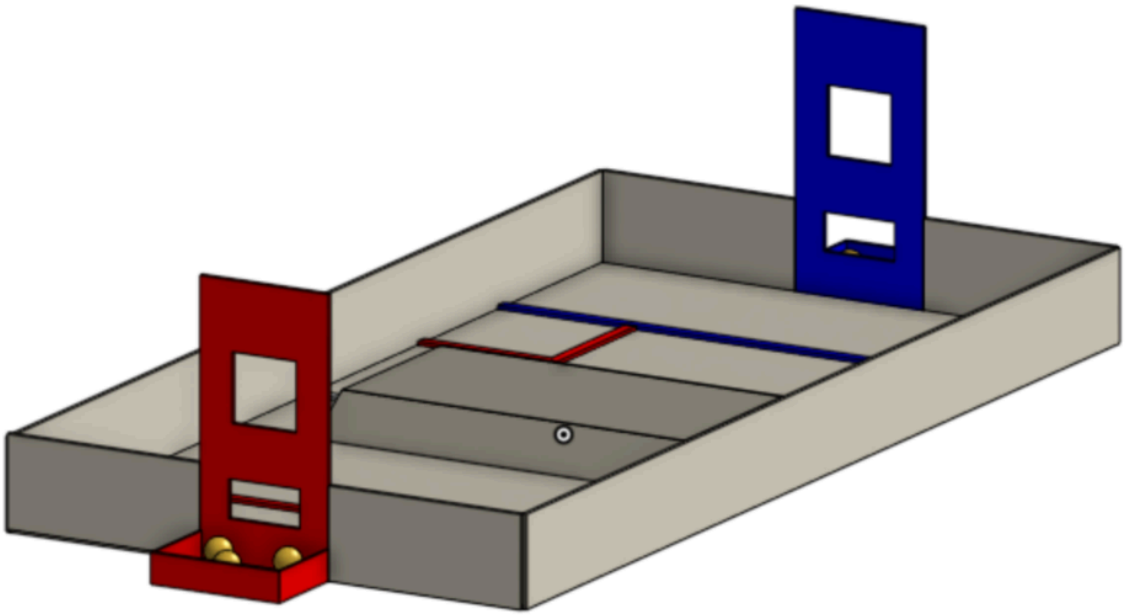
Team 4159
CardinalBotics

Internal Robotics Competition 2024

Non-Finite Replenishment

Overview

The 2024 Team 4159 Internal Robotics Competition (IRC) will be Non-Finite Replenishment, a remix of 2020's Infinite Recharge and 2024's Charged Up FRC games.



I. Introduction

The Internal Robotics Competition begins with the Kickoff on Friday, September 20th, 2024. Six teams of 4-5 people will work over the following ten weeks to construct their IRC robots. They will assemble a prepared drivetrain and create their own mechanisms to compete in the tournament at Lowell on the evening of December 6th, 2024. The objective is to efficiently train new members and offer opportunities to explore different subteams. Mentors will be assigned to each team, and general mentors will be available to everyone.

II. Matches

Each match will be 2 minutes, 15 seconds long. In the first 15 seconds of the match, the robots will be in the AUTONOMOUS period, and not controlled by their DRIVER. In the last 20 seconds of the match (the ENDGAME), alliance robots will race to DOCK or ENGAGE on the CHARGING STATION. DRIVERS and COACHES will stand behind a protective wall on opposite ends of the field and control the robots remotely for the entire match.

III. The Drive Team

The drive team of each team will be made up of 1 DRIVER, 1 COACH and 1 HUMAN PLAYER. The DRIVER controls the robot from behind their ALLIANCE WALL. The COACH stands behind the wall and may talk to the DRIVER, HUMAN PLAYERS, and the allied drive team. The HUMAN PLAYER will stand outside of the field near the designated alliance's LOADING ZONE and inbound POWER CELLS.

IV. Tournament

The tournament begins with a series of six qualification matches, with each team playing in four. Teams will earn ranking points through winning matches and for accomplishing certain in-match tasks. At the end of the qualification matches, teams will be ranked in order of most to least average ranking points per match. If teams have the same amount of average ranking points, average match score will be used as a tiebreaker. The highest-ranked teams will participate in alliance selection, choosing another team to join their Finalist ALLIANCE. These two two-team Finalist ALLIANCES will play in a best-two-out-of-three set to determine the winner of the IRC.

The Game Field

I. The Game Field

The game field will be divided into two 12' x 12' zones with a CENTER LINE down the middle of the field. The two zones will be referred to as the Red ALLIANCE ZONE and the Blue ALLIANCE ZONE. There will be an INITIATION LINE 4 ft away from the alliance walls. The red ALLIANCE ZONE is on the same side as the red alliance wall. The blue ALLIANCE ZONE is on the same side as the blue alliance wall.

II. The Game Pieces

The game pieces will be 7 in. diameter foam balls called POWER CELLS. There will be no POWER CELLS beginning on the field itself; instead they will be placed either into the LOADING ZONE or directly into a ROBOT positioned mostly within the LOADING ZONE.

III. The POWER PORTS

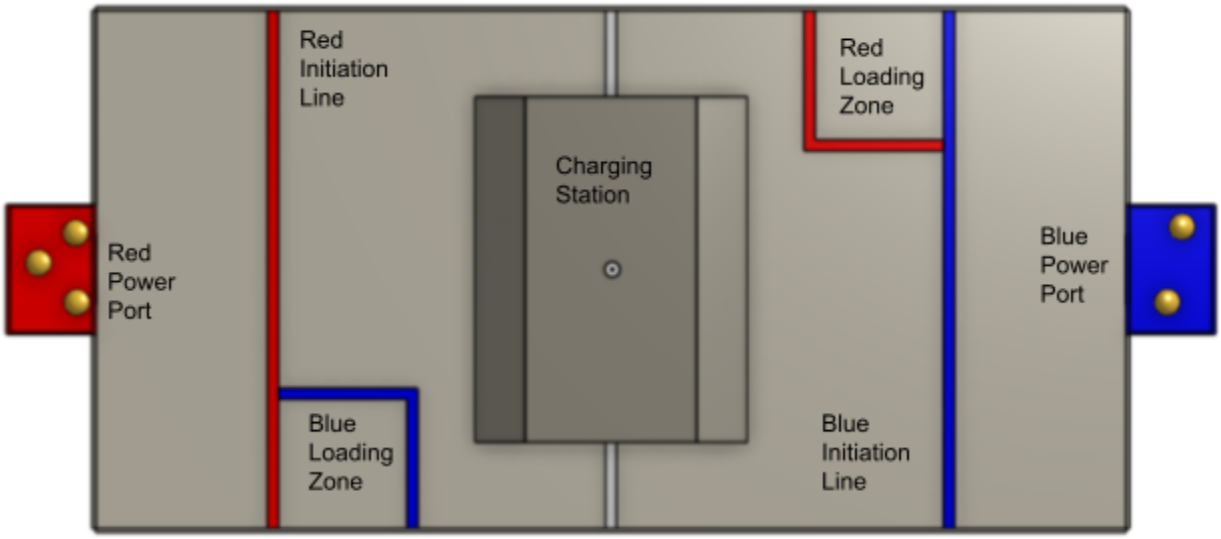
The field has two POWER PORTS, one per alliance on each side of the field with both being 6' tall and 3' wide. Each POWER PORT has an UPPER and BOTTOM PORT. The BOTTOM PORT is a 10 in. tall and 1 ft. 8 in. wide rectangle with the bottom 1 ft. above the carpet. The UPPER PORT is a 1 ft. square, its bottom 2 ft. 10 in. above the carpet.

IV. The CHARGE STATION

In the center of the field there is one **fixed** CHARGE STATION. Points are awarded during AUTONOMOUS and ENDGAME. Robots must either be DOCKED (CHARGE STATION is in contact with the robot) or ENGAGED (CHARGE STATION is leveled) on the station for both alliances. A CHARGE STATION is a 4 ft. by 6 ft. structure big enough to fit two robots.

V. The INITIATION LINES

There is an INITIATION LINE for each alliance across the length of the field, which is taped out 4 feet away from the alliance wall. Robots will attempt to cross the INITIATION LINE to score points in the AUTONOMOUS period.



Gameplay

I. Match Start and End

The game starts with each alliance's robots placed touching their alliance wall. Each team may start with one POWER CELL in contact with and fully supported by their robot. The match will start with an audible signal from the Head Referee, at which point teams start their robots' AUTONOMOUS routines by enabling their robots. The match ends 2 minutes, 15 seconds later with another audible signal. The DRIVERS of both alliances must immediately bring their robots to rest and release the controls of their robots when the end game signal sounds. POWER CELLS scored after the end game signal will not count, and teams will be penalized for egregious movement after the end of the match.

II. Match Periods

Match Period	Duration
AUTONOMOUS	0:00 - 0:15 (15s)
TELEOPERATED	0:15 - 1:55 (100s)
ENDGAME	1:55 - 2:15 (20s)

AUTONOMOUS: The first 15 seconds of a match are the AUTONOMOUS period, during which robots move with pre-programmed routines. Robots may be preloaded with one POWER CELL. Drivers may not touch the controls or otherwise attempt to influence the match until the end of the AUTONOMOUS period.

TELEOPERATED: This is the main period of the match. During this time teams earn points by scoring POWER CELLS into the PORTS. They may use POWER CELLS that start on the field, or ones that are inbounded by their HUMAN PLAYER into an alliance robot or the ALLIANCE LOADING ZONE.

ENDGAME: Teams may continue to score POWER CELLS, and now may also attempt to DOCK or ENGAGE on the CHARGING STATION by the end of the match to score points. The CHARGING STATION is large enough to fit two robots in any combination of alliance colors. CHARGING STATION points are awarded based on the robots' final positions at the *instant the match ends*.

III. Scoring

Scoring Method	AUTO	TELEOP
Cross the INITIATION LINE in AUTONOMOUS	3 points	
POWER CELL scored in the LOWER PORT	3 points	1 point
POWER CELL scored in the UPPER PORT	8 points	3 points
DOCKED but not ENGAGED on CHARGING STATION		2 points
DOCKED and ENGAGED on CHARGING STATION		5 points

To have officially crossed the INITIATION LINE, a robot must have moved from its starting position and had at least some part of its bumper moved across the line at any point during AUTONOMOUS.

Teams may score POWER CELLS in the POWER PORT at any point in the match. A POWER CELL must be fully contained in a POWER PORT to be considered scored.

Alliances may also earn additional ranking points by accomplishing certain tasks in the match. There are three possibilities to earn these:

- Both robots on the alliance cross the INITIATION line in AUTONOMOUS
- The alliance scores a minimum of 15 points
- Having one robot ENGAGED on the CHARGING STATION at the end of the match
- Having the other robot ENGAGED on the CHARGING STATION at the end of the match

Thus, a maximum of *6* ranking points may possibly be earned in a match: two from winning, and one from each of the additional in-match tasks or completing a MATCH with the same number of points as your opponent.

IV. POWER CELL Inbounding

POWER CELLS must enter play by being inbounded by a HUMAN PLAYER. To inbound, a HUMAN PLAYER introduces a POWER CELL from their reserve to the field (they can gently toss or place the POWER CELL). It must land either on the ground in their alliance's LOADING ZONE (in the designated, taped-out area at center of the field), or in a ROBOT **mostly contained** within that LOADING ZONE. The POWER CELLS cannot be thrown outside the LOADING ZONE.

V. Penalty Assessment

Rule violations lead to consequences, many of which include FOULs, which immediately credit points to the opposing alliance.

FOUL	5 Points
TECHNICAL FOUL	10 Points

YELLOW and RED CARDS are held up by the HEAD REFEREE, and the alliance or team receiving them must immediately respond by fixing their behavior or disabling their robot (respectively). Two YELLOW CARDS add up to a RED CARD. RED CARDS immediately disqualify the recipient ROBOT or ALLIANCE.

Directly below is a list of particularly common rule violations you should seek to avoid. **This abbreviated list is here for your convenience and is *not* comprehensive. You should read *all* the rules that follow in the manual.**

- **G7:** A ROBOT may only possess no more than three POWER CELLS at a time.
- **G15:** ROBOTS may not pass the center line in AUTONOMOUS.
- **G18:** An ALLIANCE may not pin an opponent ROBOT for more than five (5) seconds.
- **G19:** ROBOTS may not contact an opposing ALLIANCE ROBOT while the opposing robot is in its respective LOADING ZONE.
- **G22:** Inbounded POWER CELLS must land in the alliance's own LOADING ZONE, or in a ROBOT that is **mostly contained** in that LOADING ZONE.

VI. Game Rules

G2 ROBOTS whose operation or design is unsafe are not permitted.
Violation: DISQUALIFICATION

Pre-MATCH

G3 When placed on the FIELD, each ROBOT must be:
A. in compliance with all ROBOT rules (i.e. have passed inspection)
B. confined to its STARTING CONFIGURATION
C. contained within their own ALLIANCE ZONE
D. fully supported by the floor.
Violation: MATCH will not start until the situation is corrected.

G4 Each TEAM member must be in designated areas:
A. COACHES and DRIVERS must be in the ALLIANCE STATION
B. HUMAN PLAYERS must be outside the field near their alliance's LOADING ZONE.
Violation: MATCH will not start until the situation is corrected. During match, TECHNICAL FOUL

General Rules

G5 The following actions are prohibited with regards to interaction with FIELD elements (items A-D exclude POWER CELLS):
A. grabbing,
B. grasping
C. grappling
D. attaching to,
E. damaging,
F. becoming entangled
Violation: FOUL. If the Head Referee determines that further damage is likely to occur, DISABLED.

- *Corrective action (such as eliminating sharp edges, removing the damaging mechanism, and/or re-Inspection) may be required before the ROBOT will be allowed to compete in subsequent MATCHES.*
- *ROBOTS may push or react against any element of the FIELD.*
- *POWER CELLS are expected to undergo a reasonable amount of wear and tear as they are handled by ROBOTS, such as scratches and occasional marks. However, ROBOTS that break, crush, or routinely mark POWER CELLS will be considered in violation of G5.*

G6 POWER CELLS may not be intentionally or repeatedly ejected from gameplay.
Violation: FOUL per instance, YELLOW CARD if strategic.

G7 A ROBOT may only possess at most 3 POWER CELLS at a time. The following criteria define POSSESSION:
A. "carrying" (moving while supporting POWER CELLS in or on the ROBOT or holding the POWER CELL in or on the ROBOT),
B. "herding" (repeated pushing or bumping),

C. “launching” (impelling POWER CELLS to a desired location or direction via a MECHANISM in motion relative to the ROBOT), or
D. “trapping” (overt isolation or holding one or more POWER CELLS against a FIELD element or ROBOT in an attempt to shield them).
Violation: FOUL, if unintentional and inconsequential (i.e. does not significantly impact MATCH play). TECHNICAL FOUL per consequential instance. TECHNICAL FOUL per extended instance. If strategic, YELLOW CARD for the ALLIANCE.

G9 Strategies aimed solely at forcing the opposing ALLIANCE to violate a rule are not in the spirit of FIRST and are not allowed. Rule violations forced in this manner will not result in assessment of a penalty on the target ALLIANCE.
Violation: YELLOW CARD

G10 ROBOTS on the same ALLIANCE may not blockade the FIELD in an attempt to stop the flow of the MATCH. This rule has no effect on individual ROBOT-ROBOT interaction.
Violation: TECHNICAL FOUL, YELLOW CARD if strategic.

ROBOT Actions

G11 ROBOTS may not intentionally detach or leave parts on the FIELD.
Violation: TECHNICAL FOUL

G12 ROBOTS may not extend outside the FIELD.
Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL. If contact with anything outside the field (other than the floor), RED CARD and the ROBOT will be DISABLED.

G13 A ROBOT’S horizontal dimensions must remain within 18” of its FRAME PERIMETER
Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL.

G14 ROBOTS may not attempt to push other ROBOTS already engaged on the CHARGE STATION

G15 ROBOTS may not pass the CENTER LINE during autonomous.
Violation: FOUL.

- *If another ROBOT is impeded from crossing the AUTO line and receiving the AUTONOMOUS QUALIFYING POINT, the robot who did not cross may still be awarded the QUALIFYING POINT by the HEAD REFEREE.*

ROBOT-ROBOT Interaction

G16 Strategies aimed at and/or game play resulting in the damage, destruction or inhibition of opponent ROBOTS via actions such as high-speed or repeated, aggressive ramming, attachment, tipping, or entanglement of ROBOTS are not allowed.
Violation: FOUL. If strategic, TECHNICAL FOUL. Potential YELLOW CARD.

- *For example, a wedge-like mechanism to flip ROBOTS would be considered a violation of G16. MECHANISMS outside the FRAME PERIMETER are particularly susceptible to causing such damage and drawing this penalty and/or penalties associated with violations of G16. Teams are*

encouraged to be cautious in their use of such appendages when engaging in ROBOT to ROBOT MATCH play.

G17 Initiating deliberate or damaging contact with an opponent ROBOT on or inside the vertical extension of its FRAME PERIMETER is not allowed.
Violation: TECHNICAL FOUL.

- *High speed accidental collisions may occur during the MATCH and are expected. Generally, ROBOTS extend elements outside of the FRAME PERIMETER at their own risk. A ROBOT with an element outside its FRAME PERIMETER may be penalized under this rule if it appears they are using that element to purposefully contact another ROBOT page inside its FRAME PERIMETER. Regardless of intent, a ROBOT with an element outside its FRAME PERIMETER that causes damage to another ROBOT inside of its FRAME PERIMETER will be penalized, unless the actions of the damaged ROBOT are the catalyst for the damage.*

G18 An ALLIANCE may not pin an opponent ROBOT for more than five (5) seconds. A ROBOT will be considered pinned if it is held in place on the field and unable to escape the maneuver, and will still be considered "pinned" until the ROBOTS have separated by at least three (3) ft. The pinning ROBOT(S) must then wait for at least three (3) seconds before attempting to pin the same ROBOT again. Pinning is transitive through other objects.
Violation: TECHNICAL FOUL.

- *If the pinned ROBOT chases the pinning ROBOT upon retreat, the pinning ROBOT will not be penalized per G18, and the pin will be considered complete.*

G19 ROBOTS may not contact an opposing ALLIANCE ROBOT while the opposing robot is in its respective LOADING ZONE.
Violation: FOUL, TECHNICAL FOUL if contact is repeated/egregious.

Human Actions

G22 Only HUMAN PLAYERs may contact POWER CELLS. Inadvertent, inconsequential, or contact for safety reasons will not be penalized.
Violation: FOUL.

G23 Inbounded POWER CELLS must land in the alliance's own LOADING ZONE, or in a ROBOT that is mostly contained in that LOADING ZONE.
Violation: FOUL. If repeated or egregious, TECHNICAL FOUL

G24 During the MATCH, TEAMS may not extend any body part into the field, beyond the GUARDRAIL, except when inbounding.
Violation: TECHNICAL FOUL.
Accidentally crossing over the barrier when no ROBOTS are nearby will not be penalized unless it is repeated or prolonged.

Robot Rules

R1 The ROBOT must satisfy the following size constraints:
A. The ROBOT's Frame perimeter (not including bumpers) must fit in a 21" wide x 21" deep x 25" tall box at the start of every match. (STARTING CONFIGURATION)
B. A ROBOT may not extend more than 20 in. HORIZONTALLY beyond the FRAME PERIMETER at any point in the match
C. No part of the ROBOT can extend higher than 60 in. during the Match

R2 The ROBOT weight may not exceed 60 lbs. When determining weight, the basic ROBOT structure and all elements of all additional MECHANISMS that might be used in different configurations of the ROBOT shall be weighed together. For the purposes of determining compliance with the weight limitations the ROBOT battery isn't counted.

R3 Traction devices may not have surface features such as metal, sandpaper, hard plastic studs, cleats, or similar attachments. Traction devices include all parts of the ROBOT that are designed to transmit any propulsive and/or braking forces between the ROBOT and the FIELD.

R4 ROBOTS must allow removal of POWER CELLS from the ROBOT and the ROBOT from FIELD elements while powered off.

Safety & Damage Prevention

R5 ROBOT parts shall not be made from hazardous materials, be unsafe, cause an unsafe condition, or interfere with the operation of other ROBOTS.

R6 Protrusions from the ROBOT and exposed surfaces on the ROBOT shall not pose hazards to the ARENA elements (including the POWER CELLS) or people. If the ROBOT includes protrusions that form the "leading edge" of the ROBOT as it drives and has a surface area of less than 1 in.2, it will invite detailed Inspection. For example, forklifts, lifting arms, or grapplers may be carefully Inspected for these hazards.

Budget

R7 The total cost of all items on the ROBOT shall not exceed $400 USD. All costs are to be determined as explained in Section 4.3: Budget Constraints. Exceptions are as follows:
A. individual COTS (Commercial off-the-shelf) items that are less than $1 each and
B. Kit of Parts (KOP) items
Teams should be prepared to disclose to Inspectors the cost of any non-KOP item and the total cost of the ROBOT.

Note: No team should have access to a part unavailable to any team.

BUMPER Rules

R8 ROBOTS are required to use BUMPERS to protect all sides of the FRAME PERIMETER. For adequate protection, at least 4 in. of BUMPER must be placed on each side of each outside corner (see Figure 4-5). If a side is shorter than 4 in., the entire side must be protected by BUMPER (see Figure 4-6). For the purposes of R8, a round or circular FRAME PERIMETER has an infinite number of corners.

R9 BUMPERS must be constructed as follows:
A. be backed by at least ⅛ in. (nominal) thick by 5 in. (± 1/2 in) tall plywood or solid, robust wood. Small clearance pockets and/or access holes in the plywood backing are permitted, as long as they do not significantly affect the structural integrity of the BUMPER.
B. hard BUMPER parts allowed per R9-A and -E may not extend more than 1 in. beyond the end of the FRAME PERIMETER
C. use one to two approximately 2 1/2 in. round, petal, or hex “pool noodles” (solid or hollow) as the BUMPER cushion material . Cushion material may extend up to 2 1/2 in. beyond the end of the plywood.
D. BUMPERS may be permanently attached to the ROBOT OR may attach to the FRAME PERIMETER of the ROBOT with a rigid fastening system to form a tight, robust connection to the main structure/frame (e.g. not attached with hook-and-loop or tie-wraps). The attachment system must be designed to withstand vigorous game play. All removable fasteners (e.g. bolts, locking pins, pip-pins, etc.) will be considered part of the BUMPERS.
E. be sufficiently covered with duct tape.

R10 BUMPERS must be located entirely within the BUMPER ZONE, which is between two (2) and ten (10) in. from the floor, in reference to the ROBOT standing normally on a flat floor.
There is no explicit requirement that BUMPERS be perfectly parallel to the floor. However
BUMPERS are required to have the same vertical cross-section all over.

R11 Corner joints between BUMPERS must be filled with pool noodle material.

R12 BUMPERS must be supported by the structure/frame of the ROBOT (see Figure 4-10). To be considered supported, a minimum of 1/2 in. at each end of the BUMPER must be backed by the FRAME PERIMETER. Additionally, any gap between the backing material and the frame
A. must not be greater than 1/4 in. deep, or
B. not more than 8 in. wide.

R13 A ROBOT’S alliance color must be clearly displayed on its BUMPERS.

Motors & Actuators

R14 The only motors and actuators permitted on IRC ROBOTS include the following:
2 Mini CIM motors for the drivetrain, and up to 3 additional Mini CIM, BAG, and 775 pro motors.

Battery

R15 The ROBOT must use a single, standard FRC 12V battery, secured such that it will not dislodge should the ROBOT be turned over or placed in any arbitrary orientation.

R17 Non-electrical sources of energy used by the ROBOT, (i.e., stored at the start of a MATCH), shall come only from the following sources:
A. a change in the altitude of the ROBOT center of gravity,
B. storage achieved by deformation of ROBOT parts, i.e. springs

R18 The one ROBOT battery, Anderson Power Products (or APP) Connectors (p/n SB50), the one main 120-amp (120A) circuit breaker (Cooper Bussman P/N: CB185-120), and the one Power Distribution (PD) Board shall be connected as shown in Figure 4-11. Please note that we may be using a smaller PD Board than the one shown in Figure 4-11.

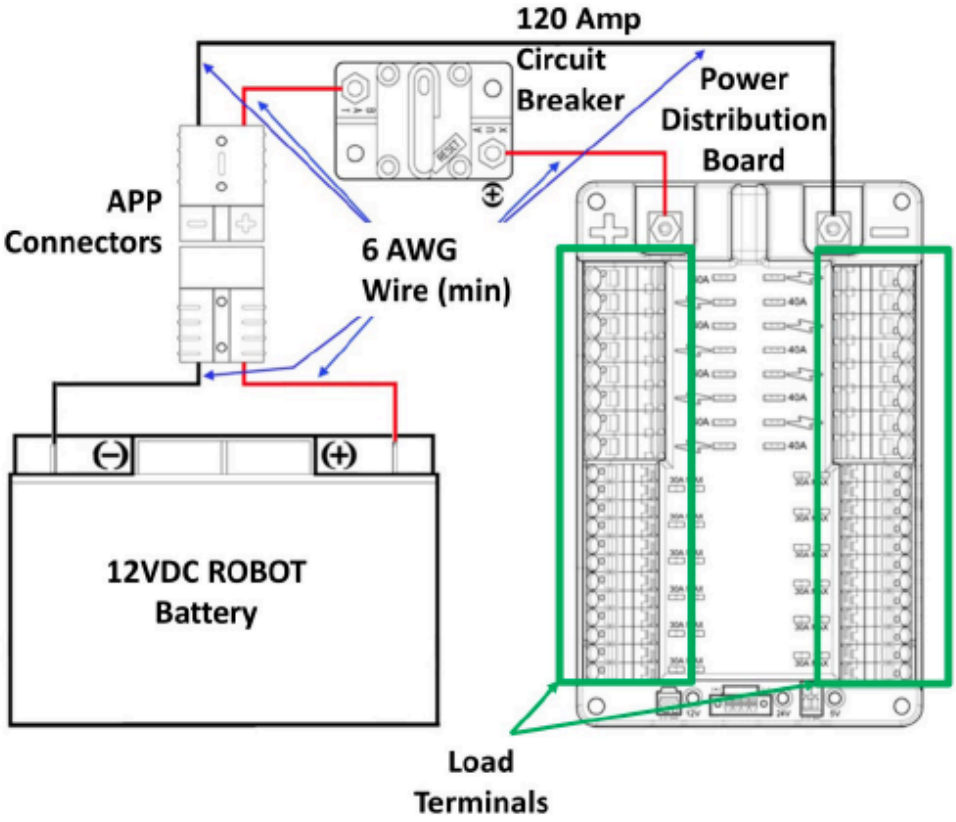


Figure 4-11: Main Power Distribution

R20 The PD Board and all circuit breakers must be easily visible for Inspection.

R21 The only circuit breakers permitted for use in the PD Board are:
A. Snap Action VB3-A Series, terminal style F57
B. Snap Action MX5-A40

R22 All circuits shall be wired with appropriately sized insulated wire:
Table 4-3: Legal Wire Size
Application Minimum Wire Size
30 – 40A protected circuit 12 AWG (2.052mm)

20 – 30A protected circuit 14 AWG (1.628mm)
5 – 20A protected circuit 18 AWG (1.024mm)
All ROBOTS will be controlled with a RoboRio and connection to a driver station laptop. More details will be provided to teams.

This manual is subject to rules updates at any time. Updates, if they occur, will be announced to teams. Rules are ultimately enforced at the Referee's discretion. If you have questions at any point about the rules, ask Luis Palacios or, during the time of competition or inspection, any referees or mentors conducting robot inspections.