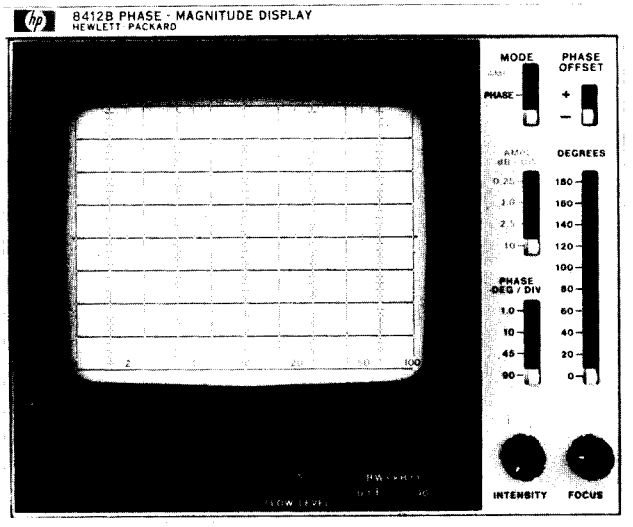
OPERATING AND SERVICE MANUAL

8412B PHASE-MAGNITUDE DISPLAY



HEWLETT PACKARD

8412B
PHASE-MAGNITUDE DISPLAY

SERIAL NUMBERS

This manual applies directly to HP Model 8412B having serial number prefix 2143A.

For additional information about serial numbers, refer to INSTRUMENTS COVERED BY MANUAL in Section I.

1400 FOUNTAIN GROVE PARKWAY, SANTA ROSA, CA 95404, U.S.A.

MANUAL PART NO. 08412-90033
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HEWLETT PACKARD

CONTENTS

ILLUSTRATIONS

TABLES

SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation. This product has been designed and tested in accordance with international standards.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by qualified personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

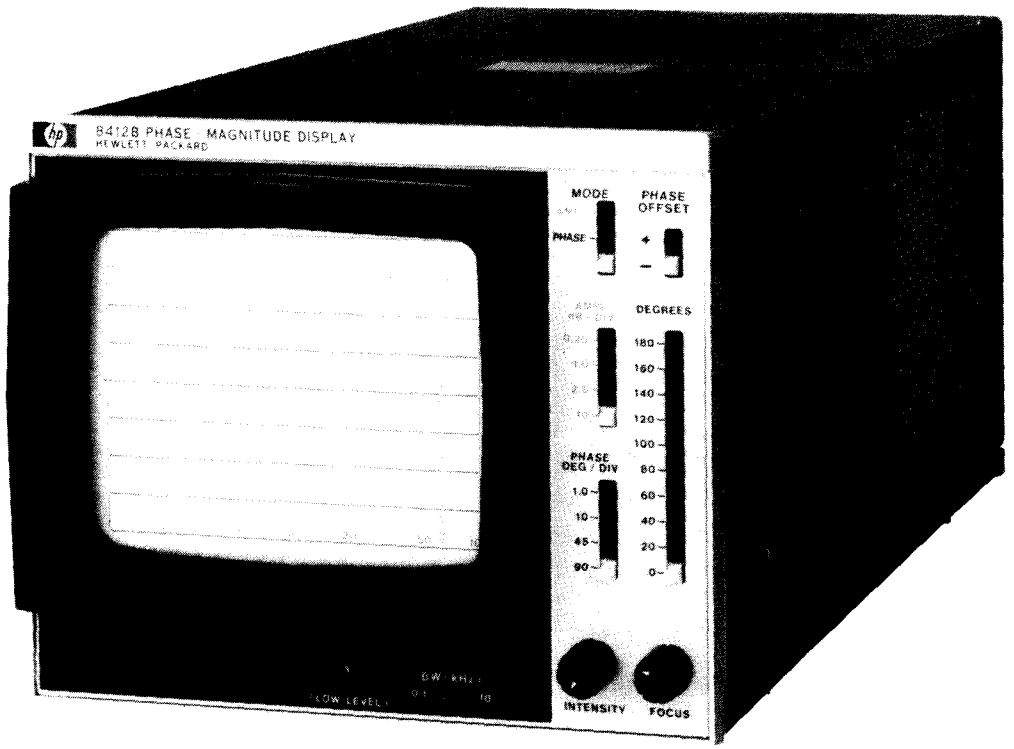


Figure 1-1. Model 8412B Phase-Magnitude Display

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. The Model 8412B Phase-Magnitude Display (Figure 1-1) is a plug-in display unit for the HP Models 8407A and 8410-Series Network Analyzers. The instrument contains a CRT which displays test signal amplitude and phase on two separate CRT traces.

1-3. The amplitude and phase display may show signals which represent various amplitude ratios depending on the transducer used in the network analyzer. The displayed quantities may be ratios of voltage, current, impedance, or an incident-to-reflected signal.

1-4. Amplitude is displayed in decibels/division and phase is displayed in degrees/division on the CRT graticule. Various vertical amplifier sensitivity ranges for both amplitude and phase may be selected. Front panel phase offset controls allow the phase to be adjusted for the most convenient display.

1-5. A rear-panel connector accepts a voltage vs. frequency sweep signal from the sweep oscillator and amplifies the signal within the instrument to provide a horizontal sweep for the CRT. Rear panel connectors also provide amplitude and phase output signals and accept Z-axis marker and blanking input signals. Specifications for the Model 8412B Phase-Magnitude Display are given in Table 1-1. Supplemental Performance Characteristics are listed in Table 1-2.

Table 1-1. Specifications

AMPLITUDE ACCURACY:

Display: 0.03 dB/dB ±0.05 div/div

Rear Output: 0.03 dB/dB

Temperature Coefficient: Typically <0.05 dB/°C at midscreen

PHASE ACCURACY:

Display: 0.015°/degree ±0.05 div/div

Rear Output: 0.015°/degree

Phase Offset: 0.3°/20 degree step, not to exceed total error of 3° for 360° of change, positive or negative direction.

Vs. Displayed Amplitude:
Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°.
Over full 80 dB amplitude range: Maximum phase change not to exceed 6°.

INSTRUMENT FUNCTION: Plug-in CRT display for HP 8407A and HP 8410-Series Network Analyzers. Displays ratio and phase versus frequency of RF signal.

DYNAMIC RANGE: 80 dB amplitude and ±180 degree phase.

CONTROLS:

MODE: Positions are amplitude, phase, or dual. In dual position, the amplitude trace is more intense than phase for identification.

AMPLITUDE RANGE: 0.25, 1.0, 2.5, and 10 dB/Division.

PHASE RANGE: 1, 10, 45, and 90 DEG/Division.

PHASE OFFSET: Offsets display in 20 degree steps from −180 degrees to +180 degrees.

BANDWIDTH: 10 kHz for maximum information display or 100 Hz to filter displayed noise.

LOW LEVEL AMPLITUDE CALIBRATION: Calibrates low level amplitude signal display.

HORIZONTAL GAIN: Adjusts length of trace.

INPUTS:

SWEEP IN: Requires sweep signal (0 to +10V minimum) from sweeper for horizontal sweep drive.

Z-AXIS: Input for positive or negative Z-axis blanking signal. An internal switch (A3S1) selects either POSitive or NEGative Z-axis. For positive Z-axis: −5 Vdc intensifies the trace (i.e. markers), and +5 Vdc blanks the trace. For negative Z-axis: −5 Vdc blanks the trace. Use POSitive for 8620 and 8350 Sweep Oscillators; use NEGative for 8601 and 8690 Sweepers.

PHASE OFFSET CONTROL: A closure to ground produces a 180-degree phase shift; the circuit is active only when the front-panel Phase Offset Polarity switch is in the "+" position. This feature is used with Automatic Network Analyzer systems to avoid taking data at the +−180 degree changeover points.

OUTPUTS:

AMPLITUDE: 50 mV/dB

PHASE: 10mV/DEGREE

POWER: 23 Watts supplied by mainframe

WEIGHT: Net 7.8 kg (17 lb.); Shipping 10 kg (22 lb.).

DIMENSIONS: 15.2 cm high 39.5 cm deep, 18.6 cm wide (6 in. x 15-9/16 in. x 7-9/32 in): excludes front panel knobs.

1-6. INSTRUMENTS COVERED BY MANUAL

1-7. Each Phase-Magnitude Display carries a two-part serial number. The number preceding the letter is a prefix. The contents of this manual apply directly to instruments having the same serial number prefixes as listed after SERIAL NUMBERS on the title page.

1-8. Changes required to adapt this manual to other serial number prefixes are given in a yellow-sheet Manual Changes insert supplied with the manual. For information concerning serial number prefixes not listed on the title page or in an insert, contact your nearest Hewlett-Packard office.

1-9. WARRANTY

1-10. Terms of the warranty on the 8412B are described on the front cover of this manual. For any additional information covering warranty. contact your nearest Hewlett-Packard field office.

SECTION II
INSTALLATION

2-1. INITIAL MECHANICAL INSPECTION

2-2. The Phase-Magnitude Display was carefully inspected both mechanically and electrically prior to shipment. If external damage to the shipping carton is evident, ask the carrier's agent to be present when the instrument is unpacked. Check the instrument for external damage such as broken controls or connectors and dents or scratches on the panel surface. If damage is evident, refer to Paragraph 2-7 for recommended claim procedure and Paragraph 2-9 for repackaging information. If the shipping carton is not damaged, check the cushioning material and note any signs of severe stress as an indication of rough handling in transit. If the instrument appears undamaged, perform the Performance Tests in Section IV.

2-3. INITIAL ELECTRICAL INSPECTION

2-4. Check the electrical performance of the Phase-Magnitude Display as soon as possible after receipt by performing the Performance Test (Paragraph 4-3). The Performance Test procedure compares the electrical performance to the specifications of Table 1-1. This test is suitable for incoming quality control inspection. If the Phase-Magnitude Display does not perform within the specifications, refer to Paragraph 2-7 for recommended clain procedure and Paragraph 2-9 for repacking information.

2-5. PREPARATION FOR USE

2-6. The 8412B Phase-Magnitude Dispaly mounts in the readout section of the Model 8407A or 8410-Series Network Analyzer mainframe. To mount the 8412B display, unlock the insertion arm on the front panel of the mainframe and if a different plug-in is installed, remove it. Slide the 8412B into position, then lock the insertion arm in place at the bottom of the display.

2-7. CLAIMS

2-8. If physical damage is evident, or if the instrument does not meet specifications when received, notify the carrier and the nearest Hewlett-Packard sales and service office. (See list at rear of manual). The sales and service office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-9. REPACKAGING FOR SHIPMENT

2-10. Using Original Packaging

2-11. The same containers and materials used in factory packaging can be obtained through the Hewlett-Packard sales and service offices listed at the rear of this manual. If the Model 8412B is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-12. Using Other Packaging

2-13. The following general instructions should be used for repackaging with commercially-available materials:

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard service office or center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container.

c. Use enough shock-absorbing material around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely and mark it FRAGILE to assure careful handling.

e. In any correspondence, refer to the instrument by model number and full serial number.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. The Model 8412B Phase-Magnitude Display is a plug-in unit for the Model 8407B or 8410-Series Network Analyzer mainframe. The 8412B provides a direct CRT trace of phase and magnitude showing the ratio between the test and reference RF signals applied to the network analyzer. Controls on the front panel provide horizontal positioning and gain, amplitude low level calibration, phase and amplitude display resolution, and phase offset of the phase trace, as well as CRT intensity and focus. Controls on the rear panel provide vertical positioning and aligning the trace with the horizontal graticule. The rear panel contains BNC connectors which allow connection of the sweeper horizontal signal, and markers blanking. Output signals from the phase and magnitude amplifiers are available at rear panel BNC connectors for use with an external X-Y recorder or oscilloscope. Provision is also made to connect a storage normalizer.

3-3. PANEL FEATURES

3-4. Front and rear panel controls, connectors, and indicators are described in Figures 3-1 and 3-2. In these figures, the numbers on the illustrations match the description numbers.

3-5. SCREWDRIVER ADJUSTMENTS

3-6. There are three operator screwdriver adjustments on the 8412B one on the front panel and two on the rear panel.

3-7. The AMPL CAL (LOW LEVEL) control on the front panel adjusts calibration of the amplitude amplifier. To properly adjust this control, set the Network Analyzer test channel gain and amplitude vernier to obtain an 8412B trace on the center graticule line. Decrease the test channel gain in 10 dB steps. With the 8412B AMPL DB/DIV control set to 10, the trace should move down one major division for each step. If not, adjust AMPL CAL (LOW LEVEL) control on front panel. Continue adjusting the test channel gain and AMPL CAL (LOW LEVEL) controls until the trace moves exactly one major division for each 10 dB step, from the center graticule line toward the bottom of the CRT.

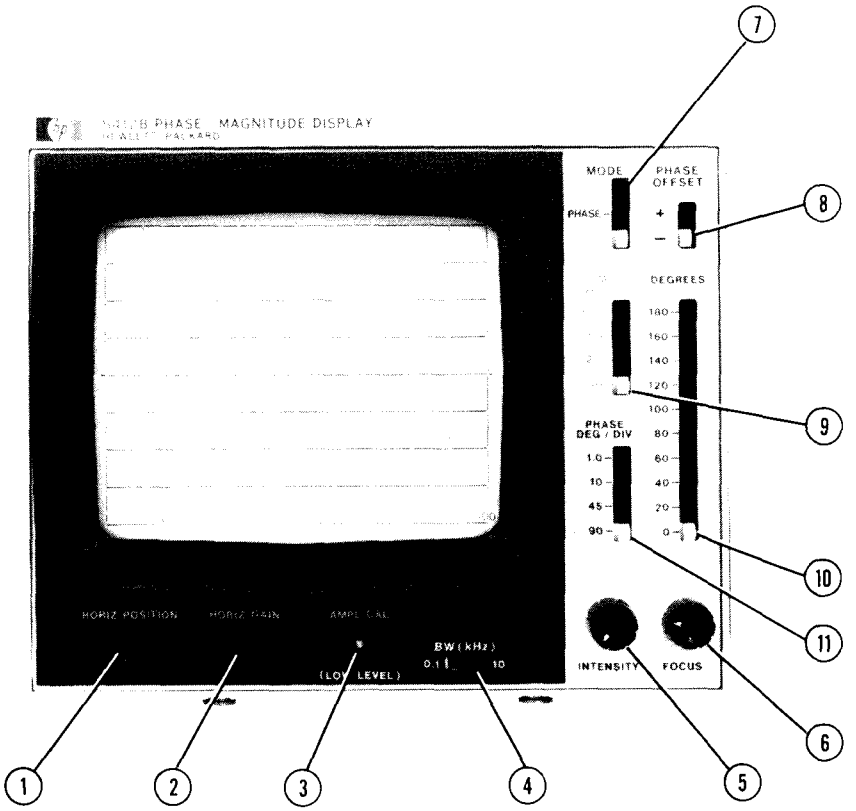
3-8. The VERT POS control on the rear panel is adjusted in a manner similar to adjusting the dc balance of a dc coupled oscilloscope. Set the Sweep Oscillator, Network Analyzer, and 8412B controls to obtain a swept amplitude display positioned near the center graticule line. With the 8412B amplitude sensitivity switch (AMPL DB/DIV) set to 0.25, adjust the Network Analyzer amplitude vernier control to position the 8412B trace on the center graticule line. Then set the 8412B AMPL DB/DIV control to 10. If the trace has moved from the center graticule line, recenter it by adjusting the VERT POS control on the rear panel. Continue adjusting the amplitude sensitivity, amplitude vernier, and vertical position controls as described above; adjust for minimum trace change with a change in sensitivity.

3-9. The TRACE ALIGN control on the rear panel is adjusted to align the 8412B trace to the horizontal graticule. The alignment is done most effectively on the center graticule line. The Sweep Oscillator should be set for minimum sweep width.

3-10. OPERATING PROCEDURES

3-11. The 8412B Phase-Magnitude Display plugs into both the Model 8407A and the Model 8410-Series Network Analyzers which together cover the entire band between 100 kHz and 18 GHz. In an amplitude test setup, the 8412B displays both magnitude and phase. Tests may be made on many types of components and circuits, whether passive or active. Tests may also be made of two matched amplifiers or other devices to see how they differ in gain and phase across a swept band of frequencies. In a reflectometer test setup, the 8412B displays return loss and phase of the reflected signal. From this information, the VSWR, reflection coefficient, and impedance can be calculated. Typical test setups for both reflection and transmission measurements are shown in Figures 3-3 through 3-6.

FRONT PANEL



1. HORIZ POSITION control. Moves trace horizontally.

2. HORIZ GAIN control. Adjusts gain of horizontal amplifier to change length of displayed trace.

3. AMPL CAL (LOW LEVEL) control. Adjusts calibration of amplitude amplifier for signals displayed on lower half of CRT screen. Refer to Paragraph 3-7.

4. BW (kHz) switch. Selects bandwidth passed by the reference and test channels. This allows decreasing bandwidth when necessary to filter noise from the display.

5. INTENSITY control. Controls brightness of the trace.

6. FOCUS control. Controls the sharpness of the trace.

7. MODE switch. Selects AMPL (amplitude), PHASE, or both amplitude and phase (DUAL) to display on screen. When both amplitude and phase are displayed, the amplitude trace is brighter than the phase trace for easy identification.

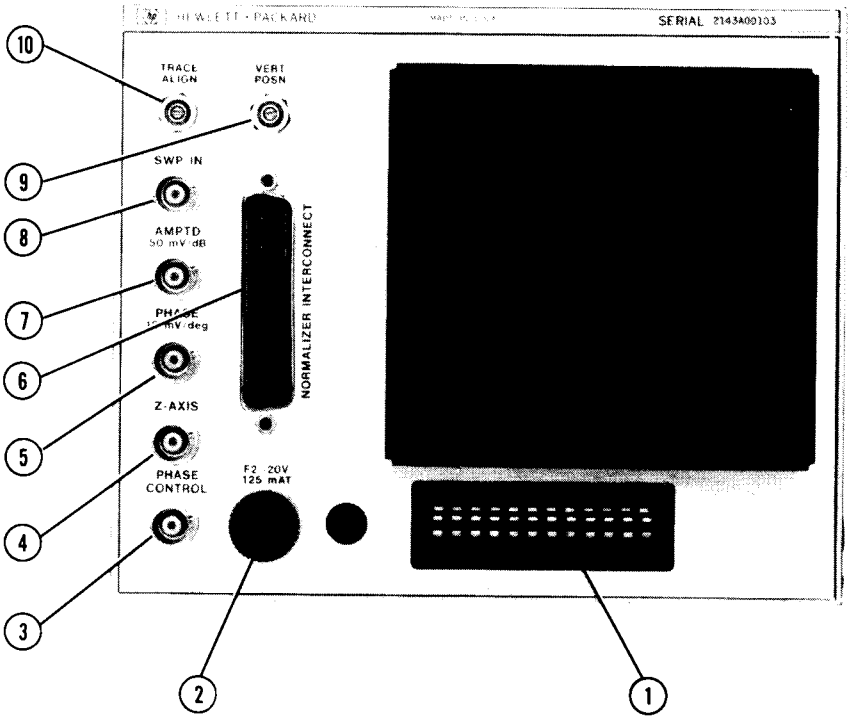
8. PHASE OFFSET polarity switch. From zero degrees, offset is selected either in the negative or positive direction up to 180 degrees. The polarity switch selects the direction from zero and works in connection with the DEGREES switch to select offset.

9. AMPL DB/DIV switch. Selects the calibrated resolution of the test channel amplitude display.

10. PHASE OFFSET DEGREES switch. Selects offset in 20-degree steps. The switch works in conjunction with the PHASE OFFSET polarity switch to select up to 180 degrees in either the positive or negative direction from zero degrees. The phase offset plus the display reading gives the measured phase reading.

11. PHASE DEG/DIV switch. Selects the calibrated resolution of phase display.

Figure 3-1. Model 8412B Front Panel Features



1. Mainframe interface connector J1. Makes all necessary connections with 8407A or 8410-Series mainframe.

2. Fuse holder. Fuse protection in −20 Volt line from mainframe. Fuse is 1/8 ampere slow blow. This −20 Volt line supplies high voltage to the CRT control grid, cathode, and focus grid.

WARNING

Removing rear-panel fuse F2 only disables the −20 Volt line. The 175 Vac line is protected by fuse F1 located inside the 8412B right side cover at the rear.

3. PHASE CONTROL connector J6. This input is used in an automatic network analyzer system. When a phase measurement is made near the + or −180 degree points, this line is closed to ground by the controller, causing the measurement to be offset by 180 degrees. This avoids taking measurements near the + or −180 degree point. When this circuit causes a 180 degree phase offset, the system controller subtracts 180 degrees from the final phase measurement value. The front-panel Phase Offset Polarity Switch must be in the "+" position for operation of this Phase Offset function.

4. Z-AXIS connector J5. Marker input to Z-axis that intensity modulates the trace, placing a bright dot on the trace at the selected marker frequency. The input can both mark and blank (−5V intensifies, +5V blanks). For negative blanking pulses, change switch setting of A3S1 on the A3 Multiplexer Board inside the 8412B to the NEG position.

5. PHASE 10 MV/DEG connector J4. Voltage output is proportional to the phase angle of the test signal compared to the reference signal. Output is 10 mV/degree positive voltage for phase angles of 0 to +180 degrees and negative voltage for angles of 0 to −180 degrees.

6. NORMALIZER INTERCONNECT J7. Makes all necessary connections with 8750A Storage Normalizer.

Figure 3-2. Model 8412B Rear Panel Features (1 of 2)

REAR PANEL (Cont'd)

7. AMPLITUDE 50 mV/DB connector J3. Depending on the transducer used on the unit under test, the voltage output is proportional to the amplitude ratio of:

   (1) $20 \log_{10} (V_{TEST}/V_{REF})$,

   (2) $20 \log_{10} (I_{TEST}/I_{REF})$, or

   (3) $20 \log_{10} (V_{RETURN}/V_{INCIDENT})$

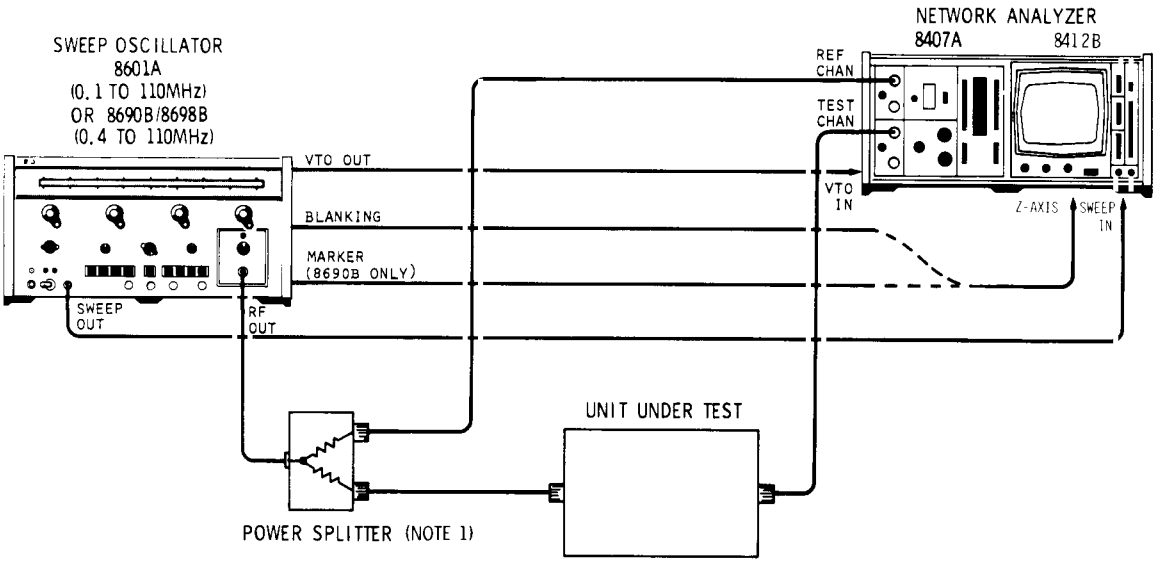
8. SWEEP IN connector J2. Input for sweeper signal that goes to horizontal (x-axis) amplifier.

9. VERT POSN control. Zeroes phase and amplitude traces vertically. Refer to Paragraph 3-8.

10. TRACE ALIGN Control. Used to align CRT trace to the horizontal graticule. Adjustment should be performed with sweep oscillator set for minimum sweep width. Refer to Paragraph 3-9.

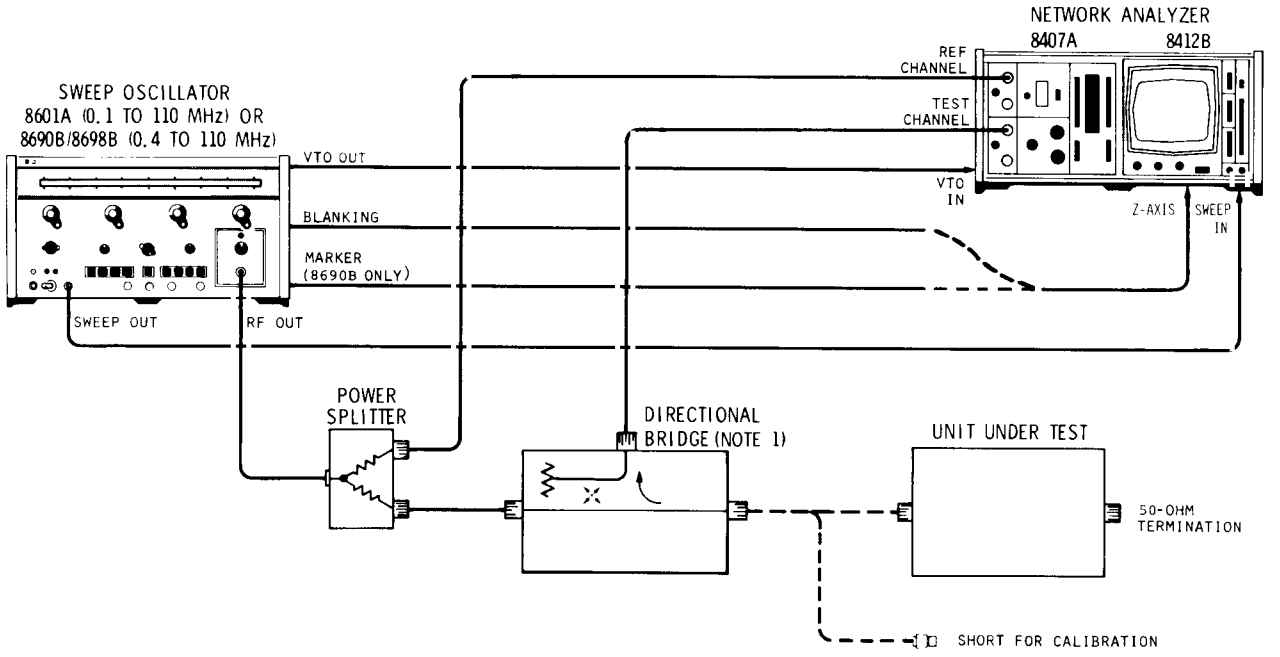
Figure 3-2. Model 8412B Rear Panel Features (2 of 2)

3-12. In another application, the 8410-Series Mainframe together with an 8412B plug-in is used as the readout instrument for an S-Parameter Test Set, HP Model 8745A (0.1 – 2 GHz), or for a Reflection/Transmission Test Unit, HP Model 8743A/B (2.0 – 18 GHz). These units test transmission and reflection characteristics of two-port devices. For transmission measurements, the 8412B displays gain or loss in dB and for reflection measurements the 8412B displays return loss in dB. For more detailed operating instruction using the 8410 System with an 8743A/B or 8745A, see the appropriate operating manual for the transmission/reflection instrument used.



NOTE: 1. POWER SPLITTER AND INTERCONNECTION CABLES ARE PART OF ACCESSORY KIT HP 11651.
2. Z-AXIS ON 8412B ACCEPTS EITHER POSITIVE BLANKING AND NEGATIVE GOING MARKER OR NEGATIVE BLANKING BY CHANGING SWITCH POSITION OF A3S1.

Figure 3-3. Typical Transmission Test Setup Using 8407A/8412B



NOTE: 1. POWER SPLITTER, DIRECTIONAL BRIDGE AND INTERCONNECTING CABLES ARE PART OF ACCESSORY KIT HP 11652.
2. Z-AXIS ON 8412B ACCEPTS EITHER POSITIVE BLANKING AND NEGATIVE GOING MARKER OR NEGATIVE BLANKING BY CHANGING SWITCH POSITION OF A3S1.

Figure 3-4. Typical Reflection Test Setup Using 8407A/8412B System

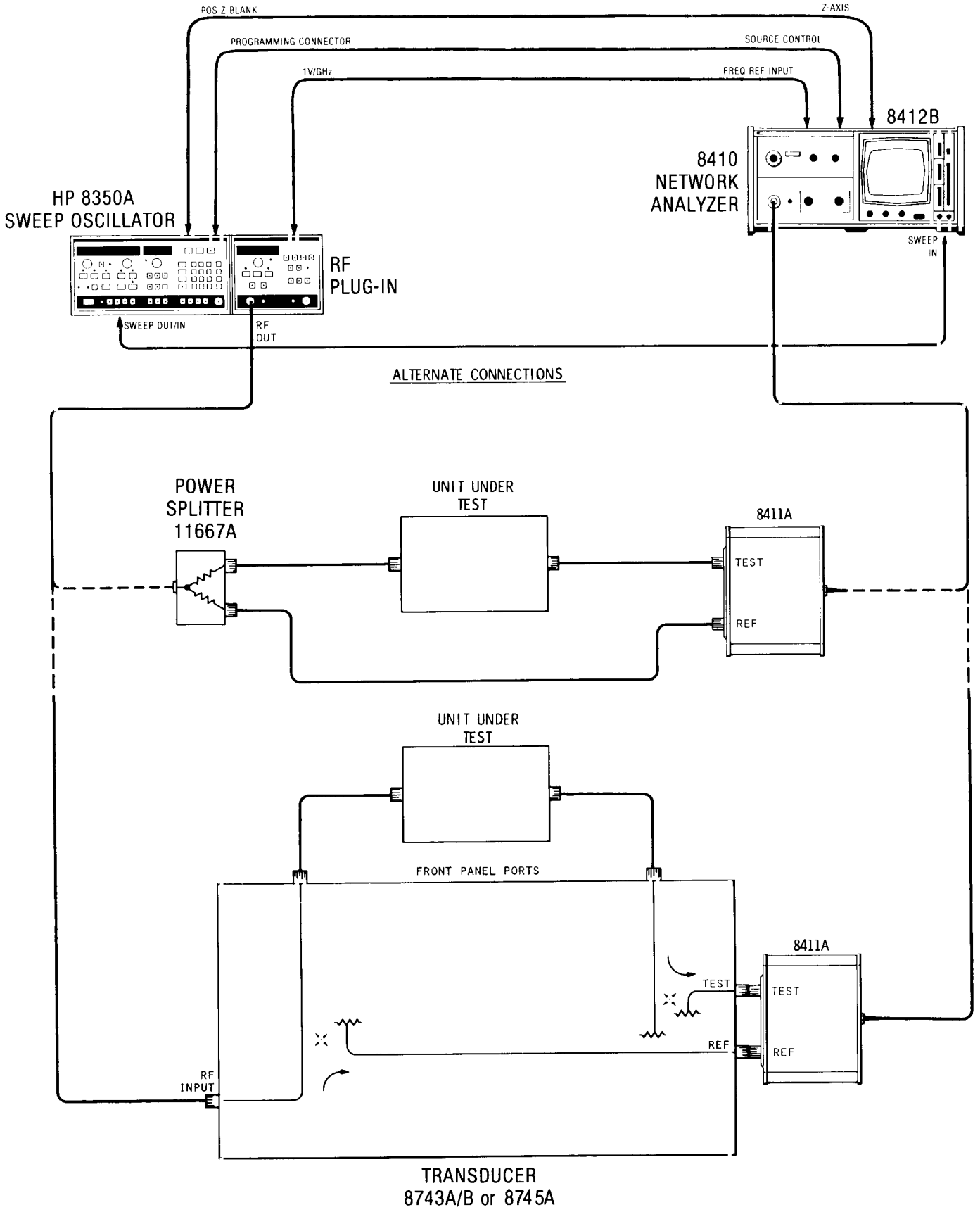


Figure 3-5. Typical Transmission Test Setup Using 8410/8411A/8412B System

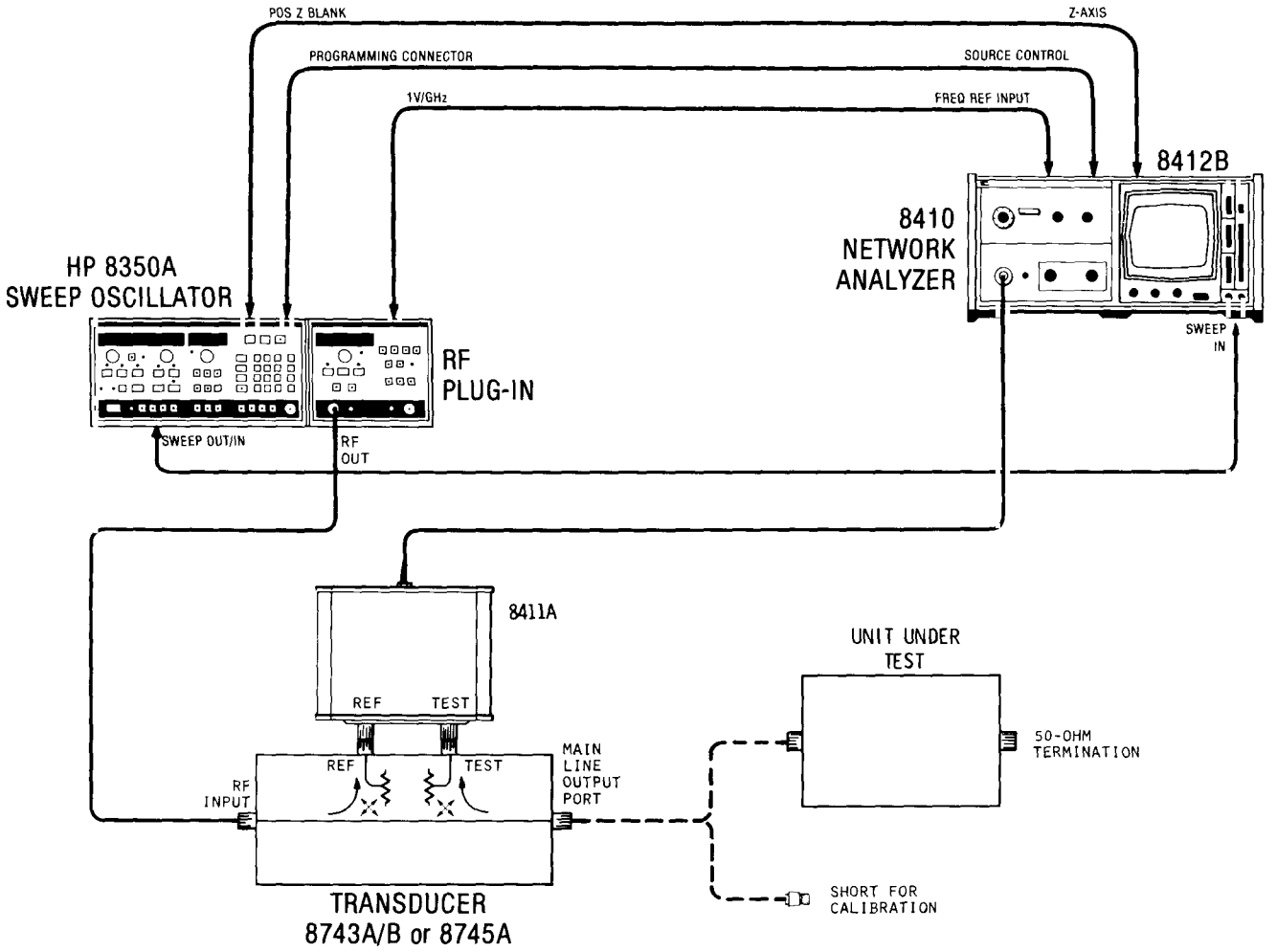


Figure 3-6. Typical Reflection Test Setup Using 8410/8411A/8412B System

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section provides instructions for performance testing of the HP 8412B Phase-Magnitude Display. Test equipment required for these procedures is listed in Table 4-1. If the test equipment recommended is not available, other equipment may be used if its performance meets the "Critical Specification" listed in the table.

4-3. PERFORMANCE TESTS

4-4. The procedures in Paragraph 4-6 through 4-21 test the performance of the 8412B. These procedures may be used during incoming inspection, periodic evaluation, or after repair or alignment. The test may be performed without access to the instrument interior. The specifications of Table 1-1 are the performance standards.

4-5. Two similar procedures are presented, one for the 8410-Series mainframe (Paragraphs 4-6 through 4-13) and one for the 8407A mainframe (Paragraphs 4-14 through 4-21). The two procedures differ only because of the differences in operation between the two mainframes.

Table 4-1. Recommended Test Equipment (1 of 2)

Instrument	Critical Specifications	Recommended HP Model
Dual-trace Oscilloscope with 10 pF 10:1 probes	Vertical Amplifier: Dual trace Bandwidth: 20 MHz minimum Horizontal Sweep Rate: 0.2 μS/cm Vertical Sensitivity: 5 mV/cm	180A/1801A/1820A
Digital Voltmeter	Accuracy: 0.01% Input Impedance: 10 megohms min. Automatic Range Selection: Range to ±50V	3455A
Power Supply	Output: ±5 Vdc at 50mA	6213A
DC Voltmeter with High Voltage Probe	Range: 4000 Vdc Current Drain: 2.5 μA maximum Accuracy: ±5% Input Impedance of Voltmeter: 10 megohm	427A with 11044A high voltage probe
Service Cable (Supplied with 8407A & 8410)		08410-60067
0 – 110 dB Step Attenuator	Range: 0 to 110 dB in 10 dB Steps	8496B

Table 4-1. Recommended Test Equipment (2 of 2)

Instrument	Critical Specifications	Recommended HP Model
USED WITH 8410-SERIES MAINFRAME ONLY		
Network Analyzer with Harmonic Frequency Converter		8410/8411A
Sweep Oscillator	Range: 0.11 to 18 GHz (any part) RF Output: 25mW into 50 ohm Sweep Width: One Octave min.	8350A/83540A (2 to 8.4 GHz)
Transducer (Power Splitter)	Impedance: 50 ohms	8743B (2 to 18 GHz) 8745A (0.1 to 2 GHz) 11667A (DC to 18 GHz)
USED WITH 8407A MAINFRAME ONLY		
Network Analyzer		8407A
11651A Transmission Kit	Includes 50 ohm power splitter and two matched, double shielded cables.	11651A
Sweep Oscillator	Range: 0.1 to 110 MHz (any part) RF Output: +20 dBm VTO Output: Tracks 200 MHz from RF Output signal	8601A (0.1 to 110 MHz) 8690B/8698B (0.4 to 110 MHz)

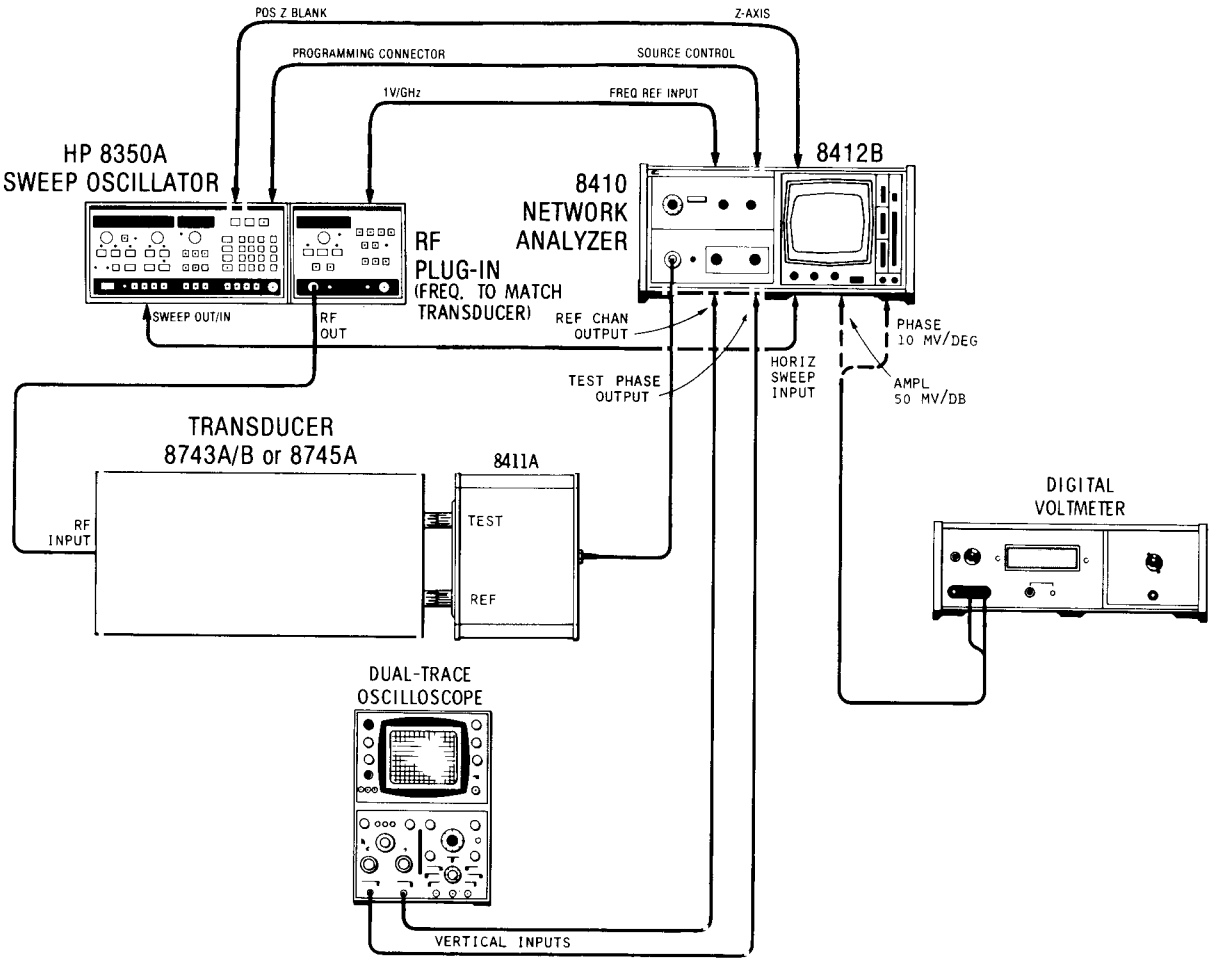


Figure 4-1. Equipment Setup for Performance Test with 8410-Series

4-6. PERFORMANCE TEST WITH 8410-SERIES MAINFRAME

4-7. Initial Setup

SPECIFICATIONS: General operation

DESCRIPTION: Set up and adjust instrument for amplitude and phase trace on CRT.

PROCEDURE:

a. Connect equipment as shown in Figure 4-1. Set sweep oscillator for swept mode over the narrowest band possible. Set the 8410 AMPL VERNIER to midrange. Adjust 8410 SWEEP STABILITY control and sweep oscillator RF output for REF CHANNEL meter indication in the middle of the OPERATE range.

b. While observing oscilloscope, adjust 8410 AMPLITUDE TEST CHANNEL GAIN to obtain 316 mV p-p from 8410 TEST CHAN OUTPUT.

c. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to (+), DEGREES switch to 100, and BW (KHz) switch to 10. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB. Both amplitude and phase traces should be displayed across 8412B CRT. If necessary, adjust transducer REFERENCE PLANE EXTENSION to obtain horizontal phase trace. Adjust 8412B FOCUS control and both traces should be in good focus. The amplitude trace should be brighter than the phase trace.

4-8. Trace Align

SPECIFICATIONS: General operation

DESCRIPTION: Check that CRT circuits are properly aligned by adjusting trace to superimpose center graticule line.

PROCEDURE:

Set 8412B MODE switch to AMPL. Adjust 8410 AMPL VERNIER control to superimpose the amplitude trace over the center horizontal graticule. The trace should align with the graticule within 1 mm of the trace.

4-9. Amplitude Test

SPECIFICATIONS: ±.03 dB/dB and ±.05 division/division; auxiliary outputs ±.03 dB/dB.

DESCRIPTION: The accuracy of the rear panel output is checked then the CRT trace is checked through the 60 dB amplitude range. All of the amplitude resolution ranges are then checked for calibration.

PERFORMANCE TESTS

4-9. Amplitude Test (Cont'd)

PROCEDURE:

a. Connect digital voltmeter (DVM) to 8412B AMPL 50 mV/dB rear-panel output. Set signal source for single-frequency CW operation. Adjust 8410 AMPL VERNIER control for 0.000 Vdc on DVM. Check DVM readout at AMPLITUDE TEST CHANNEL GAIN control settings listed in table on following page. If necessary, adjust 8412B front panel AMPL CAL (LOW LEVEL) control at zero and 10 dB positions of 8410 AMPLITUDE TEST CHANNEL GAIN control for DVM indication within tolerance.

8410 Amplitude Test Channel Gain*		Digital Voltmeter Reading
	60	+2.000 ± .070
	50	+1.500 ± .055
	40	+1.000 ± .040
	30	+0.500 ± .020
(set ref.)	20	+0.000 ± .001
	10	−0.500 ± .020
	0	−1.000 ± .040

b. Set sweep oscillator for swept mode over narrowest band possible. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB. Set MODE switch to AMPL. Adjust 8410 AMPL VERNIER for the trace superimposed on the center graticule line. Check trace position at 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control settings listed in table below. If necessary, adjust 8412B front panel AMPL CAL (LOW LEVEL) control for CRT trace within tolerance at positions of 10 dB and zero dB on 8410 AMPLITUDE TEST CHANNEL GAIN control.

8410 Amplitude Test Channel Gain Setting*		Tolerance of 8412B Trace To Major Graticule Division
	60	± 0.34 DIV
	50	± 0.26 DIV
	40	± 0.18 DIV
	30	± 0.09 DIV
(set ref.)	20	± 0.05 DIV
	10	± 0.09 DIV
	0	± 0.18 DIV

PERFORMANCE TESTS

4-9. Amplitude Test (Cont'd)

c. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and set 8412B AMPL DB/DIV switch to 2.5. Adjust 8410 AMPL VERNIER for 0.000 Volt indication on DVM. Change 8410 AMPLITUDE TEST CHANNEL GAIN control by +5 dB. The 8412B dot should move up two major graticule divisions ±1.3 minor graticule division and the DVM should indicate 250mV ±20mV.

d. Set 8412B AMPL DB/DIV switch to 1.0 and set 8410 AMPLITUDE TEST CHANNEL GAIN control to 20 dB.* If necessary, readjust 8410 AMPL VERNIER for 0.000 Volt on DVM. Change 8410 AMPLITUDE TEST CHANNEL GAIN control by +1 dB. The 8412B dot should move up one major graticule division ±0.7 minor graticule divisions and the DVM should indicate 50 mV ±4 mV.

*1 dB/step control set at setting determined in Paragraph 4-7, step b.

e. Set 8412B AMPL DB/DIV switch to 0.25 position. Adjust 8410 AMPL VERNIER control and AMPLITUDE TEST CHANNEL GAIN control to place the amplitude dot on the screen. Change the AMPLITUDE TEST CHANNEL GAIN control by one dB and 8412B dot should move 4 major graticule divisions ±2.6 minor divisions.

4-10. Phase Test

SPECIFICATIONS: ±0.015 degrees/degree, ±.05 divisions/division; ≤3 degrees cumulative; auxiliary output ±0.015 degree/degree.

DESCRIPTION: The accuracy of the rear panel output is checked, then the CRT trace is checked through 360 degrees. All of the phase resolution ranges are then checked for calibration.

PROCEDURE:

a. Set sweep oscillator to single-frequency (CW) operation. Connect DVM to PHASE 10 MV/DEG connector at rear panel of 8412B. On 8412B, set MODE switch to PHASE and PHASE DEG/DIV switch to 90. Set 8410 PHASE VERNIER control to mid range and AMPLITUDE TEST CHANNEL GAIN control to 60 dB. Adjust transducer REFERENCE PLANE EXTENSION (line stretcher), 8410 PHASE VERNIER, and sweep oscillator frequency to superimpose the two sine waves on the oscilloscrope, showing an in-phase condition at the input of the 8412B. (See Figure 4-2.)

b. Set 8412B DEGREES switch to zero. Make slight adjustment of 8410 PHASE VERNIER for 0.000 Volt DVM indication. Set PHASE switch from positive to negative and DVM should indicate 0.000 Volt ±0.003 Volt in both positions.

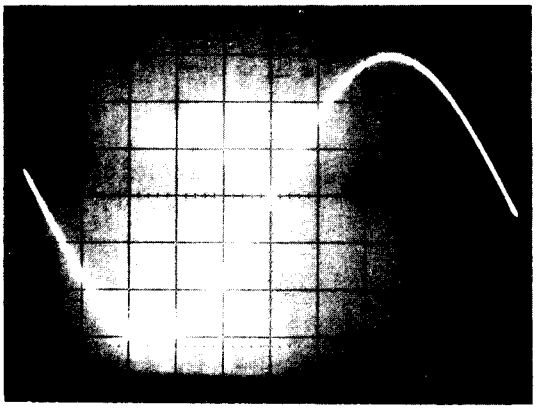
PERFORMANCE TESTS

4-10. Phase Test (Cont'd)

c. Set PHASE switch to positive (+) position. Set DEGREES switch to positions shown in table below and obtain DVM indication as shown. Set PHASE switch to negative (−) position and recheck DVM indication at each position of DEGREES switch. (The DVM indication will now be negative.)

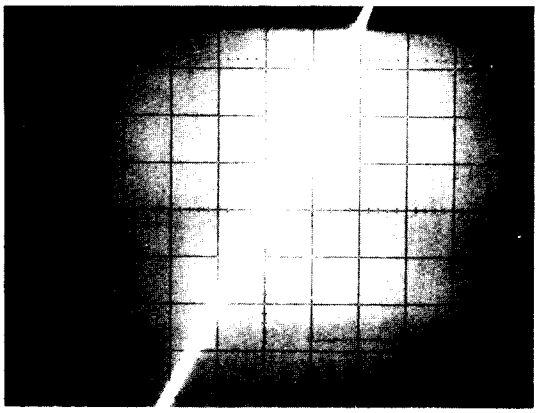
DEGREES Setting	DVM Indication
0	0.000 ± .003
20	0.200 ± .003
40	0.400 ± .006
60	0.600 ± .009
80	0.800 ± .012
100	1.000 ± .015
120	1.200 ± .018
140	1.400 ± .021
160	1.600 ± .024

d. Set sweep oscillator for swept mode over narrowest band possible. Set DEGREES switch to each switch position and note the phase trace movement. It should change by two large graticules for 180 degrees offset. (Each small division is 18 degrees.)



WAVEFORM A

Oscilloscope trace of one 278 kHz sinewave cycle showing in-phase condition with Channel A superimposed on Channel B. (Horizontal scale is 36 degrees/cm.)



WAVEFORM B

Trace A expanded horizontally and vertically x 10. (Horizontal scale is 3.6 degrees/cm.)

Figure 4-2. Oscilloscope Display of In-Phase IF Outputs

PERFORMANCE TESTS

4-10. Phase Test (Cont'd)

e. Set PHASE DEG/DIV switch to 45. Change DEGREES switch by 180 degrees and phase trace should move four large graticule divisions.

f. Set PHASE DEG/DIV switch to 10. Change DEGREES switch by 20 degrees and phase trace should move two major graticule divisions.

g. Check the 1 DEG/DIV range of the phase circuit by comparing its accuracy to the 10 DEG/DIV range as follows. Set DEGREES switch to zero and PHASE DEG/DIV switch to 10. Adjust the 8410 PHASE VERNIER to place the trace two small graticule lines below the center graticule line. Set PHASE DEG/DIV switch to 1 and trace should move to the bottom graticule line.

4-11. Bandwidth Switch Test

SPECIFICATIONS: General operation.

DESCRIPTION: The change in frequency response is observed on the CRT trace when a low-pass filter is connected in both channels.

PROCEDURE:

Set sweep oscillator for swept mode over narrowest band possible. Set 8410 AMPLITUDE TEST CHANNEL GAIN control to 20 dB. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 0.25, PHASE DEG/DIV to 1.0, PHASE polarity switch to positive(+), DEGREES switch to zero, and BW (KHz) switch to 10. Adjust 8410 AMPL VERNIER to place amplitude trace on screen. Both phase and amplitude traces should be on 8412B CRT and both traces should be jagged, showing normal noise on test channel. Set BW (KHz) switch to 0.1 and the traces should change to a continuous smooth trace due to the low-pass filter connected across the amplifier inputs.

4-12. Z-Axis Modulation Test

SPECIFICATION: General operation.

DESCRIPTION: Voltages simulating marker or blanking pulses are applied to the rear-panel Z-AXIS input and the CRT trace intensifies or blanks.

PROCEDURE:

a. Connect a −5 Vdc supply to 8412B rear-panel Z-AXIS connector and −5 Vdc return to ground. The traces should intensify. (If it does not, check that switch A3S1 inside 8412B is set to POS position (Figure 5-1).

b. Connect +5 Vdc to 8412B rear-panel Z-AXIS connector and +5 Vdc return to ground. The traces should blank.

PERFORMANCE TESTS

4-13. Phase Change Due to Amplitude Change

SPECIFICATIONS:

Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°.

Over full 80 dB amplitude range: Maximum phase change not to exceed 6°.

DESCRIPTION: The phase trace is observed for change while the signal amplitude in the test channel is changed through the 69 dB range of the 8410.

NOTE

When using the 8410, the full 80 dB range of the 8412B cannot be checked.

PROCEDURE:

a. Set sweep oscillator for single-frequency (CW) operation. Set PHASE DEG/DIV switch to 1 position. Set 8410 TEST CHANNEL GAIN controls for an on-screen amplitude display. Set PHASE polarity and DEGREES switches and 8410 PHASE VERNIER control to place the phase dot near the middle CRT graticule line.

b. Adjust the 8410 TEST CHANNEL GAIN controls to zero dB. The difference between maximum and minimum positions of the phase dot trace should not be more than 4 degrees through the 69 dB amplitude range of the 8410.

4-14. PERFORMANCE TEST WITH 8407A MAINFRAME

4-15. Initial Setup

SPECIFICATIONS: General operation.

DESCRIPTION: Set up and adjust instrument for amplitude and phase trace on CRT.

PROCEDURE:

a. Connect equipment as shown in Figure 4-3. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A AMPL VERNIER to midrange, set DISPLAY REFERENCE CAL controls for zero dB at top DISPLAY REFERENCE switch position, and set DISPLAY REFERENCE switches to +10 dB. (One step down from top on 10 dB/step switch and top position on 1 dB/step switch.) Set 8407A REF CHANNEL LEVEL RANGE switch to the middle position. Adjust sweep oscillator RF output for REF CHAN LEVEL meter indication at the top of the OPERATE range. If UNCAL REDUCE INPUT RATIO light comes on, reduce sweep oscillator RF power or change position of REF CHAN LEVEL range switch to a lower position to cause the light to go out.

b. The 278 kHz sine wave signal from the 8407A IF TEST OUTPUT should be ≥0.07V p-p and the IF REF OUTPUT should be ≥1.0V p-p on oscilloscope.

c. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to +, DEGREES switch to 100, and BW (kHz) switch to 10. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB position. Both amplitude and phase traces should be displayed across 8412B CRT. Adjust the HORIZ POSITION and HORIZ GAIN controls so that the ends of the trace are at the two edge graticules. Adjust 8412B FOCUS control and both traces should be in good focus. The amplitude trace should be brighter than the phase trace.

PERFORMANCE TESTS

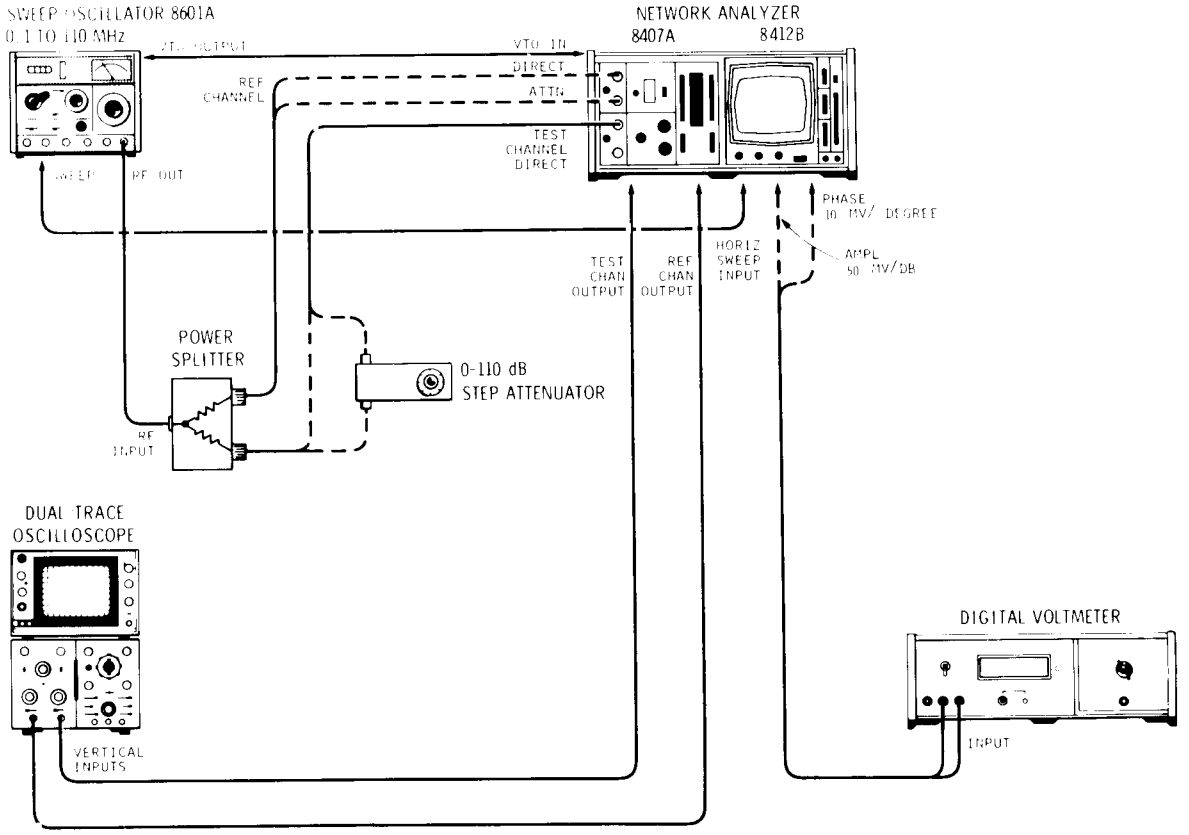


Figure 4-3. Equipment Setup for Performance Test with 8407A Mainframe

4-16. Trace Align

SPECIFICATIONS: General operation.

DESCRIPTION: Check that CRT circuits are properly aligned by adjusting trace to superimpose center graticule line.

PROCEDURE:

Set 8412B MODE switch to AMPL. Adjust 8407A AMPL VERNIER and DISPLAY REFERENCE 1 dB/step controls to superimpose the amplitude trace over the center horizontal graticule. The trace should align with the graticule within 1 mm of the trace except at the very end points .

PERFORMANCE TESTS

4-17. Amplitude Test

SPECIFICATIONS: ±.03 dB/dB and ±0.05 division/division; auxiliary output ±.03 dB/dB.

DESCRIPTION: The accuracy of the rear panel output is checked then the CRT amplitude trace is checked through the 80 dB amplitude range. All of the amplitude resolution ranges are then checked for calibration.

PROCEDURE:

a. Connect digital voltmeter (DVM) to 8412B AMPL 50 MV/dB rear-panel output. Set sweep oscillator for single-frequency CW operation. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB position. Adjust 8407A DISPLAY REFERENCE 1 dB/step and AMPL VERNIER control for 0.000 Vdc on DVM. Check DVM readout at 8407A DISPLAY REFERENCE 10 DB/step control settings listed in table below. If necessary, adjust 8412B front panel AMPL CAL (LOW LEVEL) control for DVM indication within tolerance at positions of +40 to +80 dB on 8407A DISPLAY REFERENCE control.

8407A DISPLAY REFERENCE 10 dB/step (Top Switch Position is zero dB)		Digital Voltmeter Reading
	0	+2.000 ± .070
	+10	+1.500 ± .055
	+20	+1.000 ± .040
	+30	+0.500 ± .020
(Set Ref.)	+40	0.000 ± .001
	+50	−0.500 ± .020
	+60	−1.000 ± .040
	+70	−1.500 ± .055
	+80	−2.000 ± .070

PERFORMANCE TESTS

4-17. Amplitude Test (Cont'd)

b. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. Set MODE switch to AMPL. Adjust 8407 AMPL VERNIER for the trace superimposed on the center graticule line. Check trace position at 8407A DISPLAY REFERENCE 10 dB/step control settings listed in table below. If necessary, adjust 8412B front panel AMPL CAL (LOW LEVEL) control for CRT trace within tolerance at positions of +40 through +80 dB on 8407A DISPLAY REFERENCE control.

8407A DISPLAY REFERENCE 10 dB/step (Top Switch Position is zero dB)		Tolerance of 8412B Trace to Major Graticule Division
	0	±0.34 DIV
	+10	±0.26 DIV
	+20	±0.18 DIV
	+30	±0.09 DIV
(Set Ref.)	+40	±0.05 DIV
	+50	±0.09 DIV
	+60	±0.18 DIV
	+70	±0.26 DIV
	+80	±0.34 DIV

c. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB and set 8412B AMPL DB/DIV switch to 2.5. Adjust 8407A AMPL VERNIER to superimpose the trace on the center CRT graticule. Change 8407A DISPLAY REFERENCE 10 dB step control to +30 dB position. The 8412B trace should move up four major graticule divisions ±2.6 minor graticule divisions.

d. Set 8412B AMPL DB/DIV switch to 1.0 and set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. If necessary, readjust 8407A AMPL VERNIER to superimpose the trace on the center CRT graticule. Change 8407A DISPLAY REFERENCE 1 dB/step control to +1 dB. The 8412B trace shold move down one major division ±0.7 minor division.

e. Set 8412B AMPL DB/DIV switch to 0.25. Set 8407A DISPLAY REFERENCE 1 dB/step control to zero and 10 dB/step control to 40. Adjust 8407A AMPL VERNIER control to place the amplitude trace on the middle CRT graticule. Change the 8407A DISPLAY REFERENCE 1 dB/step control to +1 dB and 8412B trace should move down four major graticule divisions ±2.6 minor divisions.

PERFORMANCE TESTS

4-18. Phase Test

SPECIFICATIONS: ±0.015 degrees/degree ±.05 divisions/division, ≤3 degrees cummulative; auxiliary output ±0.015 degree/degree.

DESCRIPTION: The accuracy of the rear panel output is checked, then the CRT trace is checked through 360 degrees. All of the phase resolution ranges are then checked for calibration.

PROCEDURE:

a. Set sweep oscillator to single-frequency (CW) operation. Connect DVM to PHASE 10 MV/DEG connector at rear panel of 8412B. On 8412B, set MODE switch to PHASE, PHASE DEG/DIV switch to 90, and Degrees switch to zero. Set 8407A DISPLAY REFERENCE CONTROLS for an on-screen amplitude display. Adjust 8407A PHASE VERNIER control to obtain .000 Volt on DVM. Set PHASE DEG/DIV switch to 1. Adjust sweep oscillator RF output for the smallest phase dot on 8412B screen (best signal to noise ratio). The 8407A REFERENCE CHANNEL LEVEL meter should indicate near the top of the OPERATE range.

b. Set 8412B DEGREES switch to zero. Make slight adjustment of 8407A PHASE VERNIER for 0.000 DVM indication. Set PHASE switch from positive (+) to negative (−) and DVM should indicate 0.000 Volt ±0.003 Volt in both positions.

c. Set PHASE switch to positive position. Set DEGREES switch to positions shown in table below and obtain DVM indication as shown. Set PHASE switch to negative (−) position and recheck DVM indication at each position of DEGREES switch. (The DVM indication will now be negative.)

DEGREES Setting	DVM Indication
0	0.000 ± 0.003
20	0.200 ± 0.003
40	0.400 ± 0.006
60	0.600 ± 0.009
80	0.800 ± 0.012
100	1.000 ± 0.015
120	1.200 ± 0.018
140	1.400 ± 0.021
160	1.600 ± 0.024

d. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set DEGREES switch to each switch position and note the phase trace movement. It should change by two large graticules for 180 degree offset. (Each small division is 18 degrees.)

e. Set PHASE DEG/DIV switch to 45. Change DEGREES switch by 180 degrees and phase trace should move four large graticule divisions.

4-18. Phase Test (Cont'd)

f. Set PHASE DEG/DIV switch to 10. Change DEGREES switch by 20 degrees and phase dot should move two major graticule divisions.

g. Check the 1 DEG/DIV range of the phase circuit by comparing its accuracy to the 10 DEG/DIV range as follows. Set DEGREES switch to zero and PHASE DEG/DIV switch to 10. Adjust the 8407A PHASE VERNIER to place the trace two small graticule lines below the center graticule line. Set PHASE DEG/DIV switch to 1 and trace should move to the bottom graticule line.

4-19. Bandwidth Switch Test

SPECIFICATIONS: General operation.

DESCRIPTION: The change in frequency response is observed on the CRT trace when a low-pass filter is connected in both channels.

PROCEDURE:

Set signal source for swept mode with sweep width of 10 kHz or less. Set 8407A DISPLAY REFERENCE controls to +40 dB. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 0.25, PHASE DEG/DIV to 1, PHASE polarity switch to positive (+), DEGREES switch to zero, and BW (kHz) switch to 10. Adjust 8407A AMPL VERNIER and DISPLAY REFERENCE 1 dB/step switch to place amplitude trace on screen. Both phase and amplitude traces should be on 8412B and both traces should be jagged, showing normal noise on test channel. Set BW (kHz) switch to 0.1 and both amplitude and phase trace should change to continuous smooth traces due to the low-pass filter connected across the amplifier inputs.

4-20. Z-Axis Modulation Test

SPECIFICATIONS: General operation.

DESCRIPTION: Voltages simulating marker or blanking pulses are applied to the rear-panel Z-AXIS input and the CRT trace intensifies or blanks.

PROCEDURE:

a. Connect the −5 Vdc supply to 8412B rear-panel Z-AXIS connector and −5 Vdc return to ground. The traces should intensify. (If not, check that A3S1 is in POS position, figure 5-1.)

b. Connect +5 Vdc to 8412B rear-panel Z-AXIS connector and +5 Vdc return to ground. The traces should blank.

PERFORMANCE TESTS

4-21. Phase Change Due to Amplitude Change

SPECIFICATION:

a. Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°.

b. Over full 80 dB amplitude range: maximum phase change not to exceed 6°.

NOTE

Phase error due to amplitude change in the Model 8412B can not be measured accurately independent of the phase error contributed by the Model 8407A. Therefore, this test measures the combined phase error of the Models 8407A and 8412B. A test procedure starting at step (j) explains how to measure error contributed by 8407A.

DESCRIPTION: Test channel power is varied in 10 dB steps while observing the 8412B phase indication.

PROCEDURE:

a. Connect equipment as shown on Figure 4-3, with reference input signal to REF CHANNEL DIRECT (0-120 dB attenuator not used).

b. Set 8407A REF CHANNEL LEVEL switch to middle position.

c. Set sweep oscillator for narrowest possible sweep and output level for about 20 mV peak-to-peak at 8407A input.

d. Set 8407A 10 dB/step DISPLAY REFERENCE switch to top position. Set DISPLAY REFERENCE CAL thumbwheel for 0 dB.

e. Set 8412B MODE switch to AMPL and AMPL dB/DIV to 10.

f. Adjust 8407A 1 dB/step DISPLAY REFERENCE switch and amplitude vernier for amplitude trace across top graticule line of 8412B display. If 8412B input signal level is set too high initially, excessive phase error will occur when signal level is decreased.

g. Set 8412B BW (kHz) switch to 0.1 and MODE switch to PHASE.

PERFORMANCE TESTS

4-21. Phase Change Due to Amplitude Change (Cont'd)

h. Adjust 8412B PHASE OFFSET and 8407A PHASE VERNIER controls for a center screen phase trace on the 1 degree/division range.

NOTE

Although the 8412B phase error cannot be accurately measured independent of the phase error contributed by the Model 8407A, a qualitative indication can be obtained as follows:

(1) Connect a dual trace oscilloscope to the 8407A rear-panel IF REF and IF TEST outputs.

(2) Adjust oscilloscope and 8407A PHASE VERNIER control to superimpose one waveform on the other. Expand one cycle of trace so that the zero degree point on the sine wave is at the left edge, the 180 degree point is at the center, and the 360 degree point is at the right edge of the graticule (Figure 4-2, Waveform A). (With an oscilloscope having 10 cm graticule width, each cm is 36 degree.) Expand the oscilloscope waveform horizontally by a factor of ten so that each cm represents 3.6 degrees. Adjust oscilloscope to position the center of the waveform on the screen (Figure 4-2, Waveform B).

(3) Observe the oscilloscope display as the 8407A DISPLAY REFERENCE switch is changed. Any phase shift observed on the oscilloscope is due to 8407A phase error. On low level test channel signals the oscilloscope display approaches a horizontal line; however, a small ringing appears on the test channel waveform. this ringing can be observed for horizontal movement down to the last two 8407A DISPLAY REFERENCE switch positions.

i. Change the 8407A DISPLAY REFERENCE switch from 0 to 80 dB. The 8412B phase indication should not vary more than 1.0 degree/10 dB step or more than 4 degrees over the upper 70 dB amplitude range. The phase indication should not vary more than 6 degrees over the full 80 dB amplitude range.

j. To measure that part of the error contributed by the 8407A phase change with amplitude change, use the following precedure.

k. Connect equipment as shown in Figure 4-3. Connect the Reference channel input to the 8407A REF CHANNEL ATTEN input. Connect the step attenuator between the power splitter and the 8407A TEST CHANNEL DIRECT input. Set the 0-110 dB attenuator to 80 dB. Set the 8407A REF CHAN LEVEL ADJ switch to the middle position.

l. Set the 8407A DISPLAY REFERENCE 10 dB/step switch to the top position and adjust the DISPLAY REFERENCE CAL thumbwheel for 0.

PERFORMANCE TESTS

4-21. Phase Change Due to Amplitude Change (Cont'd)

m. Set the sweep oscillator for minimum sweep width at any frequency in the 8407A operating range. Adjust RF output level for maximum power out or until the 8407A REF CHAN LEVEL meter indication is slightly above the operate region, whichever comes first.

n. Adjust the display unit PHASE OFFSET and 8407A PHASE VERNIER for a zero degree phase reference on the display unit.

o. Check each DISPLAY REFERENCE 10 dB step as follows:

(1) Set the DISPLAY REFERENCE 10 dB/step switch one position down.

(2) Observe the phase shift indication of the display unit and record.

(3) Increase the test channel input power by 10 dB by removing 10 dB from the step attenuator at the test channel input. Adjust the PHASE VERNIER for a zero degree phase indication.

(4) Repeat the above steps to check the remaining 10 dB/step positions. Readings recorded are phase changes with amplitude change of the 8407A.

NOTE

The 8407A REDUCE INPUT RATIO light may come on at high test channel input levels. If so, reduce the sweep oscillator output power to extinguish the light.

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION

5-2. This section provides instructions for adjustment of the HP 8412B Phase-Magnitude Display. Test equipment required for these procedures is listed in Table 5-1. If the test equipment recommended is not available, other equipment may be used if its performance meets the "Critical Specifications" listed in the table.

5-3. MAINTENANCE PRECAUTIONS

WARNING

Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.

CAUTION

When replacing bottom covers, do not exceed original screw length or a short may be produced.

5-4. ADJUSTMENT PROCEDURES

5-5. Adjustment procedures are given in Paragraphs 5-9 through 5-26. These procedures should not be performed as a routine maintenance procedure but should be used (1) after replacement of a part or component, (2) when the performance test shows that the specifications of Table 1-1 cannot be met, or (3) when instructed to do so in the troubleshooting tree (Figure 8-5). Before attempting any adjustment, allow 30 minutes warm-up time for the 8412B and mainframe.

Table 5-1. Recommended Test Equipment (1 of 2)

Instrument	Critical Specifications	Recommended HP Model
Dual-trace Oscilloscope with 10 pF 10:1 probes	Vertical Amplifier: Dual trace Bandwidth: 20 MHz minimum Horizontal Sweep Rate: 0.2 μS/cm Vertical Sensitivity: 5mV/cm	180A/1801/1820A
Digital Voltmeter	Accuracy: 0.01% Input Impedance: 10 megohms min. Automatic Range Selection: Range to ±50V	3455A
Power Supply	*Output: ±5 Vdc at 50mA*	*6213A*
DC Voltmeter with High Voltage Probe	Range: 4000 Vdc Current Drain: 2.5 μA maximum Accuracy: ±5%	427A with 11044A high voltage probe.
Service Cable (Supplied with 8407A & 8410)		08410-6032

Table 5-1. Recommended Test Equipment (2 of 2)

Instrument	Critical Specifications	Recommended HP Model
USED WITH 8410-SERIES MAINFRAME ONLY		
Network Analyzer with Harmonic Frequency Converter		8410/8411A
Sweep Oscillator	Range: 0.11 to 18 GHz (any part) RF Output: 25mW into 50 ohm Sweep Width: One Octave min.	8350A/83540A (2 to 8.4 GHz)
Transducer (Power Splitter)	Impedance: 50 ohms	8743B (2 to 18 GHz) 8745A (0.1 to 2 GHz) 11667A (DC to 18 GHz)
USED WITH 8407A MAINFRAME ONLY		
Network Analyzer		8407A
11651A Transmission Kit	Includes 50 ohm power splitter and two matched, double shielded cables.	11651A
Sweep Oscillator	Range: 0.1 to 110 MHz (any part) RF Output: +20 dBm VTO Output: Tracks 200 MHz from RF Output signal.	8601A (0.1 to 110 MHz) 8690B/8698B (0.4 to 110 MHz)

5-6. Table 5-1 lists the test equipment required for adjustments. Figure 5-1 shows the location of the controls and Table 5-2 lists the adjustments in the instrument.

5-7. SELECTED COMPONENTS

5-8. Some component values are selected during manufacturing in order to achieve a desired circuit performance. These components are listed in Table 5-3. The typical value used in a circuit is shown on the schematic, along with a star after the value. These components are listed in the parts list as "factory selected."

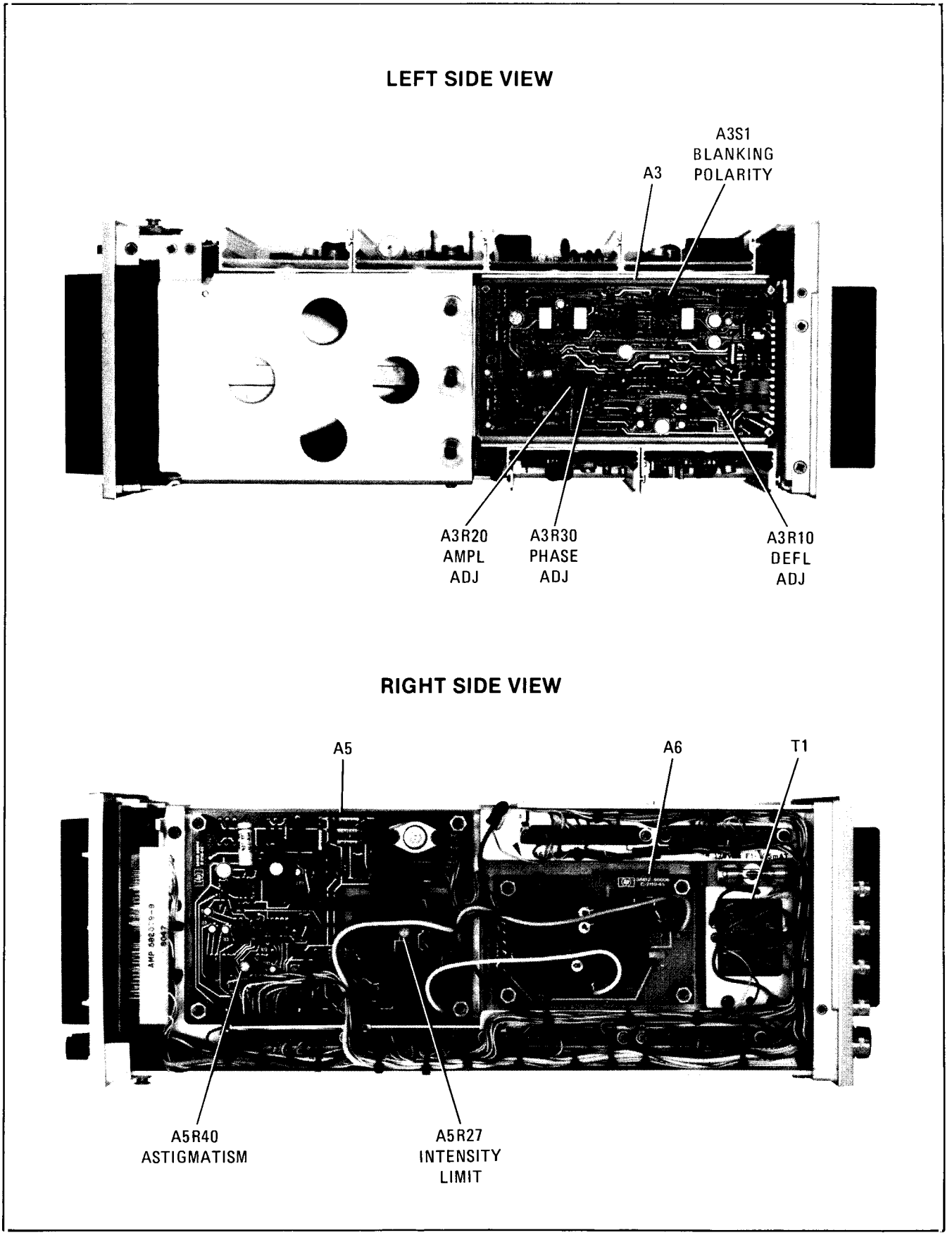


Figure 5-1. Adjustment Control Locations (Sheet 1 of 2)

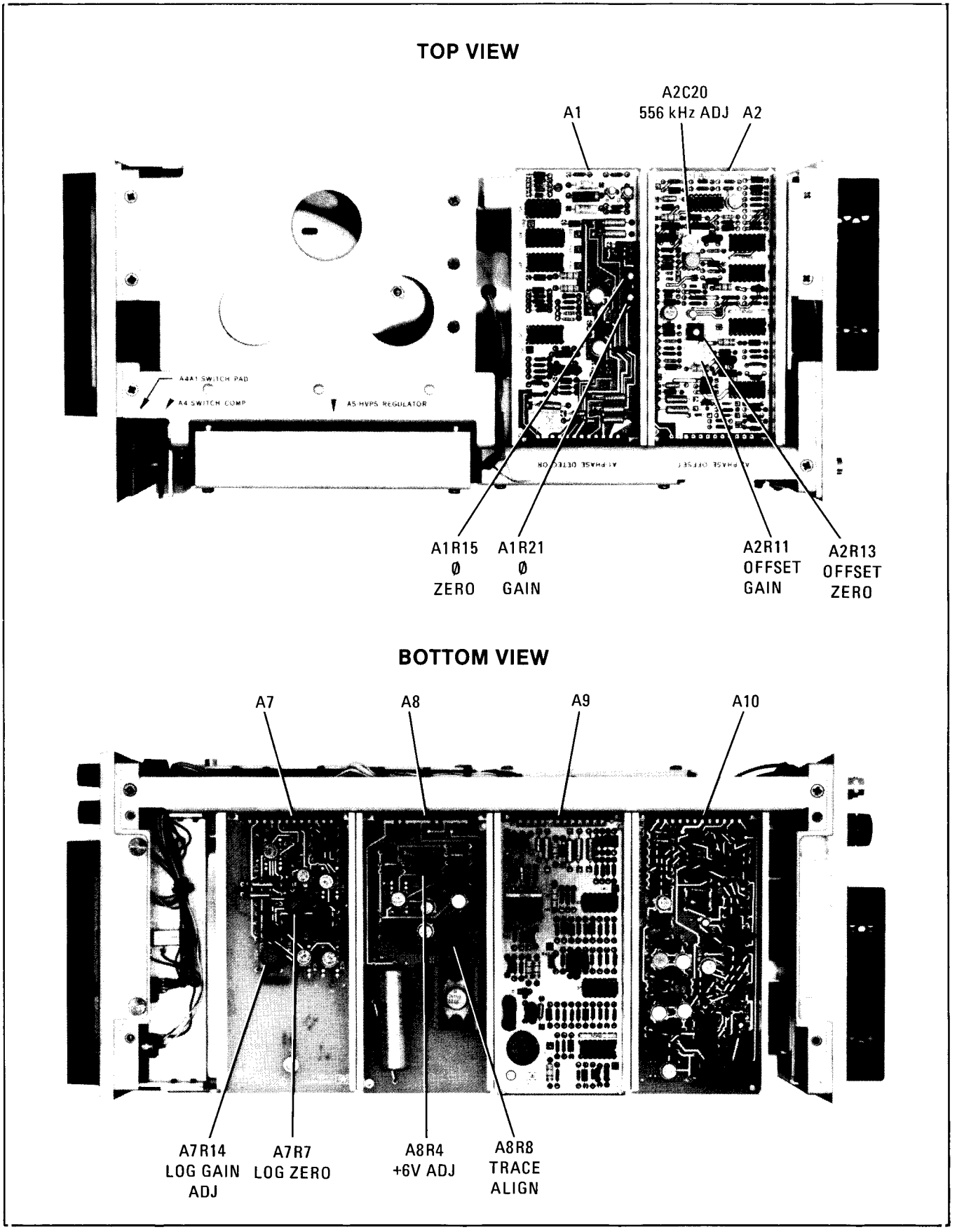


Figure 5-1. Adjustment Control Locations (Sheet 2 of 2)

Table 5-2. Adjustment Controls

			Performance Paragraph		Adjustment Step	
Reference Designation	Name	Function	8407A	8410A	8407A	8410A
A1R15	ϕZERO	Phase offset calibration at zero degrees with in-phase input signals.	4-18	4-10	5-24	5-15
A1R21	ϕGAIN	Calibrates phase readout and auxiliary output from phase detector.	4-18	4-10	5-24	5-15
A2R11	OFFSET GAIN	Adjusts current modulator gain.	4-18	4-10	5-24	5-15
A2R13	OFFSET ZERO	Adjusts phase offset calibration to correspond with input phase.	4-18	4-10	5-24	5-15
A2C20	556 KHz ADJUST	Calibrates 556 KHz VCO center frequency accuracy.	4-18	4-10	5-24	5-15
A3R10	DEFLECTION ADJ	Adjusts gain of vertical amplifier for proper display calibration.	4-17	4-9	5-23	5-14
A3R20	AMPL ADJ	Zeroes the amplitude trace vertically.	4-17	4-9	5-23	5-14
A3R30	PHASE ADJ	Zeroes the phase.	4-18	4-10	5-24	5-15
A5R27	Intensity Limit	Adjusts range of front-panel intensity control.	4-15	4-7	5-25	5-16
A4R40	Astigmatism	Adjust trace astigmatism and works with front panel focus control.	4-15	4-7	5-22	5-13
A7R7	Log Zero	Calibrates logging circuit at zero volts on auxillary output.	4-17	4-9	5-23	5-14
A7R14	Log Gain	Calibrates the post-log circuit.	4-17	4-9	5-23	5-14
A8R4	+6V Adjust	Calibrates + and −6 Volt supply.	4-17	4-9	5-20	5-11
A8R8	Trace Align	Adjusts CRT field to align the trace to the CRT graticule.	4-16	4-8	5-21	5-12
R9	Trace Align	Adjusts CRT field to align the trace to the CRT graticule.	4-16	4-8	5-21	5-12

Table 5-3. Selected Value Components

Reference Designator	Selection Criteria	Nominal Value	Range
A5R2	High Voltage output between −2800 Vdc and −3000 Vdc.	110 KΩ	90.9 K to 121 KΩ
A9C31	To minimize phase shift between A9TP2 and A9TP3.	300 pF	120 pF to 750 pF
A10R12 A10R30 A10R33 A10R41	Adjust for balance in the mixer detector with no test channel signal. Display should go off the graticule at the bottom.	511Ω 511Ω 511Ω 511Ω	422Ω to 619Ω 422Ω to 619Ω 422Ω to 619Ω 422Ω to 619Ω
A1C25	Minimize phase shift between A1TP1 and A1TP3.	220 pF	100 pF to 300 pF

ADJUSTMENTS

5-9. ADJUSTMENT WITH 8410-SERIES MAINFRAME

WARNING

Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.

5-10. Initial Setup

DESCRIPTION: Set up and adjust instrument for amplitude and phase trace on CRT.

PROCEDURE:

a. Connect equipment as shown in Figure 5-2. Set sweep oscillator for swept mode over as narrow a band as possible. Adjust 8410 SWEEP STABILITY control and sweep oscillator RF output for RF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

b. While observing the oscilloscope, adjust 8410 AMPLITUDE TEST CHANNEL GAIN to obtain 316 mV p-p from 8410 TEST CHAN OUTPUT. The setting in the TEST CHANNEL GAIN 1 dB/step window necessary to obtain 316 mV p-p must be used for the AMPLITUDE CALIBRATION PROCEDURE in this procedure, Paragraph 5-14, step a.

ADJUSTMENTS

5-10. Initial Setup (Cont'd)

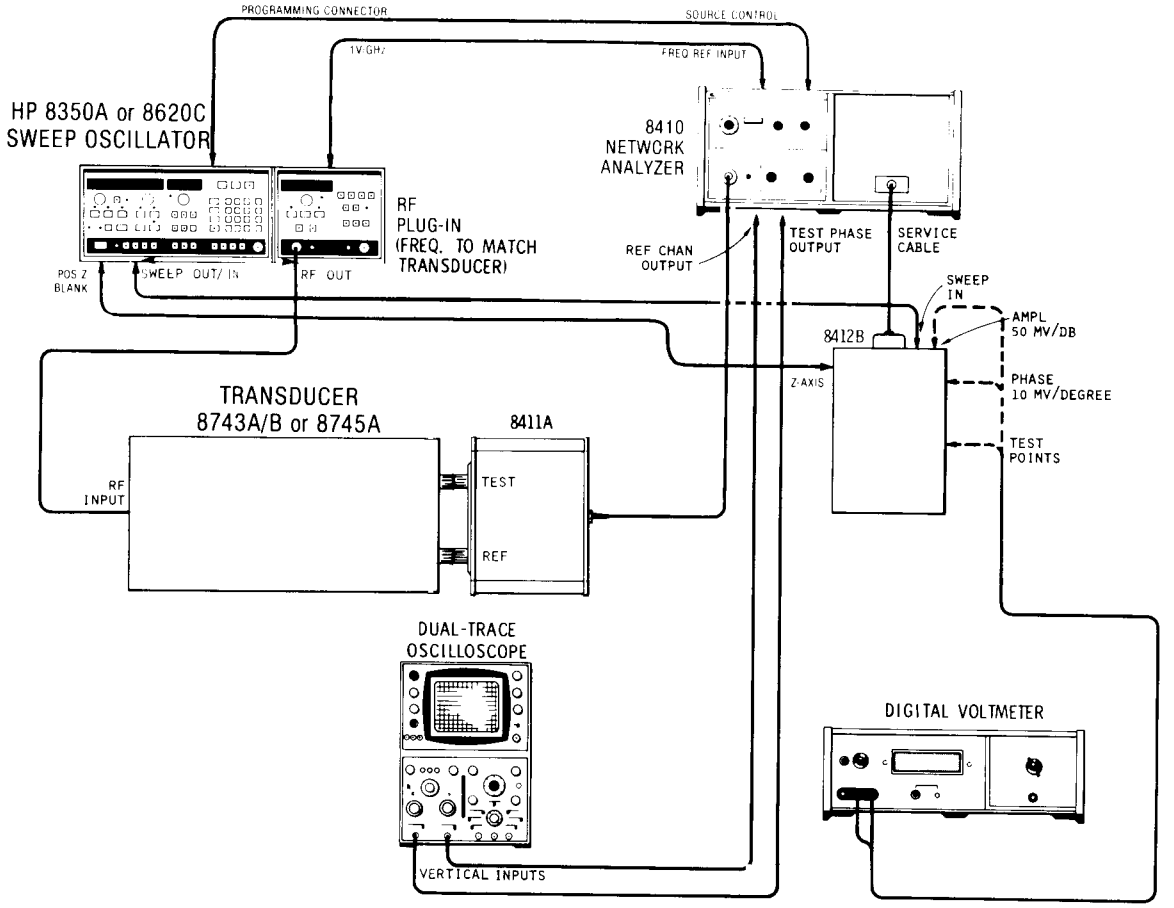


Figure 5-2. Equipment Setup for Adjustment Procedures with 8410-Series Mainframe

c. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90. PHASE switch to positive (+), DEGREES switch to 100, and BW (kHz) switch to 10. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step (leave 1 dB/Step control at setting determined in step b above). Both amplitude and phase traces should be displayed on 8412B CRT.

5-11. Power Supply (A8R4)

DESCRIPTION: The ±6 Volt power supplies are adjusted for correct output.

PROCEDURE:

Check for +6 Vdc ±0.03 Vdc at A8TP1 and −6 Vdc ±0.03 Vdc at A8TP3. If either is out of tolerance, adjust A8R4 and recheck both test points again.

ADJUSTMENTS

5-12. Trace Align (A8R8)

DESCRIPTION: The voltage to the CRT trace-align coil is adjusted to align trace to graticule on CRT face.

PROCEDURE:

Set Sweep oscillator for minimum sweep width. Set 8412B MODE switch to AMPL. Adjust 8410 AMPL VERNIER control to superimpose the amplitude trace over the center horizontal graticule. For instruments with rear-panel TRACE ALIGN control R9, center rear-panel control and adjust A8R8 TRACE ALIGN control for best alignment of trace to graticule. For instruments without rear-panel TRACE ALIGN control adjust A8R8 for best alignment of trace to graticule. If trace alignment is not correct when 8412B is installed directly into mainframe, readjust TRACE ALIGN control.

5-13. Astigmatism (A5R40)

DESCRIPTION: The CRT trace is adjusted for best focus.

PROCEDURE:

Set sweep oscillator to single-frequency (CW) mode. Adjust ASTIGMATISM control A5R40 and front panel FOCUS control for the smallest dot trace on screen.

5-14. Amplitude Calibration (A3R10, A3R20, A7R7, A7R14, and AMPL. CAL. R4)

DESCRIPTION: The log converter is adjusted for proper calibration at the rear-panel amplitude auxiliary output over the 60 dB range of 8410 mainframe. The CRT amplitude trace is then adjusted for calibration to CRT graticule.

NOTE

For all of the following settings of the 8410 AMPLITUDE TEST CHANNEL GAIN control set only the 10 dB/step control. The 1 dB/step control should remain at setting determined in Paragraph 5-10, step b unless otherwise stated.

PROCEDURE:

a. Connect digital voltmeter (DVM) to rear-panel AMPL 50 MV/DB connector. Set 8412B MODE switch to AMPL and AMPL DB/DIV control to 10. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and adjust AMPL VERNIER control for 0.000 Vdc on DVM. If zero Vdc cannot be obtained, adjust A7R7. Check DVM readout at AMPLITUDE TEST CHANNEL GAIN control settings listed in table following. Make alignment adjustments listed in table as necessary.

5-14. Amplitude Calibration (Cont'd)

8410 Amplitude Test Channel Gain*	Digital Voltmeter Reading	Adjustment
60	+2.000 ± .040	LOG GAIN A7R14
50	+1.500 ± .030	LOG GAIN A7R14
40	+1.000 ± .020	LOG GAIN A7R14
30	+0.500 ± .010	LOG GAIN A7R14
20	0.000 ± .005	LOG ZERO A7R7
10	−0.500 ± .010	AMPL CAL − LOW LEVEL (Front Panel)
0	−1.000 ± .020	AMPL CAL − LOW LEVEL (Front Panel)

*1 dB/step control set at setting determined in Paragraph 5-10, step b.

b. Set sweep oscillator for swept mode over as narrow a band as possible. Set the 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and readjust AMPL VERNIER, if necessary, to get a 0.000 Vdc indication on the DVM. For instruments with rear-panel VERT POS control, center the VERT POS control. The trace on the 8412B should be on the center horizontal graticule. If not, adjust A3R20 AMPL control. Check vertical deflection amplifier dc balance by moving the 8412B AMPL DB/DIV switch through its full range. If trace moves from center graticule line, readjust 8410 AMPL VERNIER for 0.000 Volt indication on DVM and readjust A3R20 AMPL control slightly to obtain minimum change in trace deflection with change in vertical sensitivity (AMPL DB/DIV). Set the 8412B AMPL DB/DIV switch to 10 and change the AMPLITUDE TEST CHANNEL GAIN control in 10 dB steps. The 8412B trace should move one major division for each step. If not, adjust A3R10 DEFL ADJ and front panel AMPL CAL (LOW LEVEL) controls.

c. Set 8410 AMPLITUDE TEST CHANNEL GAIN 10 dB/step control to 20 dB and set 8412B AMPL DB/DIV switch to 2.5. Adjust 8410 AMPL VERNIER for 0.000 Volt indication on DVM. Change 8410 AMPLITUDE TEST CHANNEL GAIN control by +5 dB. The 8412B trace should move up two major division. If not, make slight adjustment of A3R10.

d. Set 8412B AMPL DB/DIV switch to 1.0 and set 8410 AMPLITUDE TEST CHANNEL GAIN control to 20 dB (1 dB/step control set at setting determined in Paragraph 5-10, step b). If necessary, readjust 8410 AMPL VERNIER for 0.000 Volt on DVM. Change 8410 AMPLITUDE TEST CHANNEL GAIN control by +10dB. The 8412B trace should move up one major division. If not, make slight adjustment of A3R10.

e. Set 8412B AMPL DB/DIV switch to 0.25 position. Adjust 8410 AMPL VERNIER control and AMPLITUDE TEST CHANNEL GAIN control to place the amplitude trace on the screen. Change the AMPLITUDE TEST CHANNEL GAIN control by one dB and dot should move 4 major divisions. If not, make slight adjustment of A3R10. If A3R10 was adjusted in steps c, d, or e, recheck steps b through e again.

ADJUSTMENTS

5-15. Phase Calibration with 8410-Series Mainframe (A1R15, A1R21, A2C20, A2R11, A2R13, A3R30, A9C31)

DESCRIPTION: The Phase Offset circuits are adjusted for correct calibration and the Phase Detector output levels are calibrated.

PROCEDURE:

a. Connect equipment as shown in Figure 5-2.

b. Set signal source for CW operation, any frequency from 110 MHz to 12.4 GHz (according to appropriate plug-in used).

c. Set the 8410 FREQ RANGE switch to a position that includes the signal source frequency. Set the SWEEP STABILITY control to the CW detent position (fully counterclockwise).

d. On 8412B, set MODE to PHASE, PHASE DEG/DIV to 45, PHASE OFFSET to (−), and DEGREES switch to 0.

e. Connect dual-trace oscilloscope to the 8410B/C rear panel TEST PHASE OUTPUT and REF CHAN OUTPUT connectors.

f. Slowly increase signal source power until the 8410 REF CHANNEL LEVEL meter indicates in the OPERATE region.

g. Set TEST CHANNEL GAIN for a convenient TEST CHANNEL indication on the oscilloscope.

h. Adjust 8410 PHASE VERNIER, AMPLITUDE TEST CHANNEL GAIN, transducer REFERENCE PLANE EXTENSION, and oscilloscope controls to display one sine wave superimposed on the other.

i. Connect DVM to A2TP6. Adjust A2C20 FREQ ADJ for a minimum DVM reading (typically $\leq \pm 100$ mVdc).

j. Connect DVM to PHASE 10mV/DEG connector at rear of 8412B. Connect oscilloscope to A1TP2. Adjust oscilloscope horizontal sensitivity so that one cycle of the 278 kHz square wave occupies 10 horizontal divisions. Center the square wave vertically.

k. Adjust A2R13 OFFSET ZERO so that the positive and negative swing of the square wave are of equal time duration (50 percent duty cycle).

l. Adjust A1R15 Φ ZERO for a DVM indication of 0 ± 1.5 mVdc.

m. Observe DVM indication, then switch 8412B PHASE OFFSET switch between (+) and (−) positions. Adjust A2R11 OFFSET GAIN for <1 mVdc change between (+) and (−) switch settings.

n. Adjust A2R13 OFFSET ZERO for a DVM reading of 0 ± 1.5 mVdc.

o. Set 8412B PHASE OFFSET to +160 degrees. Adjust A1R21 PHASE GAIN for a DVM indication of -1.600V ± 5 mVdc.

ADJUSTMENTS

5-15. Phase Calibration with 8410-Series Mainframe (Cont'd)

p. Check voltage reading at −160 degrees of PHASE OFFSET for +1.600V ±5 mVdc. Readjust A1R21 ϕ GAIN, if necessary.

q. Verify the accuracy of the rear panel PHASE 10 mV/DEG output according to the DVM readings in the following table.

Phase Deg/Div	Phase Offset	Phase Vernier	Phase 10 mV/Deg Output Vdc
90	−0	Adjust PHASE VERNIER for a DVM reading of	0.000 ± 0.002
	−20	Verify DVM reading at these settings	+0.200 ± 0.003
	−40		+0.400 ± 0.004
	−60		+0.600 ± 0.005
	−80		+0.800 ± 0.006
	−100		+1.000 ± 0.007
	−120		+1.200 ± 0.008
	−140		+1.400 ± 0.009
	−160		+1.600 ± 0.010
	−180		+1.800 ± 0.012
	+0	Adjust PHASE VERNIER for a DVM reading of	0.000 ± 0.002
	+20	Verify DVM reading at these settings	−0.200 ± 0.003
	+40		−0.400 ± 0.004
	+60		−0.600 ± 0.005
	+80		−0.800 ± 0.006
	+100		−1.000 ± 0.007
	+120		−1.200 ± 0.008
	+140		−1.400 ± 0.009
	+160		−1.600 ± 0.010
	+180		−1.800 ± 0.012

r. Set PHASE DEG/DIV to 90, set PHASE OFFSET to −0, and adjust PHASE VERNIER for a DVM indication at rear panel PHASE 10 mV/DEG of 0.000 Vdc ±0.002 Vdc.

s. Adjust resister A3R30 to place the phase trace on the center CRT graticule line.

ADJUSTMENTS

5-16. Intensity Limit (A5R27)

DESCRIPTION: The range of the front panel INTENSITY control is adjusted so that fully counterclockwise turns trace off and clockwise turns trace to full brightness.

PROCEDURE:

Adjust front-panel INTENSITY control fully counterclockwise and traces on 8412B should disappear near the counterclockwise stop. If not, adjust A5R27 for a range of INTENSITY control that gives no trace near counterclockwise position and maximum brightness of trace at fully clockwise position.

5-17. High Voltage (Select A5R2)

DESCRIPTION: The high voltage applied to the CRT is adjusted by selecting the value of resistor A5R2.

PROCEDURE:

a. Connect High Voltage probe and DVM to A5 Test Point 10 (green wire). Select negative voltage on DVM.

b. Adjust 8412B front panel INTENSITY control for midrange.

c. DVM indication should be −2900 Vdc ± 100 Vdc. If not, select a value of resistor A5R2 in the range of 90.9K to 121K ohm that produces high voltage in the range of −2800 Vdc to −3000 Vdc. For a higher voltage, select a lower value resistor. A 10K ohm change produces about 140 Vdc change.

5-18. ADJUSTMENT WITH 8407A MAINFRAME

WARNING

Voltages greater than 1000 Volts are present at the CRT and in assemblies A5 and A6. These voltages could cause injury to personnel.

5-19. Initial Setup.

DESCRIPTION: Setup and adjust instrument for amplitude and phase trace on CRT.

PROCEDURE:

a. Connect equipment as shown in Figure 5-3. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A AMPL VERNIER to midrange and both DISPLAY REFERENCE switches to top position. Set DISPLAY REFERENCE CAL so that zero dB is at the top on both scales. Set 8407A REF CHAN LEVEL switch to the middle position. Adjust sweep oscillator RF output for REF CHANNEL LEVEL meter indication at the top of the OPERATE range.

ADJUSTMENTS

5-19. Initial Setup. (Cont'd)

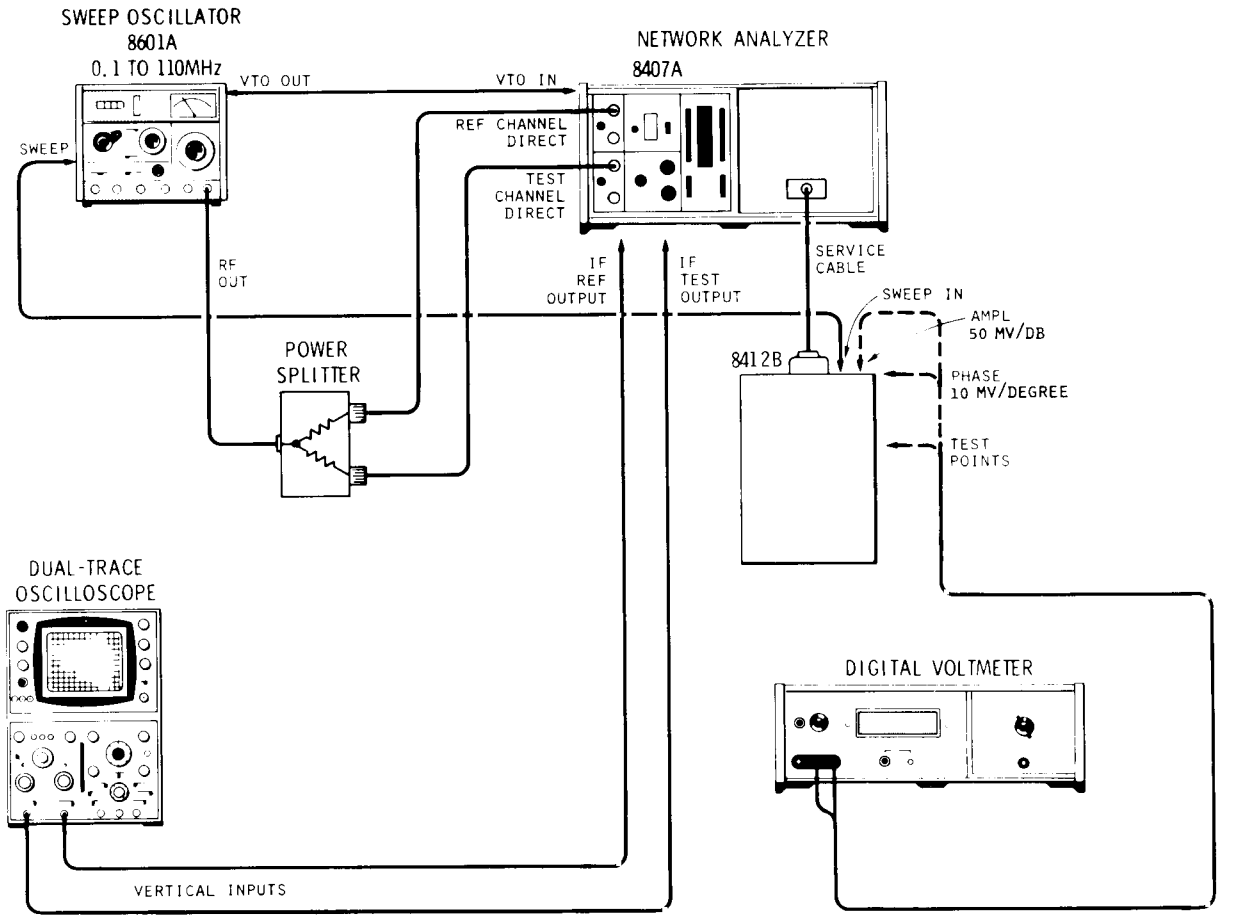


Figure 5-3. Equipment Setup for Adjustment Procedures with 8407A Mainframe

b. While observing the oscilloscope, adjust 8407A DISPLAY REFERENCE 1 dB/step switch and AMPL VERNIER control to obtain 316 mV p-p from 8407A IF TEST output. It may be necessary to slightly readjust Sweep Oscillator RF output to obtain desired result. Set DISPLAY REFERENCE CAL so that zero dB appears in the 1 dB/step scale.

c. Set 8412B MODE switch to DUAL, AMPL DB/DIV switch to 10, PHASE DEG/DIV switch to 90, PHASE switch to +(up), DEGREES switch to 100, and BW (kHz) switch to 10. Set 8407A DISPLAY REFERENCE 10 dB/step control to +40 dB. Both amplitude and phase traces should be displayed on 8412B CRT.

ADJUSTMENTS

5-20. Power Supply (A8R4)

DESCRIPTION: The ±6 Volt power supplies are adjusted for corrected output.

PROCEDURE:

Check for +6 Vdc ±0.03 Vdc at A8TP1 and −6 Vdc ±0.03 Vdc at A8TP3. If either is out of tolerance, adjust A8R4 and recheck both test points again.

5-21. Trace Align (A8R8)

DESCRIPTION: The voltage to the CRT trace-align coil is adjusted to align trace to graticule on CRT face.

PROCEDURE:

Set Sweep Oscillator for minimum sweep width. Set 8412B MODE switch to AMPL. Adjust 8407A AMPL VERNIER control and DISPLAY REFERENCE 1 dB/step switch to superimpose the amplitude trace over the center horizontal graticule. For instruments with rear-panel TRACE ALIGN control R9, center rear-panel control and adjust A8R8 TRACE ALIGN control for best alignment of trace to graticule. For instruments without rear-panel TRACE ALIGN control, adjust A8R8 for best alignment of trace to graticule. If trace alignment is not correct when 8412B is installed directly into mainframe, readjust TRACE ALIGN control.

5-22. Astigmatism (A5R40)

DESCRIPTION: The CRT trace is adjusted for best focus.

PROCEDURE:

Set sweep oscillator to single-frequency (CW) mode. Adjust ASTIGMATISM control A5R40 and front panel FOCUS control for the smallest dot trace on screen.

5-23. Amplitude Calibration (A3R10, A3R20, A7R7, A7R14, and AMPL. CAL R4)

DESCRIPTION: The log converter is adjusted for proper calibration at the rear-panel amplitude auxiliary output over the 80 dB range of 8407A mainframe. The CRT amplitude trace is then adjusted for calibration to CRT graticule.

PROCEDURE:

a. Connect digital voltmeter (DVM) to rear-panel AMPL 50 MV/DB connector. Set 8412B MODE switch to AMPL and AMPL DB/DIV control to 10. Set 8407A DISPLAY REFERENCE control to +40 dB and adjust AMPL VERNIER control for 0.000 Vdc on DVM. If zero Vdc cannot be obtained, adjust A7R7. Check DVM readout at DISPLAY REFERENCE control settings listed in following table. Make alignment adjustments listed in table as necessary.

ADJUSTMENTS

5-23 Amplitude Calibration (Cont'd)

8407A DISPLAY REFERENCE (Zero at top)	Voltmeter Reading	Adjustment
0	+2.000 ± .040	LOG GAIN A7R14
+10	+1.500 ± .030	LOG GAIN A7R14
+20	+1.000 ± .020	LOG GAIN A7R14
+30	+0.500 ± .010	LOG GAIN A7R14
+40	0.000 ± .005	LOG ZERO A7R7
+50	−0.500 ± .010	AMPL CAL − LOW LEVEL (Front Panel)
+60	−1.000 ± .020	AMPL CAL − LOW LEVEL (Front Panel)
+70	−1.500 ± .030	AMPL CAL − LOW LEVEL (Front Panel)
+80	−2.00 ± .040	AMPL CAL − LOW LEVEL (Front Panel)

b. Set sweep oscillator for swept mode with sweep width of 10 kHz or less. Set the 8407A DISPLAY REFERENCE control to +40 dB and readjust AMPL VERNIER, if necessary, to get a 0.000 Volt indication on the DVM. For instruments with rear-panel VERT POS control, center the VERT POS control. The trace on the 8412B should be on the center horizontal graticule. If not, adjust A3R20 AMPL control. Check vertical deflection amplifier dc balance by moving the 8412B AMPL DB/DIV switch through its full range. If trace moves from center graticule line, readjust 8407A AMPL VERNIER for 0.000 Volt indication on DVM. Readjust A3R20 AMPL control slightly to obtain minimum change in trace deflection with change in vertical sensitivity (AMPL DB/DIV). Set the 8412B AMPL DB/DIV switch to 10 and change the 8407A DISPLAY REFERENCE control in 10 dB steps. The 8412B trace should move one major division for each step. If not, adjust A3R10 DEFL and front panel AMPL CAL (LOW LEVEL) controls.

c. Set the 8407A DISPLAY REFERENCE switches to +40 dB and set 8412B AMPL DB/DIV switch to 2.5. Adjust 8407A AMPL VERNIER for 0.000 Volt indication on DVM. Change 8407A DISPLAY REFERENCE controls to +35 dB. The 8412B trace should move up two major divisions. If not, make slight adjustment of A3R10.

d. Set 8412B AMPL DB/DIV switch to 1.0 and 8407A DISPLAY REFERENCE controls to +40 dB. If necessary, readjust 8407A AMPL VERNIER for 0.000 Volt on DVM. Change 8407A DISPLAY REFERENCE controls to +39 dB. The 8412B trace should move up one major division. If not, make slight adjustment of A3R10.

e. Set 8412B AMPL DB/DIV switch to 0.25 position. Adjust 8407A AMPL VERNIER control and DISPLAY REFERENCE controls to place the amplitude trace on the screen. Change the DISPLAY REFERENCE control by one dB and trace should move 4 major divisons. If not, make slight adjustment of A3R10. If adjustment of A3R10 was necessary in steps c, d, or e, recheck steps b through e again.

ADJUSTMENTS

5-24. Phase Calibration With 8407A Mainframe (A1R15, A1R21, A2C20, A2R11, A2R13, A3R30, A9C31)

DESCRIPTION: The Phase Offset circuits are adjusted for correct calibration and the Phase Detector output levels are calibrated.

PROCEDURE:

a. Connect equipment as shown in Figure 5-3. Set controls as follows:

8601A:
- FREQUENCY ..... 30 MHz
- CW/SWEEP ..... SYM
- SWP MODE ..... MANUAL
- TRIGGER ..... FREE RUN
- OUTPUT LEVEL ..... −24 dBm

8407A:
- REF CHAN LEVEL ..... Center position
- DISPLAY REF CAL
  - 10 dB step ..... 0 at top
  - 1 dB step ..... 0 at top
- DISPLAY REF
  - 10 dB step ..... 0 dB
  - 1 dB step ..... +2 to +6 dB

8412B:
- MODE ..... PHASE
- DEG/DIV 45
- PHASE OFFSET ..... ±0

b. Connect dual trace oscilloscope to the 8407A rear panel IF REF and IF TEST outputs.

c. Adjust Network Analyzer PHASE VERNIER, DISPLAY REFERENCE, and oscilloscope to display one sine wave superimposed on the other.

d. Connect DVM to A2TP6. Adjust A2C20 FREQ ADJ for a minimum DVM reading (typically ≤ ± 100 mVdc).

e. Connect DVM to PHASE 10 mV/DEG connector at rear of 8412B. Connect oscilloscope to A1TP2. Adjust oscilloscope horizontal sensitivity so that one cycle of the 278 kHz square wave occupies 10 horizontal divisions. Center the square wave vertically.

f. Adjust A2R13 OFFSET ZERO so that the positive and negative swing of the square wave are of equal time duration (50 percent duty cycle). If necessary, select the value of capacitor A9C31 for 50 percent duty cycle.

g. Adjust A1R15 Φ ZERO for a DVM indication of 0 ±1.5 mVdc.

h. Observe DVM indication, then switch 8412B PHASE OFFSET switch between (+) and (−) positions. Adjust A2R11 OFFSET GAIN for <1 mVdc change between (+) and (−) switch settings.

ADJUSTMENTS

5-24. Phase Calibration with 8407A Mainframe (Cont'd)

i. Adjust A2R13 OFFSET ZERO for a DVM reading of 0 ±1.5 mVdc.

j. Set 8412B PHASE OFFSET to +160 degrees. Adjust A1R21 PHASE GAIN for a DVM indication of −1.600V ±5 mVdc.

k. Check voltage reading at −160 degrees of PHASE OFFSET for +1.600V ±5 mVdc. Readjust A1R21 ϕ GAIN, if necessary.

l. Verify the accuracy of the rear panel PHASE 10 MV/DEG output according to the DVM readings in the following table.

PHASE DEG/DIV	PHASE OFFSET	PHASE VERNIER	PHASE 10 mV/DEG OUTPUT Vdc
90	−0	Adjust PHASE VERNIER for a DVM reading of	0.000±0.002
	−20	Verify DVM reading at these settings	+0.200±0.003
	−40		+0.400±0.004
	−60		+0.600±0.005
	−80		+0.800±0.006
	−100		+1.000±0.007
	−120		+1.200±0.008
	−140		+1.400±0.009
	−160		+1.600±0.010
	−180		+1.800±0.012
	+0	Adjust PHASE VERNIER for a DVM reading of	0.000±0.002
	+20	Verify DVM reading at these settings	−0.200±0.003
	+40		−0.400±0.004
	+60		−0.600±0.005
	+80		−0.800±0.006
	+100		−1.000±0.007
	+120		−1.200±0.008
	+140		−1.400±0.009
	+160		−1.600±0.010
	+180		−1.800±0.012

m. Set PHASE DEG/DIV to 90, set PHASE OFFSET to −0, and adjust PHASE VERNIER for a DVM indication at rear panel PHASE 10 mV/DEG of 0.000 Vdc ±0.002 Vdc.

n. Adjust resistor A3R30 to place the phase trace on the center CRT graticule line.

ADJUSTMENTS

5-25. Intensity Limit (A5R27)

DESCRIPTION: The range of the front panel INTENSITY control is adjusted so that fully counterclockwise turns trace off and clockwise turns trace to full brightness.

PROCEDURE:

Adjust front-panel INTENSITY control fully counterclockwise and traces on 8412B should disappear near the counterclockwise position and maximum brightness of trace at fully clockwise position. If not, adjust A5R27 INTENSITY LIMIT for correct range of INTENSITY control that gives no trace near counterclockwise position and maximum brightness of trace at fully clockwise position.

5-26. High Voltage (Select A5R3)

DESCRIPTION: The high voltage applied to the CRT is adjusted by selecting the value of resistor A5R2.

PROCEDURE:

a. Connect High Voltage Probe and DVM to A5 Test Point 10 (green wire). Select negative voltage on DVM.

b. Adjust 8412B front panel INTENSITY control for midrange.

c. DVM indication should be −2900 Vdc ± 100 Vdc. If not, select a value of resistor A5R2 in the range of 90.9K to 121K ohm that produces high voltage in the range of −2800 Vdc to −3000 Vdc. For a higher voltage, select a lower value resistor. A 10K ohm change produces about 140 Vdc change.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations and reference designators used in the parts list and the names and addresses that correspond to the manufacturer's code numbers. Table 6-2 lists all replaceable parts in reference designator order.

WARNING

Any services or adjustment performed with the covers removed should only be performed by qualified service personnel. A shock hazard exists with the covers removed.

6-3. REPLACEABLE PARTS LIST

6-4. Table 6-2 is the list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alpha-numerical order by reference designation.

b. Chassis-mounted parts in alpha-numerical order by reference designation.

c. Miscellaneous parts.

6-5. The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. Part number check digit (CD).

c. The total quantity (Qty) in the major assembly (A1, A2, or A3).

d. The description of the part.

e. A typical manufacturer of the part in a five-digit code.

f. The manufacturer's number for the part.

6-6. The total quantity for each part is given only once — at the first appearance of the part number in the list for each major assembly.

NOTE

Total quantities for optional assemblies are totaled by assembly and not integrated into the standard list.

6-7. ORDERING INFORMATION

6-8. To order a part listed in the replaceable parts table, quote the Hewlett-Packard Part Number (with the check digit) indicate the quantity required, and address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

6-9. To order a part that is not listed in the Replaceable Parts Table, include the instrument model number, instrument serial number, description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

6-10. SPARE PARTS KIT

6-11. Stocking spare parts for an instrument is often done to ensure quick return to service after a malfunction occurs. Hewlett-Packard has a "Spare Parts Kit" available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the "Recommended Spares" list are based on failure reports and repair data, and provides parts suport for one year. A complimentary "Recommended Spares" list for this instrument may be obtained on request and the "Spare Parts Kit" may be ordered through your nearest Hewlett-Packard office.

Table 6-1. Manufacturers Code List, Reference Designations, and Abbreviations (1 of 3)

REFERENCE DESIGNATIONS

A ..... Assembly
AT ..... Attenuator, Isolator, Limiter, Termination
B ..... Fan, Motor
BT ..... Battery
C ..... Capacitor
CP ..... Coupler
CR ... Diode, Diode Thyristor, Step Recovery Diode (SCR), Varactor
DC ..... Directional Coupler
DL ..... Delay Line
DS .... Annunciator, Lamp, Light Emitting Diode (LED), Signaling Device (Audible or Visible)
E ..... Miscellaneous Electrical Part
F ..... Fuse
FL ..... Filter
H ..... Hardware
HY ..... Circulator
J ..... Electrical Connector (Stationary Portion), Jack
K ..... Relay
L ..... Coil, Inductor
M ..... Meter
MP ..... Miscellaneous Mechanical Part
P ..... Electrical Connector (Movable Portion), Plug
Q .... Silicon Controlled Rectifier (SCR), Transistor, Triode Thyristor
R ..... Resistor
RT ..... Thermistor
S ..... Switch
T ..... Transformer
TB ..... Terminal Board
TC ..... Thermocouple
TP ..... Test Point
U ..... Integrated Circuit, Microcircuit
V ..... Electron Tube
VR ... Breakdown Diode (Zener), Voltage Regulator
W ..... Cable, Transmission Path, Wire
X ..... Socket
Y ..... Crystal Unit (Piezoelectric, Quartz)
Z ... Tuned Cavity, Tuned Circuit

ABBREVIATIONS

A

A ..... Across Flats, Acrylic, Air (Dry Method), Ampere
ADJ ..... Adjust, Adjustment
ALC ..... Alcohol, Automatic Level Control
AM ..... Amplitude Modulation
AMP ..... Amperage
AMPL ..... Amplifier
ANLG ..... Analog
ASSY ..... Assembly
ASTBL ..... Astable
ATTEN ... Attenuation, Attenuator

B

BCD ..... Binary Coded Decimal
BFR ..... Before, Buffer
BNC ..... Type of Connector
BSC ..... Basic

C

C ..... Capacitance, Capacitor, Center Tapped, Centistoke, Ceramic, Cermet, Circular Mil Foot, Closed Cup, Cold, Compression
CER ..... Ceramic
CH ..... Center Hole
CHAM ..... Chamfer
CNTR ..... Container, Counter
COAX ..... Coaxial
COM .... Commercial, Common
CONN .... Connect, Connection, Connector
CONT ..... Contact, Continuous, Control, Controller
CONV ..... Converter
CP ..... Cadmium Plate, Candle Power, Centipoise, Conductive Plastic, Cone Point
CRP ..... Crepe, Crimp
CS .... Case, Centistoke, Cesium, Cross Section

D

D ..... Deep, Depletion, Depth, Diameter, Direct Current
DB ..... Decibel, Double Break
DBL ..... Double
DCDR ..... Decoder
DEG ..... Degree
DIFF ..... Differential
DO ... Package Type Designation
DRVR ..... Driver
DX ..... Duplex

E

E-MODE ... Enhancement Mode
ECL ..... Emitter-Coupled Logic
EPROM ..... Eraseable Programmable Read Only Memory
EXCL ..... Excluding, Exclusive
EXT ..... Extended, Extension, External, Extinguish

F

F ..... Fahrenheit, Farad, Female, Film (Resistor), Fixed, Flange, Flint, Fluorine, Frequency
FEM ..... Female
FF ... Flange, Female Connection; Flip Flop
FL ..... Flash, Flat, Fluid
FM ... Flange, Male Connection; Foam, Frequency Modulation
FR ..... Folder
FT ..... Current Gain Bandwidth Product (Transition Frequency); Feet, Foot
FXD ..... Fixed

G

GE ..... Germanium
GEN ..... General, Generator
GHZ ..... Gigahertz
GL ..... Glass
GP ..... General Purpose, Group

H

HD ..... Hand, Hard, Head, Heavy Duty
HEX ..... Hexadecimal, Hexagon, Hexagonal

Table 6-1. Manufacturers Code List, Reference Designations, and Abbreviations (2 of 3)

HI ..... High
HS .... Heat Sealed, Heat Shrink, High Speed

I

IC ..... Collector Current, Integrated Circuit
ID ..... Identification, Inside Diameter
IF ..... Forward Current, Intermediate Frequency
IN ..... Inch, Indium
IN ..... Inch, Indium
INP ..... Input
INT ..... Integral, Intensity, Internal
INTL ..... Internal, International
INV ..... Invert, Inverter

J

J-FET ..... Junction Field Effect Transistor
JFET ..... Junction Field Effect Transistor
JGK ..... Jade Gray Knob (HP 6009-0021)

K

KB ..... Knob

L

LED ..... Light Emitting Diode
LG ..... Length, Long
LKG ..... Leakage, Locking
LKWR ..... Lockwasher
LO ..... Local Oscillator, Low
LS ..... Loudspeaker, Low Power Schottky, Series Inductance
LT ..... Left, Light, Liter

M

MA ..... Milliampere
MACH ..... Machined
MCD ..... Millicandela
MISC ..... Miscellaneous
MLD ..... Mold, Molded
MOD ..... Model, Modified, Modular, Modulated, Modulator
MONO/ASTBL ..... Monostable/ Astable
MONOSTBL ..... Monostable
MOSFET ..... Metal Oxide Semiconductor Field Effect Transistor
MTG ..... Mounting
MV ..... Millivolt, Multivibrator
MW ..... Milliwatt

N

N-CHAN ..... N-Channel
NAND ..... Logic Not-AND
NM .... Nanometer, Nonmetallic
NMOS ..... N-Channel Metal Oxide Semiconductor
NO .... Normally Open, Number
NPN ... Negative Positive Negative (Transistor)
NS ..... Nanosecond, Non-Shorting, Nose

O

OCTL ..... Octal
OD ..... Olive Drab, Outside Diameter
OP ..... Operational
OPT ... Optical, Option, Optional

P

PAN-HD ..... Pan Head
PC ..... Picocoulomb, Piece, Printed Circuit
PCB ..... Printed Circuit Board
PD ..... Pad, Palladium, Pitch Diameter, Power Dissipation
PF ..... Picofarad; Pipe, Female Connection; Power Factor
PL ..... Phase Lock, Plain, Plate, Plug
PLSTC ..... Plastic
POS ..... Position, Positive
POZI ..... Pozidriv Recess
PRCN ..... Precision
PRP ..... Purple, Purpose
PVC ..... Polyvinyl Chloride

Q

QUAD ..... Set of Four

R

RCVR ..... Receiver
RCVY ..... Recovery
REF ..... Reference
RES ..... Research, Resistance, Resistor, Resolution
RETRIG ..... Retriggerable
RGLTR ..... Regulator
RKR ..... Rocker
RND ..... Round
RPG .... Rotary Pulse Generator
RT ..... Real Time, Right

S

SCR ..... Screw, Scrub, Silicon Controlled Rectifier
SEC ..... Second, Secondary
SGL ..... Single
SHFT ..... Shaft
SI ..... Silicon, Square Inch
SLDR ..... Solder
SM ..... Samarium, Seam, Small, Square Meter, Sub Modular, Subminiature
SMB ..... Subminiature, B Type (Snap-On Connector)
SNP ..... Snap
STAT ..... Status
STL ..... Steel
SW ..... Single Wall, Switch
SZ ..... Size

T

TA ..... Ambient Temperature, Tantalum
TC ..... Thermoplastic
THD ..... Thread, Threaded
THK ..... Thick
TPG ..... Tapping
TPL ..... Triple
TRIG ..... Trigger, Triggerable, Triggering, Trigonometry
TRMR ..... Trimmer
TRN ..... Turn, Turns
TTL ..... Tan Translucent, Transistor Transistor Logic

U

U/W ..... Used With
UF ..... Microfarad

V

V ..... Vanadium, Variable, Violet, Volt, Voltage
VAR ..... Variable
VDC ..... Volts, Direct Current
VID ..... Video

Table 6-1. Manufacturers Code List, Reference Designations, and Abbreviations (3 of 3)

8412 MANUFACTURERS CODE LIST AS OF 11/06/81 PAGE 1

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
00000	ANY SATISFACTORY SUPPLIER			
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS	SC	29671
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
02768	ILLINOIS TOOL WORKS INC FASTEX DIV	DES PLAINES	IL	60016
03888	K D I PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85008
06665	PRECISION MONOLITHICS INC	SANTA CLARA	CA	95050
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
11236	CTS OF BERNE INC	BERNE	IN	46711
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
27167	CORNING GLASS WORKS (WILMINGTON)	WILMINGTON	NC	28401
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
3L585	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	
30983	MEPCO/ELECTRA CORP	SAN DIEGO	CA	92121
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
54294	SHALLCROSS INC	SELMA	NC	27576
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
72136	ELECTRO MOTIVE CORP	FLORENCE	SC	06226
73138	BECKMAN INSTRUMENTS INC HELIPOT DIV	FULLERTON	CA	92634
74970	JOHNSON E F CO	WASECA	MN	56093
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
75915	LITTELFUSE INC	DES PLAINES	IL	60016
76680	FEDERAL-MOGUL CORP RBR & PLSTC GP	REDWOOD CITY	CA	94062
91637	DALE ELECTRONICS INC	COLUMBUS	NE	68601

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	**08412-60061**	**9**	**1**	**PHASE DETECTOR ASSEMBLY**	**28480**	**08412-60061**
A1C1	0160-0174	9	8	CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A1C2	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A1C3	0160-4835	7	33	CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C4	0160-2228	8	1	CAPACITOR-FXD 2700PF ±5% 300VDC MICA	28480	0160-2228
A1C5	0160-4832	4	4	CAPACITOR-FXD .01UF ±10% 100VDC CER	28480	0160-4832
A1C6	0160-4832	4		CAPACITOR-FXD .01UF ±10% 100VDC CER	28480	0160-4832
A1C7	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C8	0180-0116	1	14	CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A1C9	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A1C10	0180-0197	8	10	CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A1C11	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C12	0180-2141	6	2	CAPACITOR-FXD 3.3UF±10% 50VDC TA	56289	150D335X9050B2
A1C13	0180-2141	6		CAPACITOR-FXD 3.3UF±10% 50VDC TA	56289	150D335X9050B2
A1C14	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C15	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C16	0160-0301	4	2	CAPACITOR-FXD .012UF ±10% 200VDC POLYE	28480	0160-0301
A1C17	0160-0301	4		CAPACITOR-FXD .012UF ±10% 200VDC POLYE	28480	0160-0301
A1C18	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C19	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A1C20	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A1C21	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C22	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A1C23	0160-4574	1	1	CAPACITOR-FXD 1000PF ±10% 100VDC CER	28480	0160-4574
A1C24	0160-4832	4		CAPACITOR-FXD .01UF ±10% 100VDC CER	28480	0160-4832
A1CR1	1901-0028	5	3	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A1L1	9100-1641	0	11	INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A1L2	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A1L3	9100-1664	7	3	INDUCTOR RF-CH-MLD 3MH 5% .23DX.57LG	28480	9100-1664
A1L4	9100-2459	0	4	INDUCTOR RF-CH-MLD 121UH 1% .166DX.385LG	28480	9100-2459
A1Q1	1853-0451	5	10	TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A1Q2	1853-0316	1	1	TRANSISTOR-DUAL PNP PD=500MW	28480	1853-0316
A1R1	0757-0280	3	43	RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A1R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A1R3	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A1R4	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A1R5	0757-0274	5	3	RESISTOR 1.21K 1% .125W F TC=0±100	24546	C4-1/8-TO-1211-F
A1R6	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0±100	24546	C4-1/8-TO-1211-F
A1R7	0698-0083	8	4	RESISTOR 1.96K 1% .125W F TC=0±100	24546	C4-1/8-TO-1961-F
A1R8	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0±100	24546	C4-1/8-TO-1961-F
A1R9	0698-0084	9	4	RESISTOR 2.15K 1% .125W F TC=0±100	24546	C4-1/8-TO-2151-F
A1R10	0698-3440	7	10	RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A1R11	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A1R12	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0±100	24546	C4-1/8-TO-2151-F
A1R13	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0±100	24546	C4-1/8-TO-2151-F
A1R14	0698-4425	0	1	RESISTOR 1.54K 1% .125W F TC=0±100	24546	C4-1/8-TO-1541-F
A1R15	2100-3212	8	2	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	28480	2100-3212
A1R16	0698-3152	8	1	RESISTOR 3.48K 1% .125W F TC=0±100	24546	C4-1/8-T0-3481-F
A1R17	0757-0401	0	17	RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A1R18	0757-0279	0	7	RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A1R19	0757-0402	1	2	RESISTOR 110 1% .125W F TC=0±100	24546	C4-1/8-TO-111-F
A1R20	0698-0082	7	6	RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A1R21	2100-0568	1		RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568
A1R22	0757-0428	1	4	RESISTOR 1.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-1621-F
A1R23	0757-0421	4	1	RESISTOR 825 1% .125W F TC=0±100	24546	C4-1/8-T0-825R-F
A1R24	0698-6624	5	2	RESISTOR 2K .1% .125W F TC=0±25	28480	0698-6624
A1R25	0698-6624	5		RESISTOR 2K .1% .125W F TC=0±25	28480	0698-6624
A1R26	0698-3237	0	1	RESISTOR 5K .25% .125W F TC=0±50	28480	0698-3237
A1R27	0698-3236	9	1	RESISTOR 15K .25% .125W F TC=0±50	28480	0698-3236
A1R28	0757-0123	3	1	RESISTOR 34.8K 1% .125W F TC=0±100	28480	0757-0123
A1R29	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A1R30	0698-6362	8	1	RESISTOR 1K .1% .125W F TC=0±25	28480	0698-6362
A1R31	0757-0442	9	32	RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A1TP1	0360-0535	0	20	TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A1U1	1820-1308	4	4	IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116L
A1U2	1820-1225	4	3	IC FF ECL D-M/S DUAL	04713	MC10231P
A1U3	1810-0037	3	1	NETWORK-RES 16-DIP1.0K OHM X 8	11236	761-3-R1K
A1U4	1858-0032	8	4	TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A1U5	1826-0229	8	3	IC OP AMP LOW-DRIFT TO-99 PKG	06665	OP-05CJ
A1U6	1826-0229	8		IC OP AMP LOW-DRIFT TO-99 PKG	06665	OP-05CJ
A1VR1	1902-0692	1	2	DIODE-ZNR 6.3V 1% DO-7 PD=.4W TC=+.001%	28480	1902-0692

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1VR2	1902-0692	1		DIODE-ZNR 6.3V 1% DO-7 PD=.4W TC=+.001%	28480	1902-0692
A2	**08412-60062**	**0**	**1**	**PHASE OFFSET BOARD ASSEMBLY**	**28480**	**08412-60062**
A2C1	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C2	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C3	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C4	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C5	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C6	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C7	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C8	0160-3009	5	1	CAPACITOR-FXD 982PF ±1% 100VDC MICA	28480	0160-3009
A2C9	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C10	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C11	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C12	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C13	0160-4819	7	2	CAPACITOR-FXD 2200PF ±5% 100VDC CER	28480	0160-4819
A2C14	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C15	0160-4819	7		CAPACITOR-FXD 2200PF ±5% 100VDC CER	28480	0160-4819
A2C16	0160-0174	9		CAPACITOR-FXD .47UF +80-20% 25VDC CER	28480	0160-0174
A2C17	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C18	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C19	0160-3537	4	1	CAPACITOR-FXD 680PF ±5% 100VDC MICA	28480	0160-3537
A2C20	0121-0451	3	1	CAPACITOR-V TRMR-AIR 1.7-11PF 175V	74970	187-0106-028
A2C21	0160-3535	2	1	CAPACITOR-FXD 560 ±1% 300VDC MICA	28480	0160-3535
A2C22	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C23	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C24	0180-0291	3	8	CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A2C25	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C26	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C27	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C28	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A2C29	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A2C30	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A2C31	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A2C32	0160-4832	4		CAPACITOR-FXD .01UF ±10% 100VDC CER	28480	0160-4832
A2C33	0160-2306	3		CAPACITOR-FXD 27PF ±1% 300VDC MICA	28480	0160-2306
A2CR1	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A2CR2	1901-0033	2	8	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2CR3	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2CR4	1901-0179	7	2	DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A2CR5	1901-0179	7		DIODE-SWITCHING 15V 50MA 750PS DO-7	28480	1901-0179
A2CR6	0122-0300	3	1	DIODE-VVC 100PF 5% C2/C20-MIN=2 BVR=20V	28480	0122-0300
A2CR7	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2CR8	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A2L1	9140-0318	0	1	INDUCTOR RF-CH-MLD 338UH 1% .166DX.385LG	28480	9140-0318
A2L2	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A2L3	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A2L4	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A2L5	9100-2459	0		INDUCTOR RF-CH-MLD 121UH 1% .166DX.385LG	28480	9100-2459
A2L6	9100-2459	0		INDUCTOR RF-CH-MLD 121UH 1% .166DX.385LG	28480	9100-2459
A2L7	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A2Q1	1854-0019	3	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A2Q2	1854-0295	7	4	TRANSISTOR-DUAL NPN PD=400MW	28480	1854-0295
A2Q3	1854-0295	7		TRANSISTOR-DUAL NPN PD=400MW	28480	1854-0295
A2Q4	1854-0071	7	12	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2R1	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A2R2	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A2R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A2R4	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R5	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R7	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R8	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R9	0757-0278	9	1	RESISTOR 1.78K 1% .125W F TC=0±100	24546	C4-1/8-T0-1781-F
A2R10	0698-6652	9	1	RESISTOR 1.74K 1% .125W F TC=0±25	28480	0698-6652
A2R11	2100-0568	1	1	RESISTOR-TRMR 100 10% C TOP-ADJ 1-TRN	28480	2100-0568
A2R12	0698-3441	8	1	RESISTOR 215 1% .125W F TC=0±100	24546	C4-1/8-T0-215R-F
A2R13	2100-0554	5	1	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A2R14	0698-3447	4	1	RESISTOR 422 1% .125W F TC=0±100	24546	C4-1/8-T0-422R-F
A2R15	0698-8911	7	2	RESISTOR 1.3K .1% .125W F TC=0±25	28480	0698-8911
A2R16	0757-0317	7	2	RESISTOR 1.33K 1% .125W F TC=0±100	24546	C4-1/8-T0-1331-F
A2R17	0698-3446	3	1	RESISTOR 383 1% .125W F TC=0±100	24546	C4-1/8-T0-383R-F
A2R18	0698-8911	7		RESISTOR 1.3K .1% .125W F TC=0±25	28480	0698-8911
A2R19				DELETED		
A2R20				DELETED		
A2R21	0698-6620	1	2	RESISTOR 150K .1% .125W F TC=0±25	28480	0698-6620
A2R22	0698-6628	9	2	RESISTOR 500K .1% .125W F TC=0±25	91637	MFF-1/8-T9-5003-B
A2R23				DELETED		
A2R24	0698-6620	1		RESISTOR 150K .1% .125W F TC=0±25	28480	0698-6620

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R25				DELETED		
A2R26	0698-6628	9		RESISTOR 500K .1% .125W F TC=0±25	91637	MFF-1/8-T9-5003-B
A2R27	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A2R28	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R29	0757-0438	3	22	RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A2R30	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A2R31	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R33	0698-0085	0	3	RESISTOR 2.61K 1% .125W F TC=0±100	24546	C4-1/8-T0-2611-F
A2R34	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A2R35	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A2R36	0698-3158	4	4	RESISTOR 23.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2372-F
A2R37	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2372-F
A2R38	0698-3429	2	2	RESISTOR 19.6 1% .125W F TC=0±100	03888	PME55-1/8-T0-19R6-F
A2R39	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2R40	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A2R41	0757-0199	3	1	RESISTOR 21.5K 1% .125W F TC=0±100	24546	C4-1/8-T0-2152-F
A2R42	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A2TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP7	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2TP8	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A2U1	1820-1545	1	1	IC MULTIPLXR 2-CHAN-ANLG TRIPLE 16-DIP-C	3L585	CD4053BY
A2U2	1820-1308	4		IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116L
A2U3	1810-0205	7	4	NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A2U4	1820-1225	4		IC FF ECL D-M/S DUAL	04713	MC10231P
A2U5	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A2U6	1826-0229	8		IC OP AMP LOW-DRIFT TO-99 PKG	06665	OP-05CJ
A2U7	1820-1119	5	1	IC OSC ECL	04713	MC1648L
A2U8	1820-1225	4		IC FF ECL D-M/S DUAL	04713	MC10231P
A2VR1	1902-3002	3	1	DIODE-ZNR 2.37V 5% DO-35 PD=.4W	28480	1902-3002
A2VR2	1902-3048	7		DIODE-ZNR 3.48V 5% DO-35 PD=.4W	28480	1902-3048
A3	**08412-60063**	**1**	**1**	**MULTIPLIER/DEFLECTION BOARD ASSEMBLY**	**28480**	**08412-60063**
A3C1	0160-3879	7	4	CAPACITOR-FXD .01UF ±20% 100VDC CER	28480	0160-3879
A3C2	0160-3879	7		CAPACITOR-FXD .01UF ±20% 100VDC CER	28480	0160-3879
A3C3	0160-0575	4	1	CAPACITOR-FXD .047UF ±20% 50VDC CER	28480	0160-0575
A3C4	0180-0374	3	4	CAPACITOR-FXD 10UF±10% 20VDC TA	56289	150D106X9020B2
A3C5	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A3C6	0160-0574	3	2	CAPACITOR-FXD .022UF ±20% 100VDC CER	28480	0160-0574
A3C7	0160-0574	3		CAPACITOR-FXD .022UF ±20% 100VDC CER	28480	0160-0574
A3C8	0160-0302	5	1	CAPACITOR-FXD .018UF ±10% 200VDC POLYE	28480	0160-0302
A3C9	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A3C10	0160-3536	3	4	CAPACITOR-FXD 620PF ±5% 100VDC MICA	28480	0160-3536
A3C11	0160-3536	3		CAPACITOR-FXD 620PF ±5% 100VDC MICA	28480	0160-3536
A3C12	0160-3879	7		CAPACITOR-FXD .01UF ±20% 100VDC CER	28480	0160-3879
A3C13	0160-3879	7		CAPACITOR-FXD .01UF ±20% 100VDC CER	28480	0160-3879
A3C14	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A3C15	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A3C16	0180-0374	3		CAPACITOR-FXD 10UF±10% 20VDC TA	56289	150D106X9020B2
A3CR1	1901-0040	1	15	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR4	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR10	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR11	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A3E1	1200-0173	5	4	INSULATOR-XSTR DAP-GL	28480	1200-0173
A3L1	9100-1664	7		INDUCTOR RF-CH-MLD 3MH 5% .23DX.57LG	28480	9100-1664
A3L2	9100-1664	7		INDUCTOR RF-CH-MLD 3MH 5% .23DX.57LG	28480	9100-1664
A3L3	9140-0210	1	1	INDUCTOR RF-CH-MLD 100UH 5% .166DX.385LG	28480	9140-0210
A3MP1	1205-0050	7	2	HEAT SINK TO-5/TO-39-CS	28480	1205-0050
A3Q1	1854-0232	2	4	TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A3Q2	1854-0404	0	5	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A3Q3	1854-0404	0		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A3Q4	1854-0475	5	5	TRANSISTOR-DUAL NPN PD=750MW	28480	1854-0475
A3Q5	1854-0404	0		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3Q6	1854-0404	0		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A3Q7	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A3Q8	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q10	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A3Q11	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A3Q12	1854-0404	0		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A3Q13	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A3Q14	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A3Q15	1854-0475	5		TRANSISTOR-DUAL NPN PD=750MW	28480	1854-0475
A3Q16	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A3R1	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A3R2	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R5				DELETED		
A3R6	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R7	0698-3646	5	2	RESISTOR 12K 5% 2W MO TC=0±200	27167	FP42-2-T00-1202-J
A3R8	0698-3646	5		RESISTOR 12K 5% 2W MO TC=0±200	27167	FP42-2-T00-1202-J
A3R9	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2372-F
A3R10	2100-2515	2	1	RESISTOR-TRMR 200K 10% C SIDE-ADJ 1-TRN	30983	ET50W204
A3R11	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A3R12	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A3R13	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A3R14	0698-3443	0	4	RESISTOR 287 1% .125W F TC=0±100	24546	C4-1/8-T0-287R-F
A3R15	0698-3443	0		RESISTOR 287 1% .125W F TC=0±100	24546	C4-1/8-T0-287R-F
A3R16	0757-0198	2	1	RESISTOR 100 1% .5W F TC=0±100	28480	0757-0198
A3R17	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R18	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A3R19	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R20	2100-2521	0	2	RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	ET50X202
A3R21	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R22	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R23	0757-0317	7		RESISTOR 1.33K 1% .125W F TC=0±100	24546	C4-1/8-T0-1331-F
A3R24	0698-3443	0		RESISTOR 287 1% .125W F TC=0±100	24546	C4-1/8-T0-287R-F
A3R25	0698-3443	0		RESISTOR 287 1% .125W F TC=0±100	24546	C4-1/8-T0-287R-F
A3R26	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R27	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A3R28	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R29	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R30	2100-2521	0		RESISTOR-TRMR 2K 10% C SIDE-ADJ 1-TRN	30983	ET50X202
A3R31	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R32	0757-0465	6	8	RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R33	0757-0458	7	6	RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A3R34	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A3R35	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R36	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R37	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R38	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R39	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R40	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R41	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R42	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R43	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R44	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R45	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R46	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R47	0698-3155	1	7	RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A3R48	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A3R49	0698-3449	6	2	RESISTOR 28.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2872-F
A3R50	0698-3449	6		RESISTOR 28.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2872-F
A3R51	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A3R52	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-1621-F
A3R53	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R54	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R55				DELETED		
A3R56	0757-0309	7	2	RESISTOR 61.9K 1% .5W F TC=0±100	28480	0757-0309
A3R57	0757-0309	7		RESISTOR 61.9K 1% .5W F TC=0±100	28480	0757-0309
A3R58	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R59	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R60	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R61	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R62	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R63	0757-0795	5	1	RESISTOR 75 1% .5W F TC=0±100	19701	MF-1/2-T0-75R0-F
A3R64	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R65	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R66	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R67	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R68	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3R69	0757-0459	8	2	RESISTOR 56.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-5622-F
A3R70	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R71	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A3R72	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A3R73	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A3R74	0757-0279	0		RESISTOR 3.16K 1% .125W F TC=0±100	24546	C4-1/8-T0-3161-F
A3R75	0757-0459	8		RESISTOR 56.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-5622-F
A3R76	0698-3151	7	1	RESISTOR 2.87K 1% .125W F TC=0±100	24546	C4-1/8-T0-2871-F
A3R77	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R78	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A3R79	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R80	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R81	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A3R82	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R83	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A3R84	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3R85	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A3R86	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A3S1	3101-1273	0	1	SWITCH-SL DPDT SUBMIN 2A 120VAC PC	28480	3101-1273
A3TP1	1251-0600	0	12	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP5	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP6	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP7	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP8	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP9	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP10	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP11	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3TP12	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A3U1	1826-0582	6	3	IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U2	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A3U3	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U4	1826-0582	6		IC SWITCH ANLG QUAD 16-DIP-C PKG	27014	LF13201D
A3U5	1826-0092	3	1	IC OP AMP GP DUAL TO-99 PKG	28480	1826-0092
A3VR1	1902-0202	9	4	DIODE-ZNR 15V 5% PD=1W IR=5UA	28480	1902-0202
A3VR2	1902-0202	9		DIODE-ZNR 15V 5% PD=1W IR=5UA	28480	1902-0202
A3VR3	1902-0049	2	2	DIODE-ZNR 6.19V 5% DO-35 PD=.4W	28480	1902-0049
A3VR4	1902-0041	4	2	DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
A3VR5	1902-0041	4		DIODE-ZNR 5.11V 5% DO-35 PD=.4W	28480	1902-0041
	0380-0059	5	1	SPACER-RVT-ON .25-IN-LG .152-IN-ID	00000	ORDER BY DESCRIPTION
A4	**08412-60011**	**9**	**1**	**PHASE OFFSET & FUNCTION SWITCH ASSY** (DOES NOT INCLUDE A4A1)	**28480**	**08412-60011**
A4E1	08412-40005	9	1	CONNECTOR-PC SPACER	28480	08412-40005
A4R1	0698-5438	7	9	RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R2	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R3	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R4	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R5	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R6	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R7	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R8	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R9	0698-5438	7		RESISTOR 100 .25% .125W F TC=0±50	28480	0698-5438
A4R10	0698-6076	1	1	RESISTOR 39K 1% .125W F TC=0±100	24546	C4-1/8-T0-3902-F
A4R11	0698-6253	6	2	RESISTOR 9K .5% .125W F TC=0±100	24546	C4-1/8-T0-9001-D
A4R12	0757-1093	8	1	RESISTOR 3K 1% .125W F TC=0±100	24546	C4-1/8-T0-3001-F
A4R13				DELETED		
A4R14	0698-7354	0	1	RESISTOR 99K 1% .125W F TC=0±100	19701	MF4C1/8-T0-9902-F
A4R15	0698-6253	6		RESISTOR 9K .5% .125W F TC=0±100	24546	C4-1/8-T0-9001-D
A4R16	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0±100	24546	C4-1/8-T0-1211-F
A4R17	0757-0402	1		RESISTOR 110 1% .125W F TC=0±100	24546	C4-1/8-T0-111-F
A4A1	08412-60012	0	1	SWITCH BOARD (DOES NOT INCLUDE A4)	28480	08412-60012
A5	**08412-60048**	**2**	**1**	**HIGH VOLTAGE POWER SUPPLY & REGULATOR**	**28480**	**08412-60048**
A5C1	0160-0889	3	1	CAPACITOR-FXD .33UF ±10% 80VDC POLYE	28480	0160-0889
A5C2	0170-0040	9	1	CAPACITOR-FXD .047UF ±10% 200VDC POLYE	56289	292P47392
A5C3				NOT ASSIGNED		
A5C4				NOT ASSIGNED		
A5C5	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A5C6	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A5C7	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A5C8	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A5C9				NOT ASSIGNED		

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5C10	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A5C11	0160-2236	8	1	CAPACITOR-FXD 1PF ±.25PF 500VDC CER	28480	0160-2236
A5C12	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A5C13	0160-3460	2	2	CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0160-3460
A5C14	0160-3460	2		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0160-3460
A5C15	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A5C16	0160-3007	3	4	CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3007
A5C17	0160-3008	4	3	CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3008
A5C18	0160-3007	3		CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3007
A5C19	0160-3008	4		CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3008
A5C20	0160-3007	3		CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3007
A5C21	0160-2403	1	1	CAPACITOR-FXD 1500PF ±20% 5KVDC CER	28480	0160-2403
A5CR1	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR2	1902-0049	2		DIODE-ZNR 6.19V 5% DO-35 PD=.4W	28480	1902-0049
A5CR3	1901-0050	3	8	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR4	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A5CR5	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR6	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR9	1901-0026	3	1	DIODE-PWR RECT 200V 750MA DO-29	28480	1901-0026
A5CR10	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A5CR11	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR12	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A5CR13	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A5L1	9100-1630	7	5	INDUCTOR RF-CH-MLD 51UH 5% .166DX.385LG	28480	9100-1630
A5L2	9100-1630	7		INDUCTOR RF-CH-MLD 51UH 5% .166DX.385LG	28480	9100-1630
A5L3	9100-1630	7		INDUCTOR RF-CH-MLD 51UH 5% .166DX.385LG	28480	9100-1630
A5L4	9100-1630	7		INDUCTOR RF-CH-MLD 51UH 5% .166DX.385LG	28480	9100-1630
A5L5	9100-1630	7		INDUCTOR RF-CH-MLD 51UH 5% .166DX.385LG	28480	9100-1630
A5MP1	1205-0011	0	1	HEAT SINK TO-5/TO-39-CS	28480	1205-0011
A5MP2	1205-0085	8	2	HEAT SINK TO-66-CS	28480	1205-0085
A5Q1	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q3	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q4	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q5	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q6	1853-0038	4	2	TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A5Q7	1854-0022	8	1	TRANSISTOR NPN SI TO-39 PD=700MW	07263	S17843
A5Q8	1854-0475	5		TRANSISTOR-DUAL NPN PD=750MW (RECOMMENDED REPLACEMENT)	28480	1854-0475
A5Q9	1853-0038	4		TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0038
A5Q10	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q11	1854-0282	2	1	TRANSISTOR NPN 2N3583 SI TO-66 PD=35W	3L585	2N3583
A5Q12	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q13	1853-0451	5		TRANSISTOR PNP 2N3799 SI TO-18 PD=360MW	01295	2N3799
A5Q14	1855-0020	8	1	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0020
A5R1	0757-0464	5	1	RESISTOR 90.9K 1% .125W F TC=0±100	24546	C4-1/8-T0-9092-F
A5R2*	0757-0466	7	1	RESISTOR 110K 1% .125W F TC=0±100	24546	C4-1/8-T0-1103-F
A5R3	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A5R4	0698-3136	8	2	RESISTOR 17.8K 1% .125W F TC=0±100	24546	C4-1/8-T0-1782-F
A5R5	0757-1094	9	1	RESISTOR 1.47K 1% .125W F TC=0±100	24546	C4-1/8-T0-1471-F
A5R6	0698-3432	7	1	RESISTOR 26.1 1% .125W F TC=0±100	03888	PME55-1/8-T0-26R1-F
A5R7	0757-0467	8	1	RESISTOR 121K 1% .125W F TC=0±100	24546	C4-1/8-T0-1213-F
A5R8	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A5R9	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0±100	24546	C4-1/8-T0-1961-F
A5R10	0698-3338	2	1	RESISTOR 1.5K 5% 2W MO TC=0±200	28480	0698-3338
A5R11	0698-3158	4		RESISTOR 23.7K 1% .125W F TC=0±100	24546	C4-1/8-T0-2372-F
A5R12	0757-0420	3	1	RESISTOR 750 1% .125W F TC=0±100	24546	C4-1/8-T0-751-F
A5R13	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A5R14	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A5R15	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A5R16	0698-3157	3	2	RESISTOR 19.6K 1% .125W F TC=0±100	24546	C4-1/8-T0-1962-F
A5R17	0757-0200	7	2	RESISTOR 5.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-5621-F
A5R18	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-5621-F
A5R19	0698-3435	0	1	RESISTOR 38.3 1% .125W F TC=0±100	24546	C4-1/8-T0-38R3-F
A5R20	0698-0335	3	1	RESISTOR-FXD 3.3 5% 0.5W	28480	0698-0335
A5R21	0698-3450	9	2	RESISTOR 42.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-4222-F
A5R22	0698-3450	9		RESISTOR 42.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-4222-F
A5R23	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A5R24	0698-3444	1	2	RESISTOR 316 1% .125W F TC=0±100	24546	C4-1/8-T0-316R-F
A5R25	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A5R26	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A5R27	2100-1618	4	1	RESISTOR-TRMR 1M 20% C TOP-ADJ 1-TRN	32997	3329H-1-105
A5R28	0698-8427	0	2	RESISTOR 29M 10% 1W C TC=0±250	28480	0698-8427
A5R29	0686-1055	1	1	RESISTOR 1M 5% .5W CC TC=0+1000	01121	EB1055
A5R30	0683-1215	9	1	RESISTOR 120 5% .25W FC TC=-400/+600	01121	CB1215
A5R31	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100 (RECOMMENDED REPLACEMENT)	24546	C4-1/8-T0-1001-F
A5R33	0698-3444	1		RESISTOR 316 1% .125W F TC=0±100	24546	C4-1/8-T0-316R-F
A5R34	0698-8018	5	1	RESISTOR 30M 1% 3W C TC=0±100	03888	PVC175-3-T0-3004-F
A5R35	0686-2225	9	1	RESISTOR 2.2K 5% .5W CC TC=0+647	01121	EB2225
A5R36	0686-3355	8	1	RESISTOR 3.3M 5% .5W CC TC=0+1000	01121	EB3355
A5R37	0698-8427	0		RESISTOR 29M 10% 1W C TC=0±250	28480	0698-8427
A5R38	0686-4735	0	1	RESISTOR 47K 5% .5W CC TC=0+765	01121	EB4735
A5R39	0686-6235	9	1	RESISTOR 62K 5% .5W CC TC=0+765	01121	EB6235
A5R40	2100-2650	6	1	RESISTOR-TRMR 200K 10% C TOP-ADJ 1-TRN	73138	82PR200K
A5R41	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A5R42	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0±100	24546	C4-1/8-T0-1961-F
A5R43	0757-0465	6		RESISTOR 100K 1% .125W F TC=0±100	24546	C4-1/8-T0-1003-F
A5R44	0757-0458	7		RESISTOR 51.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-5112-F
A5R45	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A5R46	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A5R47	0698-3260	9	2	RESISTOR 464K 1% .125W F TC=0±100	28480	0698-3260
A5R48	0698-3260	9		RESISTOR 464K 1% .125W F TC=0±100	28480	0698-3260
A5V1	2140-0014	6	1	LAMP-GLOW 4A8 135/70VDC 500UA T-2-BULB	28480	2140-0014
A6	**08412-60006**	**2**	**1**	**HIGH VOLTAGE TRANSFORMER & RECTIFIER**	**28480**	**08412-60006**
A6C1	0160-3007	3		CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3007
A6C2	0160-3008	4		CAPACITOR-FXD 4700PF ±20% 4KVDC CER	28480	0160-3008
A6CR1	1901-0341	5	2	DIODE-HV RECT 7.5KV 10MA 250NS	28480	1901-0341
A6CR2	1901-0341	5		DIODE-HV RECT 7.5KV 10MA 250NS	28480	1901-0341
A6MP1	2200-0125	8	2	SCREW-MACH 4-40 1.5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A6MP2	2200-0125	8		SCREW-MACH 4-40 1.5-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
A6MP3	2260-0001	5	2	NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001
A6MP4	2260-0001	5		NUT-HEX-DBL-CHAM 4-40-THD .094-IN-THK	28480	2260-0001
A6MP5	5040-0402	7	1	TRANSFORMER MOUNT	28480	5040-0402
A6MP6	5040-0430	1	1	PLASTIC HOLDER	28480	5040-0430
A6MP7	08412-20022	8	4	SPACER, HV POWER SUPPLY RECTIFIER	28480	08412-20022
A6MP8	08412-20022	8		SPACER, HV POWER SUPPLY RECTIFIER	28480	08412-20022
A6MP9	08412-20022	8		SPACER, HV POWER SUPPLY RECTIFIER	28480	08412-20022
A6MP10	08412-20022	8		SPACER, HV POWER SUPPLY RECTIFIER	28480	08412-20022
A6R1	0683-2235	5	1	RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A6R2	0683-1635	7	1	RESISTOR 16K 5% .25W FC TC=-400/+800	01121	CB1635
A6T1	08412-80001	9	1	TRANSFORMER ASSEMBLY-HIGH VOLTAGE	28480	08412-80001
*						
A7	**08412-60007**	**3**	**1**	**AMPLITUDE CHANNEL LOG CONVERTER ASSEMBLY**	**28480**	**08412-60007**
A7C1	0160-2225	5	2	CAPACITOR-FXD 2000PF ±5% 300VDC MICA	28480	0160-2225
A7C2	0160-2225	5		CAPACITOR-FXD 2000PF ±5% 300VDC MICA	28480	0160-2225
A7C3	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A7C4	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A7CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR3	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A7CR4	1902-0202	9		DIODE-ZNR 15V 5% PD=1W IR=5UA	28480	1902-0202
A7CR5	1902-0202	9		DIODE-ZNR 15V 5% PD=1W IR=5UA	28480	1902-0202
A7IC1	1826-0261	8	6	IC-LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0261
A7IC2	1826-0261	8		IC-LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0261
A7IC3	1826-0261	8		IC-LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0261
A7IC4	1826-0261	8		IC-LINEAR(RECOMMENDED REPLACEMENT)	28480	1826-0261
A7Q1	1854-0295	7		TRANSISTOR-DUAL NPN PD=400MW	28480	1854-0295
A7R1	0698-3153	9	1	RESISTOR 3.83K 1% .125W F TC=0±100	24546	C4-1/8-T0-3831-F
A7R2	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0±100	24546	C4-1/8-T0-2611-F
A7R3	0757-0441	8	4	RESISTOR 8.25K 1% .125W F TC=0±100	24546	C4-1/8-T0-8251-F
A7R4	0757-0439	4	1	RESISTOR 6.81K 1% .125W F TC=0±100	24546	C4-1/8-T0-6811-F
A7R5	0698-4348	6	1	RESISTOR 4.99M 1% .5W F TC=0±100	28480	0698-4348
A7R6	0757-0440	7	2	RESISTOR 7.5K 1% .125W F TC=0±100	24546	C4-1/8-T0-7501-F
A7R7	2100-1775	4	1	RESISTOR-TRMR 5K 5% WW TOP-ADJ 1-TRN	28480	2100-1775
A7R8	0757-0440	7		RESISTOR 7.5K 1% .125W F TC=0±100	24546	C4-1/8-T0-7501-F
A7R9	0757-0059	4	1	RESISTOR 1M 1% .5W F TC=0±100	28480	0757-0059
A7R10	0757-0444	1	4	RESISTOR 12.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1212-F
A7R11	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A7R12	0811-1780	6	1	RESISTOR 1K 5% .25W PWW TC=+3400±300	54294	VA12-1/4-1001-J
A7R13	0757-0447	4	2	RESISTOR 16.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-1622-F
A7R14	2100-1774	3	1	RESISTOR-TRMR 2K 5% WW TOP-ADJ 1-TRN	28480	2100-1774
A7R15	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A7R16	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A7R17	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A7R18	0698-3442	9	3	RESISTOR 237 1% .125W F TC=0±100	24546	C4-1/8-T0-237R-F
A7R19	0698-3442	9		RESISTOR 237 1% .125W F TC=0±100	24546	C4-1/8-T0-237R-F
A8	**08412-60008**	**4**	**1**	**LOW VOLTAGE POWER SUPPLY**	**28480**	**08412-60008**

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8C1	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A8C2	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A8C3	0160-2307	4	1	CAPACITOR-FXD 47PF ±5% 300VDC MICA	28480	0160-2307
A8C4	0180-1748	7	1	CAPACITOR-FXD 45UF+50-10% 250VDC AL	28480	0180-1748
A8IC1	1820-0247	8	1	IC V RGLTR TO-99 (RECOMMENDED REPLACEMENT)	27014	LM305H
A8IC2	1826-0261	8		IC-LINEAR (RECOMMENDEDED REPLACEMENT)	28480	1826-0261
A8MP1	1205-0085	8		HEAT SINK TO-66-CS	28480	1205-0085
A8Q1	1853-0027	1	1	TRANSISTOR PNP SI TO-39 PD=1W FT=100MHZ	28480	1853-0027
A8Q2	1854-0039	7	1	TRANSISTOR NPN 2N3053S SI TO-39 PD=1W	3L585	2N3053S
A8Q3	1853-0052	2	1	TRANSISTOR PNP 2N3740 SI TO-66 PD=25W	04713	2N3740
A8R1	0757-0290	5	1	RESISTOR 6.19K 1% .125W F TC=0±100	19701	MF4C1/8-T0-6191-F
A8R2	0698-0084	9		RESISTOR 2.15K 1% .125W F TC=0±100	24546	C4-1/8-T0-2151-F
A8R3	0757-0289	2	1	RESISTOR 13.3K 1% .125W F TC=0±100	19701	MF4C1/8-T0-1332-F
A8R4	2100-1773	2	1	RESISTOR-TRMR 1K 5% WW TOP-ADJ 1-TRN	28480	2100-1773
A8R5	0698-3491	8	2	RESISTOR 1K .1% .125W F TC=0±50	28480	0698-3491
A8R6	0698-3491	8		RESISTOR 1K .1% .125W F TC=0±50	28480	0698-3491
A8R7	0811-1666	7	1	RESISTOR 1 5% 2W PW TC=0±800	75042	BWH2-1R0-J
A8R8	2100-1777	6	1	RESISTOR-TRMR 20K 5% WW TOP-ADJ 1-TRN	28480	2100-1777
A8R9	0757-0984	4	2	RESISTOR 10 1% .5W F TC=0±100	28480	0757-0984
A8R10	0757-0984	4		RESISTOR 10 1% .5W F TC=0±100	28480	0757-0984
A8R11	0757-0310	0	1	RESISTOR 133K 1% .5W F TC=0±100	28480	0757-0310
A9	**08412-60056**	**2**	**1**	**TEST CHANNEL AM BOARD ASSEMBLY**	**28480**	**08412-60056**
A9C1	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C2	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C3	0180-0374	3		CAPACITOR-FXD 10UF±10% 20VDC TA	56289	150D106X9020B2
A9C4	0180-0374	3		CAPACITOR-FXD 10UF±10% 20VDC TA	56289	150D106X9020B2
A9C5	0160-0127	2	10	CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C6	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A9C7	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C8	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C9	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C10	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C11	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A9C12	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C13	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C14	0140-0184	9	1	CAPACITOR-FXD 8200PF ±1% 100VDC MICA	72136	DM20F822F0100WV1CR
A9C15	0160-3533	0	1	CAPACITOR-FXD 470PF ±5% 300VDC MICA	28480	0160-3533
A9C16	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C17	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C18	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C19	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C20	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C21	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A9C22	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C23	0180-0197	8		CAPACITOR-FXD 2.2UF±10% 20VDC TA	56289	150D225X9020A2
A9C24	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C25	0160-0127	2		CAPACITOR-FXD 1UF ±20% 25VDC CER	28480	0160-0127
A9C26	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C27	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C28	0180-0116	1		CAPACITOR-FXD 6.8UF±10% 35VDC TA	56289	150D685X9035B2
A9C29	0160-4835	7		CAPACITOR-FXD .1UF ±10% 50VDC CER	28480	0160-4835
A9C30	0160-2227	7	1	CAPACITOR-FXD 2400PF ±5% 300VDC MICA	28480	0160-2227
A9C31*	0160-2207	3	1	CAPACITOR-FXD 300PF ±5% 300VDC MICA	28480	0160-2207
A9CR1	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A9L1	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A9L2	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A9L3	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A9L4	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A9L5	9100-2209	8	1	INDUCTOR RF-CH-MLD 37.8UH .75DX.61LG	28480	9100-2209
A9L6	9100-1641	0		INDUCTOR RF-CH-MLD 240UH 5% .166DX.385LG	28480	9100-1641
A9L7	9100-2459	0		INDUCTOR RF-CH-MLD 121UH 1% .166DX.385LG	28480	9100-2459
A9Q1	1854-0882	8	1	TRANSISTOR NPN PD=300MW FT=200MHZ	28480	1854-0882
A9R1	0698-0082	7		RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A9R2	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R3	0698-0082	7		RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A9R4	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R5	0698-3154	0	2	RESISTOR 4.22K 1% .125W F TC=0±100	24546	C4-1/8-T0-4221-F
A9R6	0698-3154	0		RESISTOR 4.22K 1% .125W F TC=0±100	24546	C4-1/8-T0-4221-F
A9R7	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R8	0698-3157	3		RESISTOR 19.6K 1% .125W F TC=0±100	24546	C4-1/8-T0-1962-F
A9R9	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R10	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9R11	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R12	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R13	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R14	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R15	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R16	0757-0424	7	1	RESISTOR 1.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1101-F
A9R17	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R18	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R19	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R20	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R21	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R22	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R23	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R24	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R25	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R26	0698-3429	2		RESISTOR 19.6 1% .125W F TC=0±100	03888	PME55-1/8-T0-19R6-F
A9R27	0698-3442	9		RESISTOR 237 1% .125W F TC=0±100	24546	C4-1/8-T0-237R-F
A9R28	0698-0082	7		RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A9R29	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R30	0698-0082	7		RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A9R31	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A9R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R33	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A9R34	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R35	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R36	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R37	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A9R38	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R39	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A9R40	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9R41	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0±100	24546	C4-1/8-T0-5111-F
A9TP1	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP2	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP3	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP4	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP5	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9TP6	0360-0535	0		TERMINAL TEST POINT PCB	00000	ORDER BY DESCRIPTION
A9U1	1820-1308	4		IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116L
A9U2	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A9U3	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A9U4	1820-1308	4		IC RCVR ECL LINE RCVR TPL 2-INP	04713	MC10116L
A9U5	1810-0205	7		NETWORK-RES 8-SIP4.7K OHM X 7	01121	208A472
A9U6	1858-0032	8		TRANSISTOR ARRAY 14-PIN PLSTC DIP	3L585	CA3146E
A10	**08412-60010**	**8**	**1**	**AMPLITUDE SYNCHRONOUS DETECTOR ASSEMBLY**	**28480**	**08412-60010**
A10C1	0150-0096	3	7	CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C2	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C3	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A10C4	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C5	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C6	0160-2202	8	1	CAPACITOR-FXD 75PF ±5% 300VDC MICA	28480	0160-2202
A10C7	0160-0157	8	2	CAPACITOR-FXD 4700PF ±10% 200VDC POLYE	28480	0160-0157
A10C8	0160-0157	8		CAPACITOR-FXD 4700PF ±10% 200VDC POLYE	28480	0160-0157
A10C9	0160-0161	4	4	CAPACITOR-FXD .01UF ±10% 200VDC POLYE	28480	0160-0161
A10C10	0160-0161	4		CAPACITOR-FXD .01UF ±10% 200VDC POLYE	28480	0160-0161
A10C11	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A10C12	0160-0161	4		CAPACITOR-FXD .01UF ±10% 200VDC POLYE	28480	0160-0161
A10C13	0160-0161	4		CAPACITOR-FXD .01UF ±10% 200VDC POLYE	28480	0160-0161
A10C14	0180-0291	3		CAPACITOR-FXD 1UF±10% 35VDC TA	56289	150D105X9035A2
A10C15	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C16	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10C17	0150-0096	3		CAPACITOR-FXD .05UF +80-20% 100VDC CER	28480	0150-0096
A10CR1	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10CR2	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A10IC1	1826-0261	8		IC-LINEAR	28480	1826-0261
A10Q1	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q3	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q4	1854-0414	2	3	TRANSISTOR-DUAL NPN PD=600MW	28480	1854-0414
A10Q5	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q6	1854-0295	7		TRANSISTOR-DUAL NPN PD=400MW	28480	1854-0295
A10Q7	1854-0414	2		TRANSISTOR-DUAL NPN PD=600MW	28480	1854-0414
A10Q8	1854-0475	5		TRANSISTOR-DUAL NPN PD=750MW (RECOMMENDED REPLACEMENT)	28480	1854-0475
A10Q9	1854-0414	2		TRANSISTOR-DUAL NPN PD=600MW	28480	1854-0414
A10Q10	1854-0475	5		TRANSISTOR-DUAL NPN PD=750MW	28480	1854-0475

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
				(RECOMMENDED REPLACEMENT)		
A10Q11	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q12	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10Q13	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A10R1	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0±100	24546	C4-1/8-T0-8251-F
A10R2	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A10R3	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1212-F
A10R4	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A10R5	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A10R6	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A10R7	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A10R8	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A10R9	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A10R10	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0±100	24546	C4-1/8-T0-8251-F
A10R11	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1212-F
A10R12*	0757-0416	7	14	RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A10R13	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A10R14	0698-3427	0	1	RESISTOR 13.3 1% .125W F TC=0±100	03888	PME55-1/8-T0-13R3-F
A10R15	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A10R16	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A10R17	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-1621-F
A10R18	0698-3431	6	2	RESISTOR 23.7 1% .125W F TC=0±100	03888	PME55-1/8-T0-23R7-F
A10R19	0698-0082	7		RESISTOR 464 1% .125W F TC=0±100	24546	C4-1/8-T0-4640-F
A10R20	0698-3431	6		RESISTOR 23.7 1% .125W F TC=0±100	03888	PME55-1/8-T0-23R7-F
A10R21	0757-0428	1		RESISTOR 1.62K 1% .125W F TC=0±100	24546	C4-1/8-T0-1621-F
A10R22	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A10R23	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A10R24	0757-0418	9	2	RESISTOR 619 1% .125W F TC=0±100	24546	C4-1/8-T0-619R-F
A10R25	0757-0441	8		RESISTOR 8.25K 1% .125W F TC=0±100	24546	C4-1/8-T0-8251-F
A10R26	0757-0444	1		RESISTOR 12.1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1212-F
A10R27	0698-7649	6	2	RESISTOR 383 .1% .125W F TC=0±25	19701	MF4C1/8-T9-383R-B
A10R28	0757-0418	9		RESISTOR 619 1% .125W F TC=0±100	24546	C4-1/8-T0-619R-F
A10R29	0698-5490	1	1	RESISTOR 2K 1% .125W F TC=0±50	28480	0698-5490
A10R30*	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A10R31	0698-3136	8		RESISTOR 17.8K 1% .125W F TC=0±100	24546	C4-1/8-T0-1782-F
A10R32	0757-0280	3		RESISTOR 1K 1% .125W F TC=0±100	24546	C4-1/8-T0-1001-F
A10R33	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A10R34	0811-1150	4	1	RESISTOR-MATCHED SET 2K OHMS; ±.05 TOL (MATCHED PAIR, SEE R40)	28480	0811-1150
A10R35	0757-0442	9		RESISTOR 10K 1% .125W F TC=0±100	24546	C4-1/8-T0-1002-F
A10R36	0698-7649	6		RESISTOR 383 .1% .125W F TC=0±25	19701	MF4C1/8-T9-383R-B
A10R37	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A10R38	0698-0085	0		RESISTOR 2.61K 1% .125W F TC=0±100	24546	C4-1/8-T0-2611-F
A10R39	0757-0447	4		RESISTOR 16.2K 1% .125W F TC=0±100	24546	C4-1/8-T0-1622-F
A10R40				PART OF R34		
A10R41	0757-0416	7		RESISTOR 511 1% .125W F TC=0±100	24546	C4-1/8-T0-511R-F
A10R42	0757-0401	0		RESISTOR 100 1% .125W F TC=0±100	24546	C4-1/8-T0-101-F
A10R43	0698-3162	0	1	RESISTOR 46.4K 1% .125W F TC=0±100	24546	C4-1/8-T0-4642-F
A10R44	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A10R45	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A10R46	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0±100	24546	C4-1/8-T0-4641-F
A10R47	0698-3440	7		RESISTOR 196 1% .125W F TC=0±100	24546	C4-1/8-T0-196R-F
A11	**08412-60004**	**0**	**1**	**BOARD ASSEMBLY-EXTENDER** CHASSIS PARTS	**28480**	**08412-60004**
C1	0180-2198	3	1	CAPACITOR-FXD 2700UF+75-10% 25VDC AL	00853	500272U025AA2C
CR1	1901-0049	0	2	DIODE-PWR RECT 50V 750MA DO-29	28480	1901-0049
CR2	1901-0049	0		DIODE-PWR RECT 50V 750MA DO-29	28480	1901-0049
CR3	1901-0029	6	2	DIODE-PWR RECT 600V 750MA DO-29	28480	1901-0029
CR4	1901-0029	6		DIODE-PWR RECT 600V 750MA DO-29	28480	1901-0029
E1	08412-60014	2	1	WIRING HARNESS(INCL R1-R6,J1,XA1-10,XV1)	28480	08412-60014
F1	2110-0064	3	2	FUSE .125A 250V TD 1.25X.25 UL	28480	2110-0064
F2	2110-0064	3		FUSE .125A 250V TD 1.25X.25 UL	28480	2110-0064
J1	1251-0055	9	1	CONNECTOR 24-PIN M BLUE RIBBON	28480	1251-0055
J2	1250-0118	3	5	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
J3	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
J4	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
J5	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
J6	1250-0118	3		CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0118
J7	1251-2197	4	1	CONNECTOR 24-PIN F D SERIES	28480	1251-2197
J7MP1	1251-2942	7	2	LOCK-SUBMIN D CONN	28480	1251-2942
J7MP2	1251-2942	7		LOCK-SUBMIN D CONN	28480	1251-2942
L1	01200-66001	9	1	COIL ASSEMBLY-ALIGNMENT	28480	01200-66001
R1	2100-2843	9	1	RESISTOR-VAR CONTROL CCP 5K 10% LIN	28480	2100-2843
R2	2100-2847	3	1	RESISTOR-VAR CONTROL CC 5M 20% LIN	28480	2100-2847
	5040-0453	8	1	COVER-POTENTIOMETER (FOCUS)	28480	5040-0453
R3	2100-2838	2	2	RESISTOR-VAR CONTROL CCP 20K 10% LIN	28480	2100-2838

See introduction to this section for ordering information
*Indicates factory selected value

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
R4	2100-2869	9	1	RESISTOR-TRMR 10 20% C SIDE-ADJ 20-TRN	28480	2100-2869
R5	2100-2838	2		RESISTOR-VAR CONTROL CCP 20K 10% LIN	28480	2100-2838
R6	0683-1045	3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
R7	0683-1035	1	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
R8	2100-3653	1	1	RESISTOR-VAR CONTROL CCP 5K 10% LIN	28480	2100-3653
R9	2100-3654	2	1	RESISTOR-VAR CONTROL CCP 20K 10% LIN	28480	2100-3654
S1	3101-2171	9	1	SWITCH-SLIDE (RECOMMENDED REPLACEMENT)	28480	3101-2171
T1	9100-2850	5	1	TRANSFORMER-175V 50-400HZ	28480	9100-2850
V1	5083-1874	9	1	CRT	28480	5083-1874
XA1	1251-1190	5		CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1190
XA2	1251-2309	0	4	CONNECTOR-PC EDGE 12-CONT/ROW 1-ROW	28480	1251-2309
XA3	1251-0159	4	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-0159
XA4A	1251-2308	9	1	CONNECTOR-PC EDGE 22-CONT/ROW 1-ROW	28480	1251-2308
XA4B	1251-2075	7	1	CONTACT-CONN CRP	28480	1251-2075
XA5	5060-0115	1	1	CONNECTOR ASSEMBLY-15 CONTACT	28480	5060-0115
XA6				NOT ASSIGNED		
XA7	1251-2309	0		CONNECTOR-PC EDGE 12-CONT/ROW 1-ROW	28480	1251-2309
XA8	1251-1190	5	2	CONNECTOR-PC EDGE 12-CONT/ROW 2-ROWS	28480	1251-1190
XA8E1	1251-1115	4	1	POLARIZING KEY-PC EDGE CONN	28480	1251-1115
XA9	1251-2309	0		CONNECTOR-PC EDGE 12-CONT/ROW 1-ROW	28480	1251-2309
XA10	1251-2309	0		CONNECTOR-PC EDGE 12-CONT/ROW 1-ROW	28480	1251-2309
XF1	2110-0470	5	1	FUSEHOLDER BODY EXTR PST; BAYONET; TND	75915	345003-010
XF1MP1	2110-0465	8	1	FUSEHOLDER CAP EXTR PST; BAYONET; 20A	28480	2110-0465
XF1MP2	2110-0467	0	1	FUSEHOLDER COMPONENT HEX NUT: 1/2-28	28480	2110-0467
XF1MP3	0900-0016	8	1	O-RING .487-IN-ID .103-IN-XSECT-DIA NTRL	76680	AS-112 B46
XF2	08412-40002	6	1	FUSEHOLDER	28480	08412-40002
XV1	1200-0037	0	1	SOCKET-TUBE 14-CONT CRT	28480	1200-0037
	1200-0050	7	1	CONTACT-CRT SOCKET	28480	1200-0050

See introduction to this section for ordering information
*Indicates factory selected value

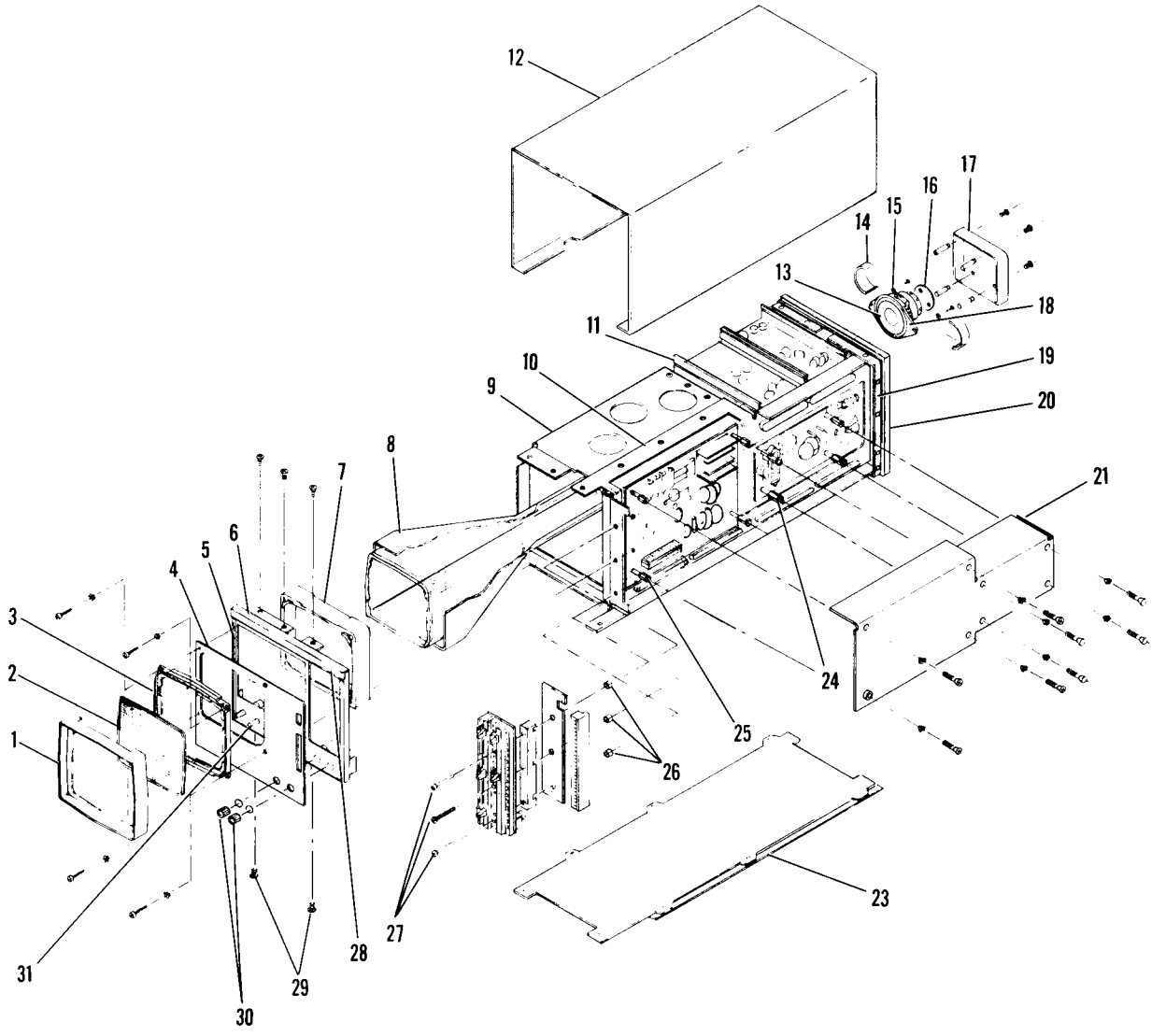


Figure 6-1. Cabinet Parts, Exploded View (Sheet 1 of 2)

				CABINET PARTS		
1	5040-0508	4	1	SHIELD-LIGHT	28480	5040-0508
2	10178A	2	1	CONTRAST IMPROVEMENT SCREEN	28480	10178A
3	5020-0476	3	1	BEZEL-CRT	28480	5020-0476
4	08412-00025	9	1	PANEL (FRONT)	28480	08412-00025
5	08412-20013	7	1	SUB-PANEL (FRONT)	28480	08412-20013
6	5020-3281	4	1	TRIM-NAMEPLATE	28480	5020-3281
7	01200-44703	2	1	SUPPORT-CRT SHIELD	28480	01200-44703
8	01200-60605	7	1	SHIELD-CRT	28480	01200-60605
9	08412-00003	3	1	SUPPORT-TOP CROSS	28480	08412-00003
10	08412-00007	7	1	FRAME (RIGHT SIDE)	28480	08412-00007
11	08412-20016	0	6	SHIELD-PC BOARD	28480	08412-20016
12	08412-00032	8	1	COVER ASSEMBLY(TOP), OLIVE GRAY	28480	08412-00032
13	0905-0330	9	1	O-RING 2.614-IN-ID .07-IN-XSECT-DIA NTRL	28480	0905-0330
14	00180-41207	8	35	BRACKET-PLASTIC	28480	00180-41207
15	1400-0026	1	1	CLAMP-HOSE 2-2.625-DIA .5-WD SST	28480	1400-0026
16	1200-0408	9	1	COVER PLATE-CRT SOCKET COVER RING FOR	28480	1200-0408
17	08412-00012	4	1	COVER-CRT (REAR)	28480	08412-00012
18	08412-40003	7	1	RETAINER-R SHIELD	28480	08412-40003
19	08412-20037	5	1	PANEL-SUB (REAR)	28480	08412-20037
20	08412-00039	5	1	PANEL (REAR)	28480	08412-00039
21	08412-00038	4	1	COVER-HVPS RECTIFIER-REGULATOR (RECOMMENDED REPLACEMENT)	28480	08412-00038
22				DELETED		
23	08414-00033	1	1	COVER ASSEMBLY(BOTTOM), OLIVE GRAY	28480	08414-00033
24	08412-20018	2	4	SCREW-ADAPTER (LONG)	28480	08412-20018
24	08412-20023	9	1	INSULATOR-HVPS	28480	08412-20023
25	08412-20017	1	4	SCREW-ADAPTER (SHORT)	28480	08412-20017
26	08412-20021	7	3	SPACER-INSULATOR SWITCH	28480	08412-20021
27	0520-0226	6	1	SCREW-MACH 2-56 1.25-IN-LG FIL-HD-POZI	00000	ORDER BY DESCRIPTION
28	7120-2330	6	1	PLATE-IDENTIIFICATION	28480	7120-2330
29	08412-20020	6	2	PIN EXTRACTOR	28480	08412-20020
30	0370-0151	7	2	KNOB .500 IN OD:.125 IN DIA SHAFT	28480	0370-0151
31	08412-40001	5	3	KNOB-CONTROL	28480	08412-40001
32	08412-40001	5		KNOB-CONTROL	28480	08412-40001
	7120-4162	6	1	LABEL-WARNING (NOT SHOWN)	28480	7120-4162
	7124-0891	8	1	LABEL-LOGO (NOT SHOWN)	28480	7124-0891
	5040-0274	1	4	FOOT-PLUG-IN (NOT SHOWN)	28480	5040-0274
	0403-0026	6	2	GLIDE-NYLON (NOT SHOWN)	02768	207-120241-03-0101

See introduction to this section for ordering information
*Indicates factory selected value

Figure 6-1. Cabinet Parts, Exploded View (Sheet 2 of 2)

SECTION VII
MANUAL BACKDATING CHANGES

7-1. INTRODUCTION

7-2. This manual has been written for and applies directly to instruments with serial numbers prefixed as indicated on the title page. Earlier versions of the instrument (serial number prefixes lower than the one indicated on the title page) may be slightly different in design or appearance. The purpose of this section of the manual is to document these difference. With the information provided in this section, this manual can be corrected so that it applies to any earlier version or configuration of the instrument. later versions of the instrument (serial number prefixes higher than the one indicated on the title page) are documented in a yellow Manual Changes Supplement.

7-3. Since there are no earlier versions of the HP Model 8412B, there is no change information provided here. This manual applies directly to instruments with serial numbers prefixed as indicated on the title page. If your instrument serial number is different than the one on the title page, it will be documented in a yellow Manual Changes Supplement. Complimentary copies of this supplement can be obtained from your nearest Hewlett-Packard Office. Refer to INSTRUMENTS COVERED BY MANUAL in Section I for more information about serial number coverage.

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains the overall instrument theory of operation as well as the more detailed theory of each P. C. Board, together with the schematic diagram and parts location drawing of each board. These are furnished as an aid in troubleshooting to a defective P. C. board and then to a defective component.

8-3. OVERALL INSTRUMENT DESCRIPTION

8-4. The Model 8412B Phase-Magnitude Display detects and displays magnitude and phase differences inherent in the RF input signals to the mainframe. This is accomplished by detecting the 278 kHz IF test and reference signals, multiplexing them into the vertical amplifier, and displaying the relative magnitude and phase on two separate traces on the CRT.

8-5. Z-axis input connector on the rear panel is provided for blanking and frequency marking of the CRT trace. Outputs allow display on an external recorder or oscilloscope. The horizontal sweep is driven by a dc voltage vs. frequency sweep signal from the external sweep oscillator. A simplified block diagram of the 8412B is shown in Figure 8-1. A more detailed theory of operation is presented opposite the individual schematic diagrams.

8-6. SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

8-7. As shown in Figure 8-1, RF input signals from a unit under test are converted to 278 kHz IF signals by the HP 8407A or 8410/8411 Network Analyzer, then these signals are applied to the 8412B plug-in display. The Network Analyzer mainframe has dual channel automatic gain control (AGC) so that only the test channel amplitude needs to be measured to effectively measure the test-to-reference amplitude ratio.

8-8. The test channel is separated into two signal channels in the mainframe, the test phase signal and the test amplitude signal. The test phase signal is amplified and limited in the 8412B test channel amplifier A9. Two functions are accomplished, (1) a very fast zero crossing is obtained which is used for phase measurement, and (2) a square-wave constant-amplitude signal is obtained which is used for the drive signal in the amplitude detector. The second test channel input, the test amplitude signal, is amplified then detected in amplitude synchronous detector A10, using the drive from A9. The detected amplitude signal is converted in amplitude-channel log converter A7 to a logarithmic signal read in decibels. The logarithmic amplitude information is then multiplexed together with the phase information in multiplexer A3 and displayed on the CRT.

8-9. The reference phase channel passes through phase offset A2. The output of phase offset A2 is applied to phase detector A1 where it is compared with the test channel phase signal from A9. The phase information at the output of the phase detector is applied to multiplexer-deflection amplifier A3 along with the amplitude information. Multiplexer-deflection amplifier A3 time-multiplexes the phase and amplitude signals to the CRT where they are displayed.

8-10. The network analyzer mainframe (8407A or 8410) also supplies ±20 Vdc and 175 Vac to the 8412B. The high-voltage power supply A5 and high-voltage rectifier A6 convert plus and minus 20 Vdc to −3000 Vdc for the CRT. Low-voltage power supply A8 converts the 175 Vac to ±6 Vdc and 135 Vdc for other circuit requirements within the instrument.

8-11. SCHEMATIC DIAGRAMS

8-12. The schematic diagrams in this section represent the circuits electrically. They are not wiring diagrams, though colors are given where practical.

8-13. The large numbers in the lower right corners of the schematics are the schematic numbers. These are used to cross reference

connections between schematics. The smaller numbers, preceded by an "A" and located below the schematic number, list the assemblies included in the schematic.

8-14. Some of the general information obtainable from the schematic diagrams is shown in Figure 8-2. Notes and explanations of symbols pertaining to all the diagrams are contained in Figure 8-3. Figure 8-3 also contains the test setup and measurement conditions required to obtain the normal test point waveforms and voltages noted on the schematic diagrams. Notes about specific components, circuits, or conditions are given on the diagram to which they apply.

8-15. As an aid to finding components and assemblies on the set of diagrams, each diagram has a box labelled Reference Designations that contains all the reference designations appearing on the diagram.

8-16. An asterisk indicates a factory selected part; the component value shown is the typical or most commonly selected value.

8-17. Component procurement information and specific component descriptions are included in Section VI. Refer to paragraph 6-3 for information on how to order parts.

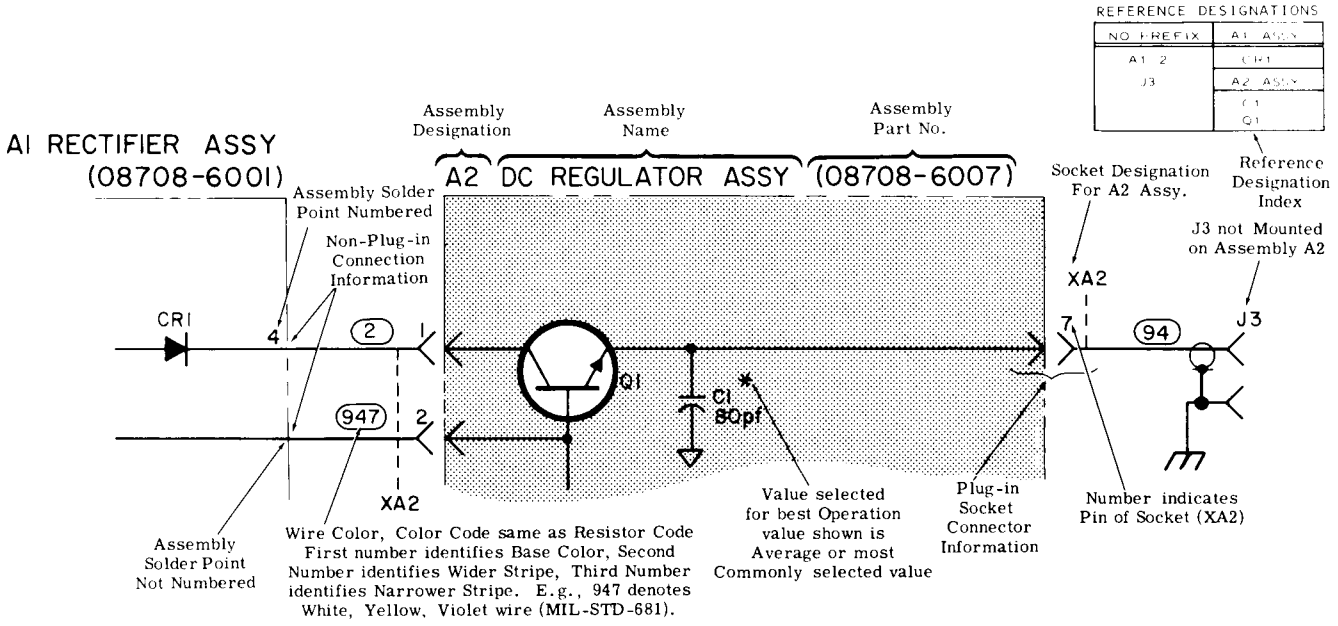


Figure 8-2. General Information on Schematic Diagrams

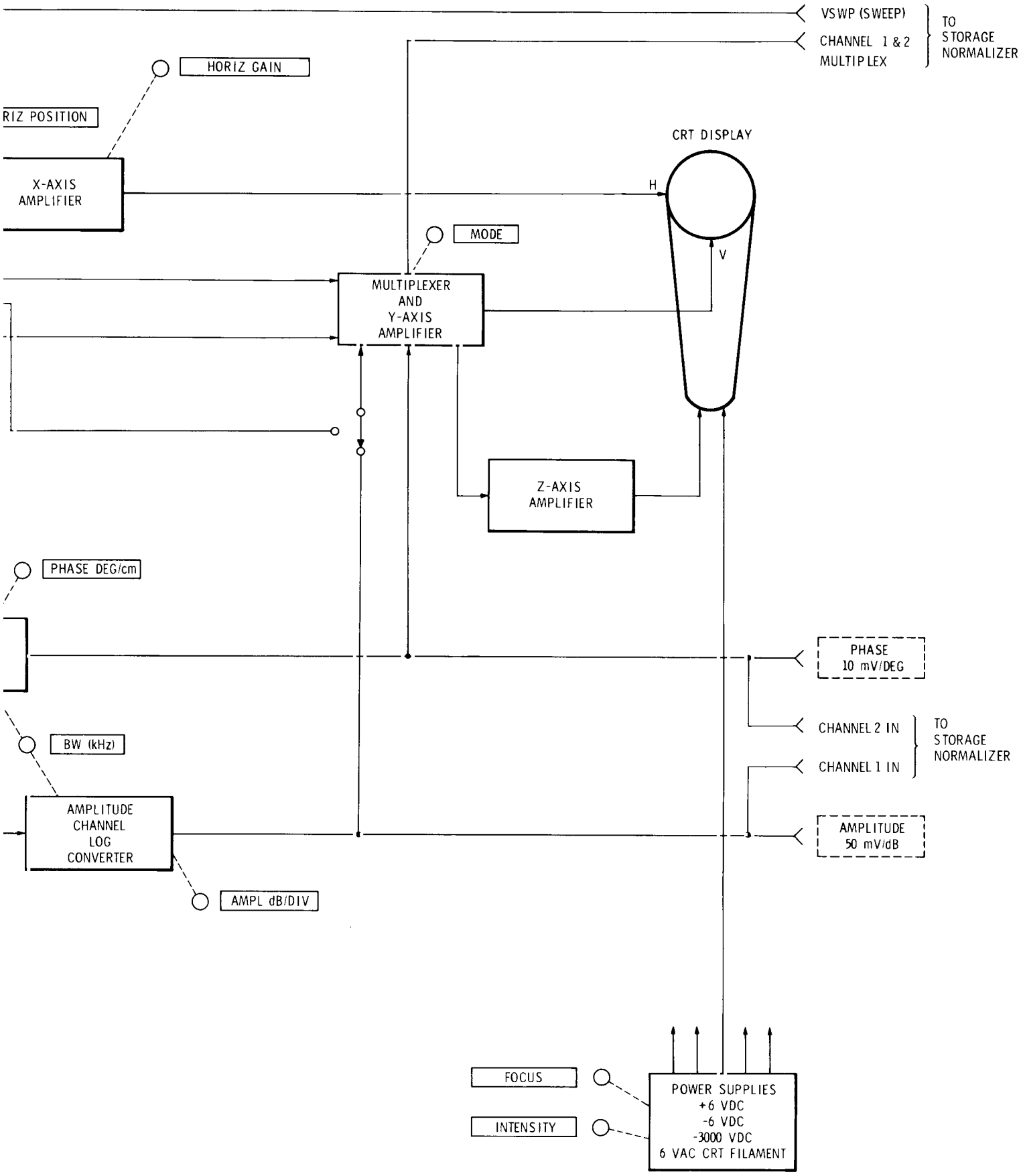
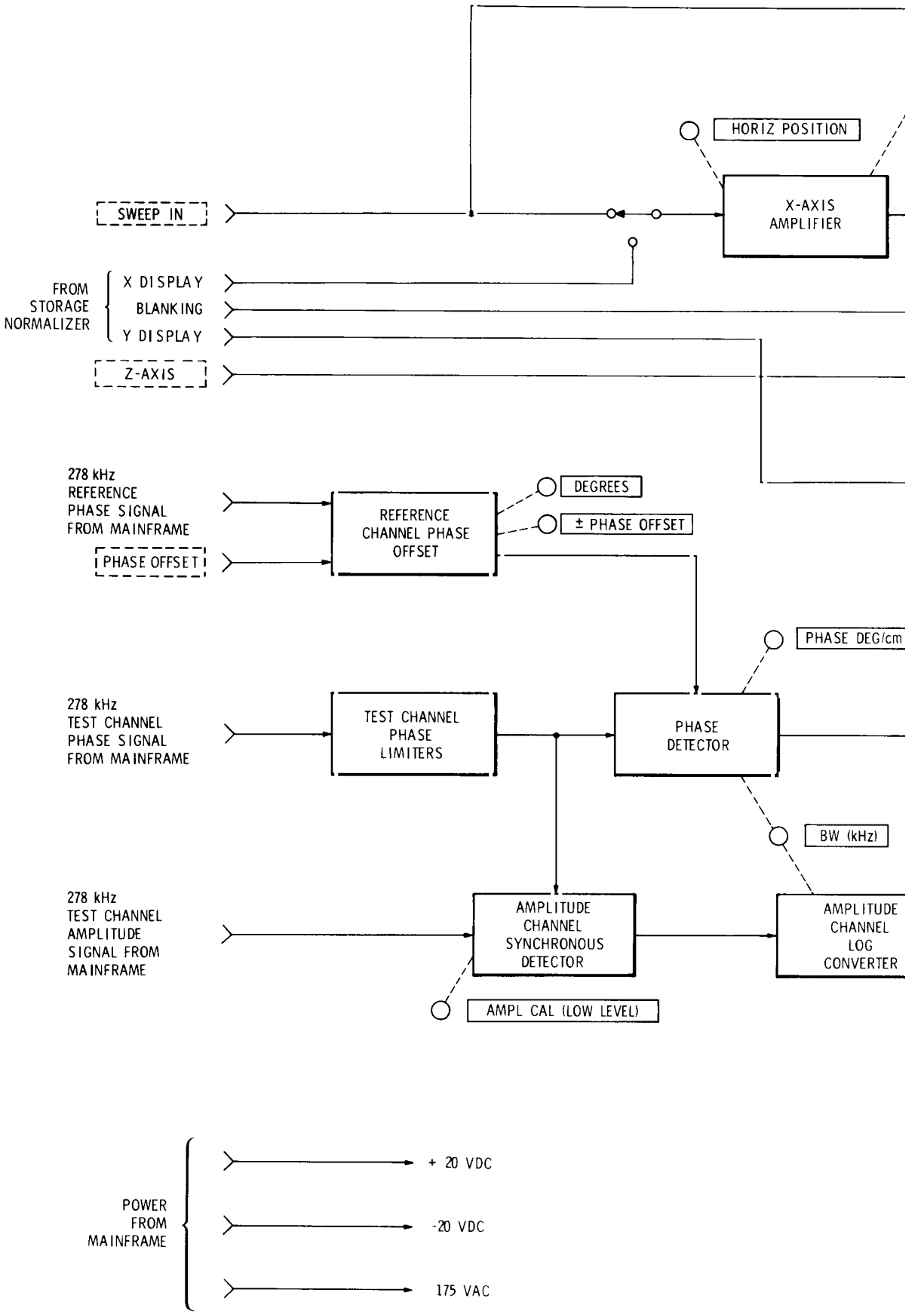


Figure 8-1. Model 8412B Simplified Block Diagram


HORIZ POSITION
X-AXIS AMPLIFIER
SWEEP IN
FROM STORAGE NORMALIZER
X DISPLAY
BLANKING
Y DISPLAY
Z-AXIS
278 kHz REFERENCE PHASE SIGNAL FROM MAINFRAME
PHASE OFFSET
REFERENCE CHANNEL PHASE OFFSET
DEGREES
± PHASE OFFSET
PHASE DEG/cm
278 kHz TEST CHANNEL PHASE SIGNAL FROM MAINFRAME
TEST CHANNEL PHASE LIMITERS
PHASE DETECTOR
BW (kHz)
278 kHz TEST CHANNEL AMPLITUDE SIGNAL FROM MAINFRAME
AMPLITUDE CHANNEL SYNCHRONOUS DETECTOR
AMPLITUDE CHANNEL LOG CONVERTER
AMPL CAL (LOW LEVEL)
POWER FROM MAINFRAME
+ 20 VDC
-20 VDC
175 VAC

1. Resistance is in ohms and capacitance is in microfarads unless otherwise noted.

2. P/O = part of.

3. *Asterisk denotes a factory-selected value. Value shown is typical. Capacitors may be omitted or resistors jumpered.

4. Screwdriver adjustment.

   Panel control.

5. Encloses front panel designations.

   Encloses rear panel designation.

6. Circuit assembly borderline.

   Other assembly borderline.

7. Heavy line with arrows indicates path and direction of main signal.

   Heavy dashed line with arrows indicates path and direction of main feedback.

8. CW — Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.

9. Numbers in circles on circuit assemblies show locations of test points.

10. Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number indentifies the base color, second number the wider stripe, and the third number identifies the narrower stripe. E.g., (947) denotes white base, yellow wide stripe, violet narrow stripe.

11. Voltage regulator (breakdown diode).

12. CONDITIONS FOR WAVEFORMS AND DC VOLTAGES ON SCHEMATICS.

a. For Model 8407A Network Analyzer Mainframe,

1) Connect equipment as shown in test setup.

2) Set 8407A controls as follows:

DISPLAY REFERENCE CAL - Zero dB at top switch positions.

DISPLAY REFERENCE - 10 dB/step switch at one position down from top (+10 dB), and 1 dB/step switch at top position (0 dB).

REF CHANNEL LEVEL ADJ - Middle position.

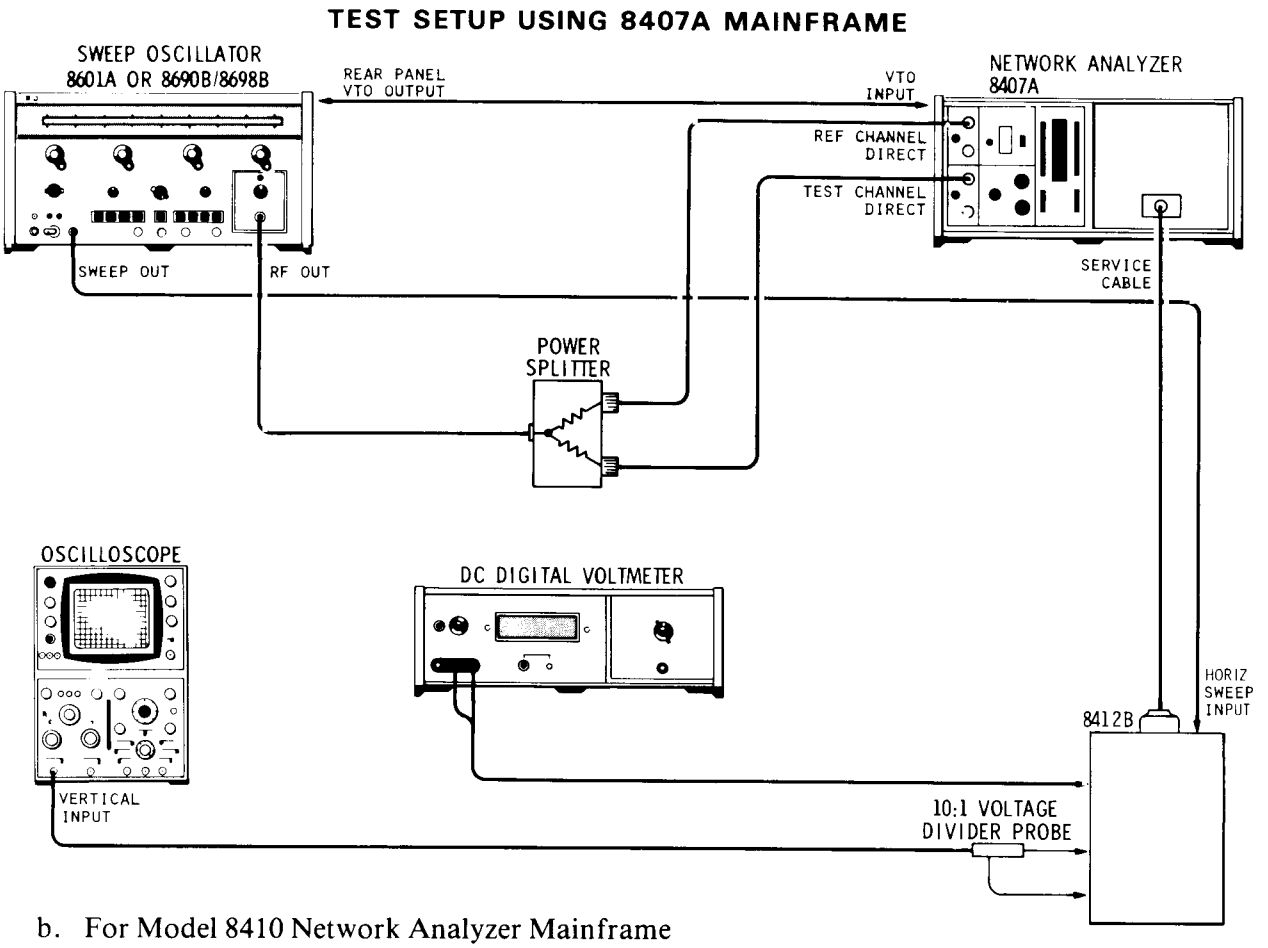
AMPL VERNIER - Midrange.

PHASE VERNIER - Midrange.

3) Set sweep oscillator controls for symmetrical sweep, 10 kHz or narrower sweep width, fast sweep mode, and output signal unmodulated.

4) Adjust sweep oscillator RF output for an 8407A REF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

Figure 8-3. Schematic Diagram Notes (Sheet 1 of 3)



b. For Model 8410 Network Analyzer Mainframe

1) Connect equipment as shown in test setup

2) Set 8410 controls as follows:

FREQ. RANGE - Frequency to match sweep oscillator.
AMPLITUDE TEST CHANNEL GAIN - 55 dB.
AMPL VERNIER - Midrange.
PHASE VERNIER - Midrange.
SWEEP STABILITY - Adjust for best phase lock.

3) Set sweep oscillator controls for symmetrical sweep over narrowest band possible and output signal unmodulated

4) Adjust sweep oscillator RF output for an 8410 REF CHANNEL LEVEL meter indication in the middle of the OPERATE range.

c. On Model 8412B Plug-In, set controls as follows:
MODE to DUAL.
AMPL DB/DIV to 10.
PHASE DEG/DIV to 90.
PHASE OFFSET polarity to +.
DEGREES to zero.
INTENSITY for moderate trace intensity.

Figure 8-3. Schematic Diagram Notes (Sheet 2 of 3)

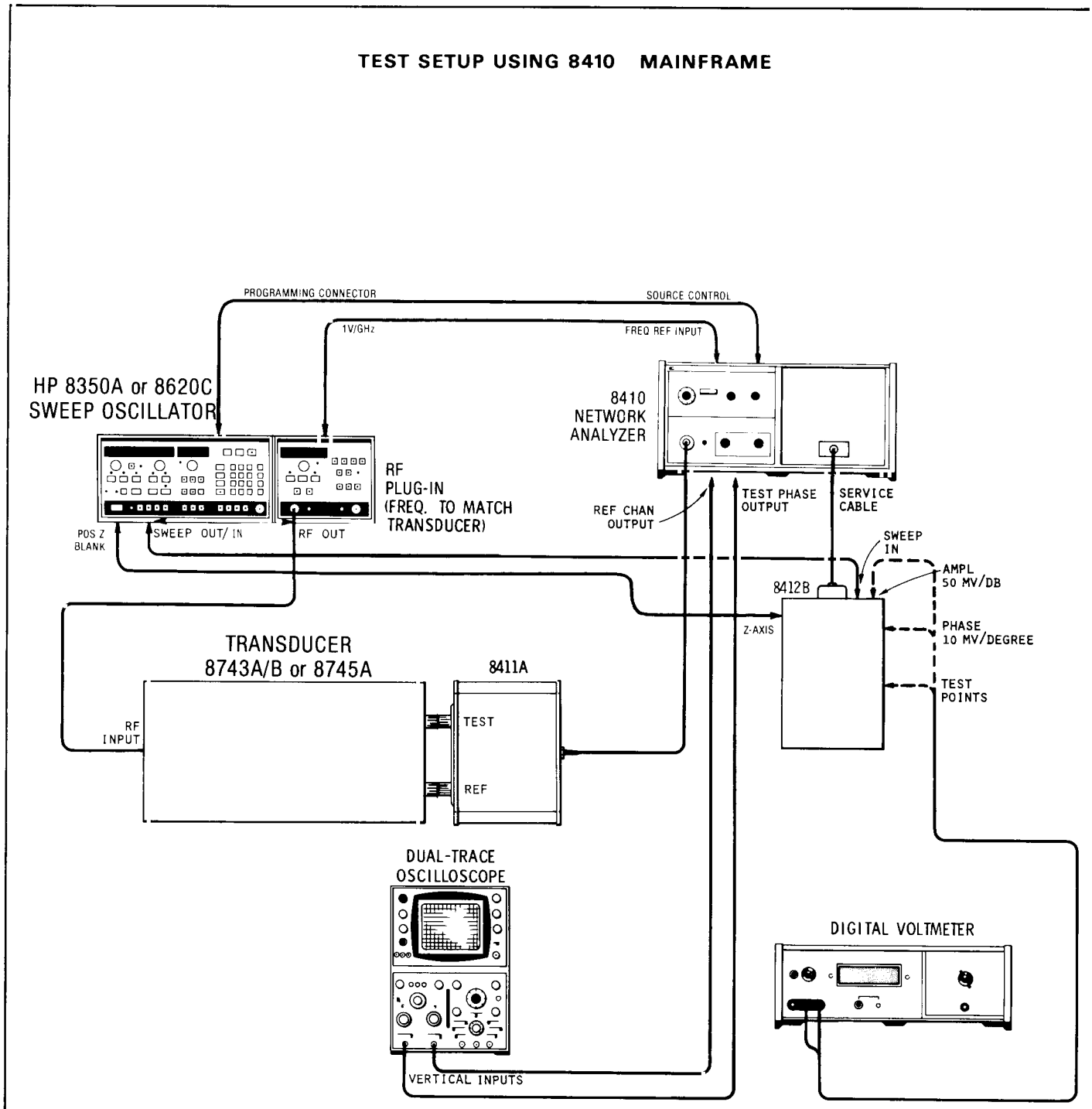
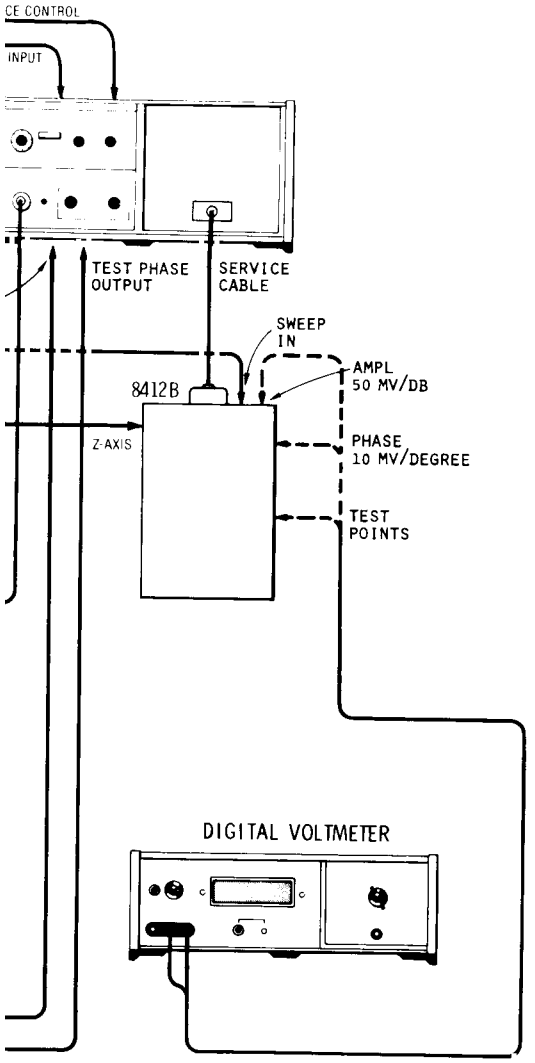


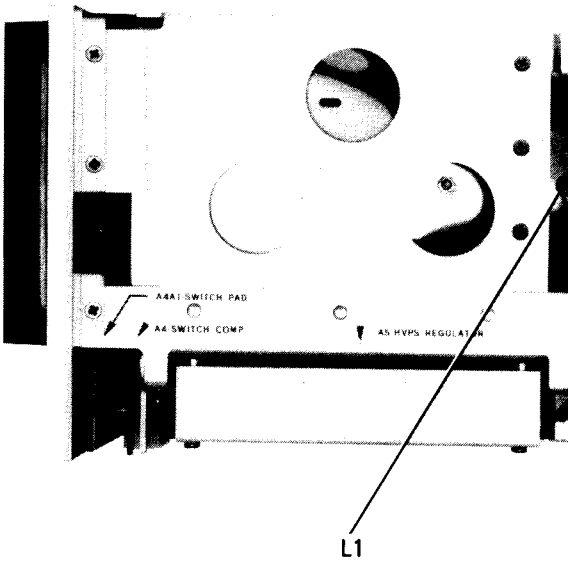
Figure 8-3. Schematic Diagram Notes (Sheet 3 of 3)

INFRAME

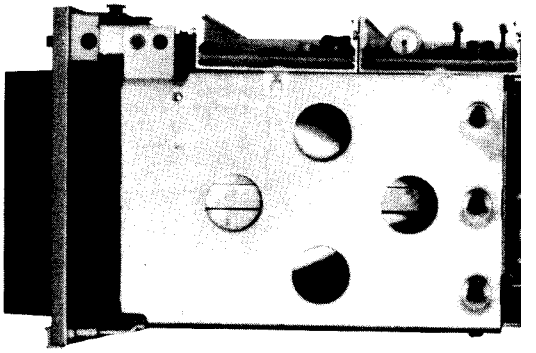


Sheet 3 of 3)

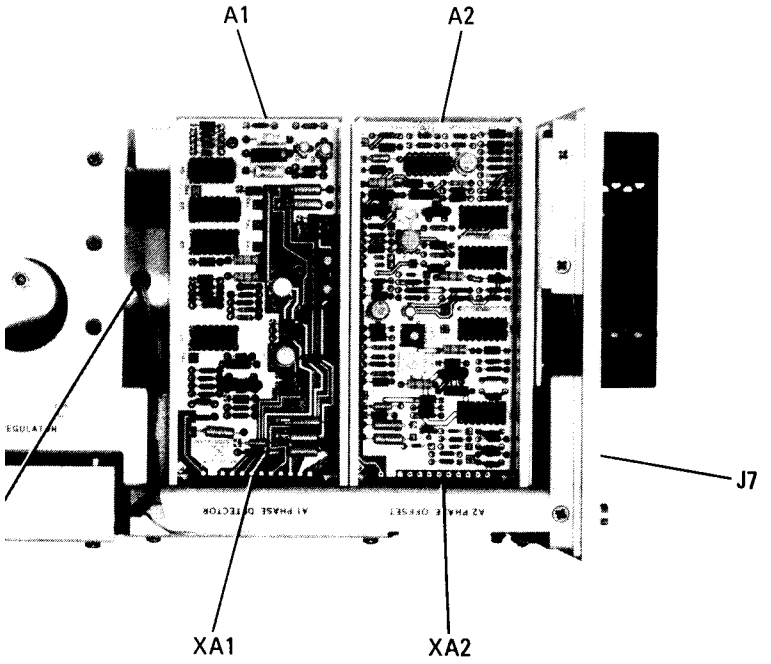
TOP

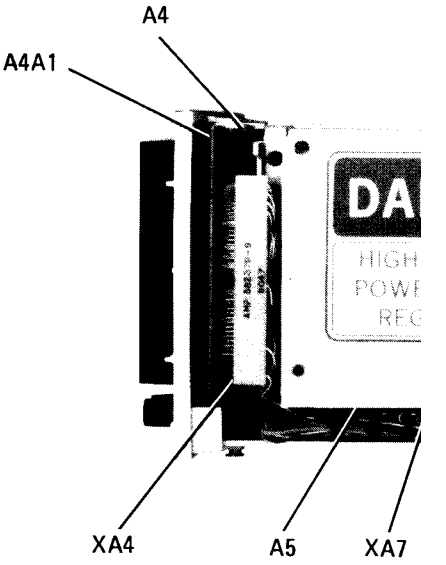


LEFT

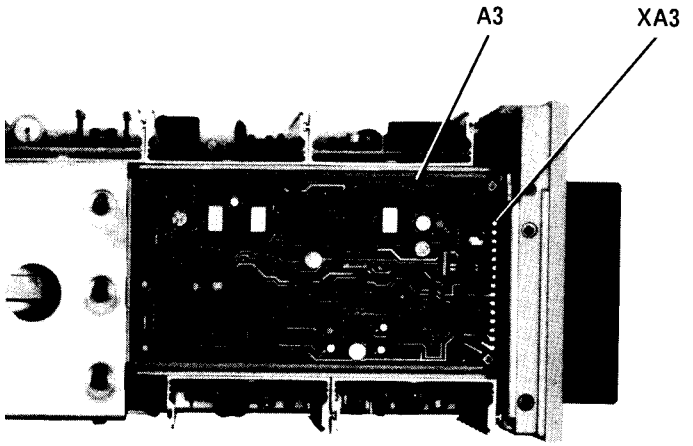


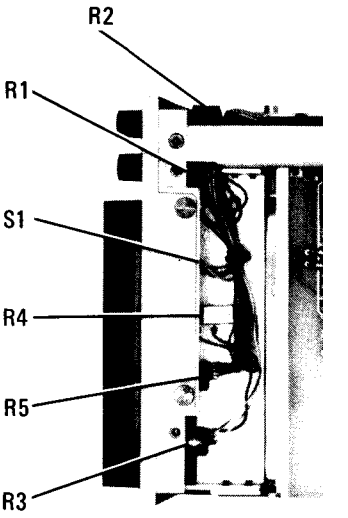
TOP VIEW





LEFT VIEW

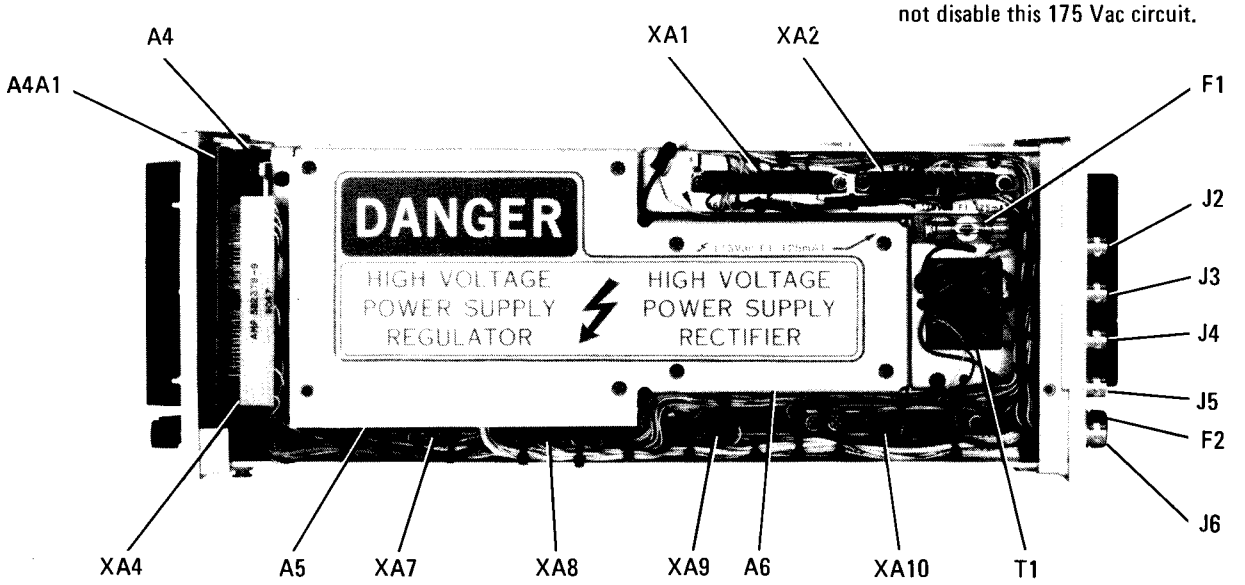




RIGHT VIEW

WARNINGS

Fuse F1 energizes the 175 Vac line. Removing the rear-panel fuse, F2 does not disable this 175 Vac circuit.



BOTTOM VIEW

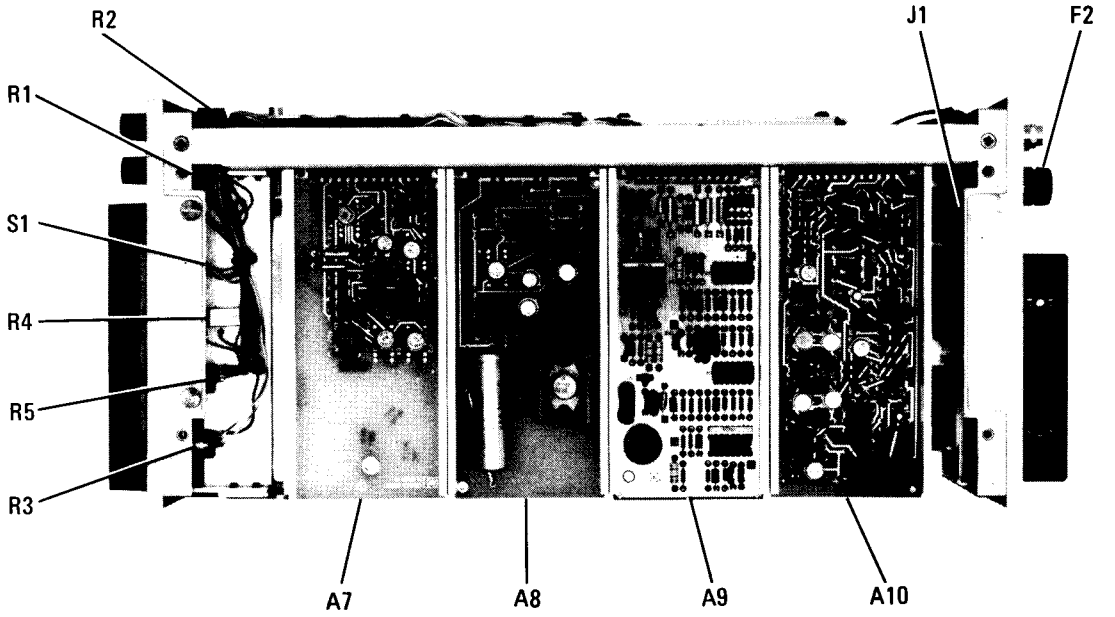


Figure 8-4. Location of Major Assemblies

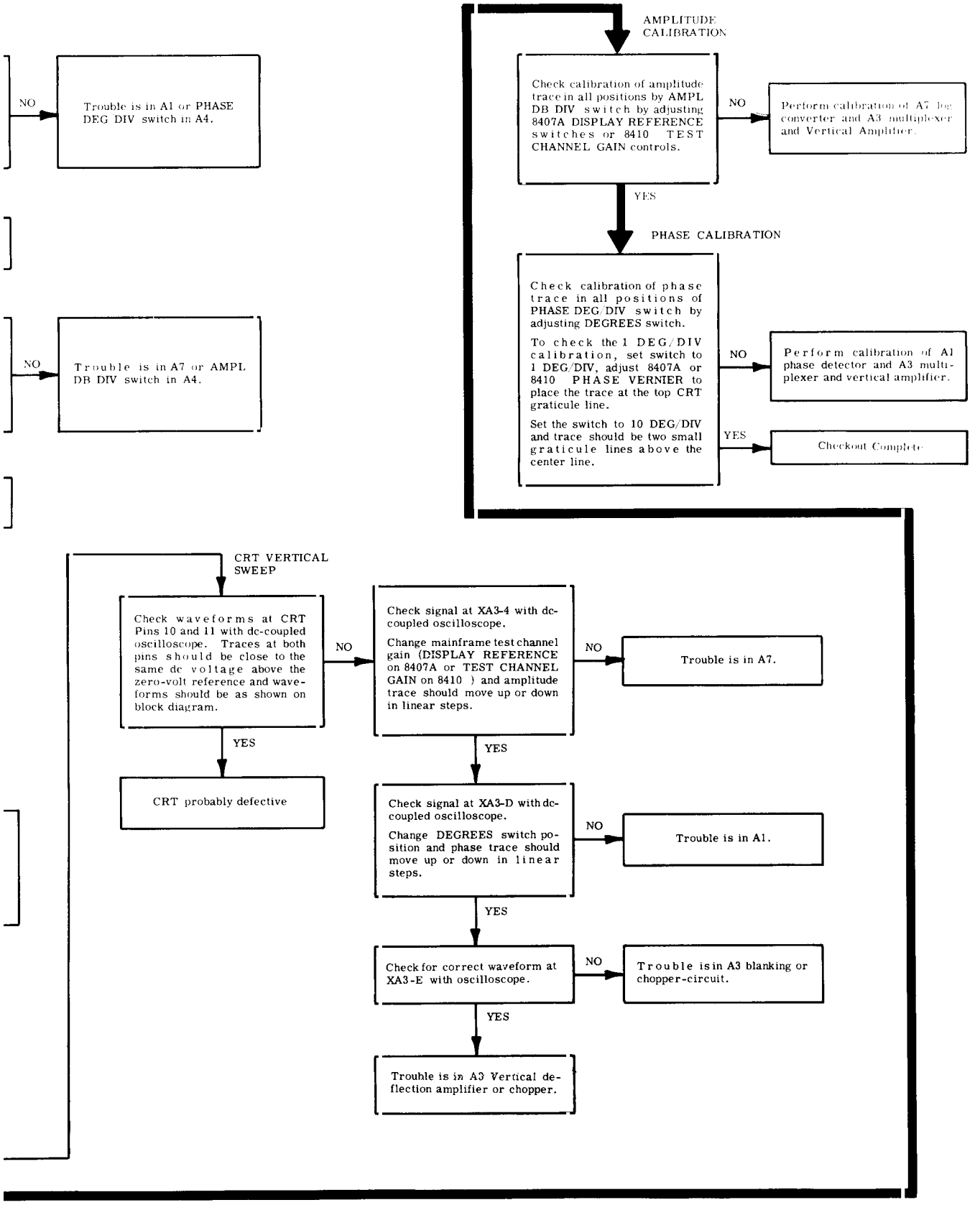
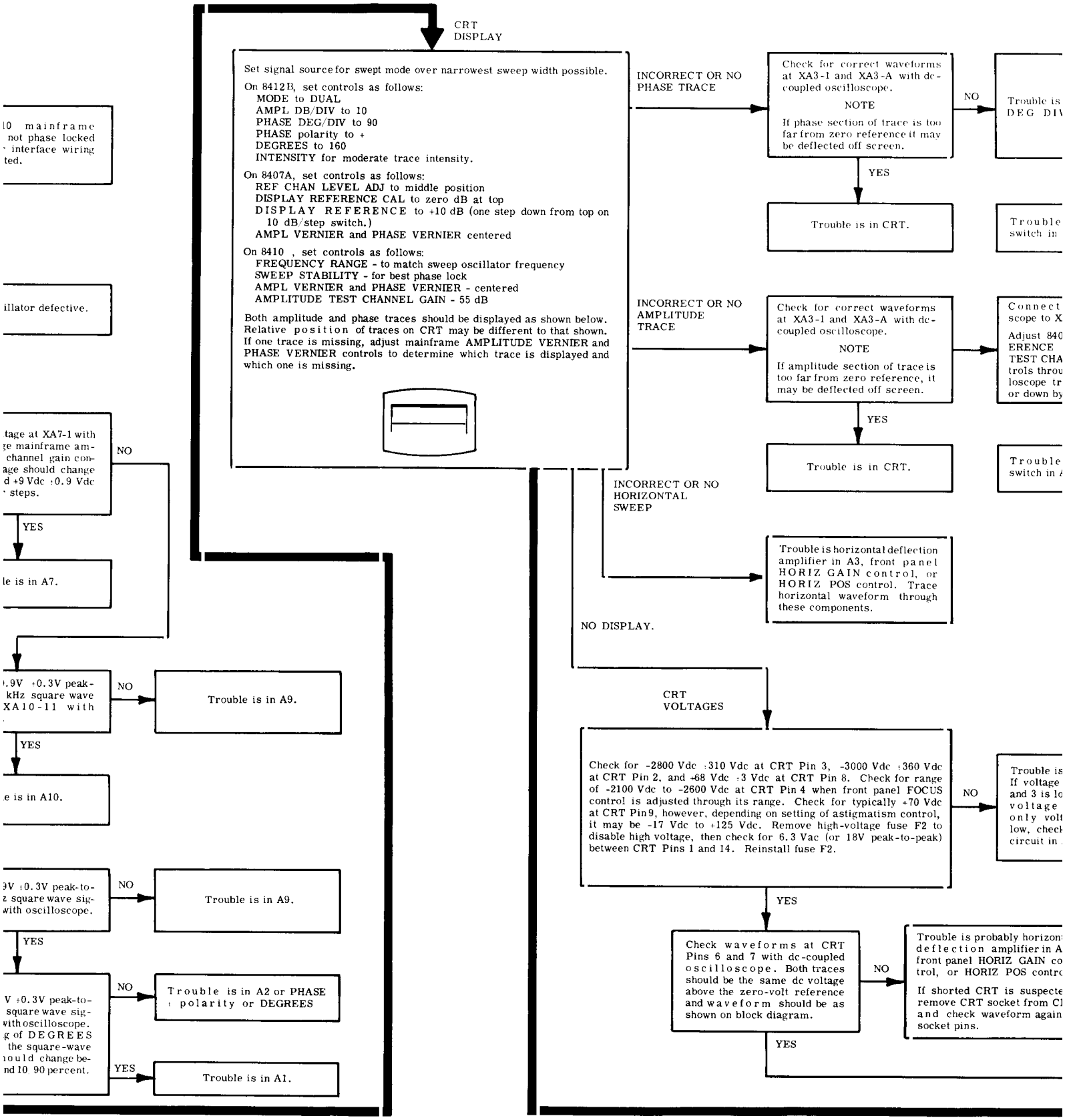


Figure 8-5. Troubleshooting Tree


CRT DISPLAY
Set signal source for swept mode over narrowest sweep width possible.
On 8412B, set controls as follows:
MODE to DUAL
AMPL DB/DIV to 10
PHASE DEG/DIV to 90
PHASE polarity to +
DEGREES to 160
INTENSITY for moderate trace intensity.
On 8407A, set controls as follows:
REF CHAN LEVEL ADJ to middle position
DISPLAY REFERENCE CAL to zero dB at top
DISPLAY REFERENCE to +10 dB (one step down from top on 10 dB/step switch.)
AMPL VERNIER and PHASE VERNIER centered
On 8410 , set controls as follows:
FREQUENCY RANGE - to match sweep oscillator frequency
SWEEP STABILITY - for best phase lock
AMPL VERNIER and PHASE VERNIER - centered
AMPLITUDE TEST CHANNEL GAIN - 55 dB
Both amplitude and phase traces should be displayed as shown below. Relative position of traces on CRT may be different to that shown. If one trace is missing, adjust mainframe AMPLITUDE VERNIER and PHASE VERNIER controls to determine which trace is displayed and which one is missing.
INCORRECT OR NO PHASE TRACE
Check for correct waveforms at XA3-1 and XA3-A with dc-coupled oscilloscope.
NOTE
If phase section of trace is too far from zero reference it may be deflected off screen.
NO
YES
Trouble is in CRT.
INCORRECT OR NO AMPLITUDE TRACE
Check for correct waveforms at XA3-1 and XA3-A with dc-coupled oscilloscope.
NOTE
If amplitude section of trace is too far from zero reference, it may be deflected off screen.
YES
Trouble is in CRT.
INCORRECT OR NO HORIZONTAL SWEEP
Trouble is horizontal deflection amplifier in A3, front panel HORIZ GAIN control, or HORIZ POS control. Trace horizontal waveform through these components.
NO DISPLAY.
CRT VOLTAGES
Check for -2800 Vdc ±310 Vdc at CRT Pin 3, -3000 Vdc ±360 Vdc at CRT Pin 2, and +68 Vdc ±3 Vdc at CRT Pin 8. Check for range of -2100 Vdc to -2600 Vdc at CRT Pin 4 when front panel FOCUS control is adjusted through its range. Check for typically +70 Vdc at CRT Pin 9, however, depending on setting of astigmatism control, it may be -17 Vdc to +125 Vdc. Remove high-voltage fuse F2 to disable high voltage, then check for 6.3 Vac (or 18V peak-to-peak) between CRT Pins 1 and 14. Reinstall fuse F2.
NO
YES
Check waveforms at CRT Pins 6 and 7 with dc-coupled oscilloscope. Both traces should be the same dc voltage above the zero-volt reference and waveform should be as shown on block diagram.
NO
YES
NO
Trouble is in A9.
YES
NO
Trouble is in A2 or PHASE ± polarity or DEGREES
YES
Trouble is in A1.
NO
YES

NOTE

...waveforms and voltages at key test ... the ... Figure 8-7.

8412B ... to mainframe through

... shown in test setup.

... or swept mode ... narrowest sweep width

... s as follows

... 10.
... o 90.

... derate trace intensity.

... s as follows
... ADJ to middle position.
... NCE CAL to zero dB at top.
... ENCE to +10 dB (one step down from top on ... h).
... nd PHASE VERNIER centered.

... s as follows:
... GE - to match sweep oscillator frequency
... - for best phase lock.
... nd PHASE VERNIER - centered.
... CHANNEL GAIN - 55 dB.

FUSE BLOWN

... d F2. → Troubleshoot fused circuit for cause of overload.

... ES OK

... 0.1 Vdc ... 1 Vdc at ... 0V -50V ... 0 with ... — NO → 8407A or 8410 mainframe defective, or short in 8412B. Disconnect 8412B from mainframe and isolate trouble to either the plug-in or mainframe. If short is in 8412B, remove all plug-in boards and reinsert, one at a time, until the shorted board is found.

... 3 Vdc at ... Vdc at ... +15 Vdc — NO → If either +6 Vdc or -6 Vdc is slightly out of tolerance, adjustment of A8R4 (+6V ADJUST) control may be necessary. If both + and - 6 Vdc is out of tolerance or zero, remove A8 board and check for 18 Vdc between XA8-D (+) and XA8-1 (-) with DVM. If +18 Vdc is present, transformer T1, rectifiers, and 18 Vdc filter is good. Trouble is either A8 or short on + or - 6 Vdc line.

NOTE: Both + and - line must be loaded approximately equal or regulator circuit in A8 will not operate properly.

If +120V is not present, remove A8 board, short together XA8-11 and XA8-12, then check for +90 Vdc +9 Vdc at XA8-11. If correct voltage present, trouble probably is filter A8C4. If incorrect voltage present, trouble probably is short on +120V line, diodes CR3 or CR4, or transformer T1.

Adjust signal source RF output and mainframe controls as necessary to obtain an OPERATE indication at the mainframe reference channel level meter.

Check for 278 kHz signal, 1.5V peak-to-peak at XA10-1, >1.0V (8407A) or 0.04V (8410A) peak-to-peak signal at XA9-1, and 1.8V peak-to-peak signal at XA2-12.

- NO → 8407A or 8410 mainframe defective or not phase locked properly, or interface wiring open or shorted.
- YES ↓

Check for 5V peak-to-peak signal at connector J2 (SWEEP IN).

- NO → Sweep oscillator defective.
- YES ↓

AMPLITUDE AUXILIARY OUTPUT

Set sweep oscillator for single frequency (CW) operation. Check for amplitude signal at rear panel AMPLITUDE (50 MV DB) connector with DVM. Change mainframe DISPLAY REFERENCE (8407A) or AMPLITUDE TEST CHANNEL GAIN (8410) controls and DVM indication should change at 50 mV dB (+3% of DVM reading).

- NO → Check dc voltage at XA7-1 with DVM. Change mainframe amplitude test channel gain control and voltage should change between 0 and +9 Vdc +0.9 Vdc in non-linear steps.
  - YES → Trouble is in A7.
  - NO → Check for 0.9V +0.3V peak-to-peak, 278 kHz square wave signal at XA10-11 with oscilloscope.
    - NO → Trouble is in A9.
    - YES → Trouble is in A10.
- YES ↓

PHASE AUXILIARY OUTPUT

Check for phase signal at 8412B rear panel PHASE (10 mV degree) connectors with DVM. Change DEGREES switch position and DVM should change 0.2 Vdc per 20 degree step (+3% of DVM reading).

- NO → Check for 0.9V +0.3V peak-to-peak, 278 kHz square wave signal at XA1-1 with oscilloscope.
  - NO → Trouble is in A9.
  - YES → Check for 0.9V +0.3V peak-to-peak, 278 kHz square wave signal at XA1-N with oscilloscope. Change setting of DEGREES switch and the square-wave symmetry should change between 40 60 and 10 90 percent.
    - NO → Trouble is in A2 or PHASE + polarity or DEGREES
    - YES → Trouble is in A1.
- YES ↓

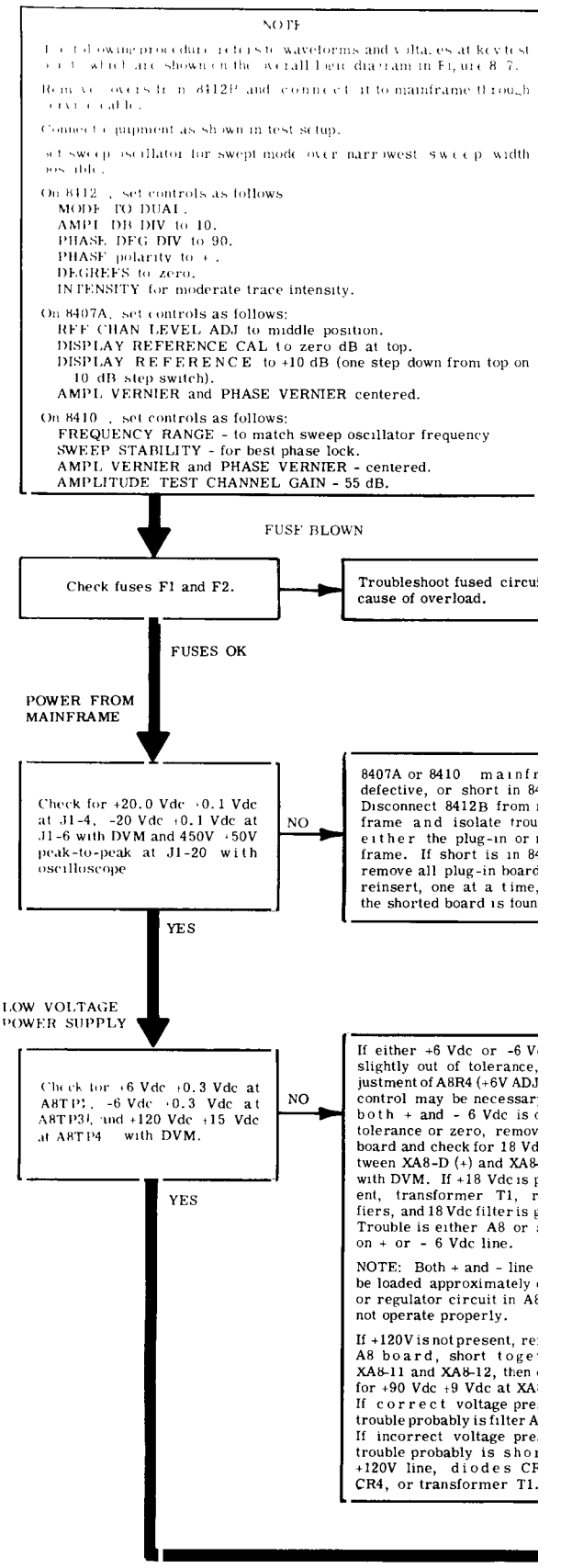
Set signal source for s...

On 8412B, set controls ...
MODE to DUAL
AMPL DB DIV to 1...
PHASE DEG DIV to ...
PHASE polarity to ...
DEGREES to 160
INTENSITY for mod...

On 8407A, set controls ...
REF CHAN LEVEL ...
DISPLAY REFEREN...
DISPLAY REFE...
10 dB step switch ...
AMPL VERNIER an...

On 8410 , set controls ...
FREQUENCY RANG...
SWEEP STABILITY ...
AMPL VERNIER an...
AMPLITUDE TEST ...

Both amplitude and ph... Relative position o... If one trace is missing ... PHASE VERNIER con... which one is missing.


NOTE
The following procedure refers to waveforms and voltages at key test points which are shown on the overall logic diagram in Figure 8-7.
Remove covers from 8412B and connect it to mainframe through extender cable.
Connect equipment as shown in test setup.
Set sweep oscillator for swept mode over narrowest sweep width possible.
On 8412B, set controls as follows:
MODE TO DUAL.
AMPL DB DIV to 10.
PHASE DEG DIV to 90.
PHASE polarity to +.
DEGREES to zero.
INTENSITY for moderate trace intensity.
On 8407A, set controls as follows:
REF CHAN LEVEL ADJ to middle position.
DISPLAY REFERENCE CAL to zero dB at top.
DISPLAY REFERENCE to +10 dB (one step down from top on 10 dB step switch).
AMPL VERNIER and PHASE VERNIER centered.
On 8410, set controls as follows:
FREQUENCY RANGE - to match sweep oscillator frequency
SWEEP STABILITY - for best phase lock.
AMPL VERNIER and PHASE VERNIER - centered.
AMPLITUDE TEST CHANNEL GAIN - 55 dB.
FUSE BLOWN
Check fuses F1 and F2.
Troubleshoot fused circui
cause of overload.
FUSES OK
POWER FROM MAINFRAME
Check for +20.0 Vdc ±0.1 Vdc at J1-4, -20 Vdc ±0.1 Vdc at J1-6 with DVM and 450V ±50V peak-to-peak at J1-20 with oscilloscope
NO
8407A or 8410 mainfr
defective, or short in 8
Disconnect 8412B from
frame and isolate trou
either the plug-in or
frame. If short is in 8
remove all plug-in board
reinsert, one at a time,
the shorted board is foun
YES
LOW VOLTAGE POWER SUPPLY
Check for +6 Vdc ±0.3 Vdc at A8TP2, -6 Vdc ±0.3 Vdc at A8TP3, and +120 Vdc ±15 Vdc at A8TP4 with DVM.
NO
If either +6 Vdc or -6 V
slightly out of tolerance,
justment of A8R4 (+6V ADJ
control may be necessar
both + and - 6 Vdc is
tolerance or zero, remov
board and check for 18 Vd
tween XA8-D (+) and XA8-
with DVM. If +18 Vdc is
ent, transformer T1, r
fiers, and 18 Vdc filter is
Trouble is either A8 or
on + or - 6 Vdc line.
NOTE: Both + and - line
be loaded approximately
or regulator circuit in A8
not operate properly.
If +120V is not present, re
A8 board, short toge
XA8-11 and XA8-12, then
for +90 Vdc ±9 Vdc at XA
If correct voltage pre
trouble probably is filter A
If incorrect voltage pre
trouble probably is sho
+120V line, diodes CR
CR4, or transformer T1.
YES

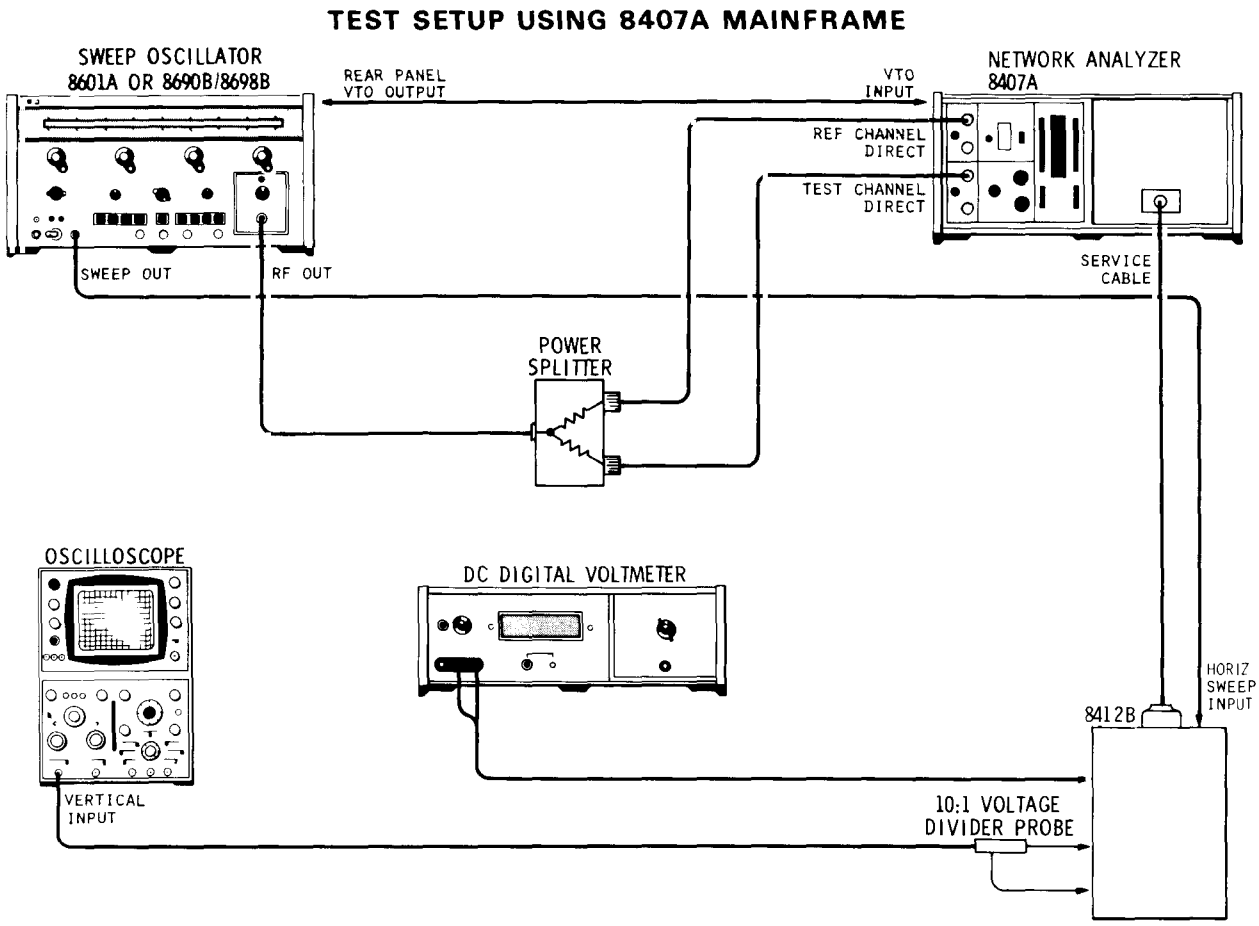


Figure 8-6. Test Setup for Troubleshooting Tree and Block Diagram (1 of 2)

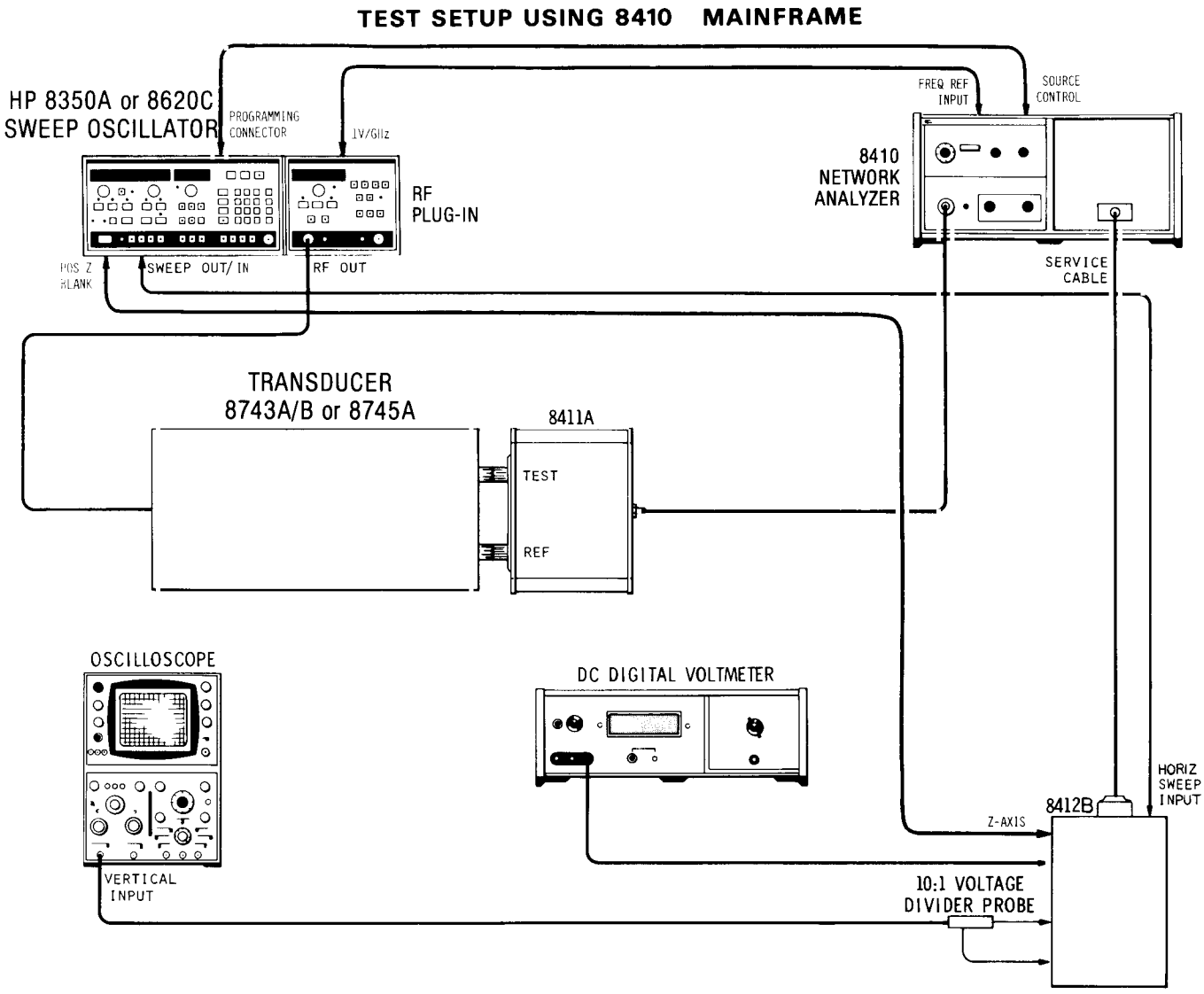
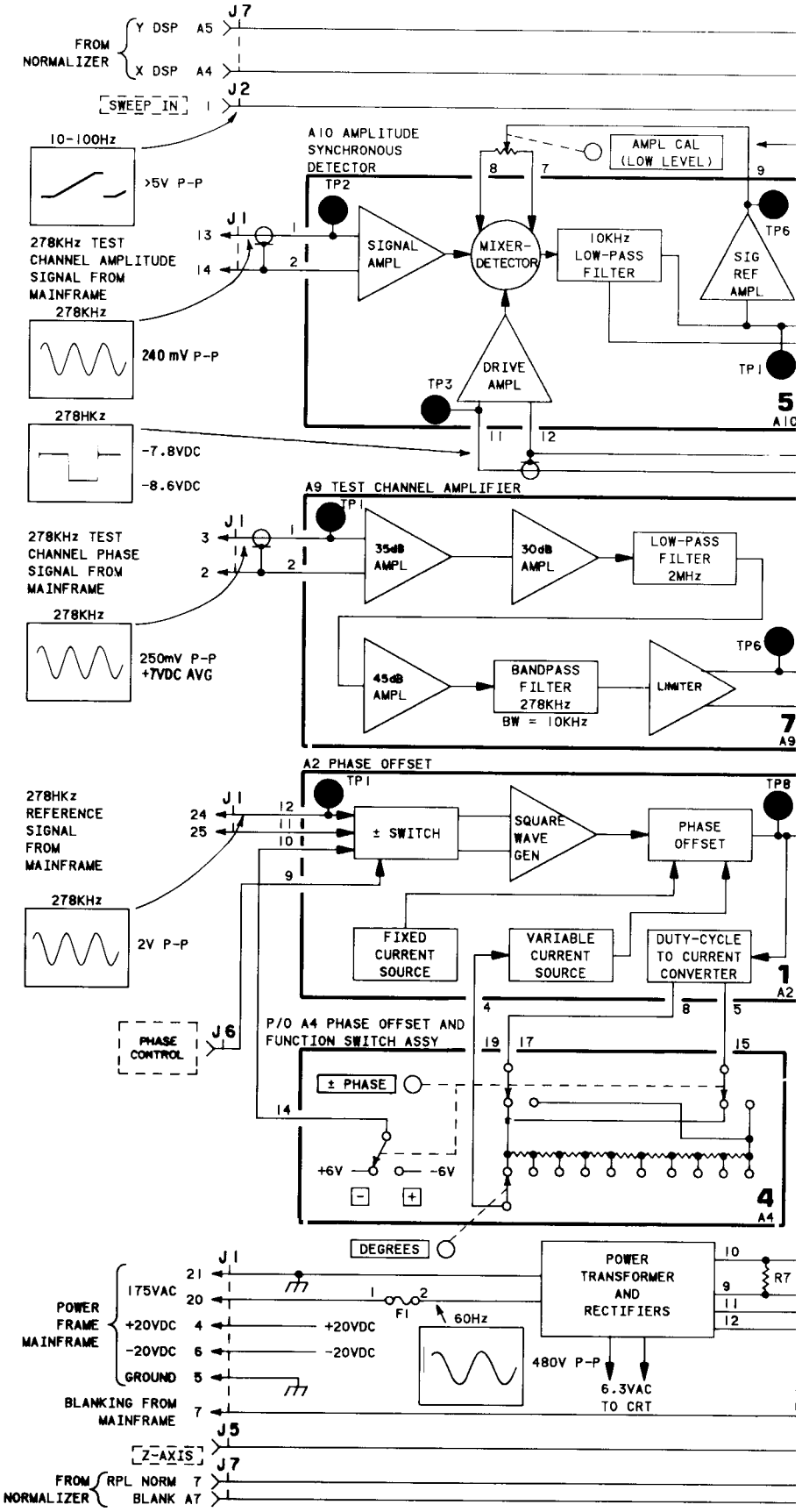
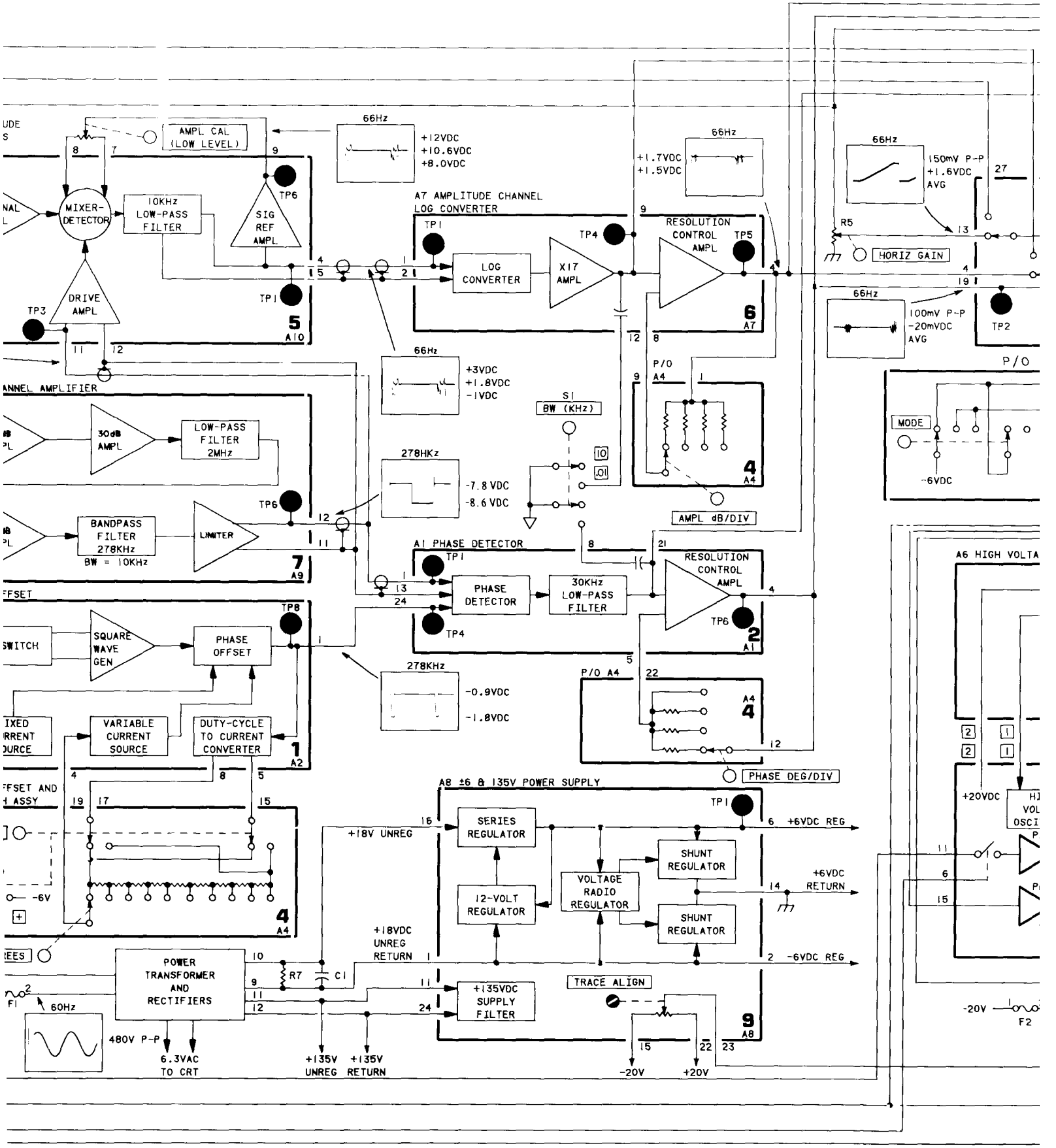


Figure 8-6. Test Setup for Troubleshooting Tree and Block Diagram (2 of 2)


FROM NORMALIZER
Y DSP A5
X DSP A4
J7
SWEEP IN
J2
10-100Hz
>5V P-P
278KHz TEST CHANNEL AMPLITUDE SIGNAL FROM MAINFRAME
278KHz
240 mV P-P
278HKz
-7.8VDC
-8.6VDC
A10 AMPLITUDE SYNCHRONOUS DETECTOR
AMPL CAL (LOW LEVEL)
TP2
SIGNAL AMPL
MIXER-DETECTOR
10KHz LOW-PASS FILTER
SIG REF AMPL
TP6
TP1
DRIVE AMPL
TP3
5
A10
A9 TEST CHANNEL AMPLIFIER
278KHz TEST CHANNEL PHASE SIGNAL FROM MAINFRAME
278KHz
250mV P-P
+7VDC AVG
35dB AMPL
30dB AMPL
LOW-PASS FILTER 2MHz
45dB AMPL
BANDPASS FILTER 278KHz
BW = 10KHz
LIMITER
7
A9
A2 PHASE OFFSET
278HKz REFERENCE SIGNAL FROM MAINFRAME
278KHz
2V P-P
± SWITCH
SQUARE WAVE GEN
PHASE OFFSET
FIXED CURRENT SOURCE
VARIABLE CURRENT SOURCE
DUTY-CYCLE TO CURRENT CONVERTER
1
A2
PHASE CONTROL
J6
P/O A4 PHASE OFFSET AND FUNCTION SWITCH ASSY
± PHASE
+6V
-6V
4
A4
DEGREES
POWER FRAME MAINFRAME
175VAC
+20VDC
-20VDC
GROUND
BLANKING FROM MAINFRAME
F1
60Hz
480V P-P
POWER TRANSFORMER AND RECTIFIERS
R7
6.3VAC TO CRT
Z-AXIS
J5
FROM NORMALIZER
RPL NORM
BLANK A7


AMPL CAL (LOW LEVEL)
MIXER-DETECTOR
10KHz LOW-PASS FILTER
SIG REF AMPL
DRIVE AMPL
TP6
TP1
TP3
5 A10
66Hz
+12VDC
+10.6VDC
+8.0VDC
A7 AMPLITUDE CHANNEL LOG CONVERTER
LOG CONVERTER
X17 AMPL
RESOLUTION CONTROL AMPL
TP4
TP5
6 A7
+1.7VDC
+1.5VDC
66Hz
150mV P-P
+1.6VDC AVG
R5
HORIZ GAIN
66Hz
100mV P-P
-20mVDC AVG
TP2
P/O A4
4 A4
AMPL dB/DIV
S1
BW (KHz)
10
.01
+3VDC
+1.8VDC
-1VDC
278HKz
-7.8 VDC
-8.6 VDC
ANNEL AMPLIFIER
30dB AMPL
LOW-PASS FILTER 2MHz
BANDPASS FILTER 278KHz
BW = 10KHz
LIMITER
7 A9
A1 PHASE DETECTOR
PHASE DETECTOR
30KHz LOW-PASS FILTER
RESOLUTION CONTROL AMPL
TP8
TP6
2 A1
278KHz
-0.9VDC
-1.8VDC
P/O A4
4 A4
PHASE DEG/DIV
SQUARE WAVE GEN
PHASE OFFSET
VARIABLE CURRENT SOURCE
DUTY-CYCLE TO CURRENT CONVERTER
1 A2
-6V
4 A4
A8 ±6 & 135V POWER SUPPLY
+18V UNREG
SERIES REGULATOR
12-VOLT REGULATOR
VOLTAGE RADIO REGULATOR
SHUNT REGULATOR
SHUNT REGULATOR
+6VDC REG
+6VDC RETURN
-6VDC REG
+18VDC UNREG RETURN
TRACE ALIGN
+135VDC SUPPLY FILTER
POWER TRANSFORMER AND RECTIFIERS
R7
C1
60Hz
480V P-P
6.3VAC TO CRT
+135V UNREG
+135V RETURN
-20V
+20V
9 A8
A6 HIGH VOLTA
+20VDC
-20V
F2

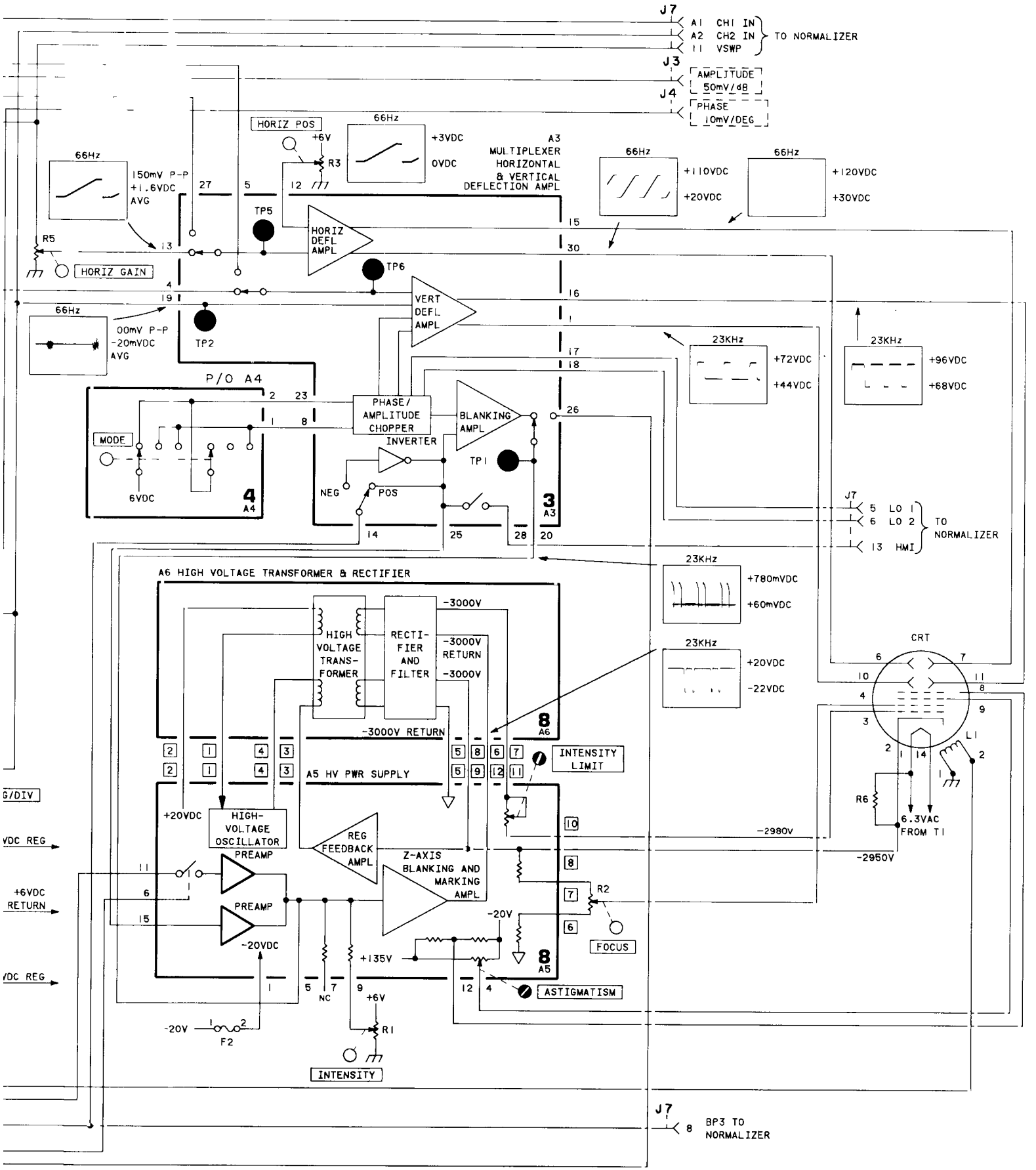


Figure 8-7. Detailed Block Diagram

Phase Error Amplifier

U6 is an operational amplifier operating in a differential mode. It compares the Phase Offset voltage as set by the front panel PHASE OFFSET switch to the DC output of the Low Pass Filter and generates an error voltage used to tune the 556 kHz VCO. The output of U6 is clamped by VR1 and VR2 to approximately ±4.1V so that the operational amplifier will not latch up to the supply voltages.

Voltage Controlled Oscillator (VCO)

U7 is an ECL VCO whose free running frequency is determined by the parallel tuned circuit L6, C20, C21 and tuning diode CR1. C19 and L5 provide a low impedance path to ground for CR1 at 556 kHz. C20 sets the oscillator frequency at 556 kHz with a near zero volt tune input.

Divide By 2 Counter

The Divide by 2 counter consists of differential amplifier Q3A and Q3B and ECL flip-flops U8A and U8B. The differential amplifier converts the VCO output into complementary 556 kHz square waves. The complementary signals are then divided by two again by U8A and U8B, resulting in four 278 kHz signals that are displaced 90° in phase as shown in Figure 8-11.

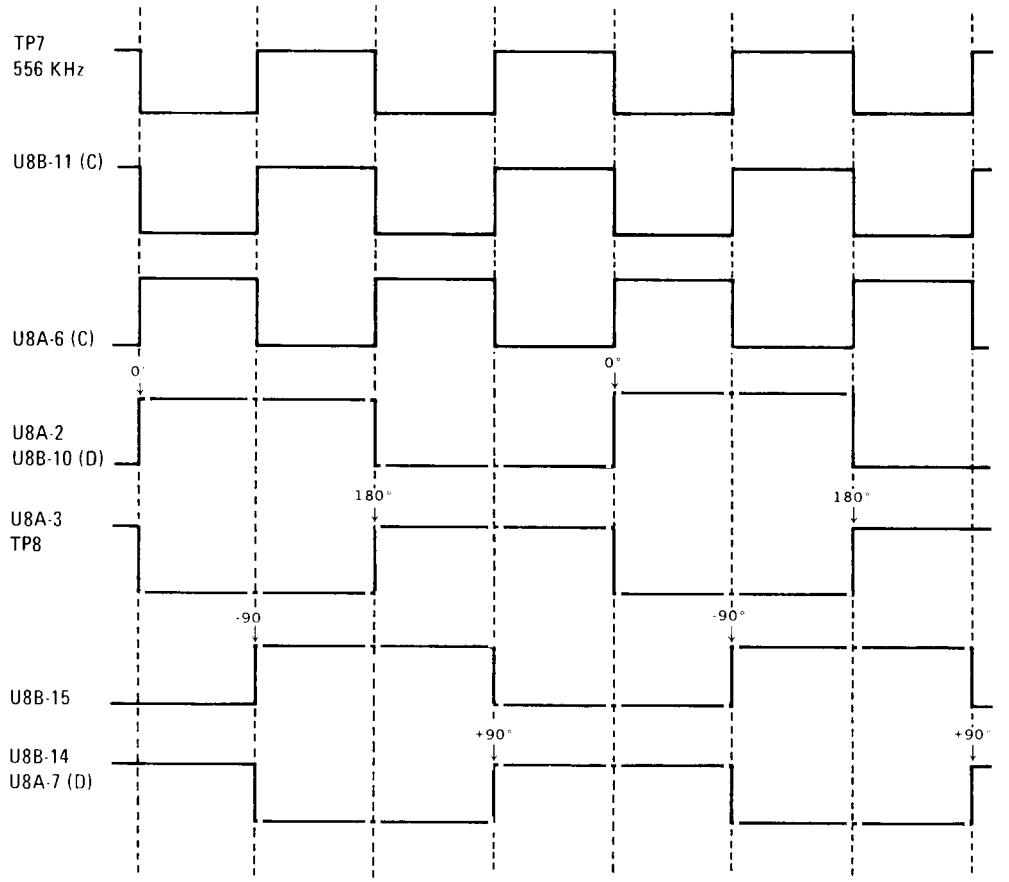


Figure 8-11. Divide by 2 Counter, Timing Diagram

The Q_B output is fed back to U4 for phase locking while the Q_A output (shifted −90° from Q_B) is fed to the A1 Phase Detector assembly. This arrangement allows the phase lock loop to operate in the 90° to 270° range, away from the inherently unstable points of the digital Phase Comparator at 0° and 360°. At the same time, this enables the phase output to be within a few degrees of the Reference Phase input.

Limiter

Limiter U2 converts the incoming sine wave signal to a square wave output signal with a fast rising edge. ECL device U2 is a triple line receiver with outputs connected in cascade as differential amplifiers. Each amplifier provides approximately 15 dB of gain for a total stage gain of about 45 dB.

± 180° Phase Comparator

The ± 180° Phase Comparator converts the time displacement of the rising edges of the two input signals to an output pulse whose width is proportional to the phase difference. The cross-coupled ECL D flip-flops U4A and U4B are set when a rising edge appears at their respective clock input. The cross-coupling causes U4A to be reset whenever U4B is set and vice versa to insure that the circuit responds to rising edges only. The Q_B output of U4B is set by the Reference Phase signal and is reset by the Test Phase signal through U4A. Complete timing waveforms for the ± 180° Phase Comparator are shown in Figure 8-10.

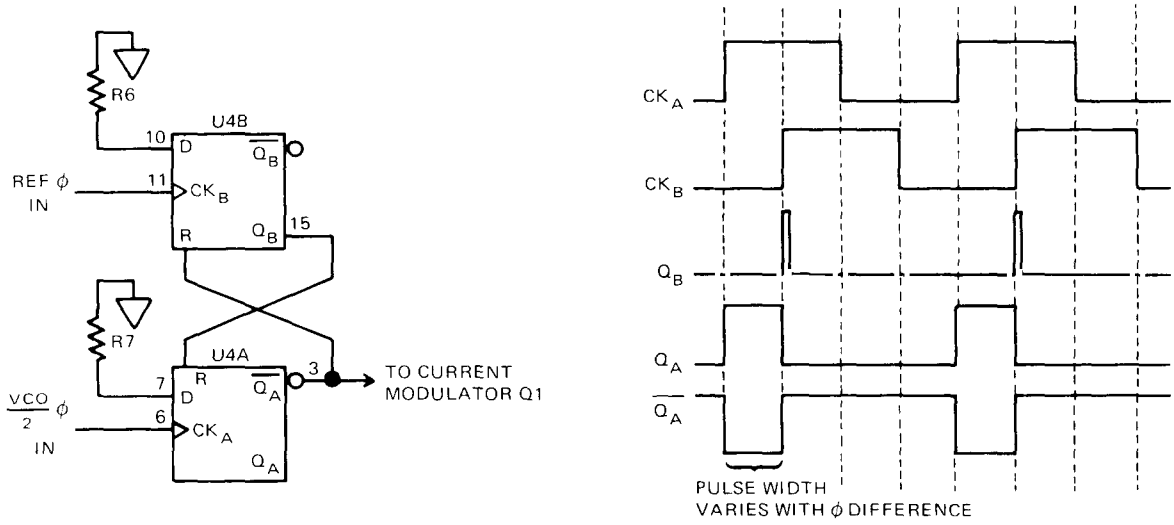


Figure 8-10. ± 180° Phase Comparator and Timing Diagram.

Current Modulator and Phase Offset Voltage Generator

Differential amplifier Q1 and Q2A operates as a current switch controlled by the output pulses from the Phase Comparator. Q2B is the phase offset voltage generator current sink. As can be seen in the Block Diagram Figure 7-6A, the bias on the base of Q2A/B along with R15 and R18 form two identical current sinks of approximately 3.17 mA each. These current sinks follow each other exactly which reduces resulting phase offset errors. The Q_A output of U4A turns current Modulator Q1 and Q2A on and off which in turn switches the 3.17 mA Reference Current Sink through R10 and R11 or R9. If R10 plus R11 is adjusted to 1.8K ohms, the modulated current drawn through it produces an average voltage drop equal to approximately 5.71V/360° or 15.85 mV/degree of phase difference. The 3.17 mA Offset Current Sink draws through the offset resistor chain on the A4 PHASE OFFSET DEGREES switch. Since the offset resistors are 100 ohms each, the voltage drop across each one is then 0.317V or equivalent to 20 degrees per resistor. R13 sets the initial offset to match the Test and Reference phases.

Low Pass Filter

A2C15 acts as part of a low-pass filter that integrates the output of the current modulator, eliminating any high-frequency noise that is present. The resulting DC Voltage is now our phase-lock error voltage.

A2 Phase Offset General Description

The Phase Offset circuit is a second order phase lock loop whose function is that of accurately tracking the 278 kHz Phase Reference signal input and offsetting this signal as a function of the front panel PHASE OFFSET switch. This offset is accomplished by summing an error offset voltage, according to the PHASE OFFSET switch, into the feedback amplifier in the phase lock loop. This shifts the phase of the output signal by a calibrated amount in 20° steps from 0° to ±180°. The sine wave input signal is converted to a square wave output signal in the process for use in the A1 Phase Detector. Figure 8-9 is a block diagram of the circuit.

In atuomatic system operation, a 180 degree phase shift is selected through the PHASE OFFSET CONTROL input when it is necessary to avoid making measurements in the ±180 degree phase transition range

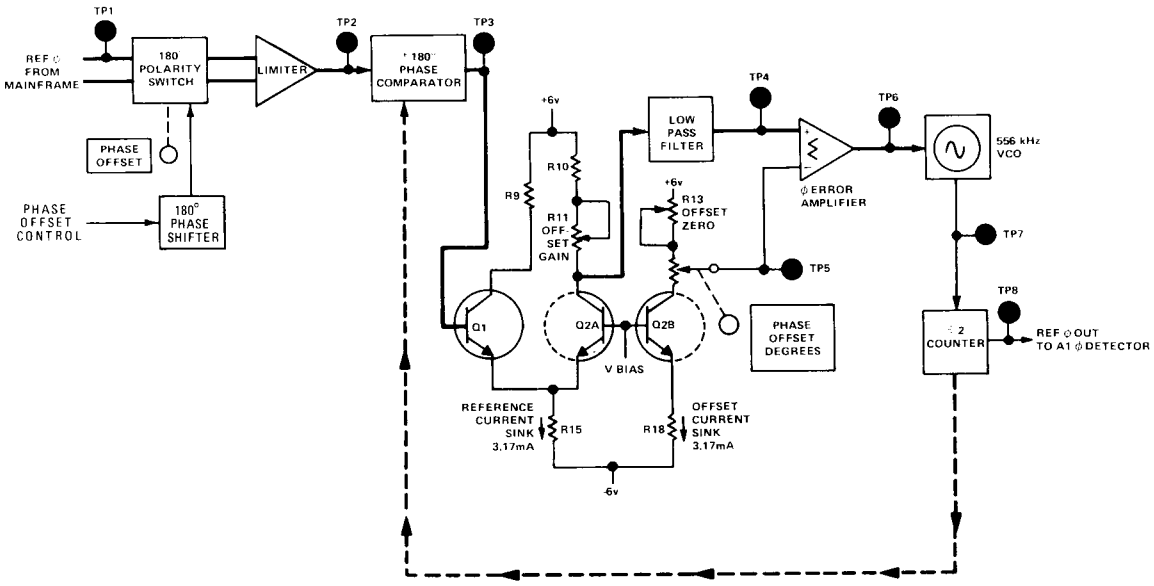
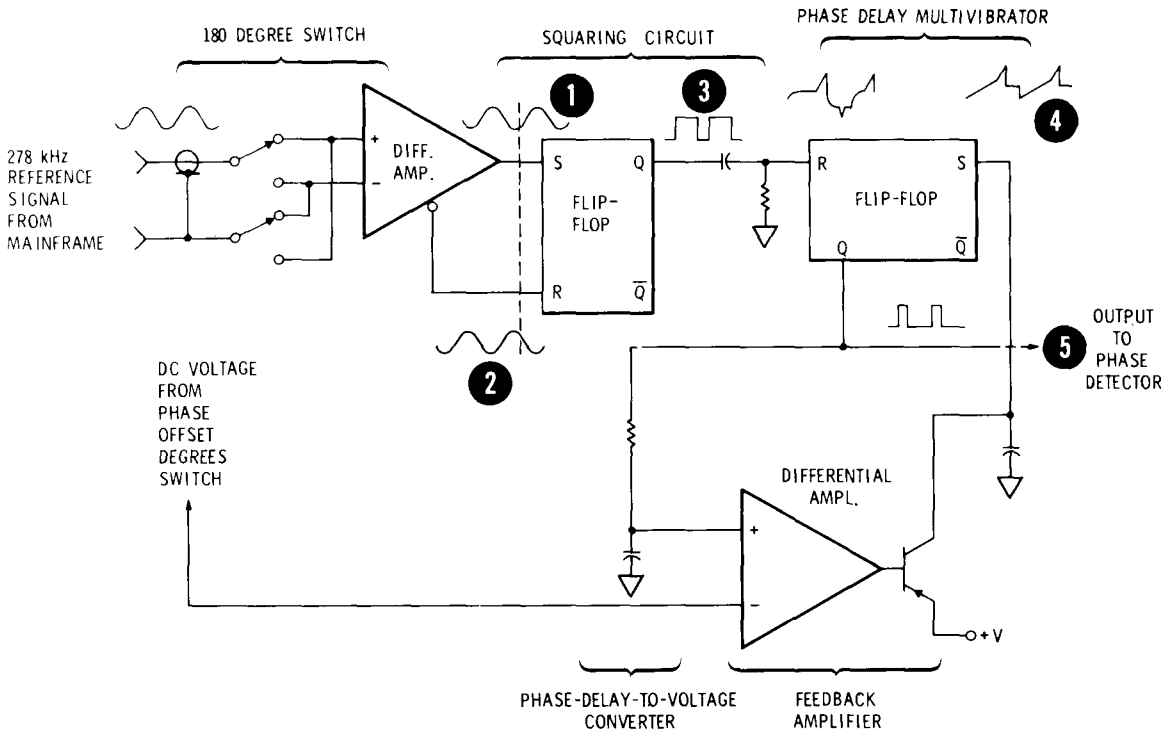


Figure 8-9. A2 Phase Offset Assembly, Block Diagram.

180° Polarity Switch

U1, the 180° Polarity Switch, changes the polarity of the 278 kHz Phase Reference input signal by 180 degrees as a function of the front panel ±PHASE OFFSET polarity switch. U1 is a CMOS triple two-channel analog multiplexer with the inputs and outputs connected as shown on the schematic diagram. When the ±PHASE OFFSET polarity switch is set to (+), −6V is connected to the control line. CR2 blocks the −6V input and causes control inputs A and B to go low through pull down resistor R3. This enables A_0 and B_0 noninverting outputs. With the ±PHASE OFFSET polarity switch set to (−), +6V is applied to CR2 and pulls A and B control inputs high, enabling A_1 and B_1 outputs, thus inverting the input signal to Limiter U2.

In automatic system operation, the front panel PHASE OFFSET switch must be set to "+". This allows a closure to ground (or a TTL "0" signal) on the PHASE OFFSET CONTROL input through Q4 to produce a 180 degree phase shift in U1. This allows the automatic measurement system to avoid taking data near the ±180 degree phase transition point.



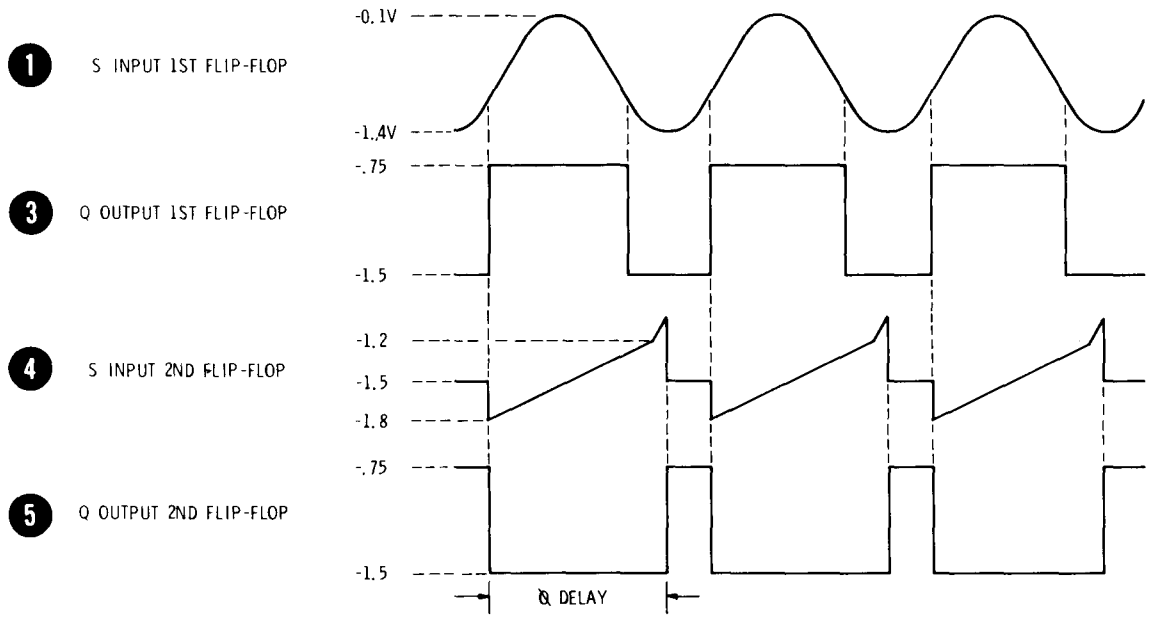


Figure 8-8. Phase Offset A2

A2

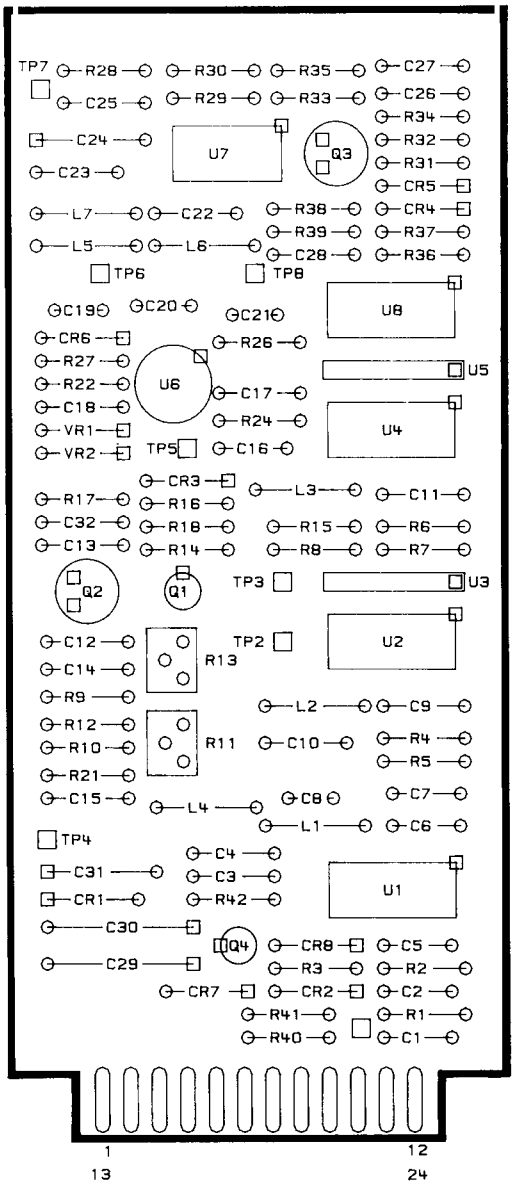
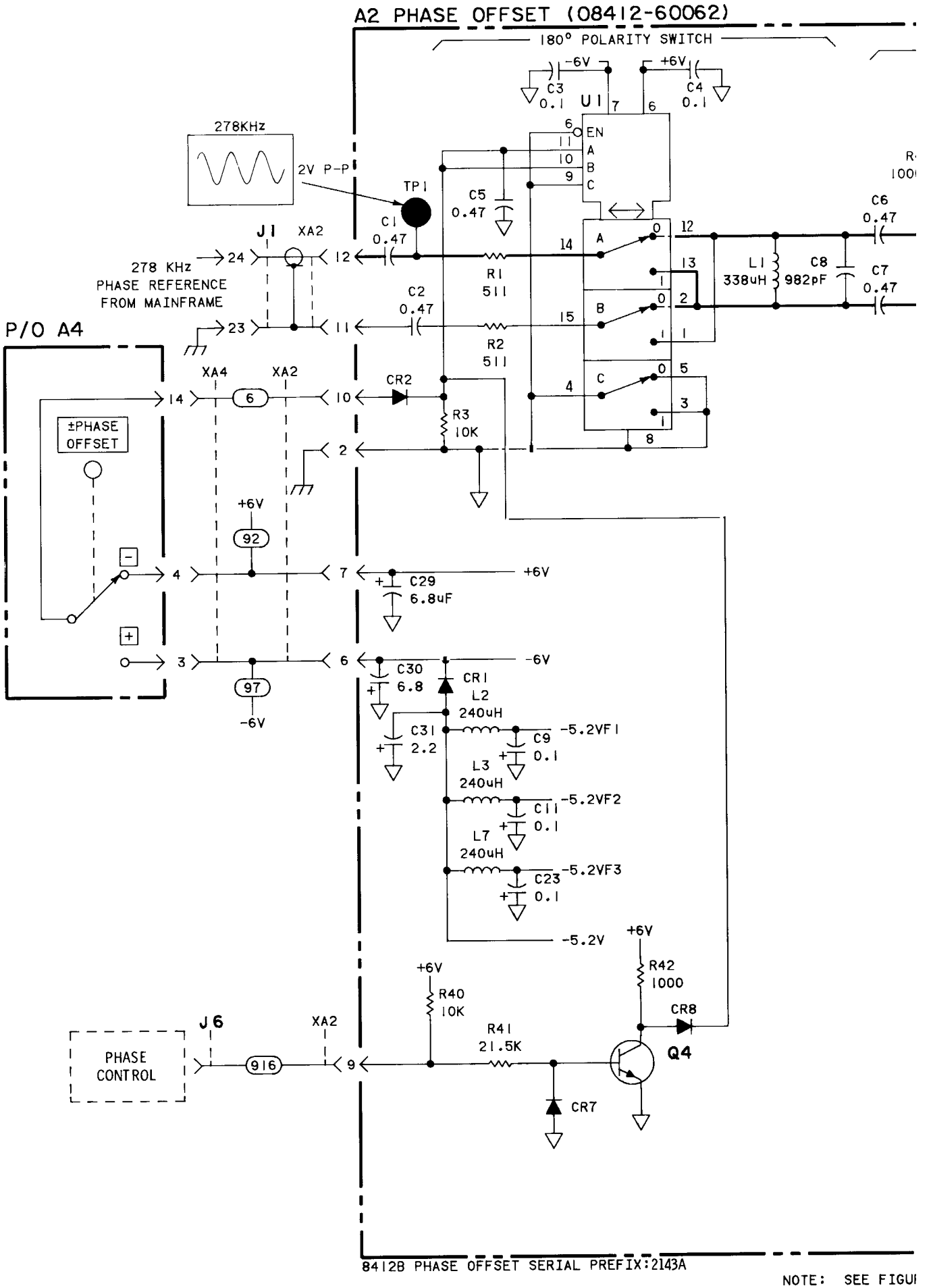
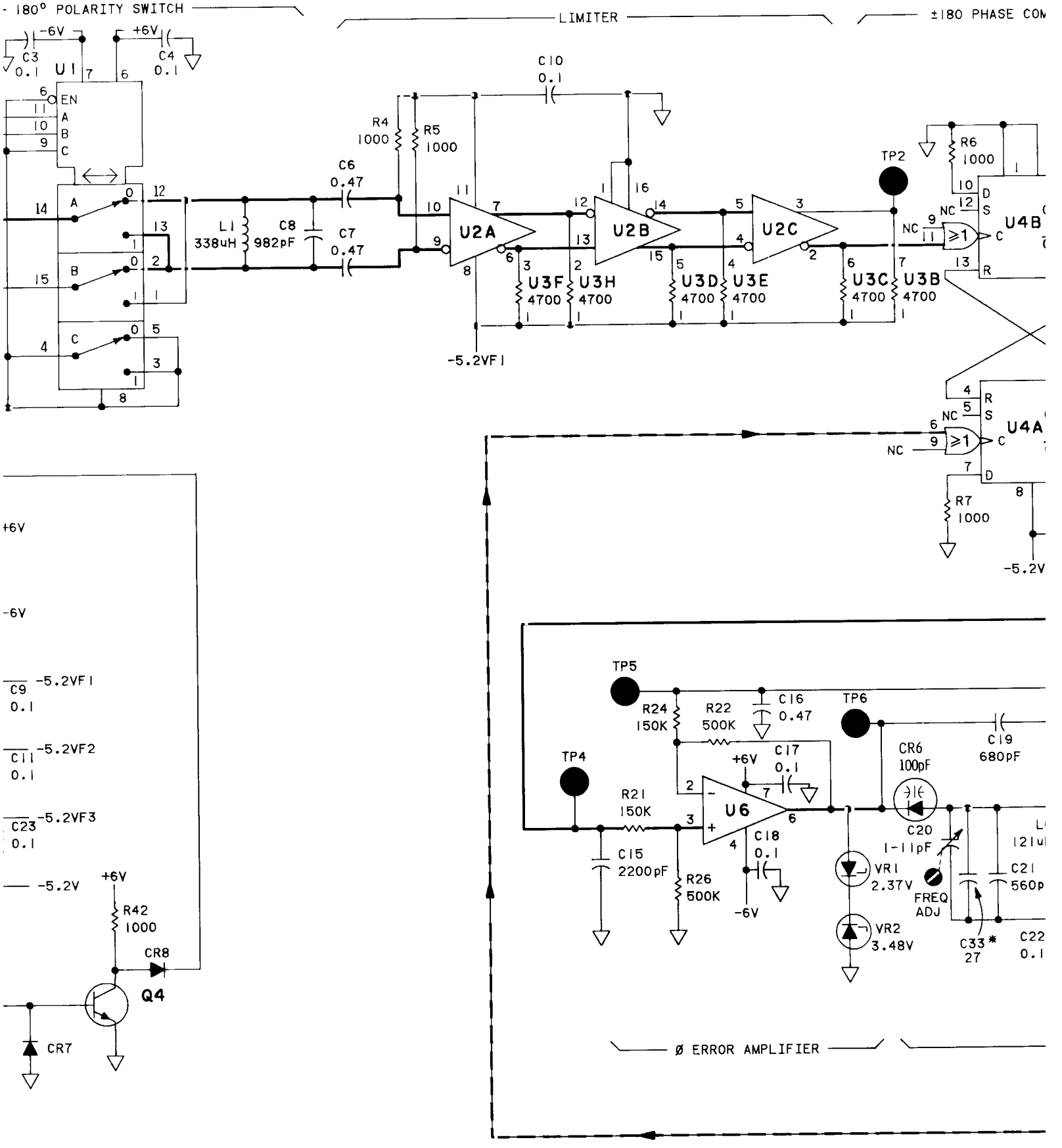


Figure 8-12. Component Location for Phase Offset A2

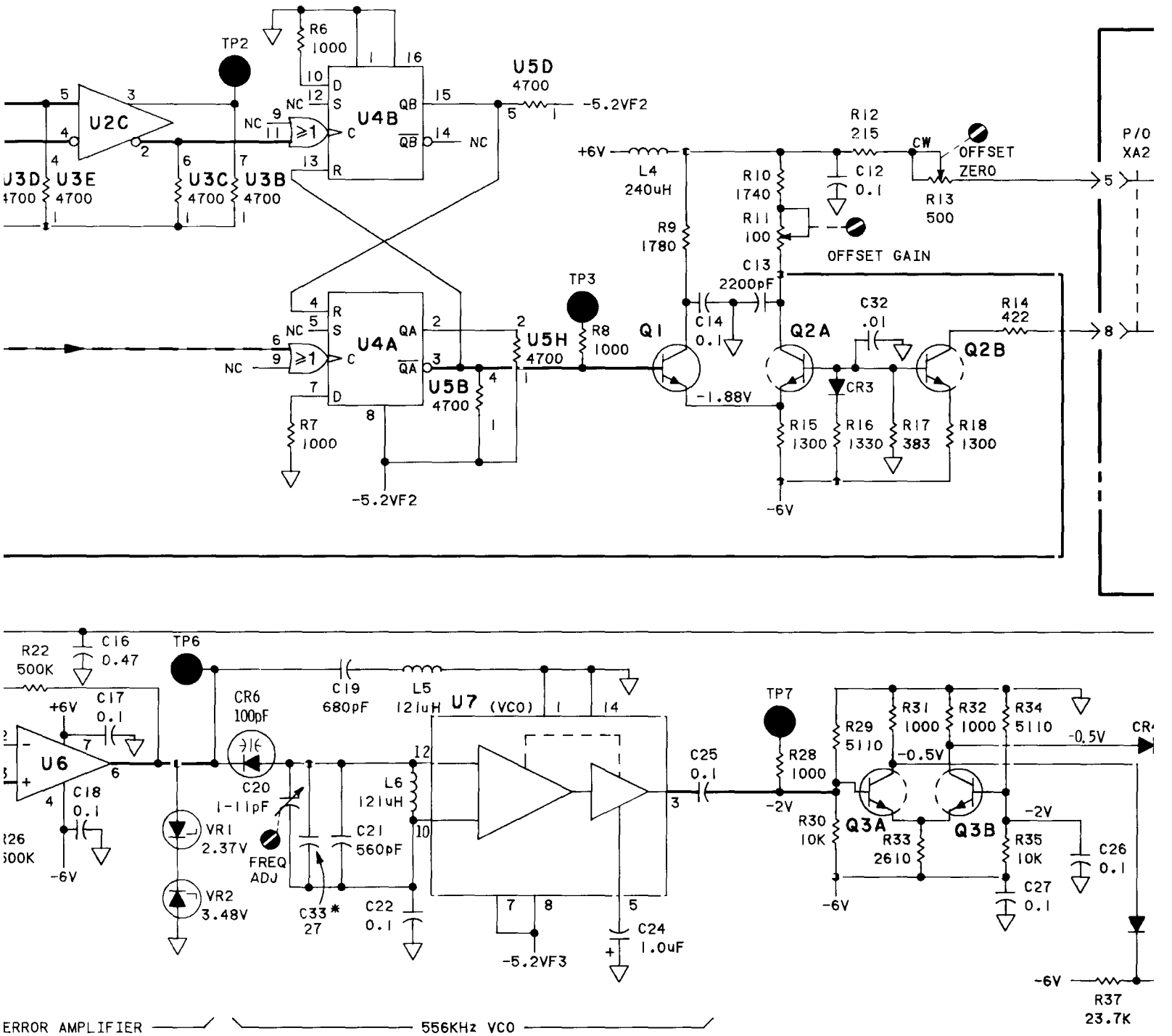

A2 PHASE OFFSET (08412-60062)
180° POLARITY SWITCH
-6V
+6V
C3
0.1
C4
0.1
U1
278KHz
2V P-P
TP1
C5
0.47
C1
0.47
J1
XA2
278 KHz
PHASE REFERENCE
FROM MAINFRAME
C2
0.47
R1
511
R2
511
R3
10K
CR2
C6
0.47
L1
338uH
C8
982pF
C7
0.47
P/O A4
XA4
XA2
±PHASE
OFFSET
+6V
92
C29
6.8uF
97
-6V
C30
6.8
CR1
L2
240uH
C31
2.2
C9
0.1
-5.2VF1
L3
240uH
C11
0.1
-5.2VF2
L7
240uH
C23
0.1
-5.2VF3
-5.2V
R42
1000
CR8
R40
10K
R41
21.5K
Q4
CR7
J6
PHASE
CONTROL
916
8412B PHASE OFFSET SERIAL PREFIX:2143A
NOTE: SEE FIGU
AND TEST

ET (08412-60062)



SERIAL PREFIX:2143A

NOTE: SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN VOLTAGES SHOWN.


±180 PHASE COMPARATOR
CURRENT MODULATOR
TP2
R6
1000
U5D
4700
-5.2VF2
U2C
U4B
U3D
4700
U3E
4700
U3C
4700
U3B
4700
NC
≥1
R12
215
CW
OFFSET
ZERO
R13
500
P/O
XA2
+6V
L4
240uH
R10
1740
C12
0.1
R9
1780
R11
100
OFFSET GAIN
C13
2200pF
TP3
C32
.01
R14
422
U4A
U5H
4700
R8
1000
Q1
C14
0.1
Q2A
Q2B
U5B
4700
-1.88V
CR3
R7
1000
R15
1300
R16
1330
R17
383
R18
1300
-6V
-5.2VF2
R22
500K
C16
0.47
TP6
+6V
C17
0.1
CR6
100pF
C19
680pF
L5
121uH
U7 (VCO)
U6
C18
0.1
C20
1-11pF
L6
121uH
VR1
2.37V
FREQ
ADJ
C21
560pF
VR2
3.48V
C33*
27
C22
0.1
-5.2VF3
C24
1.0uF
C25
0.1
TP7
R28
1000
R29
5110
R31
1000
R32
1000
R34
5110
-0.5V
-2V
R30
10K
Q3A
Q3B
R33
2610
R35
10K
C26
0.1
C27
0.1
-6V
R37
23.7K
ERROR AMPLIFIER
556KHz VCO

÷2 COUNTE

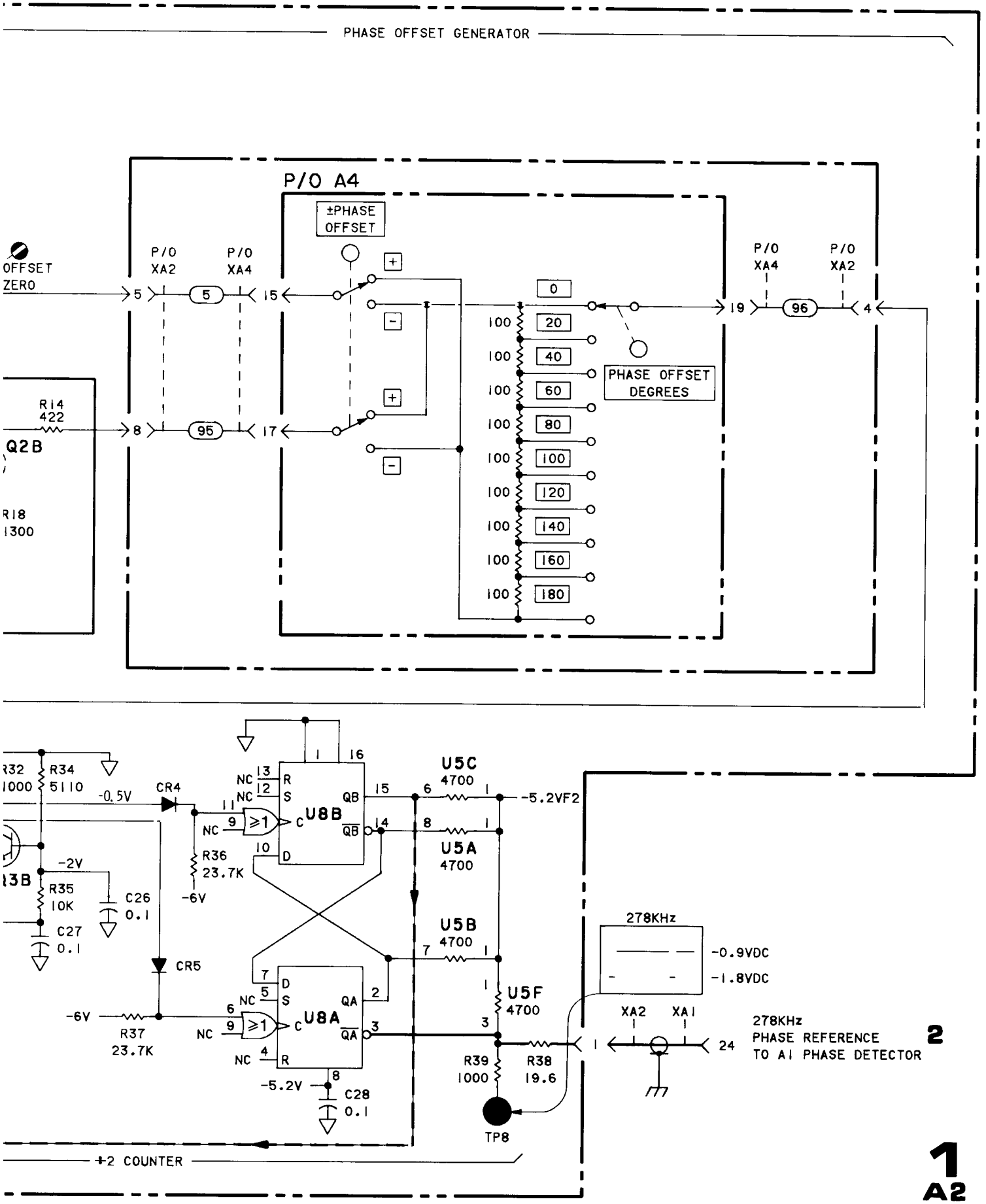


Figure 8-13. Phase Offset A2, Schematic Diagram

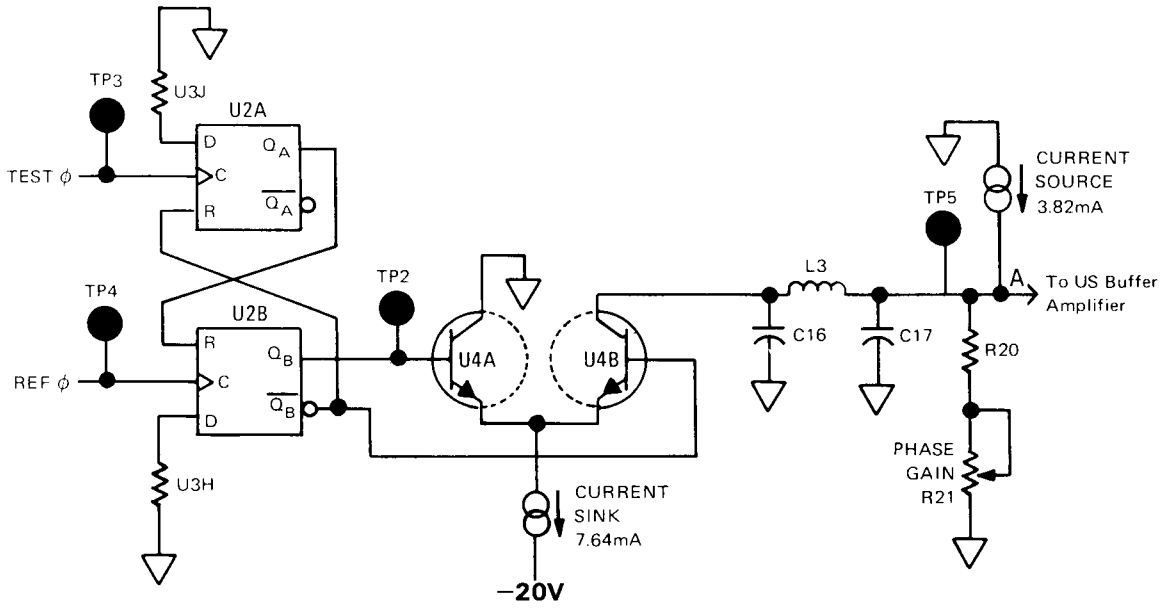


Figure 8-15. ± 180° Phase Comparator and Current Modulator, Simplified Schematic.

Current to Voltage Convertor

The current from the Current Modulator (−3.82 mA to +3.82 mA) is converted to a voltage by R20 and R21. R21 is adjusted to provide ±1.8V/±180° of phase shift. U6 provides isolation between the converter and the phase output. The output of U6 is also fed back to the Hysteresis Summing Amplifier to provide stability at the ±180 degree switch points.

Hysteresis Summing Amplifier

The Hysteresis Summing Amplifier in the Test Channel is a ±9 degree voltage control phase shifter whose phase shift is controlled by the output of the Phase Comparator. The Test Phase signal from the A9 Test Channel Amplifier is converted to a sine wave by L4 and C4. This provides a waveform with a slow rise and fall time. This signal is AC coupled to the differential input of U1B, whose bias voltage is controlled by the feedback network from the output of the Phase Comparator. The ±2.5V phase voltage changes the bias voltage of U1B approximately ±70 mV (computed from the sine of 9 degrees times the differential peak voltage of 0.45V). This change in bias varies the time at which the input waveform is equal to the threshold voltage by about 9 degrees. (The threshold voltage is a bias voltage available at pin 11 of U1.) The output of U1B is fed to Schmitt Trigger U1C to square the waveform so that a fast rising edge is available to drive the clock input of the Phase Comparator.

Resolution Control Amplifier

The Resolution Control Amplifier is a noninverting amplifier which provides gains of 100, 10, 2.2, and 1.1 as controlled by the PHASE DEG/DIV switch. This insures that the 5 mV/degree signal, half of the buffer amplifier output, can drive a CRT display with 500 mV/division resolution. This is equal to a resolution setting of 1 degree, 10 degrees, 45 degrees, and 90 degrees per division, respectively.

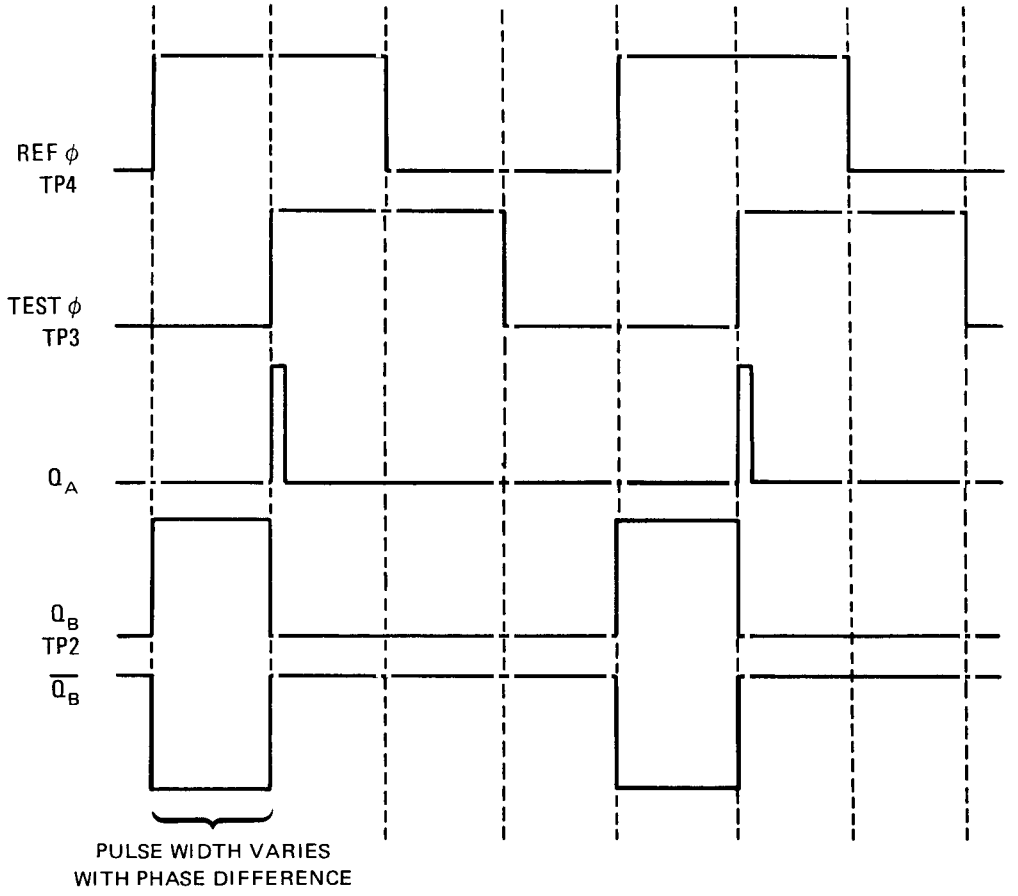


Figure 8-14. ± 180° Phase Comparator and Current Modulator, Timing Diagram.

Current Modulator

The Phase Comparator differentially drives a Current Modulator that generates an average current proportional to the pulse width. The current modulator consists of a Current Source (Q1, Q2A, and Q2B), a Current Sink (U4C, U4D, and U4E), and a differential amplifier (U4A and U4B). As shown in Figure 8-15, the Current sink is twice that of the Current Source (7.64 mA and 3.82 mA, respectively).

When U4A is on, U4B is off. This causes 3.82 mA to flow from the Current Source, through Node A, and into the Current-to-Voltage Convertor (R20 and R21). When U4A is off, U4B is on. This causes 7.64 mA to flow into the Current Sink, through Node A, from the Current Source and the Current-to-Voltage Convertor. If U4A/B turn on and off an equal amount of time, the average current in R20 and R21 is zero. Therefore, the average output current in R20 and R21 varies from −3.82 mA to +3.82 mA, corresponding to a range of −180 degrees to +180 degrees of phase difference.

2 THEORY FOR PHASE DETECTOR A1

A1 Phase Detector, General Description

The Phase Detector circuit provides a DC output that is proportional to the phase difference between its two signal inputs: (a) the test channel phase signal from the A9 Test Channel Amplifier, and (b) the Reference Phase signal from the A2 Phase Offset assembly. The Phase Detector consists of four main stages:

- ±180° Phase Comparator, which converts the phase difference between the 278 kHz Test Channel phase signal and the 278 kHz Reference Channel phase signal to a pulse whose width is proportional to the phase difference.
- Current Modulator (consisting of a Current Source, Current Switch, and Current Sink,) which converts the pulse width output of the phase comparator to a proportional current.
- Low Pass Filter (C16, L3, and C17), which filters the high-frequency IF components from the output of the Current Modulator.
- Current-to-Voltage Converter, which converts the current output from the Current Modulator to a corresponding voltage, then scales this voltage to provide a voltage-to-phase relationship of ±1.8V/±180 degrees.

A secondary circuit, the Hysteresis Summing Amplifier, prevents the output of the Phase Detector from oscillating between the +180° and −180° output states when the phase difference between the test and reference signals is near 180 degrees.

±180° Phase Comparator

The ±180° Phase Comparator converts the time displacement of the rising edges of the two input signals to an output pulse whose width is proportional to the phase difference. The cross-coupled ECL D flip-flops U2A and U2B are set when a rising edge appears at the clock input. The cross-coupling causes U2A to be reset whenever U2B is set and vice versa to ensure that the circuit responds to the rising edge only. The Q_B output of U2B is set by the Reference Phase signal and is reset by the Test Phase signal through U2A. Complete timing waveforms for the ±180° Phase Comparator are shown in Figure 8-14.

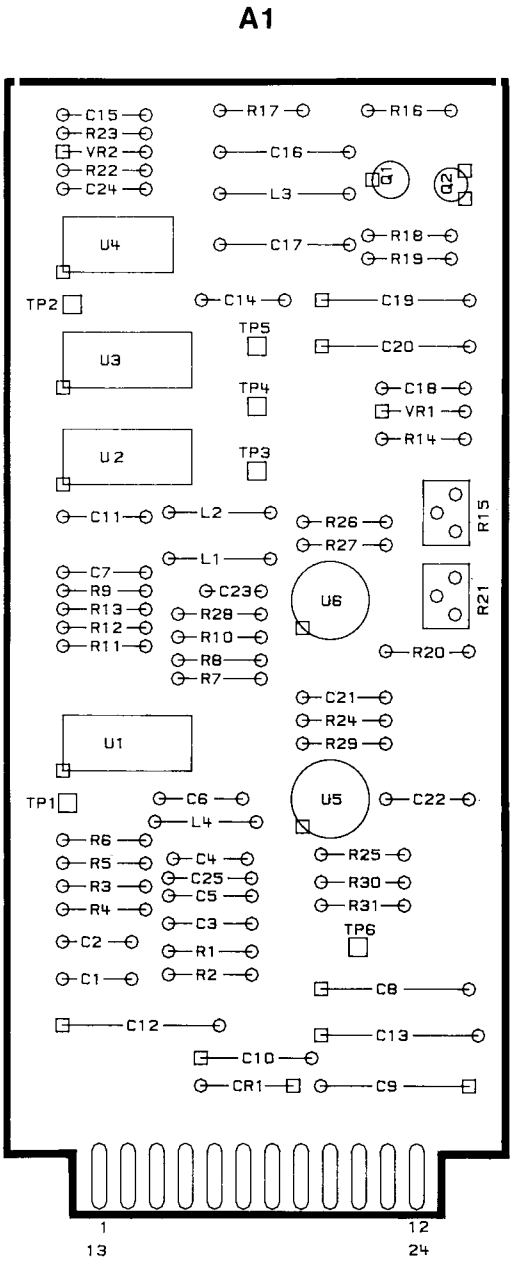
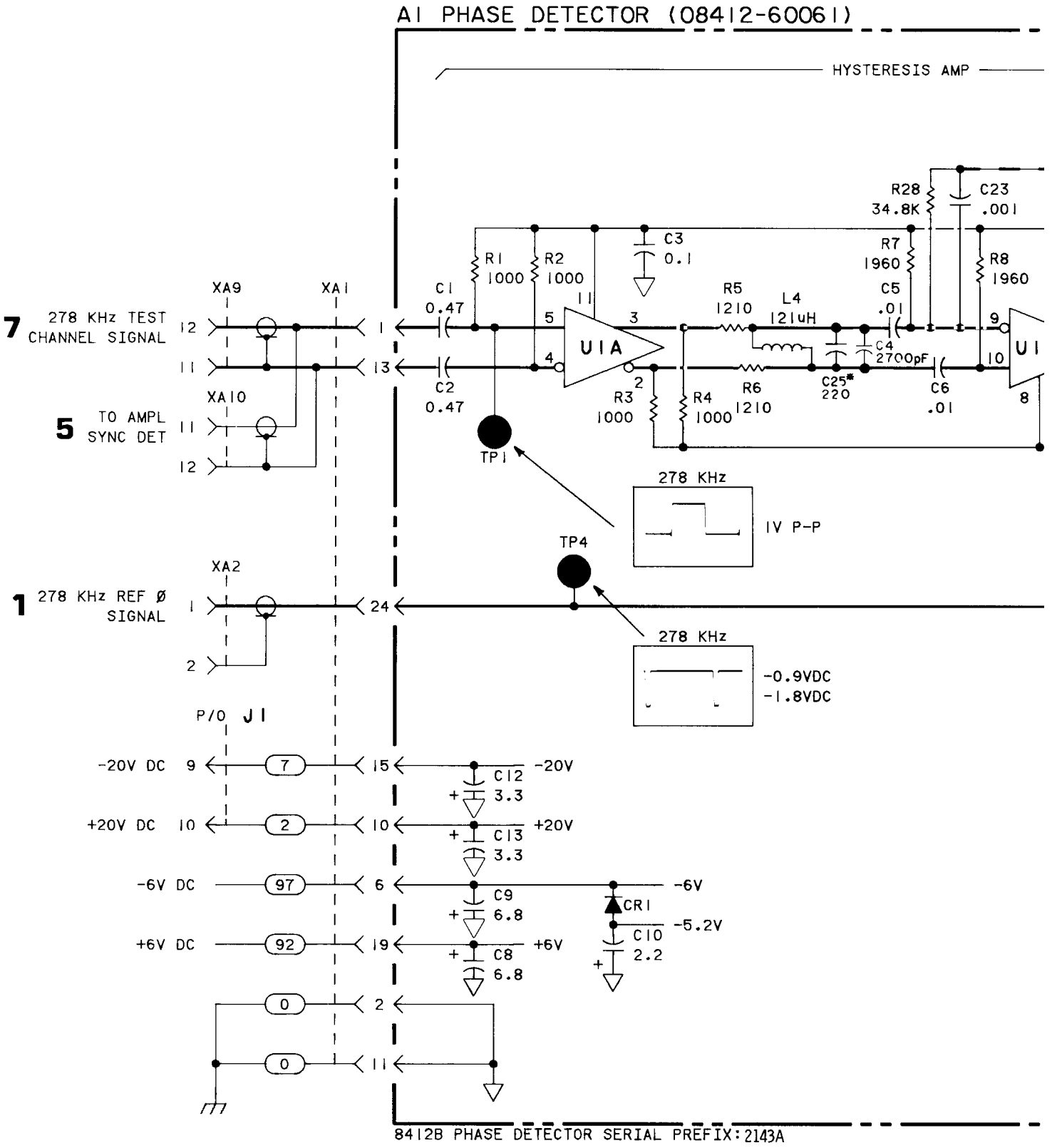
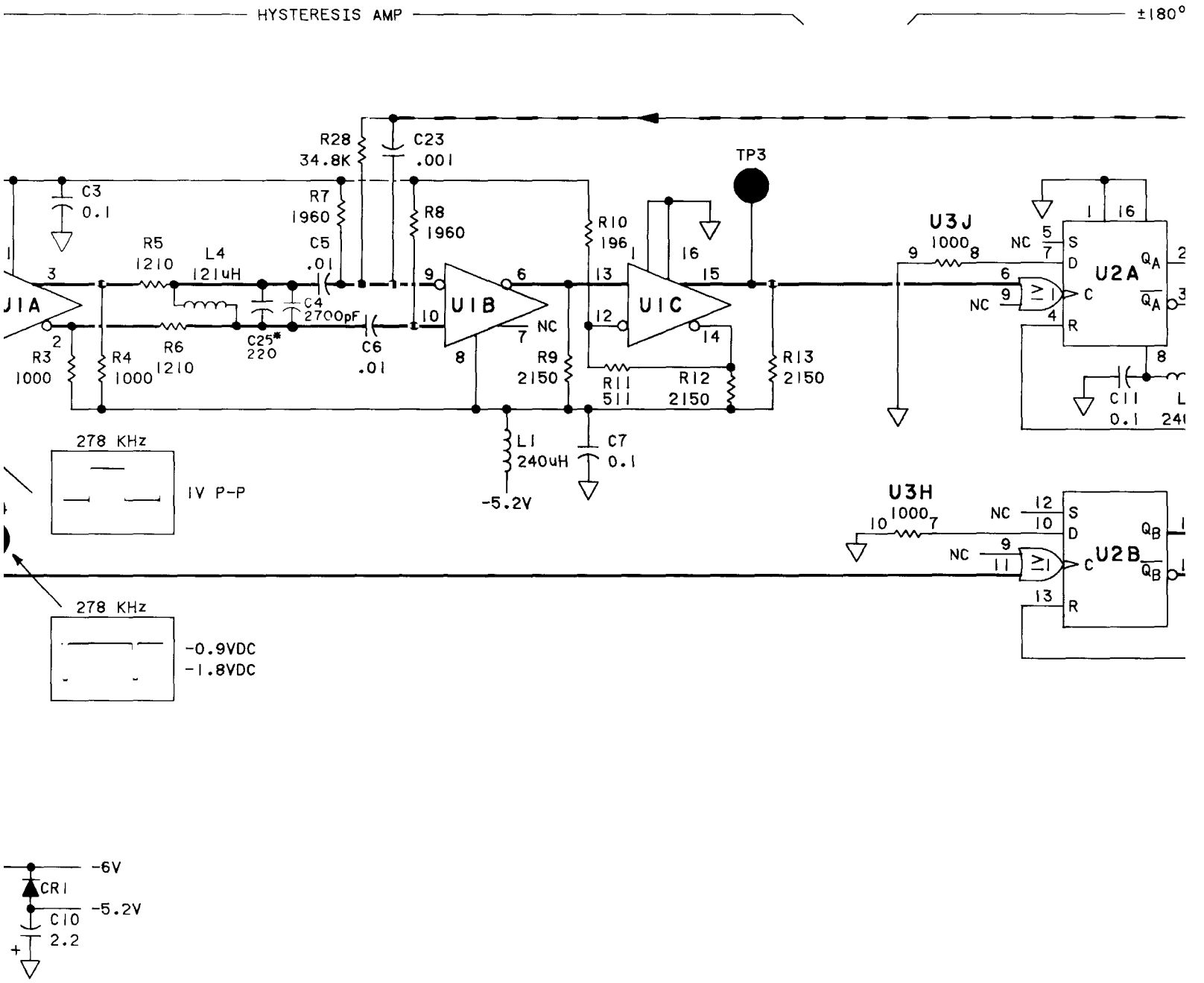


Figure 8-16. Component Location for Phase Detector A1



NOTE:

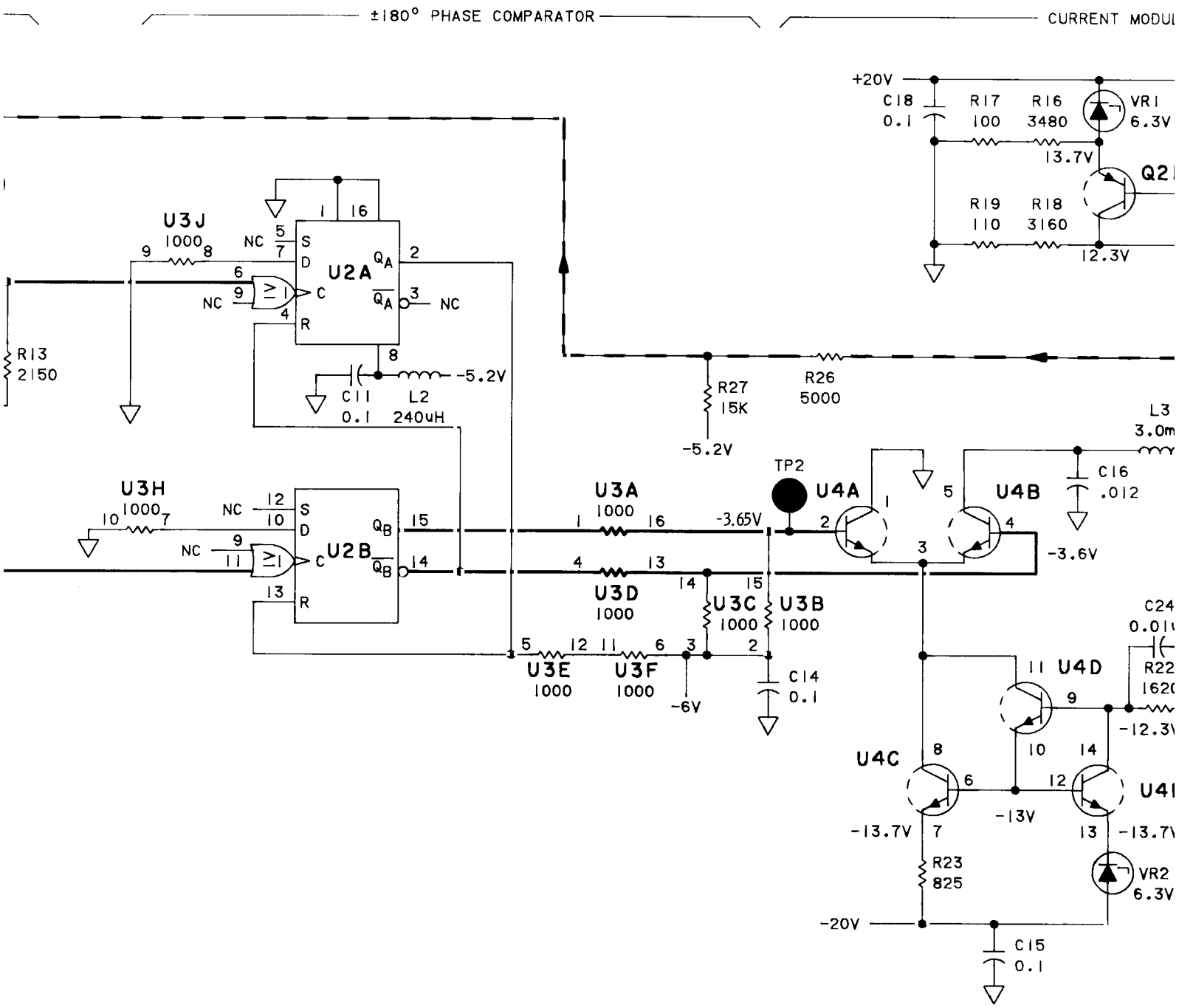
SEE FIGURE 8-3 F
CONDITIONS AND 1
TO OBTAIN VOLTAG

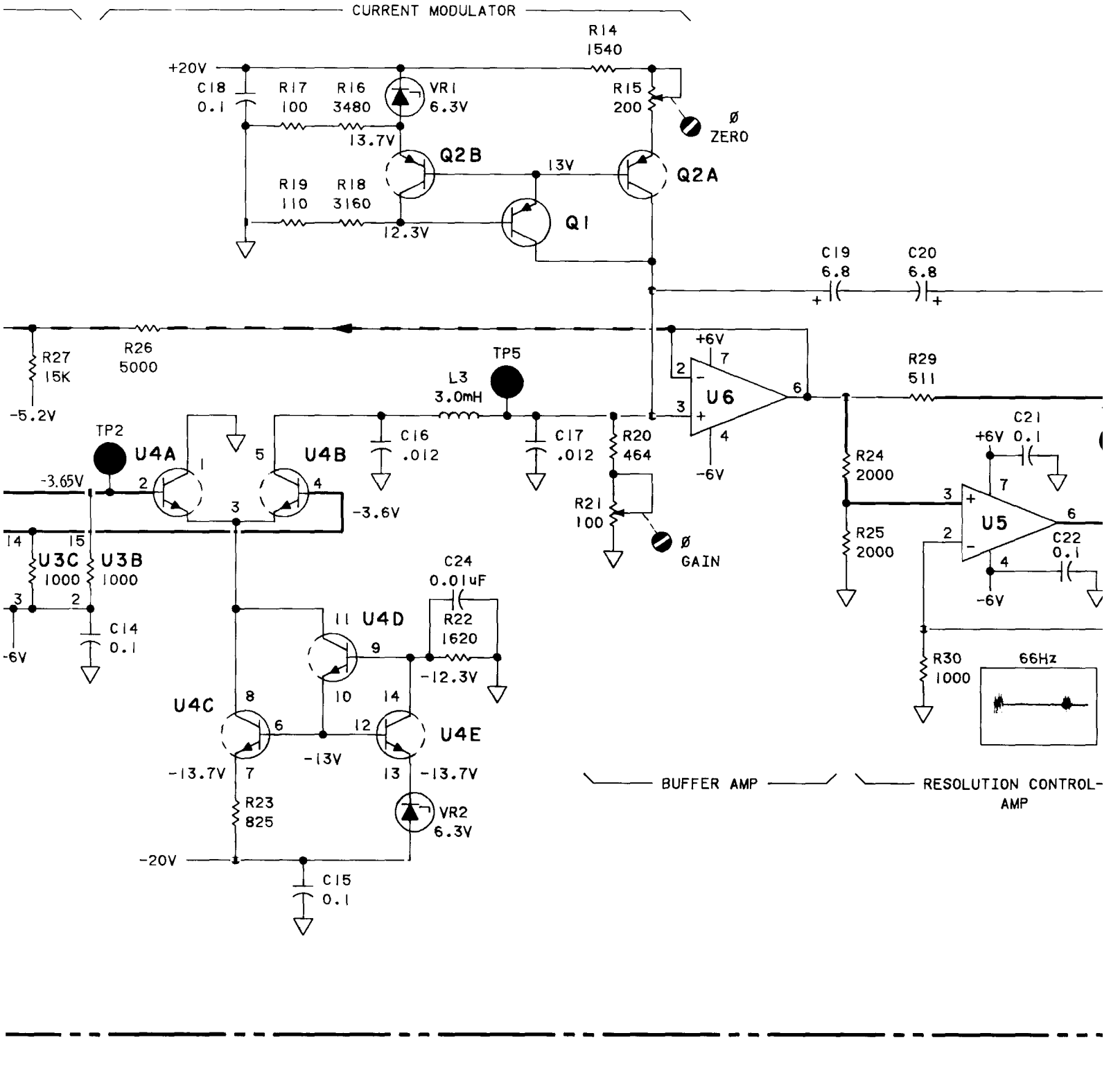


R SERIAL PREFIX: 2143A

NOTE:

SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN VOLTAGES SHOWN.


±180° PHASE COMPARATOR
CURRENT MODU
+20V
C18
0.1
R17
100
R16
3480
VR1
6.3V
13.7V
Q2
R19
110
R18
3160
12.3V
U3J
1000
U2A
NC
R13
2150
C11
0.1
L2
240uH
-5.2V
R27
15K
R26
5000
-5.2V
L3
3.0m
TP2
U4A
U4B
C16
.012
-3.6V
U3H
1000
U2B
U3A
1000
-3.65V
U3D
1000
U3C
1000
U3B
1000
U3E
1000
U3F
1000
-6V
C14
0.1
C24
0.01
U4D
R22
162
-12.3V
U4C
-13V
-13.7V
U4I
R23
825
VR2
6.3V
-20V
C15
0.1


CURRENT MODULATOR
R14
1540
+20V
C18
0.1
R17
100
R16
3480
VR1
6.3V
R15
200
ø
ZERO
13.7V
Q2B
13V
Q2A
R19
110
R18
3160
12.3V
Q1
C19
6.8
C20
6.8
R27
15K
R26
5000
-5.2V
TP5
L3
3.0mH
+6V
U6
R29
511
TP2
U4A
U4B
C16
.012
C17
.012
R20
464
-3.65V
-3.6V
R21
100
ø
GAIN
-6V
C21
+6V
0.1
R24
2000
U5
C22
0.1
R25
2000
U3C
1000
U3B
1000
C24
0.01uF
U4D
R22
1620
C14
0.1
-12.3V
U4C
U4E
-13V
-13.7V
-13.7V
R23
825
VR2
6.3V
-20V
C15
0.1
R30
1000
66Hz
BUFFER AMP
RESOLUTION CONTROL-
AMP

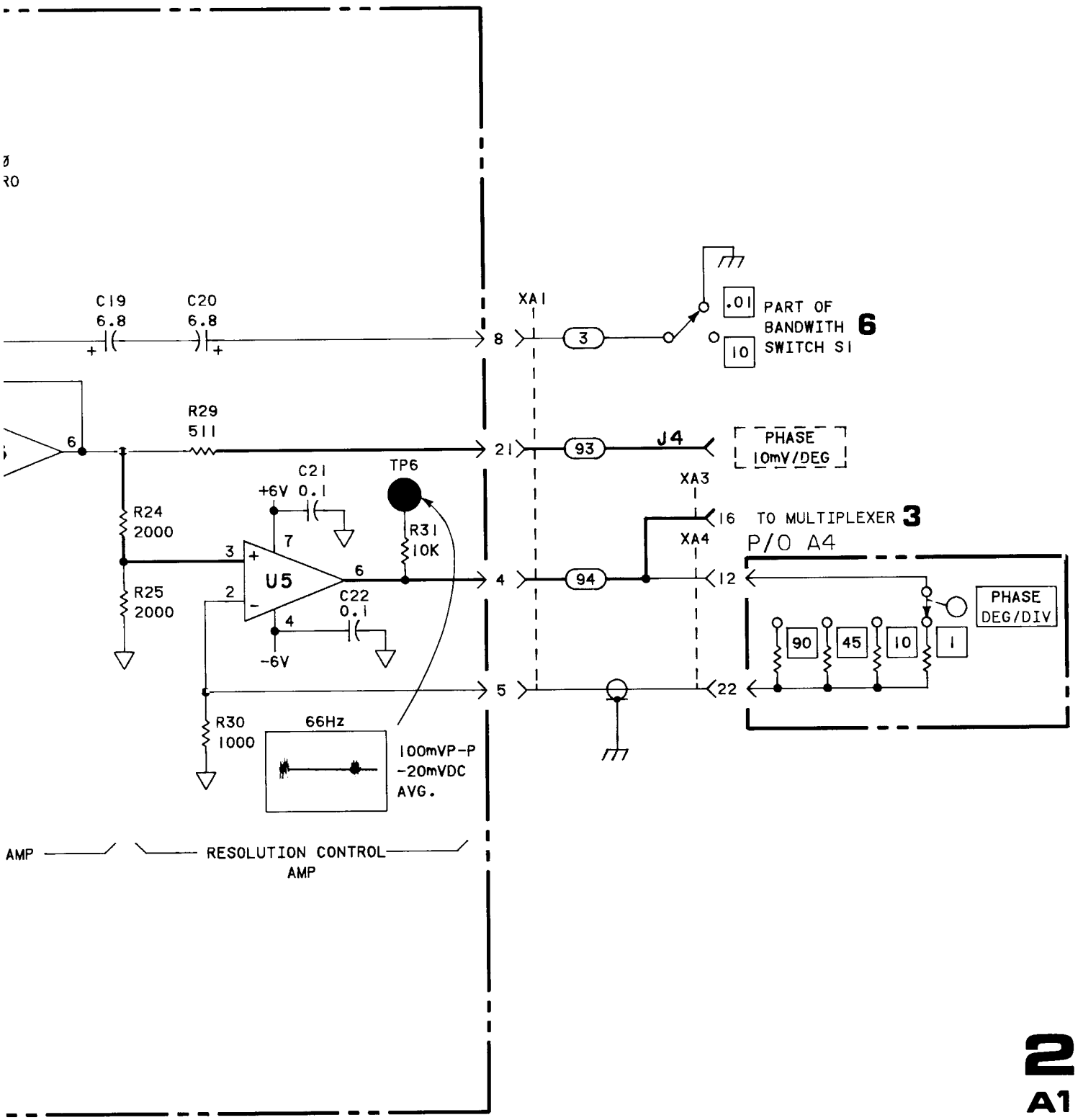
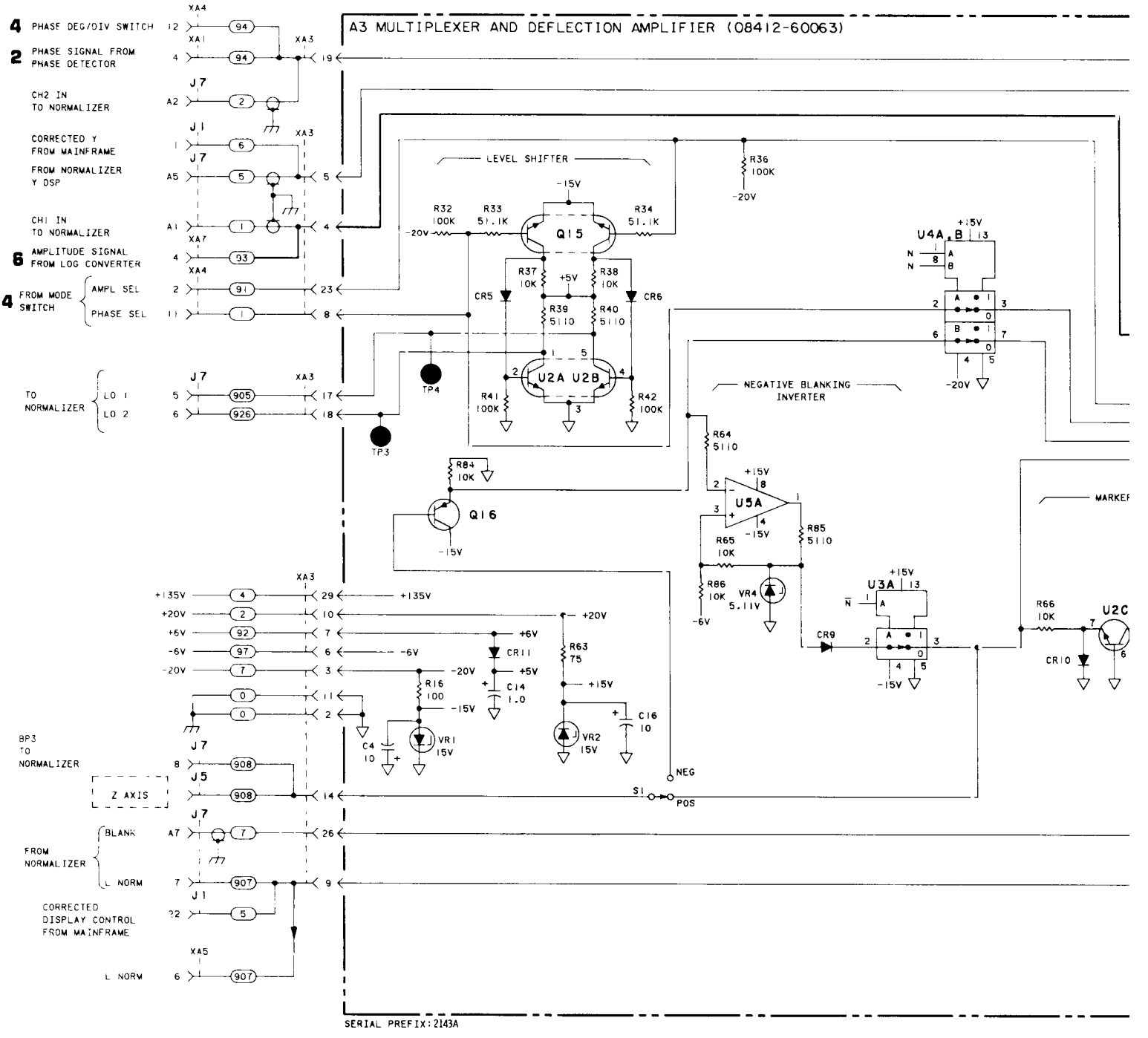
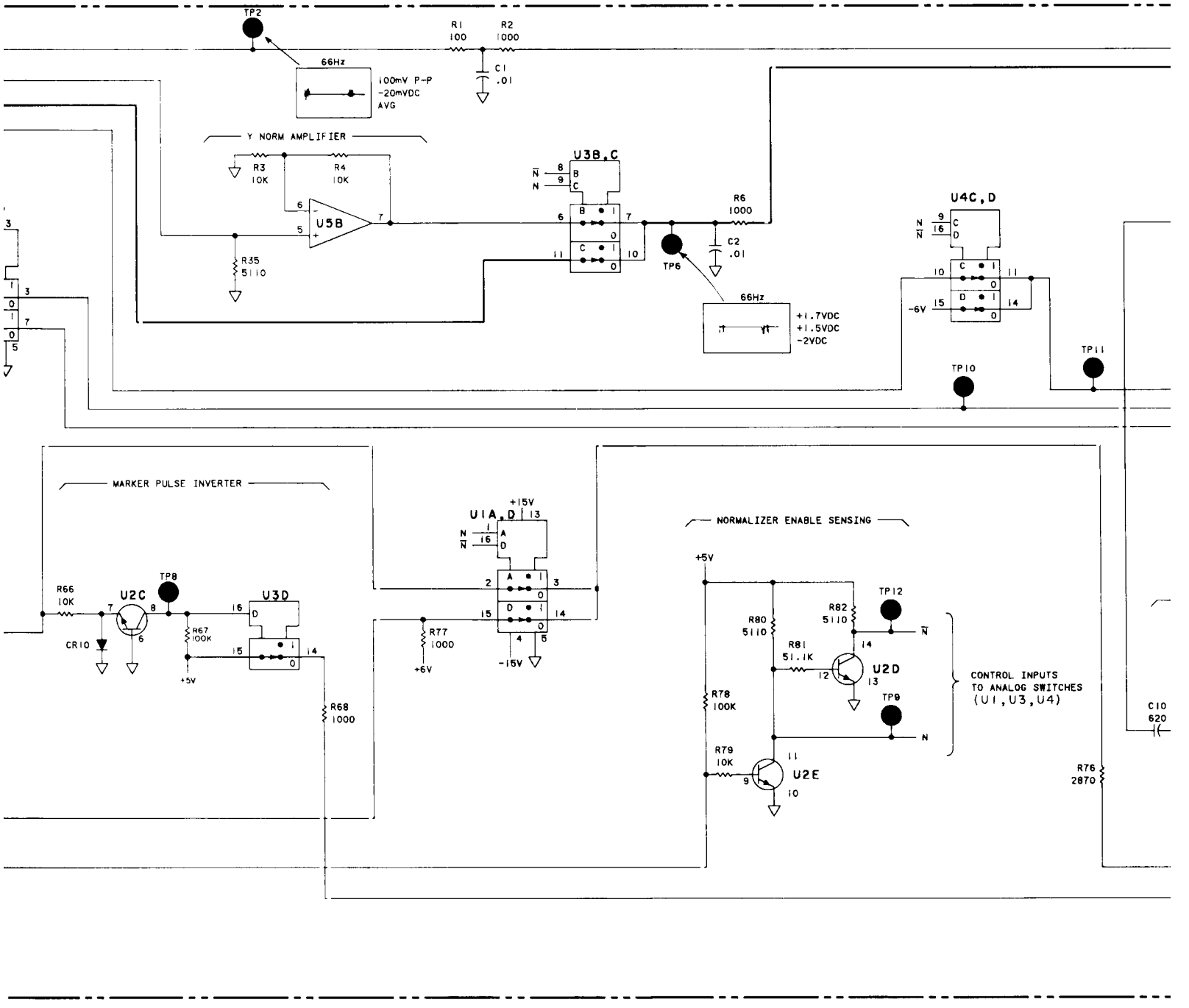
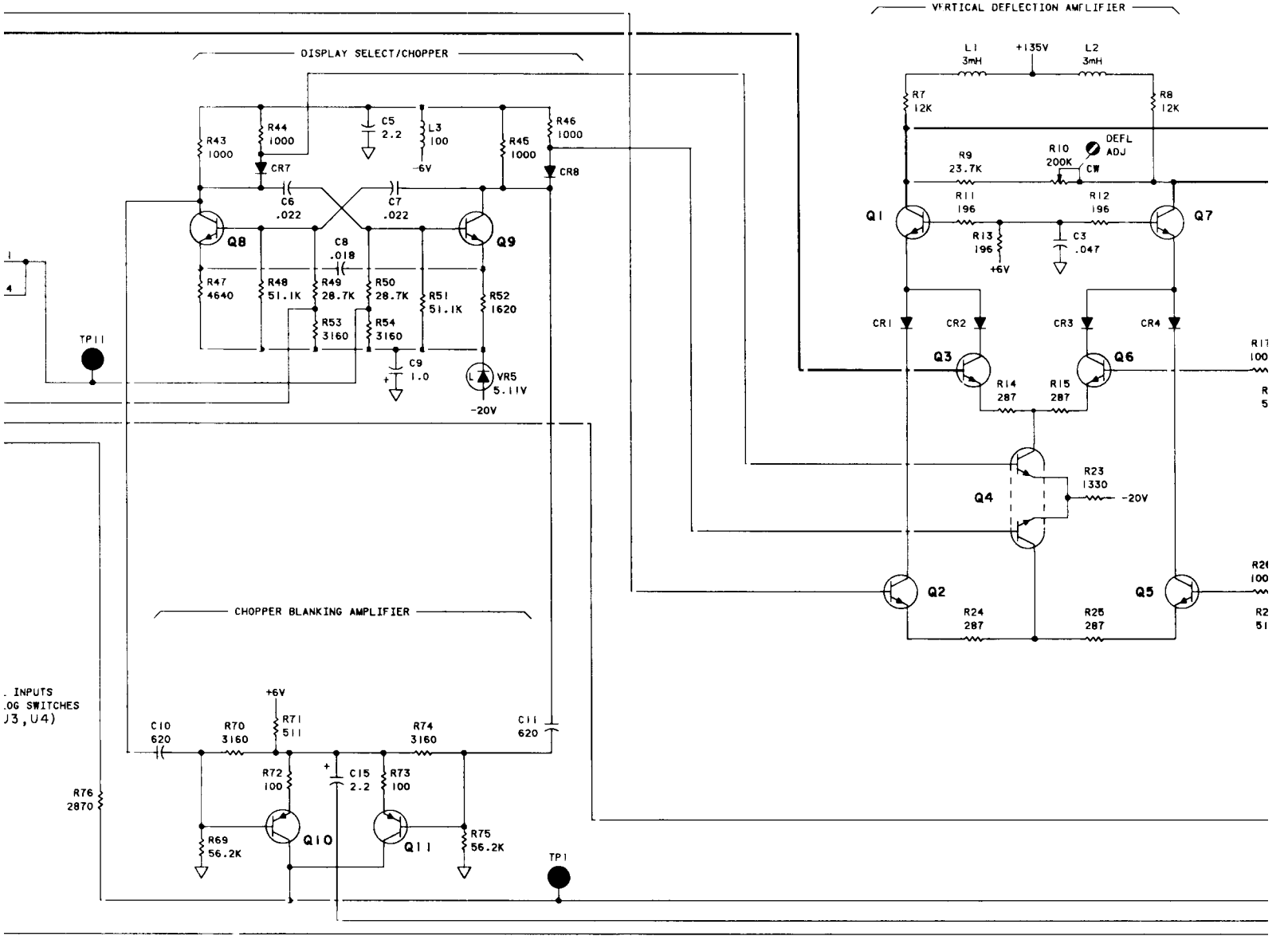


Figure 8-17. Phase Detector A1, Schematic Diagram


A3 MULTIPLEXER AND DEFLECTION AMPLIFIER (08412-60063)
4 PHASE DEG/DIV SWITCH
2 PHASE SIGNAL FROM PHASE DETECTOR
CH2 IN TO NORMALIZER
CORRECTED Y FROM MAINFRAME
FROM NORMALIZER Y DSP
CH1 IN TO NORMALIZER
6 AMPLITUDE SIGNAL FROM LOG CONVERTER
4 FROM MODE SWITCH
AMPL SEL
PHASE SEL
TO NORMALIZER
LO 1
LO 2
BP3 TO NORMALIZER
Z AXIS
BLANK
L NORM
CORRECTED DISPLAY CONTROL FROM MAINFRAME
L NORM
LEVEL SHIFTER
NEGATIVE BLANKING INVERTER
Q15
Q16
U2A U2B
U5A
U3A
U4A,B
U2C
R36 100K
R32 100K
R33 51.1K
R34 51.1K
R37 10K
R38 10K
R39 5110
R40 5110
R41 100K
R42 100K
R64 5110
R84 10K
R85 5110
R65 10K
R86 10K
R66 10K
R16 100
R63 75
C4 10
C14 1.0
C16 10
VR1 15V
VR2 15V
VR4 5.11V
CR5
CR6
CR9
CR10
CR11
TP3
TP4
NEG
POS
S1
SERIAL PREFIX: 2143A


TP2
66Hz
100mV P-P
-20mVDC
AVG
R1
100
R2
1000
C1
.01
Y NORM AMPLIFIER
R3
10K
R4
10K
U5B
R35
5110
U3B,C
R6
1000
C2
.01
TP6
66Hz
+1.7VDC
+1.5VDC
-2VDC
U4C,D
-6V
TP10
TP11
MARKER PULSE INVERTER
R66
10K
U2C
TP8
CR10
R67
100K
U3D
+5V
R68
1000
U1A,D
+15V
R77
1000
+6V
-15V
NORMALIZER ENABLE SENSING
+5V
R80
5110
R82
5110
TP12
R81
51.1K
U2D
TP9
R78
100K
R79
10K
U2E
CONTROL INPUTS
TO ANALOG SWITCHES
(U1, U3, U4)
C10
620
R76
2870


VERTICAL DEFLECTION AMPLIFIER
DISPLAY SELECT/CHOPPER
CHOPPER BLANKING AMPLIFIER
L1 3mH
+135V
L2 3mH
R7 12K
R8 12K
R9 23.7K
R10 200K
DEFL ADJ
CW
R11 196
R12 196
R13 196
+6V
C3 .047
Q1
Q7
CR1
CR2
CR3
CR4
Q3
Q6
R14 287
R15 287
Q4
R23 1330
-20V
Q2
Q5
R24 287
R25 287
R43 1000
R44 1000
CR7
C5 2.2
L3 100
-6V
R45 1000
R46 1000
CR8
C6 .022
C7 .022
Q8
Q9
C8 .018
R47 4640
R48 51.1K
R49 28.7K
R50 28.7K
R51 51.1K
R52 1620
R53 3160
R54 3160
C9 1.0
VR5 5.11V
-20V
TP11
+6V
C10 620
R70 3160
R71 511
R74 3160
C11 620
R72 100
C15 2.2
R73 100
R76 2870
R69 56.2K
Q10
Q11
R75 56.2K
TP1
INPUTS
LOG SWITCHES
U3, U4)

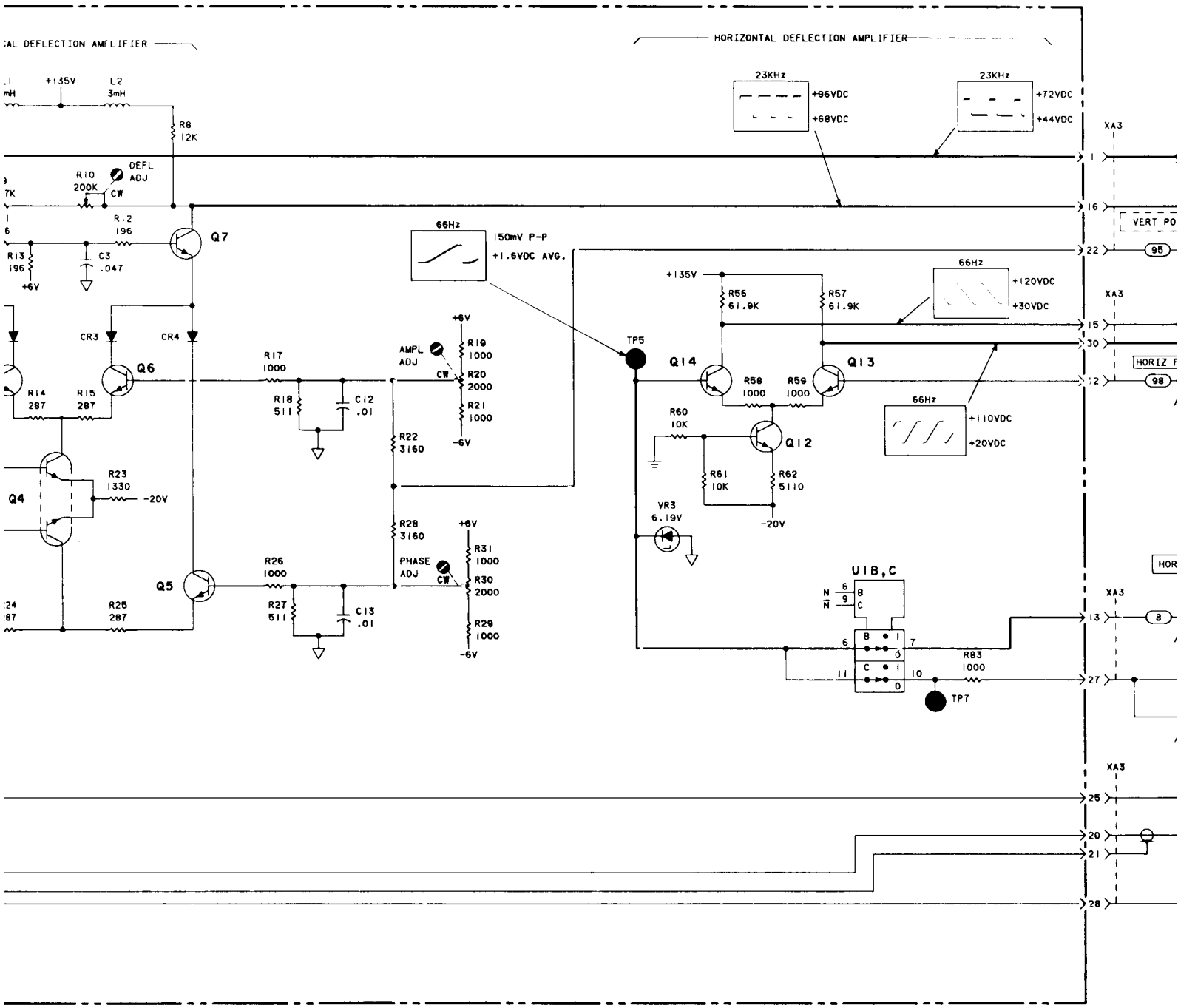
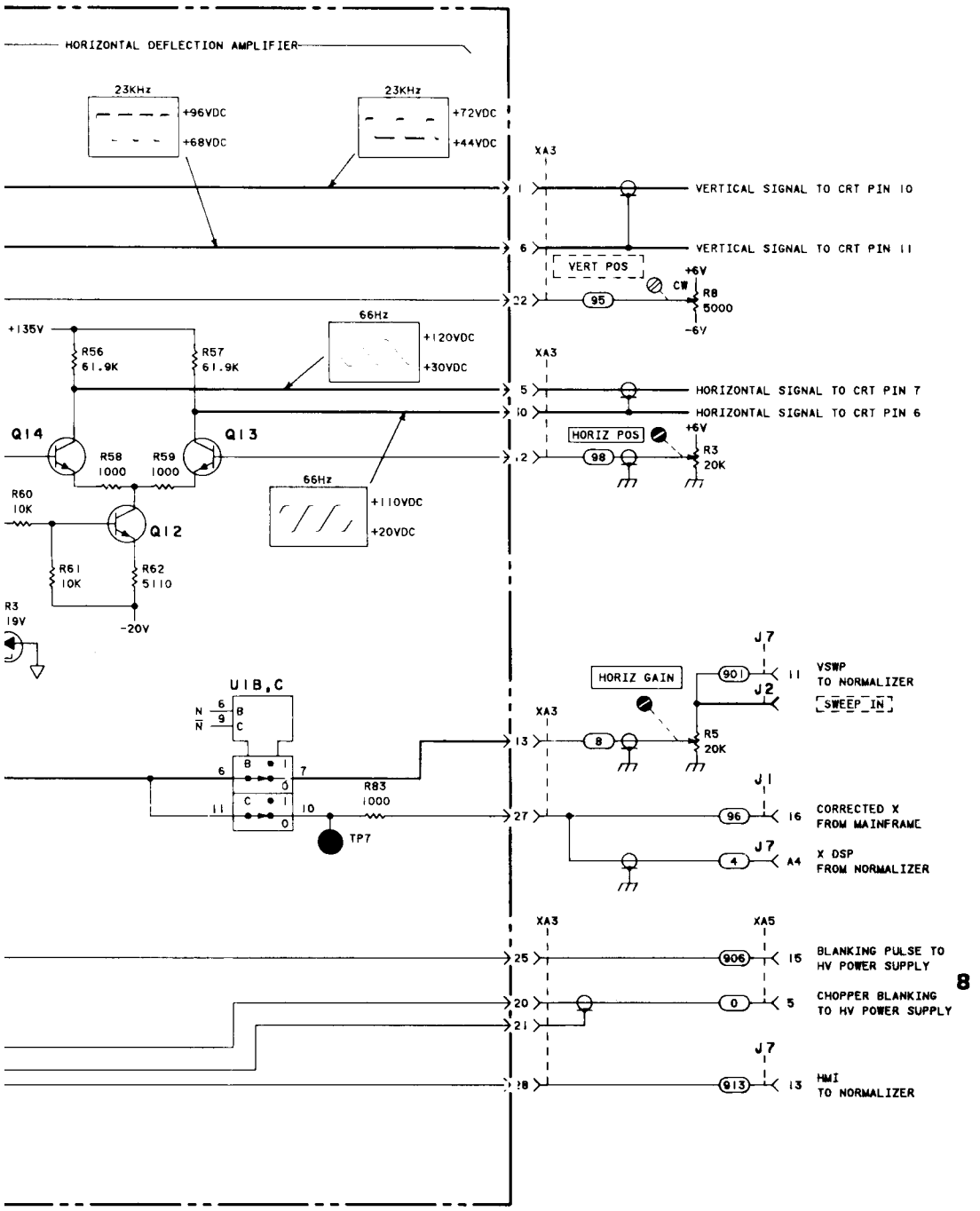

AL DEFLECTION AMPLIFIER
HORIZONTAL DEFLECTION AMPLIFIER
+135V
L2
3mH
R8
12K
R10
200K
DEFL
ADJ
CW
R12
196
Q7
R13
196
+6V
C3
.047
CR3
CR4
Q6
R14
287
R15
287
Q4
R23
1330
-20V
Q5
R25
287
R17
1000
R18
511
C12
.01
AMPL
ADJ
CW
R19
1000
R20
2000
R21
1000
-6V
R22
3160
R28
3160
PHASE
ADJ
CW
R31
1000
R30
2000
R29
1000
R26
1000
R27
511
C13
.01
66Hz
150mV P-P
+1.6VDC AVG.
TP5
23KHz
+96VDC
+68VDC
23KHz
+72VDC
+44VDC
+135V
R56
61.9K
R57
61.9K
66Hz
+120VDC
+30VDC
Q14
Q13
R58
1000
R59
1000
R60
10K
Q12
R61
10K
R62
5110
-20V
66Hz
+110VDC
+20VDC
VR3
6.19V
U1B,C
R83
1000
TP7
XA3
1
16
22
95
15
30
12
98
13
8
27
25
20
21
28
VERT PO
HORIZ F
HOR

Figure 8-19.



NOTES

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (uF)
   INDUCTANCE IN MICROHENRIES (uH)
3. ASTERISK (*) INDICATES, FACTORY SELECTED VALUE.
4. SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SET UP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

A3 ASSY
C1-16
CR1-11
L1-3
Q1-16
R1-86
U1-5
VR1-4
CHASSIS
R3,5,8

3
A3

Figure 8-19. Multiplexer and Deflection Amplifier A3, Schematic Diagram

4 THEORY FOR PHASE OFFSET AND FUNCTION SWITCH A4

Phase Offset Switch

The two phase offset switches work together to select the desired phase offset. The phase offset polarity is selected by the ± phase offset switch and the phase offset magnitude by the PHASE OFFSET DEGREES switch.

Ampl DB/DIV Switch

The AMPL DB/DIV switch controls the display amplitude resolution by supplying the feedback resistor for A7IC3.

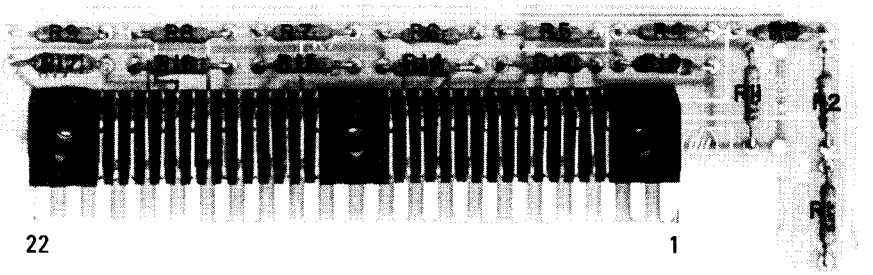
Phase DEG/DIV Switch

The PHASE DEG/DIV switch controls the display phase resolution by supplying the feedback resistor for A1IC2.

Mode Switch

The MODE switch controls the multivibrator-chopper in A3.

A4



A4 A1

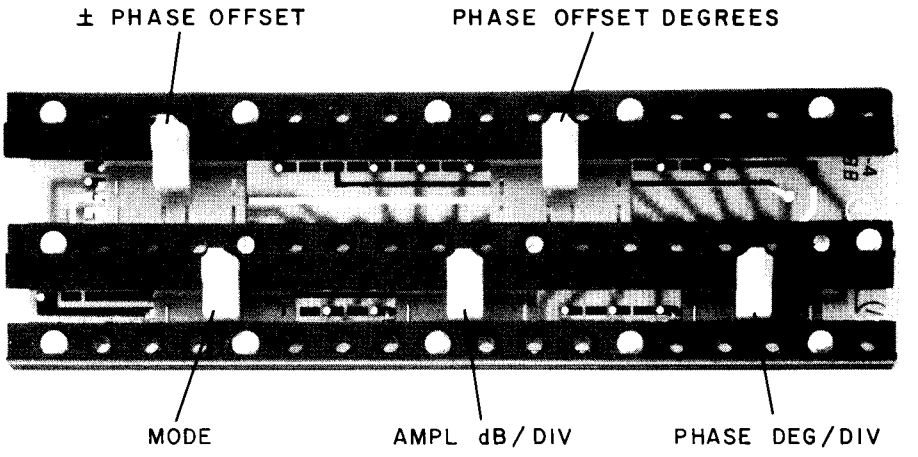
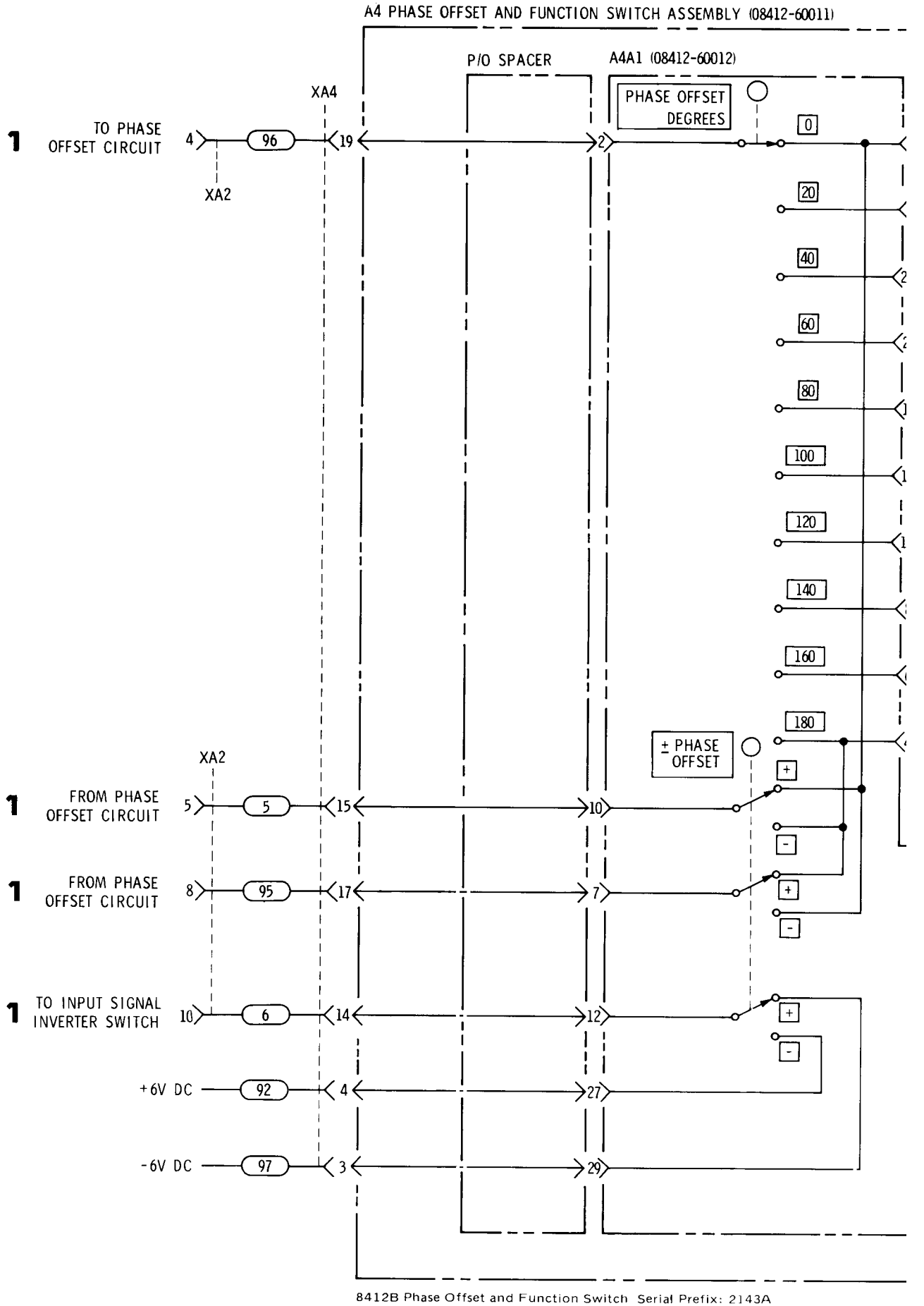
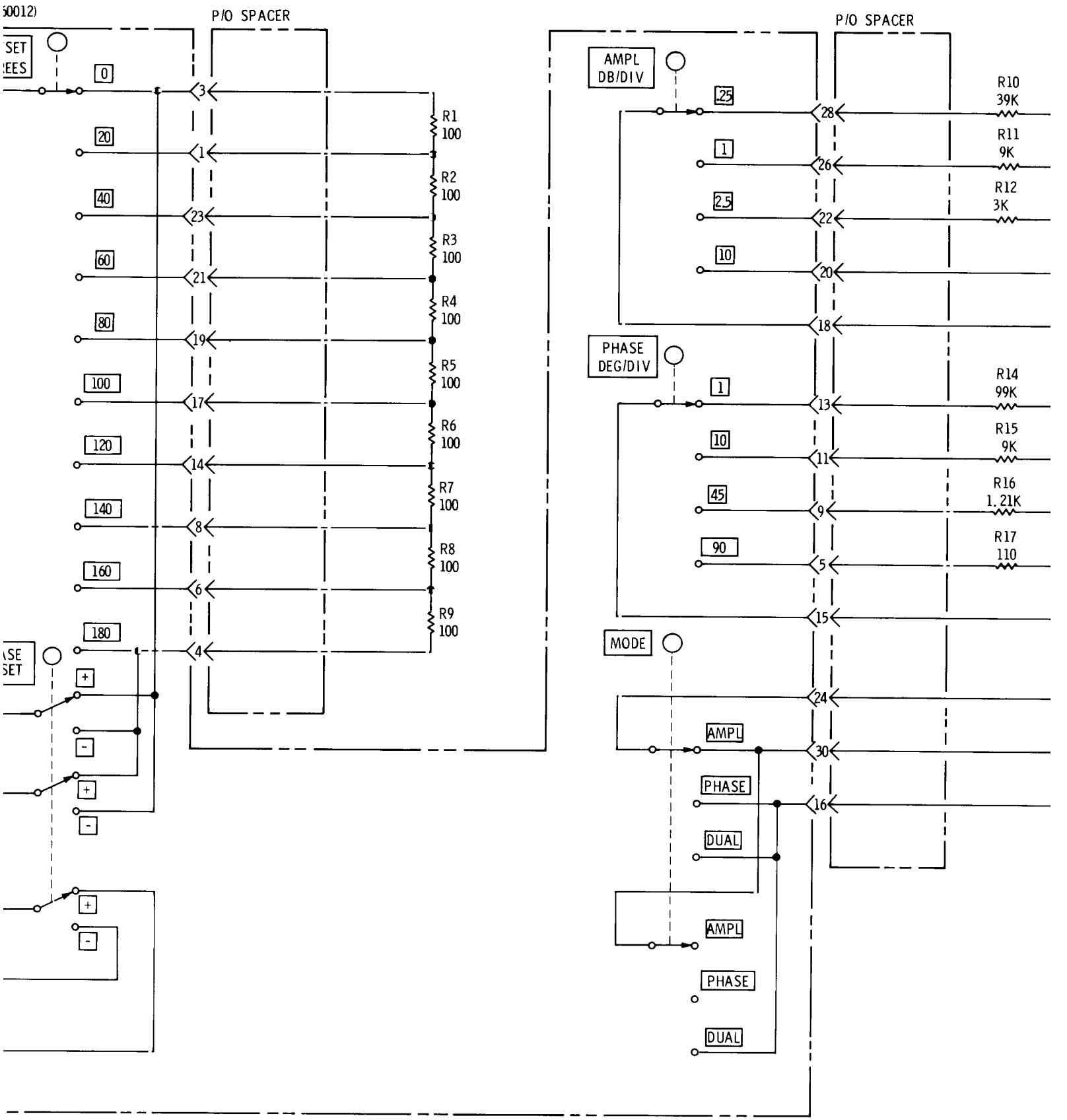


Figure 8-20. Component Location for Phase Offset and Function Switch A4



8412B Phase Offset and Function Switch Serial Prefix: 2143A


60012)
P/O SPACER
SET
EES
0
20
40
60
80
100
120
140
160
180
3
1
23
21
19
17
14
8
6
4
R1 100
R2 100
R3 100
R4 100
R5 100
R6 100
R7 100
R8 100
R9 100
+
-
+
-
+
-
P/O SPACER
AMPL DB/DIV
.25
1
2.5
10
28
26
22
20
18
R10 39K
R11 9K
R12 3K
PHASE DEG/DIV
1
10
45
90
13
11
9
5
15
R14 99K
R15 9K
R16 1.21K
R17 110
MODE
24
AMPL
30
PHASE
16
DUAL
AMPL
PHASE
DUAL

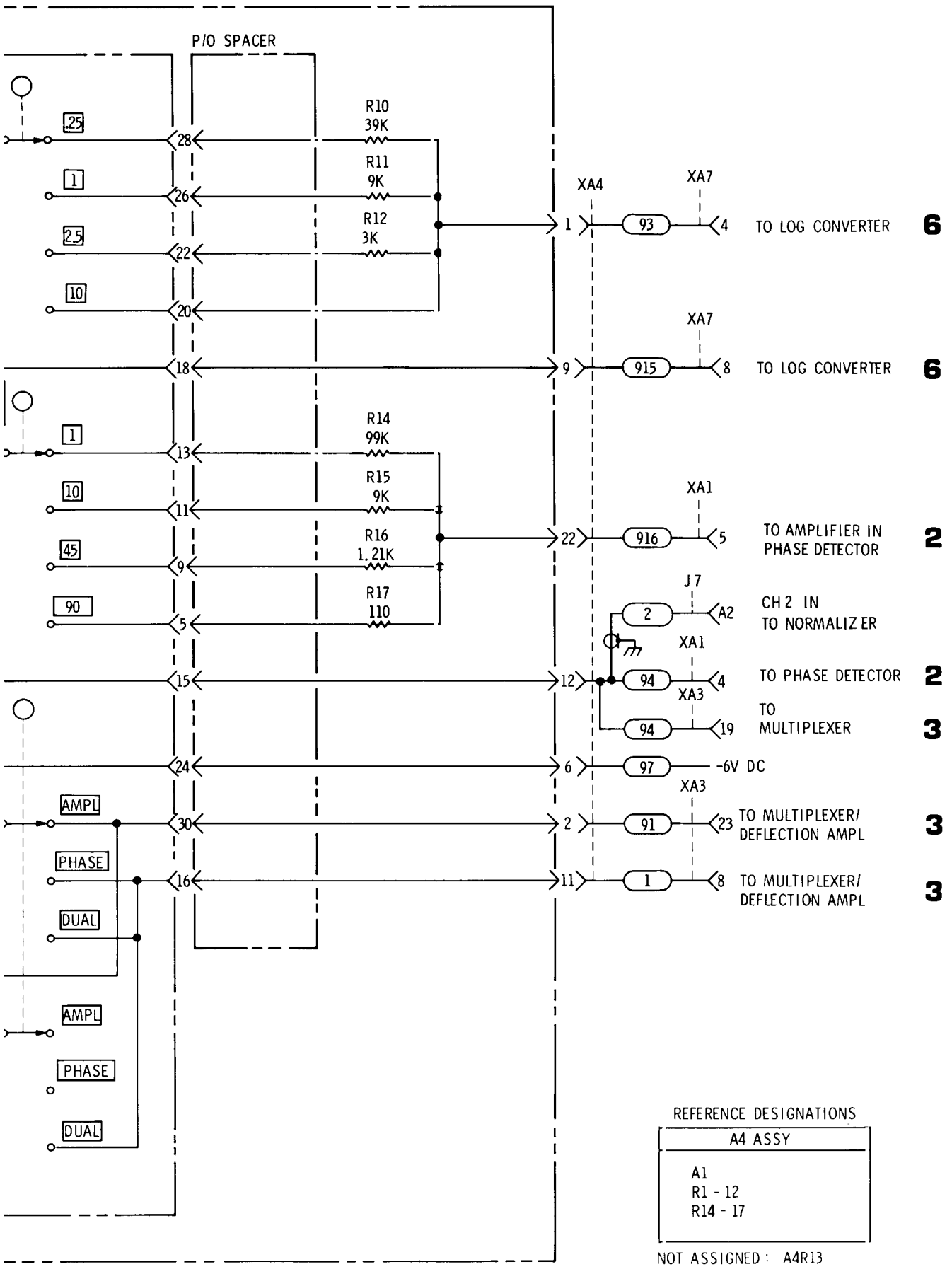


Figure 8-21. Phase Offset and Function Switch A4, Schematic Diagram

5 THEORY FOR AMPLITUDE SYNCHRONOUS DETECTOR A10

Input Amplifier

The 278 kHz test channel amplitude signal at test point (2) is amplified through Q1 and Q2 and applied to the amplitude detector input at the bases of Q4A and Q4B.

Drive Amplifier

The amplitude detector drive signal from A9 (test point 3) is amplified through Q6A and Q6B and applied to the amplitude detector at the bases of Q7-Q10. The drive signal is synchronous with the test channel amplitude signal because both are derived from the test channel.

Mixer Detector

The drive signal switches Q7-Q10 such that the current through R34 and R40 is the full wave rectified input amplitude signal. Front panel AMPL CAL (LOW LEVEL) control R10 balances the circuit so that for zero-amplitude signal input, the voltages at test points (1) and (7) are equal.

Ground Referencing

The feedback circuit composed of IC1, Q11, and Q12 maintains the output voltage referenced to ground.

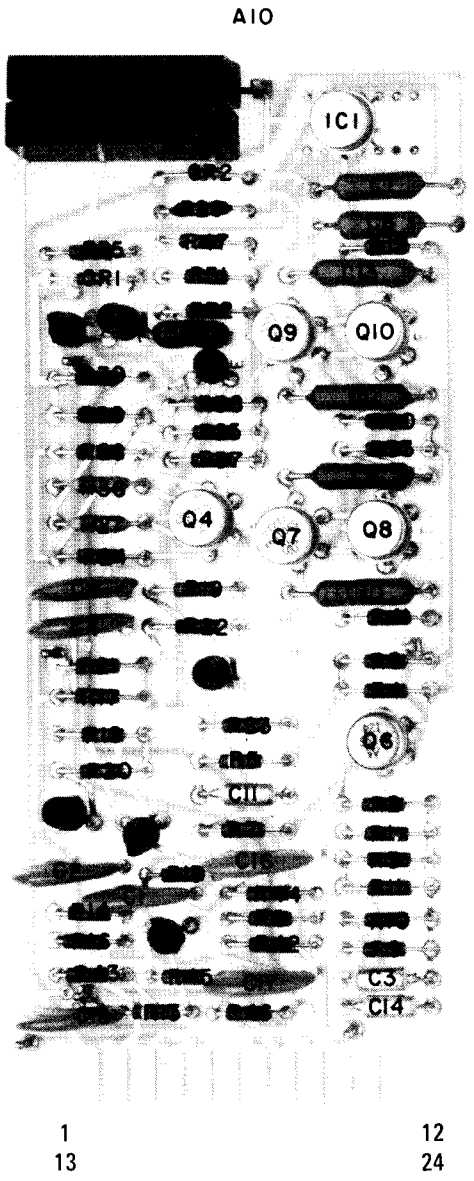
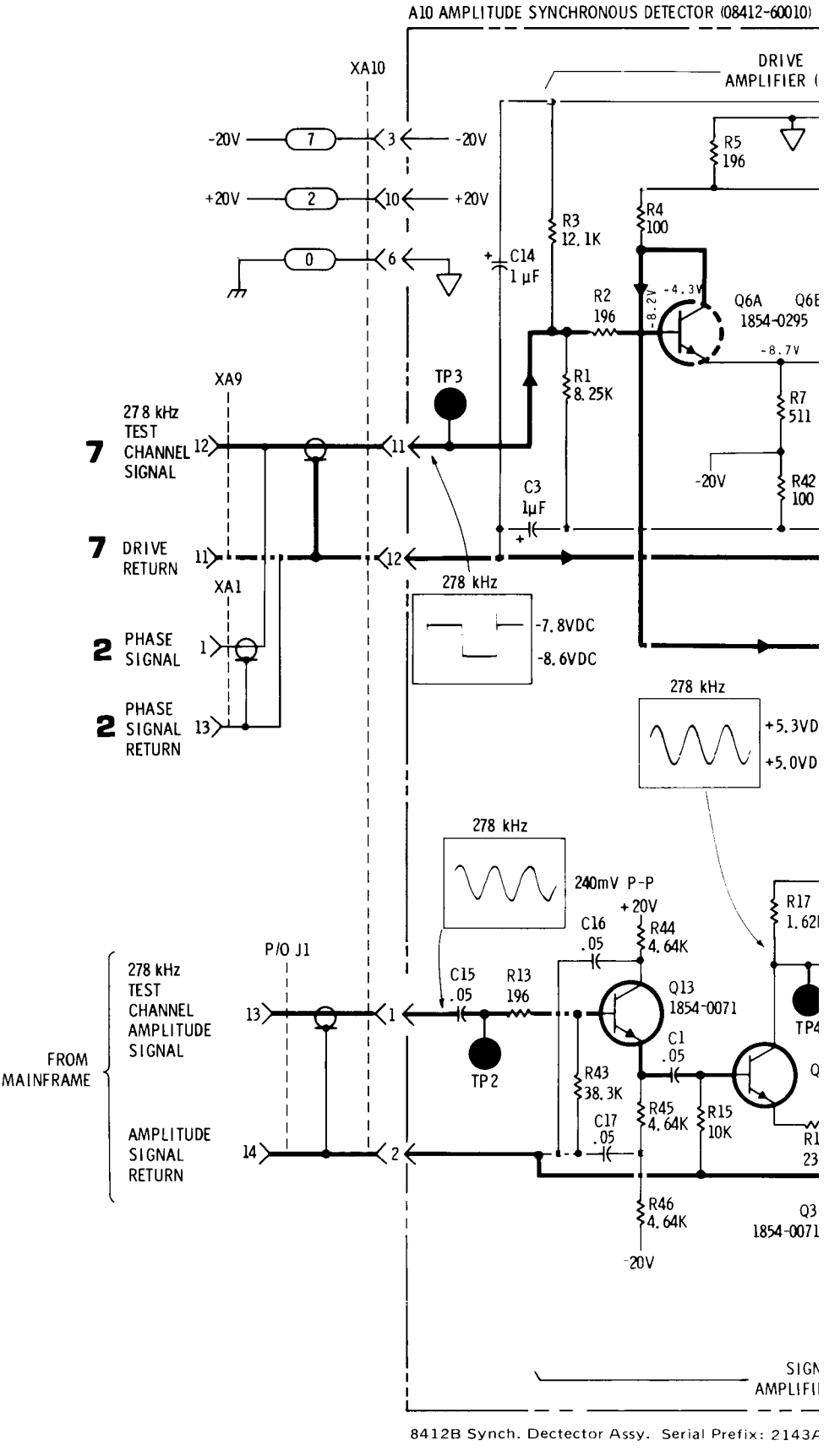
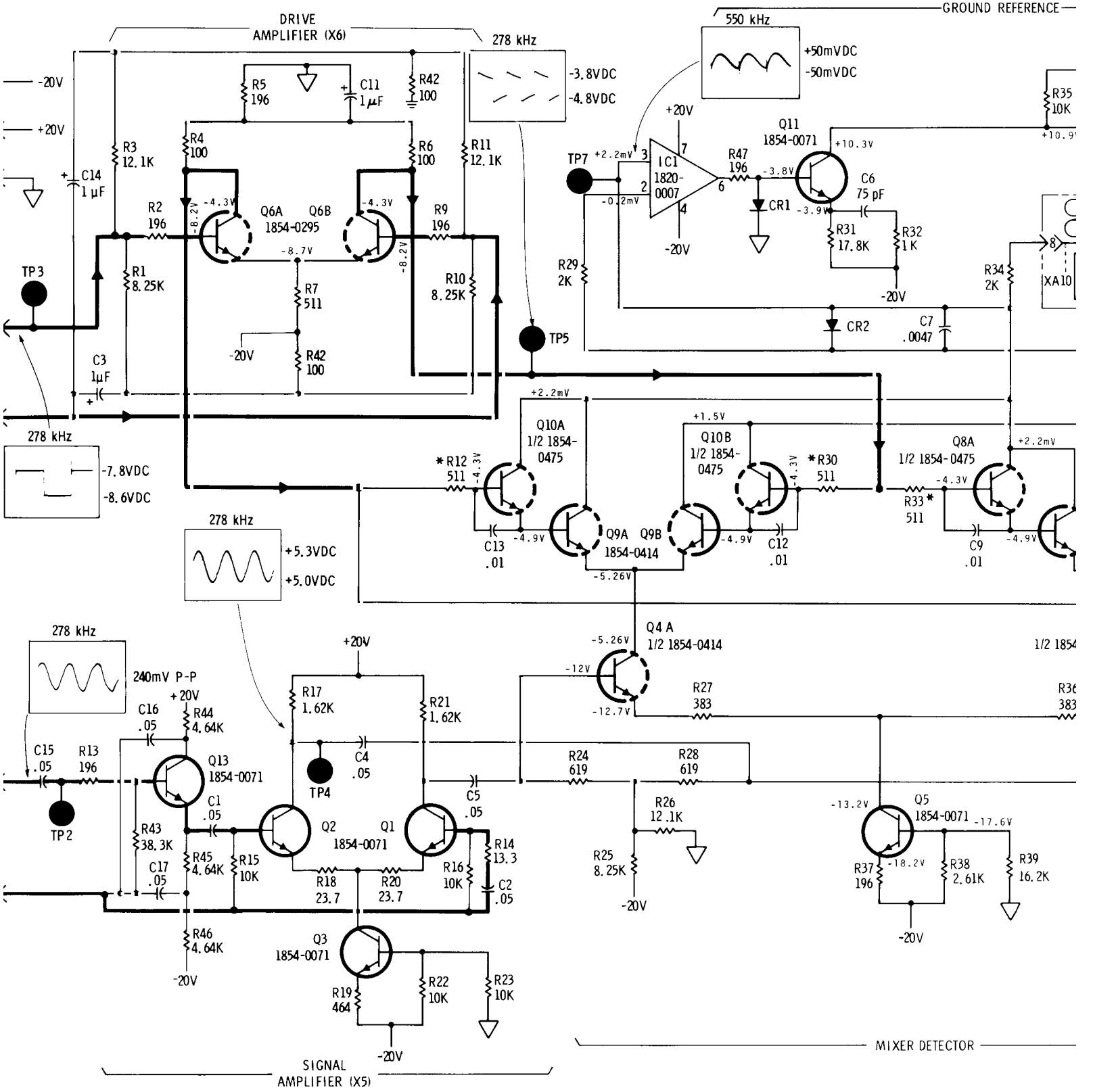


Figure 8-22. Component Location for Amplitude Synchronous Detector A10


A10 AMPLITUDE SYNCHRONOUS DETECTOR (08412-60010)
DRIVE AMPLIFIER
XA10
-20V
+20V
R5 196
R4 100
R3 12.1K
C14 1 µF
R2 196
Q6A 1854-0295
R1 8.25K
R7 511
R42 100
TP3
XA9
278 kHz TEST CHANNEL SIGNAL
7
DRIVE RETURN
C3 1µF
XA1
PHASE SIGNAL
PHASE SIGNAL RETURN
2
278 kHz
-7.8VDC
-8.6VDC
+5.3VD
+5.0VD
240mV P-P
R17
C16 .05
R44 4.64K
P/O J1
C15 .05
R13 196
Q13 1854-0071
TP2
C1 .05
R43 38.3K
R45 4.64K
C17 .05
R15 10K
R46 4.64K
Q3 1854-0071
FROM MAINFRAME
278 kHz TEST CHANNEL AMPLITUDE SIGNAL
AMPLITUDE SIGNAL RETURN
8412B Synch. Dectector Assy. Serial Prefix: 2143A

A10 AMPLITUDE SYNCHRONOUS DETECTOR (08412-60010)



8412B Synch. Dectector Assy. Serial Prefix: 2143A

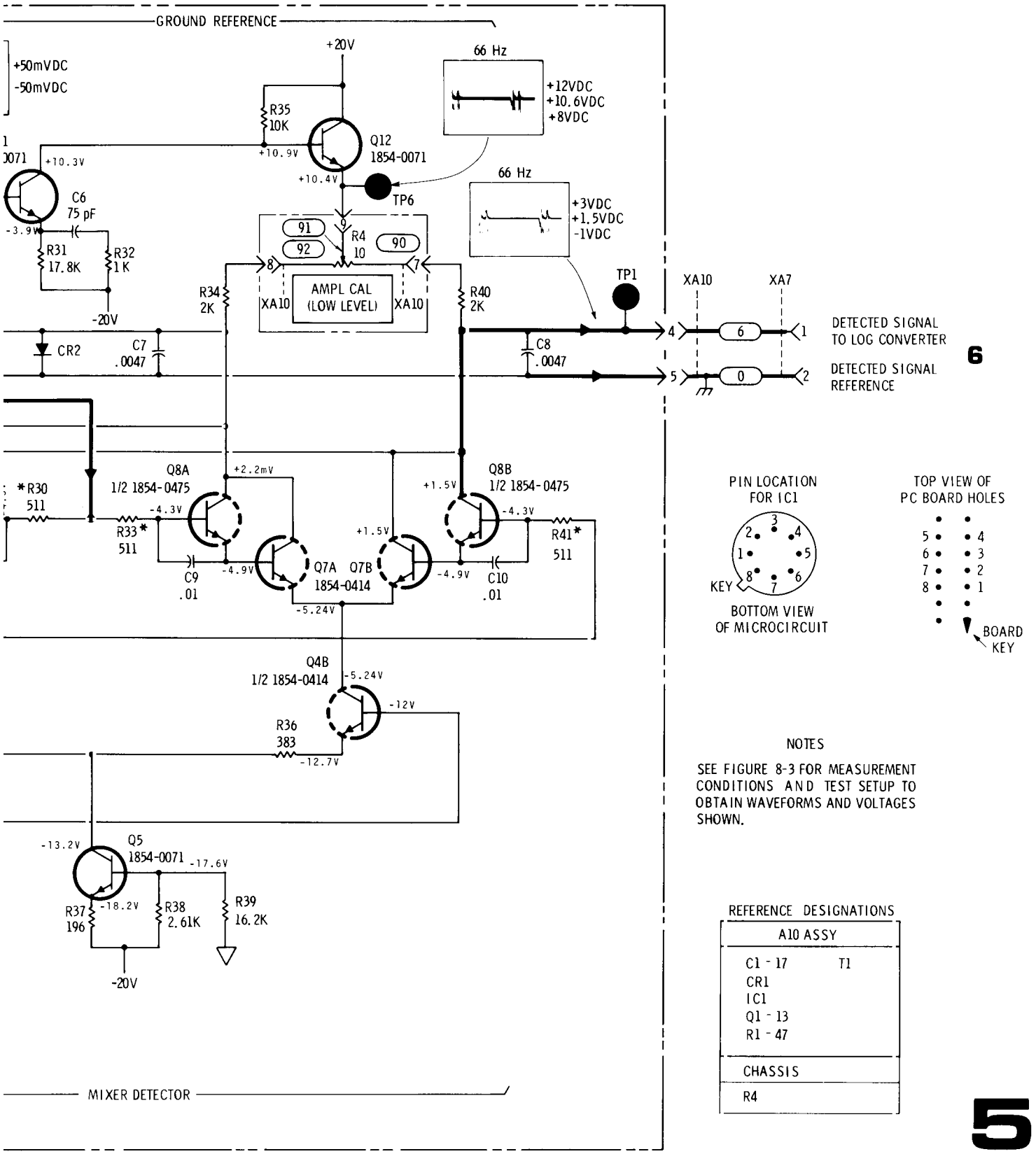


Figure 8-23. Amplitude Synchronous Detector A10, Schematic Diagram

6 THEORY FOR LOG CONVERTER A7

Log Converter

The log circuit consists of transistor Q1A and operational amplifier IC1. The voltage at test point (1) and virtual ground at IC1 pin 4 causes a current. This current must be equal to the collector current of Q1A, since no input current flows into the operational amplifier. The operational amplifier maintains the base-to-emitter voltage of Q1A so that the correct collector current is maintained. Since the base-to-emitter voltage of Q1A is proportional to the log of the collector current, the output voltage is the log of the input voltage.

Voltage Follower

Q1B shifts voltage level so that at test point (2), the log output operates about ground at approximately 30 mV output for X3 input at test point (1). R7 sets the correct amplitude center level. IC2 is a voltage follower. IC4 is a fixed gain amplifier with adjustment R14 so that a 1 dB input change produces 50 mV output. The dc voltage is brought to the rear panel AMPLITUDE (50 mV/dB) connector. The BW (kHz) switch connects a capacitor from IC3, pin 5 to ground, which forms a 100 Hz low-pass filter.

Resolution Control

The feedback resistor between the output and the input of IC4 sets the gain of the amplitude channel. The value of this resistance is changed by the AMPL dB/DIV switch, thus changing the resolution of the CRT display.

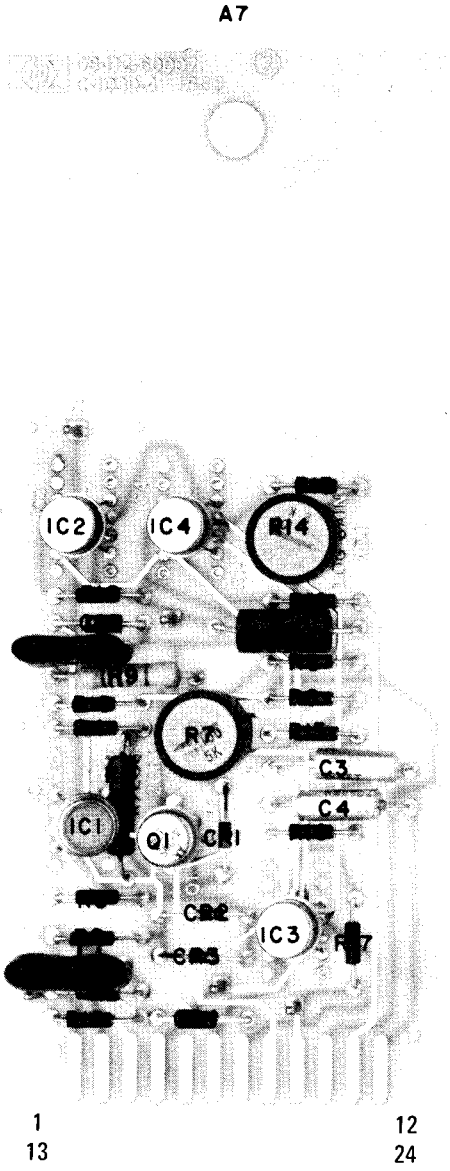
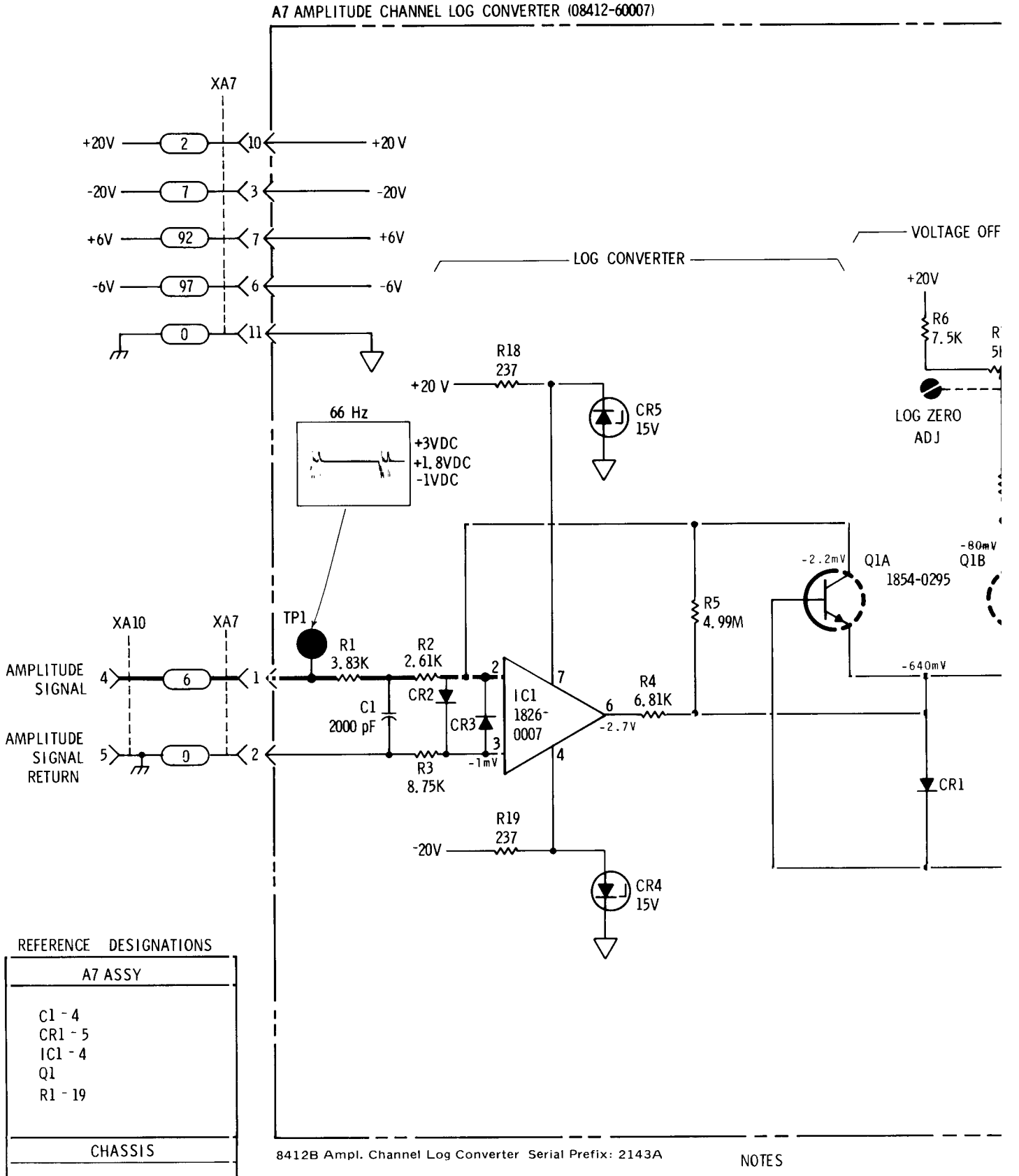


Figure 8-24. Component Location for Amplitude Channel Log Converter A7

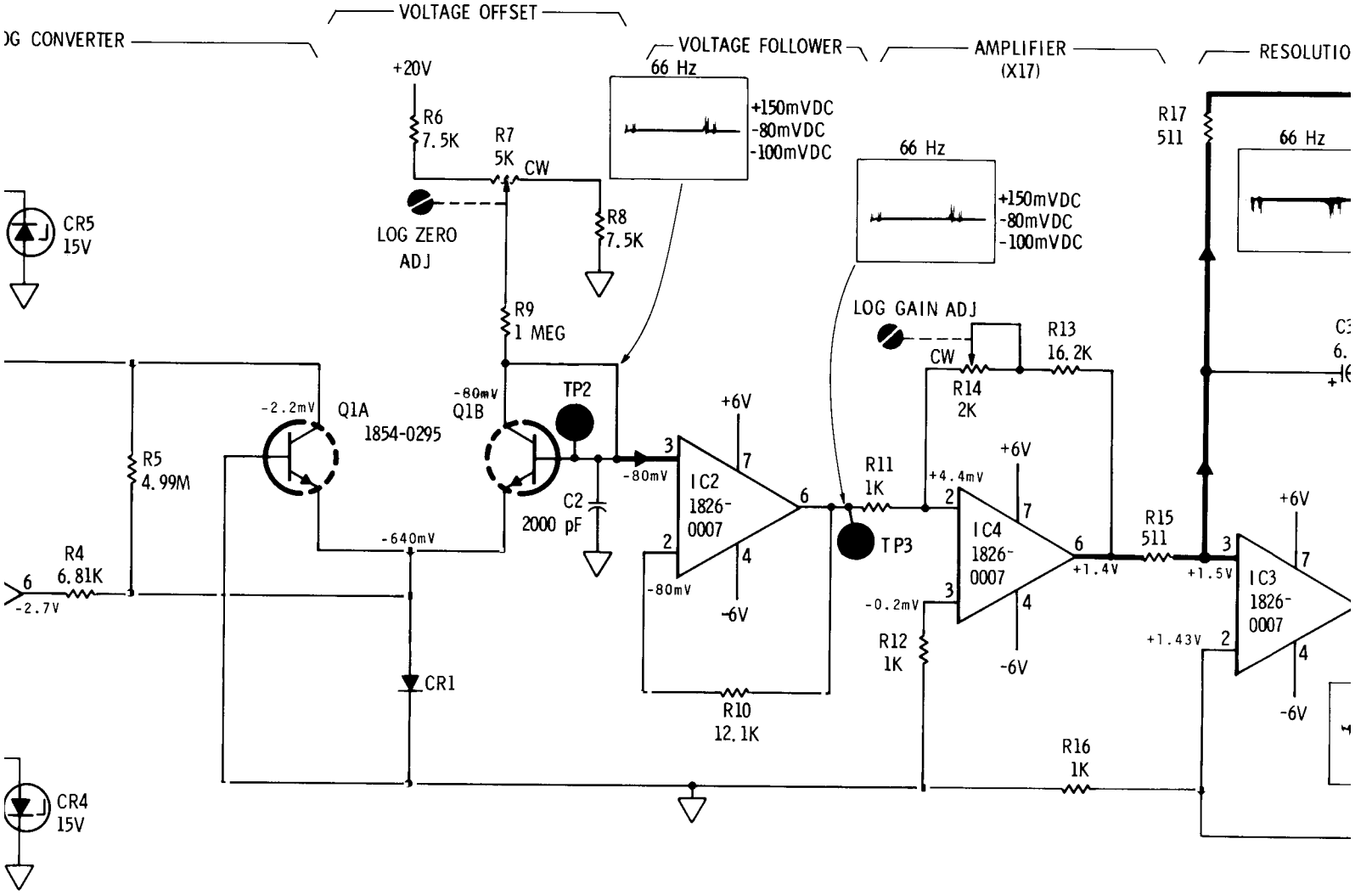


REFERENCE DESIGNATIONS
A7 ASSY
C1 - 4 CR1 - 5 IC1 - 4 Q1 R1 - 19
CHASSIS
S1

8412B Ampl. Channel Log Converter Serial Prefix: 2143A

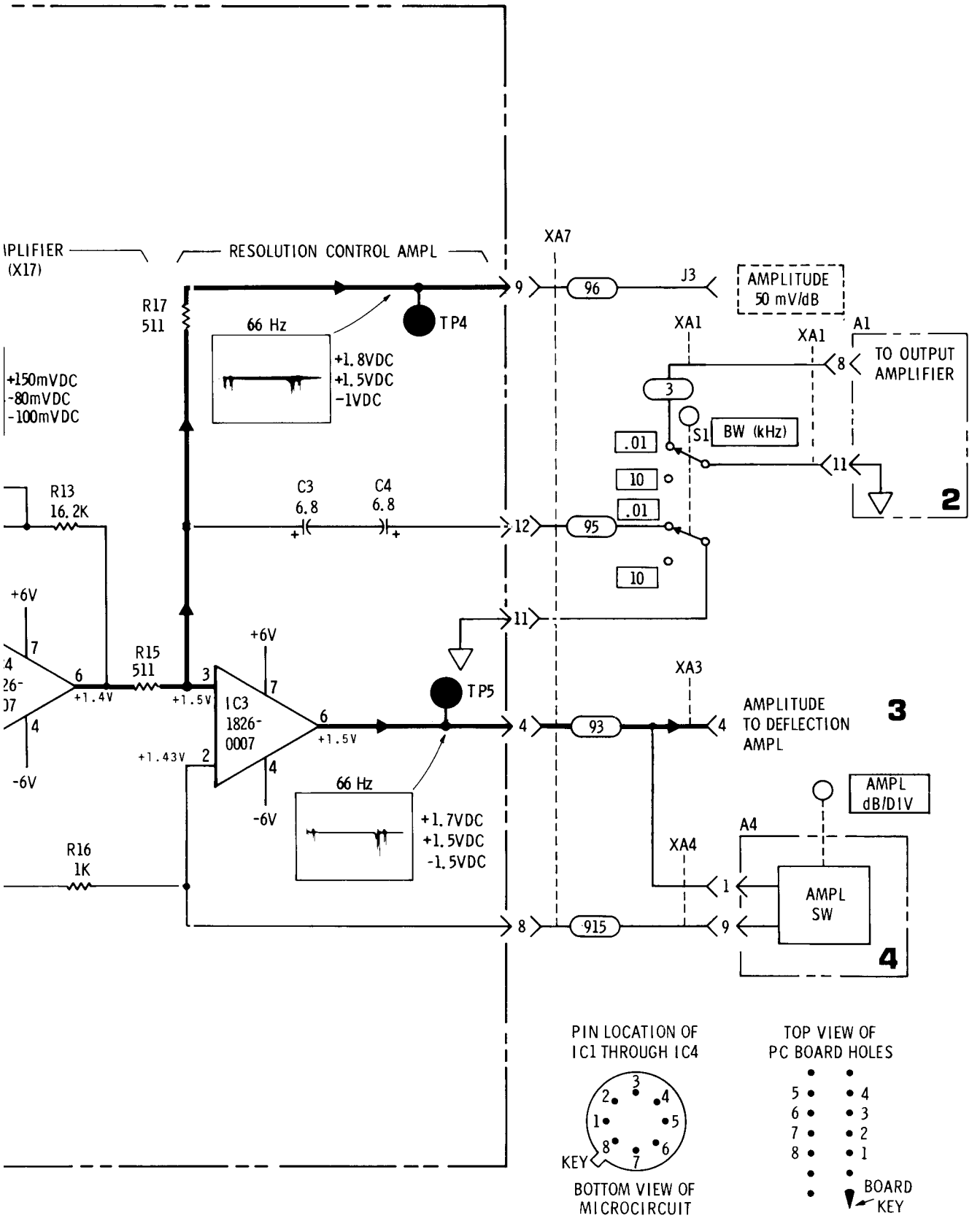
NOTES

SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.



NOTES

SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.



6

A7

Figure 8-25. Amplitude Channel Log Converter A7, Schematic Diagram

A9

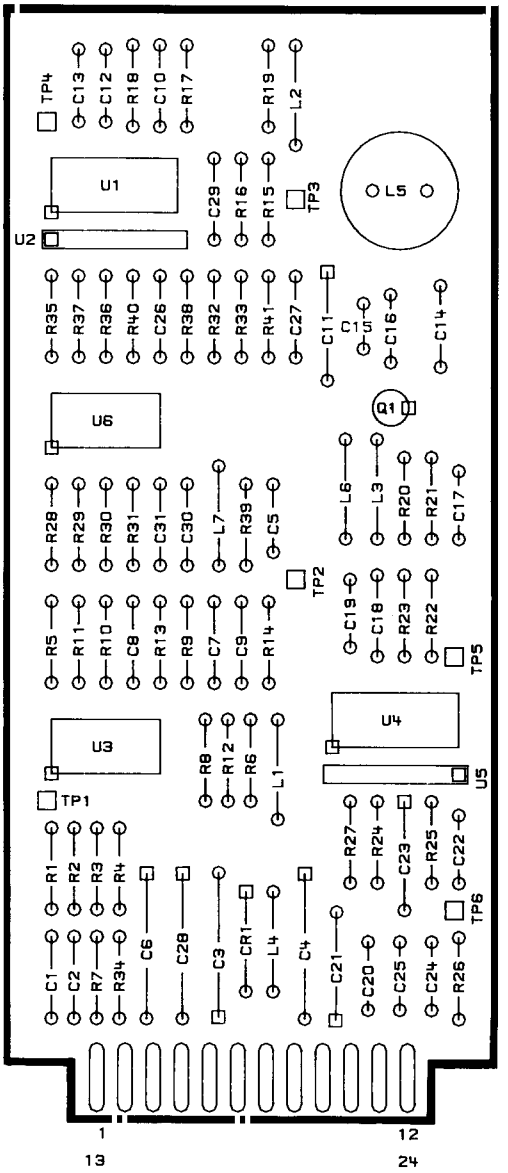


Figure 8-26. Parts Location for Test Channel Amplifier A9

Limiter

Limiter U4 is comparable to amplifier U1 in operation. Symmetry of the output is maintained by a similar feedback network. The emitter follower output stage in each ECL amplifier requires an external emitter resistor for biasing. U4A emitter resistor R27 additionally provides the low impedance output necessary to match the coaxial transmission lines feeding the A10 Amplitude Synchronous Detector and the A1 Phase Detector. U4A is connected as an inverting amplifier, thus providing 180 degrees of phase shift for subsequent use in the A1 Phase Detector circuit. R26 minimizes ringing on the square-wave output. C24 provides isolation for the outer conductors of the coaxial transmission lines, eliminating changes in reference leg bias on the A10Q6 input differential amplifier

7 THEORY FOR TEST CHANNEL AMPLIFIER A9

A9 Test Channel Amplifier, General Description

The Test Channel Amplifier provides the necessary gain, filtering, and limiting of the Test Phase signal from the Network Analyzer mainframe, and shifts it by 180 degrees. The amplifier consists of five stages:

- 35 dB Preamplifier
- 30 dB Preamplifier
- 40 dB Amplifier
- 278 kHz Bandpass Filter
- Limiter

The amplifier output is then sent to the A10 Amplitude Synchronous Detector and the A1 Phase Detector.

35 dB Preamplifier

Transistor array U3 is connected as a differential amplifier with buffered differential outputs. Collector current in U3E, the current source for the emitters of the input transistors U3A and U3B, is approximately 0.5 milliamperes. With a 4220 ohm load on each of the collectors (R5 and R6), the stage gain is about 35 dB. With large signal inputs, the amplifier limits the output to about the same voltage swing as ECL devices.

30 dB Preamplifier

The 30 dB preamplifier is similar in operation to the 35 dB preamplifier described above. The only differences are the addition of a 278 kHz bandpass filter (L7, C30 and C31) and different collector load values for U6A and U6B.

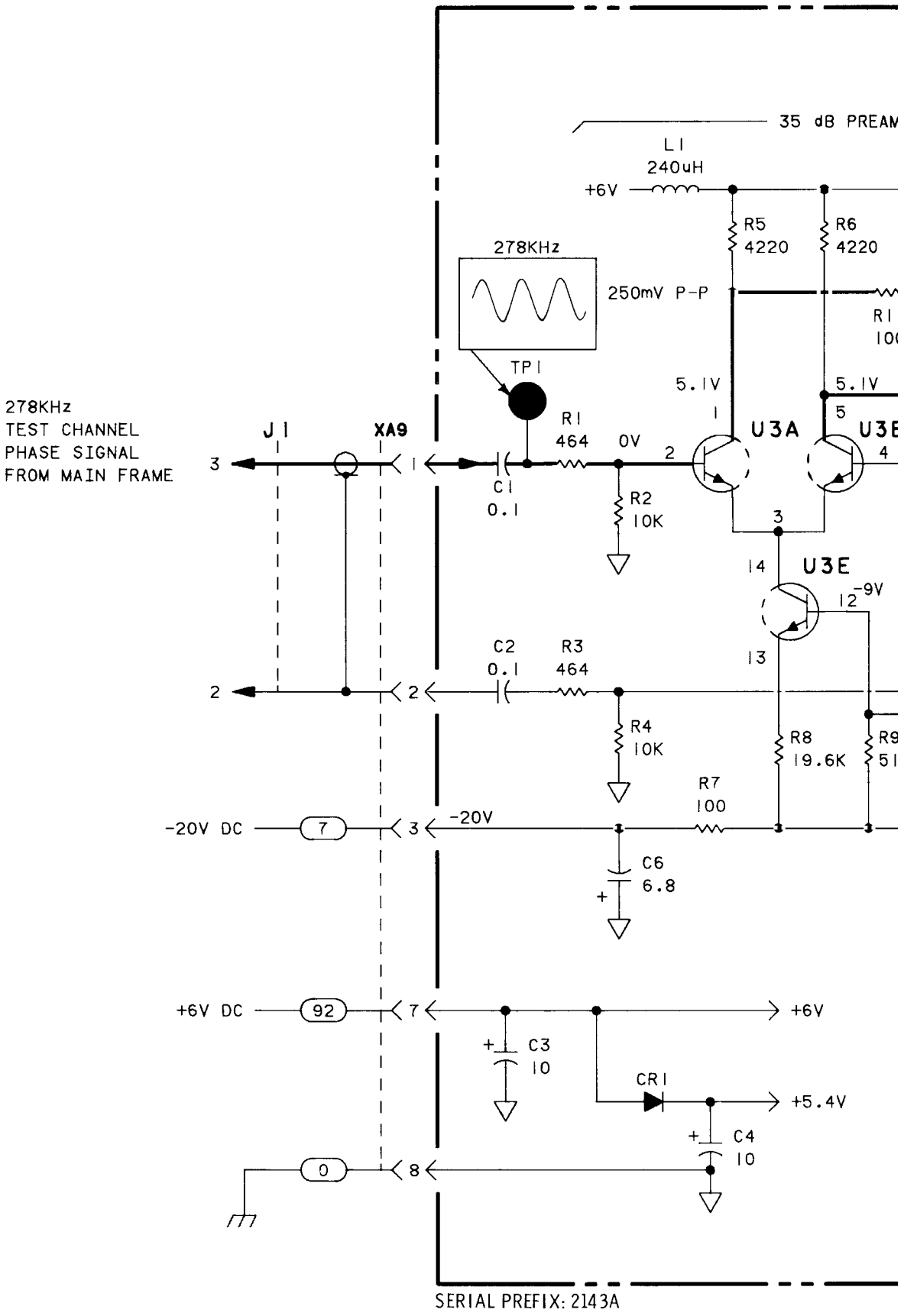
40 dB Amplifier

The 40 dB Amplifier, U1, consists of three ECL line receivers connected in cascade differentially. Wired in the double-ended output configuration, line receivers U1B and U1C provide approximately 15 dB of differential gain each. The single-ended, negative output of U1A provides approximately 10 dB of differential gain. In order to maintain true phase relationship, the output waveform must be symmetrical. Symmetry of the output is maintained by negative feedback provided by R17, R18 and C11. When the input signal level is high enough, the amplifier provides a limiting function as well.

278 kHz Bandpass Filter

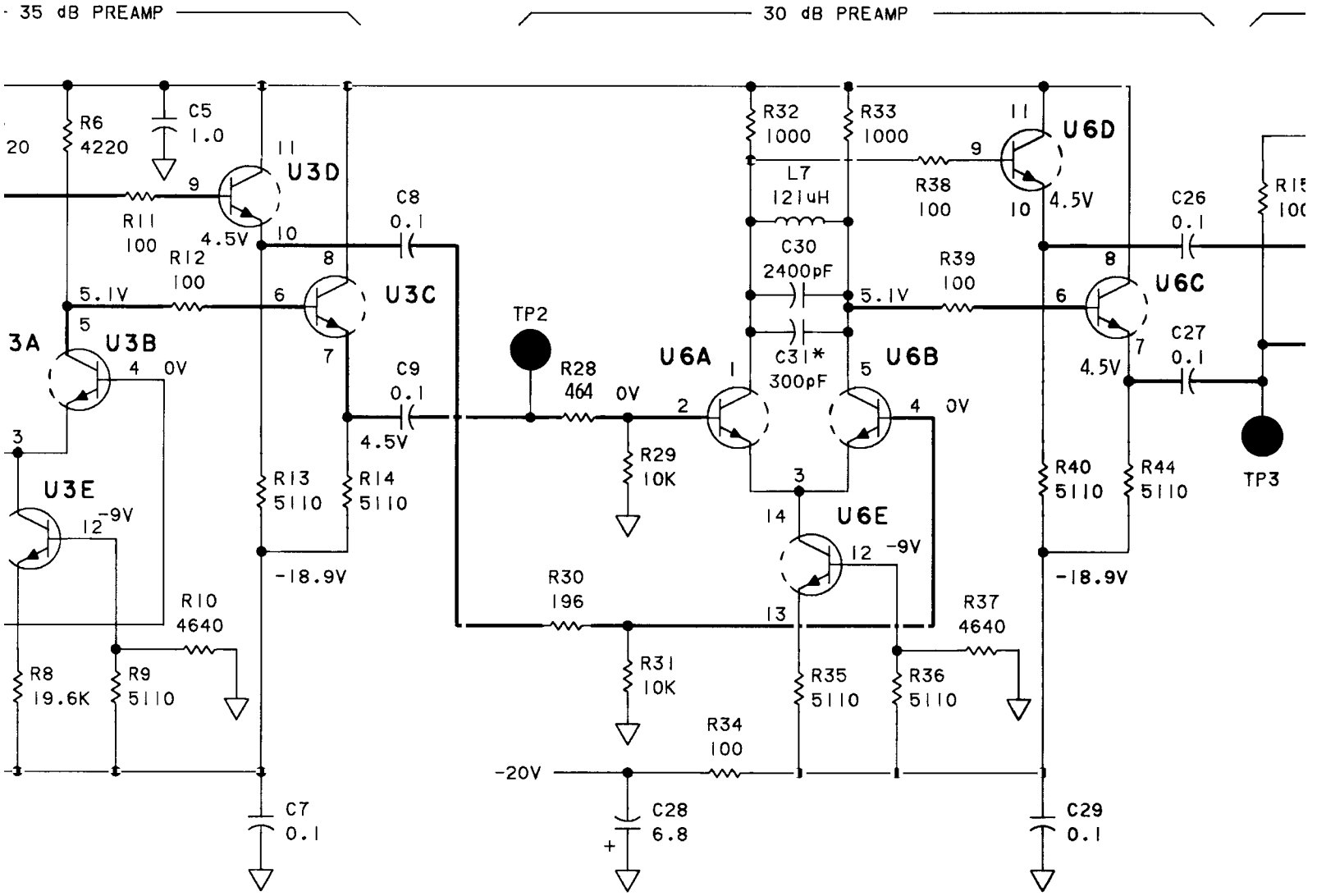
The output signal from U1 goes through a 278 kHz Bandpass Filter with a bandwidth of approximately 10 kHz. The filter removes broadband noise from the previous amplifier stages and further enhances the waveform symmetry. Emitter follower Q1 provides buffering.

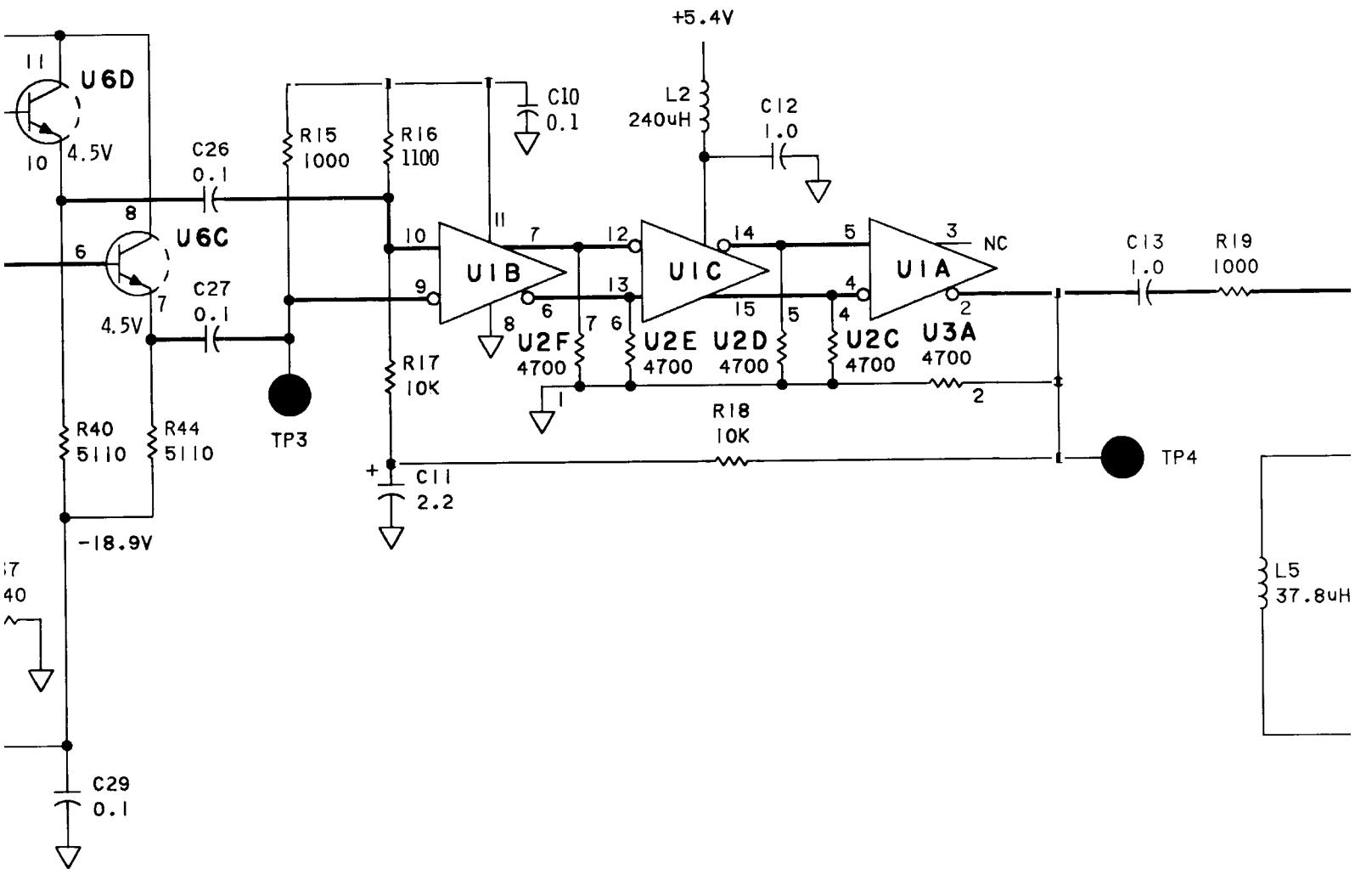
A9 TEST CHANNEL AMPLIFIER (



SERIAL PREFIX: 2143A

LIFIER (08412-60056)



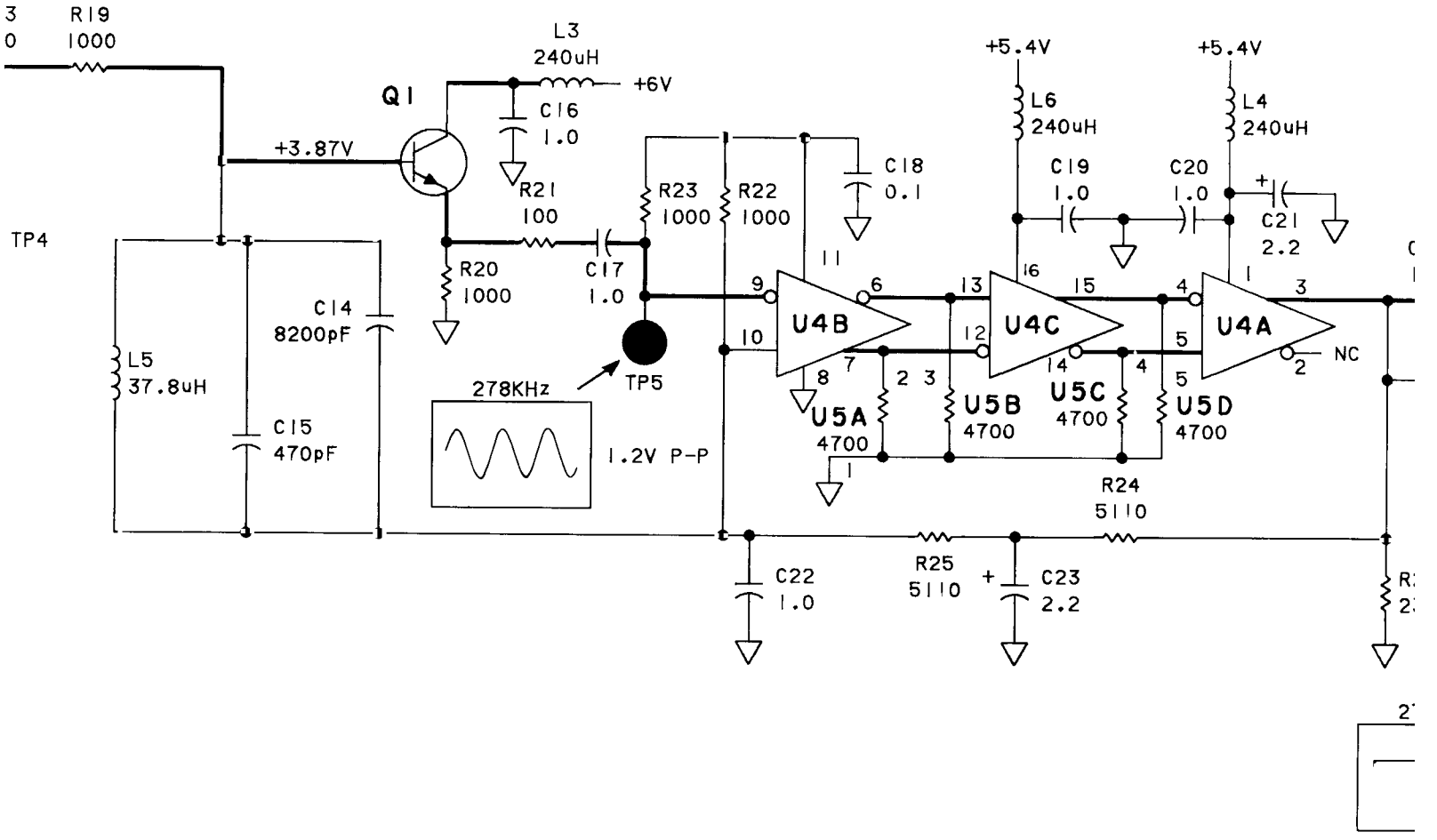


NOTES:

SEE FIGURE 8-3 FOR MEASUREM
CONDITIONS AND TEST SETUP T
OBTAIN VOLTAGES SHOWN.

278 KHz BPF
BW=10KHz

LIMITER



-3 FOR MEASUREMENT
ND TEST SETUP TO
GES SHOWN.

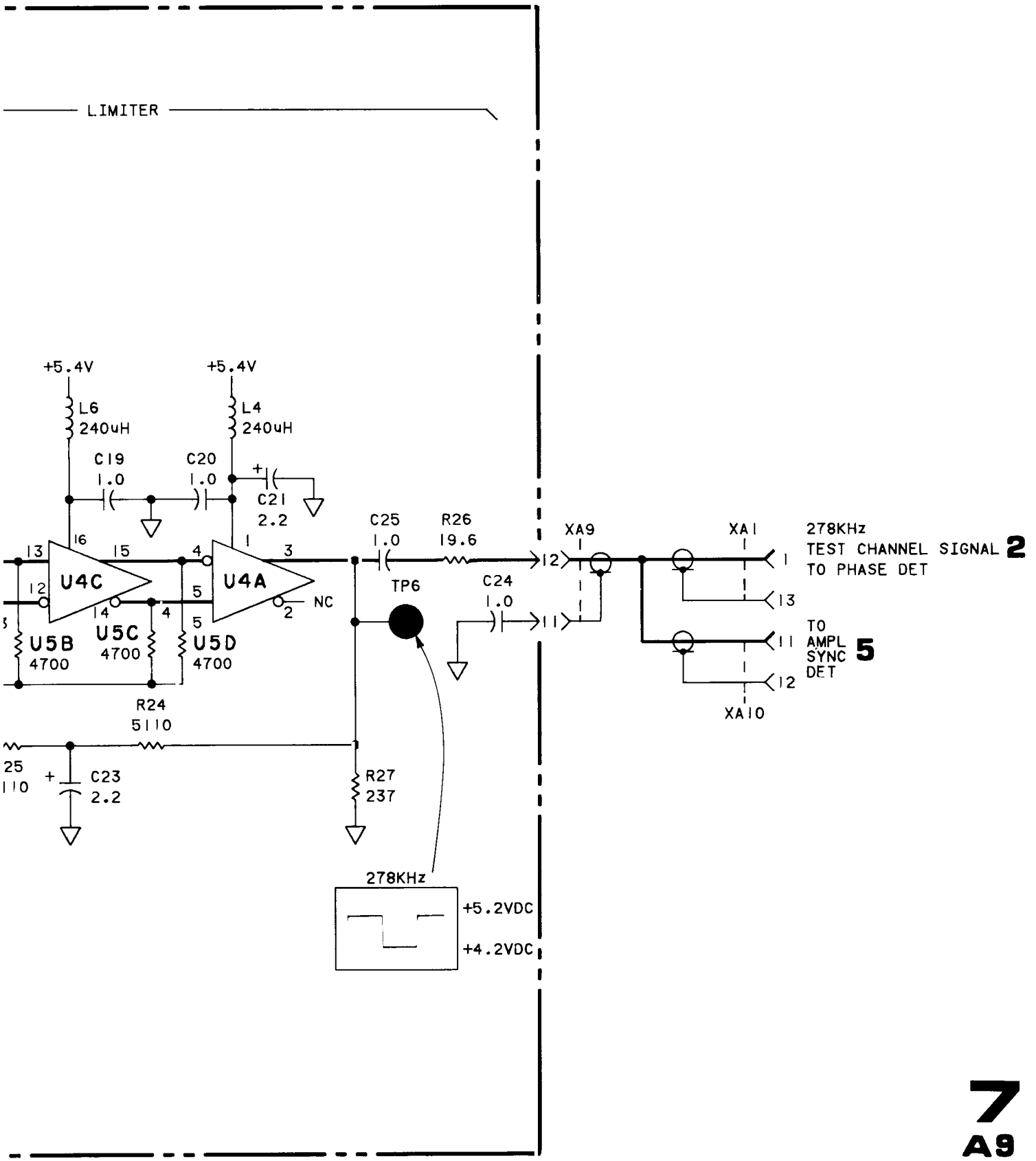


Figure 8-27. Test Channel Amplifier A9, Schematic Diagram

8 THEORY FOR HIGH-VOLTAGE POWER SUPPLY A5 AND RECTIFIER A6

High-Voltage Oscillator

High voltage is developed by an oscillator circuit consisting of Q11 and the two primary windings of A6T1.

Fifty kHz oscillator energy is transformer coupled through A6T1 to the two high-voltage secondary windings, then rectified and filtered, producing a −2950 Vdc CRT cathode supply and a −2980 Vdc control grid supply.

Regulator Feedback Amplifier

The −2950 Vdc supply for the CRT cathode is voltage regulated. A small amount of voltage is obtained by a high resistance voltage divider across the supply output consisting of A5R1, A5R2, and A5R34. This is amplified through Q8, Q9, and Q10, then applied back to oscillator Q11 through T1 feedback windings. This feedback loop changes the bias on Q11, thus controlling the peak current flowing in transformer T1. This, in turn, controls the peak-to-peak voltage at the secondary of A6T1 and thus controls the high voltage output.

CRT Protection

V1, R35, and CR10 form a protective circuit for the CRT. This circuit prevents the CRT grid from going positive relative to the cathode and from going farther than 120V negative from the cathode since these voltages might cause arcing between elements and damage to the CRT.

Z-AXIS Blanking and Intensity Modulator

The ground return circuit for the −2980V supply driving the CRT grid is used to modulate the Z-Axis. This provides means to insert CRT blanking from several sources, and intensity modulation for frequency marking on the CRT trace. The Z-Axis modulation amplifier is composed of Q4-Q7.

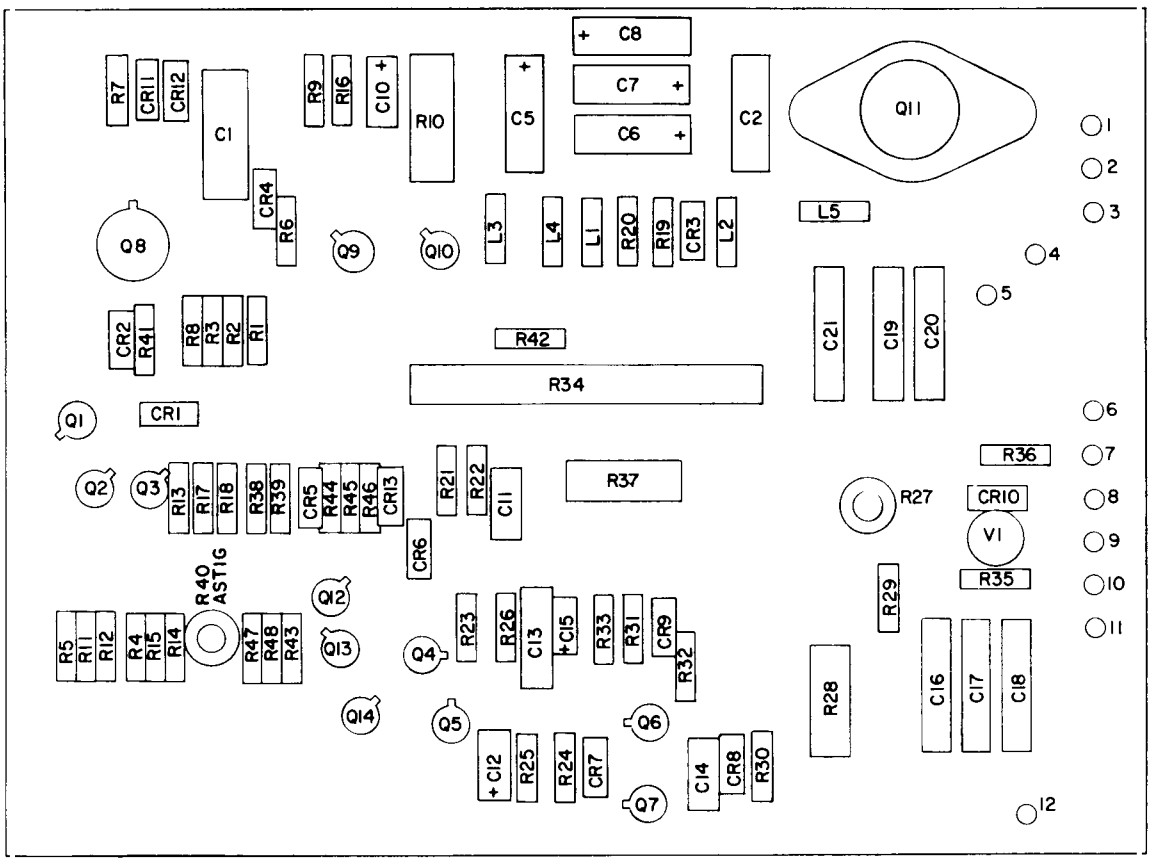
Blanking Preamplifiers

The Blanking preamplifiers sum blanking and intensity modulation signals from several sources to drive the Z-Axis Blanking and Intensity Modulator. Q2 and Q3 form a level shifting network to convert the −20V to −6V mainframe blanking pulse to a 0V to −6V pulse input to the resistance summing network. Q1 inverts the negative blanking pulse from the Multiplexer/Deflection Amplifier A3. Blanking inputs from the mainframe and rear panel are disabled whenever the 8412B is operated with the 8750A Storage-Normalizer. The mainframe blanking input is switched off by Q13 and Q14 when L NORM input from the 8750A is low (0V). Blanking and Z-Axis inputs from the rear panel are disabled on the Multiplexer/ Deflection Amplifier A3.

Astigmatism

R40 adjusts astigmatism.

A5



A6

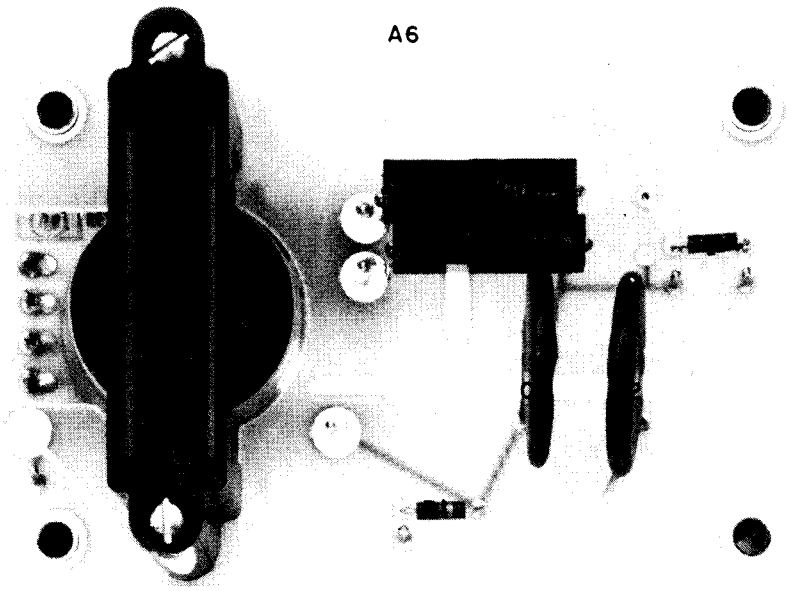
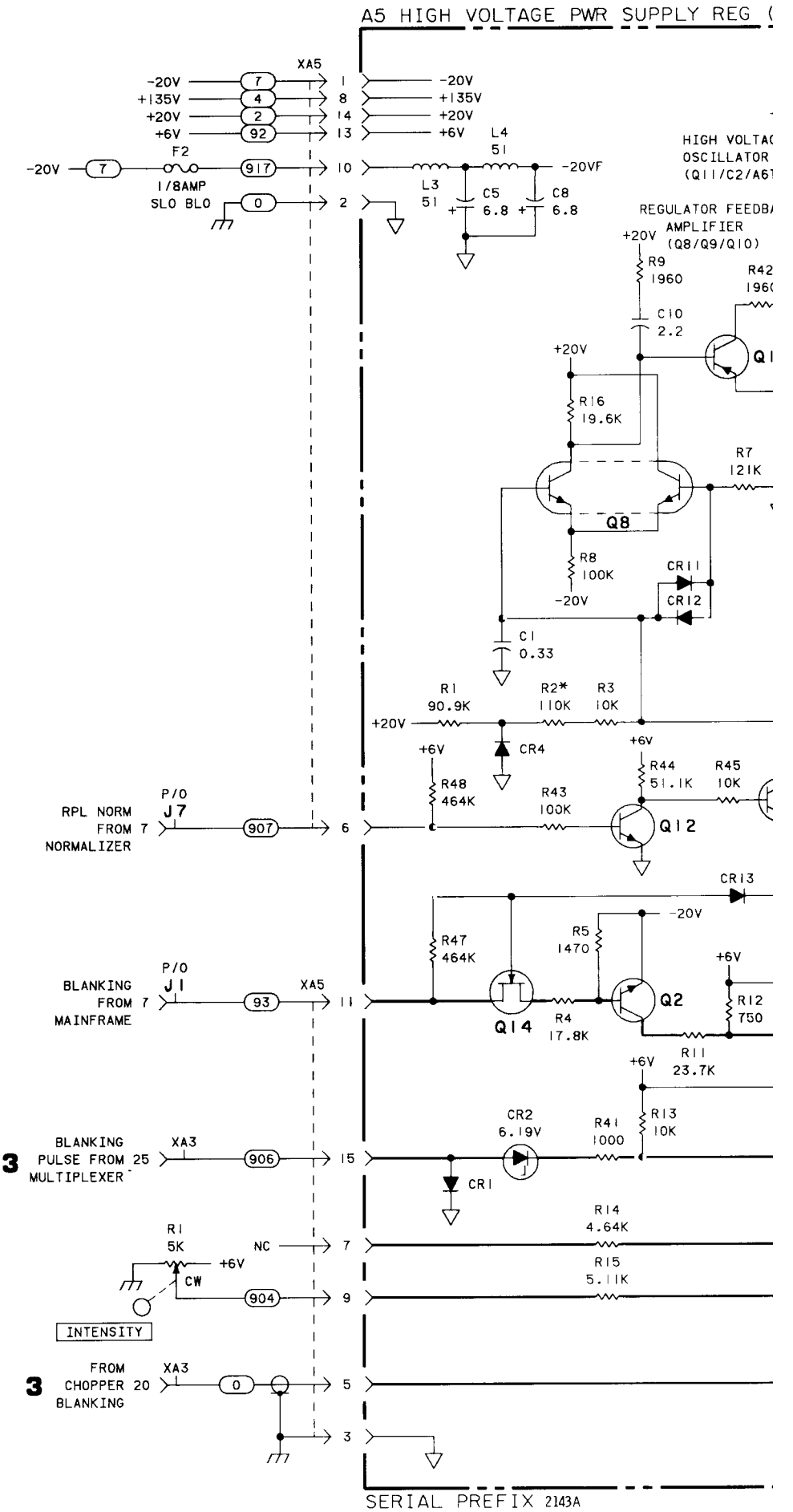
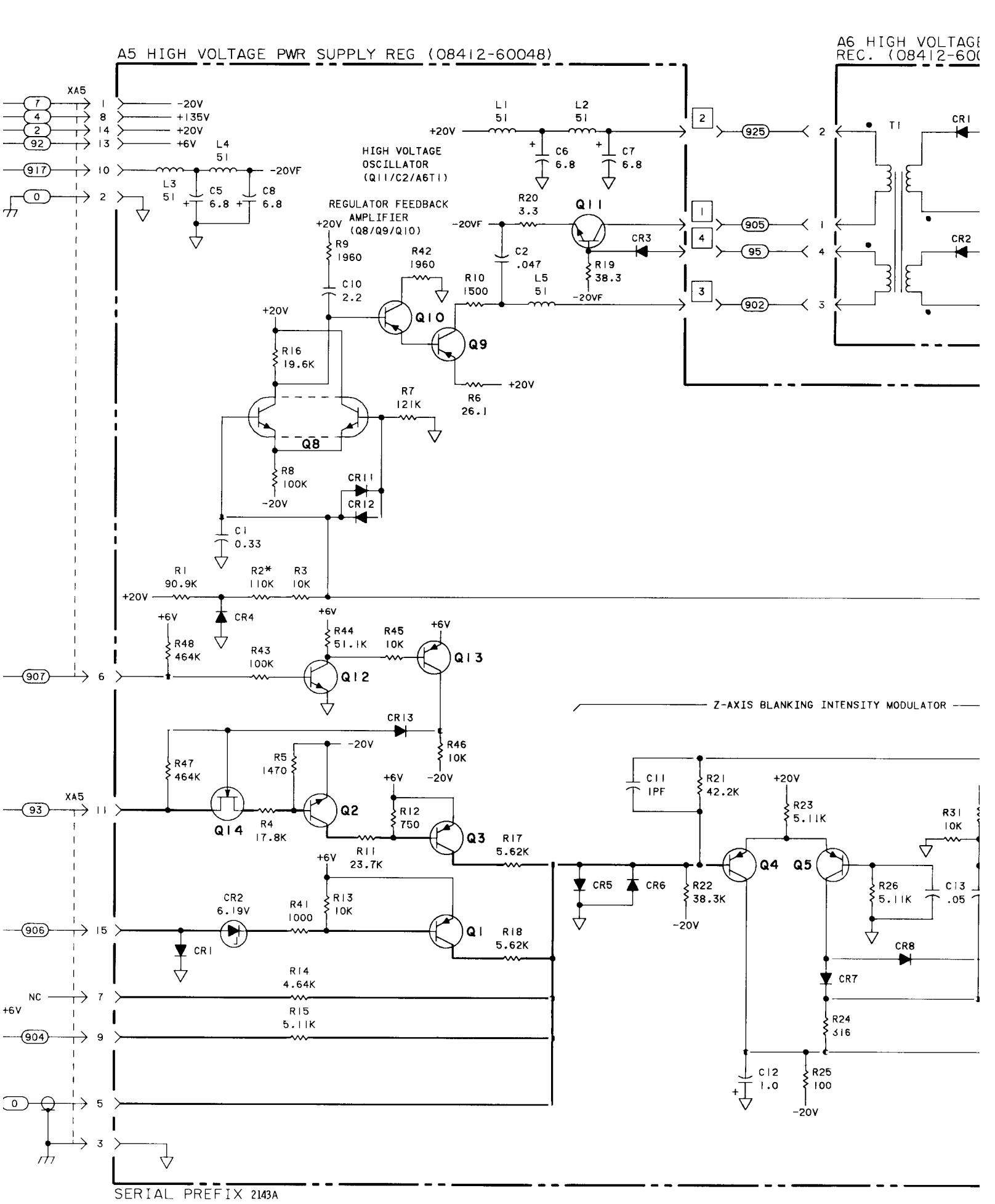
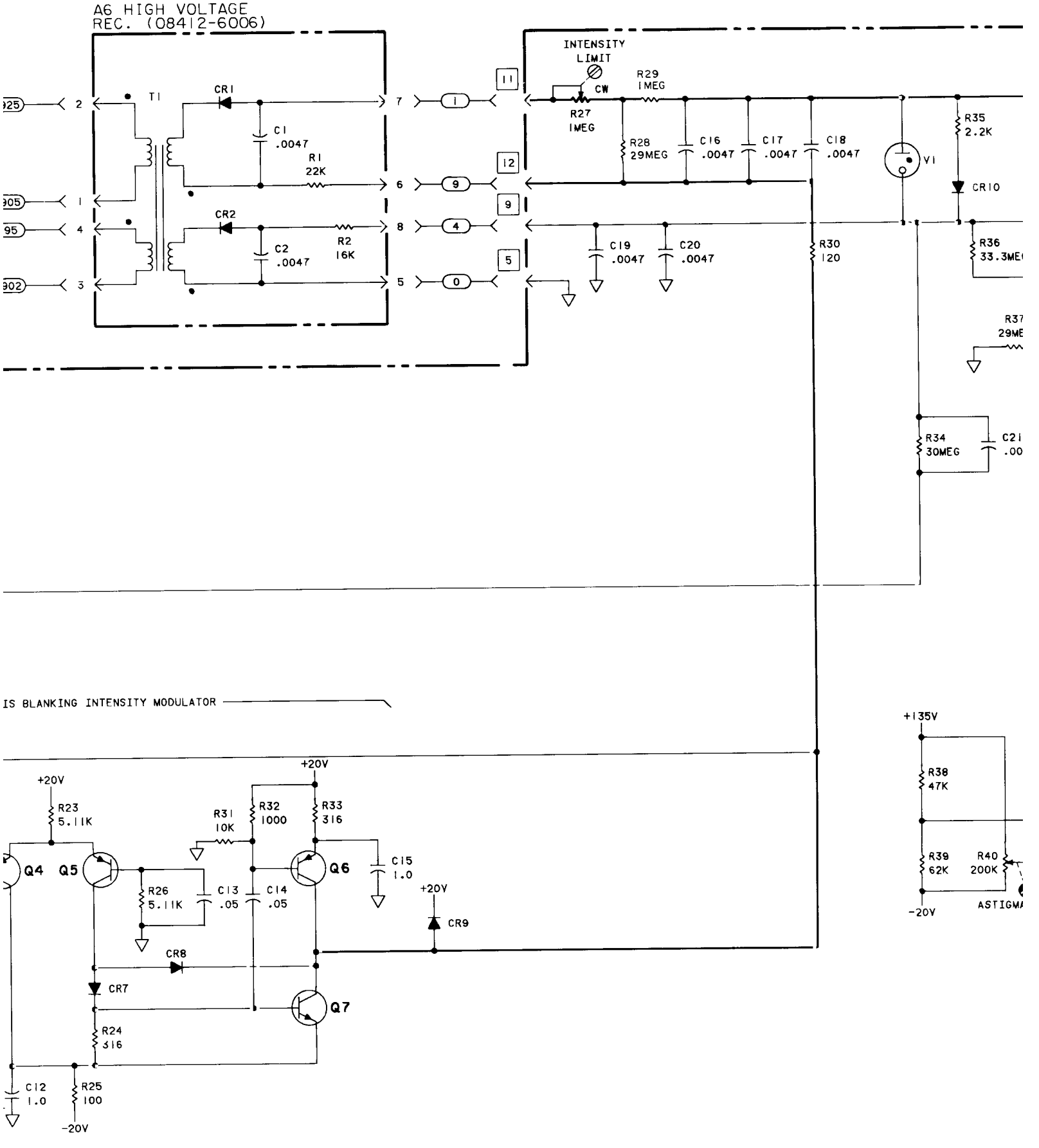


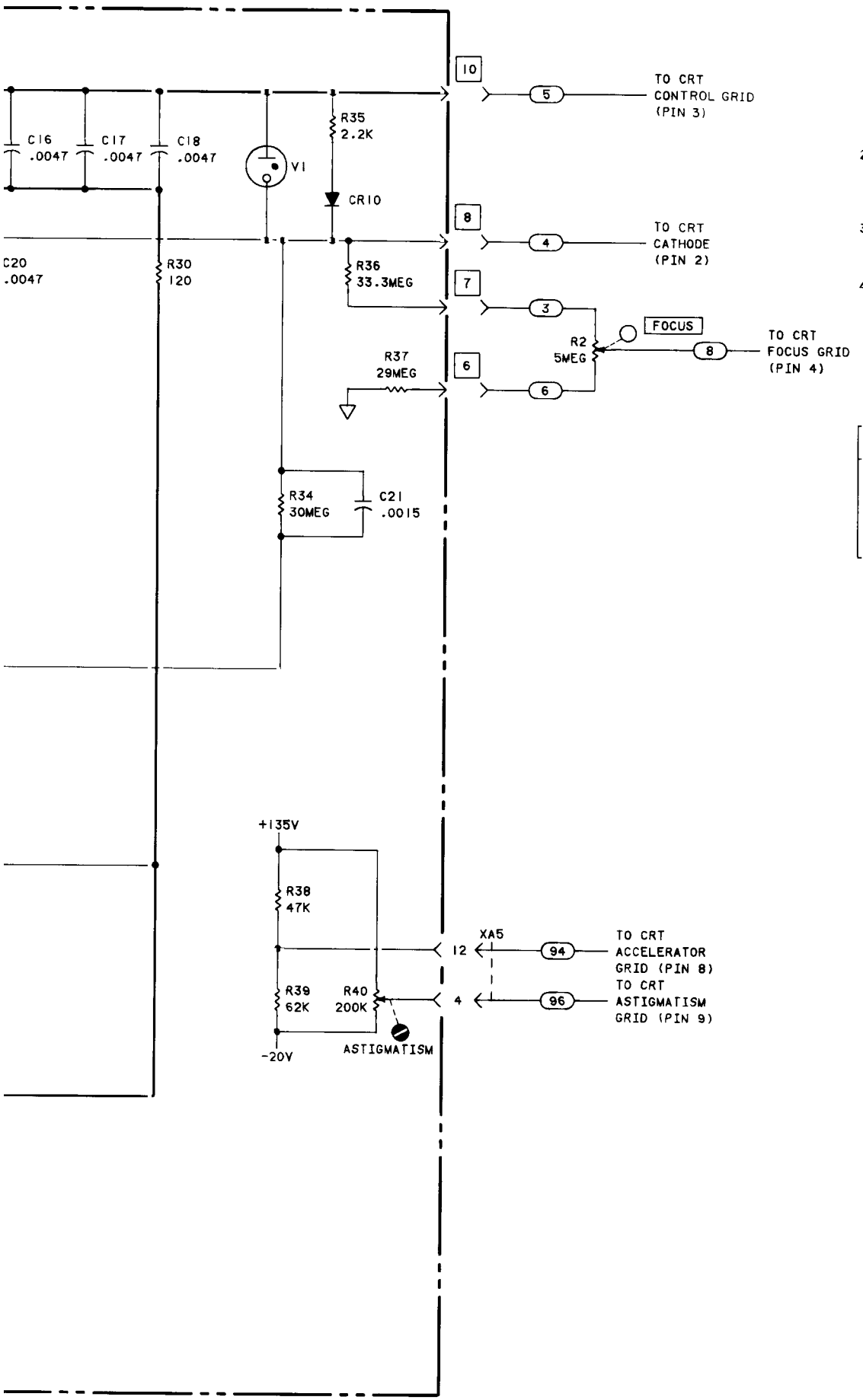
Figure 8-28. Component Location for High Voltage Power Supply A5, and Rectifier A6


A5 HIGH VOLTAGE PWR SUPPLY REG
XA5
-20V
+135V
+20V
+6V
F2
1/8AMP
SLO BLO
L4
51
L3
51
C5
6.8
C8
6.8
HIGH VOLTAG
OSCILLATOR
(Q11/C2/A6
REGULATOR FEEDBA
AMPLIFIER
(Q8/Q9/Q10)
R9
1960
R42
196
C10
2.2
R16
19.6K
R7
121K
Q8
R8
100K
CR11
CR12
C1
0.33
R1
90.9K
R2*
110K
R3
10K
CR4
R48
464K
R43
100K
R44
51.1K
R45
10K
Q12
RPL NORM
FROM 7
NORMALIZER
P/O
J7
907
CR13
R47
464K
R5
1470
Q14
R4
17.8K
Q2
R12
750
R11
23.7K
BLANKING
FROM 7
MAINFRAME
P/O
J1
93
CR2
6.19V
R41
1000
R13
10K
CR1
BLANKING
PULSE FROM 25
MULTIPLEXER
XA3
906
R14
4.64K
R15
5.11K
R1
5K
CW
NC
904
INTENSITY
FROM
CHOPPER 20
BLANKING
SERIAL PREFIX 2143A


A5 HIGH VOLTAGE PWR SUPPLY REG (08412-60048)
A6 HIGH VOLTAGE REC. (08412-60
XA5
-20V
+135V
+20V
+6V
-20VF
HIGH VOLTAGE OSCILLATOR (Q11/C2/A6T1)
REGULATOR FEEDBACK AMPLIFIER (Q8/Q9/Q10)
L1 51
L2 51
L3 51
L4 51
L5 51
C1 0.33
C2 .047
C5 6.8
C6 6.8
C7 6.8
C8 6.8
C10 2.2
C11 1PF
C12 1.0
C13 .05
R1 90.9K
R2* 110K
R3 10K
R4 17.8K
R5 1470
R6 26.1
R7 121K
R8 100K
R9 1960
R10 1500
R11 23.7K
R12 750
R13 10K
R14 4.64K
R15 5.11K
R16 19.6K
R17 5.62K
R18 5.62K
R19 38.3
R20 3.3
R21 42.2K
R22 38.3K
R23 5.11K
R24 316
R25 100
R26 5.11K
R31 10K
R41 1000
R42 1960
R43 100K
R44 51.1K
R45 10K
R46 10K
R47 464K
R48 464K
Q1
Q2
Q3
Q4
Q5
Q8
Q9
Q10
Q11
Q12
Q13
Q14
CR1
CR2 6.19V
CR3
CR4
CR5
CR6
CR7
CR8
CR11
CR12
CR13
T1
Z-AXIS BLANKING INTENSITY MODULATOR
SERIAL PREFIX 2143A


A6 HIGH VOLTAGE
REC. (08412-6006)
T1
CR1
C1
.0047
R1
22K
CR2
C2
.0047
R2
16K
INTENSITY
LIMIT
CW
R27
1MEG
R29
1MEG
R28
29MEG
C16
.0047
C17
.0047
C18
.0047
V1
R35
2.2K
CR10
C19
.0047
C20
.0047
R30
120
R36
33.3ME
R37
29ME
R34
30MEG
C21
.00
IS BLANKING INTENSITY MODULATOR
+20V
R23
5.11K
R31
10K
R32
1000
R33
316
Q4
Q5
Q6
C15
1.0
R26
5.11K
C13
.05
C14
.05
CR9
CR8
CR7
Q7
R24
316
C12
1.0
R25
100
-20V
+135V
R38
47K
R39
62K
R40
200K
-20V
ASTIGMA

Fig



NOTES

1. REFERENCE DESIGNATORS WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS (Ω)
   CAPACITANCE IN MICROFARADS (uF)
   INDUCTANCE IN MICROHENRIES (uH)
3. ASTERISK (*) INDICATES, FACTORY SELECTED VALUE.
4. SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN.

REFERENCE DESIGNATIONS

A5	A6
C1-2,5-8,10-21	C1,2
CR1-12	CR1,2
L1-5	R1,2
Q1-14	T1
R1-48	CHASSIS:F2
V1	

C3,4,9 NOT ASSIGNED

Figure 8-29. High Voltage Power Supply A5, and Rectifier A6, Schematic Diagram

9 THEORY FOR LOW VOLTAGE POWER SUPPLY A8

± 6 Volt Supply

Series regulator Q3 is driven by IC1, maintaining a regulated 12 Volts across the +6 Volt and −6 Volt supplies (between pins 1 and 6). The 12 Volts is adjusted by R4. Resistors R2, R3 and R4 sense any change from 12 Volts, amplifying the change through IC1, then changing the bias on Q3 to bring the output back to 12 Volts. Resistors R5 and R6 form a voltage divider across the 12 Volt output, dropping 6 volts across each resistor. The voltage at the center of the voltage divider is compared to ground at the input of IC2. The resultant output from IC2 drives Q1 and Q2. Q1 and Q2 together with their associated resistors R9 and R10 balance the load impedance across the plus and minus 6 Volts to maintain 6 Volts across each supply. This compensates for the difference in load presented by the instrument circuits to the two supplies. This means that the total current drawn by Q1 and the −6 Volt load circuits will equal the total current drawn by Q2 and the +6 Volt load circuits.

+ 135 Volt Supply

Capacitor C4 together with rectifier diodes CR3 and CR4 and transformer T1 make the unregulated 135 Volt supply.

Trace Align

R8 adjusts trace align on CRT.

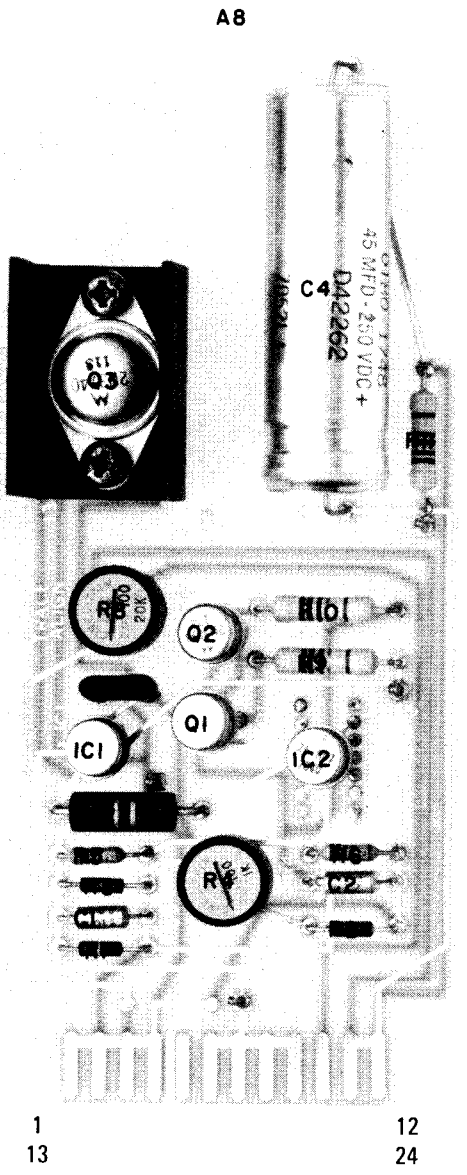
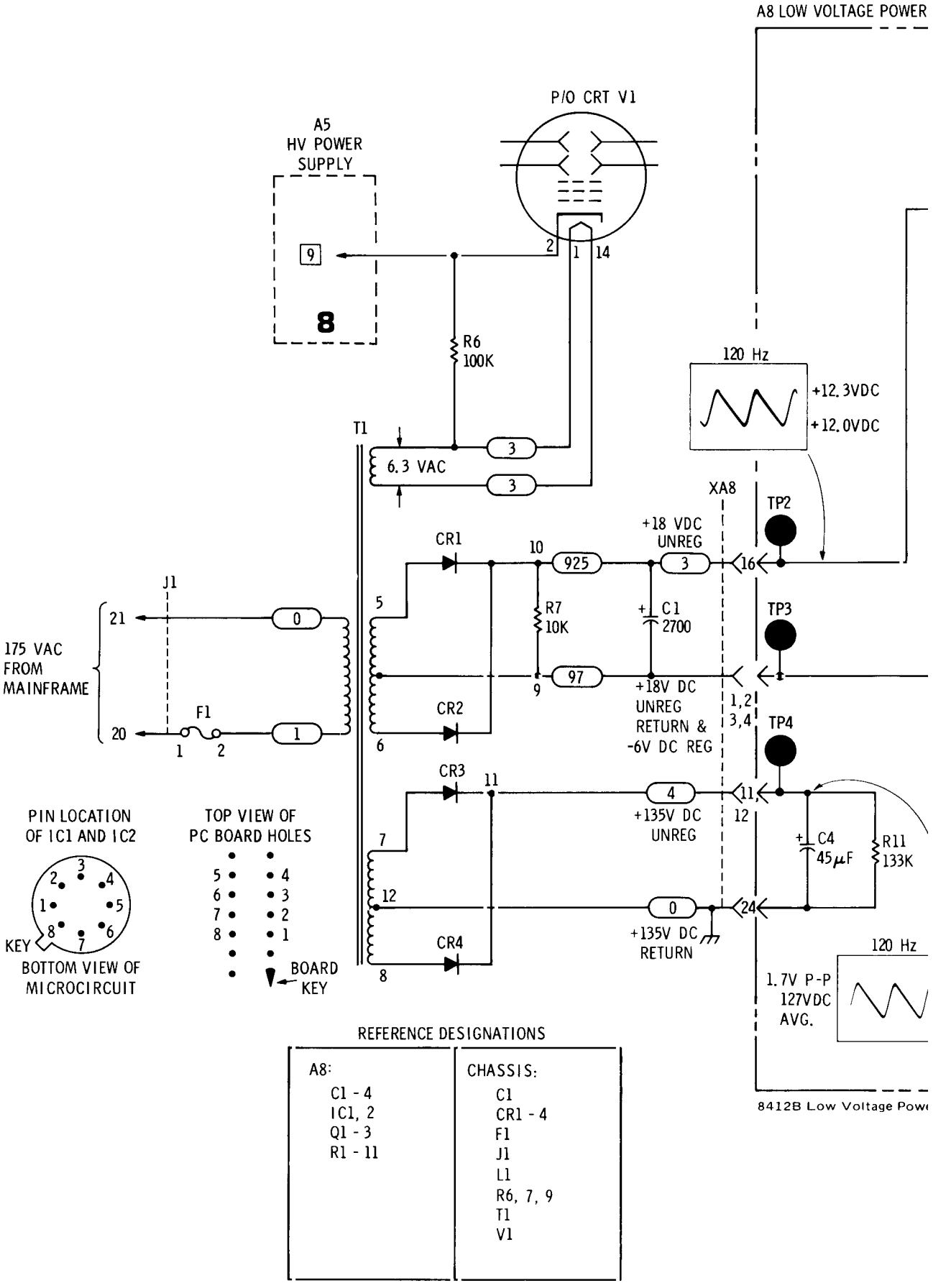


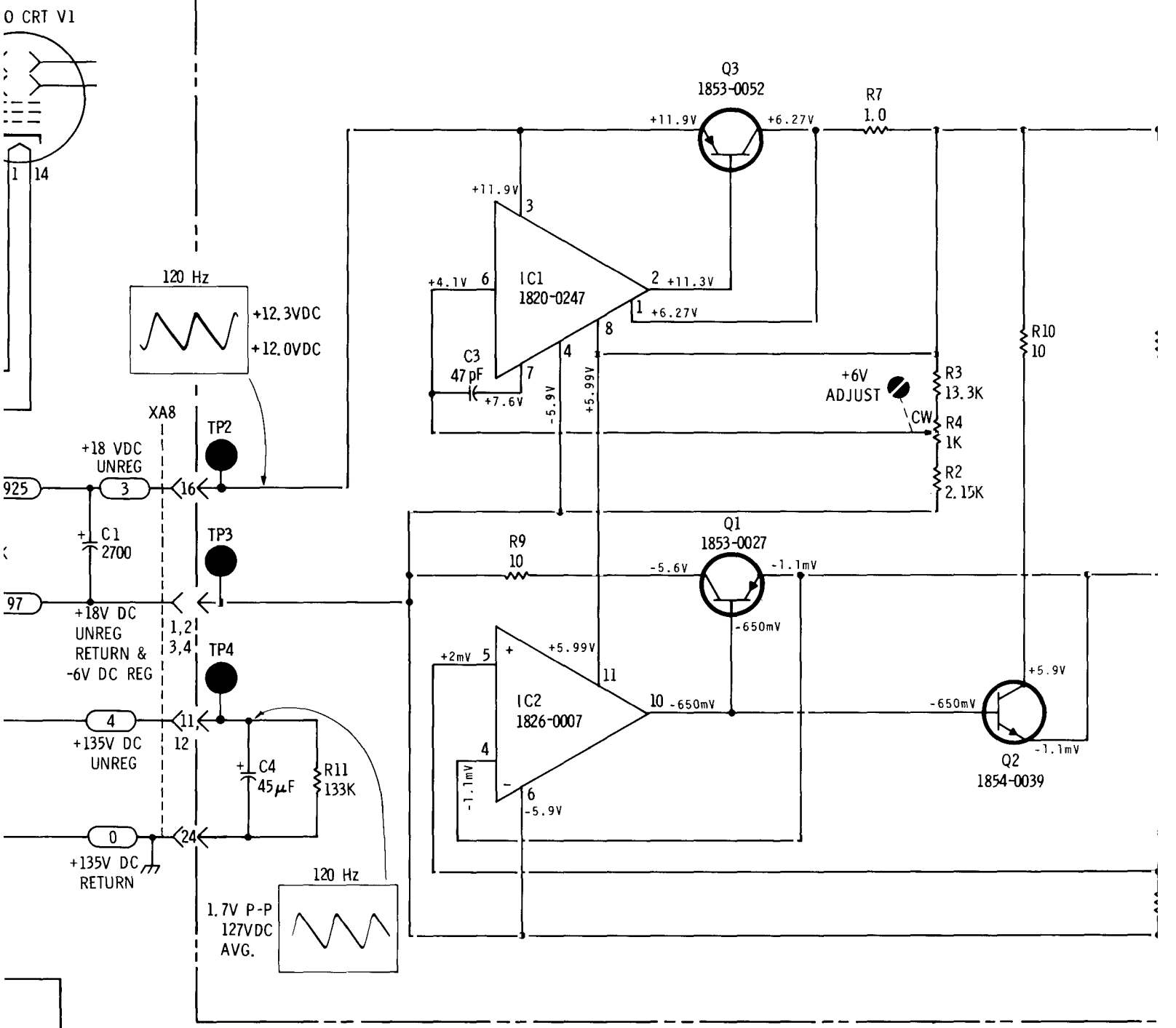
Figure 8-30. Component Location for Low-Voltage Power Supply A8



REFERENCE DESIGNATIONS

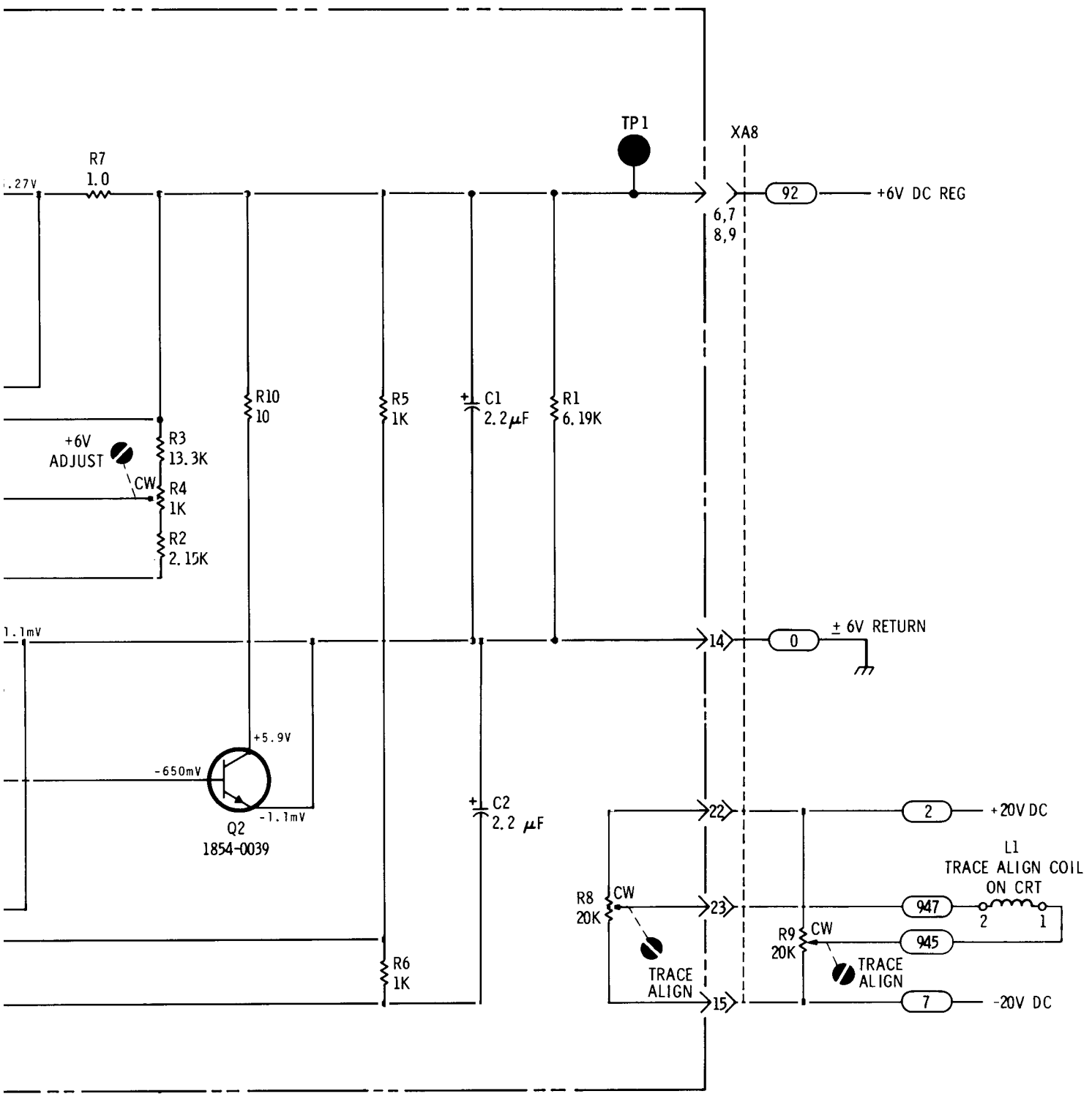
A8:	CHASSIS:
C1 - 4	C1
IC1, 2	CR1 - 4
Q1 - 3	F1
R1 - 11	J1
	L1
	R6, 7, 9
	T1
	V1

A8 LOW VOLTAGE POWER SUPPLY (08412-60008)



8412B Low Voltage Power Supply Serial Prefix: 2143A

NOTES
SEE FIGURE 8-3 FOR MEASUREMENT CONDITIONS AND TEST SETUP TO OBTAIN WAVEFORMS AND VOLTAGES SHOWN



ONS
AIN
GES

9

A8

Figure 8-31. Low-Voltage Power Supply A8, Schematic Diagram

MANUAL CHANGES

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of this supplement. Free copies are available from all HP offices. When requesting copies, quote the manual identification information from your supplement, or the model number and print date from the title page of the manual.

MANUAL IDENTIFICATION

Model Number: 8412B
Date Printed: December 1981
Part Number: 08412-90033

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement, make all ERRATA corrections and all appropriate serial number related changes indicated in the tables below.

▶ = NEW ITEM

Serial Prefix or Number	Make Manual Changes
2240A	1
2246A	1, 2
2302A	1, 2, 3
2412A	1, 2, 3, 4
2417A	1−5
2427A	1−6

Serial Prefix or Number	Make Manual Changes

ERRATA

Page 4-7, PERFORMANCE TEST:

In paragraph under heading "**4-10. Phase Test,**" change the last sentence of Paragraph c to read: "(The DVM indication will now be positive.)"

Page 5-6, Table 5-3:

Add Capacitor, Reference Designator: A2C33, Selection Critieria: Center the range of A2C20, Nominal Value: 91pF, Range: 12pF to 100pF.

Page 5-10, Paragraph 5-15:

Change step i as follows:

i. Connect DVM to A2TP6. Adjust A2C20 FREQ ADJ for a minimum DVM reading (typically ≤ ± 50mVdc. If A2C20 does not have sufficient range, change the value of A2C33.

Page 5-16, Paragraph 5-24:

Change step d as follows:

d. Connect DVM to A2TP6. Adjust A2C20 FREQ ADJ for a minimum DVM reading (typically ≤ ± 50mVdc). If A2C20 does not have sufficient range, change the value of A2C33.

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14 pages

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ERRATA (Cont'd)

Page 6-5, Table 6-2:
Add A2C25*, HP Part Number 0160-0134, CD1, CAPACITOR-FXD 220PF 300V.
Change A1R21 to HP Part Number 2100-3383, Check Digit 4, 50 Ohms.
▶ Change A1R28 to HP Part Number 0698-3162, 46.4K Ohm.

Page 6-6, Table 6-2:
Change A2C15 to HP Part Number 0160-2225, Check Digit 5, CAPACITOR-FXD 2000PF ± 5% VDC CER.
Change A2C21 to HP Part Number 0140-0178, Check Digit 1, CAPACITOR-FXD 560PF ± 2% 300 VDC MICA.
Change A2C33 to HP Part Number 0160-4786, Check Digit 7, CAPACITOR-FXD 27PF ± 5% 100 VDC CER0 ± 30.
Add A2C34, HP Part Number 0160-2201, Check Digit 7, CAPACITOR-FXD 51PF ± 5% 300 VDC MICA.
Add A2C35, HP Part Number 0160-2201, Check Digit 7, CAPACITOR-FXD 51PF ± 5% 300 VDC MICA.
Change A2R22 to HP Part Number 0698-6620, Check Digit 1, RESISTOR 150K .1% .125W F TC = 0 ± 25.

Page 6-7, Table 6-2:
Change A2R26 to HP Part Number 0698-6620, Check Digit 1, RESISTOR 150K .11% .125W F TC = 0 ± 25.
Change A2R27 to HP Part Number 0757-0438, Check Digit 3, RESISTOR 5110 1% .125W F TC = 0 ± 10.
Change A2U6 to HP Part Number 1826-0932, Check Digit 0, IC OP AMP PRCN 8-DIP-C-PKG.
Change A2VR1 to HP Part Number 1902-3002, Check Digit 3, DIODE-ZNR 2.37V 5% D0-7 PD = .4W TC = .074%.

Page 6-9, Table 6-2:
Change A3U1, U3, U4 to HP Part Number 1826-0811, Check Digit 4 (Recommended Replacement).

Page 6-11, Table 6-2:
Change A7R11 to HP Part Number 0811-1790, Check Digit 6, RESISTOR 1K 5% .25W PWW TC = ± 3400$300.
Change A7R12 to HP Part Number 0757-0280, Check Digit 3, RESISTOR 1K 1% .125W F TC = 0$100.
Change A7IC1-A71C4 to HP Part Number 1826-1058, Check digit 3, IC 2C M1 OP-AMP.

Page 6-13, Table 6-2:
Change A9TP1, 2, 3, 4, 5, and 6 to HP Part Number 1251-0600, CD0, CONN CONT M (Recommended Replacement).
Change A10IC1 to HP Part Number 1826-1058, Check Digit 3, IC 2C M1 OP-AMP.

Page 6-14, Table 6-2:
Change E1 to HP Part Number 08412-60065, Check Digit 3.

Page 6-15, Table 6-2:
Change T1 to HP Part Number 9100-2699, CD0.
Change XF1 to HP Part Number 2110-0564, Check Digit 8.

Page 6-16, Figure 6-1 (Sheet 1 of 2):
Delete Item 2, Contrast Improvement Screen. It is no longer supplied.

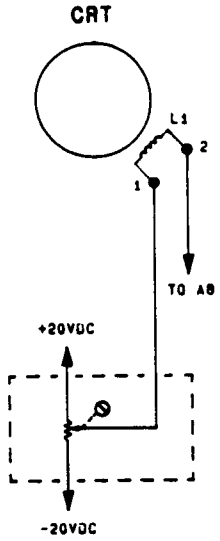
Page 6-17/6-18, Figure 6-1 (Sheet 2 of 2):
Delete Item 2, Contrast Improvement Screen. It is no longer supplied.

Page 6-17/6-18, Figure 6-1 (Sheet 2 of 2):
Change the Part Number of Item 8 to HP Part Number 5001-3569, Check Digit 1.
Change the Part Number of Item 28 to HP Part Number 7121-2595, Check Digit 7.

Page 6-17/6-18, Figure 6-1 (Sheet 2 of 2):
Change Item 23 to HP Part Number 08412-00033, Check Digit 9.

ERRATA (Cont'd)

Page 8-7, Figure 8-7:
Insert the following partial schematic into the existing Detailed Block Diagram:



P/O Figure 8-7 (Errata).

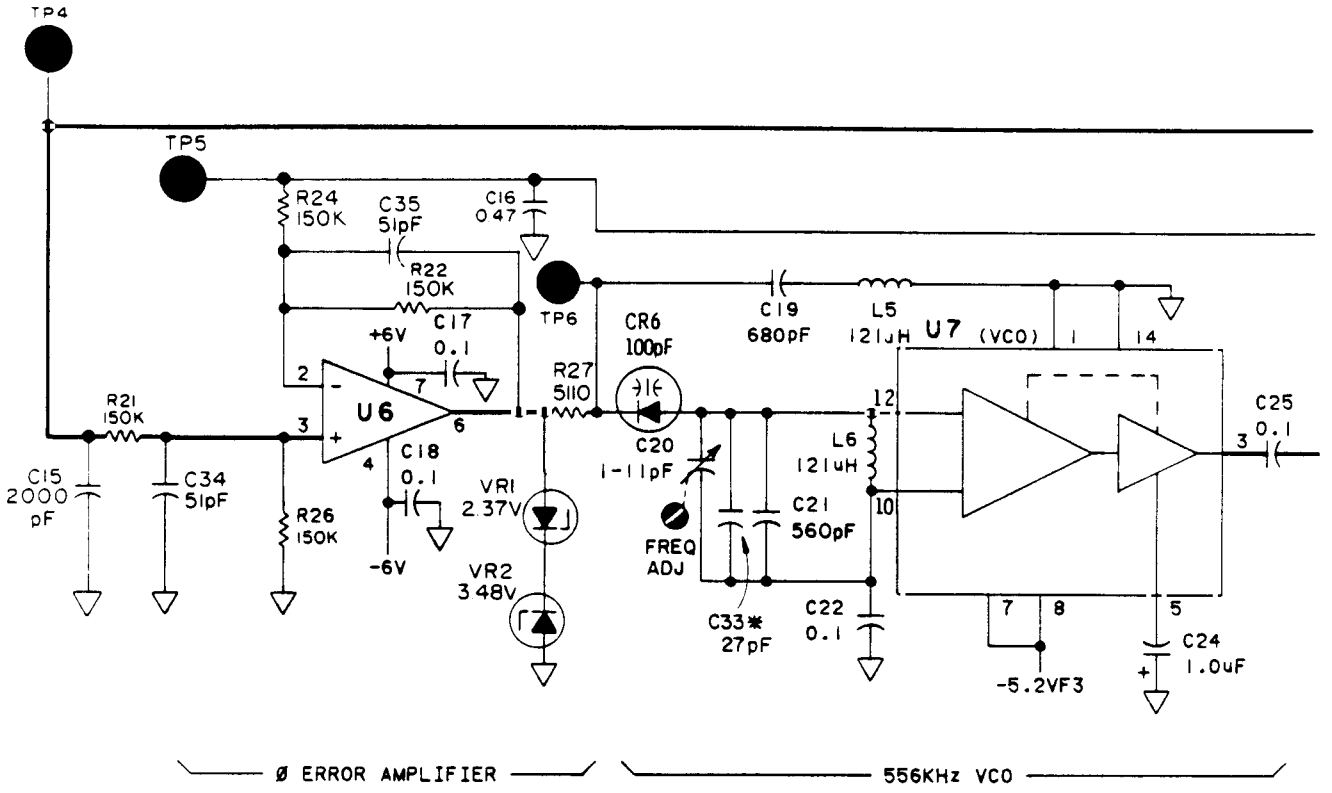
Page 8-8, Theory of A2:
In Paragraph under heading "Current Modulation and Phase Offset Voltage Generator", Change "Figure 7-6A" to "Figure 8-9".
Change "The Q_A output of U4A" to "The $\overline{Q_A}$ output of U4A".

In paragraph under heading "Phase Error Amplifier", change "±4.1V" to "+4V or −3V".
In paragraph under heading "Voltage Controlled Oscillator (VCO)", after C21 and "C33," and change "CR1" to "CR6". (two places)

Page 8-9, Figure 8-12:
Add C34 directly above and connected across R26.
Add C35 directly above and connected across R22.

ERRATA (Cont'd)

Page 8-9, Figure 8-13:
Change A2U1 pin 6 (connected to +6V) to pin 16.
Change Phase Error Amplifier as shown in the following partial schematic.



P/O Figure 8-13

Page 8-10, Theory for A1:
In paragraph under heading "Hysteresis Summing Amplifier", change "9 degrees" in two places to "4 degrees".

Page 8-11, Figure 8-17:
Change the value of R28 to 75K Ohm.
Change the value of R21 to 50 Ohms.
Change the upper position of switch S1 from .01 to 0.1 kHz.

Page 8-12, THEORY OF A3:
In paragraph under heading "Display Select Chopper", change "R52" to "R47". Change "R47" to "R52".
In paragraph under heading "Chopper Blanking Amplifier", change "(Q10, Q12)" to "Q10, Q11)".

Page 8-12, Figure 8-18:
Change the A3 Multiplexer and Deflection Amplifier board finger contacts as follows: 12 to 15, 13 to 16, 24 to 30.

Page 8-13, Figure 8-19:
Change the pointers of the following multiplexer IC's to state "1": A3U1C and D, A3U3A and B, A3U4B and D.
Change the wire color code of the coaxial cable center conductor connected to XA3 pin 20 to 9.

▶ Page 8-15, Figure 8-21:
XA4 pins 3, 4 and 6 (−6V, +6V) originate on the A8 board, Figure 8-31.

ERRATA (Cont'd)

Page 8-17, Figure 8-23:
Change IC1 to HP Part Number 1826-1058 CD3.
Change the following wire color codes for AMPL CAL (Low Level) Pot R4: 90 to 4, 91 to 2, 92 to 5.

Page 8-19, Figure 8-25:
Change IC1, 2, 3, and 4 to HP Part Number 1826-1058 CD3.
Change the upper position of switch S1 BW (kHz) in two places from .01 to 0.1 kHz.
Change R3 (located next to IC1) to 8.25K.

Page 8-21, Figure 8-27:
Change A9U3A (connected to TP4) to A9U2A.

Page 8-23, Figure 8-29:
Change the wire color code of the wire connected to the center wiper of FOCUS Adjust Pot R2 to 98.

Page 8-25/26, Figure 8-31:
Change IC2 to HP Part Number 1826-1058 CD3.
Change the pin numbers of IC2 as follows:

Positive input	-	pin #3
Negative input	-	pin #2
Positive supply	-	pin #7
Negative supply	-	pin #4
Output	-	pin #6

CHANGE 1

Page 6-11, Table 6-2:
Change A8 to HP Part Number 08412-60067, CD5.

Page 6-12, Table 6-2:
Add A8E1 and A8E2, HP Part Number 1200-0173, CD5, INS XSTR TO-5.
Add A8MP2 and A8MP3, HP Part Number 1205-0050, CD7, HT SK T05/T039.

Page 8-25/26, Figure 8-31:
Change A8 Low Voltage Power Supply to HP Part Number 0812-60067.

CHANGE 2

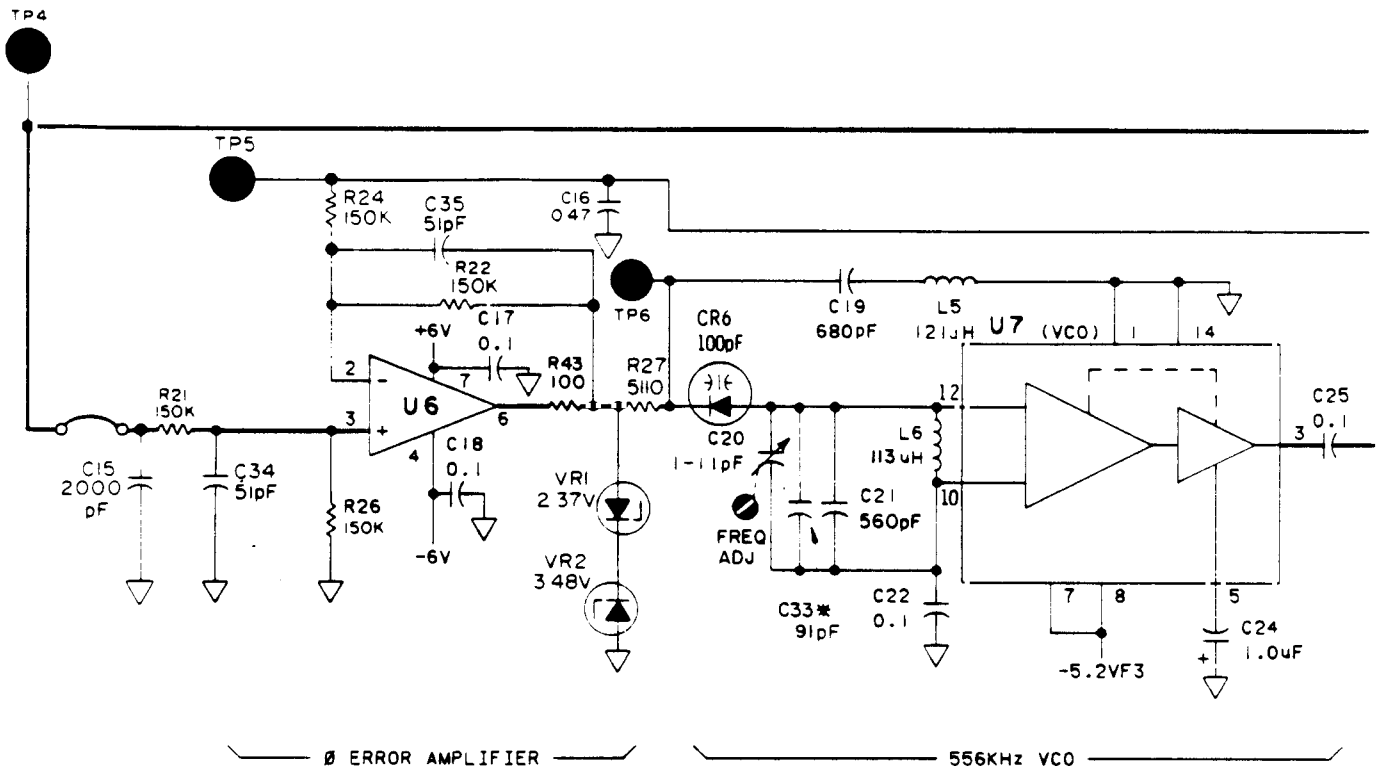
Page 6-6, Table 6-2:
Change A2 to HP Part Number 08412-60066, CD4.
Change A2C33* to HP Part Number 0160-2203, CD9, CAPACITOR-FXD 91PF±5% 300VDC MICA 0+70.
Change A2L6 to HP Part Number 9140-0317, CD9, INDUCTOR RF-CH-MLD 113UH 1% .166 DX .385LG.

Page 6-7, Table 6-2:
Add A2R43, HP Part Number 0757-0401, CD0, RESISTOR 100 1% .125W F TC 0±100.
Add A2W1, HP Part Number 8159-0005, CD0, JUMPER 1X22.

Page 8-9, Figure 8-12:
Replace the existing parts location diagram for A2 with the one in this change sheet (CHANGE 2).

CHANGE 2 (Cont'd)

Page 8-9. Figure 8-13:
Change Phase Error Amplifier as shown in the following partial schematic.



P/O Figure 8-13 (Change 2)

CHANGE 3

Page 6-17. Figure 6-1:
Change item 9 to HP Part Number 08412-00042. CD0.
Add item 9A. HP Part Number 08412-00044: CD2; SUPPORT. BOTTOM CROSS.
Change item 10 to two entries as follows:
10: HP Part Number 08412-00040: CD8; FRAME. UPPER RIGHT.
10A: HP Part Number 08412-00041; CD9; FRAME. LOWER RIGHT.
Change item 11 to HP Part Number 08412-20068. CD2.
Add item 11A: HP Part Number 08412-00045; CD3; BRACKET. ANGLE.
Add Item 19A: HP Part Number 08412-00043; CD1; BRACKET. REAR SHIELD MOUNTING.

CHANGE 4

Page 6-17. Figure 6-1:
Delete Item 11A. HP Part Number 08412-00045. (It was added in Change 3).

CHANGE 5

Page 6-6, Table 6-2:

▶ Change A2C20 to HP Part Number 0121-0061 CD1, CAPACITOR-V TRMR-CER 5.5− 18PF 350V.

Page 6-13, Table 6-2:

Change A10 to HP Part Number 08412-600069, CD7.

Add A10C18 having HP Part Number 0160-4300 CD1, CAPACITOR-FXD .047UF +80 −20% 100 VDC CER.

▶ Change A10Q3 TO HP Part Number 1854-0404.

Page 6-14, Table 6-2:

Change A10R43 to HP Part Number 0757-0442, CD9, RESISTOR 10K 1% .125W F TC=0±100.

Change A10R45 to HP Part Number 0757-0439, CD4, RESISTOR 6.81K 1% .125W F TC=0±100.

Change A10R46 to HP Part Number 0698-3150, CD6, RESISTOR 2.37K 1% .125W F TC=0±100.

Add A10R48 having HP Part Number 0698-3449, CD6, RESISTOR 28.7K 1% .125W F TC=0±100.

Page 6-17/6-18, Figure 6-1:

Add the following parts to the list:

08412-00046, CD4, SHIELD − PHASE OFFSET DET. BOARD ASSY. (NOT SHOWN).

08412-00047, CD5, SHIELD − PHASE OFFSET BOARD ASSY. (NOT SHOWN).

08412-00048, CD6, SHIELD − TEST CHANNEL BOARD ASSY. (NOT SHOWN).

Page 8-17, Figure 8-22:

Replace the existing Component Location Diagram with the one supplied in this Change Sheet.

Page 8-17, Figure 8-23:

Insert the Partial Amplitude Synchronous Detector A10 Schematic Diagram, supplied in this Change Sheet, onto the existing schematic.

Insert the following Reference Designations Table in place of the existing table located at the far lower right-hand side of the schematic:

REFERENCE DESIGNATIONS

A10
C1-18 T1 CR1 IC1 Q1-13 R1-48
CHASSIS
R4

CHANGE 6

Page 6-12, Table 6-2:
Change A9 to HP Part Number 08412-60017 CD1.
Change A9C5, C12, C13, C16, C17, C19, C20, C22, C24, C25 to HP Part Number 0160-4535, CD4, CAPACITOR-FXD 1μf ±10% 50 VDC CER.

Page 8-21, Figure 8-27:
Change the A9 HP Part Number to 08412-60071 located at the top of the A9 Schematic.

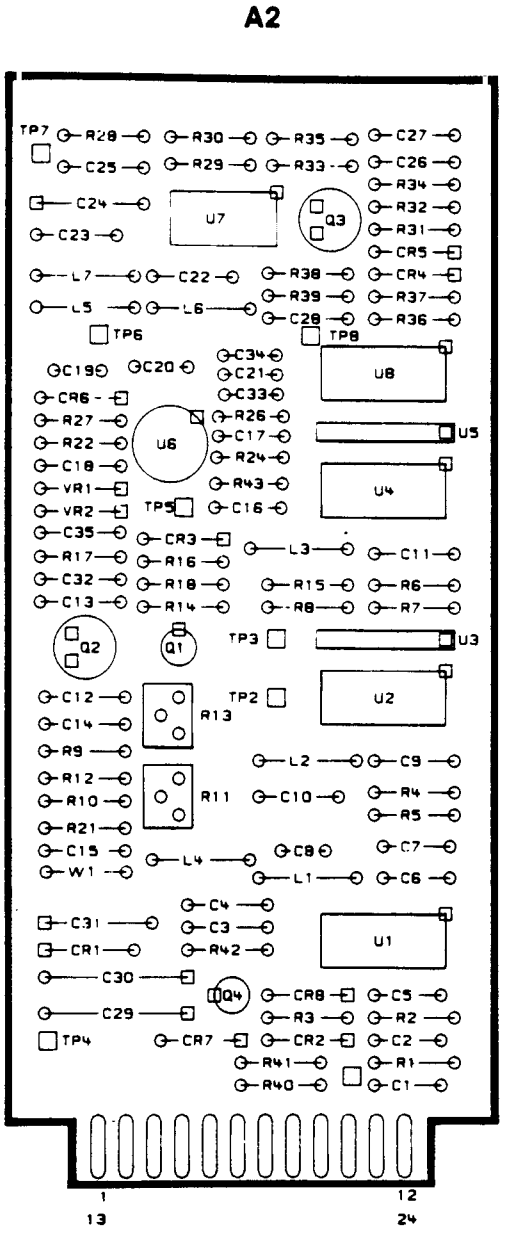


Figure 8-2. Component Location for Phase Offset A2 (Change 2)

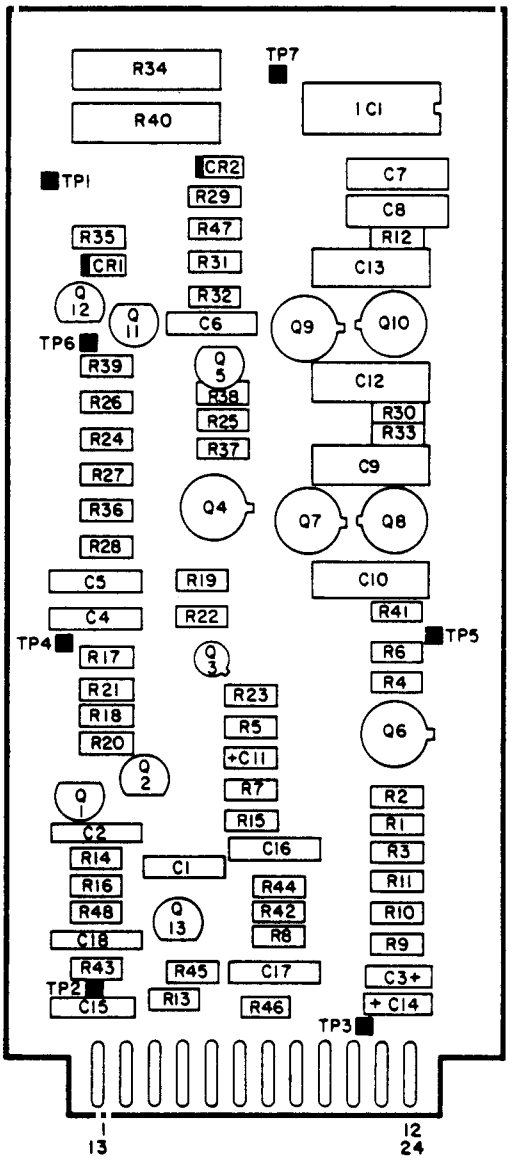
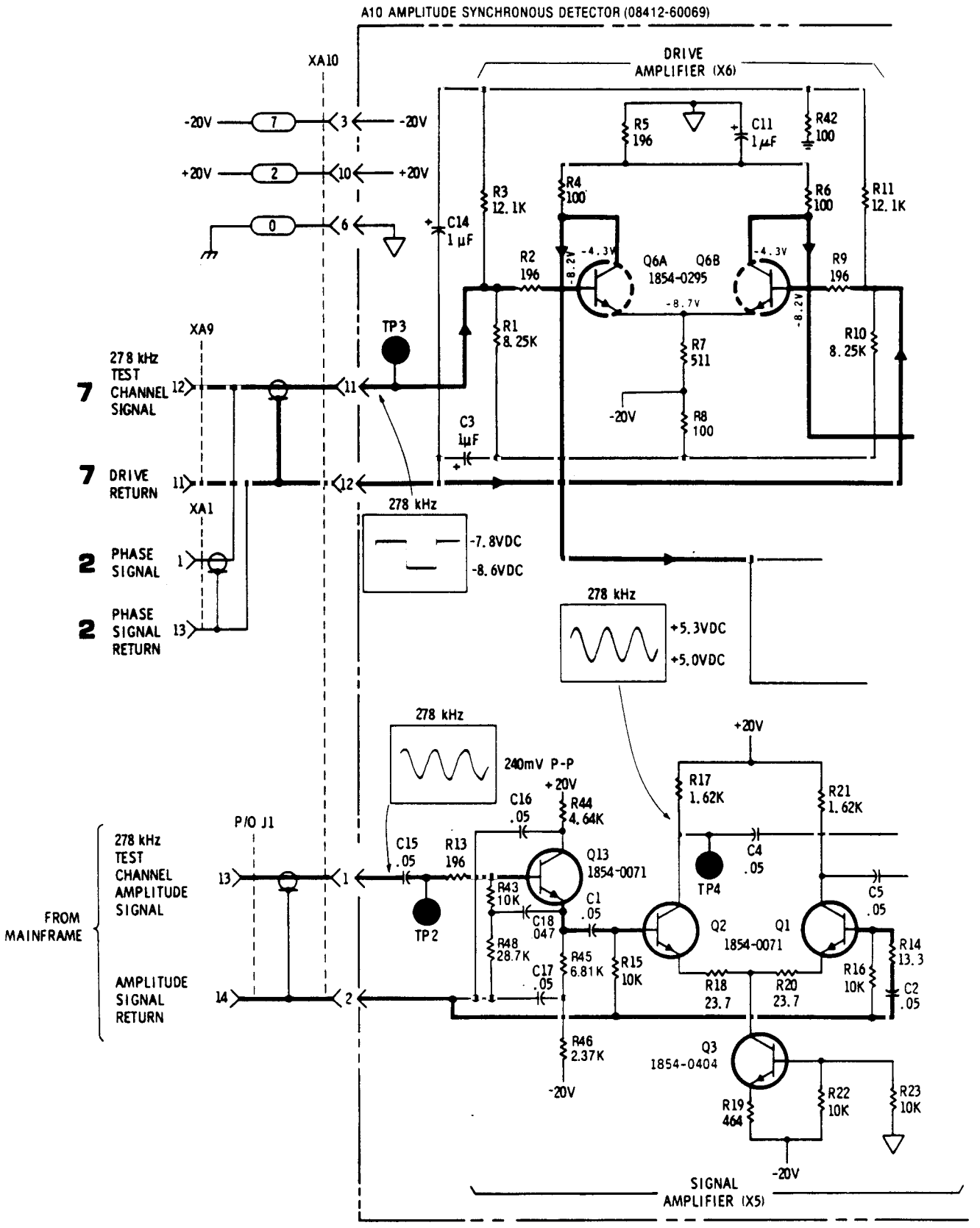


Figure 8-22. Component Location for Amplitude Synchronous Detector A10 (CHANGE 5)



P/O Figure 8-23. Amplitude Synchronous Detector A10, Schematic Diagram (CHANGE 5)

HP Part No. 08412-90033

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