

# LabVIEW SignalExpress for Teaching and Research

National Instruments LabVIEW SignalExpress, an interactive environment based on the industry-leading NI LabVIEW graphical system design platform, helps make hands-on, experiential learning possible for students across multiple disciplines, from biomedical engineering to aerospace engineering, and across multiple levels, from freshman to senior, with its powerful, interactive, step-by-step approach.

Because NI LabVIEW SignalExpress can connect to thousands of devices and interfaces over several buses such as USB, GPIB, or serial, students and researchers can use it in labs for a variety of purposes. With LabVIEW SignalExpress, they now can perform analysis interactively on-the-fly and customize their algorithms quickly and easily. This white paper explores some of these benefits with examples from various courses.

## Interactively Compare Simulation with Real-World Results

One of the fundamental concepts of engineering is circuit design. Traditionally, students used SPICE simulation software, such as National Instruments Multisim, for circuit design, but they could not compare the results easily with real-world data because the process was extremely cumbersome – it involved manual steps such as writing the real data on paper or storing it on a floppy disk. The tools, simply put, were not integrated seamlessly. With LabVIEW SignalExpress, the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS), and industry-leading NI Multisim SPICE simulation software, students now have access to a seamless platform, from design to prototyping and result comparison, between the simulation domain and the real world. Figure 1 shows an example of how LabVIEW SignalExpress completes the picture and helps in providing a seamless, completely integrated platform to teach circuits and electronics.

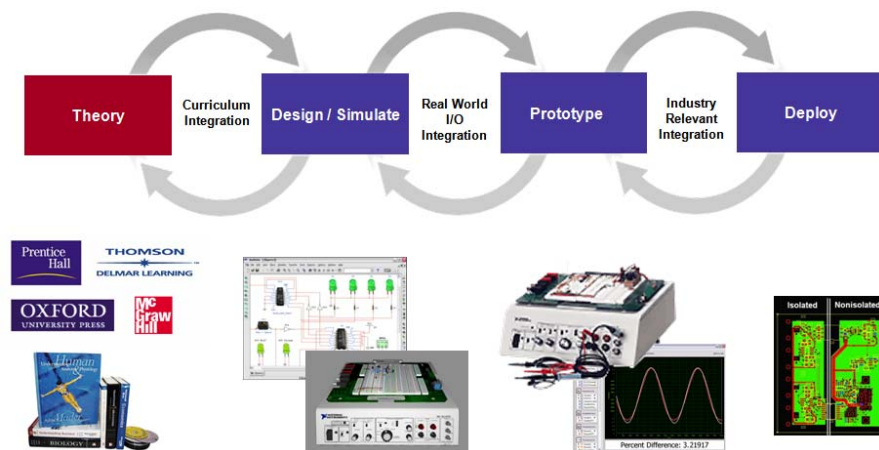


Figure 1. LabVIEW SignalExpress for Seamless Platform Integration

To examine this in more detail, consider the power of the NI electronics education platform (Multisim, NI ELVIS, and LabVIEW SignalExpress) in an RLC circuit example. Every engineering student must learn about RLC circuits. Typically, students first learned this concept from leading textbooks. Then they used SPICE simulation and capture software such as Multisim to design and simulate the RLC circuit to understand its characteristics. With features such as virtual components and several analysis capabilities, Multisim offers an ideal option to simulate circuits.

After simulating the circuits, students prototyped the RLC circuits on a prototyping platform such as NI ELVIS. With 12 integrated instruments including an oscilloscope, a function generator, and a digital multimeter (DMM), NI ELVIS provided a compact and versatile platform for prototyping. Finally, students compared the simulation results with real-world data. Again, using traditional methods, this might have been a cumbersome step, but with LabVIEW SignalExpress, students can easily import both the SPICE simulation results and the real-world data from their prototyping stages and compare them interactively to understand the effects of real-world phenomena such as noise. Thus, LabVIEW SignalExpress helps provide a simple and intuitive interface to bring concepts to life.

## Connect to Hundreds of Instruments and Signals with Plug-and-Play Technology

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There is a variety of instrumentation available in academia today such as the new generation of modular instruments (as shown in Figure 1); traditional instruments such as oscilloscopes, DMMs, and function generators; and hundreds of other customized instrumentation in emerging areas such as biomedical engineering and nanotechnology. With different types of instruments communicating over different buses, and each instrument typically using a different type of software, it becomes increasingly difficult to connect to and work with multiple instruments in a single environment.



Figure 2. Next-Generation Modular Instruments

With LabVIEW SignalExpress, students and researchers now have the ability to connect to and measure from thousands of instruments over different buses using a single interface. They can interactively analyze and report data whether in the classroom or in the lab instead of having to manually save to a floppy or

USB drive and then post-process the data using software such as Microsoft Excel. Because LabVIEW SignalExpress is a completely interactive platform, students and researchers can now analyze data on-the-fly and make changes even as their applications are running. In addition, they can apply multiple analyses to the system faster and make adjustments in real time.

## Analyze Data Interactively

With LabVIEW SignalExpress, students and researchers do not have to wait to complete the whole system before making tweaks to it. For example, traditionally, to acquire a signal and apply a fast Fourier transform (FFT) to it, they typically wrote a program that performs the complete process (acquired the signal, filtered the signal, and performed an FFT) and then ran it, evaluated the results, and tweaked the system through tasks such as specifying different parameters for the FFT and changing the filter type. With LabVIEW SignalExpress, students and researchers now can add and modify analysis functions while acquiring data from the sensor. Figure 3 shows an example of a system acquiring data while an FFT function is being added to the system.

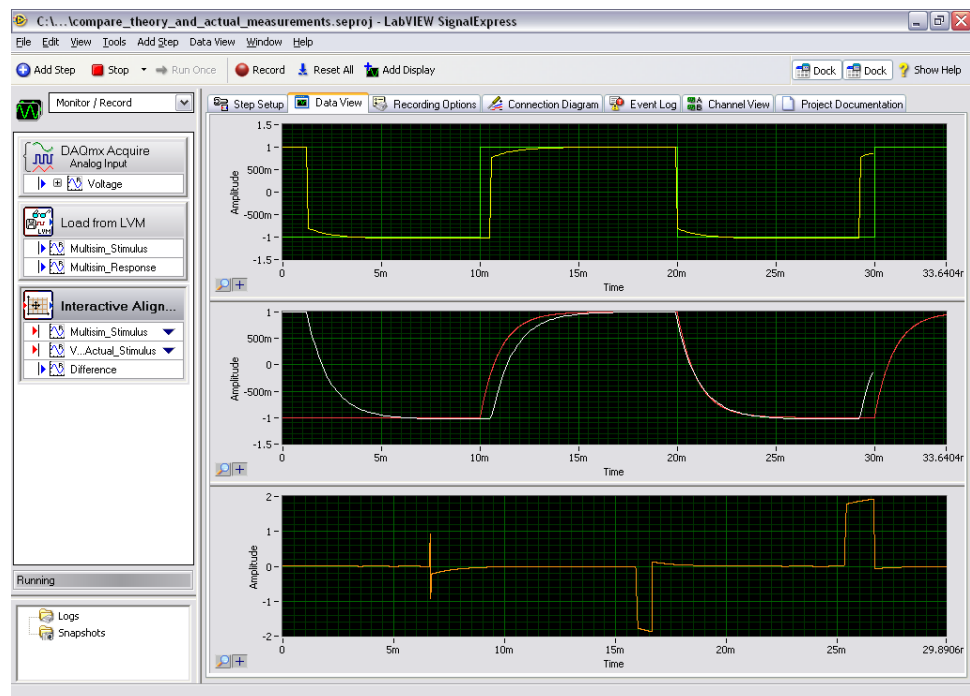


Figure 3. Data Acquisition with Addition of FFT Function

Because students can now interactively analyze data, they can more easily see the nuances of the various concepts better. For example, it is now possible to fully grasp the difference between an IIR filter and an FIR filter, the effect of filter topology choices on the output, and the effect of the sampling rate on FFT results and other such concepts. Using traditional methods, this takes a long time because the student has to build the whole program, run it, change the function, and recompile and run it again to understand the changes. Being able to apply and change analysis functions on-the-fly is also beneficial for research. Students

now can explore multiple designs for their algorithms with minor tweaks and see the results instantaneously to help them develop powerful solutions to research problems and report them.

## Generate Interactive Reports

Creating reports is critical for both homework assignments and research projects. Traditionally, students had to rely on third-party software such as word processing and image processing systems. In addition, there were limited options for annotating graphs and exporting them. LabVIEW SignalExpress, for the first time, provides a simple interface to create interactive reports. In addition to text and tables, interactive reports include dynamic charts and graphs that display the data acquired and analyzed. Figure 4 shows an interactive report created in LabVIEW SignalExpress.

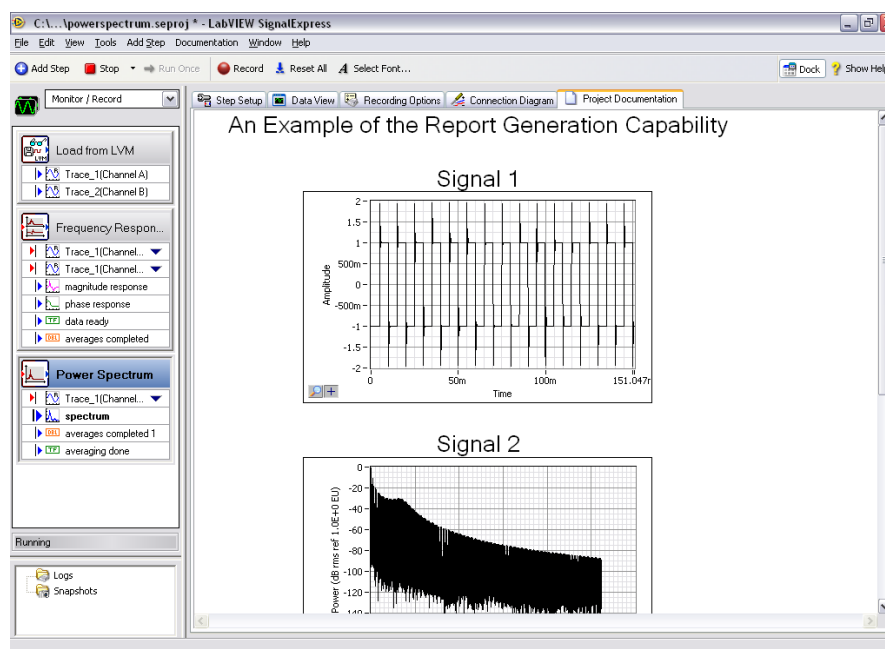


Figure 4. Interactive Report Created in LabVIEW SignalExpress

With LabVIEW SignalExpress, students and researchers can easily import graphs into their reports and export graphs in a variety of formats for use within LabVIEW SignalExpress itself or with other third-party software to create reports. In addition, they can export data to analysis packages such as Excel. They can either drag the data from LabVIEW SignalExpress to Excel or export data with one click. Students and researchers also can export the data to other common packages such as Microsoft Word or PowerPoint. Additionally, if they choose to create reports using the documentation tools in LabVIEW SignalExpress, they can view the data interactively in the report. If their data extends over several chart lengths, they can import the chart into the report and press "Run" to actually see all of the data.

## Extend Projects Using LabVIEW with Automatic Code Generation

Research, which drives innovation, is based on many of the fundamental concepts taught in classrooms. Because researchers can use graphical programming languages such as LabVIEW to target multiple hardware platforms such as FPGAs, digital signal processors, and embedded boards, these languages are fast becoming the de facto research tools in academia. Researchers now have access to a completely graphical programming language to design, prototype, and deploy their systems.

Because LabVIEW SignalExpress is based on LabVIEW, students now can use additional functionality to extend their work from areas such as senior design to research projects with automatic LabVIEW code generation, as shown in Figure 5.

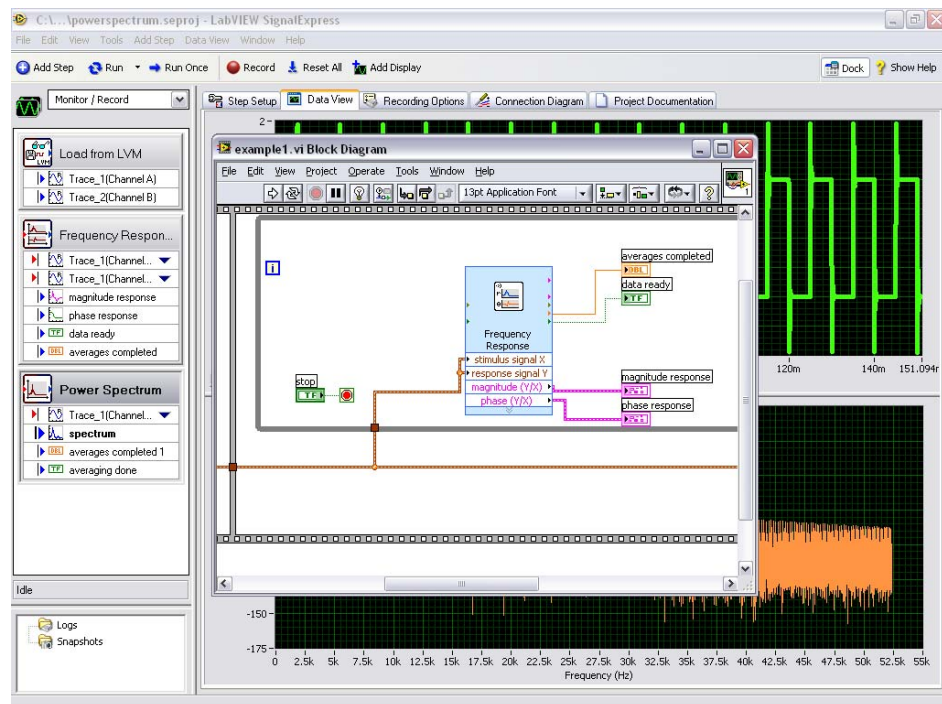


Figure 5. Automatic LabVIEW Code Generation

For example, some students may have designed, simulated, and tested a filter using LabVIEW SignalExpress and may wish to use this filter and deploy it on an FPGA. They can use the automatic code generation feature in LabVIEW SignalExpress, add the required I/O nodes through the LabVIEW FPGA Module, and implement the new system on an FPGA. This helps students save time because they do not have to recreate their filter, avoiding the errors generated during that process. Combined with the functionality to connect to thousands of instruments, LabVIEW SignalExpress presents a viable platform to quickly design systems for research.

## Conclusion

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LabVIEW SignalExpress offers benefits that enhance teaching, learning, and research. Capabilities such as interactive, on-the-fly acquisition and analysis; connectivity to thousands of instruments; and the generation of interactive reports facilitate better learning and research through increased productivity. In addition, with its foundations in LabVIEW, LabVIEW SignalExpress spans from classroom to research lab seamlessly with automatic LabVIEW code generation, reducing design time. LabVIEW SignalExpress delivers significant performance improvement while providing a simple, intuitive, and interactive interface that is easier to learn and use than other academic tools.



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