APPH6040B / APPH20G-B Specification V2.0

(July 2014, Serial XXX-XX33XXXXX-XXXX or higher)

A fully integrated high-performance cross-correlation signal source analyzer for 5 MHz to 7 or 26 GHz

Introduction

The APPH20G 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 VCOs, DROs, and others.
The flexible instrument comprises a two-channel cross-correlation system with two internal tunable references sources and allows also measurements with external references.

The APPH provides a complete set of measurement such as

- ❖ absolute and additive phase noise measurements,
- ❖ direct access to the two channel 50 MHz FFT analyzer,
- ❖ transient measurements (frequency vs time, modulation domain analyzer)
- ❖ oscillator test bench (tuning, pushing, phase noise, current, power,..)
- ❖ spectrum monitoring
- ❖ or frequency counter function / power meter

Using proven cross-correlation measurement procedures and self-calibration routines, reproducible, and accurate measurements are obtained even under changing environmental conditions. Fully automated frequency acquisition and self-calibration greatly simplify use and applicability of the instrument, resulting in much faster measurement throughput and greater ease-of-use in actual operation.

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.

Application   supported:

- ✓ Additive or absolute phase noise measurement
- ✓ Measure frequency droop on individual channels in frequency hopping systems
- ✓ Analyze chirp radar performance
- ✓ Calibrate frequency sweep signals.
- ✓ Calibrate intentional modulation (FM or FSK)
- ✓ Analyze PLL's and Frequency locked-loops
- ✓ Measure frequency settling times of VCO's
- ✓ Characterize start-up/warm-up of oscillators
- ✓ Spectrum and noise monitoring
- ✓ VCO characterization (tuning, supply pushing, power, current...)
- ✓ 50 MHz bandwidth FFT analyzer mode

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 26 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]			
APPH20G RF Frequency Range	5 MHz		26 GHz	using internal references
	5 MHz		15 GHz	using external references
APPH6040 RF Frequency Range	5 MHz		7 GHz	using internal references
	5 MHz		7 GHz	using external references
Input Power Range				+26 dBm is damage level
	-10 dBm		+20 dBm	< 20000 MHz
		+5 dBm	+23 dBm	>20000 MHz
Input impedance VSWR		50 Ω 2		AC coupled, 10V DC max
Offset Analysis Range	0.1 Hz		50 MHz	for RF > 70 MHz
			20 MHz	for RF < 70 MHz
			5 MHz	RF < 25 MHz
Measurement Accuracy		±4 dB		< 10 Hz offset
		±3 dB		< 1 kHz offset
		±2 dB		> 1 kHz
System Phase Noise Floor 1 Hz		-140 dBc/Hz		
10 Hz		-150 dBc/Hz		
100 Hz		-160 dBc/Hz		(cross-correlation, external references)
1 kHz		-175 dBc/Hz		
10 kHz		-180 dBc/Hz		
10 MHz		-180 dBc/Hz		
Phase Noise Sensitivity	See plot for sensitivity of internal sources			
Measurement time				See Table "Measurement Time"
Internal References				Cross-correlation
Frequency Range	5 MHz		26 GHz	APPH20G
	5 MHz		7 GHz	APPH6040
Phase Noise Sensitivity				See Plots "Sensitivity"
RF Tracking Range		±2 / 15 / 200 ppm / s		PLL Mode

Parameter	Min.	Typ.	Max.	Note
External References				One or Cross-correlation
Frequency Range	5 MHz		15 GHz 7 GHz	APPH20G APPH6040
Reference Level Range	+13 dBm	+15 dBm	+ 23 dBm	
Tuning Voltage Range	0 V		+20 V	adjustable
Output current			10 mA	

Additive Phase Noise Measurement 5 MHz to 15 GHz

Parameter	Min.	Typ.	Max.	Note
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		15 GHz 7 GHz	APPH20G APPH6040
Input Power Range (RF port) **(REF ports)**	3 dBm 13 dBm		+23 dBm +23 dBm	
Offset Analysis Range	0.1 Hz 0.1 Hz 0.1 Hz		50 MHz 20 MHz 5 MHz	0.01 Hz via SCPI control for RF < 70 MHz RF < 25 MHz
Measurement Accuracy		±3 dB ±3 dB ±2 dB		< 10 Hz offset < 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 -185 dBc/Hz -185 dBc/Hz		(cross-correlation engine)

Transient Measurements

Parameter	Min.	Typ.	Max.	Note
Measurement parameters	Frequency, Phase (narrowband)			
Frequency range	5 MHz 500 MHz 1 GHz 2 GHz		2.5 GHz 6 GHz 12 GHz 20 GHz	4 bands
Measurement bandwidth				See table
Frequency resolution				See table
Phase resolution		tbd		
Measurement time	50 us		10 s	
Time resolution	16 ns		500 ms	
Trigger mode		Free-run, Internal, external		

Parameter	Min.	Typ.	Max.	Note
Spectrum Monitoring				
Measurement parameters	dBm, dBm/Hz, dBc/Hz			
Frequency range	5 MHz		20 GHz	
Monitoring bandwidth	1 kHz		20 MHz	
Resolution bandwidth (RBW)	1.8 Hz		1 MHz	
Absolute measurement uncertainty		± 2 dB		Pin = 0 dBm
Relative measurement uncertainty		± 1.5 dB		
Residual noise floor		tbd		RBW =
Trigger mode		Free-run, Internal		

Parameter	Min.	Typ.	Max.	Note
FFT Analyzer				
Input Connectors	2 BNC female (rear panel), AC coupled			
Measurement parameters	dBV/Hz, dBm/Hz, nV/√Hz			
DC Voltage Range Input Impedance	-12 V	1 kΩ	+ 12 V	DC
AC Voltage Range			+ 10 dBm	
Frequency Range	1 Hz		50 MHz	
Input Noise Density		< 1 nV/√Hz		10 kHz offset

Parameter	Min.	Typ.	Max.	Note
VCO Characterization				
Measurement parameters	Frequency (Hz), Tuning sensitivity ($\Delta f / \Delta Vc$) (Hz/V), Frequency Pushing (Hz/V), RF power level [dBm], DC supply current [mA]			
Sweep parameters DC Supply Voltage Tuning Voltage	0 to 15 V / max 500 mA 0 to 20 V / max 20 mA			adjustable
RF frequency uncertainty	5 MHz	0.5 ppm	26 GHz	
RF Power (up to 13 GHz) Uncertainty	-10 dBm	1 dB	20 dBm	
DC current measurement range uncertainty	0	1%	500 mA	
Output settling time		20 ms		

Trigger		Start, Software		

Frequency Counter

Measurement parameters		Frequency [Hz]		
Frequency Range	5 MHz		26 GHz	
Absolute Accuracy		300 ppb		
Sensitivity		-10 dBm		See typical sensitivity plot

Power Detector

Measurement parameters		Power mW ,dBm		
Frequency Range	5 MHz		13 GHz	
Accuracy		< 2 dB		
Power Range	-10 dBm		+23 dBm	

Dual Power Supply (option SUPPLY)

| DC Voltage Range	0		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		500 mA	Per channel
Uncertainty		< 100 uA		

Performance Data Plots

Phase Noise Sensitivity (dBc /Hz)

Measurement time ~25 seconds, after first cross-correlation; further correlations will improve sensitivity by 5 dB by for 10, 10 dB for 100, and 15 dB for 1000 respective correlations performed.
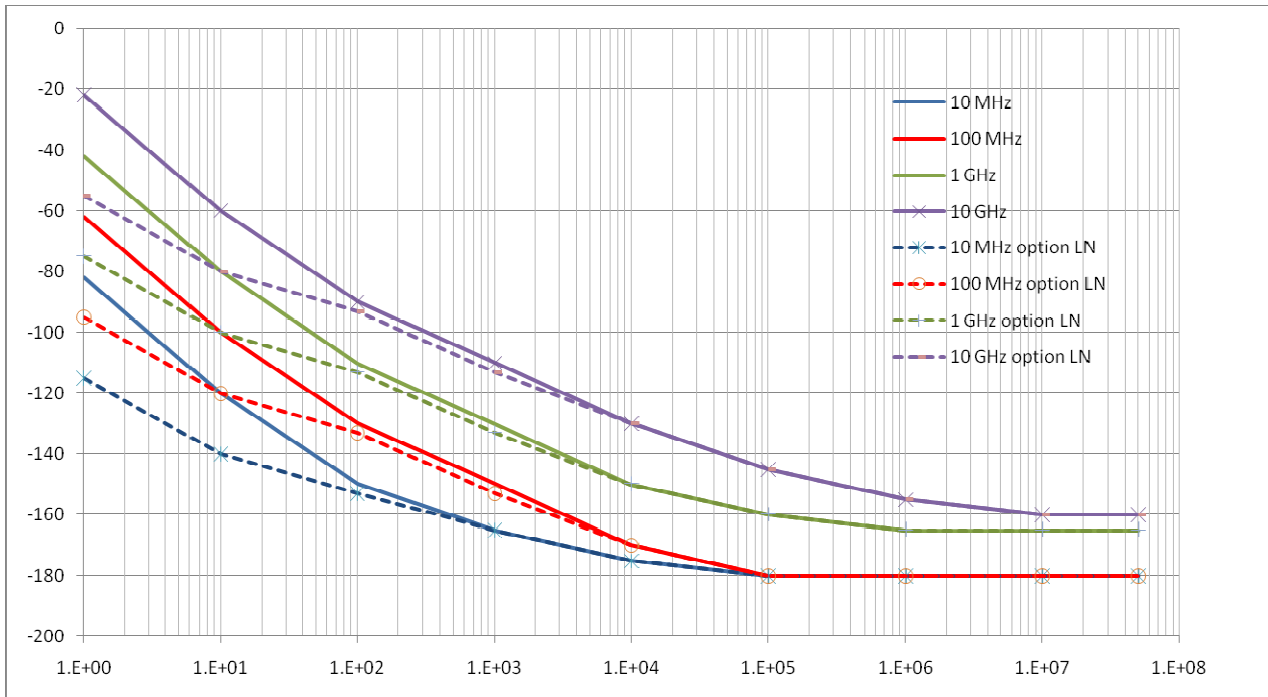
Phase Noise typical RF Sensitivity (dBm)
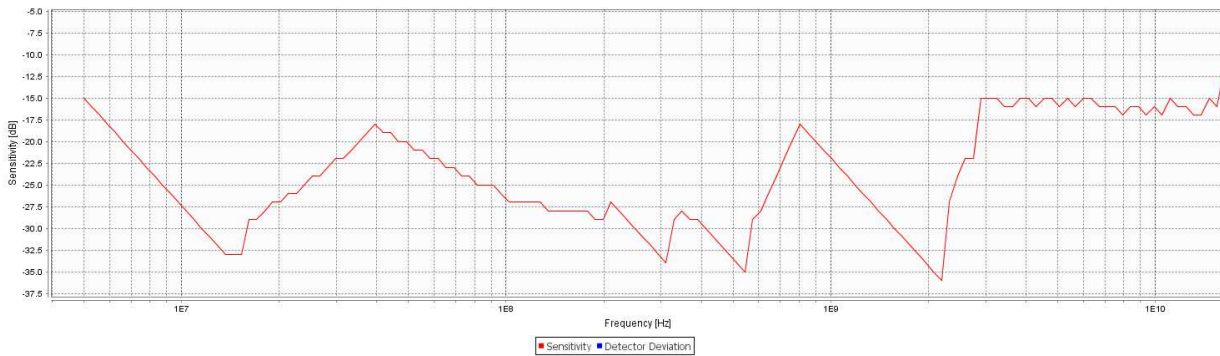
Phase Noise Measurement Time

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

	Typical setup time (sec)	Time per average (sec)	Nr. of points
0.1 Hz to 50 MHz	2	80	~ 1800
1 Hz to 50 MHz	2	10	~ 1700
10 Hz to 50 MHz	2	1.5	~ 1500
100 Hz to 50 MHz	2	0.5	~ 1300
1 kHz to 50 MHz	<2	0.2	~ 1050
10 kHz to 50 MHz	<2	<0.1	~ 800

Transient Measurement Time Resolution vs Frequency Resolution (wideband)

Time resolution \ Frequency Bands	16 ns	256ns	1us	4us	33us	1ms
5 MHz to 2.5 GHz	500 kHz					200 Hz
1000 MHz to 2.5 GHz	100 kHz					
500 MHz to 6 GHz						
1 to 12 GHz						
2 to 20 GHz						

Transient Measurement Time Resolution vs Frequency Resolution (narrowband)

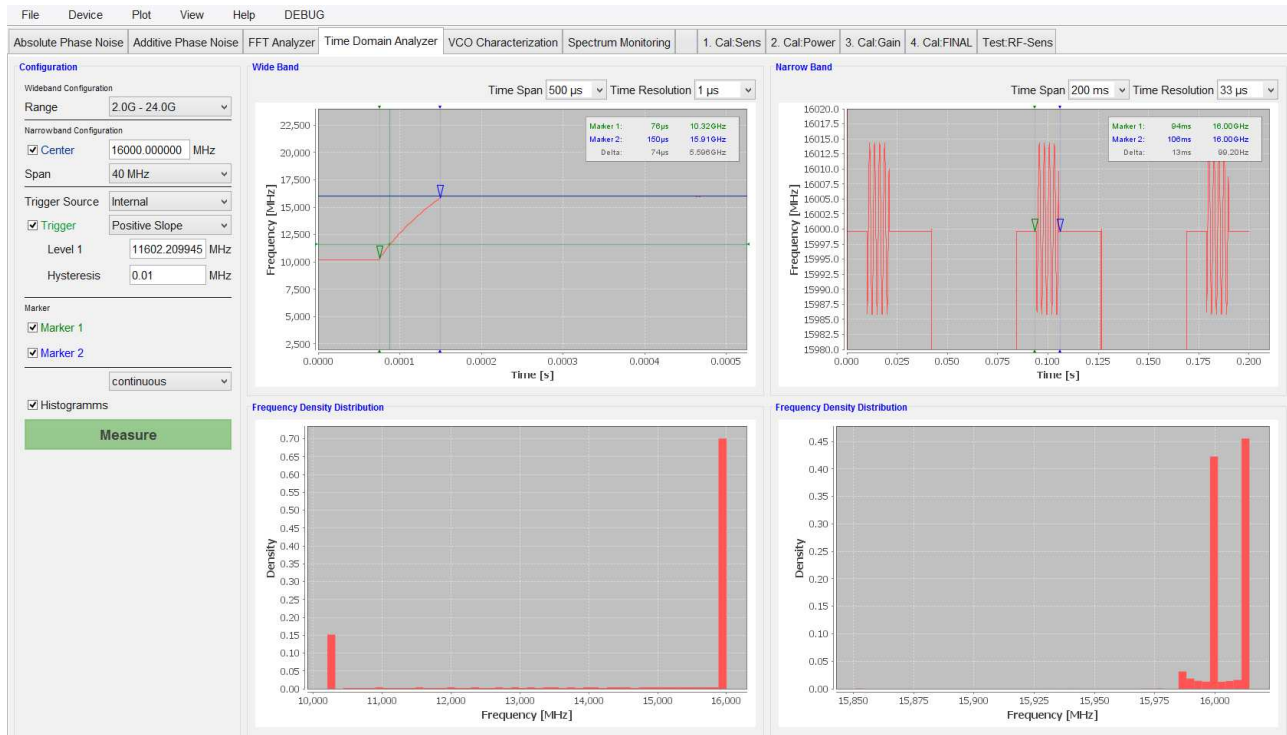| Time resolution \ Span	16 ns	256ns	1us	4us	33us	1ms
10 kHz						50 Hz

Data Processing Capabilities

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

GUI Interface (Absolute Phase Noise)

| **Display Functions**	Phase Noise, Time Domain, Data Table, Residual, Statistics

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

Marker Functions	16 independent markers

GUI Interface (Transient)

GUI Interface (VCO Characterization)
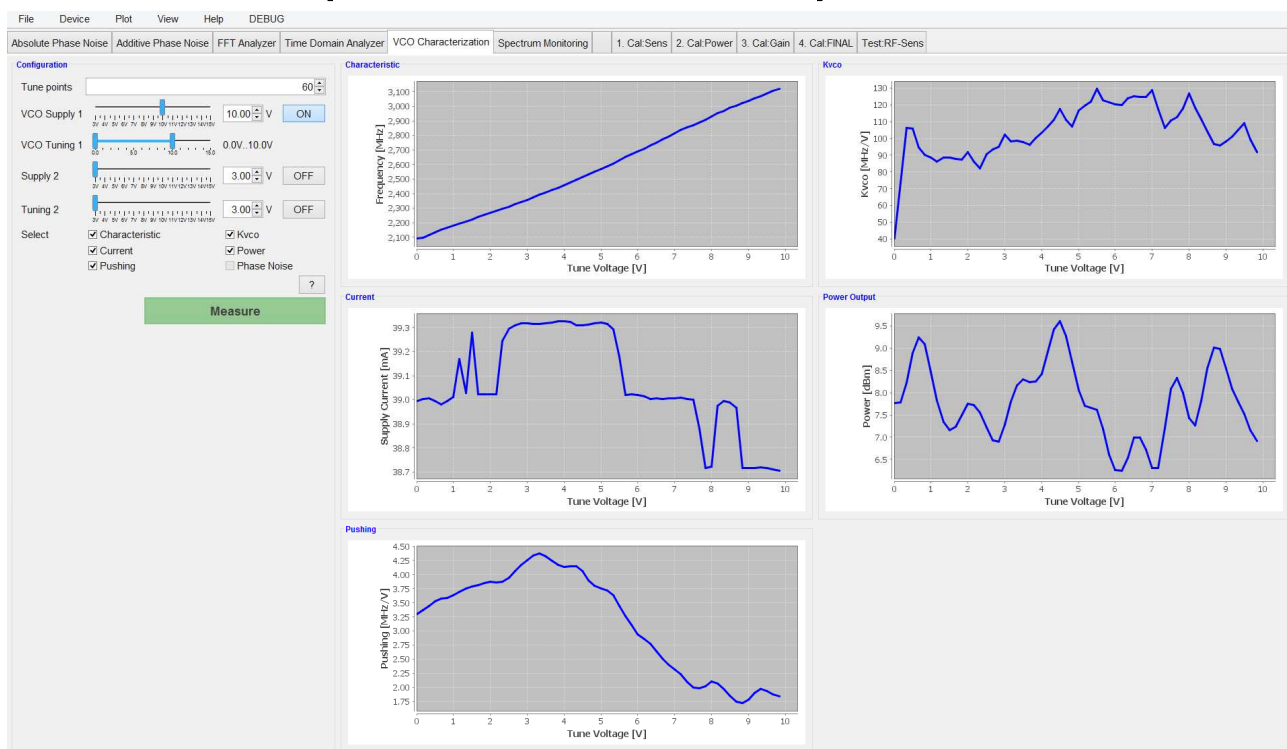
GUI Interface (Spectrum Monitoring)
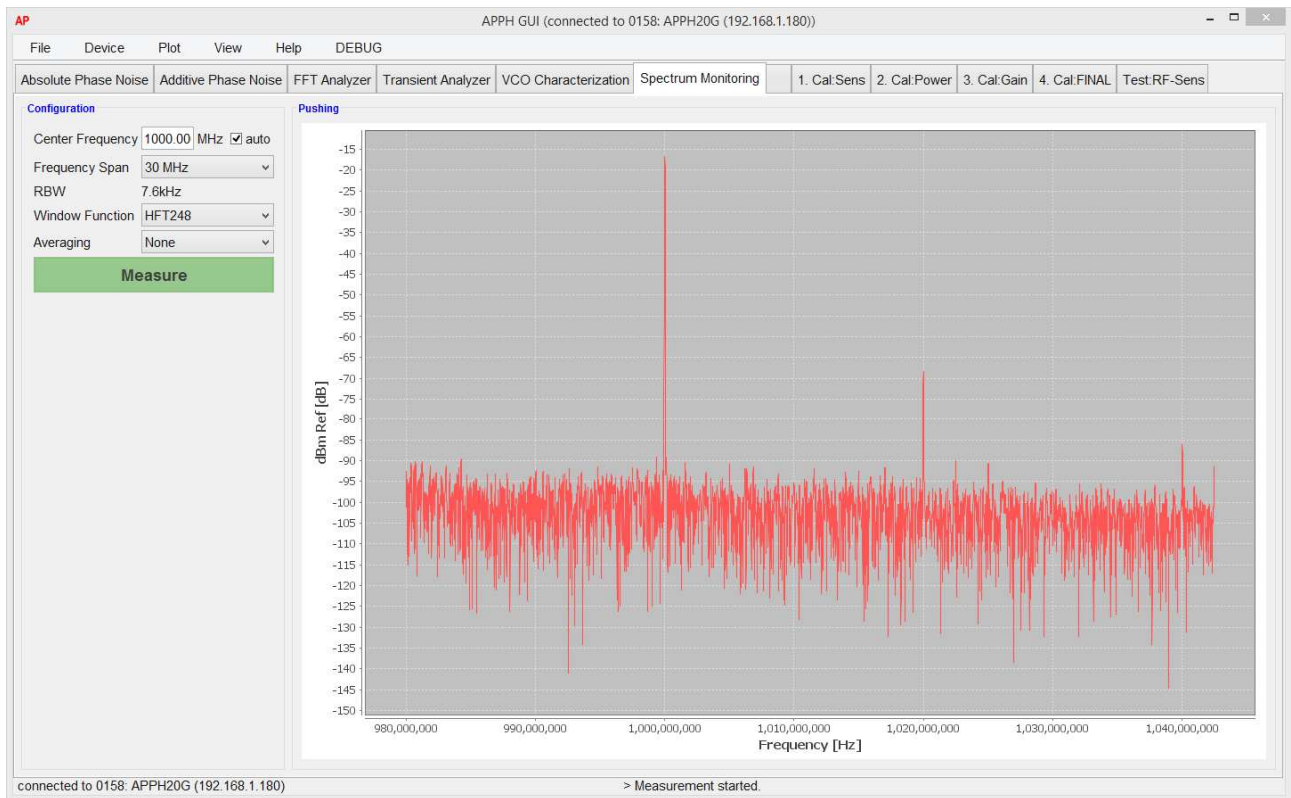
Connectors

1. RF inputs: , RF IN, REFIN1, REFIN2, REFOUT1, REFOUT2 : 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 (option SUPPLY only)
3. LAN connection: RJ-45
4. USB 2.0 host and device
5. DC Power plug (24V, 2A)
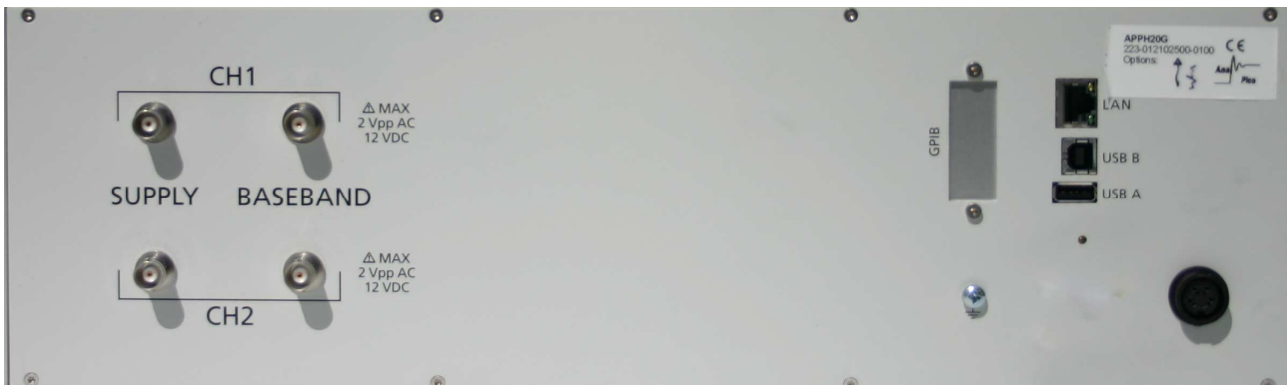
General Characteristics

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 45 °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 ≤   4 kg (9 lbs) net
Dimensions

Options

- *GPIB*: *IEEE-488.2,1987 programming interface*
- *SUPPLY: dual programmable low noise supply*
- *LN: ultra low close to carrier phase noise*

Document History

Version/Status	Date	Author	Notes
V10	2012-10-30	jk	first release
V11	2012-12-27	jk	Modified frequency range, added transient measurement info
V11	2013-3-10	jk	Refined FFT analyzer specs
V12	2013-5-10	jk	GUI
V121	2013-6-10	jk	Additive Phase Noise
V122	2013-7-30	jk	Frequency counter and power detector specs
V123	2014-2-1	jk	Supply option added
V20	2014-7-20	jk	Version B