

DOCUMENTATION SUR L'OSCILLOSCOPE HEWLETT-PACKARD HP 8412A

FICHE N° 3913

PRÉSERVER
SAUVEGARDER
VALORISER

Période de fabrication : 1950-1974
Fabricant : Hewlett-Packard Company
Domaines : Physique
Sous-domaines : Electronique
Organisme : Université de Rennes
Ville : Rennes
Modèle : HP 8412A
Matériaux : Papier

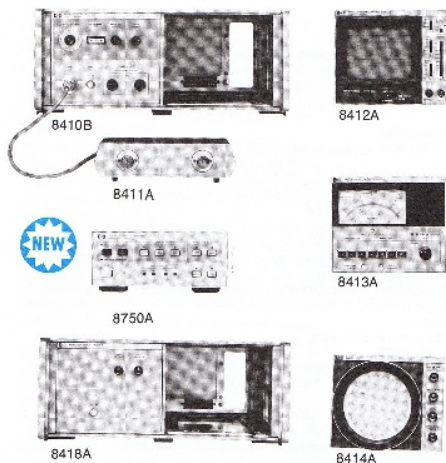
Description

Un manuel d'utilisation de l'oscilloscope HP 8412A (Phase-Magnitude Display) a été édité par Hewlett-Packard en 1969 et révisé en avril 1972. Ce manuel de 120 pages décrit dans le détail le fonctionnement de l'appareil, ses propriétés, les circuits électroniques et les tests de mesures possibles.

Cet appareil est aussi présenté dans le catalogue général Hewlett-Packard de 1970 (page 374) mais aussi de 1982 (page 498). Il est souvent associé à l'analyseur de réseau 8410A.

Utilisation

Cet oscilloscope était très utilisé en travaux pratiques d'électronique à la Faculté des Sciences de Rennes dans les années 1970-1980. On pouvait tracer des diagrammes de phases (degrés) et d'amplitudes (dB) de circuits électriques et électroniques et observer leur évolution en fonction de la nature des composants et de la fréquence. Les échelles sont de 30 dB pour le gain et de 360 ° pour l'angle de phase. On peut aussi traiter des questions comme l'impédance complexe ou les coefficients de réflexion et tracer des abaques de Smith. L'abaque de Smith est un nomogramme reliant le rapport des ondes guidées incidentes et réfléchies le long d'un guide de propagation, à la variation d'impédance caractéristique le long de ce guide.



Specifications

8410B/8411A Network Analyzer

Function: 8411A converts RF signals to IF signals for processing in 8410B mainframe. 8410B is the mainframe for display plug-in units. Mainframe includes tuning circuits (octave bands or multioctave bands when used with HP 8620/86290 sweep oscillator), IF amplifiers and precision IF attenuator.

8410B frequency range: 0.11 to 18 GHz.

8411A frequency range: 0.11 to 12.4 GHz.

Opt 018: 0.11 to 18 GHz.

8411A input impedance: 50 ohms nominal. SWR <1.5, 0.11 to 8.0 GHz; <2.0, 8.0 to 12.4 GHz; typically increases to a 10:1 SWR, 12.4 to 18 GHz.

Channel isolation: >65 dB, 0.1 to 6 GHz; >60 dB, 6 to 12.4 GHz; >50 dB, 12.4 to 18 GHz.

Amplitude

Reference channel: -16 to -26 dBm, 0.11 to 18 GHz; -16 to -36 dBm, 0.11 to 12.4 GHz.

Test channel: -10 to -78 dBm from 0.11 to 12.4 GHz; -10 to -68 dBm from 12.4 to 18 GHz.

Maximum RF input to either channel: 50 mW.

IF gain control: 69 dB range in 10 dB and 1 dB steps with a maximum cumulative error of ± 0.2 dB.

Phase

Phase range: 0 to 360°.

Control: vernier control $\approx 90^\circ$.

Connectors (8411A): APC-7.

Power: 115 or 230 V ac $\pm 10\%$, 50-60 Hz, 70 watts (includes 8411A).

Weight

8410B: net, 14.9 kg (33 lb). Shipping, 18.5 kg (41 lb).

8411A: net, 3.2 kg (7 lb). Shipping, 4.5 kg (10 lb).

Size

8410B: 191 H $\times$ 425 W $\times$ 467 mm D (7 $\frac{1}{2}$ " $\times$ 16 $\frac{1}{2}$ " $\times$ 18 $\frac{3}{8}$ ").

8411A: 67 $\times$ 228 W $\times$ 143 mm D (2 $\frac{5}{8}$ " $\times$ 9" $\times$ 5 $\frac{5}{8}$ ") exclusive of connectors and cable.

8412A Phase-Magnitude Display

Function: plug-in CRT display unit for 8410B. Displays relative amplitude in dB and/or relative phase in degrees between reference and test channel inputs versus frequency.

Amplitude

Range: 80 dB display range with selectable resolutions of 10, 2.5, 1 and 0.25 dB/division.

Accuracy: 0.08 dB/dB from midscreen.

Phase

Range: $\pm 180^\circ$ display range with selectable resolutions of 90, 45, 10, and 1°/division.

Accuracy: 0.065°/degree from midscreen.

Phase offset: 0.3°/20° step cumulative <3°.

Power: 23 watts supplied by mainframe.

Weight: net, 7.8 kg (17 lb). Shipping, 10 kg (22 lb).

Dimensions: 152 H $\times$ 186 W $\times$ 395 mm D (6" $\times$ 7 $\frac{3}{8}$ " $\times$ 15 $\frac{5}{16}$ ") excluding front panel knobs.

New 8750A Storage-Normalizer

General: the 8750A Storage-Normalizer provides digitally stored and normalized CRT displays when used with the 8412A Phase Magnitude Display. Measurements are faster, easier and more accurate when the 8750A is employed because the CRT is flicker-free and frequency response errors are eliminated. The 8750A is not compatible with the 8414A Polar Display.

Power: selection of 100, 120, 220, or 240V $\pm 5\%$ -10%. 48 to 440 Hz and ≈ 20 VA ≈ 20 watts).

Weight: net, 2.72 kg (6 lbs). Shipping, 5.0 kg (11 lbs).

Detailed specifications on page 459.

8413A Phase-Gain Indicator

Function: plug-in meter display unit for 8410B. Displays relative amplitude in dB between reference and test channel inputs or relative phase in degrees. Pushbutton selection of meter function and range.

Amplitude

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

Accuracy: $\pm 3\%$ of end scale.

Log output: 50 millivolts per dB up to 60 dB total.

Phase

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

Accuracy: $\pm 2\%$ of end scale.

Output: 10 millivolts per degree.

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

Accuracy: $\pm 0.2^\circ + 0.3^\circ/10^\circ$ step, cumulative <2°.

Power: additional 15 watts supplied by 8410B.

Weight: net, 4.9 kg (11 lb). Shipping, 6.7 kg (15 lb).

Size: 152 H $\times$ 186 W $\times$ 395 mm D (6" $\times$ 7 $\frac{3}{8}$ " $\times$ 15 $\frac{5}{16}$ ").

8414A Polar Display

Function: plug-in CRT display unit for 8410B. Displays amplitude and phase data in polar coordinates on 5-in. cathode ray tube.

Range: normalized polar coordinate display; magnitude calibration 20% of full scale per division. Scale factor is a function of IF setting on 8410B. Phase calibrated in 10-degree increments over 360-degree range.

Accuracy: error circle on CRT ± 3 mm.

Power: additional 35 watts supplied by 8410B.

Weight: net, 5.8 kg (13 lb). Shipping, 8.1 kg (18 lb).

Size: 152 H $\times$ 186 W $\times$ 395 mm D (6" $\times$ 7 $\frac{3}{8}$ " $\times$ 15 $\frac{5}{16}$ ") excluding front panel knobs.

8418A Auxiliary Power Supply

Function: the 8418A power supply unit provides power for operating of the 8412A, 8413A or the 8414A display units. Used in conjunction with the 8410B Network Analyzer, it provides the capability of viewing amplitude and phase readout in both rectangular and polar coordinates simultaneously. Option H01 adds a remotely programmable 0-70 dB IF attenuator required for autoranging in semi-automatic applications.

Weight: net, 11.2 kg (25 lb). Shipping, 19.7 kg (44 lb).

Size: 177 H $\times$ 483 W $\times$ 450 mm D (6 $\frac{3}{4}$ " $\times$ 19" $\times$ 17 $\frac{1}{8}$ ").

Ordering information

8410B mainframe

Opt 908: Rack Flange Kit

8411A Frequency Converter

Opt 018: 0.11 to 18 GHz

8412A Phase-Magnitude Display

8413A Phase-Gain Display

8414A Polar Display

8418A Auxiliary Power Supply

Opt H01: Programmable 0-70 dB IF Attenuator

8750A Storage-Normalizer

Only recently has network analysis become similarly possible in the very important range 100 kHz to 110 MHz. There have been efficient, direct ways to measure magnitude and phase point by point across these bands;³ separation of the real and the imaginary components of impedance, similarly on a point-to-point basis, can be accomplished without lengthy nulling or calculating functions.⁴ Combinations of earlier equipment could make some valuable swept measurements.⁵

Only now, however, has a measuring method for this range combined the following list of desirable capabilities:

- Measure as much as 80 dB circuit gain or loss on a single swept display

- While thus showing magnitude, simultaneously display phase relations $\pm 180^\circ$.
- Reject responses to signal-source spurious and harmonic signals
- On a swept CRT display, resolve amplitude to 0.05 dB, phase to 0.2°
- Achieve accuracies, in swept measurements, equaling and in some cases exceeding those previously common with CW methods.

The instrumentation is the Hewlett-Packard Network Analyzer, Model 8407A and associated equipment (Fig. 1 and Table I). The network analyzer requires one of two sweep sources. This may be either HP Model 8601A⁶ or HP Model 8690B/8698B.



Fig. 1. Network analyzer system for range 0.1 to 110 MHz includes optional plug-in displays. Two are shown here, Model 8412A Phase-Magnitude (partly installed) and Model 8414A Polar (above). In the foreground (left) is a new directional bridge with more than 40 dB directivity across the band of concern. Also shown are power splitter, passive probe and divider, parts of the transducer kits designed for the system.

NETWORK ANALYZERS *continued*

Mainframe, display plug-ins, accessories

Models 8407A, 8412A, 8414A, 11651A, 11652A, 11654A

Specifications

8407A

Test input:

Direct: -10 to -90 dBm.

Attenuated: $+20$ to -50 dBm.

Impedance: 50Ω , VSWR <1.08 .

Reference input:

Direct: level required is -10 to -60 dBm.

Attenuated: level required is -20 to -30 dBm.

Impedance: 50Ω , VSWR <1.08 .

Amplitude accuracy:

Frequency response (may be calibrated out): ± 0.3 dB, 0.1 to 116 MHz; ± 0.1 dB over any 10 MHz portion.

Display reference: <0.05 dB/1 dB step, total error does not exceed 0.1 dB; <0.1 dB/10 dB step, total error does not exceed 0.25 dB.

Reference channel level variation: <0.5 dB/10 dB over 50 dB operating range. For minor source and transducer variations (<0.5 dB), this error is negligible.

Phase accuracy (amplitude reading must be on-scale at the 10 dB/division setting):

Frequency response (may be calibrated out): $\pm 5^\circ$ 0.1 to 116 MHz; $\pm 2^\circ$ over any 10 MHz portion.

Display reference: $<0.1^\circ$ /1 dB step, total error does not exceed 0.2° ; $<0.5^\circ$ /10 dB step, total error does not exceed 1° .

Reference channel level variation: $<0.4^\circ$ /10 dB, $<1^\circ$ total error over 40 dB operating range. Negligible for minor source and transducer variations.

Power: 64 watts, $50-60$ Hz, $115/230 \pm 10\%$ Vac.

Weight: net, 32 lb (14.6 kg). Shipping, 39 lb (17.8 kg).

Dimensions: $7\frac{1}{4}"$ high, $18\frac{3}{8}"$ deep, $16\frac{3}{4}"$ wide.

Price: 8407A, \$2,950.00.

8412A

Amplitude accuracy:

Display: 0.08 dB/dB.

Rear output: 0.03 dB/dB.

Temperature coefficient: typically <0.05 dB/ $^\circ$ C at midscreen.

Phase accuracy:

Display: 0.065° /degree.

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: $<1^\circ$ /10 dB, 4° total error for 80 dB.

Temperature coefficient: typically $<0.1^\circ$ / $^\circ$ C.

Power: 23 watts, supplied by 8407A.

Weight: net, 17 lb (7.8 kg). Shipping, 22 lb (10 kg).

Dimensions: $6"$ high, $15\text{-}9/16"$ deep, $7\text{-}9/32"$ wide.

Price: 8412A, \$1,575.00.

8414A

General: normalized polar coordinate display; Magnitude calibration is in 0.2 of full scale graduations, full scale determined DISPLAY REFERENCE setting on 8407A. Phase calibration in 10° increments over a 360° range.

Accuracy: all errors in amplitude and phase due to the display contained within a circle of 3 mm about the measurement point.

Power: 35 watts, supplied by 8407A.

Weight: net, 13 lb (5.9 kg). Shipping, $17\frac{1}{2}$ lb (7.8 kg).

Dimensions: $6"$ high, $15\text{-}9/16"$ deep, $7\text{-}9/32"$ wide.

Price: 8414A, \$1,250.00.

11651A

General: Transmission Kit, contains power splitter (6 dB through each arm) and matched, low-leakage cables.

Weight: net, 1.5 lb (0.7 kg). Shipping, 2.5 lb (1.2 kg).

Dimensions: $3"$ high, $8"$ deep, $10\frac{1}{2}"$ wide.

Price: 11651A, \$80.00.

11652A

General: Reflection-Transmission Kit, contains power splitter, reciprocal bridge, two precision 50Ω terminations, calibrating sl BNC adapters and matched, low-leakage cables.

Directional bridge: 6 dB coupling in main and auxiliary arm. Frequency response is ± 0.5 dB, 0.1 to 110 MHz (may be calibrated out). Directivity is >40 dB, 1 to 110 MHz. Return at LOAD port is >30 dB ($\rho < 0.03$).

Power splitter: 6 dB loss through each arm.

50Ω termination: return loss is >43 dB.

Weight: net, 1.5 lb (0.7 kg). Shipping, 2.5 lb (1.2 kg).

Dimensions: $3"$ high, $8"$ deep, $10\frac{1}{2}"$ wide.

Price: 11652A, \$300.00.

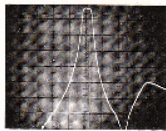
11654A

General: Passive Probe Kit, contains a pair each of six resistive divider probes ($1:1$, $5:1$, $10:1$, $20:1$, $50:1$, $100:1$) current probes and variety of adapters.

Weight: net, 2 lb (0.9 kg). Shipping, 3 lb (1.4 kg).

Dimensions: $3"$ high, $8"$ deep, $10\frac{1}{2}"$ wide.

Price: 11654A, \$225.00.



Bandpass Filter—This tunable bandpass filter has a skirt that disappears below the -80 dB line, clearly seen on the 8412A display.

60 dB points are measured at 35 and 63 MHz off the calibrated 10 MHz/div. graticule. The trace could be raised by another 20 dB, identifying the -100 dB point on the lower skirt.



Feedback Amplifier—Plotting the open-loop phase-gain margin of a feedback amplifier results in optimizing amplifier stability vs. gain.

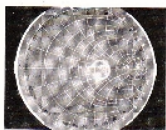
Adjustment while sweeping yields nearly instantaneous results. Shown is the open-loop feedback response of the amplifier. Amplitude is 2.5 dB/div., phase is 100°/div. Sweep is 1-50 MHz (5 MHz/div.).

Reflection-Transmission Measurements

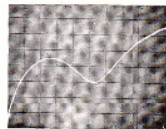
The 11651A Reflection-Transmission Kit does everything that the 11651A can and further adds the capability of swept return-loss (VSWR) and complex impedance (reflection coefficient) measurements. In addition to the power splitter and matched, low-leakage cables, the kit includes a directional bridge, two precision 50 ohm terminations, and a calibrating short.

The system is calibrated by placing the short on the LOAD port of the bridge, adjusting the display to a 0 dB, -180° reference. By replacing the short with the test device, return loss and phase are measured directly on the 8412A CRT display; complex impedance is measured directly on the 8414A Polar Display with a Smith Chart overlay.

In addition to the applications shown, the Reflection-Transmission Kit is useful for matching networks, designing low VSWR devices, and measuring S-parameters on active components and circuits.



Antenna Complex Impedance—An FM antenna was swept over its usable range of 88 to 108 MHz, using the 8414A display with Smith Chart overlay. 300-ohm input Z is desired (the exact center of the display) but the antenna varies from inductive to capacitive over the sweep range. Values of complex impedance can be read directly off the Smith Chart.



Cable Return Loss—A length of cable is seldom a perfect 50-ohm transmission line. This one varies from return losses of 40 dB at 1 MHz to 25.5 dB at 110 MHz. Other passive and active devices can be measured just as quickly and accurately.

Passive Probe Measurements 11654A

The 11654A Passive Probe Kit is the answer for probing circuits still in the breadboard stage or which are not characterized by 50 ohm impedance.

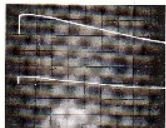
The kit includes two each of probe cables, current probe tips, six different voltage probe tips (1:1, 5:1, 10:1, 20:1, 50:1, and 100:1) and a wide variety of accessories for grounding and getting at those "difficult to measure" circuits.

Voltage and current transfer functions can be easily measured using two sets of voltage and current probes.

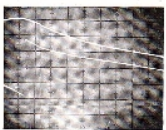
Calibration is accomplished by touching both voltage probes to a single point of RF voltage in the circuit or by placing the current probes around the same circuit lead at the point of interest.

A. (Transistor Current Gain)—Current gain (β) may be measured using the current probes. This is a power transistor whose gain is 33 dB at 1 MHz (sweep is 1 to 10 MHz or 1 MHz per division). Amplitude is 10 dB/division, phase 100°/division, showing 16 dB gain at 10 MHz and a flat phase response (about 45° from 1 to 10 MHz). Center of graticule is 0 dB and 0° phase.

B. (Amplifier Voltage Gain)—This open-loop, video amplifier can be analyzed for gain, bandwidth, and phase shift while still in the breadboard stage. Gain is 50 dB at low frequencies, dropping down to about 27 dB at 50 MHz. Amplitude is 10 dB/division; phase 100°/division.



Transistor Current Gain—Current gain (β) may be measured using the current probes. This is a power transistor whose gain is 33 dB at 1 MHz (sweep is 1 to 10 MHz or 1 MHz per division). Amplitude is 10 dB/division, phase 100°/division, showing 16 dB gain at 10 MHz and a flat phase response (about 45° from 1 to 10 MHz). Center of graticule is 0 dB and 0° phase reference.



Amplifier Voltage Gain—This open-loop, video amplifier can be analyzed for gain, bandwidth, and distortion (phase shift) while still in the breadboard stage with the passive voltage probes. Gain is 50 dB at low frequencies, dropping down to about 27 dB at 50 MHz. Amplitude is 10 dB/division; phase 100°/division. Phase shift is quite linear above 20 MHz.

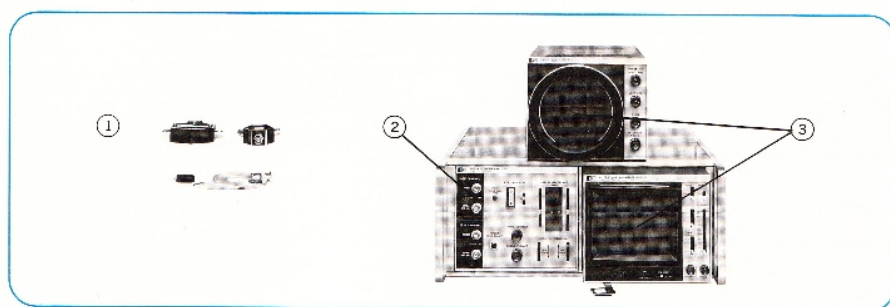
NETWORK ANALYZERS



NETWORK ANALYZER

Accurate measurement of amplitude & phase

Models 8407A, 8412A, 8414A, 11651A, 11652A, 11654A



8407A Network Analyzer System

The 8407A system accurately measures amplitude ratio and phase difference between two signals on a swept basis from 100 kHz to 110 MHz. A wide variety of transducers and displays offers the ideal solution to practically any application in this frequency range. The system, shown above, consists of:

Transducers—process your device's response for accurate measurement.

The 11651A Transmission kit allows accurate transmission measurements. A power splitter splits the source's output to provide both TEST and REFERENCE signals. The kit includes three matched low-leakage cables for wide dynamic range measurements.

The 11652A Reflection-Transmission Kit allows you to measure return loss, VSWR, complex impedance and reflection coefficient, as well as transmission. Included are a directional bridge, precision terminations, and cable.

If you prefer to probe circuits directly, the 11654A Passive Probe Kit allows minimum disturbance voltage and current measurements.

8407A Mainframe—the heart of the system. The 8407A accepts signals from the transducers and processes them for convenient display.

Since the 8407A is a ratiometer, it requires both a TEST and REFERENCE channel. The reference signal is held constant within the instrument and the test signal compared to it. These signals then go to the display where both amplitude and phase are measured.

The DIRECT input operates at levels of -10 to -90 dBm. For high gain measurements, the ATTENUATED input accepts signals ranging from -20 to -50 dBm. By using the two in combination, ratios to $+90$ and -100 dB can be measured with no additional accessories (up to 80 dB range is possible on each input separately).

The 8407A tracks two Hewlett-Packard sources: the 8601A, 0.1 to 110 MHz Generator/Sweeper, and the 8690B/8698B, 0.4 to 110 MHz Sweeper. Their 0.5% linearity and accurate sweep widths en-

hance 8407A capability. Tracking eliminates unwanted responses from source harmonics and spurious signals and allows extremely sensitive, low noise detection.

A warning light on the front panel tells you if an improper TEST/REF ratio is applied. This prevents erroneous measurements.

Another convenience is the DISPLAY REFERENCE. It allows you to read directly off the front panel the number of dB measured without having to mentally add or subtract values.

The 8407A has 50-ohm BNC inputs. Thus, you use only BNC cable or detachable probes simply by connecting them to the inputs. Probe power is also supplied at the front panel.

Displays—to see best what your device is doing.

The 8412A Phase-Magnitude Display is an accurate oscilloscope readout. It displays amplitude and phase vs. frequency. It has 80 dB $\pm 180^\circ$ display range with selectable resolutions up to 0.25 dB and 1° per division, allowing resolution of 0.05 dB and 0.2° .

The 8412A is ideal for making transmission measurements of gain or attenuation and phase shift or for measuring return loss (VSWR).

Amplitude and phase may be displayed either separately or simultaneously.

The 8414A is a polar display having 30 dB and 360° range. If you want Smith Chart displays of complex impedance or reflection coefficient, the 8414A is a natural. The 8414A includes Smith Chart overlays with full scale values of 0.2, 1.0, and 3.16.

Transmission Measurements

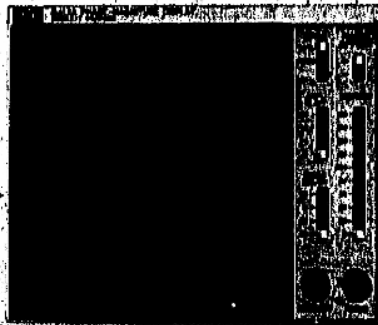
The 11651A Transmission Kit provides you with all the equipment necessary to make accurate transmission measurements from 0.1 to 110 MHz. A power splitter and matched, low-leakage cables assure you of phase matching (so you don't need a line stretcher) and negligible crosstalk.

Some common applications are shown on the next page. Others include measuring cable loss, attenuator accuracy, feedback amplifiers, coupler flatness and directivity. The ability to measure phase greatly enhances the power of your measurement—now you can design and test your devices for linear phase shift (constant group delay) to reduce signal distortion through the device.

OPERATING AND SERVICE MANUAL

PHASE- MAGNITUDE DISPLAY

8412A

HEWLETT  PACKARD

HP 8412A



Pour nous citer :

Base de la Mission nationale de sauvegarde et de valorisation du patrimoine scientifique et technique contemporain, PATSTEC, Documentation sur l'oscilloscope Hewlett-Packard HP 8412A (Hewlett-Packard Company),
<https://www.patstec.fr/ressources/objets/detail?id=15931>, consulté le 2026-07-28