WaveAce Integration with LogicStudio

APPLICATION BRIEF

August 22, 2012

Summary

The WaveAce oscilloscopes and LogicStudio logic-analyzer module combine to form a highly capable mixed-signal instrument.

Introduction

Because almost all modern system designs combine both analog and digital circuitry, debugging the design requires visibility into both analog and digital signal paths, and, increasingly, serial-link circuitry. The basic diagnostic tool of choice for the analog side is an oscilloscope, while digital signals are often best observed with a logic analyzer. Thus, a well-rounded test bench will carry both instruments. Unfortunately, logic analyzers are often too slow, complicated, and costly. A mixed-signal oscilloscope is one way to approach the issue, but another cost-effective approach is to combine an oscilloscope with a logic-analyzer module. LeCroy's WaveAce oscilloscope and LogicStudio 16-channel logic analyzer combine with a PC to form a mixed-signal instrument that addresses a wide range of applications. LogicStudio supports both the WaveAce 1000 and 2000 series of oscilloscopes, as well as the WaveJet 300A series.

About LogicStudio

LogicStudio, shown in Figure 1, provides 16 digital channels with a sampling rate of 1 GS/s on eight channels and 500 MS/s on the full 16 channels. It will detect pulse widths as small as 3.75 ns. An important element of LogicStudio is its companion software, which resides on a PC and provides the user interface for capturing, analyzing, and flexibly triggering waveforms.

Figure 1: Shown is LeCroy's LogicStudio 16-channel logic analyzer, which links to a PC running the companion LogicStudio software

LogicStudio also includes protocol analysis capabilities for the I^2C, SPI, and UART serial protocols. With LogicStudio, users can display analog waveforms from the WaveAce oscilloscope (as well as many Agilent and Tektronix models).

About the WaveAce

When teamed with an oscilloscope such as LeCroy's WaveAce series of instruments, shown in Figure 2, LogicStudio becomes a formidable mixed-signal debugging tool. The WaveAce oscilloscopes come in bandwidths from 40 MHz to 300 MHz and with sample rates of up to 2 GS/s.

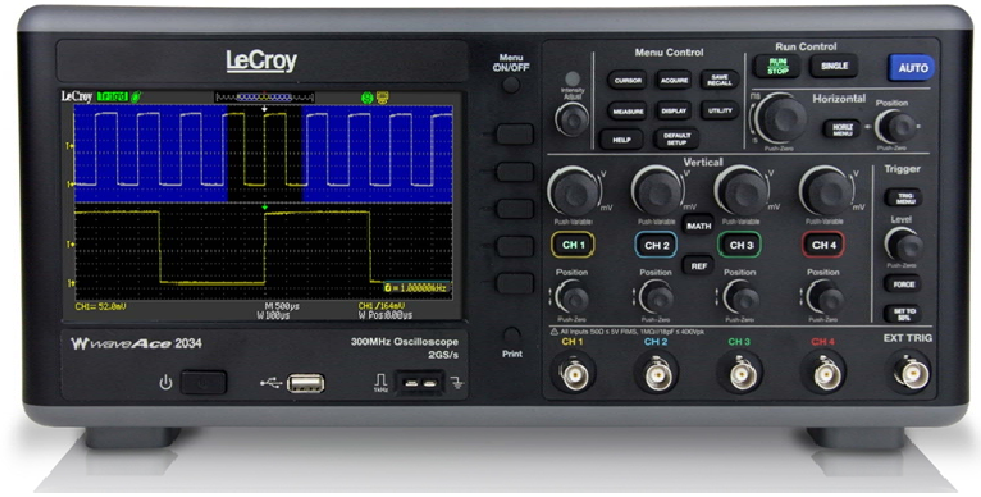

Figure 2: Shown is the WaveAce 2034 oscilloscope, which offers a 300-MHz bandwidth, four channels, and maximum sampling rate of 2 GS/s. All WaveAce instruments feature a 7" wide display

A long memory of up to 1 Mpts/channel (2 Mpts/channel when interleaved) means that a sizable record of a signal is retained. The oscilloscopes also offer advanced triggering options, a 7" wide screen, 32 automatic measurements, and four math functions as well as fast-Fourier transform (FFT) capabilities.

Note also that LogicStudio integrates well with LeCroy's WaveJet oscilloscopes, which are offered in two- and four-channel versions with bandwidths from 100 MHz to 500 MHz and sample rates up to 2 GS/s. WaveJet provides a long waveform memory of 500 kpoints/channel and a 7.5-inch color display.

Configuring the System

A key feature of the combination of WaveAce and LogicStudio is its ability to import analog waveforms from the WaveAce and digital waveforms from LogicStudio and display them on a PC in one view. This is accomplished by connecting both instruments to the PC via USB cable and installing necessary PC software.

A prerequisite is to download and install LogicStudio software, which is freely available from the LeCroy website. LogicStudio software serves as a full-featured user interface for the logic analyzer as well as the scope. With the LogicStudio software, users can navigate the waveform display area by panning across the analyzer's timeframe, zooming specific regions of the waveforms, or scaling the timeframe itself. LogicStudio software provides facilities for triggering, setting cursors, controlling run modes, and much more.

Facilitating a USB connection between the WaveAce oscilloscope and the PC also requires installation of NI VISA drivers as well as the NI Measurement and Automation Explorer application. These can be downloaded from NI's support page.

Preparing for Signal Acquisition and Display

The first step in displaying signals in LogicStudio is to acquire them with the oscilloscope. For this demonstration, a WaveAce 2034 oscilloscope was fed signals from LeCroy's WaveSource 100, an oscilloscope evaluation signal source that plugs into a front-panel USB device port on the WaveAce. The WaveSource 100 provides eight parallel digital outputs clocked at 40 kHz. Lines D0 through D7 on the LogicStudio module were connected to the WaveSource 100's eight digital I/O pins. Additionally, lines D8-D10 were used to acquire an SPI signal from the WaveSource 100 board.

Configuring the WaveAce, LogicStudio, and PC hardware requires three interconnections:

1. A coaxial-cable connection between the WaveAce's front-panel EXT TRIG input and LogicStudio's TRIG OUT jack.

2. USB connections between the WaveAce and the PC and between the LogicStudio and the PC. Once these connections are established, open the LogicStudio software and turn on the WaveAce. A Device Finder wizard, shown in Figure 3, is found at the upper left-hand corner of the GUI or in the Devices menu. Click on the top center button in the wizard, which denotes a logic analyzer being added to an oscilloscope. Then highlight the LogicStudio and WaveAce listings and click Next.

Figure 3: LogicStudio's Device Finder wizard facilitates USB connection of the LogicStudio logic-analyzer module and the WaveAce oscilloscope to the PC

After clicking the Next button seen in Figure 3, the Device Wizard provides a diagram of the connections outlined above, shown in Figure 4.

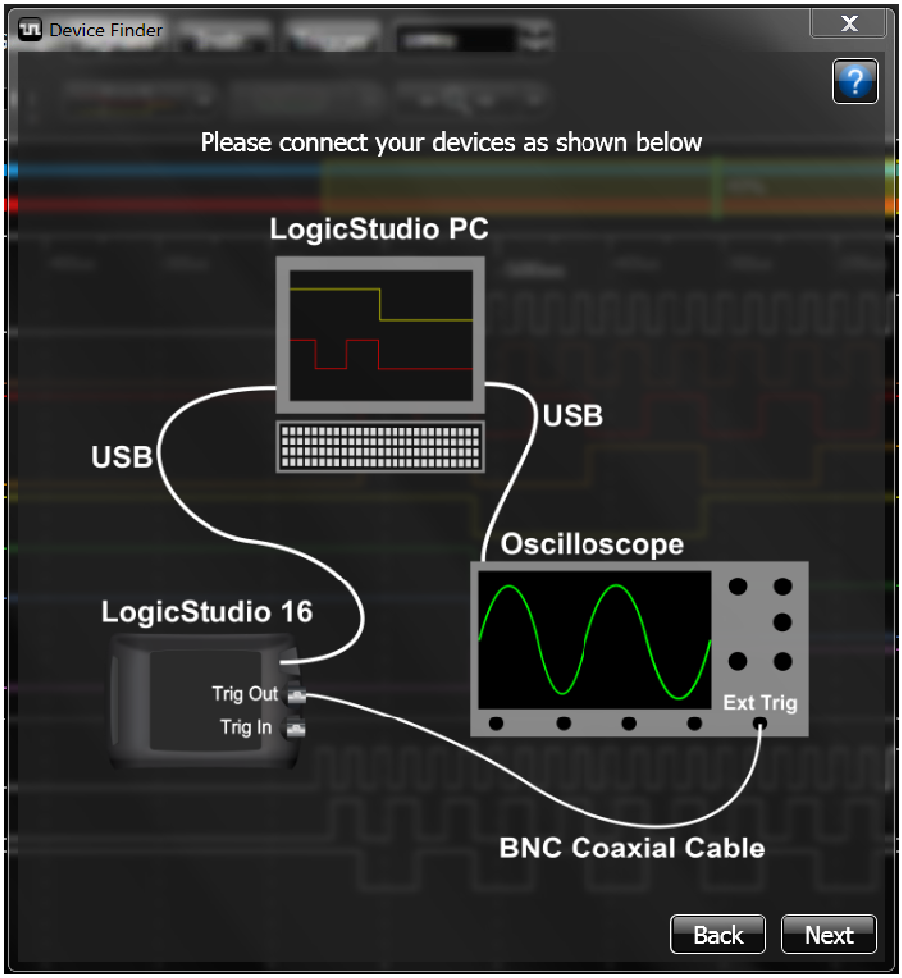

Figure 4: After confirming that the hardware is connected, the Device Wizard provides a diagram of all interconnections required for mixed-signal operation

Clicking Next again brings up confirmation that the LogicStudio and WaveAce "have been successfully connected in MSO mode."

Displaying Signals in LogicStudio software

With all hardware connected and software running, the next step is to configure the newly-configured MSO to display the desired signals. Figure 5 shows the initial LogicStudio screen.

Figure 5: The initial LogicStudio screen with its large waveform display area, channel indicators (left-hand column), and signal-display tools

The Signals Control panel, which is the multicolored column of channel designators on the left-side of the LogicStudio GUI, provides for channel-by-channel modification of signal display. It is a simple manner to add or subtract channels using the large “plus” and “delete” buttons at the top of the column. Existing channels can be modified and/or renamed one by one by simply clicking on them, which brings up a dialog box shown in Figure 6.

Figure 6: Clicking on any channel in the left-hand Signals Control panel brings up a dialog box in which the channel may be modified and/or renamed. Also, this is where the source of the channel’s signal is specified

Referring to Figure 6, the channel type for channel D0 is in this case a digital line. It can be changed to numerous options, including digital bus, digital wave, analog channel, I^2C decode, SPI decode, or UART decode. The name for each channel can be edited in the name field to reflect each channel’s usage. The data field designates which line from the LogicStudio module is receiving the signal.

Thus, in the case of the SPI signal, the nominal D8 channel was renamed and reconfigured for SPI decode in the manner shown in Figure 7.

Figure 7: To ready the LogicStudio software for SPI decode, channel D8 was redesignated for SPI Decode as shown in the Type: field. The channel was renamed "SPI," and the Data, Clock, and Chip Select signals were indicated as being on lines D8, D9, and D10 of the LogicStudio module, respectively

All channels can also be brought up simultaneously for reconfiguration/renaming by using the Setup: options in the GUI shown in Figure 8. The resulting screen is shown in Figure 9.

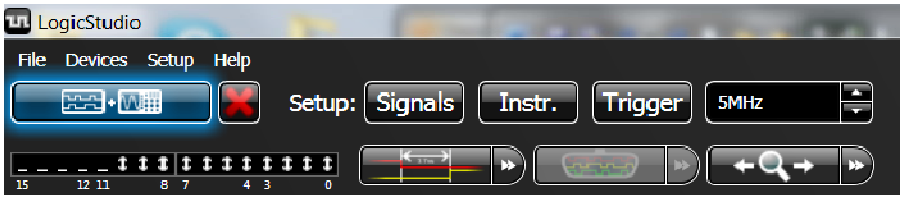

Figure 8: All channel configurations can be displayed at once by clicking the Signals button in the Setup: area of the LogicStudio GUI

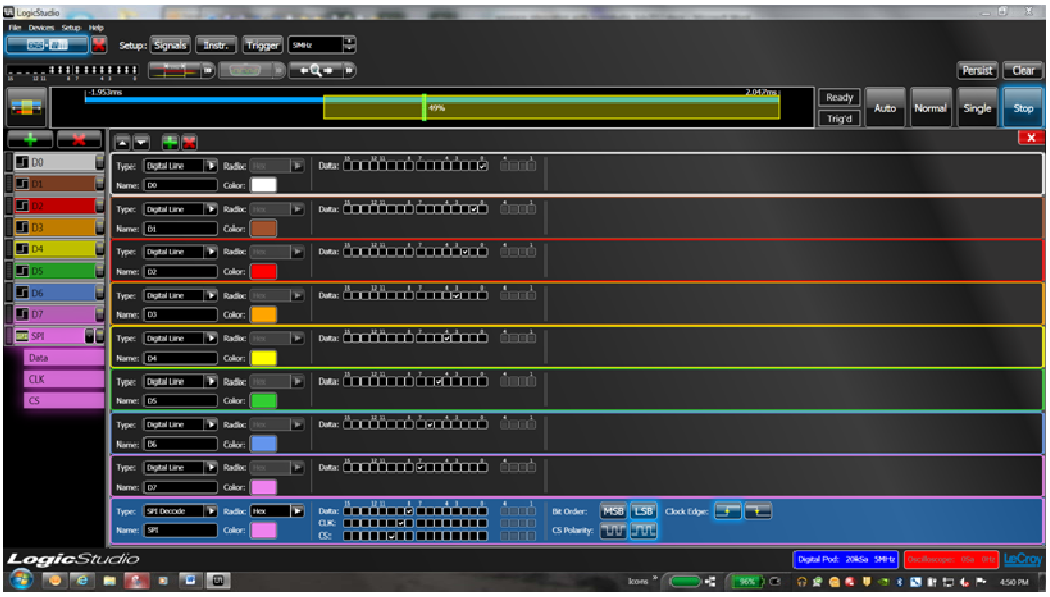

Figure 9: Shown are the configuration dialog boxes for all channels

With all channels connected in hardware and configured in software, select a run mode for the mixed-signal environment using the Auto, Normal, or Single buttons at the top right of the GUI. Figure 10 is a screen capture of Normal triggering.

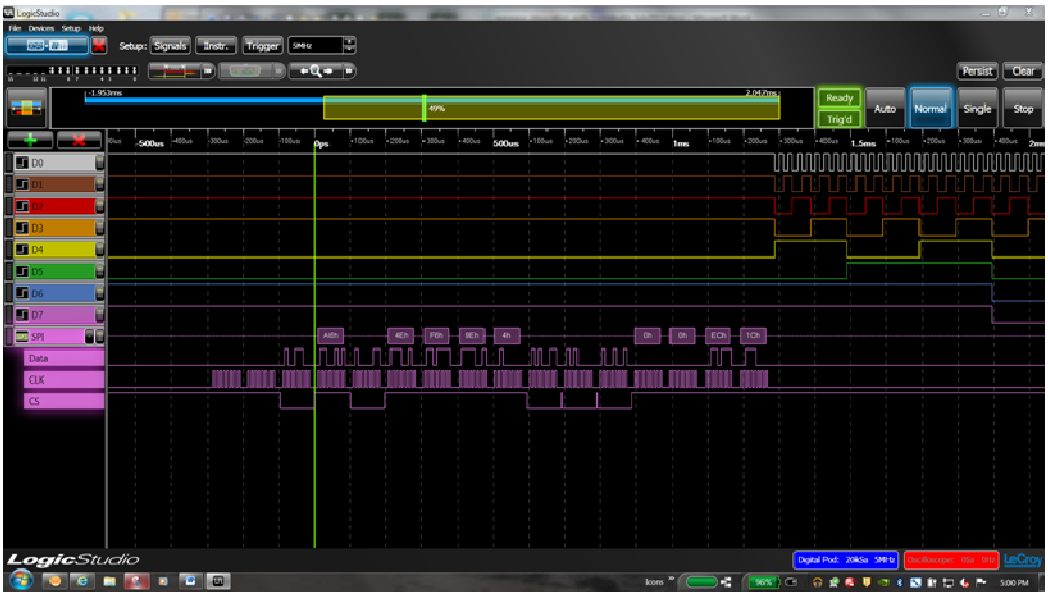

Figure 10: The LogicStudio screen shot shown here depicts the display of eight digital I/O channels as well as decoding of an SPI signal

LogicStudio affords great flexibility in serial-data decoding as well as in triggering. Referring again to Figure 9, note that the SPI signal can be specified as having a bit order of MSB or LSB, a Chip Select polarity of active-low or active-high, or a falling or rising clock edge.

Triggering options are many. The Triggering setup button opens a pop-up window for configuring trigger conditions, which offers four tabs for different trigger categories. The Simple Logic tab is for configuring simple, logic-based triggers with edge, level, pattern, and immediate modes. In the Advanced Logic tab, logic-based triggers can be more complex. The Serial Protocol tab is for definitions of triggers on serial decode signals in the I2C, SPI, or UART protocols. Finally, an External Trigger tab enables setting the LogicStudio module to trigger on an external signal; a threshold voltage for this signal may be set.

Finally, LogicStudio is equally adept with the display of analog signals as it is with digital signals as shown in Figure 11.

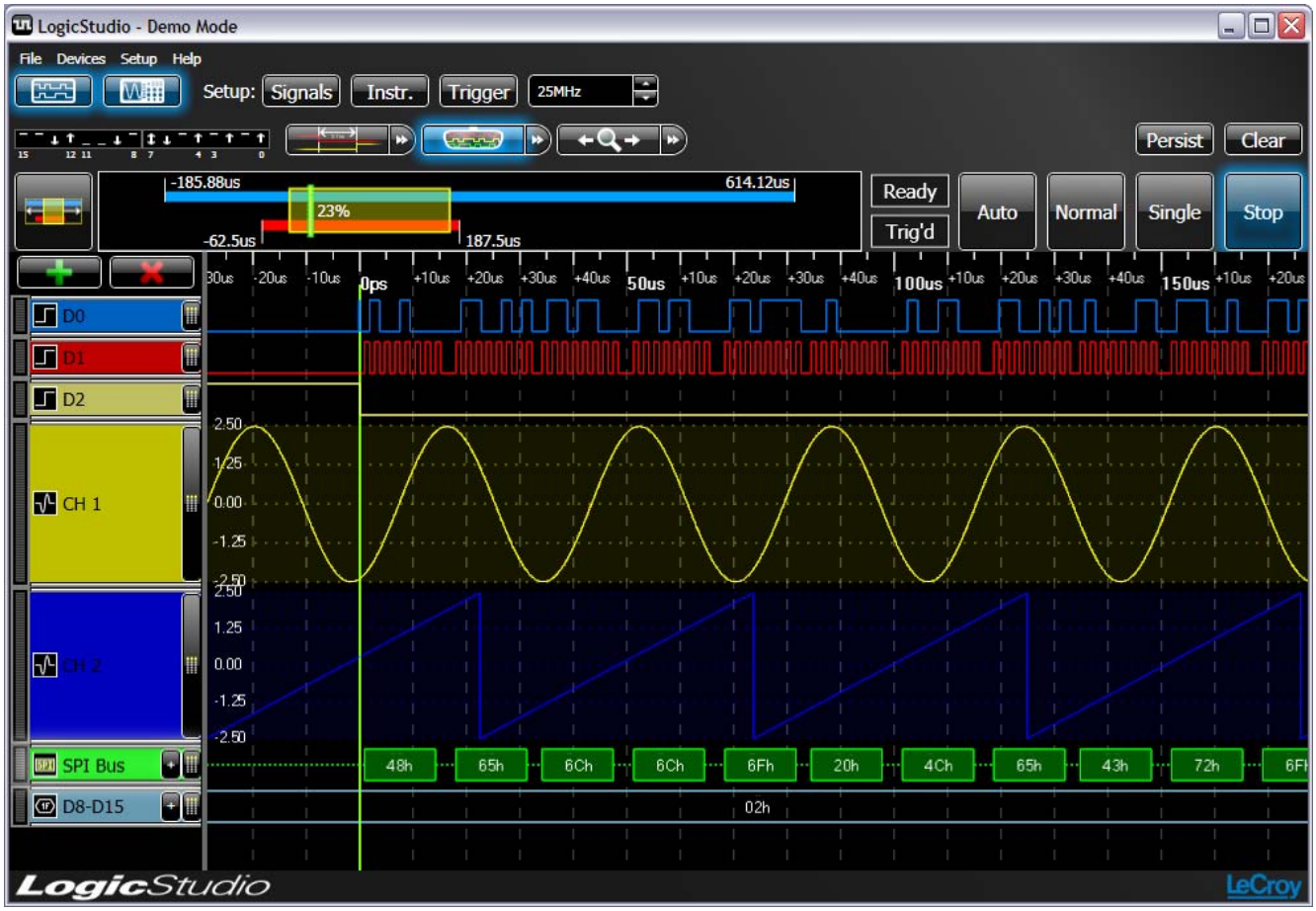

Figure 11: This LogicStudio screen capture demonstrates the software's ability to display a mixture of analog signals, digital signals, and serial protocols as captured on the WaveAce oscilloscope.

Displaying of signals such as the sine and ramp waves in Figure 11 is simply a matter of applying the same setup procedures described earlier to the analog signals. In the channel configuration for Channels 1 and 2 from the WaveAce, the signals are designated in LogicStudio as analog channels. Note that when a channel is given the type "Analog Signal," the digital I/O pin designations are greyed out in the channel configuration dialog box. Instead, the Channels 1-4 designations from the WaveAce are live.

It's important to note that digital signals acquired using the LogicStudio module and analog signals from the WaveAce oscilloscope are displayed aligned in time on the PC. Thus, users may capture analog and digital signals on two different instruments and accurately measure the digital signals with reference to the analog signals. For example, it is possible to measure the delay in capacitor discharge time (analog) after an I^2C command is issued by a microcontroller (digital). LogicStudio software comes with a full complement of timing cursors that make it easy to measure the time between transitions on a single digital line, across digital lines, or from a digital line to an analog waveform. As a result, users gain mixed-signal oscilloscope capabilities at a cost far lower than an actual MSO.