FIRST Robotics Competition Control System

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History Of *FIRST*

FIRST was founded in 1989 by Dean Kamen to engage young individuals in STEM related activities. *FIRST* (For Inspiration and Recognition of Science and Technology) now operates three main branches called: FLL, FTC, and FRC.

- FLL (*FIRST* lego league) is targeted to show kids in ages 9- 14 years of age, the basics of engineering and promoting STEM activities along with a little competition.
- FTC (*FIRST* Technical Challenge) is a robotics program that teaches individuals ranging from the age of 8 - 18 years of age. FTC is basically the “trainer” for FRC as it teaches the kids how to use CAD and program robots using JAVA. Which gets them ready for the workforce and even for FRC, if they choose to continue with *FIRST*.
- FRC (*FIRST* Robotics Competition) is the flagship robotics competition for hte high school world with over thousands of teams competing every year to make it to *FIRST* Championship. The age range is 14 - 18 but even if the age range is small it is very action packed and very fun.
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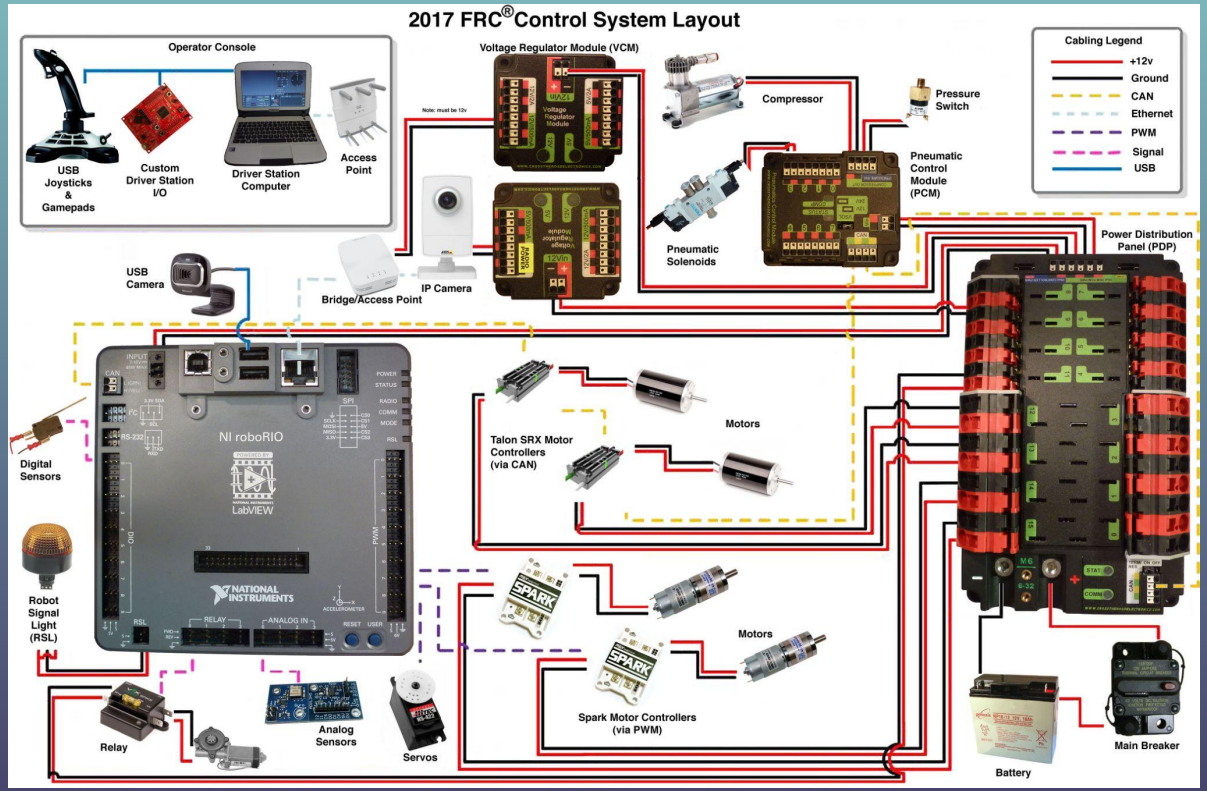
“FIRST is the Hardest Fun You'll Ever Have.”

Overview of the FRC Control System



Overview of the FRC Control System Part 2

Core Components:

- RoboRIO
- Power Distribution Panel
- OpenMesh Radio
- Voltage Regulation Module
- Pneumatics Control Module
- Driver Station

Secondary Components:

- Motors (CIM, Falcon, NEO, NEO550, and many more…)
- Motor Controllers (TalonSRX, Victor SP, and many more…)
- Pneumatic Solenoids
- LED’s
- LimeLight Vision Tracking
- USB/IP Cameras

Where to Start?

Core Components: RoboRIO

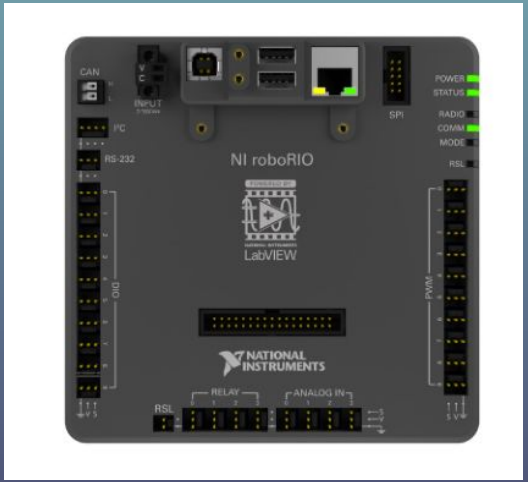
National Instruments RoboRIO (Reconfigurable Robot Input/Outputs)

- The RoboRIO is the heart of the FRC Control System. The brain of the robot is the best way to remember it's function.
- It runs a customized Linux OS specially designed for FRC and training for real world circumstances.
- The RoboRIO is packed full of different I/O options with a the two most important and used being the CAN-Bus and full Ethernet functionality. (Supports TCP and UDP ports for custom programs)
- In 2022, NI announced the RoboRIO 2.0 which is an updated version of the older RoboRIO 1.0 with the addition of an SD card and more RAM and a faster processor.

Core Components: RoboRIO

RoboRIO Specs:

- CPU: ARM Cortex A-9 Dual Core Processor with an operating frequency of 667MHz
- RAM: DDR3 256MB at 553 MHz
- Storage: 512 MB
- Main IO:
  - CAN-Bus
  - PWM
  - DI (Digital Input)
  - DO (Digital Output)
  - Analog Input
  - Analog Output
  - I²C
  - Serial



Core Components: Power Distribution Hub

The Power Distribution Panel (PDP) is the electrical backbone of the FRC control system. It provides all the power from the battery to all the other electrical components on the robot, without it your robot would sit there. In 2022, Rev Robotics introduced an alternative to the CTRE PDP which features more in depth APIs for monitoring and controlling voltage flow.

PDP Specs:

- 20 High Current Sockets for Motor Controllers (12v 40 Amp Max)
- 3 Low Current Sockets for RoboRIO, Bridge, and Pneumatics Control Module (15 Amp Max)
- 1 Switchable Low Current Socket (15 Amp Max)
- LED Display for Monitoring Voltage
- USB-C Port for Monitoring and Troubleshooting with the REV Hardware Client

Core Components: OpenMesh Radio

The OpenMesh Radio is the link between your RoboRIO and your Driver Station. It offers a two main operating modes, Access Point and Bridge.

OpenMesh Specs:

- Runs modified OpenMesh configuration specifically made for communicating with the RoboRIO and the FRC DriverStation
- Dual Band (2.4GHz & 5GHz) allowing teams to move their robots communication to a less congested and faster band
- POE Support (12 - 24 Volt)

Core Components: Voltage Regulation Module

The Voltage Regulation Module is a piece of electronics that allows teams to create custom 12 volt 15 amp circuits. In 2022 Rev Robotics introduced an new VRM to be an alternative to the older CTRE VRM

VRM Specs:

- 6 12 Volt Low Current Sockets for Custom Circuits (15 Amp Combined)
- All Fused Sockets for Extra Voltage Protection

Core Components: Pneumatics Control Module

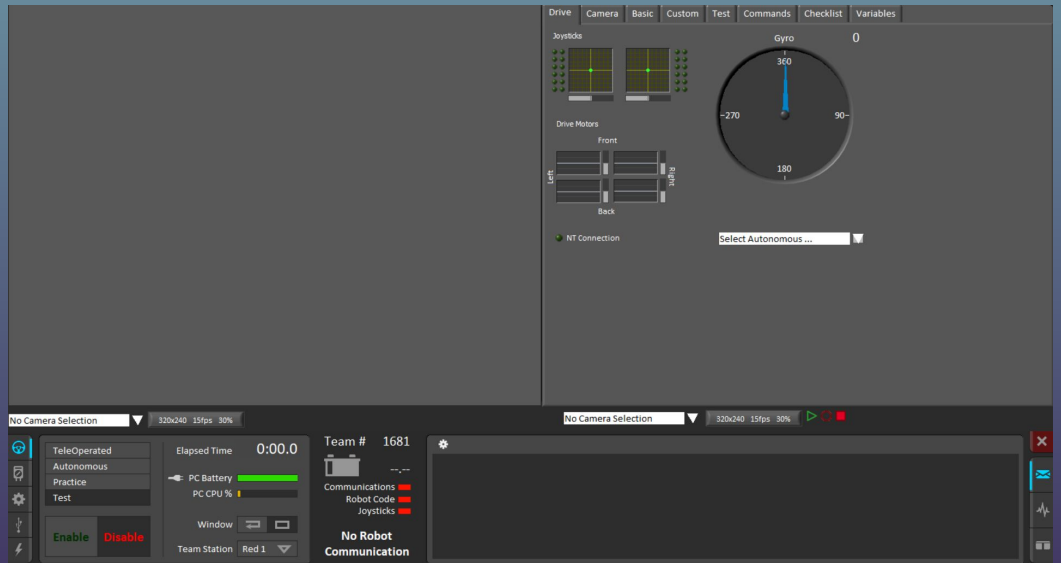
The Pneumatics Control Module is the heart of the pneumatic system from controlling the compressor to controlling each solenoid. In 2022 Rev Robotics introduced a new version of the PCM which enables teams to have more options of solenoids and pressure switches.

PCM Specs:

- 15 12 Volt or 3 Volt Solenoid Channels
- 2 Pressure Switch Inputs (Analog/Digital)
- 1 Onboard Air Compressor Output
- 1 USB-C Port for quick diagnostics and setup of the PCM

Core Components: FRC DriverStation

The FRC DriverStation is a software application that allows communications between your robot and your computer. This program is chucked full of features such as allowing teams to enable/disable your robot in different modes, take USB controller inputs, send/receive FMS data during matches, and a very in depth log viewer for easy troubleshooting.

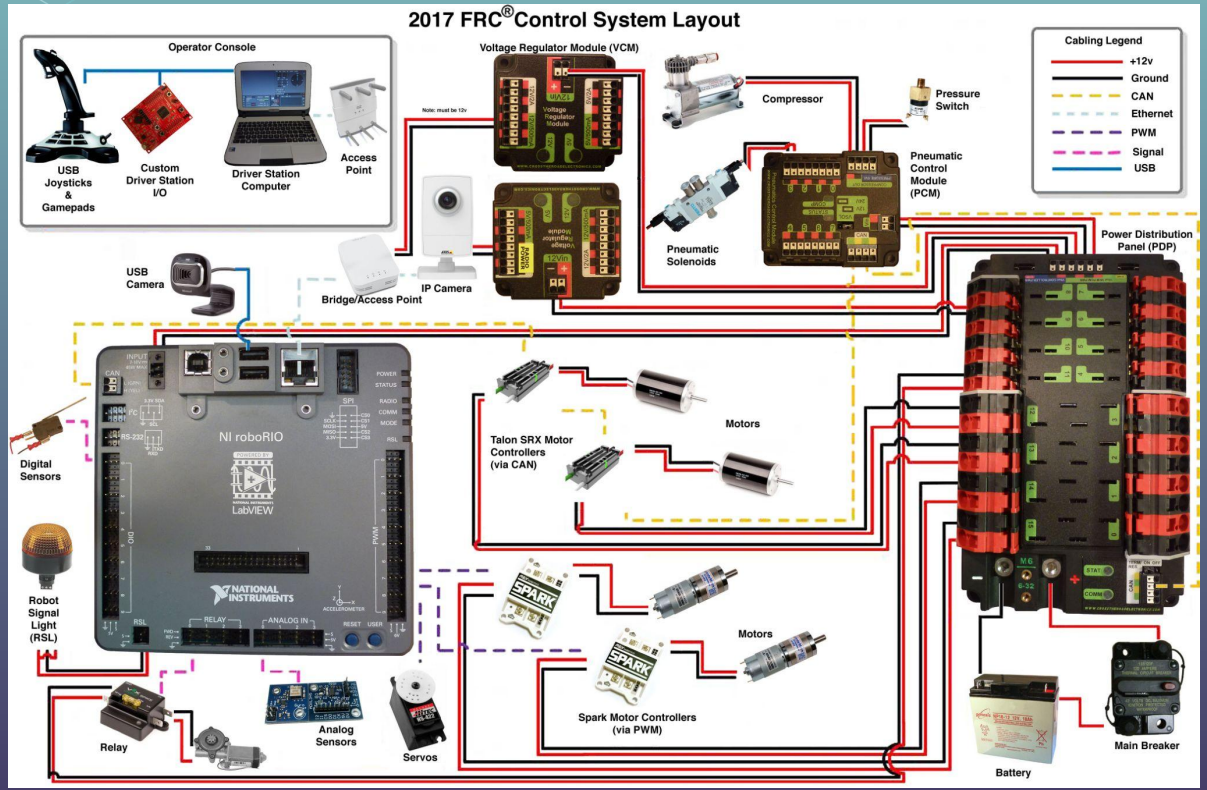


Secondary Components: Motor Controllers

The list of legal motor controllers for FRC is quite long so we'll only cover the most commonly used options. Most of the motor controllers are connected through the robots CAN-Bus but some also have the ability to be used with PWM but it's not recommended. Most motor controllers also have integrated encoder abilities.

- TalonSRX by CTRE (CAN-Enabled)
- TalonFX by CTRE (CAN-Enabled)
- VictorSP by Vex Robotics (PWM on RIO)
- SparkMax by REV Robotics (CAN-Enabled)
- Spike Relay (DIO on RIO)

Time To Put It All Together



Questions?