KS2201A PathWave Test Sync Executive

Release 2022

Real Time Synchronous Solutions

Keysight's PathWave Test Sync Executive software enables rapid development of high-performance multi-instrument and multi-channel real-time solutions. This powerful software tool is critical in applications requiring tight synchronization, real-time control, and feedback including quantum physics experiments, radar, communication systems, and more.

Keysight's Hard Virtual Instrument (HVI) technology

PathWave Test Sync Executive is built on Hard Virtual Instrument (HVI) technology. HVI provides the capability to program one or multiple instruments to execute time-deterministic sequences of operations and execute them with precise synchronization as if they were a single instrument. This is done by deploying a code executable into the *HVI Engine* integrated into supported Keysight instruments. Each instrument that is supported has specific instructions and detailed documentation

Test Sync Executive unlocks the instrument hardware for complex applications by utilizing the HVI technology.

For the current list of instruments and firmware compatibility, see KS2201A Firmware Version Requirements.

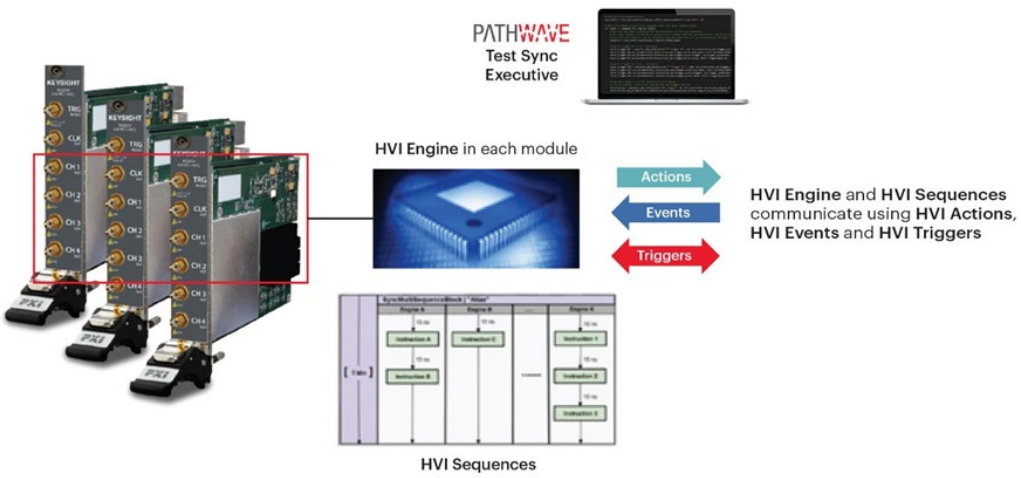

Figure 1. Hard Virtual Instrument (HVI) overview

Abstract Away the Complexity

PathWave Test Sync Executive is a powerful API for synchronizing multiple instruments for precise real-time execution. With a scalable architecture for multi-chassis and 1000s of channels, you can execute at the speed of hardware.

Application Programming Interface (API)

PathWave Test Sync Executive delivers an Application Programming Interface (API) which is a set of programming classes and methods needed to define, program, and execute an HVI instance. Test Sync Executive supports Python and C# programming languages.

The API is class-based and is a combination of the HVI-native API (used by all instruments) and the HVI instrument add-on API (specific to the instrument). HVI uses a program-within-a-program model that enables the definition of a program that runs on the instrument's hardware while the software programs run in parallel and interact with the instruments. HVI is responsible for the setup, compilation, and hardware execution management. When the application runs, it generates an HVI instance and the sequences within it are executed on the instruments. Applications follow a series of steps to program and execute the HVI instance.

The API allows for easy integration into programming environments and provides maximum flexibility. With extensive help files for both languages as well as programming examples, getting started is fast and easy.

Time Management and Latency

To take advantage of the real-time capability of Test Sync Executive, statement execution time management and latency concepts are application specific. Once the sequence is created, Test Sync Executive will verify the complex timing requirements at compilation time to ensure the code developed can be executed.

Fast Data Sharing

PathWave Test Sync Executive integrates seamlessly with PathWave FPGA software. PathWave FPGA provides the tools and interface to easily add custom IP (Intellectual Property) blocks and control logic to a wide range of Keysight instruments. Instruments that support both PathWave FPGA and Test Sync Executive offer enhanced capability for real-time synchronous applications.

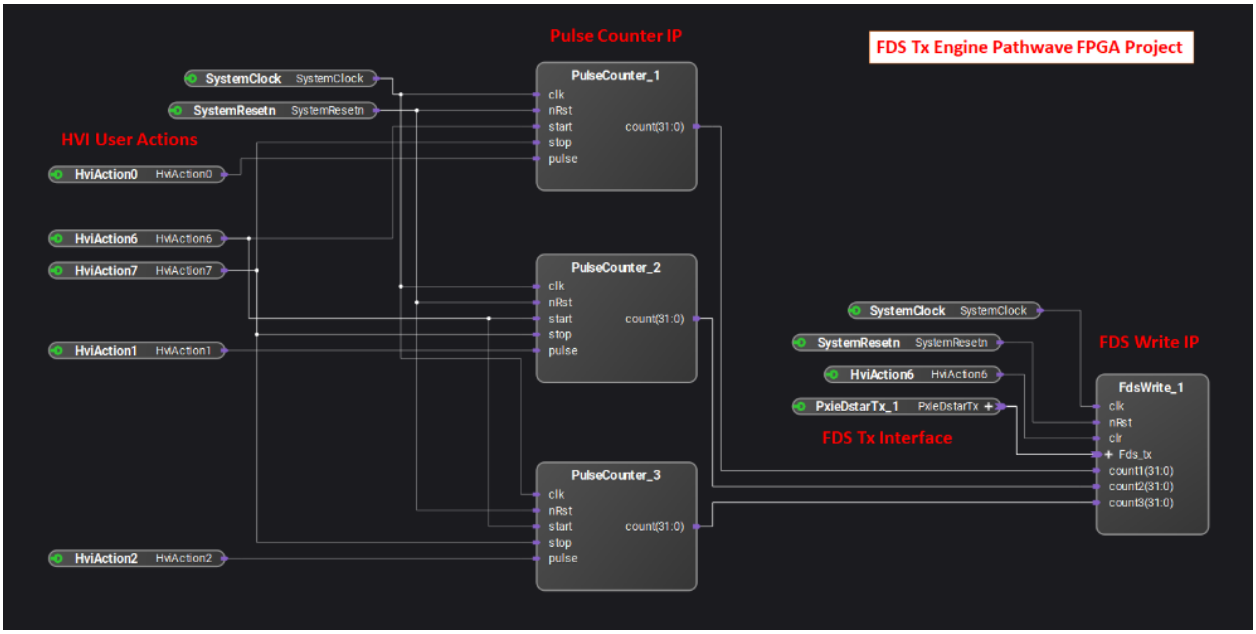

Figure 2. Example of a PathWave FPGA sandbox design including custom IP blocks and interfaces for Fast Data Sharing.

One of the most powerful new features is **Fast Data Sharing** (FDS). FDS enables data sharing between FPGA sandboxes with known fixed low latency. This can be done during the execution of sequences between sandboxes in different instruments in the same or different chassis.

Multi-Chassis Synchronization

Multi-Chassis systems now use improved configuration and synchronization and can be set up using the HVI API delivered by PathWave Test Sync Executive. With the 2022 release, a new multi-chassis topology utilizes the Keysight M9032A/M9033A PXIe System Synchronization Modules (SSMs). More functionality is available including:

- Distribution of precise reference clock
- Management of Fast Data Sharing
- Chassis interconnectivity
- Synchronization of all PXI instruments in the multi-chassis

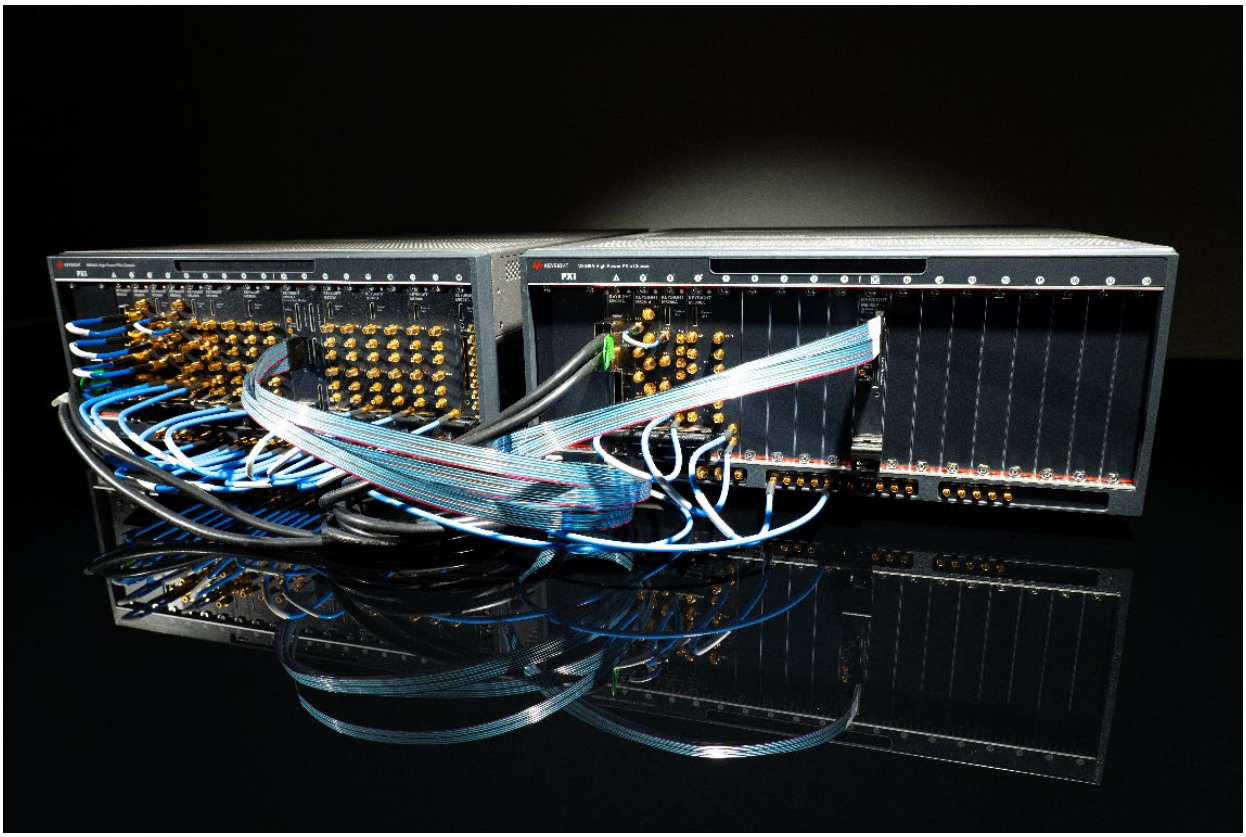

Figure 3. Keysight PXIe Chassis and modules

Programming Examples and Getting Started

To get started with PathWave Test Sync Executive, there are programming examples available with more being added. Each example contains detailed instructions as well as code that can be downloaded as a starting point for developing other applications. Most examples use Keysight Arbitrary Waveform Generators (AWGs) and Digitizers from the M3xxxA PXI instrument family along with the M5302A Digital I-O PXI instrument.

Programming examples	Details
#1 Multi-Channel Sync Playback (Python)	• PathWave Test Sync Executive is used to program multiple M3xxxA AWGs to synchronously output a Front Panel (FP) trigger pulse and then a saved waveform. All modules run fully synchronized and actions across modules can be controlled with the timing resolution of the M3xxxA AWGs which is 10ns
#2 Synchronous Mixed-Signal Measurements (Python)	• The M3102A digitizer performs sequenced acquisition of heterogeneous signals generated by multiple M320xA arbitrary waveform generators (AWGs). • The first AWG generates a train of RF pulses, and the other AWGs output a queued arbitrary waveform. PathWave Test Sync Executive ensures each cycle of digitizer measurements are precisely synchronized with the AWG output signals.
#3 Test Sync Executive Integration with PathWave FPGA (Python)	• Communication is managed between a sequence of real-time instructions created using PathWave Test Sync Executive and a custom FPGA (*Field Programmable Gate Array*) integrated into the sandbox of a Keysight instrument using Keysight PathWave FPGA software. • PathWave FPGA software can be used with supported Keysight instruments to insert custom logic into the instrument FPGA
#4 Real-Time Pulsed Characterization of a Device Under Test (Python)	• The M3202A AWG and M3102A digitizer are used to perform a real-time pulsed characterization experiment on a Device Under Test (DUT). Different waveforms are loaded to the AWG and the digitizer can use the register sharing functionality to select in real-time the waveform to be played by the AWG at each iteration • The example can be repeated for a user-defined number of loops, allowing the user to choose the delay between each loop, such as what's necessary to allow the DUT return to its equilibrium state.
#5 Multi-Channel Sync Playback (C#)	• PathWave Test Sync Executive is used to program multiple M3xxxA AWGs to synchronously output a Front Panel (FP) trigger pulse and then a saved waveform. • All modules run fully synchronized and actions across modules can be controlled with the timing resolution of the M3xxxA AWGs which is 10ns.
#6 Synchronized MIMO Measurements (Python)	• Test Sync Executive is used to program multiple M5302A Digital I/O (DIO) and M3xxxA PXI instruments. By using HVI (Hard Virtual Instrument) capabilities, DIO instruments can output a pulsed signal from any of their Front Panel SMB trigger ports and M320xA AWGs can synchronously play a previously queued waveform. • Multiple M3102A Digitizers can also be included in the same HVI to synchronously capture all the generated analog and digital signals. This example demonstrates a Multiple-Input Multiple-Output (MIMO) measurement setup with all input and output channels fully synchronized.

For more information and to download the latest versions:
www.keysight.com/find/ks2201a-programming-examples

Abstract Away the Complexity

Keysight's PathWave Test Sync Executive software enables rapid development of high-performance multi-instrument and multi-channel real-time solutions for the most demanding applications. Get hardware speed and precision with this powerful software tool.

- Simplify system configuration and initialization
- Set up multi-instrument synchronization for parallelism without scaling penalty
- Execute real-time synchronous commands with sequencing, branching, and looping
- Achieve time-deterministic hardware-based execution with low latency data exchange between instruments

Download a Free Trial and see for yourself.

Find out more at www.keysight.com/find/ks2201a