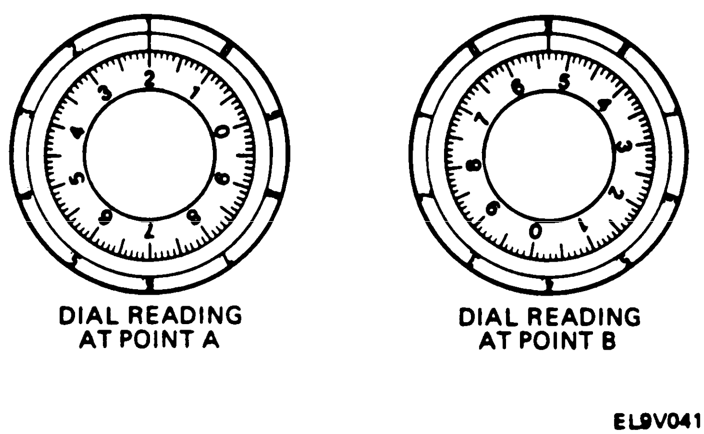
7. Adjust B INTENSITY control (9) to display trace.

8. Adjust appropriate channel 1 or 2 vertical POSITION control (10 or 11) and A/B SWP SEP control (12) to display A trace above B trace.

9. Set B SEC/DIV control (7) to fastest sweep speed that provides visible intensified zone.

10. Adjust B DELAY TIME POSITION control (13) to move intensified zone to leading edge of first point of interest on A trace; then fine adjust until selected portion on B trace is centered on any vertical graticule line. Record B DELAY POSITION control reading.

11. Adjust B DELAY TIME POSITION control clockwise to move intensified zone to leading edge of second point of interest on A trace, then fine adjust until rising portion on B trace is centered at same vertical graticule used in step (10). Record B DELAY TIME POSITION control (13) dial reading.



12. Calculate time difference between repetitive pules using formula

time		second		first		A SEC/DIV
difference	=	dial	-	dial	x	switch
(duration)		setting		setting		setting

EXAMPLE: A SEC/DIV switch is set to 0.2 ms per division, first B DELAY TIME POSITION control is set to 1.20, and second B DELAY TIME POSITION control is set to 9.53. Substituting given values:

Time difference = (9.53 - 1.20)(0.2 ms/div) = 1.666 ms

r. **Measurement of Time Difference Between Pulses on Time-Related Signals.**

1. Obtain baseline trace as described in para 2-3a.

2. Depress CH 1 TRIGGER SOURCE switch (1).

3. Set both AC/ GND/ DC switches (2 and 3) to desired position and ensure that both are set to same position.

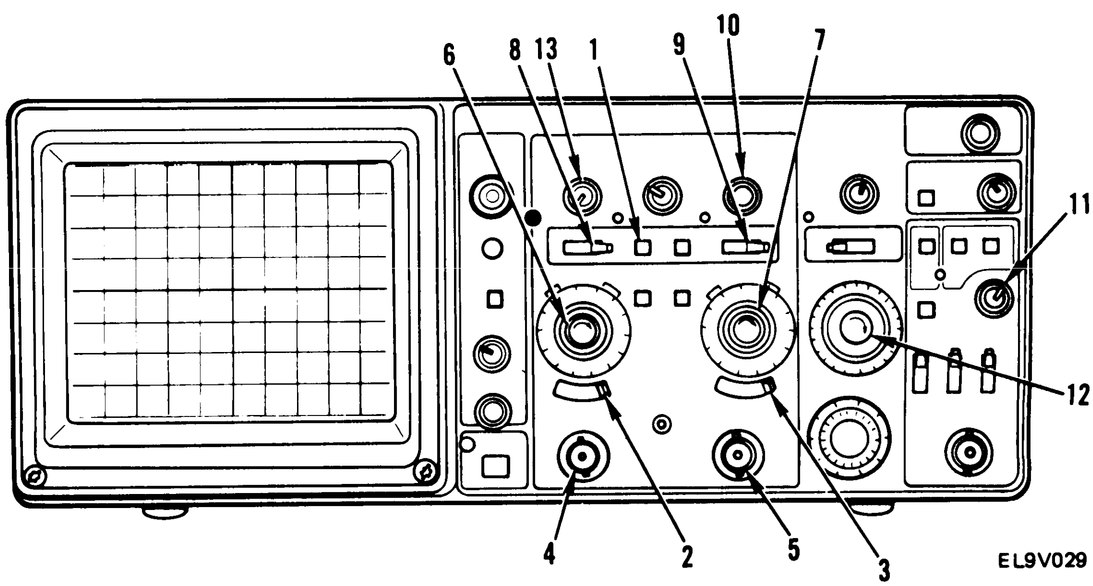
4. Using either probes or cables with equal time delays, connect known reference signal to CH 1 OR X connector (4) and comparison signal to CH 2 OR Y connector (5).

5. Set both CH 1 and CH 2 VOLTS/ DIV switches (6 and 7) for four- or five-division display.

6. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (8) to BOTH.

7. Set VERTICAL MODE ADD/ALT/ CHOP switch (9) to either ALT or CHOP, depending on frequency of input signals.

8. If two signals are opposite polarities, pull out channel 2 vertical POSITION control (10) to invert channel 2 display.



9. Adjust A TRIGGER LEVEL control (11) for stable display.

10. Set A SEC/DIV switch (12) to sweep speed setting which provides three or more divisions of horizontal separation between reference points on two displays.

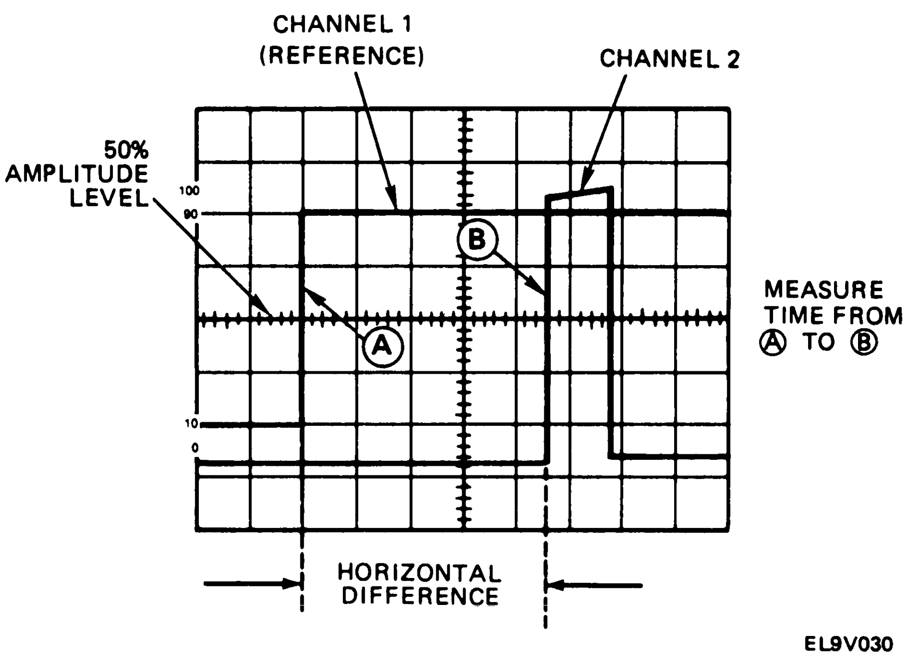
11. Rotate both vertical POSITION controls (10 and 13) to vertically center both displays.

12. Determine horizontal distance between two signal reference points and calculate time difference using formula:

$$\text{time difference} = \frac{\text{A SEC/DIV switch setting} \times \text{horizontal difference (divisions)}}{\text{magnification factor}}$$

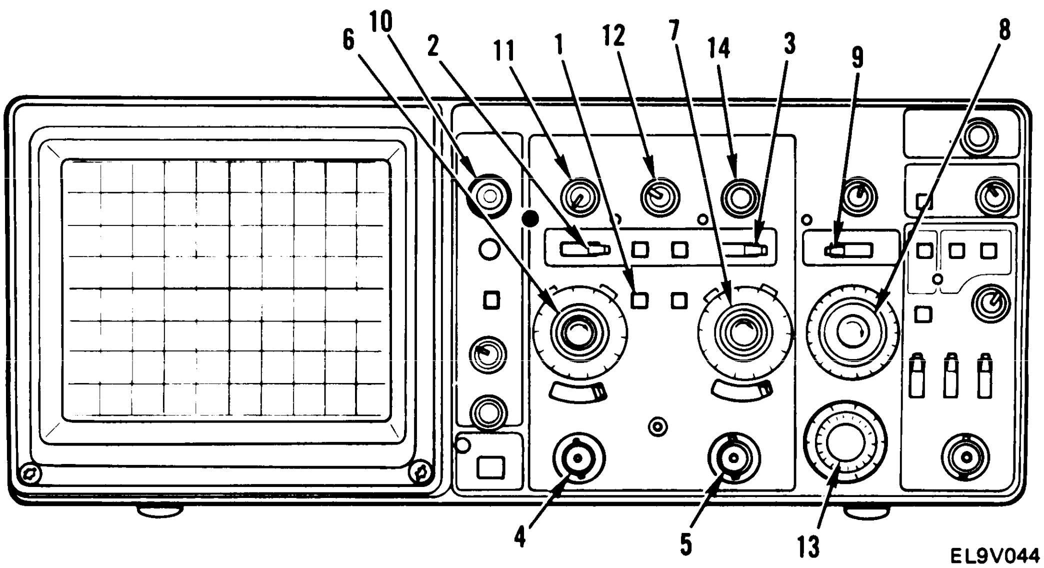
EXAMPLE: The A SEC/DIV switch is set to 50 us per division, the X10 magnifier is on (button out), and horizontal difference between signal measurement points is 4.5 divisions. Substituting the given values:

$$\text{time difference} = \frac{50\ \text{us/div} \times 4.5\ \text{div}}{10} = 22.5\ \text{us}$$



s. **Time Difference Measurement Between Two Pulses on Two Time-Related Signals in Delayed Sweep Mode.**

1. Obtain baseline trace as described in para 2-3a.
2. Depress CH 1 TRIGGER SOURCE switch (l).
3. Set VERTICAL MODE CH 1/BOTH/ CH 2 switch (2) to BOTH.
4. Set VERTICAL MODE ADD/ ALT/ CHOP switch (3) to ALT.



5. Using either probes or cables with equal time delays, connect known reference signal to CH 1 OR X connector (4) and comparison signal to CH 2 OR Y connector (5).
6. Set both CH 1 and CH 2 VOLTS/DIV switches (6 and 7) for two- or three-division display.
7. Set A SEC/DIV switch (8) to display measurement points within graticule area.
8. Set HORIZONTAL MODE switch (9) to ALT.
9. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (2) to CH 1.

10. Adjust B INTENSITY control (10) to display trace.

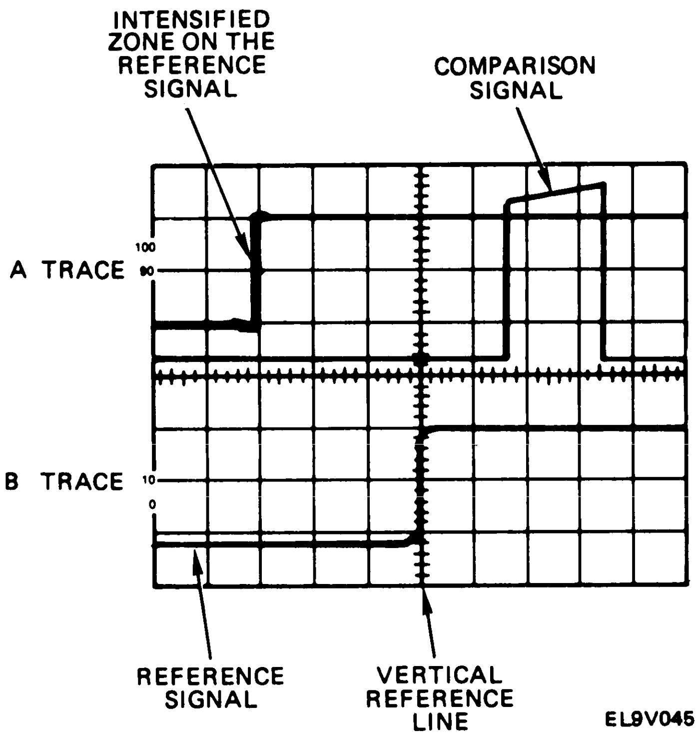
11. Adjust channel 1 vertical POSITION control (11) and A/B SWP SEP control (12) to display A trace above B trace,

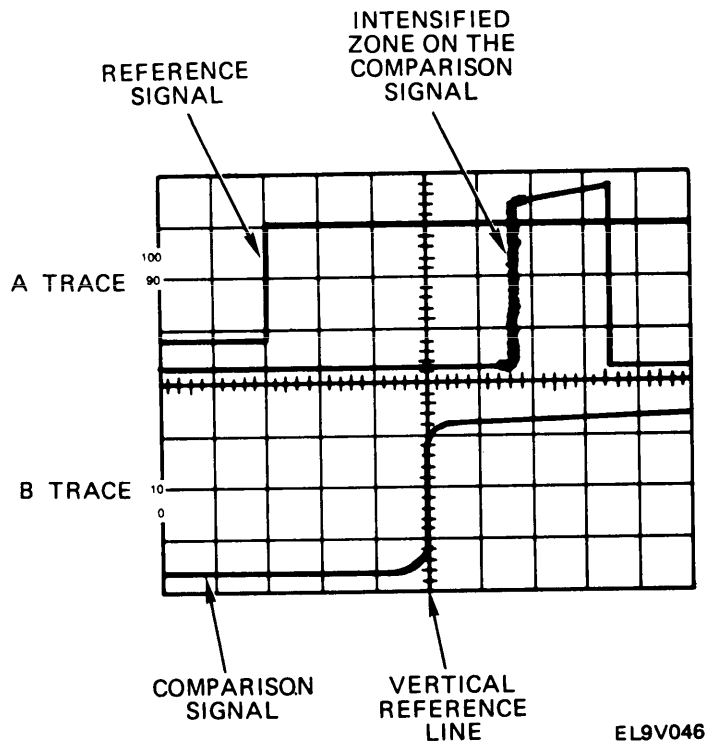
12. Rotate B DELAY TIME POSITION control (13) to move intensified zone to appropriate edge of comparison signal on A trace, then fine adjust until edge of reference signal on B trace is centered at any convenient vertical graticule line. Record B DELAY TIME POSITION control dial reading.

13. Set VERTICAL MODE CH 1 /BOTH/CH 2 switch (2) to CH 2.

14, Adjust channel 2 vertical POSITION control (14) and A/B SWP SEP control (12) to display A trace above B trace.

15. Rotate B DELAY TIME POSITION control (13) to move intensified zone to appropriate . edge of comparison signal on A trace, then fine adjust until edge of reference signal on B trace is centered on same vertical graticule line used in step 14. Do not move horizontal POSITION control. Record B DELAY TIME POSITION dial reading.





16. Calculate time difference between reference signal and comparison signal using formula:

$$\text{time difference (duration)} = \left(\text{second dial setting} - \text{first dial setting}\right) \times \text{A SEC/DIV switch setting}$$

EXAMPLE: A SEC/DIV switch is set to 50 us per division, first B DELAY TIME POSITION control is set to 2.60, and second B DELAY TIME POSITION control is set to 7.10. Substituting given values:

time difference = (7.10 - 2.60)(50 us/div) = 225 us

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

2-4. OPERATION IN UNUSUAL WEATHER

The oscilloscope was designed as a bench-type instrument to be used in a controlled environment. It does not have a weatherproof or waterproof case. It may be used outdoors as long as it is protected from extreme heat, excessive cold, water, sand, mud, or similar conditions. Refer to chapter 1, para 1-13, for oscilloscope specifications that should not be exceeded.

CHAPTER 3
ORGANIZATIONAL MAINTENANCE

	Para	Page
A and B Intensity Knobs Replacement	3-11	3-8
A and B SEC/DIV Knob Replacement	3-13	3-10
CH 1 VOLTS/DIV and CH 2 VOLTS/DIV Knob Replacement	3-12	3-9
Checking Unpacked Equipment	3-5	3-2
Cleaning	3-14	3-11
Common Tools and Equipment	3-1	3-1
Initial Checks, Adjustments and Tests	3-6	3-2
Line Fuse Replacement	3-10	3-7
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Preparation for Storage or Shipment	3-15	3-12
Repair Parts	3-3	3-1
Safety Precautions	3-7	3-3
Special Tools, TMDE, and Support Equipment	3-2	3-1
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Types of Storage	3-16	3-12
Unpacking	3-4	3-2

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

3-1. COMMON TOOLS AND EQUIPMENT

Common tools and equipment required for organizational maintenance of Oscilloscope AN/USM-488 are listed in Appendix B (Maintenance Allocation Chart).

3-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

No special tools, TMDE, or support equipment are required.

3-3. 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

3-4. 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.

3-5. CHECKING UNPACKED EQUIPMENT

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

b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA PAM 738-750.

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

3-6. INITIAL CHECKS, ADJUSTMENTS AND TESTS

a. **Checks.** Check that installed fuse in 1.0 amp, 250 volt, slow-blow.

b. **Adjustments.** Compensate probes as described in para 2-3b.

c. **Tests.** Perform complete operational test detailed in para 3-9.

Section III. TROUBLESHOOTING

3-7. SAFETY PRECAUTIONS

WARNING

High voltage is used in the operation of this equipment. Death on contact may result if you fail to observe safety precautions.

3-8. TROUBLESHOOTING PROCEDURES

The troubleshooting procedures listed in table 3-1 are those that may be done by organizational maintenance level personnel. Problems that may arise during operation are listed under malfunction. Tests or inspections to conduct and corrective actions to take to repair the malfunction are listed in the two columns to the right of the malfunction column.

Table 3-2. Troubleshooting

Malfunction
Test or inspection
Corrective Action

1. POWER INDICATOR DOES NOT COME ON.

Step 1. Check that POWER ON/ OFF switch is in (ON).

- If not, set to in (ON).

Step 2. Check that ac power cable is connected to ac source.

- If not, connect to ac source.

Step 3. Check condition of line fuse.

- Replace open fuse. See para 3-10.

Step 4. Check ac power cord and connections.

- Replace ac power cord, if faulty.
- If malfunction still remains, contact next higher level of maintenance.

2. CRT DISPLAY IS NOT CORRECT FOR ANY INPUT SIGNAL.

Step 1. Check that front panel controls are set properly.

- If not, set correctly. See para 2-3.

Step 2. Check probes and connectors.

- Replace faulty probes.
- If malfunction remains, contact next higher level of maintenance.

3. ANY MALFUNCTION NOT COVERED IN (1) OR (2).

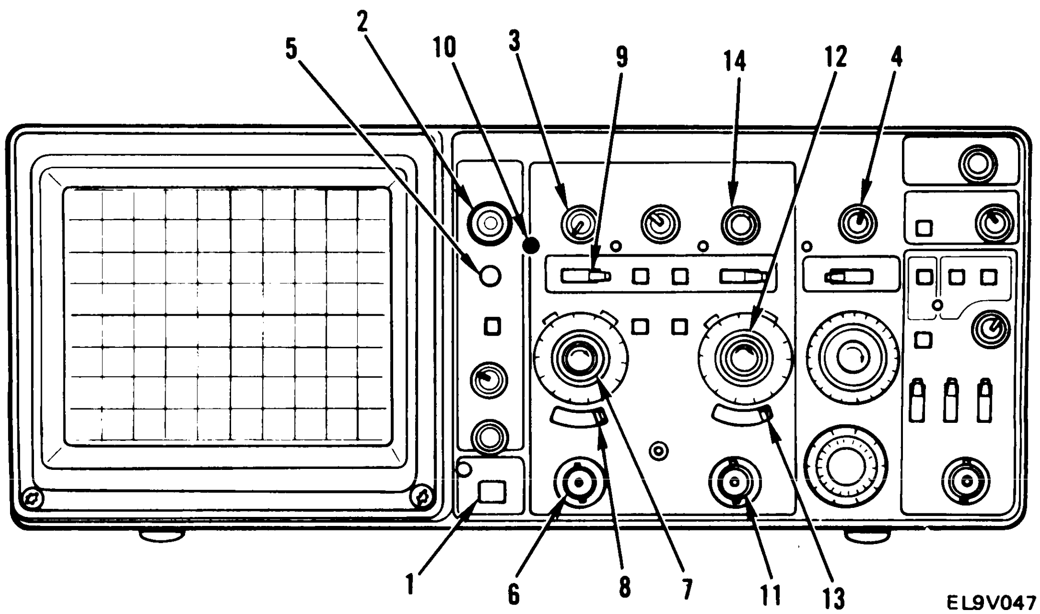
Contact next higher level of maintenance.

Section IV. MAINTENANCE PROCEDURES

3-9. OPERATIONAL TEST

DESCRIPTION

This procedure covers: Operational readiness check of oscilloscope.



WARNING

Do not attempt to measure input signals that exceed the maximum input signals listed in para 1-13.

1. Set POWER ON/ Off switch (1) to OFF (out).
2. Connect oscilloscope power cord to proper ac power source
3. Depress POWER ON/OFF switch (1).
   - POWER indicator comes on.
4. Obtain baseline trace as described in para 2-3a.
   - Straight-line trace appears on crt screen,

5. Adjust A INTENSITY control (2) for desired display brightness.

6. Using channel 1 vertical POSITION control (3) and horizontal POSITION control (4), center trace on crt.

NOTE

If the trace is not parallel with the center horizontal graticule, adjust TRACE ROTATION pot (5).

7. Connect 10X probe to CH 1 OR X connector (5).

8. Set CH 1 VOLTS/DIV switch (6) to 0.1 10X PROBE.

9. Set channel 1 AC/ GND/ DC switch (7) to DC.

10. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (8) to CH 1 and connect tip of 10X probe to AMP CAL connector (9).

    . Trace on crt is square wave approximately five divisions in amplitude and 1 kHz in frequency.

11. Disconnect 10X probe from CH 1 OR X connector (5) and connect to CH 2 OR Y connector (10).

12. Set CH 2 VOLTS/DIV switch (11) to 0.1 10X PROBE.

13. Set CH 2 AC/GND/DC switch (12) to DC.

14. Set VERTICAL MODE CH 1/BOTH/CH 2 switch (8) to CH 2 and connect tip of 10 X probe to AMP CAL connector (9).

    - Trace on crt is square wave approximately five divisions in amplitude and 1 kHz in frequency.

15. Pull channel 2 vertical POSITION INVERT switch (13).

    - Crt display inverts.

16. Disconnect 10X probe and shut off oscilloscope, if desired.

END OF TASK

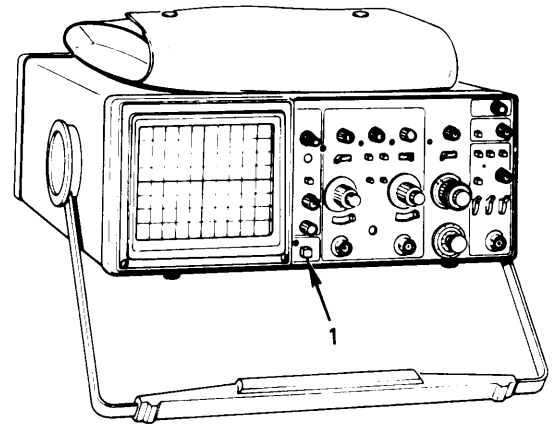
3-10. LINE FUSE REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.

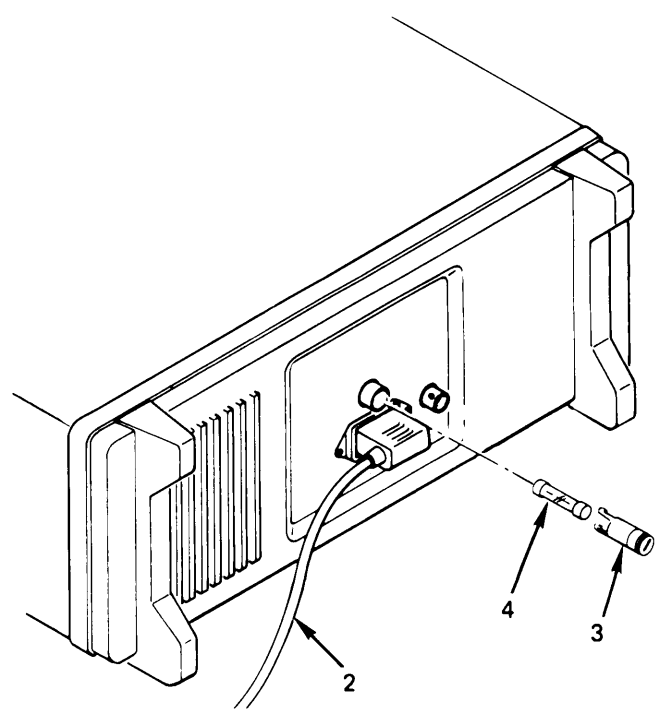
REMOVE

1. Ensure that POWER ON/ OFF switch (1) is set to OFF (out).
2. Disconnect ac power cord (2) from ac source.
3. Using common screwdriver, press in and slightly rotate fuseholder cap (3) in counter-clockwise direction to release fuseholder cap.
4. Withdraw fuseholder cap (3) with fuse (4) from fuseholder.
5. Remove fuse (4) from fuseholder cap (3).



INSTALL

1. Install new 1.0 A, 250 V, slow-blow fuse (4) into fuseholder cap (3).
2. Insert fuse F1 and fuseholder cap (3) into fuseholder.
3. Press in and slightly rotate fuseholder cap (3) in clockwise direction to secure fuse-holder cap.
4. Connect ac power cord (2) to ac source.

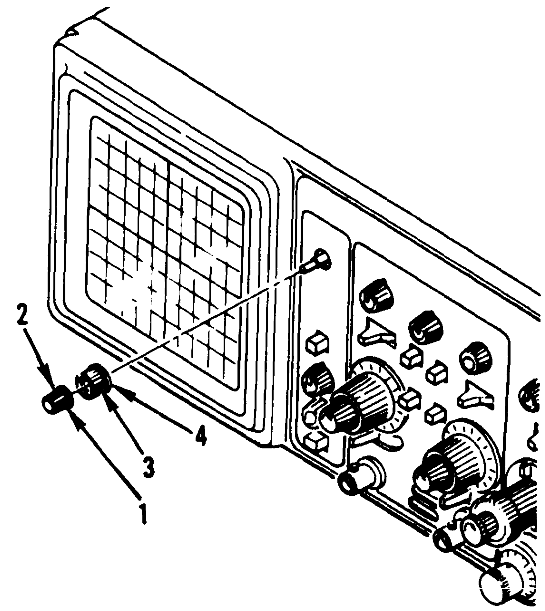


END OF TASK

3-11. A AND B INTENSITY KNOBS REPLACEMENT

DESCRIPTION

This procedure covers: Remove and Install.



REMOVE

1. Loosen setscrew (1) and remove inner knob (2).
2. Loosen setscrew (3) and remove outer knob (4).

INSTALL

1. Install outer knob (4) on shaft and tighten setscrew (3).
2. Install inner knob (2) on shaft and tighten setscrew (1).

END OF TASK

3-12. CH 1 VOLTS/DIV AND CH 2 VOLTS/DIV KNOB REPLACEMENT

DESCRIPTION

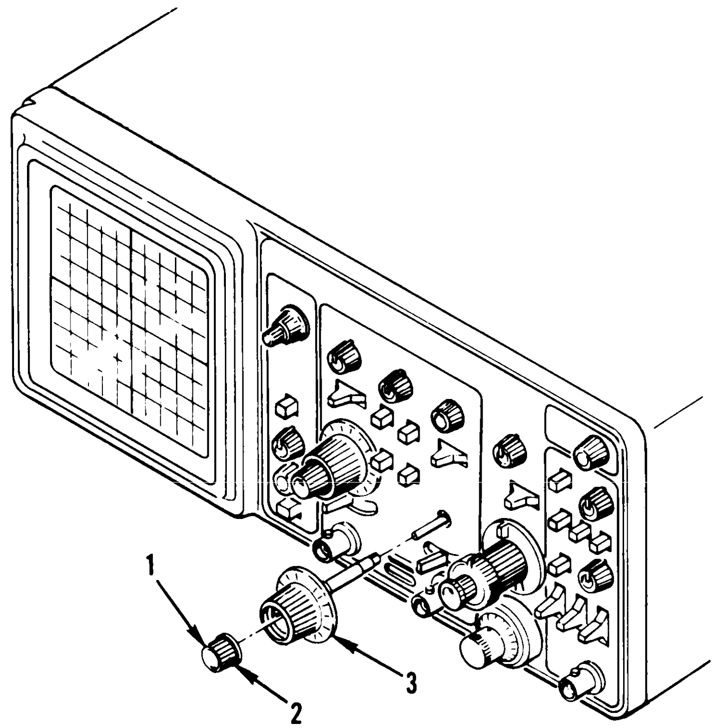
This procedure covers: Remove and Install .

REMOVE

1. Loosen setscrew (1) and remove red cal knob (2).
2. Remove outer knob (3)

INSTALL

1. Install outer knob (3) on plastic shaft.
2. Install red cal knob (2) and tighten setscrew (1).



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END OF TASK

3-13. A AND B SEC/DIV KNOB REPLACEMENT

DESCRIPTION

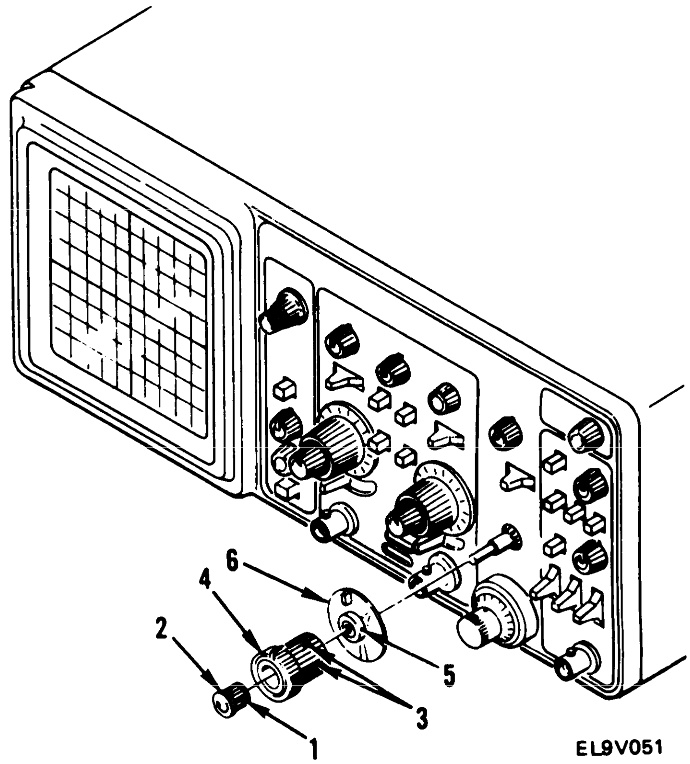
This procedure covers: Remove and Install.

REMOVE

1. Rotate control fully counterclockwise, then loosen setscrew (1) and remove red cal knob (2).
2. Loosen two setscrews (3) and remove gray knob (4).
3. Loosen two setscrews (5) and remove clear plastic knob (6).

INSTALL

1. Install clear plastic knob (6) and tighten two setscrews (5).
2. Install gray knob (4) and tighten two setscrews (3).
3. Install red knob (2) and tighten setscrew (1).



END OF TASK

3-14. CLEANING

Loose dirt on the outside of the oscilloscope may be removed with a soft cloth or small soft-bristle brush. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. Clean the light filter face with soft lint-free cloth dampened with either isopropyl alcohol, denatured ethyl alcohol, or mild detergent and water solution. The crt filter mesh should be cleaned only with isopropyl or ethyl alcohol.

Section V. PREPARATION FOR STORAGE OR SHIPMENT

3-15. PREPARATION FOR STORAGE OR SHIPMENT

If original packing material was saved, pack the 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 275 pounds.

c. Use plenty of shock-absorbing material all around the oscilloscope to protect it against damage.

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

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

3-16. 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 publications referenced in this manual.

A-2. FORMS

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

Recommended Changes to Equipment Technical Manuals . . . . DA Form 2028-2

Equipment Inspection and Maintenance Worksheet . . . . DA Form 2404

Report of Discrepancy . . . . Form SF 364

Product QualityDeficiencyReport. . . . . Form SF 368

A-3. TECHNICAL MANUALS

The Army Maintenance Management Systems (TAMMS) . . . . DA Pam 738-750

Procedures for Destruction of Electronics Materiel to Prevent
Enemy Use (Electronics Command) . . . . TM 750-2442

Organizational, Direct Support and General Support Repair Parts and
Special Tools List,Oscilloscope AN/USM-488 (NSN 6625-01–187-7847) TM11-6625-3135-24P

A-4. MISCELLANEOUS

Common Table of Allowances . . . . CTA 50-970

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

Safety Precautions for Maintenance of Electrical/ElectronicEquipment . . . . TB 385-4

First Aid for Soldiers . . . . FM 21-11

Abbreviations for Use on Drawings, Specifications, Standards
and in Technical Documents MIL-STD-12

APPENDIX B
MAINTENANCE ALLOCATION CHART

Sectlon I. INTRODUCTION

B-1. General

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories,

c. Section III lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. Maintenance Functions

Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and /or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

b, Test. To verify serviceability by measuring the mechanical and electrical characteristics of the oscilloscope and comparing these characteristics with prescribed standards.

c. *Service,* Operations required periodically to keep the oscilloscope in proper operating condition; i.e., to clean (or decontaminate), to preserve, etc.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters,

e. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. Replace is authorized by the MAC and is shown as the third position code of the SMR code.

f. Repair. The application of maintenance services, including fault location/ troubleshooting, removal/ installation, and disassembly/ assembly procedures, and maintenance actions to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module, or end item or system.

B-3. Explanation of Columns in the MAC (Section II)

a. Column 1, Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be 00.

b. Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2 (see para B-2).

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a “worktime'' figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate “worktime” figures will be shown for each category. The “worktime” figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/ assembly time), troubleshooting/fault location time, and quality assurance/ quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the MAC. The symbol designations for the maintenance categories are as follows:

c — Operator or Crew
O — Organizational Maintenance
F — Direct Support Maintenance
H — General Support Maintenance
D — Depot Maintenance

e. Column 5, Tools and Equipment. Column 5 specifies by code, those common tool sets (not individual tools) and special tools, TM DE, and support equipment required to perform the designated function.

f. Column 6, Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in section IV.

B-4. Explanation of Columns in Tool and Test Equipment Requirement (Section III)

a. Column 1, Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, section II, column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3, Nomenclature. Name or identification of the tool or test equipment

d. Column 4, National Stock Number, The national stock number of the tool or test equipment.

e. Column 5, Tool Number. The manufacturer's part number.

B-5. Explanation of Columns in Remarks (Section IV)

a. Column 1, Reference Code. The code recorded in column 6, section II.

b. Column 2, Remarks, This column lists information pertinent to the maintenance function being performed as indicated in the MAC, section II.

SECTION II. MAINTENANCE ALLOCATION CHART FOR OSCILLOSCOPE AN/USM-488

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY C	O	F	H	D	(5) TOOLS AND EQPT.	(6) REMARKS
00	OSCILLOSCOPE AN/USM-488 TEKTRONIX TYPE 2235	Inspect		0.1				Visual	
		Test				2.0		2 thru 15	
		Cal				3.0		2 thru 15	
		Repair		0.5				1	A
		Repair				2.0		16, 17	
01	MAIN CIRCUIT BOARD ASSY A1, PART NO. 670-8404-00	Inspect				0.2		16, 17	
		Test				2.0		2 thru 15	
		Replace				1.5		16, 17	
		Repair				1.5		16, 17	B

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR OSCILLOSCOPE AN/USM-488

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	O	Tool Kit, Electronic Equipment,TK-101/G	5180-00-064-5178	
2	H	Oscilloscope Calibrator, Ballantine 6126M	6695-01-057-2207	
3	H	Power Modular Main Frame, TEKTRONIX Type RTM-506	6625-01-048-8920	
4	H	Function Generator, TEKTRONIX Type FG 502	6625-01-074-7956	
5	H	Cable, 2 ea., 50 Ohms, RG-58/U, 42 in., TEKTRONIX Part No. 012-0057-01	6625-00-495-4831	
6	H	Termination, 2 ea., TEKTRONIX Part No. 011-0049-01	5985-00-087-4954	
7	H	Dual-Input Coupler, TEKTRONIX Part No. 067-0525-02	6695-01-058-2187	
8	H	10X Attentuator, TEKTRONIX Part No. 011-0059-02	5985-00-572-7428	
9	H	T-Connector, BNC, TEKTRONIX Part No. 103-0030-00	5935-00-284-1962	
10	H	Digital Multimeter, TEKTRONIX Type DM501A	6625-01-075-8583	
11	H	Test Oscilloscope with included 10X Probe, TEKTRONIX Type SC 504	6695-01-074-7954	
12	H	Multimeter, Digital, Hewlett Packard Model 3490A	6625-00-557-8305	
13	H	Isolation Transformer		
14	H	X1 Probe, TEKTRONIX Part No. 010-6101-03		
15	H	Probe, High-Voltage, Hewlett Packard Model K25-3490A	6625-01-023-6253	
16	H	Torx Screwdrivers, TEKTRONIX Part Nos. 003-1293-00, 003-0965-00, 003-0814-00, 003-0966-00, and 003-0866-00		
17	H	Tool Kit, Electronic Equipment, JTK-17LAL	4931-01-073-3845	

SECTION IV. REMARKS

REFERENCE CODE	REMARKS
A	Repair by replacing knobs and fuse.
B	Circuit Board Assemblies A2 thru A8 and A10 are not reparable. These assemblies are to be replaced and disposed of when found to be non-operational.

APPENDIX C
COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

Section i. INTRODUCTION

C-1. SCOPE

This appendix lists components of end item and basic issue items for the Oscilloscope AN/ USM-488 to help you inventory items required for safe and efficient operation.

C-2. GENERAL

The Components of End Item and Basic Issue Items Lists are divided into the following sections:

a. **Section Il. Components of End Item.** This listing is for informational purposes only, and is not authority to requisition replacements. These items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Illustrations are furnished to assist you in identifying the items.

b. **Section Ill. Basic Issue Items (Bll).** These are the minimum essential items required to place the oscilloscope in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged, BII must be with the oscilloscope during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TOE/MTOE authorization of the end item.

C-3. EXPLANATION OF COLUMNS

The following is an explanation of columns found in the tabular listings:

a. **Column (1) - Illustration Number (Illust. No.).** This column indicates the number of the illustration in which the item is shown.

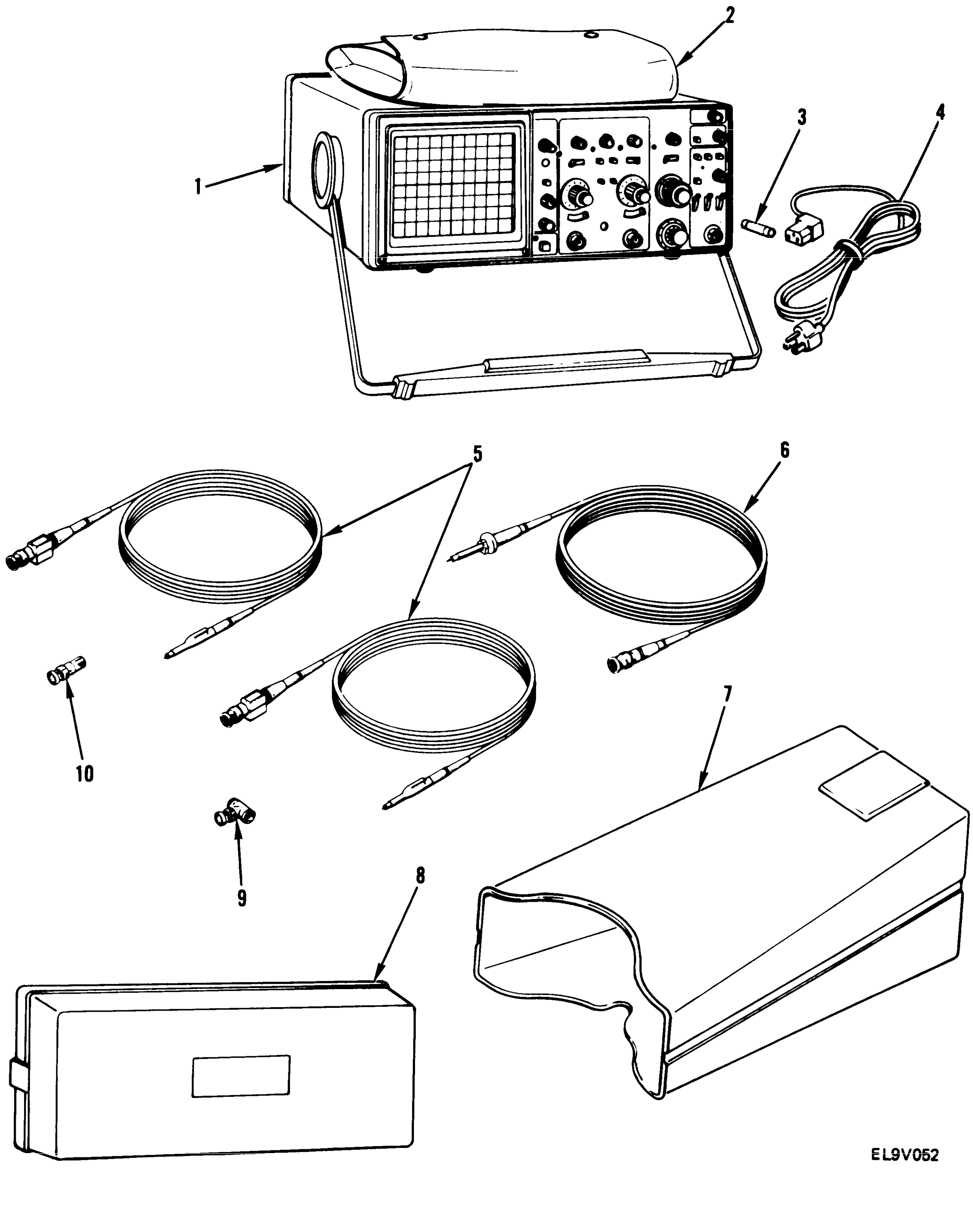
b. **‘Column (2) - National Stock Number.** Indicates the National stock number assigned to the item and will be used for requisitioning purposes.

c. Column (3) - Description. Indicates the Federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) (in parentheses) followed by the part number. If item needed differs for different models of this equipment, the model is shown under the Usable On heading in this column.

d. **Column (4) - Unit of Measure (U/M).** Indicates the measure used in performing the actual operational/ maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr).

e. Column (5) - Quantity Required (Qty Rqr). Indicates the quantity of the item authorized to be used with the oscilloscope.

Section II. COMPONENTS OF END ITEM



(1) Illust. No.	(2) National Stock Number	(3) Description FSCM and Part Number	Usable On Code	(4) U/M	(5) Qty Rqr
1		Oscilloscope, Model 2235 (80009)		ea	1
2		Pouch (80009) 016-0677-02		ea	1
3		Fuse (71400) NDL1		ea	1
4		AC Power Cord (16428) CH8352		ea	1
5		10X Probe Set (80009) 010-6122-01		st	2
6		IX Probe Set (80009) 010-6101-03		st	1
7		Viewing Hood (80009) 016-0566-00		ea	1
8		Cover (80009) 200-2520-00		ea	1
9		BNC Tee Connector (95712) 3424-9		ea	1
10		BNC to Binding Post Connector (95712) 2048-2NT34		ea	1

APPENDIX D
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

D-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 items (Except Medical, Class V, Repair Parts, and Heraldic Items).

D-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 Federal Supply C-ode for Manufacturer (FSCM) (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 No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	O	7920-00-862-6710	Lint-free Cloth	yd
2	O		Detergent	oz
3	O		Denatured Ethyl Alcohol	gal
4	O		Isopropyl Alcohol	gal

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TECHNICAL MANUAL

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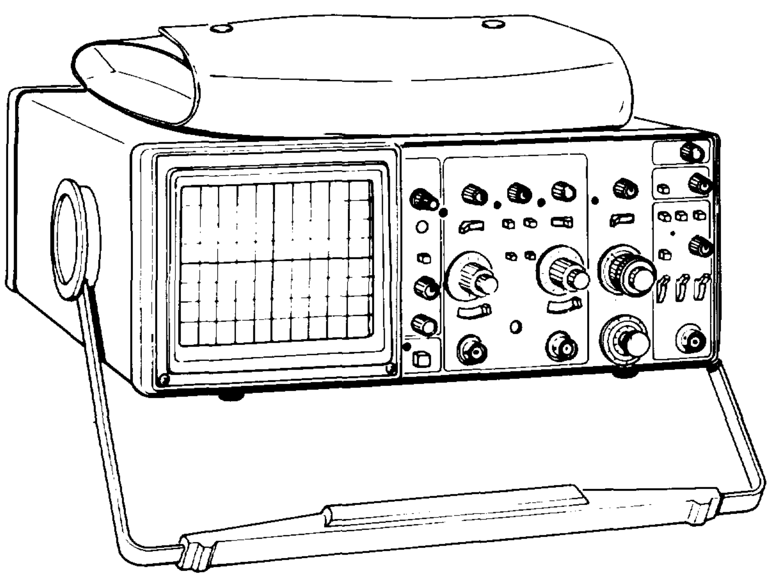


OSCILLOSCOPE AN/USM-488

(NSN 6625-01-187-7847)

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

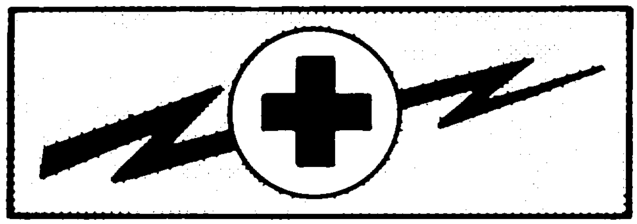
2 IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3 IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A WOODEN POLE OR A 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 is another person nearly 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 be warned about dangerous areas.

A periodic review of safety precautions in TB 385-4, Safety Precautions for Maintenance of Electrical/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 or 115 volt ac input connections 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 the body.

WARNING Do not be misled by the term "low voltage", Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-1 I

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 faceplate.

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

GENERAL HANDLING PROCEDURES FOR ESDS ITEMS

- USE WRIST GROUND STRAPS OR MANUAL GROUNDING PROCEDURES
- KEEP ESDS 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 ESDS ITEMS ONLY IN PROTECTED AREAS

MANUAL GROUNDING PROCEDURES

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

ESD PROTECTIVE PACKAGING AND LABELING

- INTIMATE COVERING OF ANTISTATIC 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, MNOS, 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 an 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 from their packages until actually used or tested.

TECHNICAL MANUAL
No. 11-6625-3135-40

TM 11-6625-3135-40
HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 15 0ctober 1986

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

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), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communication—Electronics Command and Fort Monmouth, ATTN: AM SEL-ME-MP, Fort Monmouth, New Jersey 07703-5000.

A reply will be furnished to you.

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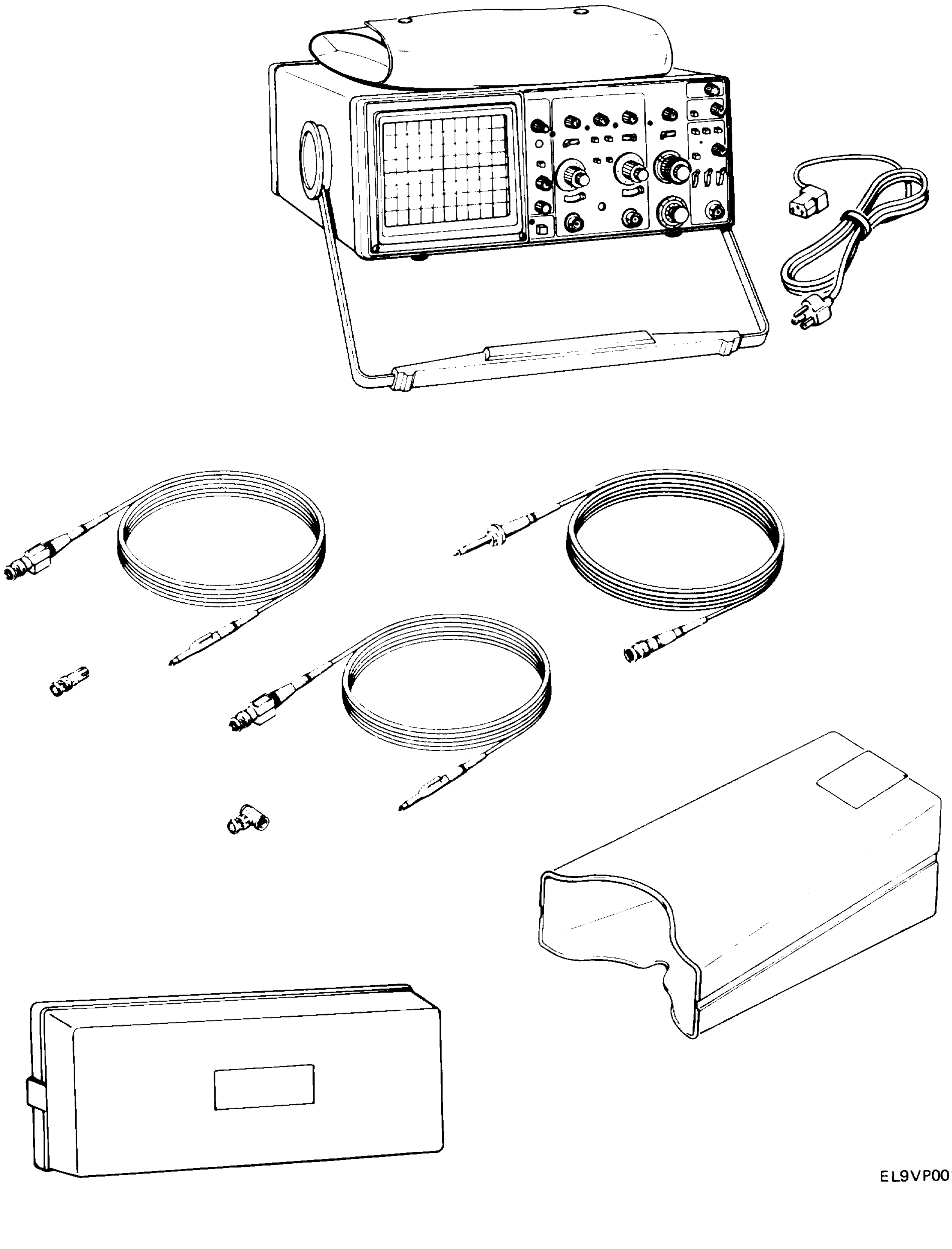

Figure 1-1. Oscilloscope AN/USM-488

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Section 1. GENERAL INFORMATION

1-1. SCOPE

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

1-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS

Refer to-the-latest issue of DA Pam 310-1 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 738-750, as contained in Maintenance Management Update.

b. **Report of Packaging and Handling Deficiencies.** Fill out and forward SF 364 [Report of Discrepancy (ROD)]as prescribed in AR 735-1 1-2/ DLAR 4140.55/ NAVMATINST 4355.73A/AFR 400-54/ MCO 4430.3F.

c. **Discrepancy in Shipment Report (DISREP) (SF 361).** Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/ AFR 75-18/MCO P4610.19D/DLAR 4500.15.

1-4. CALIBRATION

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

1-5. DESTRUCTION OF ARMY MATERIAL 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 (Quality Deficiency Report). Mail it to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-PA-MA-D, Fort Monmouth, New Jersey 07703-5000. 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)
Ic	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.

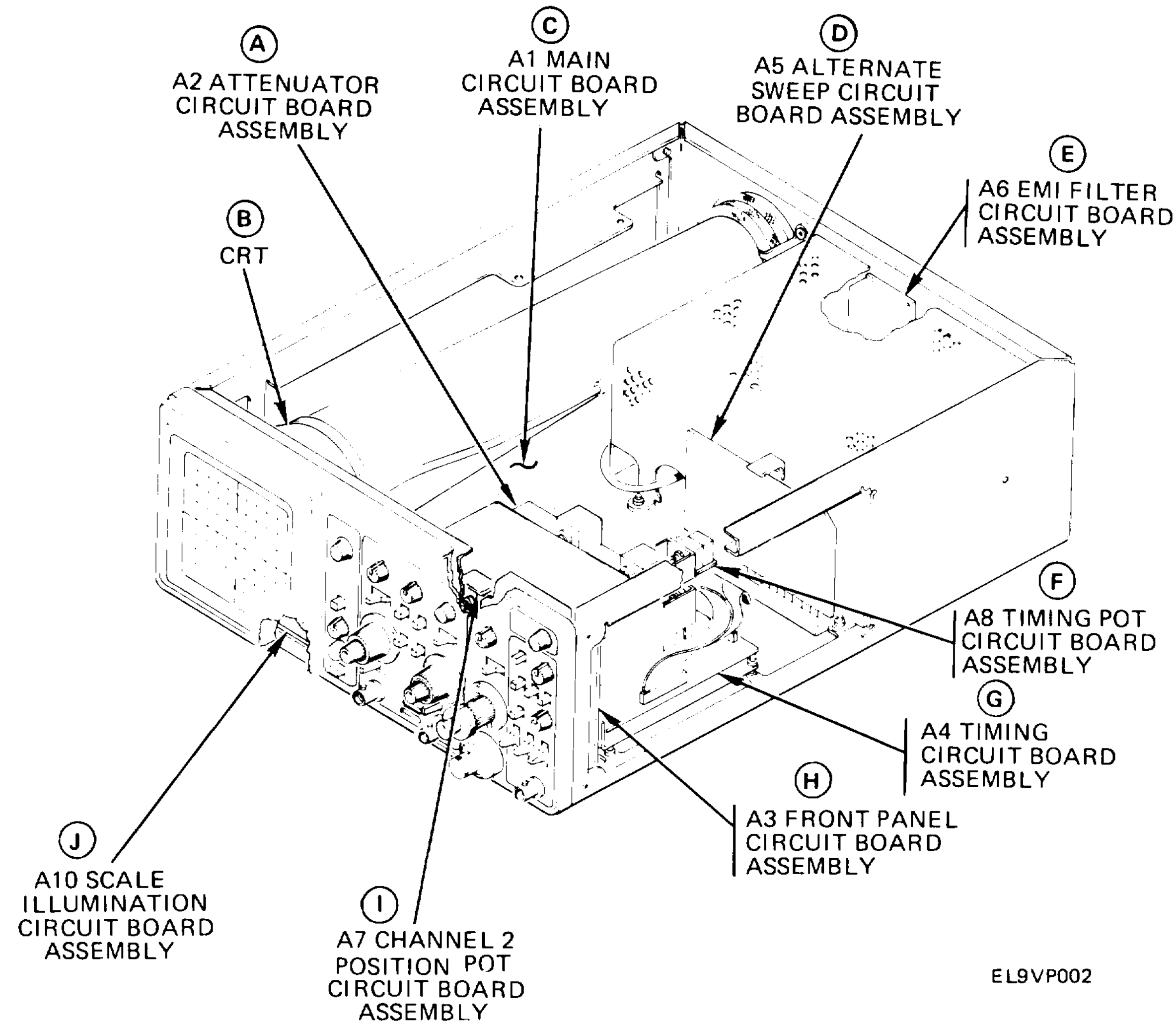
A8 TIMING POT CIRCUIT BOARD ASSEMBLY (F) — Provides sweep timing adjustment.

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.

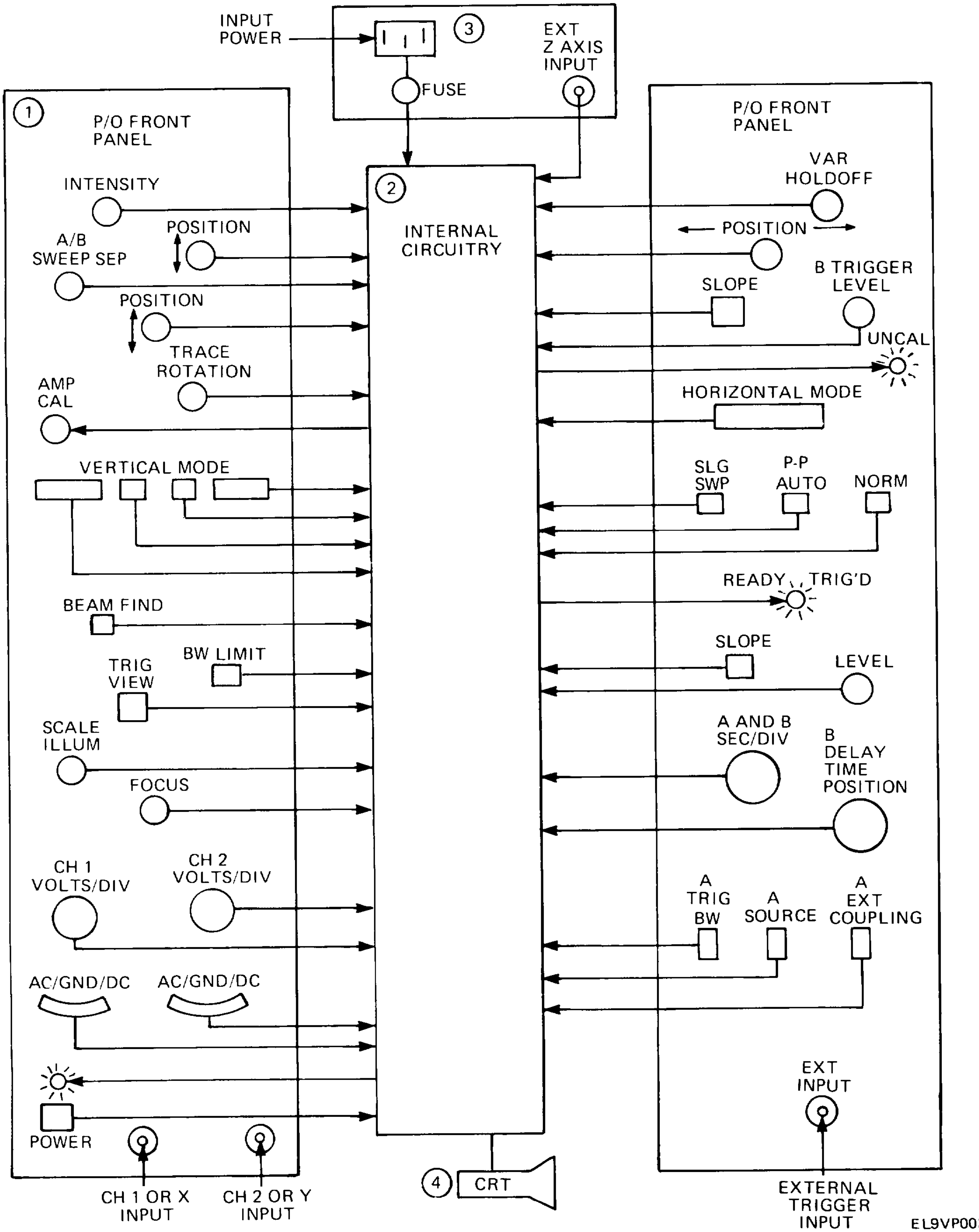


FIGURE 1-2. OSCILLOSCOPE GENERAL BLOCK DIAGRAM

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

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Section 1. 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 738-750.

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

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2.	NO BASELINE TRACE APPEARS ON CRT	2-7
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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).

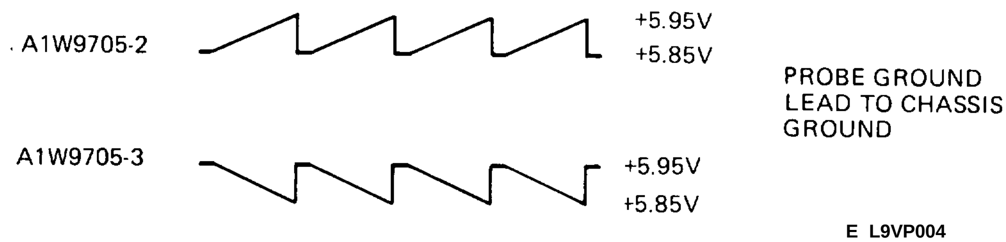
Step 7. Depress BEAM FIND control.

- 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)

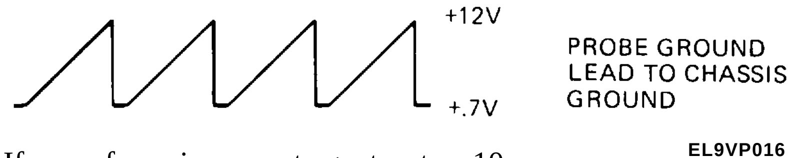
Malfunction
Test or Inspection
Corrective Action

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).

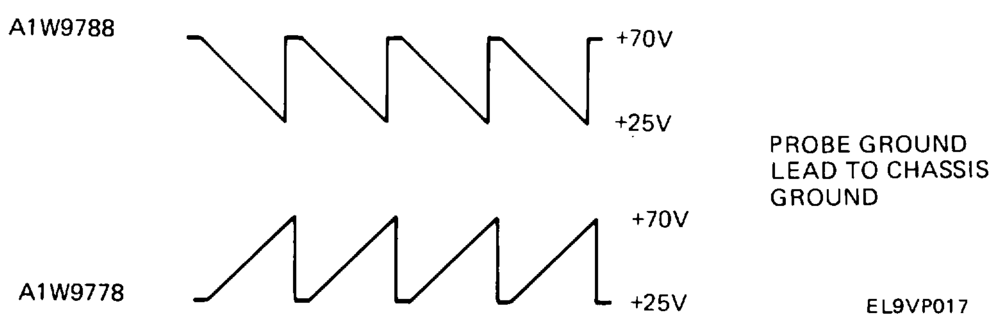


- If waveform is correct, go to step 10.
- If waveform is incorrect, go to step 12.

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

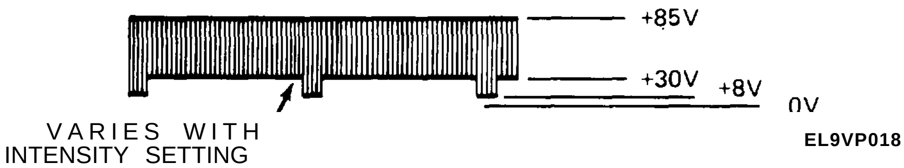
Step 18. Check W9001 (148) pin 16 for low(low is zero).

- 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.

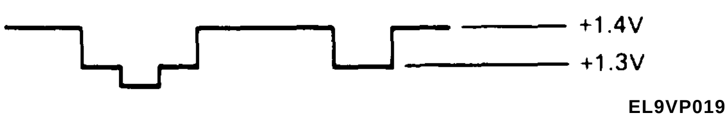
Step 22. Measure for approximately -1500 vdc at W9870 pin 4 (40).

- 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.

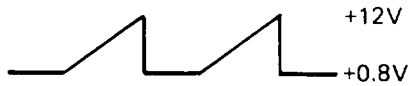
Step 2. Check J9400 (88) pin 14 for +6.2 to less than +1.0 vdc as B DELAY TIME POSITION control is rotated from stop to stop.

- 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.

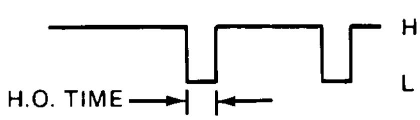
Step 4. Measure J9400 pin 13 (88) for +5 vdc.

- 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.

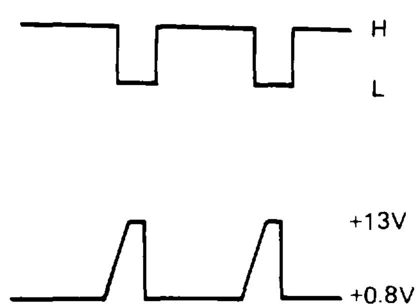
Step 7. Check J9400 pin 4 (88) for +8.6 ±0.2 vdc.

- 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).



EL9VP037

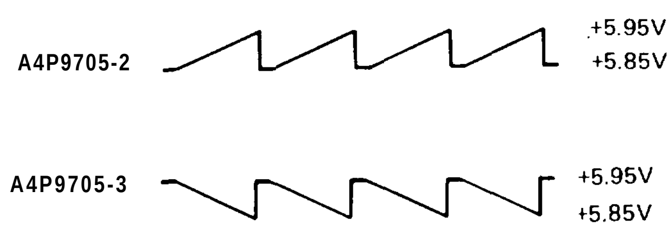
- If correct, replace A5 (para 2-18).
- If not correct (both high or low at the same time), replace A4 (para 2-20).

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.



EL9VP038

- 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.

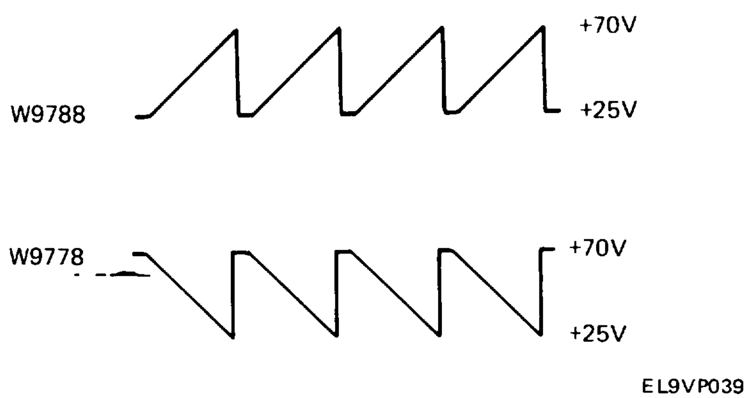


Table 2-2. Troubleshooting (Cent)

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.

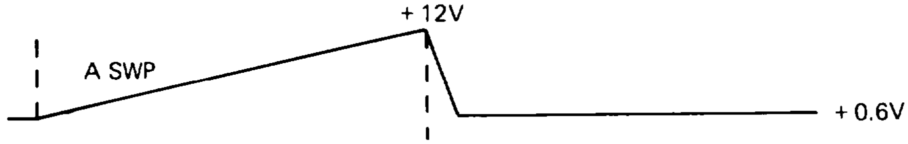
- If correct, replace A4 (para 2-20).
- If not correct, check U758 (81), Q756 (79), and associated components.

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).



EL9VP040

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

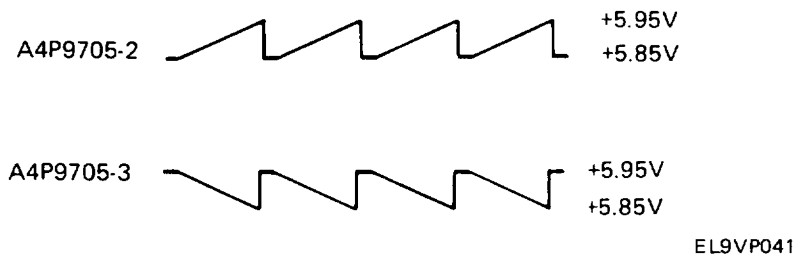
Table 2-2. Troubleshooting (Cent)

Malfunction

Test or Inspection

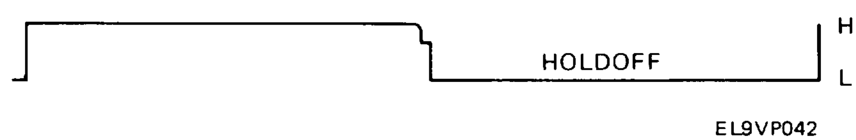
Corrective Action

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

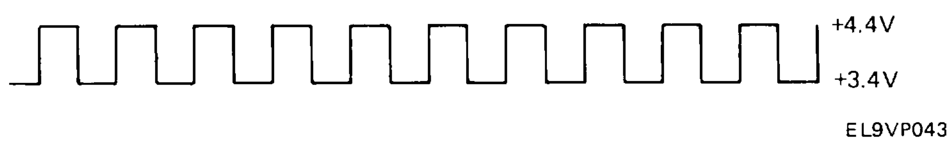
Corrective Action

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.
- lf 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.

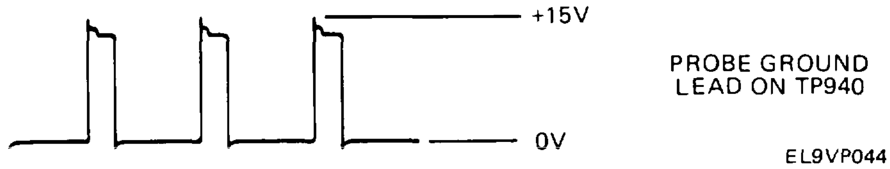
NOTE

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.

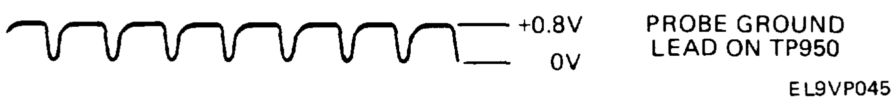
2-12. POWER SUPPLY FAULT ISOLATION TEST (CONT)

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

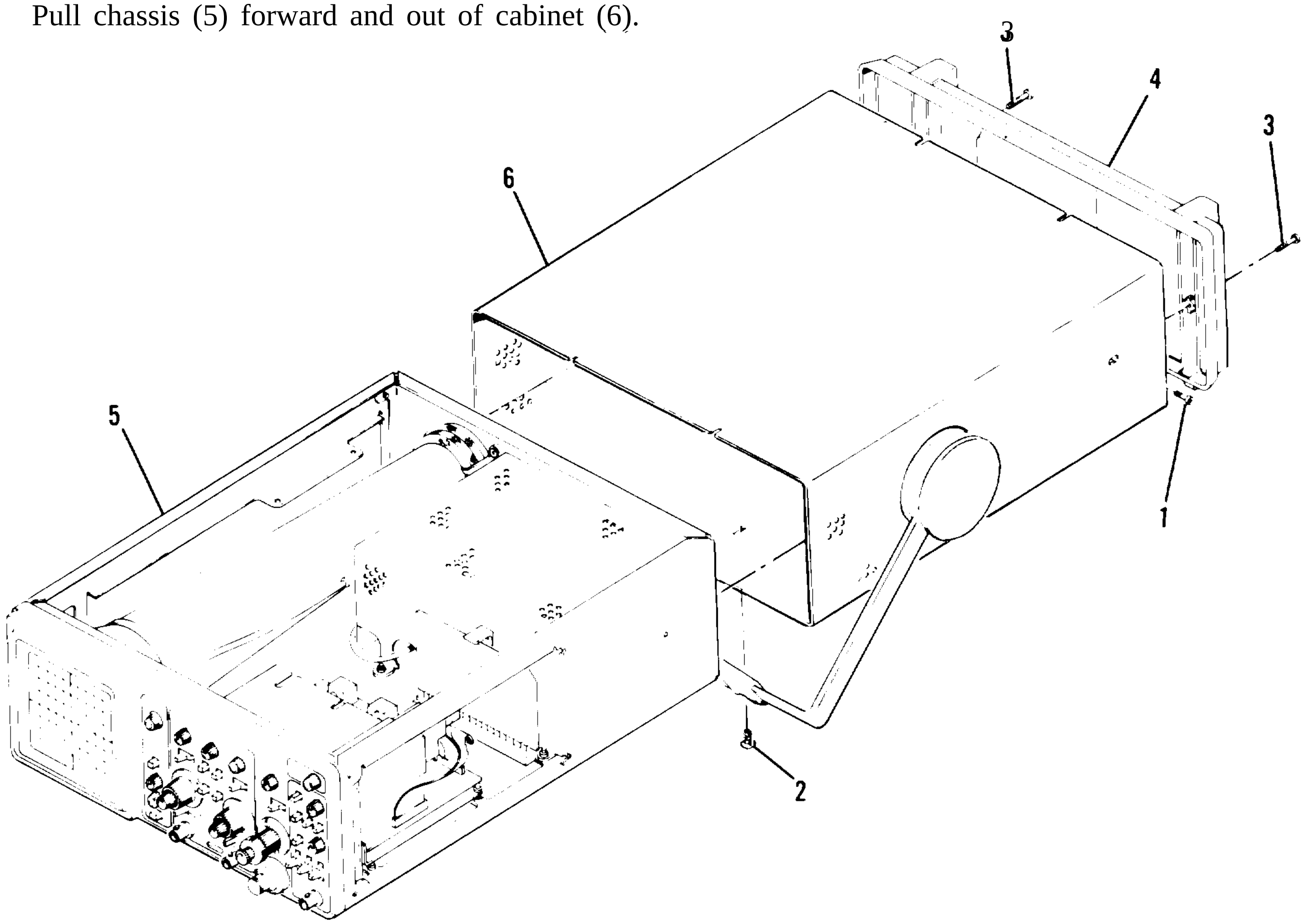
This procedure covers: Remove and Install

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).



EL9VP005

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).

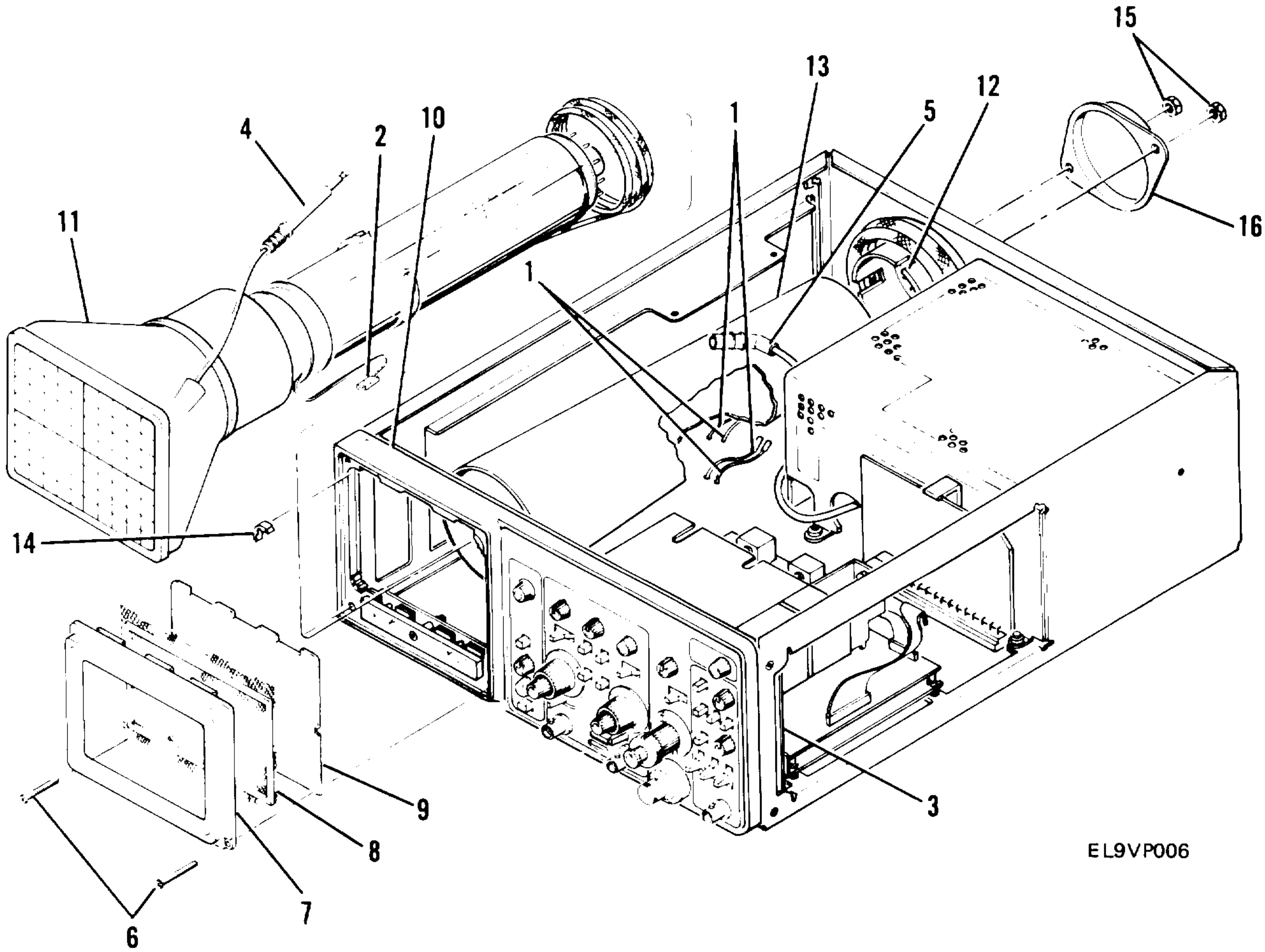
2-14. CRT REPLACEMENT (CONT)

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

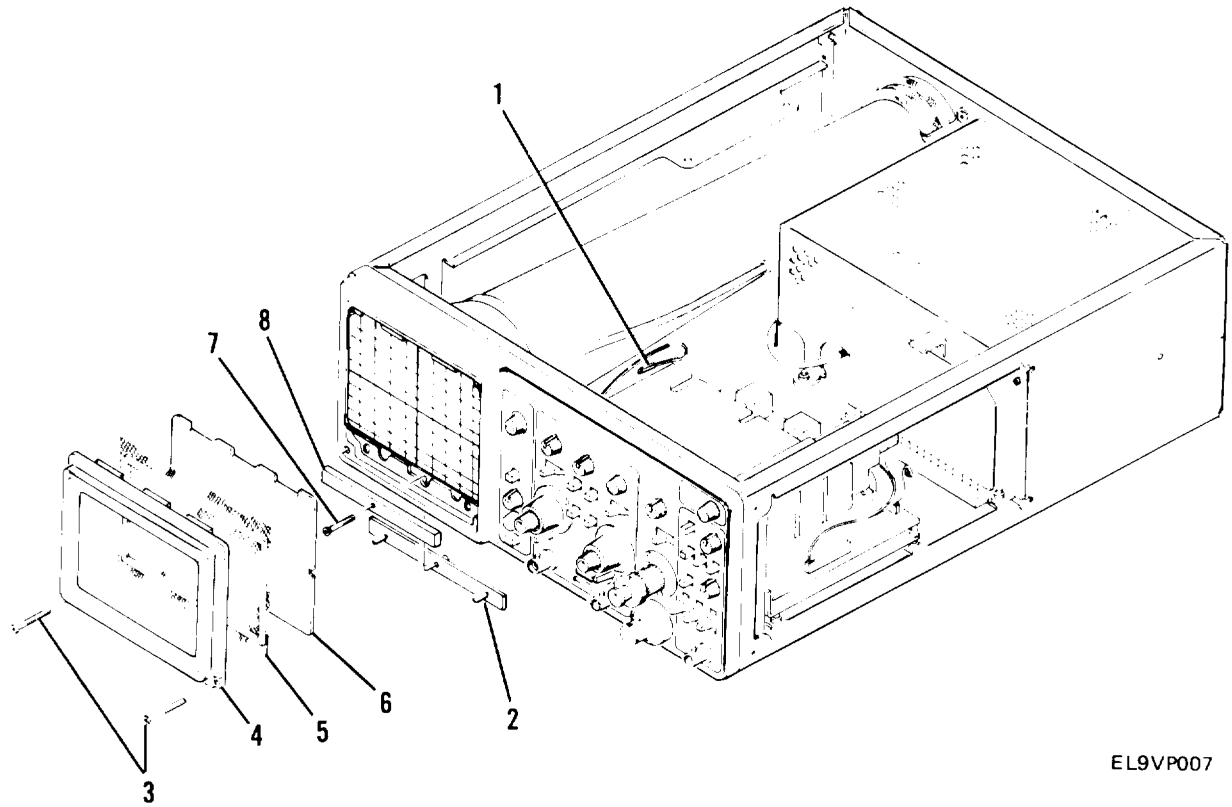
DESCRIPTION

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

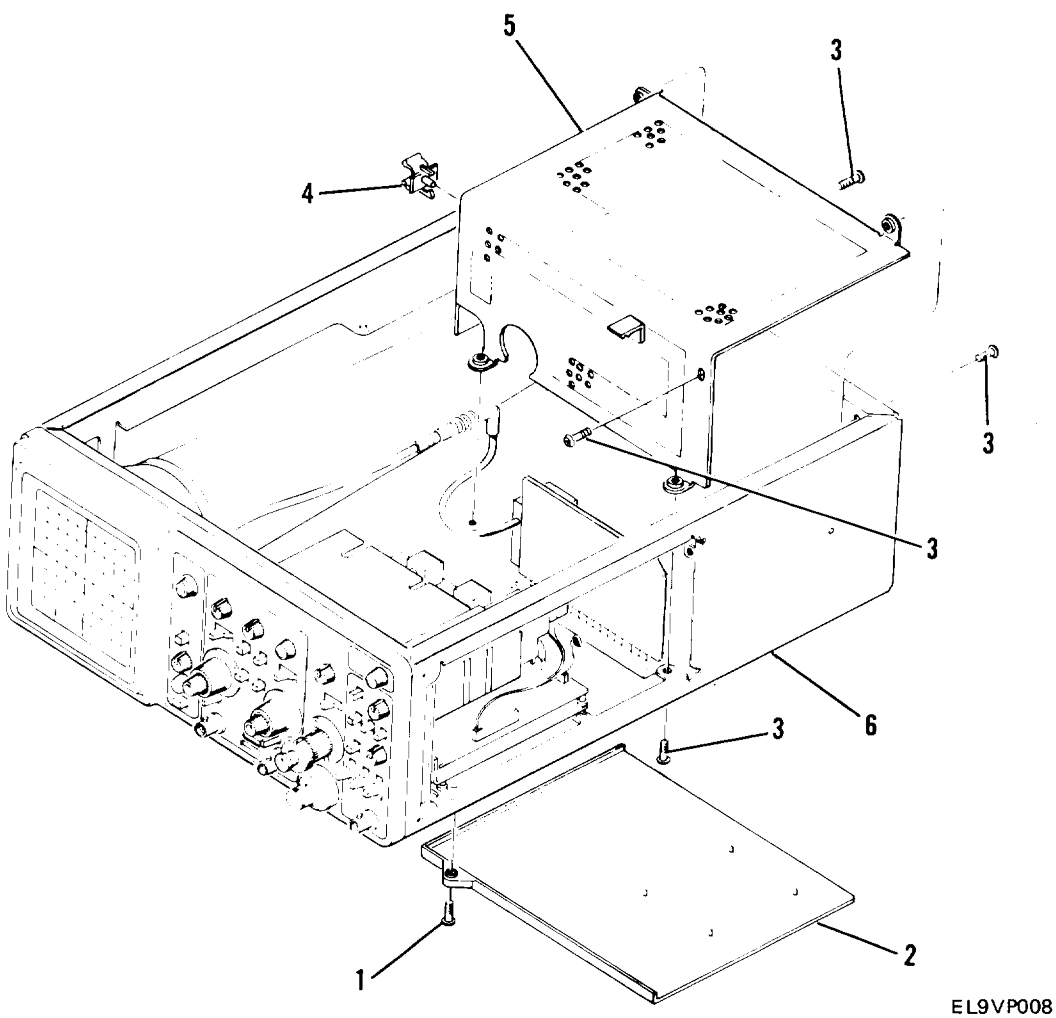
2-16. POWER SUPPLY SHIELD REMOVAL

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

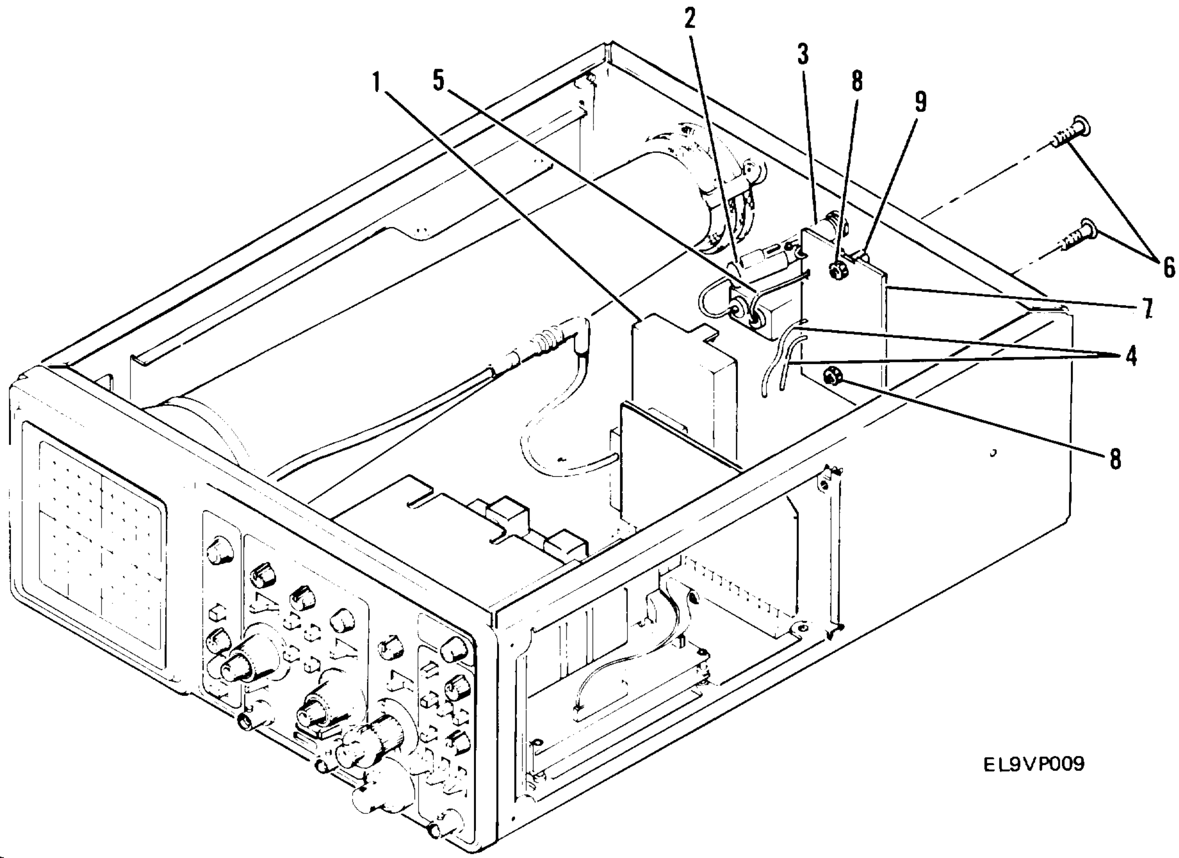
1. Remove cabinet (para 2-13) and power supply shield (para 2-16).
2. Pull off cover (l).

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

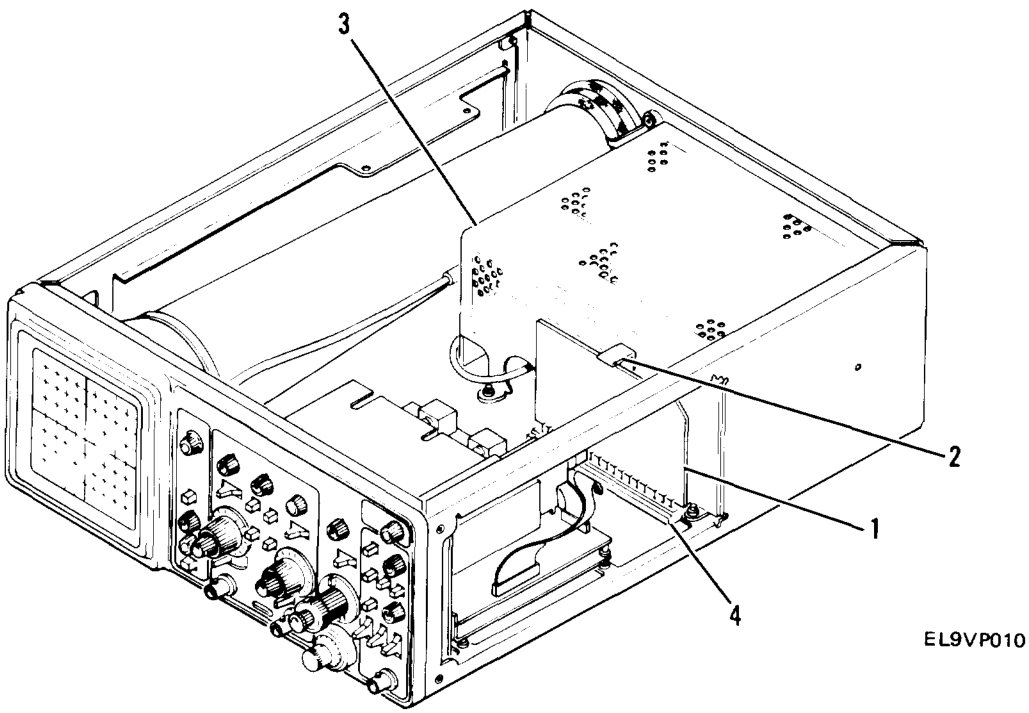
2-18. A5 ALTERNATE SWEEP CIRCUIT BOARD ASSEMBLY REPLACEMENT

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

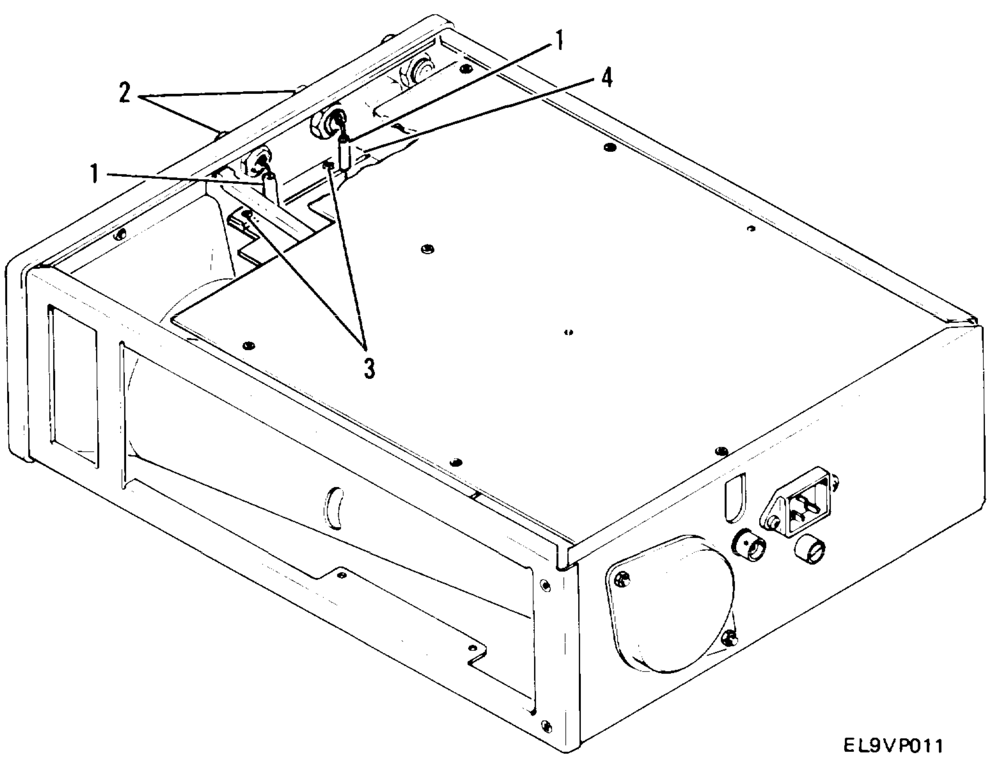
2-19. A2 ATTENUATOR CIRCUIT BOARD ASSEMBLY REPLACEMENT

DESCRIPTION

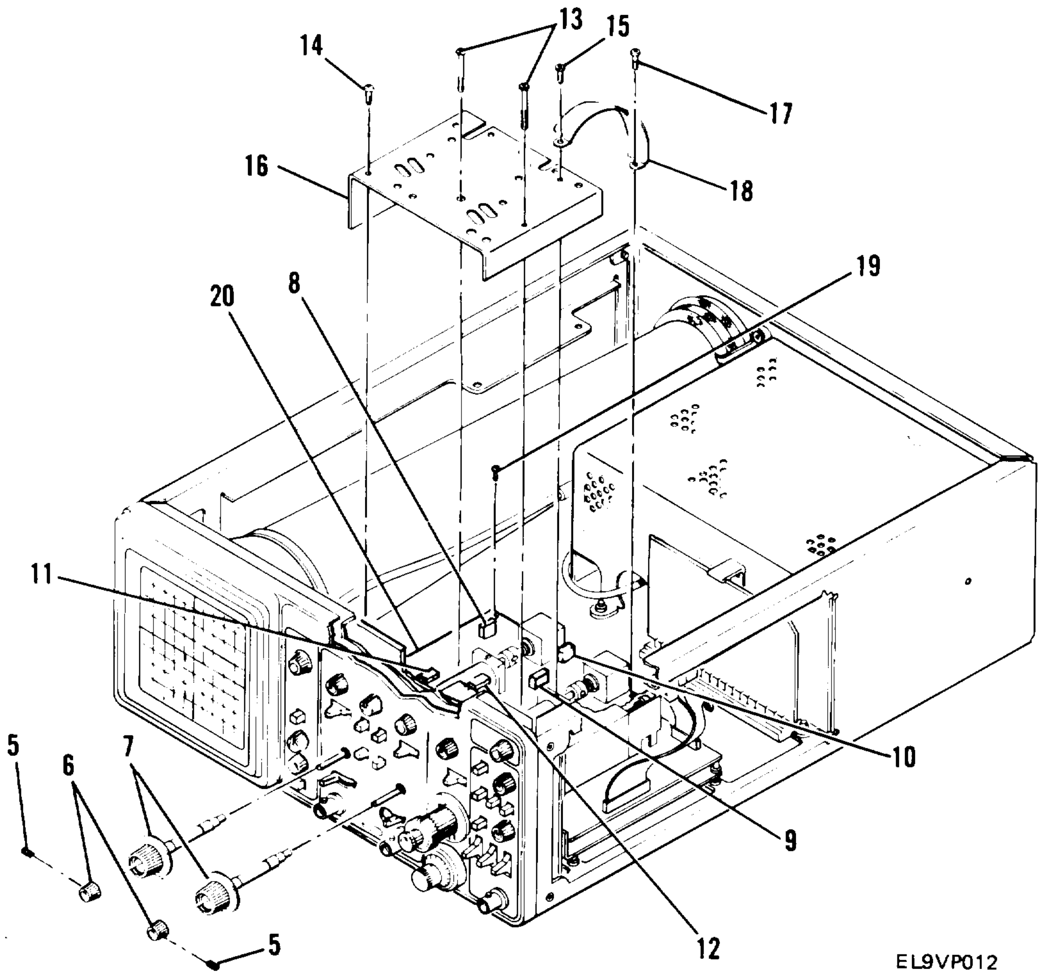
This procedure covers: Remove and Install

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.



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

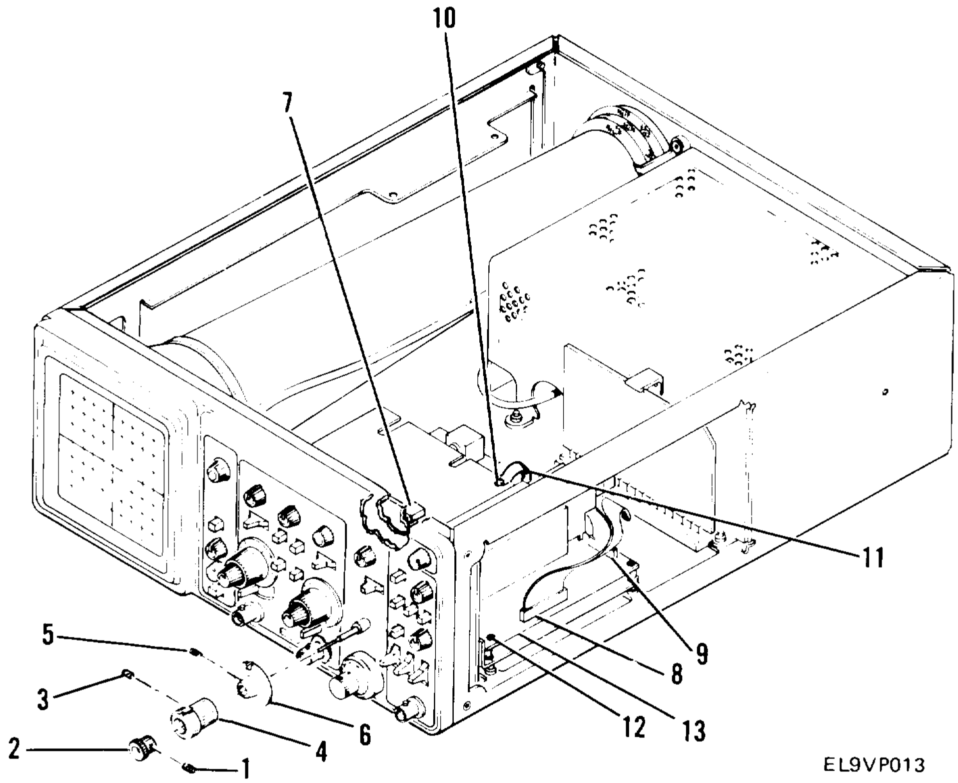
DESCRIPTION

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

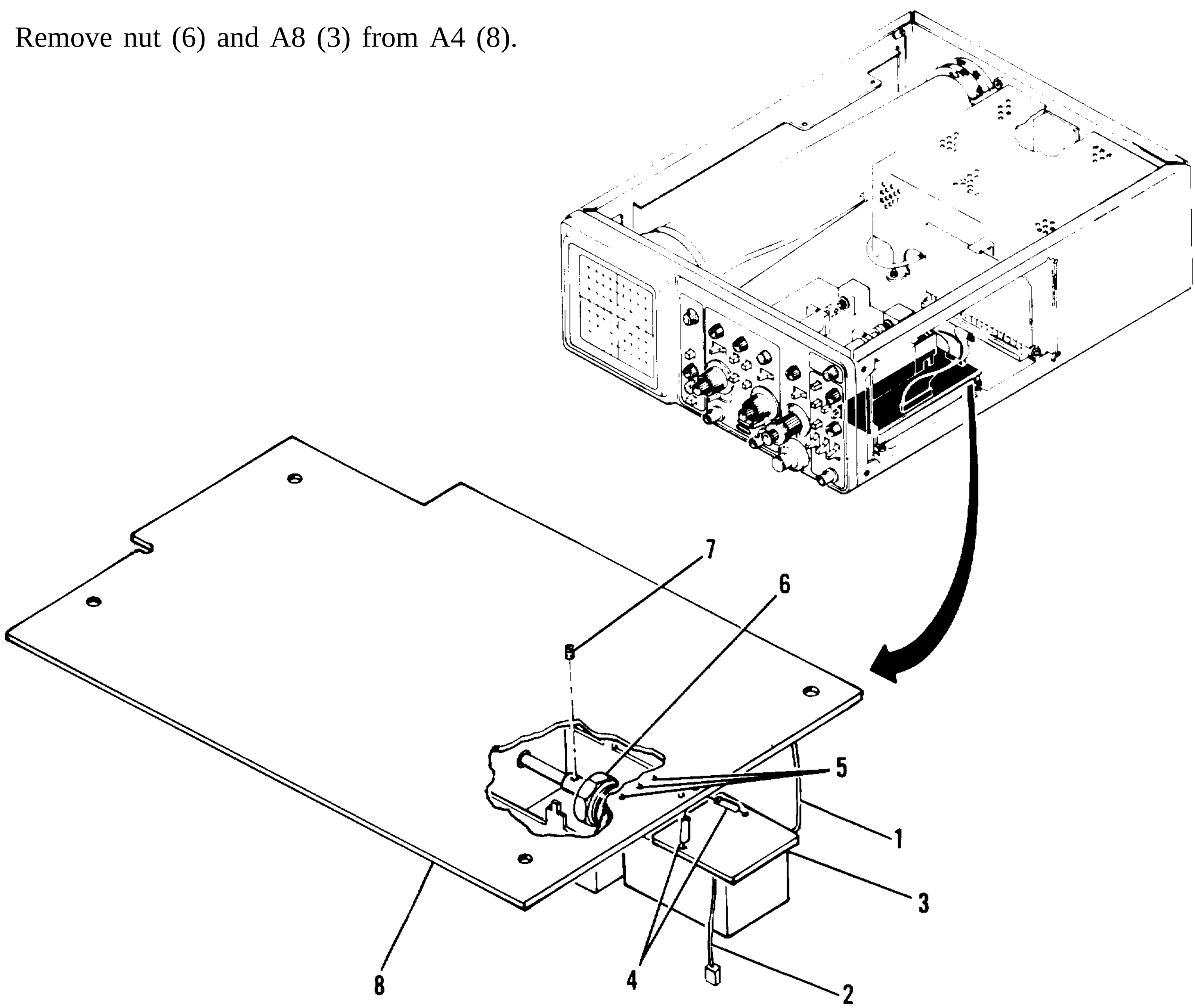
2-21. A8 TIMING POT CIRCUIT BOARD ASSEMBLY REPLACEMENT

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).



EL9VP014

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

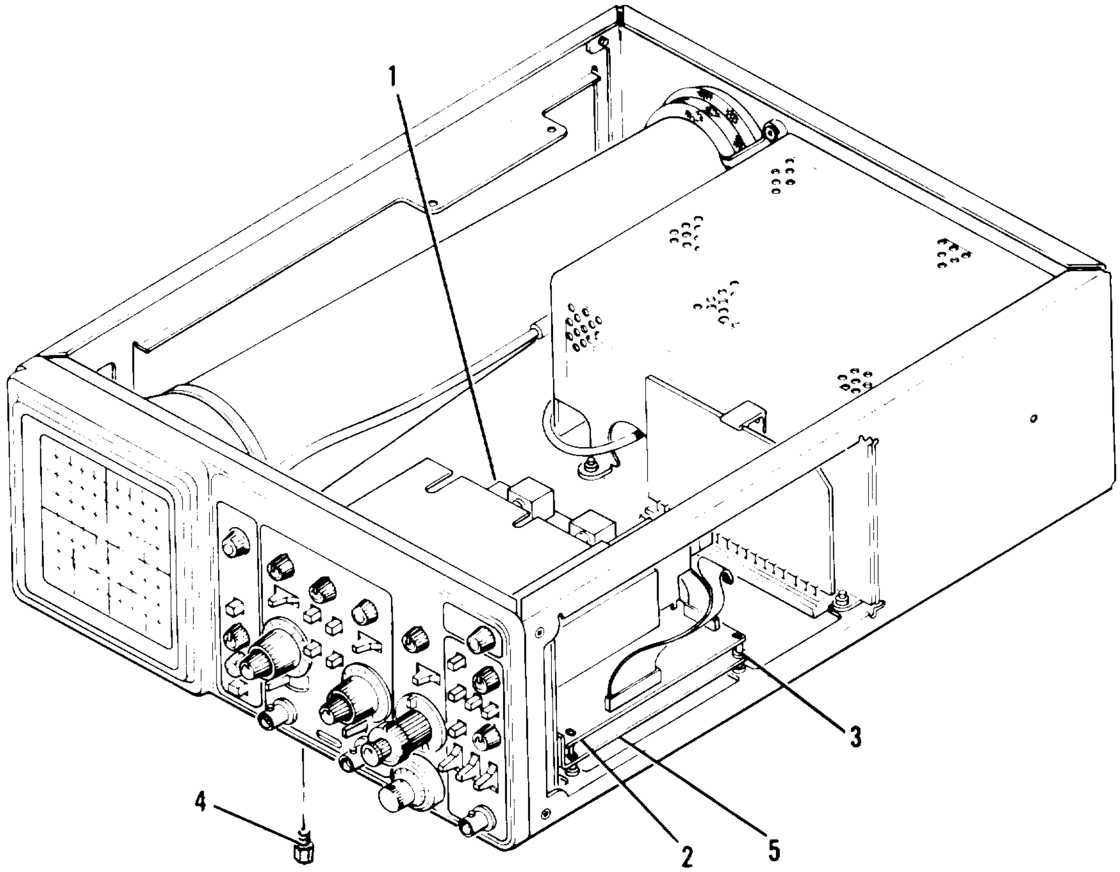
NOTE

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)



EL9VP015

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).

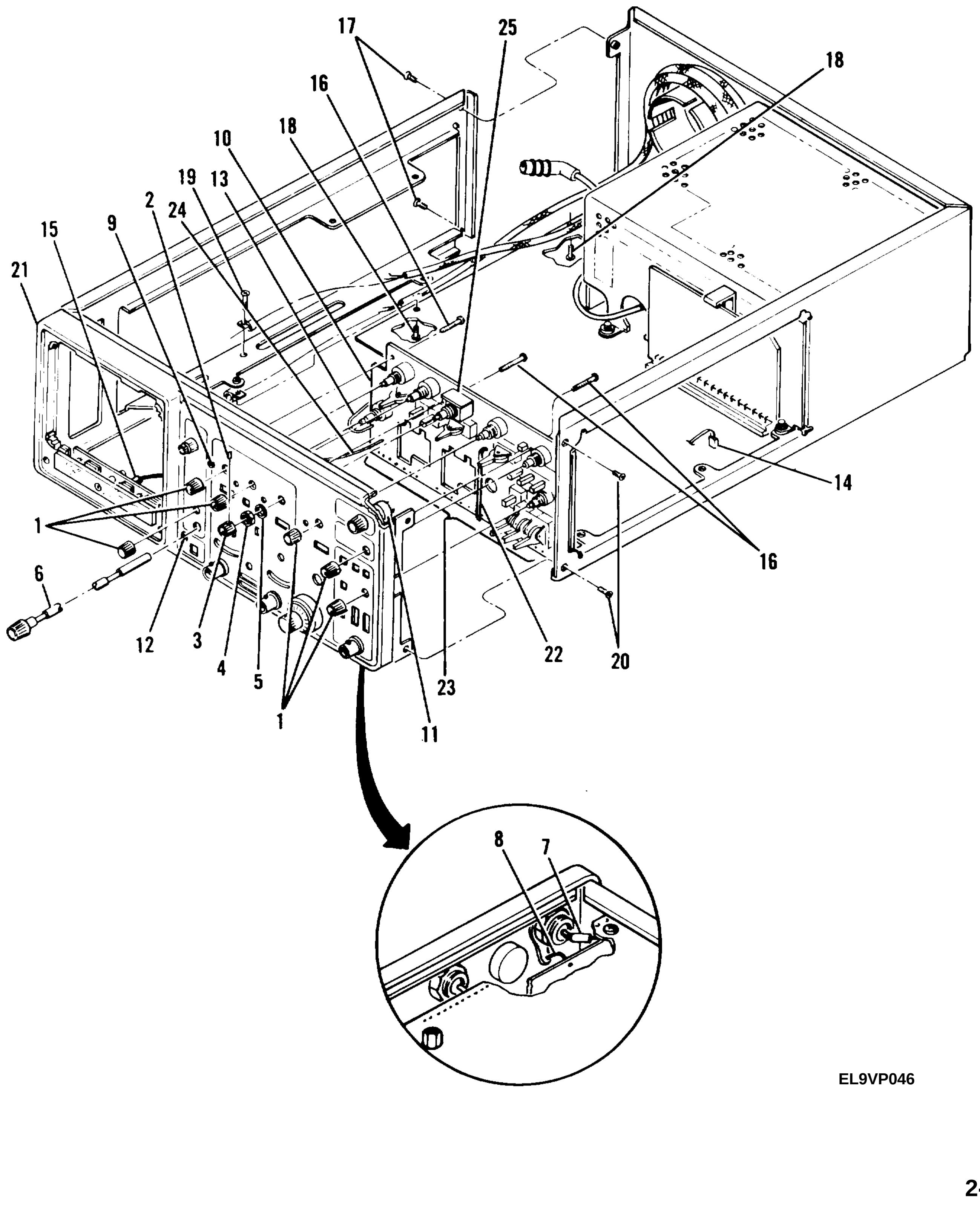
END OF TASK

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

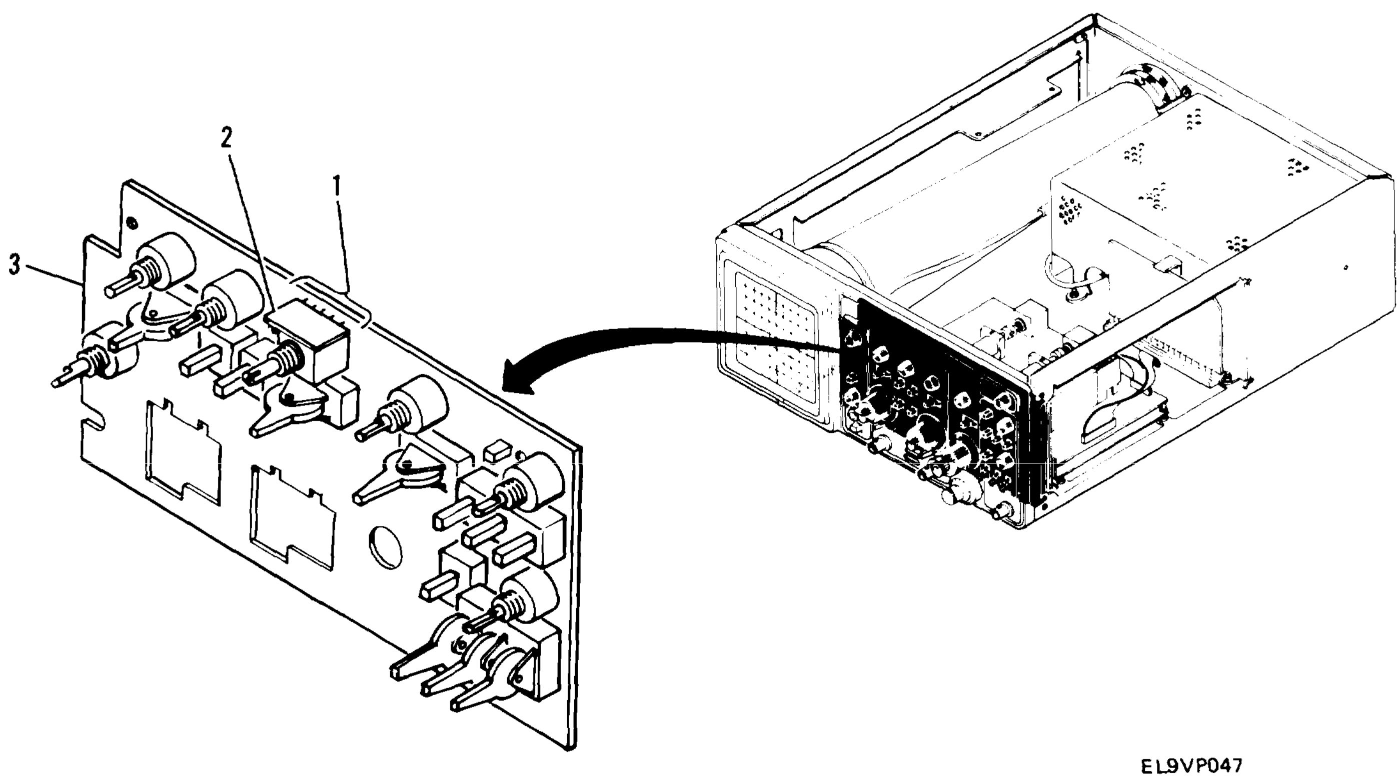
2-24. A7 CHANNEL 2 POSITION POT CIRCUIT BOARD ASSEMBLY REPLACEMENT

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.

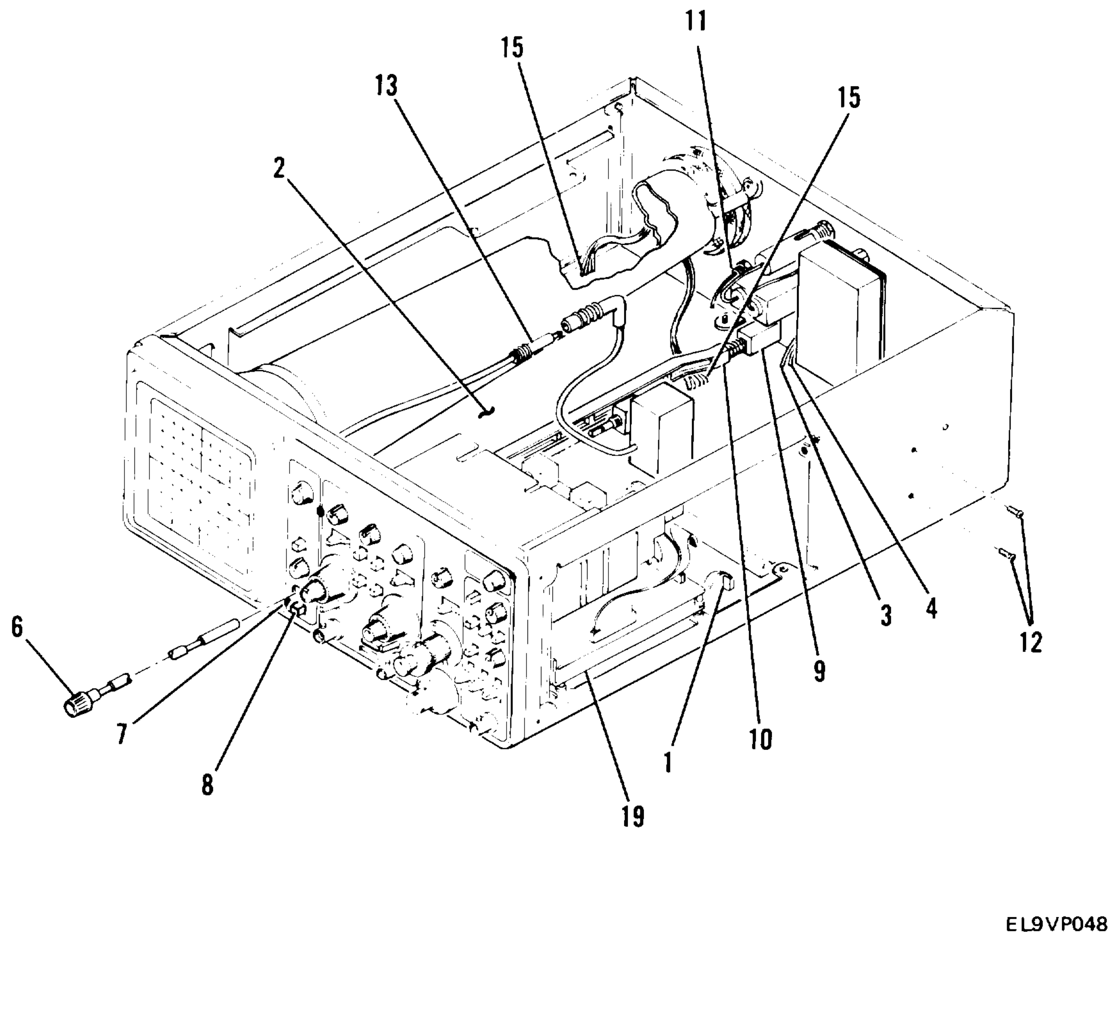
2-25. Al MAIN CIRCUIT BOARD ASSEMBLY REPLACEMENT (CONT)

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

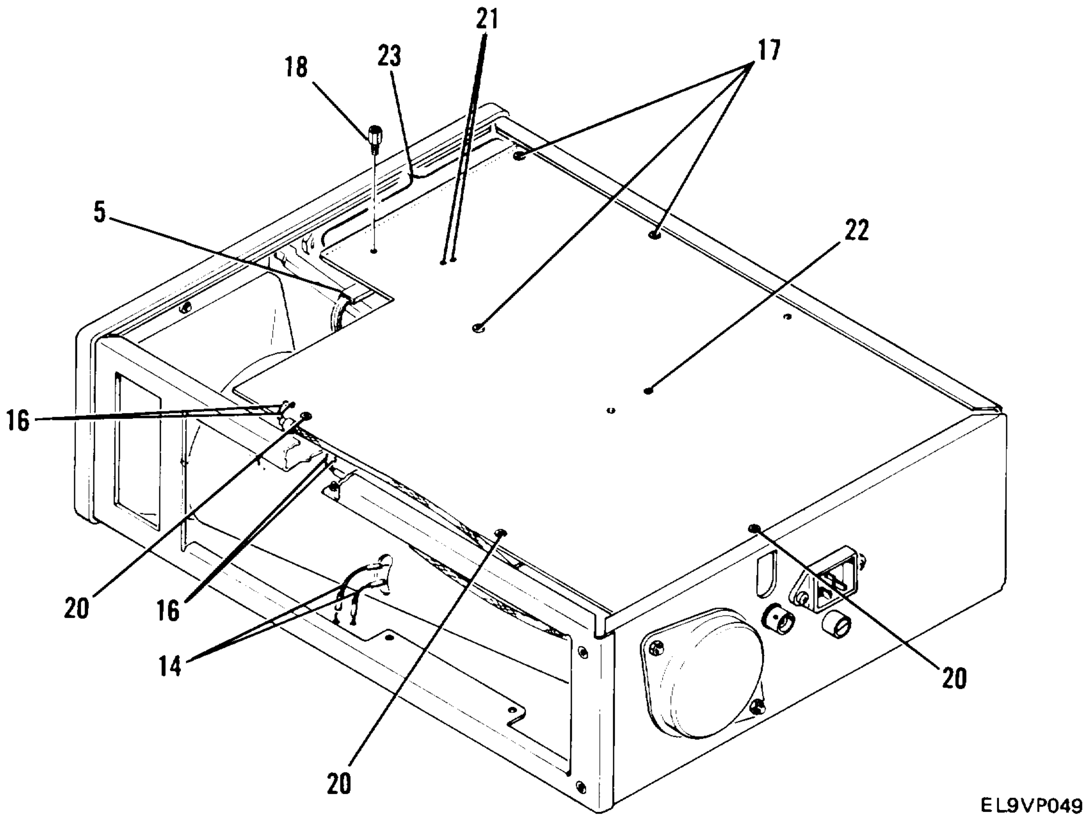
17. Identify and unsolder two leads (21) at W941O and one lead (22) at W9880 on A1.

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.



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
• 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

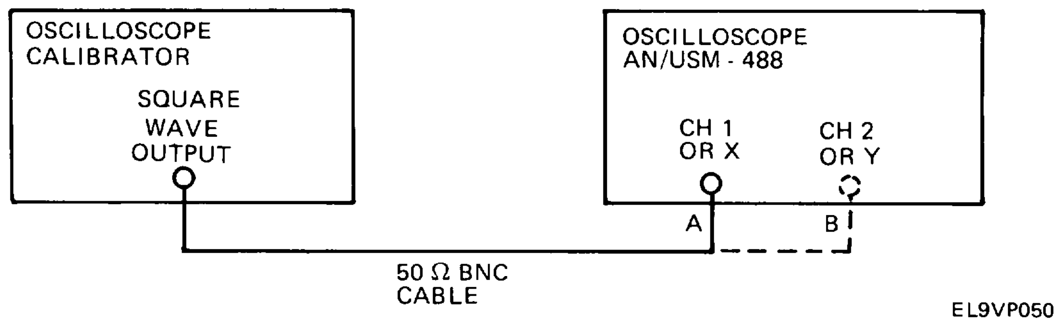
a. **Vertical Circuits Tests.** perform vertical circuit tests in their entirety and in the following order:

- 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.

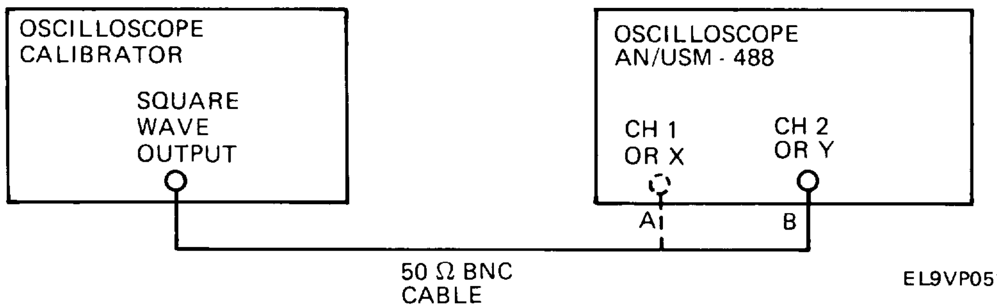
VOLTS/DIV Switch Setting	VOLTS/DIV Variable Setting	Oscilloscope Calibrator Signal	Vertical Defelection (Divisions)	Accuracy Limits (Divisions)
2 mV	Detent	10 mV	5	4.90 - 5.10
5 mV	Detent	20 mV	4	3.92 - 4.08
10 mV	Detent	50 mV	5	4.90 - 5.10
20 mV	Detent	0.1 V	5	4.90 - 5.10
20 mV	Fully CCW	0.1 V	2	1.50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

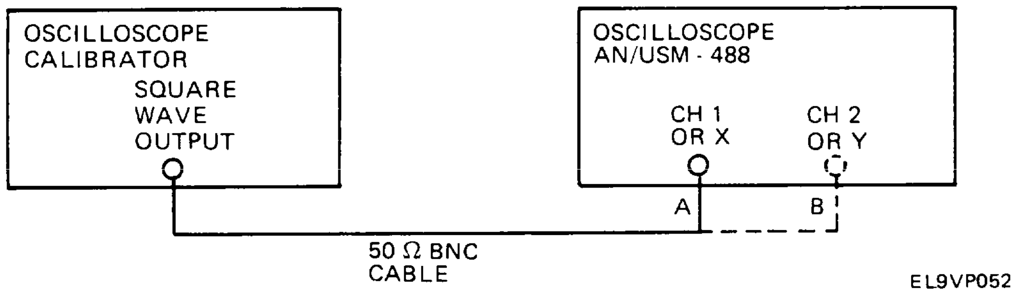
7. Reconnect test equipment to oscilloscope as shown above.

8. Move cable to connection A.

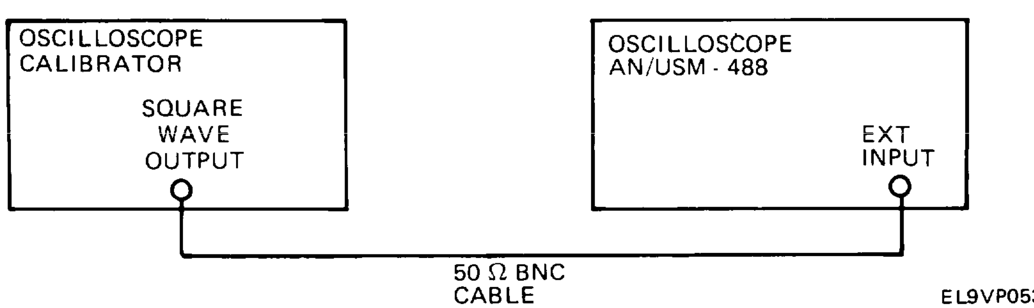
9. Repeat steps 3 through 5 using channel 1 controls.

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.

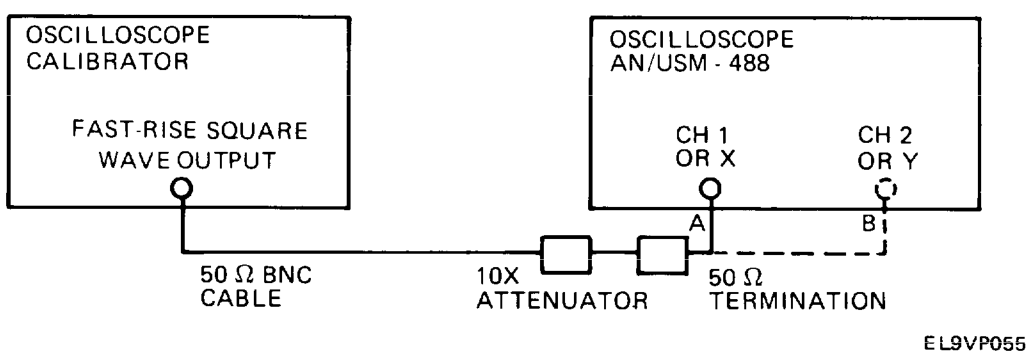
13. Disconnect test equipment.

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)

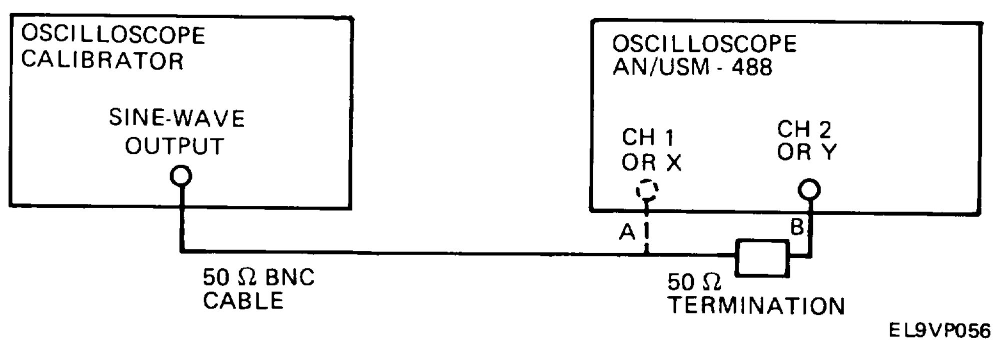
8. Move cable to connection B.
9. Set oscilloscope VERTICAL MODE to CH 2.
10. Set calibration generator for l-MHz, 5 division display.
11. Use vertical POSITION control to set display top at center graticule.
12. Repeat steps 5 and 6 using channel 2 controls.
13. Disconnect test equipment.

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

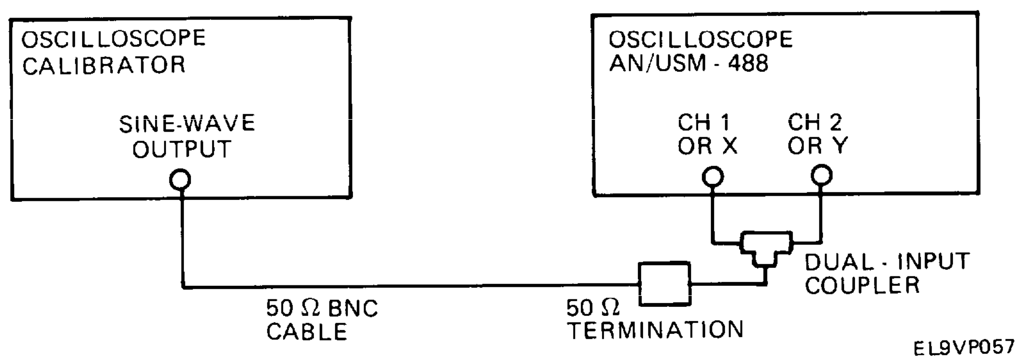
1. Set oscilloscope controls as follows:
   - BW LIMIT switch to On (switch in)
   - CH 1 VOLTS/DIV switch to 10 mV
   - A SEC/DIV switch to 20 us
2. Set oscilloscope calibrator output for 50 kHz, 6-division display.
3. Increase oscilloscope calibrator output frequency until display amplitude decreases 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.

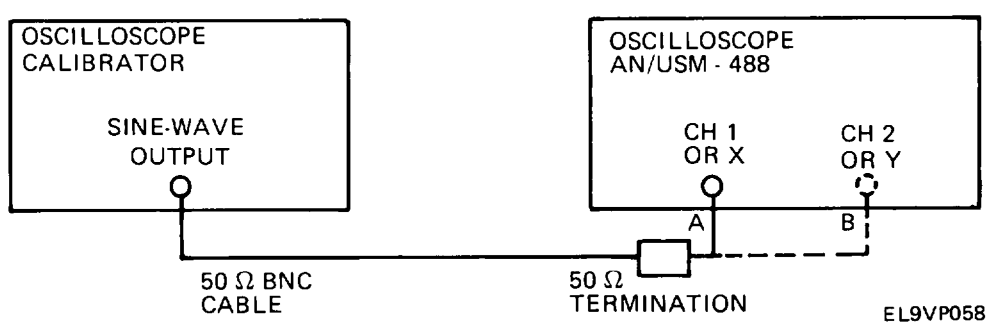
17. Disconnect test equipment from oscilloscope.

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

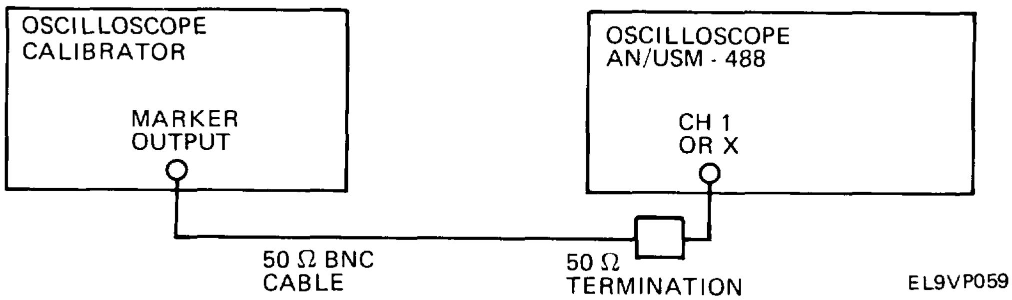
INITIAL SETUP

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:

   - A SEC/DIV to 0.05 US
   - 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:

    - B SEC/DIV to 0.05 US
    - 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.

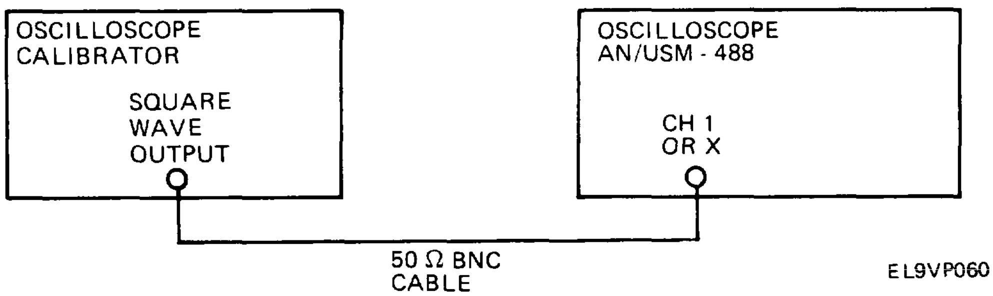
10. Disconnect test equipment.

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

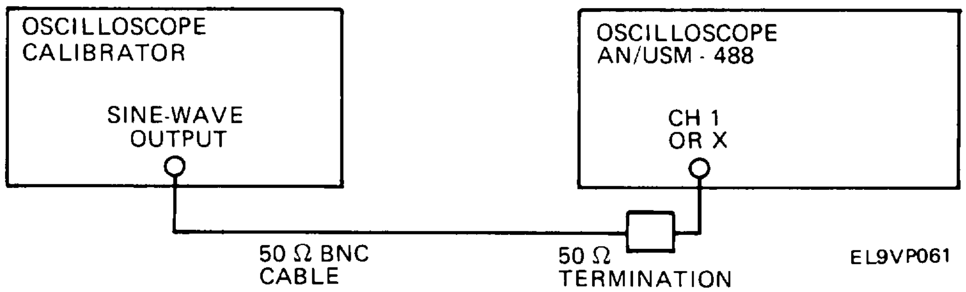
2. Connect test equipment as shown below.



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

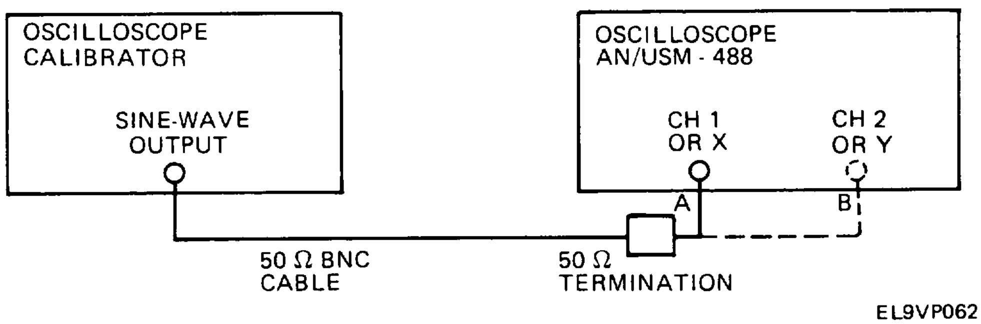
INITIAL SETUP

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)

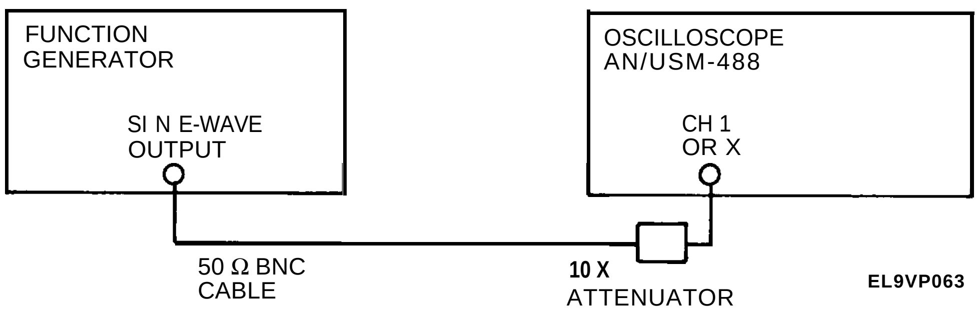
11. Move cable to connection B.
12. Repeat steps 3 through 9 using channel 2 controls.
13. Set oscilloscope controls as follows:
    - HORIZONTAL MODE to A
    - A SEC/DIV to 0.1 US
    - X 10 Magnifier to On.
14. Set oscilloscope calibrator for 60 MHz, l-division amplitude display.
15. Repeat steps 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.



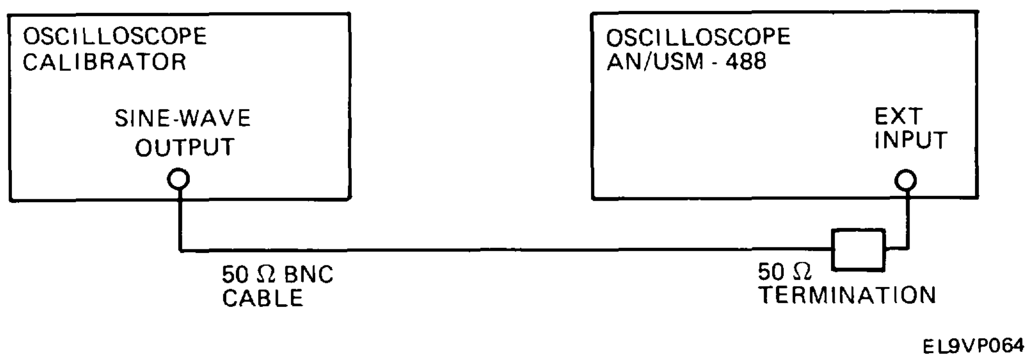
3. Push in and hold TRIG VIEW switch.
4. Set function generator for 1 kHz, 6-division display.
5. Increase function generator frequency for a 4.2-division display.
6. Check that function generator reads between 30 and 50 kHz.
7. Set A TRIG BW switch to LF REJ.
8. Push in and hold TRIG VIEW switch.
9.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

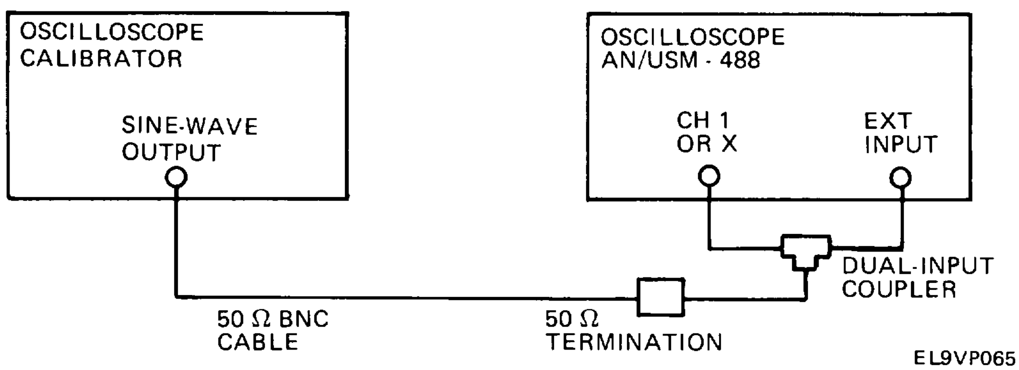
10. Disconnect test equipment.

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

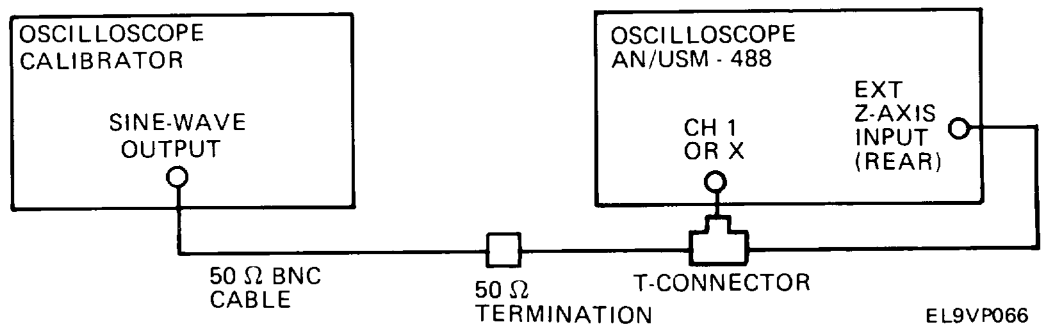
INITIAL SETUP

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.

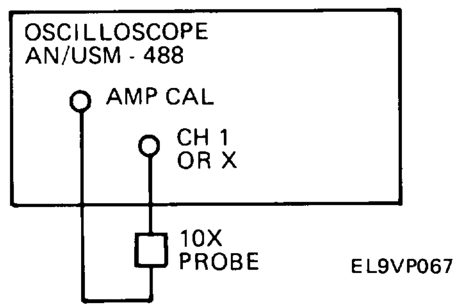
5. Disconnect test equipment.

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.

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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 publications referenced in this manual.

A-2. FORMS

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

Recommended Changes to Equipment Technical Manuals . . . . DA Form 2028-2

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

Quality Deficiency Report . . . . Form SF 368

A-3. TECHNICAL MANUALS

The Army Maintenance Management System (TAMMS) . . . . DA PAM 738-750

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

Operator's and Organization Maintenance Manual, Oscilloscope AN/USM-488 (NSN 6625-01-187-7847) . . . . TM 11-6625-3135-12

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

A-4. MISCELLANEOUS

Consolidated Index of Army Publications and Blank Forms . . . . DA Pam 310-1

First Aid for Soldiers FM21-11

Safety Precautions for Maintenance of Electrical/ Electronic Equipment . . . . TB 385-4

Abbreviations for Use on Drawings, Specifications, Standards and in Technical Documents . . . . MI L-STD-12

APPENDIX B
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section 1. 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 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 Federal Supply Code for Manufacturer (FSCM) (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 No.	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	H	8305-00-267-3015	Cloth, Cheesecloth, Cotton, Lintless CCC-C-440, Type II, Class 2(8 1348)	yd
2	H		Detergent, Liquid, General Purpose Specification No. P-D-223B	oz
3	H		Isopropyl Alcohol	oz
4	H		Applicator, Cotton-Tipped	ea

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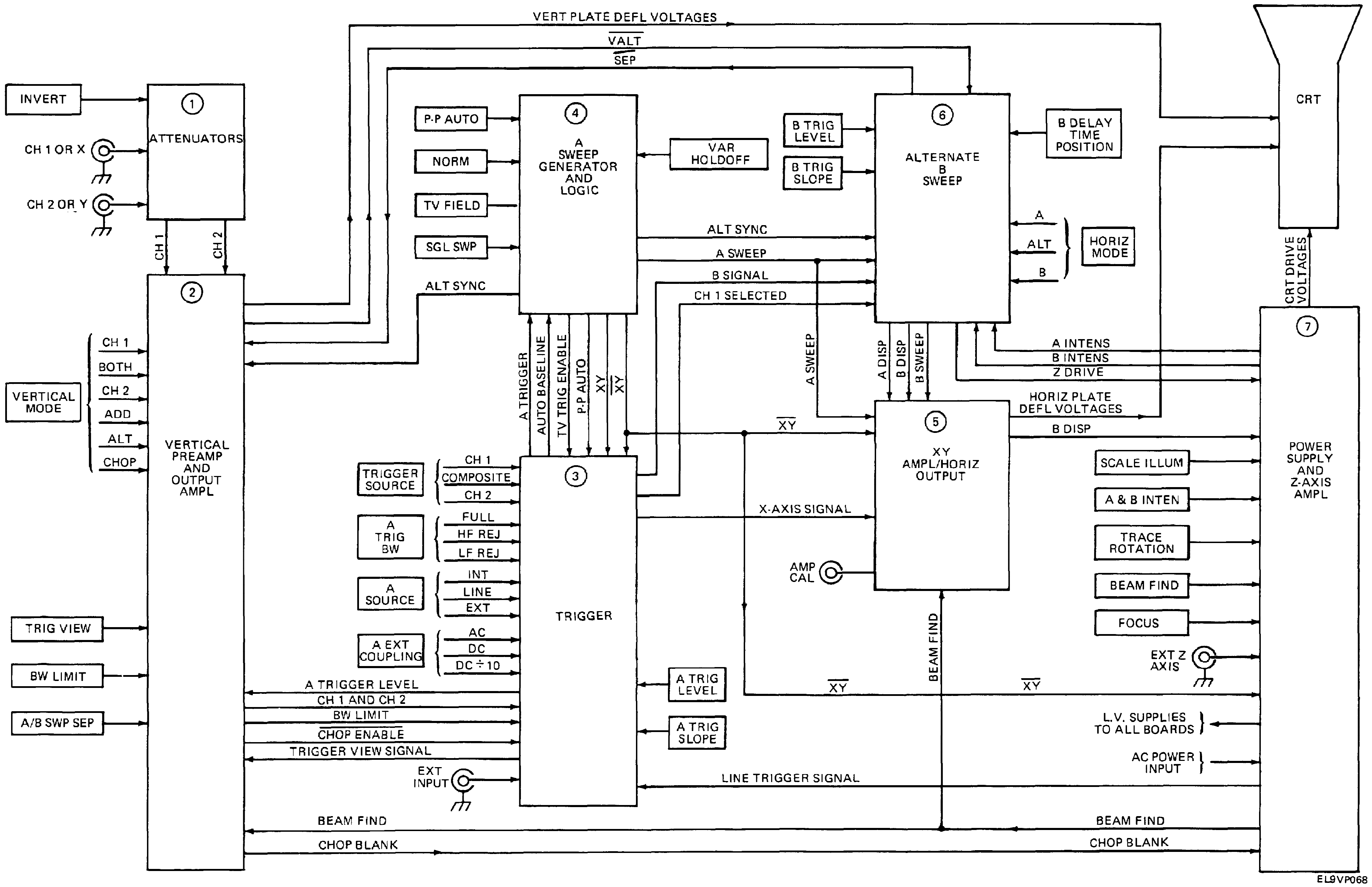

Figure FO-1. Simplified Block Diagram.

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)

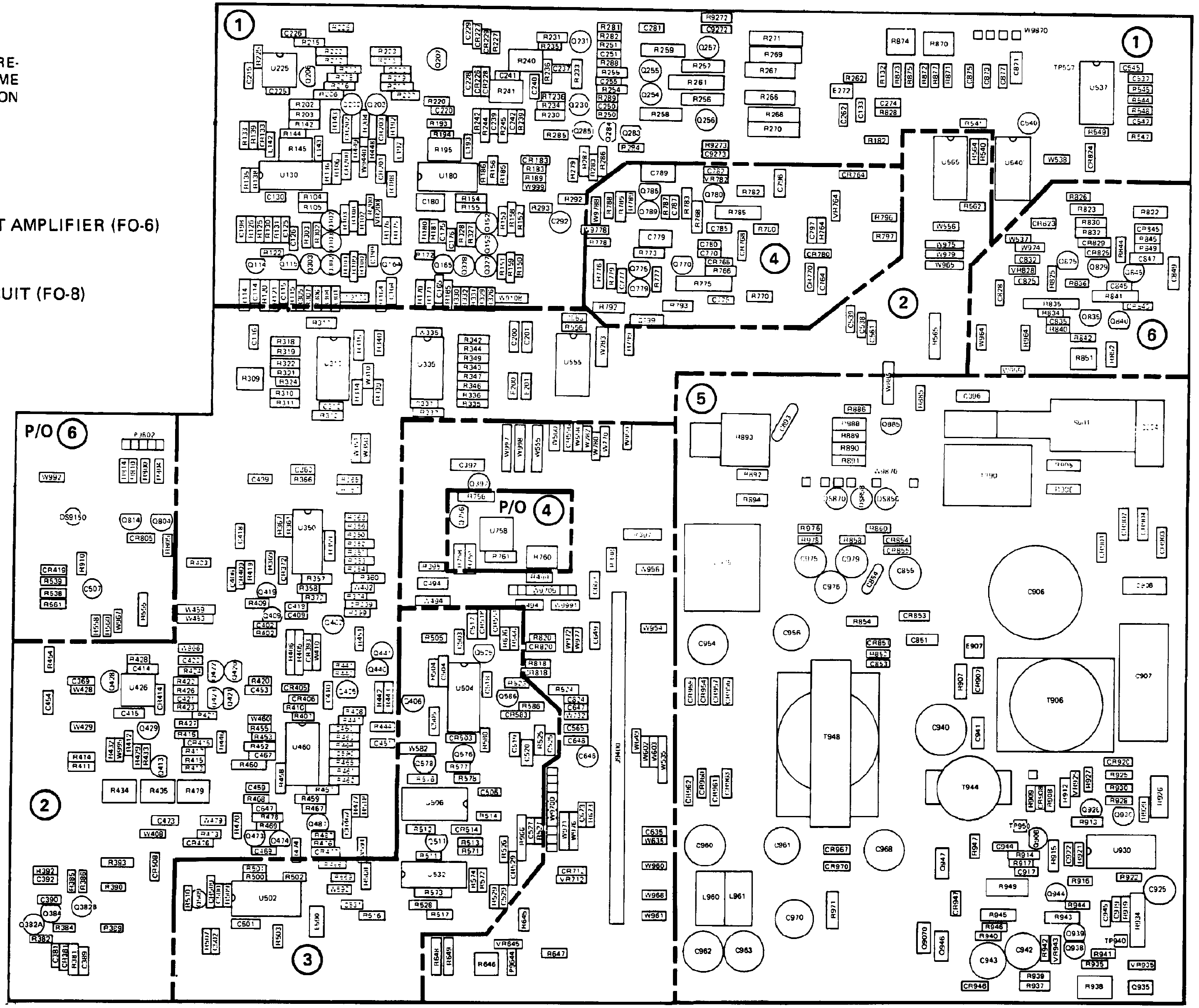

Figure FO-2. A1 Main Board Functional Blocks.

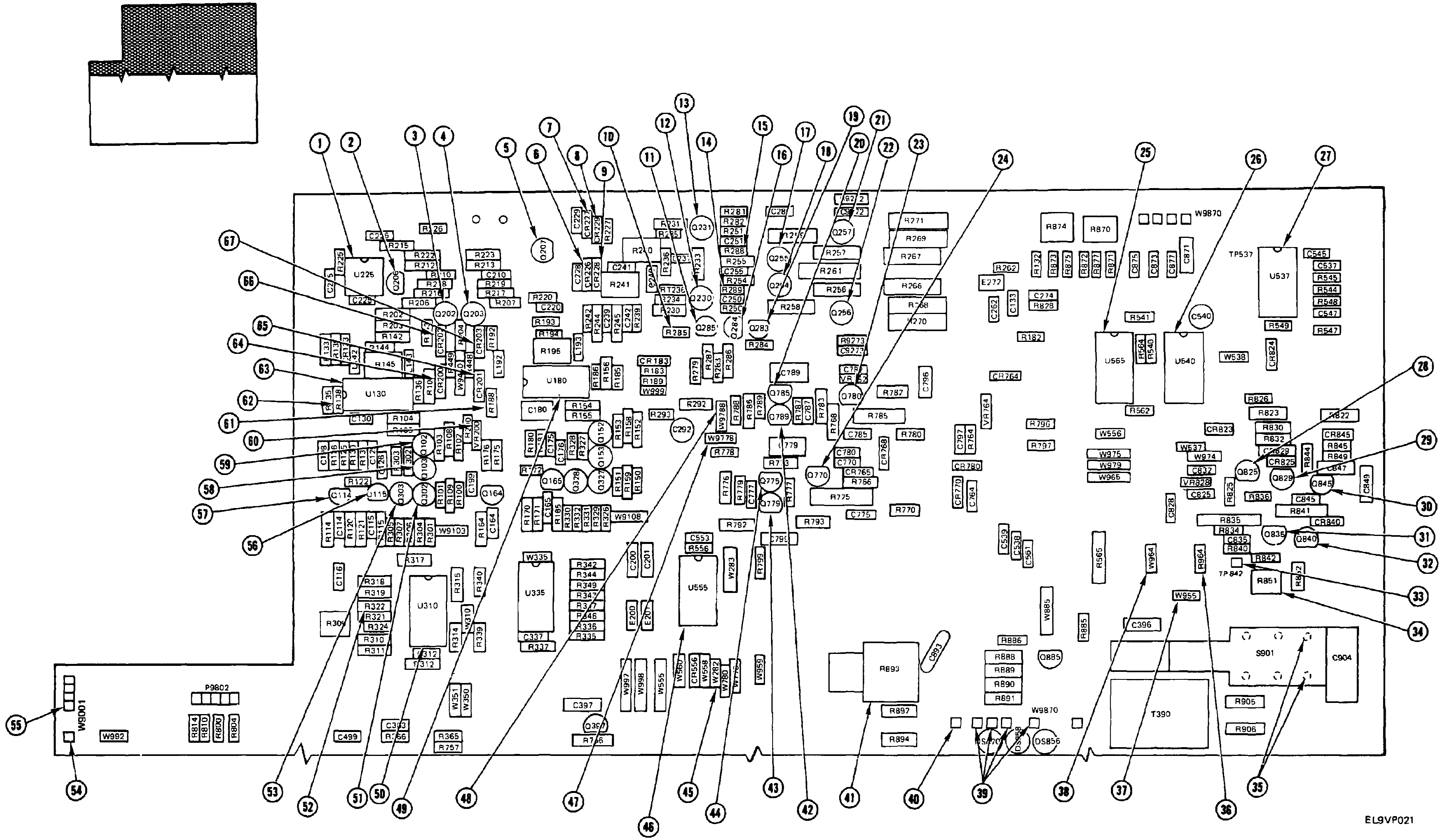

Figure FO-3. Troubleshooting Test Points
(Sheet 1 of 3)

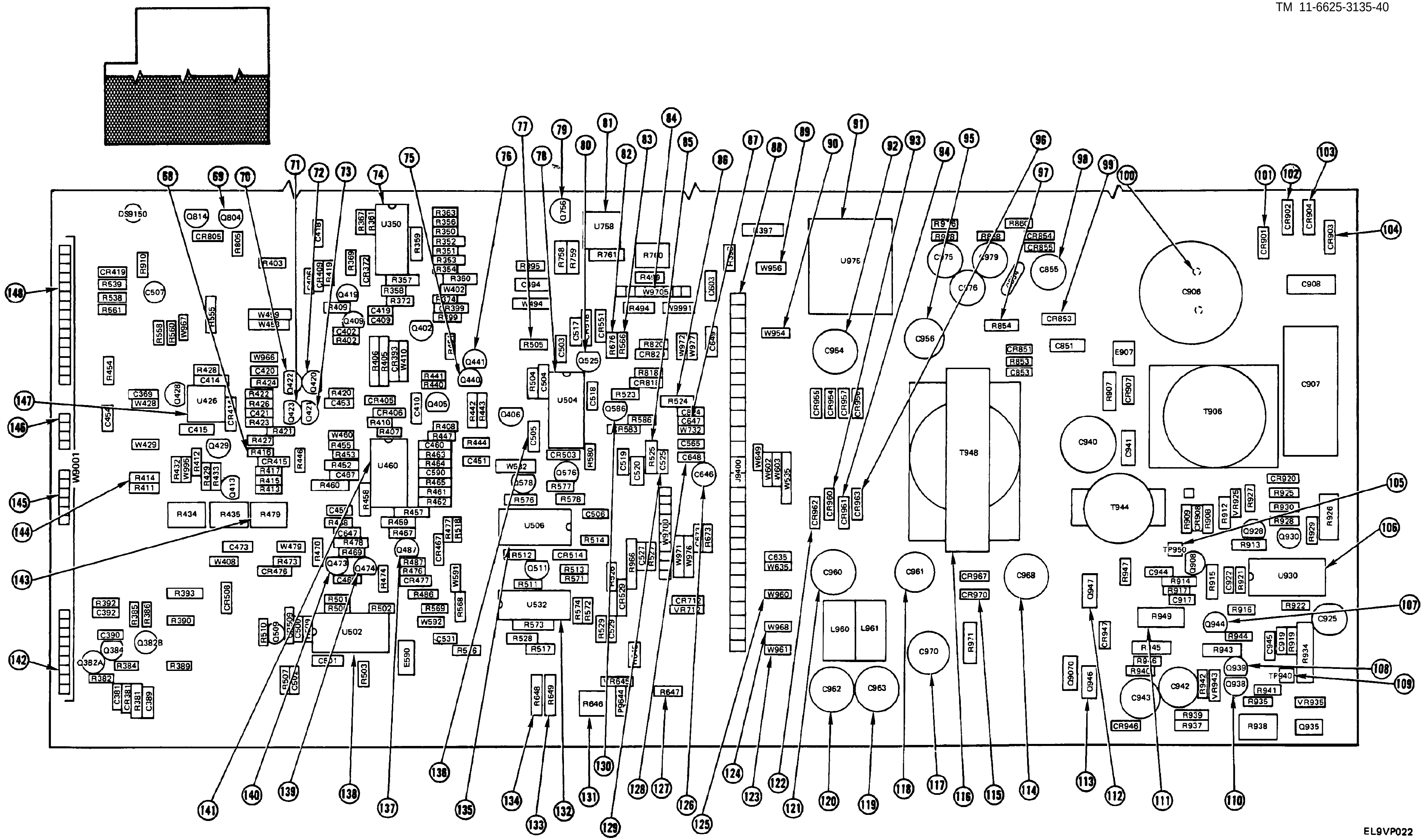

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Figure FO-3. Troubleshooting Test Points (Sheet 2 of 3).

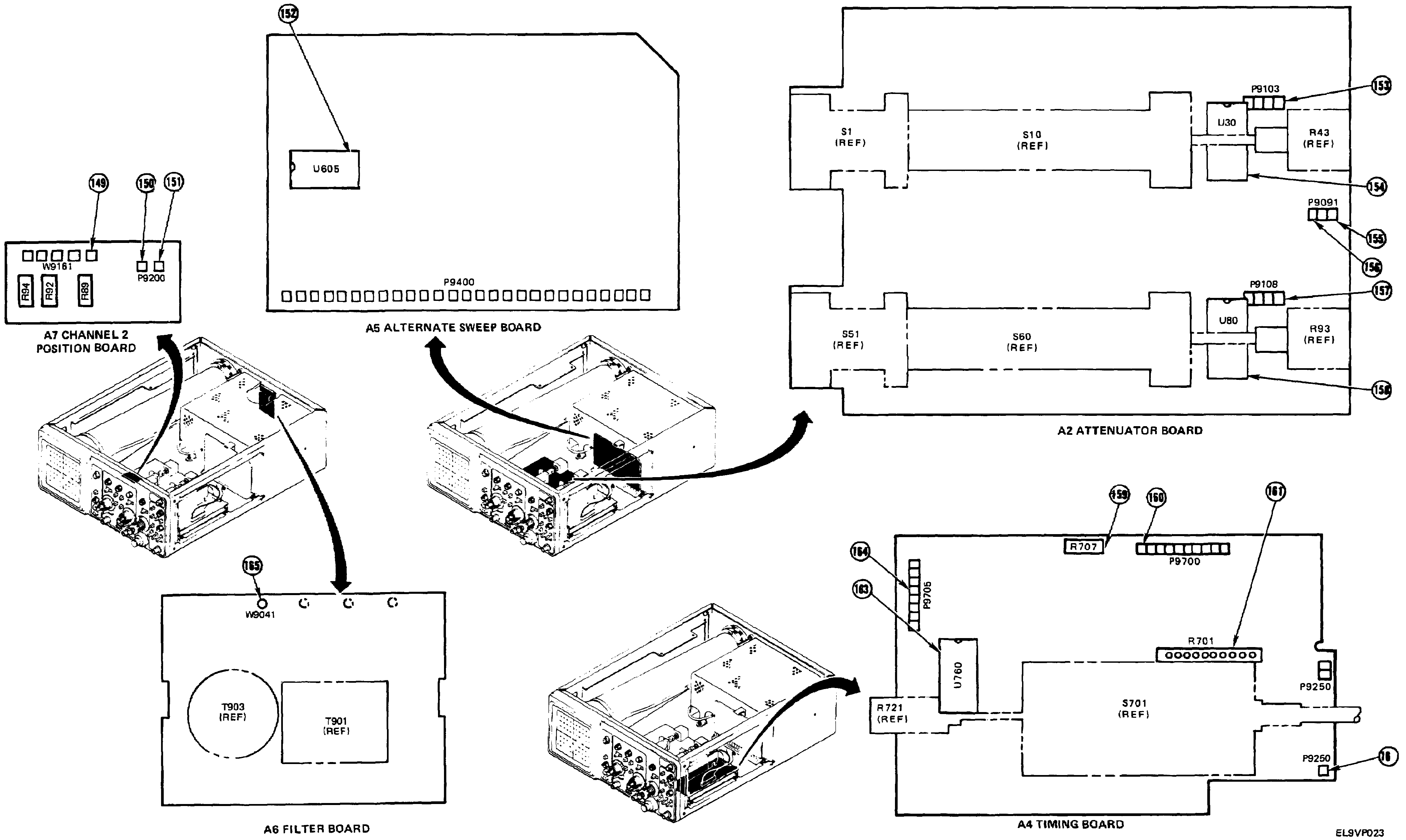

Figure FO-3. Troubleshooting Test Points
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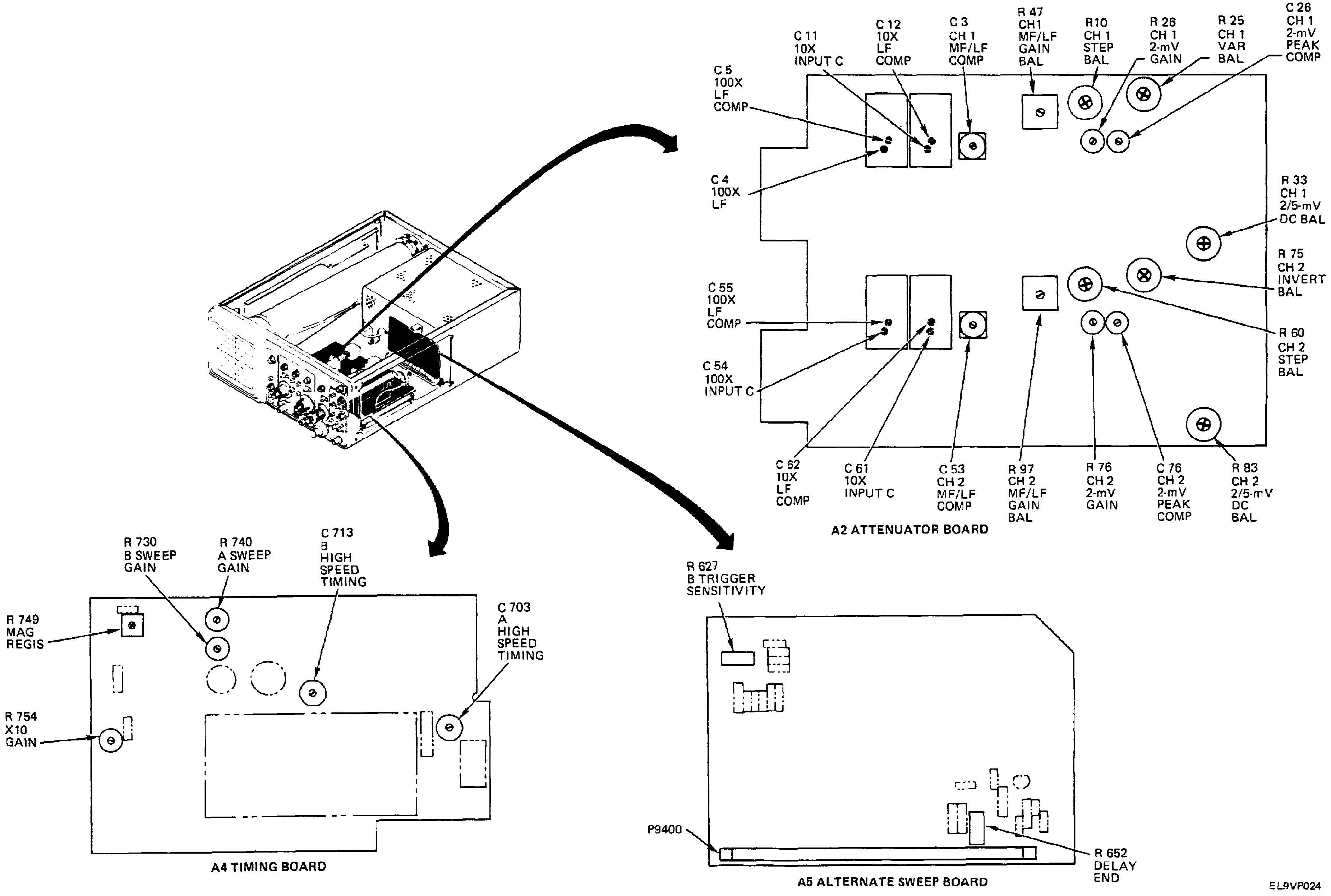


Figure FO-4. Adjustment Points (Sheet 1 of 2).

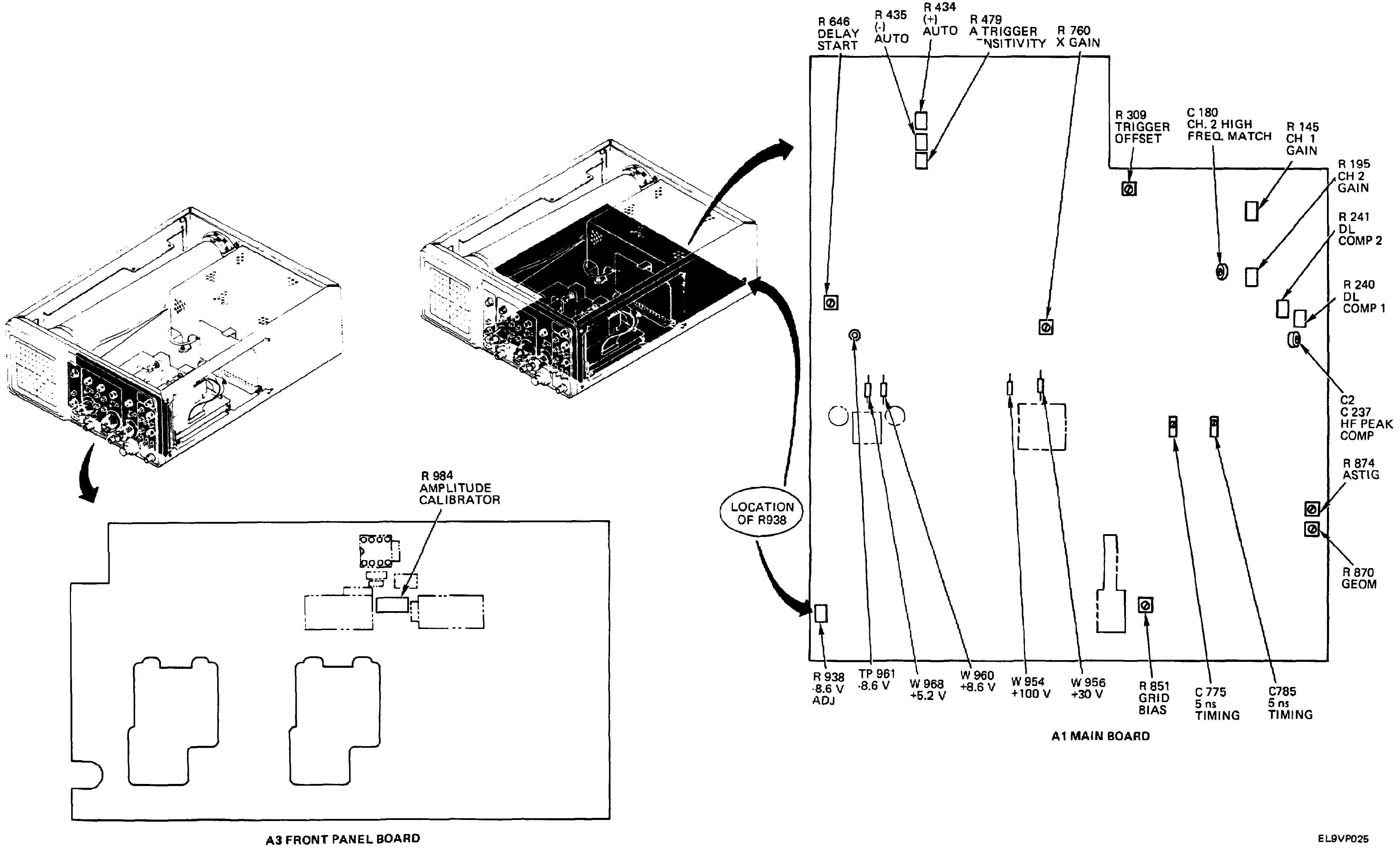


Figure FO-4. Adjustment Points (Sheet 2 of 2)

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.

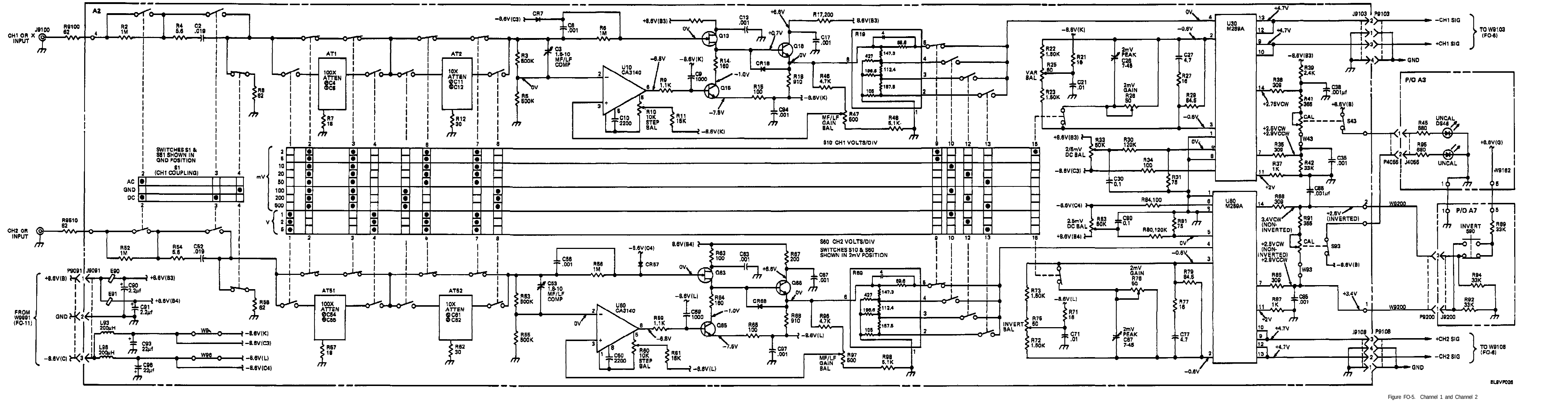
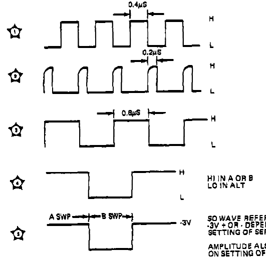


Figure FO-5. Channel 1 and Channel 2 Attenuators Schematic Diagram.

CONTROL SETTINGS

DC VOLTAGES	
INPUT COUPLING (BOTH)	GND
VOLTS/DIV (BOTH)	0.1V
AC WAVEFORMS	
VERTICAL MODE	BOTH, CHOP
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.

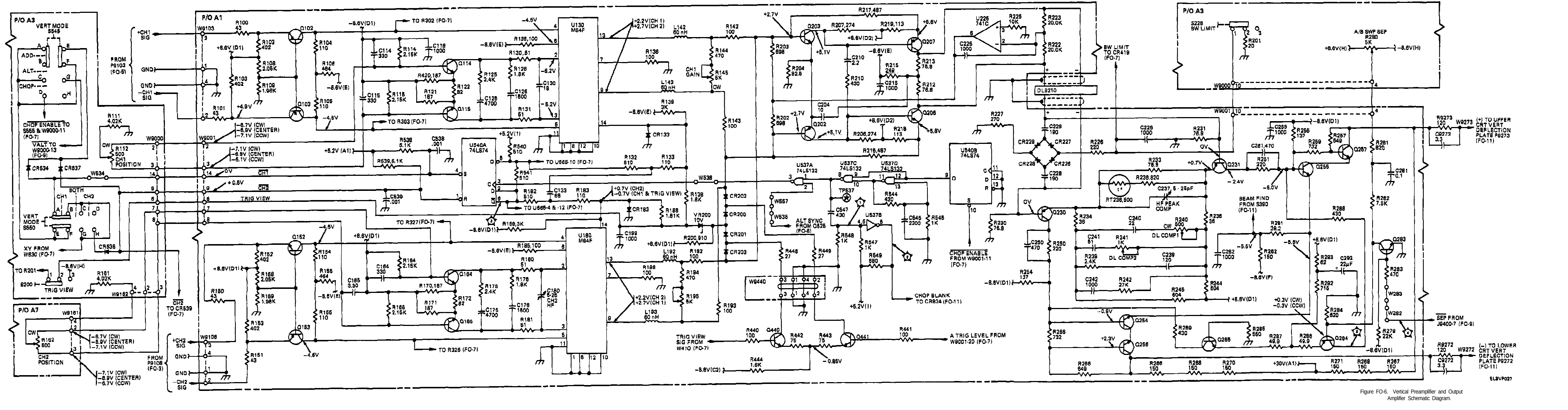


Figure FO-6. Vertical Preamplifier and Output Amplifier Schematic Diagram.

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.

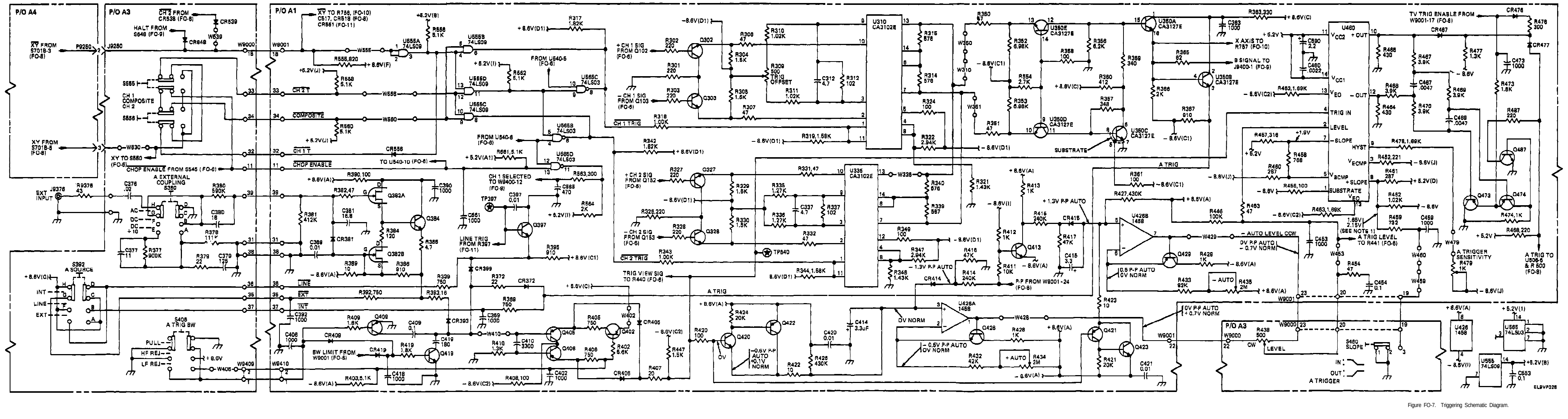
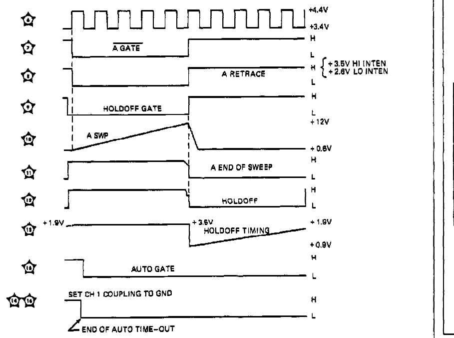


Figure FO-7. Triggering Schematic Diagram.

CONTROL SETTINGS

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



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.

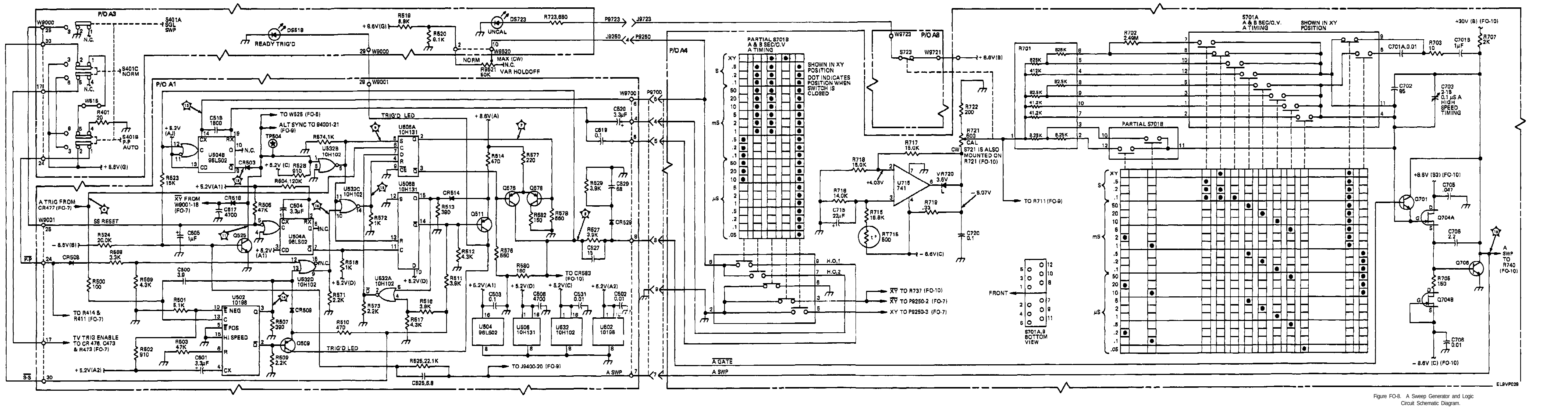


Figure FO-8. A Sweep Generator and Logic Circuit Schematic Diagram.

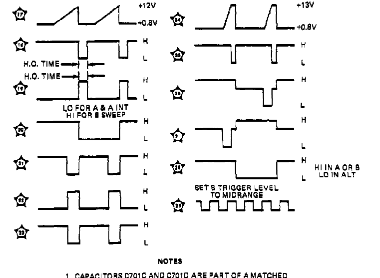
CONTROL SETTINGS

DC VOLTAGES

INPUT COUPLING (BOTH)	GND
A TRIGGER MODE	NORM (SWEEP NOT RUNNING)

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 BW	FULL
A SOURCE	INT
CH 1 INPUT SIGNAL	1-kHz SINE WAVE, 5 DIV.



NOTES

1. CAPACITORS C701C AND C701D ARE PART OF A MATCHED SET. C701A AND C701B ARE SHOWN ON FO-8.
2. WITH SLOPE SWITCH S602 IN (↘), LEVEL IS 1.65V. WITH S602 OUT (↗), LEVEL IS 2.15V.
3. CAPACITOR VALUES GREATER THAN ONE ARE EXPRESSED IN PICOFARADS (pF); VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (μF) UNLESS OTHERWISE NOTED.
4. RESISTOR VALUES ARE EXPRESSED IN OHMS.

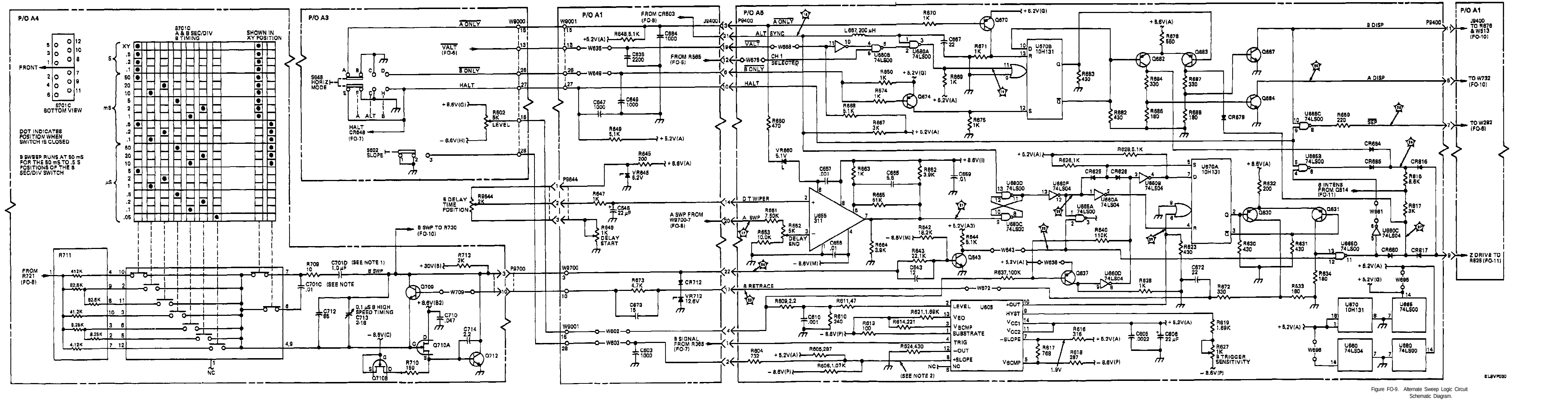


Figure FO-9. Alternate Sweep Logic Circuit Schematic Diagram.

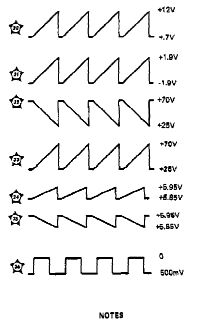
CONTROL SETTINGS

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.

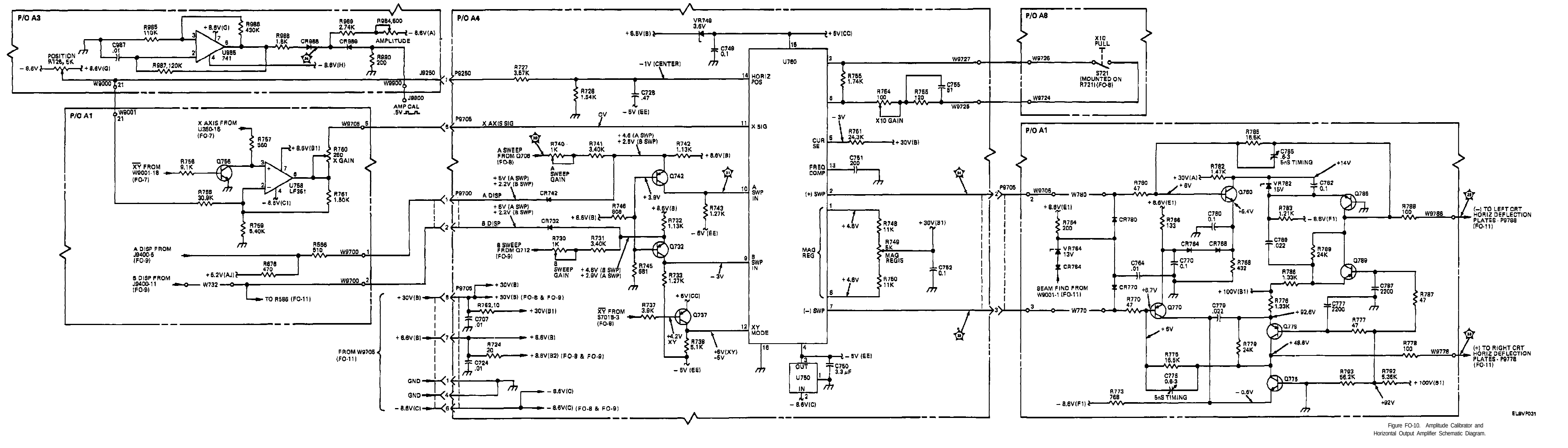


Figure FO-10. Amplitude Calibrator and Horizontal Output Amplifier Schematic Diagram.

WARNING

SOURCE AC POTENTIAL IS PRESENT ON THE POWER SUPPLY INVERTER 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 PICOFARADS (pF); VALUES LESS THAN ONE ARE EXPRESSED IN MICROFARADS (µF) UNLESS OTHERWISE NOTED.
4. RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE NOTED.

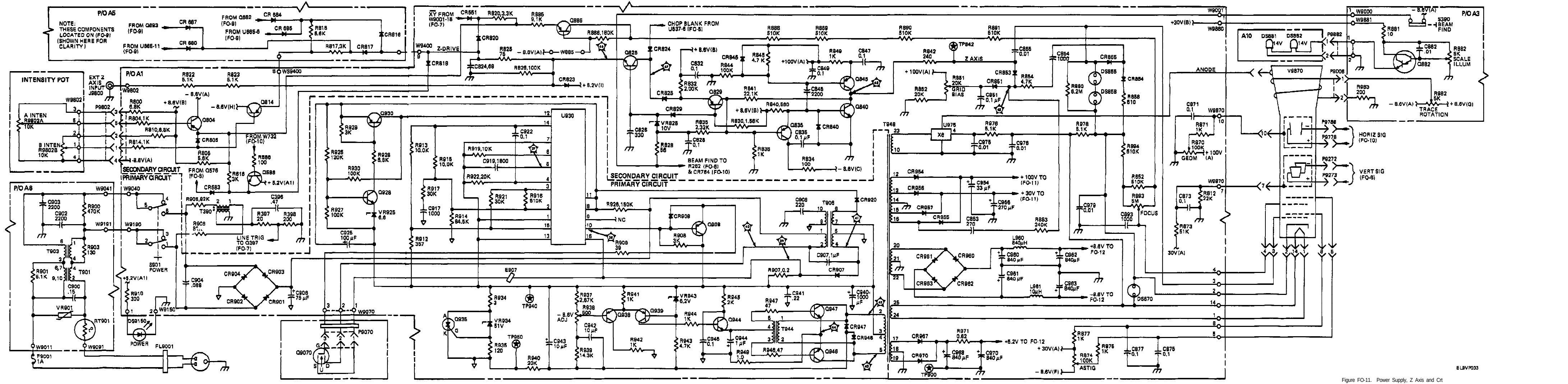
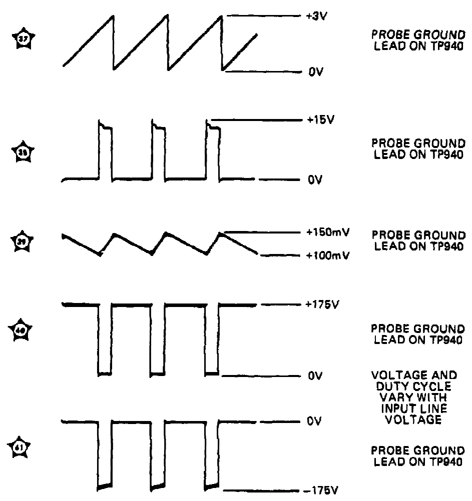


Figure FO-11. Power Supply, Z Axis and Crt Circuits Schematic Diagram and Waveforms (Sheet 1 of 2).

CONTROL SETTINGS



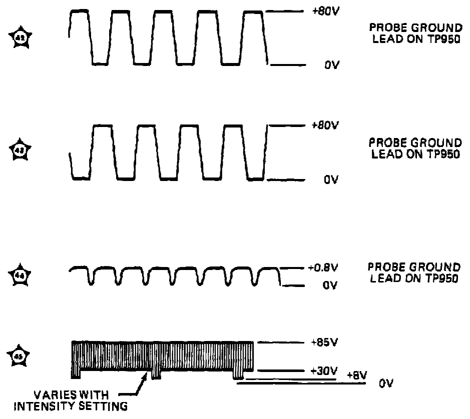
AC WAVEFORMS

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.

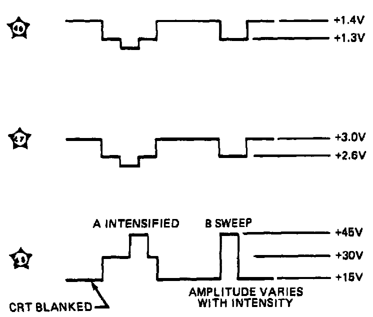
DC VOLTAGES

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 BW	FULL
A SOURCE	INT
CH 1 INPUT SIGNAL	1-kHz SINE WAVE, 5 DIV.



ELSVP032

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.

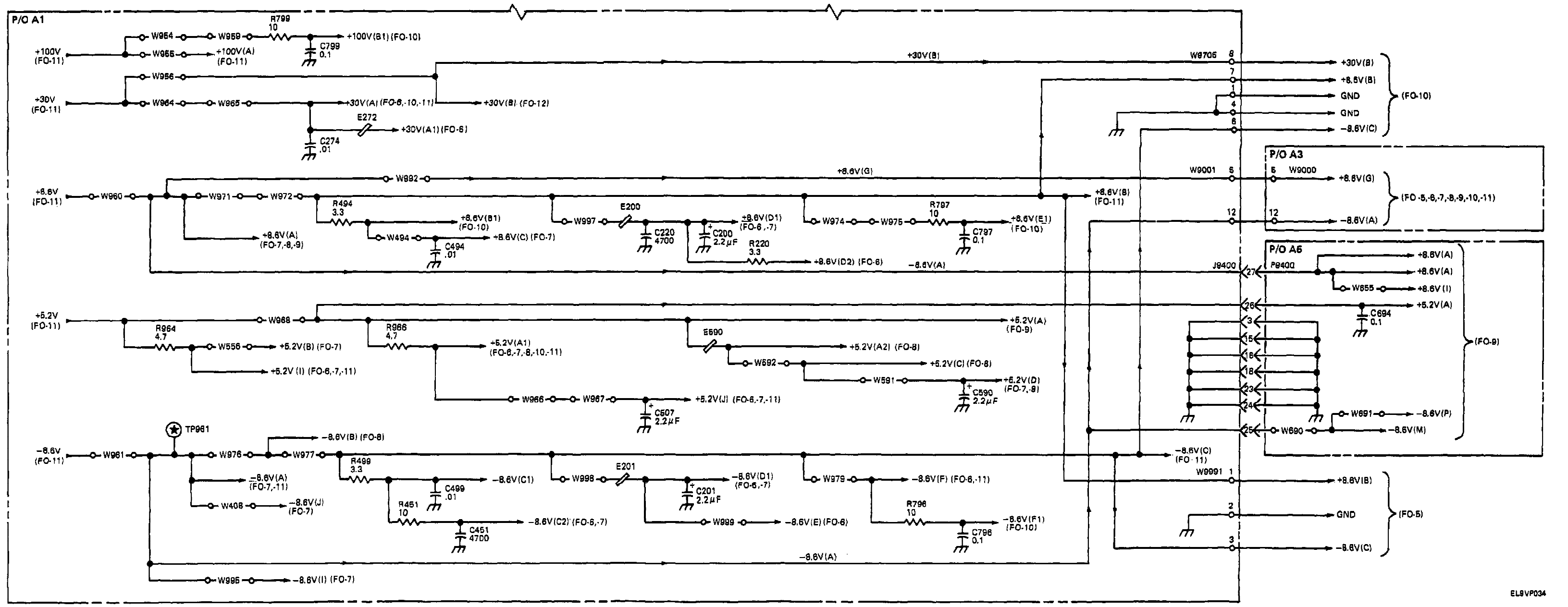


Figure FO-12. Power Supply Distribution Schematic Diagram.

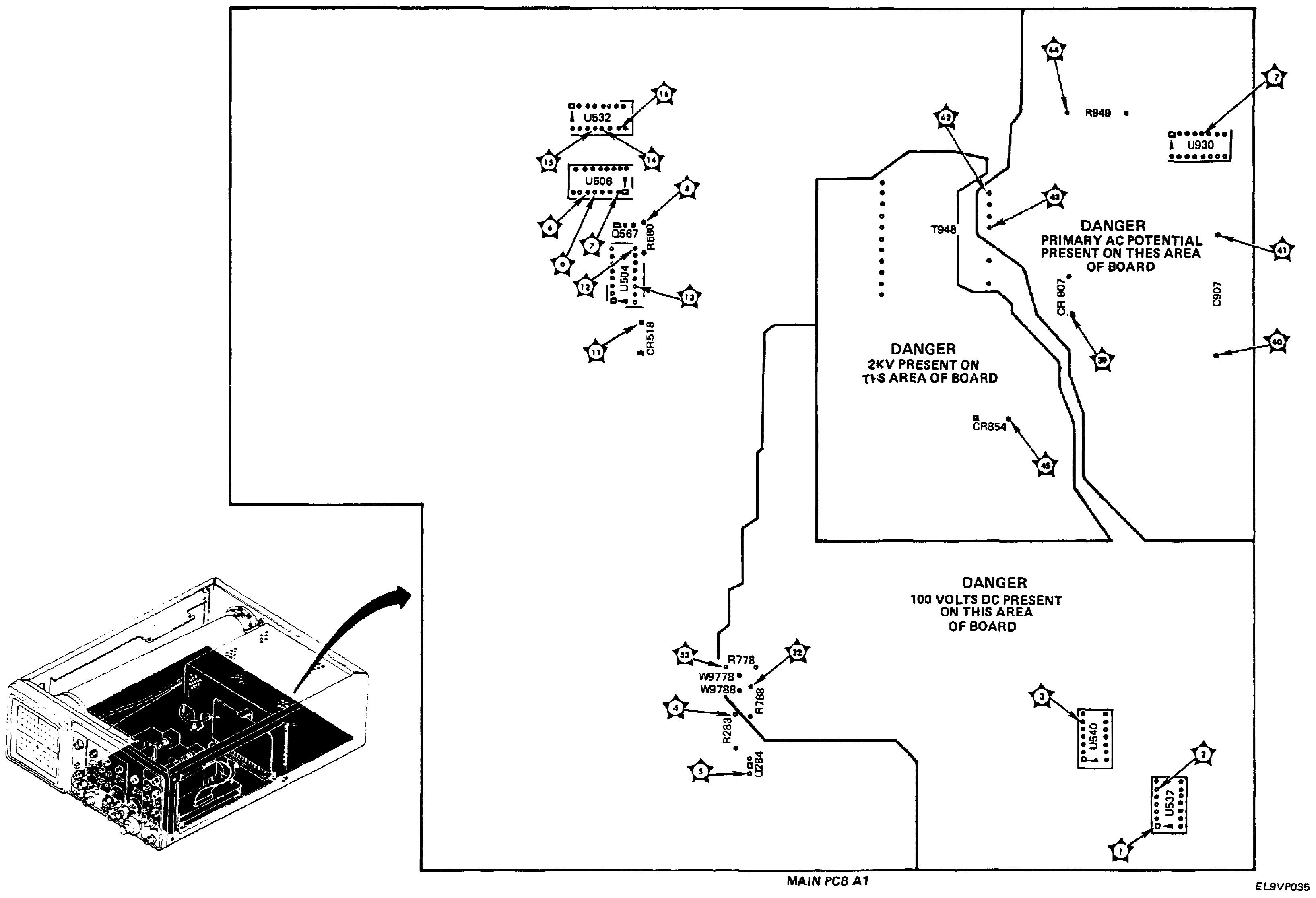


Figure FO-13. Waveform Test Point Locations
(Sheet 1 of 2).

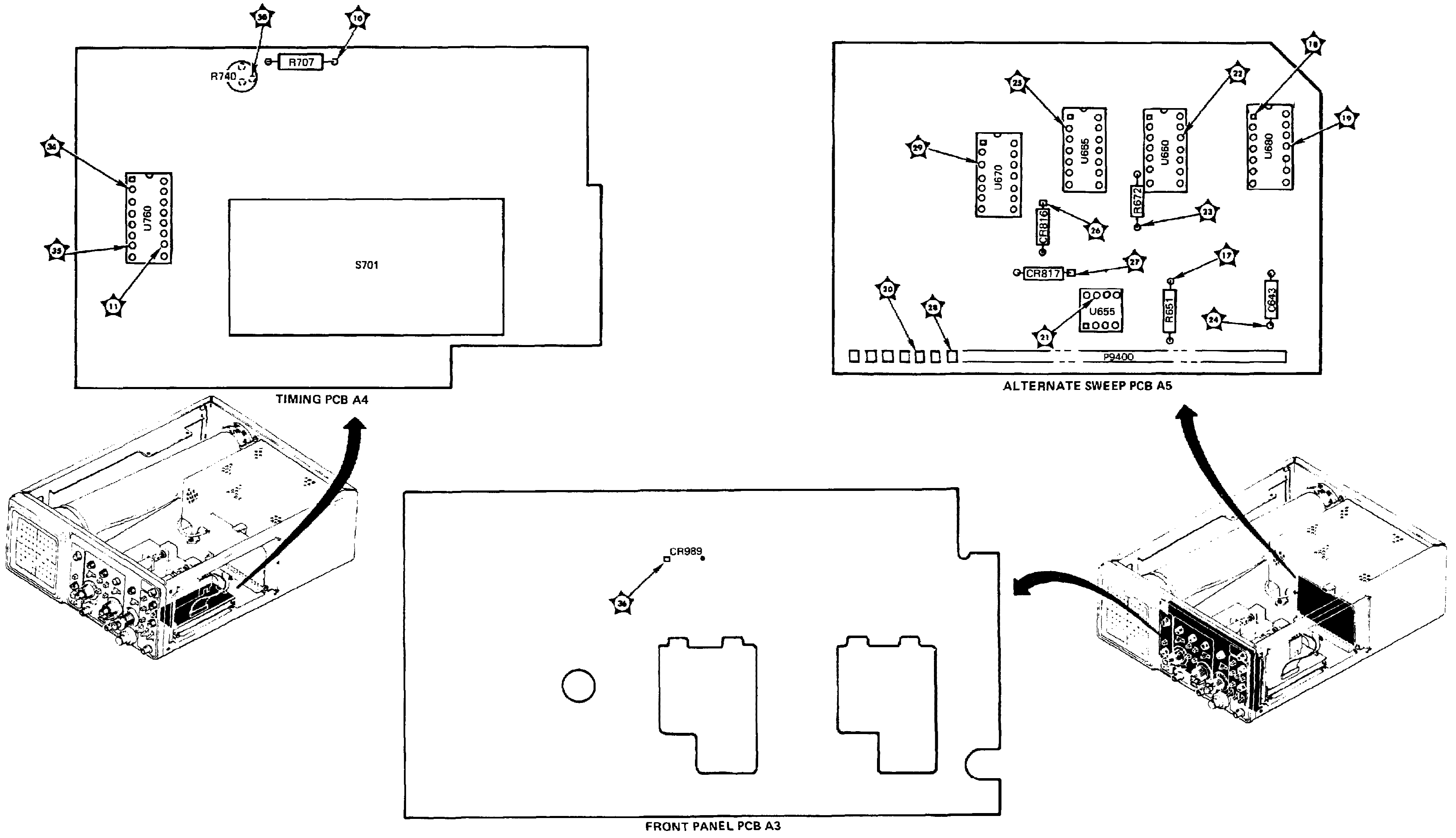


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Figure FO-13. Waveform Test Point Locations
(Sheet 2 of 2)

*TB 9-6625-2139-35

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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-488 AND TEKTRONIX, TYPE 2235

Headquarters, Department of the Army, Washington, DC
27 September 1993

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*This bulletins supersedes TB 9-6625-2139-35, dated 26 September 1990.

SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope AN/USM-488 and Tektronix, Type 2235. The manufacturer's manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are listed in text.

b. Time and Technique. The time required for this calibration is approximately 2 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. Adjustments to be reported are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Vertical	
Deflection	Range: 2 mV/div to 5 V/div Accuracy: ±2%
Bandwidth	Range: 2 mVldiv Accuracy: Dc to at least 90 MHz Range: 5 mV/div to 5 V/div Accuracy: Dc to at least 100 MHz
Aberrations	Range: 2 mV/div to 0.5 V/div Accuracy: +4%, -4%, 4% p-p
horizontal	
A sweep timing	Range: 0.5 s/div to 0.05 µs/div Accuracy: ±2% Range: (Xl0 mag): 50 ms/div to 5 ns/div Accuracy: ±3%
B sweep timing	Range: 50 ms/div to 0.05 µs/div Accuracy: ±2% Range: (Xl0 mag): 5 ms/div to 5 ns/div Accuracy: ±3%
Sweep linearity	Accuracy: ±5% (measured over any 2 of the center 8 divisions)
Deflection (X-Axis)	Range: 2 mV/div to 5 V/div Accuracy: ±3%

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications			
A trigger sensitivity	Frequency	10 MHz	60 MHz	100 MHz
	Internal	0.35 div[1]	1.0 div	1.5 div
	External	35 mV	120 mV	150 mV[2]
B trigger sensitivity	Internal only	0.35 div	1.0 div	1.5 div
Calibrator amplitude	Range: 0.5 V Accuracy: ±2%[3]			

[1]0.3 division for type 2235.
[2]200 mV for type 2235.
[3]±5% for type 2235.

SECTION II
Equipment Requriements

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories required for this calibration are common usage accessories issued as indicated in **4** above, and are not listed in this calibration procedure. The following peculiar accessories are also required for this calibration: Standardizer, 5-80 pF, APN 7916146, and Comparator, Tektronix, Type 015-0310-01.

Table 2. Minimun Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
DIGITAL MULTIMETER	Range: -8.64 to <0.1 V dc Accuracy: ±0.12%	John Fluke, Model 8840A/AF-05/09 (AN/GSM-64D)
OSCILLOSCOPE CALIBRATION WORKSTATION	Volts out: Range: 10 mV to 20 V Accuracy: ±0.5% Time markers: Range: 5 ns/D to 0.5 s/D Accuracy: ±0.5% Sine wave frequency: Range: 50 kHz to >100 MHz	(MIS-38938) consisting of: Tektronix, Type 1 (F7529A1) (MIS-38938 Type1); Tektronix, Type II (F7529A2) MIS-38938 Type II); calibration generator, Tektronix, Type CG5011 (CG5011), pulse head, Tektronix, Type 015-0611-00 (015-0611-00); leveled sine wave generator, Tektronix, Type SG5030 (SG5030); w/leveling head, Tektronix, Type 015-2350-01 (015-2350-01)

SECTION III
CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs **6** and **7** are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.

c. Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.

d. When indications specified in paragraphs **8** through **11** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **7** through **11.** Do not perform power supply check if all other parameters are within tolerance.

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

7. Equipment Setup

WARNING

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

a. Remove protective cover from TI only when necessary to make adjustments. Replace cover after completing the adjustments.

b. Connect TI to a 115 V ac source.

c. Position controls as listed in (1) through (22) below:

(1) **A** and **B INTENSITY** controls fully ccw.

(2) **POSITION** controls to midrange.

(3) **CH 2 POSITION INVERT (PULL)** control to in position (AN/USM-488).

(4) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1.**

(5) **VERTICAL MODE TRIGGER SOURCE CH 1 and CH 2** pushbuttons pressed to **COMPOSITE** (AN/USM-488).

(6) **CH 1** and **CH 2 VOLTS/DIV CAL** controls fully cw to detent.

(7) **CH 2 INVERT** pushbutton to out position (type 2235).

(8) **CH 1** and **CH 2 AC GND DC** switches to **DC.**

(9) **BW LIMIT 20 MHz** pushbutton to out position.

(10) **HORIZONTAL MODE** switch to **A.**

(11) **A AND B SEC/DIV** switches to **.2 ms.**

(12) **X10 CAL** control fully cw and in position.

(13) **VAR HOLDOFF** control fully ccw to **NORM.**

(14) **B TRIGGER SLOPE** pushbutton to **OUT:⟋** .

(15) **B TRIGGER LEVEL** control fully cw.

(16) **A TRIGGER P-P AUTO** pushbutton to in position.

(17) **A TRIGGER NORM** pushbutton to out position.

(18) **A TRIGGER SLOPE** pushbutton to **OUT:** ⟋ .

(19) **A TRIGGER LEVEL** control to midrange.

(20) **A TRIGGER A TRIG BW** switch to **FULL** (ANA/USM-488).

(21) **A TRIGGER A&B INT** switch to **VERT MODE** (type 2235).

(22) **A TRIGGER A SOURCE** switch to **INT.**

d. Press **POWER** pushbutton to **ON** and allow at least 20 minutes for warm-up.

e. Adjust **A INTENSITY** and **FOCUS** controls for suitable viewing.

8. Vertical

a. Performance Check

(1) Connect oscilloscope calibration workstation calibration generator **OUTPUT** to TI **CH 1.**

(2) Set **CH 1 VOLTS/DIV** switch to **2m.**

(3) Position calibration generator controls for **AMPL MODE VOLT, VARIABLE ON** and a 10 mV, 1 kHz output.

(4) Adjust **A TRIGGER LEVEL** and **POSITION** controls, as necessary, to view waveform.

(5) Adjust calibration generator **VAR** control for 5 divisions of vertical deflection on T1. If calibration generator error readout does not indicate within ±2%, perform **b(1)** through (40) below.

(6) Repeat technique of (2) through (5) above for settings listed in table 3. If calibration generator error readout does not indicate within ±2%, perform **b(1)** through (40) below.

(7) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and repeat technique of (1) through (6) above for **CH 2.** If calibration generator error readout does not indicate within limits specified, perform **b(41)** through (80) below.

Table 3. Vertical Deflection

Test instrument **VOLTS/DIV** switch settings	Calibration generator output settings	Test instrument divisions of vertical deflection
5 m	20 mV	4
10 m	50 mV	5
20 m	.1 V	5
50 m	.2 V	4
.1	.5 V	5
.2	1 V	5
.5	2 V	4
1	5 V	5
2	10 V	5
5	20 V	4

(8) Position controls as listed in (a) through (c) below:

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1.**

(b) **CH 1** and **CH 2 VOLTS/DIV** switches to **2m.**

(c) **A AND B SEC/DIV** switches to .05 µs.

(9) Connect calibration generator **OUTPUT** to TI **CH 1** using an X10 attenuator and a **50Ω** feedthrough termination.

(10) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON, 1 MHz,** and 5 divisions of vertical deflection on TI.

(11) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line. If aberrations exceed 1 minor division positive or 1 minor division negative or 1 minor division peak to peak, perform **b(81)** through (95) below.

(12) Repeat technique of (10) and (11) above for **CH 1 VOLTS/DIV** settings **5 m** through **.2** (remove X10 attenuator at **20m).** If aberrations exceed 1 minor division positive or 1 minor division negative or 1 minor division peak to peak, perform **b(81)** through (95) below.

(13) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and repeat technique of (9) through (12) above for **CH 2.** If aberrations are not within limits specified, perform **b(81)** through (95) below.

(14) Position controls as listed in **(a)** through **(c)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) CH 1 and **CH 2 VOLTS/DIV** switches to **2m.**

(c) A AND B SEC/DIV switches to **20 µs.**

(15) Connect oscilloscope calibration workstation leveled sine wave generator leveling head to TI **CH 1** using a **50Ω** feedthrough termination.

(16) Position leveled sine wave generator frequency controls for 50 kHz and amplitude controls for 6 divisions of vertical defection on TI.

(17) Position leveled sine wave generator frequency controls for 4.2 divisions of vertical deflection on TI If leveled sine wave generator frequency is not 90 MHz or greater, perform **b(81**) through (95) below.

(18) Set **CH 1 VOLTS/DIV** switch to **5m** and repeat technique of (16) and (17) above. If leveled sine wave generator frequency is not 100 MHz or greater, perform **b(81)** through (95) below.

(19) Repeat technique of (18) above for **CH 1 VOLTS/DIV** switch settings **10m** through **.5.** If leveled sine wave generator frequency is not 100 MHz or greater for each setting, perform **b(81)** through (95) below.

(20) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and repeat technique of (15) through (19) above for **CH 2.**

b. Adjustments.

(1) Disconnect calibration generator **OUTPUT** from TI **CH 1.**

(2) **Set CH 1 AC GND DC** switch to **AC**.

(3) Set **CH 1 VOLTS/DIV** switch to **50m.**

(4) Adjust **CH 1 POSITION** control to position trace on center horizontal graticule line.

(5) Set **CH 1 VOLTS/DIV** switch to **5m.**

(6) Adjust RIO (fig. 1) to position trace on center horizontal graticule line.

(7) Repeat (3) through (6) above for minimum trace shift when setting **CH 1 VOLTS/DIV** switch from **50m** to **5m.**

(8) Adjust **CH 1 POSITION** control to position trace on center horizontal graticule line.

(9) Set **CH 1 VOLTS/DIV** switch to **2m.**

(10) Adjust R33 (fig. 1) to position trace on center horizontal graticule line.

(11) Set **CH 1 VOLTS/DIV** switch to **5m.**

(12) Repeat (8) through (11) above for minimum trace shift when setting **CH 1 VOLTS/DIV** switch from **5m** to **2m.**

(13) Connect calibration generator **OUTPUT** to TI **CH 1** using a **50Ω** feedthrough termination.

(14) Position controls as listed in **(a)** through **(c)** below:

(a) CH 1 VOLTS/DIV switch to **10m.**

(b) CH 1 AC GND DC switch to **DC.**

(c) A AND B SEC/DIV switches to **20 µs.**

(15) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON, 10 kHz,** and **5** divisions of vertical deflection on TI.

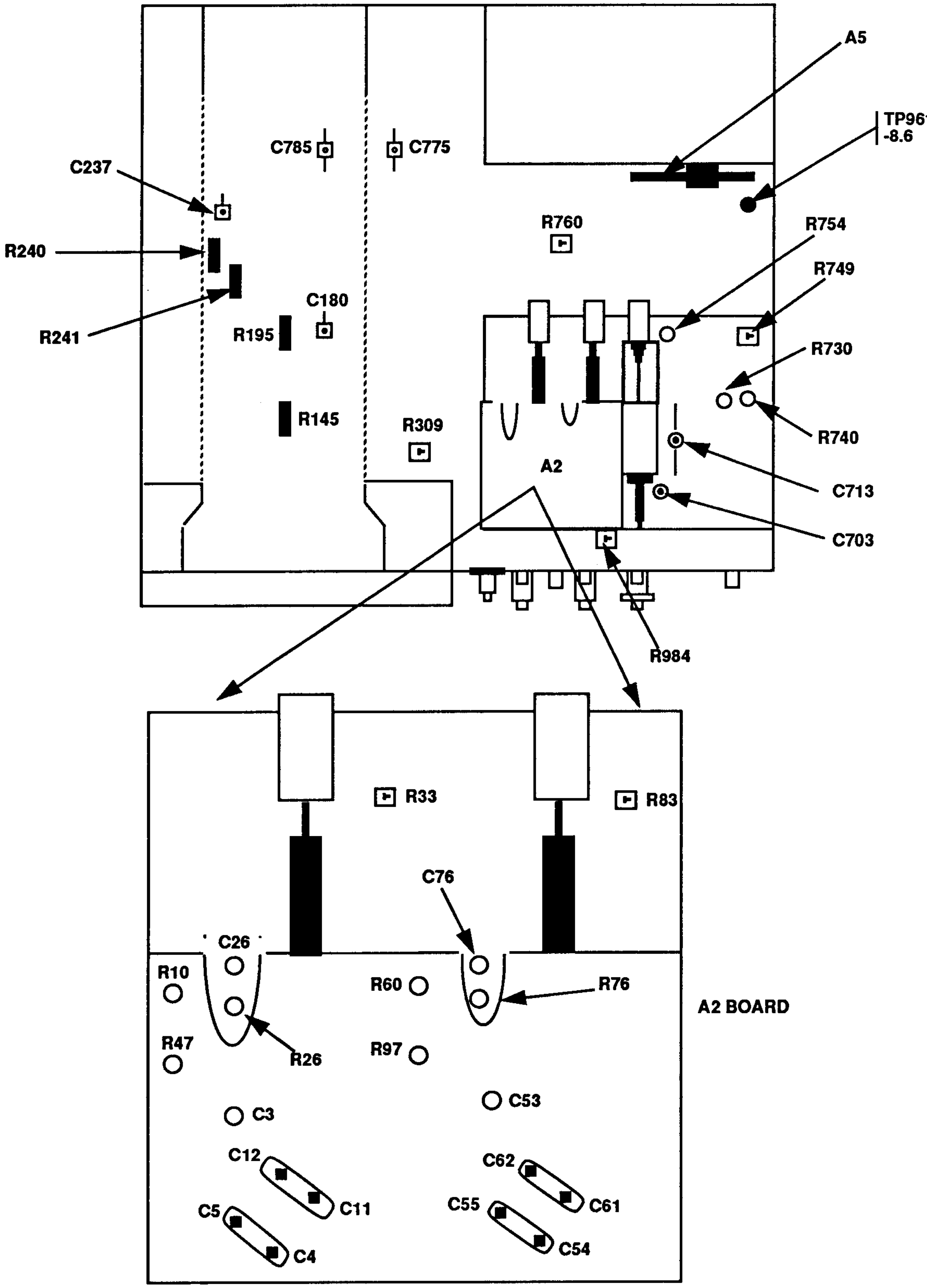

Figure 1. Adjustment locations - top view.

(16) Adjust **CH 1 POSITION** control to position top of waveform to the center horizontal graticule line.

(17) Adjust C3 (fig. 1) and R47 (fig. 1) for the best square corner and flat top.

(18) Remove 50Ω feedthrough feedthrough termination and connect calibration generator **OUTPUT** to TI **CH1.**

(19) Position calibration generator controls for **AMPL MODE VOLT, VARIABLE** ON to off, and a 10 mV, 1 kHz output.

(20) Position controls as listed in **(a)** through **(c)** below:

(a) CH 1 VOLTS/DIV switch to **2m.**

(b) A AND B SEC/DIV switches to **.2 ms.**

(c) CH 1 POSITION control to view waveform.

(21) Adjust R26 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(22) Set **CH 1 VOLTS/DIV** switch to **10m.**

(23) Position calibration generator controls for a 50 mV output.

(24) Adjust R145 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(25) Connect calibration generator **OUTPUT** to TI **CH 1** using a 5-80 pF standardizer.

(26) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON, 1 kHz,** and 5 divisions of vertical defection on Tl.

(27) Adjust 5-80 pF standardizer for optimum square wave.

(28) Set **CH 1 VOLTS/DIV** switch to 1.

(29) Replace 5-80 pF standardizer with a 50f2feedthrough termination.

(30) Position calibration generator controls for 5 divisions of vertical deflection on Tl.

(31) Adjust C12 (fig. 1) for best front corner.

(32) Replace 50Ω feedthrough termination with a 5-80 pF standardizer and repeat (30) above.

(33) Adjust C11 (fig. 1) for best flat top.

(34) Repeat (29) through (33) above until no further improvement is noted.

(35) Set **CH 1 VOLTS/DIV** switch to 1.

(36) Remove 5-80 pF standardizer and connect calibration generator **OUTPUT** to TI **CH 1.** Repeat (30) above.

(37) Adjust C5 (fig. 1) for best front corner.

(38) Connect calibration generator **OUTPUT** to TI **CH 1** using a 5-80 pF standardizer and repeat (30) above.

(39) Adjust C4 (fig. 1) for best flat top.

(40) Repeat (36) through (39) above until no further improvement is noted.

(41) Disconnect calibration generator **OUTPUT** from TI **CH 2.**

(42) Set **CH 2 AC GND DC** switch to **AC.**

(43) Set **CH 2 VOLTS/DIV** switch to **50m.**

(44) Adjust **CH 2 POSITION** control to position trace on center horizontal graticule line.

(45) Set **CH 2 VOLTS/DIV** switch to **5m.**

(46) Adjust R60 (fig. 1) to position trace on center horizontal graticule line.

(47) Repeat (43) through (46) above for minimum trace shift when setting **CH 2 VOLTS/DIV** switch from **50m** to **5m.**

(48) Adjust **CH 2 POSITION** control to position trace on center horizontal graticule line.

(49) Set **CH 2 VOLTS/DIV** switch to **2m.**

(50) Adjust R83 (fig. 1) to position trace on center horizontal graticule line.

(51) Set **CH 2 VOLTS/DIV** switch to **5m.**

(52) Repeat (48) through (51) above for minimum trace shift when setting **CH 2 VOLTS/DIV** switch from **5m** to **2m.**

(53) Connect calibration generator **OUTPUT** to TI **CH 2** using a 50Ω feedthrough termination.

(54) Position controls as listed in **(a)** through **(c)** below:

(a) CH 2 VOLTS/DIV switch to **10m.**

(b) CH 2 AC GND DC switch to **DC.**

(c) A AND B SEC/DIV switches to **20 µs.**

(55) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON, 10 kHz,** and 5 divisions of vertical deflection on TI.

(56) Adjust **CH 2 POSITION** control to position top of waveform to the center horizontal graticule line.

(57) Adjust C53 (fig. 1) and R97 (fig. 1) for the best square corner and flat top.

(58) Remove 50Ω feedthrough termination and connect calibration generator **OUTPUT** to TI **CH 2.**

(59) Position calibration generator controls for **AMPL MODE VOLT, VARIABLE ON** to off, and a 10 mV, 1 kHz output.

(60) Position controls as listed in **(a)** through **(c)** below:

(a) CH 2 VOLTS/DIV switch to **2m.**

(b) A AND B SEC/DIV switches to **.2 ms.**

(c) CH 2 POSITION control to view waveform.

(61) Adjust R76 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(62) Set **CH 2 VOLTS/DIV** switch to **10m.**

(63) Position calibration generator controls for a 50 mV output.

(64) Adjust R195 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(65) Connect calibration generator **OUTPUT** to TI **CH 2** using a 5-80 pF standardizer.

(66) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON,** 1 kHz, and 5 divisions of vertical defection on TI.

(67) Adjust 5-80 pF standardizer for optimum square wave.

(68) Set **CH 2 VOLTS/DIV** switch to **.1.**

(69) Replace 5-80 pF standardizer with a 50Ω feedthrough termination.

(70) Position calibration generator controls for 5 divisions of vertical deflection on TI.

(71) Adjust C62 (fig. 1) for best front corner.

(72) Replace the 50Ω feedthrough termination with a 5-80 pF standardizer and repeat (70) above.

(73) Adjust C61 (fig. 1) for best flat top.

(74) Repeat (69) through (73) above until no further improvement is noted.

(75) Set **CH 2 VOLTS/DIV** switch to **1.**

(76) Remove 5-80 pF standardizer and connect calibration generator **OUTPUT** to TI **CH 2.** Repeat (70) above.

(77) Adjust C55 (fig. 1) for best front corner.

(78) Connect calibration generator **OUTPUT** to TI **CH 2** using a 5-80 pF standardizer and repeat (70) above.

(79) Adjust C54 (fig. 1) for best flat top.

(80) Repeat (76) through (79) above until no further improvement is noted.

(81) Position controls as listed in (a) through (c) below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) CH 1 and **CH 2 VOLTS/DIV** switches to **10m.**

(c) A AND B SEC/DIV switch to **.05 µs.**

(82) Connect calibration generator **OUTPUT** to TI **CH 1** using a X10 attenuator and a **50Ω** feedthrough termination.

(83) Position calibration generator controls for **AMPL MODE EDGE, VARIABLE ON, 1 MHz,** and 5 divisions of vertical deflection on TI.

(84) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line.

(85) Adjust C237 (fig. 1) for minimum overshoot and R240 (fig. 1) and R241 (fig. 1) for best flat top on front corner of waveform (R).

(86) Set **CH 1 VOLTS/DIV** switch to **2m.**

(87) Position calibration generator controls for 5 divisions of vertical deflection on TI.

(88) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line.

(89) Adjust C26 (fig. 1) for minimum overshoot on waveform (R).

(90) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and repeat technique of (82) through (84) above for **CH 2.**

(91) Adjust C180 (fig. 1) for minimum overshoot on displayed waveform (R).

(92) Set **CH 2 VOLTS/DIV** switch to **2m.**

(93) Position calibration generator controls for 5 divisions of vertical deflection on TI.

(94) Adjust **CH 2 POSITION** control to position top of waveform to center horizontal graticule line.

(95) Adjust C76 (fig. 1) for minimum overshoot on waveform (R).

9. Horizontal

a. Performance Check

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

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) CH 1 VOLTS/DIV switch to **.5.**

(c) A AND B SEC/DIV switches to **.05 µs.**

(d) B DELAY TIME POSITION control fully ccw.

(e) B TRIGGER LEVEL control fully cw.

(f) A TRIGGER NORM pushbutton pressed.

(2) Connect calibration generator **OUTPUT** to TI **CH 1** using a **50Ω** feedthrough termination.

(3) Position calibration generator controls for **MARKERS, VARIABLE ON,** and 50 nS/D output.

(4) Adjust **A TRIGGER LEVEL, A INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(5) Adjust horizontal **POSITION** control to aline 2d time marker with 2d vertical graticule line.

(6) Adjust calibration generator **VAR** control to aline 10th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±2% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

(7) Repeat technique of (3) through (6) for settings listed in table 4. If calibration generator error readout indication is not within ±2% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

Table 4. A Sweep TIming

Test instrument **A AND B SEC/DIV** switch settings	Calibration generator output settings
.1 µs	.1 µS/D
.2 µs	.2 µS/D
.5 µs	.5 µS/D
1 µs	1 µS/D
2 µs	2 µS/D
5 µs	5 µS/D
10 µs	10 µS/D
20 µs	20 µS/D
50 µs	50 µS/D
.1 ms	.1 mS/D
.2 ms	.2 mS/D
.5 ms	.5 mS/D
1 ms	1 mS/D
2 ms	2 mS/D
5 ms	5 mS/D
10 ms	10 mS/D
20 ms	20 mS/D
50 ms	50 mS/D
.1 sec A ONLY	.1 S/D
.2 sec A ONLY	.2 S/D
.5 sec A ONLY	.5 S/D

(8) Set **A AND B SEC/DIV** switches to **.05** µs and pull **XIO CAL** control to out position.

(9) Position calibration generator controls for 10nS/D output.

(10) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2d vertical graticule line.

(11) Adjust calibration generator **VAR** control to aline the 5th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±3%. and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

(12) Set **A AND B SEC/DIV** switches to **.1 µs.** Repeat (4) above.

(13) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2d vertical graticule line.

(14) Adjust calibration generator **VAR** control to aline the 10th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±3%. and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

(15) Repeat technique of (12) through (14) above for settings listed in table 5. If calibration generator readout indications are not within ±3% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

Table 5. A Sweep X10 Mag TIming

Test instrument **A AND B SEC/DIV** switch settings	Calibration generator output settings
.2 µs	20 nS/D
.5 µs	50 nS/D
1 µs	.1 µS/D
2 µs	.2 µS/D
5 µs	.5 µS/D
10 µs	1 µS/D
20 µs	2 µS/D
50 µs	5 µS/D
.1 ms	10 µS/D
.2 ms	20 µS/D
.5 ms	50 µS/D

Table 5. A Sweep X10 Mag Timing - Continued

Test instrument **A AND B SEC/DIV** switch settings	Calibration generator output settings
1 ms	.1 mS/D
2 ms	.2 mS/D
5 ms	.5 mS/D
10 ms	1 mS/D
20 ms	2 mS/D
50 ms	5 mS/D
.1 sec A ONLY	10 mS/D
.2 sec A ONLY	20 mS/D
.5 sec A ONLY	50 mS/D

(16) Position controls as listed in **(a)** through **(d)** below:

(a) HORIZONTAL MODE switch to **B.**

(b) A SEC/DIV switch to **.1 µs.**
(c) B SEC/DIV switch to **.05 µs.**
(d) X10 CAL control to in position.

(17) Position calibration generator controls for 50 nS/D output.

(18) Adjust **A** and **B TRIGGER LEVEL, B INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(19) Adjust horizontal **POSITION** control to aline 2d time marker with 2d vertical graticule line.

(20) Adjust calibration generator **VAR** control to aline 10th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±2% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

(21) Repeat technique of (16) through (20) for settings listed in table 6. If calibration generator error readout indication is not within ±2% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

Table 6. B Sweep Timing

Test instrument		Calibration generator output settings
A SEC/DIV switch settings	**B SEC/DIV** switch settings	
.2 µs	.1 µs	.1 µS/D
.5 µs	.2 µs	.2 µS/D
1 µs	.5 µs	.5 µS/D
2 µs	1 µs	1 µS/D
5 µs	2 µs	2 µS/D
10 µs	5 µs	5 µS/D
20 µs	10 µs	10. µS/D
50 µs	20 µs	20 µS/D
.1 ms	50 µs	50 µS/D
.2 ms	.1 ms	.1 mS/D
.5 ms	.2 ms	.2 mS/D
1 ms	.5 ms	.5 mS/D
2 ms	1 ms	1 mS/D
5 ms	2 ms	2 mS/D
10 ms	5 ms	5 mS/D
20 ms	10 ms	10 mS/D
50 ms	20 ms	20 mS/D
.1 sec A ONLY	50 ms	50 mS/D

(22) Position controls as listed in **(a)** through **(c)** below:

(a) A SEC/DIV switch to **.1 µs.**
(b) B SEC/DIV switch to **.05 µs.**
(c) XI O CAL control to out position.

(23) Position calibration generator controls for 10 nS/D output.

(24) Adjust **A** and **B TRIGGER LEVEL, B INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(25) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2d vertical graticule line.

(26) Adjust calibration generator **VAR** control to aline the 5th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±3% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

(27) Set **A SEC/DIV** switch to **.2µs** and **B SEC/DIV** switch to .1µs. Repeat (24) above.

(28) Adjust horizontal **POSITION** control to aline the first time marker that is 25 ns beyond start of sweep with the 2d vertical graticule line.

(29) Adjust calibration generator **VAR** control to aline the 10th time marker with 10th vertical graticule line. If calibration generator error readout indication is not within ±3% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform b(l) through (28) below.

(30) Repeat technique of (27) through (29) above for settings listed in table 7. If calibration generator readout indications are not within ±3% and linearity is not within 0.1 division over any 2 of the center 8 divisions, perform **b(1)** through (28) below.

Table 7. B Sweep X10O Mag Timing

Test instrument		Calibration generator output settings
A SEC/DIV switch settings	**B SEC/DIV** switch settings	
.5 µs	.2 µs	20 nS/D
1 µs	.5 µs	50 nS/D
2 µs	1 µs	.1 µS/D
5 µs	2 µs	.2 µS/D
10 µs	5 µs	.5 µS/D
20 µs	10 µs	1 µS/D
50 µs	20 µs	2 µS/D
.1 ms	50 µs	5 µS/D
.2 ms	.1 ms	10 µS/D
.5 ms	.2 ms	20 µS/D
1 ms	.5 ms	50 µS/D
2 ms	1 ms	.1 mS/D
5 ms	2 ms	.2 mS/D
10 ms	5 ms	.5 mS/D
20 ms	10 ms	1 mS/D
50 ms	20 ms	2 mS/D
.1 sec A ONLY	50 ms	5 mS/D

(31) Position controls as listed in (a) through (f) below:

(a) A SEC/DIV switch to **.5µs.**

(b) B SEC/DIV switch to **.05 µs.**

(c) Xl0 CAL control to in position.

(d) B DELAY TIME POSITION dial to **1.00.**

(e) B TRIGGER LEVEL control fully cw.

(f) A TRIGGER P-P AUTO pushbutton pressed.

(32) Position calibration generator controls for .5 µS/D output and **VARIABLE ON** to off.

(33) Adjust **A TRIGGER LEVEL, B INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(34) Adjust horizontal **POSITION** control to aline the first fully displayed time marker with the center vertical graticule line.

(35) Adjust **B DELAY TIME POSITION** dial to approximately 9.00 to aline time marker with the center vertical graticule line. If **B DELAY TIME POSITION** dial indication is not between 8.91 and 9.09, perform **b(29)** through (37) below.

(36) Repeat technique of (31) through (35) above for settings listed in table 8. If **B DELAY TIME POSITION** dial indication is not between 8.91 and 9.09 at each setting, perform **b(29)** through (37) below.

Table 8. B Delay Time Position Accuracy

Test instrument		Calibration generator output settings
A SEC/DIV switch settings	B SEC/DIV switch settings	
5 µs	.5 µs	5 µS/D
.5 ms	50 µs	.5 mS/D
5 ms	.5 ms	5 mS/D
.5 s	50 ms[1]	.5 S/`D

[1]Press **A TRIGGER NORM pushbutton.**

(37) Remove 50Ω feedthrough termination and connect calibration generator **OUTPUT** to TI **CH1.**

(38) Position controls as listed in **(a)** through **(d)** below:

(a) CH1 VOLTS/DIV switch to **10 m.**

(b) HORIZONTAL MODE switch to **A.**

(c) A AND B SEC/DIV switches to **X-Y.**

(d) A TRIGGER P-P AUTO pushbutton pressed.

(39) Position calibration generator controls for **AMPL MODE VOLT, VARIABLE ON,** and a 50 mV, 1 kHz output.

(40) Adjust **A INTENSITY** and **CH 2** and horizontal **POSITION** controls for suitable viewing.

(41) Adjust calibration generator **VAR** control for 5 divisions of horizontal display. If calibration generator error readout indication is not within ±3%, perform **b(38)** and (39) below.

b. Adjustments.

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

(a) HORIZONTAL MODE switch to **A.**

(b) A AND B SEC/DIV switches to **.1 ms.**

(c) Xl0 CAL control to in position.

(2) Position calibration generator controls for .1 mS/D output and **VARIABLE ON** to off.

(3) Adjust horizontal **POSITION** control to aline 1st time marker with the 1st (extreme left) vertical graticule line.

(4) Adjust R740 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(5) Set **HORIZONTAL MODE** switch to B and adjust B **INTENSITY** control for suitable viewing. Adjust horizontal **POSITION** control to aline 1st time marker with 1st vertical gratical line.

(6) Adjust R730 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(7) Set **HORIZONTAL MODE** switch to **A** and pull **Xl0 CAL** control to out position.

(8) Position calibration generator controls for 10 µS/D output.

(9) Adjust horizontal **POSITION** control to aline the nearest time marker to the 1st vertical graticule line with the 1st vertical graticule line.

(10) Adjust R754 (fig. 1) for 1 time marker per division (R).

(11) Set **A AND B SEC/DIV** switches to **.2 ms.**

(12) Position calibration generator controls for 1 mS/D output.

(13) Adjust horizontal **POSITION** control to position middle time marker to center vertical graticule line.

(14) Push **X10 CAL** control to in position.

(15) Adjust R749 (fig. 1) to position the middle time marker to the center vertical graticule line.

(16) Pull **X10 CAL** control to out position and check for no horizontal shift in time marker.

(17) Repeat (13) through (16) above until no further improvement is noted.

(18) Set **A AND B SEC/DIV** switches to **.1 µs** and push **X10 CAL** control to in position.

(19) Position calibration generator controls for .1 µS/D output.

(20) Adjust **A TRIGGER LEVEL** control for a triggered display and horizontal **POSITION** control to aline 1st time marker with 1st vertical graticule line.

(21) Adjust C703 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(22) Position controls as listed in **(a)** through **(c)** below:

(a) HORIZONTAL MODE switch to **B.**

(b) A SEC/DIV switch to **1 µs.**

(c) B SEC/DIV switch to **.1 µs.**

(23) Adjust horizontal **POSITION** control to aline 1st time marker with 1st vertical graticule line.

(24) Adjust C713 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(25) Position controls as listed in **(a)** through **(c)** below:

(a) HORIZONTAL MODE switch to **A.**

(b) A AND B SEC/DIV switches to **.05 µs.**

(c) X10 CAL control to out position.

(26) Position calibration generator controls for 10 nS/D output.

(27) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2d vertical graticule line.

(28) Adjust C775 (fig. 1) and C785 (fig. 1) alternately for 1 time marker every 2 divisions over the center 8 divisions (R).

(29) Position controls as listed in **(a)** through **(d)** below:

(a) HORIZONTAL MODE switch to **ALT.**

(b) A SEC/DIV switch to **.1 ms.**

(c) B SEC/DIV switch to **1 µs.**

(d) B DELAY TIME POSITION dial to **1.00.**

(30) Position calibration generator controls for .1 mS/D output.

(31) Adjust **A/B SWP SEP** control to separate **A** and **B** sweeps.

(32) Adjust R646 **DELAY START** (fig. 2) so that the 2d A sweep time marker is intensified and the B sweep time marker's rising edge starts at the beginning of B sweep (R).

(33) Adjust **B DELAY TIME POSITION** dial to **9.00.**

(34) Adjust R652 **DELAY END** (fig. 2) so that the 10th A sweep time marker is intensified and the B sweep time marker's rising edge starts at the beginning of B sweep.

(35) Adjust **B DELAY TIME POSITION** dial to **1.00.**

(36) Repeat (32) through (35) above until no further improvement is noted.

(37) Set **HORIZONTAL MODE** switch to **B.**

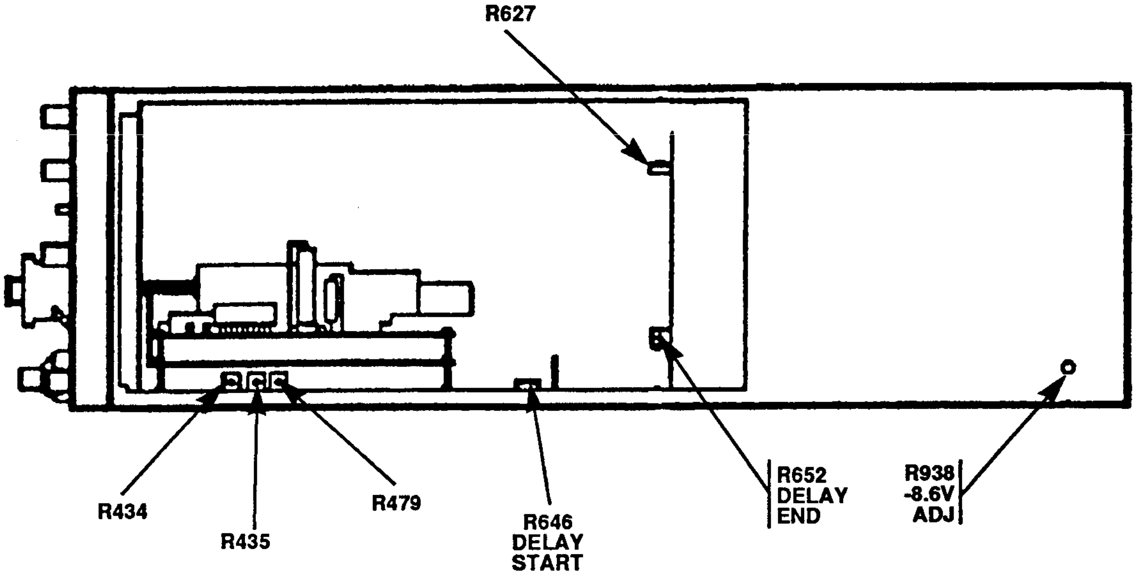

Figure 2. Adjustment locations - right side view.

(38) Press calibration generator **VARIABLE ON** pushbutton to off.

(39) Adjust R760 (fig. 1) for exactly 5 divisions of horizontal display (R).

10. Triggering

a. Performance Check

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

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) CH 1 and **CH 2 VOLTS/DIV** switches to **5m.**

(c) A AND B SEC/DIV switches to **.2 μs.**

(d) B DELAY TIME POSITION dial fully ccw.

(e) B TRIGGER SLOPE pushbutton to **OUT:** ⁄ .

(f) B TRIGGER LEVEL control to midrange.

(g) A TRIGGER P-P AUTO pushbutton pressed.

(h) A TRIGGER SLOPE pushbutton to **OUT:** ⁄ .

(i) A TRIGGER LEVEL control to midrange.

(j) A TRIGGER A TRIG BW switch to **FULL (AN/USM-488).**

(k) A TRIGGER A&B INT switch to **VERT MODE** (type 2235).

(l) A TRIGGER A SOURCE switch to **INT.**

(m) A TRIGGER A EXT COUPLING switch to **DC.**

(2) Connect leveled sine wave generator leveling head to TI **CH 1** using a **50Ω** feedthrough termination.

(3) Position leveled sine wave generator controls for 10 MHz and 3.5 divisions (3.0 divisions for type 2235) of vertical display on TI.

(4) Set **CH 1 VOLTS/DIV** switch to **50m.**

(5) Press **A TRIGGER NORM** pushbutton and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform **b** below.

(6) Repeat technique of (5) above for **A TRIGGER** pushbutton combinations listed in table 9. If a stable display cannot be obtained for each combination, perform b below.

Table 9. A Triggger

Test instrument **A TRIGGER** pushbutton combinations	
Mode	SLOPE
NORM	IN:
P-P AUTO	IN:
P-P AUTO	**OUT:**

(7) **Set HORIZONTAL MODE** switch to **B.** Adjust **B INTENSITY** control for suitable viewing.

(8) Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(9) Press **B TRIGGER SLOPE** pushbutton to **IN:** and repeat (8) above.

(10) Position controls as listed in **(a)** through **(e)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 2.**

(b) VERTICAL MODE TRIGGER SOURCE CH 1 pushbutton to out position (AN/USM-488).

(c) HORIZONTAL MODE switch to **A.**

(d) B TRIGGER SLOPE pushbutton to **OUT:** .

(e) A TRIGGER A&B INT switch to **CH 2** (type 2235).

(11) Repeat technique of (2) through (9) above for **CH 2.**

(12) Position controls as listed in **(a)** through **(f)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1**

(b) VERTICAL MODE TRIGGER SOURCE CH 1 and **CH 2** pushbuttons to **COMPOSITE** (AN/USM-488).

(c) HORIZONTAL MODE switch to **A.**

(d) A AND **B SEC/DIV** switches to **.1 µs.**

(e) B TRIGGER SLOPE pushbutton to **OUT:** .

(f) A TRIGGER A&B INT switch to VERT MODE (type **2235).**

(13) Connect leveled sine wave generator leveling head to TI **CH 1** using a 50Ω feedthrough termination.

(14) Position leveled sine wave generator controls for 60 MHz and 1.0 division of vertical display on TI.

(15) Repeat (5) through (9) above.

(16) Position controls as listed in **(a)** through **(c)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 2.**

(b) HORIZONTAL MODE switch to **A.**

(c) B TRIGGER SLOPE pushbutton to **OUT:** .

(17) Repeat technique of (13) through (15) above for **CH 2.**

(18) Position controls as listed in **(a)** through **(d)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) HORIZONTAL MODE switch to **A.**

(c) A AND B SEC/DIV switches to **.05 μs.**

(d) B TRIGGER SLOPE pushbutton to **OUT:⟋** .

(19) Connect leveled sine wave generator leveling head to TI **CH 1** using a **50Ω** feedthrough termination.

(20) Position leveled sine wave generator controls for 100 MHz and 1.5 divisions of vertical display on TI.

(21) Repeat (5) through (9) above.

(22) Position controls as listed in **(a)** through (c) below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 2.**

(b) HORIZONTAL MODE switch to **A.**

(c) B TRIGGER SLOPE pushbutton to **OUT:⟋** .

(23) Repeat technique of (19) through (21) above for **CH 2.**

(24) Position controls as listed in **(a)** through **(d)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) HORIZONTAL MODE switch to **A.**

(c) A TRIGGER NORM pushbutton pressed.

(d) A TRIGGER A SOURCE switch to **EXT.**

(25) Connect leveled sine wave generator leveling head to TI **EXT INPUT** using a **50Ω** feedthrough termination.

(26) Position leveled sine wave generator controls for a 35 mV, 10 MHz output.

(27) Press in and hold **TRIG VIEW** pushbutton and adjust **A TRIGGER LEVEL** control to obtain a stable display.

(28) Repeat technique of (27) above for **A TRIGGER** pushbutton combinations listed in table 9.

(29) Release **TRIG VIEW** pushbutton.

(30) Pull **X10 CAL** control to out position and press **A TRIGGER NORM** pushbutton.

(31) Position leveled sine wave generator controls for a 120 mV, 60 MHz output.

(32) Repeat (27) through (29) above.

(33) Position leveled sine wave generator controls for a 150 mV (200 mV for type 2235), 100 MHz output.

(34) Press **A TRIGGER NORM** pushbutton and repeat (27) through (29) above.

b. Adjustments.

(1) Disconnect leveled sine wave generator leveling head and **50Ω feedthrough** termination from TI.

(2) Position **controls as listed in (a) through (o) below:**

(a) POSITION controls to midrange.

(b) VERTICAL MODE CH 1 BOTH CH 2 switch to **BOTH.**

(c) VERTICAL MODE TRIGGER SOURCE CH 1 pushbutton to out position (AN/ USM-488).

(d) VERTICAL MODE TRIGGER SOURCE CH 2 pushbutton to in position (AN/ USM-488).

(e) VERTICAL MODE ADD ALT CHOP switch to **ALT.**

(f) CH 1 and CH 2 VOLTS/`DIV switches to **.5.**

(g) CH 1 and CH 2 AC GND DC switches to **GND.**

(h) HORIZONTAL MODE switch to **A.**

(i) A AND B SEC/DIV switches to 1 ms.

(j) B TRIGGER SLOPE to OUT:⟋ .

(k) B TRIGGER LEVEL control to midrange.

(l) A TRIGGER P-P AUTO pushbutton pressed.

(m) A TRIGGER SLOPE pushbutton to **OUT:⁄.**

(n) A TRIGGER LEVEL control to midrange.

(o) A TRIGGER A&B INT switch to **CH 2** (type 2235).

(3) Adjust **CH 1** and **CH 2 POSITION** controls to set both traces to the center horizontal graticule line.

(4) Connect digital multimeter **LO** to chassis ground and **HI** to pin 1 on A5 (fig. 1) board connector. Digital multimeter indication will be less than 100 mV dc. Record digital multimeter indication.

(5) Position controls as listed in (a) through'(c) below:

(a) VERTICAL MODE TRIGGER SOURCE CH 1 pushbutton to in position (AN/USM-488).

(b) VERTICAL MODE TRIGGER SOURCE CH 2 pushbutton to out position (AN/USM-488).

(c) A TRIGGER A&B INT switch to **CH 1** (type 2235).

(6) Adjust R309 (fig. 1) for digital multimeter indication recorded in (4) above.

(7) Position controls as listed in **(a)** through **(c)** below:

(a) VERTICAL MODE TRIGGER SOURCE CH 1 pushbutton to out position (AN/USM-488).

(b) VERTICAL MODE TRIGGER SOURCE CH 2 pushbutton to in position (AN/USM-488).

(c) A TRIGGER A&B INT switch to **CH 2** (type 2235).

(8) Repeat (4) through (7) above until digital multimeter indications in (4) and (6) above are equal within ±1 mV dc.

(9) Disconnect digital multimeter.

(10) Position controls as listed in **(a)** through **(g)** below:

(a) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(b) VERTICAL MODE TRIGGER SOURCE CH 1 pushbutton to in position (AN/USM-488).

(c) VERTICAL MODE TRIGGER SOURCE CH2 pushbutton to out position (AN/USM-488).

(d) CH 1 VOLTS/DIV switch to .1.

(e) CH 1 AND CH 2 AC GND DC switches to **AC.**

(f) A AND B SEC/DIV switches to **10 µs.**

(9) **A TRIGGER A&B INT** switch to **CH 1** (type 2235).

(11) Connect leveled sine wave generator leveling head to TI **CH 1** using- a **50Ω** feedthrough termination.

(12) Position leveled sine wave generator controls for 50 kHz and 2.2 divisions of vertical display on TI.

(13) Set **CH 1 VOLTS/DIV** switch to **1.**

(14) Adjust R479 (fig. 2) while rotating A **TRIGGER LEVEL** control slowly so that the A trigger is just able to be maintained (R).

(15) Set **CH 1 VOLTS/DIV** switch to **50m** and adjust **A TRIGGER LEVEL** control fully cw.

(16) Position leveled sine wave generator amplitude controls for 5 divisions of vertical display on TI.

(17) Set **CH 1 VOLTS/DIV** switch to **.5.**

(18) Adjust R434 (fig. 2) so that the display just solidly triggers on positive peak of signal (R).

(19) Press **A TRIGGER SLOPE** pushbutton to **IN:⁀** and adjust A **TRIGGER LEVEL** control fully ccw.

(20) Adjust R435 (fig. 2) so that the display just solidly triggers on the negative peak of signal (R).

(21) Connect leveled sine wave generator leveling head to one side of a BNC tee. Connect BNC tee to TI **CH 1** using an Xl0

attenuator and a 50Ω feedthrough termination. Connect the other side of BNC tee to TI **EXT INPUT.**

(22) Set CH 1 VOLTS/DIV switch to **10m** and **A TRIGGER A SOURCE** switch to **EXT.**

(23) Position leveled sine wave generator amplitude controls for 2.2 divisions of vertical display on TI.

(24) Adjust **A TRIGGER LEVEL** control for a stable display.

(25) Set **HORIZONTAL MODE** switch to **B** and adjust **B TRIGGER LEVEL** control for a stable display.

(26) Set **CH 1 VOLTS/DIV** switch to **.1.**

(27) Adjust R627 (fig. 2) so that a display can just be maintained by adjusting B **TRIGGER LEVEL** control (R).

11. Calibrator Amplitude

(a) Performance Check

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

(a) POSITION controls to midrange.

(b) VERTICAL MODE CH 1 BOTH CH 2 switch to **CH 1.**

(c) VERTICAL MODE TRIGGER SOURCE CH 1 and **CH 2** pushbuttons to **COMPOSITE** (AN/USM-488).

(d) CH 1 VOLTS/DIV switch to **.1.**

(e) CH 1 AC GND DC switch to **DC.**

(f) HORIZONTAL MODE switch to **A.**

(g) A AND B SEC/DIV switches to **.5 ms.**

(h) Xl0 CAL control to in position.

(i) A TRIGGER P-P AUTO pushbutton pressed.

(j) A TRIGGER SLOPE pushbutton to **OUT:** .

(k) A **TRIGGER LEVEL control to** midrange.

(l) A TRIGGER A TRIG BW switch to **FULL** (AN/USM-488).

(m) A TRIGGER A&B INT switch to **VERT MODE** (type 2235).

(n) A TRIGGER A SOURCE switch to **INT.**

(2) Connect calibration generator **OUTPUT** to TI **CH 1** using comparator.

(3) Connect TI **AMP CAL (PROBE ADJUST** on type 2235) to comparator **FROM DUT CALIBRATOR.**

(4) Set comparator **INTERNAL TERMINATION** switch to **OPEN** and press **DUT** pushbutton.

(5) Adjust **A TRIGGER LEVEL** and **CH 1** and horizontal **POSITION** controls, as necessary, to view waveform.

(6) Note waveform amplitude.

(7) Position calibration generator controls for **AMPL MODE VOLT, VARIABLE ON,** and a.5 V, 1kHz output.

(8) Press comparator **CG** pushbutton and repeat (5) above.

(9) Adjust calibration generator **VAR** control for waveform amplitude noted in (6) above. If calibration generator error readout indication is not within ±2% (±5% for type 2235), perform **b** below.

b. Adjustments

(1) Press calibration generator **VARIABLE ON** pushbutton to off.

(2) Note waveform amplitude.

(3) Press comparator **DUT** pushbutton and adjust TI **CH 1 POSITION** control to view waveform.

(4) Adjust R984 (fig. 1) for waveform amplitude noted in (2) above (R).

(5) Press comparator **CG** pushbutton and adjust TI **CH 1 POSITION** control to view waveform.

(6) Repeat (2) through (5) above as necessary.

12. Power Supply

a. Performance Check. Connect digital multimeter **LO** to chassis ground and **HI** to TP961 -8.6 (fig. 1). If digital multimeter indication is not between -8.56 and -8.64 V dc, perform b below.

b. Adjustments. Adjust R938 -8.6V ADJ (fig. 2) for a -8.60 V dc indication on digital multimeter (R).

13. Final Procedure

a. Deenergize and disconnect all equipment.

b. Annotate and affix Label/Form in accordance with TB 750-25.

TECHNICAL MANUAL

ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST FOR

OSCILLOSCOPE AN /USM-488
(NSN 6625=01 -1 87-7847)

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HEADQUARTERS, DEPARTMENT OF THE ARMY

12 SEPTEMBER 1985

Technical Manual
No. 11-6625-3135-24P

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 12 September 1985

ORGANIZATIONAL, DIRECT SUPPORT, AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST FOR OSCILLOSCOPE AN/USM-488 (NSN 6625-01-187-7847)

Current as of 1 April 1985

REPORTING OF 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), or DA Form 2028-2 located in the back of this manual direct to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ME-MP, Fort Monmouth, NJ 07703-5007. A reply will be furnished to you.

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SECTION I
INTRODUCTION

1. Scope

This manual lists and authorizes spares and repair parts; special tools; special test, measurement, and diagnostic equipment (TMDE), and other special support equipment required for performance of organizational, direct support, and general support maintenance of the AN/USM-488. It authorizes the requisitioning, issue, and disposition of spares, repair parts and special tools as indicated by the source, maintenance and recoverability (SMR) codes.

2. General

This Repair Parts and Special Tools List is divided into the following sections:

a. Section II. Repair Parts List. A list of spares and repair parts authorized by this RPSTL for use in the performance of maintenance. The list also includes parts which must be removed for replacement of the authorized parts. Parts lists are composed of functional groups in ascending numeric sequence, with the parts in each group listed in ascending item number sequence. Figure numbers are listed directly beneath the group header.

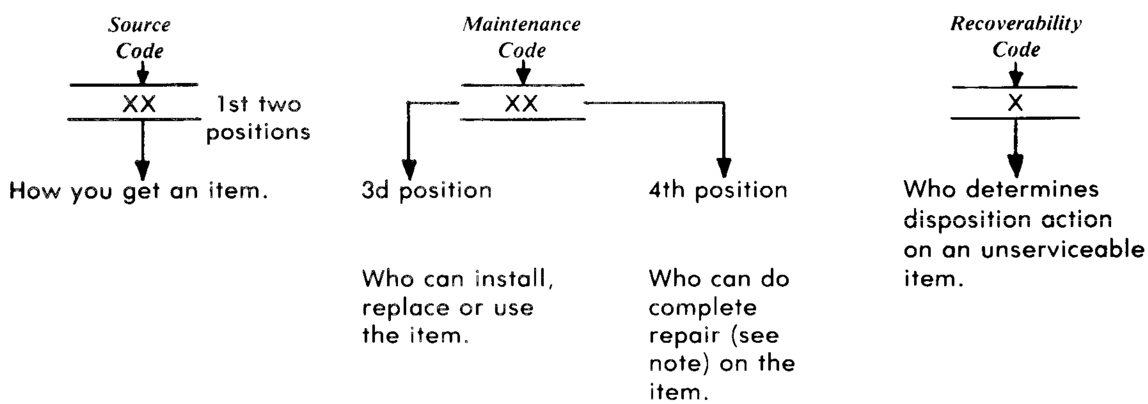
b. Section III. Special Tools List. Not applicable.

c. Section IV. National Stock Number and Part Number Index. A list, in National item identification number (NIIN) sequence, of all National stock numbered items appearing in the listings, followed by a list in alphamerical sequence of all part numbers appearing in the listings. National stock numbers and part numbers are cross referenced to each illustration figure and item number appearance.

3. Explanation of Columns (Section II and III)

a. Item No. (Column (1)). Indicates the number used to identify items called out in the illustration.

b. SMR Code (Column (2)). The source, maintenance, and recoverability (SMR) code is a five-position code containing supply/requisitioning information, maintenance category authorization criteria, and disposition instruction, as shown in the following breakout:



NOTE

Complete repair: Maintenance capacity, capability, and authority to perform all corrective maintenance tasks of the "Repair" function in a use/user environment in order to restore serviceability to a failed item.

(1) *Source Code.* The source code tells you how to get an item needed for maintenance, repair, or overhaul of an end item/equipment. Explanations of source codes follows:

Code	*Explanation*
PA PB PC PD PE PF PG	Stocked items; use the applicable NSN to request/requisition items with these source codes. They are authorized to the category indicated by the code entered in the third position of the SMR code. **NOTE** Items coded PC are subject to deterioration.
KD KF KB	Items with these codes are not to be requested/requisitioned individually. They are part of a kit which is authorized to the maintenance category indicated in the third position of the SMR code. The complete kit must be requisitioned and applied.
MO — Made at org/ AVUM category MF — Made at DS/ AVUM category MH — Made at GS category ML — Made at Specialized Repair Activity (SRA) MD — Made at Depot	Items with these codes are not to be requested/requisitioned individually. They must be made from bulk material which is identified by the part number in the description and usable on code (UOC) column and listed in the Bulk Material group of the repair parts list. If the item is authorized to you by the third position code of the SMR code, but the source code indicates it is made at a higher category, order the item from the higher category of maintenance.
AO — Assembled by org/ AVUM category AF — Assembled by DS/ AVIM category AH — Assembled by GS category AL — Assembled by SRA AD — Assembled by Depot	ms with these codes are not to be requested/requisitioned individually. The parts that make up the assembled item must be requisitioned or fabricated and assembled at the category of maintenance indicated by the source code. If the disposition code of the SMR code authorizes you to replace the item, but the source code indicates the item is assembled at a higher category, order the item from the higher category of maintenance.

XA - Do not requisition an "XA" coded item. Order its next higher assembly.
XB - If an "XB" item is not available from salvage, order it using the FSCM and part number given.
XC - Installation drawing, diagram, instruction sheet, field service drawing, that is identified by manufacturers part number.
XD - Item is not stocked. Order an "XD" coded item through normal supply channels using the FSCM and part number given, if no NSN is available.

NOTE

Cannibalization or controlled exchange, when authorized, may be used as a source of supply for items with the above source codes, except for those source coded "XA" or those aircraft support items restricted by requirements of AR 750-1.

(2) *Maintenance Code.* Maintenance codes tell you the category of maintenance authorized to USE and REPAIR support items. The maintenance codes are entered in the third and fourth positions of the SMR code as follows:

(a) The maintenance code entered in the third position tells you the lowest maintenance category authorized to remove, replace, and use an item. The maintenance code entered in the third position will indicate authorization to one of the following categories of maintenance.

Code	*Application/Explanation*
C	Crew or operator maintenance done within organizational or aviation maintenance.
O	Organizational or aviation unit category can remove, replace, and use the item.
F	Direct support or aviation intermediate category can remove, replace, and use the item.
H	General support category can remove, replace, and use the item.
L	Specialized repair activity can remove, replace, and use the item.
D	Depot category can remove, replace, and use the item.

(b) The maintenance code entered in the fourth position tells whether or not the item is to be repaired and identifies the lowest maintenance category with the capability to do complete repair (i. e., perform all authorized repair functions). This position will contain one of the following maintenance codes:

NOTE

Some limited repair may be done on the item at a lower category of maintenance, if authorized by the Maintenance Allocation Chart (MAC) and SMR codes.

Code	*Application/Explanation*
O	Organizational or aviation unit is the lowest category that can do complete repair of the item.
F	Direct support or aviation intermediate is the lowest category that can do complete repair of the item.
H	General support is the lowest category that can do complete repair of the item.
L	Specialized repair activity (designate the specialized repair activity) is the lowest category that can do complete repair of the item.
D	Depot is the lowest category that can do complete repair of the item.
z	Nonreparable. No repair is authorized.
B	No repair is authorized. (No parts or special tools are authorized for the maintenance of a "B" coded item.) However, the item may be reconditioned by adjusting, lubricating, etc., at the user category.

(3) *Recoverability Code.* Recoverability codes are assigned to items to indicate the disposition action on unserviceable items. The recoverability code is entered in the fifth position of the SMR Code as follows:

Recoverability codes	*Application/Explanation*
Z	- Nonreparable item. When unserviceable, condemn and dispose of the item at the category of maintenance shown in the third position of SMR Code.
O	- Reparable item. When uneconomically reparable, condemn and dispose of the item at organizational or aviation unit category.
F	- Reparable item. When uneconomically reparable, condemn and dispose of the item at the direct support or aviation intermediate category.
H	- Reparable item. When uneconomically reparable, condemn and dispose of the item at general support category.
D	- Reparable item. When beyond lower level repair capability, return to depot. Condemnation and disposal of item not authorized below depot category.
L	- Reparable item. Condemnation and disposal not authorized below specialized repair activity (SRA).
A	- Item requires special handling or condemnation procedures because of specific reasons (e.g., precious metal content, high dollar value, critical material, or hazardous material). Refer to appropriate manuals/directives for specific instructions.

c. FSCM (Column (3)). The Federal Supply Code for Manufacturer (FSCM) is a 5-digit numeric code which is used to identify the manufacturer, distributor, or Government agency, etc., that supplies the item.

d. Part Number (Column (4)). Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity), which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.

NOTE

When you use a NSN to requisition an item, the item you receive may have a different part number from the part ordered.

e. *Description and Usable on Code (UOC)(Column (5)).* This column includes the following information.

(1) The Federal item name and, when required, a minimum description to identify the item.

(2) The statement "END OF FIGURE" appears just below the last item description in Column (5) for a given figure in both section II and section III.

f. Qty (Column (6)). Indicates the quantity of the item used in the breakout shown on the illustration figure, which is prepared for a functional group, subfunctional group, or an assembly, A "V" appearing in this column in lieu of a quantity indicates that the quantity is variable and the quantity may vary from application to application.

4. Explanation of Columns (Section IV)

a. *National Stock Number (NSN) Index.*

(1) Stock number column. This column lists the NSN by National item identification number (NIIN) sequence. The NIIN consists of the last nine digits of the NSN. When using this column to locate an item, ignore the first four digits of the NSN. When requisitioning items use the complete NSN (13 digits).

(2) *Fig. column.* This column lists the number of the figure where the item is identified/located. The illustrations are in numerical sequence in sections II and III.

(3) *Item column.* The item number identifies the item associated with the figure listed in the adjacent Fig. column. This item is also identified by the NSN listed on the same line.

b. Part Number Index. Part numbers in this index are listed by part number in ascending alphameric sequence.

(1) *FSCM column.* This column lists the Federal supply code for manufacturer (FSCM).

(2) *Part number column.* This column indicates the part number assigned to the item.

(3) *Stock number column.* This column lists the National stock number for the associated part number and manufacturer identified in the part number and FSCM columns to the left.

(4) Fig. column. This column lists the number of the figure where the item is identified/located in sections II and Ill.

(5) *Item column.* The item number is that number assigned to the item as it appears in the figure referenced in the adjacent figure number column.

5. Special Information

a. Associated Publications. The publications listed below pertain to the AN/USM-488 and its components:

TM 11-6625-3135-12, Oscilloscope AN/USM-488

TM 11-6625-3135-40, Oscilloscope AN/USM-488

b. National Stock Numbers. National stock numbers (NSN'S) that are missing from P source coded items have been applied for and will be added to this TM by future change/revision when they are entered in the Army Master Data File (AMDF). Until the NSN'S are established and published, submit exception requisitions to: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-MM, Fort Monmauth, NJ 07703-5006 for the part required to support your equipment.

6. How to Locate Repair Parts

a. When National stock number or part number is not known.

(1) First. Using the table of contents, determine the assembly group or subassembly group to which the item belongs. This is necessary since figures are prepared for assembly groups and subassembly groups, and listings are divided into the same groups.

(2) *Second.* Find the figure covering the assembly group or subassembly group to which the item belongs.

(3) *Third.* Identify the item on the figure and note the item number.

(4) *Fourth.* Refer to the Repair Parts List for the figure to find the part number for the item number noted on the figure.

(5) *Fifth.* Refer to the Part Number Index to find the NSN, if assigned.

b. When National stock number or part number is known.

(1) *First.* Using the Index of National stock numbers and part numbers, find the pertinent National stock number or part number. The NSN index is in National item identification number (NIIN) sequence (para *4a(1)).* The part numbers in the part number index are listed in ascending alphameric sequence (para *4b).* Both indexes cross-reference you to the illustration figure and item number of the item you are looking for.

(2) *Second.* After finding the figure and item number, verify that the item is the one you're looking for, then locate the item number in the repair parts list for the figure.

7. Abbreviations

Not applicable.

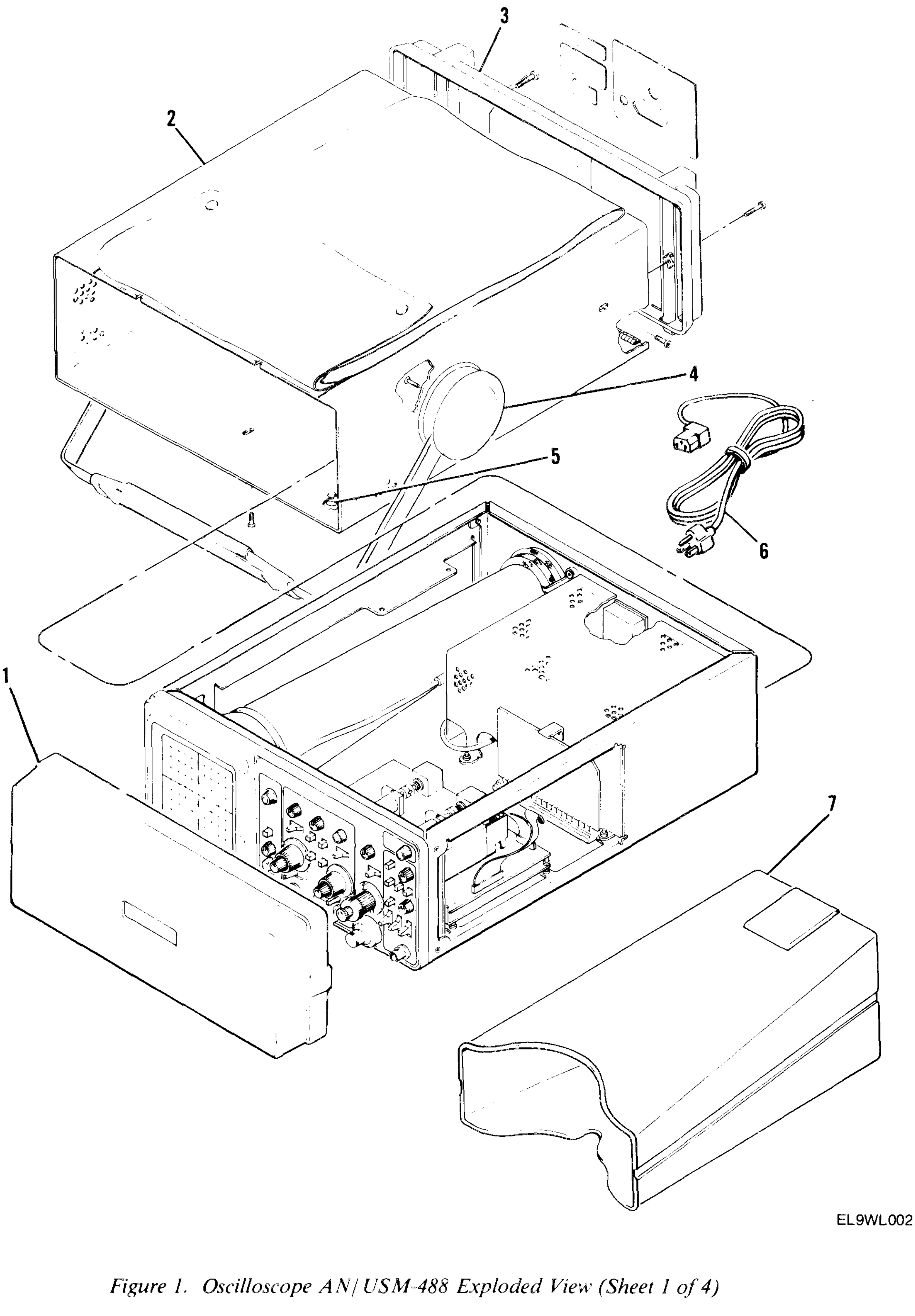


Figure 1. Oscilloscope AN/USM-488 Exploded View (Sheet 1 of 4)

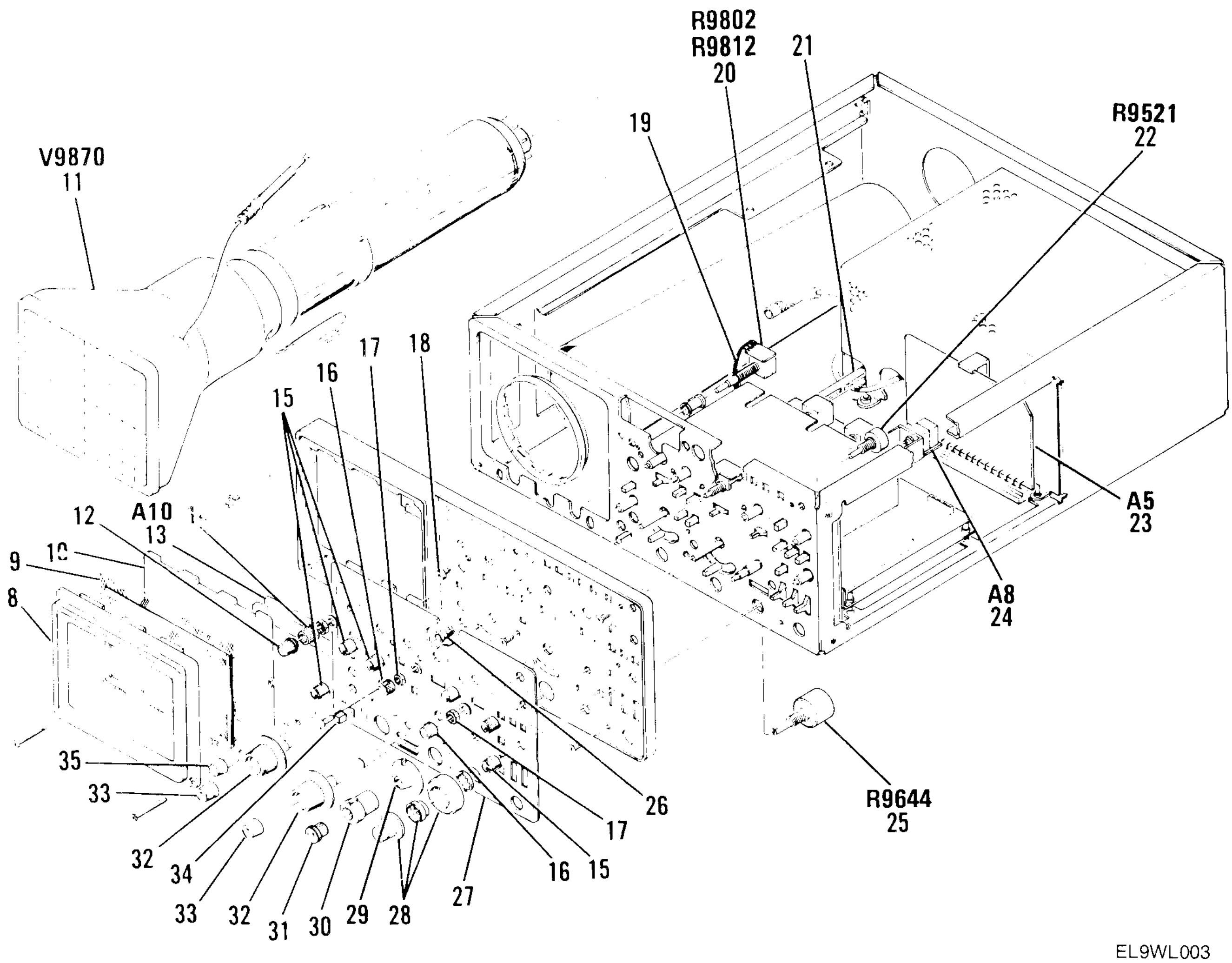


Figure 1. Oscilloscope AN/USM-488 Exploded View (Sheet 2 of 4)

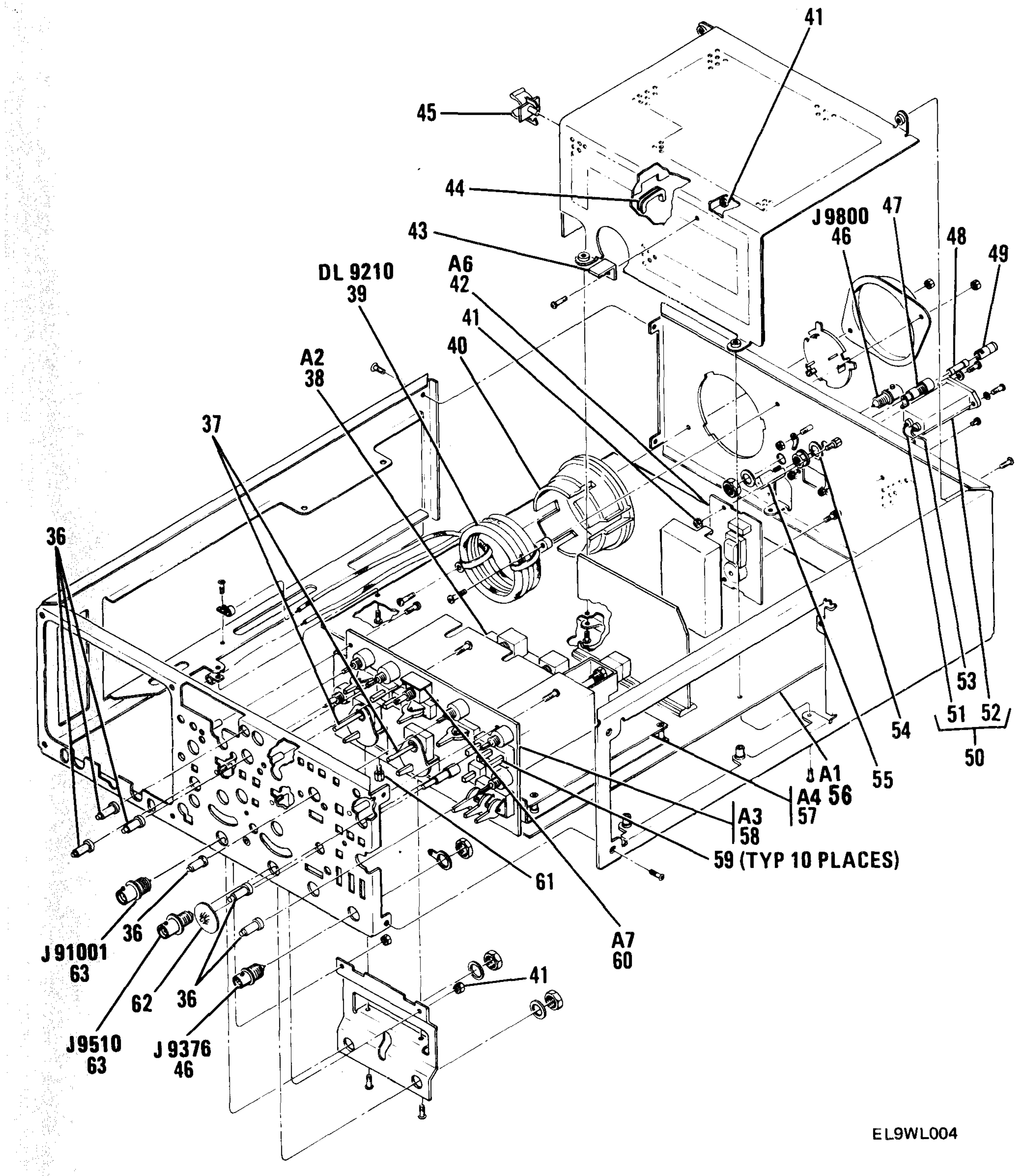


Figure 1. Oscilloscope AN/USM-488 Exploded View (Sheet 3 of 4)

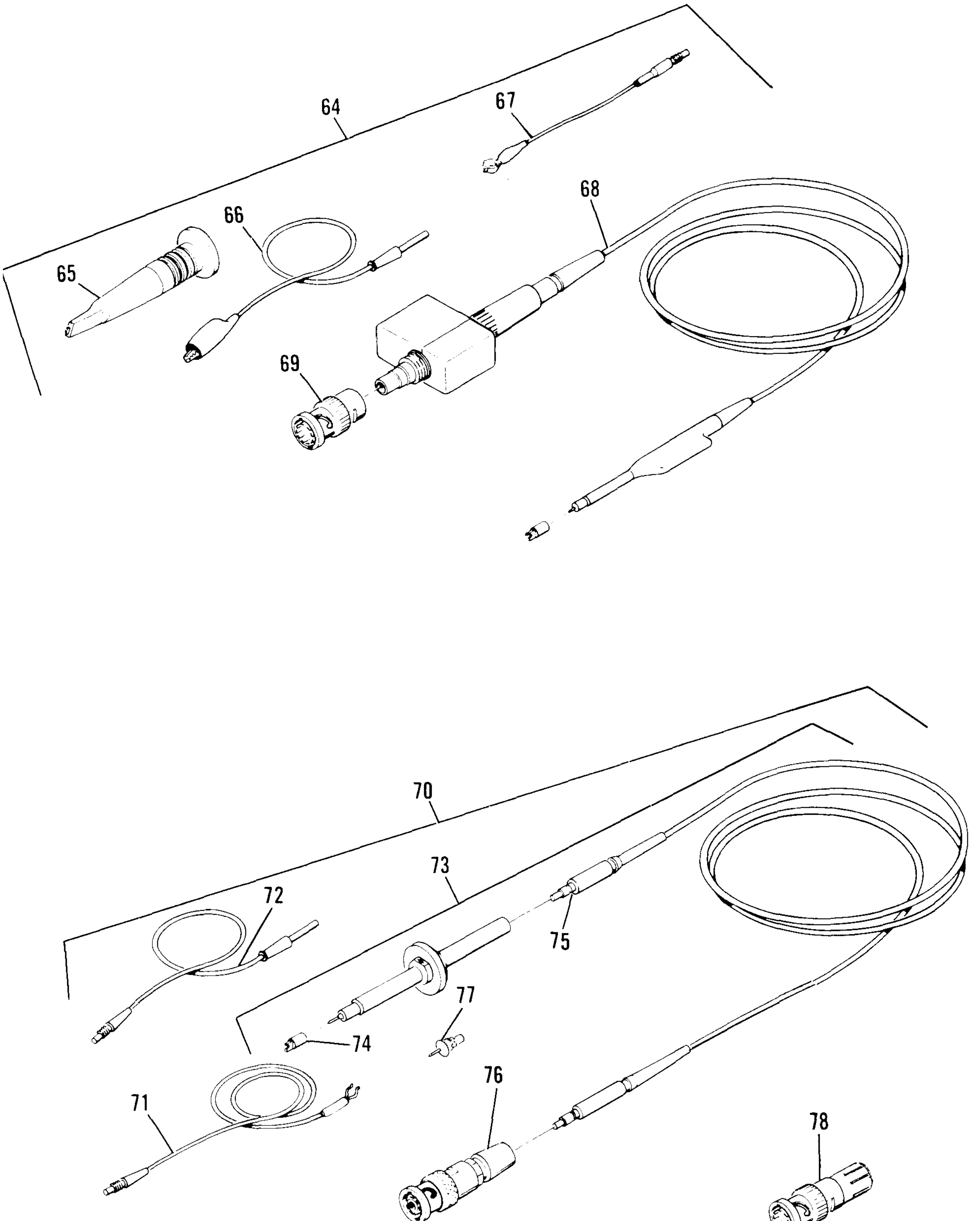


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Figure 1. Oscilloscope AN/USM-488 Exploded View (Sheet 4 of 4)

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
				GROUP 00 OSCILLOSCOPE AN/USM-488	
				FIG 1	
1	PAHZZ	80009	200-2520-00	COVER,OSCILLOSCOPE	1
2	PAHZZ	80009	390-0790-11	CABINET, OSCILLOSCOP	1
3	PAHZZ	80009	200-2538-00	COVER,REAR	1
4	PAHZZ	80009	367-0289-00	HANDLE,CARRYING	1
5	PAHZZ	80009	348-0659-01	FOOT,CABINET	2
6	PAHZZ	16428	CH8352	CABLE ASSY,PWR	1
7	PAHZZ	80009	016-0566-00	VISOR,CATHODE RAY T	1
8	PAHZZ	80009	426-1765-02	FRAME	1
9	PAHZZ	80009	378-0237-00	FILTER,MESH	1
10	PAHZZ	80009	337-2775-01	SHIELD,IMPLOSION	1
11	PAHZZ	80009	154-0861-00	ELECTRON TUBE	1
12	PAOZZ	80009	366-1391-03	KNOB	1
13	PAHZZ	80009	670-8418-00	CIRCUIT CARD ASSEMB	1
14	PAOZZ	80009	366-2146-03	KNOB	1
15	PAOZZ	80009	366-2049-01	KNOB	6
16	PAOZZ	80009	366-1146-00	KNOB	2
17	PAHZZ	73743	2X-20319-402	NUT,PLAIN,HEXAGON	1
18	PAHZZ	80009	136-0628-00	JACK,TIP	1
19	PAHZZ	80009	175-6140-00	CABLE ASSEMBLY,SPEC	1
20	PAHZZ	80009	311-2177-02	RESISTOR,VARIABLE N	1
21	PAHZZ	80009	384-1576-01	EXTENSION SHAFT	1
22	PAHZZ	12697	CM41773	RESISTOR,VARIABLE,N	1
23	PAHZZ	80009	670-8407-00	CIRCUIT CARD ASSEMB	1
24	PAHZZ	80009	670-8819-00	CIRCUIT CARD ASSEMB	1
25	PAHZZ	80009	311-1183-02	RESISTOR,VARIABLE W	1
26	PAHZZ	80009	358-0550-00	BUSHING,SHAFT	1
27	PAHZZ	8009	333-3109-00	PANEL,BLANK	1
28	PAHZZ	05129	461-S-70	DIAL,CONTROL	1
29	PAHZZ	80009	366-1850-00	KNOB	1
30	PAOZZ	80009	366-1840-03	KNOB	1
31	PAOZZ	80009	366-2052-01	KNOB	1
32	PAOZZ	80009	366-2148-01	KNOB	2
33	PAOZZ	80009	366-1031-03	KNOB	2
34	PAHZZ	80009	366-1480-03	PUSH BUTTON	1
35	PAHZZ	80009	384-1575-00	EXTENSION SHAFT	1
36	PAOZZ	80009	377-0512-00	INSERT,KNOB	6
37	PAHZZ	80009	214-3375-00	SWITCH,LEVER	2
38	PAHZZ	80009	672-0111-00	CIRCUIT CARD ASSEMB	1
39	PAHZZ	80009	119-1515-00	DELAY LINE	1
40	PAHZZ	80009	200-2519-00	CAP,CIRCUIT SOCKET	1
41	PAHZZ	78189	211-041800-00	NUT,PLAIN,ASSEMBLED	5
42	PAHZZ	80009	670-7615-00	CIRCUIT CARD ASSEMB	1
43	PAHZZ	80009	344-0132-00	CLIP,SPRING TENSION	1
44	PAHZZ	80009	348-0555-00	GROMMET,PLASTIC	1
45	PAHZZ	80009	344-0347-00	CLIP,ELECTRICAL	1
46	PAHZZ	13511	31-279	CONNECTOR,RECEPTACL	2
47	PAHZZ	80009	204-0833-00	FUSEHOLDER,EXTRACTO	1
48	PAOZZ	81349	F03B250V1A	FUSE,CARTRIDGE	2

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
49	PAHZZ	80009	200-2264-00	CAP,FUSEHOLDER	1
50	PAHZZ	80009	119-1788-00	LINE FILTER ASSEMBL	1
51	PAHZZ	80009	195-0389-00	LEAD,ELECTRICAL	1
52	PAHZZ	54583	ZUB2203-00	RADIO FREQUE	1
53	PAHZZ	80009	195-5499-00	LEAD,ELECTRICAL	1
54	PAHZZ	78189	1224-02	WASHER,LOCK	1
55	PAHZZ	80009	200-1388-03	COVER,FUSE	1
56	PBHHH	80009	670-8404-00	CIRCUIT CARD ASSEMB	1
57	PAHZZ	80009	670-8405-00	CIRCUIT CARD ASSEMB	1
58	PAHZZ	80009	670-8406-00	CIRCUIT CARD ASSEMB	1
59	PAHZZ	80009	366-2013-00	PUSH BUTTON	10
60	PAHZZ	80009	670-8444-00	CIRCUIT CARD ASSEMB	1
61	PAHZZ	80009	129-0999-00	SPACER,POST	2
62	PAHZZ	80009	131-2844-00	CONTACT,ELECTRICAL	1
63	PAHZZ	77820	9663-1 NT-34	CONNECTOR	2
64	PAHZZ	80009	010-6122-01	PROBE,VOLTAGE	2
65	PAHZZ	80009	013-0107-04	TIP,PROBE	2
66	PAHZZ	80009	195-1870-00	LEAD,ELECTRICAL	2
67	PAHZZ	80009	195-6176-00	LEAD,ELECTRICAL	2
68	PAHZZ	80009	175-3217-00	CABLE ASSEMBLY,RADI	2
69	PAHZZ	95712	33600-1	SHELL,ELECTRICAL CO	2
70	PAHZZ	80009	010-6101-03	LEAD,TEST	1
71	PAHZZ	80009	175-0124-01	LEAD,ELECTRICAL	1
72	PAHZZ	80009	175-0125-01	LEAD,ELECTRICAL	1
73	PAOZZ	80009	010-6101-02	LEAD,TEST	1
74	PAOZZ	80009	015-0201-04	COVER,TEST PROD	1
75	PAHZZ	80009	175-1661-01	CABLE ASSEMBLY,RADI	1
76	PAOZZ	24931	28P224-1	PROBE SUBASSEMBLY	1
77	PAOZZ	80009	206-0191-03	TIP,TEST PROD	1
78	PAHZZ	95712	2048-2NT34	ADAPTER,CONN	1

END OF FIGURE

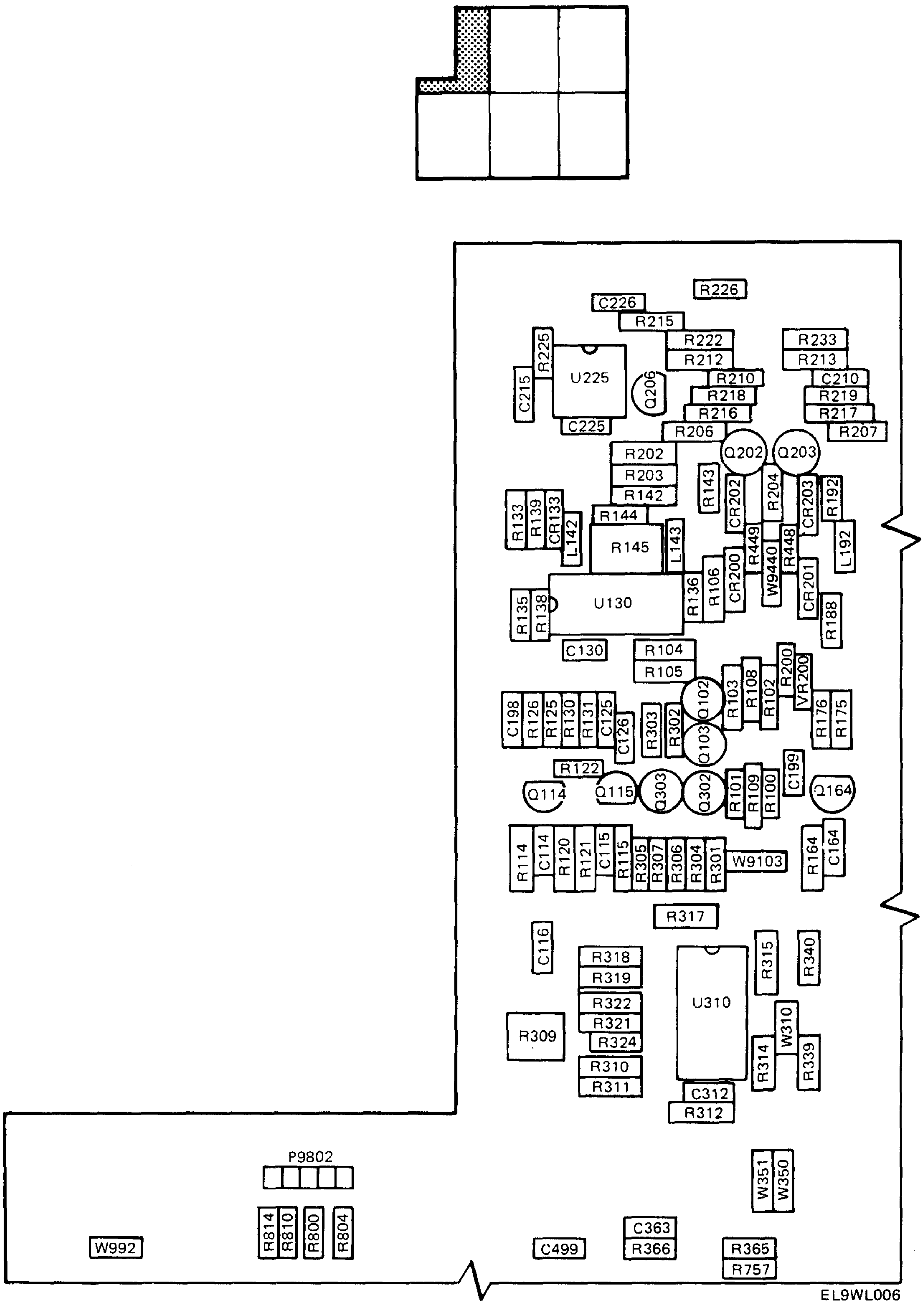


Figure 2. Circuit Card Assembly A1 (Sheet 1 of 11)

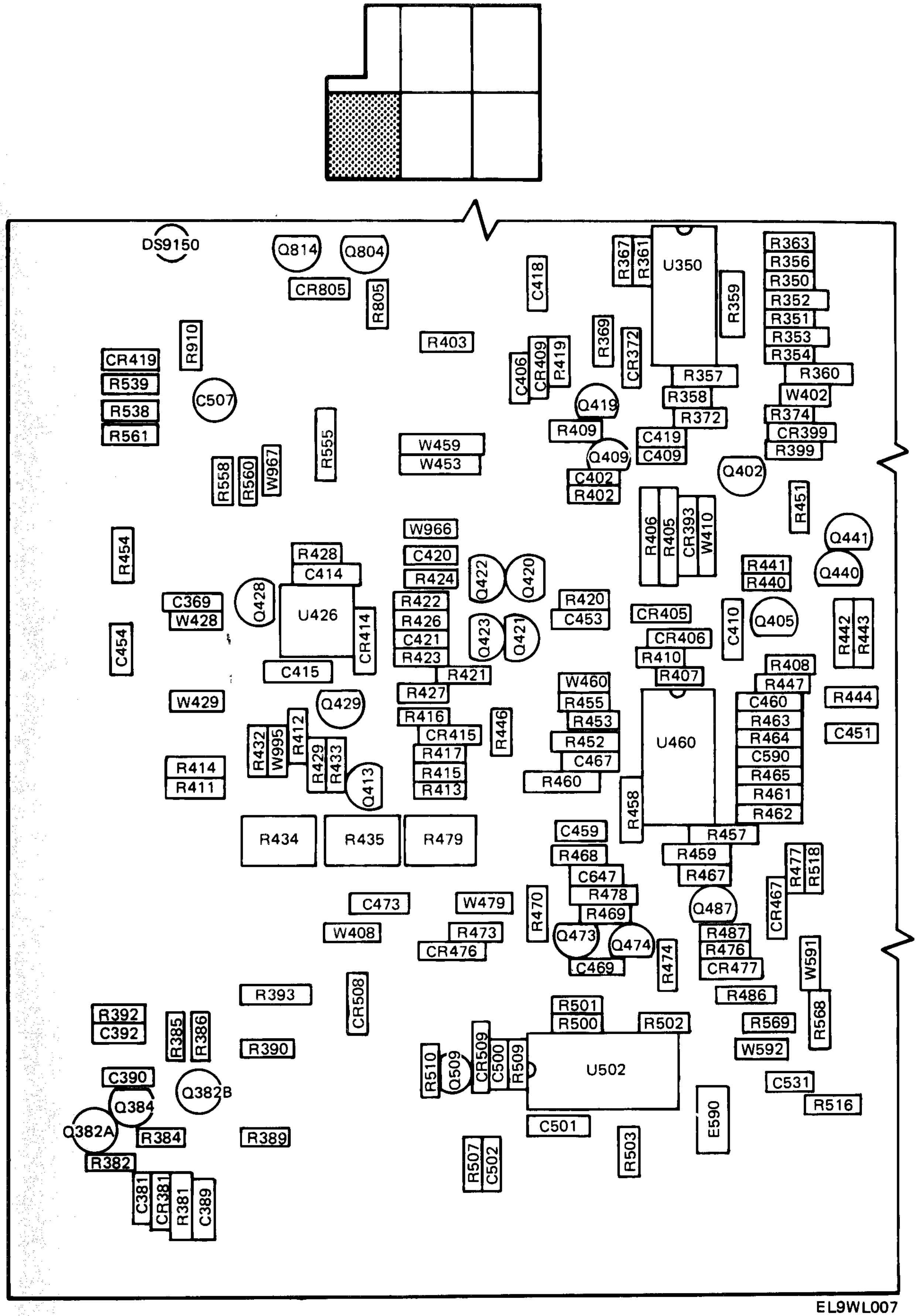


Figure 2. Circuit Card Assembly A1 (Sheet 2 of 11)

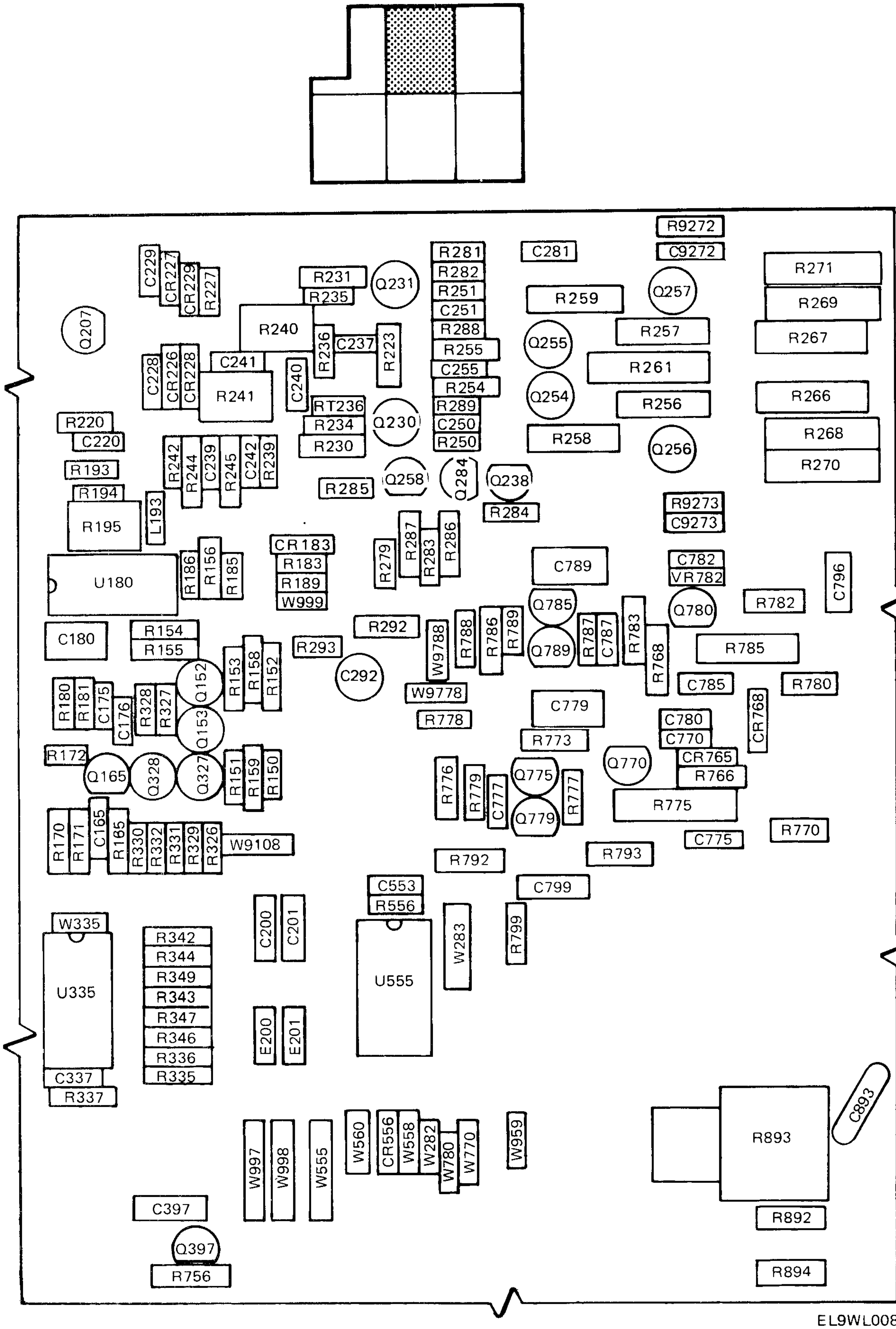


Figure 2. Circuit Card Assembly A1 (Sheet 3 of 11)

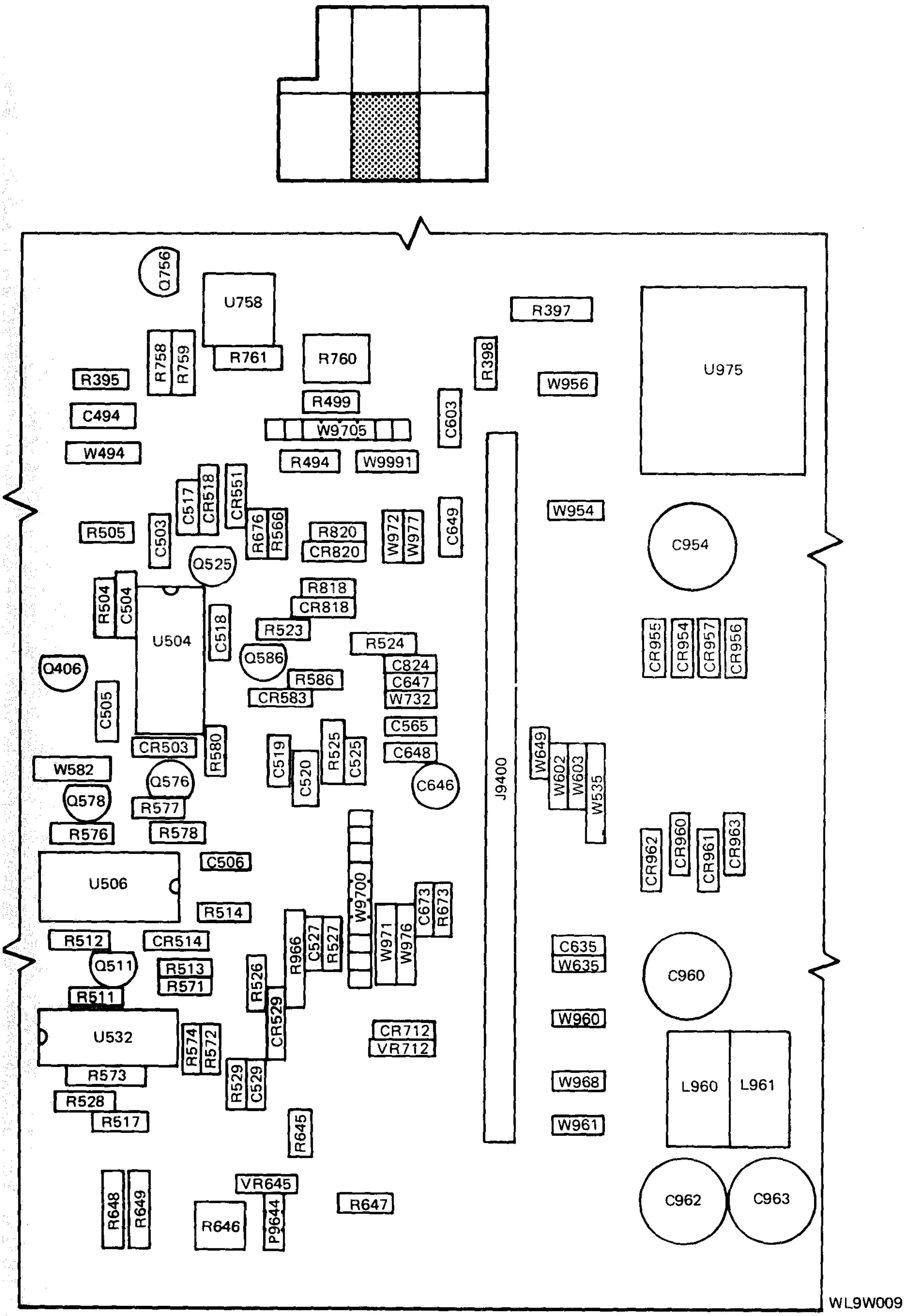
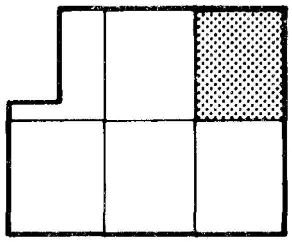


Figure 2. Circuit Card Assembly A1 (Sheet 4 of 11)



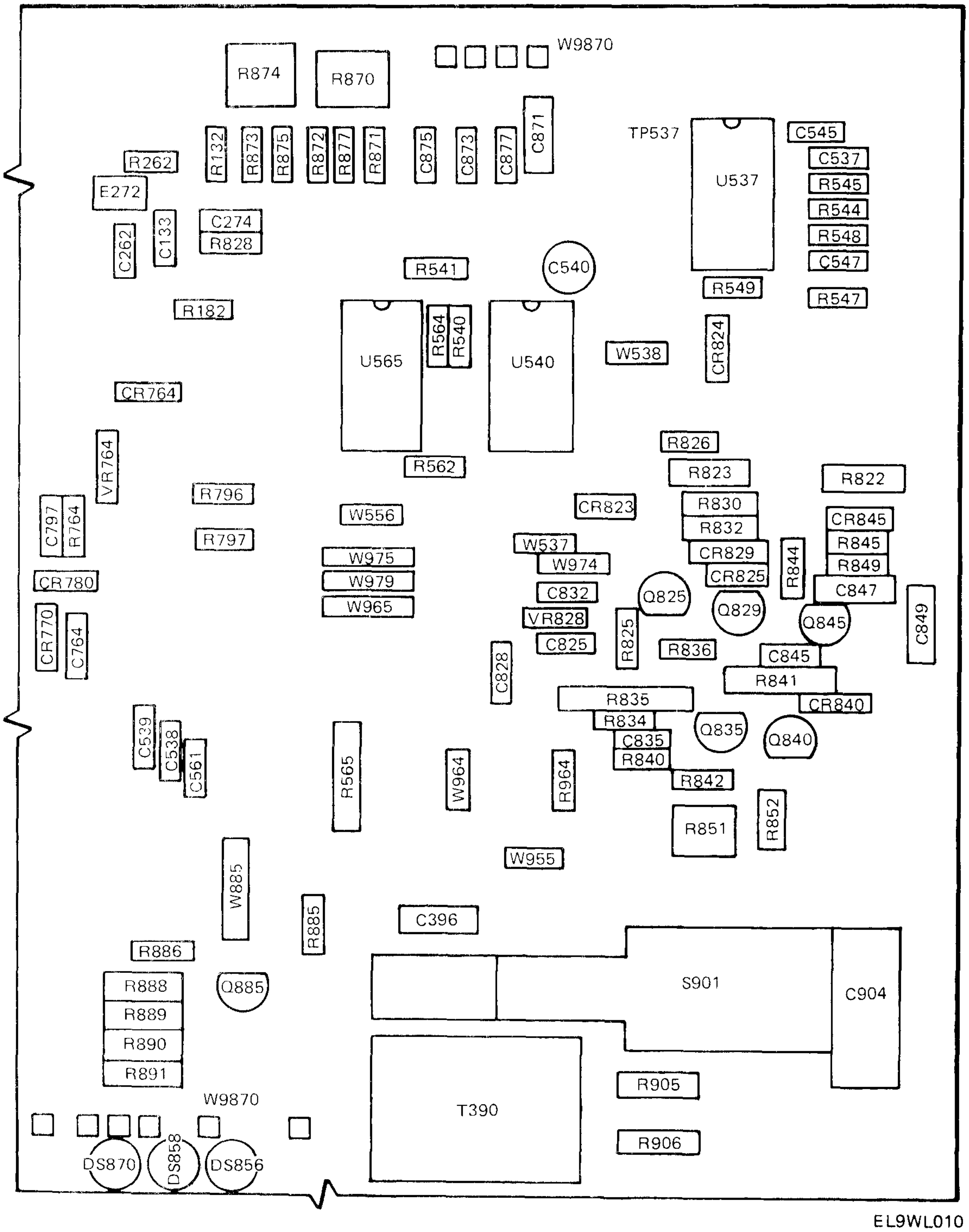
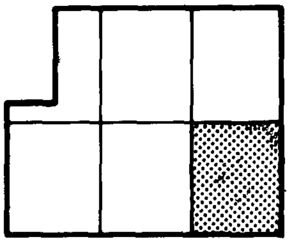


Figure 2. Circuit Card Assembly A1 (Sheet 5 of 11)



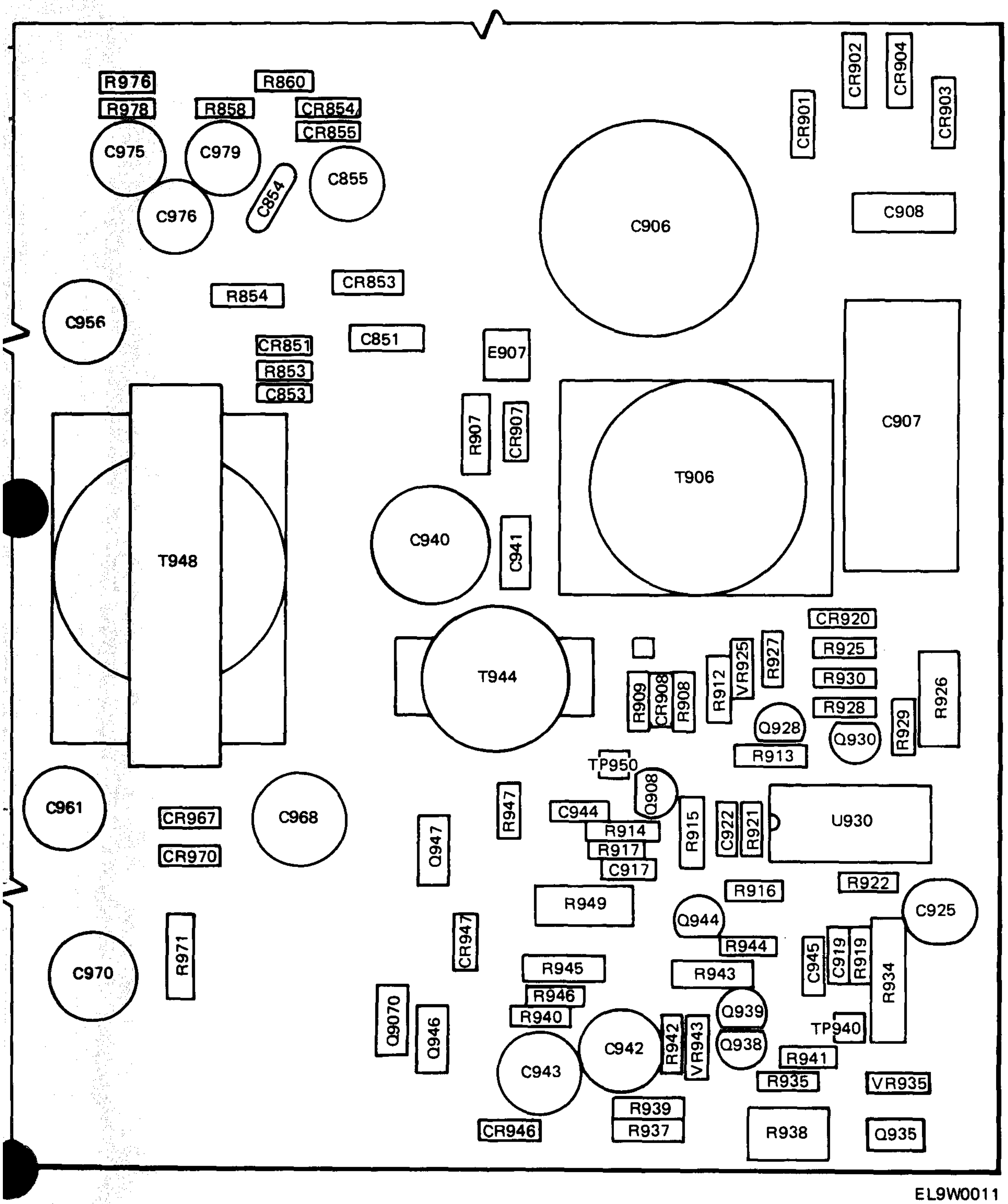


Figure 2. Circuit Card Assembly A1 (Sheet 6 of 11)

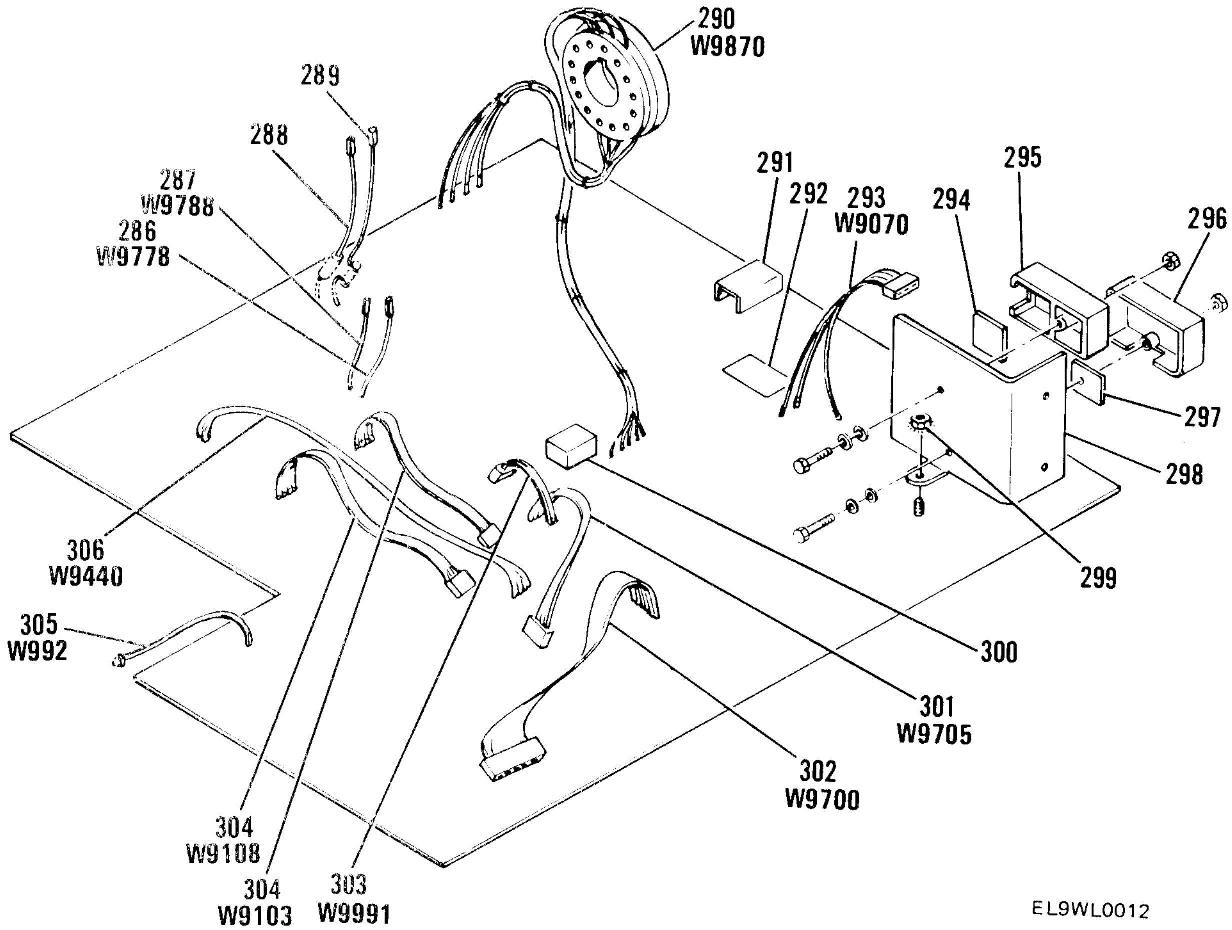


Figure 2. Circuit Card Assembly A1 (Sheet 7 of 11)

REFERENCE DESIGNATION-TO-ITEM NUMBER TABLE

REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM
A1C114	1	A1C409	22	A1C647	2	A1C945	17	A1CR764	51
A1C115	1	A1C410	23	A1C648	2	A1C954	47	A1CR765	51
A1C116	2	A1C414	24	A1C649	2	A1C956	48	A1CR768	51
A1C125	3	A1C415	24	A1C673	31	A1C960	49	A1CR770	51
A1C126	4	A1C418	2	A1C764	16	A1C961	49	A1CR780	51
A1C130	5	A1C419	25	A1C770	17	A1C962	49	A1CR805	51
A1C133	6	A1C420	16	A1C775	33	A1C963	49	A1CR818	51
A1C164	1	A1C421	16	A1C777	34	A1C968	49	A1CR820	51
A1C165	1	A1C451	3	A1C779	35	A1C970	49	A1CR823	51
A1C175	3	A1C453	2	A1C780	17	A1C975	39	A1CR824	51
A1C176	4	A1C454	17	A1C782	17	A1C976	39	A1CR825	51
A1C180	7	A1C459	2	A1C785	33	A1C979	39	A1CR829	51
A1C198	2	A1C460	26	A1C787	34	A1C9272	50	A1CR840	51
A1C199	2	A1C467	3	A1C789	35	A1C9273	50	A1CR845	51
A1C200	8	A1C469	3	A1C796	17	A1CR133	51	A1CR851	53
A1C1201	8	A1C473	2	A1C797	17	A1CR183	51	A1CR853	53
A1C210	9	A1C494	16	A1C799	36	A1CR200	51	A1CR854	53
A1C215	2	A1C499	16	A1C824	6	A1CR201	51	A1CR855	53
A1C220	3	A1C500	27	A1C825	1	A1CR202	51	A1CR901	54
A1C225	2	A1C501	24	A1C828	17	A1CR203	51	A1CR902	54
A1C226	2	A1C502	16	A1C832	17	A1CR226	51	A1CR903	54
A1C228	10	A1C503	17	A1C835	17	A1CR227	51	A1CR904	54
A1C229	10	A1C504	24	A1C845	34	A1CR228	51	A1CR907	55
A1C237	7	A1C505	28	A1C847	36	A1CR229	51	A1CR908	51
A1C239	11	A1C506	3	A1C849	36	A1CR372	51	A1CR920	56
A1C240	12	A1C507	18	A1C851	36	A1CR381	51	A1CR946	57
A1C241	13	A1C517	3	A1C853	37	A1CR393	51	A1CR947	57
A1C242	14	A1C518	29	A1C854	38	A1CR399	51	A1CR954	58
A1C250	15	A1C519	17	A1C855	39	A1CR405	51	A1CR955	58
A1C251	15	A1C520	24	A1C871	36	A1CR406	51	A1CR956	57
A1C255	2	A1C525	30	A1C873	17	A1CR409	51	A1CR957	57
A1C262	2	A1C527	31	A1C875	17	A1CR414	51	A1CR960	57
A1C274	16	A1C529	6	A1C877	17	A1CR415	51	A1CR961	57
A1C281	17	A1C531	16	A1C893	38	A1CR419	51	A1CR962	57
A1C292	18	A1C537	17	A1C904	40	A1CR467	51	A1CR963	57
A1C312	19	A1C538	2	A1C906	41	A1CR476	51	A1CR967	59
A1C337	19	A1C539	2	A1C907	42	A1CR477	51	A1CR970	59
A1C363	2	A1C540	18	A1C908	43	A1CR503	52	A1DS856	60
A1C369	2	A1C545	32	A1C917	14	A1CR508	51	A1DS858	60
A1C381	20	A1C547	1	A1C919	29	A1CR509	51	A1DS870	60
A1C389	16	A1C553	17	A1C922	17	A1CR514	51	A1DS9150	61
A1C390	2	A1C561	2	A1C925	44	A1CR518	51	A1E200	62
A1C392	2	A1C565	15	A1C940	45	A1CR529	51	A1E201	62
A1C396	21	A1C590	8	A1C941	36	A1CR551	51	A1E272	63
A1C397	16	A1C603	2	A1C942	46	A1CR556	51	A1E590	62
A1C402	2	A1C635	26	A1C943	46	A1CR583	51	A1E907	64
A1C406	2	A1C646	18	A1C944	28	A1CR712	51	A1J9400	65

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Figure 2. Circuit Card Assembly A1 (Sheet 8 of 11)

REFERENCE DESIGNATION-TO-ITEM NUMBER TABLE

REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM
A1L142	66	A1Q428	79	A1R114	99	A1R200	111	A1R271	135
A1L143	66	A1Q429	70	A1R115	99	A1R202	112	A1R279	136
A1L192	66	A1Q440	79	A1R120	100	A1R203	112	A1R281	125
A1L193	66	A1Q441	79	A1R121	100	A1R204	113	A1R282	137
A1L960	67	A1Q473	83	A1R122	101	A1R206	114	A1R283	109
A1L961	67	A1Q474	83	A1R125	102	A1R207	114	A1R284	138
A1P9644	68	A1Q487	82	A1R126	103	A1R210	115	A1R285	139
A1P9802	69	A1Q509	80	A1R130	104	A1R212	116	A1R286	140
A1Q102	70	A1Q511	80	A1R131	104	A1R213	116	A1R287	140
A1Q103	70	A1Q525	71	A1R132	105	A1R215	117	A1R288	115
A1Q114	71	A1Q576	81	A1R133	106	A1R216	118	A1R289	115
A1Q115	71	A1Q578	81	A1R135	107	A1R217	118	A1R292	141
A1Q152	70	A1Q586	84	A1R136	107	A1R218	119	A1R293	142
A1Q153	70	A1Q756	85	A1R138	103	A1R219	119	A1R301	123
A1Q164	71	A1Q770	80	A1R139	108	A1R220	120	A1R302	123
A1Q165	71	A1Q775	86	A1R142	107	A1R222	121	A1R303	123
A1Q202	72	A1Q779	87	A1R143	107	A1R223	121	A1R304	143
A1Q203	72	A1Q780	71	A1R144	109	A1R225	122	A1R305	143
A1Q206	73	A1Q785	86	A1R145	110	A1R226	123	A1R306	144
A1Q207	73	A1Q789	87	A1R150	93	A1R227	123	A1R307	144
A1Q230	74	A1Q804	80	A1R151	93	A1R230	116	A1R309	145
A1Q231	74	A1Q814	80	A1R152	94	A1R231	116	A1R310	146
A1Q254	75	A1Q825	82	A1R153	94	A1R233	116	A1R311	146
A1Q255	75	A1Q829	81	A1R154	95	A1R234	124	A1R312	147
A1Q256	75	A1Q835	81	A1R155	95	A1R235	124	A1R314	148
A1Q257	75	A1Q840	86	A1R156	96	A1R236	125	A1R315	148
A1Q283	76	A1Q845	87	A1R158	97	A1R239	102	A1R317	149
A1Q284	70	A1Q885	88	A1R159	98	A1R240	126	A1R318	150
A1Q285	70	A1Q908	89	A1R164	99	A1R241	127	A1R319	151
A1Q302	77	A1Q928	85	A1R165	99	A1R242	128	A1R321	152
A1Q303	77	A1Q930	89	A1R170	100	A1R244	129	A1R322	153
A1Q327	77	A1Q935	90	A1R171	100	A1R245	129	A1R324	107
A1Q328	77	A1Q938	83	A1R172	101	A1R250	123	A1R326	123
A1Q382A	78	A1Q939	83	A1R175	102	A1R251	123	A1R327	123
A1Q382B	78	A1Q944	85	A1R176	103	A1R254	130	A1R328	123
A1Q384	79	A1Q946	91	A1R180	104	A1R255	130	A1R329	143
A1Q397	71	A1Q947	91	A1R181	104	A1R256	131	A1R330	143
A1Q402	80	A1Q9070	92	A1R182	105	A1R257	131	A1R331	144
A1Q405	70	A1R100	93	A1R183	106	A1R258	132	A1R332	144
A1Q406	70	A1R101	93	A1R185	107	A1R259	132	A1R335	154
A1Q409	80	A1R102	94	A1R186	107	A1R261	133	A1R336	154
A1Q413	71	A1R103	94	A1R188	103	A1R262	134	A1R337	147
A1Q419	79	A1R104	95	A1R189	108	A1R266	135	A1R339	147
A1Q420	79	A1R105	95	A1R192	107	A1R267	135	A1R340	148
A1Q421	70	A1R106	96	A1R193	107	A1R268	135	A1R342	149
A1Q422	81	A1R108	97	A1R194	109	A1R269	135	A1R343	150
A1Q423	82	A1R109	98	A1R195	110	A1R270	135	A1R344	151

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Figure 2. Circuit Card Assembly A1 (Sheet 9 of 11)

REFERENCE DESIGNATION-TO-ITEM NUMBER TABLE

REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM
A1R346	152	A1R416	178	A1R478	192	A1R568	202	A1R799	168
A1R347	153	A1R417	178	A1R479	127	A1R569	198	A1R800	221
A1R349	107	A1R419	103	A1R486	123	A1R571	197	A1R804	175
A1R350	144	A1R420	107	A1R487	123	A1R572	175	A1R805	172
A1R351	144	A1R421	179	A1R494	120	A1R573	197	A1R810	221
A1R352	155	A1R422	168	A1R499	120	A1R574	175	A1R814	175
A1R353	155	A1R423	168	A1R500	107	A1R576	139	A1R818	108
A1R354	156	A1R424	179	A1R501	173	A1R577	123	A1R820	202
A1R356	157	A1R426	180	A1R502	111	A1R578	139	A1R822	222
A1R357	158	A1R427	180	A1R503	178	A1R580	203	A1R823	222
A1R358	107	A1R428	175	A1R504	195	A1R586	107	A1R825	223
A1R359	159	A1R429	175	A1R505	178	A1R618	204	A1R826	185
A1R360	160	A1R432	181	A1R507	196	A1R645	171	A1R828	224
A1R361	107	A1R433	181	A1R509	197	A1R646	205	A1R830	151
A1R363	161	A1R434	182	A1R510	109	A1R647	175	A1R832	225
A1R365	142	A1R435	182	A1R511	193	A1R648	173	A1R834	107
A1R366	162	A1R440	107	A1R512	198	A1R649	173	A1R835	226
A1R367	111	A1R441	107	A1R513	196	A1R673	206	A1R836	175
A1R369	163	A1R442	183	A1R514	109	A1R676	109	A1R840	139
A1R372	164	A1R443	183	A1R516	193	A1R756	207	A1R841	227
A1R374	162	A1R444	184	A1R517	198	A1R757	139	A1R842	228
A1R381	165	A1R446	185	A1R518	175	A1R758	208	A1R844	185
A1R382	144	A1R447	143	A1R523	199	A1R759	209	A1R845	206
A1R384	166	A1R448	186	A1R524	121	A1R760	210	A1R849	175
A1R385	167	A1R449	186	A1R525	200	A1R761	211	A1R851	229
A1R386	111	A1R451	168	A1R526	143	A1R764	171	A1R852	179
A1R389	168	A1R452	187	A1R527	193	A1R766	212	A1R853	177
A1R390	107	A1R453	144	A1R528	111	A1R768	213	A1R854	206
A1R392	163	A1R454	144	A1R529	193	A1R770	144	A1R858	105
A1R393	169	A1R455	107	A1R538	173	A1R773	189	A1R860	230
A1R395	111	A1R457	188	A1R539	173	A1R775	214	A1R870	231
A1R397	170	A1R458	189	A1R540	105	A1R776	215	A1R871	175
A1R398	171	A1R459	190	A1R541	105	A1R777	144	A1R872	136
A1R399	163	A1R460	191	A1R544	115	A1R778	107	A1R873	232
A1R402	172	A1R461	191	A1R545	175	A1R779	216	A1R874	231
A1R403	173	A1R462	146	A1R547	175	A1R780	144	A1R875	175
A1R405	163	A1R463	192	A1R548	175	A1R782	217	A1R877	175
A1R406	163	A1R464	115	A1R549	201	A1R783	218	A1R885	207
A1R407	170	A1R465	115	A1R555	125	A1R785	216	A1R886	233
A1R408	107	A1R467	193	A1R556	173	A1R786	217	A1R888	234
A1R409	103	A1R468	193	A1R558	173	A1R787	144	A1R889	234
A1R410	174	A1R469	193	A1R560	173	A1R788	107	A1R890	234
A1R411	122	A1R470	193	A1R561	173	A1R789	216	A1R891	234
A1R412	175	A1R473	103	A1R562	173	A1R792	219	A1R892	234
A1R413	176	A1R474	175	A1R564	162	A1R793	220	A1R893	235
A1R414	177	A1R476	194	A1R565	194	A1R796	168	A1R894	234
A1R415	177	A1R477	174	A1R566	105	A1R797	168	A1R905	236

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Figure 2. Circuit Card Assembly A1 (Sheet 10 of 11)

REFERENCE DESIGNATION-TO-ITEM NUMBER TABLE

REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM	REF DES	ITEM
A1R906	236	A1R941	175	A1U335	262	A1W335	285	A1W732	285
A1R907	237	A1R942	175	A1U350	263	A1W350	285	A1W770	285
A1R908	108	A1R943	248	A1U426	264	A1W351	285	A1W780	285
A1R909	238	A1R944	175	A1U460	265	A1W402	285	A1W885	285
A1R910	194	A1R945	249	A1U502	266	A1W408	285	A1W954	285
A1R912	239	A1R946	144	A1U504	267	A1W410	285	A1W955	285
A1R913	240	A1R947	144	A1U506	268	A1W428	285	A1W956	285
A1R914	241	A1R949	250	A1U532	269	A1W429	285	A1W959	285
A1R915	240	A1R964	251	A1U537	270	A1W453	285	A1W960	285
A1R916	242	A1R966	251	A1U540	271	A1W459	285	A1W961	285
A1R917	243	A1R971	252	A1U555	272	A1W460	285	A1W964	285
A1R919*	122	A1R976	173	A1U565	273	A1W479	285	A1W965	285
A1R919*	176	A1R978	173	A1U758	274	A1W494	285	A1W966	285
A1R919*	207	A1R9272	253	A1U930	275	A1W535	285	A1W967	285
A1R921	243	A1R9273	253	A1U975	276	A1W537	285	A1W968	285
A1R922	179	A1RT236	254	A1VR200	277	A1W538	285	A1W971	285
A1R925	195	A1S901	255	A1VR645	278	A1W555	285	A1W972	285
A1R926	244	A1T390	256	A1VR712	279	A1W556	285	A1W974	285
A1R927	185	A1T906	257	A1VR764	280	A1W558	285	A1W975	285
A1R928	221	A1T944	258	A1VR782	281	A1W560	285	A1W976	285
A1R929	108	A1T948	259	A1VR828	282	A1W582	285	A1W977	285
A1R930	185	A1TP940	68	A1VR925	283	A1W591	285	A1W979	285
A1R934	245	A1TP950	68	A1VR935	284	A1W592	285	A1W992	285
A1R935	166	A1U130	260	A1VR943	278	A1W602	285	A1W995	285
A1R937	246	A1U180	260	A1W282	285	A1W603	285	A1W997	285
A1R938	126	A1U225	261	A1W283	285	A1W635	285	A1W998	285
A1R939	247	A1U310	262	A1W310	285	A1W649	285	A1W999	285
A1R940	179								

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* RESISTOR A1R919 VALUE SELECTED DURING TEST, AND MAY BE ITEM 122, 176, OR 207

Figure 2. Circuit Card Assembly A1 (Sheet 11 of 11)

GROUP 01 CIRCUIT CARD ASSEMBLY A1

FIG 2

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
1	PAHZZ	DD81349	M39014/05-2228	CAPACITOR,FIXED,CER	6
2	PAHZZ	04222	MA101C102MAR	CAPACITOR,FIXED,CER	25
3	PAHZZ	80009	281-0772-00	CAPACITOR,FIXED,CER	8
4	PAHZZ	59660	805534Y5D0152J	CAPACITOR,FIXED,CER	2
5	PAHZZ	51642	T150-050NP0180J	CAPACITOR,FIXED,CER	1
6	PAHZZ	04222	MA101A680KAA	CAPACITOR,FIXED,CER	3
7	PAHZZ	80009	281-0140-//	CAPACITOR,VARIABLE	2
8	PAHZZ	56289	173D225X0020V	CAPACITOR,FIXED,ELE	3
9	PAHZZ	80009	281-0500-00	CAPACITOR,FIXED,CER	1
10	PAHZZ	00853	D155F191F0	CAPACITOR,FIXED,MIC	2
11	PAHZZ	54583	MA12C0G2A121J	CAPACITOR,FIXED,CER	1
12	PAHZZ	59660	301-000C0G0220K	CAPACITOR	1
13	PAHZZ	04222	MA101A510JAA	CAPACITOR,FIXED,CER	1
14	FAHZZ	81349	M39014/05-2237	CAPACITOR,FIXED,CER	2
15	PAHZZ	80009	281-0768-00	CAPACITOR,FIXED,CER	3
16	PAHZZ	04222	MA201C103KAA	CAPACITOR,FIXED,CER	10
17	PAHZZ	80009	281-0775-00	CAPACITOR,FIXED,CER	19
18	PCHZZ	55680	ULA1A220TEA	CAPACITOR,FIXED,ELE	4
19	PAHZZ	04222	MA101A4R7DAA	CAPACITOR,FIXED,CER	2
20	PAHZZ	72136	DM15CD16R8D04CR	CAPACITOR,FIXED,MIC	1
21	PAHZZ	04222	5R305SE474MAA	CAPACITOR,FIXED,CER	1
22	PAHZZ	81349	M39014/02-1350	CAPACITOR,FIXED,CER	1
23	PAHZZ	56289	1C20C0G332J100B	CAPACITOR,FIXED,CER	1
24	PAHZZ	56289	173D335X9015V	CAPACITOR,FIXED,ELE	5
25	PAHZZ	04222	MA101A181JAA	CAPACITOR,FIXED,CER	1
26	PAHZZ	96733	R3207	CAPACITOR,FIXED,CER	2
27	PAHZZ	04222	MA101A3R9DAA	CAPACITOR,FIXED,CER	1
28	PAHZZ	90201	TAC105K035P02	CAPACITOR,FIXED,ELE	2
29	PAHZZ	04222	GC101C182KAA	CAPACITOR,FIXED,CER	2
30	PAHZZ	04222	MA101A6R8DAA	CAPACITOR,FIXED,CER	1
31	PAHZZ	04222	MA101A150KAA	CAPACITOR,FIXED,CER	2
32	PAHZZ	59660	855-XXXY5E0222J	CAPACITOR,FIXED,CER	1
33	PAHZZ	80031	2502A0R503VP02F0	CAPACITOR,VARIABLE	2
34	PAHZZ	20932	202EL200AT222K	CAPACITOR,FIXED,CER	3
35	PAHZZ	19396	223K02PT485	CAP,FXD,PLASTIC	2
36	PAHZZ	56289	2C20Z5U104Z200B	CAPACITOR,FIXED,CER	6
37	PAHZZ	0422	MA101A271KAA	CAPACITOR,FIXED,CER	1
38	PAHZZ	59660	878521SY5S102M	CAPACITOR,FIXED,CER	2
39	PAHZZ	56289	430P582	CAPACITOR,FIXED,PLA	4
40	PAHZZ	60935	158/.068/M/250/H	CAPACITOR,FIXED,PLA	1
41	PAHZZ	56289	17D1149	CAPACITOR,FIXED,ELE	1
42	PAHZZ	14752	230B1E105K	CAPACITOR,FIXED,PLA	1
43	PAHZZ	80009	283-0481-00	CAPACITOR,FIXED,CER	1
44	PAHZZ	55680	ULB1E101MEA	CAPACITOR,FIXED,ELE	1
45	PAHZZ	55680	ULB1E102TFAANA	CAPACITOR,FIXED,ELE	1
46	PAHZZ	54473	ECE-A100V10L	CAPACITOR,FIXED,ELE	2
47	PAHZZ	55680	UHC2C330TFA	CAPACITOR,FIXED,ELE	1
48	PAHZZ	90201	VPR271N040E1E1C	CAPACITOR,FIXED,ELE	1

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
49	PAHZZ	90201	VPX841N012E1E1C	CAPACITOR,FIXED,ELE	6
50	PAHZZ	59660	0301-080C0J0339C	CAPACITOR,FIXED,CER	2
51	PAHZZ	80009	152-0141-02	SEMICONDUCTOR DEVIC	47
52	PAHZZ	14433	G866	SEMICONDUCTOR DEVIC	1
53	PAHZZ	07263	FDH5004	SEMICONDUCTOR DEVIC	4
54	PAHZZ	81349	JAN1N3191	SEMICONDUCTOR DEVIC	4
55	PAHZZ	12969	UES1106	RECTIFIER,SEMICONDU	1
56	PAHZZ	07263	FDH2161	SEMICONDUCTOR DEVIC	1
57	PAHZZ	12969	UTR308	SEMICONDUCTOR DEVIC	8
58	PAHZZ	12969	UTR307	SEMICONDUCTOR DEVIC	2
59	PAHZZ	04713	1N5817	SEMICONDUCTOR DEVIC	2
60	PAHZZ	43944	A1B-3	LAMP,GLOW	3
61	PAHZZ	50434	HLMP3910	LIGHT EMITTING DIOD	1
62	PAHZZ	34899	2743001111	CORE,ELECTROMAGNET	3
63	PAHZZ	02114	56-590-65/4A6	CORE,ELECTROMAGNET	1
64	PAHZZ	56880	J41405-TC	CORE,ELECTROMAGNET	1
65	PAHZZ	00779	5-3809509	CONNECTOR,RECEPTACL	3
66	PAHZZ	80009	108-0420-00	COIL,RADIO FREQUENC	4
67	PAHZZ	02113	B8724	COIL,RADIO FREQUENC	2
68	PAHZZ	22526	48283-036	TERMINAL,STUD	3
69	PAHZZ	22526	48283-029	CONTACT,ELECTRICAL	7
70	PAHZZ	04713	SPS8223	TRANSISTOR	10
71	PAHZZ	80131	2N3904	TRANSISTOR	8
72	PAHZZ	04713	SRF 518	TRANSISTOR	2
73	PAHZZ	01295	SKA6664	TRANSISTOR	2
74	PAHZZ	04713	SPS8236	TRANSISTOR	2
75	PAHZZ	01281	LT4403	TRANSISTOR	4
76	PAHZZ	04713	SPS8317	TRANSISTOR	1
77	PAHZZ	04713	SPS8608M	TRANSISTOR	4
78	PAHZZ	17856	J2012	SEMICONDUCTOR DEVIC	1
79	PAHZZ	04713	SPS8224	TRANSISTOR	7
80	PAHZZ	04713	SPS6868	TRANSISTOR	6
81	PAHZZ	04713	SPS6866K	TRANSISTOR	5
82	PAHZZ	04713	SPS8246	TRANSISTOR	3
83	PAHZZ	80009	151-0276-00	TRANSISTOR	4
84	PAHZZ	04713	SPS8802-1	TRANSISTOR	1
85	PAHZZ	27014	T07391E2	TRANSISTOR	3
86	PAHZZ	80009	151-0347-00	TRANSISTOR	3
87	PAHZZ	04713	SPS6700	TRANSISTOR	3
88	PAHZZ	80009	151-0443-00	TRANSISTOR	1
89	PAHZZ	80009	151-0164-00	TRANSISTOR	2
90	PAHZZ	03508	C106B2X283	DIODE	1
91	PAHZZ	04713	SJE389	TRANSISTOR	2
92	PAHZZ	04713	MPT3N40	TRANSISTOR	1
93	PAHZZ	01121	CB4305	RESISTOR,FIXED,COMP	4
94	PAHZZ	81349	RNC55H4020FS	RESISTOR,FIXED,FILM	4
95	PAHZZ	81349	RNC55K1100FS	RESISTOR,FIXED,FILM	4
96	PAHZZ	91637	MFF1816G464R0F	RESISTOR,FIXED,FILM	2
97	PAHZZ	8009	321-0223-0	RESISTOR,FIXED,FILM	2
98	PAHZZ	91637	CMF55116G19600F	RES,FXD,FILM	2
99	PAHZZ	91637	CMF55116G21500F	RES,FXD,FILM	4
100	PAHZZ	91637	MFF1816G187R0F	RESISTOR,FIXED,FILM	4

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
101	PAHZZ	81349	RCR07G820JS	RESISTOR,FIXED,COMP	2
102	PAHZZ	81349	RCR07G242JS	RESISTOR,FIXED,COMP	3
103	PAHZZ	81349	RCR07G182GS	RESISTOR,FIXED,COMP	6
104	PAHZZ	81349	RCR07G510JS	RESISTOR,FIXED,COMP	4
105	PAHZZ	01121	CB5115	RESISTOR,FIXED,COMP	6
106	PAHZZ	81349	RCR07G111JS	RESISTOR,FIXED,COMP	2
107	PAHZZ	81349	RCR07G101JS	RESISTOR,FIXED,COMP	23
108	PAHZZ	81349	RCR07G302JS	RESISTOR,FIXED,COMP	5
109	PAHZZ	81349	RCR07G471JS	RESISTOR,FIXED,COMP	6
110	PAHZZ	73138	72-27-0	RESISTOR,VARIABLE,N	2
111	PAHZZ	81349	RCR07G911JS	RESISTOR,FIXED,COMP	6
112	PAHZZ	81349	RNC60K6980FS	RESISTOR,FIXED,FILM	2
113	PAHZZ	81349	RNC55K82R5FS	RESISTOR,FIXED,FILM	1
114	PAHZZ	91637	MFF1816G274R0F	RESISTOR,FIXED,FILM	2
115	PAHZZ	01121	CB4315	RESISTOR,FIXED,COMP	6
116	PAHZZ	91637	CMF55116G76R80F	RESISTOR,FIXED,FILM	5
117	PAHZZ	81349	RNC55K2490FS	RESISTOR,FIXED,FILM	1
118	PAHZZ	81349	RNC55K4870FS	RESISTOR,FIXED,FILM	2
119	PAHZZ	81349	RNC55H1130FS	RESISTOR,FIXED,FILM	2
120	PAHZZ	01121	CB33G5	RESISTOR,FIXED,COMP	3
121	PAHZZ	81349	RNC55K2002FS	RESISTOR,FIXED,FILM	3
122	PAHZZ	80031	5043CX10K00J	RESISTOR,FIXED,COMP RESISTOR R919 SELECTED BY TEST	3
123	PAHZZ	81349	RCR07G221JS	RESISTOR,FIXED,COMP	13
124	PAHZZ	81349	RCR07G360JS	RESISTOR,FIXED,COMP	2
125	PAHYZZ	81349	RCR07G821JS	RESISTOR,FIXED,COMP	3
126	PAHZZ	73138	72-23-0	RESISTOR,VARIABLE,N	2
127	PAHZZ	32997	3386X-T07-102	RESISTOR,VARIABLE,N	2
128	PAHZZ	81349	RCR07G273JS	RESISTOR,FIXED,COMP	1
129	PAHZZ	81349	RNC55K6040FS	RESISTOR,FIXED,FILM	2
130	PAHZZ	91637	MFF1816G137R0F	RESISTOR,FIXED,FILM	2
131	PAHZZ	75042	CEBT0-6490F	RES,FXD,FILM	2
132	PAHZZ	81349	RNC60K7320FS	RESISTOR,FIXED,FILM	2
133	PAHZZ	91637	CMF65116G39R20F	RES,FXD,FILM	1
134	PAHZZ	81349	RCR07G151JS	RESISTOR,FIXED,COMP	1
135	PAHZZ	75042	CECT0-1500F	RESISTOR,FIXED,FILM	6
136	PAHZZ	81349	RCR07G223JS	RESISTOR,FIXED,COMP	2
137	PAHZZ	81349	RCR07G752JS	RESISTOR,FIXED,COMP	1
138	PAHZZ	80009	315-0621-00	RESISTOR	1
139	PAHZZ	01121	CB5615	RESISTOR,FIXED,COMP	5
140	PAHZZ	91637	CMF55116G49R90F	RESISTOR,FIXED,FILM	2
141	PAHZZ	81349	RNC55K7150FS	RESISTOR,FIXED,FILM	1
142	PAHZZ	81349	RCR07G620JS	RESISTOR,FIXED,COMP	2
143	PAHZZ	81349	RCR07G152JS	RESISTOR,FIXED,COMP	6
144	PAHZZ	81349	RCR07G470JS	RESISTOR,FIXED,COMP	15
145	PAHZZ	32997	3352T-CK5-501	RESISTOR,VARIABLE,W	1
146	PAHZZ	81349	RNC55K1021FS	RESISTOR,FIXED,FILM	3
147	PAHZZ	81349	RNC55J1000FS	RESISTOR,FIXED,FILM	2
148	PAHZZ	81349	RNC55K5760FS	RESISTOR,FIXED,FILM	4
149	PAHZZ	81349	RNC60K1821FS	RESISTOR,FIXED,FILM	2
150	PAHZZ	91637	CMF55116G10000F	RESISTOR,FIXED,FILM	2
151	PAHZZ	81349	RNR60C1581FS	RESISTOR,FIXED,FILM	3

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
152	PAHZZ	91637	CMF55116G14300F	RES,FXD,FILM	2
153	PAHZZ	81349	RNC55J2942FS	RESISTOR,FIXED,FILM	2
154	PAHZZ	80009	321-0203-00	RESISTOR,FIXED,FILM	2
155	PAHZZ	80009	321-0274-00	RESISTOR,FIXED,FILM	2
156	PAHZZ	81349	RCR07G272JS	RESISTOR,FIXED,COMP	1
157	PAHZZ	01121	CB6225	RESISTOR,FIXED,COMP	1
158	PAHZZ	81349	RNC55K3480FS	RESISTOR,FIXED,FILM	1
159	PAHZZ	81349	RNC55K3400FS	RESISTOR,FIXED,FILM	1
160	PAHZZ	81349	RNC60K4120FS	RESISTOR,FIXED,FILM	1
161	PAHZZ	81349	RCR07G331JS	RESISTOR,FIXED,COMP	1
162	PAHZZ	57668	NTR25J-E02K0	RESISTOR,FIXED,COMP	3
163	PAHZZ	57668	NTR25J-E750E	RESISTOR,FIXED,COMP	5
164	PAHZZ	81349	RCR07G220JS	RESISTOR,FIXED,COMP	1
165	PAHZZ	81349	RNC55K4123FS	RESISTOR,FIXED,FILM	1
166	PAHZZ	81349	RCR07G121JS	RESISTOR,FIXED,COMP	2
167	PAHZZ	01121	CB1305	RESISTOR,FIXED,COMP	1
168	PAHZZ	81349	RCR07G100JS	RESISTOR,FIXED,COMP	7
169	PAHZZ	81349	RCR07G240JS	RESISTOR,FIXED,COMP	1
170	PAHZZ	011212	CB2005	RESISTOR,FIXED,COMP	2
171	PAHZZ	57668	NTR25J-E200E	RESISTOR,FIXED,COMP	3
172	PAHZZ	81349	RCR07G562JS	RESISTOR,FIXED,COMP	2
173	PAHZZ	81349	RCR07G512JS	RESISTOR,FIXED,COMP	13
174	PAHZZ	81349	RCR07G132JS	RESISTOR,FIXED,COMP	2
175	PAHZZ	81349	RCR07G102JS	RESISTOR,FIXED,COMP	21
176	PAHZZ	01121	CB1135	RESISTOR,FIXED,COMP RESISTOR R919 SELECTED BY TEST	1
177	PAHZZ	01121	CB2445	RESISTOR,FIXED,COMP	3
178	PAHZZ	57668	NTR25J-E47K0	RESISTOR,FIXED,COMP	4
179	PAHZZ	81349	RCR32G103JS	RESISTOR,FIXED,COMP	5
180	PAHZZ	57668	NTR25J-E430K	RESISTOR,FIXED,COMP	2
181	PAHZZ	81349	RCR07G823JS	RESISTOR,FIXED,COMP	2
182	PAHZZ	01121	E4A205	RESISTOR,VARIABLE,N	2
183	PAHZZ	81349	RNC60K75R0FS	RESISTOR,FIXED,FILM	2
184	PAHZZ	01121	CB1625	RESISTOR,FIXED,COMP	1
185	PAHZZ	81349	RCR07G104JS	RESISTOR,FIXED,COMP	5
186	PAHZZ	01121	CB2705	RESISTOR,FIXED,COMP	2
187	PAHZZ	81349	RNC55K2210FS	RESISTOR,FIXED,FILM	1
188	PAHZZ	91637	MFF1816G316R0F	RESISTOR,FIXED,FILM	1
189	PAHZZ	81349	RNC60K7680FS	RESISTOR,FIXED,FILM	2
190	PAHZZ	81349	RNC55K7320FS	RESISTOR,FIXED,FILM	1
191	PAHZZ	81349	RNC55K2870FS	RESISTOR FIXED FILM	2
192	PAHZZ	81349	RNC60K1691FS	RESISTOR,FIXED,FILM	2
193	PAHZZ	813490	RCR07G392JS	RESISTOR,FIXED,COMP	8
194	PAHZZ	81349	RCR07G301JS	RESISTOR,FIXED,COMP	3
195	PAHZZ	01121	CB1245	RESISTOR,FIXED,COMP	2
196	PAHZZ	81349	RC707G391JS	RESISTOR,FIXED,COMP	2
197	PAHZZ	81349	RCR07G222JS	RESISTOR,FIXED,COMP	3
198	PAHZZ	81349	RCR07G432JS	RESISTOR,FIXED,COMP	3
199	PAHZZ	01121	CB1535	RESISTOR,FIXED,COMP	1
200	PAHZZ	81349	RNC55J2212FS	RESISTOR,FIXED,FILM	1
201	PAHZZ	57668	NTR25J-E680E	RESISTOR,FIXED,COMP	1
202	PAHZZ	80009	315-0332-00	RESISTOR,FIXED,COMP	2

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
203	PAHZZ	81349	RCR07G181JS	RESISTOR,FIXED,COMP	1
204	PAHZZ	81349	RNC55K2800FS	RESISTOR,FIXED,FILM	1
205	PAHZZ	32997	3352T-1-102	RESISTOR,VARIABLE,N	1
206	PAHZZ	57668	NTR25J-E04K7	RESISTOR,FIXED,COMP	3
207	PAHZZ	81349	RCR07G912JS	RESISTOR,FIXED,COMP RESISTOR R919 SELECTED BY TEST	2
208	PAHZZ	81349	RNC55K3092FS	RESISTOR,FIXED,FILM	1
209	PAHZZ	91637	CMF55116G59000F	RES,FXD,FILM	1
210	PAHZZ	32997	3352T-1-251	RESISTOR,VARIABLE,W	1
211	PAHZZ	81349	RNC60K1501FS	RESISTOR,FIXED,FILM	1
212	PAHZZ	81349	RNC60K1330FS	RESISTOR,FIXED,FILM	1
213	PAHZZ	81349	RNC55K4320FS	RESISTOR,FIXED,FILM	1
214	PAHZZ	75042	CECT0-1652F	RES,FXD,FILM	2
215	PAHZZ	81349	RNC60K1331FS	RESISTOR,FIXED,FILM	2
216	PAHZZ	7668	NTR25J-E24K0	RESISTOR,FIXED,COMP	2
217	PAHZZ	8009	321-0209-00	RESISTOR,FIXED,FILM	1
218	PAHZZ	91637	CMF55116G12100F	RESISTOR,FIXED,FILM	1
219	PAHZZ	81349	RNC55K5361FS	RESISTOR,FIXED,FILM	1
220	PAHZZ	91637	MFF1816G56201F	RESISTOR,FIXED,FILM	1
221	PAHZZ	81349	RCR07G682JS	RESISTOR,FIXED,COMP	3
222	PAHZZ	57668	TR50J-E 5K1	RESISTOR,FIXED,COMP	2
223	PAHZZ	81349	RC707G750JS	RESISTOR,FIXED,COMP	1
224	PAHZZ	81349	RCR07G560JS	RESISTOR,FIXED,COMP	1
225	PAHZZ	81349	RNC60K2001FS	RESISTOR,FIXED,FILM	1
226	PAHZZ	80009	321-0228-00	RESISTOR,FIXED,FILM	1
227	PAHZZ	24546	NA60D2212F	RES,FXD,FILM	1
228	PAHZZ	01121	CB2415	RESISTOR,FIXED,COMP	1
229	PAHZZ	32997	3352T-1-203	RESISTOR,VARIABLE,N	1
230	PAHZZ	011212	CB6255	RESISTOR,FIXED,COMP	1
231	PAHZZ	32997	3352T-1-104	RESISTOR,VARIABLE,N	2
232	PAHZZ	81349	RCR07G513JS	RESISTOR,FIXED,COMP	1
233	PAHZZ	81349	RCR07G184JS	RESISTOR,FIXED,COMP	1
234	PAHZZ	57668	TR50J-E 510K	RESISTOR,FIXED,COMP	6
235	PAHZZ	011212	23M909	RESISTOR,VARIABLE,N	1
236	PAHZZ	57668	TR50J-E82K	RESISTOR,FIXED,COMP	2
237	PAHZZ	91637	RS1A-90-R2J	RESISTOR,FIXED,WIRE	1
238	PAHZZ	57668	NTR25J-E39E0	RESISTOR	1
239	PAHZZ	81349	RNC55K3570FS	RESISTOR,FIXED,FILM	1
240	PAHZZ	81349	RNC60K1002FS	RESISTOR,FIXED,FILM	2
241	PAHZZ	81349	RNC60K8452FS	RESISTOR,FIXED,FILM	1
242	PAHZZ	19701	5043CX510K0J	RESISTOR,FIXED,COMP	1
243	PAHZZ	01121	CB3035	RESISTOR,FIXED,COMP	2
244	PAHZZ	01121	GB1545	RES,FXD,CMPSN	1
245	PAHZZ	80009	308-0441-00	RESISTOR,FIXED,WIRE	1
246	PAHZZ	81349	RNC55K2671FS	RESISTOR,FIXED,FILM	1
247	PAHZZ	81349	RNC55J1432FS	RESISTOR,FIXED,FILM	1
248	PAHZZ	57668	TR50J-E 4K7	RESISTOR,FIXED,COMP	1
249	PAHZZ	57668	TR50J-E2K	RESISTOR,FIXED,COMP	1
250	PAHZZ	80009	308-0677-00	RESISTOR,FIXED,WIRE	1
251	PAHZZ	01121	CB47G5	RESISTOR,FIXED,COMP	2
252	PAHZZ	75042	BW200.620HM5PCT	RESISTOR,FIXED,WIRE	1
253	PAHZZ	57668	TR50J-E 120E	RESISTOR,FIXED,COMP	2

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
254	PAHZZ	50157	2D1595	RESISTOR,THERMAL	1
255	PAHZZ	31918	NE15/F2U103EE	SWITCH,PUSH	1
256	PAHZZ	54937	DMI 500-2044	TRANSFORMER,POWER	1
257	PAHZZ	54937	5002573	TRANSFORMER,RADIO F	1
258	PAHZZ	80009	120-1347-00	TRANSFORMER,RF	1
259	PAHZZ	80009	120-1594-00	TRANSFORMER,POWER	1
260	PAHZZ	80009	155-0274-00	MICROCIRCUIT,LINEAR	2
261	PAHZZ	81349	M38510/10101BPC	MICROCIRCUIT,LINEAR	1
262	PAHZZ	02735	CA3102E-98	MICROCIRCUIT,LINEAR	2
263	PAHZZ	02735	CA3127E-98	MICROCIRCUIT,LINEAR	1
264	PAHZZ	18324	MC1458N	MICROCIRCUIT,LINEAR	1
265	PAHZZ	80009	234-0107-20	MICROCIRCUIT,LINEAR	1
266	PAHZZ	04713	MC10198	MICROCIRCUIT,DIGITA	1
267	PAHZZ	07263	96LS02	MICROCIRCUIT,DIGITA	1
268	PAHZZ	04713	MC10H131	MICROCIRCUIT,DIGITA	1
269	PAHZZ	04713	MC10H102	MICROCIRCUIT,DIGITA	1
270	PAHZZ	04713	SN74LS132NDS	MICROCIRCUIT,DIGITA	1
271	PAHZZ	07263	74LS74A	MICROCIRCUIT,DIGITA	1
272	PAHZZ	01295	SN74LS09	MICROCIRCUIT,DIGITA	1
273	PAHZZ	01295	SN74LS03	MICROCIRCUIT,DIGITA	1
274	PAHZZ	27014	GLEA134	MICROCIRCUIT,LINEAR	1
275	PAHZZ	01295	TL594CN	MICROCIRCUIT,LINEAR	1
276	PAHZZ	12969	CMX647	SEMICONDUCTOR DEVIC	1
277	PAHZZ	04713	SZG35009K3	SEMICONDUCTOR DEVIC	1
278	PAHZZ	04713	SZG20012	SEMICONDUCTOR DEVIC	2
279	PAHZZ	04713	SZ13294RL	SEMICONDUCTOR DEVIC	1
280	PAHZZ	04713	SZG30214RL	SEMICONDUCTOR,DEVIC	1
281	PAHZZ	14552	TD3810983	SEMICONDUCTOR DEVIC	1
282	PAHZZ	04713	SZG15RL	SEMICONDUCTOR DEVIC	1
283	PAHZZ	04713	SZ11738RL	SEMICONDUCTOR DEVIC	1
284	PAHZZ	04713	SZG35009K7	SEMICONDUCTOR DEVIC	1
285	PAHZZ	57668	JWW-0200E0	LEAD,ELECTRICAL	57
286	PAHZZ	80009	195-7065-00	LEAD,ELECTRICAL	1
287	PAHZZ	80009	195-7064-00	LEAD,ELECTRICAL	1
288	PAHZZ	80009	195-7063-00	LEAD,ELECTRICAL	1
289	PAHZZ	80009	195-8235-00	LEAD,ELECTRICAL	1
290	PAHZZ	80009	136-0830-00	SOCKET,PLUG IN ELEC	1
291	PAHZZ	80009	200-2735-00	COVER,POWER SWITCH	1
292	PAHZZ	80009	334-2363-00	MARKER,IDENTIFICATI	1
293	PAHZZ	80009	175-6139-00	CABLE ASSEMBLY,SPEC	1
294	PAHZZ	80009	342-0582-00	INSULATOR,PLATE	1
295	PAHZZ	80009	343-1025-00	RETAINER,TRANSISTOR	1
296	PAHZZ	80009	343-0969-00	RETAINER,TRANSISTOR	1
297	PAHZZ	80009	342-0555-00	INSULATOR,PLATE	1
298	PAHZZ	80009	407-2729-00	BRACKET,HEAT SINK	1
299	PAHZZ	78189	211-041800-00	NUT,PLAIN,ASSEMBLED	3
300	PAHZZ	80009	361-1047-00	SPACER,VARIABLE,RES	1
301	PAHZZ	80009	175-6137-00	CABLE ASSEMBLY,SPEC	1
302	PAHZZ	80009	175-6136-00	CABLE ASSEMBLY,SPEC	1
303	PAHZZ	80009	198-4819-00	CABLE ASSEMBLY,SPEC	1
304	PAHZZ	80009	175-6138-00	CABLE ASSEMBLY,SPEC	1
305	PAHZZ	80009	175-2546-01	CABLE ASSEMBLY,SPEC	1

(1) ITEM NO	(2) SMR CODE	(3) FSCM	(4) PART NUMBER	(5) DESCRIPTION AND USABLE ON CODE (UOC)	(6) QTY
306	PAHZZ	80009	175-6141-00	CABLE ASSEMBLY,SPEC	1

END OF FIGURE

NATIONAL STOCK NUMBER AND PART NUMBER INDEX

NATIONAL STOCK NUMBER INDEX

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5905-00-055-6118	2	176	5905-00-138-1285	2	225
5961-00-087-4063	2	54	5905-00-138-7530	2	94
5910-00-098-9281	2	14	5905-00-141-0742	2	203
5961-00-103-6748	2	72	5905-00-141-0743	2	193
5905-00-104-8362	2	174	5905-00-141-0744	2	172
5905-00-104-8363	2	101	5905-00-141-1132	2	137
5905-00-104-8368	2	144	5905-00-141-1183	2	107
5961-00-105-7681	2	51	5910-00-163-3938	2	20
5905-00-105-7764	2	197	5905-00-163-7092	2	187
5905-00-105-7768	2	139	5961-00-189-1266	2	74
5905-00-106-1248	2	184	5905-00-192-3461	2	112
5905-00-106-1249	2	104	5310-00-197-4505	1	54
5905-00-106-1356	2	143	5310-00-231-4954	1	17
5905-00-106-3668	2	164	5905-00-233-9202	2	190
5905-00-106-9357	2	223	5910-00-237-1196	2	34
5905-00-107-0656	2	168	5905-00-242-2546	2	153
5905-00-110-0388	2	185	5905-00-247-2970	2	245
5905-00-110-7620	2	175	5905-00-254-2451	2	191
5905-00-110-7622	2	221	5905-00-258-5403	2	208
5905-00-111-1679	2	173	5905-00-258-5882	2	219
5905-00-111-4727	2	156	5905-00-259-4433	2	146
5905-00-111-4750	2	194	5905-00-264-4330	2	158
5905-00-112-7039	2	192	5999-00-275-0213	2	69
5905-00-113-4860	2	186	5905-00-284-6076	2	159
5910-00-113-5499	2	22	5905-00-289-3920	2	200
5905-00-114-0710	2	161	5905-00-305-7959	2	119
5910-00-114-0805	2	15	5905-00-307-4104	2	95
5905-00-114-5343	2	103	5905-00-311-2351	2	241
5905-00-114-5344	2	233	5905-00-346-8062	2	148
5905-00-115-2261	2	207	5961-00-359-9493	2	87
5905-00-116-8556	2	136	5961-00-365-9935	2	86
5905-00-119-3504	2	128	5905-00-369-6931	2	106
5905-00-119-8768	2	125	5905-00-372-0039	2	151
5905-00-119-8811	2	134	5905-00-400-8999	2	93
5905-00-119-8812	2	166	5905-00-402-4258	2	230
5905-00-120-9154	2	109	5961-00-404-5537	2	83
5910-00-121-7849	2	1	5905-00-405-7784	2	188
5905-00-121-9932	2	196	5905-00-405-7790	2	96
5905-00-126-6692	2	142	5905-00-405-7803	2	130
5905-00-126-6698	2	124	5961-00-417-4107	2	73
5905-00-126-6705	2	251	5905-00-419-2845	2	147
5961-00-131-1196	2	53	5355-00-419-4032	1	16
5905-00-131-9729	2	108	5905-00-426-7129	2	149
5905-00-133-0440	2	224	5905-00-426-7144	2	183
5905-00-135-3972	2	170	5905-00-426-7708	2	97
5905-00-135-3973	2	123	5905-00-428-3857	2	212
5905-00-136-3890	2	232	5905-00-431-7827	2	217
5905-00-136-8406	2	102	5905-00-432-0370	2	247
5905-00-136-8431	2	198	5905-00-432-0402	2	121

NATIONAL STOCK NUMBER AND PART NUMBER INDEX

NATIONAL STOCK NUMBER INDEX

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5905-00-432-0425	2	129	5905-00-916-7739	2	135
5905-00-432-6378	2	117	5961-00-931-8250	2	89
5905-00-435-1718	2	228	5961-00-936-7720	2	283
5905-00-435-6374	2	181	5961-00-946-6635	2	81
5961-00-436-3317	2	78	5355-01-005-4089	1	28
5905-00-436-9884	2	238	5961-01-005-9751	2	279
5905-00-437-1696	2	140	5962-01-011-0382	2	264
5905-00-442-9356	2	169	5905-01-013-1415	2	126
5950-00-443-9512	2	63	5905-01-013-3179	2	132
5905-00-452-0736	2	113	6625-01-014-3446	2	285
5905-00-452-0764	2	220	6625-01-016-8693	1	72
5910-00-456-9019	2	7	5961-01-017-0390	2	59
6625-00-463-5241	1	73	5961-01-026-5373	2	58
5910-00-465-9742	2	32	5905-01-034-0704	2	254
5950-00-472-0426	2	66	5905-01-034-3413	2	145
5340-00-479-4346	1	43	5905-01-036-6416	2	210
5905-00-481-1330	2	239	5961-01-039-1194	2	90
5905-00-482-5044	2	114	6625-01-039-3503	1	77
5905-00-485-2918	2	120	5962-01-057-7884	2	261
5905-00-485-4554	2	111	5910-01-062-1968	2	17
5905-00-485-4648	2	177	5910-01-062-1970	2	3
5905-00-488-3277	2	189	5961-01-062-2704	2	61
5910-00-491-2446	2	31	5910-01-062-7224	2	33
5355-00-492-2316	1	33	5910-01-062-7349	2	18
5905-00-506-6563	2	160	5905-01-077-9702	2	231
5961-00-548-1964	2	282	5905-01-077-9708	2	229
5905-00-556-2944	2	110	5961-01-078-3606	2	85
5905-00-560-3132	2	127	6240-01-083-0238	2	60
6625-00-563-0090	1	71	5905-01-091-5481	2	155
5920-00-636-0963	1	48	5905-01-102-8712	2	165
5910-00-682-3287	2	9	6625-01-112-5250	1	76
5905-00-721-2376	2	215	6625-01-112-5966	1	74
5905-00-721-3736	2	141	5905-01-113-2859	2	205
5910-00-726-1024	2	10	6625-01-119-0155	1	70
5905-00-758-4802	2	213	5920-01-123-9854	1	47
5905-00-758-4840	2	211	5920-01-126-8941	1	49
5905-00-766-9392	2	115	5961-01-127-8397	2	88
5935-00-832-4946	1	69	5961-01-128-2797	2	82
5310-00-836-3520	1	41	5905-01-132-1353	2	122
	2	299	5910-01-137-6341	2	46
5961-00-879-7450	2	84	5999-01-138-5897	1	7
5961-00-892-8706	2	71	6625-01-139-3375	1	75
5961-00-896-6805	2	57	5935-01-147-3771	1	63
5910-00-903-8336	2	12	5910-01-153-2519	2	16
5905-00-904-5676	2	195	5940-01-159-2407	2	68
5905-00-904-5689	2	199	5910-01-185-9359	2	44
5961-00-905-6871	2	56	5910-01-187-6085	2	26
5961-00-908-7598	2	52	5961-01-188-6042	2	55

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STOCK NUMBER	FIG.	ITEM	STOCK NUMBER	FIG.	ITEM
5910-01-189-9228	2	25			
5910-01-191-9817	2	29			
5961-01-192-0077	2	70			
5961-01-192-1602	2	79			
6625-01-197-1938	1	56			

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
53944	A1B-3	6240-01-083-0238	2	60
75042	BW200.620HM5PCT		2	252
02113	B8724		2	67
02735	CA3102E-98		2	262
02735	CA3127E-98		2	263
01121	CB1135	5905-00-055-6118	2	176
01121	CB1245	5905-00-904-5676	2	195
01121	CB1305		2	167
01121	CB1535	5905-00-904-5689	2	199
01121	CB1625	5905-00-106-1248	2	184
01121	CB2005	5905-00-135-3972	2	170
01121	CB2415	5905-00-435-1718	2	228
01121	CB2445	5905-00-485-4648	2	177
01121	CB2705	5905-00-113-4860	2	186
01121	CB3035	5905-00-909-3954	2	243
01121	CB33G5	5905-00-485-2918	2	120
01121	CB4305	5905-00-400-8999	2	93
01121	CB4315	5905-00-766-9392	2	115
01121	CB47G5	5905-00-126-6705	2	251
01121	CB5115		2	105
01121	CB5615	5905-00-105-7768	2	139
01121	CB6225	5905-00-911-3757	2	157
01121	CB6255	5905-00-402-4258	2	230
75042	CEBT0-6490F		2	131
75042	CECT0-1500F	5905-00-916-7739	2	135
75042	CECT0-1652F		2	214
16428	CH8352		1	6
91637	CMF55116G10000F		2	150
91637	CMF55116G12100F		2	218
91637	CMF55116G14300F		2	152
91637	CMF55116G19600F		2	98
91637	CMF55116G21500F		2	99
91637	CMF55116G49R90F	5905-00-437-1696	2	140
91637	CMF55116G59000F		2	209
91637	CMF55116G76R80F		2	116
91637	CMF65116G39R20F		2	133
12969	CMX647		2	276
12697	CM41773		1	22
03508	C106B2X283	5961-01-039-1194	2	90
54937	DMI 500-2044		2	256
72136	DM15CD16R8D04CR	5910-00-163-3938	2	20
00853	D155F191F0	5910-00-726-1024	2	10
54473	ECE-A100V10L	5910-01-137-6341	2	46
01121	E4A205		2	182
07263	FDH2161	5961-00-905-6871	2	56
07263	FDH5004	5961-00-131-1196	2	53
81349	F03B250V1A	5920-00-636-0963	1	48
01121	GB1545		2	244
04222	GC101C182KAA	5910-01-191-9817	2	29
27014	GLEA134		2	274
14433	G866	5961-00-908-7598	2	52

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
50434	HLMP3910	5961-01-062-2704	2	61
81349	JAN1N3191	5961-00-087-4063	2	54
57668	JWW-0200E0	6625-01-014-3446	2	285
17856	J2012	5961-00-436-3317	2	78
56880	J41405-TC		2	64
01281	LT4403		2	75
04222	MA101A150KAA	5910-00-491-2446	2	31
04222	MA101A181JAA	5910-01-189-9228	2	25
04222	MA101A271KAA		2	37
04222	MA101A3R9DAA		2	27
04222	MA101A4R7DAA		2	19
04222	MA101A510JAA		2	13
04222	MA101A6R8DAA		2	30
04222	MA101A680KAA		2	6
04222	MA101C102MAR		2	2
54583	MA12C0G2A121J		2	11
04222	MA201C103KAA	5910-01-153-2519	2	16
04713	MC10H102		2	269
04713	MC10H131		2	268
04713	MC10198		2	266
18324	MC1458N	5962-01-011-0382	2	264
91637	MFF1816G137R0F	5905-00-405-7803	2	130
91637	MFF1816G187R0F		2	100
91637	MFF1816G274R0F	5905-00-482-5044	2	114
91637	MFF1816G316R0F	5905-00-405-7784	2	188
91637	MFF1816G464R0F	5905-00-405-7790	2	96
91637	MFF1816G56201F	5905-00-452-0764	2	220
04713	MPT3N40		2	92
81349	M38510/10101BPC	5962-01-057-7884	2	261
81349	M39014/02-1350	5910-00-113-5499	2	22
81349	M39014/05-2228	5910-00-121-7849	2	1
81349	M39014/05-2237	5910-00-098-9281	2	14
24546	NA60D2212F		2	227
31918	NE15/F2U103EE		2	255
57668	NTR25J-E02K0		2	162
57668	NTR25J-E04K7		2	206
57668	NTR25J-E200E		2	171
57668	NTR25J-E24K0		2	216
57668	NTR25J-E39E0	5905-00-436-9884	2	238
57668	NTR25J-E430K		2	180
57668	NTR25J-E47K0		2	178
57668	NTR25J-E680E		2	201
57668	NTR25J-E750E		2	163
81349	RCR07G100JS	5905-00-107-0656	2	168
81349	RCR07G101JS	5905-00-141-1183	2	107
81349	RCR07G102JS	5905-00-110-7620	2	175
81349	RCR07G104JS	5905-00-110-0388	2	185
81349	RCR07G111JS	5905-00-369-6931	2	106
81349	RCR07G121JS	5905-00-119-8812	2	166
81349	RCR07G132JS	5905-00-104-8362	2	174
81349	RCR07G151JS	5905-00-119-8811	2	134

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
81349	RCR07G152JS	5905-00-106-1356	2	143
81349	RCR07G181JS	5905-00-141-0742	2	203
81349	RCR07G182GS	5905-00-114-5343	2	103
81349	RCR07G184JS	5905-00-114-5344	2	233
81349	RCR07G220JS	5905-00-106-3668	2	164
81349	RCR07G221JS	5905-00-135-3973	2	123
81349	RCR07G222JS	5905-00-105-7764	2	197
81349	RCR07G223JS	5905-00-116-8556	2	136
81349	RCR07G240JS	5905-00-442-9356	2	169
81349	RCR07G242JS	5905-00-136-8406	2	102
81349	RCR07G272JS	5905-00-111-4727	2	156
81349	RCR07G273JS	5905-00-119-3504	2	128
81349	RCR07G301JS	5905-00-111-4750	2	194
81349	RCR07G302JS	5905-00-131-9729	2	108
81349	RCR07G331JS	5905-00-114-0710	2	161
81349	RCR07G360JS	5905-00-126-6698	2	124
81349	RCR07G392JS	5905-00-141-0743	2	193
81349	RCR07G432JS	5905-00-136-8431	2	198
81349	RCR07G470JS	5905-00-104-8368	2	144
81349	RCR07G471JS	5905-00-120-9154	2	109
81349	RCR07G510JS	5905-00-106-1249	2	104
81349	RCR07G512JS	5905-00-111-1679	2	173
81349	RCR07G513JS	5905-00-136-3890	2	232
81349	RCR07G560JS	5905-00-133-0440	2	224
81349	RCR07G562JS	5905-00-141-0744	2	172
81349	RCR07G620JS	5905-00-126-6692	2	142
81349	RCR07G682JS	5905-00-110-7622	2	221
81349	RCR07G752JS	5905-00-141-1132	2	137
81349	RCR07G820JS	5905-00-104-8363	2	101
81349	RCR07G821JS	5905-00-119-8768	2	125
81349	RCR07G823JS	5905-00-435-6374	2	181
81349	RCR07G911JS	5905-00-485-4554	2	111
81349	RCR07G912JS	5905-00-115-2261	2	207
81349	RCR32G103JS		2	179
81349	RC707G391JS	5905-00-121-9932	2	196
81349	RC707G750JS	5905-00-106-9357	2	223
81349	RNC55H1130FS	5905-00-305-7959	2	119
81349	RNC55H4020FS	5905-00-138-7530	2	94
81349	RNC55J1000FS	5905-00-419-2845	2	147
81349	RNC55J1432FS	5905-00-432-0370	2	247
81349	RNC55J2212FS	5905-00-289-3920	2	200
81349	RNC55J2942FS	5905-00-242-2546	2	153
81349	RNC55K1021FS	5905-00-259-4433	2	146
81349	RNC55K1100FS	5905-00-307-4104	2	95
81349	RNC55K2002FS	5905-00-432-0402	2	121
81349	RNC55K2210FS	5905-00-163-7092	2	187
81349	RNC55K2490FS	5905-00-432-6378	2	117
81349	RNC55K2671FS	5905-00-432-0408	2	246
81349	RNC55K2800FS	5905-00-432-0410	2	204
81349	RNC55K2870FS	5905-00-254-2451	2	191
81349	RNC55K3092FS	5905-00-258-5403	2	208

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
81349	RNC55K3400FS	5905-00-284-6076	2	159
81349	RNC55K3480FS	5905-00-264-4330	2	158
81349	RNC55K3570FS	5905-00-481-1330	2	239
81349	RNC55K4123FS	5905-01-102-8712	2	165
81349	RNC55K4320FS	5905-00-758-4802	2	213
81349	RNC55K4870FS	5905-00-137-4277	2	118
81349	RNC55K5361FS	5905-00-258-5882	2	219
81349	RNC55K5760FS	5905-00-346-8062	2	148
81349	RNC55K6040FS	5905-00-432-0425	2	129
81349	RNC55K7150FS	5905-00-721-3736	2	141
81349	RNC55K7320FS	5905-00-233-9202	2	190
81349	RNC55K82R5FS	5905-00-452-0736	2	113
81349	RNC60K1002FS		2	240
81349	RNC60K1330FS	5905-00-428-3857	2	212
81349	RNC60K1331FS	5905-00-721-2376	2	215
81349	RNC60K1501FS	5905-00-758-4840	2	211
81349	RNC60K1691FS	5905-00-112-7039	2	192
81349	RNC60K1821FS	5905-00-426-7129	2	149
81349	RNC60K2001FS	5905-00-138-1285	2	225
81349	RNC60K4120FS	5905-00-506-6563	2	160
81349	RNC60K6980FS	5905-00-192-3461	2	112
81349	RNC60K7320FS	5905-01-013-3179	2	132
81349	RNC60K75R0FS	5905-00-426-7144	2	183
81349	RNC60K7680FS	5905-00-488-3277	2	189
81349	RNC60K8452FS	5905-00-311-2351	2	241
81349	RNR60C1581FS	5905-00-372-0039	2	151
91637	RS1A-90-R2J		2	237
96733	R3207	5910-01-187-6085	2	26
04713	SJE389		2	91
01295	SKA6664	5961-00-417-4107	2	73
01295	SN74LS03		2	273
01295	SN74LS09		2	272
04713	SN74LS132NDS		2	270
04713	SPS6700	5961-00-359-9493	2	87
04713	SPS6866K	5961-00-946-6635	2	81
04713	SPS6868		2	80
04713	SPS8223	5961-01-192-0077	2	70
04713	SPS8224	5961-01-192-1602	2	79
04713	SPS8236	5961-00-189-1266	2	74
04713	SPS8246	5961-01-128-2797	2	82
04713	SPS8317		2	76
04713	SPS8608M		2	77
04713	SPS8802-1	5961-00-879-7450	2	84
04713	SRF 518	5961-00-103-6748	2	72
04713	SZG15RL	5961-00-548-1964	2	282
04713	SZG20012		2	278
04713	SZG30214RL		2	280
04713	SZG35009K3		2	277
04713	SZG35009K7		2	284
04713	SZ11738RL	5961-00-936-7720	2	283
04713	SZ13294RL	5961-01-005-9751	2	279

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
90201	TAC105K035P02		2	28
14552	TD3810983		2	281
01295	TL594CN		2	275
57668	TR50J-E 120E		2	253
57668	TR50J-E 4K7		2	248
57668	TR50J-E 5K1		2	222
57668	TR50J-E 510K		2	234
57668	TR50J-E2K		2	249
57668	TR50J-E82K		2	236
27014	T07391E2	5961-01-078-3606	2	85
51642	T150-050NP0180J		2	5
12969	UES1106	5961-01-188-6042	2	55
55680	UHC2C330TFA		2	47
55680	ULA1A220TEA	5910-01-062-7349	2	18
55680	ULB1E101MEA	5910-01-185-9359	2	44
55680	ULB1E102TFAANA		2	45
12969	UTR307	5961-01-026-5373	2	58
12969	UTR308	5961-00-896-6805	2	57
90201	VPR271N040E1E1C		2	48
90201	VPX841N012E1E1C		2	49
54583	ZUB2203-00		1	52
80009	010-6101-02	6625-00-463-5241	1	73
80009	010-6101-03	6625-01-119-0155	1	70
80009	010-6122-01		1	64
80009	013-0107-04		1	65
80009	015-0201-04	6625-01-112-5966	1	74
80009	016-0566-00	5999-01-138-5897	1	7
59660	0301-080C0J0339C		2	50
56289	1C20C0G332J100B		2	23
04713	1N5817	5961-01-017-0390	2	59
80009	108-0420-00	5950-00-472-0426	2	66
80009	119-1515-00		1	39
80009	119-1788-00		1	50
80009	120-1347-00		2	258
80009	120-1594-00		2	259
78189	1224-02	5310-00-197-4505	1	54
80009	129-0999-00		1	61
80009	131-2844-00		1	62
80009	136-0628-00		1	18
80009	136-0830-00		2	290
80009	151-0164-00	5961-00-931-8250	2	89
80009	151-0276-00	5961-00-404-5537	2	83
80009	151-0347-00	5961-00-365-9935	2	86
80009	151-0443-00	5961-01-127-8397	2	88
80009	152-0141-02	5961-00-105-7681	2	51
80009	154-0861-00		1	11
80009	155-0274-00		2	260
60935	158/.068/M/250/H		2	40
56289	17D1149		2	41
56289	173D225X0020V		2	8
56289	173D335X9015V		2	24

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
80009	175-0124-01	6625-00-563-0090	1	71
80009	175-0125-01	6625-01-016-8693	1	72
80009	175-1661-01	6625-01-139-3375	1	75
80009	175-2546-01		2	305
80009	175-3217-00		1	68
80009	175-6136-00		2	302
80009	175-6137-00		2	301
80009	175-6138-00		2	304
80009	175-6139-00		2	293
80009	175-6140-00		1	19
80009	175-6141-00		2	306
80009	195-0389-00		1	51
80009	195-1870-00		1	66
80009	195-5499-00		1	53
80009	195-6176-00		1	67
80009	195-7063-00		2	288
80009	195-7064-00		2	287
80009	195-7065-00		2	86
80009	195-8235-00		2	289
80009	198-4819-00		2	303
56289	2C20Z5U104Z200B		2	36
50157	2D1595	5905-01-034-0704	2	254
80131	2N3904	5961-00-892-8706	2	71
73743	2X-20319-402	5310-00-231-4954	1	17
80009	200-1388-03		1	55
80009	200-2264-00	5920-01-126-8941	1	49
80009	200-2519-00		1	40
80009	200-2520-00		1	1
80009	200-2538-00		1	3
80009	200-2735-00		2	291
20932	202EL200AT222K	5910-00-237-1196	2	34
80009	204-0833-00	5920-01-123-9854	1	47
95712	2048-2NT34		1	78
80009	206-0191-03	6625-01-039-3503	1	77
78189	211-041800-00	5310-00-836-3520	1	41
			2	299
80009	214-3375-00		1	37
19396	223K02PT485		2	35
01121	23M909		2	235
14752	230B1E105K		2	42
80009	234-0107-20		2	265
80031	2502A0R503VP02F0	5910-01-062-7224	2	33
34899	2743001111		2	62
24931	28P224-1	6625-01-112-5250	1	76
80009	281-0140-//	5910-00-456-9019	2	7
80009	281-0500-00	5910-00-682-3287	2	9
80009	281-0768-00	5910-00-114-0805	2	15
80009	281-0772-00	5910-01-062-1970	2	3
80009	281-0775-00	5910-01-062-1968	2	17
80009	283-0481-00		2	43
59660	301-000C0G0220K	5910-00-903-8336	2	12

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FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
80009	308-0441-00	5905-00-247-2970	2	245
80009	308-0677-00		2	250
13511	31-279	5935-00-001-7558	1	46
80009	311-1183-02		1	25
80009	311-2177-02		1	20
80009	315-0332-00		2	202
80009	315-0621-00		2	138
80009	321-0203-00		2	154
80009	321-0209-00	5905-00-431-7827	2	217
80009	321-0223-0	5905-00-426-7708	2	97
80009	321-0228-00		2	226
80009	321-0274-00	5905-01-091-5481	2	155
80009	333-3109-00		1	27
80009	334-2363-00		2	292
32997	3352T-CK5-501	5905-01-034-3413	2	145
32997	3352T-1-102	5905-01-113-2859	2	205
32997	3352T-1-104	5905-01-077-9702	2	231
32997	3352T-1-203	5905-01-077-9708	2	229
32997	3352T-1-251	5905-01-036-6416	2	210
95712	33600-1	5935-00-832-4946	1	69
80009	337-2775-01		1	10
32997	3386X-T07-102	5905-00-560-3132	2	127
80009	342-0555-00		2	297
80009	342-0582-00		2	294
80009	343-0969-00		2	296
80009	343-1025-00		2	295
80009	344-0132-00	5340-00-479-4346	1	43
80009	344-0347-00		1	45
80009	348-0555-00		1	44
80009	348-0659-01		1	5
80009	358-0550-00		1	26
80009	361-1047-00		2	300
80009	366-1031-03	5355-00-492-2316	1	33
80009	366-1146-00	5355-00-419-4032	1	16
80009	366-1391-03		1	12
80009	366-1480-03		1	34
80009	366-1840-03		1	30
80009	366-1850-00		1	29
80009	366-2013-00		1	59
80009	366-2049-01		1	15
80009	366-2052-01		1	31
80009	366-2146-03		1	14
80009	366-2148-01		1	32
80009	367-0289-00		1	4
80009	377-0512-00		1	36
80009	378-0237-00		1	9
80009	384-1575-00		1	35
80009	384-1576-01		1	21
80009	390-0790-11		1	2
80009	407-2729-00		2	298
80009	426-1765-02		1	8

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PART NUMBER INDEX

FSCM	PART NUMBER	STOCK NUMBER	FIG.	ITEM
56289	430P582		2	39
05129	461-S-70	5355-01-005-4089	1	28
22526	48283-029	5999-00-275-0213	2	69
22526	48283-036	5940-01-159-2407	2	68
00779	5-3809509		2	65
04222	5R305SE474MAA		2	21
54937	5002573		2	257
80031	5043CX10K00J	5905-01-132-1353	2	122
19701	5043CX510K0J		2	242
02114	56-590-65/4A6	5950-00-443-9512	2	63
80009	670-7615-00		1	42
80009	670-8404-00	6625-01-197-1938	1	56
80009	670-8405-00		1	57
80009	670-8406-00		1	58
80009	670-8407-00		1	23
80009	670-8418-00		1	13
80009	670-8444-00		1	60
80009	670-8819-00		1	24
80009	672-0111-00		1	38
73138	72-23-0	5905-01-013-1415	2	126
73138	72-27-0	5905-00-556-2944	2	110
07263	74LS74A		2	271
59660	805534Y5D0152J		2	4
59660	855-XXXY5E0222J	5910-00-465-9742	2	32
59660	878521SY5S102M		2	38
07263	96LS02		2	267
77820	9663-1 NT-34	5935-01-147-3771	1	63