2CAN User Manual

Rev 1.5 (2CAN and 2CAN 2.0)

Cross the Road Electronics, LLC

www.crosstheroadelectronics.com

Device Overview

Multi-Color Status LED

Wide Supply Voltage Range 6.5-28V

Dual Port Ethernet Switch

RJ 11 6p/4c CAN Connector

Rugged Plastic Enclosure with Mounting Tabs

Push-in Type Power Connector 6.5-28 VDC

1) What is a 2CAN?

A 2CAN is an embedded device that allows teams to use CAN (Controller Area Network) devices on the FIRST cRIO based control system. The intent is to provide a CAN solution to FIRST robotics teams without having to implement expensive or complicated solutions. 2CAN is a great solution for quickly using CAN devices like the Jaguar speed controller. Teams interested in learning the finer details of CAN, or communicating with custom CAN modules will also benefit from the 2CAN.

2) What can you do with the 2CAN

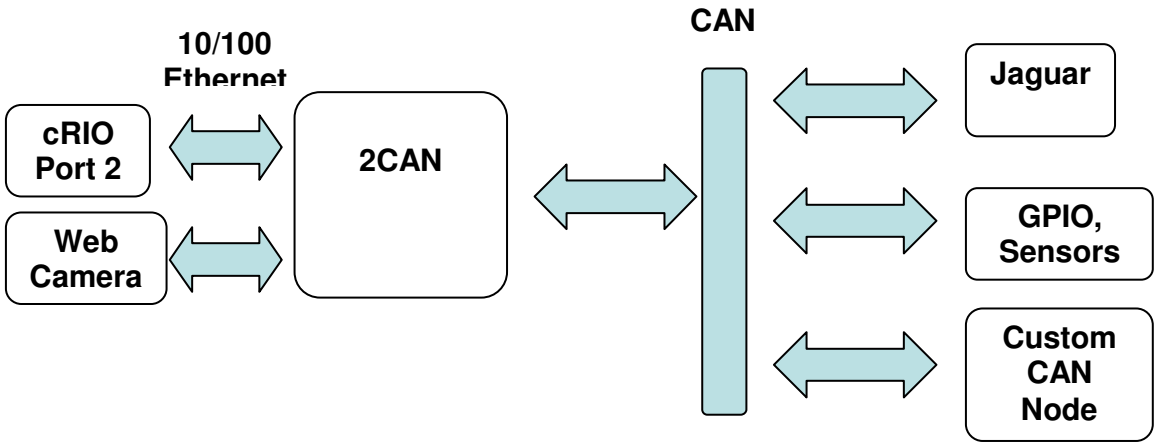
The 2CAN can be used to control speed controllers such as the Jaguar using CAN. The 2CAN supports enabling and configuring voltage, current, position, and velocity modes of the Jaguar. Additionally the 2CAN can also flash the Jaguar's firmware with the latest version. Jaguar IDs can also be set using the 2CAN.

The 2CAN also provides a means for the cRIO to transmit and receive custom CAN frames to interact manually with unsupported devices. This allows teams to add other devices to the CAN bus and even design their own CAN nodes!

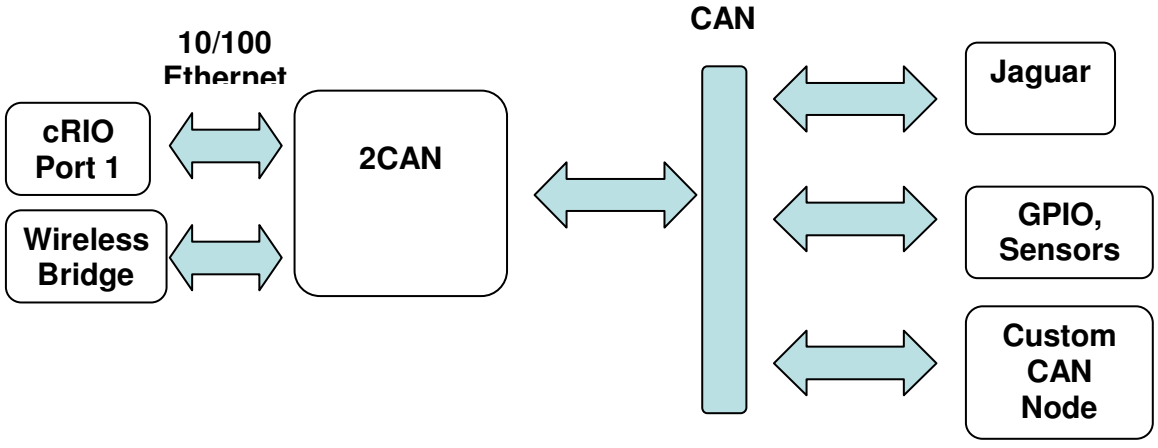
The 2CAN also provides a web host dashboard that reports information on all of the Jaguars on the CAN bus. Information such as voltage, current, temperature, faults, etc… are displayed in an easy to read webpage accessible to any laptop connected to the Ethernet bus. This allows teams to perform quick diagnostics on their motor controllers and also debug hardware issues.

3) Block Diagram

Using 2CAN on port 2.



Using 2CAN on port 1.



4) Features

Two 10/100 Mbps Ethernet ports with integrated switch

Each Ethernet port supports auto-MDIX – use straight through or cross over cables

Low impedance reverse battery protection

Power, CAN and both Ethernet ports ESD protected using PESD technology

Multicolor LED for indicating status

1 CAN channel, bit rate software selectable up to 1Mbps

Selectable 120 ohm bus termination resistor

Ability to restore default factory settings

Robust Boot loader with firmware corruption protection

2CAN Dashboard real-time web host allowing users to view multiple devices on the CAN bus simultaneously.

Set jaguar IDs anytime, anywhere, any laptop.

User assignable text descriptions of each CAN ID – great for Pit Crew!

Wind River C++ Driver
(available at FIRST Forge http://firstforge.wpi.edu)

Java Driver (available at FIRST Forge http://firstforge.wpi.edu)

LabView VI (available at FIRST Forge http://firstforge.wpi.edu)

5) Upcoming features

Set Jaguar modes and PID gains “on the fly” through the webpage.

Supporting plotting PID signals in Web Dashboard (Position, velocity, error).

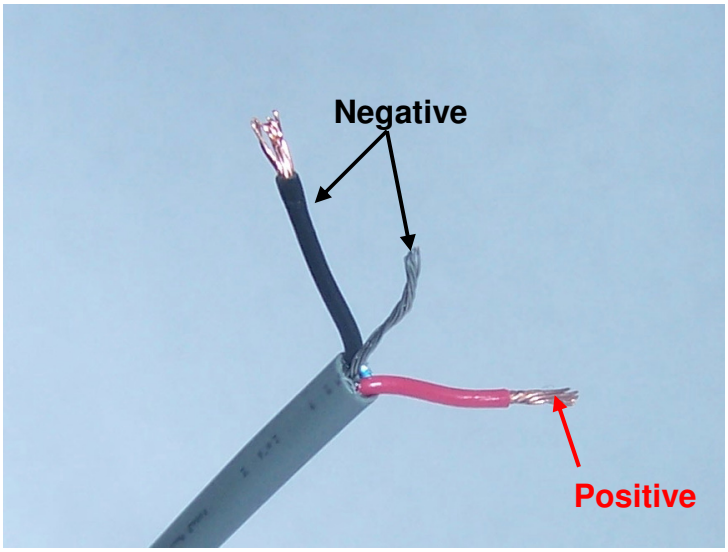
Reflashing 2CAN firmware through the web page without flash utility.

Allow teams to load custom Java Applets into the web server.

Implement a web proxy to allow teams to use the web dashboard wireless when 2CAN is on cRIO Ethernet port 2. This is explained in **(8) PC Ethernet Settings**.

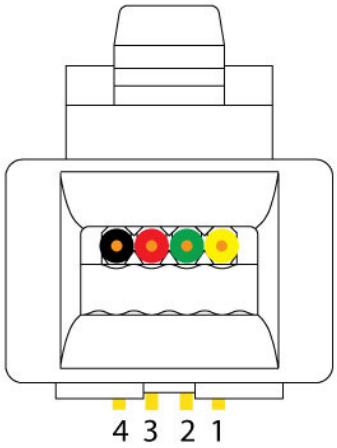
6) Connecting Power

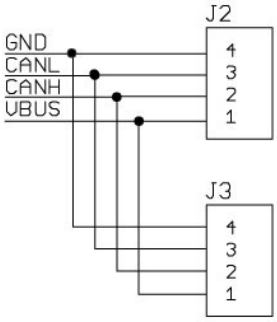
The 2CAN requires an input voltage between 6.5 and 28 volts DC. Positive voltage should be applied to the red wire and negative supply voltage should be connected to the black and bare drain wire.



7) Wiring CAN

The CAN connector on the 2CAN is a 6 place 4 contact connector (6p4c). Although there are four contacts, only 2 wires are needed for CAN communication, CAN High and CAN Low. The cable should be wired as a pass through connecting pin 1 to pin 1, pin 2 to pin 2… When wired correctly the tabs of the connector should line up in opposing directions with the tab down on one connector and the tab up on the other.





Pin 1 – Vbus (user supplied)
Pin 2 – CAN High
Pin 3 – CAN Low
Pin 4 – Ground (common to the 2CAN)

8) CAN Termination Resistor

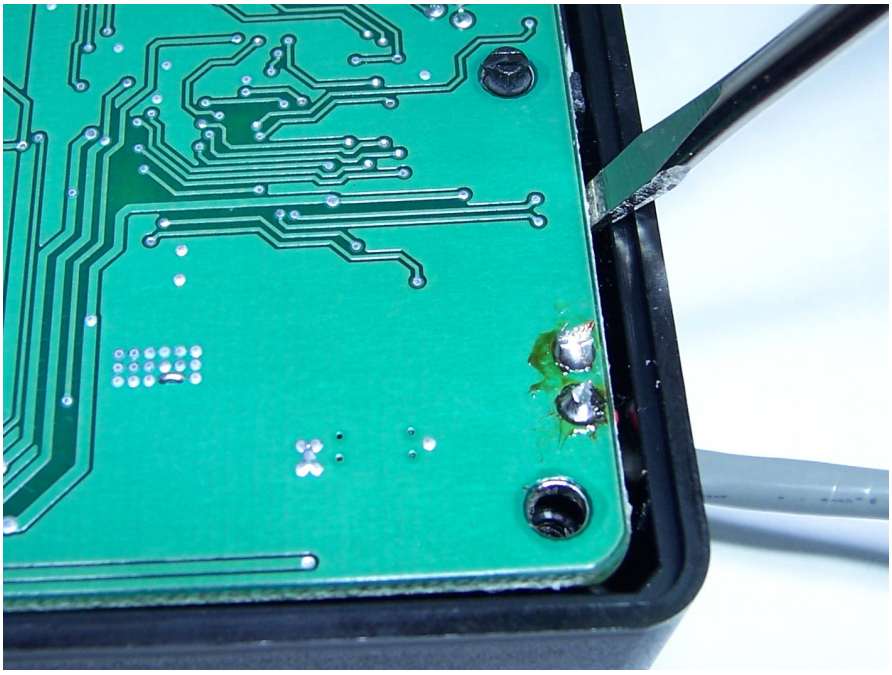
CAN requires a 120 ohm termination resistor on each end of the CAN Bus. The 2CAN has an internal 120 ohm resistor as described in section 8, Jumper configurations. The second resistor needs to be placed at the end of the Bus. If you are using Jaguar speed controllers, this can be accomplished by inserting a 120 ohm resistor between the two inner most pins (CAN high and CAN Low) of an RJ11 or RJ12 connector. Pins 2 and 3 respectively.

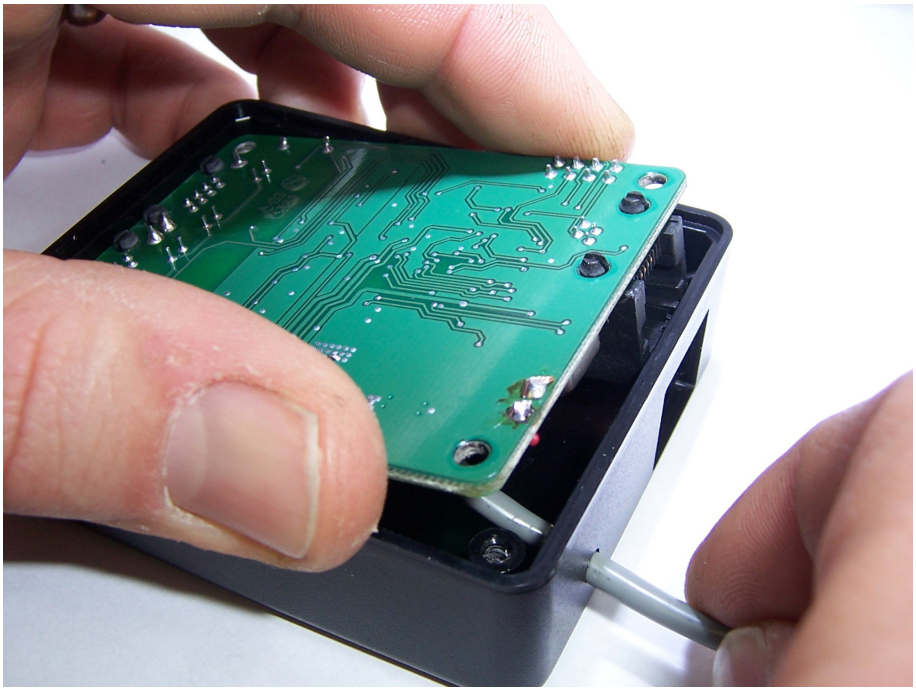
9) Jumper Configurations

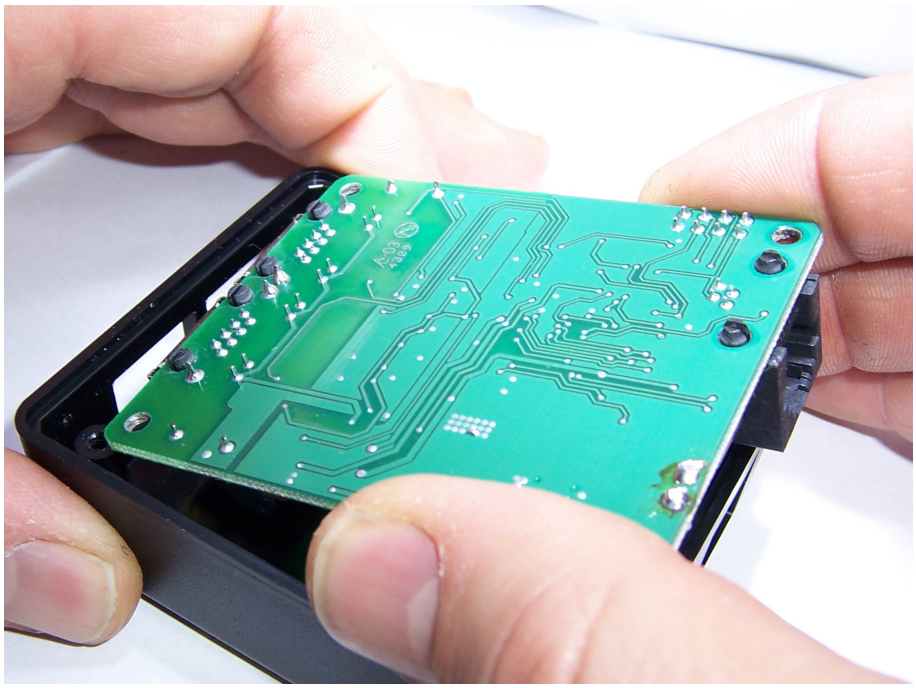
The 2CAN contains an internal jumper that is used to enable one of the two 120 ohm termination resistors required for CAN communication. By default this jumper is enabled so normally there is no need to modify the jumper arrangement.

10) Load Factory Defaults

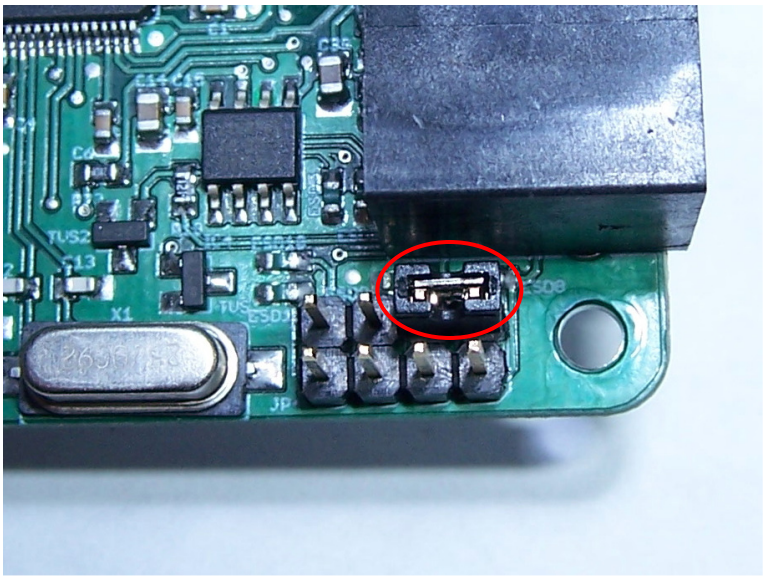
This jumper can also be used to regress the IP settings. In order to access the jumper the 2CAN must be removed from its enclosure. This can be accomplished by inserting a small flat head screwdriver between the board edge and the enclosure on the **CAN** side of the device. After inserting the screw driver gentle pry the board using only the tip of the screwdriver. After the board is lifted slightly push the grey power cable into the enclosure as the Ethernet connectors are slid out of place. To reassemble the device, reverse the above process by inserting the gray power cable (if it has been completely removed) first and then the Ethernet side of the board. Use your thumb to gently flex the enclosure on the CAN side of the board while pulling the gray power cable away from the enclosure. This process is inconvenient by design to avoid accidental regression so DO NOT FORGET YOUR IP SETTINGS. A good practice would be to label the 2CAN with your IP settings.





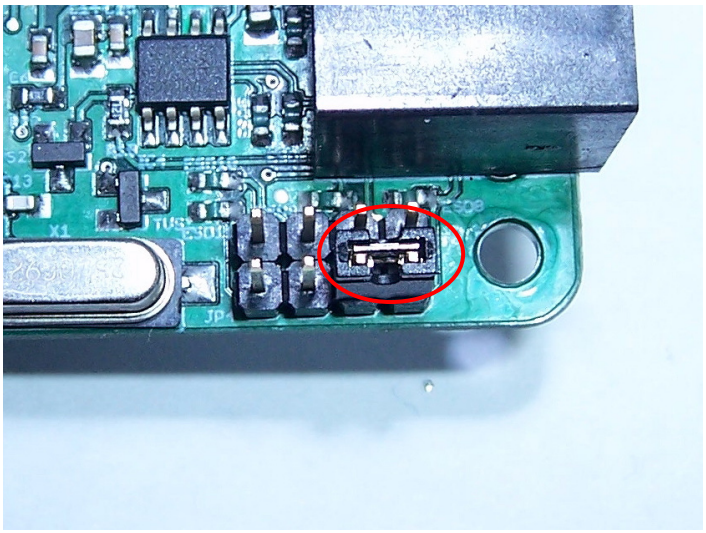


The 2CAN is equipped with an internal 120 ohm termination resistor. This resistor is user selectable by either removing or placing the internal jumper across pin 6 and pin 8. The termination resistor is in place when the jumper is in place (default from factory).



The internal jumper can also be configured to regress all of the IP settings back to original factory settings by placing it across pin 5 and 7. The 120 ohm resistor jumper may be used for this. A power cycle is required once the jumper is in place. The jumper must be replaced across pin 6 and 8 after regression is complete. For more information on regression see the section on loading factory defaults.

IP: 10.0.0.10
SUBNET: 255.0.0.0
DEFAULT GATEWAY: 10.0.0.1



11) PC Ethernet Settings

To communicate with the 2CAN you may need to modify your computer's IP settings. This may be done manually or through the firmware utility. The 2CAN's default IP is 10.0.0.10.

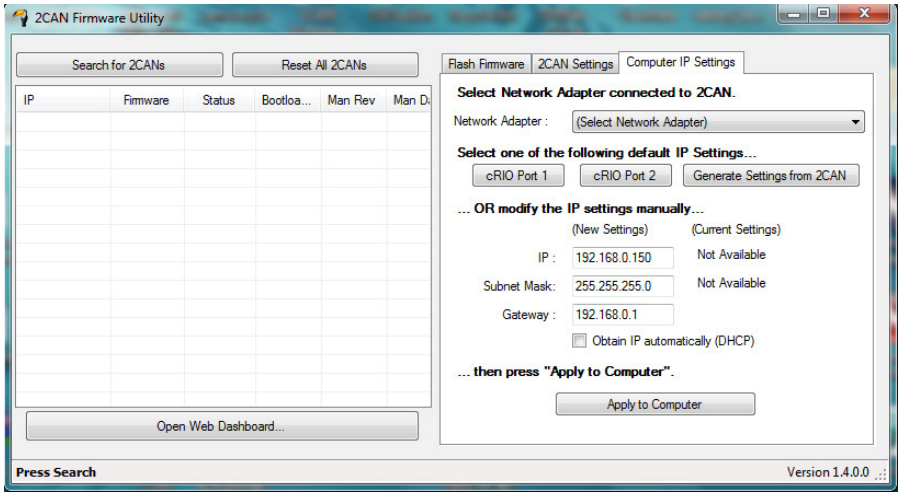
If the PC's IP settings are set as specified in the FIRST Section 5 Document – Control System Configuration, then the PC will also be able to interact with the 2CAN.
These settings are…

IP : 10.XX.YY.06
Subnet 255.0.0.0
Gateway (not necessary for 2CAN) 10.XX.YY.4
Where XXYY is your team number.

When you first get your 2CAN it will be important that the subnet of your PC is 255.0.0.0 and not 255.255.255.0. This is so that your PC can talk to any Ethernet device as long as the first octet matches your subnet, i.e. the first number is a 10.

The 2CAN Firmware Utility may be used to quickly detect and change your computer and 2CAN IP's.

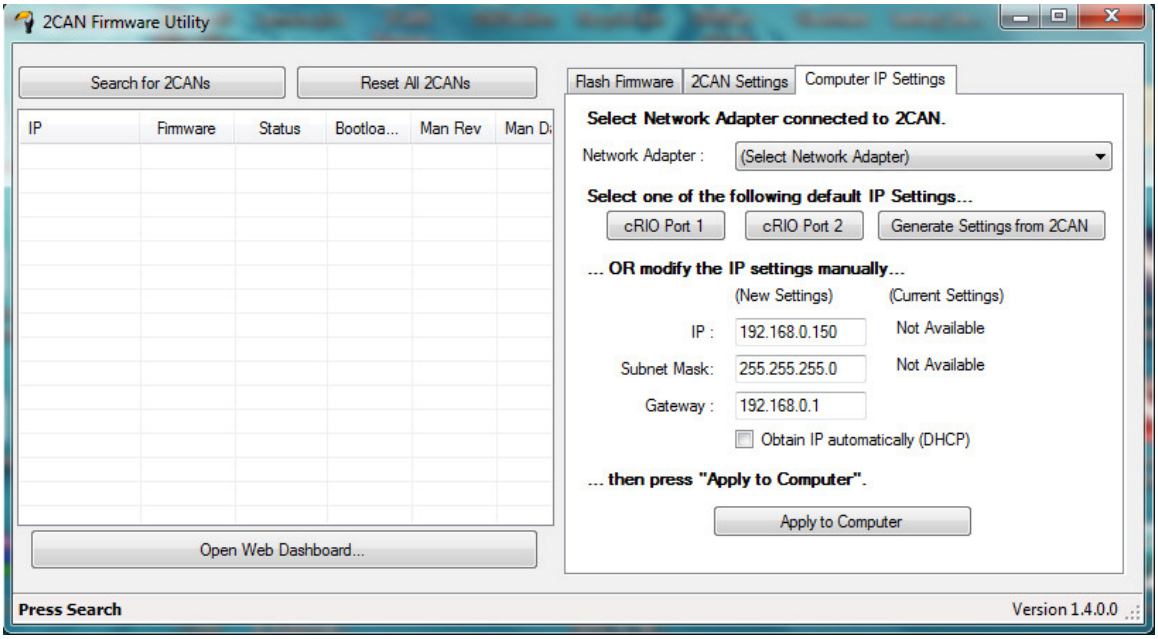
After downloading the 2CAN Firmware Utility, run 2CANFirmwareUtility.exe



12) Updating 2CAN Firmware

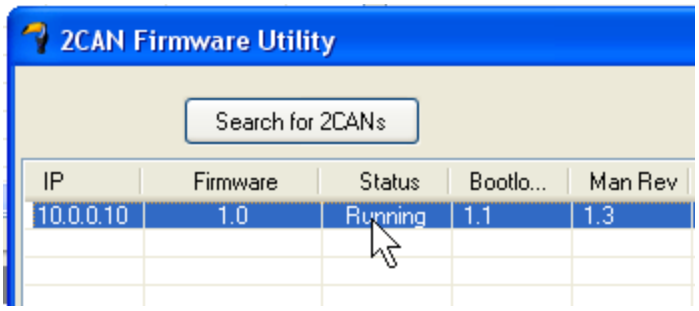
Before using your 2CAN you should always check to see if new firmware is available.

Latest firmware, and the 2CAN Firmware Utility, can be found at www.crosstheroadelectronics.com

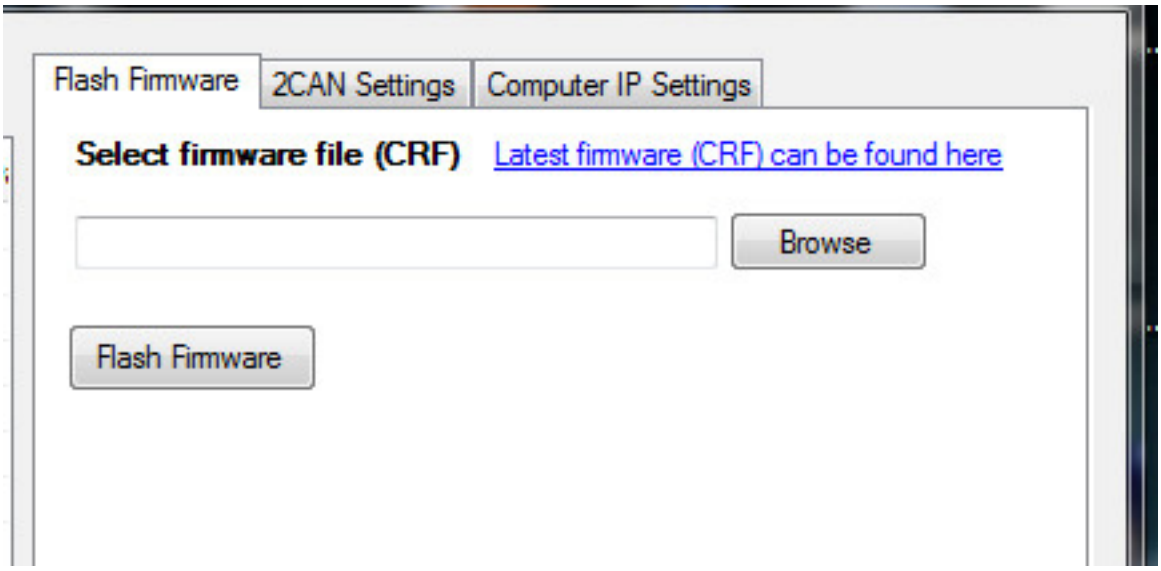


Ensure that the IP Settings for the PC are correct (previous section) and press the “Search for 2CANs” button. The 2CAN will initially have an IP of 10.0.0.10. If your computer IP settings are not correct you may select the ‘Generate Settings from 2CAN’ button to automatically configure your computers IP. You must first select the network adaptor that is connected to your 2CAN using the ‘(Select Network Adaptor)‘ dropdown.

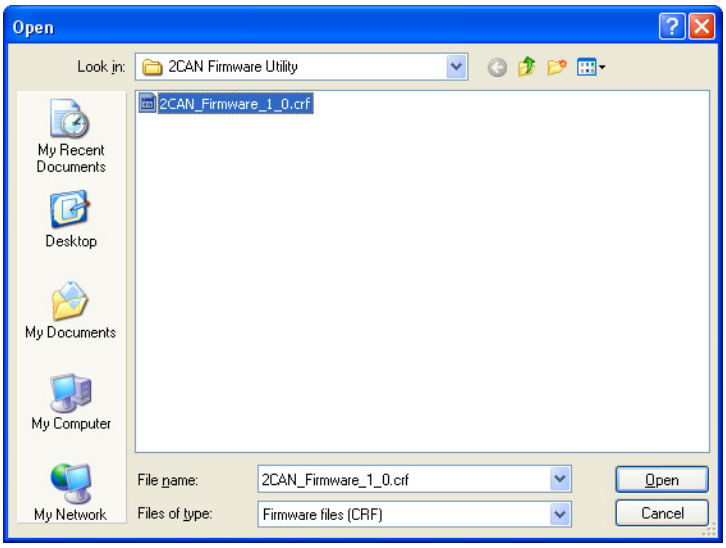
To flash new firmware select the 2CAN entry in the left grid…



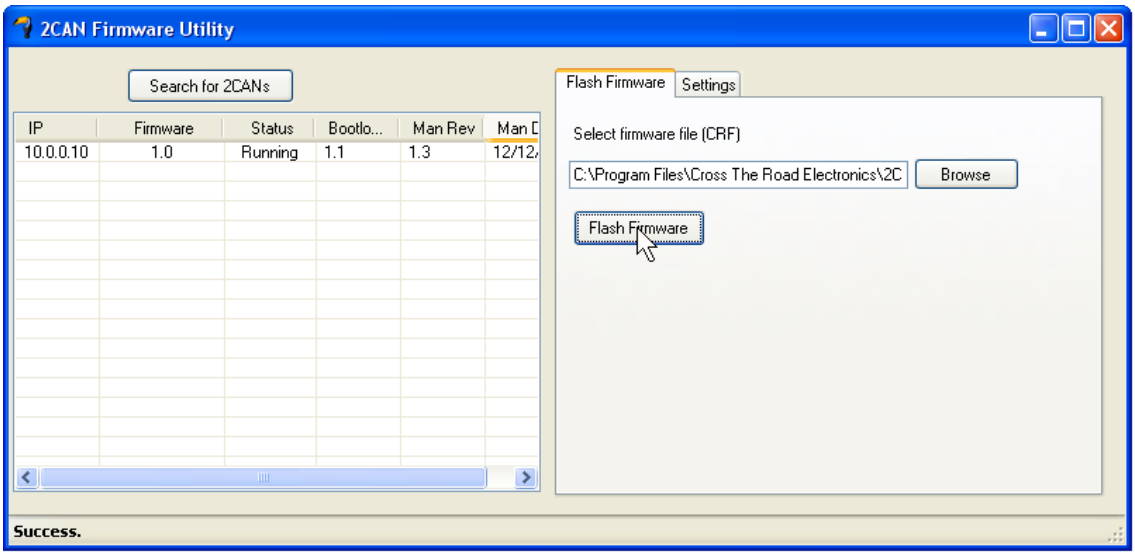
Then press the browse button to select the firmware file.



The firmware utility will have default firmware in directory where the utility was installed. However the latest firmware should be retrieved from www.crosstheroadelectronics.com



Finally press the flash firmware button to reflash the 2CAN with selected firmware.



13) Setting Team Number/IP

The 2CAN may be connected to either Ethernet port of the cRIO, However, for testing purposes it may be advantageous to use Ethernet port 1 as it allows wireless access to the web dashboard. I you are using the four slot cRIO use the method described for connecting to port 1. The firmware utility may also be used to configure the 2CAN for either port. If connected to the wireless bridge the 2CAN must be configured to communicate with port 1.

See **3) Block Diagram** for how to connect to either cRIO Ethernet port.

Each port on the cRIO has a different subnet.

Port Number	Subnet
1	10.XX.YY.0
2	192.168.0.0

For the 2CAN to function on port 2 it must have an IP address in the format 192.168.0.XX, where XX can be any value 0-254, so long as it does not conflict with other Ethernet devices also on port 2 (like the camera).

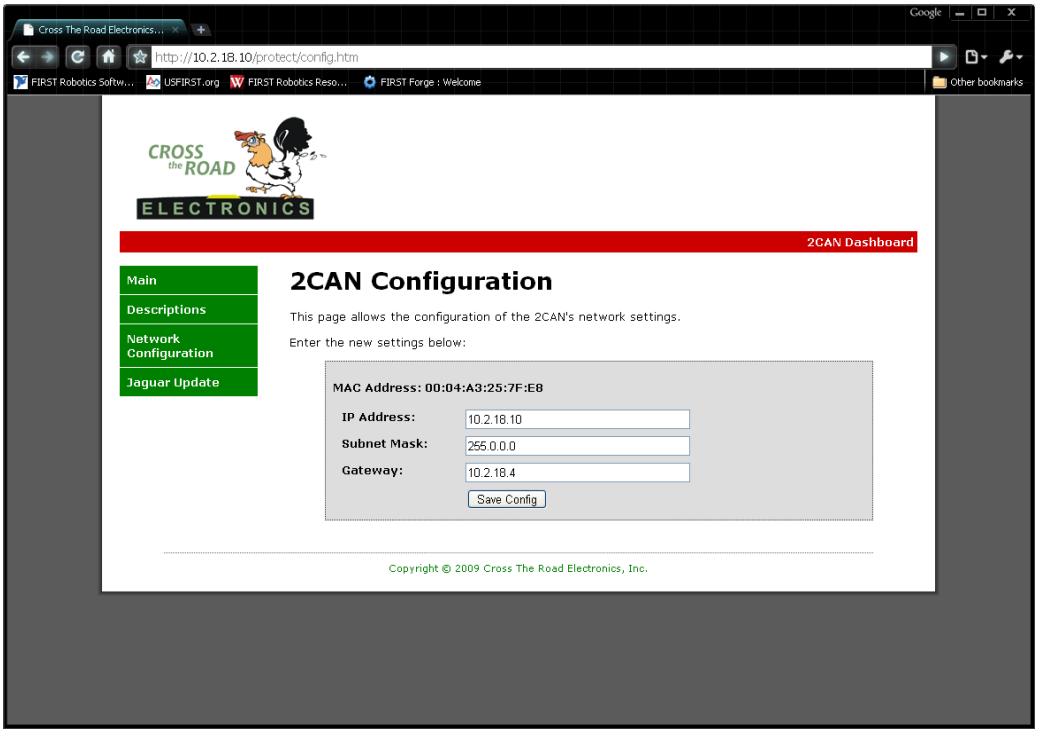
To use the 2CAN on port 1 the IP address must be set using the team's number.

The IP is set as follows : 10.XX.YY.10 where XX is the upper 2 digits of the team number and YY are the bottom digits.

Example Team Numbers	IP
1	10.0.1.10
12	10.0.12.10
123	10.1.23.10
1234	10.12.34.10

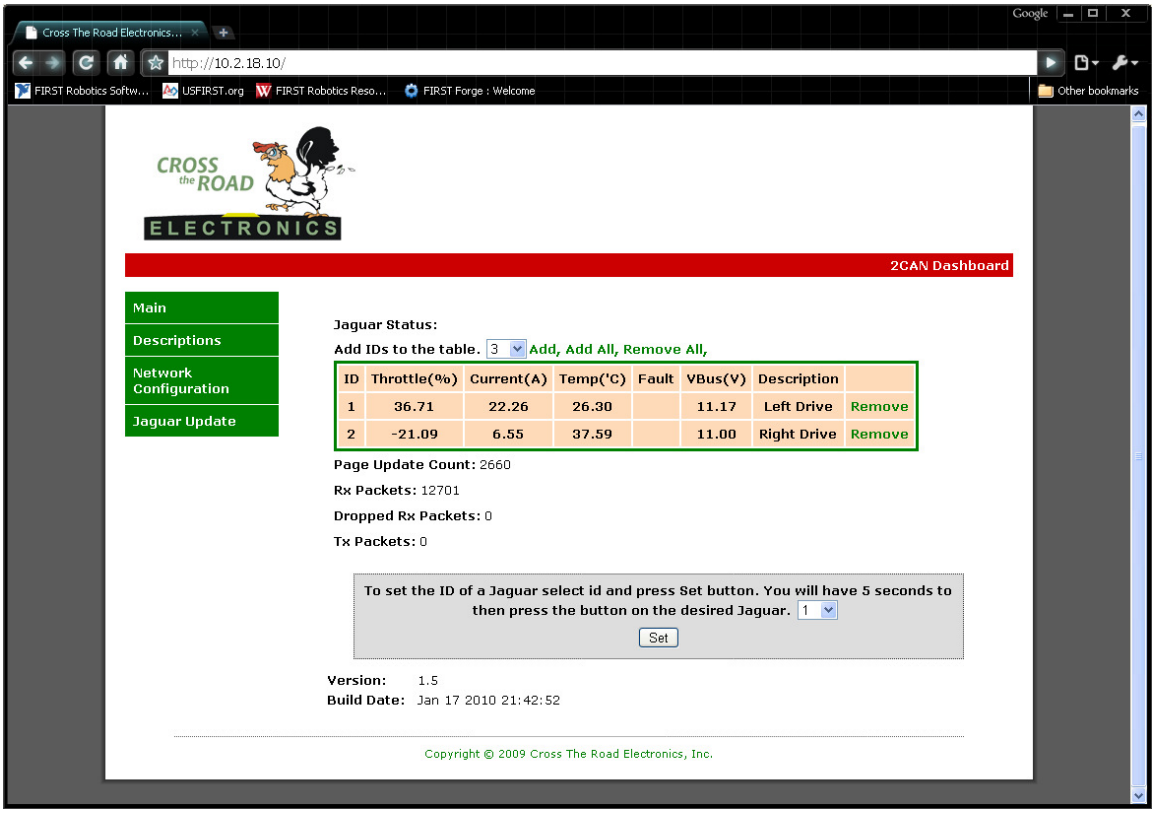
Setting the team number (2CAN IP) can be done two ways. The firmware utility can be used to set the IP Address.

The web host also provides a means of setting the IP address. Click on the “Network Configuration” link on the menu bar on the left.



14) 2CAN Web Dashboard

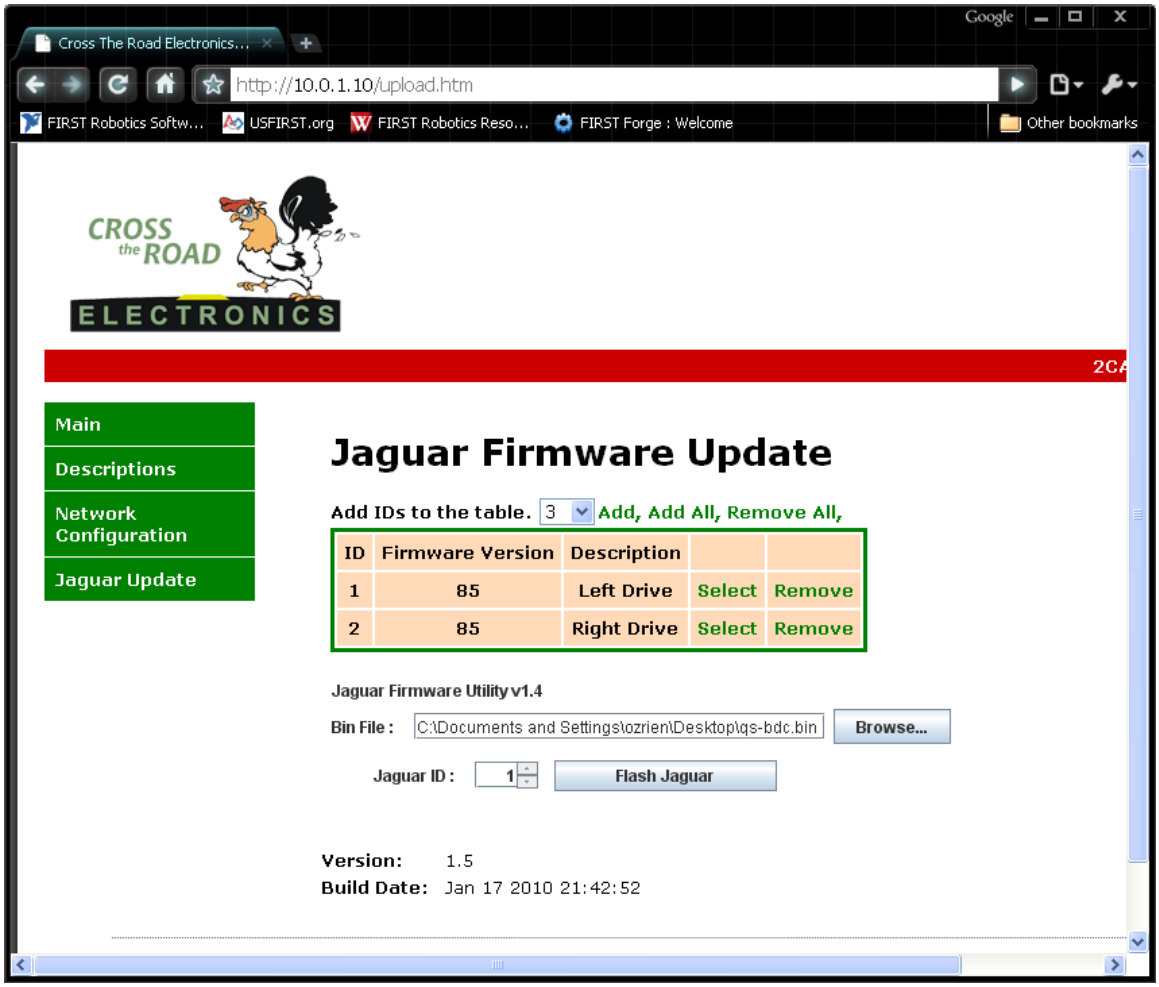
The 2CAN Web Dashboard displays real-time information retrieved from the CAN bus. This can even be viewed while driving your robot, if the 2CAN is on port 1. To view the Web Dashboard type the IP address of the 2CAN into your web browser while your PC is connected to the 2CAN (either directly or through the robot’s router/gateway).



Web dashboard should function in any modern web browser. Each firmware release is formerly tested against Internet Explorer 8, Mozilla Firefox 3.5, and Google Chrome 3.0.
Javascript must be enabled in the browser. Additionally, the Jaguar Firmware applet requires Java 6 (1.6.0_17 or greater).

15) Updating Jaguar Firmware

The 2CAN can be used to reflash Jaguar firmware by clicking on “Update” hyperlink on the left menu bar. By adding Jaguar IDs to the table you can poll for firmware versions of several Jaguars. This allows you to quickly determine if all Jaguars have the latest legal firmware.

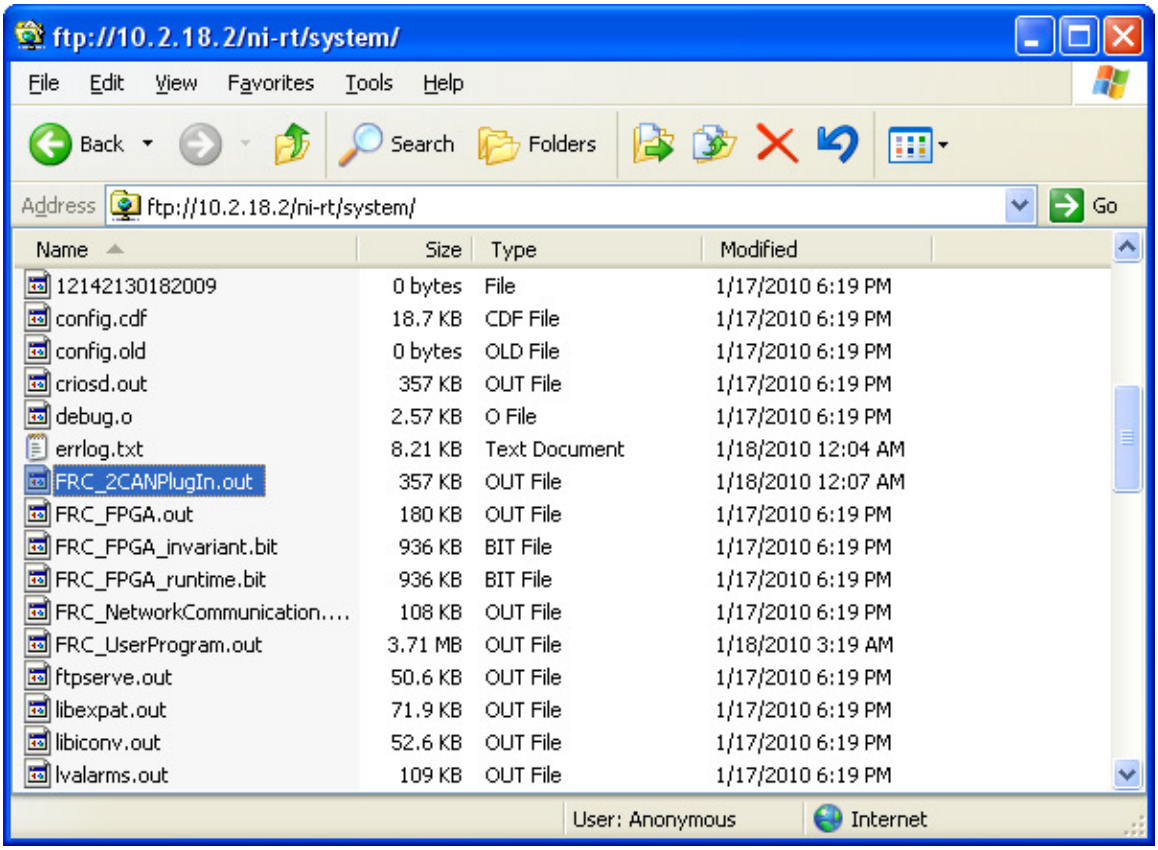


The Jaguar Firmware Utility Java Applet beneath the table can be used to reflash a particular Jaguar. First select which Jaguar by either clicking the "Select" hyperlink in the table, or select the Jaguar ID from the drop down box in the applet. Then press "Browse" and navigate to the BIN file holding the Jaguar Firmware. Then press "Flash Jaguar". It should take approximately 2-4 second to flash Firmware onto a Jaguar.

16) Using the 2CAN with WindRiver C++/Java/Labview

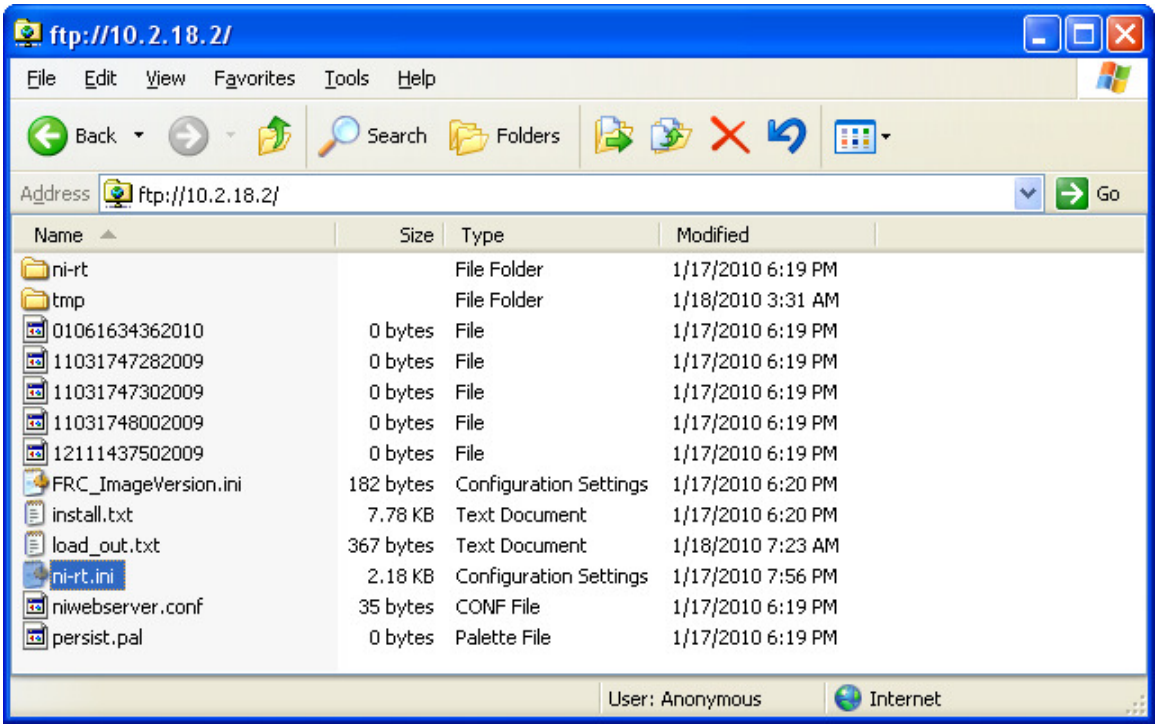
In order to use the 2CAN you must add a plugin to the cRIO's ftp server. This procedure is identical to adding the BlackJaguar Plugin. The plug-in can be downloaded at www.crosstheroadelectronics.com and will also be available at FIRST Forge.

The plug-in is a single file (FRC_2CANPlugIn.out). First connect to the ftp server on your cRIO by entering its IP address into your browser with the ftp prefix (ftp://10.XX.YY.2). Then navigate to the ni-rt directory, then system directory



It's here that you should place FRC_2CANPlugIn.out.

Then navigate back to ftp://10.XX.YY.2/. Here we need to modify ni-rt.ini so that the cRIO invokes the plug-in. This is done by adding "FRC_2CANPlugIn.out" to the startup dll list.



Copy out ni-rt.ini to your computer and open it in a text editor. Find the line beginning with StartupDlls and include FRC_2CANPlugIn.out in the list. Be sure to add the out file so that it is immediately after “FRC_NetworkCommunication.out”:

Before…

StartupDlls= ...;FRC_NetworkCommunication.out; ... ;

After…

StartupDlls= ...;FRC_NetworkCommunication.out;FRC_2CANPlugIn.out;...;

Now when the cRIO boots it will load the plugin, which will automatically find the 2CAN regardless of which port it’s on. Again be sure that the IP Address of the 2CAN is correct, 10.XX.YY.10 for port 1 and 192.168.0.XX for port 2.

Once the plugin is installed you should be able to use the example C++/Java/Labview examples on FIRST Forge.

http://firstforge.wpi.edu/

17) LED States

LED	Description
Orange Blink	Device is in bootloader. See updating firmware (Section 12).
Orange/Green Blink	2CAN has loaded factory defaults, pull jumper for normal functionality (Section 10).
Fast Red Strobe	CAN problem. There is no other CAN node connected to the 2CAN. No CAN communication with 2CAN. WEB dash: **2CAN Status:** There is no Cross-link/CAN traffic. Check CAN cables/termination resistor.
Fast Orange Strobe	2CAN is not receiving UDP datagram's from the cRIO. WEB Dash: **2CAN Status:** No Ethernet communication with cRIO. Are the Ethernet LEDs blinking? If not check Ethernet cables. Are network IP settings correct? Check that FRC_2CANPlugIn.out is loaded correctly.
Slow Green Blink	2CAN is communicating with the cRIO successfully (Ethernet). There is at least one CAN node responding to the 2CAN (CAN). WEB Dash: **2CAN Status:** 2CAN is running successfully.
Red/Orange Blink	Hardware failure, 2CAN has failed hardware test on booting.

Note that this information can also be viewed on the Main page in Web Dashboard under "Status".

Jaguar Status:

Add IDs to the table. 3 Add, Add All, Remove All,

ID	Throttle(%)	Current(A)	Temp('C)	Fault	VBus(V)	Description	
1	0.00	0.00	25.53		11.49		Remove
2	0.00	0.00	34.53		11.33		Remove

Status: 2CAN is awaiting CAN Frames. Plugin is communicating successfully.

Page Update Count: 9662

Rx Packets: 11614

Dropped Rx Packets: 0

Tx Packets: 0

18) Revision History

Rev 1.5
- Updated section 13 to reflect new firmware utility features.

Rev 1.4
– Updated diagrams in section 7) Wiring CAN
– Updated LED states to reflect the latest firmware.

Rev 1.3
– Changes to Section 17 for latest firmware (1.06).
– Fixed date in header and footer.

Rev 1.2
– Changes to Section 16 for latest out file (1.0.0.0).

Rev 1.1
– Various changes for 2010 FIRST Robot Season Rules.

Rev 1.0
– Initial Release.