X-Apps Mark the Spot

Essential Signal Analyzer Measurement Apps for Faster Testing

eBook

KEYSIGHT

How Can Measurement Software Help?

Do you ever find yourself in the lab struggling to recreate test results your co-worker produced? Do you have to run similar measurements repeatedly during validation or manufacturing? This can be a common time-sink in the lab. It can take a great deal of time to generate test setup documentation and then recreate those test setups, just to make consistent measurements between design and development phases. With the right software, you have access to ready-to-use measurements featuring built-in results windows and standards conformance tests.

In this e-book you will learn how measurement applications increase both the capability and functionality of signal analyzers, while reducing your time to achieve measurement insights. Signal analyzer applications provide essential measurements for specific tasks across cellular communications, wireless connectivity, or general-purpose applications – all of which cover the latest standards or modulation types. These applications make understanding test results easier and faster with intuitive displays and graphs. Additionally, they can help you maintain consistent measurement results between different teams and over your entire design cycle from R&D to production. The increased efficiency and consistency of applications means engineers can spend less time dialing in measurements and more time evaluating and improving designs.

Keysight's signal analyzers offer a unique family of measurement applications called PathWave X-Series Applications which accelerate the analysis performance of your designs by simplifying complex tasks and delivering repeatable measurements. Ensure your designs meet the latest standards and gain more insight into device performance with trusted results from Keysight's PathWave X-Apps.

Explore general-purpose measurement applications, including:

- Phase noise
- Noise figure
- Vector modulation
- Analog demodulation

Learn more about application-specific measurements, such as:

- LTE FDD
- 5G NR
- EMI
- WLAN

Contents

CHAPTER 1

Phase Noise

CHAPTER 1

Phase Noise

Phase noise can be expressed as random, short-term frequency instability. Phase noise is a key specification in both transmitter and receiver performance. For example, transmitting phase noise with digitally-modulated signals leads to the spreading of symbols, limiting the symbol rate. Phase noise in a receiver's local oscillator limits sensitivity by obscuring a weak signal in LO phase noise sidebands. Identifying system weaknesses such as these is crucial to the performance of your device.

One way to test for phase noise is the direct spectrum method. This is recommended to ensure the accuracy of your results. The direct spectrum method involves measuring the single-sideband phase noise power in the signal analyzer and using those results to optimize the signal analyzer's setting for accurate measurements. For example, you may set resolution bandwidth (RBW) and set up phase locked loops. This is tedious to perform every time you want to make such a common measurement. Instead, you could make use of an application such as Keysight's Phase Noise PathWave X-App, which can automatically configure these settings for you.

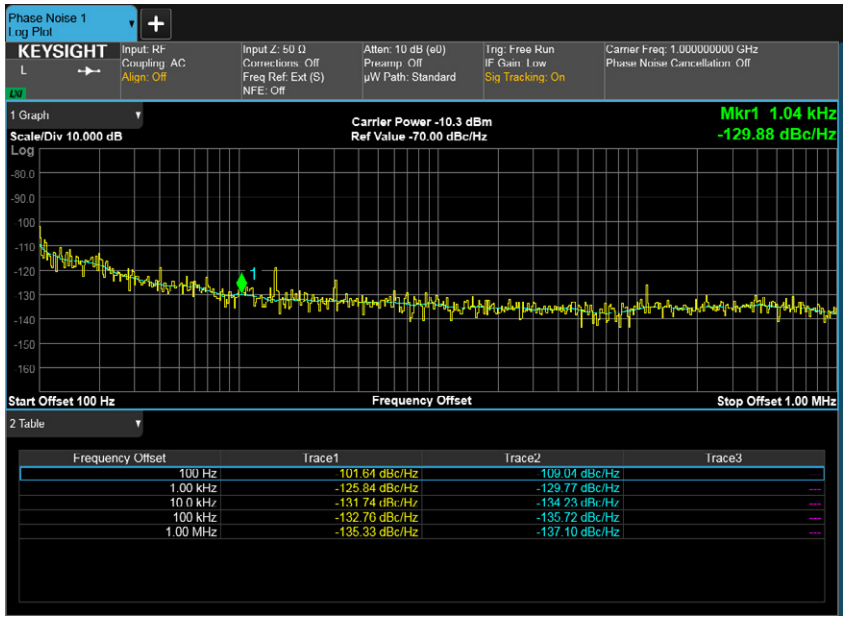


Figure 1. Using phase noise measurement application with Log Spot measurement to make a noise measurement over the range of frequencies

In addition, a phase noise measurement application may also be able to log plot SSB phase noise versus offset frequencies, so you can view the phase noise behavior of your signal across decades of offset frequencies. An application may also allow you to set many advanced markers on your log plot to analyze:

- Integrated noise
- Averaged noise density
- Residual FM
- Spurious peaks
- Absolute slope
- Octave slope
- Decade slope

Another useful tool in a phase noise application is the spot frequency measurement, which can continuously measure the phase noise and delta frequency at any offset from the carrier.

Curious to learn more about phase noise and what existing solutions are out there? Read more in the *Phase Noise Measurement Solutions – Selection Guide.*

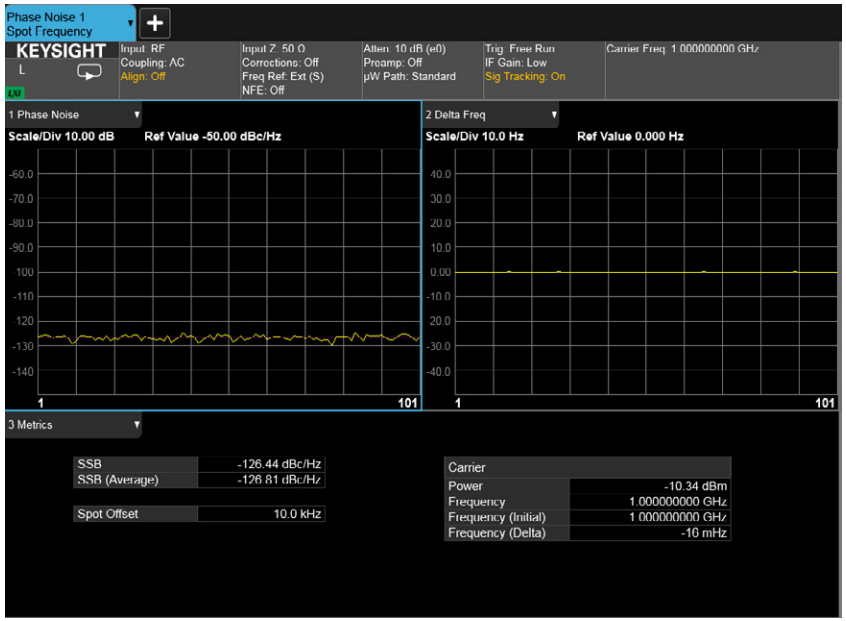
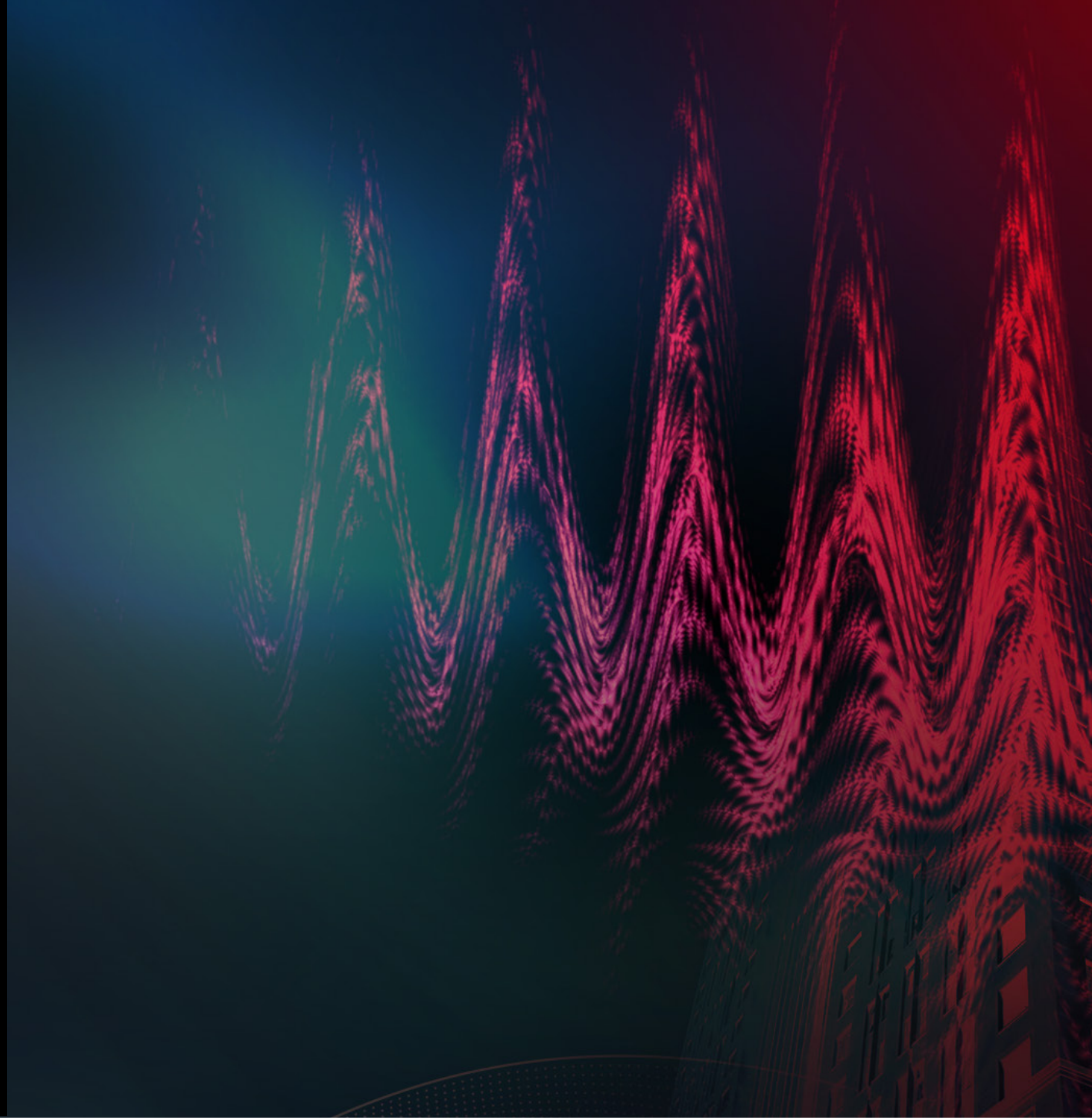


Figure 2. Using phase noise measurement application with Spot Frequency measurement to measure the phase noise at a single offset frequency

CHAPTER 2

Noise Figure



Noise Figure

Noise figure is key to characterizing the performance of a receiver. It indicates your receiver's ability to detect weak incoming signals in the presence of self-generated noise. To minimize problems resulting from noise generated in receiver systems, you can either make a weak signal stronger, or reduce the noise of that system. As one of the fundamental parameters of your system, you'll need a simple way to make fast, accurate, and repeatable measurements. An application like Keysight's Noise Figure PathWave X-App enables this along with:

- Noise factor
- Gain
- Effective temperature
- Y-factor
- Hot/cold power density

For more on noise figure check out this application note:
10 Hints For Making Successful Noise Figure Measurements.

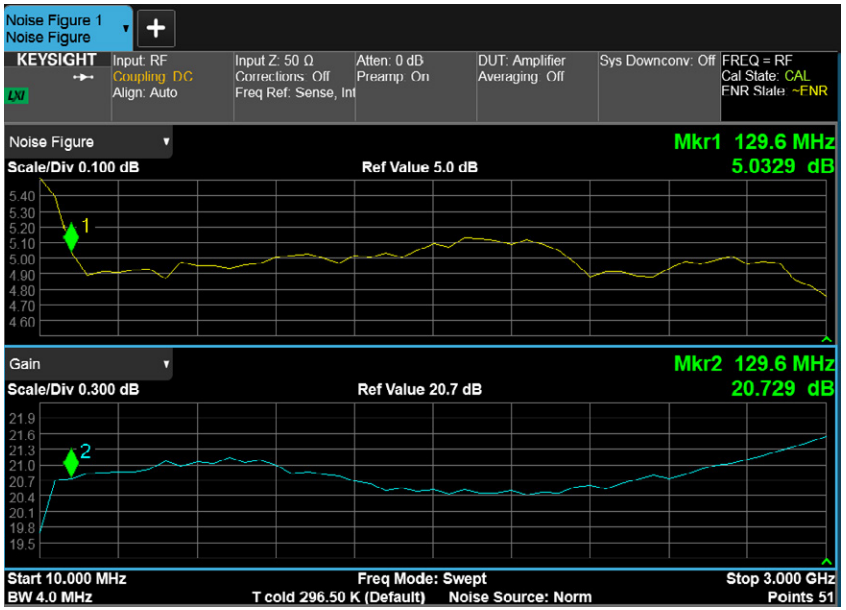
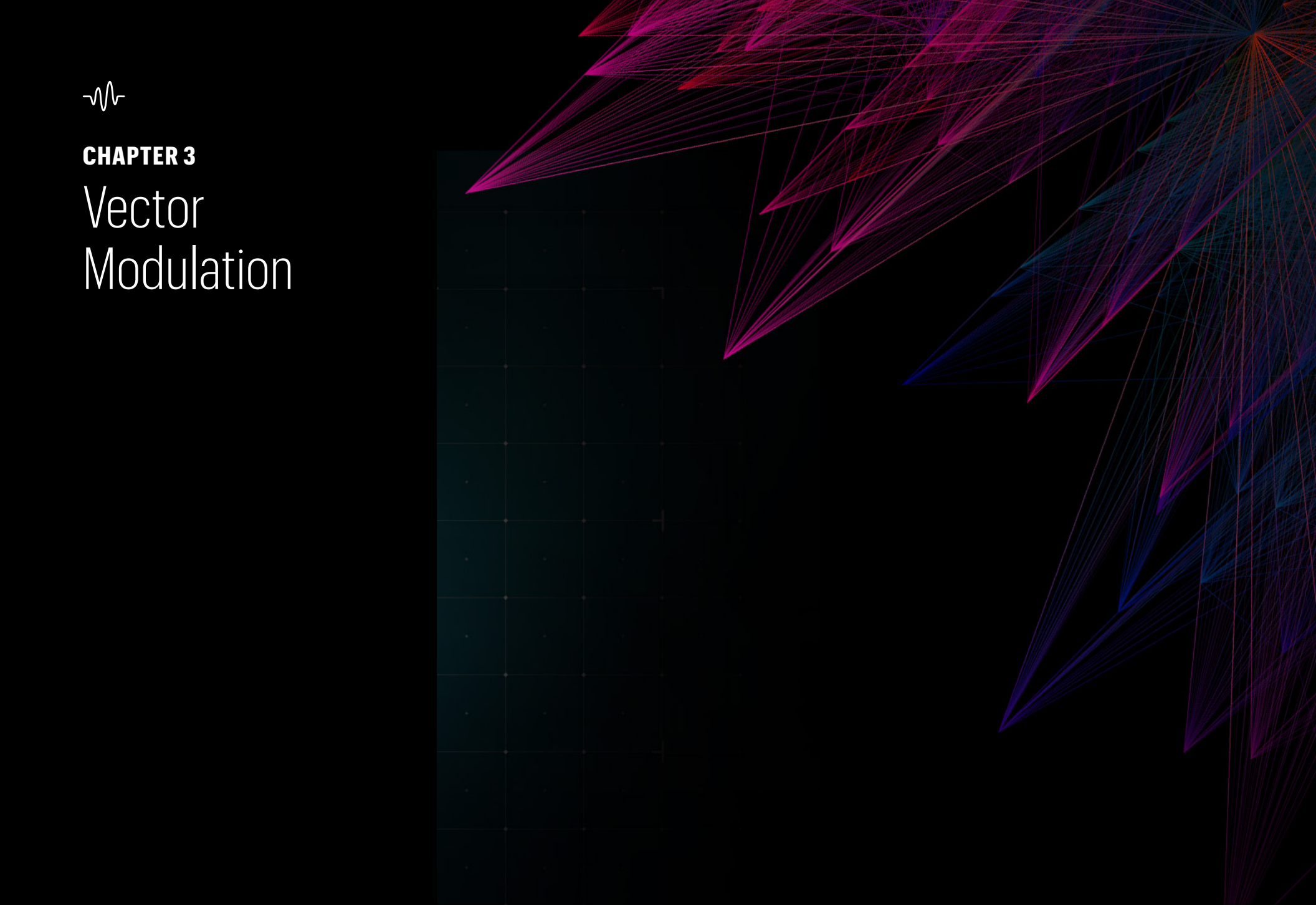


Figure 3. Using a noise figure measurement application to make a number of noise figure measurements over a specified frequency range



CHAPTER 3

Vector Modulation

CHAPTER 3

Vector Modulation

Using a signal analyzer for time domain measurements, such as I/Q waveform, may not seem intuitive – you may be thinking, "do spectrum analyzers even make time domain measurements?" But you don't need to go through the cumbersome process of unhooking your test setup and reconnecting to different test equipment to get the required results. With the right software, signal analyzers can provide digital modulation vector measurements. The Vector Modulation PathWave X-App with your signal analyzer can support digital demod measurements with multiple result traces like:

- Raw main time
- I/Q time and spectrum results
- EVM time and spectrum results
- Demodulation bits

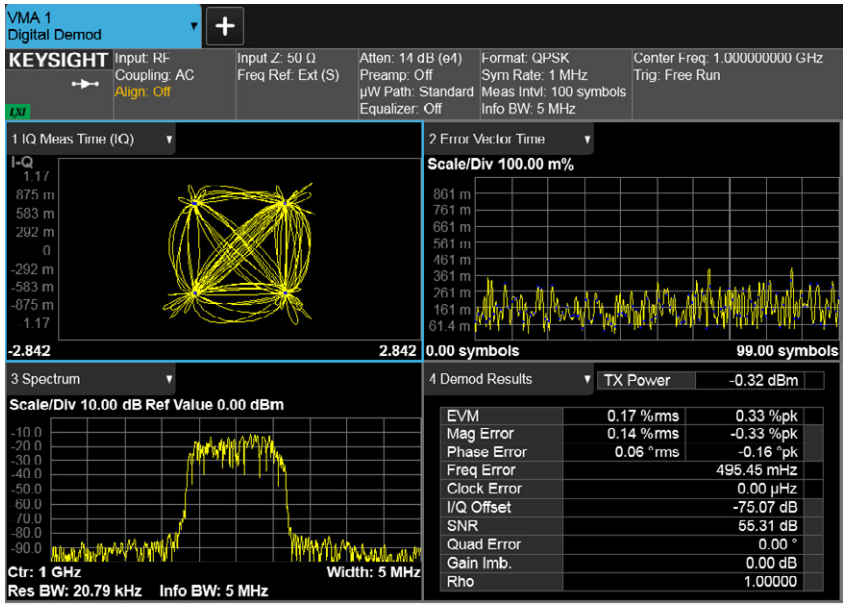


Figure 4. Using the Vector Modulation Analysis (VMA) digital demodulation measurement application to analyze the QPSK signal quality

Depending on the application you use, it may even have convenient presets for popular formats such as NADC, EDGE, PDC, MIL-STD CPM, and 16/32/64/256 QAM.

Learn more about vector modulation in the following application note: *Use Vector Modulation Analysis to Analyze Complex Signals*

CHAPTER 4

Analog Demodulation

CHAPTER 4

Analog Demodulation

Audio signals do not have the right propagation properties to be transmitted over a great distance. Therefore, you may use analog modulation to combine your audio data with a radio frequency (RF) carrier which can be transmitted over huge distances and through obstacles.

The Analog Demodulation PathWave X-App can help you analyze your mixed, transmitted signal and even take the two components back apart (demodulation), so you can recover the valuable information and measure the quality of your modulation and transmission.

- Analog demodulation application measurements help you:
- Monitor the RF spectrum
- Demodulate your waveform
- Evaluate your modulation metrics
- Apply post-demodulation filters
- Analyze transient signals
- Analyze FM stereo and RDS signals

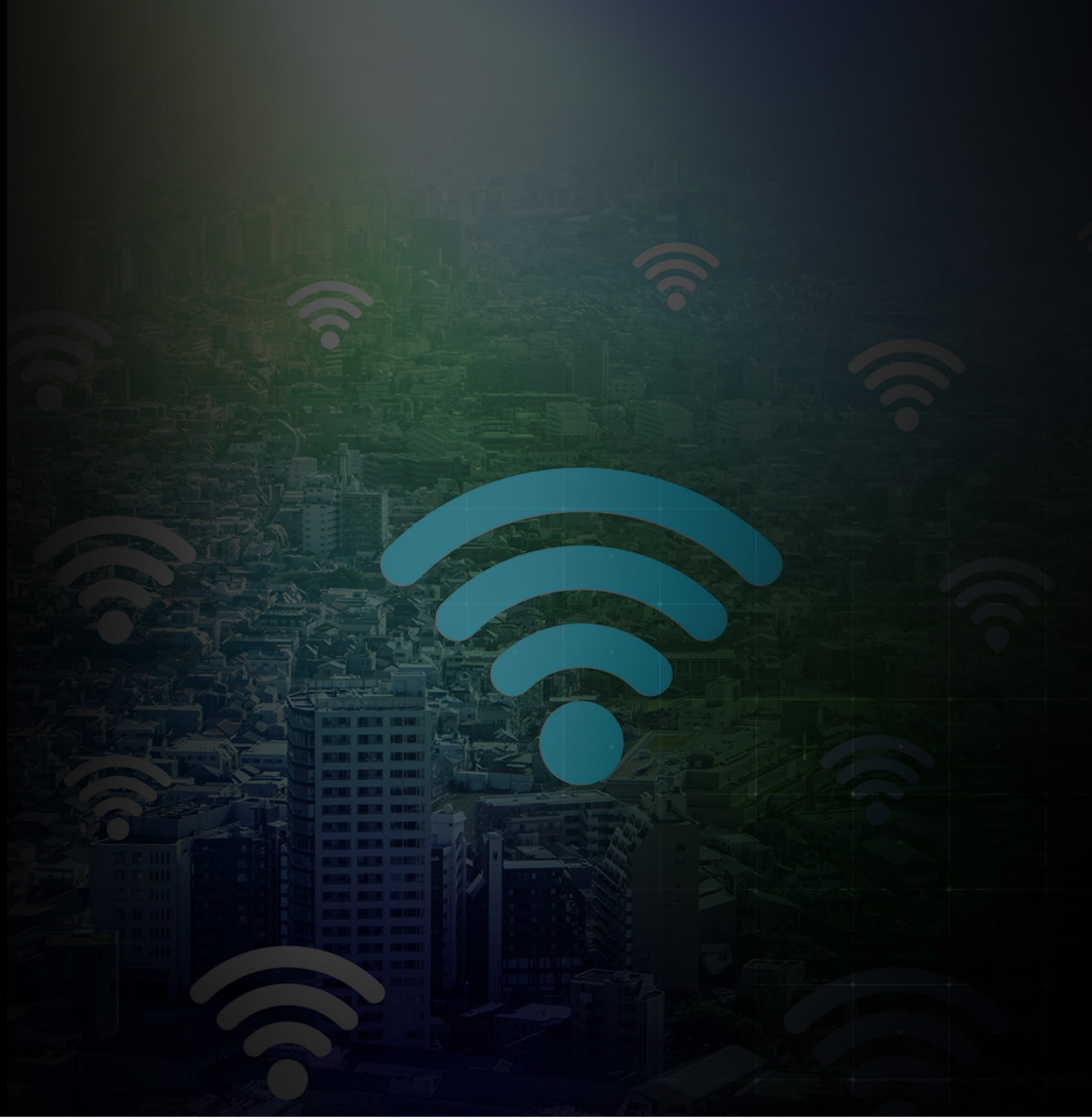
Figure 5. Using an analog demodulation measurement application to analyze the FM Stereo with RDS signal

Being able to easily access this information will improve design, evaluation, and manufacturing of your analog devices.

Learn more in this webcast: *Analog Demodulation with Spectrum Analyzers*

CHAPTER 5

LTE (long-term evolution)



CHAPTER 5

LTE (Long-Term Evolution)

Mobile devices prevalently use LTE FDD or TDD (frequency and time division duplex, respectively). Understanding detailed LTE specifications and then implementing them in products and systems that meet the needs of consumers can present many challenges. Using software in combination with signal analyzers can provide you with a package of test configurations to help you evaluate if you are in conformance with LTE base stations. They can also help you test 256QAM downlink transmission and perform RF transmitter measurements on eNB and UE devices in time, frequency, and modulation domains. Be sure to choose the LTE PathWave X-App which closely follows the 3GPP standard to ensure you stay aligned with the latest standard regulations and are on the leading edge of your design and manufacturing challenges.

For more information on characterizing LTE, check out this application note: *Measuring ACLR Performance in LTE Transmitter.*

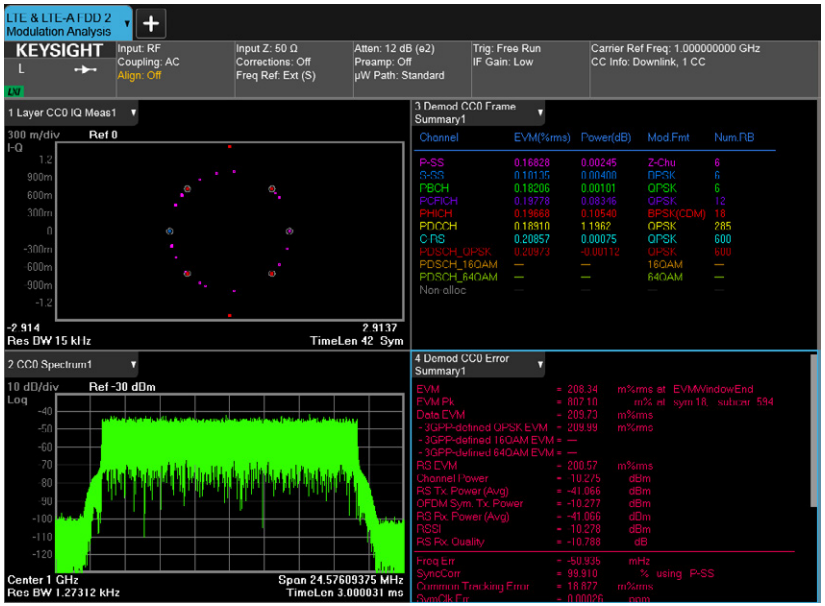
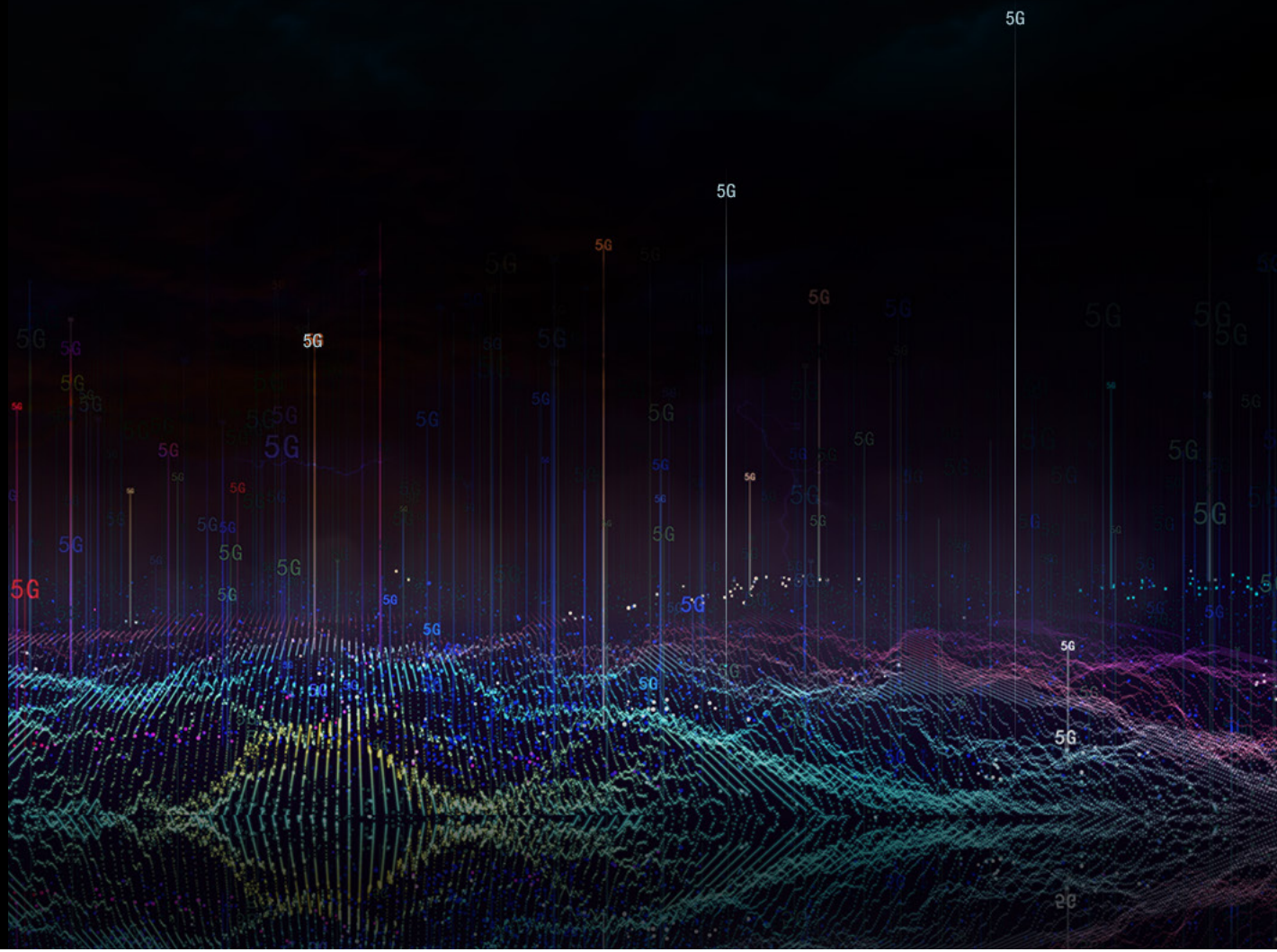


Figure 6. Using the LTE-Advanced FDD measurement application to analyze LTE FDD test model signal quality

5G

CHAPTER 6

5G NR (New Radio)



CHAPTER 6

5G NR (New Radio)

Working to stay up to date with the latest wireless standards? Likely you're working on 5G NR designs. It's important to conformance test in-house throughout the design process. Not only will this keep you efficiently debugging through your design phases, but also prevents surprises when you move towards validation and manufacturing. In a world hurtling towards 5G, you can't afford to fall behind.

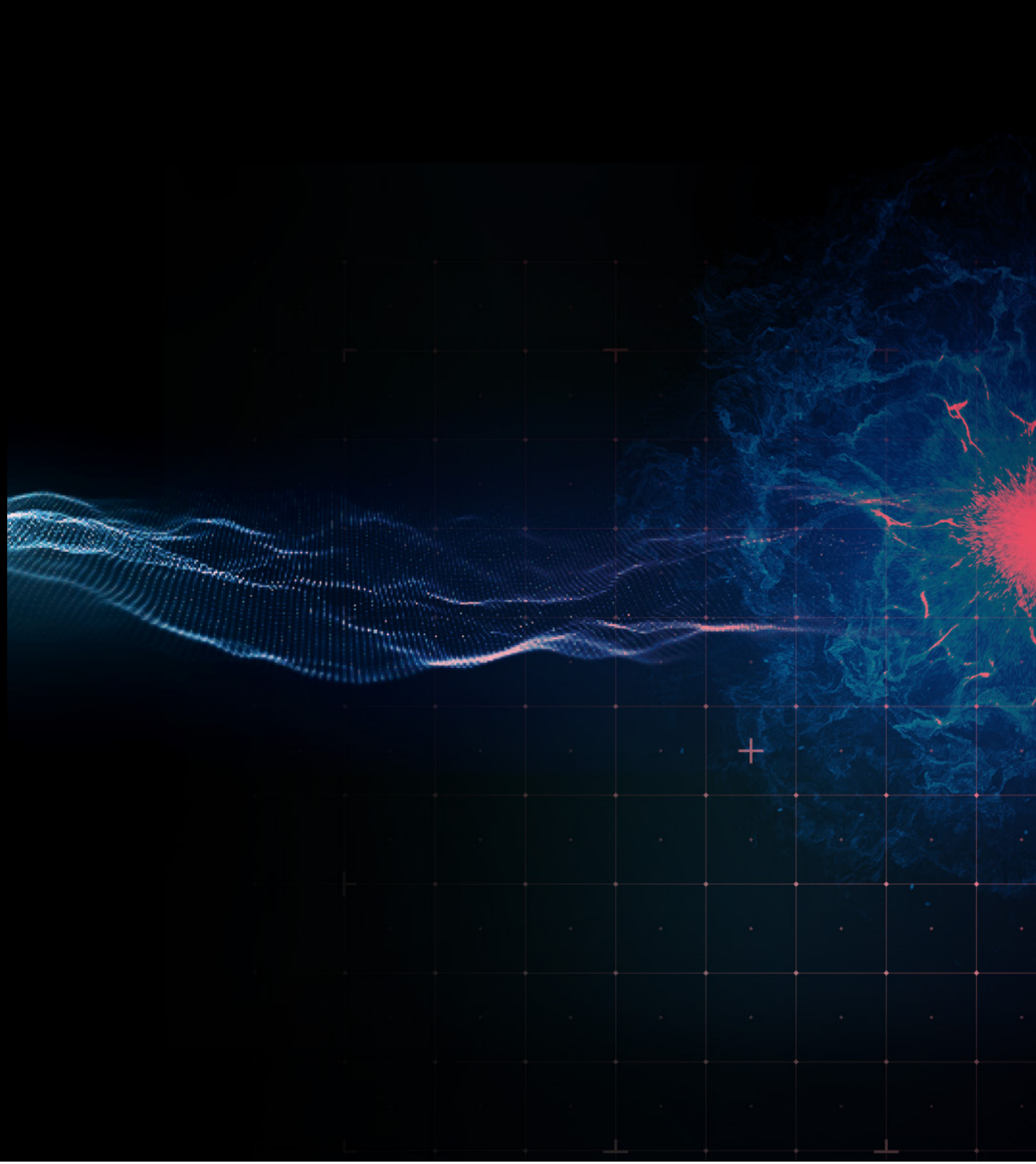
The 5G NR PathWave X-App can help you convert your lab's standard signal analyzer into a standards-based RF transmitter tester, streamlining your measurements. Use an application that closely follows the 3GPP standard to make sure you are delivering ultra-reliable low latency communication systems (URLLC). Applications can also make it easier to switch between time, frequency, and modulation domains, which are common with gNB and UE devices.

To learn more about the 5G NR standard check out part 1 of 4 of this white paper series: *First Steps in 5G, Overcoming New Radio Device Design Challenges Series*

Figure 7. Using the 5G NR measurement application to analyze 5G NR downlink signal quality

CHAPTER 7

EMI (Electromagnetic Interference)



CHAPTER 7

EMI (Electromagnetic Interference)

All wireless devices have electromagnetic emissions. If they are not controlled, they could cause interference and the malfunction of nearby devices. Therefore, your device must pass electromagnetic compatibility tests. You should have a third-party test this for you to certify your device. However, before submitting your device to a third-party tester, you'll want to know that your design is going to pass. Building another prototype revision this far along the design cycle can be costly. The EMI Pathwave X-App on your signal analyzer can keep you informed about your device's electromagnetic emissions, so you can correct it from the beginning, avoiding costly prototype revisions. EMI test applications make tests easy, consistent, and conform with third party standards so you can be confident in your device's certification test results.

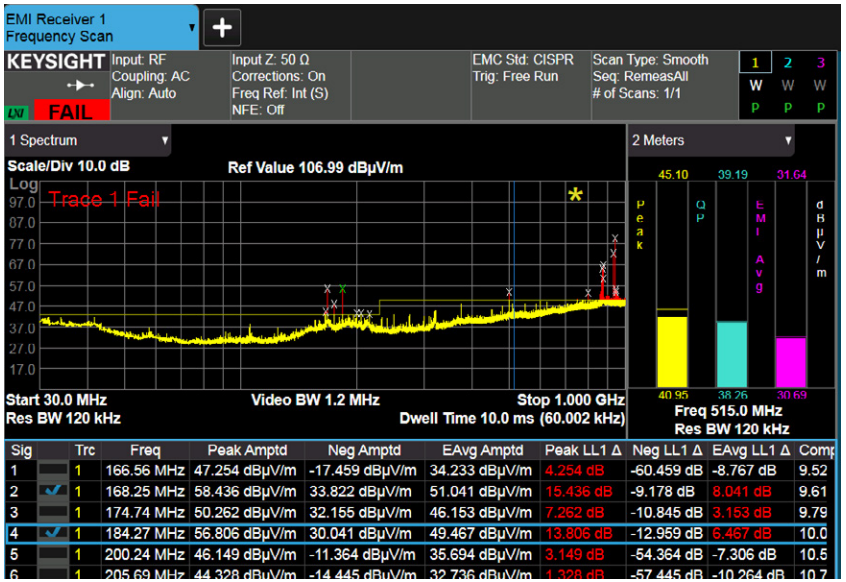


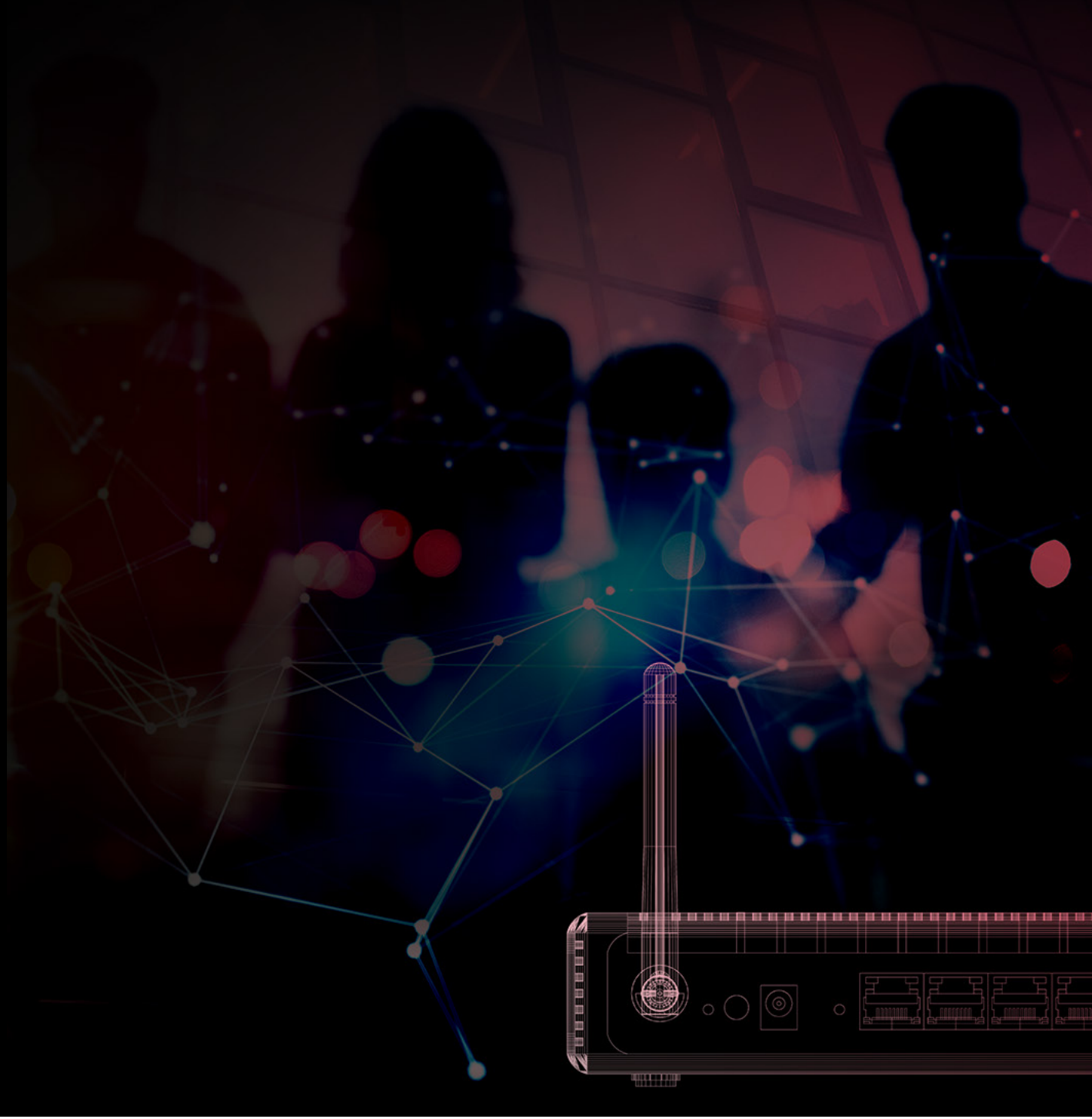
Figure 8. Using the EMI measurement application with frequency scan measurement to make compliance or pre-compliance EMI measurements

Interested in discovering more about EMI testing? Check out these literature pieces on pre-compliance testing:

- *EMC Pre-Compliance Fundamentals*
- *EMI Compliance Test vs. EMI Pre-Compliance Test*
- *EMI Troubleshooting: The Need for Close Field Probes*
- *Making EMI Compliance Measurements*

CHAPTER 8

WLAN (Wireless Local Area Networks)



CHAPTER 6

WLAN (Wireless Local Area Networks)

Gone are the days of ethernet cables running everywhere and traditional "LAN parties," where groups of gamers would haul around their desktop systems with cables to each other's houses. In this era of wireless connectivity, local area networks no longer require hardwired connections. And with the use of handheld devices, smart appliances, and wireless office spaces (at work and in the home), video streaming, and more, WLAN has become a vital part of everyday life. These wireless rich environments require engineers to design demanding modulation schemes including MIMO spatial multiplexing configurations. If you are designing, testing, or manufacturing WLAN connected devices, you'll need to conform to the IEEE 802.11 standards. A signal analyzer can help greatly with this by demodulating multi-stream waveforms. With the WLAN PathWave X-App your signal analyzer can provide one-button pass/fail test results in conformance to the standard. You'll also be able to quickly and intuitively make IQ measurements, view constellation diagrams, and analyze EVM results. Make sure you're using this application on signal analyzer hardware that can support wide bandwidths and multi-channel capabilities to stay on top of evolving needs for 4 channel, 160 MHz designs.

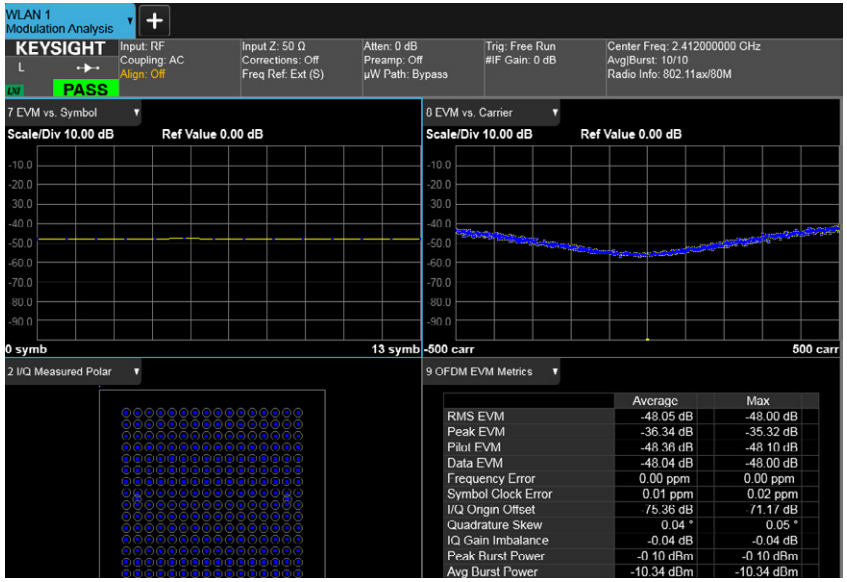


Figure 9. Using the WLAN measurement application to analyze WLAN 802.11ax signal quality

Read more about WLAN in this application note: *Testing New-Generation WLAN 802.11ac*

CONCLUSION

Measurement applications increase the capability and functionality of signal analyzers while reducing your time to insight. Signal analyzer applications provide essential measurements for specific tasks in general-purpose, cellular communications, and wireless connectivity applications, covering established standards or modulation types. With PathWave X-Series Applications on Keysight's X-Series signal analyzers you can realize measurement integrity across your organization with consistent operation and test methods, proven algorithms, applications, and accurate results. Your team can leverage the test system software through all phases of product development, allowing them to move at a quicker pace and deliver products to market faster.

The measurement applications covered in this eBook are a subset of more than 25 measurement applications available with the Keysight X-Series signal analyzers. This combination of hardware and software provides an evolutionary approach to signal analysis, transforming X-Series signal analyzers into comprehensive analysis machines.

Learn more about applications covered in this eBook:

- Phase Noise
- Noise Figure
- Vector Modulation
- Analog Demodulation
- LTE FDD
- 5G NR
- EMI
- WLAN

See the comprehensive set of X-Series of signal analyzers and applications:

- X-Series Measurement Applications
- N9020B MXA Signal Analyzer
- 89600 VSA Software

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.