

Agilent Modular Products M9392A PXI Vector Signal Analyzer System with Streaming Capability

Application Note

How to get the most from Agilent's M9392A PXI Vector Signal Analyzer with 100 MHz streaming option

Engineers face challenging test scenarios when developing RF and Microwave products, especially those using complex signaling or those expected to make measurements in noisy environments. To address these challenges, engineers need new methods and tools to effectively test these signals.

One emerging test method involves continuous acquisition of digitized data, otherwise known as "streaming" data, where the data is captured and stored in memory or on disk for detailed processing and analysis during or after the acquisition.

The most effective test setup depends on the details of your application:

- Frequency range and signal bandwidth
- Required sampling rate and resolution
- Expected duration of the acquisition

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Introduction

Engineers require tools to overcome the challenges of capturing gapless data and quickly locate the target signal from the data record for analysis. The solution, presented in this application note, includes easy-to-use interfaces that help with recording to disk, accessing the disk to process the data, and provides the capability to peruse and analyze the data.

This application note outlines how to best employ the Agilent M9392A PXI Microwave Vector Signal Analyzer with 100 MHz streaming capability, including a radar measurement example.

Abstract

The Agilent M9392A PXI Microwave Vector Signal Analyzer with streaming provides compact, modular, cost-effective 100 MHz bandwidth signal capture. This solution, with its 12-bit IF digitizer, enables long gapless capture of signals up to 100 MHz bandwidth to RAID storage solutions. It also includes software tools to enable signal identification and signal export to analysis software such as the industry standard Agilent 89600B VSA.

- This application note provides:
- Measurement solution overview
- Configuration guidance for storage solutions
- Procedural examples detailing setup and data capture
- Procedural examples using the DataViewer to locate the target data
- Signal analysis example

Your Benefits

- Capture intermittent signals and analyze using the M9392A PXI Vector Signal Analyzer with Streaming option
- Easy search capability to look for the target signal of interest
- Thorough analysis capability with the Agilent 89600B VSA
- Tips to improve implementation

Applications

- Aerospace and defense
- Wireless communications
- Radar and wideband signal capture
- Electronic test



Figure 1. M9392A Vector Signal Analyzer system



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How to get the most from Agilent's M9392A 100 MHz streaming capability



Measurement Challenge

When developing RF products—especially those using complex signaling or those expected to make measurements in noisy environments—testing may need to address situations where the device under test does not operate as expected. Intermittent failure modes make data analysis particularly challenging; and when the root cause of the problem is not yet known, it is a challenge for engineers to setup a measurement that captures the failure.

Widely used standard measurement techniques capture only a few hundred milliseconds of data during each measurement. Intermittent failures can be easily missed due to gaps in the captured data and often the failure using standard test methodology cannot be seen. Each time the measurement is reset, there is a gap where data is not captured (Figure 2).

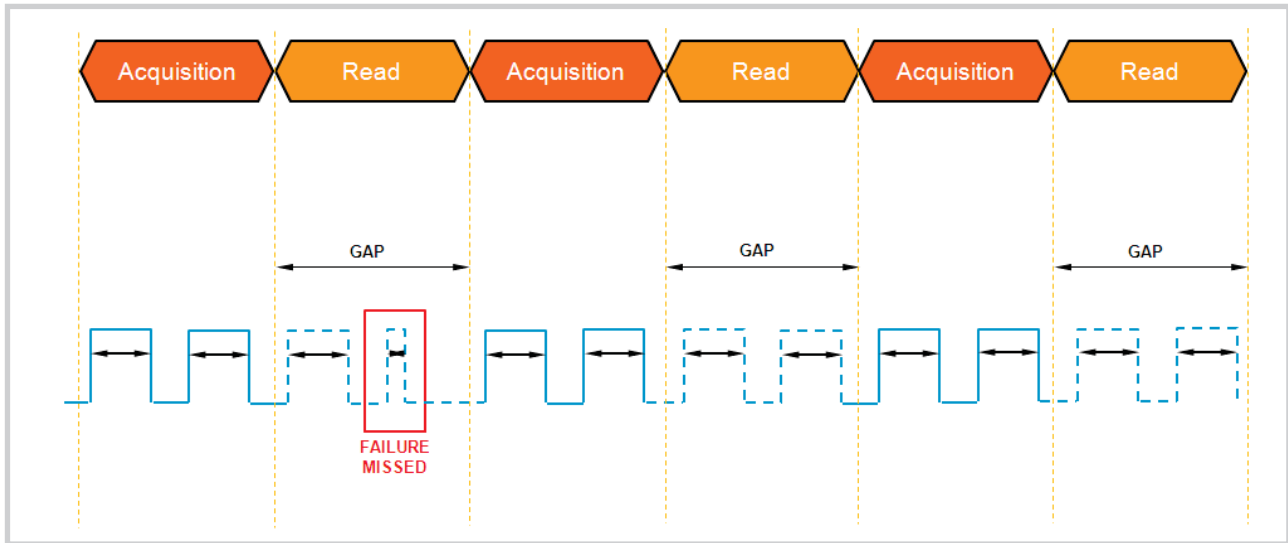


Figure 2. Acquisition with gaps

Another challenge is storing long runs of contiguous measurement data for offline analysis as the standard test methodology can only read as much data as can be held in physical memory. In situations like this, it may be necessary for engineers to use tools which enable long captures of gapless data (Figure 3).

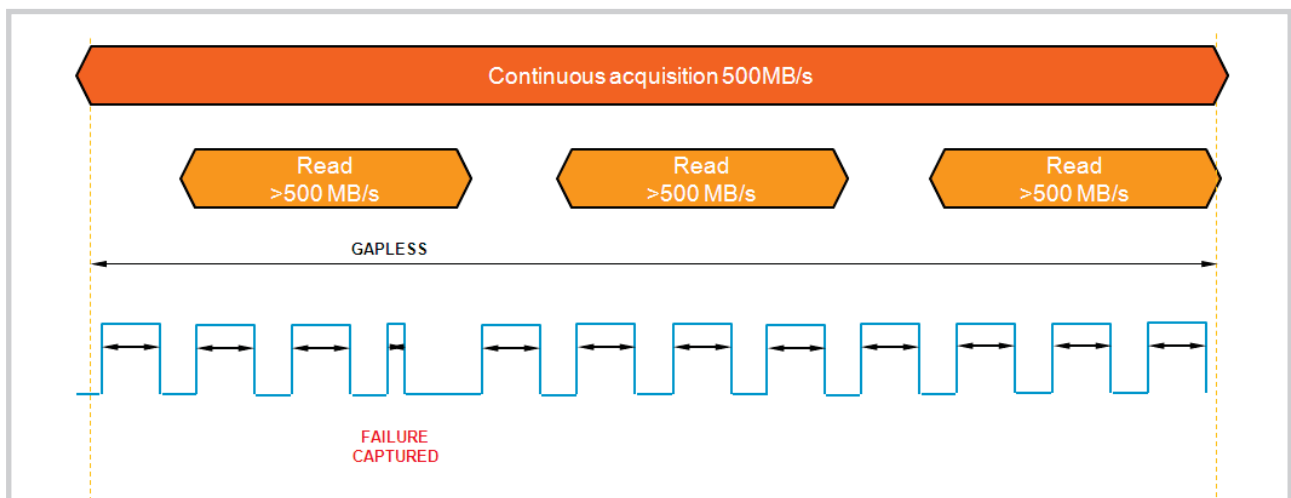


Figure 3. Continuous "gapless" acquisition

In the absence of an automated process allowing engineers to review a summary of a long streaming record, it is often necessary to locate a subset of the data to examine and analyze the target signal. To quickly find the signal of interest, engineers need tools they can use to peruse the data and display in multiple domains.

How to get the most from Agilent's M9392A 100 MHz streaming capability



Measurement Solution Overview

The Agilent M9392A PXI Microwave Vector Signal Analyzer with streaming provides a compact, modular 100 MHz bandwidth gapless capture to the controller or RAID storage solution.

The M9392A includes a graphical user interface to control the signal capture, a data viewer to enable signal identification and a connection to the Agilent 89600B VSA software for thorough data analysis.

The following pages will provide instruction on:

- Configuration guidance for storage solutions
- Procedural examples detailing setup and data capture
- Procedural examples using the DataViewer to locate the target data
- Signal analysis example

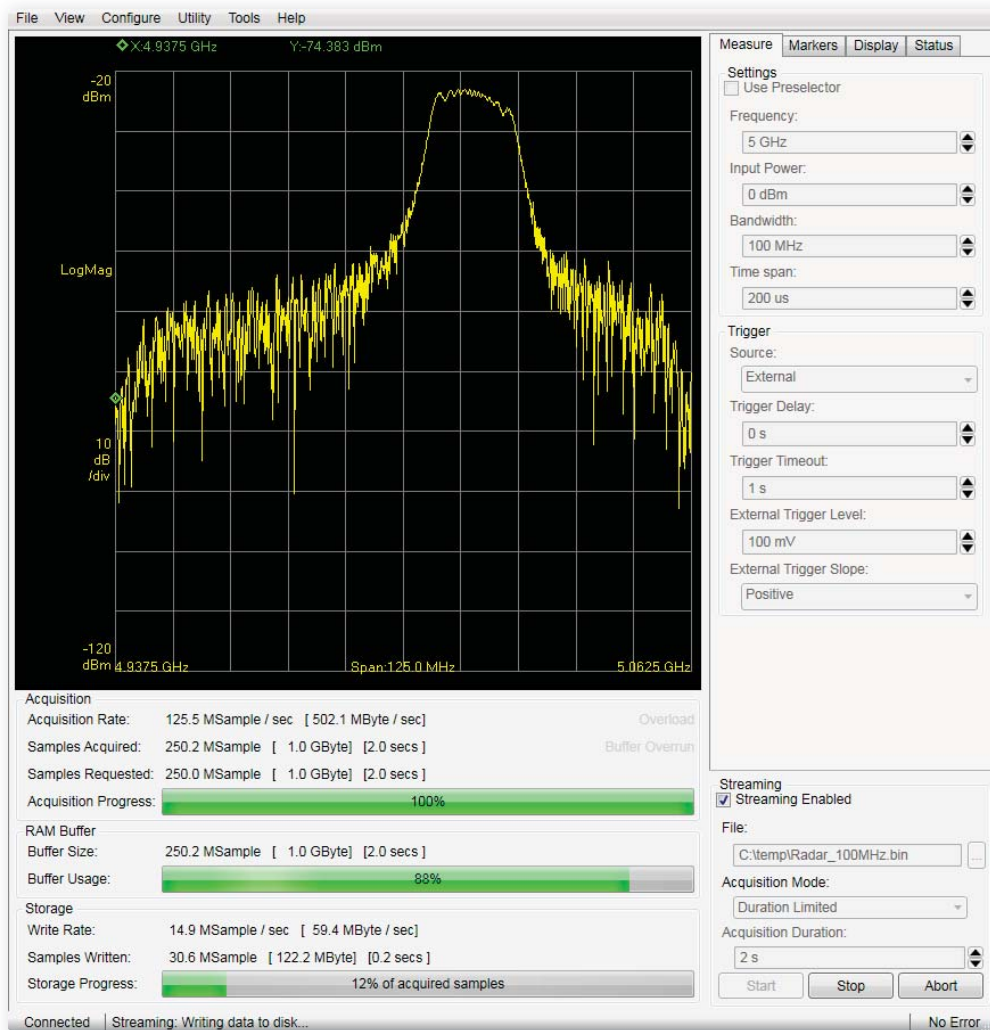


Figure 4. M9392A PXI Vector Signal Analyzer soft front panel with streaming enabled

Selecting the Storage Capability



During streaming acquisition, data is written to digitizer RAM. From digitizer RAM, data is copied to a circular RAM buffer on the controller and from this RAM buffer, the data is copied to final storage.

To sustain long gapless captures the data must be written to the final storage solution faster than the buffer is filled with new data. For narrow bandwidth captures, where the required data acquisition rate is <40MB/s, or the capture time is only a few seconds, a standard computer disk drive may suffice for storage.

For wide bandwidth captures, or where capture duration is long (minutes or hours), then a multi-disc RAID storage

system is required. The drives that are used in the RAID system can vary depending on the measurement environment.

Solid State Drives (SSD) are useful if the measurement environment is susceptible to vibration that could damage a standard Hard Disc Drive (HDD). If there are no vibration issues, the HDDs provide the most storage memory for very long data capture.

To help in selecting the optimum storage capacity for the particular test setup, engineers need to consider all areas of the measurement requirements:

- Bandwidth (BW) required
- Data rates to support the RF BW
- Length of time to record the data
- Physical environmental requirements

How to choose the right solution for your needs:

The Agilent M9392A solution can be used with either external RAID solutions or with the controller's disk drive depending on the data needs (Figure 5).

Step 1: Select your controller of choice:

- Embedded Controller M9036A OR
- Desktop Configuration (eg. Dell T3500): Desktop computer from the Tested computer list (<http://cp.literature.agilent.com/litweb/pdf/5990-7632EN.pdf>)

Step 2: Optionally expand your storage with RAID:

- Agilent's tested and recommended storage solutions are from JMR Electronics (see Figure 5 for capacity options)

Agilent's predefined external RAID packages have been tested to guarantee sustained data rates with the M9392A. These predefined mass storage packages ensure performance when used with the recommended controllers.

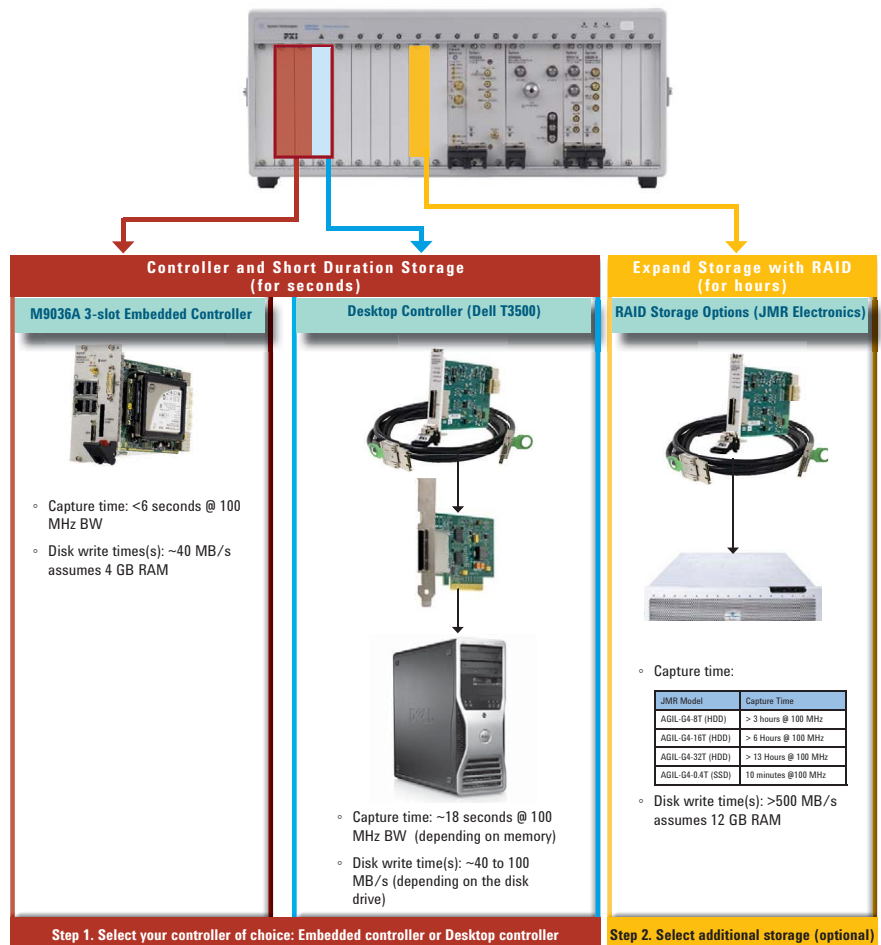


Figure 5. Configurations for RAID, Embedded Controller and Desktop PC

Capturing Data Using the M9392A Soft Front Panel (SFP)



The M9392A Soft Front Panel

The M9392A Soft Front Panel (SFP) provides a graphical user interface (GUI) that allows the engineer to control the capture of signals connected to the instrument (Figure 6). The SFP is ideal when the engineer needs to make quick and easy gapless captures, as opposed to programming the API to make repeated automated measurements. The SFP opens in a standard acquisition mode that is similar to standard vector signal analyzers. Specific controls are also available for streaming mode; both the streaming and standard modes use many of the same controls to setup and trigger the signal being captured or analyzed. To access the instrument controls specific to the streaming mode, click the “Streaming Enabled” checkbox.

To find an existing file or to specify a new target data file, standard windows file dialogs are used. In addition to setting up the instrument, the SFP monitors the data flow. To initiate the data capture, click the start button. Once the data capture has started, the data flow indicators update the user with the data capture process for: Data Window, Acquisition, RAM buffer, and Storage. The Data Window provides a spectrum view of the signal being captured.

If an error occurs during the data capture then an appropriate error flag is displayed on the SFP. The Error indicator in the lower right hand side of the window displays more error message details.

If the RAM buffer usage increases to 100%, this indicates that the data cannot be written to the final storage device fast enough to keep up with the data acquisition; in turn, this will cause the buffers to overrun and data acquisition to stop, since there is no memory available for continuous data capture, and an error will be displayed.

Using a high speed RAID system, it is common that this buffer is nearly empty since the data can be written to the RAID as fast as it is acquired.

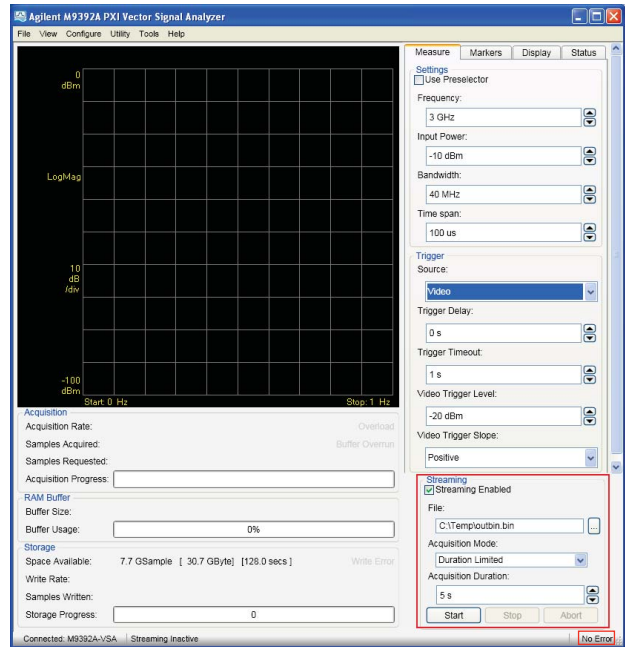


Figure 6. M9392A PXI Vector Signal Analyzer SFP streaming GUI when “streaming enabled” checkbox is selected

Capturing Data Using the M9392A Soft Front Panel (SFP)



Trigger and Acquisition Modes

Freerun trigger mode

If the stream of data being captured has continuous bursts with only very short gaps, you can use the Freerun trigger to begin capturing data as soon as the digitizer is ready.

Video and External trigger modes

For sparse data having intermittent bursts and large amounts of off-time in the data stream, it could be appropriate to trigger the initial data capture on a rising or falling edge by using External trigger or Video trigger. The trigger event will initiate a single streaming capture.

In Video or External trigger mode, trigger slope, trigger level and trigger delay can be set the same as trigger modes on other vector signal analyzers. Data during the trigger delay time will also be captured and saved to the streaming file. For example, a delay time of -1 second saves 1 second of pre-trigger data.¹

Acquisition modes

There are two acquisition modes, duration limited or unlimited mode.

- Duration limited mode: an acquisition time in seconds is set.
- Unlimited mode: you must manually start and stop the streaming process using the **Start**, **Stop**, or **Abort** buttons.

If there is a need to trigger the data, either Video or External triggering mode should be used—supported in both duration limited and unlimited modes. In duration limited mode, when used with a Video trigger or External trigger, the acquisition will begin as soon as the trigger is received and continues for the duration in seconds set in the SFP Acquisition Duration field. If there is a pre-trigger data capture, then the total duration of the acquisition is the pre-trigger delay plus the capture duration in seconds.

Stop and Abort options

Pressing the Stop button during an active streaming acquisition will end the acquisition. The data in the RAM buffer will then be saved to file.

Pressing the Abort button during an active streaming acquisition will end the acquisition and terminate the process of saving to file. Data Acquisition and Storage to disk will be terminated. Any data written to the drive prior to the Abort is retained.

Triggering the Capture Process using the SFP

The trigger system for streaming is comparable to standard vector signal analyzers—the digitizer monitors the external trigger input, or for video trigger it checks the power on the incoming RF signal.

In streaming mode the trigger initiates a data capture to file. The generated raw binary data file has an accompanying header file that indicates under what conditions the capture was created—a few of the items required to correctly process the raw binary data are Center Frequency, XDelta and YScale.

Once armed, and in external or video trigger mode, the digitizer looks for the trigger event in the sequential data blocks it transfers to the M9392A software residing on the controller. When the trigger event occurs, the trigger point is marked as an offset from the start of the current data block. The capture actually commences from the beginning of the digitizer data block that contains the trigger.

1. If a valid trigger occurs within the pre-triggered data window then the remaining pre-triggered time is discarded.

Capturing Data Using the M9392A Soft Front Panel (SFP)



Figure 7 illustrates the trigger and capture process. XStart in the text header file is the item that indicates the time in the streaming record that the trigger event occurred.

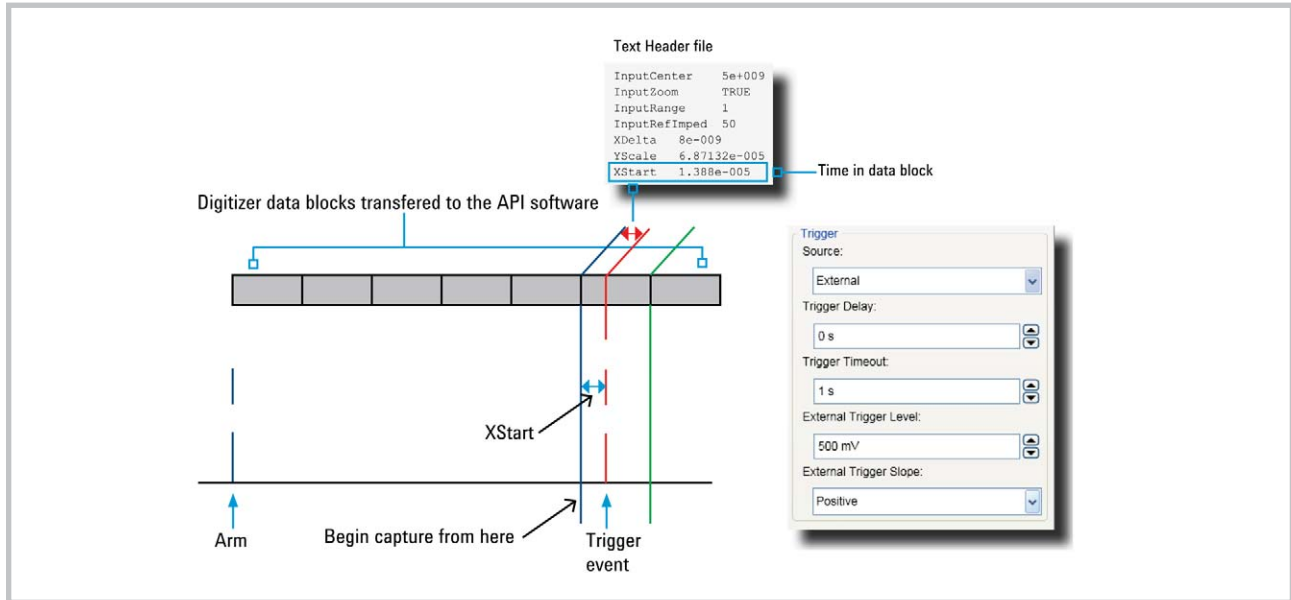


Figure 7. Triggering the capture process

Pre-triggering the Capture Process using the SFP

In Streaming mode, if the Trigger Delay is set to a negative value, the value will indicate the maximum amount of pre-trigger data that can be captured before the trigger event. If the trigger event occurs before the specified trigger time delay time elapses, then the process will capture a shorter amount of pre-trigger data as illustrated by Trigger A in Figure 8. If the trigger happens after the trigger delay time has elapsed the maximum pre-trigger data will be captured as illustrated by Trigger B in Figure 8. The XStart parameter in the Text header file, shown in Figure 7, will indicate a start time that includes the pre-trigger value.

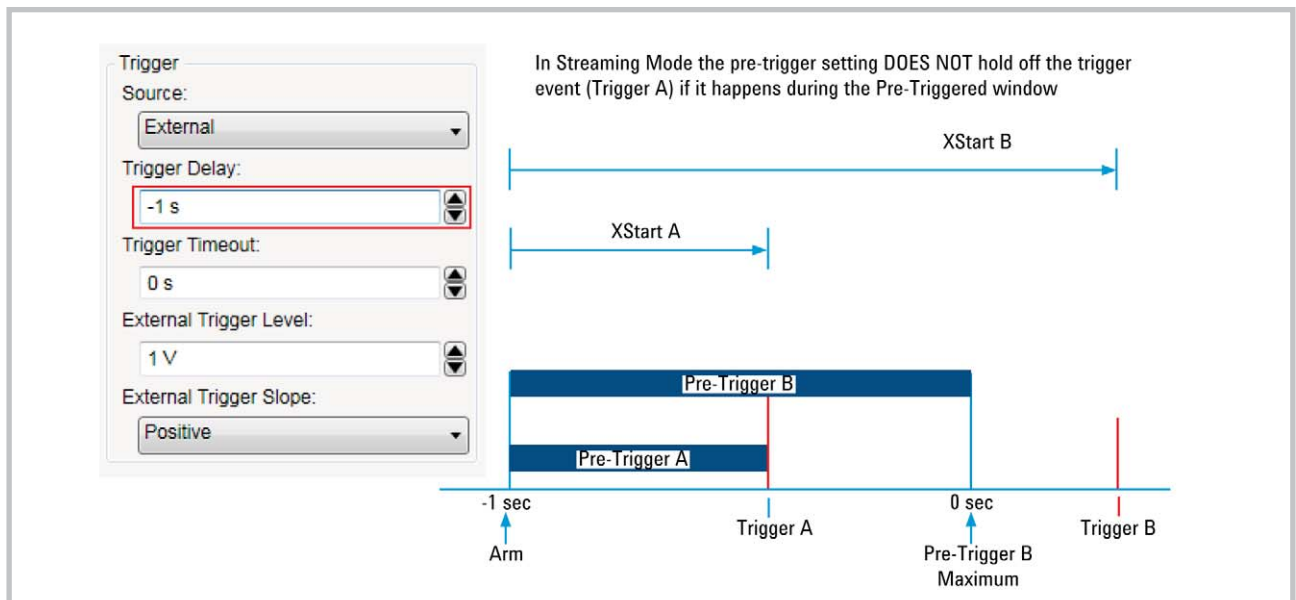


Figure 8. Pre-trigger the capture process

Finding Target Data Using the DataViewer



The M9392A DataViewer enables easy search capability to look for the target signal of interest within the stored data file. It allows the data to be viewed in different domains and at varying sample sizes. The DataViewer allows the engineer to search through the data quickly until the target data is found. In addition, the M9392A creates streaming files that are directly compatible with the Agilent 89600B Vector Signal Analysis (VSA) software.

For step-by-step instructions see the following page: “Setting up the Data Viewer”.

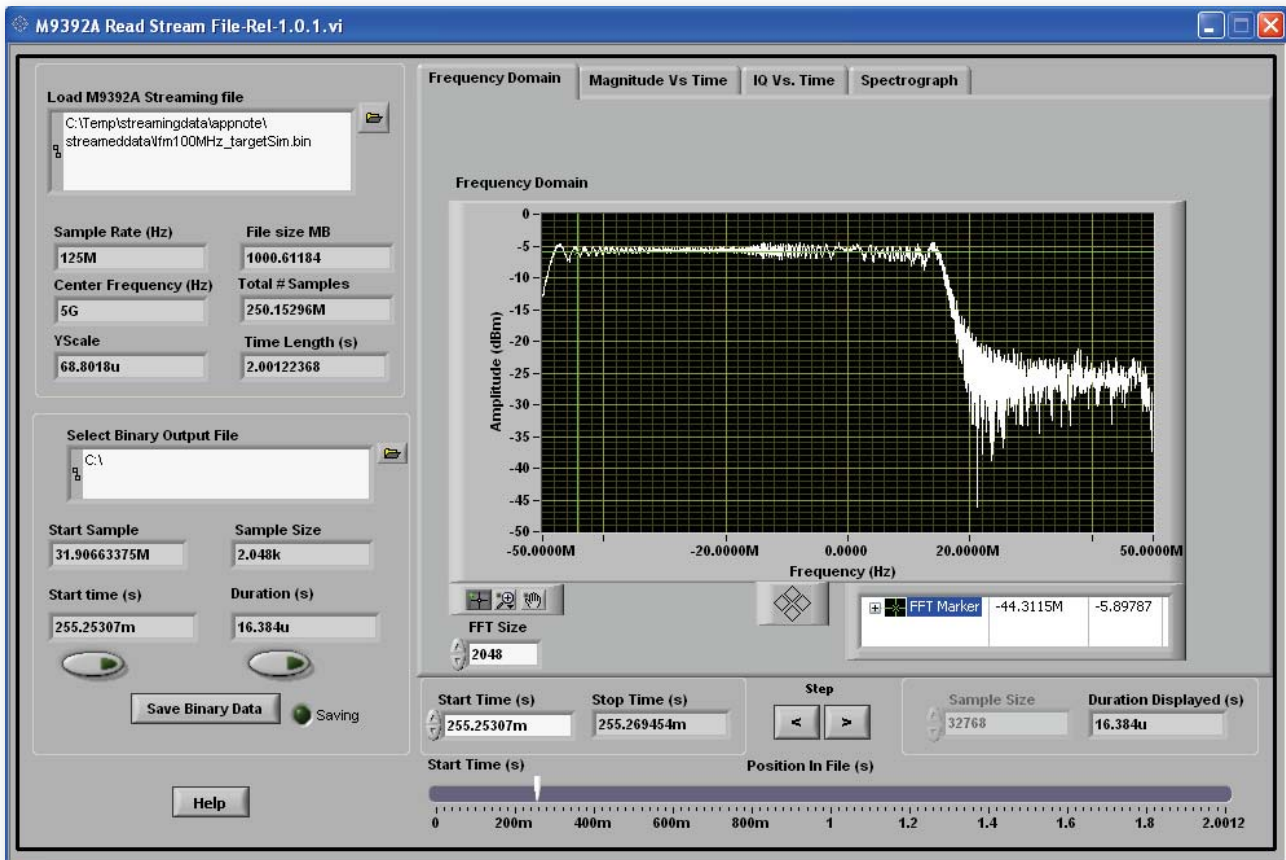


Figure 9. Streaming DataViewer Graphical User Interface

Finding Target Data Using the DataViewer



Setting up the Data Viewer

Steps 1-8 provide procedures for using the M9392A DataViewer to load, search and save streaming files. (For detailed information refer to the M9392A vector signal analyzer user guide).

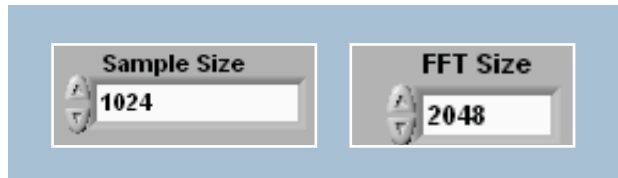
Step 1.

When the DataViewer application is opened a dialog box opens directing you to “Load M9392A Streaming File”. Navigate to the saved file containing the streamed data(lfm100MHz_targetSim.bin).



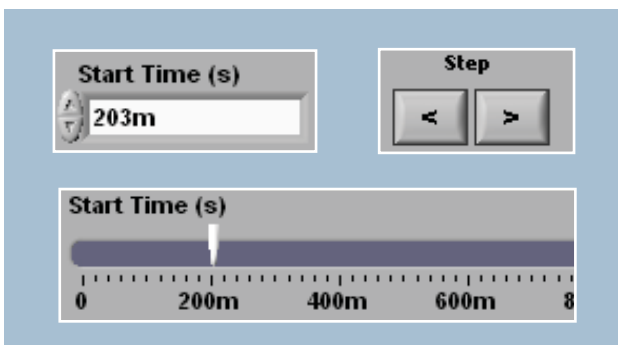
Step 2.

Set sample size or FFT size in frequency domain.



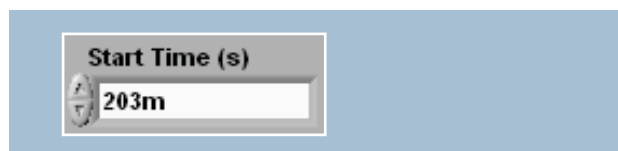
Step 3.

Use the start time controls or the step buttons to move to a new start position in the file.



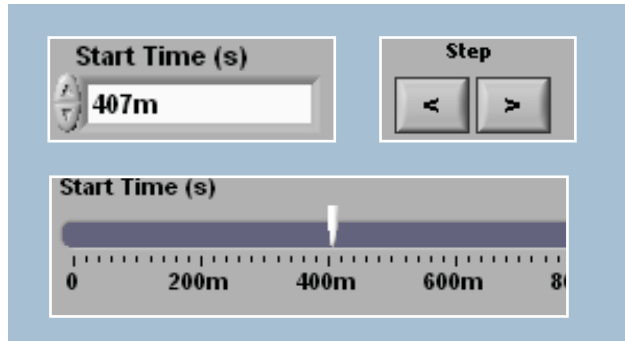
Step 4.

Lock in the start time in seconds (s) by pressing the button below the setting indicator.



Step 5.

Use the start time controls or step buttons to set the duration by setting a start time position deeper into the streaming file.



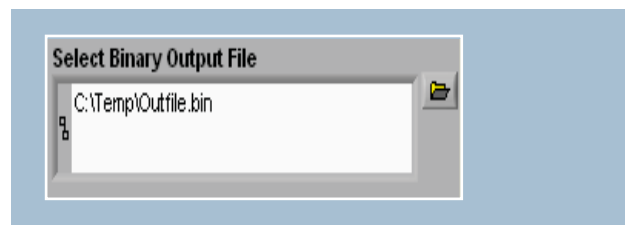
Step 6.

Lock in the duration(s) by pressing the button below the duration setting indicator.



Step 7.

Set or select the binary output file name.



Step 8.

Click the Save Binary Data button.



End

The new, smaller file is now saved and available for import to an analysis tool such as the 89600B VSA. A real measurement example follows.

Finding Target Data Using the DataViewer



Radar example

Finding the proverbial needle in a haystack...

Repetitive failure modes can be simpler to diagnose as symptoms are persistent. Intermittent, or even repetitive failure modes with a relatively long time between failures, can make data analysis particularly challenging.

As discussed previously, it is a challenge for engineers to set up a measurement to capture intermittent failures with widely used standard measurement techniques which capture a few hundred milliseconds of data during each measurement. Failures can be missed due to gaps in the captured data.

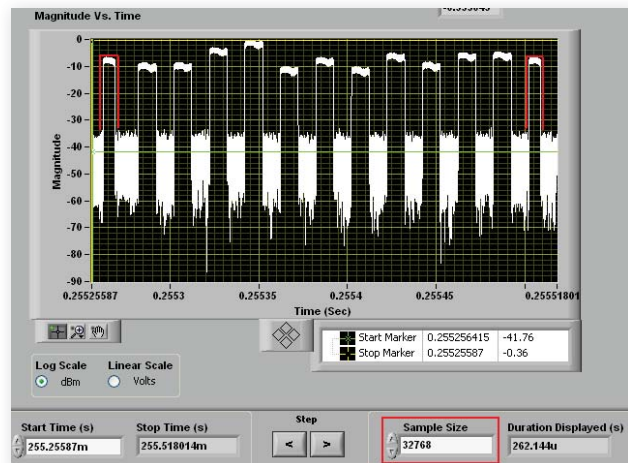
Acquiring a long gapless capture gives a high probability that the failure has been recorded. The following radar example illustrates the steps to review a recording that contains a failing event. A radar target simulation has been captured using the M9392A SFP then loaded into the DataViewer. The goal is to search through the M9392A streaming file and identify the failing event.

Helpful Hints:

- **FFT Size:** Set the Spectrograph FFT Size to be less than the size in samples of the active data. Use the IQ graph or Magnitude vs. time graph to make an approximation of the width of the pulse. If the data for a single pulse covers 1024 samples the FFT size in the Spectrograph should be set below 1024 for better resolution. Setting the FFT size in the spectrograph to be any more than the width of a pulse makes it difficult to see patterns because the irregularities tend to get averaged out.
- **Sample Size:** Set the Spectrograph Sample size to be at least an order of magnitude larger than the FFT Size. This allows more time for the pattern to reveal itself.
- **Navigation:** Step through the data set using the forward and backward arrows.
- **Adjust:** Fine adjustment may be needed to FFT Size, Sample size or Start Time

Magnitude Response of a Pulse Train

- This waveform has a characteristic where every 12 pulses has a narrower time duration
- The number of samples before the pattern repeats is around 32768 samples



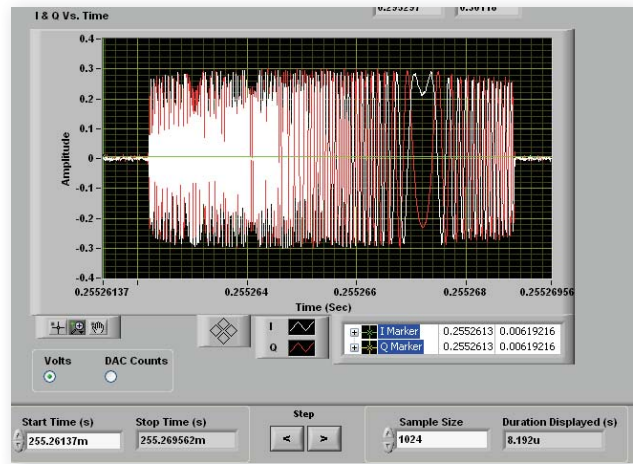
Finding Target Data Using the DataViewer



Radar example (continued)

Pulse Width in Samples—IQ View

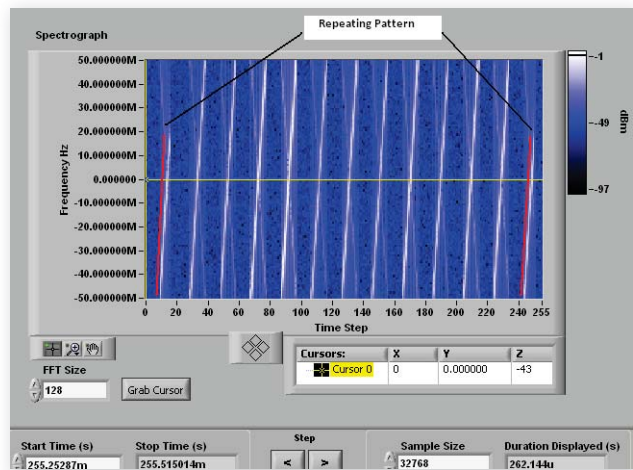
- Use the IQ vs Time graph to find the “On-Time” width of the narrower pulse
- The pulse can be bounded by adjusting in combination the sample size and Start Time
- The bounded pulse is displayed fully by 1024 samples
- The FFT Size in the following Spectrograph should be set to less than the pulse “on time” of 1024 samples
A smaller FFT size will provide better frequency resolution



Spectrograph of a Pulse Train

This is a spectrograph of the waveform samples shown in the Magnitude versus time graph

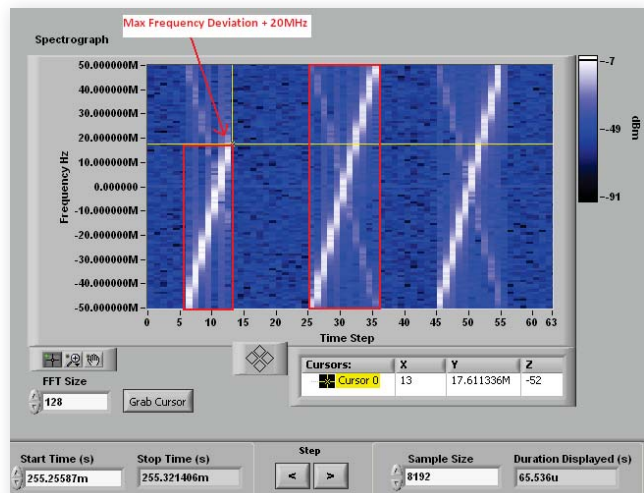
- The FFT size in this case has been set to 128, while the sample size is the same as the Magnitude vs. Time graph (32768)
- A repeating pattern has been revealed that shows that the narrow pulse also has a reduced positive frequency deviation of less than 20 MHz



Zoomed in Spectrograph ¹

This zoomed-in spectrograph has a response of three pulses—the first pulse is narrow.

- Response time axis for each pulse is around 8 steps for the narrow pulse and around 12 steps for the wider pulse
 - Narrow pulse: $8 * 128 = 1024$ samples
 - Wide pulse: $12 * 128 = 1536$ samples
- Each diagonal line represents the strongest frequency components of a single pulse over time
- This characteristic is indicative of a Linear FM chirp waveform which is used in this example



1. Note: The Spectrograph can readily detect patterns in the data if the FFT Size is set to a sufficient resolution to reveal details in the waveform being analyzed.

Analyzing Captured Data with the Agilent 89600B VSA Software



The M9392A creates streaming files that are directly compatible with the Agilent 89600B Vector Signal Analysis (VSA) software for further analysis. Data from the streaming record can be loaded directly into the 89600B for detailed analysis. Or, smaller segments of the data can be selected using the Data Viewer and this file can then be imported to the VSA software.

Steps to load, playback, and analyze captured data using the 89600B VSA software.

Step 1.

Open the 89600B VSA application

(note: no hardware is needed to playback the file for analysis)

Step 4.

Set the playback trigger: Select Input -> Playback Trigger

Stable triggering is important to display and measure complex data consistently.

Step 2.

Select File -> Recall Recording

- Using the file open window (Figure 10) select the streaming file
- Select the file type as N5110A and click open

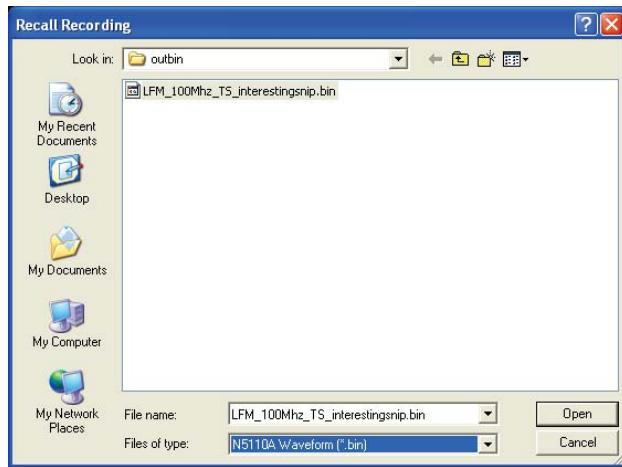


Figure 10. Recall Recording Dialog.

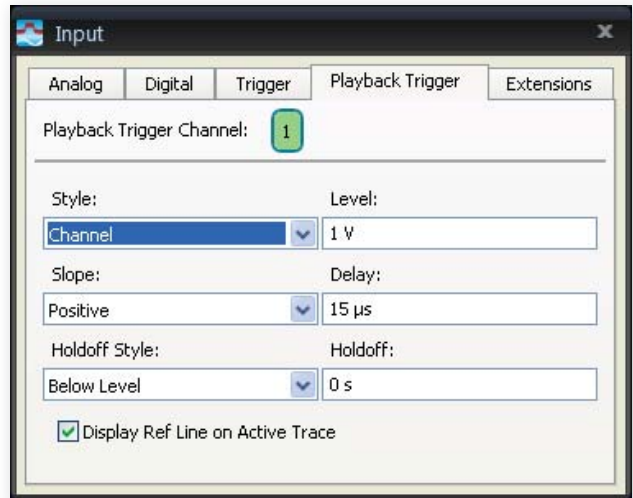


Figure 12. Set Playback Trigger

Step 3.

Open the playback control: Select Window -> Player

Playback control which allows the user to set file position and playback start/stop times.

Step 5.

Save option: Create a setup file to easily recall the measurement setup: File -> Save Setup

Saving the measurement settings allows them to be recalled at a later date.

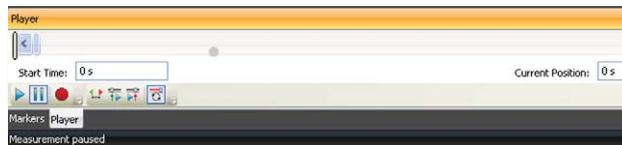


Figure 11. Player for controlling how recordings are played back

Analyzing Captured Data with the Agilent 89600B VSA Software



Step 6.

Access measurements

Once the streaming file has been successfully loaded and the playback trigger set, the full suite of 89600B VSA measurements is available for analysis. Detailed operating information for the Agilent 89600 VSA software can be found by visiting the online guide at: <http://wireless.agilent.com/wireless/helpfiles/89600B/WebHelp/89600.htm>.

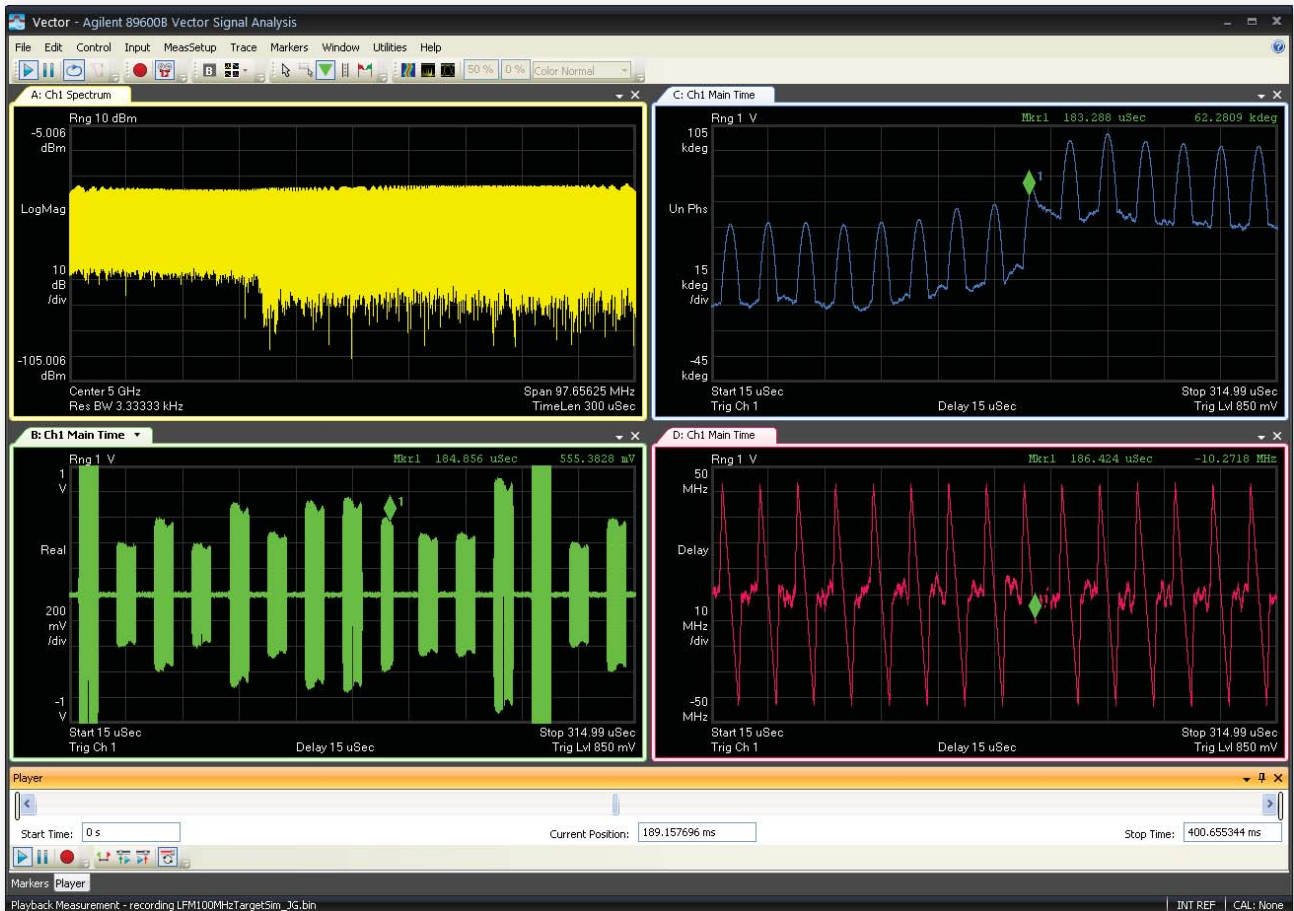


Figure 13. Playing back and analyzing the target signal of interest in 89600B VSA measurement.

Summary

In contrast to the benefits offered by wideband communication, the complexity of the technology creates significant measurement challenges. Capturing an intermittent failing signal for measurements using complex signaling or those made in a noisy environment is one such challenge.

The Agilent M9392A PXI Microwave Vector Signal Analyzer with streaming allows engineers to dig deep into their signals and extract the information they need to identify and isolate physical layer signal problems.

Compatibility with the 89600B VSA signal analysis software ensures engineers have added flexibility to quickly and accurately measure and analyze target signals from different perspectives, using advanced techniques. Together, these tools provide the fast and accurate solution today's engineers need to develop, troubleshoot, and optimize their wideband solutions.



Appendix A

Using the M9392A Streaming file format

A key benefit of the M9392A software is the ability to create streaming files that are directly compatible with the Agilent 89600B VSA software and make them ready for detailed offline analysis.

Helpful Hints:

- The streaming process in the M9392A software stores the data in binary 16 bit interleaved I/Q, little endian format. This format matches the N5110A binary recording format supported by the 89600B VSA.
- The M9392A file naming convention is <streamfilename.bin>.
- The same process that creates the binary streaming file also creates a test header file using the naming convention <streamfilename.bin.txt>. This header file provides additional information that describes the conditions under which the data was captured.



Figure 14. Agilent M9392A PXI Vector Signal Analyzer placed within the M9018A PXI Chassis

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Header Variable	Value	Description [Not in header file]
InputCenter	3000000000.0	Indicates the center frequency of the input data in Hz
InputZoom	TRUE	If Input Zoom is true, the input was zoomed rather than baseband. This implies that time data is complex [Always true for IF Digitized data]
InputRange	1	Input Range indicates the input hardware range setting for the data in Volts peak
InputReflmped	50	Indicates the input reference impedance of the data in Ohms [not used by M9392A]
XStart	0.000	Indicates the time value of first point in data. If external or video trigger are used then XStart represents the time instant within the acquisition that the trigger event happened. If pretrigger data is captured, then this variable indicates the time in the data file when trigger event occurred plus any pre-trigger time
XDelta	1.6e-008	XDelta indicates the time difference between two adjacent points The sample rate is (1 / XDelta)
YScale	1.94985e-005	Multiply the 16-bit I/Q time data by this factor to scale to Volt units



Configuration and Ordering Information

Model	Description
<input checked="" type="checkbox"/> M9392A ¹	PXI Vector Signal Analyzer: 50 MHz to 26.5 GHz
<input checked="" type="checkbox"/> M9302A ²	PXI Local Oscillator: 3 GHz to 10 GHz
<input checked="" type="checkbox"/> M9360A ²	PXI Attenuator/Preselector: 100 kHz to 26.5 GHz
<input checked="" type="checkbox"/> M9202A ²	PXIe IF Digitizer: 2 GS/s, 1 GHz, 50 MHz BW streaming (with options -C01, -F02, -M05, -DDS, -V05)
<input type="checkbox"/> M9202A-V10	PXIe IF Digitizer: 100 MHz BW streaming option
<input checked="" type="checkbox"/> M9361A ²	PXI Downconverter: 2.75 GHz to 26.5 GHz
<input checked="" type="checkbox"/> M9351A	PXI Downconverter: 50 MHz to 2.9 GHz
<input checked="" type="checkbox"/> 89601B	VSA software
<input checked="" type="checkbox"/> 89601B-200	Basic Vector Signal Analyzer
<input checked="" type="checkbox"/> 89601B-300	Connectivity option
<input checked="" type="checkbox"/> 89601B-AYA	Vector modulation analysis
<input checked="" type="checkbox"/> M9021A	PCIe Cable Interface
<input checked="" type="checkbox"/> M9018A	18-slot PXIe Chassis
<input checked="" type="checkbox"/> M9045A	PCIe ExpressCard Adaptor
<input checked="" type="checkbox"/> Y1200A	PCIe cable: x4 to x8, 2.0m (used with M9045A)
<input checked="" type="checkbox"/> <i>Recommended configuration</i>	

1. For the M9392A to work properly, at least one PXI chassis and one PXI controller type must be available.

2. Included with purchase of M9392A.



The Modular Tangram

The four-sided geometric symbol that appears in this document is called a tangram. The goal of this seven-piece puzzle is to create identifiable shapes—from simple to complex. As with a tangram, the possibilities may seem infinite as you begin to create a new test system. With a set of clearly defined elements—hardware, software—Agilent can help you create the system you need, from simple to complex.



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For other unlisted Countries: www.agilent.com/find/contactus

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