NAVSHIPS 0969-092-0010

TECHNICAL MANUAL

for

OSCILLOSCOPE

AN / USM-117

AN / USM-117A

AN / USM-117B

and

AN / USM-117C

This manual supersedes Navships
94344(A), Navships 0969-087-6010
and Navships 0969-087-6012.

DEPARTMENT OF THE NAVY
NAVAL ELECTRONIC SYSTEMS COMMAND

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LIST OF EFFECTIVE PAGES

PAGE NUMBERS	CHANGE IN EFFECT	PAGE NUMBERS	CHANGE IN EFFECT
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1-1 to 1-12	Original	6-1 to 6-60	Original
2-1 to 2-6	Original	7-1 to 7-66	Original
3-1 to 3-16	Original	i-1 to i-7	Original

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Manufacturing Division
P.O. Box 527
Lansdale, Pennsylvania

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Philadelphia 18, Pennsylvania

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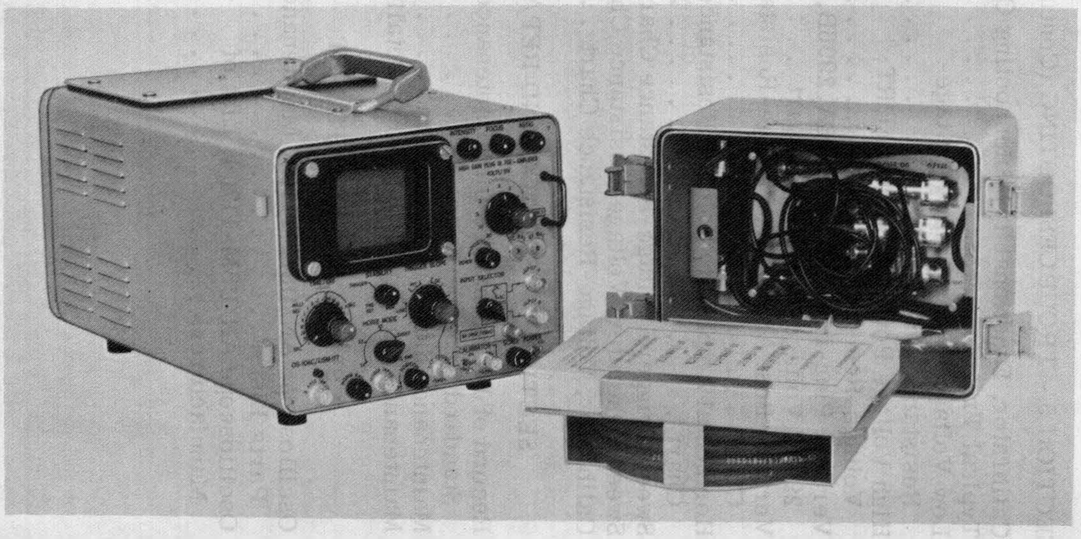


Figure 1-1. Oscilloscope AN/USM-117( )

SECTION 1
GENERAL INFORMATION

1-1. PURPOSE OF TECHNICAL MANUAL

The purpose of this technical manual is to supply information which will assist in the installation, operation, and maintenance of Oscilloscopes AN/USM-117, 117A, 117B, and 117C. Failure to follow the procedures outlined in this manual may result in incorrect operation, improper maintenance procedures, and generally poor performance of the instrument. All references to AN/USM-117 apply equally to AN/USM-117A, AN/USM-117B, and AN/USM-117C unless otherwise specified.

1-2. FUNCTIONAL DESCRIPTIONS.

Oscilloscope AN/USM-117( ), shown in figure 1-1. is a transistorized general purpose portable test instrument, suited for a wide variety of waveform viewing applications. It may be used at any base, field installation, or aboard ships having a power source of 115 volts at 50, 60, or 400 cps available. Differences between the four models are in the circuitry and the dimensions of the assembled case. Operation of the four models is identical. The AN/USM-117A, 117B, 117C provide storage of the line cord inside the cover. The circuits of the instrument function as follows:

The low voltage power supply provides regulated dc for all circuitry throughout the instrument.

Vertical Plug-in MX-2996, 2996A, 2996B, 2996C are high gain preamplifiers having a basic 10 millivolts per division sensitivity with five megacycle bandpass. Vertical Plug-in MX-2295 series are dual trace preamplifiers having a basic 50 millivolts per division sensitivity with five megacycle bandpass. Refer to NAVSHIPS 95712 for description and use of the dual trace preamplifiers.

Output signals from the vertical plug-in preamplifier are further amplified by the vertical post amplifier and then delayed before being applied to the vertical deflection plates.

The horizontal amplifier selects either external or internal sweep signals and provides the horizontal deflection signals for the crt. Magnification of the sweep is accomplished by increasing the sensitivity of the output amplifier by a factor of five.

The sweep trigger selects internal, external, or line triggering signals and provides an amplified sharp positive-going spike coincident with the trigger input waveform, which is used to actuate the sweep generator.

An internal voltage calibrator provides two accurate amplitude square wave outputs which are used as a reference for accurate amplitude measurements.

1-3. FACTORY OR FIELD CHANGES.

For applicable field changes refer to the Electronic Installation and Maintenance Book (EIMB), NAVSHIPS 900,000 .4. This book contains a complete field change identification guide for test equipment.

1-4. QUICK REFERENCE DATA.

Oscilloscope AN/USM-117( ) consists of an indicator unit designated OS-106( ) /USM-117 and a plug-in preamplifier designated MX-2996( )/USM-117. Tables 1 - 1, 1 - 2, and 1 - 3 list equipment supplied with AN/USM-117( ) Oscilloscopes. Reference data for these units are as follows:

a. HORIZONTAL AMPLIFIER CHARACTERISTICS.

(1) BANDWIDTH. - Dc to 500 kc, within 3 db.

(2) SENSITIVITY. - Three ranges provide sensitivity figures of 0.5 volt per division, 1.0 volt per division, and 2.5 volts per division. The HORIZ GAIN control provides a variable sensitivity adjustment between ranges and extends the 2.5 volt range beyond 5.0 volts per division.

(3) INPUT IMPEDANCE. - 100 kilohms minimum, shunted by 30 uuf maximum (capacity typically less than 20 uuf).

b. SWEEP GENERATOR CHARACTERISTICS.

(1) SWEEP RANGE. - Adjustable in 19 calibrated steps in a 1, 2, 5, 10 sequence from 0.1 microsecond per division to 0.1 second per division, accurate to within 3 percent. The VARIABLE TIME/DIV control provides continuous adjustment of sweep timing between all ranges.

(2) SWEEP MAGNIFIER. - Sweep may be expanded five times with accuracy maintained within 3 percent for sweep speed of 0.1 u sec per division or slower.

(3) GATE OUTPUT. - Positive-going waveform coincident with the start of the sweep and lasting for the duration of the sweep. Output voltage is approximately 20 volts peak-to-peak.

c. TRIGGER CIRCUIT CHARACTERISTICS.

(1) TRIGGER SLOPE. - Line, internal, or external signal sources may be selected on either positive or negative polarity. Ac or Dc coupling may be selected for the EXT TRIGGER INPUT.

(2) TRIGGERING MODE. - The STABILITY control selects the operational state of the sweep generator. The STABILITY control may be set to TRIGGER, PRESET, or FREE RUN providing driven or recurrent operation of sweep.

(3) TRIGGER REQUIREMENTS.

(a) INTERNAL. - At least one-half division deflection on graticule.

(b) EXTERNAL. - At least 0.5 volt.

d. VERTICAL PLUG-IN MX-2996, 2996A, 2996B, 2996C CHARACTERISTICS.

(1) BANDWIDTH. - Dc to 5 mc within 3 db, direct coupled; 2 cps to 5 mc within 3 db, capacity coupled.

(2) SENSITIVITY. - Adjustable in 11 calibrated steps in a 1, 2, 5, 10 sequence from 0.01 volt per division to 20 volts per division, accurate to within 5 percent. The VARIABLE VOLTS/DIV control provides continuous adjustment between ranges and extends the 20 VOLTS/DIV range to approximately 50 volts per division.

(3) INPUT IMPEDANCE. - 1 megohm shunted by 47 uuf maximum.

(4) INPUT ISOLATION. - 50 db minimum between INPUT A and INPUT B.

(5) RISE TIME. - Less than .07 us between the 10 and 90 percent points of max. amplitude.

e. VERTICAL POST AMPLIFIER CHARACTERISTICS.

(1) BANDWIDTH. - In excess of 5 mc, within 3 db. for oscilloscope AN/USM-117 and 10 mc within 3 db for oscilloscope AN/USM-117A, 117B, 117C.

(2) SENSITIVITY. - Fixed at 0.1 volts peak-to-peak per division.

f. PROBE MX-2817/U or MX-4073/U.

(1) INPUT IMPEDANCE. - 10 megohms (±10 percent) shunted by 13 uuf maximum.

(2) VOLTAGE RATING. - 600 volts (dc plus peak ac.).

g. CALIBRATOR CHARACTERISTICS.

(1) WAVESHAPE. - Square wave of 1 kc (±10 percent) with rise and fall time of 1.5 u sec maximum.

(2) VOLTAGE AMPLITUDE. - Two calibrated voltages of 0.04 and 0.4 volt peak-to-peak, accurate to within 2 percent.

h. CATHODE-RAY TUBE CHARACTERISTICS.

(1) TYPE. - A 2-1/4 in. by 3-1/4 in. flat face, helical band, 3 kv post accelerator type 4QP crt with P31 phosphor screen. AN/USM-117 with ser. nos. prefixed by A used P2 phosphor.

(2) GRATICULE. - Edge illuminated type, 10 divisions long by 8 division high (1 division = 1/4 in.). Green filter, compatible with P31 phosphor, also supplied.

(3) DEFLECTION FACTORS.

(a) VERTICAL DEFLECTION PLATE (D3-D4) FACTOR. - Approximately 4.0 volts per division.

(b) HORIZONTAL DEFLECTION PLATE (D1-D2) FACTOR. - Approximately 6.8 volts per division.

(4) INTENSITY MODULATION. - Signal of plus 40 volts is required to blank the screen.

i. POWER REQUIREMENTS. - 115 volts ±10 percent, 50 - 60 cps ±5 percent or 400 cps ±10 percent. Power required is approximately 25 watts.

1-5. EQUIPMENT LISTS.

a. EQUIPMENT SUPPLIED. - The Oscilloscope consists of the equipment listed in table 1-1, 1-2, and 1-3.

b. SEMICONDUCTOR COMPLEMENT. - The semiconductor complement is given in tables 1-4 and 1-5.

c. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED. - Refer to table 1-6 and paragraph 5-2 for equipment required but not supplied.

TABLE 1-1. OSCILLOSCOPE AN/USM-117, EQUIPMENT SUPPLIED

QTY PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS*				
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	VOLUME	WEIGHT
1	Oscilloscope Assembly	AN/USM-117	8-9/16	9-13/16	18-1/4**	1,530	23
1	Oscilloscope	OS-106/USM-117	8-9/16	9-5/32	15-27/32	1,240	17
1	Vertical Plug-in	MX-2996/USM-117	4-13/16	3-1/8	9	135	2
2	Test Prod	MX-2817/U or MX-4073/U					
1	Oscilloscope Cover	CW-541/USM-117 or CW-541A/USM-117	7 7	9-13/16 9-13/16	4 5-1/2	275 375	4 7
1	Electrical Power Cable Assy	CX-4704/U	8 ft				
2	Radio Freq Cable Assy	CG-409E/U	8 ft				
2	Adapter Connector	UG-1035/U					
2	Adapter Connector	UG-255/U					
2	Adapter Connector	UG-273/U					
2	Adapter Connector	UG-274A/U					
1***	Preamplifier Test Cable	Figure 5-1					
2	Technical Manual						

*Note: Dimensions are in inches, volume in cubic inches, and weight in pounds. Dimensions include protrusions. Handle in resting position.

**Note: 19-3/4 for Serial Numbers B - 1 and above.

***Note: Not supplied with units whose Ser. No. are prefixed by A.

TABLE 1-2. OSCILLOSCOPE AN/USM-117A. EQUIPMENT SUPPLIED

QTY PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS*				
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	VOLUME	WEIGHT
1	Oscilloscope Assembly	AN/USM-117A	8-9/16	9-13/16	20-1/2	1720	26
1	Oscilloscope	OS-106A/USM-117	8-9/16	9-5/32	15-27/32	1240	17
1	Vertical Plug-in	MX-2996A/USM-117	4-13/16	3-1/8	9	135	2
2	Test Prod	MX-2817/U or MX-4073/U					
1	Oscilloscope Cover	CW-541B/USM-117	7	9-13/16	6	420	7
1	Electrical Cable Assy	CX-4704/U	8 ft				
2	Radio Freq Cable Assy	CG-409E/U	8 ft				
2	Adapter Connector	UG-1035/U					
2	Adapter Connector	UG-255/U					
2	Adapter Connector	UG-273/U					
2	Adapter Connector	UG-274A/U					
1	Preamplifier Test Cable	Figure 5-1					
2	Technical Manual						

TABLE 1-3. OSCILLOSCOPE AN/USM-117B, EQUIPMENT SUPPLIED

QTY PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS*				
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	VOLUME	WEIGHT
1	Oscilloscope Assembly	AN/USM-117B	8-9/16	9-13/16	20-1/2	1720	26
1	Oscilloscope	OS-106B/USM-117	8-9/16	9-5/32	15-27/32	1240	17
1	Vertical Plug-in	MX-2996B/ USM-117	4-13/16	3-1/8	9	135	2
2	Test Prod	MX-2817/U or MX-4073/U					
1	Oscilloscope Cover	CW-541B/USM-117	7	9-13/16	6	420	7
1	Electrical Power Cable Assy	CX-4704/U	8 ft				
2	Radio Freq Cable Assy	CG-409E/U	8 ft				
2	Adapter Connector	UG-1035/U					
2	Adapter Connector	UG-255/U					
2	Adapter Connector	UG-273/U					
2	Adapter Connector	UG-274A/U					
1	Preamplifier Test Cable	Figure 5-1					
2	Technical Manual	Figure 5-2					

*Note: Dimensions are in inches, volume in cubic inches, and weight in pounds. Dimensions include protrusions. Handle in resting position.

TABLE 1-4. OSCILLOSCOPE AN/USM-117, TRANSISTOR AND SEMICONDUCTOR COMPLEMENT

SECTION	NUMBER OF SEMICONDUCTORS OF TYPES INDICATED																											
	2N388	2N780	2N711	2N965	2N1225	2N337	2N1304	2N1226	2N706	2N338	2N1309	2N863	2N1307	2N1546	2N1305	2N1547	1N643	1N751A	1N3031B	1N752A	1N756A	1N538	1N914	KX1140	KX1139	1N3051B	SZ540	Total
Low Voltage Power Supply														3	5			2	1	2	1	12						26
High Voltage Power Supply								2						1	1	2								2	1	1	4	14
Vertical Plug-in MX-2996/ USM-117		2	4	1													2											9
Vertical Post Amplifier			4		5																							9
Horizontal Amplifier						1	1	2																				4
Sweep Trigger			2		2																							4
Sweep Generator			2		1				1	1	1	2	1				3			1								13
Calibrator	1						2																2					5
Total Number of Each Type	1	2	12	1	8	1	3	4	1	1	1	2	1	4	6	2	5	2	1	3	1	12	2	2	1	1	4	84

Notes:
1. Crt is type 4QP2 in early units. Ser. No. B 1 and subsequent use type 4QP31
2. Substitute transistor type 2N705 for type 2N711 when making replacement.
3. Four SZ540 zener diodes may be replaced by three 1N989B and one 1N992B diodes per MIL-S-19500/117.
4. Substitute diode type 1N1734 for type KX1140 when making replacement.
5. Substitute diode type 1N1731 for type KX1139 when making replacement.

TABLE 1-5. OSCILLOSCOPE AN/USM-117A, 117B, 117C, TRANSISTOR AND SEMICONDUCTOR COMPLEMENT

SECTION	NUMBER OF SEMICONDUCTORS OF TYPES INDICATED																												
	2N388	2N780	2N705	2N965	2N1225	2N337	2N1304	2N1226	2N706	2N338	2N1309	2N863	2N1307	2N1546	2N1305	2N1547	1N643	1N751A	1N3031B	1N752A	1N756A	1N538	1N914	1N1734	1N1731	1N3051B	1N989B	1N992B	Total
Low Voltage Power Supply														3	5			2	1	2	1	12							26
High Voltage Power Supply								2						1	1	2							1	2	1	1	3	1	15
Verticle Plug-in MX-2996A, 2996B		2	4	1													2												9
Vertical Post Amplifier			4		5																								9
Horizontal Amplifier						1	1	2																					4
Sweep Trigger			2		2																								4
Sweep Generator			2		1				1	1	1	2	1				3			1									13
Calibrator	1						2																2						5
Total Number of Each Type	1	2	12	1	8	1	3	4	1	1	1	2	1	4	6	2	5	2	1	3	1	12	3	2	1	1	3	1	85

Note: Crt is type 4QP31

TABLE 1-6. TEST EQUIPMENT REQUIRED BUT NOT SUPPLIED

ITEM	FUNCTION	DESCRIPTION	TYPE NUMBER
1	Measurement of off ground voltages without shock hazard	20,000 ohms/V Multimeter	AN/PSM-4B
2	Measurement of voltage and resistance	Vacuum Tube Voltmeter	AN/USM-116
3	Signal Source	Time Mark Generator	Tektronix type 180A
4	Signal Source	Sine Wave Generator	AN/URM-127
5	Signal Source	Square Wave Generator	Hewlett Packard model 211A
6	Calibrating Source	Precision Calibrator	Hewlett Packard model 738AR
7	Measurement of Waveforms	Oscilloscope	AN/USM-105A with MX-2930/USM-105 Plug-in
8	Measurement of Transistors	Transistor Test Set	AN/USM-206

Items 3, 5 and 6 required for calibration and major repair.

SECTION 2
INSTALLATION

2-1. UNPACKING AND HANDLING.

Care must be taken when unpacking and removing Oscilloscope AN/USM-117( ) from its shipping container. Refer to figure 2-1 for packing sequence. Dropping the instrument may affect its calibration, damage components, or cause the crt to crack or implode. To remove the instrument from its case, unlatch and remove the front cover; turn the fastener, located in the rear-center area of the case, one-quarter turn; slide the instrument forward. Once removed, check to see that the high voltage cap is firmly in place on the side of the crt. Likewise, check the deflection plate and geometry pin connections on the neck of the crt. Also note if the crt itself is firmly seated in its socket. When returned to its case and secured in place, the instrument is ready for use.

2-2. POWER REQUIREMENTS.

Oscilloscope AN/USM-117( ) is designed to operate from a power source of 115 volts ±10 percent, 50-60 cps ±5 percent or 400 cps ±10 percent, at 25 watts or more. It is important that Power Cable CX-4704/U be plugged into a properly grounded three connector power receptacle which matches the three prong polarized plug of the cable. If for any reason the third (ground) connector is removed from the plug or an adapter is used, the green (ground) wire on the plug must be connected to a suitable earth type ground.

WARNING

A shock hazard will result if the green (ground) lead is not properly grounded.

2-3. INSTALLATION REQUIREMENTS.

The amount of bench space required for convenient operation of Oscilloscope may be judged by referring to the outline drawing given in figure 2-2.

2-4. INSPECTION AND ADJUSTMENT.

After unpacking Oscilloscope from its shipping container and removing its case as described in paragraph 2-1, carefully inspect the instrument for physical damage. If the instrument is new or has just been repaired, it should be operational. If in doubt, make a preliminary amplitude check using the internal calibrator. Sweep time may be checked with a fair degree of accuracy by measuring the period of the calibrator waveform which is equal to one millisecond. More extensive checks along with complete adjustment instructions are given in section 6. The only external adjustments to be made are DC BAL and EF BAL on Vertical Plug-in preamplifier. Refer to paragraph 3-3b for balancing adjustments.

AN/USM-117		
COVER USED	"A"	"B"
CW-541/USM-117	19-7/8	20-7/8
CW-541A/USM-117	21-3/8	22-3/8

AN/USM-117A,-117B-117C		
COVER USED	"A"	"B"
CW-541B/USM-117	21-7/8	22-7/8

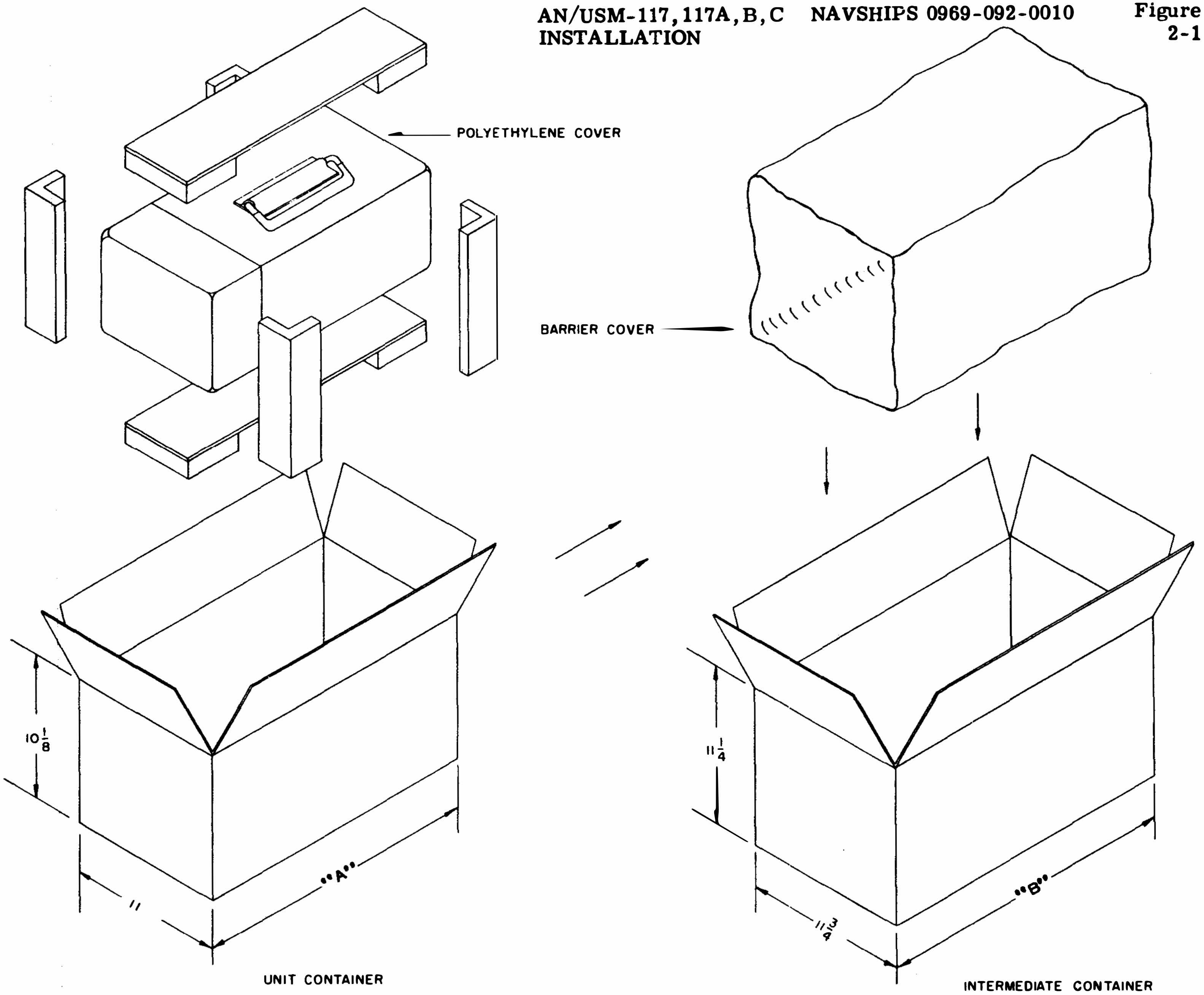


Figure 2-1. Oscilloscope AN/USM-117( ) Packing

AN/USM-117	
COVER USED	"A"
CW-541/USM-117	17-7/8
CW-541A/USM-117	

AN/USM-117A,-117B,-117C	
COVER USED	" A "
CW-541B/USM-117	19-7/8

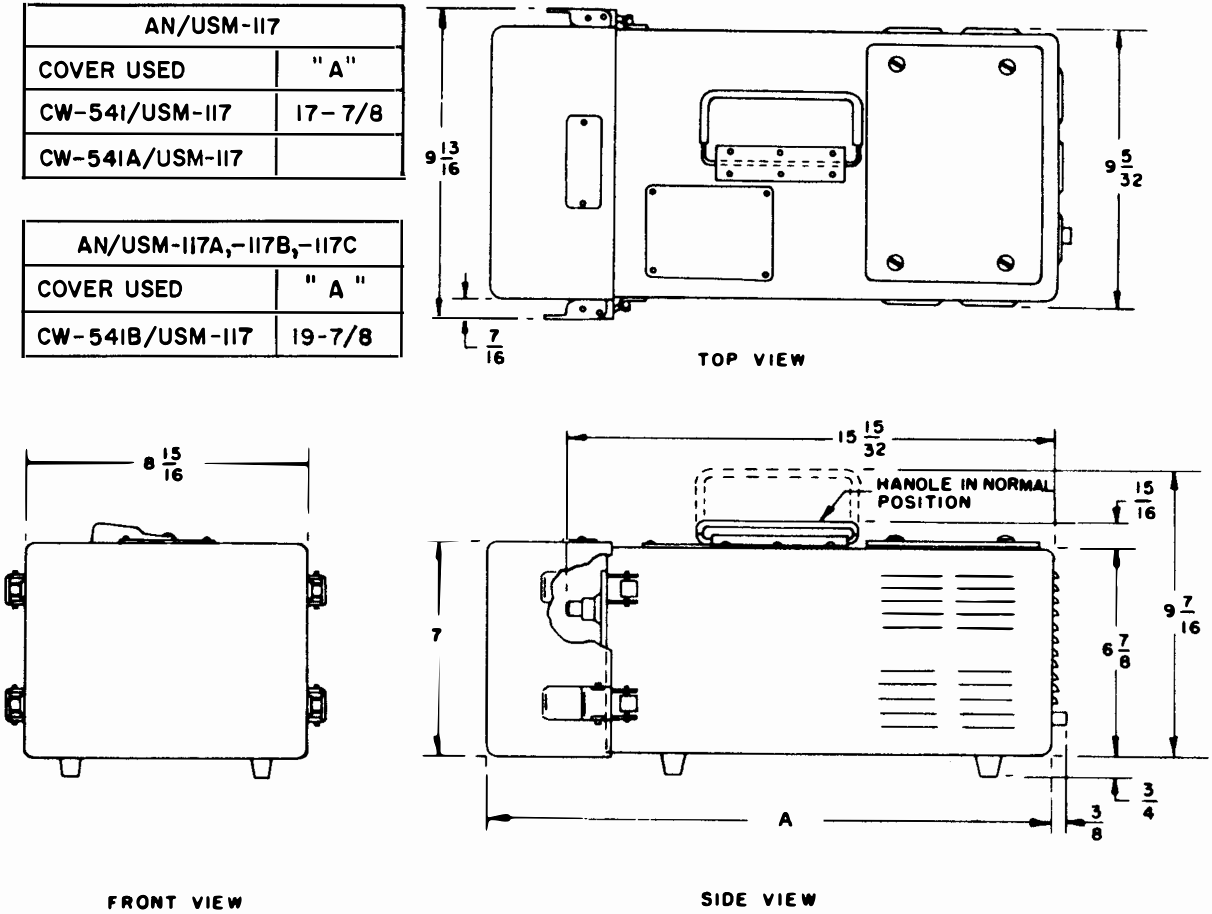


Figure 2-2. Oscilloscope AN/USM-117( ), Outline Drawing

SECTION 3
OPERATOR'S SECTION

3-1. FUNCTIONAL OPERATION.

Although designed as a general purpose instrument, the compact size and light weight of Oscilloscope AN/USM-117( )make it especially useful in field maintenance applications. A wide range of signal levels may readily be viewed using the high gain vertical plug-in MX-2996 series which has a basic sensitivity of 10 millivolts per division and a bandpass of five megacycles. Dual channel operation can also be provided if the dual trace vertical preamplifier MX-2995/USM-117 described in NAVSHIPS 95712 is available. Calibrated sweep time and vertical amplitude selectors permit accurate input signal measurements. Control of sweep circuit funtioning provides for either triggered or free-running operation. Stability of operation is insured by the use of a regulated power supply.

3-2. PREPARATION FOR USE.

With the polarized line cord properly inserted into a power receptacle, turn the POWER switch to ON. Allow at least a five minute warm-up period. Never allow a bright undeflected spot to remain on the crt screen.

3-3. OPERATING PROCEDURES.

Since proper operation depends on correct interpretation and use of controls and connectors, the location, markings, and functions of these devices are described before the operating procedures are presented. Paragraph 3-4 offers a detailed explanation of typical operating procedures.

a. DESCRIPTION OF CONTROLS. - All controls required for normal operation are mounted on the front panel of the Oscilloscope. Figure 3-1 illustrates all front panel controls and connectors. The functions of the controls and connectors are described in table 3-1.

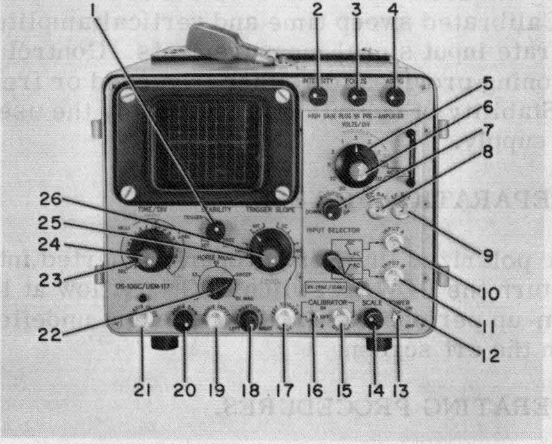


Figure 3-1. Oscilloscope AN/USM-117( ), Front Panel Controls

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
POWER switch	13	Turns power on or off.
CATHODE RAY TUBE CONTROLS AND CONNECTOR		
INTENSITY control	2	Adjusts the degree of spot or trace brightness.
FOCUS control	3	Adjusts size and sharpness of spot on crt screen.
ASTIG control	4	Adjusts shape of spot on crt screen.
SCALE control	14	Adjusts illumination of lines on crt graticule.
Z-AXIS INPUT connector	21	Accepts signals for modulation of crt.
VERTICAL PLUG-IN MX-2996( ) USM-117 CONTROLS AND CONNECTORS		
VOLTS/DIV switch	5	Selects deflection sensitivity values from 0.01 volt to 20 volts peak-to-peak per division. Ac coupled only below 0.1 volt per division.

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
VERTICAL PLUG-IN MX-2996( )USM-117 CONTROLS AND CONNECTORS - Contd.		
VARIABLE control	6	Concentric red knob with VOLTS/DIV switch provides uncalibrated variable sensitivity between steps on the VOLTS/DIV switch. Also extends sensitivity on 20 VOLTS/DIV range to 50 VOLTS/DIV.
POSITION control	7	Positions the trace on a vertical plane.
INPUT SELECTOR switch	12	Selects either INPUT A or INPUT B with AC or DC coupling as desired.
DC BAL control	8	Adjusts balance of vertical preamplifier, thereby preventing trace shift when the VARIABLE control is rotated.

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
VERTICAL PLUG-IN MX-2996( )USM-117 CONTROLS AND CONNECTORS - Contd.		
EF BAL control	9	Adjusts input impedance of input stage to proper value, and prevents trace shift when the VOLTS/ DIV switch is rotated.
INPUT A connector	10	Accepts signals fed to vertical preamplifier.
INPUT B connector	11	Accepts signals fed to vertical preamplifier.
HORIZONTAL CONTROLS AND CONNECTOR		
POSITION control	18	Positions the trace on a horizontal plane.
HORIZ MODE switch	22	Functions to attenuate external horizontal deflection waveforms on the X1, X2, and X5 positions. Also provides sweep and 5X MAG sweep.

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
HORIZONTAL CONTROLS AND CONNECTOR - Contd.		
HORIZ GAIN control	20	Adjusts uncalibrated variable sensitivity between X1, X2, and X5 ranges. Also extends sensitivity on X5 range beyond five volts per division.
HORIZ. INPUT connector	19	Accepts . signals for horizontal deflection when the HORIZ MODE switch is set to X1, X2, or X5.
SWEEP AND TRIGGER CONTROLS AND CONNECTORS		
TIME/DIV switch	23	Selects sweep speeds in 19 calibrated steps in a 1, 2, 5, 10 sequence from 0.1 microsecond to 0.1 second per division.
VARIABLE control	24	Concentric red knob with TIME/DIV switch provides adjustment between steps on TIME/DIV switch. When turned from the maximum cw position, the sweep is uncalibrated.

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
SWEEP AND TRIGGER CONTROLS AND CONNECTORS - Contd.		
STABILITY control	1	Adjusts the time base generator for TRIGGER (driven) operation or FREE RUN (recurrent) operation. PRESET position provides optimum triggering point as determined by an internal stability control.
TRIGGER SLOPE switch	25	Selects the type of triggering signal: LINE, INT, and EXT on either + or - slope. AC or DC coupling may be selected on EXT TRIGGER.
LEVEL control	26	Concentric red knob with TRIGGER SLOPE switch determines the level on the amplitude of the triggering waveform for the start of the sweep.
EXT TRIGGER INPUT connector	17	Accepts signals to trigger the sweep when the TRIGGER SLOPE switch is set to any position on the right hand side of its dial.

TABLE 3-1. OPERATING CONTROLS AND CONNECTORS
(Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
SWEEP AND TRIGGER CONTROLS AND CONNECTORS - Contd.		
GATE OUT connector*		Provides a positive-going waveform coincident with the start of the sweep and lasting for the duration of the sweep.
CALIBRATOR CONTROL AND CONNECTOR		
CALIBRATOR switch	16	Selects accurate square wave of either 0.04 or 0.4 volt peak-to-peak. Output waveform is available at front panel jack.
CALIBRATOR OUTPUT connector	15	Provides accurate square wave of either 0.04 or 0.4 volt peak-to-peak as determined by the setting of the CALIBRATOR switch.

*NOTE: Located in top-rear area of instrument below access cover.

b. BALANCING ADJUSTMENTS. - Two initial adjustments are required for proper balance when using Vertical Plug-in MX-2996/series. These adjustments prevent trace shift when the VOLTS/DIV switch and VARIABLE control are rotated. With no signal applied and the STABILITY control set to FREE RUN, rotate the VOLTS/DIV switch back and forth between the 0.1 and 0.2 positions. If any vertical deflection of the trace is noted on screen, adjust the EF BAL control until such deflection has ceased. Next, set the VOLTS/DIV switch to the 0.1 position and vary the VARIABLE control back and forth over its entire range. If any vertical deflection of the trace is noted on screen, adjust the DC BAL control until such deflection has ceased. Repeat procedure for finer adjustment. Use 0.1 in. blade width screwdriver for this adjustment. When using vertical plug-in MX-2995 refer to NAVSHIPS 95712 for adjustments.

c. AD-DC COUPLING. - Many applications permit the use of ac coupling. The dc level of the signal (if any) will be lost, and frequencies below 2 cps will be sharply attenuated. These conditions, however, may be of little consequence, making ac coupling most desirable. Note that ac coupling is a "must" when viewing small signals having a high dc component. For example, observing the ripple signal riding on the high dc level of the power supply output. Remember that the coupling on all ranges below 0.1 VOLTS/DIV of Vertical Plug-in preamplifier is AC ONLY.

d. SWEEP STABILITY SETTING. - Use of the PRESET position of the STABILITY control provides the best triggering in most all general test applications. Advancing this control into the area marked TRIGGER affords manual operation for the triggering state of the sweep. Advancing the control still farther, into the FREE RUN area, causes the sweep circuit to oscillate at a rate relative to the setting of the TIME/DIV switch. Repetitive signals may be synchronized in the free-running state. However, most test applications require triggered operation which is provided for by the PRESET or TRIGGER positions of the STABILITY control.

e. TRIGGER LEVEL SETTING. - Once the sweep is in a triggered state, its starting point, relative to the applied triggering signal, may be established by the setting of the trigger LEVEL control. For example, if a sine wave is being viewed, rotating the LEVEL control would cause the slope of the waveform to slide up and down at the starting point of the trace.

Large trigger signals (25 volts and up) applied to the external trigger connector require a wide range of rotation on this control. Trigger signals having a small amplitude may require only a few degrees rotation to traverse the entire slope of the waveform.

f. APPLYING EXTERNAL HORIZONTAL SIGNALS. - Application of external horizontal deflection waveforms may be made to the HORIZ INPUT connector on the front panel. Such signals may be used to (1) substitute for the internal time base, (2) display Lissajous (X vs Y) figures at frequencies below the roll off characteristic of the horizontal bandwidth, and (3) perform other tests requiring special X axis input signals. Paragraph 3-4e gives further details regarding application of external horizontal deflection signals.

g. INTENSITY MODULATION. - External signals such as time-mark pulses may be coupled through the Z AXIS INPUT connector on the front panel to the crt cathode for intensifying or blanking the beam. The coupling time constant is 0.22 millisecond. Positive-going signals blank the beam; negative-going signals intensify the beam. About 40 to 50 volts peak-to-peak of signal is required for good intensity modulation with high light output of the crt.

h. HIGH IMPEDANCE PROBES. - Two each of Test Prods MX-2817/U or MX-4073/U are supplied with each Oscilloscope. When loading effects of the normal vertical input impedance are considered detrimental, a probe should be used. Using the probe affords ten times the normal one megohm input resistance and a much lower shunt capacity (13 uuf max). Sensitivity figures read from the VOLTS/DIV switch dial should be multiplied by 10 when the probe is used. For example, 0.1 VOLTS/DIV would become 1.0 VOLTS/DIV.

Frequency compensation of the probe should be checked before use. The 0.4 volt square wave output of the CALIBRATOR may be used for this check. Set the VOLTS/DIV switch to 0.01 and probe to the CALIBRATOR OUTPUT connector. Adjust the pattern. Back off on the locking ring at the rear section of the probe and rotate the capacitor adjustment which was held tight by the locking ring. Adjust the probe for optimum square wave response: no overshoot or undershoot. Tighten the locking ring to hold this adjustment. The probe is now properly compensated.

3-4. SUMMARY OF OPERATING PROCEDURE.

a. GENERAL. - Details of typical operating procedures, as related to Oscilloscope AN/USM-117( ), are listed in the following paragraphs. Observe all applicable directions given in paragraphs 3-2 and 3-3. Required cable connections may be made with cable assemblies supplied as accessories with the equipment, or with shorter length cables if desired.

b. INTERNAL SWEEP WITH INTERNAL TRIGGERING.

(1) Apply a vertical input signal to INPUT A connector on plug-in.

(2) Set the INPUT SELECTOR switch to INPUT B-DC, or INPUT A-AC if ac coupling is desired.

(3) Set the VOLTS/DIV switch for desired sensitivity. Turn the VARIABLE VOLTS/DIV control to CAL position (maximum clockwise).

(4) Set the TRIGGER SLOPE switch for +INT or -INT triggering, depending upon polarity desired.

(5) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(6) Set the HORIZ MODE switch to SWEEP.

NOTE

In most general test applications, the STABILITY control may be set at PRESET in step (7).

(7) Rotate the STABILITY control counterclockwise until sweep stops; advance this control slightly clockwise until most stable waveform presentation is obtained.

(8) Rotate the trigger LEVEL control to zero; then adjust slowly to select some point on the amplitude of the waveform for the start of the sweep.

c. INTERNAL SWEEP WITH EXTERNAL TRIGGERING.

(1) Apply a vertical input signal to INPUT A connector on plug-in.

(2) Set the INPUT SELECTOR switch to INPUT B-DC, or INPUT A-AC if ac coupling is desired.

(3) Set the VOLTS/DIV switch for desired sensitivity. Turn the VARIABLE VOLTS/DIV control to CAL position (maximum clockwise).

(4) Apply an external trigger signal to the EXT TRIGGER INPUT connector.

(5) Select +DC, -DC, +AC, or -AC external triggering, depending upon the polarity and coupling desired.

(6) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(7) Set the HORIZ MODE switch to SWEEP.

NOTE

In most general test applications, the STABILITY control may be set at PRESET in step (8).

(8) Rotate the STABILITY control counterclockwise until sweep stops; advance this control slightly clockwise until most stable waveform presentation is obtained.

(9) Rotate the trigger LEVEL control to zero; then adjust slowly to select some point on the amplitude of the waveform for the start of the sweep.

d. MAGNIFIED SWEEP.

(1) Set the HORIZ MODE switch to SWEEP.

(2) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(3) Adjust the horizontal POSITION control until that portion of the waveshape which is to be magnified coincides with the center vertical line on the graticule.

NOTE

Refer to reference data listed in paragraph 1-4 for limit of magnification.

(4) Set the HORIZ MODE switch to 5X MAG. Sweep expands from center, and sweep calibration is equal to TIME/DIV setting divided by five.

e. EXTERNAL HORIZONTAL INPUT.

(1) Apply external horizontal deflection signal to the HORIZ INPUT connector.

(2) Turn the STABILITY control fully counterclockwise to PRESET position.

(3) Adjust the horizontal POSITION control as desired.

(4) Advance the INTENSITY control for desired brightness.

(5) Set HORIZ MODE switch to X1, X2, or X5, depending upon degree of horizontal deflection sensitivity desired.

f. CONNECTION TO DEFLECTION PLATES - EXTERNAL SIGNALS.

(1) Turn the POWER switch to OFF and remove access cover.

(2) Disconnect deflection leads from crt pin terminals.

(3) Connect external circuitry illustrated in figure 3-2 to either set of deflection plates.

(4) Position trace on horizontal or vertical axis using normal front panel controls (these controls remain active when circuitry shown in figure 3-2 is used).

3-5. OPERATOR'S MAINTENANCE.

a. OPERATING CHECKS AND ADJUSTMENTS. - No special operating checks need be performed by the operator. However, balance of Vertical Plug-in preamplifier should be checked periodically. Refer to paragraph 3 - 3b for the adjustment procedure.

b. REPLACEMENT OF PARTS. - When necessary, fuses may be replaced by operating personnel. Fuses F201 and F202 are located just below the access cover in the rear of the instrument. Two spare fuses are housed in a dual clip-type fuse holder on the inside rear chassis wall on the left hand side of the instrument. Fuse failure is indicated when the instrument is completely inoperative with the absence of illumination in the pilot light.

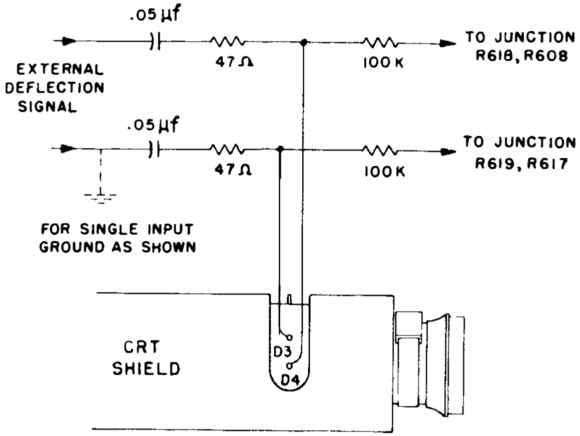


Figure 3-2. Oscilloscope AN/USM-117( ), External Connection to Cathode Ray Tube

SECTION 4
PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION.

Figure 4-1 illustrates the block diagram of Oscilloscope AN/USM-117( ), including principal waveforms. The function of each section is discussed in the following paragraphs. A more detailed analysis of individual circuit action is covered by the group of paragraphs beginning with paragraph 4-2.

a. LOW VOLTAGE POWER SUPPLY. - The low voltage power supply section provides regulated dc for all circuitry throughout the instrument, and is designed to operate on 115 volts at 50, 60, or 400 cycles. Five regulated voltage sources are employed: +20 volts, +5 volts, -15 volts, and -55 volts.

b. VERTICAL CHANNEL. - The vertical channel may be divided into two distinct parts: Vertical plug-in preamplifier and the post amplifier, an integral part of Indicator OS 106( ) USM-117. The plug-in type preamplifier consists of an A or B input selector, compensated input attenuator, and a balanced amplifier stage with emitter follower outputs to drive the post amplifier. Vertical positioning is accomplished in the preamplifier. Output signals from the preamplifier enter the post amplifier through interconnecting plug J803. Signals presented to the post amplifier are further amplified and then delayed before being applied to the vertical deflection plates. Signal delay insures that the sweep has started before the signal itself is presented on the time base.

c. HORIZONTAL CHANNEL. - External deflection signals applied to the horizontal amplifier pass through a three step compensated input attenuator. Internal sweep is applied directly to an emitter follower stage at the input of the horizontal amplifier. HORIZ MODE switch S401 selects either external or internal (sweep) signals. When the amplifier is driven by some external signal the HORIZ GAIN control is made active through S401 switching, and may be used for continuous adjustment between the **X1**, **X2**, and **X5** ranges. Magnification of the sweep is accomplished by increasing the sensitivity of the output amplifier by a factor of five.

d. HIGH VOLTAGE SUPPLY AND CRT. - High voltage for the type 4QP crt is furnished by a regulated high voltage supply. The oscillator stage of the dc to dc converter generates a signal which is stepped up by action of high voltage transformer T301. It is then rectified, filtered, and fed to the crt. The cathode ray tube is a helical band post-accelerator type having an overall accelerating potential of 3 kilovolts. Shunt capacity effects are minimized by having the deflection plate terminals located on the neck of the tube rather than the base. A Z AXIS INPUT connector for external intensity modulation of the crt beam is also incorporated.

e. TRIGGERING STAGES. - Triggering stages consist of a trigger amplifier and Schmitt trigger circuit. Internal, external (ac or dc), or line triggering signals are selected by TRIGGER SLOPE switch S501 and applied to the trigger amplifier which provides amplification and, if desired, polarity inversion. The Schmitt trigger circuit develops a sharp positive-going spike, coincident with the trigger input waveform which is used to actuate the sweep generator.

f. SWEEP GENERATOR. - A time base display is provided by a sawtooth waveform produced by the sweep generator. TIME/DIV switch S702 selects the desired sweep speed and the STABILITY control selects the operational state of the sweep generator. Normally this circuit is operated in a triggered state with the aid of pulses supplied by the triggering stages.

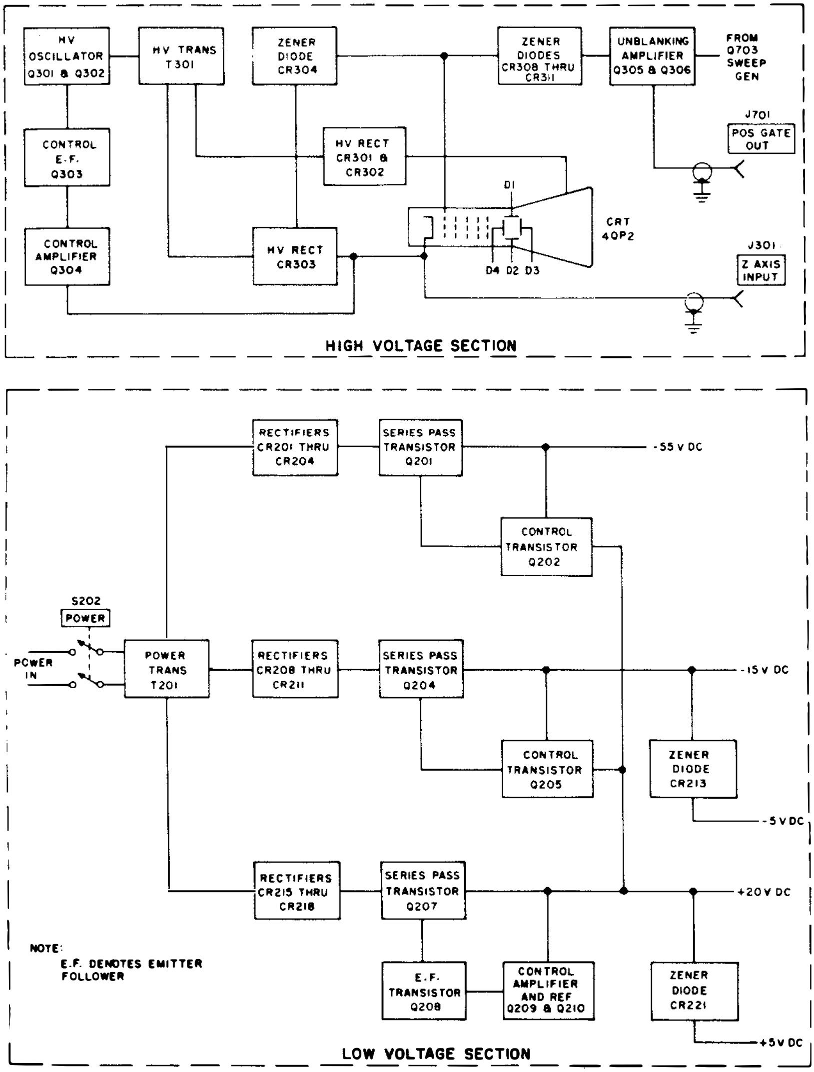


Figure 4-1. Oscilloscope AN/USM-117( )
Block Diagram (Sheet 1 of 2)

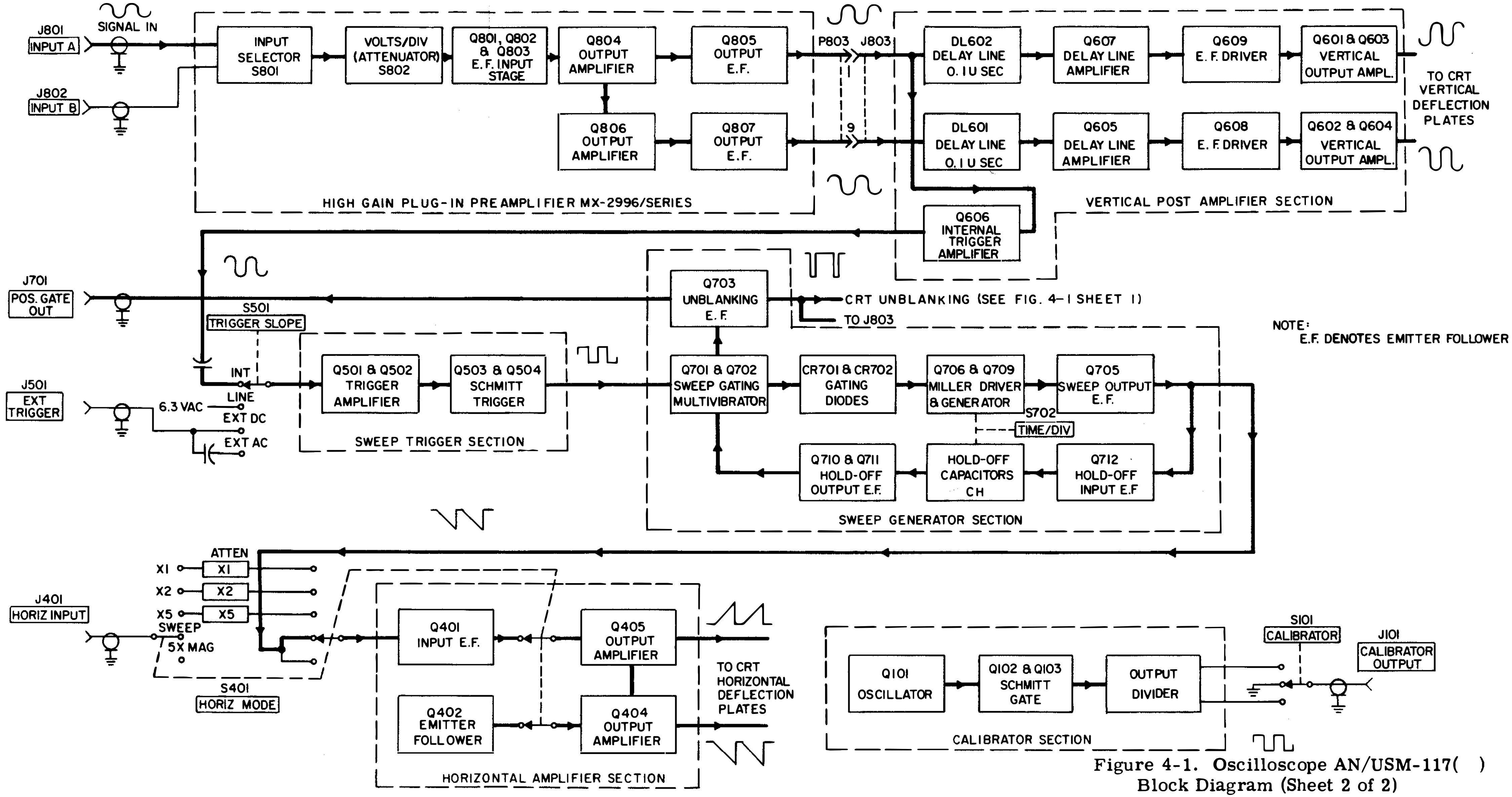


Figure 4-1. Oscilloscope AN/USM-117( )
Block Diagram (Sheet 2 of 2)

Advancing the STABILITY control in a clockwise direction causes the circuit to function in a free-running state. It is also possible to synchronize the free-running sweep generator with repetitive trigger pulses. An unblanking waveform is taken from the sweep generator circuitry to intensify the beam when tracing, and blank it when retracing. A positive-going gate waveform, used to synchronize external equipment, is also derived from the sweep generator.

g. CALIBRATOR. - CALIBRATOR switch S101 selects one of two accurate amplitude square wave outputs: 0.4 or 0.04 volt peak-to-peak. A Schmitt trigger circuit, similar to the one used in the sweep triggering stage is used to square off and improve the slopes of the sine wave fed to it. The sine wave is produced by a Colpitts type oscillator.

4-2. FUNCTIONAL SECTIONS.

a. LOW VOLTAGE POWER SUPPLY. - Although five regulated voltage sources are provided, only three series regulated supplies are employed in this instrument. The two remaining sources are obtained by means of zener diode voltage drops (across CR213 and CR221) in the output of two series regulated supplies. One unregulated source of minus 38 volts is picked off at the input to pass transistor Q204 in the minus 15-volt series regulated supply. Each series regulated supply is fed by an individual secondary winding on power transformer T201. Each winding drives a full-wave bridge rectifier circuit using four identical silicon diodes. The plus 20-volt supply serves as a reference for the other two series regulated supplies. Since all three supplies operate in essentially the same manner, it is only necessary to consider one in the circuit analysis. A discussion of the minus 15-volt supply follows.

Output of the minus 15-volt supply is developed across the voltage divider consisting of R214, R217, R215, and R216. The bottom side of this divider is returned to the plus 20-volt reference supply. Load current flows through pass transistor Q204. Any variation in output voltage across the load is sensed as a bias change at the base of control transistor Q205. The resulting change in the collector current through the collector load (R213) of Q205 is applied to the base of pass transistor Q204 as a change in bias. Depending upon the nature of the original voltage variation across the load, the effective series resistance from collector to emitter of Q204 increases or decreases to regulate the flow of load current, thereby maintaining the output voltage virtually constant. Zener diode CR212 in the emitter circuit of Q204 establishes a reference so that the only possible change in bias in its emitter to collector circuit is the change caused by a load voltage variation in the minus 15-volt supply. Potentiometer R215 permits adjustment of the supply output to exactly minus 15 volts. Capacitor C208 couples ripple voltage and more rapid voltage changes seen at the output back to the base of Q205.

R217 is a sensistor; its resistance increases with an increase in temperature. Since the minus 15-volt supply tended to decrease its output voltage (a positive-going change) by a half volt or so at higher temperatures, R217 was added to the circuit to correct this effect. As temperature increases, the combined value of R214 and R217 increases in resistance. Accordingly, the base of Q205 is driven more positive by a small degree. Considering the direction or polarity of change, the sequence is as follows: the base of Q205 becomes positive-going; the collector of Q205 and base of Q204 become negative-going; and the emitter of Q204 becomes negative-going toward the original minus 15 volts. Another sensistor, R207, is included in the minus 55-volt supply. Note that it is added in series with the voltage divider in this case, since this supply tended to increase its output voltage with an increase in temperature.

b. VERTICAL PLUG-IN MX-2996( )USM-117. - Input signals enter the vertical plug-in through A or B INPUT SELECTOR switch S801. Either input A or B may be selected along with direct or capacitive coupling of the applied information. Large signals are reduced in amplitude by means of VOLTS/DIV switch S802 which employs five frequency compensated attenuator networks. The attenuator networks are used separately or in cascade depending upon the setting of the VOLTS/DIV switch. The most sensitive range, 0.01 VOLTS/DIV, affords no attenuation since it couples the signal straight through. The variable capacitor bridged across the resistor in the top leg of each attenuator network passes higher frequencies which would normally be lost due to the preamplifier's input capacity. For optimum frequency response, these variable R-C sections are adjusted to equal the R-C product or time constant of the input circuit.

The signal at the output of the attenuator is impressed at the base of input emitter follower Q801 through a frequency compensated series resistor, R815. CR801 and CR802 are clamping diodes used to protect Q801 by preventing the applied level of voltage at its base from exceeding plus or minus five volts. Adjustment of EF BAL control R818 prohibits dc current flow in the input signal path. The total or combined resistance looking into the base circuit of Q801 from the attenuator side of R815 is one megohm. Two additional emitter followers, Q802 and Q803, lower the driving impedance of the signal source. From here the signal is coupled into Q804, one side of the push-pull output amplifier. Transistors Q804 and Q806 are connected as an emitter-coupled phase inverter, thus offering a balanced or push-pull type output signal. DC BAL control R825, in conjunction with R827 and R828, sets the level at the base of Q806. This control is adjusted so that zero dc potential exists across VARIABLE control R831, thus preventing trace shift when this control is rotated. Calibrated sensitivity is established in the emitter circuit of this stage by having .01V ADJ control R829 set the amount of emitter degeneration. C820 is adjustable to provide the proper degree of emitter peaking when the VARIABLE control is in its full clockwise or CAL position. Similar frequency compensation is provided by C822 when the VARIABLE control is rotated counterclockwise.

Emitter follower pair Q805 and Q807 offer a low impedance driving source for the post amplifier. Rotating POSITION control R838 from its midpoint causes the bias at the base of one output emitter follower to increase and the other to decrease. Resistors R837 and R839 have been chosen to set the required range of positioning.

c. VERTICAL POST AMPLIFIER. - After entering the vertical post amplifier, one phase of the output signal from the preamplifier is applied to the internal trigger amplifier. Internal trigger information is fed to the base of Q606 from the compensated voltage divider network consisting of R601, R602, and C601. The output of Q606 is passed on to the trigger amplifier through TRIGGER SLOPE switch S501. Both signal phases enter the balanced delay line arrangement. These delay lines, DL601 and DL602, are matched to their characteristic impedance at the input and output. The matching resistors also serve as emitter loads for Q805 and Q807 in the preamplifier. The delay lines employed here are the distributed constant type having a bandwidth several times that of the vertical channel. Transistors Q605 and Q607 act as a balanced or push-pull amplifier which restores the two times gain loss effected by the terminated delay lines. The emitter follower driver stages consisting of Q608 and Q609 provide light loading for the output of the delay line amplifier and a low impedance driving source for the vertical output amplifier. C603 used in Oscilloscopes AN/USM-117A, 117B, 117C extends the bandpass in the post amplifier to 10 mc.

Since relatively large signal swings fed from a low impedance source are required to drive the vertical deflection plates, a special circuit configuration is used for the vertical output amplifier. Stacking two transistors in series to share the total signal swing solves this problem. In this way, the swing across either transistor will not exceed its rated maximum collector voltage. Consider only one side of the circuit which is identical to the opposite side: R608 and R609 is a divider network which establishes the proper bias level at the base of Q603. The bias source is taken at the bottom side of output load resistor R618, thus providing degenerative feedback to improve the distortion figure. Adjustment of GAIN ADJ control R612 calibrates the sensitivity of the post amplifier by affecting the amount of emitter degeneration. C605 and C605A act as peaking capacitors which provide frequency compensation for a given setting of R612.

d. HORIZONTAL AMPLIFIER. - Input emitter follower Q401 accepts either external deflection signals or internal sweep through the switching of S401. Adjustment of ZERO SET control R408 for zero potential at the junction of R410 and R411 prohibits dc current flow in the input signal path. Sweep signals from the output of Q401 drive Q405, one half of the push-pull output stage. External deflection signals from the output of Q401 drive Q404, the opposite half of the push-pull output stage. This arrangement, brought about by S401 switching, is necessary in order that positive-going external signals deflect the beam from left to right, while the time-base also traces from left to right. Transistors Q404 and Q405 function as an emitter-coupled phase inverter. Emitter follower Q402 sets the quiescent level at the base of the output stage transistor which is not driven by the signal source. Since the bias at the base of Q402 may be varied by adjustment of horizontal POSITION control R421, the collector to collector level of the output stage may be caused to shift, offering positioning on the horizontal plane.

Horizontal sweep and times five sweep calibration are established by a given amount of emitter degeneration in the output stage. The common emitter resistor in this stage, labeled BIAS ADJ R435, determines the optimum operating point for the applied signal. The output amplifier employs shunt peaking in the form of L401 and L402 to extend its high frequency response.

e. HIGH VOLTAGE POWER SUPPLY. - The oscillator section of the dc to dc high voltage supply consists of two transistors, Q301 and Q302, in a balanced, over-driven, transformer coupled circuit. Collector to base feedback through transformer T301 allows each transistor to operate alternately in a nonconducting and saturated current state. Frequency of operation is about 1.5 kilocycles. Maximum stepped up secondary voltage of the transformer is fed to a conventional voltage doubler circuit consisting of C302, C303, and two high voltage diode rectifiers, CR301 and CR302. This positive polarity 2400-volt source supplies the high voltage anode of the crt. A lower voltage tapped off in the secondary of the transformer is fed to a half wave rectifier circuit and L-C type filter network in Oscilloscope AN/USM-117 and an R-C type in the AN/USM-117A, 117B, 117C Oscilloscopes, The diode rectifier in this circuit, CR303, is connected to obtain negative polarity output. Zener diode CR304 drops the output of this supply to minus 580-volts which is applied to the cathode of the crt.

The regulator circuit samples the output of the minus 580-volt source for any error. The error signal, if any, is fed to a direct coupled amplifier which controls the signal output level of the oscillator stage. Q304 functions as the direct coupled amplifier, and Q303 is connected as an emitter follower which sets the level of the collector supply for Q301 and Q302. This controlled supply attempts to maintain the output of the minus 580-volt supply constant as the error signal changes. Since the error signal amplifier controls the oscillator stage, adjustment of HV ADJ control R311 causes a change in voltage output of the minus 580-volt supply.

Unblanking for the crt is applied at the top of the voltage divider network consisting of R319, R320, R321, and R322. INTENSITY control R321 sets the dc voltage level at the control grid of the crt. The unblanking waveform is coupled to the crt control grid through a series of four zener diodes. Since these diodes provide a low impedance signal path, no loss in unblanking waveform amplitude is brought about by the voltage divider. Capacitor C314 insures that the leading edge of the unblanking waveform is passed on to the control grid without being degraded.

f. TRIGGER CIRCUITS. - Signals from any of the three trigger sources are applied to the base of Q501 or Q502, depending upon the setting of TRIGGER SLOPE switch S501. The base which does not receive signal is returned to an adjustable bias source controlled by LEVEL control R505. Circuit arrangement shows a combined emitter follower, Q501, and amplifier, Q502, which share the common emitter resistor, R508. Consider circuit action with switch S501 set to a positive slope position: a positive-going input signal is fed to emitter follower Q501 which drives Q502, acting as a grounded base amplifier. Therefore, the signal at the collector of Q502 is positive-going, since no phase reversal takes place in a grounded base stage. Under these conditions, the sweep starts on the positive slope of the triggering signal. With switch S501 set to a negative slope position, the positive-going input signal is fed directly to the base of Q502, acting as a conventional amplifier. The resulting phase reversal causes a negative-going signal to appear at the collector of Q502. Accordingly, the sweep will not start until one half cycle later (on the negative slope of the trigger signal), when the signal at the collector of Q502 is positive-going.

Output signals from Q502 are directly coupled to the input of the Schmitt trigger circuit consisting of Q503 and Q504. Amplified trigger signals applied to the base of Q503 vary about the quiescent level of the collector of Q502. This level, adjustable by means of the LEVEL control, determines the operational state of the Schmitt trigger circuit. When the sweep generator is dormant, Q503 is conducting and Q504 is cut off. A positive-going signal appearing at the collector of Q502 drives Q503 toward cutoff. Note that Q503 and Q504 are PNP type transistors operating from a negative collector supply. Therefore, positive-going signals drive them toward cutoff and negative-going signals drive them toward conduction. As the current through Q503 decreases, its collector swings negative. This negative-going collector voltage is directly coupled to Q504 through the voltage divider R515 and R516. When the base of Q504 is driven negative, it starts to conduct. The resulting current through common emitter resistor R512 reinforces cutoff action on Q503, thus increasing the negative-going signal fed to the base of Q504 from the collector of Q503. This chain of events causes the Schmitt trigger circuit to transfer to its other state: Q503 cutoff and Q504 conducting. Only a fraction of a microsecond is required to complete this transition. During this transition, a fast rise time positive-going step voltage appears at the collector of Q504. The step waveform is differentiated, and the resulting positive spike is used to actuate the sweep generator.

g. SWEEP GENERATOR. - Four principal circuits are incorporated in the sweep generator: the gating multivibrator, Miller circuit, hold-off circuit, and the unblanking/gate out circuit (the latter circuit is physically located in the high voltage section). Positive spikes from the Schmitt trigger circuit are coupled to the base of Q701 in the gating multivibrator. When Q701 is waiting to receive a trigger pulse (no sweep on crt), it is conducting and Q702 is cutoff. Advancing STABILITY control R725 in a clockwise direction causes the base of Q701 to swing in a positive direction. A point is reached, near mid rotation on the control, where the positive spikes from the Schmitt-trigger circuit are of sufficient amplitude to cause Q701 to swing toward cutoff. Note that Q701 and Q702, like Q503 and Q504, are PNP type transistors; they require negative levels for conduction and positive levels for cutoff. As the collector voltage of Q701 decreases, it causes the base of Q702 to be driven in a negative direction, the change being coupled through by R703 and R706. Current starts to flow in Q702. Current flow, due to the conduction of Q702, causes the voltage drop across R705 to swing in a negative direction. Since this voltage controls the bias of Q701, it lowers the current flow through Q701, further dropping its collector voltage. The effect is cumulative, terminating with Q701 cutoff and Q702 conducting.

When Q702 conducts, its collector generates a positive-going step which back-biases gating diodes CR701 and CR702. These open circuited diodes no longer shunt sweep timing capacitor Ct, thus permitting the base of the Miller driver Q706, connected as a modified emitter follower, to swing positive. Note that the output of Q706 is taken from the emitter with a high frequency feedback network connected in its collector to base circuit. As the base of Q706 swings positive, its emitter which is direct coupled to the base of Q709, likewise swings positive. The collector of the Miller transistor, Q709, is negative-going. This negative-going signal swing is direct coupled to the base of emitter follower Q705 through zener diode CR703. The output signal of Q705 is negative-going. Notice that this voltage swing opposes the input voltage swing seen at the base of Q706. Degenerative action restricts the swing in signal at the base of Q706 and causes the negative-going sawtooth slope being generated at the collector of the Miller transistor to decline in a highly linear manner.

When the sawtooth reaches a predetermined amplitude, as set by SWP LGTH control R734, Q701 is forced into conduction by action of the hold-off circuit. This, in turn, causes retrace of the sawtooth waveform. Hold-off insures that the sweep circuits will have enough time to return to their initial state before they are triggered for the next sweep cycle. The negative-going sawtooth waveform applied to the base of hold-off emitter follower Q712 is also present at its emitter in the same phase. Hold-off capacitor Ch is driven by Q712, as is the double emitter follower stage (Q710 and Q711) which isolates Ch from the trigger and sweep gating circuits. During active sweep time, Q701 is cutoff but the negative-going sawtooth applied to its base from the emitter of Q710 will force it into conduction at a given point on the negative slope. When Q701 conducts, Q702 shuts off. The resulting negative step at the collector of Q702 forward-biases CR701 and CR702, discharging the timing-capacitor and causes the sweep to retrace. Capacitor Ch in the hold-off circuit attempts to follow the positive-going retrace, but the time constant of the circuit is relatively long (Q712 is not a low impedance emitter follower) so that Q701 is held in conduction for a finite period of time after retrace. This period is referred to as hold-off time.

Unblanking for the displayed time base and the positive gate output for external use are derived from the sweep gating multivibrator. When the crt beam is tracing, Q701 is cutoff producing a negative step voltage (coincident with the start of the sweep). The addition of CR305 in the emitter circuit of Q305 in the Oscilloscope AN/USM-117A, 117B, 117C improves the leading edge of this step voltage. This waveshape is applied to the base of emitter follower driver Q703. The unblanking amplifier, Q305, is driven by Q703. Emitter follow Q306 provides a low impedance driving source for the amplified and inverted signal appearing at the collector of Q305. Resistors R325 and R326 make up the total emitter resistor for Q306, with C315 serving as high frequency compensation for the positive gate output.

h. CALIBRATOR. - The calibrator may be divided into three distinct circuits: a Colpitts oscillator, Schmitt trigger, and precision voltage divider with associated diode clamps. Output from the 1000 cps sine wave generator is taken from the split tank capacitor junction (tank to emitter feedback point). This output signal is fed to the input of the Schmitt trigger circuit consisting of Q102 and Q103. Circuit action is similar to that of the trigger circuit described in paragraph 4-2f, except for the type of transistors used; Q102 and Q103 are NPN rather than PNP type. However, the end result is the same: a fast rise time, rectangular output signal. Total swing of this signal as seen at the collector of Q103 is about 8 volts peak-to-peak. Since the quiescent level at this point is approximately zero, CR101 will remove all signal swing below this level. CAL ADJ control R112 is adjustable to obtain an accurate 0.4-volt peak-to-peak swing at the top of R114. The signal appearing across R115 is exactly one-tenth this value or 0.04 volt peak-to-peak. Diode CR102 insures low impedance clamping to ground level and removes any undershoots which may tend to appear in the output waveform.

SECTION 5
TROUBLESHOOTING

5-1. GENERAL.

Successful troubleshooting depends to a great extent upon the ability of the technician to localize the trouble. Finding the component or components at fault, once the trouble area has been isolated, is a matter of routine in most instances. Troubles can often be related to a particular functional section simply by the way the trouble mainfests itself on the crt presentation. Further localization can be effected by making use of the illustrated waveforms on the schematic diagrams and the voltage-resistance tabular data found in section 5. When a particular component is suspected, it is best to replace it with one which is known to be good. Because of the inherent stability of transistors they should be the last elements suspected in case of equipment failure.

The troubleshooting procedures listed herein are of a general nature, covering the more common problems likely to be found. More specialized procedures related to less common problems may be readily formulated after a careful study of the circuit description given in section 4. Another good reference, when applicable, is NAVSHIPS 900,000.103, Handbook of Test Methods and Practices. Troubles may vary in nature. Incorrect control settings for a given test may produce apparent troubles. Also, malfunctions in a particular stage may stem from troubles which are actually in the low voltage supply, since this supply acts as a source of power for all stages. Misadjustment of the -15 volt power supply has a serious effect on the trigger circuits.

5-2. TEST EQUIPMENT AND SPECIAL TOOLS.

The only special equipment required for troubleshooting and adjustment is a test cable for the vertical plug-in. The test cable is supplied with the AN/USM-117A, 117B, 117C and some AN/USM-117 Oscilloscopes or it may be fabricated as illustrated in figure 5-1. A small screwdriver (0.1 in. wide blade) is required for EF BAL and DC BAL adjustments. Test equipment equivalent to that listed may also be used.

TABLE 5-1. REQUIRED TEST EQUIPMENT

ITEM	FUNCTION	DESCRIPTION	TYPE NUMBER
1	Measurement of off ground voltages without shock hazard	20,000 ohms/V Multimeter	AN/PSM-4B
2	Measurement of voltage and resistance	Vacuum Tube Voltmeter	AN/USM-116*
3	Signal Source	Time Mark Generator	Tektronix type 180A
4	Signal Source	Sine Wave Generator	AN/URM-127
5	Signal Source	Square Wave Generator	Hewlett Packard model 211A
6	Calibrating Source	Precision Calibrator	Hewlett Packard model 738AR

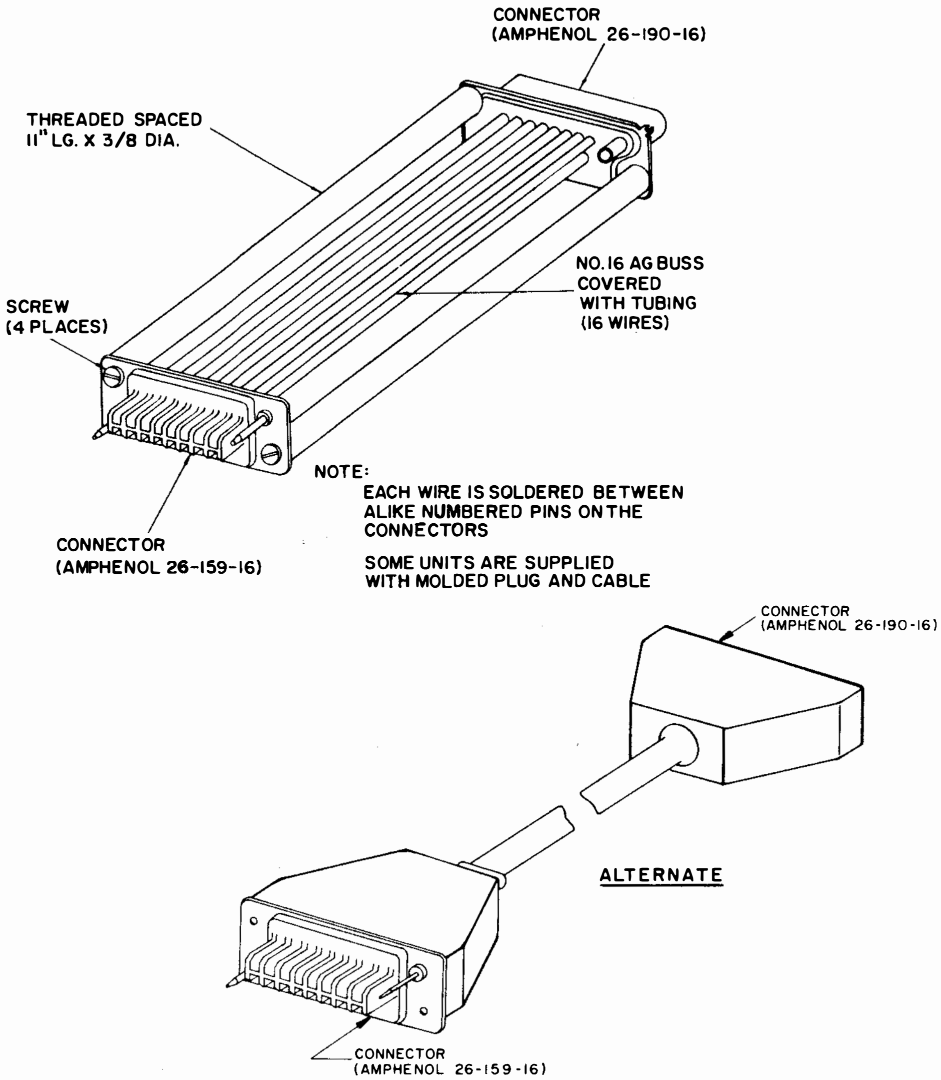
TABLE 5-1. REQUIRED TEST EQUIPMENT (Contd.)

ITEM	FUNCTION	DESCRIPTION	TYPE NUMBER
7	Measurement of Waveforms	Oscilloscope	AN/USM-105A with MX-2930/ USM-105 Plug-in
8	Measurement of Transistors	Transistor Test Set	AN/USM-206

*Resistance readings in the voltage-resistance charts were taken with the Hewlett-Packed model 410B vtvm rather than the AN/ USM-116. Since the ohmmeter circuit source voltage is different in these instruments, variations in resistance readings should be expected.

5-3. OVERALL TROUBLESHOOTING.

a. PRELIMINARY CHECK. - When no specific cause of trouble is apparent, a good preliminary check is to make a visual inspection of all areas of the instrument for broken or loose wires, broken switch wafers or loose switch mountings, loose control mountings, blown fuses, pointer knobs turned beyond marked positions, switch not centered in detent and charred wires or components. To make a safe and more careful inspection, remove the power cord from the instrument. After making a check for physical damage, verify all control functions by performing the tests described in paragraphs 3-3 and 3-4. Also make a preliminary amplitude check (using the internal calibrator) and sweep time check. Sweep time may be checked with a fair degree of accuracy by measuring the period of the calibrator waveform which is equal to one millisecond. Preliminary checks should be followed by the troubleshooting procedures outlined in the following paragraphs. If the Oscilloscope is operated under high humidity and high temperature conditions, compression of sweep and flaring of the trace



NOTE:

EACH WIRE IS SOLDERED BETWEEN ALIKE NUMBERED PINS ON THE CONNECTORS

SOME UNITS ARE SUPPLIED WITH MOLDED PLUG AND CABLE

Figure 5-1. Test Cable for Vertical Plug-in may result if the crt is not coated to resist moisture. Refer to paragraph 6-5f for repair procedure. Crt's manufactured by General Atronics are coated at time of manufacture.

b. CONTROL SETTINGS. - Initial control settings of front panel controls are listed in table 5-2. These settings will change, as testing progresses, in accordance with information given in table 5-3 for system troubleshooting.

TABLE 5-2. PRELIMINARY CONTROL SETTINGS

CONTROL	SETTING
POWER switch	ON
SCALE control	Best display
INTENSITY control	Normal
FOCUS control	Best display
ASTIG control	Best display
POSITION (vert.) control	Trace centered
POSITION (horiz) control	Trace centered
VOLTS/DIV switch	0.1
VARIABLE control	CAL (full cw)
INPUT SELECTOR switch	INPUT A - AC
TRIGGER SLOPE switch	+INT

TABLE 5-2. PRELIMINARY CONTROL SETTINGS (Continued)

CONTROL	SETTING
HORIZ MODE switch	SWEEP
HORIZ GAIN control	Full cw
TIME/DIV switch	0.1 MILLISEC
VARIABLE control	CAL (full cw)
STABILITY control	PRESET
LEVEL control	CENTERED
CALIBRATOR switch	OFF

c. SYSTEM TROUBLESHOOTING CHART. - The over-all troubleshooting chart, table 5-3, indicates the steps to follow after the physical check is completed. This chart gives a cause-and-effect procedure aimed at localizing the trouble in one functional section. The Oscilloscope is divided into eight functional sections: (1) low voltage power supply - Table 5-4, (2) high voltage power supply - Table 5-5, (3) vertical plug-in preamplifier - Table 5-6, (4) vertical post amplifier - Table 5-7, (5) horizontal amplifier - Table 5-8, (6) sweep trigger - Table 5-9, (7) sweep generator - Table 5-10, (8) calibrator - Table 5-11. The NEXT STEP column of table 5-3 refers to one of eight functional section troubleshooting charts. (Tables) listed above. The eight functional section charts include more detailed procedures to isolate the particular part at fault.

Test points are included in the tables and on the schematic diagram to facilitate rapid identification of circuits and functions. These test points are consistent throughout and have the following significance:

★1 Indicates a major test point, used to identify points for checking over-all functions.

Ⓐ Indicates secondary test points, for isolating faults within a unit or sub-assembly.

(A1) Indicates minor test points, used to locate test points within a specific circuit.

TABLE 5-3. SYSTEM TROUBLESHOOTING CHART

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Set POWER switch S202 to ON.	Red indicator lamp lights.	If lamp fails to light, turn POWER switch OFF and check power cord, fuses, and POWER switch with power cord unplugged.
2	With HORIZ MODE switch S401 set to X1, rotate horizontal POSITION control R421.	Spot deflects on horizontal axis.	If no spot appears, check low voltage power supply and then high voltage power supply. Also check leads to all deflection plates.

TABLE 5-3. SYSTEM TROUBLESHOOTING CHART (Continued)

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
			If no deflection occurs, check horizontal amplifier.
3	Rotate vertical POSITION control R838.	Spot deflects on vertical axis.	If no deflection occurs, check vertical plug-in and vertical post amplifier.
4	Set HORIZ MODE switch S401 to SWEEP. Advance STABILITY control to FREE RUN.	Trace seen on crt.	If spot rather than trace appears, check sweep generator.
5	Connect a short BNC cable from CALIBRATOR OUTPUT to INPUT A. Set TRIGGER SLOPE switch S501 to +INT. Rotate STABILITY Control CCW until sweep stops. Advance control slightly until sweep just starts. Adjust LEVEL control R505.	Stable calibrator waveform seen on crt.	If a stable waveform does not appear, check internal trigger section If no waveform appears, check calibrator.

5-4. FUNCTIONAL SECTION TROUBLESHOOTING.

Once the trouble producing section (or sections) of the instrument has been determined, further tests related to that section should be performed to isolate the defective component or transistor. Tests should be conducted in the sequence listed. Remove the cabinet from the instrument and proceed with the appropriate test. Refer to figure 5-2 for location of printed circuit boards and subassemblies.

WARNING

The high crt voltages found in this instrument may be dangerous. The high voltage section contains high voltage points above 2000-volts. One side of R310 located on low voltage supply printed circuit board Z201 is close to 300-volts. When the equipment is in operation, keep your free hand away from the metal frame and any external grounds. A shock hazard will result if the green (ground) lead of the power cord is not properly grounded.

a. PRELIMINARY CHECK. - Further examinations similar to those described in paragraph 5-3a, but in the trouble section rather than overall equipment may prove highly rewarding. Typical tests are listed below:

(1) Inspect for: poor solder joints at terminal points; breaks or cracks in the printed wiring or the printed circuit board itself.

(2) Check for: charred or darkened resistors: dark areas on printed circuit board indicating voltage breakdown.

(3) Inspect for corroded or loose ground lugs and switch terminals.

(4) If crt trace "breaks up", check for corona on high voltage printed circuit board Z301 (remove shield cover) and in the encased high voltage oscillator, located in front of low-voltage transformer T201, just below the crt shield. Subdued lighting or the absence of ambient lighting may aid in the detection of corona.

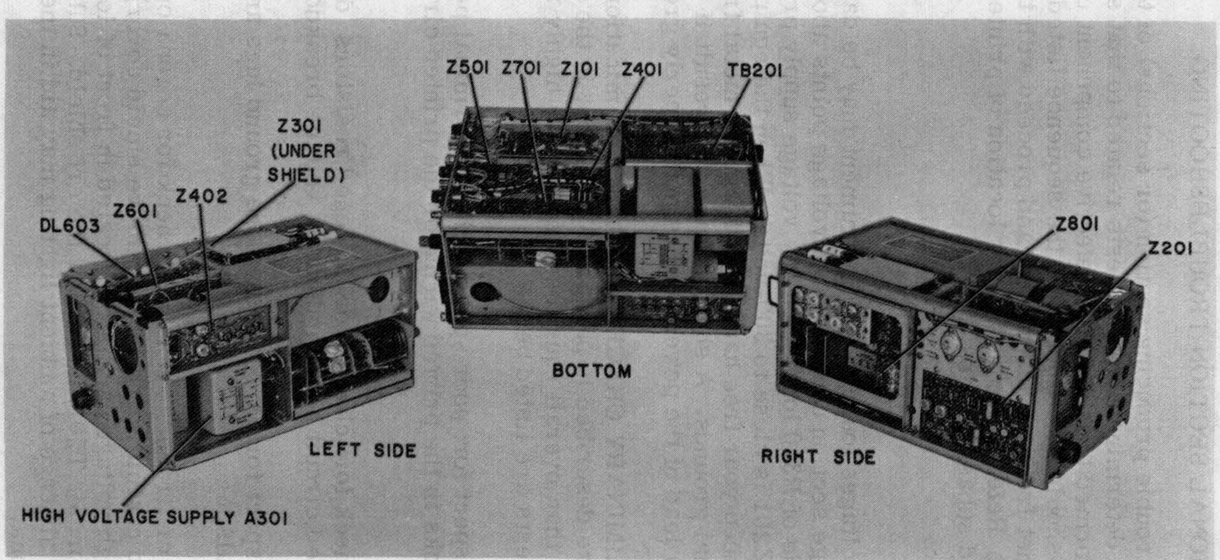


Figure 5-2. Location of Printed Circuit Boards and Subassemblies

(5) Particular attention should be given to fuses. If a break in the element occurs below the metal end caps, it may not be detectable to the eye. A continuity check should be made.

b. SCHEMATIC DIAGRAM AND VOLTAGE-RESISTANCE CHART MEASUREMENTS.

(1) All voltage chart measurements are made with respect to chassis ground. Voltage and resistance measurements shown in the charts may be taken with the vtvm. Transformer and other off ground measurements require the use of a multimeter to avoid shock hazard. Remove ac power cord when making resistance measurements to avoid ground currents which may damage transistors.

(2) When making resistance chart measurements, use the RX100 range of the meter. All measurements are made with the positive lead grounded. This is the black or common lead on the AN/USM-116 but may be reversed on other models.

(3) For principal control settings and applied signal, refer to applicable schematic diagram given in figures 5-12 through 5-26 and to the applicable voltage-resistance chart given in tables 5-13 through 5-20.

(4) Resistance readings in the voltage-resistance charts were taken with the Hewlett-Packard model 410B vtvm rather than the AN/USM-116. Since the ohmmeter circuit source voltage is different in these instruments, variations in resistance readings should be expected.

c. BASIC TESTS. - When troubleshooting transistor circuits certain precautions must be observed. Transistors can be damaged by small voltages or by heat. Be very careful not to short the circuit and thereby apply excessive voltage to the transistors. When using a VTVM to measure emitter-to-base voltages to a common point, such as the chassis (there may be enough loop current between the leads of the VTVM to damage transistors). When measuring resistance use only the ranges on the ohmmeter which have 1.5 volts or less betwwen the leads and whose short-circuit current is less than 3 ma. The AN/PSM-4B on the RX100 scale and black or common lead grounded is suitable.

(1) IN-CIRCUIT TESTING. - The most common causes of transistor failures are internal short- and open-circuits. In transistor circuit testing the most important consideration is the transistor base-emitter junction. Like the control grid of a vacuum tube, the base is the control point of the transistor. The emitter-base voltage should be a fraction of a volt, the polarity and exact value depending upon the material of the transistor and the current carried. Short the emitter to the base. If the transistor is working the voltage on the collector should go toward the supply voltage. In-circuit tests may be accomplished with AN/USM-206 transistor test set if the transistor is not shunted with less than 500 ohms.

(2) OUT-OF-CIRCUIT TESTING. - While it is not recommended to remove the transistors from the instrument for troubleshooting as a general rule, sometimes it is impossible to isolate troubles to a particular transistor. In such case it may be necessary to remove the suspected transistor and test it. Do NOT remove transistors for testing without some indication that this particular transistor is at fault. Use a heat sink, such as a pair of long-nosed pliers, between the soldering iron and the transistor. When soldering a transistor back in the circuit use the same precautions as when unsoldering. If a particular transistor is all right but the circuit still does not work try the transistor ahead and behind the suspected one.

(3) RECTIFIERS. - Faulty rectifiers may be identified as follows: open rectifiers produce low output supply voltage with a significant increase in ripple amplitude; shorted units usually cause a power line fuse (F201 and/or F202) to blow. A shorted

rectifier pair is a normal case. If this occurs, replace all four rectifiers in that particular bridge circuit, since the other two rectifiers will have, no doubt, been weakened. No replacement should be made until the source of trouble has been found. Rectifiers may also be checked by disconnecting one lead and making a forward and reverse resistance test. These rectifiers are characterized by extremely high forward to reverse resistance ratios. Zener diodes may also be checked using an ohmmeter. The ohmmeter test current should be low enough to prevent zener action. High voltage diodes used in the -780 and +2400 volt supplies cannot be tested with an ohmmeter. Replace these units if they are suspected.

d. LOW VOLTAGE POWER SUPPLY.

(1) GENERAL. - Table 5-4 outlines the various tests which should be conducted to isolate a defective component or transistor in the low voltage power supply. A practical method for checking transistors is an in-circuit voltage comparison test. That is, comparing the actual element voltage of the transistor to those listed on the circuit diagrams. Depending upon the type of transistor used, typical emitter to collector voltages may range from 5.0 volts to 15 volts. The difference voltage between base and emitter is normally a few tenths of a volt. If the transistor is shorted, the emitter voltage nearly equals the collector voltage. If the transistor is open, no current flows through the collector load resistor to produce a voltage drop, so the collector voltage equals the collector supply voltage. Allow about 20 percent variation between actual measurements and the readings indicated on the circuit diagram, figure 5-12 and 5-13, or voltage resistance chart, table 5-13, as the case may be. When replacing power transistors, be sure they are fitted with mica washers coated with silicon grease.

(2) CONTROL SETTINGS. - Set POWER switch S202 to ON. Other controls have no effect on voltage measurements. When making waveform observations, turn the STABILITY con-

trol to TRIGGER to inactivate the sweep. This will prevent spurious signals from being superimposed on the ripple waveforms.

NOTE

All measurements referred to on the following charts are made with respect to ground, unless otherwise stated. Line voltage input should be adjusted to 115 volts ac.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
+20 VOLT SUPPLY				
1	A_1 Figure 5-3	Measure voltage at junction of CR216 and CR218.	Voltage equal to approximately -16V.	If incorrect, check rectifiers CR215 through CR218, C214, and transformer T201 (terms. 7 and 8).
2	★5 Figure 5-3	Measure voltage at PJ203.	Voltage equal to +20V	If supply output is high, check Q207 for short. If indication is normal, proceed to step 3.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3	★5 Figure 5-3	Connect test prod of oscilloscope to PJ203.	Waveshape shown in schematic figure 5-12 or 5-13 Ripple equal to 5 my peak-to-peak.	If ripple is high, substitute Q207, C216, and C215. If ripple is still high (or normal) proceed step 4.
4	A_2 Figure 5-3	Measure voltage at junction of CR220 and	Voltage equal to approximately +14. 5V.	If incorrect, check CR220, R228, and Q209.
5	A_3 Figure 5-3	Measure voltage at junction of CR219 and R226.	Voltage equal to 11.5V.	If incorrect, check CR219, R226, and Q208.
6		Disconnect + end of C215 and C216 from circuit and meas- across each using ohmmeter.	More than 20 megohms with red (+)lead of ohmmeter connected to + lead of capacitor.	If leakage is indicated, replace faulty capacitor.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6 (contd.)				If indication is normal but ripple level is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 7.
7		Measure all voltages at elements of Q210, Q209, Q208, and Q207.	Refer to schematic, figure 5-12 or 5-13.	
8	★ 4 Figure 5-3	Measure voltage at junction of CR221 and R235. Disconnect meter and connect test prod of oscilloscope to same point.	Voltage equal to +5V; ripple equal to 3 mv (internal calibrator turned on).	If incorrect, check value of R235. Change CR221.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
		-15 VOLT SUPPLY		
9	A4 Figure 5-3	Measure voltage at junction of C207 and R212.	Voltage equal to approximately -33V.	If incorrect, check rectifiers CR208 through CR211, C205, C206, C207, transformer T201 (terms. 5 and 6).
10	★2 Figure 5-3	Measure voltage at PJ202.	Voltage equal to -15V.	If supply output is high, check Q204 for short. If supply output is low, check C209 for leakage or short. If indications are normal, proceed to step 11.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
11	★2 Figure 5-3	Connect test prod of oscilloscope to PJ202.	Waveshape shown in schematic, figure 5-12 or 5-13. Ripple equal to 5 mv peak-to-peak.	If ripple is high substitute Q204 and Q208. If ripple is still high (or normal), proceed to step 12.
12	A5 Figure 5-3	Measure voltage at junction of CR212 and emitter of Q205.	Voltage equal to -5.2V.	If incorrect, check CR212 and Q205. Also check C208 as indicated in step 6. If indication is normal but ripple is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 13.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
13		Measure all voltages at elements of Q205 and Q204.	Refer to schematic in figure 5-13 or 5-14.	
14	3 Figure 5-3	Measure voltage at junction of CR213 and R220. Disconnect meter and connect test prod of oscilloscope to same point.	Voltage equal to -5V; ripple equal to 3 mv (internal calibrator turned on).	If incorrect, check value of R220. Change CR213.
-55 VOLT SUPPLY				
15	A_6 Figure 5-3	Measure voltage at junction of C201 and R201.	Voltage equal to approximately -73V.	If incorrect, check rectifiers CR201 through CR204, C201, and transformer T201 (terms. 3 and 4).
16	1 Figure 5-3	Measure voltage at PJ201.	Voltage equal to -55V.	If supply output is high, check Q201 for short. If indication is normal, proceed to step 17.

TABLE 5-4. LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
17	1 Figure 5-3	Connect test prod of oscilloscope to PJ201.	Waveshape shown in schematic, figure 5-12 or 5-13. Ripple equal to 100 mv peak-to-peak.	If ripple is high, substitute Q201. If ripple is still high (or normal), proceed to step 18.
18	A7 Figure 5-3	Measure voltage at junction of CR205 and R203.	Voltage equal to 29.5V.	If incorrect, check R203, and CR205. Also check C202 as indicated in step 6. If indication is normal but ripple is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 19.
19		Measure all voltages at elements of Q201 and Q203.	Refer to schematic in figure 5-12 or 5-13.	

e. HIGH VOLTAGE POWER SUPPLY.

(1) GENERAL. - The procedure outlined in table 5-5 will aid in detecting defective components of the high voltage power supply. Other troubles, less typical by nature, may be traced with power removed from the instrument, using resistance checks. Refer to the voltage-resistance chart, table 5-14, and schematic diagram, figure 5-14 or 5-15.

WARNING

When checking voltages related to the high voltage section of the equipment exercise utmost caution, particularly when measuring the cathode and post-accelerating anode voltages of the crt.

(2) CONTROL SETTINGS. - Like the low voltage power supply, front panel control settings have little effect on the measurements taken. In order to duplicate the direct current readings listed for the unblanking amplifier section, controls should be set as indicated on the schematic, figure 5-14 or 5-15.

(3) Shorted diodes CR301, CR302 and CR303 will cause excessive loading of high voltage transformer and loss of both high voltage outputs. Remove the diodes in one output circuit and check for recover of other output. Ohmmeter tests are not satisfactory for testing these diodes.

NOTE

Before conducting tests outlined in table 5-5, make sure all regulated low voltage points along with the minus 38-volts unregulated source measure their specified value.

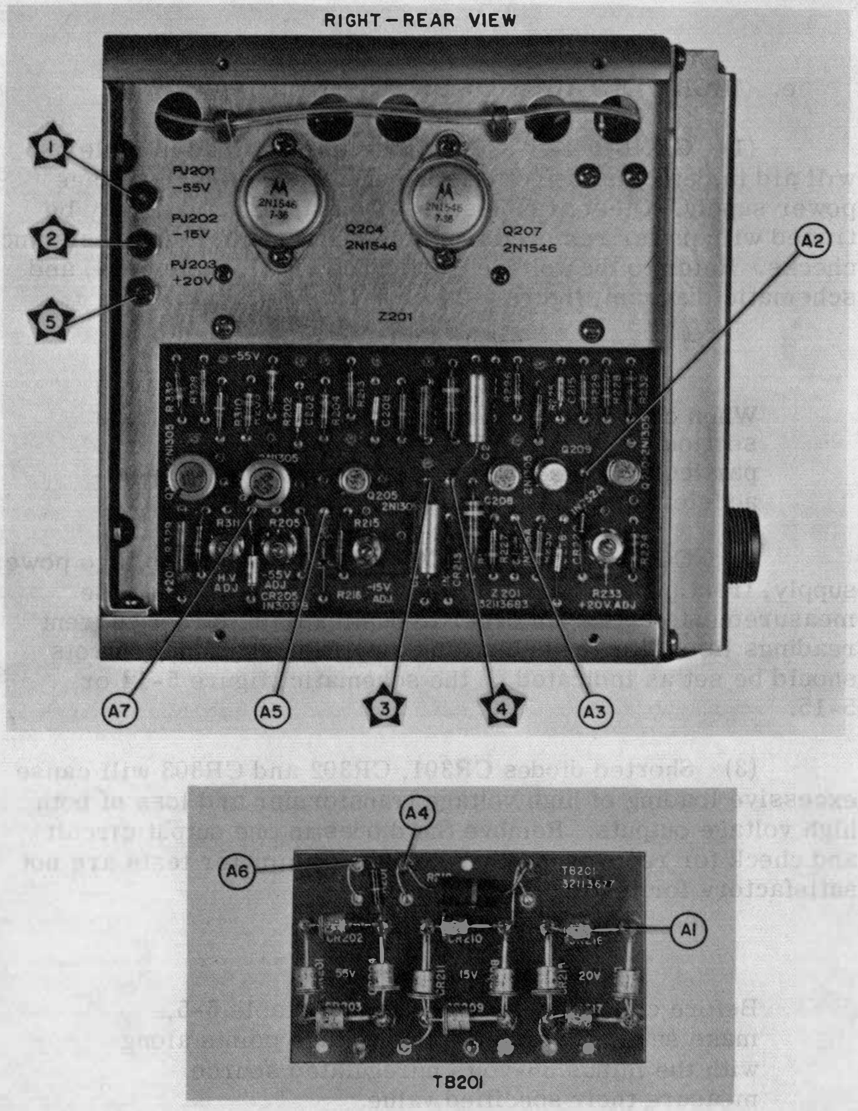


Figure 5-3. Location of Low Voltage Power Supply Test Points

TABLE 5-5. HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	6 Figure 5-4	Measure voltage at PJ301.	Voltage equal to -580V.	If voltage measures more negative, check CR304 and C312 for short or high leakage. If voltage measures less negative, CR304 may be open. Substitute CR304 and C312. If voltage is still incorrect, proceed to step 2; if correct, proceed to step 3.
2	B_3 Figure 5-5	Measure voltage at junction of C308 and CR304 (marked terminal base of HV can).	Voltage equal to approximately -780V.	IF incorrect, check CR303, R336, C304, C306, C307, C308, C319, and L301.

TABLE 5-5. HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3	(B_1) Figure 5-5	Measure voltage at junction of CR302 and C303 (marked terminal base of HV can).	Voltage equal to approximately +2400 V.	If incorrect, check R303, C302, C303, CR301, and CR302.
4	(B_2) Figure 5-5	Measure voltage at junction of C301 and emitter of Q301 (marked terminal base of HV can).	Voltage equal to approximately -23V.	If voltage is low (less than -10V), check Q301 and Q303 for emitter to collector short.
5	(B_4) Figure 5-5	Connect test prod of oscilloscope to junction of term. 1 on T301.	Waveshape shown in schematic, figure 5-14 or 5-15. Amplitude is approximately 45V peak-to-peak.	If waveshape is nonexistent, check C301 and R301.

TABLE 5-5. HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6		Note crt trace pattern in mid sweep ranges (1 MILLISEC to 0.1 MILLISEC).	Uniform intensification of trace.	If trace is bright on one side and dim or dark on the other, check zener diodes CR308 to CR311.

f. VERTICAL PLUG-IN MX-2996, 2996A, 2996B, 2996C

(1) General. - Table 5-6 describes checks to be made if Vertical Plug-in preamplifier becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-15, and schematic diagrams, figures 5-16 and 5-17.

NOTE

Before conducting tests outlined in table 5-6, make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - First, set balancing adjustments of the Vertical plug-in as described in paragraph 3-3b. If balance cannot be effected and trace returns to normal with plug-in removed check for grounds in emitter follower stage or perform voltage measurements to locate unbalance in preamplifier output. Voltage readings given in table 5-6 are obtained with the vertical POSITION control set to center the trace, as noted in table 5-2. Note that the readings listed on the schematic, figure 5-16, are obtained with the vertical POSITION control set to its counter-clockwise and clockwise positions respectively.

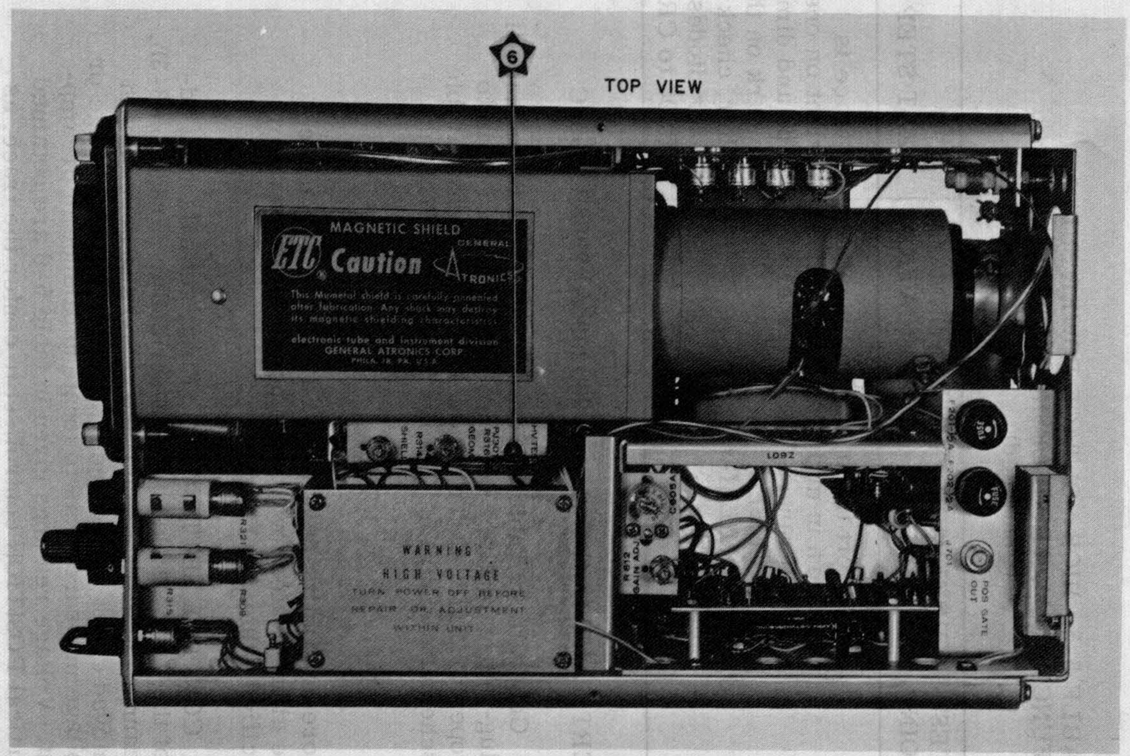


Figure 5-4. Location of High Voltage Power Supply Test Points

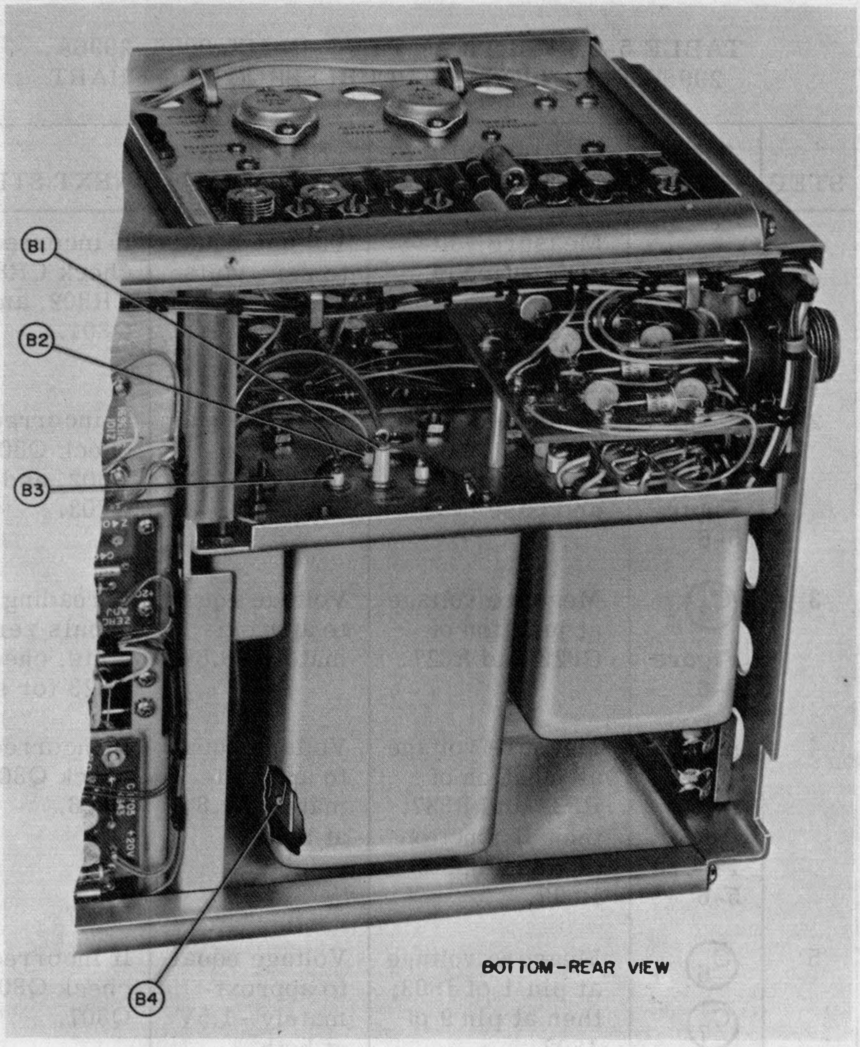


Figure 5-5. Location of High Voltage Power Supply Test Points

TABLE 5-6. VERTICAL PLUG-IN MX-2996, 2996A, 2996B FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	C_1 Figure 5-6	Measure voltage at junction of CR801 and CR802.	Voltage equal to zero volts.	If incorrect, check CR801, CR802, and Q801.
2	C_2 Figure 5-6	Measure voltage at junction of emitter of Q803 and base of Q804.	Voltage equal to approximately -0.8V.	If incorrect, check Q801, Q802, and Q803.
3	C_3 Figure 5-6	Measure voltage at junction of C823 and R827.	Voltage equal to approximately -0.8 V.	If reading equals zero volts, check C823 for short.
4	C_4 C_5 Figure 5-6	Measure voltage at junction of R832 and R837; then at junction of R834 and R839.	Voltage equal to approximately -1.8V at both points.	If incorrect, check Q804 and Q806.
5	C_6 C_7 Figure 5-7	Measure voltage at pin 1 of J803; then at pin 9 of J803.	Voltage equal to approximately -1.5V at both points.	If incorrect, check Q805 and Q807.

TABLE 5-6. VERTICAL PLUG-IN MX-2996, 2996A, 2996B FUNCTIONAL TROUBLESHOOTING CHART
(Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	C_6 C_7 Figure 5-7	Rotate vertical POSITION control CCW then CW.	Voltage swing equal to approximately 0.7V each side of 1.5V reading.	If incorrect, check R838, R837, R839, Q805, and Q807.
7	C_1 through C_7 Figures 5-6, 5-7	Connect short BNC cable between CALIBRATOR OUTPUT and INPUT A-AC. Set CALIBRATOR switch to 0.4 VOLTS. Set VOLTS/DIV switch to 0.05. Connect test prod of oscilloscope to test points C_1 to C_7 in succession.	Voltage gain of signal between C_1 and C_2 is approximately X1. Voltage gain from C_2 to C_4 is approximately X5; signal at C_5 is equal in amplitude to signal at C_4 Gain from C_4 to C_6 and C_5 to C_7 is X1.	After localizing trouble by signal tracing method, check individual components in the defective stage.

g. VERTICAL POST AMPLIFIER.

Since the vertical post amplifier and Vertical Plug-in preamplifier function together to amplify the applied vertical signal, the troubleshooting procedure for the vertical post amplifier is simply an extension of that listed in table 5-6. Test conditions are unchanged. Refer to the voltage-resistance chart, table 5-16, and schematic diagram, figure 5-18 or 5-19.

NOTE

Before conducting tests outlined in table 5-7 make sure all regulated low woltage points measure their specified value.

TABLE 5-7. VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	D_2 D_3 Figure 5-7	Measure voltage at collector of Q605, then at collector of Q607.	Voltage equal to approxi- -2.8V at both points.	If reading is high, in the order of -3.5V, at the collector of Q605, check DL601 for open circuit. If high reading is obtained at collector of Q607 check DL602 for open circuit.

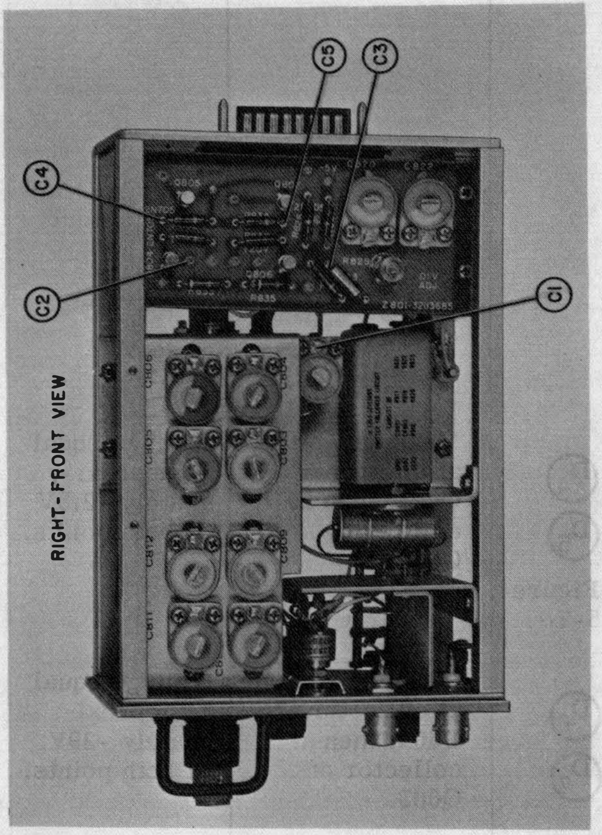


Figure 5-6. Location of Vertical Preamplifier Plug-in Test Points

TABLE 5-7. VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1 (Contd)				If reading is low, near zero volts at collector of Q605, check Q605 for collector to emitter short. If reading is low at collector of Q607, check Q607 for collector to emitter short.
2	D_4 D_5 Figure 5-7	Measure voltage at emitter of Q608, then at emitter of Q609.	Voltage equal to approximately -2.5V at both points.	If incorrect, check respective transistor (Q608 or Q609) for emitter to collector short.
3	D_6 D_7 Figure 5-7	Measure voltage at collector of Q604, then at collector of Q603.	Voltage equal to approximately -29V at both points.	If incorrect at collector of Q604, check Q604 and Q602. If incorrect at collector of Q603, check Q603 and Q601.

TABLE 5-7. VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
4	C_6 D_1 Figure 5-7	Connect short BNC cable between CALIBRATOR OUTPUT and INPUT A-AC. Set CALIBRATOR switch to 0.4V. Set VOLTS/DIV switch to 0.05. Connect test prod of oscilloscope to test points C_6 and D_1 in succession.	Voltage gain of signal between C_6 and D_1 is approximately X 5* or more.	If incorrect, check C602 for short. Check Q606 for collector to emitter short. Check -15 volt supply adjustment.

*NOTE: Gain is 1.5 or more in AN/USM-117 Oscilloscope.

TABLE 5-7. VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	C_6 through D_7 Figure 5-7	Connect input signal as described in step 4. Connect test prod of oscilloscope to test points C_6 through D_7 in succession.	Voltage gain of signal (measured with respect to ground) between C_6 and D_3 is approximately X2. Same figure applies for gain between C_7 and D_2 Voltage gain between D_2 and D_4 approximately X-1. Same figure applies between D_3 and D_5 Voltage gain between D_4 and D_6 is approximately X17. Same figure applies between D_5 and D_7	After localizing trouble by signal tracing method, check individual components in the defective stage.

h. HORIZONTAL AMPLIFIER.

(1) GENERAL. - Table 5-8 describes checks to be made if the horizontal amplifier becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-17, and schematic diagram, figure 5-20 and 5-21.

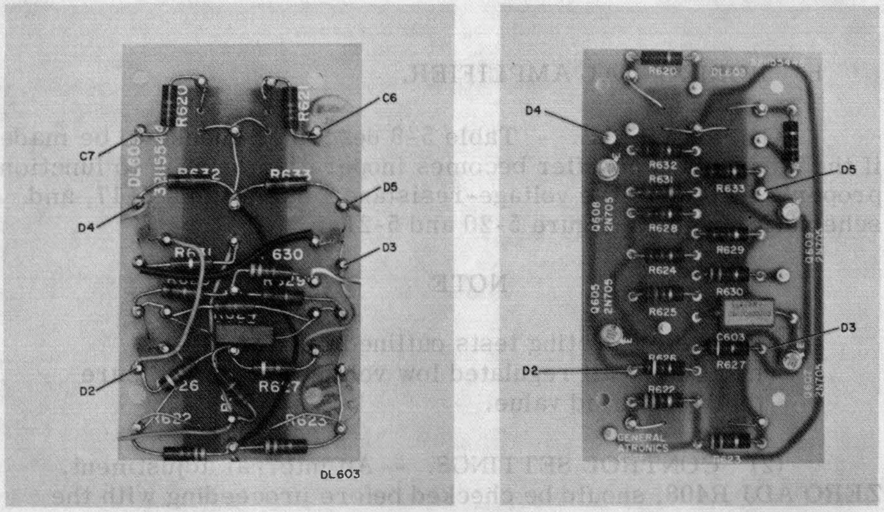
NOTE

Before conducting tests outlined in table 5-8, make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - An internal adjustment, ZERO ADJ R408, should be checked before proceeding with the tests outlined in table 5-8. Refer to paragraph 6-4c(1) for the adjustment procedure. Panel controls are set in accordance with table 5-2, except the STABILITY control which is advanced to the FREE RUN position. Voltage readings given in table 5-8 are obtained with horizontal POSITION control set to center the trace, as noted in table 5-2. Note that the readings listed on the schematic (figure 5-20 and 5-21) are obtained with the horizontal POSITION control set to its counterclockwise and clockwise positions respectively.

NOTE

Since the BIAS ADJ control R430 is set for optimum sweep linearity in individual instruments, the inherent variation in dc levels may be somewhat more than in other circuits. Any radical difference in these levels, however, from those listed, should be considered as an indication of trouble.



AN/USM-117, 117A, 117B

AN/USM-117C

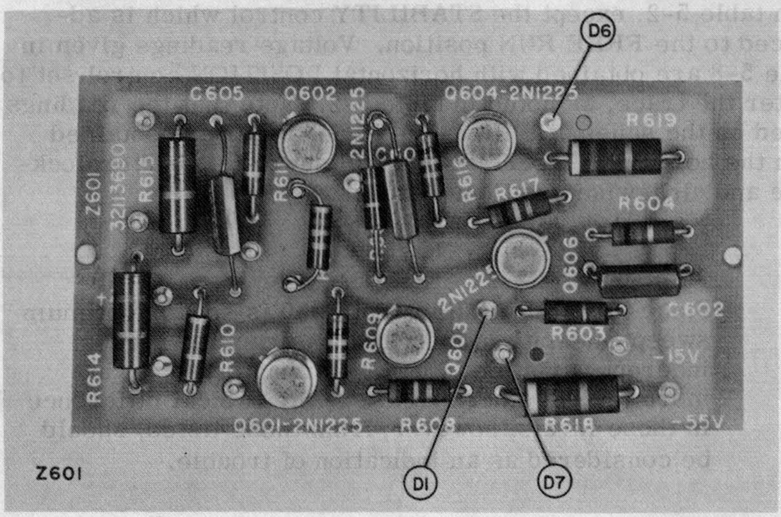


Figure 5-7. Location of Post Amplifier Test Points

TABLE 5-8. HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	E2 Figure 5-8	Measure voltage at emitter Q401.	Voltage equal to approximately -1.0V.	If incorrect, check adjustment of ZERO ADJ control R408. Refer to paragraph 6-4c(1). If adjustment is correct but voltage at E_5 incorrect, proceed to step 2.
2	E_1 E_2 Figure 5-8	Connect test prod of oscilloscope to base of Q401, then to emitter of Q401.	Negative-going sawtooth waveform of 1.7V peak-to-peak.	If waveform is absent refer to table 5-10. If waveform is present at E_1 but not at E_2, check Q401 for emitter to collector short.

TABLE 5-8. HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3	E_3 Figure 5-8	Measure voltage at base of Q404.	Voltage equal to approximately -1.2V.	If incorrect, rotate horizontal POSITION control slightly. If reading is unchanged, manipulate detent of HORIZ MODE switch S401 checking connection continuity.
4	E_4 Figure 5-8	Connect test prod of oscilloscope to base of Q405.	Negative-going sawtooth waveform of 1.7V peak-to-peak.	If waveform is absent check switch S401 as indicated in step 3.
5	E_5 E_6 Figure 5-8	Measure voltage at collector of Q404, then at collector of Q405.	Voltage equal to approximately -23V at E_5 and -38V at E_6	If incorrect, check Q404 and Q405. Also check continuity from Q402 to Q404 through S401.

TABLE 5-8. HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	E_4 through E_6 Figure 5-8	Connect test prod of oscilloscope to test points E_4 to E_6 in succession.	Voltage gain from E_4 to E_6 is approximately X20; signal at E_6 is equal in amplitude to signal at E_5	After localizing trouble to either side of balanced output stage, check individual components in that area.

i. SWEEP TRIGGER.

(1) GENERAL. - Any form of instability of the crt presentation, other than actual trace shift, is indicative of trouble in the sweep trigger circuit. If such instability (jitter, random motion, etc.) is observed, follow the troubleshooting procedure given in table 5-9. First, however, check the applied waveform on an oscilloscope known to be in good working order to make sure the trouble does not stem from the applied signal itself. Refer to the voltage-resistance chart, table 5-18, and schematic diagram, figure 5-22.

NOTE

Before conducting tests outlined in table 5-9 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - Although controls are set in accordance with table 5-2, the setting of the LEVEL control must be made very precisely for electrical center rather than physical centering. Otherwise, it would not be possible to duplicate the dc levels listed in table 5-9 or on the schematic, figure 5-22. Apply a 10kc, 0.5 -volt peak-to-peak sine wave to INPUT A-AC. Rotate the LEVEL control until the start of the trace is midway between the negative and positive peaks of the displayed waveform.

NOTE

> Although meter loading effects may cause the crt display to disappear when testing the Schmitt trigger section of the sweep trigger circuit, the voltage readings themselves are not affected. Advancing the STABILITY control from PRESET to TRIG will restore the display when the meter is connected into the circuit.

TABLE 5-9. SWEEP TRIGGER. FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	F_1 F_3 Figure 5-9	Measure voltage at base of Q501, then at base of Q502.	Voltage equal to less than 0.1 volt.	If voltage at F_1 is incorrect, check C505 for short or leakage.

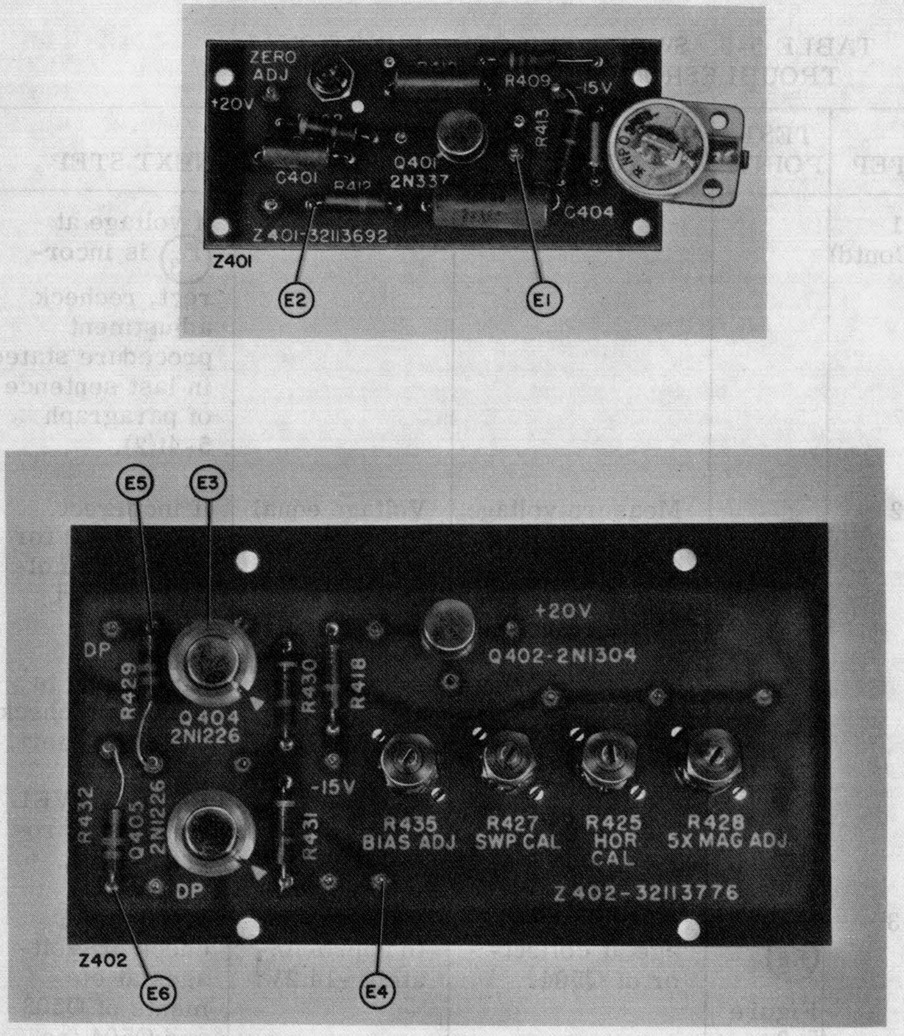


Figure 5-8. Location of Horizontal Amplifier Test Points

TABLE 5-9. SWEEP TRIGGER. FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1 (Contd)				If voltage at F_3 is incorrect, recheck adjustment procedure stated in last sentence of paragraph 5-4i(2).
2	F_4 Figure 5-9	Measure voltage at collector of Q502.	Voltage equal to approximately -9.3V.	If incorrect, check Q502 for emitter to collector short or open.
		Measure voltage at F_4 while rotating LEVEL control back and forth.	Voltage swings above and below -9.3V.	If no swing is indicated, check C503 for short. Return LEVEL control to proper setting.
3	F_5 Figure 5-9	Measure voltage at collector of Q504.	Voltage equal to approximately -14.2V.	If incorrect, check all voltages at elements of Q503 and Q504 (refer to schematic of figure 5-22) to localize

TABLE 5-9. SWEEP TRIGGER. FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3 (Contd)				trouble. Perform resistance checks if necessary.
4	F_1 through F_5 Figure 5-9	Connect test prod of oscilloscope to test points F_1 to F_5 in succession.	Voltage gain between F_1 and F_4 is approximately X10. Waveshape at F_5 is about one quarter of the amplitude at F_4 but has fast rise and fall times.	After localizing trouble by signal tracing method, check individual components in the defective stage.

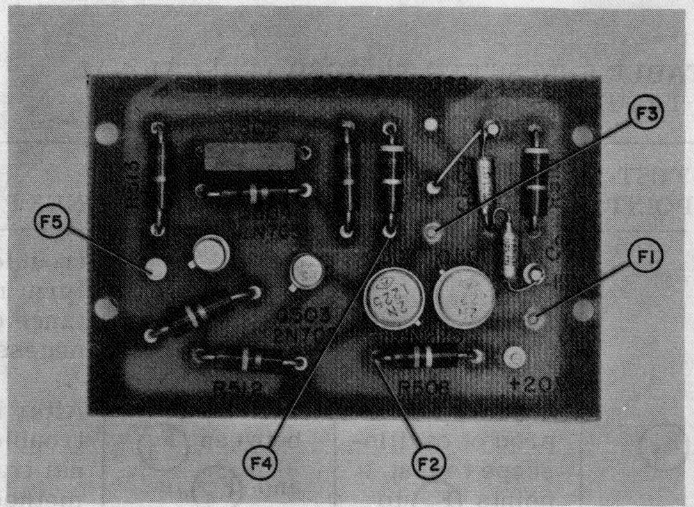


Figure 5-9. Location of Sweep Trigger Test Points

j. SWEEP GENERATOR.

(1) GENERAL. - The sweep generator is the most difficult of all circuits to troubleshoot. This is because all stages of the sweep circuit operate within a loop. Any change from a normal voltage level in a given stage causes a corresponding change in all voltage levels throughout the loop. For this reason, voltage values listed on the sweep generator schematic, figure 5-23, are less helpful than in other circuit areas.

Basic troubles in the sweep generator circuit may be considered in two parts: (1) will the beam trace? (2) will the beam retrace? Typical trouble areas related to these effects are noted in table 5-10. Refer to the voltage-resistance chart, table 5-19, and schematic diagrams, figures 5-23 and 5-24.

NOTE

Before conducting tests outlined in table 5-10 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - Set controls in accordance with table 5-2. Triggering controls must be adjusted for a stable presentation of the applied 10 kc, 0.5-volt peak-to-peak signal (refer to paragraph 5-4i(2).

(3) The sweep generator boards used in the AN/USM-117A, 117B, -117C are coated with epoxy resin for moisture protection. Refer to the Maintenance section of EIMB NAVSHIPS 9000,000.100 change 3 of June 1965 before attempting repair of these boards. Use needle point probes to measure voltages.

TABLE 5-10. SWEEP GENERATOR. FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	G_1 Figure 5-10	Connect test prod of oscilloscope to base of Q701.	Waveform shown in schematic of figure 5-23.	If proper waveform is not present at G_1, check F_5 for triggering waveform. If beam is locked to left hand side of screen, see step 2.

TABLE 5-10. SWEEP GENERATOR. FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1 (Contd)				If beam is locked to right hand side of screen, see step 3.
2	G_4 Figure 5-10	Measure voltage at emitter of Q705.	Voltage equal to approximately -3.4V.*	If reading is near zero volt, substitute Q701 and Q702.
3		Same test as in step 2.	Voltage equal to approximately -3.4V.*	If reading is above 10 volts, substitute Q710 and Q711.
4	G_1 through G_6 Figure 5-10	Connect test prod of oscilloscope, to test points G_1 to G_6 in succession.	Waveforms shown in schematic of figure 5-23.	If waveform is present but unlike the one illustrated, check individual components in the related circuit area.

*Note: Refer to note 3 in Voltage-Resistance Chart, table 5-19.

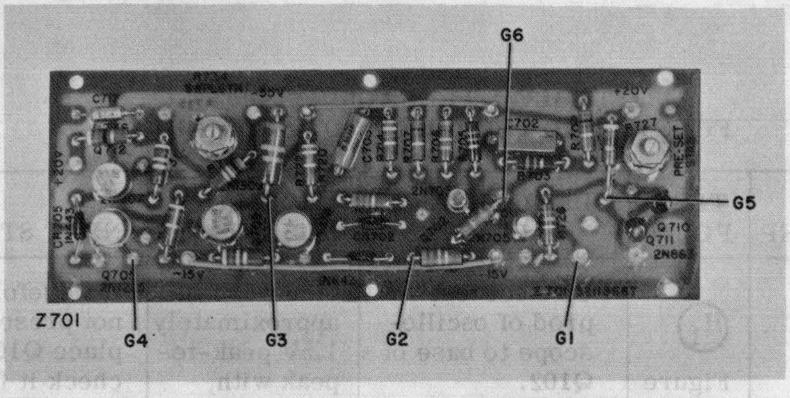


Figure 5-10. Location of Sweep Generator Test Points

k. CALIBRATOR.

(1) GENERAL. - Table 5-11 describes checks to be made if the calibrator becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-20, and schematic diagram, figure 5-25.

NOTE

Before conducting tests outlined in table 5-11 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - In these tests the CALIBRATOR is set to the 0.4 position rather than the OFF position, as indicated in table 5-2.

TABLE 5-11. CALIBRATOR, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	H_1 Figure 5-11	Connect test prod of oscilloscope to base of Q102.	Sine wave of approximately 1.5V peak-to-peak with slight distortion.	If waveform is not present, replace Q101 or check it for emitter to collector short.
2	H_2 Figure 5-11	Connect test prod of oscilloscope to collector of Q103.	Square wave of approximately 8V peak-to peak.	If incorrect, check Q102 and Q103.
3	H_3	Connect test prod of oscilloscope to junction of R113 and R114.	Square wave of 0.4V peak-to-peak.	If waveform is not present, check CR101 for open and CR102 for short; if amplitude is incorrect, reset CAL ADJ control R112.

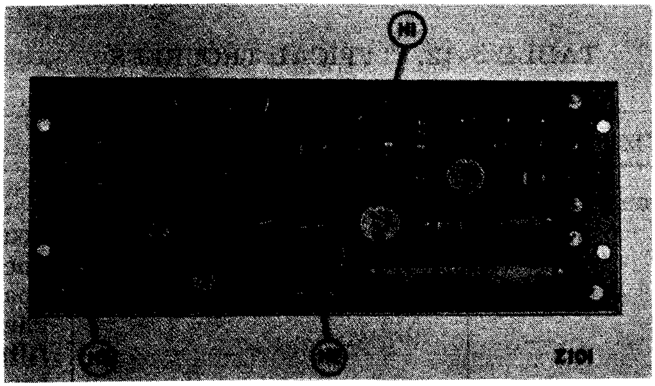


Figure 5-11. Location of Calibrator Test Points

5-5. TYPICAL TROUBLES.

Table 5-12 lists troubles of a general nature which could occur in Oscilloscope AN/USM-117( ). Tests are conducted with front panel controls set in accordance with table 5-2.

Symptoms, possible causes, and repair steps are given. If a breakdown occurs, the symptoms should be noted, the nature of the trouble determined, and the fault identified.

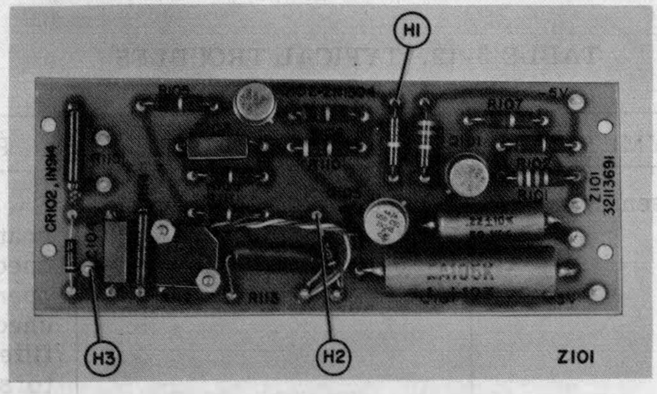


Figure 5-11. Location of Calibrator Test Points

5-5. TYPICAL TROUBLES.

Table 5-12 lists troubles of a general nature which could occur in Oscilloscope AN/USM-117( ). Tests are conducted with front panel controls set in accordance with table 5-2.

Symptoms, possible causes, and repair steps are given. If a breakdown occurs, the symptoms should be noted, the nature of the trouble determined, and the fault identified.

TABLE 5-12. TYPICAL TROUBLES

SYMPTOM	POSSIBLE CAUSE	REPAIR
Spot absent on crt.	Defective high or low voltage supplies; defective crt.	Check for open heater in crt; check C301 for open or short; check all HV filter capacitors; check fuses F201 and F202.
Spot absent on crt.	Spot off screen.	Check DC BAL and EF BAL adjustments; dc at vertical input too high; loose deflection plate lead connection on crt.
Ripple on trace.	Defective filter in low voltage supply; noisy input transistor.	Check C210, C219,C201, and C209. Replace Q801.
Loss of calibrated sensitivity (vert.)	Change in high or low voltage; change in plug-in or post amplifier gain.	Check -580V at PJ301; check all low voltage supplies. Check setting of .01V ADJ and GAIN ADJ controls. Check emitter follower input stage.

TABLE 5-12. TYPICAL TROUBLES
(Continued)

SYMPTOM	POSSIBLE CAUSE	REPAIR
Loss of calibrated sensitivity (horiz).	Change in high or low voltage; change in horizontal amplifier gain.	Check -580V at PJ301; check all low voltage supplies. Check setting of HORIZ CAL control.
No sweep but external horizontal signals offer deflection.	Defective or misadjusted sweep circuit.	Check transistors in sweep circuit. Check setting of SWP LGTH control.
No sweep and external horizontal input inoperative.	Defective horizontal amplifier.	Check transistors in horizontal amplifier.
No LEVEL control action.	No bias swing in trigger amplifier.	Shorted C503.
Poor triggering (internal only).	Defective internal trigger amplifier.	Replace Q606. -15 volt supply misadjusted.
Square wave distortion.	Incorrect compensation adjustment.	Check adjustment of all capacitors in input attenuator plus C317, C321, C322, and C605A.
Trace drifts vertically	Defective clamping diodes.	Replace CR801 and CR802.

TABLE 5-13. LOW VOLTAGE POWER SUPPLY, VOLTAGE-RESISTANCE CHART

		VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
TSTR NO.	TYPE	E	B	C	E	B	C
Q201	PNP	-55V	-55V	-73V	1.7K	1.8K	1.7K
Q202	PNP	-29.5V	-29.4V	-55V	5.0K	2.0K	1.8K
Q204	PNP	-15V	-15V	-33V	200	250	180
Q205	PNP	-5.2V	-5.4V	-15V	300K[2]	500	250
Q207	PNP	OV	-0.15V	-16V	0	90	70[3]
Q208	PNP	+11.5V	+11.2V	-0.15V	1.2K	400	90
Q209	PNP	+14.8V	+14.5V	+11.2V	2.0K	700	400
Q210	PNP	+14.8V	+14.5V	0V	2.0K	240	0

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measure on RX10K range (large variation).
3. Measure on RX10 range (large variation).

TABLE 5-14. HIGH VOLTAGE POWER SUPPLY AND CRT, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q301	PNP	OV	+5.0V	-23V	0	50	25[2]
Q302	PNP	0V	+5.0V	-23V	0	50	25[2]
Q303	PNP	-23.5V	-23.8V	-29V	100[2]	110	70
Q304	PNP	-2.3V	-2.4V	-23.8V	1.0K	400	120
Q305	PNP	-0.52	-0.78	-35V	7.5K[4]	12.5K[5]	2.3K
Q306	PNP	-35V	-35V	-55V	22K[3]	2.3K	1.8K

V301 Crt cathode E = -580V (Test point PJ301, ⑥)
R = 1.0 MEG (RX10K range)

(CRT) Crt anode E = +2400V (See WARNING paragraph 5-4e. (1) Use AN/PSM-4B, 5KV Range.
R = 500K (RX 10K range; neg. polarity)

Check only crt elements which are listed above.

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.

2. Measure on RX1 range.

3. Measure on RX1K range.
4. Value is 270 in AN/USM-117
5. Value is 600 in AN/USM-117

TABLE 5-15. VERTICAL PLUG-IN MX2996, 2996A, 2996B, 2996C USM-117 VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q801	NPN	-0.54V	0V	+4.8V	5.0K	1.5K	1.0K
Q802	NPN	-1.1V	-0.54V	+4.8V	750	5.0K	1.0K
Q803	PNP	-0.8V	-1.1V	-5.0V	900	750	350
Q804	PNP	-0.48V	-0.8V	-1.8V	3.0K	900	700
Q805	PNP	-1.5V	-1.8V	-8.0V	600	700	450
Q806	PNP	-0.48V	-0.8V	-1.8V	3.0K	220	700
Q807	PNP	-1.5V	-1.8V	-8.0V	600	700	450

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measurements taken with trace centered vertically.

TABLE 5-16. VERTICAL POST AMPLIFIER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q601	PNP	-2.5V	-3.0V	-13.8V	3.0K	850	NOTE 3
Q602	PNP	-2.5V	-3.0V	-13.8V	3.0K	850	NOTE 3
Q603	PNP	-13.8V	-14V	-28V	NOTE 3	4.5K	5.0K
Q604	PNP	-13.8V	-14V	-28V	NOTE 3	4.5K	5.0K
Q605	PNP	-0.4V	-0.7V	-3.0V	1.3K	300	650
Q606	PNP	-0.1V	-0.3V	-13.5V	100	400	3.0K
Q607	PNP	-0.4V	-0.7V	-3.0V	1.3K	300	650
Q608	PNP	-2.8V	-3.0V	-6.8V	850	650	1.8K
Q609	PNP	-2.8V	-3.0V	-6.8V	850	650	1.8K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measurements taken with trace centered vertically.
3. Large variations between units; average value is 300K.

TABLE 5-17. HORIZONTAL AMPLIFIER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q401	NPN	-0.9V	-0.3V	+20V	2.0K	10K	300
Q402	NPN	-1.3V	-1.2V	+20V	240	120	250
Q404	PNP	-1.2V	-1.3V	-23V	4.5K	250	11K
Q405	PNP	-0.85V	-1.0V	-37V	4.5K	2.0K	11K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measurements taken with trace centered horizontally.

TABLE 5-18. SWEEP TRIGGER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q501	PNP	+0.2V	0±.1V	-15V	11K	450	220

TABLE 5-18. SWEEP TRIGGER, VOLTAGE-RESISTANCE CHART (Continued)

		VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
TSTR. NO.	TYPE	E	B	C	E	B	C
Q502	PNP	+0.2V	0±.1V	-9.3V	11K	1.8K	2.0K
Q503	PNP	-10V	-9.3V	-13.2V	16K[2]	2.0K	2.8K
Q504	PNP	-10V	-8.0V	-14.2V	16K[2]	2.5K	3.0K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.

2. Set LEVEL control as outlined in paragraph 5-4i(2).

TABLE 5-19. SWEEP GENERATOR, VOLTAGE-RESISTANCE CHART

		VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
TSTR. NO.	TYPE	E	B	C	E	B	C
Q701	PNP	+5.8V	+5.6V	0V	7.5K	1.0K	800
Q702	PNP	+5.8V	+5.7V	+0.1V[2]	7.5K	1.1K	900
Q703	NPN	-0.78V	0V	+20V	600	800	300

TABLE 5-19. SWEEP GENERATOR, VOLTAGE-RESISTANCE CHART (Continued)

		VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
TSTR. NO.	TYPE	E	B	C	E	B	C
Q705	PNP	$-3.0V^3$	$-3.2V^3$	-24V	9K	2.8K	3.5K
Q706	NPN	-0.15V	+0.45V	+17.5V	260	$60K^4$	4.0K
Q709	PNP	0V	-0.15V	$-7.0V^3$	0	280	10K
Q710	PNP	+5.6V	+5.2V	0V	1.0K	1.7K	0
Q711	PNP	+5.2V	+4.8V	0V	1.7K	1.9K	0
Q712	PNP	+10V	+10V	0V	$30K^4$	270	0

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.

2. Variation may exceed 0.1 volts.

3. Value depends upon setting of STABILITY and/or PRESET.

4. Measure on RX1K range.

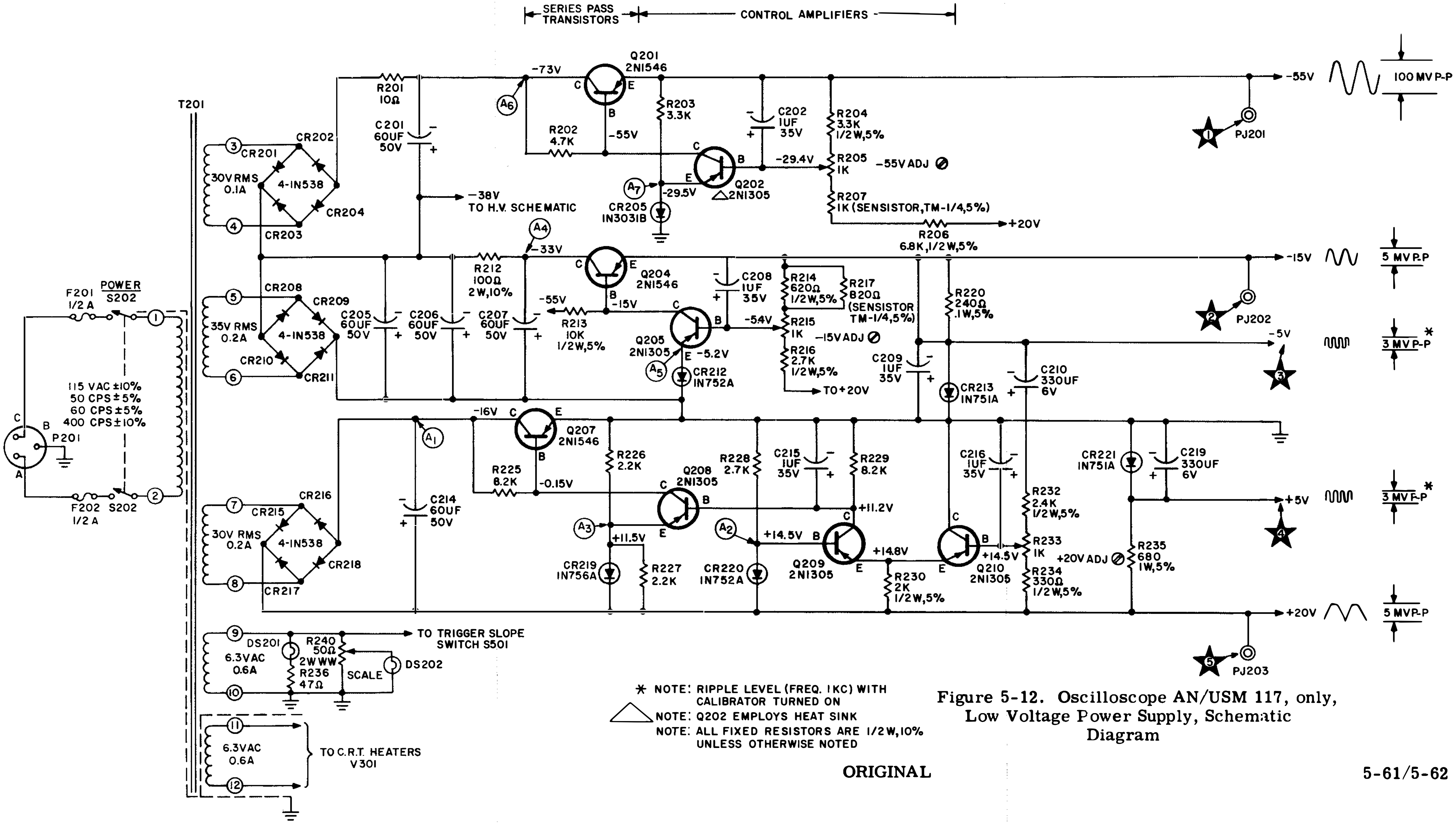
TABLE 5-20. CALIBRATOR, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q101	NPN	-4.4V	-5.0V	+5.0V	450	1.5K	450
Q102	NPN	-4.4V	-4.6V	-1.8V	400	700	500
Q103	NPN	-4.4V	-4.5V	-0.15V[2]	400	700	500

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.

2. Variation may exceed 1 volt.

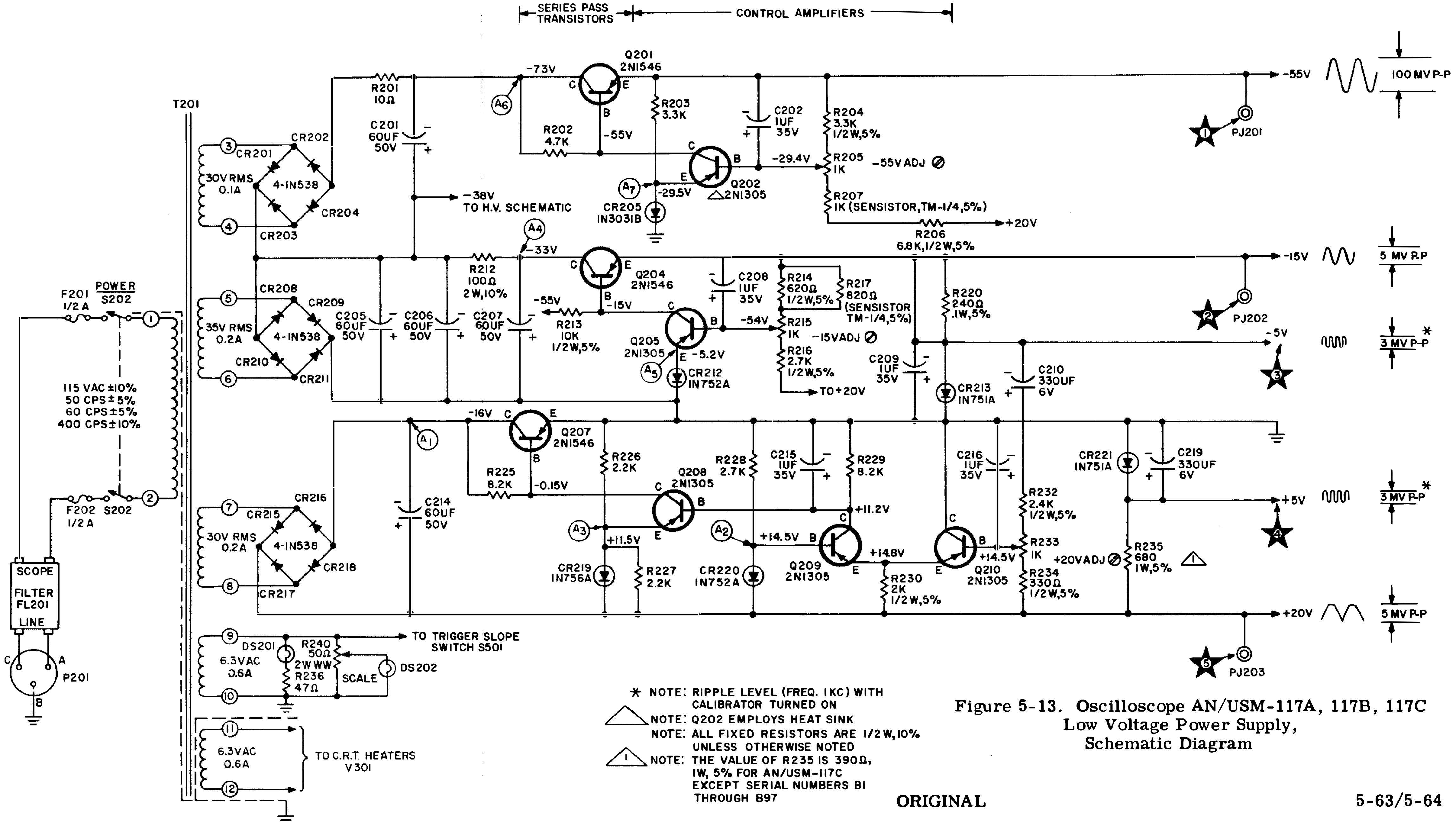


* NOTE: RIPPLE LEVEL (FREQ. 1KC) WITH CALIBRATOR TURNED ON

△ NOTE: Q202 EMPLOYS HEAT SINK

NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

Figure 5-12. Oscilloscope AN/USM 117, only, Low Voltage Power Supply, Schematic Diagram



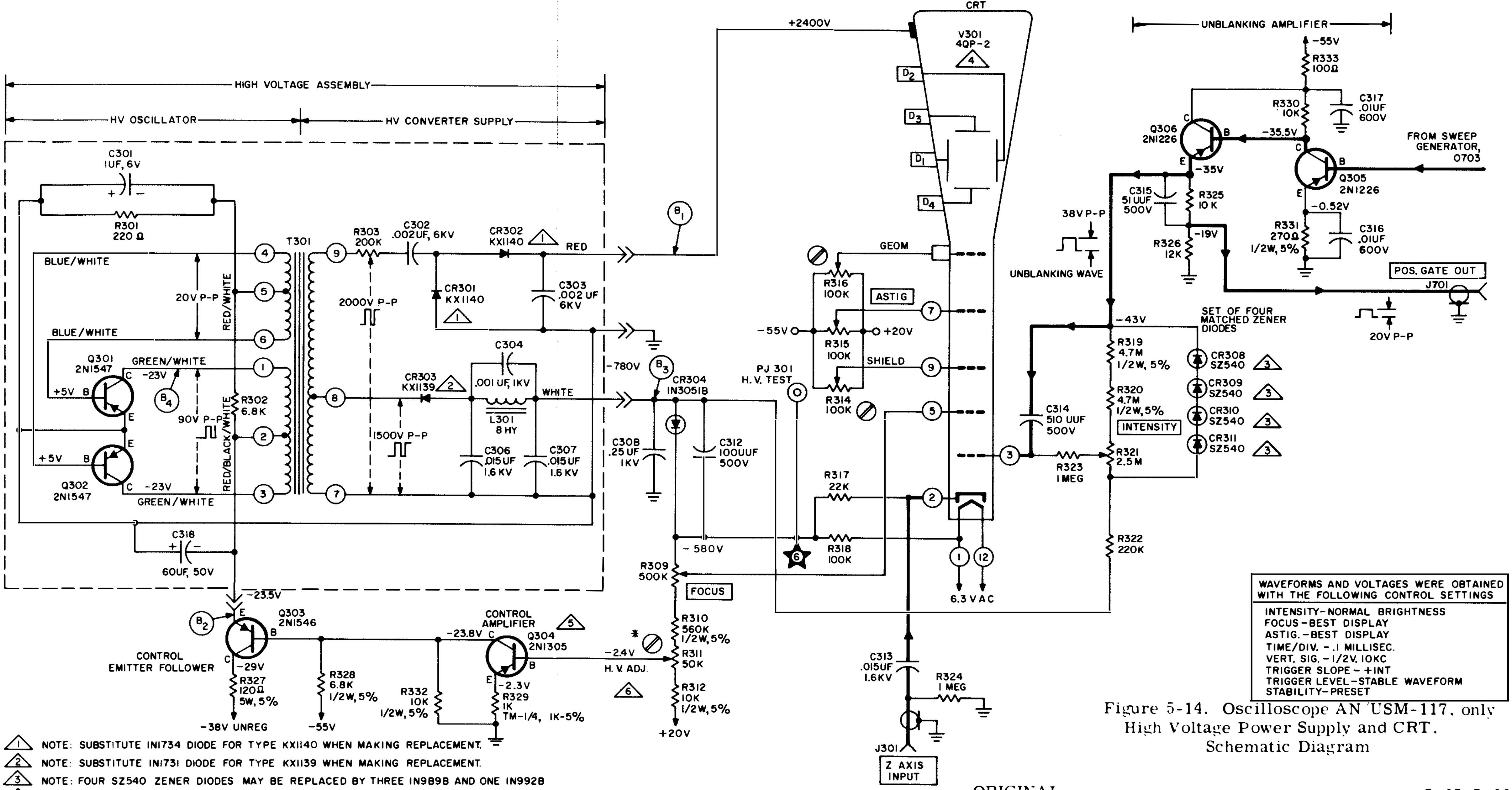
* NOTE: RIPPLE LEVEL (FREQ. 1KC) WITH CALIBRATOR TURNED ON

△ NOTE: Q202 EMPLOYS HEAT SINK

NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

△1 NOTE: THE VALUE OF R235 IS 390Ω, 1W, 5% FOR AN/USM-117C EXCEPT SERIAL NUMBERS B1 THROUGH B97

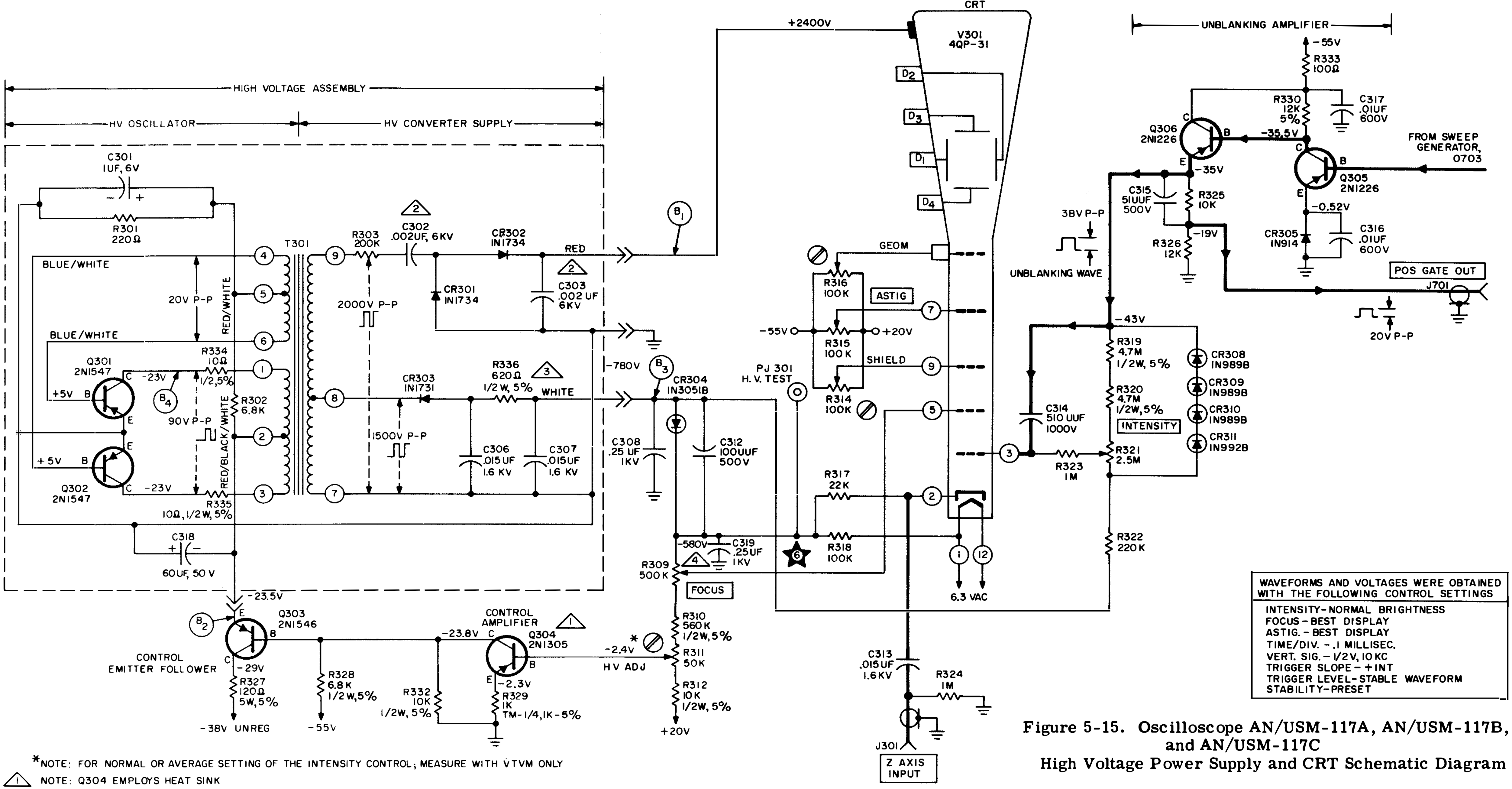
Figure 5-13. Oscilloscope AN/USM-117A, 117B, 117C Low Voltage Power Supply, Schematic Diagram



WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS
INTENSITY-NORMAL BRIGHTNESS
FOCUS-BEST DISPLAY
ASTIG.-BEST DISPLAY
TIME/DIV. -.1 MILLISEC.
VERT. SIG. - 1/2V. 10KC
TRIGGER SLOPE - +INT
TRIGGER LEVEL-STABLE WAVEFORM
STABILITY-PRESET

Figure 5-14. Oscilloscope AN/USM-117, only High Voltage Power Supply and CRT, Schematic Diagram

1 NOTE: SUBSTITUTE 1N1734 DIODE FOR TYPE KX1140 WHEN MAKING REPLACEMENT.
2 NOTE: SUBSTITUTE 1N1731 DIODE FOR TYPE KX1139 WHEN MAKING REPLACEMENT.
3 NOTE: FOUR SZ540 ZENER DIODES MAY BE REPLACED BY THREE 1N989B AND ONE 1N992B
4 NOTE: 4QP31 USED IN SER NO B1 AND SUBSEQUENT
5 NOTE: Q304 EMPLOYS HEAT SINK
6 NOTE: FOR NORMAL OR AVERAGE SETTING OF THE INTENSITY CONTROL; MEASURE WITH VTVM ONLY.
NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED.



WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS

INTENSITY-NORMAL BRIGHTNESS
FOCUS-BEST DISPLAY
ASTIG.-BEST DISPLAY
TIME/DIV. -.1 MILLISEC.
VERT. SIG. - 1/2V, 10KC
TRIGGER SLOPE - +INT
TRIGGER LEVEL-STABLE WAVEFORM
STABILITY-PRESET

Figure 5-15. Oscilloscope AN/USM-117A, AN/USM-117B, and AN/USM-117C High Voltage Power Supply and CRT Schematic Diagram

*NOTE: FOR NORMAL OR AVERAGE SETTING OF THE INTENSITY CONTROL; MEASURE WITH VTVM ONLY

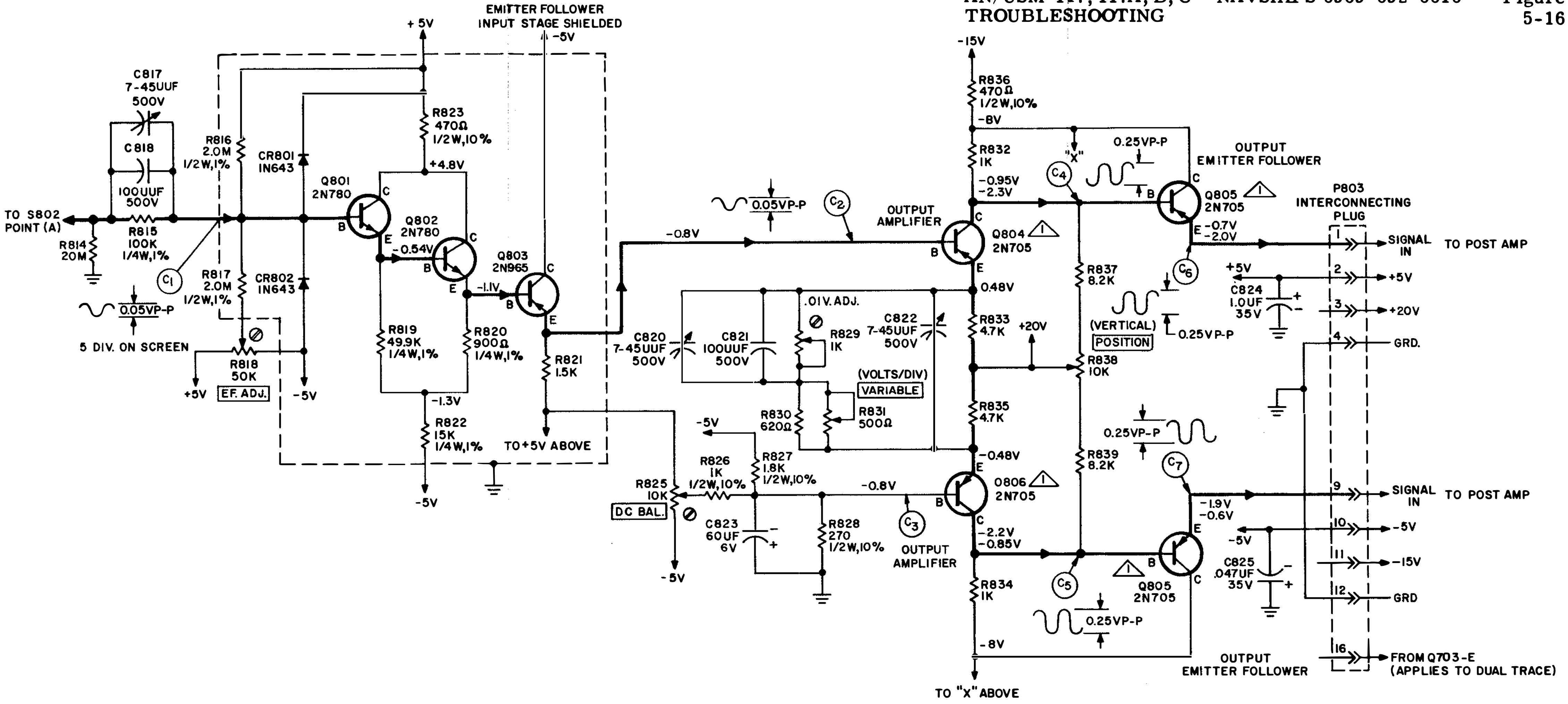
⚠1 NOTE: Q304 EMPLOYS HEAT SINK

NOTE: ALL FIXED RESISTORS ARE 1/2W 10% UNLESS OTHERWISE NOTED

⚠2 NOTE: PART OF CAPACITOR ASSEMBLY C302/C303A

⚠3 NOTE: THIS RESISTOR MARKED R331 IN CHASSIS OF AN/USM-117A SER. NO. A1 THRU A78

⚠4 NOTE: THIS CAPACITOR MARKED C304 IN CHASSIS OF AN/USM-117A SER. NO. A1 THRU A78



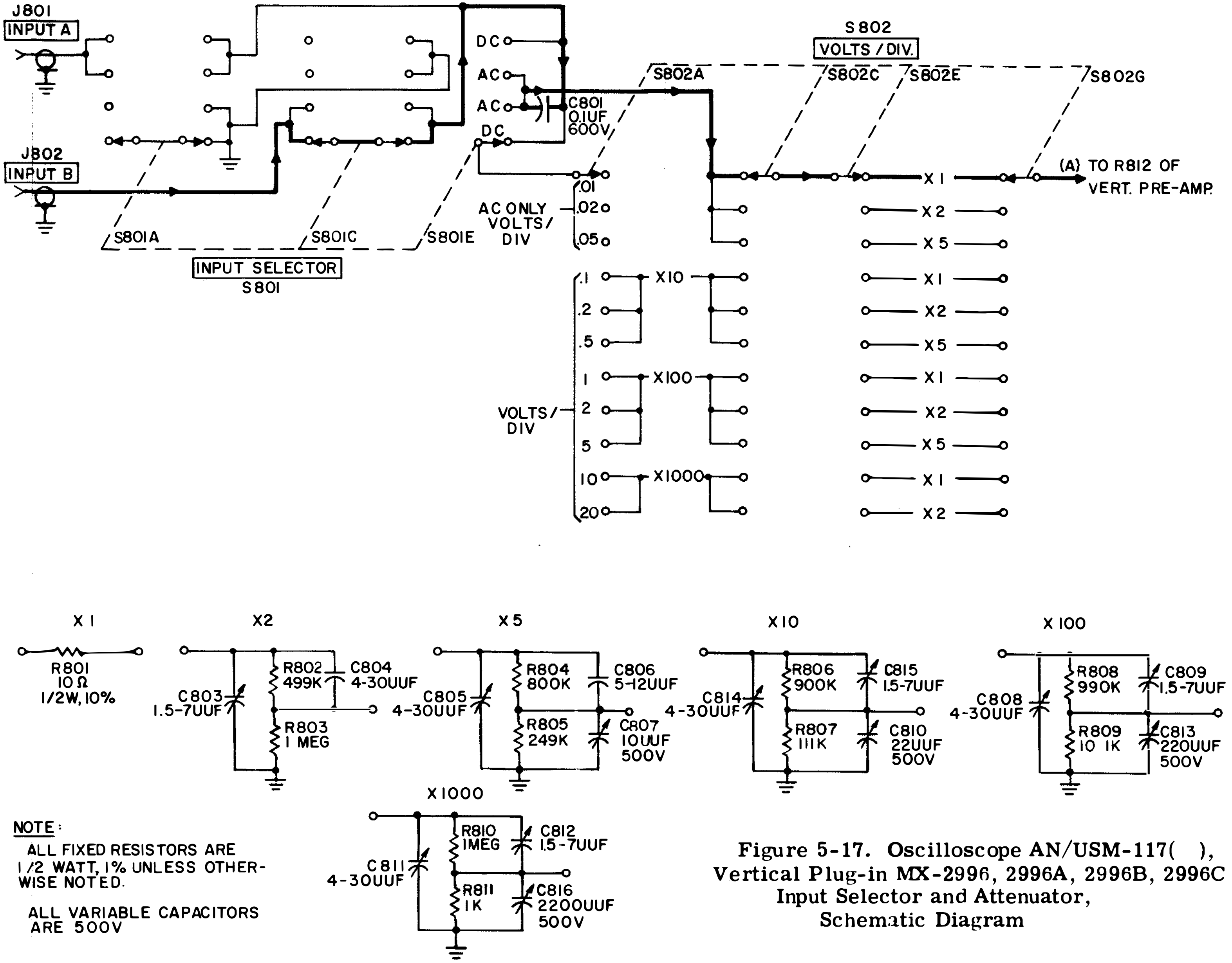
⚠ NOTE: Q804, Q805, Q806 AND Q807 ARE 2N711 TYPE TRANSISTORS IN MX2996/USM-117 PLUG-IN. USE 2N705 TYPE FOR REPLACEMENT

NOTE: ALL FIXED RESISTORS ARE 1/2W,5% UNLESS OTHERWISE NOTED

WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS

VOLTS/DIV.-0.1
VERTICAL POSITION-CCW(UPPER READING)
CW(LOWER READING)
VARIABLE-CAL. POSITION
INPUT SELECTOR-DC INPUT A
INPUT SIGNAL-10KC,0.5VP-P

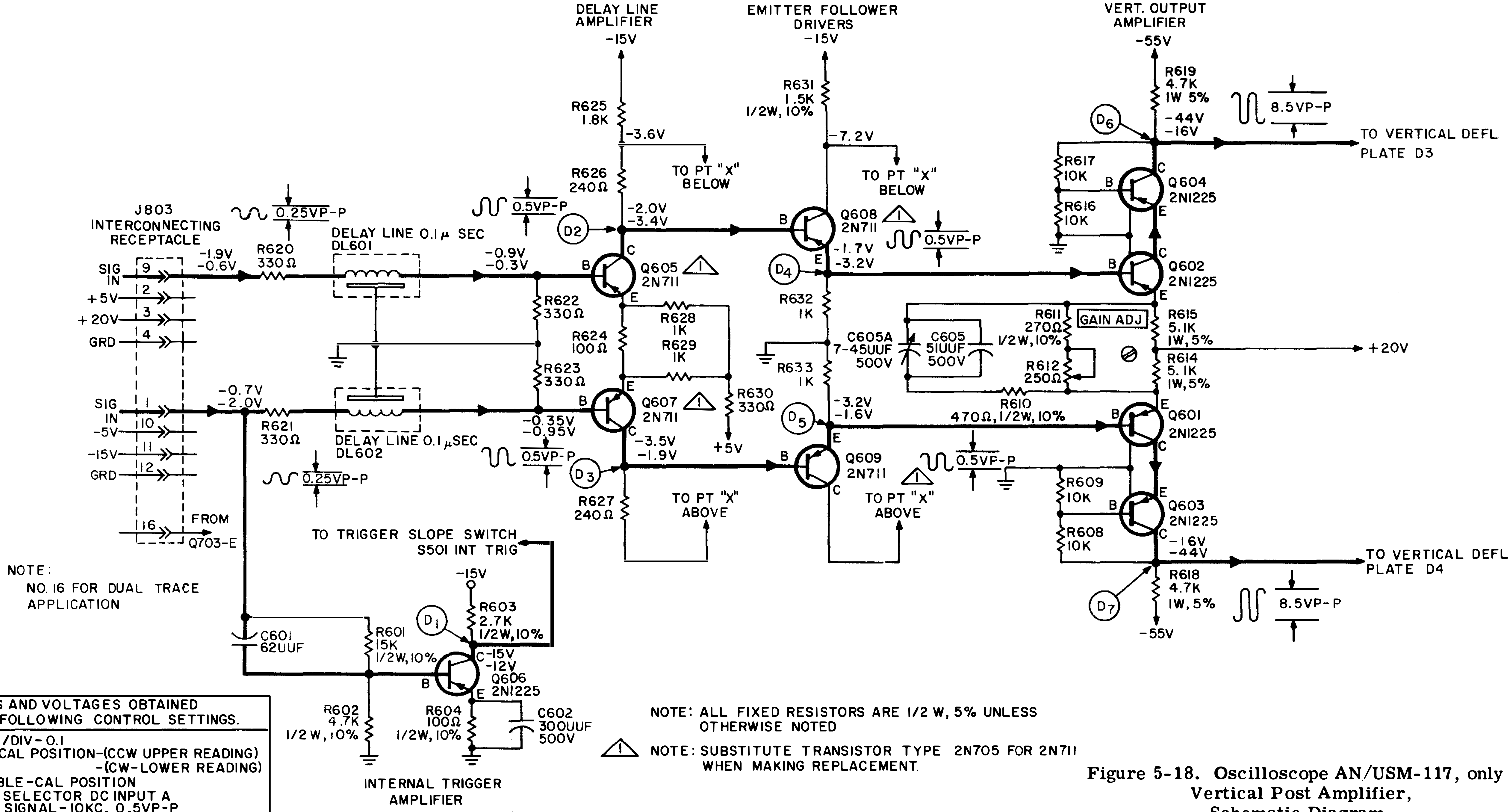
Figure 5-16. Oscilloscope AN/USM-117( ), Vertical Plug-in MX-2996, 2996A, 2996B, 2996C Preamplifier, Schematic Diagram



NOTE:
ALL FIXED RESISTORS ARE 1/2 WATT, 1% UNLESS OTHERWISE NOTED.

ALL VARIABLE CAPACITORS ARE 500V

Figure 5-17. Oscilloscope AN/USM-117( ), Vertical Plug-in MX-2996, 2996A, 2996B, 2996C Input Selector and Attenuator, Schematic Diagram



NOTE:
NO. 16 FOR DUAL TRACE APPLICATION

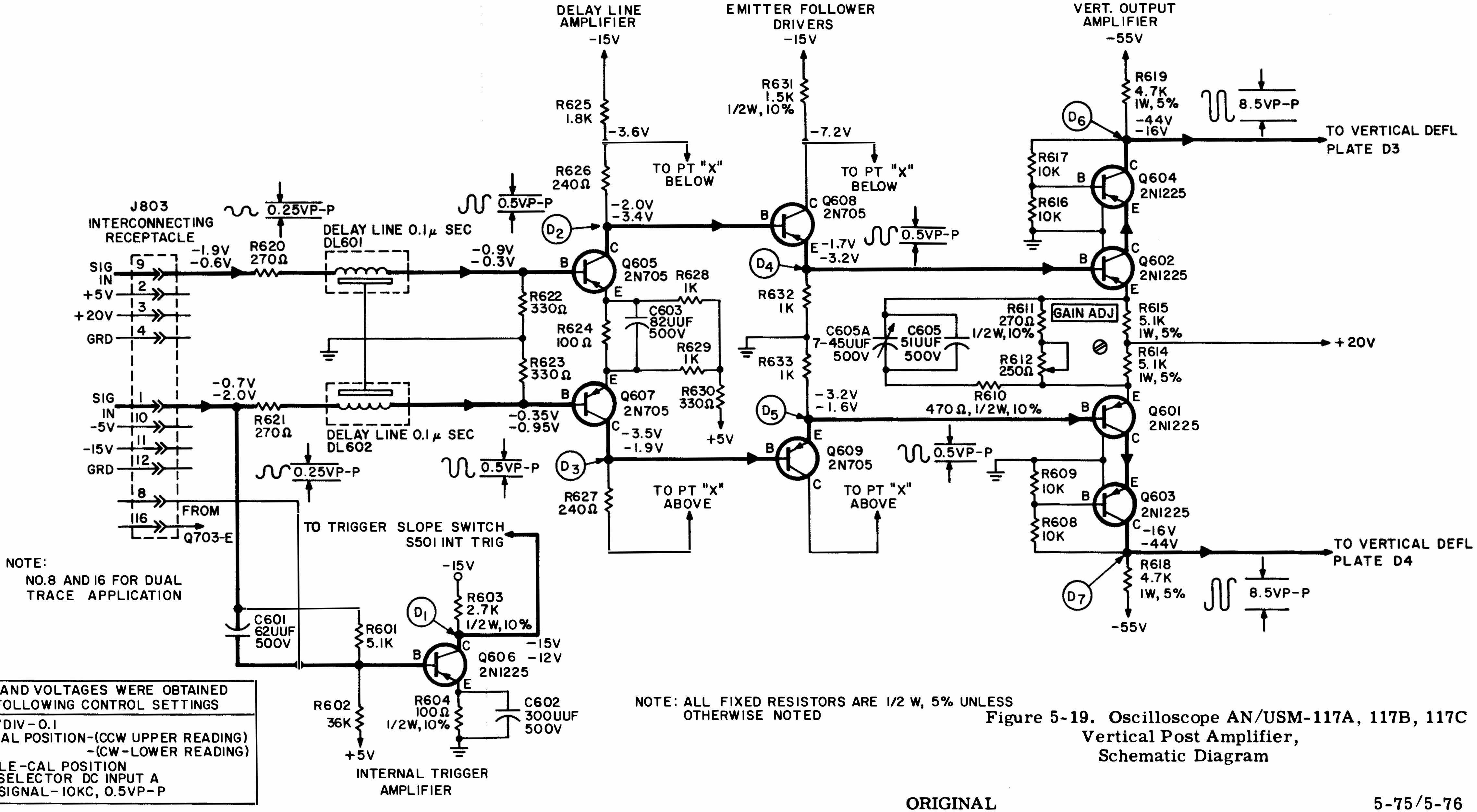
WAVEFORMS AND VOLTAGES OBTAINED WITH THE FOLLOWING CONTROL SETTINGS.

VOLTS/DIV - 0.1
VERTICAL POSITION-(CCW UPPER READING)
-(CW-LOWER READING)
VARIABLE-CAL POSITION
INPUT SELECTOR DC INPUT A
INPUT SIGNAL - 10KC, 0.5VP-P

NOTE: ALL FIXED RESISTORS ARE 1/2 W, 5% UNLESS OTHERWISE NOTED

⚠ NOTE: SUBSTITUTE TRANSISTOR TYPE 2N705 FOR 2N711 WHEN MAKING REPLACEMENT.

Figure 5-18. Oscilloscope AN/USM-117, only Vertical Post Amplifier, Schematic Diagram



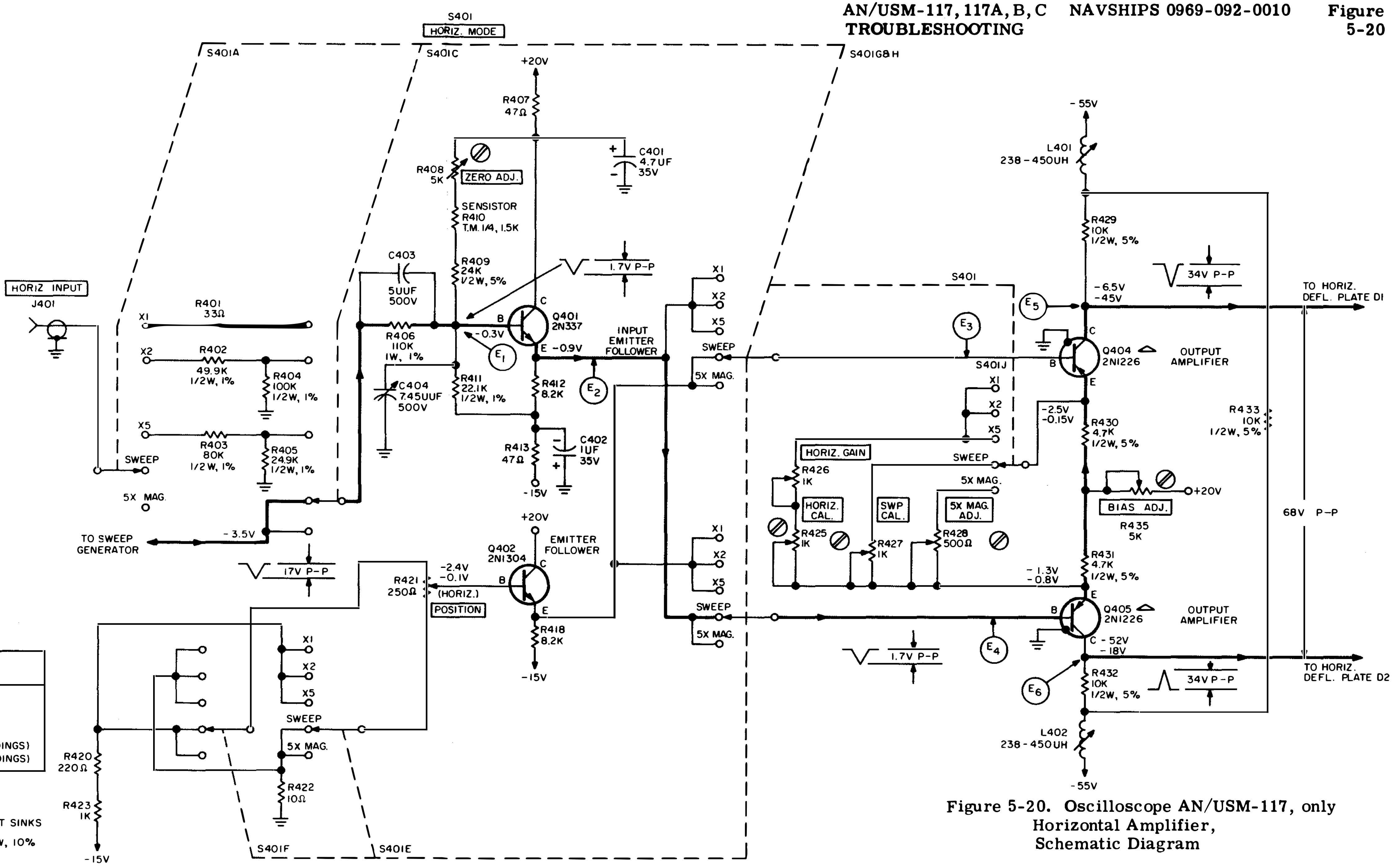
NOTE:
NO. 8 AND 16 FOR DUAL TRACE APPLICATION

WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS

VOLTS/DIV-0.1
VERTICAL POSITION-(CCW UPPER READING)
-(CW-LOWER READING)
VARIABLE-CAL POSITION
INPUT SELECTOR DC INPUT A
INPUT SIGNAL-10KC, 0.5VP-P

NOTE: ALL FIXED RESISTORS ARE 1/2 W, 5% UNLESS OTHERWISE NOTED

Figure 5-19. Oscilloscope AN/USM-117A, 117B, 117C Vertical Post Amplifier, Schematic Diagram



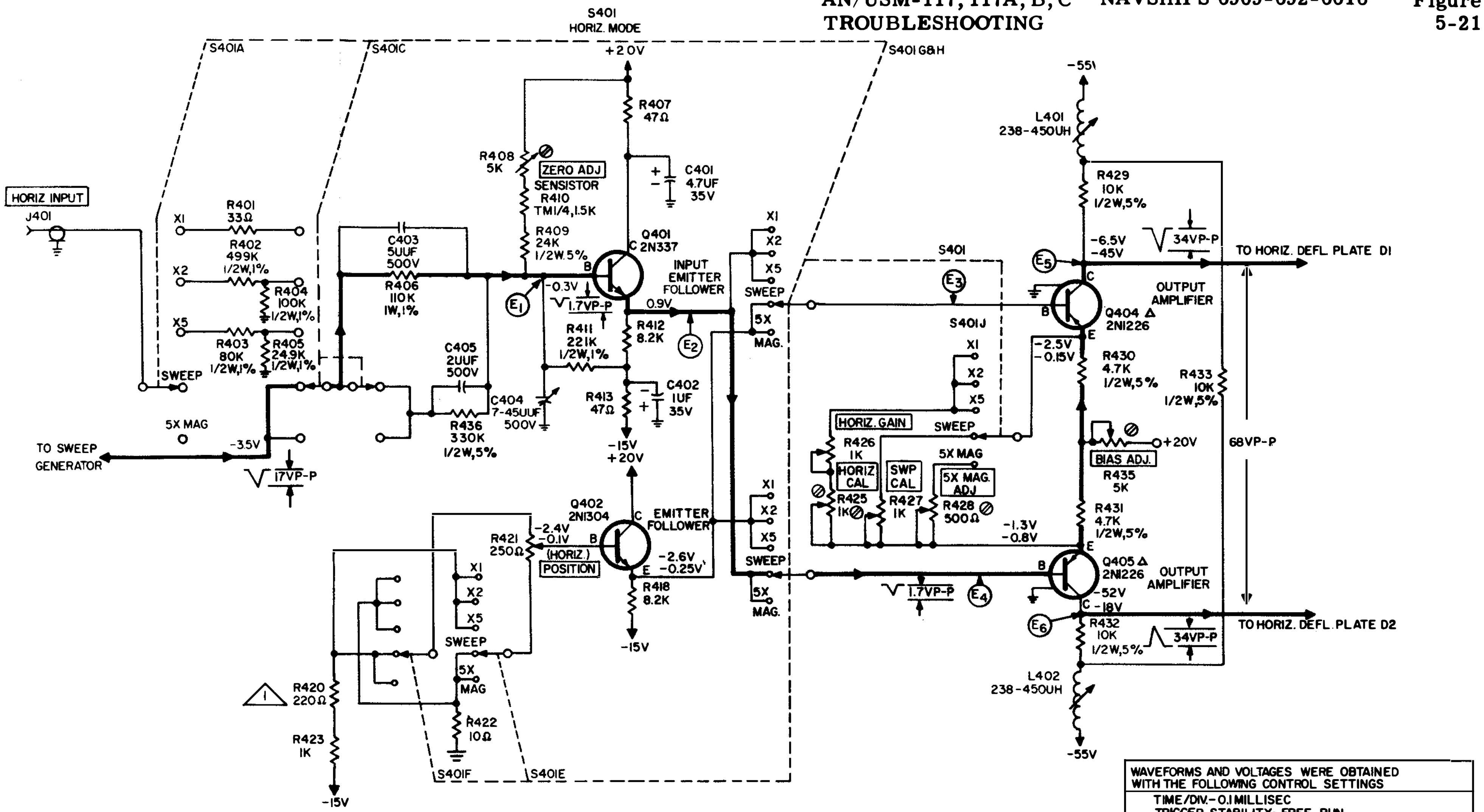
WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS

TIME/DIV.-0.1 MILLISEC.
TRIGGER STABILITY-FREE RUN
HORIZ. MODE-SWEEP
HORIZ. POSITION-TRACE CENTERED
-CCW-(UPPER VOLTAGE READINGS)
-CW-(LOWER VOLTAGE READINGS)

△ NOTE: Q404 AND Q405 EMPLOY HEAT SINKS

NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

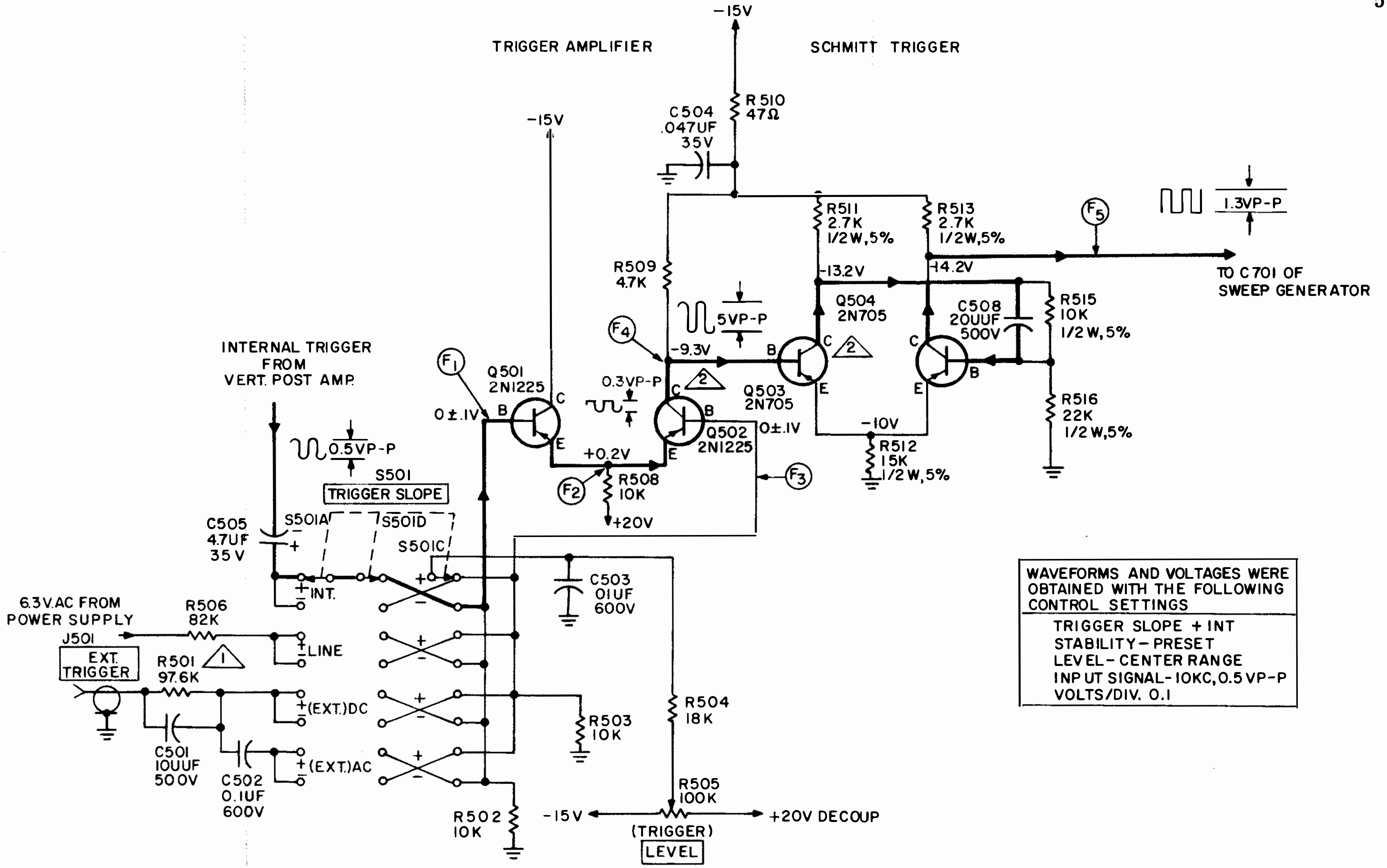
Figure 5-20. Oscilloscope AN/USM-117, only Horizontal Amplifier, Schematic Diagram



WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS
TIME/DIV.-0.1 MILLISEC TRIGGER STABILITY-FREE RUN HORIZ. MODE-SWEEP HORIZ POSITION-TRACE CENTERED -CCW-(UPPER VOLTAGE READINGS) -CW- (LOWER VOLTAGE READINGS)

△ NOTE: Q404 AND Q405 EMPLOY HEAT SINKS
NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED
⚠ NOTE: R420 DOES NOT EXIST IN AN/USM-117C SERIAL NO. D1 AND SUBSEQUENT.

Figure 5-21. Oscilloscope AN/USM-117A, 117B, 117C Horizontal Amplifier, Schematic Diagram



WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS

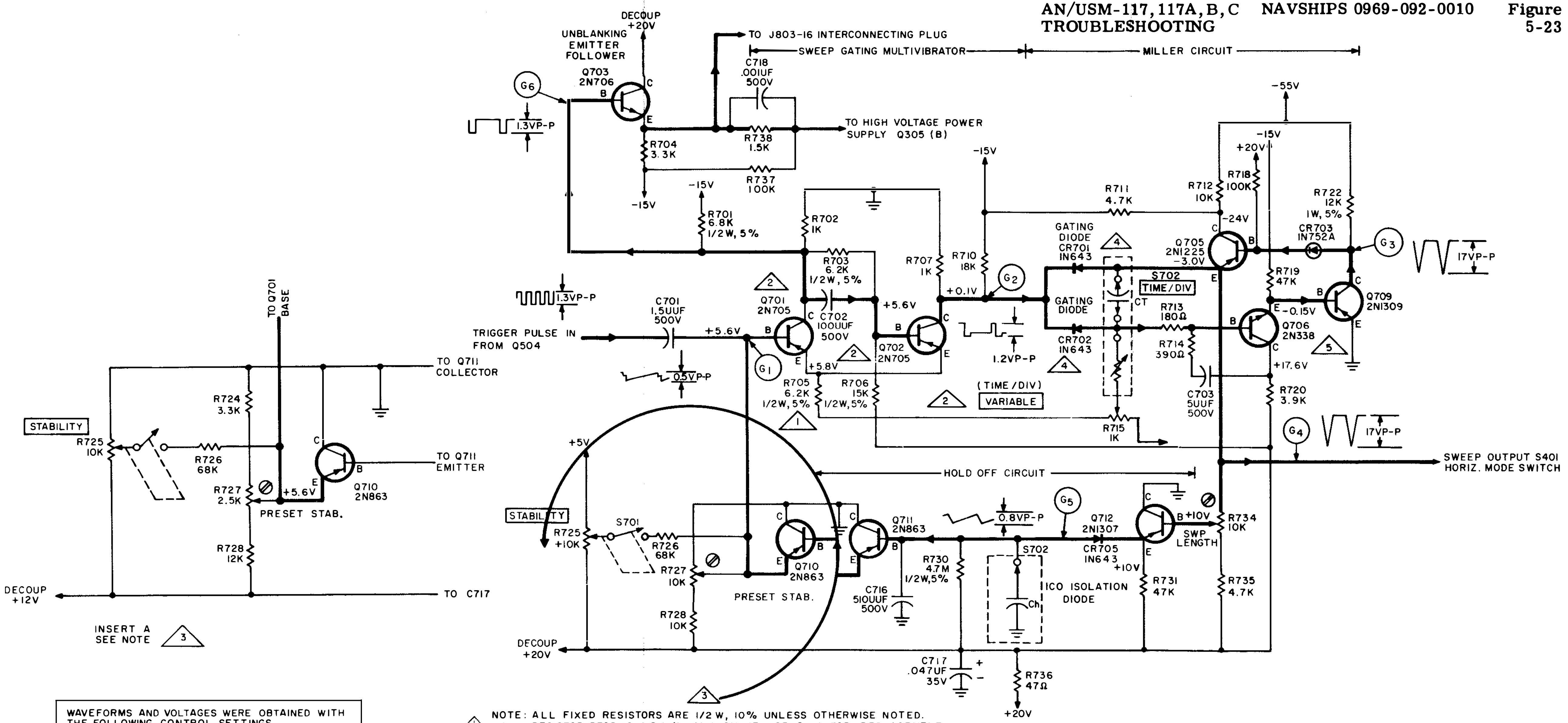
TRIGGER SLOPE + INT
STABILITY - PRESET
LEVEL - CENTER RANGE
INPUT SIGNAL - 10KC, 0.5 VP-P
VOLTS/DIV. 0.1

NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

1 NOTE: RESISTOR R501 IS 100K IN AN/USM-117

2 NOTE: Q503 AND Q504 ARE 2N711 IN AN/USM-117 USE 2N705 FOR REPLACEMENT.

Figure 5-22. Oscilloscope AN/USM-117( ), Sweep Trigger, Schematic Diagram



WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS
TIME/DIV - 0.1 MILLISEC. VARIABLE TIME/DIV. - CAL. VERT. SIGNAL - 0.5VP-P, 10KC TRIGGER SLOPE - +INT. TRIGGER LEVEL - STABLE WAVEFORM STABILITY - PRESET VOLTS/DIV. - 0.1

NOTE: ALL FIXED RESISTORS ARE 1/2 W, 10% UNLESS OTHERWISE NOTED.

△1 NOTE: RESISTOR R705 IS 6.8K IN AN/USM-117 USE 6.2K FOR REPLACEMENT.

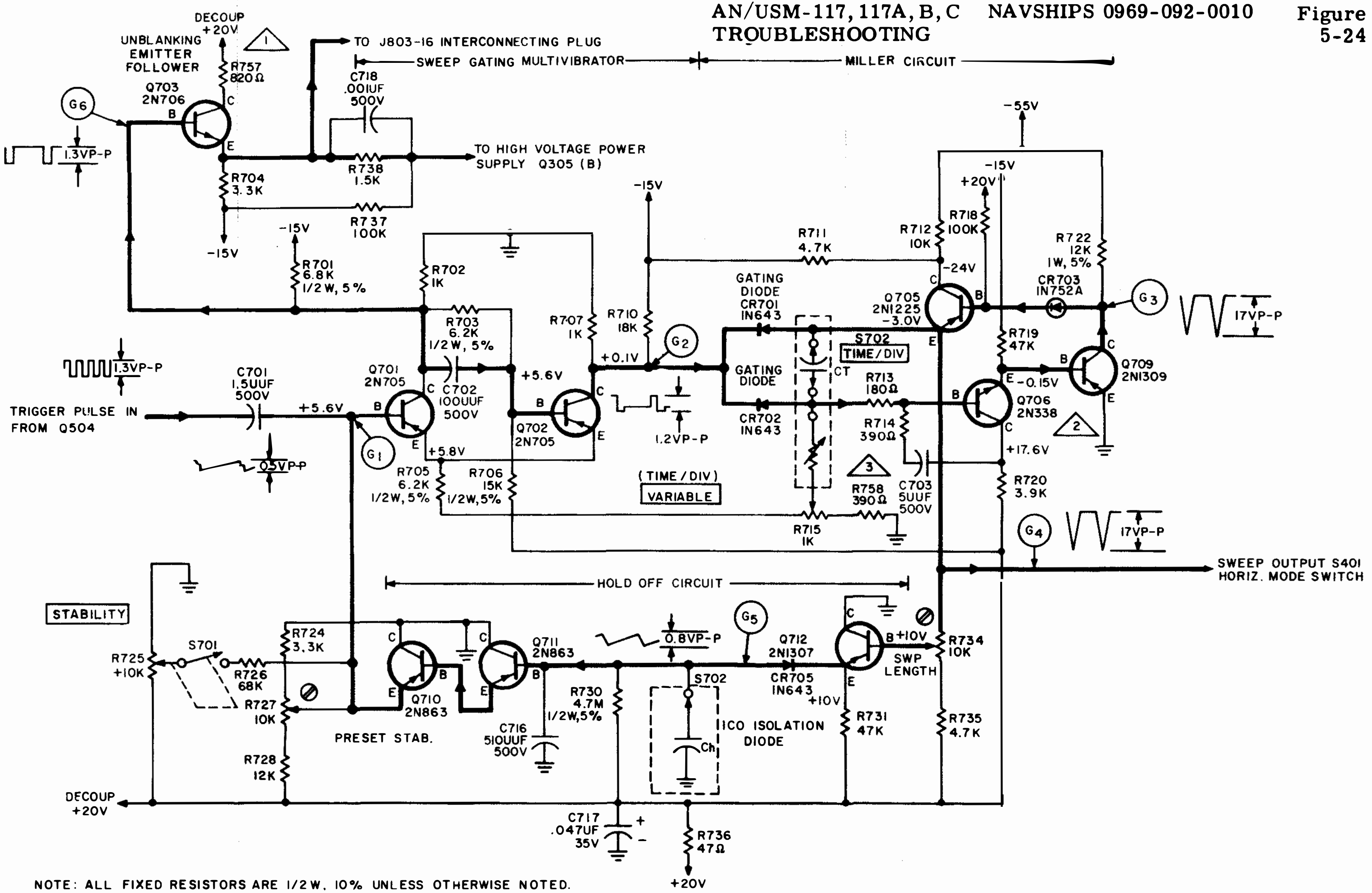
△2 NOTE: Q701 AND Q702 ARE 2N711 IN AN/USM-117. USE 2N705 FOR REPLACEMENT.

△3 NOTE: INSERT A IS CIRCUIT OF AN/USM-117B.

△4 NOTE: DIODES CR701 AND CR702 ARE 1N914 IN AN/USM-117B

△5 NOTE: TRANSISTOR Q706 2N338 CAN BE INTERCHANGED WITH 2N760A.

Figure 5-23. Oscilloscope AN/USM-117, 117A, 117B, Sweep Generator, Schematic Diagram



NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED.

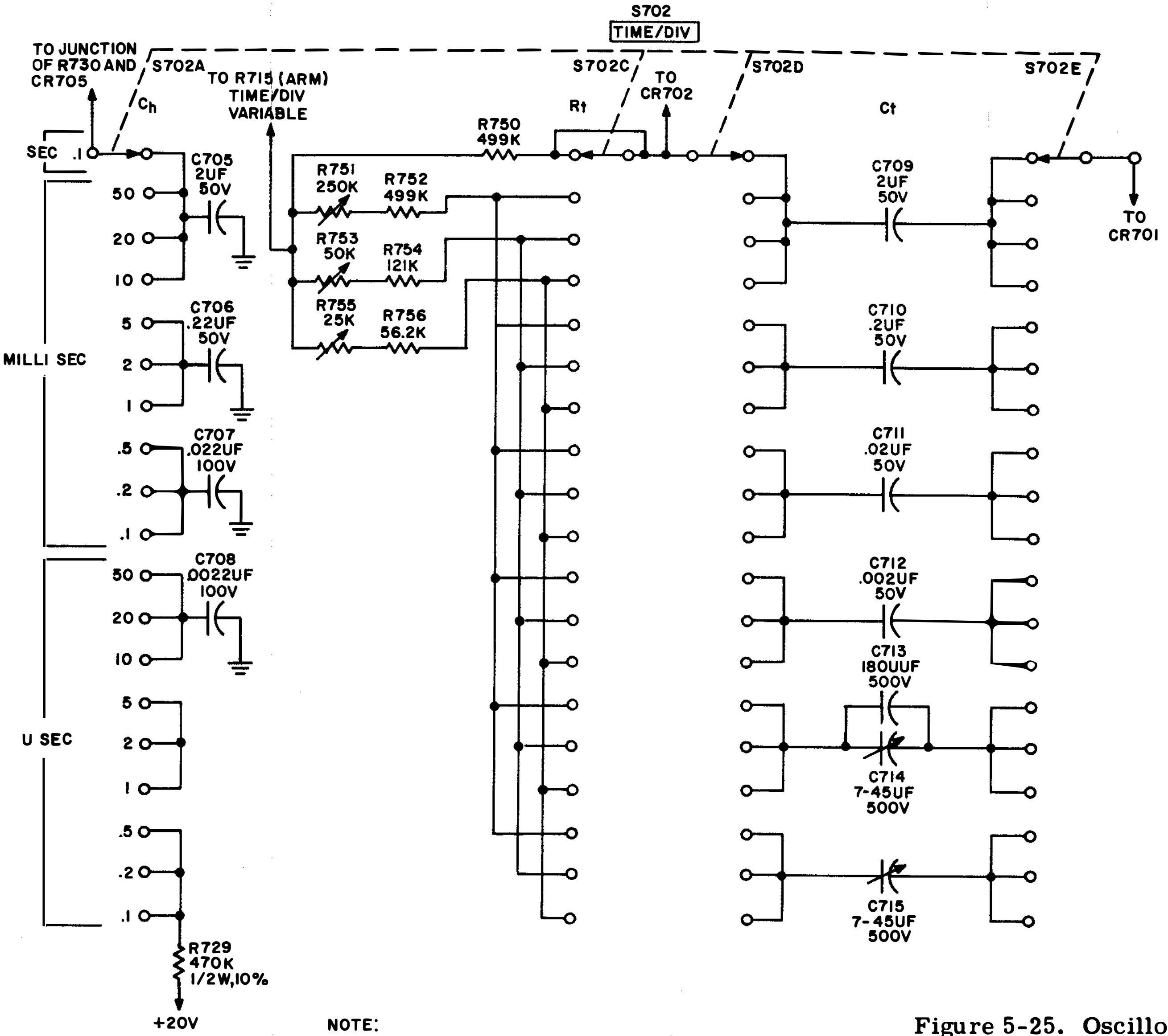
⚠1 NOTE: R757 DOES NOT EXIST FOR AN/USM-117C IN SERIAL NUMBERS A1 THROUGH A299 AND B1 THROUGH B97.

⚠2 NOTE: THE TRANSISTOR Q706 2N338 CAN BE INTERCHANGED WITH 2N760A.

⚠3 NOTE: THIS CIRCUIT IS CONNECTED AS SHOWN IN FIGURE 5-23 IN AN/USM-117C SERIAL NUMBERS B1 THROUGH B97.

WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS
TIME/DIV - 0.1 MILLISEC.
VARIABLE TIME/DIV.-CAL.
VERT. SIGNAL-0.5VP-P, 10KC
TRIGGER SLOPE-+INT.
TRIGGER LEVEL-STABLE WAVEFORM
STABILITY-PRESET
VOLTS/DIV.-0.1

Figure 5-24. Oscilloscope AN/USM-117C, Sweep Generator, Schematic Diagram



NOTE:
ALL FIXED RESISTORS ARE 1/4 WATT, ±1% UNLESS OTHERWISE NOTED.
ALL VARIABLE RESISTORS ARE 1/4 WATT, ± 10%.

Figure 5-25. Oscilloscope AN/USM-117 ( ), Sweep Time Switch, Schematic Diagram

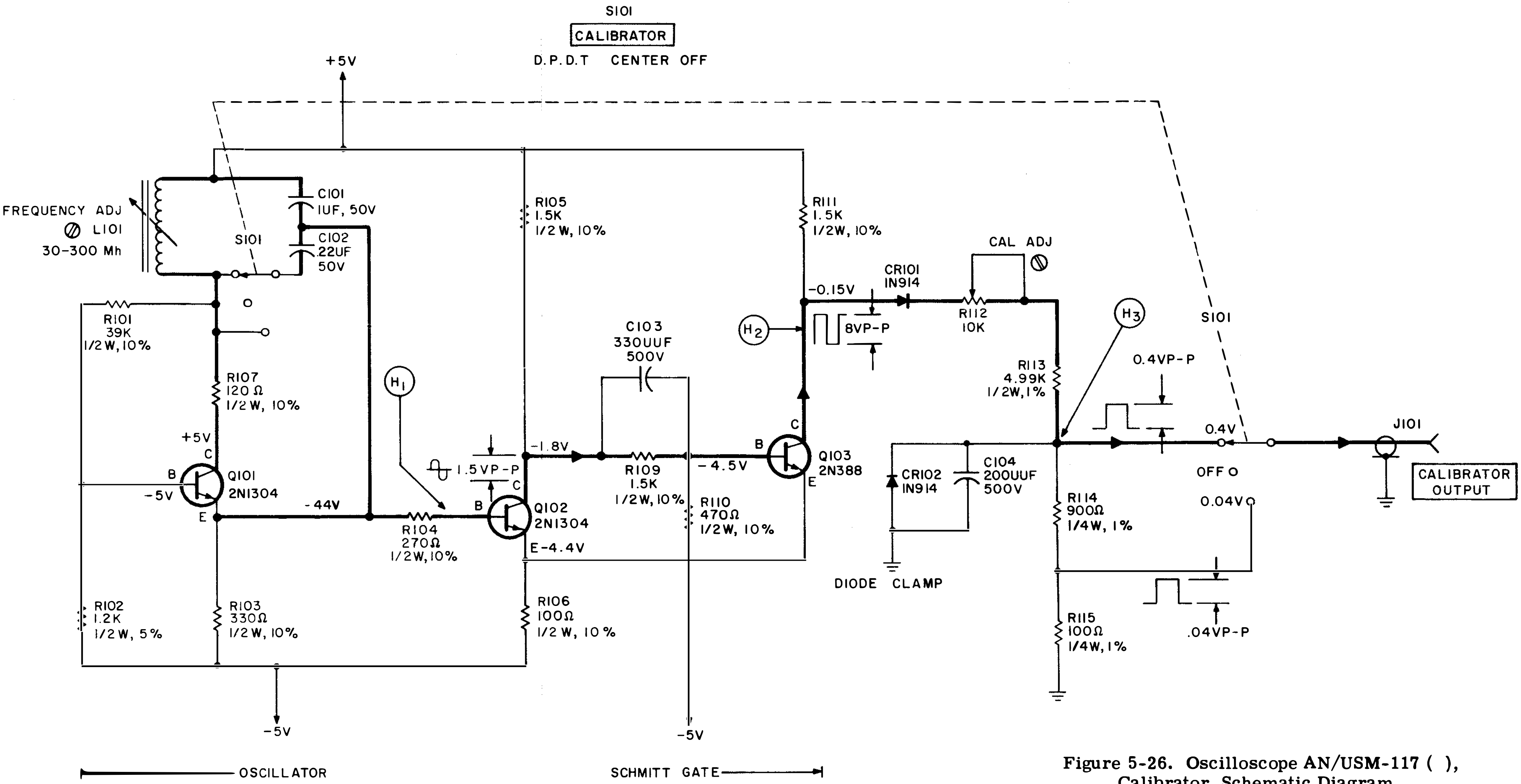
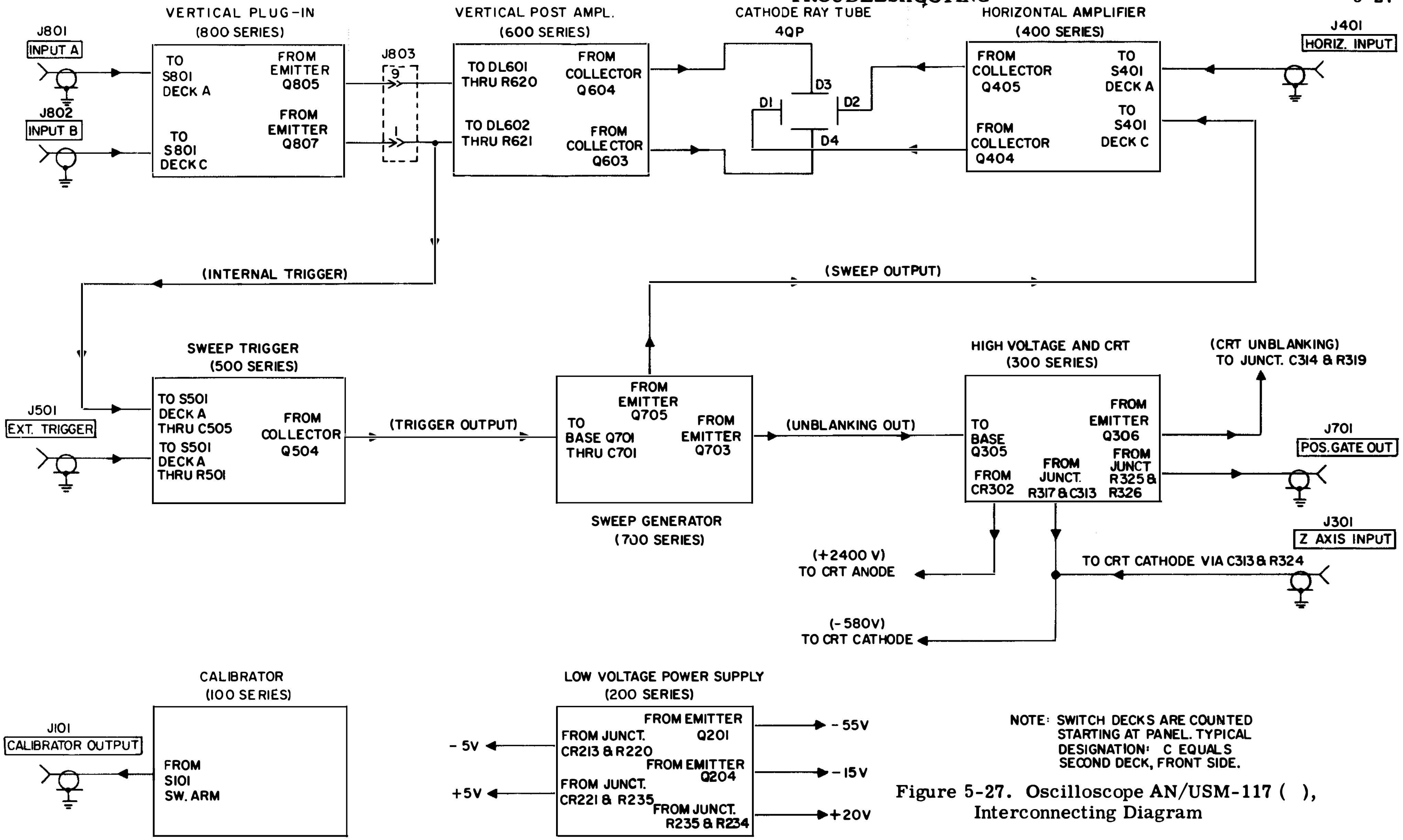


Figure 5-26. Oscilloscope AN/USM-117 ( ), Calibrator, Schematic Diagram



NOTE: SWITCH DECKS ARE COUNTED STARTING AT PANEL. TYPICAL DESIGNATION: C EQUALS SECOND DECK, FRONT SIDE.

Figure 5-27. Oscilloscope AN/USM-117 ( ), Interconnecting Diagram

SECTION 6
SERVICE AND REPAIR

6-1. FAILURE, AND PERFORMANCE AND OPERATIONAL REPORTS.

NOTE

The Bureau of Ships no longer requires the submission of failure reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipments (refer to Electronics Installation and Maintenance Book, NAVSHIPS 900,000) only to the extent required by existing directives. All failures shall be reported for those equipments requiring the use of Failure Reports.

6-2. PREVENTATIVE MAINTENANCE.

Preventative maintenance consists chiefly of cleaning and visual inspection. The instrument should be given a periodic visual inspection for potential sources of trouble which should include inspection for loose switch knobs, damaged plugs, loose or frayed wires and burned or damage components. Operability may be tested by referring to Section 3 and reviewing the calibrator waveform.

TABLE 6-1. RECORD OF FIELD CHANGES FOR MAINTENANCE STANDARD PROCEDURES

FLD CHG NO.	DATE COMPLETED	TESTS AFFECTED	FLD CHG NO.	DATE COMPLETED	TESTS AFFECTED
		PAGE NO. STEP NO.			PAGE NO. STEP NO.

6-3. MAINTENANCE STANDARDS PROCEDURES.

a. INTRODUCTION. - The procedures listed in table 6-2 constitute the minimum number of reference standards which will indicate, when completed, the relative performance of the oscilloscope and its plug-in unit. Each group of tests represents a functional section of the instrument. The procedures are listed in the suggested sequence of performance, and the power supply test must always be performed first, as indicated, to assure that all units are being supplied proper power. Otherwise, however, deviation from the listed order will in no way affect the unity or result of the reference standards.

b. RECORD OF FIELD CHANGES. - Field changes shall be recorded in table 6-1.

c. PREPARATION FOR MAINTENANCE STANDARDS TESTS.

WARNING

Observe safety precautions given in paragraph 5-4 relating to high voltage found in this Oscilloscope. Before performing the maintenance standards tests it is important that the Oscilloscope be in good operating condition. The function of all controls may be checked by referring to Section 3. If faulty operation is encountered or if the Oscilloscope fails any of the maintenance standards tests perform the adjustment procedures listed in paragraph 6-4.

TABLE 6-2. MAINTENANCE STANDARDS PROCEDURES

SECTION	ACTION REQUIRED	PROCEDURE STEPS TABLE 6-3
Power Supply Low Voltage	Check DC Voltages	(Step 2)
Power Supply High Voltage	Check DC Voltages	(Step 3)
Sweep Timing	Check Time Per Division	(Step 4)
Sweep Expansion	Check 5X Magnifier	(Step 5)
Vertical Response	Check Rise Time	(Step 6)
Vertical Attenuator	Check Vertical Amplitude	(Step 8)

TABLE 6-2. MAINTENANCE STANDARDS PROCEDURES (Continued)

SECTION	ACTION REQUIRED	PROCEDURE STEPS TABLE 6-3
Calibrator	Check Frequency and Rise Time	(Step 9)
Sweep Trigger	Check Amplitude Triggering Voltage	(Step 10)

d. TEST EQUIPMENT.

Test equipment required to complete the maintenance standard procedures is listed in table 5-1. The preamplifier test cable shown in figure 5-1 is also required.

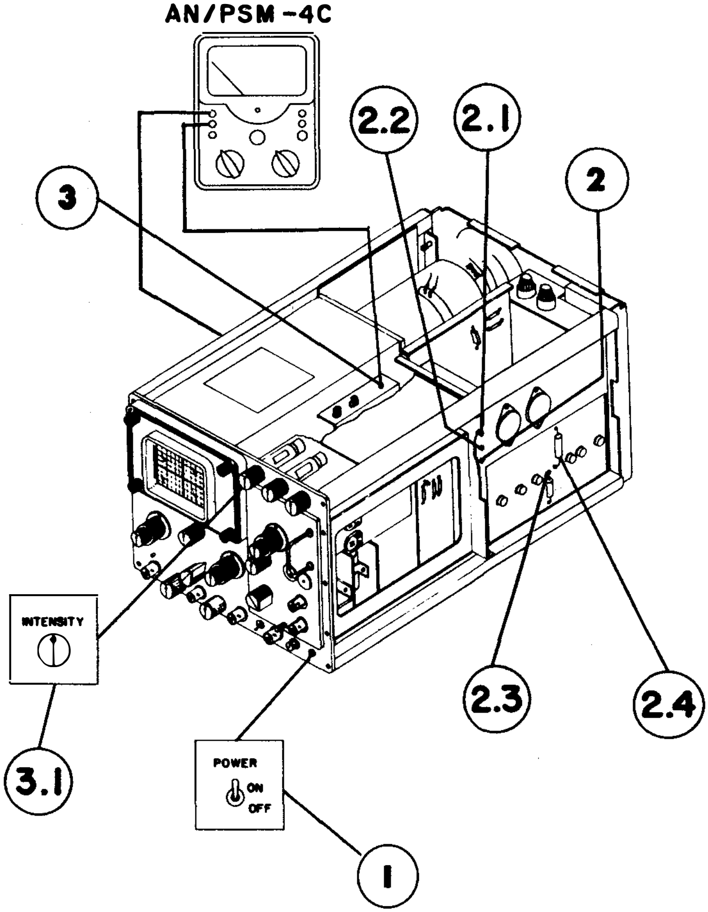

AN/PSM-4C
2.2
2.1
3
2
INTENSITY
2.3
2.4
3.1
POWER
ON
OFF
1

TABLE 6-3

Operating Conditions and Control Settings: Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
①	Verify power line operation.	Turn POWER switch to ON.	Pilot lamp	Pilot Lamp glows.
②	Check low voltage supply	Connect multimeter to PJ203	Multimeter	+20V ±0.5V
(2.1)		Connect multimeter to PJ202	Multimeter	-15V +.5V - 0V
(2.2)		Connect multimeter to PJ201	Multimeter	-55V ±1.5V
(2.3)		Connect multimeter to junction of CR213 and R220	Multimeter	-5V ±0.5V
(2.4)		Connect multimeter to junction of CR221 and R235	Multimeter	+5V ±0.5V
③	Check high voltage supply	Connect multimeter to PJ301	Multimeter	-580V ±10V

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(3.1)		Vary setting of INTENSITY control over normal range.	Multimeter	Variation should not exceed approx. ±10V.

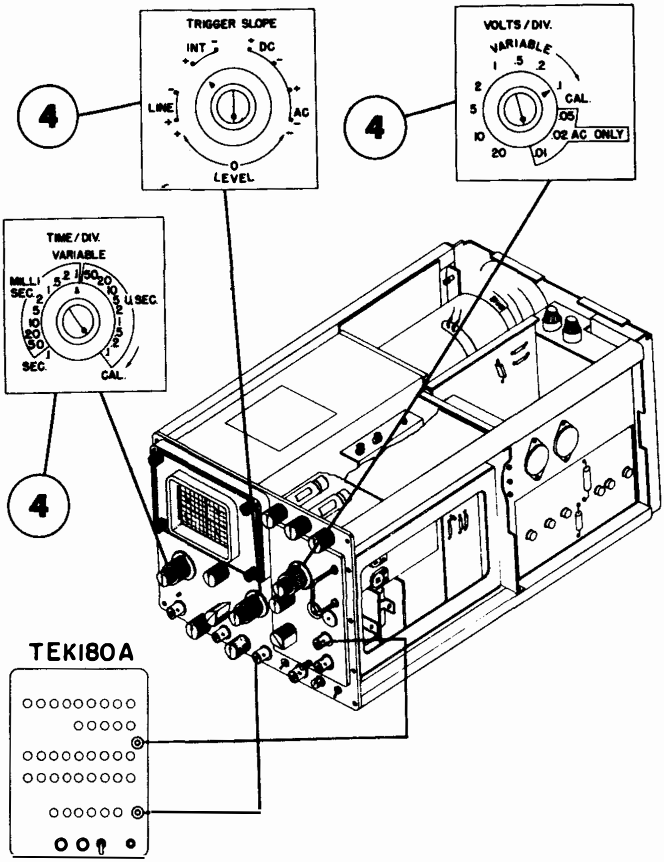

TRIGGER SLOPE
INT
DC
LINE
AC
0
LEVEL
VOLTS / DIV.
VARIABLE
1
.5
.2
.1
2
5
10
20
.01
.02 AC ONLY
.05
CAL.
TIME / DIV.
VARIABLE
MILLI SEC.
U SEC.
SEC.
CAL.
4
4
4
TEK180A

TABLE 6-3

Operation Conditions and Control Settings: Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
④	Check sweep timing	Connect time mark generator to INPUT A-AC. Connect the TRIGGER OUT of the Time Mark generator to the EXT TRIGGER INPUT. Set other controls as follows: TRIGGER SLOPE +AC; VOLTS/DIV -2div display; TRIGGER RATE -10 cps; MARKER -100 MILLISEC; TIME/DIV 0.1 SEC.	Crt screen	One marker every division Maximum timing error: ±3 percent
(4.1)		TRIGGER RATE -1 kc MARKER - 1 MILLISEC TIME/DIV - 1 MILLISEC	Crt screen	One marker every division. Maximum timing error: ±3 percent

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(4.2)		TRIGGER RATE -10 kc MARKER -100 u SEC TIME/DIV -20 u SEC	Crt screen	One marker every fifth division. Maximum timing error: ±3 percent
(4.3)		TRIGGER RATE -100 kc MARKER - 5 u SEC TIME/DIV - 5 u SEC	Crt screen	One marker every division. Maximum timing error. ±3 percent
(4.4)		TRIGGER-RATE -100 kc MARKER -5mc TIME/DIV -0.2 u SEC	Crt screen	Sine wave to cross its 50 percent rise point at every division within 3 percent.

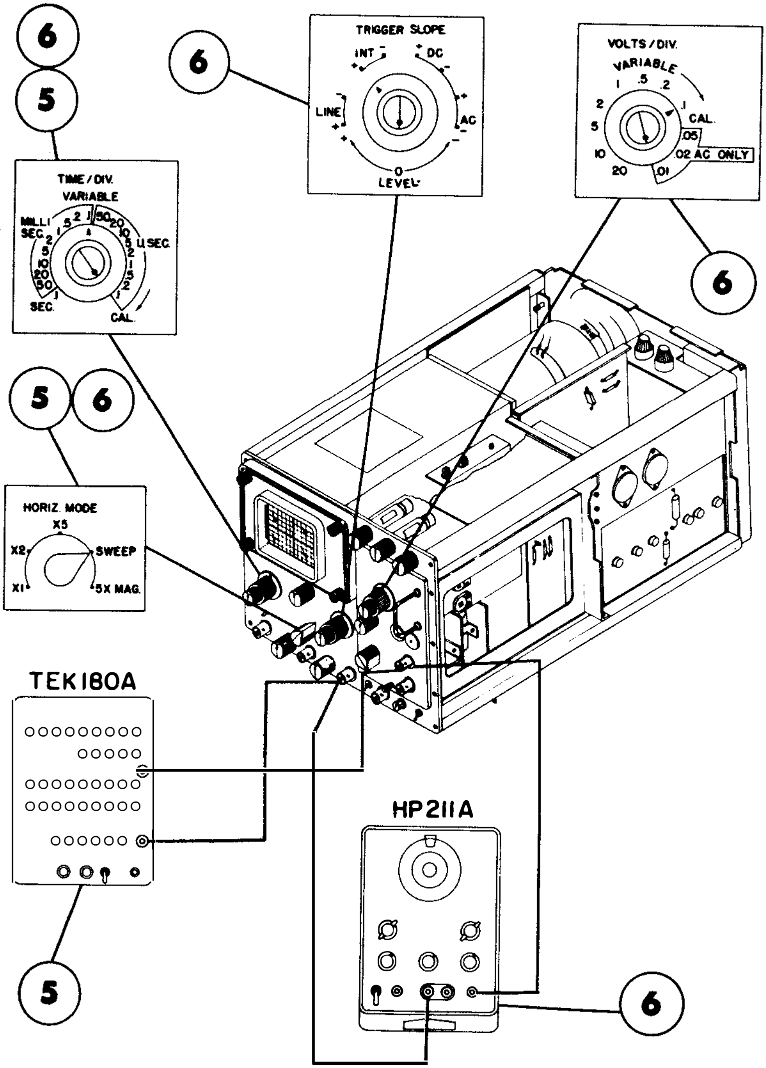

⑥
⑤
⑥
TRIGGER SLOPE
INT
DC
LINE
AC
LEVEL
0
VOLTS / DIV.
VARIABLE
1 .5 .2
.1
2
5
10
20
CAL.
.05
.02 AC ONLY
.01
⑥
TIME / DIV.
VARIABLE
MILLI SEC.
SEC.
U SEC.
CAL.
⑤ ⑥
HORIZ. MODE
X5
X2
SWEEP
X1
5X MAG.
TEK180A
HP211A
⑤
⑥

TABLE 6-3

Operating Conditions and Control Settings.
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
⑤	Check sweep expansion	Using equipment set up in step 4, set controls as follows: HORIZ MODE 5X MAG; TRIGGER RATE- 1 kc; MARKER -1 MILLISEC; TIME/DIV -5 MILLISEC; Position display through its entire horizontal range.	Crt screen	One marker every division. Maximum timing errors ±3 percent.
⑥	Check vertical response (high range)	Connect the 75-ohm OUTPUT of the square wave generator to INPUT A-DC. Connect 600-ohm OUTPUT of generator to EXT TRIGGER INPUT.	Crt screen	Rise time of square wave should measure 0.074 u SEC. or less between 10 and 90 percent amplitude points.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
		Set generator frequency to 1 mc. Set amplitude controls of 75-ohm OUTPUT to display 5 div high waveform. Set 600-ohm OUTPUT control mid-way. Set other controls as follows: TRIGGER SLOPE +AC; VOLTS/DIV -.01; TIME/DIV -0.5 u SEC; HORIZ MODE -5X MAG.		

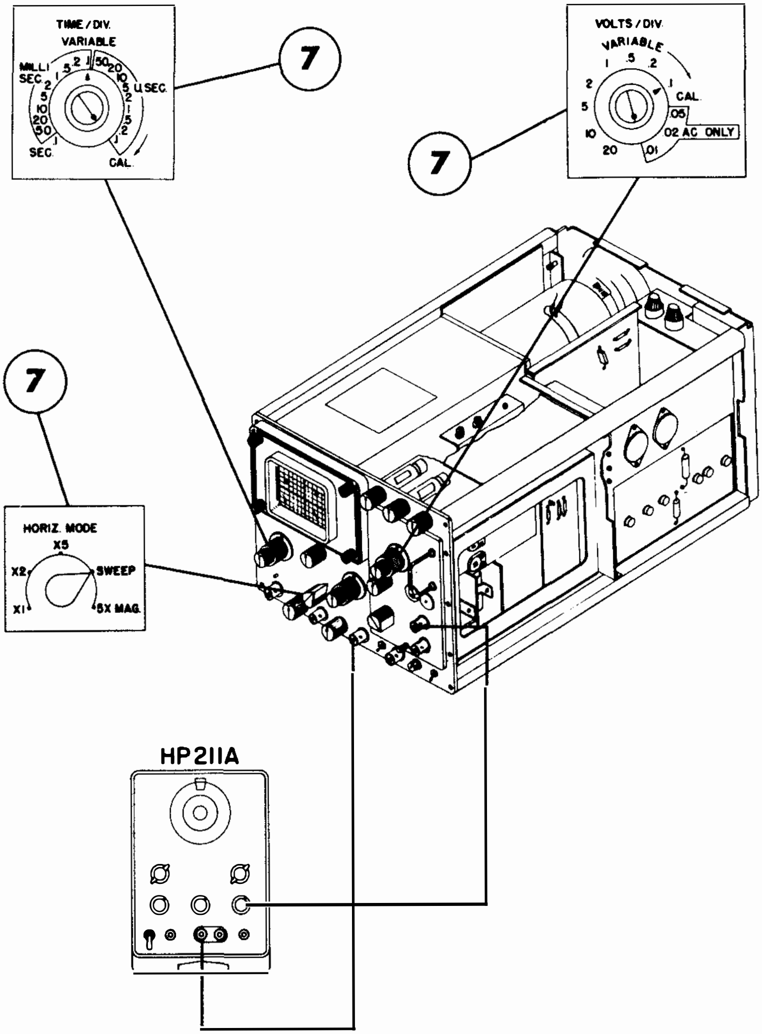

TIME / DIV.
VARIABLE
MILLI SEC.
.5 .2 .1 50 20 10 5 2 1 .5 .2 .1
2 5 10 20 50
U SEC.
SEC.
CAL.
7
VOLTS / DIV.
VARIABLE
1 .5 .2 .1
2 5 10 20
CAL.
.05
.02 AC ONLY
.01
7
7
HORIZ. MODE
X5
X2
SWEEP
X1
5X MAG.
HP211A

TABLE 6-3

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
⑦	Check vertical response (mid range)	Using equipment set up in step 6, change the frequency of the generator to 5 kc. Adjust generator output to display 5 div. high waveform. Also change to the following control settings: VOLTS/DIV - .01 TIME/DIV - 50 u SEC HORIZ MODE - SWEEP	Crt screen	Square wave with overshoot slope, droop etc, less than ±0.1 division.
(7.1)		Set VOLTS/DIV switch to 0.5	Crt screen	Waveform identical to step 7.
(7.2)		Set VOLTS/DIV switch to Interchanged 75-ohm and 600-ohm OUTPUTS.	Crt screen	Waveform identical to step 7.

STEPS ⑦ THRU (7.3)

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(7.3)		Set VOLTS/DIV switch to 20	Crt screen	Waveform reduced in amplitude (refer to step 7), but with no noticeable overshoot, slope, droop etc.

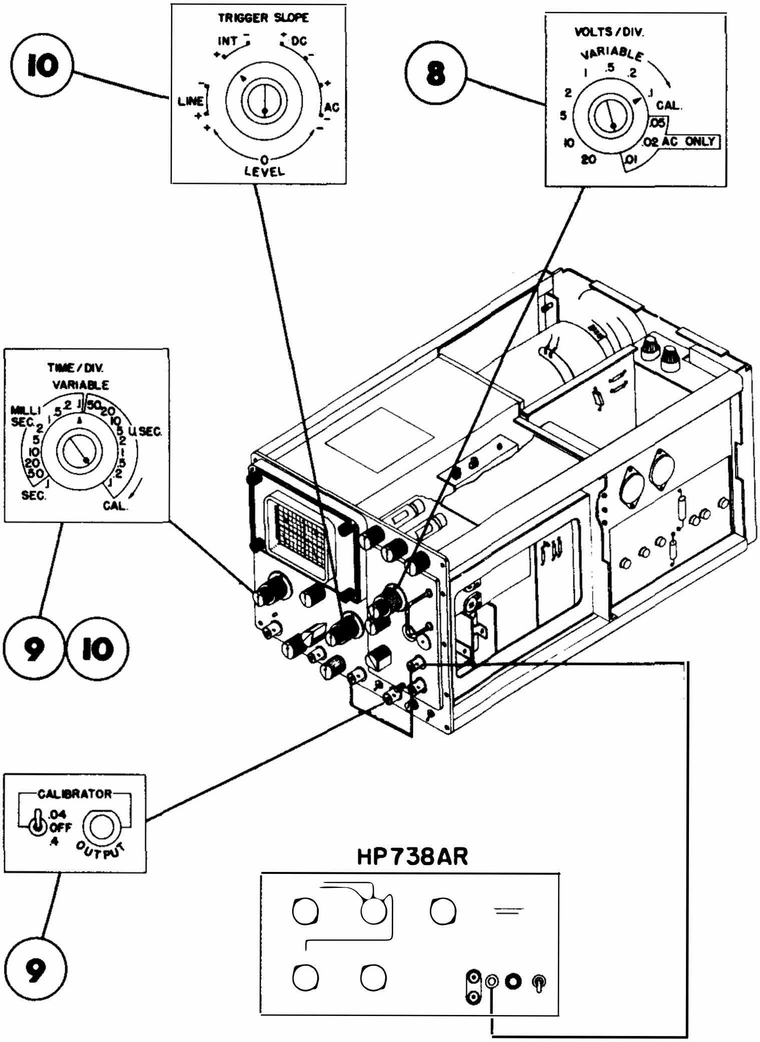

⑩
TRIGGER SLOPE
INT
DC
LINE
AC
0
LEVEL
⑧
VOLTS/DIV.
VARIABLE
1 .5 .2 .1
2
5
10
20
CAL.
.05
.02 AC ONLY
.01
TIME/DIV.
VARIABLE
MILLI SEC.
.5 .2 .1
50 20 10 5
µ SEC.
2 5 10 20 50
.1
SEC.
CAL.
⑨ ⑩
CALIBRATOR
.04
OFF
4
OUTPUT
⑨
HP738AR

TABLE 6-3

Operating Conditions and Control Settings: Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
⑧	Check vertical attenuator calibration	Connect precision calibrator to INPUT A-DC and apply .05V peak-to-peak. Set VOLTS/DIV switch to .01.	Crt screen	Sine wave waveform having amplitude of five divisions within 5 percent.
(8.1)		Set VOLTS/DIV switch to 0.5. Set output of precision calibrator to 3V peak-to-peak.	Crt screen	Sine wave waveform having amplitude of six divisions within 5 percent.
(8.2)		Set VOLTS/DIV switch to 2. Set output of precision calibrator to 10V peak-to-peak.	Crt screen	Waveform identical to step 8.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(8.3)		Set VOLTS/ DIV switch to 20. Set output of precision calibrator to 100V peak-to-peak.	Crt screen	Waveform identical to step 8.
⑨	Check calibrator amplitude, frequency, and rise time.	Connect precision calibrator to INPUT A-DC and apply 0.4V peak-to-peak sine wave (use TRACKING scale).	Crt screen	Record exact amplitude of waveform to be used as Reference Standard in following step.
(9.1)		Set CALIBRATOR to 0.4V, and connect CALIBRATOR OUTPUT to INPUT B-DC.	Crt screen	Waveform same amplitude as step 9 within 2 percent.
(9.2)		Measure period (time of one cylce) of waveform at INPUT B-DC.	Crt screen	Time of one cycle should measure 1 MILLISEC. ±10 percent.

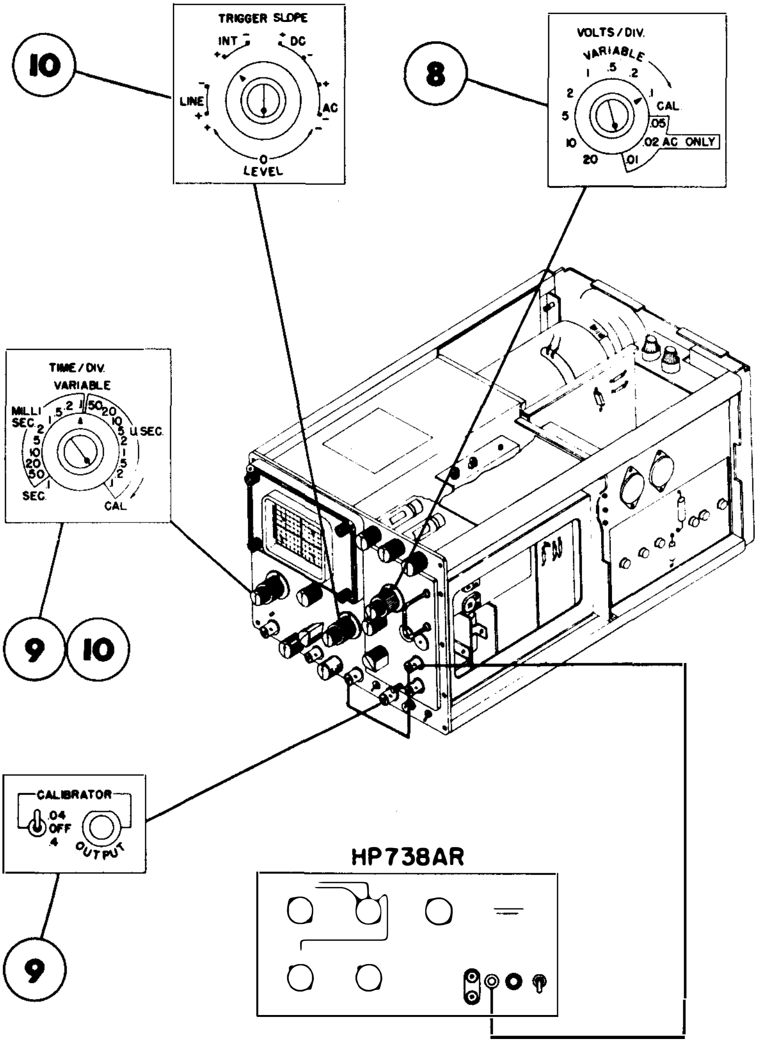

10
TRIGGER SLOPE
INT
DC
LINE
AC
0
LEVEL
8
VOLTS/DIV.
VARIABLE
1
.5
.2
.1
2
5
10
20
CAL
.05
.02 AC ONLY
.01
TIME/DIV.
VARIABLE
MILLI SEC
1 .5 .2 .1 50 20 10 5 2 1 .5 .2 .1
U SEC
2
5
10
20
50
1
SEC
CAL
9
10
CALIBRATOR
.04
OFF
.4
OUTPUT
9
HP738AR

TABLE 6-3

Operating Conditions and Control Settings: Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
9.3		Increase TIME/ DIV switch to u SEC. Measure rise time of waveform at INPUT B-DC.	Crt screen	Rise time should measure less than 1.5 u SEC. between 10 and 90 percent amplitude points.
10	Check sweep trigger (internal) and external)	Connect precision calibrator to INPUT A-DC and apply 0.05V peak-to-peak sine wave. Set TIME/DIV switch to 0.5 MILLISEC.	Crt screen	Stable waveform, five cycles, one half division amplitude.
10.1		Add short cable from INPUT A to EXT. TRIGGER INPUT using BNC tee. Set TRIGGER SLOPE switch to +AC. Increase output of precision calibrator to 1.0V peak-to-peak set VOLTS/ DIV switch to 0.5		Stable waveform, five cycles, two divisions of amplitude.

6-4. ADJUSTMENTS.

The following paragraphs describe the complete adjustment procedure related to the calibration of the oscilloscope. Initial control settings should conform with those listed in table 5-2. Changes in settings will be noted in the individual procedures. Make all adjustments in the sequence listed; this is very important. Secure the lock nut on each control after adjustment.

a. LOW VOLTAGE POWER SUPPLY ADJUSTMENTS.

Adjust the following controls in the sequence listed, measuring voltage at the test points indicated. Refer to figure 6-10 (Sheet 1).

CAUTION

Never allow any power supply voltage to short directly to ground or to another circuit. Such a short will destroy the power supply transistors instantaneously.

Supply Voltage	Control	Test Point	
+ 20V	R233	PJ203	5
- 55V	R205	PJ201	1
- 15V	R215	PJ202	2

b. HIGH VOLTAGE SUPPLY AND CRT ADJUSTMENTS.

(1) -580V ADJUSTMENTS. - Adjust HV ADJ control R311 (figure 6-10, sheet 1), until the voltage at test point 6 (PJ301) is equal to -580V.

(2) CRT ALIGNMENT. - Advance the STABILITY control to FREE RUN and center the trace vertically. Loosen the mounting strap at the base of crt. Rotate the crt a few degrees, carefully holding it by the base, until the trace is aligned with the center graticule line. Fasten strap.

(3) GEOMETRY ADJUSTMENT. - Apply a 100 kc signal from the sine wave generator to the vertical INPUT. Set the TIME/DIV switch to .1 MILLISEC. Set AMPLITUDE control of generator and VOLTS/DIVswitch to offer eight division high display. Adjust INTENSITY control for average brightness. Adjust GEOM control R316 (figure 6-4) until the displayed raster pattern has a rectangular shape.

(4) SHIELD ADJUSTMENT. - Remove protective cap from rear of crt socket and measure voltage from pin 9 to ground. Adjust SHIELD control R314 (figure 6-4) until the meter reads -25V. Replace cap on crt socket. Using the equipment set-up of paragraph 6-4b(3), further trim the adjustment of the SHIELD control as follows: reduce the frequency of the generator to display about six full cycles. Trim the control adjustment for best overall or edge to edge focus of the waveform. Slight readjustment of the FOCUS and ASTIG controls may be necessary.

c. HORIZONTAL AMPLIFIER ADJUSTMENTS

(1) ZERO ADJUSTMENT. - Set the HORIZ MODE switch to X1. Set the vtvm to 1 VOLT DC; adjust ZERO ADJ control of vtvm with test leads shorted. Connect test leads to HORIZ INPUT. Adjust ZERO ADJ control R408 (figure 6-17) until meter indicates zero volts.

(2) SENSITIVITY ADJUSTMENT. - Set the HORIZ MODE switch to X1 and the HORIZ GAIN control fully clockwise. Connect the output of the voltage calibrator to the HORIZ INPUT. Set the output of the calibrator to 3 volts peak-to-peak. Adjust HORIZ CAL control R425 (figure 6-17) for 6 divisions of deflections with the trace centered.

(3) SQUARE WAVE ADJUSTMENTS. - Connect output of the square wave generator to HORIZ INPUT using a 75-ohm cable. Connect 600-ohm output of the generator to EXT TRIGGER INPUT. Connect a clip lead jumper wire from the junction

of the SWP LENGTH control R734 and resistor R735 (mounted between this control and printed circuit board) over to the vertical INPUT. Set controls as follows: TRIGGER SLOPE to +AC EXT, HORIZ MODE to X1 and TIME/DIV to 10 uSEC. Adjust 75-ohm output of generator to give five divisions of horizontal deflection. Advance 600-ohm output control half way. Set frequency of generator to 25 kc. Set VOLTS/DIV switch to provide a two cycle square wave presentation (having vertical time base) on screen.

Adjust C404 (figure 6-17) for optimum square wave response with no overshoot or undershoot. Increase the frequency of the generator to 100 kc. Set TIME/DIV switch to 2 uSEC. Adjust L401 and L402 (figure 6-8) for best square wave. Alternate between the coils, adjusting each by a small amount until the total adjustment is complete.

d. SWEEP GENERATOR ADJUSTMENTS.

(1) GENERAL. - When making sweep timing adjustment, avoid parallax to obtain accurate calibration settings. Accurate readings may be obtained by aligning your eye at a right angle to the graticule at the point of measurement.

(2) AMPLIFIER BIAS. - Connect the MARKER OUT of the time mark generator to the verticle INPUT. Connect the TRIGGER OUT of this generator to the TRIGGER INPUT of the equipment. Set the TRIGGER RATE switch of the generator to 100 kc.

Switch on the 5 mc sine wave output. Set the TRIGGER SLOPE switch to +AC, the TIME/DIV switch to 0.1 u sec, the VOLTS/DIV and VARIABLE controls for six divisions of vertical deflection and the STABILITY AND LEVEL controls for a stable pattern. Adjust BIAS ADJ controls R435 (figure 6-17) for optimum linearity. That is, uniform spacing of individual cycles with minimum compression or distorition. Check linearity through the enitre range of horizontal positioning. Do not consider the accuracy of sweep timing at this time. Recheck horizontal sensitivity as outlined in paragraph 6-4c(2).

(3) PRESET STABILITY. - Apply a 1 kc, 0.5-volt peak-to-peak signal from the square wave generator to the vertical INPUT and EXT TRIGGER INPUT using a BNC tee connector. Set the TRIGGER SLOPE switch to + AC and the STABILITY to PRESET. Adjust PRESET STAB control R727 (figure 6-20) until the waveform disappears; then advance control until it reappears and becomes stable. Adjust the LEVEL control during the procedure for most stable triggering point.

(4) SWEEP LENGTH. - Set the TIME/DIV switch to 0.1 MILLISEC and the STABILITY control to FREE RUN. Center the trace on the screen and adjust SWP LGTH control R734 (figure 6-20) for a trace length of 10.5 divisions.

(5) BASIC TIMING. - Using the equipment setup and control settings described in paragraph 6-4d(2), set the TRIGGER RATE switch of the generator to 10 cps and switch on the 100 MILLISEC markers. Set the TIME/DIV switch to 0.1 SEC and the VOLTS/DIV switch to display a waveform about two divisions high. Align the first marker with the left graticule line and adjust SWP CAL control R427 (figure 6-17) until each marker falls directly on each vertical graticule line over the 10 division area. Repeat SWEEP LENGTH adjustment, paragraph 6-4d(4).

(6) SEQUENCE TIMING. - Set the TIME/DIV switch to 0.1 MILLISEC. Set the TRIGGER RATE switch of the generator to 10 kc and switch on the 100 u sec markers. Adjust R755 marked "1" (figure 6-6) until each marker coincides with a vertical line on the graticule.

Set the TIME/DIV switch to 0.2 MILLISEC. Set the TRIGGER RATE switch of the generator to 1 kc and switch the 1MILLISEC markers. Adjust R753 marked "2" (figure 6-6) until the first, center, and last markers fall on the first, center, and last vertical graticule lines.

Set the TIME/DIV switch to 0.5 MILLISEC. Leave the TRIGGER RATE switch of the generator set at 1 kc and switch on the 500 u sec markers. Adjust R751 marked "5" (figure 6-6) until each marker coincides with a vertical line on the graticule. To obtain proper alignment in these procedures, it may be necessary to vary the horizontal POSITION control somewhat.

(7) FAST SWEEP TIMING. - Set the TIME/DIV switch to 1 u sec. Set the TRIGGER RATE switch of the generator to 100 kc and switch on the 1 u sec markers. Adjust C714 (Figure 6-4) until each marker coincides with a vertical line on the graticule.

Set the TIME/DIV switch to 0.1 u sec. Leave the TRIGGER RATE switch set at 100 kc and switch on the 5 mc sine wave output from the generator. Position the upper tip of the first sine wave to the left hand graticule. Adjust C715 until the upper tip of each sine wave coincides with every other vertical line on the graticule.

After making each fast sweep timing adjustment check the two previous ranges. It may be desirable to make an adjustment which would distribute any existing error equally among the ranges.

(8) 5X MAGNIFIER. - Set the TIME/DIV switch to 0.1 MILLISEC and the HORIZ MODE to 5X MAG. Set the TRIGGER RATE switch of the generator to 10 kc and switch on the 100 u sec markers. Adjust 5X MAG ADJ control R428 (figure 6-17) until the first, center, and last markers fall on the first, center, and last markers fall on the first, center and last vertical graticule lines. Check timing through entire range of horizontal positioning.

e. VERTICAL SENSITIVITY.

(1) PRELIMINARY. - Balance Vertical Plug-in Preamplifier as outlined in paragraph 3-3b. Use the differential mode (a-b) of test oscilloscope; see table 5-1. Set its VARIABLE control to CAL and check calibration on 0.1 VOLT/CM range of channels A and B. Connect one set of differential test leads to test point C6; connect the other set to C7 (see test points, figure 5-7). Apply a 0.1-volt peak-to-peak signal from voltage calibrator to vertical INPUT of unit under test. Set the VOLTS/DIV switch to 0.01. Display about three cycles of waveform. Adjust the LEVEL control for a stable pattern.

(2) GAIN ADJUSTMENT. - Rotate the VARIABLE VOLTS/DIV control of the unit under test until the amplitude of the waveform viewed on the test oscilloscope is exactly four centimeters high. If waveform will not reduce to this height, lower the output of the voltage calibrator to 0.05 volts peak-to-peak. With exactly four centimeters displayed on the test oscilloscope, adjust GAIN ADJUST control R612 (figure 6-1) until the waveform viewed on the unit under test is exactly four divisions high (0.4 volts peak-to-peak). Remove leads of test oscilloscope.

(3) .01 VOLT ADJUSTMENT. - Return the VARIABLE control of the unit under test to the CAL position. With 0.05-volt peak-to-peak applied from the voltage calibrator, adjust .01V ADJ control R829 (figure 6-26) until the waveform viewed on the unit under test is exactly five divisions high. Rebalance plug-in as outlined in paragraph 3-3b.

f. VERTICAL SQUARE WAVE RESPONSE.

(1) BASIC ADJUSTMENT. - Set the VOLTS/DIV switch to 0.01. Connect the 75-ohm output of the square wave generator to the vertical INPUT, using a 75-ohm cable. Set the FREQUENCY dial of the generator to 5 kc and its ATTEN-AMPLI-

TUDE controls to offer a five division high waveform on screen. Set the TIME/DIV switch to display five or more cycles of waveform. Adjust C817 (figure 6-26) for optimum square wave response with no overshoot or undershoot.

(2) HIGH FREQUENCY PEAKING. - Increase the frequency of the generator to 250 kc. Set the TIME/DIV switch to display several cycles of waveform. Adjust C820 (figure 6-26) and C605A (figure 6-1) for optimum square wave response with no overshoot or undershoot. Since C820 and C605A peak in slightly different areas of the waveform, this dual adjustment is not difficult to make. Rotate the VARIABLE control full counter clockwise and increase the output of the generator to maintain the original amplitude. Adjust C822 (figure 6-26) for optimum square wave response. Since the adjustments of C822 and C820 interact somewhat, it may be necessary to make these adjustments one or two times.

(3) ATTENUATOR ADJUSTMENTS. - Return the frequency of the generator to 5 kc and display several cycles of the waveform. Make the specified adjustments for a correctly compensated waveshape (no overshoot or undershoot) on the following VOLTS/DIV ranges: 0.02-C804; 0.05-C806; 0.1-C815; 0.2-C803; 0.5-C805; 1-C809; 2-none; 5-none; 10-C812; 20-none.

After making each adjustment, place a small (approx. 4-1/2 in. x 4-1/2 in.) aluminum plate over the adjustment area to simulate the shielding effect of the instrument case. Trim the adjustment accordingly. In the higher VOLTS/DIV ranges, it will be necessary to transfer to the 600-ohm output of the generator. Adjustments of C815 and C814 (listed below) require the use of the extension cable illustrated in figure 5-1. The attenuator adjustment variable capacitors may be locked tight due to their Humi-Seal coating. If so, apply a coat of thinner (Xylol or Triad) to soften the coating. Allow thinner to dry completely before making adjustments.

To make input capacity adjustments, proceed as follows: connect probe to vertical INPUT and make basic probe adjustment as outlined in paragraph 3-3h with VOLTS/DIV switch set to .01. With the probe properly adjusted, set the VOLTS/DIV switch to .1, connect the probe to the 600-ohm output of the square wave generator (set to 1 kc) and adjust C814 for best square wave response. Adjust output of square wave generator to maintain five division high display. Set the VOLTS/DIV switch to 1 and adjust C808 for best square wave response. Set the VOLTS/DIV switch to 10 and adjust C811 for best square wave response. All adjustments are shown in figure 6-26, except C814 and C815 which is shown in figure 6-27. Recheck all adjustments when the instrument is inserted in its case.

g. CALIBRATOR ADJUSTMENTS.

(1) FREQUENCY. - Set the VOLTS/DIV switch to 0.1 and the CALIBRATOR output switch to 0.4. Connect a short cable between the CALIBRATOR OUTPUT and the vertical INPUT. Set the TIME/DIV switch to 0.1 MILLISEC. Adjust FREQ ADJ control L101 (figure 6-6) until one cycle of the waveform is exactly 10 division long or 1.0 MILLISEC.

(2) AMPLITUDE. - Connect the output of the voltage calibrator to vertical INPUT A-DC. Connect the CALIBRATOR OUTPUT to INPUT B-DC. Set the voltage calibrator to 0.4 volt peak-to-peak on the TRACKING position of the generator. Set the CALIBRATOR OUTPUT to 0.4 volt peak-to-peak and the VOLTS/DIV switch to 0.1. Adjust CAL ADJ control R112 (figure 6-18) until the waveform amplitude at INPUT B is to equal that of INPUT A.

6-5. REPAIR.

a. GENERAL.

In many instances the parts used in the AN/USM-117A, AN/USM-117B and AN/USM-117C differ from those used in the original

AN/USM-117 Oscilloscopes. The improved parts are manufactured to more recent military specifications and are more readily available for replacement purposes. When the improved part is interchangeable with the original part it should be used for replacement purposes as explained in paragraph 7-3.

b. TUNING AND ADJUSTMENT.

Adjustment instructions are given in paragraph 6-4.

c. REMOVAL OF PARTS AND SUBASSEMBLIES.

(1) GENERAL. - The emitter follower circuit board MP801 requires particular attention when replacing components and leads to avoid grounding terminals to the shield. Wrap this board with one layer of plastic insulating tape before assembly for additional protection. When circuit boards must be removed use a low-power soldering iron (50 watts maximum) and apply heat sparingly to the lead of the part to be replaced. Slip the lead from the board as soon as the solder softens. Use a small awl or toothpick to clean the softened solder from the lead hole in the board. Bend the tinned leads of the replacement part and carefully insert through the cleaned holes. Hold the part against the board and, when possible, solder the leads from the other side. Avoid overheating and use ONLY a high quality rosin-core solder. NEVER USE PASTE FLUX. After soldering trim off excess leads and flux. A break in the copper should be repaired by soldering a short length of tinned copper wire across the break. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties. When reinstalling the board, carefully align it with its respective chassis holes. Do not force the board into place by tightening the mounting screws. The simplest way to remove a defective transistor is to cut its leads, and unsolder the ends of the leads that are left in the board. When removing these remaining leads, use a toothpick or a small awl to clear the holes of softened solder. Avoid excessive heat, and always insulate the instrument from the ground or ground the body of the soldering iron to prevent leakage voltage from damaging the component. When connecting a replacement transistor, trim the leads so they will penetrate the board about 1/16 inch with the transistor positioned about 1/8 inch above the

board. Solder the leads with an absolute minimum of heat necessary to completely melt the solder. If possible, place a heat sink (such as a pair of needlenosed pliers) between the transistor and the soldering iron. Because of the inherent stability of transistors, they should be the last elements suspected in case of equipment failure. When other elements have been checked in the defective circuit, locate open or shorted transistors by resistance measurements across the elements. Because of the difference in ohmmeters, no specific information can be given about exact resistances; however, generally the ratio of forward and backward emitter-collector resistance is from 10:1 to 100:1, the ratio being lower for the higher powered transistors. When a defective transistor is located, always look for another faulty element in the circuit which might have caused its failure.

(2) REMOVAL OF CABINET. - Refer to Section 2, paragraph 2-1 for this procedure.

(3) REMOVAL OF CRT. - Remove the following items in the order listed: Crt bezel, HV anode cap, pin connectors on neck of crt, and the crt socket. Loosen crt clamp and slide crt forward to remove.

WARNING

> The type 4QP crt has been chemically coated to insure optimum performance under adverse environmental conditions. To avoid irritation to the skin, handle the crt with gloves. Goggles must also be worn. Store crt horizontally in a safe location. Tube is not dangerous if handled with due care.

(4) REMOVAL OF CRT SHIELD. - Remove the two screws at the top of the horizontal amplifier printed circuit board (Z402) which fasten it to the upper left hand support member. Remove the support member itself. Remove screws from L401-L402 support bracket. Loosen the support member at bottom of printed circuit board Z402 and swing board outward about 30 degrees. Remove screw on the crt shield mounting tab which fastens it to center bulkhead. Remove pilot lamp socket and the unblanking wire from its clip on the rear of the crt shield. Remove four screws which fasten crt shield to front panel. Elevate rear or neck portion of crt shield until center mounting tab is clear of bulkhead and slip the shield backward until it is free of instrument framework.

(5) CLEANING GRATICULE AND FILTER. - If the crt graticule and filter are removed for cleaning, use the following procedures: moisten a soft clean rag with an anti-static plastics cleaner. Clean all surfaces of the graticule and filter. Add more anti-static solution to the rag and apply an even coat to the crt face and inside surface (nearest crt face) of the graticule and filter before they are placed in the bezel.

d. REPLACEMENT OF PREAMPLIFIER FASTENER. - The miniature fastener used to retain the preamplifier in the AN/USM-117, 117A, Oscilloscopes has been discontinued by the manufacturer. The miniature fastener used in the AN/USM-117B, AN/USM-117C oscilloscopes and identified as Ref Designation MP 12 in the Maintenance Parts List of Section 7 requires a larger mounting hole and may be installed in the AN/USM-117, 117A Oscilloscopes as follows.

(1) Remove the heads on the inside of the front panel from the two rivets retaining the old fastener, using a small cold chisel, and remove the fastener (do not remove the rivets from the panel).

(2) Enlarge the hole in the panel to .316 in. Dia (use leter size 0 drill).

(3) Remove the trim nut from the new fastener and turn the hex nut to the rear. Assemble the new fastener in the panel and install and tighten the trim nut finger tight.

(4) Orient the fastener for proper operation and tighten the hex nut with a 3/8 in. wrench.

e. REPAIR OF COATED CIRCUIT BOARDS. - Sweep generator circuit boards Z 701 and unblanking amplifier circuit boards Z 301 used in the AN/USM-117A, 117B, 117C oscilloscopes are coated with epoxy resin. Use needle point probes for voltage measurements and refer to EIMB NAVSHIPS 900,000.100, change 3 of June 1965 before attempting repair.

f. COATING OF CRT. - Under high temperature humidity conditions compression of the horizontal sweep and flaring of the trace may exist and can be reduced by application of General Electric SC-87 DRI-FILM silicon water repellent or equivalent to the crt. The DRI-FILM solution may be obtained from the General Electric Co., Waterford, N.Y. in one pound containers. The containers should be kept tightly closed until ready for use, and cannot be stored for more than one year. The following procedure will assure satisfactory application of the coating.

WARNING

> Wear rubber gloves and goggles when handling the crt and the solution and perform the procedure only in a well ventilated area. The solution should be handled as a very dilute acid and should not contact the hands or skin.

(1) Remove the crt as described in paragraph 6-5c(3).

(2) Thouroughly clean the surface of the tube with a degreasing solvent.

(3) Pour the coating solution into a shallow dish.

(4) Immerse a clean cloth in the solution and rub the entire glass surface of the tube with the dampened cloth.

CAUTION

It is particularly important that the surface between the neck connectors be thoroughly coated.

(5) Immediately after coating, burnish the entire glass surface until thoroughly dry using a clean cotton cloth.

(g) LOCATION OF PARTS. - All electrical components of Oscilloscope AN/USM-117 are illustrated in figures 6-1 through 6-29. Cross reference of all illustrated parts may be found in table 7-1.

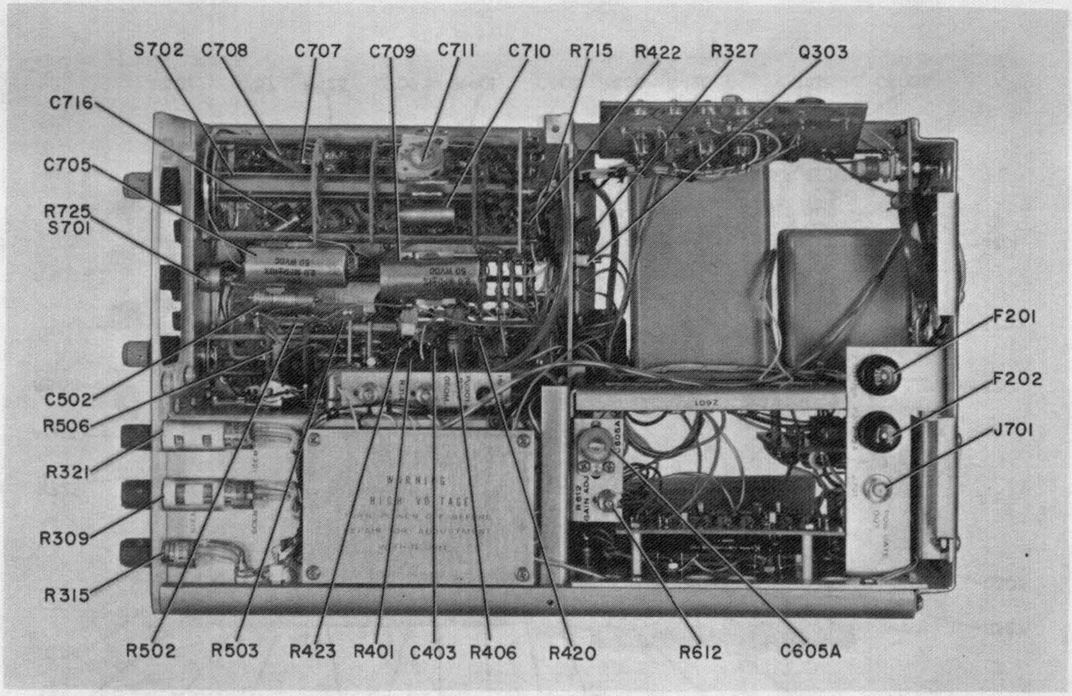


Figure 6-1. Oscilloscope AN/USM-117, only, Chassis Assembly, Top View

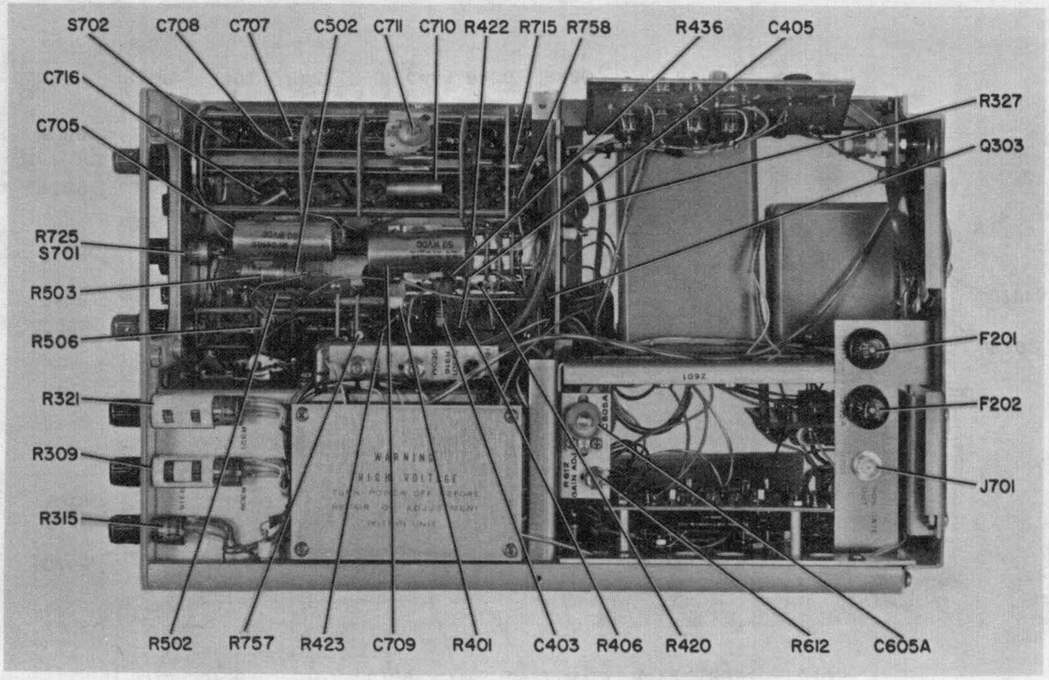


Figure 6-2. Oscilloscope AN/USM-117C, Chassis Assembly, Top View

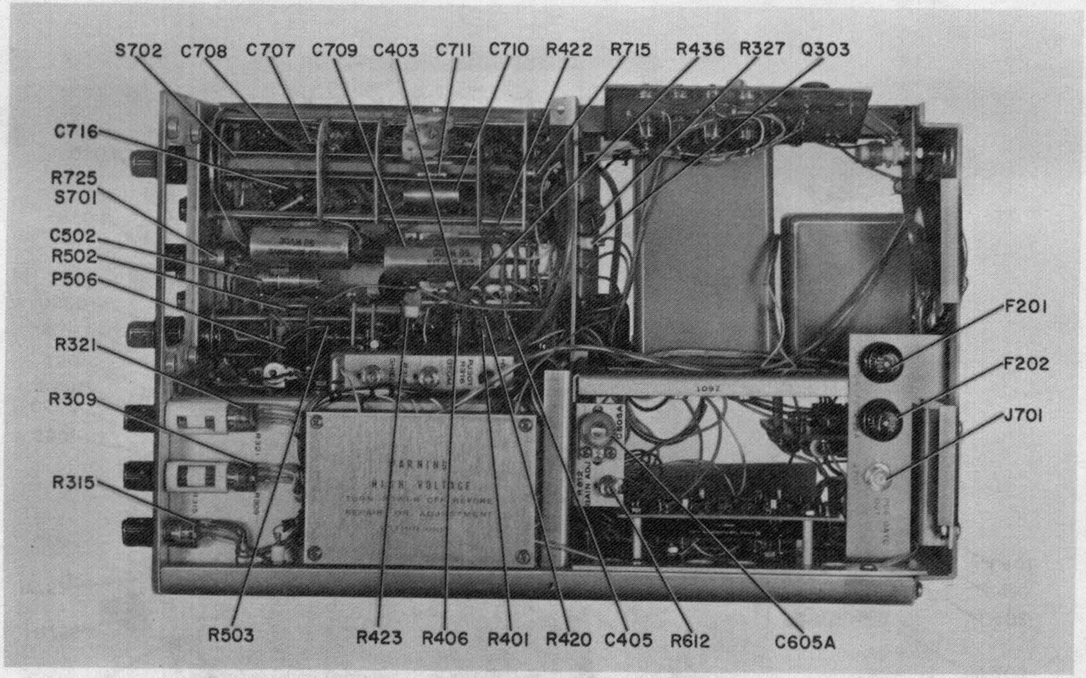


Figure 6-3. Oscilloscope AN/USM-117A, 117B, Chassis Assembly, Top View

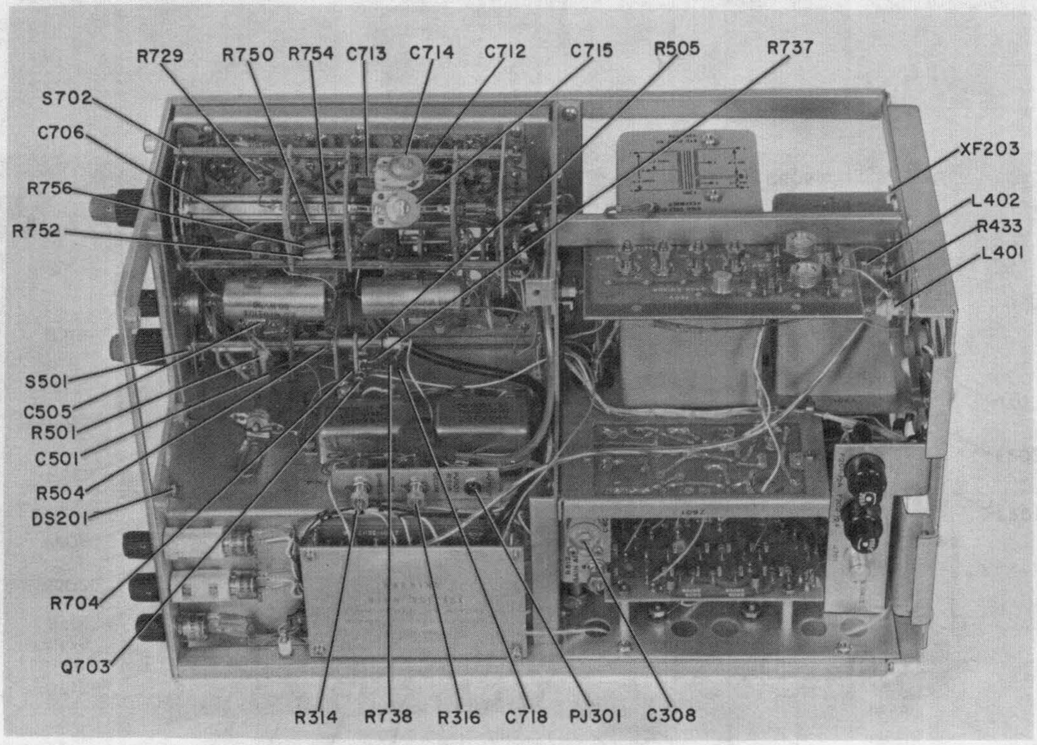


Figure 6-4. Oscilloscope AN/USM-117, only, Chassis Assembly, Side View

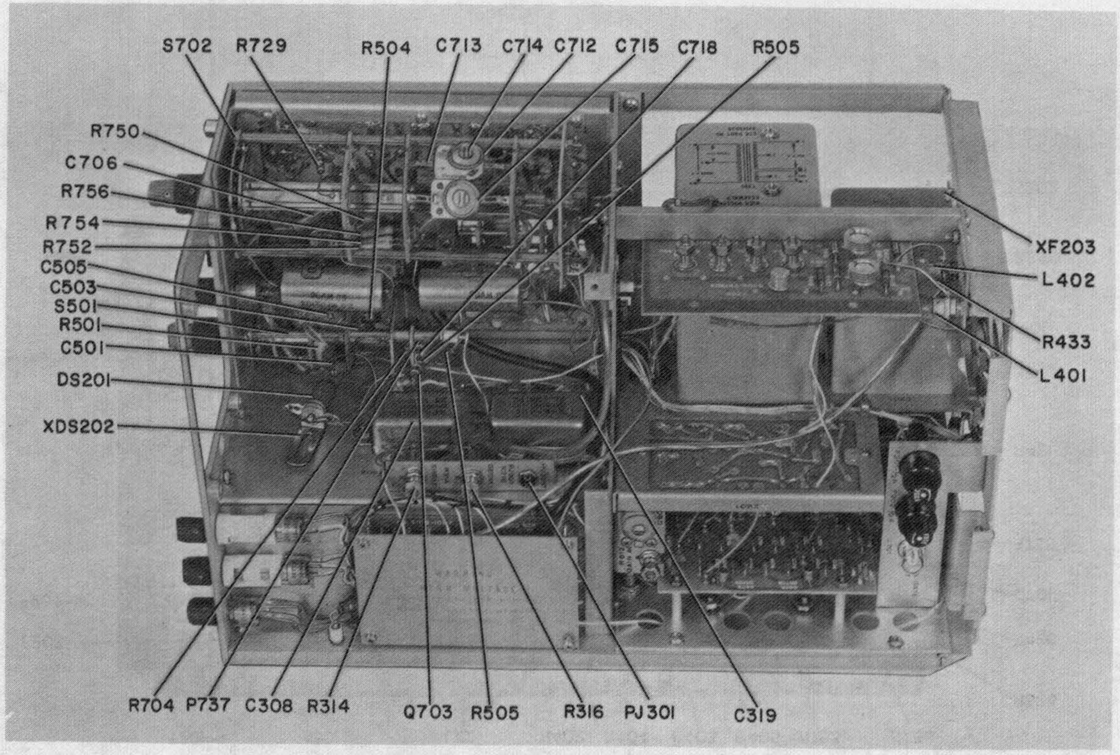


Figure 6-5. Oscilloscope AN/USM-117A, 117B, 117C Chassis Assembly, Side View

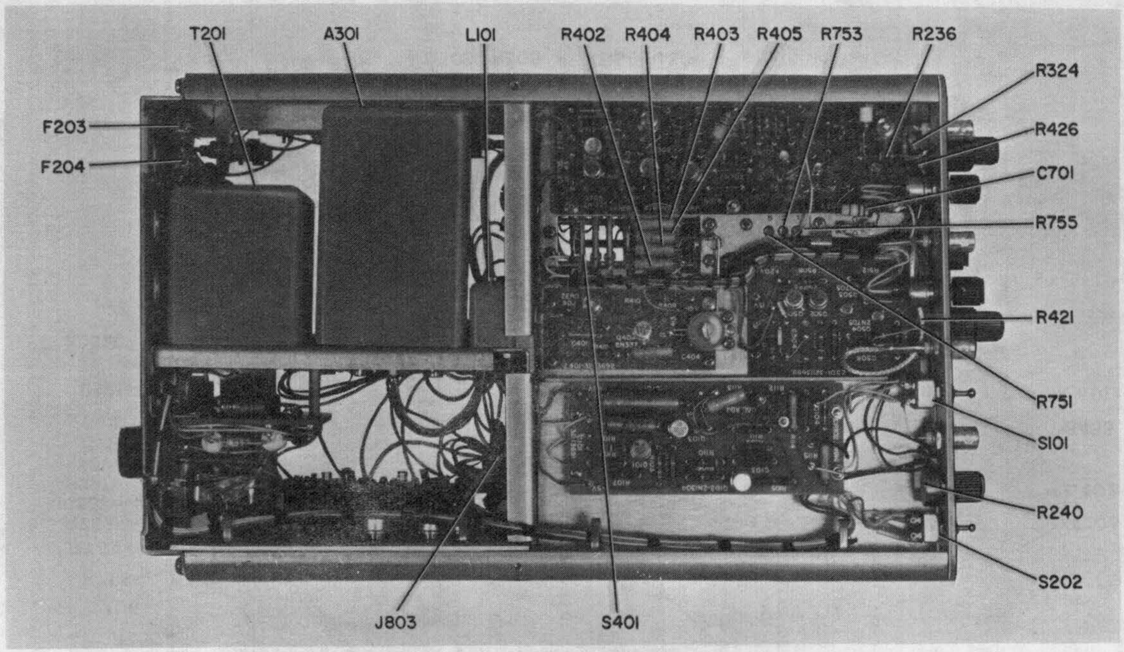


Figure 6-6. Oscilloscope AN/USM-117, only, Chassis Assembly, Bottom View

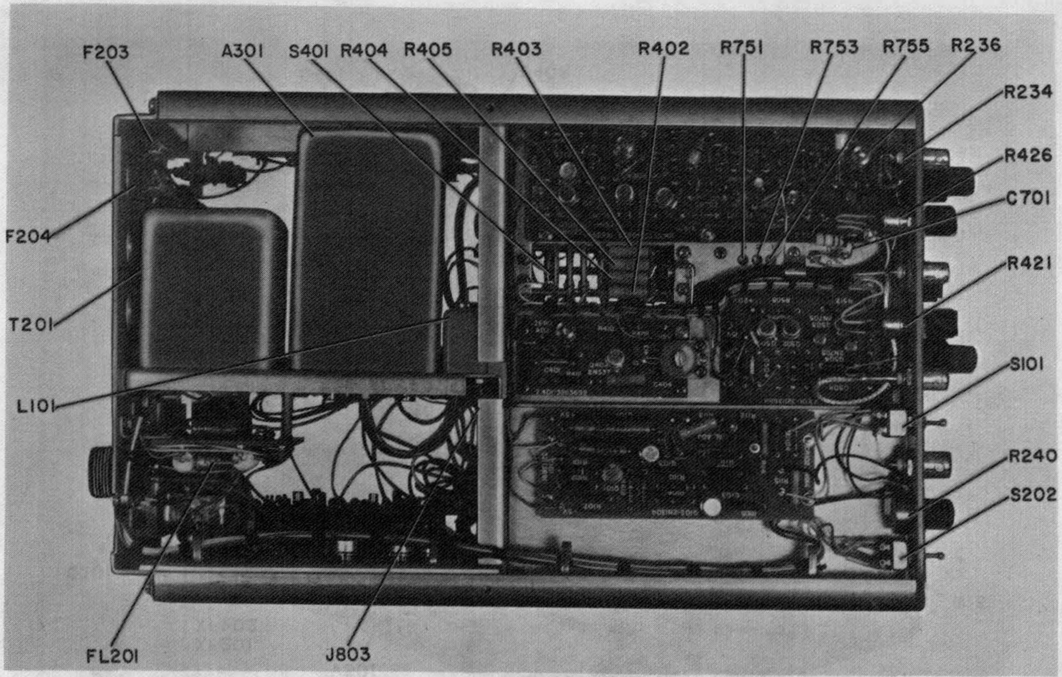


Figure 6-7. Oscilloscope AN/USM-117A, 117B, 117C, Chassis Assembly, Bottom View

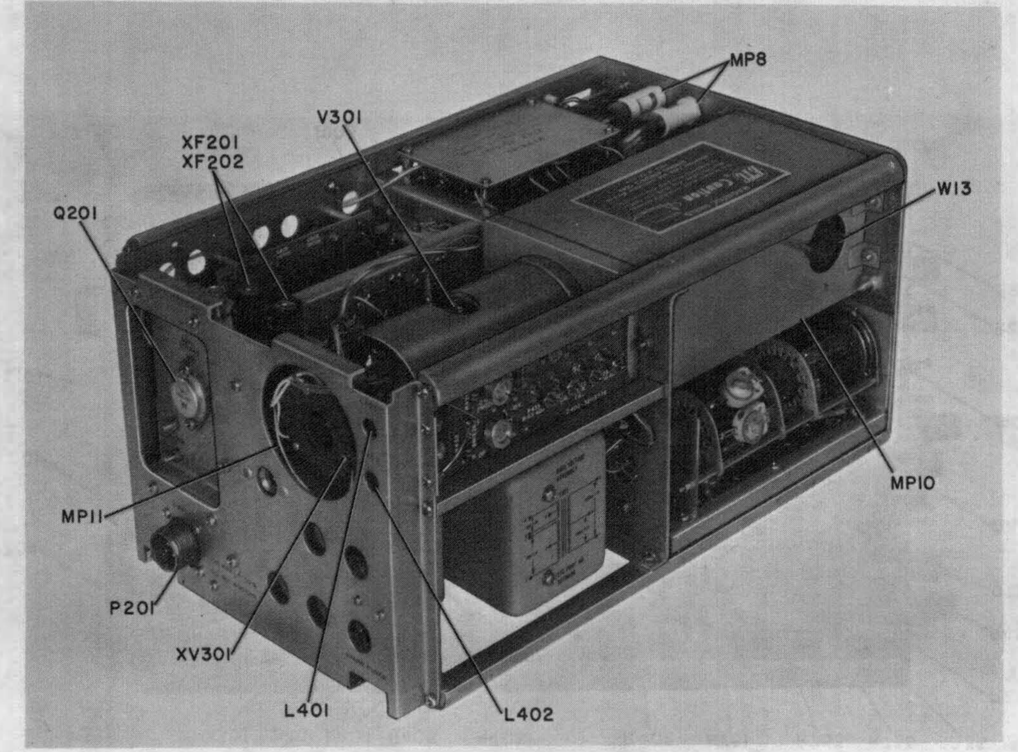


Figure 6-8. Chassis Assembly, Rear View

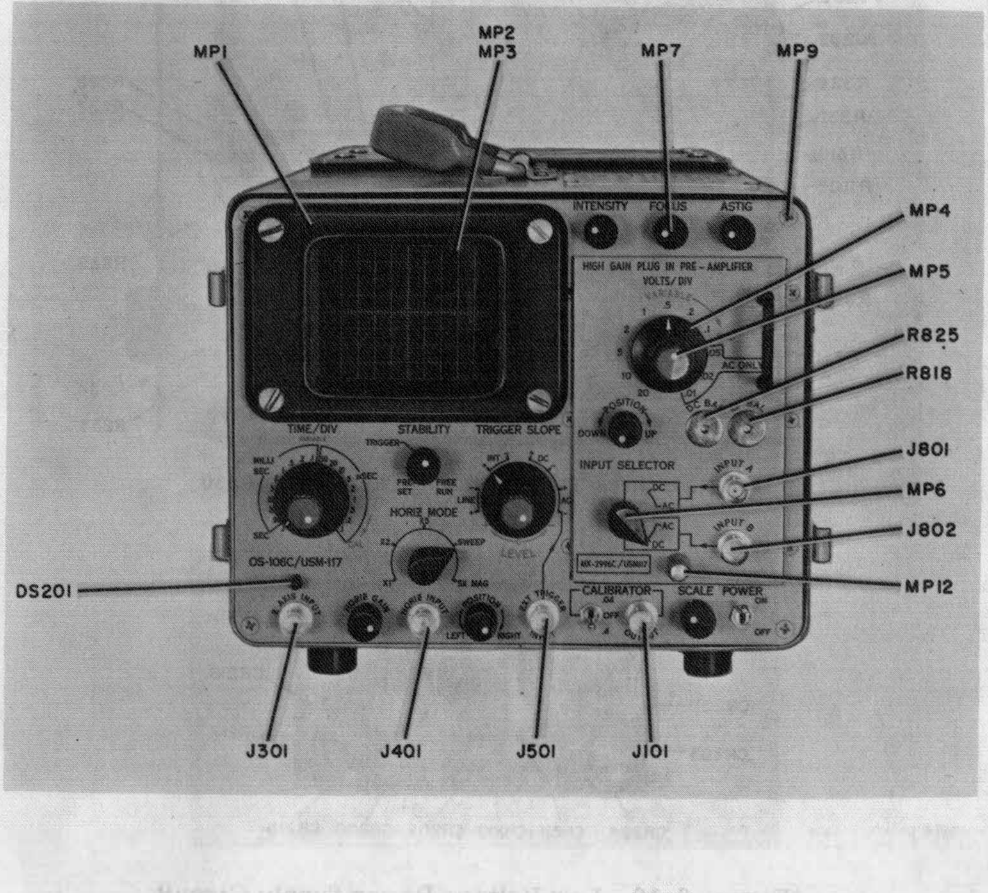


Figure 6-9. Front Panel

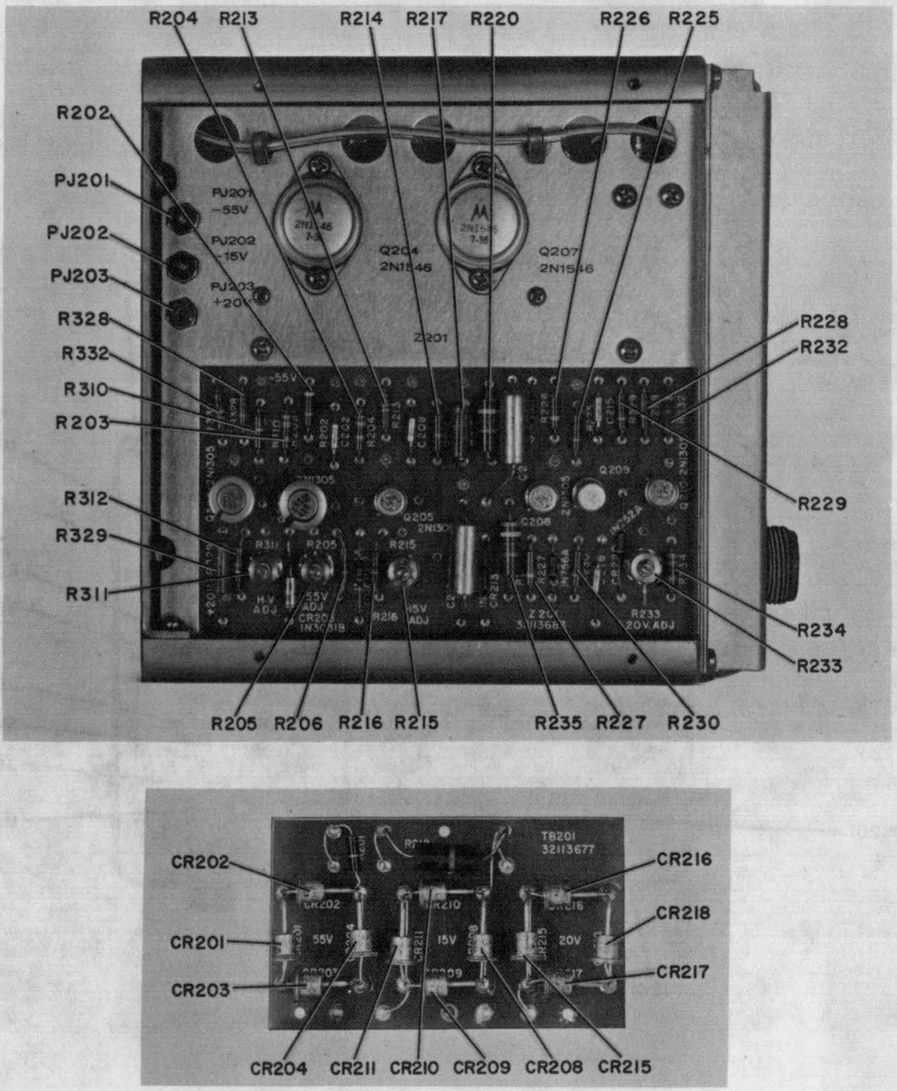


Figure 6-10. Low Voltage Power Supply Circuit Branch Z201 and TB201 (Sheet 1 of 2)

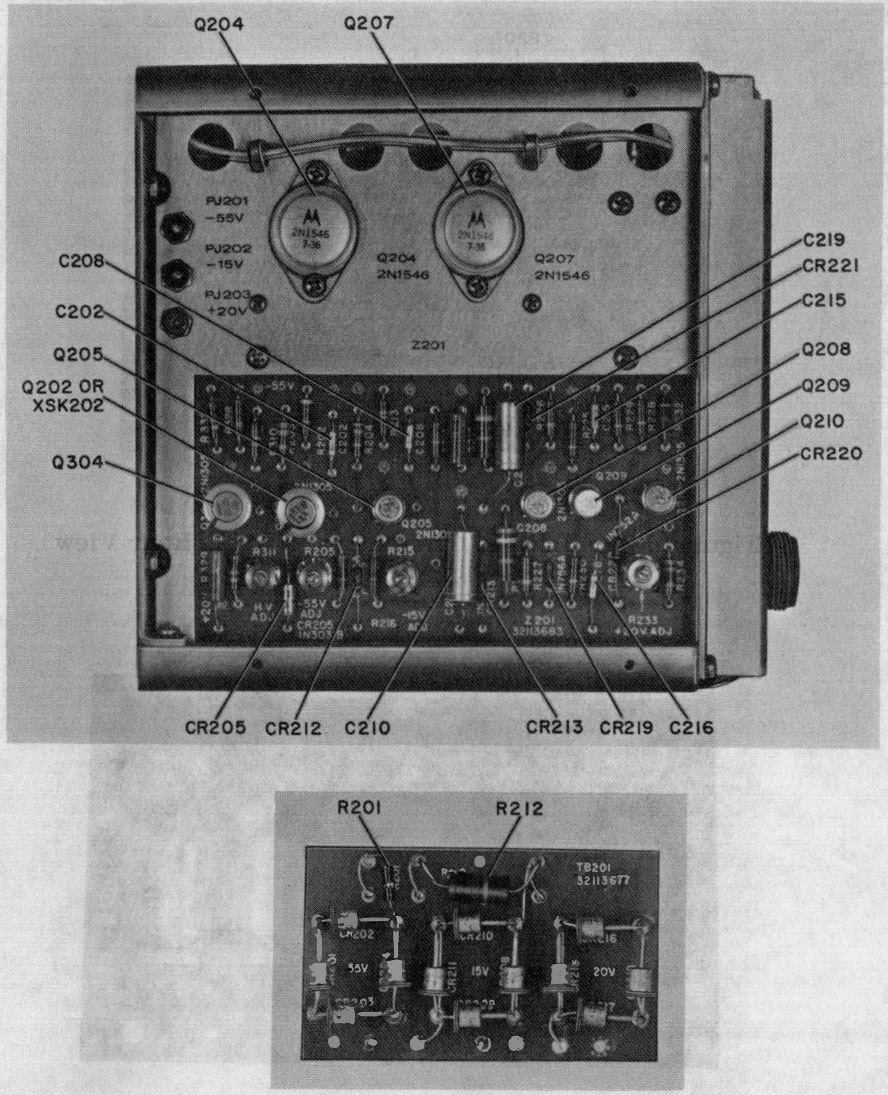


Figure 6-10. Low Voltage Power Supply Circuit Branch Z201 and TB201 (Sheet 2 of 2)

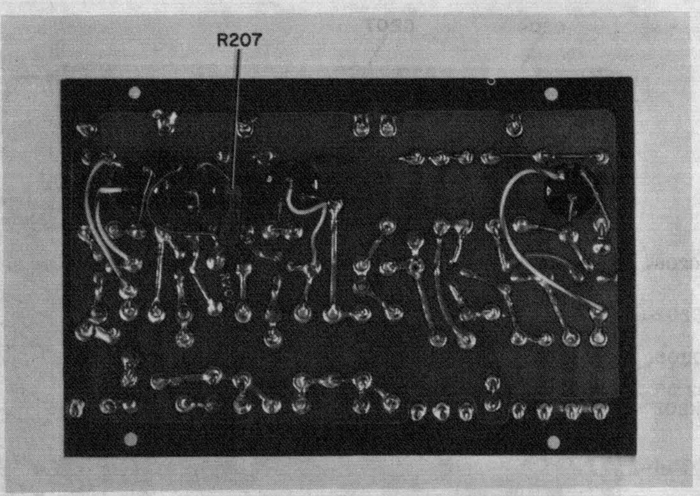


Figure 6-11. Printed Circuit Board Z201, Rear View

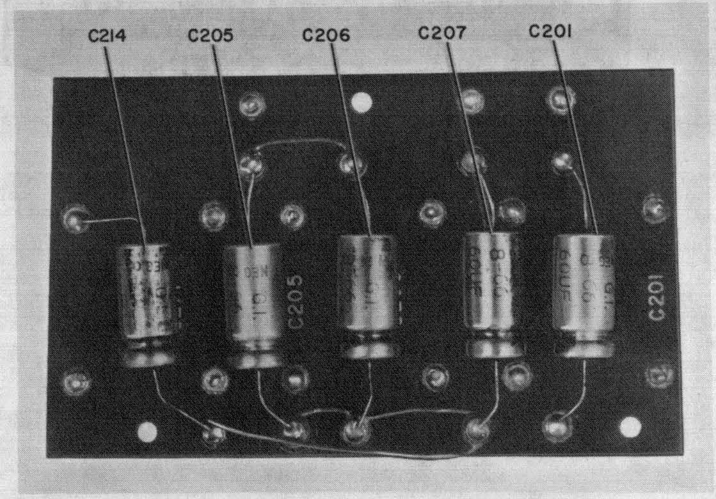


Figure 6-12. Terminal Board TB201, Rear View

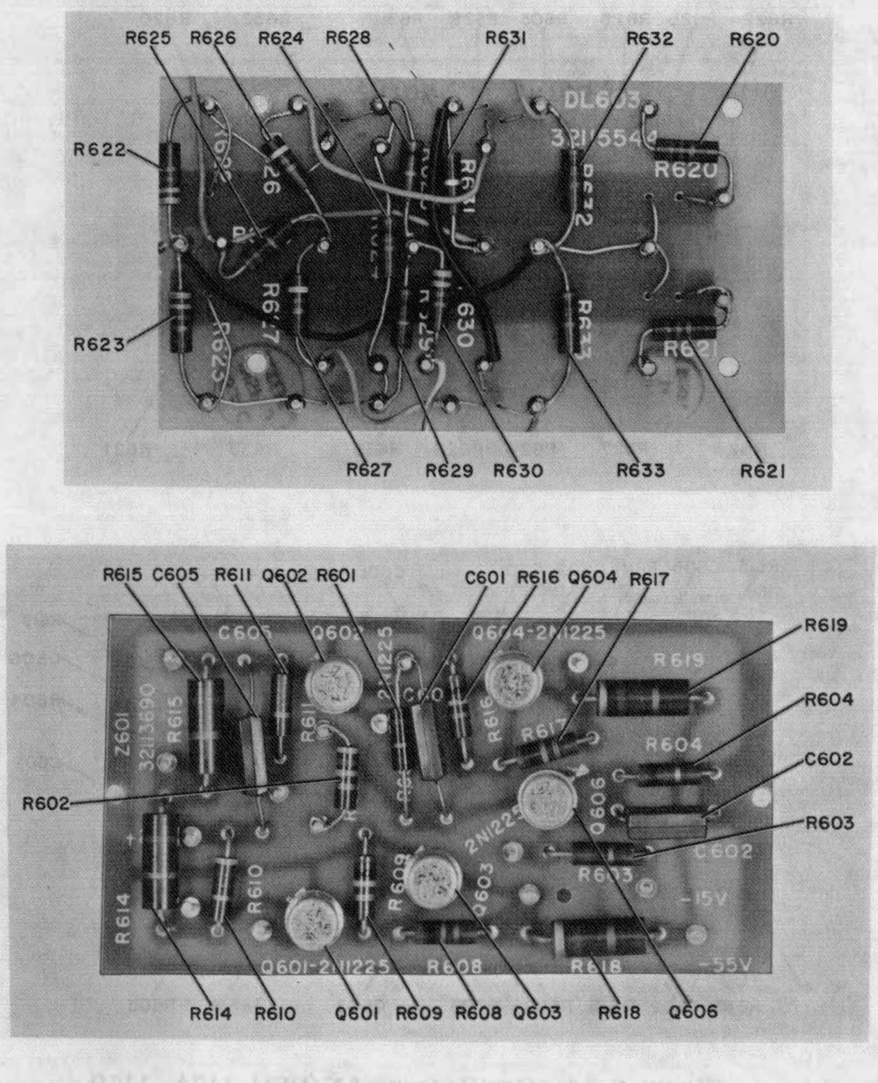


Figure 6-13. Oscilloscope AN/USM-117, only, Vertical Post Amplifier, Circuit Board DL603 and Z601

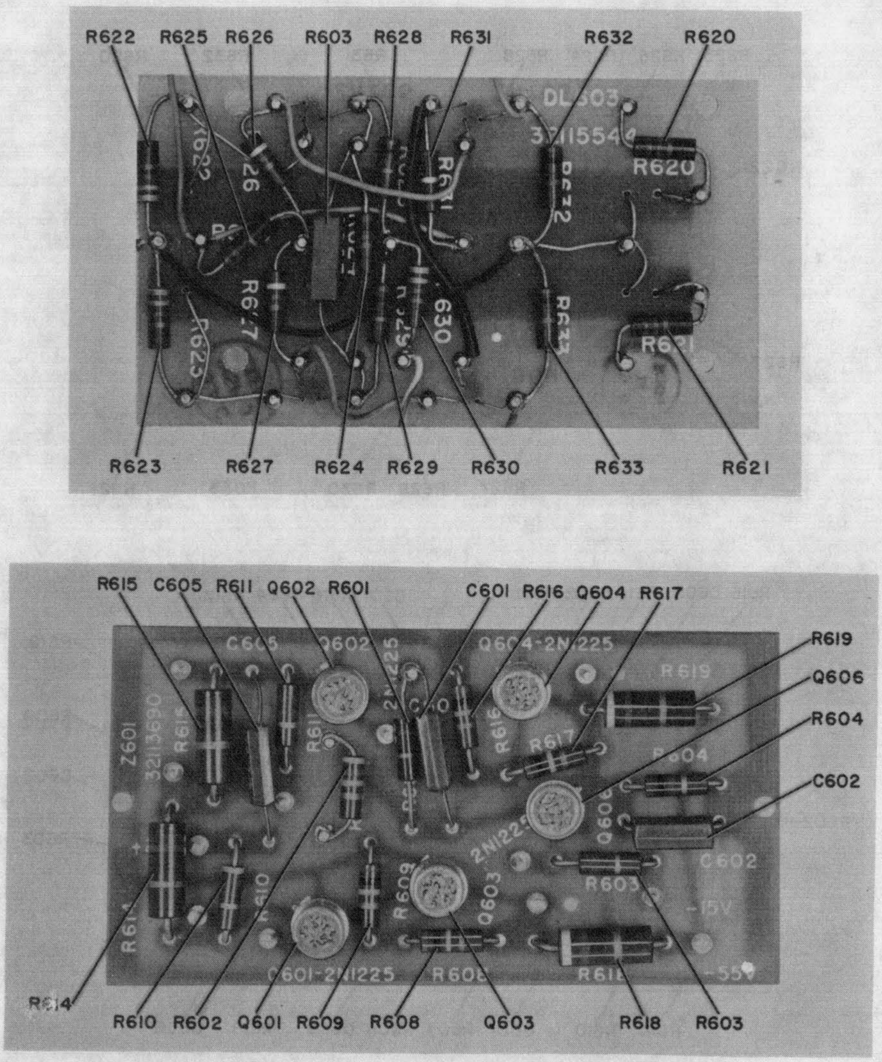
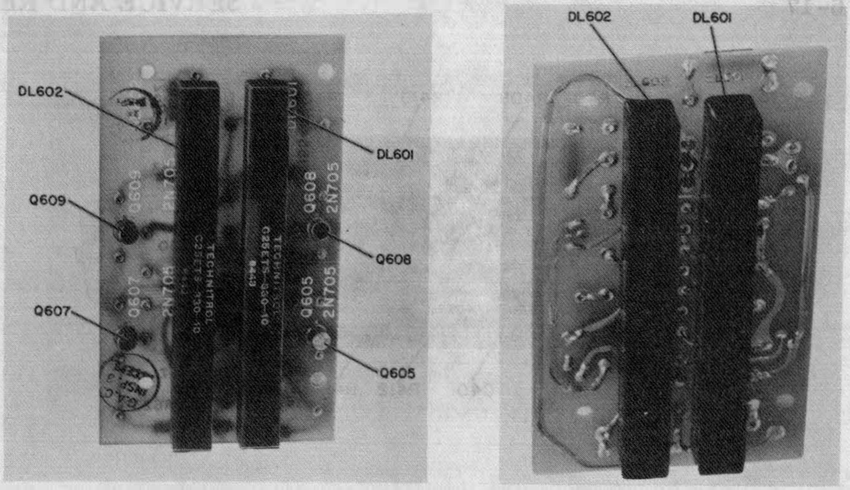


Figure 6-14. Oscilloscope AN/USM-117A, 117B, 117C, Vertical Post Amplifier, Circuit Boards DL603 and Z601



AN/USM-117, 117A, 117B AN/USM-117C

Figure 6-15. Terminal Board DL603, Rear View

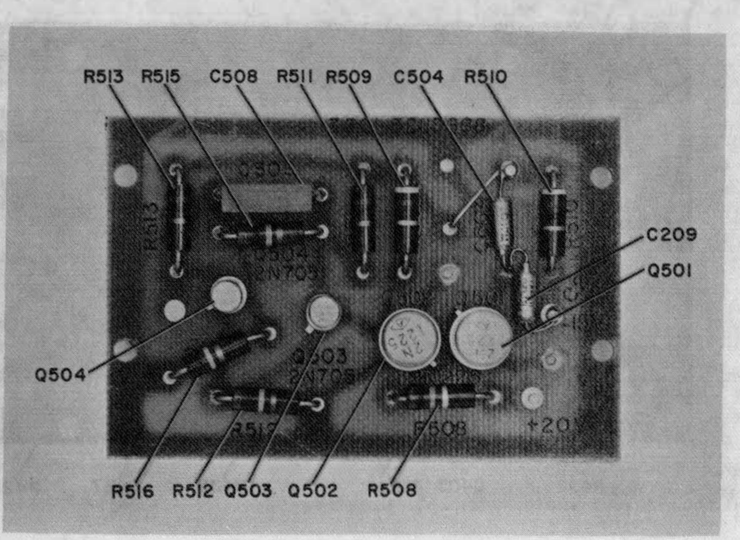
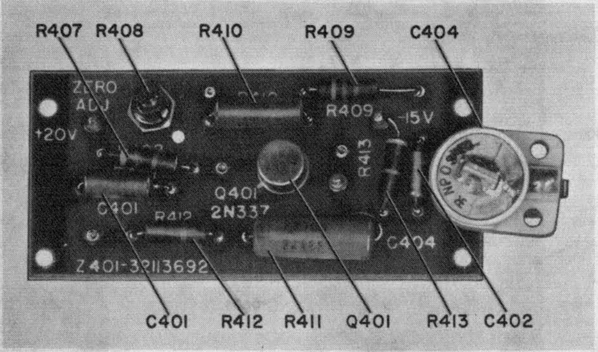


Figure 6-16. Sweep Trigger, Printed Circuit Board Z501



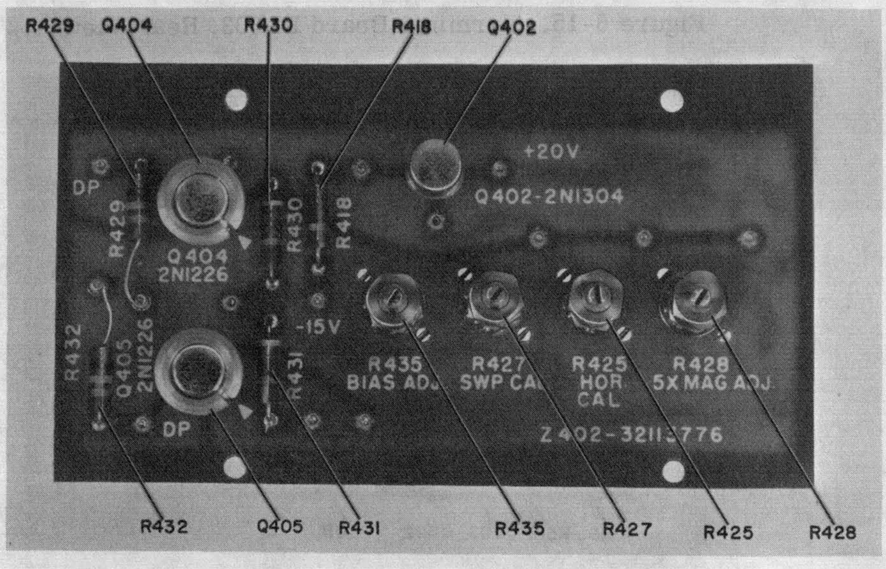


Figure 6-17. Horizontal Amplifier, Printed Circuit Boards Z401 and Z402

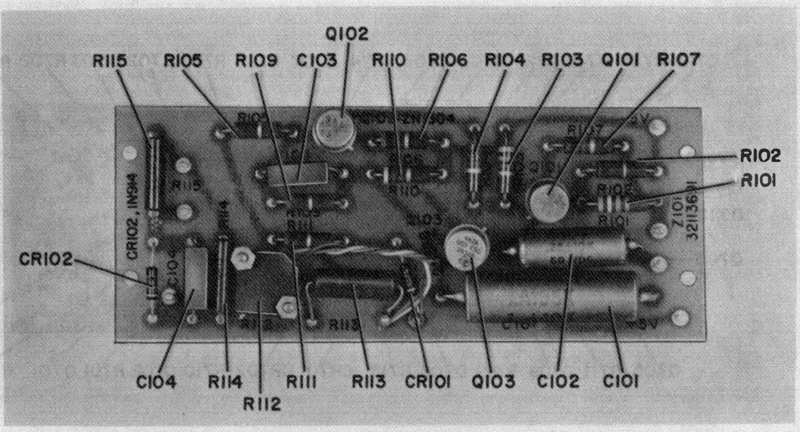


Figure 6-18. Calibrator, Printed Circuit Board Z101

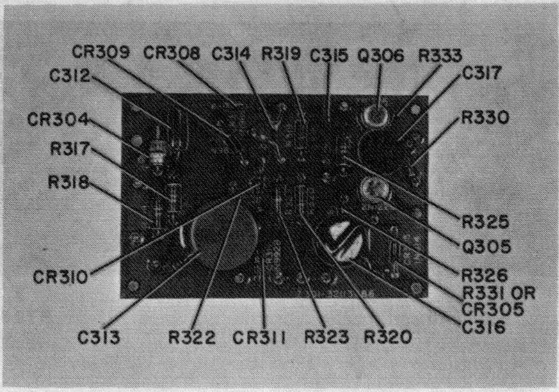


Figure 6-19. Printed Circuit Board Z301

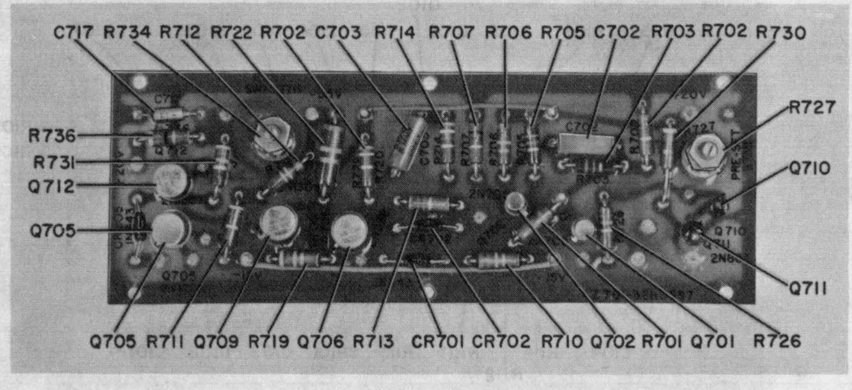


Figure 6-20. Sweep Generator, Printed Circuit Board Z701

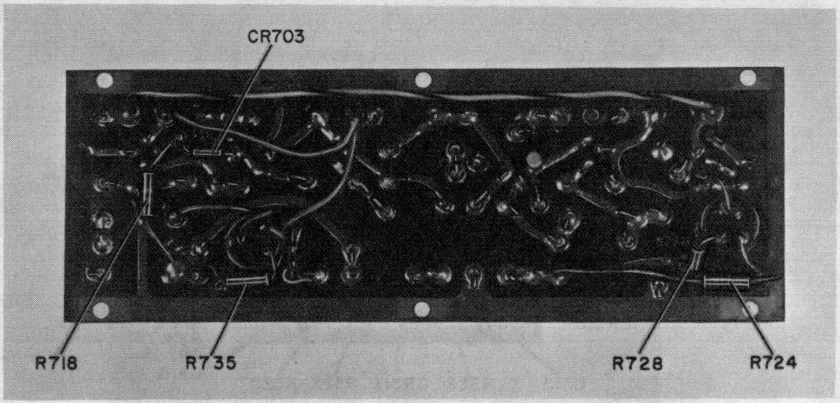


Figure 6-21. Sweep Generator, Printed Circuit Board Z701, Rear View

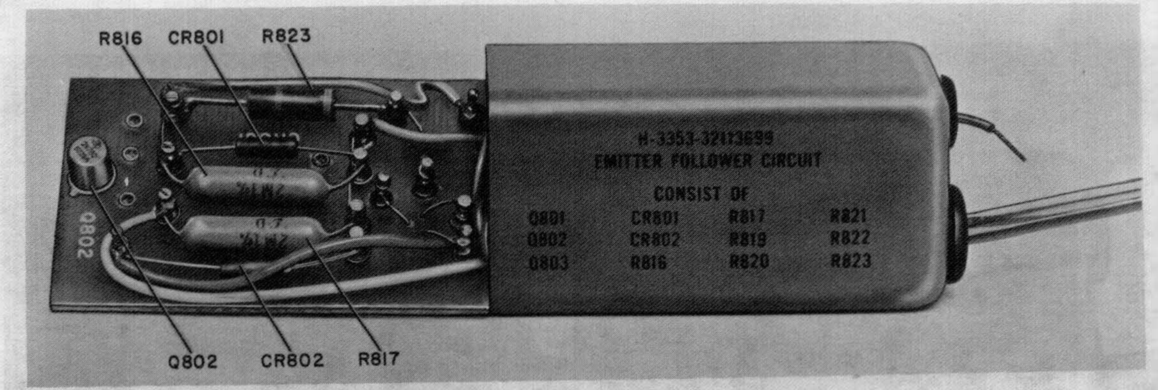


Figure 6-22. Emitter Follower Assembly, MP801, Front View

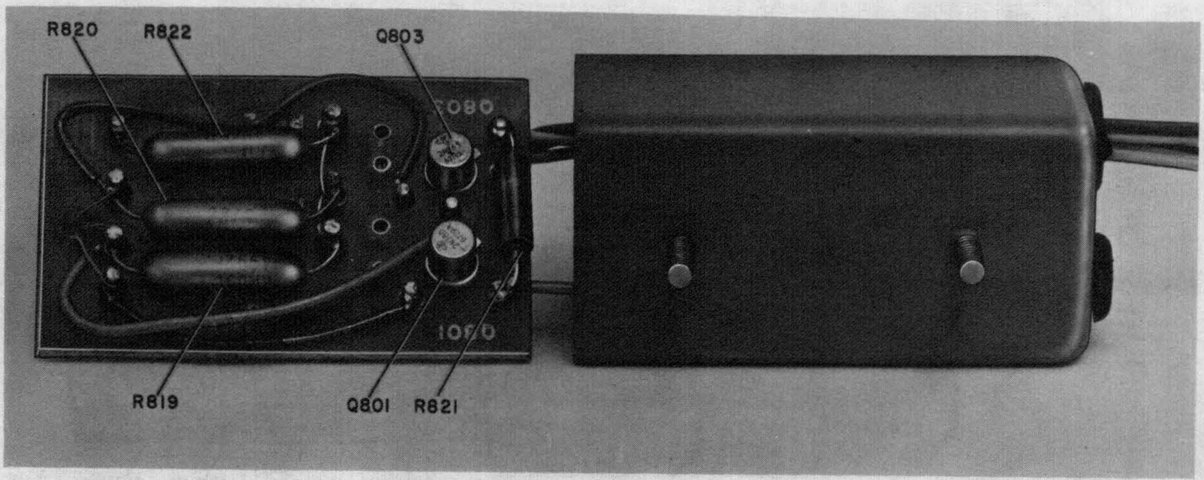


Figure 6-23. Emitter Follower Assembly, MP801, Rear View

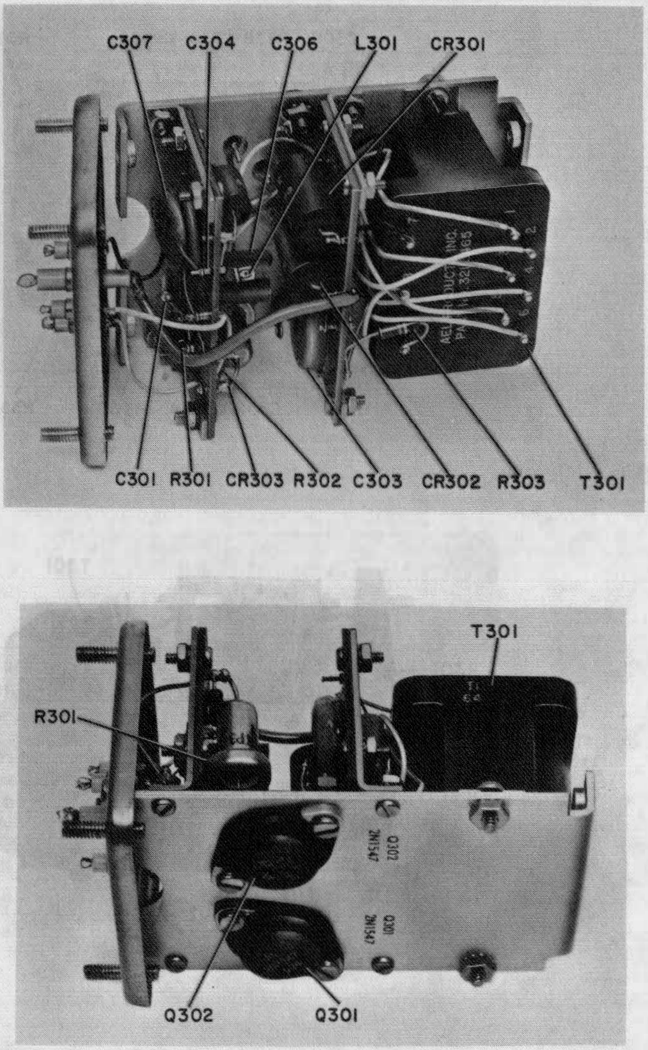


Figure 6-24. Oscilloscope AN/USM-117, only, High Voltage Assembly A301

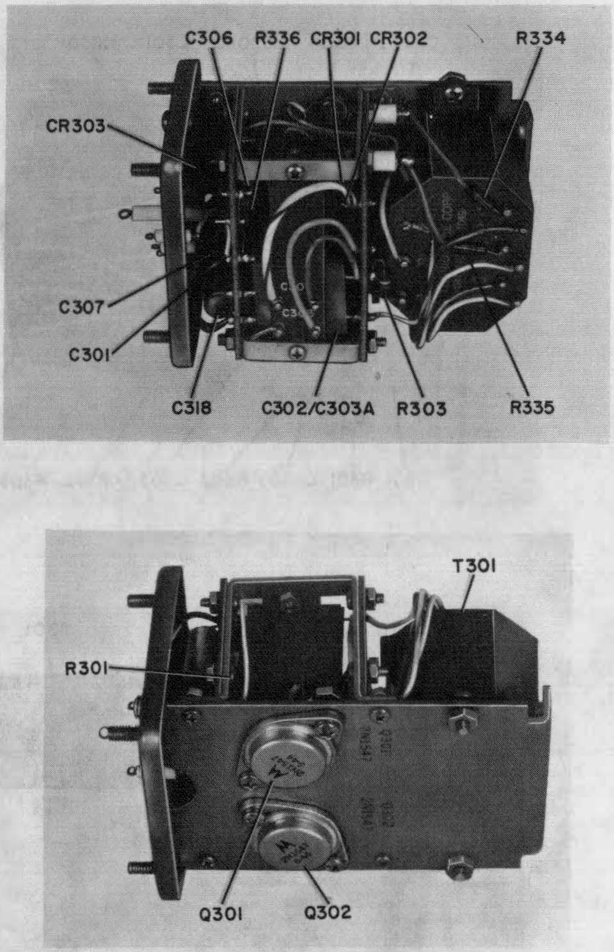


Figure 6-25. Oscilloscope AN/USM-117A, 117B, 117C, High Voltage Assembly A301

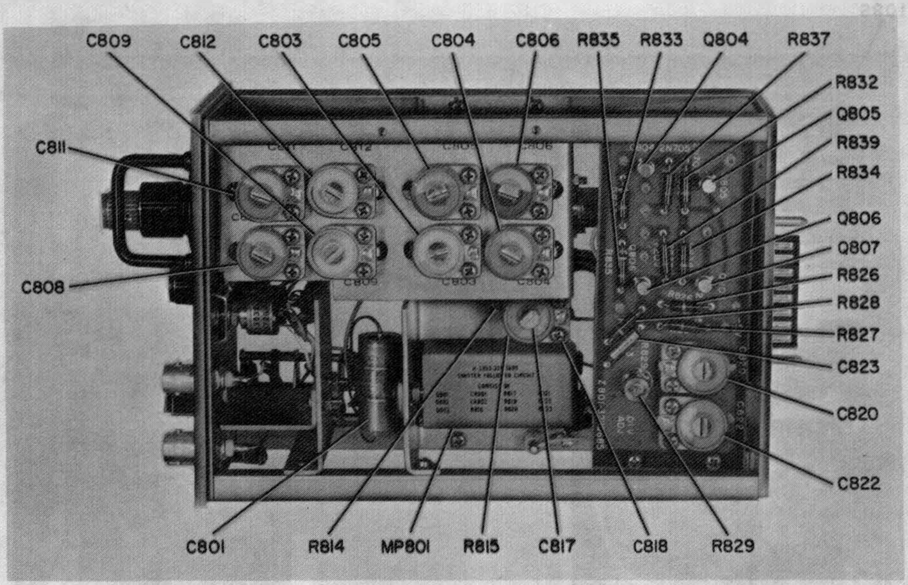


Figure 6-26. Vertical Plug-in, Right Side View

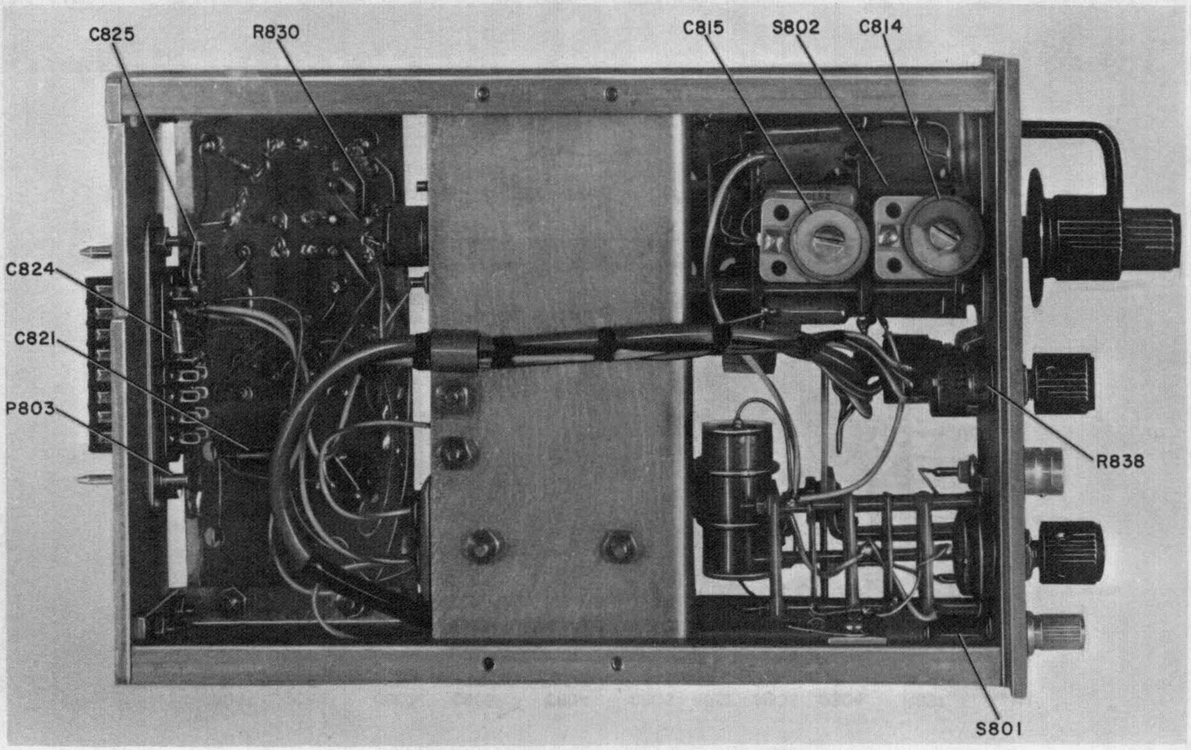
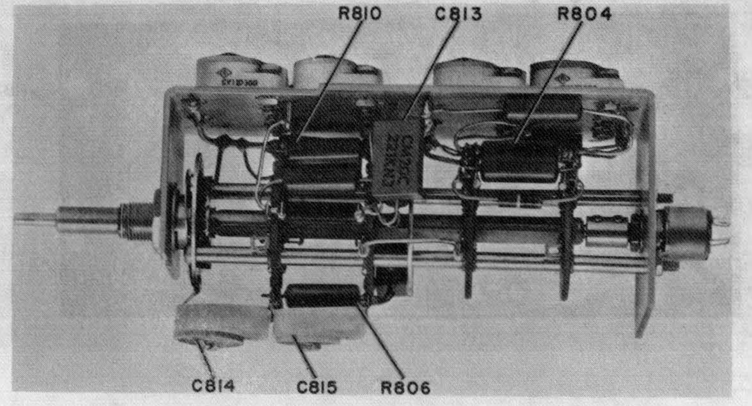


Figure 6-27. Vertical Plug-in, Left Side View



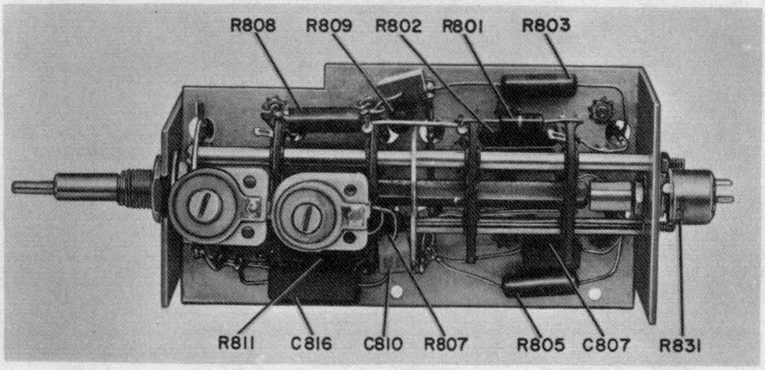


Figure 6-28. Switch Assembly S802

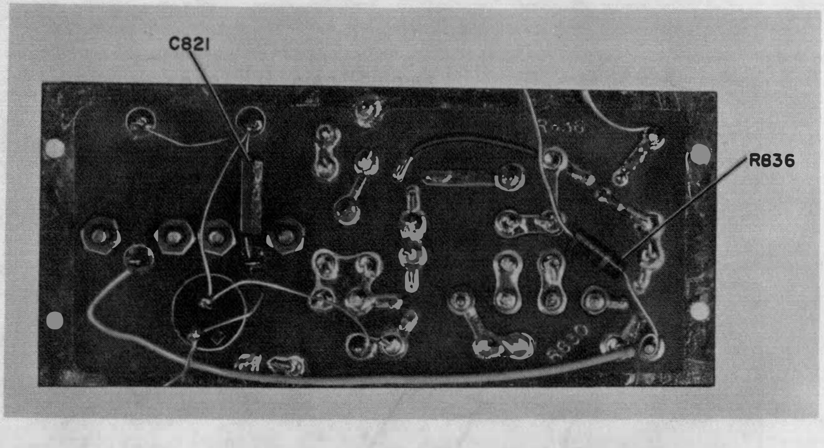


Figure 6-29. Printed Circuit Board Z801, Rear View

SECTION 7
PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify maintenance parts of the Oscilloscope AN/USM-117( ). They are used for marking the equipment and are included on drawings, diagrams and parts list. The letters of reference designation indicate the kind of part, such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same group.

All major sections of the Oscilloscope AN/USM-117( ) are identified with a specific series of numbers. The series number related to each section is given as follows:

Calibrator	100
Low Voltage Power Supply	200
High Voltage Power Supply	300
Horizontal Amplifier	400
Sweep Trigger	500
Vertical Post Amplifier	600
Sweep Generator	700
Vertical Plug-in Preamplifier	800

7-2. MAINTENANCE PARTS LIST.

Table 7-1 lists maintenance parts of the Oscilloscope AN/USM-117, 117A, 117B, 117C. Part designations appear in numerical order. Notes, name and description of parts and locating function of parts are also given. Refer to Stock Number Identification Table (SNIT) published by Electronic Supply Office for stock numbers. The SNIT rather than this publication shall govern if there is any conflict between stock numbers and support information

Most parts used in the AN/USM-117, 117A, 117B, 117C Oscilloscopes are operationally interchangeable, however, the AN/USM-117A, 117B, 117C Oscilloscopes use certain parts which meet more recent military standards. Where the standard part is interchangeable with the original part only the standard part is listed, and the change is indicated in the notes column. These standard parts should be used for replacement purposes in all AN/USM-117 Oscilloscopes. Where parts are different and not interchangeable both parts are listed and the note designates the application.

7-3. NOTES.

Additional information regarding parts listed in table 7-1 as referenced under the notes column is given below:

(1) Used with AN/USM-117.

(2) Used with AN/USM-117A.

(3) Used only in AN/USM-117C. Serial numbers A300 and subsequent but not Serial Nos. B1 through B97.

(4) Improved part. Use for replacement purposes in all AN/USM-117, 117A, 117B, 117C Oscilloscopes can be interchanged with 2N338.

(5) Three 1N989B and one 1N992B diodes should be used to replace the set of four SZ540 diodes in AN/USM-117. The SZ540 diode sets, not the individual diodes, are matched within five percent. These diodes may be changed individually in the AN/USM-117A, the AN/USM-117B, and AN/USM-117C, and in the AN/USM-117 after initially changing the set of four SZ540 diodes.

(6) In AN/USM-117A Serial No. A1 thru A78 substitute part with REF DESIG R336.

(7) In AN/USM-117A Serial No. A1 thru A78 substitute part with REF DESIG C319.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
		Oscilloscope AN/USM-117, 117A, 117B, 117C. Indicator OS-106, 106A, 106B/ USM-117. Sweep speeds from 0.1 SEC/DIV. to 0.1 usec/div. Five times magnification increases sweep speed. Triggering is driven or repetitive. Horizontal sensitivity from 0.5 volts/div. to 2.5 volts/div. Vertical Plug-in MX-2269/USM-117: Vertical sensitivity from 0.01 VOLTS/DIV. to 20 VOLTS/DIV.	
C101		Capacitor, Fixed, Paper Dielectric, 1 uf±10%, 50 v, Part/Dwg. 32113567-2 (20183)	Tuning/Feedback Capacitor for L101. Figure 6-18.
C102		Capacitor, Fixed, Paper Dielectric, 0.22 uf ±10%, 50 v, Part/Dwg. 32113567-1 (20183)	Same as C101. Figure 6-18.
C103		Capacitor, Fixed, Mica Dielectric, CM15D331JN3 per Mil-C-5B	Compensating Capacitor for R109. Figure 6-18.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C104		Capacitor, Fixed, Mica Dielectric, CM15C201JN3 per MIL-C-5B	Bypass Capacitor for calibrator output. Figure 6-18.
C201		Capacitor, Fixed, Electrolytic (Tantalum), CL64B-J600TP per MIL-C-3965	Filter Capacitor for -55v supply. Figure 6-12.
C202		Capacitor, Fixed, Electrolytic (Tantalum), 1 uf ±10%, 35 v, Part/Dwg. 321135662 (20183)	Feedback Capacitor for -55 v supply. Figure 6-10 (Sheet 2).
C205		Same as C201	Filter Capacitor for -15 v supply. Figure 6-12.
C206		Same as C201	Same as C205. Figure 6-12.
C207		Same as C201	Same as C205. Figure 6-12.
C208		Same as C202	Feedback Capacitor for -15 v supply. Figure 6-10 (Sheet 2)
C209		Same as C202	Same as C205. Figure 6-16.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ). MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C210		Capacitor, Fixed, Electrolytic (Tantalum), 330 uf ±20%, 6 v, Part/Dwg. 32113566-3 (20183)	Filter Capacitor for -5 v supply. Figure 6-10 (Sheet 2).
C214		Same as C201	Filter Capacitor for +20 v supply. Figure 6-12.
C215		Same as C202	Feedback Capacitor for +20 v supply. Figure 6-10 (Sheet 2)
C216		Same as C202	Same as C215. Figure 6-10 (Sheet 2)
C219		Same as C210	Filter Capacitor for +5 v supply. Figure 6-10 (Sheet 2).
C301		Capacitor, Fixed, Electrolytic (Tantalum), 1 uf ±10%, 6 v, Part/Dwg. 32113566-1 (20183)	Bias network capacitor for Q301 and Q302. Figure 6-24
C302	1	Capacitor, Fixed, Ceramic Dielectric, 0.002 uf ±20%, 6 kv, Part/Dwg. 32113565-2 (20183)	Charging Capacitor for +HV supply. Figure 6-24

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ). MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C303	1	Same as C302	Same as C302. Figure 6-24.
C302/ C303A	2,3	Capacitor Assy, Fixed, Ceramic Dielectric, Quan two (2) encased, 0.002 uf ±20%, 6 kv, Part/Dwg. 32115538 (20183)	Charging capacitor for +HV supply. Figure 6-25.
C304	1,7	Capacitor, Fixed, Ceramic Dielectric, 0.001 uf ±20%, 1 kv, Part/Dwg. 32113565-1 (20183)	Filter Capacitor for -HV supply. Figure 6-24.
C306		Capacitor, Fixed, Ceramic Dielectric, 0.015 uf ±20%, 1.6 kv, Part/Dwg. 32113881 (20183)	Filter Capacitor for -HV supply. Figure 6-24.
C307		Same as C306	Same as C306. Figure 6-24.
C308		Capacitor, Fixed Paper Dielectric, CP53B1FG254K per MIL-C-25C	Same as C306. Figure 6-24
C312		Capacitor, Fixed, Mica Dielectric, CM15C101JN3 per MIL-C-5B	Bypass Capacitor for CR304. Figure 6-19

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C313		Same as C306	Coupling Capacitor for Z axis input. Figure 6-19.
C314	4	Capacitor, Fixed, Ceramic Dielectric, 510 uuf ±10% 1 kv Part/Dwg. 32115559 (20183)	Compensating Capacitor for CRT grid divider. Figure 6-19.
C315		Capacitor, Fixed, Mica Dielectric, CM15C510J per MIL-C-5B	Compensating Capacitor for gate output. Figure 6-19.
C316		Capacitor, Fixed, Ceramic Dielectric, 0.01 uf ±20%, 600 v, Part/Dwg. 32113565-3 (20183)	Bypass Capacitor for R331. Figure 6-19.
C317		Same as C316	Decoupling Capacitor for Q305 and Q306. Figure 6-19.
C318		Same as C201	Filter Capacitor for Q303. Figure 6-24.
C319	2,3	Capacitor, Fixed, Paper Dielectric, CP53B1FG254 K1	Filter capacitor for -HV supply. Figure 6-5.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C401		Capacitor, Fixed, Electrolytic (Tantalum), CS12AF4R7K per MIL-C-26655	Decoupling Capacitor for Q401. Figure 6-17.
C402		Same as C202	Same as C401. Figure 6-17
C403		Capacitor, Fixed, Ceramic Dielectric, CC21CK050C per MIL-C-20	Compensating Capacitor for Q401 input. Figure 6-1.
C404		Capacitor, Variable, Ceramic Dielectric, CV11D450 per MIL-C-81	Same as C403. Figure 6-17
C405	2,3	Capacitor, Fixed, Ceramic Dielectric, CC21CK020C per MIL-C-20.	Compensating capacitor for R436. Figure 6-3
C501		Capacitor, Fixed, Mica Dielectric, CM15B100KN3 per MIL-C-5B	Compensating Capacitor for ext. trigger input. Figure 6-4
C502		Capacitor, Fixed, Paper Dielectric, CP05A1KF104 K3 per MIL-C-25C	Coupling capacitor for ext. trigger input. Figure 6-1.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C503		Same as C316	Bypass Capacitor for R504. Figure 6-4.
C504		Capacitor, Fixed, Electrolytic (Tantalum), 0.047 uf ±20%, 35 v, Part/Dwg. 32115562 (20183)	Decoupling Capacitor for Q501 through Q504. Figure 6-16.
C505		Same as C401	Coupling Capacitor for int. trigger input. Figure 6-4.
C508		Capacitor, Fixed, Mica Dielectric, CM15C200JN3 per MIL-C-5B	Compensating Capacitor for divider R515 and R516. Figure 6-16.
C601		Capacitor, Fixed, Mica Dielectric, CM15C620JN3 per MIL-C-5B	Compensating Capacitor for input to Q606. Figure 6-13.
C602		Capacitor, Fixed, Mica Dielectric, CM15D301JN3 per MIL-C-5B	Bypass Capacitor for R604. Figure 6-13.
C603	2,3	Capacitor, Fixed, Mica Dielectric, CM15C820JN3 per MIL-C-5.	Compensating capacitor for delay line amplifier. Figure 6-14.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ) MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C605		Same as C315	Compensating Capacitor for output stage. Figure 6-13.
C605A		Same as C404	Same as C605. Figure 6-1.
C701		Capacitor, Fixed, Ceramic Dielectric, CC21CK1R5C per MIL-C-20	Coupling/Differentiating Capacitor for trigger output. Figure 6-6.
C702		Same as C312	Compensating Capacitor for divider R703 and R706. Figure 6-20.
C703		Same as C403	Feedback Capacitor, parasitic suppression network. Figure 6-20.
C705		Capacitor, Fixed, Mylar Dielectric, 2 uf ±10%, 50 v, Part/Dwg. 32113547-2 (20183)	Hold-off Capacitor for sweep generator. Figure 6-1.
C706		Same as C102	Same as C705. Figure 6-4.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ) MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C707		Capacitor, Fixed, Paper Dielectric, CP04A1KB223K per MIL-C-25C	Same as C705. Figure 6-1
C708		Capacitor, Fixed, Paper Dielectric, CP04A1KB222K per MIL-C-25C	Same as C705. Figure 6-1
C709		Capacitor, Fixed, Mylar Dielectric, 2 uf ±1%, 50 v, Part/Dwg. 32113547 (20183)	Timing Capacitor for sweep generator. Figure 6-1
C710		Capacitor, Fixed, Mylar Dielectric, 0.2 uf ±1%, 50 v, Part/Dwg. 32113546 (20183)	Same as C709. Figure 6-1
C711		Capacitor, Fixed, Mylar Dielectric, 0.02 uf ±1%, 50 v, Part/Dwg. 32113545-2 (20183)	Same as C709. Figure 6-1
C712		Capacitor, Fixed, Mylar Dielectric, 0.002 uf ±1%, 50 v, Part/Dwg. 32113545-1 (20183)	Same as C709. Figure 6-4.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C713		Capacitor, Fixed, Mica Dielectric, CM15C181JN3 per MIL-C-5B	Same as C709. Figure 6-4.
C714		Same as C404	Same as C709. Figure 6-4.
C715		Same as C404	Same as C709. Figure 6-4.
C716		Capacitor, Fixed, Mica Dielectric, CM15D511J per MIL-C-5B	Same as C709. Figure 6-1.
C717		Same as C504	Decoupling Capacitor for sweep generator Figure 6-20.
C718		Capacitor, Fixed, Ceramic Dielectric, CK60AW102M per MIL-C-11015	Bypass Capacitor for R738. Figure 6-4.
C801		Same as C502	Coupling Capacitor for vertical input. Figure 6-26.
C803		Capacitor, Variable, Ceramic Dielectirc, CV11A070 per MIL-C-81	Compensating Capacitor for vertical input attenuator. Figure 6-26.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ) MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C804		Capacitor, Variable, Ceramic Dielectric, CV11D300 per MIL-C-81	Same as C803. Figure 6-26.
C805		Same as C804	Same as C803. Figure 6-26
C806		Capacitor, Variable, Ceramic Dielectric, CV11A120 per MIL-C-81	Same as C803. Figure 6-26
C807		Same as C501	Same as C803. Figure 6-28.
C808		Same as C804	Same as C803. Figure 6-26.
C809		Same as C803	Same as C803. Figure 6-26.
C810		Capacitor, Fixed, Mica Dielectric, CM15C220JN3 per MIL-C-5B	Same as C803. Figure 6-28.
C811		Same as C804	Same as C803. Figure 6-26.
C812		Same as C803	Same as C803. Figure 6-26.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C813		Capacitor, Fixed, Mica Dielectric, CM20C221KN3 per MIL-C-5B	Same as C803. Figure 6-28.
C814		Same as C804	Same as C803. Figure 6-28.
C815		Same as C803	Same as C803. Figure 6-28.
C816		Capacitor, Fixed, Mica Dielectric, CM30C222KN3 per MIL-C-5B	Same as C803. Figure 6-28.
C817		Same as C404	Compensating Capacitor for input to Q801. Figure 6-26.
C818		Same as C312	Same as C817. Figure 6-26.
C820		Same as C404	Compensating Capacitor for preamp output. Figure 6-26.
C821		Same as C312	Same as C820. Figure 6-27.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
C822		Same as C404	Same as C820. Figure 6-26.
C823		Capacitor, Fixed, Electrolytic (Tantalum), 60 uf ±20%, 6 v, Part/Dwg. 32113566-4 (20183)	Bypass Capacitor for balance ckt. Figure 6-26.
C824		Same as C202	Bypass Capacitor for +5 v supply. Figure 6-27.
C825		Same as C504	Bypass Capacitor for -5 v supply. Figure 6-27.
CR101		Semiconductor Device, Diode, 1N914 per MIL-S-19500/116	Coupling Diode for calibrator output. Figure 6-18.
CR102		Same as CR101	Clamping Diode for calibrator output. Figure 6-18.
CR201	4	Semiconductor Device, Diode, 1N538 per MIL-S-19500/202	Rectifier for -55 v supply. Figure 6-10 (Sheet 2)
CR202		Same as CR201	Same as CR201. Figure 6-10 (Sheet 2)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
CR203		Same as CR201	Same as CR201. Figure 6-10. (Sheet 2)
CR204		Same as CR201	Same as CR201. Figure 6-10. (Sheet 2)
CR205		Semiconductor Device, Diode, 1N3031B per MIL-S-19500/115	Reference diode for Q202. Figure 6-10. (Sheet 2)
CR208		Same as CR201	Rectifier for -15 v supply. Figure 6-10. (Sheet 2)
CR209		Same as CR201	Same as CR208. Figure 6-10. (Sheet 2)
CR210		Same as CR201	Same as CR208 Figure 6-10. (Sheet 2)
CR211		Same as CR201	Same as CR208. Figure 6-10. (Sheet 2)
CR212		Semiconductor Device, Diode, 1N752A per MIL-S-19500/127	Reference Diode for Q205. Figure 6-10. (Sheet 2)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
CR213		Semiconductor Device, Diode, 1N751A per MIL-S-19500/127	Zener Diode for -5 v supply. Figure 6-10. (Sheet 2)
CR215		Same as CR201	Rectifier for +20 v supply. Figure 6-10 (Sheet 2)
CR216		Same as CR201	Same as CR215. Figure 6-10. (Sheet 2)
CR217		Same as CR201	Same as CR215. Figure 6-10. (Sheet 2)
CR218		Same as CR201	Same as CR215. Figure 6-10. (Sheet 2)
CR219		Semiconductor Device, Diode, 1N756A per MIL-S-19500/127	Reference Diode for Q208. Figure 6-10 (Sheet 2)
CR220		Same as CR212	Reference Diode for Q209. Figure 6-10. (Sheet 2)
CR221		Same as CR213	Zener Diode for +5 v supply. Figure 6-10. (Sheet 2)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
CR301	4	Semiconductor Device, Diode, 1N1734 per MIL-S-19500/142	Rectifier for +HV supply. Figure 6-24.
CR302	4	Same as CR301	Same as CR301. Figure 6-24.
CR303	4	Semiconductor Device, Diode, 1N1731A per MIL-S-19500/142	Rectifier for -HV supply. Figure 6-24.
CR304		Semiconductor Device, Diode, 1N3051B per MIL-S-19500/115	Zener Diode for -HV supply. Figure 6-19.
CR305	2,3	Semiconductor Device, Diode, 1N914 per MIL-S-19500/116	Biasing Diode for Q305. Figure 6-19.
CR308	5	Semiconductor Device, Diode, 1N989B per MIL-S-19500/117	Coupling Diode for unblanking signal. Figure 6-19.
CR309	5	Same as CR308	Same as CR308. Figure 6-19.
CR310	5	Same as CR308	Same as CR308. Figure 6-19.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
CR311	5	Semiconductor Device, Diode, 1N992B per MIL-S-19500/117	Coupling Diode for unblanking signal. Figure 6-19.
CR701	1,2	Semiconductor Device, Diode, 1N643 per MIL-S-19500/94	Gating Diode for sweep generator. Figure 6-20.
CR701	3	Same as CR101	Figure 6-20.
CR702	1,2	Same as CR701 (Note 1, 2)	Same as CR701. Figure 6-20.
CR702	3	Same as CR101	Figure 6-20.
CR703		Same as CR212	Coupling Diode, Q709, to Q705. Figure 6-21.
CR705		Same as CR701 (Note 1, 2)	Isolation Diode for hold-off circuit. Figure 6-20.
CR801		Same as CR701 (Note 1, 2)	Protection Diode for Vertical input. Figure 6-22.
CR802		Same as CR701 (Note 1, 2)	Same as CR801. Figure 6-22.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
DL601		Delay Line, 0.1 u sec. delay Part/Dwg. 32113826 (20183)	Delay Line, vertical post amplifier. Figure 6-15.
DL602		Same as DL601	Same as DL601. Figure 6-15.
DS202		Lamp, Incandescent, #47, 6.8 v @0.15 amp, bayonet base. per MS-1571-2 (24455)	Graticule Lamp. Figure 6-4.
DS201		Lamp, Indicator, 5 v @0.06 amp, Assy, Part/Dwg. 32113523 (20183)	Pilot Lamp. Figure 6-9
F201		Fuse, 0.5 amp, 250 v, 3 AG, per MS-90078-5-1 (71400)	Power Fuse, low voltage power supply. Figure 6-1
F202		Same as F201	Same as F201. Figure 6-1
F203		Same as F201	Spare fuse. Figure 6-6
F204		Same as F201	Same as F203. Figure 6-6

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
FL201	2,3	Filter, Power Line, Radio Interference, Part/Dwg. 33285098 (20183)	R.F.I. Power Line Filter. Figure 6-7
J101		Connector, Receptacle, Electrical, UG-625B/U per MIL-C-3608	Connector, calibrator output. Figure 6-9.
J301		Same as J101	Connector, Z axis input, Figure 6-9.
J401		Same as J101	Connector, horizontal input. Figure 6-9.
J501		Same as J101	Connector, external trigger input. Figure 6-9.
J701		Same as J101	Connector, positive gate output. Figure 6-1.
J801		Same as J101	Connector, vertical input A. Figure 6-9
J802		Same as J101	Connector, vertical input B. Figure 6-9

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
J803		Connector, Receptacle Electrical, 16 pins Part/Dwg. 26-190-16 (02660)	Figure 6-6
L101		Inductor, Variable, 30 to 300 uh, Part/Dwg. 32113923 (20183)	Oscillator tank for calibrator circuit. Figure 6-6.
L301	1	Inductor, Fixed, 8 h @ 0.5 ma, Part/Dwg. 32113869 (20183)	Filter choke for -HV supply. Figure 6-24
L401		Inductor, Variable, 238 to 450 uh, Part/Dwg. 32113608 (20183)	Peaking Coil for horizontal amplifier. Figure 6-8
L402		Same as L401	Same as L401. Figure 6-8
MP1		Bezel, CRT, Part/Dwg. 32113074 (20183)	Figure 6-9
MP2		Scale, CRT Graticule, Part/Dwg. 32113075 (20183)	Figure 6-9
MP3		Filter, CRT, Part/Dwg. 32113187 (20183)	Filter, green for P2 screen. Figure 6-9

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
MP4		Knob, skirted, round type, 1-1/8 in. dia. x 11/16 h, Part/Dwg. 32113540 (3 required) (20183)	Figure 6-9
MP5		Knob, round type, 1/2 in. dia. x 1/2 in. h., Red Matte finish, Part/Dwg. 5D-1-1G(MS91528C) (3 required) (99687)	Figure 6-9
MP6		Knob, pointer type, 3/4 in. long x 1/2 in. h., Matte finish, Part/Dwg. 50-4-1G (MS91528C) (2 required) (99687)	Figure 6-9
MP7		Knob, round type, 1/2 in. dia. x 1/2 in. h., Matte finish, Part/Dwg. 50-1WD-1 (MS91528C) (8 required) (99687)	Figure 6-9
MP9		Screw, captive type, Part/Dwg. 32113526 (4 required) (20183)	Figure 6-9
MP12	4	Miniature fastener Part/Dwg. 27-10-301-10 (94222)	Figure 6-9

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
P201		Connector, Receptacle, Electrical, MS-3102E-14S-7P per MIL-C-5015 (02660)	Figure 6-8
P803		Connector, Plug Electrical, 16 Pins Part/Dwg 26-159-16 (02660)	Figure 6-22
Q101	4	Transistor, type 2N1304, germanium NPN per MIL-S-19500/126B	Oscillator for calibrator. Figure 6-18
Q102	4	Same as Q101	Schmitt gate for calibrator. Figure 6-18
Q103	4	Transistor, type 2N388, germanium NPN per MIL-S-19500/65	Same as Q102. Figure 6-18
Q201		Transistor, type 2N1546, germanium PNP (04713)	Pass Transistor -55 v supply. Figure 6-8
Q302	4	Transistor, type 2N1305, germanium PNP per MIL-S-19500/126B	Control Transistor, -55 v supply. Figure 6-10 (Sheet 2)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q204		Same as Q201	Pass Transistor -15 v supply. Figure 10 (Sheet 2)
Q205	4	Same as Q202	Control Transistor, -15 v supply. Figure 6-10 (Sheet 2)
Q207		Same as Q201	Pass Transistor, +20 v supply. Figure 6-10 (Sheet 2)
Q208	4	Same as Q202	Control Transistor +20 v supply. Figure 6-10 (Sheet 2)
Q209	4	Same as Q202	Same as Q208. Figure 6-10 (Sheet 2)
Q210	4	Same as Q202	Same as Q208. Figure 6-10 (Sheet 2)
Q301		Transistor, type 2N1547, germanium PNP (04713)	Oscillator for HV converter. Figure 6-24
Q302		Same as Q301	Same as Q301. Figure 6-24.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q303		Same as Q201	Control Transistor for HV control stage. Figure 6-1.
Q304	4	Same as Q202	Amplifier for HV control stage. Figure 6-10 (Sheet 2)
Q305		Transistor, type 2N1226, germanium PNP (49675)	Unblanking amplifier. Figure 6-19
Q306		Same as Q305	Unblanking output. Figure 6-19.
Q401	4	Transistor, type 2N337, silicon NPN (01295) per MIL-S-19500/69	Horizontal input emitter follower Figure 6-17
Q402		Same as Q101	Positioning emitter follower. Figure 6-17
Q404		Same as Q305	Horizontal output amplifier. Figure 6-17
Q405		Same as Q305	Same as Q404. Figure 6-17
Q501	4	Transistor, type 2N1225, germanium PNP per MIL-S-19500/189	Trigger amplifier. Figure 6-16

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q502	4	Same as Q501	Same as Q501. Figure 6-16
Q503	4	Transistor, type 2N705, germanium PNP per MIL-S-19500/86	Schmitt trigger. Figure 6-16
Q504	4	Same as Q503	Same as Q503. Figure 6-16
Q601	4	Same as Q501	Vertical output amplifier. Figure 6-13.
Q602	4	Same as Q501	Same as Q601. Figure 6-13
Q603	4	Same as Q501	Same as Q601. Figure 6-13
Q604	4	Same as Q501	Same as Q601. Figure 6-13
Q605	4	Same as Q503	Delay Line amplifier. Figure 6-15.
Q606	4	Same as Q501	Internal Trigger amplifier. Figure 6-13

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q607	4	Same as Q503	Same as Q605. Figure 6-15
Q608	4	Same as Q503	Driver Transistor for vertical output amplifier. Figure 6-15
Q609	4	Same as Q503	Same as Q608. Figure 6-15
Q701	4	Same as Q503	Sweep gating multivibrator. Figure 6-20.
Q702	4	Same as Q503	Same as Q701. Figure 6-20
Q703	4	Transistor, type 2N706, silicon NPN per MIL-S-19500/120	Unblanking amplifier driver. Figure 6-4
Q705	4	Same as Q501	Sweep output. Figure 6-20
Q706	4	Transistor, type 2N760A, silicon NPN per MIL-S-19500/218	Miller circuit driver. Figure 6-20

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q709	4	Transistor, type 2N1309, germanium PNP per MIL-S-19500/126B	Miller circuit (saw-tooth formation). Figure 6-20
Q710		Transistor, type 2N863, silicon PNP (98329)	Hold-off circuit emitter follower Figure 6-20
Q711		Same as Q710	Same as Q710. Figure 6-20.
Q712	4	Transistor, type 2N1307, germanium PNP per MIL-S-19500/126B	Same as Q711. Figure 6-20.
Q801		Transistor, type 2N780, silicon NPN (01295)	Vertical plug-in input emitter follower. Figure 6-23
Q802		Same as Q801	Same as Q801. Figure 6-22
Q803		Transistor, type 2N965, germanium PNP (04713)	Same as Q801. Figure 6-23
Q804	4	Same as Q503	Vertical plug-in amplifier stage. Figure 6-26

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Q805	4	Same as Q503	Vertical plug-in output driver. Figure 6-26
Q806	4	Same as Q503	Same as Q804. Figure 6-26
Q807	4	Same as Q503	Same as Q805. Figure 6-26
R101		Resistor, Fixed, Composition, RC20GF393K per MIL-R-11	Bias divider for Q101. Figure 6-18
R102		Resistor, Fixed, Composition, RC20GF122J per	Same as R101. Figure 6-18
R103		Resistor, Fixed, Composition, RC20GF331K per MIL-R-11	Emitter Resistor for Q101. Figure 6-18
R104		Resistor, Fixed, Composition, RC20GF271K per MIL-R-11	Isolation Resistor for Q102. Figure 6-18
R105		Resistor, Fixed, Composition, RC20GF152K per MIL-R-11	Collector load resistor for Q102. Figure 6-18

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R106		Resistor, Fixed, Composition, RC20GF101K per MIL-R-11	Emitter Resistor for Q102 and Q103. Figure 6-18
R107		Resistor, Fixed, Composition, RC20GF121K per MIL-R-11	Current limiting resistor for Q101. Figure 6-18
R109		Same as R105	Coupling divider for Q103. Figure 6-18
R110		Resistor, Fixed, Composition, RC20GF471K per MIL-R-11	Same as R109. Figure 6-18
R111		Same as R105	Collector load resistor for Q103. Figure 6-18.
R112		Resistor, Variable, Composition, 10 k ±5%, 1 watt, Part/Dwg. 32113570 (20183)	Calibration adjustment for calibrator. Figure 6-18
R113		Resistor, Fixed, Film, RN70B4991F per MIL-R-10509C	Divider resistor for calibrator output. Figure 6-18

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R114		Resistor, Fixed, Film, RN65B9000F per MIL-R-10509C	Same as R113. Figure 6-18
R115		Resistor, Fixed, Film, RN65B1000F per MIL-R-10509C	Same as R113. Figure 6-18
R201		Resistor, Fixed, Composition, RC20GF100K per MIL-R-11	Filter network resistor for -55 v supply. Figure 6-10 (Sheet 1)
R202		Resistor, Fixed, Composition, RC20GF472K per MIL-R-11	Collector load resistor for Q202. Figure 6-10 (Sheet 1)
R203		Resistor, Fixed, Composition, RC20GF332K per MIL-R-11	Dropping Resistor for CR205. Figure 6-10 (Sheet 1)
R204		Resistor, Fixed, Composition, RC20GF332J per MIL-R-11	Voltage divider resistor for Q202. Figure 6-10 (Sheet 1)
R205		Resistor, Variable, Composition, RV6LAXSA102A per MIL-R-94	Adjustment for -55 v supply. Figure 6-10 (Sheet 1)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R206		Resistor, Fixed, Composition, RC20GF682J per MIL-R-11	Same as R204. Figure 6-10 (Sheet 1)
R207		Resistor, Sensistor, 1000 ohm, Part/Dwg. H-5039 (20183)	Temperature compensation for -55 v supply. Figure 6-11
R212		Resistor, Fixed, Composition, RC42GF101K per MIL-R-11	Filter network resistor for -15 v supply. Figure 6-10 (Sheet 1)
R213		Resistor, Fixed, Composition, RC20GF103J per MIL-R-11	Collector load resistor for Q205. Figure 6-10 (Sheet 1)
R214		Resistor, Fixed, Composition, RC20GF621J per MIL-R-11	Voltage divider resistor for Q205. Figure 6-10 (Sheet 1)
R215		Same as R205	Adjustment for -15 v supply. Figure 6-10 (Sheet 1)
R216		Resistor, Fixed, Composition, RC20GF272J per MIL-R-11	Same as R214. Figure 6-10 (Sheet 1)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R217		Resistor, Sensitor, 820 ohm, Part/Dwg. H-5038 (20183)	Temperature compensation for -15 v supply. Figure 6-10 (Sheet 1)
R220		Resistor, Fixed, Composition, RC32GF241J per MIL-R-11	Dropping Resistor for CR213. Figure 6-10 (Sheet 1)
R225		Resistor, Fixed, Composition, RC20GF822K per MIL-R-11	Collector load resistor for Q208. Figure 6-10 (Sheet 1)
R226		Resistor, Fixed, Composition, RC20GF222K per MIL-R-11	Dropping Resistor for CR219. Figure 6-10 (Sheet 1)
R227		Same as R226	Shunt Resistor for CR219. Figure 6-10 (Sheet 1)
R228		Resistor, Fixed, Composition, RC20GF272K per MIL-R-11	Dropping Resistor for Q209. Figure 6-10 (Sheet 1)
R229		Same as R225	Collector load resistor for Q209. Figure 6-10 (Sheet 1)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R230		Resistor, Fixed, Composition, RC20GF202J per MIL-R-11	Emitter Resistor for Q209 and Q210. Figure 6-10 (Sheet 1)
R232		Resistor, Fixed, Composition, RC20GF242J per MIL-R-11	Voltage divider resistor for Q210. Figure 6-10 (Sheet 1)
R233		Same as R205	Adjustment for +20v supply. Figure 6-10 (Sheet 1)
R234		Resistor, Fixed, Composition, RC20GF331J per MIL-R-11	Same as R232. Figure 6-10 (Sheet 1)
R235	2	Resistor, Fixed, Composition, RC32GF391J per MIL-R-11	Dropping Resistor for CR221. Figure 6-10 (Sheet 1)
R236		Resistor, Fixed, Composition, RC20GF470K per MIL-R-11	Current limiting resistor for DS201. Figure 6-6
R240	4	Resistor, Variable, Wirewound, 50 ohm, 2 watt wire wound, Part/Dwg. 32113525 (20183)	Adjusts illumination of DS202. Figure 6-6

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R301		Resistor, Fixed, Composition, RC20GF221K per MIL-R-11	Bias network resistor for Q301 and Q302. Figure 6-24
R302		Resistor, Fixed, Composition, RC20GF682K per MIL-R-11	Voltage dropping resistor for bias network. Figure 6-24
R303		Resistor, Fixed, Composition, RC20GF204J per MIL-R-11	Dropping Resistor for +HV supply. Figure 6-24
R309		Resistor, Variable, Composition, 500k ±20%, 0.5 watt, Part/Dwg. 32113532-4 (20183)	Focus adjustment. Figure 6-1
R310		Resistor, Fixed, Composition, RC20GF564J per MIL-R-11	Voltage divider resistor for Q304. Figure 6-10 (Sheet 1)
R311		Resistor, Variable, Composition, RV6LAXSA-503A per MIL-R-94	HV adjustment. Figure 6-10 (Sheet 1)
R312		Same as R213	Same as R310. Figure 6-10 (Sheet 1)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R314		Resistor, Variable, Composition, RV6LAXSA104B per MIL-R-94	Shield adjustment. Figure 6-4
R315		Resistor, Variable Composition, 100k ±20%, 0.5 watt, Part/Dwg. 32113532-3 (20183)	Astigmatism control. Figure 6-1
R316		Same as R314	Geometry adjustment. Figure 6-4
R317		Resistor, Fixed, Composition, RC20GF223K per MIL-R-11	Load Resistor for Z axis input. Figure 6-19
R318		Resistor, Fixed, Composition, RC20GF104K per MIL-R-11	Coupling Resistor for CRT heater. Figure 6-19
R319		Resistor, Fixed, Composition, RC20GF475J per MIL-R-11	Voltage divider for unblanking signal. Figure 6-19
R320		Same as R319	Same as R319. Figure 6-19
R321		Resistor, Variable Composition, 2.5 meg ±20%, 0.5 watt, Part/Dwg. 32113532-5 (20183)	Intensity control. Figure 6-1

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R322		Resistor, Fixed, Composition, RC20GF224K per MIL-R-11	Same as R320. Figure 6-19
R323		Resistor, Fixed, Composition, RC20GF105K per MIL-R-11	Series Resistor for CRT control grid. Figure 6-19
R324		Same as R323	Input Resistor for Z axis input. Figure 6-6
R325		Resistor, Fixed, Composition, RC20GF103K per MIL-R-11	Emitter Resistor for Q306. Figure 6-19
R326		Resistor, Fixed, Composition, RC20GF123K per MIL-R-11	Same as R325. Figure 6-19
R327		Resistor, Fixed, Wire Wound, RW55G121J per MIL-R-26	Dropping Resistor for Q303. Figure 6-1
R328		Same as R206	Collector load resistor for Q304. Figure 6-10 (Sheet 1)
R329		Same as R207	Temperature compensation resistor for Q304. Figure 6-10 (Sheet 1)

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R330	1	Same as R325	Collector load resistor for Q305. Figure 6-19
R330	2,3	Resistor, Fixed, Composition, RC20GF123J per MIL-R-11	Collector load resistor for Q305. Figure 6-19
R331	1,6	Resistor, Fixed, Composition, RC20GF271J per MIL-R-11	Emitter Resistor for Q305. Figure 6-19
R332		Same as R213	Level set resistor for Q304. Figure 6-10 (Sheet 1)
R333		Same as R106	Decoupling Resistor for Q305 and Q306. Figure 6-19
R334	2,3	Resistor, Fixed, Composition, RC20GF100J per MIL-R-11	Transient Suppression Resistor for T301. Figure 6-25
R335	2,3	Same as R334	Transient Suppression Resistor for T301. Figure 6-25
R336	2,3	Same as R214	Filter Resistor for -HV Supply. Figure 6-14

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R401		Resistor, Fixed, Composition, RC20GF330K per MIL-R-11	Attenuator Resistor for horizontal input Figure 6-1
R402		Resistor, Fixed, Film, RN70B4992F per MIL-R-10509C	Same as R401 Figure 6-6
R403		Resistor, Fixed, Film, RN70B8002F per MIL-R-10509C	Same as R401. Figure 6-6
R404		Resistor, Fixed, Film, RN70B1003F per MIL-R-10509C	Same as R401. Figure 6-6
R405		Resistor, Fixed, Film, RN70B2492F per MIL-R-10509C	Same as R401. Figure 6-6
R406		Resistor, Fixed, Film, RN75B1103F per MIL-R-10509C	Protection Resistor for Q401. Figure 6-1
R407		Same as R236	Decoupling Resistor for Q401. Figure 6-17.

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R408		Resistor, Variable, Composition, RV6LAXSA502B per MIL-R-94	Zero adjustment. for Q401 input Figure 6-17
R409		Resistor, Fixed, Composition RC20GF243J per MIL-R-11	Bias divider resistor for Q401. Figure 6-17.
R410		Resistor, Sensitor, 1.5k Part/Dwg. H-5040 (20183)	Temperature compensation for Q401 input. Figure 6-17
R411		Resistor, Fixed, Film, RN70B2212F per MIL-R-10509	Same as R409. Figure 6-17
R412		Same as R225	Emitter Resistor for Q401. Figure 6-17
R413		Same as R236	Same as R407. Figure 6-17
R418		Same as R225	Emitter Resistor for Q402. Figure 6-17
R420		Same as R301	Voltage divider resistor for horizontal position. Figure 6-1

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTIONS
R421		Resistor, Variable, Composition, 250 ohm ±20%, 0.5 watt, Part/Dwg. 32113532-1 (20183)	Horizontal position control. Figure 6-6
R422		Same as R201	Same as R420. Figure 6-1
R423		Resistor, Fixed, Composition, RC20GF102K per MIL-R-11	Same as R420. Figure 6-1
R425		Same as R205	Horizontal calibration adjustment. Figure 6-17
R426		Resistor, Variable, Composition, 1000 ohms, ±20%, 0.5 watt, Part/Dwg. 32113532-2 (20183)	Horizontal gain control. Figure 6-6
R427		Same as R205	Sweep calibration adjustment. Figure 6-17
R428		Resistor, Variable, Composition, RV6LAXSA501A per MIL-R-94	5x Magnification adjustment. Figure 6-17

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R429		Same as R213	Collector load resistor for Q404. Figure 6-17
R430		Resistor, Fixed, Composition, RC20GF472J per MIL-R-11	Emitter resistor for Q404. Figure 6-17
R431		Same as R430	Emitter resistor for Q405. Figure 6-17
R432		Same as R213	Collector load resistor for Q405. Figure 6-17
R433		Same as R213	Shunt Resistor for L401 and L402. Figure 6-4
R435		Same as R408	Bias adjustment for Q404 and Q405. Figure 6-17
R436	2,3	Resistor, Fixed, Composition, RC20GF334J per MIL-R-11	Sweep divide resistor for Q401. Figure 6-3
R501	4	Resistor, Fixed, Film, RN70B9762F per MIL-R-10509C	Dropping Resistor for external trigger. Figure 6-4

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R502		Same as R325	Input Resistor for Q501. Figure 6-1
R503		Same as R325	Input Resistor for Q502. Figure 6-1
R504		Resistor, Fixed, Comconposition, RC20GF183K per MIL-R-11	Dropping Resistor for level control. Figure 6-4
R505		Resistor, Variable, Composition 100k, ±20%, 0.5 watt Part/Dwg. 32113532-7 (20183)	Trigger lever control. Figure 6-4
R506		Resistor, Fixed, Composition, RC20GF823K per MIL-R-11	Series Resistor for 6.3v ac trigger. Figure 6-1
R508		Same as R325	Emitter Resistor for Q501 and Q502. Figure 6-16
R509		Same as R202	Collector load resistor for Q502. Figure 6-16
R510		Same as R236	Decoupling Resistor for Q501 and Q504. Figure 6-16

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R511		Same as R216	Collector load resistor for Q503. Figure 6-16
R512		Resistor, Fixed, Composition, RC20GF153J per MIL-R-11	Emitter Resistor for Q503 and Q504. Figure 6-16
R513		Same as R216	Collector load resistor for Q504. Figure 6-16
R515		Same as R213	Coupling divider resistor for Q504. Figure 6-16
R516		Resistor, Fixed, Composition, RC20GF223J per MIL-R-11	Same as R515. Figure 6-16
R601	1	Resistor, Fixed, Composition, RC20GF153K per MIL-R-11	Divider Resistor for input Q606. Figure 6-13
R601	2,3	Resistor, Fixed, Composition, RC20GF512J per MIL-R-11	Divider Resistor for input Q606. Figure 6-13
R602	1	Same as R202	Same as R601. Figure 6-13

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R602	2,3	Resistor, Fixed, Composition, RC20GF363J per MIL-R-11	Divider Resistor for input Q606. Figure 6-13
R603		Same as R228	Collector load resistor for Q606. Figure 6-13
R604		Same as R106	Emitter Resistor for Q606. Figure 6-13
R608		Same as R213	Bias divider for Q601 and Q603. Figure 6-13
R609		Same as R213	Same as R608. Figure 6-13
R610		Same as R110	Compensation network resistor. Figure 6-13
R611		Same as R104	Dropping Resistor for R612. Figure 6-13
R612		Resistor, Variable, Composition RV6LAXSA-251B per MIL-R-94	Gain adjustment post amplifier. Figure 6-1

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R614		Resistor, Fixed, Composition, RC32GF512J per MIL-R-11	Emitter degeneration resistor for horizontal output. Figure 6-13
R615		Same as R614	Same as R614. Figure 6-13
R616		Same as R213	Bias divider for Q602 and Q604. Figure 6-13
R617		Same as R213	Same as Q616. Figure 6-13
R618		Resistor, Fixed, Composition, RC32GF472J per MIL-R-11	Collector load resistor for Q601 and Q603. Figure 6-13
R619		Same as R618	Collector load resistor for Q602 and Q604. Figure 6-13
R620		Same as R234	Matching Resistor for delay line. Figure 6-13

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R621		Same as R234	Same as R620. Figure 6-13
R622		Same as R234	Termination Resistor for delay line. Figure 6-13
R623		Same as R234	Same as R622. Figure 6-13
R624		Resistor, Fixed, Composition, RC20GF101J per MIL-R-11	Emitter degeneration resistor for Q605 and Q607. Figure 6-13
R625		Resistor, Fixed, Composition, RC20GF182J per MIL-R-11	Dropping Resistor for delay line amplifier. Figure 6-13
R626		Resistor, Fixed, Composition, RC20GF241J per MIL-R-11	Collector load resistor for Q605. Figure 6-13
R627		Same as R626	Collector load resistor for Q607. Figure 6-13
R628		Resistor, Fixed, Composition, RC20GF102J per MIL-R-11	Emitter Resistor for delay line amplifier. Figure 6-13

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R629		Same as R628	Same as R628. Figure 6-13
R630		Same as R234	Same as R628. Figure 6-13
R631		Same as R105	Dropping Resistor for driver stage. Figure 6-13
R632		Same as R628	Emitter Resistor for Q608. Figure 6-13
R633		Same as R628	Emitter Resistor for Q609. Figure 6-13
R701		Same as R206	Level set resistor for Q701. Figure 6-20
R702		Same as R423	Collector load resistor for Q701. Figure 6-20
R703		Resistor, Fixed, Composition, RC20GF622J per MIL-7-11	Coupling divider resistor for Q702. Figure 6-20

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R704		Same as R203	Emitter Resistor for Q703. Figure 6-4
R705	4	Same as R703	Emitter Resistor for Q701 and Q702. Figure 6-20
R706		Same as R512	Same as R703. Figure 6-20
R707		Same as R423	Collector load resistor for Q702. Figure 6-20
R710		Resistor, Fixed, Composition, RC20GF183K per MIL-R-11	Level set resistor for Q702. Figure 6-20
R711		Same as R202	Level set resistor for Q705. Figure 6-20
R712		Same as R325	Collector load resistor for Q705. Figure 6-20
R713		Resistor, Fixed, Composition, RC20GF181K per MIL-R-11	Parasitic suppression network. Figure 6-20

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R714		Resistor, Fixed, Composition, RC20GF391K per MIL-R-11	Same as R713. Figure 6-20
R715		Resistor, Variable, Composition, 1000 ohms ±20%, 0.5 watt, Part/Dwg. 32113532-6 (20183)	Time/div. variable control. Figure 6-1
R718		Same as R318	Dropping Resistor for CR703. Figure 6-21
R719		Resistor, Fixed, Composition, RC20GF473K per MIL-R-11	Emitter Resistor for Q706. Figure 6-20
R720		Resistor, Fixed, Composition, RC20GF392K per MIL-R-11	Dropping Resistor for Q706. Figure 6-20
R722		Resistor, Fixed, Composition, RC32GF123J per MIL-R-11	Collector load for Q709. Figure 6-20
R724	3	Same as R203	Voltage divider resistor for R727. Figure 6-21

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R725		Resistor, Variable, Composition, 10k ±10%, 0.5 watt, Part/Dwg. 32113536 (20183)	Stability control. Figure 6-1
R726		Resistor, Fixed, Composition, RC20GF683K per MIL-R-11	Dropping Resistor for stability control. Figure 6-20
R727	1,2	Resistor, Variable, Composition, RV6LAXSA103B per MIL-R-94	Preset stability adjustment. Figure 6-20
R727	3	Resistor, Variable, composition RV6LAXSA252B per MIL-R-94	Preset stability adjustment. Figure 6-20
R728	1,2	Same as R325	Voltage divider resistor for R727. Figure 6-21
R728	3	Same as R326	Voltage divider resistor for R726. Figure 6-21
R729		Resistor, Fixed, Composition, RC20GF474K per MIL-R-11	Level set resistor for Q711. Figure 6-4

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R730		Same as R319	Same as R729. Figure 6-20
R731		Same as R719	Emitter Resistor for Q712. Figure 6-20
R734		Same as R727	Sweep length adjustment. Figure 6-20
R735		Same as R202	Emitter resistor with R734, for Q705. Figure 6-21
R736		Same as R236	Decoupling Resistor, sweep generator. Figure 6-20
R737		Same as R318	Level set resistor for Q305. Figure 6-4
R738		Same as R105	Dropping resistor for Q305. Figure 6-4
R750		Resistor, Fixed, Film, RN65B4993F per MIL-R-10509C	Sweep timing resistor. Figure 6-4

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R751		Resistor, Variable, Composition, 250k ±10%, 0.25 watt Part/Dwg. 32113578-1 (20183)	Sweep timing adjustment. Figure 6-6
R752		Same as R750	Same as R750. Figure 6-4
R753		Resistor, Variable, Composition, 50K ±10%, 0.25 watt Part/Dwg. 32113578-2 (20183)	Same as R751. Figure 6-6
R754		Resistor, Fixed, Film, RN65B1213F, per MIL-R-10509C	Same as R750. Figure 6-4
R755		Resistor, Variable, Composition, 25k ±10%, 0.25 watt, Part/Dwg. 32113578-3 (20183)	Same as R751. Figure 6-6
R756		Resistor, Fixed, Film, RN65B5622F per MIL-R-10509C	Same as R750. Figure 6-4
R757	3	Resistor, Fixed, Composition RC20GF821K per MIL-R-11	Suppressor resistor for Q703. Figure 6-2

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R758	2	Resistor, Fixed, Composition RC20GF391K per MIL-R-11	Voltage divider resistor for R715. Figure 6-2
R801		Same as R201	Parasitic suppression resistor. Figure 6-28
R802		Resistor, Fixed, Film, RN70B4993F per MIL-R-10509	Attenuator Resistor for vertical input. Figure 6-28
R803		Resistor, Fixed, Film, RN70B1004F per MIL-R-10509	Same as R802. Figure 6-28
R804		Resistor, Fixed, Film, 800 ±1%, 0.5 watt, Part/ Dwg. 32113562-4 (20183)	Same as R802. Figure 6-28
R805		Resistor, Fixed, Film, RN70B2493F per MIL-R-10509	Same as R802. Figure 6-28
R806		Resistor, Fixed, Film, 900k ±1%, 0.5 watt, Part/ Dwg. 32113562-5 (20183)	Same as R802. Figure 6-28
R807		Resistor, Fixed, Film, 111k ±1%, 0.5 watt, Part/ Dwg. 32113562-3 (20183)	Same as R802. Figure 6-28

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R808		Resistor, Fixed, Film, 990k ±1%, 0.5 watt, Part/ Dwg. 32113562-6 (20183)	Same as R802. Figure 6-28
R809		Resistor, Fixed, Film, 10.1k ±1%, 0.5 watt, Part/ Dwg. 32113562-1 (20183)	Same as R802. Figure 6-28
R810		Same as R803	Same as R802. Figure 6-28
R811		Resistor, Fixed, Film, RN70B1001F per MIL-R-10509	Same as R802. Figure 6-28
R814		Resistor, Fixed, Composition, RC20GF206J per MIL-R-11	Input loading resistor for Q801. Figure 6-26
R815		Resistor, Fixed, Film, RN65B1003F per MIL-R-10509	Protection resistor for Q801. Figure 6-26
R816		Resistor, Fixed, Film, RN65B2004F per MIL-R-10509	Voltage divider resistor for Q801. Figure 6-22
R817		Same as R816	Same as R816. Figure 6-22

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R818		Resistor, Variable, Composition, 50k ±20%, 0.5 watt, Part/Dwg. 32113532-11 (20183)	Emitter follower adjustment for Q801. Figure 6-9
R819		Resistor, Fixed, Film, RN65B4992F per MIL-R-10509	Emitter resistor for Q801. Figure 6-23
R820		Same as R114	Emitter resistor for Q802. Figure 6-23
R821		Resistor, Fixed, Composition, RC20GF152J per MIL-R-11	Emitter resistor for Q803. Figure 6-23
R822		Resistor, Fixed, Film, RN65B1502F per MIL-R-10509	Dropping resistor for Q801 and Q802. Figure 6-23
R823		Same as R110	Same as R822. Figure 6-22
R825		Resistor, Variable, Composition, 10k ±20%, 0.5 watt, Part/Dwg. 32113532-10 (20183)	DC balance adjustment. Figure 6-9
R826		Same as R423	Voltage divider resistor for Q806. Figure 6-26

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R827		Resistor, Fixed, Composition, RC20GF182K per MIL-R-11	Level set resistor for Q806. Figure 6-26
R828		Same as R104	Same as R826. Figure 6-26
R829		Same as R205	.01V calibration adjustment. Figure 6-26
R830		Same as R214	Shunt resistor for R831. Figure 6-27
R831		Resistor, Variable, Composition, 500 ohms ±20%, 0.5 watt, Part/Dwg. 32113532-8 (20183)	Variable vertical gain control. Figure 6-28
R832		Same as R628	Collector load resistor for Q804. Figure 6-26
R833		Same as R430	Emitter resistor for Q804. Figure 6-26
R834		Same as R628	Collector load resistor for Q806. Figure 6-26

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
R835		Same as R430	Emitter resistor for Q806. Figure 6-26
R836		Same as R110	Dropping resistor for Q805 and Q806. Figure 6-29
R837		Resistor, Fixed, Composition, RC20GF822J per MIL-R-11	Positioning limit resistor. Figure 6-26
R838		Resistor, Variable, Composition 10k ±20%, 0.5 watt, Part/Dwg. 32113532-9 (20183)	Vertical position control. Figure 6-27
R839		Same as R837	Same as R837. Figure 6-26
S101		Switch, Toggle, DPDT center off, Part/Dwg. 32113541 (20183)	Calibrator Switch. Figure 6-6
S202		Switch, Toggle, DPDT, Part/Dwg. 32113524 (20183)	Power switch. Figure 6-6
S401	1	Switch, Rotary, 5 positions, 5 sections, Part/Dwg. 32113509 (20183)	Horizontal Mode Switch. Figure 6-6

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
S401	2,3	Switch, Rotary, 5 positions, 5 sections	Horizontal Mode Switch. Figure 6-6
S501		Switch, Rotary, 8 positions, 2 sections, Part/Dwg. 32113112 (20183)	Trigger slope SWITCH. Figure 6-4
S701		Switch, part of R725	Preset Switch. Figure 6-1
S702		Switch, Rotary, 19 positions, 3 sections, Part/Dwg. 32113510 (20183)	Time/Div. Switch. Figure 6-1
S801		Switch, Rotary, 4 positions, 3 sections, Part/Dwg. 32113105 (20183)	Input Selector Switch. Figure 6-27
S802		Switch, Rotary, 11 positions, 4 sections, Part/Dwg. 32113104 (20183)	Volts/Div. Switch. Figure 6-27
T201		Transformer, Power, 115v ac ±10%, 50, 60, 400 cps, Part/Dwg. 32113188 (20183)	Low Voltage Supply Transformer. Figure 6-6
T301		Transformer, high voltage type, Part/Dwg. 32113465 (20183)	High Voltage Supply Transformer. Figure 6-24, 6-25

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
V301	4	Cathode Ray Tube, type 4QP31 per MIL-E-1/1386C	Figure 6-8
Z101		Calibrator Printed Board Assy., Part/Dwg. 32113691 (20183)	Figure 5-2
Z201		Low Voltage Supply Printed Board Assy., Part/Dwg. 32113683 (20183)	Figure 5-2
Z301		High Voltage Supply Printed Board Assy., Part/Dwg. 32113686 (20183)	Figure 5-2
Z401		Horizontal Input Printed Board Assy., Part/Dwg. 32113692 (20183)	Figure 5-2
Z402		Horizontal Amplifier Printed Board Assy., Part/Dwg. 32113776 (20183)	Figure 5-2
Z501		Trigger Printed Board Assy., Part/Dwg. 32113688 (20183)	Figure 5-2
Z601		Vertical Post Amplifier Printed Board Assy., Part/Dwg. 32113690 (20183)	Figure 5-2

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
Z701		Sweep Generator Printed Board Assy., Part/Dwg. 32113687 (20183)	Figure 5-2
Z801		Vertical Preamplifier Printed Board Assy., Part/Dwg. 32113685 (20183)	Figure 5-2
XV301		CRT Socket, Part/Dwg. CMG-492005 (71785)	Figure 6-8
A301	1	High Voltage Supply Assy., Part/Dwg. 32113673 (20183)	Figure 6-6
A301	2,3	High Voltage Supply Assy., Part/Dwg. 32115539 (20183)	Figure 6-7
DL603		Delay Line Board Assy., Part/Dwg. 32113828 (20183)	Figure 5-2
MP10		CRT Shield Assy., Part/Dwg. 32113754 (20183)	Figure 6-8
MP11		CRT Clamp Assy., Part/Dwg. 32113561 (20183)	Figure 6-8

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTIONS	LOCATING FUNCTION
MP801		Emitter Follower Can Assy., Part/Dwg. 32113699 (20183)	Figure 6-26
S401		Horizontal Mode Switch Assy., Part/Dwg. 32113775 (20183)	Figure 6-6
S501		Trigger Slope Switch Assy., Part/Dwg. 32113714 (20183)	Figure 6-4
S702		Time/Div. Switch Assy., Part/Dwg. 32113716 (20183)	Figure 6-4
S802		Volts/Div. Switch Assy., Part/Dwg. 32113680 (20183)	Figure 6-27
TB201		Low Voltage Term. Board Assy., Part/Dwg. 32113677 (20183)	Figure 5-2
W12		Cable Assembly, Power Electrical, CX-4704/U Part/Dwg. RE62D2005	Figure 1-1
W13		High Voltage Lead Assy., Part/Dwg. 32113870 (20183)	Figure 6-8

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
W906		Probe Assy, MX-2817/U, Part/Dwg. E01-10001A(2 req'd)-(28480). Also see alternate assy., W908.	Figure 1-1
W907		Cable Assembly, RF, Part/Dwg. CG-409E/U, (2 required) (20183)	Figure 1-1
W908		Probe Assy., MX-4073/U, Part/Dwg. 1804-19 (2 req'd)-(28569). Also see alternate assy., W906	Figure 1-1
		MISSCELLANEOUS	
MP8		Shaft Coupling Part/Dwg. M-023 (required)-(76487)	Figure 6-8
J902		Connector, Adapter, UG-274A/U (2 required).	Figure 1-1
J903		Connector, Adapter, UG-1035/U, (2 required)	Figure 1-1
J904		Connector, Adapter, UG-273/U, (2 required)	Figure 1-1
J905		Connector, Adapter, UG-255/U, (2 required)	Figure 1-1

TABLE 7-1. OSCILLOSCOPE AN/USM-117( ), MAINTENANCE PARTS LIST (Continued)

REF. DESIG.	NOTES	NAME AND DESCRIPTION	LOCATING FUNCTION
PJ201		Jack Tip, Part/Dwg. 19175-2 (74868)	Figure 6-10
PJ202		Same as PJ201	Figure 6-10
PJ203		Jack Tip, Part/Dwg. 19175-1, (74868)	Figure 6-10
PJ301		Same as PJ201	Figure 6-4
XF201		Fuse Holder, Part/Dwg. 342012 (2 required)-(75915)	Figure 6-8
XF202		Same as XF201	Figure 6-8
XSK201		Heat Sink, Transistor, Part/Dwg. 6025-4 (08730)	Figure 6-17
XSK202		Same as XSK201	Figure 6-17 (Sheet 2)
XSK203		Same as XSK201	Figure 6-10 (Sheet 2)
XSK204		Same as XSK201	Figure 6-10 (Sheet 2)
XDS202		Lamp Holder, Part/Dwg. 7-06 (95263)	Figure 6-4
XF203		Fuse Holder, Part/Dwg. 357002 (71400)	Holder for Spare Fuses. Figure 6-4

TABLE 7-2. OSCILLOSCOPE AN/USM-117( ), LIST OF MANUFACTURERS

CODE NO.	MANUFACTURER
01295	Texas Instrument Inc., Houston, Texas
02660	American Phenolic, Chicago, Ill.
04713	Motorola Inc., Phoenix, Ariz.
08730	Vemaline Products Co., Hawthorne, N.J.
20183	General Atronics Corp., Phila., Pa.
24455	General Electric Corp., Cleveland, Ohio
28480	Hewlett-Packard Co., Palo Alto, Calif.
28569	Hickok Electrical Inst., Co.
49675	RCA, Camden, N.J.
71400	Bussman, St. Louis, Mo.
71590	Centralab, Milwaukee, Wis.
71785	Cinch Mfg. Co., Chicago, Ill.
74868	Industrial Products Co., Danbury, Conn.
75915	Littlefuse Inc., Des Plaines, Ill.
76433	Micamold Products Corp., Yonkers, N.Y.
76487	Millen, James, Mfg. Co., Malden, Mass.
81641	Hetherington Inc., Folcroft, Pa.
93332	Sylvania Electric Co., Woburn, Mass.
95263	Leecraft Mfg. Co., New York, N.Y.
87216	Philco Corp., Lansdale, Pa.
94222	Southco Div., So. Chester Corp., Lester, Pa.

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