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HEWLETT PACKARD

HP 3048A Phase Noise Measurement System

5 MHz to 26.5 GHz

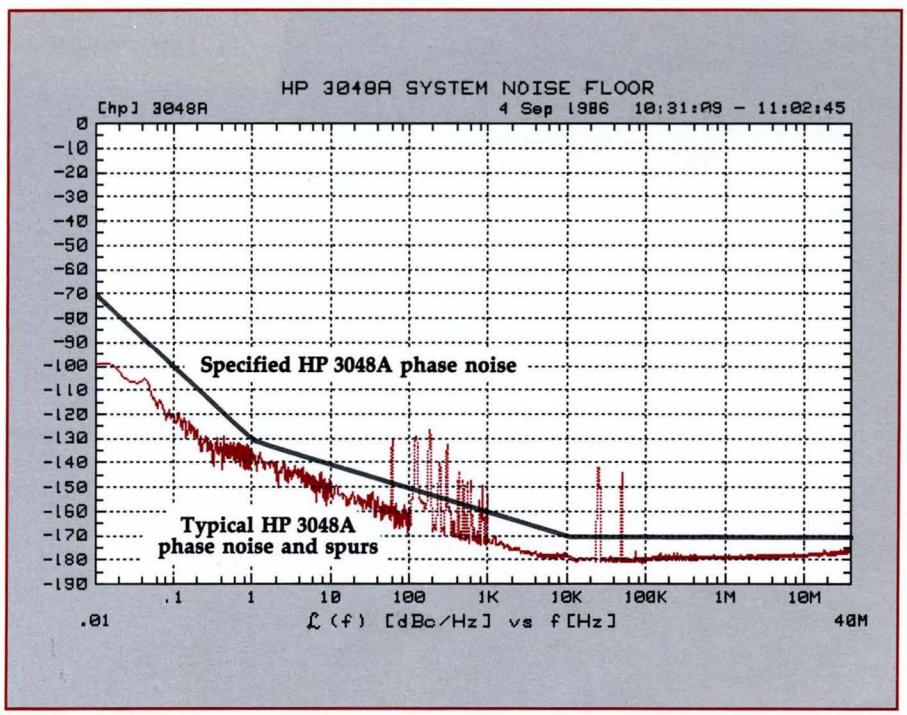
Technical Data



Accurate measurements from a flexible solution

The exceptional performance of the HP 3048A . . .

. . . Provides sensitivity necessary to measure very low noise sources

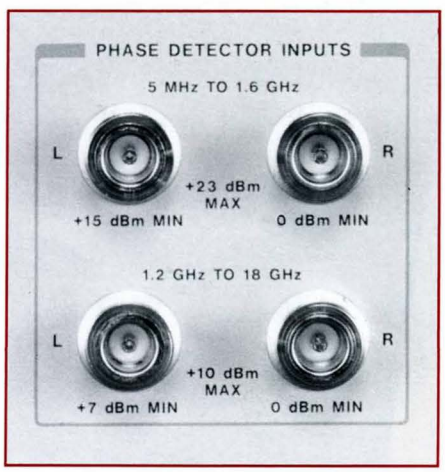


The HP 3048A Phase Noise Measurement System has an internal noise floor well below the noise of most reference sources. This means the actual noise sensitivity will be limited by the reference source used to demodulate the phase noise. Since even excellent low-noise sources such as the HP 8662A or 8663A Synthesized Signal Generators may not offer sufficient measurement sensitivity, the HP 3048A can use any voltage-tunable source as a reference source. The system will also provide HP-IB commands to set up this custom reference source for the measurement.

. . . Has specified amplitude accuracy to reduce measurement uncertainty

The random noise and discrete spurious signals measured by the HP 3048A system over an offset range of 0.01 Hz to 1 MHz are specified to an accuracy of ±2 dB. This accuracy is possible because the system corrects for possible errors from signal path losses, phase lock loop effects, and the nonlinear output of phase detectors. At offsets greater than 1 MHz the measured output has ±4 dB accuracy. The HP 3048A supports most spectrum analyzers to measure offsets beyond 100 kHz.

. . . Covers a wide frequency range



The HP 3048A's standard frequency range of 5 MHz to 1.6 GHz covers RF sources and devices that need phase noise characterization. Adding Option 201 provides a microwave phase detector for extending residual measurements to 18 GHz. With a tunable microwave phase noise reference, the microwave phase detector can also be used to measure absolute microwave phase noise.

In addition, the HP 3048A was designed to provide specified measurements outside the 5 MHz to 18 GHz range through a noise input port which accepts the baseband signal from any external phase detector that demodulates the carrier's noise. The noise input port also accepts the output of an external crystal detector for AM noise measurements.

. . . sets the standard for phase noise measurements

The HP 3048A Phase Noise Measurement System has established new standards for phase and AM noise measurements. The system provides hardware and software for calibrated measurements over a frequency range of 5 MHz to 18 GHz, offsets from 0.01 Hz to 40 MHz. Special options are available to measure frequencies below 5 MHz, up to 110 GHz, and to offsets from 0.001 Hz to 1 GHz.

The HP 3048A:

- Provides guaranteed accuracy: ±2 dB for offsets from 0.01 Hz to 1 MHz, ±4 dB for offsets from 1 MHz to 40 MHz.
- Repeatability is guaranteed.
- Supports absolute, residual (or two-port), AM, and pulse measurements, as well as a real-time analysis mode.
- Measures a continuous noise spectrum over the offset range selected, with corrections for the phase lock loop response.
- Has optimized measurement speed, approximately 10 minutes to calibrate, measure, and plot the data from 1 Hz to 40 MHz offsets.
- Identifies and marks spurious, plotting them at their absolute amplitude.
- Measurements can be defined and stored in memory to increase efficiency.
- The software provides a wide range of data analysis tools:

  Spec Lines, allows you to draw your limits on the Results Graph.

  Marker, reads the amplitude and frequency of the displayed noise or spur level at a discrete point.

  Two- and Three-Source Comparisons, determine the phase noise levels of two or three similar devices.

  Spur List, provides a listing of the frequency and amplitude of the discrete spurious.

  Plot Without Spurs, plots the measured noise data excluding the recognized spurs.

  Plot In Alternate Bandwidth (user defined) or in the Actual Measurement Bandwidth.

  Computed Outputs; Sigma vs. Tau, Allan Variance, Residual FM, Integrated $\mathcal{L}(f)$, $S_\phi(f)$, $S_\nu(f)$, $S_y(f)$.

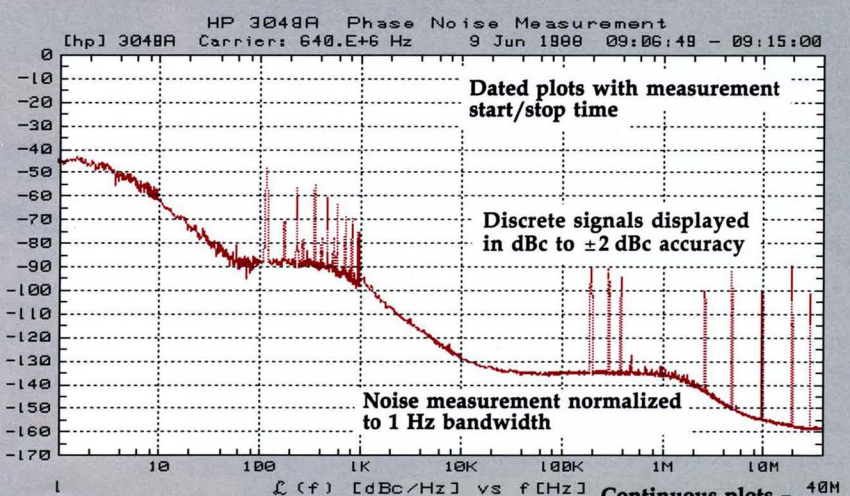
  Parameter Summary, lists all of the parameters that are defined for a measurement.

  Color Outputs, RMB system software supports HP plotters, PC compatible system software supports any color printer supported by GRAFPLUS® such as the HP Paintjet.

- Support Life of 5 years after product obsolescence.
- System calibration is fully supported by the software. There are internal sources built into the interface to verify system performance. This and a minimal set of test equipment (frequency counter, power meter and audio source) will completely calibrate the system.

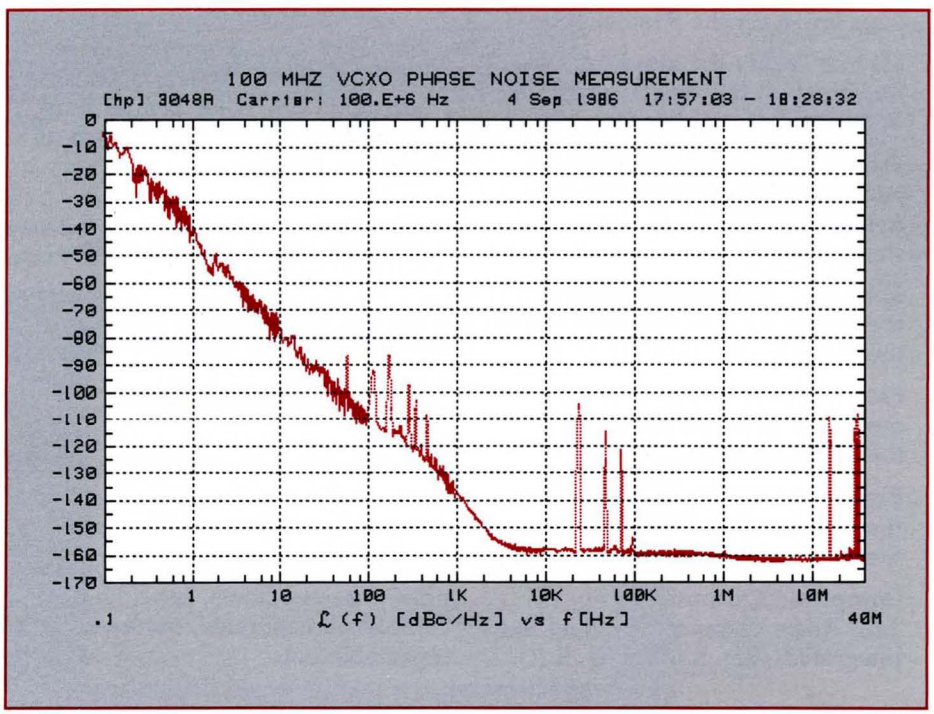
The HP 3048A standardizes phase noise measurements, providing completely calibrated, accurate, repeatable data.

User annotation of up to 58 characters

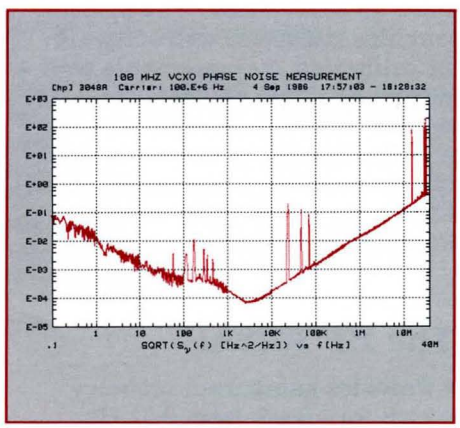


Accurately delivers the results you need . . .

For example, single sideband phase noise ($\mathcal{L}(f)$)



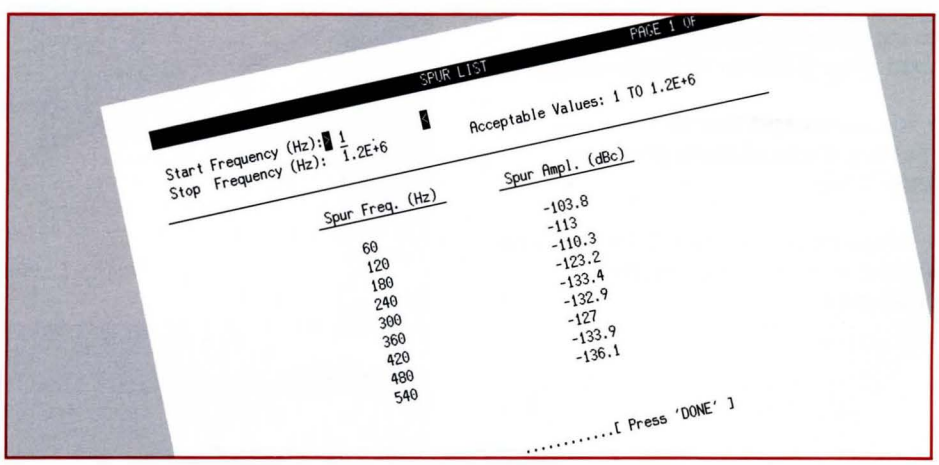
For example, spectral density graphs



The HP 3048A was designed to plot the measured noise data in any of several output formats; $\mathcal{L}(f)$, $S_\phi(f)$, $S_y(f)$ or $S_\nu(f)$.

For example, tabulated results of detected spurs

The HP 3048A system can provide a list of all the spurs identified in a measured frequency range. Other outputs such as a calculation of the total noise power or residual FM contained in a measured offset range is also available with the HP 3048A system along with a conversion of the data to its corresponding Allan variance.



. . . with a flexible system configuration



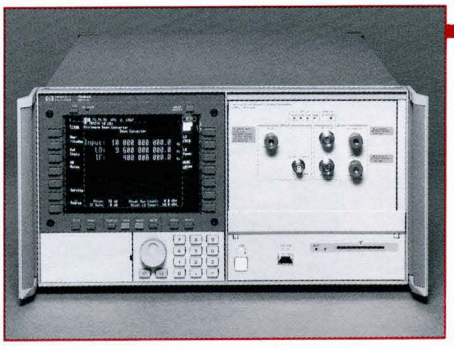
A basic HP 3048A system makes high performance RF measurements

When you order an HP 3048A system you receive an HP 11848A Phase Noise Interface, an HP 3561A Dynamic Signal Analyzer, the HP 3048A Measurement Software, and a 90-day on-site system warranty. Option +24A is recommended with the HP 3048A system. This provides two days of phase noise measurement training at your site by an HP Applications Engineer. Combine this package with a computer and you are ready to make a wide variety of phase noise measurements in the carrier frequency range of 5 MHz to 1.6 GHz. Adding Option 201, microwave phase detector, extends the frequency range of this basic system to 18 GHz.



Add an optional reference source for specified low-noise capability

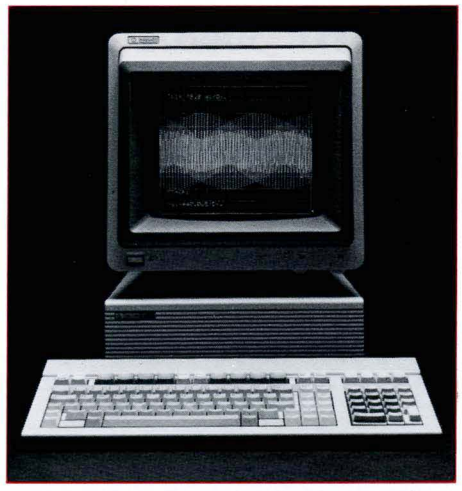
If you need a reference source with low phase noise close to the carrier, the HP 8662A Synthesized Signal Generator can be ordered as Option 001. The HP 8662A provides a reference signal up to 1280 MHz and has two mode of tuning available to meet differing phase noise measurement requirements. Similarly, an HP 3048A Option 002 adds an HP 8663A to the phase noise measurement system for coverage to 2.56 GHz. The HP 8642A (0.1 to 1057 MHz) or HP 8642B (0.1 to 2115 MHz) offer low phase noise at offsets greater than 10 kHz as HP 3048A Options 005 and 006 respectively.



Add an optional downconverter for microwave source measurements

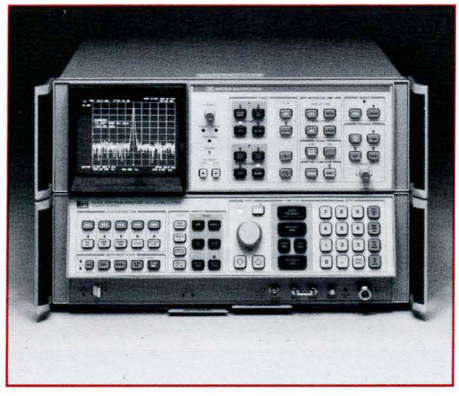
Because it is difficult to find a low noise microwave reference source for measuring absolute phase noise on microwave signals, Hewlett-Packard offers the HP 11729C Carrier Noise Test Set and HP 71707A Microwave Downconverter. These products downconvert the test signal using a low-noise, multiplied reference signal. Once the test signal is converted to RF, a low-noise, tunable RF source such as the HP 8662A or HP 8663A can be used as a phase noise reference.

The HP 71707A offers state-of-the-art phase noise, specified spurious performance, and an internal AM noise detector.



Choose a workstation or PC for computer control

With the system software options available, choose either the HP 98580C or an IBM® PC compatible as your system controller. Both provide fast operation and excellent graphics. Option 301 MS-DOS® compatible software also provides automatic control of the HP 71707A downconverter.

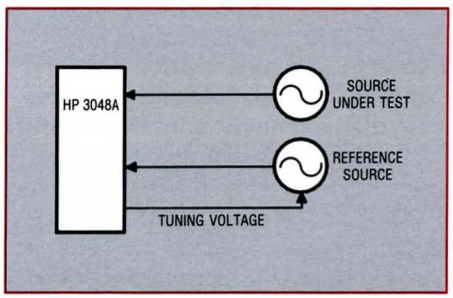


Connect a spectrum analyzer for 40 MHz offset measurements

The software of the HP 3048A provides phase noise measurements with specified accuracy over an offset range of 100 kHz to 40 MHz using any of the following spectrum analyzers: the HP 3585A/B (HP 3048A Option 101), 8562A/B, 8568A/B, 8567A, 8566A/B, 71100A, 71209A, or 71210A. The measurements are completely automatic and have a specified amplitude accuracy of ±2 dB to 1 MHz and ±4 dB to 40 MHz offset frequency.

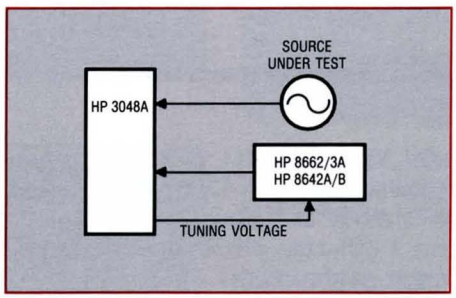
The HP 3048A has many configurations to meet specific needs

All of the following configurations make use of a basic HP 3048A system (includes HP 11848A Interface and HP 3561A Signal Analyzer) under control of a computer. Each of these measurements are executed by the HP 3048A and the results are covered by the system specifications.



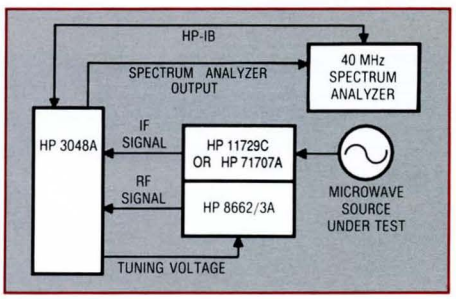
To economically measure a source

Use your own tunable source with similar or better phase noise as the reference source to demodulate the test signal's phase noise. Add the microwave phase detector to the HP 3048A (Option 201) to measure sources above 1.6 GHz.



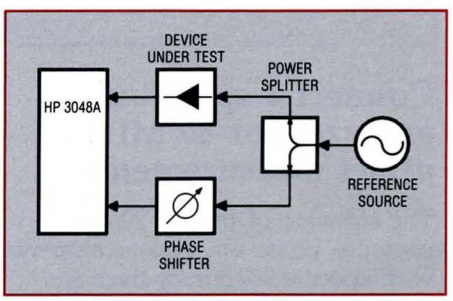
To make RF measurements with a specified low-noise reference

Add one of several Hewlett-Packard synthesized signal generators to the HP 3048A for completely automated phase noise measurements using a reference source of guaranteed phase noise performance.



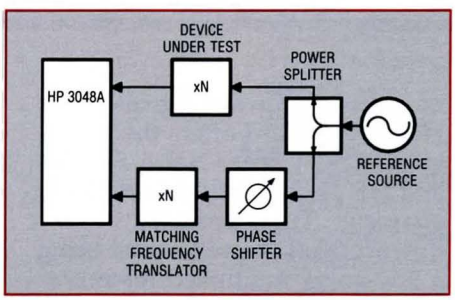
To measure microwave sources using a specified downconverter/reference

Adding the HP 11729C or HP 71707A and an HP 8662A or 8663A to the HP 3048A provides specified phase noise measurements to microwave frequencies. For the lowest phase noise performance commercially available to 26.5 GHz, select the HP 71707A.



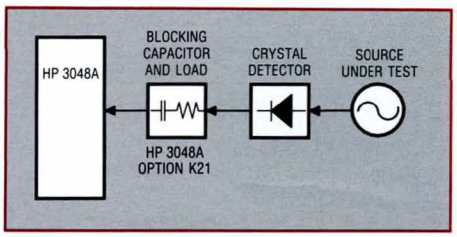
To measure the added noise of a two-port device

The HP 3048A's low internal phase noise provides the necessary dynamic range to accurately measure the phase noise added by an amplifier or other two-port device.



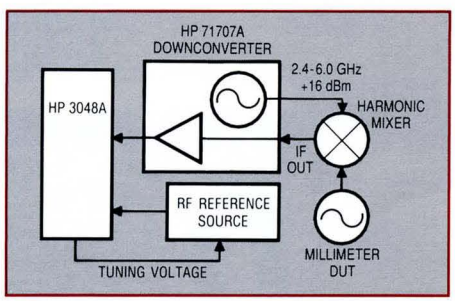
To measure the added noise of a frequency translating device

The HP 3048A system will measure the combined noise of two similar frequency translating devices and can mathematically correct the data to present the noise of one device.



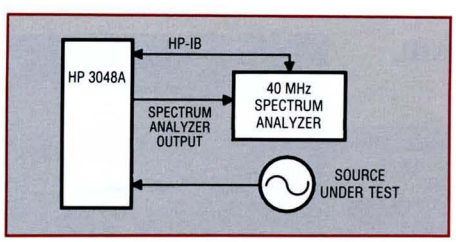
To measure AM noise

Using an external crystal detector, the HP 3048A system can automatically quantify the level of AM noise that could affect a phase noise measurement. The HP 71707A provides an internal AM noise detector. The HP 11729C offers an optional AM detector.



To measure sources above 26.5 GHz or below 5 MHz

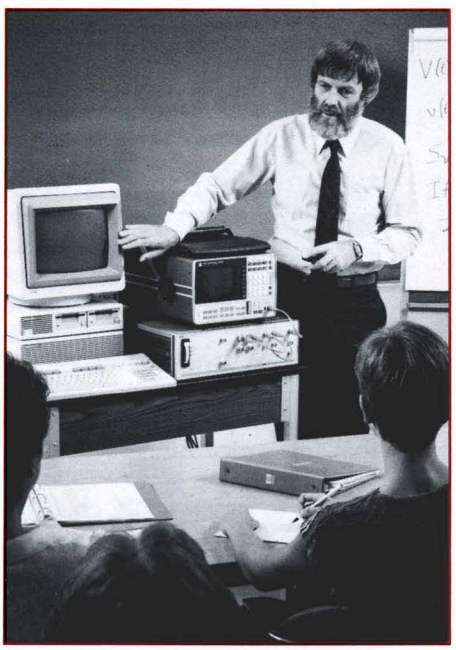
For measurements below 5 MHz, an external phase detector can be used to provide the demodulated phase noise for analysis. Above 26.5 GHz, simply add a harmonic mixer to extend the frequency range of the HP 71707A up to 110 GHz.



To increase offset range from 100 kHz to 40 MHz

Several spectrum analyzers can be controlled by the HP 3048A system for calibrated phase noise measurements at offsets up to 40 MHz.

Option +24A operator training ensures productive operation and satisfactory measurements



Option +24A provides two days of operator training with the HP 3048A system. This class is given by a trained Hewlett-Packard Application Engineer at your site for up to six potential operators of the system. The course explains all of the operating modes of the HP 3048A, when each measurement technique is appropriate, and how to analyze the measured data. Specific assistance is given on measuring your device as time and equipment availability permit. This course was created to provide system operators with a fast way to master phase noise measurements using the HP 3048A system. Additional time for measurement consultation by the Application Engineer can also be purchased.

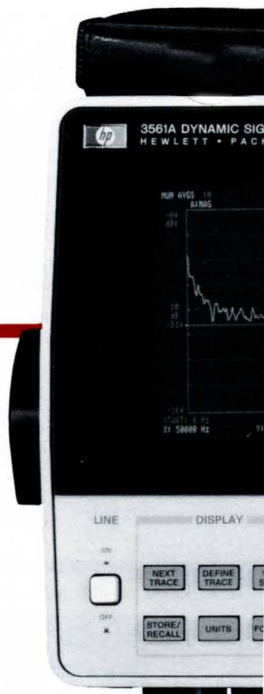
The HP 3048A Phase Noise Measurement System

The HP 3048A system consists of an interface box specifically designed for high performance phase noise measurements, a fourier analyzer, and a software program that guides the operator. Option +24A operator training course is recommended for a fast transition to highly productive operation.

The HP 11848A Phase Noise Interface supports several measurement techniques for phase noise and AM noise measurements. Inside are the phase detectors, amplifiers, filters, and switches necessary to measure phase noise over a frequency range of 5 MHz to 18 GHz. An input for an external phase detector outside that frequency range is also provided. The built-in sources allow the system to functionally check all of its signal handling circuits to ensure proper operation before measurements are made.

The HP 3561A Dynamic Signal Analyzer makes fourier-type measurements on signals within a 125 μHz to 100 kHz frequency range. This analyzer's built-in data averaging, large dynamic range and fast measurement speed make it ideal for quantifying demodulated phase noise.

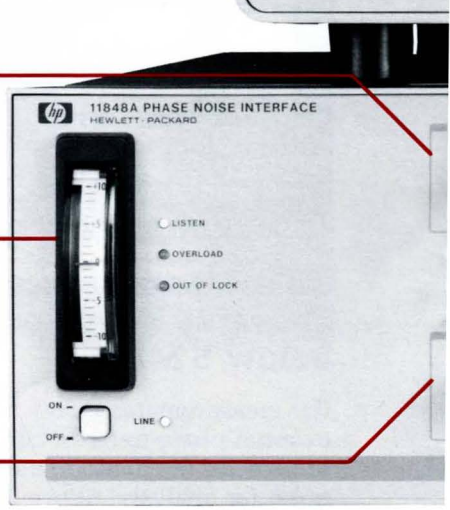
Front panel features



The Tuning Voltage Output provides the control voltage for tuning external signal sources.

The analog meter provides the operator with a visual check of the quadrature voltage from the phase detector.

The Noise Input accepts the output of external phase detectors for phase noise measurements and of external crystal detectors to quantify AM noise.

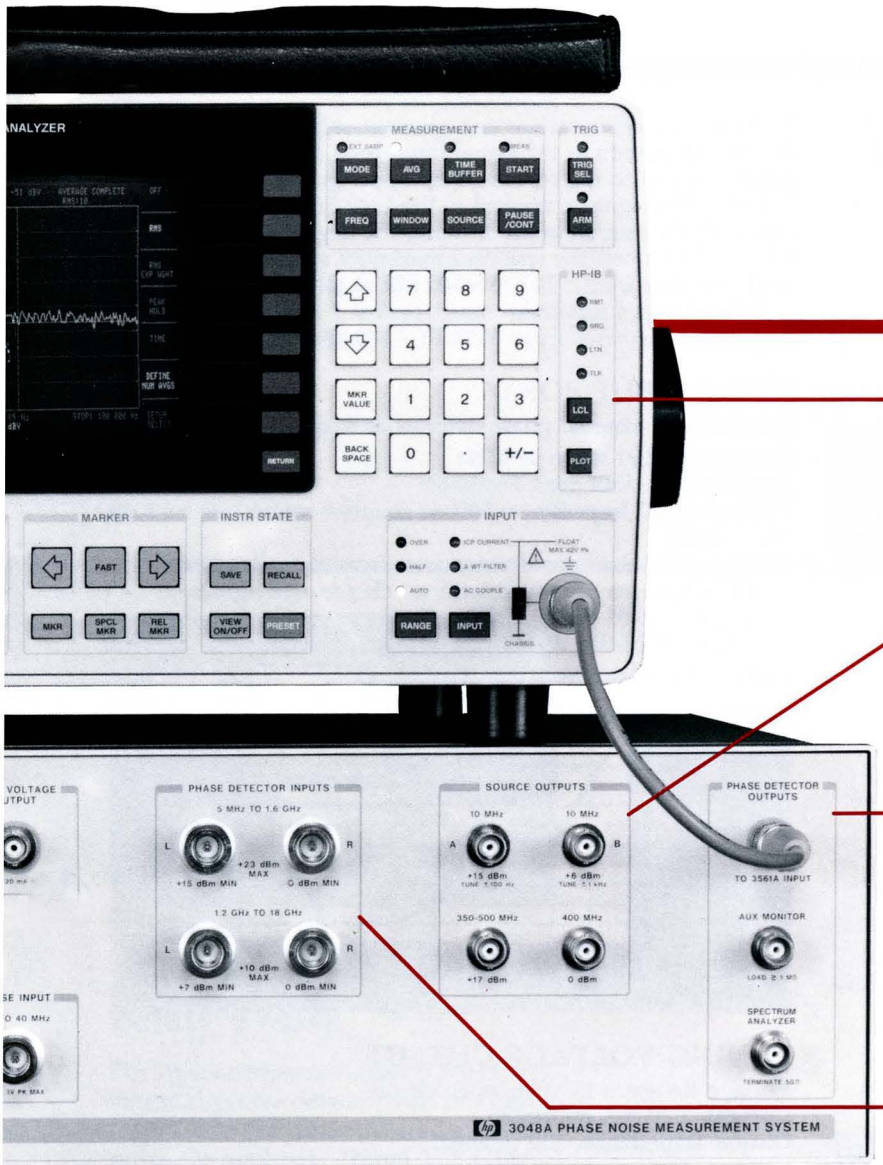


Software, documentation, and training

Whether you select a workstation or a PC for computer control, the HP 3048A system software provides the measurement program, including all drivers necessary to run both standard and optional instruments of the HP 3048A system. The drivers for the HP 71707A downconverter are only available with Option 301 MS-DOS® PC compatible system software.

The system documentation and Option +24A operator training course ensure that users are productive quickly.





The HP 3561A measures the noise data to a maximum of 100 kHz offset frequency. It is also extensively used for system calibration and real-time noise monitoring.

These built-in sources provide calibration signals for the system and can also be used as reference sources for phase noise measurements.

The Phase Detector Outputs present the demodulated noise from the phase detectors for measurement with spectrum analyzers or monitoring by an oscilloscope.

Two phase detectors provide maximum sensitivity across a wide carrier frequency range. The 1.2 to 18 GHz phase detector is optional to the HP 3048A system.

Rear panel features



Complete calibration of the HP 3048A requires very simple instruments. A function generator is used to inject a tone at this port.

This output duplicates the front panel Tune Voltage output for easy connection to a signal generator in a system rack.

These inputs are used for calibration and phase lock loop characterization (HP 3585A/B is optional to HP 3048A).

Duplicate output for built-in 10 MHz "A" source.

HP 3048A system specifications

Specifications describe the instruments' warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving typical, but not warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

PHASE DETECTOR PORTS

Frequency

Range: 5 MHz to 1.6 GHz (Low-frequency inputs)
Additional Range with Option 201: 1.2 to 18 GHz (High-frequency inputs) (The frequency range can be extended with a customer-supplied phase detector)

Amplitude

	Low-Frequency Inputs		High-Frequency Inputs	
	L in	R in	L in	R in
Maximum Signal (dBm)	+23	+23	+10	+5
Minimum Signal (dBm)	+15	0	+7	+0

Maximum dc Input: ±20V

Offset Frequency Range

0.01 Hz to 40 MHz for carriers from 95 MHz to 18 GHz
0.01 Hz to 2 MHz for carriers from 5 MHz to 95 MHz
(Assumes addition of 40 MHz spectrum analyzer to the system, otherwise offset range limited to 100 kHz.)

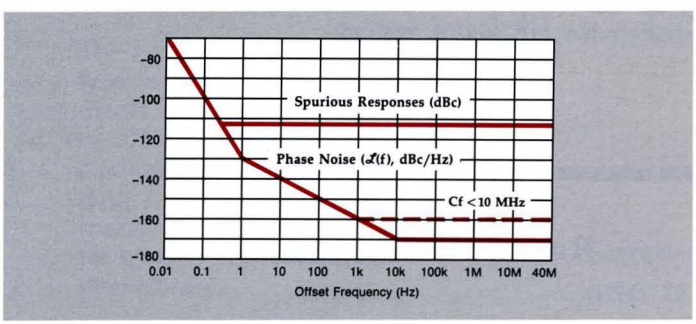
Accuracy (measurement of all noise and spurious present at the two inputs to the phase detector and system contribution):
±2 dB for 0.01 Hz to 1 MHz offsets
±4 dB for 1 MHz to 40 MHz offsets

In order for the HP 3048A to meet its accuracy specifications, the following qualifications must be met:

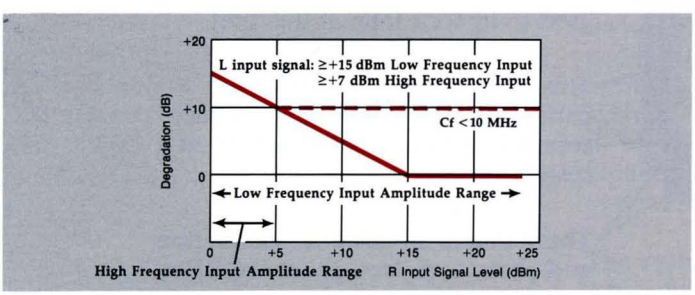
- Source return loss >9.5 dB (<2 : 1 SWR)
- Source harmonic distortion <−20 dB (or a square wave)
- Nonharmonic spurious, except for phase modulation close to the carrier, ≤−26 dBc

System Phase Noise and Spurious Responses

(Does not include phase noise and spurious signals from a reference source.)



System Noise and Spurious Response Increase with Input Level Decrease



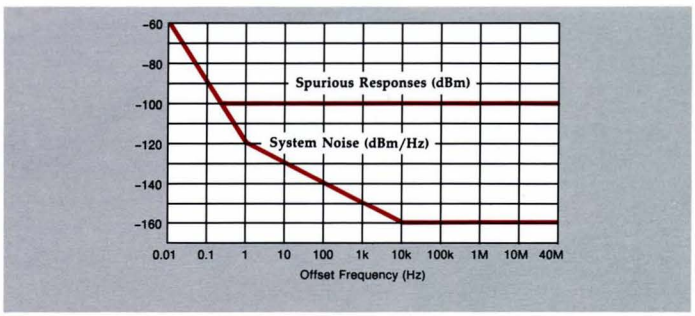
To determine system noise and spurious response levels, find the dB degradation at the signal input level from the lower graph and add to the curves of the upper graph. For example, if a +15 dBm signal is applied to the Low Frequency L Input and a +5 dBm signal to the R Input, the degradation is +10 dB. Therefore, the specified maximum spurious signal level increases from −112 to −102 dBc at all offset frequencies and the system's maximum noise level at >10 kHz offset frequencies increases from −170 to −160 dBc/Hz.

NOISE INPUT PORT

(For use with external phase detector or frequency discriminator)

Frequency: 0.01 Hz to 40 MHz
Amplitude: 1 Volt peak maximum
Typical Input Impedance: 50Ω dc coupled; return loss >9.5 dB (<2:1 SWR)
Accuracy: External phase detector or frequency discriminator measurements calibrated with ±1 dB accurate signals.
±2 dB for 0.01 Hz to 1 MHz offsets
±4 dB for 1 MHz to 40 MHz offsets

System Noise and Spurious Responses



TUNING VOLTAGE OUTPUT

Voltage Range: ±12 volts, open circuit
Current: ±20 mA maximum
Output Impedance: 50Ω nominal

SOURCE OUTPUT TYPICAL PERFORMANCE

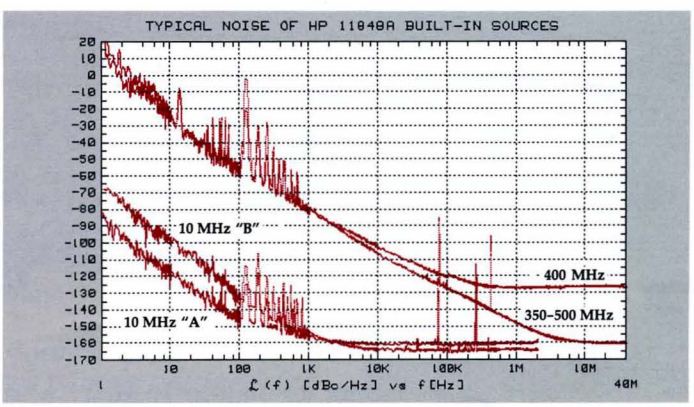
10 MHz Source A
Amplitude: +15 dBm
Tuning: ±100 Hz

10 MHz Source B
Amplitude: +6 dBm
Tuning: ±1 kHz

350-500 MHz
Amplitude: +17 dBm

400 MHz
Amplitude: −5 dBm
Tuning: Fixed Frequency

Typical Noise and Spur Levels



HP 3048A option specifications

The HP 3048A can be ordered with any of several optional signal generators as a reference source for phase noise measurements. The following specifications address system operation with these signal generators. The data that follows is in addition to that given previously under the heading of HP 3048A System Specifications. Refer to the data sheet for each signal generator for more complete information on each model.

OPTIONS 001 OR 002: ADDING THE HP 8662A OR 8663A SIGNAL GENERATOR

The following data applies only if either the HP 8662A Opt. 003 or 8663A Opt. 003 is used as the reference source to demodulate the test signal.

Frequency

Range: 100 kHz to 1280 MHz (to 2560 MHz with HP 8663A).[1]
Resolution: 0.1 Hz, 0.2 Hz: 640 to 1280 MHz, 0.4 Hz above 1280 MHz.
Accuracy and Stability (internal 10 MHz quartz oscillator): Aging rate $<5 \times 10^{-10}$/day after 10-day warm-up (typically 24 hrs in normal operating environment).
EFC: Provides a drift tracking range of $\pm 10^{-8}$ with no degradation of phase noise or spurious.

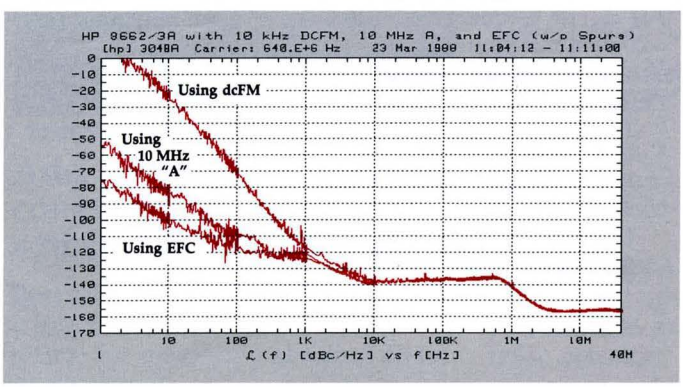
Spectral Purity[2]

Absolute Phase Noise

		Offset from Carrier (Hz)								
		1	10	100	1k	3k	5k	10k	100k	1M
0.1 to 120 MHz	Typ.	-78	-108	-126	-132	-135	-138	-138	-139	-145
	Spec.	-68	-98	-116	-126	-126	-128	-132	-132	
120 to 160 MHz	Typ.	-76	-106	-125	-135	-138	-141	-148	-148	-150
	Spec.	-66	-96	-115	-129	-129	-131	-142	-142	
160 to 320 MHz	Typ.	-70	-100	-119	-130	-133	-136	-142	-142	-148
	Spec.	-60	-90	-109	-124	-124	-126	-136	-136	
320 to 640 MHz	Typ.	-64	-94	-114	-125	-127	-130	-136	-136	-141
	Spec.	-54	-84	-103	-118	-118	-120	-131	-131	
640 to 1280 MHz	Typ.	-58	-88	-108	-119	-121	-124	-130	-130	-135
	Spec.	-48	-78	-97	-112	-112	-114	-124	-124	
1280 to 2560 MHz*	Typ.	-52	-82	-102	-113	-115	-118	-124	-124	-134
	Spec.	-42	-72	-92	-106	-106	-108	-118	-118	

*HP 8663A Option 003 only.

Typical HP 8662A/8663A Phase Noise
(With DCFM, 10 MHz "A" and EFC tuning)



Spurious Signals

	Frequency Range (MHz)					
	0.1 to 120	120 to 160	160 to 320	320 to 640	640 to 1280	1280 to 2560
Spurious nonharmonically related[1]	-90 dBc	-100 dBc	-96 dBc	-90 dBc	-84 dBc	-78 dBc
Subharmonically related (1/2, 3f/2, etc.)	none	none	none	none	-70[2] dBc	-40 dBc
Power line (60 Hz) related to microphonically generated (within 300 Hz)[3]	-90 dBc	-85 dBc	-80 dBc	-75 dBc	-70 dBc	-65 dBc
Harmonics	≤30 dBc					

[1] In the remote mode it is possible to have microprocessor clock-related spurious signals spaced 3 MHz apart at an absolute level of typically less than -145 dBm.
[2] 3/2 spurs not specified for HP 8662A carrier frequencies above 850 MHz.
[3] At a 50 Hz line frequency, powerline or microphonically related spurious signals may be up to 3 dB higher and appear at offsets as high as 1 kHz from the carrier.

Amplitude

Typical Maximum Output Level: +16 dBm

Modulation

Modulation Types: FM, AM (Pulse with the HP 8663A)
FM Deviation

Center Frequency (MHz)	Maximum Peak Deviation dc FM (kHz)
0.1 – 120	100
120 – 160	25
160 – 320	50
320 – 640	100
640 – 1280	200
1280 – 2560*	400

*HP 8663A Option 003 only

Indicated FM Accuracy: ±8% (7% for HP 8663A) of reading plus 10 Hz (50 Hz to 20 kHz rates).
Input Impedance: HP 8662A: 1kΩ, HP 8663A: 600Ω.
Maximum Input Level: 1V peak for specified accuracy.
Temperature Range: +15° to 35°C.

OPTION 005 OR 006: ADDING THE HP 8642A OPT. 001 OR 8642B OPT. 001 SIGNAL GENERATOR

The following data applies only if the HP 8642A Opt. 001 or 8642B Opt. 001 is used as the reference source to demodulate the test signal.

Frequency

Range: 100 kHz to 1057.5 MHz (to 2115 MHz with the HP 8642B)[2]
Opt. 001 Stability: $<10^{-9}$/day aging after 8 days warm-up.

[1]Measurements <5 MHz require external phase detector.
[2]Specified only with FM off.

HP 3048A option specifications

Spectral Purity

Absolute Phase Noise[3]

Carrier Frequency Band	SSB Phase Noise 20 kHz Offset dBc/Hz	SSB Phase Noise Floor 200 kHz Offset dBc/Hz
1057.5 - 2115*	−125	−134
528.7 - 1057.5	−134	−144
264.3 - 528.7	−137	−144
132.1 - 264.3	−141	−144
66.0 - 132.1	−144	−145
33.0 - 66.0	−145	−145
16.5 - 33.0	−146	−147
8.2 - 16.5	−147	−148
4.1 - 8.2	−148	−149
0.1 - 4.1	−137	−138
0.1 - 132.1 HET	−125	−137

* HP 8642B only.

Spurious

Type of Spurious	0.1 to 1057.5 MHz	1057.5 to 2115 MHz[1]
Harmonics		
Output Level ≤+10 dBm	−30 dBc	−25 dBc
Output Level ≤+16 dBm	−20 dBc	−20 dBc
Subharmonics	none	−45 dBc
Nonharmonics, >10 kHz from the carrier	−100 dBc[2]	−94 dBc

[1] HP 8642B only. [2] Not specified in HET band.

Typical SSB AM Noise Floor at 200 kHz Offset, +16 dBm Output Power:
<−157 dBc/Hz, 4.13 to 1057 MHz
<−150 dBc/Hz, 1057 to 2115 MHz

Amplitude

Maximum Output Level: >16 dBm.

[3]Specified only for dc FM <200 kHz.
[4]Specified only with FM off.

Modulation

Modulation Types: FM, AM, Phase, Pulse

FM Deviation

Carrier Frequency Band	Maximum Deviation dc Coupled
1057.5 - 2115[1]	3 MHz
528.7 - 1057.5	1.5 MHz
264.3 - 528.7	750 kHz
132.1 - 264.3	375 kHz
66.0 - 132.1[2]	187 kHz
33.0 - 66.0[2]	93.8 kHz
16.5 - 33.0[2]	46.9 kHz
8.2 - 16.5[2]	23.4 kHz
4.1 - 8.2[2]	11.7 kHz
0.1 - 4.1[2]	93.8 kHz
0.1 - 132.1 HET	1.5 MHz

[1] HP 8642B only.
[2] Maximum deviation may be increased up to that shown for the HET band (0.1 MHz to 132.1875 MHz carrier frequency) by selecting deviation larger than the value shown here. HET band can also be selected with the special function.

FM Accuracy, Rates <100 kHz: ±(5% of setting + 10 Hz).
Typical Input Impedance: 600Ω nominal.
Maximum Input Level: 1V peak.

OPTIONS 003 OR 004: ADDING THE HP 11729C OR 11729C OPT 130 CARRIER NOISE TEST SET

The following data is applicable to using the HP 11729C to downconvert the test signal to an IF between 5 MHz and 1280 MHz for subsequent demodulation using the Low Frequency phase detector of the HP 3048A system. The HP 8662A Opt. 003 or 8663A Opt. 003 Signal Generators provide a reference signal for this downconversion process. These signal generators also provide a signal between 5 MHz to 1280 MHz to demodulate the downconverted IF noise. The specifications that follow assume this measurement set-up is used.

Input Requirements

Frequency

Measurement Frequency Range: 5 MHz to 18 GHz in 8 bands, excluding ±5 MHz around band center frequencies.

Band Center Frequencies: 1.92 GHz, 4.48 GHz, 7.04 GHz, 9.60 GHz, 12.16 GHz, 14.72 GHz, 17.28 GHz.

Amplitude

For carrier frequencies <1.28 GHz: −5 dBm minimum to +23 dBm maximum.

For carrier frequencies >1.28 GHz: +7 dBm minimum to +20 dBm maximum.

Measurement Specifications

Offset Frequency Range

For carriers between 5 and 95 MHz from band centers: 0.01 Hz to 2 MHz.

For carriers >95 MHz from band center: 0.01 Hz to 40 MHz.

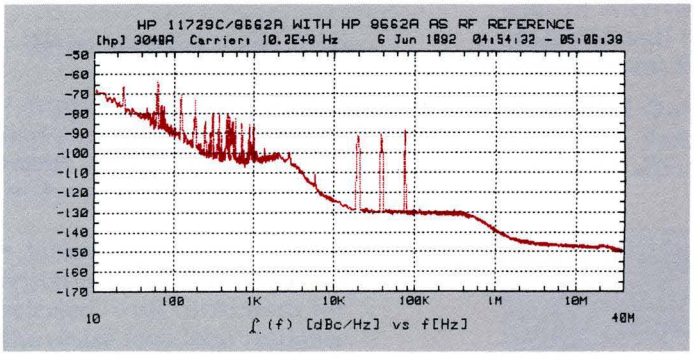
(Assumes addition of 40 MHz spectrum analyzer to the system, otherwise offset frequency range limited to 100 kHz.)

System Noise Floor[4]

Absolute System Noise Floor (dBc/Hz), when used with the HP 11729C and HP 8662A Option 003 or HP 8663A Option 003 as the reference source, phase locking via the signal generator's EFC.

		Offset from Carrier (Hz)								
		1	10	100	1k	3k	5k	10k	100k	1M
0.1 to 1280 MHz		See HP 3048A Option 001 or 002, Absolute Phase Noise table on page 11.								
1280 to 3200 MHz	Typ.	-50	-80	-100	-112	-112	-123	-129	-129	-140
	Spec.	-40	-70	-90	-107	-107	-113	-124	-124	
3.2 to 5.76 GHz	Typ.	-45	-75	-95	-107	-107	-120	-127	-127	-138
	Spec.	-35	-65	-85	-102	-102	-110	-123	-123	
5.76 to 8.32 GHz	Typ.	-42	-72	-92	-104	-104	-127	-125	-128	-135
	Spec.	-32	-62	-82	-99	-99	-107	-121	-124	
8.32 to 10.88 GHz	Typ.	-40	-70	-90	-102	-102	-115	-123	-128	-134
	Spec.	-30	-60	-80	-97	-97	-105	-119	-124	
10.88 to 13.44 GHz	Typ.	-38	-68	-88	-100	-100	-113	-122	-126	-132
	Spec.	-28	-58	-78	-95	-95	-103	-118	-123	
13.44 to 16.0 GHz	Typ.	-36	-66	-86	-98	-98	-111	-122	-126	-131
	Spec.	-26	-56	-76	-93	-93	-101	-117	-123	
16.0 to 18.0 GHz	Typ.	-35	-65	-85	-97	-97	-110	-119	-127	-129
	Spec.	-25	-55	-75	-92	-92	-100	-115	-123	

System Noise of HP 3048A Options 001 or 002, and 003 or 004 at 10 GHz (Phase locking via EFC)



System Spurious

System spurious signals in the HP 3048A Options 003 or 004 arise in three ways. First, from the detection and baseband signal processing, <−104 dBc for offsets greater than 0.2 Hz from the carrier. Second, any line-related or other spurious signals on the HP 8662A or 8663A outputs are translated to the noise spectrum output. Third, the downconversion process gives rise to system spurious signals whose frequency and level are determined by the relation between the test signal frequency and the band center frequency. The presence of system spurious signals does not affect the typical measurement of random noise.

AM Noise Detection

The HP 3048A can be used for AM noise measurements using either an external AM detector or the AM detector built-in to the HP 11729C Option 130 (ordered as Option 004 of the HP 3048A). AM measurements with the HP 11729C Option 130 can be made with a typical sensitivity of −165 dBc/Hz at a 1 MHz offset.

OPTION 007: ADDING THE HP 71707A MICROWAVE DOWNCONVERTER

The following data is applicable to using the HP 71707A to downconvert the test signal to an IF between 5 and 1200 MHz for subsequent demodulation using the low frequency phase detector of the HP 3048A system. It includes a reference signal for the downconversion process. An RF signal source must also be supplied to demodulate the downconverted IF noise.

RF Input

Frequency Range: 1.5 GHz to 26.5 GHz

Input Power:

+30 dBm maximum
-40 dBm minimum

Noise Figure (typical): 15 dB

IF Output

Frequency Range: 5 MHz to 1200 MHz

Absolute Output Power (typical) (input signal ≥-40 dBm):

0 to +5 dBm

Local Oscillator

Frequency Range: 2.4 GHz to 25.8 GHz

Frequency Resolution: 600 MHz

Spectral Purity: Absolute system noise floor (dBc/Hz), when used with the HP 71707A and the HP 8662A Option 003 or HP 8663A Option 003 as the reference source, phase locking via the HP 71707A's 10 MHz reference. For spurious specifications and more information, refer to the HP 71707A data sheet, part number 5091-4435.

		Offset from Carrier (Hz)									
Input frequency		1[1]	0	100	1k	3k	5k	10k	100k	1M	≥10M
1.5 to 3.0 GHz	Typ.	-50	80	-100	-119	-121	-124	-130	-130	-135	-147
	Spec.	-43	-73	-92	-112	-112	-114	-124	-124	130	-142
3.0 to 4.2 GHz	Typ.	-47	77	-97	-122	-129	-130	-133	-136	-141	-149
	Spec.	-42	72	-92	-115	-117	-120	-128	-131	-136	-144
4.2 to 6.0 GHz	Typ.	-44	74	-94	-120	-124	-127	-131	-136	-141	-148
	Spec.	-39	-69	-89	-114	-117	-119	-126	-131	136	-143
6.0 to 7.8 GHz	Typ.	-42	-72	-92	-119	-123	-125	-130	-136	-140	-147
	Spec.	-37	-67	-87	-113	-116	-118	-125	-131	-135	-142
7.8 to 10.2 GHz	Typ.	-40	-70	-90	-118	121	-124	-129	-135	-139	-145
	Spec.	-35	-65	-85	-112	115	-117	-124	-130	-134	-140
10.2 to 12.6 GHz	Typ.	-38	-68	-88	-116	-121	-123	-128	-134	-138	-143
	Spec.	-33	-63	-83	-111	-114	-116	-123	-129	-133	-138
12.6 to 18.0 GHz	Typ.	-35	-65	-85	-113	-119	-121	-125	-133	-137	-140
	Spec.	-30	-60	-80	-108	-112	-114	-120	-128	-132	-135
18.0 to 26.5 GHz	Typ.	-32	-62	-82	-110	-115	-117	-122	-128	-133	-136
	Spec.	-27	-57	-77	-105	-108	-110	-117	-123	-127	-131

[1] All noise levels above -30 are 3 dB below $S_\phi(f)$ expressed in dB with respect to 1 rad²/Hz.

HP 3048A option specifications

Typical Tuning Sensitivity:
10 MHz: 0.05 ppm/volt
100 MHz: 1 ppm/volt
600 MHz: 20 ppm/volt

Typical Tuning Port Voltage Range: ±5 volts

Typical Tuning Port Input Impedance: 2 kΩ

AM Noise Detection

Input Power Level: 0 dBm to +30 dBm

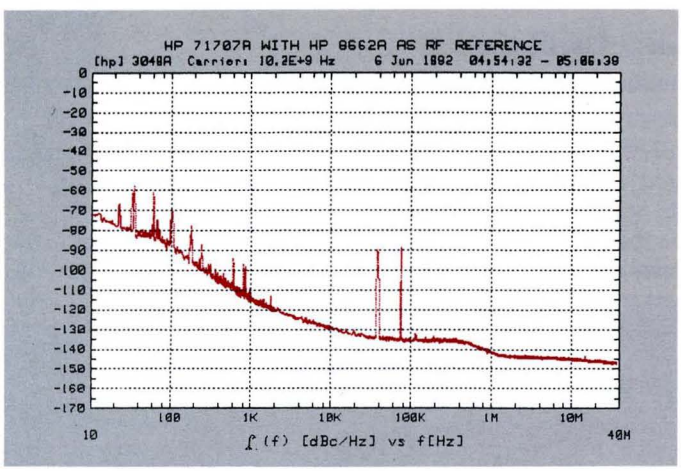
Bandwidth: 1 Hz to 40 MHz

Noise Floor (dBc/Hz)

Offset from Carrier (Hz)							
1	10	100	1k	10k	100K	1M	10M
-108	-118	-128	-138	-145	-155	-155	-155

Note: The AM noise output port of the HP 71707A feeds the "noise input" port of the HP 3048A for AM noise measurements.

System Noise of HP 3048A Option 007, at 10 GHz (10 MHz)



OPTION 202: ADD SYSTEM RACK

This option provides the HP 3048A system and its options installed in a full size instrument rack. Rack includes a power module, all necessary signal cabling, and a pull-out shelf to use as a work surface. Outside dimensions are approximately 163 H × 61 W × 81 D cm (64 × 24 × 32 inches). The net weight varies from 191 to 275 kg (418 to 603 lbs.) depending on the options installed. Shipping weight varies from 248 to 347 kg (543 to 758 lbs).

HP 3048A general specifications

Power Requirements: Between 190 and 900 VA depending on options included; 48 to 66 Hz; 100V, 110V, 220V, 240V (+5%, −10% of line voltage)

Operating Temperature Range: +0°C to +55°C

EMI: Satisfies level B of VDE specification 0871

General Considerations: The HP 3048A has low susceptibility to RFI and mechanical vibration. Care must be exercised however in making measurements in high RFI or mechanical vibration environments as spurious signals may be induced in the system.

Warm-up time: The HP 3048A will meet specification 20 minutes after turn-on.

Size: The HP 3048A system is composed of individual instruments that vary in size. Each instrument's individual specifications should be consulted for its dimensions. The HP 11848A Phase Noise Interface is approximately 146 H × 425 W × 593 D cm (5.7 × 16.8 × 23.3 inches).

Weight: Net weight varies from 31 to 275 kg (68 to 603 lbs) depending on the options ordered. Shipping weight varies from 42 to 347 kg (93 to 758 lbs).

Ordering information

The HP 3048A Phase Noise Measurement System can be configured many different ways to optimize it for specific applications. All configurations of this system must include the HP 3048A's components and a desktop computer to be operational. Additional capabilities may be needed such as reference sources, etc. listed below.

HP 3048A Phase Noise Measurement System

Selected Items

The HP 3048A System includes the following components:

- **HP 11848A Phase Noise Interface** for phase noise measurements of carriers from 5 MHz to 1.6 GHz. (Includes RMB workstation system software on 3½-inch double-sided disks). ☐
- **HP 3561A Dynamic Signal Analyzer**

HP 3048A Reference Source Options

- **Option 001 Adds HP 8662A Opt. 003 Synthesized Signal Generator** as a 10 kHz to 1280 MHz reference source. (Opt. 003 specifies absolute phase noise on the HP 8662A.) ☐
- **Option 002 Adds HP 8663A Opt. 003 Synthesized Signal Generator** as a 10 kHz to 2560 MHz reference source. (Opt. 003 specifies absolute phase noise on the HP 8663A.) ☐
- **Option 003 Adds HP 11729C Carrier Noise Test Set** as a 5 MHz to 18 GHz downconverter to the system (uses an HP 8662A Opt. 003 or 8663A Opt. 003 as its reference source). ☐
- **Option 004 Adds HP 11729C Opt. 130 Carrier Noise Test Set** as a 5 MHz to 18 GHz downconverter to the system (uses an HP 8662A Opt. 003 or 8663A Opt. 003 as its reference source). (Opt. 130 adds AM detector to HP 11729C.) ☐
- **Option 005 Adds HP 8642A Opt. 001 Synthesized Signal Generator** as a 100 kHz to 1057 MHz reference source. (Opt. 001 adds a high stability time base to the HP 8642A.) ☐
- **Option 006 Adds HP 8642B Opt. 001 Synthesized Signal Generator** as a 100 kHz to 2115 MHz reference source. (Opt. 001 adds a high stability time base to the HP 8642B.) ☐
- **Option 007 Adds HP 71707A Microwave Downconverter** as a 1.5 to 26.5 GHz downconverter to the system. It includes an internal local oscillator and AM detector. Automatic control requires Option 301 MS-DOS® PC compatible system software. ☐

HP 3048A Spectrum Analyzer Options

- **Option 101 Adds HP 3585B Spectrum Analyzer** (20 Hz to 40 MHz) to extend the system's offset measurement range from 100 kHz to 40 MHz. ☐
- **Option 110 Deletes HP 3561A Dynamic Signal Analyzer** from the system for replacement by the user. (The HP 3048A system will not operate without the HP 3561A, see footnote 1 on next page.) ☐

HP 3048A System Options

- **HP 3048A+24A Operator's Training Course** provides phase noise measurement training and is given by an HP representative at the user's location after the system has been delivered and is operational. Contact your local HP sales office for specific information. ☐
- **Option 201 Adds 1.6 GHz to 18 GHz Input to HP 11848A Phase Noise Interface** for microwave phase noise measurements without a downconverter. ☐
- **Option H26 Extends Option 201 Phase Noise Interface Input to 26.5 GHz** for microwave phase noise measurements to 26.5 GHz without a downconverter. ☐
- **Option 202 Adds System Rack** with built-in signal cabling, fan and power module (includes racking hardware and installation of the HP 11848A, 3561A and any HP 3048A instrument options). Order a power line option as listed in footnote 2, on the next page. ☐
- **Option 910 Adds Extra HP 3048A Manual Set** to the system (adds an extra HP 11848A Instrument Manual and an extra HP 3048A Operating Manual). ☐
- **Option K21 AM Detector Filter** provides the filtering and bias for use with a HP 33330C AM Detector (dc to 26 GHz) for making AM noise measurements. ☐
- **Option K22 Dual RF Amplifier** two 5-1500 MHz amplifiers with a gain of 9 dB (±1.5 dB) noise figure of <7.5 dB typical (f_c>50 MHz), and dynamic range meets HP 3048A System Phase Noise Specifications (f_c>50 MHz). ☐
- **Option K23 dc Blocking Filter** has flatness of <1 dB from 5 Hz to 40 MHz for inputs of up to ±30 Vdc. ☐

Remember to order HP-IB cables, HP 10833B or equivalent, to connect the computer and each accessory instrument chosen from the following list to the HP 3048A system.

HP 3048A System Software Option

Selected Items

- **Option 301** replaces standard RMB workstation system software with MS-DOS® PC compatible system software on 5¼-inch 1.2 Mbyte and 3½-inch 1.44 Mbyte floppy disks. It provides automatic control of the HP 71707A microwave downconverter. GRAFPLUS® is also shipped with this option for hard copy output of data. ☐

Desktop Computers

A computer is required for the HP 3048A Phase Noise Measurement System. The type of computer depends on the system software option chosen. Standard system software requires a workstation with an HP BASIC 6.0 operating system and 3 Mbytes of RAM memory. Option 301 system software requires an IBM® PC/AT/XT or true compatible with 640 Kbytes RAM, MS-DOS® 2.0 or later, EGA or compatible video card with 128 Kbytes video RAM, EGA or compatible color display, and an HP-IB or GP-IB card (HP 82335A HP-IB card recommended).

Recommended Computer Configurations

- **HP 3048A Standard:** HP 98580C Option 104 332MMA Monochrome Instrument Controller (includes HP 98572A Model 332 SPU, HP Basic 6.0, HP 35371A 12-inch monitor). Also required is a 3½-inch disc drive (recommend an HP 9122D Dual Disc Drive or an HP 9153C Winchester Hard Disc Drive). To control the graphics marker of the HP 3048A, add an HP 46083A HP-HIL knob. ☐
- **HP 3048A Option 301:** HP D2512A Vectra 386s/20 Model 50, 5¼-inch or 3½-inch floppy drive, 50 Mbyte hard drive, 640 Kbyte RAM, VGA Card, D1192A 14" VGA display, MS-DOS® 2.0 or later, and an HP 82335A HP-IB card. ☐

Phase Noise Measurement Accessory Kits.

- **HP 11826A RF Phase Noise Accessory Kit** contains the miscellaneous components to measure phase, residual, and AM noise with the HP 3048A Phase Noise Measurement System from 5 MHz to 2 GHz. Included is a refurbished mechanical phase shifter. ☐
- **HP 11826B Microwave Phase Noise Accessory Kit** contains the miscellaneous components to measure phase, residual, and AM noise with the HP 3048A Phase Noise Measurement System from 2 GHz to 18 GHz. Included is a refurbished mechanical phase shifter. ☐
- **HP 11826C RF and Microwave Phase Noise Accessory Kit** contains the miscellaneous components to measure phase, residual, and AM noise with the HP 3048A Phase Noise Measurement System from 5 MHz to 18 GHz. Included is a refurbished mechanical phase shifter. ☐

Spectrum Analyzers

Extend the offset measurement range of the HP 3048A to 40 MHz with any of the following supported spectrum analyzers:

- HP 3585A/B, HP 8562A/B, HP 8566A/B, HP 8567A/B, HP 8568A/B, HP 71100A, HP 71209A, HP 71210A. ☐

Printers/Plotters

RMB workstation system software

- HP 2225A Thinkjet Printer ☐
- HP 7475A Graphics plotter ☐

HP 3048A Option 301 PC system software

- Any printer with parallel/centronics I/O supported by GRAFPLUS®. Recommend an HP 2228A QuietJet Printer or an HP 3630A Option 001 PaintJet Color Graphics Printer. ☐

[1] Option 110 allows a customer-owned HP 3561A to be integrated into a new system. The HP 3561A must meet its specifications for the HP 3048A system specifications to be warranted. Note that the HP 3048A system will not operate without the HP 3561A.

[2] Ordering Option 202 will provide a rack for HP 3048A system to be installed in. Order one of the following options in addition to Option 202 to specify the rack's power line voltage (there is no charge for these options):

- Option 211: 100 Vac line operation
- Option 212: 120 Vac line operation
- Option 213: 220 Vac line operation
- Option 214: 240 Vac line operation

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