

# 2009 FRC Controller

## Frequently Asked Questions –TECHNICAL

### General

**Q *What are some important terms I will need to know?***

- A The new FRC Controller brings with it some new terminology that will be important to teams:
- cRIO: National Instrument's CompactRIO, the new Robot Controller
  - Digital SideCars: provide the link between the cRIO and devices such as motor controllers
  - Driver Station: formerly known as the 'Operator Interface', includes inputs for USB control devices (such as joysticks) and a graphical LCD display
  - Analog Bumper: An interface that plugs in to a cRIO module and provides analog inputs for sensors on the robot
  - Pneumatic Bumper: An interface that plugs in to a cRIO module to allow for control of devices such as pneumatics and solenoids.

**Q *What are some of the benefits of the new controller?***

- A Teams will have the ability to build more sophisticated autonomous robots, perform advanced control during the tele-operated tasks and a whole new realm of possibilities in future years including:
- Object avoidance based on vision feedback
  - Communication among robots on the playing field
  - More precise robotic control

**Q *What new features and capabilities can our teams expect?***

- A Some new features and capabilities will include:
- Optical Character Recognition (OCR)
  - Expanded number crunching with 32bit/64bit floating point math is directly possible on the processor
  - Expanded IO capacity with standard KOP offering that can be further augmented with additional cRIO modules that are plug-n-play with future KOP upgrades
  - Options may allow for multiple motor controller support

**Q *How large can we expect the receiver on the robot to be?***

- A The manufacturer and model of wireless device is not yet selected. The intention is to provide a robust, high performance package at the lowest cost/foot print possible.

**Q *Will there be instructions for how install the control system in an old robot for testing and training purposes?***

- A There is an effort to develop training on the use and interfacing of the new control system that could be used for this purpose.

### System

**Q *What are the modules included with the cRIO and are they standard?***

- A The kit will include off-the-shelf standard National Instruments modules. No additional modules will be allowed for the 2009 competition, however, future competitions may allow for additional modules. There are analog outputs, digital input/outputs, and a higher voltage digital output. Specifically, included are:
- Analog 9201 – 8 channels 12-bit 500kHz +/-10V
  - Digital 9403 – 32 channel General Purpose IO module
  - Digital output 9472 – 8 channel Digital outputs 1A capacity
  - The controller is the cRIO integrated system 9074 with integrated chassis and processor

**Q *Are there any special mounting restrictions?***

- A The cRIO unit itself has a grounded case that must be taken into account with mounting and placement.

- Q ***Will the control system come pre-assembled?***  
A No. However, there will be a standard way the controller components must go together. Documentation for this will be provided by *FIRST*.
- Q ***How much more powerful of a system is it?***  
A The current system has a 40Mhz 8-bit processor and the new system has a 400Mhz 32bit processor with a large FPGA providing hardware level support for devices such as quadrature encoders, PWM generation, and analog oversampling, among others..
- Q ***Can we use existing components (like speed controllers) with the system?***  
A The plan is to allow teams to use existing Victors (884), Spikes, and pneumatic solenoids. A few new options are also in the process of being tested with pricing at or below the current costs teams incur for these items.
- Q ***Is the new controller in a sealed case (exclude metal shavings)?***  
A The new controller is in a metal chassis that is very robust. Flexible covers will be provided for unused ports on the controller.
- Q ***How much onboard memory does the new system have?***  
A The system has 64 MB of RAM (some of which is used by the operating system) and 128 MB of non-volatile flash memory.
- Q ***What is the new Driver Station? Can we hook up a laptop?***  
A The Driver Station is a Linux-based single board controller with an LCD Display as well as Ethernet and USB ports. One of the Ethernet ports will be dedicated to the wireless router and the other to an optional laptop supplied by the team.
- Q ***Will the Driver Station accept "plug and play" devices, or will the controllers have to meet certain requirements?***  
A The Driver Station (DS) will allow for a wide range of USB joystick devices enabling teams to pick their own. Other than HID, the driver station will have limited USB driver support
- Q ***What about other USB devices on the driver station?***  
A Other than HID, the driver station will have limited USB driver support. There are no plans to support mass storage or other USB devices at this time. That said, there are Analog Input, and Digital I/O connections on the driver station as well as the optional laptop
- Q ***How much power does the cRIO and modules consume?***  
A The cRIO and modules consume about 10W of power.
- Q ***What batteries will we use? Will we be able to use our batteries from past robots with the system?***  
A *FIRST* will continue to use the standard 12V SLA type batteries. Past year's batteries would be compatible.
- Q ***Will there be a backup battery for the controller***  
A The power distribution block provides the power for all control system components and is designed to maintain power during stall conditions. No backup battery is required, which also helps with system weight.
- Q ***Will any changes be made to the weight limit?***  
A Weight limit has not yet been determined for the 2009 season.

## Communication

- Q **What type of communication does the system use?**  
A The new system uses proven 802.11 wireless communications. More features are being considered for future expansion including robot-to-robot direct wireless communications and wireless joystick operation.
- Q **Is there a tether mode that is independent of the radio and what is the specification on that interface?**  
A The new control system interface for the drive team is called the Driver Station and has Ethernet ports for connection to both a PC or laptop and the robot controller.
- Q **Must they be tethered in order to apply/change certain settings?**  
A No, the new system will include the ability to do wireless programming. However, this may not be allowed in competitions (in the PITS) to avoid wireless contention with the field.
- Q **Teams in our area like to get together off-season and do demonstrations and events. Will we still be able to do this without our channels conflicting?**  
A Yes, 802.11 has 11 clear channels and we can currently run multiple robots on a single channel.
- Q **What protocol is used to communicate with the cRIO? Are there multiple serial ports that can be used for operation and interface to custom circuits?**  
A One planned addition is an I<sup>2</sup>C interface on the Digital SideCars. Other options are possible use of cRIO modules that provide direct serial interface support.
- Q **Is there user bit space in the cRIO to Driver Station stream to use for data back to the operators? If so, is this documented and easy to use for student programmers?**  
A There will be both a fixed block available for use by the robot program to interact with the digital IOs on the Driver Station and the use of an external PC or laptop (connected via Ethernet from the Driver Station) will enable teams to have LabVIEW or Wind River based feedback.
- Q **Are there any known forms of interference with the transmission of signals to the robot?**  
A Other 802.11 systems could interfere, but this will be detected from the Field with monitoring and tracking systems and the interfering signal will be eliminated.

## Software

- Q **What languages will we be allowed to program in? What language(s) will be used with the new controller?**  
A C, C++, and National Instruments LabVIEW will be available. Other languages such as easyC and RobotC may be supported, but no definite decision has been made.
- Q **I have had LabVIEW in my kit for 3 years and either didn't use it or didn't find it very helpful. What has changed?**  
A Because of the smaller processor on the past controller, teams could not previously program their control system using LabVIEW. While some teams found LabVIEW to be a useful tool for debugging and performing hardware simulations, it could not previously be used as the primary development language. In 2009 teams will be able to program their robot graphically in LabVIEW, the same language used in 5000 universities around the world and in thousands of engineering applications including the design of the Mars Rover, testing of BMW hybrid cars, and powering the largest instrument on earth – the CERN particle accelerator.
- Q **Was a new version of LabVIEW created specifically for this competition?**  
A NI is creating a custom build of LabVIEW made specifically to meet the needs of the FRC competition. The graphical programming environment, though, is the same one used by engineers and scientists in many fields of industry.

- Q ***Is it open-source?***  
A The library code that interfaces with the hardware is all open source and will be available to teams. There will be a procedure for teams to submit changes and improvements to the library. In addition there will be a repository of custom team code for teams that want to share their work with other teams.
- Q ***Will there be a 'default code' to help teams get started?***  
A There will be a default programs to assist teams in getting started. In addition there will be many sample programs that teams can use for resources in developing their own robot programs.
- Q ***Are there alternative compilers that will be compatible with the hardware?***  
A Currently, the Wind River Compiler is planned and provides an impressive debug and user interface for program development and debug.
- Q ***Are there software emulation tools?***  
A None currently, but discussions have been started.
- Q ***Are there any firmware restrictions that would limit or cease operation?***  
A There will be the *FIRST* required safety protections built into the cRIO. These would disable the PWMs/Relays/Solenoids/etc. upon loss of wireless communication, loss of control from Driver Station, or an e-stop being activated.
- Q ***Will there be different firmware updates for the controller?***  
A There will be a provision for field updates that is in the works for both robot and Driver Station.
- Q ***What IDE(s) will be available for use with the new controller/programming language?***  
A Both Wind River Workbench (Eclipse) for C/C++ and LabVIEW.
- Q ***Will the new controller be programmable through a USB 1.1 or USB 2.0 port?***  
A No, it will use an Ethernet connection.
- Q ***How do I download code to the controller?***  
A Using either LabVIEW or the Wind River Workbench tools.
- Q ***Will there be any dashboard software to monitor the controller?***  
A Yes, on the Driver Station there will be a graphics LCD with various window views. Teams may also hook up a PC or laptop to the Driver Station and be able to view status and could have a dashboard program running for feedback.