

S7970A Playback

Wideband streaming solutions

Introduction

Testing modern RF systems requires realistic but controllable signal environments that stress designs to ensure they survive in the field. The new Keysight S7970A playback solutions enable quality playback of previously recorded data representing live signal environments. The system is self-contained in a convenient, transportable package. The intuitive software guides the user through a structured workflow that turns a complex process into an easy setup and execution. At the heart of the S7970A streaming playback solution is the M9383A PXIe microwave signal generator, a compact modular instrument that provides frequency coverage from 1 MHz to 20 GHz or 44 GHz, with up to 400 MHz of streaming modulation bandwidth. The playback solutions include an internal baseband generator, and over 2 GHz RF modulation bandwidth with external I/Q inputs. The compact PXIe form factor enables side-by-side placement of the M9383A signal generator components of the S7960A streaming record solution to provide a complete record and playback system in a single PXIe chassis. Refer to the S7980A technical overview for more details.

Whether your work is on the bench, in a test chamber, or the field, the S7970A playback solutions make it easy to playback captured signal environments with the settings and conditions to meet your requirements.

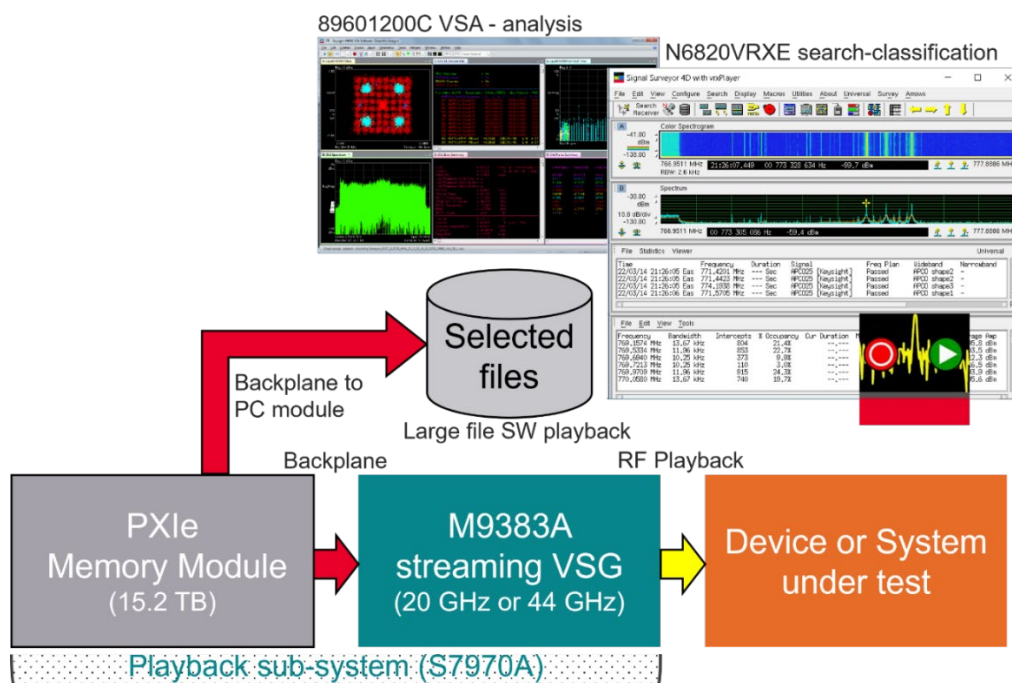


RF/ μ W Playback Solutions

The S7970A wideband RF/ μ W streaming playback solution provides users with intuitive software for configuration, setup, signal preview, and file management. A combination of well-integrated instruments, conversion utilities, and easy-to-use workflow make the Playback solutions a flexible tool for a wide variety of playback applications.

Key features

- Intuitive operation and workflow
- Reliable, transportable packaging
- Quick and easy integrated file viewer with trimming tool for isolation of file segments for analysis or playback
- Advanced alignments for high-fidelity RF playback



Solution Descriptions

S7970A-020

The S7970A-020 includes a pre-configured M9383A with the options described below (refer to the M9383A technical data sheet for more details):

- F20: (1 MHz to 20 GHz tuning)
- ST2: basic voltage-controlled oscillator offering excellent phase noise performance
- 300: provides an M9300A frequency reference module (required to meet data sheet specifications. The M9300A provides five 100 MHz outputs)
- C05: 500 MHz RF modulation bandwidth
- M10: 1 MSample waveform memory
- LW1: Long waveform playback (streaming)

The S7970A-020 is integrated into an M9019A PXIe 10-slot Gen 3 chassis that delivers flexibility, compatibility, and performance in a compact form factor ideal for a range of applications. It has 18 PXIe slots providing the flexibility to mix and match the number and location of PXIe and hybrid-compatible modules. The ultra-high performance PCIe® switch fabric can operate up to Gen 3 providing up to 24 GB/s of system data bandwidth needed for the S7980A's high bandwidth streaming feature. The cooling design provides exceptional per-slot cooling while producing much less fan noise.

The S7970A-020 includes these other PXIe modules:

- A Conduant DM-4M.2 PXIe storage module configured with 15.2 TB of memory based on NVME SSD devices. The host interface is PCI Express x8 Gen3 (8GB/s) providing a sequential read of 7.1 GB/s and sequential write of 7.1 GB/s. Multiple units can be combined for additional storage capacity.
- An M9037A PXI host PC configured with options W16 (Microsoft Windows 10 IoT Enterprise LTSCB (64bit)) and M16 (Memory upgrade from 4 GB RAM to 16 GB RAM). The M9037A is a four-slot PXIe embedded PC controller with Windows 10 operating systems designed for high-performance, complex, multi-chassis systems. It is also well suited for secure environments due to its front-panel, removable solid-state drive (SSD). The embedded controller is built upon a high-performance, low-power Intel i74700EQ 2.4 GHz processor with 8 threads supported through 4 cores and hyper-threading.

S7970A-044

The S7970A-044 includes a pre-configured M9383A with the options described below. Also, refer to the [M9383A PXI microwave signal generator technical data sheet](#) for more details:

- F44: (1 MHz to 44 GHz tuning)
- ST2: basic voltage-controlled oscillator offering excellent phase noise performance
- 300: provides an M9300A frequency reference module (required to meet data sheet specifications. The M9300A provides five 100 MHz outputs)
- C06: 500 MHz RF modulation bandwidth

- M10: 1 MSample waveform memory
- LW1: Long waveform playback (streaming)

The M9383A comprises three components designed to produce high-fidelity RF playback capability from either short or long waveform files. These components include a synthesizer, vector modulator, and source output modules. Part of the vector modulator is the arbitrary waveform generator which is capable of reading streamed digital data from the PXIe backplane that originates in the S7970A data module. It is also ideal for creating digitally modulated waveforms for wideband communication systems and high-resolution waveforms for radar and satellite tests. Industry-standard waveforms can be easily generated using Keysight software application tools such as PathWave Signal Generation, or Signal Studio. In addition, users can generate their waveforms using MATLAB or custom tools to play out.

As mentioned previously, the M9383A is capable of streaming at a data rate of 500 MSamples per second supporting a 400 MHz modulation bandwidth. However, what makes the M9383A extremely well-suited for streaming applications is the comprehensive corrections made in the system and on the fly to produce an accurate representation of the streaming file data in RF. The M9383A has 256 real-time FIR filters in the gateway of its FPGA to apply corrections as needed to amplitude, and timing skew. These corrections allow a nice flat amplitude response across the entire wideband channel. It also has an integral re-sampler that can interpolate and correct the data in real time.

Achieving proper I/Q balance when attempting to use a standard AWG with a vector signal generator can be very tricky. The I/Q can become out of balance by very small differences in the cabling such as lengths, temperature differentials, or subtle differences in the velocity factor. This I/Q imbalance will create a large DC component appearing as a tone in the center of the playback bandwidth. The M9383A's tight integration compensates for these situations. Quick and automatic alignments, performed in the field, will remove distortions before playing back an important file.

The S7970A systems also include a soft front panel for the M9383A that provides the user with full manual control of the generator to playback individual waveform files or output standard test signals typical of a high-quality signal generator.

Solution software

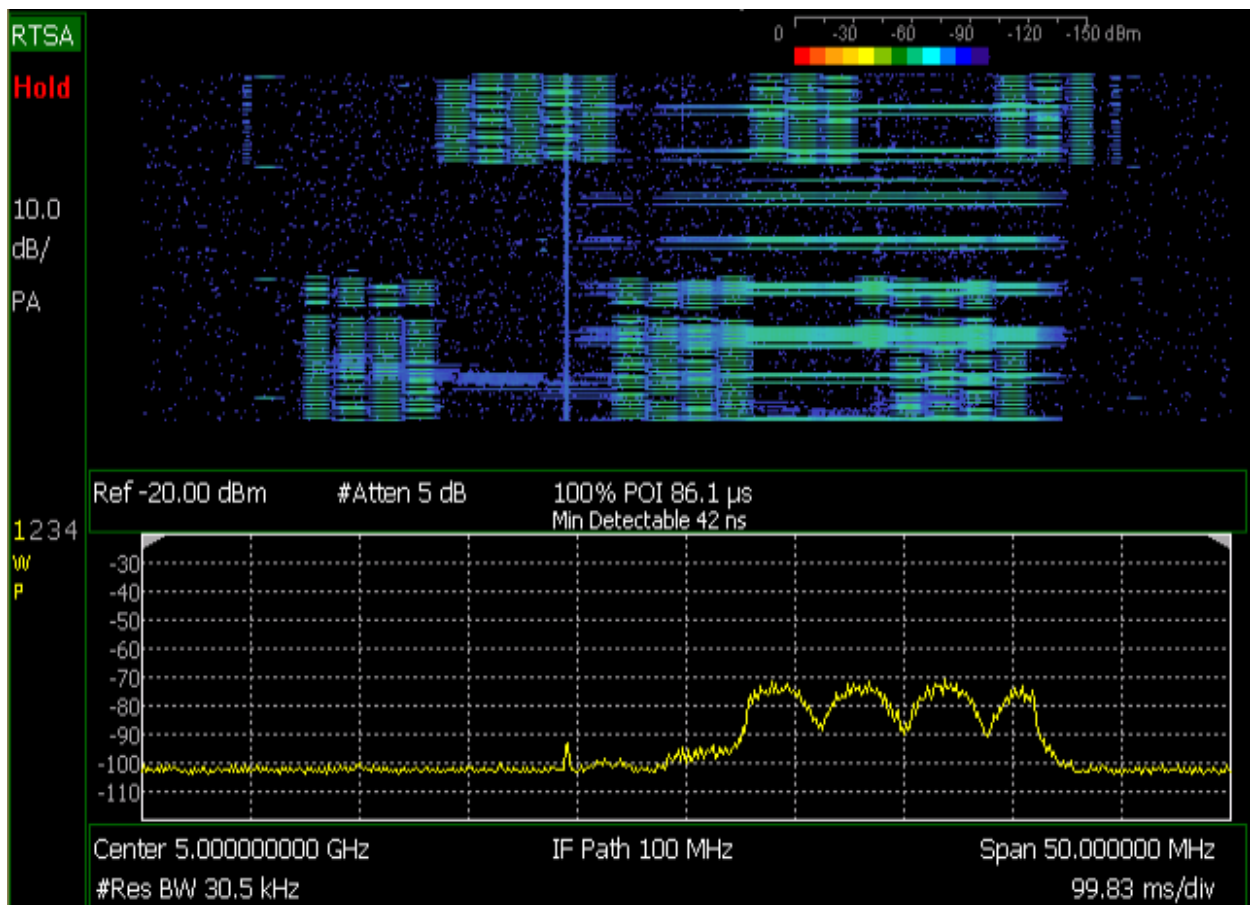
All S7970A software is pre-installed on the M9037A PXI host PC and includes the following:

- N6880AR01 Record Playback Manager (RPM) software. A perpetual, node-locked license for the application is installed. A software subscription service can be purchased to receive updates to the application.
- Keysight IO Libraries are installed to manage the PXI modules but do not need user interaction for normal operation of the RPM software.
- Soft Front Panel (SFP) applications for each of the installed Keysight modules (M9203A, M9300A). These enable the manual operation of the modules. For more information, refer to the technical data sheets for the modules.
- 89601200C Vector Signal Analyzer (VSA) software is installed but licensed separately. The S7960A solution does not include a license for the VSA software.

Use Cases

Recreate RF environments

The Keysight playback solution is ideal for easy transport in the field and quick setup. You may have a wideband recording of a busy RF environment to use as a background for an RF test at a range or in a test chamber. You can easily transport the S7970A solution to the field and set it up quickly with an amplifier and transmit antenna. Once you initialize the system and load the recorded content, it is ready to playback the scenario recording at RF with high fidelity with complete control over the frequency and amplitude. The FieldFox real-time spectrum analyzer display below shows an example of the S7970A-020 Playback solution and a portion of the 2.4 GHz ISM band.



Algorithm training

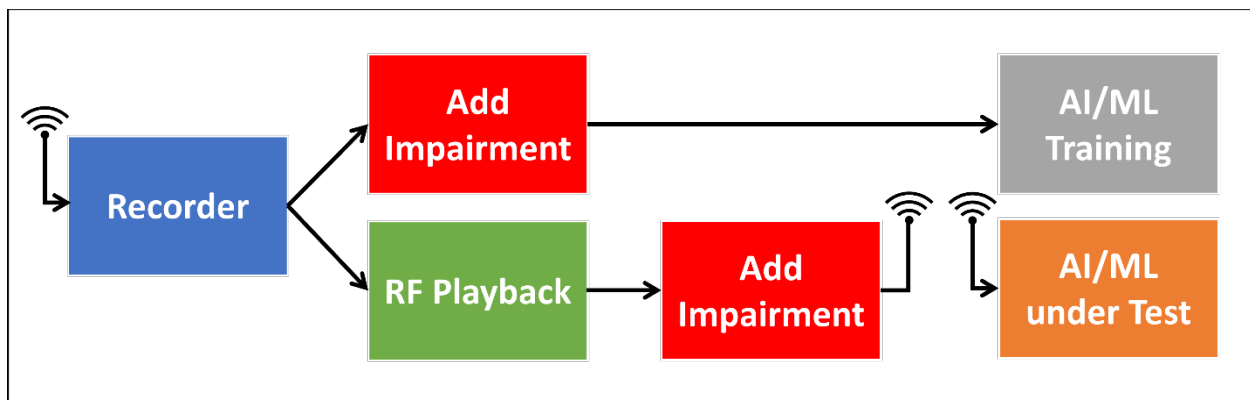
The Record and Playback system can be used to train and test Artificial Intelligence / Machine Learning (AI/ML) algorithms. AI/ML development requires copious amounts of training data, and the closer to

reality the training data is, the better the potential for success for the algorithm. Today, AI/ML engineers spend the first phase of their research and development accumulating or producing data to train their AI/ML. Depending on the problem at hand, it may entail developing a software simulation to produce data. For example, if the task is to build an AI/ML to control a power system, one might first develop a software simulation of a power system to customize the training data more easily.

The issue with heavy reliance on simulated data is the practical difference between simulation and reality. This difference directly affects the quality of the AI/ML to be trained.

In the category of problems having to do with wireless communications signals, many AI/ML are created to classify signals or make decisions on signals received off the air. For these cases, record/playback solutions can be used to increase the fidelity of the training data because these systems are used to record *real-world* signals off-the-air.

The figure below illustrates how to use the record/playback solution for training and testing AI/ML. The recorder is used to record real-world signals off-the-air, and then impairments are added to the software. These impairments could include multipath propagation, noise, or signal interference. Software tools that could be used to do this include MATLAB, Keysight SystemVue, or one's own software program. The impairments need to be varied to provide extensive amounts of training data which are functions of real-world recording. Then this data is used to train the AI/ML.

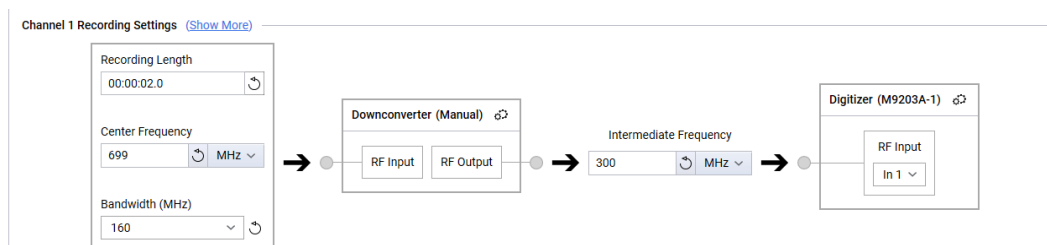


Once trained, AI/ML can be tested similarly. The recorded data has impairments added, then the Playback solution transmits the signal to RF. The AI/ML is put within its host receiver, processes the transmitted test signal, and makes decisions. In this way, the Record and Playback solution becomes a vital part of the AI/ML workflow.

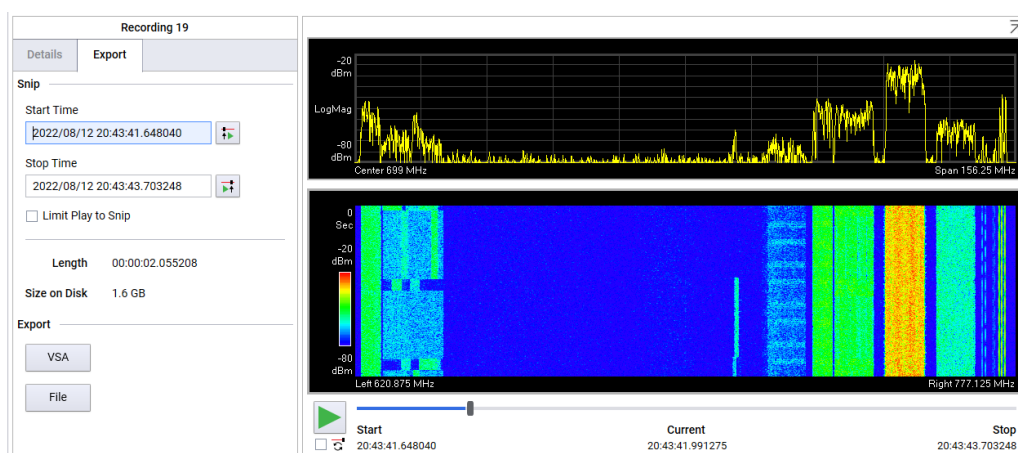
Record and Playback Workflow

Easy to configure and control, the N6880A Record and Playback Manager (RPM) software uses an intuitive workflow model that provides a user's interface with a sequential tab structure starting with recorder setup, data view, and then playback. The Project Recordings (file management) window is viewable on all three workflow tabs providing convenient access to recordings file data and the associated controls. You can convert recordings for playback in RF, load any file to the view, or export files to the 89601200C VSA software from the file management section available on all three tabs. Key functions for each tab include:

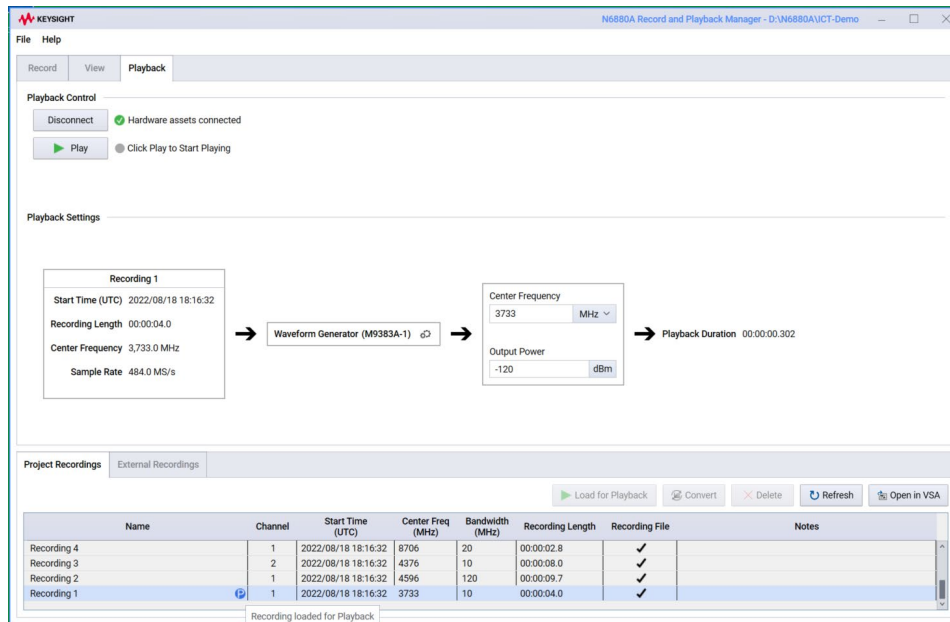
1. The recording session begins with the Record tab. The menu guides you through connecting to the hardware, adjusting settings to meet your specific signal conditions, arming, and starting the recording. During this process, the analog-to-digital converter can run a self-calibration that aligns the I and Q to remove any residual DC component or distortions that may appear in the recording. The result is a high-fidelity recording ready for analysis or playback.



2. View tab enables you to preview the recording to ensure it contains the desired signal content. You can load the file data in spectrum and spectrogram trace displays for quick verification of the content and use the precision time tags to move to areas of particular interest within the file. A subset of the recording file can be selected and saved as another, smaller file, or exported to the 89601200C VSA software for detailed analysis.



- Playback tab – Users can playback recordings using the solution’s M9383A vector signal generator by connecting the Playback hardware and loading a file for playback. Next, users can adjust the playback parameters by selecting the center frequency, amplitude, and adjusting the sampling rate. The flexible playback settings enable the user to get the most out of previously recorded files for their specific application.



Playback Performance Expectations

The S7970A Playback solution's playback performance expectations are reliant on the M9383A signal generator. Please refer to the [M9383A PXI microwave signal generator datasheet](#) for details.

Description	Performance expectation
Frequency range	020: 1 MHz to 20 GHz 044: 1 MHz to 44 GHz
Frequency resolution	0.01 Hz
Frequency stability – aging rate	Daily < ± 0.5 ppb/day, after 72-hour warm-up
Output signal types	Arbitrary waveform from VSG RAM, IQ Stream from PXIe storage module, Continuous Wave (CW) The internal arbitrary waveform generator can create the following: Sine, Dual-sine, Triangle, Ramp Up, Ramp Down, and Square. It is possible to use these as modulation sources for AM, FM, and PM outputs.
Internal waveform memory	1024 MSamples
Sample resolution	32-bit with 16-bit on I, and 16-bit on Q
Sample rate	<3.2 GHz carrier: 200 MSample/sec >3.2 GHz carrier: 625 MSample/sec
Vector accuracy	(Measured EVM% at -7 dBm for Pre-5G VZ 1CC 100 MHz channel, 100 kHz subcarrier spacing): 5 GHz: 0.49% 20 GHz: 1.1% 40 GHz: 1.8%
Power range	10 MHz to 40 GHz: -40 dBm to 10 dBm 40 GHz to 44 GHz: -40 dBm to 8 dBm
Power resolution	0.01 dB

Phase noise

Frequency	10 Hz spec (typ)	100 Hz spec (typ)	1 kHz spec (typ)	10 kHz spec (typ)	100 kHz spec (typ)
10 to 400 MHz	(-75)	(-95)	(-110)	(-117)	(-116)
>400 MHz to 10 GHz	-40 (-51)	-64 (-79)	-91 (-97)	-97 (-103)	-97 (-102)
>10 GHz to 20 GHz	-34 (-45)	-60 (-73)	-84 (-91)	-92 (-97)	-91 (-97)
>20 GHz to 26.5 GHz	(-38)	(-68)	(-88)	(-95)	(-94)
26.5 GHz to 44 GHz	(-31)	(-59)	(-80)	(-84)	(-85)

Configuring Your Solution

Refer to the [Wideband Streaming Solutions configuration guide](#) to select the right hardware and software configuration to support your unique system requirements.

Support Options

KeysightCare for Solutions Support services

KeysightCare for Solutions is your priority-one connection for your teams, providing committed repair and calibration turnaround times and access to technical experts. This premium service can help you stay ahead of the curve and accelerate the win. See the [KeysightCare for S79x0A Wideband Streaming Solutions flyer](#) for service details.

Keysight extended warranty and calibration plans

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Measurement challenges are intensifying as standards and technologies constantly evolve. Build confidence and gain new skills to make accurate measurements through our flexible [Education Services](#) developed by Keysight experts.

Consulting services

Technology acceleration and evolving standards are driving the relentless pace to bring breakthrough products to market faster and at a lower cost. Our experts know advanced test methods and standards and can help through consulting services. Using the latest hardware and software, we analyze your specific measurement needs and work with you to achieve optimized test strategies. Whether you need consulting on characterization or compliance measurements or want to automate your test system, we deliver the technical expertise and programming support you are looking for. A few examples of [Keysight's consulting services](#) include:

- Accelerate Multichannel Measurements for RF and mmW
- Achieve Wideband Device Characterization
- Attain High-Speed Digital Test Compliance
- Get the Most of Your 5G/CV2X Device Test Solution
- Accelerate Replicating RF Environments
- Expedite Device Modeling
- Get the Most from PathWave Design Software

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