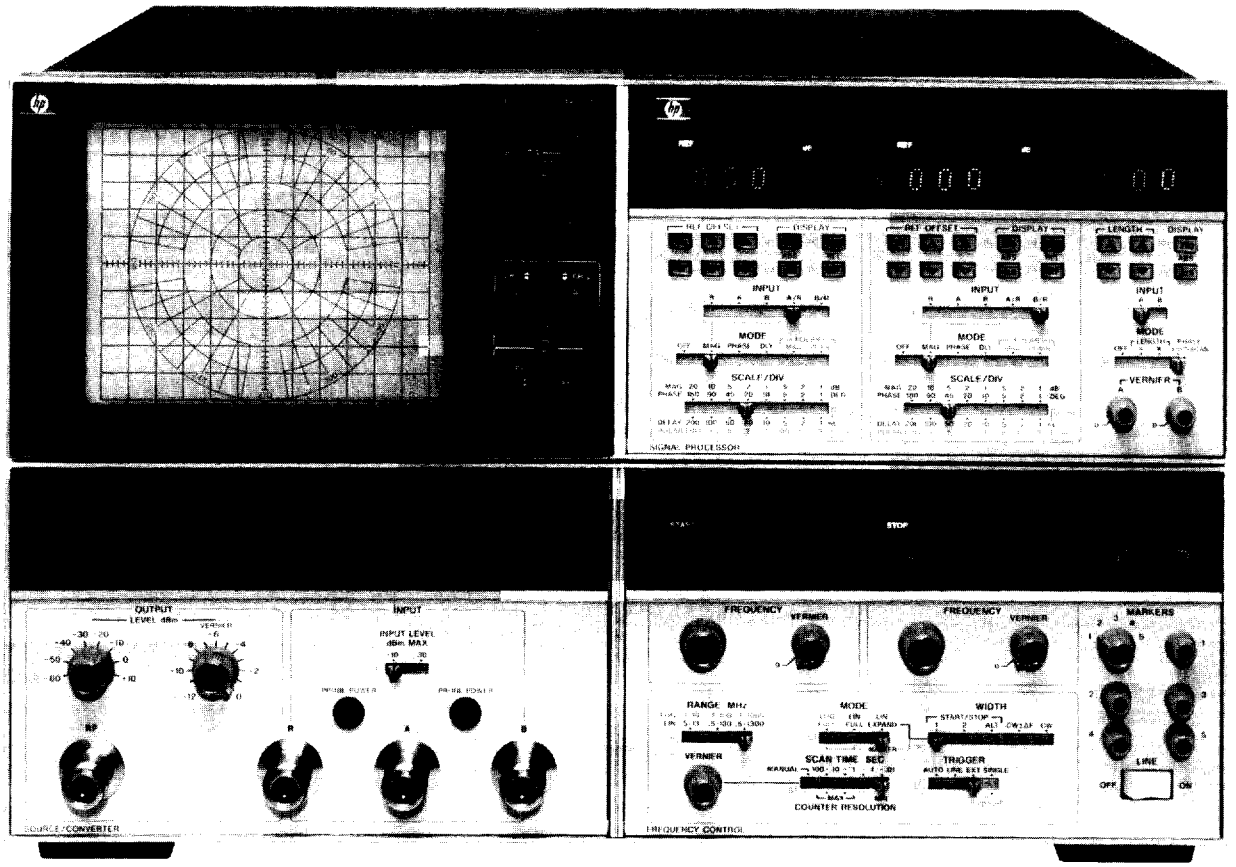
NETWORK ANALYZERS

RF Network Analyzer, 500 kHz to 1.3 GHz

Model 8505A

- 100 dB of dynamic range
- Digital readout of data with analog display
- Direct group delay and deviation from linear phase
- High performance sweep oscillator
- Complete family of 50 Ω and 75 Ω test sets
- Digital storage and normalization



HP 8505A

DESIGNED FOR HP-IB SYSTEMS

The HP 8505A is a high performance RF network analyzer operating over the 500 kHz to 1.3 GHz frequency range. It accurately and easily measures complex impedance, transfer functions and group delay of coaxial components and semiconductors. Because both magnitude and phase are measured, it is possible to completely characterize the linear behavior of either active or passive networks.

Since magnitude and phase can be measured and displayed over 100 dB of dynamic range (−10 to −110 dBm), it is a simple process for the HP 8505A to measure transmission loss of high rejection devices such as filters or gain and return loss of small signal devices like amplifiers. Distortion parameters like group delay, deviation from linear phase, and deviation from constant amplitude are measured in an equally straightforward manner. Group delay is measured and displayed directly to resolutions of 1 ns per major division using a new linear FM measurement technique. A unique new electrical line stretcher compensates for the linear phase shift of the device under test so that phase non-linearities may be examined at high resolution (1° per major division). Amplitude deviations with frequency can be similarly observed to resolutions 0.1 dB per major division with clear, crisp trace stability. In addition, it is possible to read out swept amplitude, phase and delay digitally at any one of five continuously variable markers with resolutions of 0.01 dB, 0.1°, and 0.1 ns respectively.

Many of the HP 8505A's high performance features and operating conveniences are derived from the fact that it is a completely integrated system including both the sweep oscillator and receiver. The basic instrument also includes a built-in frequency counter, polar and rectangular displays on the same CRT, the new electronic line stretcher, group delay measurement, and frequency selective digital readings of swept amplitude, phase and delay. The frequency counter with resolutions up to 100 Hz adds further precision to the measurements by allowing frequency as well as amplitude, phase and delay to be read out at any of the five markers. The HP 8505A is fully programmable in a straightforward fashion using the Hewlett-Packard Interface Bus (HP-IB operation is standard). The user can configure a customized automatic system or for convenience HP offers a fully configured system, the HP 8507D. (See pages 624 and 625.)

Companion instruments include the HP 11850A Three Way Power Splitter for high resolution transmission comparison measurements, the HP 8502A Transmission/Reflection Bridge for simultaneous transmission and reflection measurements, and the HP 8503A S-parameter Test Set for complete characterization of two port devices in a single test set-up. The HP 8501A Storage-Normalizer adds digital storage, normalization, signal averaging, increased resolution, and graphics to HP 8505A measurements.

HP 8505A Specifications

Source

Frequency Characteristics

Frequency range: 500 kHz to 1.3 GHz in three ranges, 500 kHz to 13 MHz, 500 kHz to 130 MHz and 500 kHz to 1.3 GHz.
Swept frequency accuracy: ±1% of range for linear sweep.
CW frequency accuracy: ±2 counts ±time-base accuracy.
Frequency stability: better than ±0.01% of reading ±0.01% of frequency range over 10 minutes after warm-up.

Frequency counter characteristics: frequency counter measurements are made at any one of five continuously variable marker positions without interrupting the swept RF signal.

Resolution (least significant digit)

Frequency Range (MHz)	0.5 to 13	0.5 to 130	0.5 to 1300
10 ms Sweep time	10 kHz	100 kHz	1 MHz
100 ms Sweep time	1 kHz	10 kHz	100 kHz
>1 second Sweep time	100Hz	1 kHz	10 kHz

Counter accuracy: ±2 counts ± time-base accuracy.
Marker frequency accuracy: ±0.002% of scan width ± counter accuracy. Measured in CW ±ΔF.
Time-base accuracy: ±5 ppm ±1 ppm/°C ±3 ppm/90 days.

Output Characteristics

Output power range: +10 dBm to −72 dBm.
Attenuator accuracy: ±1.5 dBm over 70 dB range.
Vernier accuracy: ±1 dB.
Leveling: ±0.5 dB from 500 kHz to 1.3 GHz.
Impedance: 50 Ω; ≥16 dB return loss at −10 dBm output level (<1.38 SWR).

Residual FM

Frequency Range (MHz)	0.5 to 13	0.5 to 130	0.5 to 1300
Residual FM	50 Hz rms	200 Hz rms	2 kHz rms
Bandwidth	20 Hz-1 kHz	20 Hz-1 kHz	20 Hz-10 kHz

Harmonics: >25 dB below main signal at +10 dBm output level.
Sub-harmonics and spurious signals: below −50 dBm at +10 dBm output level.

General Characteristics

Sweep modes: linear Full, Log Full, Start/Stop 1, Start/Stop 2, Alternate, CW ± ΔF, and CW.
Sweep times: 10 ms to 100 s in decade ranges.
Trigger modes: auto, line sync., single scan or external sync.
RF Output connector: type N female.

Receiver

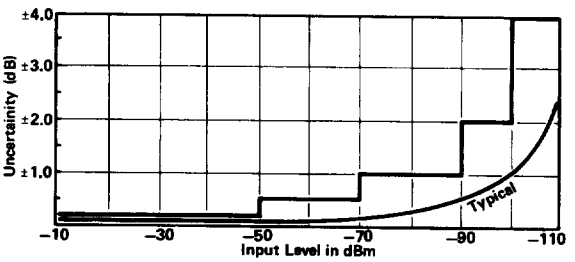
Frequency range: 500 kHz to 1.3 GHz.

Input Characteristics

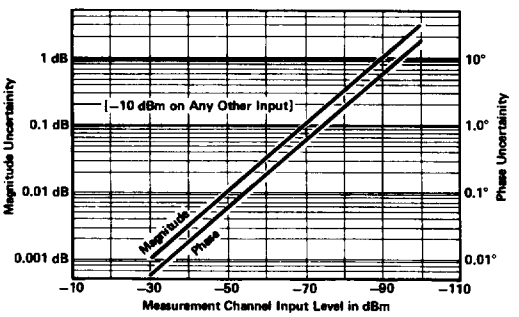
Input channels: three channels (R, A, and B) with 100 dB dynamic range.
Damage level: +20 dBm or ≥50 V dc.
Noise (average, 10 kHz BW): −110 dBm from 10 to 1300 MHz; −100 dBm from 2 to 10 MHz; −95 dBm from 0.5 to 2 MHz.
Impedance: 50 Ω: ≥20 dB return loss (<1.22 SWR). Typically >26 dB return loss (<1.11 SWR).

Magnitude Characteristics

Absolute frequency response (A, B, R): ±1.5 dB.
Ratio frequency response (A/R, B/R): ±0.3 dB from 0.5 MHz to 1.3 GHz.
Dynamic accuracy: ±0.01 dB/dB from −20 to −40 dBm; ±0.2 dB from −10 to −50 dBm; ±0.5 dB from −50 to −70 dBm; ±1.0 dB from −70 to −90 dBm; ±2.0 dB from−90 to −100 dBm; ±4.0 dB from −100 to −110 dBm.



Crosstalk error limits: >100 dB isolation between inputs.



Reference offset range: ±199.9 dB.
Reference offset accuracy: ±0.03 dB ±0.003 dB/dB of offset.
Marker measurement resolution: 0.01 dB over any <10 dB range; 0.1 dB over any ≥10 dB range.
CRT display resolution: 0.1 dB to 20 dB/division in 1, 2, 5 sequence.

Phase Characteristics

Frequency response: ±3° from 500 kHz to 750 MHz; ±5 ° from 750 MHz to 1.3 GHz.
Range: ±180°.
Accuracy: ±0.01°/degree for ±170°; ±0.01°/degree ±0.5° for ±180°.

Dynamic accuracy (in 10 kHz Bandwidth): ±0.02°/dB from −20 to −40 dBm; ±0.5° from −10 to −50 dBm; ±1° from −50 to −70 dBm; ±3° from −70 to −90 dBm.
Crosstalk: see amplitude crosstalk specification.
Reference offset accuracy: ±0.3° ±0.5% of offset.
Marker measurement resolution: ±0.1° over <100° range and 1° for ≥100° range.
CRT display resolution: 1° to 180° per division in 8 steps.

Polar characteristics: frequency Response, Dynamic Response, Reference Offset and Marker Measurement specifications are the same as magnitude and phase characteristics.
CRT display accuracy: actual value is within less than 3 mm circle of the displayed value.
Tracking between dB offset controls and polar full switch positions: ≤0.2 dB.
Full scale magnitude range: 1 to 0.01 in a 1, 0.5, 0.2 sequence.

Delay Characteristics

Frequency response: ±1 ns from 1 MHz to 1.3 GHz.
Delay accuracy:[1] ±3% of reading ±3 units (Units = 1ns for 0.5 to 1300 MHz range, 10 ns for 0.5 to 130 MHz range, and 100 ns for 0.5 to 13 MHz range.).

[1]±3 units may be calibrated out with thru connection.

NETWORK ANALYZERS

RF Network Analyzer, 500 kHz to 1.3 GHz (cont.)

Model 8505A

Range Resolution and Aperture

Frequency Range (MHz)	0.5 to 13	0.8 to 130	4.0 to 1300
Range	0 to 80 μs	0 to 8 μs	0 to 800 ns
Resolution			
CRT:	100 ns	10 ns	1 ns
Marker:	100 ns	10 ns	1 ns
Marker with Delay scale/Div Switch set to:	10 ns (<1 μs)	1 ns (≤100 ns)	0.1 ns (≤10 ns)
Aperture[1]	7 kHz	20 kHz	200 kHz

Reference offset range: ±1999 dB.
Reference offset accuracy: ±0.3 units ±0.3% of offset.

Electrical Length/Ref. Plane Extension Characteristics
Calibrated Electrical Length Range and Resolution[2]

Frequency Range (MHz)		0.5 to 13	0.5 to 130	0.5 to 1300
Range	X1	±19.9 m	±1.99 m	±19.9 cm
	X10	±100 m	±10 m	±1 m
Resolution	X1	10 cm	1 cm	0.1 cm
	X10	1 m	10 cm	1 cm

Calibrated electrical length accuracy: ±3% of reading ±1% of range.
Linear phase substitution (degrees/scan) range: ±1700° per scan with 0° offset.

$$\frac{\pm 1.4\ \text{km}}{\text{scan width (MHz)}} \quad \text{or} \quad \frac{\pm 4.7\ \mu\text{s}}{\text{scan width (MHz)}}$$

Linear phase substitution resolution: 10°
Linear phase substitution accuracy: ±3% of reading ±10°/scan.
Phase compensation linearity: <0.2% of phase slope inserted.

General Characteristics

RF input connectors: type N female.
Display bandwidth: selectable IF bandwidths of 10 kHz and 1 kHz. A video filter position is also provided.
CRT overlays: Smith Charts (2, 1, 0.5, 0.2, 0.1 full scale), Log Charts (10 MHz, 100 MHz and 1000 MHz).
CRT photography: HP 197A Opt 006 camera or HP 197A with HP 10375A Bezel Adapter required to fit HP 8505A display. A CRT illumination control is provided.
Auxiliary Outputs
Channel 1 and 2 outputs: 0.25 V/display division.
Sweep output: 0.25 V/display division.
Pen lift: dc coupled, 200 mA current sink.
Programming
The HP 8505A has a remote programming interface using the Hewlett-Packard Interface Bus with Learn Mode. One 0.5 m (HP 10833D) HP-IB cable included.
Power: selection of 100, 120, 200 or 240 V +5% −10%, 50 to 60 Hz, approximately 275 watts.
Size: 279 H x 426 W x 553 mm D (11 x 16.75 x 21.75 in.).

HP 8505A Opt 005 Specifications (phase-lock operation)

Source

Frequency Characteristics
Modes (HP 8505A): CW and CW ±ΔF only.
Range and Resolution (HP 8505A and 8656B):
(Total frequency range is 500 kHz to 990 MHz)

	HP 8656B Frequency Ranges (MHz)	HP 8505A Frequency Range MHz		
		0.5 to 13	0.5 to 130	0.5 to 1300
CW Resolution (set on HP 8656)	All freq. ranges	10 Hz	10 Hz	10 Hz
± ΔF Resolution (set on HP 8505)	All freq. ranges	1 Hz	10 Hz	100 Hz
Max +/− ΔF	0.5-123.5 123.5-247 247-990	1.3kHz	13kHz 13 kHz	50kHz 99kHz

Range and Resolution (HP 8505A and 8642B):[2]
(Total frequency range 500 kHz to 1300 MHz)

	HP 8642B Frequency Ranges (MHz)	HP 8505A Frequency Range MHz		
		0.5 to 13	0.5 to 130	0.5 to 1300
CW Resolution (set on HP 8642)	All freq. ranges	1 Hz	1 Hz	1 Hz
± ΔF Resolution (set on HP 8505)	All freq. ranges	1 Hz	10 Hz	100 Hz
Max +/− ΔF[3]	0.5-132[1] 132-1300	1.3 kHz	13 kHz	130 kHz 130 kHz

Typical system residual FM: the residual FM of a phase-locked HP 8505A approaches that of the HP 8642A/B or 8656B.

Output Characteristics
Power output, harmonics, spurious outputs, RF noise, etc. are determined by the HP 8642A/B or the HP 8656B.

Receiver

Magnitude and phase characteristics are unchanged with the exception of the dynamic range specification.

Delay Characteristics
Accuracy: ±3% of reading ±3 units. Units: 1 μs for 0.5–1300 MHz; 10 μs for 0.5–130 MHz; 100 μs for 0.5–13 MHz.
Range, resolution and aperture: (HP 8642A/B or 8656B) (HP 8505A indicated units x 1000)

	8505 Frequency Range (MHz)		
	0.5-13	0.5-130	0.5-1300
Range	0-80 ms	0-8 ms	0-800 μs
Resolution:			
CRT & Digital Marker	100 μs	10 μs	1 μs
Digital Marker with Delay Switch Setting	10 μS <1 ms	1 μs <100 μs	100 ns <10 μs
Aperture[4]	1.5 kHz	2.0 kHz	4.0 kHz

Electrical Length Characteristics
Accuracy: ±3% of reading ±3% of range.
Calibrated electrical length, range, and resolution[5]: (HP 8642A/B or 8656B): (HP 8505A digital readouts × 1000) give electrical length 1000 times larger and resolution divided by 1000.

General Characteristics

RF Inputs
L.O. drive input level: 10 dBm ±2 dB (Rear panel BNC).
RF drive input level: 0 dBm ±2 dB (Rear panel BNC).
Tunable FM output: ±1.3 V maximum (rear panel BNC with output level controlled by ±ΔF control on front panel of HP 8505A). ±1.3 V output is obtained independent of the frequency range switch setting.
Capture range of phase-lock loop: 100 kHz (0.5–13 MHz range); 400 kHz (0.5–130 MHz range); 4 MHz (0.5–1300 MHz range).
Standard/phase-lock operation: rear panel switch can disable all phase-lock circuitry when using the instrument in its standard (non phase-lock) operating mode.

[1]Heterodyne band.
[2]HP 8642A and the HP 8505A have a total frequency range of 500 kHz to 1057.5 MHz. Resolution and ΔF performance is the same as the HP 8642B.
[3]Max deviation for the HP 8642A/B exceeds 1 MHz for various frequency bands.
[4]Typical measurement Aperture using linear FM modulation technique.
[5]Vernier provides continuous adjustment of electrical length. Calibrated Electrical Length Linearity: $\Delta\theta = 0.7\% \times 1.2\ f\ (\text{MHz}) \times 1\ (\text{metres})$.