7000 Series
Signal Source Analyzer &
Dedicated Phase Noise Test System

A fully integrated high-performance cross-correlation signal source analyzer with platforms from 5MHz to 7GHz, 26GHz, and 40GHz

Key Features

- Complete broadband in one box from 5MHz to 40GHz
- Absolute and additive phase noise measurements in one instrument
- .01hz to 100MHz offset
- Pulse and AM measurements
- Oscillator test bench (tuning, pushing, phase noise, current, power)

BNC Berkeley Nucleonics

Test, Measurement and Nuclear Instrumentation since 1963

Introduction

The 7000 series is an integrated solution that offers an indispensable set of measurement functions for evaluating signal sources ranging from VHF to microwave frequencies such as crystal oscillators, PLL synthesizers, clocks, phase-locked or free-running VCOs, DROs, SAW or YIG oscillators, and others.

The flexible instrument comprises a two-channel cross-correlation system with two internal tunable references sources and allows also measurements with externally fed references. The 7000 series Phase Noise Testers support many other functions including:

- absolute and residual phase noise measurements
- amplitude noise measurements
- PULSED absolute and residual phase noise measurements
- two channel 100 MHz FFT analyzer
- transient measurements (frequency, phase, amplitude versus time)
- oscillator test bench (tuning, pushing, phase noise, current, power,..)
- spectrum analysis
- frequency counter function / power meter

Additionally, the unit offers

- two programmable low noise DC supplies up to 15V and 600mA current capability
- three low noise tuning voltages for -5 to +22 V voltage range

It is a compact and powerful instrument available with LAN (VXI-11), USBTMC, or with GPIB (optionally) interfaces. Platform independent intuitive graphical user interface (GUI), API library, and powerful SCPI command language set is available.

Specifications

The specifications in the following pages describe the warranted performance of the instrument for 25 ± 5 °C after a 30 minute warm-up period. Typical specifications describe expected, but not warranted performance. Min and Max specifications are warranted.

Warranted performance. Specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Parameter	Min.	Typ.	Max.	Note
Absolute Phase Noise Measurement 5 MHz to 40 GHz (CW)				
Measurement parameters	SSB phase noise [dBc/Hz], Spurious noise [dBc], Integrated rms phase deviation [deg, rad] or time jitter [s], Residual FM/PM [Hz rms]			
7000 20G RF Frequency Range **7070** **7300-26** **7340-40G**	***FMIN*** 5 MHz 5 MHz 5 MHz		***FMAX*** 7 GHz 26 GHz 40 GHz	 using internal/external references internal references internal references
Input Power Range to 2 GHz 2 to 9 GHz 9 to 18 GHz 18 to 30 GHz 30 to 40 GHz	 -15 dBm -12 dBm -10 dBm -13 dBm 0 dBm		 +17 dBm +20 dBm +20 dBm +20 dBm +23 dBm	+26 dBm is damage level See also RF sensitivity plot
Input impedance **VSWR**		50 Ω 2		AC coupled, 10V DC max
Offset Analysis Range **Resolution**	0.01 Hz 2		100 MHz 3800	 points per decade, RBW adjustable
Measurement Accuracy		±4 dB ±3 dB ±2 dB		< 10 Hz offset < 1 kHz offset > 1 kHz
System Phase Noise Floor (100 MHz) 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz 10 MHz		 -140 dBc/Hz -150 dBc/Hz -160 dBc/Hz -175 dBc/Hz -188 dBc/Hz -188 dBc/Hz		 (cross-correlation, external references)
Phase Noise Sensitivity	See plot for sensitivity of internal sources			
Spurious levels External References Internal references		 -85 dBc -90 dBc		
Measurement time				See Table “Measurement Time”
Trigger		Single, continuous, manual, bus		

Parameter	Min.	Typ.	Max.	Note
Internal References				Cross-correlation
Frequency Range	1 MHz		FMAX	
Phase Noise Sensitivity				See Plots “Sensitivity”
RF Tracking Range		±1 ppm ±10 ppm >±1000 ppm		Option LN Standard High drift mode
External References				One or Cross-correlation
Frequency Range	5 MHz		18 GHz	
RF Input Level Range < 10 GHz > 10 GHz	 +10 dBm +13 dBm		 +23 dBm +23 dBm	+26 dBm is damage level
Reference Level Range	+13 dBm	+17 dBm	+ 21 dBm	
Tuning Voltage Range	-5 V		+20 V	User adjustable
Output current			>20 mA	

PULSED Absolute Phase Noise Measurement 30 MHz to 18 GHz (option PULSE)

7340 20G RF Frequency Range	30 MHz		18 GHz	7070: 7 GHz
Input Power Range	0 dBm		+20 dBm	
Pulse rate (PRF)	200 Hz		2 MHz	
Pulse width **Duty cycle**	200 ns 0.2%		2 ms 60%	
Offset Analysis Range	0.01 Hz		To PRF	
Measurement Accuracy		±4 dB ±3 dB ±2 dB		< 10 Hz offset < 1 kHz offset > 1 kHz
Measurement time				See Table “Measurement Time”

Residual CW or PULSED (option PULSE) Phase Noise Measurement 5 MHz to 18 GHz

Measurement parameters	SSB phase noise [dBc/Hz], Spurious noise [dBc], Integrated rms phase deviation [deg, rad] or time jitter [s], Residual FM/PM [Hz rms]			
RF Frequency Range	5 MHz		18 GHz	7070: 7 GHz
Input Power Range (RF port) **(REF ports)**	+3 dBm +13 dBm		+23 dBm +20 dBm	
Offset Analysis Range	0.01 Hz		100 MHz	

Parameter	Min.	Typ.	Max.	Note
Measurement Accuracy		±3 dB ±2 dB		< 1 kHz offset > 1 kHz
Residual Phase Noise Floor 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz 10 MHz		 -140 dBc/Hz -150 dBc/Hz -160 dBc/Hz -175 dBc/Hz -188 dBc/Hz -188 dBc/Hz		(cross-correlation engine, external source)

Transient Measurements

Measurement parameters Wideband mode Narrowband mode	Frequency Frequency, RF power, Phase			
Frequency bands (wideband)	5 MHz 20 MHz 80 MHz 320 MHz 1.3 GHz 5.2 GHz		100 MHz 400 MHz 1.6 GHz 3 GHz 26 GHz FMAX	Band 1 Band 2 Band 3 Band 4 Band 5 Band 6
Measurement spans Wideband Narrowband		Bands 1-6 200 kHz, 1.25 MHz, 80 MHz		
Frequency resolution Wideband mode Narrowband mode		 See table See table		
Time span	10 µs		1 min	
Time resolution	16 ns		50 ms	
Trigger mode		Single, continuous, bus, wideband or narrowband video, internal, external		

Absolute Amplitude Noise Measurement (option AM)

Measurement parameters	SSB Amplitude Noise [dBc/Hz],			
RF Frequency Range	5 MHz		18 GHz	7070: 7 GHz
Input Power Range				
<100 MHz	-20 dBm		0 dBm	
100-150 MHz	-20 dBm		+6 dBm	
150-3000 MHz	-20 dBm		+9 dBm	
3-6 GHz	-20 dBm		+11 dBm	
6-18 GHz	-10 dBm		+15 dBm	
Offset Analysis Range	0.1 Hz		40 MHz	
Measurement Uncertainty		±2 dB		
AM Noise Sensitivity (1 corr)				1 GHz, Pin=5 dBm
1 Hz		-100 dBc/Hz		
10 Hz		-115 dBc/Hz		
100 Hz		-135 dBc/Hz		
1 kHz		-145 dBc/Hz		
10 kHz		-155 dBc/Hz		
>100 kHz		-160 dBc/Hz		

Baseband Noise Analyzer

Input Connectors	2 BNC female (rear panel), AC coupled			
Measurement parameters	dBV/Hz, dBm/Hz, nV/√Hz			
DC Voltage Range	-12 V		+ 12 V	
Input Impedance		1 kΩ		DC
AC Voltage Range			+ 10 dBm	
Frequency Range	1 Hz		100 MHz	
Input Noise Density (1corr)		< 1 nV/√Hz		10 kHz offset
Trigger		Single, continuous, manual, bus		

Spectrum Monitoring

Measurement parameters	dBm, dBm/Hz, dbV/Hz			
RF Frequency Range	10 MHz		FMAX	
Monitor Span	5.8 Hz		58 kHz	
RBW	tbd		100 kHz	
Measurement Uncertainty absolute relative		 ±3 dB 1 dB		
Noise floor				
Trigger		continuous, manual, bus		

VCO Characterization

Measurement parameters	Frequency (Hz), Tuning sensitivity (Δf/ΔVc) (Hz/V), Frequency Pushing (Hz/V), RF power level [dBm], DC supply current [mA] SSB PhN / AN [dBc/Hz]			
Sweep parameters DC Supply Voltage Tuning Voltage	 0 to 15 V / max 550 mA -5 to 20 V / max 20 mA			Adjustable
RF frequency Uncertainty	5 MHz	 0.5 ppm	FMAX	
RF Power Uncertainty	-5 dBm	 0.5 dB	20 dBm 2 dB	
DC supply current Uncertainty	0 mA	 1%	550 mA	
Output settling time		20 ms		
Measurement speed		70 ms per point		One point includes frequency, Kvco, pushing, DC supply, and power measurement
Trigger		Manual, bus, external		

Frequency Counter

Measurement parameters	Frequency [Hz]			
Frequency Range	1 MHz		FMAX	
Absolute Accuracy		300 ppb		or accuracy of external reference
Sensitivity		-10 dBm		See typical sensitivity plot

Power Detector

Measurement parameters	Power mW ,dBm			
Frequency Range	5 MHz		FMAX	
Accuracy		±1 dB		
Power Range	-10 dBm		+13 dBm	

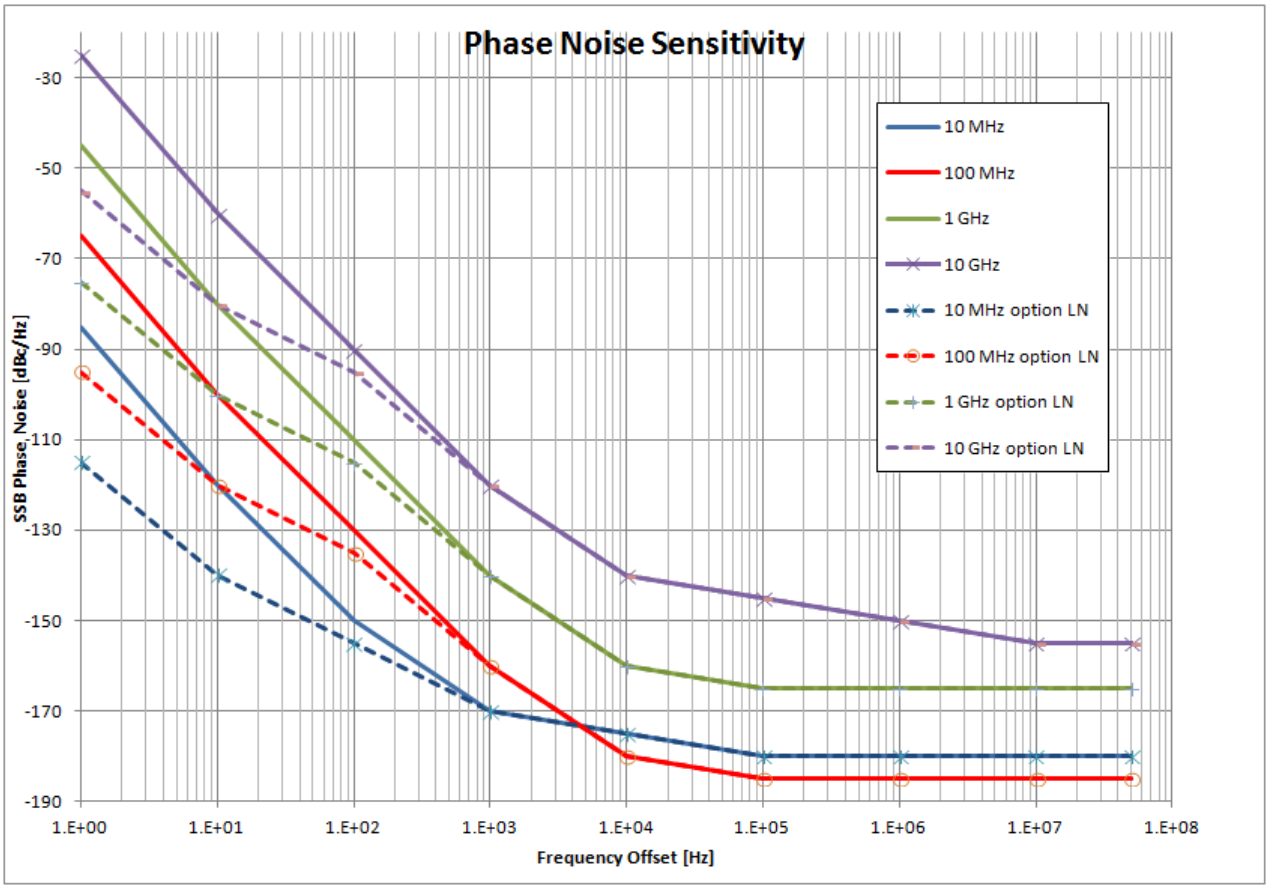
Tuning Voltage & Dual Power Supply

DUT TUNING				
DC Voltage Range	-5 V		+22 V	
Setting Resolution		1 mV		
Setting Uncertainty		±2 mV		
Noise Level		< 2 nVrms/√Hz		> 2 kHz
DC current range	0 mA		35 mA	
DC POWER SUPPLIES (Channel 1 & 2)				
DC Voltage Range	0 V		15 V	
Setting Resolution		10 mV		
Setting Uncertainty		±10 mV		
Noise Level		< 10 nVrms/√Hz		> 20 kHz
Output Resistance		< 0.5 Ohm		
DC current meas. range	0 mA		550 mA	Per channel
Resolution		100 uA		

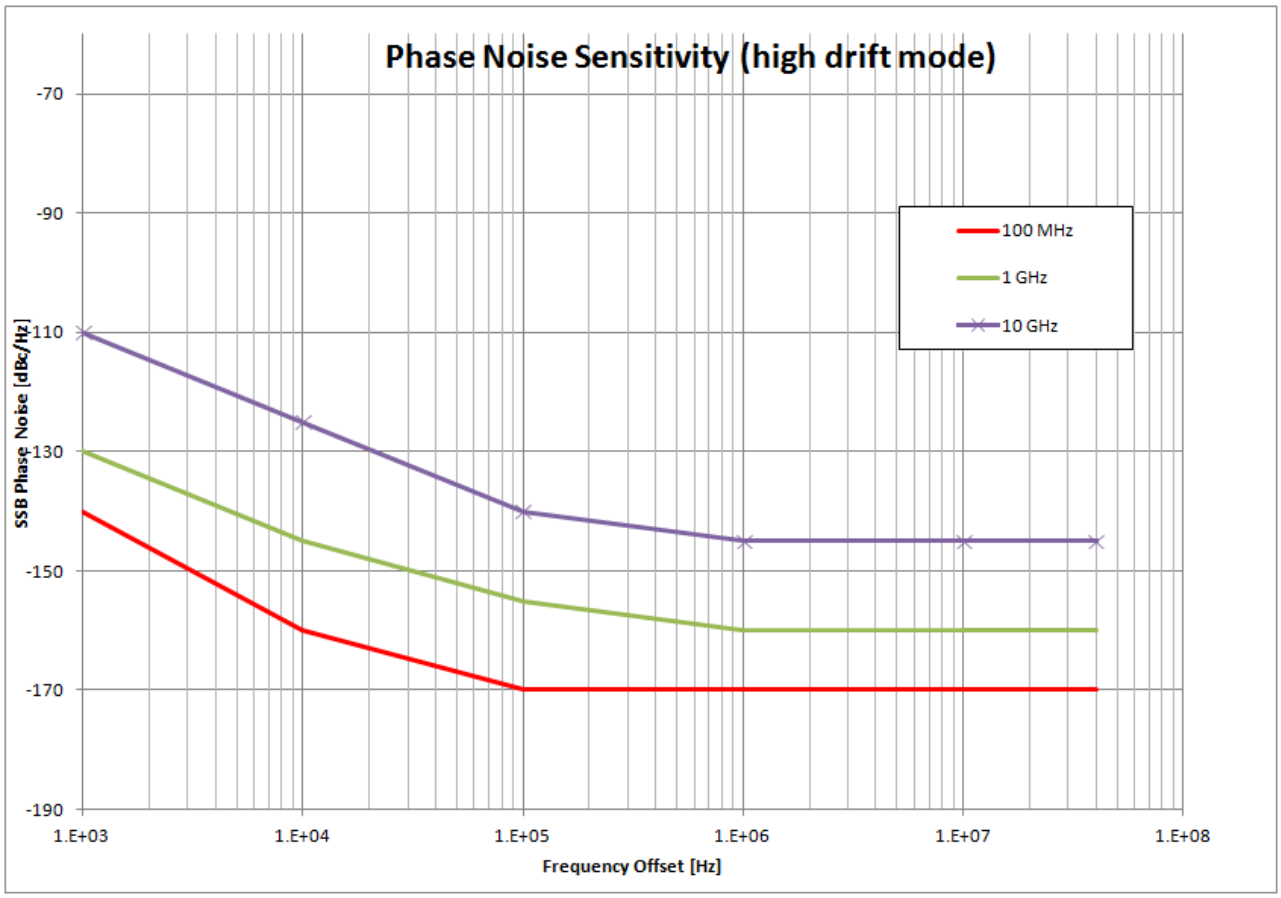
Performance Data Plots

Phase Noise Sensitivity (dBc /Hz) **(standard and LN mode)**

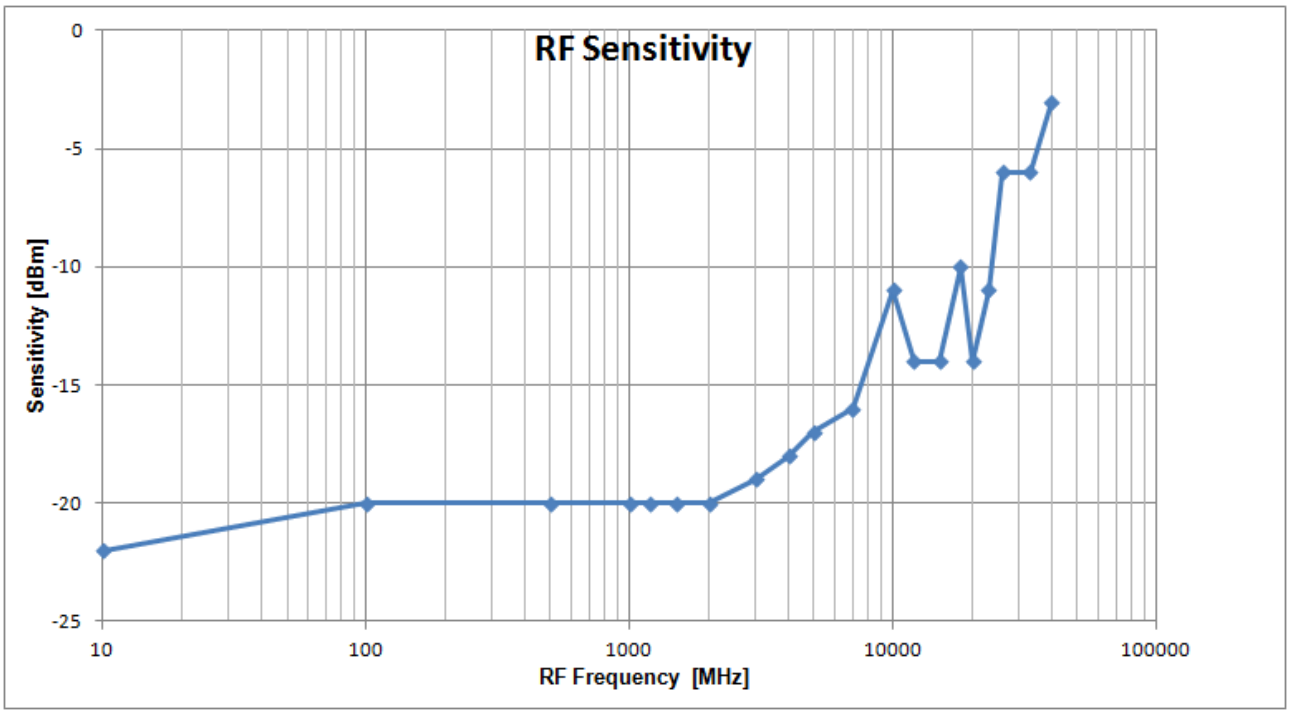
Measurement time ~25 seconds, after first cross-correlation; further correlations will improve sensitivity by 5 dB for 10, 10 dB for 100, and 15 dB for 1000 respective correlations performed.



Phase Noise Sensitivity (high drift mode)



Typical RF Sensitivity 5 MHz to 40 GHz (blue trace, in dBm)



Phase Noise Measurement Time

Total measurement time consists of setup time, transfer time plus the number of performed correlations times the time per correlation

	Time per average (sec)	Default Nr. of points (settable)
0.1 Hz to 100 MHz	**80**	**200 per decade**
1 Hz to 100 MHz	**10**	**200 per decade**
10 Hz to 100 MHz	**1.5**	**200 per decade**
100 Hz to 100 MHz	**0.5**	**200 per decade**
1 kHz to 100 MHz	**0.2**	**200 per decade**
10 kHz to 100 MHz	**<0.1**	**200 per decade**

Transient Mode Frequency Measurement

Frequency measurement uncertainty is +/- (resolution + time-base uncertainty). Tabulated resolutions are measured with the APPH and DUT locked to the same 10 MHz reference. Input level 0 dBm.

Wideband: Transient Measurement Frequency Resolution vs Time Resolution (residual FM, 5% video bandwidth, typical)

Time resolution	16 ns	128 ns	500 ns	1 µs	>=10 µs
Frequency band	**Frequency resolution [Hz]**				
5 to 100 MHz	3 k	100	30	15	10
20 to 400 MHz	5 k	700	200	100	20
80 to 1600 MHz	10 k	1 k	200	100	50
320 to 3000 MHz	30 k	1.5 k	300	150	150
1.3 to 26 GHz	100 k	6 k	2 k	1 k	1 k
5.2 GHz to FMAX	500 k	20 k	4 k	2 k	2 k

Narrowband: Transient Measurement Frequency Resolution vs Time Resolution (residual FM, 80 MHz Span, 5% video bandwidth, typical)

Time resolution	16 ns	128 ns	500 ns	1 µs	10 µs	>=20 µs
Frequency range	**Frequency resolution [Hz]**					
< 200 MHz	1.5 k	50	10	4	4	4
< 800 MHz	2.5 k	150	15	10	4	4
< 2 GHz	2.5 k	500	20	10	4	4
< 20 GHz	30 k	4 k	150	70	20	7
> 20 GHz	50 k	4 k	400	150	50	15

Narrowband: Transient Measurement Frequency Resolution vs Time Resolution (residual FM, 1.25 MHz Span, no video filter, typical)

Time resolution	256 ns	500 ns	1 µs	10 µs	>= 20 µs
Frequency range	**Frequency resolution [Hz]**				
< 200 MHz	60	30	15	1.5	0.5
< 800 MHz	70	30	15	1.5	1.5
< 2 GHz	100	40	15	3	1.5
< 20 GHz	1 k	300	150	30	15
> 20 GHz	3 k	1 k	400	60	30

Narrowband: Transient Measurement Frequency Resolution vs Time Resolution (residual FM, 200 kHz Span, no video filter, typical)

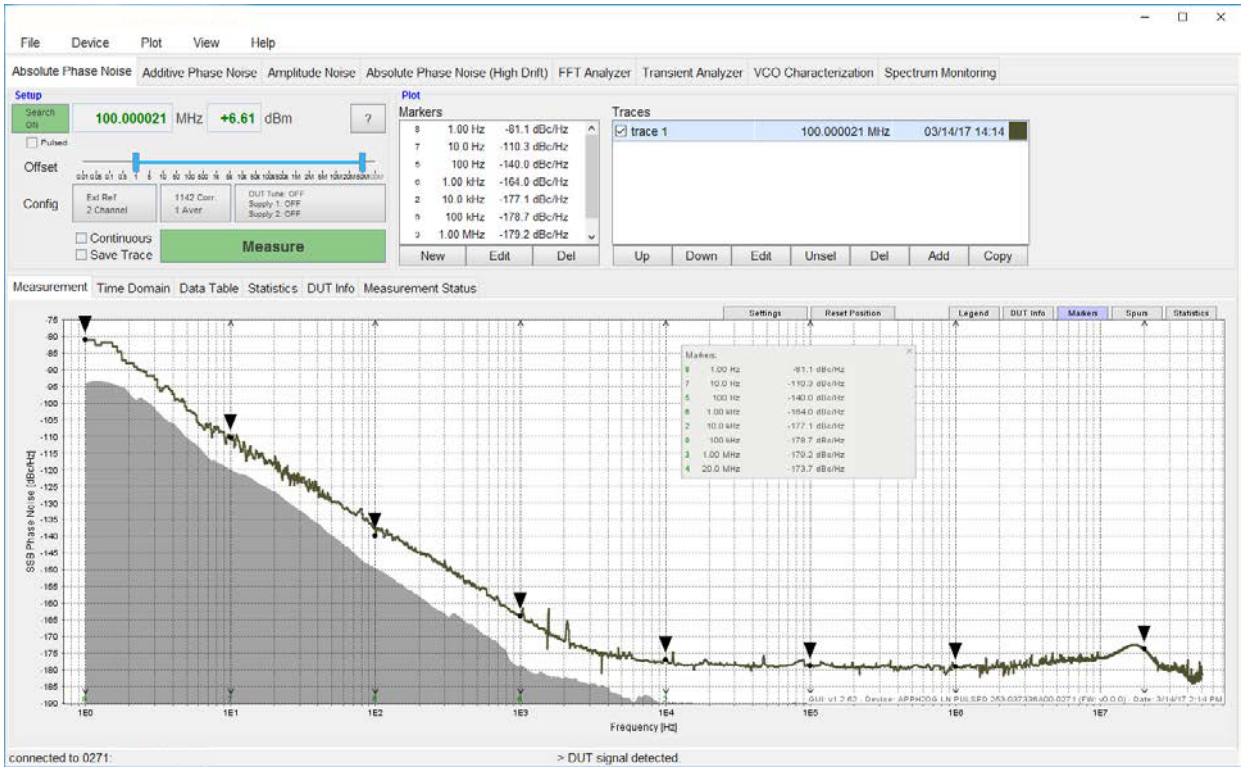
Time resolution	1 µs	10 µs	>=20 µs
Frequency range	**Frequency resolution [Hz]**		
< 200 MHz	1	0.5	0.3
< 800 MHz	1.5	0.5	0.3
< 2 GHz	3	1	0.4
< 20 GHz	20	10	3
> 20 GHz	50	20	10

Data Processing Capabilities

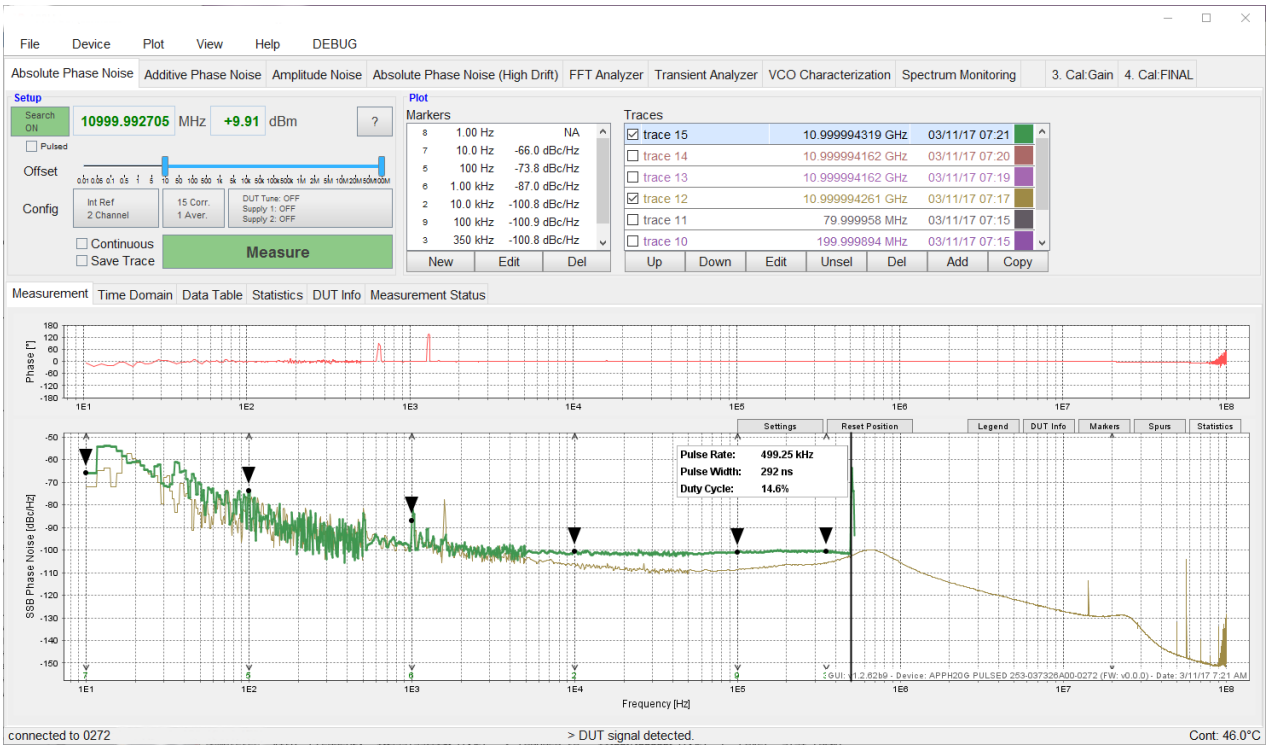
Graphical user interface: The analyzer employs a graphical user interface based on Windows OS.

Display Functions	Phase Noise, Time Domain, Data Table, Residual, Statistics
Trace Functions **Data Traces**	Display current measurement and/or multiple memory data (up to 16 traces)
Math	Addition, subtraction, multiplication, or division of trace data, offset corrections
Title	Add customized title to each measurement window
Auto-Scale	Automatically selects scale resolution and reference value to vertically center the trace.
Statistics	Calculates and displays mean, standard deviation, and peak-to-peak deviation of the trace.
Marker Functions	16 independent markers

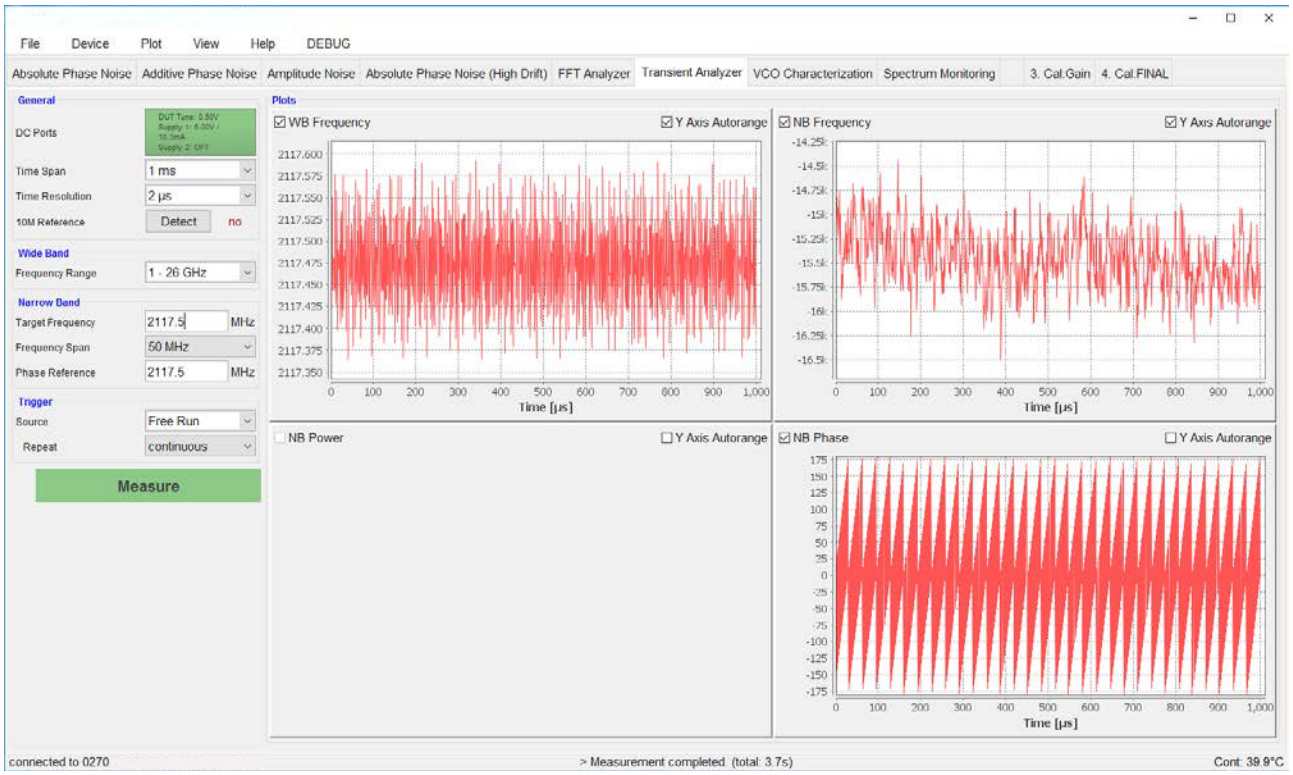
GUI Interface (Absolute Phase Noise)



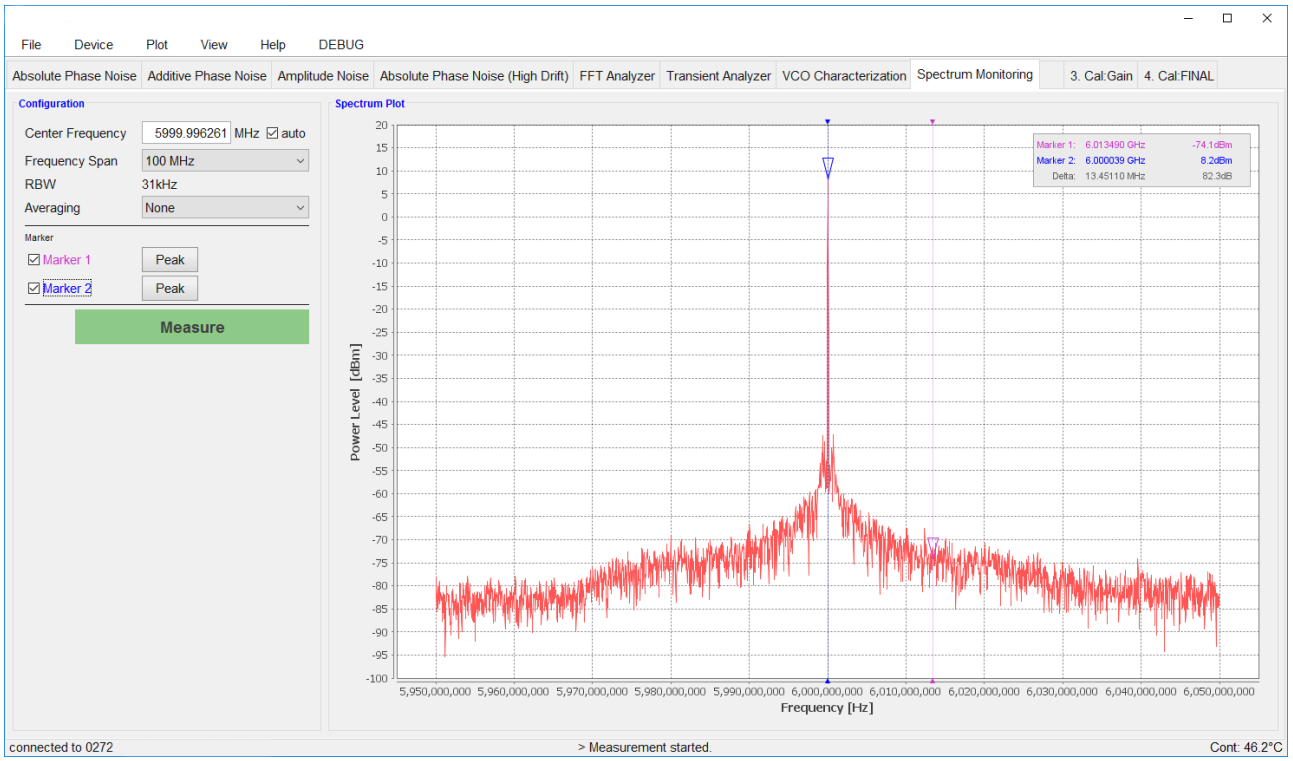
GUI Interface (Pulsed RF Absolute Phase Noise)



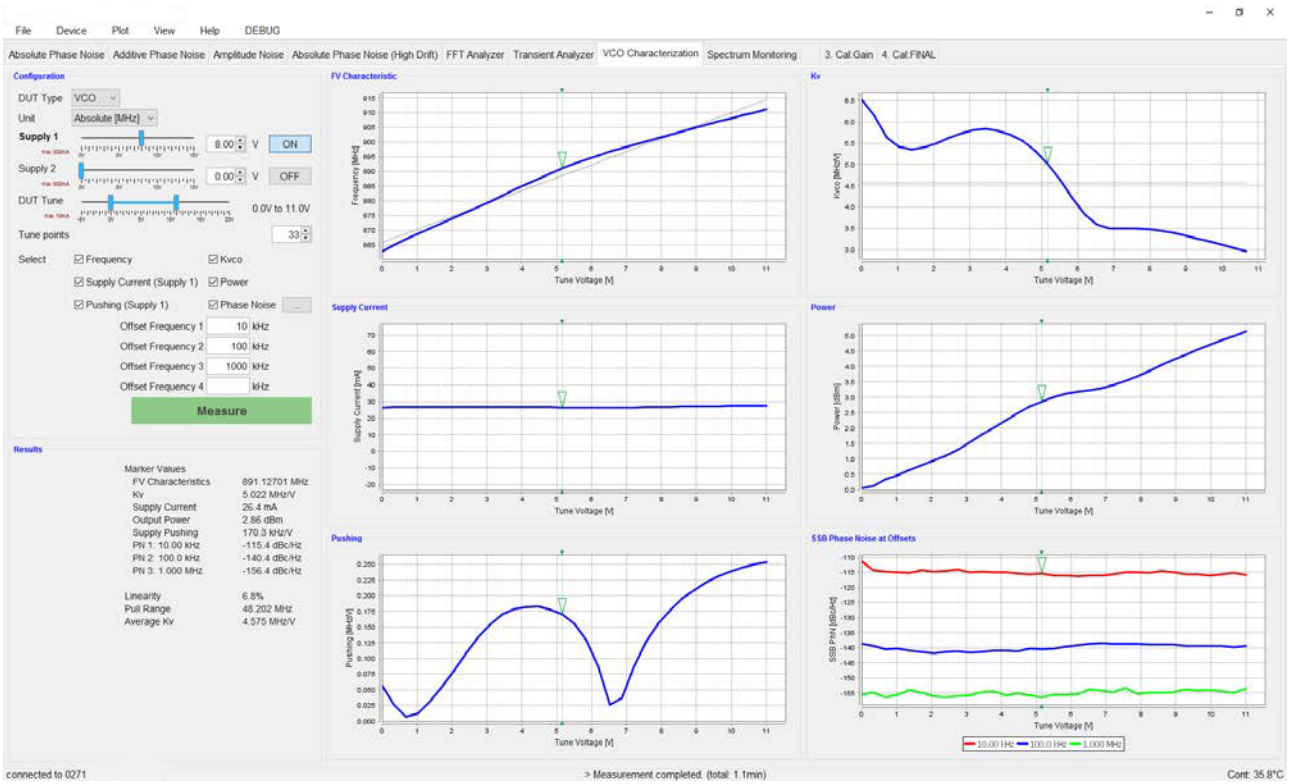
GUI Interface (Transient Analyzer)



GUI Interface (Spectrum Monitoring)



GUI Interface (VCO Testing)



Connectors

1. RF inputs: RF IN, REFIN1 HIGH and LOW, REFIN2 HIGH and LOW: SMA female
2. Tuning outputs: TUNE1, TUNE2 : BNC female
3. DC power switch
4. Status LEDs: POWER, READY, REMOTE

Connectors (Rear)

1. Baseband inputs (BB1, BB2): BNC female
2. Supply outputs (SUPPLY1, SUPPLY2): BNC female
3. AUX inputs: EXT TRIG and 10 MHz REF IN: BNC female
4. LAN connection: RJ-45
5. USB 2.0 host and device
6. DC Power plug (24V, 2A)

General Characteristics

Remote programming interfaces
Ethernet 100BaseT LAN interface,
USB 2.0 host & device
GPIB (IEEE-488.2,1987) with listen and talk (optional)
Control language SCPI Version 1999.0

Power requirements 24 VDC; 24 W maximum
Mains adapter supplied: 100-240 VAC in/ 24V, 2A DC out
Operating temperature range 0 to 40 °C
Storage temperature range –40 to 70 °C
Operating and storage altitude up to 15,000 feet

CE notice
Safety/EMC complies with applicable Safety and EMC regulations and directives.

Weight ≤ 10 kg (21 lbs) net
Dimensions incl. rubber: 154 mm H x 467.5 mm W x 342 mm L [6.1 in H x 18.4 in W x 13.5 in L]
with handle: 154 mm H x 520 mm W x 342 mm L [6.1 in H x 20.5 in W x 13.5 in L]
handle: radius 230mm [9 in]; can be turned 360°

Options

- ***GPIB****: IEEE-488.2,1987 programming interface*
- ***LN:*** *ultra low close to carrier phase noise*
- ***PULSE:*** *pulsed RF measurement capability*
- ***AN:*** *Amplitude noise measurement capability*