

2025 FRC Control System Educational Diagrams

A Visual Look at how a control system can be set up for an FRC Robot at a basic level, at a more comprehensive level using two different vendor architectures, and how a pneumatic system can be set up for an FRC Robot.

For more information regarding the control system in FRC robots please visit:
<https://docs.wpilib.org>

Designed in Canada by Team 3161 and Stefen Acepcion.

Instructions for Printing

Each diagram is optimised as a 24 x 36 inch poster. Optimally print in that size, it may be printed in smaller or larger size provided its aspect ratio is similar.

Print in colour on a recommended 170 GSM or thicker paper.

Including this page when printing is not nessesary, this page serves as an instruction and attribution page only.

Ackowlegements

Thank you so much to FRC community for giving suggestions to help improve these diagrams, to the WPILib documentation team, and TheThriftyBot for giving their support in enabling these diagrams to be distributed.

Parts Inclusion

Parts that are specified as examples are either components that can be obtained from the KOP, FIRST Choice, mandated by the Game Rules, or is an example part that is widely used by FRC teams.

Design System

This diagram package uses a design system employed in Team 3161 Diagrams and Infographics

Read more on it here:
<https://team3161.ca/brand>

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TEAM 3161

The FRC Control System - A Primer

Laying out and explaining the Integral control system hardware that is needed to make an FRC Robot run.

Please consult the Regular FRC Control System Diagrams for a more complete implementation of the system.

Robot Signal Light
An industrial-grade light that allows a robot to visually communicate its status either to your drive team, or field staff.

RSL Wiring
Minimum 22 AWG
"La" and "Lb" terminals connected to each other.
CAN wires should be a twisted pair with a twist per 1 inch or denser.

Ethernet Cable
Must be connected to the radio using the port labeled "RIO".
It is Recommended that you use a new ethernet cable to ensure reliability of the connection.

Radio Power
Minimum 22 AWG

Radio
Enables wireless communication from your robot to the field, and to your team's Driver's Station.

Robot Communication

Main Power Distribution

High Current Channels
Up to 40A continuous load.
Used for motors, pneumatics controllers, and everything else

Low Current Channels
Up to 15A continuous, 20A peak.
Used for the RoboRIO, Radio and other low current devices.

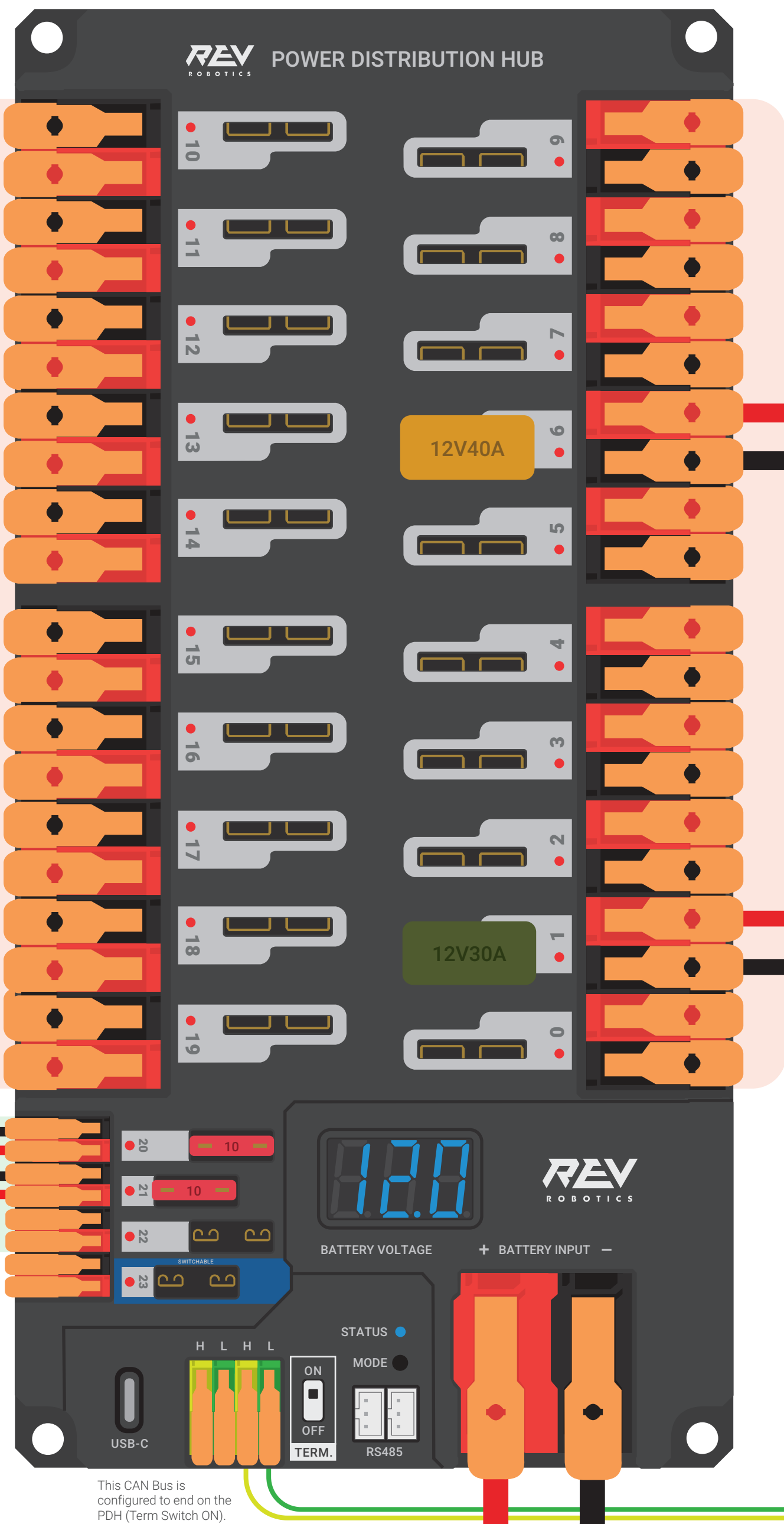
PDH Wire Strip Guide
Following these strip lengths for the Power Distribution Hub wire connections ensures that your connections are robust and reliable. Illustrated Lengths are 1:1 scale if the diagram is printed at 24 x 36.

Low Current Channel, Switchable, and CAN Wires
0.33"
High Current Channel Wires
0.5"
Battery Input Wires
0.75"

12V40A 12V20A 12V30A
ATO Breakers (10A Not Shown) ATM Fuses

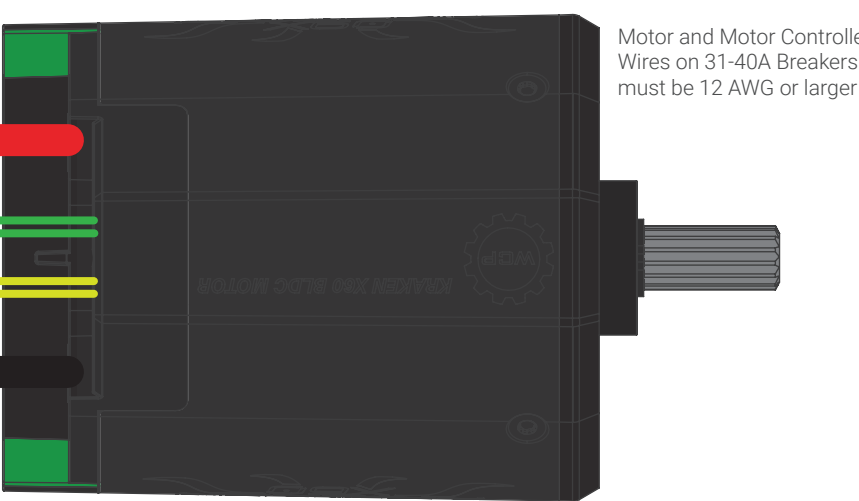
Circuit Breakers / Fuses
Comes in ATO (High Current) or ATM (Low Current) form factors. These slot in to allow supplying power but also to give current protection to the channel its connected to.

Power Distribution Hub
Distributes battery power, and provides fused low and high current channels towards various components in the robot.

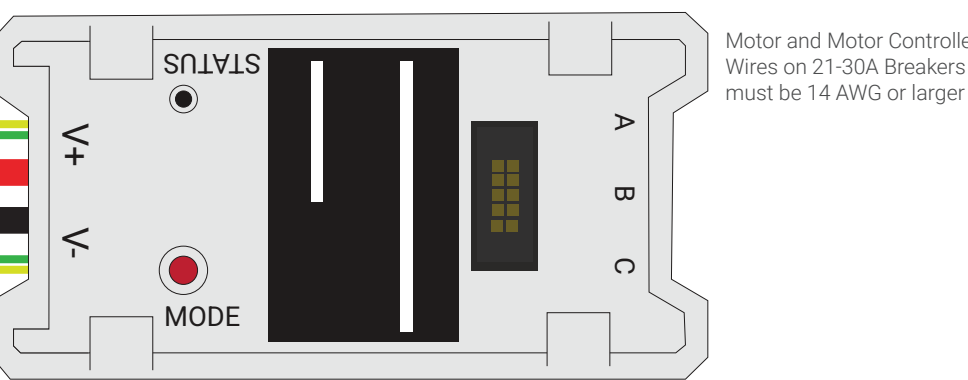


Motor Controllers
Controls the motors that your robot has. Only 1 motor is allowed per controller in most cases. Motor Controllers come in different types.

Integrated Controllers
Example Shown is a Kraken X60 Motor + Talon FX
These controllers are integrated into their motor, making it either inseparable, or separable as an installable module. These controllers can either be controlled through CAN or PWM.



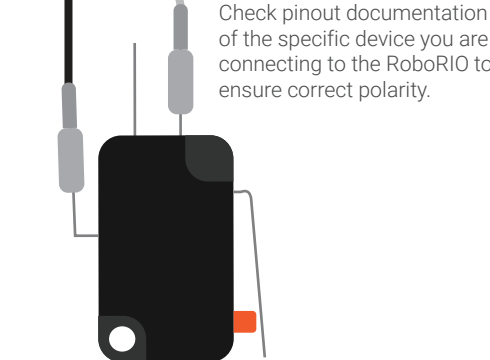
Discrete Controllers
Example Shown is a Spark MAX motor controller
These controllers are separate from their motors, meaning you can pair any of these with any compatible motor. These controllers can either be controlled through CAN or PWM.



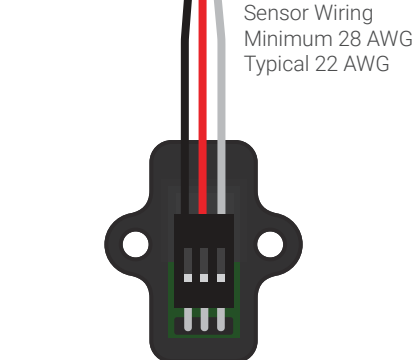
Motor Control

Making your robot aware
Sensors detect movements or certain changes in your robot or its surroundings, so that you can utilize them for your robot's functionality.

Read more on the different types of sensors and how you could utilize them at: <https://docs.wpilib.org>



Limit Switch Example



Analog Encoder Example



USB Camera Example

Sensors

BASIC FRC CONTROL SYSTEM

V.3.21.PR

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Power

12V DC Main
LIVE (+) (-) GND

PWM

26 AWG Minimum
+5V GND SIG

CAN

28 AWG Minimum
HI LO

Wires

American Wire Gauge (AWG)
Minimum Gauge per connection type shown.

6 AWG 12 AWG 14 AWG 18 AWG 22 AWG 26 AWG 28 AWG

Always practice proper safety precautions and practices when working with electrical systems.

More Information about the FRC Control System can be found at <https://docs.wpilib.org>

KEEP IN MIND

Communication

Robot Signal Light
855PB-B12ME522 shown

RS-485 Wire 18 AWG Typical
22 AWG Minimum

CAN Bus Wiring
Minimum 28 AWG
Typical 22 AWG

The main robot CAN loop must start with the RoboRIO.

The use of the discrete I2C/PC port may induce system lockups. Please refer to WPILib docs for possible workarounds.

Robot Radio
VH-109

Downstream Power over Ethernet (PoE)

Disabled by default. Please check DIP Switches 1 and 2 to verify unless you want to have them on.

If enabled, devices must support PoE at the supply voltage provided to the radio. Otherwise damage will occur to them.

Radio Power
Minimum 22 AWG

Ethernet Cable

Connection to the RoboRIO connected to the port labeled "RIO"

Please refer to the latest Game Manual for specific rules on how to power this radio.

Spark MAX

Brushless/Brushed, CAN/PWM

Talon SRX

Brushed Only, CAN/PWM

Motor and Motor Controller Wires on 31-40A Breakers must be 12 AWG or larger

Koors 40

Brushed Only, PWM Only

Motor and Motor Controller Wires on 31-40A Breakers must be 14 AWG or larger

High Current Channel Strip Length
0.5" Typical 0.43" Min 0.51" Max

Discrete Motor Controllers
(CAN/PWM Controlled)

Servo
Generic shown

PWM Wiring
Minimum 26 AWG
Typical 22 AWG

PWM

PH/PCM power must be 18 AWG or larger if using a 20A breaker

On-board Compressor

Refer to latest Game Manual for specific rules

Compressor wires must be 18 AWG or larger

Pneumatic Hub

Push Button WAGO Strip Length
0.35" Typical 0.33" Min 0.37" Max

Solenoid Valve
SMC SY3240-6LZ shown

Pressure Sensors

Digital (am-2006 shown) or Analog (REV-11-1107 shown)

Neo Vortex (Spark FLEX)

Modular Brushless, CAN/PWM

Kraken X44 (Talon FX)

Integrated Brushless, CAN/PWM

Kraken X60 (Talon FX)

Integrated Brushless, CAN/PWM

Integrated/Modular Motor Controllers
(CAN/PWM Controlled)

120A Breaker
CB285-120 shown

Battery lugs must be crimped and properly insulated.

12V Battery

Refer to latest Game Manual for specific rules and examples

Main Power

Digital Input/Output

Limit Switch
Generic Switch shown

IR Break
2168 Sensor shown

Analog Encoder
TTB-0040 shown

Potentiometer
Generic shown

Analog Input

Power

12V DC Main

PWM

26 AWG Minimum

CAN

28 AWG Minimum

Wires

American Wire Gauge (AWG)

Minimum Gauge per connection type shown.

6 AWG

12 AWG

14 AWG

18 AWG

22 AWG

26 AWG

28 AWG

LIVE (+) (-) GND

GND SIG

HI LO

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FRC CONTROL SYSTEM - REV

V.3.21.RV

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Communication

Robot Signal Light
855PB-B12ME522 shown

RSL Wire 18 AWG Typical
22 AWG Minimum

CAN Bus Wiring
Minimum 28 AWG
Typical 22 AWG

Robot Radio
VH-109

Downstream Power over Ethernet (PoE)

Disabled by default. Please check DIP Switches 1 and 2 to verify unless you want to have them on.

If enabled. Devices must support PoE at the supply voltage provided to the radio.

Otherwise damage will occur to them.

Radio Power
Minimum 22 AWG

Ethernet Cable

Connection to the RoboRIO connected to the port labeled "RIO"

Please refer to the latest Game Manual for specific rules on how to power this radio.

Spark MAX
Brushless/Brushed, CAN/PWM

Talon SRX
Brushed Only, CAN/PWM

Motor and Motor Controller
Wires on 31-40A Breakers must be 12 AWG or larger

Koors 40
Brushed Only, PWM Only

Discrete Motor Controllers
(CAN/PWM Controlled)

The CTRE System was the original complement to the new, RoboRIO-based control system debuted in 2015. It was superseded by the newer REV System in 2022.

The original CTRE complement however are still legal and available for use in FRC, and how it is wired against other FRC components is shown in this diagram.

Power Distribution Panel

This CAN Bus is configured to end on the PDP (TERM RES set to "ON").

Large WAGO Strip Length ~0.5" Typical

Small WAGO Strip Length ~0.4375" Typical

Weidmuller Connector Strip Length 0.3125" Typical

120A Breaker
CB285-120 shown

12V Battery
Refer to latest Game Manual for specific rules and examples

Main Power

Neo Vortex (Spark FLEX)
Modular Brushless, CAN/PWM

Kraken X44 (Talon FX)
Integrated Brushless, CAN/PWM

Kraken X60 (Talon FX)
Integrated Brushless, CAN/PWM

Integrated/Modular Motor Controllers
(CAN/PWM Controlled)

CAN wires should be a twisted pair with a twist per 1 inch or denser.

The main robot CAN loop must start with the RoboRIO.

The use of the discrete I2C/PC port may induce system lockups. Please refer to WPILib docs for possible workarounds.

DIO Wiring
Minimum 28 AWG
Typical 22 AWG

RoboRIO

POWER STATUS
RADIO
COMM
MODE
RSL

PC
RS-232
DIO
PWM

roboRIO 2.0

RELAY
ANALOG IN
RESET
USER

USB Camera
C270 Shown

Servo
Generic shown

LED Strip
Generic WS2812B shown

PWM Control

Limit Switch
Generic Switch shown

IR Break
2168 Sensor shown

Analog Encoder
TTB-0040 shown

Potentiometer
Generic shown

Digital Input/Output

Analog Input

Solenoid Valve
SMC SY3240-6LZ shown

Pressure Sensor
am-2006 shown

On-board Compressor
Refer to latest Game Manual for specific rules

Pneumatic Systems

Pneumatics Control Module

PH/PWM power must be 18 AWG or larger if using a 20A breaker

Compressor wires must be 18 AWG or larger

Pneumatics Control Module

FRC CONTROL SYSTEM - CTRE

V3.21.CR

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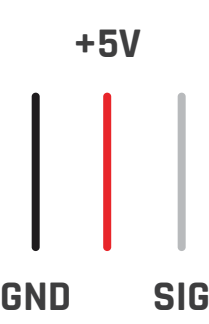
Power

12V DC Main



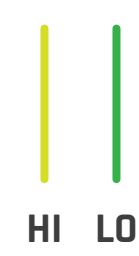
PWM

26 AWG Minimum



CAN

28 AWG Minimum



Wires

American Wire Gauge (AWG)

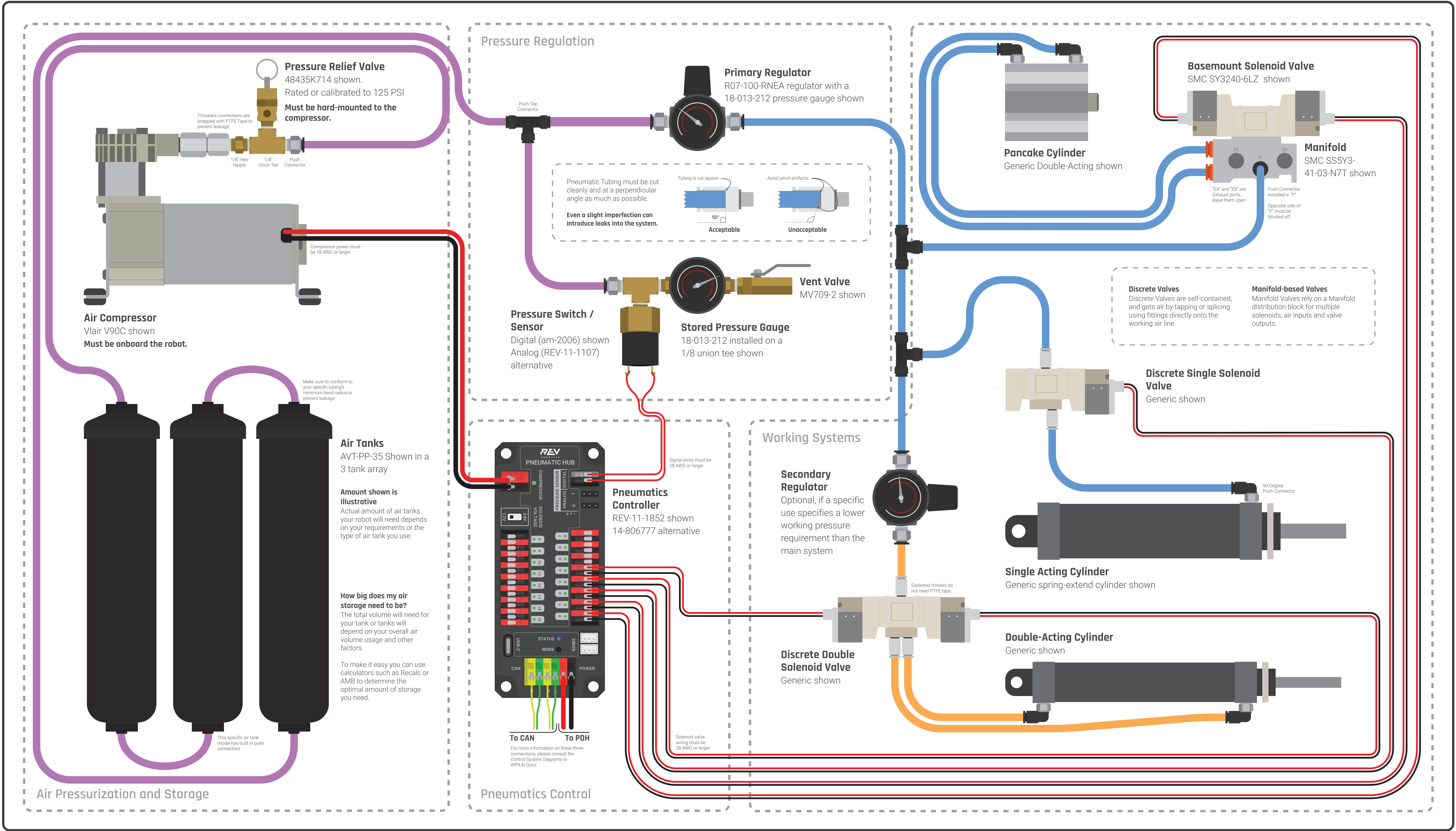
Minimum Gauge per connection type shown.



Always practice proper safety precautions and practices when working with electrical systems.

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FRC PNEUMATIC SYSTEM

V3.21.PS

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Tubing must be max 1/4" (6mm) OD.

There is no rigid rule on what color pneumatic tubing should be in FRC.

However it is recommended to color code your tubing to differentiate between stored and working pressures.

Stored

120 PSI Max

Stored

Working

60 PSI Max

Primary

Secondary

Power

12V DC Main

LIVE (+)

(-) GND

Wires

American Wire Gauge (AWG)

Minimum Gauge per connection type shown.

18 AWG

28 AWG

This Diagram is not official and any specifications on it is based off the 2024 FRC Game Manual.

Always check the latest game manual for final rules and regulations on the FRC pneumatic system.

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