# DNA

## Digital Phase Noise and Frequency Analyzer

2 MHz to 400 MHz

NOISE XT


The DNA is the highest performance Frequency Stability and Phase Noise Analyzer with unique digital architecture that allows down to thermal noise and state of the Art close-in phase noise performance with a limitation set by the user's reference clock. The DNA also includes built-in oscillators for advanced autonomous operation.

The key advantages of this platform are not only the extremely low noise floor but the fact that it does not require any phase locking of a reference as all phase detector-based phase noise analyzers do. Its amazing phase noise extraction process even works on different frequencies, the reference can be at a different frequency than the DUT.

No isolation problem, no phase lock loop bandwidth, no DC FM tuning port required; this is so many benefits to avoid errors and get simple, fast and reliable performance. And as phase noise is just one of the two ways of analyzing signal purity and stability, the DNA also integrates an excellent frequency stability analyzer making is the new Time and Frequency analyzer standard for the advanced research and development industry.

All specifications in this document are typical values unless specified otherwise.

## RF Input Port

| Description | Specification |
|---|---|
| RF IN connector | Type-N Female, 50 ohms nominal |
| RF IN frequency range | 2 MHz to 400 MHz |
| RF IN measurement level | -10 dBm to +20 dBm |
| Input damage level | AC > +23dBm, 0V DC max |

## Phase Noise Analyzer performance

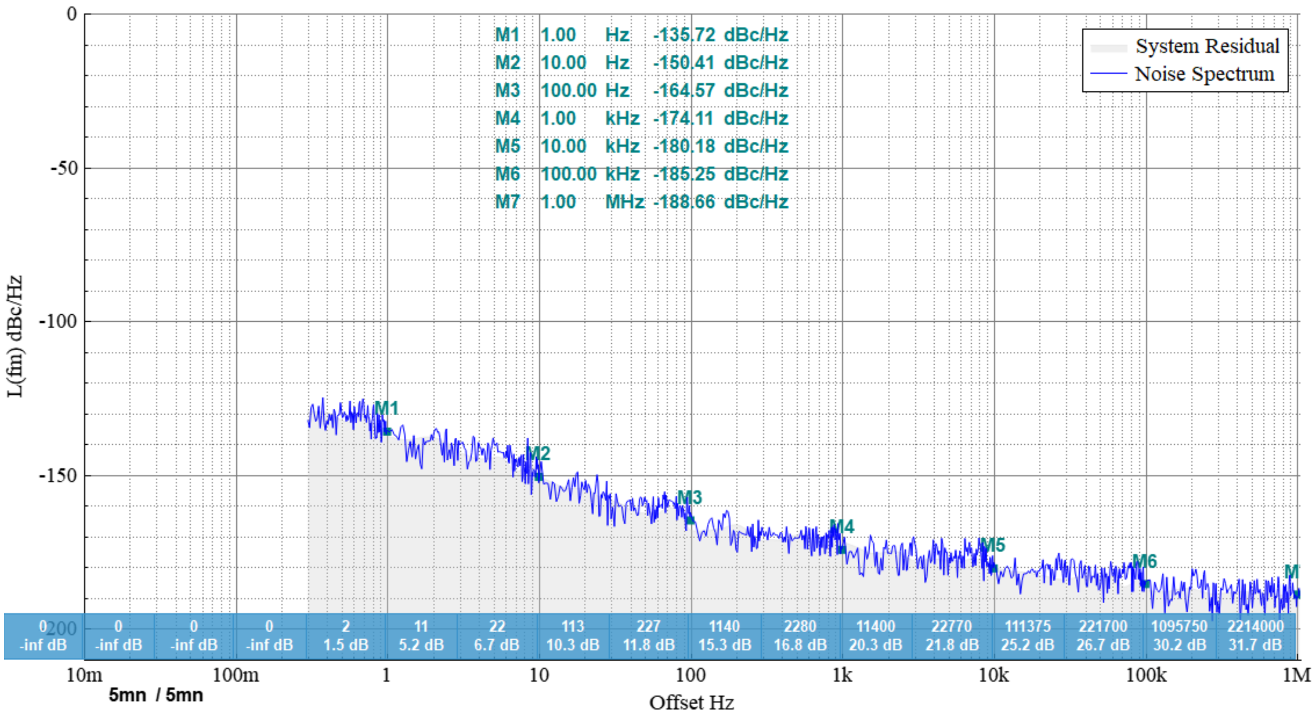
| Description | Specification |
|---|---|
| RF IN frequency range | 2 MHz to 400 MHz |
| Measurement parameters | SSB noise (dBc/Hz), Spurious (dBc), Allan & overlapped Allan Variance, Hadamar & overlapped Hadamar variance.<br>Fractional frequency noise chronogram. |
| Number of traces | 20 data traces for SSB phase noise and Frequency stability. |
| Number of markers | 20 |
| Offset frequency range | 1 mHz to 1 MHz, 10 MHz Typical |
| Phase Noise accuracy | +/- 2 dB |
| SSB noise sensitivity<br><br>Typical residual phase noise<br>15min measurement 10 MHz<br><br>100 MHz | See Table for complete values<br><br>-137dBc/Hz@1Hz<br>-190dBc/Hz@1MHz<br><br>-121dBc/Hz@1Hz<br>-194dBc/Hz@10MHz |
| Enhanced sensitivity | Fully continuous Cross-correlation method up to millions of averages |
| Reference Local Oscillator | Internal or External Sources (single or dual) |
| Residual Allan deviation (5MHz to 400 MHz)<br>(t=1s)<br>(t=1000s) | <br>< 7E-14 (5Hz ENBW)<br>< 5E-16 (5Hz ENBW) |
| Residual spurious response level (measurement engine), excluding AC power related spurs | -50 dBc at 1 Hz offset<br>-70 dBc at 10 Hz offset<br>-90 dBc at 100 Hz offset<br><-110 dBc above 1kHz offset |
| Spurious detection Algorithm | Adjustable Peak detection based on noise statistical information |
| Measurement time | See time table |
| Resolution Bandwidth | Variable settings in each independent decade Based on 1024 FFTs in a cascaded continuous noise decimation chain |
| Internal Source output power | +10 dBm +/- 3 dB |

## Residual Phase Noise

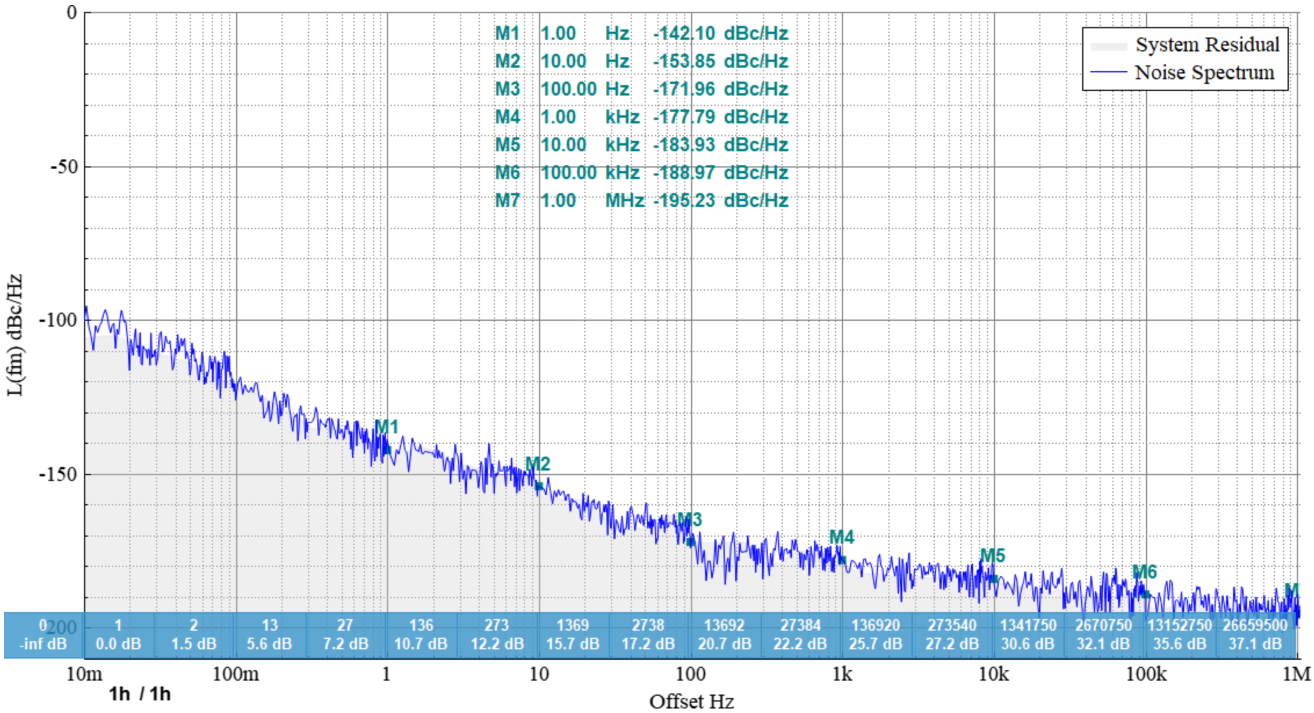
- 10 MHz residual phase noise, nominal Conditions: RF +15dBm Input Power.

| Measurement time | dBc/Hz vs Offset (Hz) | 1 | 10 | 100 | 1k | 10k | 100k | 1M |
|---|---|---|---|---|---|---|---|---|
| 5 min | Typical Phase Noise | -135 | -150 | -164 | -174 | -180 | -185 | -188 |
| 15 min | Typical Phase Noise | -137 | -151 | -166 | -175 | -182 | -187 | -190 |
| 60 min | Typical Phase Noise | -141 | -154 | -170 | -177 | -184 | -189 | -192 |

Please add +5dB for guaranteed performance




*Typical 10 MHz residual Phase Noise, 5min measurement time*

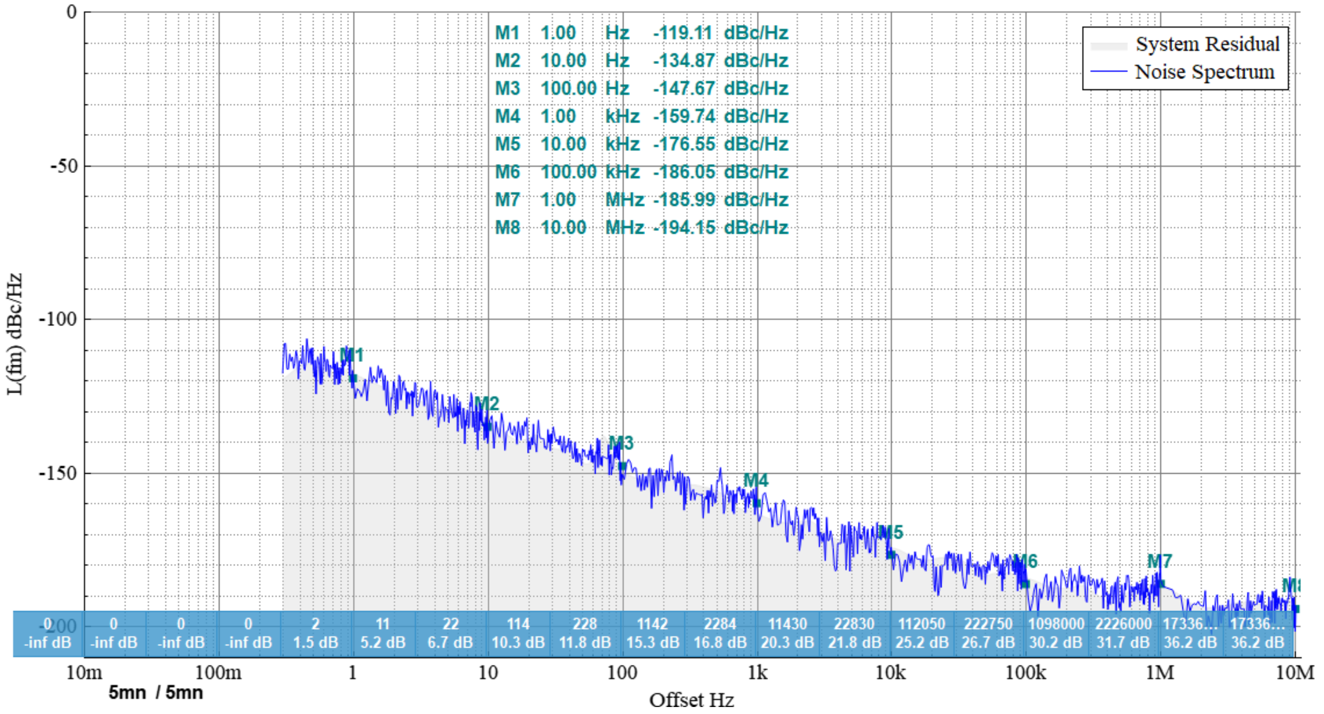



*Typical 10 MHz residual Phase Noise, 60 min measurement time*

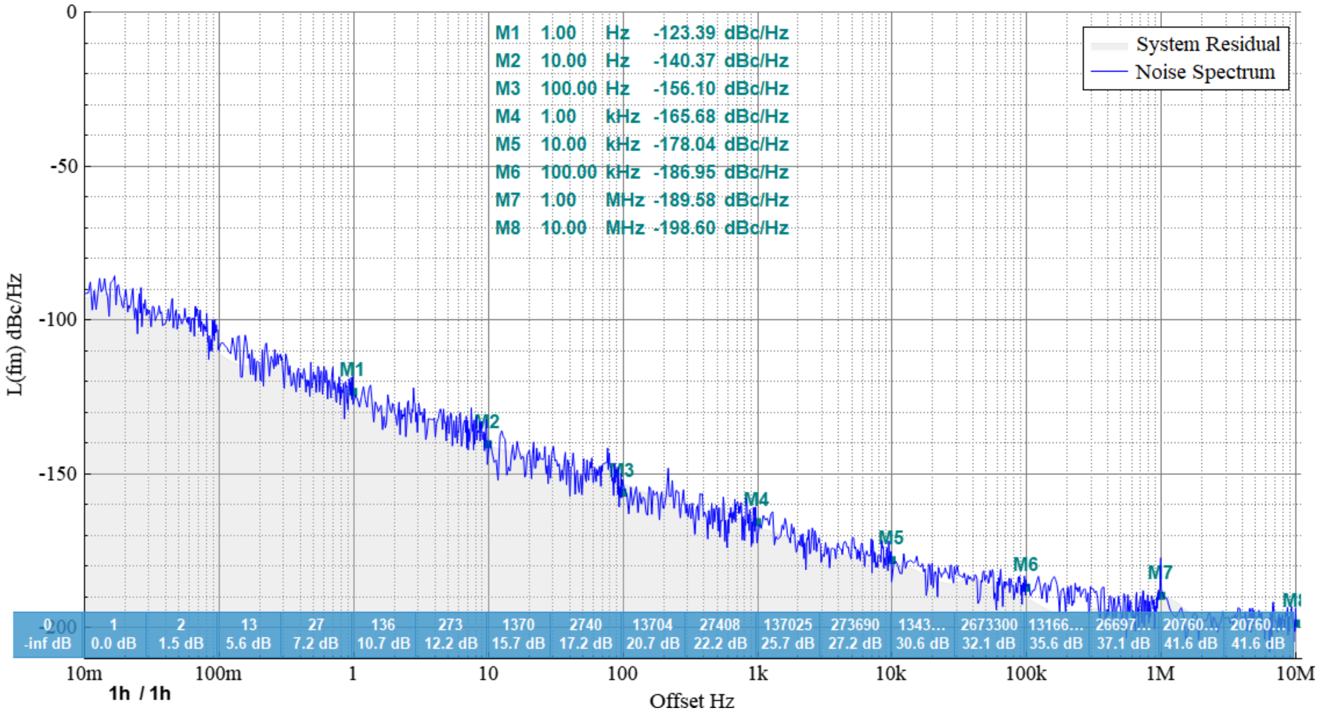
- 100 MHz residual phase noise, nominal Conditions: RF +15 dBm Input Power.

| Measurement time | dBc/Hz vs Offset (Hz) | 1 | 10 | 100 | 1k | 10k | 100k | 1M | 10M option |
|---|---|---|---|---|---|---|---|---|---|
| 5 min | Typical Phase Noise | -119 | -134 | -146 | -159 | -175 | -185 | -185 | -192 |
| 15 min | Typical Phase Noise | -121 | -136 | -150 | -164 | -178 | -185 | -188 | -192 |
| 60 min | Typical Phase Noise | -123 | -140 | -156 | -165 | -178 | -186 | -189 | -192 |

Please add +5dB for guaranteed performance



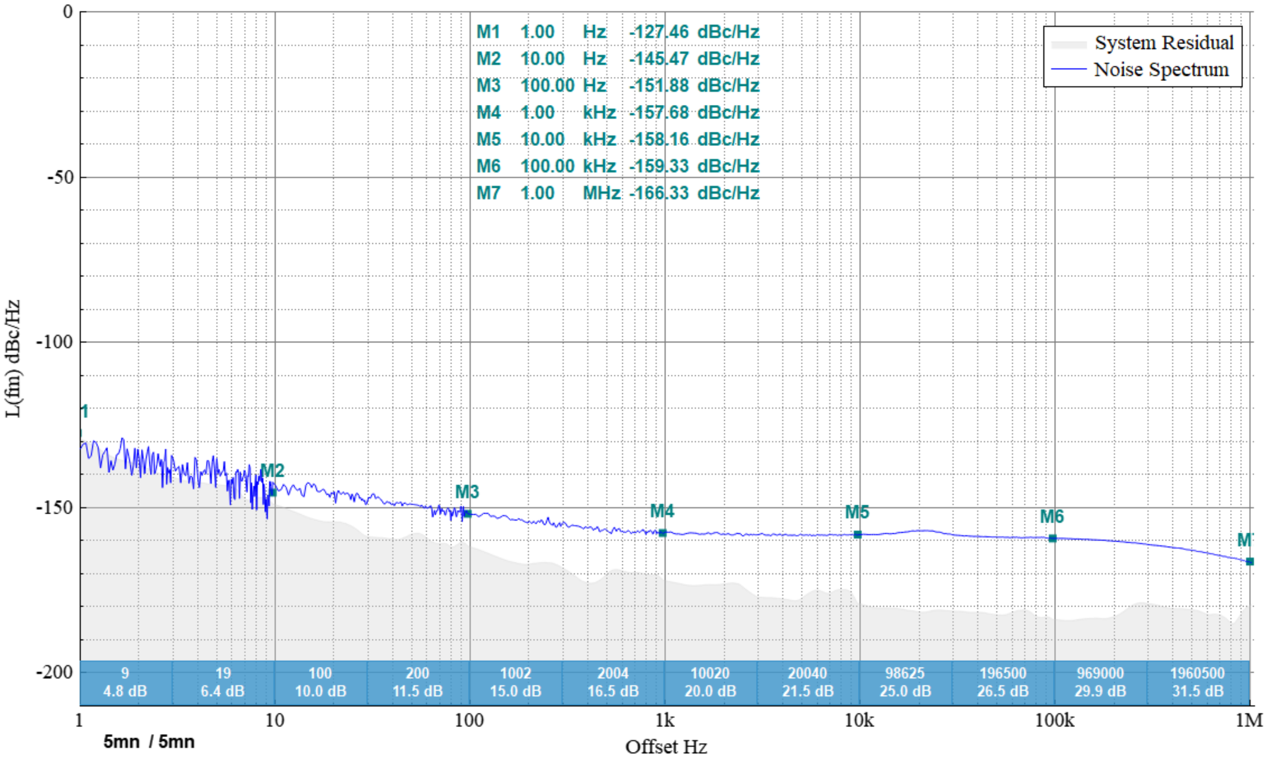

*Typical 100 MHz residual Phase Noise, 5 min measurement time*



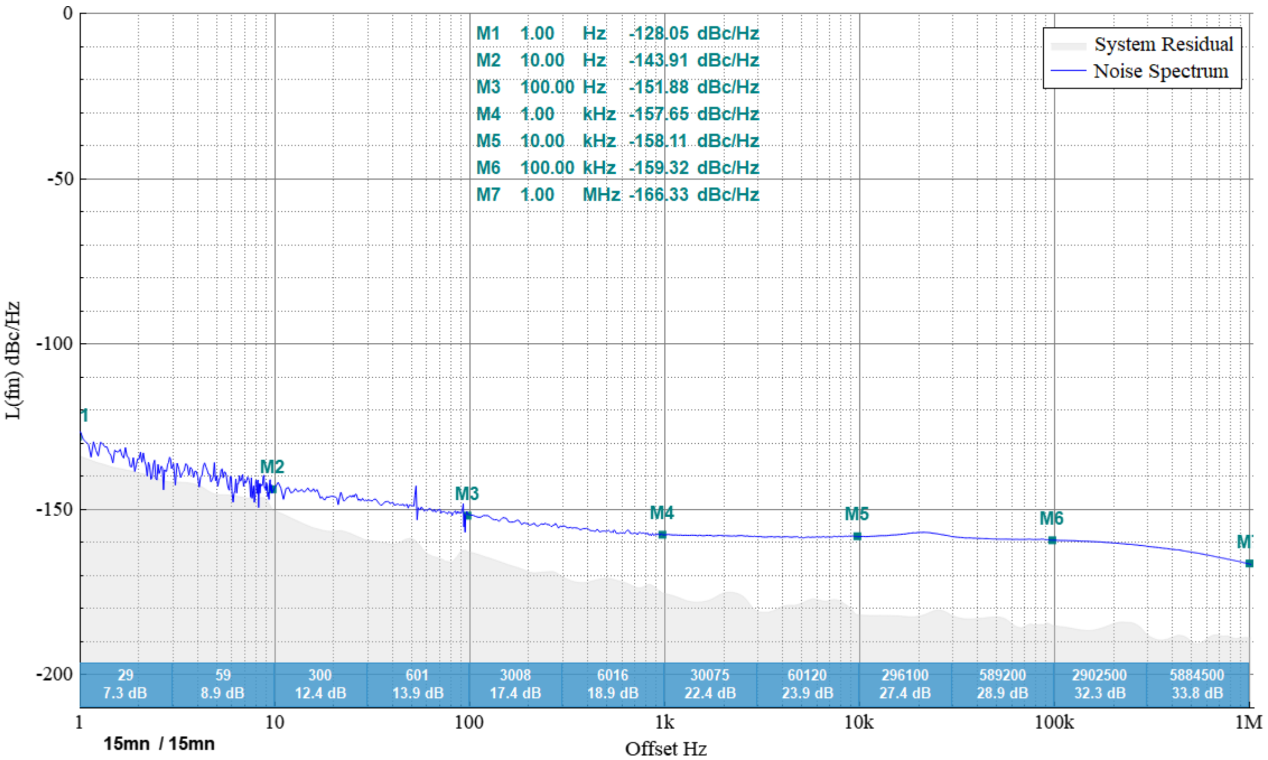

*Typical 100 MHz residual Phase Noise, 60 min measurement time*

## Measurement time

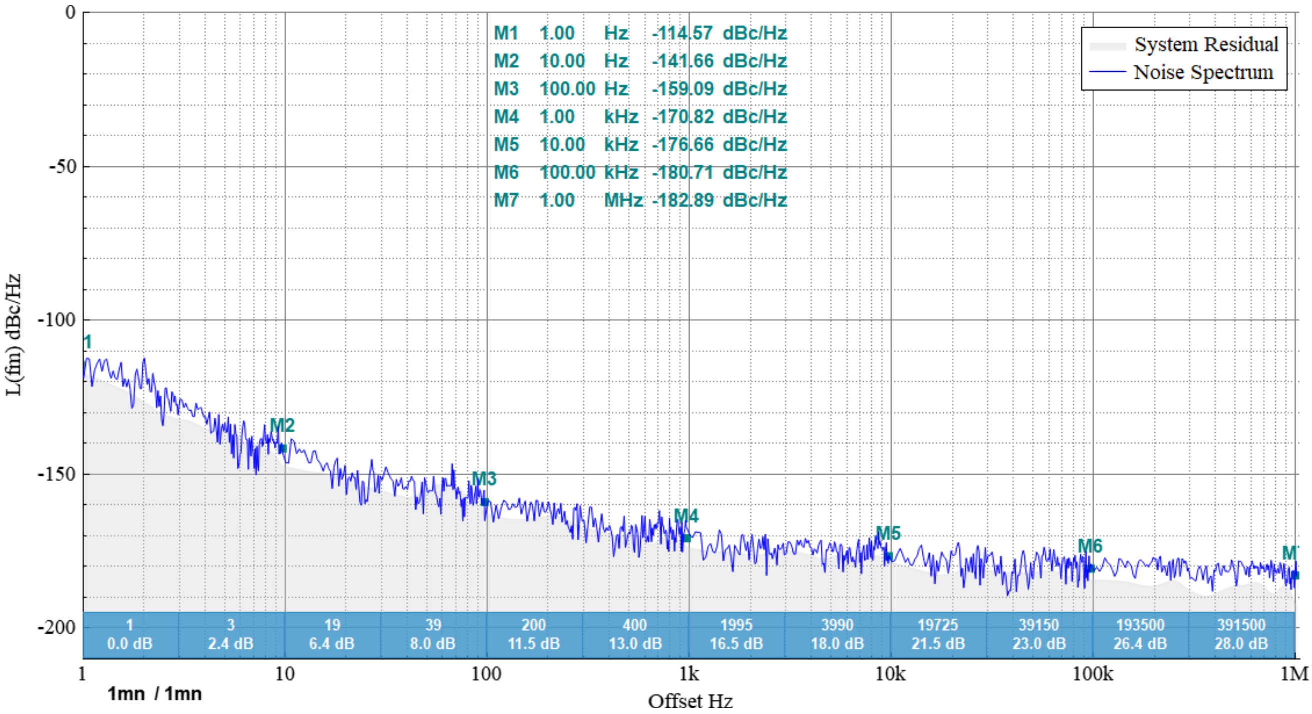
The DNA can measure continuously up to days and automatically uses the maximum number of cross-correlation averages. The only thing that can be set is the measurement time you wish to allow to this test. Measurement time depends on reference specification and expected result.
The results shows below are using the internal reference.



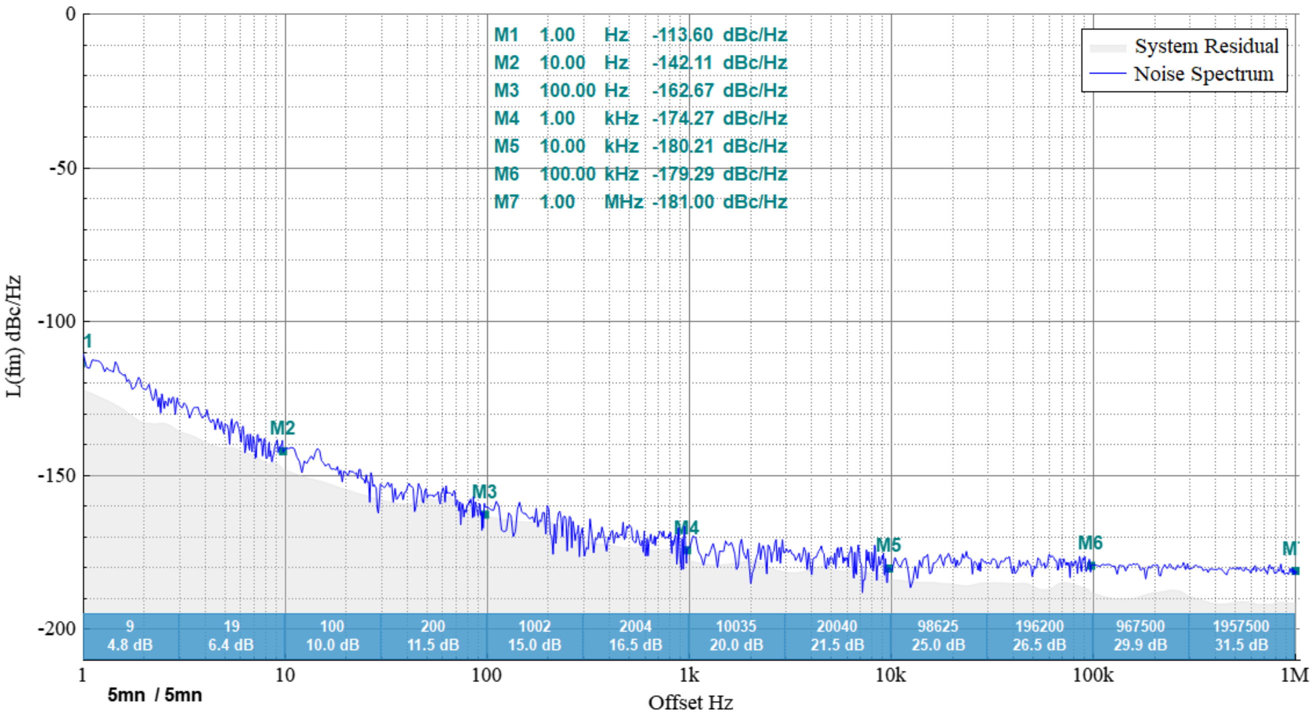

*5 MHz OCXO / **5 min measurement time** phase noise plot*



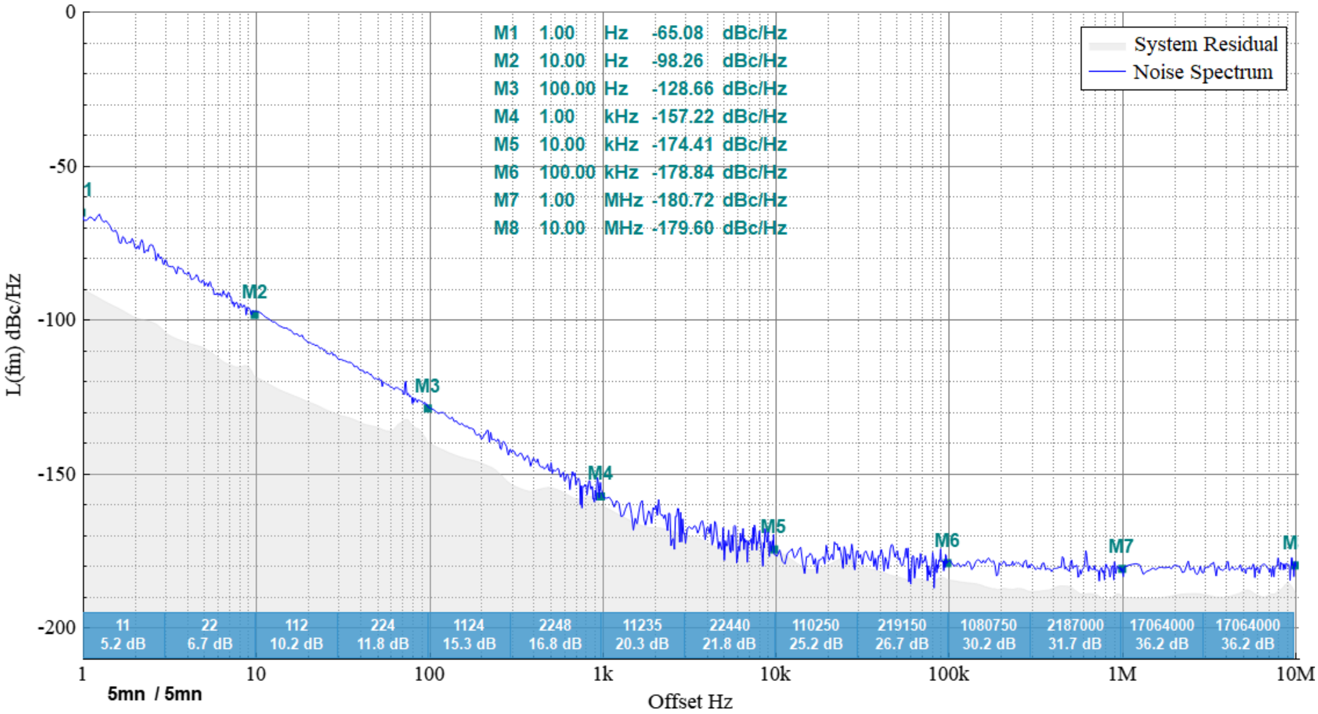

*5 MHz OCXO / **15 min measurement time** phase noise plot*



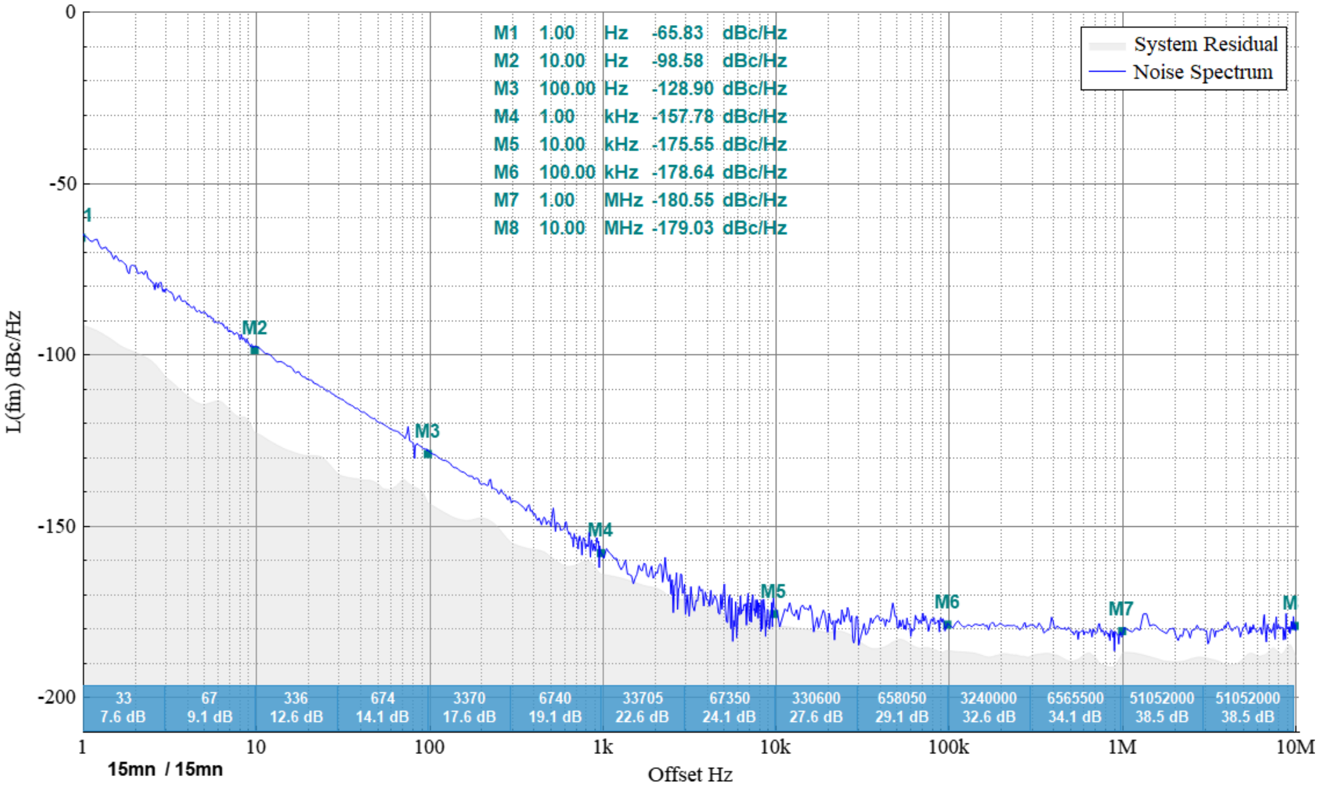

*10 MHz OCXO / **1 min measurement time** phase noise plot*




*10 MHz OCXO / **5 min measurement time** phase noise plot*




*100 MHz OCXO / **5 min measurement** time phase noise plot*




*100 MHz OCXO / **15 min measurement time** phase noise plot*

## Frequency Stability Measurements

The DNA has a feature to measure frequency stability and display plots from 0.01 to 10,000 seconds.
This measurement can be done at any frequency where the regular phase noise plots can be done.
It uses the instantaneous frequency measure between DUT and reference. An external 10 MHz reference can be used.

The frequency stability measurements available are:

- Allan Variance & Overlapped Allan variance
- Hadamar & Overlapped Hadamar variance

There are two methods for measuring the variance: the auto-variance and the cross-variance.

- The auto-variance method uses the instantaneous fractional frequency between the DUT and the first reference. It is noted that both the DUT and the first reference contribute to this value.
- The cross-variance method uses the instantaneous frequency between the DUT and both references. This method allows minimizing the contribution of the references on the variance measurement.

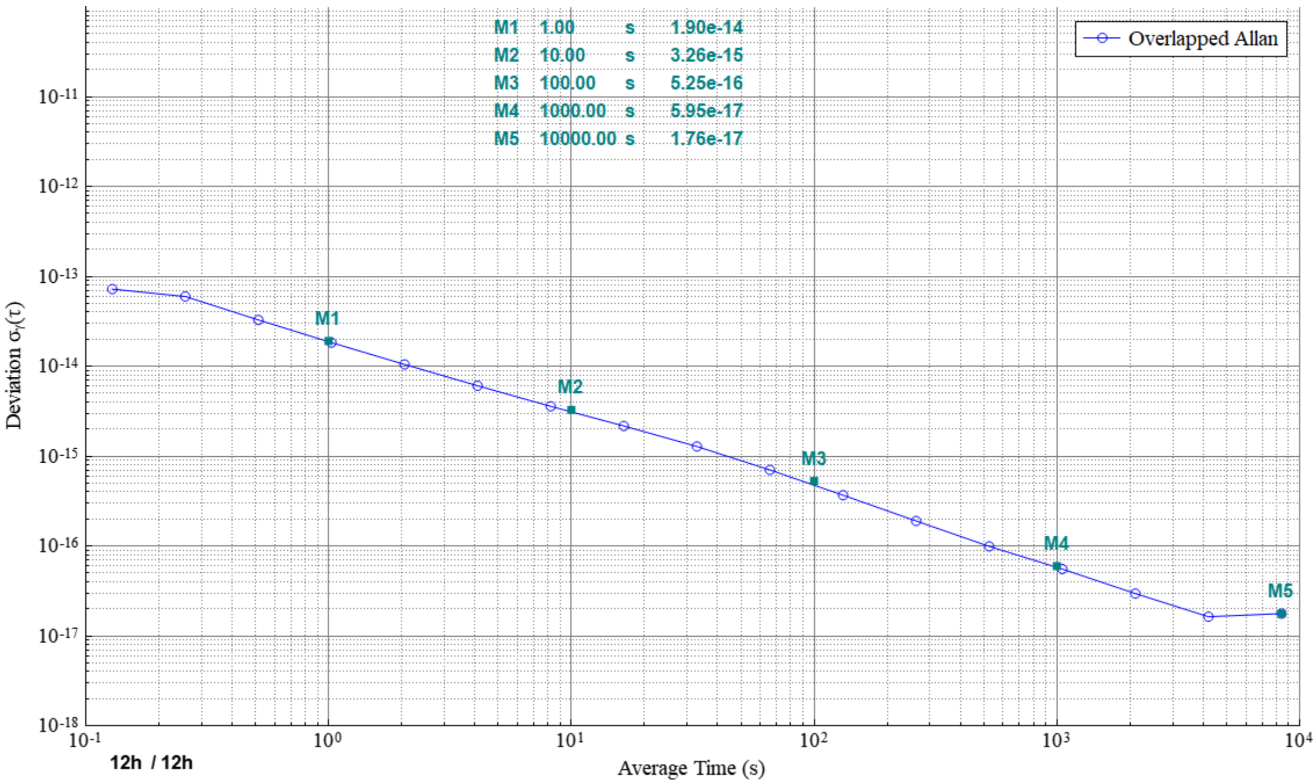
All frequency measurement data is available as text files for external post processing through any statistical analysis software.

| | | |
|---|---|---|
| Residual Allan deviation specification (*1) (5MHz to 400 MHz) | *(t=1s)* | *< 7E-14 (5Hz ENBW)* |
| | *(t=1000s)* | *< 5E-16 (5Hz ENBW)* |

**(*1) The best results will be obtained by using the cross-variance and an external reference 10 with a good stability.**

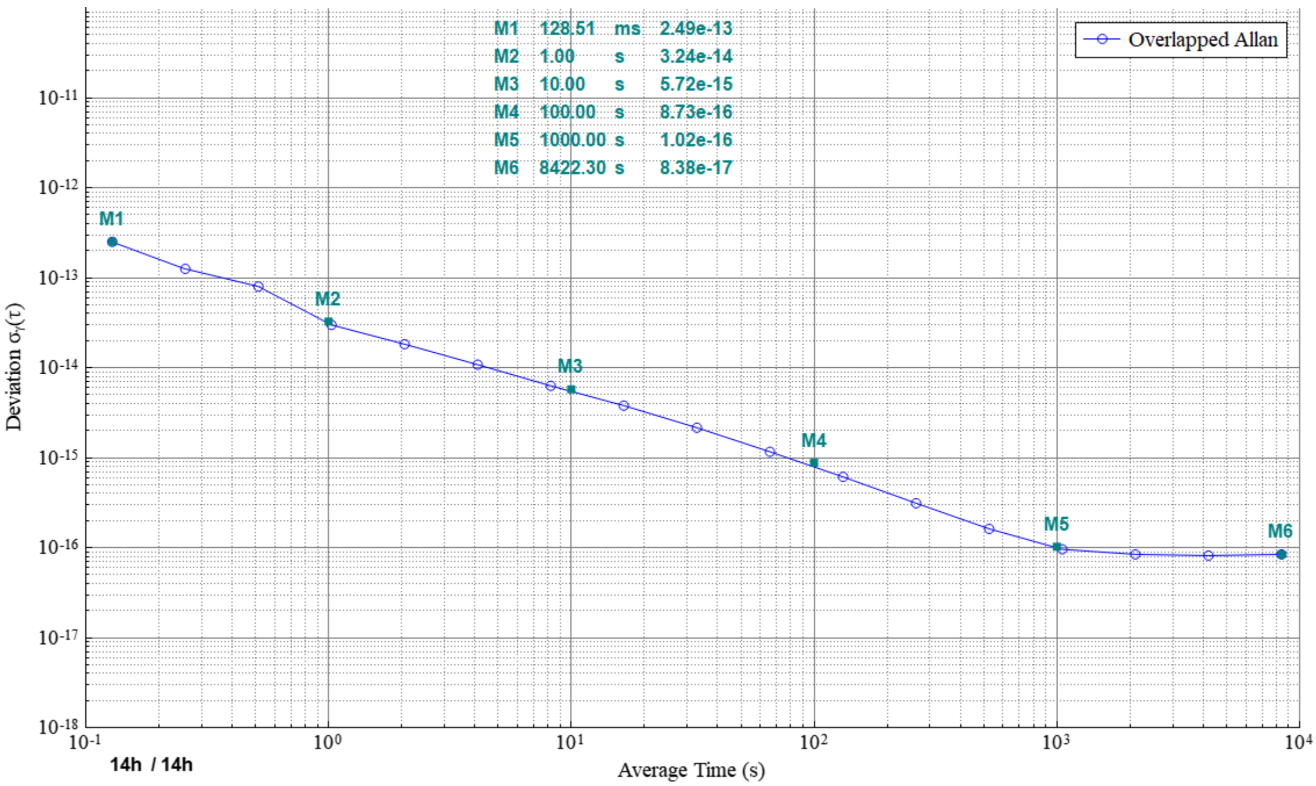
**Residual Allan Deviation Typical results:**

| Residual Allan Deviation ENBW = 5Hz | 0.125 | 1 | 10 | 100 | 1k | 10k |
|---|---|---|---|---|---|---|
| Typical results at 100 MHz | $1.10^{-13}$ | $2.10^{-14}$ | $3.10^{-15}$ | $6.10^{-16}$ | $6.10^{-17}$ | $2.10^{-17}$ |



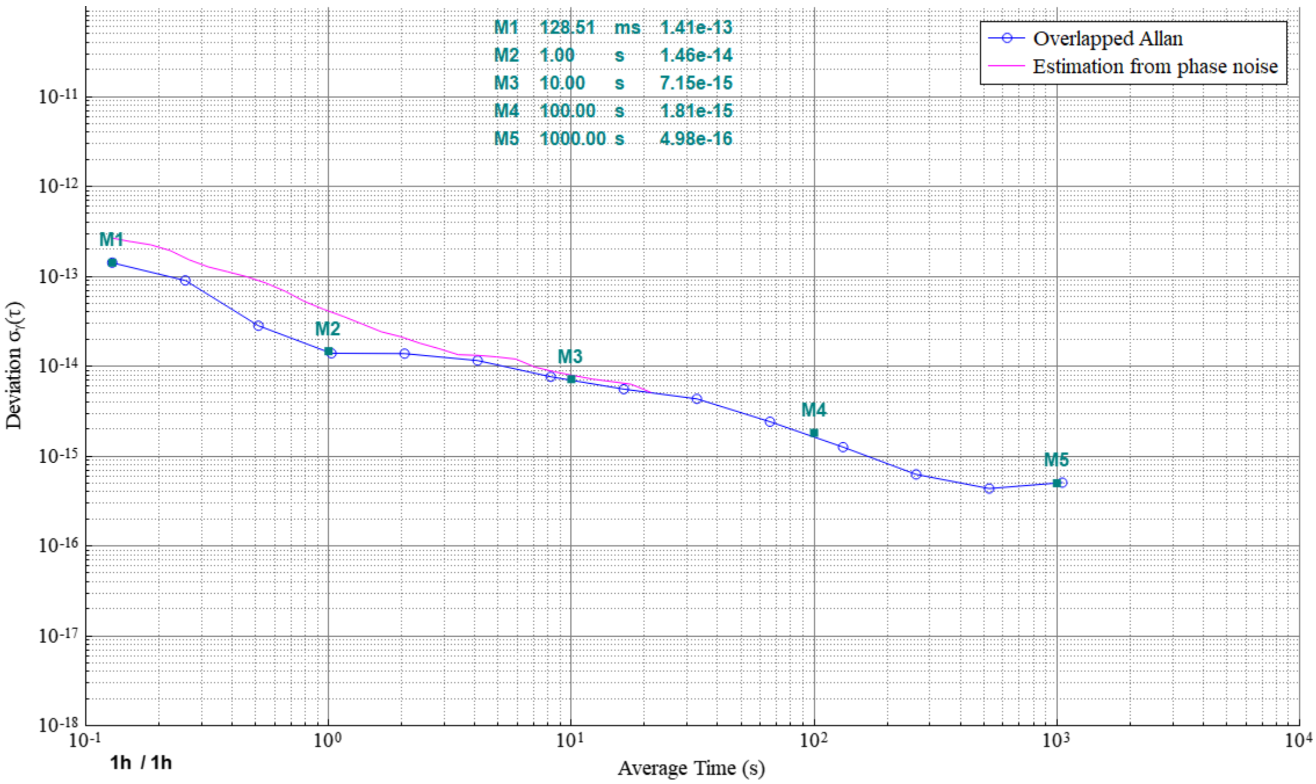

*100 MHz / **12H measurement time** Residual Overlapped Allan Deviation ENBW=5Hz*

| Residual Allan Deviation ENBW = 5Hz | 0.125 | 1 | 10 | 100 | 1k | 10k |
|---|---|---|---|---|---|---|
| Typical results at 10 MHz | $2.10^{-13}$ | $3.10^{-14}$ | $5.10^{-15}$ | $1.10^{-15}$ | $1.10^{-16}$ | $1.10^{-16}$ |




*10 MHz / **14H measurement time** Residual Overlapped Allan Deviation ENBW=5Hz*

| Residual Allan cross Deviation ENBW = 5Hz | 1 | 10 | 100 | 1k | 10k |
|---|---|---|---|---|---|
| Typical results at 5 MHz | $4.10^{-14}$ | $8.10^{-15}$ | $2.10^{-15}$ | $5.10^{-16}$ | |




*5 MHz / **60min measurement time** Residual Overlapped Allan cross variance Deviation ENBW=5Hz*

## General Information

### Front panel information

| Description | Supplemental information |
|---|---|
| RF Input | N type (female), 50 ohms |
| Reference Oscillator Input/output | SMA type (female), 50 ohms |
| Digitizer channel A to D Input | SMA type (female), 50 ohms |

### Rear panel information

| Description | Supplemental information |
|---|---|
| RJ-45 | Gigabit Ethernet |
| AC | 100-240 VAC 50/60Hz 2A max |
| FAN | Exhaust |

### Analyzer environment and dimensions

| Description | Supplemental information |
|---|---|
| **Operating environment** | |
| Temperature | +10 °C to +40 °Celsius |
| Humidity | RH 20% to 80% at wet bulb temp.<29 °C (non-condensing) |
| **Non-operating storage environment** | |
| Temperature | -10 °C to +60 °C |
| Humidity | RH 20% to 90% at wet bulb temp.<40 °C (non-condensing) |
| Vibration | 0.5 G maximum, 5 Hz to 500 Hz |
| Instrument dimensions | 19’’ 4U |
| Weight (NET) | Base is 10 kg + options |

## Display functions

| Description | Supplemental information |
|---|---|
| Spectrum Window | 10 traces or specification lines<br>trace color, thickness adjustable by trace and by type (noise in dBc/Hz and spurious in dBc)<br>Math tools: Addition, subtraction, multiplication or division of trace data<br>Combination of traces (concatenate tool)<br>X-axis adjustable by decade<br>Y-axis min/max values set by user |
| Marker functions | 20 independent markers |
| Frequency stability plots | In addition to a real-time measurement based on instantaneous fractional frequency values, the frequency stability is also estimated from the phase noise trace. |
| Fractional Frequency Plot | A fractional frequency plot versus time can be added. This plot can help to see if the DUT has some transitory frequency instabilities. |
| Special Processing | Additional specialty functions can be added in the software, please contact Noise XT for details. |

## Data Processing Capabilities

| Description | Supplemental information |
|---|---|
| Graphical user interface | The analyzer uses a graphical user interface based on Windows® 10 OS with a Touch Screen<br>The user can use keyboard, the mouse or any combination of the two. |
| File Management | The DNA uses *.csv format to store and load traces. |
| Limit-line test | Any limit-line test can be done and load using the *.csv format. |
| *Raw Data (Option)* | Raw phase data (radian) at the output of the four channels can be optionally recorded into disk for post processing. It is noted that the phase values have been already unwrapped. |
| Internal Data Storage | Internal Removable SSD drive (option) that contains Operating System, DNA Operating Software and calibration tables<br>This HDD/SSD drive may be used to store measurements and configuration files |
| *Removable Internal Data Storage (Option)* | Internal Removable SSD drive (option) that contains Operating System, DNA Operating Software and calibration tables<br>This HDD/SSD drive may be used to store measurements and configuration files |
| External Data Storage | USB thumb drives may be connected to any USB port of the DNA |
| Printing | Any Windows® OS compatible printer may be used. |
| Automation | Remote control of the DNA can be done over the TCP/IP. |