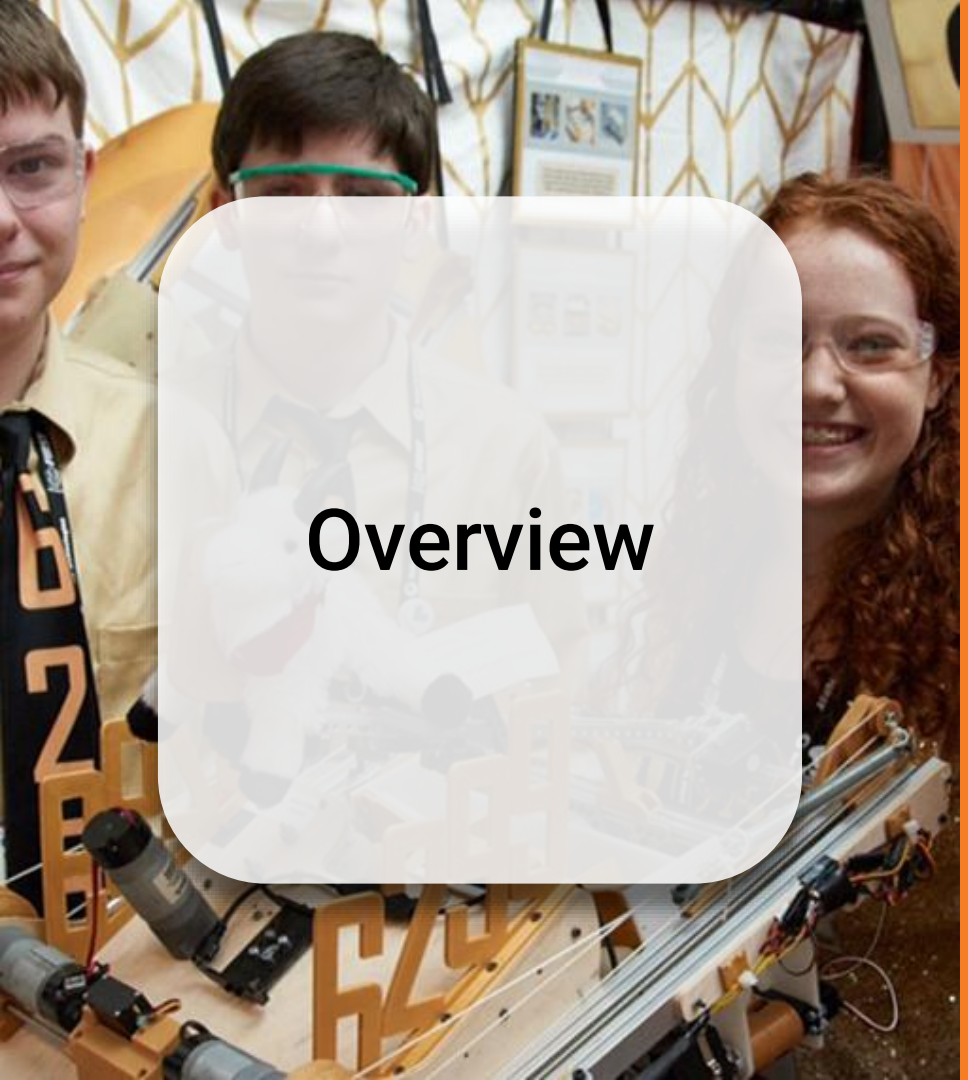
FTC DECODE Kickoff
Control System Intro

FIRST

FIRST LEGO LEAGUE

FIRST TECH CHALLENGE

FIRST ROBOTICS COMPETITION



Overview

- Introduction
- Hardware Overview
- Expansion Hub
- Control Hub
- Driver Hub
- REV Hardware Client
- Robot Software
- Best Practices

Introduction

- What is *FIRST* Tech Challenge?
- The Game Manual
- Building Your Robot

What is *FIRST* Tech Challenge?

"FIRST® Tech Challenge is a student-centered program that focuses on giving students a unique and stimulating experience. Each year, teams engage in a new game where they design, build, test, and program autonomous and driver operated robots that must perform a series of tasks."

- *FIRST* is an international program for K-12 students with four levels of progression throughout elementary, middle, and high school.
- Pairs students with industry mentors to learn valuable experiences.
- Prepares students for the workforce and college with both technical and nontechnical skills.
- $80 million in scholarships available to *FIRST* alumni.

Gracious Professionalism

"Gracious Professionalism® is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community."

The Game Manual

- Reading the game manual is critical!
- Contains a list of game rules and legal parts to use on your robot.
- Run through the self-inspection checklist before competition to ensure legality of parts.
- Manual is divided into two sections: part 1 is released before kickoff, and part 2 is game-specific.

Building Your Robot

2024-25 Basic 'Bot Resources

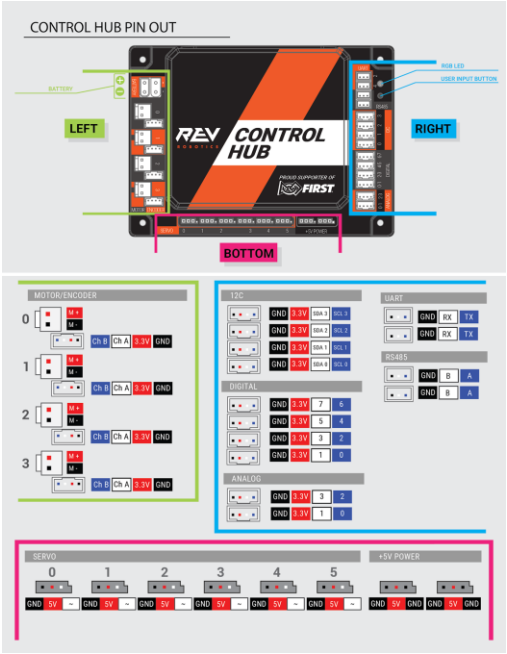
https://www.firstinspires.org/resource-library/ftc/robot-building-resources

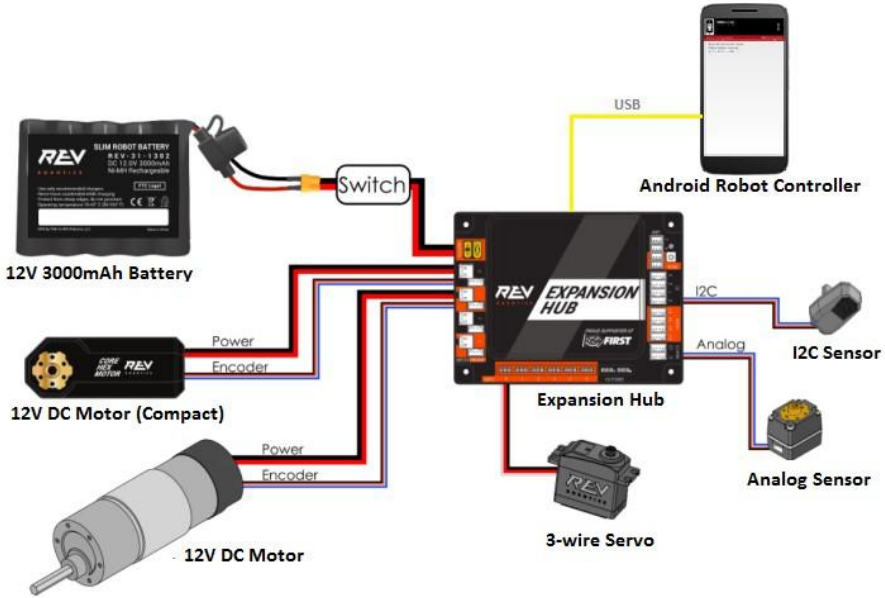
- Detailed instructions for building, wiring, and configuring Basic 'Bot.
- Uses resources found in your kit of parts.
- Rookie team members learn good building practices by following build instructions.
- FTC Control System SDK comes with programs that operate the PushBot.
- Adapt Basic 'Bot to play the game, or build and design a robot from scratch with the knowledge gained.

Hardware Overview

- Android Device
- Powering Your Robot
- Sensors

Hardware Layout





Naming Conventions

- The robot controller should follow the format "XXXX-RC" and the driver station "XXXX-DS", where XXXX is the team number.
- If a team has multiple sets of phones or Control Hubs, use the "XXXX-A-RC" and "XXXX-A-DS" format, with the letter "A" following the alphabet sequence.
- Example: Team 529's second set of devices would be named "529-B-RC" and "529-B-DS"

Battery & Power

- Remember to constantly charge batteries and phones at competition. Phones work best above 50% and robot batteries should be at 13 volts.
- Consider having multiple sets of batteries and phones to swap out throughout the competition.
- Some queueing areas at competition may have outlets available to charge phones.
    - You will only be at these stations for a couple of minutes before matches, so be sure not to rely on these stations!
- Check your fuse to make sure it's connected and working!

Motors & Servos

- Motors
  - Power output range is from 100% (forward) to -100% (reverse).
  - Requires an encoder to keep track of the position, which can be complicated to code.
- Servos
  - Multiple sizes for small and large applications.
  - Generally low-power and low-torque.
  - Come in 180-degree range of motion or continuous operation types.
- **Both motors and servos can move forwards and backwards.**
- **Motors accept a speed to move at, whereas servos move at a fixed speed.**

Sensors

Ultrasonic Sensor	Returns how far away an object is from the front of the sensor.
Color Sensor	Returns how much red, green, and blue light is in front of the sensor. Must be calibrated at each venue.
Light Sensor	Returns the brightness of an object in front of the sensor. Useful for detecting field lines.
Bump Sensor	Returns true or false depending on whether the button is pressed.
Encoders	Returns how much a motor has turned.
USB Camera	Used for processing vision targets.

Expansion Hub

- REV Robotics Hubs
- Android Phones

REV Robotics Expansion Hub

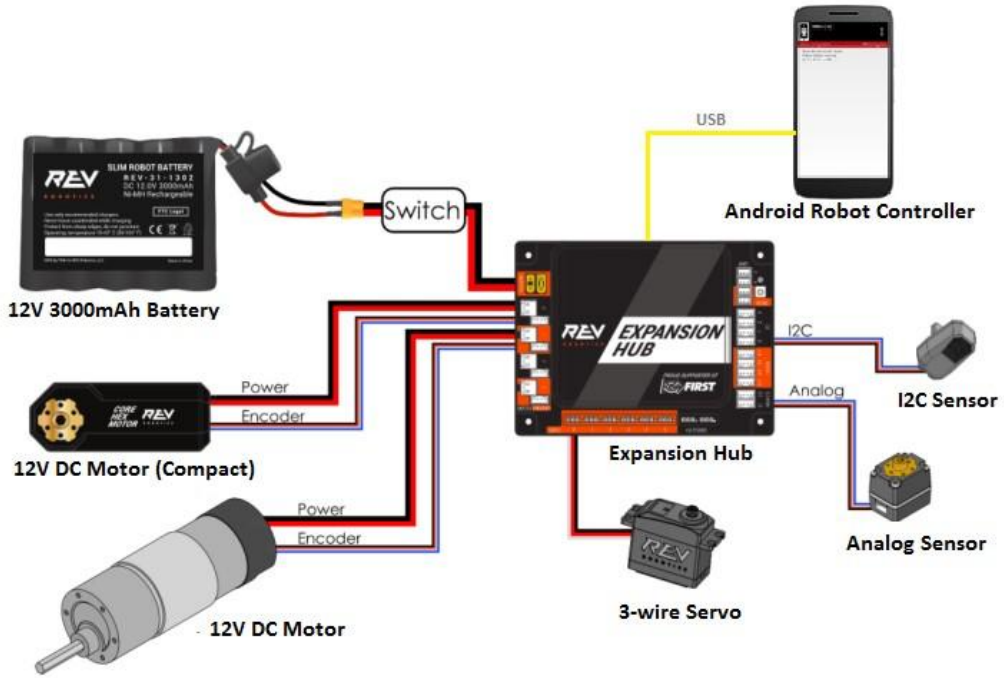
- The Expansion Hub receives signals from the robot controller device and outputs to motors and servos.
- Contains 4 motor outputs + 4 encoder inputs, 6 servos, 2 auxiliary power ports, 8 digital I/O, 4 analog inputs, 4-channel I2C bus.
- Built-in inertial measurement unit on I2C port 0.

FTC Legal

Connection


Team 1
Driver 1
Team 1
Driver 2
Driver Station
WiFi Direct Connection
Robot Controller

Connection


USB
Android Robot Controller
Switch
12V 3000mAh Battery
REV EXPANSION HUB
I2C
I2C Sensor
Power
Encoder
Analog
12V DC Motor (Compact)
Expansion Hub
Power
Encoder
Analog Sensor
3-wire Servo
12V DC Motor

Android Phones - WiFi Direct

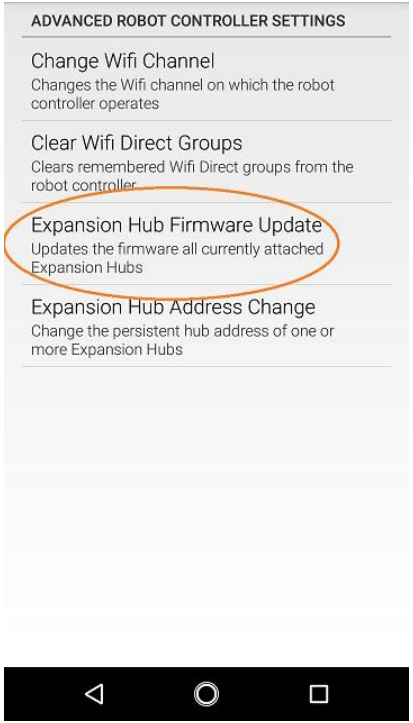
- WiFi Direct is a wireless system that allows two wireless devices to communicate between each other.
- Designate one device as the driver station and one device as the robot controller.
  - The robot controller will be placed on the robot and runs the team's code, while the driver station sends the current gamepad data.
- The robot controller should follow the format "XXXX-RC" and the driver station "XXXX-DS", where XXXX is the team number.
  - If a team has multiple sets of phones, use the "XXXX-A-RC" and "XXXX-A-DS" format, with the letter "A" following the alphabet sequence.
  - Example: Team 529's second set of phones would be named "529-B-RC" and "529-B-DS"

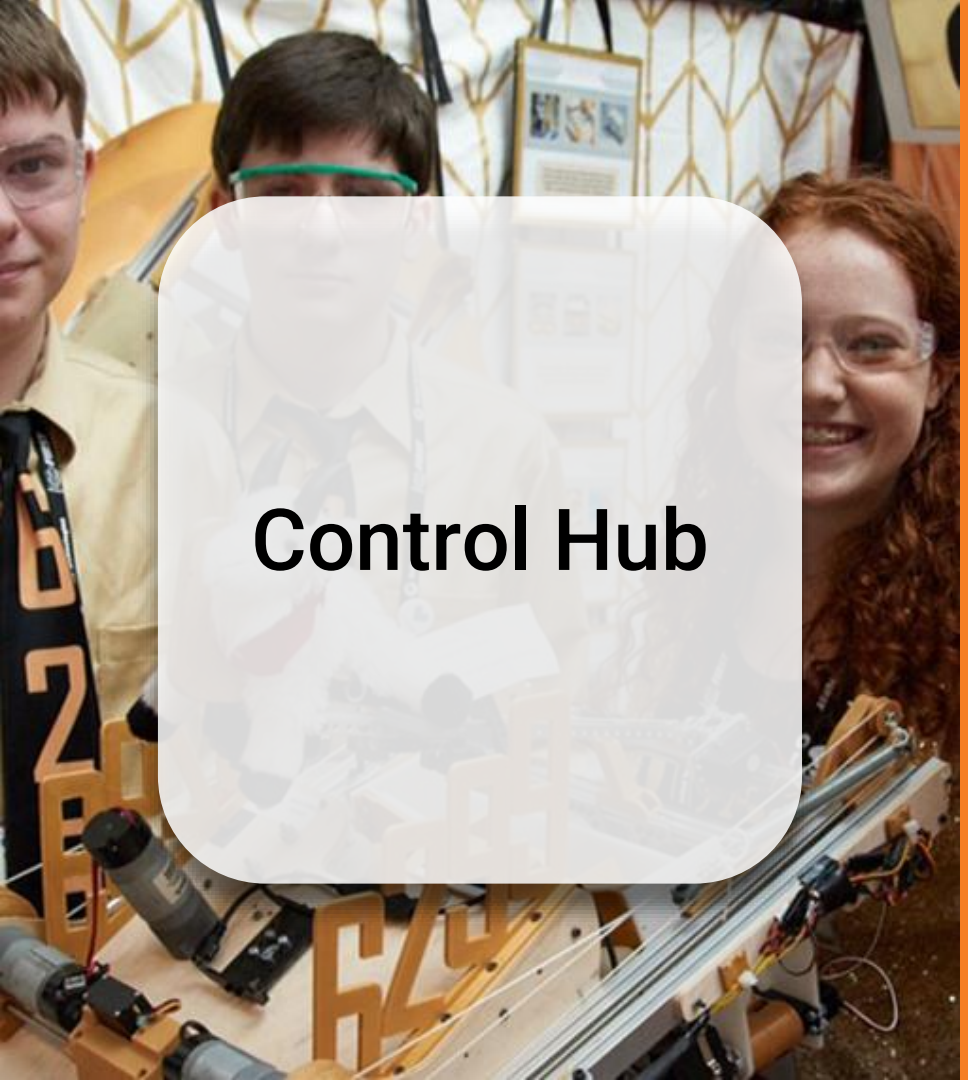
Android Phones - WiFi Direct

- To modify WiFi direct settings, first open the settings app and navigate to "WiFi".
- Tap the three dots in the upper-right hand corner. Select "Advanced". Select "WiFi Direct" from the list.
- Tap the three dots in the upper-right hand corner. Select "Configure". Set the name appropriate to the device.
- Be sure to set WiFi direct to never timeout!

Updating the Expansion Hub Firmware

1. With the driver station phone, download the latest version of the firmware from the REV Control System Whitepages
2. Using the driver station, connect to the robot
3. Open the driver station app and navigate to settings -> advanced settings -> expansion hub firmware update

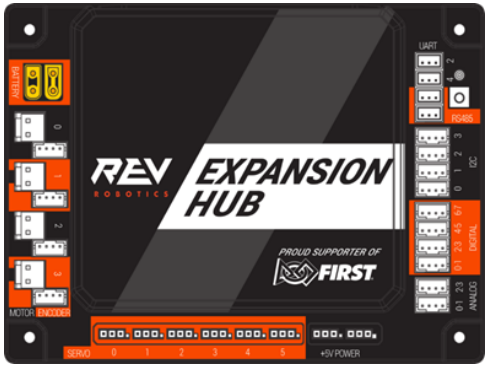




Control Hub

- Overview
- Ports
- Status Codes

Overview

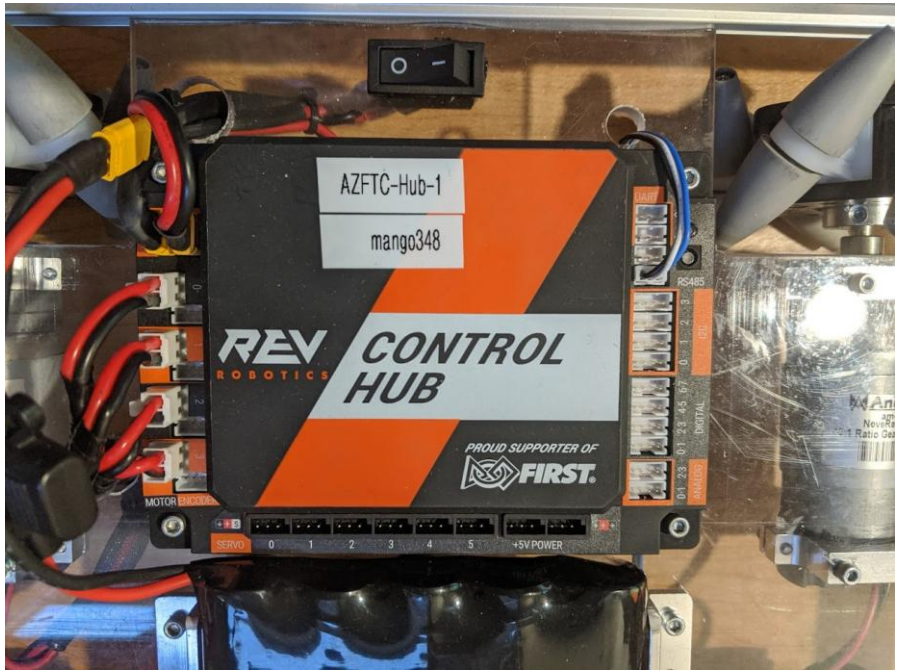

REV ROBOTICS
EXPANSION HUB
PROUD SUPPORTER OF FIRST


REV ROBOTICS
CONTROL HUB
PROUD SUPPORTER OF FIRST

Overview

- Smaller footprint by avoiding the Robot Controller phone
- One less USB connection, fewer places to disconnect
- Ability to use a USB camera for vision targeting, rather than a built-in camera on a phone
- Firmware and software is preloaded onto the Control Hub
- Programming tools, languages, and driver controls are the same as the previous season

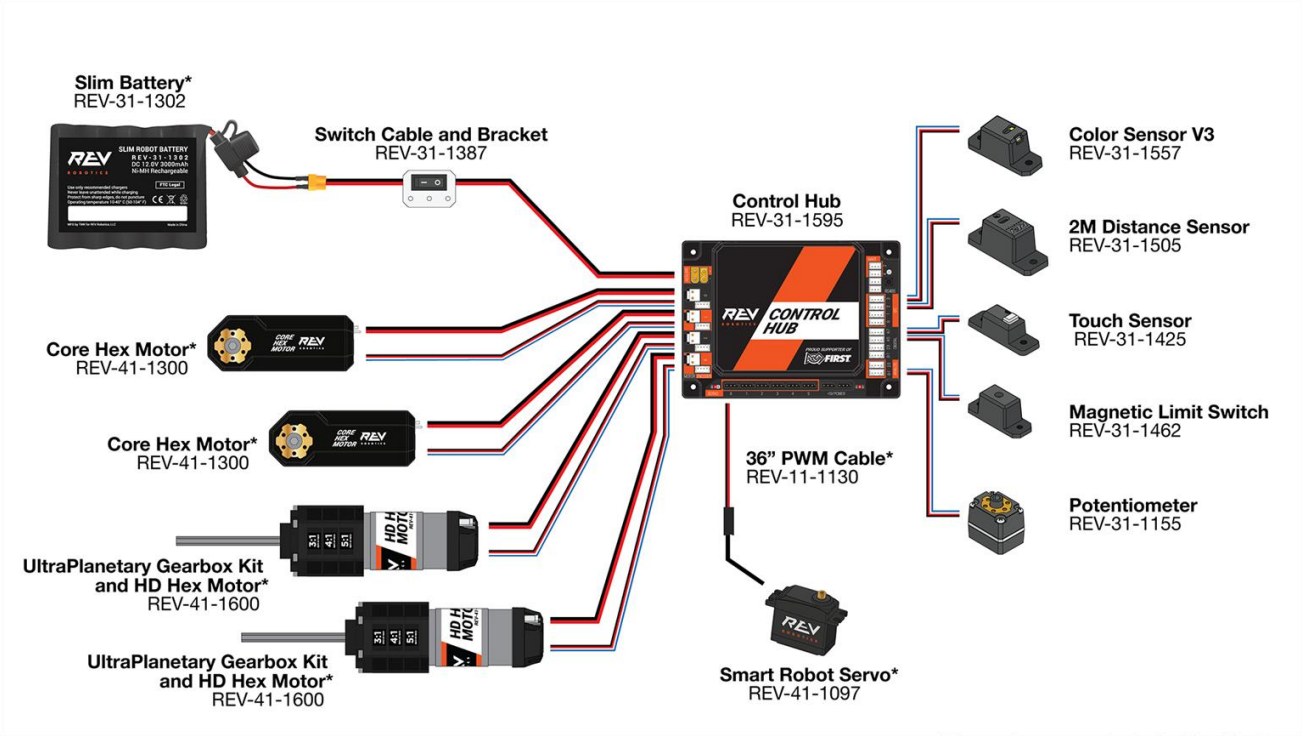
Overview


AZFTC-Hub-1
mango348
REV ROBOTICS
CONTROL HUB
PROUD SUPPORTER OF FIRST
MOTOR ENCODER
SERVO
0 1 2 3 4 5
+5V POWER
RS485
DIGITAL
ANALOG

Expansion Ports

- USB A (2.0 speed)
  - Connects USB cameras and other USB devices, 1.5A source max
- USB A (3.0 speed)
  - Connects USB cameras and other USB devices, 1.5A source max
- USB C (2.0 speed)
  - Used for programming
- HDMI A
  - Supports 4k @ 60Hz resolution

Wiring Diagram

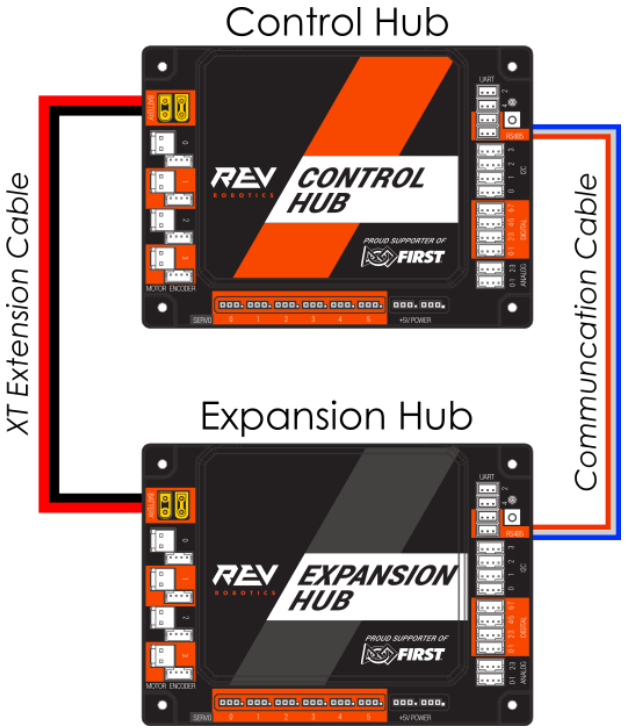


Status LED Codes

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. Control Hub has power, and battery is >7V
	Solid Green with one or more blue blinks every ~5 seconds	Anytime	Hub has communication with the Driver Station. The number of blue blinks is the same as the Hub's address.
	Blinking Blue	Anytime	Keep alive has timed out. Fault will clear when communication resumes.
	Blinking Orange	Anytime	Battery voltage is lower than 7V.

Adding an Expansion Hub

1. Turn off robot power. Use an XT Extension Cable to connect power from the first hub to the second hub, and a JST PH cable to connect the RS485 ports from the first hub to the second hub
2. Turn on robot power. Create a new configuration file, and the second hub will appear inside the first hub
3. If no hub appears, power off the robot, disconnect the second hub, and assign a new address from the settings in the Driver Station app



Setting the WiFi Channel

- Teams can use either the 2.4GHz or 5GHz channel with the Control Hub; defaults to 2.4GHz in the settings
- Setting can be changed from the web console or “program and manage” from a connected Driver Station phone
- Performance impact will be sizable in crowded venues
- Tested 2.4GHz performance with a Moto G4 Play, 3ms ping rates at 50 feet distance in an isolated environment

Setting the WiFi Channel

Phone	WiFi Band
Moto G4 Play	2.4 GHz (Single Band)
Moto G5	2.4 GHz & 5 GHz (Dual Band)
Moto G5 Plus	2.4 GHz & 5 GHz (Dual Band)
Moto E4	2.4 GHz & 5 GHz (Dual Band)
Moto E5	2.4 GHz & 5 GHz (Dual Band)
Moto E5 Play	2.4 GHz & 5 GHz (Dual Band)

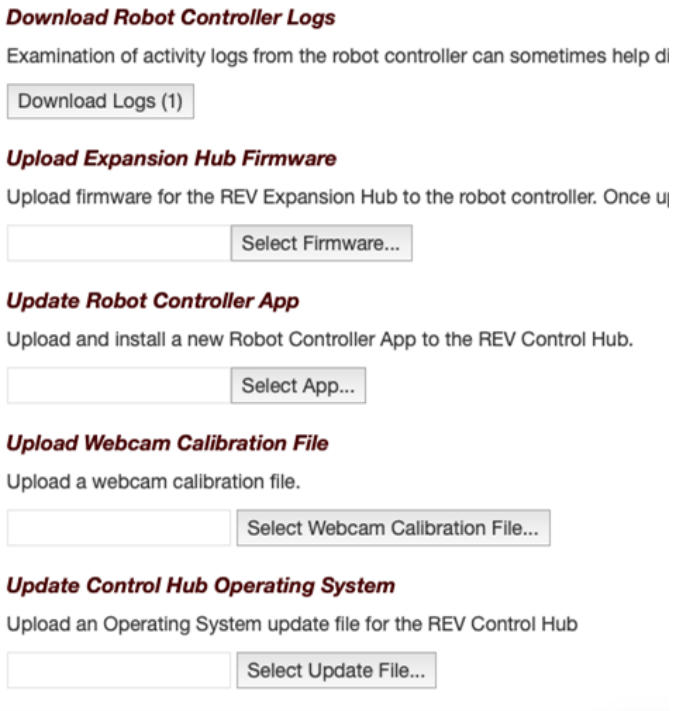
Resetting WiFi Network

- Resets the password and SSID name while preserving OpModes

1. Disconnect power from the robot
2. Press and hold the button on the front of the Control Hub, near the RS485 connection
3. While pressing the button, power on the Control Hub
4. Release button when the Control Hub LED flashes pink. Once the hub flashes blue then green, it has completed the reset.

Updating the Firmware and Operating System

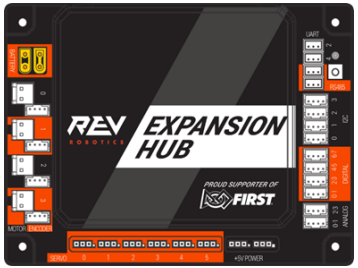
1. Visit the REV Robotics website for the latest version and download the update files first
2. Connect a device to the Control Hub's WiFi network
3. Navigate to "192.168.43.1:8080" on a separate device and select the manage tab to see the options



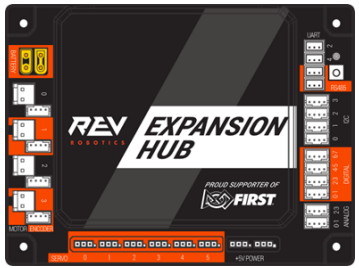
Robot Controller Configurations

Single Control Hub

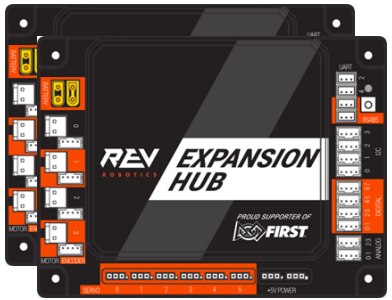
Single Control Hub + Single Expansion Hub



Single Expansion Hub + RC Phone

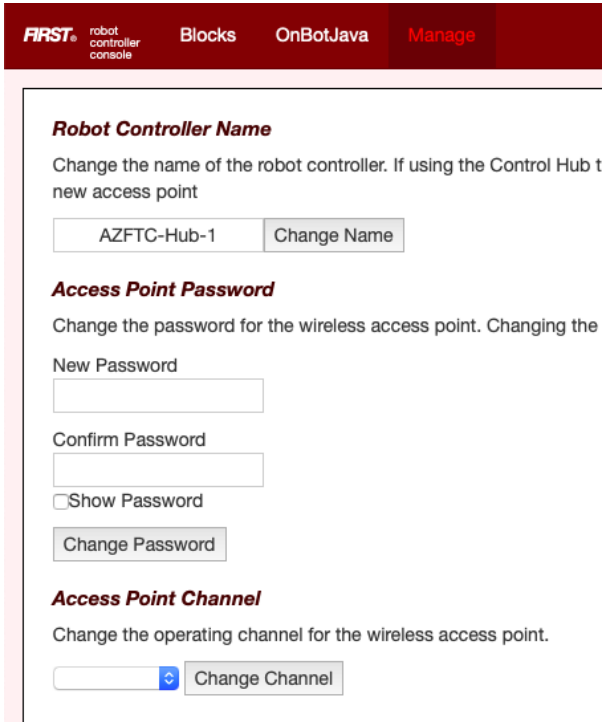


Double Expansion Hubs + RC Phone



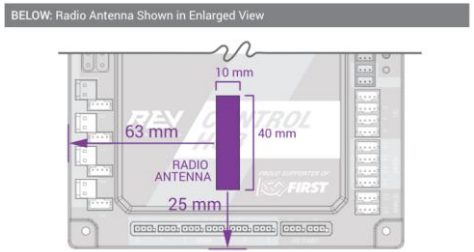
Configuring WiFi Network

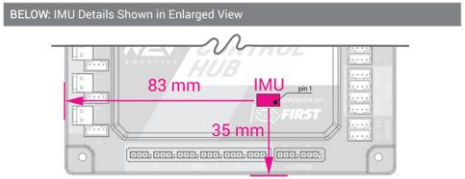
1. Power on the robot. On a computer, select the network that begins with “FTC-” or “FIRST-” followed by four random numbers
    a. We recommend doing this away from other robots so you know which one is yours!
2. Provide the default WiFi password: `password`
3. Open a web browser and navigate to “192.168.43.1:8080”

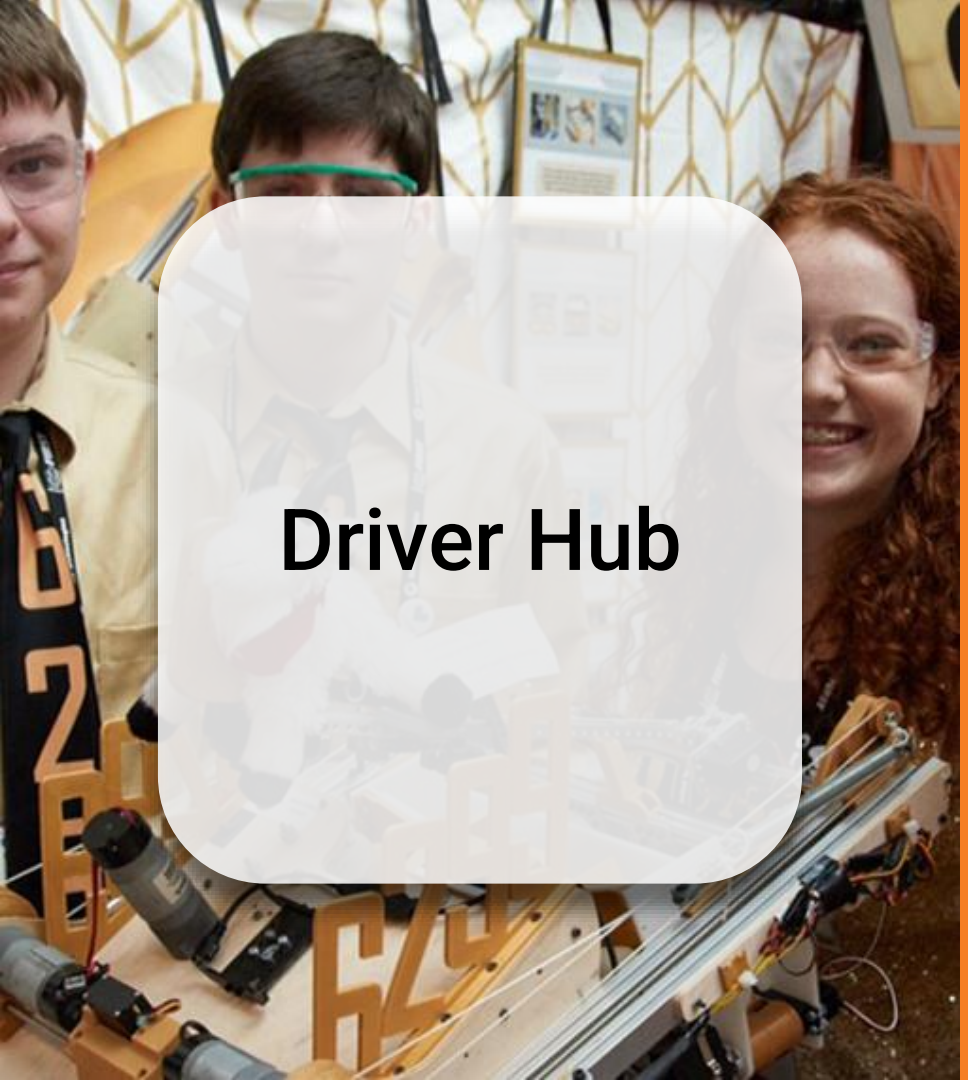


Best Practices

- Do not place objects on top of the Control Hub as the WiFi antenna can become obscured, leading to high ping times
- Orienting the hub perpendicular to the field can cause the IMU's axis to become offset; can be corrected in code







Driver Hub

- Specifications and Overview
- Updating the Drive Hub
- Getting Started

Specifications and Overview

- The REV Driver Hub is a compact mobile device designed for interfacing with the Control Hub
- Supports many off-the-shelf gamepads connected through built in USB ports
- When the Driver Hub Software is updated with new features, the device can receive a “field upgrade” update through the REV Hardware Client
- They cost $200, and they sell out quickly

Specifications and Overview

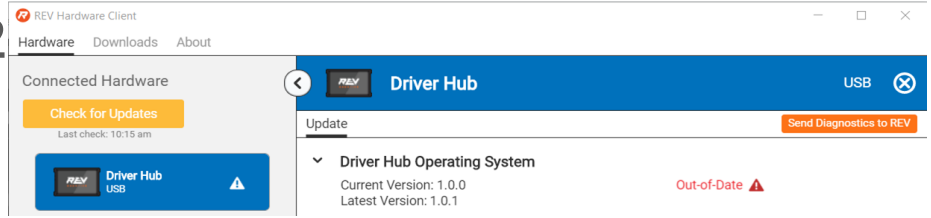
- Ethernet port
- 3 USB-A 2.0 ports
- 1 USB-C port
- 1 power button
- Memory 1GB
- Storage 8GB
- Dual Band 2.4 and 5 GHz Wifi
- Android Operating System

Updating Through REV Hardware Client

1. Open the REV Hardware Client, and connect Driver Hub to PC using a USB A or USB C cable
2. Select Driver Hub
3. After selecting Driver Hub, Software that needs an update Will say “out of date” next to it. Click the update button.

1

2

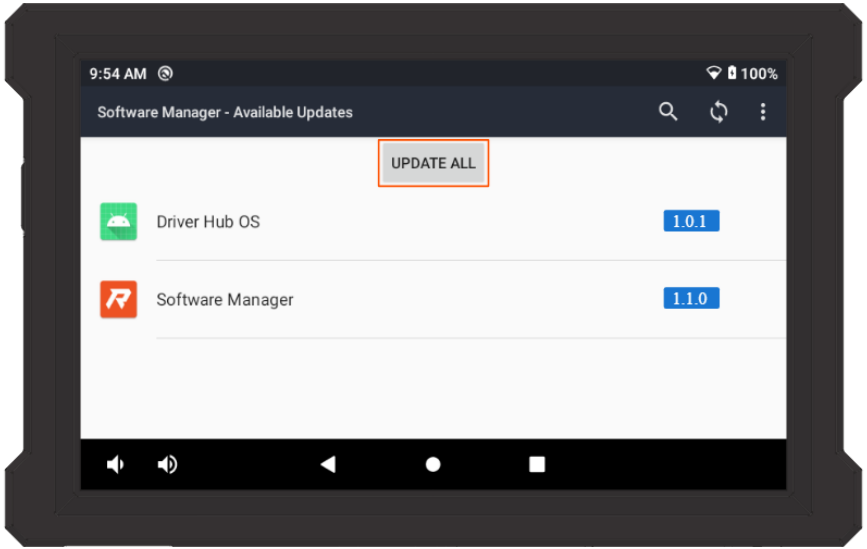


Updating through Software Manager

The Software Manager is a pre installed application on the Driver Hub.

Open, and select update all.

- Make sure you are connected to Wifi with internet
- This could take awhile, so make sure that it is fully charged, or plug it in during update



Getting Started

Required Materials:

- Driver Hub
- USB-A to USB-C cable
- USB-A wall charger

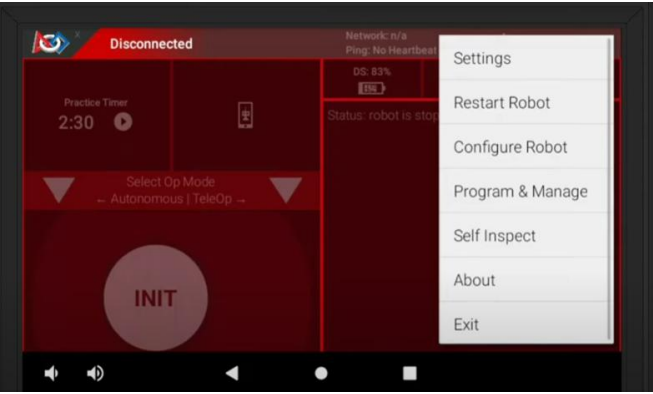
1. Charge Driver Hub fully
2. Connect to Wifi and internet and the Software Manager will open automatically to check for updates. If it needs an update, click the update all button
3. Open the Driver Station Application, and connect to Control Hub

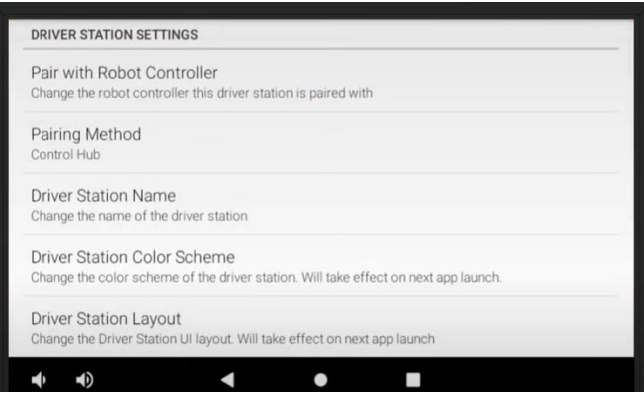
Getting Started

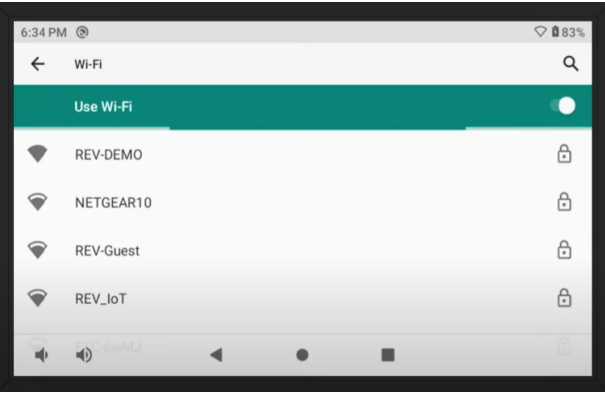
Connecting Driver Hub to Control Hub

1. In the Driver Station application, click the three dots in the top right corner. Click settings, then pair with robot controller
2. Click Wifi settings, then it will scan for the pre-configured Control Hub Network.
3. Click on the control hub, and type the password.

Getting Started







REV Hardware Client

- Overview
- Installation
- Navigating the Client
- Troubleshooting

Overview

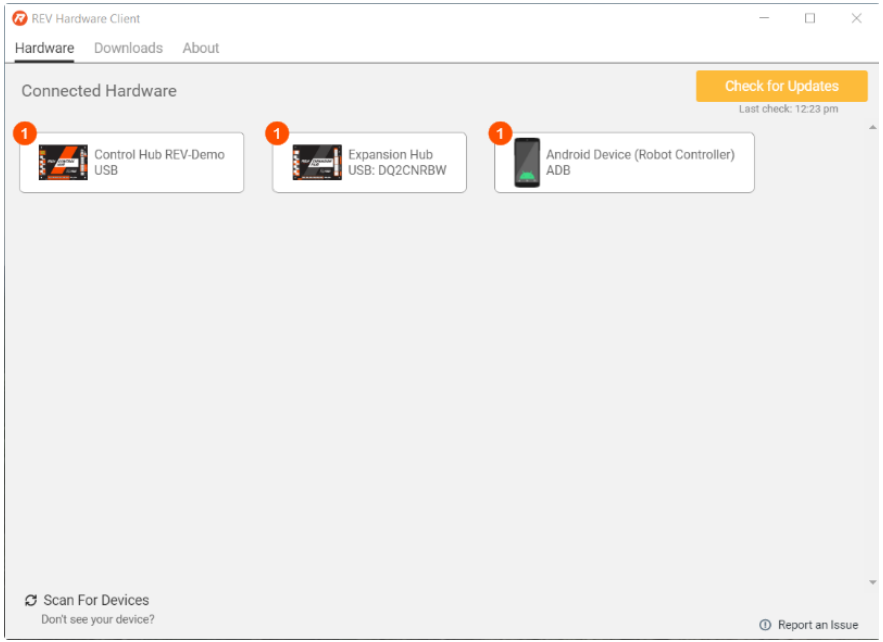
- The Rev hardware client is software that lets you manage your REV devices easier
- It will automatically detect supported devices when they are connected via USB and display them
- It allows you to update the software on connected devices with one click
- You can backup and restore user data from supported devices as well

Installation

- You want to download the client onto a computer running Windows 7 or newer. To download it go to revrobotics.com and navigate to the installation page. From there you will find a download button to get started.
- Once it's downloaded, you will run the installer, which will install the application.
- You can run it from a desktop shortcut or the Windows start menu.

Navigating the Client

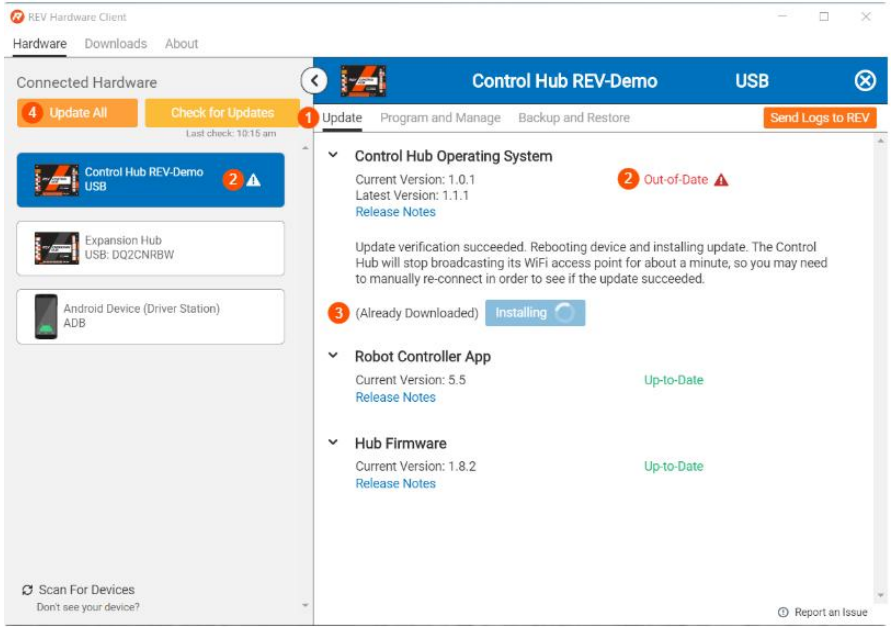
Hardware Tab:



The hardware tab will show all the supported devices currently plugged into your computer

Navigating the Client

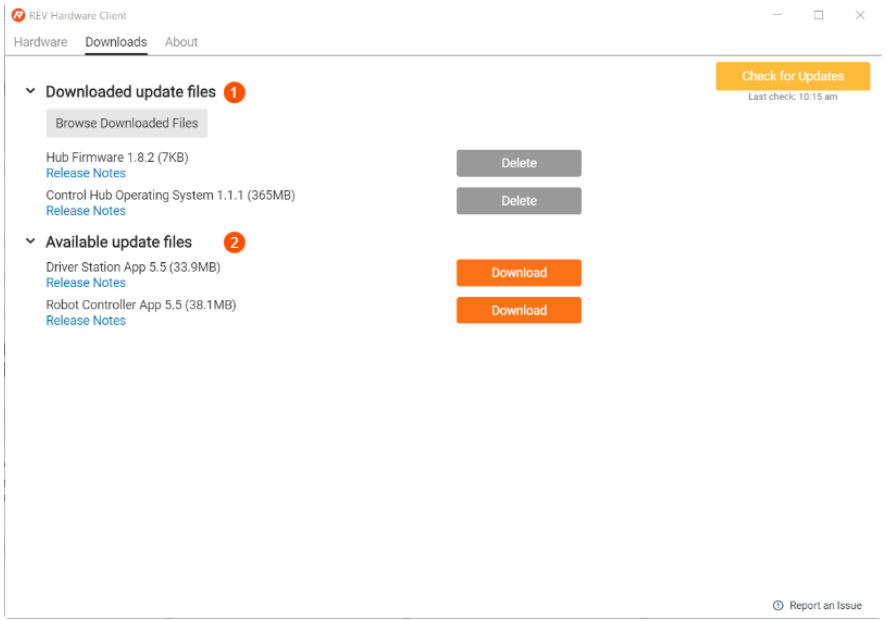
Hardware Tab:



Selecting a device will give you information about it. This is how you can update the software on different devices.

Navigating the Client

Downloads Tab:



From the downloads tab you can download update files to update your devices.

Troubleshooting

- If a device is plugged in and not showing up:
  - Start by unplugging and replugging the device in, don't forget to click "Scan for devices"
  - Make sure your computer is connected to the internet because you might not have all the right drivers installed
  - If none of these work, follow the steps for the specific device:

Control Hubs connected via WiFi

- Make sure that the Control Hub is running version 5.5 or later of the Robot Controller app
- Make sure the Control Hub has had a chance to finish starting up, and that its light is green
- Make sure that you are currently connected to the Control Hub's WiFi network
- Try rebooting the Control Hub. Re-connect to its WiFi network after its light turns green

Control Hubs connected via USB

- Make sure that the Control Hub is plugged in via USB-C, not Mini USB
- Make sure the Control Hub has had a chance to finish starting up, and that its light is green

Troubleshooting

Expansion Hubs connected to a Control Hub

- Make sure that the Expansion Hub is in the active configuration file

SPARK MAX Motor Controller

- Make sure that the SPARK MAX is not being used by another application, such as the REV SPARK MAX Client

Android phones

- Make sure that USB debugging is enabled in the Developer Options
  - If you can't find Developer Options anywhere in the Settings app (it may be listed on a System screen or similar), make sure it is enabled by tapping on the Build number 7 times on the About screen of the Settings app.
- Unplug the phone from the computer and plug it back in. Look for a prompt to allow USB debugging, and click OK when it comes up.

Feel free to take a picture, this information is also available on revrobotics.com under troubleshooting under the Rev Hardware Client

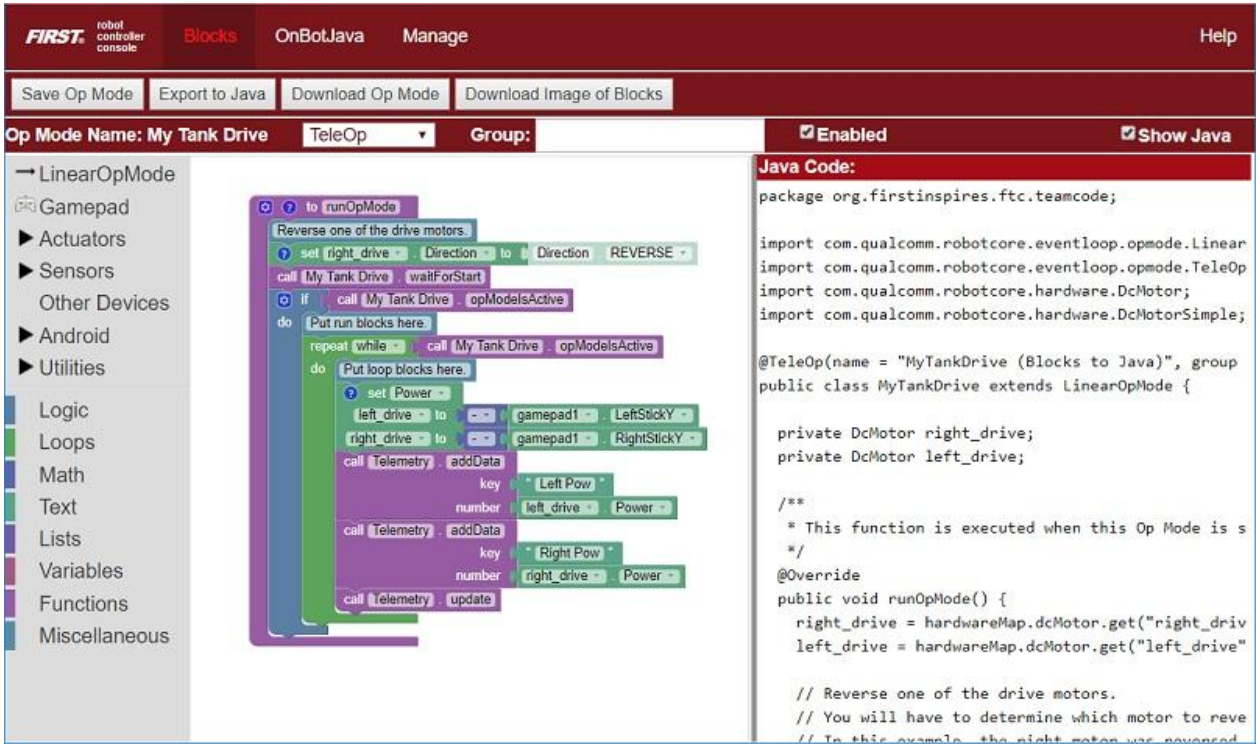
Robot Software

- Programming Languages
- Installing the Apps
- Building a Config File

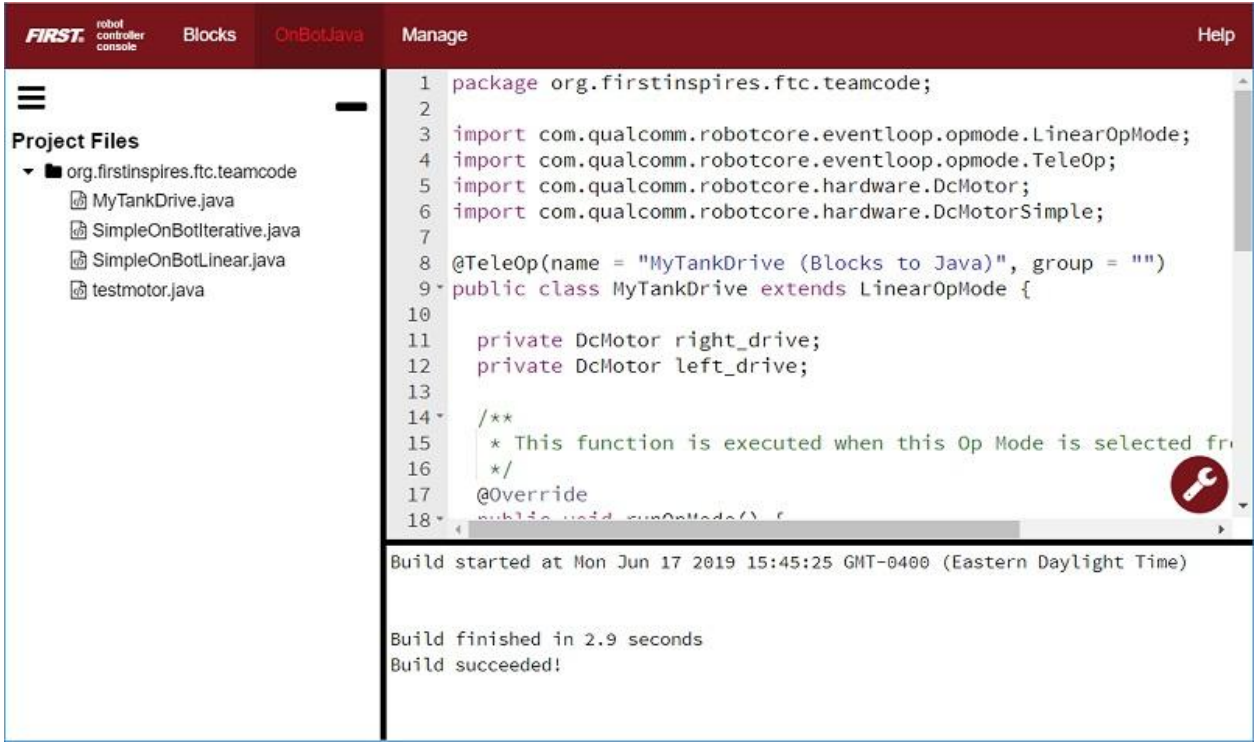
Programming Languages Overview

- Three options for programming the robot.
- Blocks: a visual, drag-and-drop tool that runs in a web browser. Create, edit, and save op modes directly on the phone.
- OnBot Java: similar to Blocks, but utilizes the Java language rather than drag-and-drop blocks. Useful for learning Java programming.
- Android Studio: advanced integrated development environment for designing, coding, and publishing Android apps. Recommended for advanced users only.

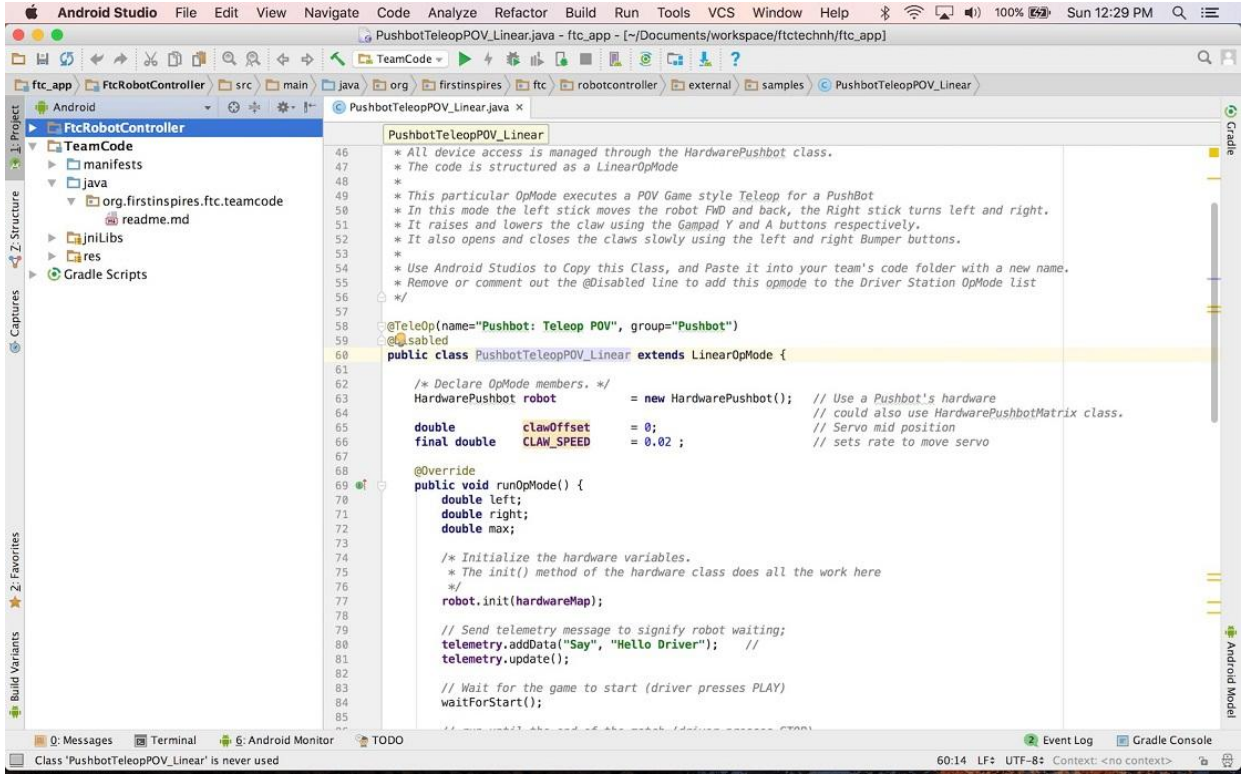
Blocks Programming



OnBot Java Programming



Android Studio Programming



Installing the Apps

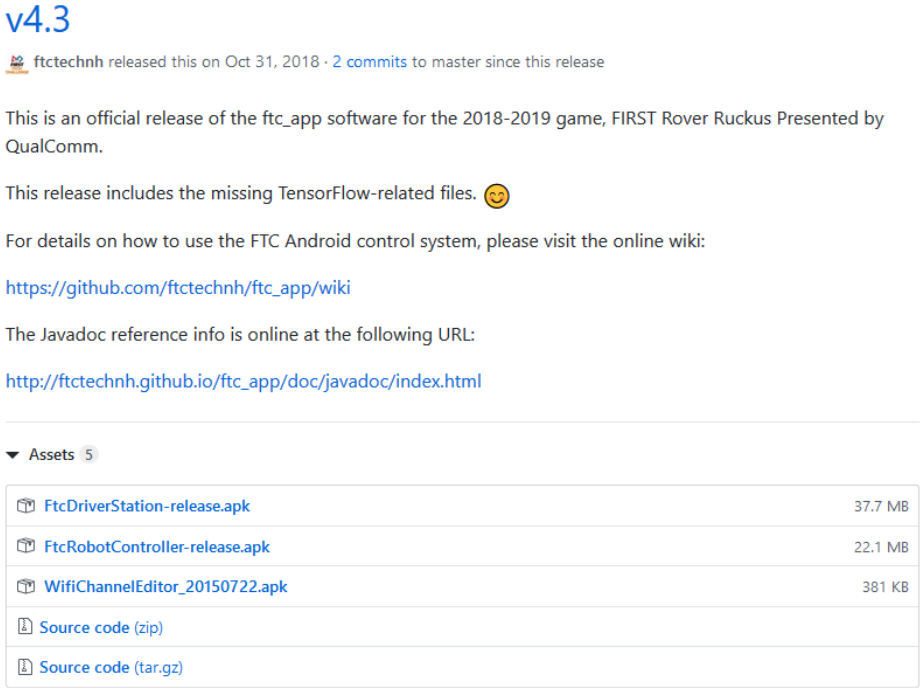
- Two apps are required for the robot to operate: the driver station and robot controller.
- Apps are included in the FIRST Tech Challenge GitHub repo or the Google Play Store.
  - Link: https://github.com/FIRST-Tech-Challenge/SkyStone/releases
- When updating the robot controller software, be sure to update the driver station software as well.
- Be sure to only install the appropriate app on one device.
  - For example, only install the driver station app on the driver station phone

Installing the Apps

- Option 1: Install both apps from the Google Play store.
- Option 2: Sideload the apps using the Android Debug Bridge.
  - Connect the phone and computer using a USB cable.
  - Open the folder containing "adb.exe" (see following picture for example)
  - Copy and paste the APK files into this directory.
  - Shift + Right-Click on the whitespace and select "Open PowerShell Window Here"
  - Type the command "`.\adb.exe install .\FtcRobotController-release.apk`"
  - If you receive an error that the device is unauthorized, ensure that USB debugging is enabled on the phone. After attempting to push the app, you may have to tap "authorize this device" on the computer.
  - Repeat for the driver station APK, replacing ".\FtcRobotController-release.apk" with ".\FtcDriverStation-release.apk"

Installing the Apps

- If you are installing the apps manually, download the APK files from the FTC FtcRobotController GitHub.
- Android Studio teams will need to download the source code as well.



v4.3

ftctechnh released this on Oct 31, 2018 · 2 commits to master since this release

This is an official release of the ftc_app software for the 2018-2019 game, FIRST Rover Ruckus Presented by QualComm.

This release includes the missing TensorFlow-related files. 😊

For details on how to use the FTC Android control system, please visit the online wiki:

https://github.com/ftctechnh/ftc_app/wiki

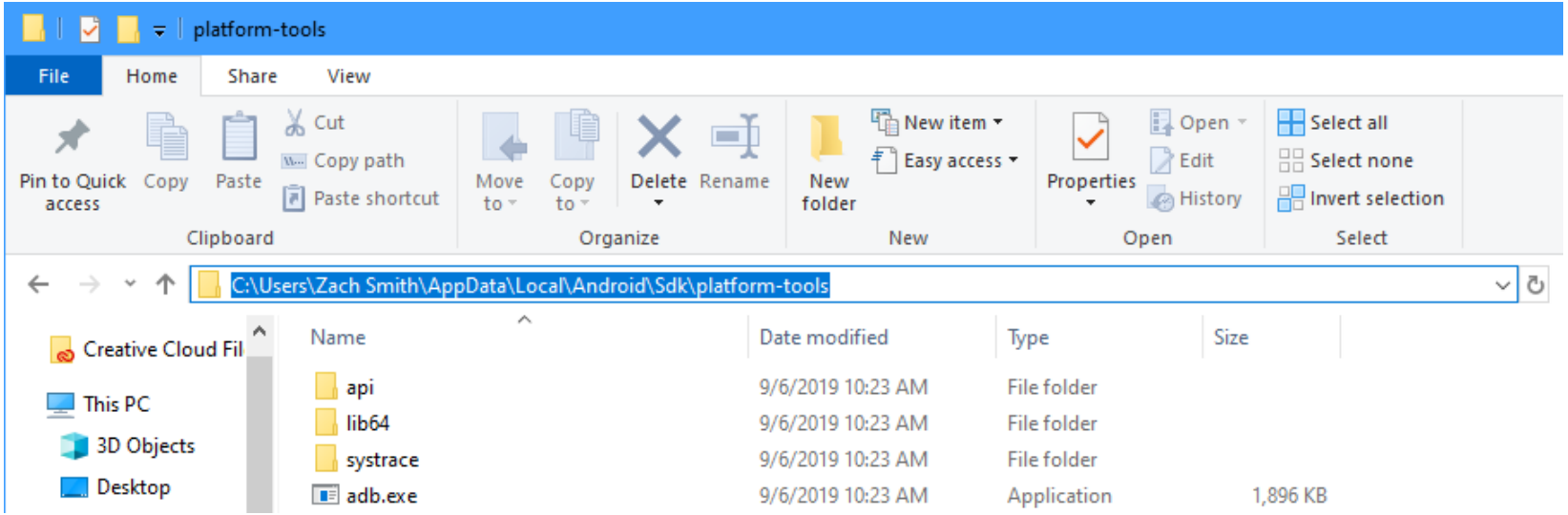
The Javadoc reference info is online at the following URL:

http://ftctechnh.github.io/ftc_app/doc/javadoc/index.html

▼ Assets 5

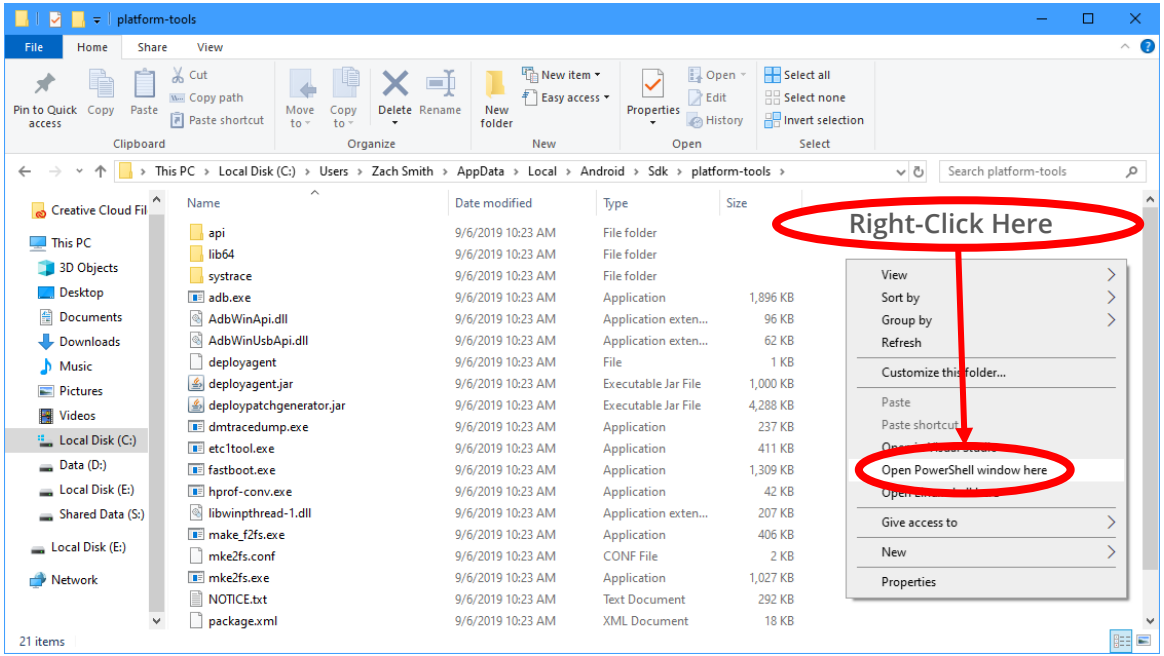
FtcDriverStation-release.apk	37.7 MB
FtcRobotController-release.apk	22.1 MB
WifiChannelEditor_20150722.apk	381 KB
Source code (zip)	
Source code (tar.gz)	

Installing the Apps Manually

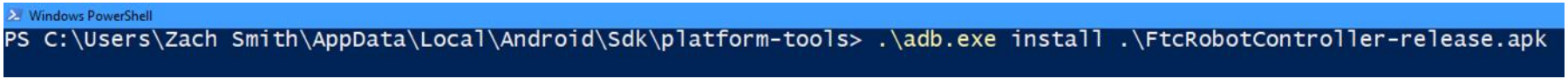


- Windows may hide this folder; try typing "%localappdata%" in the path bar instead of searching for it manually.

Installing the Apps Manually



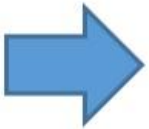
Installing the Apps Manually

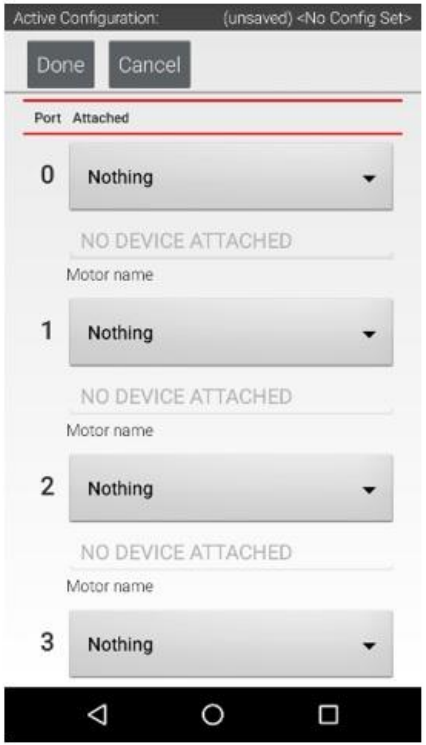


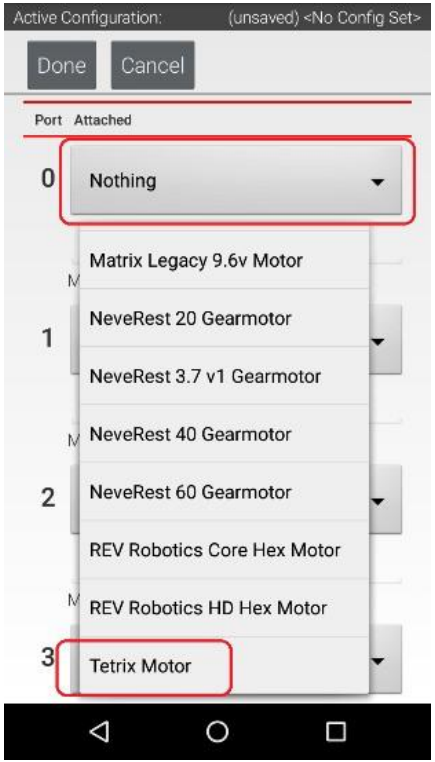
Building a Config File

- Config files map hardware IDs to the software.
- Each device you connect to the Control Hub must be assigned.
- Avoid using obfuscated, confusing names.
  - For example, the left motor should be named "LeftMotor" and a left servo for a claw should be named "LeftClawServo"

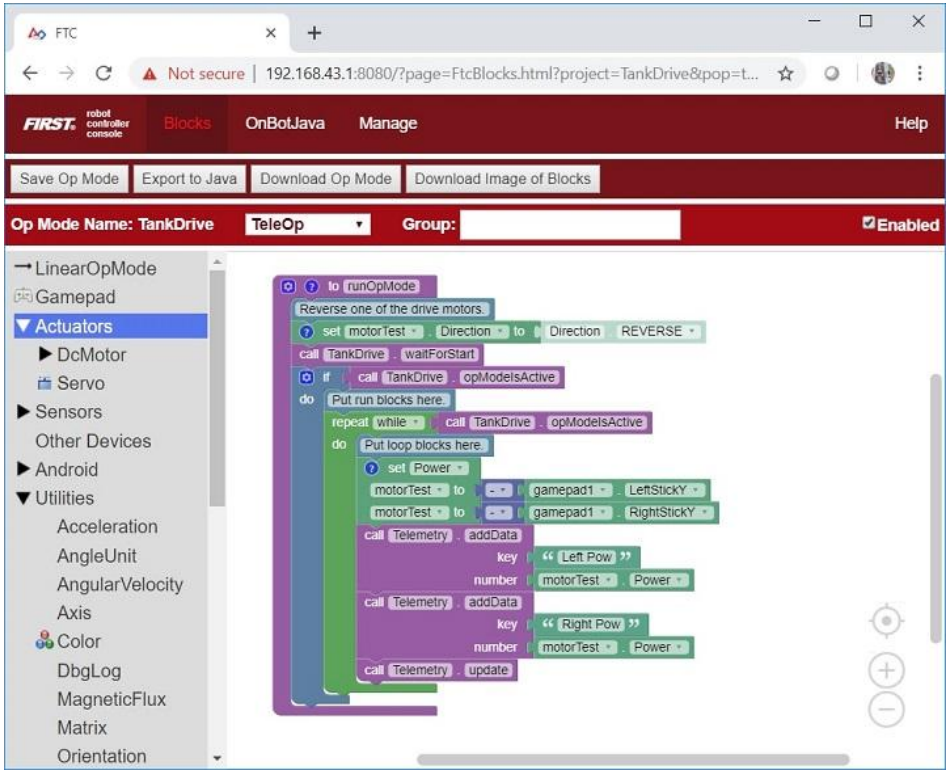
Building a Config File



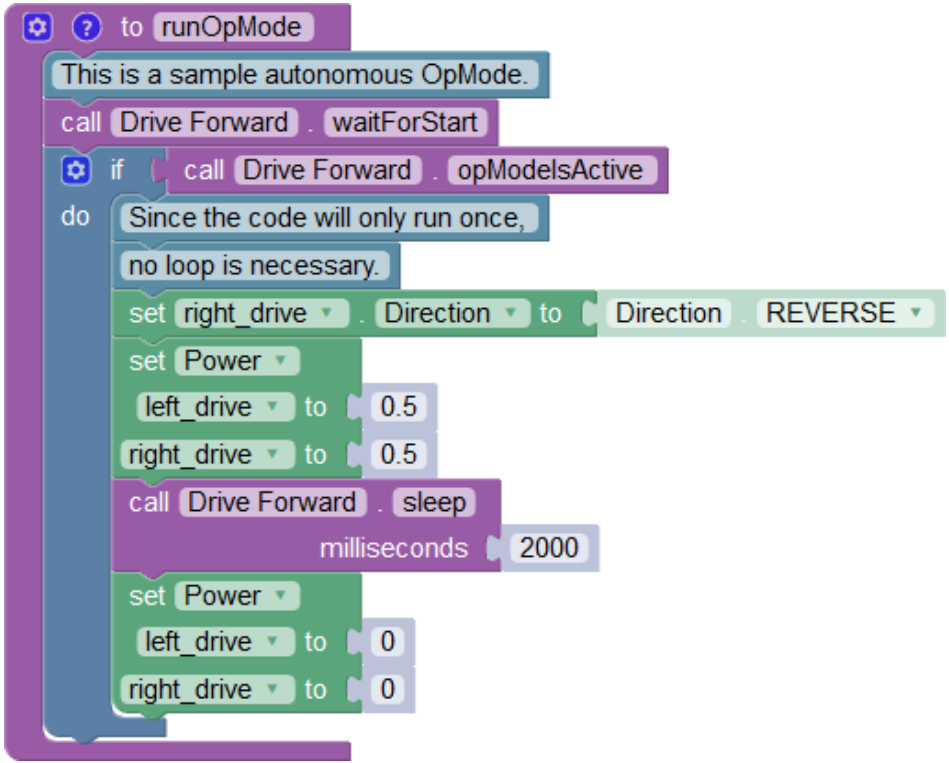




Live Demo - Blocks TeleOp Program



Live Demo - Blocks Autonomous Program



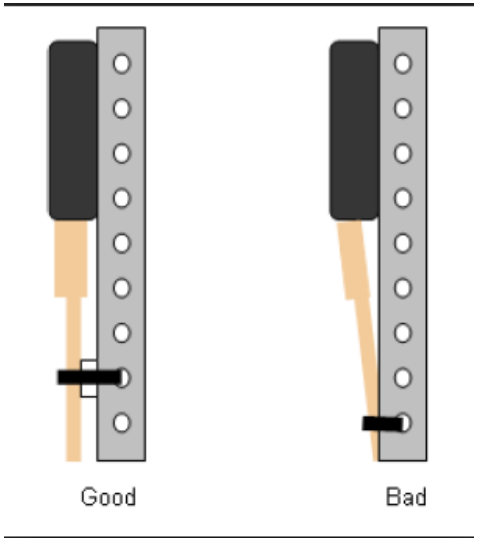
Best Practices

- Rebooting Phones
- Securing Cables
- My Robot Stopped Working - What Now!?

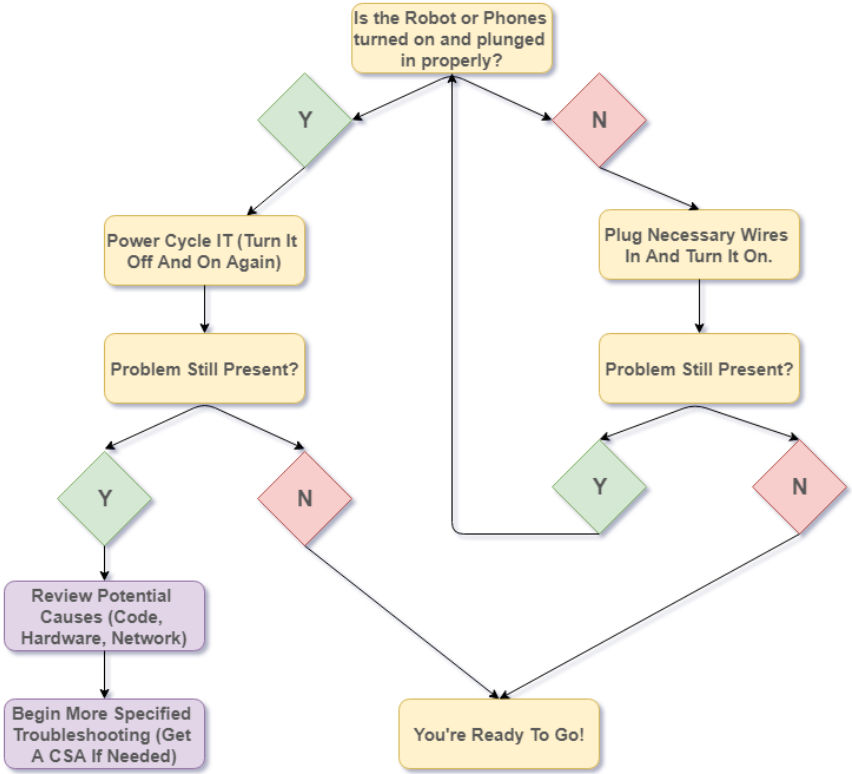
Self Inspect

Securing Cables

- Ensure cables are not stressed as they will fray and break.
- Cables can also become loose with improper use, creating an intermittent connection.
- Use zip-ties to secure cables and modules.



Troubleshooting



Questions & Resources

FIRST Tech Challenge Forum	https://ftcforum.firstinspires.org/
FIRST Tech Challenge GitHub	https://github.com/FIRST-Tech-Challenge/
FIRST Tech Challenge Docs	https://ftc-docs.firstinspires.org/en/latest/index.html
REV Robotics Whitepages	https://docs.revrobotics.com/docs/duo/
CocoNuts Team Email	fusd1robotics@gmail.com
Field Technical Advisor, Erick Yoakum	ericky@arizona.edu

https://docs.google.com/presentation/d/1FixYHwFz3P39ZYhFnK8uF-1NaHZi9m9fwjPp4vanq6E/edit?usp=sharing

Be sure to reach out to local teams and volunteers!