



CONTROL HUB

USER'S MANUAL

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1 OVERVIEW

1.1 Control Hub Basics

The REV Robotics Control Hub is an affordable all in one educational robotics controller that provides the interfaces required for building robots, as well as other mechatronics, with multiple programming language options. The Control Hub was designed and built as an easy to use, dependable, and durable device for use in classroom and the competition. It features an Android operating system, and a mature software package designed for both basic and advanced use cases. When the Control Hub software is updated with performance enhancements and features, the controller can receive a "field upgrade," through an update process that is fast and simple.

The Control Hub is an approved device for use in **FIRST®** Global and **FIRST** Tech Challenge.

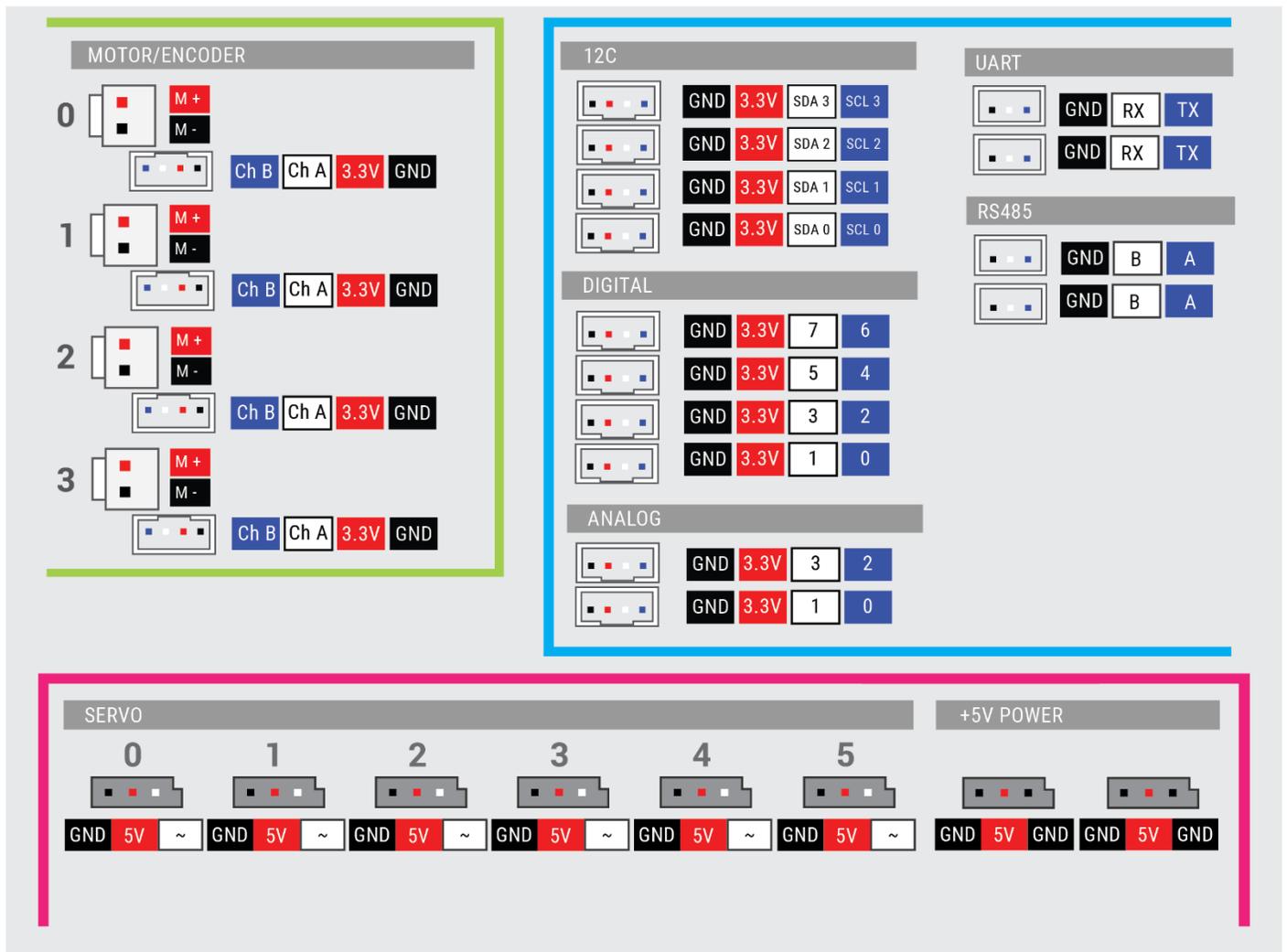
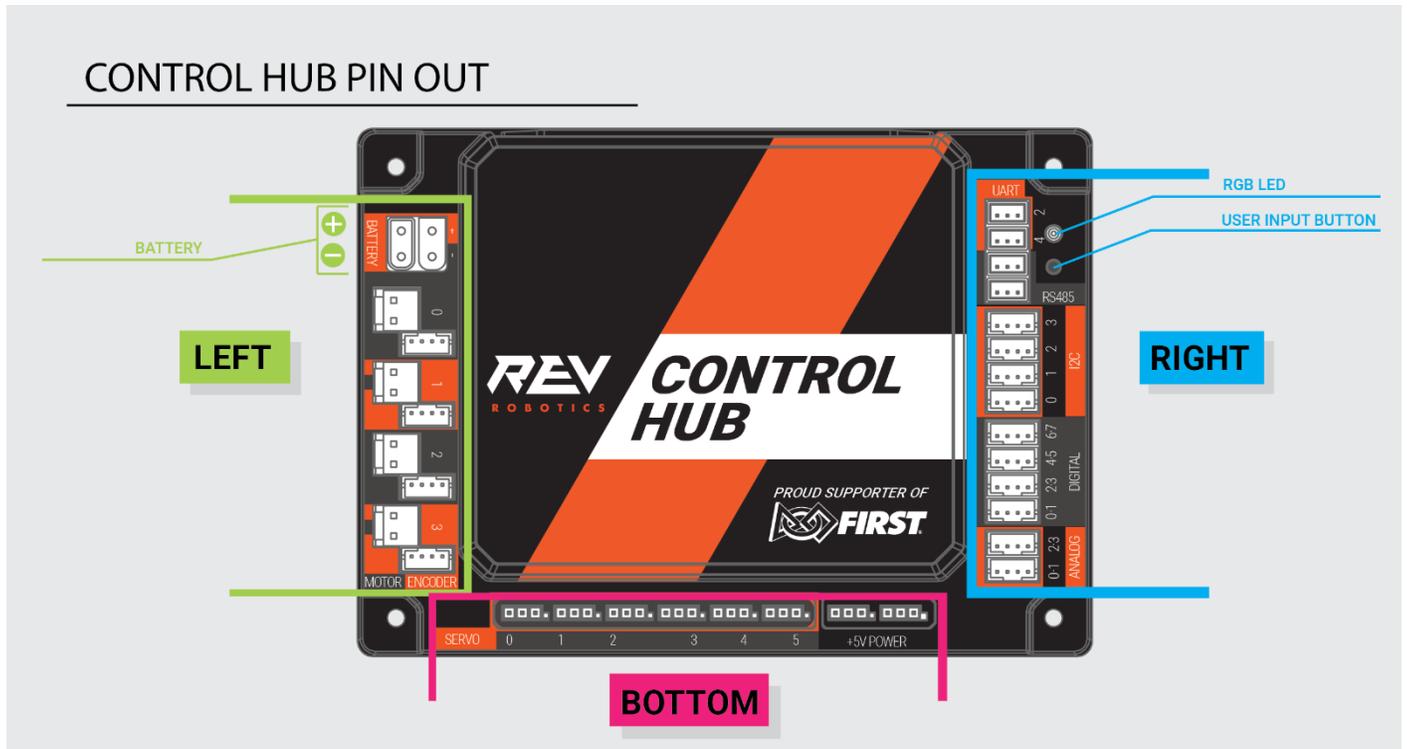
- **Physical Dimensions**
 - 143mm X 103mm X 29.5 mm
 - Mounting holes on a 16mm spacing
- **Input Voltage:**
 - 12V Nominal (8-15VDC)
- **Processors**
 - RK3328 Quad-core ARM® Cortex-A53
 - Texas Instruments ARM® Cortex-M4
- **3.3V Ports**
 - **8x Digital I/O:** 1A Source Max
 - **4x I2C 100kHz/400kHz Busses:** 500mA Max
 - **4x 12-bit Analog Inputs:** 500mA Max
 - **4x Quadrature Encoder Inputs:** 500mA Max
- **5V Ports**
 - **5V Aux Power:** 2A Max
 - **Servos:** 2A Maximum per Pair
 - **USB 2.0:** 1.5A Max



PORT	QTY	CONNECTOR	DESCRIPTION
Battery	2	XT30	Connect one 12V NiMH battery, add an Expansion Hub with second port
Motor	4	JST VH, 2-pin	Motor power output
Encoder	4	JST PH, 4-pin	Quadrature encoder input
Servo	6	0.1" Header	Extended range 5V servo output (500-2500ms)
5V Aux Power	2	0.1" Header	Auxiliary device 5V/2A
Analog	4	JST PH, 4-pin	Analog input 0-3.3V with two channels per connector
Digital	8	JST PH, 4-pin	Digital Input/Output with two channels per connector
I2C	4	JST PH, 4-pin	Four separate I2C busses, 400kHz bus speed
RS485	2	JST PH, 3-pin	Use this serial communication port to add another Expansion Hub
UART	2	JST PH, 3-pin	Debugging only
USB	1	C Type	Connect directly to the Control Hub via PC
USB	2	A Type	Connect USB Cameras and other USB peripherals to the Control Hub
HDMI	1	A Type	Supports 4k @ 60Hz

1.2 Port Pin Outs

CONTROL HUB PIN OUT



1.3 Protection Features

- Reverse Battery Input Protection
- ESD Protection on all Connections
- Overcurrent PTC Protection
 - Digital I/O Bus
 - I2C Bus
 - Analog Bus
 - USB
 - Servos per Channel Pair
 - Encoder Bus
- Over Current Monitoring for individual Motor Channels
- Keyed and Locking Connectors
- Failsafe Mode at Communication Loss

1.4 Cables and Connectors

The REV Robotics Control Hub connector selection provides a robust high-density solution for the user. All connectors are keyed and locking except for the Servo, 5V auxiliary power, HDMI, and USB ports.

1.4.1 XT30 – Power Cable

The XT30 connector is used for connecting a battery and powering a Control Hub. Each Control Hub has both a Male and Female XT30 connector. The male connector is the power in for the Control Hub while the female connector is power out to power a connected secondary device, like an Expansion Hub, from a single battery source.

Most teams will want to use premade cables which can be sourced from the REV Robotics website directly (Table 1) for convenience, but teams can also make their own cables. These connectors are solder cup style and do not require any crimping tools; connectors are available from various online vendors. These connectors are an open design so they are manufactured by a variety of sources and quality may vary. AMASS branded connectors are recommended, but there are many other quality vendors available.

Table 1: Premade XT30 Cables and Accessories

	Length	REV Robotics Part Number
XT30, Male - XT30, Female	30cm	REV-31-1392
XT30, Male - XT30, Female	50cm	REV-31-1393
XT30, Female - Tamiya	8cm	REV-31-1382
XT30, Female - Anderson Power Pole Style	8cm	REV-31-1385
Power Switch Cable (XT30 Male – XT30 Female)		REV-31-1387
XT30 Connector Pack – 5 Pairs	-	REV-31-1399

1.4.2 JST VH – Motor Power

Motor Power connections on the Control Hub use the JST VH style connector. This connector is keyed and locking with a small latch (Figure 1) which must be depressed to release the cable.

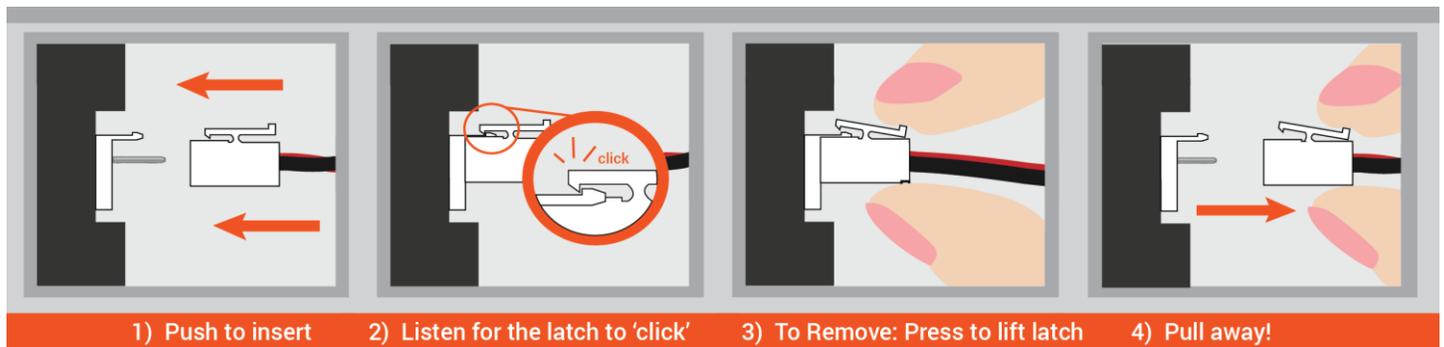


Figure 1: How to Use a JST VH Cable

REV Robotics recommends in most cases that teams use pre-made cables because the quality of the crimp is better when made using industrial tooling. These cables can be bought directly from the REV Robotics Website (Table 2) or through other online vendors.

Table 2: Premade JST VH Cables and Accessories

	Pins	Length	REV Robotics Part Number
JST VH - JST VH	2 pins	30cm	REV-31-1412
JST VH - JST VH	2 pins	50cm	REV-31-1413
JST VH - JST VH	2 pins	100cm	REV-31-1526
JST VH - Anderson Power Pole Type	2 pins	12cm	REV-31-1381
JST VH Cable Extension Board	2 pins		REV-31-1429

For teams that want to try crimping their own cables, or to find more information about the connectors, Table 3 lists the appropriate part numbers.

Connector Specifications

- 10A Continuous Current (16AWG)
- 3.96mm Pitch
- Accepts 22-16AWG Wire

Table 3: JST VH Connector Part Number Reference

	Manufacturer Part Number	DigiKey Part Number
Contact, JST VH, 18-22AWG	SVH-21T-P1.1	455-1133-1-ND
Contact, JST VH, 16-20AWG	SVH-41T-P1.1	455-1319-1-ND
Housing, JST VH, 2-pin	VHR-2N	455-1183-ND
Header, JST VH, 2-pin, Top Entry	B2P-VH	455-1639-ND
Header, JST VH, 2-pin, Side Entry	B2PS-VH	455-1648-ND

Connector Datasheet: <http://www.jst-mfg.com/product/pdf/eng/eVH.pdf>

1.4.3 JST PH – Sensors and RS485

The JST PH style connector is used for motor encoder, analog, digital, I2C, RS485, and UART connections on the Control Hub. These are all 4-pin connections except for the RS485 and UART which are 3 pin. The connectors are keyed (they only insert in one orientation) and are friction locking. In Figure 2 the keying feature aligned with the cable is shown.

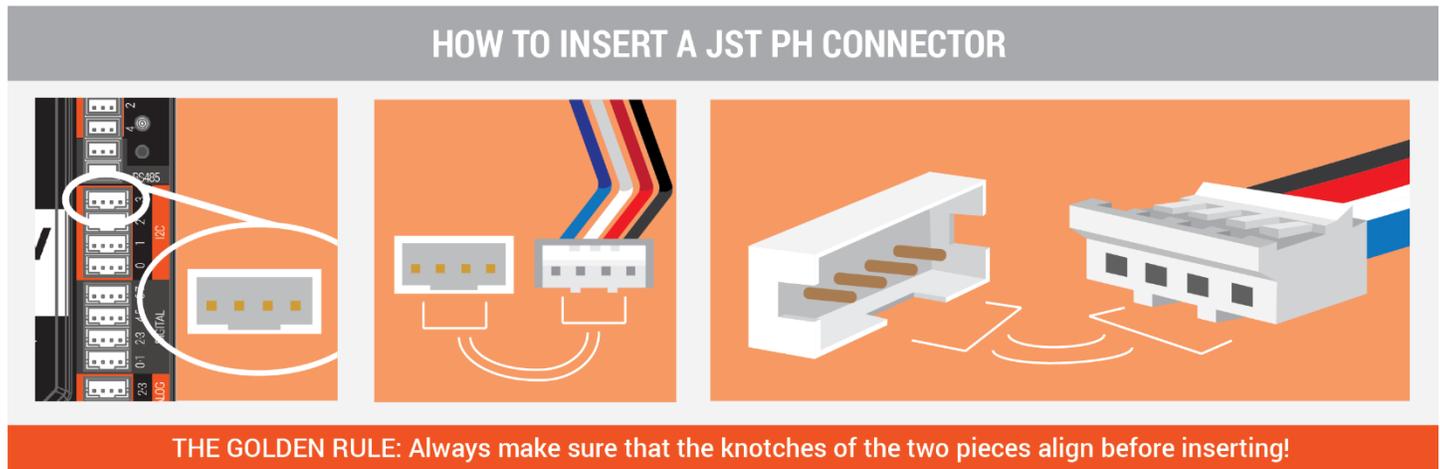


Figure 2: How to Use a JST PH Cable

REV Robotics recommends in most cases that teams use pre-made cables because the quality of the crimp is better when made using industrial tooling. These cables can be bought directly from the REV Robotics Website (Table 4 and Table 5) or through other online vendors.

Table 4: Premade 4-pin JST PH Cables and Accessories

	Pins	Length	REV Robotics Part Number
JST PH - JST PH	4 pins	30cm	REV-31-1407
JST PH - JST PH	4 pins	50cm	REV-31-1408
JST PH - JST PH	4 pins	100cm	REV-31-1409
JST PH Cable Extension Board	4 pins		REV-31-1388

Table 5: Premade 3-pin JST PH Cables

	Pins	Length	REV Robotics Part Number
JST PH - JST PH	3 pins	30cm	REV-31-1417
JST PH - JST PH	3 pins	50cm	REV-31-1418
JST PH - JST PH	3 pins	100cm	REV-31-1565

For teams that want to try crimping their own cables, or to find more information about the connectors, Table 6 lists the appropriate part numbers.

Connector Specifications

- 2A Continuous Current (24AWG)
- 2.0mm Pitch
- Accepts 32-24AWG Wire

Table 6: JST PH Connector Part Number Reference

	Manufacturer Part Number	DigiKey Part Number
Contact, JST PH, 30-24AWG	SPH-002T-P0.5S	455-1127-1-ND
Contact, JST PH, 28-24AWG	SPH-002T-P0.5L	455-2148-1-ND
Housing, JST PH, 4-pin	PHR-4	455-1164-ND
Header, JST PH, 4-pin, Top Entry	B4B-PH-K-S	455-1706-ND
Header, JST PH, 4-pin, Side Entry	S4B-PH-K-S	455-1721-ND
Housing, JST PH, 3-pin	PHR-3	455-1126-ND
Header, JST PH, 3-pin, Top Entry	B3B-PH-K-S	455-1705-ND
Header, JST PH, 3-pin, Side Entry	S3B-PH-K-S	455-1720-ND

Connector Datasheet: <http://www.jst-mfg.com/product/pdf/eng/ePH.pdf>

2 QUICK START

2.1 Required Materials



Control Hub
REV-31-1595



12V NiMH Slim Battery *
REV-31-1302



Properly Configured Driver Station (DS) *



USB Game Pad *



USB A Female to Micro USB *
REV-31-1426

* Other FTC legal part numbers exist.

Optional Additional Materials needed to [Connect an Expansion Hub](#):

- Expansion Hub (REV-31-1153)
- XT30 Extension Cable (REV-31-1392)
- JST PH 3-pin Communication Cable (REV-31-1417)

2.2 System Wiring Diagram

Control Hub Wiring Reference

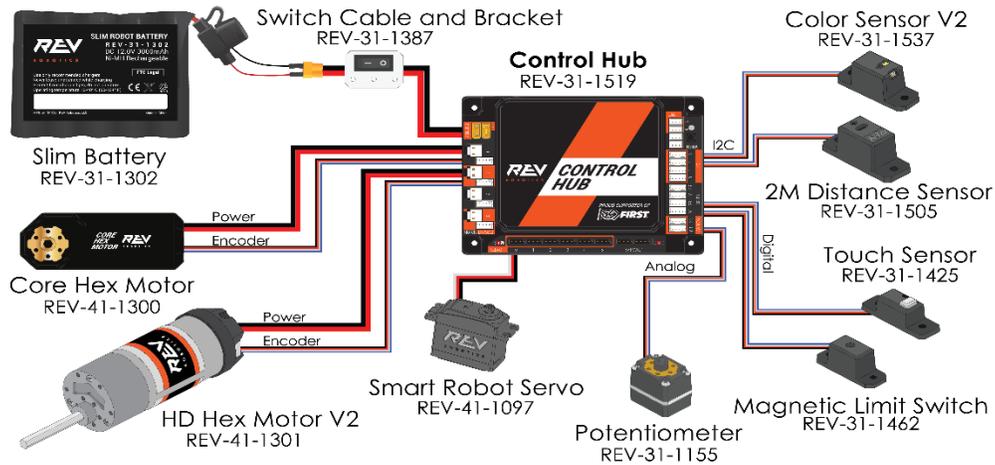


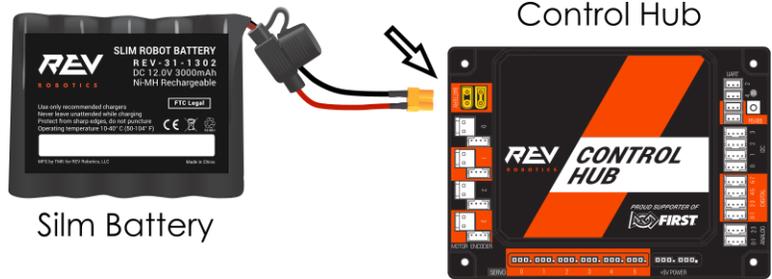
Figure 3: System Wiring Diagram

2.3 Driver Station and Robot Controller Pairing

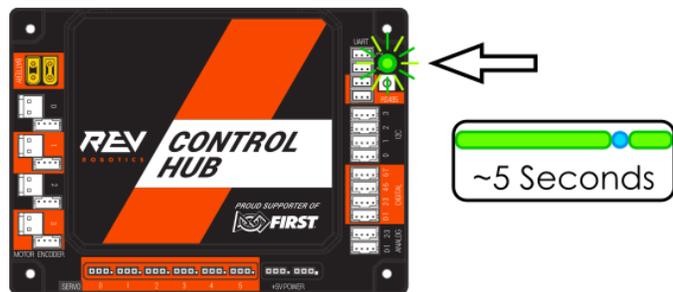
When you first receive your Control Hub, you will have to pair (link) your Driver Station (Android Device) to your Control Hub. This procedure only needs to be performed once for each set of hardware. If you replace your Driver Station or Control Hub, this procedure will need to be repeated. The steps below assume the FTC Driver Station Application or FIRST Global Driver Station Application are installed on your Android device.

Pairing the Driver Station with the Control Hub

1. Power on the Control Hub, by plugging the 12V Slim Battery into the XT30 connector labeled "BATTERY" on the Control Hub.



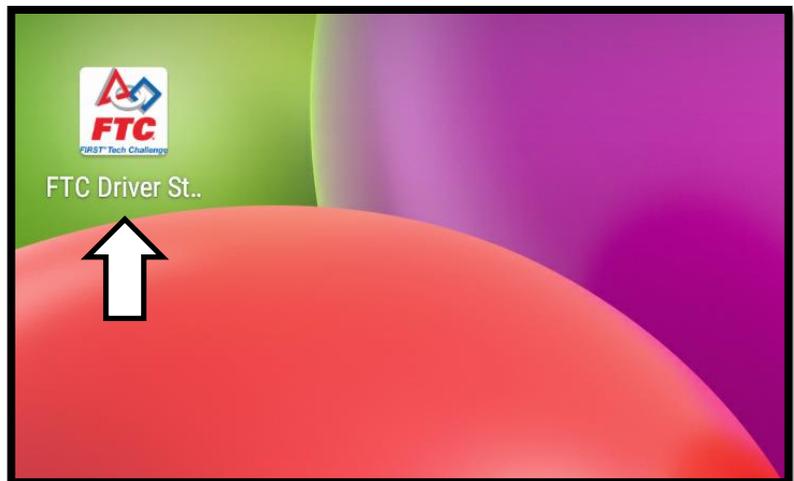
2. The Control Hub is ready to pair with the Driver Station when the LED turns green. Note: the light blinks blue every ~5 seconds to indicate that the Control Hub is healthy.



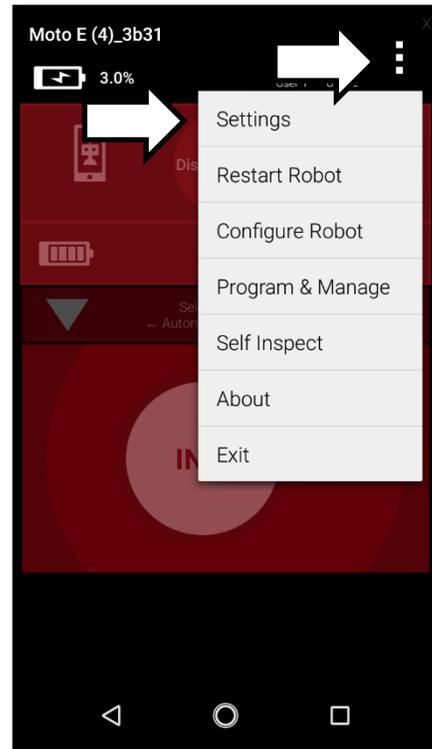
3. Power on your Android Device by holding down the power button.



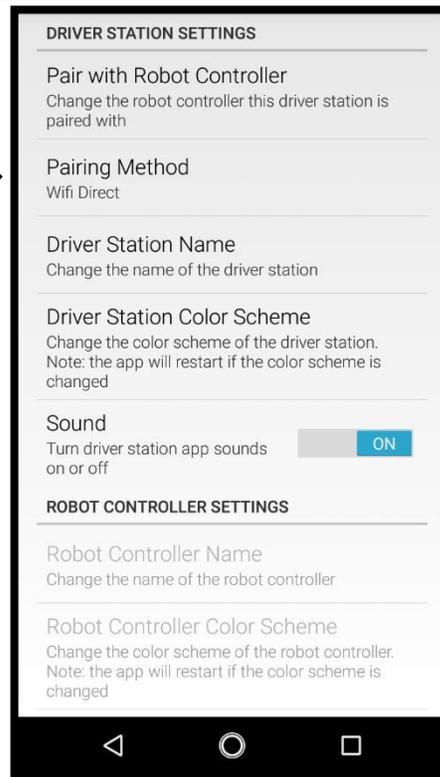
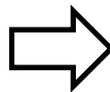
4. Open the Driver Station application from the HOME Screen.



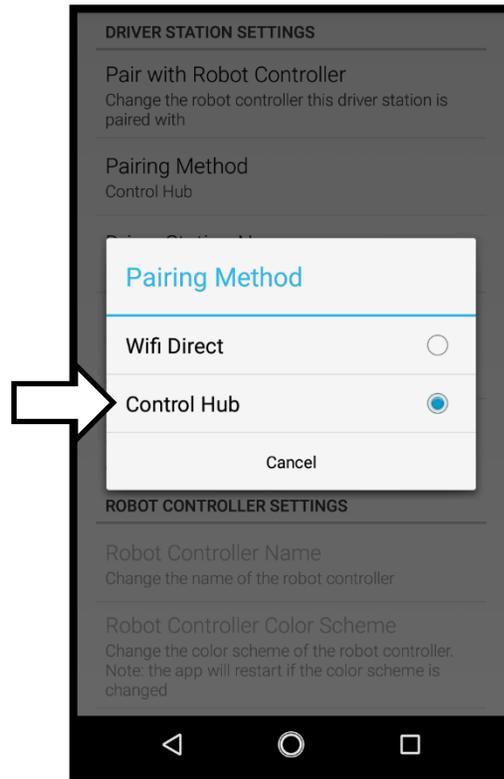
5. On the Driver Station page, open the menu from the top right corner, then select "Settings".



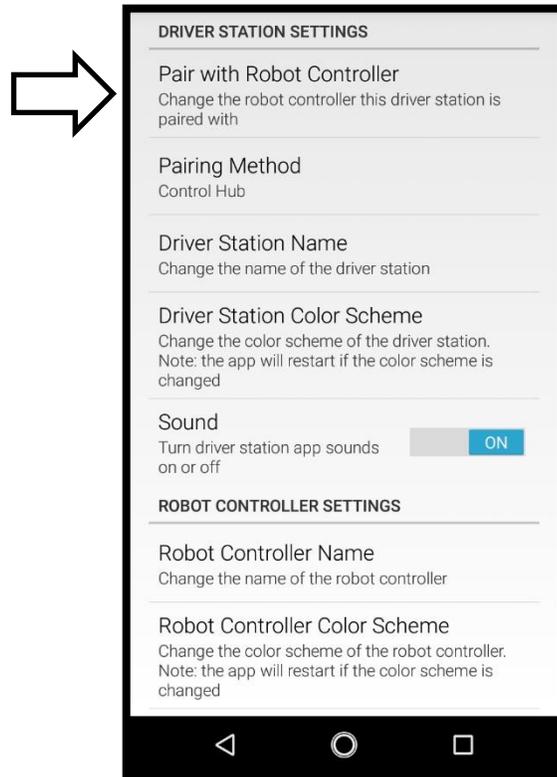
6. Select, "Pairing Method"



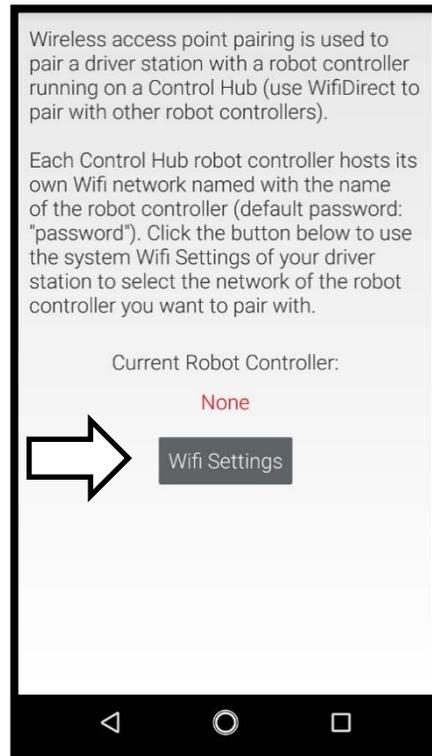
7. Select, "Control Hub"



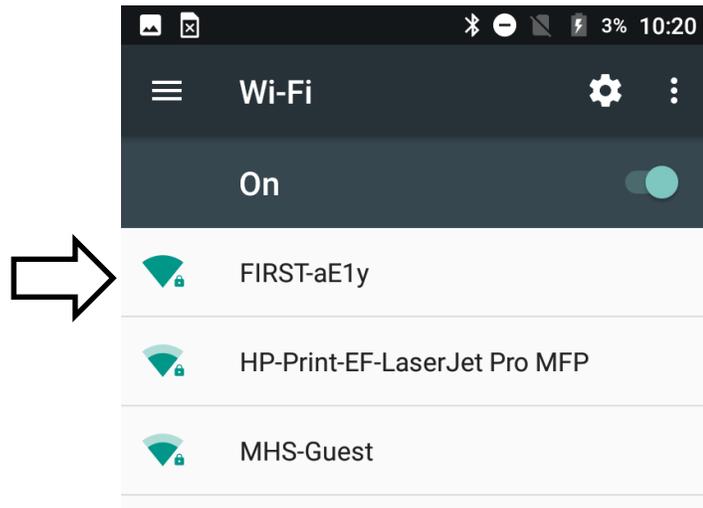
8. Select, "Pair with Robot Controller".



9. Select "Wifi Settings"

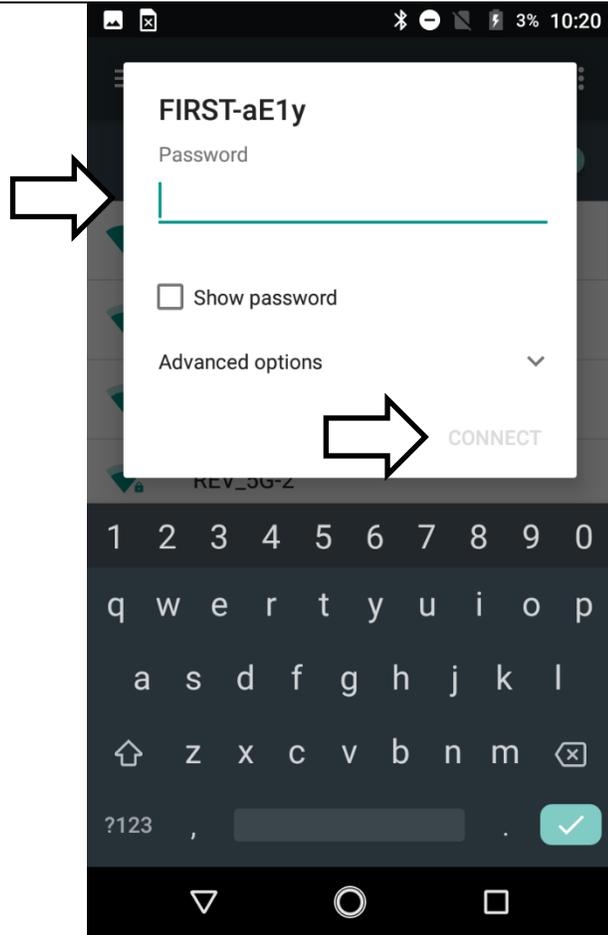


10. Select the name of the Wifi network generated by your Control Hub. The SSID name starts with either "FIRST-" or "FTC-".

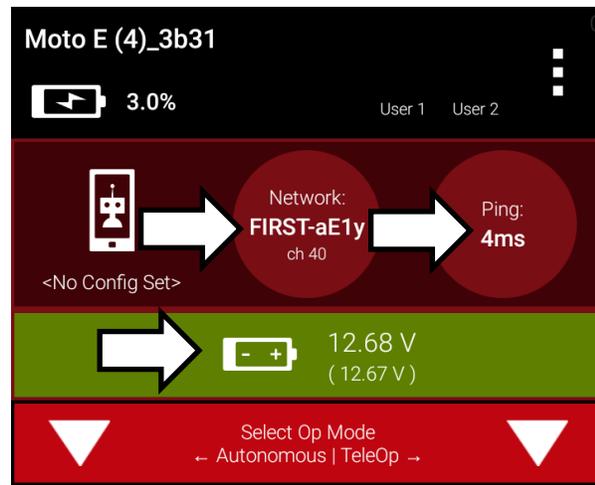


11. Enter the password to the Wifi network in the password field. This defaults to "password". Press "CONNECT".

After pressing connect, press the back arrow at the bottom of the display until you return to the main driver station screen.



12. After a couple of seconds, the Driver Station page will indicate the network name, a ping time, and battery voltage.



Your Driver Station is now paired with your Control Hub!

2.4 Robot Configuration

Every device connected to the Control Hub will need to be added to the Robot Configuration file before you can use the device in your program. The Robot Configuration will allow you to give your sensors and actuators meaningful names that you can reference while programming.

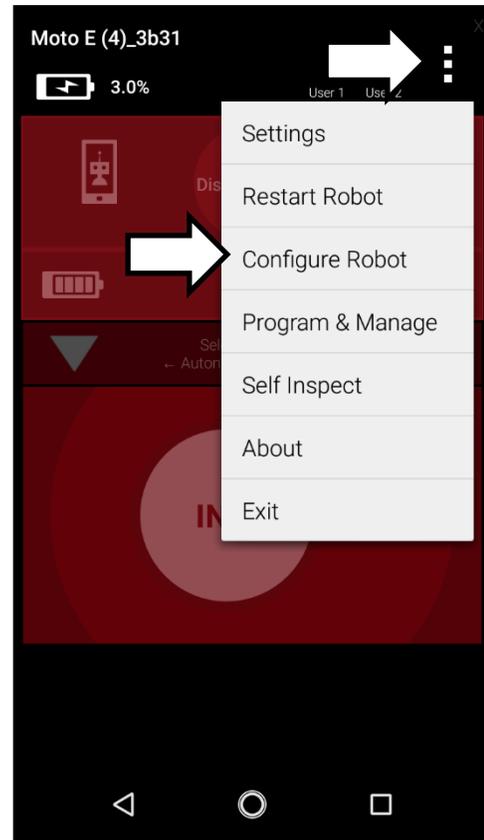
For this example, we will configure a simple two motor robot drivetrain (Figure 4).

Figure 4: The miniBot is a Simple 2-Motor Robot

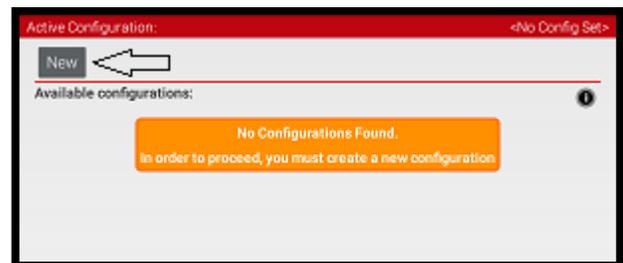


Configuring Your Robot for the First Time

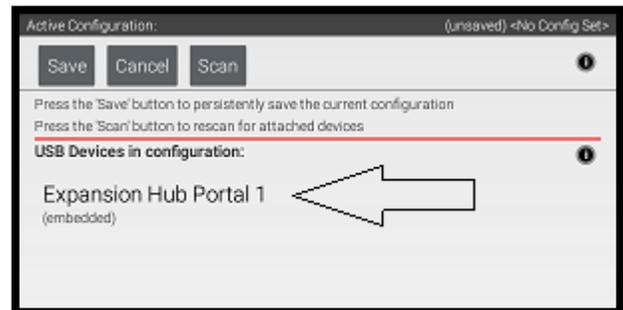
1. Select the menu on either the Driver Station or Robot Controller. Then select "Configure Robot".



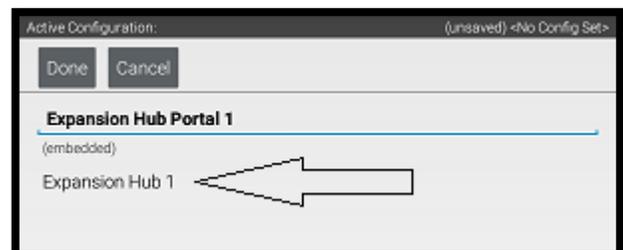
2. Select "New" in the top left hand corner.



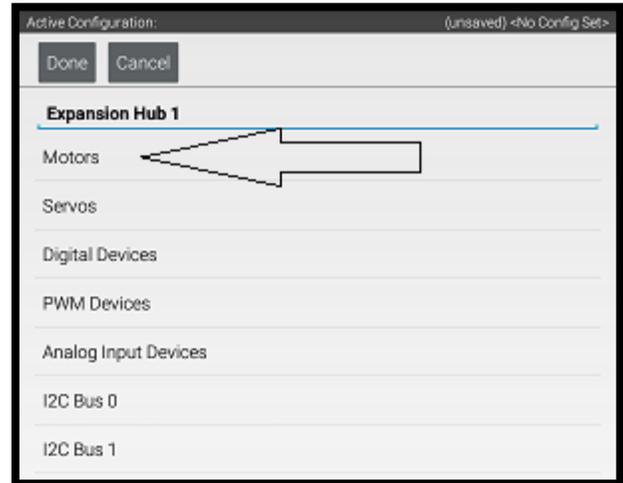
3. Select "Expansion Hub Portal 1" (embedded).



4. Select "Expansion Hub 1".



5. Select "Motors".

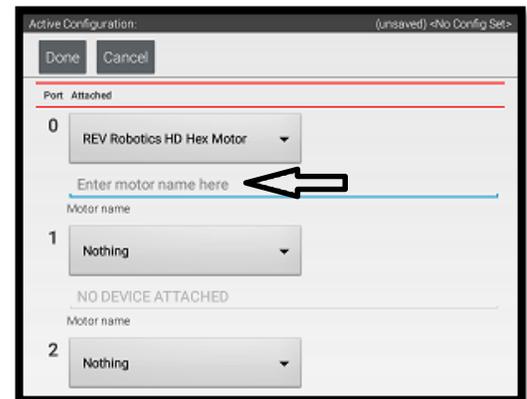


6. Select the Drop Down menu for "Port 0" then select the motor type attached to the port. In the case of the Minibot in Figure 4, select the "Rev Robotics Core Hex Motor".

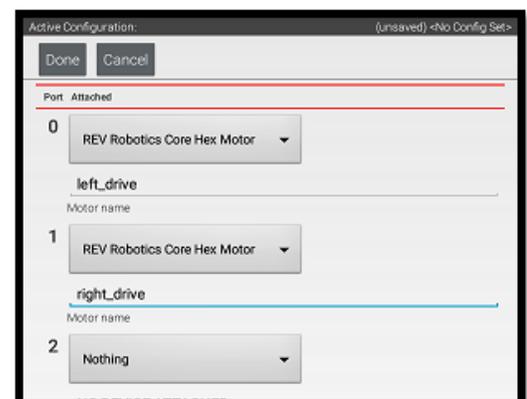


7. Press "Enter motor name here" and name the motor "left_drive".

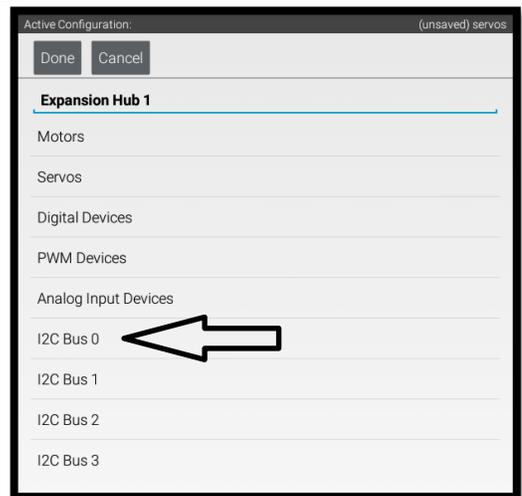
This is the name that you will use when you are programming your robot to control this motor. Always use descriptive names so that you can remember what a device does when you are programming.



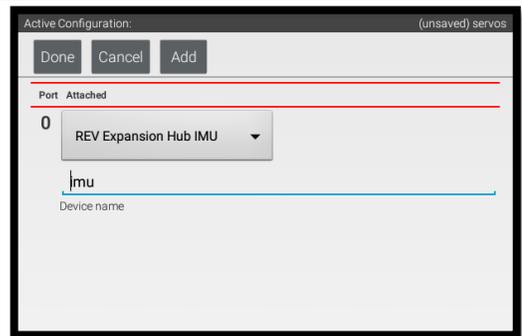
8. Repeat the process for "Port 1" and name the motor "right_drive".



9. Press "Done" once to go back to the list of device ports and then select I2C Bus 0.



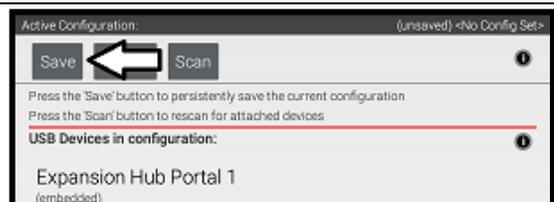
10. Add the built-in REV Expansion Hub IMU. Name it "imu"



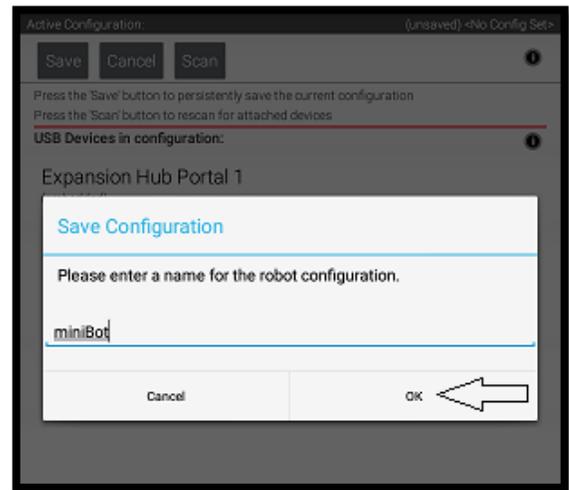
11. Press the "Done" button (at the top left corner of the page) 3 times.



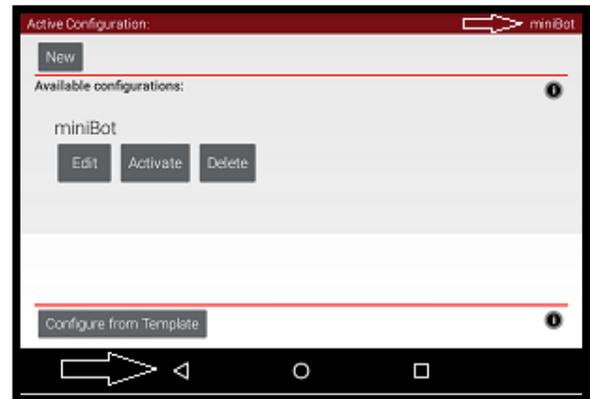
12. Press "Save".



13. Enter "miniBot" as your configuration name, then select "OK".



14. You now have an active configuration called "miniBot". Press the Android back button to return to the Driver Station page.



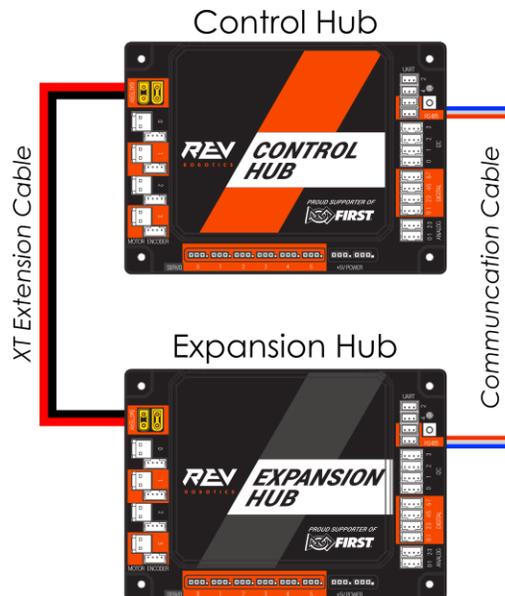
2.5 Adding an Additional Expansion Hub

If you want to use more than 4 motors or 6 servos, you will need to add an Expansion Hub to your robot. An Expansion Hub can be added to a Control Hub. The Expansion Hub has all of the same ports as the Control Hub but without the wireless capability.

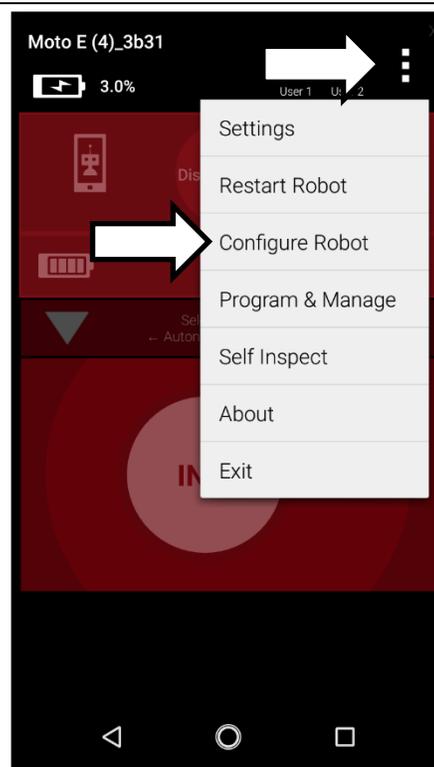
Control Hub vs Expansion Hub in FIRST	
FIRST Tech Challenge	FIRST Global
FIRST Tech Challenge teams may use one (1) Control Hub and may add one (1) Expansion Hub starting in the 2020-2021 season. Read the official FTC Game Manuals for complete game rules.	FIRST Global teams must use one (1) Control Hub and may add one (1) Expansion Hub to their robot. Read the official FIRST Global manual for complete game rules.

Adding an Expansion Hub to your Robot

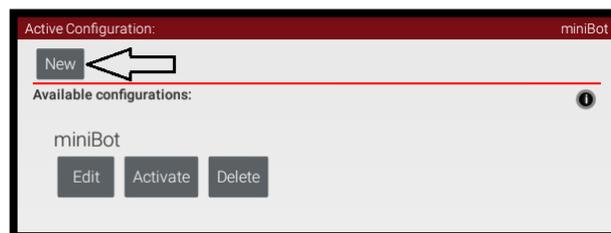
1. Use the XT Extension Cable to connect power between the Control Hub and the Expansion Hub.
2. Use a 3-pin JST PH cable to connect the RS485 port on the Control Hub to the Expansion Hub.



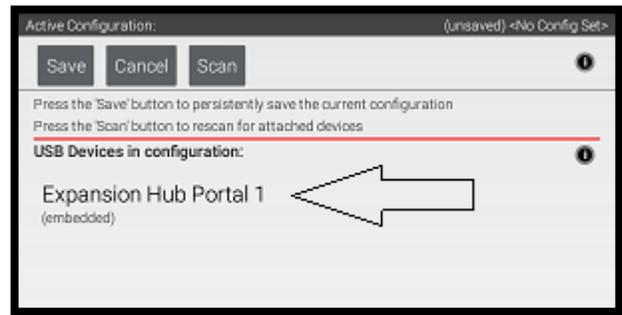
3. From the Driver Station choose "Configure Robot"



4. Select "New" in the top left hand corner.



5. Select "Expansion Hub Portal 1"



6. Now you have two Expansion Hubs to choose from. "Expansion Hub 1" is the embedded device of the Control Hub. "Expansion Hub 2" is the connected Expansion Hub.

Configure and program as necessary. Please see the "Configure your robot" section of this document for an overview of configuration.

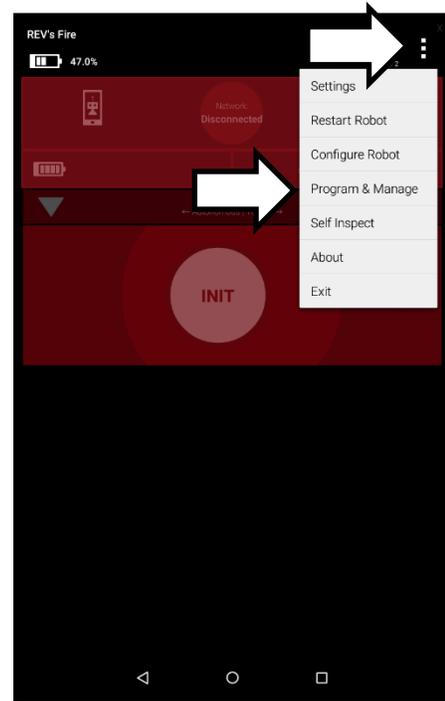


2.6 Switching WiFi Channels

The Control Hub can utilize either the 2.4 GHz or 5 GHz WiFi band. By default the Control Hub is set to a channel on the 2.4 GHz band. REV Robotics advises that during competition teams utilize a 5 GHz channel for robot communication. Consulting with the FTA/CSA at a tournament for the channel to utilize is advised. The following steps will show how to switch the Control Hub to a 5 GHz channel.

Changing WiFi Channel on your Robot

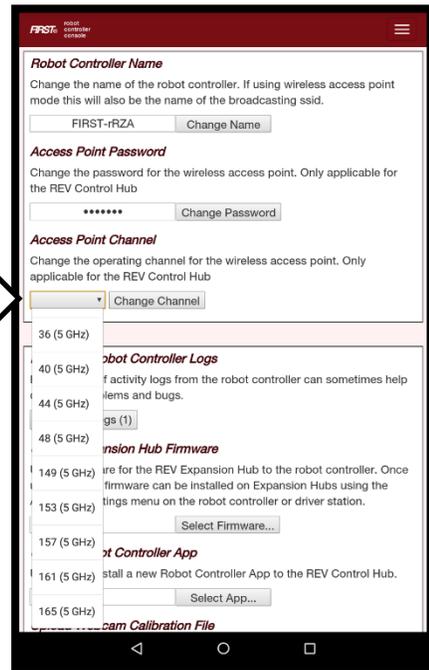
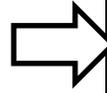
1. Press the triple dots in the upper right. Then select "Program & Manage" from the Driver Station Menu.



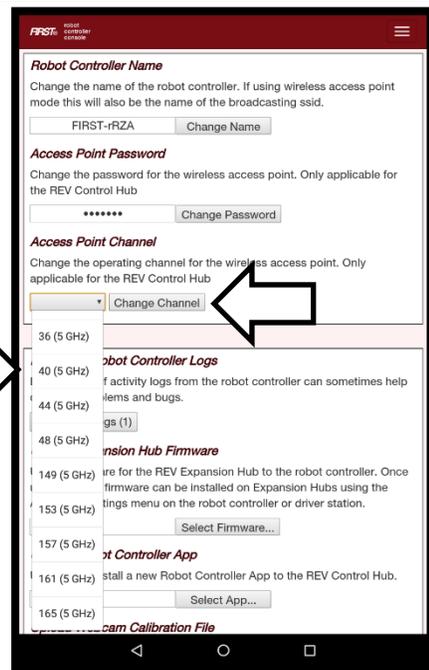
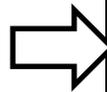
2. Select the menu button in the top right. Then select "Manage".



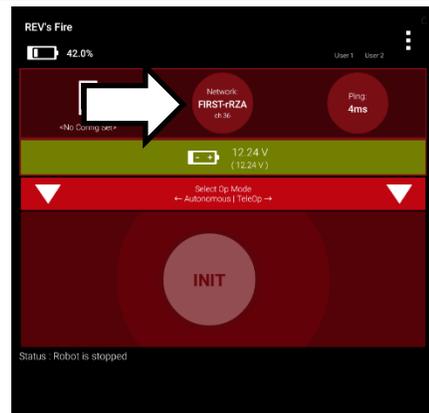
3. Select the drop down menu under “Access Point Channel”.



4. Select a 5 GHz channel noted in the () next to the channel number. Then select the “Change Channel” button next to the drop down.



5. At the main screen, confirm the channel is changed under “Network”.



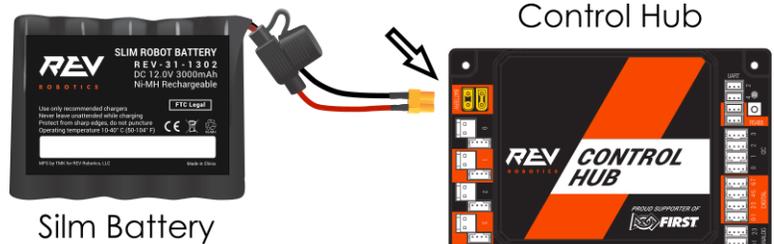
2.7 Updating Control Hub Operating System

The Control Hub's Operating System is field upgradable. New updates are released to incorporate fixes, improvements, and new features as they are developed. Using a web browser and a PC, follow the steps below for updating the Operating System on the Control Hub.

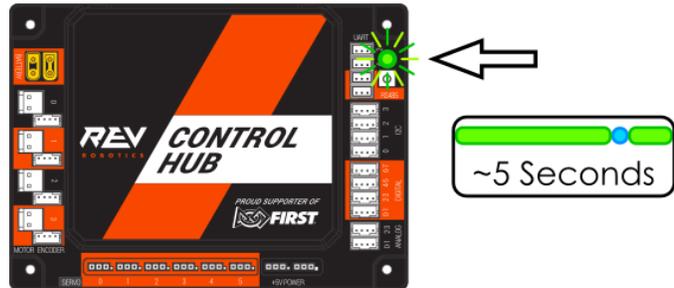
Updating Control Hub OS

Download the latest version of the Operating System from the REV Robotics website (www.revrobotics.com/software)

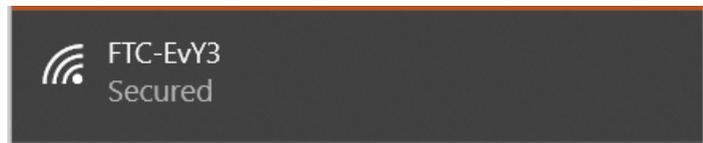
1. Power on the Control Hub, by plugging the 12V Slim Battery into the XT30 connector labeled "BATTERY" on the Control Hub.



2. The Control Hub is ready to connect with a PC when the LED turns green. Note: the light blinks blue every ~5 seconds to indicate that the Control Hub is healthy.



3. Connect to the Control Hub's WiFi Network. If it is not renamed, the name will begin with either "FIRST-" or "FTC-".



4. Open a browser and navigate to the FIRST Robot Controller Console (type 192.168.43.1:8080 in the navigation bar)



5. Scroll down to "Update Control Hub Operating System" and press the "Select Update File" button.

Update Control Hub Operating System

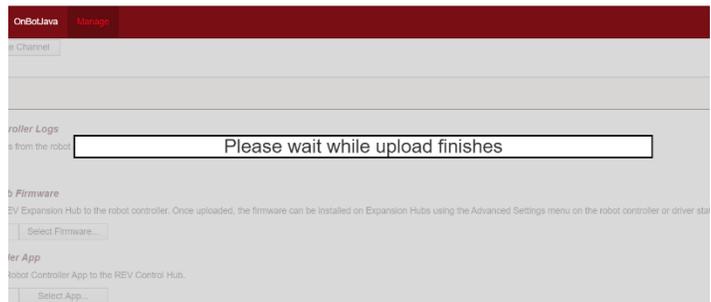
Upload an Operating System update file for the REV Control Hub

6. Choose the latest version downloaded in Step 1 and press the "Update & Reboot" button.

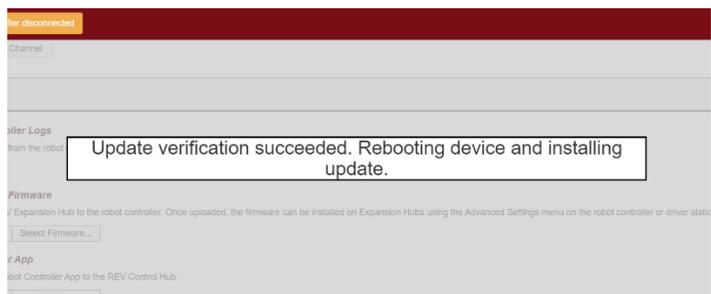
Update Control Hub Operating System

Upload an Operating System update file for the REV Control Hub

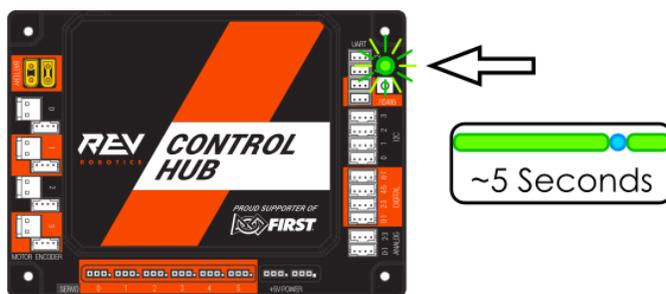
7. Keep the Control Hub powered while the upload finishes.



8. Keep the Control Hub powered while the update is installed. The Control Hub will reboot to complete the update.



- When the OS update has completed, the Control Hub LED will switch from blue, back to its normal blink pattern.



- Reconnect your computer to the Control Hub network and verify that the update was a success.

192.168.43.1:8080 says
Update installed successfully.

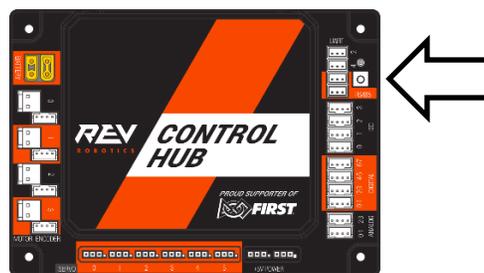


2.8 WiFi Reset

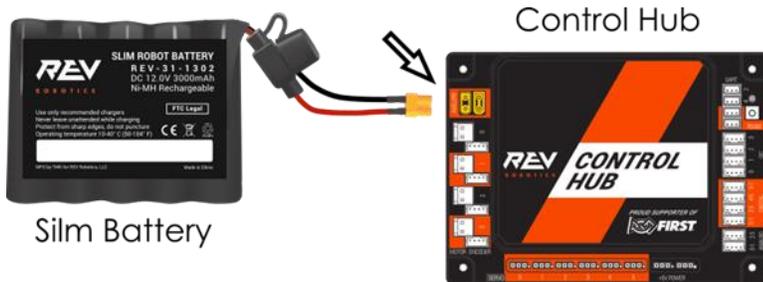
The Control Hub can be reset to the default WiFi settings. This will reset the password and SSID name while keeping the Robot Controller application installed on the Control Hub.

Factory Reset Procedure

- Press and hold the button on the front of the Control Hub.



- While pressing the button, power on the Control Hub.



3. Release button when the Control Hub LED flashes PINK. When the Control Hub flashes BLUE then GREEN, it has completed the reset and is ready to connect.

2.9 LED Blink Codes

The RGB LED located on the Control Hub near the RS485 ports provides user feedback regarding the status of the Control Hub. Reference Table 7 for firmware LED codes.

Table 7: Firmware Version 1.07.00 or Higher LED Codes

Firmware Version 1_07_00			
LED Status	LED Description	When	Hub Status
	Solid Blue	At Boot	Control Hub has power; Battery is >7V and is waiting to initialize communications.
	Solid Blue	Anytime	Hub is waiting for communication with the Driver Station Host. Control Hub has power; Battery is >7V.
	Solid Green with one or more blue blinks every ~5 Seconds	Anytime	Hub has power and active communication with the Android Platform. The number of blue blinks is the same as the Hub's address. The factory default address is 2 ().
	Blinking Blue	Anytime	Keep alive has timed out. Fault will clear when communication resumes.
	Blinking Orange	Anytime	Battery Voltage is lower than 7V. Either the 12V battery needs to be charged, or the Expansion Hub is running on USB power only. This fault will clear when battery voltage is raised above 7V. This will not be overwritten by the keepalive timeout pattern.

3 INTEGRATED SENSORS

The REV Robotics Control Hub integrates a number of feedback sensors. Some of these are user accessible in the latest FTC Android Studio SDK, but others are not yet directly user accessible. These sensors are in some cases also used by the Control Hub for internal safety monitoring.

- Battery Voltage Monitoring [**Accessible**]
- Integrated 9-axis IMU [**Accessible**]
 - Bosch BNO055 9-axis absolute orientation sensor
 - Internally connected to I2C port 0 and configured to address 0x28
- Current Monitoring
 - Battery [**Accessible**]
 - I2C Bus [**Accessible**]
 - Digital Power Bus [**Accessible**]
 - Servo Power Bus [Not Accessible]
- Per Motor Channel Current Monitoring [**Accessible**]

4 LEGACY SENSOR SUPPORT

4.1 Logic Level Converter

The Control Hub is a 3.3V logic level device, but many of the sensors that teams have previously purchased through companies such as Modern Robotics are 5V logic level devices. Many of these previously purchased sensors can be used with the new system by using a logic level converter. REV Robotics offers a Logic Level Converter (REV-31-1389) and an optional Sensor Adapter Cable (REV-31-1384) so teams can more easily use their legacy sensors with the Control Hub system.

The REV Robotics Logic Level Converter is a PCB which generates a 5V output from the 3.3V input and uses a MOSFET on each signal line to create a bidirectional communication appropriate for a variety of digital signals include I2C communication (Figure 5). For more information on how bidirectional level shifting communication is accomplished, please reference the [NXP Application Note AN10441](#).

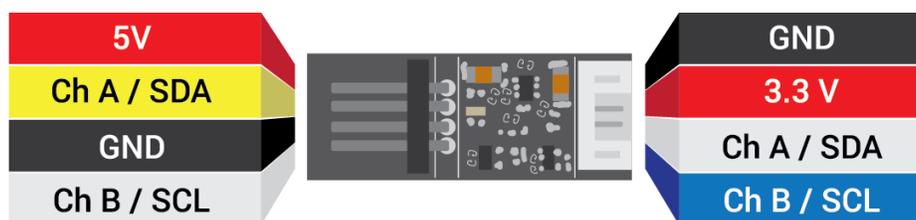


Figure 5: 3.3V to 5V Logic Level Converter Board

4.2 Connecting a 5V Motor Encoder

The Logic Level Converter pin out directly matches the encoder cable pin out for FTC legal motors. Encoder cables plug directly into the Logic Level Converter board and then the 4-pin JST PH Cable (REV-31-1407), which is included with the Logic Level Converter, is plugged into the appropriate Control Hub Encoder Port. Motors which are terminated with Anderson Power Pole style connectors use the JST VH to Anderson Power Pole Style (REV-31-1382) cable to connect to the motor output port on the Control Hub (Figure 6).

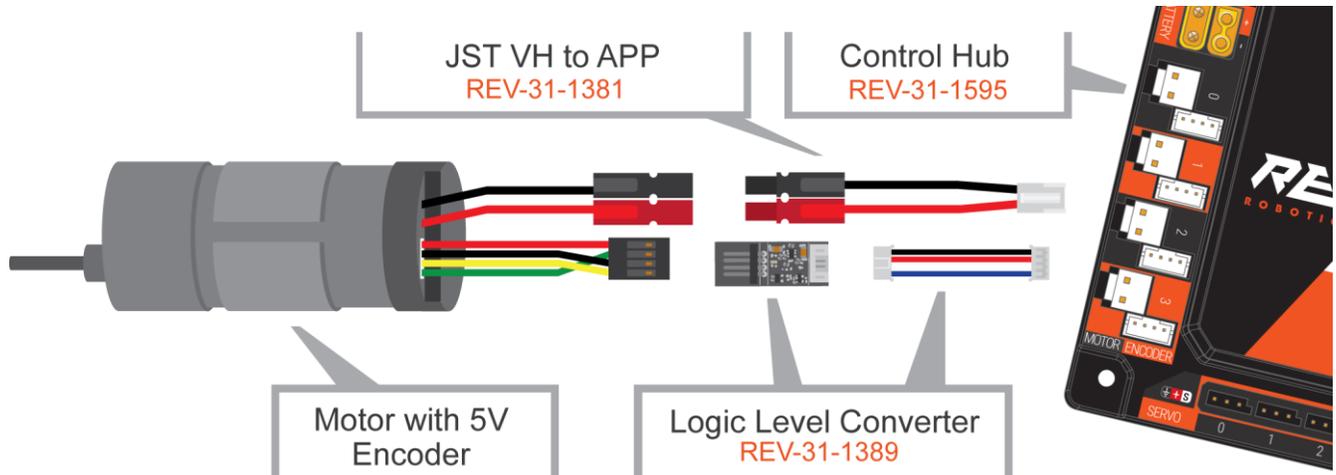


Figure 6: Connecting a Motor with 5V Encoder to a Control Hub

Note: All REV Robotics Motors work directly with the Control Hub and Expansion Hub.

4.3 Connecting a 5V Sensor

A variety of 5v sensors are usable with the Control Hub when used with a Logic Level Converter. For some Modern Robotics I2C sensors a Logic Level Converter, and a change in wiring to match the pin out of the Control Hub are needed.. Teams can either purchase a Sensor Cable as an add on to the Logic Level Converter Kit (REV-31-1389) which will cross over the correct wires, or they can carefully rearrange the pin order on the sensor cable. If using the Sensor Cable, connect the sensor to the Control Hub as shown in Figure 7. It is recommended to zip tie the connection between the sensor and the sensor cable to prevent accidental disconnects. See Section 4.4 for more information on hardware required for other sensors.

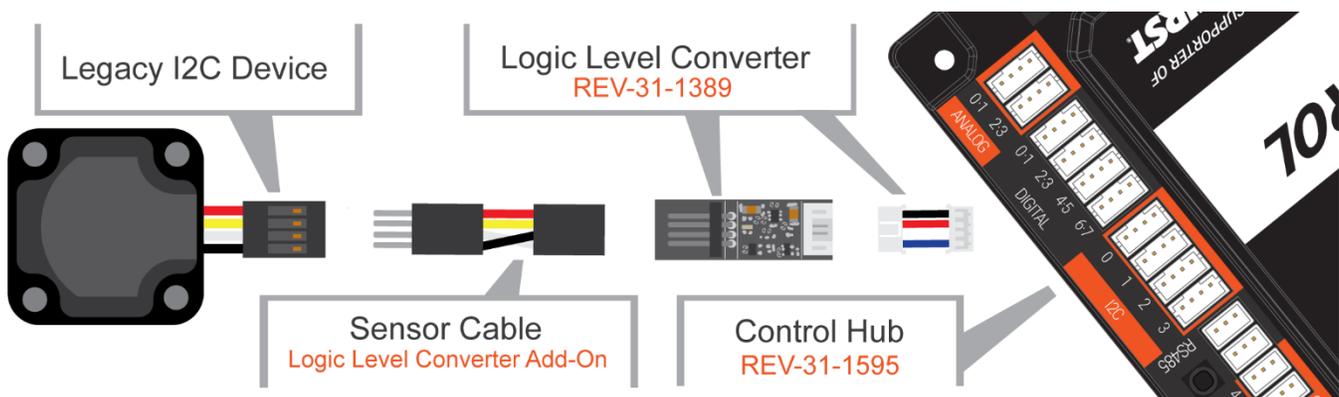
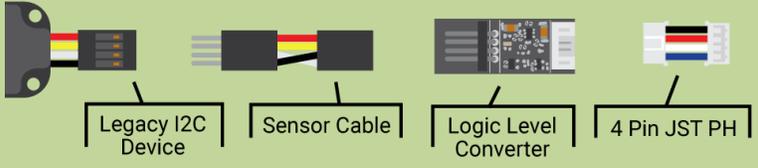
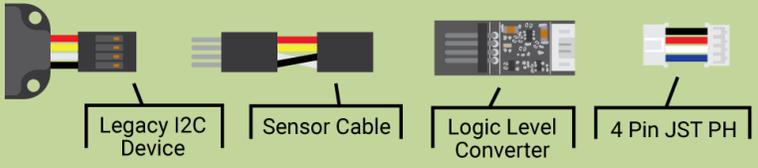
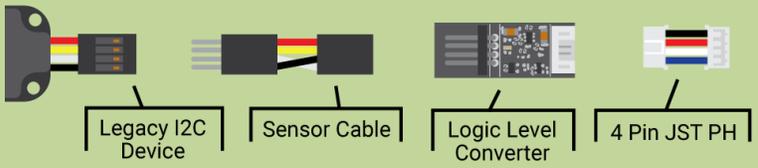
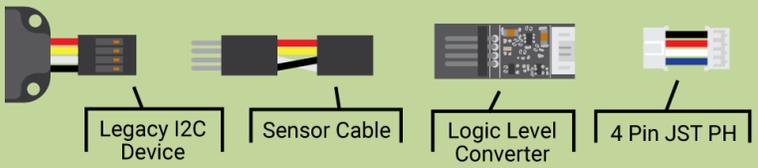
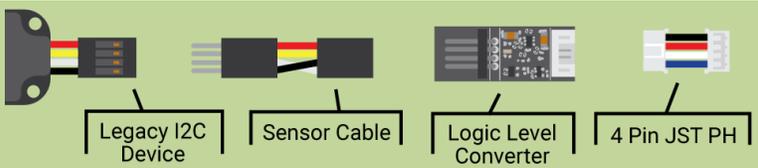
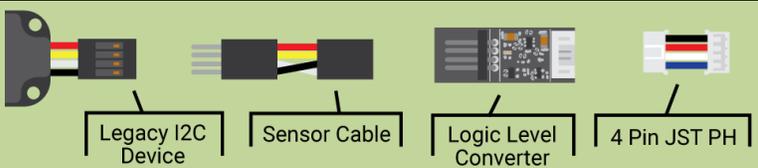


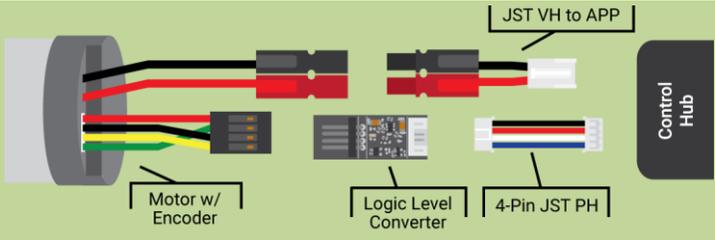
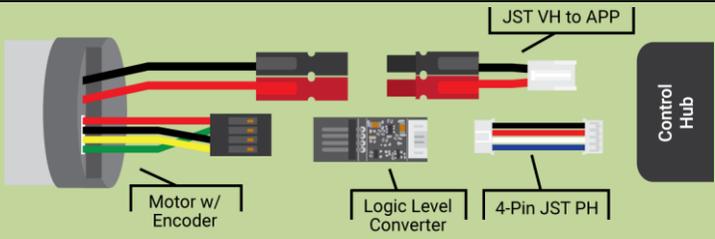
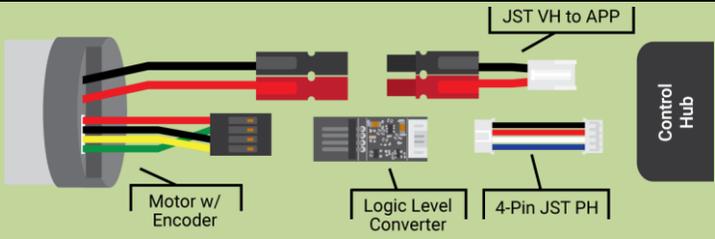
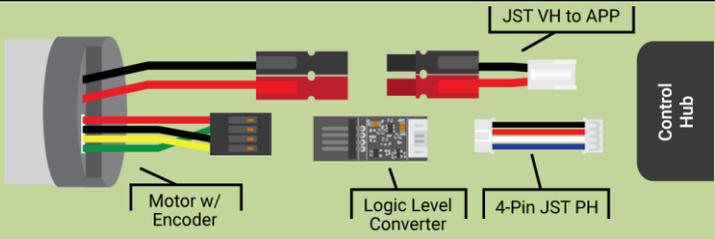
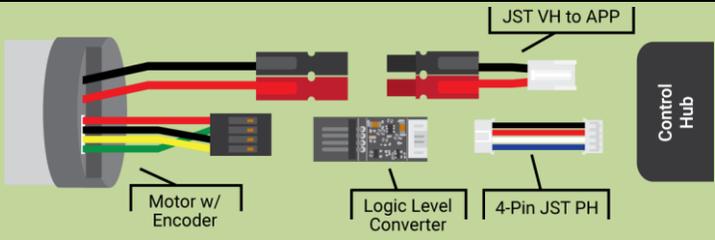
Figure 7: Connecting a Legacy 5V Sensor to a Control Hub

4.4 Sensor Compatibility Chart

To determine if your existing sensors can be used with the Control Hub, along with additional hardware needed, reference Table 8.

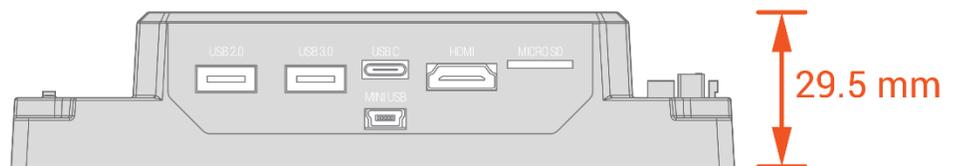
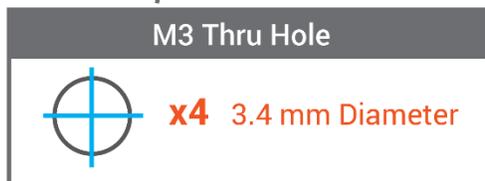
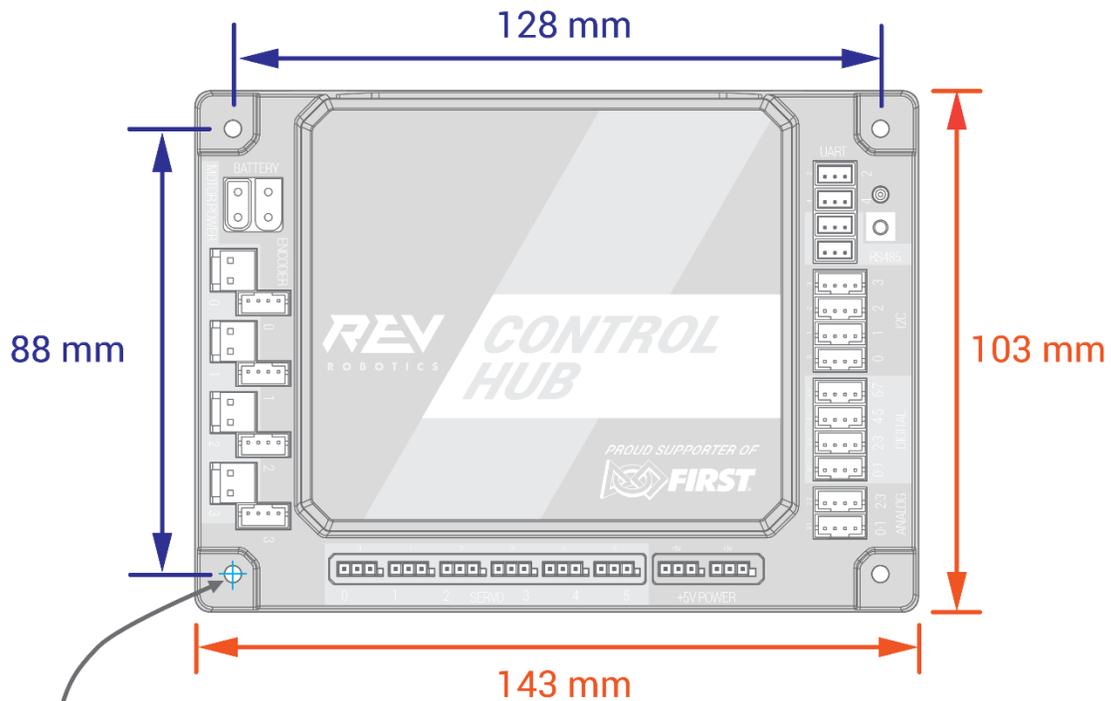
Table 8: Sensor Compatibility Table

Sensor	Type	Compatible	Adapters Needed	
Absolute Orientation IMU Fusion Breakout - BNO055 2472 Adafruit	I2C	Yes	3.3V Compatible Custom Wiring Harness Needed	
RGB Color Sensor with IR filter and White LED - TCS34725 1334 AdaFruit	I2C	Yes	3.3V Compatible Custom Wiring Harness Needed	
Color Sensor 45-2018 Modern Robotics	I2C	Yes		Control Hub
Compass 45-2003 Modern Robotics	I2C	Yes		Control Hub
Integrating Gyro 45-2005 Modern Robotics	I2C	Yes		Control Hub
IR Locator 360 45-2009 Modern Robotics	I2C	Yes		Control Hub
IR Seeker V3 45-2017 Modern Robotics	I2C	Yes		Control Hub
Ranger Sensor 45-2008 Modern Robotics	I2C	Yes		Control Hub

<p>NeveRest Motor AM-3461, AM-3102, AM-2964a, AM-3103, AM-3104 AndyMark</p>	<p>Quad Encoder</p>	<p>Yes</p>	
<p>HD Hex Motor REV-41-1301 REV Robotics</p>	<p>Quad Encoder</p>	<p>Yes</p>	<p>Directly Compatible No Custom Adapters Needed</p>
<p>Core Hex Motor REV-41-1301 REV Robotics</p>	<p>Quad Encoder</p>	<p>Yes</p>	<p>Directly Compatible No Custom Adapters Needed</p>
<p>12v 4mm Motor Kit 50-0119 MATRIX</p>	<p>Quad Encoder</p>	<p>Yes</p>	
<p>12v 6mm Motor Kit 50-0120 MATRIX</p>	<p>Quad Encoder</p>	<p>Yes</p>	
<p>Standard Motor Kit 50-0001 MATRIX</p>	<p>Quad Encoder</p>	<p>Yes</p>	
<p>Max Motor Shaft Encoder Kit W38000 Tetrix</p>	<p>Quad Encoder</p>	<p>Yes</p>	
<p>Limit Switch 45-2401 Modern Robotics</p>	<p>Digital</p>	<p>Yes</p>	<p>No Adapter Needed Custom Wiring Harness Required. See Section 4.5 for Details</p>

Rate Gyro 45-2004 Modern Robotics	Analog	No	Not Officially Supported
Optical Distance Sensor 45-2006 Modern Robotics	Analog	No	Not Officially Supported
Touch Sensor 45-2007 Modern Robotics	Analog	Yes	No Adapter Needed Custom Wiring Harness Required
Light Sensor 45-2015 Modern Robotics	Analog	No	Not Officially Supported
Magnetic Sensor 45-2020 Modern Robotics	Analog	No	Not Officially Supported

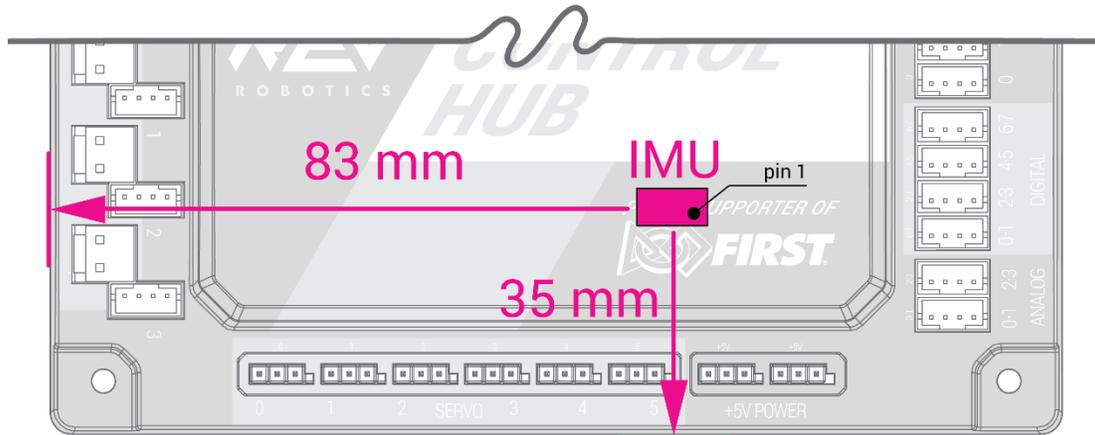
5 DIMENSIONS



5.1 IMU Location

When using the Control Hub please note the location of the IMU in the graphic below. The Control Hub's orientation may impact the values received from the embedded IMU.

BELOW: IMU Details Shown in Enlarged View



5.2 WiFi Radio Antenna

When using the Control Hub please note the location of the WiFi Radio Antenna in the graphic below. Do not place a battery or thick metal plate above the Control Hub as it will interfere with the WiFi Radio signal.

BELOW: Radio Antenna Shown in Enlarged View

