


# DATASHEET APPH Specification v1.24

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  $23 \pm 5$  °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   |
|--|--|--------------------------------|--|--|
| <b>RF Frequency Range</b>  | <i>FMIN</i><br>1 MHz<br>1 MHz<br>1 MHz |                                | <i>FMAX</i><br>7 GHz<br>26 GHz<br>42 GHz | Using internal references<br>APPH6040<br>APPH20G<br>APPH40G  |
| <b>RF Frequency Range</b>  | 5 MHz<br>5 MHz                         |                                | 7 GHz<br>18 GHz                          | Using external references<br>APPH6040<br>APPH20G / APPH40G   |
| <b>Input Power Range</b><br><18 GHz<br>18 GHz to 30 GHz<br>> 30 GHz  | -15 dBm<br>-15 dBm<br>-5 dBm           |                                | +20 dBm<br>+23 dBm<br>+23 dBm            | Damage level +26 dBm<br><br><i>See RF sensitivity plots</i>  |
| <b>Input Impedance</b><br>VSWR                                       |  | 50 Ω<br>2                      |  | AC coupled, 10 V DC max  |
| <b>Offset Analysis Range</b>   | 0.01 Hz<br>0.01 Hz                     |                                | 100 MHz<br>> 25% of $f_c$                | $f_c > 150$ MHz<br>$f_c < 150$ MHz   |
| <b>Resolution (PPD)</b>  | 200                                    | 200                            | 1600                                     | RBW adjustable (x1/x2/x4/x8),<br>PPD (points per decade) can<br>be lower for lowest decade of<br>measurement |
| <b>Measurement Accuracy</b>  |  | ±4 dB<br>±3 dB<br>±2 dB        |  | Offset < 10 Hz<br>Offset 10 Hz to 1 kHz<br>Offset 1 kHz to 100 MHz   |
| <b>Phase Noise Sensitivity</b>                                       |  |                                |  | <i>See plot &amp; sensitivity tables</i>   |
| <b>Spurious Levels</b><br>Internal References<br>External References |  | -90 dBc<br>-85 dBc             |  |  |
| <b>Measurement Time</b>  |  |                                |  | <i>See table "Measurement Time"</i>  |
| <b>Trigger</b>   |  |                                |  | Single, continuous, manual,<br>bus   |
| <b>Internal References</b>   |  |                                |  | Cross-correlation  |
| Frequency Range  | 1 MHz                                  |                                | <i>FMAX</i>                              |  |
| Phase Noise Sensitivity  |  |                                |  | <i>See plots "Sensitivity"</i>   |
| RF Tracking Range  |  | ±1 ppm<br>±10 ppm<br>±1000 ppm |  | Option LN<br>Standard<br>High drift mode   |
| <b>External References</b>   |  |                                |  | Single channel / cross-corr.   |

|   |                    |                    |                    |  |
|---|--------------------|--------------------|--------------------|--|
| Frequency Range                                       | 5 MHz<br>5 MHz     |                    | 7 GHz<br>18 GHz    | APPH6040<br>APPH20G / APPH40G          |
| RF Input Power Range<br>< 1.3 GHz<br>> 1.3 GHz        | 0 dBm<br>0 dBm     |                    | +23 dBm<br>+23 dBm | Damage level +26 dBm                   |
| Phase Noise Sensitivity                               |                    |                    |                    | See plot & sensitivity tables          |
| Reference Input Level Range<br>< 1.3 GHz<br>> 1.3 GHz | +10 dBm<br>+13 dBm | +15 dBm<br>+15 dBm | +21 dBm<br>+21 dBm | Lower input ports<br>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<br>30 MHz |                         | 7 GHz<br>26 GHz<br>42 GHz | APPH6040<br>APPH20G<br>APPH40G                                     |
| RF Input Power Range  | +5 dBm           |                         | +20 dBm                   | No power measurement   |
| Input Parameters      |                  |                         |                           |  |
| Pulse Rate (PRF)      | 200 Hz           |                         | 2 MHz                     | TBD  |
| Pulse Width           | 200 ns           |                         | 2 ms                      |  |
| Duty Cycle            | 0.2%             |                         | 60%                       |  |
| Offset Analysis Range | 0.01 Hz          |                         | PRF                       |  |
| Measurement Accuracy  |                  | ±4 dB<br>±3 dB<br>±2 dB |                           | Offset < 10 Hz<br>Offset 10 Hz to 1 kHz<br>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<br>10 MHz |                | 7 GHz<br>18 GHz | APPH6040<br>APPH20G / APPH40G    |
| RF Input Power Range  |                  |                |                 |                                  |
| RF Port               | +3 dBm           |                | +23 dBm         |                                  |
| REF Ports             | +13 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<br>±2 dB |                 | Offset < 1 kHz<br>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  |
|--------------------------------|------------|---------|---------|---|
| <b>RF Frequency Bands (WB)</b> | 5 MHz      |         | 100 MHz | Band 1  |
|                                | 20 MHz     |         | 400 MHz | Band 2  |
|                                | 80 MHz     |         | 1.6 GHz | Band 3  |
|                                | 320 MHz    |         | 3 GHz   | Band 4  |
|                                | 1.3 GHz    |         | 26 GHz  | Band 5  |
|                                | 5.2 GHz    |         | FMAX    | Band 6  |
| <b>Measurement Spans</b>       |            |         |         |   |
| Wideband Mode (WB)             |            |         |         | Bands 1-6   |
| Narrowband Mode (NB)           | 200 kHz    |         | 80 MHz  | 200 kHz, 1.25 MHz, 80 MHz                                     |
| <b>Frequency Resolution</b>    |            |         |         | See table   |
| <b>Time Span</b>               | 10 $\mu$ s |         | 1 min   |   |
| <b>Time Resolution</b>         | 16 ns      |         | 50 ms   |   |
| <b>Trigger Mode</b>            |            |         |         | 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                      |
|--------------------------------|------------|-------------|--------|---------------------------|
| <b>RF Frequency Range</b>      | 5 MHz      |             | FMAX   |                           |
| <b>Offset Analysis Range</b>   | 1 / T      |             | 30 MHz |                           |
| <b>Time Span (T)</b>           | 10 $\mu$ s |             | 1 min  |                           |
| <b>Phase Noise Sensitivity</b> |            |             |        | Single Channel, f = 1 GHz |
| 1 kHz                          |            | -120 dBc/Hz |        |                           |
| 10 kHz                         |            | -128 dBc/Hz |        |                           |
| 100 kHz                        |            | -131 dBc/Hz |        |                           |
| 1 MHz                          |            | -131 dBc/Hz |        |                           |
| 10 MHz                         |            | -147 dBc/Hz |        |                           |

### Absolute Amplitude Noise Measurement (Option AM)

Measurement parameters:

SSB Amplitude Noise [dBc/Hz]

| PARAMETER                   | MIN     | TYPICAL | MAX                       | NOTE                           |
|-----------------------------|---------|---------|---------------------------|--------------------------------|
| <b>RF Frequency Range</b>   | 5 MHz   |         | 7 GHz<br>26 GHz<br>40 GHz | APPH6040<br>APPH20G<br>APPH40G |
| <b>RF Input Power Range</b> |         |         |                           |                                |
| 5 MHz to 10 GHz             | -20 dBm |         | +20 dBm                   |                                |
| 10 GHz to 40 GHz            | -10 dBm |         | +20 dBm                   |                                |

|                                       |        |             |        |   |
|---------------------------------------|--------|-------------|--------|---|
| <b>Offset Analysis Range</b>          | 0.1 Hz |             | 40 MHz |   |
| <b>Measurement Uncertainty</b>        |        | ±2 dB       |        |   |
| <b>AM Noise Sensitivity (1 corr.)</b> |        |             |        | 1 GHz, P <sub>in</sub> = -10 dBm to +20 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 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                            |
|--|-------|-----------|---------|---------------------------------|
| <b>Frequency Input Range</b>               | 1 Hz  |           | 100 MHz |                                 |
| <b>DC Voltage Input Range</b>              | -12 V |           | +12 V   |                                 |
| Input Impedance                            |       | 1 kΩ      |         | DC                              |
| <b>AC Voltage Range</b>                    |       |           | +10 dBm |                                 |
| <b>Input Noise Density (1 correlation)</b> |       |           |         |                                 |
| 10 kHz                                     |       | < 1nV/√Hz |         |                                 |
| <b>Trigger</b>                             |       |           |         | Single, Continuous, Manual, Bus |

## Time Stability Measurement (Option TSTAB)

Measurement parameters:

ADEV (no dead time)

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

## Spectrum Monitoring (Option SPEC)

Measurement parameters:

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

| PARAMETER                      | MIN    | TYPICAL    | MAX    | NOTE                        |
|--------------------------------|--------|------------|--------|-----------------------------|
| <b>RF Frequency Range</b>      | 5 MHz  |            | 7 GHz  | APPH6040                    |
|                                | 5 MHz  |            | 26 GHz | APPH20G                     |
|                                | 5 MHz  |            | 42 GHz | APPH40G                     |
| <b>RBW</b>                     | 5.8 Hz |            | 58 kHz |                             |
| <b>Measurement Uncertainty</b> |        |            |        |                             |
| Absolute                       |        | ±3 dB      |        |                             |
| Relative                       |        | ±1 dB      |        |                             |
| <b>Noise Floor</b>             |        |            |        |                             |
| 10 MHz to 4 GHz                |        | -95 dBm/Hz |        |                             |
| 4 GHz to 18 GHz                |        | -90 dBm/Hz |        |                             |
| 18 GHz to 40 GHz               |        | -80 dBm/Hz |        |                             |
| <b>Spurious (SFDR)</b>         |        |            |        | Spurious Free Dynamic Range |
| 10 MHz to 4 GHz                |        | -70 dBc    |        |                             |
| 4 GHz to 18 GHz                |        | -60 dBc    |        |                             |
| 18 GHz to 40 GHz               |        | -55 dBc    |        |                             |
| <b>Spurious (absolute)</b>     |        | dBm        |        |                             |
| 10 MHz to 4 GHz                |        |            |        |                             |
| 4 GHz to 18 GHz                |        |            |        |                             |
| 18 GHz to 40 GHz               |        |            |        |                             |
| <b>Trigger</b>                 |        |            |        | 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  |
|-----------------------------|--------|---------------|--------------|---|
| <b>Sweep Parameters</b>     |        |               |              |   |
| DC Supply Voltage           | 0 V    |               | 15 V         | Adjustable  |
| DC Supply Current           |        |               | 550 mA       |   |
| Tuning Voltage              | -5 V   |               | 20 V         | Adjustable  |
| Tuning Current              |        |               | 20 mA        |   |
| <b>RF Frequency Range</b>   | 5 MHz  |               | <i>F</i> MAX |   |
| Uncertainty                 |        | 0.5 ppm       |              |   |
| <b>RF Input Power Range</b> | -5 dBm |               | +20 dBm      |   |
| Uncertainty                 |        | 0.5 dB        | 2 dB         |   |
| <b>DC Supply Current</b>    | 0 mA   |               | 550 mA       |   |
| Uncertainty                 |        | 1%            |              |   |
| <b>Output Settling Time</b> |        | 20 ms         |              |   |
| <b>Measurement Speed</b>    |        | 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 |         | <i>FMAX</i> |  |
| 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<br>5 MHz |         | <i>FMAX</i><br>42 GHz | APPH6040, APPH20G<br>APPH40G |
| Absolute Accuracy  |                | ±1 dB   | ±2.5 dB               |                              |
| Power Range        | -10 dBm        |         | +13 dBm               |                              |

## Tuning Voltage & Dual Power Supply

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

## LO Output (Option LO)

| PARAMETER                        | MIN   | TYPICAL | MAX    | NOTE |
|----------------------------------|-------|---------|--------|------|
| <b>Use: Additive Phase Noise</b> |       |         |        |      |
| Frequency Range                  | 0 GHz |         | 20 GHz |      |
| Frequency Resolution             |       | 1 Hz    |        |      |



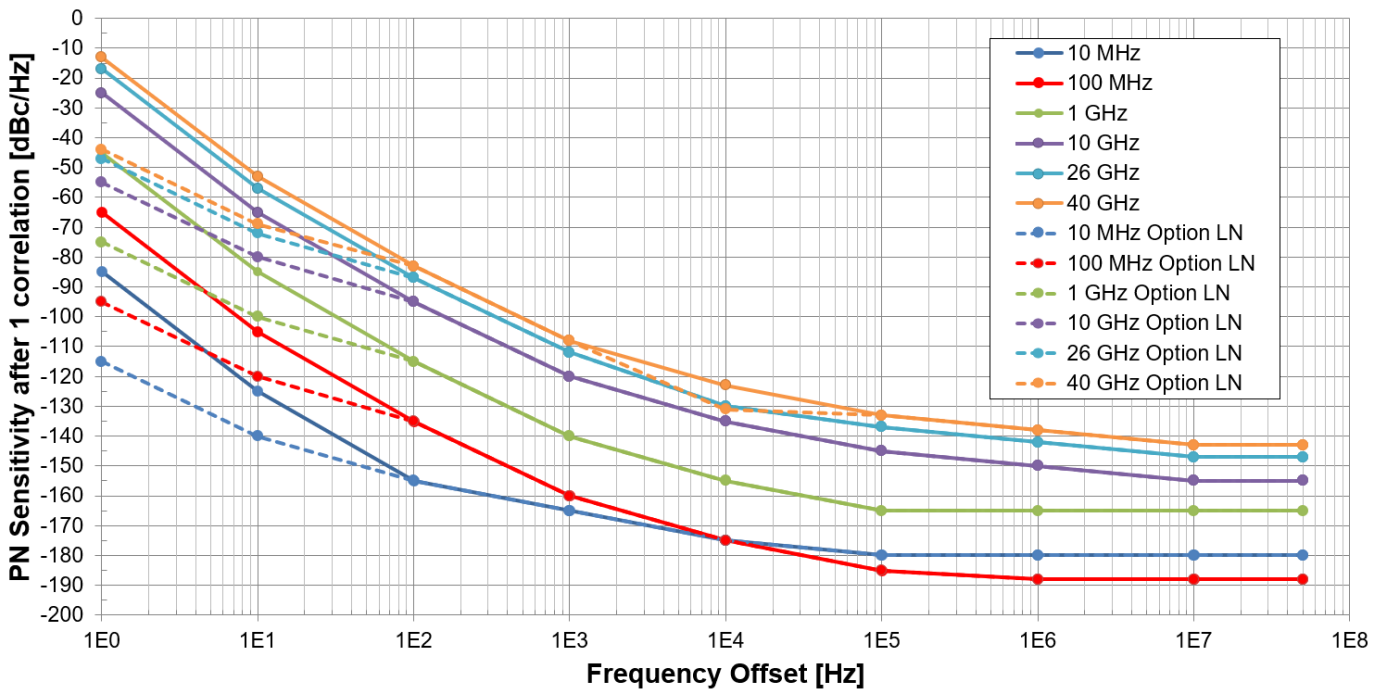
|                                   |        |          |        |  |
|-----------------------------------|--------|----------|--------|--|
| Power Level                       | 15 dBm | 17.5 dBm | 20 dBm |  |
| <b>Use: LO for Downconversion</b> |        |          |        |  |
| Frequency Range                   | 2 GHz  |          | 20 GHz |  |
| Frequency Resolution              |        | 0.5 GHz  |        |  |
| Power Level                       | 15 dBm | 17.5 dBm | 20 dBm |  |

# PERFORMANCE CURVES

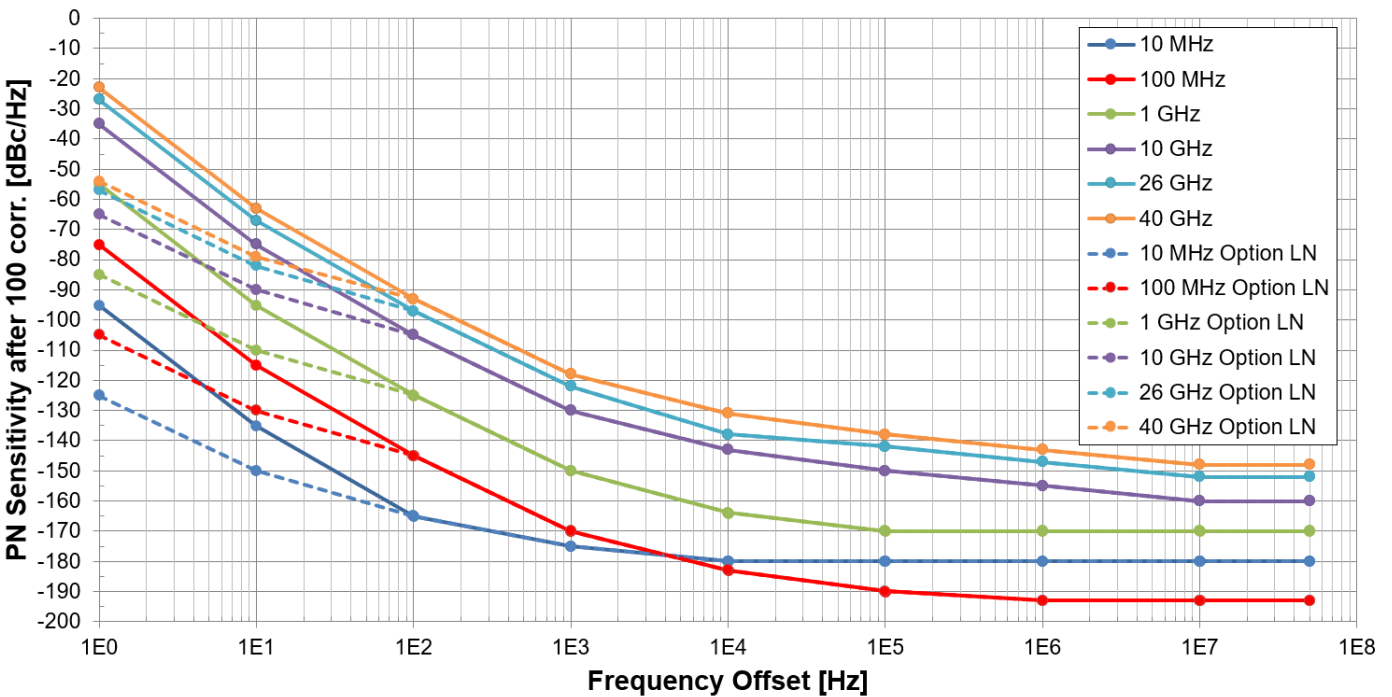
## Phase Noise Sensitivity - Standard and Low Noise (Option LN) Internal References

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.

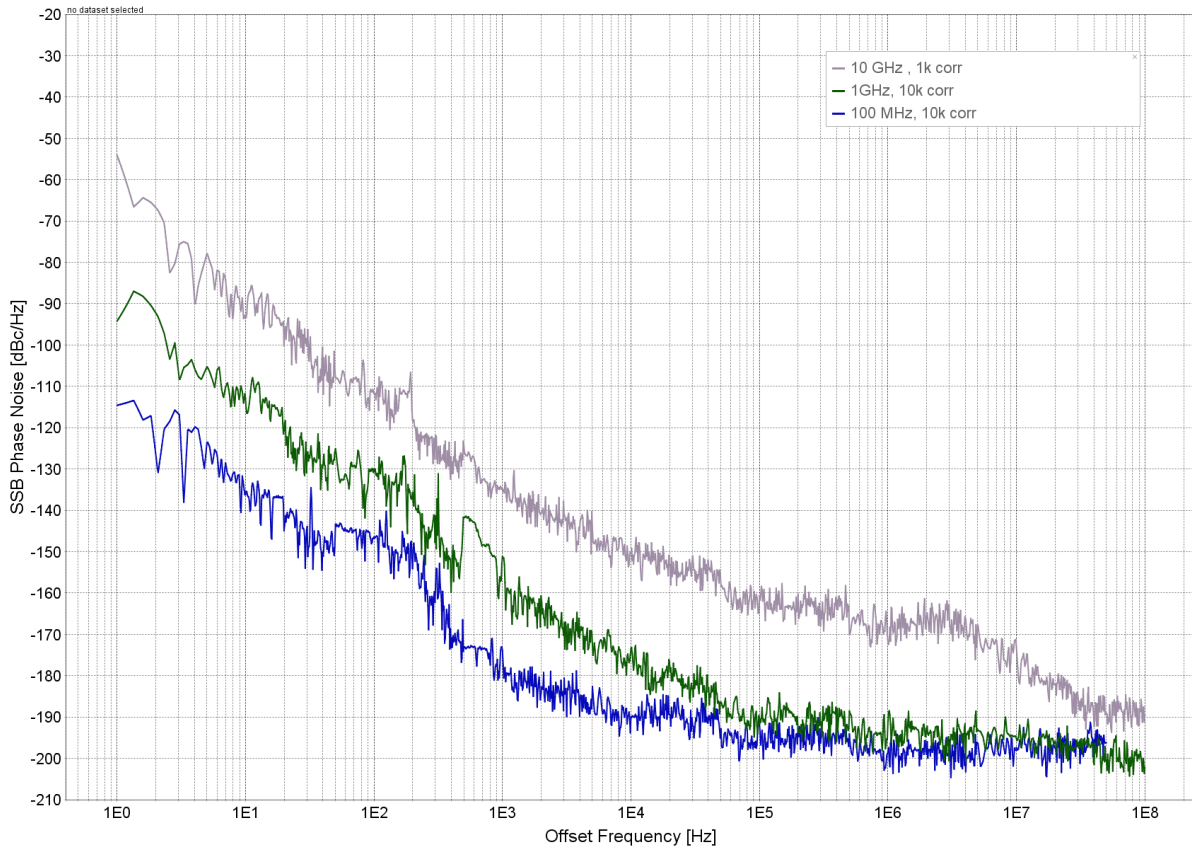
### After 1 Correlation



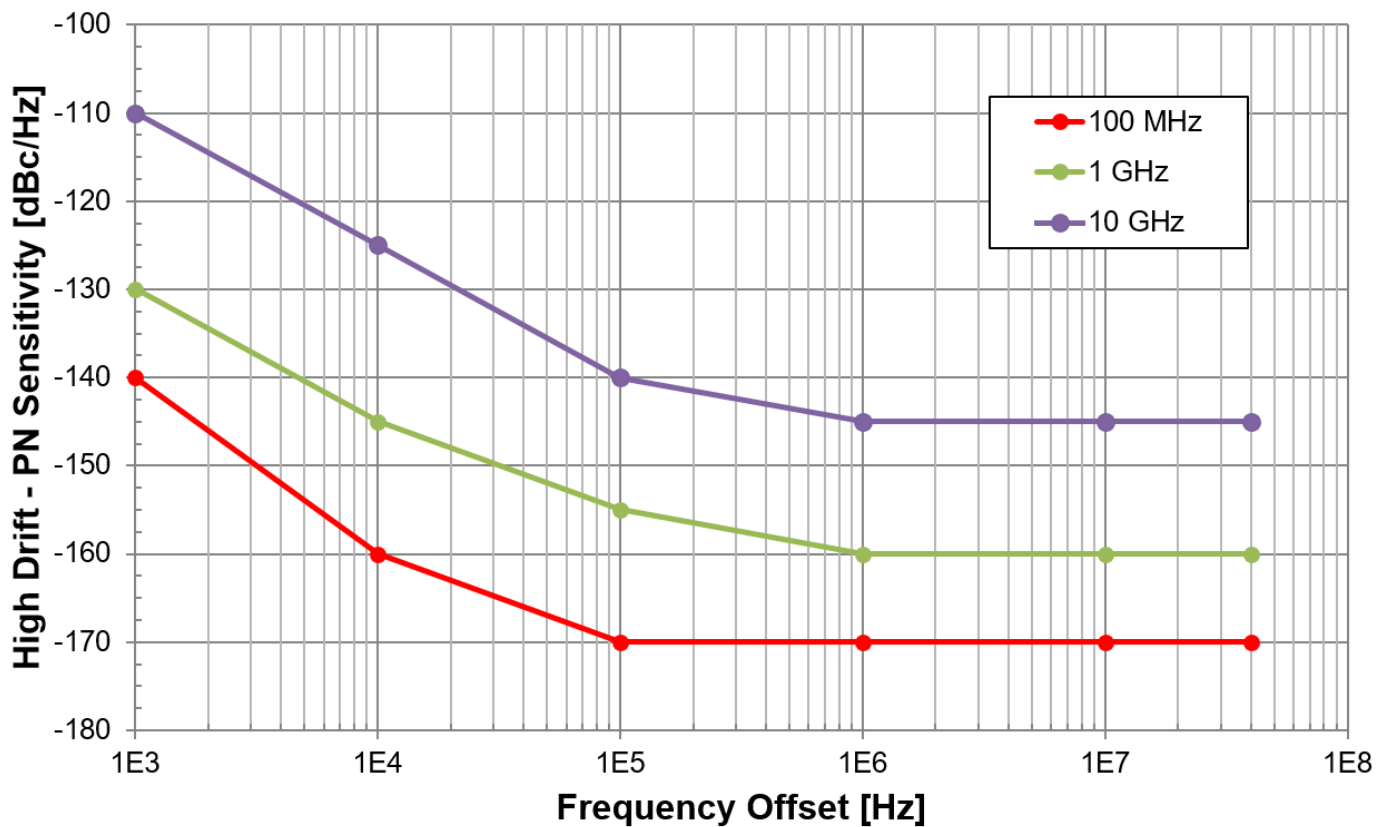
### After 100 Correlations



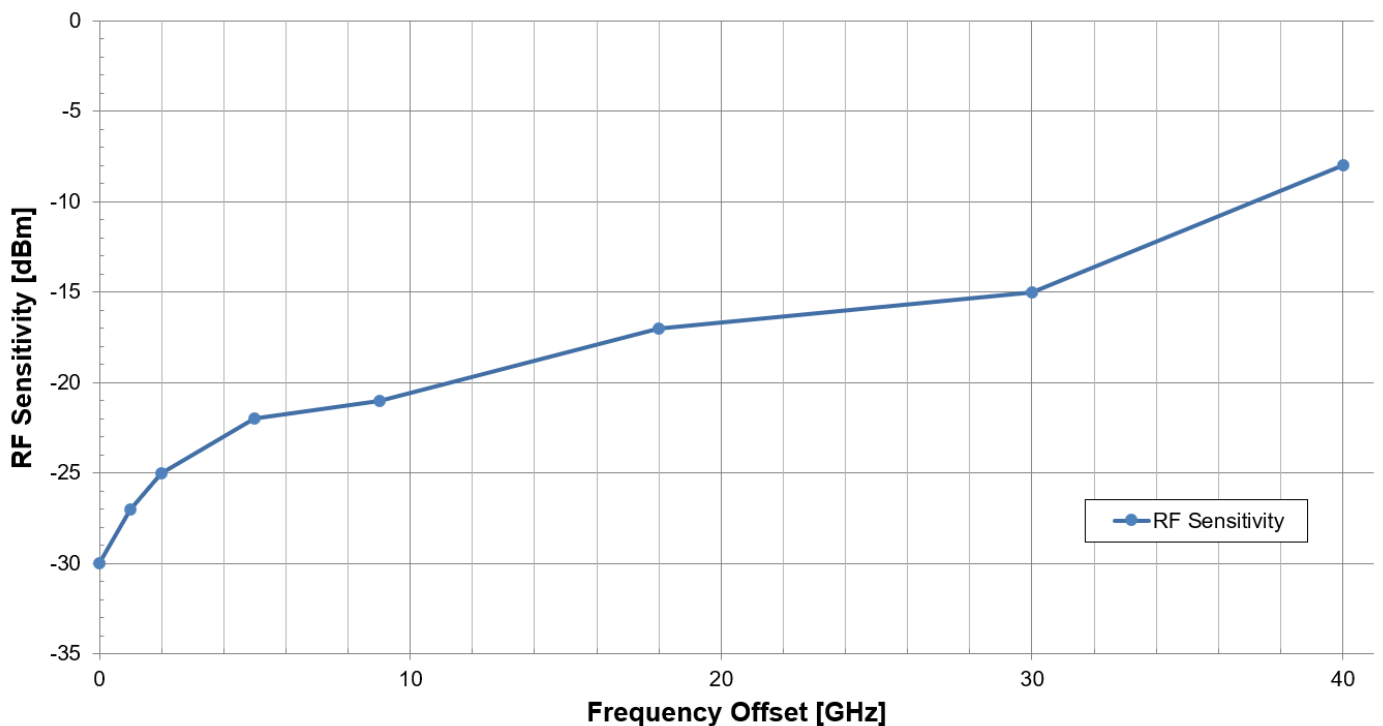
# Typical Noisefloor Example (after >1k correlations at 100MHz, 1GHz, 10GHz)



## 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 $\geq$ 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 $\geq$ 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 |
| $10 \text{ MHz} \leq f \leq 1 \text{ GHz}$ | -130   | -140  | -150   | -160  | -170   | -170    | -170  |
| $1 \text{ GHz} \leq f \leq 4 \text{ GHz}$  | -130   | -140  | -150   | -160  | -170   | -170    | -170  |
| $4 \text{ GHz} \leq f \leq 16 \text{ GHz}$ | -115   | -125  | -135   | -145  | -150   | -155    | -160  |
| Remarks                                    | Test conditions: RF carrier power $\geq 10 \text{ dBm}$ ; REF $\geq 13 \text{ dBm}$<br>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  $\pm$  (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 $\mu\text{s}$ | $\geq 10 \mu\text{s}$ |
|------------------------|---------------------------|--------|--------|-----------------|-----------------------|
| 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 <i>FMAX</i> | 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  $\pm$  (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 $\mu\text{s}$ | 10 $\mu\text{s}$ | $\geq 20 \mu\text{s}$ |
|-----------------|---------------------------|--------|--------|-----------------|------------------|-----------------------|
| 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  $\pm$  (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 $\mu$ s | 10 $\mu$ s | $\geq$ 20 $\mu$ s |
|-----------------|---------------------------|--------|-----------|------------|-------------------|
| 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  $\pm$  (resolution + time-base uncertainty). Tabulated resolutions are measured with the APPH and DUT locked to the same 10 MHz reference. Input level 0 dBm.

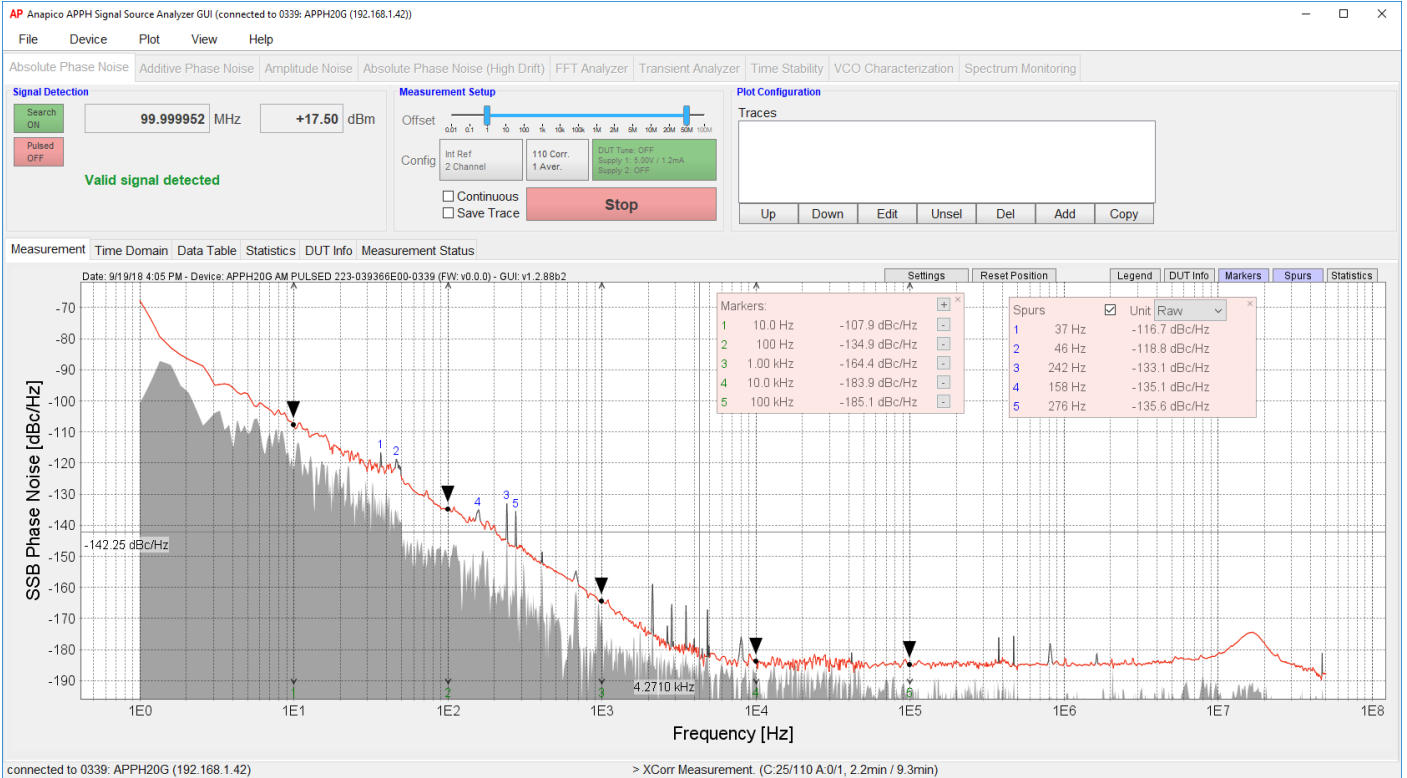
| Time Resolution | 1 $\mu$ s                 | 10 $\mu$ s | $\geq$ 20 $\mu$ s |
|-----------------|---------------------------|------------|-------------------|
| Frequency Range | Frequency Resolution [Hz] |            |                   |
| < 200 MHz       | 1                         | 0.5        | 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

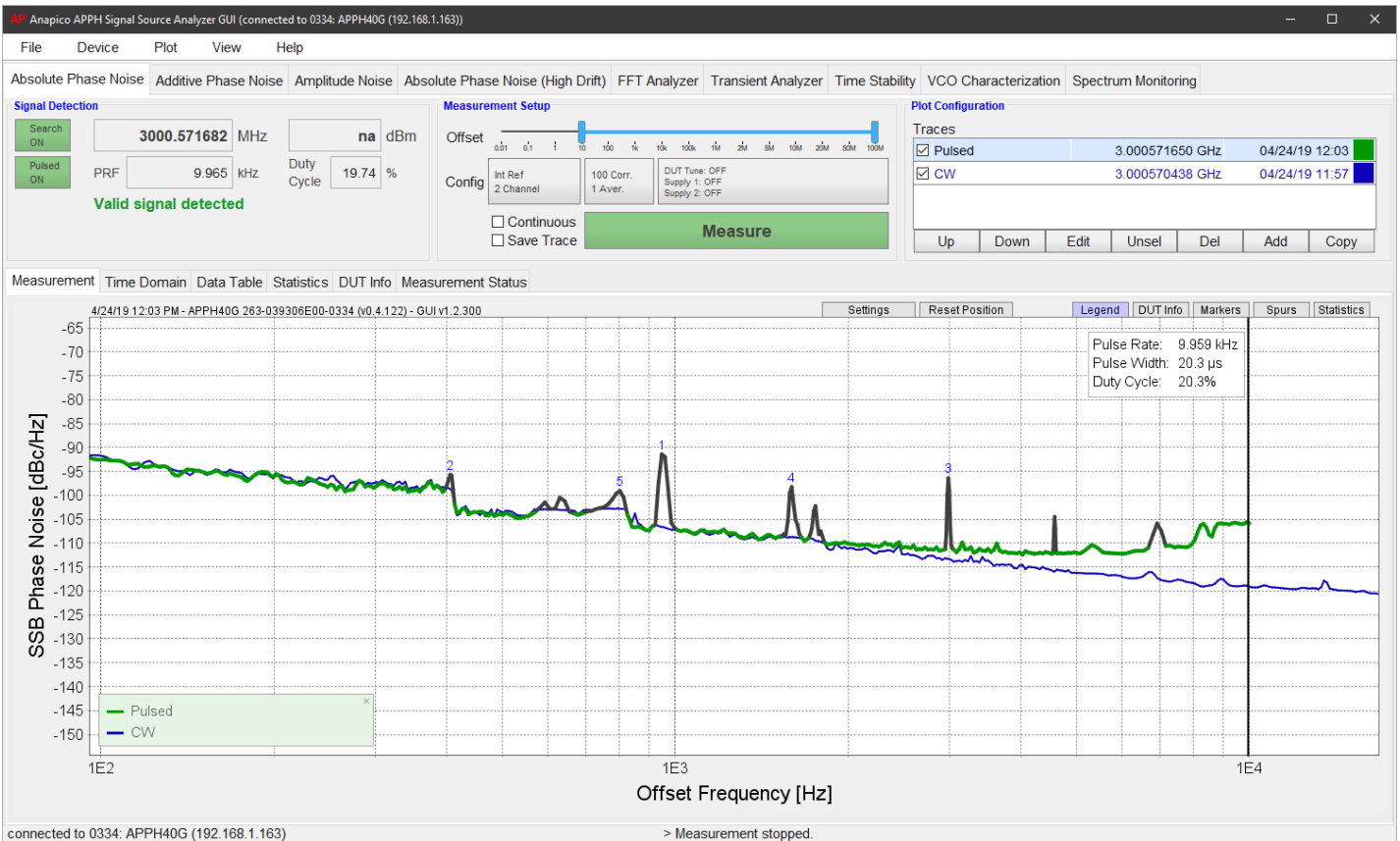
Graphical User Interface: The analyzer employs a graphical user interface based on the Windows operating system.

|                          |   |
|--------------------------|---|
| <b>Display Functions</b> | Phase Noise, Time Domain, Data Table, Residual, Statistics                                |
| <b>Trace Functions</b>   |   |
| 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 |
| <b>Marker Functions</b>  | 16 independent markers  |

# GUI Interface (Absolute Phase Noise)

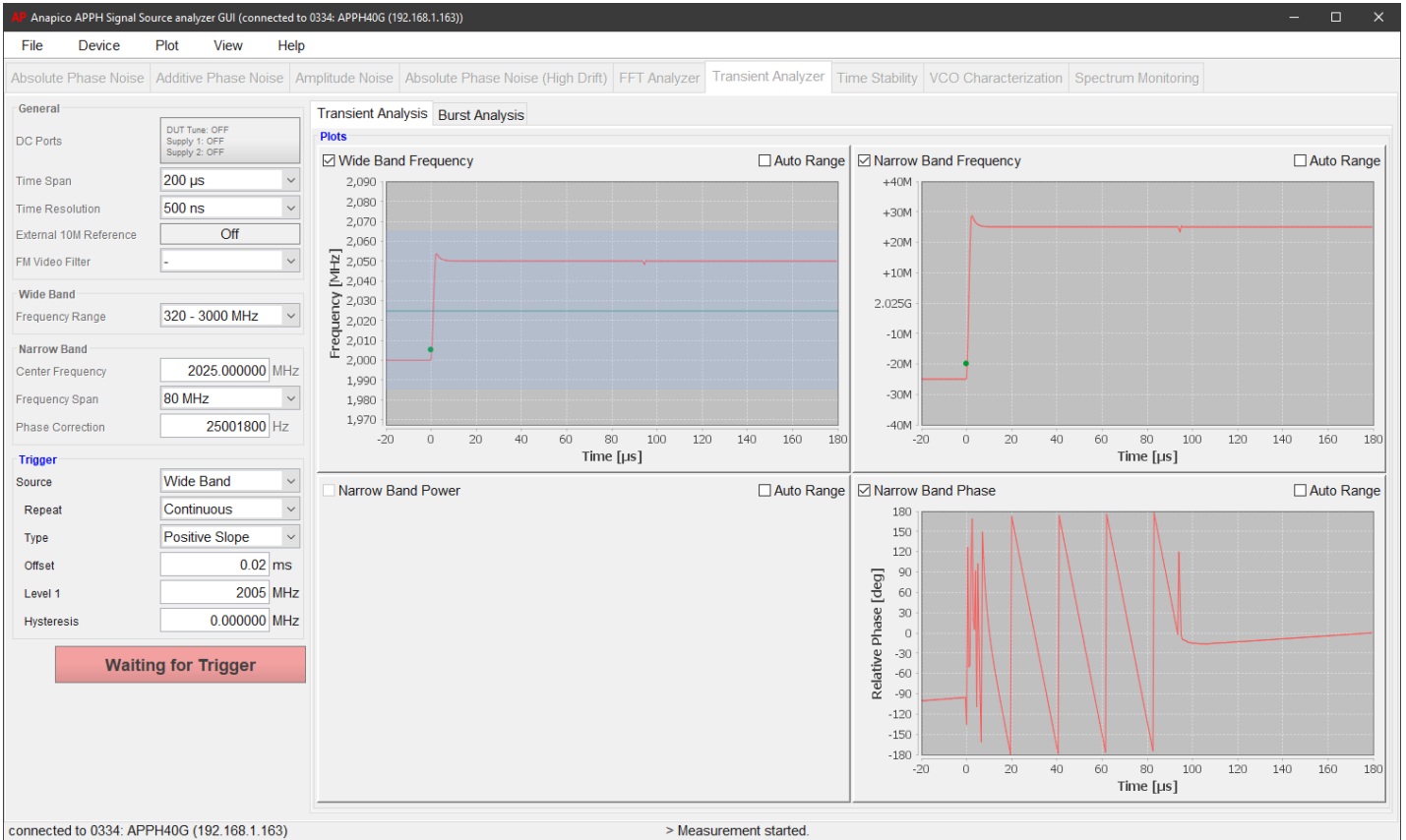


# GUI Interface (PULSED RF Absolute Phase Noise)

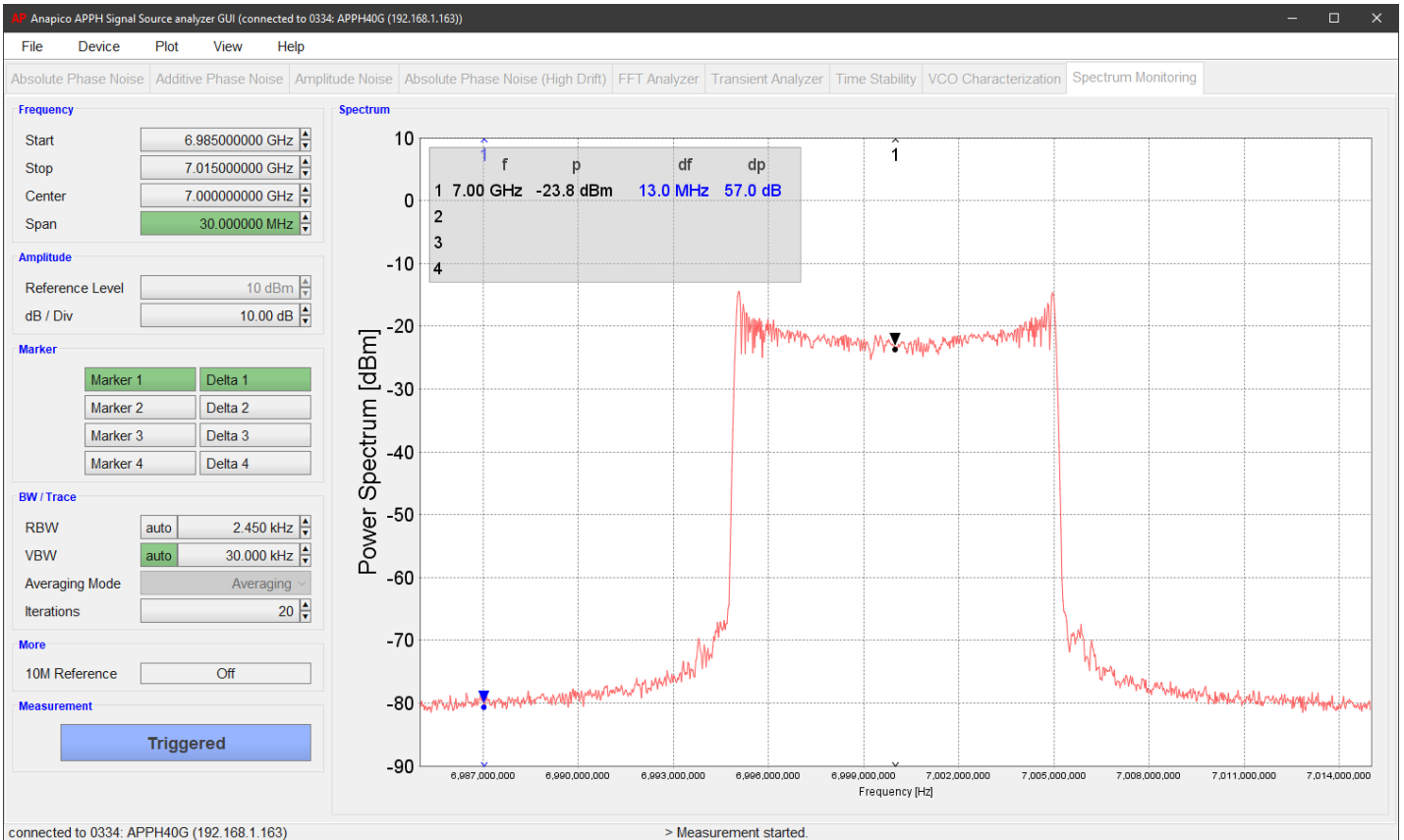




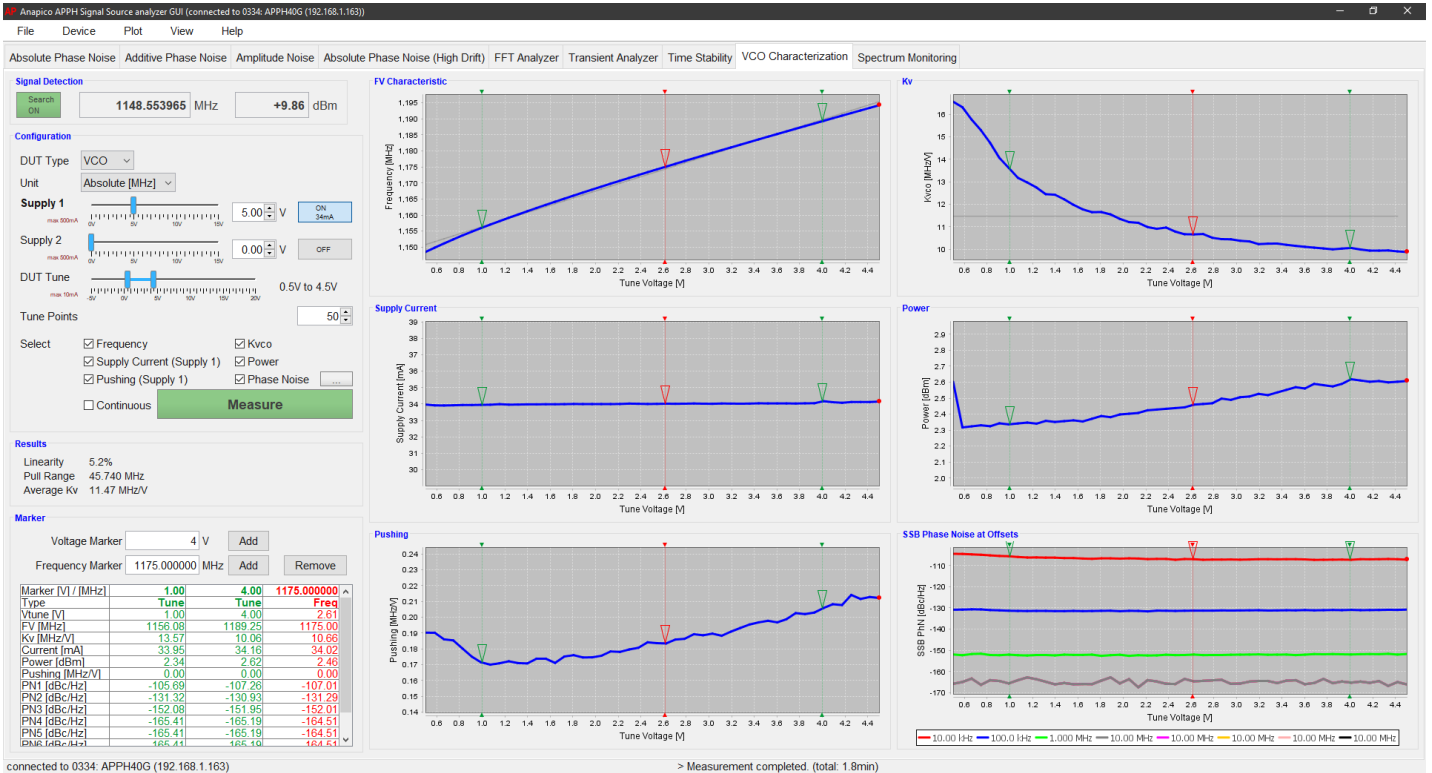
# GUI Interface (Transient Analyzer)



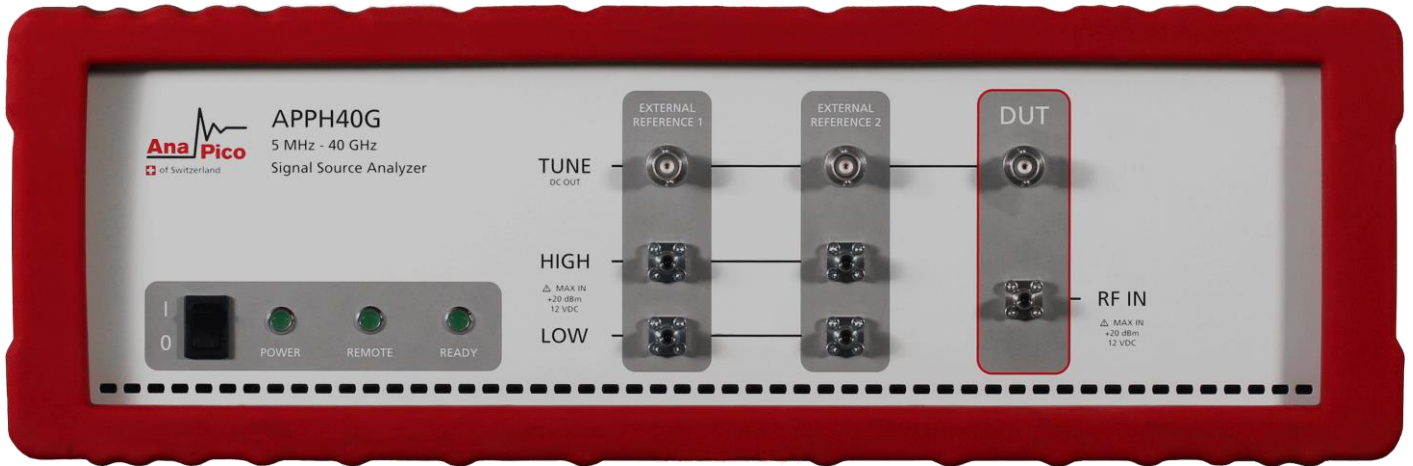
# GUI Interface (Spectrum Monitoring)



# 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/O:** 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

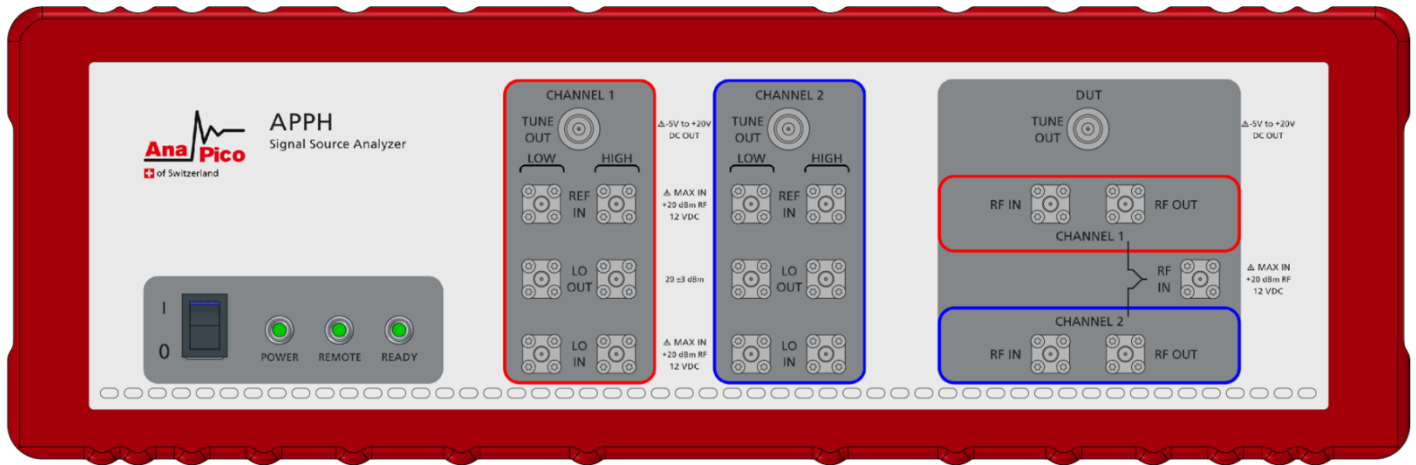
### DC Outputs

**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  
RF1 IN, RF2 IN: SMA female

### Additional RF Outputs

LO1 OUT HIGH/LOW, LO2 OUT HIGH/LOW: SMA female  
RF1 OUT, RF2 OUT: 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
- GPIO (IEEE-488.2,1987) with listen and talk (Option GPIO)
- 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  |
| V124    | 2019-10-11 | SD     | Extended LO specification  |
|         |            |        |  |
|         |            |        |  |

