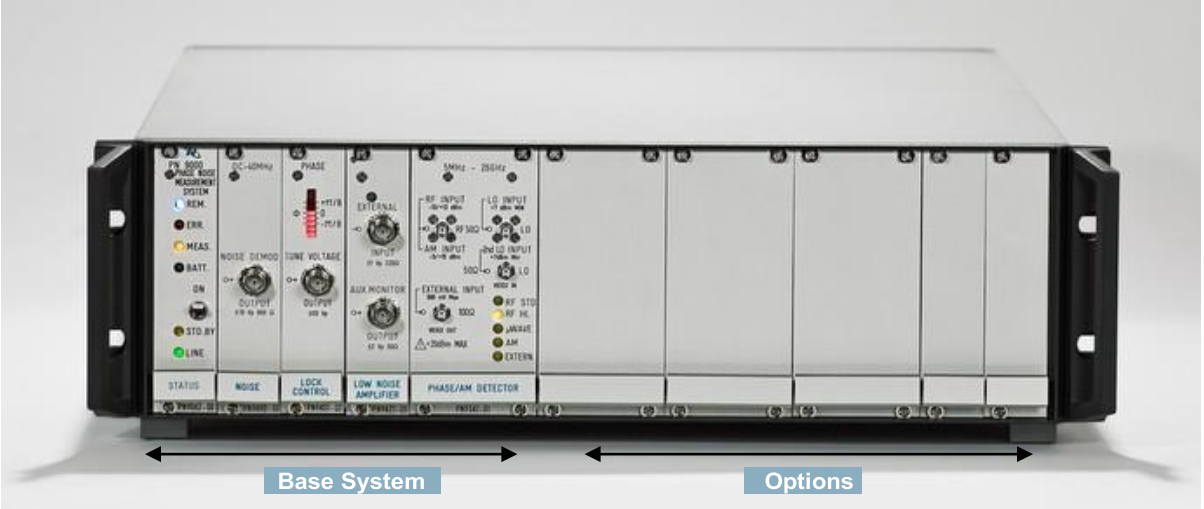
PN9000
Phase Noise Test System

Rev1.6

PN9000 Phase Noise Measurement System



The Modular design of the PN9000 provides versatility and flexibility to setup the appropriate configuration to measure any kind of frequency source from 2 MHz to 140 GHz.

Techniques:

- Phase Lock Loop
- Delay line (option)
- Added phase noise (option)
- Amplitude Noise (option)

Plug-in optional modules:

- Internal phase detectors up to 50 GHz
- Low Noise Built-in DC FM Reference Synthesizer
- MW down-converters 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:

- WPN9000: Windows based graphical user interface with file management
- Remote control option through 10/100/1000 BaseT Ethernet or GPIB

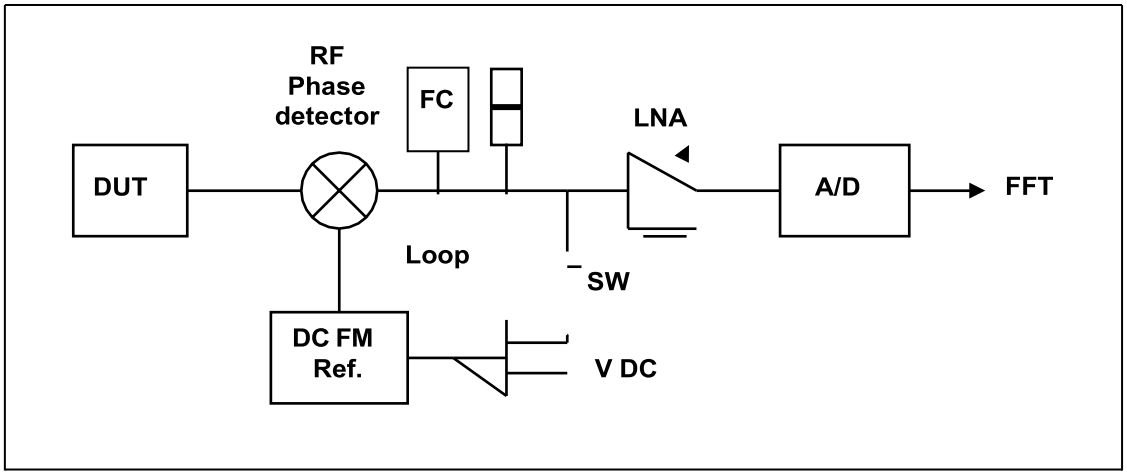
System Controller:

- The standard controller is a desktop workstation with USB, printer ports and DVD writer; HDD is 40GB or better, TFT monitor, keyboard and mouse.
- Optionally, the desktop can be replaced by an industrial computer.
- The operating system is Windows XP pro.

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.

Note: All the options are described and specified in separate datasheets.

PN9000 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 frequency. The beat signal between DUT and reference is used to measure the demodulation factor of the phase detector using multiples 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'sone, 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 computer. 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 0.01 Hz from the carrier.

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

The PN9000 also exists in Dual Channel configuration for Cross-Correlation processing; it is then called a DCNTS.

PN9000 Base System

PN9000 mainframe including:
- Noise output module
- Phase lock control module
- LNA module
- Standard and High level RF phase detectors
- Power Supply

Personal Computer including:
- TFT flat screen monitor
- Digitizing board
- Set of Cables
- OS, Software and manual

PN9000 Base System Specifications

Frequency Input Range	: 2 MHz to 1.8 GHz, optional to 26.5GHz, 40 GHz, 50 GHz
Offset Analysis	: 0.01 Hz to 1 MHz
RF Input Impedance	: 50 Ohms
Measurement Accuracy	: ± 2 dB up to 1 MHz offset, ± 3 dB above 1 MHz offset
Reference Tuning Voltage	: ± 20 Volt with 5mV resolution
Phase Lock Loop Gain	: Proportional and Integral (DUT drift compensation)
Loop Compensation	: Automatic (can be disabled)

Parameters	**Standard RF**	**High Level RF**
Frequency range, GHz	0.002 to 1.8	0.002 to 1.6
RF Input min. dBm	- 20	+ 10
RF input max. dBm	+ 10	+ 20
LO input min. dBm	0	+ 10
LO input max. dBm	+ 10	+ 20
RF input Gain, dB	-10, 0, 10, 20	None
LO input Gain, dB	0, 10	None
Noise floor, in dBc/Hz at		
1 Hz offset	- 130	- 140
10 Hz	- 140	- 150
100 Hz	- 150	- 160
1 kHz	- 160	- 170
10 kHz	- 168	- 178
100 kHz & beyond	- 168	- 178
Nominal RF input level, dBm	+ 6	+ 16
Nominal LO input level dBm	+ 7	+ 17

For specified values add + 3dB (± 2 dB accuracy). For RF levels < nominal value, the noise floor will increase by the number of dB below the nominal value. For example, for 0 dBm RF input, instead of +6, the typical system residual noise is, at 10 kHz offset : -168 dBc/Hz – 6 dB = – 162 dBc/Hz.

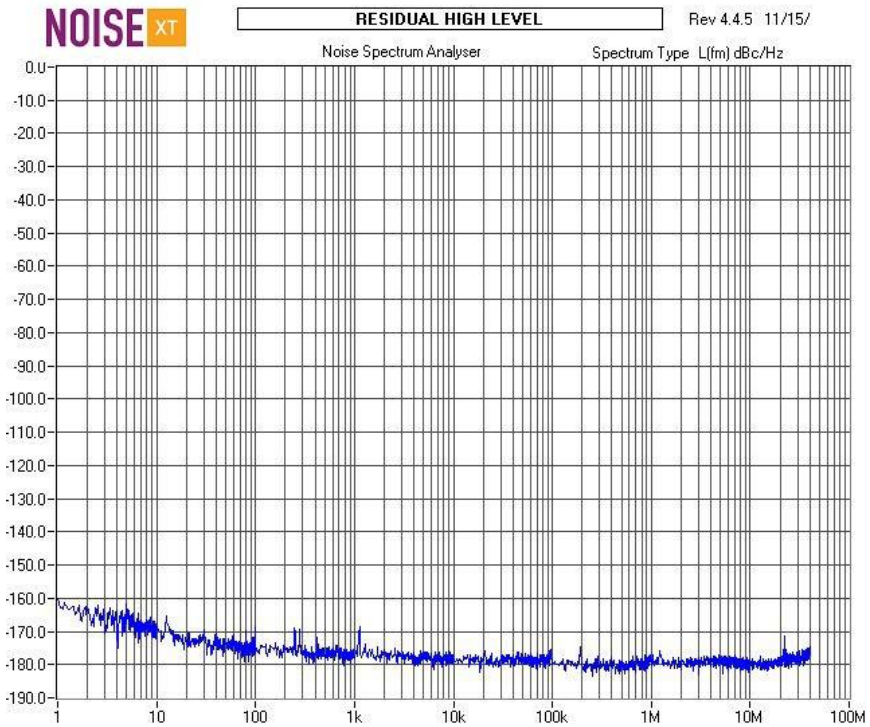
Spurious level	: - 110 dBc
Built-in Counter, RF and LO ports	: 2MHz to 2 GHz
IF/Beat	: 0.3 Hz to 400 kHz
Mechanical Dimensions: PN9000A	: HxWxD :13.3 x 38.5 x 68.5 cm or 5.25”x17.72”x26.97”
Power Supply	: 100-240 VAC +/- 10%, 50/60 Hz
Temperature & Humidity , operating	: +10 to + 40 °C
Storage	: - 40 to + 75 °C. Up to 95 % non condensing.

PN9000 typical phase and amplitude detectors options Specifications

Parameters	MW (option) Std level	MW (option) High level	MW (option) PN9361-02	MW (option) PN9361-04	AM (option) PN9341-03
Frequency range, GHz	1.6 to 26.5	1.6 to 26.5	5 to 40	1.8 to 50	0.01 to 26.5
RF Input min. dBm	- 10	+ 5	- 10	- 10	- 5
RF input max. dBm	+ 15	+ 20	+ 15	+ 15	+ 15
LO input min. dBm	+ 7	+ 10	+ 7	+ 7	NA
LO input max. dBm	+ 15	+ 23	+ 15	+ 15	NA
RF input Gain, dB	None	None	None	None	None
LO input Gain, dB	None	None	None	None	None
Noise floor, in dBc/Hz at					
1 Hz offset	- 120	- 128	- 125	- 125	NA
10 Hz	- 130	- 138	- 135	- 135	NA
100 Hz	- 140	- 148	- 145	- 145	- 142
1 kHz	- 150	- 158	- 155	- 155	- 150
10 kHz	- 160	- 168	- 168	- 168	- 160
100 kHz & beyond	- 168	- 174	- 168	- 168	- 160
Nominal RF input level, dBm	+ 10	+ 15	+ 10	+ 10	+ 12
Nominal LO input level dBm	+ 10	+ 20	+ 10	+ 10	NA

Notes:

- PN9361-02 use K type connectors for RF and LO ports; others use SMA type.
- PN9361-04 use 2.4mm type connectors for RF and LO ports; others use SMA type.
- PN9341-01 and PN9348 modules integrates the MW Std level option
- PN9341-03 integrates the MW High level option
- Minimum pulsed signals duty cycle is 1%
- For specified values add + 3dB



Residual noise with high-level phase detector option

WPN9000 Software

The Windows software provides a friendly interface to the system:

Measurement method control

Selection of measurement method, depending on the DUT

PLL Synth for reference synthesizer method, for stable sources
PLL Xtal for crystal sources
VCO (delay line) for free running sources
AM noise
Noise voltage for voltage sources
ADD NOISE added noise for two port devices
PULSE for pulsed sources or pulsed two ports devices (PM, AM, Added noise)

Photographic based cabling help 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 specifications lines with direct access memories. Plot export as text, BMP or JPEG file to any windows accessible storage device.

Measurement mode - Automatic and Manual

Automatic 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 ± B, N*A, A:N, A±N*B, A±NdB
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
Speed (PN969x-HR options)	: less than 30 seconds for 10 averages (100Hz to 40MHz)
Plot Printing	: Any windows supported printers
External synthesizer driver signal generator	: User defined IEEE-488 control menu to set up most of commercial