

INTRODUCTION

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1 INTRODUCTION

1.1 The 2010 FRC Control System

Welcome to the 2010 season. The 2010 *FIRST* Robotics Competition Control System is a combination of proven components from 2009 and new elements introduced after feedback from teams. This document has been created to guide both rookie and veteran teams through the initial set up and test of their 2010 Control System.

Please read through this document carefully as many of the steps for success have changed since last year. Completing the steps in Chapter 2 in order will make it easier for mentors monitoring the Public Forum to provide assistance to your team if you should encounter any problems.

If you have feedback on either the control system or this document, please post your comments on the *FIRST* Control System Forum at <http://forums.usfirst.org/forumdisplay.php?f=23>

1.2 Technical Support for the 2010 FRC Control System

Technical support is available from *FIRST* if you encounter any difficulties with the initial set up and operation of the 2010 FRC Control System. Please post requests for technical support to the 2010 FRC Control System Public Forum at <http://forums.usfirst.org/forumdisplay.php?f=1260>

1.3 The 2010 FRC Control System Documentation Organization

The 2010 FRC Control System Documentation consists of the following items:

- Introduction (Chapter 1, this document)
- Getting Started (Chapter 2)
- Control System Component Datasheets and website pointers (Chapter 3)
- Software Users Guide - available at <http://www.usfirst.org/roboticsprograms/frc/content.aspx?id=10934>
- Robot Programming with the WPI Robotics Library - available at <http://www.usfirst.org/roboticsprograms/frc/content.aspx?id=10934>

1.4 Overview of the 2010 FRC Control System

The 2010 FRC control system is composed of a Driver Control System, the Robot Control System and a Wireless Communication system.

The Driver Control System controls the robot mode of operation and allows teams to drive remotely over either a tethered or wireless connection. The Driver Control System (Shown in Fig 1.1) is composed of a Classmate PC with power supply, E-stop button, USB hub, I/O module and up to 3 USB Joysticks.

The Robot Control System (Shown in Fig. 1.2 connected to its wireless adaptor) consists of the cRIO with modules, the power distribution system, expansion I/O modules, motor controllers and relays for control of powered devices.

The Wireless Communications System is composed of the Linksys / Cisco WGA600N Dual Band Wireless-N Gaming Adapter and either the Linksys / Cisco WRT610N Simultaneous Dual N Band Wireless Router (Veteran teams) or the Linksys / Cisco WRT160N Simultaneous Dual N Band Wireless Router (Rookie teams). The system uses the 802.11N standard in the 5GHz band and connects via Ethernet to both the Driver Control System and the Robot Control System. Currently, the Ethernet addressing is based on the team number and is set on both the Classmate and in the Robot Control System (with imaging tool).



Figure 1.1 Driver Control System



Figure-1.2 Robot Control System with Wireless adaptor

The 2010 FRC Control System can be programmed in LabVIEW, Java or C/C++. National Instruments provided the LabVIEW programming tool, Sun Microsystems provided Java, and WindRiver provided the C/C++ programming and debugging tools. WPI developed extensive libraries in both C/C++ and Java for use with the 2010 Control System. These tools run on a standard windows PC or Laptop and will be distributed via DVDs for team installation.

1.5 The New 2010 Hardware

The 2010 Driver Station solution has several components that provide many attributes that the FRC community is used to (I/O, dashboard capability, USB, etc), but also has added features such as a development environment, resident monitor, and emergency stop function. The following sections provide more detailed descriptions of each component, hardware and software.

1.5.1 Classmate Netbook

When the Classmate is first turned on, the user will be prompted to set up basic features of the unit. Instructions for the initial setup are included in Section 2.

Once the initial setup of the Classmate is complete, the Classmate will function as both a Driver Station for competition, and also as a development environment. There are two accounts setup on the Classmate: Driver and Developer. The Driver account is used for robot control and operation. The Developer account is for robot software development. The details of these accounts are discussed further in Section 2.

Do not use the 2009 KwikByte Driver Station and the 2010 Driver Station at the same time as this will cause IP address conflicts on your Ethernet LAN.



Figure 1.3: Classmate

1.5.2 USB Hub

Because the Classmate comes with two USB ports, a 4-port hub has been added to allow for up to 3 joysticks or other USB devices in a team's Operator Console. The Classmate Driver Station can accommodate hubs with more ports; however teams must be careful not to exceed the 500mA per USB port or the Classmate when pulling from a single USB port.

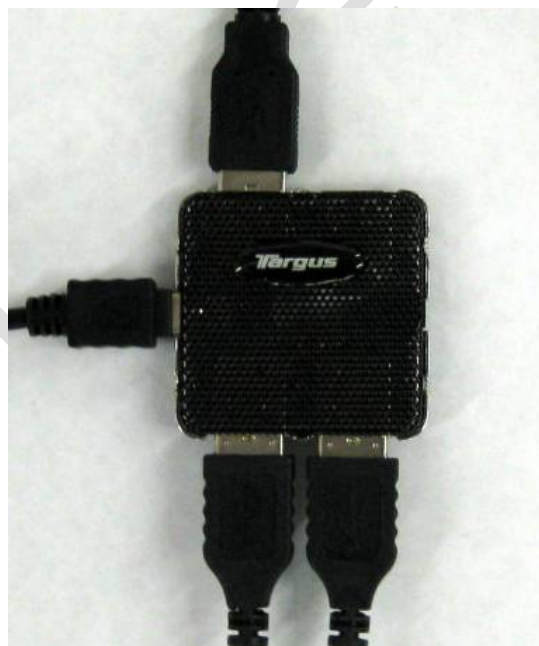


Figure 1.4 USB Hub

1.5.3 E-stop Button

The E-stop button is a new functionality in the 2010 system. This piece of hardware provides a blatant and obvious way in which anyone can stop a robot in a precarious situation while not at a regional competition. The FRC field is already equipped with E-Stop Buttons, so teams should not have this device when running on an FRC field.

Note that the E-Stop command (a simple keystroke sequence of *Ctrl-Alt-Enter*) disables the robot. The only way to clear the E-Stop command from the cRIO is to reboot the robot. This is the same protocol that has been used on the FRC field, but having this capability at home allows teams to become familiar with its affect on the robot before coming to the field.

The Driver Station will not enable the robot unless it detects the E-Stop button. In the event that you must drive your robot but don't have an E-Stop button, you can by-pass this feature by double-clicking on the E-Stop LED indicator in the *Diagnostics* tab of the Driver Station software. Since bypassing the E-Stop is not a recommended practice, the bypass is slow by design in an effort to discourage teams from bypassing the E-Stop by default.



Figure 1.5: E-Stop Button.

1.5.4 Input/output module

The I/O device is a Cypress FirstTouch development board, accompanied by a standard breadboard. This device allows teams to customize their Driver Station with digital and analog inputs and outputs.



Figure 1.6: Cypress FirstTouch Kit.

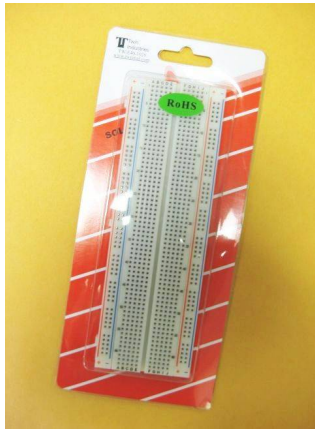


Figure 1.7: Breadboard to be used with Cypress FirstTouch kit.

1.5.5 The New 2010 Software

The software used in the 2010 Driver Station solution is contained within the Classmate PC, which has been specially imaged for use in the 2010 FRC season. The off-the-shelf software packages that have been loaded onto the Classmate include, but are not limited to the following:

- Windows XP Pro (Windows updates are scheduled to download and install every Monday at 3am)
- National Instruments LabVIEW 8.6
- Sun Microsystems Java
- OpenOffice.org
- Cypress Programmer 3.10
- AVG Anti-Virus
- Foxit Reader, Free Version (pdf reader)

In addition to the standard software packages listed above, there are also custom settings and software pre-loaded on the Classmate to meet FRC and team needs. There are two accounts set up on the Classmate. The *Driver* account and the *Developer* account.

The *Driver* account is to be used when the Classmate is to function as a Driver Station (at home, at a competition, etc). When in the *Driver* account, teams will not be able to access Windows Explorer, the Task Manager or run additional software applications. The result is that the *Driver* account functions like a kiosk for the user. The applications that are permitted in the *Driver* account are the *Driver Station* software and the *Dashboard* software. Both applications are discussed in Sections 1.5.6 and 1.5.7 respectively.

The *Developer* account is much more like a typical Windows interface. Teams may use this account to develop code, create and modify documents, image the cRIO, download code to the cRIO, and much more.

We recommend that when switching from the *Driver* account to the *Developer* account that you actually log off the account instead of simply switching users. To log out of the *Driver* account, click on the red *Exit* button in the *Setup* tab. You will quickly see a dialog box appear that says that the *Task Manager* has been disabled. This message can be ignored.

While the Classmate has significant functionality, we discourage teams from installing additional software (with the exception of WindRiver Tools which can be done via USB storage device, external disk drive, etc), storing large files on the disk, etc to prevent the Classmate from becoming bogged down and sluggish.

In the event your Classmate has been corrupted, the USB key required to restore your Classmate has been included in your kit. Please note that this USB Key, a 4GB Thumb Drive, is not a general use storage device, but instead has been loaded with the Classmate default image and should be protected and kept pristine in case you need to restore your machine.

To restore your machine, please follow the steps below (note, this process takes approximately 20 minutes):

- With the Classmate powered OFF, insert the USB Key into an available USB port. Do not use a USB hub, plug the Key directly into the Classmate.
- Power on the Classmate and when you see the 2GoPC screen, repeatedly press F11 until a small window appears entitled "Please Select Boot Device."
- Using the cursor keys, select the USB Key. It is the second item in the list (the Key will appear twice, select the first instance of the name, which is the second item on the list), beginning with USB:xxxx. Do NOT select "USB: Generic Device," this is not your USB Key.
- Press Enter and allow the Classmate to boot from the USB Key. Be patient, it can take a minute or more for it to finish. You will now be at x:/windows/system32.
- Follow the on screen instructions to complete the process. It is recommended that, to do a clean restore, select Option 3, Prepare AND Restore.

1.5.6 Driver Station software

The *Driver Station* software is a locked application that provides fundamental diagnostic details about the robot system to teams. When in the *Driver* account, the *Driver Station* application is located in the bottom portion of the screen.

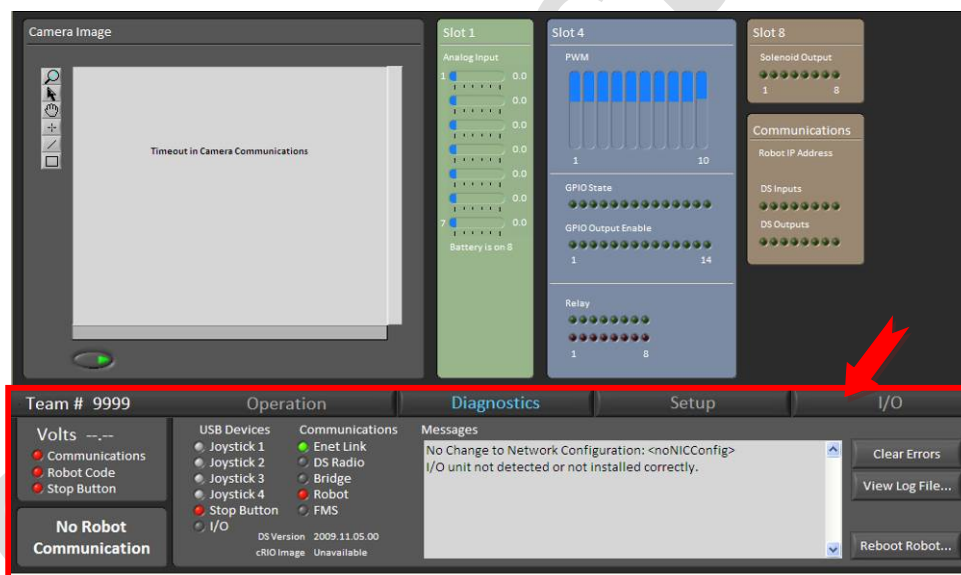


Figure 1.8: The *Driver Station* application appears at the bottom of the *Driver* account screen.

The *Driver Station* software has a Diagnostics field and tabs which provide access to various nuggets of information about the robot system.

Top Level Diagnostics

Top level diagnostics are located on the left side of the screen and are visible by users at all times. This area displays information about the following parameters.

- The team number is displayed at the very top of the *Driver Station* window.



- The battery voltage of the robot is displayed (Note, this is only operable when the cRIO is configured correctly. Refer to the *Control System* manual for details).
- *Communications* indicates if there is a connection between the Classmate and the cRIO.
- *Robot Code* indicates if there is code running on the cRIO.
- *Stop Button* indicates if the E-Stop button is connected to the Classmate (this is required for all operation off the FRC field).

Operation Tab

The *Operation* tab is the primary tab. Here teams can

- identify which match mode has been selected (*Teleoperated*, *Autonomous*, or *Practice*),
- *Enable* and *Disable* their robot in non competition mode,
- see the amount of time elapsed since the robot was enabled,
- monitor the Classmate's battery strength,
- review the *User Messages* (the same as the LCD screen from 2009) sent back to the Driver Station from the cRIO,
- see the user account being used to run the *Driver Station* software, and
- identify or select the team station into which the team is plugged.

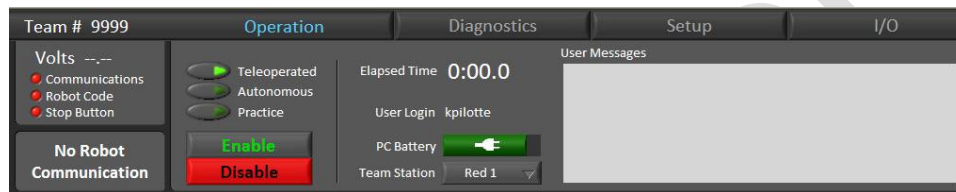


Figure 1.9: The *Operations* tab

Diagnostics Tab

The *Diagnostics* tab is the second tab. Here teams can

- monitor USB connectivity (joysticks, Estop, and I/O),
- see detail regarding Communication status,
- review and clear error messages originating from the cRIO program
- view log files,
- check the DS and cRIO image versions, and
- remotely reboot the cRIO.

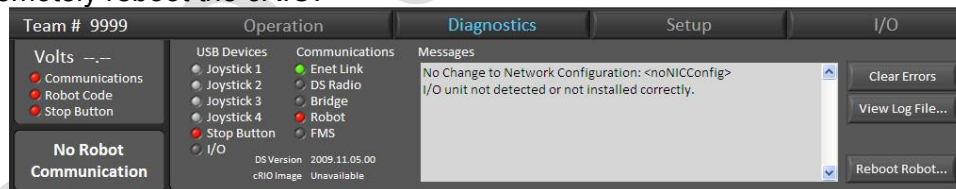


Figure 1.10: The *Diagnostics* tab.

Setup Tab

The *Setup* tab is the third tab. Here teams can

- set their team number,
- select the *Dashboard* they'd prefer to use (local or remote) along with adding the IP address for the remote *Dashboard*,
- specify practice round durations (Please note, this will not operate when connected to the FRC field. To restore the default values, you can delete the edits you made in the .ini file),
- toggle field sound effect on and off,
- *Exit* the *Driver* account, and
- set up the joysticks.

Note that the *Driver Station* software uses DirectInput to locate and read the joystick values. The joystick values are not determined by port location, but instead by vendor ID and product ID. This means that referring to the joysticks in your robot code as joysticks 1, 2, 3, and 4 doesn't always read the joystick you expect it to read. The *Setup* tab allows for configuration to

specify which joystick to call 1, 2, 3, and 4 by clicking and dragging the joysticks to the appropriate designation.

The joystick position when the software is opened is considered to be zero. If a joystick has a bias and you wish to calibrate it, unplug and replug. Conversely, be careful not to have a joystick or throttle set to a nonzero value when inserting or removing any other joystick. The Driver Station software is pretty non-discriminating regarding what it considers to be a joystick. This should allow the widest variety of driving wheels, throttles, and HID devices to function. The downside is that especially on development computers, you may find devices that show up which you do not consider a joystick. Please report these on the forum as we would like to modify the filter to exclude those.

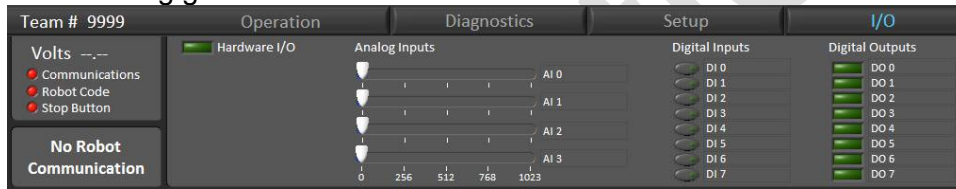


Figure 1.11 The Setup tab.

I/O Tab

The I/O tab is the last tab. Here teams can

- interface with the robot using the “virtual” analog inputs and digital I/O and
- indicates the presence of the Cypress FirstTouch I/O module via the Hardware I/O indicator being green.



Hot Key Reference List

There are some functions in the *Driver Station* software that can be executed via hot key presses in addition to using the mouse. Hot key combinations are listed below.

Function	Key Combination
Disable the robot	Space
Enable the robot/Re enumerate USB Joysticks	F1
E-Stop the robot	Ctrl-Alt-Enter

1.5.7 Dashboard software

The *Dashboard* application is optional for teams, but is an opportunity for the user to customize the feedback provided by the robot system. The Classmate is loaded with a default Dashboard which includes

- a vision feed if the camera is used (which requires imaging the cRIO with the 2010 image first),
- data received from the analog inputs on the robot,
- PWM signals,
- general purpose input/output information
- relay status
- output status of the Solenoid Breakout board, and
- added *Communications* detail.

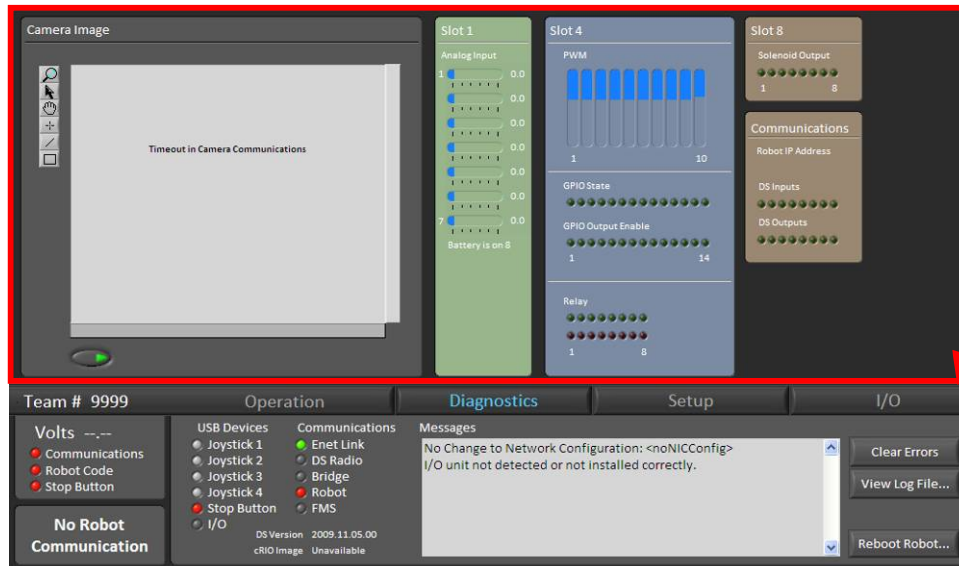


Figure 1.12: The *Dashboard* application appears at the top of the *Driver* account screen.

1.5.8 Other Software Notes

You will discover that there are additional software tools loaded on the Classmate image as described Section 2 – Getting Started. Please read below for important notes regarding other applications on your Classmate

AVG Antivirus

AVG Antivirus has been pre-installed on your Classmate. Be sure to keep update the software regularly. This can be done by connecting your Classmate to the internet and downloading the updates directly or by saving the updates to a disk (USB stick, SD card, etc) and transferring them to the Classmate (the latter is preferred).

Your AVG Antivirus software may report the file *flashupdate.exe* as a Trojan. This file is not a Trojan and should be preserved.

1.5.9 The returning FRC Control System Components

- **Driver Console**
 - Joysticks – Logitech Attack 3 USB joysticks provided in your kit should be 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 6-axis control plus 12 switches.
- **Wireless Communication**
 - Wireless Game Adapter – The WGA600N Linksys wireless is used on the robot and connects to the cRIO port #1. This uses 802.11n protocol and must be configured to match the Driver Station Wireless Router setup.
 - Driver Station Wireless Router- This radio is used at the Driver Station and links the WGA600N robot radio with the Classmate PC. In typical use, there is no difference in performance between the two models provided to teams.
 - VETERAN - WRT610N from Linksys uses the 802.11N protocol and operates at 5GHz.
 - ROOKIE: WRT160N from Linksys uses the 802.11N protocol and operates at 2.4GHz.
- **Robot Control**
 - cRIO - The National Instruments cRIO is a special edition 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 an 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 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 required use is for the analog breakout connected to slot 1 NI9201 to monitor the battery voltage on the robot for 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 relay controls, and an on board 6V supply to power servos (from the PWM pins via the jumper). See section 3.3 for more information.
- Jaguar motor controller – This motor controller has 12V 40A continuous capabilities with both a PWM and a CAN bus interface.
- 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 vision and video programs on the robot.
- Robot Signal Light – this amber light allows teams to troubleshoot their robot while on the field. There are 5 states:
 - **Solid ON** = Autonomous Enabled
 - **Solid ON, but blinks OFF every 1.5s** = Teleoperated Enabled
 - **Slow Blink** (900ms on / 900ms off) = System Disabled; caused by system watchdog, user watchdog, or Driver's Station set to disabled
 - **Fast-Slow Blink** (200ms on / 900ms off) - Low battery (<12 Volts) or no user code **and** system disabled either by system watchdog, user watchdog, or Driver's Station set to disabled
 - **Fast Blink** (200ms on / 200ms off) - System error: No driver's station communication, bad cRIO Image, bad team ID, extensive communication errors.