TECHNICAL OVERVIEW

N522x/4xB PNA/PNA-X Vector Network Analyzers Enhancement

Signal Source Breakthrough

Proprietary DDS (Direct Digital Synthesizer) improves your active device characterization and decreases test time

- Extremely low phase noise
- Excellent phase stability improving measurement speed
- Three sources to simplify measurement setups

KEYSIGHT TECHNOLOGIES

New DDS Synthesizers Improve PNA Measurement Performance

Measuring next generation devices

Testing mixers and frequency converters for 5G and satellite applications involves many parameters including gain, phase, delay, IMD, gain compression, and noise figure. With so many parameters to capture, it can take days or even weeks to characterize complex transponders. When you finally have your test results, you need to know if spurious or phase noise at the device's output is from the device itself or from your input signal. It's impossible to trace the origins of errors without a consistent and reliable test setup.

The new DDS sources in the PNA and PNA-X feature extremely low phase noise and spurious emissions to help you measure complex components faster.

Very low phase noise of RF source signal

New N522xB PNA and N524xB PNA-X Vector Network Analyzers employ DDS (Direct Digital Synthesizers) as the signal sources. DDS sources typically introduce unwanted spurious emissions, but Keysight's proprietary DDS developed for high-end signal generators achieves both extremely low phase noise, -122 dBc/Hz at 100 kHz offset at 10 GHz carrier (typical) and low spur levels, < -80 dBc (typical). The new sources improve the phase noise by 30 dB and also measurements that require input signals with low phase noise such as close two-tone IMD measurements.

The new sources with DDS with very low phase noise make phase measurements more stable and improves the measurement performance of some applications that require stable phase noise measurements: SMC+phase, differential IQ, true mode stimulus analysis.

Option UNY Enhanced low phase noise improves the phase noise performance of the new standard PNA/PNA-X by 10 dB or better, -131 dBc/Hz at 100 kHz offset at 10 GHz carrier (typical). The phase noise performance is comparable to the low phase noise option of high-performance analog signal generators like Keysight PSG with Option UNY mode 1.

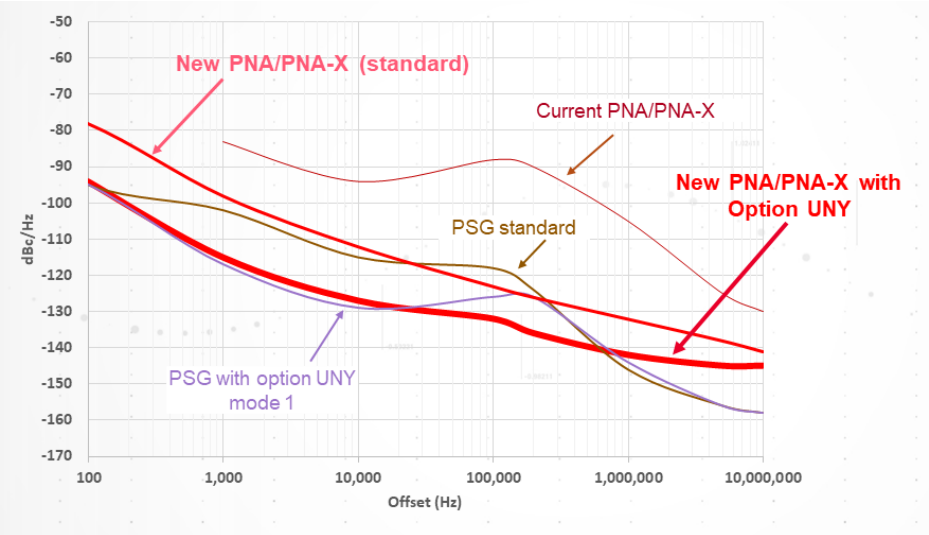

Figure 1. 10 GHz phase noise comparison

The two-tone measurements in the Figure 2 compare the spectral purity of the previous signal source in PNA and that of the new source in the current version of PNA with option UNY. The phase noise is much better and also the close-in spurious signals are essentially eliminated.

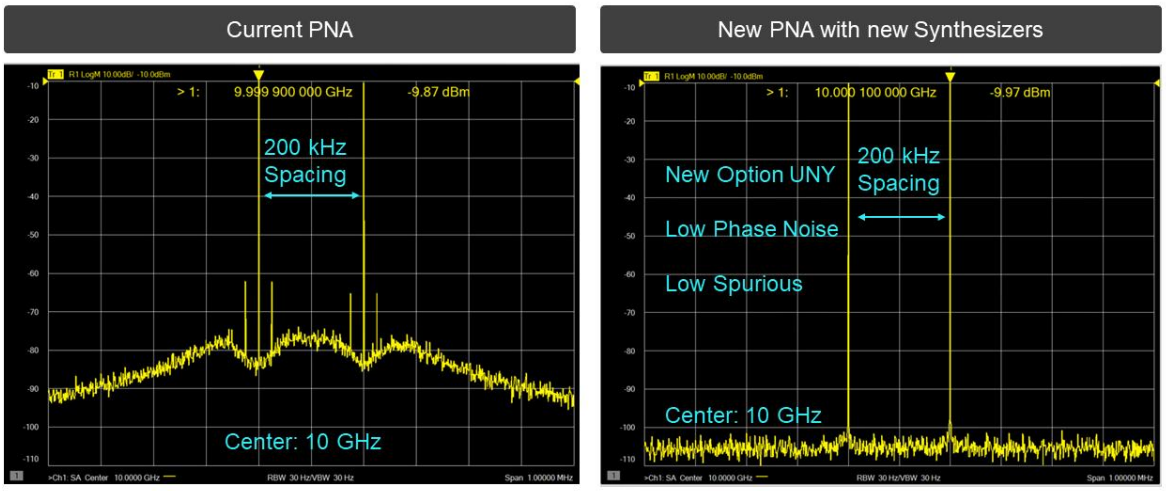

Figure 2. Two-tone measurements

Measurement speed improvement

The frequency converter test is typically time-consuming, and you need to measure various measurement parameters such as gain, delay, phase, IMD, spurious, gain compression, and noise figure. One of the biggest benefits from the new DDS source is the phase measurement stability. When you measure the phase and delay of frequency converters, you may need to take averages due to relatively large trace noise of phase measurements, which slows down the measurements. The new sources achieve excellent phase measurement stability and eliminate the need for averaging. The combination of general speed improvement and excellent phase measurement stability significantly reduces the test time, and in some cases, it drastically improves the test throughput of the frequency converters by more than 50 times without compromising the measurement accuracy.

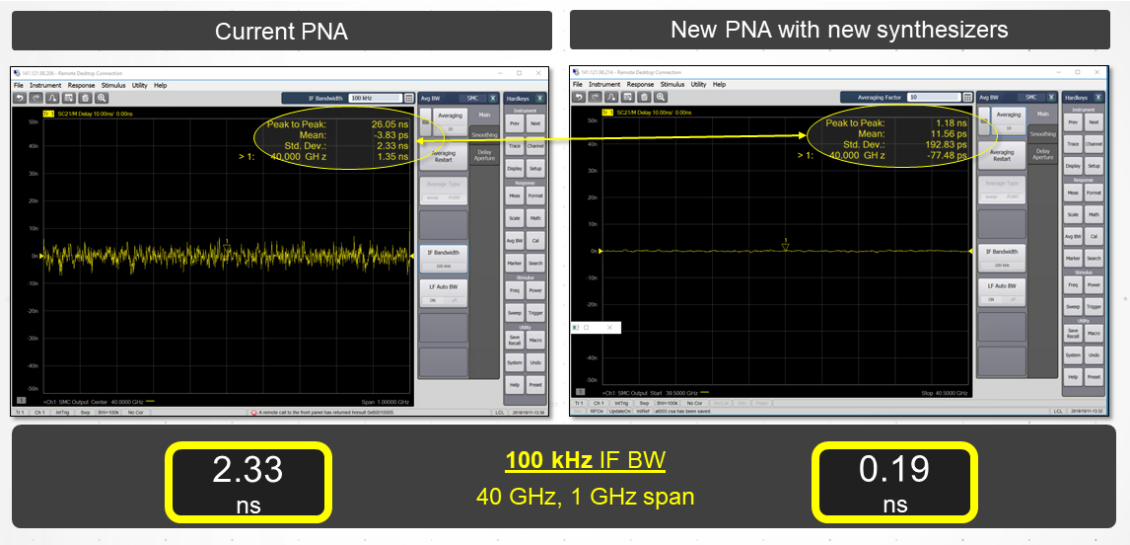

Figure 3. Mixer group delay measurement with SMC+phase application

Additional RF source port

A third RF source up to 13.5 GHz (option XSB) can be added to the N524xB 4-port PNA with option 422 or 423. The third source also has the same low-phase noise performance as the two internal RF sources. You can use it as the local source of the DUT for two-tone frequency converter measurements or two-stage frequency converter measurements. It eliminates the need of an external signal generator. You can also use it as an independent analog signal generator. For example, it can be used as the reference signal for a DUT that requires the external reference clock signal, and as the reference signal of another measurement instrument like Keysight's UXG agile vector adapter. If you add both Option UNY and Option XSB, the 4-port PNA-X has three signal sources with extremely low phase noise performance. You gain the equivalent of three high-performance analog signal generators built in the 4-port PNA-X.

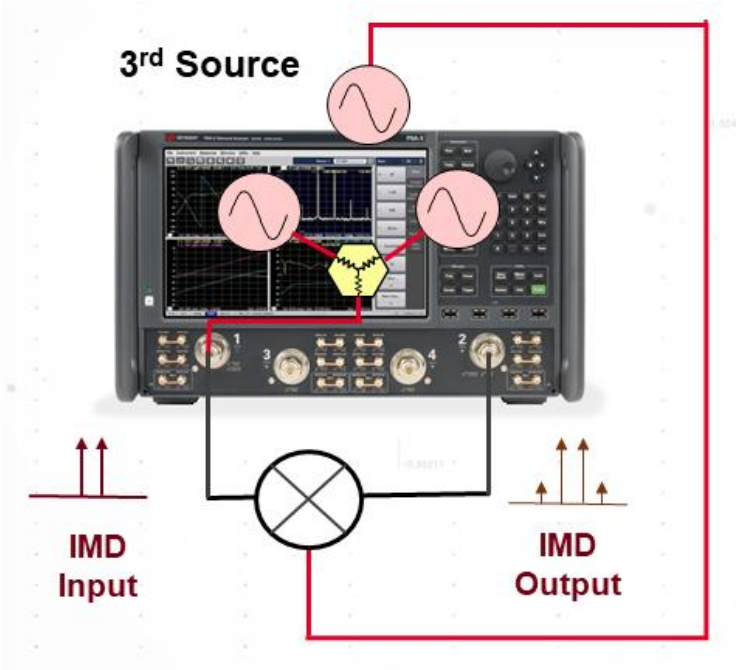

Figure 4. Two-tone IMD mixer measurement

Dynamic range improvement by 30 dB in sub-THz region

Measuring highly integrated devices in the sub-THz region brings new challenges. As the source signal is multiplied into millimeter frequencies, the phase noise also multiplies and decreases the dynamic range of the measurement with the N5292A test set and frequency extenders. The new PNA/-X signal sources with extremely low phase noise improve the measurement dynamic range within sub-THz frequency range from 70 dB to 100 dB.

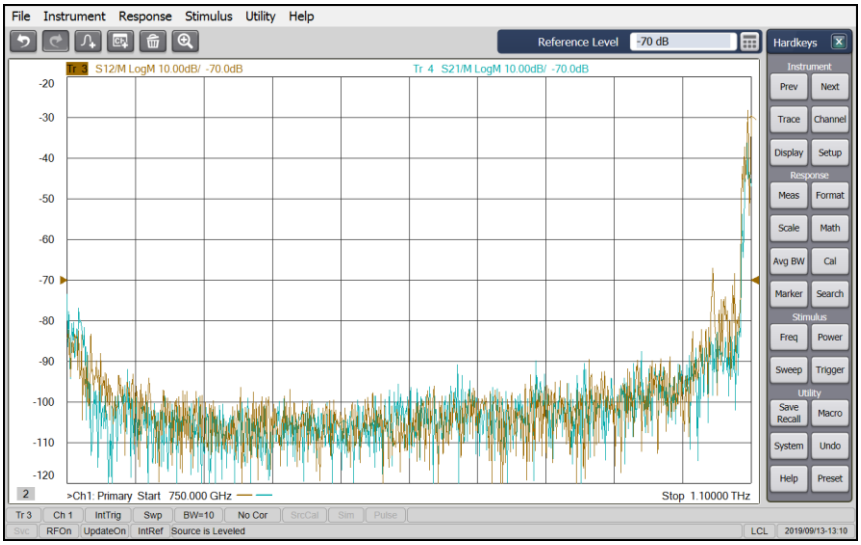

Figure 5. 100 dB dynamic range 750 GHz to 1.1 THz (IFBW = 10 Hz)

Software Enhancement

Modulation distortion application

The PNA applications also keep evolving. The S93070xB modulation distortion application allows you to measure EVM/NPR/ACPR under modulated stimulus condition. With vector error correction, the modulation distortion application allows you to measure very low EVM. The application originally only covered amplifiers, but the S93070xB application has been enhanced to include mixers and frequency converters as DUTs. Now you can measure EVM/NPR/ACPR of mixers or frequency converters under wideband modulated stimulus condition without losing any advantages of this application: very low residual EVM and NPR, intuitive operation with simple setup, no bandwidth restriction, and accurate and consistent reproducibility.

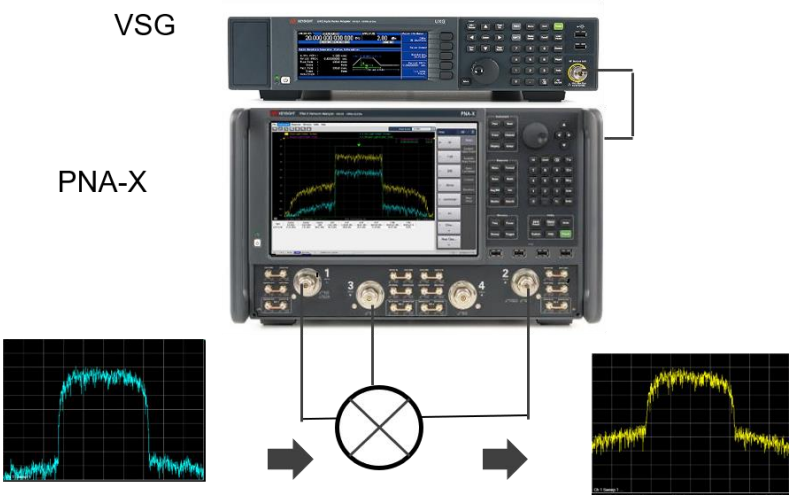

Figure 6. Mixer EVM/NPR/ACPR measurement with Modulation distortion application

Phase noise measurement application

The phase noise measurement application, S930317B/S930321B, enables you to make phase noise measurements with the PNA or PNA-X. The application eliminates the need for a signal analyzer for phase noise measurements by taking the advantage of the new DDS source with low phase noise. This application allows you to measure the phase noise of RF signal sources and 2-port active devices such as embedded-LO frequency converters. You can also measure the residual noise of amplifiers. The application simplifies your active device measurement configuration by using the same cable connection as other measurements. The phase noise measurement noise floor is comparable with high-performance signal analyzers with phase noise measurement capability like the UXA signal analyzer with phase noise measurement application. It however achieves much lower noise floor of residual noise measurements at close-in offset frequencies. This application can also make AM noise, spurious and integrated noise measurements.

Embedded-LO frequency converter

Signal Source under Test

Figure 7. Phase noise measurement setup examples

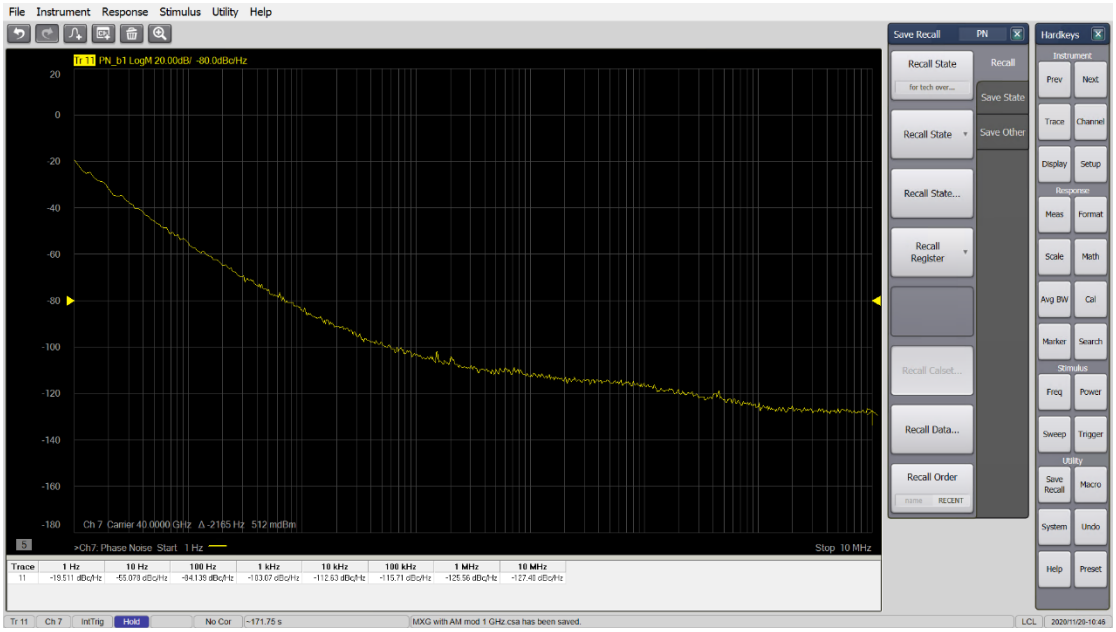

Figure 8. Phase noise measurement example

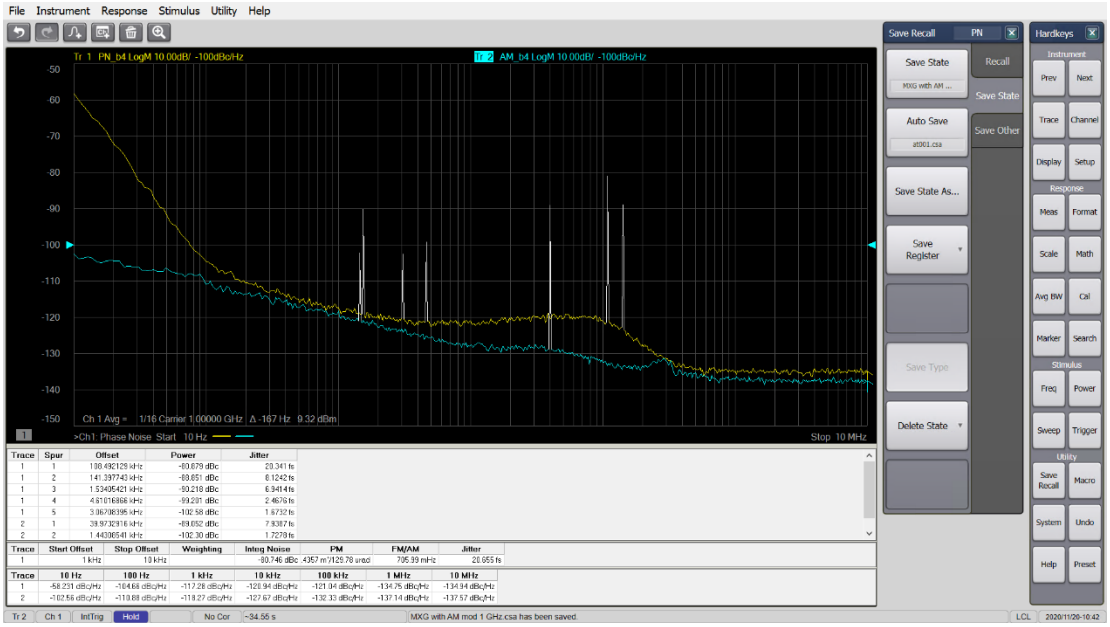

Figure 9. Oscillator phase noise, AM noise, and spurious measurement example

No need for harmonic mixers for millimeter-wave phase noise measurement

The measurement frequency range is from 10 MHz to the highest frequency of the PNA or PNA-X. When the N5292A test set controller and the N5293AXxx/5AXxx frequency extenders are connected to the PNA or PNA-X, (or the N5290A/91A broadband millimeter-wave test system is used), the phase noise can be measured up to 110 GHz/125 GHz. Unlike the dedicated phase noise test systems, no harmonic mixers are needed even for millimeter-wave frequencies.

Measurement performance

- Offset frequency range: 0.1 Hz to 10 MHz
- Sweep speed (typical): 34 seconds (1 Hz to 10 MHz offset in normal mode)

Sensitivity (Supplemental Performance Data) [1]

SSB Phase noise sensitivity [dBc/Hz] (Supplemental Performance Data) [2]

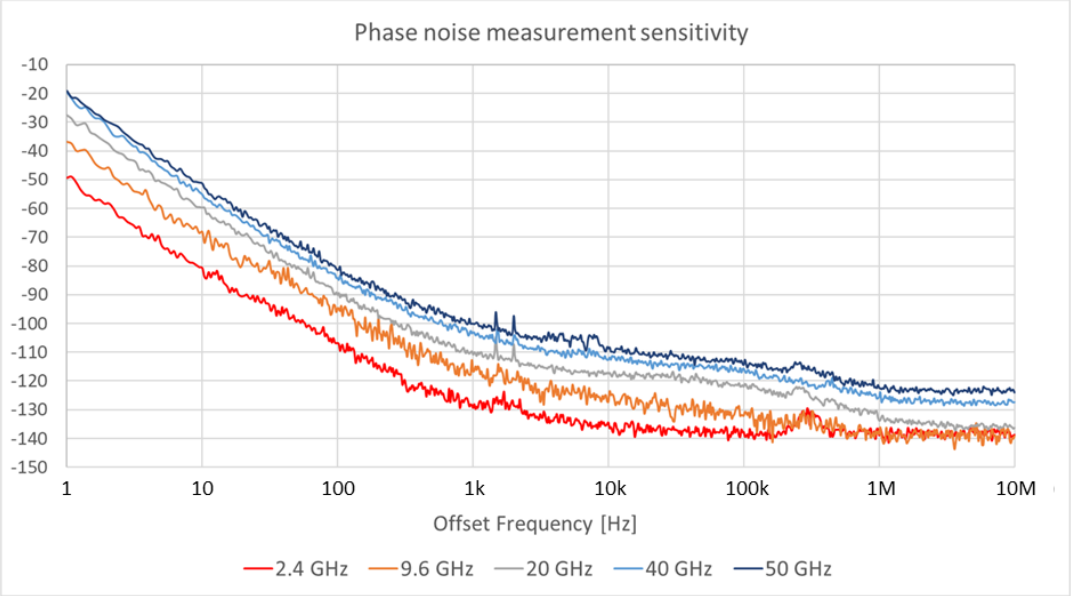

Figure 10. PNA phase noise measurement noise floor

SSB residual noise sensitivity [dBc/Hz] (Supplemental Performance Data) [2]

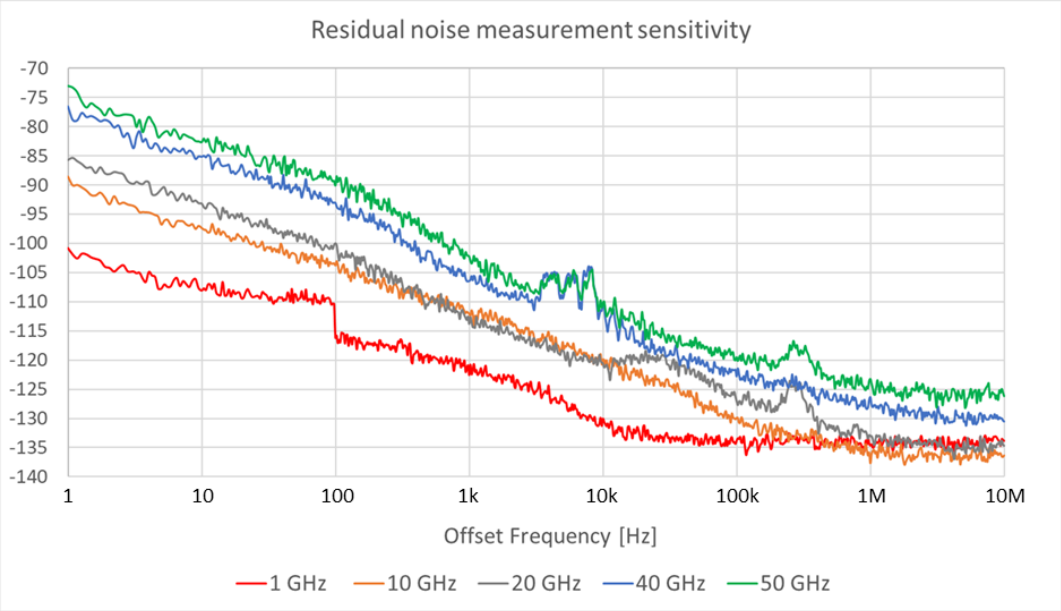

Figure 11. PNA residual measurement noise floor

1. Supplemental performance data (SPD) represents the value of a parameter that is most likely to occur; the expected mean or average.
2. N5245B PNA-X sensitivity at 300 kHz offset may be worse than that at 100 kHz offset by a few dB for certain carrier frequencies.

Summary

The new PNA-X allows you to simplify the measurement setup to measure gain, phase, delay, EVM, NPR gain compression and other parameters of the frequency converters for 5G and satellite transponders and reduce the test time.

Ordering Information

N522xB PNA Network Analyzers/N524xB PNA-X Network Analyzers

- Option UNY Enhanced low phase noise (Export-controlled)
- Option XSB 3rd RF source (available only with N524xB with option 422 or 423)

EVM, NPR and ACPR measurement with Modulation distortion application

• Amplifier	S93070xB
• Frequency converter/Mixer	S93070xB and S93083B
• Frequency converter with embedded LO	S93070xB, S93083B and S93084B

Phase noise measurement application [1]

• Phase noise measurement up to 70 GHz	S930317B
• Phase noise measurement up to 125 GHz	S930321B

1. Phase noise measurement application does not support general spectrum analysis. Spectrum Analysis application, S9309xB is recommended for full SA capabilities.

Related Literature

Literature	Publication number
PNA Family Microwave Network Analyzers (N522x/3x/4xB) - Configuration Guide	5992-1465EN
Microwave Network Analyzers PNA-X Series - Brochure	5990-4592EN
PNA and PNA-L Series Microwave Network Analyzers - Brochure	5990-8290EN
S93070xB Modulation Distortion Application for the PNA-X – Technical Overview	5992-3974EN
Keysight 2-Port and 4-Port PNA Network Analyzer: N5221B – 900 Hz to 13.5 GHz, N5222B – 900 Hz to 26.5 GHz – Data Sheet	N5221-90003
Keysight 2-Port and 4-Port PNA Network Analyzer: N5224B – 900 Hz to 43.5 GHz, N5225B – 900 Hz to 50 GHz – Data Sheet	N5224-90003
Keysight 2-Port and 4-Port PNA Network Analyzer: N5227B – 900 Hz to 67 GHz – Data Sheet	N5227-90005
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5249B – 900 Hz to 8.5 GHz, N5241B – 900 Hz to 13.5 GHz, N5242B – 900 Hz to 26.5 GHz – Data Sheet	N5242-90027
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5244B – 900 Hz to 43.5 GHz, N5245B – 900 Hz to 50.0 GHz – Data Sheet	N5245-90028
Keysight 2-Port and 4-Port PNA-X Network Analyzer: N5247B – 900 Hz to 67 GHz – Data Sheet	N5247-90029

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