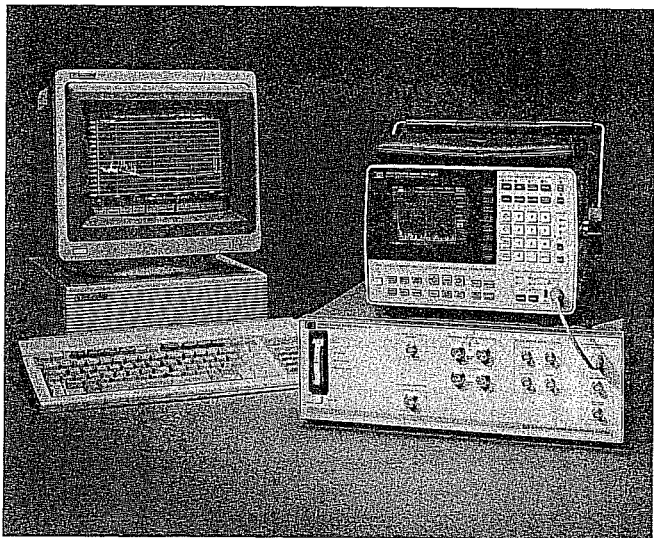


Calibrated, Automated Phase Noise Measurements with

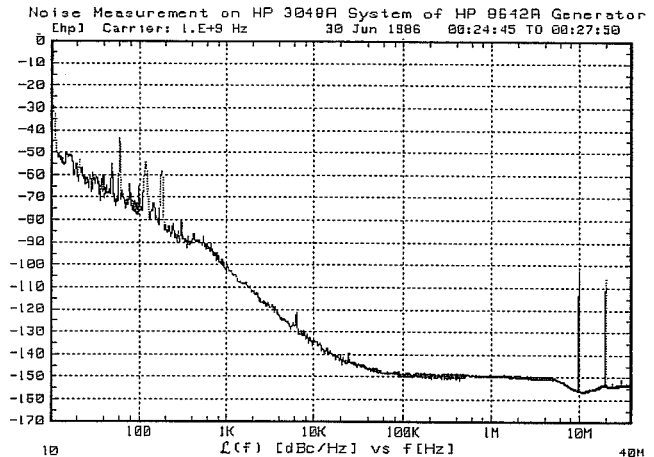
- Specified amplitude accuracy of  $\pm 2$  dB
- Offset frequency range of 0.01 Hz to 40 MHz
- Carrier frequency range from 5 MHz to beyond 18 GHz
- Spurs separated from noise spectra
- Optimization for several measurement techniques



HP 3048A Phase Noise Measurement System controlled by an HP 98580A Desktop Computer.

The HP 3048A Phase Noise Measurement System uses the power of a flexible software program to automate the measurement of the phase noise of a carrier signal. The basic HP 3048A system includes the HP 11848A Phase Noise Interface containing the phase detectors and phase lock loop circuitry, the HP 3561A Dynamic Signal Analyzer, measurement software, and a comprehensive operator training course that teaches measurement procedures. Using an HP 98580A Desktop Computer, this basic system will measure carrier frequencies from 5 MHz to 1.6 GHz (to 18 GHz with option 201) and characterize the demodulated phase noise over an offset range of 0.01 Hz to 100 kHz. Adding other HP spectrum analyzers such as the HP 8566B, 8567A, 8568B, 3585A, 71000S, or 8590A provides automated measurements to offsets of 40 MHz. A variety of signal generators such as the HP 8662A, 8663A, 8642A or 8642B can also be added to the system to provide a low-noise reference signal up to a frequency of 2.56 GHz. Adding an HP 11729C Carrier Noise Test Set in combination with an HP 8662A or HP 8663A provides a low-noise reference signal for measuring carrier signals up to 18 GHz.

The HP 3048A system software uses the HP 11848A interface to demodulate the phase noise of a carrier in the frequency range of 5 MHz to 18 GHz (and beyond with external, user-supplied mixers) and measures the resulting baseband signal with the spectrum analyzers. Measurement menus allow the operator to specify the measurement to be made and the system software controls the measurement process, including the calibration of the system. Several output formats are available to the user, including plots of the single sideband phase noise power of a signal, integrated noise power, or the calculated Allan variance. A real-time measurement mode is available to monitor the level of phase noise and discrete spurs as changes are made to the device under test.

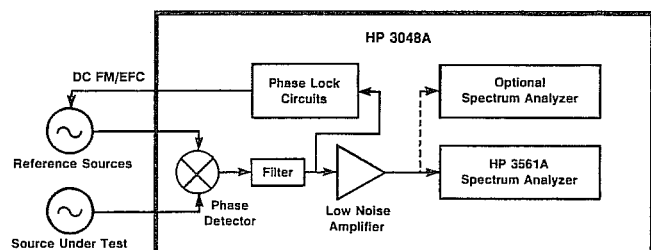


Typical single sideband phase noise measurement by the HP 3048A Phase Noise Measurement System.

As measured by the HP 3048A, the term "phase noise" includes all forms of a signal's frequency and phase instabilities. Randomly occurring frequency and phase noise modulation, as well as discrete sidebands resulting from power-line phase modulation and phase jitter, are detected and accurately measured. Coherent signals are displayed at the power level that was detected while random phase signals are normalized for a 1 Hz bandwidth. The HP 3048A system is optimized for several measurement techniques that are chosen based on the stability and tuning capability of the signal to be measured and the availability of comparable reference oscillators. The two primary techniques for demodulating the phase noise of a signal use either a phase detector or a frequency discriminator as the following diagrams illustrate.

#### Operation with a Phase Detector

This measurement technique uses a double-balanced mixer included in the HP 11848A interface as a phase detector and a separate reference oscillator to demodulate the phase noise from the carrier being tested. With the two signals in quadrature, the phase detector offers excellent sensitivity to reveal very low level phase noise sidebands of the carrier. Based on the tuning range of the source under control, the system automatically sets up a phase lock loop to hold the two signals in quadrature. An offset range of 0.01 Hz to 40 MHz can be measured regardless of the bandwidth of the phase lock loop as the software measures the loop's bandwidth and removes its effects from the measured phase noise. Due to this combination of excellent sensitivity and broadband operation, the HP 3048A system can provide calibrated ( $\pm 2$  dB) phase noise plots of almost any type of source ranging from frequency standards to free-running VCOs. The phase detector method also provides two port measurements of amplifiers, mixers, multipliers, etc.



Typical test set-up for measuring the phase noise of relatively stable oscillators.

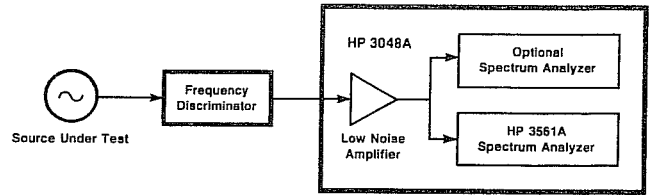
# SIGNAL ANALYZERS

## Automated Spectrum Analysis (cont'd)

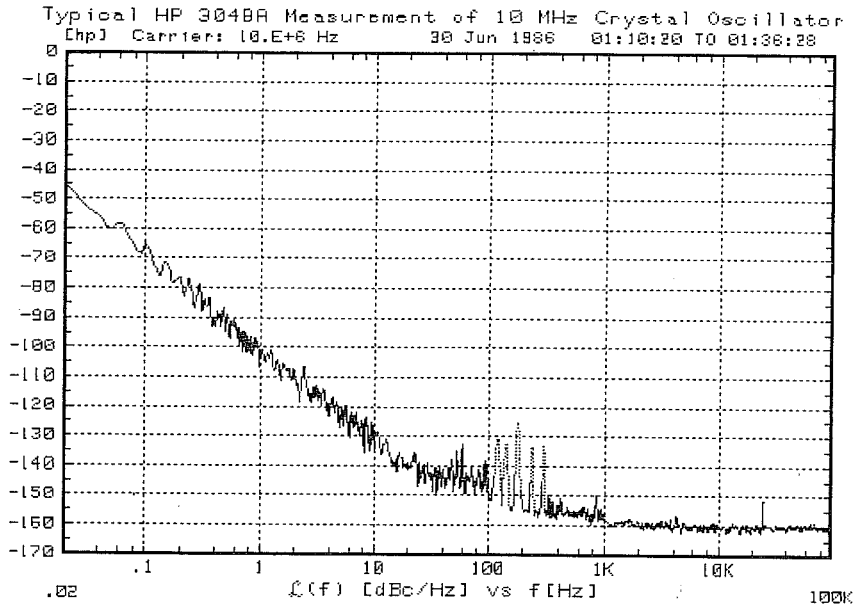
### Model 3048A

#### Operation with a Frequency Discriminator

With the HP 3048A, fully calibrated phase noise measurements of drifting or less stable signals are possible with user-supplied frequency discriminators. The HP 3048A software calibrates the system for the discriminator that is used to maintain the  $\pm 2$  dB amplitude accuracy of the measurement. Although the frequency discriminator limits the system's sensitivity close-in to the carrier, it does allow measurement of noisy or drifting sources that cannot be phase locked to a reference oscillator.



Typical test set-up for measuring the phase noise of drifting and less stable sources.

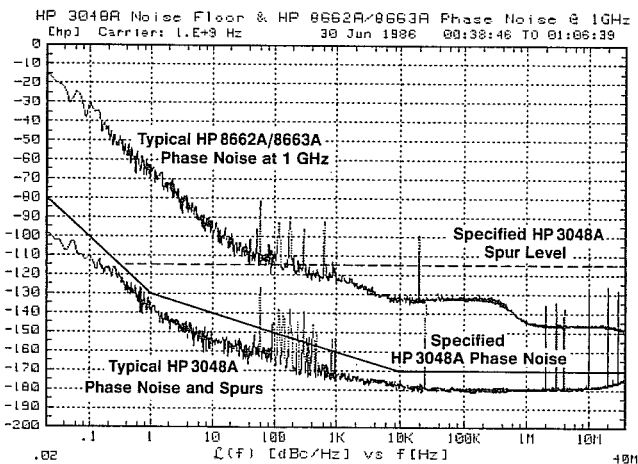


Typical HP 3048A system measurement results for a 10 MHz crystal oscillator.

#### Specifications Summary

##### Sensitivity

The system's sensitivity is a function of the measurement technique that is used. The following graph indicates the sensitivity of the system as limited by its own internally-generated noise for a signal under test of +15 dBm. Also plotted is the phase noise that would limit the measurement sensitivity for a 1 GHz signal using HP signal generators as reference sources.



##### Carrier Frequency Range

**Internal Mixer:** 5 MHz to 1.6 GHz, optional to 18 GHz.

**External (user-supplied) Mixer:** The frequency range of the carrier is limited only by the frequency range of the external mixer or the frequency discriminator that is used.

**Offset Frequency Range:** 0.01 Hz to 100 kHz, extended to 40 MHz with an optional spectrum analyzer such as the HP 3585A.

**Amplitude Accuracy:**  $\pm 2$  dB to 1 MHz offset;  $\pm 4$  dB for offsets greater than 1 MHz. This accuracy is verified by the system at the time of the measurement. The system advises the user of any potential accuracy degradations detected during measurement set-up.

##### Ordering Information

##### HP 3048A Phase Noise Measurement System

Includes the **HP 11848A** Phase Noise Interface, **HP 3561A** Dynamic Signal Analyzer, measurement software and operator training

##### Reference oscillator options:

- Opt 001** Adds HP 8662A Opt. 003 Synthesized Signal Generator (0.01 to 1280 MHz)
- Opt 002** Adds HP 8663A Opt. 003 Synthesized Signal Generator (0.01 to 2560 MHz)
- Opt 003** Adds HP 11729C Carrier Noise Test Set (5 MHz to 18 GHz)
- Opt 005** Adds HP 8642A Opt. 001 Synthesized Signal Generator (0.1 to 1057 MHz)
- Opt 006** Adds HP 8642B Opt. 001 Synthesized Signal Generator (0.1 to 2114 MHz)

**System Computer:** HP 98580A Opt. 008 Desktop Computer with 3 megabytes of memory and HP-HIL knob.

For full details on available system options and ordering information, see the HP 3048A Phase Noise Measurement System Ordering Information Guide.