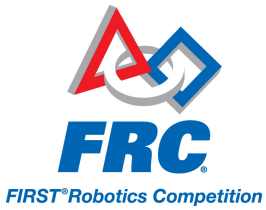
2015 Control System Hardware



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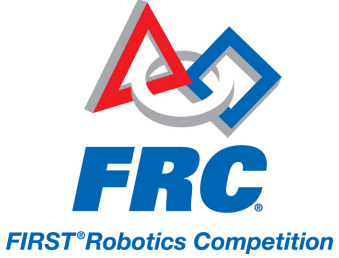
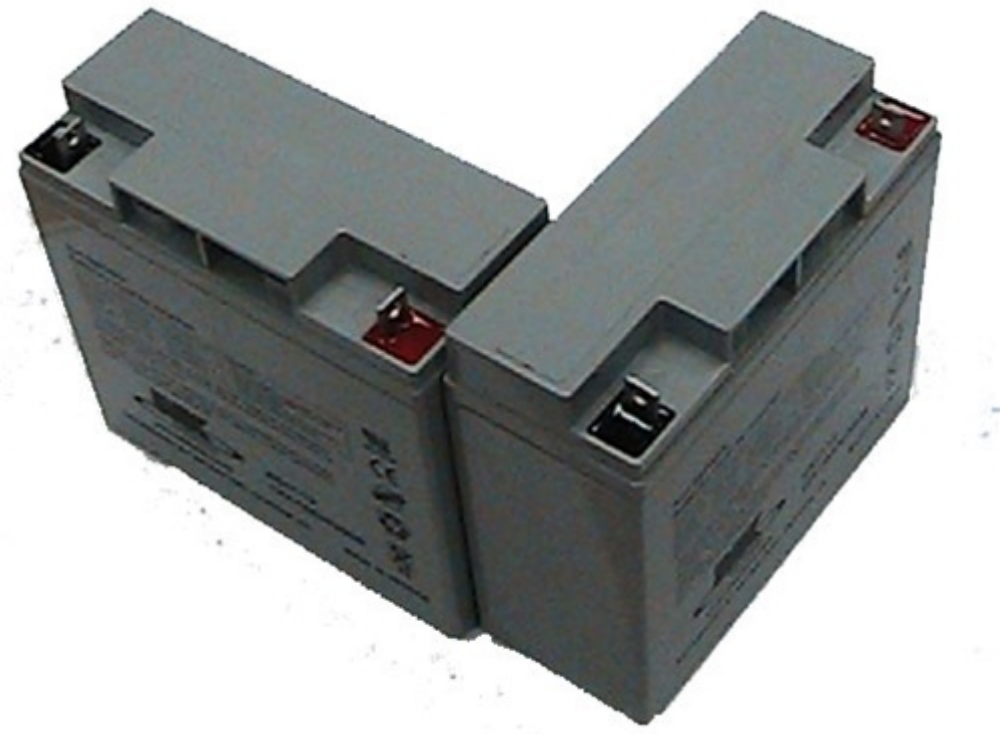


Articles

2015 FRC Control System Hardware Overview

The goal of this document is to provide a brief overview of the hardware components that make up the 2015 FRC Control System. Each component will contain a brief description of the component function, a brief listing of critical connections, and a link to more documentation if available. Note that for complete wiring instructions/diagrams, please see the Wiring the 2015 Control System document.

Robot Battery



The power supply for an FRC robot is a single 12V 18Ah battery. The batteries used for FRC are sealed lead acid batteries capable of meeting the high current demands of an FRC robot. For more information, see the Datasheets for the MK ES17-12 and Enersys NP18-12. Note that other battery part numbers may be legal, consult the 2015 FRC Manual for a complete list.

120A Circuit Breaker

The 120A Main Circuit Breaker serves two roles on the robot: the main robot power switch and a protection device for downstream robot wiring and components. The 120A circuit breaker is wired to the positive terminals of the robot battery and Power Distribution boards. For more information, please see the Cooper Bussmann 18X Series Datasheet (PN: 185120F)

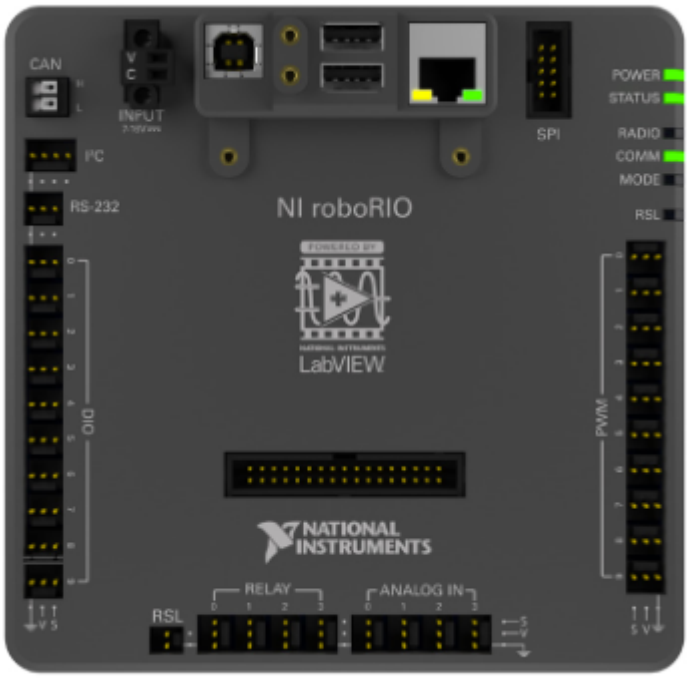
Power Distribution Panel

The Power Distribution Panel (PDP) is designed to distribute power from a 12VDC battery to various robot components through auto-resetting circuit breakers, as well as provide specialized, regulated supplies for powering specific Control System Components. The PDP provides 8 output pairs rated for 40A continuous current and 8 pairs rated for 30A continuous current. The PDP provides a dedicated 12V power supply to power the roboRIO, as well as dedicated connectors for the Voltage Regulator Module and Pneumatics Control Module. It also includes a CAN interface for logging current, temperature, and battery voltage.

Snap Action Circuit Breakers

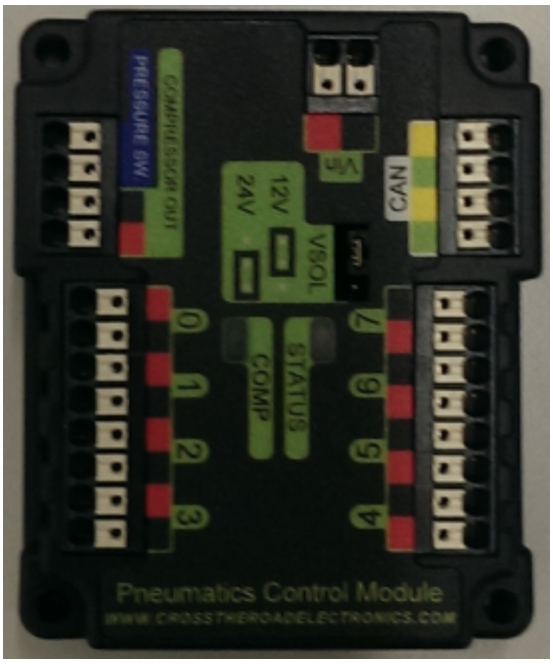
The Snap Action circuit breakers, MX5-A40 and VB3 series, are used with the Power Distribution Panel to limit current to branch circuits. The MX5-A40 40A MAXI style circuit breaker is used with the larger channels on the Power Distribution Panel to power loads which draw current up to 40A continuous. The VB3 series are used with the smaller channels on the PDP to power circuits drawing current of 30A or less continuous. For more information, see the Datasheeets for the MX5 series and VB3 Series.

National Instruments roboRIO



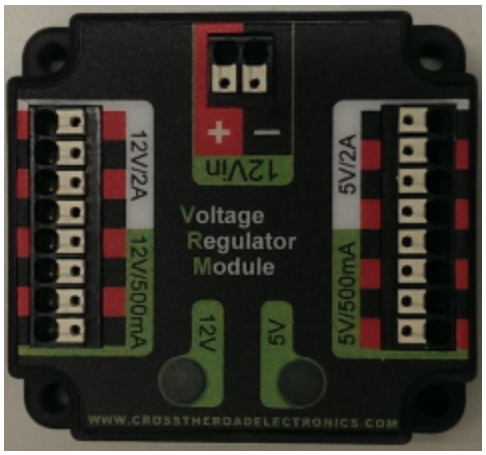
The NI-roboRIO is the main robot controller used for FRC 2015. The roboRIO includes a dual-core ARM Cortex™-A9 processor and FPGA which runs both trusted elements for control and safety as well as team-generated code. Integrated controller I/O includes a variety of communication protocols (Ethernet, USB, CAN, SPI, I2C, and serial) as well as PWM, servo, digital I/O, and analog I/O channels used to connect to robot peripherals for sensing and control.The roboRIO should connect to the dedicated 12V port on the Power Distribution Panel for power. Wired communication is available via USB or Ethernet.

Pneumatics Control Module



The PCM is a device that contains all of the inputs and outputs required to operate 12V or 24V pneumatic solenoids and the on board compressor. The PCM is enabled/disabled by the roboRIO over the CAN interface. The PCM contains an input for the pressure sensor. The device also collects diagnostic information such as solenoid states, pressure switch state, and compressor state. The module includes diagnostic LED's for both CAN and the individual solenoid channels.

Voltage Regulator Module



The VRM is an independent module that is powered by 12 volts. The device is wired to a dedicated connector on the PDP. The module has multiple regulated 12V and 5V outputs. The purpose of the VRM is to provide regulated power for the D-Link 1522 RevB radio, custom circuits, and IP vision cameras.

D-Link DAP-1522 Rev B

The D-Link DAP-1522 Rev B robot radio is used to provide wireless communication functionality to the robot. The device can be configured as an Access Point for direct connection of a laptop for use at home. It can also be configured as a bridge for use on the field. The robot radio should be powered by

one of the 5V outputs on the VRM and connected to the roboRIO controller over Ethernet. For more information, see Programming your radio for home use and the D-Link DAP1522 Support Page.

Axis M1011 / Axis 206 Ethernet Camera

The Axis M1013, M1011 and Axis 206 Ethernet cameras are used for capturing images for vision processing and/or sending video back to the Driver Station laptop. The camera should be wired to a 5V power output on the Voltage Regulator Module and either the D-Link 1522 RevB (if used on the robot) or the ethernet port of the roboRIO. For more information, see Configuring an Axis Camera and the Axis 206, Axis M1011, Axis M1013 pages.

Jaguar Motor Controller

The Jaguar Motor Controller from VEX Robotics is one of three variable speed motor controllers for use in FRC. The Jaguar can be controlled using either the PWM interface or over the CAN bus. The Black Jaguar can also be used to convert from RS232 (from the BDC-Comm PC program) to the CAN bus. The Jaguar should be connected using one of these control interfaces and powered from the Power Distribution Panel. For more information, see the Jaguar Getting Started Guide, Jaguar Datasheet and Jaguar FAQ on this page.

Talon Motor Controller

The Talon Motor Controller from Cross the Road Electronics is one of three variable speed motor controllers for use in FRC. The Talon is controlled over the PWM interface. The Talon should be connected to a PWM output of the roboRIO and powered from the Power Distribution Panel. For more information see the Talon User Manual.

Victor 888 Motor Controller / Victor 884 Motor Controller

The Victor 888 Motor Controller from VEX Robotics is one of three variable speed motor controllers for use in FRC. The Victor 888 replaces the Victor 884, which is also usable in FRC. The Victor is controlled over the PWM interface. The Victor should be connected to a PWM output of the roboRIO and powered from the Power Distribution Panel. For more information, see the Victor 884 User Manual and Victor 888 User Manual.

Spike H-Bridge Relay

The Spike H-Bridge Relay from VEX Robotics is a device used for controlling power to motors or other custom robot electronics. When connected to a motor, the Spike provides On/Off control in both the forward and reverse directions. The Spike outputs are independently controlled so it can also be used to provide power to up to 2 custom electronic circuits. The Spike H-Bridge Relay should be connected to a relay output of the roboRIO and powered from the Power Distribution Panel. For more information, see the Spike User's Guide.

Image credits

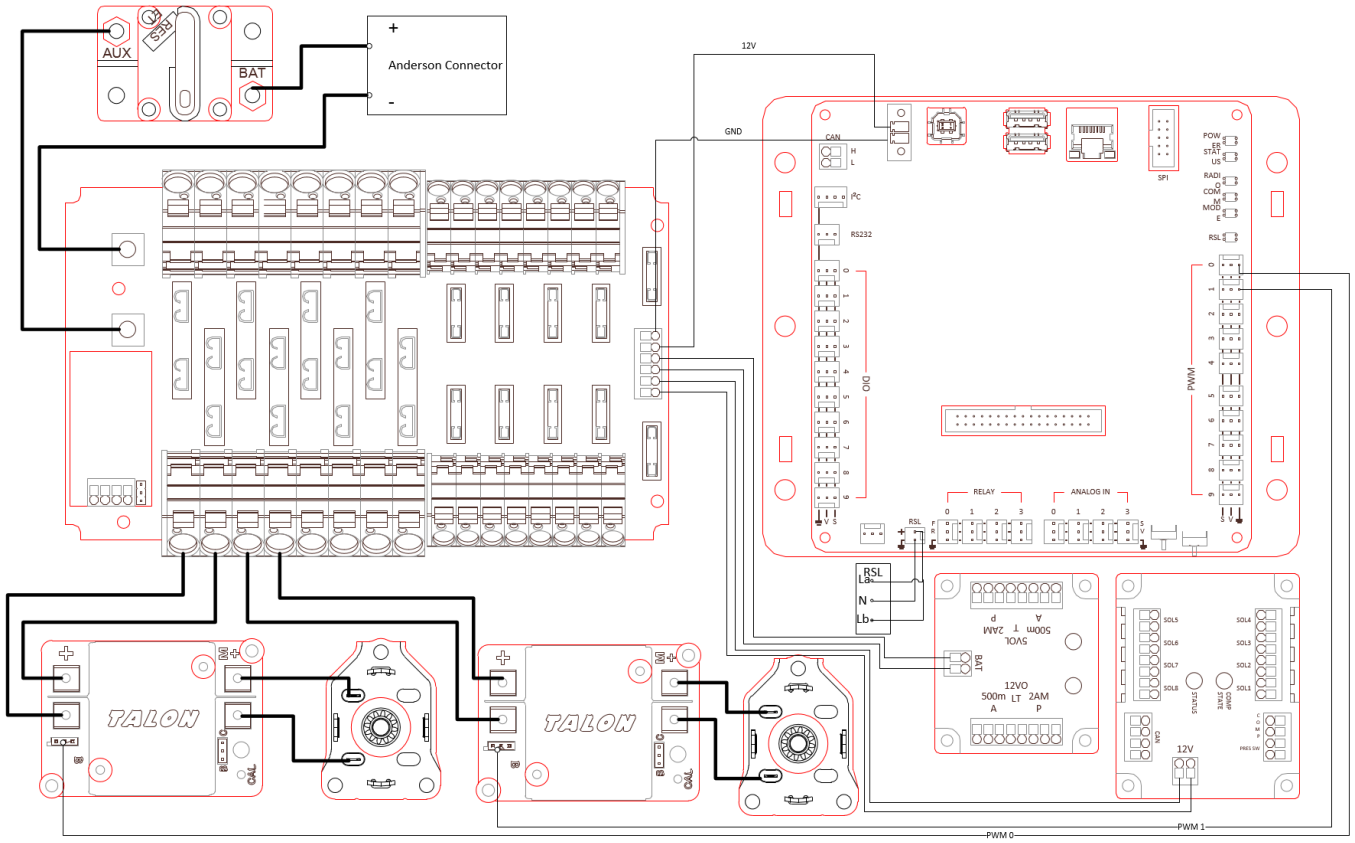
Image of roboRIO courtesy of National Instruments. Images of Jaguar Motor Controller, Victor 888 Motor Controller and Spike H-Bridge Relay courtesy of VEX Robotics, Inc. PDP, PCM, and VRM courtesy of Cross The Road Electronics. All other photos courtesy of AndyMark Inc.

Wiring the 2015 FRC Control System

This document details the wiring of a basic electronics board for bench-top testing.

The images shown in this section reflect the setup for a Robot Control System using a roboRIO and Talon motor controllers. The setup is similar for Jaguars and/or Victors.

Gather Materials



Locate the following control system components and layout their locations on an appropriate nonconductive surface (e.g. plywood or plastic) to permit wiring connections as shown in the power distribution diagram shown above. Plan the positions of the components to leave space to access the various connectors.

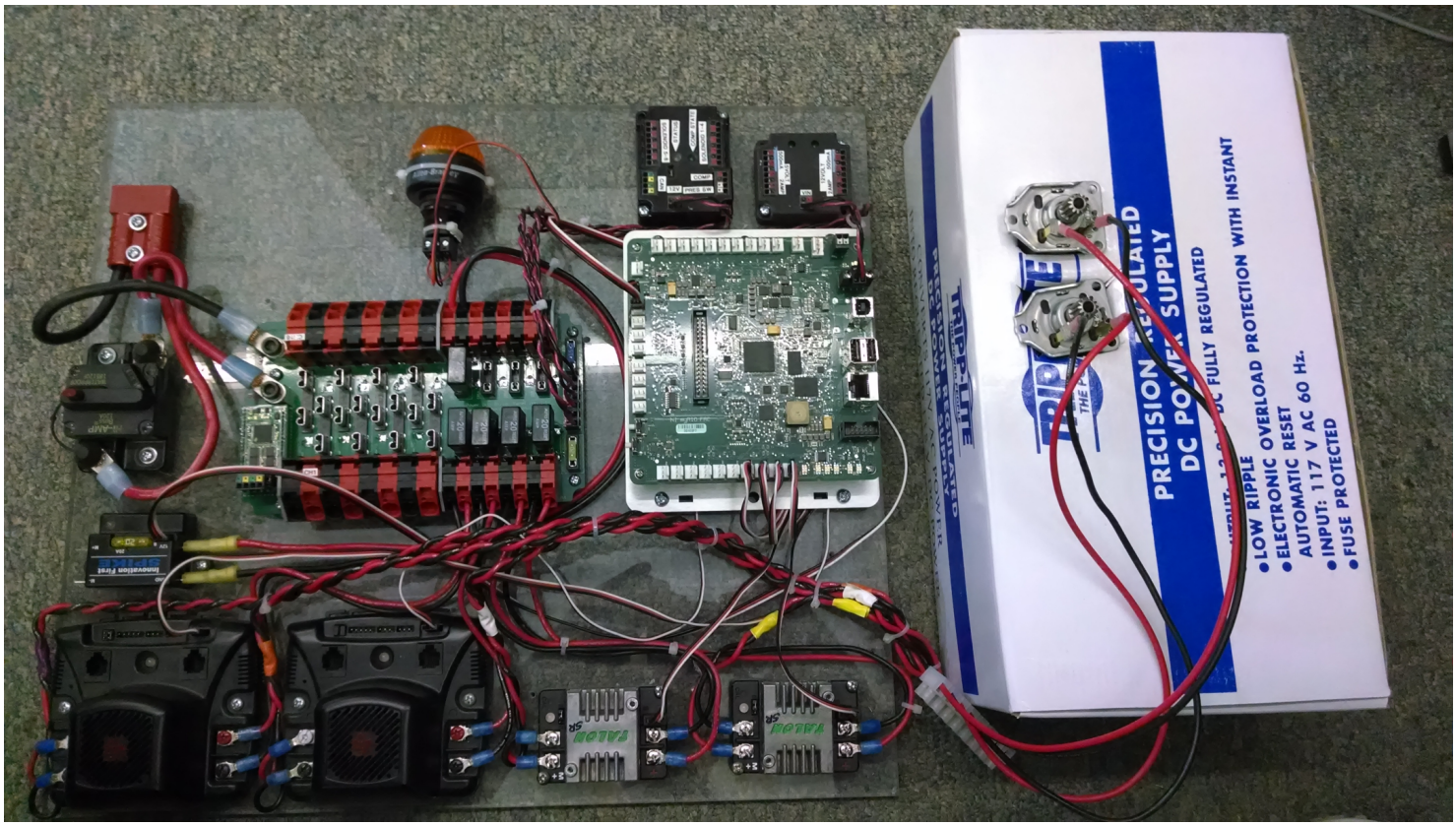
- Kit Materials:
  - Power Distribution Panel (PDP)
  - roboRIO
  - Pneumatics Control Module (PCM)
  - Voltage Regulator Module (VRM)
  - Robot Signal Light (RSL)
  - Circuit breakers
  - Talon speed controllers, qty 2 (Team-provided Jaguars or Victors may be used)
  - 2 PWM cables
  - 120-amp circuit breaker
  - DC motors (Denso shown), qty 2
  - 6 AWG wire and terminal connectors
  - 18 AWG or larger (lower number AWG) wire for motor wiring
  - 16 to 24AWG wiring for CAN connections (green and yellow preferred but not required)
  - Appropriate wire and connectors for size of motors
  - 12V Battery (Enersys NP18-12 recommended)
  - Dual Lock material or fasteners

- Tools Required:
  - Wago Tool or small flat-head screwdriver
  - Philips head screw driver
  - 5mm Hex key
  - 2mm Hex key
  - Wire cutters, strippers, and crimpers
  - 7/16” nut driver

Create the Base for the Control System

Cut piece of ¼” material (wood or plastic) approximately 18" x 18"

Layout the Core Control System Components

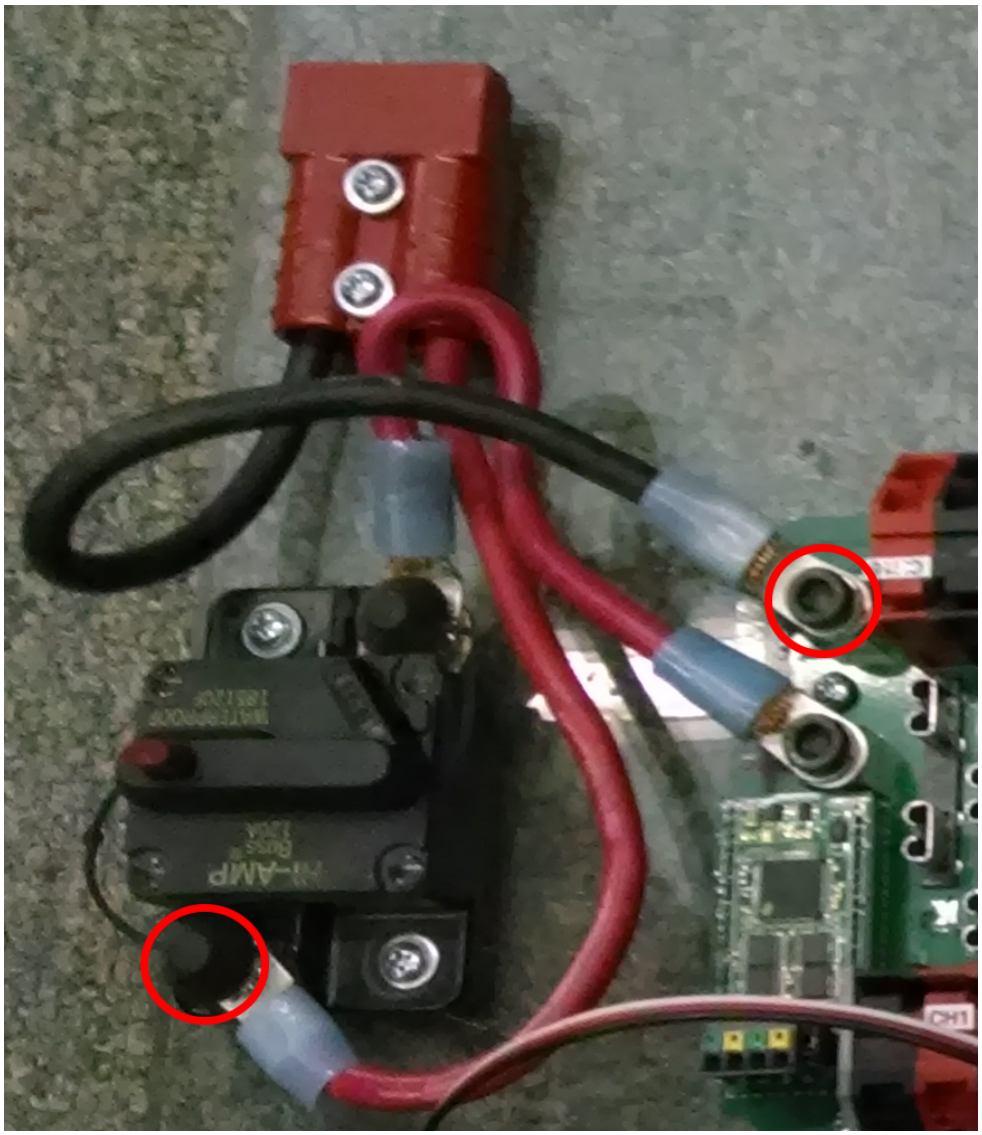


Layout the roboRIO, Power Distribution Panel, Pneumatics Control Module, Voltage Regulator Module,120A Main Breaker, and (2) motor controllers per the image (picture shows additional Jaguars and Spike)

Fasten components

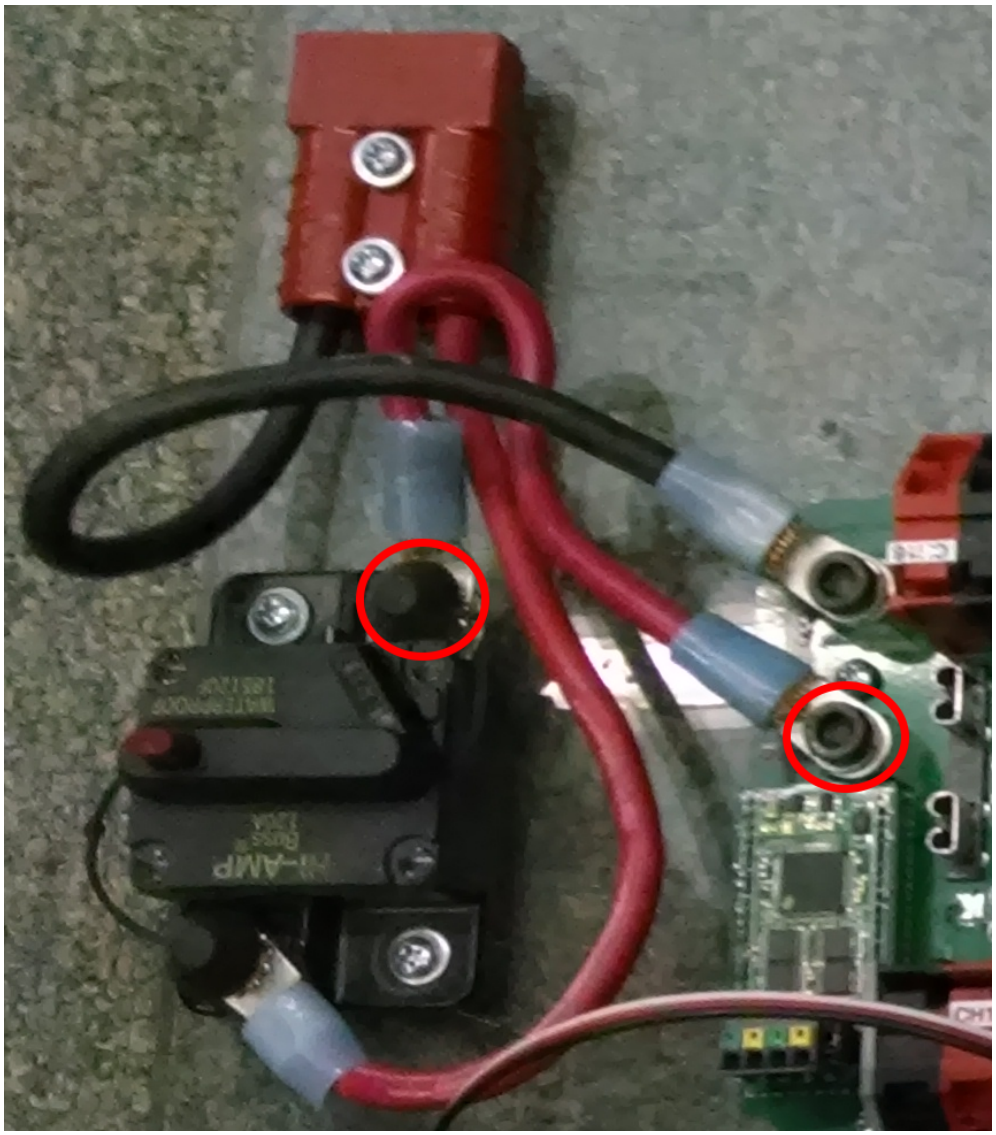
Using the Dual Lock or hardware, fasten all components to the board.

Attach Battery Connector



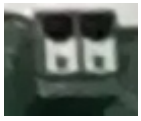
Attach terminal lugs to a battery connector. Then, attach the battery connector to the Power Distribution Panel and the 120A Main Breaker.

Wire Breaker to PDP



Connect the 120A Main Breaker to the positive terminal on the PDP using red 6AWG wire and terminal lugs.

Weidmuller Connectors



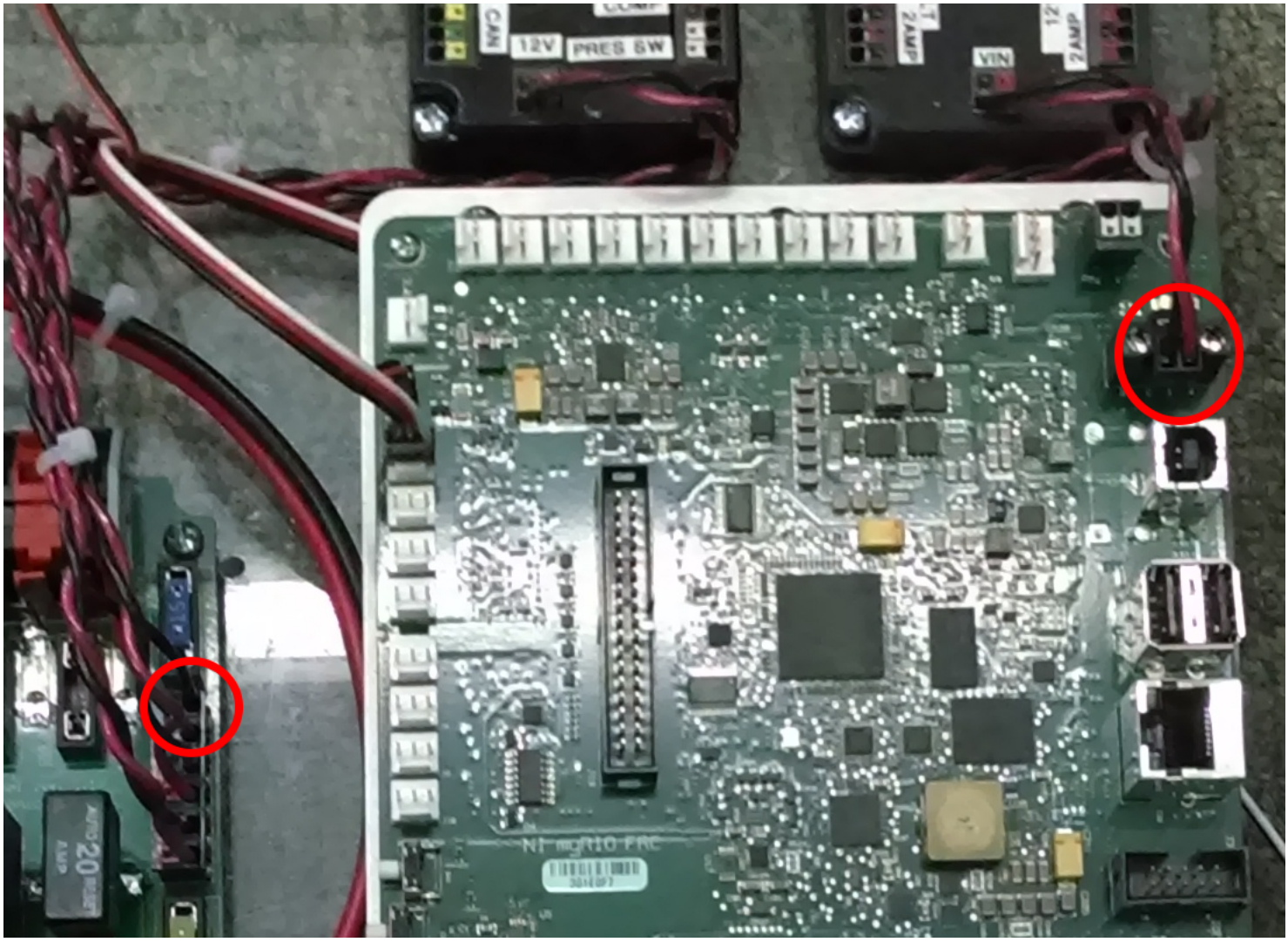
A number of the CAN and power connectors in the system use a Weidmuller LSF series wire-to-board connector. There are a few things to keep in mind when using this connector for best results

- Wire should be 16AWG to 24AWG (consult rules to verify required gauges for power wiring)
- Wire ends should be stripped approximately 5/16"
- To insert or remove the wire, press down on the corresponding "button" to open the terminal

After making the connection check to be sure that it is clean and secure:

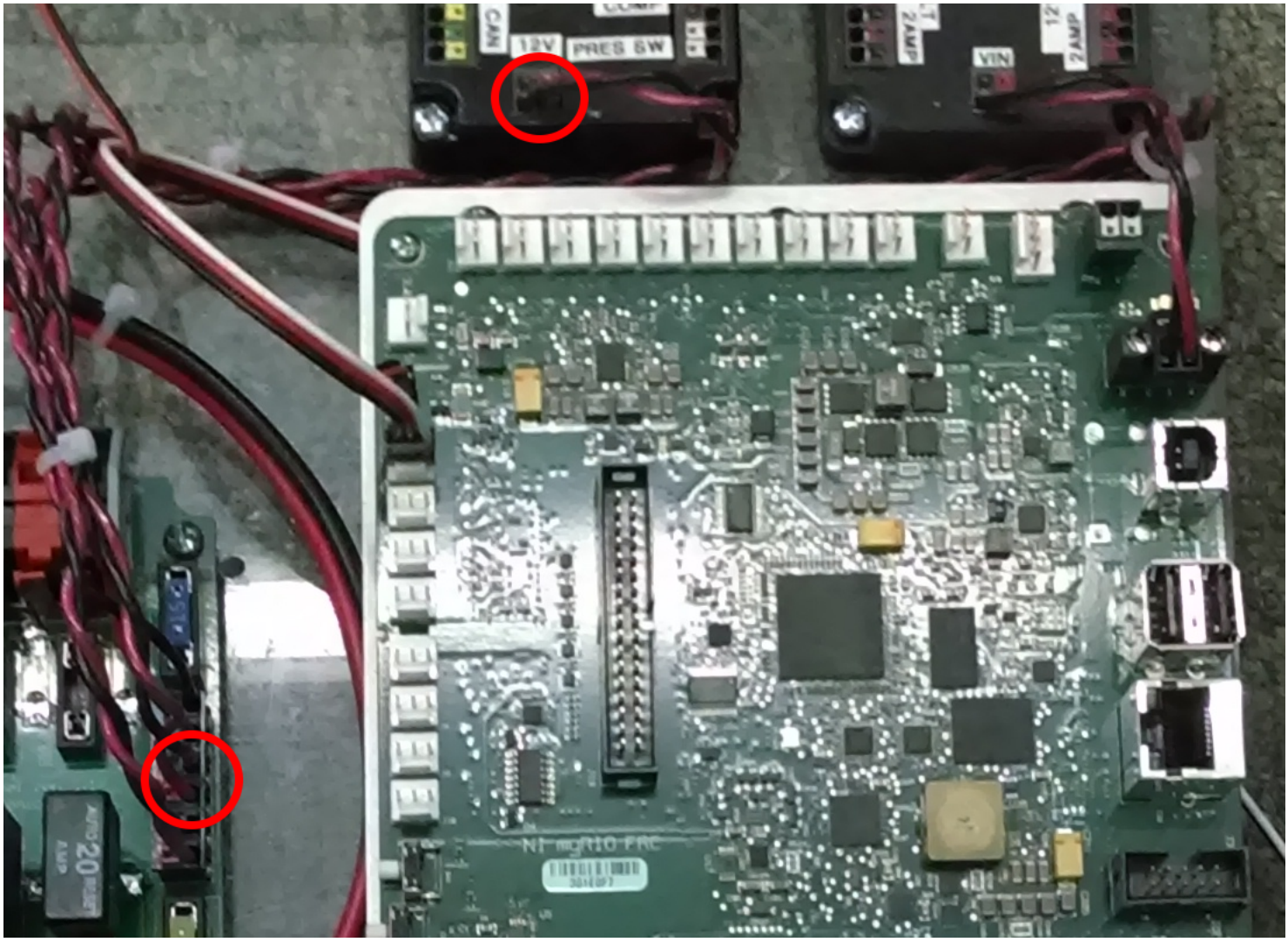
- Verify that there are no "whiskers" outside the connector that may cause a short circuit
- Tug on the wire to verify that it is seated fully. If the wire comes out and is the correct gauge it needs to be inserted further and/or stripped back further.

roboRIO Power



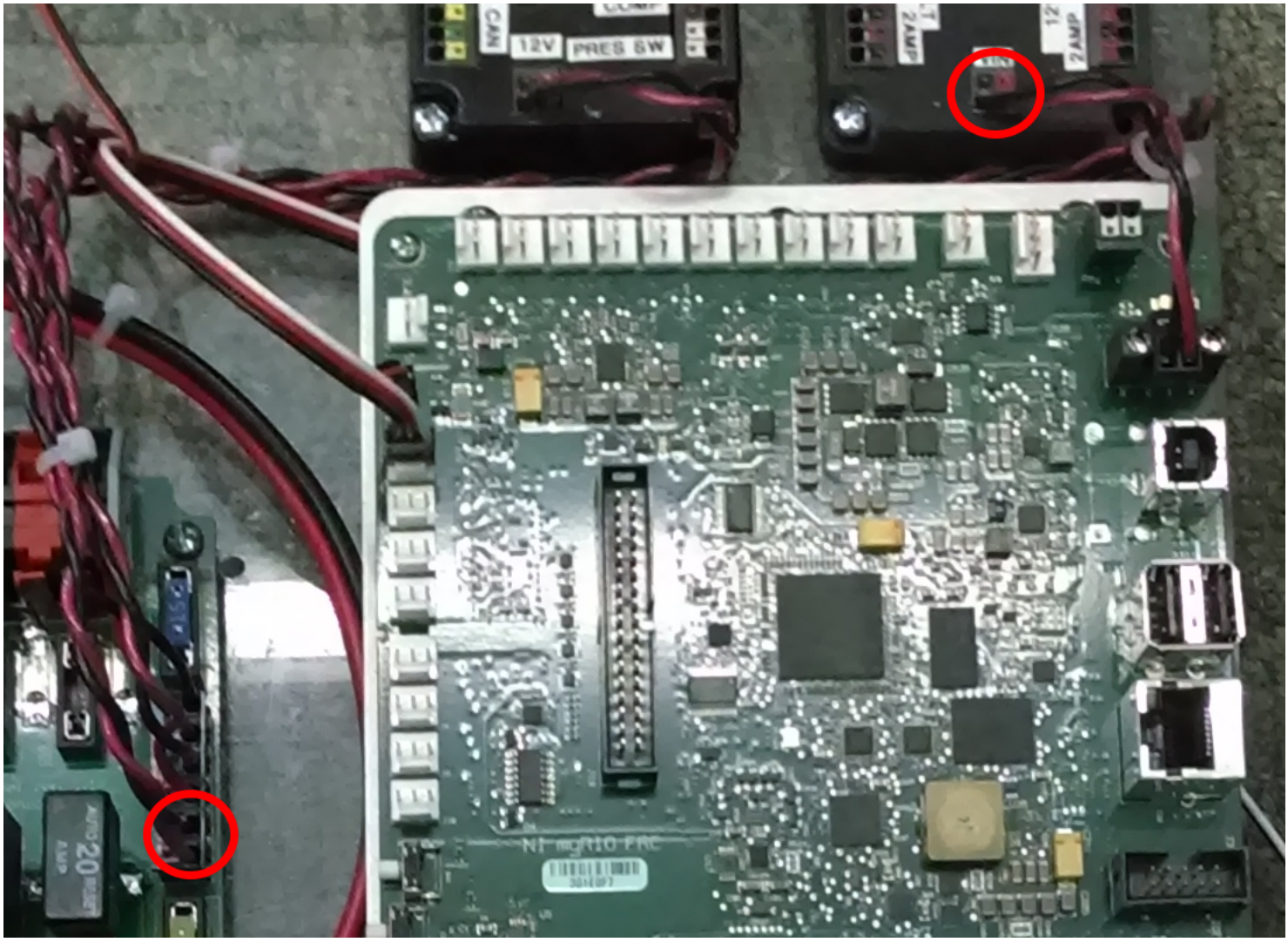
Connect the roboRIO power input (Sauro connector) to the roboRIO 12V terminal on the PDP.

Pneumatics Control Module Power



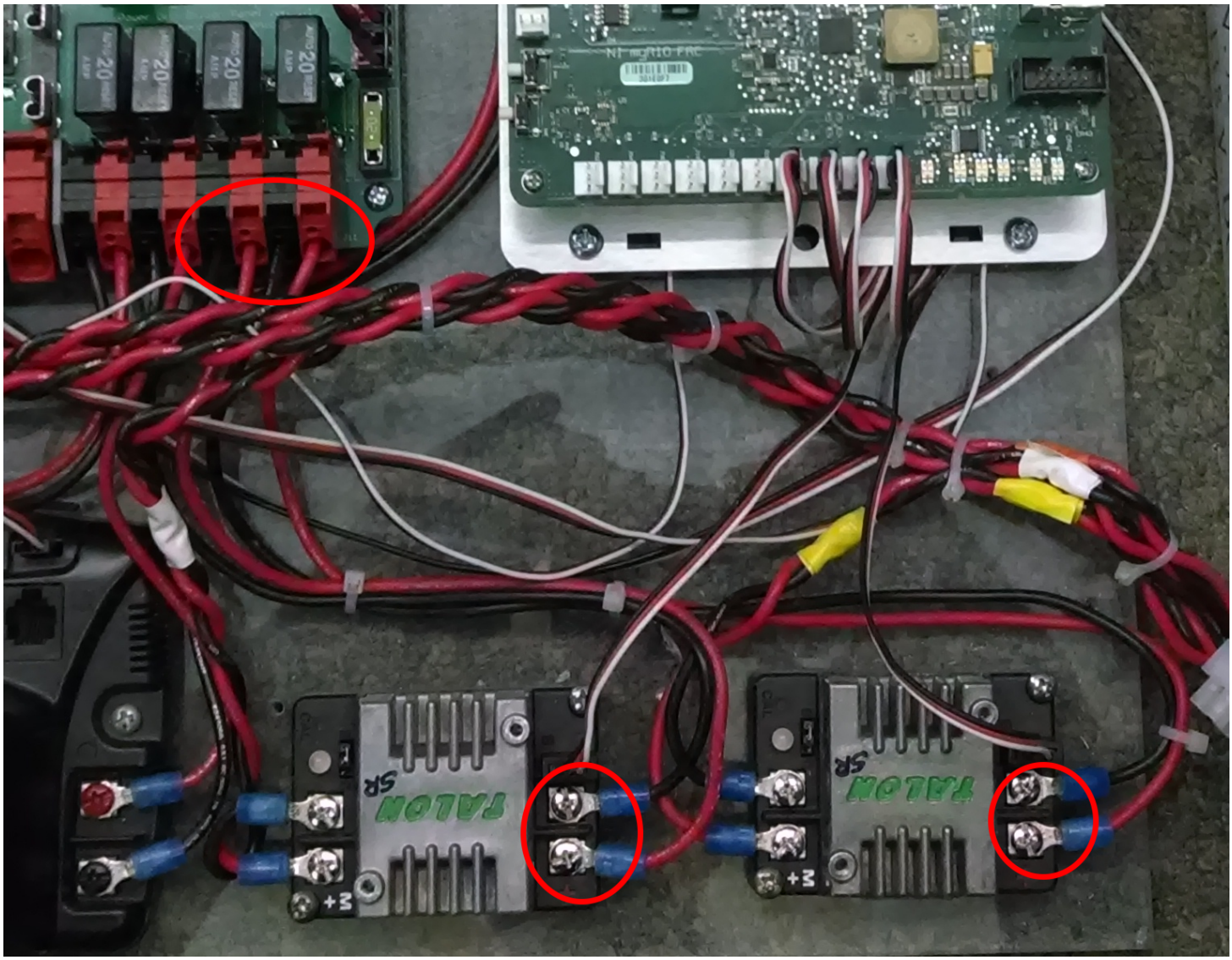
Connect the PCM power input to the PCM 12V terminal on the PDP.

Voltage Regulator Module Power



Connect the VRM power input to the VRM 12V terminal on the PDP.

Motor Controller Power

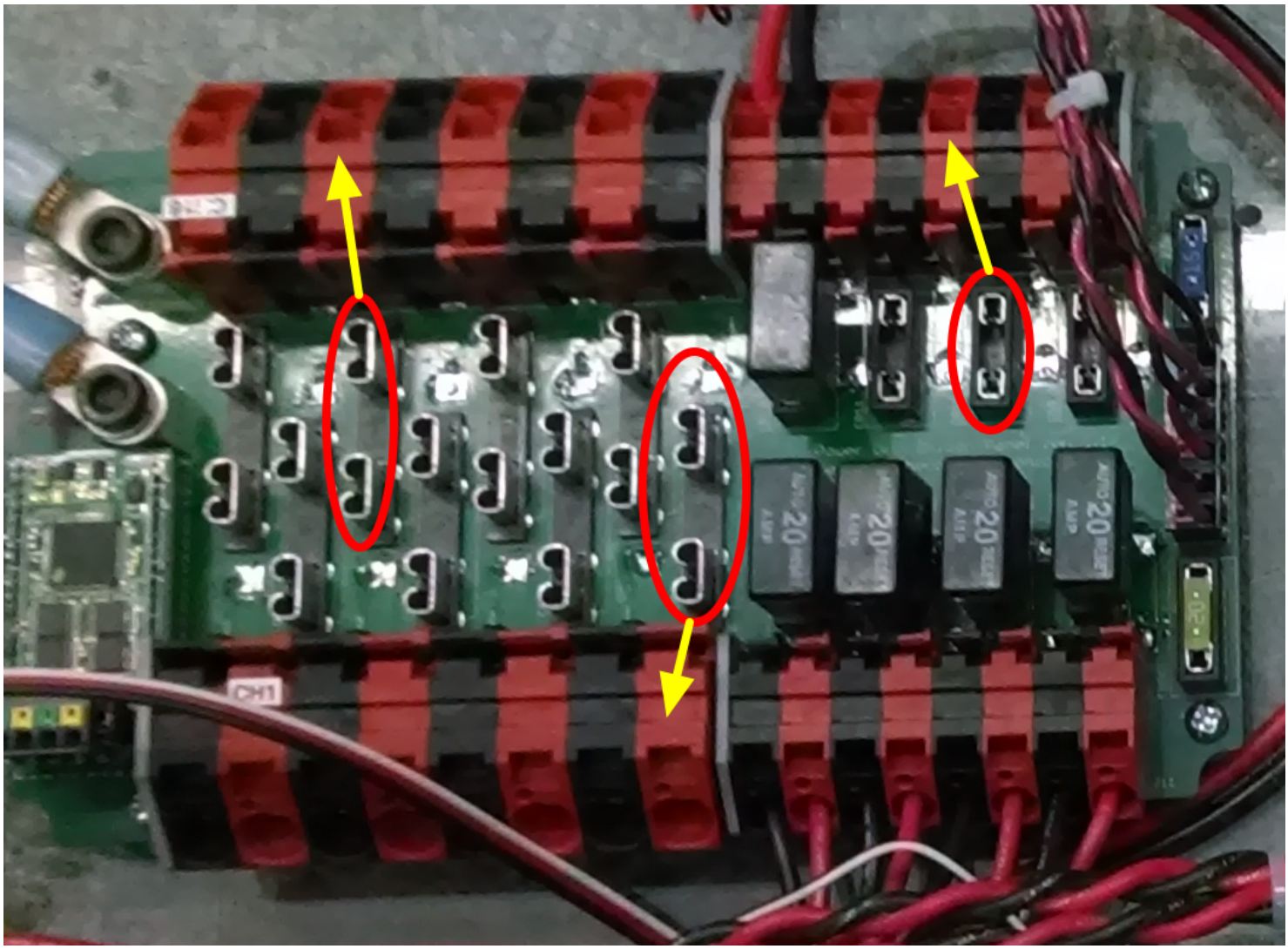


Connect the Motor Controllers to a 30A or 40A position on the PDP. Also, connect the fan wires (if present) to the power input terminals on the motor controller.

Robot Signal Light

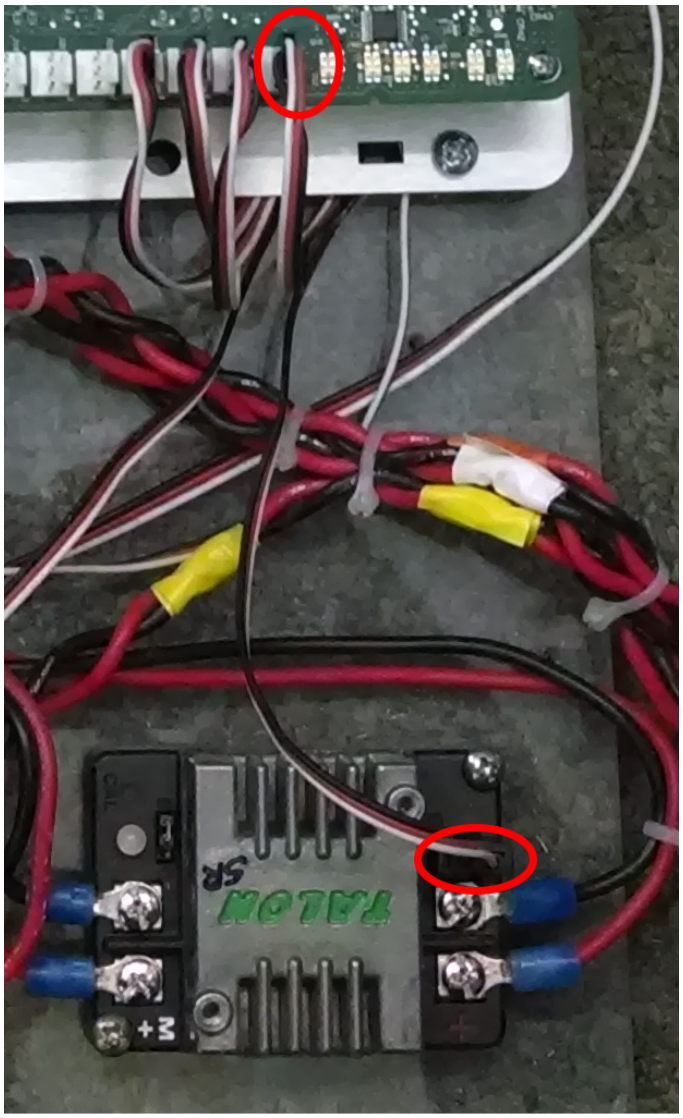
Connect the Robot Signal Light to the “RSL” terminals on the roboRIO. Then, create a jumper between the “La” and “Lb” terminals on the RSL.

Circuit Breakers



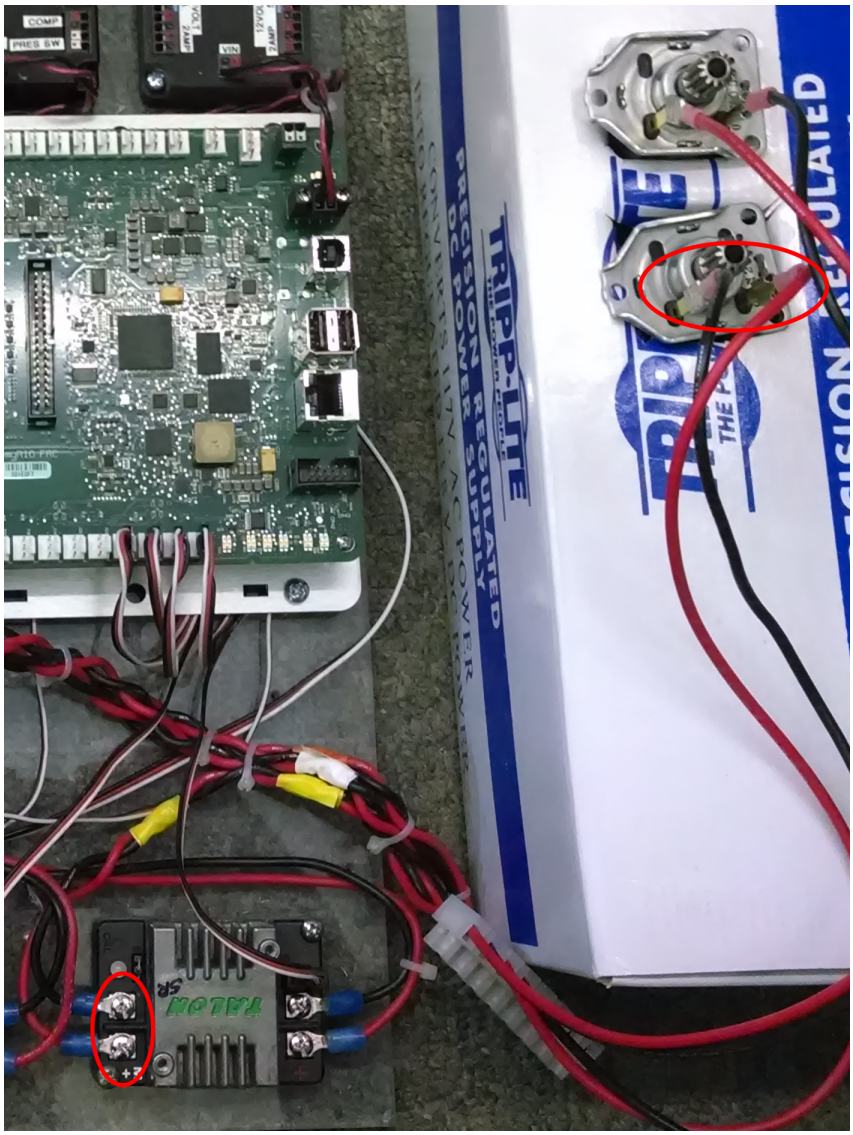
Insert 20-amp or 40-amp Circuit Breakers into positions on the PDP. Note that, for all breakers, the breaker corresponds with the nearest positive (red) terminal (see graphic above). All negative terminals on the board are directly connected internally.

PWM Cables



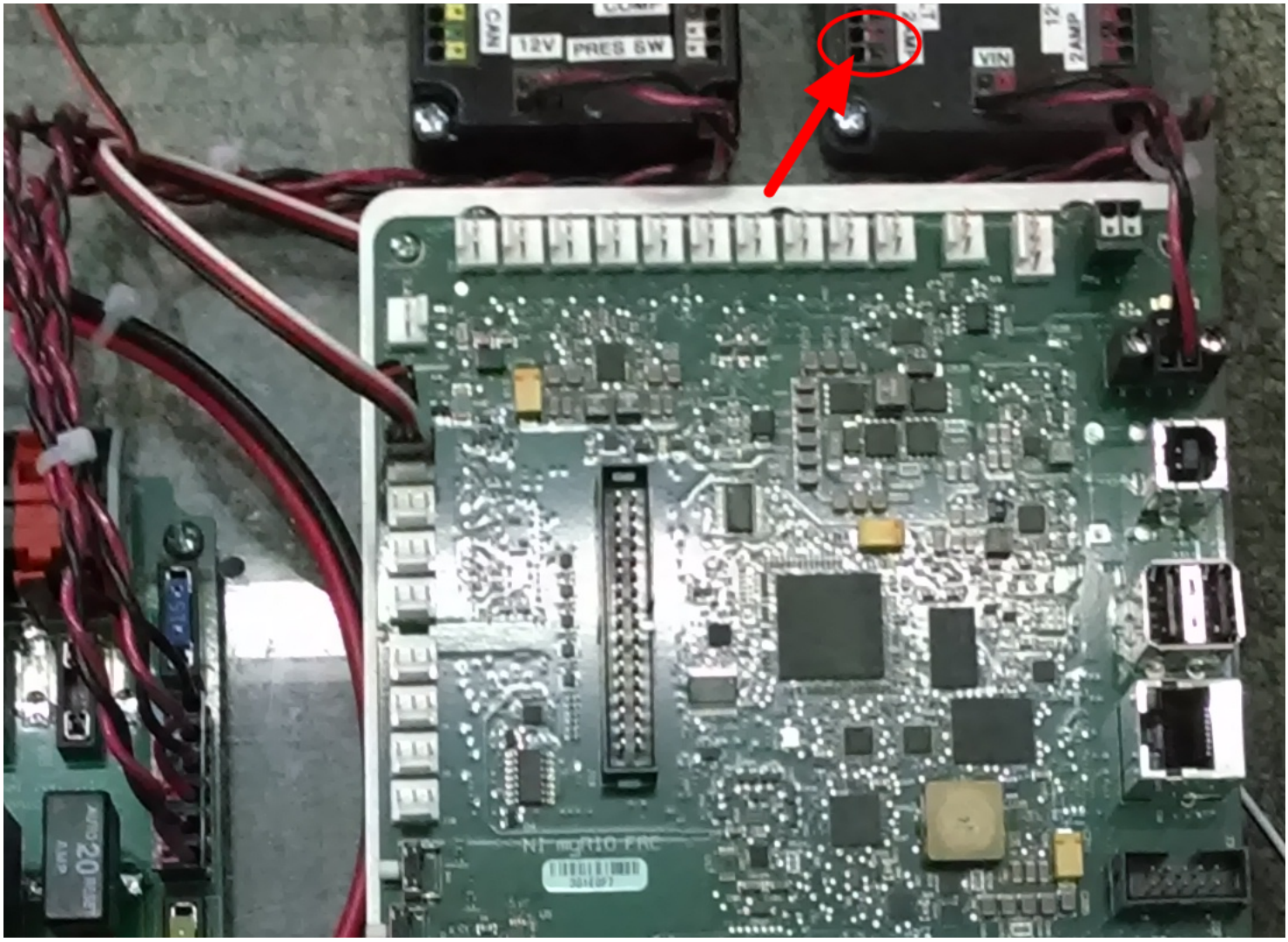
Use a 3-conductor cable (PWM cable) to connect the roboRIO (PWM OUT Ports 0 and 1) to the Motor Controllers. Make sure to take note of the proper cable orientation on both ends. Also make sure that the male end of the cable seats fully inside the receptacle on the speed controller.

Motor Power



Connect the motors' power leads to the M+ and M- terminals on the Motor Controllers.

Radio Power



Wire the radio power:

1. Remove the "wall wart" from the provided radio power supply.
2. Connect the black wire with the white stripe to the red (positive) terminal of the 5v 2A supply of the Voltage Regulator Module
3. Connect the solid black wire to the adjacent black terminal

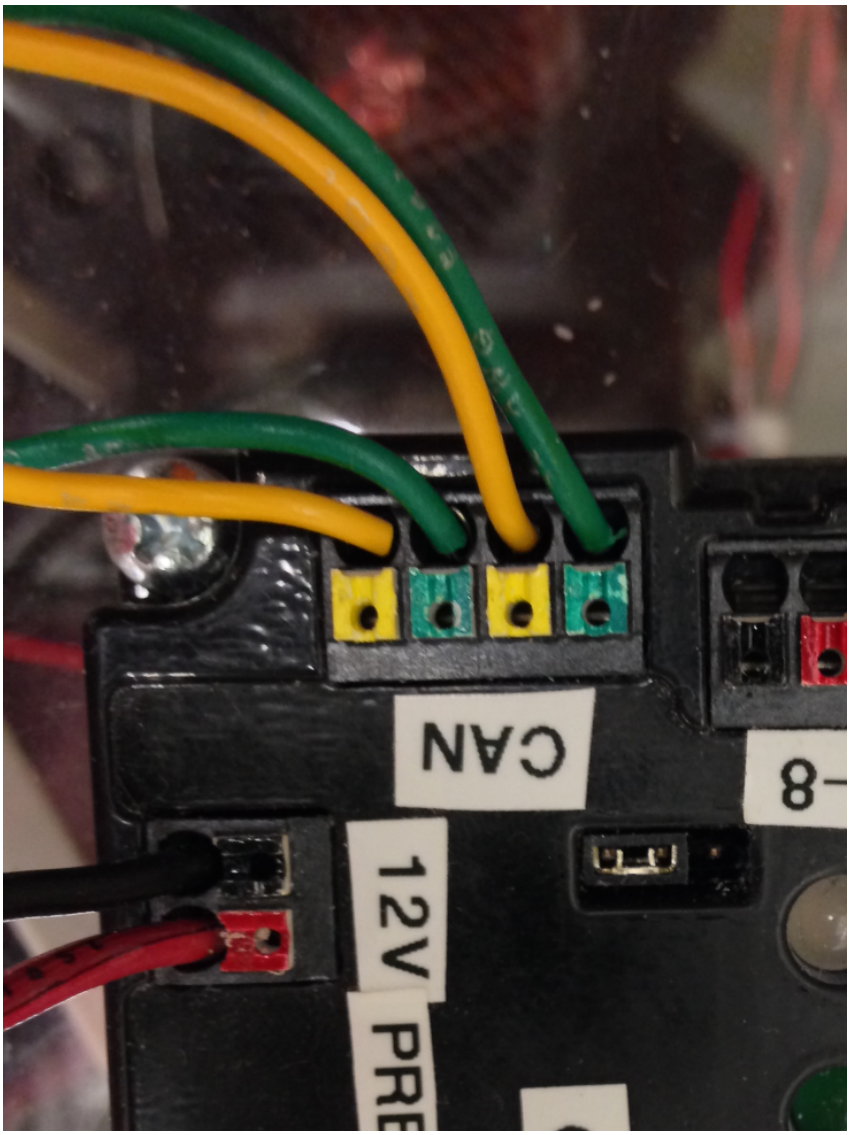
CAN wiring

This article covers the CAN wiring of the core system components (roboRIO, PCM and PDP). For details on wiring CAN Jaguars, see this article. CAN wiring between these three components should be 16AWG to 24AWG twisted pair (either purchased or hand twisted) wire. Green and yellow wire is recommended as this will match the labeling on the components.

roboRIO CAN

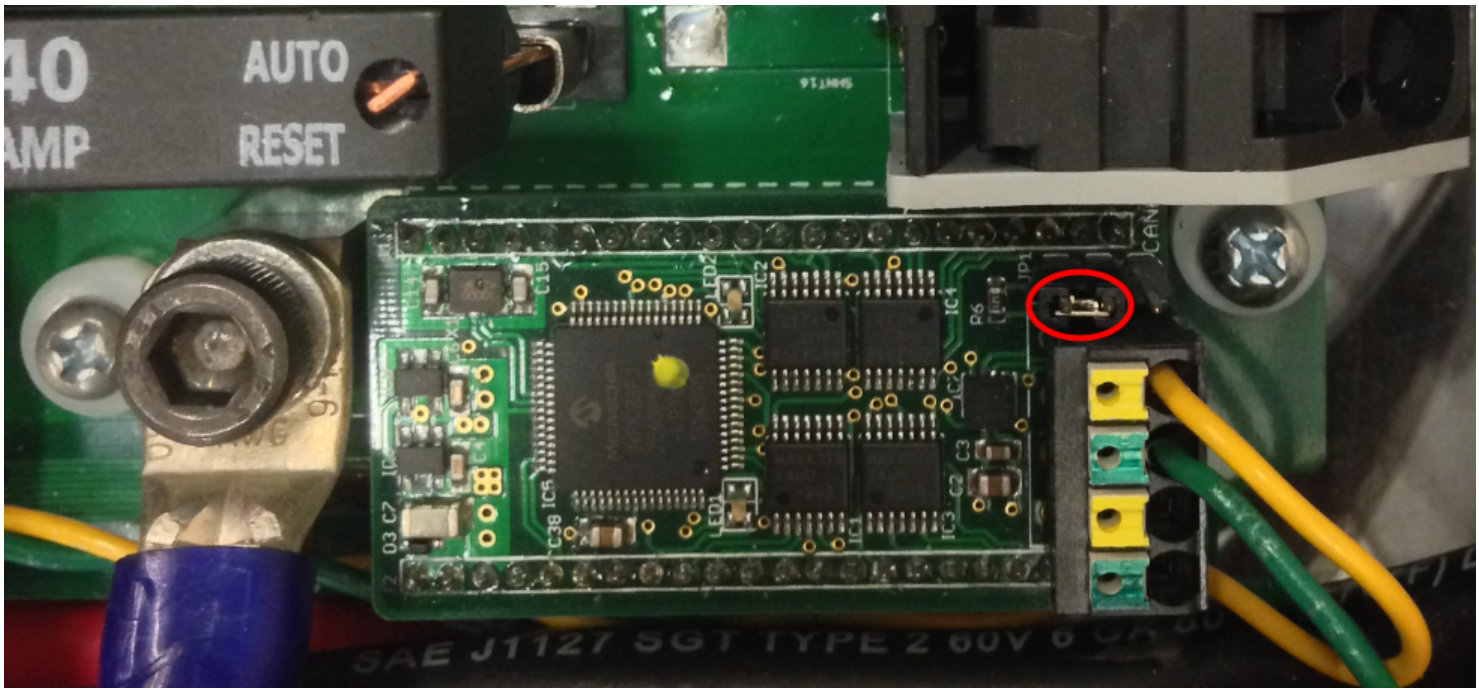
The roboRIO has a built-in CAN termination resistor, meaning it must be at one end of the CAN bus chain. Connect the wires to the CAN connector on the roboRIO, these will run to a PCM , a CAN speed controller, or directly to the PDP if neither of those are used.

PCM CAN



The Pneumatics Control Module has two pairs of CAN connectors to allow it to be easily placed in the middle of the CAN bus chain. There is no designated "in" or "out" port. Connect the wires coming from the roboRIO to one of the pairs on the PCM. Connect another pair of wires to run to CAN speed controllers or directly to the PDP is no CAN speed controllers are present.

PDP CAN

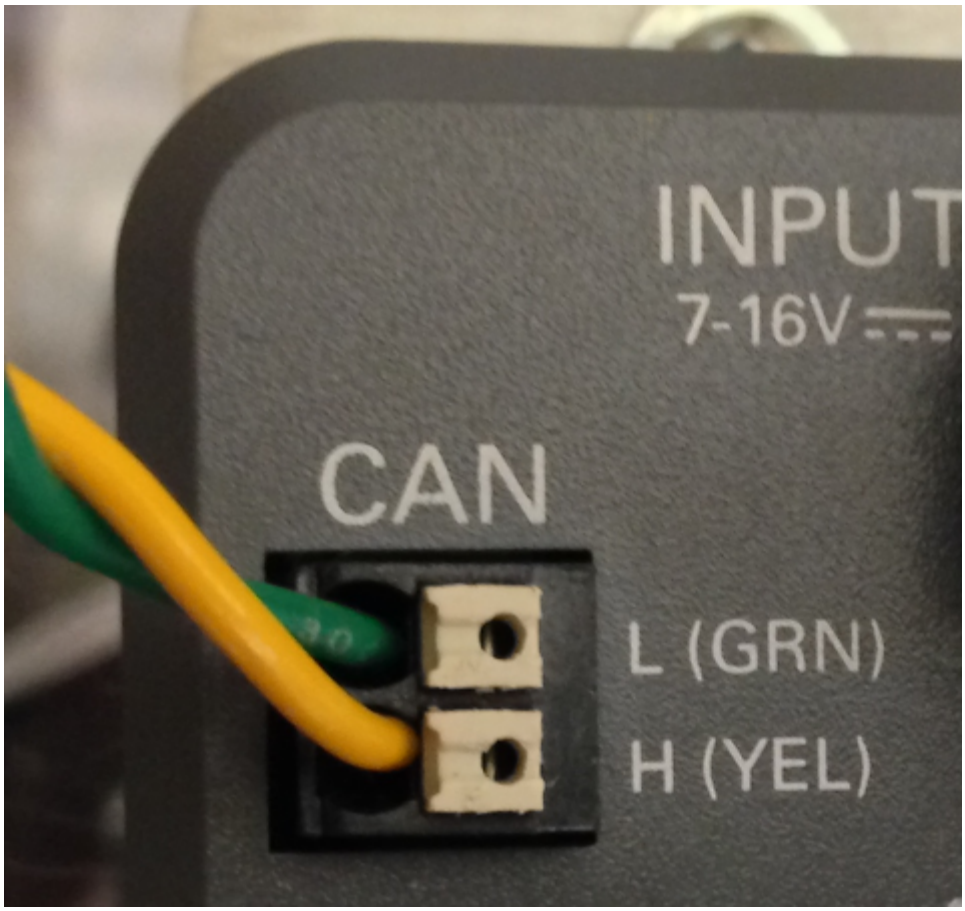


The Power Distribution Panel has a jumper selectable termination resistor, so it si recommended to make the PDP the other end of the CAN chain. As with the PCM, the PDP contains two pairs of CAN connectors with no designated "in" or "out". Connect the wires coming from the PCM or CAN speed controllers to one of the pairs on the PDP. Check to make sure that the termination jumper (adjacent to the CAN connector) is in the termination enabled state (on the two pins toward the inside of the board).

Wiring CAN Jaguars in the 2015 System

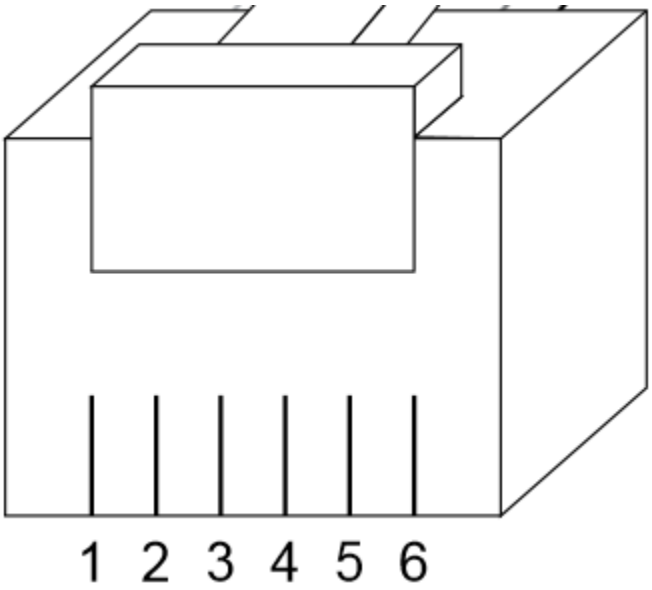
This article describes how to connect Jaguar speed controllers to the CAN bus of the 2015 FRC Control System

2015 FRC Control System CAN wiring



The 2015 FRC Control System uses simple twisted pair wiring for the CAN connections with Weidmuller wire-to-board connectors on the components allowing you to wire to them directly. The wiring is labeled with CAN High (CANH) as Yellow and CAN Low (CANL) as Green.

Jaguar CAN Wiring



The Jaguar uses an RJ-45 connector for the CAN connection. The center two pins of the connector are used for the CAN wiring. If crimping to a 6P6C connector, pin 3 is CANH and pin 4 is CANL. If using a 6P4C connector, pin 2 is CANH and pin 3 is CANL. If connecting to a standard telephone cable with standard wire colors, Red will be CANH and Green will be CANL

Wiring Jaguars into 2015 FRC Control System

The recommended method of wiring the 2015 FRC Control System CAN Bus is to utilize the built-in termination of the roboRIO on one end of the bus and the selectable termination (set to On) of the Power Distribution Panel on the other end of the bus. To do this with CAN Jaguars you will need to create two adapter cables from the twisted pair wiring to the RJ-45 connector of the Jaguar. Use the descriptions of the color schemes and pinouts above to connect CANH from your twisted pair to CANH of the RJ45 and CANL to CANL. After the first Jaguar you can add additional Jaguars to the bus using a straight-pinned (sometime called a reverse-cable because the tabs will face opposite directions) 6P4C or 6P6C telephone cable as described in the Jaguar Getting Started Guide. After the last Jaguar in the chain you will use another adapter cable to wire from the Jaguar to the PDP.

Alternate termination

If you do not wish to use the built-in termination on the PDP you may set the PDP termination to Off. You will the need to terminate the end of the bus with your own 120 ohm termination resistor. This can be crimped directly into the RJ connector and plugged into the last Jag on the bus or (recommended) connected to stub wires which are crimped into the connector (the stub wires crimp into the contacts more securely and provide better insulation than crimping the resistor directly).

RS-232 Adapter

Though the 2015 Control System has a native CAN interface, an RS-232 to RJ-45 adapter is still necessary for updating Jaguar firmware from a PC using BDC-Comm (more details on this process in the next article). Details on making this adapter can be found in the Jaguar Getting Started Guide.

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Updating and Configuring Pneumatics Control Module and Power Distribution Panel

This document describes the process of updating the firmware on the Cross the Road Electronics CAN devices as of roboRIO Rev C with image v8. Some of these steps will be removed as the software continues to mature.

Functional Limitations

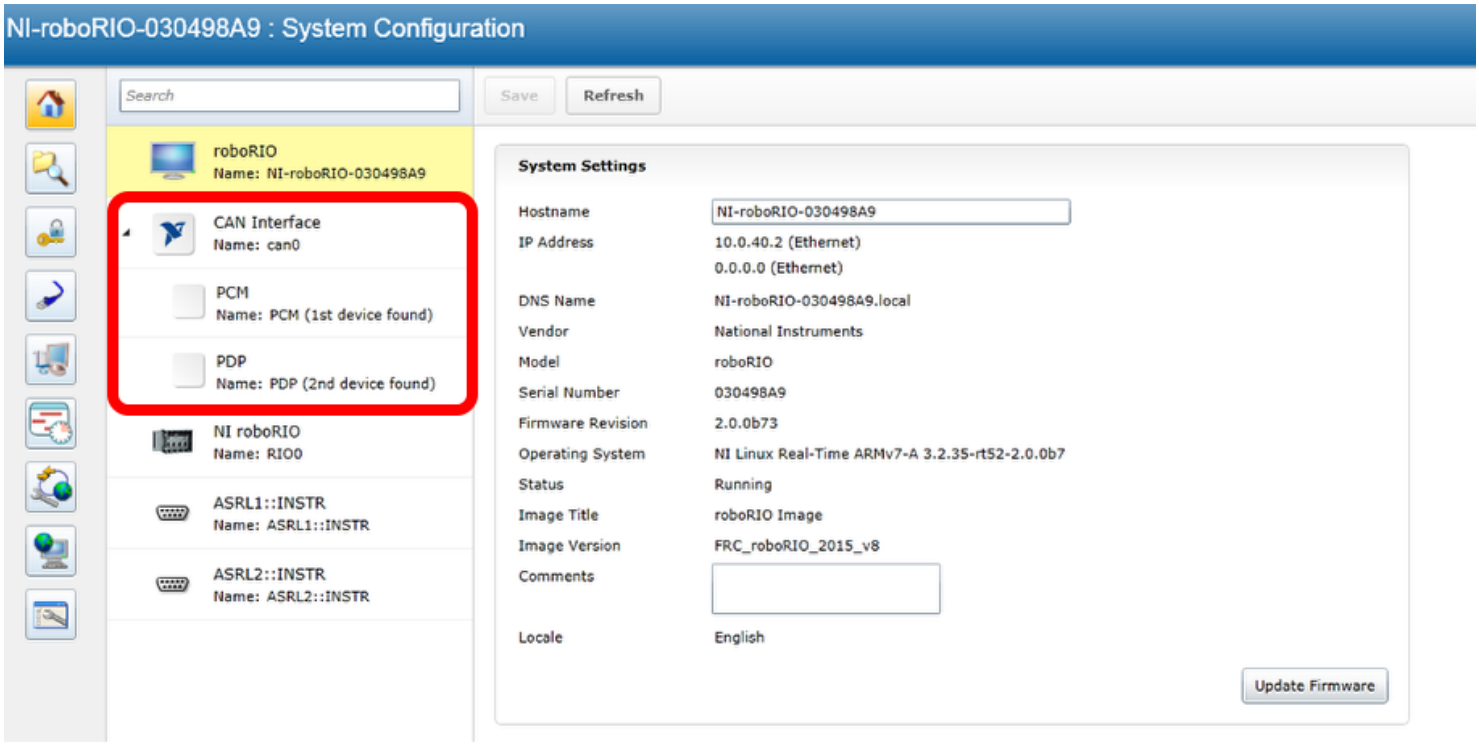
- There is a limitation to the voltage measurements taken by BETA REV Pneumatic Control Modules. Battery voltage as measured by the PCM will be inaccurate above 12V. The error between the reported voltage and actual voltage can be as high as 0.4V. Additionally the reported voltage will likely not exceed ~12.6V. Solenoid voltage measurement will not read exactly 24V when the 24V jumper is placed. The reported voltage will range from 23.5 to 26V, despite the actual solenoid voltage being 24V. Both issues will be resolved in the production version of the PCM. The Driver station, roboRIO and Power Distribution Panel(CAN) both will report battery voltage appropriately and should be used by beta teams instead for battery voltage measurement. Also the PCM solenoid voltage measurement when in 12V mode(jumper) should be accurate. Both battery voltage and solenoid voltage are available in the diagnostic webpage of the roboRIO, and available to the robot code in WPLib and Labview.
- The webdash needs about five seconds on first bootup to grab all the CAN nodes. That means it's possible to bring up the website before it finishes its first pass. On a fresh boot if there are no CAN nodes shown under "CAN Interface" refresh the browser.
- When a new CAN node is installed on the CANBus while the webpage is already up, you will need to refresh the browser to see the new device.
- If using Alpha rev hardware (bootloader is 2.1) then you should set the ID to a value greater than zero before attempting field upgrade. Alternatively you can leave the ID at zero, and let it fail to flash, then just refresh the webpage. On refresh you will see your PCM/PDP show up as a new entry with ID 50/60 and a comment indicating it's in bootloader (orange and green led pattern). At this point you can reflash successfully (second attempt). But again you can avoid all this by changing the ID in your application and in the webpage to a nonzero value, '1' for example. This is because bootloader 2.1 bounds checks the nodeId to make sure it's within [1,63]. Bootloader 2.1 was built in Oct 2013, well before the decision was made to support zero-based indexes. Beta hardware won't have this limitation.
- PCMs and PDPs with older firmware will already be set to device ID 50 and 60. You will have to manually set them to a zero-based index to match future releases of WPI library and NILabview image releases.

Downloading the update package

The most recent CTRE firmware can be downloaded from the Beta Test project File Releases section. Depending on the update, it may include a new version of the web dash plugin in addition to, or instead of, new firmware. Instructions for updating the webdash plugin are included at the bottom of the page.

The firmware in this package is the same firmware as is on the Beta units, if you reach this objective before an update, please complete the steps to reflash the device anyway to verify the procedure.

Accessing CAN Node Settings



Open the WebDash by using a browser to navigate to the roboRIO's address (172.22.11.2 for USB, or "roboRIO-####.local where #### is your team number, with no leading zeroes, for either interface). You should see a page that looks like the image above, with the CAN devices listed out below the CAN Interface.

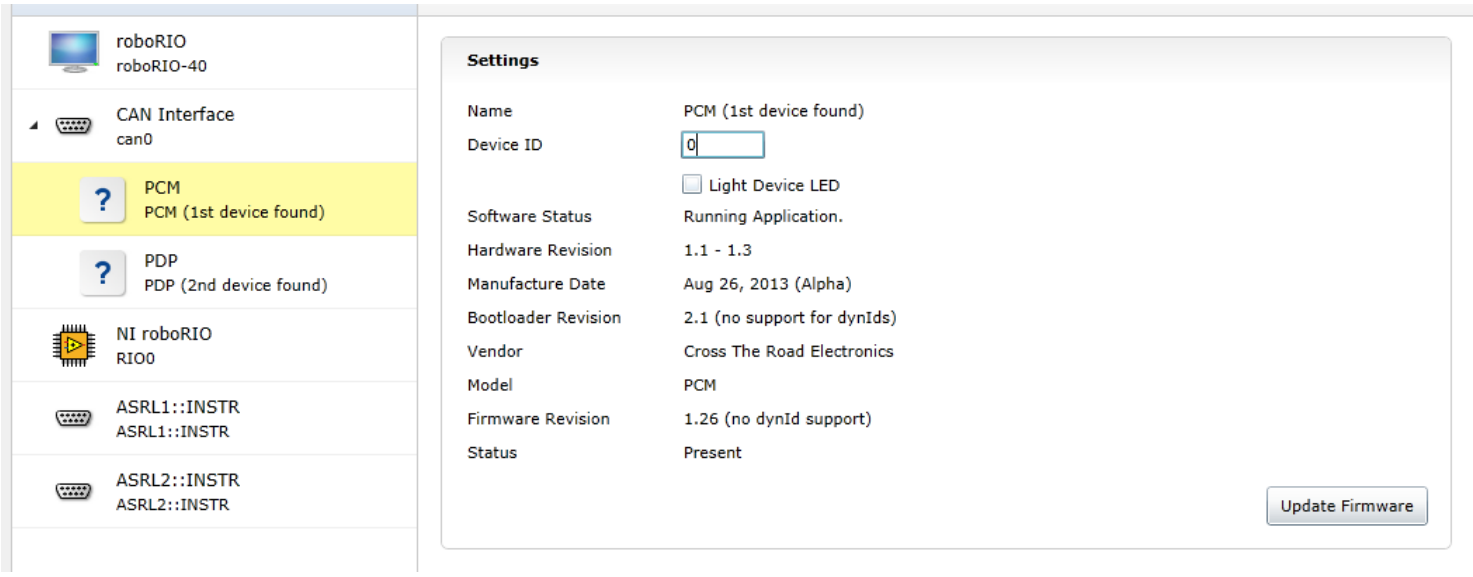
Note: The discovery order (e.g. "1st device found") is needed to separate devices of the same type but has no actual significance. You may see the PDP or a Jaguar or Talon SRX discovered first on your CAN network.

Troubleshooting

If you do not see any nodes below the CAN Interface entry try the following:

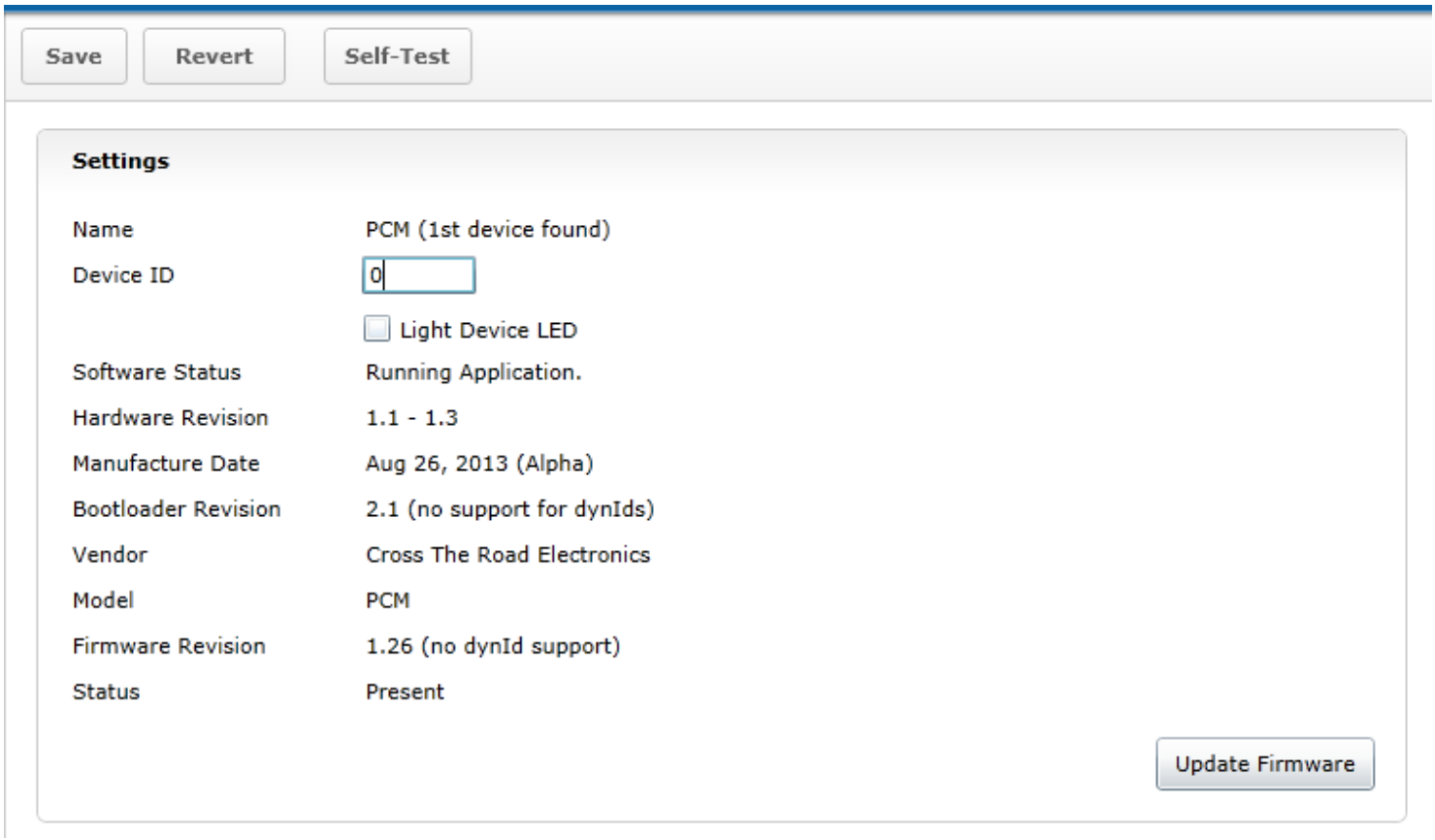
- Check the CAN cabling. If the LEDs on the PCM and PDP are red then they are not seeing CAN. Note that just because the LEDs on the devices are green does not mean the CAN cabling to the roboRIO are correct, they will turn green if the two other devices can see each other on the CAN network.
- Try refreshing the page. The device polling is done once every five seconds and the webpage itself doesn't always react to the Refresh button so if in doubt force a refresh by using the browser's refresh button or closing and re-opening the page.
- Make sure the CAN Interface is expanded. Double clicking the CAN Interface entry (or clicking the triangle to the left of the entry if present) will collapse the tree, repeating will expand it.
- Try restarting the browser. Occasionally the Silverlight plugin may crash or lock up resulting in the CAN devices silently not refreshing.

Settings



To access the Settings page of one of the CAN nodes, select the node by clicking on it's entry in the list. The settings for that node will then be displayed in the right pane.

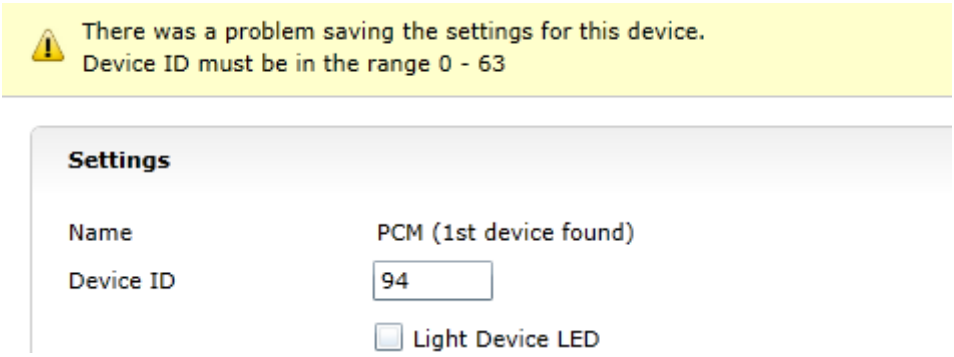
Setting CAN IDs



Each device comes with the CAN ID set to a default value of 0. If using only a single device of that type it is recommended to leave the ID at the default value to allow for the use of default Opens/ Constructors. If using multiples of a particular device type (I.E. 2 PCMs or 4 Talon SRXs) you will need to change the node ID of all but one device. To change the node ID:

- Highlight/Select the Device ID and replace it with your desired ID.
- Press "Save". The "Save button will depress and the "Refresh" button will appear.
- The Device ID field will revert back to the original ID momentarily. This is a limitation of the GUI, but the CAN Node will still apply the new Device ID.
- Wait 5 seconds, then press the "Refresh" button and the Device ID should return to the new ID you entered.

ID Ranges



The valid ID ranges for each type of device are:

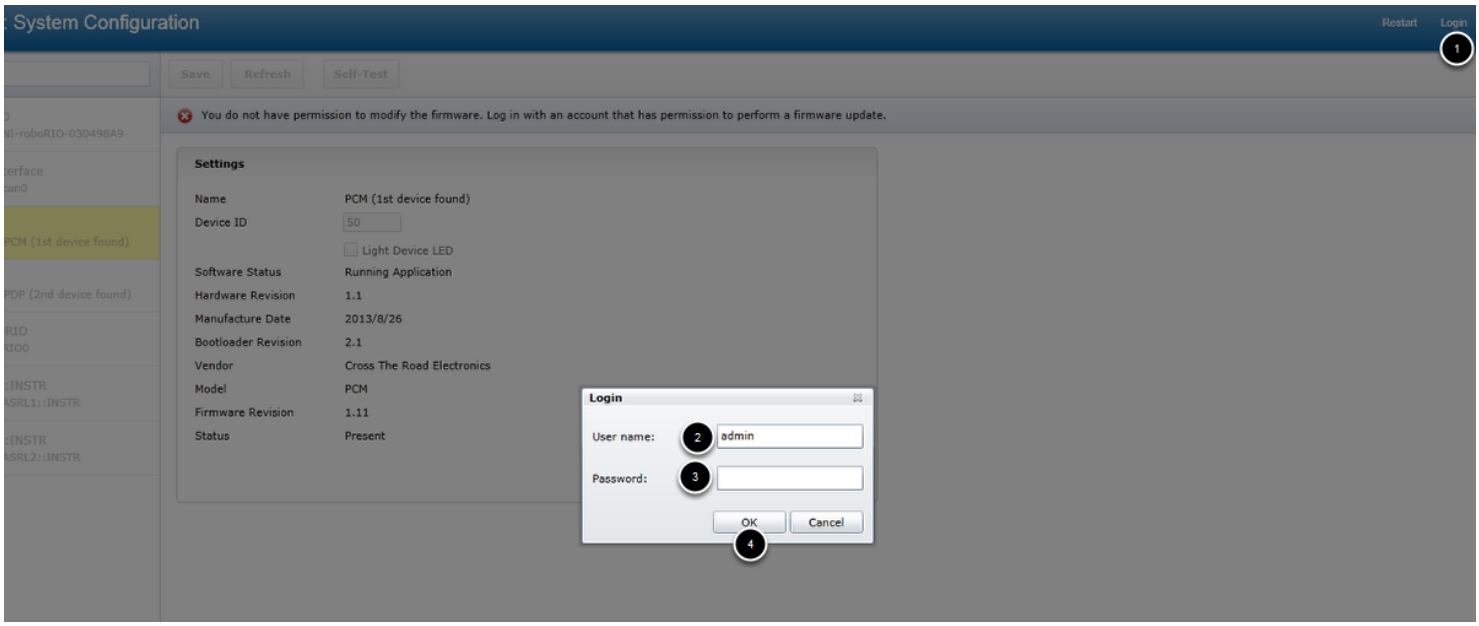
- Pneumatics Control Module (PCM) ID - 0 to 62 (inclusive)
- Power Distribution Panel (PDP) ID - 0 to 62 (inclusive)

If you select an invalid ID you will get an immediate prompt like the one shown above.

Changing the PDP ID while using WPILib is not recommended as there is no way to change the desired node ID in the library. PCM node IDs may be set as desired and addressed using the appropriate Open or Constructor of the Solenoid or Double Solenoid class.

Traditionally having two Jaguars on the same CANBus with the same device ID can cause unexpected failures symptoms. Since the ID ranges for different products don't overlap there is no risk of having two CAN nodes with the same Device ID in the case of a single PCM and PDP. Using multiple devices of the same type, such as multiple PCMs or multiple Jaguars can result in a conflict if they are set to the same node ID. The web plugin supports a strategy that will allow for recovery of this condition, but the devices are not properly usable from within a robot program while in this state.

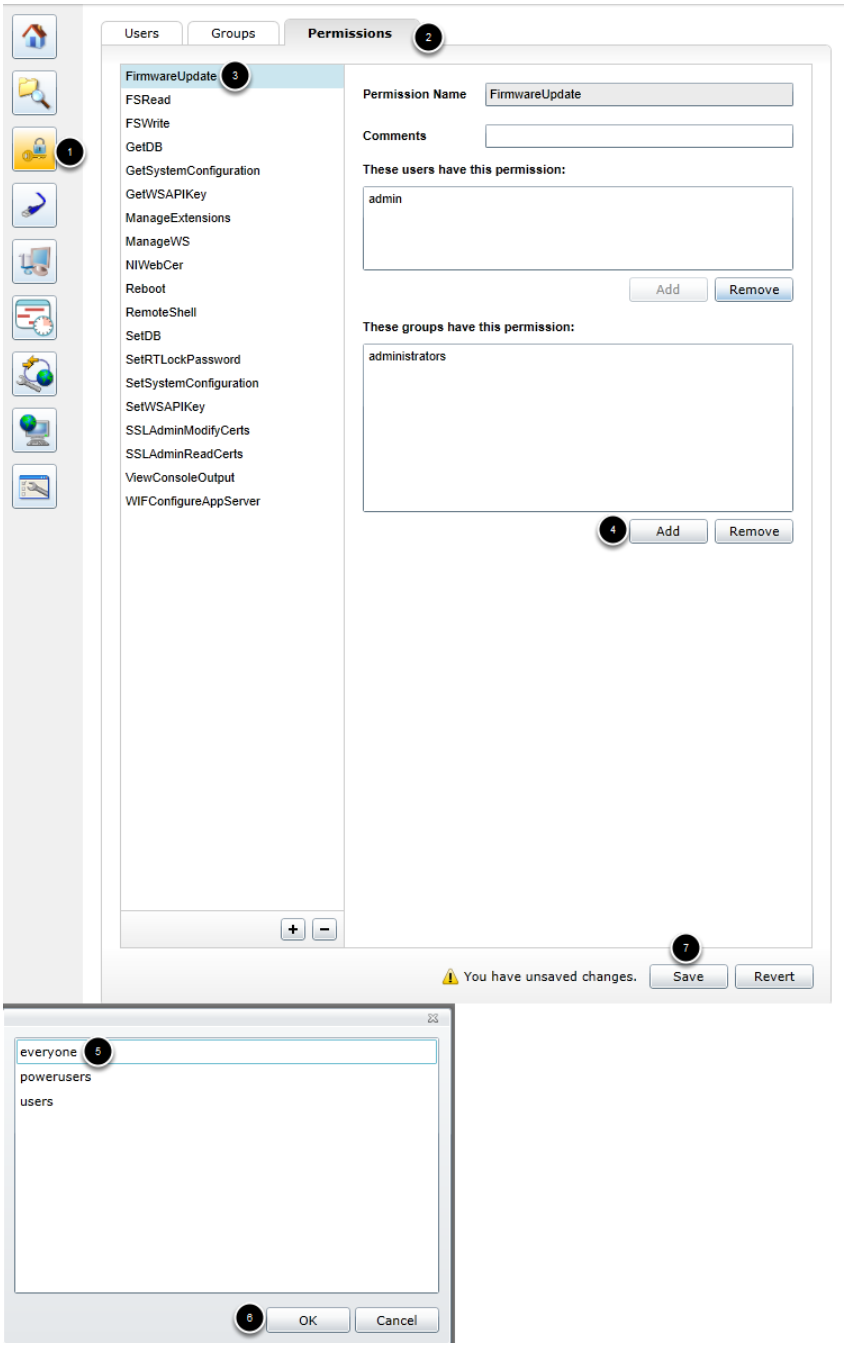
Updating CAN Node Firmware



This page can also be used to update the device firmware. To load new firmware you must be logged in:

1. Click "Login" at the top right of the page.
2. Enter the User Name "admin"
3. Leave the Password field blank.
4. Click Ok.

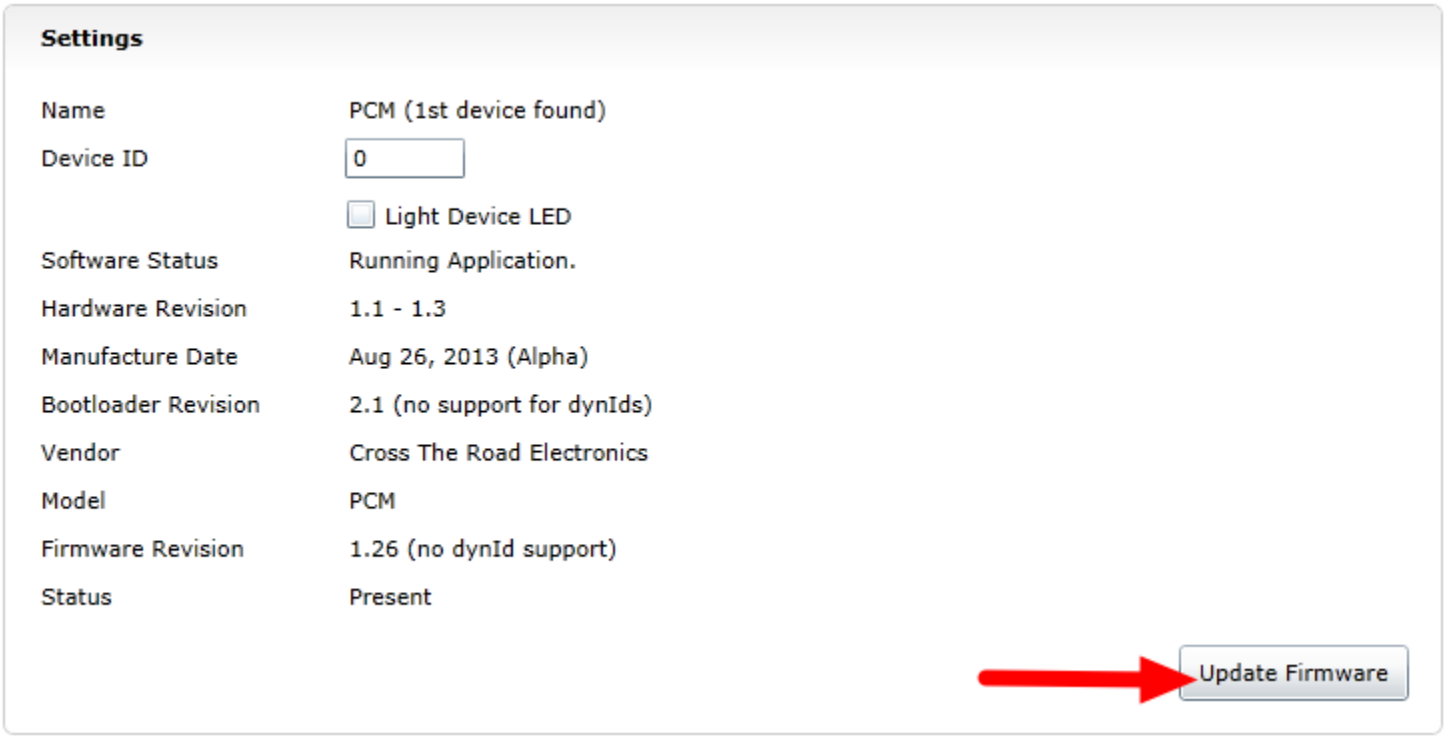
Updating Permissions



If you would like to skip the Login step in the future you can set up Permissions to allow firmware updates:

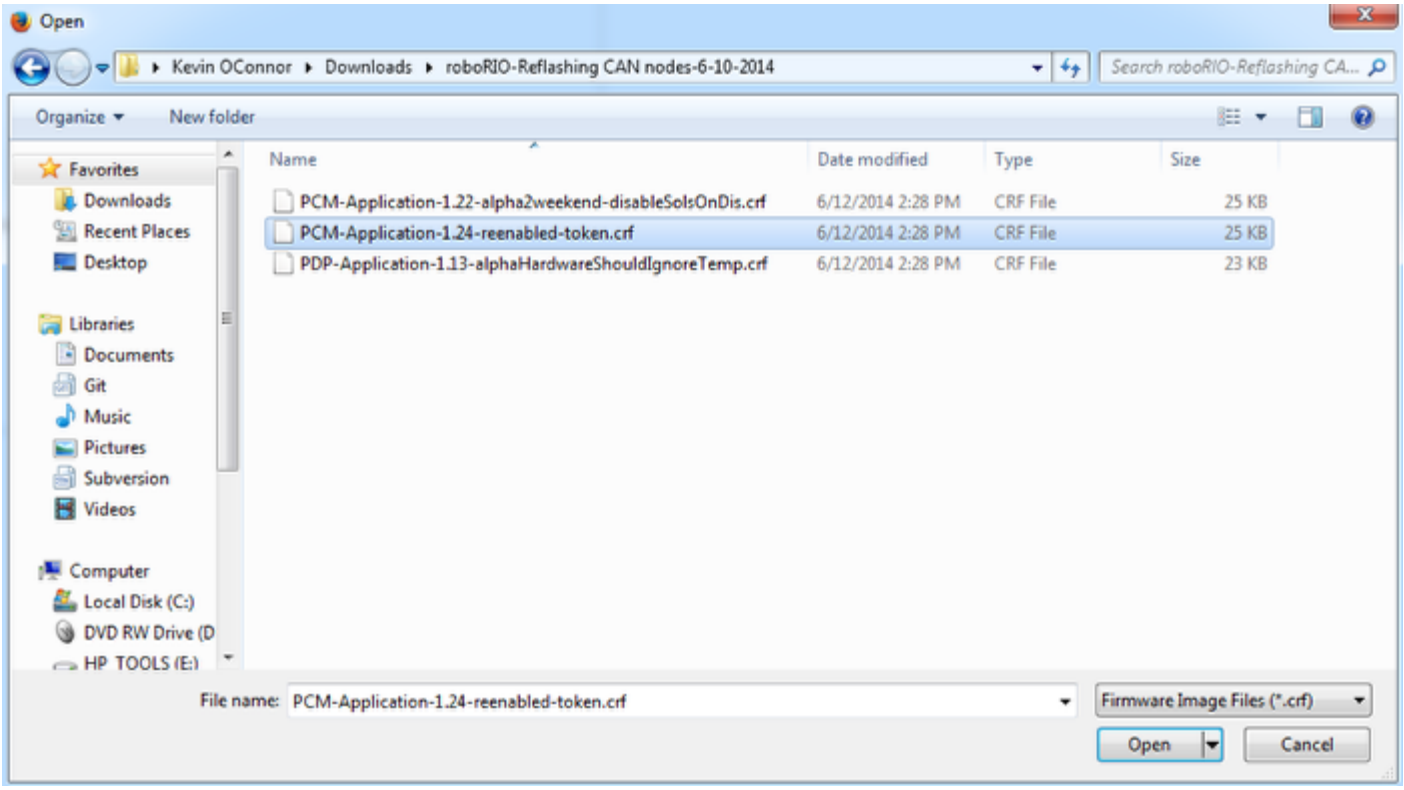
1. Click the Lock Icon in the far left pane.
2. Click the Permissions tab.
3. Select Firmware Update from the list.
4. Click Add below the second large box.
5. Select "everyone"
6. Click Ok.
7. Click Save.

Update Firmware



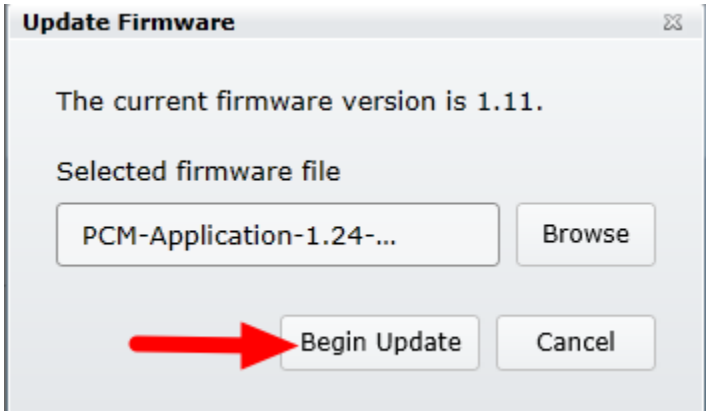
The firmware on a CAN Node is updated from the Setting's page for that node. To update the firmware of a CAN Node, press the Update Firmware button.

Select New Firmware



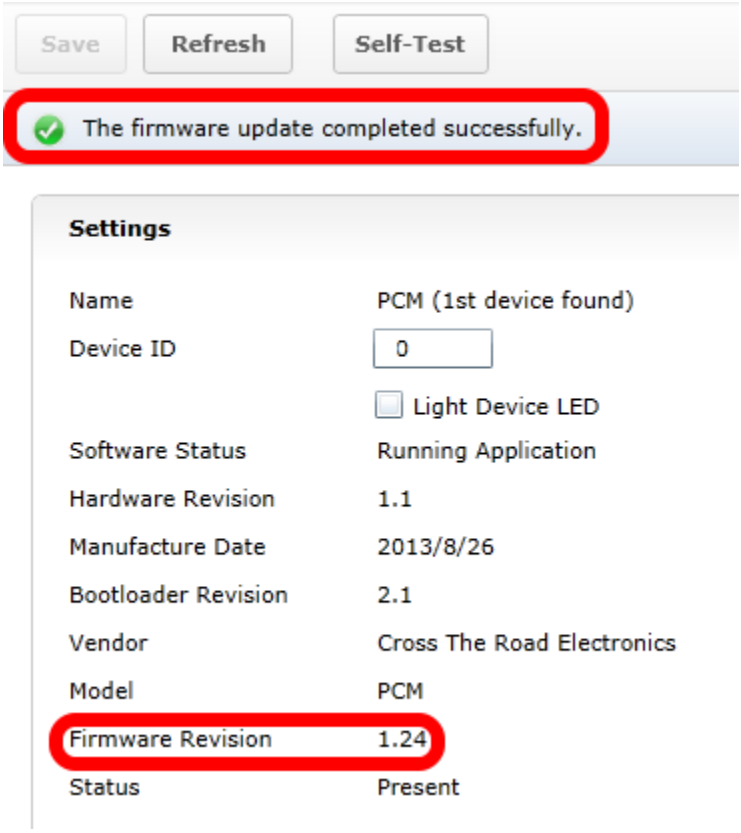
CTRE Devices use a file format call CRF (Cross The Road Firmware). Using the dialog, browse to the correct location on your computer and select the new firmware file, then click Open.

Confirmation



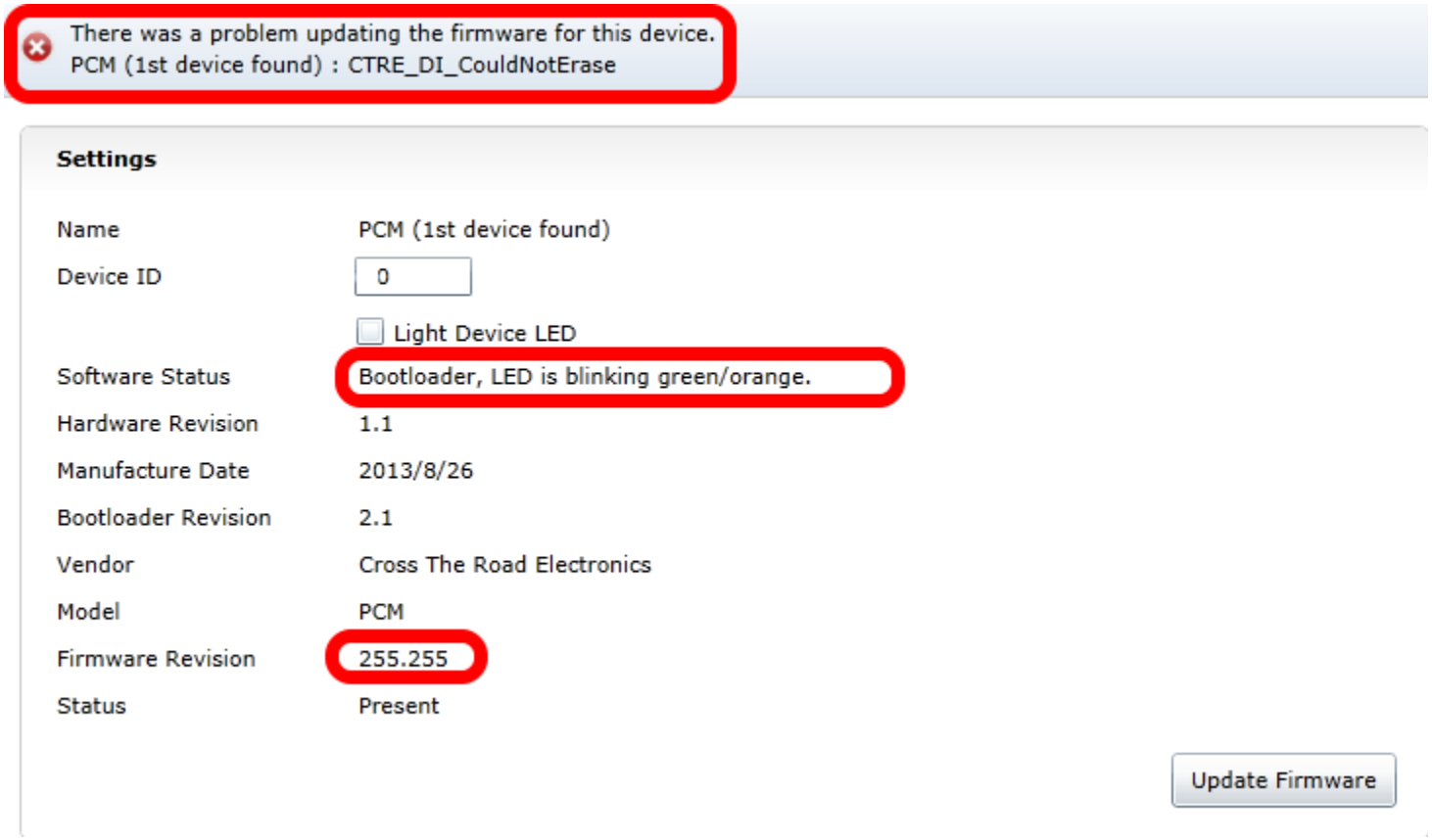
On the dialog that appears, click Begin Update.

Update Complete



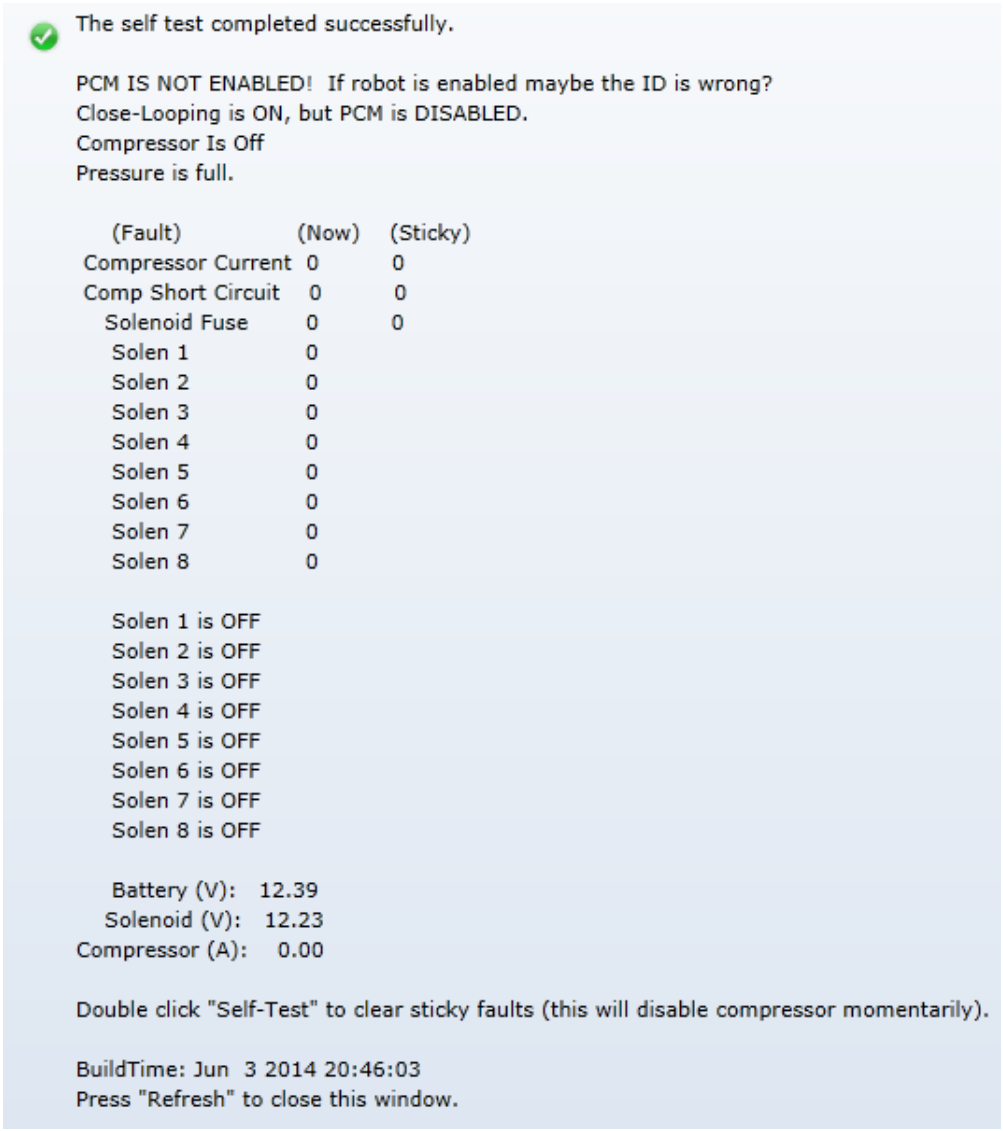
If the update completes successfully, you should see a confirmation message near the top of the page and the Firmware Revision should update to match the new file.

Troubleshooting



Since ten seconds is plenty of time for power/CAN to be disconnected, an error code will be reported if a reflash is interrupted or fails. Additionally the Software Status will report “Bootloader” and Firmware Revision will be 255.255 (blank). If a CAN Device has no firmware, it’s bootloader will take over and blink green/yellow on the device’s corresponding LED. It will also keep it’s device ID, so the RIO can still be used to set device ID and reflash the application firmware (crf). This means you can reflash again using the same web interface (there is no need for a recovery button).

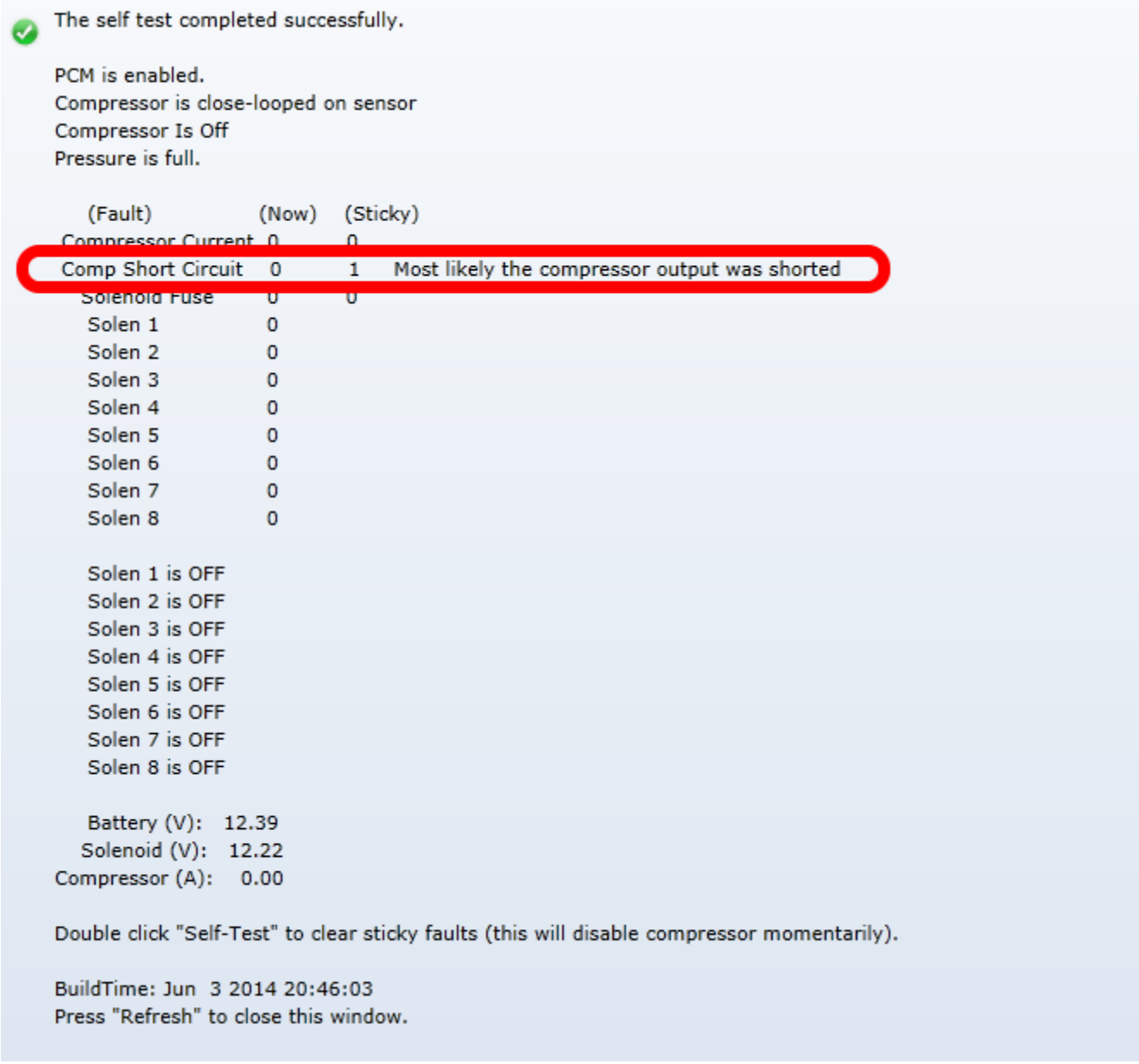
Self-Test



Pressing Self Test will display data captured from CAN Bus at time of press. This can include fault states, sensor inputs, output states, measured battery voltage,etc…

At the bottom of the section, the build time is displayed for checking what firmware revision is installed. The image above is an example of pressing “SelfTest” with PCM. Be sure to check if PCM is ENABLED or DISABLED. If PCM is DISABLED then either the robot is disabled or team code is talking to the wrong PCM device ID (or not talking to the PCM at all).

Sticky Faults

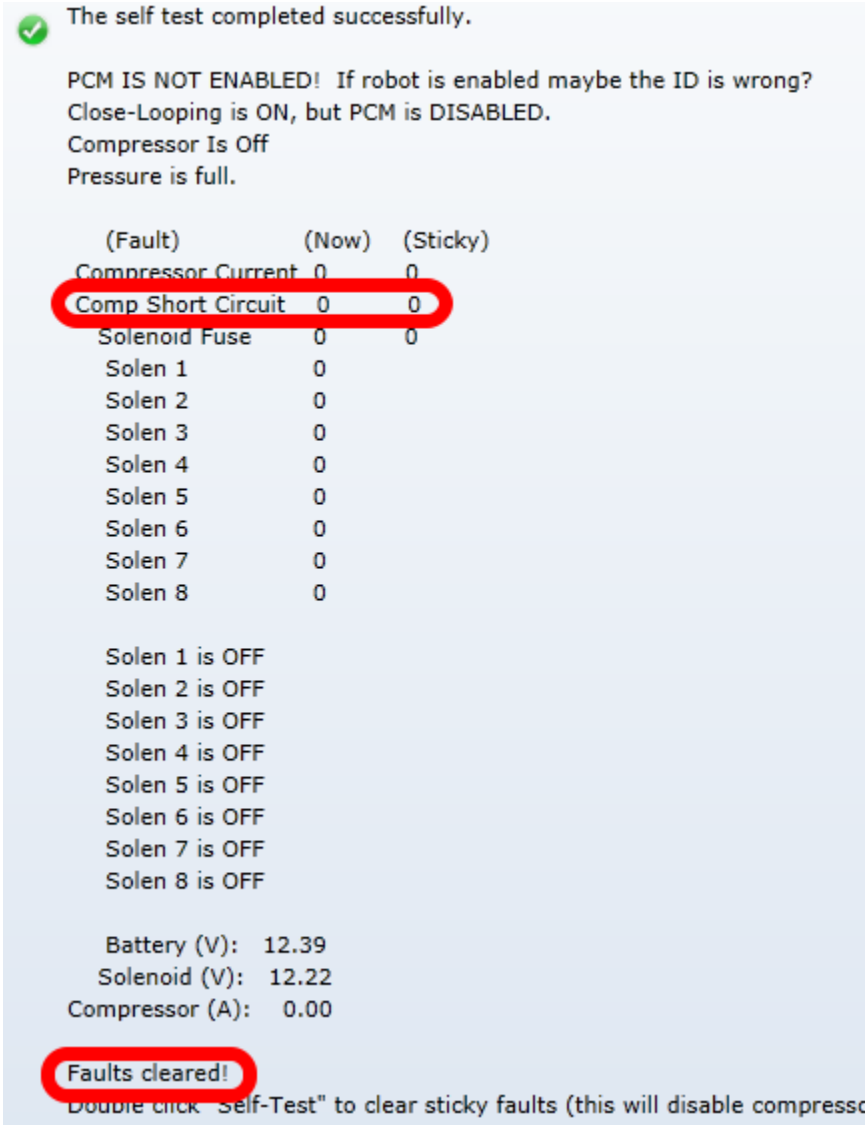


After enabling the robot and repressing “SelfTest” we see the PCM is enabled but an intermittent short on the compressor output reveals itself in a sticky fault.

Sticky faults persist across power cycles. They also cause orange blinks on the device LED. The PCM will orange blink to signal a sticky fault only when the robot is disabled. The PDP will orange blink

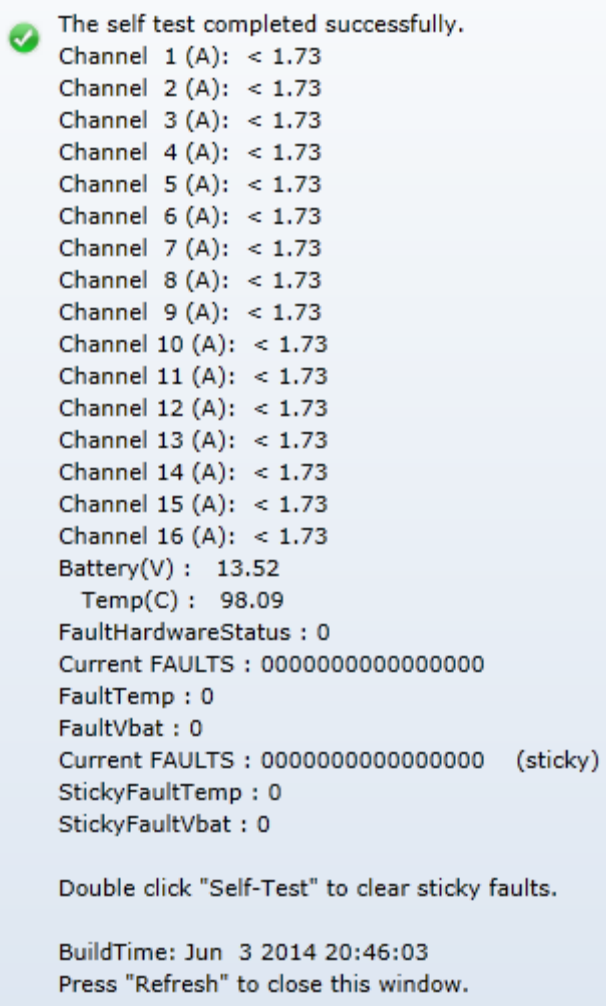
anytime it sees a sticky fault (since PDPs are not output devices they don't care if robot is enabled or not).

Clearing Sticky Faults



To clear Sticky Faults, double click Self Test in a rapid fashion. If the faults don't clear try to triple click the button. The graphical button has a substantial depress time so you will have to get your timing right. Depending on testing we may adjust the thresholding.

PDP Self-Test



Here's an example for PDP. Notice here this PDP sees a temperature of 98.09C (don't worry this board does not have the temp sensor populated). With this firmware, no temp fault is recorded because this hardware revision does not have the temp sensor populated.

PCM Firmware Changelog

PCMApplication1.22alpha2weekenddisableSolsOnDis

- PCM : debounced pressure switch.
- PCM : doubled control frame timeout so that RIO image8 works.
- PCM : Solenoids disabled when robot is disabled.

This is what we ended up with at end of Alpha2 weekend.

PCMApplication1.24reenabledtoken.crf

- Re-turned on tokenization.
- First cut of firm AFTER Alpha2 weekend.
- Doubled the compressor-current-too-high threshold from 17A@50ms to 17A@100ms.

PCM-Application-1.26-ZeroDefaultId

- Compressor current reported from PCM is now averaged so it plots more smoothly. Also makes the selftest reported current not as erratic.
- Increase compressor too high time threshold from 100ms to 500ms.
- PCM and PDP now use default id zero instead of 50/60 respectively. PCM and PDP can be any device ID from 0 to 62. The goal is to have the device ID default zero in all places (webdash, Java/C++/Labview).

PCM-Application-1.52-beta

- Support for Beta PDPs and PCMs.
- Better solenoid short detection when in 24V mode. Previous versions PCM might reset before it got a chance to disable/blacklist solenoid output when in 24V mode and solenoid output is shorted.
- Solenoid bits are flipped in PCM's control, status, and fault bit fields. now bit0 corresponds to solenoid0, and bit7 corresponds to solenoid7.
- This update supports Alpha and Beta hardware. Though if you're using Alpha hardware, you probably will want to keep the device ID at '1' instead of '0'. This is because reflashing can be cumbersome when the device enters bootloader. See **Functional Limitations.**
- Beta hardware supports dynamic Ids. This is a feature where if multiple nodes has the same ID (zero for example, which is default from production) the web interface handles this gracefully by letting you know there are multiple devices with one ID. See Section 5 for more details. Alpha hardware also supports this to a degree if it is has latest firmware. The bootloader in Alpha hardware does not support it however. The webdash will report this(does not support dynIds) to remind you.

PDP Firmware Changelog

PDPApplication1.13alphaHardwareShouldIgnoreTemp.crf

- First cut of firm AFTER Alpha2 weekend.

- If hardware rev is 1.0 than ignore temp sensor (Since it wasn't populated). Otherwise PDP blinks orange and keeps getting temperature faults.

PDP-Application-1.14-ZeroDefaultId

- PCM and PDP now use default id zero instead of 50/60 respectively. PCM and PDP can be any device ID from 0 to 62. The goal is to have the device ID default zero in all places (webdash, Java/C++/Labview).

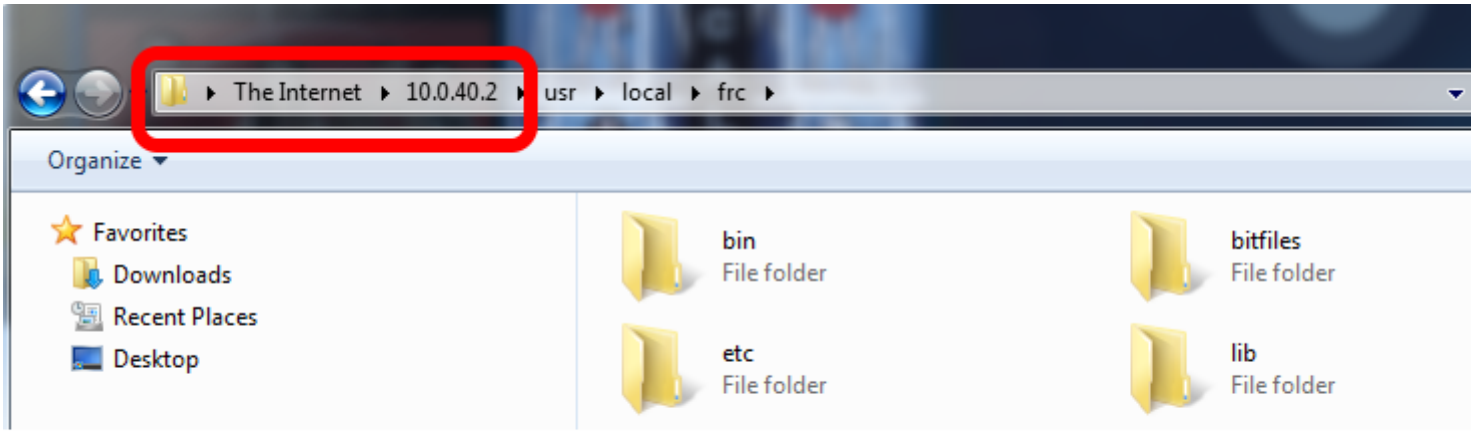
PDP-Application-1.30-beta

- support for Beta PDPs and PCMs.
- This update supports Alpha and Beta hardware. Though if you're using Alpha hardware, you probably will want to keep the device ID at '1' instead of '0'. This is because reflashing can be cumbersome when the device enters bootloader. See **Functional Limitations.**
- Beta hardware supports dynamic Ids. This is a feature where if multiple nodes has the same ID (zero for example, which is default from production) the web interface handles this gracefully by letting you know there are multiple devices with one ID. See Section 5 for more details. Alpha hardware also supports this to a degree if it is has latest firmware. The bootloader in Alpha hardware does not support it however. The webdash will report this(does not support dynIds) to remind you

(Optional) Installing roboRIO Plugin

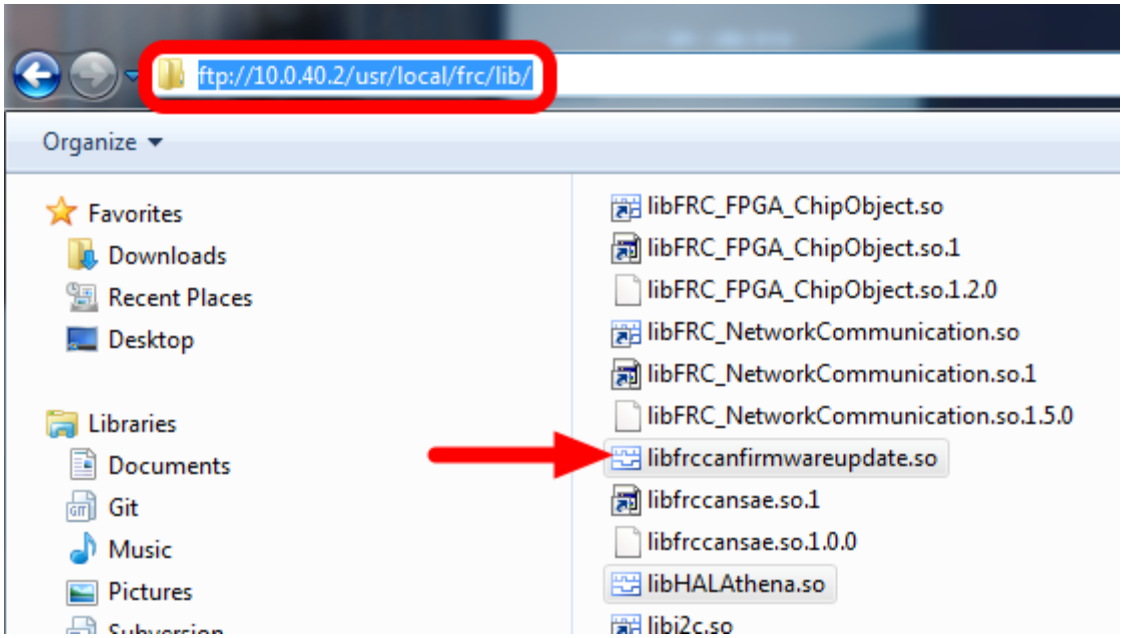
Starting with roboRIO Image v10, the CAN firmware plugin is included in the roboRIO image. As changes are made to this plugin, new versions may continue to be included in the firmware ZIP files and users may wish to update the version on their roboRIO by following the instructions below.

FTP to the roboRIO



Use FTP to navigate to the /usr/local/frc folder on the roboRIO. The example above shows this using Windows Explorer and a roboRIO with the IP 10.0.40.2. If connected over USB your roboRIO IP will be 172.22.11.2, otherwise use the mDNS name roboRIO-####.local where #### is your team number with no leading zeroes (ex. roboRIO-190.local or roboRIO-40.local)

Copy FRC CAN Firmware Update library



Navigate to /usr/local/frc and then open the "lib" folder. Copy "libfrccanfirmwareupdate.so" from the download package to this folder.

Reboot the roboRIO

Reboot your roboRIO to allow the plugin to be loaded.

Status Light Quick Reference

Many of the components of the FRC Control System have indicator lights that can be used to quickly diagnose problems with your robot. This guide shows each of the hardware components and describes the meaning of the indicators. Photos and information from Innovation FIRST and Cross the Road Electronics.

Robot Signal Light (RSL)

- Solid ON - Robot On and Disabled
- Blinking - Robot On and Enabled
- Off - Robot Off, roboRIO not powered or RSL not wired properly.

RoboRIO

Power

- Green - Power is good
- Amber - Brownout protection tripped, outputs disabled
- Red - Power fault, check user rails for short circuit

Status

- On while the controller is booting, then should turn off
- 2 blinks - Software error, reimage roboRIO
- 3 blinks - Safe Mode, restart roboRIO, reimage if not resolved
- 4 blinks - Software crashed twice without rebooting, reboot roboRIO, reimage if not resolved
- Constant flash or stays solid on - Unrecoverable error

Radio

Not currently implemented

Comm

- Off - No Communication
- Red Solid - Communication with DS, but no user code
- Red Blinking - E-stop
- Green Solid - Good communication with DS

Mode

- Off - Outputs disabled (robot in Disabled, brown-out, etc.)
- Green - Autonomous Enabled
- Amber/Orange - Teleop Enabled
- Red - Test Enabled

RSL

See above

Power Distribution Panel

LED Fault Table

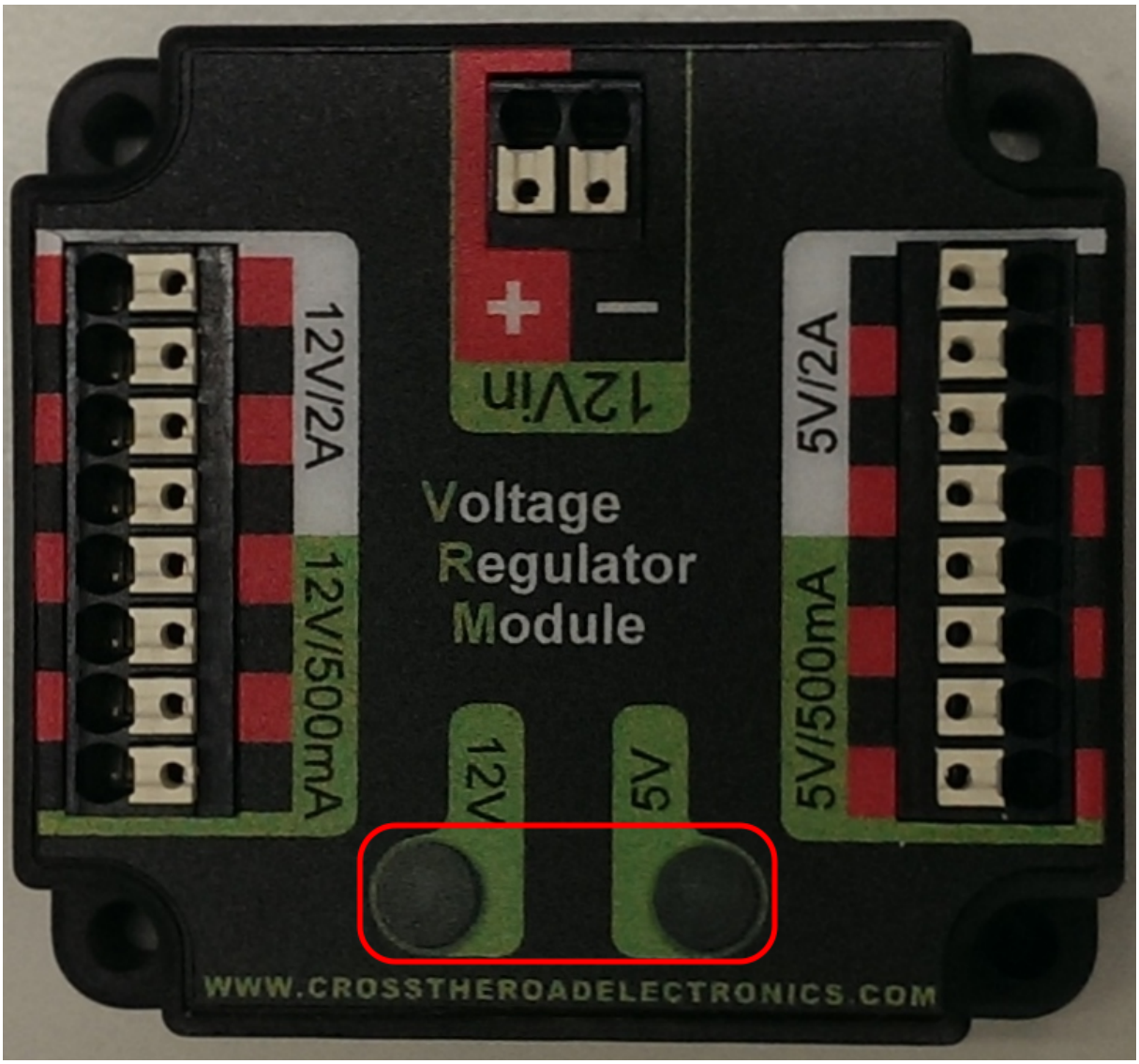
LED	Strobe	Slow	Long
Green	No Fault - Robot Enabled	No Fault - Robot Disabled	NA
Orange	NA	Sticky Fault	NA
Red	NA	No CAN Comm	NA

*If PCM LED contains more than one color, see LED Special States Table

LED Special States Table

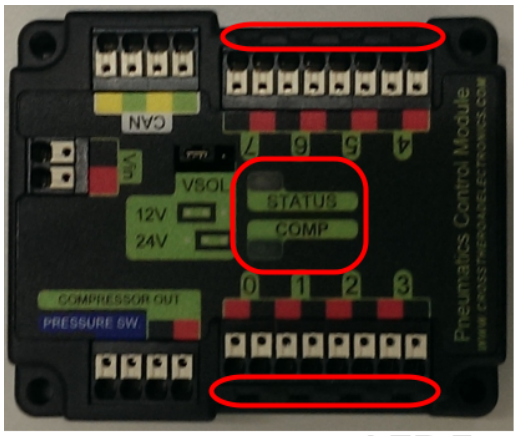
LED Colors	Problem
Red/ Orange	Damaged Hardware
Green/ Orange	In Bootloader
No LED	No Power / Incorrect Polarity

Voltage Regulator Module



The status LEDs on the VRM indicate the state of the two power supplies. If the supply is functioning properly the LED should be lit bright green. If the LED is not lit or is dim, the output may be shorted or drawing too much current.

Pneumatics Control Module



LED Fault Table

LED	Strobe	Slow	Long
Green	No Fault - Robot Enabled	No Fault - Robot Disabled	NA
Orange	NA	Sticky Fault	NA
Red	NA	No CAN Comm OR Solenoid Fault (Blinks Solenoid Index)	Compressor Fault

*If PCM LED contains more than one color, see LED Special States Table

LED Special States Table

LED Colors	Problem
Red/ Orange	Damaged Hardware
Green/ Orange	In Bootloader
No LED	No Power / Incorrect Polarity

Solenoid Channel LEDs - These LEDs are lit red if the Solenoid channel is enabled and not lit if it is disabled.

Comp - This is the Compressor LED. This LED is green when the compressor output is active (compressor is currently on) and off when the compressor output is not active.

Status - The status LED indicates device status as indicated by the two tables above. For more information on resolving PCM faults see the PCM User Manual. Note that the No CAN Comm fault will

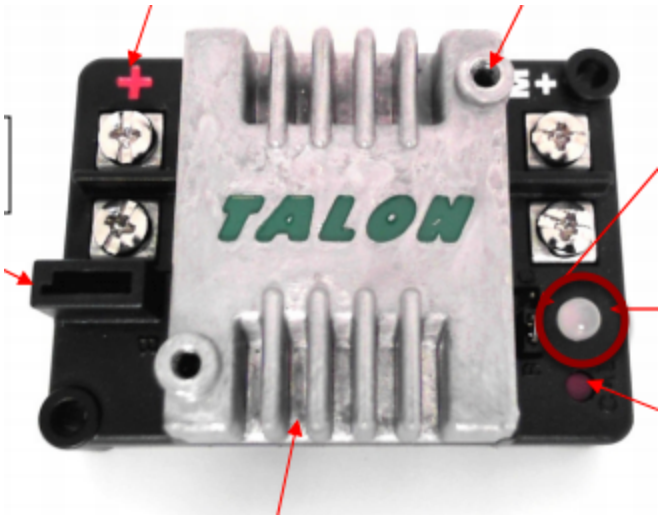
not occur only if the device cannot see communicate with any other device, if the PCM and PDP can communicate with each other, but not the roboRIO you will NOT see a No Can Comm fault.

Jaguar speed controllers

LED State	Module Status
Normal Operating Conditions	
Solid Yellow	Neutral (speed set to 0)
Fast Flashing Green	Forward
Fast Flashing Red	Reverse
Solid Green	Full-speed forward
Solid Red	Full-speed reverse
Fault Conditions	
Slow Flashing Yellow	Loss of servo or Network link
Fast Flashing Yellow	Invalid CAN ID
Slow Flashing Red	Voltage, Temperature, or Limit Switch fault condition
Slow Flashing Red and Yellow	Current fault condition

LED State	Module Status
Calibration Conditions	
Fast Flashing Red and Green	Calibration mode active
Fast Flashing Red and Yellow	Calibration mode failure
Slow Flashing Green and Yellow	Calibration mode success
Slow Flashing Red and Green	Calibration mode reset to factory default settings success
Other Conditions	
Slow Flashing Green	Waiting in CAN Assignment mode

Talon speed controllers



The LED is used to indicate the direction and percentage of throttle and state of calibration. The LED may be one of three colors; red, orange or green. A solid green LED indicates positive output voltage equal to the input voltage of the Talon. A solid Red LED indicates an output voltage that is equal to the input voltage multiplied by -1(input voltage = 12 volts, output equals -12 volts). The LED will blink it's corresponding color for any throttle less than 100% (red indicates negative polarity, green indicates positive). The rate at which the led blinks is proportional to the percent throttle. The faster the LED blinks the closer the output is to 100% in either polarity.

The LED will blink orange any time the Talon is in the disabled state. This will happen if the PWM input signal is lost, or in FRC, when the robot is disabled. If the Talon is in the enabled state and the throttle is within the 4% dead band, the LED will remain solid orange.

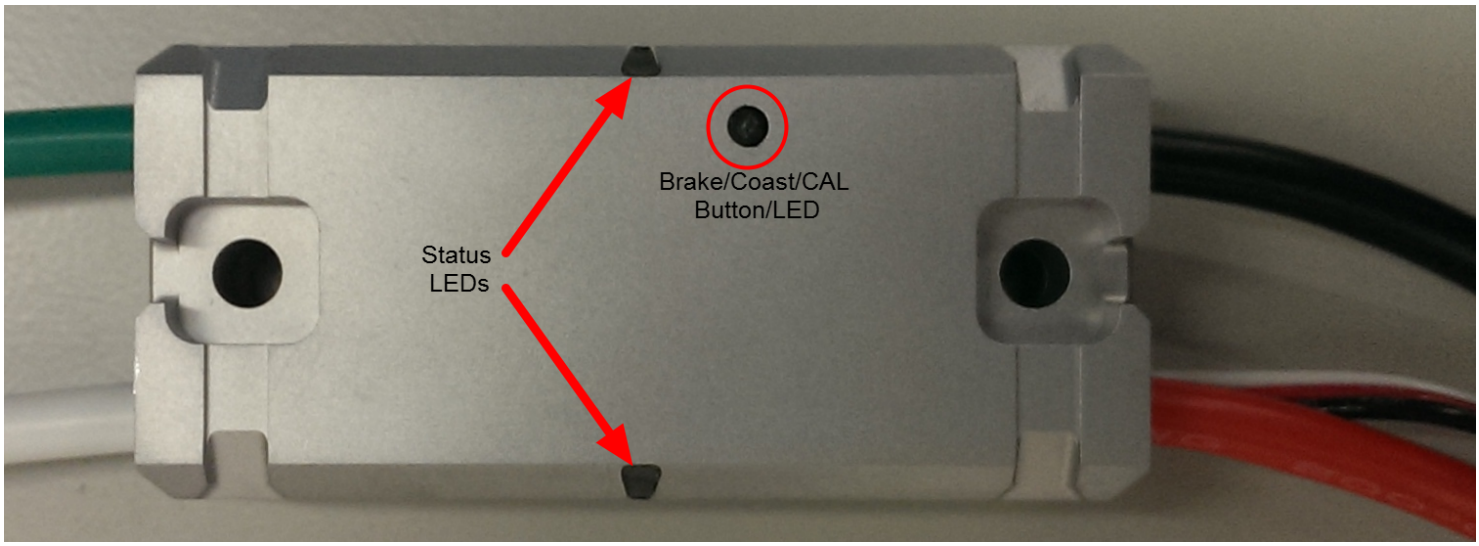
Flashing Red/Green indicate ready for calibration. Several green flashes indicates successful calibration, and red several times indicates unsuccessful calibration.

Victor speed controllers

LED Indicator Status:

Green - full forward
Orange - neutral / brake
Red - full reverse
Flashing orange - no PWM signal
Flashing red/green - calibration mode
Flashing green - successful calibration
Flashing red - unsuccessful calibration

Victor-SP speed controllers



Brake/Coast/Cal Button/LED - Red if the controller is in brake mode, off if the controller is in coast mode

Status

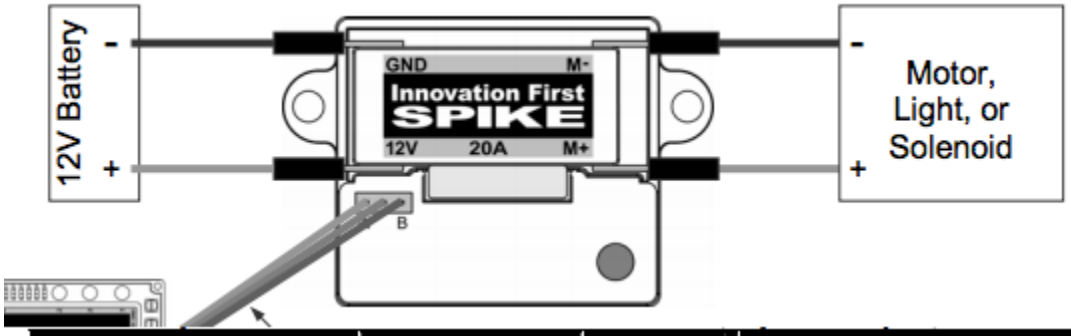
The Status LEDs are used to indicate the direction and percentage of throttle and state of calibration. The LEDs may be one of three colors; red, orange or green. Solid green LEDs indicate positive output voltage equal to the input voltage of the Victor-SP. Solid Red LEDs indicate an output voltage that is equal to the input voltage multiplied by -1(input voltage = 12 volts, output equals -12 volts). The LEDs will blink in the corresponding color for any throttle less than 100% (red indicates negative polarity, green indicates positive). The rate at which the LEDs blink is proportional to the percent throttle. The faster the LEDs blink the closer the output is to 100% in either polarity.

The LEDs will blink orange any time the Victor-SP is in the disabled state. This will happen if the PWM input signal is lost, or in FRC, when the robot is disabled. If the Victor-SP is in the enabled state and the throttle is within the 4% dead band, the LED will remain solid orange.

Flashing Red/Green indicate ready for calibration. Several green flashes indicates successful calibration, and red several times indicates unsuccessful calibration.

Talon-SRX speed controllers

Spike relay configured as a motor, light, or solenoid switch

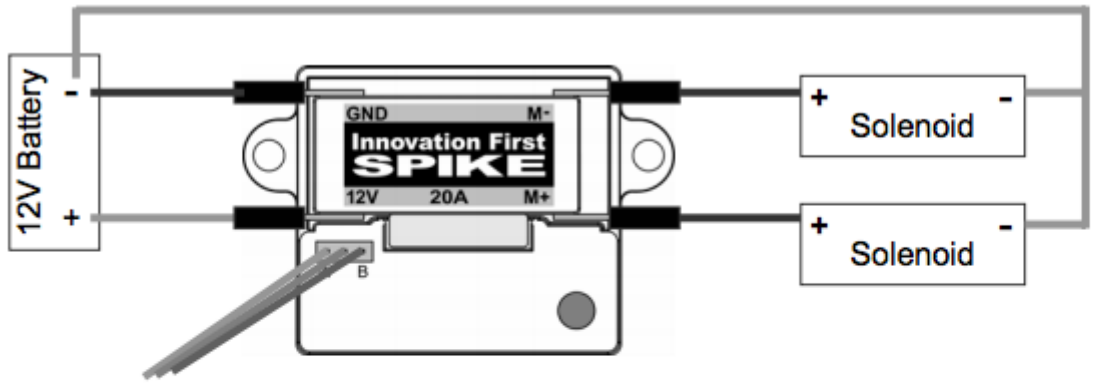


INPUTS		OUTPUTS			
Fwd(Wht)	**Rev(Red)**	**M+**	**M-**	**Indicator**	**Motor Function**
0	0	GND	GND	Orange	OFF / Brake Condition (default)
1	0	+12v	GND	Green	Motor rotates in one direction
0	1	GND	+12v	Red	Motor rotates in opposite direction
1	1	+12v	+12v	Off	OFF / Brake Condition

Notes:

1. 'Brake' refers to the dynamic stopping of the motor due to the shorting of the motor inputs. This condition is not optional when going to an off state.
2. The INPUT Fwd and Rev are defined as follows: 0 (Off) and 1 (On).

Spike relay configured as for one or two solenoids



INPUT		OUTPUTS			
Fwd(Wht)	**Rev(Red)**	**M+**	**M-**	**Indicator**	**Solenoid Function**
0	0	GND	GND	Orange	Both Solenoids OFF (default)
1	0	+12v	GND	Green	Solenoid connected to M+ is ON
0	1	GND	+12v	Red	Solenoid connected to M- is ON
1	1	+12v	+12v	Off	Both Solenoids ON

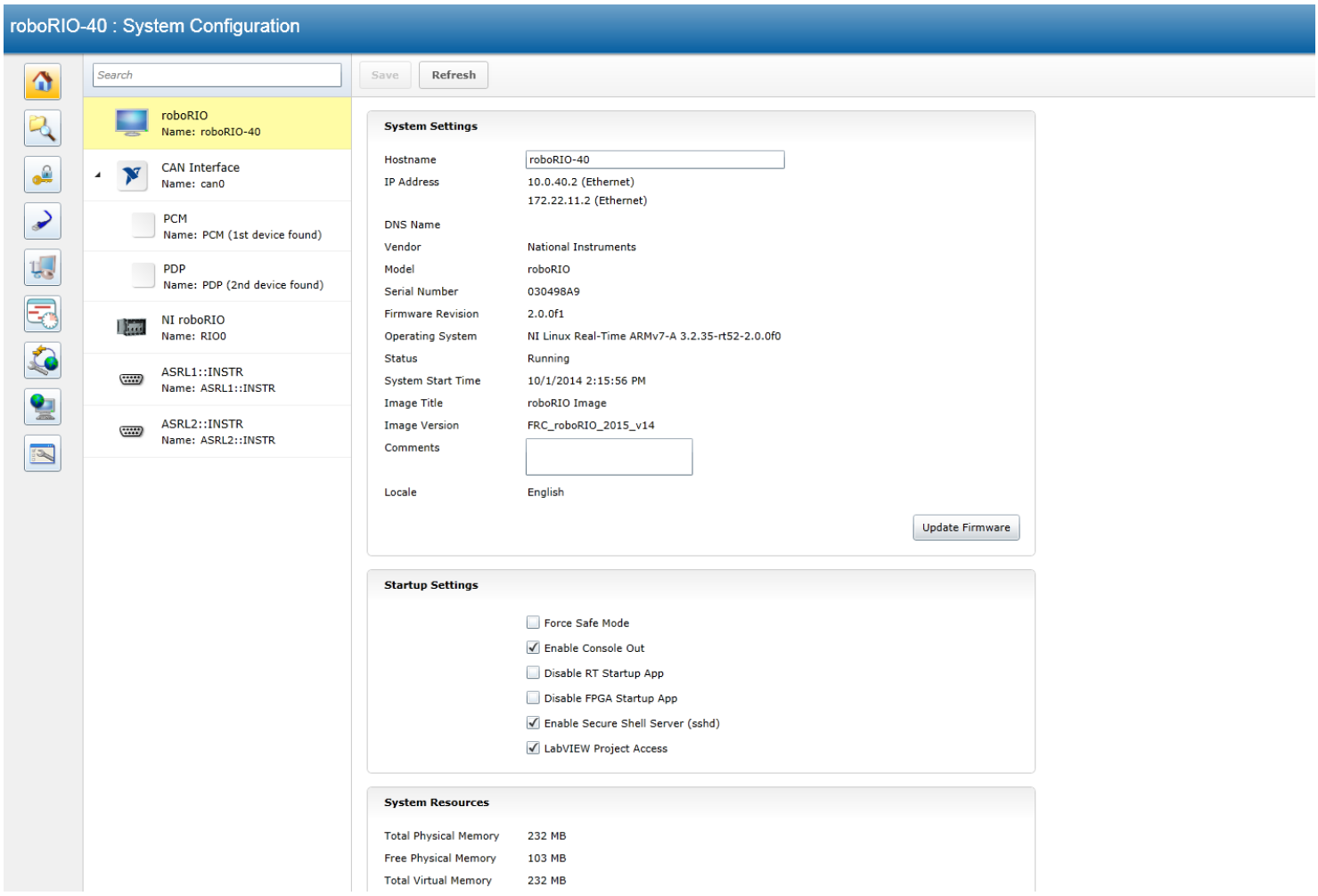
Note:

1. The INPUT Fwd and Rev are defined as follows: 0 (Off) and 1 (On).

RoboRIO Webdashboard

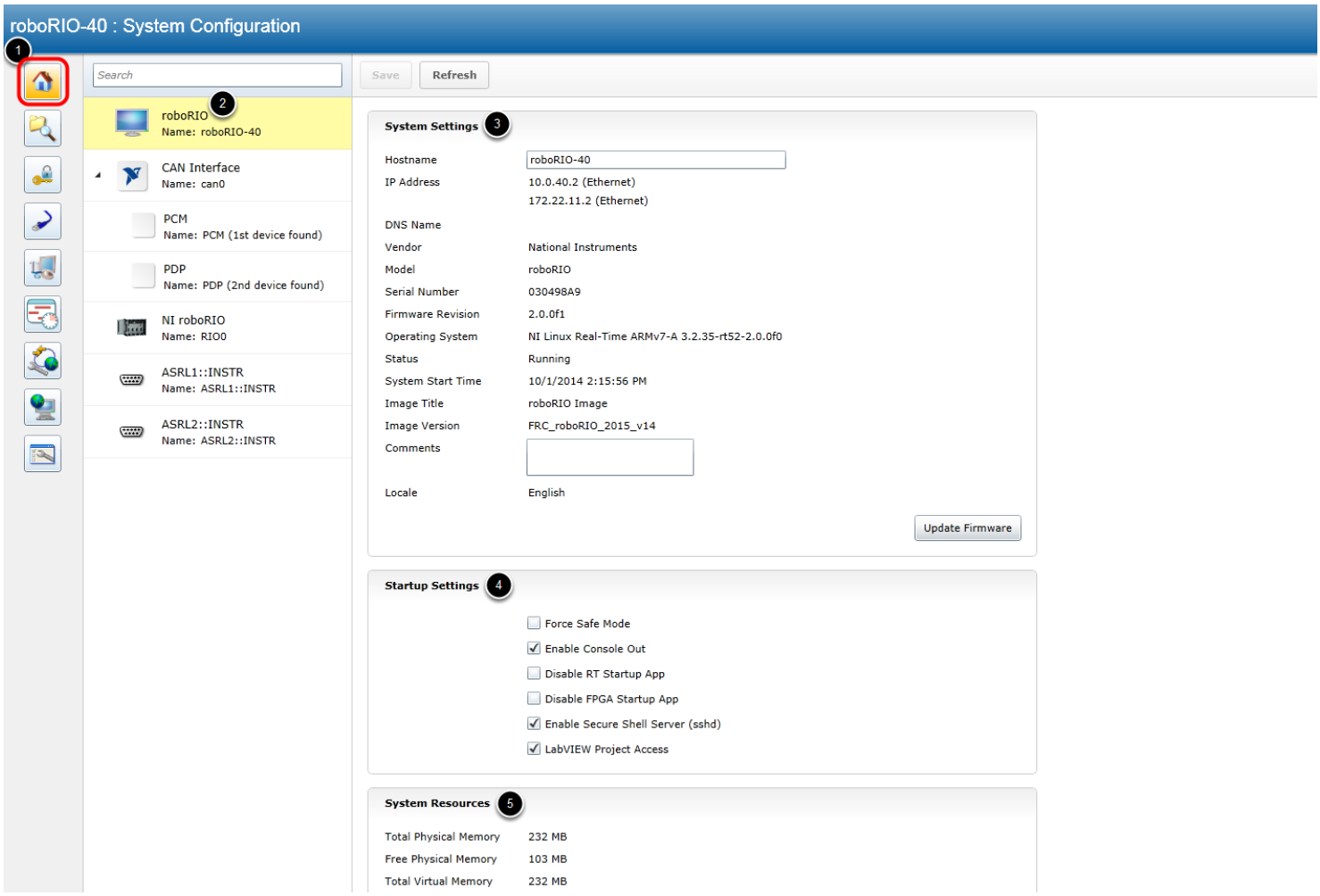
The roboRIO web dashboard is a webpage built into the roboRIO that can be used for checking status and updating settings of the roboRIO.

Opening the WebDash



To open the myRIO web dashboard, open a web browser and enter the address of the roboRIO into the address bar (172.22.11.2 for USB, or "roboRIO-####.local where #### is your team number, with no leading zeroes, for either interface). See this document for more details about mDNS and roboRIO networking: RoboRIO Networking

Home Tab



The home tab of the web dashboard has 5 main sections:

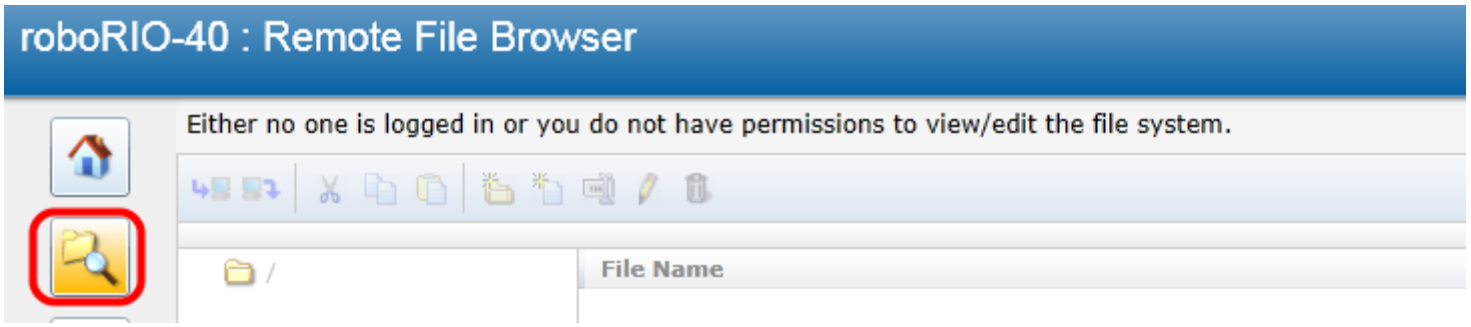
1. Navigation Bar - This section allows you to navigate to different sections of the web dashboard. The different pages accessible through this navigation bar are discussed below.
2. Device listing - This section lists out the roboRIO devices. The primary use of this section is for selecting and configuring CAN devices as shown on this page: Updating and Configuring Pneumatics Control Module and Power Distribution Panel
3. System Settings - This section contains information about the System Settings. The Hostname field should not be modified manually use the roboRIO Imaging tool to set the Hostname based on your team number. This section contains information such as the device IP, firmware version and image version.

4. Startup Settings - This section contains Startup settings for the roboRIO. These are described in the sub-step below
5. System Resources - This section provides a snapshot of system resources such as memory and CPU load.

Startup Settings

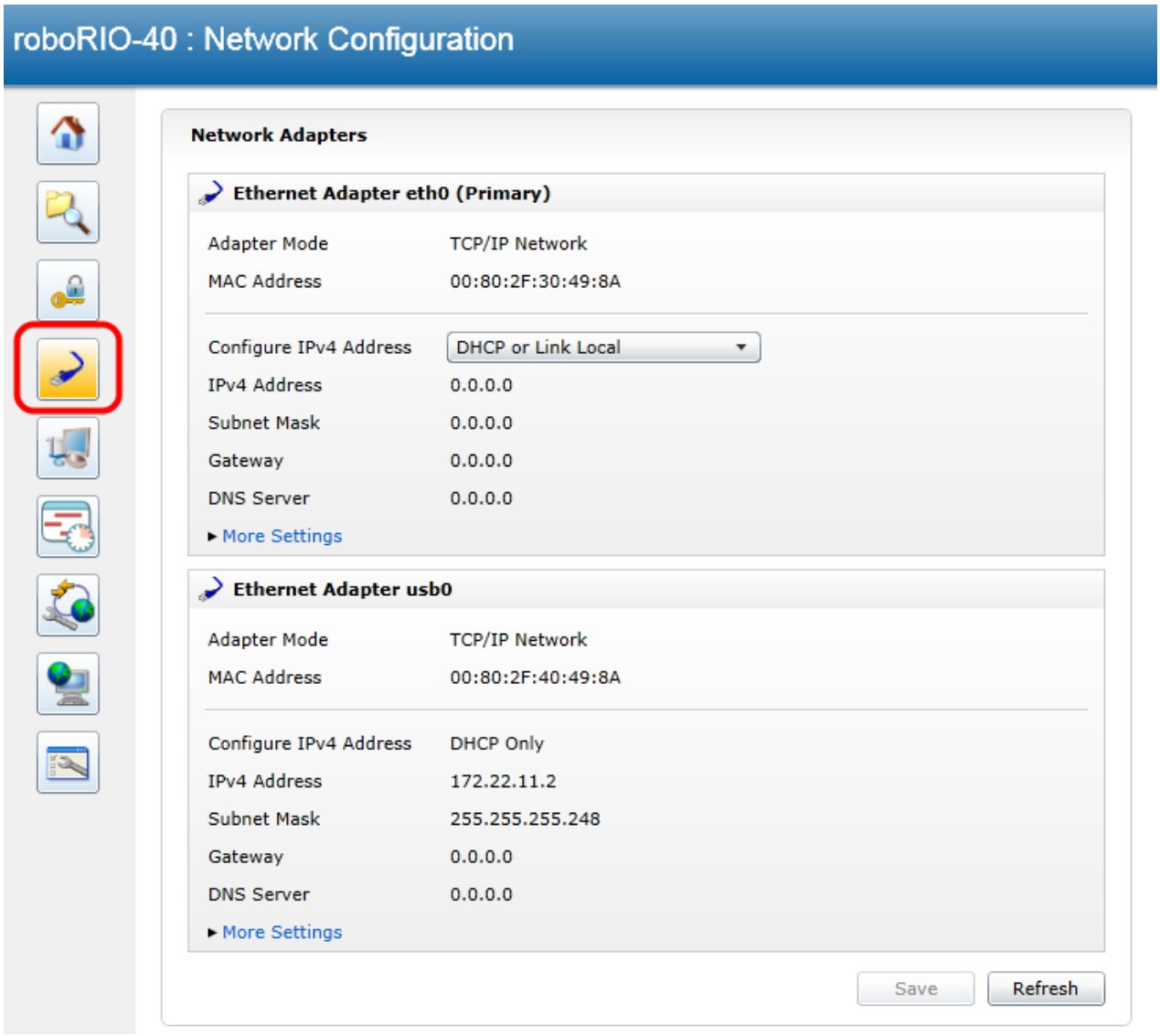
- Force Safe Mode - Forces the controller into Safe Mode. This can be used with troubleshooting imaging issues, but it is recommended to use the Reset button on the roboRIO to put the device into Safe Mode instead (with power already applied, hold the rest button for 5 seconds). **Default is unchecked.**
- Enable Console Out - This enables the on-board RS232 port to be used as a Console output. It is recommended to leave this enabled unless you are using this port to talk to a serial device (note that this port uses RS232 levels and and should not be connected to many microcontrollers which use TTL levels). **Default is checked.**
- Disable RT Startup App - Checking this box disables code from running at startup. This may be used for troubleshooting if you find the roboRIO is unresponsive to new program download. **Default is unchecked**
- Disable FPGA Startup App - **This box should not be checked.**
- Enable Secure Shell Server (sshd) - **It is recommended to leave this box checked.** This setting enables SSH which is a way to remotely access a console on the roboRIO. Unchecking this box will prevent C++ and Java teams from loading code onto the roboRIO using the Eclipse plugins.
- LabVIEW Project Access - **It is recommended to leave this box checked.** This setting allows LabVIEW projects to access the roboRIO.

Remote File Browser



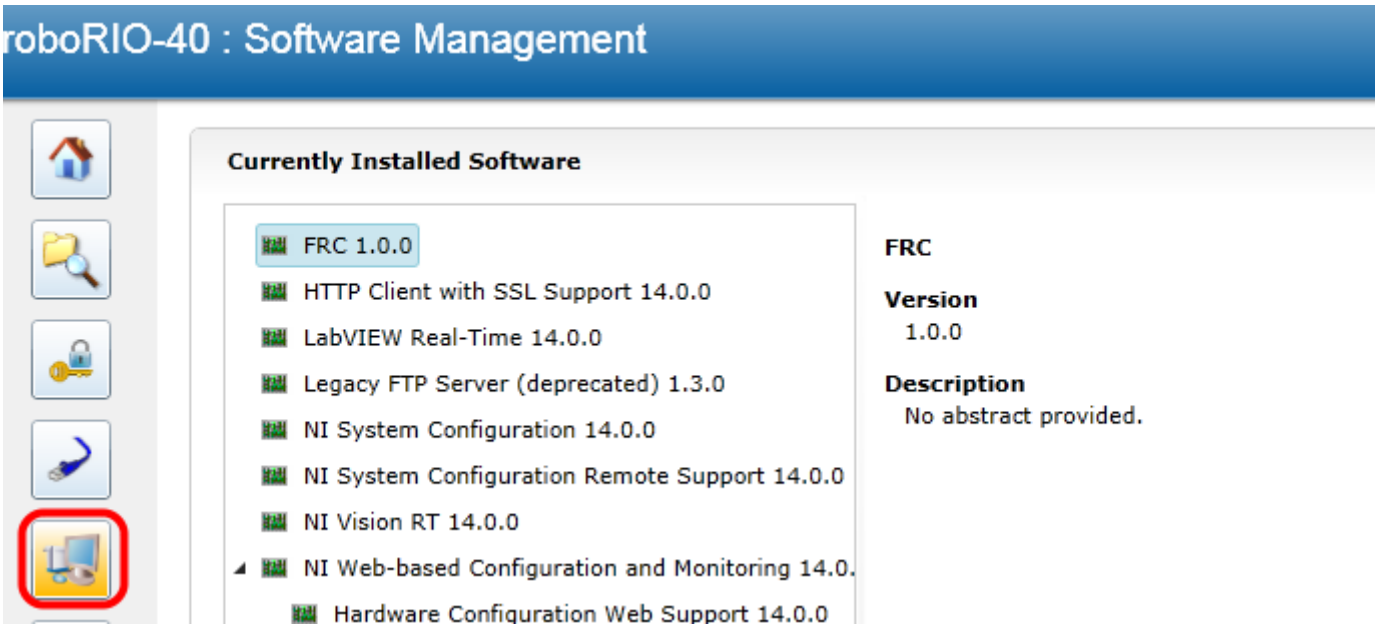
Using the Remote File Browser requires setting a password for the admin account, which is not recommended (it will break C++ and Java program download/execution). Use FTP instead.

Network Configuration



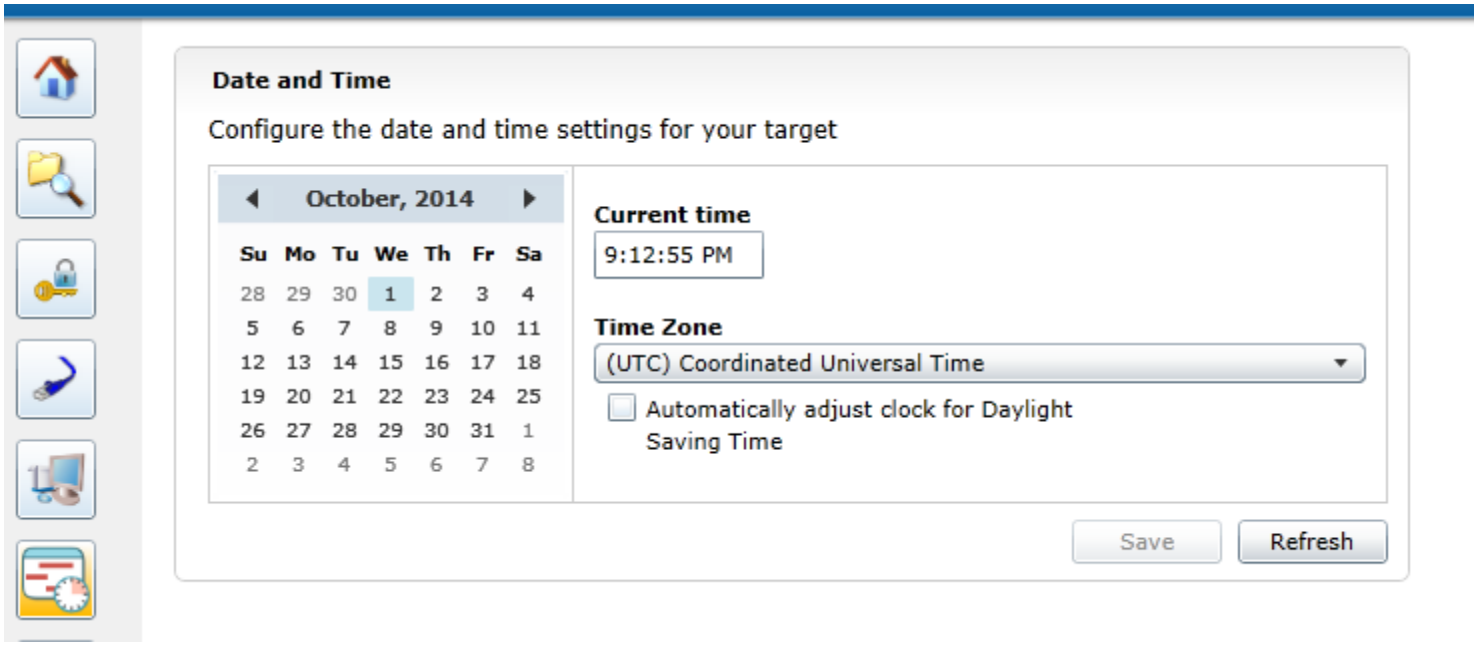
This page shows the configuration of the roboRIO's network adapters. **It is not recommended to change any settings on this page.** For more information on roboRIO networking see this article: [RoboRIO Networking]

Software Management



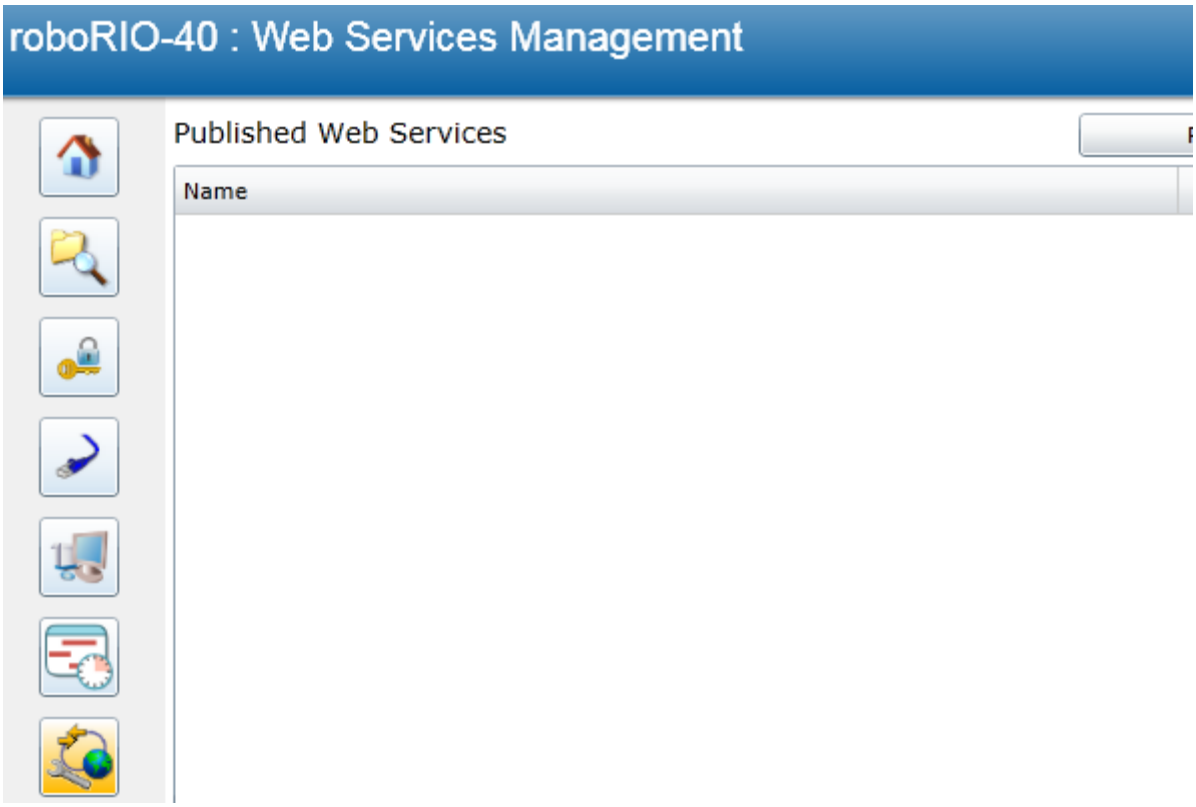
This tab shows the NI software installed on the roboRIO. **It is not recommended to make any changes on this page.**

Time Configuration



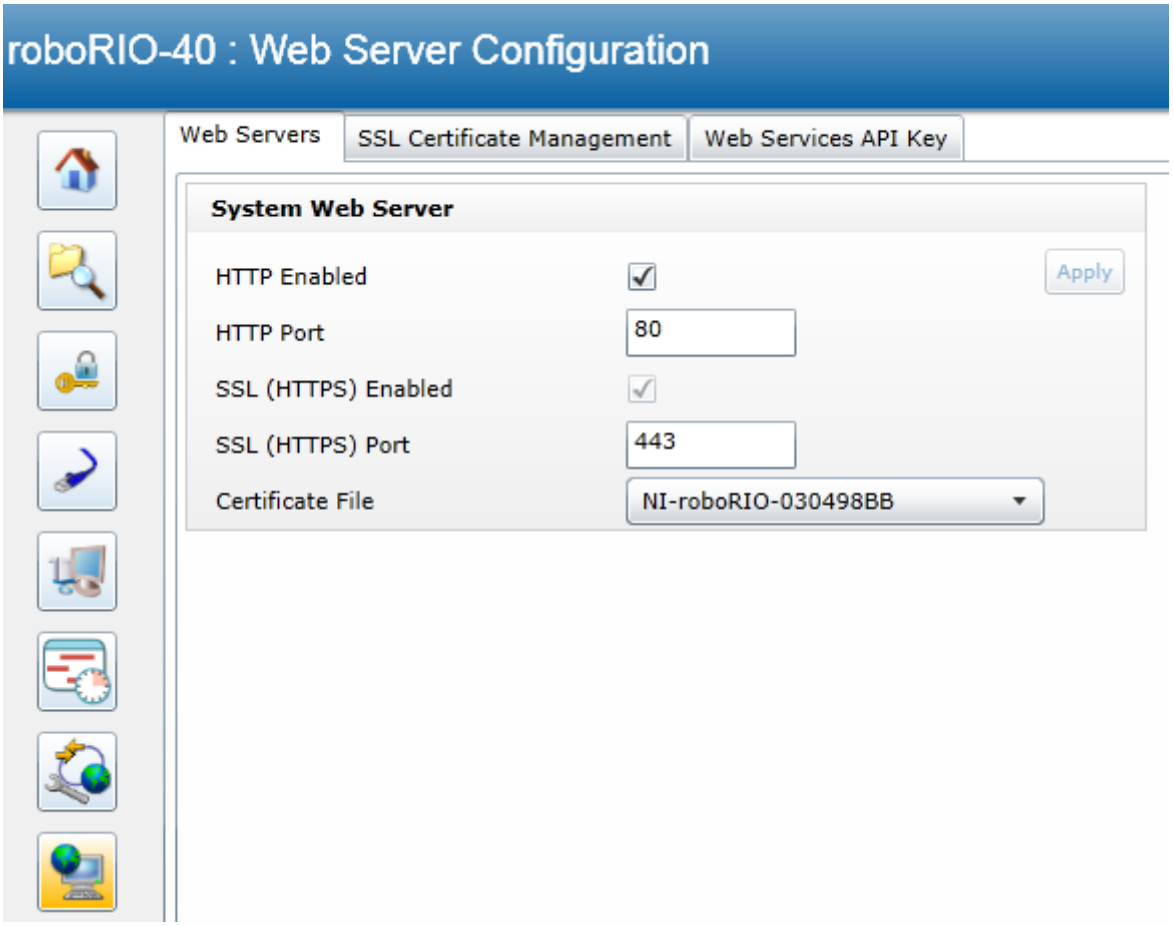
The roboRIO has no battery backup so time configuration is lost each time the device boots. **It is not recommended to make any changes on this page.**

Web Services Managaement



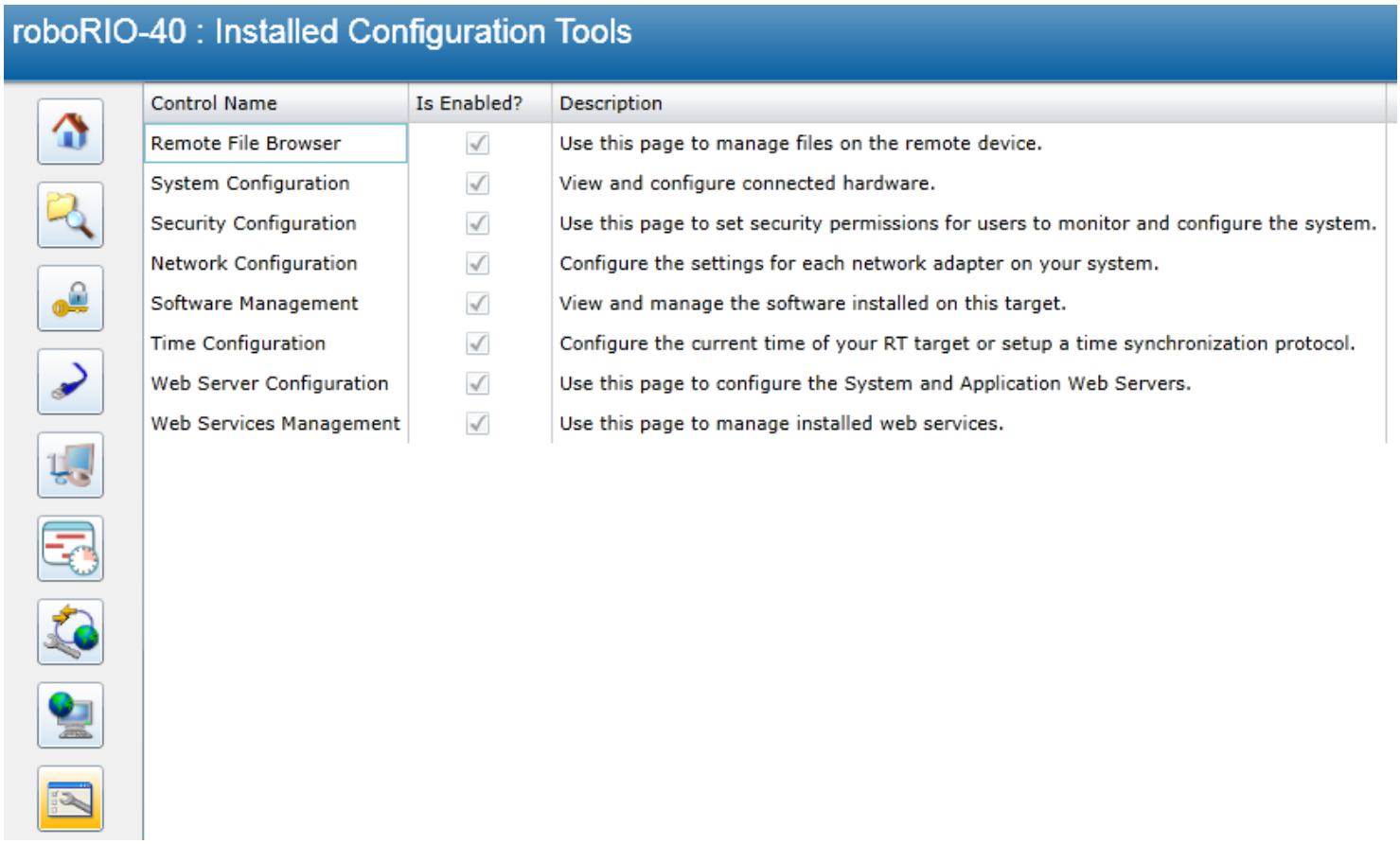
This section shows the Web Services running on the roboRIO. **It is not recommended to make any changes on this page.**

Web Server Configuration



This page shows the configuration of the roboRIO webserver. **It is not recommended to make any changes on this page.**

Installed Configuration Tools



This page shows the configuration tools installed and enabled on the roboRIO. **It is not recommended to make any changes on this page.**