

Phase Noise

PN9500 Wideband noise and jitter analyzer

AEROFLEX
A passion for performance.



The PN9500 is the only available system capable of measuring state of the art phase noise up to 500 MHz offset.

The Modular design of the PN9500 issued from the PN9000 product line provides versatility and flexibility to set up the appropriate configuration to measure any kind of frequency source from 2 MHz to 140 GHz.

The PN9500 is the only available system capable of measuring state of the art phase noise up to 500 MHz offset. But this feature is not the only unique feature of this RF & MW test set. Here is the combination that makes this system unique:

- SPEED : 1 kHz to 40 MHz, 10 averages in less than 30 sec.
- DYNAMIC RANGE : 0.001ps RMS on a 10 GHz clock buffer
- WIDE OFFSET : up to 500 MHz
- TRUE Peak-to-Peak JITTER : selectable mask filters and peak to peak detector
- EASE OF USE : "AUTO" Functions
- MODULAR Plug-in System : compact and always upgradable

The PN9500 is the ultimate testing machine when it comes to Jitter and Noise Analysis

PN9500 Techniques:

Phase Lock Loop, quadrature phase demodulation
Delay line, FM discriminator (option)
Added phase noise (option)
Amplitude Noise (option)
FFT for RMS and real PEAK-to-PEAK analog detectors combination in selectable filters

Plug-in optional module examples:

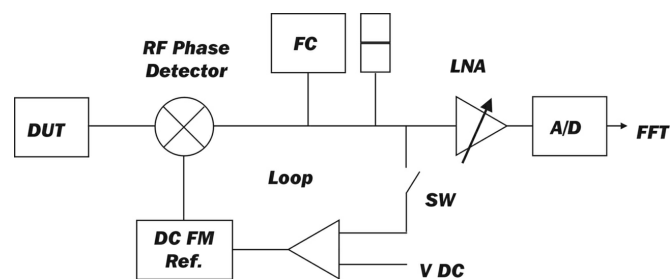
Internal phase detectors up to 44 GHz
Low Noise Built-in DC FM Reference MW Synthesizer
The best MW down-converter for stable and free-running Sources
mmW external harmonic mixers/diplexers to extend the frequency coverage up to 140 GHz
Pulse generator and modulator

Software:

WPN9500: Windows based graphical user interface with file management and math tools

The base system is the core of any measurement configuration. It includes hardware and software, except the reference source, to measure stable sources from 2 MHz to 1.8 GHz.

PN9500 System - Basic Capabilities



Base System Operating Diagram

Using the built-in frequency counter, in open loop, the DC/FM reference source is manually or automatically tuned on the DUT fre-

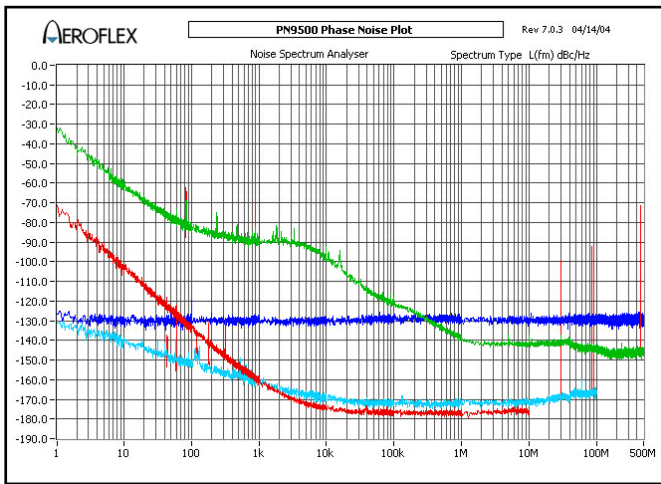
quency. The beat signal between the DUT and reference is used to measure the demodulation factor of the phase detector using multiple techniques allowing non-linear operation of the detector.

Loop bandwidth and reference FM deviation (or tune slope) will be adjusted depending on the expected noise and stability of the DUT. For most of PLL and synthesizers a few hundred Hz is an average convenient value. Then, closing the loop, the reference source will be phase locked on the DUT signal and RF/LO phase detector inputs will be set automatically in phase quadrature, providing at the output of the detector the combined phase noise of the DUT and the reference. The bar graph located on the lock control module will allow a quick visual check of the loop status (the bar graph should be centered and steady). When the reference's phase noise is 6 dB better than the DUT's, its contribution to the detected noise is 1 dB only.

The LNA, with auto-gain feature, will adjust the noise level to the optimum dynamic range of the digitizing board housed into the controller. The FFT calculation process is done in the computer and displayed on the monitor (not represented on the diagram). Loop bandwidth is fully compensated to display phase noise down to 1 Hz from the carrier.

In PLL measurements, the system residual noise, or noise floor, will be the reference oscillator's phase noise.

The PN9500 measures peak to peak jitter using internal and/or external band-pass filters. The user can also compute a real RMS value or a PP estimate based on a phase noise measurement using customizable masks.



PN9500 typical plots

PN9500 Base System

- | | |
|--|------------------------------|
| PN9500 mainframe including: | Personal Computer including: |
| - Noise output module | - TFT flat screen monitor |
| - Phase lock control module | - Digitizing board |
| - LNA module | - Set of Cables |
| - Standard and High level RF phase detectors | - OS, Software and manual |
| - Power Supply | |

PN9500 Base System Specifications

Frequency Input Range	2 MHz to 1.8 GHz
Offset Analysis	1 Hz to 1 MHz (options to 40 or 500 MHz)
Measurement Accuracy	±2 dB up to 1 MHz offset ±3 dB up to 100 MHz offset ±5 dB up to 500 MHz offset
Reference Tuning Voltage	±20 Volt with 5 mV resolution
Phase Lock Loop Gain	Proportional and Integral (DUT drift compensation)

Parameters	Standard RF	High Level RF
Frequency range, GHz	0.002 to 1.8	0.002 to 1.6
RF Input min. dBm	- 10 with input amplifier	+10
RF input max. dBm	+10	+20
LO input min. dBm	0 with input amplifier	+10
LO input max. dBm	+15	+20
RF input Gain, dB	0, 10	None
LO input Gain, dB	0, 10	None
Noise floor in dBc/Hz for a 100 MHz RF input *	RF = +9 dBm LO = +13 dBm	RF = +16 dBm LO = +20 dBm
1 Hz offset	- 135	- 140
10 Hz	- 145	- 150
100 Hz	- 155	- 160
1 kHz	- 165	- 170
10 kHz	- 168	- 178
100 kHz to 500 MHz	- 168	- 178
Noise floor variation at 1 GHz (dB)	+1	+4
Noise floor variation at 1.6 GHz (dB)	+3	+6
Recommended RF input level, dBm	0 to +10 dBm	+10 to +17 dBm
Recommended LO input level dBm	+10 to +13dBm	+17 to +20 dBm

* For specified values add + 3 dB (± 2 dB accuracy). Noise floor: for RF power levels below specified value, the noise floor will increase by the number of dB below the specified value. For example, for +6 dBm RF input, instead of +9dBm, the typical system residual noise is, at 10 kHz offset: -168 - (- 3 dB) = - 165 dBc/Hz.

Maximum Offset (option)	10 MHz for carriers up to 160 MHz 40 MHz for carriers up to 400 MHz 200 MHz for carriers up to 2 GHz 500 MHz for carriers 2 GHz and above
Spurious level under nominal settings	- 110 dBc above 2 kHz offset
Built-in Counter, RF and LO ports	2 MHz to 2 GHz (18 GHz with PN9100/51/52 option)
IF/Beat	0.3 Hz to 1 MHz
Mechanical Dimensions	HxWxD :13.3 x 38.5 x 63.5 cm or 5.25" x 17.72" x 25"
Temperature & Humidity, operating	0 to +50 °C
Storage	- 40 to +75 °C. Up to 95 % non-condensing

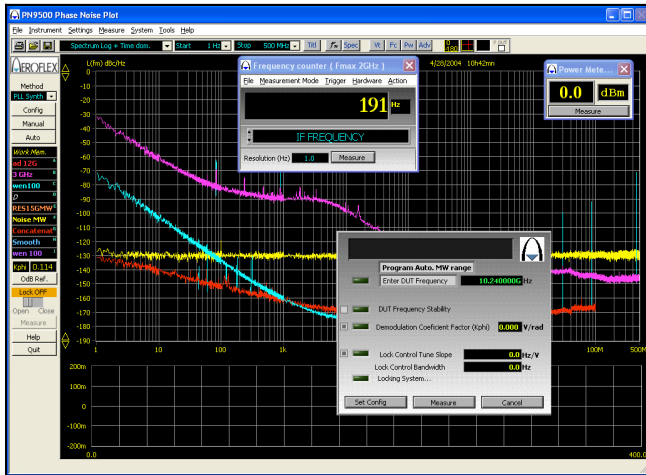
PN9500 typical phase and amplitude detector options specifications

Parameters	MW (option) Std level	MW (option) High level	MW (option) PN9361-02	AM (option)
Frequency range, GHz	1.6 to 26.5	1.6 to 26.5	5 to 40 GHz	0.01 to 26.5
RF Input min. dBm	- 10	+10	0	0
RF input max. dBm	+15	+20	+15	+19
LO input min. dBm	+7	+10	+7	None
LO input max. dBm	+15	+23	+15	None
Noise floor *, in dBc/Hz at	RF = +6 dBm LO = +10 dBm	RF = +16 dBm LO = +20 dBm	RF = +6 dBm LO = +10 dBm	RF = +17 dBm
1 Hz offset	- 120	- 128	- 120	NA
10 Hz	- 130	- 138	- 130	NA
100 Hz	- 140	- 148	- 140	- 142
1 kHz	- 150	- 158	- 150	- 150
10 kHz	- 160	- 168	- 160	- 160
100 kHz to 500 MHz	- 168	- 174	- 168	- 160
Recommended RF input level, dBm	0 to +10	+10 to +16	0 to +10	+10 to +17
Recommended LO input level, dBm	+10 to +13	+17 to +20	+ 10 to +13	NA

* For specified values add +3dB (± 2 dB accuracy). Noise floor: for RF power levels below specified value, the noise floor will increase by the number of dB below the specified value. For example, for +3 dBm RF input, instead of +6 dBm, the typical system MW residual noise is, at 10 kHz offset: $-160 - (-3 \text{ dB}) = -157 \text{ dBc/Hz}$.

WPN9500 Software

The Windows software provides a friendly interface to the system



WPN9500 typical screenshot

Measurement method control

Selection of measurement method, depending on the DUT:

PLL Synth for internal or GPIB controlled reference synthesizer method (for stable sources)

PLL Xtal for DC-FM controlled sources like crystal oscillators

VCO (delay line) for free running sources

AM noise

Noise voltage for voltage sources

ADDED NOISE added noise for two port devices

PULSE for pulsed sources or pulsed two ports devices (PM, AM, Added noise)

Photographic based cabling helps to guide the user in wiring settings.

System configuration, file management, phase detector, frequency range, down-converter, selections

Store and display up to ten measurements or specification lines with direct access memories. Plot export as TXT, BMP, JPEG or PNG file to any windows accessible storage device.

Measurement mode - Automatic and Manual

Automated Measurements are based on embedded expertise that guides the user through the measurement process. In most of the cases, a single click is enough.

Manual Measurement for reference LO selection and tuning, phase detector calibration factor measurement, loop bandwidth and reference tune slope, reference phase locking

Data processing

Noise/Spurious differentiation Spurs expressed and displayed in dBc

Display functions Smooth, spec-line, frequency & level markers, spurs list

Data Computation $A \pm B$, $N * A$, $A : N$, $A \pm N * B$, $A \pm N dB$

Integrated power in dBc, radian rms, radian², degree rms, degree², Hz rms, Hz²

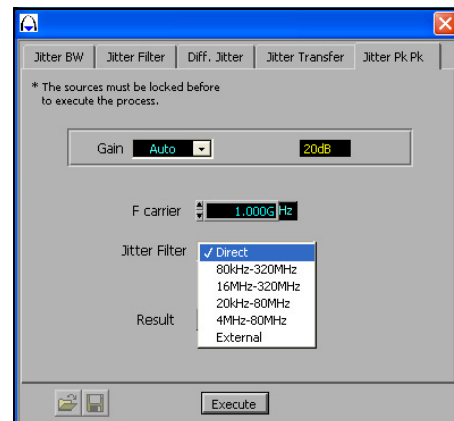
Variance Allan, True, Modified and Tvar

Jitter Sec_{rms} , Sec_{pp} , UI_{pp}

FFT / Spectrum Analysis $L(f)$ dBc/Hz, Power dBV^2/Hz , $M(f)$ dBc/Hz

Plot Printing Any windows supported printer

External synthesizer driver User defined IEEE-488 control menu to set up most of commercial signal generators



PN9500 Jitter Tool box

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.

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