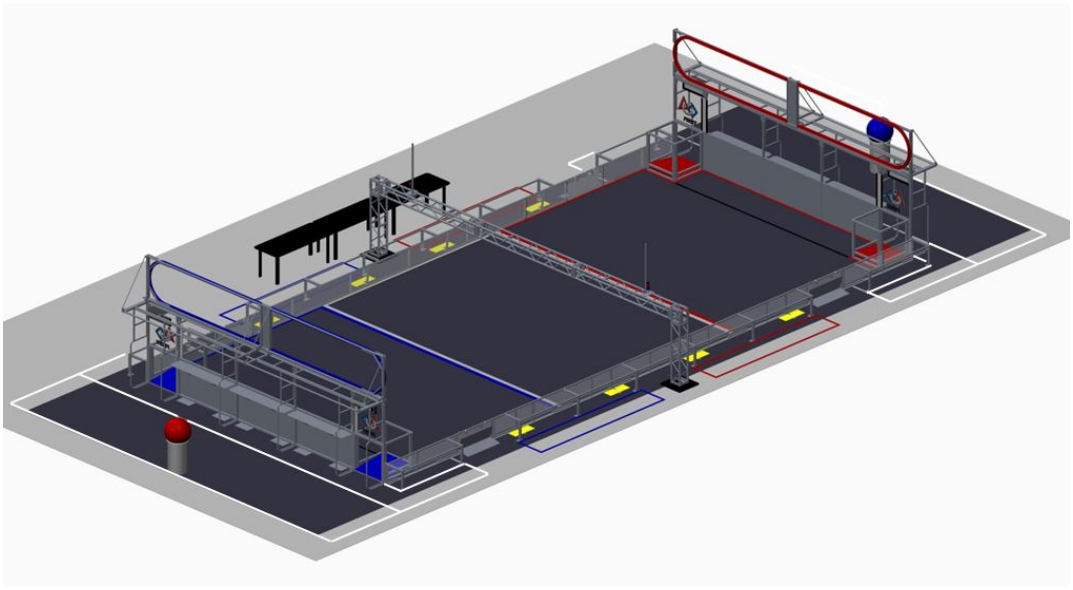
Game Manual
1 Summary



AERIAL ASSIST is played by two competing Alliances of three Robots each on a flat 25’ x 54’ foot field, straddled by a lighting truss suspended just over five feet above the floor. The objective is to score as many balls in goals as possible during a 2 minute and 30 second match. The more Alliances score their ball in their goals, and the more they work together to do it, the more points their alliance receives.

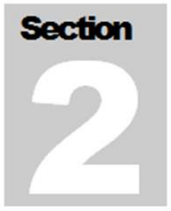
The match begins with one 10-second Autonomous Period in which robots operate independently of driver. Each robot may begin with a ball and attempt to score it in a goal. Alliances earn bonus points for scoring balls in this mode and for any of their robots that move in to their zones. Additionally, each high/low pair of goals will be designated “hot” for five seconds, but the order of which side is first is randomized. For each ball scored in a “hot” goal, the Alliance earns additional bonus points.

For the rest of the match, drivers remotely control robots from behind a protective wall. Once all balls in autonomous are scored, only one ball is re-entered in to play, and the Alliances must cycle a single ball as many times as possible for the remainder of the match. With the single ball, they try to maximize their points earned by throwing balls over the truss, catching balls launched over the truss, and scoring in the high and low goals on the far side of the field.

Alliances receive large bonuses for "assists," which are earned for each robot that has possession of the ball in a zone as the ball moves down the field. Points are awarded for each action per the table below.

Action	Base	AUTO (=Base+5)	AUTO & HOT (=Base+AUTO+5)	1 ASSIST (=Base+0)	2 ASSIST (=Base+10)	3 ASSIST (=Base+30)
LOW GOAL	1	6	11	1	11	31
HIGH GOAL	10	15	20	10	20	40
TRUSS	10					
Mobility		5				
CATCH	10					

2 The Arena



2.1 Overview

Note: These illustrations are for a general visual understanding of the AERIAL ASSIST ARENA only. Please refer to the 2014 Official FIRST Field Drawings & Models for exact dimensions and construction details.

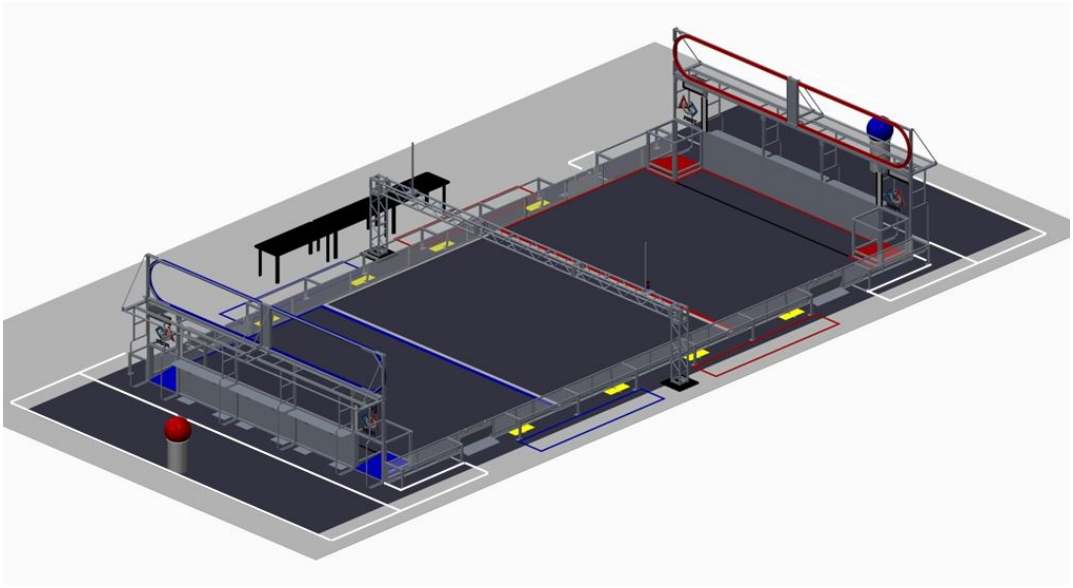


Figure 2-1: AERIAL ASSIST ARENA

The ARENA includes all elements of the game infrastructure that are required to play AERIAL ASSIST: the FIELD, the ALLIANCE STATIONS, the BALLS, and all supporting communications, ARENA control, and scorekeeping equipment.

ROBOTS play AERIAL ASSIST in a rectangular space known as the FIELD. During MATCHES, ROBOTS are controlled from ALLIANCE STATIONS located outside the ends of the FIELD. Each ALLIANCE STATION consists of three (3) PLAYER STATIONS that provide connectivity between the controls used by the DRIVERS and the ROBOTS. There are GOALS in each FIELD corner and atop the entire length of the ALLIANCE WALLS.

The drawings and CAD models, drawings for low-cost versions of the important elements of the ARENA, and links to CAD models for AERIAL ASSIST can be found in the *2014 Official FIRST Field Drawings & Models* (dimensions stated in this document are nominal).

The competition ARENA is a modular construction that is assembled, used, disassembled, and shipped many times during the competition season. It will undergo wear and tear. The ARENA is designed to withstand rigorous play and frequent shipping, and every effort is made to ensure that the ARENAS are consistent from event to event. However, as the ARENA is assembled in different venues by different event staff, some small variations do occur. For details regarding assembly tolerances, please refer to *FE-00037 – 2014 ARENA Layout and Marking*. Successful teams will design ROBOTS that are insensitive to these variations.

2.2 The ARENA

Note: The official AERIAL ASSIST *ARENA description, layout, dimensions and parts list are contained in FE-00037 - 2014 ARENA Layout and Marking. Diagrams and dimensions below are for illustrative purposes only.*

2.2.1 The FIELD

The FIELD for AERIAL ASSIST is a 24 ft. 8 in. x 54 ft. carpeted area, bounded by and including the GUARDRAILS, ALLIANCE WALLS, and rear faces of the LOW GOALS. The FIELD floor is covered with carpet (Shaw Floors, Philadelphia Commercial, Neyland II, 20, 30550, “Ground Pepper”). Two (2) HIGH GOALS are located at each end of

the FIELD above the ALLIANCE WALLS. Two (2) LOW GOALS are located in the corners next to each ALLIANCE WALL. A TRUSS bisects and spans the width of the FIELD.

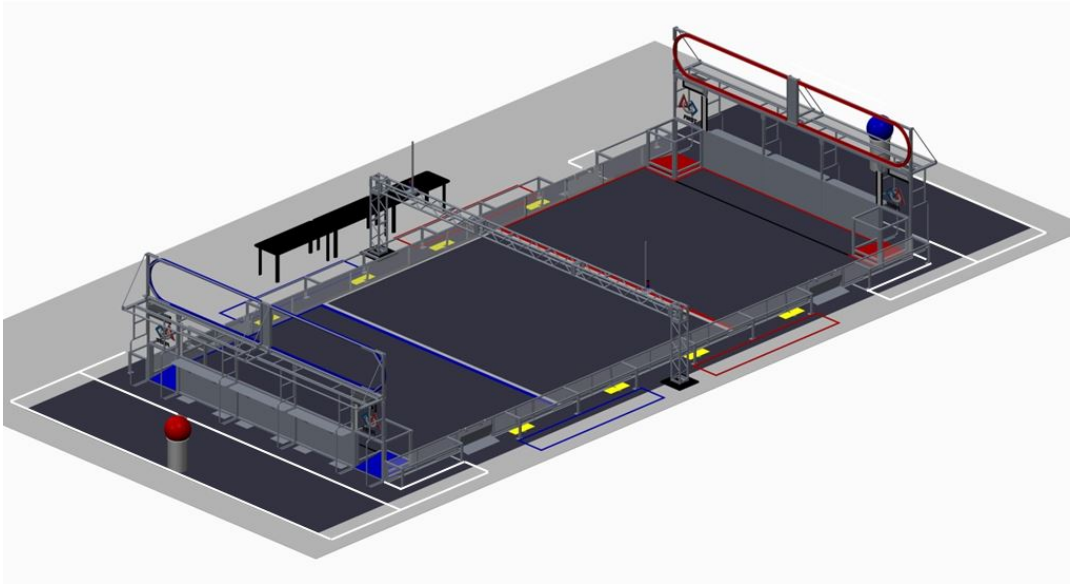


Figure 2-2: Basic FIELD Layout

The ALLIANCE WALLS are 6 ft. 6 in. high, 18 ft. wide, and define the ends of the FIELD. The ALLIANCE WALL protects the PLAYER STATIONS and is composed of a 3 ft. high base of diamond plate aluminum topped with a 3 ft. 6in. tall transparent acrylic panel.

The GUARDRAIL is a system that consists of horizontal pipes that are 1 ft. 8 in. above the floor and supported by vertical struts mounted on a 3 in. aluminum angle. A transparent polycarbonate shield is attached on the inside of the GUARDRAIL, extending from the floor to the top of the GUARDRAIL, and running the length of the GUARDRAIL. The shield is intended to help prevent ROBOTS, in whole or in part, from inadvertently exiting the FIELD during a MATCH. The GUARDRAIL defines the borders of the FIELD, except where it is bounded by the ALLIANCE WALL.

Four (4) gates in the GUARDRAIL allow access to the FIELD for placement and removal of ROBOTS. The gates are 38 in. wide, and are closed and shielded during MATCHES.

The HUMAN PLAYER BARRIER is a system that consists of horizontal pipes that are 1 ft. 8 in. above the floor and are supported by sheet metal structs that are integrated into the GUARDRAIL. The HUMAN PLAYER BARRIER extends 1 ft. 8 in. wider than the GUARDRAIL and creates a barricade between HUMAN PLAYERS and ROBOTS.

2.2.2 FIELD Markings

FIELD markings are shown in Figure 2-3 and are for illustrative purposes only. Please refer to drawing *FE-00037 - 2014 ARENA Layout and Marking* for exact dimensions.

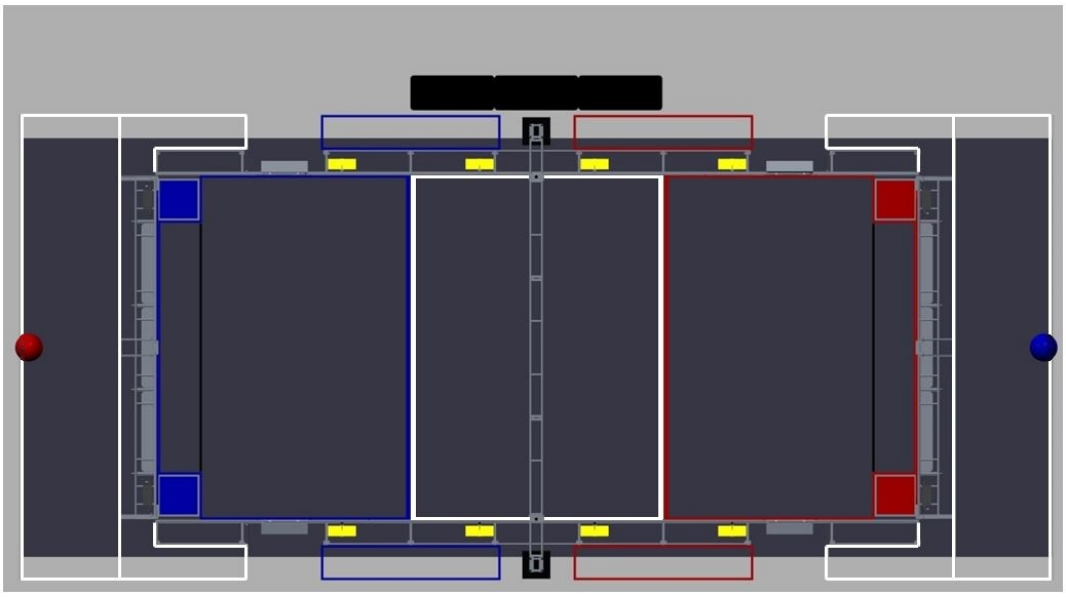


Figure 2-3: FIELD Markings

The FIELD is segmented in to three ZONES of equal length and width; Blue, White, and Red. The perimeters of each ZONE are marked on the FIELD with 2 in. gaffers tape along the FIELD border and 4 in. of gaffers tape across the width of the FIELD, in the corresponding color. At each end of the FIELD, Black lines mark the front of the GOALIE ZONE and span from the inside corner of one LOW GOAL to the inside corner of the other LOW GOAL.

2.2.3 The GOALS

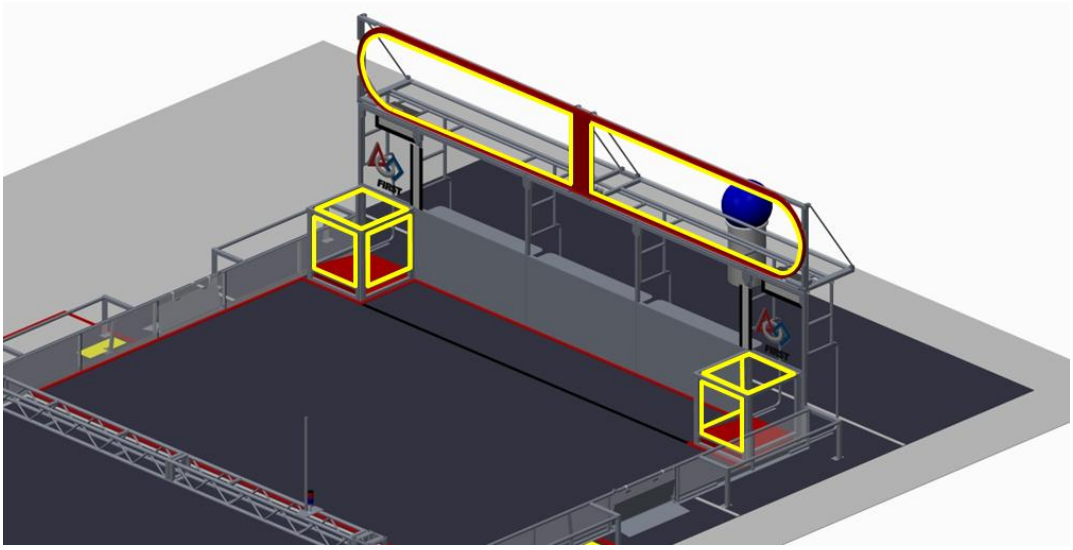


Figure 2-4: The GOALS

Each ALLIANCE has two (2) HIGH GOALS located above their opponent's ALLIANCE WALL. The HIGH GOALS are 11 ft. 6 in. wide and 3ft. 1 in. tall with the bottom edge of the opening located 6 ft. 10 ¾ in. above the carpet. The outside edge of each HIGH GOAL is semi-circular with a radius of 1 ft. 6 ½ in. The HIGH GOALS are separated from each other by a 1 ft. wide divider

The perimeter of each HIGH GOAL is surrounded by Phillips Color Kinetics iColor Flex LMX LED light strings. The LEDs have several states that indicate GOAL status:

A. The perimeter of a HOT GOAL is lit with yellow LEDs. The non-HOT GOAL'S perimeter is not lit.

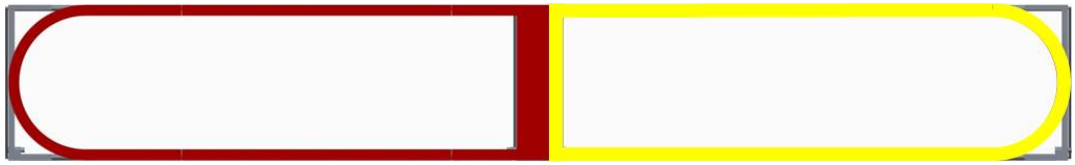


Figure 2-5: HOT GOAL

B. The inside third of the GOAL perimeters are illuminated in the ALLIANCE color if an ALLIANCE has one (1) ASSIST.

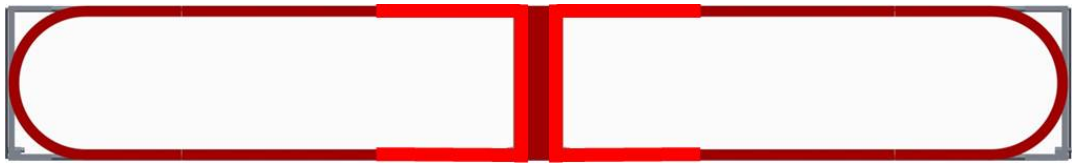


Figure 2-6: One (1) Assist

C. The inside two-thirds of the GOAL perimeters are illuminated in the ALLIANCE color if an ALLIANCE has two (2) ASSISTS.

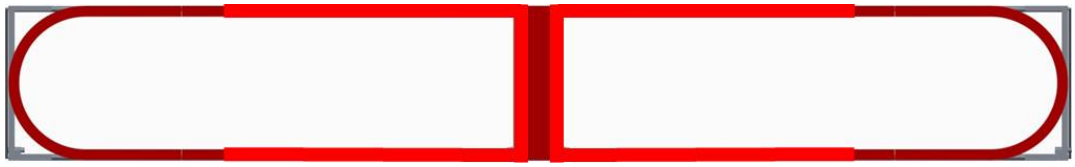


Figure 2-7: Two (2) Assists

D. The full GOAL perimeters are illuminated in the ALLIANCE color if an ALLIANCE has three (3) ASSISTS.

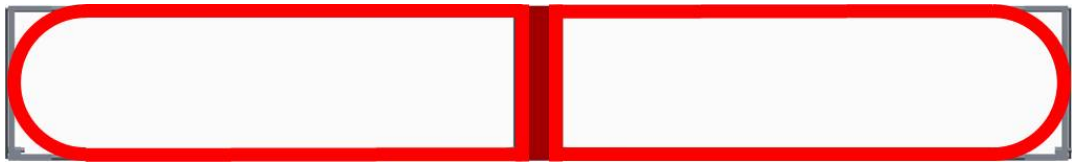


Figure 2-8: Three (3) Assists

The back of each HIGH GOAL has a light string. The two light strings together mimic the information portrayed in bullets A-D above.

Each ALLIANCE has two (2) LOW GOALS, one located in each corner of the FIELD which is formed by the opponent's ALLIANCE WALL and the GUARDRAILS. The side openings of the LOW GOAL are 2 ft. 5 in. wide x 2 ft. 4 in. tall. The top opening of the LOW GOAL is 2 ft. 8 ½ in. x 2 ft. 8 ½ in. The bottom edge of the LOW GOAL is located 7 in. from the carpet.

2.2.4 The VISION TARGETS

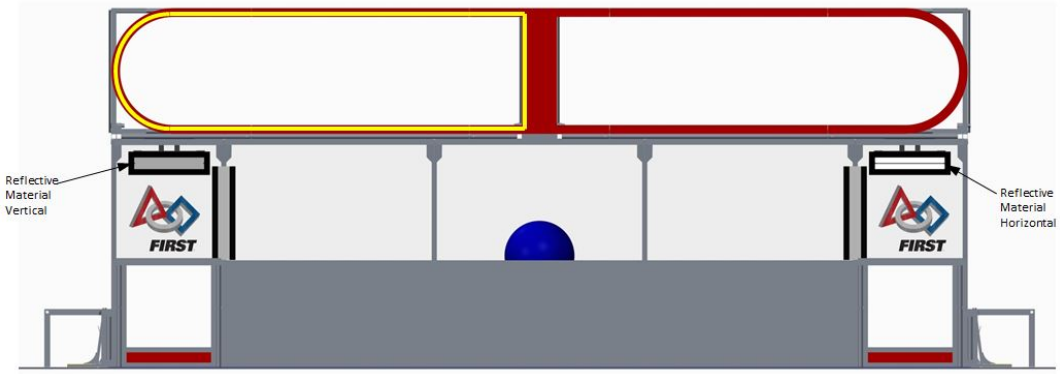


Figure 2-9: The VISION TARGETS

There are four (4) VISION TARGETS on each end of the FIELD: two (2) dynamic VISION TARGETS and two (2) static VISION TARGETS. There is one (1) dynamic VISION TARGET located above each LOW GOAL. Each dynamic VISION TARGET is located behind the polycarbonate panel on the ALLIANCE WALL. The dynamic VISION TARGET is horizontal and begins 5 ft. 8 in. above the FIELD carpet, is centered over the LOW GOAL, and consists of a panel with one (1) 4 in. wide, 1 ft. 11 ½ in. long strip of retro-reflective material (3M 8830 Silver Marking Film) adhered horizontally along the length of the panel with a 2 in. black ABS plastic border surrounding the retro-reflective material. The dynamic VISION TARGET is actuated to show the retro-reflective material when its corresponding HIGH and LOW GOAL are HOT. It will rotate to hide the retro-reflective material (pointing it upwards) when its corresponding HIGH and LOW GOAL are not HOT. Both of these conditions are shown in Figure 2-9.

Before the MATCH starts and throughout TELEOP, both dynamic VISION TARGETS are positioned such that the the reflective material faces the FIELD.

The static VISION TARGET is mounted such that half is behind the polycarbonate sheet above the LOW GOAL and half is behind the acrylic panel of the PLAYER STATION. It uses vertical reflectors which are located above the inside edge of the LOW GOAL. The vertical reflector consists of a 4 in. wide, 2 ft. 8 in. tall stripe of retro-reflective material bordered by 2 in. wide black gaffers tape on the left and right sides. The vertical reflectors begin 3 ft. 1 ½ in. above the FIELD carpet.

2.2.5 The TRUSS

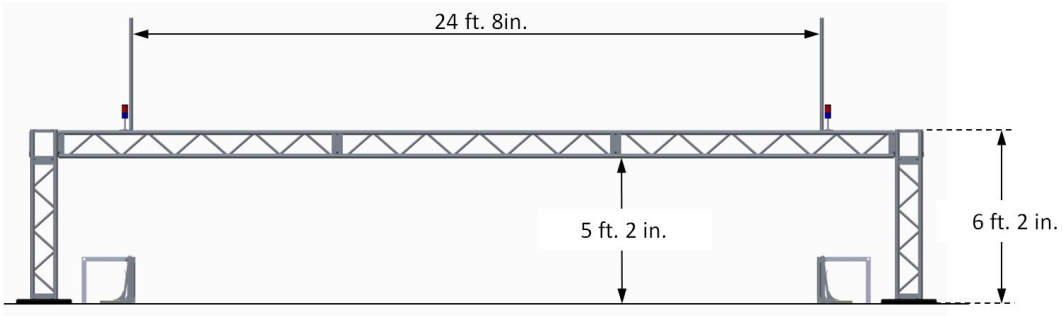


Figure 2-10: The TRUSS

The middle of the FIELD is spanned by the TRUSS. It is a General Purpose 1 ft. x 1 ft. square TRUSS made by James Thomas Engineering. The TRUSS is manufactured from 2 in. diameter x ? in. wall and 1 in. diameter x ? in. wall 6082-T6 or 6061-T6 Aluminum round tubing. The bottom of the TRUSS is located 5 ft. 2 in. off the playing surface of the FIELD. The top surface of the TRUSS is located 6 ft. 2 in. off the playing surface of the FIELD. The TRUSS is 32 ft. long and is supported at each end by 5 ft. support columns (identical in construction to the main part of the TRUSS) mounted to steel base plates. The steel base plates are 2 ft. x 2 ft. steel plate approximately 2 in. tall, and they sit outside the HUMAN PLAYER BARRIER.

There are two (2) TRUSS POLES mounted to the top of the TRUSS that extend up. The TRUSS POLES are aligned with the GUARDRAIL and depict the vertical projection of the FIELD. Each TRUSS POLE has a 1 ? in. diameter and is 4 ft. tall.

Stack lights, one of each ALLIANCE color, are mounted on each end of the TRUSS. These lights turn on to indicate that the corresponding ALLIANCE has achieved a TRUSS SCORE for the current CYCLE.

2.2.6 The ALLIANCE STATIONS

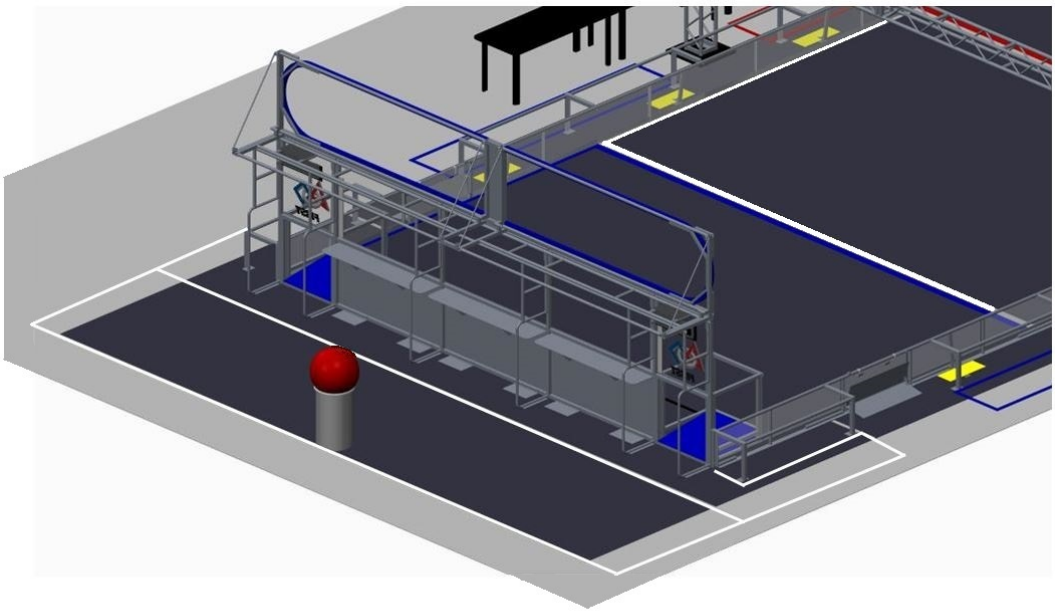


Figure 2-11: The ALLIANCE STATION

The Red and Blue ALLIANCE STATIONS are located at either end of the FIELD, behind the ALLIANCE WALLS. The ALLIANCE STATION extends 10 ft. back from the ALLIANCE WALL and 1 ft. 8 in. beyond the carpet on each side. The ALLIANCE STATION includes the three (3) PLAYER STATIONS and one (1) PEDESTAL. The STARTING LINE is marked with white 2 in. wide gaffers tape 2 ft. 6 in. behind the ALLIANCE WALL. The ALLIANCE STATION includes the area up to the entry gates of the FIELD, with the end of the ALLIANCE STATION marked out in 2 in. white gaffers tape.

Each ALLIANCE has a PEDESTAL used to stage the next BALL available to the ALLIANCE. It is centered behind the middle PLAYER STATION and tangent to the edge of the carpet. The PEDESTAL is constructed from a US Plastics Tamco 30 Gallon Polyethylene Tank (Item #: 4031) and capped with a nylon cover. A light inside the PEDESTAL indicates the BALL'S eligibility for play. The PEDESTAL is illuminated red or blue (matching the ALLIANCE color) if the ALLIANCE may retrieve the BALL. The base is off if the BALL may not yet be removed. The PEDESTAL will turn

green with other FIELD lights to indicate that the FIELD is safe to enter.

Each ALLIANCE STATION has one (1) flat panel display centrally mounted above the middle PLAYER STATION. The display shows the ALLIANCE each ZONE where the ALLIANCES' ROBOTS have been granted credit for POSSESSION. Further, the panel highlights the unique ROBOT-ZONE pairs that are recognized as ASSISTS. The display is shown in Figure 2-12, Figure 2-13, and Figure 2-14.

Figure 2-12: Display Location

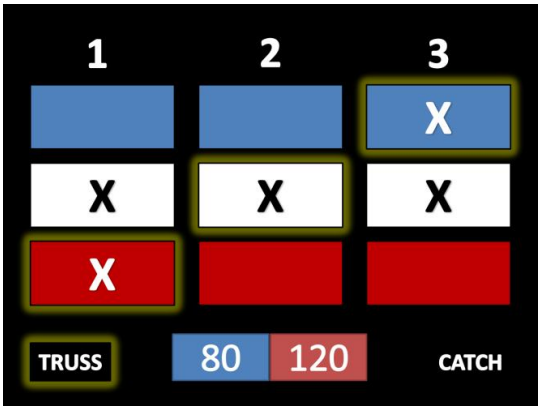


Figure 2-13: Blue Panel Display

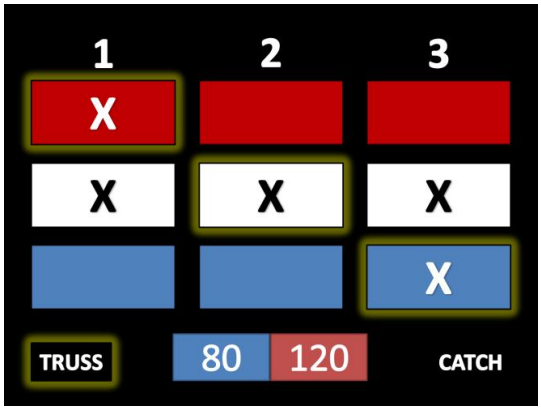


Figure 2-14: Red Panel Display

2.2.7 The HUMAN PLAYER AREAS

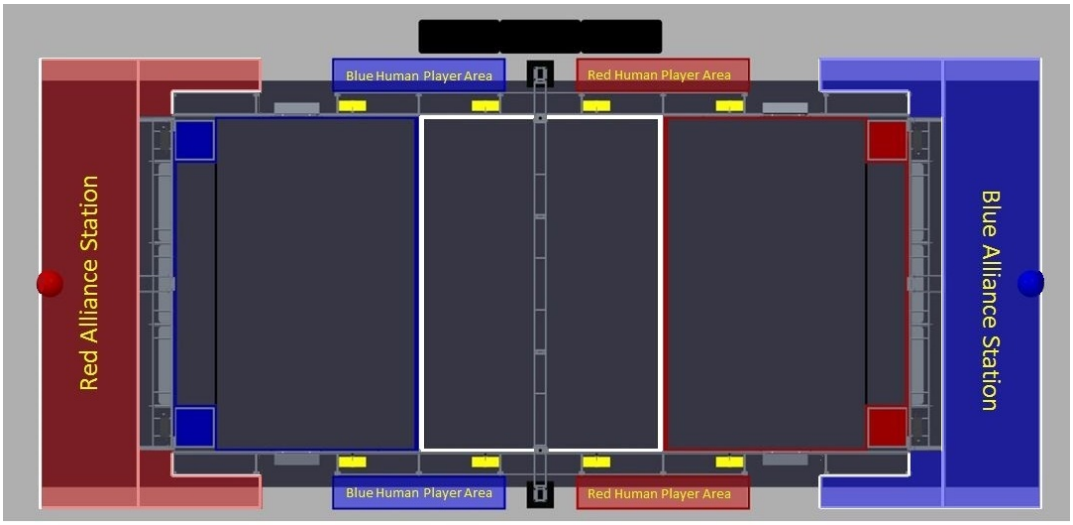


Figure 2-15: The HUMAN PLAYER AREAS

There are two (2) rectangular HUMAN PLAYER AREAS per ALLIANCE; each rectangle is 12 ft. 10 in. x 2 ft. 6 in. They are located on the same end of the FIELD as an ALLIANCE'S GOALS. They extend along the HUMAN PLAYER BARRIER from the TRUSS to the gate. The perimeter of each HUMAN PLAYER AREA is indicated with 2in. wide, corresponding red or blue gaffers tape.

2.2.8 The PLAYER STATIONS

Attached to the ALLIANCE WALL in each PLAYER STATION is an aluminum shelf to support the OPERATOR CONSOLE for the Team in that PLAYER STATION. The support shelf measures 5 ft. 9 in. wide x 1 ft. deep. There is a 4 ft. 6 in. long x 2 in. wide strip of hook-and-loop tape ("loop" side) along the center of the support shelf that may be used to secure the OPERATOR CONSOLE to the shelf. Each setup location includes a competition cable (to provide Ethernet connectivity) that attaches to the Ethernet Port of the OPERATOR CONSOLE. The cable provides communications with the ROBOT via the ARENA network.

Each PLAYER STATION also includes a single 120VAC NEMA 5-15R power outlet. It is located on the right side of each PLAYER STATION shelf. This outlet is protected by a 3-Amp circuit breaker and can be used to power the OPERATOR CONSOLE.

There is no longer a Classmate power adapter at each PLAYER STATION.

Emergency Stop (E-Stop) buttons for each ROBOT are located on the left side of each PLAYER STATION shelf. ARENA parts (including Team number displays, competition ARENA hardware, ALLIANCE lights, control hardware cabinets and clock displays) are also located above the PLAYER STATIONS and below the shelf.

Each PLAYER STATION includes one (1) Phillips Color Kinetics iColor Flex LMX LED light string. This light string is used to indicate the following states:

- During the MATCH, the string indicates the ZONES in which the Team's ROBOT has been credited with POSSESSION. Each string is segmented into red, white, and blue thirds, representing the FIELD ZONES.
- If the string is GREEN, then the Head Referee has determined that the FIELD is safe for humans.

Once plugged in to the Field Management System (FMS) via the Ethernet cable provided, the only open ports in the ARENA network are as follows:

A. TCP 1180: This port is typically used for camera data from the cRIO to the Driver Station (DS) when the camera is connected to port 2 on the 8-slot cRIO (P/N: cRIO-FRC). This port is bidirectional.
B. TCP 1735: SmartDashboard, bidirectional
C. UDP 1130: Dashboard-to-ROBOT control data, directional
D. UDP 1140: ROBOT-to-Dashboard status data, directional
E. HTTP 80: Camera connected via switch on the ROBOT, bidirectional
F. HTTP 443: Camera connected via switch on the ROBOT, bidirectional

Teams may use these ports as they wish if they do not employ them as outlined above (i.e. TCP 1180 can be used to pass data back and forth between the ROBOT and the DS if the team chooses not to use the camera on port 2).

2.2.9 The BALLS

The BALLS are approximately 2 ft. diameter exercise BALLs with 6-panel 400D nylon red or blue covers. They are manufactured by Sportogo. BALLS are inflated per guidelines provided in the *2014 BALL Inflation Guide*.

Figure 2-16: Blue and Red BALLS

2.3 Revision History

Date	Section	Change
1/10/14	2.2.4	Added detail on starting and TELEOP position of dynamic VISION TARGETS

3 The Game

ALLIANCES playing AERIAL ASSIST score BALLS in GOALS, over a TRUSS, and are rewarded bonus points for employing teamwork to achieve the objective. This chapter contains two sections: the first section describes the Game, and the second section covers the detailed rules by which competitors must abide.

3.1 Game Details

Details such as the FIELD set up, MATCH execution, point values, etc. are defined in this section.

3.1.1 MATCH Timing

A MATCH is two (2) minutes and thirty (30) seconds long. The Autonomous (AUTO) Period is the first ten (10) seconds of the MATCH. The Teleoperated Period (TELEOP) is the remaining two (2) minutes and twenty (20) seconds. Each Period ends when the ARENA timer displays zero (0) seconds.

3.1.2 MATCH Logistics

Although an ALLIANCE may start a MATCH with up to three (3) BALLS, the PEDESTAL will only be illuminated when the last BALL that started the MATCH is SCORED, effectively reducing the number of BALLS in play per ALLIANCE

to one (1).

BALLS that are ejected from gameplay during a MATCH will be delivered to the closest HUMAN PLAYER of that BALL'S ALLIANCE by event staff at the next safe opportunity. This includes BALLS that go in GOALS but don't meet the criteria to be considered SCORED.

If a BALL becomes damaged or completely deflated, it will be replaced by a new BALL of the same color at the next safe opportunity. Once the new BALL enters the FIELD, the damaged BALL is invalidated, considered debris, and can no longer be used in MATCH play.

If an ALLIANCE's BALL becomes stuck in an ALLIANCE'S ROBOT, the ALLIANCE may signal to the Head Referee that the BALL is "dead" (specifics regarding the signaling process are yet to be determined). At this point, the Head Referee will suspend the CYCLE (TRUSS and CATCH points are maintained, ASSIST accruals are voided) and re-illuminate the PEDESTAL, beginning another CYCLE for that ALLIANCE. If the dead BALL is freed, that BALL must be removed from the FIELD through one of the ALLIANCE'S GOALS or by passing to an ALLIANCE HUMAN PLAYER before the ALLIANCE can earn any more points. Each ALLIANCE is allowed to indicate one (1) BALL as "dead" per MATCH.

If an ALLIANCE'S BALL becomes stuck in an opposing ALLIANCE'S ROBOT, the Head Referee will signal an extended infraction of G12 (the assumption is that the ALLIANCE has already been penalized for the initial G12 infraction). At this point, the Head Referee will suspend the current CYCLE and re-illuminate the PEDESTAL, beginning another CYCLE for that ALLIANCE. If the stuck BALL is freed, that ball will be considered FIELD debris.

If a BALL becomes stuck on the TRUSS, the Head Referee will shake the TRUSS to free the BALL. In this situation, the ALLIANCE will not earn TRUSS points. While shaking the TRUSS, the Head Referee will take care not to impact gameplay of the other ALLIANCE.

3.1.3 Penalty Assignment

Upon a rule violation, FOUL or TECHNICAL FOUL points will immediately be credited to the opposing ALLIANCE. Values are defined in Table 3-1: Penalty Point Values.

Table 3-1: Penalty Point Values

FOUL	20
TECHNICAL FOUL	50

3.1.4 Scoring

For BALLS with which the ALLIANCE started the MATCH, points are awarded when they are SCORED in GOALS.

For BALLS retrieved from an ALLIANCE'S PEDASTAL, points are awarded to ALLIANCES per the details below. Final scores will be assessed five (5) seconds after the ARENA timer displays zero (0) or when all elements come to rest, whichever event happens first.

Points are awarded once per CYCLE for BALLS SCORED by ROBOTS in the GOALS, BALLS SCORED by ROBOTS over the TRUSS, and for each ROBOT CATCH and as each objective is achieved. Additional points are credited to an ALLIANCE upon each GOAL based on the number of ASSISTS earned by the ALLIANCE for that CYCLE.

A BALL is considered SCORED in an ALLIANCE'S GOAL if

A. a ROBOT causes one (1) of their ALLIANCE'S BALLS to cross completely through the opening(s) of one (1) of their ALLIANCE'S GOALS and into the opposing ALLIANCE STATION without intervening human contact,
B. the ALLIANCE ROBOT last in contact with the BALL was entirely between the TRUSS and their ALLIANCE'S HIGH GOALS, and
C. the BALL is not in contact with any ROBOT from that ALLIANCE.

A CYCLE is the series of events that recur regularly, and each CYCLE begins with an ALLIANCE member retrieving their BALL from their lit PEDESTAL and ends when the BALL is SCORED in a GOAL. Major events in a CYCLE are depicted in Figure 3-1.

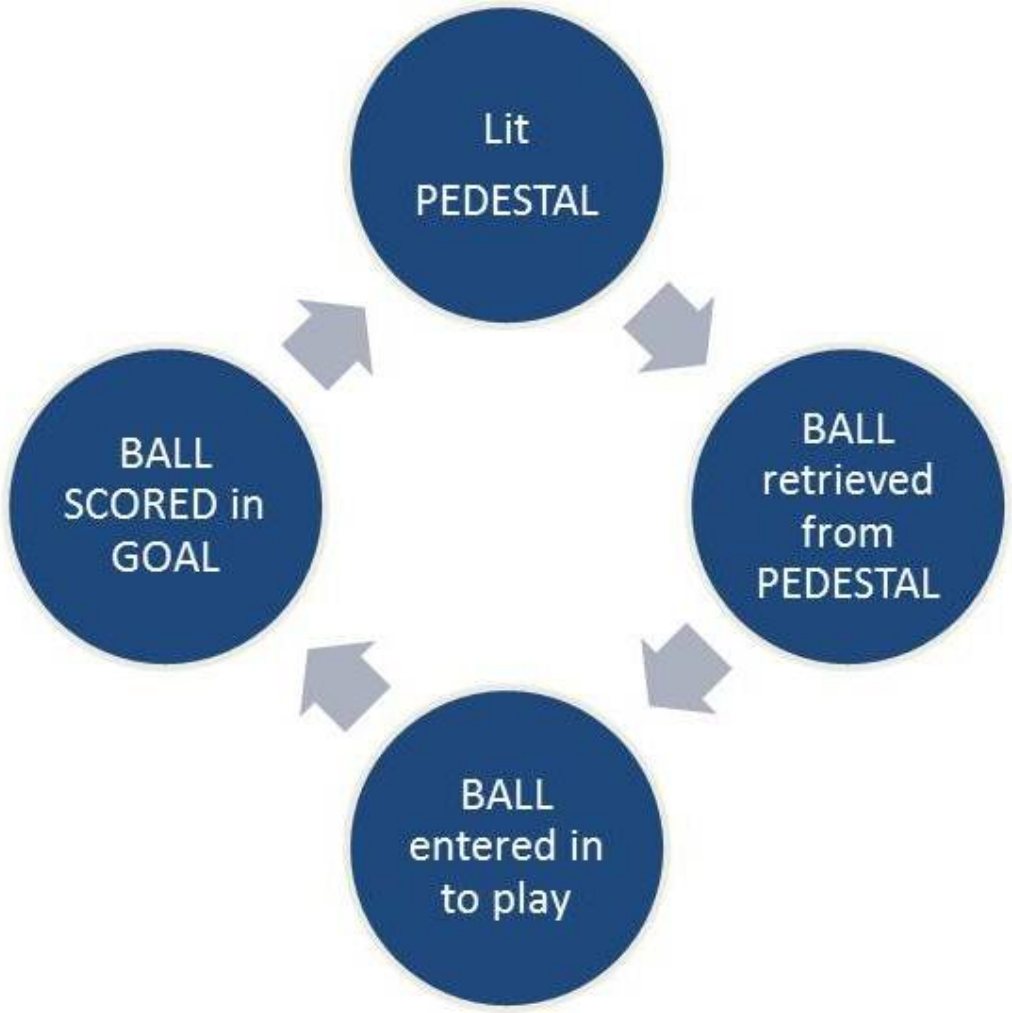


Figure 3-1: CYCLE

The Red ALLIANCE'S eight (8) GOAL openings are outlined in yellow in Figure 3-2.

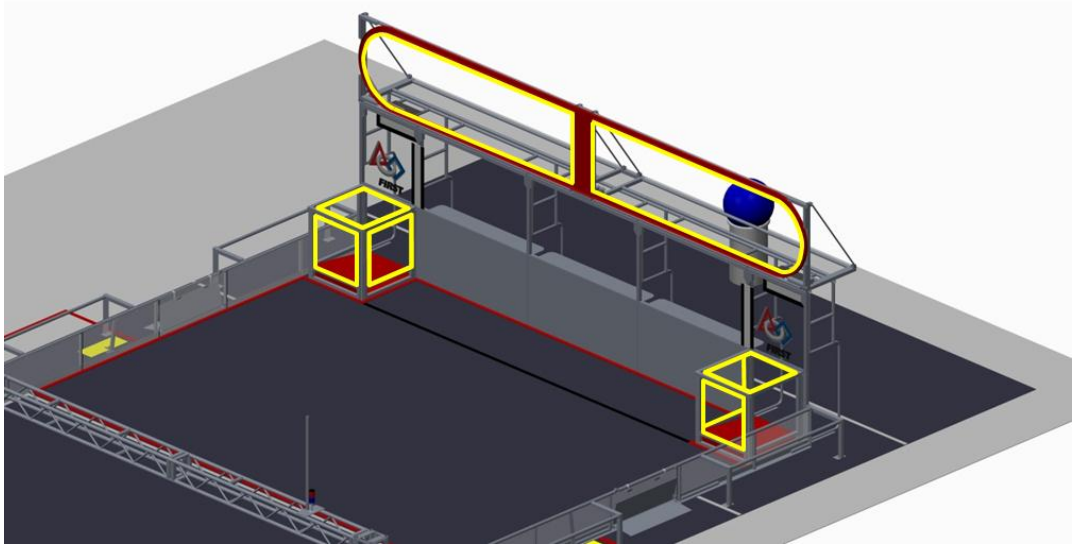


Figure 3-2: Red ALLIANCE'S six (6) LOW and two (2) HIGH GOAL Openings

A BALL is considered SCORED over the TRUSS if a ROBOT causes a BALL to pass though the infinitely tall plane that is bounded by the top of the TRUSS and the TRUSS POLES toward the ALLIANCE'S GOALS (e.g. a red BALL towards the red GOALS). This plane is depicted in yellow in Figure 3-3.

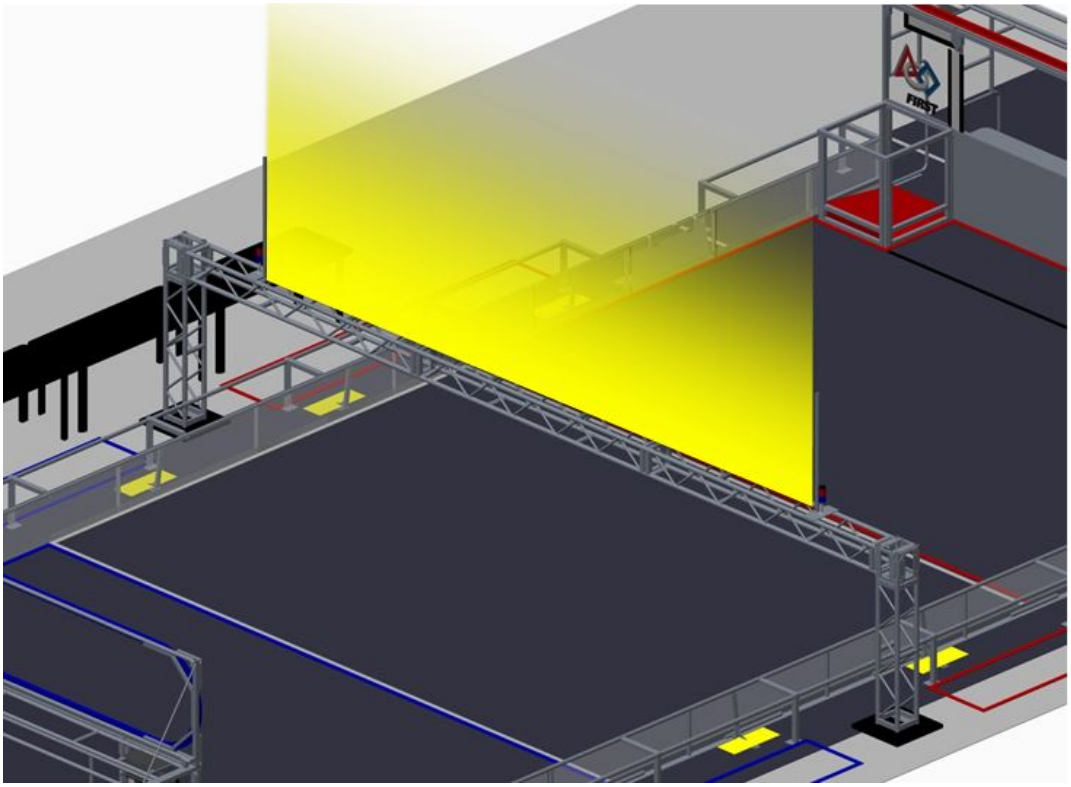


Figure 3-3: TRUSS Scoring Plane

An opponent ROBOT that contacts, but fails to stop a BALL from going over the TRUSS or in a GOAL has not caused either of these actions and does not invalidate the SCORE.

A CATCH occurs when a BALL SCORED over the TRUSS by a ROBOT'S ALLIANCE partner is POSSESSED by that ROBOT before contacting the carpet or HUMAN PLAYER.

An ALLIANCE receives CATCH points only if the CATCH is directly preceded by a TRUSS SCORE. This means that an ALLIANCE can only receive CATCH points once per CYCLE and will not receive CATCH points if the TRUSS SCORE criteria are not met.

Base point values are as follows:

LOW GOAL	1
HIGH GOAL	10
CATCH	10
TRUSS	10

ASSISTS are earned when a unique ALLIANCE ROBOT POSSESSES the ALLIANCE'S BALL in a unique ZONE (i.e. red, white, or blue ZONE) during a CYCLE. A ROBOT is considered in a ZONE if it is in contact with the carpet in a ZONE or the tape marking the ZONE, but not in contact with carpet or tape for another ZONE. Because there are up to three (3) ALLIANCE ROBOTS and three (3) ZONES, the maximum number of ASSISTS in a single CYCLE is three (3). Examples of the number of ASSISTS credited to an ALLIANCE are shown in Figure 3-4 (X = POSSESSION, yellow highlight = credited ASSIST, ROBOT IDs are across the top, ZONES are depicted by color).

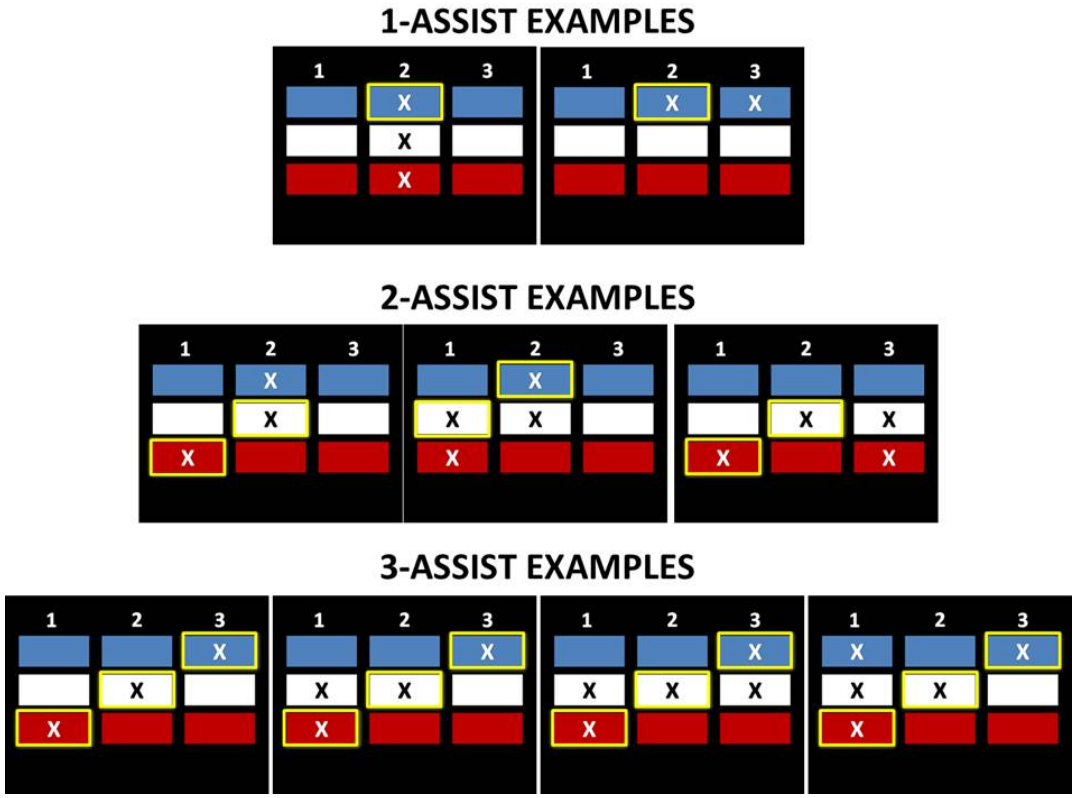


Figure 3-4: ASSIST Examples

ALLIANCEs earn one bonus for each BALL SCORED in a GOAL based on the number of ASSISTS in that CYCLE. The corresponding points for accrued ASSISTS are as follows:

1 ASSIST	+0
2 ASSISTS	+10
3 ASSISTS	+30

All GOALS SCORED during AUTO will earn a five (5)-point bonus. If the BALL is SCORED in a HOT GOAL, the ALLIANCE earns an additional five (5)-point bonus. Each pair of an ALLIANCE'S LOW and HIGH GOALS are sequentially HOT for five (5) seconds during AUTO; the first pair to be HOT is determined randomly by the FMS. The pairs are the same for each ALLIANCE, relative to their ROBOTS' perspective. For details regarding HOT GOAL indication, please reference *The ARENA Section 2.2.3: The GOALS*.

ALLIANCES earn an additional five (5)-point Mobility bonus for each ROBOT that fully crosses in to their ZONE (e.g. a red ROBOT fully crosses in to the red ZONE) during AUTO (such that the entire ROBOT is contained in their ZONE at some point during AUTO).

Cumulative point values are included in Table 3-2.

Table 3-2: Cummulative Point Values

Action	Base	AUTO (=Base+5)	AUTO & HOT (=Base+AUTO+5)	1 ASSIST (=Base+0)	2 ASSIST (=Base+10)	3 ASSIST (=Base+30)
LOW GOAL	1	6	11	1	11	31
HIGH GOAL	10	15	20	10	20	40
TRUSS	10					
Mobility		5				
CATCH	10					

As competition at the *FIRST* Championship is typically different from that during the competition season, *FIRST* may alter each scoring value at the *FIRST* Championship by up to ten (10) points.

3.2 Game Rules

The rules in this section legislate game play and define the consequences for rule violations.

3.2.1 Safety

3.2.1.1 G1

Teams may only enter the FIELD if the PLAYER STATION LED strings are green.

Violation: YELLOW CARD

3.2.1.2 G2

Teams may not climb on any FIELD element.

Violation: YELLOW CARD

3.2.1.3 G3

ROBOTS whose operation or design is unsafe are not permitted.

Violation: FOUL & DISABLED. If the issue is due to design: Re-Inspection.

An example of unsafe operation would be uncontrolled motion that cannot be stopped by the DRIVERS.

3.2.2 Pre-MATCH

3.2.2.1 G4

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. entirely within their GOALIE ZONE, or
   entirely within the white ZONE and between the TRUSS and their GOALS, and
D. fully supported by the floor.

TEAMS positioning ROBOTS in the white ZONE have precedence over opponents placing ROBOTS in the GOALIE ZONE.

Violation: If fix is a quick remedy: the MATCH won't start until all requirements are met. If it is not a quick remedy: the ROBOT will be DISABLED and must be re-Inspected.

3.2.2.2 G5

For ROBOTS starting in the white ZONE, the TEAM may preload one (1) of their ALLIANCE's BALLS such that the BALL is touching their ROBOT.

For ROBOTS starting in their GOALIE ZONE the TEAM may decide if the BALL is: staged between the TRUSS and the ZONE LINE and not contacting an ALLIANCE partner, or removed from the FIELD for the MATCH.

If a ROBOT does not report to a MATCH, its ALLIANCE may decide if the BALL is: staged between the TRUSS and

the ZONE LINE and not contacting an ALLIANCE partner, or removed from the FIELD for the MATCH.

Violation: If the situation is not corrected before the start of the MATCH, TECHNICAL FOUL per BALL improperly staged.

3.2.2.3 G6

TEAMS may not cause significant or repeated delays to the start of a MATCH.

Violation: ROBOT will be DISABLED.

TEAMS are expected to stage their ROBOTS for a MATCH safely and swiftly. TEAM efforts that, either intentionally or unintentionally, delay the start of a MATCH will not be tolerated. Examples of such delays include, but are not limited to:

A. use of alignment devices such as templates, tape measures, laser pointers, etc. to precisely place and/or align the ROBOT

B. late arrival to the FIELD

C. being indecisive about where/how to position a ROBOT

D. installing BUMPERS, charging pneumatic systems, or any other ROBOT maintenance or assembly, once on the FIELD

3.2.2.4 G7

TEAMS may not leave items other than ROBOTS on the FIELD prior to or during the MATCH.

Violation: The MATCH will not start until the situation is corrected.

3.2.2.5 G8

Each TEAM member must be in designated areas:

A. COACHES and DRIVERS must be in the ALLIANCE STATION and behind the STARTING LINE.
B. HUMAN PLAYERS must be either in one of their HUMAN PLAYER AREAS or in the ALLIANCE STATION and behind the STARTING LINE.

Violation: MATCH will not start until the situation is corrected.

3.2.3 General Rules

3.2.3.1 G9

Only TEAM members and their ROBOT may report to the ARENA for a MATCH. TEAM members are limited to:

A. 1 COACH,
B. 2 DRIVERS, and
C. 1 HUMAN PLAYER

Violation: MATCH will not start until the situation is corrected.

3.2.3.2 G10

The following actions are prohibited with regards to interaction with FIELD elements (excluding BALLS):

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.

BALLS are expected to undergo a reasonable amount of wear and tear as they are handled by ROBOTS, such as scratches and occasional marks. ROBOTS that pop, rip, or routinely mark BALLS will be considered in violation of G10.

3.2.3.3 G11

BALLS may not be intentionally or repeatedly ejected from gameplay.

Violation: FOUL per instance.

Passing a BALL to a HUMAN PLAYER is within gameplay and not considered a violation of G11.

3.2.3.4 G12

An ALLIANCE may not POSSESS their opponent’s BALLS. The following criteria define POSSESSION :

A. “carrying” (moving while supporting BALLS in or on the ROBOT),
B. “herding” (repeated pushing or bumping),
C. “launching” (impelling BALLS to a desired location or direction), and
D. “trapping” (overt isolation or holding one or more BALLS against a FIELD element or ROBOT in an attempt to shield them).

Violation: TECHNICAL FOUL per instance. If extended, another TECHNICAL FOUL. If strategic, RED CARD for the ALLIANCE.

Examples of BALL interaction that are not POSSESSION are

A. “bulldozing” (inadvertently coming in contact with BALLS that happen to be in the path of the ROBOT as it moves about the FIELD) and

B. “deflecting” (being hit by a propelled BALL that bounces or rolls off the ROBOT).

A BALL that becomes unintentionally lodged on a ROBOT will be considered POSSESSED by the ROBOT. It is important to design your ROBOT so that it is impossible to inadvertently or intentionally POSSESS an opponent’s BALL.

3.2.3.5 G13

All Teams must be civil towards other Teams, competition personnel, and event attendees.

Violation: Potential RED CARD for violations in the ARENA.

Teams will not receive RED/YELLOW CARDS for off-ARENA actions; however, designated competition personnel will hold them accountable for their off-ARENA actions.

3.2.3.6 G14

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

Violation: TECHNICAL FOUL

3.2.4 AUTO Rules

3.2.4.1 G15

During AUTO,

A. a ROBOT starting in the white ZONE may not cross fully beyond the TRUSS
B. a ROBOT starting in its GOALIE ZONE must remain in contact with the carpet in its GOALIE ZONE.

Violation: FOUL. If contact with an opponent ROBOT, TECHNICAL FOUL.

3.2.4.2 G16

During AUTO, TEAM members in the ALLIANCE STATION must remain behind the STARTING LINE and may not contact the OPERATOR CONSOLE.

Violation: FOUL. If contact with the OPERATOR CONSOLE, TECHNICAL FOUL.

Exceptions will be made for person or equipment safety situations (e.g. catching a falling OPERATOR CONSOLE).

3.2.4.3 G17

During AUTO, any control devices worn or held by the DRIVERS must be disconnected from the OPERATOR CONSOLE.

Violation: FOUL

3.2.5 ROBOT Actions

3.2.5.1 G18

ROBOTS may be neither fully nor partially supported by other ROBOTS.

Violation: If extended, strategic, or repeated, TECHNICAL FOUL.

3.2.5.2 G19

ROBOTS may not intentionally detach or leave parts on the FIELD.

Violation: TECHNICAL FOUL

3.2.5.3 G20

ROBOTS must be in compliance with *Section 4.6: BUMPER Rules* throughout the MATCH.

Violation: DISABLED

3.2.5.4 G21

ROBOTS may not extend outside the FIELD.

Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL. If contact with anything outside the FIELD, RED CARD and the ROBOT will be DISABLED.

3.2.5.5 G22

If a ROBOT is not in contact with the carpet in its GOALIE ZONE, its height (as defined in relation to the FIELD) must not exceed 5 ft.

Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL.

3.2.5.6 G23

If a ROBOT is in contact with carpet in its GOALIE ZONE, and for only one ROBOT per ALLIANCE at a time, there is no height restriction; however, any extension or combination of extensions above 5 ft. may not extend beyond a vertical cylinder with a 6 in. diameter (see examples in Figure 3-5).

Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL.

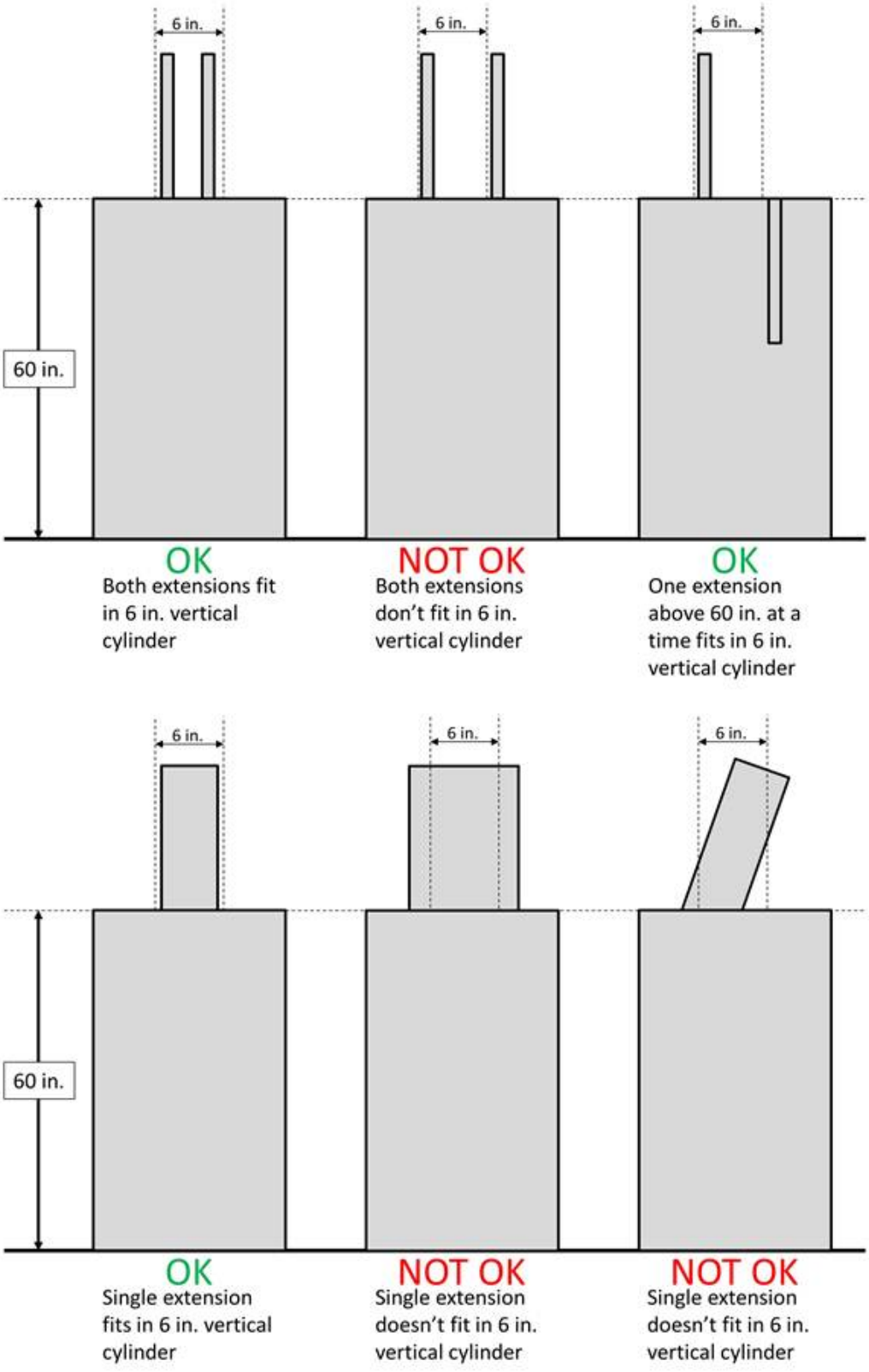


Figure 3-5: Height Extension Examples

3.2.5.7 G24

A ROBOT'S horizontal dimensions may never exceed 20 in. beyond its FRAME PERIMETER (see illustration in Figure 3-6).

Violation: FOUL. If continuous or repeated violations, TECHNICAL FOUL.

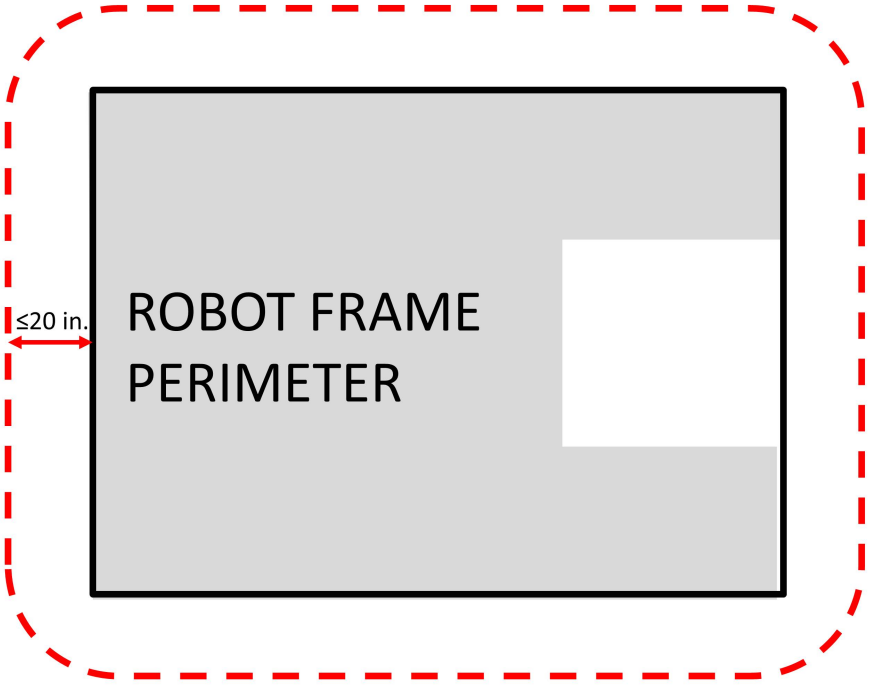


Figure 3-6: FRAME PERIMETER Extension

3.2.5.8 G25

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

3.2.5.9 G26

ROBOTS may not intentionally fall down or tip over to block the FIELD.

Violation: TECHNICAL FOUL

3.2.5.10 G26-1

ROBOTS may not break the planes of the openings of the opponent's LOW GOALS.

Violation: FOUL. If extended, strategic, or repeated, TECHNICAL FOUL.

3.2.6 ROBOT-ROBOT Interaction

3.2.6.1 G27

Strategies aimed at the destruction or inhibition of ROBOTS via attachment, damage, tipping, or entanglement of ROBOTS are not allowed.

Violation: TECHNICAL FOUL and YELLOW CARD

For example, use of wedge-like MECHANISM to flip ROBOTS would be considered a violation of G27.

3.2.6.2 G28

Deliberate or damaging contact with an opponent ROBOT on or inside its FRAME PERIMETER is not allowed.

Violation: TECHNICAL FOUL

High speed accidental collisions may occur during the MATCH and are expected. ROBOTS extend elements outside of the FRAME PERIMETER at their own risk; no penalties will be assigned for contact between two such extended elements.

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 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.

3.2.6.3 G29

An ALLIANCE may not pin an opponent ROBOT for more than five (5) seconds. A ROBOT will be considered pinned until the ROBOTS have separated by at least six (6) ft. The pinning ROBOT(S) must then wait for at least three (3) seconds before attempting to pin the same ROBOT again. Pinning is transitory through other objects.

Violation: TECHNICAL FOUL

If the pinned ROBOT chases the pinning ROBOT upon retreat, the pinning ROBOT will not be penalized per G29, and the pin will be considered complete.

3.2.6.4 G30

Fallen (i.e. tipped over) ROBOTS attempting to right themselves (either by themselves or with assistance from an ALLIANCE partner) have one (1) ten (10)-second grace period per fallen ROBOT in which the fallen ROBOT may not be contacted by an opposing ROBOT.

This protection lasts for either ten (10) seconds or until the protected ROBOT has completed the righting operation, whichever comes first.

Violation: If inadvertent, FOUL. If intentional, TECHNICAL FOUL.

Once the 10-second grace period for righting a fallen ROBOT has expired, opposing ROBOTS may interact with a fallen ROBOT with no FOUL assessed as long as G27 is not violated (as applied to the fallen over ROBOT).

3.2.7 Human Actions

3.2.7.1 G31

Strategies employing HUMAN PLAYER actions to inhibit ROBOTS are not allowed.

Violation: TECHNICAL FOUL.

3.2.7.2 G32

Strategies employing HUMAN PLAYER actions to deflect opponents' BALLS are not allowed.

Violation: TECHNICAL FOUL

3.2.7.3 G33

The COACH must wear the designated "COACH" button while in the ARENA.

Violation: MATCH will not start until the situation is corrected.

3.2.7.4 G34

COACHES may not touch BALLS. Inadvertent or inconsequential contact will not be penalized.

Violation: FOUL

3.2.7.5 G35

BALLS may only be retrieved from the PEDESTAL and only if the PEDESTAL is lit in the ALLIANCE’s color.

Violation: TECHNICAL FOUL. If the BALL is entered into the FIELD, a second TECHNICAL FOUL and the BALL is considered FIELD debris.

3.2.7.6 G36

A BALL inbounded after retrieval from the PEDESTAL must first contact a ROBOT or the carpet on its DRIVERS’ end of the FIELD before crossing beyond the TRUSS.

Violation: TECHNICAL FOUL

3.2.7.7 G37

A BALL inbounded after retrieval from the PEDESTAL must be entered on to the FIELD from the side of the FIELD (i.e. over the GUARDRAIL).

Violation: TECHNICAL FOUL

3.2.7.8 G38

HUMAN PLAYERS may not pass the BALL to a HUMAN PLAYER in another HUMAN PLAYER AREA (passing the BALL within an ALLIANCE STATION or HUMAN PLAYER AREA is permitted).

Violation: FOUL

3.2.7.9 G39

During the MATCH, TEAMS must remain in contact with the area of the FIELD (ALLIANCE STATION or HUMAN PLAYER AREA) in which they started the MATCH. Exceptions will be granted for inadvertent, momentary, and inconsequential infractions and in cases concerning safety.

Violation: FOUL

3.2.7.10 G40

TEAMS may not extend any body part into the FIELD during the MATCH.

Violation: TECHNICAL FOUL.

If not actively engaged with receiving or releasing a BALL, we strongly recommend that TEAMS stay fully behind the HUMAN PLAYER BARRIER during the MATCH.

3.2.7.11 G41

TEAMS may not contact any ROBOT or any BALL in contact with a ROBOT at any time during the MATCH.

Violation: TECHNICAL FOUL

3.2.7.12 G42

During a MATCH, the ROBOT shall be operated solely by the DRIVERS of that TEAM.

Violation: TECHNICAL FOUL

Exceptions may be made before a MATCH for major conflicts, e.g. religious holidays, major testing, transportation issues, etc.

3.3 Revision History

Date	Section	Change
1/7/2014	3.1.4	Added detail on SCORING opportunities for BALLS with which the ALLIANCE begins the MATCH.
1/7/2014	G4	Added "TEAMS positioning ROBOTS in the white ZONE have precedence over opponents placing ROBOTS in the GOALIE ZONE."
1/7/2014	G26-1	Added rule.
1/10/2014	3.1.2	Added detail on process by which an ALLIANCE can request a new BALL if their BALL becomes stuck in a ROBOT.
1/10/2014	G12	Added "If extended, another TECHNICAL FOUL. If strategic, RED CARD for the ALLIANCE." to violation of rule.
1/10/2014	G14	Corrected rule number from G16 to G14.

4 The Robot

This section of the *2014 FRC® Game Manual* presents legislation relevant to the construction of a 2014 *FIRST*® Robotics Competition (FRC) ROBOT. ROBOTS will be Inspected at each FRC event to confirm compliance before being allowed to compete, per *Section 5.5.2: Eligibility and Inspection*.

The rules listed below explicitly address what and how parts and materials may be used on a 2014 FRC ROBOT. There are many reasons for the structure of the rules, including safety, reliability, parity, creation of a reasonable design challenge, adherence to professional standards, impact on the competition, compatibility with the Kit of Parts (the collection of items listed on any *Kit of Parts Checklist*, has been distributed via *FIRST*® Choice, or obtained via a Product Donation Voucher (PDV), KOP), etc. When reading these rules, please use technical common sense (engineering thinking) rather than "lawyering" the interpretation and splitting hairs over the precise wording in an attempt to find loopholes. Try to understand the reasoning behind a rule.

In addition, another intent of these rules is to have all energy sources and active actuation systems on the ROBOT (e.g. batteries, compressors, motors, servos, cylinders, and their controllers) drawn from a well-defined set of options. This is to ensure that all Teams have access to the same actuation resources, and to ensure that the Inspectors are able to accurately assess the legality of a given part.

Teams may be asked to provide documentation proving legality of non-2014 KOP items during Inspection where a Rule specifies limits for a legal part (e.g. pneumatic items, current limits, COTS electronics, etc.).

Some of these rules make use of English unit requirements for parts. If your team has a question about a metric-equivalent part's legality, please e-mail your question to frcparts@usfirst.org for an official ruling. To seek approval for alternate devices for inclusion in future FRC seasons, please contact frcparts@usfirst.org with item specifications.

Teams should acknowledge the support provided by the corporate Sponsors and Mentors with an appropriate display of their school and Sponsors names and logos (or the name of the supporting youth organization, if appropriate).

FRC is a full-contact ROBOT competition and may include rigorous game play. While Game and ROBOT Rules limit severe damage to ROBOTS, Teams should design their ROBOTS to be robust.

4.1 General ROBOT Design

4.1.1 R1

Each registered FRC team may enter only one (1) ROBOT into the 2014 FRC. The ROBOT must be built by the FRC Team to perform specific tasks when competing in AERIAL ASSIST. The ROBOT must include all of the basic systems required to be an active participant in the game – power, communications, control, and mobility. The ROBOT implementation must obviously follow a design approach intended to play AERIAL ASSIST (e.g. a box of unassembled parts placed on the FIELD, or a ROBOT designed to play a different game would not satisfy this definition).

4.1.2 R2

The ROBOT must have a FRAME PERIMETER, contained within the BUMPER ZONE, that is comprised of fixed, non-articulated structural elements of the ROBOT. Minor protrusions no greater than ¼ in. such as bolt heads, fastener ends, and rivets are not considered part of the FRAME PERIMETER.

To determine the FRAME PERIMETER, wrap a piece of string around the ROBOT at the BUMPER ZONE described in R22. The string describes this polygon.

Note: to permit a simplified definition of the FRAME PERIMETER and encourage a tight, robust connection between the BUMPERS and the FRAME PERIMETER, minor protrusions such as bolt heads, fastener ends, rivets, etc. are excluded from the determination of the FRAME PERIMETER.

4.1.3 R3

The ROBOT must satisfy the following size constraints:

A. the total length of the FRAME PERIMETER sides may not exceed 112 in. (see Figure 4-1 for examples),
B. a ROBOT may not extend more than 20 in. beyond the FRAME PERIMETER (see Figure 4-2 for examples) (see G24), and
C. the ROBOT height may not exceed 60 in., except as allowed by G23.
D. Any extension above 60 in. may not exceed a 6 in. diameter vertical cylinder (see Figure 4-3 and Figure 4-4 for examples), per G23.

Size constraints may be met with either hardware or software.

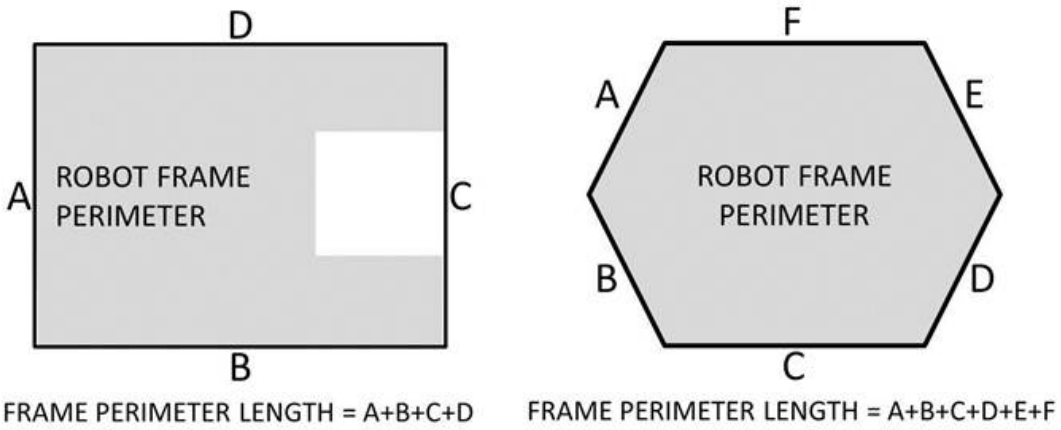


Figure 4-1: FRAME PERIMETER Length Calculation

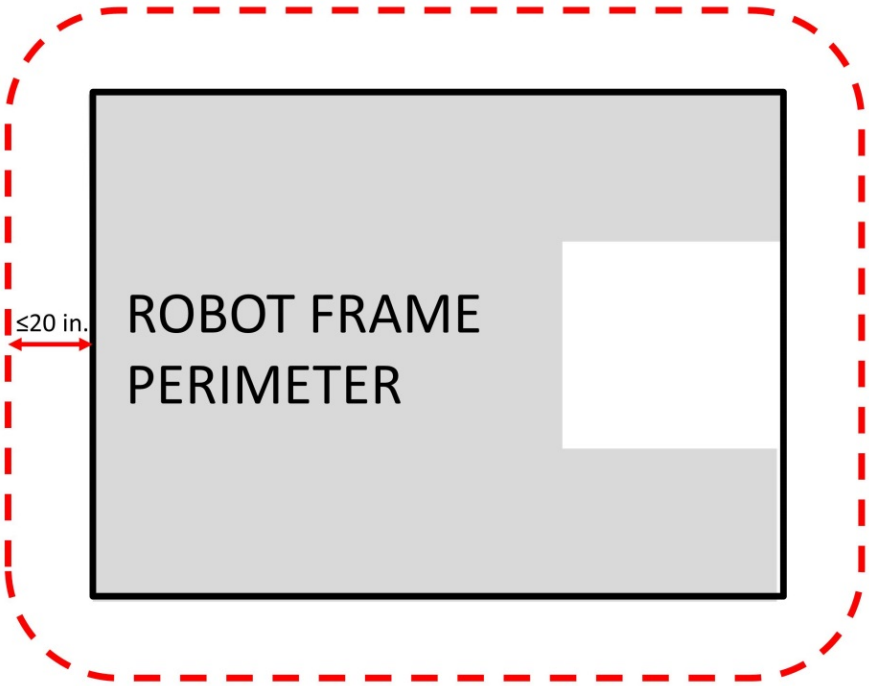


Figure 4-2: FRAME PERIMETER Extension

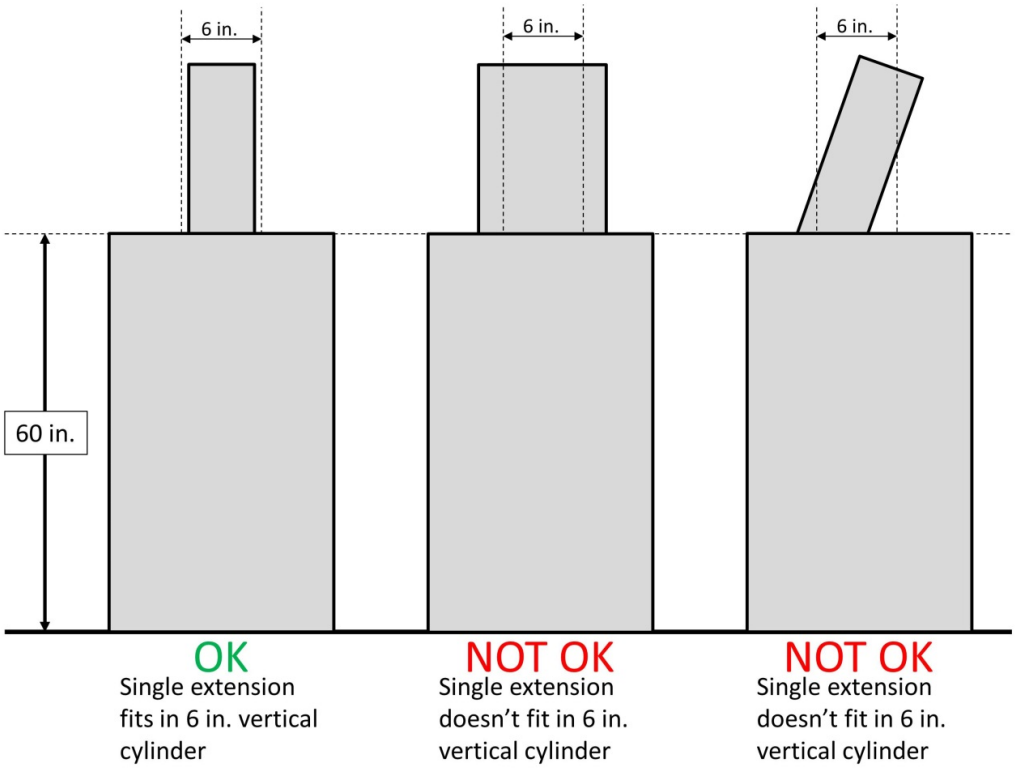


Figure 4-3: Single Vertical Extension Examples

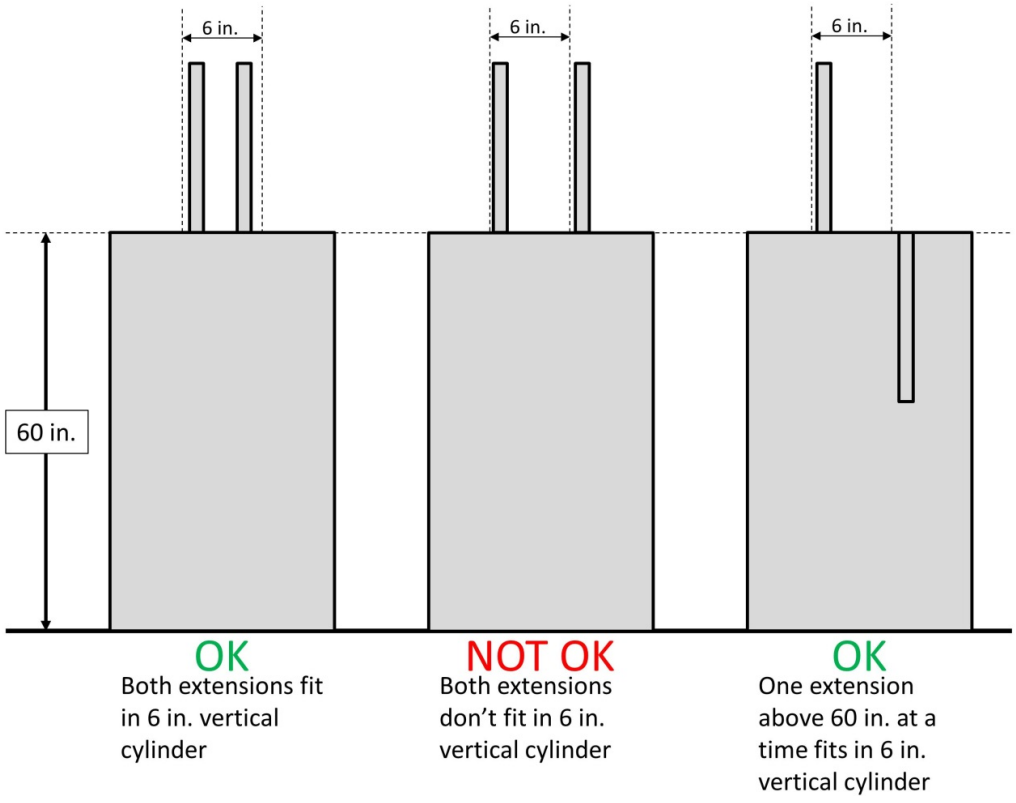


Figure 4-4: Multiple Vertical Extension Examples

4.1.4 R4

In the STARTING CONFIGURATION, the ROBOT must constrain itself such that no part of the ROBOT extends outside the vertical projection of the FRAME PERIMETER, with the exception of minor protrusions such as bolt heads, fastener ends, rivets, etc.

If a ROBOT is designed as intended and pushed up against a vertical wall (in STARTING CONFIGURATION and with BUMPERS removed), only the FRAME PERIMETER (or minor protrusions) will be in contact with the wall.

4.1.5 R5

The ROBOT weight may not exceed 120 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 items listed below are not included in the weight assessment:

A. the ROBOT battery and its associated half of the Anderson cable quick connect/disconnect pair (including no more than 12 in. of cable per leg, the associated cable lugs, connecting bolts, and insulation) and
B. BUMPERS (including BUMPER covers, if appropriate).

4.1.6 R6

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 FIELD carpet.

4.1.7 R7

ROBOTS must allow removal of BALLS from the ROBOT and the ROBOT from FIELD elements while DISABLED and powered off.

ROBOTS will not be re-enabled after the MATCH, so Teams must be sure that BALLS and ROBOTS can be quickly, simply, and safely removed.

4.2 Safety & Damage Prevention

4.2.1 R8

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

Examples of items that will violate R8include (but are not limited to):

A. Shields, curtains, or any other devices or materials designed or used to obstruct or limit the vision of any DRIVERS and/or COACHES and/or interfere with their ability to safely control their ROBOT

B. Speakers, sirens, air horns, or other audio devices that generate sound at a level sufficient to be a distraction

C. Any devices or decorations specifically intended to jam or interfere with the remote sensing capabilities of another ROBOT, including vision systems, acoustic range finders, sonars, infrared proximity detectors, etc. (e.g. including imagery on your ROBOT that, to a reasonably astute observer, mimics the VISION TARGET)

D. Exposed lasers other than Class I.

E. Flammable gasses

F. Any device intended to produce flames or pyrotechnics

G. Hydraulic fluids or hydraulic items

Teams should provide MSD Sheets for any materials they use that might be considered questionable during ROBOT Inspection.

4.2.2 R9

Protrusions from the ROBOT and exposed surfaces on the ROBOT shall not pose hazards to the ARENA elements (including the GAME PIECES) or people.

If the ROBOT includes protrusions that form the “leading edge” of the ROBOT as it drives and have 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.

4.3 Budget Constraints

4.3.1 R10

The total cost of all items on the ROBOT shall not exceed $4000 USD. All costs are to be determined as explained in *Section 4.3: Budget Constraints*. Exceptions are as follows:

A. individual COTS 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.

There is no quantity limit on KOP items in regards to R10. If the item is a KOP item, it does not require an associated cost on the BOM.

Per T9, Teams must be prepared to display a Bill of Materials (BOM) to Inspectors during Inspection. The BOM may be displayed in either printed or electronic form.

Individual COMPONENTS or MECHANISMS, not excluded in R10, that are retrieved from previous ROBOTS and used on 2014 ROBOTS must have their undepreciated cost included in the 2014 BOM and applied to the overall cost assessment.

4.3.2 R11

No individual item shall have a value that exceeds $400 USD. The total cost of COMPONENTS purchased in bulk may exceed $400 as long as the cost of an individual COMPONENT does not exceed $400.

If a COTS item is part of a modular system that can be assembled in several possible configurations, then each individual module must fit within the price constraints defined in R11.

If the modules are designed to assemble into a single configuration, and the assembly is functional in only that configuration, then the total cost of the complete assembly including all modules must fit within the price constraints defined in R11.

In summary, if a VENDOR sells a system or a kit, a team must use the entire system/kit Fair Market Value and not the value of its COMPONENT pieces.

Example 1: VENDOR A sells a gearbox that can be used with a number of different gear sets, and can mate with two different motors they sell. A team purchases the gearbox, a gear set, and a motor (which are not offered together as an assembly or kit), then assembles them together. Each part is treated separately for the purpose of BOM costing, since the purchased pieces can each be used in various configurations.

Example 2: VENDOR B sells a robotic arm assembly that the team wants to use. However, it costs $700, so they cannot use it. The Vendor sells the “hand”, “wrist”, and “arm” as separate assemblies, for $200 each. A team wishes to purchase the three items separately, then reassemble them. This would not be legal, as they are really buying and using the entire assembly, which has a Fair Market Value of $700.

4.3.3 R12

The BOM cost of each non-KOP item must be calculated based on the unit fair market value for the material and/or labor, except for labor provided by team members (including sponsor employees who are members of the team) and shipping.

Example 1: A Team orders a custom bracket made by a company to the Team's specification. The company’s material cost and normally charged labor rate apply.

Example 2: A Team receives a donated sensor. The company would normally sell this item for $52, which is therefore its fair market value.

Example 3: Special price discounts from National Instruments and other FRC Suppliers are being offered to all *FIRST* Teams. The discounted purchase price of items from these sources may be used in the additional parts accounting calculations.

Example 4: A Team purchases steel bar stock for $10 and has it machined by a local machine shop. The machine shop is not considered a team Sponsor, but donates two (2) hours of expended labor anyway. The Team must include the estimated normal cost of the labor as if it were paid to the machine shop, and add it to the $10.

Example 5: A Team purchases steel bar stock for $10 and has it machined by a local machine shop that is a recognized Sponsor of the Team. If the machinists are considered members of the Team, their labor costs do not apply. The total applicable cost for the part would be $10.

It is in the best interests of the Teams and *FIRST* to form relationships with as many organizations as possible. Teams are encouraged to be expansive in recruiting and including organizations in their team, as that exposes more people and organizations to *FIRST*. Recognizing supporting companies as Sponsors of, and members in, the Team is encouraged, even if the involvement of the Sponsor is solely through the donation of fabrication labor.

Example 6: A Team purchases a 4 by 4 ft sheet of aluminum, but only uses a piece 10 by 10 in. on their ROBOT. The Team identifies a source that sells aluminum sheet in 1 by 1 ft pieces. The Team may cost their part on the basis of a 1 by 1 ft piece, even though they cut the piece from a larger bulk purchase. They do not have to account for the entire 4 by 4 ft bulk purchase item.

4.4 Fabrication Schedule

4.4.1 R13

ROBOT elements created before Kickoff are not permitted. ROBOT elements, including software, that are designed before Kickoff are not permitted, unless they or their source files are publicly available prior to Kickoff.

Please note that this means that FABRICATED ITEMS from ROBOTS entered in previous *FIRST* competitions may not be used on ROBOTS in the 2014 FRC. Before the formal start of the FRC Build Season, Teams are encouraged to think as much as they please about their ROBOTS. They may develop prototypes, create proof-of-concept models, and conduct design exercises. Teams may gather all the raw stock materials and COTS COMPONENTS they want.

Example 1: A Team designs and builds a two-speed shifting transmission during the fall as a training exercise. After Kickoff, they utilize all the design principles they learned in the fall to design their ROBOT. To optimize the transmission design for their ROBOT, they improve the transmission gear ratios and reduce the size, and build two new transmissions, and place them on the ROBOT. All parts of this process are permitted activities.

Example 2: The same Team realizes that the transmission designed and built in the fall perfectly fits their need for a transmission to drive the ROBOT arm. They build an exact copy of the transmission from the original design plans, and bolt it to the ROBOT. This would be prohibited, as the transmission – although made during the competition season – was built from detailed designs developed prior to Kickoff.

Example 3: A Team developed an omni-directional drive system for the 2011 competition. Over the summer of 2011 they refined and improved the control software (written in C) to add more precision and capabilities. They decided to use a similar system for the 2014 competition. They copied large sections of unmodified code over into the control software of the new ROBOT (also written in C). This would be a violation of the schedule constraint, and would not be allowed.

Example 4: The same Team decides to use LabVIEW as their software environment for 2014. Following Kickoff, they use the previously-developed C code as a reference for the algorithms and calculations required to implement their omni-directional control solution. Because they developed new LabVIEW code as they ported over their algorithms, this would be permitted.

Example 5: A different Team develops a similar solution during the fall, and plans to use the developed software on their competition ROBOT. After completing the software, they post it in a generally accessible public forum and make the code available to all Teams. Because they have made their software publicly available before Kickoff, they can use it on their ROBOT.

4.4.2 R14

The ROBOT (including items intended for use during the competition in alternative configurations of the ROBOT,

excluding items permitted per R17) must be bagged or crated (as appropriate for your event), and out of Team hands by Stop Build Day, February 18, 2014 (refer to the *FRC Administrative Manual, Section 5* for more details).

4.4.3 R15

Teams must stay “hands-off” their ROBOT during the following time periods:

A. from Stop Build Day until their first event,
B. during the period(s) between their events, and
C. outside of Pit hours while attending events.

Modifying parts at night offsite (e.g. pits have closed and you bring a MECHANISM back to the hotel to fix it) is a violation of R15-C.

Additional time is allowed as follows:

D. There are no restrictions on when software may be developed.
E. On days a team is not attending an event, they may continue development of any items permitted per R18, including items listed as exempt from R18, but must do so without interfacing with the ROBOT.
F. Teams attending 2-day events may access their ROBOTS per the rules defined in the *Administrative Manual, Section 5.6, ROBOT Access Period - for Teams Attending 2-Day Events*.
G. ROBOTS may be exhibited per *Administrative Manual Section 5.4.3: Robot Displays*.

4.5 Material Utilization

4.5.1 R16

Items that are no longer commercially available but are functionally equivalent to the original condition as delivered from the VENDOR are considered COTS and may be used.

Example 1: A part that has non-functional label markings added would be permitted, but a part that has device-specific mounting holes added would be prohibited.

Example 2: A team has a COTS single-board processor version 1.0, which can no longer be purchased. Only the COTS single-board processor version 2.0 may be purchased. If the COTS single-board processor version 1.0 is functionally equivalent to its original condition, it may be used.

Example 3: A team has a COTS gearbox which has been discontinued. If the COTS gearbox is functionally equivalent to its original condition, it may be used.

4.5.2 R17

Lubricants may be used only to reduce friction within the ROBOT. Lubricants may not contaminate the ARENA or other ROBOTS.

4.5.3 R18

At an Event, Teams may have access to a static set of FABRICATED ITEMS that shall not exceed 30 lbs to be used to repair and/or upgrade their ROBOT. Items made at an Event do not count towards this weight limit.

For Teams attending 2-Day Events, these FABRICATED ITEMS may be used during the Robot Access Period and/or brought to the Event, but the total weight may not exceed 30 lbs. FABRICATED ITEMS constructed during the Robot Access Period and bagged with the ROBOT are exempt from this limit.

Items exempt from this limit are:

A. the OPERATOR CONSOLE,
B. BUMPERS, and
C. any ROBOT battery assemblies (as described in R5-A).

4.6 BUMPER Rules

4.6.1 R19

ROBOTS are required to use BUMPERS to protect all outside corners of the FRAME PERIMETER. For adequate protection, at least 8 in. of BUMPER must be placed on each side of each outside corner (see Figure 4-5). If a side is shorter than 8 in., the entire side must be protected by BUMPER (see Figure 4-6). For the purposes of R19, a round or circular FRAME PERIMETER has an infinite number of corners.

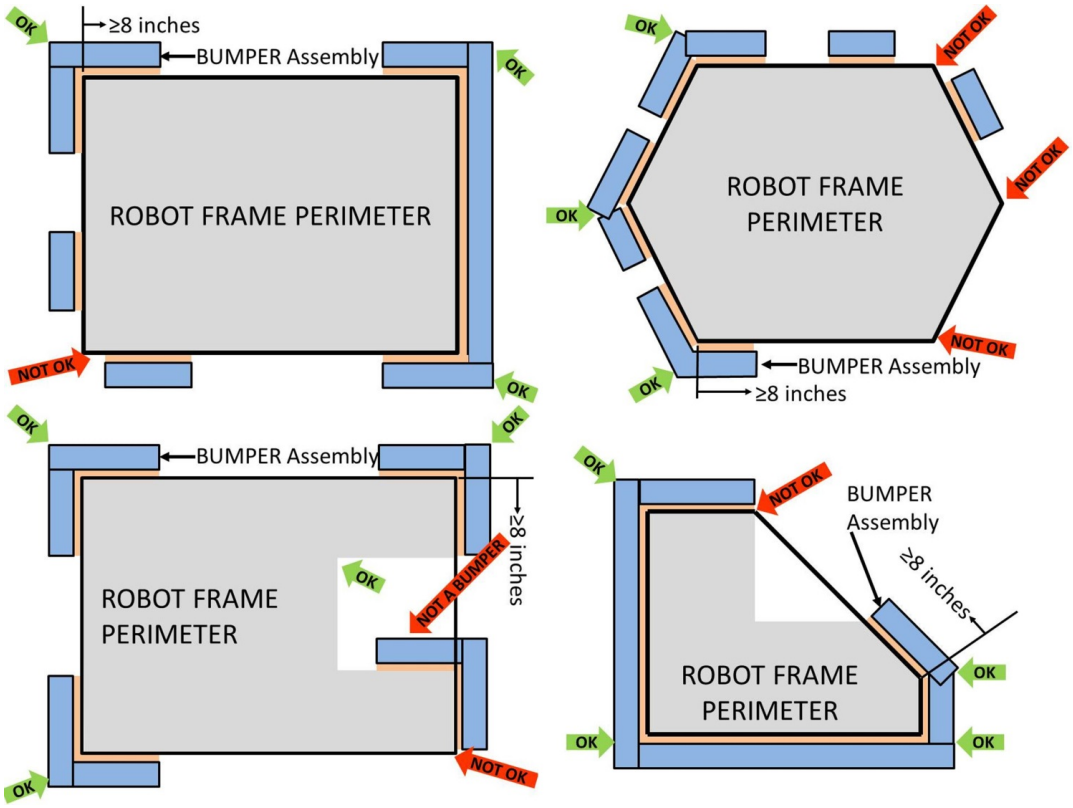


Figure 4-5: BUMPER Corner Examples

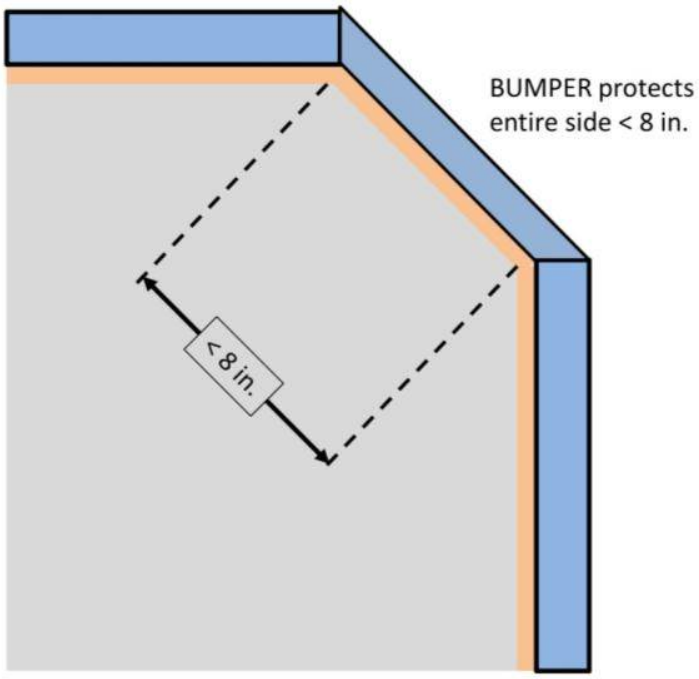


Figure 4-6: BUMPER Side Less Than 8 in.

4.6.2 R20

Each set of BUMPERS (including any fasteners and/or structures that attach them to the ROBOT) shall not weigh more than 20 lbs.

If a multi-part attachment system is utilized (e.g. interlocking brackets on the ROBOT and the BUMPER), then the elements permanently attached to the ROBOT will be considered part of the ROBOT, and the elements attached to the BUMPERS will be considered part of the BUMPER. Each element must satisfy all applicable rules for the relevant system.

4.6.3 R21

BUMPERS must be constructed as follows (see Figure 4-8):

A. be backed by ¾ in. (nominal) thick by 5 in. (± ½ in) tall plywood or solid, robust wood.

Particle board or chipboard is not likely to survive the rigors of FRC gameplay and thus not compliant with R21-A.

B. hard BUMPER parts allowed per R21-A, -E, and -F may not extend more than 1 in. beyond the end of the FRAME PERIMETER (see Figure 4-7 and Figure 4-8).

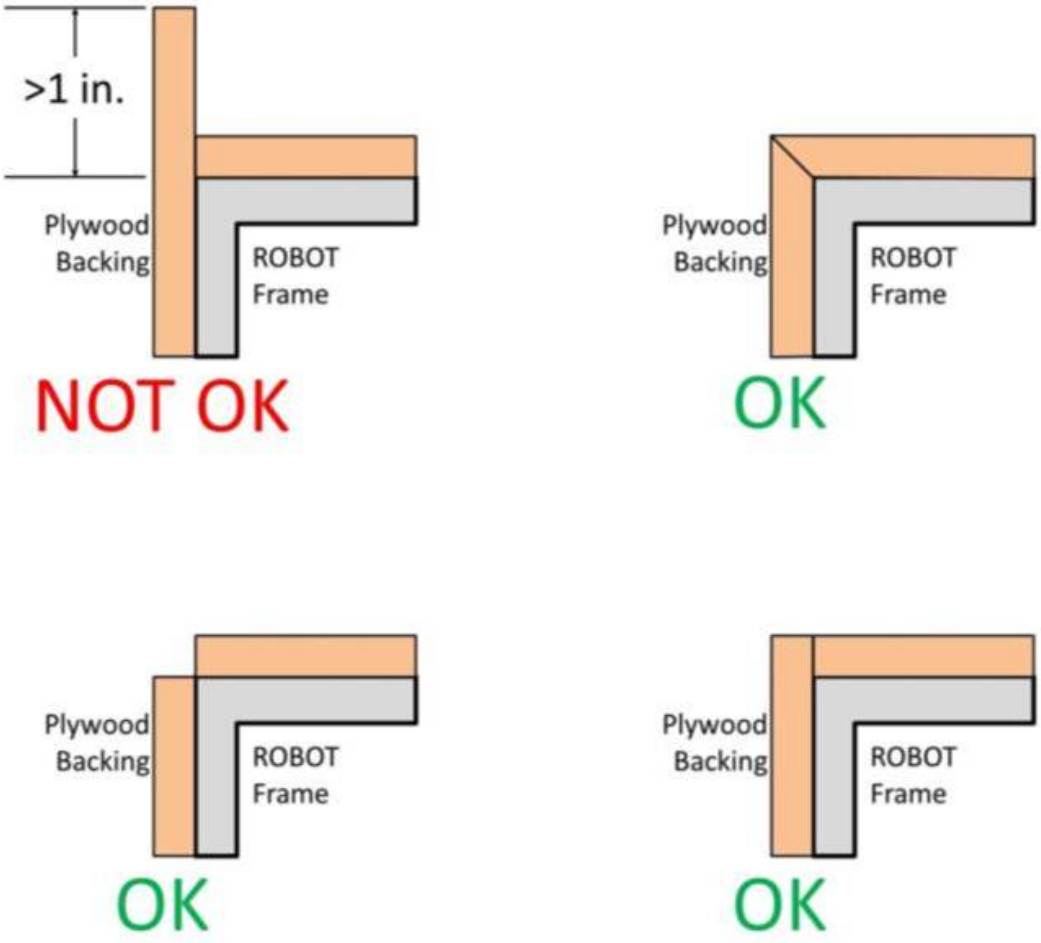


Figure 4-7: Hard Parts of BUMPER Corners

C. use a stacked pair of approximately 2 ½ in. round, petal, or hex “pool noodles” (solid or hollow) as the BUMPER cushion material (see Figure 4-8). Cushion material may extend up to 2 ½ in. beyond the end of the plywood (see Figure 4-5 and Figure 4-9).

D. be covered with a rugged, smooth cloth.

Silk or bedding are not considered rugged materials. 1000D Cordura is recommended.

E. Optionally, use aluminum angle to clamp cloth as shown in Figure 4-8

F. must 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.

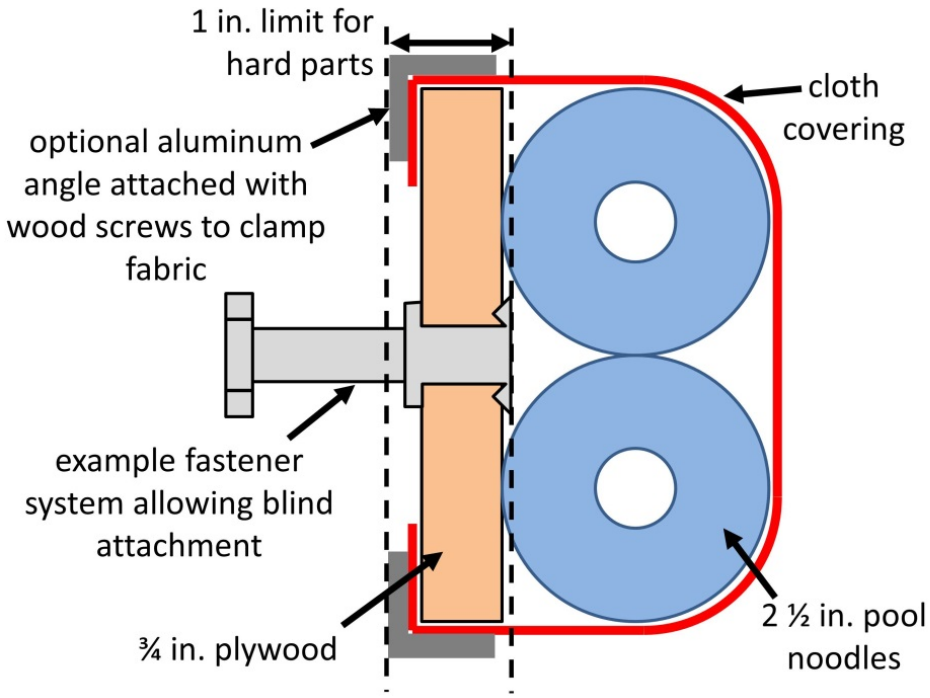


Figure 4-8: BUMPER Vertical Cross Section

4.6.4 R22

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 the requirement that BUMPERS be constructed per Figure 4?8, the vertical cross-section, does implicitly mean that a BUMPER should not overtly deviate from this orientation.

4.6.5 R23

BUMPERS may not be articulated (specifically, R23 is assessed relative to the FRAME PERIMETER).

4.6.6 R24

Corner joints between BUMPERS must be filled with pool noodle material. Examples of implementation are shown in Figure 4-9.

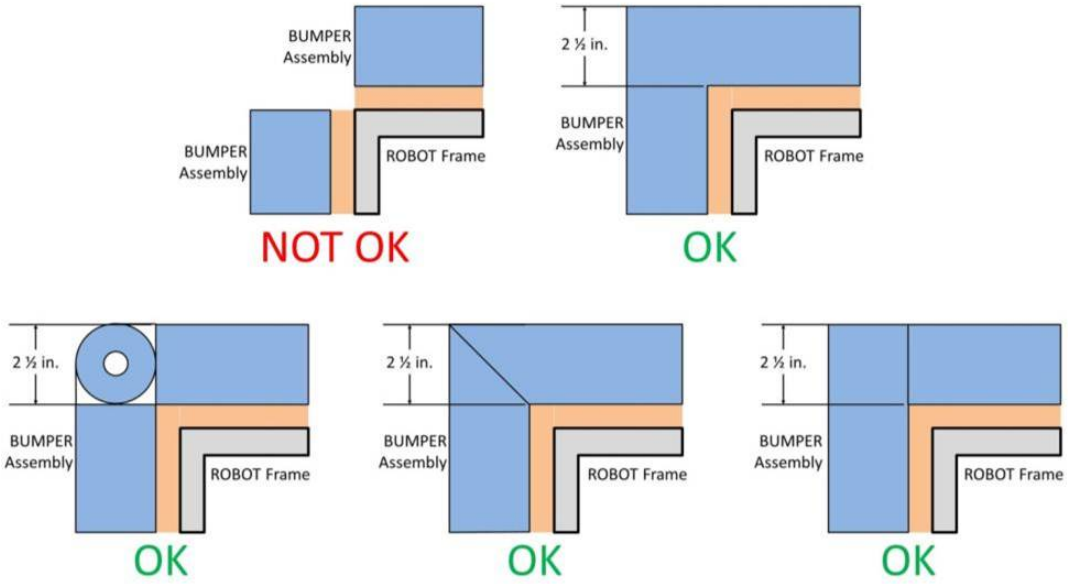


Figure 4-9: Soft Parts of BUMPER Corners

4.6.7 R25

BUMPERS (the entire BUMPER, not just the cover) must be designed for quick and easy installation and removal.

As a guideline, BUMPERS should be removable by two (2) people in fewer than five (5) minutes.

4.6.8 R26

BUMPERS must be supported by the structure/frame of the ROBOT (see Figure 4-10). To be considered supported:

A. a minimum of ½ in. at each end of the BUMPER must be backed by the FRAME PERIMETER,
B. the gap between the backing material and the frame must not be greater than ¼ in., and
C. the BUMPER must be backed by the FRAME PERIMETER at least every 8 in.

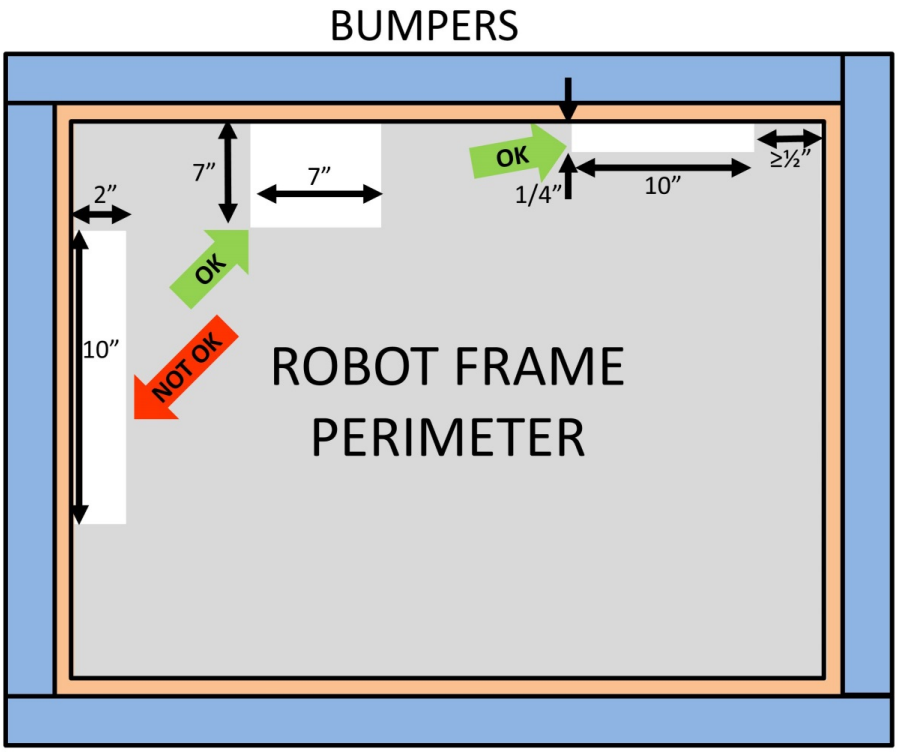


Figure 4-10: BUMPER Support Examples

4.6.9 R27

Each ROBOT must be able to display red or blue BUMPERS to match their ALLIANCE color, as assigned in the MATCH schedule distributed at the event (reference *Section 5.1.1: MATCH Schedules*).

4.6.10 R28

Team numbers must be displayed on the BUMPERS and meet the following criteria:

A. consist of numerals at least 4 in. high, at least ½ in. in stroke width, and be either white in color or outlined in white,
B. may not wrap around a corner of the FRAME PERIMETER (for the purposes of R28 a round or circular FRAME PERIMETER has no corners), and
C. be positioned around the ROBOT such that an observer walking around the perimeter of the ROBOT can unambiguously tell the Team’s number from any point of view.

There is no prohibition against splitting Team numbers onto different sections of BUMPER. The intent is that the Team’s number is clearly visible and unambiguous so that Judges, Referees, Announcers, and other Teams can easily identify competing ROBOTS.

4.7 Motors & Actuators

4.7.1 R29

The only motors and actuators permitted on 2014 FRC ROBOTS include the following:

Table 4-1: Legal Motors

Motor Name	Part Numbers Available	Max Qty Allowed
CIM	FR801-001 M4-R0062-12 AM802-001A 217-2000 PM25R-44F-1005 PM25R-45F-1004 PM25R-45F-1003 PMR25R-45F-1003 PMR25R-44F-1005	6
BaneBots Motors	M7-RS775-18 / RS775PH-6221 M7-RS775-12 / RS775WC-8514 M5-RS555-12 / RS555PH-4136F M5-RS550-12 / RS550VC-7527 M5-RS550-12-B / RS550VC-7527L M5-RS545-12 / RS545PH-5125F M5-RS540-12 / RS540BA-5040 M3-RS395-12 / RS395PH-3328 M3-RS390-12	4
AndyMark 9015	am-0912	4
Denso Throttle Control	AE235100-0160	4
VEX BAG and/or mini-CIM	217-3351 217-3371	4

AndyMark PG	am-2161 am-2194	3
Window Motors Door Motors Windshield Wiper Motors Seat Motors	262100-3030 262100-3040 Various from *FIRST*® Choice Various from Automotive Recyclers Association PDV	2
VEX 2-wire Motor 393	276-2177	2
Snow Blower Motor	am-2235	1
Electrical solenoid actuators, no greater than 1 in. stroke and rated electrical input power no greater than 10 watts (W) continuous duty at 12 volts (VDC)		Unlimited
Drive motors or fans that are part of a motor controller or COTS computing device		Unlimited
Fans included in the 2014 Kickoff Kit, *FIRST*® Choice, or as a Talon motor controller accessory		Unlimited
COTS servos with a maximum power rating of 4W each at 6VDC Per the Servo Industry, Servo Max Power Rating = (Stall Torque) X (No Load Speed)		Unlimited

This is the total number of each motor a Team may use on their ROBOT, not the quantity per part number. For example, each team may use up to six (6) CIM motors on their ROBOT, regardless of the quantity or combination of each individual part number used.

Given the extensive amount of motors allowed on the ROBOT, Teams are encouraged to consider the total power available from the ROBOT battery during the design and build of the ROBOT. Stalling many motors at the same time could lead to drops in ROBOT battery voltage that will result in loss of power to core Control System pieces or may trip the main breaker.

4.7.2 R30

The integral mechanical and electrical system of any motor may not be modified. Motors, servos, and electric solenoids used on the ROBOT shall not be modified in any way, except as follows:

A. The mounting brackets and/or output shaft/interface may be modified to facilitate the physical connection of the motor to the ROBOT and actuated part.
B. The electrical input leads may be trimmed to length as necessary.
C. The locking pins on the window motors (P/N: 262100-3030 and 262100-3040) may be removed.
D. The connector housings on the window motors (P/N: 262100-3030 and 262100-3040) may be modified to facilitate lead connections.

E. The Integrated Encoder Module (P/N: 276-1321) may be installed on the VEX 2-wire Motor 393 (P/N 276-2177).
F. The VEX 2-wire Motor 393 (P/N: 276-2177) gears may be changed or replaced per the Supplier instructions.

The intent of this rule is to allow Teams to modify mounting tabs and the like, not to gain a weight reduction by potentially compromising the structural integrity of any motor. The integral mechanical and electrical system of the motor is not to be modified.

Note that for the Window motors, the gearbox is considered integral to the motor, thus the motor may not be used without the gearbox.

4.8 Power Distribution

4.8.1 R31

The only legal source of electrical energy for the ROBOT during the competition, the ROBOT battery, is one of the following approved 12VDC non-spillable lead acid batteries:

A. Enersys (P/N: NP18-12)
B. MK Battery (P/N: ES17-12)
C. Battery Mart (P/N: SLA-12V18)
D. Sigma (P/N: SP12-18)
E. Universal Battery (P/N: UB12180)
F. Power Patrol (P/N: SLA1116)

Exception: Batteries integral to and part of a COTS computing device or self-contained camera are also permitted (e.g. laptop batteries), provided they're only used to power the COTS computing device and any peripheral COTS USB input devices connected to the COTS computing device and they must be securely fastened to the ROBOT.

To seek approval for an equivalent battery, please contact frcparts@usfirst.org with the battery supplier and part number. Approved batteries will be added to the list above.

4.8.2 R32

The ROBOT battery must be secured such that it will not dislodge should the ROBOT be turned over or placed in any arbitrary orientation.

4.8.3 R33

Each electrical terminal on the ROBOT battery and its connection (lugs, stripped wire ends, etc.) to the 6AWG wire must be fully insulated.

4.8.4 R34

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. compressed air stored in the pneumatic system that is legal per R79 and R80,
B. a change in the altitude of the ROBOT center of gravity, and
C. storage achieved by deformation of ROBOT parts.

4.8.5 R35

The one ROBOT battery, 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.

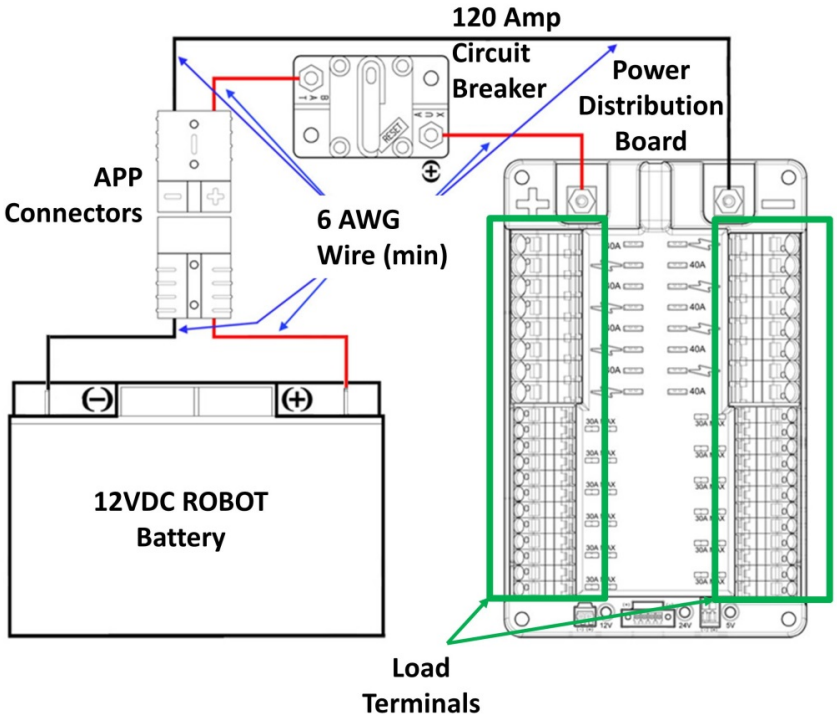


Figure 4-11: Main Power Distribution

4.8.6 R36

All circuits, with the exceptions of those listed in R42 and R45, 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 4-11) or the 5VDC supply on the PD Board (as shown in Figure 4-12), not the M6 shanks.

4.8.7 R37

All wiring and electrical devices, including all Control System COMPONENTS, shall be electrically isolated from the ROBOT frame. The ROBOT frame must not be used to carry electrical current.

R37 is checked by observing a >10k? resistance between either the (+) or (-) post within the APP connector that is attached to the PD Board and any point on the ROBOT.

The chassis for the cRIO and the Axis 206 camera have grounded enclosures. Under R37 (and for their protection), it is required that they be electrically isolated from the ROBOT frame when installed on the ROBOT.

4.8.8 R38

The 120A circuit breaker must be quickly accessible from the exterior of the ROBOT.

It is recommended that the 120A circuit breaker location be clearly and obviously labeled so it can be easily found by ARENA staff during a MATCH.

4.8.9 R39

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

4.8.10 R40

Any active electrical item not explicitly listed in R29 or R67 is considered a CUSTOM CIRCUIT. CUSTOM CIRCUITS may not produce voltages exceeding 24V when referenced to the negative terminal of the battery.

4.8.11 R41

The cRIO power input must be connected to the 24VDC supply terminals on the PD Board shown in Figure 4-12.

4.8.12 R42

With the exception of one (1) cRIO and one (1) Solenoid Breakout Board, no other electrical load may be connected to the 24 VDC supply terminals on the PD Board.

Please note per R69 that, for an 8-slot cRIO, the power drawn by the Solenoid Breakout Board may not exceed 16W. For a 4-slot cRIO, it may not exceed 21W.

4.8.13 R43

The Wireless Bridge power must be supplied by the 12VDC-to-5VDC converter (P/N: CLL25-24S05) connected to the marked 12VDC supply terminals at the end of the PD Board, and not the main WAGO connectors along the sides of the PD Board shown in Figure 4-12. No other electrical load may be connected to these terminals.

Please reference any 2014 ROBOT Power Distribution Diagram posted on the Kit of Parts site for Wireless Bridge wiring information.

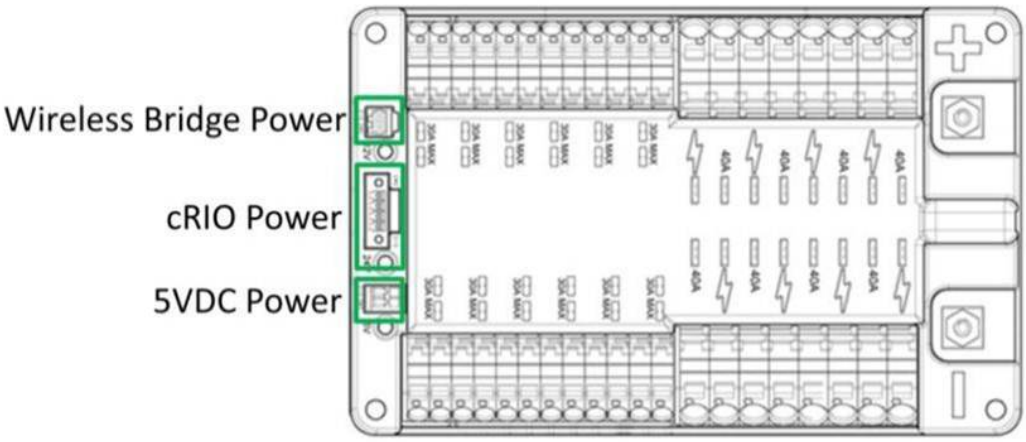


Figure 4-12: Wireless Bridge, cRIO, and 5VDC Power Connections

4.8.14 R44

Only one wire may be connected to each WAGO connector on the PD Board.

If multi-point distribution of circuit power is needed (e.g. to provide power to three (3) KOP breakout boards via one 20A circuit), then all incoming wires may be appropriately spliced into the main lead, and only one lead inserted into the WAGO connector to connect the circuit.

4.8.15 R45

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

4.8.16 R46

Each branch circuit must be protected by one and only one circuit breaker on the PD Board per Table 4-2. No other electrical load can be connected to the breaker supplying this circuit.

Table 4-2: Branch Circuit Protection

Branch Circuit	Circuit Breaker Value	Qty Allowed Per Breaker
Motor Controller	Up to 40A	1
CUSTOM CIRCUIT	Up to 40A	1
Relay Module	Up to 20A	1
Digital Sidecar	20A	1
Analog/Solenoid Breakout Board	20A	1

R46 does not prohibit the use of smaller value fuses within CUSTOM CIRCUITS for additional protection.

4.8.17 R47

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)
Between the PD Board and the Analog and/or Solenoid Breakout Boards (even though they are protected by a 20A circuit	

breaker per R46)	
Between the PD Board and the cRIO	20 AWG (0.8128mm)
Between the PD Board and the wireless bridge	
?5A protected circuit	
SIGNAL LEVEL circuits (i.e. circuits which draw ?1A continuous and have a source incapable of delivering >5A, including but not limited to DSC outputs, Solenoid Breakout outputs, and Arduino outputs)	28 AWG (0.321mm)

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 R47.

4.8.18 R48

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.

4.8.19 R49

All non-SIGNAL LEVEL wiring with a constant polarity (i.e., except for outputs of relay modules, motor controllers, or sensor outputs) shall be color-coded as follows:

A. Red, white, brown, or black-with-stripe on the +24VDC, +12VDC, and +5VDC connections
B. Black or blue for the common or negative side (-) of the connections.

Wires that are originally attached to legal devices are considered part of the device and by default legal. Such wires are exempt from R49.

4.8.20 R50

The only power regulating devices for actuators permitted on the ROBOT include:

A. Jaguar Motor Controller (P/N: MDL-BDC, MDL-BDC24, and 217-3367),
B. Victor 884 Motor Controller (P/N: VICTOR-884-12/12),
C. Victor 888 Motor Controller (P/N: 217-2769),
D. Talon Motor Controller (P/N: CTRE_Talon, CTRE_Talon_SR, and am-2195),
E. VEX Motor Controller 29 (P/N: 276-2193) for controlling VEX 2-wire Motor 393 (P/N: 276-2177) only, and
F. Spike H-Bridge Relay (P/N: 217-0220 and SPIKE-RELAY-H).

4.8.21 R51

Each power regulating device may control electrical loads per Table 4-4. Unless otherwise noted, each power regulating device may control one and only one electrical load.

Table 4-4: Legal Power Regulating Device Use

Electrical Load	Jaguar, Victor, or Talon motor controller	Spike H-Bridge Relay	VEX Motor Controller 29	Solenoid Breakout
M3-RS390-12 M3-RS395-12 M5-RS545-12 M5-RS555-12 262100-3030 262100-3040 ARA motors AE235100-0610 am-2235 am-2161 am-2194	Yes Up to 2 per controller	Yes	No	No
CIM am-0912 M5-RS540-12 M5-RS550-12 M5-RS550-12-B M7-RS775-18 217-3351 217-3371	Yes	No	No	No
276-2177	Yes Up to 2 per controller	Yes	Yes	No
Compressor	No	Yes	No	No
Pneumatic Solenoid Valves	No	Yes*	No	Yes
Electric Solenoids	No	Yes*	No	Yes
CUSTOM CIRCUITS	Yes	Yes*	No	Yes

*Multiple low-load, pneumatic solenoid valves, electric solenoids or CUSTOM CIRCUITS may be connected to a single relay module. This would allow one (1) relay module to drive multiple pneumatic actions or multiple CUSTOM CIRCUITS. No other electrical load can be connected to a relay module used in this manner.

4.8.22 R52

Servos must be directly connected to the PWM ports on the Digital Sidecar. They must not be connected to motor controllers or relay modules.

4.8.23 R53

CUSTOM CIRCUITS shall not directly alter the power pathways between the ROBOT battery, PD Board, motor controllers, relays, motors, or other elements of the ROBOT control system (items explicitly mentioned in R64). Custom

high impedance voltage monitoring or low impedance current monitoring circuitry connected to the ROBOT'S electrical system is acceptable, if the effect on the ROBOT outputs is inconsequential.

4.9 Control, Command & Signals System

4.9.1 R54

ROBOTS must be controlled via one (1) programmable National Instruments cRIO (P/N: cRIO-FRC or cRIO-FRCII), with image version FRC_2014_v52.

There are no rules that prohibit co-processors, provided commands originate from the cRIO to configure, enable, and specify all operating points for all power regulating devices. This includes Jaguar motor controllers legally wired to the CAN-bus.

4.9.2 R55

One (1) D-Link Wireless Bridge (P/N: DAP-1522), hardware revision B, is the only permitted device for communicating to and from the ROBOT during the MATCH.

Hardware revision A, distributed in 2011 and 2012, is not legal for 2014. Teams participating in the Israel Regional may use hardware version Rev A or Rev B.

4.9.3 R56

The DAP-1522 Wireless Bridge must be connected to the cRIO Ethernet port 1 (either directly or via a CAT5 Ethernet pigtail).

4.9.4 R57

Ethernet-connected COTS devices or CUSTOM CIRCUITS may connect to any remaining Ethernet port but must not transmit or receive UDP packets using ports 1100-1200 with the exception of ports 1130 and 1140.

4.9.5 R58

Communication between the ROBOT and the OPERATOR CONSOLE is restricted as follows:

A. Network Ports:
    A. TCP 1180: This port is typically used for camera data from the cRIO to the Driver Station (DS) when the camera is connected to port 2 on the 8-slot cRIO (P/N: cRIO-FRC). This port is bidirectional.
    B. TCP 1735: SmartDashboard, bidirectional
    C. UDP 1130: Dashboard-to-ROBOT control data, directional
    D. UDP 1140: ROBOT-to-Dashboard status data, directional
    E. HTTP 80: Camera connected via switch on the ROBOT, bidirectional
    F. HTTP 443: Camera connected via switch on the ROBOT, bidirectional

Teams may use these ports as they wish if they do not employ them as outlined above (i.e. TCP 1180 can be used to pass data back and forth between the ROBOT and the DS if the Team chooses not to use the camera on port 2).

B. Bandwidth: no more than 7 Mbits/second.

The *FMS Whitepaper* has more details on how to check and optimize bandwidth usage.

4.9.6 R59

The cRIO, Driver Station software, and Wireless Bridge must be configured to correspond to the correct Team number, per the procedures defined in *Getting Started with the FRC Control System*.

4.9.7 R60

All signals must originate from the OPERATOR CONSOLE and be transmitted to the ROBOT via the ARENA Ethernet network.

4.9.8 R61

No form of wireless communication shall be used to communicate to, from, or within the ROBOT, except those required per R55 and R60 (e.g. radio modems from previous *FIRST* competitions and Bluetooth devices are not permitted on the ROBOT during competition).

4.9.9 R62

The Wireless Bridge must be mounted on the ROBOT such that the diagnostic lights are visible to ARENA personnel.

Teams are encouraged to mount the wireless bridge away from noise generating devices

such as motors and the 12VDC-to-5VDC converter.

4.9.10 R63

ROBOTS must use at least one (1) diagnostic ROBOT Signal Light (RSL) (P/N: 855PB-B12ME522).

Any RSL must be:

A. mounted on the ROBOT such that it is easily visible while standing three (3) ft in front of the ROBOT,
B. connected to the “RSL” supply terminals on a Digital Sidecar that is connected to an NI 9403 module in Slot 2 of the cRIO, and
C. wired for solid light operation, by placing a jumper between the “La” and “Lb” terminals on the light per Figure 4-13.

See the *2014 ROBOT Data Diagram* on the KOP website and the item bulletin for connection details.

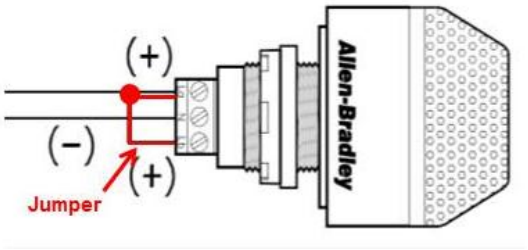


Figure 4-13: Jumper on RSL

4.9.11 R64

The Driver Station software, cRIO, Power Distribution Board, Digital Sidecars, Analog Breakouts, Solenoid Breakouts, RSL, 120A breaker, motor controllers, relay modules, Wireless Bridge, 12VDC-5VDC converter, and batteries shall not be tampered with, modified, or adjusted in any way (tampering includes drilling, cutting, machining, gluing, rewiring, disassembling, etc.), with the following exceptions:

Please note that the Driver Station application is a separate application from the Dashboard. The Driver Station software may not be modified, while teams are expected to customize their Dashboard code.

A. User programmable code in the cRIO may be customized.
B. DIP switches on the cRIO may be set (applies to cRIO-FRC only).
C. Motor controllers may be calibrated as described in owner's manuals.
D. Fans may be attached to motor controllers and may be powered from the power input terminals.
E. If powering the compressor, the fuse on a Spike H-Bridge Relay may be replaced with a 20A Snap-Action circuit breaker.
F. Wires, cables, and signal lines may be connected via the standard connection points provided on the devices.

G. Fasteners may be used to attach the device to the OPERATOR CONSOLE or ROBOT.
H. Labeling may be applied to indicate device purpose, connectivity, functional performance, etc.
I. Brake/Coast jumpers on motor controllers may be changed from their default location.
J. Limit switch jumpers may be removed from a Jaguar motor controller and a custom limit switch circuit may be substituted.
K. If CAN-bus functionality is used, the Jaguar firmware must be updated as required by *FIRST* (see Rule R67-D).
L. Devices may be repaired, provided the performance and specifications of the device after the repair are identical to those before the repair.

Please note that while repairs are permitted per the FRC Game Manual, the allowance is independent of any manufacturer's warranty. Teams make repairs at their own risk and should assume that any warranty or RMA options are forfeited. Be aware that diagnosing and repairing COMPONENTS such as these can be difficult.

4.9.12 R65

Neither 12VDC power nor relay module or motor controller outputs may be connected to the Analog/Solenoid Breakout Boards or the Digital Sidecar (with the exception of the designated 12VDC input).

4.9.13 R66

Every relay module, servo, and PWM motor controller shall be connected to a corresponding port on a Digital Sidecar and be controlled by signals provided from the cRIO. They shall not be controlled by signals from any other source.

4.9.14 R67

Each Jaguar must be controlled with signal inputs sourced from the cRIO and passed via either a connected PWM cable or a CAN-bus connection.

A. The Jaguar must receive signals via either a PWM cable or a CAN-bus connection. Both may not be used simultaneously.
B. PWM configuration: If the Jaguar motor controller is controlled via PWM communications, the PWM port on the Jaguar motor controller must be connected directly to a PWM port on the Digital Sidecar with a PWM cable. No other device may be connected to these PWM ports. No other device may be connected to any other port on the Jaguar motor controller with the exception of connection to the coast/brake port or the limit switch ports.
C. CAN-bus configuration: If the Jaguar motor controller is controlled via CAN-bus communications, each Jaguar motor controller must be connected to either the cRIO or another CAN-bus device with a CAN-bus cable.
D. If the CAN-bus configuration is used, the firmware on gray Jaguar motor controllers must be updated to at least Version 101 of the official *FIRST* firmware and Version 107 for black Jaguars.

As long as the CAN bus is wired legally so that the heartbeat from the cRIO is

maintained, all closed loop control features of the Jaguar motor controller may be used. (That is, commands originating from the cRIO to configure, enable, and specify an operating point for all Jaguar closed loop modes fit the intent of R54.)

4.9.15 R68

If CAN-bus communication is used, the CAN-bus must be connected to the cRIO through either the Ethernet network connected to Port 1, Port 2, or the DB-9 RS-232 port connection.

A. Ethernet-to-CAN bridges or RS-232-to-CAN bridges (including the “black” Jaguars) may be used to connect the CAN-bus to the cRIO.
B. Additional switches, sensor modules, CUSTOM CIRCUITS, third-party modules, etc. may also be placed on the CAN-bus.
C. No device that interferes with, alters, or blocks communications between the cRIO and the Jaguars will be permitted (tunneling packets for the purposes of passing them through an Ethernet-to-CAN bridge is acceptable as the commands are not altered).

4.9.16 R69

If powered from the PD Board 24V supply per R41, loads on each Solenoid Breakout shall not cumulatively exceed 16W if using the cRIO-FRC (8-slot) and 21W if using the cRIO-FRC II (4-slot).

4.9.17 R70

Control System pieces must be configured to report the ROBOT’S battery voltage. Specifically:

A. A National Instruments 9201 analog module must be installed in slot 1 of the cRIO.
B. An Analog Breakout Board must be connected to this module.
C. If using Analog Breakout Boards revision 6 and older, a jumper must be installed in the “Power” position (two outer pins) (see Figure 4-14).
D. The Analog Breakout Board must be powered from the PD Board.

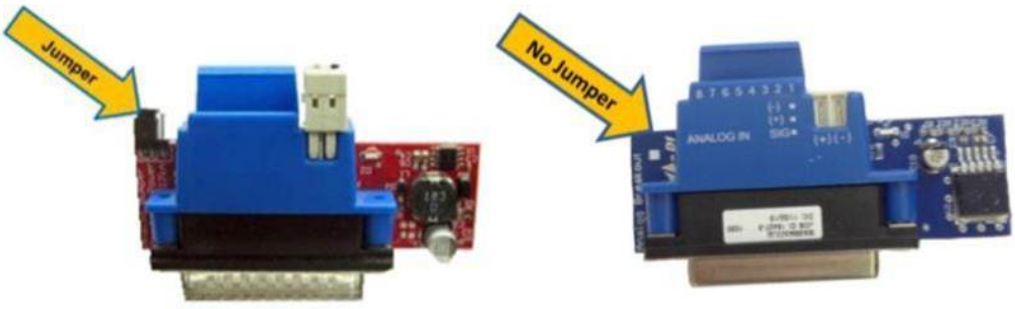


Figure 4-14: Former (left) and Current (right) KOP Analog Breakout Boards

4.9.18 R71

All outputs from CUSTOM CIRCUITS shall connect to only the following:

A. other CUSTOM CIRCUITS,
B. input ports on the Digital Sidecar,
C. input ports on the Analog Breakout Board,
D. the RS-232 port on the cRIO,
E. the Ethernet network connected to either Port 1 or Port 2 of the cRIO,
F. the CAN-bus if and only if all Jaguar motor controllers on the CAN-bus are wired in full compliance with R67and R68, or
G. the sensor inputs on the Jaguar motor controller.

CUSTOM CIRCUITS and additional electronics are allowed to utilize the Port 2 Ethernet bus on the cRIO-FRC and/or the CAN-bus to communicate between devices. Note however, that the ROBOT must be controlled by the cRIO (see R54). Thus, any additional devices on the Ethernet or CAN-bus must not provide command signals that do not originate from the cRIO.

4.9.19 R72

A noise filter may be wired across motor leads or PWM leads. Such filters will not be considered CUSTOM CIRCUITS and will not be considered a violation of R53 or R71.

Acceptable signal filters must be fully insulated and must be one of the following:

A. A one microfarad (1 µF) or less, non-polarized, capacitor may be applied across the power leads of any motor on your ROBOT (as close to the actual motor leads as reasonably possible).
B. A resistor may be used as a shunt load for the PWM control signal feeding a servo.

4.9.20 R73

Any decorations that involve broadcasting a signal to/from the ROBOT, such as remote cameras, must be approved by *FIRST* (via e-mail to frcparts@usfirst.org) prior to the event and tested for communications interference at the venue. Such devices, if reviewed and approved, are excluded from R61.

4.10 Pneumatic System

4.10.1 R74

To satisfy multiple constraints associated with safety, consistency, Inspection, and constructive innovation, no

pneumatic parts other than those explicitly permitted in *Section 4.10: Pneumatic System* may be used on the ROBOT.

4.10.2 R75

All pneumatic items must be COTS pneumatic devices rated by their manufacturers for working pressure of at least 125psi (with the exception of R77-D).

4.10.3 R76

All pneumatic COMPONENTS must be used in their original, unaltered condition. Exceptions are as follows:

A. tubing may be cut,
B. wiring for pneumatic devices may be modified to interface with the control system,
C. assembling and connecting pneumatic COMPONENTS using the pre-existing threads, mounting brackets, quick-connect fittings, etc.,
D. removing the mounting pin from a pneumatic cylinder, provided the cylinder itself is not modified,
E. labeling applied to indicate device purpose, connectivity, functional performance, etc.

Do not, for example, paint, file, machine, or abrasively remove any part of a pneumatic COMPONENT – this would cause the part to become a prohibited item. Consider pneumatic COMPONENTS sacred.

4.10.4 R77

The only pneumatic system items permitted on 2014 FRC ROBOTS include the items listed below.

A. Items available in the 2014 KOP,
B. Pneumatic pressure vent plug valves functionally equivalent to those provided in the KOP,

Parker valves PV609-2 or MV709-2 are recommended.

C. Solenoid valves with a maximum 1/8 in. NPT port diameter,
D. Solenoid valves that are rated for a maximum working pressure that is less than 125 psi rating mandated above are permitted, however if employed, an additional pressure relief valve must be added to the low pressure side of the main regulator. The additional relief valve must be set to a lower pressure than the maximum pressure rating for the solenoid valve,
E. Additional pneumatic tubing, with a maximum 0.160 in. inside diameter, functionally equivalent to that provided in the KOP,
F. Pressure transducers, pressure gauges, flow control valves, and connecting fittings,
G. Pressure regulators with a maximum bypass pressure of no more than 60 psi,

H. Pneumatic cylinders,
I. Pneumatic storage tanks, and
J. Compressors compliant with R79.

The following devices are not considered pneumatic devices and are not subject to pneumatic rules (though they must satisfy all other rules):

A. a device that creates a vacuum

B. closed-loop COTS pneumatic (gas) shocks

C. air-filled (pneumatic) wheels

4.10.5 R78

If pneumatic COMPONENTS are used, the following items are required as part of the pneumatic circuit and must be used in accordance with this section, as illustrated in Figure 4-15.

A. Compressor
B. Pressure Relief Valve
C. Pressure Switch
D. Pressure Vent Plug
E. “Stored” Pressure Gauge (upstream from Primary Regulator)
F. “Working” Pressure Gauge (downstream from Primary Regulator)
G. “Working” Pressure Regulator

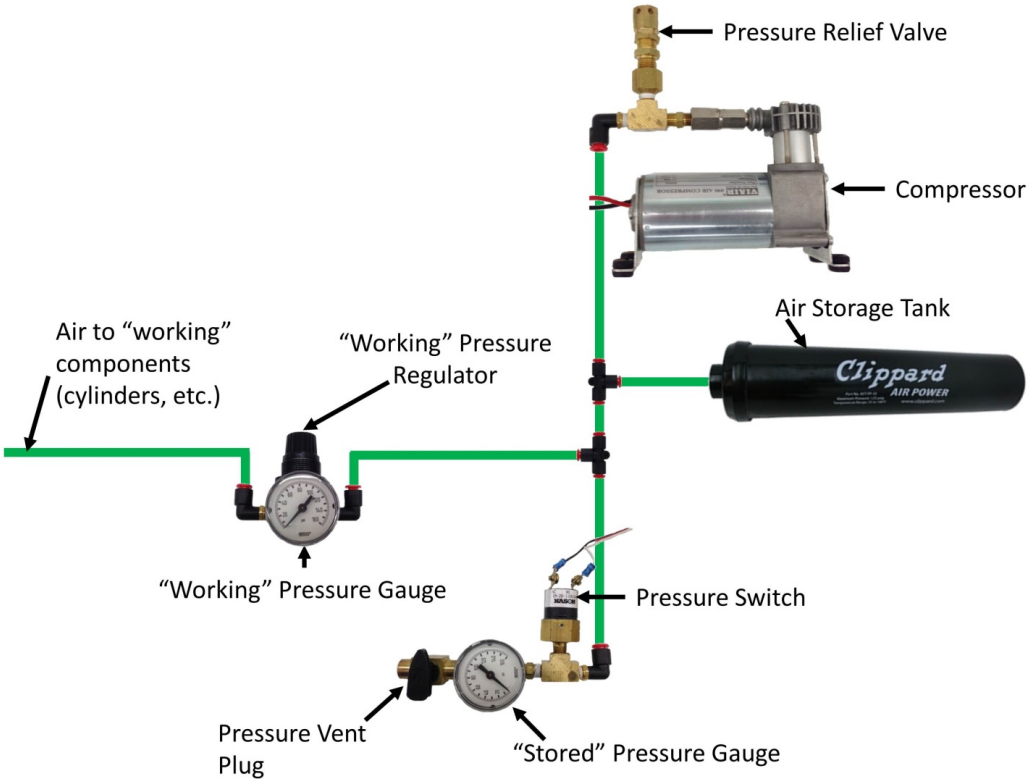


Figure 4-15: Pneumatic System Setup

4.10.6 R79

Compressed air on the ROBOT must be provided by one and only one compressor. Compressor specifications may not exceed nominal 12VDC, 1.05 cfm flow rate.

4.10.7 R80

Off-board compressors are permitted, however the compressor must be controlled and powered by the ROBOT.

The compressor may be mounted on the ROBOT, or it may be left off the ROBOT and used to pre-charge compressed air in storage tanks on the ROBOT

The intent of this rule is to permit teams to take advantage of the weight savings associated with keeping the compressor off-board. However, using the compressor off-board of the ROBOT does NOT permit non-compliance with any other applicable rules.

4.10.8 R81

“Stored” air pressure on the ROBOT must be no greater than 120 psi.

4.10.9 R82

“Working” air pressure on the ROBOT must be no greater than 60 psi and must be provided through one primary adjustable, relieving, pressure regulator.

Norgren regulator P/N: R07-100-RNEA recommended.

4.10.10 R83

Only the compressor, relief valve (P/N: 16-004-011), pressure switch, pressure vent plug, pressure gauge, storage tanks, tubing, pressure transducers, and connecting fittings may be in the high-pressure pneumatic circuit upstream from the regulator.

4.10.11 R84

Pressure gauges must be placed in easily visible locations upstream and downstream of the regulator to display the “stored” and “working” pressures.

4.10.12 R85

If the compressor is not included on the ROBOT (under the provisions of Rule R79), the “Working” Pressure Regulator, ”Stored” Pressure Gauge, and pressure switch may be located on-board (Figure 4- 16) or off-board (Figure 4-17) (but must be together), provided all other pneumatic rules are satisfied.

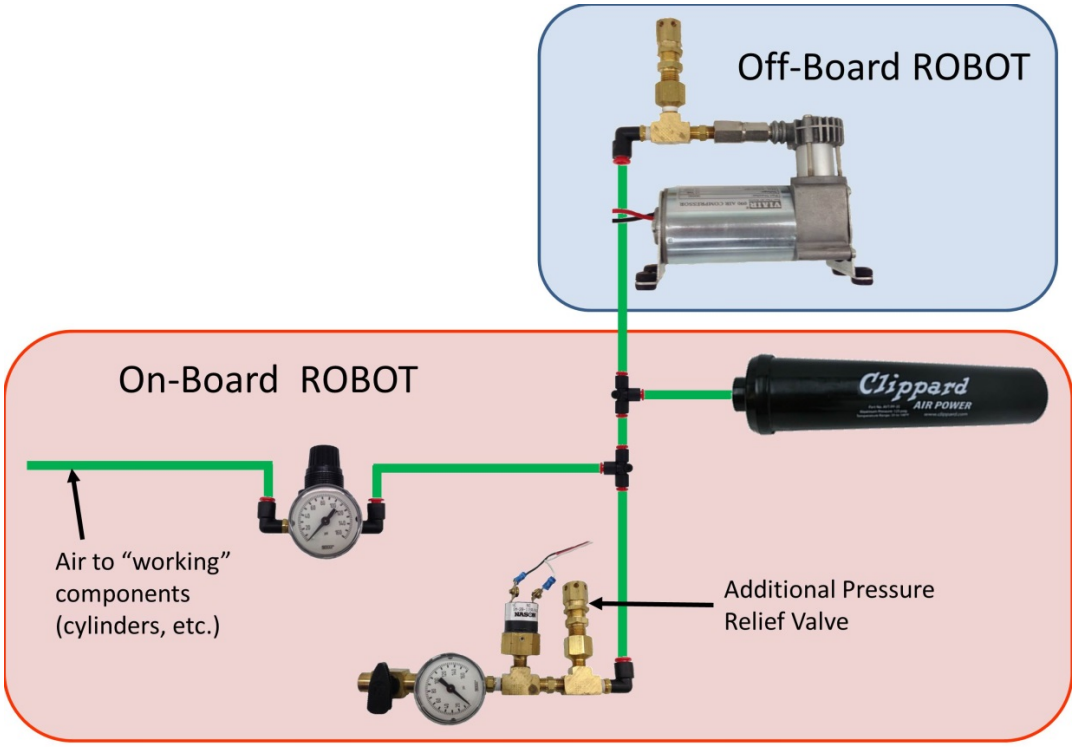


Figure 4-16: Off-Board Compressor with On-Board Regulator and Gauge

4.10.13 R86

If the regulator is kept off-board the ROBOT with the compressor, then only low-pressure (60 psi or less) “working” air can be stored on the ROBOT. The “working” pressure gauge must be installed on-board the ROBOT at all times (Figure 4-17).

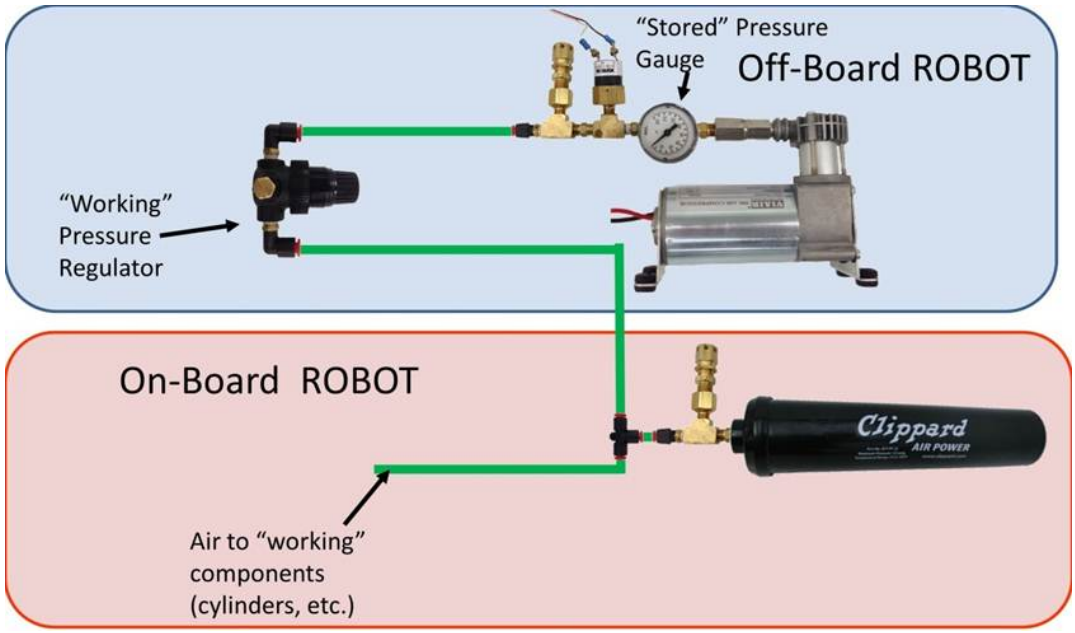


Figure 4-17: Off-Board Compressor, Regulator, and Gauge with Additional On-Board Gauge

4.10.14 R87

The relief valve must be attached directly to the compressor or attached by legal fittings connected to the compressor output port. If using an off-board compressor, an additional relief valve must be included on the ROBOT.

If necessary, Teams are required to adjust the relief valve to release air at 125 psi. The valve may or may not have been calibrated prior to being supplied to Teams.

4.10.15 R88

The pressure switch requirements are:

A. It must be connected to the high-pressure side of the pneumatic circuit (i.e. prior to the pressure regulator) to sense the “stored” pressure of the circuit.
B. The two wires from the pressure switch must be connected directly to a digital input and ground pin on the Digital Sidecar.
C. The cRIO must be programmed to sense the state of the switch and operate the relay module that powers the compressor to prevent over-pressuring the system.

4.10.16 R89

The pressure vent plug must be:

A. connected to the pneumatic circuit such that, when manually operated, it will vent to the atmosphere to relieve all stored pressure, and
B. placed on the ROBOT so that it is visible and easily accessible.

If the compressor is not used on the ROBOT, then an additional pressure vent plug must be connected to the high-pressure portion of the pneumatic circuit off-board the ROBOT with the compressor (see R79).

4.10.17 R90

The outputs from multiple valves may not be plumbed together.

4.11 OPERATOR CONSOLE

4.11.1 R91

The Driver Station software provided on the Kit of Parts website is the only application permitted to specify and communicate the operating mode (i.e. Autonomous/Teleop) and operating state (Enable/Disable) to the ROBOT. The Driver Station software must be revision 01.04.14.00 or newer.

Teams are permitted to use a portable computing device of their choice (laptop computer, PDAs, etc.) to host the Driver Station software while participating in competition MATCHES.

4.11.2 R92

The OPERATOR CONSOLE must include a graphic display to present the Driver Station disgnostic information. It must be positioned within the OPERATOR CONSOLE so that the screen display can be clearly seen during Inspection and in a MATCH.

4.11.3 R93

Devices hosting the Driver Station software may only interface with the Field Management System (FMS) via the Ethernet cable provided at the PLAYER STATION (e.g. not through a switch). The Ethernet port on the OPERATOR CONSOLE must be easily and quickly accessible.

Teams are strongly encouraged to use pigtails on the Ethernet port used to connect to the FMS. Such pigtails will reduce wear and tear on the device's port and, with proper strain relief employed, will protect the port from accidental jerks.

4.11.4 R94

The OPERATOR CONSOLE must not exceed 60 in. long by 14 in. deep (excluding any items that are held or worn by the DRIVERS during the MATCH).

There is a 54 in. long by 2 in. wide strip of hook-and-loop tape ("loop" side) along the center of the PLAYER STATION support shelf that may be used to secure the OPERATOR CONSOLE to the shelf. See Section 2.2.9 for details.

4.11.5 R95

Other than the system provided by the ARENA, no other form of wireless communications shall be used to communicate to, from, or within the OPERATOR CONSOLE.

Examples of prohibited wireless systems include, but are not limited to, active wireless network cards and Bluetooth devices. For the case of FRC, a motion sensing input device (e.g. Microsoft Kinect) is not considered wireless communication and is allowed.

4.12 Revision History

Date	Section	Change
1/10/2014	R29	Added "M7-RS775-12 / RS775WC-8514" to list of legal BaneBots motors.

5 The Tournament

5.1 Overview

Each 2014 *FIRST* Robotics Competition (FRC) event is played in a tournament format. Each tournament consists of three sets of MATCHES called “Practice MATCHES,” “Qualification MATCHES,” and “Elimination MATCHES.”

The purpose of the Practice MATCHES is to provide each Team with an opportunity to operate its ROBOT on the FIELD prior to the start of the Qualification MATCHES.

The purpose of the Qualification MATCHES is to allow each Team to earn a seeding position that may qualify them for participation in the Elimination MATCHES.

The purpose of the Elimination MATCHES is to determine the event Champions.

Each MATCH is conducted with approximately two (2)-minutes for set up, two minutes and thirty seconds (2:30) of game play, and one (1)-minute to clear the FIELD. After each MATCH, the ARENA must be cleared of ROBOTS and OPERATOR CONSOLES from the MATCH that just ended. The ROBOTS and OPERATOR CONSOLES for the

following MATCH must be placed in position and ready to operate before the start of the next MATCH. Event staff will reset the ARENA elements during this time.

5.1.1 MATCH Schedules

A MATCH schedule is used to coordinate MATCHES at an Event. Figure 5-1 details information shown on each Schedule.

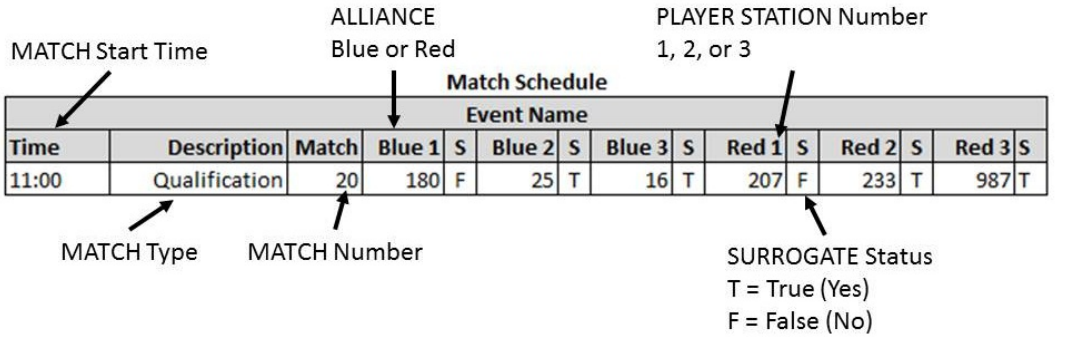


Figure 5-1: Sample MATCH Schedule

5.2 Practice MATCHES

5.2.1 Schedule

Practice MATCHES are played on the first day of each event. The Practice MATCH schedule is available as soon as possible, but no later than the start of Practice MATCHES. Practice MATCHES are randomly assigned and each Team is assigned an equal number of Practice MATCHES unless the number of Teams multiplied by number of Practice MATCHES is not divisible by six. In this case, the FMS randomly selects some Teams to play an extra Practice MATCH.

5.2.2 Filler Line

Although Teams may not switch practice times, there is a designated Filler Line at each event. Teams wanting additional Practice MATCHES may join the Filler Line if the criteria listed below are met. Teams from the Filler Line are used on a first come, first served basis to fill empty spots in Practice MATCHES left by other Teams that do not report to Queueing. The number of TEAMS in the Filler Line is dependent upon space at venues. The criteria for joining the Filler Line are as follows:

A. ROBOTS in the Filler Line must have passed Inspection;
B. Teams must join the Filler Line with their ROBOT;
C. Teams may not work on their ROBOT while in the Filler Line;
D. Teams may not occupy more than one spot in the Filler Line; and
E. If a Team is queued up for their Practice MATCH, they may not also join the Filler Line.

5.3 Qualification MATCHES

5.3.1 Schedule

The Qualification MATCH schedule is made available as soon as possible, but no later than one (1) hour before Qualification MATCHES are scheduled to begin.

5.3.2 MATCH Assignment

The Field Management System (FMS) assigns each Team two (2) ALLIANCE partners for each Qualification MATCH using a predefined algorithm. The algorithm employs the following criteria, listed in order of priority:

1. Maximize time between each MATCH played for all Teams
2. Minimize the number of times a Team plays opposite any Team
3. Minimize the number of times a Team is allied with any Team
4. Minimize the use of SURROGATES
5. Provide even distribution of MATCHES played on Blue and Red ALLIANCE

All Teams are assigned the same number of Qualification MATCHES, unless the number of Teams multiplied by number of MATCHES is not divisible by six. In this case, the FMS randomly selects some Teams to play an extra MATCH. For the purpose of seeding calculations, those Teams are designated as SURROGATES for the extra MATCH. If a Team plays a MATCH as a SURROGATE, it is indicated on the MATCH schedule, it is always their third Qualification MATCH, and the outcome of the MATCH has no affect on the Team's ranking criteria.

5.3.3 Qualification Score (QS)

Qualification Points are awarded to each eligible Team at the completion of each Qualification MATCH and are dependent on the final score:

A. Each Team on the winning ALLIANCE receives two (2) Qualification Points.
B. Each Team on the losing ALLIANCE receives zero (0) Qualification Points.
C. In the event of a tied score, all Teams receive one (1) Qualification Point.

Exceptions to these scenarios are as follows:

D. A SURROGATE receives zero (0) Qualification Points.
E. A DISQUALIFIED Team (including via a RED CARD) receives zero (0) Qualification Points. During the Qualification MATCHES, Teams may be individually DISQUALIFIED in a MATCH.
F. A "no-show" Team is DISQUALIFIED from that MATCH and receives zero (0) Qualification Points. A Team is declared a no-show if no member of the TEAM is in the ALLIANCE STATION at the start of the MATCH.

The total number of Qualification Points earned by a Team throughout their Qualification MATCHES is their Qualification Score (QS).

5.3.4 Qualification Seeding

All Teams participating in the Tournament are seeded during the Qualification MATCHES. If the number of Teams in attendance is 'n', they are seeded '1' through 'n', with '1' being the highest seeded Team and 'n' being the lowest seeded Team.

The FMS ranks all Teams in decreasing order, using the following sorting criteria:

Table 5-1: Qualification MATCH Ranking Criteria

1st order sort	Qualification Score
2nd order sort	Cumulative Sum of ASSIST Points
3rd order sort	Cumulative Sum of AUTO points
4th order sort	Cumulative sum of TRUSS and CATCH points
5th order sort	Cumulative sum of TELEOP GOAL points and FOUL points
6th order sort	Random sorting by the FMS

5.4 Elimination MATCHES

At the end of the Qualification MATCHES, the top eight (8) seeded Teams become the ALLIANCE Leads. The top seeded ALLIANCES are designated, in order, ALLIANCE One, ALLIANCE Two, etc., down to ALLIANCE Eight. Using the ALLIANCE selection process described below, each ALLIANCE Lead chooses two (2) other Teams to join their ALLIANCE.

5.4.1 ALLIANCE Selection Process

Each Team chooses a student Team Representative who will proceed to the ARENA at the designated time (typically before the lunch break on the final day of the event) to represent their Team. The Team Representative from each ALLIANCE Lead is called the ALLIANCE CAPTAIN.

The ALLIANCE selection process consists of two rounds during which each ALLIANCE CAPTAIN invites a Team seeded below them in the standings to join their ALLIANCE. The invited Team must not already have declined an invitation.

Round 1: In descending order (ALLIANCE One to ALLIANCE Eight), each ALLIANCE CAPTAIN invites a single Team. The invited Team Representative steps forward and either accepts or declines the invitation.

If the Team accepts, it becomes a member of that ALLIANCE. If an invitation from a top eight ALLIANCE to another ALLIANCE Lead is accepted, all lower ALLIANCE Leads are promoted one spot. The next highest-seeded, unselected Team moves up to become ALLIANCE Eight.

If the Team declines, that Team is not eligible to be picked again and the ALLIANCE CAPTAIN extends another invitation to a different Team. If an invitation from a top eight ALLIANCE to another ALLIANCE Lead is declined, the declining Team may still invite Teams to join their ALLIANCE; however, it cannot accept invitations from other ALLIANCES.

The process continues until ALLIANCE Eight makes a successful invitation.

Round 2: The same method is used for each ALLIANCE CAPTAIN'S second choice except the selection order is reversed, with ALLIANCE Eight picking first and ALLIANCE One picking last. This process results in eight (8) ALLIANCES of three (3) Teams each.

5.4.2 BACKUP TEAMS

Of the remaining eligible Teams, the highest seeded Teams (up to eight (8)) should remain on standby and be ready to play as a BACKUP TEAM. If a ROBOT from any ALLIANCE in an Elimination MATCH becomes inoperable, the ALLIANCE CAPTAIN may have the highest seeded TEAM still available join the ALLIANCE. The resulting ALLIANCE is then composed of four (4) Teams. The replaced Team remains part of the ALLIANCE for awards but cannot return to play, even if their ROBOT is repaired.

Each ALLIANCE has only one opportunity to draw from the pool of remaining TEAMS. If a second ROBOT from the ALLIANCE becomes inoperable, then the ALLIANCE must play the following MATCHES with only two (2) (or even one (1)) ROBOTS.

Example: Three (3) Teams, A, B and C, form an ALLIANCE going into the Elimination MATCHES. The highest seeded Team not on one of the eight (8) ALLIANCES is Team D. During one of the Elimination MATCHES, Team C's ROBOT becomes inoperable. The ALLIANCE CAPTAIN decides to bring in Team D to replace Team C. Team C and their ROBOT may not play in any subsequent Elimination MATCHES.

In the case where a BACKUP TEAM is part of the Champion or Finalist ALLIANCE, there will be a four (4)-TEAM Champion or Finalist ALLIANCE.

5.4.3 Elimination MATCH Bracket

The Elimination MATCHES take place following the completion of the Qualification MATCHES and the ALLIANCE selection process. Elimination MATCHES are played in a bracket format as follows:

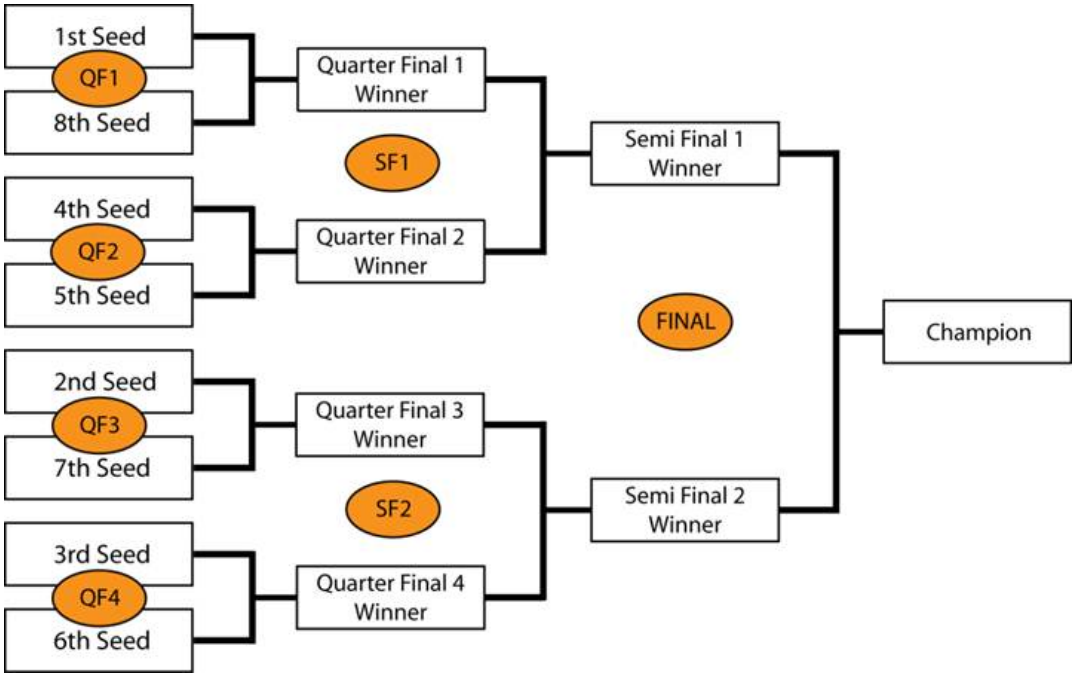


Figure 5-2: Elimination MATCH Bracket

In order to allow time between MATCHES for all ALLIANCES, the order of play is as follows:

QF1-1, QF2-1, QF3-1, QF4-1,

QF1-2, QF2-2, QF3-2, QF4-2,

QF1-3*, QF2-3*, QF3-3*, QF4-3*

Any additional Quarter-Final MATCHES due to ties*

SF1-1, SF2-1, SF1-2, SF2-2, SF1-3*, SF2-3*

Any additional Semi-Final MATCHES due to ties*

F-1, F-2, F-3*

Any additional Final MATCHES due to ties*

(* - if required)

5.4.4 Elimination Scoring

In the Elimination MATCHES, Teams do not earn Qualification Points; they earn a Win, Loss or Tie. Within each series of the Elimination MATCH bracket, the first ALLIANCE to win two (2) MATCHES will advance.

In the case where the MATCH score of each ALLIANCE is equal, the tie is broken by awarding an extra point to the ALLIANCE with (in the following order):

1. highest number of FOUL points awarded (i.e. the ALLIANCE that played the cleaner MATCH)
2. if FOUL points are equal, highest number of ASSIST points

3. if ASSIST points are equal, highest number of AUTO points
4. if AUTO points are equal, highest sum of TRUSS and CATCH points

If the criteria above are equal, the MATCH is a Tie. Additional matches will be played if needed.

5.4.5 Pit Crews

During the Elimination MATCHES, extra Team members may be needed to maintain the ROBOT between MATCHES because of the distance between the FIELD and the pit area. For this reason, each Team is permitted to have three (3) additional “pit crew” members who can also help with needed ROBOT repairs/maintenance.

5.5 Tournament Rules

Safety is paramount at all times during the Tournament. Event staff have the final decision authority for all safety-related issues within the venue.

5.5.1 Safety and Security Rules

5.5.1.1 T1

All event attendees must wear safety glasses and closed-toed shoes while in the ARENA.

5.5.1.2 T2

Wireless ROBOT control is only permitted on the FIELD or Practice Field. ROBOTS must be operated by tether when outside the FIELD or Practice Field.

5.5.1.3 T3

If operating wirelessly on the Practice Field, ROBOTS must use the provided Practice Field radio for communication.

5.5.1.4 T4

Teams may not set up their own 802.11a/b/g/n/ac (2.4GHz or 5GHz) wireless communication (e.g. access points or ad-hoc networks) in the venue.

A wireless hot spot created by a cellular device is considered an access point.

5.5.1.5 T5

No Team or Team member shall interfere or attempt to interfere with any other Team's or *FIRST's* wireless communication. Except as expressly allowed for purposes of communicating with the Team's own ROBOT on the FIELD or a Practice Field, no Team or Team member shall connect or attempt to connect to any other Team's or *FIRST's* wireless network.

Violation: Up to and including removal of the Team from the event. Legal action may also be pursued based on applicable law.

Teams are encouraged to report suspected wireless security vulnerabilities to the FTA (if at the event) or to *FIRST* via the Wireless Security Feedback Form

5.5.2 Eligibility and Inspection Rules

At each event, the Lead ROBOT Inspector (LRI) has final authority on the legality of any COMPONENT, MECHANISM, or ROBOT. Inspectors may re-Inspect ROBOTS to ensure compliance with the rules.

ROBOTS are permitted to participate in scheduled Practice MATCHES prior to passing Inspection. However, the FTA, LRI or Head Referee may determine at any time that the ROBOT is unsafe, per *Section 3.2.1: Safety*, and may prohibit further participation in Practice MATCHES until the condition is corrected and the ROBOT passes Inspection.

If a ROBOT cannot report for a MATCH, the Lead Queuer should be informed and at least one (1) member of the TEAM should report to the ARENA for the MATCH to avoid receiving a RED CARD, with the exception of a Team that has not passed Inspection, per Rule T6.

5.5.2.1 T6

A Team is only permitted to participate in a Qualification or Elimination MATCH and receive Qualification Points if their ROBOT has passed Inspection. If it is discovered after the start of the MATCH that a ROBOT did not pass Inspection and the Team participated in the MATCH, the entire ALLIANCE receives a RED CARD for that MATCH.

Please take note of this rule. It is important that FRC Teams ensure their ALLIANCE partners have passed Inspection. Allowing a partner that has not passed Inspection to play puts the ALLIANCE at risk of DISQUALIFICATION. Teams should check with their ALLIANCE partners early, and help them pass Inspection before competing.

Sending TEAM members to the ARENA without the ROBOT is considered participating in a MATCH.

5.5.2.2 T7

Any ROBOT construction technique or element that is not in compliance with the ROBOT Rules must be rectified

before a ROBOT will be allowed to compete or continue competing.

5.5.2.3 T8

At the time of Inspection, the ROBOT must be presented with all MECHANISMS (including all COMPONENTS of each MECHANISM), configurations, and decorations that will be used on the ROBOT during the entire competition event. It is acceptable, however, for a ROBOT to play MATCHES with a subset of the MECHANISMS that were present during Inspection. Only MECHANISMS that were present during the Inspection may be added, removed or reconfigured between MATCHES. If MECHANISMS are changed between MATCHES, the reconfigured ROBOT must still meet all Inspection criteria.

5.5.2.4 T9

The ROBOT Bill of Materials (BOM), listing all items on the ROBOT and their relevant costs per *Section 4.3: Budget Constraints*, including KOP items, must be presented at the time of Inspection.

Teams are encouraged to use the BOM Template posted on the *FIRST* website. Please note that while BOMs must be shown to Inspectors, Teams are not required to submit their BOMs to the Inspectors.

5.5.2.5 T10

If a ROBOT is modified after it has passed Inspection, other than modifications described in T8, that ROBOT must be re-Inspected.

If an observation is made that another Team's ROBOT may be in violation of the ROBOT rules, please approach *FIRST* officials to review the matter in question. This is an area where Gracious Professionalism™ is very important.

5.5.2.6 T11

At events, Teams may only produce FABRICATED ITEMS in the pit areas or provided machine shops, as defined in the *Administrative Manual, Section 4.8: The Pit*.

5.5.2.7 T12

For the safety of all those involved, Inspections must take place with the ROBOT powered off, pneumatics unpressurized, and springs or other stored energy devices in their lowest potential energy states (i.e. battery removed).

Power and air pressure should only be enabled on the ROBOT during those portions of the Inspection process where it is absolutely required to validate certain system functionality and compliance with specific rules (firmware check, etc.). Inspectors may allow the ROBOT to be powered up beyond the parameters above if both criteria below are met.

The ROBOT design requires power or a charged stored energy device in order to confirm that the ROBOT meets volume requirements, and

The Team has included safety interlocks that mitigate unexpected release of such stored energy.

5.5.3 Referee Interaction

The Head Referee has the ultimate authority in the ARENA during the event, but may receive input from additional sources, e.g. Game Designers, *FIRST* personnel, and technical staff. The Head Referee rulings are final. The Head Referee will not review recorded replays under any circumstances.

5.5.3.1 T13

If a TEAM needs clarification on a ruling or score, one (1) pre-college student from that TEAM should address the Head Referee after the ARENA reset signal (i.e. PLAYER STATION LED strings turn green). A TEAM member signals their desire to speak with the Head Referee by standing in a Red or Blue Question Box, which are located on the floor near each end of the scoring table. Depending on timing, the Head Referee may postpone any requested discussion until the end of the subsequent MATCH.

5.5.4 YELLOW and RED CARDS

The Head Referee may assign a YELLOW or RED CARD as a result of egregious ROBOT or Team member behavior at the ARENA. A RED CARD results in DISQUALIFICATION.

A YELLOW or RED CARD is indicated by the Head Referee standing in front of the Team's PLAYER STATION and holding a YELLOW and/or RED CARD in the air after the completion of the MATCH.

The Team carries their YELLOW CARD into subsequent MATCHES. A Team is issued a RED CARD in any subsequent MATCH in which they receive an additional YELLOW CARD. A second YELLOW CARD is indicated by the Head Referee standing in front of the Team's PLAYER STATION and holding a YELLOW CARD and RED CARD in the air simultaneously after the completion of the MATCH.

Once a Team receives a YELLOW or RED CARD, its Team number will be presented with a yellow background on the audience screen at the beginning of all subsequent MATCHES as a reminder to the Team, the Referees, and the audience that they carry a YELLOW CARD.

Examples of egregious behavior include, but are not limited to, severe and/or repeated violations of a rule and/or inappropriate behavior.

YELLOW CARDS do not carry forward from Qualification MATCHES to Elimination MATCHES (i.e. all Teams move into the Elimination MATCHES with a clean slate).

If a Team receives a RED CARD during the Elimination MATCHES, the entire ALLIANCE receives a RED CARD for that MATCH which results in a loss of that MATCH for the DISQUALIFIED ALLIANCE.

5.5.5 ARENA Reset Rules

5.5.5.1 T14

At the conclusion of a MATCH, TEAMS must remain in their ALLIANCE STATION and HUMAN PLAYER AREAS until the ARENA reset signal is issued, as indicated by the PLAYER STATION LED strings illuminating green (as described in *Section 2.2.8: The PLAYER STATIONS*).

5.5.5.2 T15

ROBOTS will not be re-enabled after the conclusion of the MATCH, nor will Teams be permitted to tether to the ROBOT.

5.5.5.3 T16

If, in the judgment of the Head Referee, an “ARENA fault” occurs that affects the outcome of the MATCH, the MATCH will be replayed.

ARENA faults include broken FIELD elements, power failure to a portion of the FIELD (tripping the circuit breaker in the PLAYER STATION is not considered a power failure), improper activation of the FMS, errors by FIELD personnel, etc.

5.5.6 TIMEOUT and BACKUP TEAM Rules

There are no TIMEOUTS in the Practice or Qualification MATCHES.

In the Elimination MATCHES, each ALLIANCE will be allotted one (1) TIMEOUT.

During a TIMEOUT, the ARENA Timer will display the time remaining in the TIMEOUT. Both ALLIANCES will enjoy the complete 6-minute window. If an ALLIANCE completes their repairs before the ARENA Timer expires, the ALLIANCE CAPTAIN is encouraged to inform the Head Referee that they are ready to play. If both ALLIANCES are ready to play before the TIMEOUT expires, the next MATCH will start.

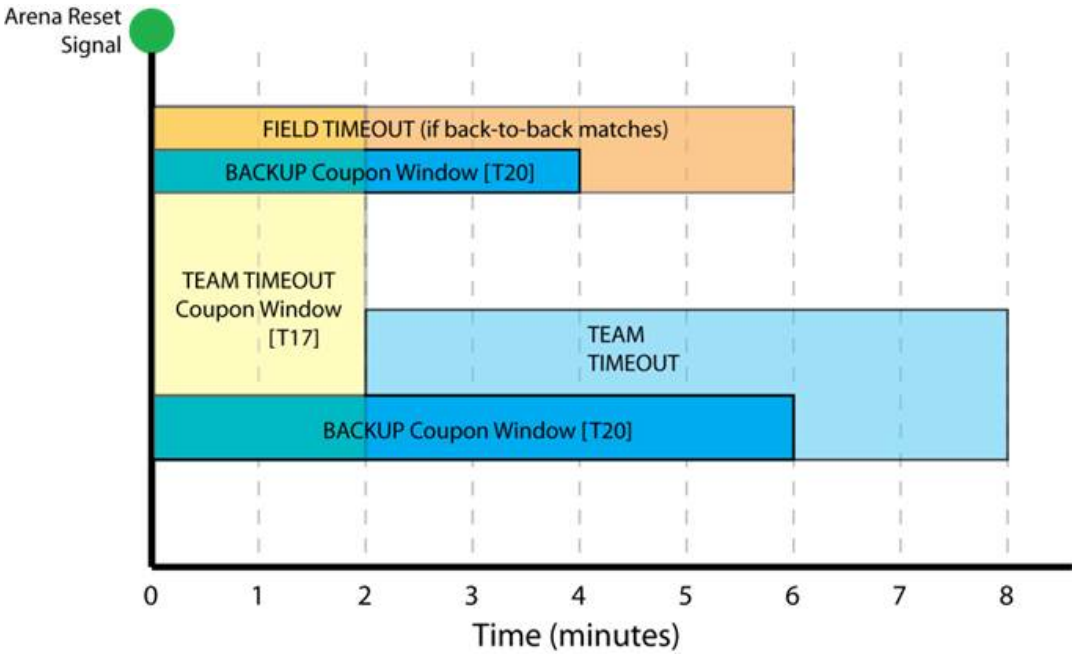


Figure 5-3: TIMEOUT Timeline

During the Elimination MATCHES, if circumstances require an ALLIANCE to play in back-to-back MATCHES, the Head Referee will issue a FIELD TIMEOUT to allow Teams to prepare for the next MATCH.

5.5.6.1 T17

If an ALLIANCE wishes to call a TIMEOUT, they must submit their TIMEOUT coupon to the Head Referee within two (2) minutes of the ARENA reset signal preceding their MATCH.

5.5.6.2 T18

There are no cascading TIMEOUTS. If an ALLIANCE calls a TIMEOUT during a FIELD TIMEOUT, the FIELD TIMEOUT will immediately expire and the ALLIANCE'S TIMEOUT will begin.

If an ALLIANCE wishes to call a TIMEOUT during a FIELD TIMEOUT, it must still do so within two (2) minutes of the ARENA reset signal preceding their MATCH, per Rule T17.

5.5.6.3 T19

TIMEOUTS are not transferrable between ALLIANCES.

5.5.6.4 T20

If during a TIMEOUT an ALLIANCE CAPTAIN determines that they need to call up a BACKUP TEAM, they must submit their BACKUP TEAM coupon to the Head Referee while there are still at least two (2) minutes remaining on the ARENA Timer. After that point, they will not be allowed to utilize the BACKUP TEAM.

Alternatively, an ALLIANCE CAPTAIN may choose to call up a BACKUP TEAM without using their TIMEOUT by informing the Head Referee directly within two (2) minutes of the Head Referee issuing the ARENA reset signal preceding their MATCH.

In the case where the ALLIANCE CAPTAIN'S ROBOT is replaced by a BACKUP TEAM, the ALLIANCE CAPTAIN is allowed in the ALLIANCE STATION as a thirteenth ALLIANCE member so they can serve in an advisory role to their ALLIANCE.

5.5.6.5 T21

An ALLIANCE may request neither a TIMEOUT nor a BACKUP TEAM after an Elimination MATCH is stopped by the Head Referee (e.g. due to an ARENA fault or a safety issue). The sole exception is if the replay is due to an ARENA fault that rendered a ROBOT inoperable.

If an Elimination MATCH is replayed per T21 the Head Referee has the option of calling a FIELD TIMEOUT.

5.5.7 Measurement

The ARENA will be open for at least one (1) hour prior to the start of Practice MATCHES, during which Teams may survey and/or measure the FIELD. The specific time that the FIELD is open will be communicated to Teams at the event. Teams may bring specific questions or comments to the FTA.

5.5.8 Special Equipment Rules

5.5.8.1 T22

The only equipment, provided it does not jam or interfere with the remote sensing capabilities of another Team, including vision systems, acoustic range finders, sonars, infrared proximity detectors, etc. (e.g. including imagery that, to a reasonably astute observer, mimics the VISION TARGET), that may be brought in to the ALLIANCE STATION are as follows:

A. the OPERATOR CONSOLE,
B. non-powered signaling devices,
C. reasonable decorative items,
D. special clothing and/or equipment required due to a disability
E. devices used solely for the purpose of planning or tracking strategy provided they meet all of the following

conditions:

i. do not connect or attach to the OPERATOR CONSOLE
ii. do not connect or attach to the FIELD or ARENA
iii. do not connect or attach to another ALLIANCE member
iv. do not communicate with anything or anyone outside of the ARENA.
v. do not include any form of enabled wireless electronic communication (e.g. radios, walkie-talkies, cell phones, Bluetooth communications, Wi-Fi, etc.)
vi. do not in any way affect the outcome of a MATCH, other than by allowing PLAYERS to plan or track strategy for the purposes of communication of that strategy to other ALLIANCE members.

5.6 Championship Additions and Exceptions

At the 2014 *FIRST* Championship, Teams are split into four (4) Divisions: Archimedes, Curie, Galileo, and Newton. Each Division plays a standard Tournament as described in Section 5.3: Qualification MATCHES, Section 5.4: Elimination MATCHES, *and* 5.5: Tournament Rules, with the exception of *Section 5.4.1: ALLIANCE Selection Process* and Section *5.4.2: BACKUP TEAMS*, to produce the Division Champions. Those four (4) Division Champions proceed to the Championship Playoffs, on the Einstein FIELD, to determine the 2014 FRC Champions.

There is no provision for BACKUP TEAMS at the Championship.

5.6.1 Four ROBOT ALLIANCES

Before each Division Elimination Tournament, ALLIANCES will be selected per the process as described in *Section 5.4.1: ALLIANCE Selection Process*, however the process will continue with a 3rd round of selection as follows.

Round 3: The same method is used for each ALLIANCE CAPTAIN'S third choice except the selection order is reversed again, with ALLIANCE One picking first and ALLIANCE Eight picking last. This process results in eight (8) ALLIANCES of four (4) Teams each.

ALLIANCES may start with any three (3) of the four (4) ROBOTS on their ALLIANCE during Elimination MATCHES and on the Einstein FIELD. The list of TEAMS participating in the MATCH is called the LINEUP. One representative from the TEAM not on the LINEUP is allowed in the ALLIANCE STATION as a thirteenth ALLIANCE member.

The ALLIANCE CAPTAIN must report the LINEUP to the Head Referee, or their designee, in writing prior to end of the preceding MATCH (e.g. the LINEUPS for MATCH QF2-1 must be submitted before the end of MATCH QF1-1). If there is no preceeding MATCH, the LINEUP is due no later than two (2) minutes before the scheduled MATCH time. The LINEUP will be kept confidential until the FIELD is set for the MATCH, at which point each ALLIANCE'S LINEUP will appear on the Team Signs. Once the LINEUP has been declared, it cannot be changed unless there is a TIMEOUT. If there is a TIMEOUT, the ALLIANCE CAPTAIN may submit a different LINEUP, but must do so while there are still more than two (2) minutes remaining in the TIMEOUT.

Example: Four (4) Teams, A, B, C and D, form an ALLIANCE going into the Elimination MATCHES on their Division FIELD. During one of the Elimination MATCHES, Team C's ROBOT becomes inoperable. The ALLIANCE decides to bring in Team D to replace Team C. Team C repairs their ROBOT and may play in any subsequent Elimination MATCHES replacing Teams A, B, or D. All four (4) ALLIANCE members are also eligible to play MATCHES on the Einstein FIELD should the ALLIANCE win the Division Tournament.

If an ALLIANCE fails to submit a LINEUP per the process above, the LINEUP will be the same as the ALLIANCE'S previous MATCH. If an ALLIANCE fails to submit a LINEUP per the process above and the MATCH is their first of the Elimination Tournament or the Einstein Tournament, the LINEUP will be the ALLIANCE Lead, first ALLIANCE selection, and second ALLIANCE selection. If any of these three (3) ROBOTS are unable to play, the ALLIANCE must play the MATCH with only two (2) (or even one (1)) ROBOTS.

If a MATCH must be replayed due to an ARENA fault, the LINEUP for the replayed MATCH is the same as the original MATCH. The sole exception is if the ARENA fault rendered a ROBOT inoperable, the LINEUP can be changed.

5.6.2 Championship Pit Crews

Only Team members wearing proper badges are allowed on the ARENA floor**.** *FIRST* will distribute these badges to the ALLIANCE CAPTAINS during the ALLIANCE CAPTAIN meeting, which takes place on the Division FIELDS. These badges will provide the necessary access to the ARENA for pit crew members.

Teams should assume they may be chosen for an ALLIANCE and think about the logistics of badge distribution and set a plan prior to the ALLIANCE selection process. It is each ALLIANCE CAPTAIN'S responsibility to get the Team's badges to the pit crew members.

5.6.3 FRC Championship MATCH Bracket

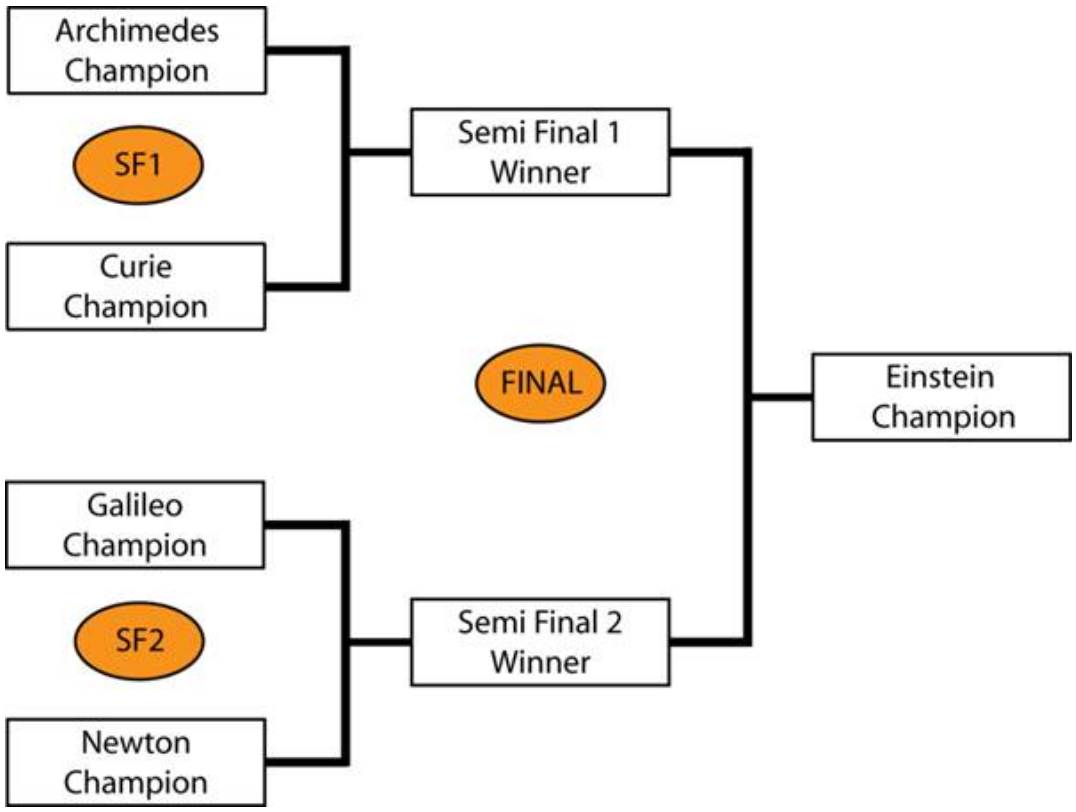


Figure 5-4: Championship Playoff MATCH Bracket

In order to allow time between MATCHES for all ALLIANCES, the order of play is as follows:

SF1-1, SF2-1, SF1-2, SF2-2, SF1-3*, SF2-3*

Any additional Semi-Final MATCHES due to ties*

F-1, F-2, F-3*

Any additional Final MATCHES due to ties*

(* - if required)

6 Glossary

ALLIANCE: a set of up to four (4) Teams who play AERIAL ASSIST together.

ALLIANCE CAPTAIN: a designated student representative from the ALLIANCE Lead.

ALLIANCE STATION: the area bounded by the ALLIANCE WALL, LOW GOALS, white tape depicted in *Figure 2.11: The ALLIANCE STATION*.

ALLIANCE WALL: a 6 ft. 6 in.tall, 18 ft. wide, barrier that defines the ends of the FIELD.

ARENA: all elements of the game infrastructure required to play AERIAL ASSIST: the FIELD, the ALLIANCE STATIONS, the BALLS, all supporting communications, ARENA control, and scorekeeping equipment.

ASSIST: an event worth bonus points that occurs when a unique ALLIANCE ROBOT POSSESSES the ALLIANCE'S BALL in a unique ZONE (i.e. red, white, or blue ZONE) during a CYCLE.

AUTO (aka Autonomous): the first ten (10) seconds of the MATCH in which ROBOTS operate without direct DRIVER control.

BACKUP TEAM: a Team used to replace an inoperable ROBOT on an ALLIANCE during Elimination MATCHES per *Section 5.4.2: BACKUP TEAMS*.

BALL: the spherical game piece used in AERIAL ASSIST.

BUMPER: a protective assembly designed to attach to the exterior of the ROBOT and constructed as specified in *Section 4.6: BUMPER Rules*.

BUMPER ZONE: the volume contained between two virtual horizontal planes, 2 in. and 10 in. above the floor.

CATCH: the event when a BALL SCORED over the TRUSS by a ROBOT'S ALLIANCE partner is POSSESSED by that ROBOT before contacting the carpet or HUMAN PLAYER.

COACH: a student or adult Mentor identified as the person wearing the designated "COACH" pin or button during a MATCH.

COMPONENT: any part in its most basic configuration, which cannot be disassembled without damaging or destroying the part or altering its fundamental function.

COTS: a "Commercial, Off-The-Shelf" COMPONENT or MECHANISM, in its unaltered, unmodified state. A COTS item must be a standard (i.e. not custom order) part commonly available from the VENDOR, available from a non-Team source, and available to all Teams for purchase.

Example 1: A Team orders two (2) ROBOT grippers from RoboHands Corp. and receives both items. They put one in their storeroom and plan to use it later. Into the other, they drill "lightening holes" to reduce weight. The first gripper is still classified as a COTS item, but the second gripper is now a FABRICATED ITEM, as it has been modified.

Example 2: A Team obtains openly available blueprints of a drive component commonly available from Wheels-R-Us Inc. and has local machine shop "We-Make-It, Inc." manufacture a copy of the part for them. The produced part is NOT a COTS item, because it is not commonly carried as part of the standard stock of We-Make-It, Inc.

Example 3: A Team obtains openly available design drawings from a professional publication during the pre-season, and uses them to fabricate a gearbox for their ROBOT during the build period following Kickoff. The design drawings would be considered a COTS item, and may be used as "raw material" to fabricate the gearbox. The finished gearbox itself would be a FABRICATED ITEM, and not a COTS item.

Generally available software modules obtained from open sources (e.g. professional publications, commonly used FRC community-accessible web resources, industry source code repositories, etc.) that are not specifically affiliated with individual FRC Teams are considered COTS items.

CUSTOM CIRCUIT: any electrical component of the robot other than motors (listed in R29), cRIO, Power Distribution Board, Digital Sidecars, Analog Breakouts, Solenoid Breakouts, RSL, 120A breaker, motor controllers, relay modules, 12VDC-5VDC converter, wireless bridge, and batteries.

CYCLE: the series of events that recur regularly, and each CYCLE begins with an ALLIANCE'S BALL being retrieved from the PEDESTAL and ends when a BALL is SCORED in a GOAL.

DISABLED: a state in which a ROBOT has been commanded by the Driver Station to deactivate all outputs.

DISQUALIFIED: the status of a TEAM, as determined by the Head Referee, in which they receive zero (0) Qualification Points in a Qualification MATCH or causes their ALLIANCE to automatically lose an Elimination MATCH.

DRIVER: a pre-college student TEAM member responsible for operating and controlling the ROBOT.

FABRICATED ITEM: any COMPONENT or MECHANISM that has been altered, built, cast, constructed, concocted, created, cut, heat treated, machined, manufactured, modified, painted, produced, surface coated, or conjured partially or completely into the final form in which it will be used on the ROBOT.

FIELD: a 24 ft. 8 in. x 54 ft. carpeted area, bounded by and including the GUARDRAILS, ALLIANCE WALLS, and rear faces of the LOW GOALS.

FIELD TIMEOUT: a TIMEOUT called by the Head Referee.

FOUL: a penalty assessed by a Referee which credits the opponent with twenty (20) points.

FRAME PERIMETER: the polygon defined by the outer-most set of exterior vertices on the ROBOT (without the BUMPERS attached) that are within the BUMPER ZONE. To determine the FRAME PERIMETER, wrap a piece of string around the ROBOT at the level of the BUMPER ZONE - the string describes this polygon.

Note: to permit a simplified definition of the FRAME PERIMETER and encourage a tight, robust connection between the BUMPERS and the FRAME PERIMETER, minor protrusions such as bolt heads, fastener ends, rivets, etc. are excluded from the determination of the FRAME PERIMETER.

GOAL: a FIELD element in which BALLS are SCORED to earn points for an ALLIANCE.

GOALIE ZONE: the area in front of an ALLIANCE'S ALLIANCE WALL, bounded by the opponent's LOW GOALS and black tape.

GUARDRAIL: a system that borders the length of the FIELD and consists of horizontal pipes, vertical struts, and polycarbonate shields.

HIGH GOAL: one (1) of two (2) ALLIANCE'S GOALS located above the opponent's ALLIANCE WALL.

HOT: the condition of a goal during AUTO, as determined by the FMS, in which it is worth more than a non-HOT GOAL. The state of a HOT GOAL is identified with yellow perimeter lighting and via the corresponding VISION TARGET.

HUMAN PLAYER: a pre-college TEAM member delegated to manage the BALLS while the BALLS are not on the FIELD.

HUMAN PLAYER AREA: one (1) of two (2) areas on the side of the FIELD bounded by ALLIANCE colored tape.

HUMAN PLAYER BARRIER: a system that consists of horizontal pipes that are 1 ft. 8 in. above the floor and are supported by sheet metal struts that are integrated into the GUARDRAIL. The HUMAN PLAYER BARRIER extends 1 ft. 8 in. wider than the GUARDRAIL and creates a barricade between HUMAN PLAYERS and ROBOTS.

Kit of Parts (KOP): the collection of items listed on any *Kit of Parts Checklist*, has been distributed via *FIRST*® Choice, or obtained via a Product Donation Voucher (PDV)

LINEUP: the list of three (3) TEAMS designated by their ALLIANCE to play in a *FIRST* Championship Division Elimination MATCH or MATCH on the Einstein FIELD.

LOW GOAL: one (1) of two (2) cubic ALLIANCE GOALS located in each corner of the FIELD adjacent to the opponent's ALLIANCE WALL.

MATCH: a two (2) minute and thirty (30) second period of time in which ALLIANCES compete in AERIAL ASSIST.

MECHANISM: a COTS or custom assembly of COMPONENTS that provide specific functionality on the ROBOT. A MECHANISM can be disassembled (and then reassembled) into individual COMPONENTS without damage to the parts.

OPERATOR CONSOLE: the set of COMPONENTS and MECHANISMS used by the DRIVERS to relay commands to the ROBOT.

PEDESTAL: the structure used to support the BALL staged in the ALLIANCE STATION. The PEDESTAL also indicates the BALL'S eligibility for play.

PLAYER STATION: one (1) of three (3) assigned positions behind the ALLIANCE WALL from where a TEAM operates their ROBOT.

PLAYING CONFIGURATION: The physical configuration and orientation of the ROBOT while playing the game (i.e. after the MATCH has started, and the ROBOT has deployed mechanisms, moved away from the starting location, and/or interacted with the field, GAME PIECES, or other ROBOTS). This configuration is dynamic, and may change multiple times during the course of a single MATCH.

POSSESS: (for a ROBOT) to carry (move while supporting BALLS in or on the ROBOT), herd (repeated pushing or bumping), launch (impel BALLS to a desired location or direction), or trap (overt isolation or holding one or more BALLS against a FIELD element or ROBOT in an attempt to shield them) a BALL.

RED CARD: a penalty assessed for egregious ROBOT or FRC Team member behavior which DISQUALIFIES a TEAM, see *Section 5.4.4: YELLOW and RED CARDS*.

ROBOT: an electromechanical assembly built by an FRC Team to perform specific tasks when competing in AERIAL ASSIST. It includes all of the basic systems required to be an active participant in the game: power, communications, control, mobility, and actuation. The implementation must obviously follow a design approach intended to play AERIAL ASSIST (e.g. a box of unassembled parts placed on the FIELD or a ROBOT designed to play a different game would not satisfy this definition).

SCORE: to accrue points for an ALLIANCE.

SCORED: the state of a BALL in which it has accrued points for an ALLIANCE.

SIGNAL LEVEL: circuits which draw ?1A continuous and have a source incapable of delivering >5 Amps, including but not limited to DSC outputs, Solenoid Breakout outputs, and Arduino outputs.

STARTING CONFIGURATION: The physical configuration and orientation of the ROBOT when the MATCH is started. This is the state of the ROBOT immediately before being Enabled by the Field Management System, before the ROBOT takes any actions, deploys any MECHANISMS, or moves away from the starting location. This configuration is static, and does not change during a single MATCH (although it may change from MATCH to MATCH). In the STARTING CONFIGURATION, no part of the ROBOT may extend outside the vertical projection of the FRAME PERIMETER, with the exception of minor protrusions such as bolt heads, fastener ends, rivets, etc.

If a ROBOT is designed as intended and pushed up against a vertical wall (in STARTING CONFIGURATION and with BUMPERS removed), only the FRAME PERIMETER (or minor protrusions) will be in contact with the wall.

STARTING LINE: the line, marked in white tape, located 2 ft. 6 in. behind the ALLIANCE WALL behind which TEAM members must stay during AUTO.

SURROGATE: a Team randomly assigned by the Field Management System to play an extra Qualification MATCH, detailed in *Section 5.2.2: MATCH Assignment*.

TEAM: 1 COACH, 2 DRIVERS, and 1 HUMAN PLAYER from the same FRC Team.

TECHNICAL FOUL: a penalty assessed by a Referee which credits the opponent with fifty (50) points.

TELEOP: the two (2) minutes and twenty (20) seconds of a MATCH in which ROBOTS may be directly controlled by DRIVERS.

TIMEOUT: a period of up to six (6) minutes between MATCHES, used to pause Elimination MATCH progression.

TRUSS: a 1 ft. x 1 ft. square frame of aluminum that spans the center of the FIELD.

TRUSS POLE: a vertical cylinder that extends up from the TRUSS and marks the width limits of the FIELD.

VENDOR: a legitimate business source for COTS items that satisfies all of the following criteria:

A. **has a Federal Tax Identification number. In cases where the VENDOR is outside of the United States, they must possess an equivalent form of registration or license with the government of their home nation that establishes and validates their status as a legitimate business licensed to operate within that country.**
B. **is not a "wholly owned subsidiary" of an FRC Team or collection of FRC Teams. While there may be some individuals affiliated with both an FRC Team and the VENDOR, the business and activities of the Team and VENDOR must be completely separable.**
C. **must be able to ship any general (i.e., non-*FIRST* unique) product within five business days of receiving a valid purchase request. It is recognized that certain unusual circumstances (such as 1,000 FIRST Teams all ordering the same part at once from the same VENDOR) may cause atypical delays in shipping due to backorders for even the largest VENDORs. Such delays due to higher-than-normal order rates are excused.**
D. **should maintain sufficient stock or production capability to fill Teams' orders within a reasonable period during the build season (less than 1 week). (Note that this criterion may not apply to custom-built items from a source that is both a VENDOR and a fabricator. For example, a VENDOR may sell flexible belting that the Team wishes to procure to use as treads on their drive system. The VENDOR cuts the belting to a custom length from standard shelf stock that is typically available, welds it into a loop to make a tread, and ships it to a Team. The fabrication of the tread takes the VENDOR two weeks. This would be considered a Fabricated Item, and the two weeks ship time is acceptable.) Alternately, the Team may decide to fabricate the treads themselves. To satisfy this criterion, the VENDOR would just have to ship a length of belting from shelf stock (i.e. a COTS item) to the Team within five business days and leave the welding of the cuts to the Team.)**
E. **makes their products available to all FRC Teams. VENDOR must not limit supply or make a product available to just a limited number of FRC Teams.**

The intent of this definition it to be as inclusive as possible to permit access to all legitimate sources, while preventing ad hoc organizations from providing special-purpose products to a limited subset of Teams in an attempt to circumvent the cost accounting rules. FIRST desires to permit Teams to have the broadest choice of legitimate sources possible, and to obtain COTS items from the sources

that provide them with the best prices and level of service available. Teams also need to protect against long delays in availability of parts that will impact their ability to complete their Robot. The FRC build season is brief, so the Vendor must be able to get their product, particularly FIRST unique items, to a Team in a timely manner. Ideally, chosen Vendors should have national distributors (e.g. Home Depot, Lowes, MSC, Radio Shack, McMaster-Carr, etc.). Remember, FRC events are not usually near home – when parts fail, local access to replacement materials is often critical.

VISION TARGET: a retro-reflective object, made of 3M 8830 Silver Marking Film, that may be used by ROBOTS to sense FIELD elements.

YELLOW CARD: a warning for egregious ROBOT or FRC Team member behavior.

ZONE: the red, white, or blue designated area of the FIELD.

ZONE LINE: the red, white, or blue line that marks the ZONE boundary.