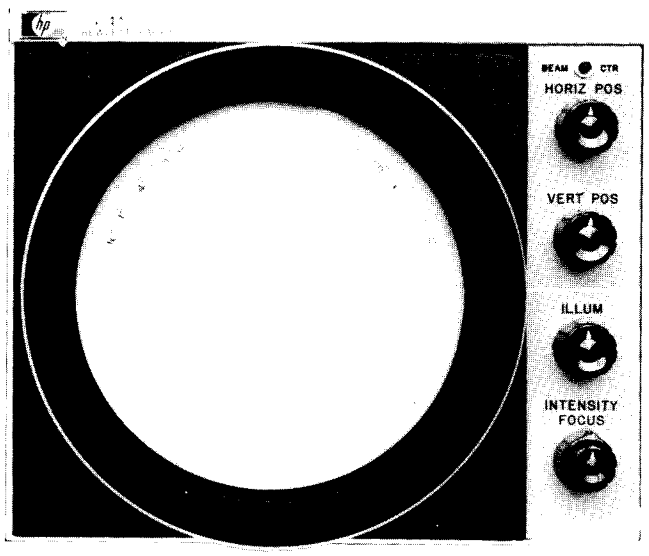
OPERATING AND SERVICE MANUAL

POLAR DISPLAY
8414A



HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

8414A
POLAR DISPLAY

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 981 and 1144A.

With changes described in Section VII, this manual also applies to instruments with serial numbers prefixed 936 and 940.

For additional important information concerning serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

This manual does not apply to serial numbers prefixed 933 and below.

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HEWLETT PACKARD

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Figure 1-1. Model 8414A Polar Display

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 8414A Polar Display (Figure 1-1) is a plug-in display unit for Hewlett-Packard Model 8410A and Model 8407A Network Analyzers. It displays, in polar form on a five-inch CRT, the relative phase and magnitude of the signals applied to the Network Analyzer.

1-3. The CRT's internal graticule has five circular magnitude divisions and 36 radial ten-degree phase divisions. Full scale magnitude calibration is determined by controls on the Network Analyzer. The internal graticule, augmented by a set of snap-on overlays, allows the display to be read directly in reflection coefficient, impedance or return loss for maximum convenience in viewing and photographing displays. An additional convenience for photographing displays is provided by panel-controlled, internal graticule illumination eliminating the need for an ultraviolet light source in the camera. A beam centering pushbutton, in conjunction with continuous action positioning controls, permits easy initial calibration and accuracy-improving offset adjustments. Rear-panel blanking and marker inputs accept externally-generated signals for between sweep display blanking and for frequency marking by beam brightening. The horizontal and vertical components of the polar display are available at separate rear-panel outputs for driving external displays such as X-Y graphic recorders. The polar display is fully transistorized, except for the CRT, and is powered by the Network Analyzer mainframe. Complete specifications are given in Table 1-1.

Table 1-1. Specifications

Range: Normalized polar coordinate display; magnitude calibration 20 percent of full scale per division. Scale factor is a function of gain setting on Network Analyzer. Maximum scale factor 10, minimum 0.0316. Phase is calibrated in ten-degree increments over 360-degree range.

Accuracy: Error circle on CRT less than 3 mm radius.

Output: Two dc outputs provide horizontal and vertical components of polar quantity. For full scale deflection output is nominally ±2.5 volts, source impedance less than 100 ohms, minimum bandwidth (3 dB) 10 kHz.

Drift: CRT, $<\pm 0.2$ mm/°C; auxiliary outputs, $<\pm 10$ mV/°C.

Beam Center: Pressing BEAM CTR pushbutton simulates zero signal input to test channel and allows convenient beam position adjustment for reference.

CRT: Five-inch, 5-kV post accelerator tube with P-2 phosphor and internal polar graticule.

Marker Input (rear panel): Accepts frequency marker output pulse from HP 8690-series or 690-series Sweep Oscillators, -5 volts peak. Trace is brightened for duration of marker pulse.

Blanking Input (rear panel): Accepts -4 volt blanking pulse from HP 8690-series and 690-series Sweep Oscillators to blank retrace during sweep operation.

Background Illumination: Controls intensity of CRT background illumination for photography. Eliminates need for ultraviolet light source in oscilloscope camera when photographing internal graticule.

Power: Additional 35 watts supplied by Network Analyzer.

Weight: Net, 11 lb (4,9 kg).

Dimensions: 6 in. high, 15-9/16 in. deep, 7-9/32 in. wide (15,2 x 39, 5 x 18, 6 cm), excluding front panel knobs.

1-4. EQUIPMENT SUPPLIED.

1-5. The Polar Display has 16 chart overlays provided as accessories, 12 Smith Chart and four return loss overlays. These overlays are plastic sheets that snap onto the face of the CRT. Three different Smith Chart scale factors are used and four different styles of each scale are supplied for different applications (refer to Figure 3-5).

1-6. INSTRUMENTS COVERED BY MANUAL

1-7. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix(es) as listed under SERIAL NUMBERS on the title page.

1-8. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Changes supplement that contains "change information" that documents the differences.

1-9. For information concerning a serial number prefix not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-10. OPTION

1-11. The Option H26 modification to the standard 8414A Polar Display allows computerized control of magnitude and phase data in the 8542A series Automatic Network Analyzer systems. See Figure 3-12 for further information.

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).

ϟ 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 or adhered to, 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.

SAFETY EARTH GROUND

This is a Safety Class I product (provided with a protective earthing terminal). An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER

Verify that the product is configured to match the available main power source per the input power configuration instructions provided in this manual.

If this product is to be energized via an autotransformer make sure the common terminal is connected to the neutral (grounded side of mains supply).

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.

Capacitors inside this product may still be charged even when disconnected from its power source.

To avoid a fire hazard, only fuses with the required current rating and of the specified type (normal blow, time delay, etc.) are to be used for replacement.

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. Inspect the instrument for shipping damage as soon as it is unpacked. Check for broken knobs and connectors; inspect cabinet and panel surfaces for dents and scratches. Check electrical performance using procedures in Section IV. If the instrument is damaged in any way, or fails to operate properly, notify the carrier and your nearest Hewlett-Packard Sales and Service Office. In the event of mechanical damage, the packing material and carton should be held for carrier's inspection. For assistance of any kind, including instruments under warranty, contact the nearest Hewlett-Packard Sales Office.

2-3. REPACKAGING FOR SHIPMENT.

2-4. Using Original Packaging.

2-5. The same type containers and materials used in factory packaging can be obtained through any Hewlett-Packard office.

2-6. If the Model 8414A 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.

2-7. In any correspondence refer to the instrument by model number and full serial number.

2-8. Using Other Packaging.

2-9. The following general instructions should be used when repackaging with commercially-available materials:

a. Wrap the 8414A in heavy paper or plastic. (If shipping to a Hewlett-Packard serivce office or center, attach a tag indicating the type of service required, the return address, model number and full serial number.)

b. Use a strong shipping container. A double-wall carton made of 350 pound test material is adequate.

c. Use enough shock-absorbing material (three to four inch layer) around all sides of the instrument to provide firm cushion 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.

2-10. PREPARATION FOR USE.

2-11. Installation.

2-12. Instructions for installing the Polar Display in the Network Analyzer mainframe are in the Network Analyzer Operating and Service manual.

2-13. Power Requirements.

2-14. The Polar Display obtains power from the Network Analyzer mainframe through the rear connector, when it is properly installed.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. Signals from the Network Analyzer containing phase and amplitude information are fed to the 8414A through a rear-panel connector. These signals are resolved into vertical and horizontal deflection signals and applied to the CRT, where they are displayed in polar form. Signals from the horizontal and vertical amplifiers are available at rear-panel output connectors for use with an external X-Y recorder or oscilloscope. Controls on the front panel provide centering, focus and intensity adjustments for the CRT display.

CAUTION

MECHANICAL SHOCK. Do not bump or jar the Polar Display as misalignment of the CRT gun may result.

MAGNETIC FIELDS. Do not place the Polar Display near a sweep generator containing a BWO which has an unshielded magnet or the CRT will be permanently magnetized, causing poor focus. Separate the 8414A from any magnetic source by at least two feet.

3-3. PANEL FEATURES.

3-4. Front and rear panel controls, connectors and indicators are described in Figure 3-1. In this figure the numbers on the illustrations match the description numbers.

3-5. MEASUREMENT PROCEDURES.

3-6. General measurement procedures are given in Figures 3-9 and 3-10. Measurement procedures using a specific transducer are given in the Operating and Service Manual or Operating Note for the particular transducer.

3-7. OPERATING INFORMATION.

3-8. Polar Display of Reflection Coefficient and Phase Angle.

3-9. If the device under test has an impedance of 50 ohms at all frequencies in the range being swept, the display of its complex reflection coefficient is a dot at the center of the graticule. If the device does not have an impedance of 50 ohms at all frequencies the display of complex reflection coefficient is an irregular pattern which represents at each point:

a. A specific frequency.

b. A reflection coefficient magnitude, and

c. Phase angle — The angle between the incident voltage and reflected voltage at the plane of measurement.

The magnitude of the reflection coefficient of the device under test may be read on the concentric circles, using the scale reflection coefficient Γ = 0.2/division, with zero at the center and 1.0 at the outer circle. The phase angle may be read directly in degrees by drawing a radial line through the point on the display that represents the frequency of interest and reading the angle off the outside ring of the graticule.

3-10. High Resolution Display of Reflection Coefficient Measurements.

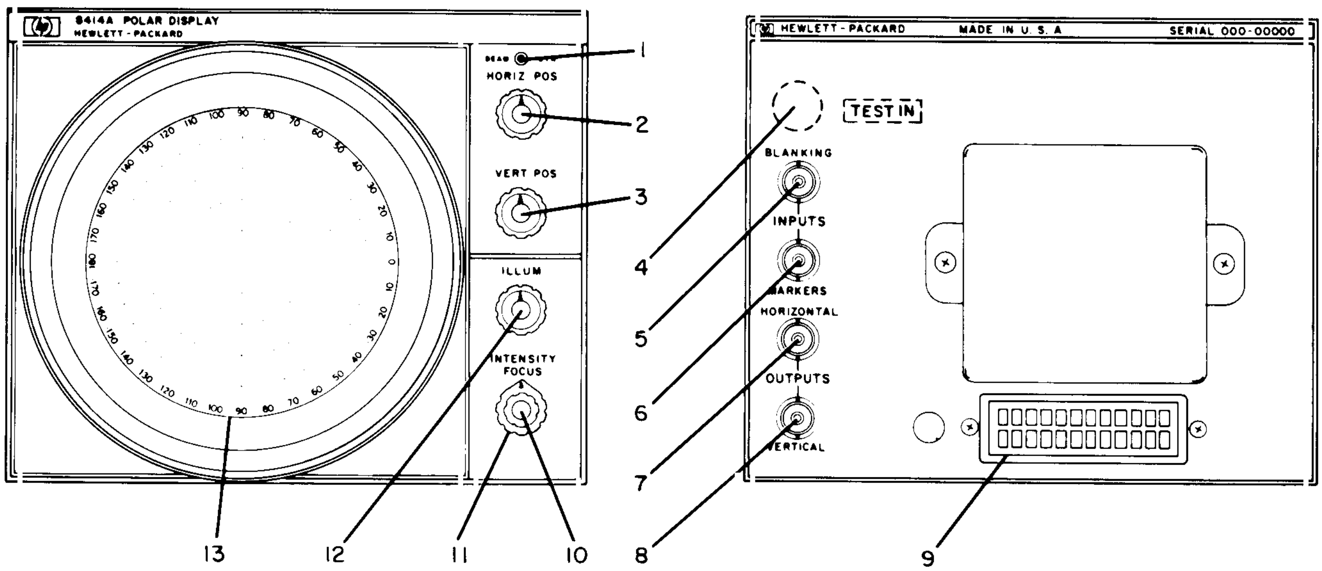
3-11. A device under test which is close to 50-ohms impedance produces a spot in the center of the CRT. This center section of the CRT may be expanded to give high resolution so that slight mismatch may be observed. To obtain higher resolution, add additional gain to the test channel by setting the Network Analyzer test channel gain[1] controls to a higher value. For instance, adding 14 dB gives full scale calibration of 0.2 and adding 20 dB gives full scale calibration of 0.1. Since initially the system was calibrated for a reflection coefficient of 1.0, determine the *change* in test channel gain[1] required to expand the full scale calibration to a desired reflection coefficient by:

$$-20 \log_{10} |\Gamma|$$

(which is equivalent to the Return Loss of the desired full scale reflection coefficient calibration).

[1]Display reference for 8407A.

FRONT AND REAR PANEL FEATURES



1. BEAM CTR. Simulates zero test channel signal so that beam can be moved to a reference position.
2. HORIZ POS. Moves trace horizontally.
3. VERT POS. Moves trace vertically.
4. TEST IN. Included on H26-8414A. Test channel amplitude signal input. Connect to Network Analyzer mainframe TEST CHAN OUT with coaxial cable such as HP 11086A (refer to paragraph 3-37).
5. BLANKING. Input for between-sweep blanking pulse from HP 8690 and 690 series Sweep Oscillators. -4 to -10 volts blanks the CRT display. Input impedance: >20k ohms.
6. MARKERS. Input for frequency marker pulses from HP 8690 and 690 series Sweep Oscillators. -4 to -10 volts intensifies CRT display. Input impedance: >20k ohms.
7. HORIZONTAL. For driving X-Y graphic recorders. Direct-coupled signal proportional to the horizontal deflection signal, ±2.5V, 100 ohms source impedance, 10 kHz bandwidth. Output is not affected by the HORIZ POS control.
8. VERTICAL. For driving X-Y graphic recorders. Direct-coupled signal proportional to the vertical deflection signal, ±2.5V, 100 ohms source impedance, 10 kHz bandwidth. Output is not affected by the VERT POS control.
9. Connector. Makes all necessary connections with the Network Analyzer mainframe.
10. FOCUS. Controls sharpness of trace.
11. INTENSITY. Controls brightness of trace.
12. ILLUM. For photography. Brightens screen for contrast with the graticule. Eliminates the need for an ultraviolet light in the oscilloscope camera.
13. Graticule. Radial lines divide phase scale into ten degree parts. Circles divide amplitude scale into five linear parts. Graticule center is amplitude zero. Amplitude scale calibration depends upon setting of the Network Analyzer controls.

Figure 3-1. Model 8414A Front and Rear Panel Features

3-12. Polar Display of Return Loss.

3-13. With the Network Analyzer test channel gain[1] set to the calibration value, giving an indication of Γ = 1.0 full scale, a Return Loss overlay, such as the one shown in Figure 3-2 may be used on the CRT to convert reflection coefficient magnitude to return loss. The Return Loss overlay has concentric circles calibrated in dB, with zero at the outer circle, 1-dB increments to 10 dB, and an inner circle representing 20 dB. For return loss measurements of greater than 10 dB, resolution can be improved by changing the full scale calibration. To obtain higher resolution, add additional gain to the test channel by setting the Network Analyzer test channel gain[1] controls to a higher value. The outer or 0 dB circle will then equal the *change* in test channel gain[1]. The total return loss is the sum of the change in test channel gain[1] plus the value indicated on the return loss overlay. For example, if the initial display indicated a return loss greater than 10 dB and a 12 dB increase in Network Analyzer test channel gain[1] moved the display indication to mid-point between the 0 and 1 dB graticule circles, the total return loss would be 12 dB plus 0.5 dB or 12.5 dB.

3-14. Four return-loss overlays are furnished with the Polar Display, two for viewing and two with parallax correction for photographing. There is a clear overlay and an opaque overlay for viewing, a clear and an opaque overlay for photographing. The opaque overlays mask the internal graticule so only the overlay lines are visible.

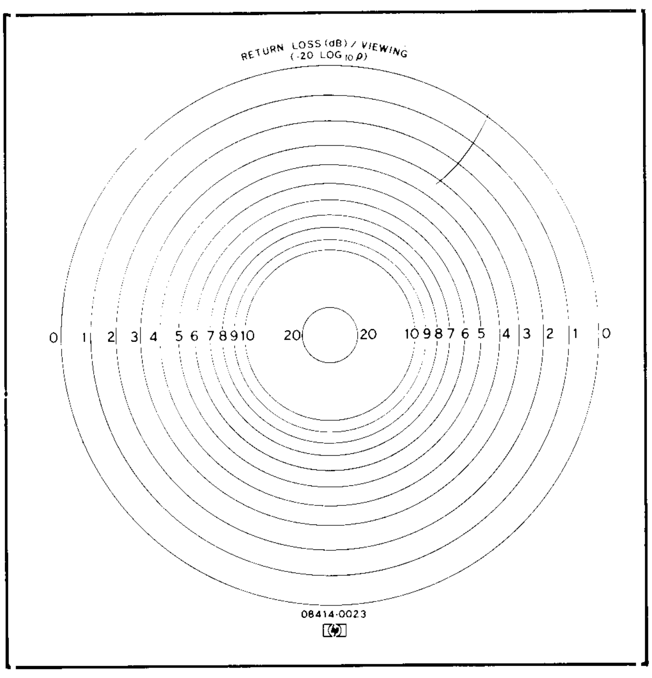


Figure 3-2. Return Loss Overlay

3-15. Polar Display of Transmission Measurements.

3-16. A polar display of transmission measurements in dB or in transmission coefficient (τ) and phase angle can be obtained using the test setup and procedures in Figure 3-10. During calibration the display's outer ring is calibrated for a gain of one (0 dB) or τ = 1. Phase angle for all transmission measurements may be read directly in degrees by drawing a radial line through the point on the display that represents the frequency of interest and reading the angle off the outside ring of the graticule.

3-17. Transmission Measurements of Attenuation or Gain in Transmission Coefficient (τ). If the unit under test is a passive device, producing attenuation of the test signal, the transmission coefficient magnitude can be determined in the same manner as reflection coefficient; i.e., the magnitude of the transmission coefficient may be read on the concentric circles, using the scale τ = 0.2/division, with zero at the center and 1.0 at the outer circle. For high attenuation measurements, resolution can be improved by changing the full scale calibration. To obtain higher resolution, add additional gain to the test channel by setting the Network Analyzer test channel gain[1] controls to a higher value. For instance, adding 14 dB gives full scale calibration of 0.2 and adding 20 dB gives full scale calibration of 0.1. If the device under test is an active device, producing gain of the test signal, the full scale calibration must be increased by setting the Network Analyzer test channel gain[1] controls to a lower value. For instance, removing 6 dB gives full scale calibration of two, removing 14 dB gives full scale calibration of five, and removing 20 dB gives full scale calibration of ten.

3-18. Transmission Measurements of Attenuation or Gain in dB. During calibration the display's outer ring is calibrated for 0 dB. The attenuation or gain of the device under test may be determined by noting the Network Analyzer's test channel gain[1] setting and changing the test channel gain[1] to return the display to the outer circle. The difference in test channel gain[1] settings is the magnitude of the attenuation or gain.

[1]Display reference for 8407A

3-19. Another way to determine attenuation or gain is to install a Return Loss overlay on the CRT. The Return Loss overlay has concentric circles in 1-dB increments to 10 dB. For attenuation of 10 dB or less, attenuation can be read directly from the overlay. For attenuation of greater than 10 dB, or for gain measurements, use a combination of change in Network Analyzer test channel gain and the Return Loss overlay. For example, if the initial display indicated an attenuation greater than 10 dB and a 12 dB increase in Network Analyzer test channel gain[1] moved the display indication to mid-point between the 0 and 1 dB graticule circles, the total attenuation would be 12 dB plus 0.5 dB or 12.5 dB.

3-20. Scattering Parameters Measurement.

3-21. Measurement of scattering or s-parameters is possible using the Polar Display. With two swept tests for transmission and two for reflection, a complete set of s-parameters for any two-port device may be derived. The four parameters that must be obtained are:

a. S_{11}, input reflection coefficient with the output port terminated by a matched load.

b. S_{22}, output reflection coefficient with the input terminated by a matched load.

c. S_{21}, forward transmission coefficient with the output port terminated in a matched load.

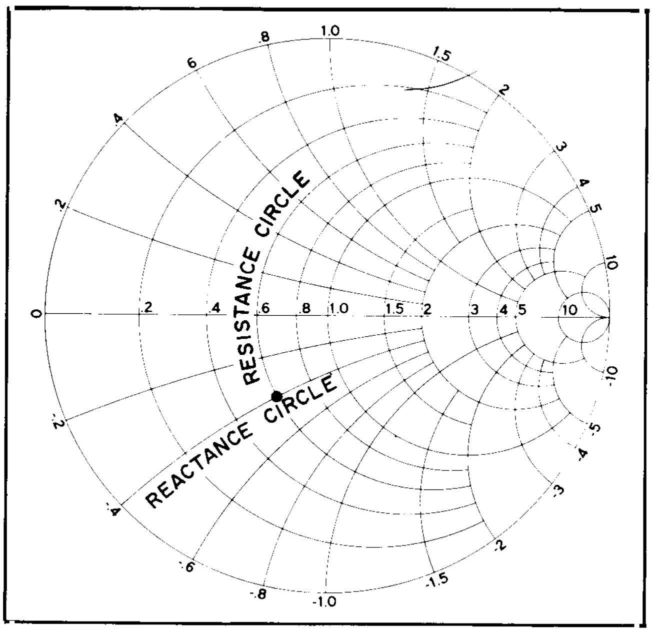


Figure 3-3. Typical Smith Chart Display of Normalized Impedance

d. S_{12}, reverse transmission coefficient with the input port terminated in a matched load.

The input reflection coefficient (S_{11}) and the output reflection coefficient (S_{22}) may be obtained using the procedure and setup in Figure 3-9. The transmission coefficients (S_{21} and S_{12}) may be obtained using the procedure outlined in Figure 3-10. Paragraph 3-17 describes how to read attenuation or gain in transmission coefficient.

3-22. Polar Display of Normalized Impedance and Admittance.

3-23. With the Network Analyzer test channel gain[1] set to the calibrated value, giving an indication of Γ = 1.0 full scale, a Smith Chart overlay may be used on the CRT to convert the reflection coefficient and phase angle directly to impedance or admittance. The standard Smith Chart overlay contains a horizontal line through the center representing the resistance component of the load impedance. The center of the resistance line is 1.0 corresponding to the normalized 50-ohm point. Circles passing through the horizontal resistance line are constant resistance lines. Numbers along the outer circle of the Smith Chart represent the reactive component of the impedance. Inductive reactance is read in the upper half of the graph and capacitive reactance is read in the lower half of the graph. Lines of constant reactance originate from a point at the center right edge of the graph and extend to points along the outer circle. Figure 3-3 shows a spot on the graph representing a normalized impedance Z_n = 0.6 -j0.4. The real part (0.6) is found by following the resistance circle up to the horizontal line through the center of the Smith Chart overlay. The real part is read from the resistance scale where the resistance circle crosses the horizontal line. The imaginary part (-j0.4) is found by following the reactance circle to the outer edge of the Smith Chart overlay. To determine the actual impedance multiply each part of the normalized impedance by Z_o (50 ohms). In this case the actual impedance is (50 x 0.6) -j (50 x 0.4) or 30 -j20 ohms. To obtain the corresponding admittance value for a given impedance value, draw an admittance circle as shown in Figure 3-4, using the 1.0 point on the resistance line for the center, and the impedance point as the circle radius. Draw a diameter line from the impedance point, through the 1.0 resistance point (center) to the opposite side of the admittance circle. The admittance point is where the diameter line intersects the admittance circle opposite the impedance point. The normal-

[1]Display reference for 8407A

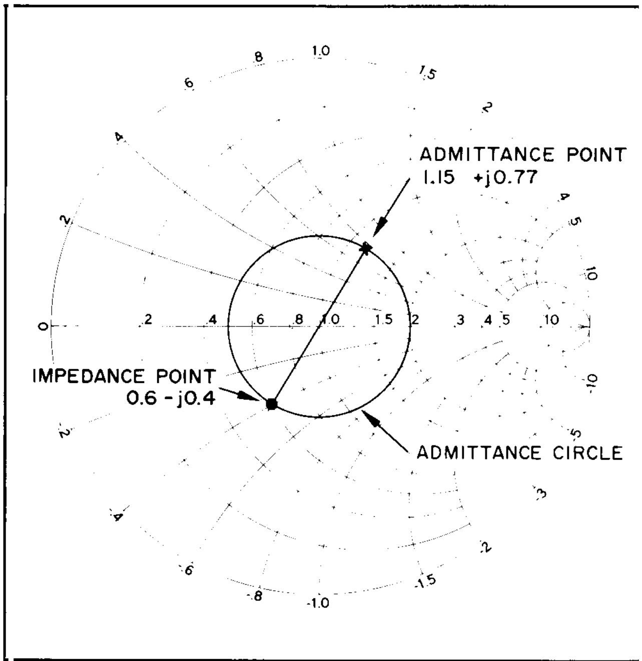


Figure 3-4. Smith Chart Plot of Admittance Point

ized admittance may be read directly from the graph. In Figure 3-4 the normalized admittance value is 1.15 + j0.77.

3-24. Alternate Smith Chart Overlays.

3-25. Twelve different Smith Chart overlay graphs are furnished with the Polar Display. There are three graph styles in the Smith Chart overlays; a standard graph, an expanded graph and a compressed graph (refer to Figure 3-5). There are four overlays for each of the graph styles, two for viewing and two with parallax correction for photographing. There is a clear overlay and an opaque overlay for viewing, a clear and an opaque overlay for photographing. The opaque overlays mask the internal graticule so only the overlay lines are visible.

3-26. Standard Smith Chart Overlay. When a standard Smith Chart overlay is installed on the face of the CRT, the standard calibration of the Polar Display provides the correct scaling factor for the Smith Chart. Scaling factors for the expanded and compressed chart overlays are computed from the standard calibration of the Polar Display. Adjustment of the test channel gain for the expanded and compressed graphs is explained in the following paragraphs.

3-27. Expanded Smith Chart Overlay. The expanded Smith Chart enlarges the center of the standard Smith Chart to full scale so that the region close to 50 ohms can be analyzed in detail. When the expanded Smith Chart is installed on the CRT, the gain of the Network Analyzer test channel amplifier must be increased by 14 dB to match the scale of the overlay. This is accomplished by first noting the calibration setting of the test channel gain[1] controls on the Network Analyzer for the standard Smith Chart. This calibration value is added to 14 dB and the total value is set at the test channel gain[1] controls.

3-28. Compressed Smith Chart Overlay. The compressed Smith Chart overlay provides a display in the negative-real impedance region. When the compressed Smith Chart overlay is installed on the CRT, the gain of the Network Analyzer test-channel amplifier must be decreased by 10 dB to match the scale of the overlay. This is accomplished by first noting the calibration setting of the test channel gain[1] controls on the Network Analyzer for the standard Smith Chart. Ten dB is then subtracted from this calibration value and the resultant number is set at the test channel gain controls[1].

3-29. Marking Frequency on the Display.

3-30. A rear-panel marker INPUT connector accepts dc frequency-marker pulses from the Sweep Oscillator. Markers appear on the trace as bright spots. This allows measurements to be made at specific frequencies on a broadband display.

3-31. Display Blanking.

3-32. Blanking pulses from HP 690 and 8690 series Sweep Oscillators may be applied to a rear-panel blanking input connector blanking the CRT during sweeper retrace. A blanking signal is also obtained from the 8410A Network Analyzer mainframe. The 8410A Network Analyzer automatically produces a blanking signal whenever it is not tuned to its input signals. This blanking signal is fed internally to the 8414A. The 8407A mainframe does not produce this second form of blanking.

3-33. Increased Accuracy for Reflection Measurements by Minimizing Directivity Errors.

3-34. Directivity errors become significant in the measurement of small reflection coefficients, but the error can be calibrated out at single frequen-

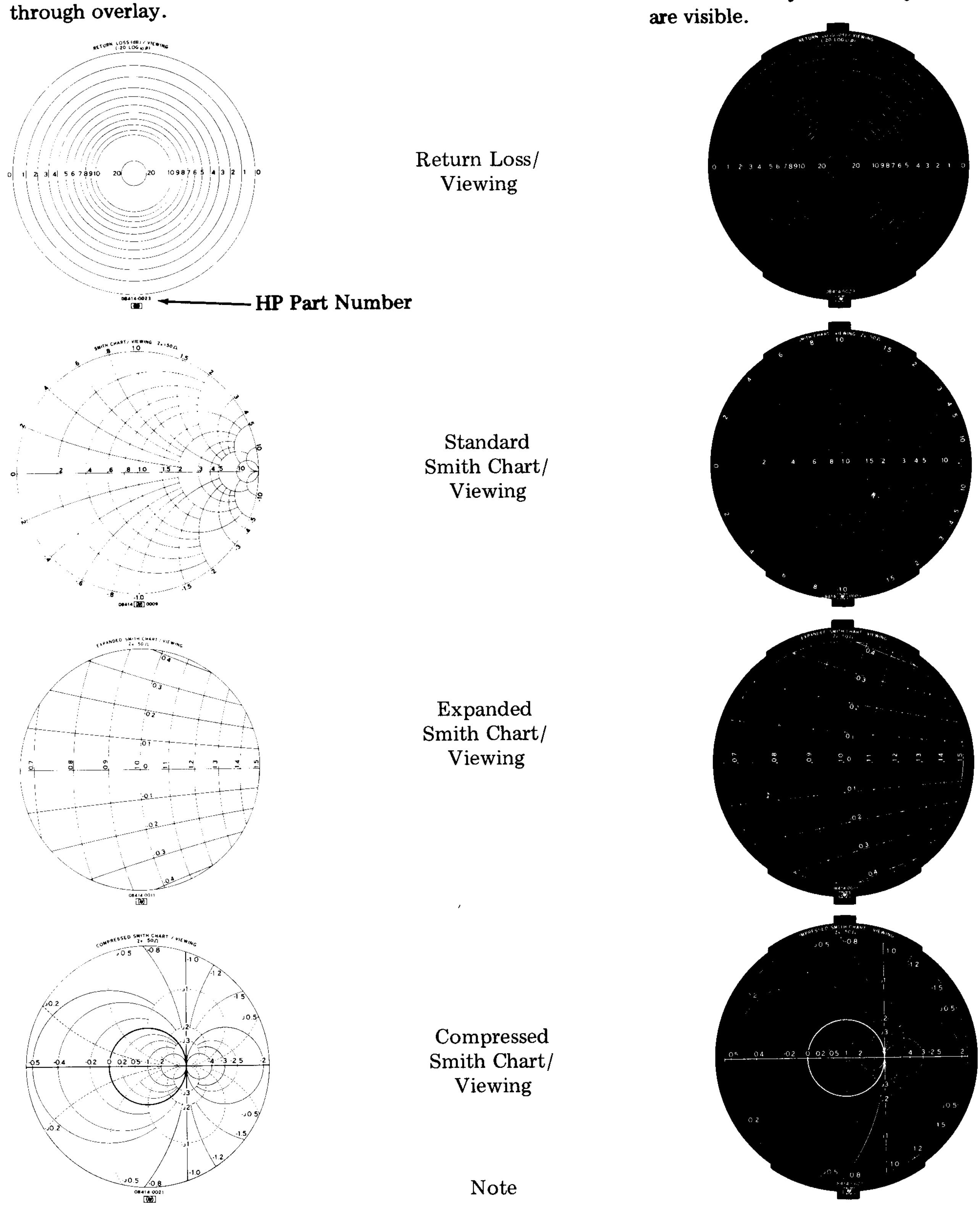
[1]Display reference for 8407A

CLEAR OVERLAYS

Internal graticule lines will show through overlay.

OPAQUE OVERLAYS

Internal graticule lines are masked so only the overlay lines are visible.



Note

There is a photographic overlay similar to each overlay above. The photographic overlays correct for parallax.

Figure 3-5. CRT Overlays

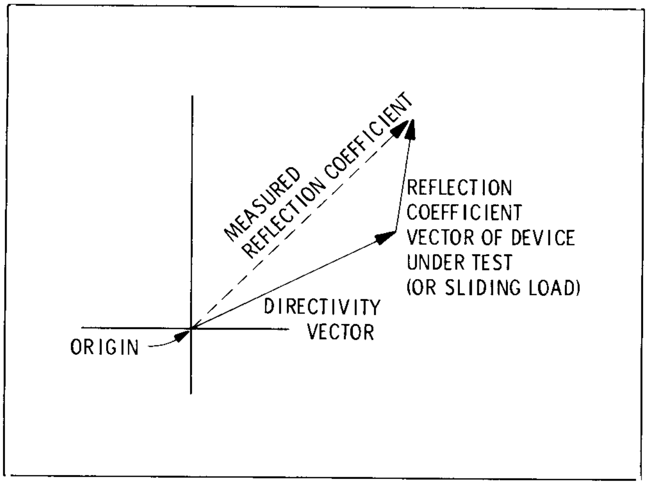


Figure 3-6. Measured Reflection Coefficient

cies. The measured reflection is the vector sum of the directivity vector plus the reflection coefficient of the device under test, or a sliding load (see Figure 3-6). The error can be calibrated out with a sliding load. Figure 3-7 depicts the sliding load in one position at a single frequency. As the sliding load is moved, the magnitude of its reflection coefficient remains constant but the phase of the coefficient changes. As the load is moved its reflection coefficient indication rotates in a circle of constant magnitude about the directivity vector. The center of this circle is the tip of the directivity vector. When the magnitude of the directivity vector is zero, the locus circle is centered about the origin as shown in Figure 3-8. When the location of the center of the circle is known, the directivity vector can be subtracted from the measured reflection. The resultant is the reflection coefficient of the device under test.

3-35. The vector subtraction can be performed directly with the horizontal and vertical controls on the 8414A Polar Display. Increase the Network Analyzer test channel gain[1] so full scale reflection on the polar display is suitable for the component you wish to measure. Attach a sliding load such as the HP 905A in place of the device under test. Slide the load and adjust the horizontal and vertical controls until the circle rotates about the center of the CRT. The effect of directivity is now cancelled for this frequency and this test channel gain[1] on the Network Analyzer. Remove the sliding load and connect the device under test. The 8414A display is now the reflection coefficient of the device under test.

3-36. H26-8414A POLAR DISPLAY.

3-37. The H26 modification to the standard 8414A Polar Display controls the display of magnitude and phase data in the Hewlett-Packard 8542 series Automatic Network Analyzer systems. The H26-8414A contains circuits to achieve compatibility with the automatic system. The H26-8414A is also compatible with the standard Network Analyzer except for the test channel amplitude signal. For the standard Network Analyzer and 8414A the test channel amplitude signal is fed to the 8414A through a 24-contact rear-panel connector. For the H26-8414A the test channel amplitude signal input is through a rear-panel BNC connector (TEST IN). To use the H26-8414A in a standard Network Analyzer mainframe connect the Network Analyzer rear-panel test output to the H26-8414A TEST IN. See Figure 3-12 on page 3-12.

[1]Display reference for 8407A

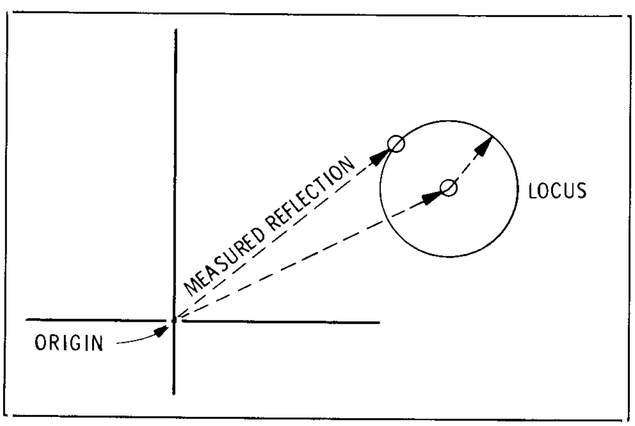


Figure 3-7. Locus of Measured Reflection when Load is Moved

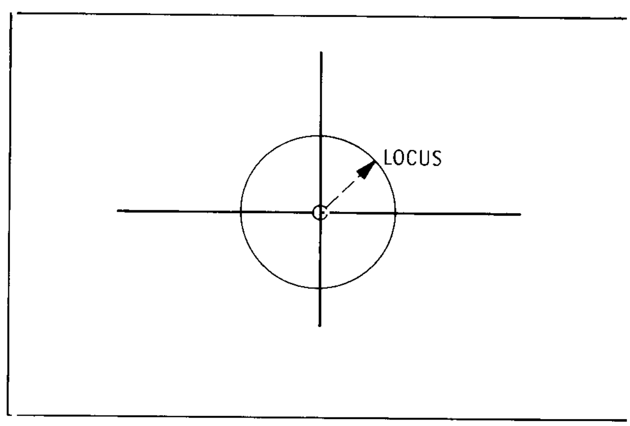


Figure 3-8. Locus of Measured Reflection with Directivity Cancelled

REFLECTION COEFFICIENT MEASUREMENT

CAUTION

MECHANICAL SHOCK. Do not bump or jar the Polar Display as misalignment of the CRT gun may result.

MAGNETIC FIELDS. Do not place the Polar Display near a sweep generator containing a BWO which has an unshielded magnet or the CRT will be permanently magnetized, causing poor focus. Separate the 8414A from any magnetic source by at least two feet.

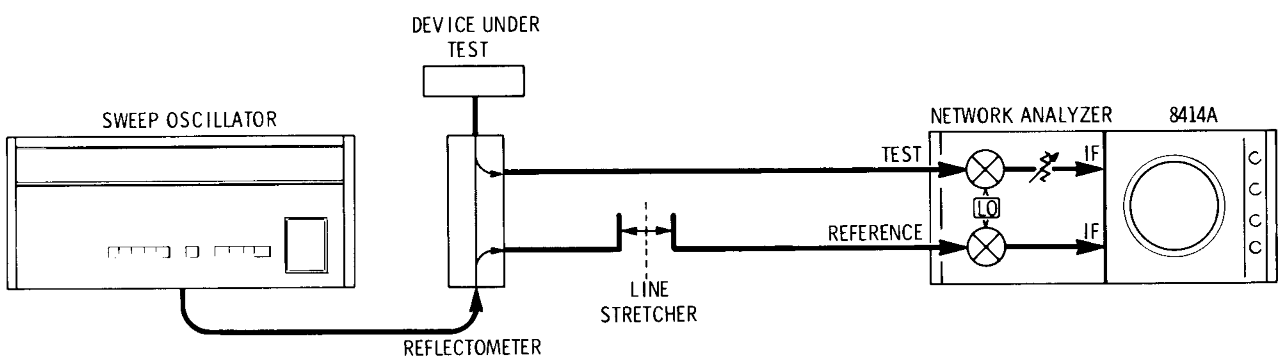


Figure 3-9. Reflection Coefficient Measurement (Sheet 1 of 2)

REFLECTION COEFFICIENT MEASUREMENT

CALIBRATION

1. Connect equipment as shown in setup.

2. Connect a coaxial short such as the HP 11565A to the reflectometer unknown port.

3. Phase lock the Network Analyzer over the desired frequency band.

4. Push and hold the 8414A BEAM CTR push-button and adjust HORIZ POS and VERT POS controls to place the dot in the center of the graticule. To bring the dot onto the display rotate each positioning control about five turns counterclockwise or until a slight increase in resistance to movement is encountered. Then turn each control about two and one-half turns clockwise.

NOTE

If an input signal does not deflect the CRT beam, S1, the TEST-NORMAL switch, may be in the TEST position. Refer to Figure 8-24 (last foldout) for location of S1 and set S1 to NORMAL.

5. Obtain equal reference and test channel electrical lengths by adjusting the Line Stretcher to collapse the trace to a dot or smallest cluster.

6. Adjust the Network Analyzer phase vernier, test channel gain[1] and amplitude vernier controls to place the dot or cluster for a reference indication of $\Gamma = 1 \angle 180^\circ$ (see Figure 3-11, Display B).

MEASUREMENT

1. Remove the coaxial short and connect the device under test to the reflectometer unknown port.

2. Read the reflection coefficient, magnitude and phase (or impedance using a Smith Chart overlay) from the display.

NOTE

For small reflection coefficients the 8414A resolution can be improved by increasing the Network Analyzer test channel gain[1]. For example, increasing the test channel gain[1] by 20 dB changes the full scale calibration from 1.0 to 0.1 at the outer circle (see paragraph 3-10). For increased accuracy by minimizing directivity errors, see paragraph 3-33.

[1]Display reference for 8407A.

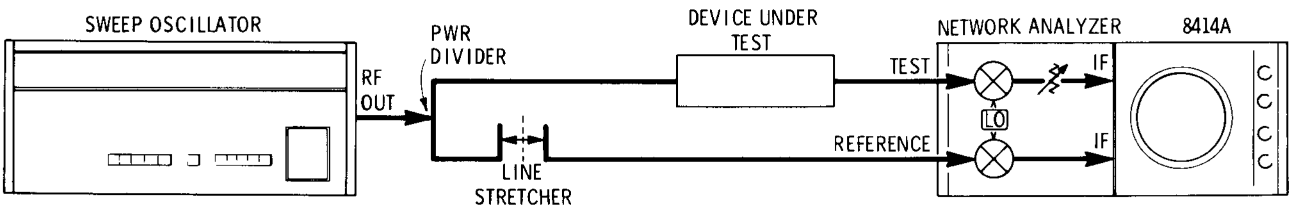
Figure 3-9. Reflection Coefficient Measurement (Sheet 2 of 2)

TRANSMISSION MEASUREMENT

CAUTION

MECHANICAL SHOCK. Do not bump or jar the Polar Display as misalignment of the CRT gun may result.

MAGNETIC FIELDS. Do not place the Polar Display near a sweep generator containing a BWO which has an unshielded magnet or the CRT will be permanently magnetized, causing poor focus. Separate the 8414A from any magnetic source by at least two feet.



CALIBRATION

1. Connect equipment as shown in setup without the device under test.
2. Phase lock the Network Analyzer over the desired frequency band.
3. Push and hold the 8414A BEAM CTR pushbutton and adjust HORIZ POS and VERT POS controls to place the dot in the center of the Polar Display. To bring the dot onto the display rotate each positioning control about five turns counterclockwise or until a slight increase in resistance to movement is encountered. Then turn each control about two and one-half turns clockwise.

NOTE

If an input signal does not deflect the CRT beam, S1, the TEST-NORMAL switch, may be in the TEST position. Refer to Figure 8-24 (last foldout) for location of S1 and set S1 to NORMAL.

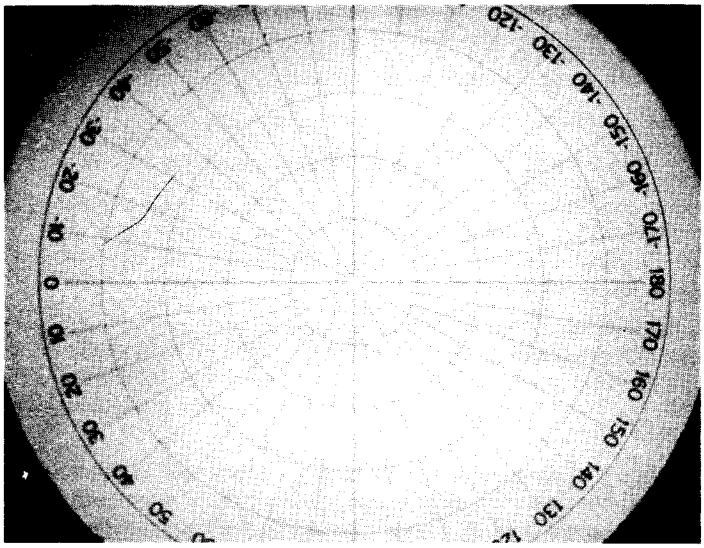
4. Obtain equal reference and test channel electrical lengths by adjusting the Line Stretcher to collapse the trace to a dot or smallest cluster.
5. Adjust the Network Analyzer phase vernier, test channel gain and amplitude vernier controls to place the dot or cluster for a reference indication of $\tau = 1 \angle 0^\circ$.

MEASUREMENT

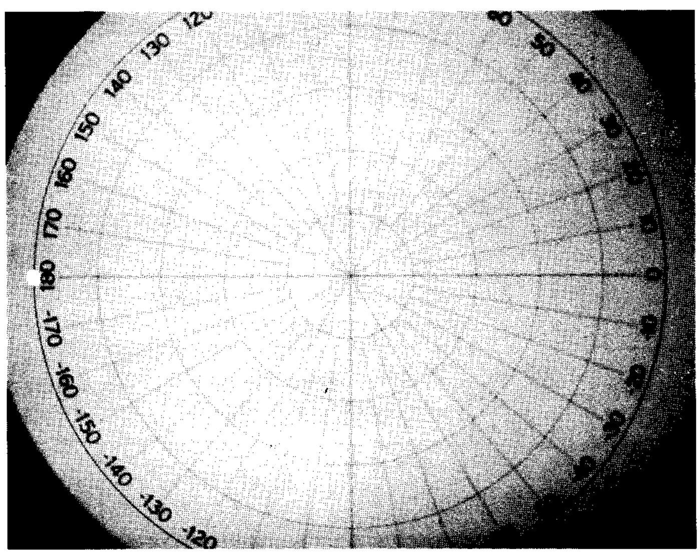
1. Insert the device under test.
2. Note the Network Analyzer test channel gain[1] setting. This is the calibrated gain setting. Adjust the test channel gain controls[1] to locate the CRT display on the outside ring. The difference in test channel gain[1] settings is the magnitude of the transmission gain or loss of the device under test.

[1]Display reference for 8407A.

Figure 3-10. Transmission Measurement



Display A. Polar Display with BEAM CTR Pushbutton Depressed, Showing Beam Correctly Centered with HORIZ POS and VERT POS Controls.



Display B. Swept Polar Display Correctly Calibrated for $\Gamma = 1.0 \angle +180^\circ$ (Reflectometer Shorted at UNKNOWN port).

Figure 3-11. Typical Polar Displays During Initial Calibration Adjustment

The H26 modification to the standard 8414A Polar Display allows computerized control of magnitude and phase data in the 8542A series Automatic Network Analyzer systems. The H26-8414A contains additional circuits as follows to achieve compatibility with the automatic system.

a. Automatic beam centering; programmable via 8419B

b. Manual offset adjusts for zeroing vertical/horizontal outputs

c. Corrected or real-time data display control; programmable via 8419B.

a. The automatic beam centering circuit permits the display spot to be centered on the screen by nulling the test channel signal under program control. A +5-volt control signal from the 8419B activates the auto beam circuit, producing the same result as depression of the manual beam center switch on the front panel. Refer to the block diagram .

b. The dc offset adjustments allow zeroing of the vertical and horizontal buffer amplifier outputs when in the beam centering mode. Manual adjustment of vertical and horizontal potentiometers reduces the output voltages at the rear panel BNC connectors to zero when a 0-volt test channel input or beam center signal is applied. The front panel vertical and horizontal position controls can then be used to center the beam spot as desired.

c. The corrected/real-time display circuit contains a relay switch actuated by a ground-level control signal from the 8419B. With the relay set in the manual position, vertical and horizontal data outputs are displayed on the screen in real time. With the relay set to the auto position, vertical and horizontal data outputs are routed through the 8419B to the computer and returned as corrected data for display.

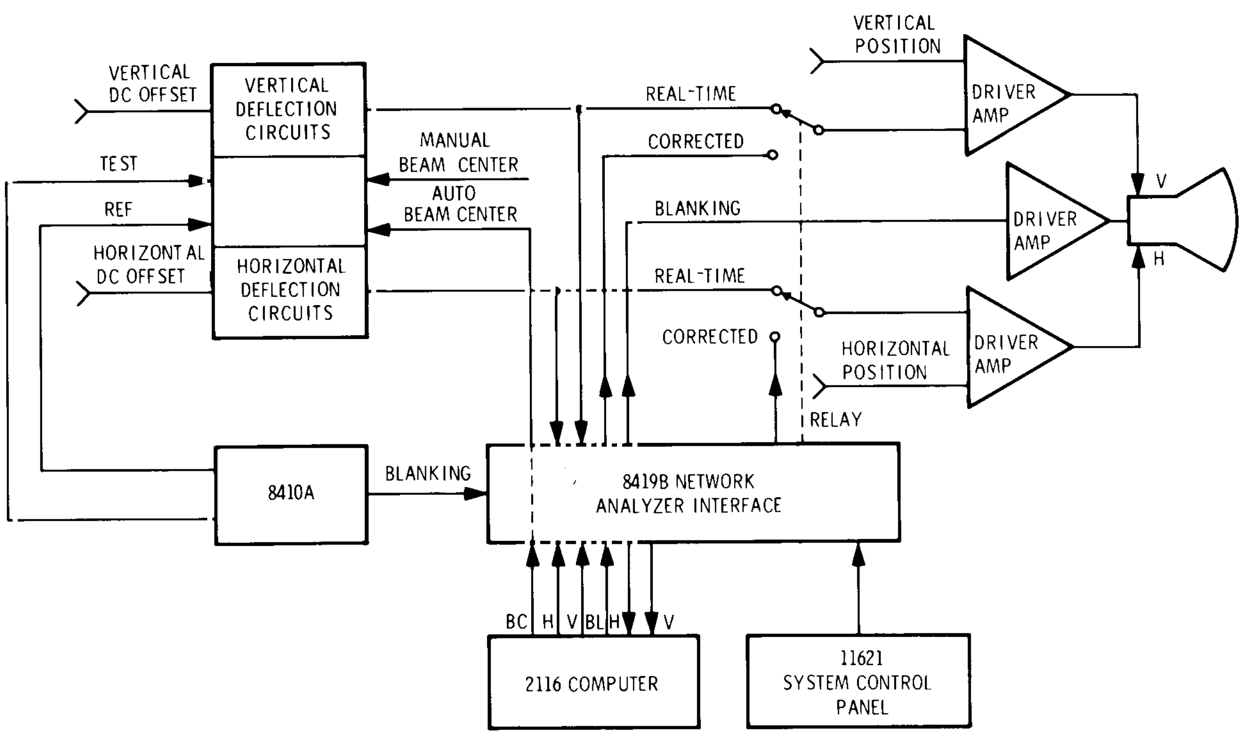


Figure 3-12. Model 8414A-H26 Polar Display and Automatic System Interface Block Diagram

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. This section provides instructions for performance testing the 8414A. If the serial prefix of your instrument is different from that listed on the title page of this manual, there are differences between your instrument and the instrument described in this manual. See Paragraphs 1-7 and 1-8.

4-3. Figure 4-1 is the equipment setup for all performance tests. The procedures in Paragraphs 4-8 through 4-10 check the 8414A performance for incoming inspection and periodic evaluation. The tests can be performed without access to the instrument interior. The specifications in Table 1-1 are the performance standards. Before starting the performance tests, allow 30 minutes warm-up time for the 8414A and Network Analyzer.

4-4. EQUIPMENT REQUIRED.

4-5. The test instruments and accessories required to make the performance tests are listed in Table 4-1. Test instruments other than the ones listed can be used provided their performance equals or exceeds the Critical Specifications listed.

4-6. TEST RECORD.

4-7. Table 4-2 is a performance test record. This table may be used during the test to record the test values obtained, and it provides a permanent record of the test values for use at a later time during calibration or periodic evaluation.

Table 4-1. Recommended Test Equipment

Item	Critical Specifications	Recommended HP Model
Oscillator	Frequency Range: 280 (±50) kHz Output Level: variable from 0 to 3.0 Vrms Output Impedance: 50 to 600 ohms	200CD, 651A
DC Power Supply	Output: -5 Vdc	6213A
Oscilloscope	Vertical: Minimum bandwidth: 5 MHz Minimum sensitivity: 10 mV/cm Input: dc and ac Horizontal: Range: 1 μsec/cm to 5 μsec/cm	180A with 1801A and 1821A
Network Analyzer	No Substitute may be used.	8410A with 8411A or 8407A
Sweep Oscillator	Frequency Range: any frequency within the operating range of the Network Analyzer.	8690A with RF unit as required (see Note 1)
20-dB Attenuator	Impedance: 50 ohms nominal Attenuation: 20 dB ±8 dB SWR: 1.3 max (280 kHz) Connector: BNC	8491A with N to BNC adapters (see Note 2)

[1]For 8407A Network Analyzers, Model 8601A Sweep Oscillator may be used.

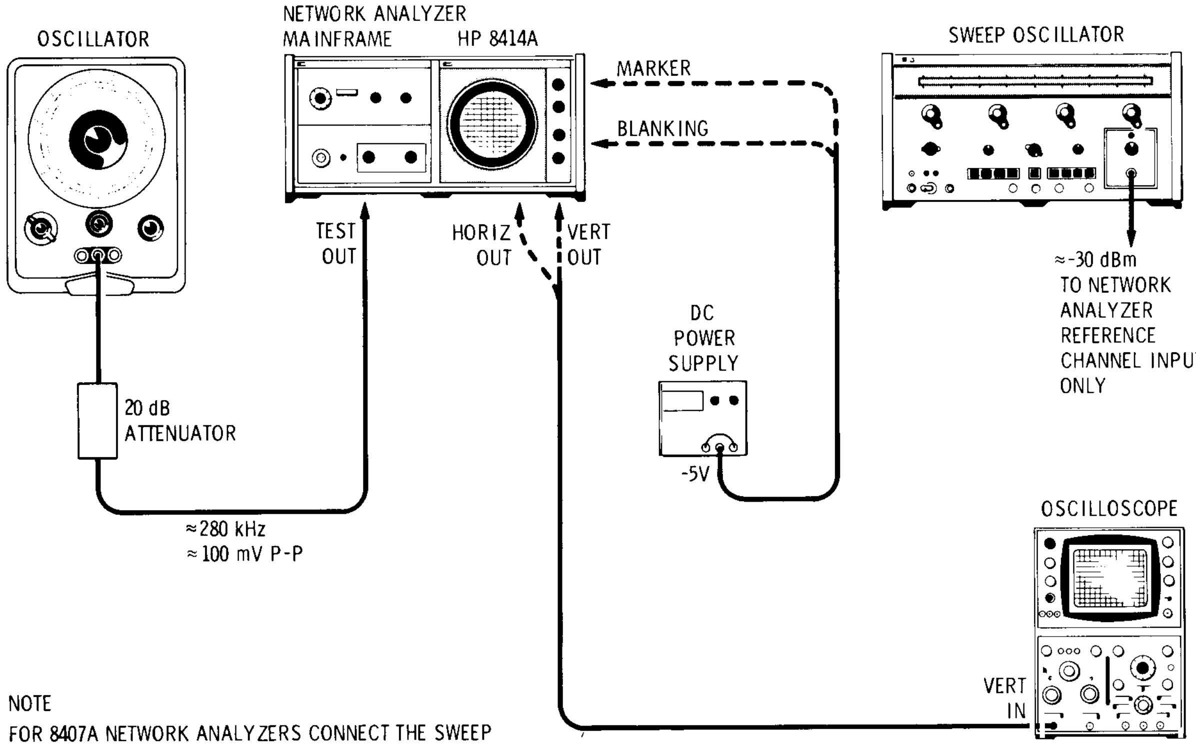
[2]Oscilloscope 10:1 divider probe, such as HP Model 10003A may be used in place of 20-dB attenuator.

PERFORMANCE TEST

OPERATING PRECAUTIONS

MECHANICAL SHOCK. Do not bump or jar the Polar Display as misalignment of the CRT gun may result.

MAGNETIC FIELDS. Do not place the Polar Display near a sweep generator containing a BWO which has an unshielded magnet or the CRT will be permanently magnetized, causing poor focus. Separate the 8414A from any magnetic source by at least two feet.



NOTE
FOR 8407A NETWORK ANALYZERS CONNECT THE SWEEP OSCILLATOR VTO OUTPUT TO THE 8407A VTO INPUT.

EQUIPMENT

20 dB ATTENUATOR	HP 8491A
OSCILLATOR	HP 200CD
NETWORK ANALYZER	HP 8410A/8411A OR HP 8407A
SWEEP OSCILLATOR	HP 8690-SERIES WITH RF UNIT AS REQUIRED
OSCILLOSCOPE	HP 180A/1801A/1821A
DC POWER SUPPLY	HP 721A

Figure 4-1. Performance Test Equipment Setup

PERFORMANCE TEST

4-8. ACCURACY TEST.

SPECIFICATION:
Error circle on CRT less than 3mm radius.

DESCRIPTION:

A CW signal is applied to the Network Analyzer to provide a reference channel input signal to the 8414A. A 280 kHz signal is applied to the 8414A amplitude channel through the Network Analyzer test channel output connector. By adjusting the frequency difference between these two signals, a circle can be displayed on the 8414A. The radius of this circle is adjusted to the radius of the outer graticule circle by adjusting the amplitude of the 280 kHz signal. The trace must be less than 3 mm from the outer graticule circle around the entire circle.

PROCEDURE:

a. Connect equipment as shown in Figure 4-1.

b. Set the sweep oscillator for single-frequency operation at any frequency within the frequency range of the Network Analyzer.

c. Set the Network Analyzer to phase lock to the applied signal and adjust the sweep oscillator RF amplitude for a Network Analyzer reference channel level meter indication in the middle of the operate region.

d. Press and hold the 8414A BEAM CTR pushbutton and adjust the HORIZ and VERT POS controls to locate the dot in the center of the Polar Display's CRT. To bring the dot onto the display, rotate each positioning control about 5 turns counterclockwise or until a slight increase in resistance to movement is encountered. Then turn each control about 2½ turns clockwise.

e. Set the Network Analyzer test channel gain controls for 00 dB. For 8407A Network Analyzers set display reference controls to bottom position.

f. Adjust the oscillator connected to the Network Analyzer test channel output as follows:

1) Adjust the frequency to obtain the best circle. The best circle will occur when the trace has a slight flicker.

2) Adjust the output amplitude to obtain a circle whose radius is equal to the radius of the CRT's outer graticule circle.

NOTE

It may be necessary to adjust the HORIZ and VERT POS controls to locate the average of the trace over the outer graticule circle.

g. The trace must be less than 3 mm from the outer graticule circle around the entire circle (3 mm is about the center of the numbers on the CRT's graticule).

PERFORMANCE TEST

4-9. HORIZONTAL AND VERTICAL OUTPUT TESTS (Rear Panel)

SPECIFICATION:
Bandwidth of rear-panel horizontal and vertical outputs at 3-dB points, 10 kHz minimum.

DESCRIPTION:
The rear-panel HORIZONTAL and VERTIAL output amplitude is observed on an oscilloscope, the test channel input frequency is varied, and the upper and lower frequencies at which the output amplitude decreases 3 dB is determined. The difference between the upper and lower 3 dB points must be greater than 10 kHz.

PROCEDURE:

a. If equipment was altered from paragraph 4-8, repeat procedures in Paragraph 4-8 to obtain a trace on the CRT's outer graticule circle.

b. Connect oscilloscope to 8414A rear-panel VERTICAL output and note peak-to-peak amplitude.

c. Increase frequency of the oscillator connected to the Network Analyzer test channel output connector, until the oscilloscope presentation decreases to 0.707 of the amplitude noted in step b. Note the oscillator frequency.

d. Decrease the oscillator frequency through 278 kHz until the oscilloscope presentation is again 0.707 of the amplitude noted in step b. Note the oscillator frequency.

e. The difference in frequency noted in steps c and d must be greater than 10 kHz.

f. Return the oscillator frequency to 280 kHz, connect oscilloscope to the 8414A rear-panel HORIZONTAL output and note the peak-to-peak amplitude.

g. Repeat steps c through e.

4-10. MARKER AND BLANKING INPUT TESTS (Rear Panel)

SPECIFICATION:
—5 volt marker input intensifies the CRT display.
—5 volt blanking input blanks the CRT display.

DESCRIPTION:
—5 volts dc is applied to the rear-panel MARKER input. The intensity of the CRT trace should increase. —5 volts is connected to the rear-panel BLANKING input. The CRT trace should be blanked.

PERFORMANCE TEST

PROCEDURE:

a. If equipment was altered from previous test, repeat procedures in Paragraph 4-8 to obtain a trace on the CRT's outer graticule circle.

b. Adjust the power supply to −5 volts. Apply −5 volts to MARKER input connector on Polar Display and −5 volt return to chassis ground. Connect and disconnect −5 volts several times. Intensity of CRT trace should brighten when −5 volts is applied.

c. Disconnect −5 volts from MARKER input connector and connect it to BLANKING input connector. The trace should be blanked.

Table 4-2. Performance Test Record

Hewlett-Packard Model 8414A   Date:________

Polar Display   Test Performed by:________

Serial No. ________

Para Number	Specification Tested	Measured
4-8	Error circle on CRT less than 3 mm radius.	Max. Error ________
4-9	Horizontal and Vertical output minimum bandwidth (3 dB) 10 kHz.	Horiz. Bandwidth ________ Vert. Bandwidth ________
4-10	-5V marker input intensifies CRT display.	________
	-5V blanking input blanks CRT display.	________

SECTION V
ADJUSTMENT PROCEDURES

5-1. INTRODUCTION.

5-2. This section provides instructions for adjusting the 8414A. If the serial prefix of your instrument is different from that listed on the title page of this manual, there are differences between your instrument and the instrument described in this manual. See paragraphs 1-7 and 1-8.

5-3. Paragraphs 5-9 through 5-15 contain the complete adjustment procedures for the 8414A. Adjustments in paragraphs 5-9 and 5-10 interact and should be performed sequentially. Adjustments in paragraphs 5-11 through 5-15 do not interact and need not be performed sequentially. These procedures should not be performed as part of routine maintenance but should be used only after replacement of a part or component, or when the performance test shows that the specifications of Table 1-1 cannot be met. Before attempting any adjustment, allow 30 minutes warm-up time for the 8414A and Network Analyzer.

5-4. The location of all adjustment controls is shown in Figure 8-24 (last foldout). Table 5-2 lists the adjustment controls and the function of each control.

5-5. FACTORY SELECTED COMPONENTS.

5-6. A2C51 is the only factory-selected component. It is selected (see paragraph 5-15) to obtain the proper phase balance between the reference and test channels; however the Network Analyzer mainframe phase vernier control has sufficient range to obtain the proper phase balance for most applications.

5-7. EQUIPMENT REQUIRED.

5-8. The test instruments and accessories required to perform the adjustment procedures are listed in Table 5-1. Test instruments other than the ones listed can be used provided their performance equals or exceeds the Critical Specifications listed.

Table 5-1. Recommended Test Equipment

Item	Critical Specifications	Recommended HP Model
Oscillator	Frequency Range: 280 (±50) kHz and 1 (±0.1) kHz Output Level: Variable from 0 to 3.0 Vrms Output Impedance: 50 to 600 ohms	200 CD, 651A
DC Power Supply	Output: -5 Vdc	6231A
Oscilloscope (Dual Trace)	Vertical: Minimum bandwidth 5 MHz Minimum Sensitivity 10 mV/cm Input: dc and ac Horizontal: Range: 1 μsec/cm to 5 μsec/cm	180A with 1801A and 1821A
Network Analyzer	No substitute may be used	8410A with 8411A or 8407A
Transducer	Frequency Range: Same as Sweep Oscillator	8740A, 8741A, 8742A, 8743A or 8745A (see Note 1)
Sweep Oscillator	Frequency Range: Any frequency within the operating range of the Network Analyzer	8690A with RF unit as required (see Note 2)
20-dB Attenuator	Impedance: 50 ohms nominal Attenuation: 20 dB ±3 dB SWR: 1.3 max (1 kHz and 280 kHz) Connector: BNC	8419A with N to BNC adapters (see Note 3)
Termination	Impedance: 50 ohms ±10% at 278 kHz Connector: Male BNC	10100A or HP Part No. 1250-0839 with adapter 1250-0831.

[1]For 8407A Network Analyzers use HP Model 11561A or BNC Tee

[2]For 8407A Network Analyzers Model 8601A Sweep Oscillator may be used

[3]Oscilloscope 10:1 divider probe, such as HP Model 10003A may be used in place of 20 dB attenuator.

Table 5-2. Adjustment Controls and Functions

Control	Function Affected
Phase Adjust A2R21.	Adjust phase shift of -90° phase shifter.
Recorder Gain Adjust A2R37.	Adjusts horizontal and vertical amplitude balance by adjusting gain of vertical buffer amplifier.
CRT Gain Adj A2R57	Adjust horizontal and vertical deflection balance by adjusting gain of vertical deflection driver.
Intensity Limit A3R20.	Sets brightness range of INTENSITY control.
Pattern Shape A3R10.	Provides grid accelerator voltage for pattern shaping.
Illumination Limit A3R9.	Adjusts uniformity of illumination from flood gun.
Astigmatism A3R11.	Adjusts uniformity of focus.
Trace Align R5.	Calibration of trace to CRT graticule.
Manual Beam Centering Horiz Zero Adj A1R32.	Sets horizontal output voltage to zero when the BEAM CTR pushbutton is pressed.
Manual Beam Centering Vert Zero Adj A1R33.	Sets vertical output voltage to zero when the BEAM CTR pushbutton is pressed.

NOTES

1. A2C51 is selected to obtain 0 ±5° phase balance between reference and test channels.

2. Adjustment locations are shown on the last foldout.

ADJUSTMENT PROCEDURE

CAUTION

MECHANICAL SHOCK. Do not bump or jar the Polar Display as misalignment of the CRT gun may result.

MAGNETIC FIELDS. Do not place the Polar Display near a sweep generator containing a BWO which has an unshielded magnet or the CRT will be permanently magnetized, causing poor focus. Separate the 8414A from any magnetic source by at least two feet.

5-9. TRACE ALIGNMENT AND VERTICAL GAIN ADJUSTMENT.

DESCRIPTION:

For 8410A Network Analyzers a CW signal is applied to the Network Analyzer and a phase locked condition is set up so that the Network Analyzer unblanks the 8414A display. 8407A Network Analyzers unblank the 8414A display without an input signal. Function switch S1 is switched to the TEST position which isolates the deflection circuits from the input circuits so that only signals applied to the 8414A rear-panel HORIZONTAL and VERTICAL outputs will be displayed on the CRT. A 1.0 kHz deflection signal is applied to the 8414A HORIZONTAL output to display a horizontal trace on the CRT. The TRACE ALIGN control is adjusted to align the trace with the horizontal graticule line.

The vertical amplifier gain is matched to the horizontal amplifier gain by applying the 1.0 kHz signal to the VERTICAL output and adjusting the vertical gain control (CRT Gain Adj) for a vertical trace equal to the magnitude of the horizontal trace.

PROCEDURE:

a. Remove top covers from both the Network Analyzer and the 8414A. All adjustments should be made with the 8414A installed in the mainframe.

b. Connect equipment as shown in Figure 5-1.

c. Set the sweep oscillator for single frequency operation at any frequency within the frequency range of the Network Analyzer.

d. Set the Network Analyzer to phase lock to the applied signal and adjust the sweep oscillator RF amplitude for a Network Analyzer reference channel level meter indication in the middle of the operate region.

e. Set the 8414A function switch A2S1 to the TEST position.

f. Terminate the 8414A rear-panel VERTICAL output connector with a 50-ohm load.

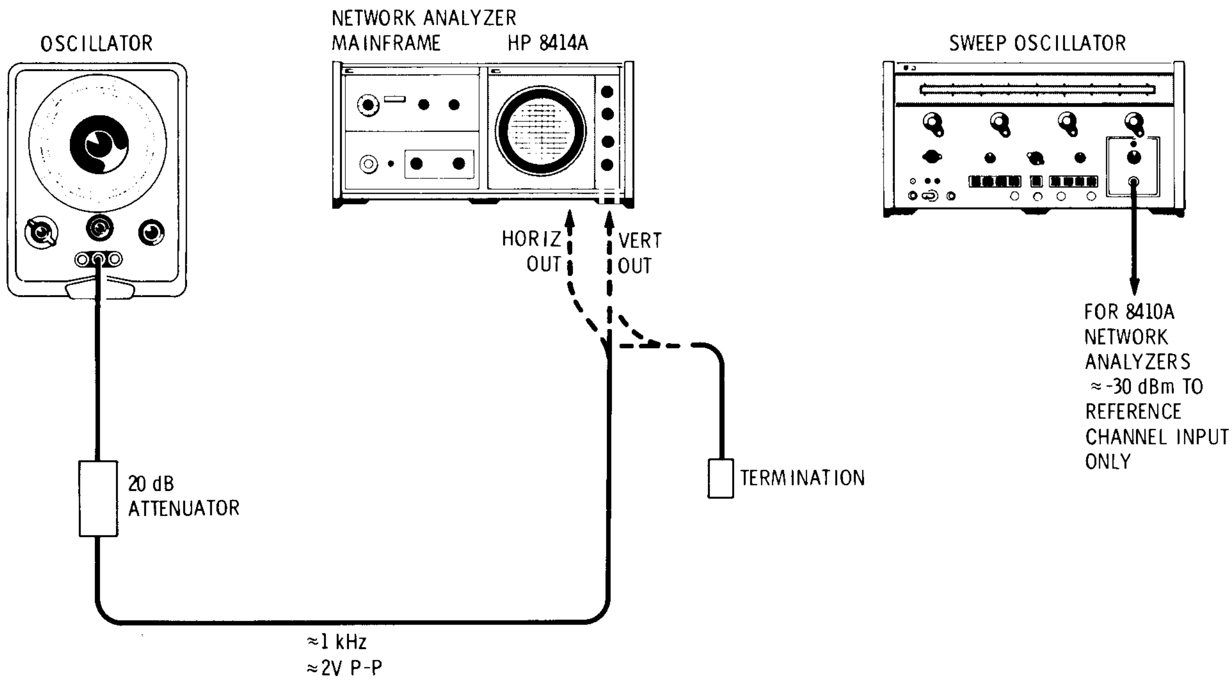
g. Adjust front-panel VERT POS and HORIZ POS controls to locate dot in center of the CRT.

h. Adjust front-panel INTENSITY control for medium beam intensity on CRT. Adjust front-panel FOCUS control for a small round dot on CRT.

i. Connect oscillator set for 1.0 kHz to the rear-panel HORIZONTAL output. Adjust oscillator signal level for a 10-cm deflection on CRT (diameter of outer graticule circle).

j. Adjust R5 (Trace Align control) and VERT POS control to superimpose the trace on the horizontal graticule line.

ADJUSTMENT PROCEDURE



NOTE
SWEEP OSCILLATOR NOT REQUIRED FOR 8407A NETWORK ANALYZERS

EQUIPMENT

OSCILLATOR	HP 200CD
NETWORK ANALYZER	HP 8410A/8411A OR HP 8407A
SWEEP OSCILLATOR	HP 8690-SERIES WITH RF UNIT AS REQUIRED
20 dB ATTENUATOR	HP 8491A
TERMINATION	HP 10100A OR HP PART NO. 1250-0839 WITH ADAPTER 1250-0831

Figure 5-1. Setup for Trace Alignment and Vertical Gain Adjustment

k. Without changing oscillator signal level, connect the oscillator to the VERTICAL output and terminate the HORIZONTAL output.

m. Adjust A2R57 (CRT Gain Adj) for a 10-cm vertical deflection.

n. Disconnect the oscillator and termination from VERTICAL and HORIZONTAL outputs and set function switch S1 to NORMAL position.

5-10. PHASE, RECORDER GAIN, AND PATTERN SHAPE ADJUSTMENTS.

DESCRIPTION:

A CW signal is applied to the Network Analyzer to provide a reference channel input signal to the 8414A and for 8410A Network Analyzers so that the Network Analyzer unblanks the 8414A display. A 280-kHz signal is applied to the 8414A amplitude channel through the Network Analyzer test channel output connector. These two signals cause a circle to be displayed on the 8414A. The radius of this circle is adjusted to the radius of the outer graticule circle by adjusting the amplitude of the 280-kHz signal. The 8414A PHASE ADJUST control, RECORDER GAIN ADJUST control and PATTERN SHAPE control are adjusted for the best circle.

PROCEDURE:

NOTE

Perform paragraph 5-9, TRACE ALIGNMENT AND VERTICAL GAIN ADJUSTMENT before performing this adjustment.

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

b. Set the sweep oscillator for single frequency operation at any frequency within the frequency range of the Network Analyzer.

c. Set the Network Analyzer to phase lock to the applied signal and adjust the sweep oscillator RF amplitude for a Network Analyzer reference channel level meter indication in the middle of the operate region.

d. Press and hold the 8414A BEAM CTR pushbutton and adjust the HORIZ POS and VERT POS controls to locate the dot in the center of the Polar Display.

e. Set the Network Analyzer test channel gain controls for *minimum* gain. For 8407A Network Analyzers set display reference control switches down.

f. Adjust the oscillator connected to the Network Analyzer test channel output as follows:

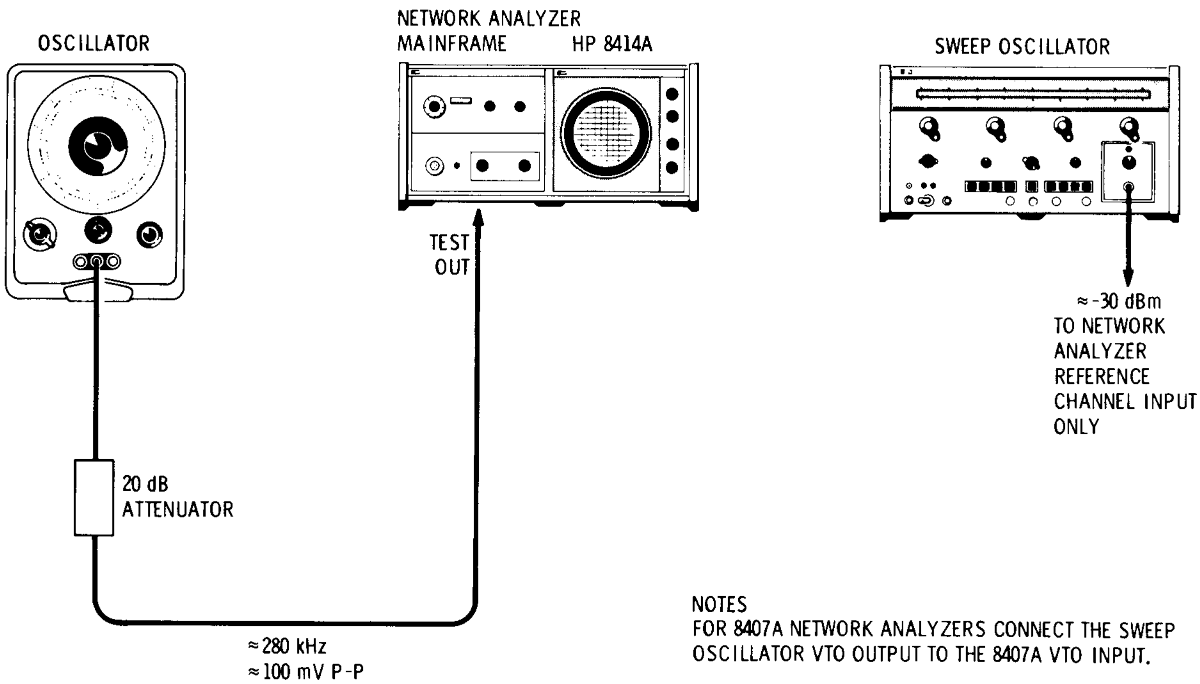
1. Adjust the frequency to obtain the best circle (slight flicker in 8414A display).
2. Adjust the output amplitude to obtain a circle whose radius is equal to the radius of the CRT's outer graticule circle.

NOTE

It may be necessary to adjust the HORIZ POS and VERT POS controls to locate the average of the trace over the outer graticule circle.

g. Adjust A2R21 (Phase Adjust), A1R37 (Recorder Gain Adjust) and A3R20 (Pattern Shape) for the best circle. The trace must be less than 3 mm from the outer graticule circle around the entire circle.

ADJUSTMENT PROCEDURE



EQUIPMENT

OSCILLATOR	HP 200CD
NETWORK ANALYZER	HP 8410A/8411A OR HP 8407A
SWEEP OSCILLATOR	HP 8690-SERIES WITH RF UNIT AS REQUIRED
20 dB ATTENUATOR	HP 8491A

Figure 5-2. Setup for Phase, Recorder Gain, and Pattern Shape Adjustments

5-11. ASTIGMATISM ADJUSTMENT.

DESCRIPTION:

Without changing the equipment from the previous setup, the Astigmatism control and FOCUS are adjusted with and without the BEAM CTR pushbutton pressed for the sharpest focus at both the center and the outside edge of the CRT.

EQUIPMENT SETUP:

Same as Figure 5-2.

PROCEDURE:

a. If equipment was altered from Paragraph 5-10, repeat procedure in Paragraph 5-10.

b. Adjust front-panel FOCUS control and A3R11 (Astigmatism control) alternately, with and without the BEAM CTR pushbutton pressed, until sharp focus is obtained at both the center and outside edge of the CRT.

5-12. ILLUMINATION ADJUSTMENT.

DESCRIPTION:

Without changing the equipment from the previous setup, the front-panel ILLUMINATION control is adjusted for maximum CRT illumination and the Illumination Limit control is adjusted for the brightest possible *uniform* illumination.

EQUIPMENT SETUP:

Same as Figure 5-2.

PROCEDURE:

a. If equipment was altered from previous test, repeat procedures in Paragraph 5-10.

b. Shield the face of the CRT from ambient light (oscilloscope viewing hood, HP Model 10175A/B may be used).

c. Turn front-panel ILLUMINATION control fully clockwise.

d. Adjust A3R9 (Illumination Limit control) until brightest possible *uniform* illumination is obtained on the CRT.

ADJUSTMENT PROCEDURE

5-13. INTENSITY ADJUSTMENT.

DESCRIPTION:

A spot is obtained in the center of the CRT, the front-panel INTENSITY control is set to mid-range and the Intensity Limit control is adjusted to make the spot just visible.

EQUIPMENT SETUP:

Same as Figure 5-2.

PROCEDURE:

a. Disconnect oscillator from the Network Analyzer test channel output connector.

b. Set the 8414A front-panel INTENSITY control to mid-range (12 o'clock position).

c. Adjust A3R10 (Intensity Limit control) until the spot is just visible.

5-14. MANUAL BEAM CENTERING ZERO ADJUSTMENT.

DESCRIPTION:

A dc coupled oscilloscope is connected to the 8414A HORIZONTAL and VERTICAL output connectors. The 8414A BEAM CTR pushbutton is pressed and the horizontal and vertical Manual Beam Centering Zero Adj controls are adjusted for 0 ±10 mV.

PROCEDURE:

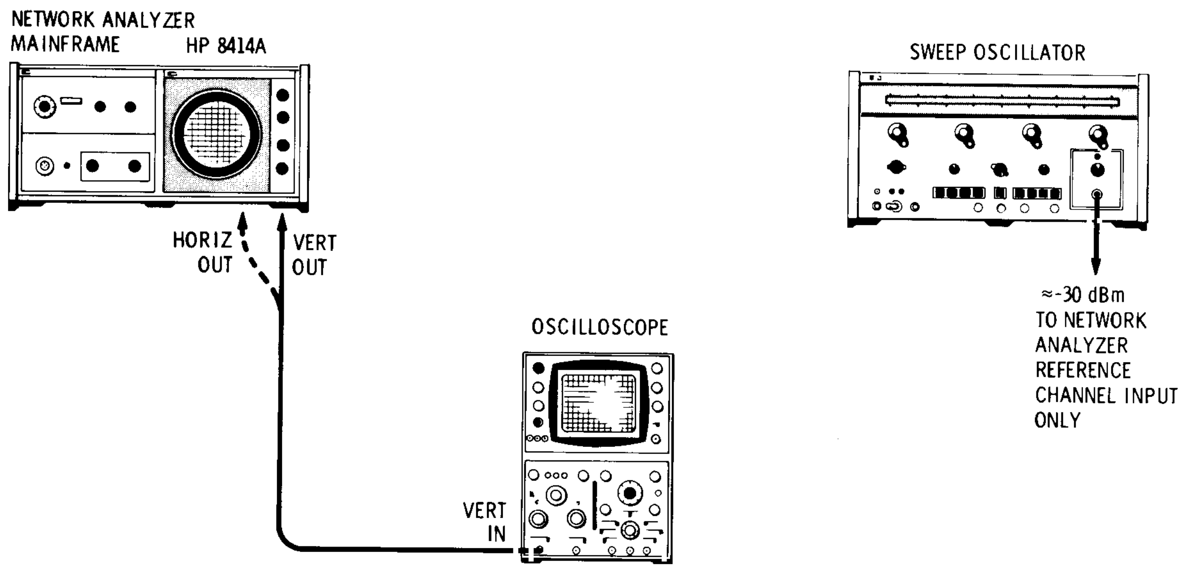
a. Connect equipment as shown in Figure 5-3.

b. Connect the oscilloscope vertical input to the 8414A rear-panel HORIZONTAL output connector, dc couple and dc balance the oscilloscope.

c. Press and hold the 8414A BEAM CTR pushbutton and adjust A1R32 (Manual Beam Centering Horiz Zero Adj) for 0 ±10 mVdc.

d. Connect the oscilloscope vertical input to the 8414A VERTICAL output connector, press and hold the 8414A BEAM CTR pushbutton and adjust A1R33 (Manual Beam Centering Vert Zero Adj) for 0 ±10 mV.

ADJUSTMENT PROCEDURE



NOTE

FOR 8407A NETWORK ANALYZERS CONNECT THE SWEEP OSCILLATOR VTO OUTPUT TO THE 8407A VTO INPUT

EQUIPMENT

NETWORK ANALYZER. . . . . HP 8410A/8411A OR HP 8407A
SWEEP OSCILLATOR . . . . HP 8690-SERIES WITH RF UNIT AS REQUIRED
OSCILLOSCOPE . . . . HP 180A/1801A/1821A

Figure 5-3. Setup for Manual Beam Centering Zero Adjustment

ADJUSTMENT PROCEDURE

5-15. PHASE ZERO ADJUSTMENT (Select A2C51).

DESCRIPTION:

The Network Analyzer mainframe phase vernier control has sufficient range to set the 8414A for a zero phase reference for most applications; however, in some applications it is desirable to adjust the 8414A phase indication close to zero with the input signals in-phase. This can be accomplished by selecting a value for A2C51 that produces the desired indication. Normal single-frequency test and reference channel signals are applied to the Network Analyzer. The mainframe 278-kHz test and reference channel output signals, which are also the 8414A input signals, are connected to a dual trace oscilloscope. The Network Analyzer phase vernier control is adjusted to superimpose the two signals on the oscilloscope and A2C51 is selected for a 0 ±5 degree indication on the Polar Display.

PROCEDURE:

a. Connect equipment as shown in Figure 5-4.

b. Set the sweep oscillator for single-frequency operation and adjust the Network Analyzer to phase lock to the applied signal.

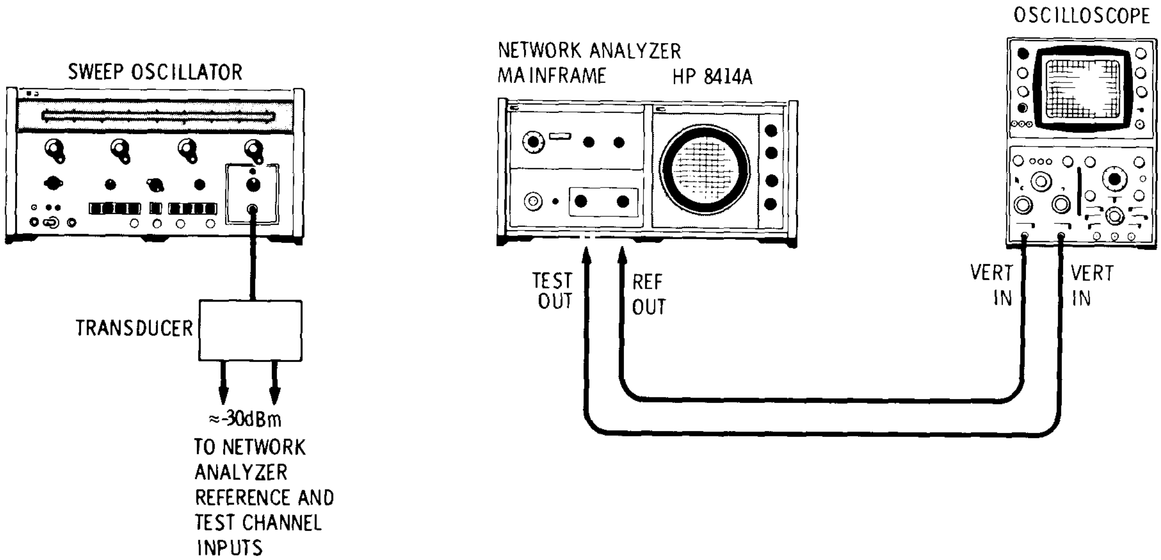
c. Connect the oscilloscope vertical inputs to the Network Analyzer rear-panel reference and test channel outputs.

d. Adjust the Network Analyzer phase vernier, test channel gain[1] and amplitude vernier controls to obtain two sine waves on the oscilloscope exactly superimposed on one another. To ensure oscilloscope and oscilloscope cables give a true in-phase indication, reverse the oscilloscope cables at the Network Analyzer. The two sine waves should still be superimposed on one another.

e. Select a value for A2C51 to obtain a 0 ±5 degree 8414A indication. Typical range of values for A2C51 is 150 pF to 250 pF.

[1]Display reference for 8407A

ADJUSTMENT PROCEDURE



NOTE

FOR 8407A NETWORK ANALYZERS CONNECT THE SWEEP OSCILLATOR VTO OUTPUT TO THE 8407A VTO INPUT.

EQUIPMENT

NETWORK ANALYZER . . . . HP 8410A/8411A OR HP 8407A
SWEEP OSCILLATOR . . . . HP 8690-SERIES WITH RF UNIT AS REQUIRED
OSCILLOSCOPE . . . . HP 180A/1801A/1821A

Figure 5-4. Setup for Phase Zero Adjustment (Select A2C51)

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-2 lists parts in alpha-numerical order of their reference designators and indicates the description and HP stock number of each part, together with any applicable notes. Miscellaneous parts are listed at the end of Table 6-2. Table 6-3 lists parts in alpha-numerical order of their HP stock number and provides the following information on each part.

a. Description.

b. Manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-4.

c. Manufacturer's part number.

d. Total quantity used (TQ column).

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. Identify parts by their Hewlett-Packard stock numbers.

6-5. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

Table 6-1. Reference Designations and Abbreviations

REFERENCE DESIGNATORS

A	= assembly	F	= fuse	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor	FL	= Filter	Q	= transistor	VR	= voltage regulator
BT	= battery	J	= jack	R	= resistor	W	= cable
C	= capacitor	K	= relay	RT	= thermistor	X	= socket
CP	= coupler	L	= inductor	S	= switch	Y	= crystal
CR	= diode	LS	= loud speaker	T	= transformer	Z	= tuned cavity, network
DL	= delay line	M	= meter	TB	= terminal board		
DS	= device signaling (lamp)	MK	= microphone	TP	= test point		
E	= misc electronic part	MP	= mechanical part	U	= integrated circuit		

ABBREVIATIONS

A	= amperes
AFC	= automatic frequency control
AMPL	= amplifier
BFO	= beat frequency oscillator
BE CU	= beryllium copper
BH	= binder head
BP	= bandpass
BRS	= brass
BWO	= backward wave oscillator
CCW	= counterclockwise
CER	= ceramic
CMO	= cabinet mount only
COEF	= coefficient
COM	= common
COMP	= composition
COMPL	= complete
CONN	= connector
CP	= cadmium plate
CRT	= cathode-ray tube
CW	= clockwise
DEPC	= deposited carbon
DR	= drive
ELECT	= electrolytic
ENCAP	= encapsulated
EXT	= external
F	= farads
FH	= flat head
FIL H	= Fillister head
FXD	= fixed
G	= giga (10^9)
GE	= germanium
GL	= glass
GRD	= ground(ed)

H	= henries
HDW	= hardware
HEX	= hexagonal
HG	= mercury
HR	= hour(s)
Hz	= Hertz
IF	= intermediate freq
IMPG	= impregnated
INCD	= incandescent
INCL	= include(s)
INS	= insulation(ed)
INT	= internal
K	= kilo = 1000
LH	= left hand
LIN	= linear taper
LK WASH	= lock washer
LOG	= logarithmic taper
LPF	= low pass filter
M	= milli = 10^{-3}
MEG	= meg = 10^6
MET FLM	= metal film
MET OX	= metallic oxide
MFR	= manufacturer
MHz	= mega Hertz
MINAT	= miniature
MOM	= momentary
MOS	= metalized substrate
MTG	= mounting
MY	= "mylar"
N	= nano (10^{-9})
N/C	= normally closed
NE	= neon
NI PL	= nickel plate

N/O	= normally open
NOM	= nominal
NPO	= negative positive zero (zero temperature coefficient)
NPN	= negative-positive-negative
NRFR	= not recommended for field replacement
NSR	= not separately replaceable
OBD	= order by description
OH	= oval head
OX	= oxide
P	= peak
PC	= printed circuit
PF	= picofarads = 10^{-12} farads
PH BRZ	= phosphor bronze
PHL	= Phillips
PIV	= peak inverse voltage
PNP	= positive-negative-positive
P/O	= part of
POLY	= polystrene
PORC	= porcelain
POS	= position(s)
POT	= potentiometer
PP	= peak-to-peak
PT	= point
PWV	= peak working voltage
RECT	= rectifier
RF	= radio frequency
RH	= round head or right hand

RMO	= rack mount only
RMS	= root-mean square
RWV	= reverse working voltage
S-B	= slow-blow
SCR	= screw
SE	= selenium
SECT	= section(s)
SEMICON	= semiconductor
SI	= silicon
SIL	= silver
SL	= slide
SPG	= spring
SPL	= special
SST	= Stainless steel
SR	= split ring
STL	= steel
TA	= tantalum
TD	= time delay
TGL	= toggle
THD	= thread
TI	= titanium
TOL	= tolerance
TRIM	= trimmer
TWT	= traveling wave tube
μ	= micro = 10^{-6}
VAR	= variable
VDCW	= dc working volts
W/	= with
W	= watts
WIV	= working inverse voltage
WW	= wirewound
W/O	= without

Table 6-2. Parts List Indexed by Reference Designation

Reference Designation	ⓗ Part No.	Description #	Note
A1	08414-6029	ASSY:Z-AXIS MOD & INTERCONNECTION (STANDARD)	
A1	08414-61003	ASSY:Z-AXIS MOD & INTERCONNECTION (OPT H26)	
A1C1	0180-0269	C:FXD ELECT 1.0 UF +50-10% 150VDCW	
A1C2	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A1CR1	1901-0040	DIODE:SILICON 30MA 30WV	
A1CR2	1902-0041	DIODE:BREAKDOWN 5.11V 5%	
A1CR3	1901-0C40	DIODE:SILICON 30MA 30WV	
A1CR4	1901-0040	DIODE:SILICON 30MA 30WV	
A1CR5	1901-0C40	DIODE:SILICON 30MA 30WV	
A1CR6	1901-0025	DIODE:SILICON 100MA/1V	
A1CR7	1901-0025	DIODE:SILICON 100MA/1V	
A1CR8	1901-0025	DIODE:SILICON 100MA/1V	
A1J1		NOT ASSIGNED	
A1J2	1251-1378	CONNECTOR:PC 9 CONTACTS	
A1J3		NOT ASSIGNED	
A1K1	0490-0739	RELAY:DPDT 2A	
		INSTALLED IN H26-8414A ONLY	
A1L1	9100-1630	COIL/CHOKE 51.0 UH 5%	
A1Q1	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A1Q2	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A1Q3	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A1Q4	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A1Q5	1854-0C71	Q:SI NPN(SELECTED FROM 2N3704)	
A1Q6	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A1Q7	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A1Q8	1854-0C71	Q:SI NPN(SELECTED FROM 2N3704)	
		INSTALLED IN H26-8414A ONLY	
A1Q9	1853-0051	Q:SI PNP	
		INSTALLED IN H26-8414A ONLY	
A1Q10	1853-0051	Q:SI PNP	
		INSTALLED IN H26-8414A ONLY	
A1Q11	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
		INSTALLED IN H26-8414A ONLY	
A1R1	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R2	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R3	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R4	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R5	0757-0290	R:FXD MET FLM 6.19K OHM 1% 1/8W	
A1R6	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A1R7	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A1R8	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R9	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A1R10	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	

 # See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A1R11	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A1R12	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A1R13	0698-3153	R:FXD MET FLM 3.83K 1% 1/8W	
A1R14	0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A1R15	0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A1R16	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R17	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R18	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R19	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R20	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R21	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R22	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R23	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R24	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R25		NOT ASSIGNED	
A1R26	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R27	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R28	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R29	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R30	0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W FACTORY SELECTED PART	
A1R31	0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W FACTORY SELECTED PART	
A1R32	2100-1770	R:VAR WW 100 OHM 5% TYPE H 1W	
A1R33	2100-1770	R:VAR WW 100 OHM 5% TYPE H 1W	
A1R34	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A1R35	0698-3156	R:FXD MET FLM 14.7K OHM 1% 1/8W	
A1R36	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A1R37	0757-0279	R:FXD MET FLM 3.16K OHM 1% 1/8W	
A1R38	0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	
A1R39	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R40	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1R41	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A1XA1		NOT ASSIGNED	
A1XA2	1251-0498	CONNECTOR:PC 22 CONTACTS	
A1XA3	1251-0498	CONNECTOR:PC 22 CONTACTS	
A2	08414-6028	ASSY:COORDINATE CONVERTER	
A2C1	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C2	0160-0168	C:FXD MY 0.1 UF 10% 200VDCW	
A2C3	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C4	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C5	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C6		NOT ASSIGNED	
A2C7	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C8	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C9	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C10	0140-0196	C:FXD MICA 150 PF 5%	

 # See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A2C11	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C12	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C13	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C14	0160-2204	C:FXD MICA 100PF 5%	
A2C15	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A2C16	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A2C17	0160-2210	C:FXD MICA 470 PF 5%	
A2C18	0160-2208	C:FXD MICA 330 PF 5% 300VDCW	
A2C19	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C20	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C21	0140-0157	C:FXD MICA 1857 PF 1%	
A2C22	0140-0157	C:FXD MICA 1857 PF 1%	
A2C23	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C24	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C25	0160-2208	C:FXD MICA 330 PF 5% 300VDCW	
A2C26	0140-0157	C:FXD MICA 1857 PF 1%	
A2C27	0150-0082	C:FXD CER 8200 PF 500VDCW	
A2C28	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C29	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C30	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C31	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C32	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C33	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C34	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C35	0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	
A2C36	0160-2204	C:FXD MICA 100PF 5%	
A2C37	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A2C38	0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	
A2C39	0160-2210	C:FXD MICA 470 PF 5%	
A2C40	0160-2208	C:FXD MICA 330 PF 5% 300VDCW	
A2C41	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C42	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C43	0140-0157	C:FXD MICA 1857 PF 1%	
A2C44	0140-0157	C:FXD MICA 1857 PF 1%	
A2C45	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C46	0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	
A2C47	0160-2208	C:FXD MICA 330 PF 5% 300VDCW	
A2C48	0140-0157	C:FXD MICA 1857 PF 1%	
A2C49	0150-0082	C:FXD CER 8200 PF 500VDCW	
A2C50	0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	
A2C51	0140-0198	C:FXD MICA 200 PF 5% FACTORY SELECTED PART	
A2CR1	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR2	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR3	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR4		NOT ASSIGNED	
A2CR5	1902-0025	DIODE,BREAKDOWN:10.0V 5% 400 MW	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A2CR6	1901-0040	DICDE:SILICON 30MA 30WV	
A2CR7	1901-0040	DIODE:SILICON 30MA 30WV	
A2J1	1250-0835	CONNECTOR:RF PC MOUNT	
A2L1	9100-1664	COIL/CHOKE 3000 UH 5%	
A2L2	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L3	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L4	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L5	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L6	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L7	9100-1664	COIL/CHOKE 3000 UH 5%	
A2L8	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L9	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L10	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2L11	9100-1641	COIL:MOLDED CHOKE 240.0 UH	
A2Q1	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q2	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q3	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q4	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q5	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q6	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q7	1854-0475	Q:SI NPN	
A2Q8	1854-0475	Q:SI NPN	
A2Q9	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q10	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q11	1854-0475	Q:SI NPN	
A2Q12	1854-0475	Q:SI NPN	
A2Q13	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q14	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q15	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q16	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A2Q17	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q18	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A2Q19	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q20	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q21	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q22	1854-0475	Q:SI NPN	
A2Q23	1854-0221	Q:SI NPN(REPLACEABLE BY 2N4044)	
A2Q24	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q25	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q26	1854-0221	Q:SI NPN(REPLACEABLE BY 2N4044)	
A2Q27	1854-0475	Q:SI NPN	
A2Q28	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q29	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A2Q30	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A2Q31	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A2Q32	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A2Q33	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A2R1	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R2	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A2R3	0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A2R4	0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A2R5	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R6	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R7	0757-0460	R:FXD MET FLM 61.9K OHM 1% 1/8W	
A2R8	0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	
A2R9	0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W	
A2R10	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A2R11	0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W	
A2R12	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R13	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R14	0757-0460	R:FXD MET FLM 61.9K OHM 1% 1/8W	
A2R15	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R16	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R17	0698-0084	R:FXD MET FLM 2.15K 1% 1/8W	
A2R18	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R19	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R20	0698-0084	R:FXD MET FLM 2.15K 1% 1/8W FACTORY SELECTED PART	
A2R21	2100-1759	R:VAR WW 2K OHM 5% TYPE V 1W	
A2R22	0757-0460	R:FXD MET FLM 61.9K OHM 1% 1/8W	
A2R23	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R24	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R25	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R26	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R27	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R28	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R29	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R30	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	
A2R31	0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A2R32	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R33	0757-0424	R:FXD MET FLM 1.10K OHM 1% 1/8W	
A2R34	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A2R35	0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	
A2R36	0698-3156	R:FXD MET FLM 14.7K OHM 1% 1/8W	
A2R37	2100-1760	R:VAR WW 5K OHM 5% TYPE V 1W	
A2R38	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R39	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R40	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R41	0698-3151	R:FXD MET FLM 2.87K OHM 1% 1/8W	
A2R42	0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A2R43	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R44	0698-3491	R:FXD MET FLM 1K OHM 0.1% 1/8W	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A2R45	0698-3491	R:FXD MET FLM 1K OHM 0.1% 1/8W	
A2R46	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	
A2R47	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A2R48	0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	
A2R49	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R50	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R51	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R52	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R53	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R54	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R55	0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A2R56	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A2R57	2100-1760	R:VAR WW 5K OHM 5% TYPE V 1W	
A2R58	0757-0279	R:FXD MET FLM 3.16K OHM 1% 1/8W	
A2R59	0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A2R60	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R61	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R62	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R63	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R64	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R65	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R66	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R67	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R68	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R69	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R70	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R71	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R72	0757-0460	R:FXD MET FLM 61.9K OHM 1% 1/8W	
A2R73	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R74	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R75	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R76	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R77	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R78	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	
A2R79	0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A2R80	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R81	0757-0424	R:FXD MET FLM 1.10K OHM 1% 1/8W	
A2R82	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A2R83	0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	
A2R84	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A2R85	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R86	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R87	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R88	0698-3151	R:FXD MET FLM 2.87K OHM 1% 1/8W	
A2R89	0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A2R90	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R91	0698-3491	R:FXD MET FLM 1K OHM 0.1% 1/8W	
A2R92	0698-3491	R:FXD MET FLM 1K OHM 0.1% 1/8W	
A2R93	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	Part No.	Description #	Note
A2R94	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A2R95	0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	
A2R96	0698-0C83	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A2R97	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A2R98	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R99	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R100	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R101	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R102	0757-C853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A2R103	0757-0290	R:FXD MET FLM 6.19K OHM 1% 1/8W	
A2R104	0757-0279	R:FXD MET FLM 3.16K OHM 1% 1/8W	
A2R105	0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A2R106	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A2R107	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A2R108	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A2R109	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R110	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A2R111	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2R112	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A2S1	3101-0973	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	
A2A1	1901-0557	DIODE:MULTIPLE	
A2A2	1901-0557	DIODE:MULTIPLE	
A3	08414-6003	ASSY:POWER SUPPLY	
A3C1	0180-0361	C:FXD ELECT 10 UF +50-10% 350VDCW	
A3C2	0160-0168	C:FXD MY 0.1 UF 10% 200VDCW	
A3C3	0170-0018	C:FXD MY 1UF 5% 200VDCW	
A3C4	0180-0013	C:FXD ELECT 100UF 100VDCW	
A3C5	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A3C6	0160-2054	C:FXD MY 0.015 UF 10% 3000VDCW	
A3C7	0160-2054	C:FXD MY 0.015 UF 10% 3000VDCW	
A3C8	0160-0151	C:FXD CER 4700 PF +80-20% 4000VDCW	
	5040-0401	SUPPORT:CAPACITOR	
A3C9	0160-2054	C:FXD MY 0.015 UF 10% 3000VDCW	
A3CR1	1901-0029	DIODE:SILICON 600 PIV	
A3CR2	1901-0C33	DIODE:SILICON 100MA 180WV	
A3CR3	1902-3428	DIODE BREAKDOWN:SILICON 100V 5%	
A3CR4	1902-3119	DIODE:BREAKDOWN 6.49V 2%	
A3CR5	1901-005C	DIODE:SILICON 75V	
A3CR6	1901-0632	DIODE:SILICON	
A3CR7	1901-0632	DIODE:SILICON	
A3L1	9140-0C51	COIL:FXD 400 UHY	
A3Q1	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	℗ Part No.	Description #	Note
A3Q2	1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	
A3R1	0698-3639	R:FXD MET OX 1.2K OHM 5% 2W	
A3R2	0757-0367	R:FXD MET FLM 100K OHM 1% 1/2W	
A3R3	0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	
A3R4	0698-3422	R:FXD MET FLM 42.2K OHM 1% 1/2W	
A3R5	0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	
A3R6	0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	
A3R7	0757-0196	R:FXD MET FLM 6.19K OHM 1% 1/2W	
A3R8	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A3R9	2100-1910	R:VAR 100K OHM 20% 3/4W	
A3R10	2100-1910	R:VAR 100K OHM 20% 3/4W	
A3R11	2100-1969	R:VAR 1 MEGOHM 20% 3/4W	
A3R12	0836-0002	R:FXD CARBON 20 MEGOHM 10% 1W	
A3R13	0686-2055	R:FXD COMP 2 MEGOHM 5% 1/2W	
A3R14	0687-1031	R:FXD COMP 10K OHM 10% 1/2W	
A3R15		NOT ASSIGNED	
A3R16	0686-1055	R:FXD COMP 1 MEGOHM 5% 1/2W	
A3R17	0836-0002	R:FXD CARBON 20 MEGOHM 10% 1W	
A3R18	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A3R19	0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	
A3R20	2100-0942	R:VAR FLM 50K OHM 20% 3/4W	
A3R21	0761-0021	R:FXD MET OX 1000 OHM 5% 1W	
A3R22	0761-0021	R:FXD MET OX 1000 OHM 5% 1W	
A3R23	0761-0021	R:FXD MET OX 1000 OHM 5% 1W	
A3A1	08414-6004	ASSY:+ 5100 V STAND OFF	
A3A1C1	0160-0151	C:FXD CER 4700 PF +80-20% 4000VDCW	
A3A1C2	0150-0036	C:FXD CER 470 PF 20% 6KV	
A3A1C3	0150-0036	C:FXD CER 470 PF 20% 6KV	
A3A1CR1	1901-0632	DIODE:SILICON	
A3A1CR2	1901-0632	DIODE:SILICON	
A3A1R1	0698-3456	R:FXD MET FLM 287K OHM 1% 1/8W	
A4	08414-6030	ASSY:PLUG-IN CONNECTION	
A4J1		NOT SEPARATELY REPLACEABLE	
A4J2	1250-0835	CONNECTOR:RF PC MOUNT	
A4P1		NOT SEPARATELY REPLACEABLE	
J1	1250-0083	CONNECTOR:BNC	
J2	1250-0083	CONNECTOR:BNC	
J3	1250-0083	CONNECTOR:BNC	
J4	1250-0083	CONNECTOR:BNC	
J5	1251-1016	CONNECTOR:2 PIN	
J5	0340-0005	INSULATOR:BUSHING CERAMIC	
J5	0520-0118	SCREW:NYLON RD HD SLOT DR 2-56"	
J6	1250-0083	CONNECTOR:BNC(INSTALLED IN H26-8414A ONLY)	
	5040-0702	WASHER:INSULATING (2 EA.)	
L1	5060-0409	COIL:ALIGNMENT	
P1 THRU P3		NOT ASSIGNED	
P4	1251-1017	CONNECTOR:2 PIN, MATES W/1251-1016	

See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

Reference Designation	ⓗⓟ Part No.	Description #	Note
Q1	1854-0072	Q:SI NPN	
Q1	0340-0162	INSULATOR:TRANSISTOR	
Q2	1854-0072	Q:SI NPN	
Q2	0340-0162	INSULATOR:TRANSISTOR	
Q3	1854-0237	Q:SI NPN	
Q3	0340-0162	INSULATOR:TRANSISTOR	
R1	2100-2415	R:VAR COMP 1K OHM 20% LIN 1/2W	
R2	2100-2415	R:VAR COMP 1K OHM 20% LIN 1/2W	
R3	2100-2708	R:VAR COMP 5K-5 MEGOHM 20-30% LIN 1W	
R4	2100-1808	R:VAR 100 OHM 20% LIN 1/2W	
R5	2100-0150	R:VAR GANGED 2X10K OHM 20% LIN 1/4W	
S1	3101-0044	SWITCH:PUSHBUTTON SPST NO	
T1	9100-2421	TRANSFORMER	
T2	9100-2422	TRANSFORMER	
V1	08414-6016	ELECTRON TUBE:CRT	
W1	08414-6014	CABLE ASSY:TEST CHANNEL INPUT	
W1	08410-61007	CABLE ASSY:TEST CHANNEL INPUT (FOR H26-8414A ONLY)	
W1	08410-6020	CABLE ASSY:FOR H26-8414A ONLY	
W2	00140-61606	CABLE:CRT	
		MISCELLANEOUS	
	1200-0408	COVER PLATE:CRT SOCKET	
	1200-0037	SOCKET:CRT TUBE	
	08414-0009	STANDARD SMITH CHART SET:VIEWING	
	08414-0021	COMPRESSED SMITH CHART SET:VIEWING	
	08414-0022	COMPRESSED SMITH CHART SET:PHOTO	
	08414-0024	RETURN LOSS:PHOTO	
	08414-0023	RETURN LOSS:VIEWING	
	08414-0010	STANDARD SMITH CHART SET:PHOTO	
	08414-0011	EXPANDED SMITH CHART SET:VIEWING	
	08414-0012	EXPANDED SMITH CHART SET:PHOTOGRAPHIC	
	5040-0421	INSULATOR(FOR R3B FOCUS	
	0340-0005	INSULATOR:BUSHING CERAMIC	
	0370-0084	KNOB:ROUND BLK 5/8 DIA	
	0370-0107	KNOB:POINTER BLK 5/8 DIA	
	0370-0134	KNOB:ROUND FOR 0.125" DIA SHAFT	
	0520-0118	SCREW:NYLON RD HD SLOT DR 2-56"	

 # See introduction to this section for ordering information

Table 6-2. Parts List Indexed by Reference Designation (Cont)

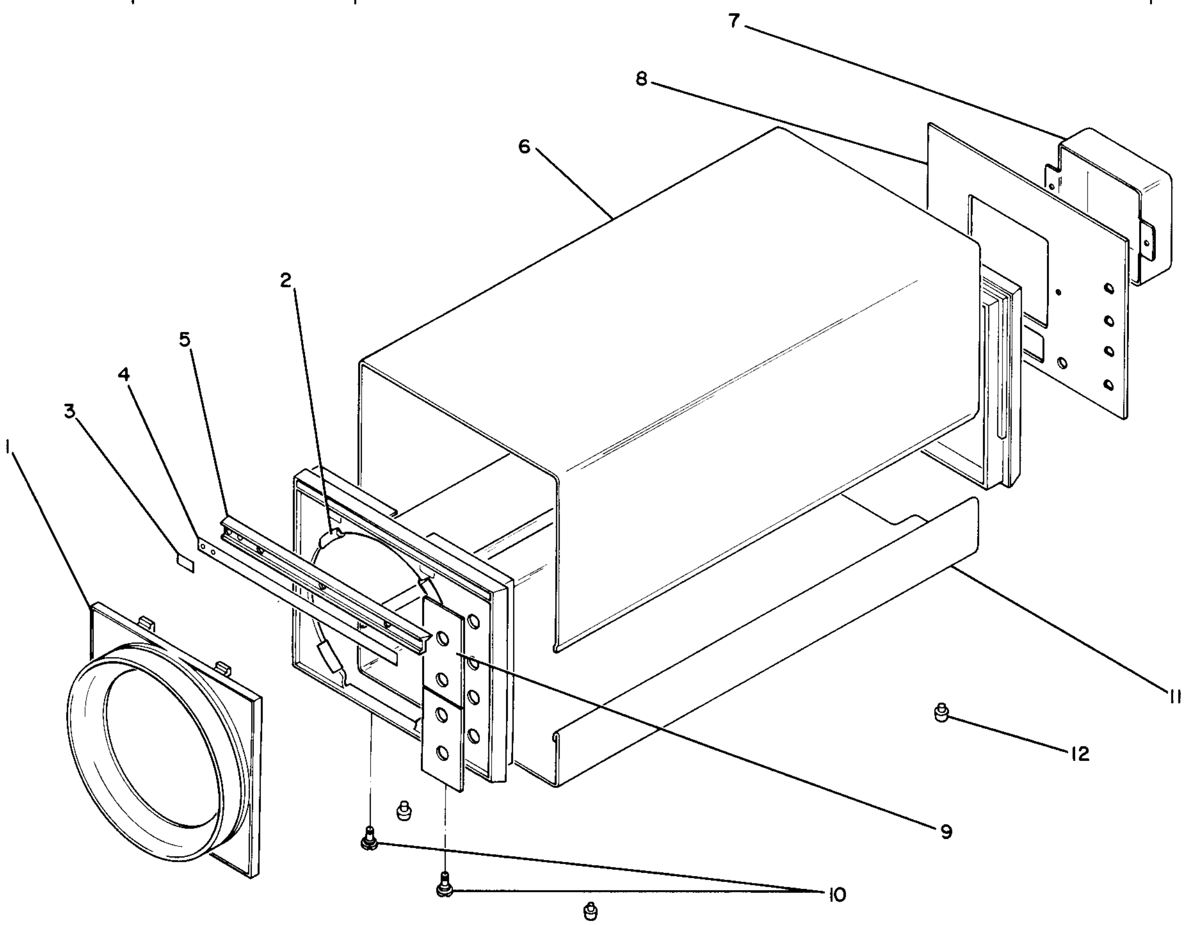


Figure 6-1. Cabinet Parts

Reference Designation	ⓗ Part No.	Description #	Note
		CABINET PARTS	
1	08414-2014	CRT BEZEL	
1	2370-0013	SCREW:SST FLAT HD PHL DR 6-32 X 3/8	
2	4320-0062	EXTRUSION,RUBBER	
3	7120-1254	TRADEMARK	
4	7120-1574	PLATE:IDENTIFICATION(POLAR DISPLAY)	
5	5020-3281	TRIM,NAMEPLATE	
5	2210-0001	SCREW:MACHINE SST FH 4-40X3/16	
6	5060-0239	TOP COVER ASSY:PLUG-IN	
6	2370-0003	SCREW:SST FLAT HD 6-32 X 0.500	
7	08414-0001	COVER:REAR CRT	
7	2370-0001	SCREW:SST FLAT HD 6-32 X 0.250	
8	08414-0005	PANEL:REAR	
9	08414-0003	PANEL:FRONT	
10	5020-3288	PIN,EXTRACTOR	
11	5000-3339	COVER,PLUG-IN BOTTOM	
11	2370-0003	SCREW:SST FLAT HD 6-32 X 0.500	
12	5040-0274	FOOT,PLUG-IN	

 # See introduction to this section for ordering information

Table 6-3. Parts List Indexed by HP Part Number

ⓗ Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0140-0157	C:FXD MICA 1857 PF 1%	28480	0140-0157	6
0140-0196	C:FXD MICA 150 PF 5%	28480	0140-0196	1
0140-0198	C:FXD MICA 200 PF 5%	72136	RDM15F201J3C	1
0150-0036	C:FXD CER 470 PF 20% 6KV	91418	6KV470 20%	2
0150-0082	C:FXD CER 8200 PF 500VDCW	C4222	TYPE D1-4	2
0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	56289	5C50BIS-CML	2
0160-0151	C:FXD CER 4700 PF +80-20% 4000VDCW	71590	DA045-040CD	2
0160-0168	C:FXD MY 0.1 UF 10% 200VDCW	28480	0160-0168	2
0160-0939	C: FXD MICA 430 PF 5% 300 VDCW	28480	0160-0939	4
0160-2054	C:FXD MY 0.015 UF 10% 3000VDCW	71436	PMS153-3MS	3
0160-2204	C:FXD MICA 100PF 5%	72136	RDM15F101J3C	2
0160-2208	C:FXD MICA 330 PF 5% 300VDCW	28480	0160-2208	4
0160-2210	C:FXD MICA 470 PF 5%	28480	0160-2210	2
0160-2917	C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA	13
0160-2930	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	6
0170-0018	C:FXD MY 1UF 5% 200VDCW	84411	TYPE 621M 10552	1
0180-0013	C:FXD ELECT 100UF 100VDCW	56289	D33067	1
0180-0116	C:FXD ELECT 6.8 UF 10% 35VDCW	28480	0180-0116	8
0180-0269	C:FXD ELECT 1.0 UF +50-10% 150VDCW	56289	30D105F150BA2-DSM	1
0180-0361	C:FXD ELECT 10 UF +50-10% 350VDCW	28480	0180-0361	1
0340-0005	INSULATOR:BUSHING CERAMIC	28480	0340-0005	2
0340-0162	INSULATOR:TRANSISTOR	28480	0340-0162	3
0370-0084	KNOB:ROUND BLK 5/8 DIA	28480	0370-0084	1
0370-0107	KNOB:POINTER BLK 5/8 DIA	28480	0370-0107	1
0370-0134	KNOB:ROUND FOR 0.125" DIA SHAFT	28480	0370-0134	1
0490-0739	RELAY:DPDT 2A	77342	HP11D-24V	1
0520-0118	SCREW:NYLON RD HD SLOT DR 2-56"	28480	0520-0118	2
0686-1055	R:FXD COMP 1 MEGOHM 5% 1/2W	01121	EB 1055	1
0686-2055	R:FXD COMP 2 MEGOHM 5% 1/2W	01121	EB 2055	1
0687-1031	R:FXD COMP 10K OHM 10% 1/2W	01121	EB 1031	1
0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	14674	C4	23
0698-0084	R:FXD MET FLM 2.15K 1% 1/8W	14674	C4	2
0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	14674	C4	1
0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	14674	C4	1
0698-3151	R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151	2
0698-3153	R:FXD MET FLM 3.83K 1% 1/8W	91637	MFF-1/10-32	1
0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154	8
0698-3156	R:FXD MET FLM 14.7K OHM 1% 1/8W	14674	C4	2
0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	14674	C4	17
0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	75042	CEA	1
0698-3422	R:FXD MET FLM 42.2K OHM 1% 1/2W	91637	MFF-1/2-10	1
0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	91637	MF-1/10-32	10
0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	14674	C4	4
0698-3450	R:FXD MET FLM 42.2K OHM 1% 1/8W	28480	0698-3450	4
0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	28480	0698-3453	1
0698-3456	R:FXD MET FLM 287K OHM 1% 1/8W	28480	0698-3456	1
0698-3491	R:FXD MET FLM 1K OHM 0.1% 1/8W	28480	0698-3491	4
0698-3639	R:FXD MET OX 1.2K OHM 5% 2W	28480	0698-3639	1
0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W	91637	MF-1/10-32	3
0757-0196	R:FXD MET FLM 6.19K OHM 1% 1/2W	14674	C4	1
0757-0279	R:FXD MET FLM 3.16K OHM 1% 1/8W	14674	C4	3
0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	14674	C4	2
0757-0290	R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290	2
0757-0367	R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367	1

 # See introduction to this section for ordering information

Table 6-3. Parts List Indexed by HP Part Number (Cont)

ⓗⓟ Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	14674	C4	1
0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	14674	C4	1
0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	28480	0757-0421	6
0757-0424	R:FXD MET FLM 1.10K OHM 1% 1/8W	28480	0757-0424	2
0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	14674	C4	3
0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439	1
0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	14674	C4	4
0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	14674	C4	18
0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	91637	MF-1/10-32	2
0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444	1
0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447	1
0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	91637	MF-1/10-32	4
0757-0460	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460	4
0757-0465	R:FXD MET FLM 100K 1% 1/8W	14674	C4	8
0757-0853	R:FXD MET FLM 51.1K OHM 1% 1/2W	28480	0757-0853	6
0761-0021	R:FXD MET OX 1000 OHM 5% 1W	14674	C-32 OBD	3
0836-0002	R:FXD CARBON 20 MEGOHM 10% 1W	28480	0836-0002	2
1200-0037	SOCKET:CRT TUBE	72825	97097	1
1200-0085	COVER PLATE:CRT SOCKET	72825	9709-1	1
1250-0083	CONNECTOR:BNC	28480	1250-0083	5
1250-0835	CONNECTOR:RF PC MOUNT	98291	50-051-0000	2
1251-0498	CONNECTOR:PC 22 CONTACTS	28480	1251-0498	2
1251-1016	CONNECTOR:2 PIN	81312	JF2P-2S-AB	1
1251-1017	CONNECTOR:2 PIN, MATES W/1251-1016	81312	JF2P-2S-AB	1
1251-1378	CONNECTOR:PC 9 CONTACTS	C2660	64-17	1
1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020	13
1853-0051	Q:SI PNP	02735	2N4037	2
1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071	14
1854-0072	Q:SI NPN	02735	2N3054	2
1854-0221	Q:SI NPN(REPLACEABLE BY 2N4044)	28480	1854-0221	8
1854-0232	Q:SI NPN(SELECTED FROM 2N3440)	28480	1854-0232	9
1854-0237	Q:SI NPN	04713	2N3738	1
1901-0025	DIODE:SILICON 100MA/1V	07263	FD 2387	3
1901-0029	DIODE:SILICON 600 PIV	28480	1901-0029	1
1901-0033	DIODE:SILICON 100MA 180WV	07263	FD3369	1
1901-0040	DIODE:SILICON 30MA 30WV	07263	FDG1088	9
1901-0050	DIODE:SILICON 75V	14433	S270	1
1901-0473	DIODE ASSY:SILICON 50 MA 7500PIV	28480	1901-0473	4
1901-0557	DIODE:MULTIPLE	28480	1901-0557	2
1902-0025	DIODE,BREAKDOWN:10.0V 5% 400 MW	28480	1902-0025	1
1902-0041	DIODE:BREAKDOWN 5.11V 5%	04713	SZ10939-98	1
1902-3119	DIODE:BREAKDOWN 6.49V 2%	04713	SZ10939-129	1
1902-3428	DIODE BREAKDOWN:SILICON 100V 5%	28480	1902-3428	1
2100-0150	R:VAR GANGED 2X10K OHM 20% LIN 1/4W	28480	2100-0150	1
2100-0942	R:VAR FLM 50K OHM 20% 3/4W	28480	2100-0942	1
2100-1759	R:VAR WW 2K OHM 5% TYPE V 1W	28480	2100-1759	1
2100-1760	R:VAR WW 5K OHM 5% TYPE V 1W	28480	2100-1760	2
2100-1770	R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770	2
2100-1808	R:VAR 100 OHM 20% LIN 1/2W	28480	2100-1808	1
2100-1910	R:VAR 100K OHM 20% 3/4W	28480	2100-1910	2
2100-1969	R:VAR 1 MEGOHM 20% 3/4W	28480	2100-1969	1
2100-2415	R:VAR COMP 1K OHM 20% LIN 1/2W	28480	2100-2415	2
2100-2708	R:VAR COMP 5K-5 MEGOHM 20-30% LIN 1W	28480	2100-2708	1
2210-0001	SCREW:MACHINE SST FH 4-40X3/16	97934	OMD	1

 # See introduction to this section for ordering information

Table 6-3. Parts List Indexed by HP Part Number (Cont)

HP Part No.	Description #	Mfr.	Mfr. Part No.	TQ
2370-0001	SCREW:SST FLAT HD 6-32 X 0.250	28480	2370-0001	1
2370-0003	SCREW:SST FLAT HD 6-32 X 0.500	28480	2370-0003	2
2370-0013	SCREW:SST FLAT HD PHL DR 6-32 X 3/8	28480	2370-0013	1
3101-0044	SWITCH:PUSHBUTTON SPST NO	81073	39- N.O.	1
3101-0973	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	79727	G126-0018	1
4320-0062	EXTRUSION,RUBBER	28480	4320-0062	1
5000-3339	COVER,PLUG-IN BOTTOM	28480	5000-3339	1
5020-3281	TRIM,NAMEPLATE	28480	5020-3281	1
5020-3288	PIN,EXTRACTOR	28480	5020-3288	1
5040-0274	FOOT,PLUG-IN	28480	5040-0274	1
5040-0401	SUPPORT:CAPACITOR	28480	5040-0401	1
5040-0421	INSULATOR(FOR R3B FOCUS	28480	5040-0421	1
5060-0239	TOP COVER ASSY:PLUG-IN	28480	5060-0239	1
5060-0409	COIL:ALIGNMENT	28480	5060-0409	1
7120-1254	TRADEMARK	28480	7120-1254	1
7120-1574	PLATE:IDENTIFICATION(POLAR DISPLAY)	28480	7120-1574	1
9100-1630	COIL/CHOKE 51.0 UH 5%	28480	9100-1630	1
9100-1641	COIL:MOLDED CHOKE 240.0 UH	28480	9100-1641	9
9100-1664	COIL/CHOKE 3000 UH 5%	28480	9100-1664	2
9100-2421	TRANSFORMER	28480	9100-2421	1
9100-2422	TRANSFORMER	28480	9100-2422	1
9140-0051	COIL:FXD 400 UHY	28480	9140-0051	1
00140-61606	CABLE:CRT	28480	00140-61606	1
08410-61007	CABLE ASSY:TEST CHANNEL INPUT	28480	08410-61007	1
08414-0001	COVER:REAR CRT	28480	08414-0001	1
08414-0003	PANEL:FRONT	28480	08414-0003	1
08414-0005	PANEL:REAR	28480	08414-0005	1
08414-0009	STANDARD SMITH CHART SET:VIEWING	28480	08414-0009	1
08414-0010	STANDARD SMITH CHART SET:PHOTO	28480	08414-0010	1
08414-0011	EXPANDED SMITH CHART SET:VIEWING	28480	08414-0011	1
08414-0012	EXPANDED SMITH CHART SET:PHOTOGRAPHIC	28480	08414-0012	1
08414-0021	COMPRESSED SMITH CHART SET:VIEWING	28480	08414-0021	1
08414-0022	COMPRESSED SMITH CHART SET:PHOTO	28480	08414-0022	1
08414-0023	RETURN LOSS:VIEWING	28480	08414-0023	1
08414-0024	RETURN LOSS:PHOTO	28480	08414-0024	1
08414-2014	CRT BEZEL	28480	08414-2014	1
08414-6003	ASSY:POWER SUPPLY	28480	08414-6003	1
08414-6004	ASSY:+ 5100 V STAND OFF	28480	08414-6004	1
08414-6014	CABLE ASSY:TEST CHANNEL INPUT	28480	08414-6014	1
08414-6016	ELECTRON TUBE:CRT	28480	08414-6016	1
08414-6028	ASSY:COORDINATE CONVERTER	28480	08414-6028	1
08414-6029	ASSY:Z-AXIS MOD & INTERCONNECTION	28480	08414-6029	1
08414-6030	ASSY:PLUG-IN CONNECTION	28480	08414-6030	1

 # See introduction to this section for ordering information

Table 6-4. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven,Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill
01960	Pulse Engineering Co.	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc, Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P. M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena, Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc.	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.

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Table 6-4. Code List of Manufacturers (Cont)

Code No.	Manufacturer	Address
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division, Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp.	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St.Louis, Mo.

Table 6-4. Code List of Manufacturers (Cont)

Code No.	Manufacturer	Address
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst. Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phanostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any Brand Tube meeting EIA Standards-Washington, D.C.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Sugundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc., Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Roltron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill

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Table 6-4. Code List of Manufacturers (Cont)

Code No.	Manufacturer	Address
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Cal.
85474	R.M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U S Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90763	United Carr Fastener Corp	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros, Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Slyvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite Inc.	Orchard Park, N.Y.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Cal.
96881	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Div.	El Monte, Cal.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Cal.

The following HP Vendors have no number assigned in the latest supplement to the Federal Supply Code for Manufacturers Handbook.

Code No.	Manufacturer	Address
0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments for which the content does not apply directly. In addition, information about recommended modifications for improvements to the instruments is provided.

7-3. MANUAL CHANGES

7-4. To adapt this manual to your instrument, refer to Table 7-1 and make all of the manual changes listed opposite your instrument serial number.

7-5. If your instrument and serial number is not listed on the title page of this manual or in Table 7-1 below, it may be documented in a yellow MANUAL CHANGES supplement. For additional important information concerning serial number coverage refer to INSTRUMENTS COVERED BY MANUAL in Section I.

7-6. Some schematic diagrams may contain a "dagger" symbol near components which have changes or have been added during the life of the instrument. The "dagger" refers to Table 7-2, Summary of Changes by Component. Information from this table in conjunction with information from Table 7-1 may be used to determine if the change applies to the instrument being serviced.

Table 7-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
936-	A, B		
940-	B		

► NEW ITEM

CHANGE A

Page 6-4, Table 6-2:
Change A2C14 and A2C36 to HP Part No. 0160-2204, C: FXD MICA 100PF 5%.

Page 6-5, Table 6-2:
Change A2L1 and A2L7 to HP Part No. 9100-1664, COIL/CHOKE 3000 UH 5%.

Page 8-13, Figure 8-14:
Change A2C14 and A2C36 to 100 pF.
Change A2L1 and A2L7 to 3 mH.

CHANGE B

Page 6-3, Table 6-2:
Delete A1R42 through A1R44.

Page 8-17, Figure 8-18:
Delete A1R42 through A1R44.

Table 7-2. Summary of Changes by Component

CHANGES	A1	A2	A3	A4	Chassis (No Prefix)
A		C14 ② C36 L1, 7			
B	R42-44	Q7, 8, 11, ① 12, 22, 23, 26, 27			

[1]Replace with new part.

[2]Replace with original part.

Table 8-1. Recommended Test Equipment

Item	Critical Specifications	Recommended HP Model
Oscillator	Frequency Range: 280 (±50) kHz and 1 (±0.1) kHz Output Level: variable from 0 to 3.0 Vrms Output Impedance: 50 to 600 ohms	200CD, 651A
DC Power Supply	Output: -5 Vdc	6213A
Oscilloscope	Vertical: Minimum bandwidth 5 MHz Minimum sensitivity 10 mV/cm Input: dc and ac Horizontal: Range: 1 μsec/cm to 5 μsec/cm	180A with 1801A and 1821A
Network Analyzer	No Substitute May be Used.	8410A with 8411A or 8407A
Sweep Oscillator	Frequency Range: Any frequency within the operating range of the Network Analyzer.	8690A with RF unit as required (see Note 1)
20-dB Attenuator	Impedance: 50 ohms nominal Attenuation: 20 dB ±3 dB SWR: 1.3 max (1 kHz and 280 kHz) Connector: BNC	8491A with N to BNC adapters (see Note 2)
Transducer	Frequency Range: Same as Sweep Oscillator	8740A, 8741A, 8742A, 8743A or 8745A (see Note 3)
Service Cable (supplied with 8410A or 8407A)	No Substitute May be Used	HP Part No. 08410-6032
High Voltage DCVM	Range: 0 to 6 kV Accuracy: ±10% of reading Input Impedance: ⩾12G ohms	410B with 11044A voltage divider probe.

[1]For 8407A Network Analyzers Model 8601A Sweep Oscillator may be used.

[2]Oscilloscope 10:1 divider probe, such as HP Model 10003A may be used in place of 20-dB attenuator.

[3]For 8407A Network Analyzers use HP Model 11561A or BNC Tee.

SECTION VIII
SERVICE

8-1. INTRODUCTION.

8-2. This section contains principles of operation, circuit descriptions, troubleshooting procedures, schematic diagrams and repair procedures.

8-3. PRINCIPLES OF OPERATION.

8-4. A description of the simplified block diagram and general principles of operation are presented on the first foldout. A detailed block diagram description is presented on the back of the foldout preceding the diagram. Schematic circuit descriptions are given on the back of the foldout preceding each schematic diagram.

8-5. TROUBLESHOOTING.

8-6. An equipment setup and preliminary instructions for all troubleshooting procedures are given in Figure 8-4. Troubleshooting procedures for the block diagram and each schematic are on the back of the foldout preceding the block diagram and each schematic.

8-7. RECOMMENDED TEST EQUIPMENT.

8-8. The test instruments and accessories required for troubleshooting are listed in Table 8-1. Test instruments other than those listed can be used provided their performance equals or exceeds the Critical Specifications listed.

8-9. REPAIR.

8-10. Part Location Aids.

8-11. The locations of adjustments, chassis-mounted parts and major assemblies are shown on the last foldout. The locations of individual components mounted on a printed circuit board are shown opposite the related schematic diagram. The part reference designator may be found from the schematic diagram, then located on the board.

8-12. Circuit Board Repair.

8-13. The printed circuit boards in the 8414A are of the plated-through type consisting of metallic conductors bonded to both sides of insulating material. Soldering can be done from either side of the board with equally good results. Table 8-2 lists required tools and materials. Following are recommendations and precautions pertinent to printed circuit repair work.

a. Avoid unnecessary component substitution; it can result in damage to the circuit board and adjacent components.

b. Do not use a high-power soldering iron. Excessive heat may lift a conductor or damage the board.

c. Use a suction device (Table 8-2) or wooden toothpick to remove solder from component mounting holes. *Do not use a sharp metal object such as an awl or twist drill for this purpose. Sharp objects may damage the plated-through conductor.*

d. After soldering, remove excess flux from the soldered area and apply a protective coating to prevent contamination and corrosion. See Table 8-2 for recommendations.

8-14. A broken or burned section of conductor can be repaired by bridging the damaged section with a length of tinned copper wire. Allow adequate overlap and remove any varnish from the conductor before soldering wire into place.

8-15. Component Replacement.

8-16. A general procedure for replacing a component is as follows:

a. Remove defective component from circuit board.

b. Remove solder from mounting holes using a suction desoldering aid (Table 8-2) or wooden toothpick.

c. Shape leads or replacement component to match mounting hole spacing.

d. Insert component leads into mounting holes and position component as original was posi-

Table 8-2. Printed Circuit Soldering Equipment

Item	Use	Specification	Item Recommended
Soldering Tool	Soldering Unsoldering	Wattage Ratings: 37.5 Tip Temp: 750 – 800°F Tip Size: 1/8" OD	Ungar #776 Handle with Ungar #1237 Heating Unit
Soldering Tip general purpose	Soldering Unsoldering	Shape: chisel Size: 1/8"	Ungar #PL113
De-soldering aid	Unsoldering multiconnection components (e.g., sockets)	Suction device to remove molten solder from connection	Soldapullt by the Edsyn Company, Arleta, California
Resin (flux) solvent	Remove excess flux from soldered area before application of protective coating	Must not dissolve etched circuit base board material or conductor bonding agent	Freon Acetone Lacquer Thinner Isopropyl Alcohol (100% dry)
Solder	Component Replacement Circuit Board repair Wiring	Resix (flux) core, high tin content (60/40 tin/lead), 18 gauge (SWG) preferred	
Protective Coating	Contamination, corrosion protection after soldering	Good electrical insulation, corrosion-prevention properties	GE DR1— FILM 88, General Electric Co., Silicone Products Dept., Waterford, New York

tioned. *Do not force leads of replacement component into mounting holes.* Sharp lead ends may damage plated-through conductor.

Note

Axial lead components, such as resistors and tubular capacitors, can be replaced without unsoldering. Clip leads near body of defective component, remove component and straighten leads left in board. Wrap leads of replacement component one turn around original leads. Solder wrapped connection and clip off excess lead.

8-17. Transistor Replacement.

8-18. A general procedure for replacing a transistor is as follows:

a. Do not apply excessive heat. See Table 8-2 for soldering tool specifications.

b. Use a heat sink such as pliers or hemostat between transistor body and hot soldering iron.

c. When installing a replacement transistor, ensure sufficient lead length to dissipate heat of soldering by maintaining about the same length of exposed lead as used for original transistor.

8-19. Diode Replacement.

8-20. Solid state diodes are in many physical forms. This sometimes results in confusion as to which lead or connection is for the cathode (negative) or anode (positive), since not all diodes are marked with the standard symbols. Figure 8-1 shows examples of some diode marking methods. If doubt exists as to polarity, an ohmmeter may be used to determine the proper connection. It is necessary to know the polarity of the ohms lead with respect to the common lead for the ohmmeter used. Ohms lead polarities for some common ohmmeters are shown in Table 8-3. When the ohm-

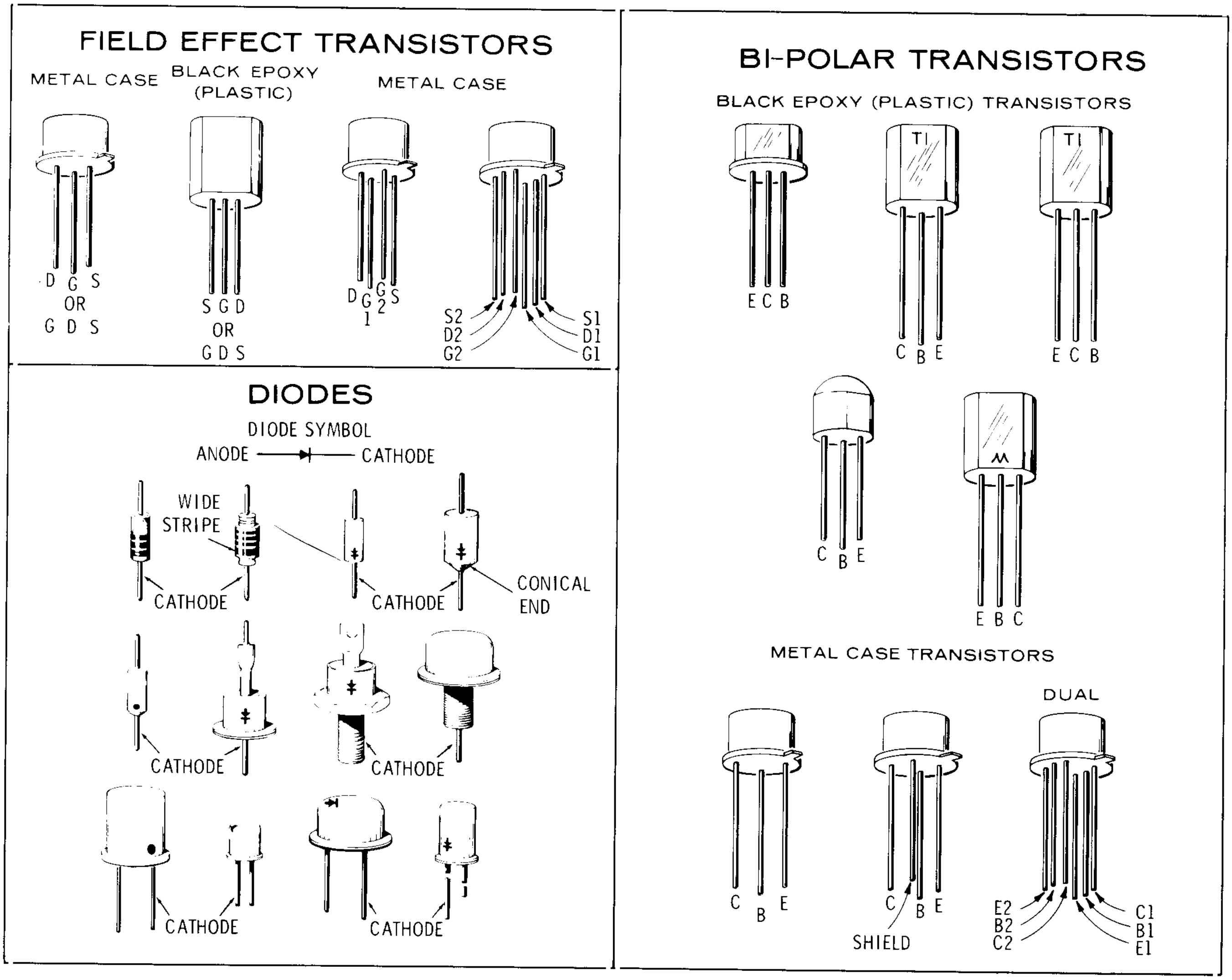


Figure 8-1. Examples of Diode and Transistor Marking Methods

meter indicates the least diode resistance, the cathode of the diode is connected to the ohmmeter lead which is negative with respect to the other lead.

Note

Diode replacement instructions are the same as those for transistor replacement.

8-21. SCHEMATIC DIAGRAMS.

8-22. The schematic diagrams in this section represent the circuits electrically. They are not wiring diagrams, though wire colors are given where practical.

8-23. The circuits are arranged according to signal flow; consequently, some switch and circuit assemblies may be shown in part on more than one diagram. If so, the reference designation is preceded by P/O, for "Part of", and is followed by a notation of the number of parts into which the assembly has been divided.

8-24. The large numbers in the lower right corners of the schematics are the schematic numbers. These numbers are used to cross reference connections between schematics.

8-25. Some of the general information obtainable from the schematics is shown in Figure 8-2. Notes

Table 8-3. Ohmmeters Used for Transistor Testing

Ohmmeter	Range(s)	Open Circuit Voltages	Short Circuit Current	Lead	
				Color	Polarity
HP 412A HP 427A	R x 1K R x 10K R x 100K R x 1M R x 10M	1.0V 1.0V 1.0V 1.0V 1.0V	1 mA 100 μA 10 μA 1 μA 0.1 μA	Red Black	+ —
HP 410C	R x 1K R x 10K R x 100K R x 1M R x 10M	1.3V 1.3V 1.3V 1.3V 1.3V	0.57 mA 57 μA 5.7 μA 0.5 μA 0.05 μA	Red Black	+ —
HP 410B	R x 100 R x 1K R x 10K R x 100K R x 1M	1.1V 1.1V 1.1V 1.1V 1.1V	1.1 mA 110 μA 11 μA 1.1 μA 0.11 μA	Black Red	+ —
Simpson 260	R x 100	1.5V	1 mA	Red Black	+ —
Simpson 269	R x 1K	1.5V	0.82 mA	Black Red	+ —
Triplett 630	R x 100 R x 1K	1.5V 1.5V	3.25 mA 325 μA	Varies with Serial Number	
Triplett 310	R x 10 R x 100	1.5V 1.5V	750 μA 75 μA		

and explanations of symbols pertaining to all the diagrams are contained in Figure 8-3. Notes about specific components, circuits or conditions are given on the diagram to which they apply.

8-26. As an aid to finding components and assemblies in the set of diagrams, each diagram has a box labelled "Reference Designations" that contains all the reference designations appearing on the diagram.

Table 8-4. Out-of-Circuit Transistor Testing

Transistor Type		Connect Ohmmeter Positive Lead to	Connect Ohmmeter Negative Lead to	Measure Resistance (Ohms)
PNP Germanium	Small Signal	emitter	base*	200—250
		emitter	collector	10K—100K
	Power	emitter	base*	30—50
		emitter	collector	several hundred
PNP Silicon	Small Signal	emitter	base*	10K—100K
		emitter	collector	Very high (might read open)
NPN Silicon	Small Signal	base	emitter	1K—3K
		collector	emitter	Very high (might read open)
	Power	base	emitter	200—1000
		collector	emitter	High, often greater than 1M

*To test for transistor action, add collector-base short. Measured resistance should decrease

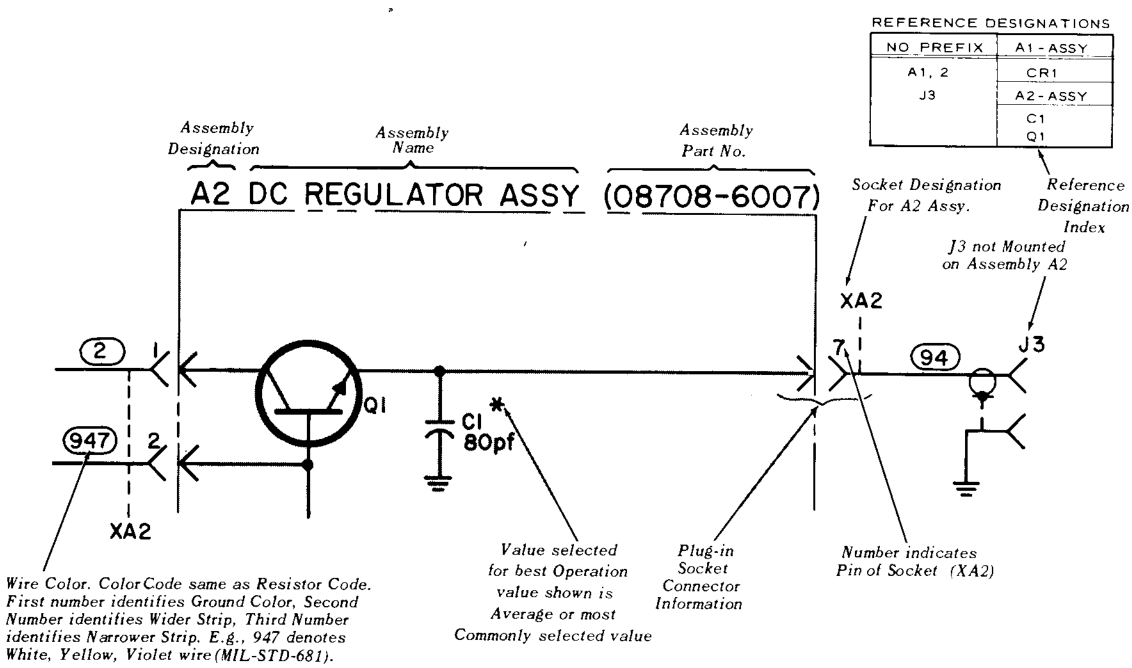


Figure 8-2. General Information on Schematic Diagrams

SCHEMATIC DIAGRAM NOTES

Refer to MIL Std 15B for Symbols Not Shown

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

P/O = part of.

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

 Screwdriver adjustment.

○ Panel control.

Encloses front panel designations.

Encloses rear panel designation.

Circuit assembly borderline.

Other assembly borderline.

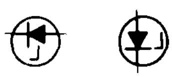
Heavy line with arrows indicates path and direction of main signal.

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

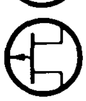
 Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.

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

Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number identifies 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.

 Voltage regulator (breakdown diode).

 Denotes Field Effect transistor (FET) with N-type base.

 Denotes FET with P-type base.

 Denotes Capacitive diode (Varicap, varactor).

 Denotes Silicon Controlled Rectifier.

 P-Type Metal Oxide Substrate FET (MOSFET)

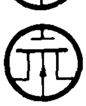
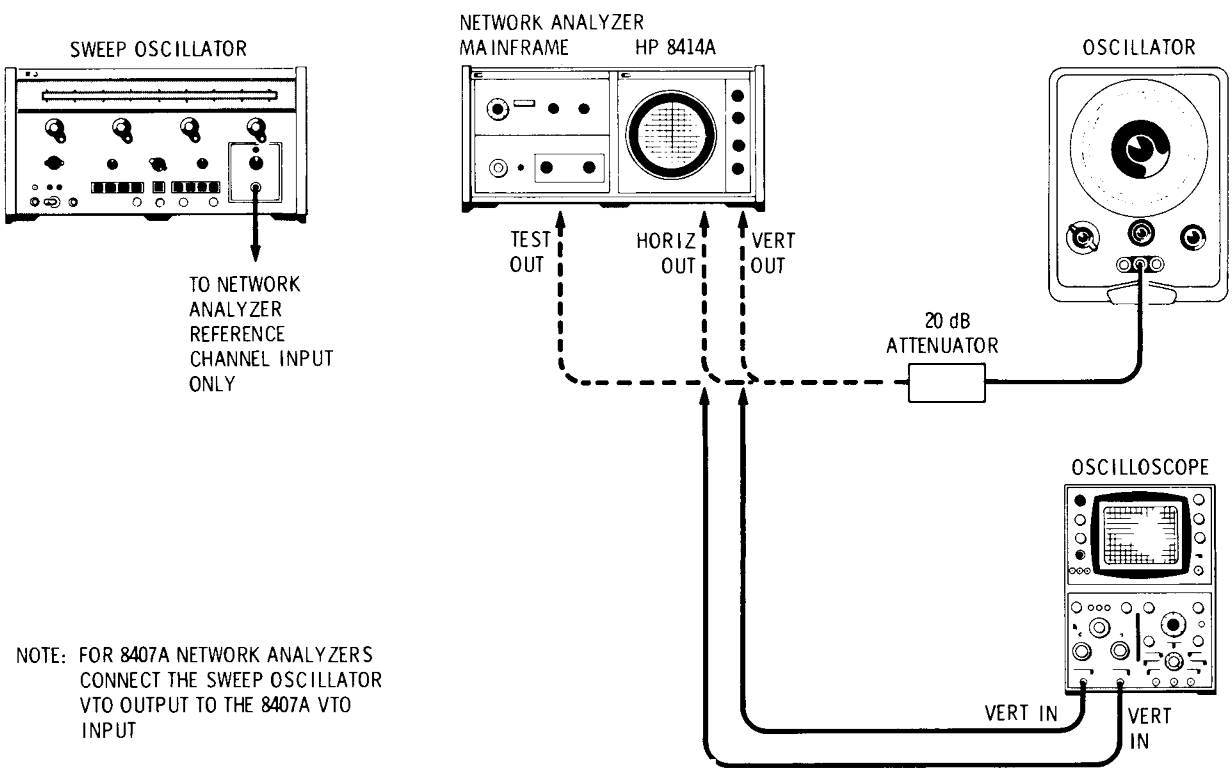
 N-Type Metal Oxide Substrate FET (MOSFET)

Figure 8-3. Schematic Diagram Notes

TROUBLESHOOTING SETUP



EQUIPMENT

SWEEP OSCILLATOR	HP 8690-SERIES WITH RF UNIT AS REQUIRED
NETWORK ANALYZER	HP 8410A/8411A OR HP 8407A
OSCILLATCR	HP 200CD
20-dB ATTENUATOR	HP 8491A
OSCILLOSCOPE	HP 180A/1801A/1821A

INITIAL EQUIPMENT SETUP:

a. Remove 8414A covers and connect 8414A to Network Analyzer mainframe with extender cable, HP Part No. 08410-6032.

b. Set the sweep oscillator for single-frequency operation and connect the RF output to the Network Analyzer reference channel input only.

c. Set the Network Analyzer to phase lock to the applied signal and adjust the sweep oscillator RF output level for a Network Analyzer reference channel level meter indication in the middle of the operate region.

d. Set the Network Analyzer test channel gain[1] controls for minimum gain.

e. Set the 8414A INTENSITY control fully clockwise.

f. Press and hold the 8414A BEAM CTR pushbutton and adjust the HORIZONTAL and VERTICAL POS controls to locate the dot in the center of the Polar Display.

Note

Perform block diagram troubleshooting.

[1]Display reference for 8407A.

Figure 8-4. Setup for Troubleshooting

HOW TWO SINE WAVES ARE CONVERTED TO A POLAR DISPLAY

The Model 8414A Polar Display provides a polar plot of the relative magnitude and phase of the signals applied to the Network Analyzer. Two signals from the Network Analyzer mainframe, a test signal and a phase reference signal, are applied to the 8414A. The phase reference signal alternately gates on two bridge detectors a sin ϕ detector and a cos ϕ detector. The test signal divides into two signals. One of these signals is shifted in phase by 180 degrees and fed to the cos ϕ detector. The other signal is shifted in phase by -90 degrees and fed to the sin ϕ detector. Each detector produces an output proportional to the test signal amplitude and phase relationship between the test signal and phase reference signal. The detector output signals are converted to deflection signals which are applied to the CRT, producing a polar display.

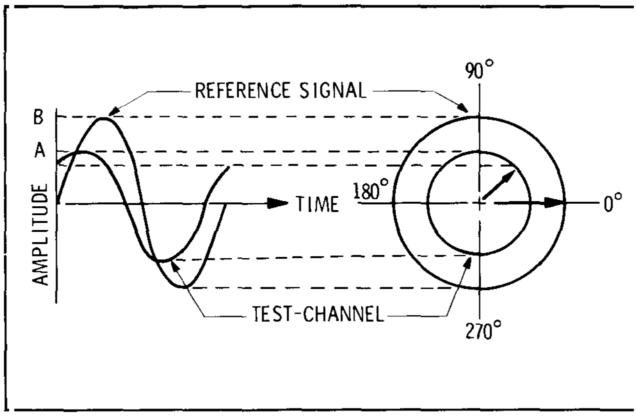


Figure 8-6. Conversion of Typical Time-Amplitude Graph to Polar Graph

An understanding of the signal processing may be obtained by discussing the trigonometric relationship between signals. Begin by assuming two sine-wave signals, a reference signal, and a test signal which leads the reference signal by some phase angle ϕ. (See figure 8-5.) For this discussion we will assume that the angle ϕ is approximately 45 degrees; however, it may be any angle.

The sine-wave relationship in Figure 8-5 may be converted to a polar relationship as shown in Figure 8-6 by laying out the 360 degrees in a circle and projecting the amplitude. The reference and test signal vectors are shown on the polar graph at zero time.

Note that the reference signal starts at zero and the test signal leads it by an angle ϕ. As time progresses, the two polar vectors rotate in the counter-clockwise direction. Since both the reference and the test signals are at the same frequency, their vectors rotate at the same rate, always separated by an angle ϕ; therefore, angle ϕ or phase is measured with respect to the reference signal.

The Polar Display must resolve the vector of the test signal shown in Figure 8-7 into a similar form

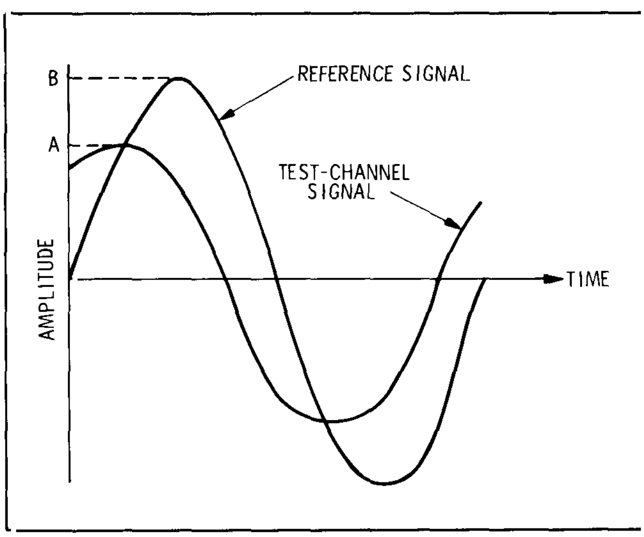


Figure 8-5. Phase and Amplitude Relationship of Typical Reference and Test Signals

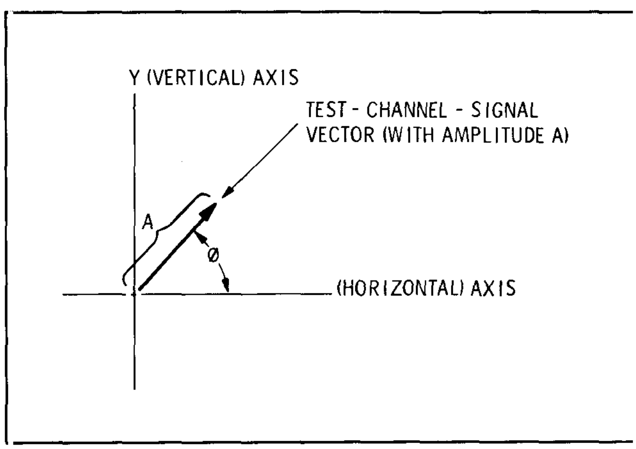


Figure 8-7. Polar Vector of Test Signal

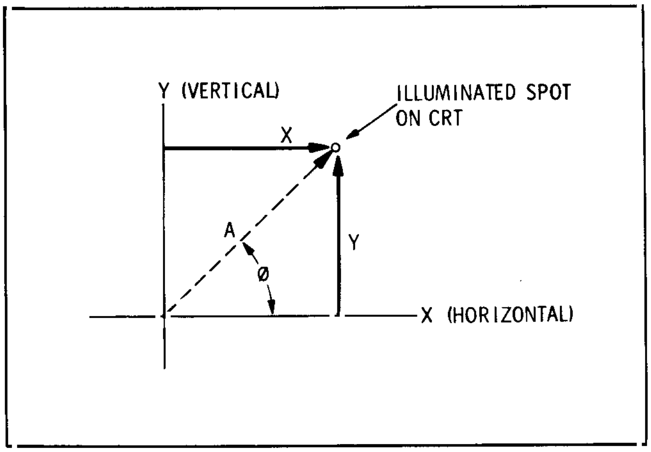


Figure 8-8. Horizontal and Vertical Vectors Required to Deflect CRT Beam

that can be displayed on the CRT. This is done by producing an illuminated spot on the CRT where the arrowhead of the vector would appear. (See Figure 8-8.) This can be interpreted into amplitude (A) and phase (ϕ) by the use of the built-in polar graph on the face of the CRT.

To produce the illuminated spot on the CRT, the amplitude and phase of the polar signal must be resolved into X (horizontal) and Y (vertical) rectangular components as shown in Figure 8-8. These X and Y signals are applied to the horizontal and vertical deflection plates producing a spot on the CRT representing the arrowhead of the vector.

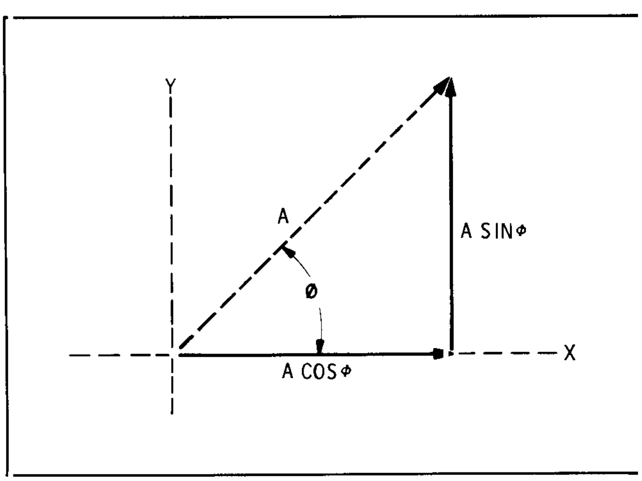


Figure 8-9. Vector Graph of a Typical Test Signal

Conversion from the two signals applied to the input of the Polar Display to the rectangular X-Y signal is accomplished by a 90 degree phase-shifter and two phase-detector circuits. To understand the operation of these circuits a brief discussion of the trigonometry used is presented. Figure 8-9 shows a vector diagram in the form of a right triangle of the signals discussed. From trigonometric relationships in a right triangle:

$$\text{Cos } \phi = \frac{\text{Adjacent Side}}{\text{Hypotenuse}} = \frac{\text{X Component}}{\text{A}};$$

therefore;

$$\text{X Component} = \text{A Cos } \phi.$$

Also,

$$\text{Sin } \phi = \frac{\text{Opposite Side}}{\text{Hypotenuse}} = \frac{\text{Y Component}}{\text{A}};$$

therefore,

$$\text{Y Component} = \text{A Sin } \phi.$$

The sin ϕ detector circuit produces a voltage with the value of A sin ϕ. This voltage is amplified and applied to the Y-axis or vertical deflection plates. The cos ϕ detector similarly produces a voltage that corresponds to the value of A cos ϕ which is amplified and applied to the X-axis or horizontal deflection plates.

The foregoing discussion explains the method of developing a spot on the CRT that represents the behavior of a device under test at one frequency. During swept-frequency operation, the device under test reacts differently as the frequency is changed. This causes a continuous trace to be produced on the CRT. This trace may be interpreted as follows. Amplitude is proportional to distance from the center of the CRT, phase can be read directly from the built-in graticule and frequency is indicated by marker pips superimposed on the trace through the intensity-modulator circuit. Marker signals applied to this circuit from a Sweep Oscillator cause a bright pip on the trace. In this manner specific frequencies may be located on the CRT display.

SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

Test-Channel Amplitude and Phase Reference Signal Inputs.

A 278-kHz test-channel amplitude signal and a 278-kHz phase-reference signal are obtained from the Network Analyzer mainframe. The test-channel signal passes through a preamplifier and divides into two signal paths. One signal is shifted by 90 degrees and fed to the sine ϕ detector. The other signal is fed to a cosine ϕ detector. The 278-kHz phase-reference signal is fed to a phase splitter-limiter which produces two signals 180 degrees apart. These two signals are fed to both the sine ϕ detector and the cosine ϕ detector.

Sin ϕ and Cos ϕ Detectors.

The sine ϕ and cosine ϕ detectors are balanced modulator phase detectors. The signals from the phase splitter-limiter turn the detectors on one at a time during alternate half cycles of the turn-on signal. Any signal appearing at a detector's input when it is turned on will be passed through the detector and the detector's output capacitor will charge to the average of the signal passed through the detector. When the input signal is in-phase with the turn-on signal the detector's output is maximum positive. When the input signal is 180 degrees out of phase with the turn-on signal the detector's output is maximum negative. When the input signal is exactly ±90 degrees with respect to the turn-on signal the average of the detector's output signal is zero. Therefore, a detector's output can vary from a maximum positive (zero degree phase difference) to a maximum negative (180 degree phase difference) and back to a maximum positive (360 degree phase difference). The magnitude of the maximum positive and negative detector output voltages is directly proportional to the amplitude of the input signal. Because the signal to the sine ϕ detector is shifted -90 degrees, the output of the sine ϕ detector is equal to the amplitude of its input signal times the sine of the angle between the reference and test channel input signals (A sine ϕ), and the output of the cosine ϕ detector is equal to the amplitude of its input signal times the cosine of the angle between the reference and test channel input signals (A cos ϕ).

Vertical and Horizontal Deflection Amplifiers.

The sine ϕ detector's output is amplified and fed to the CRT's vertical deflection plates. The signals applied to the deflection plates produce a polar display of the relative magnitude and phase of the signals applied to the Network Analyzer.

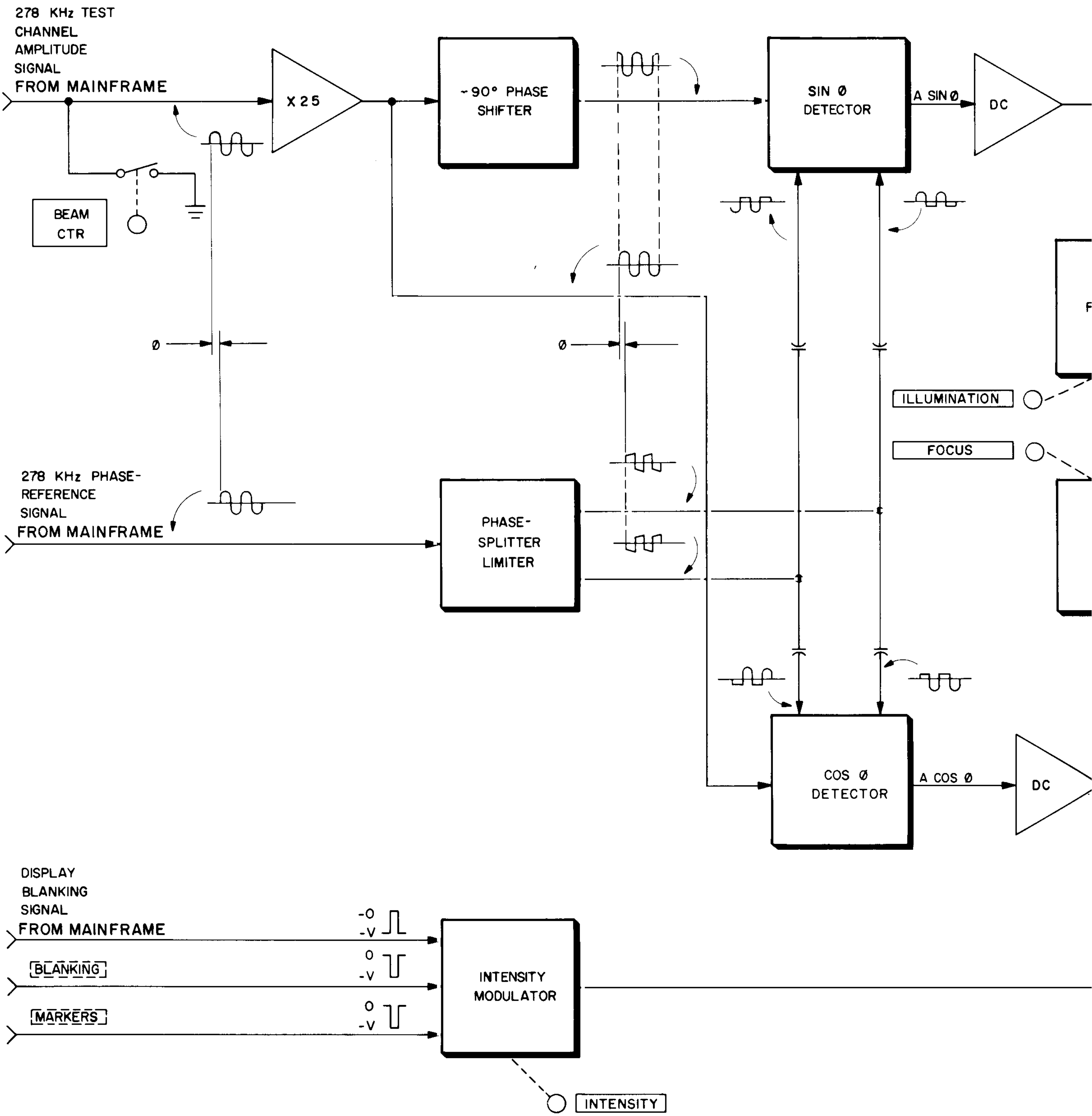
Intensity Modulator.

The Intensity Modulator controls the CRT grid to cathode bias. Intensity Modulator input signals cause the CRT's electron beam to be turned off for blanking or intensified for frequency markers.

There are three signal inputs to the intensity modulator: one from the Network Analyzer mainframe which unblanks the CRT (8410A Network Analyzers unblank the CRT only when the Network Analyzer is phase locked); the second, a rear-panel connector which may be connected to the sweep oscillator blanking output to blank the display during sweep retrace; the third, another rear-panel connector which may be connected to a sweep oscillator frequency marker output to display frequency marks on the display by brightening the display at the point which represents the frequency of interest.

Power Supplies.

The 8414A obtains power from the Network Analyzer mainframe through the rear connector. The mainframe furnishes +20 volts and -20 volts regulated which is used for low voltage stages and which provides primary power for the 8414A high voltage power supply. The mainframe also furnishes 175 Vac which provides primary power for the low voltage (250 Vdc) and filament supply.


278 KHz TEST CHANNEL AMPLITUDE SIGNAL FROM MAINFRAME
X 25
-90° PHASE SHIFTER
SIN Ø DETECTOR
A SIN Ø
DC
BEAM CTR
Ø
Ø
ILLUMINATION
FOCUS
278 KHz PHASE-REFERENCE SIGNAL FROM MAINFRAME
PHASE-SPLITTER LIMITER
COS Ø DETECTOR
A COS Ø
DC
DISPLAY BLANKING SIGNAL FROM MAINFRAME
-0
-V
BLANKING
0
-V
MARKERS
0
-V
INTENSITY MODULATOR
INTENSITY

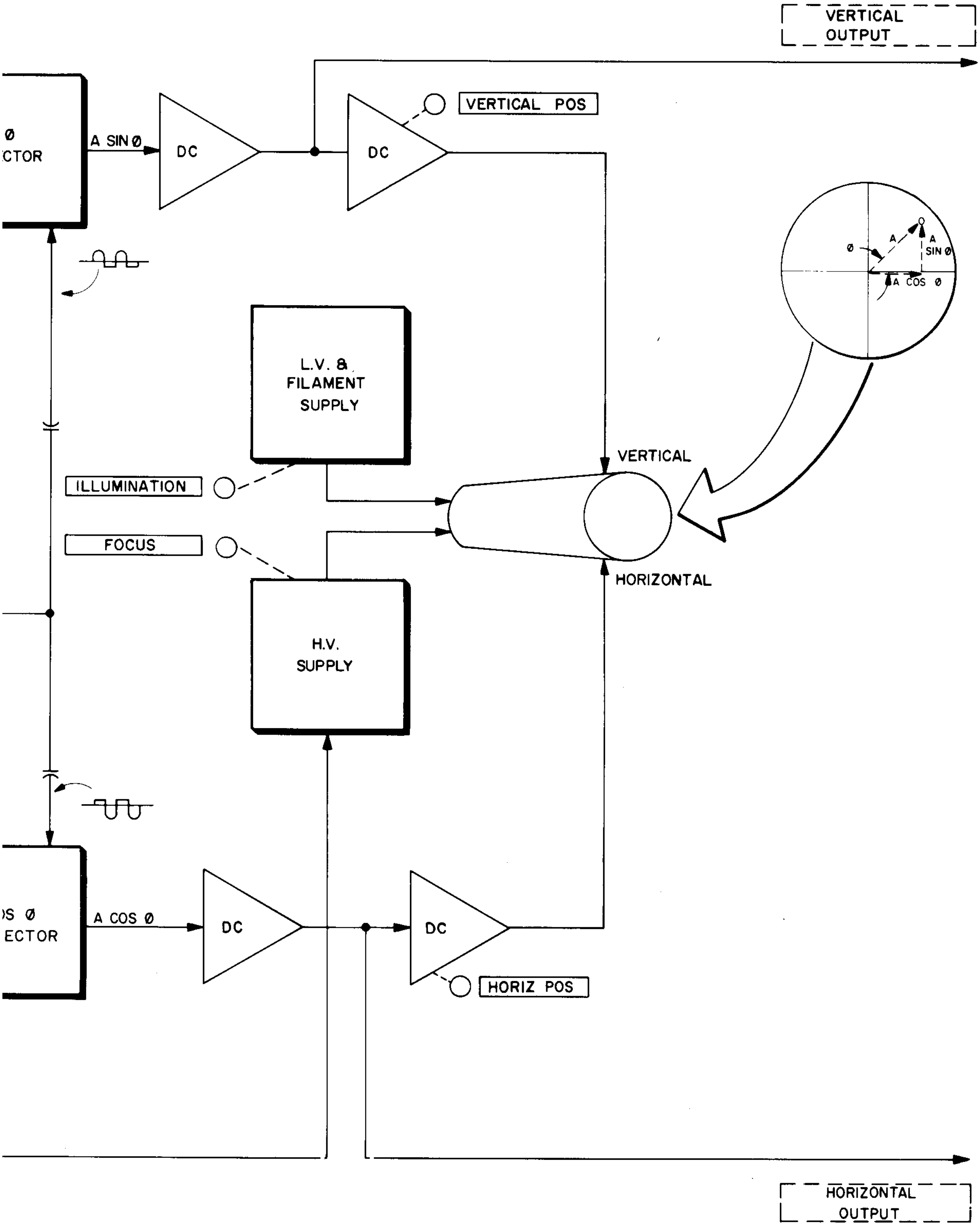


Figure 8-10. Simplified Overall Block Diagram

DETAILED BLOCK DIAGRAM DESCRIPTION

HORIZONTAL AND VERTICAL AMPLIFIERS

Test Channel Amplitude Input

The test channel signal is applied to the Polar Display Unit from either the Network Analyzer mainframe for the standard 8414A or from a rear panel BNC connector for the H26-8414A. The amplitude of this signal and phase relationship with respect to the phase reference signal contains the information that is displayed on the CRT.

Switch, Beam Center

The test channel input signal is grounded when the Beam Center pushbutton is pressed or for the H26-8414A when the Auto Beam Centering circuit is activated. With the input signal grounded there is no vertical or horizontal deflection voltage to the CRT, the CRT display is a dot and the front-panel centering controls may be used to locate the dot in the center of the CRT.

Preamplifier

The preamplifier is a feedback-pair amplifier with a voltage gain of about 25. At the output of the preamplifier the test channel signal path divides into two branches. The signal in one branch is fed through a -90 degree phase shifter and driver to the sine detector. The signal in the other branch is fed through a driver to the cosine detector.

Phase Shifter

The phase shifter retards the phase of one output of the preamplifier 90 degrees. The test channel input signal is then two signals separated in phase by 90 degrees or sine and cosine signals.

Drivers

The sine detector driver and cosine detector driver isolate the sine and cosine detectors preventing interaction with the -90 degree phase shifter and preamplifier. The gain through each driver is about unity.

Phase Splitter-Limiter

The phase splitter-limiter amplifies the phase reference signal from the mainframe. Its two output signals are limited to about 5V p-p and fed to the sin ϕ and cos ϕ detectors. These signals turn the detectors on one at a time.

Sin ϕ and Cos ϕ Detectors

The sine ϕ and cosine ϕ detectors are balanced modulator phase detectors. The signals from the phase splitter-limiter turn the detectors on one at a time during alternate half cycles of the turn-on signal. When the turn-on signal from the phase splitter limiter causes the voltage at A2TP6 to be positive and A2TP7 to be negative the cosine ϕ detector is turned on. During the next half cycle of the turn-on signal the sine ϕ detector is turned on. Any signal appearing at the input, A2TP3 or TP15, when a detector is turned on will be passed through the detector and the detector's output capacitor will charge to the average of the signal passed through the detector. When the input signal (A2TP3 or TP15) is in-phase with the turn-on signal the detector's output is maximum positive. When the input signal is 180 degrees out of phase with the turn-on signal the detector's output is maximum negative. When the input signal is exactly ±90 degrees with respect to the turn-on signal the average of the detector's output signal is zero. Therefore, a detector's output can vary from a maximum positive (0 degrees phase difference) to a maximum negative (180 degrees phase difference) and back to a maximum positive (360 degrees phase difference). The magnitude of the maximum positive and negative detector output voltages is directly proportional to the amplitude of the input signal. Because the signal to the sine ϕ detector is shifted -90 degrees, the output of the sine ϕ detector is equal to the amplitude of the signal at A2TP14 times the sine of the angle between the reference and test channel input signals (A sine ϕ), and the output of the cosine ϕ detector is equal to the amplitude of the signal at A2TP14 times the cosine of the angle between the reference and test channel input signals (A cos ϕ).

Buffer Amplifiers

The Buffer Amplifiers are differential amplifiers with a voltage gain of about ten. Phase shift through these amplifiers is negligible.

Low Pass Filter

The low pass filters filter out frequencies above 10 kHz with a capacitor to ground and a feedback loop which couples high frequency signals from the output back to the input 180 degrees out of phase. The low frequency voltage gain through these filters is about two.

S1

Switch S1, in the test position, opens the signal path from the filter output so that an external voltage can be applied at the rear-panel horizontal and vertical output connectors for troubleshooting the deflection circuits.

Vertical and Horizontal Deflection Drivers

The deflection drivers are differential amplifiers with push-pull outputs. Both output voltages of each driver are at about +55 Vdc with no input signal applied. A 1V change at either driver's input should provide about a 10V change in each of its outputs, one output going 10V more positive the other 10V less positive. The front-panel horizontal and vertical centering controls vary a dc bias to the associated driver producing the same effect as an input signal.

Intensity Modulator Inputs

The Intensity Modulator controls the CRT grid to cathode bias. Intensity Modulator input signals cause the CRT's electron beam to be turned off for blanking or intensified for frequency markers.

There are three signal inputs to the intensity modulator: one from the Network Analyzer mainframe which unblanks the CRT (8410A Network Analyzers unblank the CRT only when the Network Analyzer is phase locked); the second, a rear-panel connector which may be connected to the sweep oscillator blanking output to blank the display during sweep retrace; the third, another rear-panel connector which may be connected to a sweep oscillator frequency marker output to display frequency marks on the display by brightening the display at the point which represents the frequency of interest.

Switches

Switch A1Q2 is turned off by an unblanking signal from the Network Analyzer. Although the output of A1Q2 at A1TP8 is always a negative voltage, when A1Q2 is turned off its output appears positive-going to the following stage and the CRT is unblanked. Switch A1Q1 is normally off. When a positive blanking pulse is applied to its input, Q1 conducts. A1Q2 turns on, the voltage at A1TP8 goes more negative, and the CRT is blanked. A negative marker pulse to switch A1Q4 turns Q4 on. Its output voltage at A1TP8 approaches ground and appears as a positive-going input signal to the following stage. This signal is more positive than the unblanking signal, therefore, the CRT's electron beam is intensified.

Differential Amplifier

A1Q3 and Q6 form a differential amplifier. The amplifier gain varies with position of the intensity control; however, with the intensity control set for normal intensity (about -3.6V at A1TP5) and the intensity limit set for about +110V at A1TP2 the amplifier gain is about seven or eight. For example, if the voltage at A1TP8 changes from -5V (Q2 and Q4 off) to -0.1V (Q2 off Q4 on), a change of about 5V, the output at A1TP3 should change from about +70 to about +105V, a change of about 35V.

Emitter Follower

The output of emitter follower (A1Q7) should be about +65V for a blanked condition, about +70V for an unblanked condition, and about +105V for a marker condition.

CRT, CRT Power Supplies

+150V Power Supply. The +150V power supply is a regulated supply. Its output provides collector voltage for the deflection drivers.

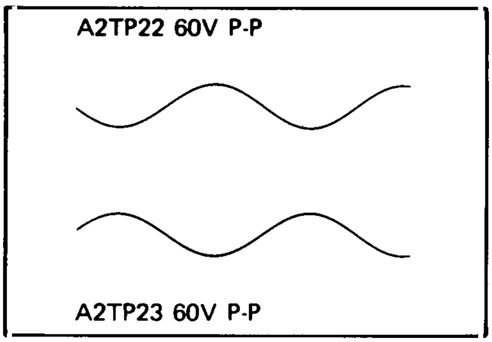
High Voltage Oscillator. The high voltage oscillator is a free-running multivibrator whose frequency, 20 kHz ±2 kHz, is determined by the L and C of T1's primary winding.

CRT Cathode Supply. One of T1's secondary windings supplies power to both the CRT's cathode supply and anode supply. The cathode supply consists of a half wave rectifier and pi section filter. Its output voltage is about -2450 Vdc. In addition to providing dc bias to the CRT cathode, the cathode supply's output voltage is used in a voltage divider to +150V to provide about -2000 Vdc to the focus control.

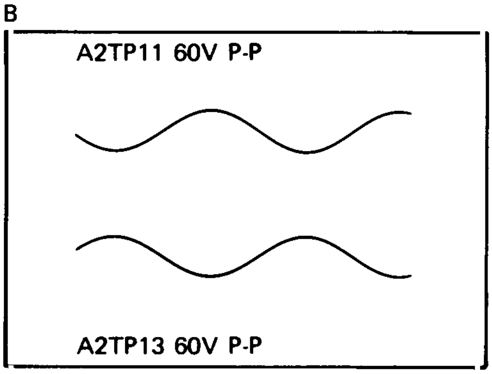
CRT Anode Supply. The anode supply consists of a voltage doubler and pi section filter. Its output voltage is about +5100 Vdc.

˙ **Grid Supply.** The grid supply consists of a wave rectifier. Its output voltage is about ı0 Vdc with the CRT unblanked. With zero ; input from the intensity modulator, the grid ıly is referenced to ground; however, an input ıge from the intensity modulator becomes the ɾence voltage for the grid supply. A change in intensity modulator output voltage causes the supply voltage to change, which changes the ˙'s grid to cathode bias and intensity modulates beam.

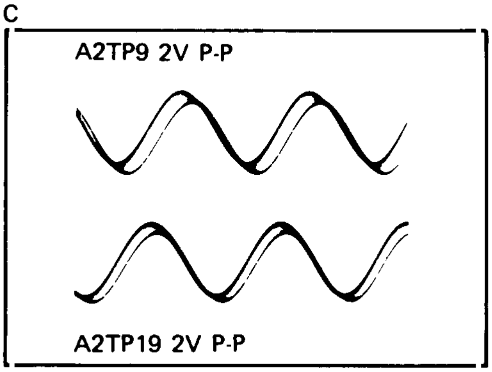
A

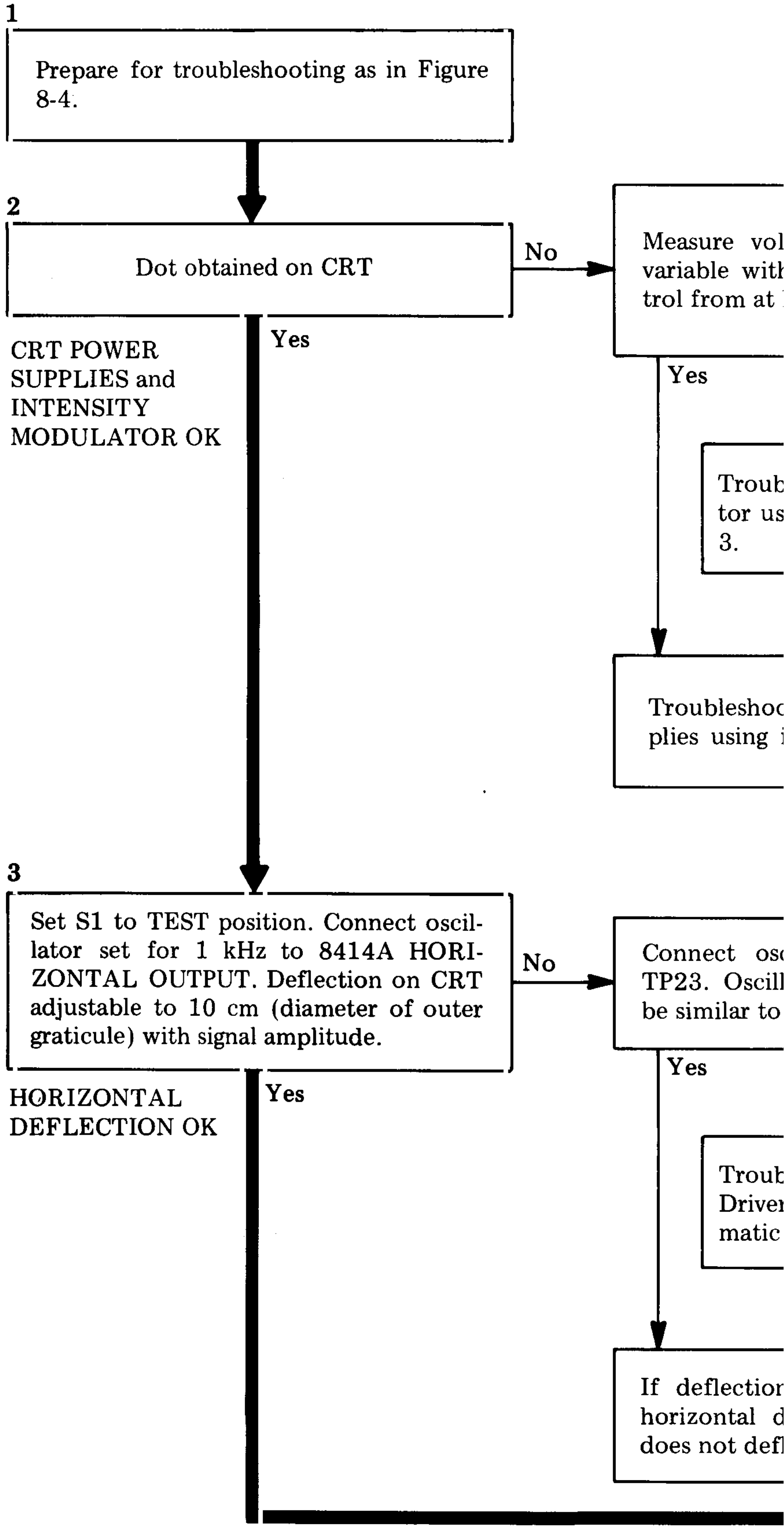


B



C





SIMPLIFIED BLOC

TP1. Voltage is
l intensity con-
o +80Vdc.

No

Intensity Modula-
tion on Schematic

CRT Power Sup-
on Schematic 4.

o A2TP22 and
sentation should

No

izontal Deflection
rmation on Sche-

present at CRT
lates and beam
CRT.

4

Without changing signal amplitude, connect oscillator set for 1 kHz to 8414A VERTICAL OUTPUT. Deflection on CRT adjustable to 10 cm with A2R7.

No → Connect oscilloscope to A2TP11 and TP13. Oscilloscope presentation should be similar to B below.

- No → Troubleshoot vertical deflection driver using information on Schematic 2.
- Yes → If deflection signal is present at CRT vertical deflection plates and beam does not deflect, replace CRT.

Yes → VERTICAL DEFLECTION OK

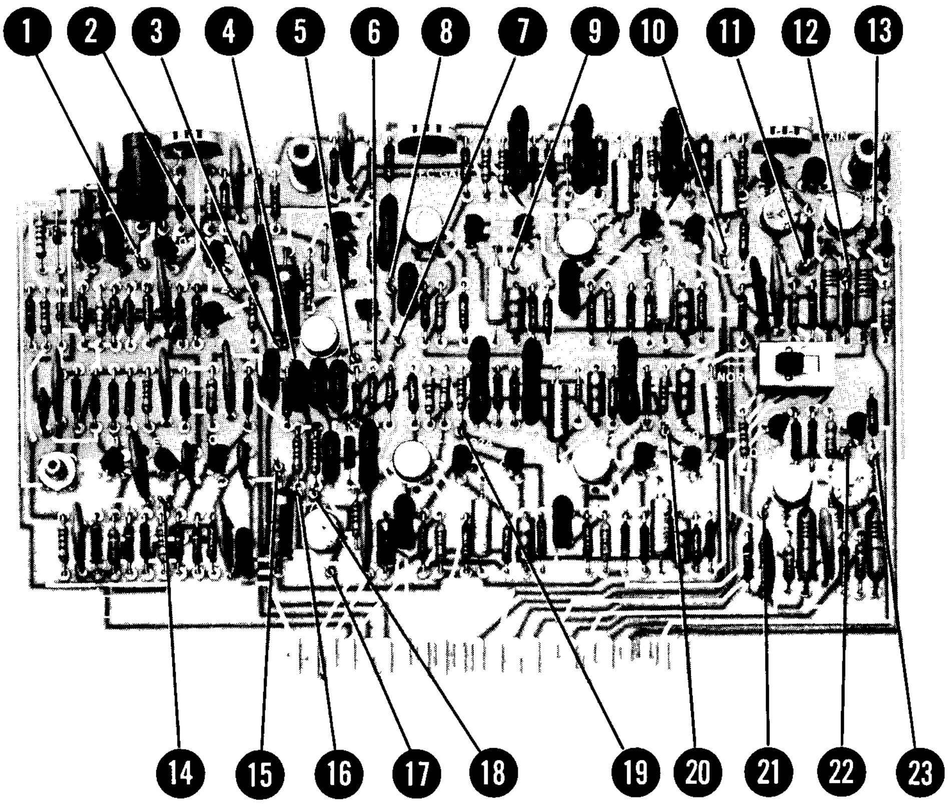
5

Set S1 to NORMAL and Network Analyzer test channel gain to minimum. Disconnect oscillator from 8414A and connect to Network Analyzer test channel output. Set oscillator frequency to 280 kHz. 8414A presentation adjustable to a 10 cm circle by adjusting oscillator frequency and amplitude.

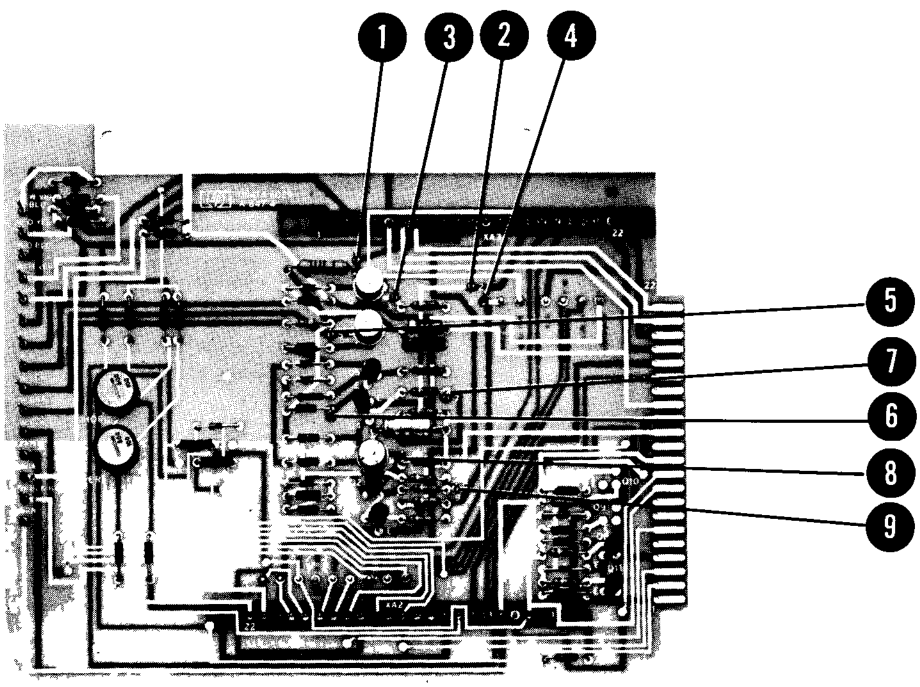
No → Connect oscilloscope to A2TP9 and TP19. Oscilloscope presentation adjustable to waveform similar to C by adjusting oscillator frequency and amplitude.

- No → Troubleshoot the A2 Assembly from Preamplifier to Buffer Amplifiers using information on Schematic 1.
- Yes → Troubleshoot Low Pass Filter circuits using infromation on Schematic 2.

Yes → 8414A OK



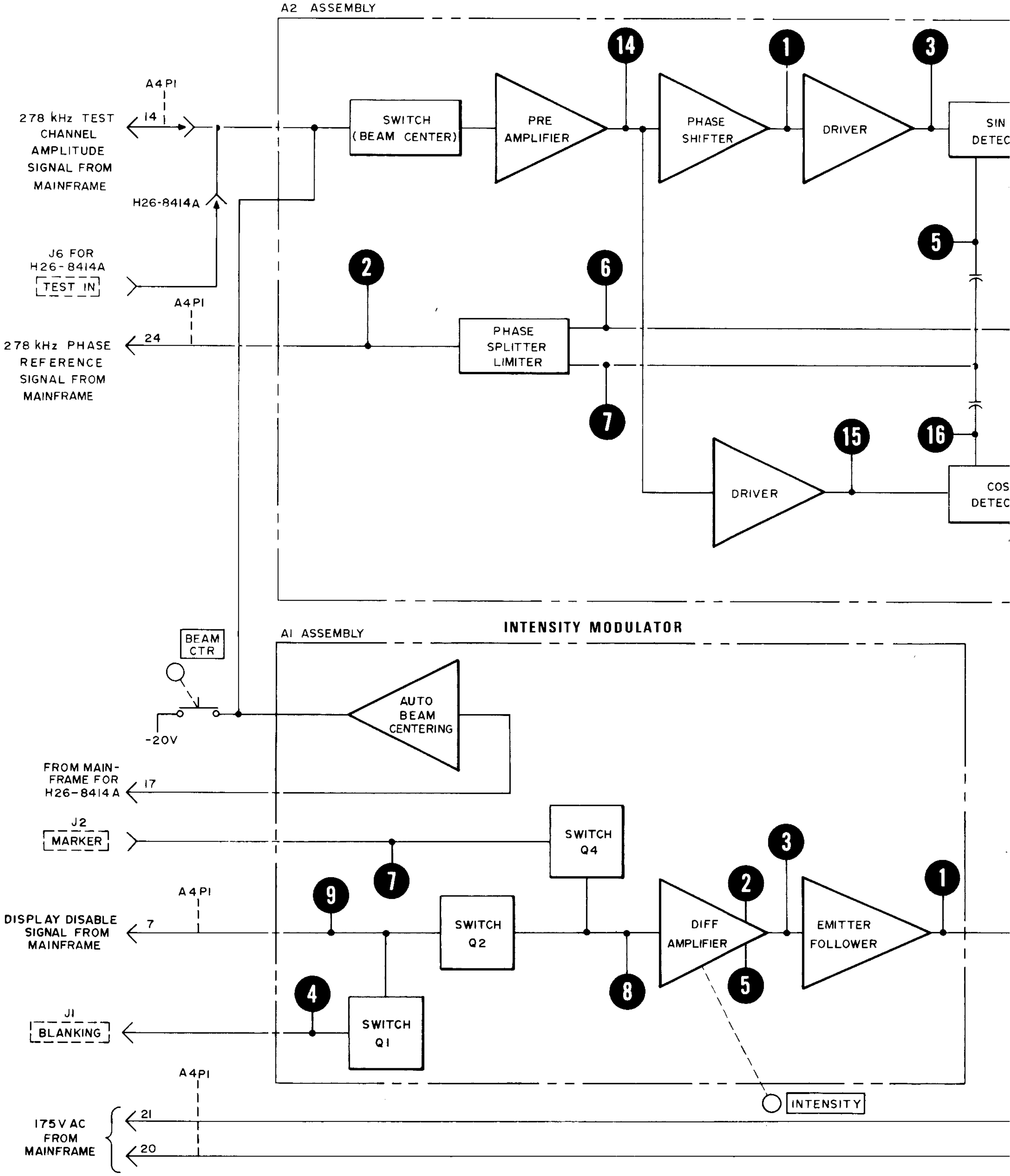
A2 ASSEMBLY

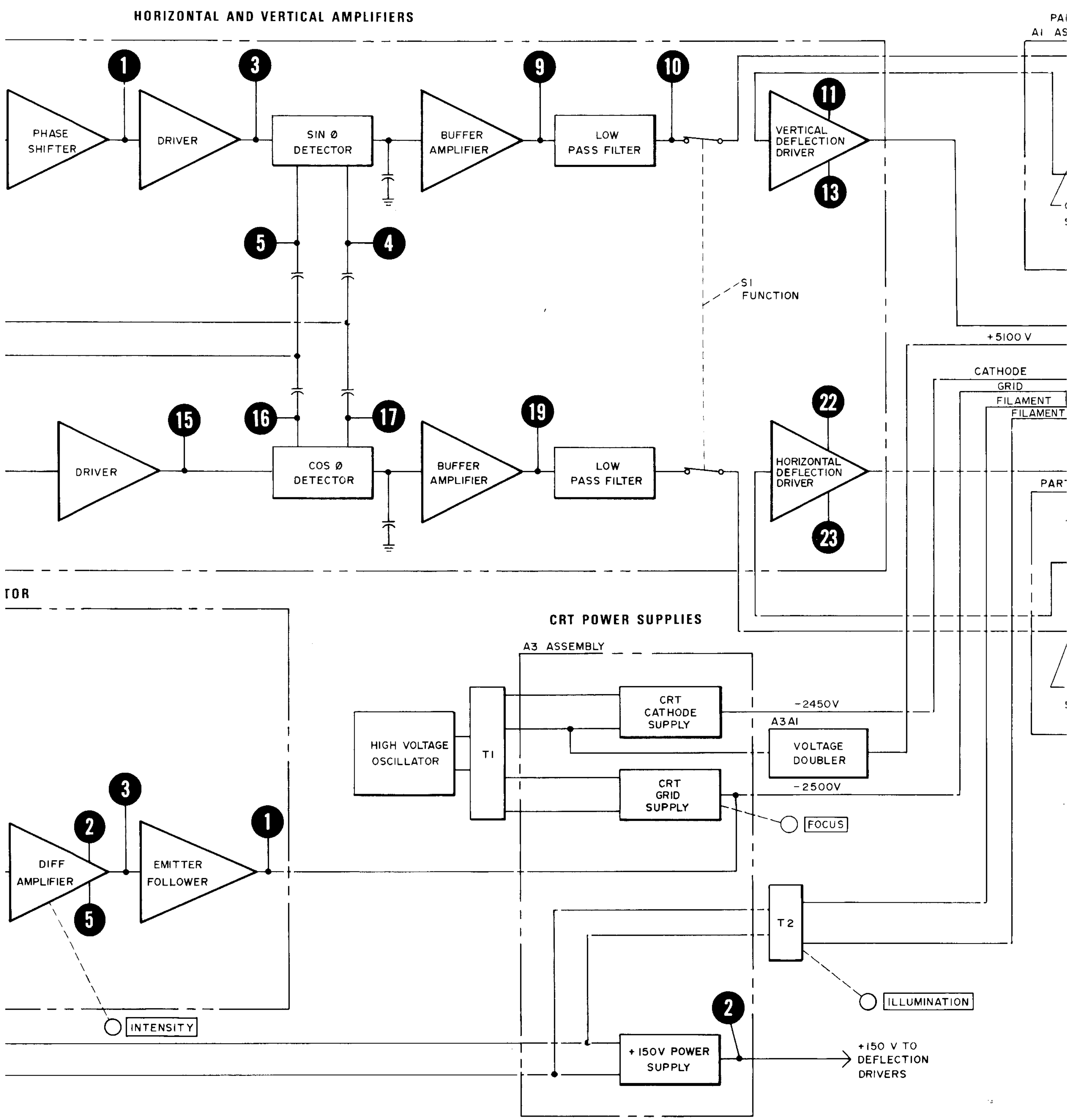


A1 ASSEMBLY

Figure 8-11. Test Point Locations

HORIZONTAL AND VERTICAL





HORIZONTAL AND VERTICAL AMPLIFIERS
PA
AI AS
1
3
9
10
11
PHASE SHIFTER
DRIVER
SIN Ø DETECTOR
BUFFER AMPLIFIER
LOW PASS FILTER
VERTICAL DEFLECTION DRIVER
13
5
4
S1 FUNCTION
+5100 V
CATHODE
GRID
FILAMENT
FILAMENT
15
16
17
19
22
DRIVER
COS Ø DETECTOR
BUFFER AMPLIFIER
LOW PASS FILTER
HORIZONTAL DEFLECTION DRIVER
PART
23
TOR
CRT POWER SUPPLIES
A3 ASSEMBLY
CRT CATHODE SUPPLY
-2450V
A3A1
HIGH VOLTAGE OSCILLATOR
T1
VOLTAGE DOUBLER
CRT GRID SUPPLY
-2500V
FOCUS
3
2
1
DIFF AMPLIFIER
EMITTER FOLLOWER
5
T2
ILLUMINATION
2
INTENSITY
+150V POWER SUPPLY
+150 V TO DEFLECTION DRIVERS

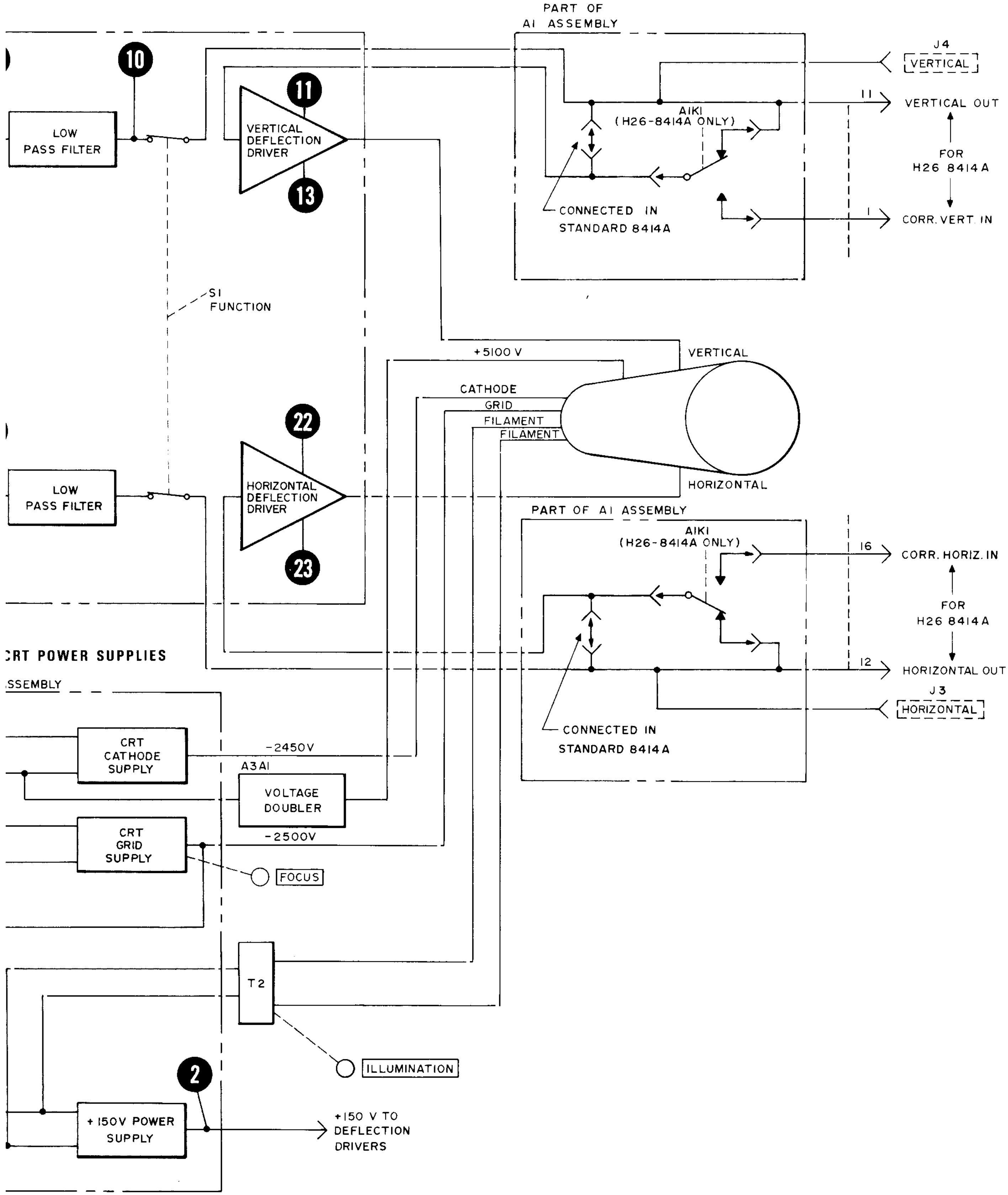


Figure 8-12. Detailed Block Diagram

Schematic 1 TROUBLESHOOTING

1 Perform Block Diagram Trouble-shooting. Oscilloscope presentation of signals at A2TP9 and/or TP19 abnormal.

Yes ↓

2 Connect oscilloscope to A2TP8 and TP18. Oscilloscope presentation similar to A *cannot* be obtained by adjusting oscillator frequency and amplitude.

- No → If normal waveform is obtained at A2TP9 and TP19, troubleshoot Buffer Amplifier circuits A2Q7 through Q10 and/or A2Q22 through Q25.

Yes ↓

3 Disconnect oscillator from Network Analyzer test channel output. Connect normal Reference and Test channel signals to the Network Analyzer. Connect oscilloscope to A2TP2 and TP14. Oscilloscope presentation similar to B can be obtained by adjusting input signal amplitude and Network Analyzer test channel gain controls.

- No → If waveform at A2TP14 is abnormal troubleshoot A2Q19 and Q20 circuits.
- No → If a waveform at A2PP2 is abnormal troubleshoot A2Q4 input circuit.

Yes ↓

4 Connect oscilloscope to A2TP6 and TP7. Oscilloscope presentation is similar to C.

- No → Troubleshoot A2Q4 and Q6 circuits.

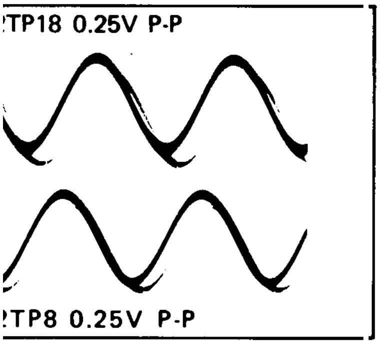
Yes ↓

5 Connect oscilloscope to A2TP3 and TP15. Oscilloscope presentation is similar to D.

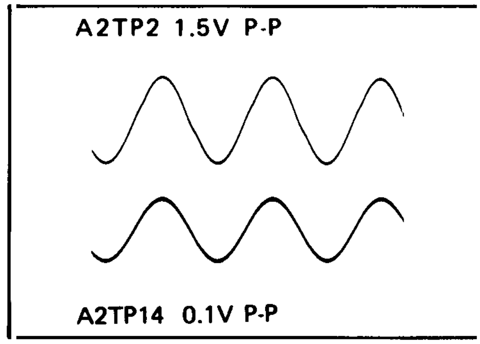
- No → If waveform at A2TP3 is abnormal troubleshoot A2Q1 through Q3 circuits.
- No → If waveform at A2TP15 is abnormal troubleshoot A2Q21 circuit.

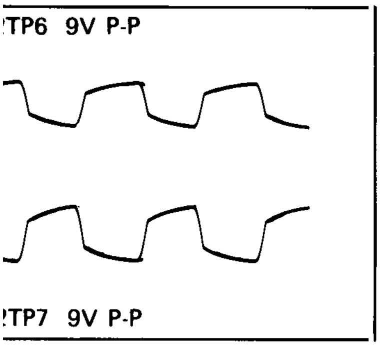
Yes ↓

6 Troubleshoot A2A1 and/or A2A2 circuits.

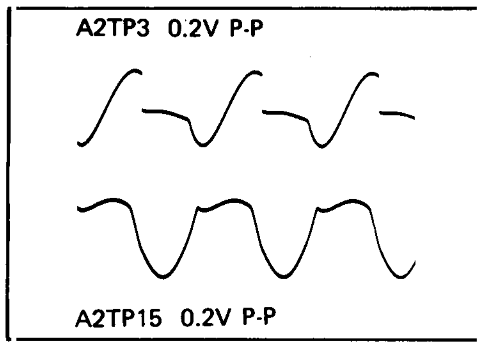


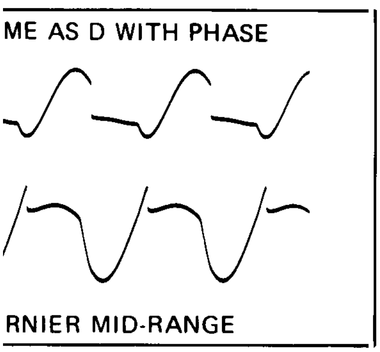
B



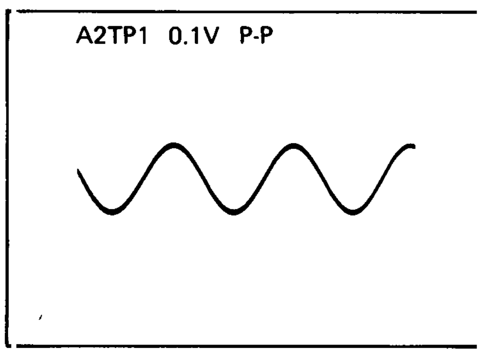


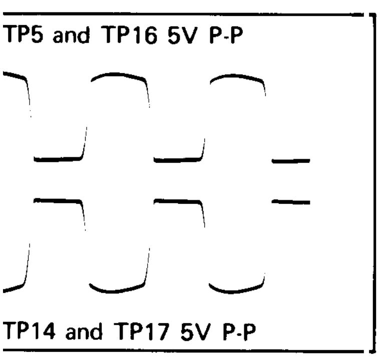
D





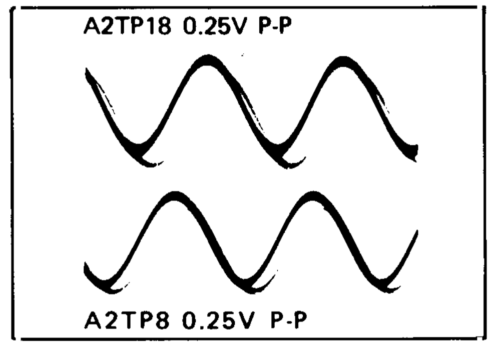
F



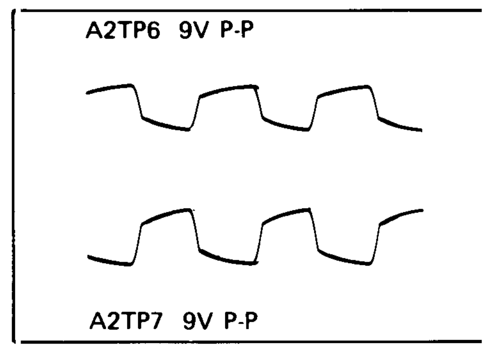


DETAILED BLOCK DIAGRAM

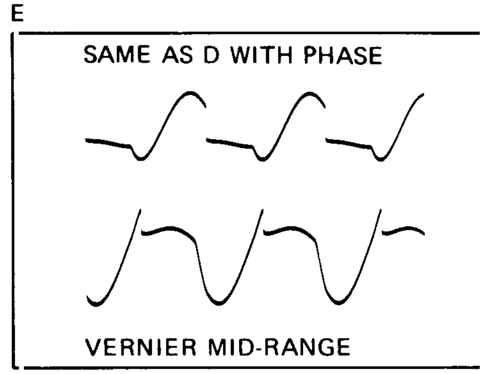
A


A2TP18 0.25V P-P
A2TP8 0.25V P-P

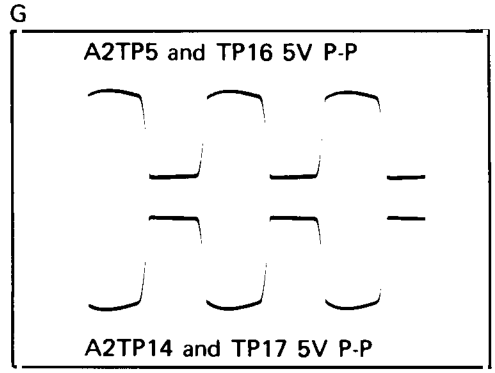
C


A2TP6 9V P-P
A2TP7 9V P-P

E


SAME AS D WITH PHASE
VERNIER MID-RANGE

G


A2TP5 and TP16 5V P-P
A2TP14 and TP17 5V P-P

SCHEMATIC 1. CIRCUIT DESCRIPTION

TEST CHANNEL AMPLITUDE

Input

The test channel signal is applied to the Polar Display Unit from either the Network Analyzer mainframe for the standard 8414A or from a rear-panel BNC connector for the H26-8414A.

Switch, Beam Center

The test channel input is fed to switch A2CR1, CR2, which grounds the input when the beam center pushbutton is pressed, or for the H26-8414A, when the Auto Beam Centering circuit is activated. During non-beam center operation a positive voltage is applied to the junction of CR1 and CR2, CR1 is biased on, CR2 is biased off and the input signal is applied to the preamplifier at A2Q19. When the beam center pushbutton is pressed or, for the H26-8414A, when the Auto Beam Centering circuit is activated the voltage at the junction of CR1 and CR2 is negative, CR2 is biased on, and the input signal is grounded through CR2.

Preamplifier

The preamplifier, A2Q19-Q20, is a feedback-pair amplifier with a voltage gain of about 25. The output of the preamplifier divides into two signal paths.

-90 Degree Phase Shifter

The -90 Degree Phase Shifter A2Q1 shifts the phase of one output of the preamplifier -90 degrees. The test channel signal is then two signals separated in phase by 90 degrees or sine and cosine signals.

Drivers

The sine detector's driver A2Q2, Q3 and the cosine detector's driver A2Q21 prevent the detectors from loading the phase shifter and preamplifier output circuits. The gain through each driver is about unity.

Phase Splitter-Limiter

The phase splitter-limiter, A2Q4, Q6, amplifies the phase reference signal from the mainframe. Its two output signals are 180 degrees apart and limited to about 5V p-p. These two signals are fed to the Sin ϕ and Cos ϕ Detectors and turn the detectors on one at a time.

Sin ϕ and Cos ϕ Detectors

The Sin ϕ and Cos ϕ Detectors, A2A1 and A2A2, are balanced modulator phase detectors. The signals from the phase splitter-limiter turn the detectors on one at a time during alternate half cycles of the turn-on signal. When the turn-on signal from the phase splitter limiter causes the voltage at A2TP6 to be positive and A2TP7 to be negative, the Cos ϕ detector is turned on. During the next half cycle of the turn-on signal the Sin ϕ detector is turned on. Any signal appearing at the input, A1TP3 or TP15, when a detector is turned on will be passed through the detector and the detector's output capacitor will charge to the average of the signal passed through the detector. When the input signal (A2TP3 or TP15) is in-phase with the turn-on signal the detector's output is maximum positive. When the input signal is 180 degrees out of phase with the turn-on signal the detector's output is maximum negative. When the input signal is exactly ±90 degrees with respect to the turn-on signal the average of the detector's output signal is zero. Therefore, a detector's output can vary from a maximum positive (zero degree phase difference) to a maximum negative (180 degrees phase difference) and back to a maximum positive (360 degrees phase difference). The magnitude of the maximum positive and negative detector output voltages is directly proportional to the amplitude of the input signal. Because the signal to the Sin ϕ detector is shifted -90 degrees, the output of the Sin ϕ detector is equal to the amplitude of the signal at A2TP14 times the sine of the angle between the reference and test channel input signals (A sin ϕ), and the output of the Cos ϕ detector is equal to the amplitude of the signal at A2TP14 times the cosine of the angle between the reference and test channel input signals (A cos ϕ).

Buffer Amplifiers

A2Q7 through Q10 and A2Q22 through Q25 are differential amplifiers with voltage gains of about ten. Phase shift through these amplifiers is negligible. An adjustable bias voltage is provided (A2R32, R33) to set the rear-panel horizontal and vertical output voltages to zero with no test channel input signal (Beam Center pressed).

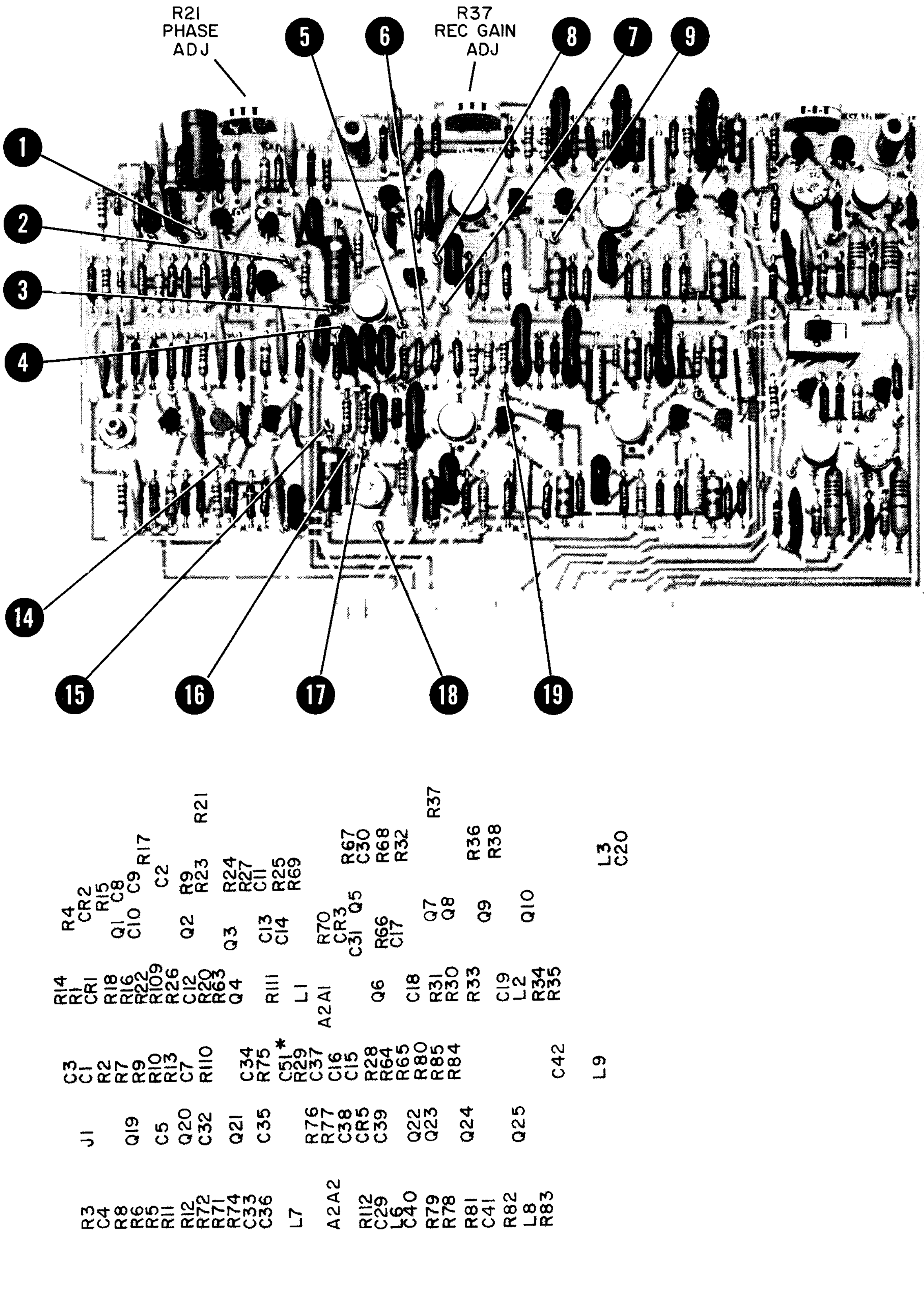
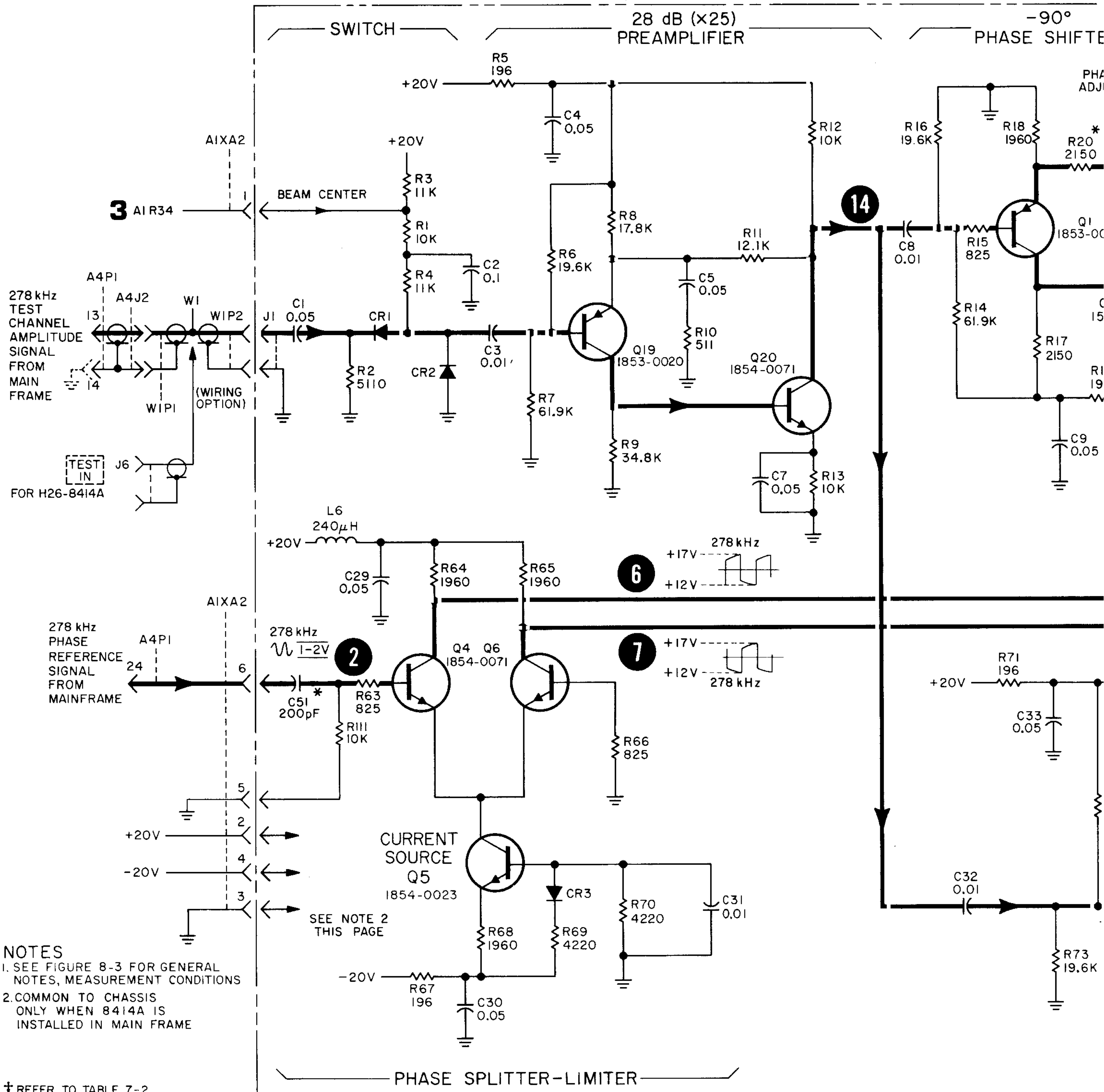


Figure 8-13. Phase Shifter and Phase Detectors, Component Identification

PART OF A2 CO-ORDINATE CONVERTER ASSEMBLY (08414-6028) 1 OF 2



NOTES

1. SEE FIGURE 8-3 FOR GENERAL NOTES, MEASUREMENT CONDITIONS
2. COMMON TO CHASSIS ONLY WHEN 8414A IS INSTALLED IN MAIN FRAME

† REFER TO TABLE 7-2

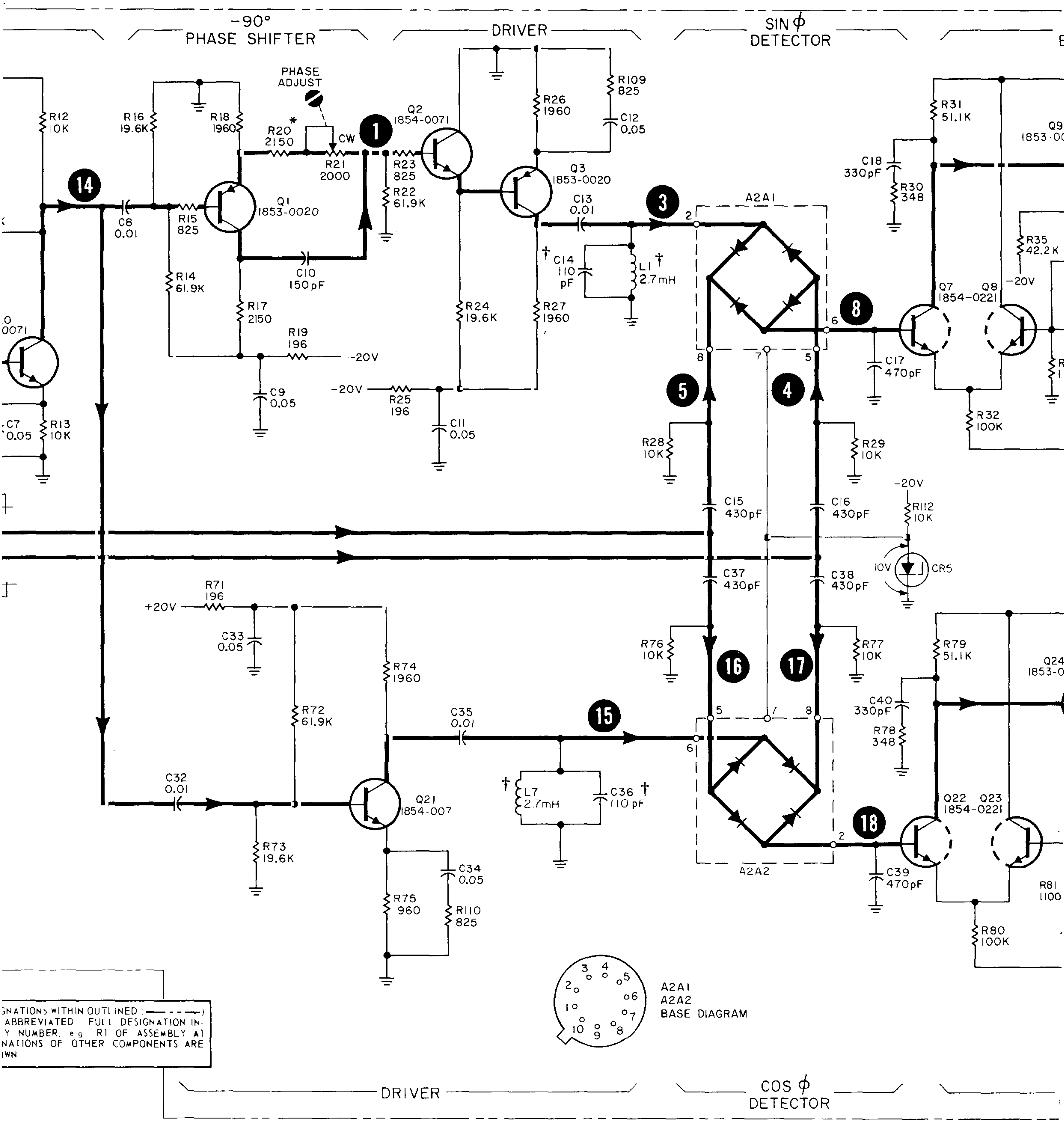
REFERENCE DESIGNATIONS

NO PREFIX	A1 ASSY	A2 ASSY	A4 ASSY	W1 ASSY
J1 W1	XA2	C1-5, 7-11, 13-20, 29-33, 35-42, 51 CR1-5 J1 L1-3, 7-9 Q1-10, 19-25 R1-38, 63-85, 109-112	J1 P1	P1, 2

UNASSIGNED: A2C6, A2CR4

8414A-CO-ORDINATE CONVERTERS (1 OF 2) 1144

REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER, e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN



NATIONS WITHIN OUTLINED (— - - —) ABBREVIATED FULL DESIGNATION IN- Y NUMBER, e.g., R1 OF ASSEMBLY A1 NATIONS OF OTHER COMPONENTS ARE WN

Fi

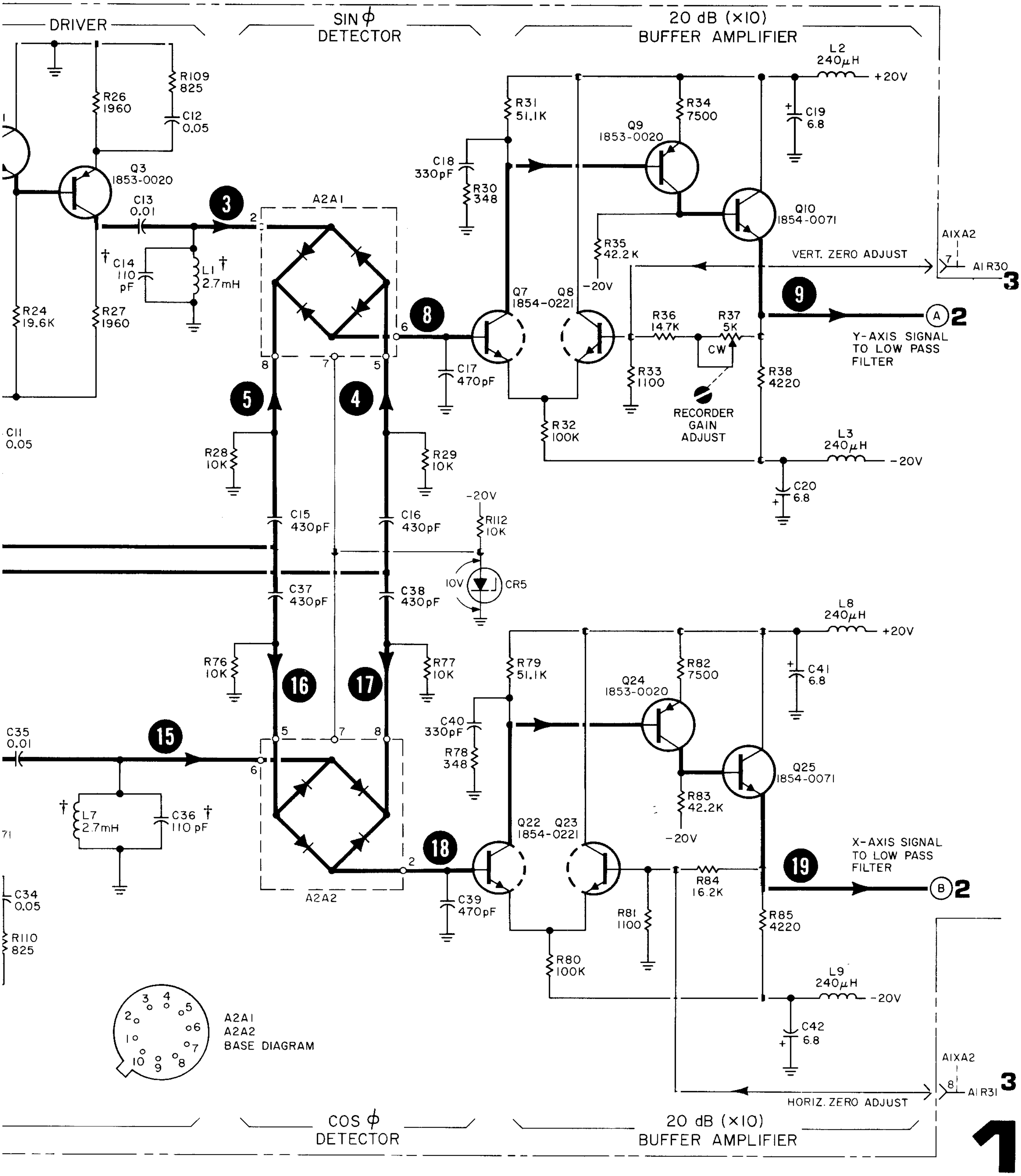


Figure 8-14. Phase Shifter and Phase Detectors, Schematic Diagram

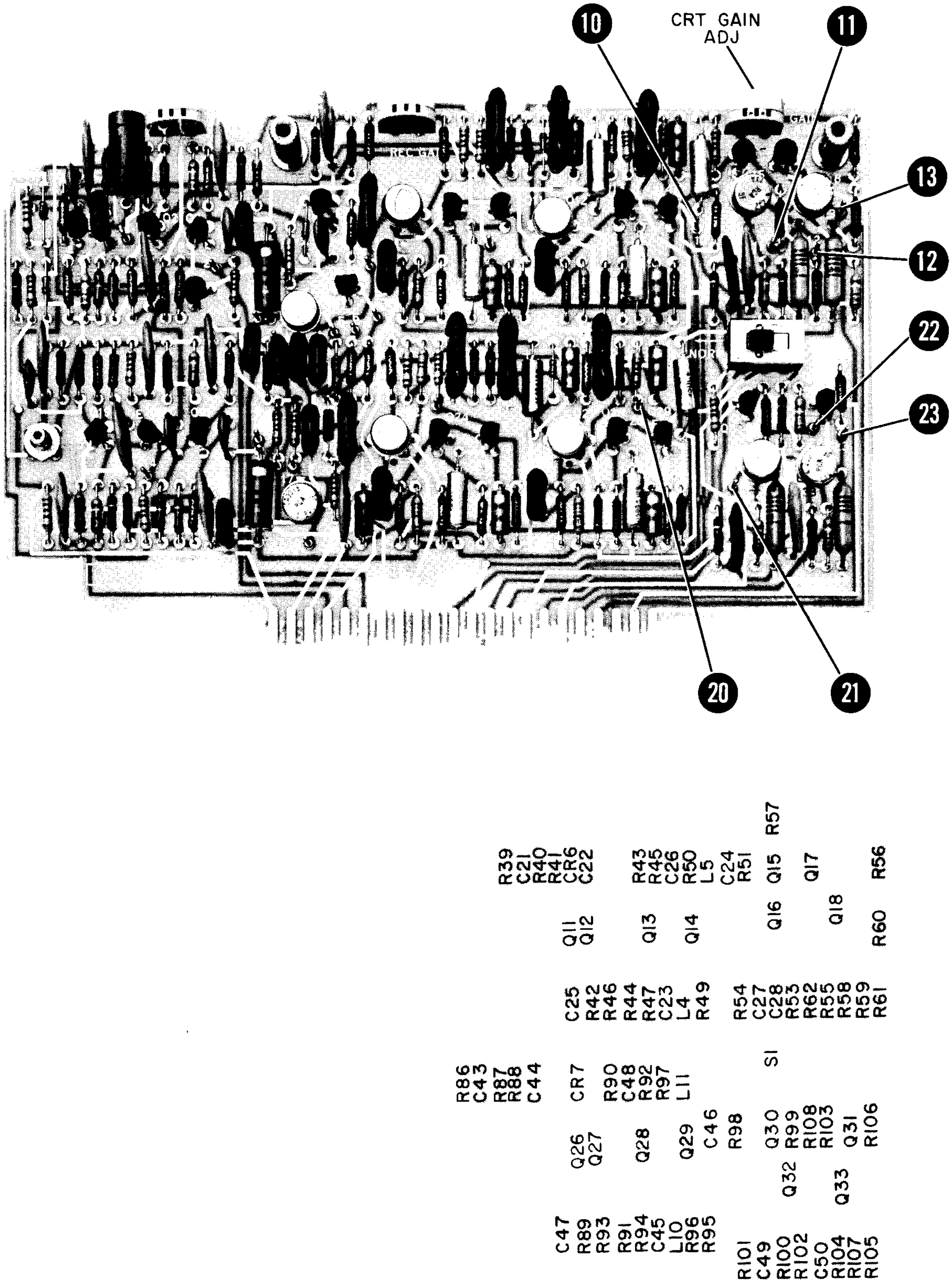
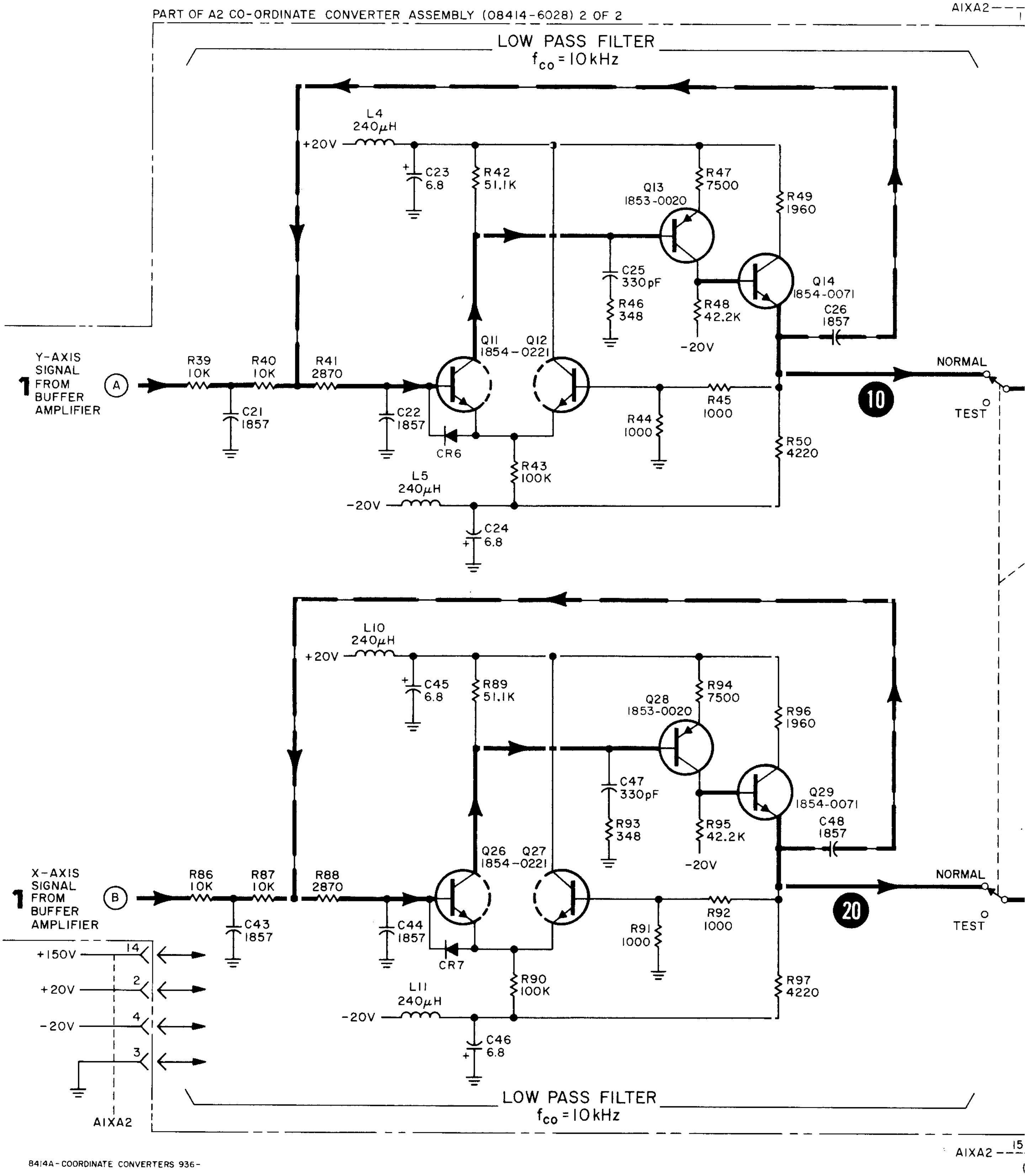
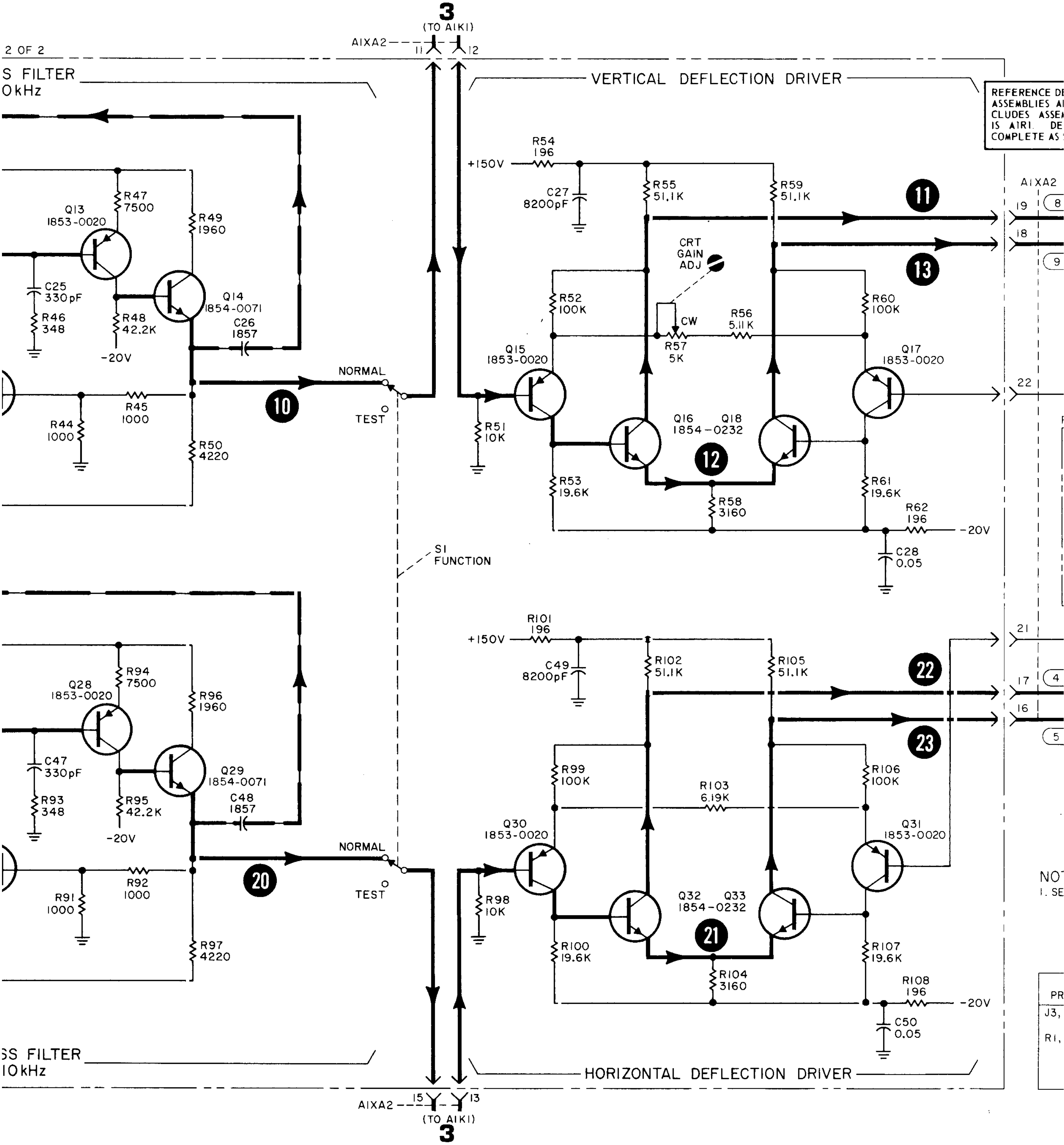
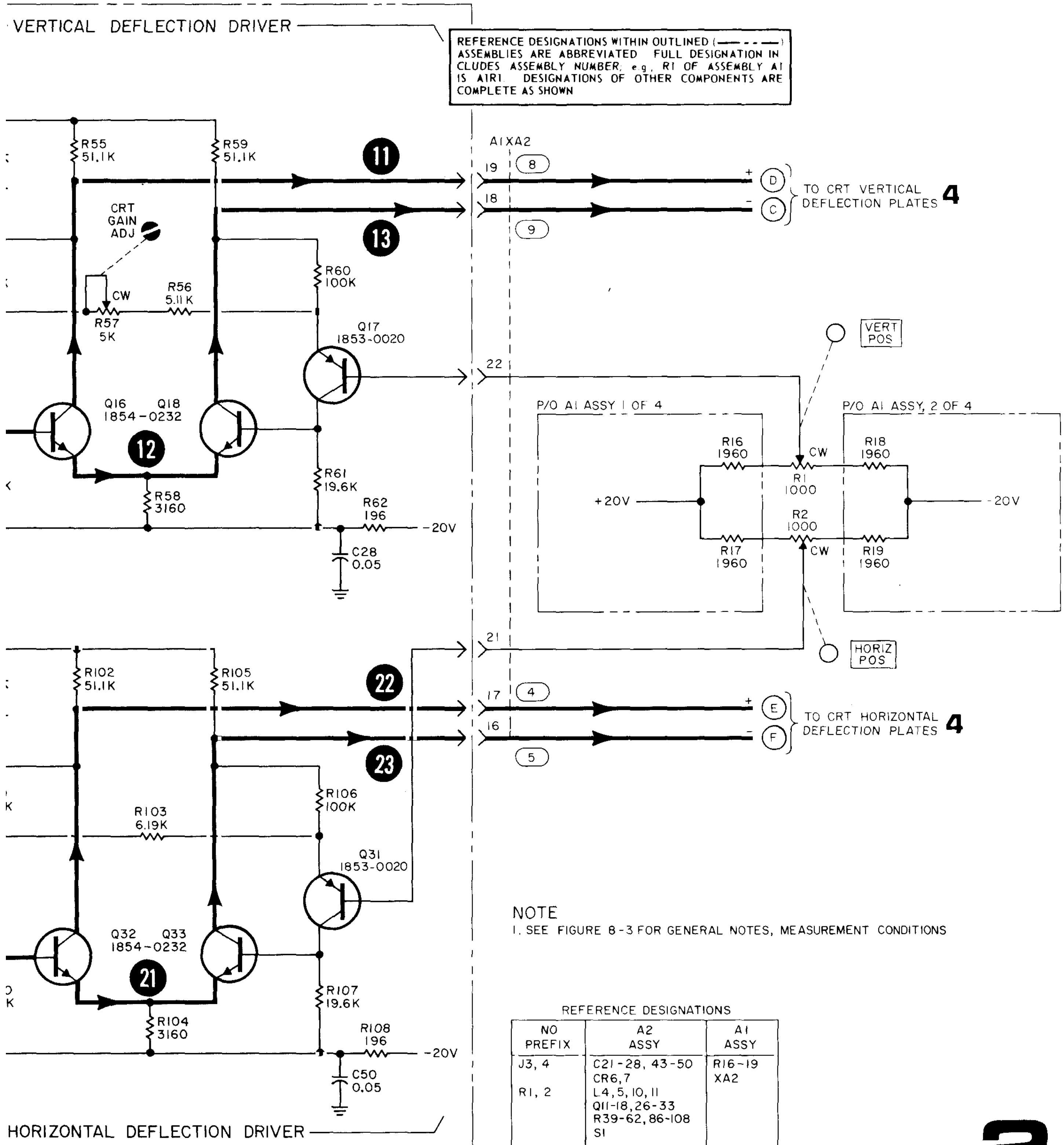


Figure 8-15. Low Pass Filters and Horizontal and Vertical Drivers, Component Identification


PART OF A2 CO-ORDINATE CONVERTER ASSEMBLY (08414-6028) 2 OF 2
A1XA2
LOW PASS FILTER
f_{co} = 10 kHz
L4 240μH
+20V
C23 6.8
R42 51.1K
Q13 1853-0020
R47 7500
R49 1960
C25 330pF
R46 348
R48 42.2K
-20V
Q14 1854-0071
C26 1857
Y-AXIS SIGNAL FROM BUFFER AMPLIFIER
1
A
R39 10K
R40 10K
R41 2870
C21 1857
C22 1857
Q11 1854-0221
Q12
CR6
R43 100K
L5 240μH
-20V
C24 6.8
R44 1000
R45 1000
R50 4220
NORMAL
TEST
10
L10 240μH
+20V
C45 6.8
R89 51.1K
Q28 1853-0020
R94 7500
R96 1960
C47 330pF
R93 348
R95 42.2K
-20V
Q29 1854-0071
C48 1857
X-AXIS SIGNAL FROM BUFFER AMPLIFIER
1
B
R86 10K
R87 10K
R88 2870
C43 1857
C44 1857
Q26 1854-0221
Q27
CR7
R90 100K
L11 240μH
-20V
C46 6.8
R91 1000
R92 1000
R97 4220
NORMAL
TEST
20
+150V
14
+20V
2
-20V
4
3
A1XA2
LOW PASS FILTER
f_{co} = 10 kHz
A1XA2
15


2 OF 2
3
(TO A1K1)
A1XA2
S FILTER
0 kHz
VERTICAL DEFLECTION DRIVER
REFERENCE DE
ASSEMBLIES AI
CLUDES ASSEM
IS A1R1. DE
COMPLETE AS
R54
196
+150V
C27
8200pF
R55
51.1K
R59
51.1K
CRT
GAIN
ADJ
R47
7500
Q13
1853-0020
R49
1960
C25
330pF
R46
348
Q14
1854-0071
R48
42.2K
C26
1857
-20V
R52
100K
R60
100K
CW
R56
5.11K
R57
5K
Q15
1853-0020
Q17
1853-0020
NORMAL
TEST
R45
1000
R44
1000
R50
4220
R51
10K
Q16
Q18
1854-0232
R53
19.6K
R61
19.6K
R58
3160
R62
196
-20V
C28
0.05
S1
FUNCTION
R101
196
+150V
C49
8200pF
R102
51.1K
R105
51.1K
R94
7500
Q28
1853-0020
R96
1960
C47
330pF
R93
348
Q29
1854-0071
R95
42.2K
C48
1857
-20V
R99
100K
R106
100K
R103
6.19K
Q30
1853-0020
Q31
1853-0020
NORMAL
TEST
R92
1000
R91
1000
R98
10K
Q32
Q33
1854-0232
R97
4220
R100
19.6K
R107
19.6K
R104
3160
R108
196
-20V
C50
0.05
SS FILTER
10 kHz
HORIZONTAL DEFLECTION DRIVER
A1XA2
(TO A1K1)
3
NOT
1. SE
PR
J3,
R1,



NOTE
1. SEE FIGURE 8-3 FOR GENERAL NOTES, MEASUREMENT CONDITIONS

REFERENCE DESIGNATIONS

NO PREFIX	A2 ASSY	A1 ASSY
J3, 4 R1, 2	C21-28, 43-50 CR6,7 L4,5,10,11 Q11-18,26-33 R39-62,86-108 S1	R16-19 XA2

2

Figure 8-16. Low Pass Filters and Horizontal and Vertical Drivers, Schematic Diagram

Schematic 3 TROUBLESHOOTING

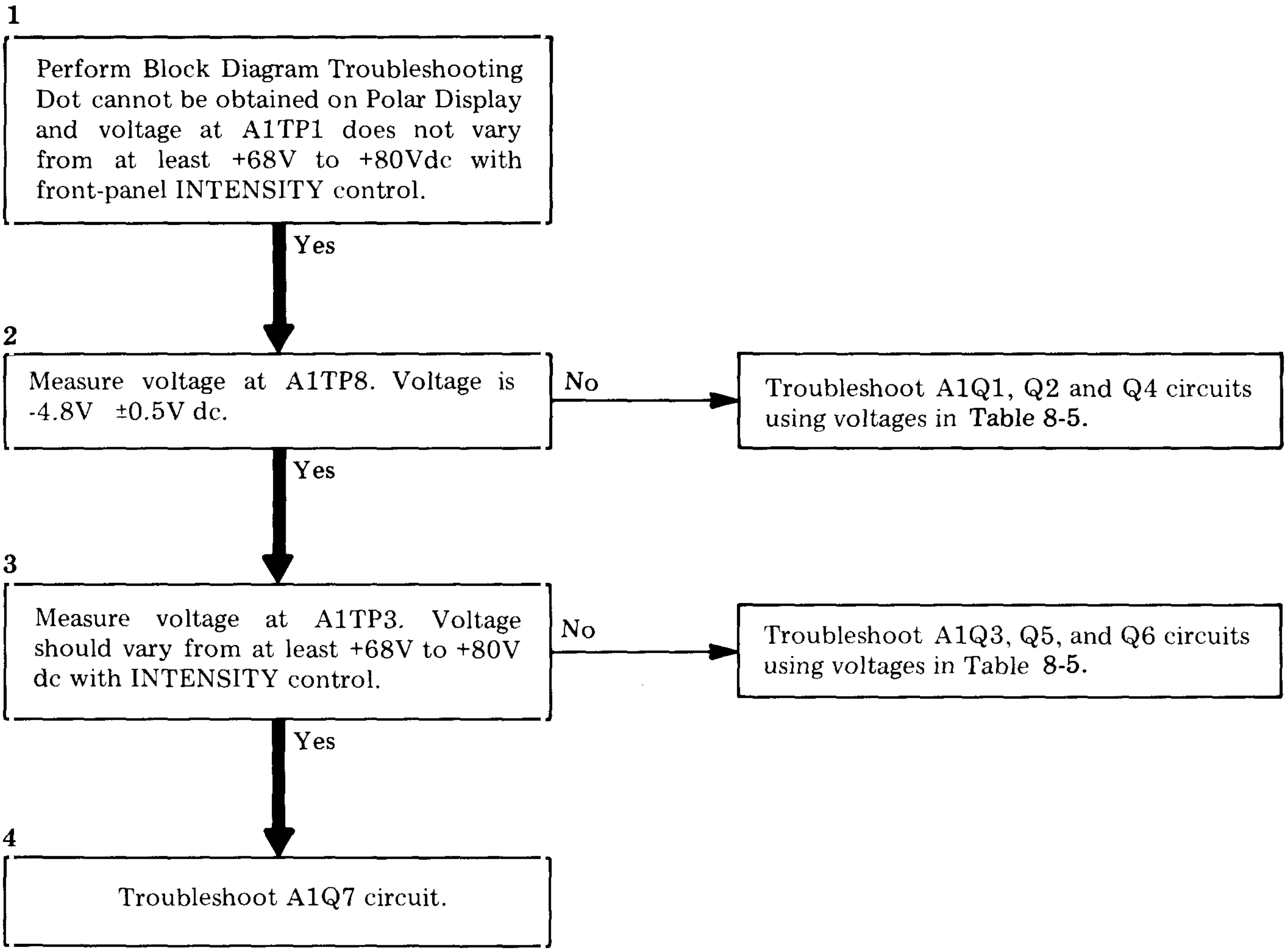


Table 8-5. Intensity Modulator DC Voltage Measurements

Condition[1]	Voltage Measurement Point								
	A1TP2	A1TP5	A1TP9	A1TP8	A1Q2B	A1Q2E	A1Q3E	A1Q6E	A1TP1 and A1TP3
I (8410A only)	+110V[2]	-3.6V[3]	-3 ±1V	-14 ±1V	-13.5 ±1V	-14 ±1V	-6.5 ±0.5V	-4.2 ±0.5V	+65V ±3V / none[4]
II	+110V[2]	-3.6V[3]	-18 ±2V	-4.8 ±0.5V	-18 ±2V	-15 ±1V	-5.5 ±0.5V	-4.2 ±0.1V	+70 ±3V / +65 to +85V[4]
III	+110V	-3.4 ±0.2V	-18 ±2V	-0.7 ±0.1V	-18 ±2V	-15 ±1V	-0.6 ±0.1V	-3.5 ±0.1V	+108 ±4V / +102 to +108V[4]
IV	+110V	-3.5 ±0.1V	-18 ±2V	-13.5 ±1V	-13 ±1V	-13.5 ±1V	-7 ±1V	-4.2 ±0.1V	+65 ±3V / none[4]

[1]I. No RF signal to 8410A Network Analyzer (No unblanking signal) Does not apply for 8407A Network Analyzer.
II. Unblanking signal from Network Analyzer (Network Analyzer phase locked for 8410A).

III. Unblanking signal from Network Analyzer and -5V applied to J2 MARKER INPUT.

IV. Unblanking signal from Network Analyzer and -5V applied to J1 BLANKING INPUT.

[2]Adjust R20 Intensity Limit control for +110V at A1TP2.

[3]Adjust front-panel INTENSITY control for -3.6V at A1TP5 (INTENSITY control will vary voltage from about -2.5V to -4.8 Vdc).

[4]Amount voltage will vary with front-panel INTENSITY control.

SCHEMATIC 3. CIRCUIT DESCRIPTION

Inputs

The Intensity Modulator controls the CRT grid to cathode bias. Intensity Modulator input signals cause the CRT's electron beam to be turned off for blanking or intensified for frequency markers. There are three signal inputs to the intensity modulator: one from the Network Analyzer mainframe which unblanks the CRT (8410A Network Analyzers unblank the CRT only when the Network Analyzer is phase locked); the second, a rear-panel connector, which may be connected to the sweep oscillator blanking output to blank the display during sweep retrace; the third, another rear-panel connector. which may be connected to the sweep oscillator frequency marker output to display frequency marks on the display by brightening the display at the point which represents the frequency of interest.

Switches

Switch A1Q2 is turned off when the Network Analyzer is phase locked. Although the output of A1Q2 at A1TP8 is always a negative voltage, when A1Q2 is turned off its output appears positive-going to the following stage and the CRT is unblanked.

Switch A1Q1 is normally off. When a positive blanking pulse is applied to its input, A1Q1 conducts which turns A1Q2 on. The voltage at A1TP8 goes more negative and the CRT is blanked.

A negative marker pulse turns switch A1Q4 on, its output voltage at A1TP8 approaches ground and appears as a positive-going input signal to the following stage. This signal is more positive than the unblanking signal; therefore, the CRT's electron beam is intensified.

Differential Amplifier

A1Q3 and Q6 form a differential amplifier. The amplifier gain varies with position of the front-panel intensity control; however, with the intensity control set for normal intensity (about -3.6V at A1TP5) and the intensity limit set for about +110V at A1TP2, the amplifier gain is about seven or eight. For example, if the voltage at A1TP8 changes from -5V (Q2 and Q4 off) to -0.1V (Q2 off Q4 on), a change of about 5V, the output at A1TP3 should change from about +70 to about +105V, a change of about 35V.

Emitter Follower

The output of emitter follower A1Q7 at A1TP7 should be about +65V for a blanked condition, about +70V for an unblanked condition, and about +105V for a marker condition.

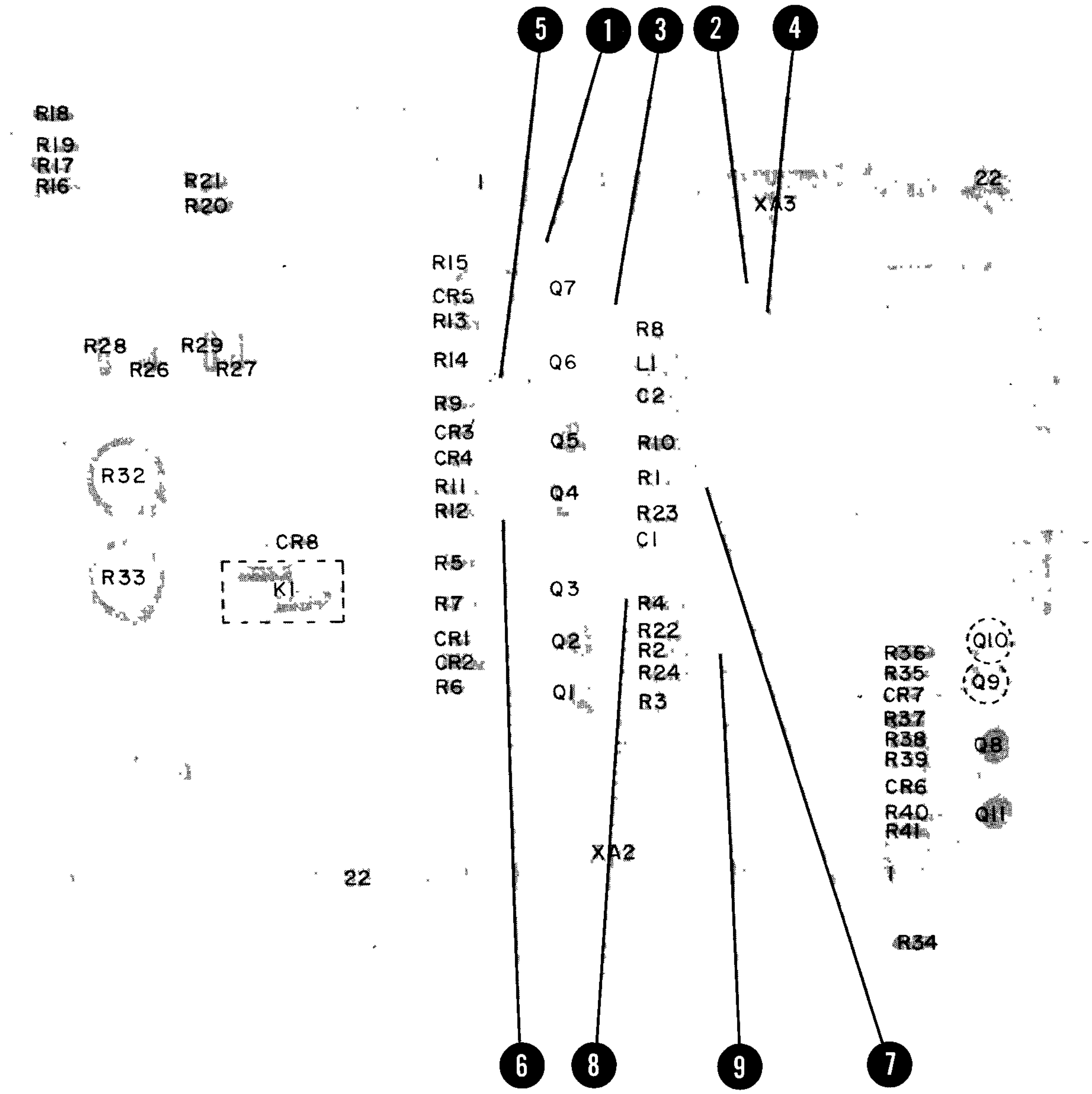
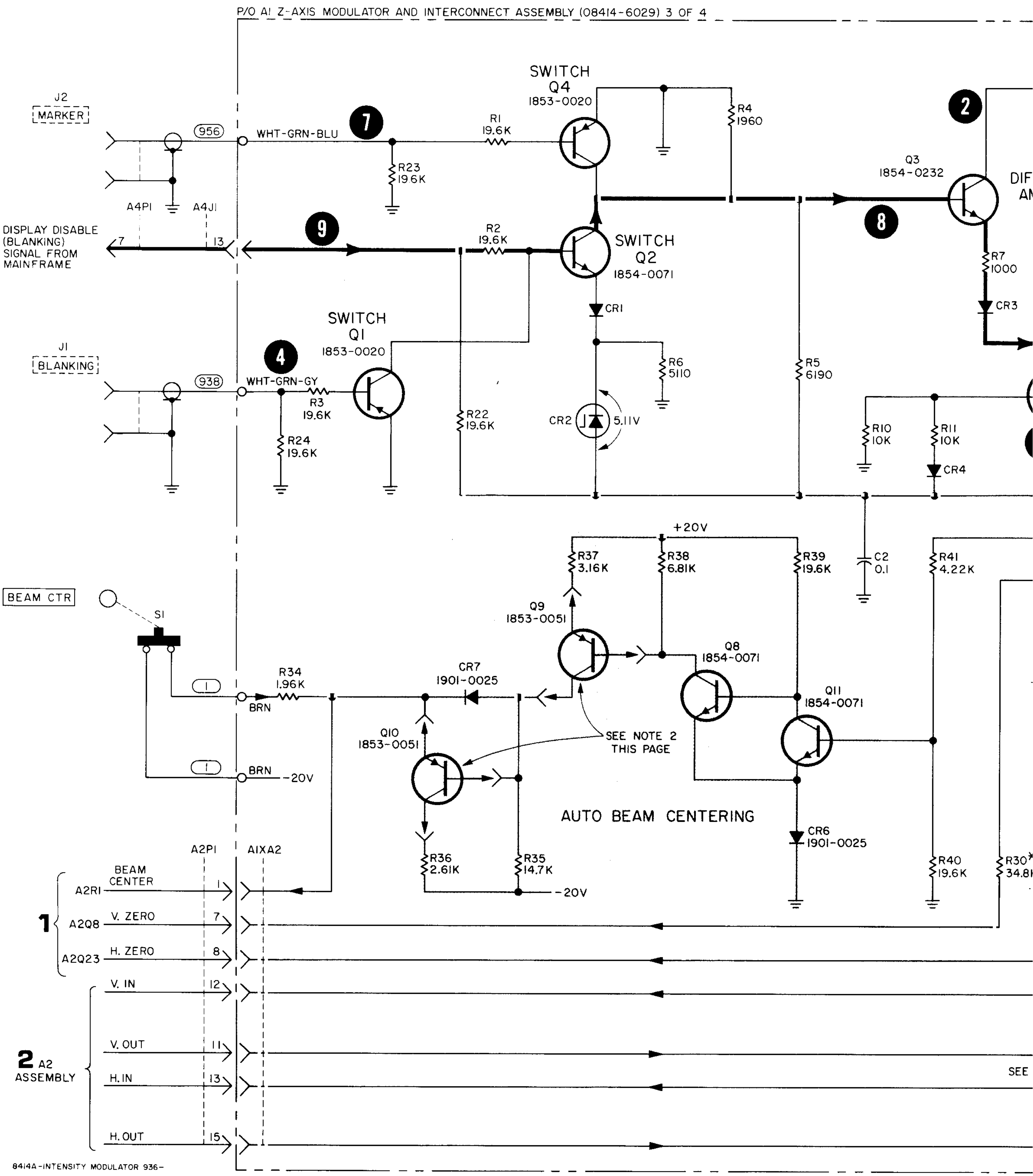
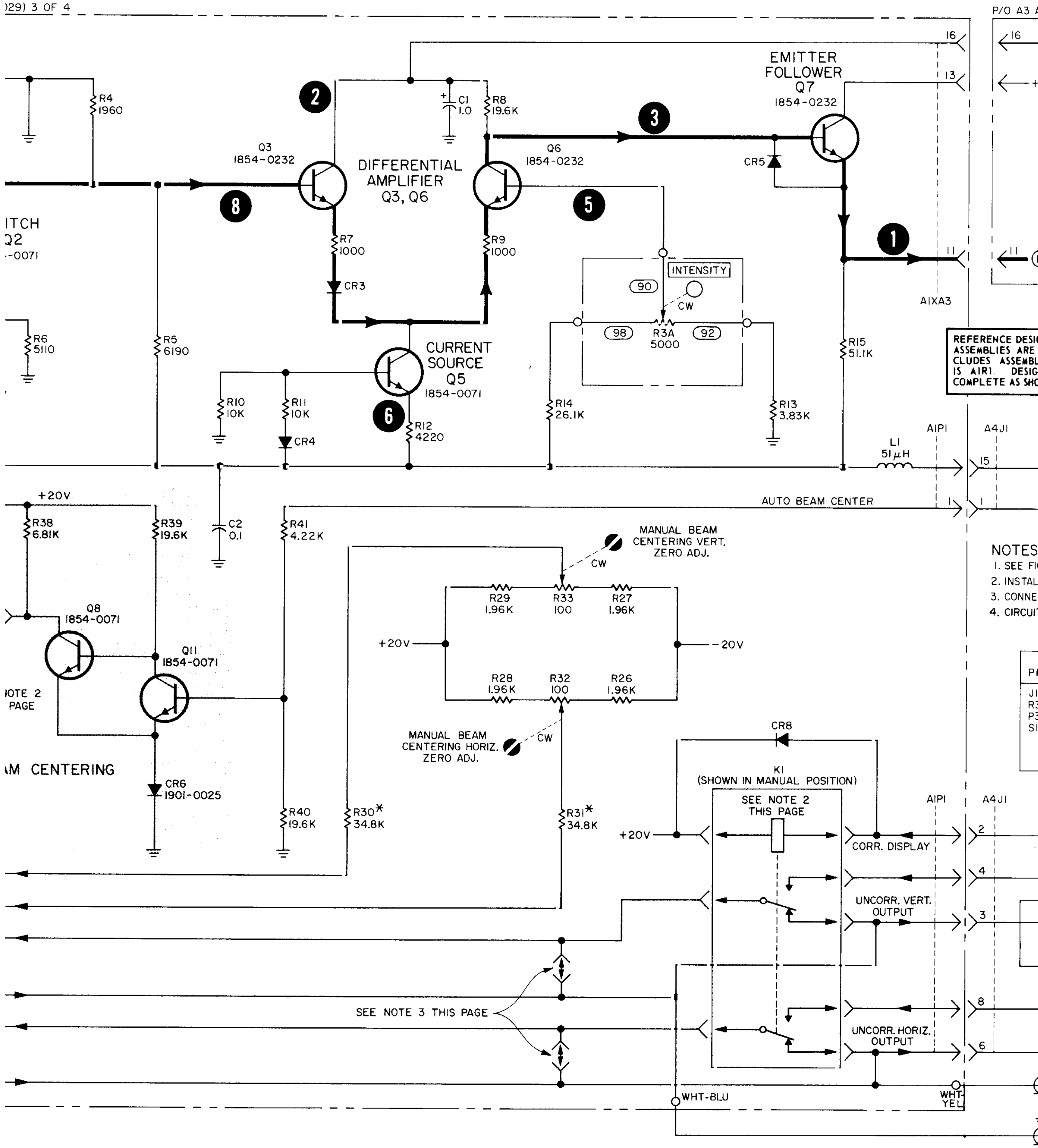
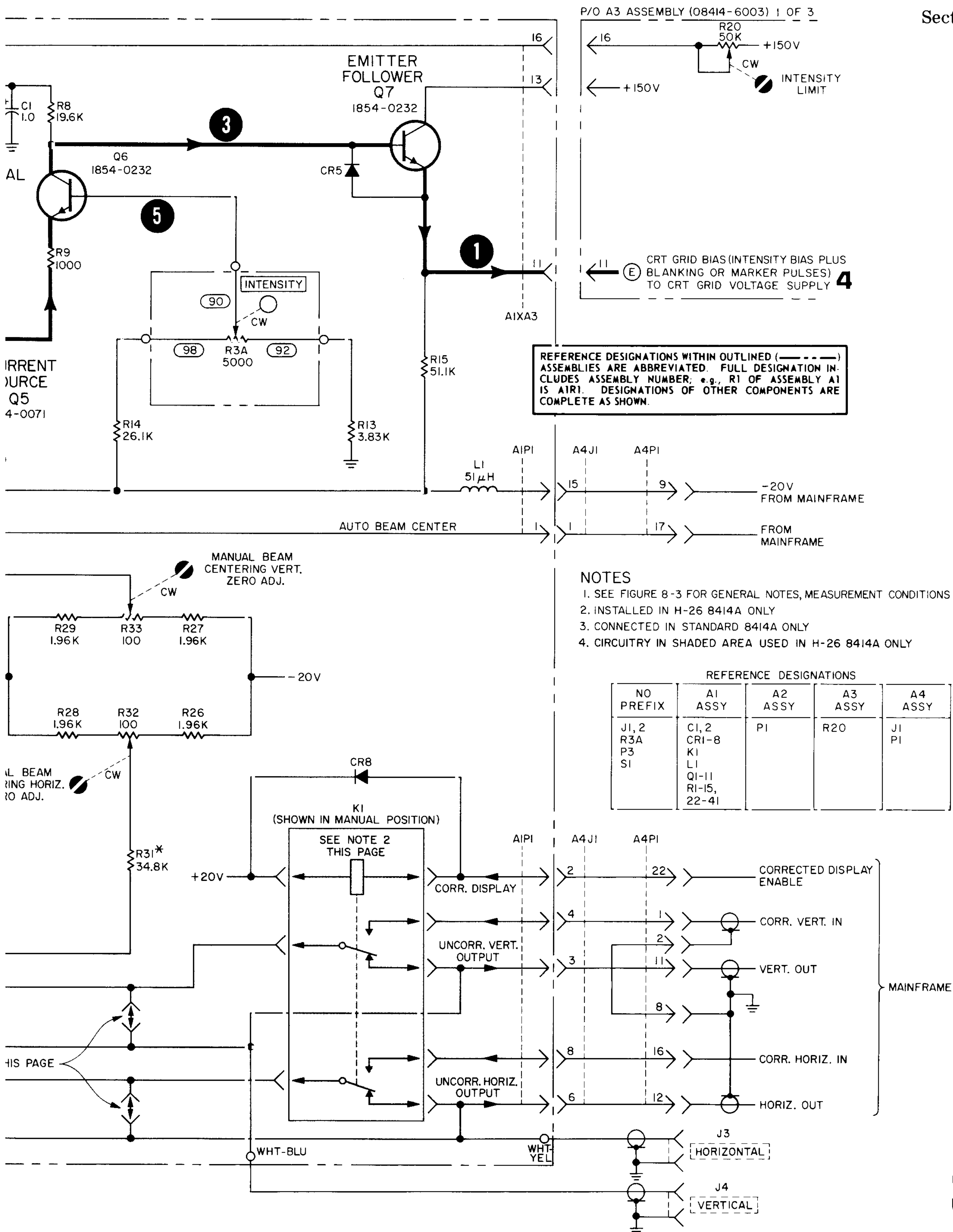


Figure 8-17. Intensity Modulator, Component Identification



P/O A1 Z-AXIS MODULATOR AND INTERCONNECT ASSEMBLY (08414-6029) 3 OF 4
J2
MARKER
956
WHT-GRN-BLU
7
R1
19.6K
SWITCH
Q4
1853-0020
R4
1960
2
R23
19.6K
Q3
1854-0232
8
A4P1
A4J1
DISPLAY DISABLE
(BLANKING)
SIGNAL FROM
MAINFRAME
9
R2
19.6K
SWITCH
Q2
1854-0071
R7
1000
CR1
CR3
SWITCH
Q1
1853-0020
J1
BLANKING
4
938
WHT-GRN-GY
R3
19.6K
R24
19.6K
R22
19.6K
R6
5110
R5
6190
CR2
5.11V
R10
10K
R11
10K
CR4
+20V
R37
3.16K
R38
6.81K
R39
19.6K
C2
0.1
R41
4.22K
BEAM CTR
S1
Q9
1853-0051
Q8
1854-0071
R34
1.96K
CR7
1901-0025
BRN
Q11
1854-0071
Q10
1853-0051
SEE NOTE 2
THIS PAGE
BRN
-20V
AUTO BEAM CENTERING
CR6
1901-0025
A2P1
A1XA2
R36
2.61K
R35
14.7K
R40
19.6K
R30*
BEAM
CENTER
A2R1
-20V
1
V. ZERO
A2Q8
7
H. ZERO
A2Q23
8
V. IN
12
2 A2
ASSEMBLY
V. OUT
11
H. IN
13
SEE
H. OUT
15
8414A-INTENSITY MODULATOR 936-


P/O A3
EMITTER FOLLOWER Q7 1854-0232
DIFFERENTIAL AMPLIFIER Q3, Q6
Q3 1854-0232
Q6 1854-0232
CURRENT SOURCE Q5 1854-0071
ITCH Q2 -0071
R4 1960
C1 1.0
R8 19.6K
R7 1000
R9 1000
CR3
CR5
R6 5110
R5 6190
R10 10K
R11 10K
CR4
R12 4220
INTENSITY
90
98
92
CW
R3A 5000
R14 26.1K
R13 3.83K
R15 51.1K
A1XA3
REFERENCE DESIG ASSEMBLIES ARE CLUDES ASSEMBL IS A1R1. DESIG COMPLETE AS SHO
A1P1
A4J1
L1 51µH
+20V
R38 6.81K
R39 19.6K
C2 0.1
R41 4.22K
AUTO BEAM CENTER
MANUAL BEAM CENTERING VERT. ZERO ADJ.
NOTES
1. SEE FI
2. INSTAL
3. CONNE
4. CIRCUI
Q8 1854-0071
Q11 1854-0071
R29 1.96K
R33 100
R27 1.96K
+20V
-20V
R28 1.96K
R32 100
R26 1.96K
NOTE 2 PAGE
MANUAL BEAM CENTERING HORIZ. ZERO ADJ.
AM CENTERING
CR6 1901-0025
CR8
K1 (SHOWN IN MANUAL POSITION)
SEE NOTE 2 THIS PAGE
R40 19.6K
R30* 34.8K
R31* 34.8K
CORR. DISPLAY
UNCORR. VERT. OUTPUT
SEE NOTE 3 THIS PAGE
UNCORR. HORIZ. OUTPUT
WHT-BLU
WHT-YEL



REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

NOTES
1. SEE FIGURE 8-3 FOR GENERAL NOTES, MEASUREMENT CONDITIONS
2. INSTALLED IN H-26 8414A ONLY
3. CONNECTED IN STANDARD 8414A ONLY
4. CIRCUITRY IN SHADED AREA USED IN H-26 8414A ONLY

REFERENCE DESIGNATIONS

NO PREFIX	A1 ASSY	A2 ASSY	A3 ASSY	A4 ASSY
J1, 2 R3A P3 S1	C1, 2 CR1-8 K1 L1 Q1-11 R1-15, 22-41	P1	R20	J1 P1

3

Figure 8-18. Intensity Modulator, Schematic Diagram

Schematic 4 TROUBLESHOOTING

1

Perform Block Diagram Troubleshooting. Dot cannot be obtained on Polar Display and voltage at A1TP1 will vary from at least +68V to +80V dc with front-panel INTENSITY control.

Yes ↓

2

NOTE: Remove Power Supply Cover and ground A3 Assembly to chassis with alligator clip.

Connect voltmeter and oscilloscope to A3TP2. Voltage should be +153 ±7V dc and ripple less than 100 mV P-P.

No →

If voltage at A3TP2 is +160V to +180V, trouble is most likely A3Q1 circuit.

If voltage at A3TP2 is greater than +180V, trouble is most likely A3Q2 circuit.

If voltage is less than +145V, trouble is most likely A3Q3 or A3C3 circuit.

If Series Regulator Q3 is bad, check A3R17 for proper resistance.

Yes ↓

3

Measure high voltage supply outputs using high voltage probe. Supply voltages are:
-2500V Supply is -2200 to -2650V
-2450V Supply is -2150 to -2600V
+5100V Supply is +4500 to +5300V

No →

If all three outputs are low, troubleshoot Multivibrator Q1, Q2 circuit. If only one output is abnormal troubleshoot the associated power supply.

Yes ↓

4

Measure voltage at center arm of R3B (FOCUS control) while varying control from one extreme to the other. Voltage should vary from about -1700V to -2000V dc.

No →

Troubleshoot R3B, A3R12, and A3R13.

SCHEMATIC 4. CIRCUIT DESCRIPTION

CRT, CRT POWER SUPPLIES

+150V Power Supply. The +150V power supply is a regulated supply. Reference Amplifier, A3Q2 senses a change in output voltage, amplifies that change and inverts the polarity of the change. The output of the reference amplifier changes the conduction of Driver A3Q1, which changes the conduction of Series Regulator A3Q3. The series regulator acts as a variable resistor whose resistance varies inversely with collector current; i.e., if the series regulator's base voltage goes in a negative direction, its collector current decreases, dropping more voltage across the regulator, decreasing output voltage.

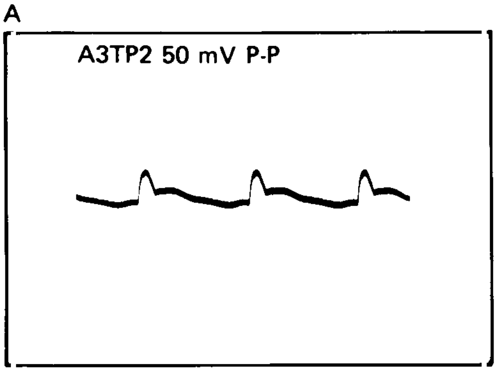
High Voltage Oscillator. High Voltage Oscillator Q1, Q2 is a free-running multivibrator whose frequency, 20 kHz ±2 kHz, is determined by the L and C of T1's primary.

CRT Cathode Supply. One of T1's secondary windings supplies power to the CRT's cathode supply and anode supply. The cathode supply consists of a half-wave rectifier and pi section filter. Its output voltage is about -2450 Vdc. In addition to providing dc bias to the CRT cathode, the cathode supply's output voltage is used in a voltage divider to +150V to provide about -2000 Vdc to the front-panel focus control.

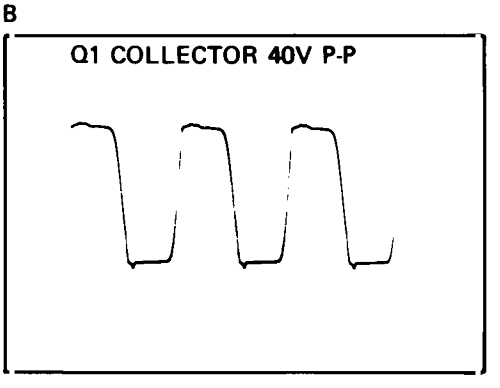
CRT Anode Supply. The anode supply consists of a voltage doubler and pi section filter. Its output voltage is about +5100 Vdc.

CRT Grid Supply. The grid supply consists of a half-wave rectifier or peak detector. Its output voltage is about -2500 Vdc with the CRT unblanked. With no input from the intensity modulator, the grid supply is referenced to ground; however, an input voltage from the intensity modulator becomes the reference voltage for the grid supply. A change in this input voltage causes the grid supply's output voltage to change, which changes the CRT's grid to cathode bias.

A



B



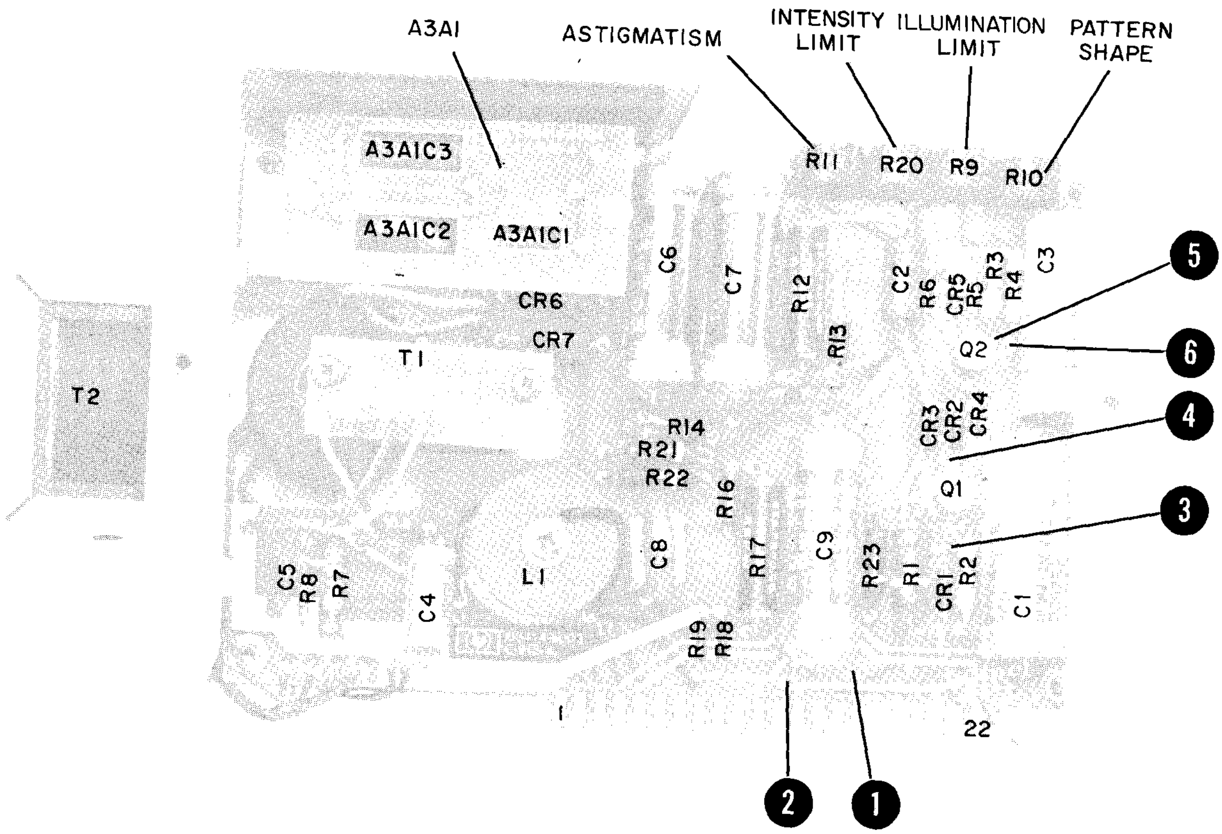


Figure 8-19. CRT High and Low Voltage Supplies and +150 Volt Supply, Component Identification

REFERENCE DESIGNATIONS

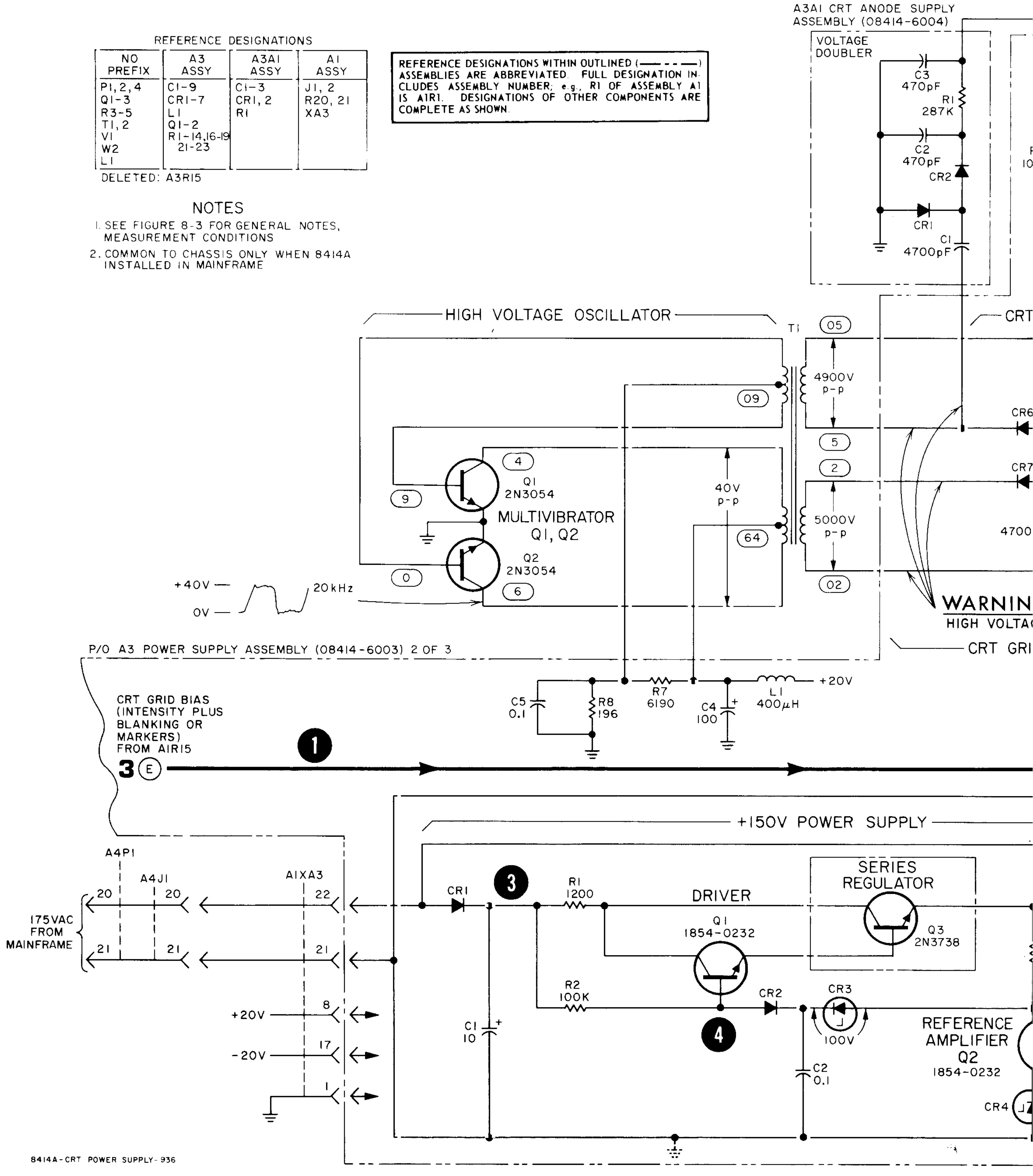
NO PREFIX	A3 ASSY	A3A1 ASSY	A1 ASSY
P1, 2, 4 Q1-3 R3-5 T1, 2 V1 W2 L1	C1-9 CR1-7 L1 Q1-2 R1-14, 16-19 21-23	C1-3 CR1, 2 R1	J1, 2 R20, 21 XA3

DELETED: A3R15

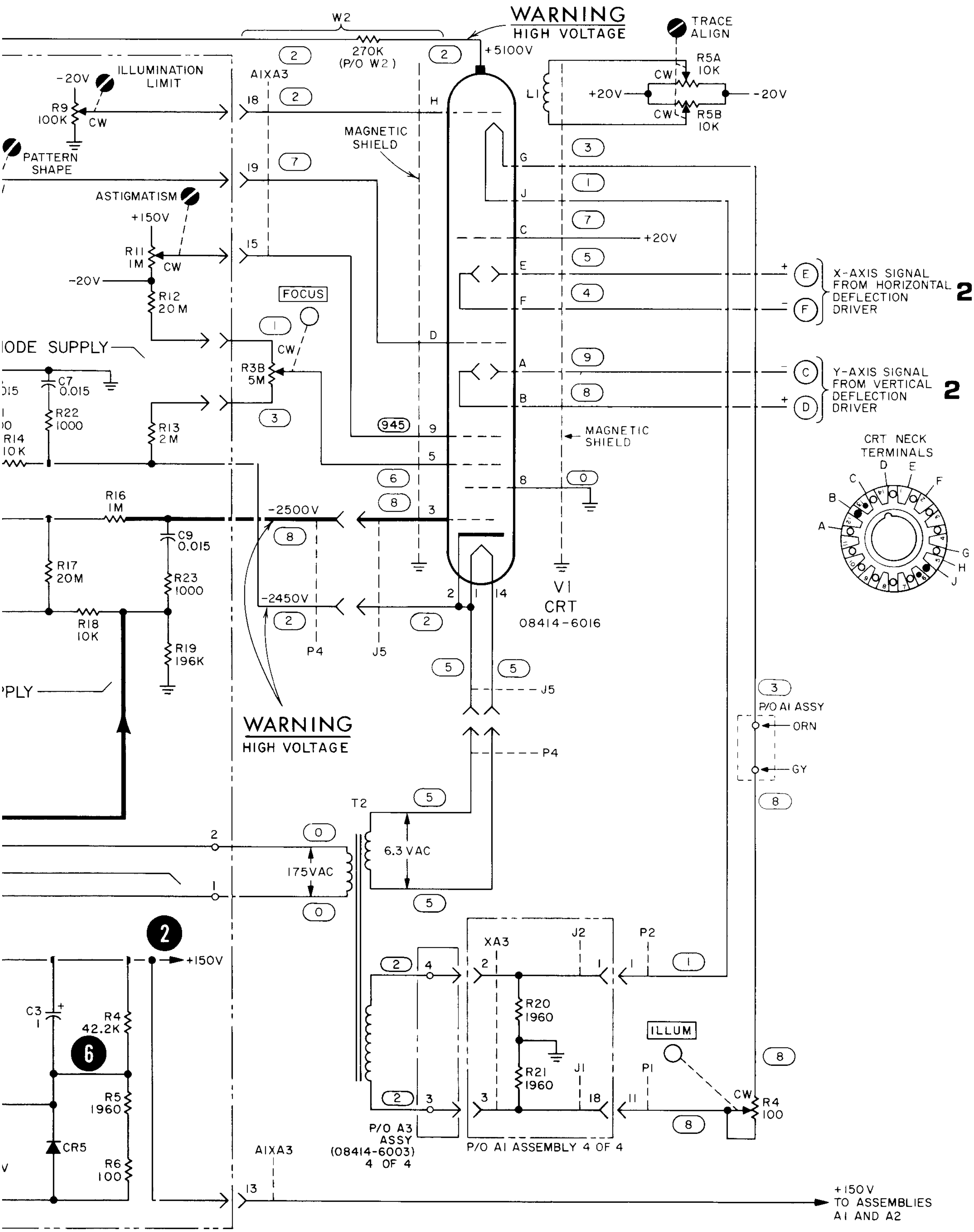
REFERENCE DESIGNATIONS WITHIN OUTLINED (— - - —) ASSEMBLIES ARE ABBREVIATED. FULL DESIGNATION INCLUDES ASSEMBLY NUMBER; e.g., R1 OF ASSEMBLY A1 IS A1R1. DESIGNATIONS OF OTHER COMPONENTS ARE COMPLETE AS SHOWN.

NOTES

1. SEE FIGURE 8-3 FOR GENERAL NOTES, MEASUREMENT CONDITIONS
2. COMMON TO CHASSIS ONLY WHEN 8414A INSTALLED IN MAINFRAME



8414A-CRT POWER SUPPLY-936



4

Figure 8-20. CRT High and Low Voltage Supplies and +150 Volt Supply, Schematic Diagram

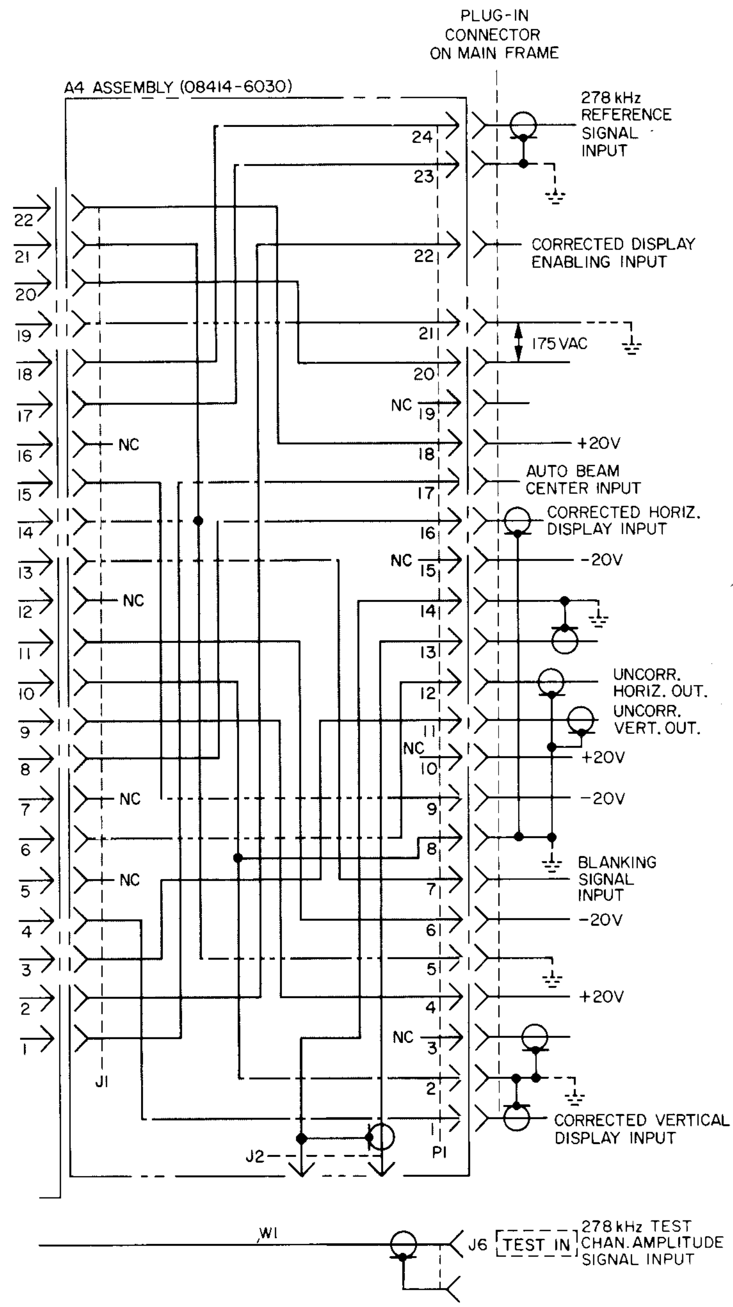


Figure 8-21. Mainframe Plug-In Connector Detail for H26-8414A

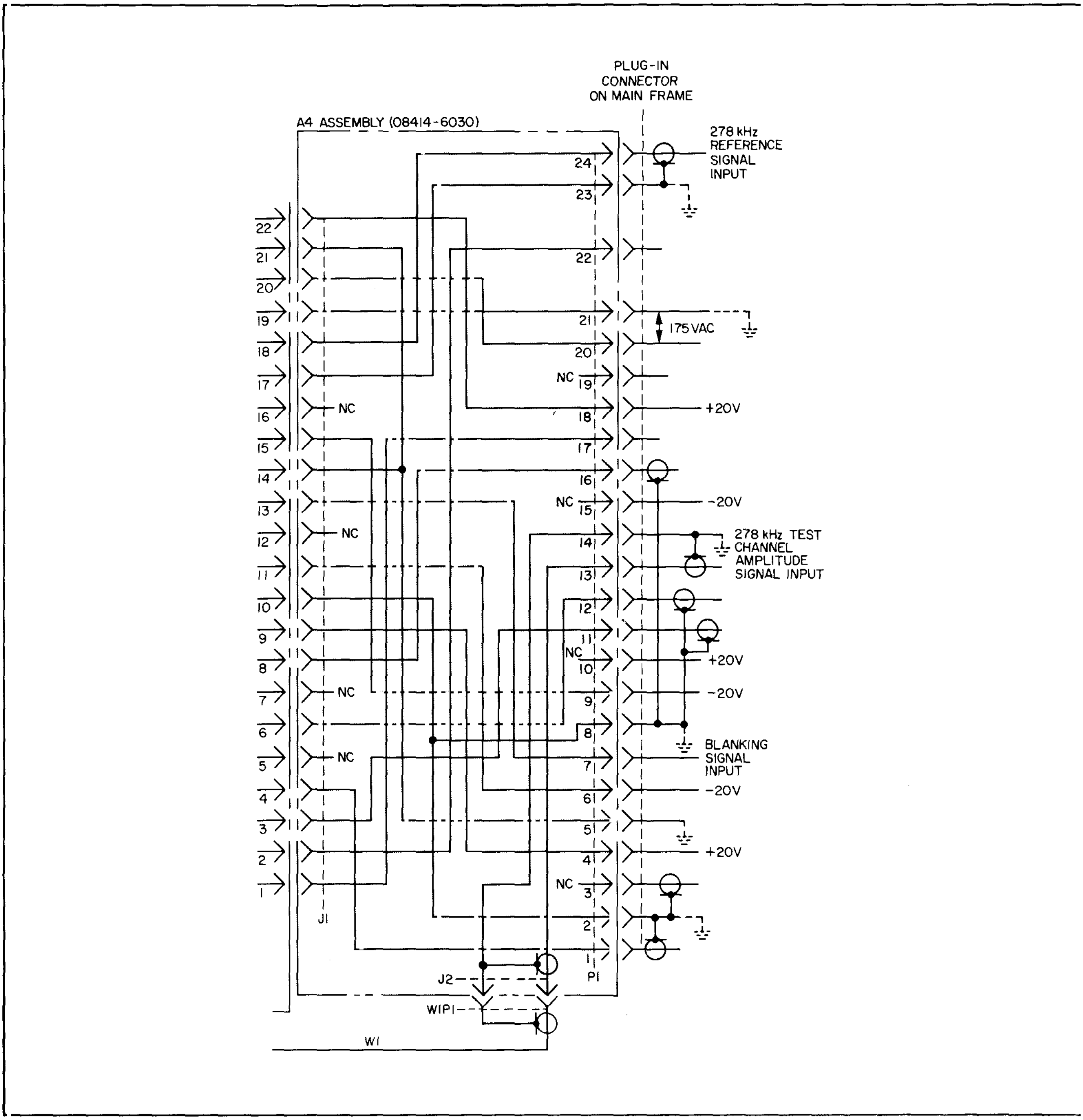
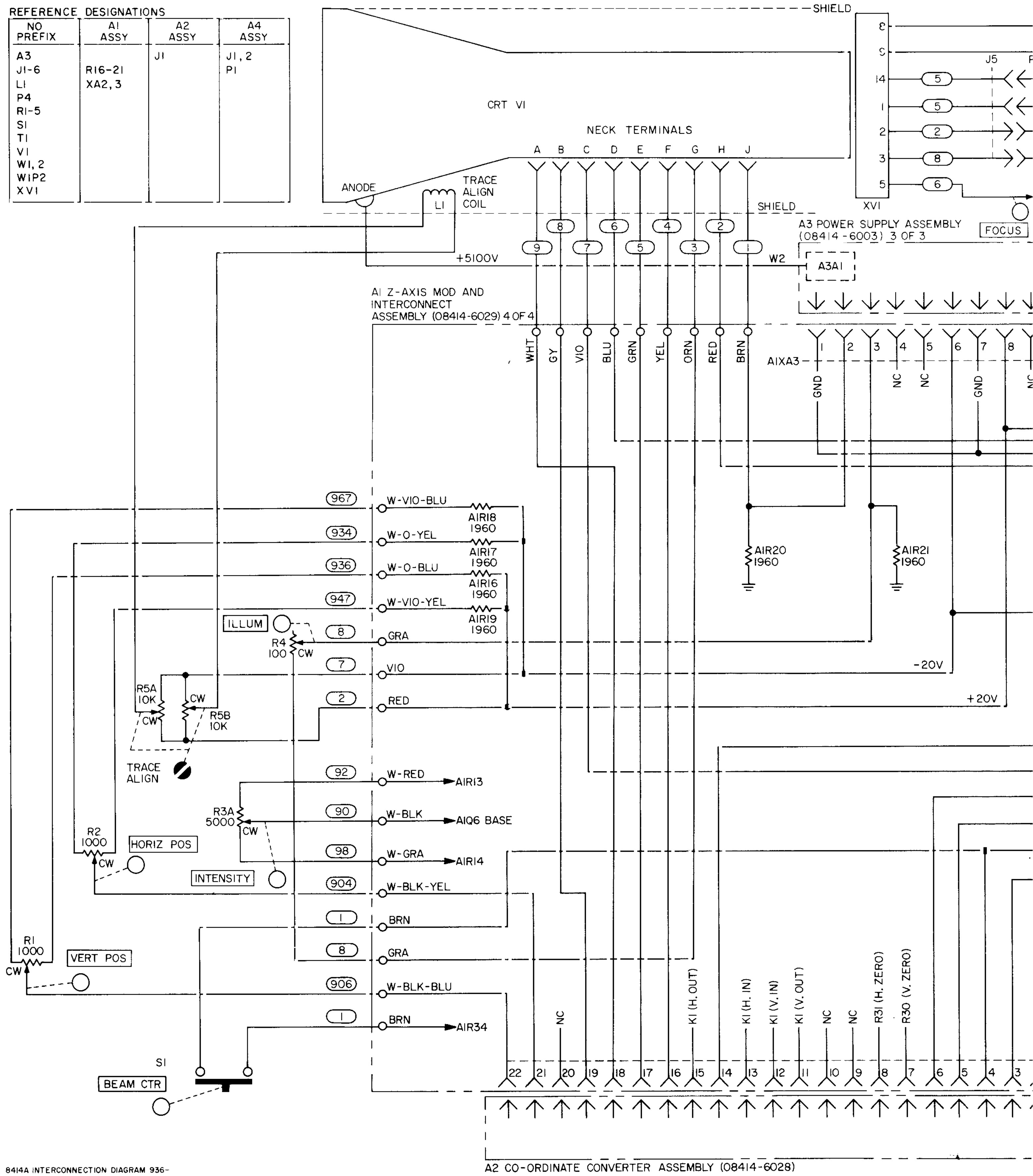


Figure 8-22. Mainframe Plug-In Connector Detail for Standard 8414A

REFERENCE DESIGNATIONS

NO PREFIX	A1 ASSY	A2 ASSY	A4 ASSY
A3	R16-21	J1	J1, 2
J1-6	XA2, 3		P1
L1			
P4			
R1-5			
S1			
T1			
V1			
W1, 2			
W1P2			
XV1			



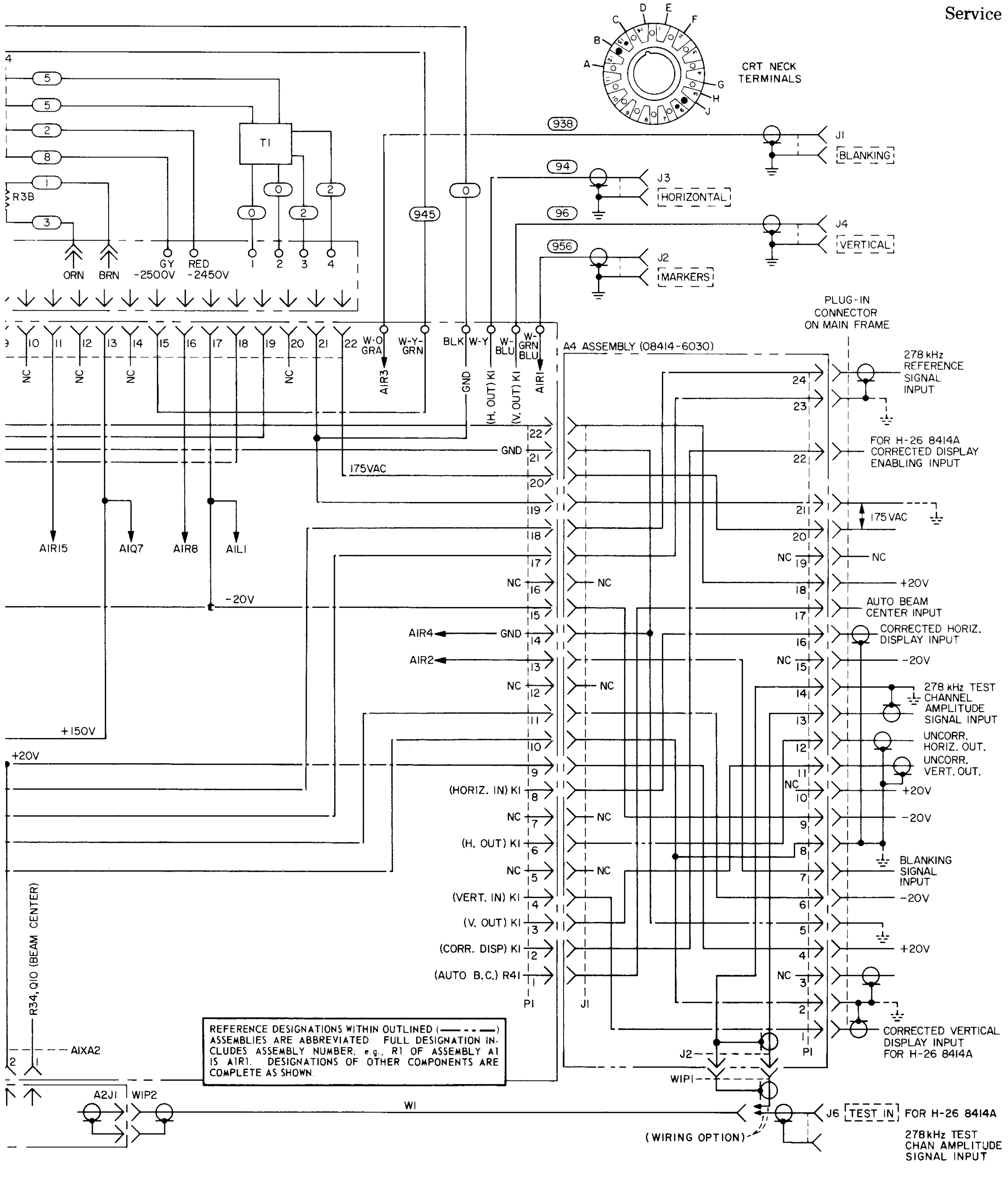
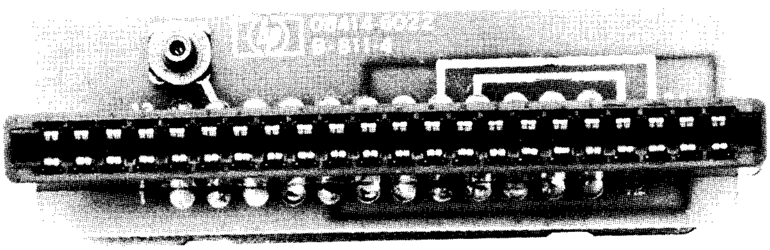
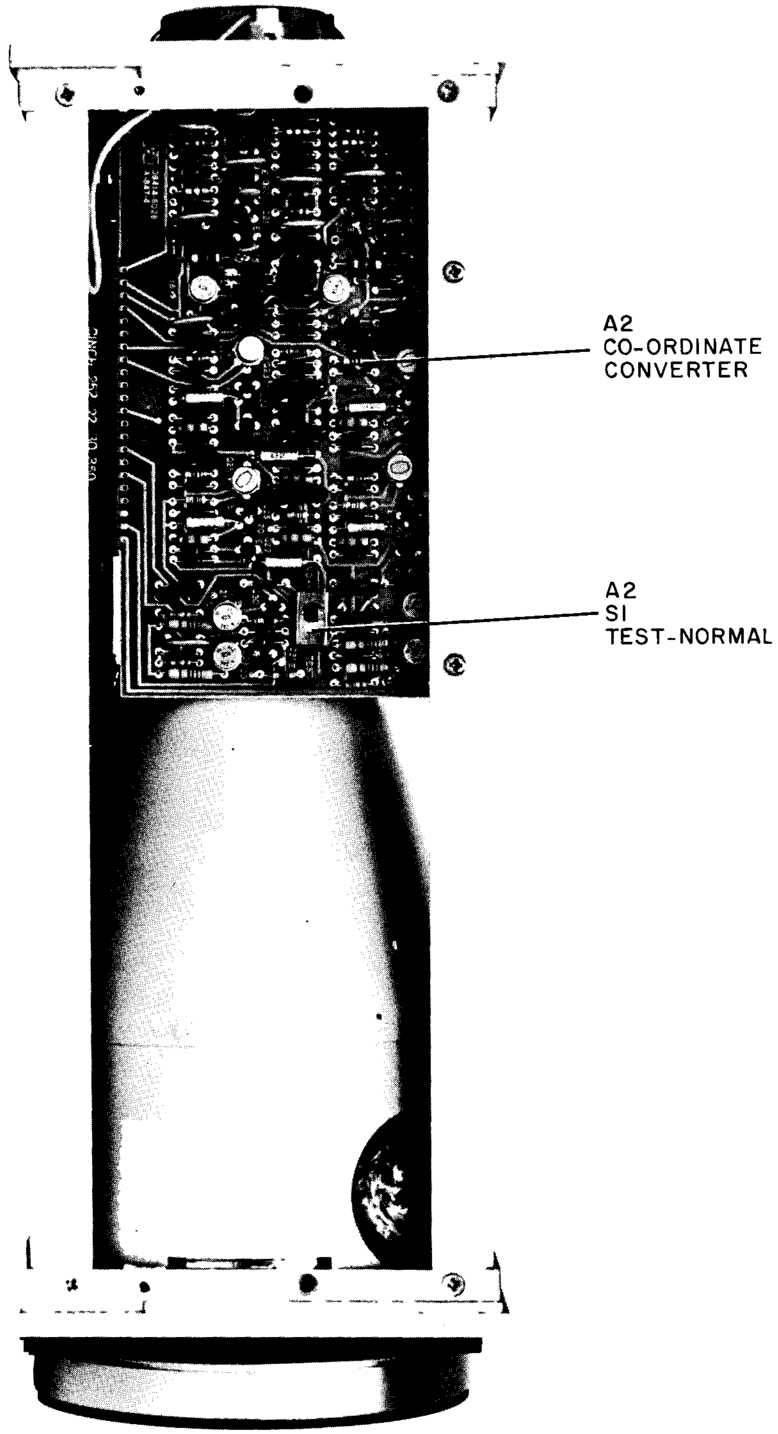


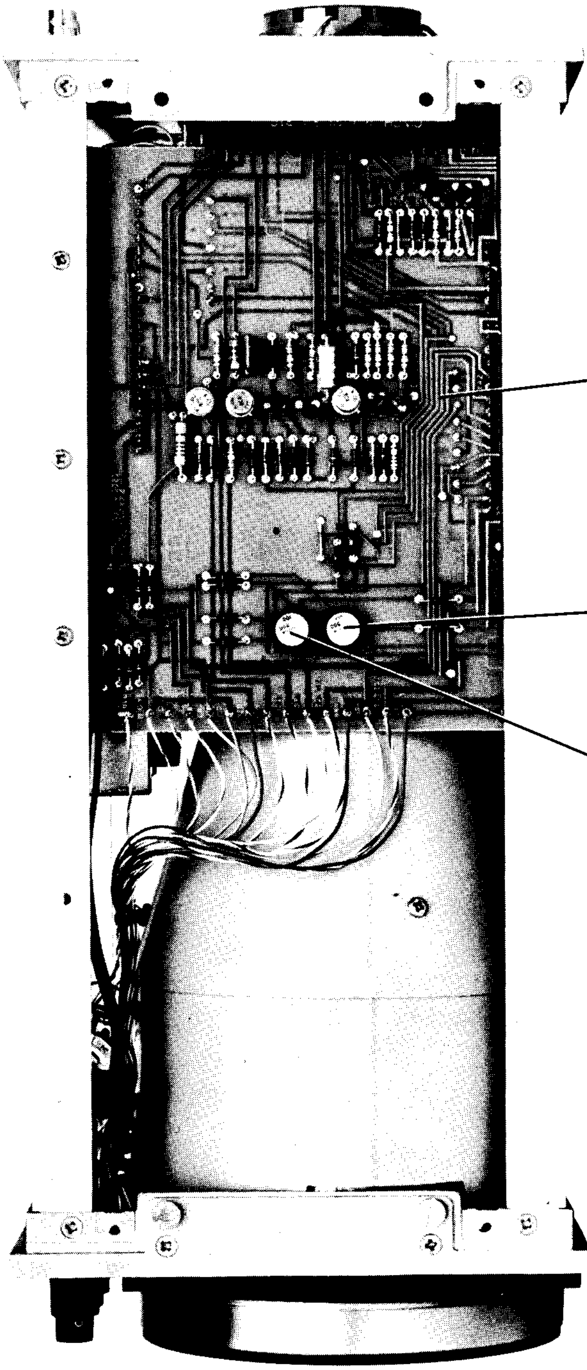
Figure 8-23. Interconnection Diagram



A4 ASSEMBLY

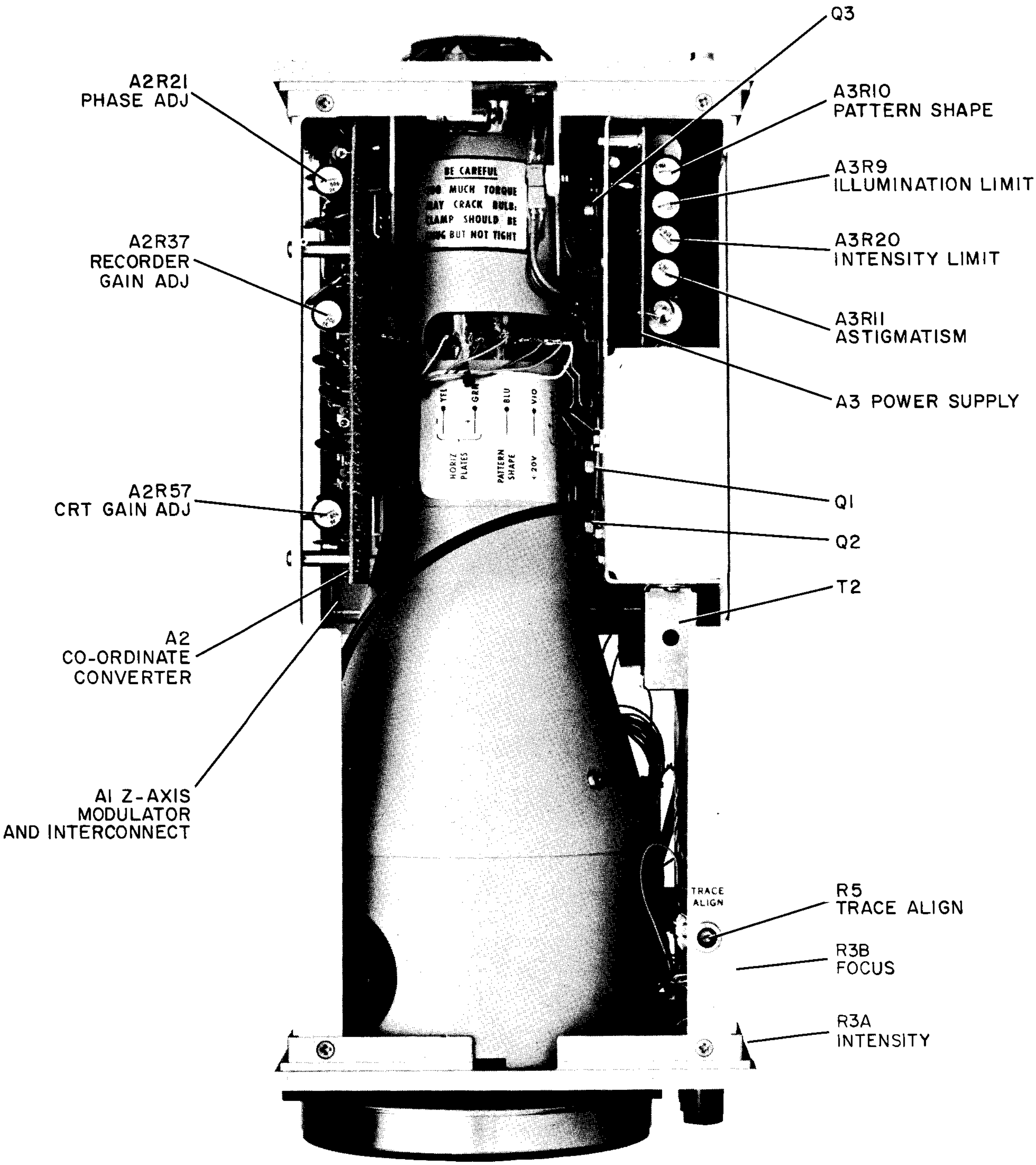


LEFT SIDE

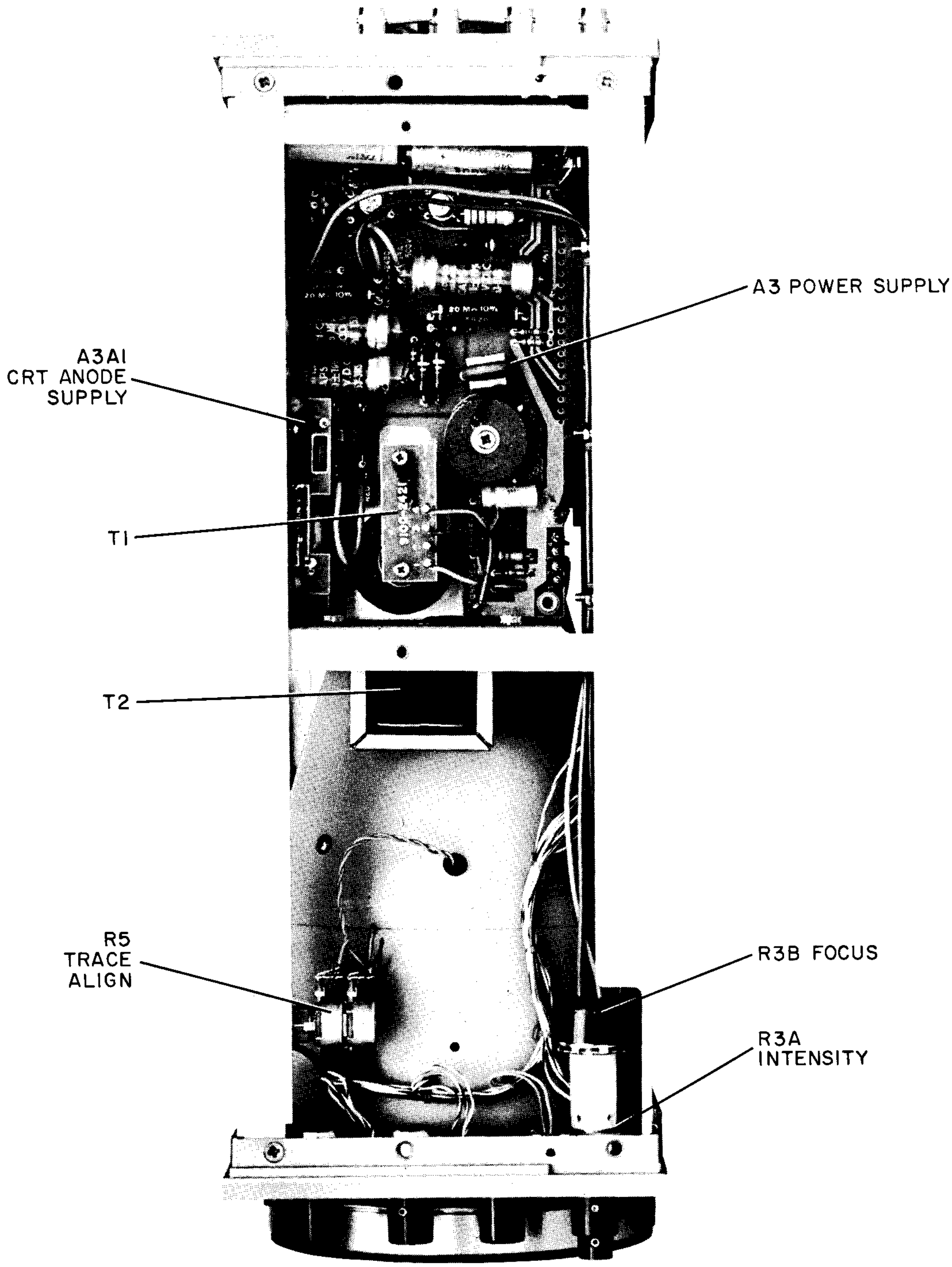


AI Z-AXIS MODULATOR AND INTERCONNECT
AIR33 MANUAL BEAM CENTERING VERT ZERO ADJ
AIR32 MANUAL BEAM CENTERING HORIZ ZERO ADJ

BOTTOM


Q3
A2R21
PHASE ADJ
A3R10
PATTERN SHAPE
A3R9
ILLUMINATION LIMIT
A2R37
RECORDER
GAIN ADJ
A3R20
INTENSITY LIMIT
A3R11
ASTIGMATISM
A3 POWER SUPPLY
A2R57
CRT GAIN ADJ
Q1
Q2
T2
A2
CO-ORDINATE
CONVERTER
A1 Z-AXIS
MODULATOR
AND INTERCONNECT
BE CAREFUL
TRACE
ALIGN
R5
TRACE ALIGN
R3B
FOCUS
R3A
INTENSITY

TOP



RIGHT SIDE

Figure 8-24. Location of Adjustments, Chassis-mounted Parts and Major Assemblies

HEWLETT
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