

**8412B
PHASE-MAGNITUDE
DISPLAY**

SERIAL NUMBERS

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

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

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SECTION I GENERAL INFORMATION

1-1. INTRODUCTION

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

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

1-4. Amplitude is displayed in decibels/division and phase is displayed in degrees/division on the

CRT graticule. Various vertical amplifier sensitivity ranges for both amplitude and phase may be selected. Front panel phase offset controls allow the phase to be adjusted for the most convenient display.

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

AMPLITUDE ACCURACY:	
Display:	0.03 dB/DB ±0.05 div/div
Rear Output:	0.03 dB/DB
Temperature Coefficient:	Typically <0.05 dB/°C at midscreen
PHASE ACCURACY:	
Display:	0.015°/degree ±0.05 div/div
Rear Output:	0.015°/degree
Phase Offset:	0.3°/20 degree step, not to exceed total error of 3° for 360° of change, positive or negative direction.
Vs. Displayed Amplitude:	Over upper 70 dB amplitude range: ≤1°/10 dB, maximum phase change not to exceed 4°. Over full 80 dB amplitude range: Maximum phase change not to exceed 6°.

Table 1-1. Specifications

Table 1-2. Supplemental Performance Characteristics

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

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

CONTROLS:

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

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

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

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

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

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

HORIZONTAL GAIN: Adjusts length of trace.

INPUTS:

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

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

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

OUTPUTS:

AMPLITUDE: 50 mV/dB

PHASE: 10mV/DEGREE

POWER: 23 Watts supplied by mainframe

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

DIMENSIONS: 15.2 cm high 39.5 cm deep, 18.6 cm wide (6 in. x 15.9/16 in. x 7-9/32 in.); excludes front panel knobs.

1-6. INSTRUMENTS COVERED BY MANUAL

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

1-8. Changes required to adapt this manual to other serial number prefixes are given in a yellow-

1-9. WARRANTY

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

sheet Manual Changes insert supplied with the manual. For information concerning serial number prefixes not listed on the title page or in an insert, contact your nearest Hewlett-Packard office.

SECTION II INSTALLATION

2-1. INITIAL MECHANICAL INSPECTION

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

2-3. INITIAL ELECTRICAL INSPECTION

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

2-5. PREPARATION FOR USE

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

2-7. CLAIMS

2-8. If physical damage is evident, or if the instrument does not meet specifications when

received, notify the carrier and the nearest Hewlett-Packard sales and service office. (See list at rear of manual). The sales and service office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-9. REPACKAGING FOR SHIPMENT

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

2-10. Using Original Packaging

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

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

- b. Use a strong shipping container.

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

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

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

SECTION III OPERATION

3-1. INTRODUCTION

3-2. The Model 8412B Phase-Magnitude Display is a plug-in unit for the Model 8407B or 8410-

Series Network Analyzer mainframe. The 8412B provides a direct CRT trace of phase and magnitude showing the ratio between the test and reference RF signals applied to the network analyzer.

Controls on the front panel provide horizontal positioning and gain, amplitude low level calibration, phase and amplitude display resolution, and phase offset of the phase trace, as well as CRT intensity and focus. Controls on the rear panel provide vertical positioning and aligning the trace with the horizontal graticule. The rear panel contains BNC connectors which allow connection of the sweeper horizontal signal, and markers blanking. Output signals from the phase and magnitude amplifiers are available at rear panel BNC connectors for use with an external X-Y recorder or oscilloscope. Provision is also made to connect a storage normalizer.

3-3. PANEL FEATURES

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

3-5. SCREWDRIIVER ADJUSTMENTS

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

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

trace moves exactly one major division for each 10 dB step, from the center graticule line toward the bottom of the CRT.

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

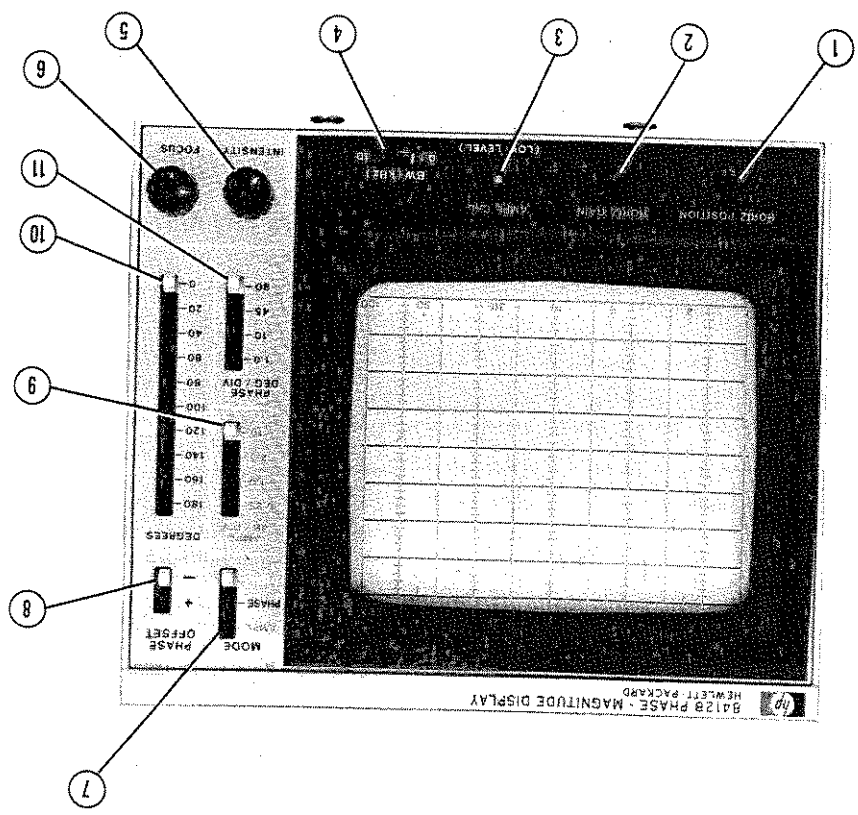
3-9. The TRACE ALIGN control on the rear panel is adjusted to align the 8412B trace to the horizontal graticule. The alignment is done most effectively on the center graticule line. The Sweep Oscillator should be set for minimum sweep width.

3-10. OPERATING PROCEDURES

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

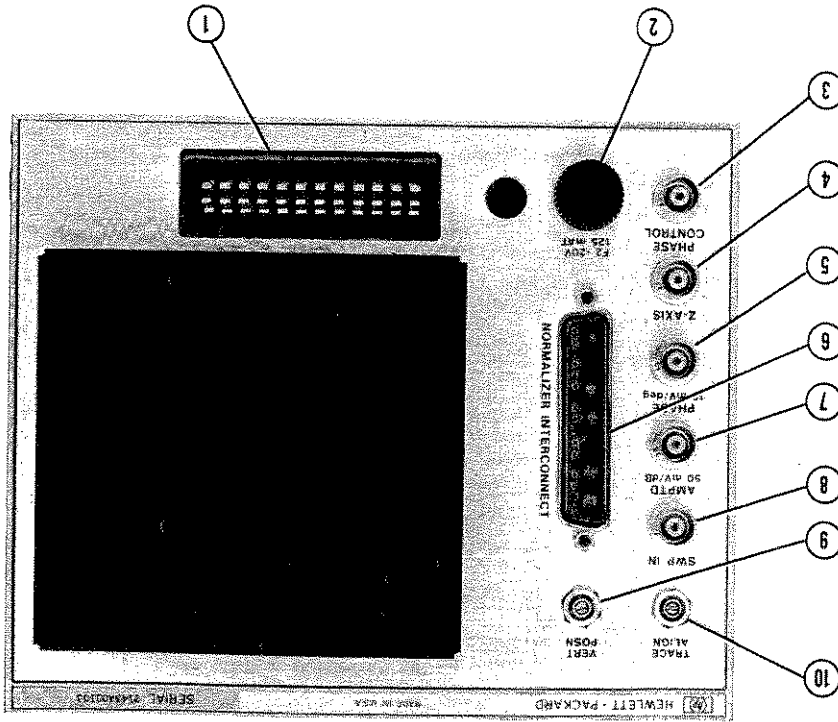
Figure 3-1. Model 8412B Front Panel Features

1. HORIZ POSITION control. Moves trace horizontally.
2. HORIZ GAIN control. Adjusts gain of horizontal amplifier to change length of displayed trace.
3. AMPL CAL (LOW LEVEL) control. Adjusts calibration of amplitude amplifier for signals displayed on lower half of CRT screen. Refer to Paragraph 3-7.
4. BW (kHz) switch. Selects bandwidth passed by the reference and test channels. This allows decreasing bandwidth when necessary to filter noise from the display.
5. INTENSITY control. Controls brightness of the trace.
6. FOCUS control. Controls the sharpness of the trace.
7. MODE switch. Selects AMPL (amplitude), PHASE, or both amplitude and phase (DUAL) to display on resolution of phase display.
8. PHASE OFFSET polarity switch. From zero degrees, offset is selected either in the negative or positive direction up to 180 degrees. The polarity switch selects the direction from zero and works in connection with the DEGREES switch to select offset.
9. AMPL DB/DIV switch. Selects the calibrated resolution of the test channel amplitude display.
10. PHASE OFFSET DEGREES switch. Selects offset in 20-degree steps. The switch works in conjunction with the PHASE OFFSET polarity switch to select direction from zero degrees. The phase offset plus the display reading gives the measured phase reading.
11. PHASE DEG/DIV switch. Selects the calibrated resolution of phase display.



FRONT PANEL

REAR PANEL



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

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

WARNING

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

3. PHASE CONTROL connector J6. This input is used in an automatic network analyzer system. When a phase measurement is made near the + or -180 degree points, this line is closed to ground by the controller, causing the measurement to be offset by 180 degrees. This avoids taking measurements near the + or -180 degree point. When this circuit causes a 180 degree phase offset, the system controller

subtracts 180 degrees from the final phase measurement value. The front-panel Phase Offset Polarity Switch must be in the "+" position for operation of this Phase Offset function.

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

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

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

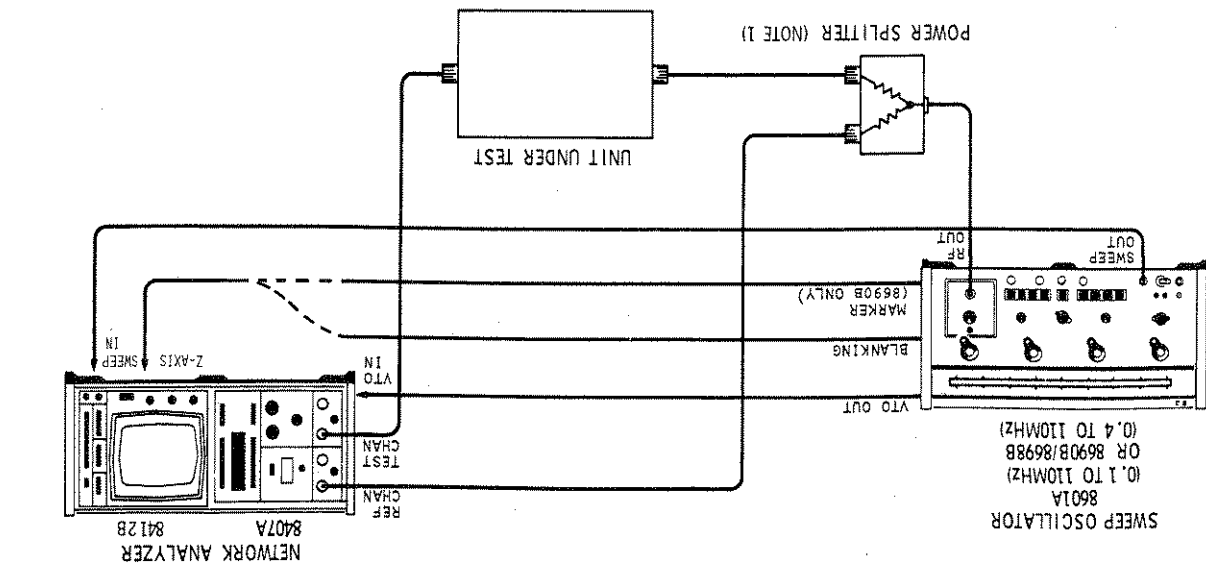
Figure 3-2. Model 8412B Rear Panel Features (1 of 2)

REAR PANEL (Cont'd)

- 7. AMPLITUDE 50 mV/DB connector J3. Depending on the transducer used on the unit under test, the voltage output is proportional to the amplitude ratio of:
 - (1) $20 \log_{10} (V_{TEST}/V_{REF})$,
 - (2) $20 \log_{10} (I_{TEST}/I_{REF})$, or
 - (3) $20 \log_{10} (V_{RETURN}/V_{INCIDENT})$
- 8. SWEEP IN connector J2. Input for sweeper signal that goes to horizontal (x-axis) amplifier.
- 9. VERT POSN control. Zeroes phase and amplitude traces vertically. Refer to Paragraph 3-8.
- 10. TRACE ALIGN Control. Used to align CRT trace to the horizontal graticule. Adjustment should be performed with sweep oscillator set for minimum sweep width. Refer to Paragraph 3-9.

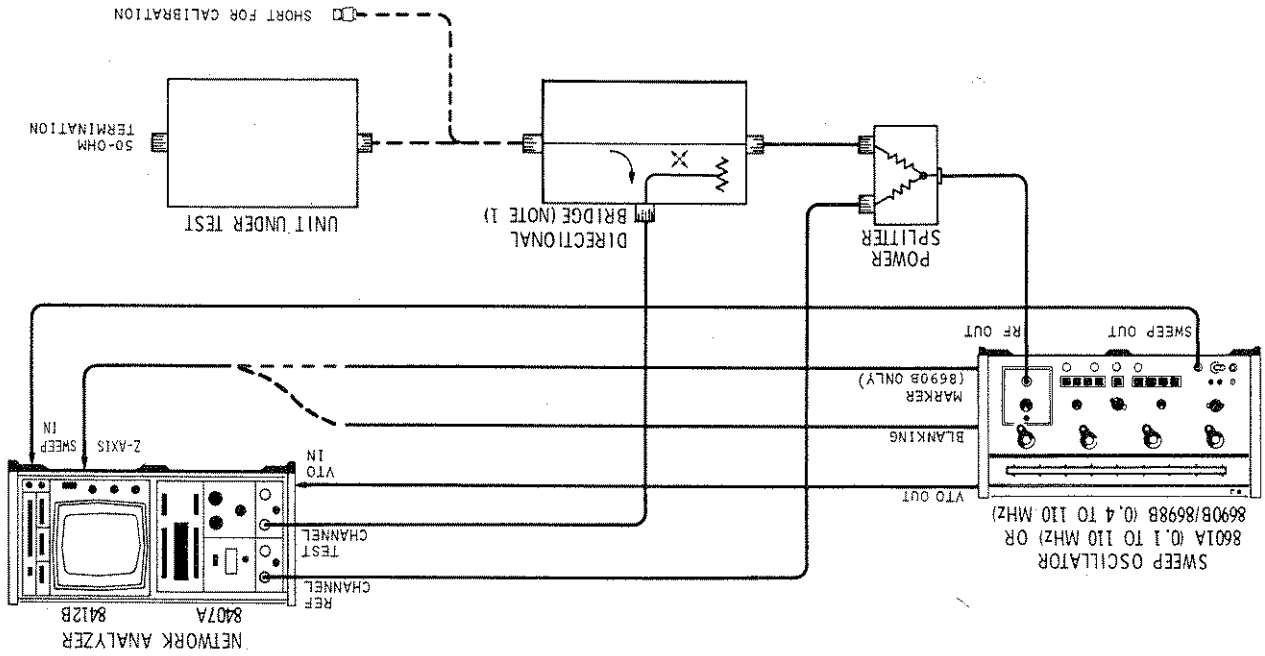
Figure 3-2. Model 8412B Rear Panel Features (2 of 2)

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



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

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

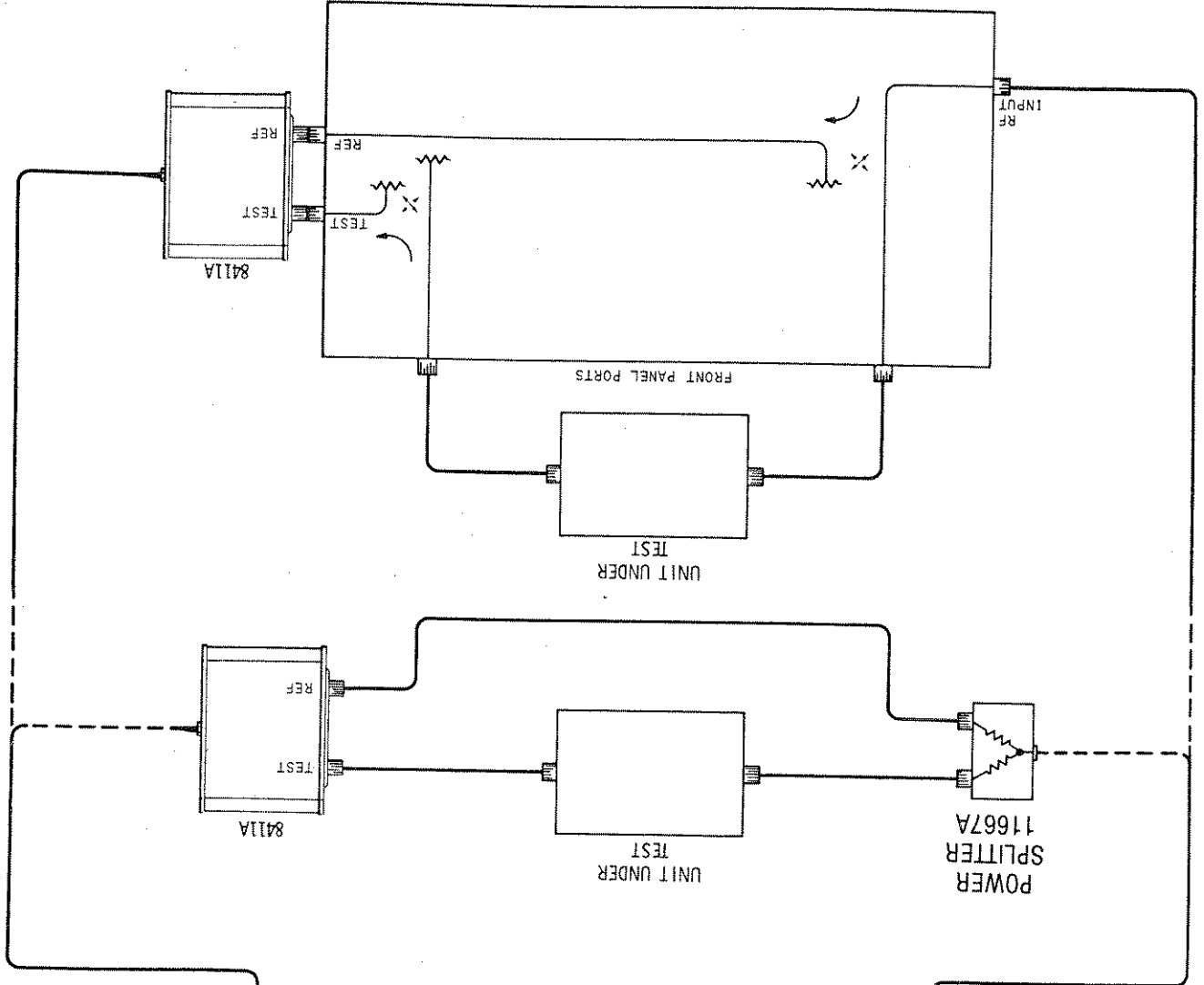


- NOTE: 1. POWER SPLITTER, DIRECTIONAL BRIDGE AND INTERCONNECTIONING CABLES ARE PART OF ACCESSORY KIT HP 11652.
2. Z-AXIS ON 8412B ACCEPTS EITHER POSITIVE BLANKING AND NEGATIVE GOING MARKER OR NEGATIVE BLANKING BY CHANGING SWITCH POSITION OF A3S1.

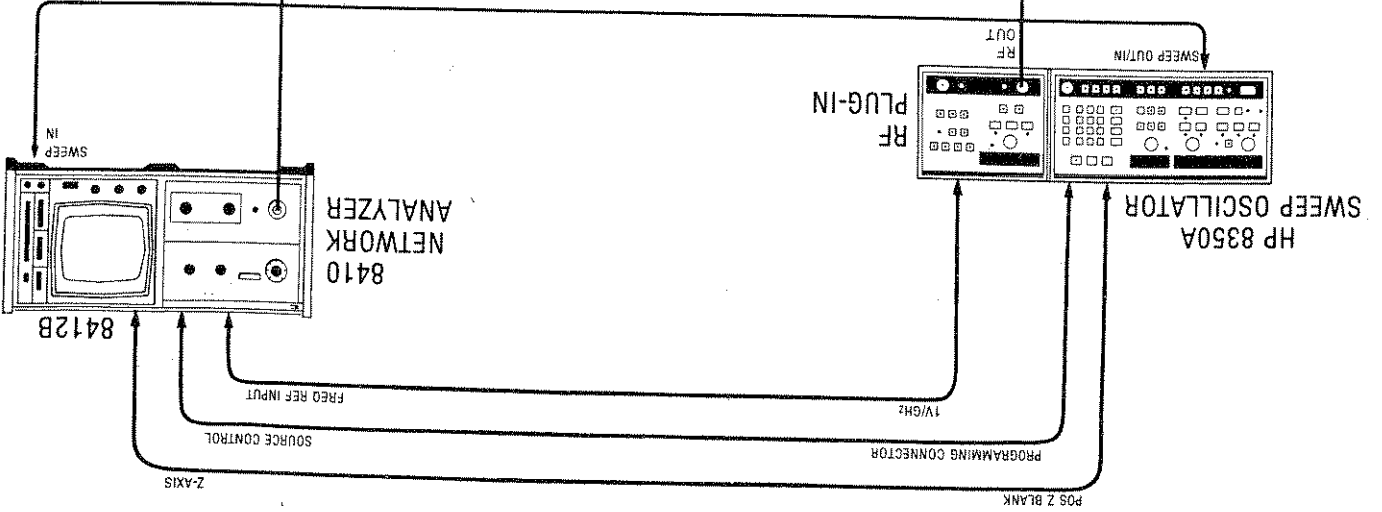
Figure 3-4. Typical Reflection Test Setup Using 8407A/8412B System

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

8743A/B or 8745A
TRANSDUCER



ALTERNATE CONNECTIONS



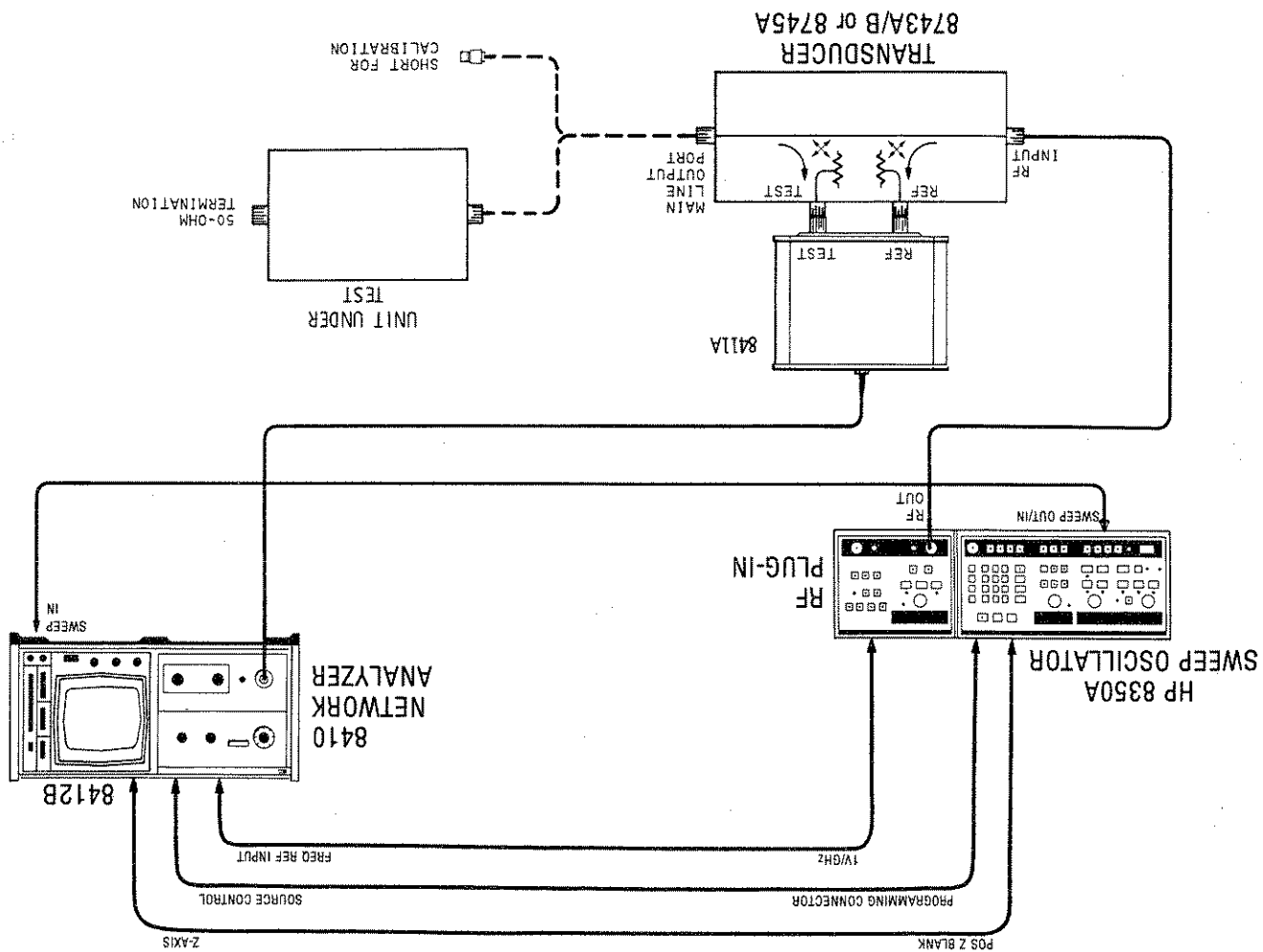


Figure 3-6. Typical Reflection Test Setup Using 8410/8411A/8412B System

