

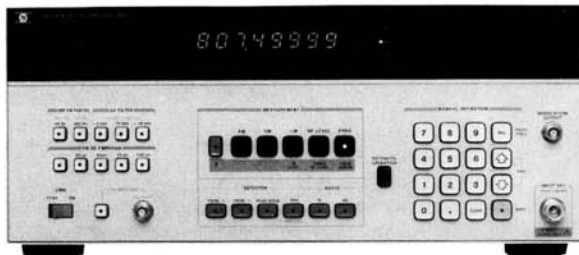
SIGNAL ANALYZERS

Modulation Analyzer, 150 kHz to 1300 MHz

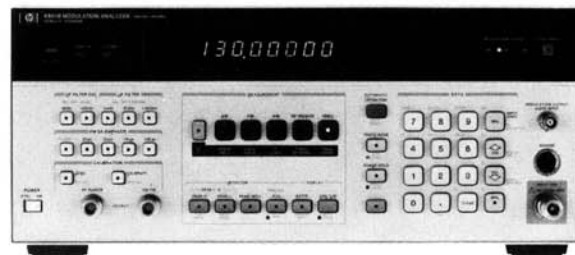
Models 8901A, 8901B

- Measures AM and FM to 1% accuracy
- Measures RF frequency
- Measures RF Power

- Low internal noise
- Completely automatic



HP 8901A



HP 8901B

HP 8901A and HP 8901B Modulation Analyzers

The HP 8901A and HP 8901B modulation analyzers combine the capabilities of several RF instruments to give complete, accurate characterization of modulated signals in the 150 kHz to 1300 MHz frequency range. Both instruments very accurately measure modulation and recover the modulation signal. They determine RF frequency and measure RF power. The major additional capabilities of the HP 8901B are its improved power meter accuracy, its ability to use external power sensors, to make adjacent channel power measurements or carrier noise measurements (with options 030-037) and its ability to count audio frequencies and measure distortion on 400 Hz and 1 kHz signals. Both instruments are fully automatic and make all major measurements with the push of a key or under HP-IB control.

Modulation Measurement Accuracy

Very accurate modulation measurements along with very low internal noise enable the HP 8901A/B to characterize even high performance signal sources. Their detection systems are configured for wideband recovery of the entire modulation spectrum so that highly precise measurements such as signal-to-noise or distortion can be made on the modulation signal. Modulation depth and deviation accuracy is generally $\pm 1\%$ of reading. Residual AM noise in a 50 Hz to 3 kHz bandwidth is $< 0.01\%$ while FM noise is < 8 Hz for 1300 MHz carrier frequencies, decreasing linearly to < 1 Hz below 100 MHz. Because the AM and FM demodulators are independent and highly insensitive to each other and because the analyzer has very low residual AM and FM, accurate incidental AM and FM measurements can be made.

Three detectors are available for depth and deviation measurements: positive peak, negative peak, and an average-responding detector with rms (sinewave) calibration. A PEAK HOLD function captures and displays the maximum peak modulation of a signal and is ideal for making transient measurements such as modulation limiting on mobile radios. The HP 8901B also has a true rms detector and the ability to measure peak to peak divided by two.

For measuring convenience, two high-pass (50 Hz and 300 Hz) and three low-pass (3 kHz, 5 kHz and > 20 kHz) post-detection filters are included for filtering the recovered modulation. The > 20 kHz Bessel filter minimizes overshoot on square-wave modulation. This allows accurate measurement of signals which are digitally modulated, such as FSK. Four de-emphasis networks commonly used in FM systems (25, 50, 75, and 750 μ s) are also provided.

A modulation output provides calibrated signal levels relative to the displayed modulation reading. The HP 8901B can make measurements on this demodulated signal such as frequency and distortion level.

Modulation calibrators (standard on the HP 8901B, Option 010 on the HP 8901A) provide two precision modulation standards. One is an amplitude modulated signal whose depth is calibrated to better than 0.1% accuracy. The second standard is a frequency modulated signal with peak deviation calibrated to 0.1% accuracy. The HP 11715A AM/FM Test Source is necessary to fully test and calibrate other modulation parameters.

Frequency Measurements

The HP 8901A/B modulation analyzers are more than just high quality modulation meters. They also perform as frequency counters. Resolution for the HP 8901A's 150 kHz to 1300 MHz frequency counter is 10 Hz below 1000 MHz, and 100 Hz above 1000 MHz. Resolution is 1 Hz for the HP 8901B. Sensitivity is -25 dBm (12 mV rms) below 650 MHz, and -20 dBm (22 mV rms) above 650 MHz. The standard instrument's time base stability is 1×10^{-6} /month, or an optional time base is available with 1×10^{-9} /day stability.

RF Power Measurements

The HP 8901A uses a diode detection circuit to measure RF input power. This technique measures peak voltage and is calibrated from 1 mW to 1 W for sinewave inputs. The RF level measurement accuracy is ± 1.5 dB from 150 MHz to 1300 MHz.

The HP 8901B delivers the accuracy and resolution of a high performance power meter. The HP 8901B, with the HP 11722A Sensor Module, measures power from $+30$ dBm to -20 dBm at frequencies from 100 kHz to 2.6 GHz. The HP 8901B also accepts all HP 8480 series power sensors for extended measurement capability.

Adjacent Channel Power and Direct Spectrum Noise Measurements

The HP 8901B offers optional selective power measurement capability (options 030-037). With this capability you can quickly and accurately make adjacent channel power measurements to CEPT standards. The HP 8901B provides a choice of selectable filters for testing transceivers with 12.5, 25 and 30 kHz channel spacings.

To meet the CEPT standard at frequencies greater than 300 MHz, the HP 8901B requires an external local oscillator (LO) such as the HP 8656B Synthesized Signal Generator. Dedicating a signal generator as the external LO is not necessary. When not being used as the LO, a built-in RF switch in the HP 8901B routes the signal generator's output out the back panel.

Used with a low-phase-noise external LO, the HP 8901B also makes single-sideband (SSB) noise measurements to 1.3 GHz. To make the noise measurement, you just select the carrier noise filter and the frequency offset from the carrier (5 kHz to 1300 MHz). The HP 8901B then makes a selective power measurement (2.5 kHz BW) and converts the power to a 1 Hz bandwidth. The noise floor of the HP 8901B is -150 dBc/Hz. The HP 8901B's measurement accuracy is better than ± 0.5 dB down to -139 dBc.

Phase noise usually dominates the carrier-noise measurement at most offsets of interest, so direct-spectrum noise measurements provide a convenient and simple way to measure phase noise of many sources. Adding the HP 11793A Microwave Converter and a low-phase-noise microwave source such as the HP 8673B Synthesized Signal Generator extends this measurement to 26.5 GHz.

HP 8901A and HP 8901B Specifications

RF Input

Frequency range: 150 kHz to 1300 MHz

Operating level:

12 mVrms to 7 Vrms, 150 kHz to 650 MHz.
22 mVrms to 7 Vrms, 650 MHz to 1300 MHz.

Input impedance: 50Ω nominal.

Tuning: manual frequency entry, automatic, or track (frequencies >10 MHz only).

Acquisition time (automatic operation): ~1.5 seconds.

Maximum safe input level (typical): 35 Vrms (25W for source SWR <4), ac; 40V, dc.

Frequency Modulation

Rates:

20 Hz to 10 kHz, 150 MHz to 10 MHz.
20 Hz to 200 kHz, 10 MHz to 1300 MHz.
20 Hz to 20 kHz with 750 μs filter, 10 MHz to 1300 MHz.

Deviations:

40 kHz peak maximum, 150 kHz to 10 MHz.
400 kHz peak maximum, 10 MHz to 1300 MHz.
40 kHz peak maximum with 750 μs filter, 10 MHz to 1300 MHz.

Accuracy^{1,2}:

±2% of reading ±1 digit, 20 Hz to 10 kHz rates, 250 kHz to 10 MHz.
±1% of reading ±1 digit, 50 Hz to 100 kHz rates; ±5% of reading ±1 digit, 20 Hz to 200 kHz rates, 10 MHz to 1300 MHz.

Demodulated output distortion³:

<0.1% THD, deviations <10 kHz, 400 kHz to 10 MHz.
<0.1% THD, rates and deviations <100 kHz, 10 MHz to 1300 MHz.
AM rejection (for 50% AM at 400 Hz and 1 kHz rates)¹: <20 Hz peak deviation measured in a 50 Hz to 3 kHz BW.

Residual FM (50 Hz to 3 kHz BW): <8 Hz rms @ 1300 MHz, decreasing linearly with frequency to <1 Hz rms for 100 MHz and below.

Maximum deviation resolution:

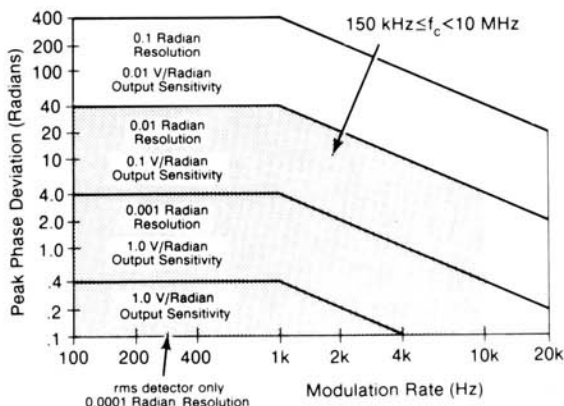
0.1 Hz (rms detector on HP 8901B only), <4 kHz peak deviation.
1 Hz, <4 kHz peak deviation.
10 Hz, 4 kHz to 40 kHz peak deviation.
100 Hz, 40 kHz to 400 kHz peak deviation.
Resolution is increased one digit with 750 μs de-emphasis and pre-display "on" and with rms detector.
Stereo separation (50 Hz to 15 kHz): >47 dB typical.

Phase Modulation

Carrier frequency: 10 MHz to 1300 MHz.

Rates: 200 Hz to 20 kHz; typically usable from 20 Hz to 100 kHz with degraded performance.

Deviation and maximum resolution:



Accuracy¹: ±3% of reading ±1 digit.

Demodulated output distortion: <0.1% THD.

AM rejection (for 50% AM at 1 kHz rate)¹: <0.03 radian peak deviation (50 Hz to 3 kHz BW).

Amplitude Modulation

Rates:

20 Hz to 10 kHz, 150 kHz to 10 MHz.
20 Hz to 100 kHz, 10 MHz to 1300 MHz.

Depth: to 99%.

Accuracy^{1,2,4}:

±2% of reading ±1 digit, 50 Hz to 10 kHz rates, >5% depth; ±3% of reading ±1 digit, 20 Hz to 10 kHz rates, 150 kHz to 10 MHz.
±1% of reading ±1 digit, 50 Hz to 50 kHz rates, >5% depth; ±3% of reading ±1 digit, 20 Hz to 100 kHz rates, 10 MHz to 1300 MHz.

Flatness (variation in indicated AM depth for constant depth on input signal): ±0.3% of reading ± 1 digit, 90 Hz to 10 kHz rates, 20% to 80% depth, 10 MHz to 1300 MHz.

Demodulated output distortion: <0.3% THD for ≤50% depth; <0.6% THD for ≤95% depth.

FM Rejection (at 400 Hz and 1 kHz rates, 50 Hz to 3 kHz BW)¹:

<0.2% AM for <5 kHz peak deviation, 250 kHz to 10 MHz.
<0.2% AM for <50 kHz peak deviation, 10 MHz to 1300 MHz.

Residual AM (50 Hz to 3 kHz BW): <0.01% rms.

Maximum Depth Resolution:

0.01% for depths ≤39.99%; 0.1% for depths ≥40%. Resolution increases 1 digit with rms detector (HP 8901B only).

Frequency Counter

Range: 150 kHz-1300 MHz.

Accuracy: ±3 counts of least significant digit ± reference accuracy.

Internal Reference:

Frequency: 10 MHz.

Aging rate: <1x10⁻⁶/month (optional⁵: 1x10⁻⁹/day).

Maximum resolution:

HP 8901A: 10 Hz for frequencies <1 GHz; 100 Hz for frequencies ≥1 GHz.

HP 8901B: 1 Hz.

HP 8901A RF Level (Peak Voltage Responding, RMS Sine Wave Power Calibrated)

Range: 1 mW to 1W.

Instrumentation accuracy: ±1.5 dB (150 kHz to 1300 MHz); 0.7 dB typical.

SWR: ≤1.3, 150kHz to 650 MHz; ≤1.5, 650 MHz to 1300 MHz.

Resolution: 0.1 mW for levels 0.1W to 1W; 0.01 mW for levels 0.01W to 0.1W; 0.001 mW for levels <0.01W.

HP 8901B RF Level (True RMS)

Frequency range with HP 11722A: 100 kHz to 2.6 GHz.

Power range: -20 dBm to +30 dBm.

RF range linearity (using recorder output):

±0.02 dB, RF ranges 2 - 5.

±0.03 dB, RF range 1.

Using front-panel display, add ±1 count of least-significant digit.

RF range-to-range change error:

±0.02 dB/RF range change from reference range.

Input SWR: <1.15, using HP 11722A Sensor Module.

Zero set (digital settability of zero):

±0.07% of full scale on lowest range.

Decrease by a factor of 10 for each high range.

RF power resolution:

0.1% of full scale in watts or volts mode.

0.01 in dBm or dB relative mode.

¹ Peak residuals must be accounted for in peak readings.

² But not to exceed: 50 Hz to 40 kHz rates for stated accuracy with rms detector (HP 8901B only).

³ With 750 μs de-emphasis and pre-display "off", distortion is not specified for modulation outputs >4V peak. This can occur near maximum deviation for a measurement range at rates <2 kHz.

⁴ For peak measurements only, AM accuracy may be affected by distortion generated by the Modulation Analyzer. In the worst case, this can decrease accuracy by 0.1% of reading for each 0.1% of distortion.

⁵ After 30 day warm-up.

SIGNAL ANALYZERS

Modulation Analyzer, 150 kHz to 1300 MHz; AM/FM Test Source

Models 8901A, 8901B, 11715A

HP 8901B Selective Power Measurements (options 030-037)

Frequency range: 10 MHz to 1.3 GHz.

Carrier power range: +30 dBm to -20 dBm, 12.5, 25 and 30 kHz filters; +30 dBm to -10 dBm, Carrier Noise Filter.

Dynamic range: 115 dB.

Carrier rejection (temp. $\leq 35^\circ\text{C}$): >90 dB, for offsets ≥ 1 channel spacing or 5 kHz, whichever is larger.

Relative accuracy: ± 0.5 dB, levels ≥ -95 dBc or levels ≥ -129 dBc/Hz.

Filter bandwidths:

2.5 kHz, Carrier Noise Filter

8.5 kHz, 12.5 kHz Filter

16.0 kHz, 25 kHz Filter

30.0 kHz, Cellular Radio Filter

Power Reference

Power output: 1.00 mW. Factory set to $\pm 0.7\%$, traceable to the U.S. National Bureau of Standards.

Accuracy: $\pm 1.2\%$ worst case ($\pm 0.9\%$ rss) for one year (0°C to 55°C).

Audio Filters

High pass (3 dB cutoff frequency): 50 Hz and 300 Hz

Low pass (3 dB cutoff frequency except >20 kHz filter): 3 kHz, 15 kHz, >20 kHz.

De-emphasis filters: 25 μs , 50 μs , 75 μs , and 750 μs .

Calibrators (Standard HP 8901B, Option 010 HP 8901A)

AM calibrator depth and accuracy: 33.33% depth, nominal; internally calibrated to an accuracy of $\pm 0.1\%$.

FM calibrator deviation and accuracy: 34 kHz peak deviation, nominal; internally calibrated to an accuracy of $\pm 0.1\%$.

General Characteristics

Operating temperature range: 0° to 55°C .

Power requirements: 100, 120, 220, or 240V (+5, -10%);

48-66 Hz; 200 VA max.

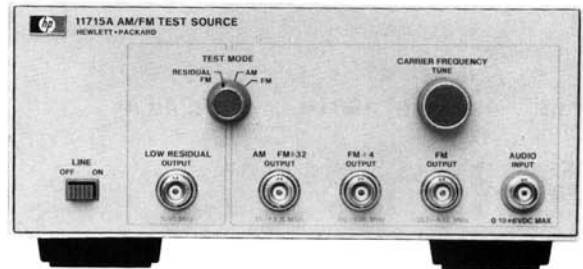
Weight: HP 8901A—net 20 kg (44 lb), shipping 25 kg (55 lb);

HP 8901B—net 23 kg (52 lb), shipping 31 kg (69 lb).

Size: HP 8901A, 190 mm H x 425 mm W x 468 mm D (7.5 in. x 16.8 in. x 18.4 in.); HP 8901B, 190 mm H x 425 mm W x 551 mm D (7.5 in. x 16.8 in. x 21.7 in.)

Ordering Information

	Price
HP 8901A Modulation Analyzer	\$9,600
Opt 001 RF connectors on rear panel only	+\$105
Opt 002 1×10^{-9} /day internal reference	+\$765
Opt 003 Connections for external local oscillator	+\$410
Opt 004 Operation from 48 to 440 Hz power (Temp. $< 40^\circ\text{C}$)	+\$280
Opt 010 AM and FM calibrators	+\$635
HP 8901B Modulation Analyzer	\$13,560
Opt 001 RF connectors on rear panel only	+\$205
Opt 002 1×10^{-9} /day internal reference	+\$765
Opt 003 Connections for external local oscillator	+\$400
Opt 004 Operation from 48 to 440 Hz power (Temp. $< 40^\circ\text{C}$)	+\$275
Opt 021 Add 11722 Sensor Module	+\$2,040
Opt 030 High selectivity (select only 2 filter options) (Options 032-037 require Option 030; Option 030 includes Option 003 connections for external local oscillators.)	+\$2,450
Opt 032 12.5 kHz filter	\$0
Opt 033 20.0/25.0 kHz filter	\$0
Opt 035 Cellular Radio Filter	\$0
Opt 037 Carrier Noise Filter	\$0



HP 11715A

HP 11715A AM/FM Test Source

The HP 11715A AM/FM Test Source provides very flat, wide-bandwidth, and low distortion amplitude or frequency modulated RF signals. Designed primarily for performance tests and adjustments of the HP 8901A/B Modulation Analyzer and HP 8902A Measuring Receiver, it will also serve as a high quality modulated test oscillator where its frequency ranges apply.

The major components of the HP 11715A are a low-noise voltage controlled oscillator (VCO), two digital dividers, and a double-balanced mixer. The VCO is the primary signal source, with a typical frequency range of 330 to 470 MHz at the FM OUTPUT. FM is produced by directly coupling the external modulation source to the VCO's tune input, providing very wide bandwidth modulation with low phase shift. This design also ensures very little incidental AM.

The HP 11715A can also be used in conjunction with an HP 8901A/B and an HP 8902A as a calibrated signal source for special applications. In particular, the U.S. commercial FM broadcast band of 88 to 108 MHz is covered by the FM $\div 4$ OUTPUT of the HP 11715A.

HP 11715A Specifications

FM Outputs

Frequency Range:

11 to 13.5 MHz, AM FM $\div 32$ output.

88 to 108 MHz, FM $\div 4$ output.

352 to 432 MHz, FM output.

Peak Deviation:

>12.5 kHz, 11 to 13.15 MHz carrier.

>100 kHz, 88 to 108 MHz carrier.

>400 kHz, 352 to 432 MHz carrier.

Distortion:

<0.025% THD (< -72 dB) for

Carrier frequency	Peak deviation	Modulation rate
12.5 MHz	12.5 kHz	<10 kHz
100 MHz	100 kHz	<100 kHz
400 MHz	400 kHz	<100 kHz

Flatness:

$\pm 0.1\%$, dc to 100 kHz rates.

$\pm 0.25\%$, dc to 200 kHz rates.

Stereo separation (88 to 108 MHz carrier, 75 kHz peak deviation, 1 kHz rate): >60 dB typical.

AM Output

Frequency range (AM FM $\div 32$ output): 11 to 13.5 MHz.

Depth: to 99%.

Distortion:

<0.05% THD (< -66 dB), 50% AM, 20 Hz to 100 kHz rates.

<0.1% THD (< -60 dB), 95% AM, 20 Hz to 100 kHz rates.

Flatness: $\pm 0.1\%$, 50 Hz to 50 kHz rates;

$\pm 0.25\%$, 20 Hz to 100 kHz rates.

Linearity: $\pm 0.1\%$, <95% AM; $\pm 0.2\%$, <99%.

Ordering Information

HP 11715A AM/FM Test Source

Price

\$2,550