

S7980A Record and Playback

Wideband streaming solution

Introduction

Modern RF systems are in a rapid state of change. Wireless designers need a comprehensive assessment of the signal environments that will stress their designs to assure they survive in target markets. The new Keysight S7980A Record solution enables quality recording of live signal environments, in-depth analysis, and high-fidelity RF playback all in one convenient, transportable chassis. The intuitive software guides the user through a structured workflow that turns a complex process into an easy setup and execution. You can quickly and easily record long signal duration files, preview the data, select the portions of interest, and play them back in RF creating a signal environment or high-quality test scenario. Additionally, you can export files to the 89601200C Vector Signal Analysis software or N6820VRXE Virtual Receiver search and classification software.

The S7980A includes a FieldFox model B which operates as a microwave downconverter with 120 MHz of acquisition bandwidth for frequencies as low as VLF up through 5G NR FR2. Alternatively, a different downconverter can be configured in the system. Playback is accomplished with the M9383A vector signal analyzer which provides up to 400 MHz of streaming RF bandwidth. The heart of the hardware system is a combination of PXIe components that form an end-to-end streaming, gap-free RF record, and playback system. For work at frequencies below 2 GHz, the M9203A ADC input offers recording bandwidths up to 320 MHz via a tunable DDC.

Whether your work is on the bench, in a test chamber, or in the field, the S7980A Record and Playback solution delivers an accurate representation of your signal environment to accelerate your test processes.



RF/ μ W Record and Playback Solutions

The S7980A wideband RF/ μ W record and streaming playback solution provides users with intuitive software for configuration, setup, signal preview, and file management. This combination of well-integrated instruments, conversion utilities, and easy-to-use workflow make this solution a flexible tool for a wide variety of record and playback applications.

Key features

- Intuitive operation and workflow
- Reliable, transportable package
- Extensive file format support with conversion utilities
- Strong preselection (FieldFox) for quality off-the-air recording
- Precision time stamping

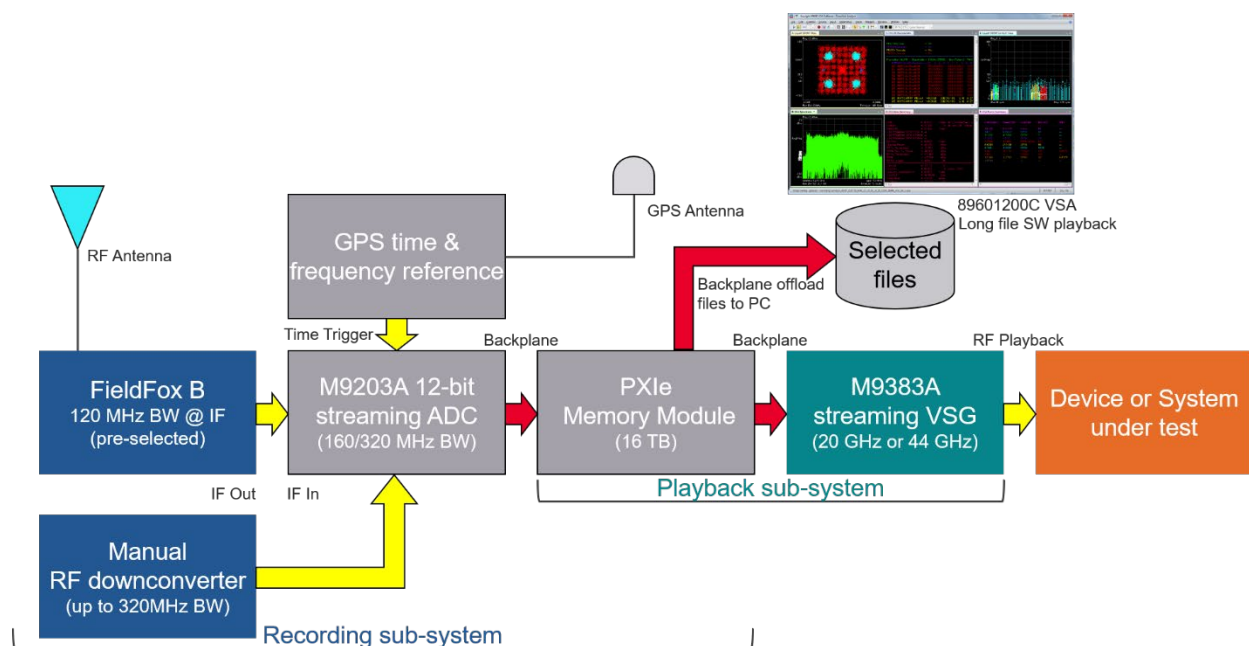


Figure 1. Block diagram of S7980 Record and Playback solutions

Solution Descriptions

S7980A-020

The S7980A-020 includes an N9938B FieldFox analyzer as a microwave downconverter extending the frequency range to 26.5 GHz. The FieldFox includes Type-N input/output connectors, an AC/DC adapter-charger, a localized power cord, a rechargeable Li-ion battery, a LAN cable, a soft carrying case with backpack and shoulder straps, and a Quick Reference Guide. Configuration of the N9938B includes the following options:

- B10 Adds 120 MHz instantaneous bandwidth
- 235 Adds wideband pre-amplifier
- 350 Adds Real-time spectrum analyzer mode

The S7980A-020 also has an IF/baseband wideband record sub-system and M9383A vector signal generator integrated into an M9019A PXIe 10-slot Gen 3 chassis which 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 S7980A-020 includes these PXIe modules:

- A pre-configured M9203A analog-to-digital converter module with the CB2 bundle and the options described below. This bundle provides a guaranteed recording specification of up to 320 MHz bandwidth, with tunable intermediate frequency. It also includes data throughput optimization (I/Q samples with 32-bit, 16-bit, or 12-bit mode). Refer to the M9203A technical data sheet for more details.
 - SR2: 1.6 GSa/second sampling rate
 - F10: Full bandwidth
 - M40: 4 GB acquisition memory
 - DDC: Digital downconverter that provides a tunable IF frequency
- An NI 6638H Time and frequency reference module provides a GPS time reference and trigger to the system enabling precision time stamping of the digitized data. The module also provides a GPS-disciplined local oscillator output (10 MHz) to the M9300A. The 6638H module initiates all system triggering.
- An M9300A frequency reference is a PXIe modular instrument for use as a 10 MHz or 100 MHz reference in various solutions. Up to four sub-systems can share a single M9300A in one PXI chassis. A soft front panel and programmatic interfaces provide instrument control. The M9300A distributes a common frequency reference to all the components in the S7980A solution.
- 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 M9383A vector signal generator configured 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
 - C05: 500 MHz RF modulation bandwidth
 - M10: 1 MSample waveform memory
 - LW1: Long waveform playback (streaming)
- An M9037A PXI host PC configured with options W16 (Microsoft Windows 10 IoT Enterprise LTSC (64-bit)) 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 i7-4700EQ 2.4 GHz processor with 8-threads supported through 4 cores and hyper-threading.
- The S7980A-020 cables include:
 - 30-foot LAN cable
 - 3-foot SMA-SMB cable for connecting the FieldFox external reference to the M9300A module
 - 2-foot SMA-SMB cable for connecting the FieldFox IF output to the M9203B input
 - 3-foot Type-N cable

All other front panel cables and adapters for connection of the modules as well as a GPS antenna with 1m cable are supplied. The solution will arrive with all connections made and ready for operation. Use a remote desktop PC to connect to the embedded PC or, connect a separate KVM device (not supplied).

S7980A-044

The S7980A-044 configuration is the same as the S7980A-020 with the following exceptions:

- S7980A-044 includes an N9961B instead of the N9938B FieldFox analyzer extending the frequency range of the Recorder up to 44 GHz and includes the same options, cables, and accessories as listed above except the Type-N cable is replaced by a rugged 2.4 mm cable. The N9961B input connector is 2.4 mm.
- S7980A-044 replaces M9383A's option F20 with option F44 to increase the tuning range to 44 GHz. F44 adds a two-slot up-conversion module (M9314A) to the M9383A.
- S7980A-044 also replaces M9383A's option C05 with option C06 to maintain the 500 MHz maximum modulation bandwidth at the higher frequencies. The M9383A output connectors are 2.4 mm.

Solution software

All S7980A software is pre-installed on the M9037A PXI host PC and includes the following applications:

- N6880AR01 Record Playback Manager (RPM) software with a perpetual, node-locked license. 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, M9383A, and 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 S7980A solution does not include a license for the VSA software.

Use Cases

RF environment emulation

The Keysight record and playback systems are ideal for easy transport to the field, where they can be put to work recording an environment important to your test needs – whether for an operational scenario or in situ wireless testing. Once you have acquired and validated the recorded content, the system is very much at home in a test chamber for an accurate replay of the field environment with complete control over the frequency and amplitude of the RF emulation.

In situ wireless or interference recording

New wireless formats have wider bandwidths and aggregated carriers which may require geographically separated time-synchronous acquisition. The S7980A makes this possible with its compact profile and precision time-enabled recording features. Keysight's analytic tools can load recordings and start the investigation right away. With the Keysight recording solutions you can use either manual or automated analysis tools to discover the signal content of the file. After returning to the lab, the S7980A can be used to stimulate your devices with the RF environment and signal content created in situ, providing a realistic test scenario.

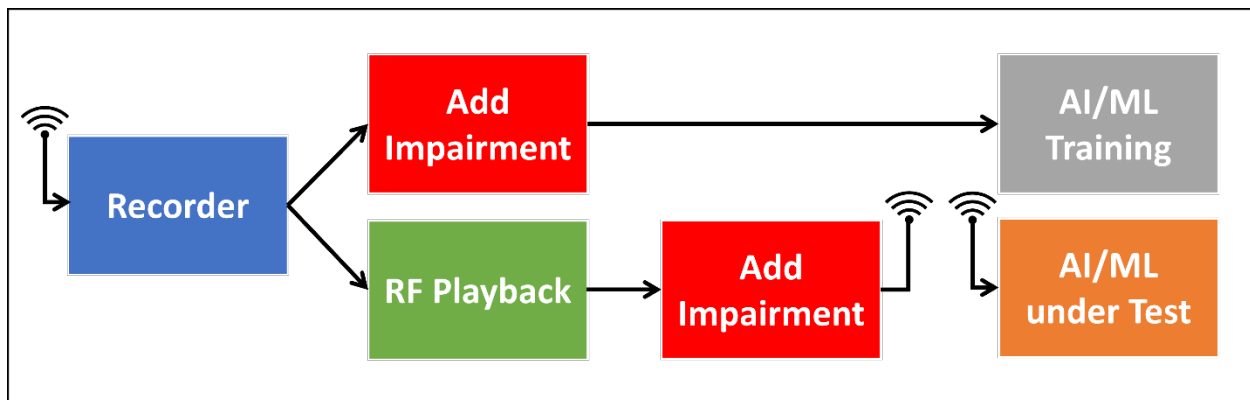
Algorithm training

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.

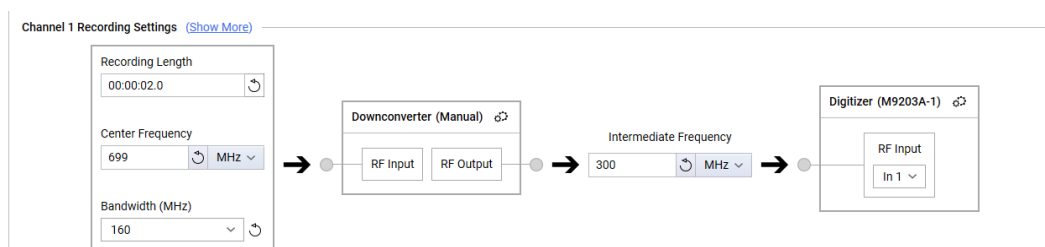


Once trained, AI/ML can be tested similarly. The recorded data has impairments added, then the Playback solution transmits the signal to RF. The AI/ML is put within its host receiver, processes the transmitted test signal, and makes decisions. In this way, the Record and Playback solution becomes a vital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

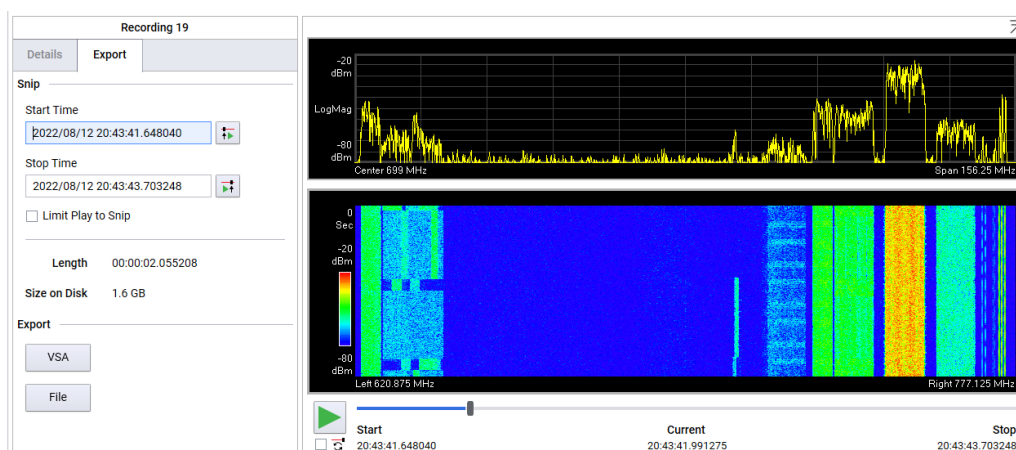
Record and Playback Workflow

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:

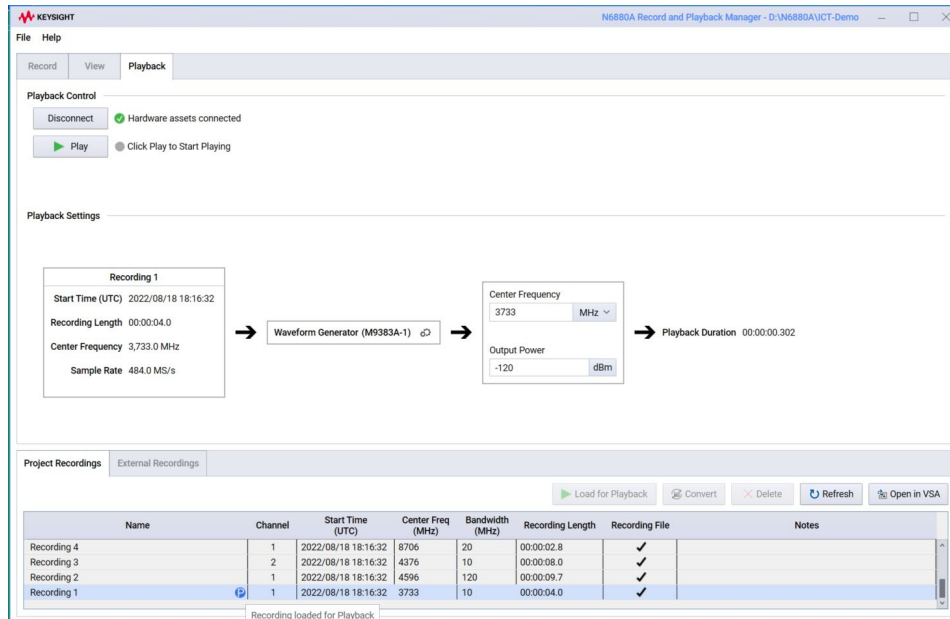
1. The recording session begins with the Record tab. The menu guides you through connecting to the hardware, adjusting settings to meet your specific signal conditions, arming, and starting the recording. During this process, the analog-to-digital converter can run a self-calibration that aligns the 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 the 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, and 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.



Record Performance Expectations

Description	Performance expectation
Frequency	
Tuning range	S7980A-020: 5 kHz to 26.5 GHz S7980A-044: 5 kHz to 44 GHz
Recording bandwidth (max.)	320 MHz (full band directly into M9203A ADC) 120 MHz with FieldFox downconverter (Acquisition bandwidth is 160 MHz, limited by the FieldFox IF filter)
Tuning resolution	1 Hz
Frequency reference	GPSDO or external 10/100 MHz reference
Frequency reference accuracy	± 20 ppb (with internal GPS reference)
Amplitude	
Analog-to-Digital converter	12-bits at 400 Msamples/second (complex)
Dynamic range	64 dB
M9203A input ranges	1 V and 2 V
Amplitude	± 3 dB
Noise figure	Refer to FieldFox technical datasheet for guidance
Inputs and outputs	
RF input connector	SMA (female) 50 ohm on M9203A SMA (female) 50 ohm on 26.5 GHz FieldFox APC 2.4mm (female) 50 ohm on 44 GHz FieldFox
FieldFox Model B Intermediate frequency	225 MHz filtered IF
Recording memory	15.2 TB Over 5 hours at 160 MHz bandwidth Over 2 hours, 30 minutes at 320 MHz bandwidth
File Formats	*.bin, 89601200C software provides files conversions

Playback Performance Expectations

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 $< \pm 0.5$ 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

Ensure accurate measurements and achieve greater peace of mind with every new instrument purchase

- Extend your peace of mind and eliminate budgetary surprises for up to 5 years with an Extended Warranty.
 - Lock in OEM-quality calibration at the lowest price, with the peace of mind that your equipment will perform at its original specification with calibration plans
 - To learn more, see www.keysight.com/find/services.

Education services

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 out of Your 5G/CV2X Device Test Solution
- Accelerate Replicating RF Environments
- Expedite Device Modeling
- Get the Most from PathWave Design Software

For more information on Keysight Technologies' products, applications, or services, please visit: www.keysight.com



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