ROBOTICS REDEFINED

FEDORA LABS

RENEGADE

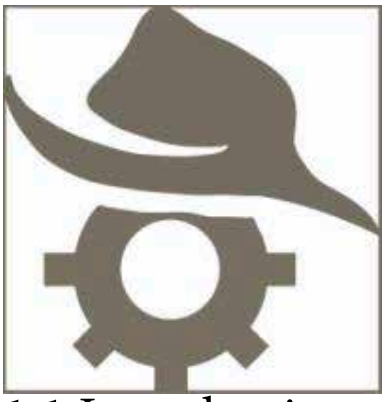
Wi-Fi Enabled Robot Controller:

RRI-REN-01

Motor Driver:

High Amp: RRI-HBRHIGH-01

Low Amp: RRI-HBRLOW-01



Chapter 1: Preface

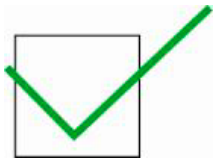
1.1 Introduction

This manual explains the components, configuration, and operation of the Robotics Redefined Inc. Renegade Robot Controller. In this document you will find a description of the components of the Renegade, an explanation of how to set up and configure your Renegade over a wireless network, an introduction to some of the standard operating commands, and descriptions and examples of how to connect external devices to the Renegade main board. For best results, please thoroughly read and understand this manual before attempting to operate your Renegade.

Please keep this manual accessible for future reference.

1.1.1 Operational Warnings

Pay special attention to the cautionary notes indicated by this symbol throughout the manual. These call your attention to operational mistakes that could damage or destroy elements of your Renegade, or the Renegade itself.



This symbol indicates special considerations to keep in mind while setting up or using your Renegade. These situations are unlikely to risk damage to your Renegade, but will help keep operation as simple as possible.

1.1.2. Customer Service

For further inquiries, please visit our online customer service forum at www.fedoralabs.com/forum.

1.1.3. Legal Information

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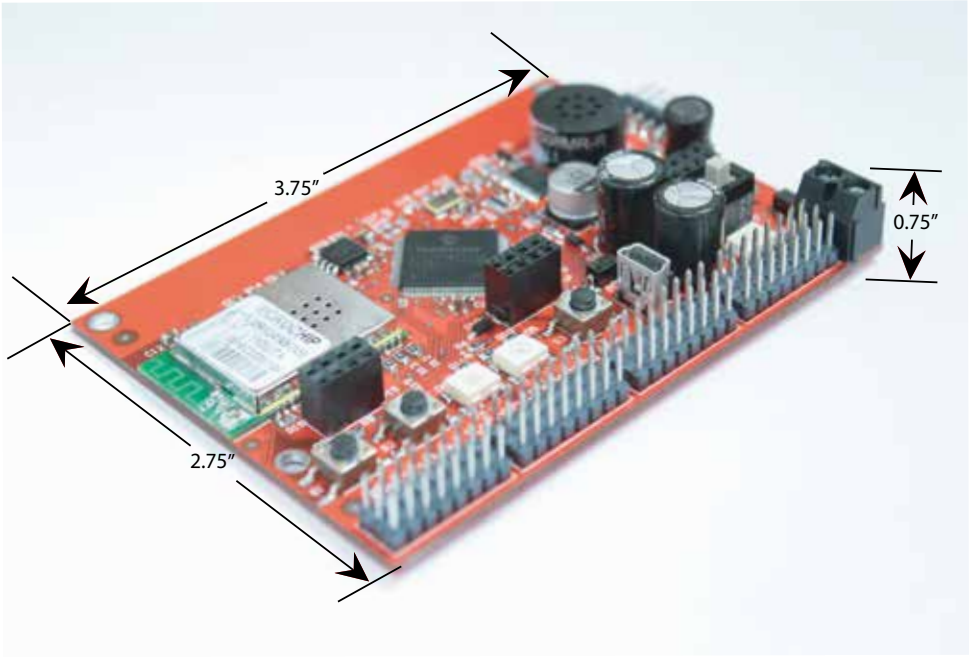
1.2 Table of Contents

Chapter 2: Renegade

2.1 Overview

Renegade is a versatile Wi-Fi operated robot controller featuring 32 fully customizable Input/Output channels. These can be set up and used as general purpose Input/Outputs (GPIOs), RC Servo motor controls, Analog to Digital Converter (ADC) Inputs, or to decode quadrature encoders. Renegade can perform all of these functions while at the same time operating two high current DC motors.

Renegade is easy to setup and use. You can directly connect to Renegade through your wireless network or send customized control commands (UDP) from your phone, laptop, or any other Wi-Fi enabled device. You can communicate with your Renegade through simple, intuitive commands in a host of programming platforms including, but not limited to: C, C++, C#, PYTHON, and MATLAB.



We have designed the Renegade around the power of the newest line of dsPIC microcontrollers providing unprecedented processing power and application flexibility. We have successfully used earlier versions of Renegade in projects ranging from remarkably speedy RC cars, to motor scooters, to cheese-chopping toaster bots. This newer, stronger version will be able to handle so much more! With the dramatically increased processing power, the flexibility of 32 servos, and two DC motors the possibilities are limited only to your ambition and imagination.

2.1.1. Features

- High Performance dsPIC33E Microcontroller
- Wi-Fi Enabled (Ad Hoc or Infrastructure)
- Up to 32 RC (radio-control) Servo Motors
- 2 DC Motor Controls with Current and Temperature Monitoring
- 32 General Purpose Input/Outputs
- 8 ADC (Analog to Digital Converter) Inputs with 10-Bit Resolution
- 2 Quadrature Encoder Inputs
- Supply Voltage Status Monitoring

2.1.2. Capability and Requirement Specifications

The table shown below lists all of the electronic specifications referring to the capabilities and requirements of the Renegade.

REQUIREMENTS		Main Board	GPIO	ADC Channels
Voltage	Minimum	4.8V DC	0V DC	0V DC
	Maximum	18V DC	3.3V DC	3.3V DC
Current	Minimum	350 mA		
	Maximum	650 mA		
Motor Driver		**Low Amp**	**High Amp**	**Motor PWM**
Voltage	Minimum	8V DC	8V DC	
	Maximum	18V DC	18V DC	
Current	Peak	45A	60A	
	Continuous	25A(*)	45A(*)	
	Continuous	20A	35A	
Frequency	Maximum			14KHz

(*) Continuous operation at this current will require additional external cooling.

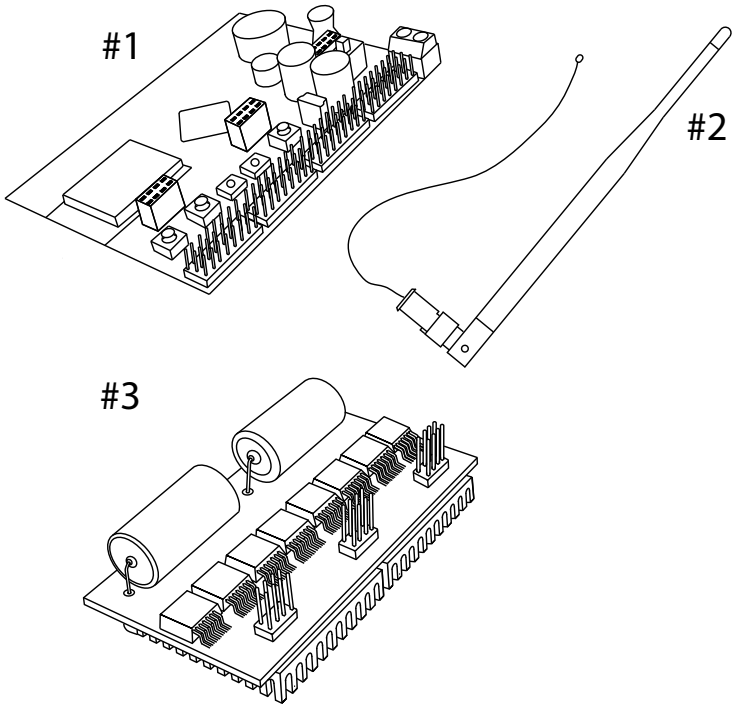
Exceeding any of the maximum limitations listed in the table above runs the risk of permanently damaging or destroying elements of or external attachments to your Renegade including the microcontroller.

2.1.3. Components

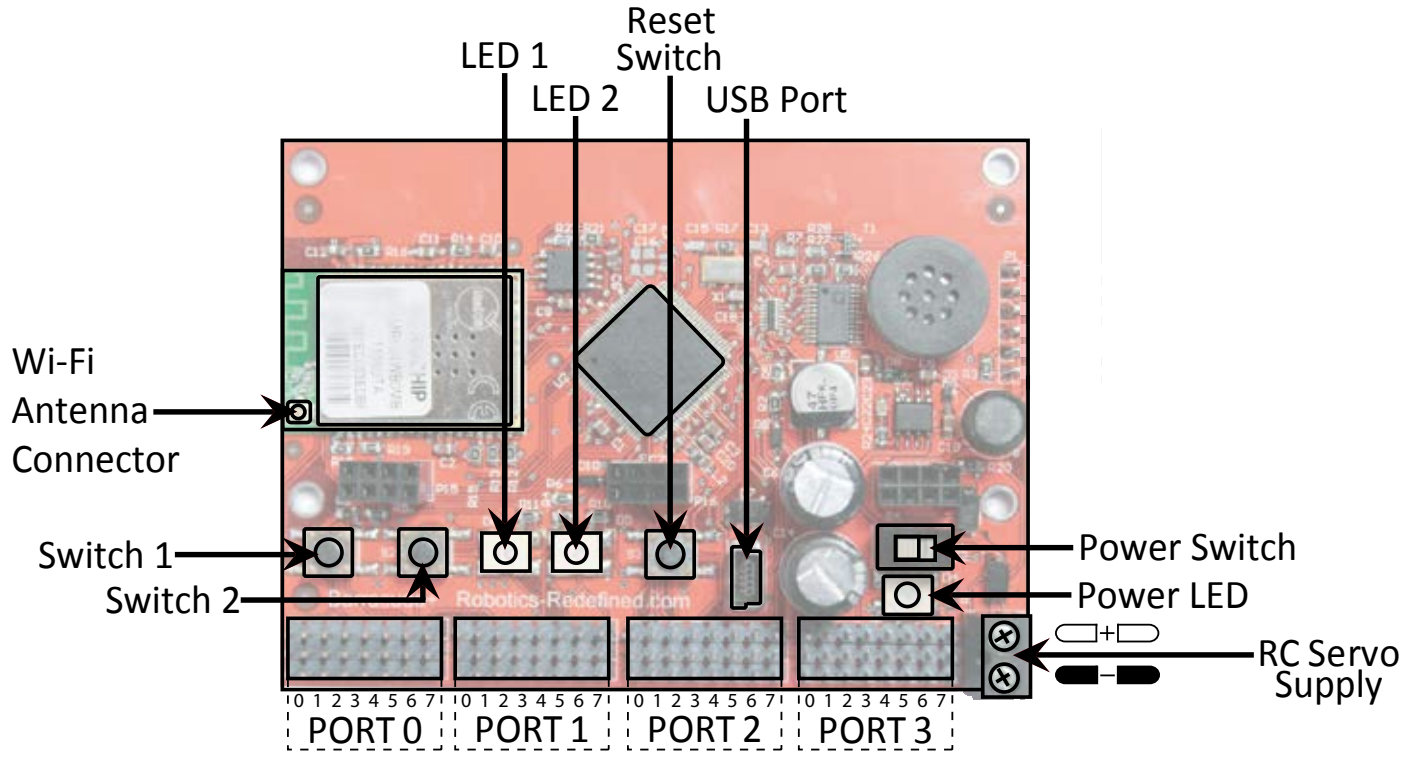
Materials Included with Renegade

Your Renegade comes with everything you will need to connect to the internet, configure your custom settings, update firmware as needed, and be ready to attach external devices. The following is a list of everything that is included with your Renegade:

- #1 - Renegade Main Board (in anti-static bag)
- #2 - External Wi-Fi Antenna
- #3 - Motor Driver: High- or Low-Amp
- Invoice
- Quick Start Guide/ Specification Sheet



Renegade Main Board



2.2. Overview

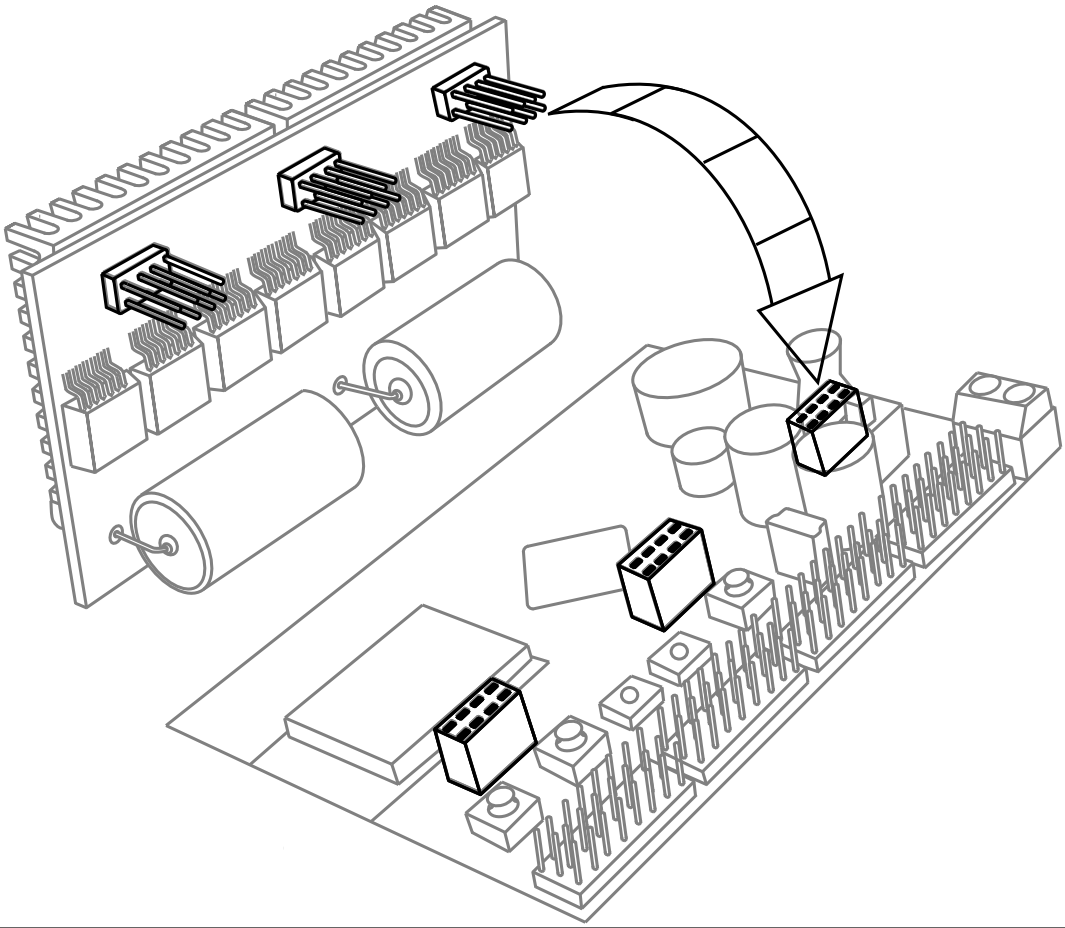
2.2.1. Connect the Motor Driver

Robotics Redefined, Inc. offers an external Motor Driver (high and low current models available at www.fedoralabs.com) boasting two HBridge switches that attaches easily to your Renegade Main Board. When coupled with the Motor Driver, the Renegade can drive two DC motors bi-directionally with speed control. Alternatively, the external Motor Driver can be configured to control up to four DC motors uni-directionally, or to drive solenoids, relays and other high-current devices. Each channel features individual current-monitoring capability.

With the addition of the high-current external Motor Driver, the Renegade's per-channel output can reach a maximum current of 60 A.

The addition of the external Motor Driver Shield significantly increases the operating temperature of the Renegade. Take care to monitor the temperature and consider incorporating fans into your design. In the interest of protecting your device, the Motor Driver will shut down automatically if it overheats.

To attach the Motor Driver, simply insert the 24 headers of the Motor Driver Board into the 24 coordinating sockets of the Renegade Main Board as seen below:



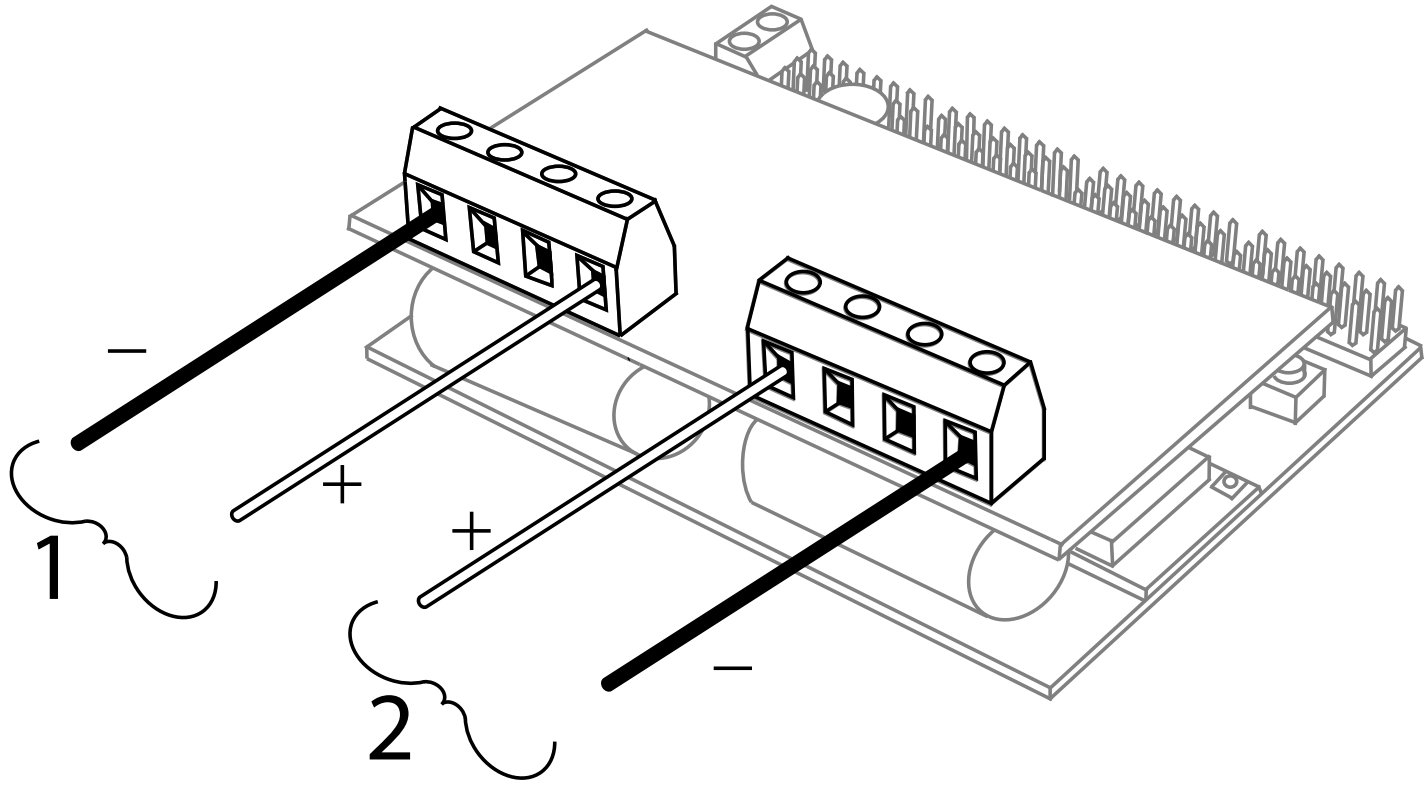
2.2.2. Connect to a Power Supply

There are three ways to supply power (from any source that meets the specification criteria) to the Renegade:

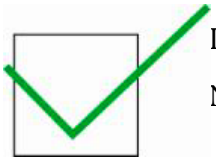
1. **Main Supply on Motor Driver Board:**

   The Main Power Supply is located at the top of the attached Motor Driver Board and can support both the main board and the Motor Driver. The input voltage range is between 4.8V DC and 18V DC.

   To increase current, supply power to both sets of inputs operating in parallel. If increased current is not required, you can connect either one individually.



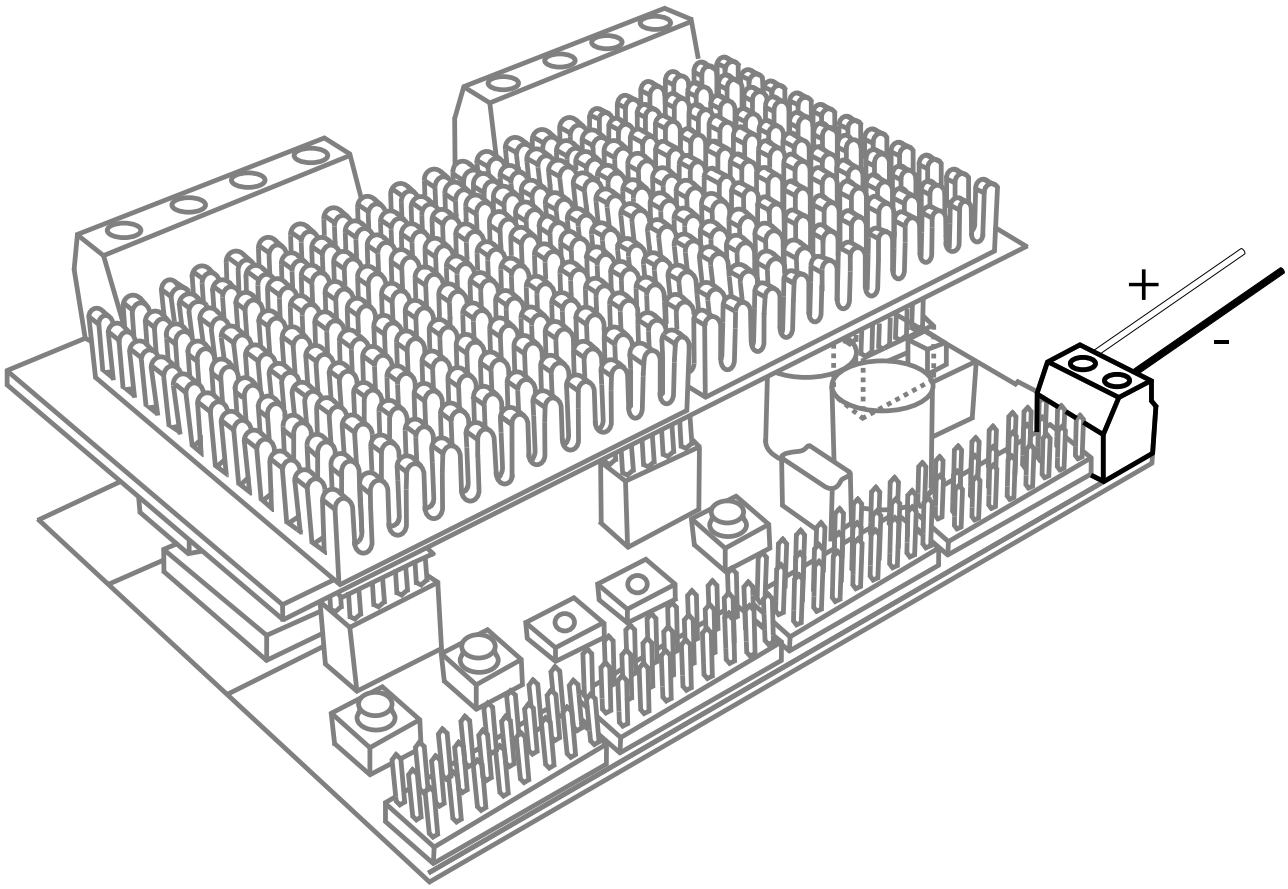
Exceeding 18V DC into the Main Power Supply could damage or destroy your Renegade



In order to protect the microcontroller from overload, power connected to the main supply will NOT power RC Servos or any other external devices attached to the 32 GPIO Channels.

2. RC Servo Supply:

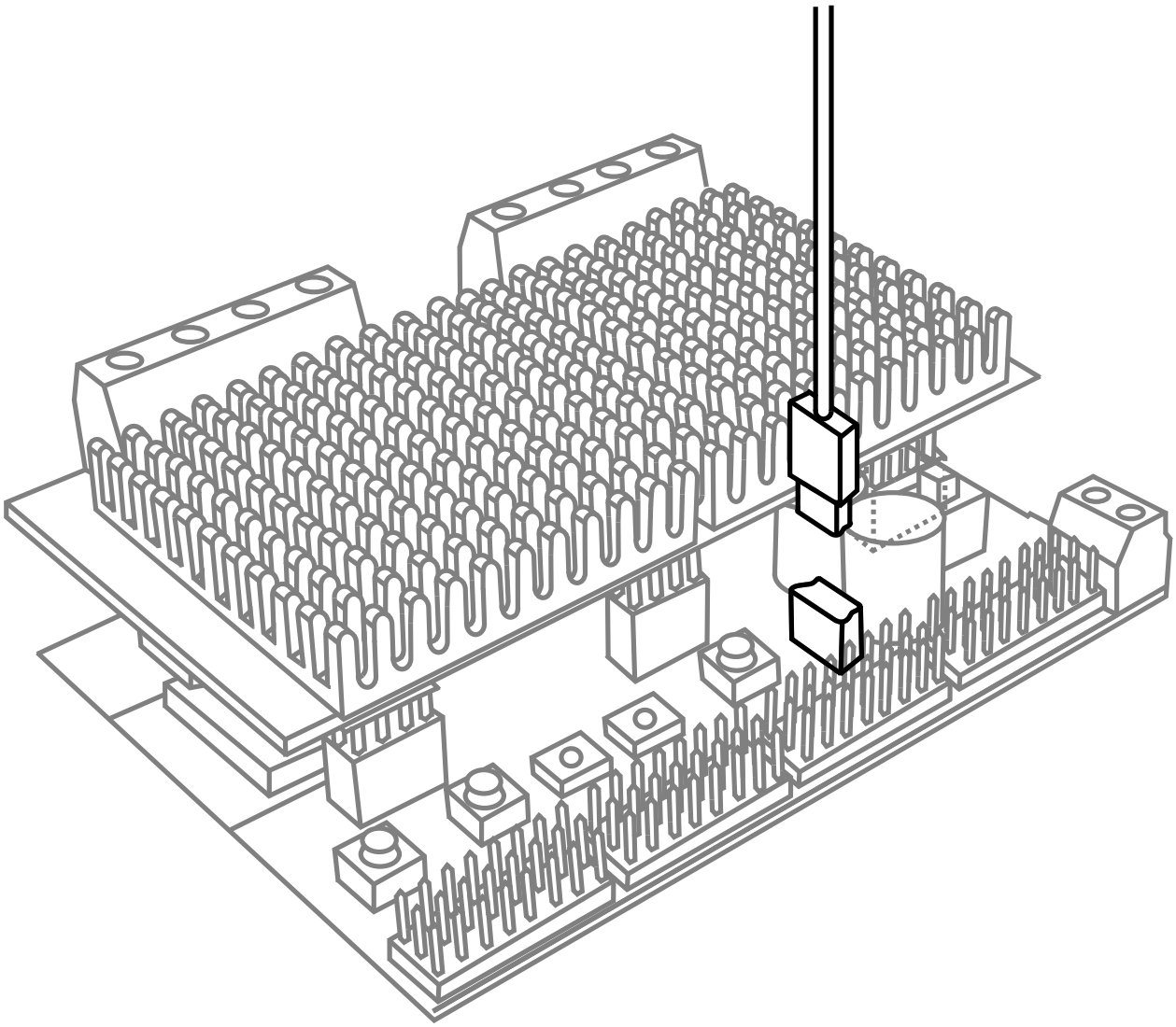
Power through the terminal block on the lower right hand corner of the Renegade Main Board is used primarily to supply the RC Servos. It can also be used to power the main board if the Motor Driver is not connected. Select your power source according to the supply range of the Servo(s) attached – these typically vary from 4.8V DC to 7.2 VDC.



The Servo and the Motor Driver power supplies are isolated from each other. Each can power the Main Board but cannot supply power to one another.

3. **USB Port (used only to update firmware):**

If necessary, enough power can be supplied through the Renegade's USB port to establish a Wi-Fi connection and begin accepting UDP commands.



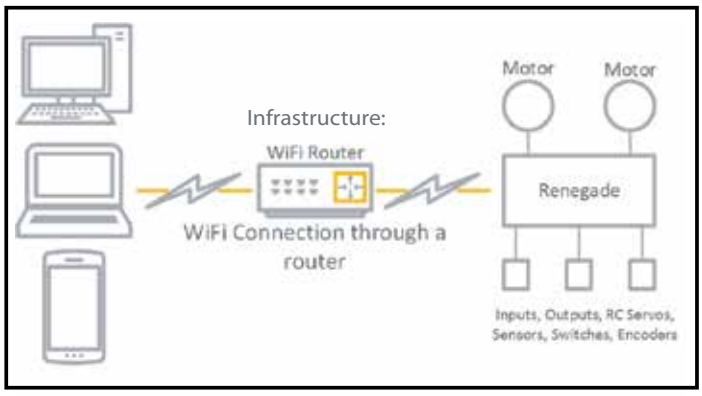
This method will NOT provide enough power for the Renegade to perform any other functions.

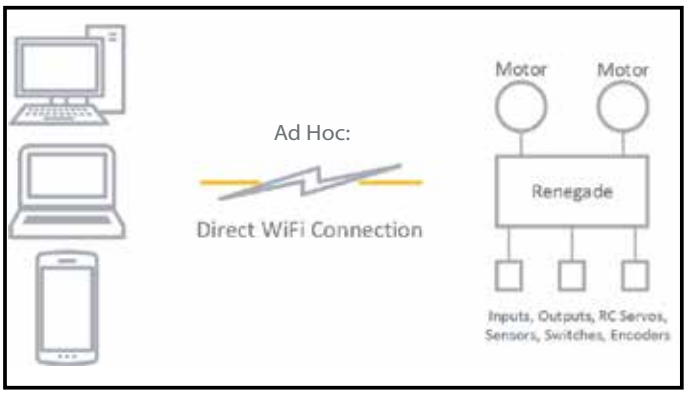
2.3. Software Setup

2.3.1. Wireless Communication

Renegade is controlled and customized via Wi-Fi – either connected into a preexisting central wireless network (infrastructure) or operating within a network established between multiple Wi-Fi capable devices (ad hoc). This section explains how to access and configure your Renegade settings.

Renegade CANNOT establish an ad hoc wireless connection with a computer running Windows 8

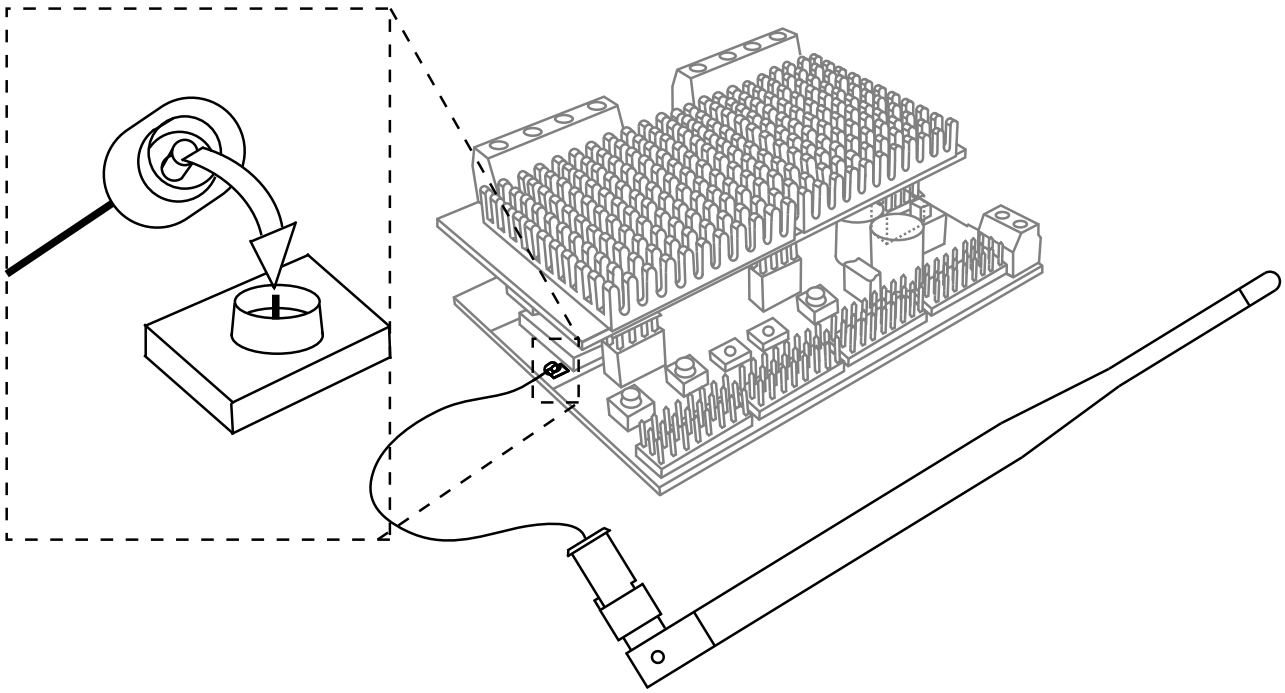




Establish Connection

With your Renegade connected to a power supply, the following steps will allow you to connect to a Wi-Fi network:

1. **Attach your External Wi-Fi Antenna to the Wireless Antenna Connector on the Wireless Chip Module.**



2. Turn on Power Switch

This will turn on your Renegade and begin to transmit its wireless signal.

Your Renegade will beep one time as it turns on and creates its own ad hoc network. You can now connect to it via your computer or other wireless device.

Power LED Indicator will now light and remain lit.

LED Indicator 2 will blink signifying wireless communication.

Your Renegade is NOT compatible with Windows 8 in Ad Hoc mode.
Likewise, some routers may need to be set to mixed mode in order to establish communication.

When troubleshooting connection problems, these are two characteristics to check first.

3. On your computer, within Wireless Networks, identify and select "RenegadeAdHocNetwork"

Having established an ad hoc connection, LED Indicator 2 will now blink at a rate of twice per second.

4. **Pull up your computer's web browser and type in the Renegade's Factory Default IP Address: 169.254.1.1**

Your computer will locate your Renegade, establish communication, and automatically pull up the Web Configuration Utility allowing you to begin customization.

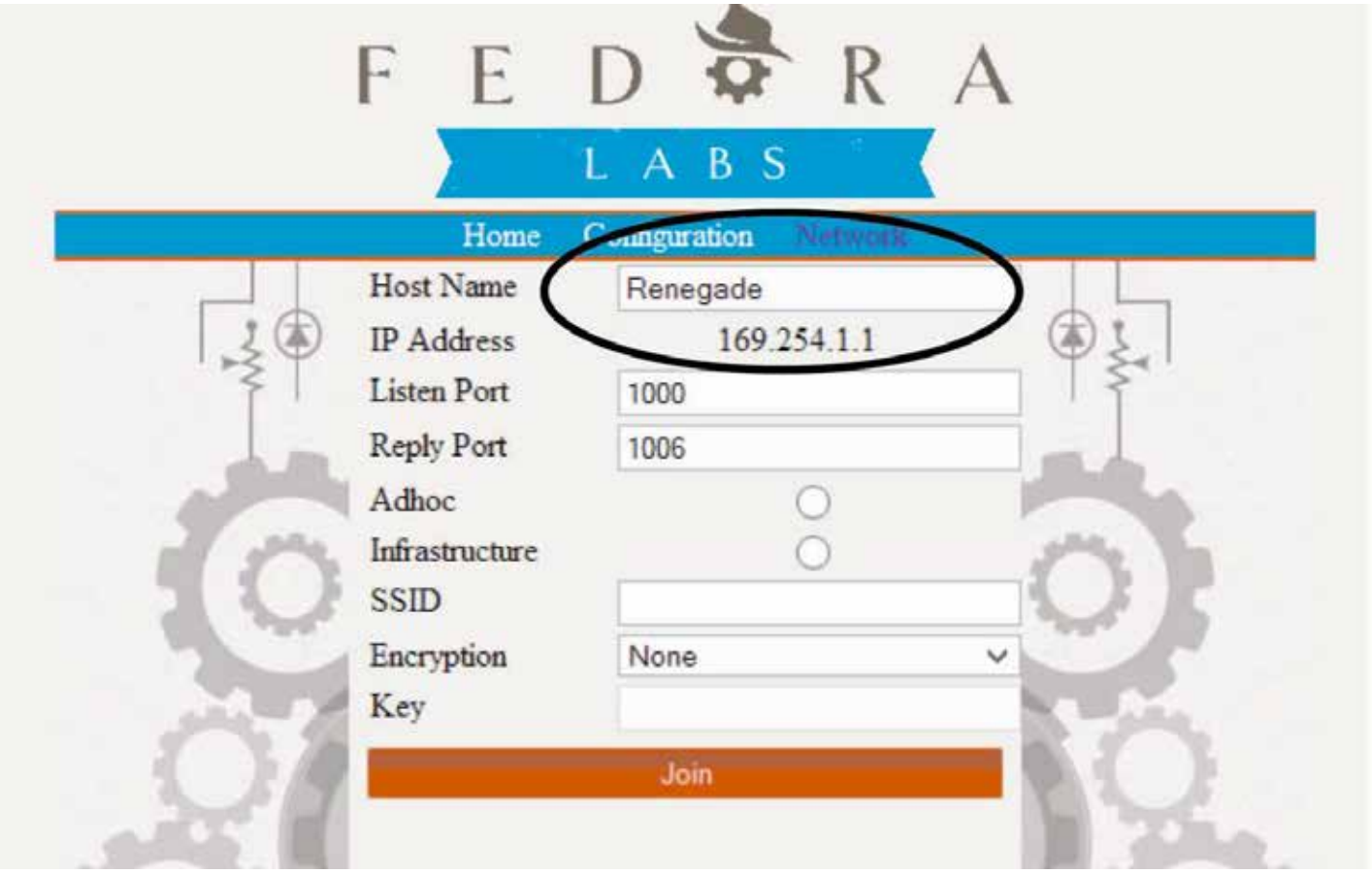
2.3.2. Web Configuration Utility

This section introduces you to the Web Configuration Utility. The Web Configuration Utility allows you to configure your Renegade's 32 I/O channels according to your specifications. This can be accomplished either through the ad hoc connection you establish initially (see above), or by connecting your Renegade to communicate over a central infrastructure wireless network:

Connecting to a Network

1. **Confirm/Customize the name of your Renegade**

   Within the Web Configuration Utility, click on "Network" – the furthest to the right of the top row of menu options.



   Here you will see a box labeled "Host Name". The default setting in this box will read "Renegade."

   By typing a new name in place of "Renegade" in this box, you will be changing the name by which your Renegade identifies itself and is identified by your Web Configuration Utility.

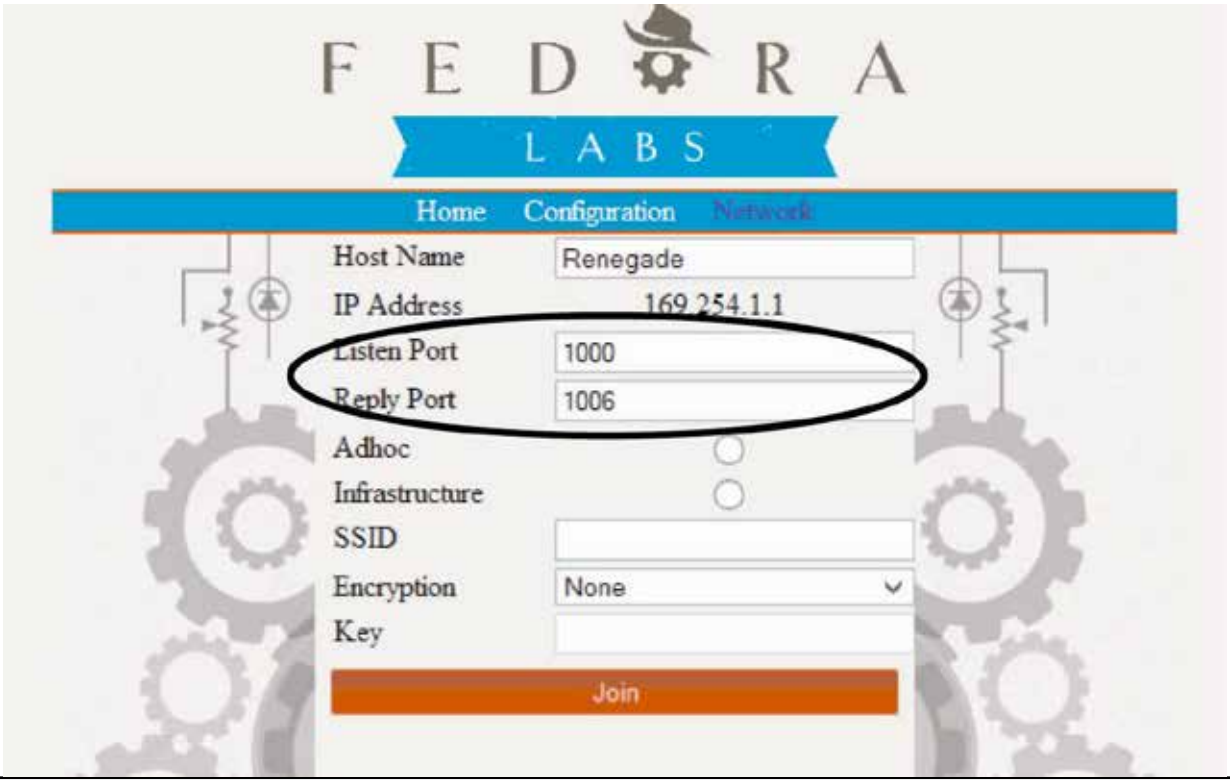
If operating multiple Renegades, you must assign each unit an individual name.

Make sure you keep track of any name changes you assign to your Renegade as that name will be crucial in establishing wireless connections.

2. Confirm/Customize Communication Settings

Below the Host Name box, you will see boxes listing the "Listen Port" and "Reply Port". The factory default settings for these are 1000 and 1006, respectively. These settings will allow for communication between your Renegade and your computer or other wireless device and generally should not be changed.

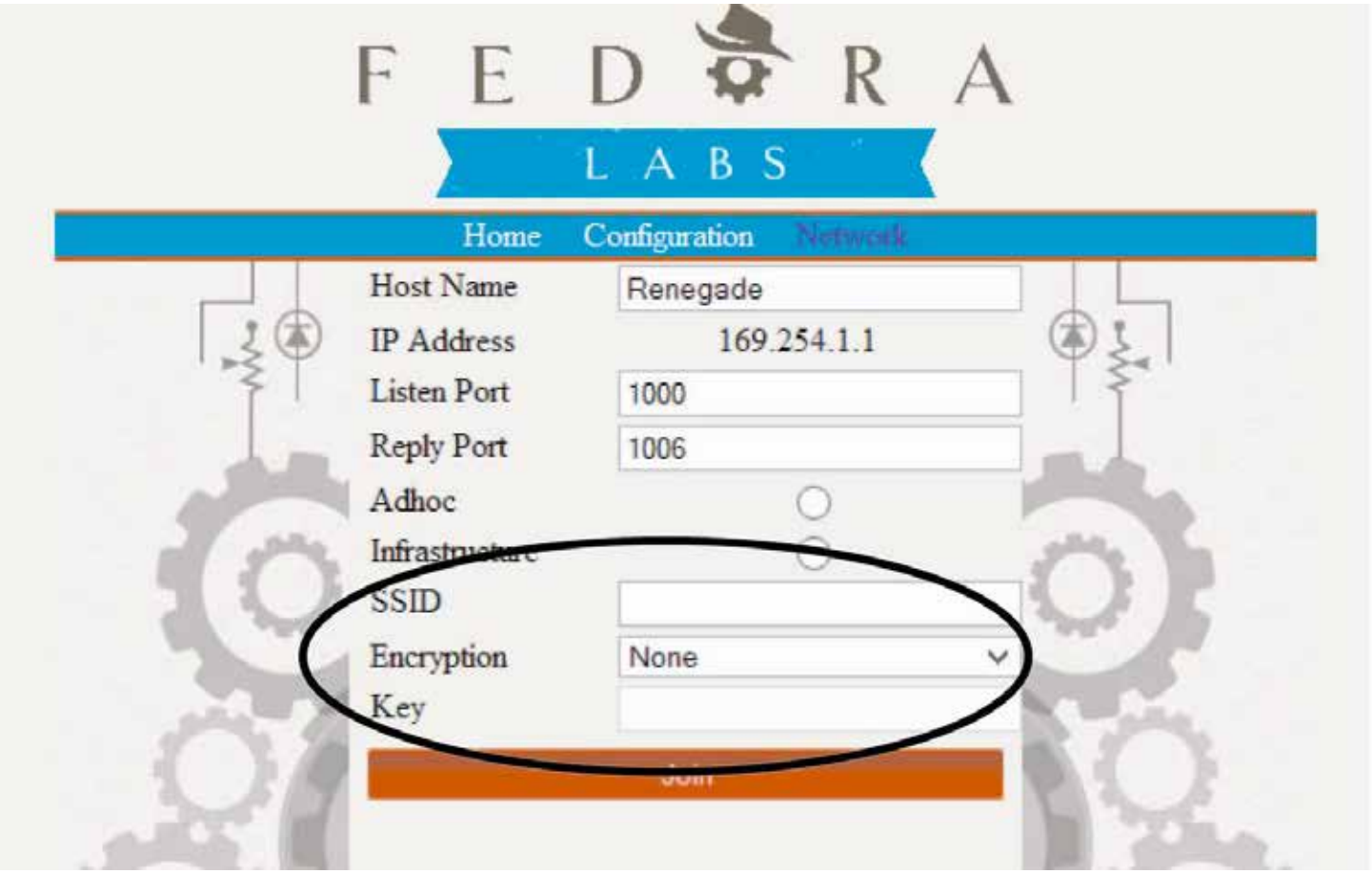
In cases where you are operating multiple Renegades you will need to alter these settings, assigning specific Listen and Reply Ports for each individually-named (see above) Renegade in operation.



The "Listen" and "Reply" settings in your Web Configuration Utility will ultimately have to match those within the Desktop Operation Utility in order to facilitate communication. Keep track of the settings assigned to your Renegade or multiple, individually-configured Renegades.

3. Connecting to a Central/Infrastructure Wireless Network

If you are operating your Renegade in an environment with a centralized, infrastructure wireless network, you can configure your settings to connect with that network.



- SSID – Insert the name of your infrastructure wireless network
- Encryption – in most cases, this should be set to WPA/WPA2Passphrase
- Key – Insert your infrastructure wireless network security password

Once you are finished with the Web Configuration Utility and your settings are sent to your unit, your Renegade will automatically connect with the infrastructure wireless network for as long as those settings remain.

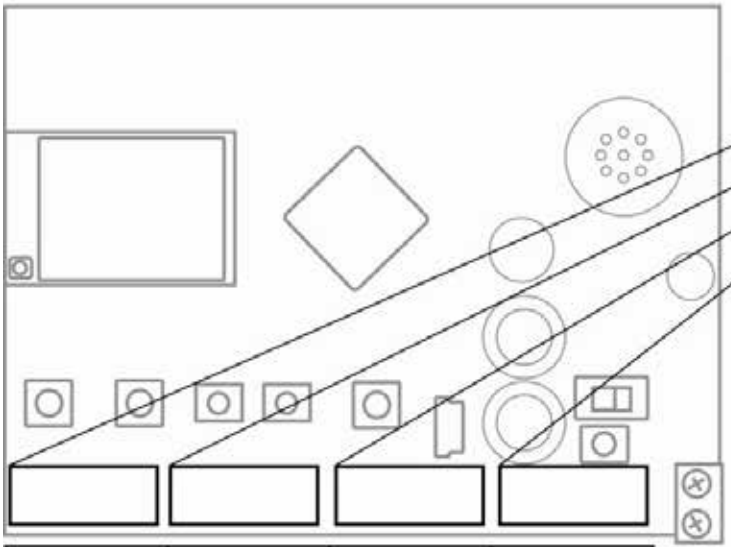
When connecting to an infrastructure network, your Renegade will beep once and LED Indicator 2 will blink, then, after about 30 seconds the Renegade will beep again indicating that it has connected to the infrastructure wireless network.

While connected to infrastructure wireless network, LED Indicator 2 will blink once every second. By contrast, while operating through an ad hoc connection, LED Indicator 2 will blink twice per second.

Configuring Your Renegade

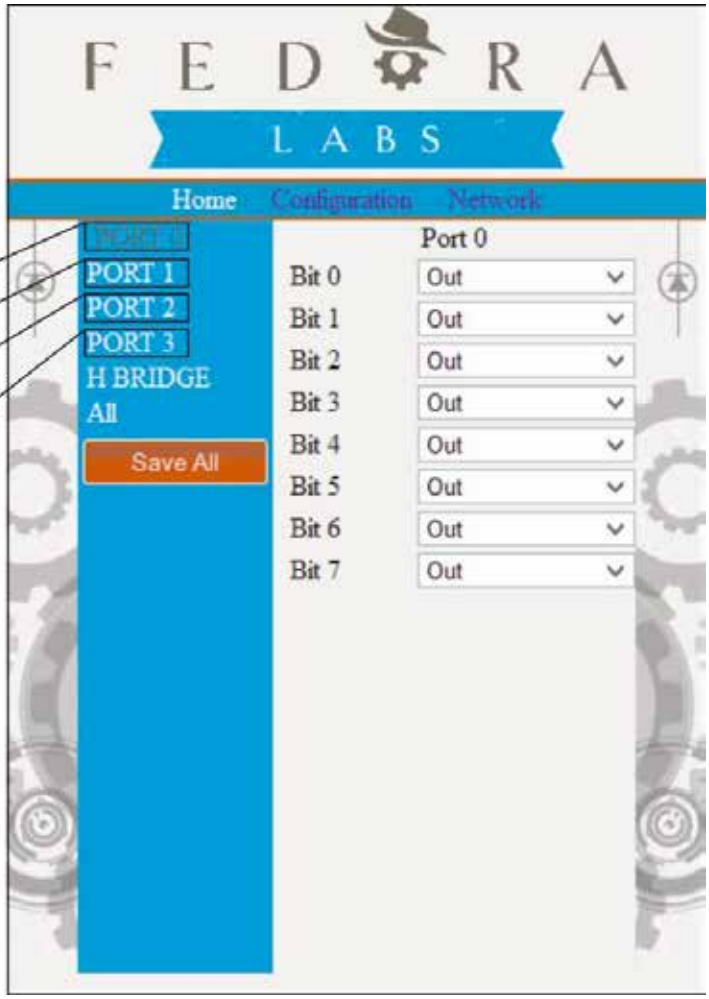
The Web Configuration Utility controls the customized settings for each of your Renegade's 32 GPIO channels. They are arranged within the Web Configuration Utility by Port, matching their arrangement on the Renegade Main Board.

Each port can serve as an Input, Output or RC Servo Channel. Additionally, PORT 2 can be configured as an Analog to Digital Converter. PORT 3 can connect with quadrature Encoders and features pull-up resistors.



PORT 0	PORT 1	PORT 2	PORT 3(1)
Input	Input	Input	Input
Output	Output	Output	Output
RC Servo	RC Servo	RC Servo	RC Servo
—	—	Analog	Encoders

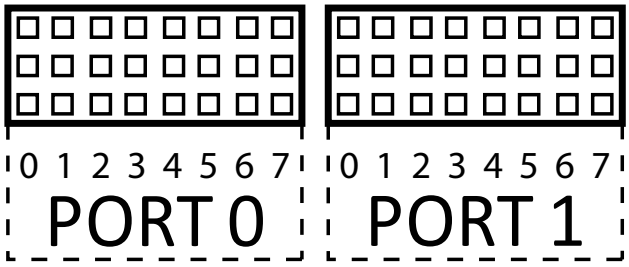
(1) Port allows user to enable pull-up resistors



1. **Configure Ports by Bit**

Access your Configuration Page by selecting the "Configuration" menu from the center of the top line of menu options.

Within this page you are given a great degree of control over the versatile customization of your Renegade as you can establish the function of each bit (that is, each of the eight columns of three pins – as shown below) of each port.



The Web Configuration Utility gives you the ability to set each bit as Input, Output or Servo (as well as Analog or Encoder on PORTS 2 and 3, respectively). In order to do so, simply select the Port that you would like to customize from the menu on the left of the screen and then select your desired function from the pull-down menu associated with each bit.

Examples of the Web Configuration Settings appropriate to the various functions of the Renegade are included below in Section 2.4.

2. **Configure Motors**

With the external Motor Driver attached, the Web Configuration Utility allows you to establish whether you would like to use your Motor Driver to run two DC motors bi-directionally or up to four DC motors uni-directionally (effectively deciding between two full HBridge switches and four half-bridge switches) .

Simply select the "H Bridge" option from the list on the left side of the screen to access the associated pull-down menus that allow you to toggle between these configurations.

Examples of Motor Driver Settings are included in Section 2.4.5 below.

3. **Review and Send Settings to Renegade**

Once you have configured each bit, each port and each motor driver you can review all of the settings in a single glance by selecting the "All" option from the list on the left side of the screen. This will display a long pull-down menu of each setting you have selected. This screen also allows you to make changes to your configuration.

- Review – Once you have configured each bit, each port and each motor, you can review all of the settings in a single glance by selecting the "All" option from the list on the left side of the screen. This will display a long pull-down menu of each setting you have selected. This menu also allows you to make changes to your configuration.

- Save/Send – Press the "Save All" button at the bottom of the list on the left side of the screen. This locks in the configurations that you have set and sends that configuration to your Renegade.

- Reset– Reset your Renegade by pressing the Reset Switch on the Main Board. Your Renegade's LED Indicators will blink off and back on. The Main Board will beep once, then again as it reestablishes a wireless connection. Finally, the LED Indicators will resume their regular blinking pace, and your Renegade is now configured according to your settings.

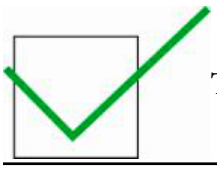
Resetting Your Renegade to Factory Defaults

On the occassion that wireless or configuration settings are causing communication problems, you may have to reset your Renegade to its factory default settings and restart the configuration process.

In order to perform this "hard" reset, simply press Switch 2 and hold it down. After about two seconds, the Renegade's LED 2 will turn off. Now release Switch 2 -- LED 2 will turn back on and the board will beep.

Your Renegade will now be set back to all default configuration settings (including the factory default IP address) and, assuming the wireless attenna is attached, will reestablish an ad hoc wireless connection.

Please refer back to the beginning of Section 2.3. for configuration instructions.

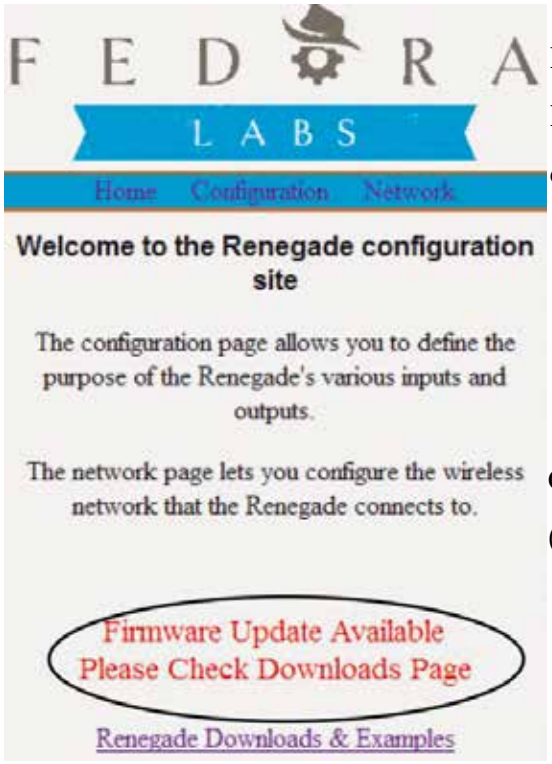


The Reset switch alone will restart your Renegade but will not return it to factory defaults.

Updating Firmware

Firmware updates will occasionally become available from Fedora Labs as need and opportunity arise. These can be installed to your Renegade via the USB connection.

Check regularly at the Renegade Downloads page (www.fedoralabs.com/renegade-downloads) to see availability of these updates.



If a new version of the firmware is available, your Renegade Home Page (Web Configuration Utility) will notify you upon establishing a connection.

Click the link to re-direct you to the Renegade downloads page (www.fedoralabs.com/renegade-downloads).

1. **From the www.fedoralabs.com/renegade-downloads page, download and extract the "Renegade Firmware Update Utility", and the most recent version of Renegade Firmware (.hex)**

   Keep track of where on your computer you download and extract your new Firmware Hex file as you will need to instruct the Utility to open that file during Step 5 of this process.

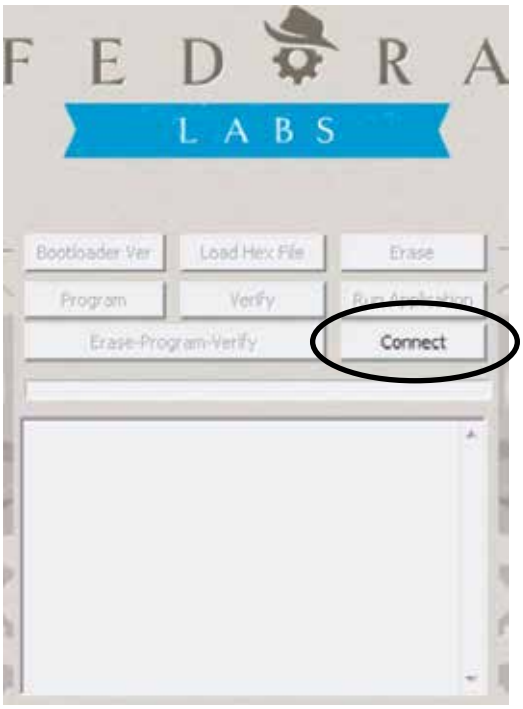
2. **Run the Renegade Firmware Update Utility**

   At this point your Renegade is powered off and not connected to your computer.

3. **Attach and Activate Your Renegade in "Firmware Update Mode"**

- With your Renegade still powered off, attach to your computer with a USB Cable (see section 2.2.2)
- Press Switch 2, with switch 2 held down, turn on Power Switch – this turns on your Renegade in "Firmware Update Mode".

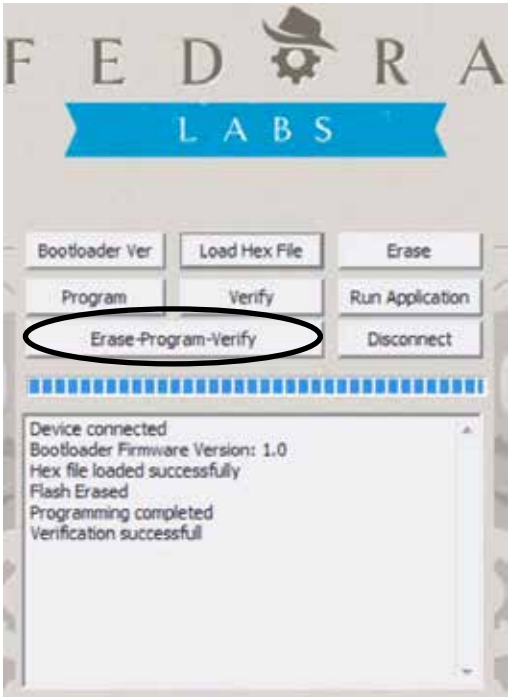
4. **In the Firmware Update Utility, click the button labeled "Connect".**



5. **With your Renegade connected, now click the button labeled "Load Hex File".**

You now have to select the particular hex file that you would like to load into you Renegade from the location on your computer where you downloaded and extracted that file in Step 1 of this process.

6. **The Firmware Update Utility will indicate when it has loaded the new Firmware.**



7. **Press the button labeled "Erase-Program-Verify" to complete the process of replacing old Firmware with the new version.**

8. **With the new Firmware Updated, you will now need to reconfigure your Renegade. Refer back to the beginning of Section 2.3.2 for instructions.**

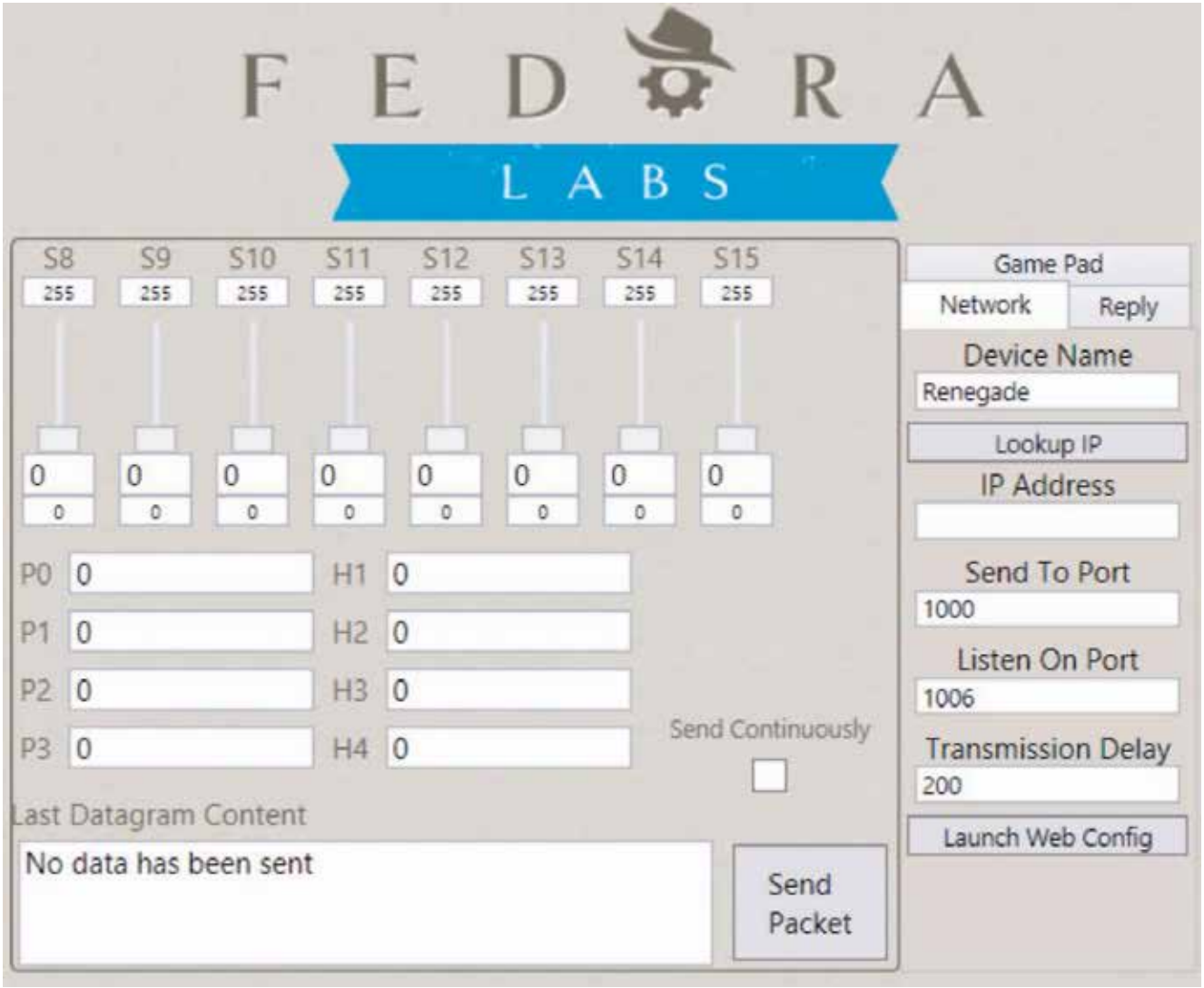
2.3.3. Desktop Control Utility

With your Renegade now configured to your desired specifications, it is time to move on to the operation of your attached external devices.

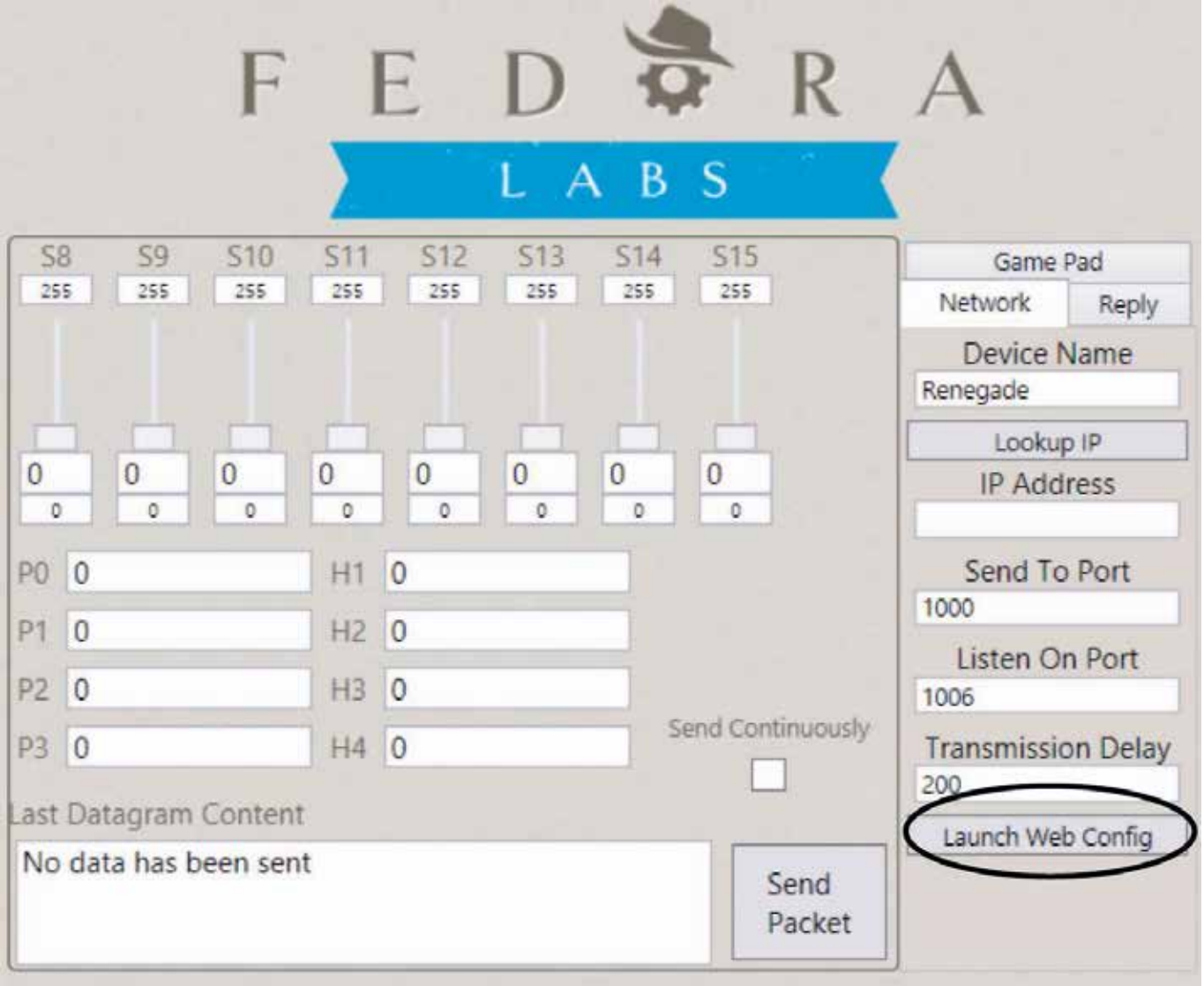
A sample operating program, The Desktop Control Utility, is available from www.fedoralabs.com/renegade-downloads.

The Desktop Control Utility allows you to communicate with each Port and the Motor Driver of your Renegade. Furthermore, it provides active control of each bit of PORT 1, controlling up to 8 RC Servos (numbered 8-15). If you would like similar control over the other ports, feel free to use the Desktop Control Utility as a template for creating and writing the code for your own customized programs.

1. **Access and Activate Desktop Control Utility**
   Navigate your web browser to www.fedoralabs.com. Access the download page and select "Desktop Control Utility." The homepage for this utility is shown below.

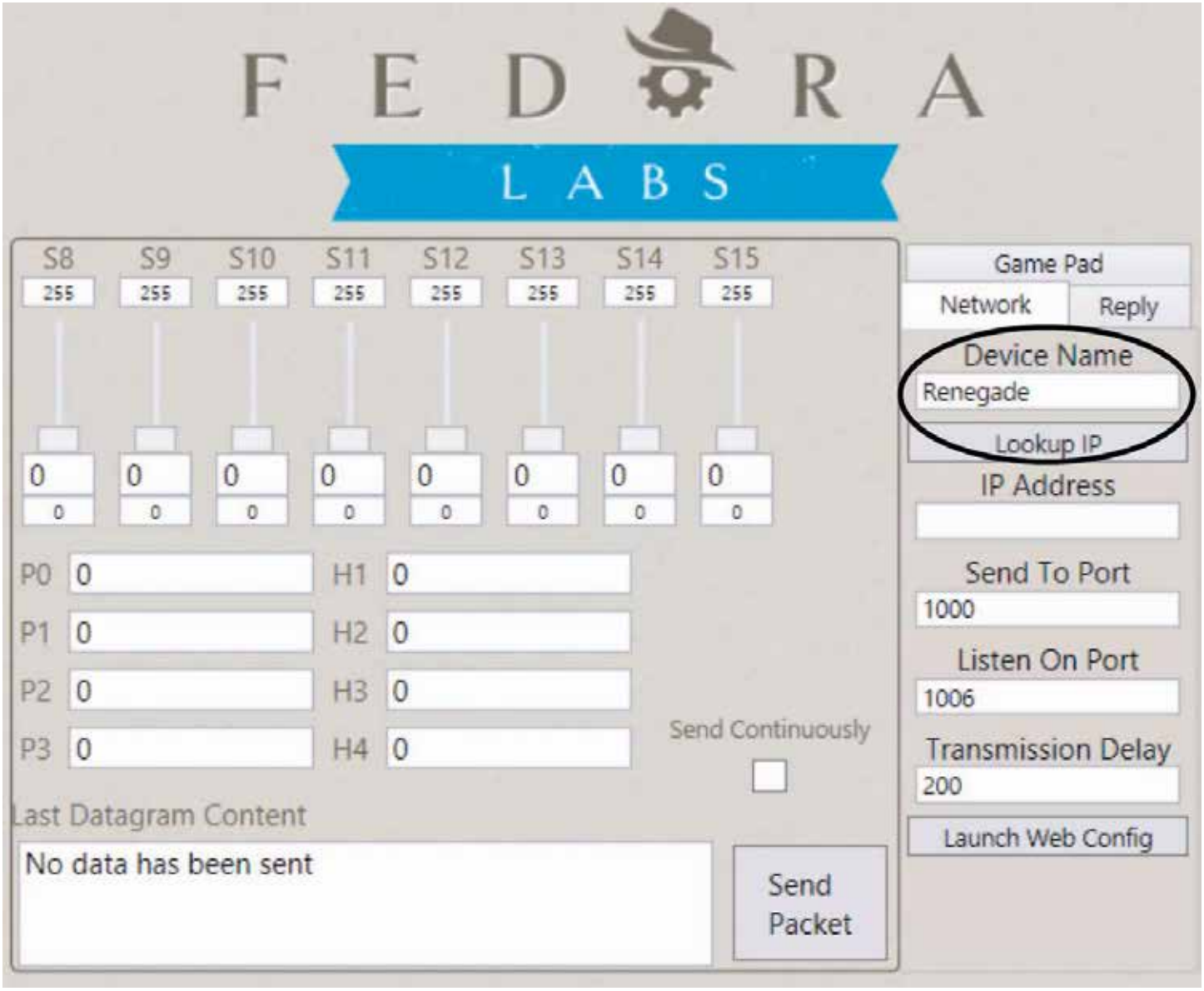


To operate your Renegade from the Desktop Control Utility, the communication settings on the Utility and the Renegade must be identical. To easily facilitate any changes that must be made, the Desktop Control Utility includes a button that will take you directly to the Web Configuration Utility which is where all changes to the communication settings on your Renegade are made.



2. **Find and Connect to your Renegade.**

Near the middle of the screen you will see a box labeled "Device Name". Insert the name of your device which will be either "Renegade" or the custom name you assigned your device in the Web Configuration Utility (see Section 2.3.2).

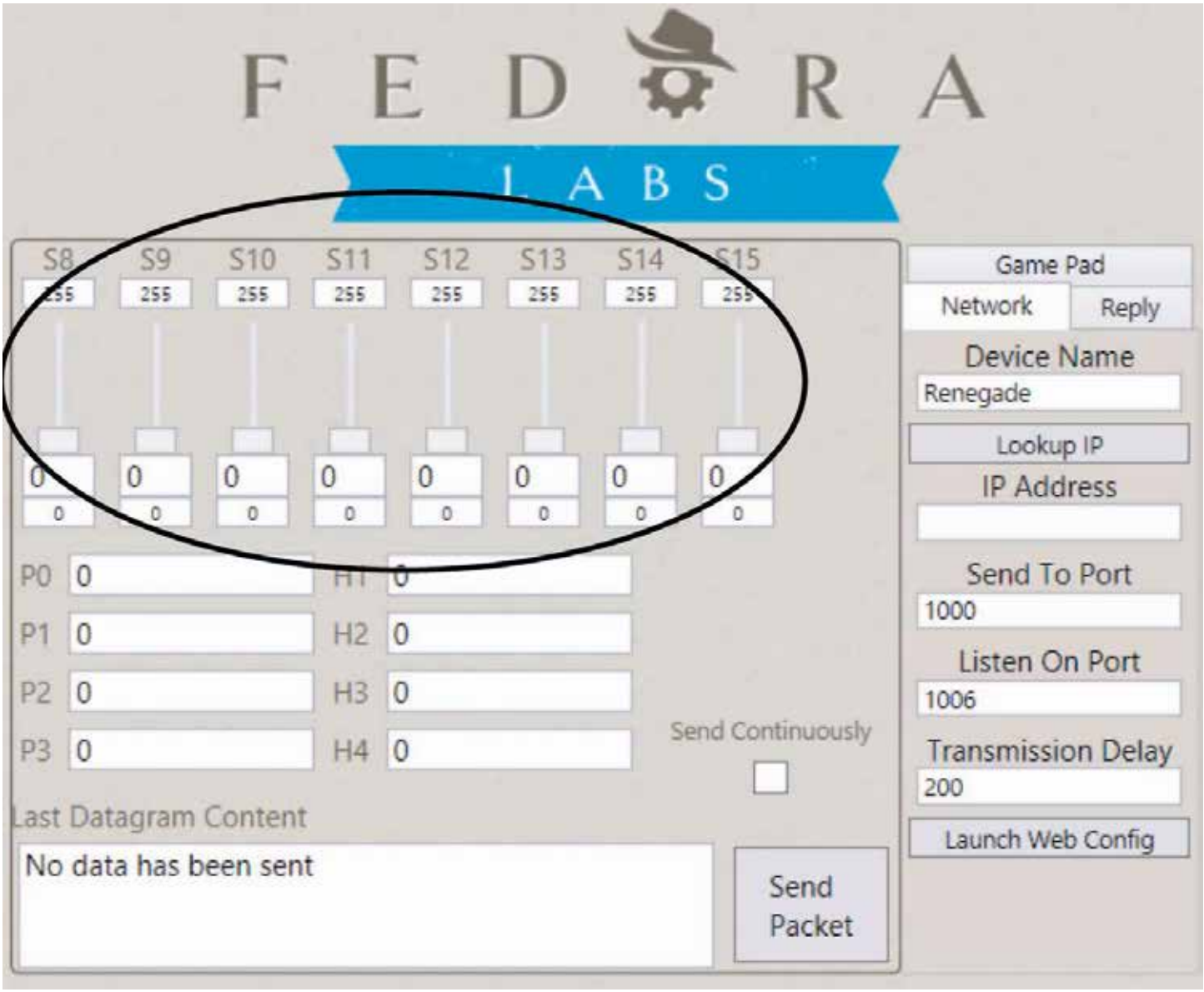


Now press the "Look Up IP" button directly underneath the "Device Name"box. The Desktop Control Utility will find your device over the wireless connection and begin communication.

To communicate with your device through the Desktop Control Utility, your settings must be identical to those of the Web Configuration Utility. Specifically, you must have the correct Device Name, and "Listen" ("Send to") and "Reply" ("Listen On") Ports.

3. **Adjust Servo Settings**

The Desktop Control Utility illustrates the settings for the eight Servo controls (bits 8-15) on PORT 1, with the adjustable bars displayed left to right.



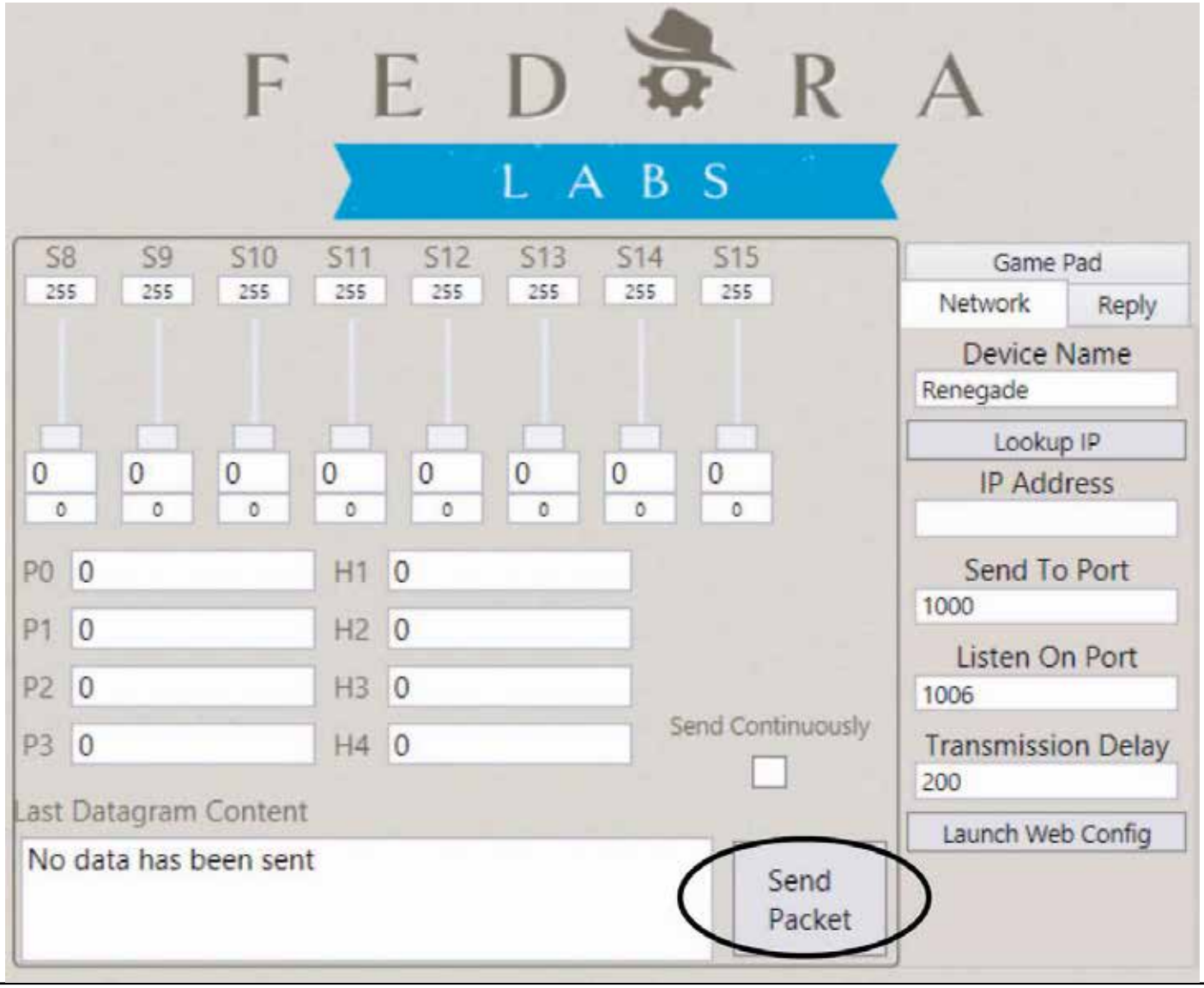
- Each Servo can be sent a minimum signal of "0" and a maximum of "255". The signal can be entered manually into each Servo Bar's setting box or adjusted by sliding the measurement box up or down.

- Every external Servo will have its own range limits. Within the Desktop Utility, "0" is will always equal 0 degrees on your servo; "255" will always equal your Servo's maximum. Accordingly, "0" functions as 0% and "255" functions as 100% of your Servo's capability.

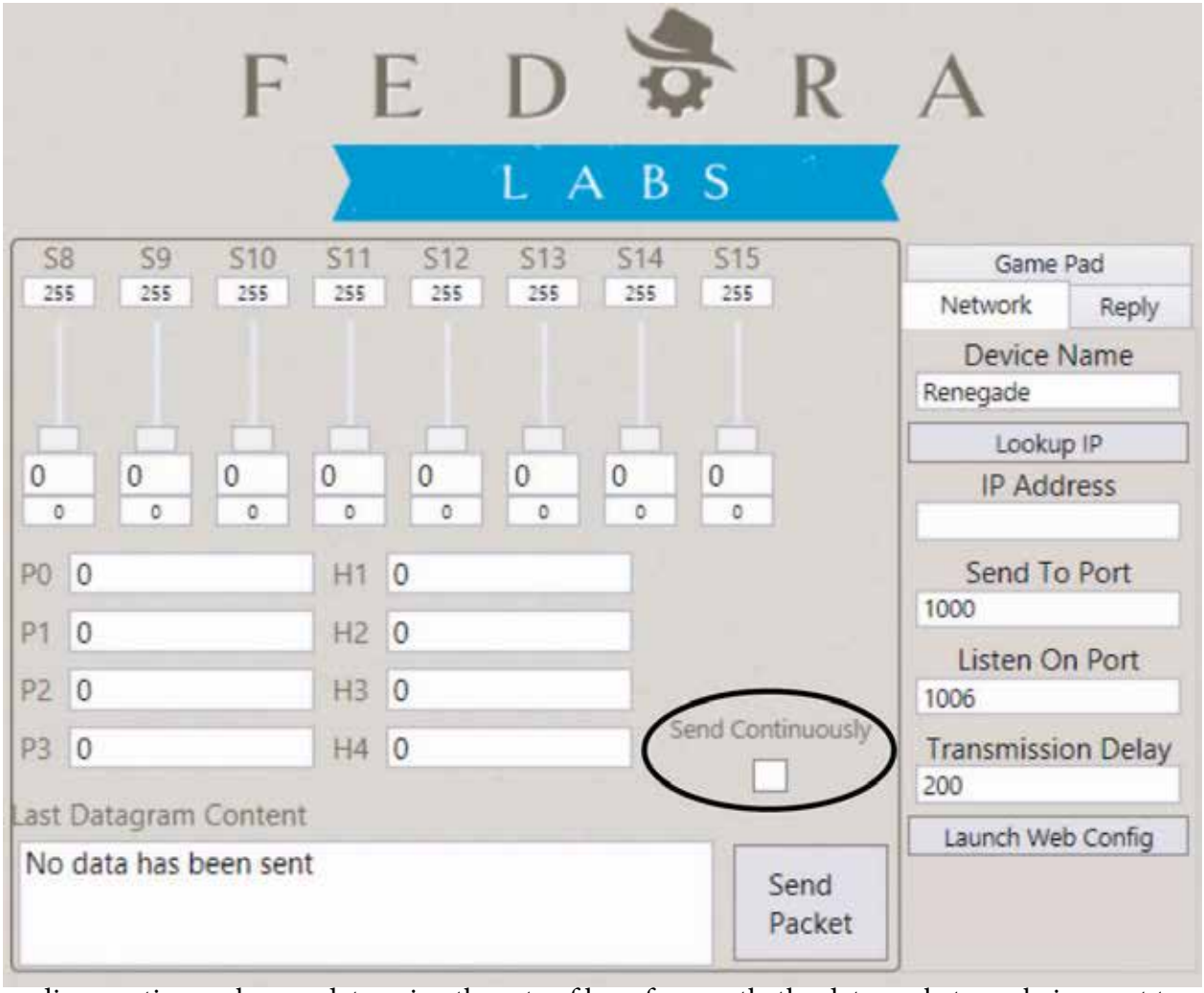
4. Adjust Signal Sending Rate

The Desktop Control Utility communicates with the Renegade by sending simple, intuitive packets of coded data (discussed in greater detail in section 2.3.5 below). These coded packets reflect the information that you are setting by raising or lowering the servo bars with your mouse, by manually entering settings, or with alternate controllers (see Section 2.3.4). You have the ability to determine how often you would like those packets to be sent from your Desktop Control Utility to your Renegade.

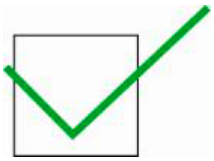
- Send Signal Once – If you would like your servos to remain in a predetermined configuration, then you can set each of your Servo ratings and send all of that data in a single packet. By pressing the button at the bottom of the screen labeled "Send Packet," all of the settings on your Desktop Utility will be communicated to your Renegade at once and stay that way until you set and send a new configuration.



- Send Continuously – Alternately, you can set your Desktop Control Utility to send data packets of commands continuously which will allow you to see the adjustments you make to your Servo settings as you make them, or allow for you to establish a repeating action. To send continuous packets, check the box under "Send Continuously," before you begin the transmission by pressing "Send Packet."



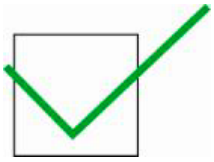
When sending continuously, you determine the rate of how frequently the data packets are being sent to your Renegade. On the right hand side of your screen in the Desktop Control Utility you will see a box labeled "Transmission Delay". This is where you set the rate for sending messages to your Renegade. The rate you choose will determine how quickly (in milliseconds) your Servos will reflect adjustments you have made to your Servo settings.



The fastest that you can expect the Renegade to function, and therefore the lowest number you can reasonably set your Transmission Delay, is one data packet every 20 ms (milliseconds). When operating at a rate faster than 20 ms your Renegade runs the risk of incorporating errors into the command data. This may potentially overload the microcontroller at which point your Renegade will reset itself into ad hoc mode and will need to be reconfigured.

LED indicator 1 will toggle each time it receives any wireless signal, including when it gets command packets from the Desktop Control Utility.

In order to interrupt a transmission or make adjustments, you will need to press the “Stop Sending” button that replaces “Send Packet” when sending continuously.



The Renegade cannot be reconfigured while receiving data packets. For this reason, the “Launch Web Config” button at the bottom right corner of the Desktop Utility will not be available while sending continuously.

2.3.4. Alternate Wireless Control

Because your Renegade is operated via Wi-fi, any wireless capable device can be used as a controller. Thanks to this feature, your Renegade is not restricted to areas with central wireless networks.

iPhone/Android

As wireless devices, smartphones can be used to control your Renegade. There is no preprogrammed app to serve this purpose but the fundamental requirements for communication have been demonstrated with the Desktop Control Utility. Regularly check the online forum at www.fedoralabs.com/forum for developments

The simple commands necessary for your Renegade to operate are described in Section 2.3.5. Any means you can devise to wirelessly transmit these codes in any compatible programming language will yield the desired results.

Gamepad

The Renegade can be configured to receive data packets through the Desktop Control Utility (or your similarly designed custom program) from a wireless gamepad. A prototype program for gamepad control that interfaces directly with the Desktop Control Utility will be available from www.fedoralabs.com/renegade-downloads.

2.3.5. Renegade Communication

The configuration and control of your Renegade is accomplished through the communication of easily-understood messages transferred between your computer or alternate wireless device and the Renegade itself. Wireless communication takes place using User Datagram Protocol (UDP) to maximize the speed of transfer. Your Renegade is capable of both receiving and sending messages.

Sending Commands to Renegade:

Renegade is capable of receiving messages in a wide variety of formats including, but not limited to: C, C++, C#, PYTHON, and MATLAB. The table below lists some of the basic commands involved in communicating with your Renegade:

Command	# Range	Data Range	Function
b	——	———	starts a command to the Renegade
P#	0-3	0-255	indicates the port to which the specified signal is sent
S#	0-31	0-255	indicates the bit to which the specified Servo signal is sent
H#	0-4	0-1024	indicates the motor to which the specified signal is sent in half-bridge mode
F#	0-1	-512 to 512	indicates the motor to which the specified signal is sent in full-bridge mode (-512=full reverse, 0=stop, 512=full forward)
e	——	———	ends a command to the Renegade

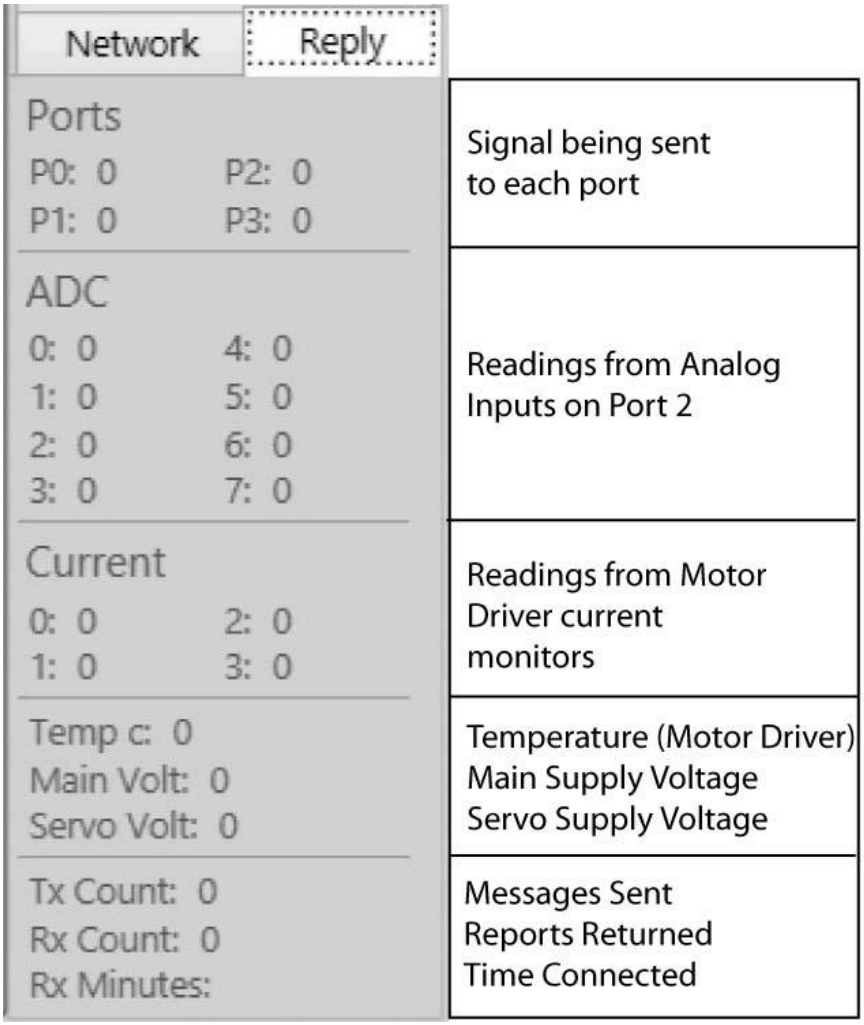
A very simple data packet might read:

b P0 255, S8 100, e

This packet would simply instruct the renegade to send a full signal to all of the bits of PORT 0 along with a signal of 100 to Servo 8 (which is the first bit of PORT 1) adjusting that servo to the coordinating position.

Receiving Reports from Renegade:

Renegade sends reports to the Desktop Control Utility in a very similar format. The reports sent from your Renegade can be read at the bottom right corner of the Desktop Control Utility.



The reports sent from your Renegade confirm configuration settings, state temperature, current and voltage measurements, and relay any data received from external devices. Below is a table outlining the general structure of those commands that are displayed in the Desktop Control Utility.

Report	# Range	Signal Range	Function
A#	0-7	0-1023	readings from Analog input (PORT 2)
C#	0-3	0-40A	readings from current monitors (motor driver)
T	——	0-175°C	readings from Temperature monitor (motor driver)
MV	——	8-18	main supply voltage reading (motor driver)
SV	——	4.8-7.2	servo supply voltage (main board)
E#	0-1	32 bit value	readings from encoders (Port 3)

Below is an example of a full report that the Renegade might send:

b P0 255, P1 0, P2 0, P3 239, C0 29.76, C1 13.07, C2 9.170, C3 7.159, MV 0.000, SV 5.175, T 511.9, A0 239, A1 198, A2 272, A3 307, A4 380, A5 435, A6 420, A7 252, E0 0, E1 4112, e

The Renegade is reporting a full signal on PORT0 (P0 255), no signal on PORTS 1 and 2, and a signal of 239 on PORT 3 which is representing the "noise" that is associated with Analog Inputs.

C0-C3 return various readings, indicating the amount of current detected by each monitor.

The Motor Driver is not attached which is why there is no reading coming through for the main voltage (MV). The Servo Power source, on the other hand, is connected and has a reading of 5.175 volts.

The Temperature (T) reads 511.9 – this number actually represents no data. The temperature is read from the Motor Driver which is not attached.

All of the Analog (A0-7) readings are returning "noise" as no devices are connected.

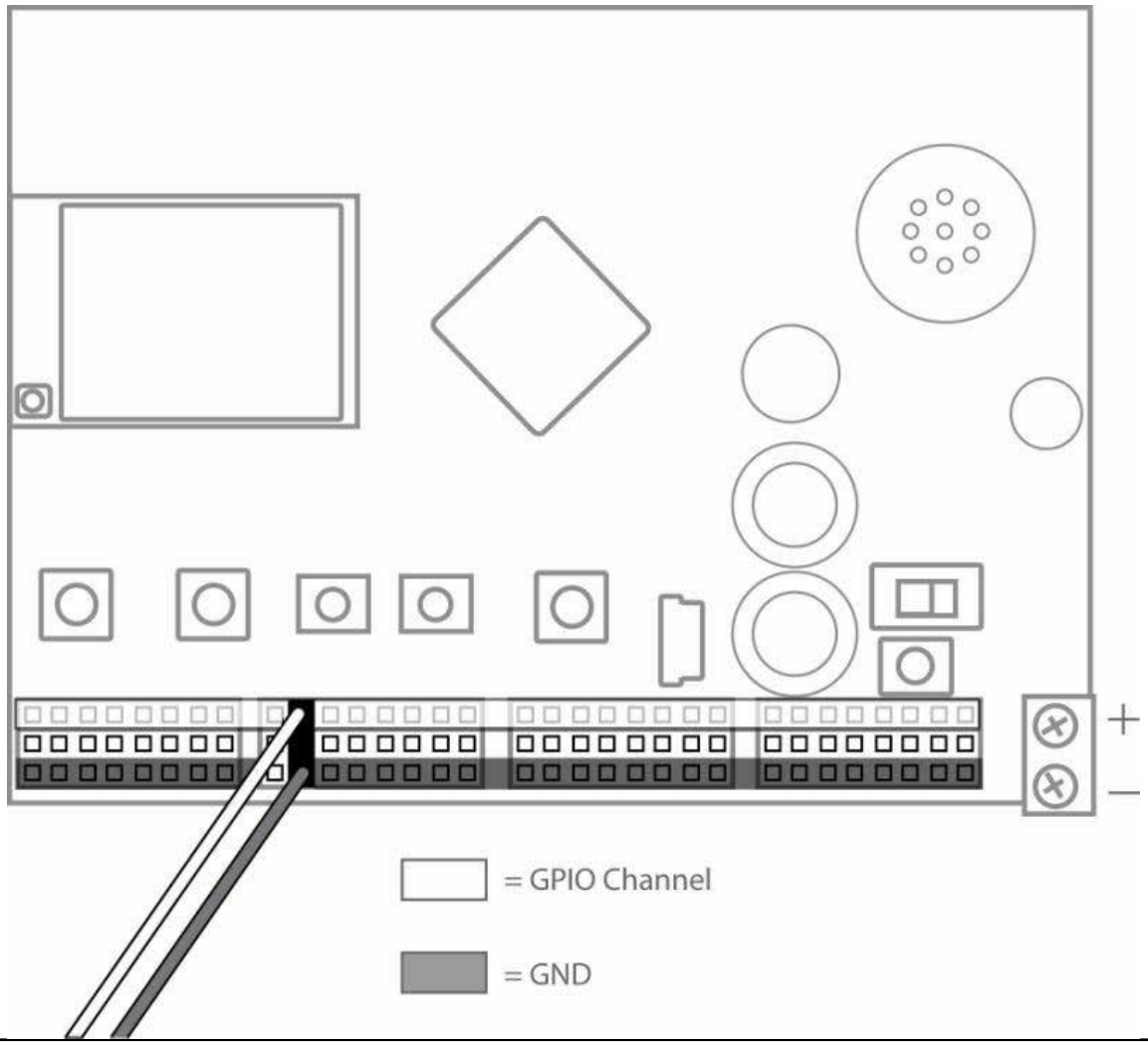
Finally, the second encoder (E1) is returning a high signal, which is an indication of the positive rotation of that external device.

2.4. General Purpose Input/Output Channel

Renegade consists of four 8-bit ports numbered from left to right (0, 1, 2, and 3). Each channel can be configured individually as an Input, Output, or RC Servo control. Additionally, PORT 2 can be configured as an Analog Input while PORT 3 can be configured as an input to interface up to two quadrature encoders.

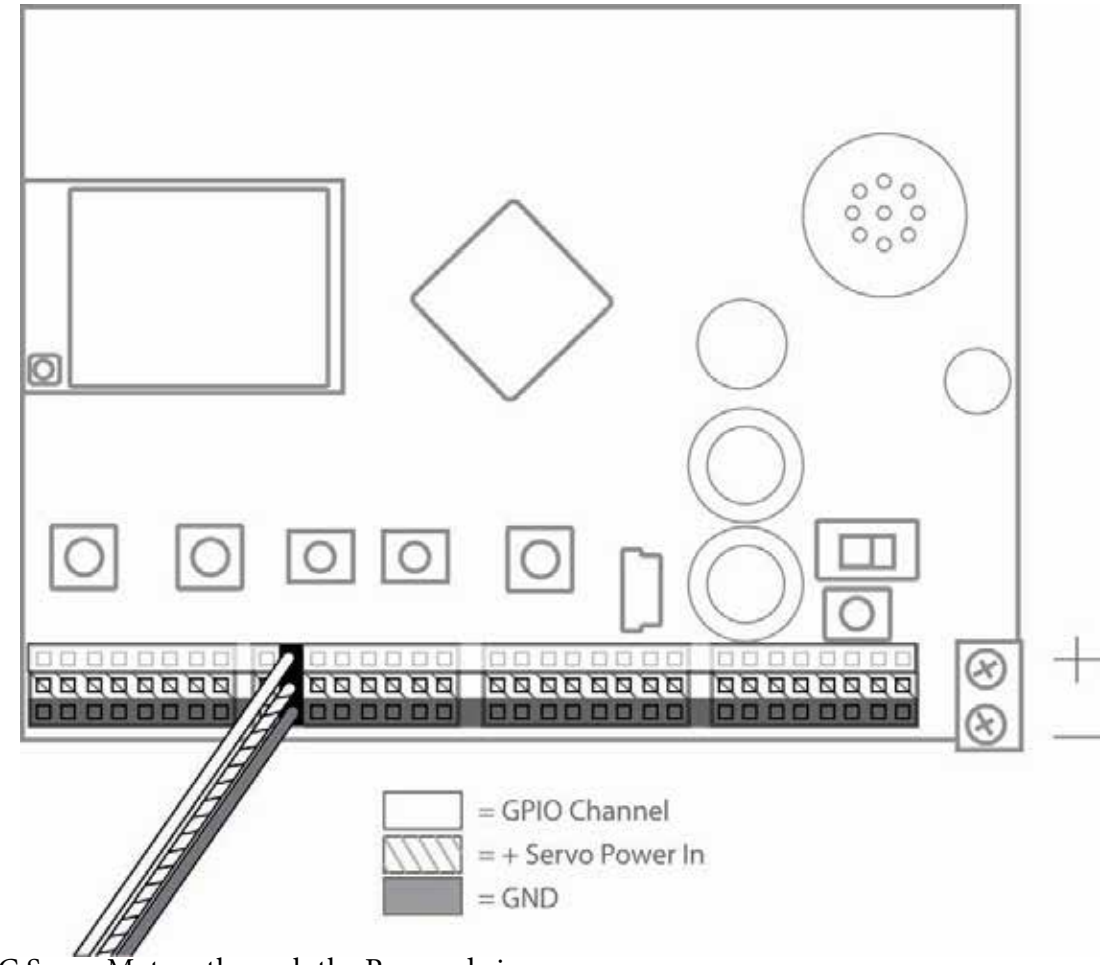
The maximum voltage limit on each pin (regardless of configuration) is 3.3V DC. Exceeding this voltage will permanently destroy your Renegade.

The image below demonstrates how to physically attach any external device to the GPIO channels. The example shows a connection to PORT 1, Bit 1 (P1, S1). While the following section demonstrates the Web Configuration Settings necessary to operate the variety of compatible devices, the only difference in the physical connection will be the Port and Bit location(s) to which you attach your device.

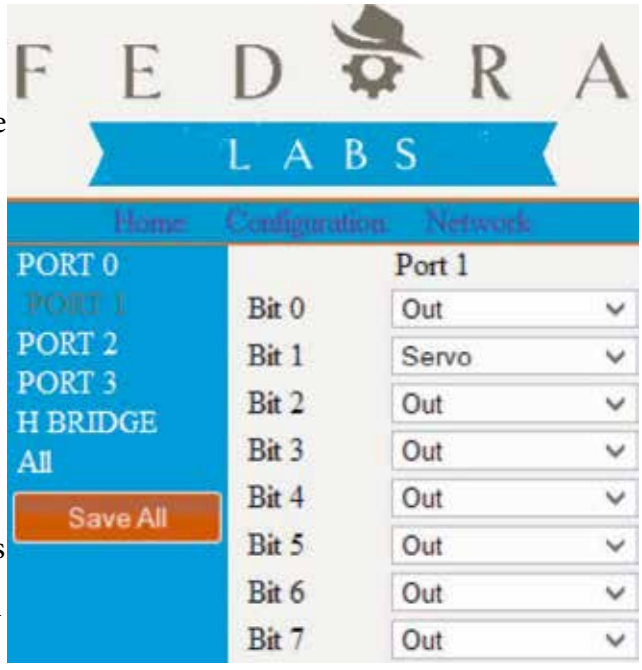


2.4.1. RC Servos

Your Renegade can control up to 32 RC Servo motors at one time. The power to the RC Servos is supplied through the terminal block connector located in the lower right corner of the board. The same supply can also be used to power the main Renegade board.



Operating RC Servo Motors through the Renegade is a very straightforward process. Simply attach the device as shown in the illustration above and configure that Port and Bit to operate as a Servo within the Web Configuration Utility. The image to the right shows the Configuration setting you would need in order to operate a Servo plugged in on PORT 1 BIT 1.



A coded data packet for this configuration is very simple and might read:

b S9 60, e

This instructs your Renegade to set the Servo attached to PORT 1, BIT 1 (=S9) to the position value of 60 which depends upon the specific range of the attached Servo (see discussion in Section 2.3.3)

Refer to your RC Servo data sheet for voltage and current requirements. Standard RC Servos operate between 4.8V DC and 6V DC. Exceeding these specifications could damage or destroy your RC Servo Motor.

Common Applications of RC Servos:

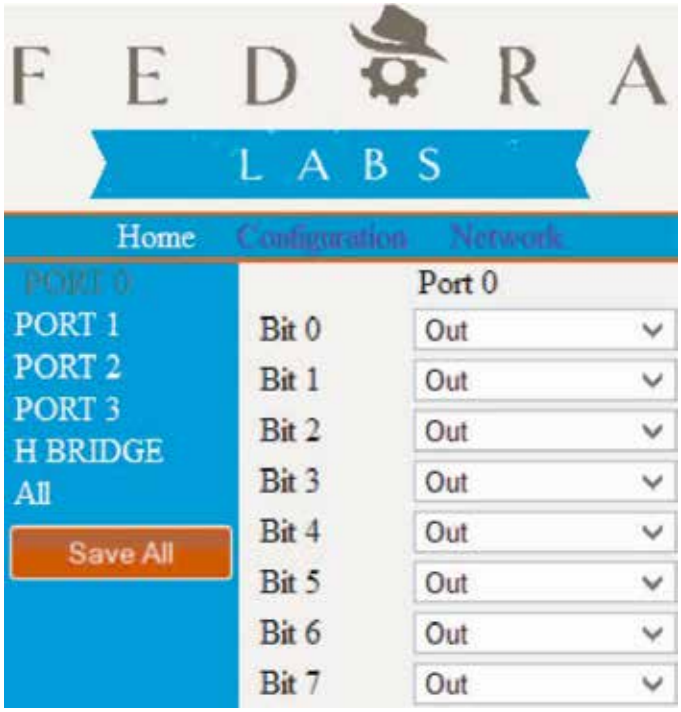
- Steering RC vehicles, actuators for hexapod, robotic arms, control robotic grippers, activate triggers, operate robotic drum, etc.

2.4.2. Digital Inputs/Outputs

Like RC Servos, each of Renegade's 32 GPIO channels can be configured as Digital Inputs or Outputs. The maximum input voltage for each GPIO channel is 3.3V DC.

Exceeding the maximum 3.3V limit on any of the GPIO channels could permanently damage or destroy the channel or the microcontroller.

Again, just like in the example of RC Servo's, the connection is very straightforward. This image shows the Configuration settings that you would need to operate all of the Bits of PORT 0 to connect to Digital Output devices.



To instead connect Digital Input devices, you would only need to change the affected Bits from "Out" to "In" in their respective pull-down menus.

Communication while configured for Digital Output is more complex than operating Servos. Here you are dealing with data sent as decimal translations of binary byte information to indicate which pins of each port to activate.

To activate the first pin (numbered pin 0), you would send the first port (Port 0) a signal of 1 (P0 1), while the second pin (numbered pin 1) would require a signal of 2 (PO 2). However, if you were to send a signal of 3 (P0 3), this would not activate the third pin (numbered pin 2), rather it would activate both the first and the second pins.

As you increase the number of pins, you exponentially increase the potential combinations of activation signals to be sent:

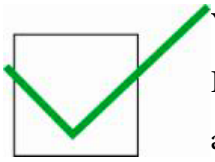
pin 0: **b P0 1, e**
pin 1: **b P0 2, e**
pin 2: **b P0 4, e**
pin 3: **b P0 8, e**
pin 4: **b P0 16, e**
pin 5: **b P0 32, e**
pin 6: **b P0 64, e**
pin 7: **b P0 128, e**

MSB							LSB
0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0
0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0
0	0	0	1	0	0	0	0
0	0	1	0	0	0	0	0
0	1	0	0	0	0	0	0
1	0	0	0	0	0	0	0

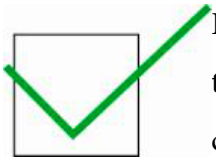
Other combinations of pin activations can be achieved by sending signals numerically located between those that identify specific pins or through their addition:

pin 1 and pin 3: **b P0 10, e (=P0 2 + P0 8)**
pin 0 and pin 7: **b P0 129, e (=P0 1 + P0 128)**
all pins: **b P0 255, e**

Readings from your Renegade when it is configured as an Input communicate in the same fashion. The numbers reported from each port represent which pins have a high signal on them.



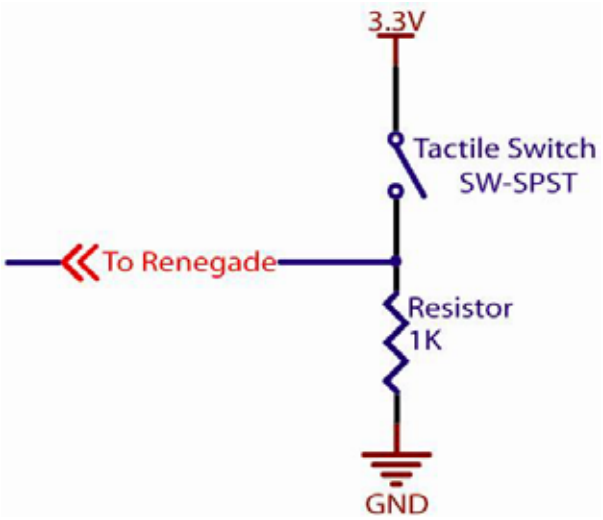
Your Renegade will NOT distinguish between the pins that have a high signal due to an external Input device communicating a high reading and those that have a high signal because they are activated and receiving commands as outputs.

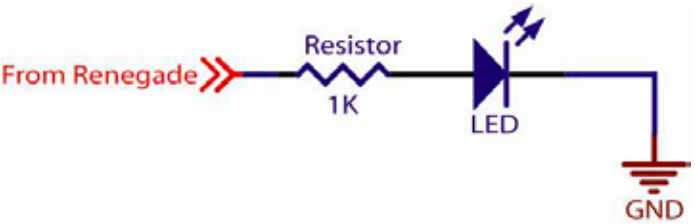


Because these decimal readings represent byte data, you will need to customize your programs to deal with any scenarios where portions of any given port are not configured as Inputs. In this case, consider investigating bitwise operations.

Common Applications of Digital Inputs/Outputs:

- Inputs: switches, discrete sensors, tactile sensors, tactile switches, limit switches, keypad
- Outputs: LED devices, peripheral devices





2.4.3. Analog Inputs

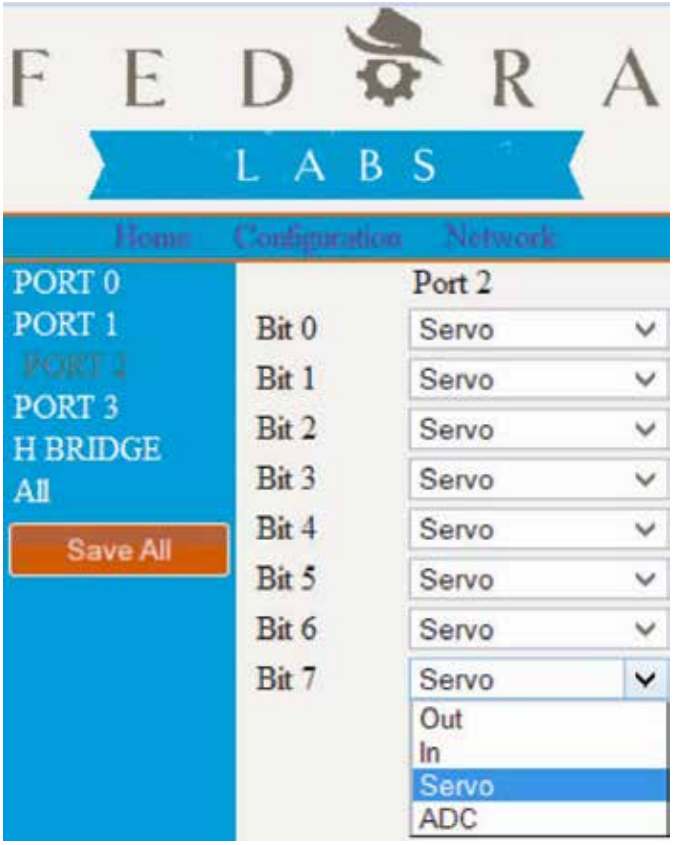
Your Renegade offers eight ADC (Analog to Digital Converter) Channels with 10-bit resolution on PORT 2 (numbered 0-1023). The maximum voltage limit on each ADC channel is 3.3V DC.

Exceeding the maximum 3.3V DC limit on any ADC Channel could damage or destroy the channel and/or the microcontroller.

Configuring your Renegade for an Analog device is only slightly more complicated than when dealing with a Digital device or RC Servo.

First, Analog devices can only be operated through PORT 2.

Select the Bit in PORT 2 where your Analog input device is connected, access that Bit's pull-down menu and select ADC (Analog to Digital Converter).



The report you get from the Renegade displays the voltage applied to the specified pin (A0-A7) in 10-bit resolution (0-1023).

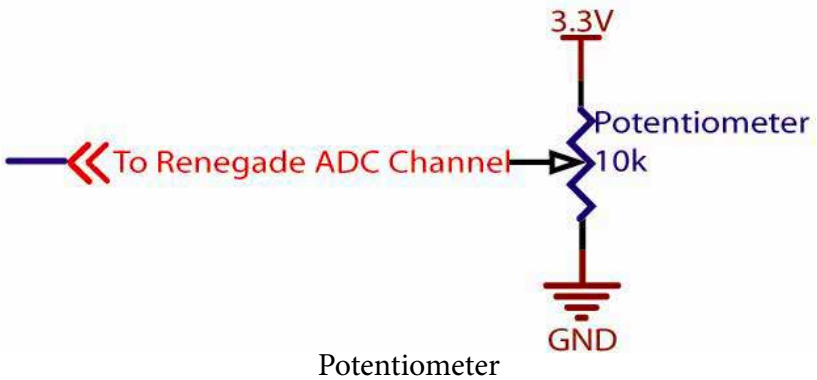
If you would like to translate the 10-bit report to volts, you consider 1024 to be equivalent to your maximum voltage (3.3) and convert your reading accordingly:

Voltage in = "ADC (10-bit) value" X 3.3/1024
or
"ADC (10-bit) value" X .0032

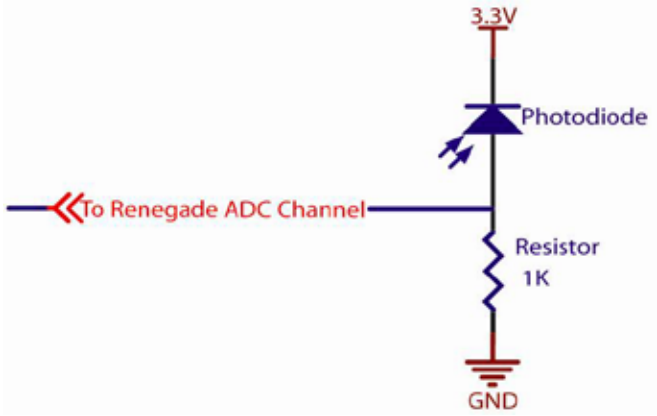
Common Applications of Analog Inputs:

- Temperature sensors, light sensors, pressure sensors, humidity sensors, distance measurements, potentiometer, etc.

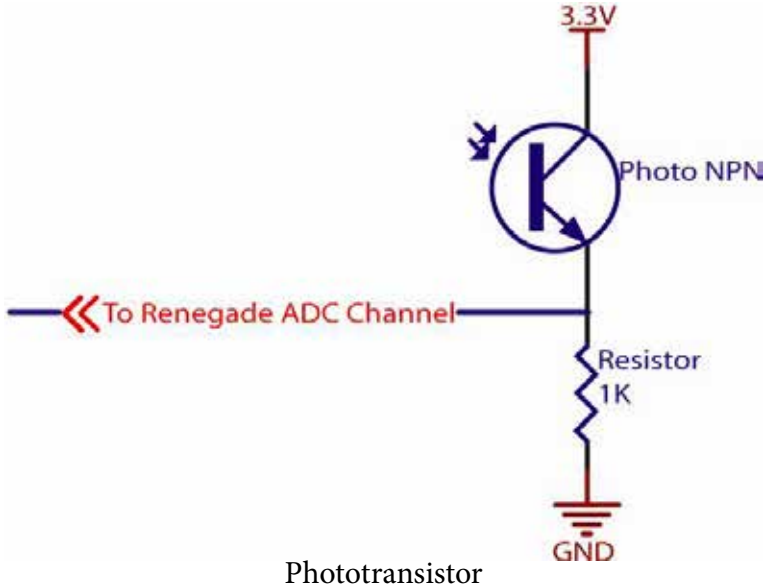
Some sample schematics demonstrating how to connect various Analog Inputs are presented below:



Potentiometer



Photodiode

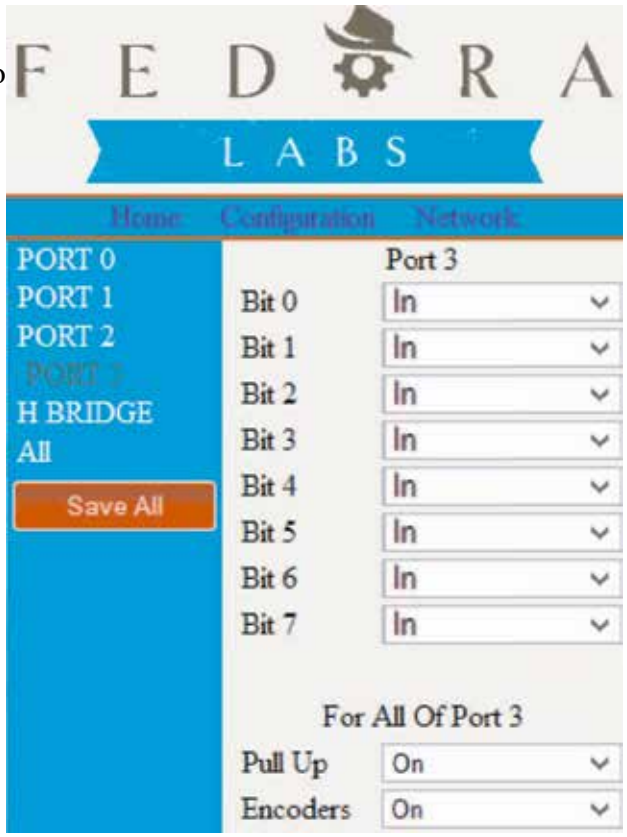


Phototransistor

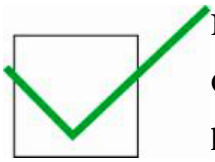
2.4.4. Encoders

Available on PORT 3, the Renegade takes advantage of the internal dual 32-bit quadrature decoder feature of the dsPIC microcontroller. PORT 3 also allows the user to activate pull-up resistors which optimizes operation in that Port when connected to certain devices.

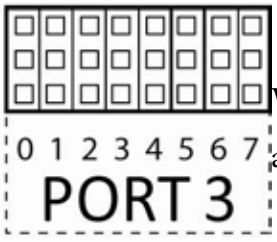
To connect encoders on PORT 3, start by configuring all bits to function as Inputs by setting the pull-down menus to "In".



Below the label that reads "For All Of Port 3" on the Web Configuration Utility, activate the pull up resistors by setting "Pull Up" to "On" and set "Encoders" to "On."



Not all Encoders will require pull-up resistors. Check the recommendations for your particular device.



When connecting encoder(s) to your Renegade, make sure to attach the specific components as demonstrated in this guide.

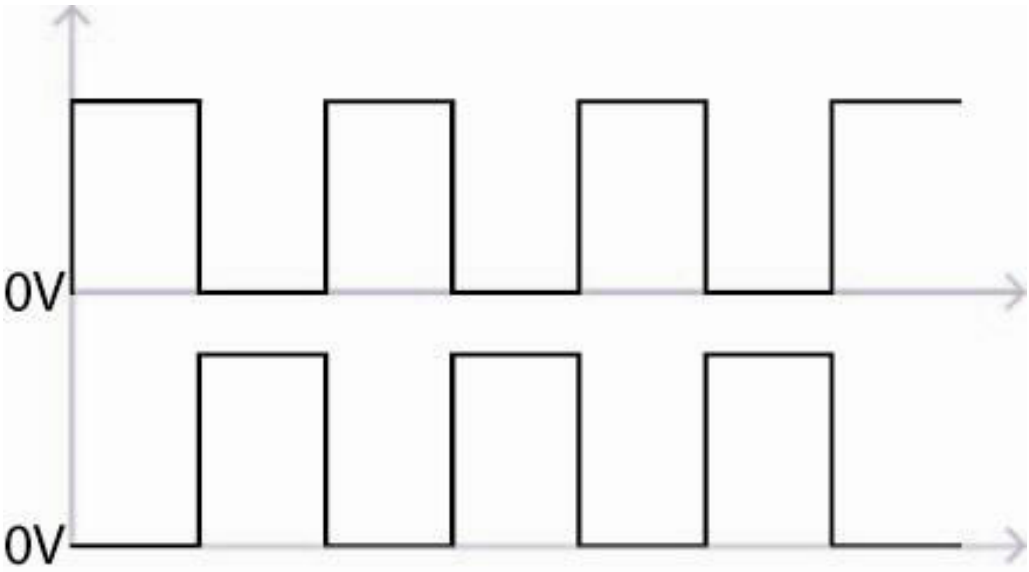
2.4.5. DC Motors

The Motor Driver includes four PWM (Pulse Width Modulation) Channels allowing bi-directional control of up to two DC motors or uni-directional control of up to four DC motors. The preset frequency of each PWM channel is 14 KHz.

Whether configured for two or four motors, the PWM Channels allow for speed control. The Desktop Control Utility, however, only operates half-bridges. That is, the sample program can run up to four motors uni-directionally but is not set up to operate two motors bi-directionally. In order to operate two motors bi-directionally, your program must be written so as to send packets containing commands prefaced by "F0" or "F1".

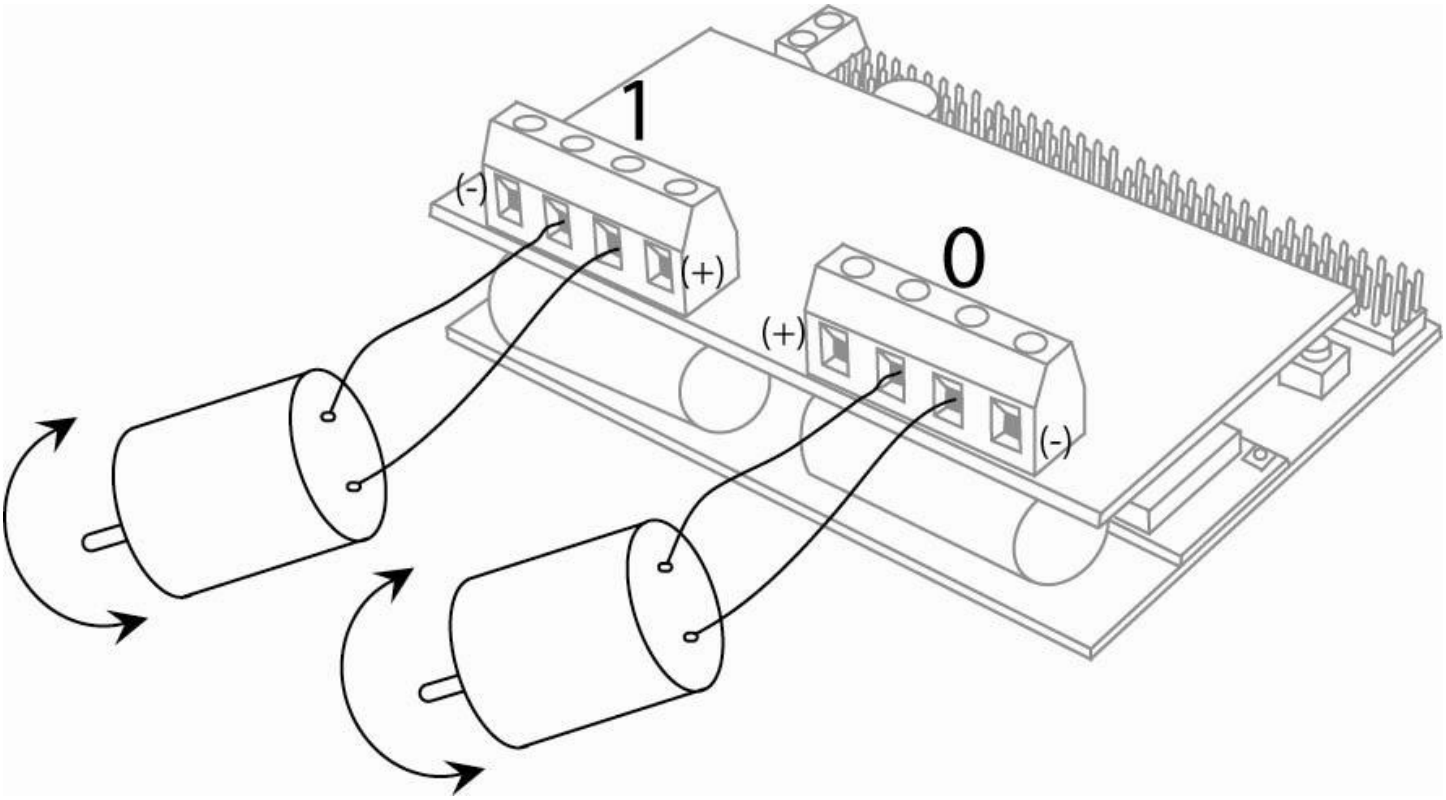
Bi-Directional Operation of Two DC Motors

The ability to drive the DC Motors bi-directionally is reliant on the nature of the PWM signal. In this case the signals are complimentary as shown below (this diagram illustrates the PWM pattern for H0 or H1):



With this complimentary pattern, current passing from negative to positive drives the motor in one direction while a reverse current drives the motors in the other direction. To that end, the current ranges from-512 (full power in one direction) to 512 (full power in the opposite direction). At a current of 0, the two directions are matched against each other so the motors are stopped.

Shown below is an example of two DC Motors connected to the Renegade:



To operate these two DC Motors bi-directionally, the two H Bridges must run as full bridge switches.

In the Web Configuration Utility, select the H BRIDGE option from the list on the left and set each pull-down menu to "Full Bridge".

The commands sent to your Renegade to control the two motors must address "F0" (Bridge 1) and "F1" (Bridge 2).

Commands to a bi-directional motor might read:

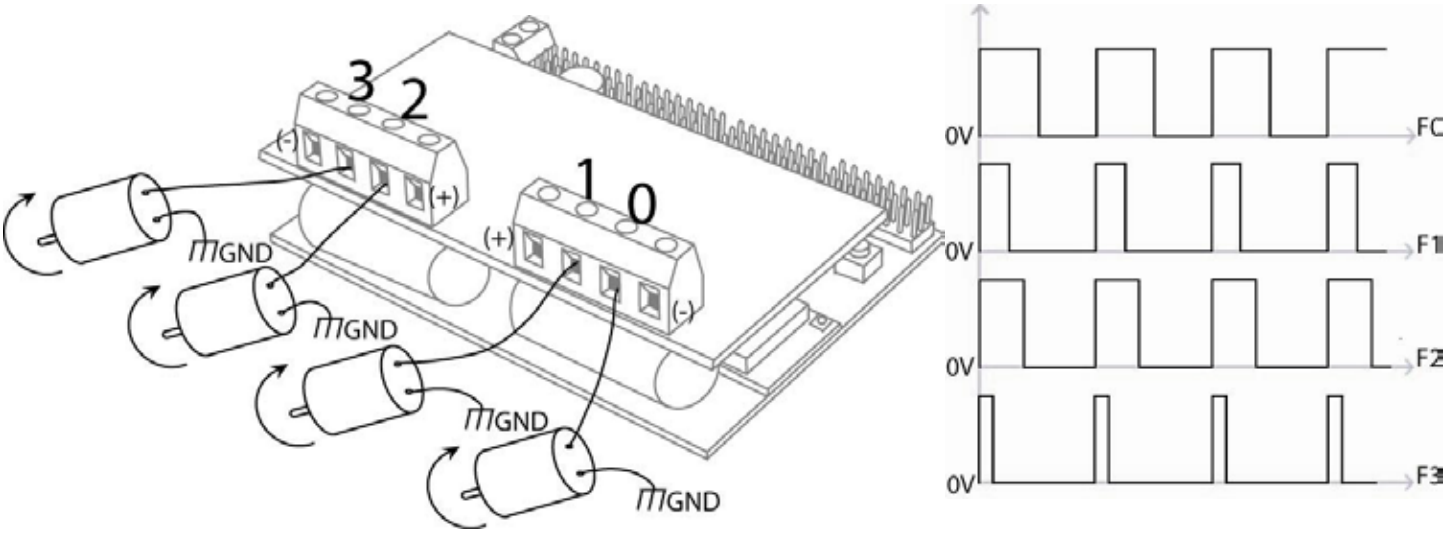
b F0 512, e – this drives a motor attached to F0 at full current in one direction
b F0 -512, e – this drives the same motor at full current in the opposite direction
b F0 0, e – this would stop that same motor
b F0 xxx, e – any number in between -512 and 512 will apply a comparable percentage of your current either forward (if > 0) or reverse (if <0).

Avoid operating motors with particularly high electrical loads in Full Bridge mode as resistance could damage or destroy your Motor Driver.

Uni-Directional Operation of up to Four DC Motors

The default setting for the HBridge is "Full Bridge" which instructs the Motor Driver to operate two DC Motors bi-directionally. The Motor Driver can also operate four DC Motors uni-directionally.

As opposed to the complimentary Pulse Width Modulation necessary to run two motors bi-directionally, uni-directional control of up to four motors relies on each PWM being distinct from the others:



In order to run four motors you must instruct the two full HBridge switches of the Motor Driver Board to function as four half bridge switches. In order to do this, change the Web Configuration Utility settings.

In the Web Configuration Utility, select the H BRIDGE option from the list on the left and set each pull-down menu to "Half Bridge".

The commands sent to your Renegade to control the four motors must address "H0"—"H3". A sample command to operate motors connected in this way might read:

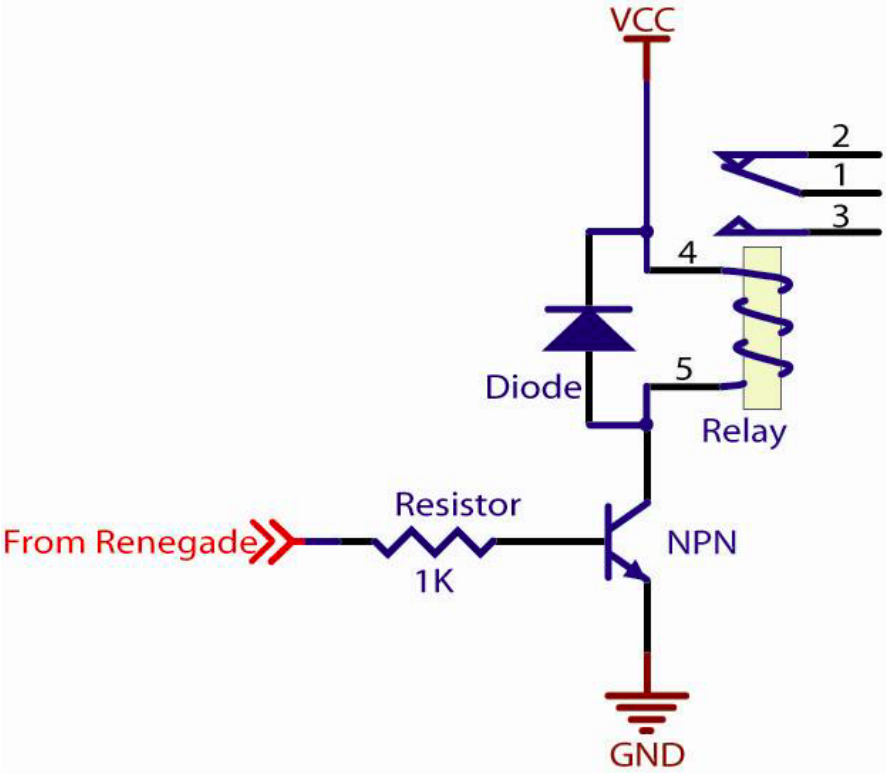
b H0 1024, e – this drives one motor attached to H0 at full power.

2.4.6. Relays

Your Renegade can be used to connect Relays as well. There are two ways to establish a relay:

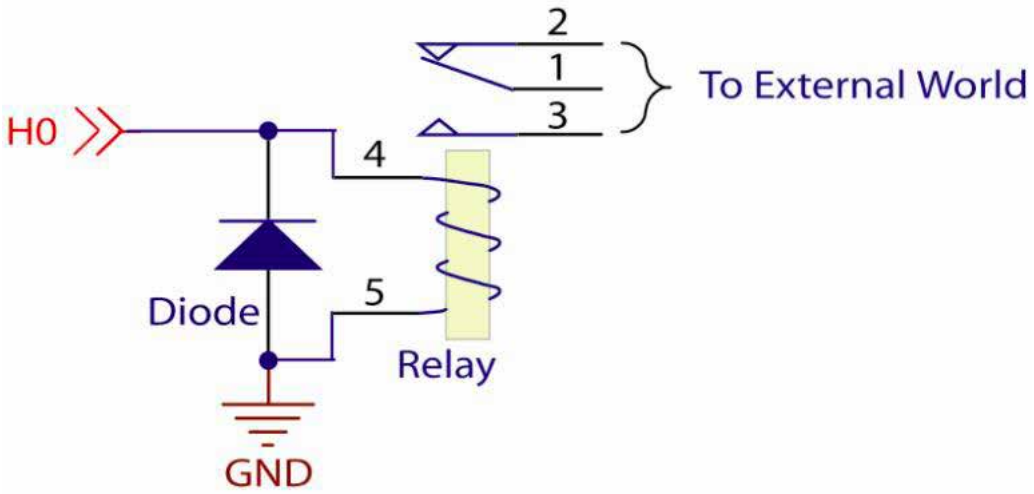
Connect through GPIO Output

You can connect a relay through a GPIO channel set as an output. This is demonstrated in the schematic presented below:



Connect through Motor Driver

Alternately, you can establish Relays using the process described above for connecting motors through a half-bridge on the Motor Driver. The circuit diagram presented below illustrates such a Relay connection:



Chapter 3: Appendix

3.1. Running the Demos

Demonstration videos will be posted at www.fedoralabs.com.

Initial videos will include tutorials instructing the viewer how to set up a simple Robot interface, how to establish simple Servo control, how to connect a simple Relay, and how to program a gamepad to control your Renegade.

Further video demonstrations will become available as demand is established from within Fedora Labs and from user feedback on our online forum (www.fedoralabs.com/forum).

3.2. Troubleshooting

For any questions, comments, suggestions or concerns, please join our ongoing conversation at www.fedoralabs.com/forum.

Here you will be able to connect with our specialists as well as other Renegade owners while also referencing a Troubleshooting guide and Frequently Asked Questions.

3.3. Index

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