Errata

Title & Document Type: **8413A Phase-Gain Indicator Operating and Service Manual**

Manual Part Number: **08413-90011**

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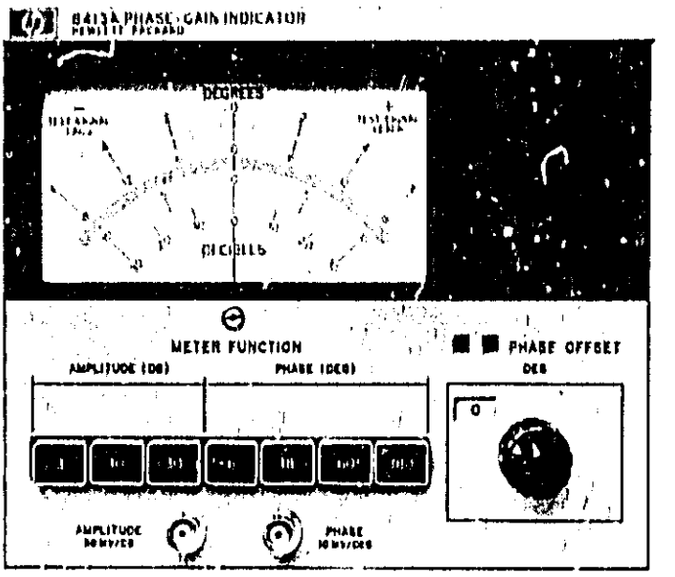
Agilent Technologies

OPERATING AND SERVICE MANUAL

PHASE-GAIN INDICATOR

8413A



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PHASE-GAIN INDICATOR
8413A

SERIAL NUMBERS

This manual applies directly to HP Model 8413A Phase-Gain Indicators having serial numbers prefixed 903- and 1144A.

OTHER PREFIXES:

For serial numbers prefixed 826- and below, see Appendix A.

For serial numbers prefixed higher than 1144A see Manual Changes insert included with this manual.

MANUAL PART NO. 08413-90011
Microfiche Part No. 08413-90012

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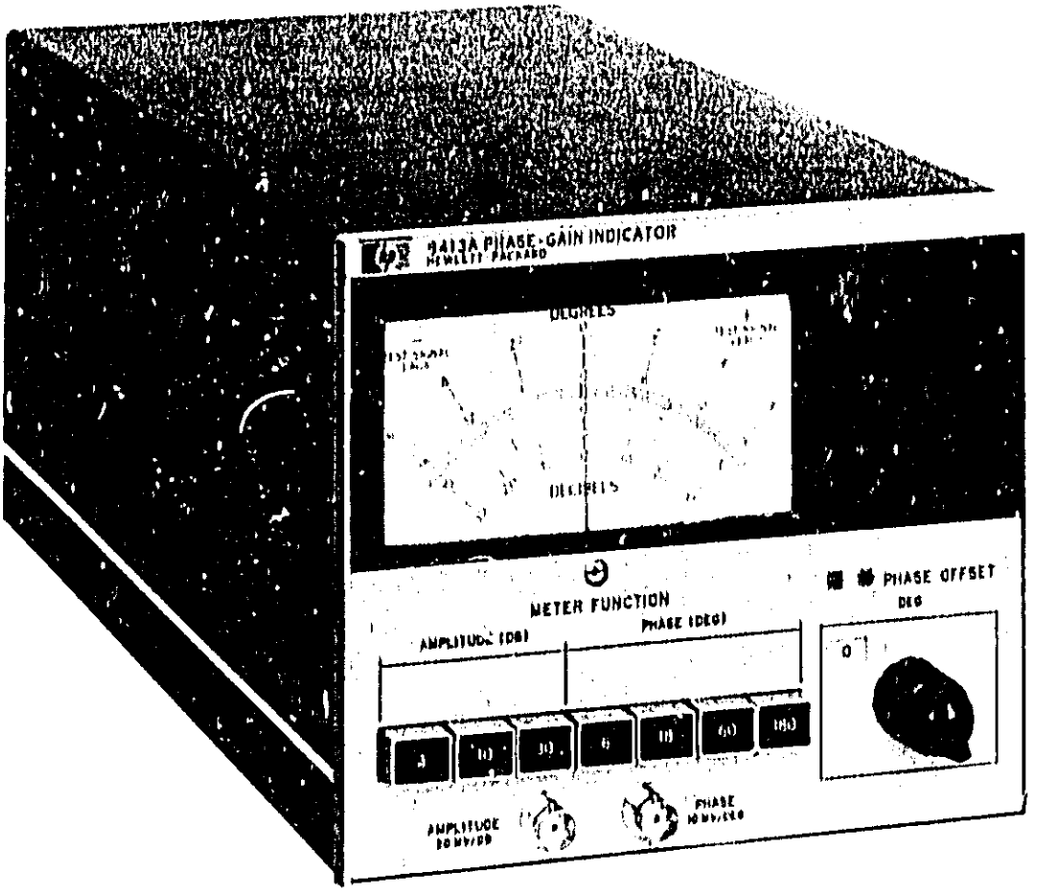


Figure 1-1. Model 8413A Phase-Gain Indicator

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Model 8413 Phase-Gain Indicator (Figure 1-1) is a plug-in meter display unit for the Model 8410A Network Analyzer. It displays relative amplitude and phase difference of two input signals. Front panel pushbutton controls select meter function and range. Two connectors on the front panel provide linear phase and logarithmic amplitude output for phase amplitude displays on an oscilloscope or X-Y recorder. A linear amplitude output signal is available at the rear panel. Complete specifications for the Model 8413A Phase-Gain Indicator are given in Table 1-1.

1-3. INSTRUMENTS COVERED BY MANUAL.

1-4. The contents of this manual apply directly to instruments that have the same serial number prefixes as those listed on the title page. With the changes indicated in Appendix A, the manual also applies to instruments having lower serial number prefixes. Note that for all instruments preceding serial number prefix 1144A, the serial number was a two-section, eight digit number, in which the first three digits were the prefix and the last five the suffix. Starting with serial prefix 1144A, the first four digits and the letter form the prefix and the last five digits form the suffix.

Table 1-1. Specifications

AMPLITUDE

Range: ±3, ±10, and ±30 dB full scale.

Accuracy: ±3% of end scale.

Log Output: 50 mV per dB up to 60 dB total; bandwidth 10 kHz nominal depending on signal level; source impedance 1 kΩ; accuracy ±3%.

Linear Output (Rear Panel): 0 to 1 V maximum; 10-kHz bandwidth; 250 Ω source impedance (approx.).

Maximum Drift:

Log: Less than ±0.1 dB/°C after one hr. warm-up.

Linear: Less than ±5 mV/°C after one hr. warm-up.

PHASE

Range: ±6, ±18, ±60 and ±180 degrees full scale.

Accuracy: ±2% of end scale.

Output: 10 mV per degree; 10-kHz bandwidth; 1 kΩ source impedance.

Accuracy: ±2% of reading on auxiliary display or ±1 mV, whichever is greater.

Maximum Drift: Less than ±0.2°/°C.

Phase Offset: ±180 degrees in 10-degree steps.

Accuracy: ±(0.2 degree + 0.3 degree per 10-degree step), not to exceed ±1.5 degrees cumulative, reference from zero degrees.

Phase Response Versus Signal Amplitude: 2 degrees maximum phase change for 60-dB amplitude change in test channel.

GENERAL

Power: Additional 15 watts supplied by 8410A.

Weight: 11 lb.

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.

SECTION II
INSTALLATION

2-1. INCOMING 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. 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 8413A 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 8413A in heavy paper or plastic. (If shipping to a Hewlett-Packard service 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 (3 to 4 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 Phase-Gain Indicator in the 8410A Network Analyzer mainframe are in the Network Analyzer Operating and Service Manual.

2-13. POWER REQUIREMENTS.

2-14. The Phase-Gain Indicator obtains all inputs, including power, from the Network Analyzer mainframe through the rear connector, when it is properly installed in the mainframe.

OPERATION

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. Signals from the Network Analyzer containing phase and amplitude information are fed to the 8413A through a rear-panel connector. These signals are detected in the Phase-Gain Indicator and dc voltages proportional to phase and amplitude are fed to the 8413A meter and to front panel connectors for display on a X-Y recorder or oscilloscope. The meter displays either phase or amplitude, function and range being selected by front-panel pushbuttons. The phase and amplitude voltages are available whenever the Network Analyzer is phase locked and are independent of meter function or range. A front panel phase offset control may be used to change the phase relationship of the input signals in 10 degree steps up to ±180 degrees. This control effects both the meter and phase voltage output. Phase offset may be used to establish a convenient reference during phase calibration and to offset the phase angle for greater resolution during measurements.

3-3. DESCRIPTION OF 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 panel illustrations match the description numbers.

3-5. OPERATING INFORMATION.

3-6. MEASUREMENT TECHNIQUES FOR GREATEST ACCURACY.

3-7. The greatest accuracy may be obtained during measurements of phase and amplitude if each instrument in the test setup is matched at input and output as close as possible to its design impedance (50 ohms). Attenuators are used between instruments to maintain a good impedance match at all times and to prevent interaction between instruments. The Model 8411A Harmonic Frequency Converter, especially, requires a well-matched input. Recommendations for attenuators to be used with each transducer are included in the transducer Operating and Service Manual or Operating Note.

3-8. MEASURING LARGE PHASE ANGLES.

3-9. When measuring a phase angle near 180° on the 180° scale, the phase meter may give an erratic indication. With a high test-signal level, erratic operation may occur close to ±180°; however, with a low test-signal level, erratic meter indications may occur as low as ±150°. Accurate measurement of these signals requires the use of the PHASE OFFSET controls to bring the meter indication close to zero (center scale). This allows the phase detection circuits to operate in the most stable measurement mode, thus providing the most accurate phase measurements. This also allows the use of the lowest scale (6°) for high-resolution phase measurements.

3-10. The technique for measuring large phase angles is performed as follows:

a. Depress the 180° PHASE pushbutton.

b. Adjust the PHASE OFFSET controls for a near-zero meter indication.

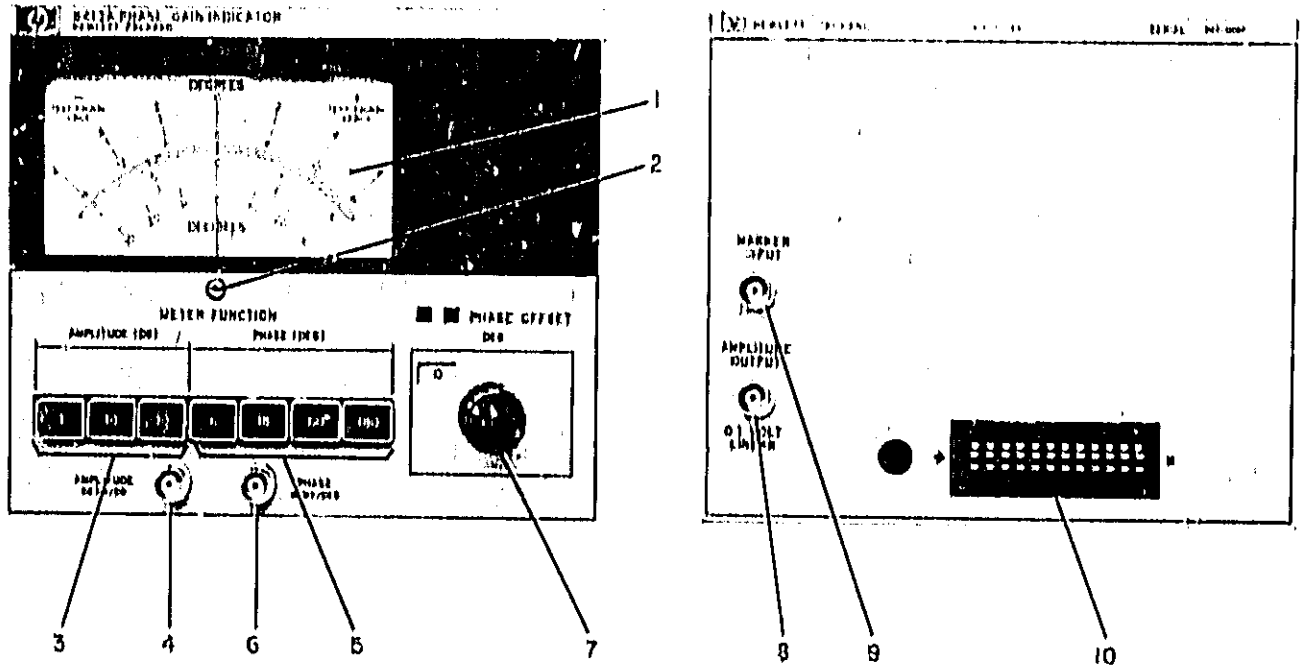
c. Select the lower scales by depressing the 60-, 18-, and 6-degree pushbuttons in succession and resetting the PHASE OFFSET controls for a near-zero meter indication after each scale selection.

d. When an on-scale meter indication on the 6° range is obtained, add algebraically the PHASE OFFSET control setting and the phase meter indication. Example: 170° on PHASE OFFSET plus -3° on phase meter = +167° phase.

3-11. MEASUREMENT PROCEDURES.

3-12. Measurements procedures are given in Figures 3-2 through 3-5. Measurement procedures using a specific transducer are given in the Operating and Service Manual or Operating Note for the particular transducer.

FRONT AND REAR PANEL FEATURES



1. Phase-Amplitude Meter. Indicates phase angle, or amplitude ratio of test channel input to reference channel input. Indicates phase angle when any PHASE pushbutton is pressed, amplitude ratio when any AMPLITUDE pushbutton is pressed. For phase measurement, meter shows test channel lead or lag relative to reference channel. For amplitude measurement, meter deflection is clockwise when test channel amplitude increases relative to the reference channel.

2. Meter Mechanical Zero Control. Used to set meter pointer over scale zero when the Model 8413A is in normal operating position without operating voltages applied.

3. AMPLITUDE (DB). Pushbuttons select meter sensitivity in dB. Number on pushbutton gives end-scale calibration of the range selected.

4. AMPLITUDE 50MV/DB. Voltage output is proportional to amplitude ratio [20 log10 (VTEST/VREF)]. Output is 50 mV/dB, positive voltage for ratios of 0 to +30 dB and negative voltage for ratios of 0 to -30 dB. Accuracy is ±3%. Output is available whether or not meter is displaying amplitude ratio.

5. PHASE (DEG). Pushbuttons select meter sensitivity in degrees. Number on pushbutton gives end-scale calibration of the range selected.

6. PHASE 10MV/DEG. Voltage output is proportional to phase angle between test and reference channel signals. Output is 10 mV/degree, positive voltage for phase angles 0 to +180° and negative voltage for angles 0 to -180°. Voltage accuracy is ±2%. Output is available whether or not meter is displaying phase angle.

7. PHASE OFFSET. For increasing resolution of phase measurements. Permits shifting phase of reference channel signal in precise 10-degree steps over 360°, so any angle can be offset to the ±6° scale for 0.1° resolution. Inner knob selects + or - offset. True phase angle is algebraic sum of offset and meter reading. Offset controls function whether or not the meter is displaying phase angle. Angle selector has no mechanical stop for easier switching.

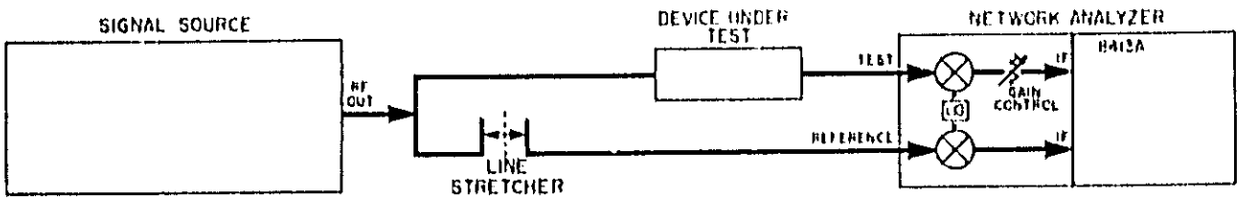
8. AMPLITUDE OUTPUT. Positive voltage output linearly proportional to the RF voltage at the Model 8411A test channel input. Range is zero to +1 volt with zero corresponding to 0 RF voltage, +1 volt to +30 dB ratio. Output is available whenever RF signals are applied to the Model 8411A whether or not the meter is displaying amplitude. Can be used for modulation measurements on amplitude-modulated RF signals.

9. MARKER INPUT. Accepts a frequency marker input from HP 690, 8690 Series Sweep Oscillators (approximately -5V). Marker is superimposed on the front-panel AMPLITUDE and PHASE output voltages.

10. Connector. Makes all necessary connections with the Model 8410A.

Figure 3-1. Model 8413A Panel Features

SINGLE-FREQUENCY TRANSMISSION MEASUREMENT



CALIBRATION

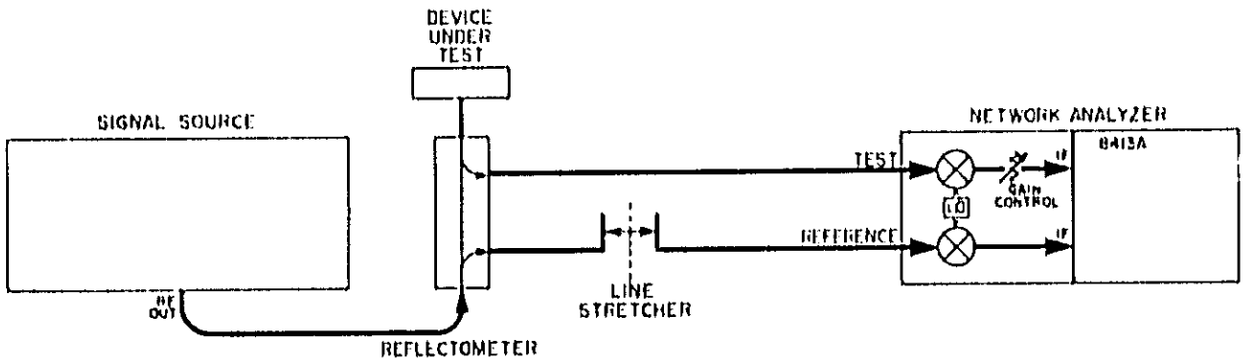
1. Connect equipment as shown in setup, without the device under test.
2. Phase lock the Network Analyzer to the applied signal.
3. Depress 8413A 30 dB AMPLITUDE pushbutton and adjust the Network Analyzer test channel gain controls and the amplitude vernier control to obtain a zero meter indication. Depress 3 dB AMPLITUDE pushbutton and re-adjust the amplitude vernier control for zero meter indication. Note the Network Analyzer gain control setting.
4. Set the 8413A PHASE OFFSET switch to zero, and depress PHASE 180 degree pushbutton.
5. Adjust the Line Stretcher for minimum extension and adjust the Network Analyzer phase vernier control for a zero meter indication on the phase meter. If the control does not have enough range, adjust the Line Stretcher until zero is obtained on the phase meter. Depress PHASE 0 degree pushbutton and re-adjust the phase vernier control for zero phase meter indication.

MEASUREMENT

1. Insert the device under test.
2. Depress the 8413A AMPLITUDE 30 dB pushbutton and read the gain or loss of the device under test on the amplitude meter. If the meter is pegged in either direction, note the Network Analyzer test channel gain setting, then adjust the test channel gain control to bring the meter indication to within 3 dB of zero. Depress AMPLITUDE 3 dB pushbutton. The gain or loss of the device under test is the algebraic sum of the change in test channel gain and meter indication. Gain or Loss in dB = (change in test channel gain) + (meter indication).
3. Depress the 8413A PHASE 180 degree pushbutton and read phase shift through the device under test on the phase meter. For best resolution, adjust PHASE OFFSET to bring the phase indication close to zero. Then press PHASE 0 degree pushbutton. Total phase shift is the algebraic sum of phase offset and meter indication.

Figure 3-2. Single-Frequency Transmission Measurement

SINGLE-FREQUENCY REFLECTION MEASUREMENT



CALIBRATION

1. Connect equipment as shown in setup.
2. Connect a coaxial short such as the HP 11505A to the Reflectometer unknown port.
3. Adjust 8413A PHASE OFFSET control for 180 degree offset (either polarity).
4. Phase lock the Network Analyzer to the applied signal.
5. Depress 8413A 30 dB AMPLITUDE pushbutton and adjust the Network Analyzer test channel gain controls and amplitude vernier control to obtain a zero meter indication. Depress 8413A 3 dB AMPLITUDE pushbutton and adjust the amplitude vernier control again for zero meter indication.
6. Depress 8413A PHASE 180 degree pushbutton.
7. Adjust the Line Stretcher for minimum extension, and adjust the Network Analyzer phase vernier control for a zero meter indication on the phase meter. If the vernier control does not have enough range, adjust the Line Stretcher, until zero is obtained on the phase meter. Depress 8413A PHASE 6 degree pushbutton and re-zero phase meter.

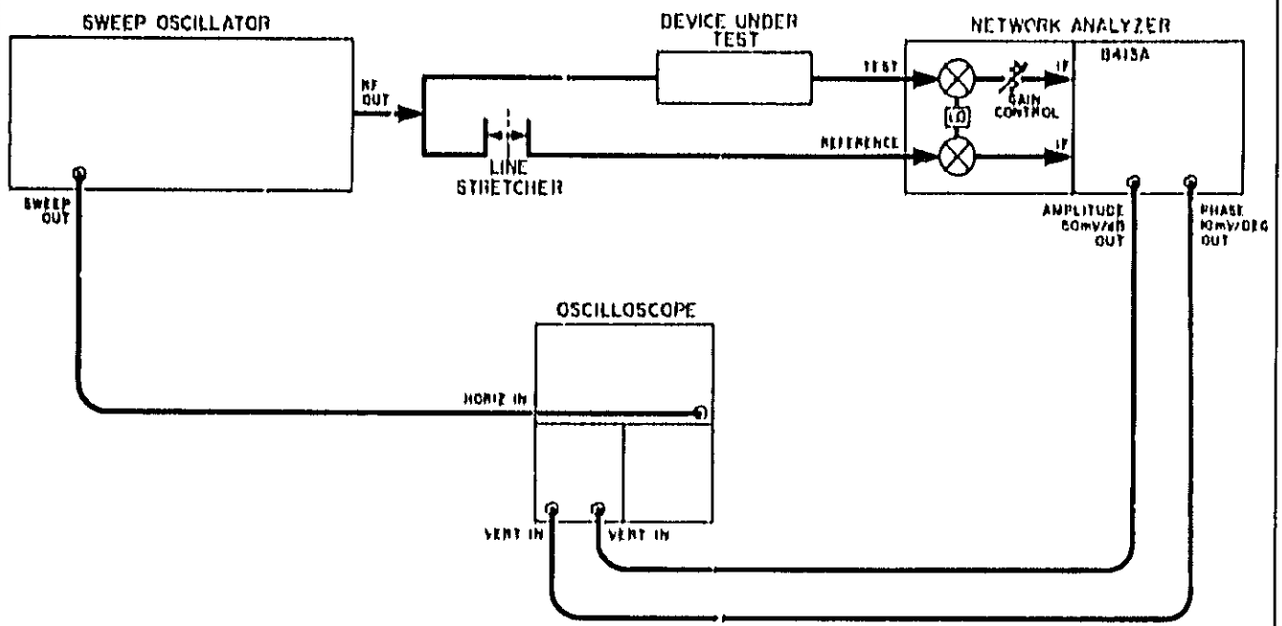
MEASUREMENT

1. Remove the coaxial short from the Reflectometer unknown port and connect the device under test.
2. For magnitude, note the Network Analyzer test channel gain setting. Adjust test channel gain control for an on scale meter indication on the 3 dB range. The reflection magnitude in return loss* is the algebraic sum of the change in test channel gain and meter indication. Return Loss in dB = (change in test channel gain) + (meter indication).
3. For phase, adjust 8413A PHASE OFFSET for an on-scale meter indication on the 6 degree range. The phase angle is the algebraic sum of phase offset and meter indication.

* $|\rho| = \dfrac{1}{\text{Log}^{-1}\,(0.05 \times \text{Return Loss})}$

Figure 3-3. Single-Frequency Reflection Measurement

SWEPT-FREQUENCY TRANSMISSION MEASUREMENT



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. De couple and de balance the Oscilloscope vertical amplifiers. Adjust the Oscilloscope to display the swept-phase output from the 8413A.
4. Obtain equal reference and test channel electrical lengths by adjusting the Line Stretcher for a horizontal phase display on the Oscilloscope.

NOTE

If the system is correctly adjusted the display should appear like Display A, Figure 3-6. If the display is similar to Display B, the system is not phase locked over the whole band, refer to the Network Analyzer Operating Manual for correct adjustment. If the waveform is similar to Display C, the electrical lengths of the test and reference channels are different, causing a linear phase shift across the swept-frequency range. Adjust the Line Stretcher to cancel the phase shift, making the phase display horizontal.

5. Disconnect the Oscilloscope vertical input from the 8413A AMPLITUDE connector, to simulate zero amplitude output from the 8413A. Note the display position.
6. Reconnect the vertical input and adjust the Network Analyzer test channel gain and amplitude vernier controls so that the average of the display falls on the zero position noted in step (5) above.
7. Adjust Oscilloscope vertical position for convenient amplitude reference.
8. Disconnect Oscilloscope vertical input from 8413A PHASE connector, to simulate zero phase output from 8413A. Note display position.
9. Reconnect vertical input and adjust Network Analyzer phase vernier control so that the average of the display falls on the zero position noted in step (8) above.
10. Adjust Oscilloscope vertical position for a convenient phase reference.

MEASUREMENT

1. Insert the device under test.
2. For magnitude, note Network Analyzer test channel gain settings. Adjust the test channel gain to return Oscilloscope display close to reference obtained during calibration. Use the calibrated 8413A (50 mV/dB) output and Oscilloscope vertical calibration plus the difference in Network Analyzer test channel gain settings to determine transmission gain or loss in dB of the device under test.
3. For phase, adjust Oscilloscope vertical sensitivity and position controls to view the swept-phase display of the device under test. Use the calibrated 8413A output (10 mV/degree) and the Oscilloscope vertical calibration to determine phase angle.

Figure 3-4. Swept-Frequency Transmission Measurement

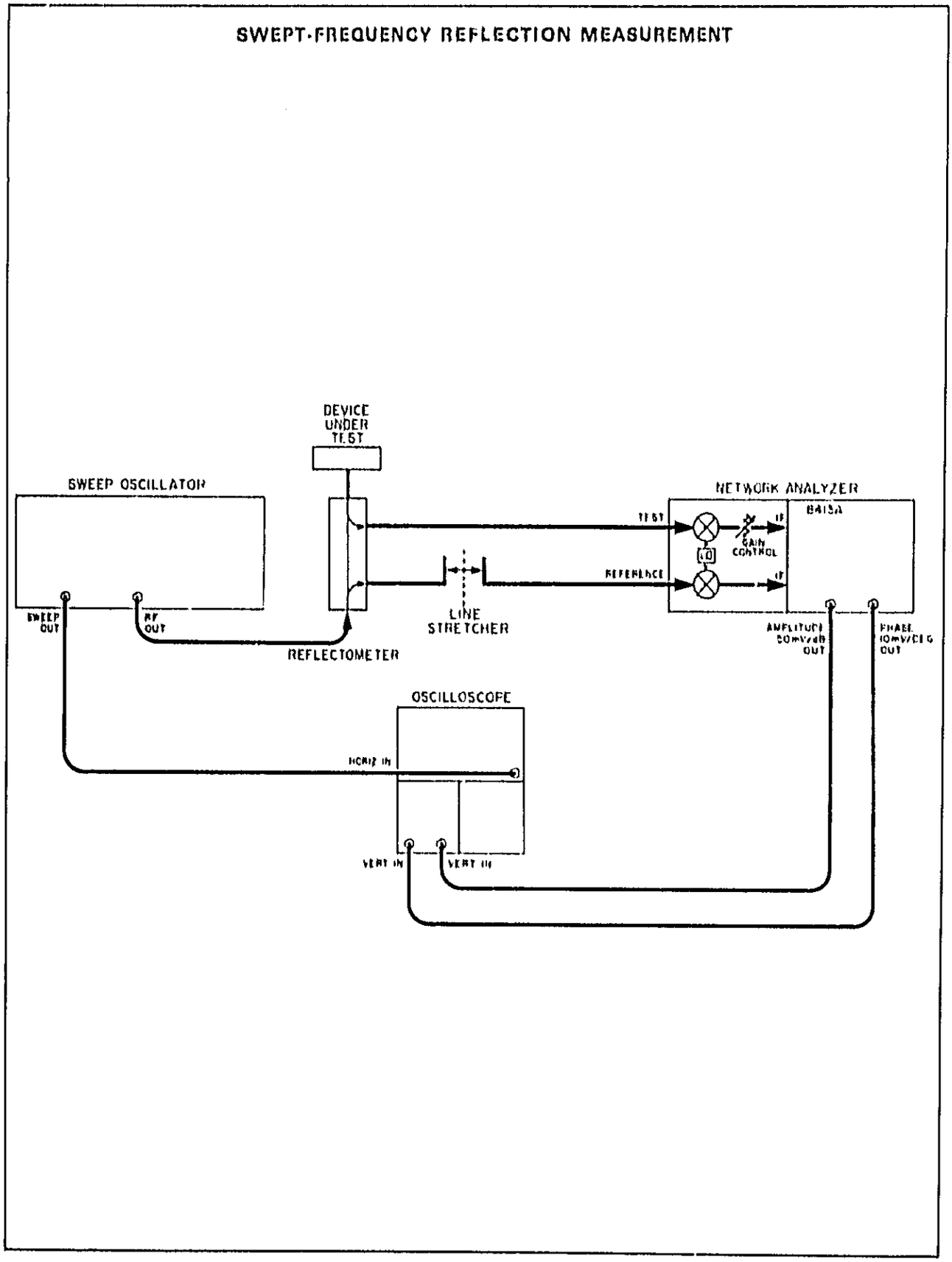


Figure 3-5. Swept-Frequency Reflection Measurement (Sheet 1 of 2)

SWEPT-FREQUENCY REFLECTION 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. Adjust 8413A PHASE OFFSET control for 180 degree offset (either polarity).
4. Phase lock the Network Analyzer over the frequency band of interest.
5. Adjust the oscilloscope to display the swept phase output from the 8413A.
6. Obtain equal reference and test channel electrical lengths by adjusting the Line Stretcher for a horizontal phase display on the oscilloscope.

NOTE

If the system is correctly adjusted the display should appear like Display A, Figure 3-6. If the display is similar to Display B, the system is not phase locked over the whole band. Refer to the Network Analyzer operating manual for correct adjustment. If the waveform is similar to Display C, the electrical lengths of the test and reference channel are different, causing a linear phase shift across the swept-frequency range. Adjust the Line Stretcher to cancel the phase shift, making the phase trace horizontal.

7. Disconnect the oscilloscope vertical input from the 8413A AMPLITUDE connector, to simulate zero amplitude output from the 8413A. Note the trace position.
8. Reconnect the vertical input and adjust the Network Analyzer test channel gain and amplitude vernier controls so that the average of the trace falls on the zero trace position noted in step (7) above.
9. Adjust Oscilloscope vertical position for a convenient amplitude reference.
10. Disconnect the Oscilloscope vertical input from the 8413A PHASE connector to simulate zero phase output from the 8413A. Note display position.
11. Reconnect the vertical input and adjust the Network Analyzer phase vernier control so that the average of the display falls on the zero position noted in step (10) above.
12. Adjust Oscilloscope vertical position for a convenient phase reference.

MEASUREMENT

1. Remove the coaxial short from the Reflectometer unknown port and connect the device under test.
2. Set the 8413A phase offset to zero.
3. For magnitude, note the Network Analyzer test channel gain settings. Increase the test channel gain to return the Oscilloscope display to the reference obtained during calibration. The difference in test channel gain settings is the reflection magnitude in return loss[1].
4. For phase, adjust the Oscilloscope vertical sensitivity and position controls to view the swept-phase display of the device under test. Use the calibrated 8413A PHASE output (10 mV degree) and the Oscilloscope vertical calibration to determine phase angle.

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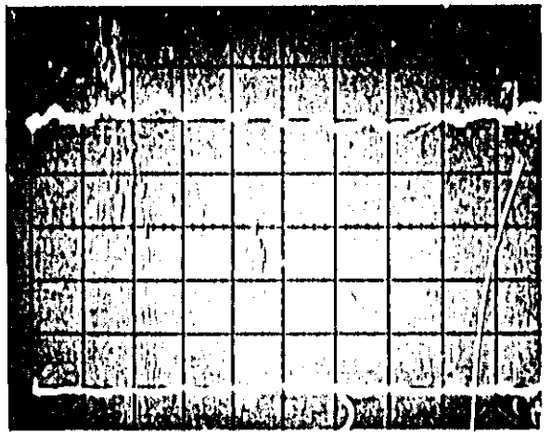
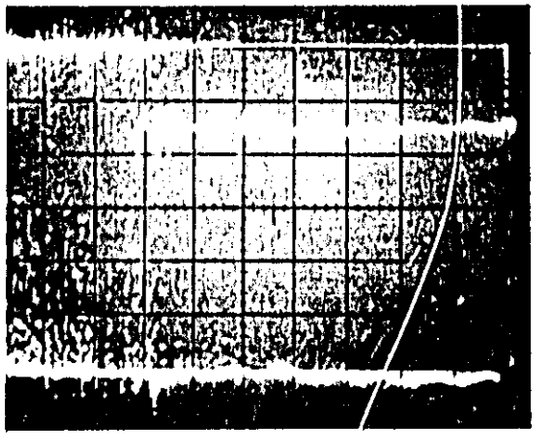
[1] $|\rho|$ = antilog 0.05 (return loss in dB)

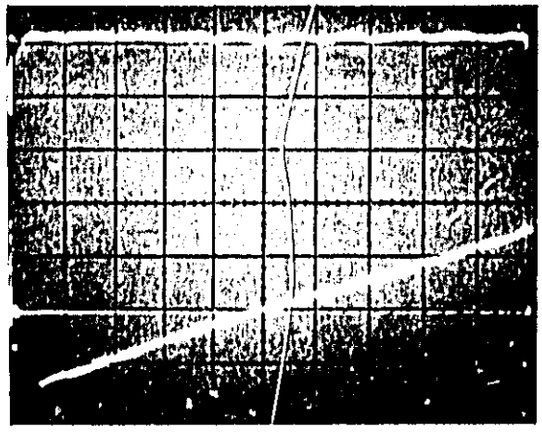
Figure 3-5. Swept-Frequency Reflection Measurement (Sheet 2 of 2)



Display A. Correct calibration display. Horizontal amplitude trace (upper) shows initial 0 dB relative amplitude difference (ripple is due to measurement system frequency response). Phase trace (lower) is horizontal indicating test and reference channel lengths are electrically equal.



Display B. Network Analyzer not properly locked to input signal. Broken phase and amplitude traces indicate loss of phase lock.



Display C. Slope or linear phase response in phase display (lower trace) is due to unequal test and reference channel electrical lengths. If the line stretcher is adjusted to make the calibration trace horizontal the resolution display sensitivity can be increased so that non-linear phase response can be displayed with more resolution.

Figure 3-6. Typical Oscilloscope Displays for Swept-Frequency Measurements

MAINTENANCE

SECTION IV
MAINTENANCE

4-1. INTRODUCTION.

4-2. This section provides instruction for performance testing, troubleshooting, and repairing the 8413A. If the serial prefix (the first three numbers of the serial number) of your instrument is different from that listed on the title page of this manual, then there are differences between your instrument and the instrument described in this manual. See Paragraphs 1-4 and 1-5.

4-3. THEORY OF OPERATION.

4-4. A block diagram circuit description is given in Figure 6-5. Talking schematic circuit descriptions are given on the back of the foldout preceding each schematic diagram.

4-5. PERFORMANCE TEST.

4-6. The procedures in Figure 4-2 check the 8413A performance for incoming inspection, periodic evaluation, and troubleshooting. The tests can be performed without access to the instrument interior. The specifications in Table 1-1 are the performance standards.

4-7. The test instruments and accessories required to make the performance checks 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.

4-8. ALIGNMENT.

4-9. Figure 4-4 is a complete alignment procedure for the 8413A. The adjustments are sequential and should be made in the order given. The alignment procedure should not be performed as a routine maintenance procedure but should only be used (1) after replacement of a part or component, (2) when the performance test shows that the specifications of Table 1-1 cannot be met, or (3) when instructed to do so in the troubleshooting procedure. Before attempting any adjustment, allow 30 minutes warm-up time for the 8413A and Network Analyzer. Figure 4-3 shows the location of the alignment controls together with the affect each adjustment has on the instrument operation.

4-10. The test instruments and accessories required to perform the alignment procedures 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.

4-11. TROUBLESHOOTING.

4-12. The overall troubleshooting plan is shown in Figure 4-1. The five 8413A operating functions provide a convenient means of isolating a trouble to a circuit section; therefore, the preliminary troubleshooting procedures in Figure 6-3, which utilize these operating functions, should be performed first.

4-13. Figure 6-3 refers the troubleshooter directly to a schematic for troubles that can be isolated to other than phase circuits, and to the block diagram for phase circuit troubles. The test equipment should be set up for troubleshooting as shown in Figure 6-4 before proceeding to a schematic or to the block diagram.

4-14. The block diagram troubleshooting isolates phase troubles to a circuit board assembly and refers the troubleshooter to the associated schematic.

4-15. Troubleshooting procedures for the block diagram and each schematic are on the page opposite the schematic or diagram.

4-16. The test instruments and accessories required for troubleshooting are listed in Table 4-1. Test instruments other than those listed can be used provided their performance equals or exceeds the Critical Specifications listed.

4-17. REPAIR.

4-18. After repairs have been made on circuit boards, clean the repaired area with a resin (flux) solvent and spray the area with a protective coating such as GE DRI-FILM* 88.

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* General Electric Co., Silicone Products Dept., Waterford, New York, U.S.A.

Figure 4-1. Troubleshooting Plan

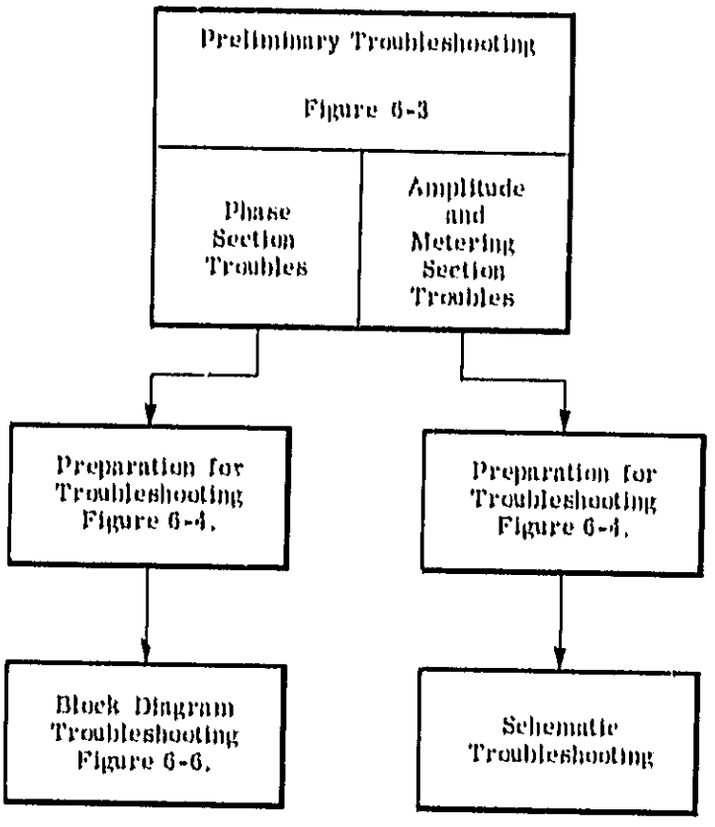


Table 4-1. Recommended Test Equipment

Item	Critical Specifications	Use[1]	Recommended HP Model
Signal Source	Frequency: 1.0 gHz[2] Output Power: 10mw into 50 ohms	A,B,C	8620A with 86220A RF Plug-In
Oscillator	Frequency: 278 kHz Amplitude: variable up to 2.5V p-p into 50 ohms.	A,C	200CD,606A/B
Digital Voltmeter	Range: DC Volts from -20V to +20V Accuracy: ±0.1% of reading Input Resistance: ≥ 10 Megohm	A,B,C	3439A with 3433A plug-in unit
Volt-Ohm Meter[3]	Voltage: Range: -20 to +30V DC Accuracy: ±3% of reading Ohms: Range: 1 ohm to 10 megohm Accuracy: ±7% of reading Input Impedance: ≥ 10 megohm shunted by 0.1 μf.	B	410C,414A

[1] Use: A = Performance Test; B = Troubleshooting; C = Alignment Procedure

[2] 1.0 GHz is required for performance test; however for alignment procedure and troubleshooting any frequency 0.11 GHz to 12.4 GHz is satisfactory.

[3] Used to make in-circuit voltage measurements. (Caution: probe capacitance of a substitute meter may cause circuit to oscillate).

Table 4-1. Recommended Test Equipment (Contd)

Item	Critical Specifications	Use	Recommended HP Model
Dual Trace Oscilloscope with 10:1 voltage probe (2 required)	Vertical: Bandwidth; dc to 20 MHz Sensitivity; 5mV/cm minimum Horizontal: Range; 1μ sec /cm External Trigger capability.	A,B,C	140A/1405A/1422A/10003A
Transducer	Includes: Power divider & Calibrated Line Stretcher, with precision 7MM connectors.	A,B,C	8740A,8741A, 8742A,8743A or 8745A
Network Analyzer	No Substitute	A,B,C	8410A/8411A
20 dB Attenuator	Attenuation: 20 dB nominal Impedance: 50 ohms nominal	A	8491A-20
1 dB Step Attenuator	Attenuation: 0-10 dB in 1-dB steps Impedance: 50 ohms nominal	A	355C
0-60 dB Variable Attenuator	Attenuation: 0-60 dB Phase Shift over 60 dB range at 278 KHz: negligible (<0.02°) Impedance: 50 ohms nominal	A	355D,354A
Coaxial Short	Connector: APC-7	A,C[5]	11565A
30 dB Attenuator	Attenuation: 30 dB nominal Frequency Range: Same as signal source used. SWR: 1.3 maximum Connectors: APC-7	A[4]	8492A, Option 30
20 dB Attenuator	Attenuation: 20 dB nominal Frequency Range: Same as signal source used. SWR: 1.3 maximum Connectors: APC-7	A[4]	8492A, Option 20
6 dB Attenuator	Attenuation: 6 dB nominal Frequency Range: Same as signal source used. SWR: 1.3 maximum Connectors: APC-7	A[5]	8492A, Option 06

[4] For use with HP Model 8740A only.

[5] For use with HP Model 8741A, 8742A, 8743A, or 8745A.

FIGURE 4-2. PERFORMANCE TESTS

1. Phase Mode: Accuracy and Phase Output

SPECIFICATION:

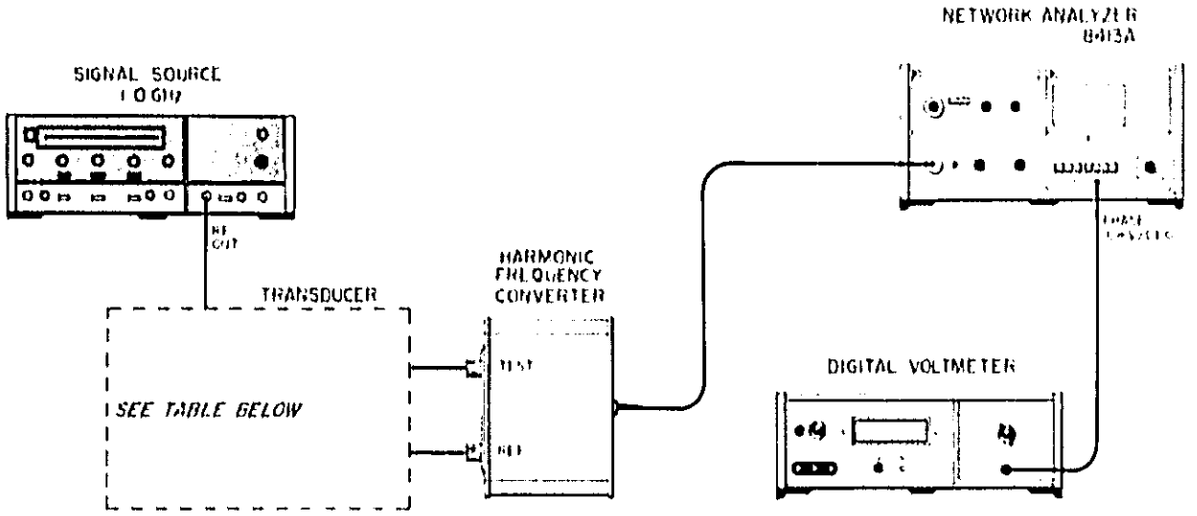
Phase Meter Accuracy: ±2° of end scale.

10MV/DEG Output: ±2° of reading.

DESCRIPTION:

An accurate phase shift is established by setting the signal source to a single frequency and inserting electrical length in one channel to unbalance the input a known portion of a wavelength. The accuracies of the 8413A meter indication and 10MV/DEG output are compared against these precise phase shifts.

TEST SETUP:



Transducer	Setup
8740A	Equal reference and test channel electrical lengths between test unit and 8411A.
8741A & 8742A*	Terminate UNKNOWN port with open circuit.
8743A*	Select REFL mode and terminate UNKNOWN port with open circuit.
8745A	Select A, S_{11} and connect a coaxial short to port A.

* The coupling of the 8742A and 8743A internal directional couplers rolls off below 2.0 GHz; however, these units may be used at 1.0 GHz for these tests.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

PROCEDURE

a. Connect equipment as shown in setup.

b. Set the Signal Source for single frequency operation at 1.0 GHz, and set the Network Analyzer to phase lock to the applied signal.

c. Obtain a RF signal with 30 cm wavelength as follows:

NOTE

To eliminate mechanical backlash error when adjusting the Transducer REFERENCE PLANE EXTENSION, always approach setting from the same direction.

(1) Adjust Transducer REFERENCE PLANE EXTENSION crank for zero digital counter indication, hold thumbwheel, and adjust crank fully counterclockwise.

(2) Adjust 8413A PHASE OFFSET and Network Analyzer phase vernier for a zero ±0.2 mV Digital Voltmeter indication.

(3) Adjust Transducer REFERENCE PLANE EXTENSION for 15.00 cm digital counter indication (30.00 cm for 8740A). Digital Voltmeter indication should be zero ±0.2 mV. If not adjust Signal Source frequency for zero ±0.2 mV Digital Voltmeter indication. Adjust Transducer REFERENCE PLANE EXTENSION counterclockwise to zero and repeat steps (2) and (3) until Digital Voltmeter indication is zero when Transducer digital counter is set to both zero and 15.00 cm (30.00 cm for 8740A).

d. Readjust Transducer REFERENCE PLANE EXTENSION as follows:

(1) Adjust crank to obtain Digital Counter indication of 7.5 cm (15 cm for 8740A).

(2) Hold thumbwheel to retain this indication, and adjust crank fully clockwise.

(3) Release thumbwheel and adjust crank counterclockwise until the digital counter indicates zero.

e. Adjust the 8413A PHASE OFFSET and Network Analyzer phase vernier for zero ±0.2 mV Digital Voltmeter indication.

f. Check the 8413A phase meter and 10MV/DEG output voltage accuracy as indicated in the following table.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

NOTE

The Signal Source frequency and Transducer REFERENCE PLANE EXTENSION settings are critical; therefore, if any indication is out of tolerance, readjust Signal Source frequency (step e). Recheck zero setting (step d), and repeat the digital counter setting.

Transducer Digital Counter Setting*		8413A Phase Range	Digital Voltmeter Indication	8413A Phase Meter Indication
8740A	8741A, 8742A 8743A, 8746A			
0.42 99.58	0.21 99.79	6°	+50mV ±1mV -50mV ±1mV	+5° ±0.12° -5° ±0.12°
1.25 98.75	0.62 99.38	18°	+150mV ±3mV -150mV ±3mV	+15° ±0.36° -15° ±0.36°
4.17 95.83	2.08 97.92	60°	+500mV ±10mV -500mV ±10mV	+50° ±1.20° -50° ±1.20°
12.50 87.50	6.25 93.75	180°	+1.5Vdc ±30mV -1.5Vdc ±30mV	+150° ±3.60° -150° ±3.60°

*Adjust Transducer REFERENCE PLANE EXTENSION to obtain digital counter settings. Instructions for obtaining initial setting are given in step d. To eliminate mechanical backlash error, always approach setting from the same direction.

NOTE

If Digital Voltmeter indications are correct and phase meter indications are out of tolerance, refer to Alignment Procedure 10.

If both Digital Voltmeter and phase indications are out of tolerance, perform the entire alignment procedure.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

2. Phase Offset Accuracy

SPECIFICATION:

Phase Offset Accuracy: ±(0.2 degree + 0.3 degree per 10-degree step), not to exceed ±1.5 degrees cumulative, referenced from zero degree.

DESCRIPTION:

An accurate phase shift is established by setting the Signal Source to a single frequency and inserting electrical length in one channel to unbalance the input a known portion of a wavelength. The accuracy of the 8413A PHASE OFFSET is compared against these precise phase shifts.

TEST SETUP:

Same as Test 1.

PROCEDURE:

a. If Signal Source frequency has been changed from Test 1, repeat Test 1, steps b and c.

b. Set 8413A PHASE OFFSET to plus (+) zero, and depress 180 degree pushbutton.

c. Adjust Network Analyzer phase vernier to approximately mid-range.

d. Adjust Transducer REFERENCE PLANE EXTENSION crank for zero digital counter indication, hold thumbwheel, and adjust crank fully counterclockwise. Continue to hold thumbwheel and adjust crank for a 8413A phase meter indication close to zero.

e. Depress 8413A 0 degree pushbutton and adjust Network Analyzer phase vernier for a zero phase meter indication.

f. Check 8413A (+) PHASE OFFSET accuracy as indicated in the following table.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

NOTE

The Signal Source frequency and Transducer REFERENCE PLANE EXTENSION settings are critical; therefore, if any indication is out of tolerance, recheck the frequency in Test 1, step c, and zero setting in Test 2, steps b through e, and repeat the digital counter setting.

Digital Counter Setting*		PHASE OFFSET	8413A Phase Meter Indication
8740A	8741A, 8742A 8743A, 8745A		
0.83	0.42	+10°	0 ± 0.5°
1.67	0.83	+20°	0 ± 0.8°
2.50	1.25	+30°	0 ± 1.1°
3.33	1.67	+40°	0 ± 1.4°
4.17	2.08	+50°	0 ± 1.5°
5.00	2.50	+60°	0 ± 1.5°
5.83	2.92	+70°	0 ± 1.5°
6.67	3.33	+80°	0 ± 1.5°
7.50	3.75	+90°	0 ± 1.5°
8.33	4.17	+100°	0 ± 1.5°
9.17	4.58	+110°	0 ± 1.5°
10.00	5.00	+120°	0 ± 1.5°
10.83	5.42	+130°	0 ± 1.5°
11.67	5.83	+140°	0 ± 1.5°
12.50	6.25	+150°	0 ± 1.5°
13.33	6.67	+160°	0 ± 1.5°
14.17	7.08	+170°	0 ± 1.5°
15.00	7.50	+180°	0 ± 1.5°

*Adjust Transducer REFERENCE PLANE EXTENSION to obtain digital counter settings. Instructions for obtaining initial setting are given in steps d and e. To eliminate mechanical backlash error, always approach setting from the same direction.

g. Adjust Transducer REFERENCE PLANE EXTENSION for zero digital counter indication, hold thumbwheel, and adjust crank fully clockwise.

NOTE

For 8745A, remove coaxial short from Port A, adjust REFERENCE PLANE EXTENSION counterclockwise (from fully clockwise) for a phase meter indication close to zero with zero PHASE OFFSET control.

h. Set 8413A PHASE OFFSET to minus (-) zero, and adjust Network Analyzer phase vernier for a zero phase meter indication on the 8413A 6 degree range.

i. Check 8413A (-) PHASE OFFSET accuracy as indicated in the following table.

FIGURE 4-2. PERFORMANCE TESTS

NOTE

The Signal Source frequency and Transducer REFERENCE PLANE EXTENSION settings are critical; therefore, if any indication is out of tolerance, recheck the frequency in Test 1, step e, and zero setting in Test 2, steps g and h, and repeat the digital counter setting.

Digital Counter Setting*		PHASE OFFSET Setting	8413A Phase Meter Indication
8740A	8741A, 8742A 8743A, 8745A		
00.17	00.68	-10°	0 ± 0.5°
00.33	00.17	-20°	0 ± 0.8°
07.5	00.75	-30°	0 ± 1.1°
00.67	00.33	-40°	0 ± 1.4°
05.83	07.92	-50°	0 ± 1.5°
05.00	07.5	-60°	0 ± 1.5°
04.17	07.08	-70°	0 ± 1.5°
03.33	00.67	-80°	0 ± 1.5°
02.5	00.25	-90°	0 ± 1.5°
01.67	05.83	-100°	0 ± 1.5°
00.83	05.42	-110°	0 ± 1.5°
00.00	05.00	-120°	0 ± 1.5°
09.17	04.58	-130	0 ± 1.5°
08.33	04.17	-140°	0 ± 1.5°
07.50	03.75	-150°	0 ± 1.5°
06.67	03.33	-160°	0 ± 1.5°
05.83	02.92	-170°	0 ± 1.5°
05.00	02.5	-180°	0 ± 1.5°

*Adjust Transducer REFERENCE PLANE EXTENSION to obtain digital counter settings. Instructions for obtaining initial setting are given in steps g and h. To eliminate mechanical backlash error, always approach setting from the same direction.

NOTE

If indications are out of tolerance, troubleshoot the phase offset circuit using schematic number 1.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

3. Amplitude Modat Accuracy and Amplitude Output

SPECIFICATION:

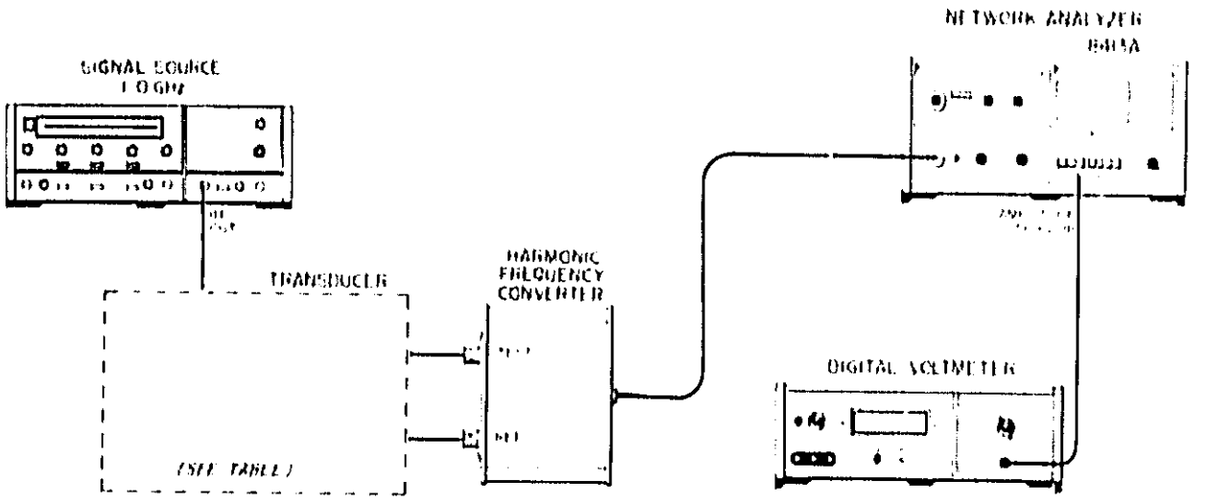
Amplitude Meter Accuracy: ±3% of end scale.

50 MV/DB Output: ±3% of reading.

DESCRIPTION:

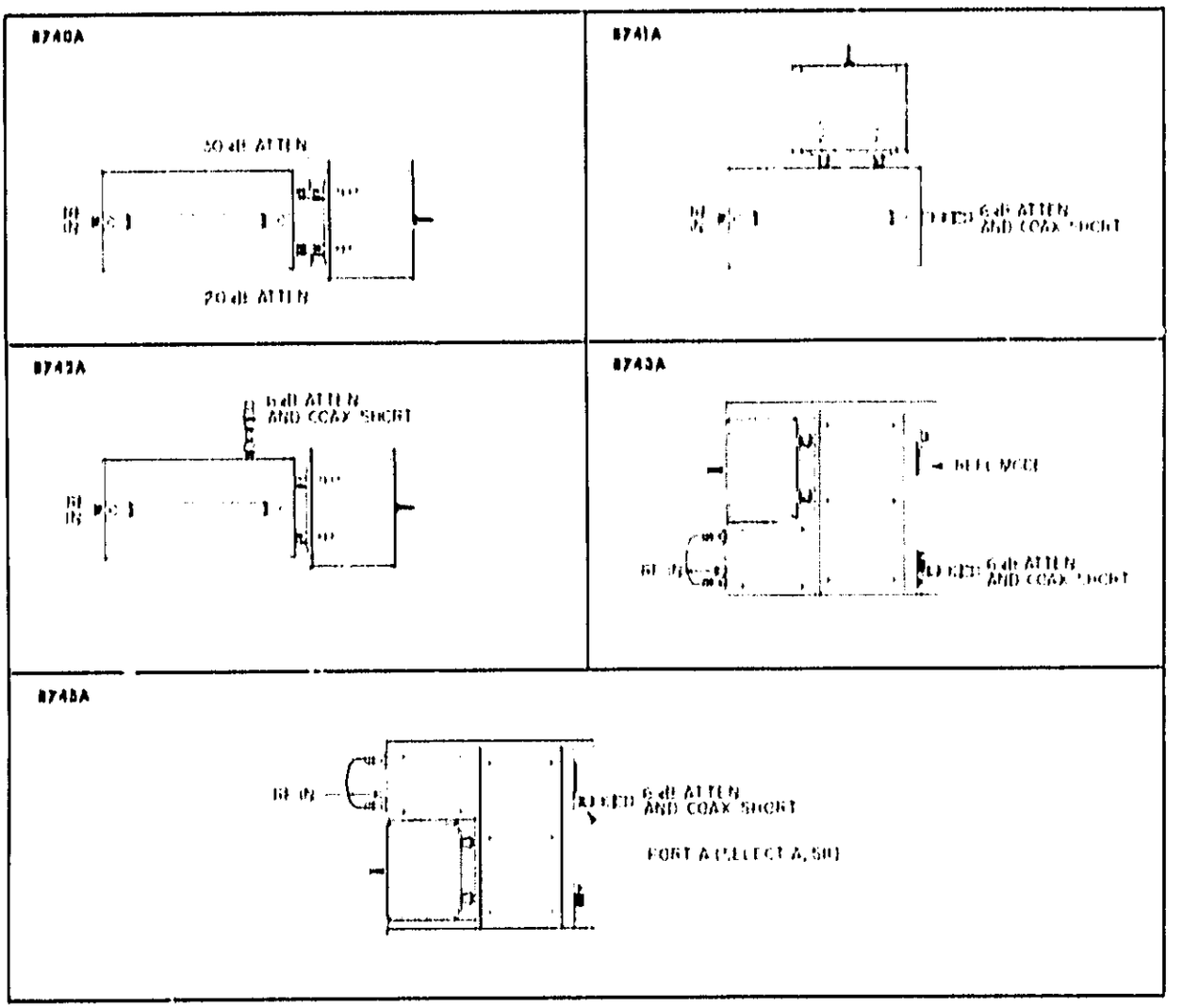
The Network Analyzer gain control is used to obtain an accurate change in 8413A input signal amplitude. The accuracies of the 8413A meter indication and 50 MV/DB voltage output are compared against these precise level changes.

TEST SETUP:



(Continued)

FIGURE 4-2. PERFORMANCE TESTS



PROCEDURE:

a. Connect equipment as shown in setup.

b. Set Signal Source to any single frequency within the range of the Network Analyzer and Transducer used.

c. Set Network Analyzer to phase lock to the applied signal.

d. Set Network Analyzer test channel gain to 35 dB.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

e. Set Network Analyzer test channel gain and amplitude vernier control for a zero dB indication on the 8413A 3 dB range. The test channel gain setting must be between 27 and 42 dB with the 1-dB/step control set between 2 and 0 dB. If a zero indication cannot be obtained with a setting in the above range, change Signal Source output power and re-adjust Network Analyzer test channel gain controls. Note Network Analyzer test channel gain settings.

f. Check the 8413A amplitude meter and 50 MV/DB output voltage accuracy as indicated in the table below.

NOTE

Recheck zero adjustment after each step.

Change in Network Analyzer Test Channel Gain Setting *	8413A Amplitude Range	Digital Voltmeter Indication	8413A Phase Meter Indication
+2 dB -2 dB	3 dB	+100mV ± 3mV -100mV ± 3mV	+2 dB ± 0.09 dB -2 dB ± 0.09 dB
+0 dB -0 dB	10 dB	+450mV ± 13.5mV -450mV ± 13.5mV	+0 dB ± 0.3 dB -0 dB ± 0.3 dB
+27 dB -27 dB	30 dB	+1.35Vdc ± 40.5mV -1.35Vdc ± 40.5mV	+27 dB ± 0.0 dB -27 dB ± 0.0 dB
* Instructions for obtaining initial setting are given in step e.			

NOTE

If indications are out of tolerance, refer to alignment procedures 6, 7, and 10 (Part two).

4. Phase Response Versus Signal Amplitude

SPECIFICATION:

2 degrees maximum phase change for 60 dB amplitude change in test channel.

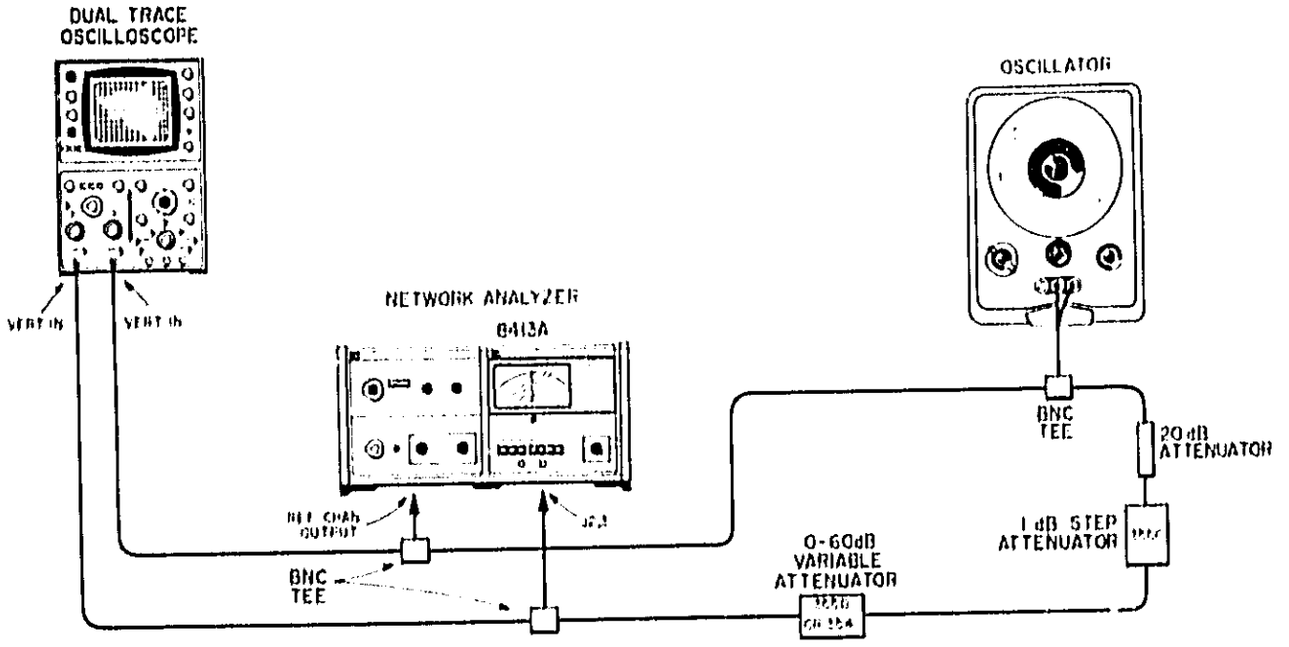
DESCRIPTION:

Two 270-kHz signals of known amplitude are applied to the 8413A inputs. The 8413A phase indication is observed while the test channel input level is varied by 60 dB.

(Continued)

FIGURE 4-2. PERFORMANCE TESTS

TEST SETUP:



PROCEDURE:

a. Remove Network Analyzer top and bottom covers and cover of rear-panel connector to 8413A. Disconnect cable W9 and cable W4 from J9 and J10 at rear of Network Analyzer bottom casting.

b. Connect equipment as shown in test setup.

c. Set Network Analyzer test channel gain controls to 0, 0 and amplitude vernier control fully counter-clockwise.

d. Adjust oscillator output to 278 kHz, and 2.3V p-p at 8410A rear-panel REF CHAN OUTPUT.

e. Set 0-60 dB variable attenuator to 0 dB.

f. Set 1-dB step attenuator for 200 mV ±10 mV peak-to-peak at 8410A J2, Pin 3.

g. Turn on Network Analyzer to supply power to the 8413A.

h. Set 8413A PHASE OFFSET control for an on-scale meter indication on the 6 degree range.

i. Record 8413A meter indication (reference at zero attenuation).

j. Vary the 0-60 dB attenuator through 60 dB of attenuation. The 8413A indication should not vary more than 2 degrees.

NOTE

If the phase indication varies more than 2 degrees the most likely trouble is low gain of the first amplifier-limiter. Troubleshoot the amplifier-limiter circuits using schematics 2 and 3.

TABLE 4-2. PERFORMANCE TEST RECORD

HP Model 8413A
PHASE-GAIN INDICATOR

Test Performed by _____

Serial No. ____-_____

Date _____

Test	Specification Tested	Condition(s)	Measured		
			Min	Actual	Max
1.	Phase meter accuracy: ±2% of end scale.	Measured at ±5° on ±6° scale	+ 4.88° - 4.88°	_____ _____	+ 5.12° - 5.12°
		Measured at ±15° on ±18° scale	+ 14.64° - 14.64°	_____ _____	+ 15.36° - 15.36°
		Measured at ±50° on ±60° scale	+ 48.8° - 48.8°	_____ _____	+ 51.2° - 51.2°
		Measured at ±150° on ±180° scale	+146.4° -146.4°	_____ _____	+153.6° -153.6°
	Phase (10 MV/DEG) voltage output: ±2% of reading	Measured at:			
		φ = +5°	+40 mV	_____	+51 mV
		φ = -5°	-40 mV	_____	-51 mV
		φ = +15°	+147 mV	_____	+153 mV
		φ = -15°	-147 mV	_____	-153 mV
		φ = +50°	+490 mV	_____	+510 mV
		φ = -50°	-490 mV	_____	-510 mV
		φ = +150°	+1.47 V	_____	+1.53 V
		φ = -150°	-1.47 V	_____	-1.53 V
2.*	Phase offset accuracy: ±(0.2 degree +0.3 degree per 10-degree step) not to exceed ±1.5 degree cumulative, referenced from zero degrees.	Measured at 0° on 6° range			
		+ 10°	-0.5°	_____	+0.5°
		+ 20°	-0.8°	_____	+0.8°
		+ 30°	-1.1°	_____	+1.1°
		+ 40°	-1.4°	_____	+1.4°
		+ 50°	-1.5°	_____	+1.5°
		+ 60°	-1.5°	_____	+1.5°
		+ 70°	-1.5°	_____	+1.5°
		+ 80°	-1.5°	_____	+1.5°
		+ 90°	-1.5°	_____	+1.5°
		+100°	-1.5°	_____	+1.5°
		+110°	-1.5°	_____	+1.5°
		+120°	-1.5°	_____	+1.5°

* The measured phase indication should not vary more than 0.5° between any 10-degree step, 0.8° between any 20-degree step, 1.1° between any 30-degree step, and 1.4° between any 40-degree step.

(Contd)

TABLE 4-2. PERFORMANCE TEST RECORD (Contd)

Test	Specification Tested	Condition(s)	Measured		
			Min	Actual	Max
2. (Contd)		+130°	-1.5°	_____	+1.5°
		+140°	-1.5°	_____	+1.5°
		+150°	-1.5°	_____	+1.5°
		+160°	-1.5°	_____	+1.5°
		+170°	-1.5°	_____	+1.5°
		+180°	-1.5°	_____	+1.5°
		- 10°	-0.5°	_____	+0.5°
		- 20°	-0.8°	_____	+0.8°
		- 30°	-1.1°	_____	+1.1°
		- 40°	-1.4°	_____	+1.4°
		- 50°	-1.5°	_____	+1.5°
		- 60°	-1.5°	_____	+1.5°
		- 70°	-1.5°	_____	+1.5°
		- 80°	-1.5°	_____	+1.5°
		- 90°	-1.5°	_____	+1.5°
		-100°	-1.5°	_____	+1.5°
		-110°	-1.5°	_____	+1.5°
		-120°	-1.5°	_____	+1.5°
		-130°	-1.5°	_____	+1.5°
		-140°	-1.5°	_____	+1.5°
		-150°	-1.5°	_____	+1.5°
		-160°	-1.5°	_____	+1.5°
		-170°	-1.5°	_____	+1.5°
		-180°	-1.5°	_____	+1.5°
3.	Amplitude meter accuracy: ±3% of end scale.	Measured at ±2 dB on ±3 dB scale	+1.91 dB	_____	+2.09 dB
			-1.91 dB	_____	-2.09 dB
		Measured at ±9 dB on ±10 dB scale	+8.7 dB	_____	+9.3 dB
			-8.7 dB	_____	-9.3 dB
		Measured at ±27 dB on ±30 dB scale	+26.1 dB	_____	+27.9 dB
			-26.1 dB	_____	-27.9 dB
	Amplitude (50 MV/DB) voltage output: ±3% of reading.	Measured at:			
		+ 2 dB	+97 mV	_____	+103 mV
		- 2 dB	-97 mV	_____	-103 mV
		+ 9 dB	+486 mV	_____	+463 mV
		- 9 dB	-486 mV	_____	-463 mV
		+27 dB	+1.31 V	_____	+1.30 V
		-27 dB	-1.31 V	_____	-1.30 V

TABLE 4-2. PERFORMANCE TEST RECORD (Contd)

Test	Specification Tested	Condition(s)	Measured		
			Min	Actual	Max
4.	Phase response versus signal amplitude: 2 degrees maximum phase change for 60-dB amplitude change in test channel.	Measured at 0 dB on 3 dB scale. 60 dB change in test channel input power	- _____	Total Variation <2°	+ _____

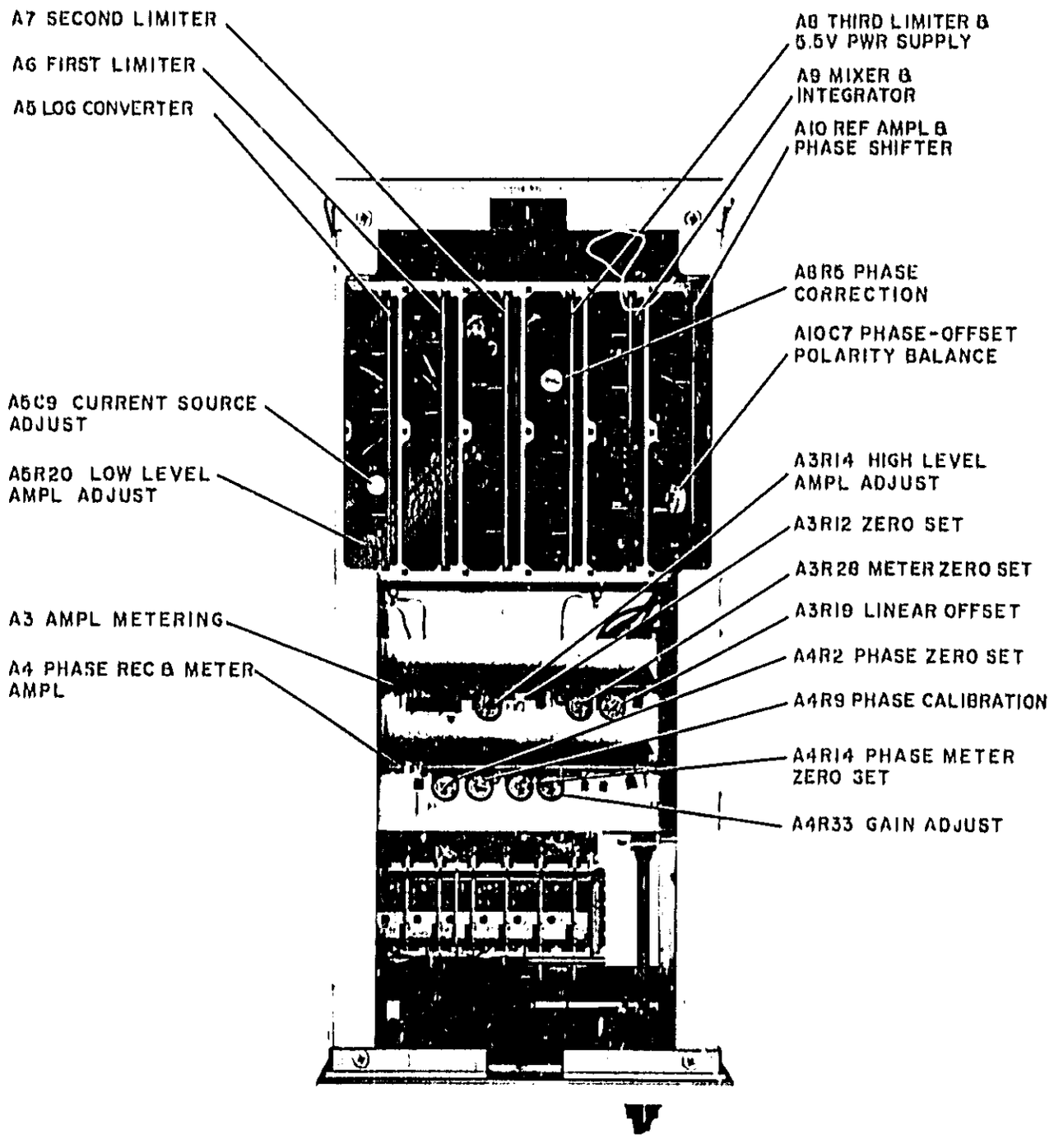
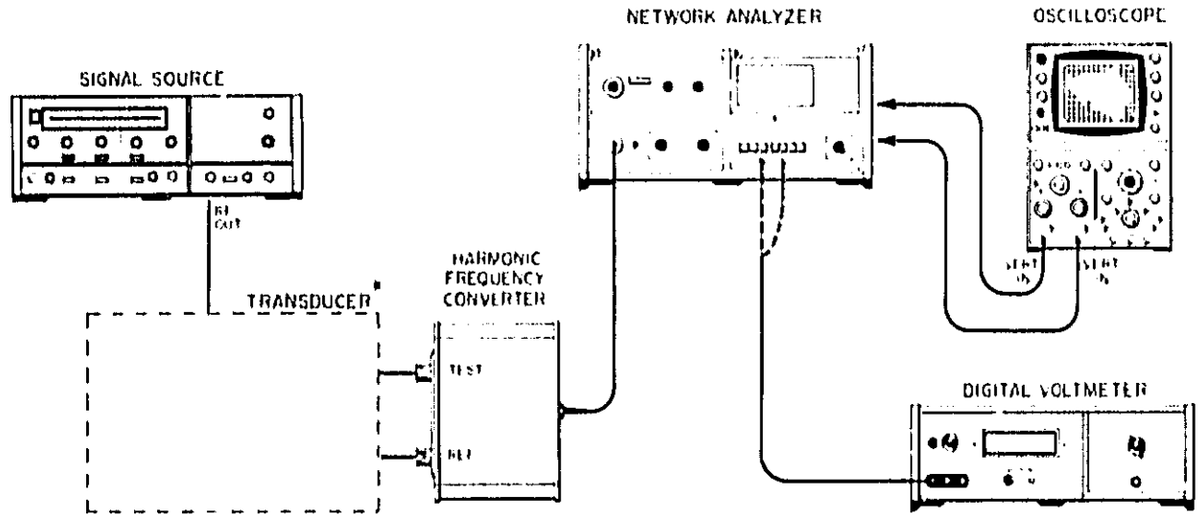


Figure 4-3. Location of Alignment Controls and Circuit Board Assemblies

FIGURE 4-4. ALIGNMENT PROCEDURE

EQUIPMENT SETUP:



* HP Model 8740A, 8741A, 8742A, 8743A, or 8745A. For an 8741A, 8742A, or 8743A in reflection mode, connect a short to the UNKNOWN port. For an 8745A, select Port A, S_{11} and connect a short to Port A.

PREPARATION:

Remove top covers from both Network Analyzer and 8413A. Remove circuit board compartment top cover from 8413A before installing it into the Network Analyzer. Connect equipment as shown in setup diagram. Power level to the Harmonic Frequency Converter REFERENCE input should be approximately -20 dBm (Network Analyzer REFERENCE CHANNEL LEVEL meter at the high end of the OPERATE region). Power to the TEST input should be approximately -10 dBm.

1. Meter Movement Zero Adjustment

Check meter zero adjustment with Network Analyzer power off. To determine if the meter needs adjusting, observe the position of the needle from directly in front of the meter using mirror scale to minimize parallax error. If the needle is at zero, do not adjust the mechanical zero adjustment screw. If the meter requires adjustment, perform the following steps.

a. Rotate meter zero-adjust screw (located just below the meter) clockwise until meter pointer is to left of 0 and moving to right toward 0. Stop pointer at 0. If pointer passes 0, repeat adjustment.

b. Rotate adjust screw about 3 degrees counterclockwise to free it from meter suspension. If pointer moves, repeat steps a and b.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

2. Power Supply Voltage Check

a. Turn on Network Analyzer and allow 30 minute warmup.

b. Connect Digital Voltmeter (DVM) to XA4 pin 8. DVM should indicate -20.00 (±0.02) volts.

c. Connect DVM to XA4 pin 12. DVM should indicate +20.00 (±0.02) volts.

NOTE

If both of these indications are not within tolerance trouble-shoot the Network Analyzer.

d. Connect DVM to 8413A-A8TP4. DVM should indicate +5.5 ±0.2 volts (+5.1 ±0.2 Vdc for instruments with serial numbers 736-00130 and below).

NOTE

If correct voltage is not obtained, troubleshoot the A8 Assembly using schematic number 4.

3. Phase Offset Polarity Switch Balance Adjustment

DESCRIPTION:

The input phase relationship is adjusted to obtain a phase indication on the most sensitive meter range, with zero phase offset. A10C7 is adjusted to balance the phase shift when switching between (+) and (-) zero phase offset. Adjustment is correct when minimum phase change occurs while switching between (-) zero and (+) zero phase offset.

PROCEDURE:

a. Set the Signal Source for single-frequency operation.

b. Adjust the Network Analyzer to phase lock to the applied signal, and set the test channel gain to zero dB.

c. Connect DVM to the 8413A PHASE 10 MV/DEG output connector. Set the PHASE OFFSET to zero, and depress the PHASE 0 degree pushbutton.

d. Adjust the Transducer REFERENCE PLANE EXTENSION for a phase meter indication near the middle of the meter scale.

e. Set the polarity switch from (+) to (-) position several times while adjusting A10C7 (Phase-Offset Polarity Balance) for minimum phase meter change. Then check the DVM readings for each position. The difference between DVM readings should not exceed 0.5 mV. If unable to obtain less than 0.5 mV difference, troubleshoot the A10 Assembly using schematic number 1.

NOTE

Excessive meter and dc output drift may be caused by trouble in the A8Q1 circuit.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

4. Test Channel Phase Adjustment

DESCRIPTION:

The 8413A input signals are adjusted for an in-phase relationship. The phase reference channel signal is shifted 180 degrees using the PHASE OFFSET control. A8R5 is adjusted to obtain the proper phase shift through the phase test channel, as indicated by erratic action of the meter needle and by the polarity of the 10 MV/DEG output voltage changing from + to - at 180 degrees.

PROCEDURE:

a. Obtain in-phase signals to the 8413A as follows:

(1) Connect one oscilloscope probe to 8413A-A6TP1, and connect the other probe to 8413A-A10TP4.

(2) Adjust the Transducer REFERENCE PLANE EXTENSION and Network Analyzer phase vernier to obtain two sine waves on the Oscilloscope exactly superimposed on one another. This adjusts the reference and test channel input signals for zero phase difference. The Oscilloscope probe electrical lengths must be equal; therefore, to be sure probes give true in-phase indication, connect both probes to A10TP4. If the two sinewaves are not superimposed the probes are not matched.

b. Depress PHASE 180 degree pushbutton, and set the PHASE OFFSET switch to 180 degrees.

c. Adjust A8R5 (Phase Correction) for an erratic meter indication, or so that adjustment of A8R5 causes meter indication to change from one side to the other. A8R5 is adjusted correctly when meter indication changes from one side of zero to the other (approximately the same amount) when the PHASE OFFSET polarity is switched from + to -. If unable to adjust A8R5 for the proper indication, troubleshoot the phase section using the block diagram.

NOTE

Problems in obtaining correct indication can be caused by A7 Assembly bandpass filter being off frequency.

Check the bandpass filter center frequency as follows:

(1) Turn off Network Analyzer power, remove the 8413A A6 Assembly, and turn on Network Analyzer.

(2) Connect a 278-kHz oscillator to A7TP3, and oscilloscope measurement probe to A7TP1.

(3) Adjust the oscillator output to obtain a 2 to 3V p-p signal on oscilloscope. Vary the oscillator frequency for maximum amplitude signal on oscilloscope.

(4) Using an electronic counter set for period measurement, measure the period of the oscillator output frequency. The period should be 3.6 μsec, $\pm$0.03 μsec. If necessary, select a value for A7C11 to obtain the correct center frequency.

(5) Disconnect the oscillator, turn off Network Analyzer power, install the A6 Assembly, and turn on the Network Analyzer.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

5. Recorder Amplifier Zero Set and Phase Calibration Adjustment

DESCRIPTION:

The 8413A input signals were set for an in-phase relationship during the previous procedure. The PHASE OFFSET is set to zero and A4R2 is adjusted for zero recorder amplifier output voltage. A phase difference between the phase detector input signals is obtained using the PHASE OFFSET control and the recorder amplifier gain is adjusted with A4R0 to obtain the dc output voltage corresponding to the phase difference set by the PHASE OFFSET control. A4R2 and A4R0 interact; therefore, these controls are adjusted for a compromise between DVM indications.

PROCEDURE:

a. Set the 8413A PHASE OFFSET as follows and make indicated adjustments.

PHASE OFFSET	DVM Indication	Adjustment*
0	0 (±1) mV	A4R2
+170	-1.700 (±0.015) volts	A4R0
-170	+1.700 (±0.015) volts	A4R0

*These controls interact; therefore, recheck each step and make adjustments as necessary until the proper indication can be obtained for all three steps without any further adjustment.

NOTE

If voltage limits cannot be met, troubleshoot the Recorder Amplifier circuit using schematic number 5. The most probable cause of trouble is A9Q4 or A9Q5 (low gain or high leakage).

6. 278-kHz IF Current Source Adjustment

DESCRIPTION:

The current source parallel resonant tank circuit is tuned to the input frequency by adjusting A5C9 for maximum amplitude meter indication.

PROCEDURE:

a. Remove the 8413A from the Network Analyzer, install circuit board compartment cover, and reinstall the 8413A in the Network Analyzer.

b. Depress 8413A AMPLITUDE 30 dB pushbutton.

c. Adjust the Network Analyzer test channel gain and amplitude vernier controls to obtain a convenient indication on the 8413A meter (left side of scale).

d. Adjust A5C9 (Current Source Adjust) for maximum positive meter indication (movement toward +30).

NOTE

Two maximum meter indications can normally be obtained - select either one.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

7. Amplitude Output (50 MV/DB) Adjustment

DESCRIPTION:

The Network Analyzer test channel gain control is used to vary the 8413A input signal level over a 60-dB range; therefore, with the Network Analyzer test channel gain at 60 dB, the 8413A input signal level is set to 100 mV p-p. A3R12, A3R14, and A5R20 are adjusted to obtain the proper 8413A 50 MV/DB output voltage for various input signal levels. A3R12, A3R14, and A5R20 internet; therefore, after adjustments are made all indications must be rechecked.

PROCEDURE:

a. Obtain 100 mV peak-to-peak signal at input to 8413A amplitude channel as follows:

(1) Set Network Analyzer test channel gain controls to 60 dB.

(2) Connect Oscilloscope vertical input to Network Analyzer rear-panel test channel output connector.

(3) Adjust the Network Analyzer test channel gain 1-dB step control and amplitude vernier control for 100 mV peak-to-peak indication on Oscilloscope. These two controls attenuate the signal applied to the Harmonic Frequency Converter TEST port to place the signal level in the required range.

b. Connect DVM to the 8413A AMPLITUDE 50 MV/DB connector.

c. Set the Network Analyzer test channel gain tens control (at left of number window) to the following positions and make adjustments if necessary:

Test Channel Gain Tens Control	Adjustment On 8413A	DVM Indication
3 (30 dB)	A3R12*	0 (±1) mV
6 (60 dB)	A3R14*	+1.500 (±0.040) V
5 (50 dB)	A5R20*	+1.000 (±0.025) V
4 (40 dB)	A5R20*	+0.500 (±0.010) V
2 (20 dB)	A5R20*	-0.500 (±0.010) V
1 (10 dB)	A5R20*	-1.000 (±0.025) V
0 (0 dB)	A5R20*	-1.500 (±0.040) V

* A3R12 (Zero Set), A3R14 (High Level Amp Adj.), and A5R20 (Low Level Amp Adj.) all internet with each other; therefore, after adjustments are made all indications must be rechecked.

NOTE

If unable to obtain proper indications recheck step 6 (278-kHz IF Current Source Adjustment). Then if proper indications are not obtained, troubleshoot the A3 and A5 Assemblies using schematic number 6.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

8. Linear 0-1 Volt Amplitude Output Adjustment

DESCRIPTION:

The 8413A input signal level, set during the previous procedure, is varied with the Network Analyzer test channel gain control. The 0-1 VOLT LINEAR output is monitored and A3R19 is adjusted to set the amplifier gain

PROCEDURE:

a. Connect DVM to 8413A rear-panel 0-1 VOLT LINEAR connector.

b. Adjust the Network Analyzer test channel gain and amplitude vernier controls for an indication on the DVM of 1.00 ± 0.001 V. Decrease the settings on the test channel gain controls by 20 dB. The DVM should indicate 0.1 V ± 0.01 V. If the indication is not within tolerance, adjust A3R19 (Linear Offset). This adjustment affects the entire range; therefore, check both indications after each adjustment.

NOTE

If unable to obtain proper indications troubleshoot the linear amplifier using schematic number 6.

9. Phase Meter Zero Adjustment

DESCRIPTION:

The 10 MV/DEG output is set to zero volts with the Network Analyzer phase vernier and Transducer REFERENCE PLANE EXTENSION. A4R14 is adjusted to obtain a zero meter indication.

PROCEDURE:

a. Connect DVM to 8413A PHASE 10 MV/DEG connector. Set PHASE OFFSET switch to zero and depress PHASE 0 degree pushbutton.

b. Adjust the Transducer REFERENCE PLANE EXTENSION and Network Analyzer phase vernier for a DVM indication of 0 ± 0.2 mV.

c. Adjust A4R14 (Phase Meter Zero Set) for zero 8413A meter indication. If a zero meter indication cannot be obtained, troubleshoot the meter amplifier circuit using schematic number 6.

10. Meter Amplifier Gain Adjustment

DESCRIPTION:

This procedure is divided into two parts, phase and amplitude. The gain adjustment affects all ranges of both phase and amplitude and must be adjusted for the best compromise. In part one the 8413A PHASE OFFSET and Network Analyzer phase vernier are used to set known input voltages at the meter amplifier, as indicated by the 10 MV/DEG output voltage. The appropriate meter range is selected, and A4R33 is adjusted to obtain the proper meter indication.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

In part two the Network Analyzer test channel gain and amplitude vernier are used to set known input voltages, as indicated by the 50 MV/DB output voltage. The Meter Zero Set (A3R28) is adjusted to set the meter to zero for a zero input voltage from the amplitude channel. The Network Analyzer test channel gain is increased, the appropriate meter range is selected, and A4R33 is adjusted to obtain the proper meter indication. For convenience the indications are given using the 6-degree and 30-dB meter scales, regardless of the range selected.

PROCEDURE, (Part One):

a. Connect DVM to the 8413A PHASE 10 MV/DEG connector.

b. Check phase meter accuracy according to the following table, and adjust A4R33 (Gain Adjust) as necessary:

8413A Control Positions		Adjust 8410A Phase Vernier For DVM Reading	Adjust A4R33* For 8413A Meter Indication (Read on 6° Meter Scale)
PHASE Range	PHASE OFFSET		
6	0	+0.050 (±0.001) V	+5 ±1/2 small scale division
6	+ 10	-0.050 (±0.001) V	-5 "
18	- 10	+0.150 (±0.001) V	+5 "
18	+ 20	-0.150 (±0.001) V	-5 "
60	+ 50	-0.500 (±0.001) V	-5 "
60	- 50	+0.500 (±0.001) V	+5 "
180	+ 60	-0.600 (±0.001) V	-2 "
180	+150	-1.500 (±0.001) V	-5 "
180	-150	+1.500 (±0.001) V	+5 "
*A4R33 METER GAIN adjustment affects all ranges and must be adjusted for best compromise.			

PROCEDURE, (Part Two):

c. Connect DVM to 8413A AMPLITUDE 50 MV/DB connector, and adjust Network Analyzer test channel gain and amplitude vernier controls for DVM indication of 0 ±1.0 mV.

d. Depress 8413A AMPLITUDE 3 dB pushbutton and adjust A3R28 (Meter Zero Set) for zero amplitude meter indication.

e. Check amplitude meter accuracy according to the following table, and adjust A4R33 as necessary.

(Continued)

FIGURE 4-4. ALIGNMENT PROCEDURE

Increase Test Channel Gain	Depress Amplitude Pushbutton	Amplitude Meter Indication (Read on 0-30 Meter Scale) Adjust A4R33*
+ 2 dB	3	+20 ±3/4 Division
- 2 dB	3	-20 ±3/4 Division
+ 0 dB	10	+27 ±3/4 Division
- 0 dB	10	-27 ±3/4 Division
+27 dB	30	+27 ±3/4 Division
-27 dB	30	-27 ±3/4 Division

* Adjustment of A4R33 affects both phase and amplitude meter accuracy. If it is adjusted, recheck accuracy of phase indications.

NOTE

If meter error is excessive, recheck meter zero setting (steps c and d). If both low and high range accuracy cannot be obtained change the value of A4R31 as follows:

Meter at high range (30 dB and 180°) reads less than it should. Connect a 100K ohm, or larger, resistor in parallel with A4R31. If the total value of A4R31 must be reduced below 3.3K troubleshoot the meter amplifier circuit using schematic number 5.

Meter at high range (30 dB and 180°) reads greater than it should. Replace A4R31 with a higher value resistor shunted with a second resistor to obtain a total resistance of not more than 3.75K. If the total value of A4R31 must be increased above 3.75K troubleshoot the Meter Amplifier circuit using schematic number 5.

PARTS LIST

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION.

5-2. This section contains information for ordering replaceable parts. Table 5-1 lists parts in alpha-numerical order by reference designation and gives the description and HP stock number for each part. Miscellaneous and cabinet parts not indexed by reference designation are listed at the end of the table. Table 5-2 lists parts in alpha-numerical order of their HP stock number and provides the following information on each part:

a. Description of the part (see list of abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in Table 5-3.

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

5-3. ORDERING INFORMATION.

5-4. When ordering a replacement part listed in Table 5-1:

a. Quote the Hewlett-Packard stock number for the part.

b. Address the order or inquiry to the nearest Hewlett-Packard sales and service office listed at the rear of this manual.

5-5. To order a part not listed in Table 5-1:

a. Give a complete description of the part including its function and location.

b. Give the instrument model number and complete serial number.

c. Address the order or inquiry to the nearest Hewlett-Packard sales and service office.

REFERENCE DESIGNATIONS

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

ABBREVIATIONS

A	amperes	H	henries	N O	normally open	RMO	rack mount only
AFC	automatic frequency control	HDW	hardware	NPO	negative positive zero (zero temperature coefficient)	RMS	root-mean square
AMPL	amplifier	HEX	hexagonal			RWV	reverse working voltage
		HG	mercury				
BFO	beat frequency oscillator	HR	hour(s)	NPS	negative-positive-negative	S-B	slow-blow
BE CU	beryllium copper	HZ	hertz			SCR	screw
BH	binder head			NRFR	not recommended for field replacement	SE	selenium
BP	bandpass	IF	intermediate freq			SECT	section(s)
BRS	brass	IMPG	impregnated	NSR	not separately replaceable	SEMICON	semiconductor
BWO	backward wave oscillator	INCD	incandescent			SI	silicon
		INCL	include(s)			SIL	silver
CCW	counter-clockwise	INS	insulation(ed)	OBD	order by description	SL	slide
CER	ceramic	INT	internal	OH	oval head	SPG	spring
CMO	cabinet mount only			OX	oxide	SPL	special
COEF	coefficient	K	kilo = 1000			SST	stainless steel
COM	common			P	peak	SR	split ring
COMP	composition	LH	left hand	PC	printed circuit	STL	steel
COMPL	complete	LIN	linear taper	PF	picofarads = 10^{-12} farads	TA	tantalum
CONN	connector	LK WASH	lock washer			TD	time delay
CP	cadmium plate	LOG	logarithmic taper	PH BRZ	phosphor bronze	TGL	toggle
CRT	cathode-ray tube	LPF	low pass filter	PHIL	Phillips	THD	thread
CW	clockwise			PIV	peak inverse voltage	TI	titanium
		M	milli = 10^{-3}	PNP	positive-negative-positive	TOL	tolerance
DEPC	deposited carbon	MEG	meg = 10^{6}			TRIM	trimmer
DR	drive	MET FLM	metal film	P O	part of	TWT	traveling wave tube
		MET OX	metallic oxide	POLY	polystyrene		
ELECT	electrolytic	MFR	manufacturer	PORC	porcelain	U	micro = 10^{-6}
ENCAP	encapsulated	MHZ	mega hertz	POS	position(s)		
EXT	external	MINAT	miniature	POT	potentiometer	VAR	variable
		MOM	momentary	PP	peak-to-peak	VDCW	dc working volts
F	farads	MTG	mounting	PT	point		
FH	flat head	MY	"mylar"	PWV	peak working voltage	W	with
FIL H	fillister head					W	watts
FXD	fixed	N	nano = 10^{-9}	RECT	rectifier	WIV	working inverse voltage
G	giga = 10^{9}	N C	normally closed	RF	radio frequency		
GE	germanium	NE	neon	RH	round head or right hand	WW	wirewound
GL	glass	NI PL	nickel plate			W O	without
GND	grounded)						

01104-13

Table 5-1. Reference Designation Index

Reference Designation	HP Part No.	Description #	Note
A1	08413-6010	SWITCH ASSY:RANGE FUNCTION	
A1A1	08413-6024	BOARD ASSY:RANGE	
A1A1R1	0698-3160	R:FXD MET FLM 31.6K 1% 1/8W	
A1A1R2	0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	
A1A1R3	0757-0439	R:FXD MET FLM 6.81K OHM 1% 1/8W	
A1A1R4	0698-3452	R:FXD MET FLM 147K OHM 1% 1/8W	
A1A1R5	0757-0421	R:FXD MET FLM 825 OHM 1% 1/8W	
A1A1R6	0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	
A1A1R7	0698-3243	R:FXD MET FLM 178K OHM 1% 1/8W	
A1A1R8	0757-0467	R:FXD MET FLM 121K OHM 1% 1/8W	
A1A1R9	0757-0456	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A1A1R10	0698-3161	R:FXD MET FLM 38.3K 1% 1/8W	
A1A1R11	0757-02CC	R:FXD MET FLM 5.62K OHM 1% 1/8W	
A1A1R12	0757-0456	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A1A1R13	0698-3446	R:FXD MET FLM 383 OHM 1% 1/8W	
A1A1R14	0698-315C	R:FXD MET FLM 2.37K OHM 1% 1/8W	
A1A1S1	3101-0996	SWITCH:PUSHBUTTON(7)	
A2	08413-6009	SWITCH ASSY:PHASE OFFSET	
A2R1	0698-5461	R:FXD FLM 2.003K OHM 0.1% 1/8W	
A2R2	0698-5469	R:FXD MET FLM 8665 OHM 1% 1/8W	
A2R3	0698-546E	R:FXD FLM 7.742K OHM 1% 1/8W	
A2R4	0698-5467	R:FXD FLM 6.764K OHM 1% 1/8W	
A2R5	0698-5466	R:FXD MET FLM 5700 OHM 1% 1/8W	
A2R6	0698-5465	R:FXD FLM 4.725K OHM 1% 1/8W	
A2R7	0698-5464	R:FXD MET FLM 3790 OHM 1% 1/8W	
A2R8	0698-5463	R:FXD MET FLM 2866 OHM 0.5% 1/8W	
A2R9	0698-5462	R:FXD MET FLM 2065 OHM 0.5% 1/8W	
A2R10	0698-5460	R:FXD MET FLM 1338 OHM 0.5% 1/8W	
A2S1	3100-2016	SWITCH:ROTARY	
A2S2		NSR PART OF S1	
A3	08413-6025	BOARD ASSY:AMPL METERING REPLACEMENT PART # 08413-6030 MATCHED PAIR INCLUDES A4 ASSY	
A3C1	0160-2216	C:FXD MICA 1000 PF 5%	
A3C2	0170-0040	C:FXD MY .047 UF 10% 200VDCW	
A3C3	0170-0040	C:FXD MY .047 UF 10% 200VDCW	
A3CR1	1901-0025	DIODE:SILICON 100MA/1V	
A3L1	9140-0137	COIL/CHOKE 1000 UH 5%	
A3Q1	1853-0005	Q:SI PNP	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Cont'd)

Reference Designation	℔ Part No.	Description #	Note
A3Q2	1853-0065	Q:SI PNP	
A3Q3	1855-0047	Q:SI DUAL FET N-CHAN	
A3Q4	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A3Q5	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A3Q6	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A3Q7	1855-0064	Q:FET(MATCHED PAIR) MATCHED TO A4Q4,REPL AS A PAIR	
A3Q8	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A3Q9	1853-002C	Q:SI PNP(SELECTED FROM 2N3702)	
A3Q10	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A3R1	0698-3155	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A3R2	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A3R3	0698-3446	R:FXD MET FLM 383 OHM 1% 1/8W	
A3R4	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A3R5	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A3R6	0757-0285	R:FXD MET FLM 13.3K OHM 1% 1/8W	
A3R7	0698-3161	R:FXD MET FLM 38.3K 1% 1/8W	
A3R8	0698-3155	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A3R9	0698-3452	R:FXD MET FLM 147K OHM 1% 1/8W	
A3R10	0811-1780	R:FXD WW 1K OHM 5.0% 1/4W	
A3R11	0757-0463	R:FXD MET FLM 82.5K 1% 1/8W FACTORY SELECTED PART	
A3R12	2100-2429	R:VAR WW 250K OHM 20% LIN 3/4W	
A3R13	0757-0285	R:FXD MET FLM 13.3K OHM 1% 1/8W	
A3R14	2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	
A3R15	0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	
A3R16	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A3R17	0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	
A3R18	0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	
A3R19	2100-1756	R:VAR WW 200 OHM 10% LIN 1/2W	
A3R20	0757-0274	R:FXD MET FLM 1.21K OHM 1% 1/8W	
A3R21	0698-3132	R:FXD MET FLM 261 OHM	
A3R22	0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	
A3R23	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A3R24	0757-0155	R:FXD MET FLM 21.5K OHM 1% 1/8W	
A3R25	0757-0199	R:FXD MET FLM 21.5K OHM 1% 1/8W	
A3R26	0698-3132	R:FXD MET FLM 261 OHM	
A3R27	0698-3158	R:FXD MET FLM 23.7K OHM 1% 1/8W	
A3R28	2100-1755	R:VAR WW 2K OHM 10% LIN 1/2W	
A3R29	0698-3158	R:FXD MET FLM 23.7K OHM 1% 1/8W	
A3R30	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A3R31	0757-0415	R:FXD MET FLM 681 OHM 1% 1/8W	
A3R32	0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	
A3R33	0698-3452	R:FXD MET FLM 147K OHM 1% 1/8W	
A3R34	0757-0458	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A4	08413-6026	BOARD ASSY:PHASE REC. & METER AMPL. REPLACEMENT PART # 08413-6030 MATCHED PAIR INCLUDES A3 ASSY	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	# Part No.	Description #	Note
A4C1	0160-0153	C:FXD MY 0.001 UF 10% 200VDCW	
A4C2	0170-004C	C:FXD MY .047 UF 10% 200VDCW	
A4C3	0180-0291	C:FXD ELECT 1.0 UF 10% 35VDCW	
A4CR1	1901-0025	DIODE:SILICON 100MA/1V	
A4CR2	1901-0025	DIODE:SILICON 100MA/1V	
A4Q1	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A4Q2	1854-0014	Q:SI NPN(SIMILAR TO 2N2060)	
A4Q3	1853-002C	Q:SI PNP(SELECTED FROM 2N3703)	
A4Q4	1855-00E4	Q:FET(MATCHED PAIR) MATCHED TO A3Q7,REPL AS A PAIR	
A4Q5	1855-0047	Q:SI DUAL FET N-CHAN	
A4Q6	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A4Q7	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A4Q8	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A4R1	0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A4R2	2100-1755	R:VAR WW 2K OHM 10% LIN 1/2W	
A4R3	0757-0465	R:FXD MET FLM 100K 1% 1/8W	
A4R4	0698-3160	R:FXD MET FLM 31.6K 1% 1/8W	
A4R5	0698-3160	R:FXD MET FLM 31.6K 1% 1/8W	
A4R6	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A4R7	0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	
A4R8	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A4R9	2100-1755	R:VAR WW 2K OHM 10% LIN 1/2W	
A4R10	0757-043E	R:FXD MET FLM 5.11K 1% 1/8W	
A4R11	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A4R12	0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	
A4R13	0698-3158	R:FXD MET FLM 23.7K OHM 1% 1/8W	
A4R14	2100-1755	R:VAR WW 2K OHM 10% LIN 1/2W	
A4R15	0698-3158	R:FXD MET FLM 23.7K OHM 1% 1/8W	
A4R16	0757-0415	R:FXD MET FLM 681 OHM 1% 1/8W	
A4R17	0757-04C5	R:FXD MET FLM 162 OHM 1% 1/8W	
A4R18	0698-3453	R:FXD MET FLM 196K OHM 1% 1/8W	
A4R19	0698-3452	R:FXD MET FLM 147K OHM 1% 1/8W	
A4R20	0757-045E	R:FXD MET FLM 51.1K OHM 1% 1/8W	
A4R21	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A4R22	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A4R23	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A4R24	0698-3431	R:FXD MET FLM 133 OHM 1% 1/8W	
A4R25	0698-3431	R:FXD MET FLM 133 OHM 1% 1/8W	
A4R26	0757-0462	R:FXD MET FLM 75.0K OHM 1% 1/8W	
A4R27	0757-0285	R:FXD MET FLM 13.3K OHM 1% 1/8W	
A4R28	0757-0276	R:FXD MET FLM 1.78K OHM 1% 1/8W	
A4R29	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A4R30	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	HP Part No.	Description #	Note
A4R31	0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	
A4R32	0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	
A4R33	2100-1757	R:VAR WW 500 OHM 10% LIN 1/2W	
A4R34	0757-0420	R:FXD MET FLM 750 OHM 1% 1/8W	
A5	08413-60C1	BOARD ASSY:LOG CONVERTER CURRENT SOURCE	
A5C1	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C2	0180-0251	C:FXD ELECT 1.0 UF 10% 35VDCW	
A5C3	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C4	0180-0291	C:FXD ELECT 1.0 UF 10% 35VDCW	
A5C5	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A5C6	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C7	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A5C8	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C9	0121-0105	C:VAR CER 9-35 PF NPO	
A5C10	0160-2261	C:FXD CER 15 PF 5% 500VDCW	
A5C11	0140-0225	C:FXD MICA 300 PF 1% FACTORY SELECTED PART	
A5C12	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C13	0180-0291	C:FXD ELECT 1.0 UF 10% 35VDCW	
A5C14	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A5C15	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A5C16	0160-0161	C:FXD MY 0.01 UF 10% 200VDCW	
A5CR1	1901-0039	DIODE:SILICON 200MA 50WV	
A5CR2	1901-0035	DIODE:SILICON 200MA 50WV	
A5L1	9140-0210	COIL:FXD RF 100 UH 5%	
A5L2	9140-0210	COIL:FXD RF 100 UH 5%	
A5L3	9100-2865	COIL/CHOKE 1000UH 5%	
A5Q1	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A5Q2	1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	
A5Q3	1854-0045	Q:SI NPN	
A5Q4	1854-0045	Q:SI NPN	
A5R1	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A5R2	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A5R3	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A5R4	0757-04C1	R:FXD MET FLM 100 OHM 1% 1/8W	
A5R5	0757-0275	R:FXD MET FLM 3.16K OHM 1% 1/8W	
A5R6	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A5R7	0757-0401	R:FXD MET FLM 100 OHM 1% 1/8W	
A5R8	0757-04C2	R:FXD MET FLM 110 OHM 1% 1/8W	
A5R9	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	
A5R10	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A5R11	0757-043E	R:FXD MET FLM 5.11K 1% 1/8W	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	HP Part No.	Description #	Note
A5R12	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A5R13	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A5R14	0757-0405	RESISTOR: MET FLM 162 OHM 1% 1/8W	
A5R15	0757-0817	RESISTOR: MET FLM 750 OHM 1% 1/2W	
A5R16	0757-0405	RESISTOR: MET FLM 162 OHM 1% 1/8W	
A5R17	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A5R18	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A5R19	0698-3443	RESISTOR: MET FLM 287 OHM 1% 1/8W	
A5R20	2100-1762	R VAR WW 20K OHM 10% LIN 1/2W	
A5R21	0686-5155	RESISTOR: COMP 5.1 MEGOHM 5% 1/2W	
A5R22	0757-0401	RESISTOR: MET FLM 100 OHM 1% 1/8W	
A6	08413-6004	BOARD ASSY: FIRST LIMITER	
A6C1	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A6C2	0150-0121	CAPACITOR: CER 0.1 UF +80-20% 50VDCW	
A6C3	0160-2307	CAPACITOR: MICA 47 PF 5%	
A6C4	0180-0291	CAPACITOR: ELECT 1.0 UF 10% 35VDCW	
A6C5	0150-0121	CAPACITOR: CER 0.1 UF +80-20% 50VDCW	
A6C6	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A6C7	0180-0291	CAPACITOR: ELECT 1.0 UF 10% 35VDCW	
A6C8	0150-0121	CAPACITOR: CER 0.1 UF +80-20% 50VDCW	
A6C9	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A6C10	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A6Q1	1854-0071	Q: SI NPN (SELECTED FROM 2N3704)	
A6Q2	1853-0020	Q: SI PNP (SELECTED FROM 2N3702)	
A6Q3	1854-0005	Q: SI NPN	
A6Q4	1854-0005	Q: SI NPN	
A6Q5	1854-0071	Q: SI NPN (SELECTED FROM 2N3704)	
A6R1	0757-0416	RESISTOR: MET FLM 511 OHM 1% 1/8W	
A6R2	0757-0442	RESISTOR: MET FLM 10.0K 1% 1/8W	
A6R3	0757-0200	RESISTOR: MET FLM 5.62K OHM 1% 1/8W	
A6R4	0698-3153	RESISTOR: MET FLM 3.83K 1% 1/8W	
A6R5	0698-3440	RESISTOR: MET FLM 196 OHM 1% 1/8W	
A6R6	0757-0401	RESISTOR: MET FLM 100 OHM 1% 1/8W	
A6R7	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A6R8	0757-0200	RESISTOR: MET FLM 5.62K OHM 1% 1/8W	
A6R9	0698-3153	RESISTOR: MET FLM 3.83K 1% 1/8W	
A6R10	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A6R11	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A6R12	0757-0442	RESISTOR: MET FLM 10.0K 1% 1/8W	
A6R13	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A6R14	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A6R15	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A6R16	0698-3440	RESISTOR: MET FLM 196 OHM 1% 1/8W	
A6R17	0698-3440	RESISTOR: MET FLM 196 OHM 1% 1/8W	
A6R18	0757-0280	RESISTOR: MET FLM 1K OHM 1% 1/8W	
A6R19	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A6R20	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	Part No. #	Description #	Note
A6R21	0757-0416	RESISTOR: MET FLM 511 OHM 1% 1/8W	
A6R22	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A7	08413-60005	BOARD ASSY: SECOND LIMITER	
A7C1	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C2	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C3	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C4	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C5	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C6	0140-0184	CAPACITOR: MICA 8200 PF 1% 100VDCW	
A7C7	0150-0056	CAPACITOR: CER 0.05 UF +80-20% 100VDCW	
A7C8	0150-0121	CAPACITOR: CER 0.1 UF +80-20% 50VDCW	
A7C9	0150-0121	CAPACITOR: CER 0.1 UF +80-20% 50VDCW	
A7C10	0160-3076	CAPACITOR: CER 470 PF 5% 200VDCW	
A7C11		CAPACITOR: NOMINAL VALUES FROM 20C-510 PF	
A7L1	9100-2209	INDUCTOR: 37.8 UH 1%	
A7Q1	1854-0005	TRANSISTOR: SI NPN	
A7Q2	1854-0009	TRANSISTOR: SI NPN	
A7Q3	1854-0071	TRANSISTOR: SI NPN (SELECTED FROM 2N3704)	
A7Q4	1854-0072	TRANSISTOR: SI NPN (SELECTED FROM 2N2857)	
A7Q5	1854-0072	TRANSISTOR: SI NPN (SELECTED FROM 2N2857)	
A7R1	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A7R2	0698-3158	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A7R3	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A7R4	0757-0442	RESISTOR: MET FLM 10.0K 1% 1/8W	
A7R5	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A7R6	0698-3158	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A7R7	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A7R8	0698-3158	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A7R9	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A7R10	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A7R11	0698-3156	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A7R12	0757-0442	RESISTOR: MET FLM 10.0K 1% 1/8W	
A7R13	0698-0083	RESISTOR: MET FLM 1.96K OHM 1% 1/8W	
A7R14	0757-0438	RESISTOR: MET FLM 5.11K 1% 1/8W	
A7R15	0698-3154	RESISTOR: MET FLM 14.7K OHM 1% 1/8W	
A7R16	0757-0394	RESISTOR: MET FLM 51.1 OHM 1% 1/8W	
A7R17	0698-3440	RESISTOR: MET FLM 196 OHM 1% 1/8W	
A7R18	0698-3440	RESISTOR: MET FLM 196 OHM 1% 1/8W	
A7R19	0757-0416	RESISTOR: MET FLM 511 OHM 1% 1/8W	
A7Z1	9170-0847	BEAD: MAGNETIC SHIELDING	
A7Z2	9170-0847	BEAD: MAGNETIC SHIELDING	
A8	08413-60066	BOARD ASSY: THIRD LIMITER & 5.1 VPS	

See Introduction to this section for ordering information

Table 6-1. Reference Designation Index (Contd)

Reference Designation	HP Part No.	Description #	Note
A8C1	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A8C2	0160-2204	C:FXD MICA 100 PF 5%	
A8C3	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A8C4	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A8C5	0160-2205	C:FXD MICA 120 PF 5%	
A8C6	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A8C7	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A8C8	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A8C9	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A8Q1	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q2	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q3	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q4	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q5	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q6	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8Q7	1854-0071	Q:SI NPN:SELECTED FROM 2N3704	
A8R1	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A8R2	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A8R3	0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	
A8R4	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A8R5	2100-1755	R:VAR WW 2K OHM 10% LIN 1/2W	
A8R6	0757-0217	R:FXD MET FLM 1.33K OHM 1% 1/8W	
A8R7	0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A8R8	0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A8R9	0757-0442	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A8R10	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A8R11	0757-0415	R:FXD MET FLM 681 OHM 1% 1/8W	
A8R12	0757-027E	R:FXD MET FLM 1.78K OHM 1% 1/8W	
A8R13	0757-028C	R:FXD MET FLM 1K OHM 1% 1/8W	
A8R14	0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	
A8R15	0757-0443	R:FXD MET FLM 11.0K OHM 1% 1/8W	
A8R16	0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	
A8R17	0757-0280	R:FXD MET FLM 9.09K OHM 1% 1/8W	
A8R18	0757-044E	R:FXD MET FLM 18.2K OHM 1% 1/8W	
A8R19	0698-3279	R:FXD MET FLM 4990 OHM 1% 1/8W	
A8R20	0698-3404	R:FXD MET FLM 383 OHM 1% 1/2W	
A8R21	0757-0403	R:FXD MET FLM 121 OHM 1% 1/8W	
A8R22	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9	08413-6007	BOARD ASSY:MIXER & INTEGRATOR	
A9C1	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C2	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C3	0140-0205	C:FXD MICA 5.0 PF 10%	
A9C4	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C5	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	

See introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	HP Part No.	Description #	Note
A9C6	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C7	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C8	0140-0205	C:FXD MICA 5.0 PF 10%	
A9C9	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C10	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C11	0140-0209	C:FXD MICA 5.0 PF 10%	
A9C12	0140-0205	C:FXD MICA 5.0 PF 10%	
A9C13-A9C14		NOT ASSIGNED	
A9C15	0160-2225	C:FXD MICA 2000 PF 5% 300VDCW	
A9C16	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9C17	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A9CR1	1901-0175	DIODE:SILICON 15WV	
A9CR2	1901-0175	DIODE:SILICON 15WV	
A9CR3	1901-0175	DIODE:SILICON 15WV	
A9CR4	1901-0175	DIODE:SILICON 15WV	
A9L1	9140-0137	COIL/CHOKE 1000 UH 5%	
A9L2	9140-0094	COIL:FXD RF: 0.68UH	
A9L3	9140-0137	COIL/CHOKE 1000 UH 5%	
A9L4	9140-0094	COIL:FXD RF: 0.68UH	
A9L5	9140-0131	COIL:FXD RF 10 MH	
A9Q1	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A9Q2	1854-0019	Q:SI NPN(SELECTED FROM 2N2365)	
A9Q3	1854-0019	Q:SI NPN(SELECTED FROM 2N2365)	
A9Q4	1854-0009	Q:SI NPN	
A9Q5	1854-0005	Q:SI NPN	
A9Q6	1854-0019	Q:SI NPN(SELECTED FROM 2N2369)	
A9Q7	1854-0019	Q:SI NPN(SELECTED FROM 2N2369)	
A9Q8	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A9R1	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A9R2	0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W	
A9R3	0698-0084	R:FXD MET FLM 2.15K 1% 1/8W	
A9R4	0757-0418	R:FXD MET FLM 619 OHM 1% 1/8W	
A9R5	0698-3404	R:FXD MET FLM 383 OHM 1% 1/2W	
A9R6	0757-0403	R:FXD MET FLM 121 OHM 1% 1/8W	
A9R7	0698-3443	R:FXD MET FLM 287 OHM 1% 1/8W	
A9R8	0757-0415	R:FXD MET FLM 681 OHM 1% 1/8W	
A9R9	0757-0288	R:FXD MET FLM 9.09K OHM 1% 1/8W	
A9R10	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R11	0757-0447	R:FXD MET FLM 16.2K OHM 1% 1/8W	
A9R12	0757-0123	R:FXD MET FLM 34.8K OHM 1% 1/8W	
A9R13	0698-0084	R:FXD MET FLM 2.15K 1% 1/8W	
A9R14	0757-0418	R:FXD MET FLM 619 OHM 1% 1/8W	
A9R15	0698-3404	R:FXD MET FLM 383 OHM 1% 1/2W	

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Table 5-1. Reference Designation Index (Contd)

Reference Designation	# Part No.	Description #	Note
A9R16	0757-0403	R:FXD MET FLM 121 OHM 1% 1/8W	
A9R17	0698-3443	R:FXD MET FLM 287 OHM 1% 1/8W	
A9R18	0757-0419	R:FXD MET FLM 681 OHM 1% 1/8W	
A9R19	0757-0288	R:FXD MET FLM 9.09K OHM 1% 1/8W	
A9R20	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R21	0698-3443	R:FXD MET FLM 287 OHM 1% 1/8W	
A9R22	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R23	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R24	0698-3435	R:FXD MET FLM 178 OHM 1% 1/8W	
A9R25	0698-3435	R:FXD MET FLM 178 OHM 1% 1/8W	
A9R26	0757-0816	R:FXD MET FLM 681 OHM 1% 1/2W	
A9R27	0698-3443	R:FXD MET FLM 287 OHM 1% 1/8W	
A9R28	0757-1054	R:FXD MET FLM 1.47K OHM 1% 1/8W	
A9R29	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R30	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A9R31		NOT ASSIGNED	
A9R32	0698-3442	R:FXD MET FLM 237 OHM 1% 1/8W	
A10	08413-60003	BOARD ASSY:REF, AMPL, & PHASE SHIFTER	
A10C1	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C2	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A10C3	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C4	0160-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C5	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C6	0160-0335	C:FXD MICA 634 PF 1%	
A10C7	0130-0017	C:VAR CER 8-50 PF	
A10C8	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C9	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C10	0160-221E	C:FXD MICA 1000 PF 5%	
A10C11	0150-0056	C:FXD CER 0.05 UF +80-20% 100VDCW	
A10C12	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C13	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C14	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
A10C15	0150-0096	C:FXD CER 0.05 UF +80-20% 10CVDCW	
A10C16	0160-2222	C:FXD MICA 1600 PF 5% 300VDCW	
A10C17	0150-0096	C:FXD CER 0.05 UF +80-20% 10CVDCW	
A10Q1	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q2	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q3	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q4	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q5	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q6	1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	
A10Q7	1854-0045	Q:SI NPN	
A10R1	0757-0442	R:FXD MET FLM 10.0K 1% 1/8W	

See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Contd)

Reference Designation	HP Part No.	Description	Note
A1OR2	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A1OR3	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A1OR4	0757-0477	R:FXD MET FLM 909 OHM 1% 1/8W	
A1OR5	0757-0280	R:FXD MET FLM 1K OHM 1% 1/8W	
A1OR6	0698-3243	R:FXD MET FLM 178K OHM 1% 1/8W	
A1OR7	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A1OR8	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A1OR9	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A1OR10	0757-0417	R:FXD MET FLM 562 OHM 1% 1/8W	
A1OR11	0698-3260	R:FXD MET FLM 464K OHM 1% 1/8W	
A1OR12	0698-3243	R:FXD MET FLM 178K OHM 1% 1/8W	
A1OR13	0757-0440	R:FXD MET FLM 7.50K 1% 1/8W	
A1OR14	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A1OR15	0698-0085	R:FXD MET FLM 2.61K OHM 1% 1/8W	
A1OR16	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1OR17	0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W	
A1OR18	0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W	
A1OR19	0757-0438	R:FXD MET FLM 5.11K 1% 1/8W	
A1OR20	0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	
A1OR21	0757-0444	R:FXD MET FLM 12.1K OHM 1% 1/8W	
A1OR22	0757-0419	R:FXD MET FLM 681 OHM 1% 1/8W	
A1OR23	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A1OR24	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A1OR25	0757-0416	R:FXD MET FLM 511 OHM 1% 1/8W	
A1OR26	0757-0278	R:FXD MET FLM 1.78K OHM 1% 1/8W	
A1OT1	9100-2708	TRANSFORMER	
A1OZ1	9170-0847	BEAD:MAGNETIC SHIELDING	
A1OZ2	9170-0847	BEAD:MAGNETIC SHIELDING	
		CHASSIS PARTS	
W1P1	1250-0082	CONNECTOR:RF FOR RG-188/U CABLE	
W2P1	1250-0082	CONNECTOR:RF FOR RG-188/U CABLE	
C1	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C2	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C3	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C4	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C5	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C6	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C7	0160-2438	C:FXD CER 5000 PF +80-20% 200VDCW	
C8	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C9	0160-2438	C:FXD CER 5000 PF +80-20% 200VDCW	
C10	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C11	0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	
C12	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
C13	0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	
C14	0180-0050	C:FXD ELECT 40 UF +75-10% 50VDCW	
DS1	2140-0025	LAMP:INCANDESCENT 28V 0.04 AMP	
	08413-0016	CONTACT:LAMP	
	08413-8002	LAMPHOLDER:MINUS	

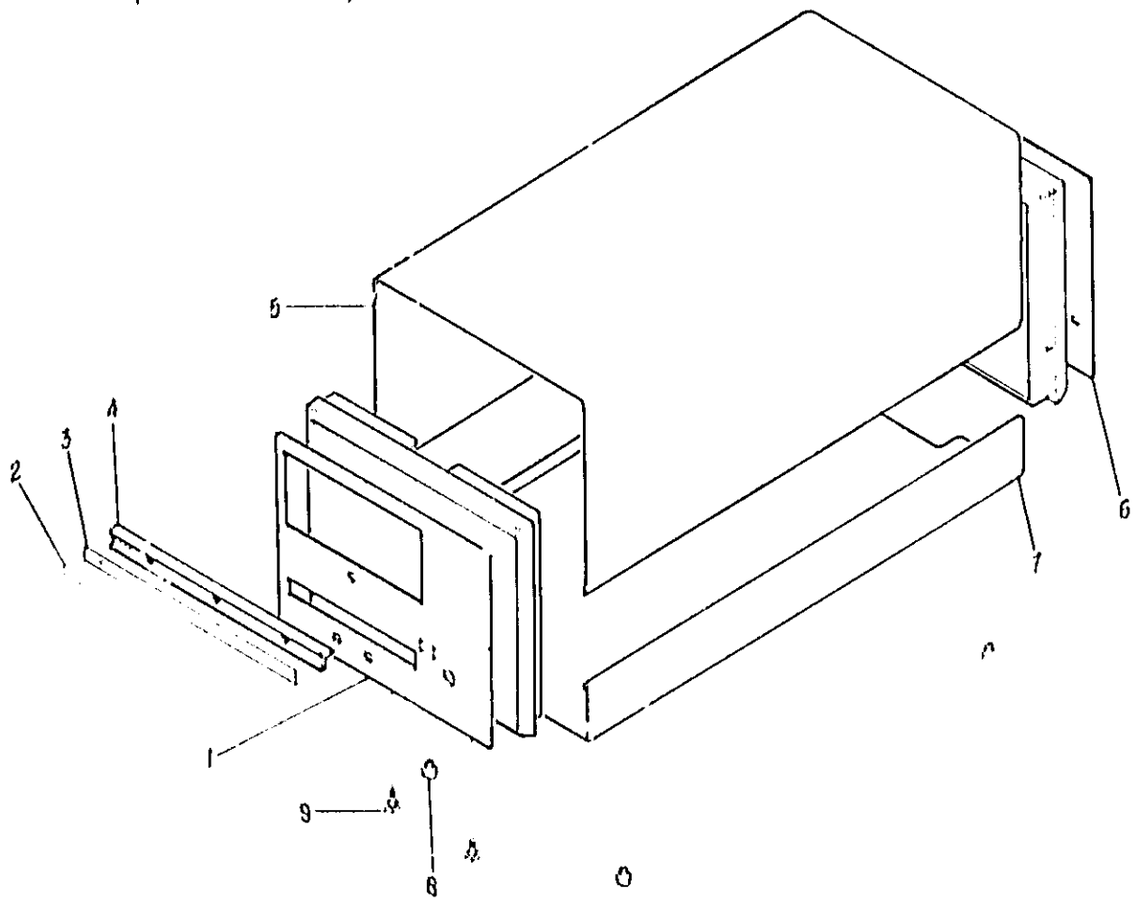
Table 6-1. Reference Designation Index (Contd)

Reference Designation	† Part No.	Description #	Note
DS2	2140-0025	LAMP:INCANDESCENT 28V 0.04 AMP	
	08413-8001	LAMP-HOLDER:PILOT	
	08413-0016	CONTACT:LAMP	
J1	1250-0081	CONNECTOR:BNC	
J2	1250-0083	CONNECTOR:BNC	
J3	1250-0083	CONNECTOR:BNC	
J4	1250-0829	CONNECTOR:RI	
J5	1250-0829	CONNECTOR:RF	
J6	1250-0083	CONNECTOR:BNC	
L1	9140-0210	COIL:FXD RF 100 UH 5%	
L2	9140-0210	COIL:FXD RF 100 UH 5%	
L3	9140-0210	COIL:FXD RF 100 UH 5%	
M1	1120-1104	METER:0-1 MA	
P1	1251-0055	CONNECTOR:MALE 24 CONTACTS	
R1	0757-0394	RES:FXD MET FLM 51.1 OHM 1% 1/8W	
W1	08413-6014	CABLE ASSY:INPUT	
W2	08413-6014	CABLE ASSY:INPUT	
XA1-		NOT ASSIGNED	
XA2-		NOT ASSIGNED	
XA3	1251-0160	CONNECTOR:15 PIN	
XA4	1251-0160	CONNECTOR:15 PIN	
XA5	1251-0160	CONNECTOR:15 PIN	
XA6	1251-0160	CONNECTOR:15 PIN	
XA7	1251-0160	CONNECTOR:15 PIN	
XA8	1251-0160	CONNECTOR:15 PIN	
XA9	1251-0160	CONNECTOR:15 PIN	
XA10	1251-0160	CONNECTOR:15 PIN	
		MISCELLANEOUS	
	08413-0015	DIAL:PHASE OFFSET	
	0370-0115	KNOB:RED BAR 5/8" DIA 1/8" SHAFT	
	0370-0162	PUSHBUTTON:METER FUNCTION	
	0370-0364	KNOB:BLK 3/4" DIA 1/4" SHAFT	
	5000-3302	LABEL:PUSHBUTTON(3)	
	5000-3305	LABEL:PUSHBUTTON(6)	
	5000-3309	LABEL:PUSHBUTTON(10)	
	5000-3375	LABEL:PUSHBUTTON(18)	
	5000-3376	LABEL:PUSHBUTTON(30)	
	5000-3377	LABEL:PUSHBUTTON(60)	
	5000-3378	LABEL:PUSHBUTTON(180)	
	5040-0170	SUPPORT:BOARD(A1,A2)	

See Introduction to this section for ordering information

Table 5-1. Reference Designation Index (Contd)

Reference Designation	* Part No.	Description #	Note
		CABINET PARTS	
1	08413-00022	PANEL:FRONT	
	2740-0002	NUT:HEX SST 10-32 X 3/8	
	2190-0064	WASHER:LOCK INT. #10	
2	7120-1254	TRADEMARK	
3	7120-1573	PLATE:IDENTIFICATION	
4	5020-3291	TRIM,NAMEPLATE	
	2210-0001	SCREW:MACHINE SST FH 4-40X3/16	
5	08413-00021	TOP COVER ASSY:PLUG-IN	
	2370-0002	SCREW:SST FLAT HD 6-32 X 0.500	
6	08413-0002	PANEL:REAR	
	2740-0002	NUT:HEX SST 10-32 X 3/8	
	2190-0064	WASHER:LOCK INT. #10	
7	5000-9160	COVER,PLUG-IN BOTTOM	
	2370-0003	SCREW:SST FLAT HD 6-32 X 0.500	
8	5040-0274	FOOT,PLUG-IN	
9	08412-20020	PIN,EXTRACTOR	



See Introduction to this section for ordering information

Table 5-2. Replaceable Parts

# Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0121-0105	C:VAR CER 9-35 PF NPO	28480	0121-0105	1
0130-0017	C:VAR CER 8-50 PF	28480	0130-0017	1
0140-0184	C:FXD MICA 8200 PF 1% 100VDCW	28480	0140-0184	1
0140-0209	C:FXD MICA 5.0 PF 10%	28480	0140-0209	4
0140-0225	C:FXD MICA 300 PF 1%	28480	0140-0225	1
0150-0096	C:FXD CER 0.05 UF +80-20% 100VDCW	91418	TA	23
0150-0121	C:FXD CER 0.1 UF +80-20% 50VDCW	56289	5C50B15-CHL	33
0160-0153	C:FXD MY 0.001 UF 10% 200VDCW	56289	192P10292-PT5	1
0160-0161	C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PT5	1
0160-0339	C:FXD MICA 534 PF 1%	28480	0160-0339	1
0160-2204	C:FXD MICA 100 PF 5%	28480	0160-2204	1
0160-2205	C:FXD MICA 120 PF 5%	28480	0160-2205	1
0160-2218	C:FXD MICA 1000 PF 5%	28480	0160-2218	2
0160-2222	C:FXD MICA 1500 PF 5% 300VDCW	28480	0160-2222	1
0160-2225	C:FXD MICA 2000 PF 5% 300VDCW	28480	0160-2225	1
0160-2261	C:FXD CER 15 PF 5% 500VDCW	72982	301-NPO-15 PF	1
0160-2307	C:FXD MICA 47 PF 5%	28480	0160-2307	1
0160-2437	C:FXD CER 5000 PF +80-20% 200VDCW	72982	2425-000-X5V-502P	9
0160-2438	C:FXD CER 5000 PF +80-20% 200VDCW	72982	2425-061-X5VU-502P	2
0160-3076	C:FXD CER 470 PF 5% 200VDCW	71590	DBD	1
0170-0040	C:FXD MY .047 UF 10% 200VDCW	28480	0170-0040	3
0180-0050	C:FXD ELECT 40 UF +75-10% 50VDCW	28480	0180-0050	1
0180-0291	C:FXD ELECT 1.0 UF 10% 35VDCW	28480	0180-0291	6
0370-0115	KNOB:RED BAR 5/8 DIA 1/8 SHAFT	28480	0370-0115	1
0370-0162	PUSHBUTTON:METER FUNCTION	28480	0370-0162	1
0370-0364	KNOB:BLK 3/4 DIA 1/4 SHAFT	28480	0370-0364	1
0686-5155	R:FXD COMP 5.1 MEGOHM 5% 1/2W	01121	EB 5155	1
0698-0083	R:FXD MET FLM 1.96K OHM 1% 1/8W	28480	0698-0083	6
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	28480	0698-0085	6
0698-3132	R:FXD MET FLM 261 OHM	14674	C4	2
0698-3136	R:FXD MET FLM 17.8K OHM 1% 1/8W	28480	0698-3136	2
0698-3150	R:FXD MET FLM 2.37K OHM 1% 1/8W	28480	0698-3150	1
0698-3152	R:FXD MET FLM 3.48K 1% 1/8W	14674	C4	5
0698-3153	R:FXD MET FLM 3.83K 1% 1/8W	91637	MFF-1/10-32	2
0698-3154	R:FXD MET FLM 4.22K OHM 1% 1/8W	28480	0698-3154	1
0698-3156	R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156	10
0698-3157	R:FXD MET FLM 19.6K 1% 1/8W	14674	C4	6
0698-3158	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158	4
0698-3159	R:FXD MET FLM 26.1K OHM 1% 1/8W	28480	0698-3159	5
0698-3160	R:FXD MET FLM 31.6K 1% 1/8W	14674	C4	3
0698-3161	R:FXD MET FLM 38.3K 1% 1/8W	14674	C4	2
0698-3243	R:FXD MET FLM 178K OHM 1% 1/8W	28480	0698-3243	3
0698-3260	R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260	1
0698-3279	R:FXD MET FLM 4990 OHM 1% 1/8W	28480	0698-3279	1
0698-3404	R:FXD MET FLM 383 OHM 1% 1/2W	28480	0698-3404	3
0698-3437	R:FXD MET FLM 133 OHM 1% 1/8W	28480	0698-3437	2
0698-3439	R:FXD MET FLM 178 OHM 1% 1/8W	14674	C4	2
0698-3440	R:FXD MET FLM 196 OHM 1% 1/8W	91637	MF-1/10-32	8
0698-3442	R:FXD MET FLM 237 OHM 1% 1/8W	28480	0698-3442	1
0698-3443	R:FXD MET FLM 287 OHM 1% 1/8W	91637	MF-1/10-32	5
0698-3445	R:FXD MET FLM 348 OHM 1% 1/8W	28480	0698-3445	1
0698-3446	R:FXD MET FLM 383 OHM 1% 1/8W	28480	0698-3446	2
0698-3452	R:FXD MET FLM 147K OHM 1% 1/8W	28480	0698-3452	4

See introduction to this section for ordering information

Table 5-2. Replaceable Parts (Contd)

℔ Part No.	Description #	Mfr.	Mfr. Part No.	TQ
0698-3453	RESISTOR:FXD MET FLM 196K OHM 1% 1/8W	28480	0698-3453	4
0698-5460	RESISTOR:FXD MET FLM 1330 OHM 0.5% 1/8W	28480	0698-5460	1
0698-5461	RESISTOR:FXD FLM 2.003K OHM 0.1% 1/8W	28480	0698-5461	1
0698-5462	RESISTOR:FXD MET FLM 2065 OHM 0.5% 1/8W	28480	0698-5462	1
0698-5463	RESISTOR:FXD MET FLM 2866 OHM 0.5% 1/8W	28480	0698-5463	1
0698-5464	RESISTOR:FXD MET FLM 3790 OHM 1% 1/8W	28480	0698-5464	1
0698-5465	RESISTOR:FXD FLM 4.725K OHM 1% 1/8W	28480	0698-5465	1
0698-5466	RESISTOR:FXD MET FLM 5700 OHM 1% 1/8W	28480	0698-5466	1
0698-5467	RESISTOR:FXD FLM 6.764K OHM 1% 1/8W	28480	0698-5467	1
0698-5468	RESISTOR:FXD FLM 7.742K OHM 1% 1/8W	28480	0698-5468	1
0698-5469	RESISTOR:FXD MET FLM 8665 OHM 1% 1/8W	28480	0698-5469	1
0757-0123	RESISTOR:FXD MET FLM 34.8K OHM 1% 1/8W	28480	0757-0123	2
0757-0199	RESISTOR:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199	2
0757-0200	RESISTOR:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200	3
0757-0274	RESISTOR:FXD MET FLM 1.21K OHM 1% 1/8W	28480	0757-0274	1
0757-0278	RESISTOR:FXD MET FLM 1.78K OHM 1% 1/8W	28480	0757-0278	4
0757-0279	RESISTOR:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279	1
0757-0280	RESISTOR:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280	8
0757-0288	RESISTOR:FXD MET FLM 9.09K OHM 1% 1/8W	28480	0757-0288	3
0757-0289	RESISTOR:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289	3
0757-0317	RESISTOR:FXD MET FLM 1.33K OHM 1% 1/8W	28480	0757-0317	1
0757-0394	RESISTOR:FXD MET FLM 51.1 OHM 1% 1/8W	14674	C4	2
0757-0401	RESISTOR:FXD MET FLM 100 OHM 1% 1/8W	14674	C4	4
0757-0402	RESISTOR:FXD MET FLM 110 OHM 1% 1/8W	28480	0757-0402	1
0757-0403	RESISTOR:FXD MET FLM 121 OHM 1% 1/8W	28480	0757-0403	3
0757-0405	RESISTOR:FXD MET FLM 162 OHM 1% 1/8W	28480	0757-0405	3
0757-0416	RESISTOR:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416	16
0757-0417	RESISTOR:FXD MET FLM 562 OHM 1% 1/8W	14674	C4	1
0757-0418	RESISTOR:FXD MET FLM 619 OHM 1% 1/8W	28480	0757-0418	2
0757-0419	RESISTOR:FXD MET FLM 681 OHM 1% 1/8W	28480	0757-0419	6
0757-0420	RESISTOR:FXD MET FLM 750 OHM 1% 1/8W	28480	0757-0420	1
0757-0421	RESISTOR:FXD MET FLM 825 OHM 1% 1/8W	28480	0757-0421	1
0757-0422	RESISTOR:FXD MET FLM 909 OHM 1% 1/8W	28480	0757-0422	1
0757-0438	RESISTOR:FXD MET FLM 5.11K 1% 1/8W	14674	C4	16
0757-0439	RESISTOR:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439	1
0757-0440	RESISTOR:FXD MET FLM 7.50K 1% 1/8W	14674	C4	2
0757-0442	RESISTOR:FXD MET FLM 10.0K 1% 1/8W	14674	C4	9
0757-0443	RESISTOR:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443	3
0757-0444	RESISTOR:FXD MET FLM 12.1K OHM 1% 1/8W	28480	0757-0444	2
0757-0447	RESISTOR:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447	5
0757-0448	RESISTOR:FXD MET FLM 18.2K OHM 1% 1/8W	28480	0757-0448	1
0757-0458	RESISTOR:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458	4
0757-0462	RESISTOR:FXD MET FLM 75.0K OHM 1% 1/8W	28480	0757-0462	1
0757-0463	RESISTOR:FXD MET FLM 82.5K 1% 1/8W	14674	C4	1
0757-0465	RESISTOR:FXD MET FLM 100K 1% 1/8W	14674	C4	1
0757-0467	RESISTOR:FXD MET FLM 121K OHM 1% 1/8W	28480	0757-0467	1
0757-0816	RESISTOR:FXD MET FLM 681 OHM 1% 1/2W	28480	0757-0816	1
0757-0817	RESISTOR:FXD MET FLM 750 OHM 1% 1/2W	28480	0757-0817	1
0757-1094	RESISTOR:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094	1
0811-1780	RESISTOR:FXD WW 1K OHM 5.0% 1/4W	28480	0811-1780	1
1120-1104	METER:0-1 MA	28480	1120-1104	1
1250-0083	CONNECTOR:BNC	28480	1250-0083	4
1250-0829	CONNECTOR:RF	58291	50-045-0000	2
1250-0888	CONNECTOR:RF FOR RG-188/U CABLE	58291	50-028-0139	2

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Contd)

# Part No.	Description #	Mfr.	Mfr. Part No.	TQ
1251-0056	CONNECTOR:MALE 24 CONTACTS	28480	1251-0056	1
1251-0160	CONNECTOR:15 PIN	28480	1251-0160	8
1853-0009	Q:SI PNP	28480	1853-0009	2
1853-0020	Q:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020	8
1854-0009	Q:SI NPN	C4713	2N709	6
1854-0014	Q:SI NPN(SIMILAR TO 2N2060)	28480	1854-0014	1
1854-0019	Q:SI NPN(SELECTED FROM 2N2369)	28480	1854-0019	4
1854-0045	Q:SI NPN	C4713	2N956	3
1854-0071	Q:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071	24
1854-0073	Q:SI NPN(SELECTED FROM 2N2857)	28480	1854-0073	2
1855-0047	Q:SI DUAL FET N-CHAN	28480	1855-0047	2
1855-0084	Q:FET(MATCHED PAIR)	28480	1855-0084	2
1901-0025	DIODE:SILICON 100MA/1V	07263	FD 2387	3
1901-0039	DIODE:SILICON 200MA 50MV	28480	1901-0039	2
1901-0179	DIODE:SILICON 15WV	28480	1901-0179	4
2100-1756	R:VAR WW 200 OHM 10% LIN 1/2W	28480	2100-1756	1
2100-1757	R:VAR WW 500 OHM 10% LIN 1/2W	28480	2100-1757	1
2100-1759	R:VAR WW 2K OHM 10% LIN 1/2W	28480	2100-1759	5
2100-1760	R:VAR WW 5K OHM 10% LIN 1/2W	28480	2100-1760	1
2100-1762	R:VAR WW 20K OHM 10% LIN 1/2W	28480	2100-1762	1
2100-2429	R:VAR WW 250K OHM 20% LIN 3/4W	28480	2100-2429	1
2140-0025	LAMP:INCANDESCENT 28V 0.04 AMP	24655	327	2
2190-0064	WASHER:LOCK INT. #10	00000	OBD	2
2210-0001	SCREW:MACHINE SST FH 4-40X3/16	57924	OBD	1
2370-0003	SCREW:SST FLAT HD 6-32 X 0.500	28480	2370-0003	2
2740-0002	NUT:HEX SST 10-32 X 3/8	00000	OBD	2
3100-2016	SWITCH:ROTARY	28480	3100-2016	1
3101-0996	SWITCH:PUSHBUTTON(7)	28480	3101-0996	1
5000-3302	LABEL:PUSHBUTTON(3)	28480	5000-3302	1
5000-3309	LABEL:PUSHBUTTON(10)	28480	5000-3309	1
5000-9140	COVER,PLUG-IN BOTTOM	28480	5000-9140	1
5000-3375	LABEL:PUSHBUTTON(1B)	28480	5000-3375	1
5000-3376	LABEL:PUSHBUTTON(30)	28480	5000-3376	1
5000-3377	LABEL:PUSHBUTTON(60)	28480	5000-3377	1
5000-3378	LABEL:PUSHBUTTON(180)	28480	5000-3378	1
5000-3505	LABEL:PUSHBUTTON(6)	28480	5000-3505	1
5020-3281	TRIM,NAMEPLATE	28480	5020-3281	1
08412-20020	PIN,EXTRACTOR	28480	08412-20020	1
5040-0170	SUPPORT:BOARD(EAL,A2)	28480	5040-0170	1
5040-0274	FOOT,PLUG-IN	28480	5040-0274	1
08413-00021	TOP COVER ASSY:PLUG-IN	28480	08413-00021	1
7120-1254	TRADEMARK	28480	7120-1254	1
7120-1573	PLATE:IDENTIFICATION	28480	7120-1573	1
9100-2208	TRANSFORMER	28480	9100-2208	1
9100-2209	INDUCTOR.:7.8 UH 1%	28480	9100-2209	1
9100-2885	COIL/CHOKE 1000UH 5%	59800	2500-28	1
9140-0094	COIL:FXD RF 0.68UH	59800	1537-08	2
9140-0131	COIL:FXD RF 10 MH	28480	9140-0131	1
9140-0137	COIL/CHOKE 1000 UH 5%	55800	2500-28	3
9140-0210	COIL:FXD RF 100 UH 5%	28480	9140-0210	5
9170-0847	BEAD:MAGNETIC SHIELDING	C2114	56-590-65/3B	4
08413-00022	PANEL:FRONT	28480	08413-00022	1
08413-0002	PANEL:REAR	28480	08413-0002	1
08413-0015	DIAL:PHASE OFFSET	28480	08413-0015	1

See introduction to this section for ordering information

Table 5-2. Replaceable Parts (Contd)

℔ Part No.	Description #	Mfr.	Mfr. Part No.	TQ
08413-0016	CONTACT:LAMP	28480	08413-0016	2
08413-6001	BOARD ASSY:LOG CONVERTER CURRENT SOURC	28480	08413-6001	1
08413-6003	BOARD ASSY:REF., AMPL. & PHASE SHIFTER	28480	08413-6003	1
08413-6004	BOARD ASSY:FIRST LIMITER	28480	08413-6004	1
08413-6005	BOARD ASSY:SECOND LIMITER	28480	08413-6005	1
08413-6006	BOARD ASSY:THIRD LIMITER & 5.1 VPS	28480	08413-6006	1
08413-6007	BOARD ASSY:MIXER & INTEGRATOR	28480	08413-6007	1
08413-6009	SWITCH ASSY:PHASE OFFSET	28480	08413-6009	1
08413-6010	SWITCH ASSY:RANGE FUNCTION	28480	08413-6010	1
08413-6014	CABLE ASSY:INPUT	28480	08413-6014	2
08413-6024	BOARD ASSY:RANGE	28480	08413-6024	1
08413-6025	BOARD ASSY:AMPL METERING	28480	08413-6025	
08413-6026	BOARD ASSY:PHASE REG. & METER AMPL.	28480	08413-6026	1
08413-8001	LAMPHOLDER:PLUS	28480	08413-8001	1
08413-8002	LAMPHOLDER:MINUS	28480	08413-8002	1

See introduction to this section for ordering information

TABLE 5-3,
CODE LIST OF MANUFACTURERS

The 5-digit code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbook H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of publication 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.
00138	Western Electronics	Westminster Springs Pa
00213	[illegible]	Rochester N Y
00281	[illegible]	Carlisle Conn
00334	[illegible]	Culver City Calif
00338	Manufacturer Supplies	[illegible] Springs N Y
00373	[illegible]	Cleveland N J
00397	Aircraft Corp	New Bedford Mass
00435	[illegible]	Huntington Pa
00481	Aircraft Radio Corp	Boonton N J
00494	Southern Engineering [illegible]	Birmingham Ala
00535	Sprague Electric Co Primary Co	[illegible] Mass
00656	Cox Engineering Co	Cuyahoga Falls Ohio
00691	[illegible]	Los Angeles Calif
00695	Microwave Inc	Livingston N J
00707	General Electric Co Capacitor Dept	Hudson Falls N Y
00779	Aircraft Products Co	Brooklyn Mass
00781	Aerobotics Co	Wilmington Mass
00797	[illegible] Manufacturing Inc	Pennsylvania Calif
00801	The Semiconductor Inc	Los Gatos Calif
00853	Texas Instruments Inc Semiconductor Components Div	Dallas Texas
01295	Texas Instruments Inc	[illegible]
01349	The Aircraft Mfg Co	Akron [illegible]
01469	Electronics Inc	[illegible] Calif
01477	Guided Missile Labs	New York N Y
01930	American Corp	Rockford [illegible]
01961	Fuse Engineering	Santa Clara Calif
02114	Ferroxcube Corporation of America	Saugerties N Y
02118	Wheelock Signals Inc	Long Beach N J
02189	Cook Electric Co Electronics Div	Skokie Ill
02202	Airpax Electronics Inc Precision	Cambridge [illegible]
02329	Radio Corp of America Semiconductor and Materials Div	Somerville N J
02330	[illegible]	[illegible]
02377	High Energy Inc	Los Angeles Calif
02444	[illegible]	[illegible]
02450	G E Specialty Controls Dept	Syracuse N Y
02533	Allen Watson & Associates	Capistrano [illegible]
02576	Electronics	[illegible] Calif
02660	[illegible]	Los Angeles Calif
02677	Electronic Engineering	Redwood Mass
02688	Crystal Products Co	Cedar Rapids N J
02698	Sigma Instruments Inc	Somerville N J
02735	Radio Corporation of America	Harrison Conn
02743	Amperex Electronic Corp	Hicksville N J
02754	Ace Engineering	Los Angeles Calif
02766	Albion Instruments	Albion N Y
02777	Hopkins Engineering Co	San Fernando Calif
02799	[illegible]	Mountain View Calif
02800	Electronic Molecular Corp	Mountain View Calif
02814	Autonetics A Division of North American Aviation Inc	Anaheim Calif
02821	Electronic Engineering Co of California	Santa Ana Calif
02828	Microwave Associates Inc	Burlington Mass
02879	Varian Associates	Palo Alto Calif
02914	Harris-Intertype Corp Electronics Div	Melbourne Fla
02916	Raytheon Co Microwave & Power Tube Operation	Quincy Mass
02935	Facet Enterprises Inc	Elmira N Y
02954	Kearfott Division of The Singer Manufacturing Co	Little Falls N J
02957	Electronic Communications Inc	St Petersburg Fla
02960	Space Technology Laboratories Inc	Los Angeles Calif
02985	Hoffman Electronics Corp Semiconductor Div	Evanston Ill
03041	Zeltex Inc	Concord Calif
03069	Finney Co	Bedford Ohio
03080	Frigitronics Inc	Shelton Conn
03134	Brown Engineering Co Inc	Huntsville Ala
03180	Wiancko Engineering Co	Pasadena Calif
03213	Hermetic Seal Products Co	Newark N J
03247	Rotron Inc	Woodstock N Y
03262	Vitramon Inc	Bridgeport Conn
03297	Electronic Molecular Corp	Mountain View Calif
03307	Unitrode Corporation	Watertown Mass
03340	Computer Measurements Co	Hayward Calif
03377	Microlab/FXR	Livingston N J
03397	National Union Electric Corp	Bloomfield N J
03508	G E Co Semiconductor Products Dept	Syracuse N Y
03554	Semtech Corp	Newbury Park Calif
03574	Photocircuits Corp	Glen Cove N Y
03594	Electronic Research Co	Evanston Ill
03611	Bourns Inc Trimpot Div	Riverside Calif
03626	Clarostat Mfg Co Inc	Dover N H
03651	Transitron Electronic Corp	Wakefield Mass
03680	Litton Industries Inc Electron Tube Div	San Carlos Calif
03693	Vactec Inc	Bridgeton Mo
03705	Nytronics Inc	Berkeley Heights N J
03797	Eitel-McCullough Inc	San Carlos Calif
03815	Nytronics Inc	Berkeley Heights N J
03838	Sperry Microwave Electronics Div	Clearwater Fla
03877	Transitron Electronic Corp	Wakefield Mass
03880	Arco Electronics Inc	Great Neck N Y
03888	KDI Pyrofilm Corp	Whippany N J
03911	Raytheon Co Lexington Labs	Lexington Mass
03954	Nytronics Inc	Berkeley Heights N J
03971	Optron Inc	Columbus Ohio
03982	Semicon Associates Inc	Lexington Mass
04009	Arrow-Hart Inc	Hartford Conn
04041	Sage Electronics Corp	East Rochester N Y
04062	Semtech Corp	Newbury Park Calif
04095	Tech Labs Inc	Palisades Park N J
04126	Ford Motor Co	Dearborn Mich
04144	Varian Associates Eimac Div	San Carlos Calif
04151	Silicon General Inc	Glendale Calif
04181	Frequency Sources Inc	Chelmsford Mass
04212	Electronic Applications Inc	Lincoln Nebr
04213	Caddock Electronics Inc	Riverside Calif
04222	Aerovox Corp New Bedford Div	New Bedford Mass
04260	Electronic Applications Inc	Lincoln Nebr
04263	Solitron Devices Inc	Westbury N Y
04264	Components Inc	Deland Fla
04273	Sprague Electric Co Marshall Div	Marshall Mo
04281	Engelhard Industries Inc Components Div	Carteret N J
04293	Components Inc	Deland Fla
04302	Yageo Corporation	Taipei Taiwan
04321	Semicon Associates Inc	Lexington Mass
04331	Protronics Inc	Timonium Md
04404	Spectrum Control Inc	Erie Pa
04455	Solitron Devices Inc	Riviera Beach Fla
04464	Semtech Corp	Newbury Park Calif
04473	Rhombus Industries Inc	Huntington Beach Calif
04497	Wilco Corp	Indianapolis Ind
04498	Matsushita Electronics Corp	Osaka Japan
04502	Midwest Components Inc	Madison S Dak
04508	Corning Glass Works Bradford	Bradford Pa
04509	Kaschke Components Inc	Hebron N Dak
04510	Electronic Devices Inc	Yonkers N Y
04511	Piconics Inc	Tyngsboro Mass
04512	Telonic Instruments	Newport Beach Calif
04513	Johnson Matthey Inc	Malvern Pa
04514	Pacific Semiconductors Inc	Culver City Calif
04515	Centralab Inc	Milwaukee Wis
04516	Pacific Semiconductors Inc	Culver City Calif
04517	Litton Systems Inc Microwave Tube Div	Bellevue Wash
04518	American Components Inc	Conshohocken Pa
04519	Barry Controls	Burbank Calif
04520	Mepco/Centralab Inc	Fort Wayne Ind
04521	Felker Manufacturing Co	Torrance Calif
04522	Aerovox Corp	New Bedford Mass
04523	Aeronutronic Ford Corp	Newport Beach Calif
04524	Precision Monolithics Inc	Santa Clara Calif
04525	RCA Corp Solid State Div	Somerville N J
04526	Dielectric Laboratories Inc	Cazenovia N Y
04527	R-Ohm Corp	Newport Beach Calif
04528	Components Inc	Deland Fla
04529	Dielectric Laboratories Inc	Cazenovia N Y
04530	Amperex Electronic Corp Electron Tube Div	Slatersville R I
04531	Twentieth Century Plastics Inc	Los Angeles Calif
04532	Arnold Engineering Co	Marengo Ill
04533	Sanders Associates Inc	Nashua N H
04534	Anaconda Electronics Co	Salisbury N C
04535	Genisco Technology Corp	Torrance Calif
04536	Fenwal Inc	Ashland Mass
04537	Waldes Kohinoor Inc	Long Island City N Y
04538	Airtron Inc	Morris Plains N J
04539	American Fine Wire Corp	Branford Conn
04540	Vitramon Inc	Bridgeport Conn
04541	Spectrol Electronics Corp	City of Industry Calif
04542	Frequency Sources Inc	Chelmsford Mass
04543	Boonton Electronics Corp	Parsippany N J
04544	Custom Electronics Inc	Urbana Ill
04545	General Instrument Corp Semiconductor Products Group	Hicksville N Y
04546	Mallory Capacitor Co	Indianapolis Ind
04547	Nytronics Inc	Berkeley Heights N J
04548	Exar Integrated Systems Inc	Sunnyvale Calif
04549	Vishay Intertechnology Inc	Malvern Pa
04550	Electronic Arrays Inc	Mountain View Calif
04551	Trimpot Products Inc	Riverside Calif
04552	Exar Integrated Systems Inc	Sunnyvale Calif
04553	Micrometals Inc	Anaheim Calif
04554	Delevan Inc	East Aurora N Y
04555	Cal-R Inc	Garland Tex
04556	Vishay Intertechnology Inc	Malvern Pa
04557	Fairchild Semiconductor Corp	Mountain View Calif
04558	Gulton Industries Inc Metuchen Resistor Div	Metuchen N J
04559	Piezo Technology Inc	Orlando Fla
04560	Measurements Group Inc	Raleigh N C
04561	Semiconductor Circuits Inc	Hicksville N Y
04562	Sheldahl Inc	Northfield Minn
04563	Dale Electronics Inc	Columbus Nebr
04564	Intersil Inc	Cupertino Calif
04565	Arco Electronics Inc Communication Systems Div	Great Neck N Y
04566	Philips ECG Inc	Smithtown N Y
04567	Vishay Dale Electronics Inc	Columbus Nebr
04568	National Semiconductor Corp	Santa Clara Calif
04569	Siliconix Inc	Santa Clara Calif
04570	Spectrum Control Inc Fairview Div	Erie Pa
04571	Vectron Laboratories Inc	Norwalk Conn
04572	Dynamics Research Corp	Wilmington Mass
04573	Isotronics Inc	New Brunswick N J
04574	Programmed Test Sources Inc	Littleton Mass
04575	Interconnect Devices Inc	Kansas City Kans
04576	Winchester Electronics Inc Oak Industries Inc	Watertown Conn
04577	Communication Systems Inc	Hector Minn
04578	Wavetek Rockland Inc	Spring Valley N Y
04579	Mini-Systems Inc	North Attleboro Mass
04580	Component Specialties Inc	Sayreville N J
04581	Unitrode Corporation	Lexington Mass
04582	Exar Integrated Systems Inc	Sunnyvale Calif
04583	Spectrum Control Inc	Erie Pa
04584	Pennsylvania Fluorocarbon Co Inc	Clifton Heights Pa
04585	Piezo Technology Inc	Orlando Fla
04586	Office of Naval Research	Arlington Va
04587	Scientific Components Corp	Gainesville Fla
04588	Lasertron	Burlington Mass
04589	San Fernando Electric Mfg Co	San Fernando Calif
04590	General Electric Co Miniature Lamp Products	Cleveland Ohio
04591	Semiconductor Circuits Inc	Hicksville N Y
04592	Crystek Crystals Corp	Fort Myers Fla
04593	International Rectifier Corp	El Segundo Calif
04594	Wavetek Indiana Inc	Beech Grove Ind
04595	Planar Systems Inc	Beaverton Oreg
04596	Scitronix Inc	Sunnyvale Calif
04597	Kepco Inc	Flushing N Y
04598	Voltronics Corp	Denville N J
04599	Beede Electrical Instrument Co Inc	Penacook N H
04600	Beckman Instruments Inc Helipot Div	Fullerton Calif
04601	Accurate Components Inc	Norristown Pa
04602	Matrix Science Corp	Port Washington N Y
04603	Analogic Corp	Wakefield Mass
04604	Perkin-Elmer Corp Electronic Components Group	Norwalk Conn
04605	Fastron Co	Hudson N H
04606	Relcom Inc	Santa Clara Calif
04607	Teledyne Relays	Hawthorne Calif
04608	Welwyn International Inc	Fort Worth Texas
04609	Analog Devices Inc	Norwood Mass
04610	Wilmington Instrument Co Inc	Wilmington Del
04611	Precision Monolithics Inc	Santa Clara Calif
04612	Keystone Carbon Co	St Marys Pa
04613	Powercube Corp	Hauppauge N Y
04614	Spectrol Electronics Corp	City of Industry Calif
04615	Premier Instrument Corp	Fairfield N J
04616	Western Fluorocarbon Corp	Chatsworth Calif
04617	Communication Systems Inc	Hector Minn
04618	Watkins-Johnson Co	Palo Alto Calif
04619	Workman Electronic Products Inc	Valley Stream N Y
04620	Electro Scientific Industries Inc	Portland Oreg
04621	Custom Electronics Inc	Champaign Ill
04622	Morton International Inc Electronics Div	Watsonville Calif
04623	Sensitron Inc	Deer Park N Y
04624	Corning Glass Works Electronic Components Div	Bradford Pa
04625	Advanced Micro Devices Inc	Sunnyvale Calif
04626	Power Conversion Inc	Elmsford N Y
04627	Renco Electronics Inc	Deer Park N Y
04628	Trans-Tek Inc	Ellington Conn
04629	Golledge Electronics Inc	Merrimack N H
04630	Magnetics Inc	Butler Pa
04631	Vitramon Inc	Bridgeport Conn
04632	Precision Monolithics Inc	Santa Clara Calif
04633	Florida Resistor Co	Deland Fla
04634	Export Packers Co Inc	Bronx N Y
04635	Caddock Electronics Inc	Riverside Calif
04636	Components Corp	Deland Fla
04637	Honeywell Test Instruments Div	Denville N J
04638	Intech Inc	Neptune N J
04639	Intech Inc	Neptune N J
04640	Communication Systems Inc	Hector Minn
04641	Comlinear Corp	Fort Collins Colo
04642	Agilent Technologies Inc	Boise Idaho
04643	Dow-Key Microwave Corp	Ventura Calif
04644	Aertech Industries Inc	Sunnyvale Calif
04645	Piher International Corp	Fairfield N J
04646	Aavid Engineering Inc	Laconia N H
04647	Pyrofilm Resistor Co Inc	Whippany N J
04648	Rectron Inc	Franklin Park Ill
04649	Exar Integrated Systems Inc	Sunnyvale Calif
04650	Pulse Engineering Inc	San Diego Calif
04651	Sprague Goodman Electronics Inc	Westbury N Y
04652	Semtech Corp	Newbury Park Calif
04653	Corning Glass Works	Corning N Y
04654	Vishay Dale Electronics Inc	Columbus Nebr
04655	Exar Integrated Systems Inc	Sunnyvale Calif
04656	Vishay Intertechnology Inc	Malvern Pa
04657	Peschel Electronics Inc	York Pa
04658	Sorrento Electronics Inc	Phoenix Ariz
04659	KMM Electronics Inc	Anaheim Calif
04660	Aavid Engineering Inc	Laconia N H
04661	Exar Integrated Systems Inc	Sunnyvale Calif
04662	Semtech Corp	Newbury Park Calif
04663	Precision Monolithics Inc	Santa Clara Calif
04664	Calorimetric Conductor Inc	Campbell Calif
04665	Rochester Instrument Systems Inc	Fairport N Y
04666	Honeywell Inc Microswitch Div	Freeport Ill
04667	Honeywell Inc Sensing and Control	Freeport Ill
04668	Honeywell Inc Test Instruments Div	Denville N J
04669	Sensor Technology Ltd	Chatsworth Calif
04670	Sunbeam Plastics Corp	Mebane N C
04671	Keithley Instruments Inc	Cleveland Ohio
04672	Honeywell Inc Solid State Electronics Div	Richardson Texas
04673	Dynamic Instruments	Framingham Mass
04674	Precision Monolithics Inc	Santa Clara Calif
04675	Mepco/Centralab Inc	Fort Wayne Ind
04676	Infinite Graphics Inc	Minneapolis Minn
04677	Communication Systems Inc	Hector Minn
04678	Centralab Inc	Milwaukee Wis
04679	Trilogy Systems Corp	Austin Texas
04680	International Rectifier Corp	El Segundo Calif
04681	Genisco Technology Corp	Torrance Calif
04682	Honeywell Inc Micro Switch Div	Freeport Ill
04683	Spectrum Control Inc	Erie Pa
04684	Communication Systems Inc	Hector Minn
04685	Professional Circuits Co	Mineola N Y
04686	Hybrid Systems Corp	Bedford Mass
04687	Kepco Inc	Flushing N Y
04688	Gowanda Electronics Corp	Gowanda N Y
04689	Sensitron Inc	Deer Park N Y
04690	Beckman Instruments Inc	Fullerton Calif
04691	Coilcraft Inc	Cary Ill
04692	Coilcraft Inc	Cary Ill
04693	Vactec Inc	Bridgeton Mo
04694	Linear Technology Inc	Milpitas Calif
04695	Dearborn Electronics Inc	Oklahoma City Okla
04696	Magnetics Inc	Butler Pa
04697	Calogic Corp	Mountain View Calif
04698	Sensitron Inc	Deer Park N Y
04699	Vishay Dale Electronics Inc	Columbus Nebr
04700	Exar Integrated Systems Inc	Sunnyvale Calif
04701	Communication Systems Inc	Hector Minn
04702	Chatham Electronics	Garfield N J
04703	Analogic Corp	Wakefield Mass
04704	Powercube Corp	Hauppauge N Y
04705	Analog Devices Inc	Norwood Mass
04706	R-Ohm Corp	Newport Beach Calif
04707	Leach Corp	Chatsworth Calif
04708	Fluke [illegible] Corp	Everett Wash
04709	General Instrument Corp Microelectronics Div	Hicksville N Y
04710	Computer Conversions Corp	Smithtown N Y
04711	General Microwave Corp	Farmingdale N Y
04712	Micrel Inc	Campbell Calif
04713	Motorola Inc Semiconductor Products Sector	Phoenix Ariz
04714	Motorola Inc Communications Sector	Franklin Park Ill

TABLE 5-3.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
11810	McGraw Edison Co	Murphysboro Ill
11837	Kemp Design Associates Inc	Los Ang. Calif
11843	Cinch Corp Connector Div	Elk Grove Calif
11878	Eagle Lab Corp	Covington Calif
11896	Ty Car Mfg Co Inc	Manhattan Beach
11898	EMM Semi Corp Div	San Fernando Calif
11903	Custom Instrument Inc	Mt Holly, N J
11917	Valley Instruments Inc	Mahwah N J
11923	E I DuPont de Nemours & Co Inc	Wilmington Del
11931	Dorset Mfg Co	Milwaukee Wis
11935	The Bendix Corp Navigation & Control Div	Teterboro N J
11950	Thermal Apparatus Instruments Div of McGraw Edison Co	Hightstown N J
11959	Curtis	Baldwin Park Calif
12040	ILC Electronics	Hackensack N J
12061	Electro Mfg Co	Bridgeport Conn
12081	Greenray Industries Corp	Phillipsburg Pa
12136	Executone Inc	Long Island City, N Y
12138	Federal Bearings Co The	New Providence N J
12150	Fluorocarbon Co Polymer Corp	Newport Beach Calif
12264	Transicoil Corp	Wickliffe Ohio
12281	Robert Rudolf Instrument Lab	Washington D C
12454	G T Long Div of	Bowling Green Chesapeake Ohio
12615	Glenair Inc	Glendale Calif
12697	Clarostat Mfg Co Inc	Dover N H
12727	Pyrofilm Inc	Whippany N J
12954	Dynamics Corp of America Instr Div	Carlstadt N J
12969	United Systems Corp	Dayton Ohio
13103	Thermalloy Co	Dallas Texas
13231	Marshall Industries	El Monte Calif
13237	Health Kit Div of	Benton Harbor Mich
13327	General Electric Co Semiconductor Prod Dept	Clyde N Y
13350	Spectrol Electronics Corp	City of Industry Calif
13415	Customcraft Corp	Mineola N Y
13434	Ideal Industries Inc	Sycamore Ill
13499	Semtech Corp	Newbury Park Calif
13606	Stackpole Components Co	Raleigh N C
13612	Systron Donner Corp Concord Instrument Div	Concord Calif
13624	Warren Telechron Co	Ashland Mass
13655	Vitramon Inc	Bridgeport Conn
13693	Hamlin Inc	Lake Mills Wis
13715	Allied Control Co Inc	New York N Y
13729	Semicon Associates Inc	Lexington Mass
13742	Aeroflex Laboratories Inc	Plainview N Y
13803	Performance Semiconductor Corp	Sunnyvale Calif
13815	Wiedemann Machine Co	Philadelphia Pa
13835	Rogers Corp	Manchester Conn
13873	Bird Electronic Corp	Solon Ohio
13911	Dietz Co	Sidney Ohio
13919	General Instrument Corp Optoelectronics Div	Hicksville N Y
13924	Clifton Precision Div of Litton Systems Inc	Warminster Pa
13934	Electro Scientific Industries Inc	Portland Oreg
13936	Hewlett Packard Co Corporate Hq	Palo Alto Calif
13950	Beemer Engineering Co	Fort Washington Pa
13955	Transitron Electronic Corp	Wakefield Mass
13958	Tensolite Co	Tarpon Springs Fla
13973	Signalite Inc	Neptune N J
13994	Harris Corp Semiconductor Sector	Melbourne Fla
14005	Semitronics Corp	Bayshore N Y
14010	Semtech Int'l Corp	Redondo Beach Calif
14042	Fenwal Inc	Ashland Mass
14048	Kahle Engineering Co	North Bergen N J
14064	Weston Instruments Inc Sub of Sangamo Weston Inc	Newark N J
14099	Semi Dice Inc	Culver City Calif
14115	Semicoa Semiconductors	Newbury Park Calif
14120	Fenwall Electronics	Framingham Mass
14128	Kaschke Components Corp	Hebron Neb
14140	Bendix Corp Electrical Components Div	Fort Myers Fla
14149	Components Specialty Inc	Boonton N J
14150	Cobilt Corp	Hauppauge N Y
14193	Cambridge Thermionic Corp	Cambridge Mass
14198	Engineered Motions Inc	New Castle Del
14213	Electronic Applications Inc	Lancaster Pa
14217	Advance Components Ltd	Plainview N Y
14221	Raytheon Co Components Div	Quincy Mass
14232	Engelhard Industries Inc Delaware Sub	Carlstadt N J
14240	Transistor Electronics Corp	Minneapolis Minn
14272	Kepco Inc	Flushing N Y
14298	American Components Inc	Conshohocken Pa
14300	Talley Industries of Arizona Inc	Mesa Ariz
14324	Cornell Dubilier Electronics Div of Federal Pacific Electric Co	Newark N J
14325	Mepco/Centralab Inc	Fort Wayne Ind
14326	Electro Motive Mfg Co Inc	Willimantic Conn
14329	Scientific Components Corp	Gardena Calif
14376	Sprague Goodman Electronics Inc	Westbury N Y
14415	Lorain Products Corp	Lorain Ohio
14419	Hewlett Packard Co Optoelectronics Div	San Jose Calif
14433	Ithaco Inc	Ithaca N Y
14483	Commercial Crystal Laboratories Inc	Fort Myers Fla
14486	Process Components Inc	Santa Clara Calif
14493	Gulton Industries Inc Data Systems Div	Albuquerque N Mex
14501	Dynamic Electronics Co Inc	Mobile Ala
14511	Communication Components Corp	Hauppauge N Y
14527	Dale Electronics Inc	Columbus Nebr
14549	Standard Thomson Corp	Waltham Mass
14552	Micro Networks Corp	Worcester Mass
14572	Component Specialties Inc	Sayreville N J
14577	Mechanical Industries Inc	Glendale Calif
14580	Penn Engineering & Mfg Corp	Danboro Pa
14597	Jermyn Industries	Vineland N J
14617	Electronic Molding Corp	Woonsocket R I
14632	Automatic Timing & Controls Inc	King of Prussia Pa
14633	United Transformer Co	Chicago Ill
14655	Cornell Dubilier Electronics Div of Federal Pacific Electric Co	Newark N J
14662	Astrodata Inc	Anaheim Calif
14674	North American Philips Corp	New York N Y
14677	Illinois Capacitor Inc	Chicago Ill
14681	Technology Instrument Corp of California	Newbury Park Calif
14683	Wilco Corp	Indianapolis Ind
14691	Amperex Electronic Corp Hicksville Div	Hicksville N Y
14698	Boonton Electronics Corp	Parsippany N J
14707	Curtis Industries Inc	Clarksburg W Va
14714	Electro Instruments Inc	San Diego Calif
14726	Chicago Miniature Lamp Works	Chicago Ill
14727	Calex Manufacturing Co Inc	Concord Calif
14737	Mallory Capacitor Co	Indianapolis Ind
14752	Electro Cube Inc	San Gabriel Calif
14771	Piezo Technology Inc	Orlando Fla
14788	Modular Components Development Inc	Palm Bay Fla
14808	Precision Monolithics Inc	Santa Clara Calif
14824	Simpson Electric Co	Elgin Ill
14829	Midwest Components Inc	South Bend Ind
14837	Deutsch Fastener Corp	Banning Calif
14846	Airpax Electronics Inc Cambridge Div	Cambridge Md
14850	Resdel Engineering Corp	Gardena Calif
14870	Nytronics Inc	Berkeley Heights N J
14894	Woodward Governor Co Fuel Systems Div	Rockford Ill
14915	Micro Component Technology Inc	St Paul Minn
14936	General Instrument Corp Microelectronics Div	Hicksville N Y
14952	Xcelite Inc	Orchard Park N Y
14954	American Electronic Components	Stamford Conn
14955	Barnes Engineering Co	Stamford Conn
14956	Calmark Corp	Ft Worth Tex
14976	Orbit Instrument Corp	Westbury N Y
14993	Cinch Connector Div of Calcoa	Carlstadt N J
15003	Semtech Corp	Garden Grove Calif
15018	Solitron Devices Inc	West Palm Beach Fla
15037	Sola Basic Industries Inc	Milford Conn
15042	Piconics Inc	Tewksbury Mass
15047	Sharp Microelectronics of the Americas	Mahwah N J
15065	Interstate Electronics Corp	Anaheim Calif
15090	Arnold Magnetics Corp	Paramount Calif
15092	Arnold Engineering Co	Marengo Ill
15102	Tinsley Laboratories	Riverside Calif
15115	Semi Processes Inc	Santa Clara Calif
15123	Tecnetics Industries Inc	Del Mar Calif
15125	Extron Electronics	Orange Calif
15126	Vitronics Inc	Stamford Conn
15128	Nytronics Inc	Berkeley Heights N J
15134	Spectrum Control Inc	Erie Pa
15136	Pulse Engineering Inc	San Diego Calif
15141	Vactec Inc	Bridgeton Mo
15148	Quality Components Inc	St Marys Pa
15151	Avnet Inc	Culver City Calif
15154	Opto Technology Inc	Wheeling Ill
15161	Corning Glass Works Electronic Components Div	Bradford Pa
15168	Electronic Devices Inc	Yonkers N Y
15171	Scientific Components	Burlington Mass
15174	Xciton Corp	Wilmington Del
15180	Rubbercraft Corp of Calif Ltd	Torrance Calif
15184	Jensen Tools Inc	Phoenix Ariz
15201	Frequency Sources Inc	Chelmsford Mass
15211	Chomerics Inc	Woburn Mass
15218	Quantic Industries Inc	San Carlos Calif
15238	Sanmina Corporation	San Jose Calif
15242	RF Monolithics Inc	Dallas Tex
15257	Mtron Corp	Yankton S Dak
15264	Weinschel Engineering Co	Gaithersburg Md
15275	Raytheon Co Microwave & Power Tube Div	Waltham Mass
15278	Tech Labs Inc	Ridgefield N J
15279	Eldec Corp	Lynnwood Wash
15284	Calogic	Mountain View Calif
15287	Electronic Research Co	Chandler Ariz
15291	Analog Devices Inc Semiconductor Div	Wilmington Mass
15295	Meret Inc	San Jose Calif
15303	Submicron Systems	Allentown Pa
15313	Transco Products Inc	Los Angeles Calif
15317	Watkins-Johnson Co	Palo Alto Calif
15321	Semiconductor Processing Corp	Raleigh N C
15323	Prime Computer Inc	Natick Mass
15330	Harris Corp Semiconductor Sector	Melbourne Fla
15333	Harvey Hubbell Inc	Bridgeport Conn
15338	Trak Microwave Corp	Tampa Fla
15342	Semiconductor Processing & Mfg Corp	Dallas Tex
15354	Micrel Inc	Milpitas Calif
15356	Plexus Scientific Corp	Horsham Pa
15360	Palomar Technologies Inc	Vista Calif
15363	Banner Engineering Corp	Minneapolis Minn
15370	Thomas & Betts Corp	Elizabeth N J
15371	Meret Optical Communications	San Diego Calif
15382	Angstrohm Precision Inc	Hanover N J
15385	Hexcel Corp	Dublin Calif
15394	Frederick Electronics Corp	Frederick Md
15396	Huber+Suhner Inc	Essex Junction Vt
15399	Associated Spring Barnes Group	Bristol Conn
15412	Tusonix Inc	Tucson Ariz
15415	Eldec Corp Lynnwood Operations	Lynnwood Wash
15418	Semtech Corp	Newbury Park Calif
15421	Exar Corp	San Jose Calif
15429	Maxim Integrated Products	Sunnyvale Calif
15434	Fujitsu Microelectronics Inc	San Jose Calif
15435	Aeroflex Laboratories Inc Plainview Div	Plainview N Y
15449	Optron Inc	Carrollton Texas
15450	Avantek Inc	Santa Clara Calif
15454	Royce Instruments	Mountain View Calif
15464	Abbott Transistor Laboratories Inc	Los Angeles Calif
15466	Precision Monolithics Inc	Santa Clara Calif
15473	Rohm Corp	Irvine Calif
15480	Herley Vega Inc	Lancaster Pa
15484	Uniwave Technologies Inc	Placentia Calif
15488	Spectrum Semiconductor Materials Inc	San Jose Calif
15491	Cherry Semiconductor Corp	East Greenwich R I
15495	Communication Microwave Corp	Moorestown N J
15499	Integrated Device Technology Inc	Santa Clara Calif
15501	Semtech Corp	Newbury Park Calif
15510	Micro Power Systems Inc	Santa Clara Calif
15513	Telcom Semiconductor Inc	Mountain View Calif
15516	Exar Corp	San Jose Calif
15518	Gain Electronics Corp	San Diego Calif
15535	Optek Technology Inc	Carrollton Texas
15542	Buckeye Stamping Co	Columbus Ohio
15545	Interconnect Devices Inc	Kansas City Kans
15550	Orbit Semiconductor Inc	Sunnyvale Calif
15561	Shukyo Electric Co Ltd	Japan
15564	Siemens Components Inc	Iselin N J
15565	Vishay Intertechnology Inc	Malvern Pa
15569	Micro Linear Corp	San Jose Calif
15574	Gowanda Electronics Corp	Gowanda N Y
15580	Gentron Corp	Monrovia Calif
15595	Amphenol Corp Sine Systems Div	Phoenix Ariz
15605	Cypress Semiconductor	San Jose Calif
15611	Trilithic Inc	Indianapolis Ind
15620	Mini-Systems Inc	North Attleboro Mass
15630	National Starch & Chemical Co	Bridgewater N J
15636	Akzo Chemie America Chemical Additives Dept	Dobbs Ferry N Y
15637	Computer Sciences Corp Mission Support Operations	Falls Church Va
15641	Blue Chip Technology Ltd	Hethersett Norwich England
15647	Precision Interconnect Corp	Cornelius Oreg
15651	Avantek Inc Microwave Semiconductor Div	Fremont Calif
15655	Vectron Laboratories Inc	Norwalk Conn
15666	Quantum Microwave Corp	Pittsburgh Pa
15669	Storm Products Co	Wilmington Calif
15672	Precision Interconnect Corp	Forest Grove Oreg
15675	Stewart Connector Systems Inc	Monaca Pa
15680	Chatham Electronics	Garfield N J
15691	Mosaic Industries Inc	Lionville Pa
15699	Mini-Circuits Laboratory	Brooklyn N Y
15701	Semtech Corp	Newbury Park Calif
15708	Knowles Electronics Inc	Itasca Ill
15712	Sipex Corp	Billerica Mass
15714	Eaton Corp Electronics Div	Cleveland Ohio
15721	Accutek Microcircuit Corp	Smithfield R I
15723	Vishay Intertechnology Inc Dale Electronics Div	Columbus Nebr
15733	Mtron Corp	Yankton S Dak
15738	Fujitsu Microelectronics Inc	San Jose Calif
15747	Intersil Corp	Cupertino Calif
15754	Gigabit Logic Inc	Newbury Park Calif
15764	Fujitsu Microelectronics Inc	San Jose Calif
15765	Fluke Electronics Corp	Everett Wash
15770	Volt Delay Relays Inc	Burbank Calif
15773	Microsemi Corp Santa Ana Div	Santa Ana Calif
15775	Mercury Systems Inc Cambridge Div	Cambridge Mass
15780	Centralab Electronics	Milwaukee Wis
15784	NEC Electronics Inc	Mountain View Calif
15788	PCB Piezotronics Inc	Depew N Y
15795	Monolithic Memories Inc	Sunnyvale Calif
15801	Fairchild Weston Systems Inc	Sterling Va
15803	Fairchild Semiconductor Corp	San Jose Calif
15810	Semtech Corp	Newbury Park Calif
15813	Sierra Monolithics Inc	Redwood City Calif
15818	Micro Networks Corp	Worcester Mass
15821	Parker Hannifin Corp Parker Seal Group	Lexington Ky
15824	California Eastern Laboratories	Santa Clara Calif
15827	Cogent Ltd	Scotland
15829	Interconnect Systems Inc	Irvine Calif
15835	Vitesse Semiconductor Corp	Camarillo Calif
15836	Filtron Ltd	Kirkham Lancashire England
15838	Xilinx Inc	San Jose Calif
15840	Microwave Technology Inc	Fremont Calif
15842	Electronic Theatre Controls Inc	Middleton Wis
15844	Reliability Inc	Houston Tex
15847	Trompeter Electronics Inc	Chatsworth Calif
15850	Teledyne Relays	Hawthorne Calif
15855	Jerry Conway Co Inc	Burlington Wash
15857	Semtech Corp	Newbury Park Calif
15859	Compositech Ltd	Hong Kong
15861	Semiconductor Circuit Inc	Hauppauge N Y
15862	Inmet Corp	Ann Arbor Mich
15863	Rochester Electronics Inc	Newburyport Mass
15864	Crystek Crystals Corp	Fort Myers Fla
15871	Anadigics Inc	Warren N J
15873	Semtech Corp	Newbury Park Calif
15874	Solid State Scientific Inc	Montgomeryville Pa
15878	Micro Lambda Wireless Inc	Fremont Calif
15880	Hamamatsu Corp	Bridgewater N J
15884	Endwave Corp	Sunnyvale Calif
15888	Applied Thin-Film Products	Fremont Calif
15891	Optical Semiconductors Inc	Lawrenceville N J
15894	Zarlink Semiconductor Inc	Ottawa Ont Canada
15895	Kavlico Corp	Moorpark Calif
15899	Anritsu Company	Morgan Hill Calif
15900	Transwave Laboratories Inc	Richardson Tex
15902	Semtech Corp	Newbury Park Calif
15903	Teledyne Microwave	Mountain View Calif
15904	Filtronetics Inc	Richardson Tex
15907	Teledyne Electronic Technologies	Newbury Park Calif
15909	Diodes Inc	Chatsworth Calif
15910	Skyworks Solutions Inc	Newbury Park Calif
15911	Analog Technologies Corp	Chung-Li Taiwan
15912	Advanced Power Technology Inc	Bend Oreg
15913	Norden Systems Inc	Norwalk Conn
15914	Agilent Technologies Inc Test & Measurement Org	Santa Clara Calif
15916	Optical Communication Products Inc	Chatsworth Calif
15917	Anadigics Inc	Warren N J
15918	Pan Jit Americas Inc	Santa Clara Calif
15919	Agilent Technologies Inc Optoelectronics Div	San Jose Calif
15920	American Fine Wire Corp	Branford Conn
15921	Comlinear Corp	Fort Collins Colo
15922	Berg Electronics	New Cumberland Pa
15923	Tripath Technology Inc	Santa Clara Calif
15924	Cree Inc	Durham N C
15925	Eudyna Devices USA Inc	San Jose Calif
15926	Fairchild Semiconductor Corp	South Portland Maine
15927	Darnell Group Inc	Chatsworth Calif
15928	Orient Semiconductor Electronics Ltd	Taipei Taiwan
15929	Apex Microtechnology Corp	Tucson Ariz
15930	Hexawave Inc	Fremont Calif
15931	Conexant Systems Inc	Newport Beach Calif
15932	Mimix Broadband Inc	Houston Tex
15933	Triquint Semiconductor Inc	Hillsboro Oreg
15934	Mercury Computer Systems Inc	Chelmsford Mass
15935	Intel Corp	Santa Clara Calif
15936	Compound Semiconductor	Roseville Calif
15937	Novellus Systems Inc	San Jose Calif
15938	Micro Analog Inc	Saratoga Calif
15939	Linear Technology Corp	Milpitas Calif
15940	Resdel Engineering Corp	Gardena Calif
15941	Micrel Semiconductor	San Jose Calif
15942	Communication Coil Inc	Hauppauge N Y
15943	Anadigics Inc	Warren N J
15944	Exar Corp	San Jose Calif
15945	Trilithic Inc	Indianapolis Ind
15946	Amplifier Research	Souderton Pa
15947	Cayman Chemical Co	Ann Arbor Mich
15948	Aavid Thermalloy	Laconia N H
15949	Apex Microtechnology Corp	Tucson Ariz
15950	Berg Electronics	New Cumberland Pa
15951	Avnet Inc Microwave Semiconductor Corp	Sunnyvale Calif
15952	Sensitron Semiconductor	Bohemia N Y
15953	Microsemi Corp Scottsdale Div	Scottsdale Ariz
15954	Ceramic Substrate Technology	Beaverton Oreg
15955	Anaren Microwave Inc	East Syracuse N Y
15956	Triquint Semiconductor Inc Texas Operation	Richardson Tex
15957	Knowles Electronics Inc	Itasca Ill
15958	Agilent Technologies Inc Components Div	San Jose Calif
15959	Aeroflex Laboratories Inc Test & Measurement Div	Plainview N Y
15960	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15961	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15962	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15963	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15964	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15965	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15966	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15967	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15968	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15969	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15970	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15971	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15972	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15973	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15974	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15975	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15976	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15977	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15978	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15979	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15980	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15981	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15982	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15983	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15984	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15985	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15986	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15987	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15988	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15989	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15990	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15991	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15992	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15993	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15994	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15995	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15996	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y
15997	Aeroflex Laboratories Inc Frequency Control Div	Plainview N Y
15998	Aeroflex Laboratories Inc Microwave Systems Div	Plainview N Y
15999	Aeroflex Laboratories Inc Integrated Microelectronics Div	Plainview N Y

TABLE 5-3.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK

From [illegible] Handbook Supplements

SCHEMATIC DIAGRAMS

SECTION VI
SCHEMATIC DIAGRAMS

6-1. INTRODUCTION.

6-2. The schematic diagrams in this section represent the circuits electrically. They are not wiring diagrams, though wire colors are given where practical.

6-3. 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.

6-4. Some of the general information obtainable from the schematic diagrams is shown in Figure 6-1. Notes and explanations of symbols pertaining to all the diagrams are contained in Figure 6-2. Notes about specific components, circuits, or conditions are given on the diagram to which they apply.

6-5. 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.

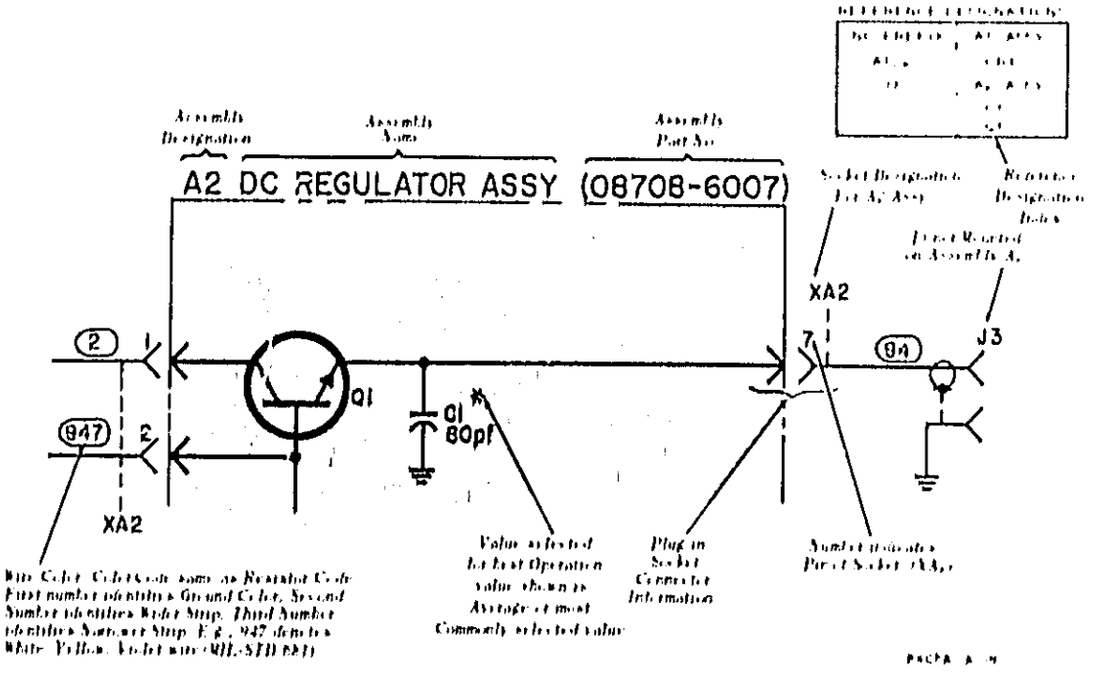


Figure 6-1. General Information on Schematic Diagrams

FIGURE 6-2. SCHEMATIC DIAGRAM NOTES

1. Resistance in ohms, capacitance in microfarads unless otherwise noted.
2. P/O = part of.
3. * Asterisk denotes a factory-selected value. Value shown is typical. Part may be omitted.
4. Screwdriver adjustment.

   Panel control.
5. Encloses front panel designations.

   Encloses rear panel designations.
6. —— -- —— Circuit assembly borderline.

   – – – – – – – Other assembly borderline.
7. Heavy line with arrows indicates path and direction of main signal.

   Heavy dashed line with arrows indicates path and direction of main feedback.
8. Wiper moves toward CW with clockwise rotation of control as viewed from shaft or knob.
9. Numbers in circles on circuit assemblies show locations of test points. Matching numbers are etched on the circuit assemblies.
10. Encloses wire color code. Code used (MIL-STD-681) is the same as the resistor color code. First number identifies the ground color, second number the wider stripe, and the third number identifies the narrower stripe. E.g., (947) denotes white ground, yellow wide stripe, violet narrow stripe.
11. Field effect transistor with N-material base.

    Field effect transistor with P-material base
12. CONDITIONS FOR WAVEFORM AND DC VOLTAGE MEASUREMENT*

    a. 8411A INPUT: Equal-amplitude, same-frequency signals to both inputs, amplitudes adjusted for OPERATE reading on 8410A REF CHANNEL LEVEL meter.

    b. 8410A CONTROL SETTINGS:
    FREQ RANGE (GHz) . . . . to include frequency applied to 8411A inputs
    SWEEP STABILITY . . . . . centered
    TEST CHANNEL GAIN . . . . . 15 dB
    AMPL VERNIER . . . . . for -5 dB reading on 8413A ±10 dB range
    PHASE VERNIER . . . . . for 0 phase reading on 8413A ±6 range

    c. 8413A CONTROL SETTINGS:
    PHASE OFFSET 0
    PHASE RANGE . . . . . ±6°
    AMPLITUDE RANGE . . . . . ±10 dB

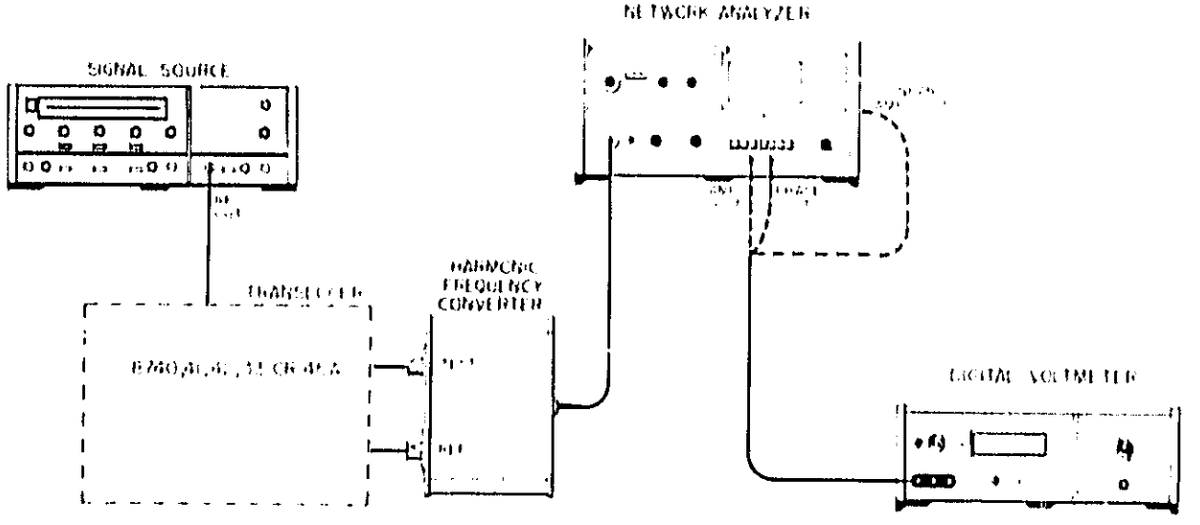
    d. LINE VOLTAGE: 115 ±10%, 50-60 Hz.

* Unless otherwise indicated on schematic diagram. DC voltages shown on schematic diagrams taken with ±0.05% 10 megohm input impedance voltmeter (HP 414A). Measured voltages should not differ from voltages shown by more than ±5%.

FIGURE 6-3. PRELIMINARY TROUBLESHOOTING

NOTE

There are five 8413A operating functions: amplitude meter indication, phase meter indication, front-panel 50 MV DB output voltage, front-panel 10 MV DEG output voltage, and rear-panel 0 - 1 VOLT LINEAR output voltage. Combinations of these functions are common to particular portions of the instrument. The following procedure checks the basic operation of these functions and will help to locate a trouble to the section of the instrument common to the faulty function(s).



PROCEDURE

1. Connect equipment as shown above. Set the Signal Source for single frequency operation and adjust the Network Analyzer to phase lock to the applied signal.

2. Perform the operating checks as indicated in the table on the following page, and note the condition of each function (OK = normal operation, X = faulty operation). Select the horizontal line corresponding to the indications noted. Then refer to the figure and diagram indicated in last column of horizontal line selected.

NOTE

Figure 6-4 shows the equipment setup for circuit troubleshooting.

(Continued)

FIGURE 6-3. PRELIMINARY TROUBLESHOOTING

Amplitude Meter (Note 1)	Phase Meter (Note 2)	Amplitude 50 MV/DB (Note 3)	Phase 10 MV/DEG (Note 4)	Amplitude 0 - 1 V (Note 5)	Refer to:
OK	X	OK	X	OK	Block Diagram
X	OK	X	OK	OK	Schematic 6
X	OK	X	OK	X	Schematic 6
OK	OK	X	X	OK	Unblanking Circuit Schematic 5 & 6
X	X	OK	OK	OK	Schematic 5

NOTES:

1. Depress the AMPLITUDE 30 dB pushbutton, and adjust the Network Analyzer test channel gain and amplitude vernier for zero meter indication.

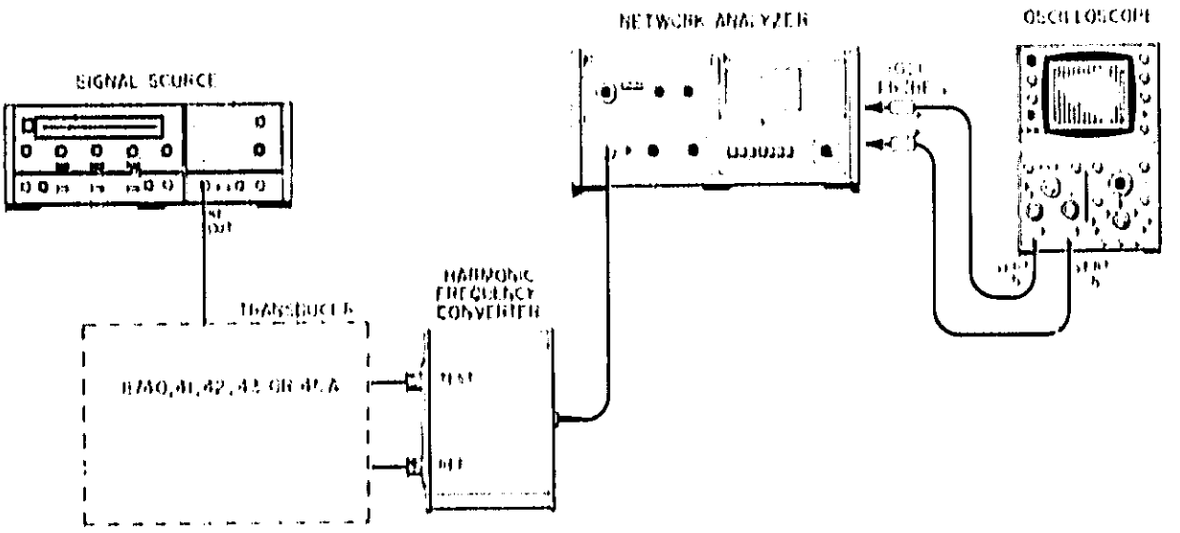
2. Depress the PHASE 180 degree pushbutton, and adjust the PHASE OFFSET and Network Analyzer phase vernier for zero meter indication.

3. Adjust the Network Analyzer test channel gain and amplitude vernier controls for maximum and minimum gain. The 50 MV/DB output voltage should vary from approximately -1.0 V (depending on the minimum gain setting, to +1.5 Vdc.

4. Adjust the 8413A PHASE OFFSET and Network Analyzer phase vernier through 360 degrees phase shift. The 10 MV/DEG output voltage should vary at least from -1.75 Vdc to +1.75 Vdc.

5. Adjust the Network Analyzer test channel gain and amplitude vernier controls for maximum and minimum gain. The LINEAR 0 - 1 V output voltage should vary from about +6 mV to at least +0.95 Vdc.

FIGURE 6-4. PREPARATION FOR TROUBLESHOOTING



1. Remove top covers from both Network Analyzer and 8413A. Remove circuit board compartment cover from 8413A before installing it into the Network Analyzer.
2. Connect equipment as shown in setup. Set up the Transducer for equal amplitude signals to the Harmonic Frequency Converter.
3. Set Signal Source for any single frequency from 0.11 to 12.4 GHz, and adjust the Network Analyzer to phase lock to the applied signal.
4. Adjust Signal Source output level for a Network Analyzer reference channel level meter indication in the OPERATE region.
5. Set up dual trace Oscilloscope as follows:
   a. Both input channels to + polarity.
   b. Select ALT display mode.
   c. Horizontal to internal trigger.
   d. Connect probe of the channel that triggers the horizontal amplifier to 8413A-A10TP4. This will be the reference signal for all waveforms. If waveform at A10TP4 cannot be obtained troubleshoot A10Q7 circuit using schematic 1.
   e. Check for equal electrical length of the Oscilloscope probes by also connecting the other probe to A10TP4. This probe is referred to as the measurement probe in the troubleshooting procedures. The two waveforms should be superimposed.
6. Connect the Oscilloscope measurement probe to A6TP3 and adjust the transducer REFERENCE PLANE EXTENSION and Network Analyzer phase vernier to obtain an in-phase relationship as shown in the waveform below. If waveform at A6TP3 cannot be obtained troubleshoot the A6 Assembly using schematic 2.

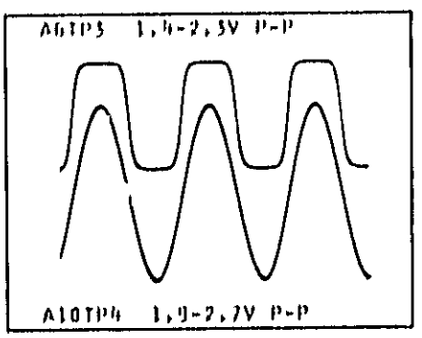


FIGURE 6-5. BLOCK DIAGRAM CIRCUIT DESCRIPTIONS

PHASE SECTION

PHASE REFERENCE CHANNEL A10 AND A2

FIRST PHASE SHIFT NETWORK. The first phase shift network consists of transformer A10T1, a series resistance R_A, P/O the Phase Offset Switch Assembly, and a shunt capacitor A10C6. In the (+) offset position T1 provides a phase reversal from primary to secondary, and by reversing the input leads in the (-) offset position the phase shift across the transformer is effectively zero. Because the center of A10T1's secondary is ground, the voltage at the base of Q6 is the resultant of R_A and A10C6 in two configurations, a series resistor and shunt capacitor to one side of the transformer, and a series capacitor and shunt resistor to the other. Changing the value of R_A with the Phase Offset switch selects steps of phase shift in this network.

SECOND PHASE SHIFT NETWORK. The second phase shift network consists of A10R10 and A10C10 in combination with P/O the Phase Offset Switch Assembly, which reverses the position of these two components. When the phase offset switch is in the -0° to -80° and +100° to +180° positions, A10R10 is a series resistor and A10C10 a shunt capacitor. The signal is taken across the capacitor and the phase shift is -45°. When the phase offset switch is in the +0° to +80° and -80° to -180° positions, A10C10 becomes a series capacitor and A10R10 a shunt resistor. The signal is taken across the resistor and the phase shift is +45°.

LIMITER. The limiter (A10Q1, A10Q2) is a differential amplifier limiter whose output square wave is limited to about 6.5V p-p.

PHASE CHANNEL A6, A7, A8

A6 ASSEMBLY. The Phase Test Channel input amplifier A6Q1, A6Q2 has a voltage gain of approximately 20. Its output signal is fed to the first limiter A6Q3, A6Q4 which is an overdriven amplifier with a voltage gain of approximately 20. The output of the first limiter and its associated emitter follower A6Q5 is a square wave about 2V p-p. When the input signal amplitude is low the first limiter output signal may approach a sine wave.

A7 ASSEMBLY. The A7 Assembly or second limiter contains two amplifier limiter circuits. The square wave output of its first limiter A7Q4, A7Q5 is about 2.5V p-p. This signal is fed through an emitter follower A7Q3 to its second limiter A7Q1, A7Q2 whose output is about 3V p-p. The square wave is then fed to a bandpass filter which removes any harmonics and whose output is a sine wave about 2 to 3V p-p.

A8 ASSEMBLY. The A8 Assembly input stage A8Q1 is a variable phase shifter whose output signal is fed through an emitter follower A8Q2 to a fixed +30° phase shifter. The signal is then fed to an amplifier limiter A8Q3, A8Q4 whose output square wave is about 6V p-p. The combination of variable and fixed phase shift is typically set to about +15° but can be varied from 0° to +30° to obtain the proper reference-to-test channel phase balance. The A8 Assembly also contains a +5.6V power supply A8Q5-A8Q7 to provide collector voltage for the phase detector.

PHASE DETECTOR A9, A4

TRIGGER GENERATORS. The two input square waves are fed through emitter followers A9Q8, A9Q9 to trigger generators A9Q2, A9Q3 and A9Q6, A9Q7 which are Schmitt Trigger circuits. The square wave outputs of the trigger generators are differentiated. The differentiated square wave or positive and negative spikes are fed to gate circuits which pass only the negative spikes. These negative spikes are equivalent to the trailing edge of the Schmitt Trigger square waves.

PHASE DETECTOR. The phase detector A9Q4, A9Q5 is a bistable multivibrator. The negative input spike from the reference channel sets the multivibrator so that its output is positive. The test channel negative spike flips the multivibrator, whose output is then less positive or negative-going. The symmetry of the multivibrator's output square wave (time of the positive portion with respect to the time of the negative portion) is proportional to the phase relationship of the input triggers. This square wave is converted to an average dc which is proportional to the square wave nonsymmetry, and thus proportional to the phase relationship of the input triggers.

RECORDER AMPLIFIER. The dc input from the phase detector is fed to the recorder differential amplifier A4Q1-A4Q3 which has a voltage gain of approximately 17. There are two outputs from the recorder amplifier. One output is fed to the meter amplifier A4Q5-A4Q8 through the meter function switch A1S1. The other output is fed to the front-panel 10 MV/DEG output J2 through the phase disable switch.

PHASE DISABLE SWITCH. The phase disable switch A4Q4 passes the dc output of the recorder amplifier to the front-panel 10 MV/DEG output when the Network Analyzer is phase locked and blocks the dc output when the Network Analyzer is not phase locked.

(Continued)

FIGURE 6-5. BLOCK DIAGRAM CIRCUIT DESCRIPTIONS

AMPLITUDE SECTION

CURRENT SOURCE A5

The amplitude section input feedback pair amplifier A5Q1, A5Q2 has a voltage gain of approximately 80. Its output is fed to a differential amplifier or current source A5Q3, A5Q4. The current source collector circuit contains a parallel tank circuit which presents a high impedance at 278 kHz. The output of the current source is fed to two peak detectors A5CR1 and A5CR2. The negative peak detector output is fed to the linear dc amplifier, the positive peak detector output to the logarithmic converter, both of which are on the A3 Assembly.

AMPLITUDE DETECTOR A3

LOGARITHMIC CONVERTER. The voltage across the logarithmic converter, A3Q1, is proportional to the log of the peak detector output voltage and is the input to the dc amplifier A3Q2-A3Q6.

LOG DC AMPLIFIER. The log dc amplifier, A3Q2-A3Q6, is a temperature stabilized feedback amplifier. It has two outputs. One output is to the meter amplifier through the meter function switch. The other output is to the front-panel 50 MV/DB output connector, J1, through the amplitude disable switch, A3Q7.

AMPLITUDE DISABLE SWITCH. The amplitude disable switch, A3Q7, passes the dc output of the log dc amplifier to the front-panel connector, J1, when the Network Analyzer is phase locked and blocks the dc output when the Network Analyzer is not phase locked.

LINEAR DC AMPLIFIER. The input to the linear dc amplifier, A3Q8-A3Q10, is a negative dc voltage from the peak detector, CR1. The output of the linear dc amplifier is approximately equal to its input but of opposite polarity and is fed to the rear-panel 0 - 1 V LINEAR output connector, J3.

METERING SECTION

METER AMPLIFIER A4

The meter amplifier A4Q5-A4Q8 is a variable gain amplifier whose gain is determined by the meter range pushbutton selected. The output of the meter amplifier drives the meter movement.

BLOCK DIAGRAM TROUBLESHOOTING

1 Prepare for troubleshooting as in Figure 6-1.

2 Connect oscilloscope measurement probe to A10TP1. Oscilloscope presentation should be similar to A below.
- No → Troubleshoot A10 and A2 Assembly using information on Schematic 1.
- Yes ↓

3 Connect oscilloscope measurement probe to A6TP3. Oscilloscope presentation should be similar to B below.
- No → Troubleshoot A6 Assembly using information on Schematic 2.
- Yes ↓

4 Connect oscilloscope measurement probe to A8TP3. Oscilloscope presentation should be similar to C below.
- No → Troubleshoot A7 and A8 Assemblies using information on Schematic 3.
- Yes ↓

5 Connect oscilloscope measurement probe to A9TP3. Oscilloscope presentation should be similar to D below.
- No → Troubleshoot A9 Assembly using information on Schematic 4.
- Yes ↓

6 If all of the presentations at the above test points appear normal and the amplitude output voltages checked OK as in Figure 6-3, refer to schematic number 5.

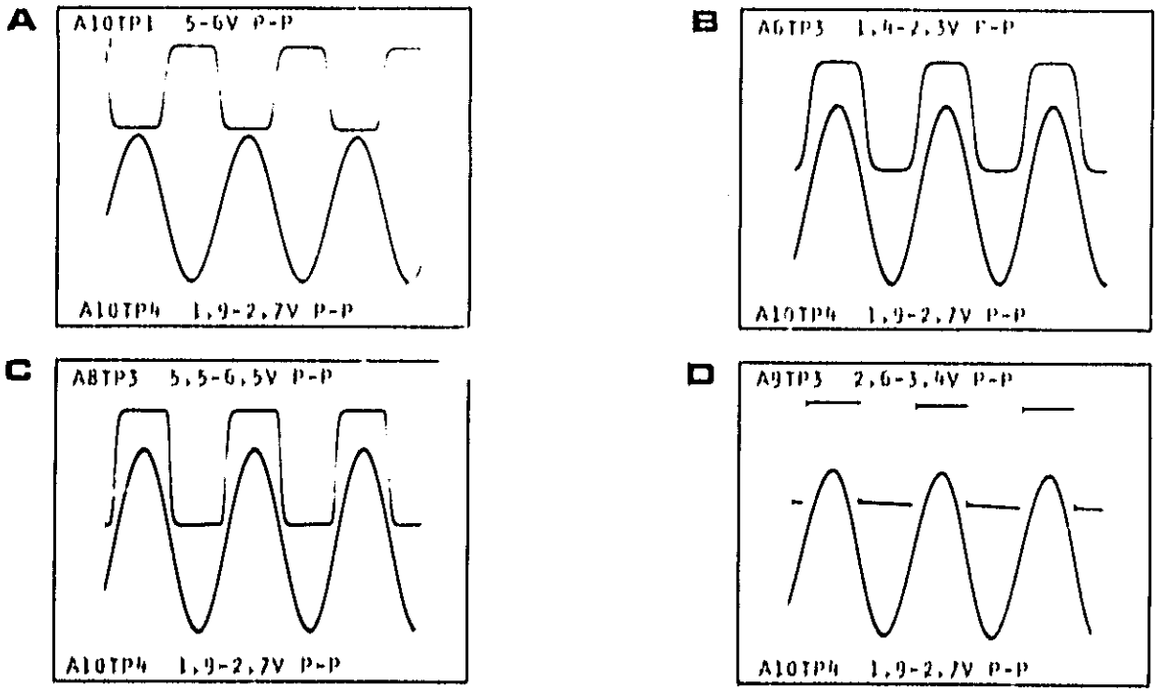


Figure 6-6. Block Diagram Troubleshooting

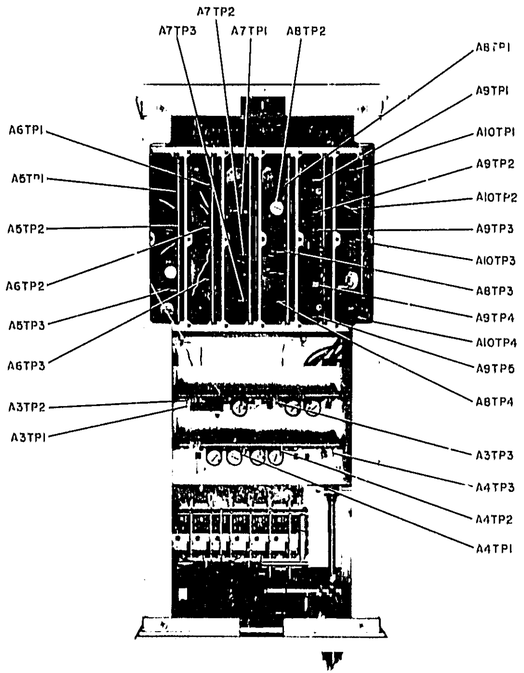


Figure 6-7. Test Point Location

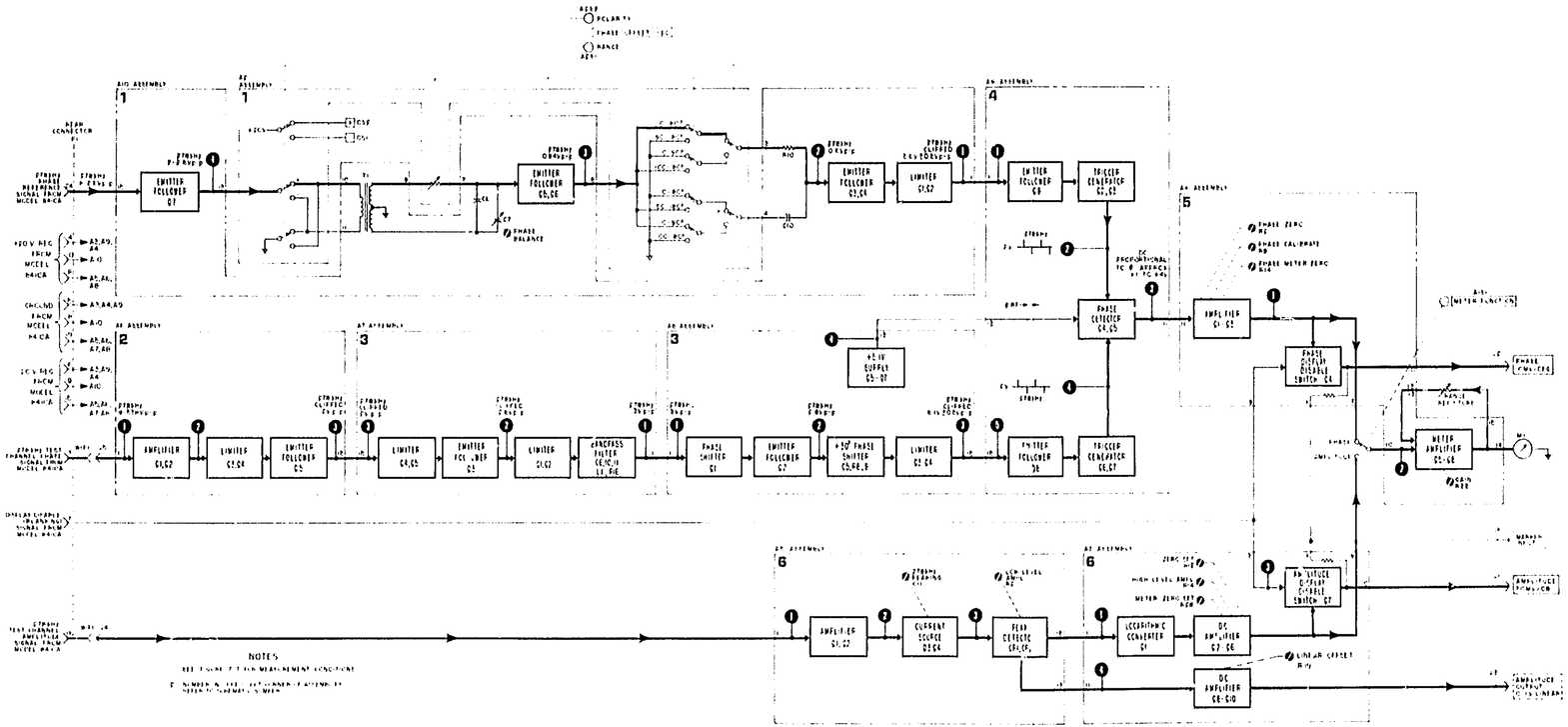


Figure 6-8. Block Diagram

SCHEMATIC DIAGRAMS

CON'T

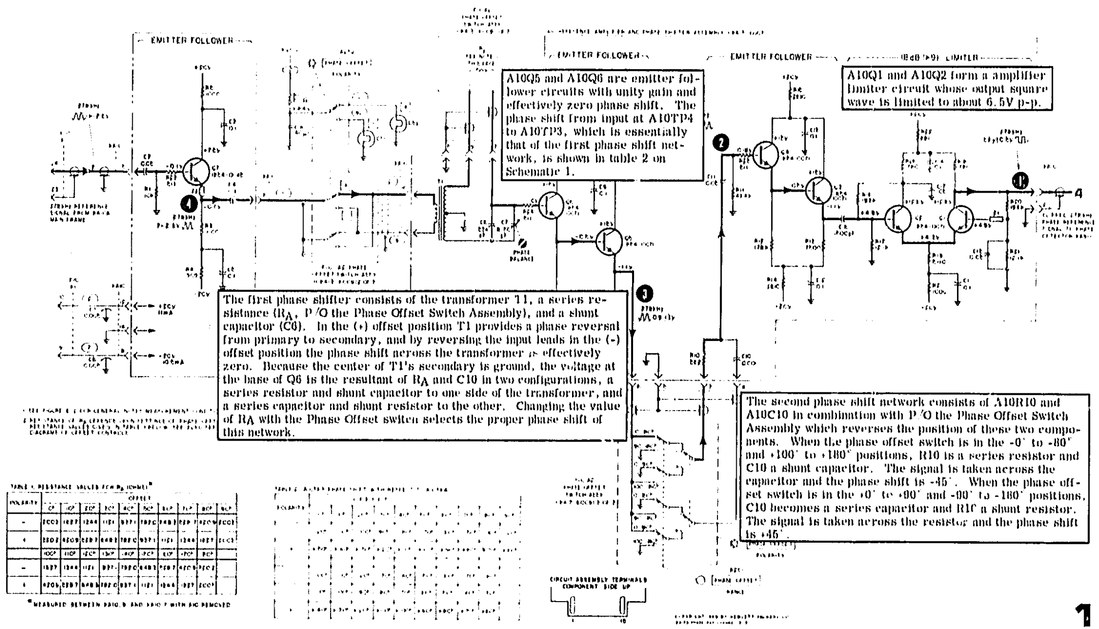


Figure 6-9. A10 Tracking Schematic

Figures 6-7, 6-8, and 6-9

BLOCK DIAGRAM

Block Diagram Troubleshooting

Test Point Location

A10 AND A2 TROUBLESHOOTING

1. Prepare for troubleshooting as in Figure 6-4.
2. Connect oscilloscope measurement probe to A10TP3. Set 8413A PHASE OFFSET to (-) zero. Oscilloscope presentation should be similar to A below.
   - No → Troubleshoot A10Q5, A10Q6 circuits and A2 Assembly.
   - Yes
3. Set 8413A PHASE OFFSET to (+) zero. Oscilloscope presentation should be similar to B below.
   - No → Troubleshoot A2 Assembly.
   - Yes
4. Connect oscilloscope measurement probe to A10TP2. Oscilloscope presentation should be similar to C below for both (+) and (-) zero offset.
   - No → Troubleshoot the A2 Assembly between A10TP3 and A10TP2.
   - Yes
5. Connect oscilloscope measurement probe to A10TP1. Oscilloscope presentation should be similar to D below.
   - No → Troubleshoot A10Q1 through A10Q4 circuits.

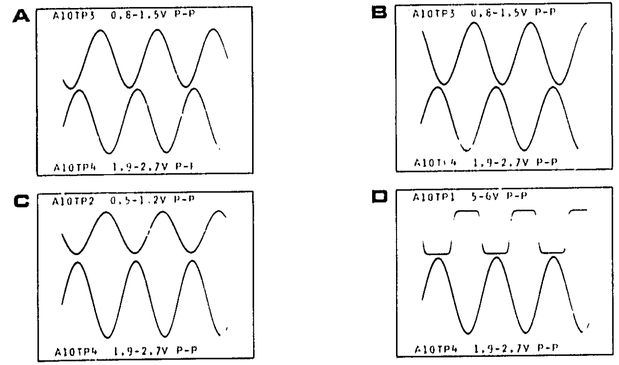


Figure 6-10. A10 and A2 Troubleshooting

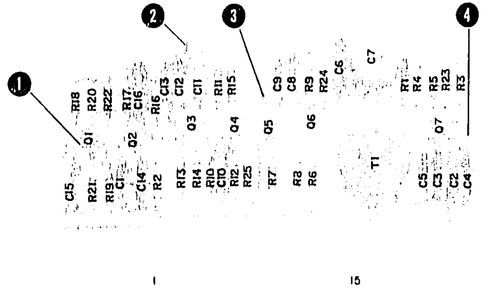


Figure 6-11A. A10 Assembly Reference Amplifier and Phase Shifter, Component Identification for Serial Numbers Prefixed 804- and Below

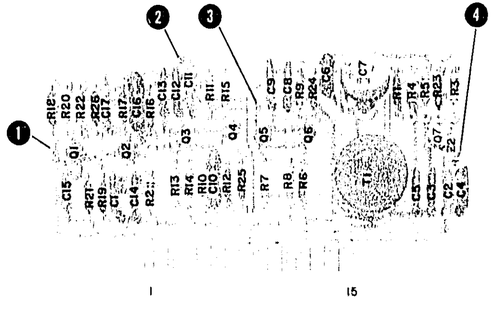


Figure 6-11B. A10 Assembly Reference Amplifier and Phase Shifter, Component Identification for Serial Numbers Prefixed 806- and Above

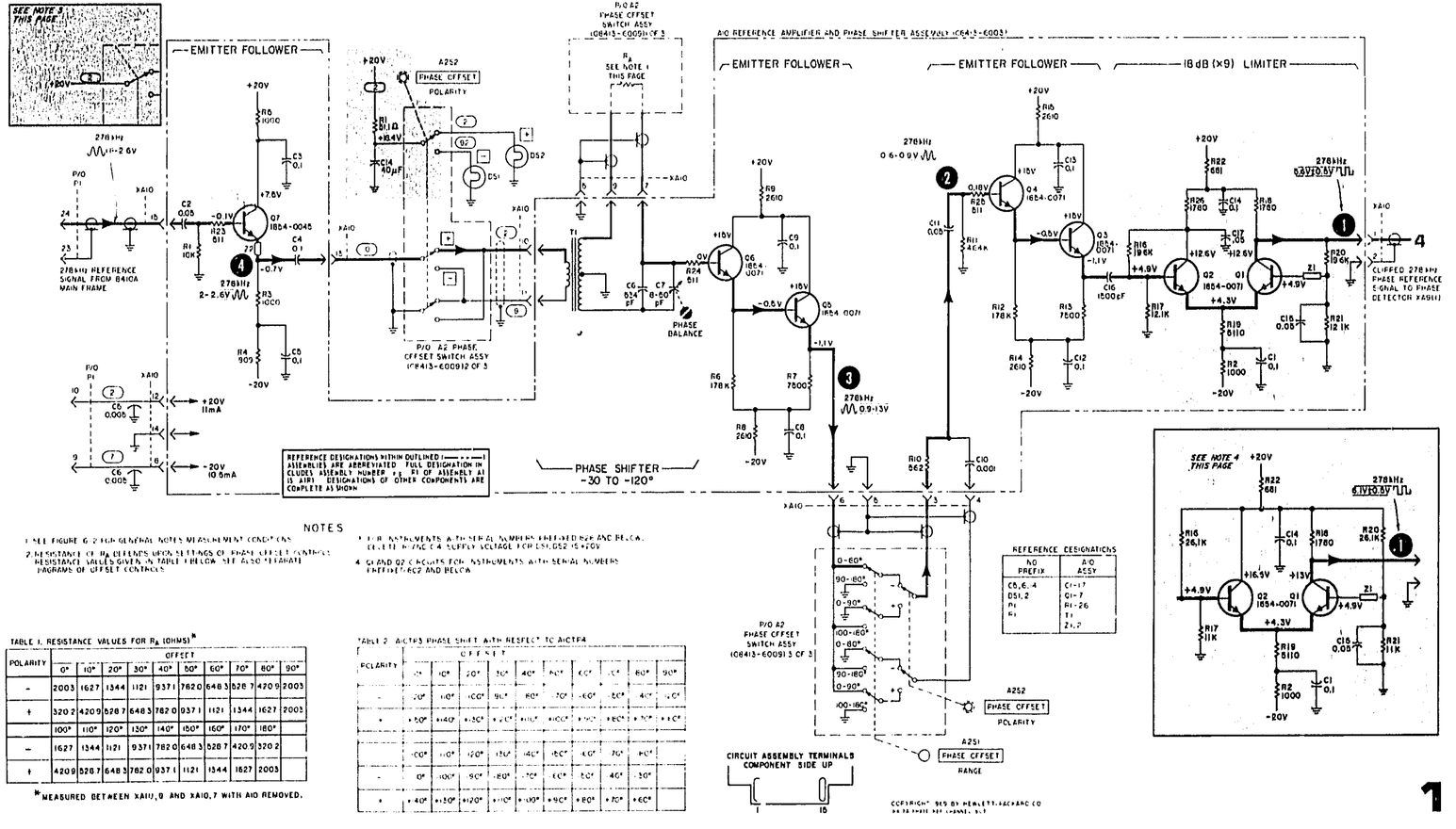


Figure 6-12. Schematic Diagram, Phase Section Reference Channel Offset and Limiter

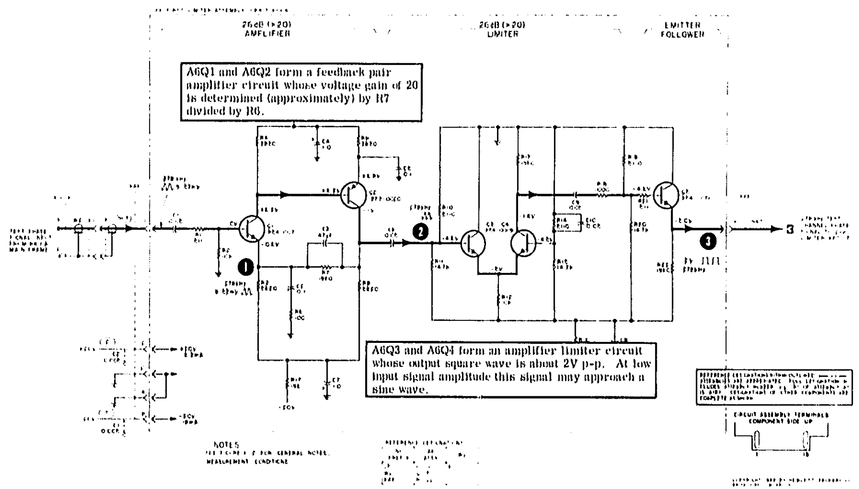


Figure 6-13. A6 Talking Schematic

REFERENCE DESIGNATIONS	
A6 PREFIX	A6 ASSY
C5,6 4	C-17
C51,2	Q1-7
P1	R1-28
	T1
	Z1,2

Figures 6-11, 6-12, and 6-13

PHASE SECTION REFERENCE
CHANNEL OFFSET AND LIMITER (A10)

Component Identification
Schematic Diagram

A6 TROUBLESHOOTING

1. Prepare for troubleshooting as in Figure 6-4.
2. Connect oscilloscope measurement probe to A6TP1. Oscilloscope presentation should be similar to A below.
   - No → Troubleshoot the A3Q1 circuit.
   - Yes ↓
3. Connect oscilloscope measurement probe to A6TP2. Oscilloscope presentation should be similar to A with p-p voltage of 0.15V to 1.1V.
   - No → Troubleshoot the A3Q1 and A3Q2 circuit.
   - Yes ↓
4. Connect oscilloscope measurement probe to A6TP3. Oscilloscope presentation should be similar to B below.
   - No → Troubleshoot the A3Q3, A3Q4, and A3Q5 circuits.

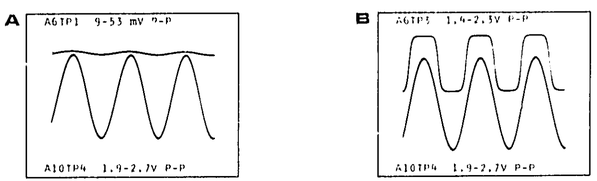


Figure 6-14. A6 Troubleshooting

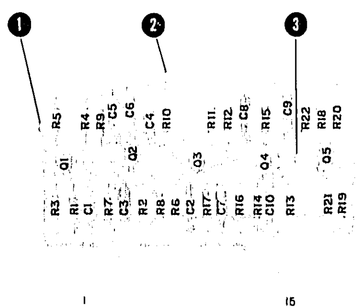


Figure 6-15. A6 Assembly First Limiter Component Identification

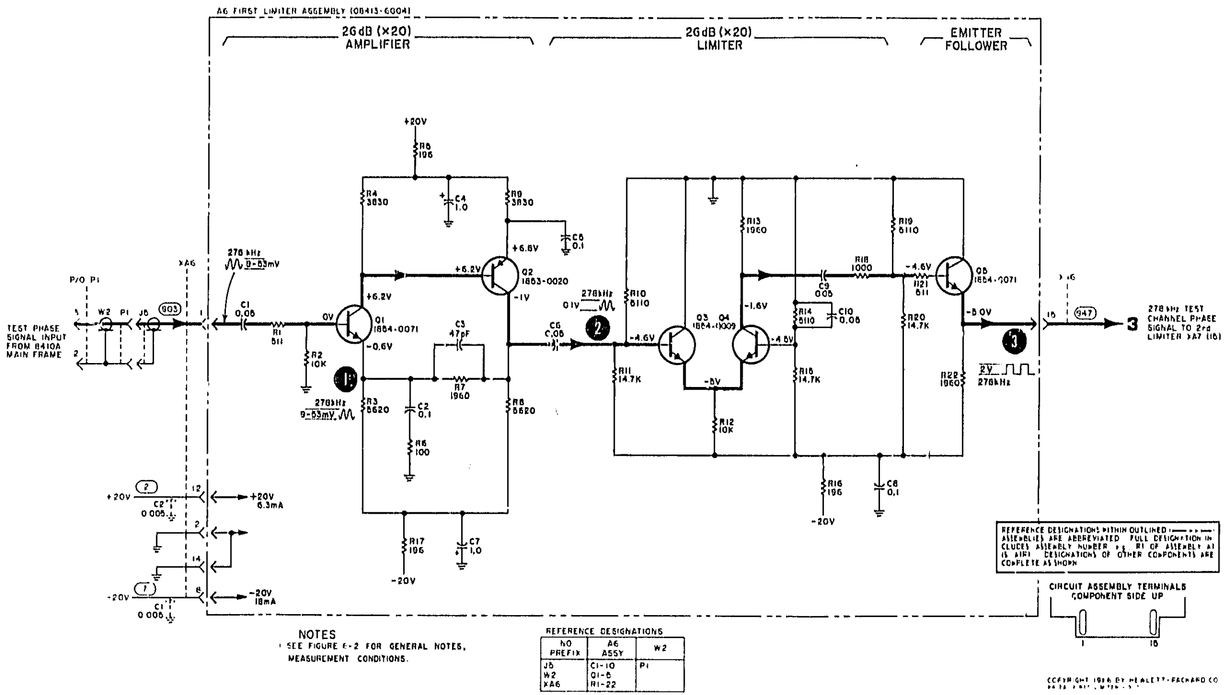


Figure 6-16. Schematic Diagram, Phase Section Test Channel First Limiter

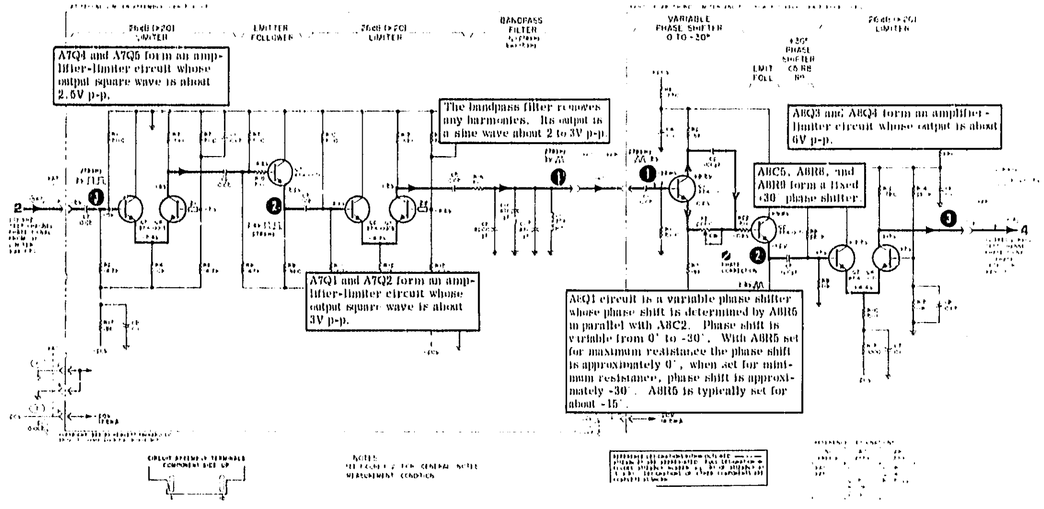
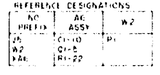


Figure 6-17. A7 and P/O A8 Talking Schematic

3



Figures 6-15, 6-16, and 6-17

PHASE SECTION TEST CHANNEL FIRST LIMITER (A6)

Component Identification
Schematic Diagram

2

A7 AND P/O A8 TROUBLESHOOTING

1. Prepare for troubleshooting as in Figure 6-4.
2. Connect oscilloscope measurement probe to A7TP2. Oscilloscope presentation should be a square wave 2.3 to 2.9V p-p.
   - No → Troubleshoot A8Q3, A8Q4, and A8Q5 circuits.
   - Yes
3. Connect oscilloscope measurement probe to A7TP1. Oscilloscope presentation should be a sine wave about 2 to 3V p-p.
   - No → Troubleshoot A8Q1, A8Q2, and the bandpass filter circuits.
   - Yes
4. Connect oscilloscope measurement probe to A8TP2. Oscilloscope presentation should be a sine wave 2.3 to 3.2V p-p.
   - No → Troubleshoot A8Q1 and A8Q2 circuits.
   - Yes
5. Connect oscilloscope measurement probe to A8TP3. Oscilloscope presentation should be similar to A below.
   - No → Troubleshoot A8Q3, A8Q4, and the +30° phase shift circuits.

A

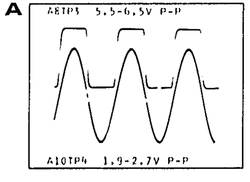


Figure 6-18. A7 and P/O A8 Troubleshooting

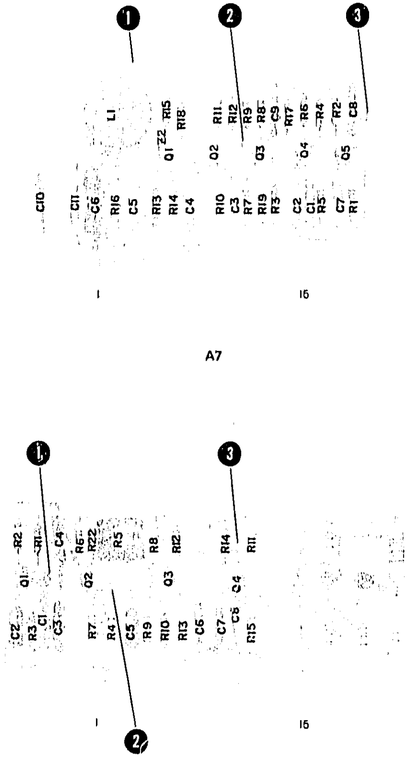


Figure 6-19. A7 Assembly Second Limiter and A8 Assembly Third Limiter Component Identification

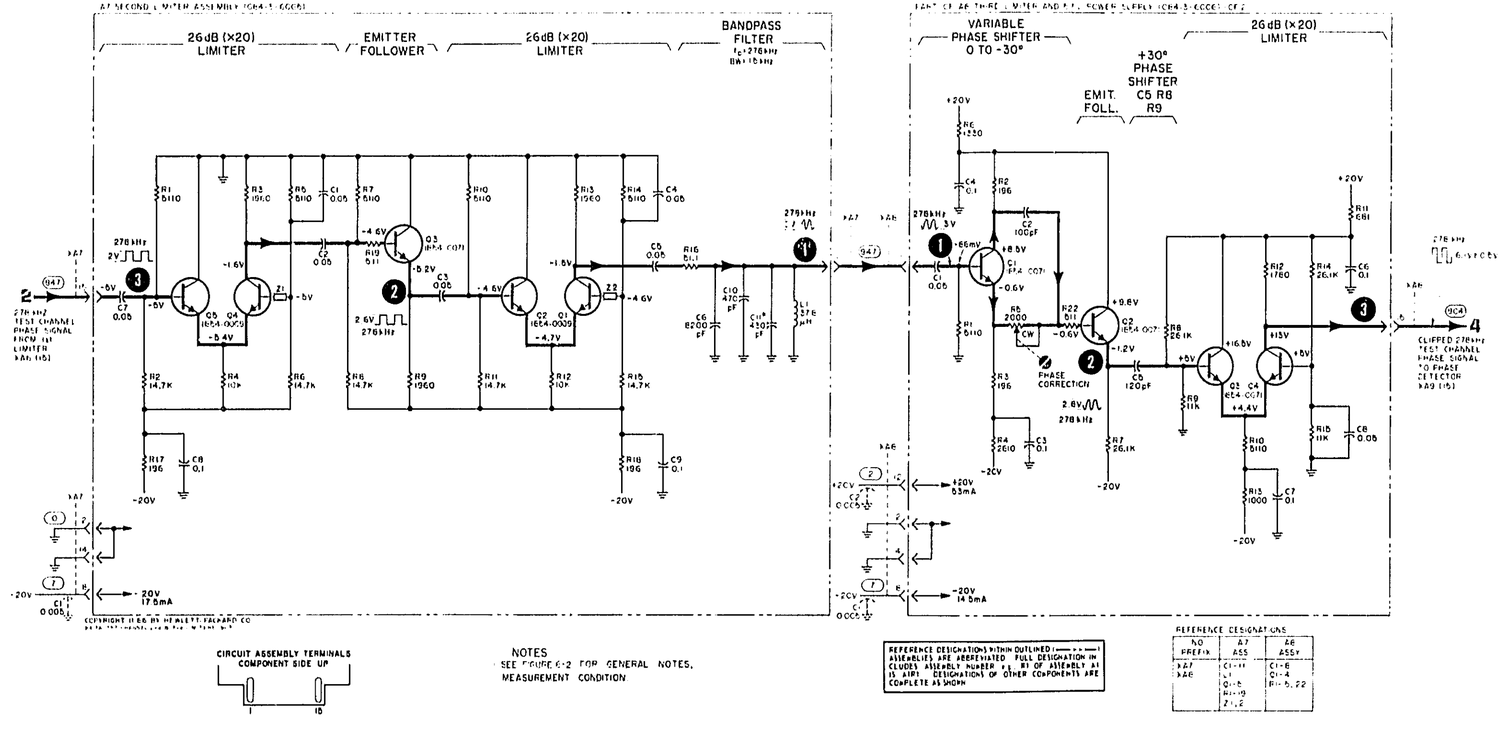


Figure 6-20. Schematic Diagram, Phase Section Second Limiter, Filter, Third Limiter, and Phase Shifter

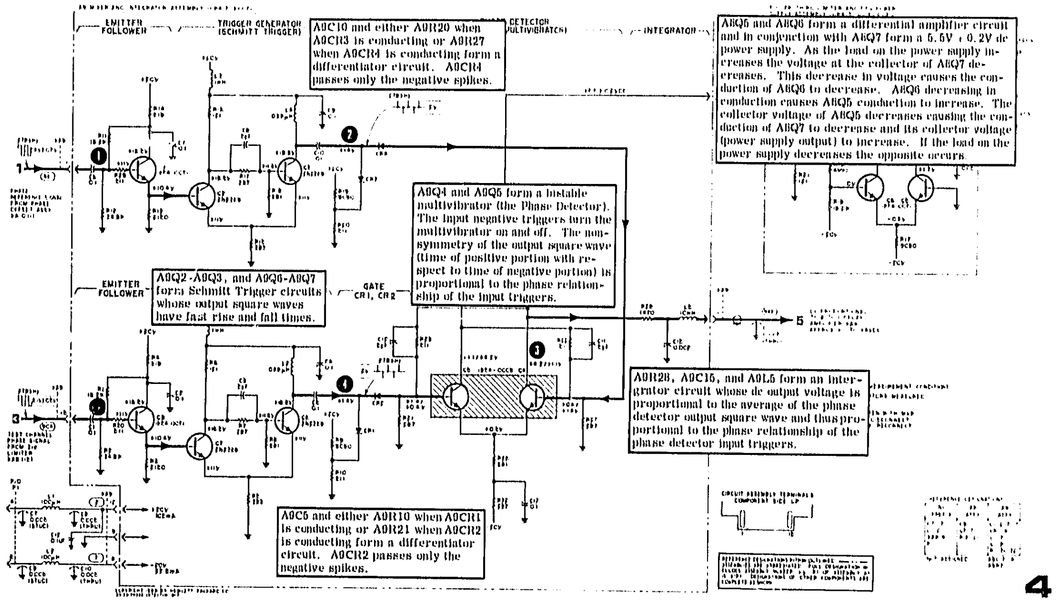


Figure 6-21. A9 and P/O A8 Talking Schematic

REFERENCE DESIGNATIONS

NO PREFIX	A7 ASSY	A8 ASSY
>A7 >A8	C1-11 L1 Q1-5 R1-19 Z1,2	C1-8 C1-4 R1-15, 22

Figures 6-10, 6-20, and 6-21

PHASE SECTION SECOND LIMITER, FILTER, THIRD LIMITER, AND PHASE SHIFTER (A7 and P/O A8)

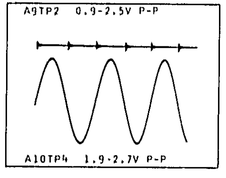
Component Identification
Schematic Diagram

3

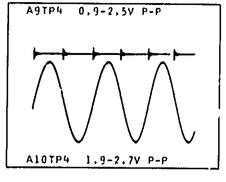
A9 AND P/O A8 TROUBLESHOOTING

1. Prepare for troubleshooting as in Figure 6-4.
2. Connect oscilloscope measurement probe to A9TP2. Oscilloscope presentation should be similar to A below.
   - No → Troubleshoot A9Q1, A9Q2, and A9Q3 circuits.
   - Yes
3. Connect oscilloscope measurement probe to A9TP4. Oscilloscope presentation should be similar to B below.
   - No → Troubleshoot A9Q6, A9Q7, and A9Q8 circuits.
   - Yes
4. Connect oscilloscope measurement probe to A9TP3. Oscilloscope presentation should be similar to C below.
   - No → Measure dc voltage at A8TP4. Voltage should be 5.5 ± 0.2 Vdc.
     - Yes → Troubleshoot the phase detector multivibrator A9Q4 and A9Q5 circuit.
     - No → Troubleshoot the 5.5V power supply using dc voltages on schematic number 4.

A



B



C

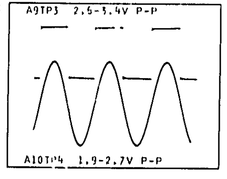


Figure 6-22. A9 and P/O A8 Troubleshooting

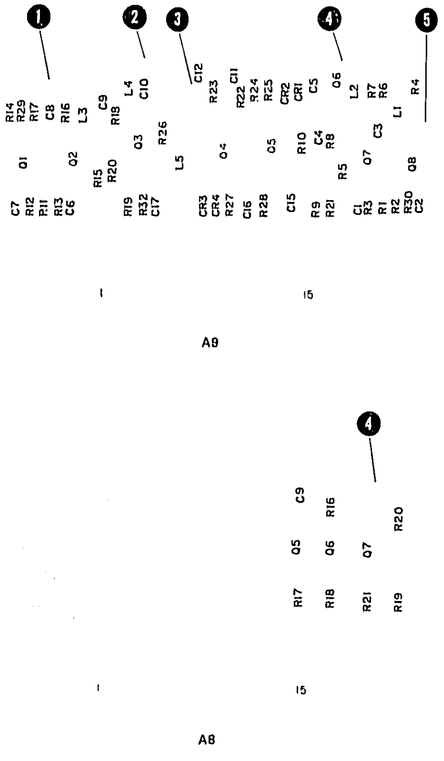


Figure 6-23. A9 Assembly Mixer and Integrator and A8 Assembly Third Limiter and 5.5V Power Supply Assembly Component Identification

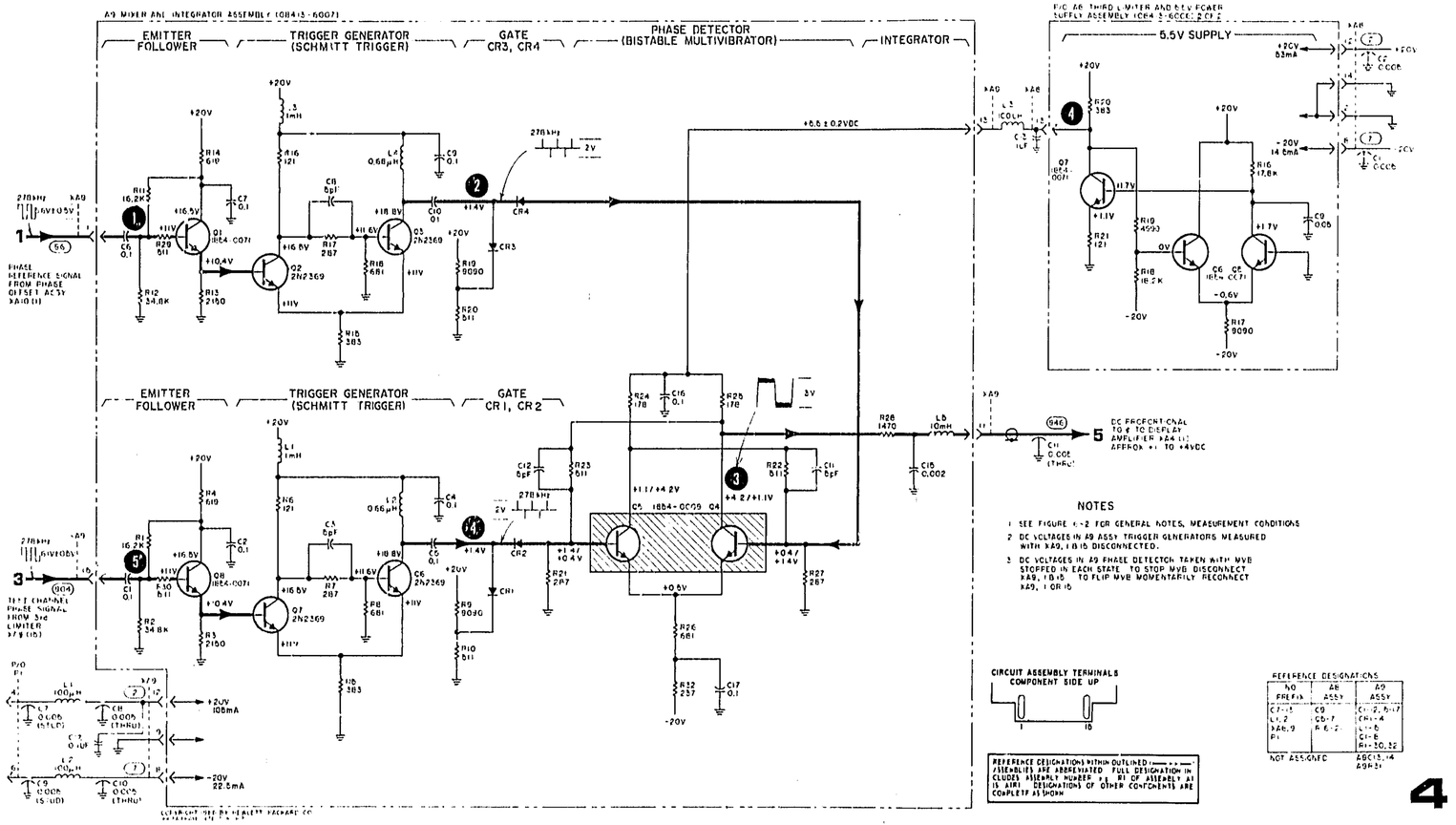


Figure 6-24. Schematic Diagram, Phase Section Detector

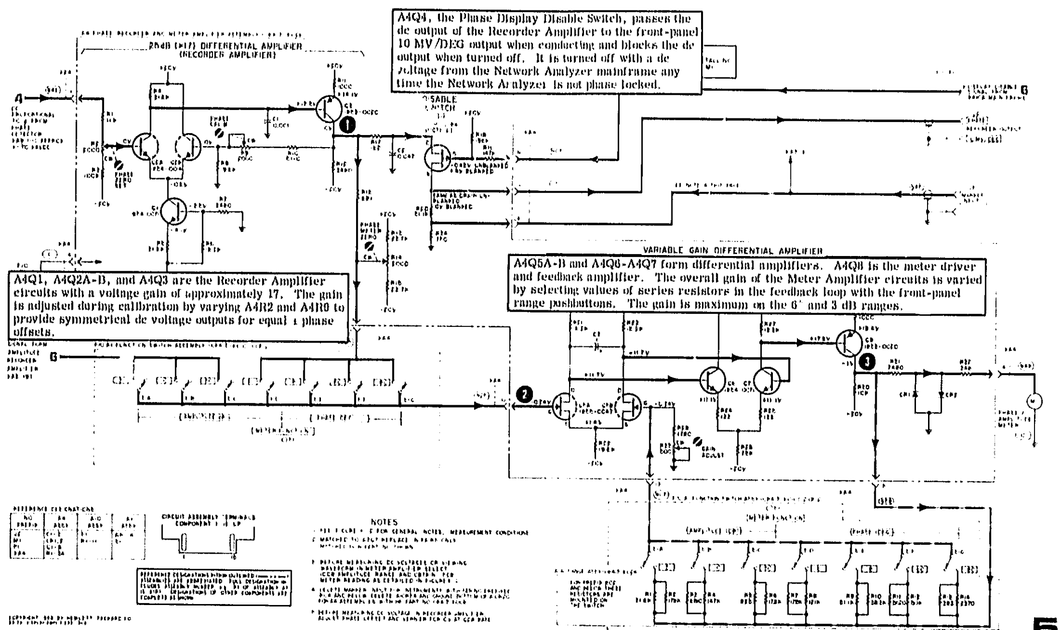


Figure 6-25. A4 Talking Schematic

5

REFERENCE DESIGNATIONS		
NO PREFIX	A8 ASSY	A9 ASSY
C7-11	C5	C1-12,15-17
L1,2	C6-7	CR1-4
MP1,2,9	R16-21	L1-5
P1		Q1-8
		R1-30,32
NOT ASSIGNED		A9C13,14 A9R31

Figures 6-23, 6-24 and 6-25

PHASE SECTION DETECTOR (A9 and P/O A8)

Component Identification Schematic Diagram

4

A4 TROUBLESHOOTING

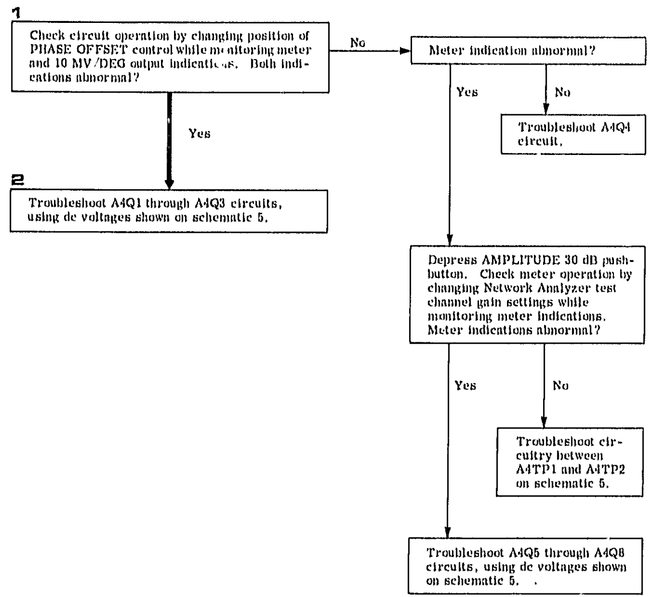


Figure 6-26. A4 Troubleshooting

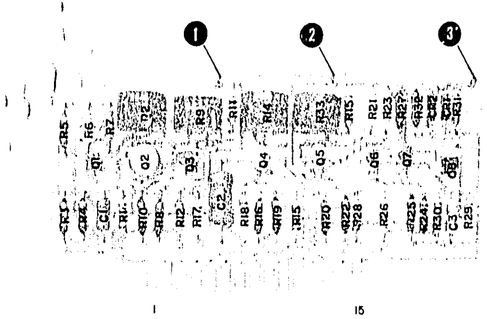


Figure 6-27A. A4 Assembly Recorder and Meter Amplifier, Component Identification for Serial Numbers Prefixed 804- and Below

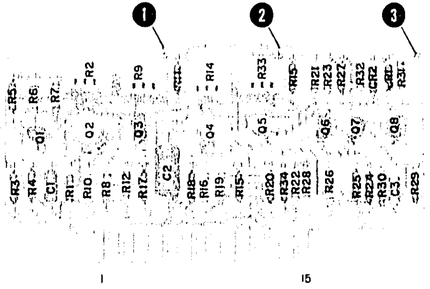


Figure 6-27B. A4 Assembly Recorder and Meter Amplifier, Component Identification for Serial Numbers Prefixed 806- and Above

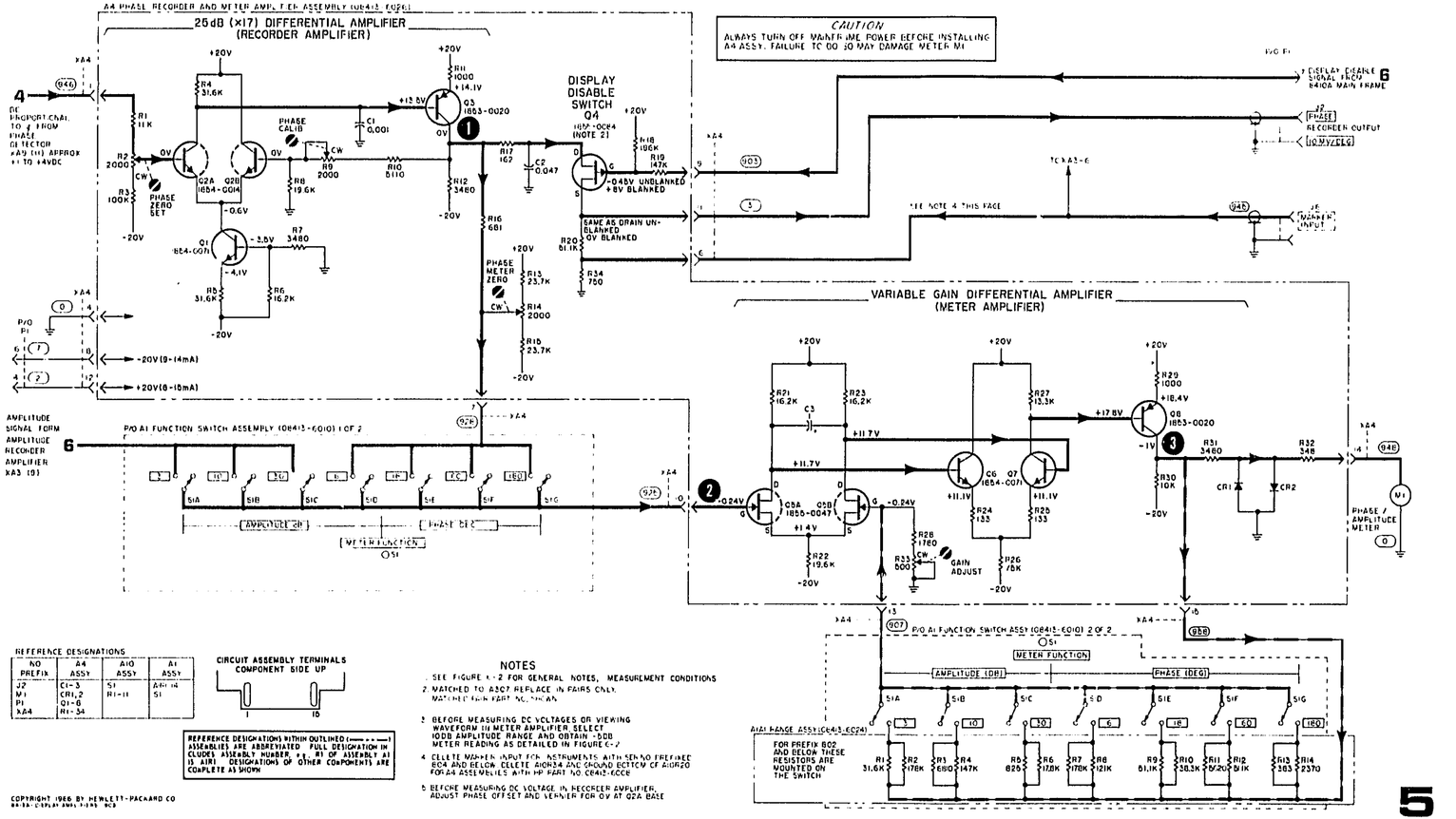


Figure 6-28. Schematic Diagram, Phase Section Recorder Amplifier and Metering Section

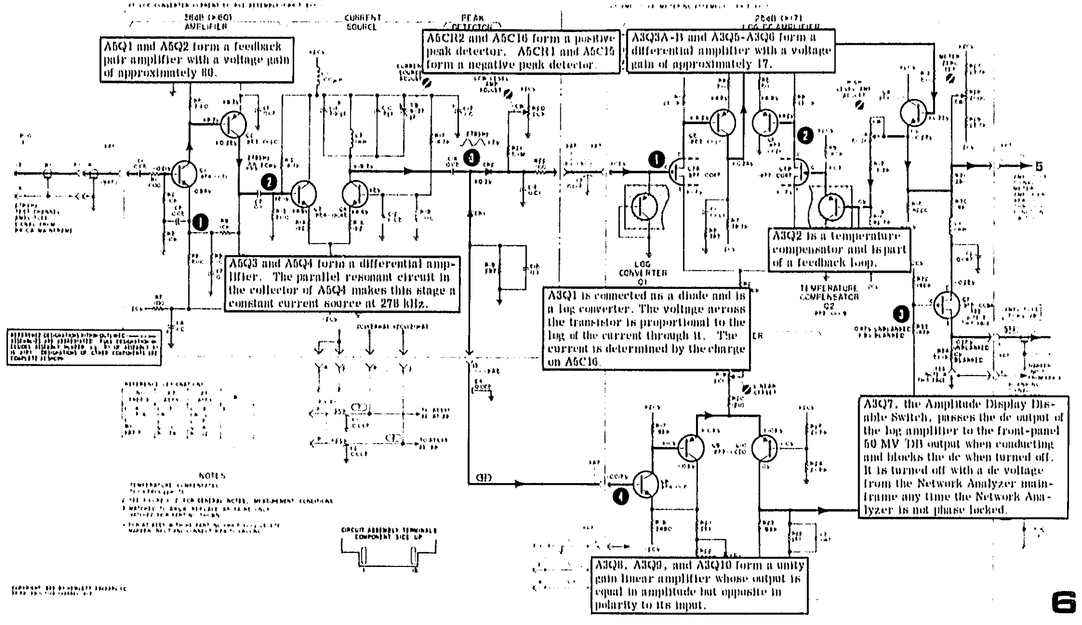


Figure 6-29. A3 and A5 Talking Schematic

REFERENCE DESIGNATIONS

A0 FREQ D	A4 ASSY	A10 ASSY	A1 ASSY
J2	C1-3	S1	A1-A
W1	CR1,2	R1-11	S1
P1	Q1-6		
XA4	XU-34		

Figures 6-27, 6-28, and 6-29

PHASE SECTION RECORDER AMPLIFIER AND METERING SECTION (A4)

Component Identification
Schematic Diagram

5

A3 AND A5 TROUBLESHOOTING

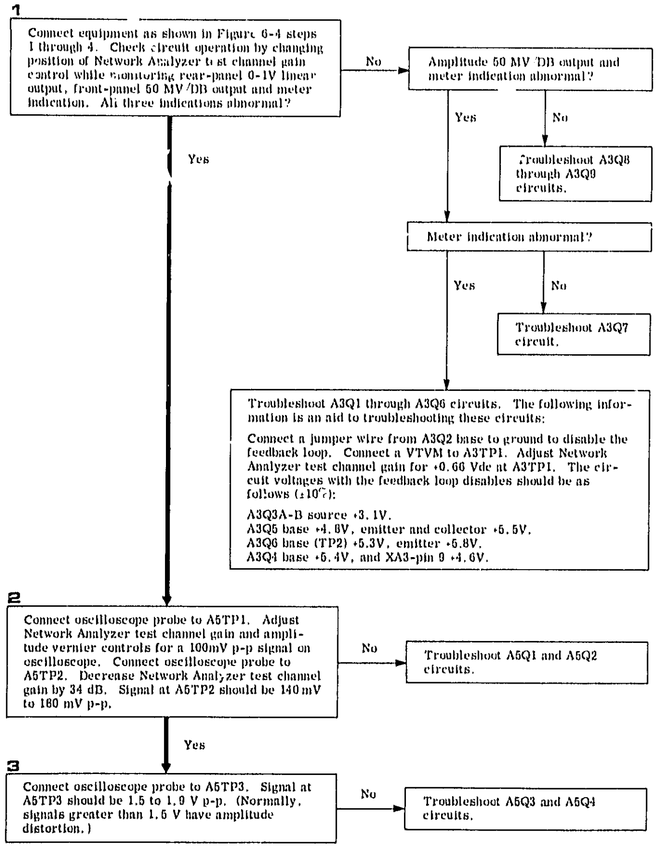


Figure 6-30. A3 and A5 Troubleshooting

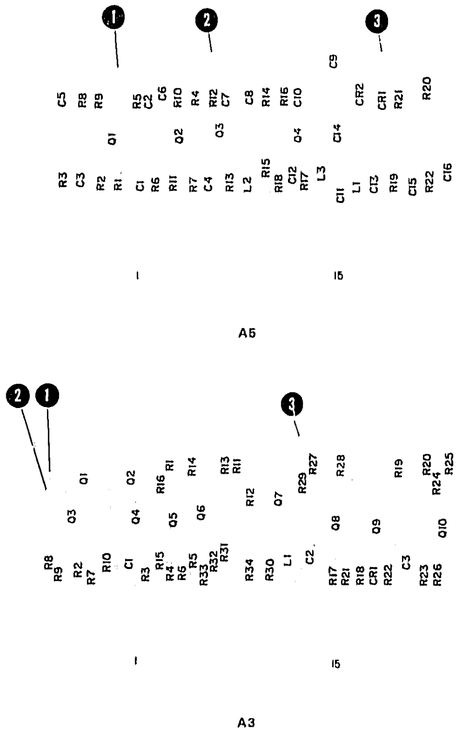


Figure 6-31. A3 Assembly Amplitude Metering and A5 Assembly Log Converter Current Source, Component Identification

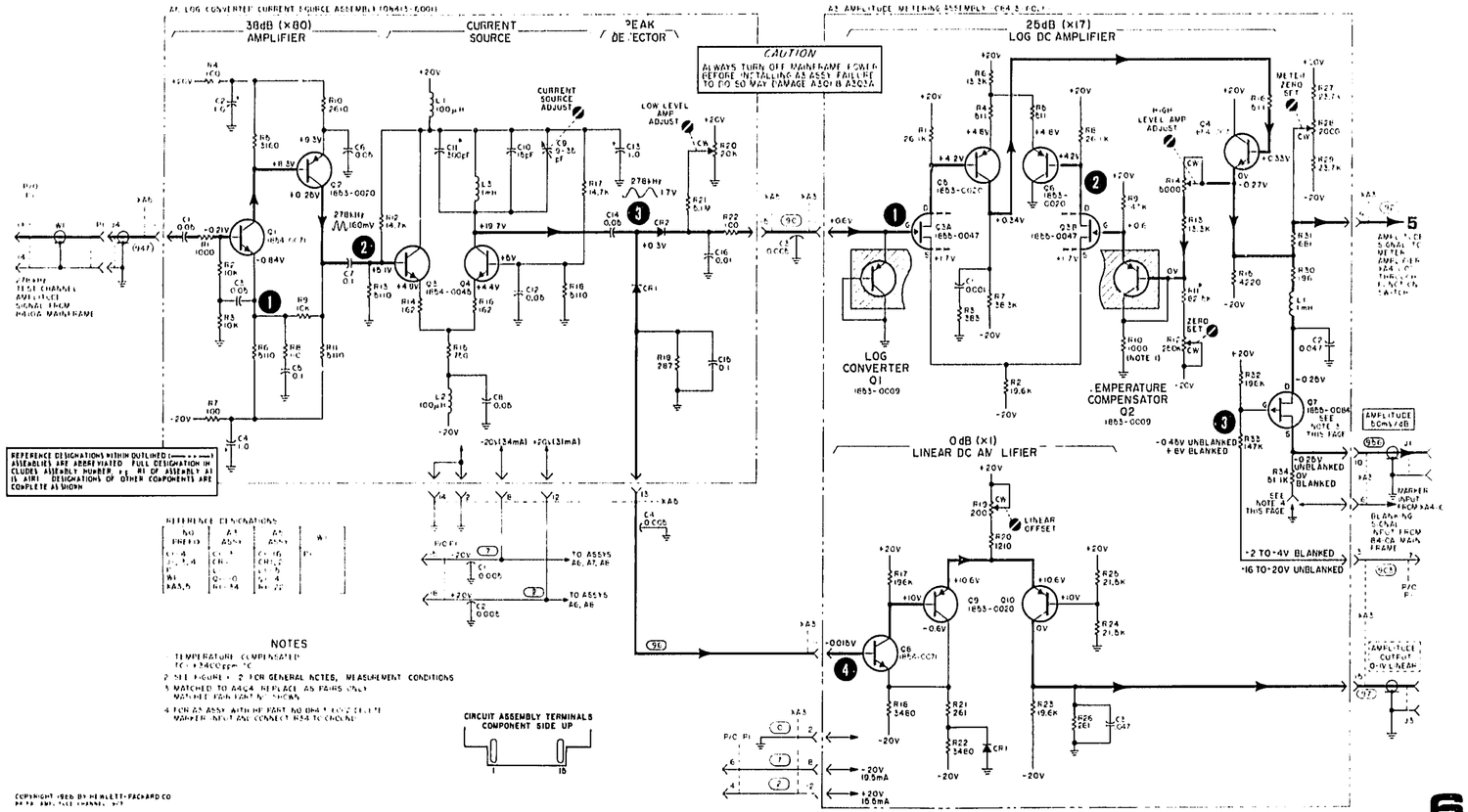
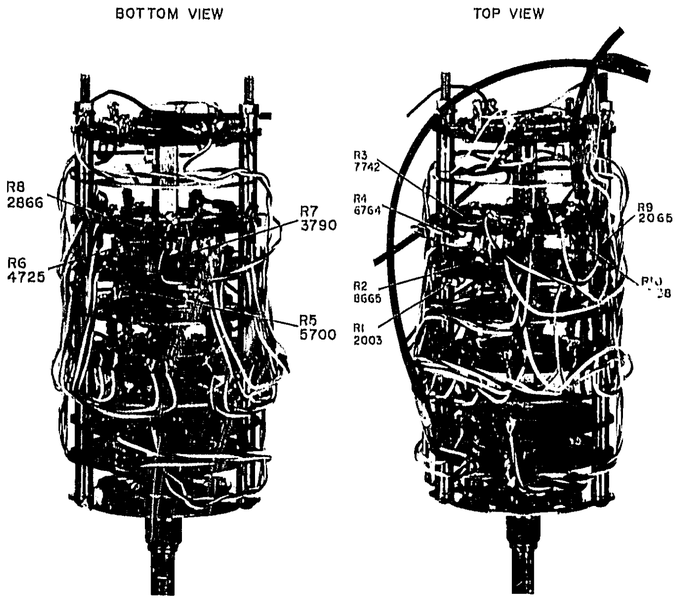


Figure 6-32. Schematic Diagram, Amplitude Section



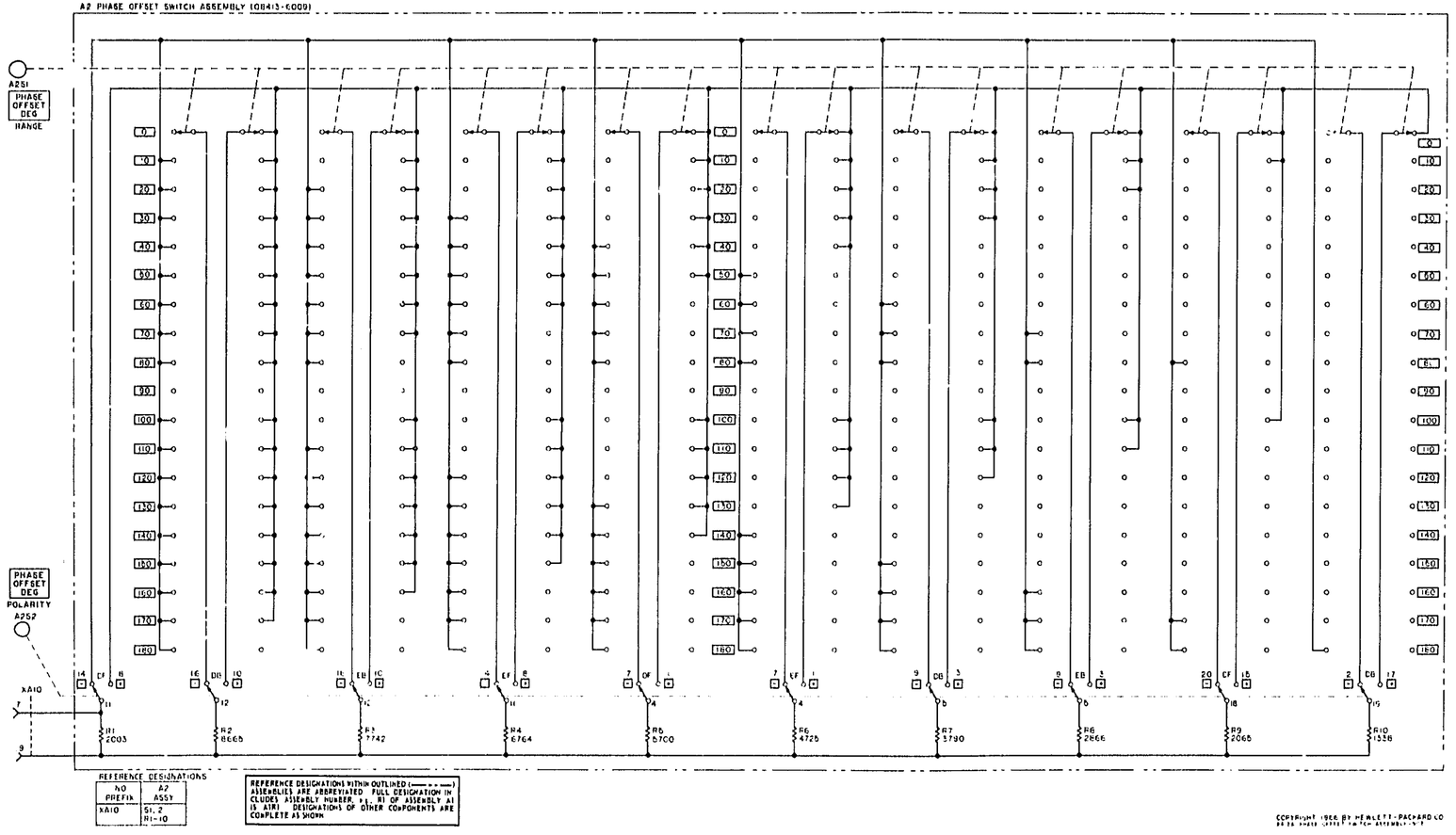


Figure 6-33. Schematic Diagram, Phase Offset Switch

Figure 6-27B. A4 Assembly Recorder and Meter Amplifier, Component Identification for Serial Numbers Prefixed 808- and Above

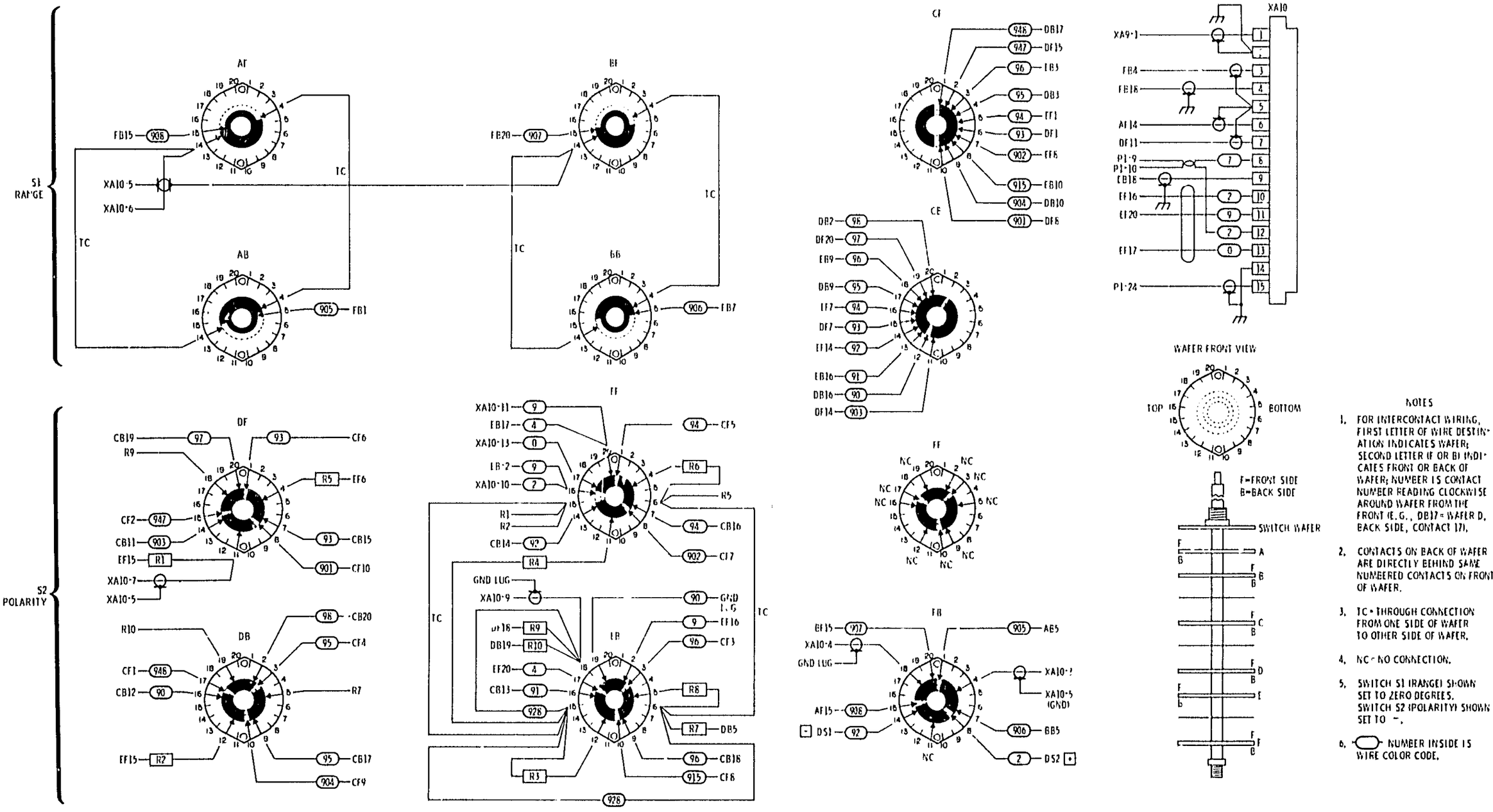
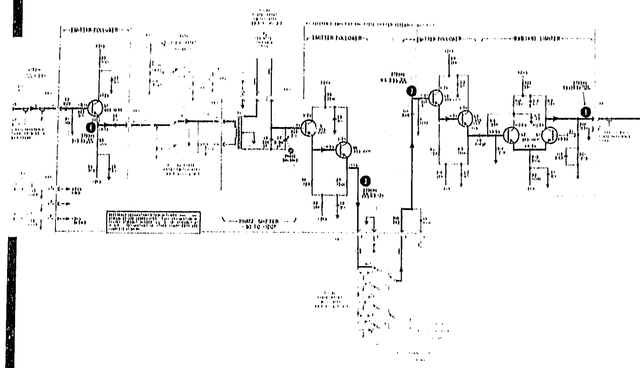


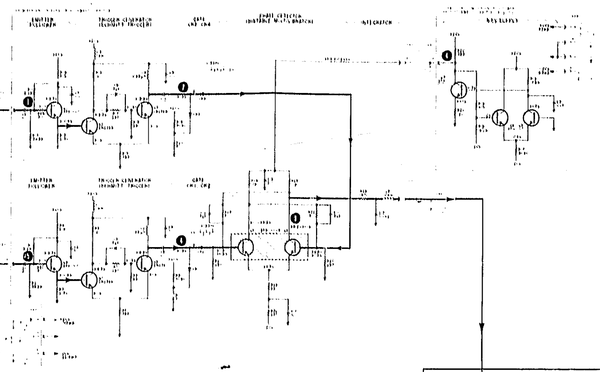
Figure 6-34. Wiring Diagram, Phase offset Switch Assembly

PHASE

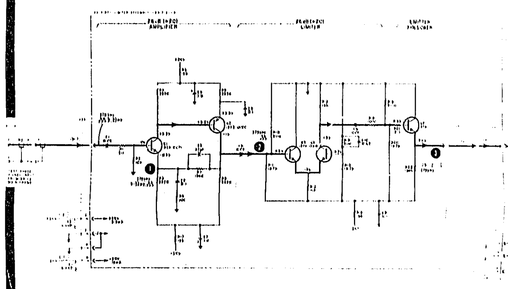
PHASE OFFSET



PHASE DETECTOR



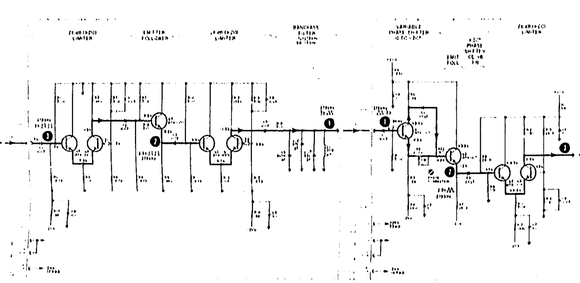
LIMITERS



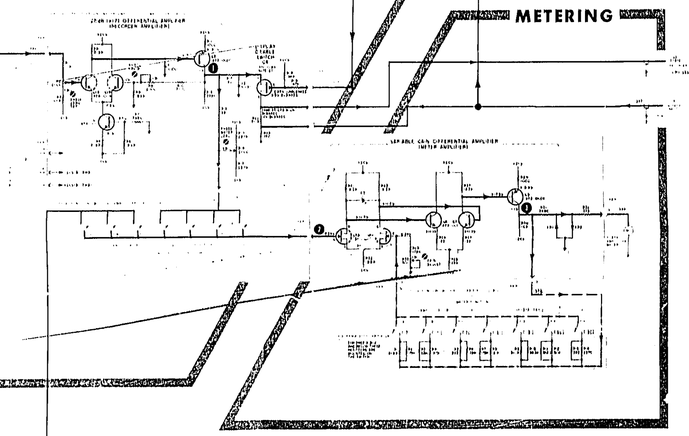
LIMITERS

FILTER

PHASE CORRECTION



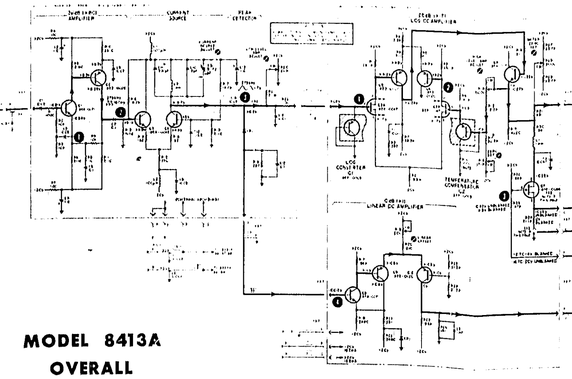
METERING



AMPLITUDE

DETECTOR

LOG AMPLIFIER



LINEAR AMPLIFIER

NOTES

FOR COMPLETE NOTES AND MEASUREMENT CONDITIONS,
SEE OPERATING AND SERVICE MANUAL

MODEL 8413A
OVERALL
SCHEMATIC DIAGRAM
FOR SERIAL PREFIX 903-

APPENDIX

APPENDIX A

MANUAL CHANGES

INTRODUCTION

This Appendix contains information for adapting this manual to instruments that it does not directly apply to. To adapt the manual to your instrument, refer to Table A-1 and make all of the manual changes listed opposite your instrument serial number. Perform the changes in the alphabetical order given.

If your instrument serial number is not listed on the title page of this manual, or in Table A-1 below, it may be documented in a yellow MANUAL CHANGES supplement supplied with this manual. For information about serial numbers not covered in any of the above ways, consult the nearest Hewlett-Packard office.

TABLE A-1.

MODEL 8413A MANUAL CHANGES BY SERIAL NUMBER

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
826-00631 through 826-00690	A
826-00506 through 826-00630	A, B
806-	A, B, C
804-	A, B, D, E
802-	A, B, D, E, I

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
747-	A, B, D, E, F, G, J
736-00181 through 736-00205	A, B, D, E, F, G, H, J
736-00156 through 736-00180	A, B, D, E, F, G, H, I, J
736-00131 through 736-00155	A, B, D, E, F, G, H, I, K
713-00100 through 736-00130	A, B, D, E, F, G, H, I, K, L

CHANGE A

Page 5-11, Table 5-1:
Delete C14

Page 5-12, Table 5-1:
Delete R1

Page 5-13, Table 5-1:
Change Item 1 to read:
HP Part No. 08413-0022 PANEL: FRONT (MINT GRAY OLIVE BLACK (STANDARD)
HP Part No. 08413-0001 PANEL: FRONT (LIGHT GRAY) OPTION A85, X95

Change Item 5 to read:
HP Part No. 08413-00021 TOP COVER ASSY: PLUG-IN (OLIVE GRAY) (STANDARD)
HP Part No. 5060-0220 TOP COVER ASSY: PLUG-IN (BLUE GRAY) (OPTION X95)

Change Item 7 to read:
HP Part No. 5000-0140 COVER: PLUG-IN BOTTOM (OLIVE GRAY) (STANDARD)
HP Part No. 5000-3330 COVER: PLUG-IN (BLUE GRAY) (OPTION X95)

Page 5-14, Table 5-2:
Delete HP Part No. 0180-0050

Change HP Part No. 0370-0945 to read:
HP Part No. 0370-0945 PUSHBUTTON: METER FUNCTION (JADE GRAY) (STANDARD)
HP Part No. 0370-0162 PUSHBUTTON: METER FUNCTION (GRAY) (OPTION X95)

Page 5-15, Table 5-2:
Change HP Part No. 0757-0394 TQ (Total Quantity) from 2 to 1

Page 5-16, Table 5-2:
Change HP Part No. 5000-0140 to read:
HP Part No. 5000-0140 COVER: PLUG-IN BOTTOM (OLIVE GRAY) (STANDARD)
HP Part No. 5000-3330 COVER: PLUG-IN BOTTOM (BLUE GRAY) (OPTION X95)

Change HP Part No. 08413-00022 to read:
HP Part No. 08413-00022 PANEL: FRONT (MINT GRAY OLIVE BLACK) (STANDARD)
HP Part No. 08413-0001 PANEL: FRONT (LIGHT GRAY) (OPTION A85, X95)

CHANGE B

Page 5-11, Table 5-1:
Delete A10Z2

Page 5-16, Table 5-2:
Change HP Part No. 0170-0016 TQ to 3

Page 6-11, Figure 6-12, Schematic #1:
Delete Z2, on A10Q7 emitter lead

CHANGE C

Page 5-11, Table 5-1:
Add A11 HP Part No. 0813-0027, BOARD, INTERCONNECTING

Add A11XA3 HP Part No. 1251-1558, CONNECTOR: PC 15 CONTACTS

Add A11XA4 HP Part No. 1251-1558, CONNECTOR: PC 15 CONTACTS

CHANGE C (Cont'd)

Page 5-12, Table 5-1:
Delete XA3 and XA4

Page 5-16, Table 5-2:
Change HP Part No. 1251-0160 TQ to 6

Add HP Part No. 1251-1558, Description CONNECTOR PC 15 CONTACTS, Mfr. 28480, Mfr. Part No. 1251-1558, TQ 2

Page 5-17, Table 5-2:
Add HP Part No. 08413-6027, Description BOARD INTERCONNECTING, Mfr. 28480, Mfr. Part No. 08413-6027, TQ 1

CHANGE D

Page 5-11, Table 5-1:
Add A11 HP Part No. 08413-6012, BOARD, INTERCONNECTING

Add A11XA3 HP Part No. 1251-1558, CONNECTOR: PC 15 CONTACTS

Add A11XA4 HP Part No 1251-1558, CONNECTOR: PC 15 CONTACTS

Page 5-12, Table 5-1:
Delete XA3 and XA4

Page 5-16, Table 5-2:
Change HP Part No. 1251-0160 TQ to 6

Add HP Part No. 1251-1558, Description CONNECTOR PC 15 CONTACTS, Mfr. 28480, Mfr. Part No. 1251-1558, TQ 2

Page 5-17, Table 5-2:
Add HP Part No. 08413-6012, Description BOARD INTERCONNECTING, Mfr. 28480, Mfr. Part No. 08413-6012, TQ 1

CHANGE E

Page 5-2, Table 5-1:
Change A5 to HP Part No. 08413-6002, BOARD ASSY, AMPL, METERING, (NOTE: When replacing A3 and A4 Assemblies with HP Part No. 08413-6030, MATCHED PAIR, in instruments without rear-panel MARKER INPUT - serial numbers prefixed 802 - and below - connect a jumper wire from XA3-pin 6 to XA4-pin 6).

Page 5-3, Table 5-1:
Delete A3R11 Part No. and change Description to NOT ASSIGNED

Change A4 to HP Part No. 08413-6008, BOARD ASSY, PHASE REC. & METER AMPL, (NOTE: When replacing A3 and A4 Assemblies with HP Part No. 08413-6030, MATCHED PAIR, in instruments without rear-panel MARKER INPUT - serial numbers prefixed 802 - and below - connect a jumper wire from XA3-pin 6 to XA4-pin 6).

Page 5-5, Table 5-1:
Delete A4R34

Page 5-10, Table 5-1:
Delete A10C17

Page 5-11, Table 5-1:
Change A10R16 to HP Part No. 0698-3150, RESISTOR MET FLM 26.1K OHM 1% 1/8W

Change A10R17 to HP Part No. 0757-0443, RESISTOR MET FLM 1% 1/8W

CHANGE E (Cont'd)

Change A10R20 to HP Part No. 0698-3150, R:FXD MET FLM 26.1K OHM [illegible] 1/8W

Change A10R21 to HP Part No. 0757-0443, R:FXD MET FLM 10K OHM [illegible] 1/8W

Delete A10R26

Page 5-14, Table 5-2:
Change HP Part No. 0150-0086 TQ to 22

Change HP Part No. 0698-3157 TQ: Decrease TQ by 2

Change HP Part No. 0698-3150 TQ to 7

Page 5-15, Table 5-2:
Change HP Part No. 0757-0278 TQ to 5

Delete HP Part No. 0757-0420

Change HP Part No. 0757-0443 TQ: Increase TQ by 1

Delete HP Part No. 0757-0444

Delete HP Part No. 0757-0463

Page 5-17, Table 5-2:
Add HP Part No. 08413-6002, Description BOARD ASSY, AMPL, METERING, Mfr. 28480, Mfr. Part No. 08413-6002, TQ 1

Add HP Part No. 08413-6008, Description BOARD ASSY, PHASE REC, & METER AMPL., Mfr. 28480, Mfr. Part No. 08413-6003, TQ 1

Delete HP Part No. 08413-6023

Delete HP Part No. 08413-6025

Page 6-11, Figure 6-12, Schematic #1:
Change voltage on output waveform at A10TP1 to 6,1 ± 0,5V

Page 6-17, Figure 6-24, Schematic #4:
Change voltage on input waveform at A9TP1 to 6,1 ± 0,5V

Page 6-19, Figure 6-26, Schematic #5:
Change A4 to 08413-6008

Page 6-21/6-22, Figure 6-32, Schematic #6:
Delete A3R11 (R12 is connected to junction formed by A3R13 and Q2 base)

Change A3 to 08413-6002

CHANGE F

Page 5-2, Table 5-1:
Delete A1A1

Change A1A1R1, to A1R1 HP Stock No. 0698-3160 R: FXD MET FLM 31.6K OHM [illegible] 1/8W

Change A1A1R2, to A1R2 HP Stock No. 0698-3453 R:FXD MET FLM 196K OHM [illegible] 1/8W

Change A1A1R3, to A1R3 HP Stock No. 0757-0430 R:FXD MET FLM 6.81K OHM [illegible] 1/8W

Change A1A1R4, to A1R4 HP Stock No. 0698-3452 R:FXD MET FLM 147K OHM [illegible] 1/8W

Change A1A1R4, to A1R5 HP Stock No. 0757-0421 R:FXD MET FLM 825 OHM [illegible] 1/8W

Change A1A1R6, to A1R6 HP Stock No. 0698-3136 R:FXD MET FLM 17.8K OHM [illegible] 1/8W

CHANGE F (Cont'd)

Change A1A1R7, to A1R7 HP Stock No. 0698-3243 RESD MET FLM 170K OHM 1% 1/8W

Change A1A1R8, to A1R8 HP Stock No. 0757-0467 RESD MET FLM 121K OHM 1% 1/8W

Change A1A1R9, to A1R9 HP Stock No. 0757-0458 RESD MET FLM 51.1K OHM 1% 1/8W

Change A1A1R10, to A1R10 HP Stock No. 0698-3161 RESD MET FLM 3,83K OHM 1% 1/8W

Change A1A1R11, to A1R11 HP Stock No. 0757-0438 RESD MET FLM 5,11K OHM 1% 1/8W

Change A1A1R12, to A1R12 HP Stock No. 0757-0462 RESD MET FLM 511K OHM 1% 1/8W

Change A1A1R13, to A1R13 HP Stock No. 0698-3446 RESD MET FLM 383 OHM 1% 1/8W

Change A1A1R14, to A1R14 HP Stock No. 0698-3150 RESD MET FLM 2,37K OHM 1% 1/8W

Page 5-15, Table 5-2:
Change HP Part No. 0757-0200 TQ to 2

Change HP Part No. 0757-0478 TQ: Increase TQ by 1

Change HP Part No. 0757-0458 TQ to 3

Add HP Part No. 0757-0462, Description RESD MET FLM 511K OHM 1% 1/8W, 5Mr, 28480, Mfr. Part No. 0757-0462, TQ 1

Page 6-10, Figure 6-28, Schematic 6:
Change A1A1R1 to A1R1

Change A1A1R2 to A1R2

Change A1A1R3 to A1R3

Change A1A1R4 to A1R4

Change A1A1R5 to A1R5

Change A1A1R6 to A1R6

Change A1A1R7 to A1R7

Change A1A1R8 to A1R8

Change A1A1R9 to A1R9

Change A1A1R10 to A1R10

Change A1A1R11 to A1R11, 5,11K OHM

Change A1A1R12 to A1R12, 511K OHM

Change A1A1R13 to A1R13

Change A1A1R14 to A1R14

CHANGE G

Page 5-3, Table 5-1:
Change A3R9 to HP Part No. 0698-3453, RESD MET FLM 100K OHM 1% 1/8W

Page 5-6, Table 5-1:
Change A6R12 to HP Part No. 0698-3153, RESD MET FLM 3,83K OHM 1% 1/8W

Change A6R13 to HP Part No. 0757-0280, RESD MET FLM 1,00K OHM 1% 1/8W

CHANGE G (Cont'd)

Page 507, Table 6-1:
Change A7R3 to HP Part No. 0757-0280, R:FXD MET FLM 1.00K OHM 1% 1 8W

Change A7R4 to HP Part No. 0698-3153, R:FXD MET FLM 3.83K OHM 1% 1 8W

Change A7R12 to HP Part No. 0698-3153, R:FXD MET FLM 3.83K OHM 1% 1 8W

Change A7R13 to HP Part No. 0757-0280, R:FXD MET FLM 1.00K OHM 1% 1 8W

Page 5-11, Table 5-1:
Change A10R11 to HP Part No. 0757-0442, R:FXD MET FLM 511K OHM 1% 1 8W

Page 5-14, Table 5-2:
Change HP Part No. 0698-0083 TQ to 3

Change HP Part No. 0698-3153 TQ to 6

Delete HP Part No. 0698-3260

Change 0698-3452 TQ to 3

Page 5-15, Table 5-2:
Change HP Part No. 0698-3453 TQ: Increase TQ by 1

Change HP Part No. 0757-0280 TQ: Increase TQ by 3

Change HP Part No. 0757-0442 TQ: Decrease TQ by 3

Add HP Part No. 0757-0442, Description R:FXD MET FLM 511K OHM 1% 1 8W, Mfr. 28480, Mfr. Part No. 0757-0442, TQ 1

Page 6-11, Figure 6-12, Schematic #1:
Change A10R11 to 511K ohm

Page 6-13, Figure 6-16, Schematic #2:
Change A6R12 to 3830 ohm

Change A6R13 to 1000 ohm

Page 6-15, Figure 6-20, Schematic #3:
Change A7R3 to 1000 ohm

Change A7R4 to 3830 ohm

Change A7R12 to 3830 ohm

Change A7R13 to 1050 ohm

Page 6-21/6-22, Figure 6-32, Schematic #6:
Change A3R9 to 196K ohm

CHANGE H

Page 5-5, Table 5-1:
Change A5R6 to HP Part No. 0757-0403, R:FXD MET FLM 121 OHM 1% 1 8W

Page 5-6, Table 5-1:
Change A5R15 to HP Part No. 0757-0819, R:FXD MET FLM 909 OHM 1% 1 8W

Page 5-15, Table 5-2:
Delete HP Part No. 0757-0402

Change HP Part No. 0757-0403 TQ to 4

CHANGE H (Cont'd.

Delete HP Part No. 0757-0817

Add HP Part No. 0757-0810, Description R:FXD MET FLM 909 OHM 1% 1 2W, Mfr. 28480, Mfr. Part No. 0757-0810, TQ 1

Page 6-21/6-22, Figure 6-32, Schematic #6:
Change A5R8 to 121 ohm

Change A5R15 to 909 ohm

CHANGE I

Page 5-11, Table 5-1:
Change A10R3 and A10R5 to HP Part No. 0698-3155, R:FXD MET FLM 4,64K OHM 1% 1 8W

Change A10R4 to HP Part No. 0698-0085, R:FXD MET FLM 2,61K OHM 1% 1 8W

Page 5-14, Table 5-2:
Change HP Part No. 0698-0085 TQ to 7

Add HP Part No. 0698-3155, Description R:FXD MET FLM 4,64K OHM 1% 1 8W, Mfr. 28480, Mfr. Part No. 0698-3155, TQ 2

Page 5-15, Table 5-2:
Change HP Part No. 0757-0280 TQ: Decrease TQ by 2

Delete HP Part No. 0757-0422

Page 6-11, Figure 6-12, Schematic #1:
Change A10R3 and A10R5 to 4640 ohm

Change A10R4 to 2610 ohm

CHANGE J

Page 5-3, Table 5-1:
Change A3R32 to HP Part No. 0698-3243, R:FXD MET FLM, 176K OHM 1% 1 8W

Page 5-4, Table 5-1:
Change A4R18 to HP Part No. 0698-3243, R:FXD MET FLM, 176K OHM 1% 1 8W

Page 5-14, Table 5-2:
Change HP Part No. 0698-3243 TQ to 5

Page 5-15, Table 5-2:
Change HP Part No. 0698-3453 TQ: Decrease TQ by 2

Page 6-10, Figure 6-28, Schematic #5:
Change A4R18 to 176K ohm

Page 6-21/6-22, Figure 6-32, Schematic #6:
Change A3R32 to 176K ohm

CHANGE K

Page 5-4, Table 5-1:
Change A4R1 to HP Part No. 0757-0442, R:FXD MET FLM 10.0K OHM 1% 1 8W

Page 5-7, Table 5-1:
Change A7C10 to HP Part No. 0160-2562, C:FXD CER 470 pF 5% 500 VDCW

CHANGE K (Cont'd)

Page 6-14, Table 6-2:
Add HP Part No. 0160-2562, Description C:FXD CER 470 PF 5% 500 VDCW, Mfr. 7160, Mfr. Part No. 0CC35N1500 471J

Delete HP Part No. 0160-3076

Page 6-15, Table 6-2:
Change HP Part No. 0757-0442 TQ: Increase TQ by 1

Change HP Part No. 0757-0443 TQ: Decrease TQ by 1

Page 6-19, Figure 6-28, Schematic #5:
Change A4R1 to 10K ohm

CHANGE L

Page 6-5, Table 6-1:
Change A5C11 to HP Part No. 0160-2208, C:FXD MICA 330 PF 5% 300 VDCW

Page 6-8, Table 6-1:
Change A8R18 to HP Part No. 0698-3157, R:FXD MET FLM 10.6K OHM 1% 1/8W

Change A8R19 to HP Part No. 0757-0438, F:FXD MET FLM 5.11K OHM 1% 1/8W

Page 6-10, Table 6-1:
Change A10C6 to HP Part No. 0160-2211, C:FXD MICA 510 PF 5% 300 VDCW

Page 6-14, Table 6-2:
Delete HP Part No. 0140-0225

Delete HP Part No. 0160-0339

Add HP Part No. 0160-2208, Description C:FXD MICA 330 PF 5% 300 VDCW, Mfr. 28480, Mfr. Part No. 0160-2208, TQ 1

Add HP Part No. 0160-2211, Description C:FXD MICA 510 PF 5% 300 VDCW, Mfr. 28480, Mfr. Part No. 0160-2211, TQ 1

Change HP Part No. 0698-3157 TQ: Increase TQ by 1

Delete HP Part No. 0698-3279

Page 6-15, Table 6-2:
Change HP Part No. 0757-0438 TQ: Increase TQ by 1

Delete HP Part No. 0757-0448,

Page 6-11, Figure 6-12, Schematic #1:
Change A10C6 to 510 pF

Page 6-16, Figure 6-20, Schematic #3:
Change the name of A8 Assembly to:
P/O A8 THIRD LIMITER AND 5.1V POWER SUPPLY ASSEMBLY
(08413-6006) 1 OF 2

Page 6-17, Figure 6-24, Schematic #4:
Change A8R18 to 10.6K ohm

Change A8R19 to 5110 ohm

Change the name of A8 Assembly to:
P/O A8 THIRD LIMITER AND 5.1V POWER SUPPLY ASSEMBLY
(08413-6006) 2 OF 2

CHANGE 1 (Cont'd)

Change the stage name to read: 5, 1V SUPPLY

Change the voltage on the line from A8TP4 to A8TP3 to read:
+5, 1V ± 0, 2 VDC

MANUAL CHANGES

MANUAL CHANGES

MANUAL IDENTIFICATION
Model Number: 8413A
Date Printed: May 1974
Part Number: 08413-90011

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

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

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES
1144A01961 thru 1144A01980	1
1513A	1,2
1548A, 2005A	1,2,3
2032A	1,2,3,4
2301A	1-5
►2424A	1-6

SERIAL PREFIX OR NUMBER	MAKE MANUAL CHANGES

►NEW ITEM

ERRATA

Page 4-13, Figure 4-2, Test 4:

On the test setup, change the lead going to J2 pin 3 of the 8413A to rear connector TEST PHASE OUTPUT on 8410B.

Change f to read: "f. Set 1-dB step attenuator for 200 mV±10 mV peak-to-peak at 8410B TEST PHASE OUTPUT.

Page 4-15, Table 4-2, step 3:

Under "Amplitude (50 mV/dB)," change the minimum value for +9 dB to +436 mV and change the minimum value for −9 dB to −436 mV.

NOTE

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

Printed in U.S.A.

20 SEPTEMBER 1984

6 pages

HEWLETT PACKARD

ERRATA (Cont'd)

Page 5-2, Table 5-1:
Change A1A1R2 to HP Part Number 0698-3243, F:FXD MET FLM 178K OHM 1% 1/8W.

Page 5-3, Table 5-1:
Change A3R11 to HP Part Number 0757-0464, Resistor 90.9K 1% .125 F TC=0±100 (FACTORY SELECTED PART).
Change A3R12 to HP Part Number 2100-3054, Resistor-Trmr 50K 10% C Side-Adj 17-Turn.

Page 5-4, Table 5-1:
Change A4Q2 to HP Part Number 1854-0475, CD 5.

Page 5-7, Table 5-1:
Change A7C6 to HP Part Number 0160-3048, C:FXD MICA 8000 PF 1% VDCW.

Page 5-12, Table 5-1:
Under Miscellaneous section, change HP Part Number 5000-3505 to 5000-3305.
Add HP Part Number 08413-00027, Switch Bracket.
Add HP Part Number 0361-1127, Eyelet (Quantity 12).

Page 6-15, Figure 6-20:
Change A7C6 to 8000 pF.

Page 6-19, Figures 6-27A and 6-27B:
Change "R15" next to test point 2 to "R13."

Page 6-21, Figure 6-32:
Change A3R11 to 90.9 K.
Change A3R12 to 50K.

CHANGE 1

Page 5-6, Table 5-1:
Change A6Q3 and A6Q4 to HP Part No. 1854-0005.

Page 5-7, Table 5-1:
Change A7Q1, A7Q2, A7Q4, and A7Q5 to HP Part No. 1854-0005.

Page 6-13, Figure 6-16:
Change A6Q3 and A6Q4 to HP Part No. 1854-0005.

Page 6-15, Figure 6-20:
Change A7Q1, A7Q2, A7Q4, and A7Q5 to HP Part No. 1854-0005.

CHANGE 2

Page 5-13, Table 5-1:
Change Item 1 to HP Part No. 08413-00024 PANEL: FRONT (MINT GRAY/JADE GRAY).

Page 5-16, Table 5-2:
Change PANEL:FRONT to HP Part No. 08413-00024.

CHANGE 3

Page 1-1, Table 1-1:
Change phase meter accuracy specification to read as follows:
Accuracy: ±2% of end scale or ±0.2 degrees, whichever is greater.

Page 4-4, Figure 4-2:
Change phase meter accuracy specification to read as follows:
Phase Meter Accuracy: ±2% of end scale or ±0.2 degrees, whichever is greater.

Page 4-6, Figure 4-2:
Change 8413A Phase Meter Indication tolerances to ±0.2 degrees when the 8413A 6 degree Phase Range is selected.

Page 4-23, Figure 4-4:
Change 8413A Phase Meter Indication tolerances to ±1 small scale division when the 8413A 6 degree Phase Range is selected.

CHANGE 4

Page 5-13, Table 5-1:
Change Item 6 as follows:

HP Part No.	Description
08413-00026	PANEL: REAR
08413-20029	SUB-PANEL: REAR
2740-0002	NUT HEX SST 10-32 X 3/8
2190-0064	WASHER: LOCK INT. #10

CHANGE 5

Page 5-2, Table 5-1:
Change A3 to HP Part Number 08413-60032.

Page 5-17, Table 5-2:
Change HP Part Number 08413-6025 to 08413-60032.

Page 6-21, Figure 6-32:
At the top of A3 Schematic, change the part number of A3 Amplitude Metering Assembly to 08413-60032.

►CHANGE 6

Page 5-7, Table 5-1:
Change A7 to HP Part Number 08413-60036 CD 9.
Change A7C1, A7C2, A7C3, A7C4, A7C5, and A7C7 to HP Part Number 0160-4834 CD 6, CAPACITOR-FXD .047 µf ±10% 100VDC CER.
Change A7C6 to HP Part Number 0160-3048 CD 2, CAPACITOR-FXD 8000 PF ±1% 100VDC MICA.
Change A7C8 and A7C9 to HP Part Number 0160-4835 CD 7, CAPACITOR-FXD .1 µf ±10% 50VDC CER.

Page 5-8, Table 5-1:
Change A9 to HP Part Number 08413-60035 CD 8.
Change A9C1, A9C2, A9C4–C7, A9C9–C10, and A9C16–C17 to HP Part Number 0160-4835 CD 7, CAPACITOR-FXD .1 µf ±10% 50VDC CER.

Page 5-10, Table 5-1:
Change A10 to HP Part Number 08413-60034 CD 7.
Change A10C1, A10C3–C5, A10C8–C9, A10C12–C14 to HP Part Number 0160-4835 CD 7, CAPACITOR-FXD .1 µf ±10% 50VDC CER.
Change A10C2, A10C11, A10C15, A10C17 to HP Part Number 0160-4834 CD 6, CAPACITOR-FXD .047 µf ±10% 100VDC CER.
Change A10C10 to HP Part Number 0160-4822 CD 2, CAPACITOR-FXD 1000 PF ±5% 100VDC CER.
Change A10C16 to HP Part Number 0160-4846 CD 0, CAPACITOR-FXD 1500 PF ±5% 100VDC CER.

Page 6-11, Figure 6-11:
Replace the A10 Assembly Component Identification diagram with the one supplied in this change supplement: Figure 6-11 (CHANGE 6).

Page 6-11, Figure 6-12:
At the top of the A10 Schematic, change the part number of the A10 Reference Amplifier and Phase Shift Assembly to 08413-60034.
Change A10C2, A10C11, A10C15 and A10C17 to .047 µf.

Page 6-15, Figure 6-19:
Replace the A7 Assembly Component Identification diagram with the one supplied in this change supplement: Figure 6-19 (CHANGE 6).

Page 6-15, Figure 6-20:
At the top of the A7 Schematic, change the part number of the A7 Second Limiter Assembly to 08413-60036.
Change A7C1–A7C5, A7C7 to .047 µf.
Change A7C6 to 8000 pf.

Page 6-17, Figure 6-23:
Replace the A9 Component Identification diagram with the one supplied in this change supplement: Figure 6-23 (CHANGE 6).

Page 6-17, Figure 6-24:
At the top of the A9 Schematic, change the part number of the A9 Mixer and Integrator Assembly to 08413-60035.

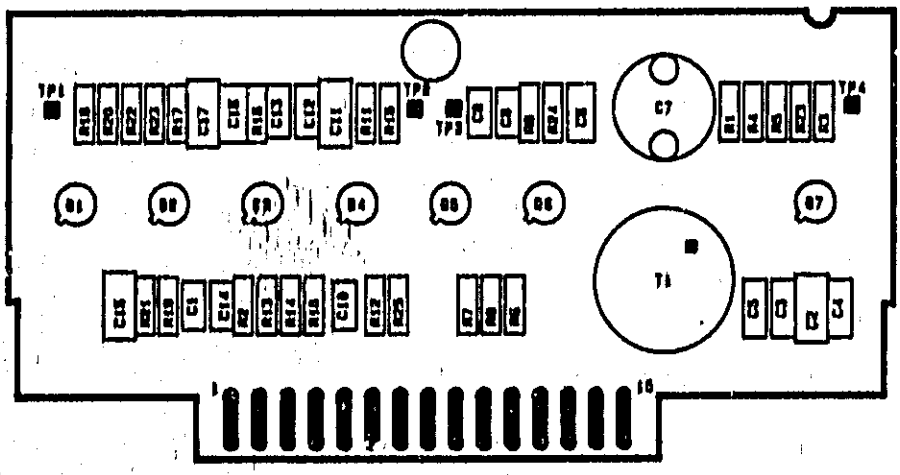


Figure 6-11. A10 Reference Amplifier and Phase Shift Assembly Component Identification (CHANGE 6)

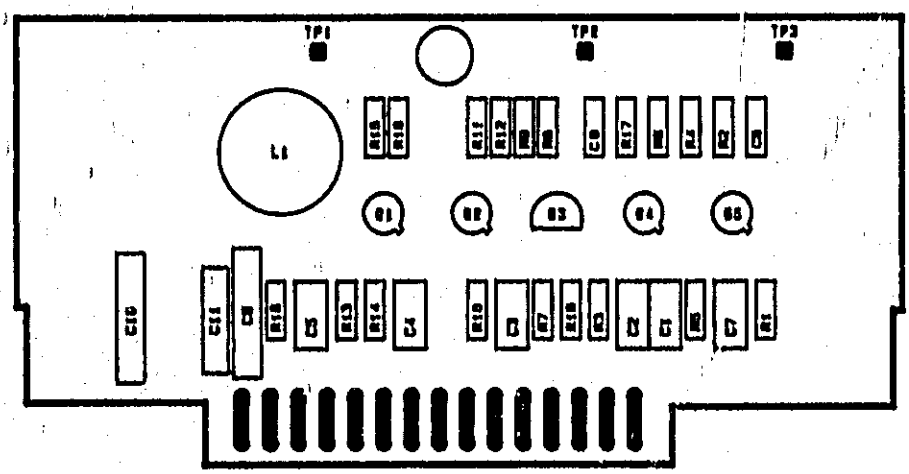


Figure 6-19. A7 Second Limiter Assembly Component Identification (CHANGE 6)

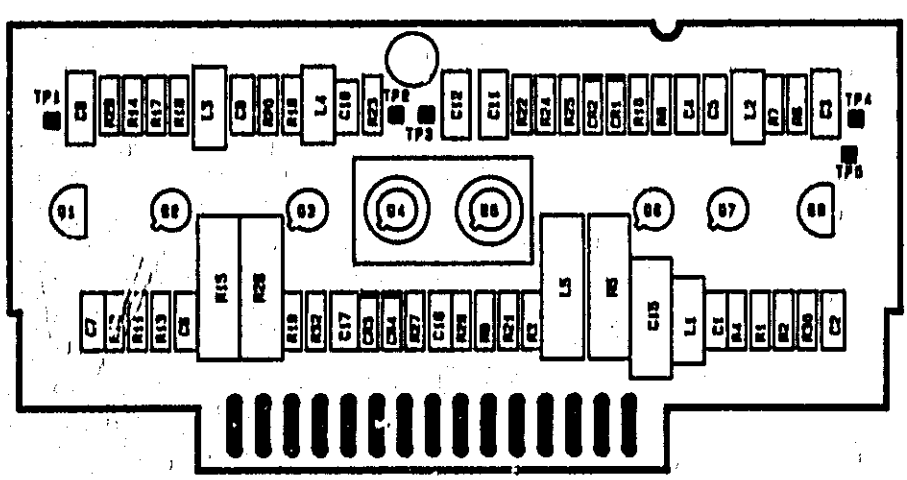


Figure 6-23. A9 Mixer and Integrator Assembly Component Identification (CHANGE 6)