INTRODUCTION

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1 INTRODUCTION

1.1 WELCOME TO THE 2009 FRC CONTROL SYSTEM

Congratulations! You are now in possession of the 2009 FIRST Robotics Competition Control System. The 2009 FRC Control System is an entirely new system, intended to provide FRC teams with a more capable robotics controller than in past years. While many hours of testing have been logged through alpha and beta testing, there is always room for improvement in any new system. We anticipate you may encounter some things that don't work as expected. We ask that you give FIRST support staff the opportunity to address and fix those issues. If you are one of the teams that received "early control system shipment", you have a unique opportunity to familiarize yourself with the new control system and to identify potential problems before the 2009 FRC Kickoff. Please remember the primary goal of "early control system shipment" is for you to learn how the system works and to resolve any potential problems before kickoff. If you have suggestions for improvement, please provide detailed feedback on the FIRST Control System Forum. We would appreciate gracious professionalism in all team and individual communications, whether in postings, emails, or conversations.

Please read through this document carefully. It contains the details you will need for success.

1.1.1 Suggestions for Getting Started

All teams are requested to start their use of the 2009 FRC Control System by following the "Getting Started" steps in section 1.6 below. The beta test teams followed these steps and found these tasks provided them with the information and experience they needed in order to successfully use the new control system. Also, if you follow the "Getting Started" steps in order, the beta test teams will be better able to provide assistance to your team if you encounter any problems.

1.2 TECHNICAL SUPPORT FOR THE 2009 FRC CONTROL SYSTEM

Please post requests for technical support to the 2009 FRC Control System Beta Test Public Forum at forums.usfirst.org. Beta test teams will be monitoring the forum to assist you.

1.3 OVERVIEW OF THE 2009 FRC CONTROL SYSTEM

The 2009 FRC control system is composed of a Driver Control System, Wireless Communications System and the Robot Control Systems. The Driver Control System controls the robot mode of operation and allows teams to drive remotely either over a tethered or wireless connection. The Driver Control System (Shown in Fig 1.1 connected to its wireless adapter) is composed of a Driver Station, up to 4 USB Joysticks, a Power Supply, and provision for optional team created custom hardware. The Robot Control Systems consist of the Mobile Device Controller (MDC) for running user robot programs, power distribution systems, motor controllers and relays for control of powered devices. The Wireless Communications System uses the 802.11N standard in the 5GHz band and connects via Ethernet to both the Driver Control System and the Robot MDC.

Figure-1.1 Driver Control System with Wireless

The 2009 FRC Control System can be programmed in LabVIEW and C/C++ using the WPI Robotics Library. National Instruments provided the LabVIEW programming tool and WindRiver provided the C/C++ programming and debugging tools. WPI developed an extensive library for use with the 2009 Control System that works directly within the C/C++ programs. These tools run on a standard windows PC or Laptop and will be distributed via DVDs for team installation.

The Wireless Communications System is composed of the Linksys / Cisco WGA600N Dual Band Wireless-N Gaming Adapter and the Linksys / Cisco WRT610N Simultaneous Dual N Band Wireless Router. The WGA600N Gaming Adapter is for use on the robot while the WRT610N is for connecting to the Driver Station. These provide for remote control of the robot and wireless programming from a laptop or PC connected to the Driver Station's 2nd Ethernet port. Currently, the Ethernet addressing is based on the team number and is set on both the Driver Station (manually via the buttons) and in the MDC (with imaging tool). The setup for both wireless units will be performed manually for 2009, with the desired goal of an executable imaging tool running on a PC or the Driver Station.

1.4 OVERVIEW OF THE 2009 FRC CONTROL SYSTEM DOCUMENTATION

The 2009 FRC Control System Documentation consists of the following items:

- Introduction (Chapter 1, this document)
- Benchtop Test (Chapter 2)
- Control System Component Datasheets (Chapter 3)
- Software Installation (Chapter 4)
- System Configuration (Chapter 5)

- LabVIEW Programming Guide (available at www.usfirst/frccontrolsystsem)
- Robot Programming with the WPI Robotics Library (aka "WPILib C/C++ Users Guide") (available at www.usfirst/frccontrolsystsem
- WPI Robotics Library (WPILib) Reference Manual for C/C++ (generated from doxygen)

1.5 THE FRC CONTROL SYSTEM COMPONENTS

The following is the list of the main components in the 2009 FRC Control System:

- **Driver Console**
    - Driver Station with power supply. See section 3.1 of this manual.
    - Joysticks – Logitech Attack 3 USB joysticks were used for initial system testing and verification. These provide the following data for use by the user program on the robot: X axis, Y axis, 12 push buttons. There is support in the communications packets to the robot for 4-axis control plus 12 switches.
- **Wireless Communication**
    - Wireless for Driver Station - WRT610N from Linksys is used in the upper 5 GHz band with the 802.11n protocol for up to 54MBs data transfers. See section 5.7.1 for setup instructions.
    - Wireless Game Adapter – The WGA600N Linksys wireless is used on the robot and connects to the cRIO port #1. This also uses 802.11n protocol and must be configured to match the Driver Station Wireless setup. See section 5.7.2 for setup instructions.
- **Robot**
    - MDC (cRIO) - The Mobile Device Controller is from National Instruments. The NI cRIO is a special edition of NI's cRIO series developed specifically for FIRST and the FRC competitions. This unit comes with 2 eight channel analog input modules, 2 thirty-two channel Digital Input/Output modules, and a eight channel relay module (for pneumatic solenoids).
    - Power Distribution Board – The PD board provides all the robot's power circuit needs through auto-resettable circuit breakers and new WAGO power connectors. In addition to the standard 12V circuits there are multiple filtered power supplies. These special power supplies have their own connectors and power the cRIO, the camera, and the wireless for the robot.
    - Analog Breakout – The Analog Breakout connects to the NI9201 eight channel analog input module and provides isolated 5V power to the PWM like connectors. This enables analog modules to have a source for 5V power and reduces noise on the analog channels. One special use for channel 8 is to monitor the battery voltage on the robot to report back to the Driver Station.
    - Solenoid Breakout – The Solenoid Breakout connects to the NI9472 eight channel relay module to supply up to 1 amp per channel at 12V. This is designed to drive the pneumatic solenoids directly without the need for a separate relay.
    - Digital SideCar – the DSC connects to the NI9403 32channel Digital IO module and provides an expansion of those 32 signals. There is buffering for 10 PWM signals, 14 general purpose IOs, an I2C interface, 8 spike controls, and an on board 6V supply to power servos (from the PWM pins with a jumper). See section 3.3 for more information
    - Jaguar motor controller – This is a new motor controller for 2009 with 12V 60A capabilities. This is intended to be the next generation PWM based motor controller. Future capabilities will include a CAN smart interfaces and many additional features.

- Spike 20A reversible relay – This is the IFI Robotics Spike as used in prior year's control systems.
- Axis 206 Camera – This is a web camera for use in the vision and video on the robot.

1.6 GETTING STARTED WITH THE 2009 FRC CONTROL SYSTEM

We highly suggest that all teams start their use of the 2009 FRC Control System by following the "Getting Started" steps below. The beta test teams followed these steps and found that these tasks provided them with the information they needed in order to successfully use the new control system. If you follow the steps below, the beta test teams will be better able to provide assistance to your team if you encounter any problems.

1.6.1 Step 1 – Acquire Needed Documentation

In order to complete the subsequent steps, you will need the following items. We suggest you print out the listed control system documentation and assemble it in a binder for immediate reference by your team.

- **Documentation:**
  - FRC Control System Manual, Chapter 1, Introduction (this document)
  - FRC Control System Manual, Chapter 2, Benchtop Test
  - FRC Control System Manual, Chapter 3, Component Datasheets
  - FRC Control System Manual, Chapter 4, Software Installation
  - FRC Control System Manual, Chapter 5, Configuration
  - Controls Kit of Parts Checklist
  - 2009 Robot Power Distribution Diagram
  - 2009 Robot Data Connectivity Diagram

1.6.2 Step 2 – Identify and Inventory All Control System Components

This step ensures that your control system kit is complete and introduces you to all of the components in the control system.

- Follow the instructions to "Identify and Inventory All Control System Components" in Chapter 2, section 2.2.2

1.6.3 Step 3 – "Out of the Box" Benchtop Test

The Benchtop test ensures that all of your control system kit components are working in a controlled environment with tethered operation.

- Set up benchtop test hardware (details in Chapter 2, section 2.2.3)
- Set up the Driver Station (details in Chapter 2, section 2.2.4)
- Verify Tethered Operation of the benchtop system (details in Chapter 2, section 2.3.1)

1.6.4 Step 4 – Install Software and Updates

This task is to verify the software and firmware installation procedures.

- Install software from FIRST 2009 Software DVDs (set of 2 discs) (details in section 4.2).
- Update the software with the latest FIRST software updates (details in section 4.2.5.2 and section 4.3).
- If using C/C++, install additional software for the C/C++ programming environment (details in section 4.4).

1.6.5 Step 5 – Update Firmware in Driver Station and cRIO

- Update firmware on Driver Station (details in section 5.2.1)
- Re-image cRIO, set correct team number (details in section 5.2.2)
- Set correct team number on Driver Station (details in section 5.4.2)
- Confirm that "benchtop" hardware still functions correctly with the updated DS and cRIO. (Repeat "benchtop" tests in section 2.3.1)

1.6.6 Step 6 – Wireless Setup of Control System

Now that you have updated the Driver Station and cRIO firmware and confirmed that your benchtop system still operates in tethered mode, set up wireless communications as follows:

- Configure wireless components (details in Chapter 2, section 2.3.2)
- Verify wireless operation for the benchtop system (details in chapter 2, section 2.3.3)

1.6.7 Step 7 – Software Development Tools Verification

This task is to verify the development tools are working properly.

- For teams using C/C++, complete the following tasks as described in the WPILib C/C++ Users Guide :
    - Configure WindRiver Workbench for use (see the C/C++ Programming Guide for FRC, section on Setting up the Environment)
    - Install the FRC 2009 WPILib source code (see section 4.4.3)
    - Create a new sample program (see the C/C++ Programming Guide, section on Creating a robot project)
    - Compile the sample program in Workbench (see the C/C++ Programming Guide, section on Building your project)
    - Create a debug configuration in Workbench and download / debug on the cRIO (see the C/C++ Programming Guide, section on Debugging)
    - Deploy the program onto the cRIO using the FIRST Downloader in Workbench (see the C/C++ Programming Guide, section on Using the FIRST Downloader)
    - Confirm the deployed program starts automatically when the cRIO reboots
    - Confirm that "benchtop" hardware still functions correctly with the software you built. (Repeat "benchtop" tests in section 2.3.1)
- For teams using LabVIEW:
    - Re-image the cRIO with an image which supports LabVIEW
    - Follow the instructions in the "LabVIEW Beta Getting Started Tutorial"
    - Confirm that "benchtop" hardware still functions correctly. (Repeat "benchtop" tests in section 2.3.1)

1.6.8 Step 8 – Transplant New Control System Hardware Into an Existing Robot

This task is to evaluate the new control system hardware installation in a real robot.

- Select a prior robot to use for evaluating the control system.
- Install the new control system in the selected robot
    - Make use of the new control system power distribution and wiring diagrams
    - Modify robot wiring, etc., as needed

1.6.9 Step 9 – Operator Control of Robot Drivetrain for an Existing Robot

This task is to verify the new control system hardware is functioning properly in the recipient robot and to verify minimal usage of the software development environment. This task also provides a baseline before porting the complete robot code.

- Choose one of the template programs, and modify appropriately to drive your robot.
- Download your modified code to your robot and test its operation.

1.6.10 Step 10 – Full Control of the Robot with the Transplanted Control System

This task is to test and evaluate the new control system in a complicated robot. It is anticipated that teams receiving early control system shipment will develop programs which are more complex than have been previously tested at FIRST. Accordingly, we anticipate that teams may encounter bugs and/or difficulties with sensor support, programming libraries and the debug and testing process. We are looking for feedback not only with respect to specific problems, but also in regard to whether the structure of the software that we provided makes it easy or difficult to develop your robot programs.

- Port (or re-implement) your prior robot software for this robot with the new control system.
- Debug and test the operation of the transplanted robot.
- Post any questions or issues found on the FIRST Control System Forum.