FIRST® GAME CHANGERS℠ *powered by Star Wars: Force for Change*

2021 *FIRST*® Robotics Competition

INFINITE RECHARGE At Home Challenge Space Manual

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1 INFINITE RECHARGE℠ AT HOME CHALLENGE SPACE LAYOUT

1.1 General Information

The INFINITE RECHARGE℠ at Home Skills Competition utilizes a common playing space known as the Challenge Space. A grid of locations is identified on the space, and Field Elements are placed only on specific locations as required by each challenge. This guide gives one solution on how to mark the Challenge Space and also options to use for the representation of the POWER PORT.

1.1.1 Overview

The Skills Competition has been developed for participation by a 2020 or 2021 INFINITE RECHARGE ROBOT and doesn't require a full competition field. As the Skills Competition is part of INFINITE RECHARGE at Home, many of the defined terms used in this manual are referencing terms from the At Home Challenges Manual. These terms are not explicitly defined in this document; for full descriptions, please see the 2021 INFINITE RECHARGE Manual.

To fully recreate the Challenge Space used in the Skills Competition, teams will need the following:

- The Challenge Space – An open space to operate the ROBOT, indoors or outdoors, on which various Field Elements will be placed on a defined grid depending on the immediate Challenge being attempted. Guidelines for this space include:
  - ~15 ft. x ~30 ft. (~458 cm x ~915 cm) of playing space is strongly recommended. Additional space is required for drivers and observers.
  - If attempting shooting challenges, adequate height for the ROBOT to shoot POWER CELLS into the POWER PORT representation. Total POWER PORT height is ~10ft. (~305 cm)
  - Carpet is not needed, any surface your ROBOT can safely drive on is permitted
- POWER CELLS
  - three (3) POWER CELLS are needed (included in the 2021 Kickoff Kit).
- POWER PORT – Team Version (wooden or comparable) Field Elements are not required. For the Interstellar Accuracy Challenge and POWER PORT Challenge a representation of the POWER PORT with approximately correct dimensions is required. See POWER PORT for more details.
- MARKERS – Up to twenty (20) physical objects each with a minimal horizontal cross-section of 2.5 in (~63 mm) wide by 2.5 in (~63 mm) deep and at least 6 in (~152 mm) tall. See MARKERS for more details.

1.1.2 The Challenge Space

All of the Skills Competition challenges utilize a common playing space known as the Challenge Space, depicted in Figure 1. This space is an area of about ~15 ft. x ~30 ft (~458 cm x ~915 cm) with a defined grid. The specific locations marked in Figure 1, NAV POINTS, are used to locate MARKERS or zones for specific challenges. NAV POINTS represent locations where Game Pieces or Field Elements (e.g. POWER CELLS or MARKERS, respectively) may be placed depending on the specific challenge being attempted and also serve as reference points for the start and end zones used in some of the challenges.

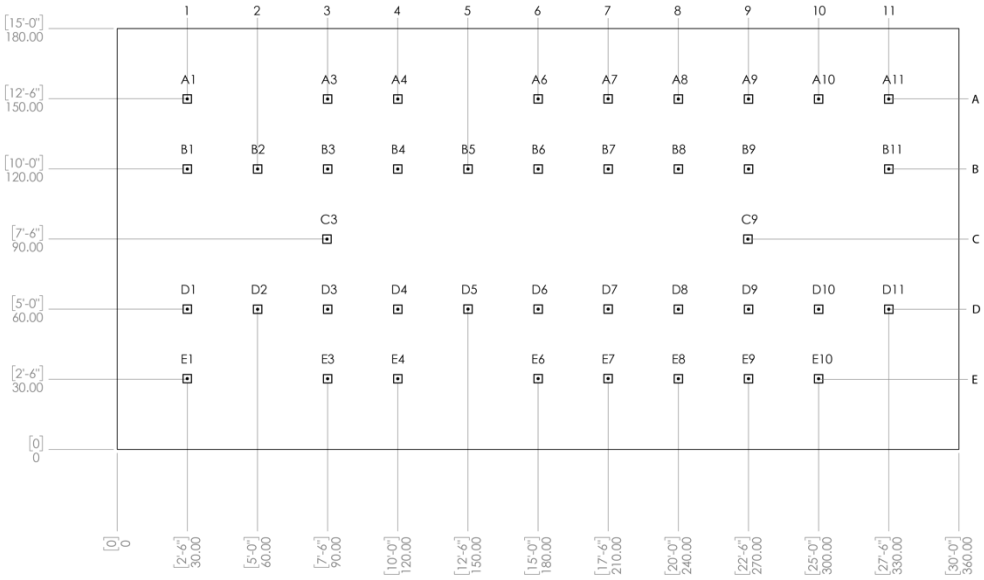


Figure 1 General Challenge Space Layout Diagram with NAV POINTS

It is recommended to measure and frame the Challenge Space so that its borders are easily discernible. If the Challenge Space is being set up on a semi-permanent basis, it is also recommended to semi-permanently identify the location of NAV POINTS by applying painter's tape, stickers, or other removable non-damaging materials to the surface. This will aid in resetting and/or reconfiguring the Challenge Space between the challenges. If the Challenge Space is an outside parking lot, for example, sidewalk chalk is a generally acceptable washable alternative.

In the example below (Figure 2), the Challenge Space is framed and marked for semi-permanent use on a painted wooden floor. Instead of marking individual NAV POINT locations, a grid is formed on the surface using tape; the intersection points identify possible NAV POINT locations. The purpose of this example is not to codify a preferred method for laying out and marking a Challenge Space, but to recognize that there are many potential ways to do this depending on the surface being used, the duration of use of the Challenge Space, and available materials.

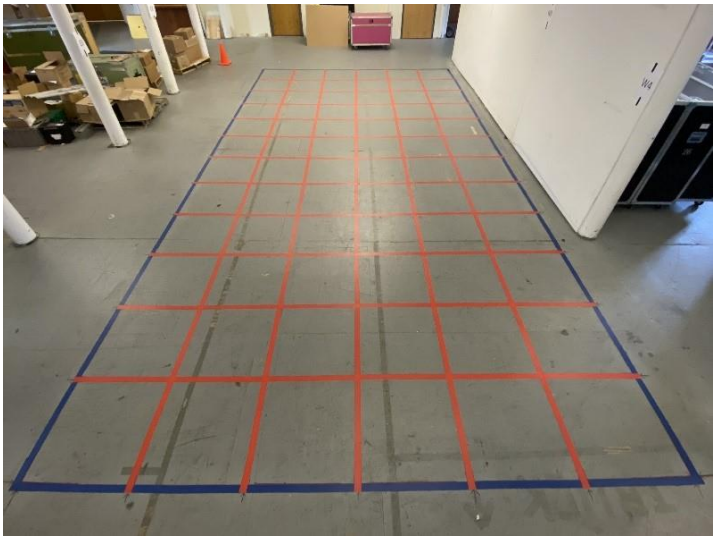


Figure 2 Example Challenge Space layout

One possible method for measuring and marking the Challenge Space is described below:

Materials

2x 15+ ft. tape measures (the process will be easier if one tape measure is longer, ideally 30+ ft.)

Materials to mark the floor of the Challenge Space (such as tape and some sort of pen or marker)

Steps

1. **Locate the Challenge Space:** The Challenge Space location should be selected carefully based on the available locations to choose from and which challenges are being attempted. Some challenges need a minimum ceiling height of 10 feet and may require the use of Team Version Field Elements or an adjacent wall depending on available resources. Please read this document and each challenge carefully and completely before deciding where to locate your Challenge Space.
2. **Mark the first short edge:** Measure out a 15 ft. line to be the first short edge of your Challenge Space. If you are placing one edge of your Challenge Space against a wall, make sure to use this edge as the first edge. Mark both corners and make intermediate marks 5 ft. in from each corner (these marks will be used to make sure your long edges are perpendicular). Optionally you may choose to mark the entire line with tape or other visible material to mark the edge of your Challenge Space (as well as the edges created in Steps 3 and 4).

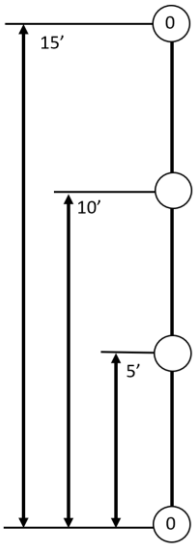


Figure 3 Mark the first short edge

3. **Mark the long edges:** From each corner, measure out a 30 foot line. In order to make sure the corners are square, use a second tape measure running from the 5 ft. point on the short edge to the 10 ft. mark on the tape measure being used to measure the long edge. The 10 ft. mark on the edge tape measure should line up with the 11 ft. 2 3/16 in. mark on the diagonal tape measure; adjust the edge tape measure in or out as necessary to align these measurements, then mark the 30 ft. corner. Note, you may want to make the intermediate marks in Step 5 at the same time as you complete this step.

> If you do not have a 30 ft. tape measure, you can measure and mark out longer distances in several steps. In order to keep lines straight it is recommended to overlap subsequent measurements by 5 ft. (i.e. to measure out your 30 ft. line with a 15 ft. tape measure,

measure out the first 15 ft., then place the end of the tape measure on the 10 ft. mark to measure and mark out to 20 ft., finally, place the end of the tape on the 15 ft. mark to measure and mark to the end).

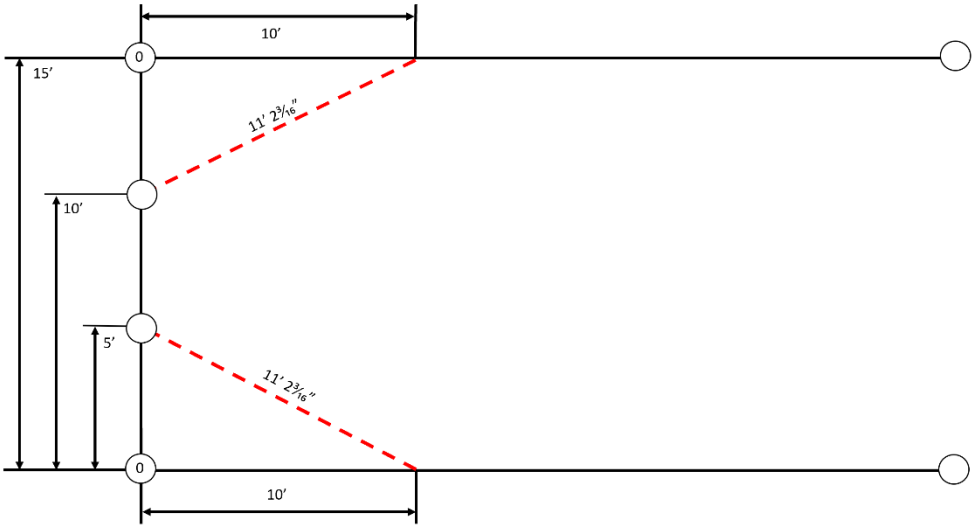


Figure 4 Mark the long edges

4. **Mark out the final short edge:** Complete the rectangle by connecting the endpoints of the two long edges created in Step 3.
5. **Mark out intermediate points on the long edges:** For each long edge, measure and mark intermediate points every 2 ft. 6 in. Where possible, measure cumulative distance from the corner, not individual 2 ft. 6 in. measurements in order to avoid error stackup.

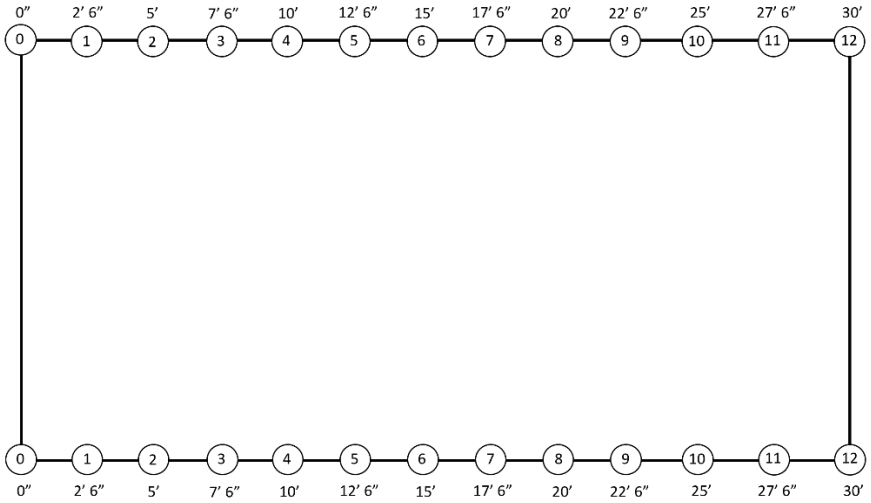


Figure 5 Mark long edge intermediates

6. **Mark NAV Points:** For each pair of numbered points in the diagram, place the tape measure between the points and mark the required NAV POINTS. Note that while all measurements are in 2 ft. 6 in. increments, some points not used by any challenges are omitted and do not need to be marked.

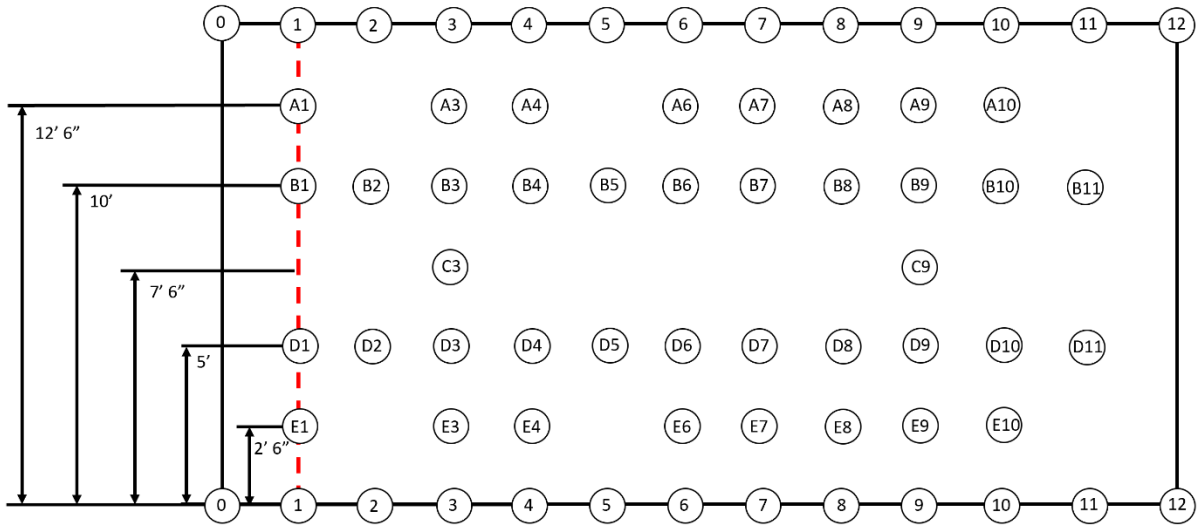


Figure 6 Mark NAV POINTS

1.1.3 POWER PORT

For the Interstellar Accuracy Challenge and POWER PORT Challenge a representation of the POWER PORT with approximately correct dimensions is required. If Team Version (wooden or comparable) Field Elements are available, necessary space is provided in one version of the challenge-specific configurations for those challenges to place the POWER PORT within the Challenge Space. However, if available space exists and it is desirable to place Team Version Field Elements outside the Challenge Space, or if Team Version Field Elements are not available, a version of the challenge-specific configuration exists that allows a representation of the POWER PORT with approximately correct dimensions to be used on the border of the Challenge Space instead. For example, if the short edge of the Challenge Space is against a wall, a representation of the POWER PORT'S INNER PORT and OUTER PORT boundaries can be recreated on the wall using painter's tape or other non-destructive materials. Details for recreating a 2-dimensional POWER PORT representation are as follows:

- The OUTER PORT is a regular hexagon that measures 2 ft. 6 in. (~76 cm) in height. This means each hexagon leg is ~1 ft. 5 5/16 in. (~44 cm) in length, and the hexagon is ~2 ft. 10 5/8 in. (~88 cm) at its widest point. The center of the OUTER PORT is 8 ft. 2 ¼ in. (~249 cm) above the playing surface.
- The INNER PORT is a 1 ft. 1 in. (~33cm) diameter circle concentric with the OUTER PORT. The center of the INNER PORT is 8 ft. 2 ¼ in. (~249 cm) above the playing surface.
- The BOTTOM PORT is a 10 in. (~25cm) tall, 2 ft. 10 in. (~ 86cm) wide rectangle, with the bottom edge located 1 ft. 6 in. (~46 cm) above the playing surface.

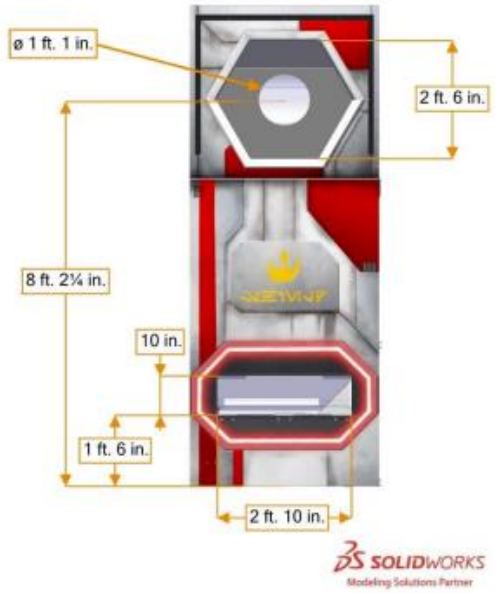


Figure 7 Power Port dimensions

A pair of detailed drawings for creating 2D INNER and OUTER port representations can be found in Appendix A and Appendix B. Appendix A shows dimensions for marking using tape, representing the INNER PORT as a hexagon with similar area as the actual INNER PORT opening. Appendix B shows dimensions for marking the hexagon and circle directly using marker, printing or another thin marking method.

For teams utilizing the BOTTOM PORT it is not recommended to use a 2D representation (such as a wall) as it will likely be logistically difficult to score and retrieve POWER CELLS. A rudimentary representation of the BOTTOM PORT can be constructed using totes received in the KOP a couple different ways:

- A single tote with the lid tied or taped closed, turned on its edge so the lid faces the playing space is approximately the right height (1ft. 5 in vs 1ft. 6 in.), is a little bit narrower than the goal (2ft. 3 in. vs 2 ft. 10 in.) and will naturally provide a slightly sloped surface for the POWER CELLS to roll back away from the ROBOT for retrieval. The “lip” of this setup will be approximately 1.75 in. back from the bottom edge, make sure to consider whether your ROBOT will be able to score over that gap. POWER CELLS would be considered scored if they pass over the top of the tote.

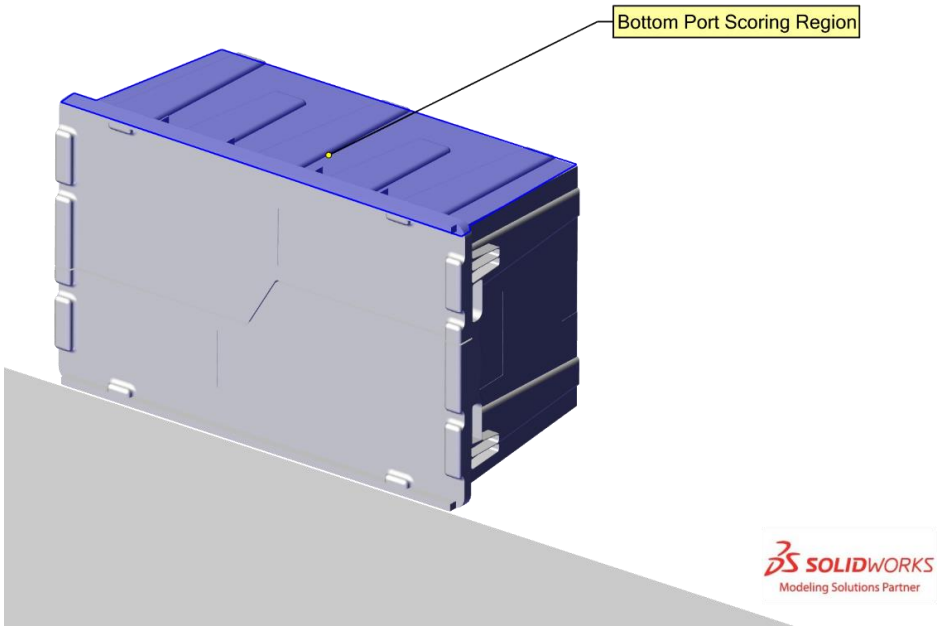


Figure 8 Bottom Port One Tote Representation

- Two totes placed side-by-side, each upright with a narrow edge facing the playing space, is very close to the correct width but is ~5.5 in. short. To achieve the necessary height, you could either:
  - Prop just the front edge, with the lids closed, to form a slope for POWER CELLS to roll down. POWER CELLS would be considered scored if they pass over the top of the totes.
  - Prop the whole tote, with the lids open, to form a pair of buckets for the POWER CELLS to fall into. POWER CELLS would be considered scored if they fall into the totes.

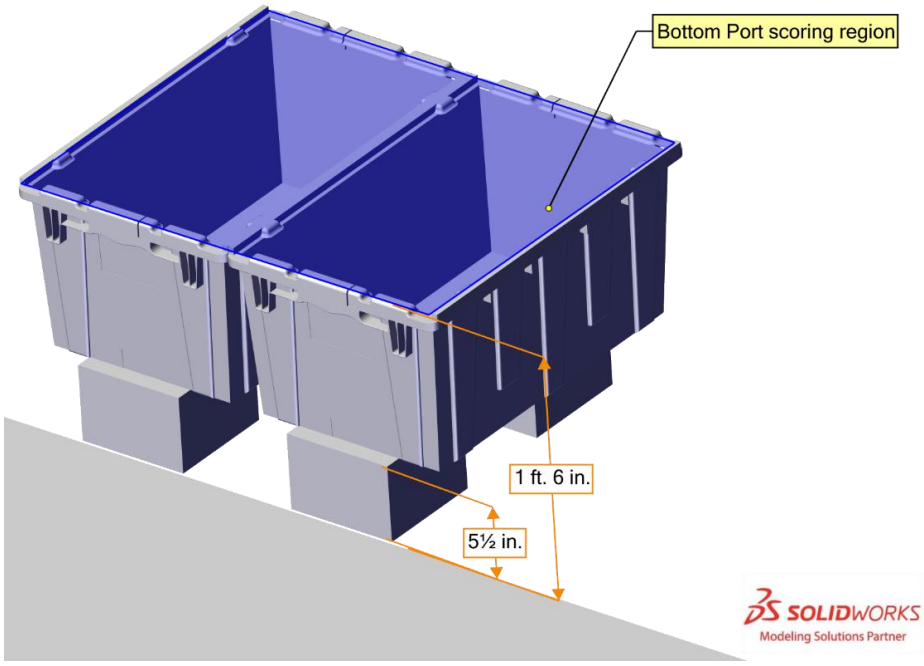


Figure 9 Bottom Port Two Tote Representation

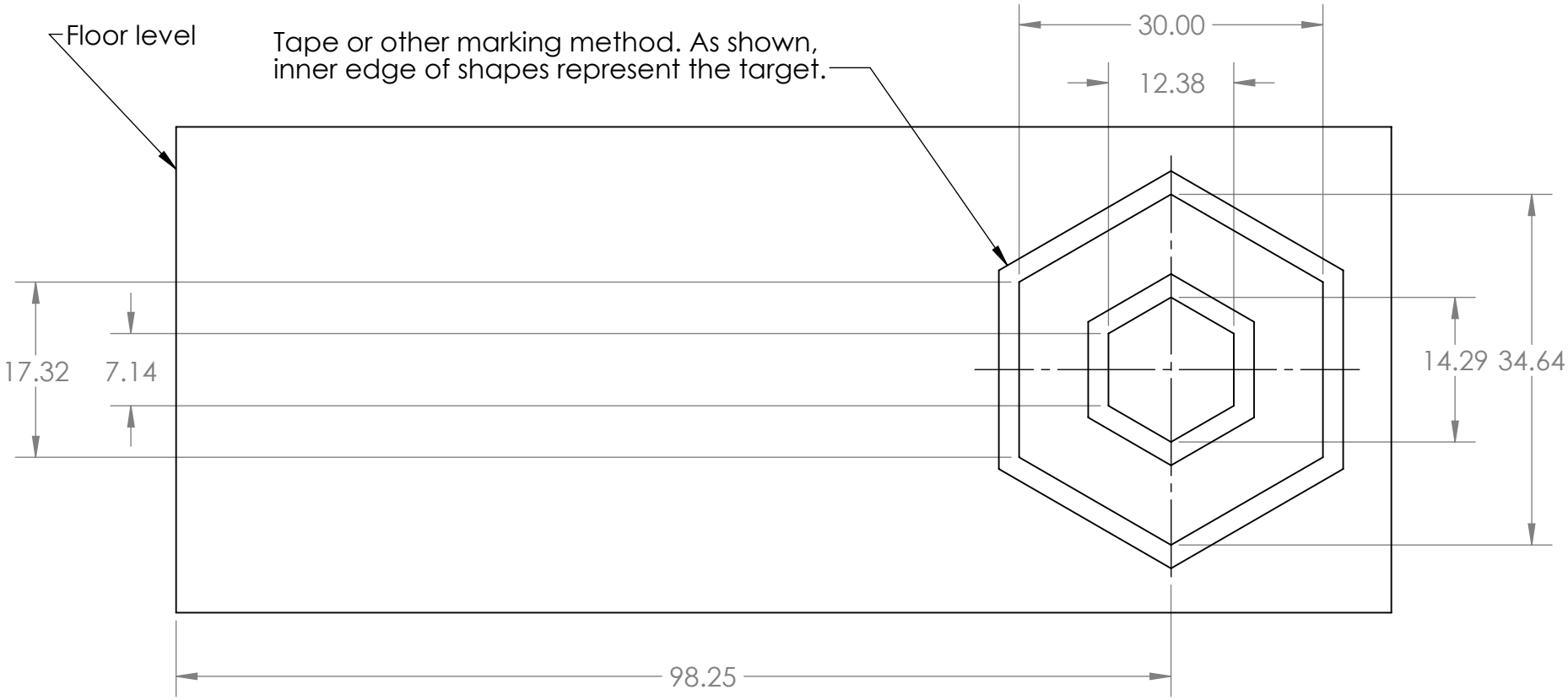
1.1.4 MARKERS

MARKERS are placed on specific NAV POINTS for each Path in the AutoNav and Hyperdrive Challenges and provide physical barriers for robot navigation; MARKERS are not required for other challenges but may optionally be placed on NAV POINTS for DRIVER reference (colored lines or other reference marks may be placed on the Challenge Space surface as well to help DRIVER performance). MARKERS may be made out of any material or composition but must minimally have a horizontal cross-section of 2.5 in (~63 mm) wide x 2.5 in (~63 mm) deep and be at least 6 in (~152 mm) tall. MARKERS on the Challenge Space should have a contrasting color or otherwise be easily distinguishable, allowing them to be easily recognizable to the DRIVERS and throughout the video. Some examples of MARKERS include, but are not limited to, 4” x 4” lumber, 2 Liter bottles, and small cones.

In the AutoNav Challenge, the Bounce Path course has the highest number of MARKERS specified at twenty (20) MARKERS. Three of these MARKERS are “starred markers,” which require the robot to contact each of these MARKERS before the challenge can be completed. If desired, POWER CELLS can be used instead of regular MARKERS (similar to the Galactic Search Challenge) as a POWER CELL meets the requirement of a MARKER and is likely visually distinct from other MARKERS.

Make sure to consider your Challenge Space surface and what may happen if MARKERS are impacted and fall over. One recommended construction is to adhere a heavy weight – such as a metal or wooden block – to the bottom of a lighter material such as an empty 2 Liter bottle. This can create a “wobble” effect on the MARKER when impacted; it’s easy to determine that the MARKER has been impacted, but depending on how hard it was impacted it may be unlikely that the MARKER will need to be reset by hand as the MARKER may self-right.

Figure 10 Example MARKER



Inner Port is represented as a hexagon for easier marking with tape or similar. Shape area is maintained almost the same. See next sheet for marking circle directly.

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/16 ANGULAR: MACH ±1° BEND ±1° TWO PLACE DECIMAL ±.01 THREE PLACE DECIMAL ±.001	DRAWN		
			CHECKED		
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			MFG APPR.		
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
		MATERIAL	COMMENTS:		
NEXT ASSY	USED ON	FINISH			
APPLICATION		DO NOT SCALE DRAWING			

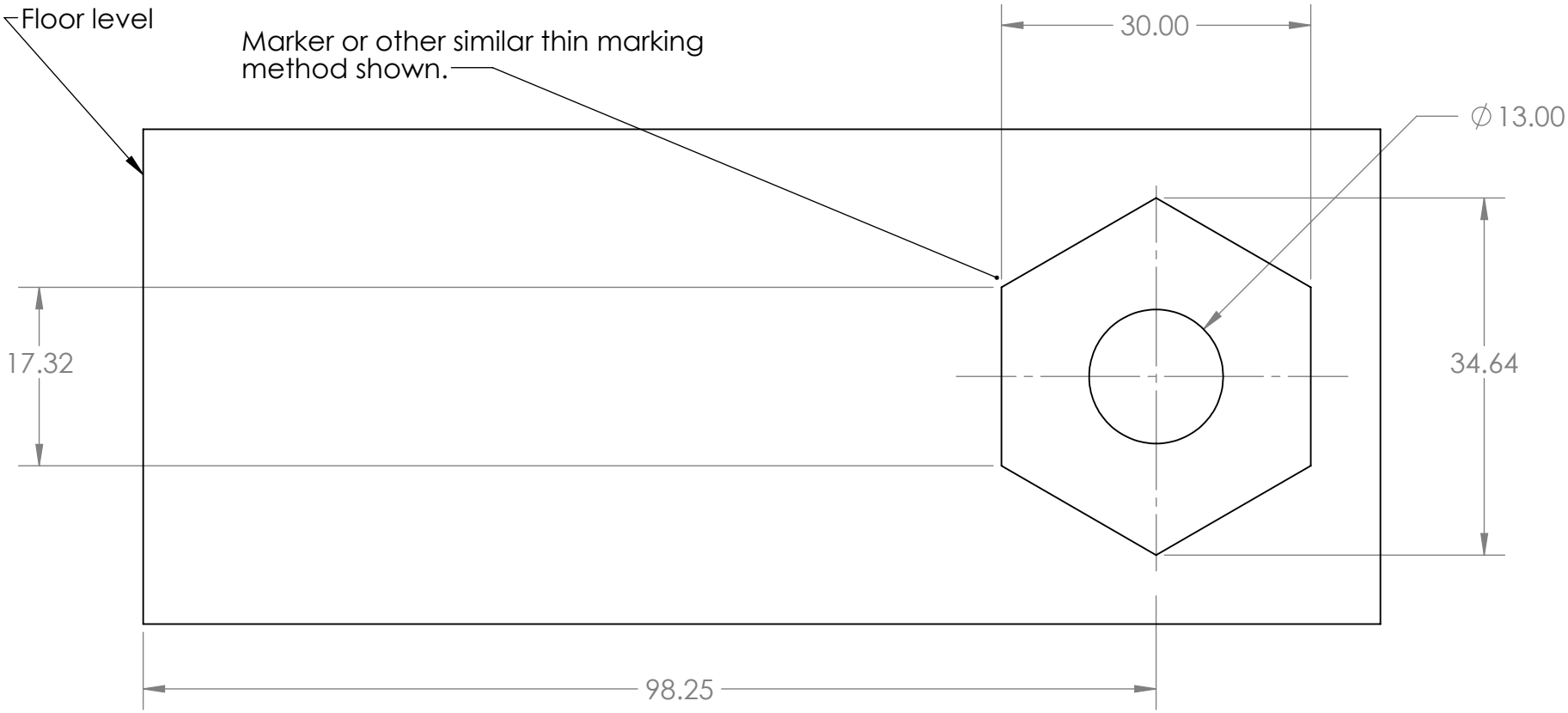
FIRST ROBOTICS COMPETITION

SOLIDWORKS Modeling Solutions Partner

TITLE:

Appendix A

SIZE	DWG. NO.	REV
A	ScoringWall	
SCALE: 1:16	WEIGHT:	SHEET 1 OF 2



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		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±1/16 ANGULAR: MACH ±1° BEND ±1° TWO PLACE DECIMAL ±.01 THREE PLACE DECIMAL ±.001	DRAWN		
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		MATERIAL	COMMENTS:		
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APPLICATION		DO NOT SCALE DRAWING			

FIRST ROBOTICS COMPETITION

SOLIDWORKS Modeling Solutions Partner

TITLE:

Appendix B

SIZE	DWG. NO.	REV
A	ScoringWall	
SCALE: 1:16	WEIGHT:	SHEET 2 OF 2