TECHNO TROJANS

CONTROLS WORKSHOP

Presented by Jeremy Martinez

Head Coach and Mentor for Fruitport ***FIRST*** Teams

FIRST® DIVE

PRESENTED BY Qualcomm

PRESENTED BY RTX

PRESENTED BY HAAS Gene Haas Foundation

2024/2025 SEASON

WHO AM I?

- ***FIRST*** Alumni 2003-2004 season on team 1254
- ~18 Years of mentoring with FRC teams 1254 and 2405
- 6th year mentoring with FTC teams at Fruitport and Montague
- Working at Bennett Pump as Technical Customer Service
- Electrical Certification from Van Buran Technology Center
- Studied Electrical Engineering at Lake Michigan College and Western Michigan University
- Controls Engineer by trade
- FTC Volunteer positions held
  - FTC Judge
  - CSA
  - Event VC and EC
  - Inspector
  - Field Setup
  - Pretty much every position
- Avid golfer: ex competitor on the Michigan Amateur Golf Tour
- Played Baseball at Lake Michigan College
- Other interest…
  - Ultimate Frisbee
  - Hockey
  - Baseball
  - Fishing
  - Corn hole
  - Texas hold'em

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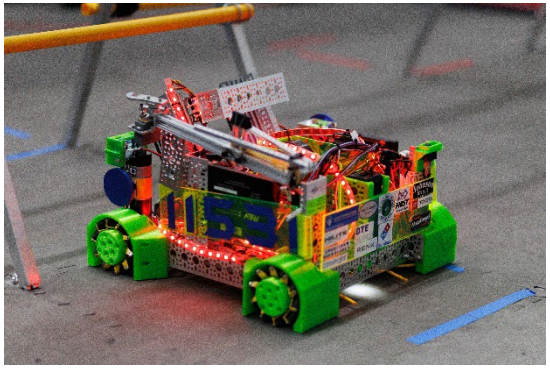
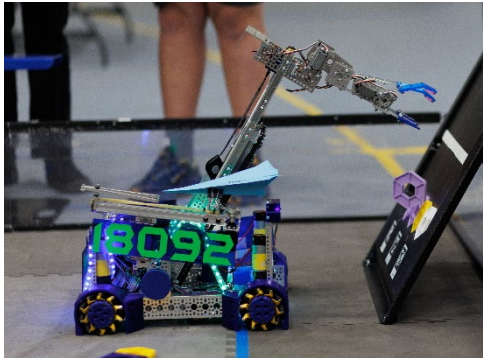
WORKSHOP BREAKDOWN

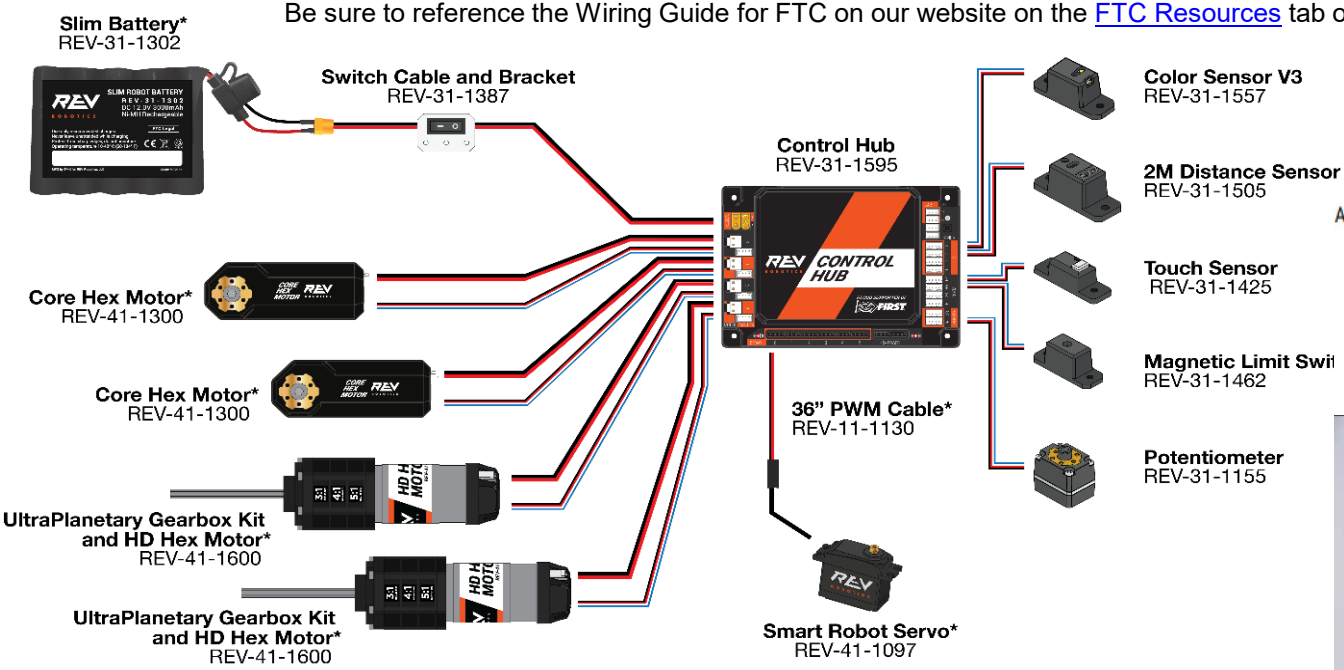
- Basic Wiring of Robot
- Motors
- Servos
- Basic Sensors
- Programming options for FTC
- Creating Op mode
- Advanced topics
- Passing Inspections
- Questions??





BASIC WIRING

Be sure to reference the Wiring Guide for FTC on our website on the FTC Resources tab or the ***FIRST*** website.

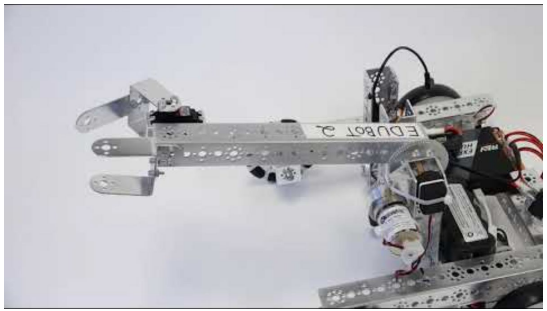


Do yourself a favor and use a grounding strap per **R611**

A. must use one of the following approved parts:

Table 12-6: Legal ROBOT Grounding Straps

Grounding Strap	Part Number
AndyMark Resistive Grounding Strap	am-4648
REV Resistive Grounding Strap	REV-31-1269



MOTORS

Be sure to reference the rules manual for current season on our website on the FTC Resources tab or the ***FIRST*** website.

12.5 Motors & Actuators

R501 ***Allowable motors.** The only allowed motor actuators are:

Table 12-1 Motor allowances

Motor Name	Part Numbers Available	Notes
AndyMark NeveRest 12V DC	am-3104	
AndyMark NeveRest Hex 12V DC	am-3104c	
goBILDA Yellow Jacket 520x Series 12V DC	5201-0002-0026, etc	5201, 5202, 5203, and 5204 series
Modern Robotics / MATRIX 12V DC	5000-0002-0001	
REV Robotics HD Hex 12V DC	REV-41-1291	
REV Robotics Core Hex 12V DC	REV-41-1300	
Studica Robotics Maverick 12V DC	75001	
TETRIX MAX 12V DC	739530	Discontinued
TETRIX MAX TorqueNADO 12V DC	W44260	
VEX EDR 393	276-2177	Counts as a servo for R503
Factory installed vibration and autofocus motors resident in COTS computing devices (e.g. rumble motor in a smartphone). Can only be used as part of the device, cannot be removed and/or repurposed. These motors do not count toward the limit in R503.		
Motors integral to a COTS sensor (e.g. LIDAR, scanning sonar, etc.), provided the device is not modified except to facilitate mounting. These motors do not count toward the limit in R503.		

Many legal gearmotors are sold with labeling based on the entire assembly. These motors may be used with or without the provided gearbox.

R503 *ROBOTs are limited to a total of 8 motors and 12 servos. A ROBOT may not have more than 8 motors and 12 servos from the allowable actuator lists per **R501** and **R502** for all MECHANISMS used in all configurations, with the following exceptions:

A. The VEX EDR 393 (276-2177) motor is counted as a servo instead of a motor.

SERVOS

Be sure to reference the rules manual for current season on our website on the FTC Resources tab or the ***FIRST*** website.

R502 ***Allowable servos.** Servo actuators must meet the requirements below. Servos must be compatible with the power regulation devices they are ultimately used with (per R505) and may include additional servo position output interfaces (e.g. 4th Wire Position Feedback).

Table 12-2 Servo Requirements at 6V

Actuator Class	Mechanical Output Power	Stall Current	Example Servos (including, but not limited to) NOT COMPLETE LIST
Servo	≤ 8 watts @6V	≤ 4 amps @6V	AndyMark High-Torque Servos (am-4954)
			Axon MAX+ Servo (Axon MAX+)
			DSSERVO 35KG Coreless (DS3235MG)
			FEETECH Digital Servo (FT5335M-FB)
			goBILDA Dual Mode Servo (2000-0025-0003)
			REV Robotics Smart Servo (REV-41-1097)
			Studica Multi-Mode Smart Servo (75002)
Linear Servo	N/A	≤ 1 amps @6V	Actuonix Micro Linear Servo (P8-100-252-12-R)
			Hitec Linear Servo (HLS12-3050-6V)
			Studica Linear Servo RC Actuator (75014)

Servo mechanical output power is approximated by the following formula (using 6V data reported by manufacturer):

- **Mechanical Output Power** = **0.25** x (**Stall Torque** in *N-m*) x (**No Load Speed** in *rad/s*)

Servos must meet both requirements to be legal for use. Refer to the Legal and Illegal Parts List for a list of servos that are pre-approved, otherwise teams must be able to provide documentation verifying servo specifications. Use the online calculator to verify output power compliance.

If a manufacturer does not provide 6V specs, any specs for voltages that exceed 6V are allowed to be used.

Stall current is the maximum stall current possible for the device at the specified voltage, regardless of any programmable software limits that may be available within the servo.

It is important to ensure the voltage provided by the intended power regulation device is within the operating voltage range of the desired servo. The REV Control Hub and REV Expansion Hub provide 5V to servos, and the REV Servo Power Module and Studica Servo Power Block provide 6V to servos. While virtually all servos are compatible with 6V, servos with an operating voltage range of 6-8.4 DCV, for example, may not work properly when only provided 5V.

R503 *ROBOTs are limited to a total of 8 motors and 12 servos. A ROBOT may not have more than 8 motors and 12 servos from the allowable actuator lists per **R501** and **R502** for all MECHANISMS used in all configurations, with the following exceptions:

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SENSORS

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VISION SENSOR

COMMON SENSORS

45-2018	Modern Robotics Color Sensor	
REV-31-1537	REV Color Sensor	
REV-31-1425	REV Touch Sensor	
REV-31-1505	REV 2m Distance Sensor	

PROGRAMMING OPTIONS

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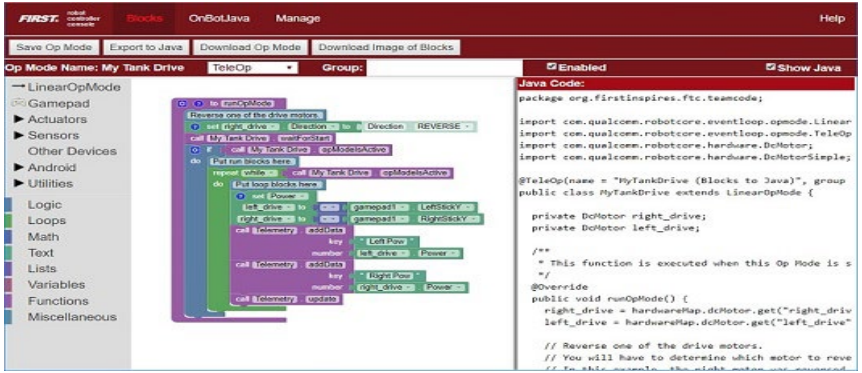

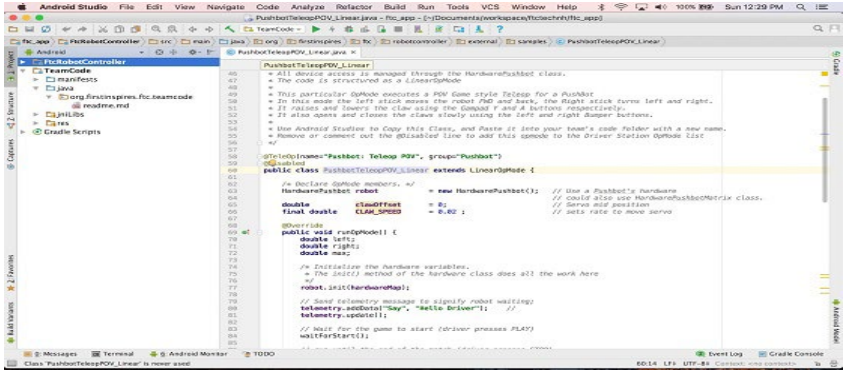

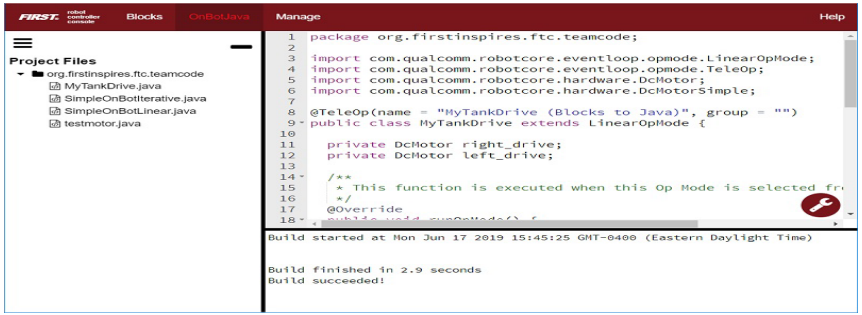

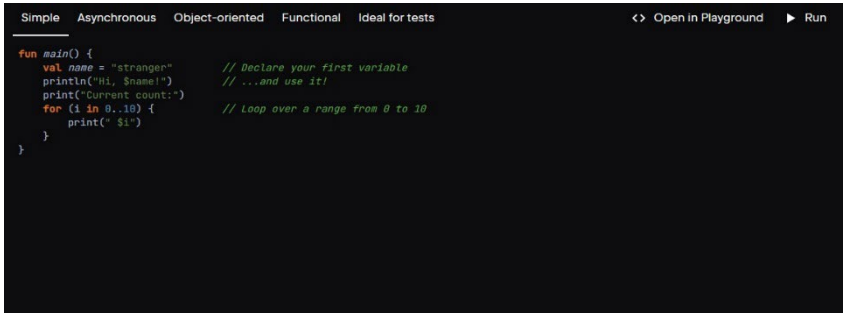

CREATING OP MODES

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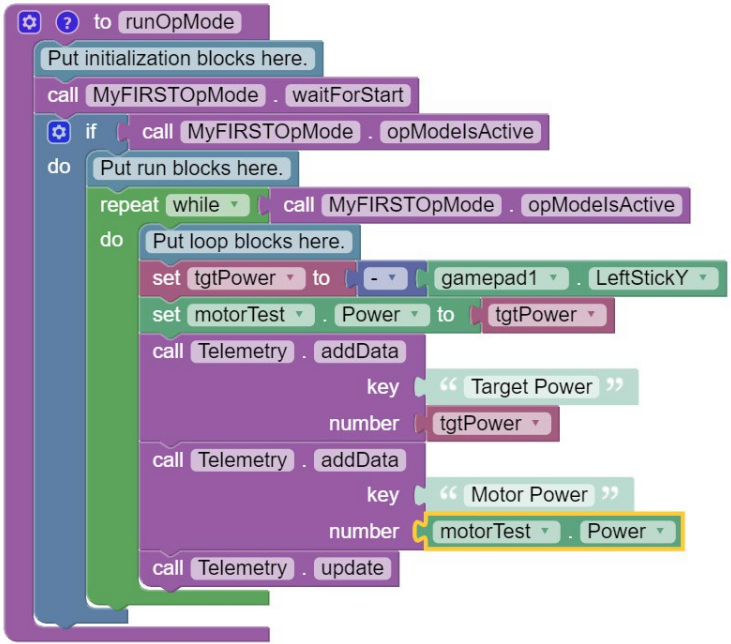

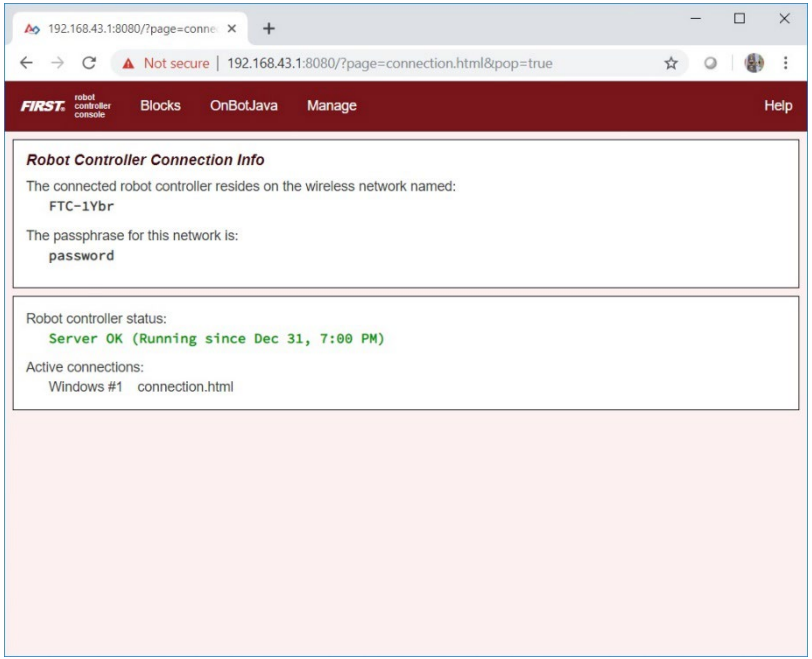

ADVANCED TOPICS

Be sure to reference the Programming resources on our website on the FTC Resources tab or the ***FIRST*** website.

AprilTag Programming

Topics for programming with AprilTags

- AprilTag Introduction
- VisionPortal Overview
- Webcams for VisionPortal
- Understanding AprilTag Values
- AprilTag Test Images

Vision Programming

Learning more about using vision

- Computer Vision Overview
- Webcam Controls
- Camera Calibration

TensorFlow Programming

Topics for programming with TensorFlow Object Detection (TFOD)

- TensorFlow for CENTERSTAGE presented by RTX
- TensorFlow for POWERPLAY presented by Raytheon Technologies
- TensorFlow for FREIGHT FRENZY presented by Raytheon Technologies
- Blocks Sample OpMode for TFOD
- Blocks Custom Model Sample OpMode for TFOD
- Java Easy Sample OpMode for TFOD
- Java Custom Model Sample OpMode for TFOD

Advanced Topics

Advanced Topics for Programmers

- Changing PID Coefficients
- Changing PIDF Coefficients
- Automatically Loading a Driver Controlled Op Mode
- Custom Blocks (myBlocks)
- External Libraries in OnBot Java and Blocks
- Universal IMU Interface
- Using the Kotlin Programming Language
- HuskyLens Intro for *FIRST* Tech Challenge

PASS INSPECTION WITH A BREEZE

- **R712** *Always keep control system device software up to date.
- **R501** and **R502** Use LEGAL motors and servos (use this list)
- **R101** Keep it in the cube 18 x 18 x 18
- **R104** There is a horizontal expansion limit.
- **R401-R403** New 12.4 ROBOT SIGN rules – No alliance makers anymore
- **R609.C** Do not forget Power Switch Label
- Know your robot!
- DO NOT be scared of the inspectors! Them and other teams will help if you fail anything
- Do a pre-inspection before your competition (use Robot inspection checklist and Field Inspection)
- **READ** and know the robot build rules!
- If something does fail inspection, ask questions and work with the inspector on a resolution
- Show off your robot. Inspection is good practice for judging

QUESTIONS?