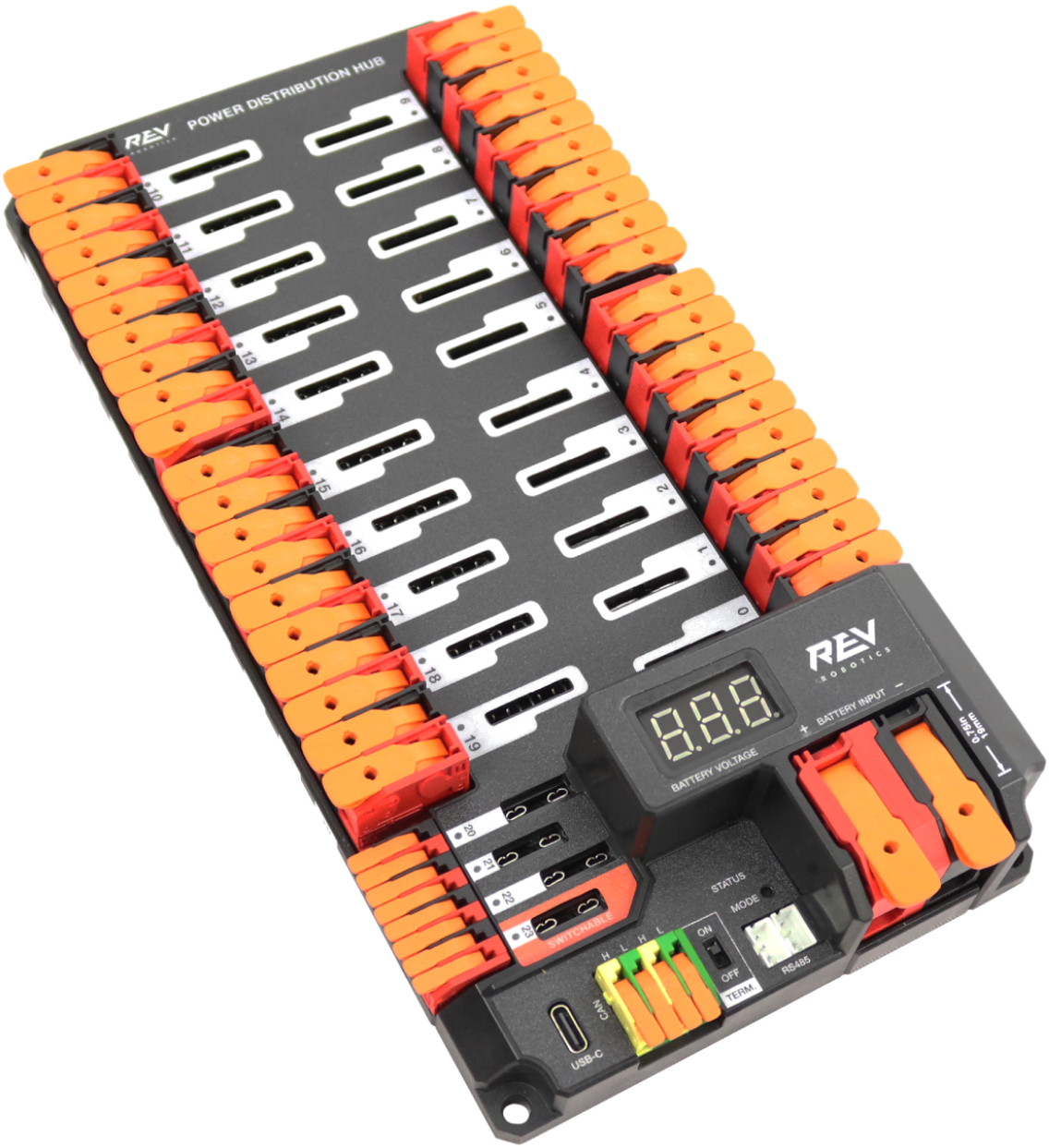
ION Control System

REV ION Control System

Refined Control

Expand upon your robot's capabilities with the REV ION Control System. This series of Hubs and Modules provide flexibility for the addition of new peripherals while delivering vital feedback back to the team. Seamlessly integrate a Hub into your CAN Bus alongside the SPARK MAX or SPARK Flex Motor Controllers.



Power Distribution Hub

Power Management

Power Distribution Hub

The REV Power Distribution Hub (PDH) is the latest evolution in power distribution for the *FIRST* Robotics Competition (FRC). With 20 high-current (40A max) channels, 3 low-current (15A max), and 1 switchable low-current channel, the PDH gives teams more flexibility for overall power delivery. The Power Distribution Hub features toolless latching WAGO terminals, an LED voltage display, and the ability to connect over CAN or USB-C to the REV Hardware Client for real-time telemetry, making it easier than ever to wire and debug your robot.

Radio Power Module

The REV Radio Power Module is designed to keep one of the most critical system components, the OpenMesh OM5P-AC WiFi radio, powered in the toughest moments of the competition. Traditional barrel jacks easily work themselves loose and often require hacks, like hot glue, to prevent intermittent power losses. The Radio Power Module eliminates the need for powering the radio through a traditional barrel power jack. Utilizing 18V Passive Power over Ethernet (PoE) with two socketed RJ45 connectors, the Radio Power Module passes signal between the radio and roboRIO while providing power directly to the radio. After connecting the radio and roboRIO, easily add power to the Radio Power Module by wiring it to the low-current channels on the Power Distribution Hub utilizing the color coded push button WAGO terminals.

Mini Power Module

The REV Mini Power Module (MPM) is a compact power distribution module that allows you to securely and quickly power peripheral devices to your robot. Need more low-current channels on your PDH? Wire the MPM to one of the high-current channels on the PDH to power more peripheral devices and custom circuits.

Pneumatics

Pneumatic Hub

Pneumatic Hub

The REV Pneumatic Hub is a standalone module that is capable of switching both 12V and 24V pneumatic solenoid valves. The Pneumatic Hub features 16 solenoid channels which allow for up to 16 single-acting solenoids, 8 double-acting solenoids, or a combination of the two types. The user-selectable output voltage is fully regulated, allowing even 12V solenoids to stay active when the robot battery drops as low as 4.75V.

Digital and analog pressure sensor ports are built into the device, increasing the flexibility and feedback functionality of the pneumatic system. The USB-C connection on the Hub works with the REV Hardware Client, allowing users to test pneumatic systems without a need for an additional robot controller.

> If there is a question that is not answered by this space, send our support team an email; **support@revrobotics.com**. We are always happy to help point you in the right direction!

Quick Links

Software

<details>
<summary>REV Hardware Client & REVLib Links</summary>

REV Hardware Client

- REV Hardware Client Documentation

REVLib

- REVLib Download and Installation Instructions
- Changelogs
  - REVLib
  - Power Distribution Hub Firmware
  - Pneumatic Hub Firmware

</details>

Power

<details>
<summary>Power Distribution Hub Links</summary>

General Resources

- Getting Started with the Power Distribution Hub
- Troubleshooting
  - Status LED Patterns
- Power Distribution Hub Specifications

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation

</details>

Radio Power Module Links

General Resources

- Getting Started with the Radio Power Module
- Radio Power Module Specifications

Mini Power Module Links

General Resources

- Mini Power Module Status LED Patterns
- Mini Power Module Specifications

Motion Control

SPARK Flex Links

General Resources

- Getting Started with the SPARK Flex
- Troubleshooting
  - Status LED Patterns
- SPARK Flex Specifications
  - SPARK Flex Data Port Pinout

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation

SPARK MAX Links

General Resources

- Getting Started with the SPARK MAX
- Troubleshooting
  - Status LED Patterns
- SPARK MAX Specifications
  - SPARK MAX Data Port Pinout
- Using Encoders with the SPARK MAX

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation
- MAXSwerve Calibration
- SPARK MAX Code Examples

Pneumatics

Pneumatic Hub Links

General Resources

- Getting Started with the Pneumatic Hub
- Troubleshooting
  - Status LED Patterns
- Pneumatic Hub Specifications

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation

Frequently Asked Questions

Coming Soon!

Power Distribution Hub

Power Distribution Hub Overview

Power Distribution Hub Resources

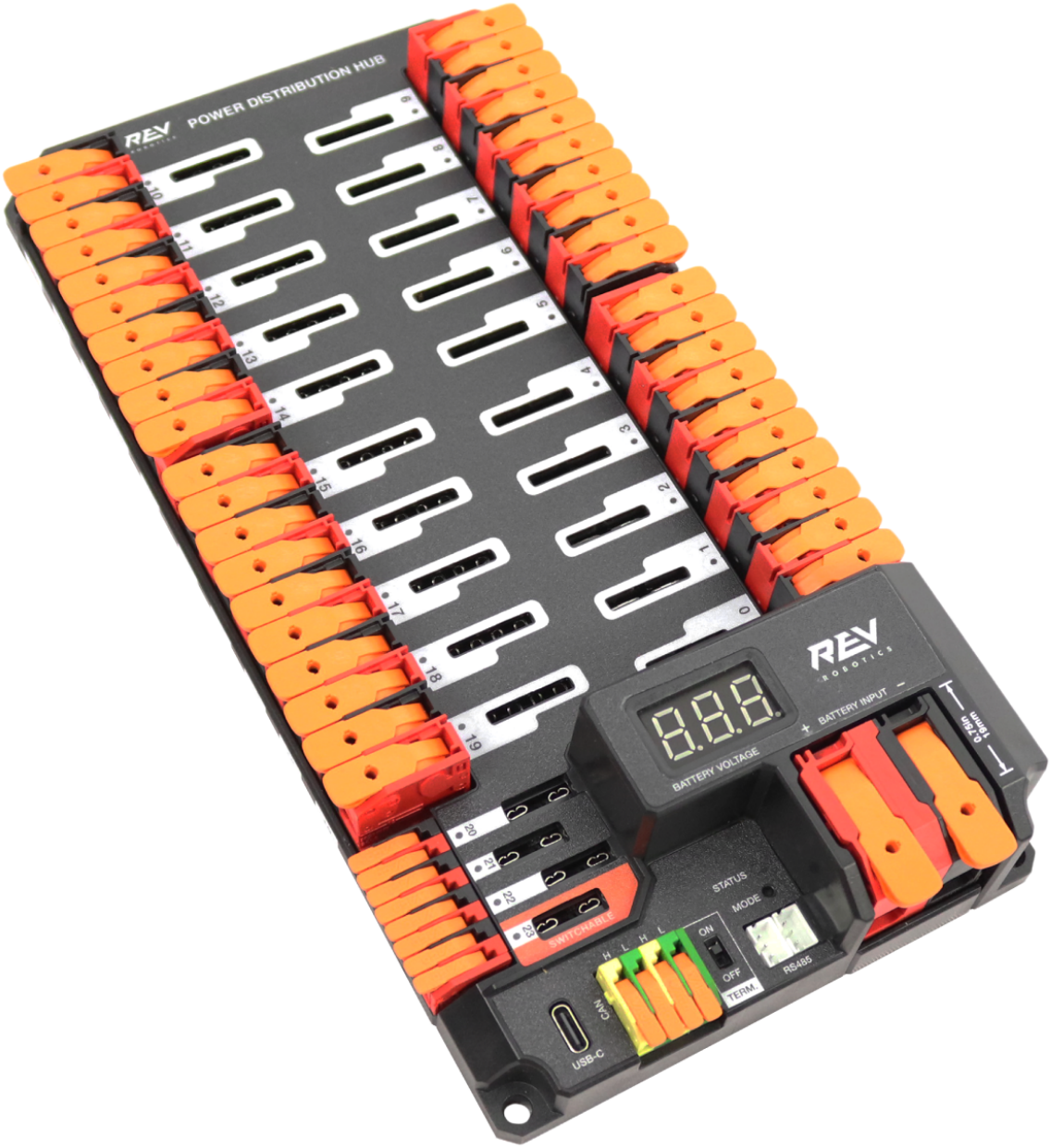
General Resources

- Getting Started with the Power Distribution Hub
- Troubleshooting
  - Status LED Patterns
- Power Distribution Hub Specifications

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation

The REV Power Distribution Hub (PDH) (REV-11-1850) is the latest evolution in power distribution for the *FIRST* Robotics Competition (FRC). With 20 high-current (40A max) channels, 3 low-current (15A max), and 1 switchable low-current channel, the PDH gives teams more flexibility for overall power delivery. The Power Distribution Hub features toolless latching WAGO terminals, an LED voltage display, and the ability to connect over CAN or USB-C to the REV Hardware Client for real-time telemetry, making it easier than ever to wire and debug your robot.


POWER DISTRIBUTION HUB
REV
ROBOTICS
BATTERY VOLTAGE
BATTERY INPUT
SWITCHABLE
STATUS
MODE
RS485
CAN
ON
OFF
TERM.
USB-C

Features

- 20 High-current channels
  - All supporting up to 40A
  - Supports ATO size breakers and fuses
- 3 Low-current channels
  - Supports up to 15A continuous, 20A peak for approved pneumatic control devices.
  - Supports ATM/APM size breakers and fuses
- 1 Switchable low-current channel
  - On/off control useful for LEDs and other indicators
  - Supports up to 15A continuous
  - Supports ATM/APM size breakers and fuses
- Toolless and color-coded WAGO terminals for all main connections
  - Main power input - latching WAGO 2616 series
  - High-current channels - latching WAGO 2606 series
  - Low-current channels and CAN - push button WAGO 250 series
- Advanced debugging features
  - Channel status LEDs for breaker status and fault feedback
  - LED input voltage display
  - Higher resolution and refresh rate current and voltage monitoring
- CAN connectivity
  - Channel telemetry feedback to main robot controller
  - Configurable CAN termination on device
  - Firmware updating over CAN network
- USB-C connectivity
  - USB-to-CAN device allowing for monitoring and updating devices on the CAN bus
  - Update and diagnose faults with the REV Hardware Client
- ESD protection

Power Distribution Hub Specifications

The following tables provide the operating and mechanical specifications for the Power Distribution Hub (PDH).

> ⚠ DO NOT exceed the maximum electrical specifications. Doing so will cause permanent damage to the Power Distribution Hub and will void the warranty.

> ⚠ The Power Distribution Hub's reverse polarity protection DOES NOT protect downstream devices. Verify the correct polarity on all power wires before operation.

Main Electrical Specifications

Parameter	Min	Typ	Max	Units
Operating Voltage Range	4.7	12	18	V
Power Input Wire Gauge (Bare Solid)	18	-	6	AWG
Power Input Wire Gauge (Bare Stranded)	18	-	4	AWG
Power Input Bare Wire Strip Length	0.72	0.75	0.79	in
Power Input Wire Gauge (Stranded, with ferrule)	18	-	6	AWG
Input Voltage Measurement Resolution	-	7.81	-	mV

> ⓘ Make sure to consider the current and safety requirements when choosing a wire gauge for any given application.

CAN Specifications

Parameter	Min	Typ	Max	Units
CAN Termination	-	120	-	Ω
Latching WAGO Connectors †				
CAN Terminal Wire Gauge (Bare Solid/Stranded)	26	-	14	AWG
CAN Terminal Bare Wire Strip Length	0.31	0.33	0.35	in
CAN Terminal Wire Gauge (Stranded, with ferrule)	24	-	18	AWG
Push Button WAGO Connectors †				
CAN Terminal Wire Gauge (Bare Solid/Stranded)	24	-	18	AWG
CAN Terminal Bare Wire Strip Length	0.33	0.35	0.37	in
CAN Terminal Wire Gauge (Stranded, with ferrule)	24	-	18	AWG

†	As of 01/04/2024, orders made from REV Robot will ship with the version of the Power Distributio Hub that features Latching WAGO Connectors o the CAN terminal blocks.

High Current Channel Specifications

Parameter	Min	Typ	Max	Units
Fuse/Circuit Breaker Size	-	ATO/ATC	-	-
Supported Fuse/Circuit Breaker Current Rating	-	-	40	A
Channel Current Measurement Range	0	-	127.9	A
Channel Current Measurement Resolution	-	125	-	mA
Supported Wire Gauge (Bare Solid/Stranded)	24	-	8	AWG
Bare Wire Strip Length	0.43	0.5	0.51	in
Supported Wire Gauge (Stranded, with ferrule)	23	-	10	AWG

Low Current Channel Specifications

Parameter	Min	Typ	Max	Unit
Fuse/Circuit Breaker Size	-	ATM/APM	-	-
Continuous Output Current	-	-	15	A
Single Channel Peak Output Current †	-	-	20	A
Supported Fuse/Circuit Breaker Current Rating	-	-	15	A
Supported Fuse/Circuit Breaker Current Rating for PH and PCM (See note below)	-	-	20	A
Channel Current Measurement Range	0	-	31.94	A
Channel Current Measurement Resolution	-	62.5	-	mA
Latching WAGO Connectors ††				
Supported Wire Gauge (Bare Solid/Stranded)	26	-	14	AWG
Bare Wire Strip Length	0.31	0.33	0.35	in
Supported Wire Gauge (Stranded, with ferrule)	24	-	18	AWG
Push Button WAGO Connectors ††				
Supported Wire Gauge (Bare Solid/Stranded)	24	-	18	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Supported Wire Gauge (Stranded, with ferrule)	23	-	18	AWG

a It is recommended to use a 20A fuse for a single Pneumatic Hub or Pneumatic Control Module connected to any of the three Low-current Channels if using a compressor with a higher peak current draw, such as the CP26 or the Thomas 405ADC38.

†	Peak current can be sustained for 5 min.
††	As of 01/04/2024, orders made from REV Robot will ship with the version of the Power Distributi Hub that features Latching WAGO Connectors o the Low Current Channel's WAGO blocks.

Switched Channel Specifications

Parameter	Min	Typ	Max	Unit
Continuous Output Current †	-	-	15	A
Fuse/Circuit Breaker Size	-	ATM/APM	-	-
Supported Fuse/Circuit Breaker Current Rating †	-	-	15	A
Low Current Channels	0	-	31.94	A
Low Current Channel Resolution	-	62.5	-	mA
Switching Frequency	-	-	10	Hz
Latching WAGO Connectors ††				
Supported Wire Gauge (Bare Solid/Stranded)	26	-	14	AWG
Bare Wire Strip Length	0.31	0.33	0.35	in
Supported Wire Gauge (Stranded, with ferrule)	24	-	18	AWG
Push Button WAGO Connectors ††				
Supported Wire Gauge (Bare Solid/Stranded)	24	-	18	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Supported Wire Gauge (Stranded, with ferrule)	23	-	18	AWG

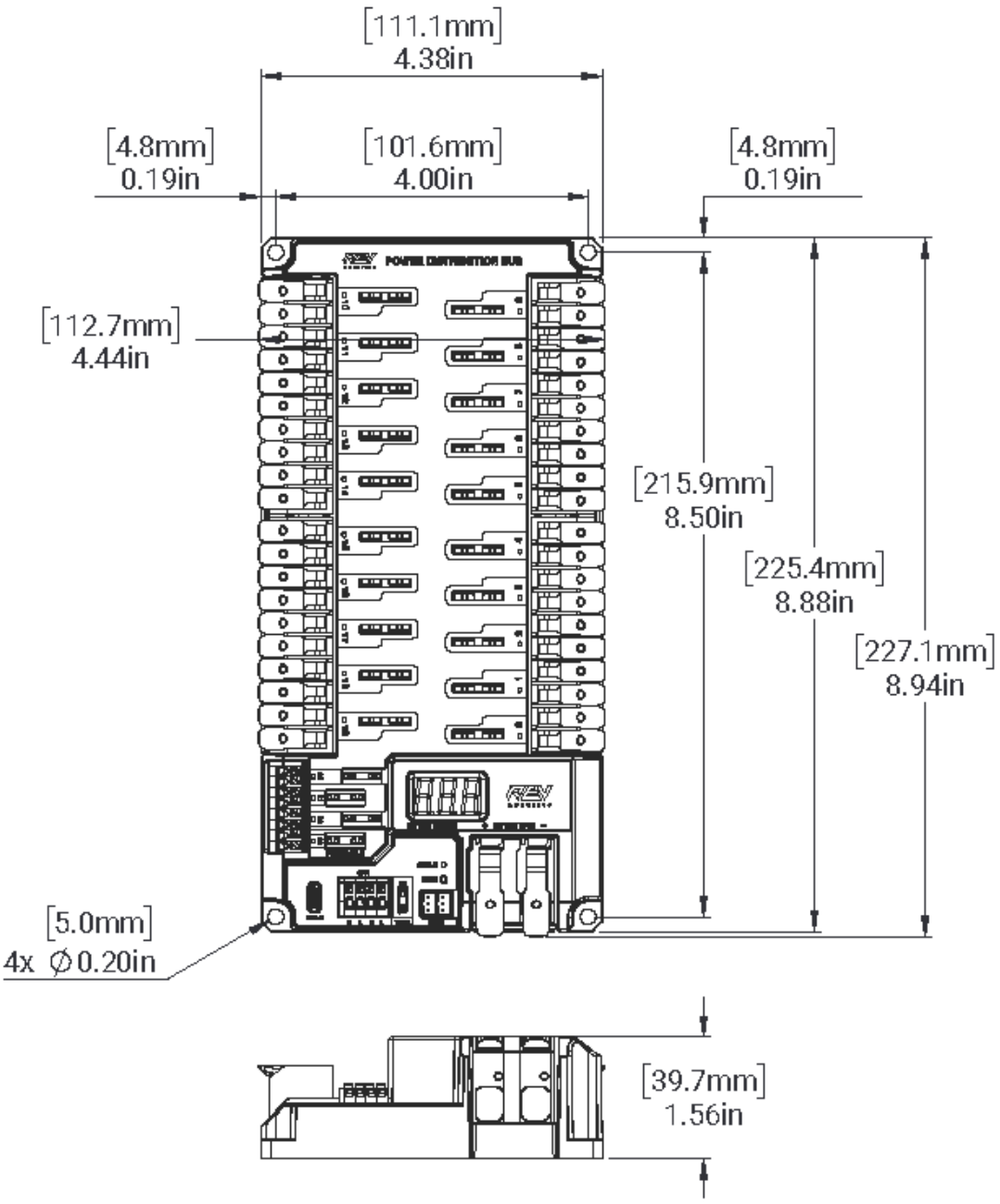
†	Continuous current is thermally limited, therefore depends on environmental and loading factors. Channel may shut itself off automatically if therm limits are reached
††	As of 01/04/2024, orders made from REV Robot will ship with the version of the Power Distributio Hub that features Latching WAGO Connectors o the Low Current Channel's WAGO blocks.

Mechanical Specifications

Parameter	Min	Typ	Max	Units
Body Length	-	8.875	-	in
Body Width	-	4.375	-	in
Body Height	-	1.563	-	in
Weight	-	1.14	-	lbs
Mounting Hole Grid Pitch	-	0.5	-	in
Mounting Screw Size (Clearance)	-	#10	-	-
Case Material	-	ABS	-	-

⚠ DO NOT use thread-locking fluid on the mounting hardware for the REV Power Distribution Hub. Thread-locking fluid will damage the ABS plastic case.

Mechanical Drawings



Power Distribution Hub mechanical drawings top & front view

Getting Started with the Power Distribution Hub

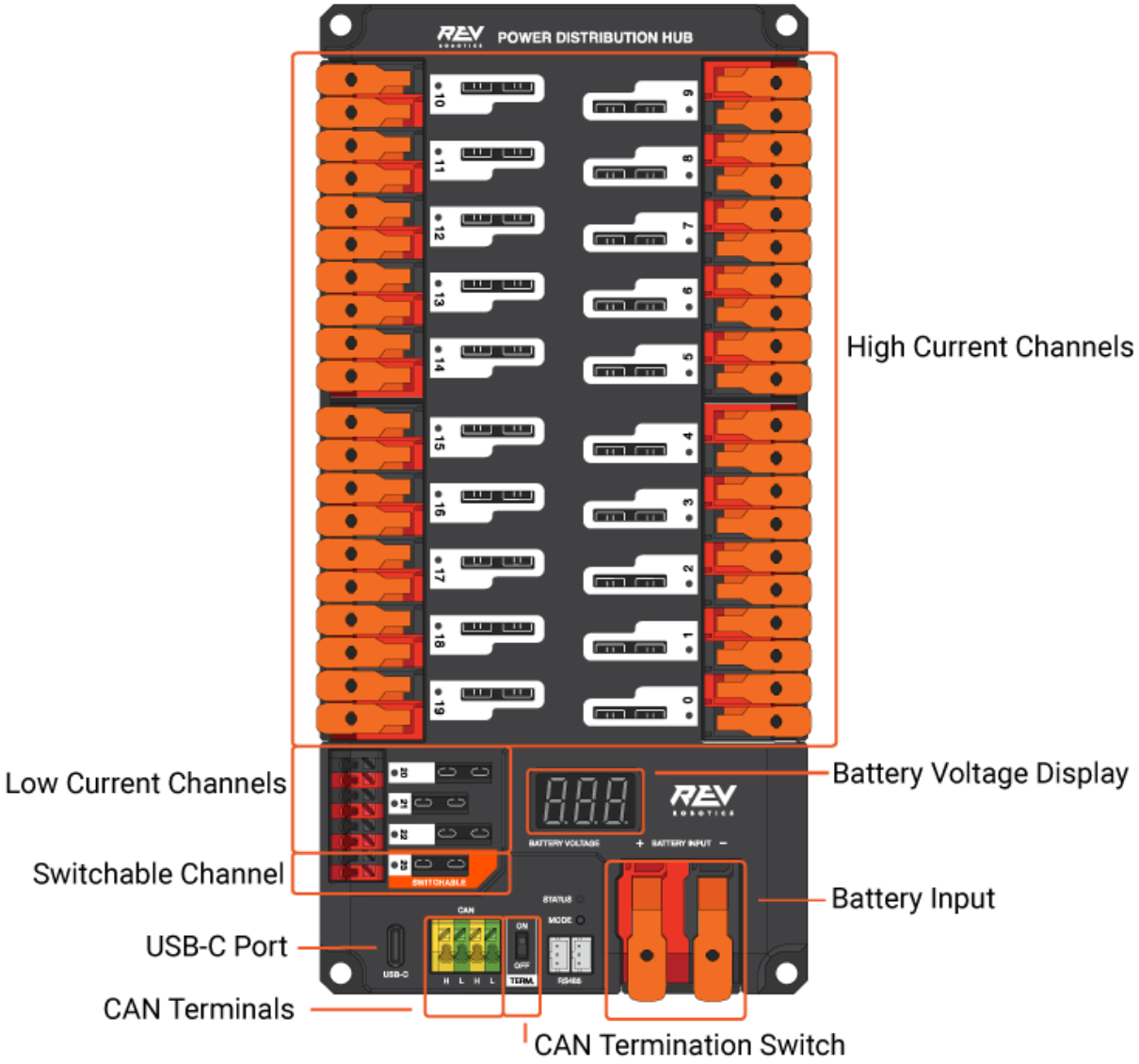
Welcome to your new Power Distribution Hub from REV Robotics! This documentation is intended to answer any questions related to the Power Distribution Hub (PDH) used in the *FIRST* Robotics Competition. If there is a question that is not answered by this space, send our support team an email at **support@revrobotics.com**. We are happy to help point you in the right direction!

- **Have a specific question?** Feel free to head straight to it using the navigation bar to the left. Each section is grouped with other similar topics.
- **Have trouble finding what you are looking for?** Try the search bar in the upper right!

> We recommend reading through this guide in its entirety at least once to fully understand all of the features of your Power Distribution Hub.

Before You Start

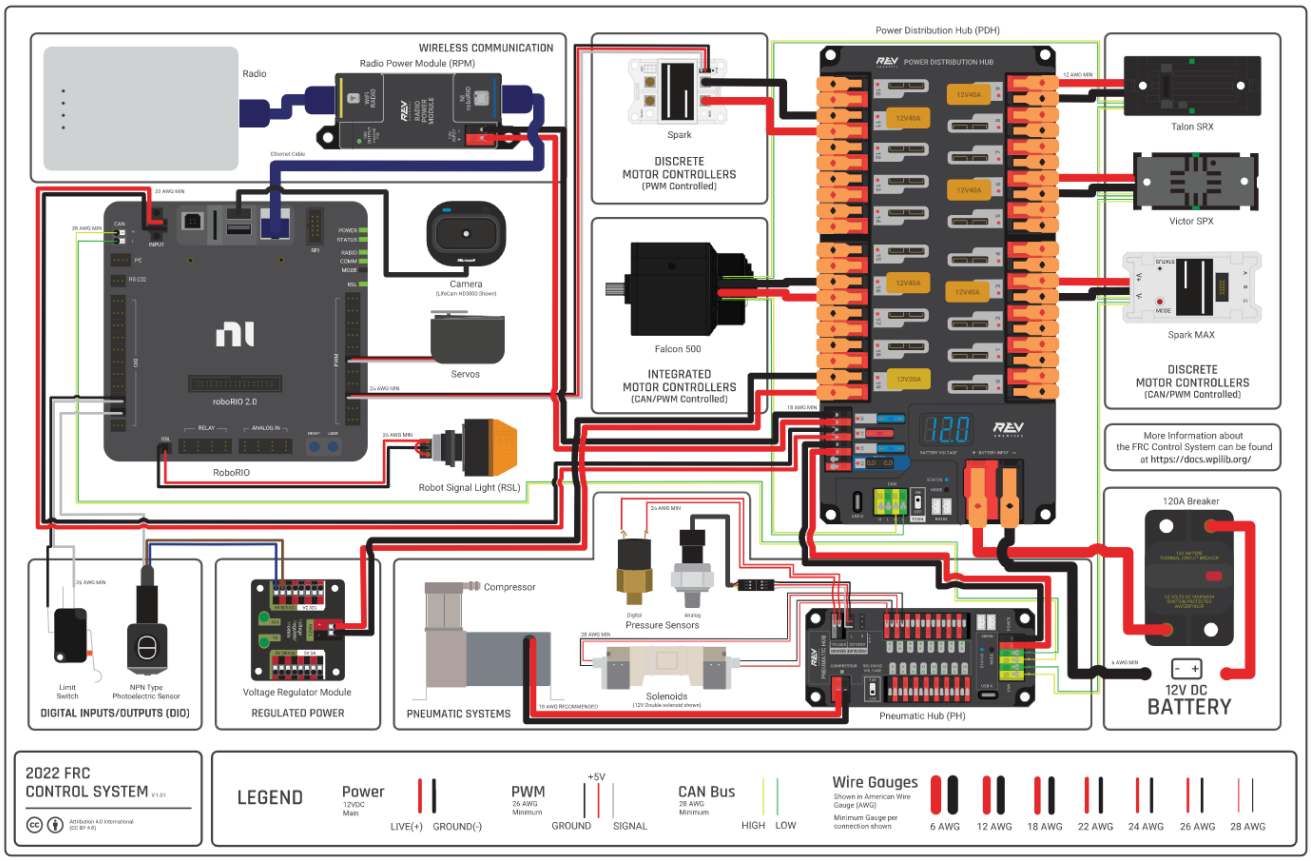
Install the REV Hardware Client before continuing with this guide. The REV Hardware Client is the best way to verify that the Power Distribution Hub is configured correctly and is ***required*** for using the CAN Interface.



RS485 Ports are not currently used in FRC and are included for potential future use

Wiring the Power Distribution Hub

Power Distribution Hub Wiring Diagram



> ⚠ Always make sure the the Power Distribution Hub is disconnected from any power source before adding or modifying connections.

Latching WAGO Terminals: Battery Input and High-Current Channels

- For Battery Input use 18 to 4 AWG Wire, Stripped back ~0.75” (20mm)
- For High-Current Channels use 24 to 8 AWG Wire, Stripped back ~0.5” (12mm)
- Flip open the lever with an upward motion.
  - You can open the lever all the way to have it stay open or you can open it half way for quick wire changes.

- Insert stripped wire into connector opening.
- Push down the lever.
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port.

> **Smart Tug** - tugging on a wire to test the connection with a reasonable amount of force.

Push-Button WAGO Terminals: CAN and Low-Current Channels

- Use 24 to 18 AWG Wire, Stripped back ~0.35” (8mm)
- Press and hold down connector button.
- Insert stripped wire into connector opening.
- Release connector button.
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port.

Circuit Breakers

- Carefully insert the Circuit Breaker (CB) directly into the circuit breaker holder. Ensure that the blades of the circuit breaker slide into the circuit breaker holder.
- Circuit breakers should not be loose or move at all when inserted correctly.
  - If the circuit breaker is loose, remove the circuit breaker and make sure you can see the opening on the circuit breaker holder, then reinsert into the holder.
- New circuit breaker holders fit circuit breakers tightly. This can make it hard to pull out the circuit breaker.

> Over time circuit breaker holders will become easier to use and stay snug!

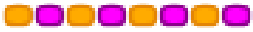
- When removing a circuit breaker, make sure to rock the circuit breaker back and forth to make it easier to pull up on.


POWER DISTRIBUTION HUB

Power Distribution Hub Status LED Patterns

> These led patterns only apply to firmware version 21.1.7 and later

General Status LED

LED Status	LED Description	When	Hub Status
	Blue Solid	Anytime	Device on but no communication established
	Green Solid	Anytime	Main Communication v roboRIO established
	Magenta Blinking	Anytime	Keep Alive Timeout
	Solid Cyan	Anytime	Secondary Heartbeat (Connected to REV Hardware Client)
	Orange/Blue Blinking	Anytime	Low Battery
	Orange/Yellow Blinking	Anytime	CAN Fault
	Orange/Cyan Blinking	Anytime	Hardware Fault
	Orange/Magenta Blinking	Anytime	Device Over Current

Channel Status LED

LED Status	LED Description	When	Component Status

	LED off	Anytime	Channel has voltage and operating as expected
	Red Solid	Anytime	Channel has NO voltage there is an active fault. Check for tripped or missi circuit breaker
	Red Blink	Anytime	Sticky fault on the channe Check for tripped circuit breaker.

Sticky Fault - an indicator that a fault has occurred that will stay until the indicator has been cleared manually.

Switched Channel LED

LED Status	LED Description	When	Component Status
	LED off	Anytime	Channel has voltage and operating as expected
	Red Solid	Anytime	Channel has NO voltage and there is an active fau Check for blown or missi fuse
	Red Blink	Anytime	Sticky fault on the channe Check for blown fuse

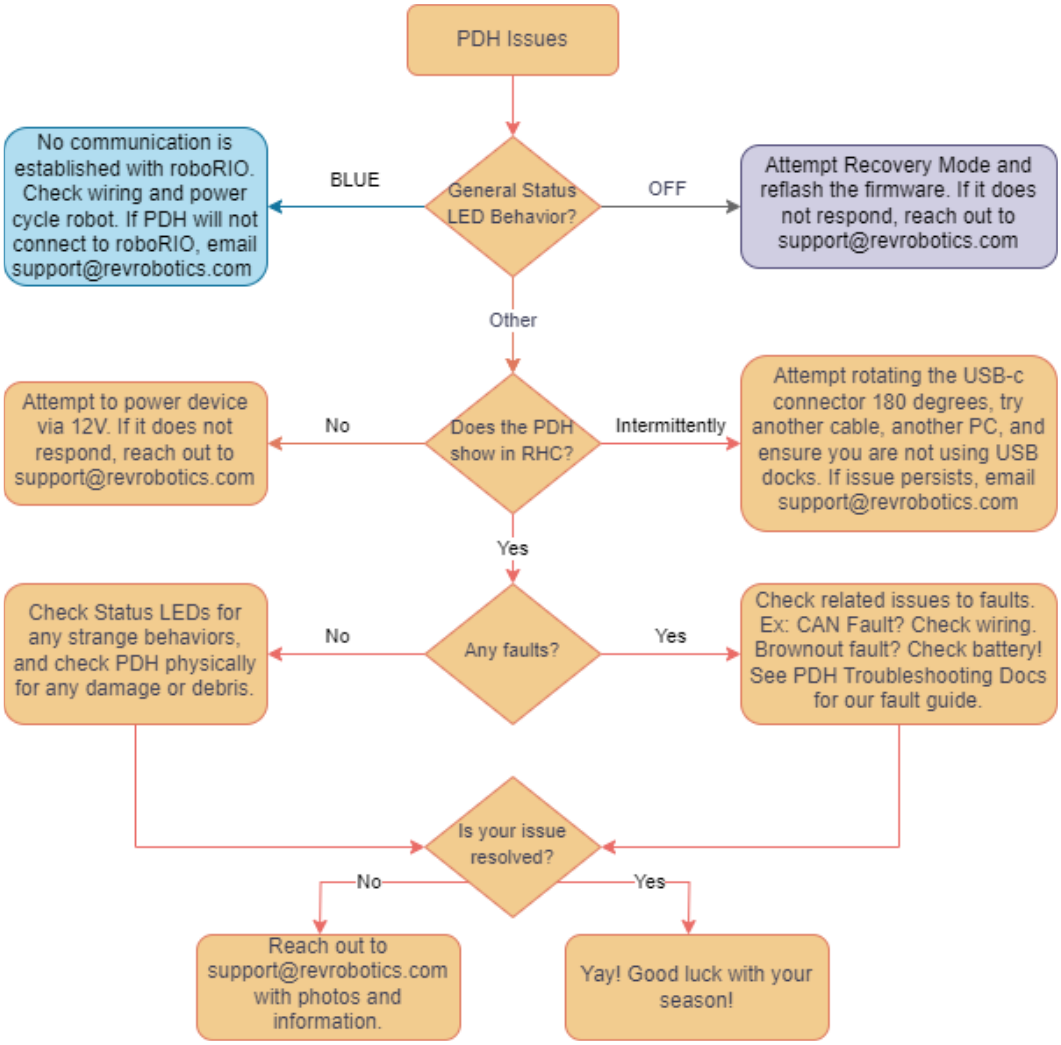
Power Distribution Hub Troubleshooting

The most common Power Distribution Hub troubleshooting issues are listed below. After reading through, if you still have questions or need additional help, reach out to us at: support@revrobotics.com

> ⓘ Is your Status LED light showing a new color or sequence? Check the Status LED Pattern page!

General Troubleshooting

If you are experiencing issues with your Power Distribution Hub that you are struggling to diagnose, we recommend following the troubleshooting guides and steps listed below, both in the flowchart and in the following subsections.



> ⓘ **Smart Tug** - tugging on a wire to test the connection with a reasonable amount of force.

Symptom	Possible Solution
No Voltage / Device Does not Turn On	• Perform a smart tug to check that the battery wires hav good connection to the input terminals • Check your battery voltage on the PDH's display, then check the voltage through the REV Hardware Client. I the readings are inconsistent or missing, check your robot's battery wiring. • If only being powered via USB there will not be any in voltage.
Channel LED Keeps Flashing	• Make sure that the circuit breaker is properly inserted a snug in the holder • If the problem persists you may have a fault on the loa causing the breaker to trip. Make sure there are no problems with your connected devices.
CAN Warning	A CAN warning means that there is something wrong with your CAN bus. Check your CAN bus wiring and the device on your CAN bus. Note: if you are operating the PH by itse using the REV hardware client, you can ignore most CAN warnings. The PH will send a CAN warning if it does not s any other device on the bus
CAN Bus Off	A CAN Bus Off fault means that the CAN bus has run into critical issue resulting in the bus network turning off. Chec your CAN bus for shorts on the high and low CAN wires. T CAN bus will turn back on once the issue is resolved.
Hardware Fault	The hardware fault is generally an internal electrical fault. This could also trigger a sticky fault if a large amount of electrical noise caused a brief communication breakdown internally. This will not affect the function of the device but there could be a small amount of data lost during the interruption.
Device has Reset	The Reset Fault will be triggered when the Power Distribution Hub has lost power. This will happen each time the robot is turned on and off. I possible that this could happen when the robot has a bad connection to the battery or the robot experiences a severe brownout.
	Sticky faults are cleared when the mode button on the Pov Distribution Hub is pressed or can be cleared using the RE

When are Sticky Faults Cleared?	Hardware Client. It is also possible to clear sticky faults us WPILib.

See Firmware Change Log

Version 21.1.7

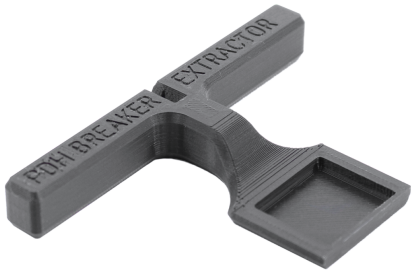
- Persists sticky faults across power cycles
- Allows sticky faults to be cleared by holding down the device's button
- Updates LED patterns
- Turns off the switchable channel LED when the switchable channel is turned off
- Reports to the REV Hardware Client whether a roboRIO is connected via the CAN network

3D Printed Breaker Extractor

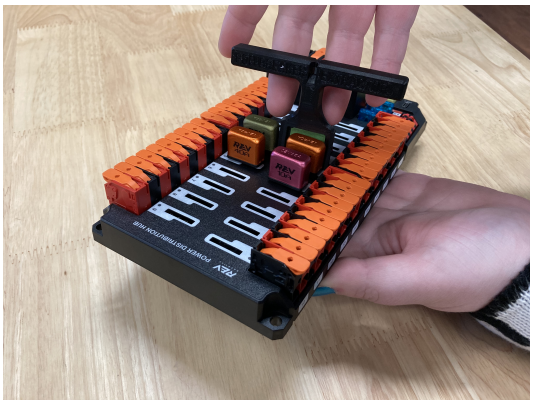
The 3D printed Breaker Extractor makes freeing REV ATO Auto-resetting Breakers from the Power Distribution Hub easy!

Breaker Extractor .STL File Download

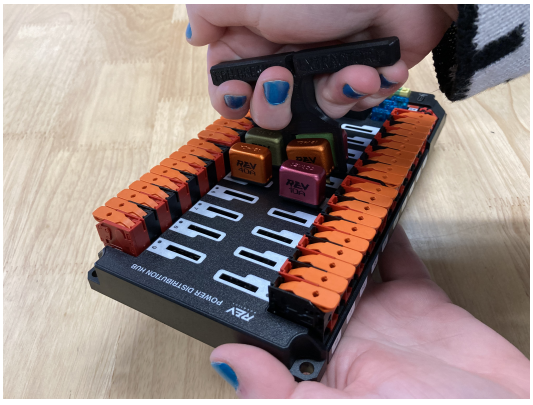
Breaker Extractor STEP File Download



First, grasp the T-handle of the extractor and slide the square frame around the breaker you would like to remove from the Power Distribution Hub.



Then, position the bottom edge of the breaker extractor under the bottom edge of the breaker. While maintaining that position, and contact with the plastic bottom of the breaker, gently rock the extractor handle side to side while pulling upwards.



Continue that motion until breaker is free.

Recovery Mode

When updating the firmware on the Power Distribution Hub, it is possible for the process to be interrupted or for the firmware to be corrupted by a bad download. In this state, the Status LED will be dark or dim and the Power Distribution Hub will fail to operate. There is a built-in recovery mode that can force it to accept new firmware even if the controller seems to be bricked and the procedure is outlined below:

Please note, performing this procedure will erase all data and settings on the device. To perform the procedure a small tool, like a straightened paper clip is necessary to press the Mode Button (located close to the LED status light), the orange USB-c cable that came with the unit (or a DATA capable USB-c cable), and a native Windows based computer with the REV Hardware Client installed:

1. With the Power Distribution Hub powered off, press and hold the Mode Button
2. While still holding the Mode Button, connect the Power Distribution Hub to the computer using the USB-c cable - the Status LED will illuminate a dim red - this is expected.
3. With the REV Hardware Client running on the computer, wait a few seconds for the audible tone or icon for the device to be recognized in recovery mode then release the Mode Button - no lights will be present on the Power Distribution Hub during this stage of the process, this is expected
4. Select the Power Distribution Hub in Recovery Mode from the REV Hardware Client window
5. From the Choose a Device type dropdown, choose - Power Distribution Hub
6. Choose latest version of Firmware from the dropdown and then click update
7. Wait for the software update to complete
8. Power cycle unit (unplug and plug in USB-c) click on Power Distribution Hub icon, clear any sticky faults - the recovery should be complete.

Pneumatic Hub

Pneumatic Hub Overview

Pneumatic Hub Resources

General Resources

- Getting Started with the Pneumatic Hub
- Troubleshooting
  - Status LED Patterns
- Pneumatic Hub Specifications

Software Resources

- Getting Started with the REV Hardware Client
- REVLib API and Installation

The REV Pneumatic Hub (REV-11-1852) is a standalone module that is capable of switching both 12V and 24V pneumatic solenoid valves. The Pneumatic Hub features 16 solenoid channels which allow for up to 16 single-acting solenoids, 8 double-acting solenoids, or a combination of the two types. The user-selectable output voltage is fully regulated, allowing even 12V solenoids to stay active when the robot battery drops as low as 4.75V.

Digital and analog pressure sensor ports are built into the device, increasing the flexibility and feedback functionality of the pneumatic system. The USB-C connection on the Hub works with the REV Hardware Client, allowing users to test pneumatic systems without a need for an additional robot controller.

Pneumatic Hub

Features

- 16 solenoid channels
  - 16 single-acting or 8 double-acting channels
  - Fully integrated user-selectable 12V or 24V solenoid output
- Pressure sensor inputs
  - 1 Digital pressure switch input
  - 2 Analog pressure sensor inputs
- CAN connectivity
  - Channel telemetry feedback to the main robot controller
- USB-C connectivity
  - USB-to-CAN device allowing for monitoring and updating devices on the CAN bus
  - Update and diagnose faults with the REV Hardware Client
- Channel status LEDs indicate channel state and faults
- Reverse polarity protection
- Overcurrent protection
- ESD protection

Pneumatic Hub Specifications

The following tables provide the operating and mechanical specifications for the Pneumatic Hub.

> ⚠ DO NOT exceed the maximum electrical specifications. Doing so will cause permanent damage to the Pneumatic Hub and will void the warranty.

Main Electrical Specifications

Parameter	Min	Typ	Max	Units
Operating Voltage Range	4.7	12	18	V
Main Power Wire Gauge (Bare Solid/Stranded) †	24	-	16	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Main Power Wire Gauge (Stranded, with ferrule) †	24	-	18	AWG
CAN Terminal Wire Gauge (Bare Solid/Stranded)	24	-	18	AWG
CAN Terminal Bare Wire Strip Length	0.33	0.35	0.37	in
CAN Terminal Wire Gauge (Stranded, with ferrule)	24	-	18	AWG

†	Due to the input current requirements for the Pneumatic Hub, it is recommended to use the maximum wire gauge possible for the Main Pow Input.

Make sure to consider the current and safety requirements when choosing a wire gauge for any given application.

Compressor Output Specifications

Parameter	Min	Typ	Max	Unit
Continuous Compressor Output Current (See note below)	-	-	15	A
Current Measurement Resolution	-	125	-	mA
Wire Gauge (Bare Solid/Stranded)	24	18	16	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Wire Gauge (Stranded, with ferrule)	24	18	18	AWG

It is recommended to use a 20A fuse or circuit breaker with the Pneumatic Hub if using a compressor with higher peak current draw, such as the CP26 or the Thomas 405ADC38.

Solenoid Channel Specifications

Parameter	Min	Typ	Max	Unit
Individual Channel Output Current	-	-	200	mA
Total Continuous Output Current (24V Mode) †	-	-	3.2	A
Total Continuous Output Current (12V Mode) †	-	-	1.5	A
Output Current Measurement Resolution	-	10	-	mA
Wire Gauge (Bare Solid/Stranded)	24	-	20	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in

†	Total combined current for all solenoid channels

Digital Pressure Switch Port Specifications

Parameter	Min	Typ	Max	Unit
Input Voltage Range †	0	-	5	V
Input High Level Voltage	-	-	2.31	V
Input Low Level Voltage	0.99	-	-	V
Wire Gauge (Bare Solid/Stranded)	24	-	20	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in

†	Internally pulled up to 5V.

Analog Pressure Sensor Port Specifications

Parameter	Min	Typ	Max	Unit
Default Pressure Measurement Range †	0	-	200	psi
Corresponding Voltage Measurement to Pressure Range †	0.5	-	5.0	V
Absolute Voltage Measurement Range ‡	0	-	5.0	V
Supply Voltage	-	5	-	V
Supply Current	-	-	95	mA

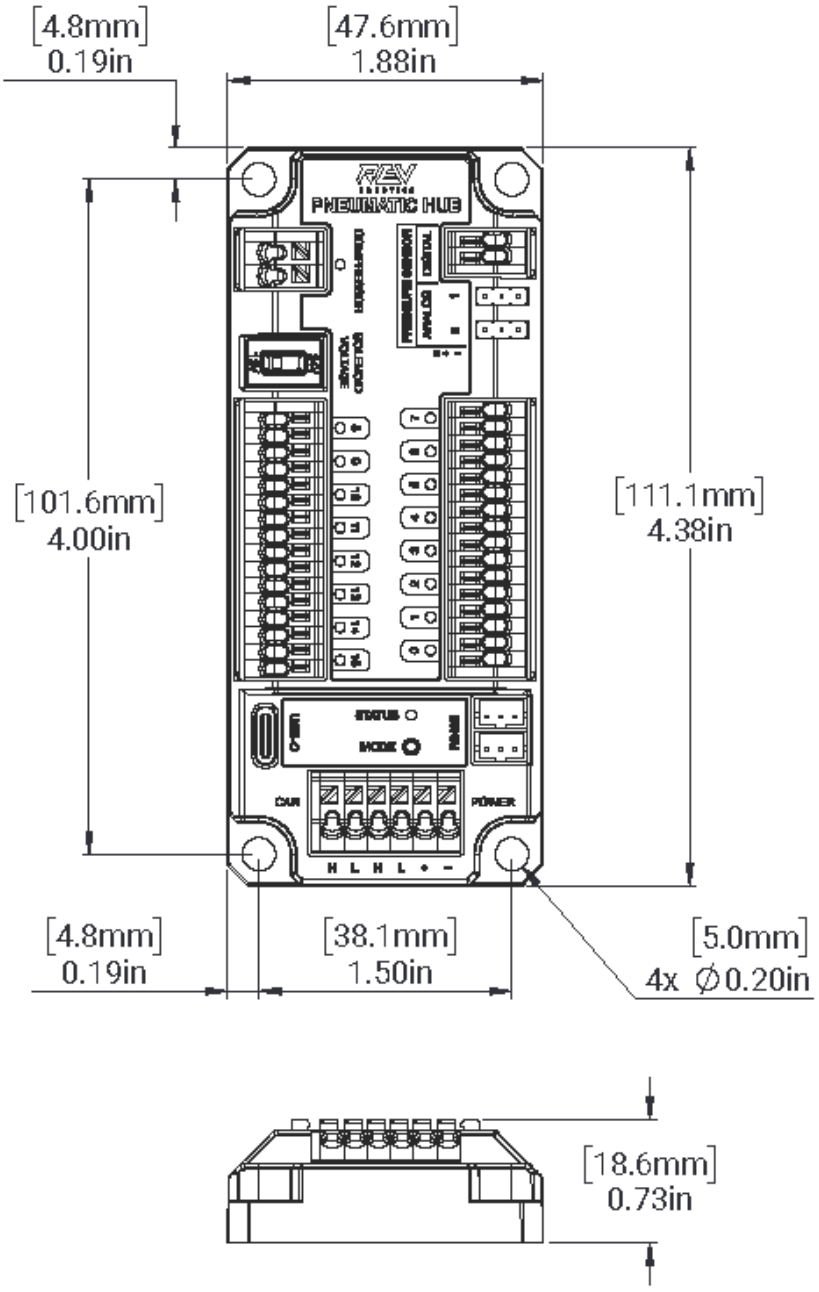
†	The Pneumatic Hub assumes a REV Analog Pressure Sensor (REV-11-1107) is connected b default.
†	The REV Analog Pressure Sensor minimum ou voltage is 0.5V. A measurement of 0V triggers a safe condition that assumes the sensor has bee disconnected.

Mechanical Specifications

Parameter	Min	Typ	Max	Units
Body Length	-	4.375	-	in
Body Width	-	1.875	-	in
Body Height	-	0.750	-	in
Weight	-	0.1625	-	lbs
Mounting Hole Grid Pitch	-	0.5	-	in
Mounting Screw Size (Clearance)	-	#10	-	-
Case Material	-	ABS	-	-

⚠ DO NOT use thread-locking fluid on the mounting hardware for the REV Pneumatic Hub. Thread-locking fluid will damage the ABS plastic case.

Mechanical Drawings



Pneumatic Hub mechanical drawings top & front view

Getting Started with the Pneumatic Hub

Welcome to your new Pneumatic Hub from REV Robotics! This documentation is intended to answer any questions related to the Pneumatic Hub (PH) used in the *FIRST* Robotics Competition. If there is a question that is not answered by this space, send our support team an email at **support@revrobotics.com**. We are happy to help point you in the right direction!

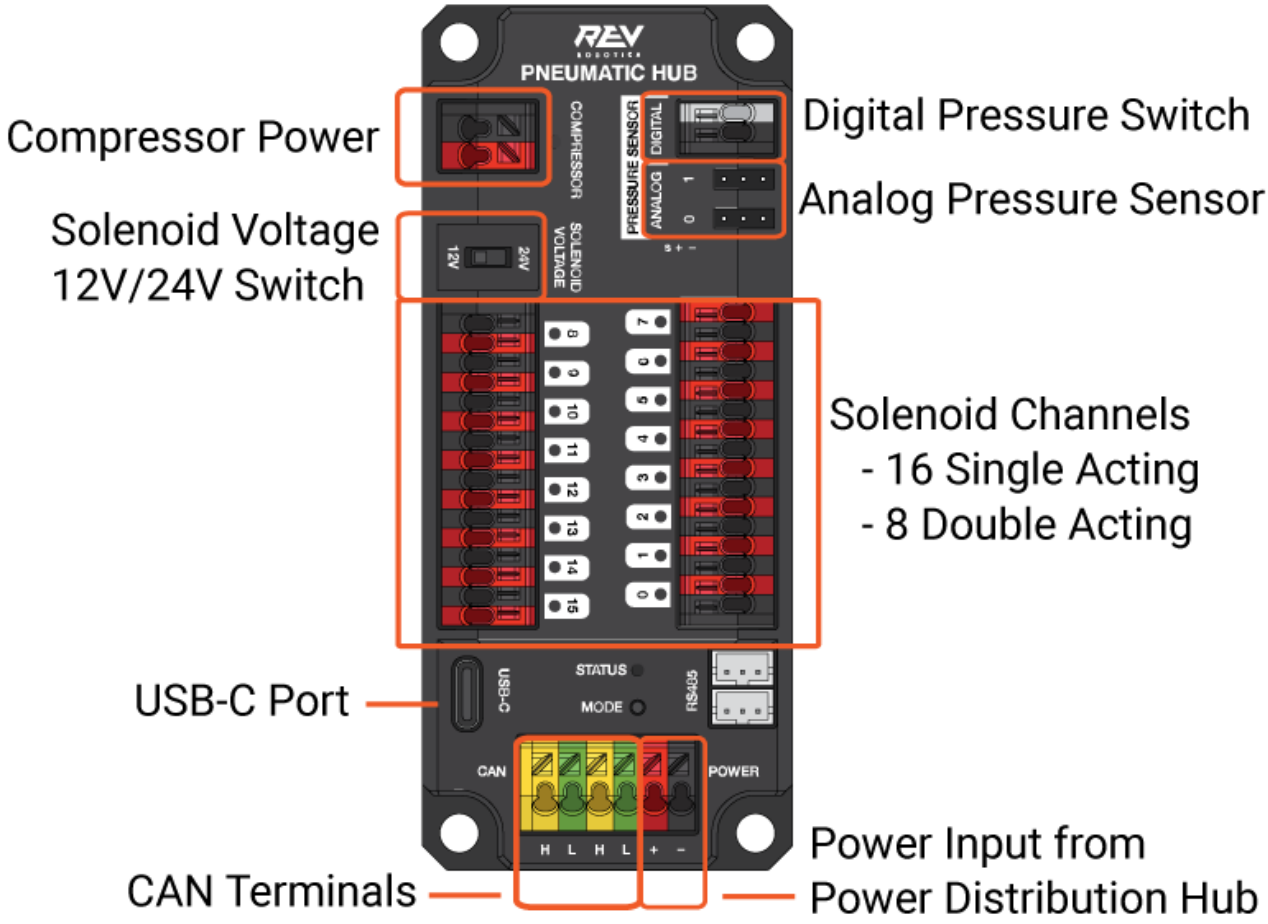
- **Have a specific question?** Feel free to head straight to it using the navigation bar to the left. Each section is grouped with other similar topics.
- **Have trouble finding what you are looking for?** Try the search bar in the upper right!

> We recommend reading through this guide in its entirety at least once to fully understand all of the features of your Pneumatic Hub.

Before You Start

Install the REV Hardware Client before continuing with this guide. The REV Hardware Client is the best way to verify that the Pneumatic Hub is configured correctly and is ***required*** for using the CAN Interface.

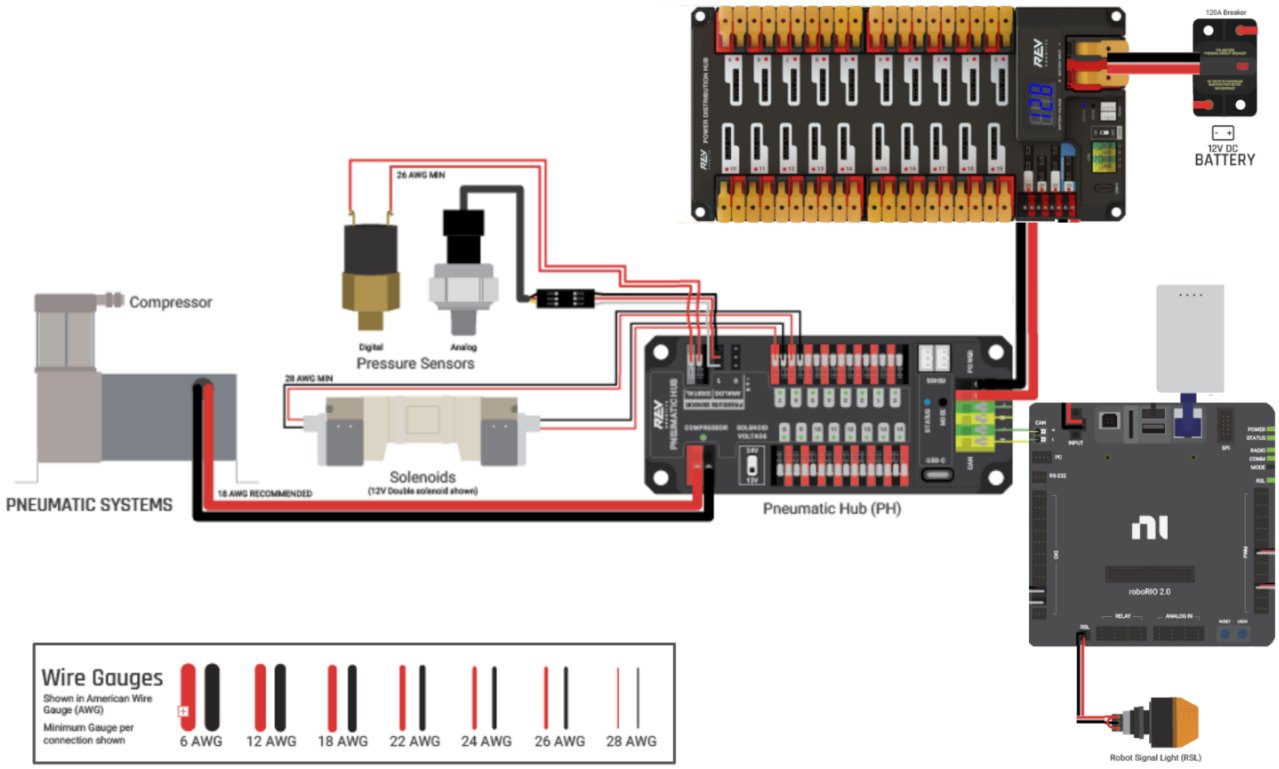
> Ensure voltage is set for solenoids before applying power, using a mix of 12V and 24V is not supported



RS485 Ports are not currently used in FRC and are included for potential future use

Wiring the Pneumatic Hub

The Pneumatic Hub is powered off of one of the three Power Distribution Hub side channels (not the switchable side channel) and can be wired into the CAN bus using the yellow and green channel ports.



Portions of diagram courtesy of: sacepcion

> ⚠ Always make sure the Pneumatic Hub is disconnected from any power source before adding or modifying connections.

Wiring the Power Input (12 Volt Supply - Battery, Power Supply, etc.)

- Use 24-16 AWG Wire, Stripped back ~0.375” (9mm)
- Make sure that a red colored wire is connected to the red/positive (+) terminals and that the black colored wire is connected to the black/negative (-) terminals. Press and hold down connector button.
- Insert wire into connector opening
- Release connector button
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port

> ⓘ **Smart Tug** - tugging on a wire to test the connection with a reasonable amount of force.

Wiring the Compressor

- Use 24-16 AWG Wire, Stripped back ~0.375” (9mm)
- Make sure that a red colored wire is connected to the red/positive (+) terminals and that the black colored wire is connected to the black/negative (-) terminals. Press and hold down connector button.
- Insert wire into connector opening
- Release connector button
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port

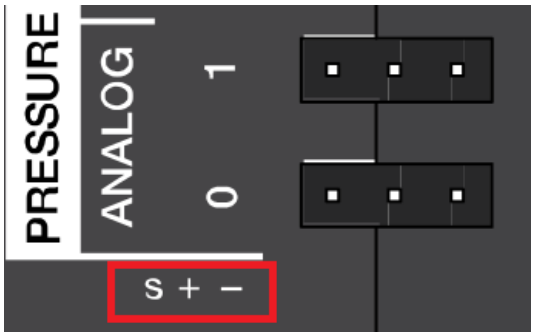
> ⓘ To test your Compressor and Pressure Relief Valve, use Compressor Test Mode!

Wiring the Digital Pressure Switch

- The digital pressure switch should be wired to the Digital Sensor Port on the PH. The polarity of the digital switch does not matter and can be wired in either direction.

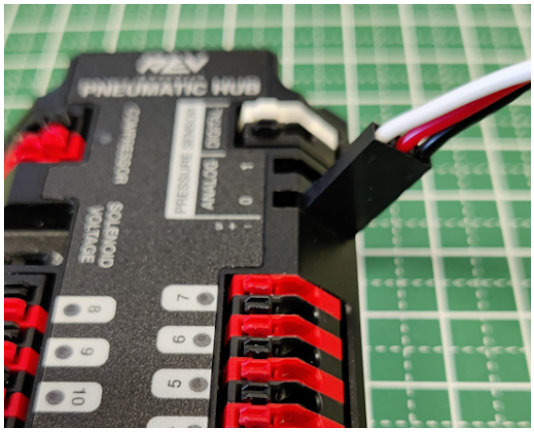
Wiring an Analog Pressure Sensor

- Most sensors that connect to analog input ports will have three wires - signal, power, and ground - corresponding precisely to the three pins of the analog input ports - see highlighted legend pic below

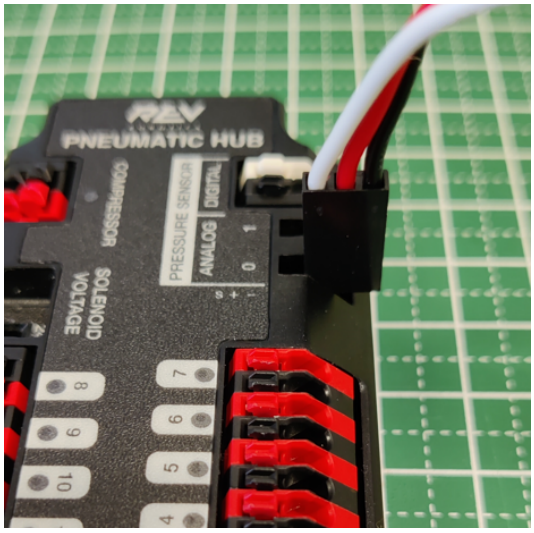


- Additionally, some sensors may need to connect to multiple analog input ports in order to function. In general, these sensors will only ever require a single power and a single ground pin - only the signal pin of the additional port(s) will be needed.

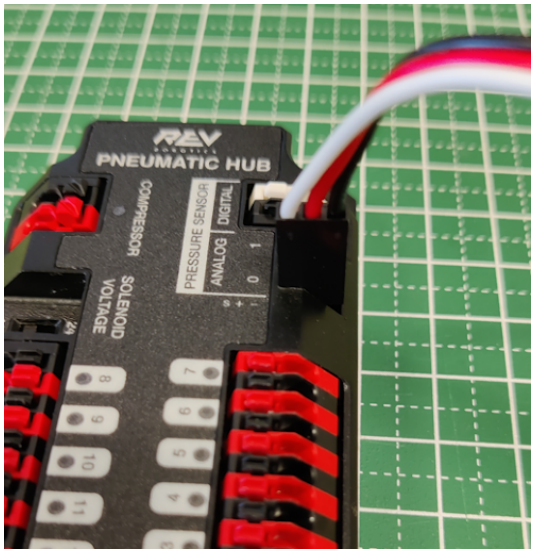
> ⓘ The Analog Pressure Sensor port is a very tight fit and requires special attention



1) Insert the 3 pin sensor connector at an angle
the sloped part of the case



2) Pivot the connector so its horizontal



3) Push the connector along the slot into positio
above the pins

4) Push down to plug in the connector

Wiring the Solenoids (please read caution below)

- Use 24 AWG wire, Stripped back ~0.375” (9mm) Press and hold down connector button.
- Insert wire into connector opening
- Release connector button
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port
- set single acting vs double acting

> Ensure voltage is set for solenoids before applying power, using a mix of 12V and 24V is not supported

Wiring the CAN bus

- Use 24 AWG - 18 AWG Wire, Stripped back ~0.375” (9mm) Press and hold down connector button.
- Insert wire into connector opening
- Release connector button
- Test the wire by giving it a **smart tug** to ensure wire is connected securely.
- Visually inspect to make sure no stray wires are outside of the connector port

> The Pneumatic Hub does not come with a terminating resistor.

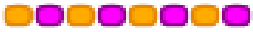
Building Pressure!

The complexity of your pneumatic system is dependent on your design and governed by the tightly defined FRC robot rules. Because of the number of variables inherent in these systems, we do not cover them within this documentation. There are, however, several references we can suggest!

- FIRST Robotics Competition Pneumatics Manual
- WPI Pneumatics

Pneumatic Hub Status LED Patterns

General Status LED

LED Status	LED Description	When	Hub Status
	Blue Solid	Anytime	Device on but no communication establishe
	Green Solid	Anytime	Main Communication established
	Magenta Blinking	Anytime	Keep Alive Timeout
	Solid Cyan	Anytime	Secondary Heartbeat
	Orange/Cyan Blinking	Anytime	Hardware Fault
	Orange/Yellow Blinking	Anytime	CAN Fault
	Orange/Magenta Blinking	Anytime	Device Over Current
	Orange/Green Blinking	Anytime	Compressor Over Current

Compressor Status LED

LED Status	LED Description	When	Component Status
	Green Solid	Anytime	Compressor On
	LED Off	Anytime	Compressor Off

Solenoid Status LED

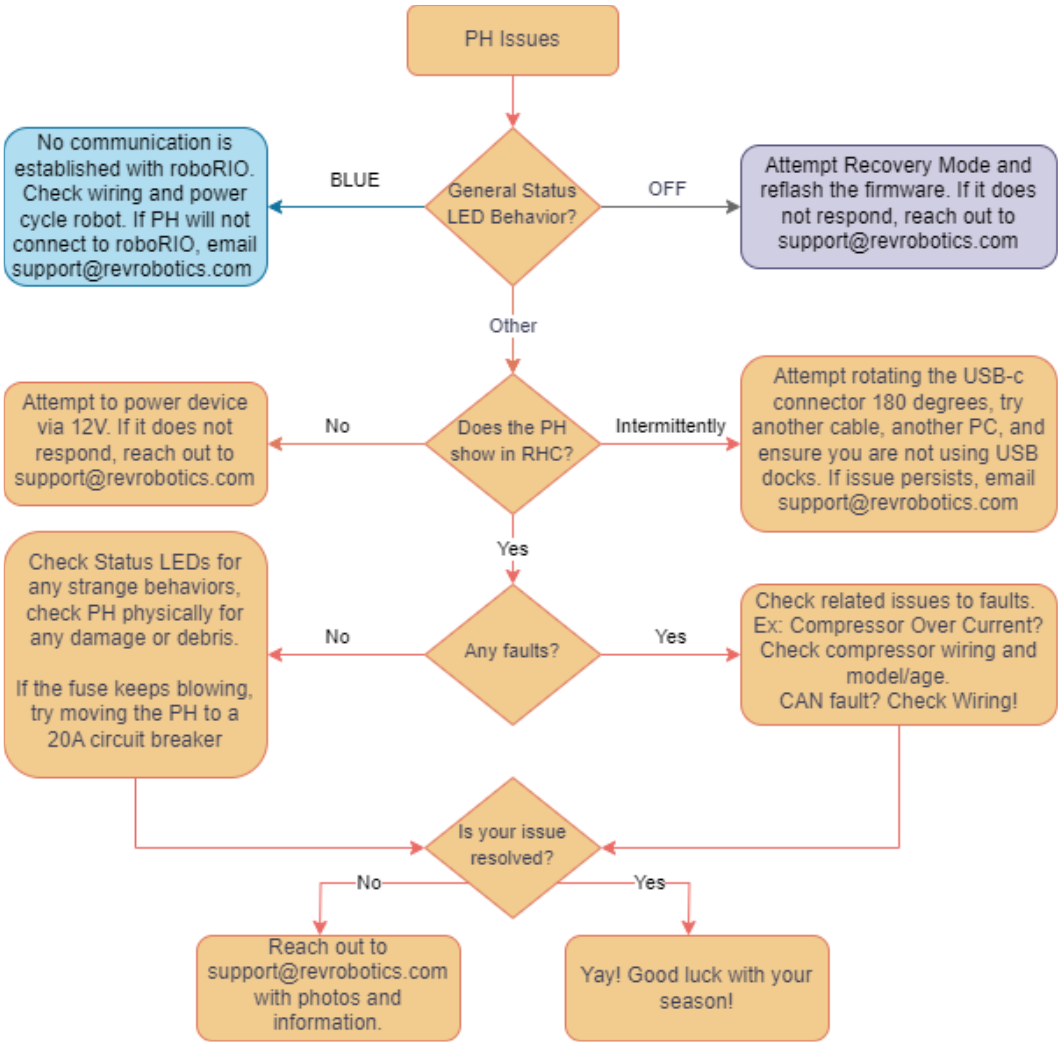
LED Status	LED Description	When	Component Status
	Green Soild	Anytime	Solenoid On
	LED Off	Anytime	Solenoid Off

Pneumatic Hub Troubleshooting

> Is your Status LED light showing a new color or sequence? Check out the Status LED Pattern page!

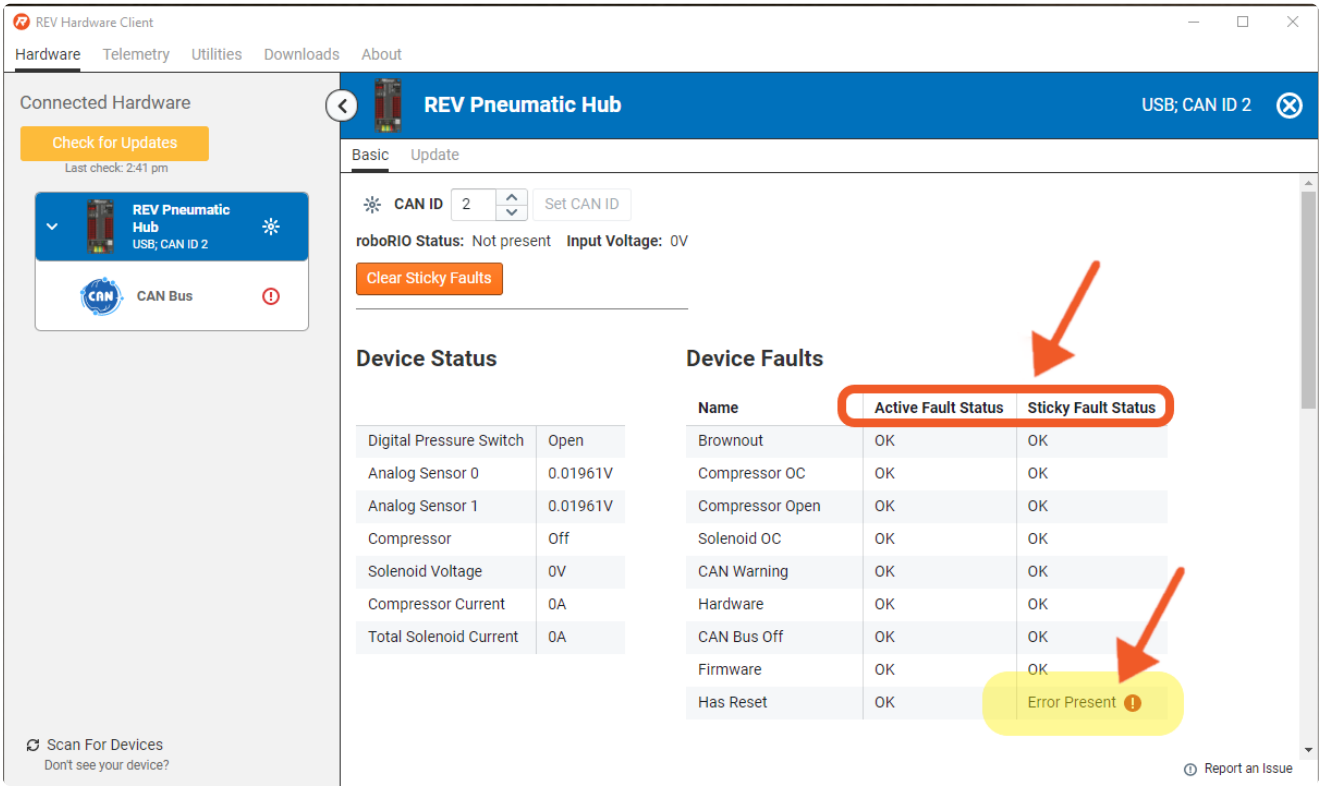
General Troubleshooting

If you are experiencing issues with your Pneumatic Hub that you are struggling to diagnose, we recommend following the troubleshooting guides and steps listed below, both in the flowchart and in the following subsections.



Checking for Faults

View **Active Faults** and **Sticky Faults** on your Pneumatic Hub by connecting it to the REV Hardware Client. Under the Device Faults section you will see two columns, one for Active Faults and one for Sticky Faults.



Clearing Sticky Faults

Sticky faults are cleared when the mode button on the Power Distribution Hub is pressed or can be cleared using the REV Hardware Client. It is also possible to clear sticky faults using WPILib.

Compressor Test Mode

To activate Compressor Test Mode, please follow these steps:

1. Turn on and enable your robot, or connect your Pneumatics Hub to the REV Hardware Client.
2. Hold down the mode button for 7 seconds.
3. Compressor will start, continue holding the mode button to keep the compressor on.
4. When done with Compressor Test Mode, release the mode button to stop the compressor.

Fuse consistently pops during use

Your Pneumatic Hub is drawing more current than the fuse can handle. If you're using a 15A fuse, try a 20A fuse.

If you're using a 20A fuse, we recommend moving your Pneumatic Hub to be powered by a High Current Channel and a 20A breaker.

You should also check your logs to see how much current the PH is pulling. Please note that the PH will draw more current at lower battery voltages.

Recovery Mode

When updating the firmware on the Pneumatic Hub, it is possible for the process to be interrupted or for the firmware to be corrupted by a bad download. In this state, the Status LED will be dark and the Pneumatic Hub will fail to operate. There is a built-in recovery mode that can force it to accept new firmware even if the controller seems to be bricked and the procedure is outlined below:

Please note, performing this procedure will erase all data and settings on the device. To perform the procedure a small tool, like a straightened paper clip is necessary to press the Mode Button (located close to the LED status light), the orange USB-c cable that came with the unit (or a DATA capable USB-c cable), and a native Windows based computer with the REV Hardware Client installed.

1. With the Pneumatic Hub powered off, press and hold the Mode Button
2. While still holding the Mode Button, connect the Pneumatic Hub to the computer using the USB-c cable - the Status LED will not illuminate, this is expected
3. With the REV Hardware Client running on the computer, wait a few seconds for the audible tone or icon for the device to be recognized in recovery mode then release the Mode Button -no lights will be present on the Pneumatic Hub during this stage of the process, this is expected
4. Select the Pneumatic Hub in Recovery Mode from the REV Hardware Client window
5. From the Choose a Device type dropdown, choose - Pneumatic Hub
6. Choose latest version of Firmware from the dropdown and then click update
7. Wait for the software update to complete
8. Power cycle unit (unplug and plug in USB-c) click on Pneumatic Hub icon, clear any sticky faults - the recovery should be complete.

Other Common Issues

Symptom	Possible Resolution
The PH won’t power on even though the PDH is on.	1. Check the polarity of the main power wiring on the P 2. Check the fuse on the PDH side channel that the PH wired to.
Solenoid does not turn on despite the channel turning on (Green LED is on).	Check the cable wiring and make sure there is enough b wire to make contact in the solenoid terminal. Verify that t solenoid voltage switch is set to the proper voltage.
Compressor does not turn on despite the compressor channel turning on (Green LED is on).	Check the wiring of the compressor and make sure there enough bare wire to make contact in the compressor terminal.
PH cannot communicate over CAN	Check your CAN wiring and make sure there is enough bare wire to make contact in the CAN terminals.
CAN Warning	A CAN warning means that there is something wrong wit your CAN bus. Check your CAN bus wiring and the devi on your CAN bus. Note: if you are operating the PH by its using the REV hardware client, you can ignore most CAN warnings. The PH will send a CAN warning if it does not see any other device on the bus
CAN Bus Off Fault	A CAN Bus Off fault means that the CAN bus has run int critical issue resulting in the bus network turning off. Che your CAN bus for shorts on the high and low CAN wires. The CAN bus will turn back on once the issue is resolve

Radio Power Module

Radio Power Module Overview

Radio Power Module Resources

General Resources

- Getting Started with the Radio Power Module
- Radio Power Module Specifications

The REV Radio Power Module (REV-11-1856) is designed to keep one of the most critical system components, the OpenMesh OM5P-AC WiFi radio, powered in the toughest moments of the competition. Traditional barrel jacks easily work themselves loose and often require hacks, like hot glue, to prevent intermittent power losses. The Radio Power Module eliminates the need for powering the radio through a traditional barrel power jack. Utilizing 18V Passive Power over Ethernet (PoE) with two socketed RJ45 connectors, the Radio Power Module passes signal between the radio and roboRIO while providing power directly to the radio. After connecting the radio and roboRIO, easily add power to the Radio Power Module by wiring it to the low-current channels on the Power Distribution Hub utilizing the color coded push button WAGO terminals.

Radio Power Module

Features

- 18V Passive Power over Ethernet (PoE)
- Easy to wire
  - WAGO 250 series push button terminals for power
  - Two socketed RJ45 connectors accepting standard Ethernet cables
- Designed for use with the OpenMesh OM5P-AC
  - Compatible with other devices that accept 18V passive PoE
- ESD protection
- Overcurrent protection

Radio Power Module Specifications

The following tables provide the operating and mechanical specifications for the Radio Power Module.

> ⚠ DO NOT exceed the maximum electrical specifications. Doing so will cause permanent damage to the Radio Power Module and will void the warranty.

> ⚠ DO NOT reverse the 12V power input polarity. Doing so will cause permanent damage to the REV Radio Power Module and will void the warranty.

Main Electrical Specifications

Parameters	Min	Typ	Max	Unit
Operating Voltage Range	4.7	12	18	V
Continuous Output Current	-	-	1	A
Latching WAGO Connectors †				
Power Input Wire Gauge (Bare Solid/Stranded)	26	-	14	AWG
Bare Wire Strip Length	0.31	0.33	0.35	in
Power Input Wire Gauge (Stranded, with ferrule)	24	-	18	AWG
Push Button WAGO Connectors †				
Power Input Wire Gauge (Bare Solid/Stranded)	24	-	16	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Power Input Wire Gauge (Stranded, with ferrule)	24	-	18	AWG

†	As of 01/04/2024, orders made from REV Robot will ship with the version of the Radio Power Module that features Latching WAGO Connecto

Make sure to consider the current and safety requirements when choosing a wire gauge for any given application.

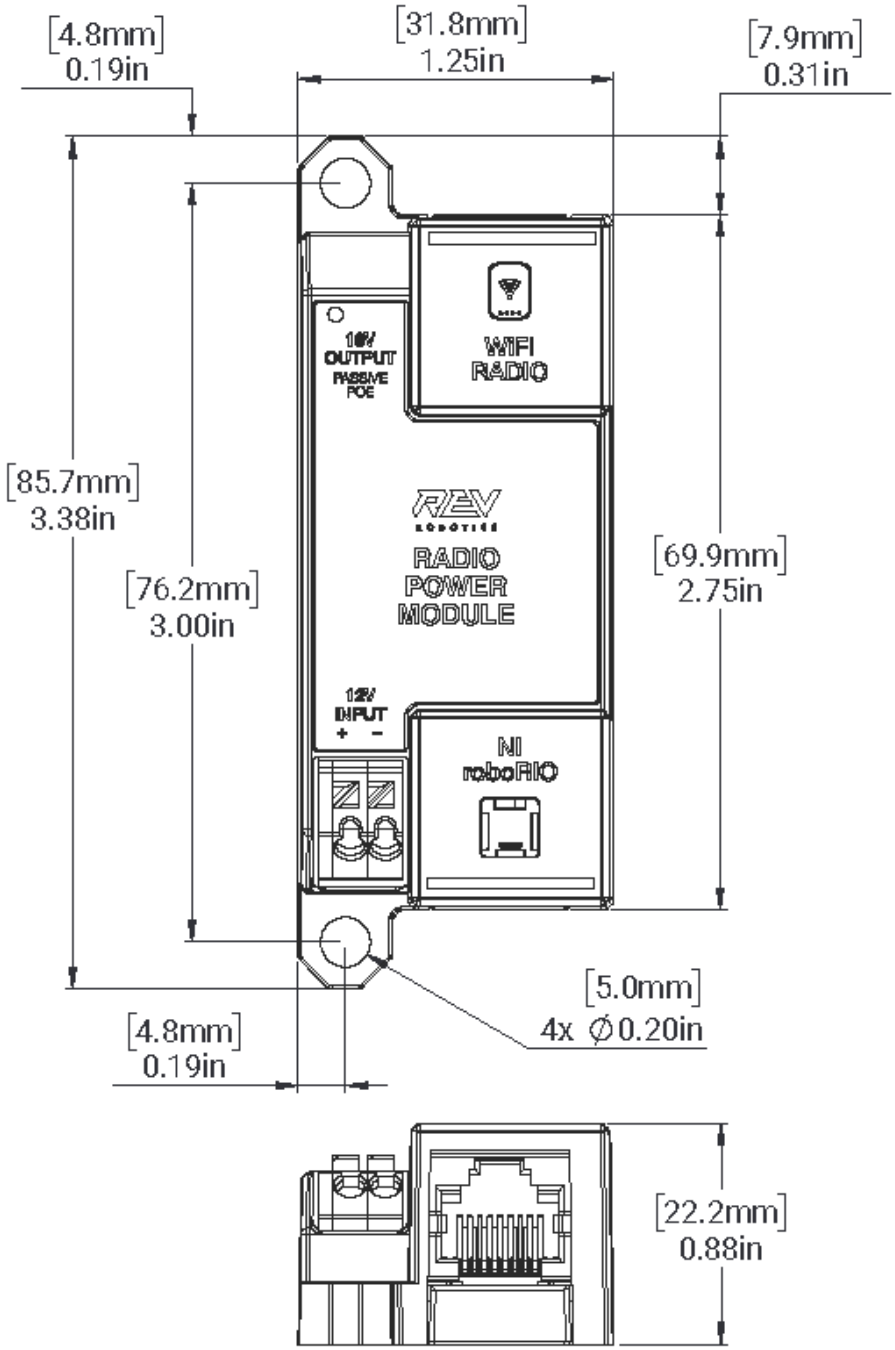
DO NOT connect the roboRIO to the WiFi Radio Ethernet port. Doing so can cause permanent damage to the roboRIO.

Mechanical Specifications

Parameter	Min	Typ	Max	Units
Body Length	-	3.375	-	in
Body Width	-	1.250	-	in
Body Height	-	0.875	-	in
Weight	-	0.09	-	lbs
Mounting Hole Grid Pitch	-	0.5	-	in
Mounting Screw Size (Clearance)	-	#10	-	-
Case Material	-	ABS	-	-

DO NOT use thread-locking fluid on the mounting hardware for the REV Radio Power Module. Thread-locking fluid will damage the ABS plastic case.

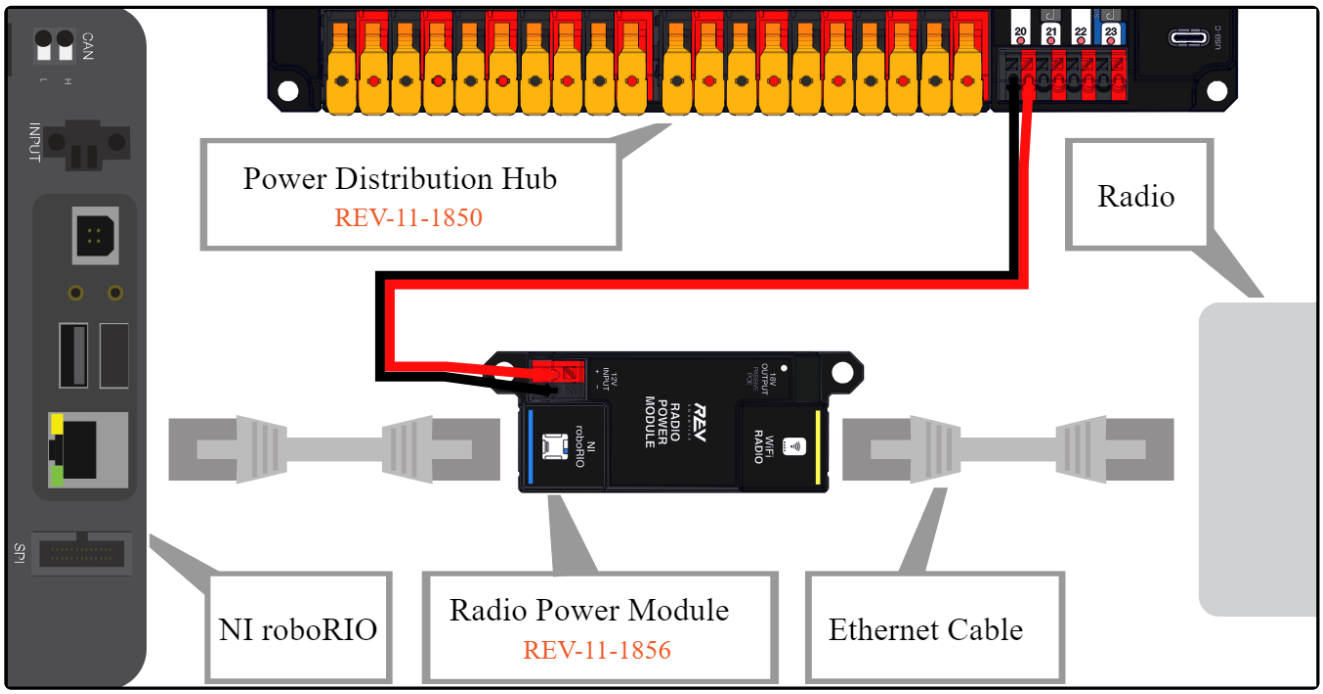
Mechanical Drawings



Radio Power Module Mechanical Drawing Top and Front View

Getting Started with the Radio Power Module

Utilizing 18V Passive PoE with two socketed RJ45 connectors, the Radio Power Module passes signal between the radio and roboRIO while providing power directly to the radio. Connect an ethernet cable into each end of the Radio Power Module, connect the NI roboRIO port to the roboRIO, then connected the WiFi Radio Power port to the radio. Once the Radio Power Module is connected, add power through the low-current channel on the Power Distribution Hub utilizing the WAGO 250 series push button connectors.



⚠ Make sure to double check the Ethernet cables are plugged into the correct port and device when using the Radio Power Module. Connecting the roboRIO to the WiFi Radio Ethernet port can cause permanent damage to the roboRIO.

Mini Power Module

Mini Power Module Overview

Mini Power Module Resources

General Resources

- Mini Power Module Status LED Patterns
- Mini Power Module Specifications

The REV Mini Power Module (MPM) (REV-11-1956) is a compact power distribution module that allows you to securely and quickly power peripheral devices to your robot. Need more low-current channels on your PDH? Wire the MPM to one of the high-current channels on the PDH to power more peripheral devices and custom circuits.

Mini Power Module

Features

- 6 Output Channels
  - ATM Fuse Protection
- Channel Status LEDs
  - Channel status LEDs for Fuse-Tripped/No Fuse Feedback
  - Power On Status LED

Mini Power Module Specifications

The following tables provide the operating and mechanical specifications for the Mini Power Module (MPM).

> ⚠ DO NOT exceed the maximum electrical specifications. Doing so will cause permanent damage to the Mini Power Module and will void the warranty.

Main Electrical Specifications

Parameter	Min	Typ	Max	Unit
Operating Voltage Range	3	12	18	V
Supported Wire Gauge (Bare Solid/Stranded)	24	-	8	AWG
Bare Wire Strip Length	0.43	0.5	0.51	in
Supported Wire Gauge (Stranded, with ferrule)	24	-	10	AWG

> ⓘ The Status LEDs will lose intensity as the input voltage approaches the minimum operating voltage.

Output Channel Specifications

Parameter	Min	Typ	Max	Unit
Operating Voltage Range	5	-	15	V
Total Combined Channel Current Rating	-	-	40	A
Latching WAGO Connectors †				
Supported Wire Gauge (Bare Solid/Stranded)	26	-	16	AWG
Bare Wire Strip Length	0.31	0.33	0.35	in
Supported Wire Gauge (Stranded, with ferrule)	24	-	18	AWG
Push Button WAGO Connectors †				
Supported Wire Gauge (Bare Solid/Stranded)	24	-	16	AWG
Bare Wire Strip Length	0.33	0.35	0.37	in
Supported Wire Gauge (Stranded, with ferrule)	24	-	18	AWG

†	As of 01/04/2024, orders made from REV Robot will ship with the version of the Mini Power Modu that features Latching WAGO Connectors for eve connection.

Mini Power Module Status LED Patterns

Input Status LED

LED Status	LED Description	When	Component Status
	LED off	Anytime	Power Off
	Green Solid	Anytime	Power On

Output Status LED

LED Status	LED Description	When	Component Status
	LED off	Anytime	Fuse is in place or the is no load on this term
	Red Solid	Anytime	Fuse is missing or trip (when a load is preser on the output channel)

Software Resources

REVLib

Below you will find information on how to download and install REVLib for LabVIEW, Java, and C++.

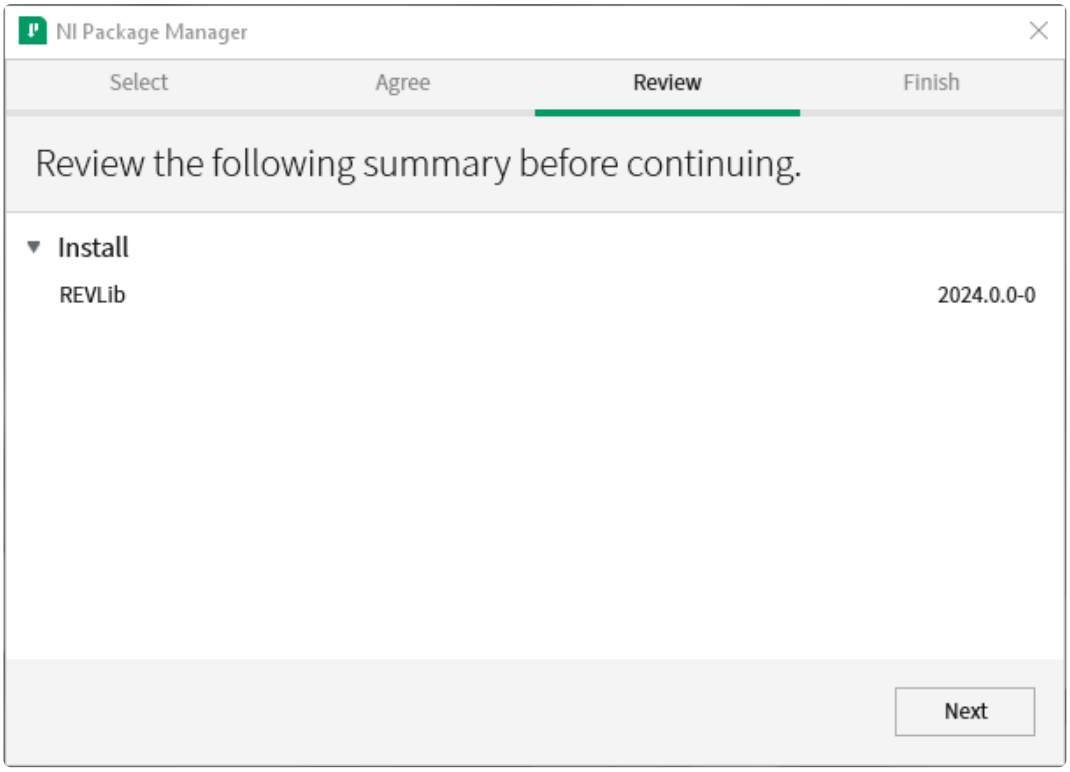
Language	Current REVLib Version	Documentation
LabVIEW	2024.2.0	Embedded (Press Ctrl-H)
Java	2024.2.0	Java Docs
C++	2024.2.0	C++ Docs

Download and Installation Instructions

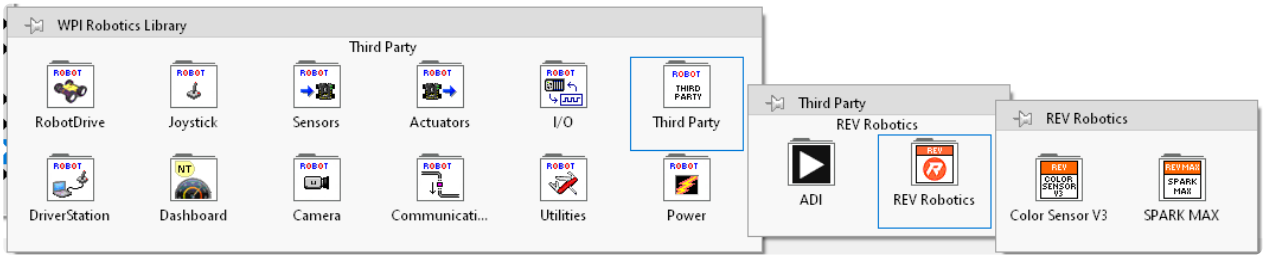
LabVIEW Installation

REVLib LabVIEW Download - Version 2024.2.0

1. Download the latest REVLib LabVIEW package from the download link above.
2. Make sure LabVIEW for FRC 2024 is installed and updated.
3. Open the REVLib LabVIEW Package. The NI Package Manager should automatically open.
4. Click **Next**:



5. Once the installation is complete, you will be able to access the REVLib VIs at **LabVIEW Functions Pallet -> WPI Robotics Library -> Third Party -> REV Robotics**.



C++ and Java Installation

REVLib C++/Java Download- Version 2024.2.0

Online Installation

You can use the online method to install REVLib C++/Java if your development machine is connected to the internet:

1. Open your robot project in VSCode.
2. Click on the WPI icon in the corner to open the WPI Command Pallet.
3. Select **Manage Vendor Libraries**.
4. Select **Install new library (online)**.
5. Enter the following installation URL and press ENTER:
   `https://software-metadata.revrobotics.com/REVLib-2024.json`

Offline Installation

1. Download and unzip the latest REVLib into the *C:\Users\Public\wpilib\2024* directory on Windows and *~/wpilib/2024* directory on Unix-like systems.
2. Follow the WPILib instructions for Adding Offline Libraries.

Java API Documentation

For a list and description of all classes:

- Online REVLib Java Documentation

C++ API Documentation

For a list and description of all classes:

- Online REVLib C++ Documentation

REVLib Changelog

Version 2024.2.0

Official 2024 FRC kickoff release for REVLib, with full support for SPARK Flex. Requires WPILib 2024 and SPARK Flex/SPARK MAX firmware 24.x.x.

Changes to C++, Java, and LabVIEW

- Throws an error if firmware version is less than 24.0.0
- Throws an error if the motor type is set to Brushed on a SPARK Flex while a SPARK Flex Dock is not connected
- Gets main encoder position with enhanced precision

Changes to C++ and Java

- Sends a warning to the Driver Station if the wrong class is used for the type of SPARK that is connected
- Adds `CanSparkBase` class that exposes functionality that is common to both the SPARK MAX and the SPARK Flex
- Adds `CanSparkFlex` class that exposes all functionality of the SPARK Flex
  - `CanSparkFlex` has a `getExternalEncoder()` method that returns a `SparkFlexExternalEncoder` instead of a `getAlternateEncoder()` method that returns a `SparkMaxAlternateEncoder`.
  - This is because Alternate Encoder Mode is not necessary for SPARK Flex, and has been replaced by the External Encoder Data Port feature:
    - Can be used simultaneously with the internal encoders in NEO class motors
    - Can be used simultaneously with an absolute encoder and limit switches
    - Virtually no RPM limit
    - No special configuration
- The following items have been deprecated in favor of new equivalents:
  - Instead of `CANSparkMaxLowLevel`, use `CANSparkLowLevel`
  - Instead of `SparkMaxAbsoluteEncoder`, use `SparkAbsoluteEncoder`
  - Instead of `SparkMaxAnalogSensor`, use `SparkAnalogSensor`
  - Instead of `SparkMaxLimitSwitch`, use `SparkLimitSwitch`
  - Instead of `SparkMaxPIDController`, use `SparkPIDController`
  - Instead of `SparkMaxRelativeEncoder`, use `SparkRelativeEncoder`
  - Instead of `ExternalFollower.kFollowerSparkMax`, use `ExternalFollower.kFollowerSpark`
    - The `ExternalFollower` enum can be accessed at `CANSparkMax.ExternalFollower`, `CANSparkFlex.ExternalFollower`, or `CANSparkBase.ExternalFollower`
- Adds a `CANSparkBase.getSparkModel()` method that returns a `SparkModel` enum

Changes to LabVIEW

- Deprecates old VIs that are prefixed with "Spark MAX" and replaces them with VIs prefixed with "SPARK"
  - Deprecated icons are "grayed out"
  - Help context (documentation) for deprecated VIs point the user to the equivalent new VI
  - New icons say "SPARK" instead of "REV MAX"
- Adds `SPARK Get Model.vi`
- Fixes `SPARK Get Analog Sensor Voltage.vi` when used with a SPARK Flex
- Updates `SPARK Get I Accum.vi` to get I Accum from status 7 instead of status 2
- Updates "Alternate Encoder" VIs to be "Alternate or External Encoder"
  - Only throw the data port config warnings when the device is a SPARK MAX

Version 2023.1.3

This version of REVLib requires SPARK MAX Firmware v1.6.3. Please update your SPARK MAX through the REV Hardware Client.

- Improves documentation for the setZeroOffset() and getZeroOffset() methods on Absolute Encoder objects
- Fixes issue where reading an absolute encoder’s zero offset could return an incorrect value in certain conditions

Version 2023.1.2

This version of REVLib requires SPARK MAX Firmware v1.6.2. Please update your SPARK MAX through the REV Hardware Client.

- Adds support to configure the hall sensor's velocity measurement
  - C++/Java: Updates `SetMeasurementPeriod()` and `SetAverageDepth()` in the `SparkMaxRelativeEncoder` class to be used when the relative encoder is configured to be of type `kHallSensor`.
  - LabVIEW: Adds `SPARK MAX Configure Hall Sensor.vi` and `SPARK MAX Get Hall Sensor Config.vi` to set and get the hall sensor's measurement period and average depth.

Version 2023.1.1

- Adds support for WPILib 2023
- Adds support for using a duty cycle absolute encoder as a feedback device for the SPARK MAX
  - C++/Java: Adds SparkMaxAbsoluteEncoder class
  - LabVIEW: Adds VIs for configuring and getting the values from a duty cycle absolute encoder
- Adds Position PID Wrapping to allow continuous input for the SPARK MAX PID controller
  - C++/Java: Adds PositionPIDWrapping methods to the SparkMaxPIDController class
  - LabVIEW: Adds VIs for setting and getting the Position PID Wrapping configuration
- Allows configuring the periodic frame rates for status frames 4-6

Version 2022.1.2

Breaking Changes

- LabVIEW: The version of NI Package Manager bundled with the FRC LabVIEW offline installer will no longer work when installing the REVLib package. NIPM must be updated to the latest version or installed from the FRC LabVIEW online installer to be able to install this package of REVLib for LabVIEW

Version 2022.0.0

Breaking changes

- C++/Java: `CANError` has been renamed to `REVLibError`.
- Java: `ColorMatch.makeColor()` and the `ColorShim` class have been removed. Use the WPILib `Color` class instead.
- C++/Java: Deleted deprecated constructors, methods, and types
  - Replace deprecated constructors with `CANSparkMax.getX()` functions.
  - Replace `CANEncoder.getCPR()` with `getCountsPerRevolution()`.
  - Remove all usages of `CANDigitalInput.LimitSwitch`.
  - Replace `CANSparkMax.getAlternateEncoder()` with `CANSparkMax.getAlternateEncoder(int countsPerRev)`.
  - Remove all usages of `CANSparkMax.setMotorType()`. You can only set the motor type in the constructor now.
  - Replace `SparkMax` with `PWMSparkMax`, which is built into WPILib.
- Java: `CANSparkMax.get()` now returns the velocity setpoint set by `set(double speed)` rather than the actual velocity, in accordance with the WPILib `MotorController` API contract.
- C++/Java: `CANPIDController.getSmartMotionAccelStrategy()` now returns `SparkMaxPIDController.AccelStrategy`.
- C++/Java: Trying to do the following things will now throw an exception:
  - Creating a `CANSparkMax` object for a device that already has one
  - Specifying an incorrect `countsPerRev` value for a NEO hall sensor
  - Java: Calling a `CANSparkMax.getX()` method using different settings than were used previously in the program
  - Java: Trying to use a `CANSparkMax` (or another object retrieved from it) after `close()` has been called
  - C++: Calling a `CANSparkMax.getX()` method more than once for a single device
- C++/Java: Deprecated classes in favor of renamed versions
  - C++ users will get `cannot declare field to be of abstract type` errors until they replace their object declarations with ones for the new classes. Java users will be able to continue to use the old classes through the 2022 season.
  - `AlternateEncoderType` is replaced by `SparkMaxAlternateEncoder.Type`.
  - `CANAnalog` is replaced by `SparkMaxAnalogSensor`.
  - `CANDigitalInput` is replaced by `SparkMaxLimitSwitch`.
  - Java: `CANEncoder` is replaced by `RelativeEncoder`.
  - C++: `CANEncoder is replaced by` SparkMaxRelativeEncoder `and` SparkMaxAlternateEncoder`.
  - `CANPIDController` is replaced by `SparkMaxPIDController`.
  - `CANSensor` is replaced by `MotorFeedbackSensor`.
  - `ControlType` is replaced by `CANSparkMax.ControlType`.
  -

- `EncoderType` is replaced by `SparkMaxRelativeEncoder.Type`.

Enhancements:

- C++/Java: Added the ability to set the rate of periodic frame 3

Fixes:

- C++/Java: `CANSparkMax.getMotorType()` no longer uses the Get Parameter API, which means that it is safe to call frequently
- Java: The `CANSparkMax.getX()` methods no longer create a new object on every call

Known issues:

- `SparkMaxPIDController.setIAccum()` only works while the control mode is active

Power Distribution Hub Firmware Changelog

Version 22.0.3

- Fixes issue where PDH will sometimes fail to update downstream devices via CAN

Version 22.0.2

- Improves accuracy of battery voltage reading
- Improves hardware fault reporting
- Improves switchable channel LED behavior
- Blinks the status LED blue when sticky faults are successfully cleared via the MODE button
- Fixes issue where the device would hang after receiving a malformed CAN frame

Version 22.0.1

- Fixes certain faults that were incorrectly triggered when the device was only powered via USB

Version 21.1.7

- Persists sticky faults across power cycles
- Allows sticky faults to be cleared by holding down the device's button
- Updates LED patterns
- Turns off the switchable channel LED when the switchable channel is turned off
- Reports to the REV Hardware Client whether a roboRIO is connected via the CAN network

Pneumatic Hub Firmware Changelog

Version 23.0.1

- Fixes issue where compressor channel does not turn on after updating to v23.0.0 without explicitly setting a compressor mode

Version 23.0.0

> ⓘ Upgrading from `v22.x.x` to this version will clear sticky faults and compressor settings.

- Improves device brownout detection
- Improves CAN fault detection
- Improves robustness against soft-bricking

Version 22.0.5

- Reduces stutters in compressor and solenoids with high CAN utilization

Version 22.0.4

- Allows compressor test mode for the pressure relief valve without having to send a solenoid command first

Version 22.0.3

- Disallows actuation from REV Hardware Client if roboRIO was previously connected
- Improves over current protection for larger compressors

Version 22.0.2

- Improves accuracy of various readings:
  - Analog sensor voltage
  - Battery voltage
  - Compressor current
- Improves performance for larger compressors
- Improves hardware fault reporting

- Adds compressor test mode for the pressure relief valve which is activated via holding the MODE button for 7 seconds
- Blinks the status LED blue when sticky faults are successfully cleared via the MODE button
- Blinks the status LED orange and green when the compressor is over current
- Fixes issue where the device would hang after receiving a malformed CAN frame

Version 22.0.1

- Fixes certain faults that were incorrectly triggered when the device was only powered via USB

Version 21.1.7

- Persists sticky faults across power cycles
- Allows sticky faults to be cleared by holding down the device's button
- Updates LED patterns
- Improves accuracy when using the analog sensor to control the compressor