# NI's roboRIO Robotics Design Platform for *FIRST* Robotics RePowered by AMD-Xilinx

## roboRIO Helps *FIRST* Turn Students into Engineers

### AT A GLANCE:

NI brings together the people, ideas and technology so forward thinkers and creative problem solvers can take on humanity's biggest challenges. From data and automation to research and validation, NI provides the tailored, software-connected systems engineers and enterprises need to Engineer Ambitiously™ every day.

**Industry:** Test & Measurement; Robotics
**Headquarters:** Austin, Texas, USA
**Established:** 1976
**Website:** www.ni.com

roboRIO™ 2.0 robotics design platform from NI
Image © 2021 National Instruments Coporation. All Rights Reserved.

### OVERVIEW:

Nearly 2.5 million students, ages 4-18, have participated in *FIRST*® programs worldwide since 1989—many learning about engineering on a robotics platform from NI, powered by AMD-Xilinx technology. The *FIRST* robotics community prepares students for their future through inclusive, team-based robotics programs and competitions. Its mission is to inspire young people to be science and technology leaders and innovators, by engaging them in exciting mentor-based programs.

Every January, the *FIRST* Robotics Competition launches a new challenge in which teams of high school students build industrial-sized robots to play a difficult field game. Sometimes robots have to climb, build, stack, or throw objects, grab things and move them, or fit components together. The regional and state competitions culminate in a global championship event held each spring in Houston, Texas.

"We originally got involved with *FIRST* when they started using the LEGO Mindstorms robotics kit for their younger division," said Joe Hershberger, a software engineer on the segment team at NI, explaining that NI was the software provider for that product. "We started by providing software support at those events," Hershberger said, adding that that relationship led to the opportunity to serve the *FIRST* community in bigger ways.

In 2009, NI developed a customized CompactRIO platform for *FIRST*. It was an eight-slot device with optimized memory and processing speed. Seeing that most teams were only using 3-4 slots for their projects, the company built a four-slot version a few years later. In 2015, NI rolled out a more powerful, lighter, and smaller controller family, named roboRIO, that has been part of *FIRST* competitions and educational programs ever since. A second-generation version of roboRIO was released in early 2022.

## CHALLENGE:

Around 2003, NI started an effort to build its first CompactRIO embedded industrial controller. "We had products that could process I/O but didn't have any real-time computation capabilities," Hershberger explained. "We knew that adding an FPGA was the next step in building more capable I/O, so we decided to partner with Xilinx."

Hershberger said the company was looking to couple an FPGA fabric with an application processor that could handle more complex tasks and offered real-time processing. "Zynq basically solved all of that for us in a single package. It was definitely a very good fit and made it possible for us to go to a smaller, less-expensive platform."

## SOLUTION:

RoboRIO is a platform based on reconfigurable hardware that is targeted for academic use.

"We had *FIRST* robotics in mind when we built the product," said Oscar Fonseca, staff systems R&D engineer at NI. "We wanted to cater to students that were looking for a powerful interface, both from the I/O and communications side and that allowed them to make something without having to customize much. We included PWM output ports all the way to SDI, I2C, CAN communication, and analog inputs; things you don't usually find in low-cost controllers."

"We use the Zynq device for all the real-time I/O," Hershberger added. "It allows us to completely open the processor side up to the users. Students can write whatever code they want, and they don't have to worry if their code has good real-time behavior. All the real-time behavior we need is handled by programmable logic. It gives the students a lot more flexibility and power to experiment."

The Zynq-7000 SoC family integrates the software programmability of ARM® processor technology with the hardware programmability of an FPGA, enabling key analytics and hardware acceleration while integrating CPU, DSP, ASSP, and mixed-signal functionality on a single device.



Joe Hershberger shows off NI's roboRIO controller
Image © 2021 National Instruments Coporation. All Rights Reserved.

## RESULT:

The roboRIO platform gives students a hands-on introduction to engineering. "Having the flexibility to control everything effectively, but not being locked down is huge," Hershberger said. "The platform doesn't weigh much, connectivity is easy, and we've maintained a standard three-pin hobby connection for the last 20 years so students can use the same hardware from long ago while adding more capabilities through things like CAN. We are advancing their abilities while not breaking backward compatibility."

NI product manager, Eric Myers, added, "With our LabVIEW graphical programming environment, we've abstracted the more difficult-to-learn programming aspects of products and have taken the extra step to make it extra easy for students to use, while providing them the flexibility to expose more power and use other features if they want to. It makes learning engineering more fun than just sitting at a computer playing with code."

"*FIRST* provides a unique opportunity for students to explore their passion, get excited about the world, and grow both personal and professional skills. It was for me and it is for thousands of kids around the world," Fonseca said. "I come back every year to help out because it's my way of saying 'thank you' and ensuring that new generations have the chance to participate in this great experience."

ADDITIONAL RESOURCES:

Learn More about Xilinx's Zynq SoCs
Learn More About NI
Learn More About *FIRST*