DATASHEET APPH
Specification v1.23

Signal Source Analyzer from 1 MHz to 7, 26 and 40 GHz

DEFINITIONS

The specifications in the following pages describe the warranted performance of the instrument for 23 ±5 °C after a 30-minute warm-up period (unless otherwise stated).

Min/Max: Parameter range that is guaranteed by product design, and/or production tested. Warranted performance specifications include guard-bands to account for the expected statistical performance distribution, measurement uncertainties, and changes in performance due to environmental conditions.

Typical: Expected mean values, not warranted performance.

INTRODUCTION

Fully integrated cross-correlation signal source analyzer for 1 MHz to 7, 26, and 40 GHz

The APPH 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 tuneable reference sources and also allows measurements with externally fed references.

The APPH supports 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 analysis
- Transient measurements (frequency, phase, amplitude vs. time)
- Spectrum analysis
- Frequency counter function / power meter

Additionally, the unit offers

- Two programmable low noise DC supplies up to 15 V and 600 mA 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.

Operated with an external 24 V DC supply, it consumes less than 70 W.

SPECIFICATIONS

Absolute Phase Noise Measurement 1 MHz to 40 GHz (continuous waveform)

Measurement parameters:
- SSB Phase Noise [dBc/Hz]
- Spurious Noise [dBc]
- Integrated RMS Phase Noise Deviation [deg, rad]
- Time Jitter [s]
- Residual FM/PM [Hz RMS]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	*FMIN* 1 MHz 1 MHz 1 MHz		*FMAX* 7 GHz 26 GHz 40 GHz	Using internal references APPH6040 APPH20G APPH40G
RF Frequency Range	 5 MHz 5 MHz		 7 GHz 18 GHz	Using external references APPH6040 APPH20G / APPH40G
Input Power Range <18 GHz 18 GHz to 30 GHz 30 GHz to 35 GHz >35 GHz	 -15 dBm -15 dBm 0 dBm		 +20 dBm +23 dBm +23 dBm +23 dBm	Damage level +26 dBm *See RF sensitivity plots*
Input Impedance VSWR		50 Ω 2		AC coupled, 10 V DC max
Offset Analysis Range	0.01 Hz 0.01 Hz		100 MHz > 25% of f_C	f_C > 150 MHz f_C < 150 MHz
Resolution (PPD)	200	200	1600	RBW adjustable (x1/x2/x4/x8), PPD (points per decade) can be lower for lowest decade of measurement
Measurement Accuracy		±4 dB ±3 dB ±2 dB		Offset < 10 Hz Offset 10 Hz to 1 kHz Offset 1 kHz to 100 MHz
Phase Noise Sensitivity				*See plot & sensitivity tables*
Spurious Levels Internal References External References		 -90 dBc -85 dBc		
Measurement Time				*See table "Measurement Time"*
Trigger				Single, continuous, manual, bus
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				Single channel / cross-corr.

Frequency Range	5 MHz 5 MHz		7 GHz 18 GHz	APPH6040 APPH20G / APPH40G
RF Input Power Range < 1.3 GHz > 1.3 GHz	 0 dBm 0 dBm		 +23 dBm +23 dBm	Damage level +26 dBm
Phase Noise Sensitivity				*See plot & sensitivity tables*
Reference Input Level Range < 1.3 GHz > 1.3 GHz	 +10 dBm +13 dBm	 +15 dBm +15 dBm	 +21 dBm +21 dBm	 Lower input ports Upper input ports
Tuning Voltage Range	-5 V		+20 V	User adjustable
Tuning Output Current			20 mA	

Absolute Phase Noise Measurement – Pulsed (Option PULSE)

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	30 MHz 30 MHz		7 GHz 18 GHz	APPH6040 APPH20G / APPH40G
RF Input Power Range	+5 dBm		+20 dBm	No power measurement
Input Parameters Pulse Rate (PRF) Pulse Width Duty Cycle	 200 Hz 200 ns 0.2%		 2 MHz 2 ms 60%	
Offset Analysis Range	0.01 Hz		PRF	
Measurement Accuracy		±4 dB ±3 dB ±2 dB		Offset < 10 Hz Offset 10 Hz to 1 kHz Offset 1 kHz to 100 MHz
Measurement Time				*See table "Meas. Time"*

Residual (Additive) Phase Noise Measurement – CW (Option APN) and Pulsed (Option APN + PULSE)

Measurement parameters:

- SSB Phase Noise [dBc/Hz]
- Spurious Noise [dBc]
- Integrated RMS Phase Noise Deviation [deg, rad]
- Time Jitter [s]
- Residual FM/PM [Hz RMS]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	10 MHz 10 MHz		7 GHz 18 GHz	APPH6040 APPH20G / APPH40G
RF Input Power Range RF Port REF Ports	 +3 dBm +13 dBm		 +23 dBm +20 dBm	
LO Output Power Range	+17 dBm		+23 dBm	Option LO
Offset Analysis Range	0.01 Hz		100 MHz	
Measurement Accuracy		±3 dB ±2 dB		Offset < 1 kHz Offset > 1 kHz
Additive Phase Noise Sensitivity				See sensitivity table

Transient Analysis (Option TRAN)

Measurement parameters:
Wideband Mode (WB): Frequency [Hz]
Narrowband Mode (NB): Frequency [Hz], RF Power [dB], Phase [deg]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Bands (WB)	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 Mode (WB) Narrowband Mode (NB)	 200 kHz		 80 MHz	 Bands 1-6 200 kHz, 1.25 MHz, 80 MHz
Frequency Resolution				See table
Time Span	10 µs		1 min	
Time Resolution	16 ns		50 ms	
Trigger Mode				Single, Continuous, Internal (WB video or NB video), external

Burst Mode Phase Noise Measurement (Option PULSE + Option BURST)

Measurement parameters:
SSB Phase Noise [dBc/Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	5 MHz		FMAX	
Offset Analysis Range	1 / T		30 MHz	
Time Span (T)	10 µs		1 min	
Phase Noise Sensitivity 1 kHz 10 kHz 100 kHz 1 MHz 10 MHz		 -120 dBc/Hz -128 dBc/Hz -131 dBc/Hz -131 dBc/Hz -147 dBc/Hz		Single Channel, f = 1 GHz

Absolute Amplitude Noise Measurement (Option AM)

Measurement parameters:
SSB Amplitude Noise [dBc/Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	5 MHz		18 GHz	
RF Input Power Range 5 MHz to 10 GHz 10 GHz to 18 GHz	 -20 dBm -10 dBm		 +20 dBm +20 dBm	
Offset Analysis Range	0.1 Hz		40 MHz	
Measurement Uncertainty		±2 dB		

AM Noise Sensitivity (1 corr.) 1 Hz 10 Hz 100 Hz 1 kHz 10 kHz > 100 kHz		 -100 dBc/Hz -115 dBc/Hz -135 dBc/Hz -145 dBc/Hz -155 dBc/Hz -160 dBc/Hz		1 GHz, P_{in} = -10 dBm to +20 dBm

Baseband Noise Analysis

Input Connectors:
2 BNC female (rear panel), AC coupled
Measurement parameters:
Noise Spectrum [dBV/Hz, dBm/Hz, nV/√Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
Frequency Input Range	1 Hz		100 MHz	
DC Voltage Input Range Input Impedance	-12 V	 1 kΩ	+12 V	 DC
AC Voltage Range			+10 dBm	
Input Noise Density (1 correlation) 10 kHz		 < 1nV/√Hz		
Trigger				Single, Continuous, Manual, Bus

Time Stability Measurement (Option TSTAB)

Measurement parameters:
ADEV (no dead time)

PARAMETER	MIN	TYPICAL	MAX	NOTE
Measurement Time	1 s		10 days	
ADEV Sensitivity τ = 1 s τ = 100 s		 5e-13 1e-13		With RBW 100 Hz

Spectrum Monitoring (Option SPEC)

Measurement parameters:

Spectral Noise Densitity [dBm, dBm/Hz, dBv/Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	5 MHz 5 MHz 5 MHz		7 GHz 20 GHz 20 GHz	APPH6040 APPH20G APPH40G
RBW	5.8 Hz		58 kHz	
Measurement Uncertainty Absolute Relative		 ±3 dB ±1 dB		
Noise Floor 10 MHz to 4 GHz 4 GHz to 18 GHz 18 GHz to 40 GHz		 -95 dBm/Hz -90 dBm/Hz -80 dBm/Hz		
Spurious (SFDR) 10 MHz to 4 GHz 4 GHz to 18 GHz 18 GHz to 40 GHz		 -70 dBc -60 dBc -55 dBc		Spurious Free Dynamic Range
Spurious (absolute) 10 MHz to 4 GHz 4 GHz to 18 GHz 18 GHz to 40 GHz		dBm		
Trigger				Continuous

VCO Characterization (Option VCO)

Measurement parameters:

Frequency [Hz]
K_{VCO} (Tuning Sensitivity) ($\Delta f/\Delta V_c$) [Hz/V]
Frequency Pushing [Hz/V]
RF Power Level [dBm]
DC Supply Current [mA]
SSB Phase Noise [dBc/Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
Sweep Parameters DC Supply Voltage DC Supply Current Tuning Voltage Tuning Current	 0 V -5 V		 15 V 550 mA 20 V 20 mA	 Adjustable Adjustable
RF Frequency Range Uncertainty	5 MHz	 0.5 ppm	*FMAX*	
RF Input Power Range 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 / point		Frequency, K_{VCO}, Pushing, Supply Current, and Power

Frequency Counter

Measurement parameters:
Frequency [Hz]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	1 MHz		*FMAX*	
Absolute Accuracy		300 ppb		Or accuracy of external reference
Sensitivity				See plot “Typical RF Sensitivity Plot”

Power Detector

Measurement parameters:
RF Power Level [mW, dBm]

PARAMETER	MIN	TYPICAL	MAX	NOTE
RF Frequency Range	5 MHz 5 MHz		*FMAX* 27 GHz	APPH6040, APPH20G APPH40G
Absolute Accuracy		±1 dB	±2.5 dB	
Power Range	-10 dBm		+13 dBm	

Tuning Voltage & Dual Power Supply

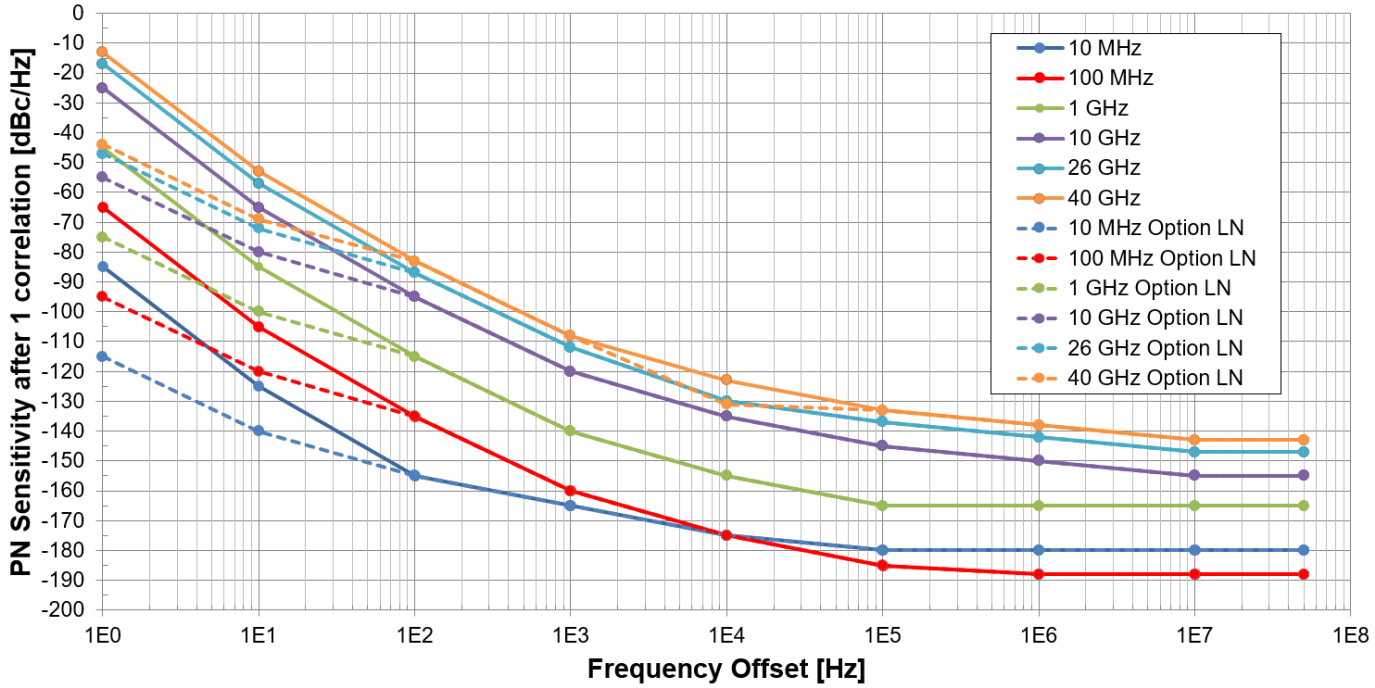
PARAMETER	MIN	TYPICAL	MAX	NOTE
DUT Tuning				BNC Front Panel Output
DC Voltage Range	-5 V		+22 V	
Setting Resolution		1 mV		
Setting Uncertainty		±2 mV		
Noise Level		< 2 $nV_{rms}/\sqrt{Hz}$		> 2 kHz
DC Current Range	0 mA		35 mA	
DC Power Supplies				BNC Rear Panel Output (Channel 1 & 2)
DC Voltage Range	0 V		15 V	
Setting Resolution		10 mV		
Setting Accuracy		±10 mV		
Noise Level		< 10 $nV_{rms}/\sqrt{Hz}$		> 20 kHz
Output Resistance		< 0.5 Ω		
DC Current Measurement Range	0 mA		550 mA	Per Channel
Resolution		100 µA		

PERFORMANCE CURVES

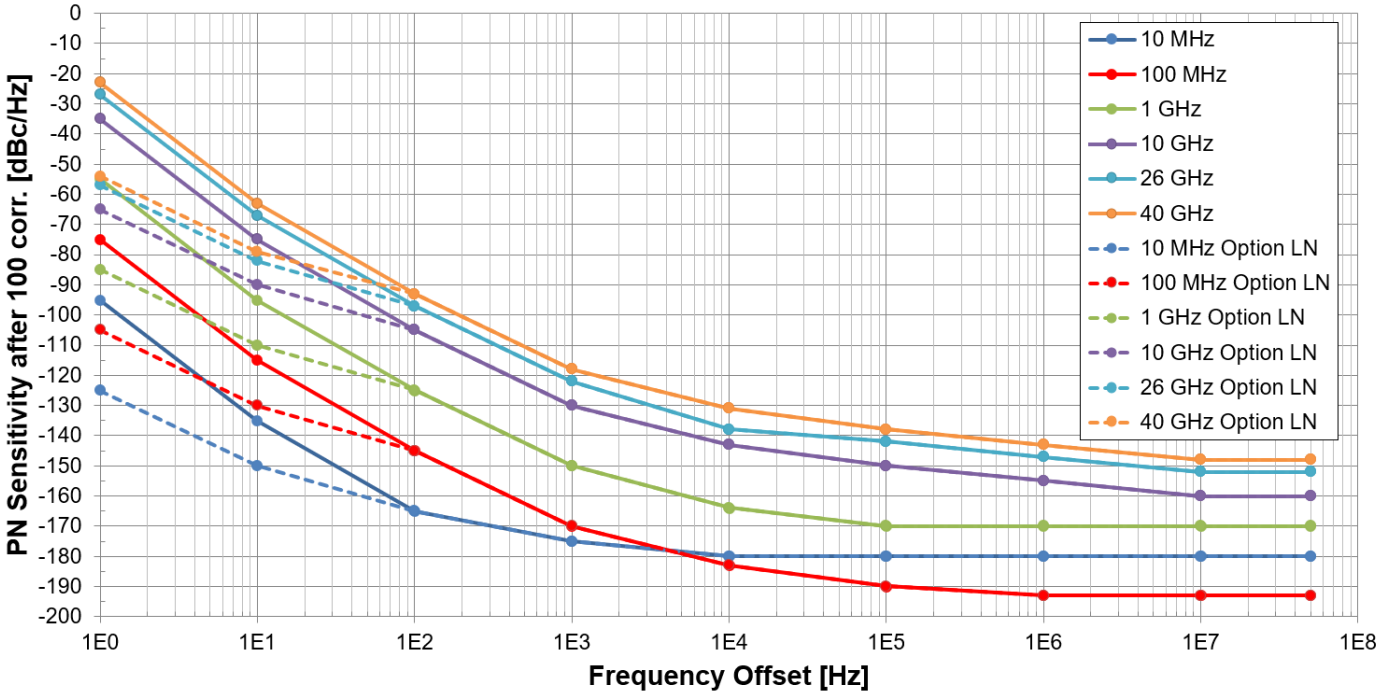
Phase Noise Sensitivity - Standard and Low Noise (Option LN) Internal References

Measurement Time ~10 seconds, after first cross-correlation; further correlations will improve sensitivity by 5 dB for 10, 10 dB for 100, and 15 dB for 1000 correlations performed. The plots show typical performance.

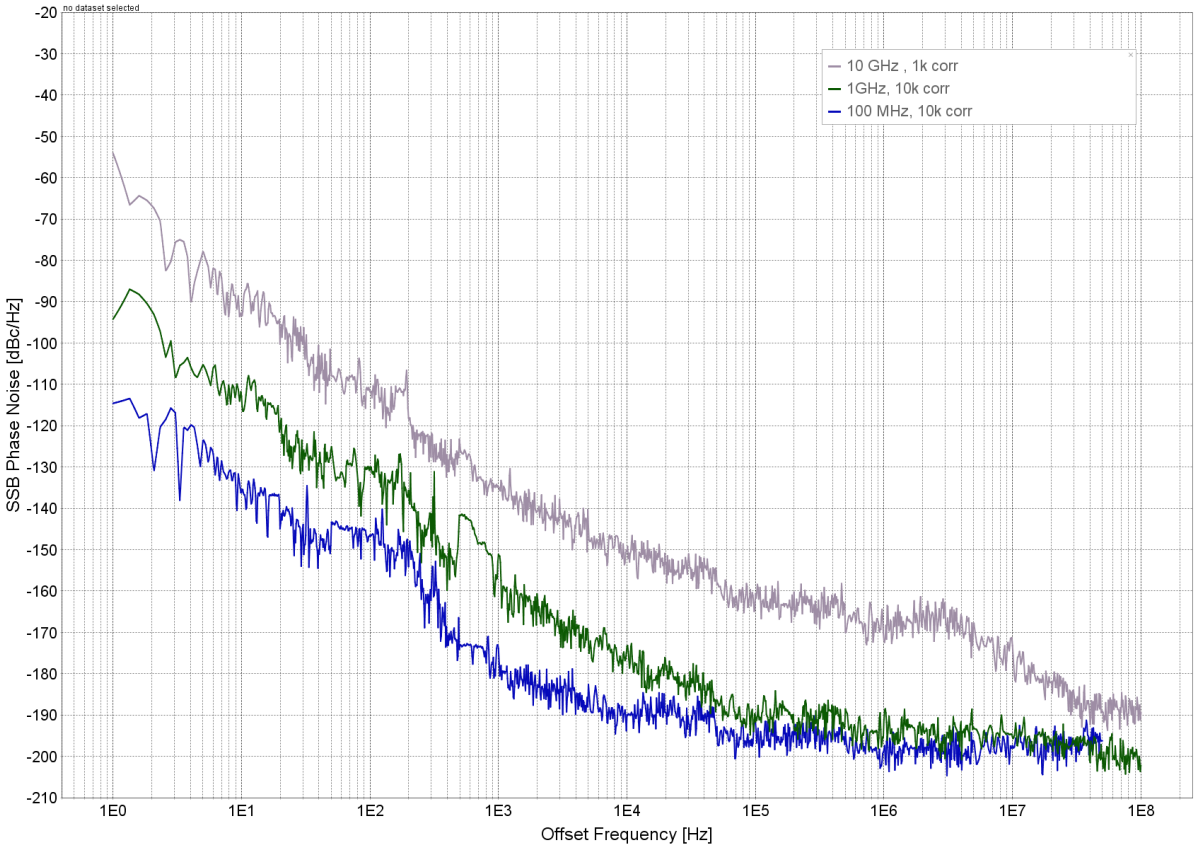
After 1 Correlation



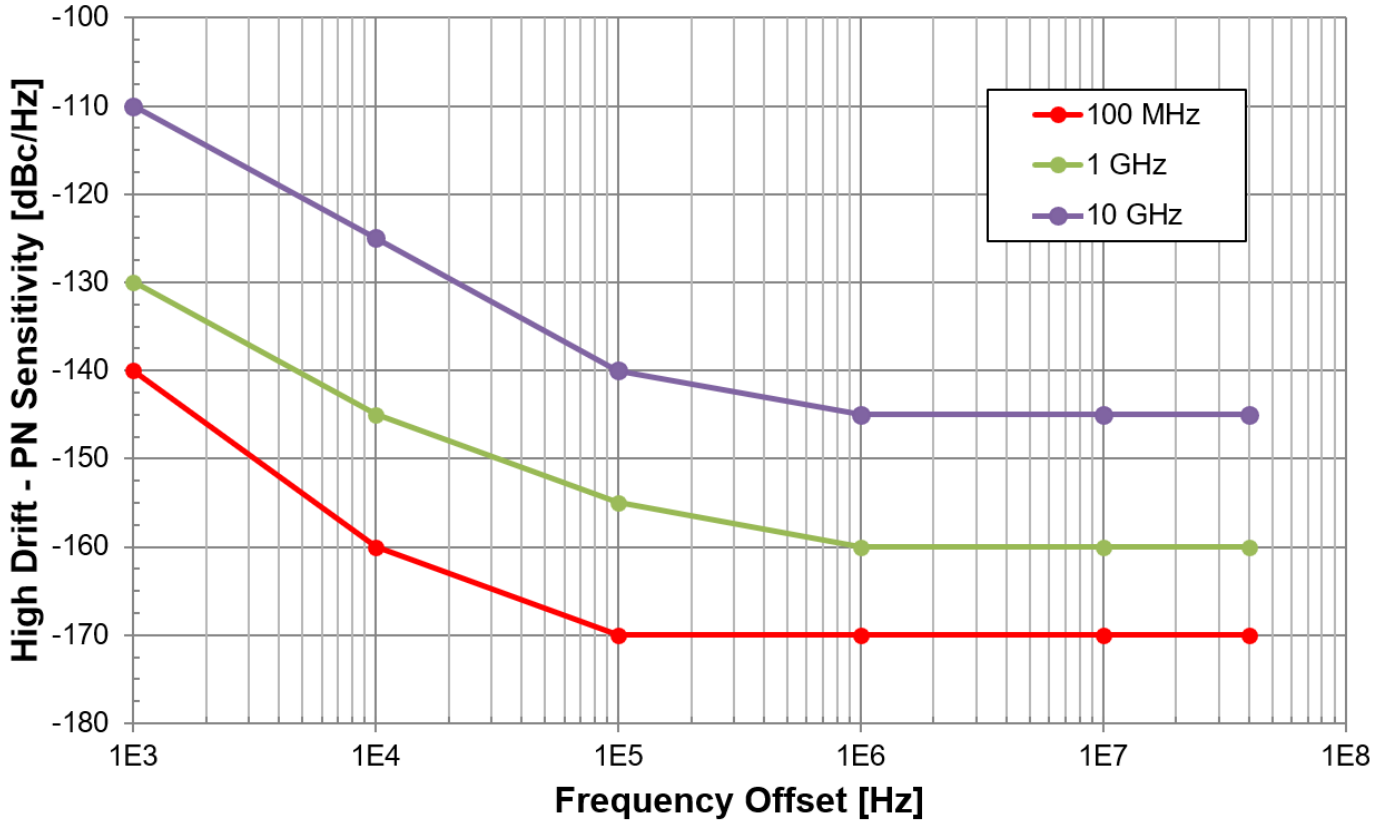
After 100 Correlations



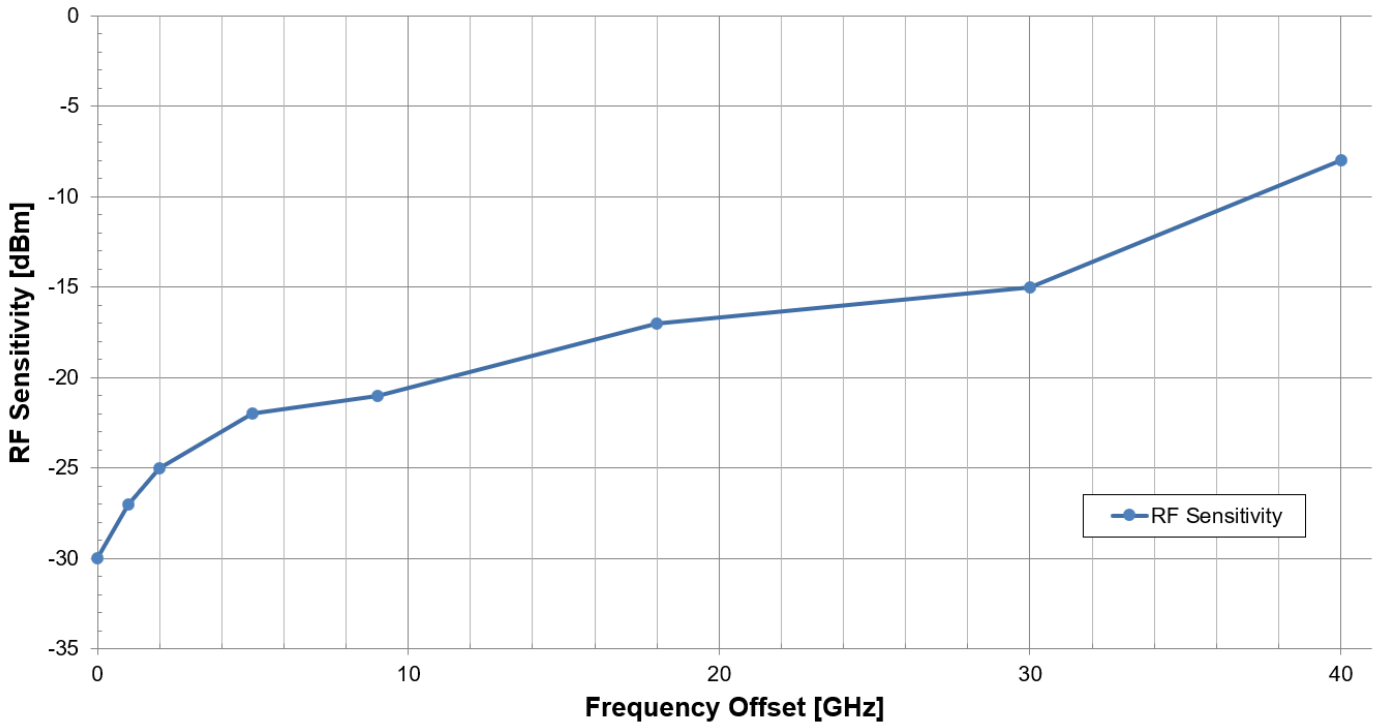
Typical Noisefloor Example (after >1k correlations at 100MHz, 1GHz, 10GHz)



Phase Noise Sensitivity - High Drift



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. The measurement times below are normalized to one correlation for nominal RBW settings per correlation and measurement times > 2 seconds.

	TIME PER CORRELATIONS	DEFAULT NR. OF POINTS (SETTABLE)
0.1 Hz to 100 MHz	80	250 per decade
1 Hz to 100 MHz	8	250 per decade
10 Hz to 100 MHz	0.8	250 per decade
100 Hz to 100 MHz	0.1	250 per decade
1 kHz to 100 MHz	0.01	250 per decade
10 kHz to 100 MHz	< 0.004	250 per decade

Absolute Phase Noise Sensitivity – Internal References (with Option LN)

Abs. PN with internal references (Option LN)	OFFSET						
	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
10 MHz	-115	-140	-155	-165	-172	-175	-175
100 MHz	-95	-120	-135	-160	-172	-178	-178
1 GHz	-75	-100	-115	-140	-155	-160	-160
3 GHz	-65	-90	-105	-130	-145	-150	-155
10 GHz	-55	-80	-95	-120	-135	-140	-145
25 GHz	-45	-70	-85	-110	-130	-135	-140
Remarks	Test conditions: carrier power ≥ 5 dBm; after one correlation						

Absolute Phase Noise Sensitivity – External References

Abs. PN with external references	OFFSET						
	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
10 MHz	-135	-150	-155	-170	-175	-175	-175
100 MHz	-120	-130	-140	-170	-178	-178	-178
1 GHz	-100	-110	-125	-155	-170	-170	-170
3 GHz	-95	-110	-125	-155	-170	-170	-170
10 GHz	-90	-110	-120	-145	-155	-155	-155
25 GHz	-85	-105	-115	-120	-140	-145	-145
Remarks	Test conditions: carrier power ≥ 5 dBm; after one correlation						

Additive Phase Noise Sensitivity – Single Channel

Additive PN (1 channel)	OFFSET						
	1 Hz	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
10 MHz ≤ f ≤ 1 GHz	-130	-140	-150	-160	-170	-170	-170
1 GHz ≤ f ≤ 4 GHz	-130	-140	-150	-160	-170	-170	-170
4 GHz ≤ f ≤ 16 GHz	-115	-125	-135	-145	-150	-155	-160
Remarks	Test conditions: RF carrier power ≥ 10 dBm; REF ≥ 13 dBm Two channel cross-correlation can improve noise floor by 5 dB per 10x correlations.						

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

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.

Time Resolution	16 ns	128 ns	500 ns	1 µs	≥10 µs
Frequency Band	**Frequency Resolution [Hz]**				
5 MHz to 100 MHz	3 k	100	30	15	10
20 MHz to 400 MHz	5 k	700	200	100	20
80 MHz to 1.6 GHz	10 k	1 k	200	100	50
320 MHz to 3 GHz	30 k	1.5 k	300	150	150
1.3 GHz 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

Transient Analysis – Narrowband: Frequency Resolution vs. Time Resolution (residual FM, 80 MHz span, 5% video bandwidth, typical)

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.

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

Transient Analysis – Narrowband: Frequency Resolution vs. Time Resolution (residual FM, 1.25 MHz span, no video bandwidth, typical)

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.

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

Transient Analysis – Narrowband: Frequency Resolution vs. Time Resolution (residual FM, 200 kHz span, no video bandwidth, typical)

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.

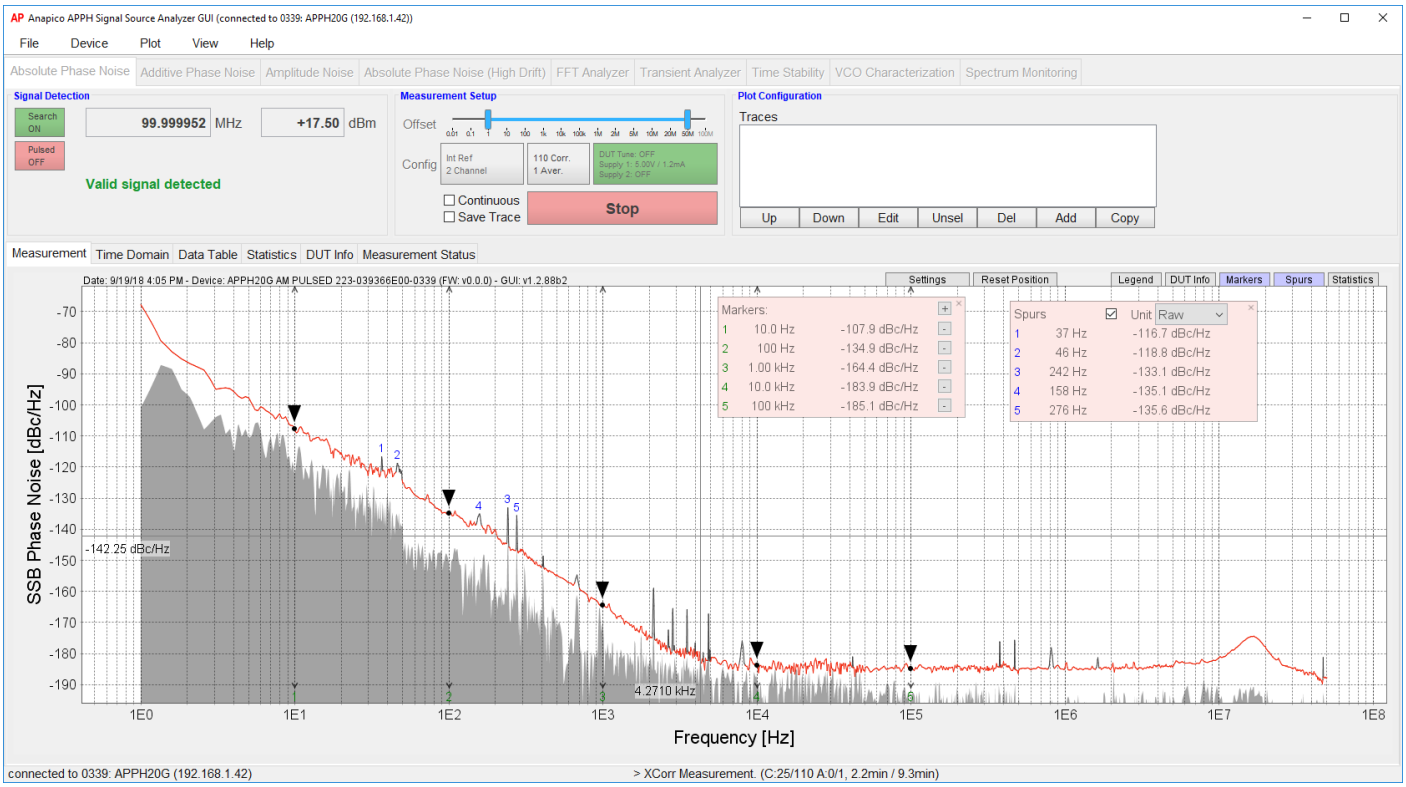
Time Resolution	1 µs	10 µs	>= 20 µs
Frequency Range	**Frequency Resolution [Hz]**		
< 200 MHz	1	0.5	0.3
< 800 MHz	1.5	0.5	0.3
< 2 GHz	3	1	0.4
< 20 GHz	20	10	3
> 20 GHz	50	20	10

Data Processing Capabilities

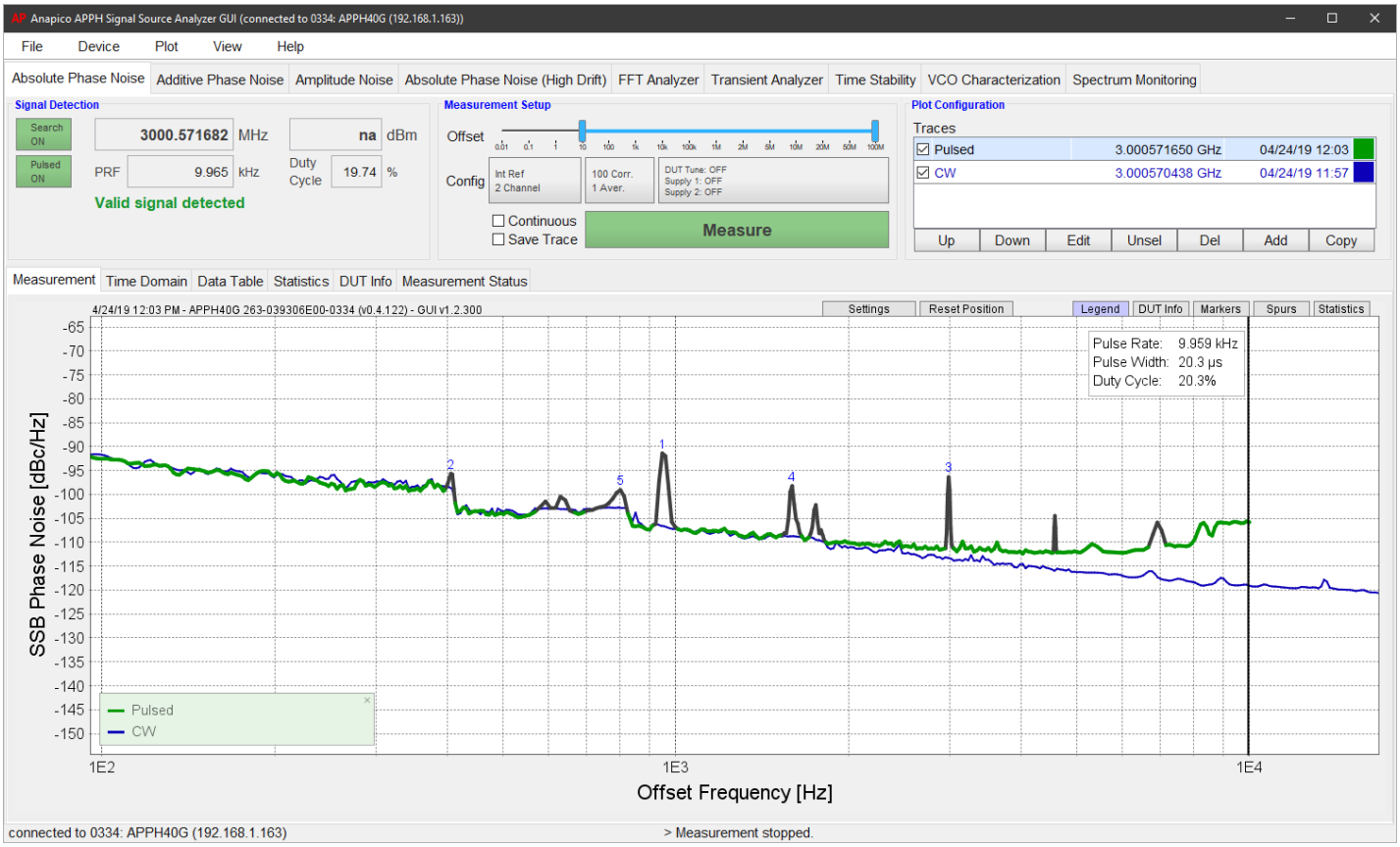
Graphical User Interface: The analyzer employs a graphical user interface based on the Windows operating system.

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)
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

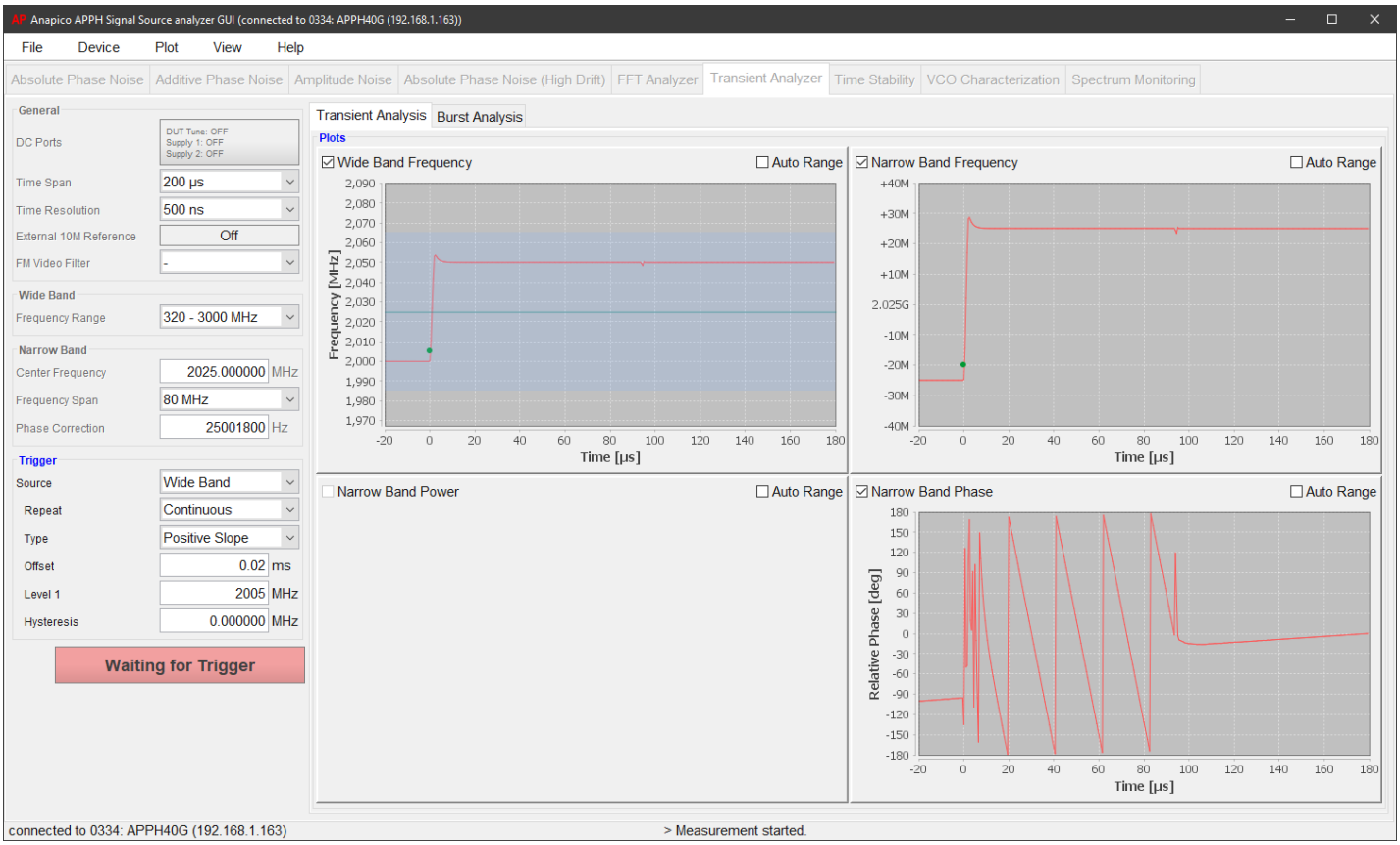
GUI Interface (Absolute Phase Noise)



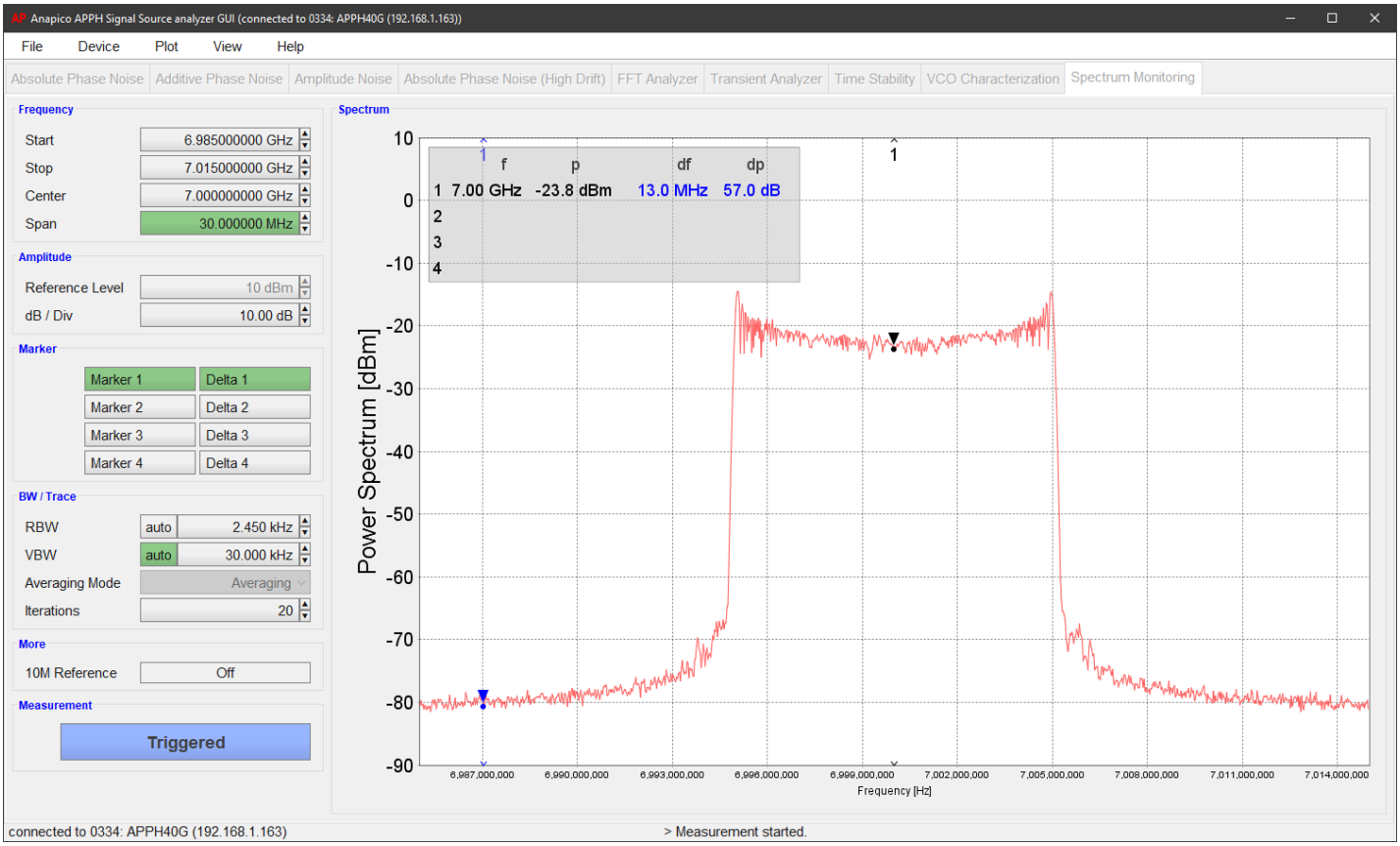
GUI Interface (PULSED RF Absolute Phase Noise)



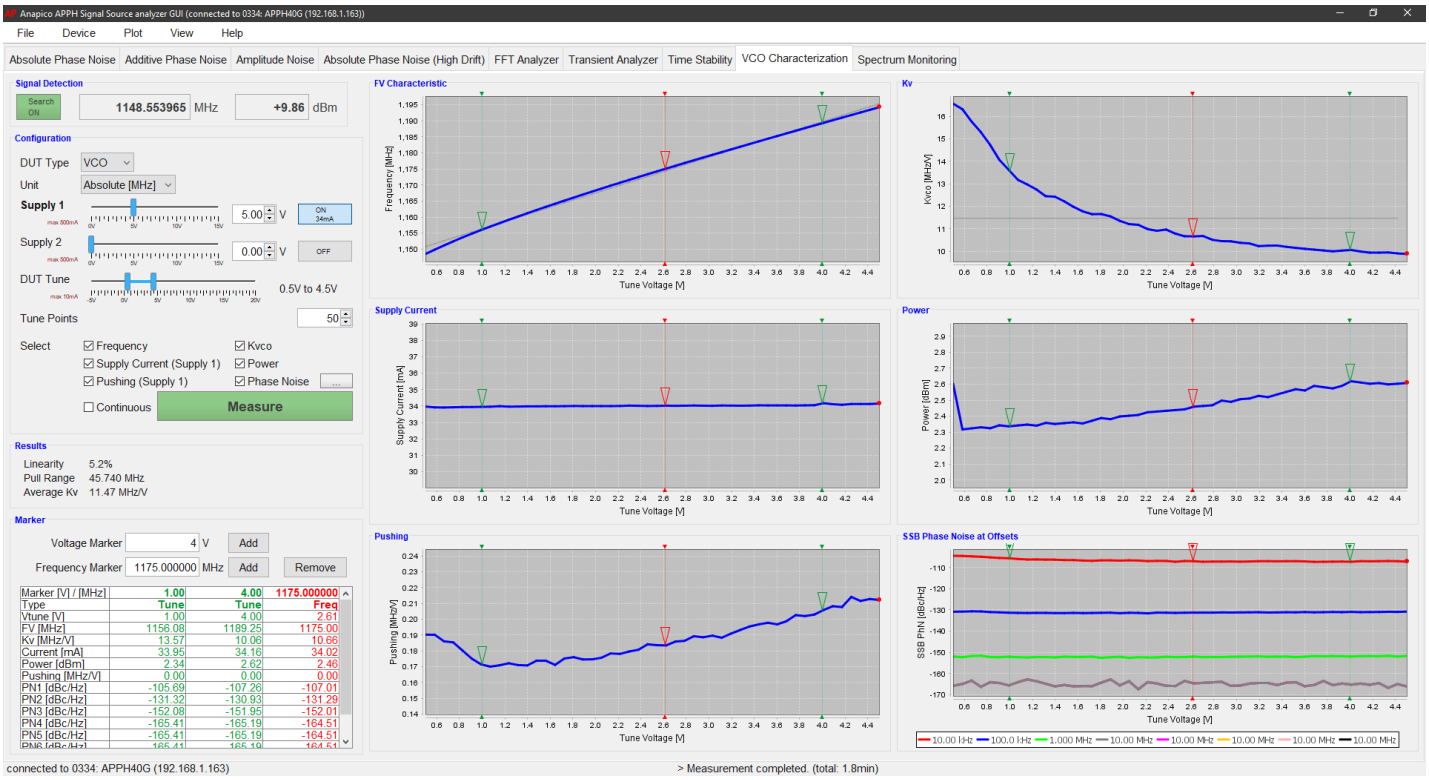
GUI Interface (Transient Analyzer)



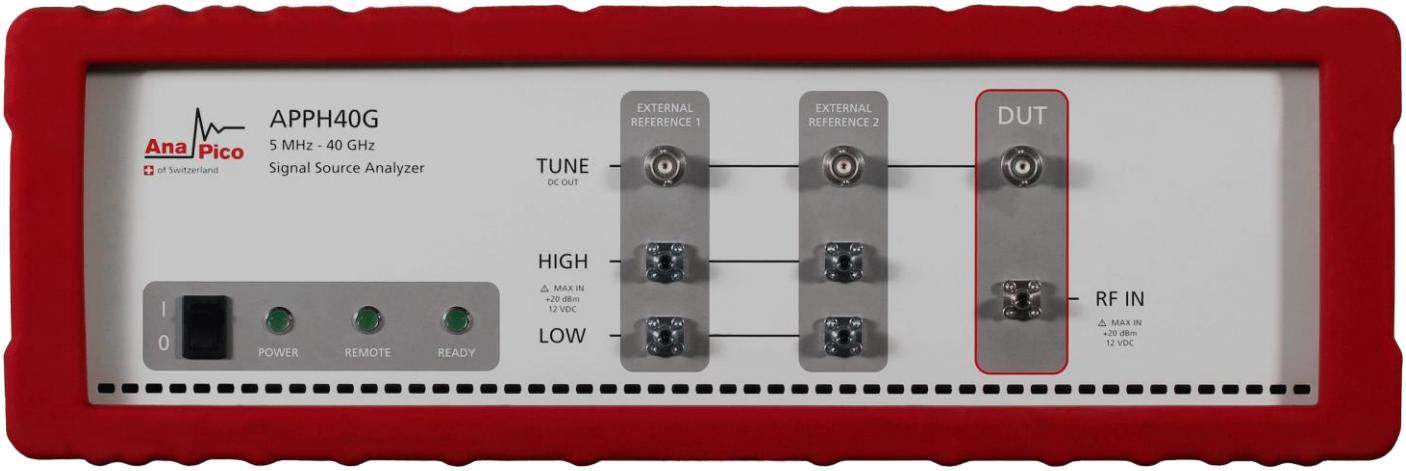
GUI Interface (Spectrum Monitoring)



GUI Interface (VCO Testing)



Connectors (Front)



RF Inputs

RF IN: SMA female (for APPH6040 / APPH20G); K female (for APPH40G)
REF1 IN HIGH/LOW, REF2 IN HIGH/LOW: SMA female

DC Outputs

REF1 TUNE, REF2 TUNE: BNC female

Operation

Switch I/0: DC Power Switch
POWER, READY, REMOTE: Status LED

Connectors (Rear)

HF/VHF/AUX Inputs

BASEBAND CH1, BASEBAND CH2: BNC female
REF IN 10 MHz: BNC female
EXT TRIG: BNC female

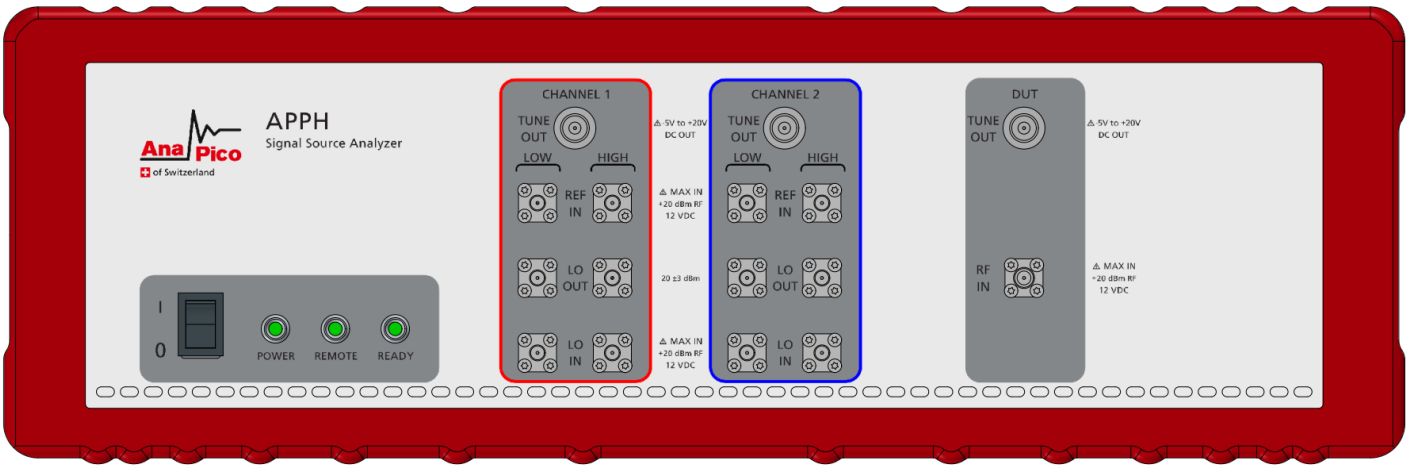
DC Outputs

DC SUPPLY CH1, DC SUPPLY CH2: BNC female

Operation

LAN: RJ-45
USB B: USB 2.0 device
DC 24V: DC Power Plug (24V, 2A)
GPIB (Option GPIB): IEEE-488 GPIB Connector

Connectors (Front – Option LO)



Additional RF Inputs

LO1 IN HIGH/LOW, LO2 IN HIGH/LOW: SMA female

Additional RF Outputs

LO1 OUT HIGH/LOW, LO2 OUT HIGH/LOW: SMA female

ORDERING INFORMATION

HOST MODEL	PRODUCT	DESCRIPTION
APPH	**APPH6040**	7 GHz Signal Source Analyzer
APPH	**APPH20G**	26 GHz Signal Source Analyzer
APPH	**APPH40G**	40 GHz Signal Source Analyzer
APPH	**Option LN**	Ultra-low noise internal sources
APPH	**Option PULSE**	Pulsed signal measurement
APPH	**Option BURST**	Burst mode phase noise measurement
APPH	**Option AM**	Amplitude noise measurement
APPH	**Option APN**	Additive phase noise measurement
APPH	**Option LO**	Access to internal reference for residual phase noise measurement (requires option APN)
APPH	**Option TRAN**	Transient analysis
APPH	**Option TSTAB**	Time stability analysis
APPH	**Option VCO**	VCO characterization
APPH	**Option SPEC**	Spectrum monitoring
APPH	**Option GPIB**	GPIB interface

GENERAL CHARACTERISTICS

Remote programming interfaces:
Ethernet 100BaseT LAN interface
USB 2.0 device
GPIB (IEEE-488.2,1987) with listen and talk (Option GPIB)
Control Language SCPI Version 1999.0

Power requirements: 24V ± 3.0 VDC; 70 W maximum

Mains adapter supplied: 100-240 VAC in/ 24 V 4.0 A DC out

Environmental: Levels similar to MIL-PRF-28800F Class 3/4

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

Weight: ≤ 10.0 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° in 30° steps

Document History

Version	Date	Author	Notes
V101	2017-01-20	JK	first release
V102	2017-02-20	JK	update
V111	2017-05-14	JK	updated frequency ranges, added plots
V112	2017-05-25	JK	completed RF sensitivity spec
V114	2017-06-19	JK	residual noise floor data refined
V115	2017-06-29	JK	phase noise sensitivity data added
V116	2017-07-29	JK	measurement times refined
V117	2017-08-09	JK	spectrum monitoring noise floors
V118	2018-03-20	JK	new screen shots
V121	2018-04-20	JK	reduced min RF frequency to 1 MHz; introduced additional product options
V122	2019-03-13	SD	new layout
V123	2019-05-08	SD	Added option LO

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