Phase Noise Measurement Personality for the Agilent ESA-E Series Spectrum Analyzers

Product Overview

Now the ESA-E series spectrum analyzers have one-button phase noise measurements, including log plot, spot frequency, carrier drifting, rms phase deviation, rms phase jitter, and residual FM.

The rugged, affordable and portable full featured spectrum analyzer series made even more capable!
An accurate, efficient phase noise measurement solution for R&D and manufacturing environments

The Agilent ESA-E series spectrum analyzers provide flexible general-purpose spectrum analysis and the newly enhanced one-button phase noise measurement capability all in a mid-priced package.

High-purity, high-stability signals have become more important to the modern communications, aerospace, and defense industries. Phase noise is one of the most crucial measures to evaluate the short-term stability of a signal. Therefore, an accurate, fast, and easy-to-use phase noise measurement tool is critical in the R&D and manufacturing environments.

Phase noise measurements can be complex and time-consuming. The previously available phase noise measurement personality (Option 226, version A) on ESA-E series simplified the measurements. By migrating Option 226 from version A to version B, we have enhanced its performance, added more features, and substantially improved the user-interface to make your phase noise measurements easier, faster and more reliable.

<table>
<thead>
<tr>
<th>Features/measurements</th>
<th>Option 226 (version A)</th>
<th>Option 226 (version B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log plot phase noise</td>
<td>Yes</td>
<td>Yes (enhanced)</td>
</tr>
<tr>
<td>Minimum offset freq.</td>
<td>100 Hz</td>
<td>10 Hz (with Options 1D5/1DR)</td>
</tr>
<tr>
<td>Maximum offset freq.</td>
<td>100 MHz</td>
<td>100 MHz</td>
</tr>
<tr>
<td>Maximum number of decades</td>
<td>5 (whole decades only)</td>
<td>7 (whole decades only)</td>
</tr>
<tr>
<td>Measurement speed*</td>
<td>1x</td>
<td>4x</td>
</tr>
<tr>
<td>Smoothing segment</td>
<td>4 discrete levels</td>
<td>Fine-adjustable</td>
</tr>
<tr>
<td>Marker functions</td>
<td>Limited</td>
<td>Fully ESA marker functions</td>
</tr>
<tr>
<td>DANL optimization</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>DANL floor display</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Phase noise cancellation</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Spot frequency phase noise</td>
<td>Yes</td>
<td>Yes (enhanced)</td>
</tr>
<tr>
<td>Carrier freq. drifting</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Graphics/tabular display</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Residual FM</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>rms phase deviation</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>rms phase jitter</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>User interface</td>
<td>Configuration table driven</td>
<td>ESA standard, very intuitive</td>
</tr>
</tbody>
</table>

*The measurement was performed for a log plot measurement from 100 Hz to 10 MHz offset frequency with 4% smoothing and the maximum video filtering on.
Here is how the Agilent ESA-E Series spectrum analyzer benefits you:

**Fully featured phase noise measurement capability**

Phase noise measurements made simple:
- View your system’s phase noise behavior across a wide range of offset frequencies with the log plot measurement.
- Monitor phase noise in real time at your specified single offset frequency.
- Verify and troubleshoot your signal source design with the residual FM measurement.
- Characterize high-frequency digital clock with the rms phase jitter measurement.
- Maximize your confidence in phase noise measurements at the far-out offset with the displayed average noise level (DANL) optimization and at the close-in with the phase noise cancellation.

With spectrum analysis

Maximize measurement capability and confidence:
- 99 dB third order dynamic range to view low level distortion and inter-modulation.
- 1 Hz digital resolution bandwidth up to 220 times faster than analog.
- Phase noise optimization that improves the instrument’s inherent phase noise.
- Continuous automatic background alignment that guarantees repeatability over varying temperatures.

Flexible

Include just the options that you need now or in the future:
- GSM/GPRS, cdmaOne and Bluetooth measurement personalities are three of many available.
- Over 30 hardware options also available.

PC connected

Speed measurement data analysis and enable remote instrument control:
- Industry standard SCPI instrument language for remote control.
- GPIB (Option A4H), RS-232 (Option 1AX) interface available.

Fast

Finish your job quicker:
- Five-minute instrument warm-up for full accuracy.
- Quick phase noise measurement set-ups.
- Phase noise measurements made 4x faster than its preceding version (Option 226, version A)

Easy-to-use

Verify and troubleshoot your design efficiently:
- One-button phase noise measurements to save your time for setting up the instrument.
- One-button, built-in power measurement suites enables quick and accurate power-related evaluation for 2G/3G comms applications.
- Built-in help key for quick reference with out manuals.

Portable

Sophisticated measurement performance anywhere:
- Rugged case, water resistant front panel.
- Snap-on battery (E1779A) or 12 Vdc adapter (Option A5D).
- Carrying/operating case (Option AYT/AYU).

Upgradeable

Ready for other applications:
- Versatile card-cage architecture for hardware expansion.
- Instrument firmware and software upgrades available over the Web.
Phase noise measurements

The Agilent ESA-E series spectrum analyzer with built-in phase noise measurement personality provides you tools to help you characterize phase noise behavior of your design and troubleshoot problems.

Log plot phase noise (frequency domain)

- View entire phase noise behavior across wide range of offset frequencies (10 Hz to 100 MHz).
- Simultaneously display up to seven decades of offset frequency in logarithmic scale.
- Measure phase noise with user-specified number of averages.
- Perform trace smoothing with user-adjustable smoothing segment length.
- A suite of comprehensive ESA marker functions.
- Automatic carrier search.
- Multi-level video filtering.
- Single and continuous measurements.

Figure 1. Log plot phase noise: averaged data superimposed with a smoothed trace

Figure 2. Log plot phase noise with marker table showing different types of measurement results
Figure 3. Phase noise at a single offset frequency and carrier drifting (the right panel)

• Monitor phase noise fluctuation versus time at a user-specified single offset frequency (between 100 Hz and 100 MHz).
• Check carrier frequency drifting with carrier signal tracking.
• Automatic carrier search.
• View results in graphic and numeric list formats.

Integrated noise measurements

• Characterize phase noise related behaviors from different angles for various applications.
• Adjust integration interval by positioning a pair of markers on the log plot.
• Calculate rms phase deviation (or residual PM) in degrees or radians
• calculate rms phase jitter in seconds.
• Calculate the residual FM in Hz.
• Numeric marker readings for the calculated results.

DANL optimization and the DANL floor measurement

• Optimize the ESA input attenuation levels at different offset frequency segments for the best measurement sensitivity.
• Measure and reference the DANL of the ESA to the carrier amplitude.
• Display the DANL curve together with the log plot phase noise.
• Easy trace management.
Phase noise cancellation

- Measure the ESA’s internal phase noise using a source with low phase noise.
- Eliminate the influence of the ESA’s internal phase noise on measurement results.
- Improve measurement accuracy and sensitivity.
- Make the best trade-off between cancellation effectiveness and computation time with user-selectable thresholds.

Figure 6. Display of the internal phase noise (the lower trace), the manifested and the corrected phase noise of the signal under test (the upper and the middle trace, respectively)

Here is how you order your ESA-E spectrum analyzer

First, choose your frequency range.

- E4401B  9 kHz* to 1.5 GHz
- E4402B  9 kHz** to 3.0 GHz
- E4404B  9 kHz** to 6.7 GHz
- E4405B  9 kHz** to 13.2 GHz
- E4407B  9 kHz** to 26.5 GHz

Now, choose your option configuration.

**ESA-E series spectrum analyzer plus options:**
- 226 – Phase noise measurement personality (Version B)
- B72 – Memory extension

Recommended options:
- 1DR† – Narrow resolution bandwidth
- 1D5†† - High stability frequency reference

*: 1 MHz for analyzers with Option 1DP, 75 Ohm Input Impedance
**: 100 Hz for analyzers with Option UKB, 100 Hz Low Frequency Extension
†: Required if the minimum offset frequency to be measured is 100 Hz.
††: Required with 1DR if the minimum offset frequency to be measured is 10 Hz.
Specfication summary

Phase noise measurement personality

Measurement modes: spectrum monitor  
log plot  
spot frequency

Carrier frequency range:
- E4401B: 1 MHz* to 1.5 GHz
- E4402B: 1 MHz* to 3.0 GHz
- E4404B: 1 MHz* to 6.7 GHz
- E4405B: 1 MHz* to 13.2 GHz
- E4407B: 1 MHz* to 26.5 GHz

Offset frequency range
Minimum offset frequency
- With Options 1DR and 1D5: 10 Hz
- With Option 1DR only: 100 Hz
- Without Option 1DR: 10 kHz

Maximum offset frequency: 100 MHz

Maximum number of decades: Seven (whole decades only)

Maximum input signal level: 20 dBm

Minimum input signal level (for optimum dynamic range): –50 dBm

Measurement accuracy (nominal)
Amplitude accuracy: < ±1.52 dB (RSS value, based upon a 1 GHz, 0 dBm signal while running the Log Plot measurement, with all other instrument settings at their factory defaults)

Amplitude repeatability: 0.44 dB (with 0.3 VBW/RBW, 4% smoothing. The measurements were made at 100 kHz offset frequency for a 1 GHz, 0 dBm signal)

Video filtering: four levels available
Smoothing: fine-adjustable between 0% and 16%

rms noise calculation: rms phase deviation, rms phase jitter, and residual FM is calculated over a user specified integration interval.

Figure 7. System phase noise

* The phase noise measurement performances are not specified for a carrier signal with its center frequency being lower than 1 MHz.
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Product literature

ESA-E Series Spectrum Analyzers, Brochure, literature number 5968-3278E

ESA-E Series Spectrum Analyzers, Technical Specifications, literature number 5968-3386E

Select the Right Spectrum Analyzer for Your Needs, Selection Guide, literature number 5968-3413E

ESA Snap-on Battery Pack, Product Overview, literature number 5966-1851E

IntuiLink Software, Data Sheet, literature number 5980-3115EN

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