Operation P.E.A.C.C.E. Robotics
2025 Electrical Documentation

REEFSCAPE

PRESENTED BY HAAS Gene Haas Foundation

OPERATION PEACCE 3461

4-H FIRST ROBOTICS TEAM 3461

www.peacce.org

Table of Contents

Vocabulary

1. "CAN (Control Area Network) Bus"

The CAN Bus is both an abbreviation for Control Area Network, as well as a communication protocol that allows for the RoboRio to communicate with the microcontrollers and sensors, such as the Falcon 500's internal motor controller (TalonFX), the Spark MAX that controls the Neo 550 motors and the CANCoder absolute encoder. It can be easily identified by the twisted Yellow and Green colored wires.

2. "Mini Power Module (MPM)"

Abbreviation for the REV Mini Power Module. This component, which is a part of the Control System, is responsible for the distribution of low voltage power. This power is supplied by one 12v channel of the Power Distribution Hub and is split between the 6 channels on the MPM. Fuses that, when combined, do not exceed the value of the breaker on the PDH channel, as well as regulate the power on the MPM channels. The fuses are non-resettable*

*resettable breakers do exist but are not commonly used along with the MPM

3. "Power Distribution Hub (PDH)"

PDH is an abbreviation for the REV Power Distribution Hub. The PDH is a component of the Control System, which is responsible for distributing power to the other control system devices. Please see Appendix A.

4. "Pneumatics Hub (PH)"

PH is an abbreviation for the REV Pneumatics Hub. A component; which is a part of the Control System. The PH, is also responsible for sending control signals to the different pneumatic control devices, such as the solenoids.

5. "Power Over Ethernet (PoE)"

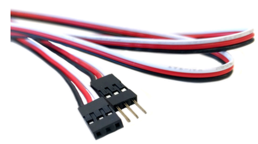
An abbreviation for Power Over Ethernet. A protocol for delivering low voltage power to a device by using an ethernet cable. This power distribution is achieved by using a PoE Harness, which is also known as a PoE Injector.

PoE Harness or PoE Injector

A PoE harness or injector is an electrical device that supplies low voltage power to the connected ethernet cable. The PoE harnesses and injectors **ARE POLARIZED**. Inserting the energized side of a PoE harness into a device that does not support PoE can cause damage to the said device.

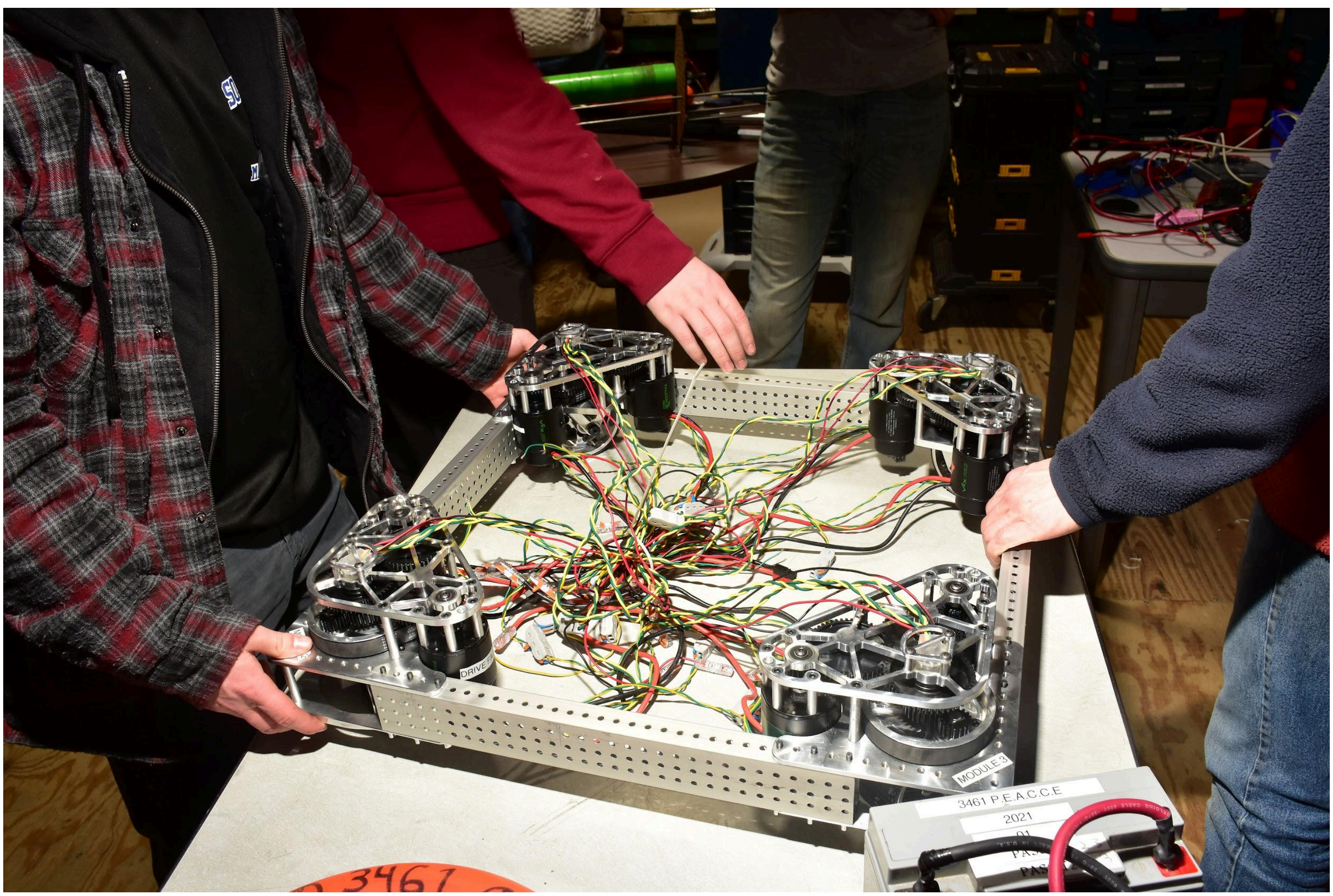
6. “Pulse Width Modulation (PWM)”

PWM is an abbreviation for Pulse Width Modulation. PWM functions as a communication protocol that operates using Pulse Width Modulation as its signal method, using this signal, the RoboRio can communicate with microcontrollers and sensors such as; the Dual Channel Encoder. The PWM can be identified easily by its three joined wires that are colored and they are in the order of White, Red, and then finally, Black.



7. “Voltage Regulator Module (VRM)”

VRM is an abbreviation for the CTRE Voltage Regulator Module. The VRM is a component of the Control System that is responsible for delivering clean as well as stable power to low voltage components.The VRM stabilizes and regulates the power for the robot’s components that are sensitive.



Reefscape Electrical Rules

FIRST Electrical rules for 2025 can be found in Section 8.6 Power Distribution of the FIRST Reefscape game manual. The most important rules are listed below for quick reference.

R505 *Don't overload controllers.

Each power regulating device may control electrical loads per Table 8-2. Unless otherwise noted, each power regulating device shall control 1 and only 1 electrical load.

Table 8-2 Power regulating device allotments

Abbreviated for brevity to show information relevant to our robot only

Electrical Load	Motor Controller	Relay Module	Pneumatics Controller
Electric Solenoids	**Yes (multiple)**	**Yes (multiple)**	**Yes (1 per channel)**

R610 *1 breaker per circuit.

All circuits, with the exceptions of those listed in R615 and R617, must connect to, and have power sourced solely by, a single protected 12VDC WAGO connector pair (i.e. the load terminals, as shown in Figure 8-9) of the PDP/PDP2.0/PDH, not the M6 cap screws.

R611 *The ROBOT frame is not a wire.

All wiring and electrical devices shall be electrically isolated from the ROBOT frame. The ROBOT frame must not be used to carry electrical current.

Compliance with this rule is checked by observing a >120Ω resistance between either the (+) or (-) post within the APP connector that is attached to the PDP/PDH and any point on the ROBOT. All legal motor controllers with metal cases are electrically isolated. They may be mounted directly to ROBOT frame COMPONENTS. Note that some cameras, decorative lights, and sensors (e.g. some encoders, some IR sensors, etc.) have grounded enclosures or are manufactured with conductive plastics. These devices must be electrically isolated from the ROBOT frame to ensure compliance with this rule.

R612 *Must be able to turn ROBOT on and off safely.

The 120A circuit breaker must be quickly and safely accessible from the exterior of the ROBOT. This is the only 120A circuit breaker allowed on the ROBOT.

> Examples considered not "quickly and safely accessible" include breakers covered by an access panel or door, or mounted on, underneath or immediately adjacent to moving COMPONENTS.
> It is strongly recommended that the 120A circuit breaker location be clearly and obviously labeled so it can be easily found by FIELD STAFF if needed.
> While the main breaker must be accessible, consider positioning or shielding it such that it's protected from accidental actuation (e.g. it's unlikely to be hit by a SCORING ELEMENT during game play).

R613 *Electrical system must be inspectable.

The PDP/PDP2.0/PDH, associated wiring, and all circuit breakers must be visible for inspection.

> "Visible for inspection" does not require that the items be visible when the ROBOT is in STARTING CONFIGURATION, provided the team can make the items viewable during the inspection process.

R614 *No high voltage allowed.

Any active electrical item that is not an actuator (specified in R501) or core control system item (specified in R710) is considered a CUSTOM CIRCUIT. CUSTOM CIRCUITS shall not produce measurable voltages exceeding 24V with the exception of COTS Power-over-Ethernet (PoE) injector devices used with COTS Ethernet cables and COTS receiving devices (i.e. not a breakout or adapter).

R618 *Use PDP/PDH terminals as designed.

Only 1 wire shall be connected to each terminal on the PDP/PDH.

> If multipoint distribution of circuit power is needed (e.g. to provide power to multiple PCMs and/or VRMs from 1 20A circuit), then all incoming wires may be appropriately spliced into the main lead (e.g. using an insulated terminal block, crimped splice or soldered wire splice), and the single main lead inserted into the terminal to power the circuit.

R619 *Only use specified circuit breakers in PDP/PDH.

The only circuit breakers permitted for use in the PDP/PDH are:

A. Snap Action VB3-A Series or AT2-A, terminal style F57, 40A rating or lower,
B. Snap Action MX5-A or MX5-L Series, 40A rating or lower, and
C. REV Robotics ATO auto-resetting breakers 40A rating or lower.

R620 *Only use specified fuses in PDP/PDH.

The only fuses permitted for use in the PDP/PDH are mini automotive blade fuses (ATM style) with the following values:
A. for the PDP, values matching the value printed on the device's corresponding fuse holder and
B. for the PDH, 15A or lower with the exception of a single 20A fuse for powering a PCM or PH.

> Note that these fuses must be pressed very firmly to seat properly. Improper seating can cause a device to reboot upon impact.

R621 *Protect circuits with appropriate circuit breakers.

Each branch circuit must be protected by 1 and only 1 circuit breaker or fuse on the PDP/PDH per Table 9-3. No other electrical load can be connected to the breaker or fuse supplying this circuit.

Table 9-3 Branch circuit protection requirements

Branch Circuit	Circuit Breaker Value	Quantity Allowed Per Breaker
Motor Controller	Up to 40A	1
Custom Circuit	Up to 40A	No Limit
Automation Direct Relay 40A (*6m40*)	Up to 40A	1
Fans permitted per R501 and not already part of COTS computing devices	Up to 20A	No Limit
Spike Relay Module	Up to 20A	1
Automation Direct Relay 25A (*6M25*)	Up to 20A	1
PCM/PH - with compressor	Up to 20A	1
Additional VRM (non-radio)/Additional PCM/PH (non-compressor)	Up to 20A	3 total
Automation Direct Relay 12A (*6M12*)	Up to 10A	1

> This rule does not prohibit the use of smaller value breakers in the PDP/PDH or any fuses or breakers within CUSTOM CIRCUITS for additional protection

R622 *Use appropriately sized wire.

All circuits shall be wired with appropriately sized insulated copper wire (SIGNAL LEVEL cables don't have to be copper):

Table 9-4 Breaker and wire sizing

Application	Minimum Wire Size
31 – 40A breaker protected circuit	12 AWG (13 SWG or 4 mm^2)
21 – 30A breaker protected circuit	14 AWG (16 SWG or 2.5 mm^2)
6 – 20A breaker protected circuit	18 AWG (19 SWG or 1 mm^2)
11 – 20A fuse protected circuit	
Between the PDP dedicated terminals and the VRM/RPM or PCM/PH	
Compressor outputs from the PCM/PH	
Between the PDH and PCM/PH	
Between the PDP/PDH and the roboRIO	22 AWG (22 SWG or 0.5 mm^2)
Between the PDH and VRM/RPM	
≤5A breaker protected circuit	
≤10A fuse protected circuit	
VRM 2A circuits	24 AWG (24 SWG or .25 mm^2)
roboRIO PWM port outputs	26 AWG (27 SWG or 0.14 mm^2)
SIGNAL LEVEL circuits (i.e. circuits which draw ≤1A continuous and have a source incapable of delivering >1A, including but not limited to roboRIO non-PWM outputs, CAN signals, PCM/PH Solenoid outputs, VRM 500mA outputs, RPM outputs, and Arduino outputs)	28 AWG (29 SWG or .08 mm^2)

Wires that are recommended by the device manufacturer or originally attached to legal devices are considered part of the device and by default legal. Such wires are exempt from this rule.

In order to show compliance with these rules, teams should use wire with clearly labeled sizes if possible. If unlabeled wiring is used, teams should be prepared to demonstrate that the wire used meets the requirements of this rule (e.g. wire samples and evidence that they are the required size).

R623 *Use only appropriate connectors.

Branch circuits may include intermediate elements such as COTS connectors, splices, COTS flexible/rolling/sliding contacts, and COTS slip rings, as long as the entire electrical pathway is via appropriately gauged/rated elements.

> Slip rings containing mercury are prohibited per R203.

R624 *Use specified wire colors (mostly).

All non-SIGNAL LEVEL wiring with a constant polarity (i.e., except for outputs of relay modules, motor controllers, or sensors) shall be color-coded along their entire length from the manufacturer as follows:

A. red, yellow, white, brown, or black-with-stripe on the positive (e.g. +24VDC, +12VDC, +5VDC, etc.) connections

B. black or blue for the common or negative side (-) of the connections

Exceptions to this rule include:

C. wires that are originally attached to legal devices and any extensions to these wires using the same color as the manufacturer

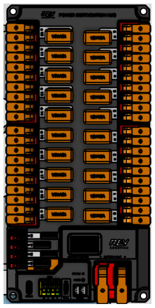
D. Ethernet cable used in PoE cables

Control System Hardware

New in 2025

The components that are being used for the first time this year by Team 3461 include; the Kraken X60, Spark FLEX, as well as, the Neo Vortex. Components that are being added to this documentation that were absent in 2024 include; the CTRE Talon SRX and the CTRE Victor SPX. Pneumatic controls were not implemented in 2024 or 2025 and have been omitted for brevity.

Power Distribution



All components on the robot receive their power from the Power Distribution Hub (PDH), or downstream from the PDH through an intermediate device. Such as a CTRE Voltage Regulator Module, a REV Mini Power Module, a Motor Controller, a Pneumatic Control Device, or another intermediate control device. The Robot's main 12v power supply comes from the battery through the main 12v120a circuit breaker into the PDH. In 2024, FRC Electrical Rules permitted extraneous power sources for sensor devices. (See 2024/25 R602 for more information.) Team 3461 does not currently use such devices, so the details of the R602 were not included within this year's documentation.

Sensors and Vision

Sensors are devices that monitor a real world element, such as rotation of a shaft or position of an element. These devices include the CTRE CANCoder, Vision devices are cameras that track a particular real world object using software processing. These devices include the OrangePI coprocessor and the Limelight camera (with included processor).

Pneumatics

Pneumatics are not implemented by Team 3461 in 2025.

Motors and Motor Controllers

Motors are not the kind of electrical components that you can simply plug in; a motor will spin as quickly as the electrical input that it is supplied with. Reversing the polarity (red to red, black to black, or red to black, and black to red) will change the direction that the motor will spin. In order to control the motor an intermediate control component must be placed in between the voltage input, as well as the motor itself. The name of this intermediate device is called a motor controller.

The motor controller will change the voltage as well as the polarity that is delivered to the motor, allowing for fine control. Some motors have motor controllers built into their housing. In those cases the motor must be connected to power in the correct polarity only, and the controller must be connected to the appropriate control bus (CAN and/or PWM). Team 3461 currently employs motors, and motor controllers from two different "ecosystems"; specifically, Cross the Road Electronics (CTRE) as well as REV Robotics. The various motors and controllers are documented by the "ecosystem" below.

Cross the Road Electronics

The below devices belong to the CTRE “ecosystem”; they are controlled by, or hosted onboard a CTRE Motor Controller.

VEX Robotics Falcon 500 with integrated CTRE Talon FX

A Falcon 500 is a brushless motor with an integrated motor controller (CTRE Talon FX). It has a red colored VDC (voltage in) and a black GND (common, “negative” or “ground”) lead. The motor controller is integrated, because of this, one is unable to reverse the polarity of the motor, or else, the said motor will short out and break. The integrated motor controller connects to the CAN bus for signal.

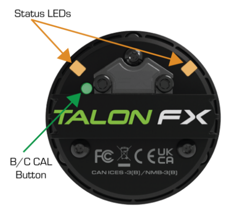
Falcon 500 Troubleshooting

General Troubleshooting

- Check the power connection
- Check the status LEDs
- Verify that the motor can spin freely and that no stall horn is heard
- Check the CAN Bus connection
- Power cycle the Falcon

Falcon 500 Integrated Talon FX Standard Operation Blink Codes

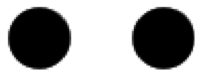
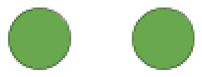
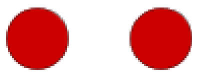
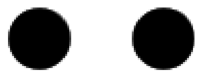
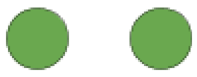
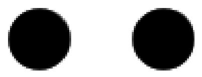
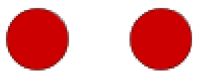
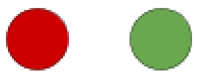
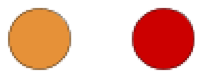
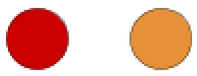
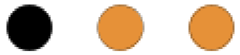
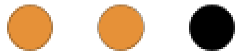
The blink code table below assumes a Falcon 500 integrated TalonFX. The blink codes for the integrated TalonFX onboard the Kraken X60 might differ from the table below. For a complete table please reference page 43 of Appendix E. The table references the left LED as the one observed on the left when the Talon FX logo is facing upright, as seen in the image depicted.



Blink Code	Left LED State	Right LED State	Description
Alternating Off/Orange	🟠 ⚫	⚫ 🟠	Talon FX is disabled. Robot controller is missing on the bus or the diagnostic server is not installed.
Simultaneous Off/Orange	🟠 ⚫	🟠 ⚫	Talon FX is disabled. Phoenix is running in Robot Controller
Simultaneous Green Flash	🟢 ⚫	🟢 ⚫	Forward throttle is applied. Blink rate is proportional to Duty Cycle
Simultaneous Red Flash	🔴 ⚫	🔴 ⚫	Reverse throttle is applied. Blink rate is proportional to Duty Cycle
Off/Slow Red	🔴 ⚫	⚫ 🔴	CAN/PWM is not detected
Off/Red (Left to Right Red Scroll)	🔴 🔴 ⚫	⚫ 🔴 🔴	Forward Limit Switch or Reverse Soft Limit
Off/Red (Right to Left Red Scroll)	⚫ 🔴 🔴	🔴 🔴 ⚫	Reverse Limit Switch or Reverse Soft Limit

Falcon 500 Integrated Talon FX Fault Blink Codes

The following blink codes occur when the Falcon 500 is in a faulted state. If these occur, please see the troubleshooting section and Appendix E.

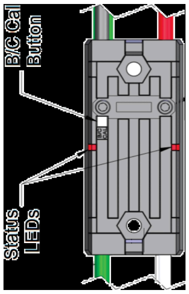
Blink Code	Left LED State	Right LED State	Description
Green/Orange			Device in Bootloader
Green/Red			Calibration Mode
Green Flash			Successful Calibration
Red Flash			Failed Calibration
Green Red flip-flop			Device has Phoenix Pro firmware and is unlicensed. Either connect this device to a Phoenix Pro licensed CANivore, apply a Phoenix Pro device license, or change firmware to use Phoenix v5.
Red Orange flip-flop			Damaged Hardware
Off/Orange			Thermal Fault / Shutoff

Falcon 500 Complete Documentation

The Falcon 500 User manual is available as an appendix to this document, Please see Appendix E. The QR code will serve as a link to the online version of the specified document.

CTRE Talon SRX

The CTRE Talon SRX is a discrete motor controller and a predecessor to the CTRE Talon FX. This motor controller drives a discrete motor that has no integrated controller. It is controlled by CAN Bus and supports a breakout board for limit switches (Forward and Reverse).



CTRE Talon SRX Blink Codes - Normal Operation

Excerpted from Appendix F on page 32

Blink Code	Left LED State	Right LED State	Description
Alternate[1] Off/Orange	🟠 ⚫	⚫ 🟠	CAN bus detected, robot disabled
Alternate[1] Red/Off	🔴 ⚫	⚫ 🔴	CAN bus/PWM is not detected
Solid Orange	🟠 🟠	🟠 🟠	Neutral throttle is applied. Throttle is zero or is within dead band.
Simultaneous Green Flash	🟢 ⚫	🟢 ⚫	Forward throttle is applied. Blink rate is proportional to Duty Cycle
Simultaneous Red Flash	🔴 ⚫	🔴 ⚫	Reverse throttle is applied. Blink rate is proportional to Duty Cycle
LEDs Strobe “towards” (M+)[2]	⚫ 🔴	🔴 ⚫	Forward Limit Switch or Forward Soft Limit
LEDs Strobe “towards” (M-)[2]	🔴 ⚫	⚫ 🔴	Reverse Limit Switch or Reverse Soft Limit
LED 1 Only “closest” to M+/V+	🟢 🟠	⚫ ⚫	In Boot-loader
Alternate[1] Red/Orange	🔴 🟠	🟠 🔴	Damaged Hardware

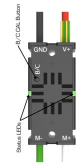
1: LEDs Alternate – Status LEDs are different colors at all times. The (2X) LEDs will swap colors when blinking.
2: (1X) Status LED will blink, followed shortly by the other with a long pause before repeating. The “direction” of the blink indicates the Talon SRX’s current state.

CTRE Talon SRX Blink Codes - Calibration

Blink Code	Left LED State	Right LED State	Description
Flashing Red/Green	🔴 🟢	🔴 🟢	Calibration Mode
Blinking Green	🟢 ⚫	🟢 ⚫	Successful Calibration
Blinking Red	🔴 ⚫	🔴 ⚫	Failed Calibration

CTRE Victor SPX

The CTRE Victor SPX is a discrete Motor Controller. It functions identically to the CTRE Talon SRX, although it has less features than the Talon SRX. The Blink Codes are identical to the Talon SRX. Please see Appendix G for complete information.



Rev Robotics

The below devices belong to the Rev Robotics “ecosystem”, they are controlled by, or hosted onboard, a Rev Robotics Motor Controller.

REV Robotics Neo 550

A Neo 550 is a brushless motor without an integrated motor controller. It has red, white, and black colored power connection leads. The motor is driven by a PWM and does not have an integrated motor controller, because of this, you must use a discrete motor controller; specifically a REV Spark MAX. The Spark MAX outputs power to the Neo 550 using the A (red), B (black), and C (white) leads. **Do not reverse the polarity of the motor, or it will damage the Neo 550!**

REV Spark MAX

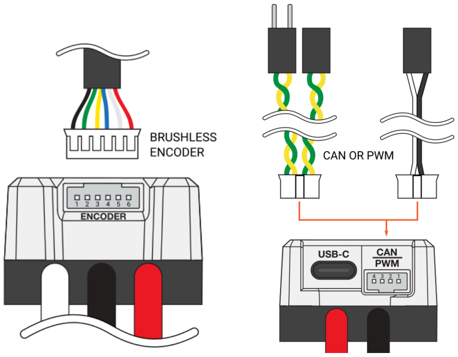
A Spark MAX is a motor controller; it has a Red VDC and a Black colored GND terminal on the input side. On the output side there are Red, White, and Black colored terminals. A Spark MAX can power both a standard brushed motor with the Red and Black colored output terminals, or, as in the team's primary use case; power a Neo 550 brushless motor using the Red, White, and Black colored output terminals. The Spark MAX accepts power with the use of the VDC (red) and GND (black) leads, and outputs power to the brushless motor using the A (red), B (black), and C (white) leads. **Do not reverse the polarity of the Spark Input or the Motor!** The Spark MAX connects to either the CAN bus or to a PWM port for control signaling.

Spark MAX Firmware Recovery Process

The Spark MAX is known to fail while updating its firmware over CAN Bus. If this happens there is a special recovery process that must be used in order to recover the device:

1. Disconnect the Spark MAX from all power sources including both robot 12v and USB
2. Close the REV Hardware Client
3. Hold down the Status Button for 3 seconds and continue holding
4. Connect to the Spark MAX via USB
5. Open the REV Hardware Client
6. Once the Spark MAX appears on the Device List, release the Status Button
7. Select the Spark MAX from the Device List
8. Run the Firmware Update again
9. The Spark MAX should now function properly

Spark MAX Troubleshooting



General Troubleshooting

- Check the CAN and Encoder Ports
- Power cycle the Spark MAX
- Connect to the Spark MAX over USB-C and check the status with the REV Hardware Client application
- Isolate issues
    - Remove motor from mechanism to allow free-spin
    - Control Spark MAX with USB-C (Remove CAN and power-cycle prior to attempting this)

Advanced Troubleshooting

- Verify brake mode is enabled/disabled according to circumstances
- Verify Brushed/Brushless mode is correct according to circumstances
- Reflash current firmware version
- Update firmware to newer version

Spark Max Blink Codes

The blink code table below assumes a brushless motor is in use; brushed motors have alternate blink codes. For a complete blink code table please see Appendix D.

Spark MAX Standard Operation Blink Codes

LED State		Description
Slow Blink Cyan		Brake Mode - No Signal
Slow Blink Magenta		Coast Mode - No Signal
Solid Cyan		Brake Mode - Valid Signal
Solid Magenta		Coast Mode - Valid Signal
Blink Green		Partial Forward
Solid Green		Full Forward
Blink Red		Partial Reverse
Solid Red		Full Reverse
Alternating Green/White		Forward Limit
Alternating Red/White		Reverse Limit

Spark MAX Fault Blink Codes

LED State		Description
Slow Alternating Orange/Cyan		Gate Driver Fault - See Full Documentation (Scan QR Code)
Slow Blink Amber		Unrecoverable Error - See Spark MAX Firmware Recovery Process
Slow Alternating Orange/Magenta		Sensor Fault - See Full Documentation

Reference Control System Diagram

The following diagram illustrates how to properly wire a FRC robot, and can be found along with the WPILib control system documentation at docs.wpilib.org. Team 3461's robot was wired according to the following diagram and the 2025 game manual. Note: not all of the depicted components are employed on team 3461's 2025 Robot, because this diagram attempts to show every use case any team might have.

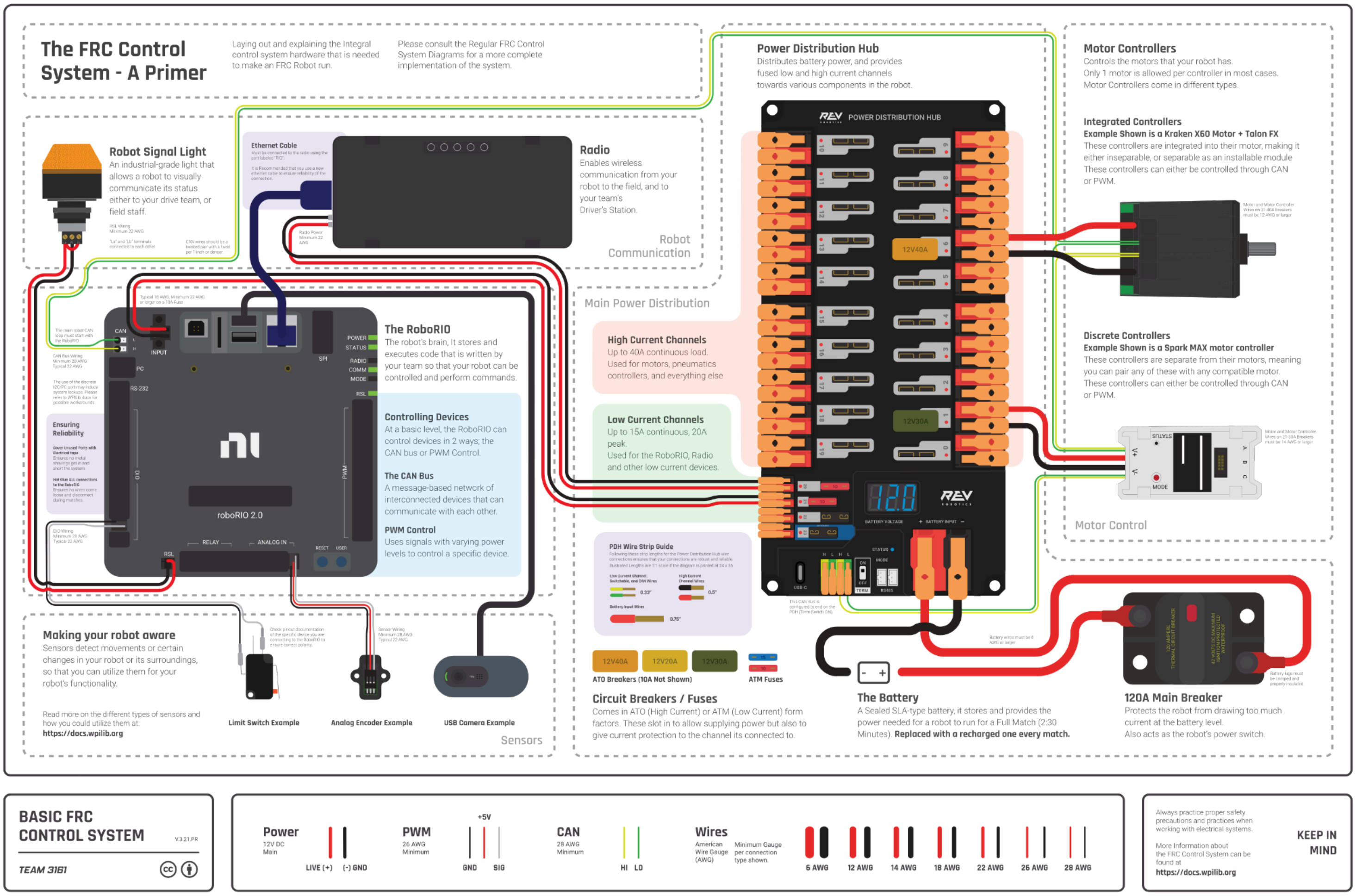


Diagram courtesy of FRC® Team 3161 and Stefen Acepcion.
Scan QR code to view online

Currently the Robot employs devices from the following categories of the diagram;

- Battery
- Discrete Motor Controllers
- Digital Input/Output
- Integrated Motor Controllers
- Pneumatics Systems
- Regulated Power
- Wireless Communication

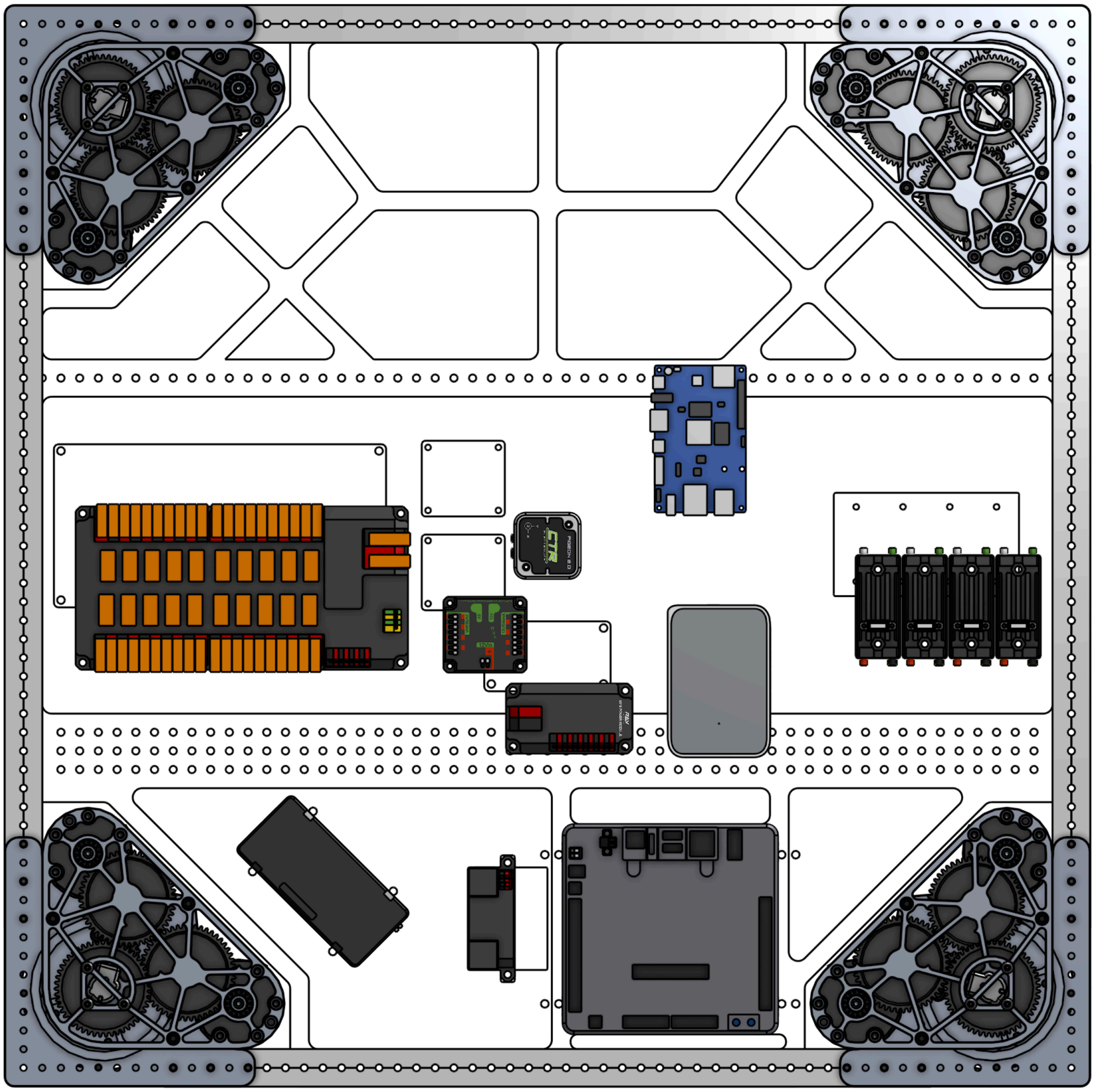
Control System

Electrical Panel(s)

This year, the robot has all of the core electronics mounted in the belly pan along with a few additional components that are mounted in auxiliary locations.

Belly Pan Electrical Panel

The robot, being built on a square frame, has no geometric “front” to reference. This documentation references the “front” as the prograde direction contrived by the software controls currently in use. Software defined prograde direction of travel references the direction the robot deposits the CORAL game piece from. Depicted below are the 4 Swerve Modules, the 4 Talon SRXs, the PDH, the Robot Rio, the Mini Power Module, the Voltage Regulator Module, the Pigeon IMU, the Network Switch, Radio Power Module, the Robot Radio and the Orange PI vision coprocessor (depicted without it’s protective case).



Power Distribution

The color of the cells in the Breaker/Fuse columns are the associated physical color of the breaker that is rated as described in each row.

REV Power Distribution Hub

PDH Terminal	Device	Breaker/ Fuse	Wire Gauge	Device Location
VDC	Main Breaker	12v120a	6 AWG	Driver Side behind Funnel
0	Swerve Module 0 Rotation Falcon 500	12v40a	12 AWG	Swerve Module 0 (Driver Side Forward Corner)
1	Swerve Module 0 Drive Falcon 500	12v40a	12 AWG	Swerve Module 0 (Driver Side Forward Corner)
2	Swerve Module 1 Rotation Falcon 500	12v40a	12 AWG	Swerve Module 1 (Passenger Side Forward Corner)
3	Swerve Module 1 Drive Falcon 500	12v40a	12 AWG	Swerve Module 1 (Passenger Side Forward Corner)
4	Swerve Module 2 Rotation Falcon 500	12v40a	12 AWG	Swerve Module 2 (Passenger Side Rear Corner)
5	Swerve Module 2 Drive Falcon 500	12v40a	12 AWG	Swerve Module 2 (Passenger Side Rear Corner)
6	Swerve Module 3 Rotation Falcon 500	12v40a	12 AWG	Swerve Module 3 (Driver Side Rear Corner)
7	Swerve Module 3 Drive Falcon 500	12v40a	12 AWG	Swerve Module 3 (Driver Side Rear Corner)
8	Funnel Talon SRX 0	12v20a	18 AWG	Driver Side of Funnel Mechanism
9	Funnel Talon SRX 1	12v20a	18 AWG	Passenger Side of Funnel Mechanism
10	Funnel Pull-Pin Talon SRX	12v20a	18 AWG	Rear of Robot on Funnel Supports
11	*Algae Talon SRX*	12v20a	18 AWG	*Not Implemented Yet*
12	*Algae Falcon 500*	12v40a	12 AWG	*Not Implemented Yet*
13	Lift Falcon 0	12v40a	12 AWG	Passenger Side Rear
14	Lift Falcon 1	12v40a	12 AWG	Driver Side Rear
15	CORAL Rotate Falcon	12v40a	12 AWG	Front of Lift on Rotator

PDH Terminal	Device	Breaker/ Fuse	Wire Gauge	Device Location
16	CORAL Place Falcon	12v40a	12 AWG	End Effector Mechanism
17	Climber Falcon 0	12v40a	12 AWG	In front of Battery to the Left
18	Climber Falcon 1	12v40a	12 AWG	In front of Battery to the Right
19	REV Mini Power Module	12v20a	18 AWG	Bellypan
20	RoboRio v2	12v10a	18 AWG	Center Back of Top Face of Electrical Panel
21	Radio Power Module	12v10a	18 AWG	Bellypan
22	Voltage Regulator Module	12v10a	18 AWG	Bellypan
23	*Not In Use*			

REV Mini Power Module

Terminal	Device	Fuse	Wire Gauge	Device Location
VDC	PDH Terminal #19	12v40a	18 AWG	Bellypan
0	OrangePI	12v20a	18 AWG	Bellypan
1	Limelight 0	12v20a	*18 AWG*	*Not Implemented*
2	Limelight 1	12v20a	*18 AWG*	*Not Implemented*
3	*Not In Use*			
4	*Not In Use*			
5	*Not In Use*			

The REV Mini Power Module is a CUSTOM CIRCUIT per R621 Table 8-3 and the R621 Blue Box

CTRE Voltage Regulator Module

Slot	Device	Wire Gauge	Physical Location
VDC	PDH Terminal #22	18 AWG	Bellypan
12v2a #1	Custom Circuit Breakout #1 (Swerve CANCoders)	18 AWG	Bellypan
12v2a #2	*Not In Use*		*Not In Use*
12v500mA #1	Custom Circuit Breakout #2	18 AWG	Belly Pan
12v500mA #2	Custom Circuit Breakout #3 (End Effector Break Beam Sensors)	22 AWG	Belly Pan
5v2a #1	Network Switch	22 AWG	Belly pan
5v2a #2	*Not In Use*		*Not In Use*
5v500mA #1	Custom Circuit Breakout #6 (Lift Limit Switches)	22 AWG	Base of Lift Mechanism
5v500mA #2	Custom Circuit Breakout #7 (End Effector Rotator Limit Switches)	22 AWG	End Effector Rotation Mechanism

Custom Circuit Breakout #1

Slot	Device	Wire Gauge	Physical Location
VDC	CTRE VRM 12v2A Terminal 1	18 AWG	Bellypan
0	Swerve Module 0 Cancoder	18 AWG	Swerve Module 0
1	Swerve Module 1 Cancoder	18 AWG	Swerve Module 1
2	Swerve Module 2 Cancoder	18 AWG	Swerve Module 2
3	Swerve Module 3 Cancoder	18 AWG	Swerve Module 3

Custom Circuit Breakout #2

Slot	Device	Wire Gauge	Physical Location
VDC	CTRE VRM 12v500mA Terminal 1	18 AWG	Bellypan
0	End Effector Rotation Cancoder	18 AWG	End Effector Rotation Mechanism
1	CTRE Pigeon IMU 2.0	18 AWG	Bellypan

Custom Circuit Breakout #3

Slot	Device	Wire Gauge	Physical Location
VDC	CTRE VRM 12v500mA Terminal 1	18 AWG	Bellypan
0	Banner Break Beam Front	18 AWG	Bellypan
1	Banner Break Beam Rear	18 AWG	Bellypan

Custom Circuit #4 and 5

Using the NPN output of the banner break beam sensor we connected a PWM end with a 100 ohm resistor between the hot and signal pin and connected the sensor signal to the signal pin as well creating a pull down signal configuration.

Custom Circuit #6

In order to use the REV magnetic limit switches with direct input into the falcon input we needed a 5V source to power the sensor. We then connected the signal pin to the falcon and the corresponding input and ground pins to the same ground as the sensor. This connection set is also connected to the second lift motor as a redundant input in case the signal is lost to the other motor input.

Custom Circuit #7

We wanted to use 3 pole limit switches on our end effector angle mechanism to provide travel limits and have that input directly fed into the falcon inputs. Unfortunately due to the way the falcons present their limit inputs there was no way to get both a HIGH and LOW signal to the input pin without providing a secondary power source. We ended up feeding a 5v source from the VRM that would connect to both possible states on the switch then connected the corresponding signal and ground pins from the falcon to the switch and power connections

Custom Circuit #8

We wanted a way to know when our lift mechanism is at its max possible height but due to the fact it goes up in 2 segments we would need to detect each stage reaching its extent. In order to do so we decided on placing 2 switches in series to pass along a true signal only when both are triggered at the same time. In order to do this we connected to the power supply from custom circuit 6 and fed both the high and low signals to the first switch then took the output of the first switch and put it into the NO pin on the second switch and tied the NC to the low pin from switch 1. The output of this switch could then be fed back into the 2 falcon's input pins

Sensor Information*

Device	Input Voltage	Protocol	Connection ID	Connection Termination	Subsystem	Physical Location
CANCoder 0	12v0.06A	CAN	3	CAN Bus	Drivetrain	Swerve Module 0
CANCoder 1	12v0.06A	CAN	6	CAN Bus	Drivetrain	Swerve Module 1
CANCoder 2	12v0.06A	CAN	9	CAN Bus	Drivetrain	Swerve Module 2
CANCoder 3	12v0.06A	CAN	12	CAN Bus	Drivetrain	Swerve Module 3
Limelight 0	12v5A	IP	10.34.61.11:5801	RJ45/Weid muller	Vision	*Not Implemented*
Limelight 0	12v5A	IP	10.34.61.12:5801	RJ45/Weid muller	Vision	*Not Implemented*
Photon Vision Orange Pi 5	5v5A	IP	10.34.61.10	RJ45/PWM	Vision	Bellypan Near Center

Device	Input Voltage	Protocol	Connection ID	Connection Termination	Subsystem	Physical Location
Photon Vision Arducam	5v	USB	#1	USB	Vision	Lift Outer Tower Drivers Side
Photon Vision Arducam	5v	USB	#2	USB	Vision	Lift Outer Tower Passengers Side
Pigeon IMU	12v	CAN	1	CAN Bus	Misc	Bellypan Near Center
CANCoder 4	12v0.06A	CAN	22	CAN Bus	End Effector Angle	End Effector Angle Shaft Drivers Side
Banner break beam	12v	DIO	N/A	PWM	Placer	Placing Mechanism Front
Banner break beam	12v	DIO	N/A	PWM	Placer	Placing Mechanism Rear
REV magnetic limit switch	5v	DIO	N/A	Wago	Lift	Lift Bottom Belly Pan Interface
Standard 3 pole limit switch	5v	DIO	N/A	Wago	Lift	Drivers Side Outer Tower Top
Standard 3 pole limit switch	5v	DIO	N/A	Wago	Lift	Drivers Side Inner Tower Bottom
Standard 3 pole limit switch	5v	DIO	N/A	Wago	End Effector Angle	Passenger Side Plate Top
Standard 3 pole limit switch	5v	DIO	N/A	Wago	End Effector Angle	Passenger Side Plate Bottom

*Does not contain built-in encoders within motors as those are handled internally by the Falcon's TalonFX Controller and the Spark MAX Controller requiring no wiring outside of the CAN Bus connection to the motor, which is documented in the "CAN Bus Connections" table.

CAN Bus Devices

CAN ID	Device	Device Description	Device Location
Bus Origin	RoboRio v2	RoboRio v2 Robot Controller	Bellypan
0	Power Distribution Hub	Power Distribution	Bellypan
1	Pigeon IMU	Odometry Device	Bellypan
2	Falcon 500	Swerve Module 0 Rotate	Swerve Module 0
3	CANCoder	Swerve Module 0 CANCoder	Swerve Module 0
4	Falcon 500	Swerve Module 0 Drive	Swerve Module 0
5	Falcon 500	Swerve Module 1 Rotate	Swerve Module 1
6	CANCoder	Swerve Module 1 CANCoder	Swerve Module 1
8	Falcon 500	Swerve Module 2 Rotate	Swerve Module 2
9	CANCoder	Swerve Module 2 CANCoder	Swerve Module 2
10	Falcon 500	Swerve Module 2 Drive	Swerve Module 2
11	Falcon 500	Swerve Module 3 Rotate	Swerve Module 3
12	Talon SRX	Funnel Motor 0	Driver Side of Funnel
13	Talon SRX	Funnel Motor 1	Passenger Side of Funnel
14	Talon SRX	Funnel Pull Pin	Funnel support bracket
15	Talon SRX	Algae Motor 0	*Not Implemented*
16	Falcon 500	Lift Falcon 0	Driver Side of Lift
17	Falcon 500	Lift Falcon 1	Passenger Side of Lift
18	Falcon 500	Climber Falcon 0	Passenger Side of Climber
19	Falcon 500	Climber Falcon 1	Driver Side of Climber
20	CANCoder	Rotator CANCoder	End Effector Rotator Shaft
21	Falcon 500	End Effector Rotator Falcon 0	End Effector Rotator Mechanism
22	Falcon 500	End Effector Placer Falcon 0	End Effector Placement Mechanism
23	Falcon 500	Algae Falcon 0	*Not Implemented*
N/A	Termination Resistor	Termination Resistor	End Effector Placer Falcon 0

Service Log

Below, Team Members may log any and all repairs or changes to the electrical system over the season, because this document is static the service log trumps the documentation.

Name	Date DD - MON - YY	Service Completed

Name	Date DD - MON - YY	Service Completed

Signoff And Approvals

By signing this approval form, you state that this electrical documentation is correct and up to date. “Post Event Check” boxes include the Service Log above as part of the “documentation” and signing includes that the service log is up to date and correct as well;

Initial Student Approval: --

Initial Mentor Approval: --

Post MAWNE Event Check: --

Post CTHAR Event Check: --

Post 3rd Event Check: --

Post 4th Event Check: --

Pre-Fair Season Check: --