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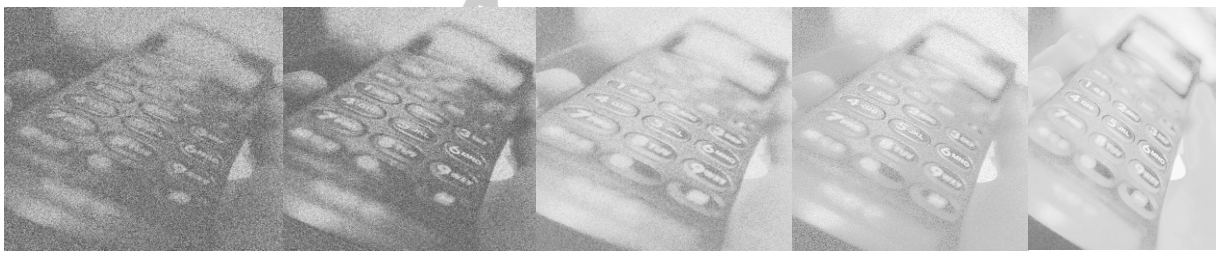
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product overview

HEWLETT PACKARD
Expanding Possibilities

HP | **8970 Series** | **Noise Figure Measurement Products**





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Whether measuring at RF or microwave frequencies, Hewlett Packard offers you complete noise figure measurement capability in an accurate and convenient way.

The HP 8970B Brings Ease And Confidence To Noise Figure Measurements

With the HP 8970B Noise Figure Meter, noise figure measurements from 10 to 1600 MHz (2047 MHz optional) are easy, accurate, and repeatable. You save precious time, money, and resources, since the measurements are done quickly, accurately, and with less chance of mistakes.

Measurements are easy because the HP 8970B does all the work:

- Tunes its input frequency between 10 and 1600 MHz
- Controls an external LO for receiver or microwave measurements
- Controls the noise source to turn it "ON" or "OFF"
- Makes the noise power measurements
- Calculates the noise figure
- Removes the effects of the measurement system's noise
- Compensates for losses before or after the DUT
- Displays the results in either noise figure, effective noise temperature (Te), or Y factor

In addition, the wide dynamic range of the HP 8970B allows simultaneous gain measurements up to 40 dB or loss measurements to 20 dB, with no external attenuation or amplification.

The low instrumentation uncertainty (±0.1 dB) and measurement stability of the HP 8970B give you confidence in your noise figure results. Automatic second-stage correction makes accurate noise figure readings possible even for low gain devices.

Direct Noise Figure Measurements to 2047 MHz With Option 020

Extend the HP 8970B operating frequency from 1600 MHz to 2047 MHz with option 020. Now measure test devices to 2047 MHz directly, with no external downconversion. For mixers or receivers with IFs less than 2047 MHz, such as those used in Direct Broadcast Satellite (DBS) applications, the HP 8970B and a suitable noise source are all you need to make measurements.

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Proven capability with enhanced speed and convenience



Save up to 4 noise source ENR tables

28 volt solid-state noise source drive for 6 to 9 measurements per second

Pullout cards show measurement setups and convenient SPECIAL FUNCTIONs. Pullout cards remain accessible when rack mounted.

Select a fixed frequency increment to a frequency of interest, or make swept measurements accross a band

STORE up to 9 panel settings to be RECALLed in an arbitrary SEQuence.

Display noise figure and gain with system noise automatically removed (read digitally or display on scope or plotter).

INCREASE or DECREASE the number of data averages for speed/jitter tradeoffs.

Easy scaling of oscilloscope or plotter output.

HP 8970B Rear Panel

28 volt noise source drive (in parallel with front panel).

20 MHz IF output



Output for swept oscilloscope display

GPIB for systems operation

System Interface Bus (SIB) for control of HP 8971C, LO and plotter

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Extend the HP 8970B To Microwave Frequencies

Many components and receivers require noise figure measurement at frequencies greater than 1600 MHz. If you already own an HP 8970B Noise Figure Meter, you don't need to worry about building a custom down-converter to measure noise figure at microwave frequencies. The HP 8971C combines, in one easy-to-use package, all of the components neccessary for microwave downconversion to the HP 8970B's frequency range (10 to 1600 MHz). Accurate broad band measurements from 10 MHz to 26.5 GHz are possible with a single calibration and sweep. Custom solutions are available to 110 GHz.

Careful design with high performance components, including a stable YIG filter and a built-in low noise preamp, allow accurate single-sideband measurements.

- The YIG filter removes the image response and harmonic mixing components for more accurate single-sideband downconversion, eliminating many potential sources of errors.

- The built-in low noise preamp improves measurment accuracy and stability by lowering the noise figure of the test system, minimizing the second stage correction.

Be assured of repeatable, accurate, and maintainable microwave noise figure measurements with the HP 8971C Noise Figure Test Set.

Configure The HP 8971C To Suit Your Application Needs And Budget

The HP 8971C can be tailored to fit your application and budget with the following options:

Option 001 adds an internal LO power amp, reducing the LO input power requirment of the HP 8971C from +7 dBm to +1 dBm. This option is usually required for measurements above 20 GHz, where source power becomes limited or in system applications, where there is considerable loss between the LO source and the 8971C LO input.

Option 002 deletes the built-in low noise RF preamp. This option is best suited for measurements of high gain devices or for measurements with a user-supplied low noise RF preamp.

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Let HP Design Your Microwave Noise Figure Measurement System

Design cycles are shrinking and you don't need the added worry of designing and supporting a microwave noise figure measurement system. With the HP 8970S/V Microwave Noise Figure Measurement Systems, HP takes care of the design details. You can spend your time designing and building products, not test systems. Combine the HP 8970B Noise Figure Meter, HP 8971C Noise Figure Test Set, and a recommended local oscillator and you have the powerful HP 8970S Microwave Noise Figure Measurement System. The HP 8970B automatically controls both the HP 8971C and local oscillator, making the microwave system as easy to use as the HP 8970B by itself. The HP 8970S gives you all the capabilities of the HP 8970B Noise Figure Meter in a system specified from 10 MHz to 26.5 GHz. Custom block downconvertors are available to extend the operating frequency to 110 GHz.

Configure A System For Your Application And Budget

The HP 8970S model number lets you configure a microwave noise figure system to fit your application and budget, while still ensuring the instruments are compatible and the shipment is coordinated. A complete HP 8970S Noise Figure Measurement System consists of an HP 8970B, an HP 8971C (with desired options), and an LO from the list of recommended sources on page 17. Frequency operation depends on the LO selected, but the HP 8970S can be configured to measure 10 MHz to 26.5 GHz. The HP 8971C with Option 001 is recommended for operation above 20 GHz.

The Most Economical System to 20GHz

For your ordering convenience, the HP 8970V is a pre-configured HP 8970S system. Consisting of the HP 8970B Noise Figure Meter, the HP 8971C Noise Figure Test Set, and the HP 83711B Synthesized CW Generator, the HP 8970V gives you accurate, convenient, and economical 10 MHz to 20 GHz measurements.

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The accuracy and convenience of RF Measurements at microwave frequencies.



Complete system control from HP 8970B front panel.

A single test port for 0.01 to 20 GHz calabration and measurement.

1 to 20 GHz synthesized signal generator for accuracy and ecomomy.*

*The system pictured is the HP 8970V which operates to 20 GHz. With the HP 8970S system, you may choose any combination of HP 8971C options and any of the recommended local oscillators listed under ordering information. Frequency operation depends on the LO selected.

(Note: For calibration and measurement repeatability in the HP 8970S/V system, the local oscillator must be synthesized.)

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Amplifiers

- Simultaneous noise figure and gain measurement
- Automatic correction for measurement system noise
- Real time, swept, corrected oscilloscope output for easy tuning
- Single-test-port calibration and measurement from 10 MHz to 26.5 GHz (with HP 8970S system)
- Permanent hard-copy plot of noise figure and gain vs. frequency with a digital plotter

Transistors

- Single-sideband allows accurate measurements with tuners
- Easy to compensate for tuner insertion loss
- Real time correction for 2nd stage effects

Receivers

- Tunable IF ranges from 10 to 1600 MHz (2047 MHz optional) with the HP 8970B and 10 MHz to 26.5 GHz with the HP 8970S
- External LO control
- Displays noise temperature for ultra-low-noise receivers

Mixers

- Simultaneous noise figure and conversion loss for design tradeoffs
- Noise figure vs. IF or LO frequency
- Noise figure as a function of LO power

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System Interface Bus

The addition of a System Interface Bus (SIB) makes computer control of the HP 8970S/V Noise Figure Measurement System as easy as controlling a single instrument. The HP 8970B uses the SIB to control instruments in the noise figure system, allowing a computer to maintain system control over GPIB while the noise figure system makes measurements. This greatly simplifies programming by taking full advantage of the controlling capabilities of the HP 8970B.

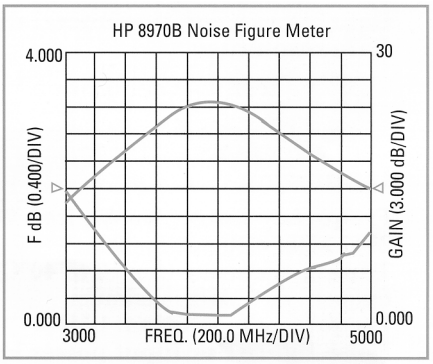
Millimeter-wave Measurements

Millimeter-wave receiver measuremets require two noise sources, for calabration (at the IF), and one for the actual measurements (at the RF). The HP 8970B can store up to four noise sourse ENR tables. This means you can calibrate and measure noise figure at several millimeter bands without re-entering ENR data. The meter displays measurement frequencies up to 99.999 GHz.

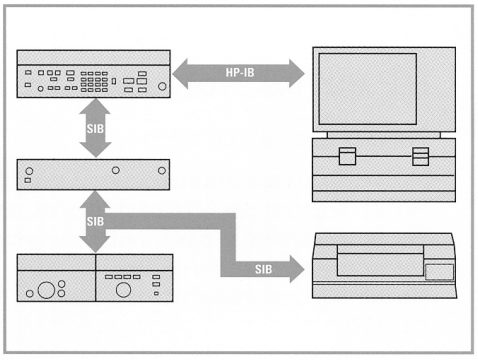
The HP 8970B also has a double down-conversion modes that use the HP 8971C as the second down-converter. These modes are helpful for measuring receivers and mixers with IFs greater than 1600 MHz or amplifiers and transistors above 26.5 GHz. With the HP 8970S/V Noise Figure Measurement System, millimeter single-sideband measurements can be made across almost a 52 GHz band (twice the HP 8970S/V's frequeny coverage) with a single filter.

Plotter Dump Capability

A noise figure and gain versus frequency display can be outputed to a digital plotter over the HP 8790B's System Interface Bus. What you see on the X vs. Y oscilloscope display is dumped to the plotter, complete with axis labeling and title.



Example of HP 8970B plot output.



HP 8970B in an automated system.

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Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving typical, but not warranted, performance parameters.

HP 8970B Noise Figure Meter Specifications

Noise Figure Measurement

Measurement range: 0 to 30 dB

Instrumentation uncertainty: ±0.1 dB
(for a 14 to 16 dB ENR noise source in a 0 to 55°C environment).

Resolution: 0.01 dB (0.001 dB over GPIB).

Gain measurement range:

Measurement range: -20 to >+40 dB
(for DUT and system noise figures totalling 30 dB or less).

Instrumentation uncertainty: ±0.15 dB.

Resolution:
Gain >-9.99 dB: 0.01 dB
Gain <-9.99 dB: 0.1 dB
(over GPIB: add 1 more digit to above)

Input Specifications

Frequency range: tunable from 10 to 1600 MHz
(10 to 2047 MHz with option 020).

Tuning accuracy (for 10 to 40°C):
±(1 MHz + 1% of frequency); 6 MHz maximum.

Frequency resolution: 1 MHz

Noise figure (for input power levels below -60 dBm):
<7 dB + 0.003 dB/MHz (<7 dB +0.002 dB/MHz with option 020).

Input SWR, 50 ohm reference impendence:
<1.7 10 MHz to 1600 MHz; (<1.8 with option 020).
<2.0 1600 MHz to 2047 MHz - (option 020 only)

Maximum operating input power: -10 dBm.

Maximum net external gain: >65 dB between noise source and HP 8970B RF input.

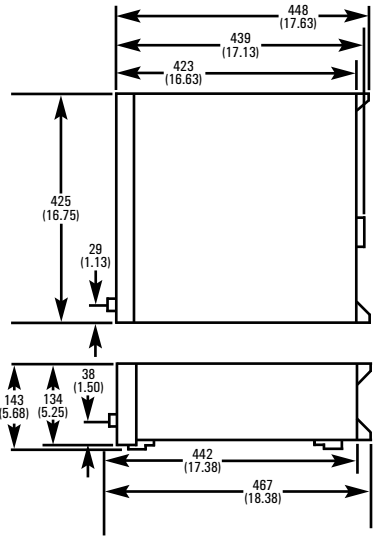
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Electromagnetic Compatibility

EMI: Conducted and radiated interference is in compliance with MIL-STD-461B CE03, RE02, EN55011, CLASS A (1991) AND CISPR, Class A (1990).

Conducted and radiated susceptibility: meets the requirements of MIL-STD-461B-1980, CS01/CS02, RS03 and EN50082-1 (1991) (IEC 801-2, 801-3 and 801-4).

General



Dimensions: HP 8970B mm (in.)

Noise source drive:
28.0 ±0.1 V for noise source ON (up to 60 mA peak); <lV for noise source OFF.

GPIB capability:
SH1, AH1, T5, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

Operating temperature: 0 to 55°C.

Storage temperature: –55 to 75°C .

Connectors: RF input: N(f), noise source drive: BNC(f).

Power: 100, 120, 220, or 240V (±5%, -10%); 48-66 Hz; 150 VA maximum.

Net weight: 15.5 kg (34 Ib).

Shipping weight: 18.5 kg (40 lb).

Dimensions: 143H x 425W x 467 mm (5.68 x 16.75 x 18.38 in.)

Nominal module: 5.25H x lMW x 14D

Supplemental Characteristics

Bandwidth: approximately 4 MHz

Sensitivity: -100 dBm
(no external gain required; able to measure its own noise figure).

Measurement speed: 6 to 9 measurements per second
with minimum smoothing.

Sweep speed at minimum smoothing (10 to 1600 Mhz):
140 ms per frequency point.

Jitter at minimum smoothing: Peak-to-peak Y- factor variation
<0.15 dB (typical).

Jitter with increased smoothing: Peak-to-peak* Y-factor variation <0.02 dB (for smoothing factor of 64) (typical).

Note: Noise figure jitter is equivalent to Y factor jitter to within 10% for ENR >14 dB and F <4 dB. At minimum smoothing, jitter can limit accuracy; at high smoothing, it does not.

Maximum safe input level: ±20 Vdc; +20 dBm peak (or average) at RF.

Audible noise level: <5.5 bels at 1 meter.

* Peak-to-peak defined here as five standard deviations about the mean of a statistically valid set of readings. This includes 99% of the readings for a normal distribution.

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Functional Properties

Noise Figure display units:

Noise Figure: dB, ratio

Uncorrected Y factor: dB, ratio

Effective Input Noise Temperature: K

Displayed measurement frequency range: 10 to 99,999 MHz

Noise figure display jitter: <0.01 dB (with appropiate smothing)

System LO control: frequency control over SIB with format "ccdddddcc" where the c's are user-setable ASCII characters and "ddddd" is the LO frequency in MHz. An auxiliary, user-settable message of 20 ASCII characters may also be sent over SIB.

Cold noise source data range: 0 to 9999K

Hot noise source data range:
ENR from -7 to +50 dB; spot T_{hot} from 0 to >2.9x10^7 K.

Number of calibration points in one sweep: 181.

Storage capacity of hot noise source tables: 4 stored ENR tables with 35 frequency's each (plus 1 working ENR table).

Smoothing: exponential averaging of gain and noise figure before display according to D = P (F–1) + M/F where D is the display result, P is the previous display result, M is the latest measurement, F is the averaging factor (1, 2, 4, 8, 16, 32, 64, 128, 256 or 512). Arithmetic averaging is used during swept operation.

Rear-panel outputs: X axis and Y axis from 0 to 6V. Z axis is TTL for penlift (on an X-Y plotter) blanking (on an oscilloscope).

Plotter capability: noise figure and gain versus frequency plot with grid, title and noise figure, gain, and frequency axis annotation.

Compatable digital plotters:
HP 7470A, HP 7475A. HP 7550A, HP 7440A, HP 9872B.

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HP 8971C Noise Figure Test Set Specifications

Specifications given are for single sideband operations using one of the recommended local oscillators.

Input Specifications

Frequency Range: 10 MHz to 26.5 GHz.

Noise Figure (Max.):

Std & Opt 001	**Opt 002**
10-30 MHz: 18 dB	10-1600 MHz: 5.4 dB
30-100 MHz: 13 dB	1.6-2.54 GHz: 28 dB
0.1-12 GHz: 10 dB	2.4-15 GHz: 26 dB
12-18 GHz: 11.5 dB	15-18 GHz: 28 dB
18-26.5 GHz: 14.5 dB	18-22 GHz: 28 dB *typical*
	22-26.5 GHz: 32 dB *typical*

Input SWR:

STD & Opt 001	**Opt 002**
10MHz-18 GHz: 2.25	10-1600 MHz: 1.5
18-26.5 GHz 2.7	1.6-18 GHz: 2
	18-26.5 GHz: 3

Electromagnetic Compatibility

EMI: Conducted and radiated interference is in compliance with FTZ 526/527 1979 CISPR publication 11, tested to the limits of MIL-T-28800D.

General

Remote Programming: All functions are GPIB programmable except the LINE switch.

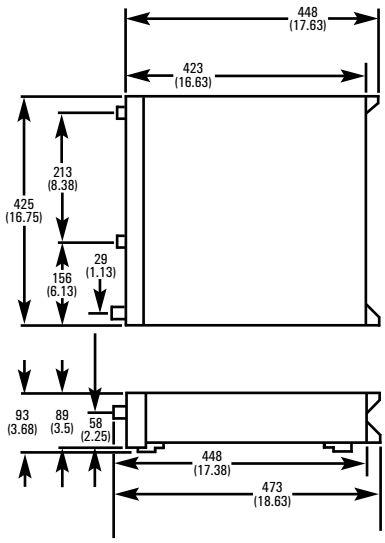
Accessories Supplied:

1 LO-to-HP 8971C cable, SMA (f) connectors, 300 mm
1 HP 8971C-to-HP 8970B cable, N (m) connectors, 190mm
1 N(m)-to-SMA (m) adaptor
2 GPIB cables, 0.5 m

Operating Temperature: 0 to 55^{0}C

Storage Temperature: -40^0 to 75^{0}C

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Dimensions: HP 8971C mm (in.)

Connectors:
LO input: APC-3.5 (m)
RF input: APC-3.5 (m)
IF output (to HP 8970B): N(f)

Power: 100, 120, 220, or 240V (+10%, -10%); 47-66 Hz;

Net Weight: 9.5 kg (21 lb)

Shipping Weight: 11.8 kg (26 lb)

Dimensions: 93H x 425W x 473 mm (3.68 x 16.75 x 18.63 in.)

Normal Module: 3.5H x 1MW x 14D.

Supplemental Characteristics

Gain (typical):

Std & Opt 001	**Opt 002**
10-1600 MHz: 23 dB	10-1600 MHz: -3 dB
1.6-2.4 GHz: 24 dB	1.6-2.4 GHz: 4dB
2.4-26.5 GHz: 27 dB	2.4-26.5 GHz: 0 dB

Maximum Operating RF Noise Input Power:

Std & Opt 001	**Opt 002**
10-1600 MHz: -29 dBm	-20 dBm
1.6-26.5 GHz: -26 dBm	

Image and Odd Harmonic Rejection: 20 dB

Maximum Safe RF Input Power:

Std & Opt 001: -5 dBm
Opt 002: +20 dBm

LO Input Power:

Minimum:
Std & Opt 002: +7 dBm
Opt 001: +1 dBm

Maximum:
Std & Opt 002: +20 dBm
Opt 001: +7dBm

Double Sideband (DSB) Noise Figure (2.4-26.5 GHz):
Std & Opt 001: Same as single sideband (SSB).
Opt 002: 21 dB

DSB Gain:
Std & Opt 001: 28 dB
Opt 002: 4 dB

Audible Noise Level: less than 5.5 bels at 1 meter.

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HP 8970S/V Noise Figure Measurement System Specifications

Specifications are the same as the HP 8970B Noise Figure Meter with the following exceptions

Noise Measurement

Noise Figure Measurement Range: 0 to 30 dB

Noise Figure Instrumentation Uncertainty: (for a 14 to 16 dB ENR noise source in a 10 to 40°C environment and for device under test noise figure plus gain greater than 10 dB). (For HP 8971C with option 002, assumes the use of a preamplifier with <10 dB noise figure and >20 dB gain).
10 MHz to 18 GHz: ±0.2 dB
Plus typical drift of ±0.015 dB /°C
18 to 26.5 GHz:±0.4 dB
Plus typical drift of ±0.08 dB /°C

Gain Measurment

Gain Instrumentation Uncertainty: less than ±0.28 dB Plus typical drift of ±0.05 dB / °C 10 MHz to 18 GHz, ±0.07 dB / °C 18 to 26.5 GHz.

Input Specifications

Frequency Range:

HP 8970S: Tunable from 10 MHz to 26.5 GHz
(upper frequency will be limited by the LO upper frequency)

HP 8970V: Tunable from 10 MHz to 20 GHz.

Noise Figure (max.): same as HP 8971C

Input SWR: same as HP 8971C

Maximum Operating RF Noise Input Power:
10-1600 MHz: -29 dBm
1.6-26.5 GHz: -26 dBm

Maximum Safe RF Input Power: -5 dBm

Maximum Net External Gain: greater than 35 dB

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General

Power requirements, net weight, shipping weight, dimensions: Sum of individual instruments.

Supplemental Characteristics

Sensitivity: -100 dBm (no external gain required; able to measure it's own noise figure with HP 346A/B/C).

Double Sideband (DSB) Noise Figure (2.4-26.5 GHz): same as HP 8971C.

Measurement Speed: 6 to 9 measurements per second with minimum smothing.

Sweep Speed at Minimum Smothing: (given for each HP 8971C frequency band with corrected readings).

SSB1 (10 to1600 MHz): 140 ms per frequency point

SSB2 (1.6 to 2.4 GHz): 150 ms per frequency point

SSB3 (2.4 to 26.5 GHz): 435 ms frequency point

DSB (2.4 to 26.5 GHz): 150 ms per frequency point

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HP 8970B Noise Figure Meter

Option 020: Extends upper frequency from 1600 to 2047 MHz
Option 700: External MATE translator
Option 907: Front panel handle kit
Option 908: Rack mounting flange kit
Option 909: Front panel handle kit plus rack mounting flange kit
Option 914: Delete operating manual
Option 915: Service manual
Option 916: Extra operating manual

HP 8971C Noise Figure Test Set

All RF and GPIB cables needed to connect the HP 8971C to the HP 8970B and a Synthesized Source are included with the HP 8971C.

Option 001: Add internal LO power amp
Option 002: Delete internal RF pre amp
Option 907: Front panel handle kit
Option 908: Rack mounting flange kit
Option 909: Front panel handle kit plus rack mounting flange kit
Option 915: Service manual
Option 916: Extra operating manual

HP 8970V Noise Figure Measurement System

HP 8970B, HP 8971C, HP 83711B

Accessories

1494-0060 Rack Slide Kit for HP 8970B or HP 8971C
9211-2649 HP 8970B Transit case
9211-2648 HP 8971C Transit case

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HP 8970S Noise Figure Measurement System

A complete HP 8970S Noise Figure Measurement System consists of the HP 8970B Noise Figure Meter, the HP 8971C Noise Figure Test Set (with options if desired), and a Synthesized Microwave Signal Source.

Recommended Synthesized Microwave Signal Sources

HP 83620B Synthesized Swept-Signal Generator, 10 MHz to 20 GHz
HP 83622B Synthesized Swept-Signal Generator, 2 GHz to 20 GHz
HP 83630B Synthesized Swept-Signal Generator, 10 MHz to 26.5 GHz
HP 83640B Synthesized Swept-Signal Generator, 10 MHz to 40 GHz
HP 83650B Synthesized Swept-Signal Generator, 10 MHz to 50 GHz
HP 83711B Synthesized CW Generator, 1 GHz to 20 GHz
HP 83712B Synthesized CW Generator, 10 MHz to 20 GHz
HP 83731B Synthesized Signal Generator, 1 GHz to 20 GHz
HP 83732B Synthesized Signal Generator, 10 MHz to 20 GHz
HP 83751A Synthesized Sweeper, 2 GHz to 20GHz
HP 83752A Synthesized Sweeper, 10 MHz to 20 GHz

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