

Virtual University Rover Challenge 2021

The Virtual University Rover Challenge 2021 will be held June 3-5, 2021. The rules and instructions are posted publicly so that any team may participate, however only teams who placed in the top 36 of the URC2021 System Acceptance Review (SAR) will be scored live by judges.

Teams will compete in the 3 Missions outlined below, and will do so during two live judging sessions (completing each Mission once). The Equipment Servicing Mission and Autonomous Navigation Mission will be completed in a single session. The sessions will be scheduled in advance, and teams will only be evaluated on their performance during the live judging, similar to the scoring for an in-person competition.

The Virtual University Rover Challenge 2021 does not take the place of the URC2021 Finals. Rather, it is an alternative event being offered to teams following the cancellation of the Finals.

Logistics

The competition sessions will take place via a video conferencing service. Teams are required to have at least 2 cameras joining as separate participants: 1) a view of the operators from behind, looking at the controls, and 2) a view following the rover performing the tasks. Camera operators must have the ability to respond to directions from the judges, which will be provided in English. Video of the sessions will be recorded, and may be live streamed and/or posted online at a later date.

Video sessions will start approximately 10 minutes prior to the start of the first Mission of that session. Prior to each mission, teams will be required to weigh-in their rover on camera to verify that it weighs less than 50 kg, and confirm that the rover fits within a 1.2 m x 1.2 m box (unbounded in height). See Section 2.a.ii of the URC2021 rules for more details.

Rules Applicability

The following sections of the official URC2021 Requirements and Guidelines document are applicable to the virtual event:

- Section 1.b - Operations. Only the following statements still apply:
 - Teams will operate their rovers in real-time from designated command and control stations.
 - Visibility of the course to the operators in the control station will be blocked.
 - All of the competition events will be held in full daylight.
 - The GPS standard shall be the WGS 84 datum. Coordinates will be provided in latitude/longitude format (e.g. decimal degrees; degrees decimal minutes; degrees minutes seconds).

- Rovers shall be able to withstand light rain, but will not be expected to compete in heavy rain or thunderstorms.
- Section 1.c - Team Members. This section applies in its entirety.
- Section 1.d - Finances. This section applies in its entirety.
- Section 2.a - Size, Weight, Power. This section applies in its entirety.
- Section 2.d - Interventions. This section applied in its entirety.

The rover shall be operated remotely using wireless communications with no time delay. The operators will not be able to directly view the rover or the site, and line-of-sight communications are not guaranteed for all of the missions (will be determined by the team's chosen test site). No aerial devices are allowed. Specific communication frequencies and channels used are at the discretion of each team. Always adhere to local regulations regarding allowed radio frequency protocols.

Extreme Retrieval and Delivery Mission

Teams will be given 40 minutes to complete the Extreme Retrieval and Delivery Mission (ERDM) course, which consists of several tasks. The tasks must be completed in order. You may skip a task but you cannot go back later. Scoring for each task is all-or-nothing; no partial credit will be given for tasks.

The start line must be clearly marked. The clock will start either on the judge's command, or once the rover passes the start line. There is no need to return to the start line. The mission is over when time elapses or the rover completes the last gate, or as otherwise provided in the rules (hit kill switch, etc).

Task 1. The rover must traverse 10 m over flat terrain, in a straight line. The rover cannot stop during the traverse until the entire rover, including wheels, passes the 10 m mark. The 10 m mark must be clearly marked on the ground. (10 points)

Task 2. The rover must grab and lift a toolbox from a scale, carry it 5 m, and place it within a marked 1 m square (1 m x 1 m). This task may be done on a flat surface. The toolbox should weigh at least 5 kg, as indicated by the scale. The toolbox's handle may be taped or fixed so that it is in the upright position to be easily grasped. There are no additional specifications for the toolbox. (10 points)

Task 3. Pick up a screwdriver that is lying on its side on the ground, carry it 5 m, and place it in a 30 cm square (30 cm x 30 cm). This task can be done on a flat surface. The screwdriver must be at least 15 cm in length. (20 points)

Task 4. Grab a 6 mm diameter rope that is attached to a weight of at least 3 kg. Drag the weight by the rope for at least 1 m and release the rope. This task can be done on a flat surface. The weight should be mounted on a scale to show its weight. The 1 m mark must be clearly marked on the ground, and the entirety of the weight must pass the line for full credit. (20 points)

Task 5. Demonstrate that the rover can climb a slope of at least 30 degrees above horizontal, to a height of at least 1 m. After 1 m of vertical ascent, the surface may continue at an incline, or may continue with no slope; the entirety of the rover must cross the line at 1 m of vertical ascent. An artificial incline (e.g. ramp built by the team) may be used. An inclinometer is recommended to show that the incline is at least 30 degrees. (20 points)

Task 6. Demonstrate that the rover can descend a 1 meter vertical drop. The rover must be flat with all wheels on a horizontal surface at the beginning and the end of the move. The rover must be in its upright and intended orientation after the descent, and must continue to drive an additional 3 m. The 3 m mark must be clearly indicated, and the entirety of the rover must pass this mark. (20 points)

Equipment Servicing Mission

Teams will be required to build equipment panels that meet the requirements below. Details that are not specified are left to the discretion of teams. The equipment should consist of multiple sides with panels arranged facing out from a central point, so that the rover has to physically move between panels and not everything can be accessed by just moving the arm. Panels do not need to be physically attached to each other.

Sub-Panel 1. **Drawer:** Open drawer; Insert a toolbox; Close drawer.

You will need **a toolbox**, or similar object to which you can add weight and **a balance or scale** to read the weight. The toolbox needs to weigh **at least 2.5 kg** and the weight needs to be readable by the camera following the rover. Toolbox must be placed on the scale at least 5m away from the panel, so the rover needs to go retrieve it. There are no requirements on the size/shape of the toolbox or drawer, other than the drawer must be big enough to close with the toolbox inside.

Sub-Panel 2. **Keyboard:** Type a 3 letter code on the keyboard.

You will need a keyboard and a display. A laptop or desktop computer sitting on a desk will work. There is no required orientation/position of the keyboard or monitor. The codeword will not be specified in advance (judges will provide it at the start of the task) and may include letters and numbers (will not be case sensitive). Word must be clearly readable by camera following the rover. Word must be correct for full points. Spelling mistakes or repeated letters may be corrected using the delete button, or ignored for partial points.

Sub-Panel 3. **USB stick:** Pick up a USB memory stick and insert into a USB (Type A) slot.

This may be combined with Sub-Panel 2; i.e. you can use the USB slot on a computer if you use one for sub-panel 2. However we do recommend a panel mounted USB receptacle not connected to any other electronics, since a \$10 sacrificial part will be more damage tolerant than a computer. Memory stick must be initially placed at least 20 cm away from the slot, such as on the other side of the keyboard.

Sub-Panel 4. **Switches:** Flip 3 toggle switches.

Toggle switches must be placed horizontally in a row, and require a vertical motion to toggle them. You may use standard metal toggle switches or ones with safety covers. No extra points will be given for safety covers.

Sub-Panel 5. **Screw:** Tighten a 5/16" or 8 mm Allen (hex) head screw.

May be combined with Sub-Panel 1 or 4. Screw must require at least 4 complete turns (1440°) to tighten and clearly move from several threads exposed to tight. May use hex driver built into rover or pick up a screwdriver placed near the screw.

Sub-Panel 6. **Joystick:** Use joystick to move a gauge.

May be combined with any other panel. Gauge may be either analog (e.g. needle voltmeter) or digital (e.g. multimeter). Bottom of gauge must be **at least 10 cm above** the top of the joystick. Any joystick will suffice in any orientation. Gauge must respond to joystick. You may build any mechanism/circuit you like, but we suggest using one of the 2 options in the Appendix using a momentary switch or potentiometer joystick. Designs using other circuits and PWM or I2C joysticks are allowed but will be the responsibility of the teams to implement if chosen.

Based on the minimum and maximum values on the gauge you will be given 2 successive values to move the gauge to. Values will not be specified in advance, except that the first position will be at either extreme and the second position will be somewhere in between. **Gauge position/value needs to be clearly observable by the camera following the rover.**

Autonomous Navigation Mission

Teams will begin the Autonomous Navigation Mission 10 minutes after the conclusion of the Equipment Servicing Mission, as they would have at the URC2021 Finals.

Mission will follow Section 3.e of the URC Regulations and Guidelines, the same as if it were to take place at MDRS in Utah.

In advance of the virtual event, find a large open area where you can set up the posts, at least 80m x 140m in size (this is a little smaller than the size of a standard 400m running track or 2 soccer/football pitches next to each other). A field or stadium will work fine. Terrain may be flat. When requested, send the judges the GPS coordinates of the corners of the 80x140m area you will use. This will be at least a week ahead of the competition. Descriptions or images from Google Maps or equivalent may also help (e.g. the stadium/soccer-fields/car-park at GPS xxx N yyy E).

Any non-movable obstacles such as goal posts, lamp posts, etc, will not be taken into account when the judges design the course, and are the responsibility of the team to deal with such as programming in no-go zones or allowing the autonomous obstacle-avoidance to do its job.

Make the 11 posts as shown in the Q&A Autonomy Q.5. (<http://urc.marssociety.org/home/q-a>). Posts must be capable of being driven into the field you select or freestanding on the hard surface, so they do

not need someone to hold them up. You may make the posts from whatever you like, but CAD files for metal signs on rebar stakes are included in the Appendix.

Make or obtain 4 large obstacles at least 0.8m tall x 0.5m diameter. This is the size of a 50 gallon drum, but you may find or make alternative obstacles including rectangular ones at least 0.5 x 0.5m across.

Designate at least 1 post placer who will place the posts and not otherwise take part in this mission.

Post placers will require a meter/yard stick/roller and a portable GPS device (most smart phones have this capability these days, although free downloadable GPS navigation apps may help). We are relying on academic integrity and the honor system that the post placer will not give the exact coordinates of the posts or obstacles to the controllers. Please make this a fair and fun competition. Post placers may be non-team members, and must have a separate e-mail connection to receive the GPS coordinates. You will need to send the e-mail addresses of the post placer and the rover controllers to the judges when requested ahead of the competition.

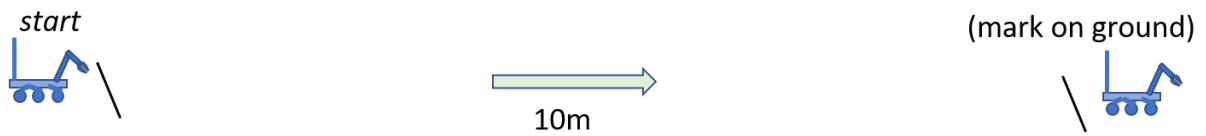
Post placers will be given the GPS locations of the obstacles at least 30 mins ahead of time so they may be pre-positioned. **Post placers may NOT give the location of the obstacles to the rest of the team.**

Controllers will be given the GPS location of the posts at the conclusion of the Equipment Servicing Mission, 10 minutes prior to the start of on-course time for this mission. For Legs with posts not at the exact GPS coordinates the post placer will be asked to walk a given distance in a random direction from the given coordinates. For gates the posts should be a given distance apart at a random orientation.

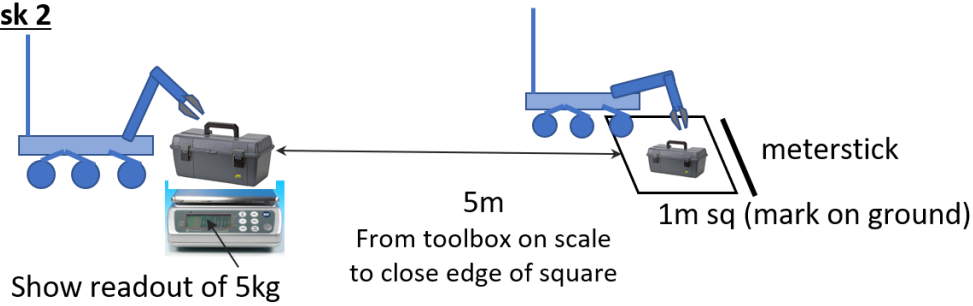
More details can be found in URC Requirements and Guidelines Section 3.e.v. and detailed instructions will be given to the post placers. Only the GPS coordinates will be given to the controllers. The post placers may continue to work beyond the start of the on-course time if for some reason they have not finished set-up by that point. Practice setting up the obstacles efficiently is strongly recommended!

Appendix A - Extreme Retrieval and Delivery Mission Course

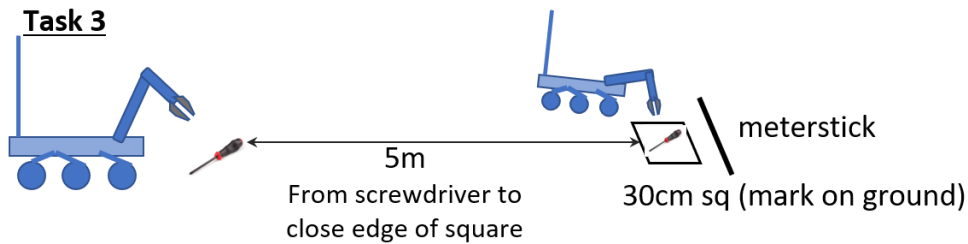
Task 1



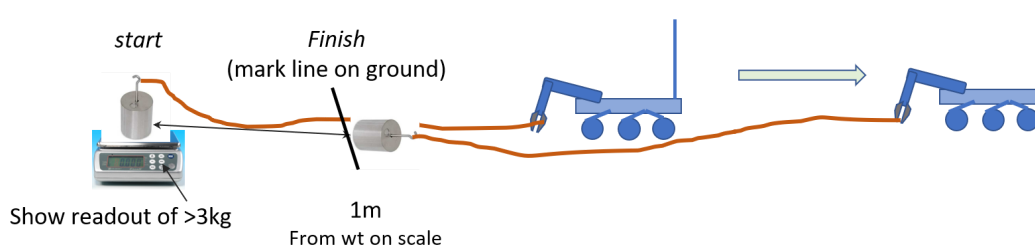
Task 2



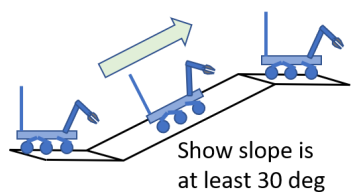
Task 3



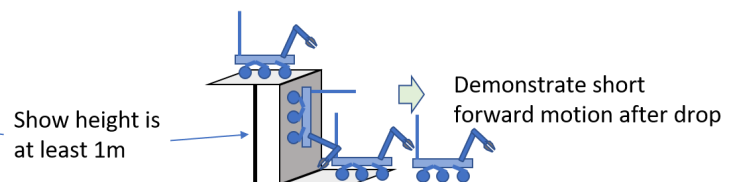
Task 4



Task 5

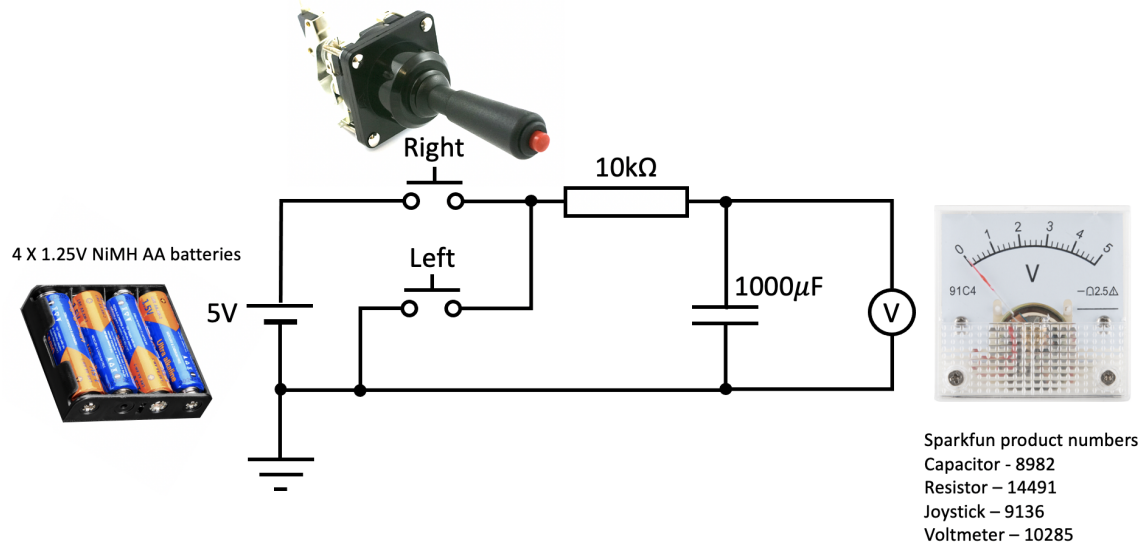


Task 6

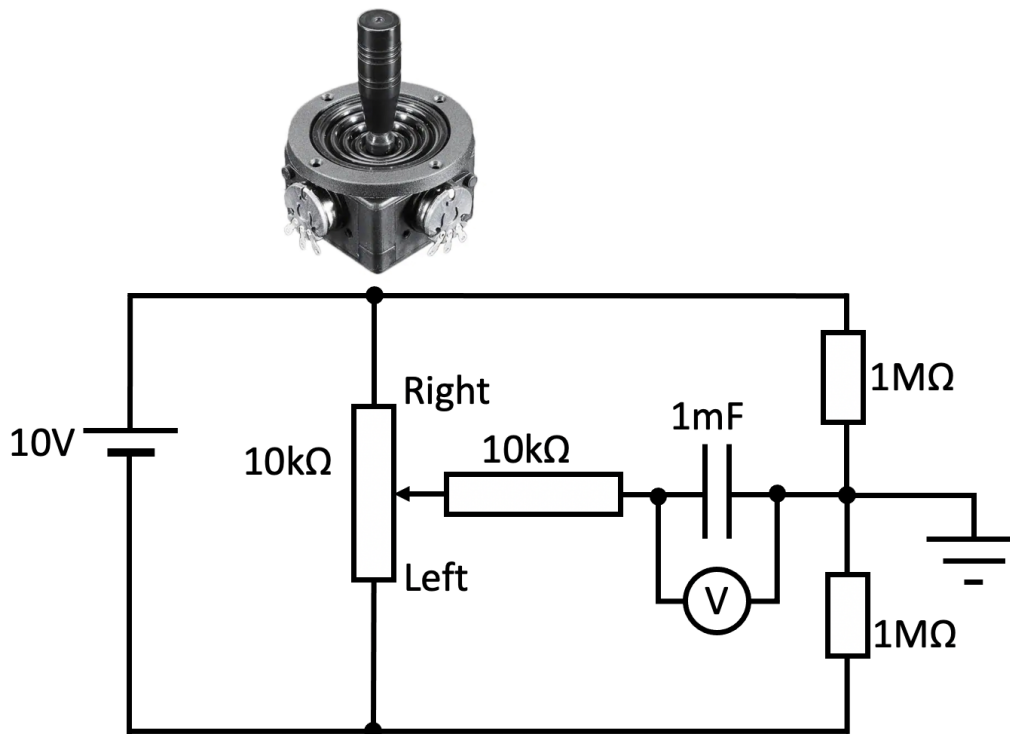


Appendix B - Suggested Joystick Circuit Design for Equipment Servicing Mission

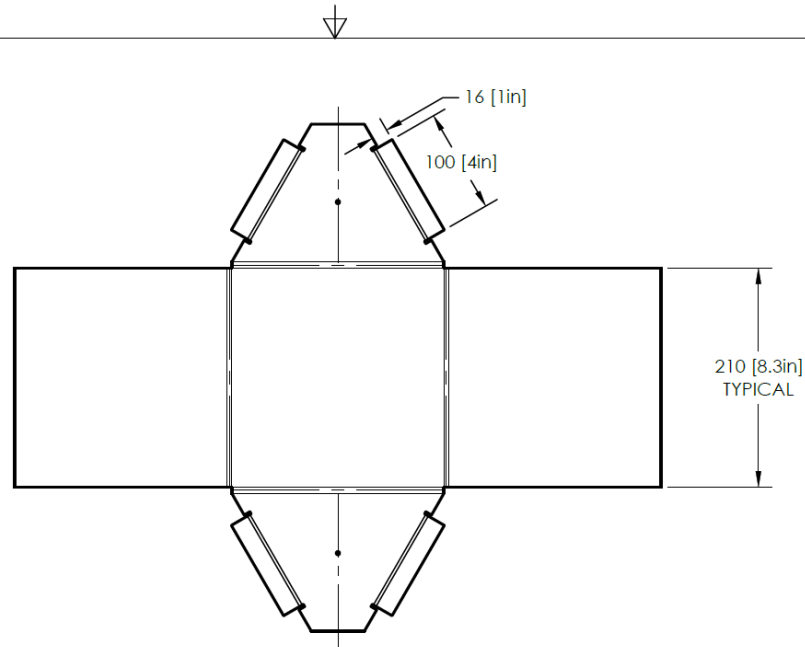
Option 1: Momentary switch joystick to control charging/discharging of a capacitor with about a 10 second time-constant.



Option 2: Potentiometer joystick will need a bridge circuit to control the charging:

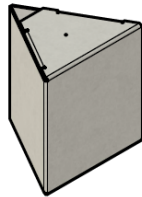


Appendix C - Autonomous Navigation Mission Marker Posts



NOTES:

- (1) PRIMARY DIMENSIONS: mm.
- (2) THE OFFICIAL NORTH SITE URC AUTONOMOUS MARKER CONSISTS OF THREE 210mm x 210mm SIDES.
- (3) DIMENSIONS ARE NOMINAL AND PROVIDED AS A GUIDE FOR TEAM BUILDS.
- (4) MATERIAL: CARDBOARD, POSTERBOARD, SHEET METAL, ETC.
- (5) ASSEMBLY INSTRUCTIONS:
 - (5)a. CUT OUT THE PROFILE USING THIS TEMPLATE AS A GUIDE.
 - (5)b. CREATE A HOLE FOR A STAKE OR PIPE ON EACH OF THE TRIANGULAR FACES.
 - (5)c. GLUE, TAPE, OR STAPLE FLANGES TOGETHER.
 - (5)d. FINISH: EACH SIDE SHALL BE BLACK BACKGROUND WITH WHITE AND BLACK TAG. PRINT AND TAPE THE ALVAR TAG TO EACH SIDE OF THE MARKER AS OUTLINED IN THE URC REQUIREMENTS. THE OFFICIAL MARKER HAS "NO" WHITE BORDER. REMOVE ANY WHITE BORDER FROM PRINTED SHEETS BY TRIMMING OR PERMANENT MARKER.
- (6) PLACE A STAKE OR PIPE THROUGH THE HOLES AND SECURE THE MARKER SUCH THAT THE BASE IS APPROXIMATELY 500mm ABOVE THE GROUND.



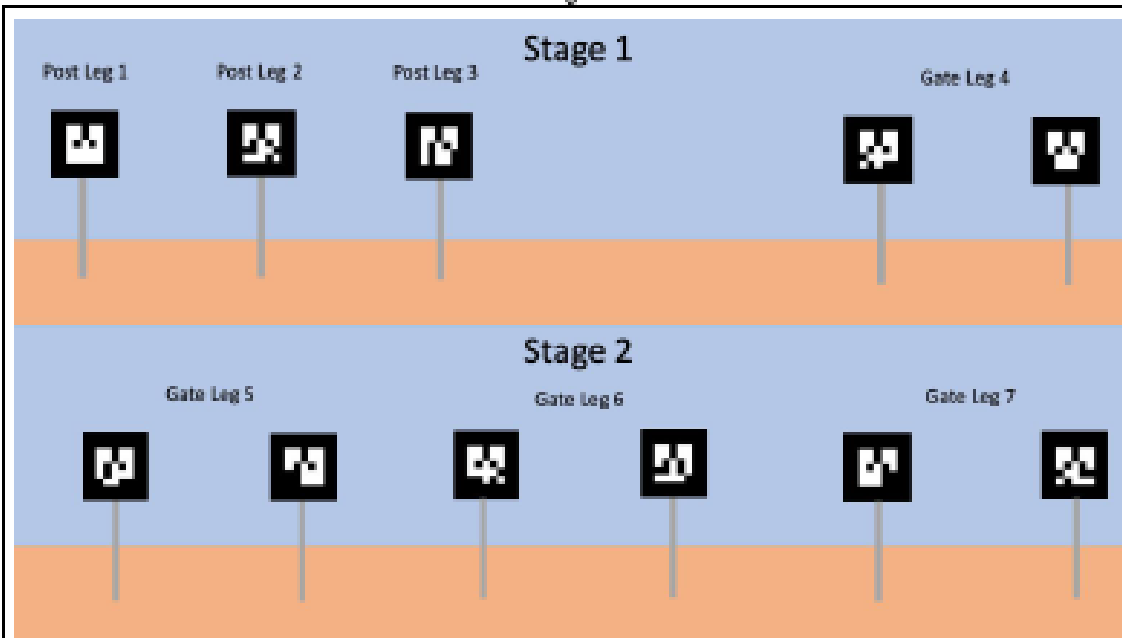
PROJECT

URC 2021

TITLE

2021 AUTONOMOUS MARKER
TEAM BUILD
VIRTUAL COMPETITION

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2021-V-D01	-
DRAWN TIM	3/20/2021	SCALE 1:5	WEIGHT	SHEET 1/3

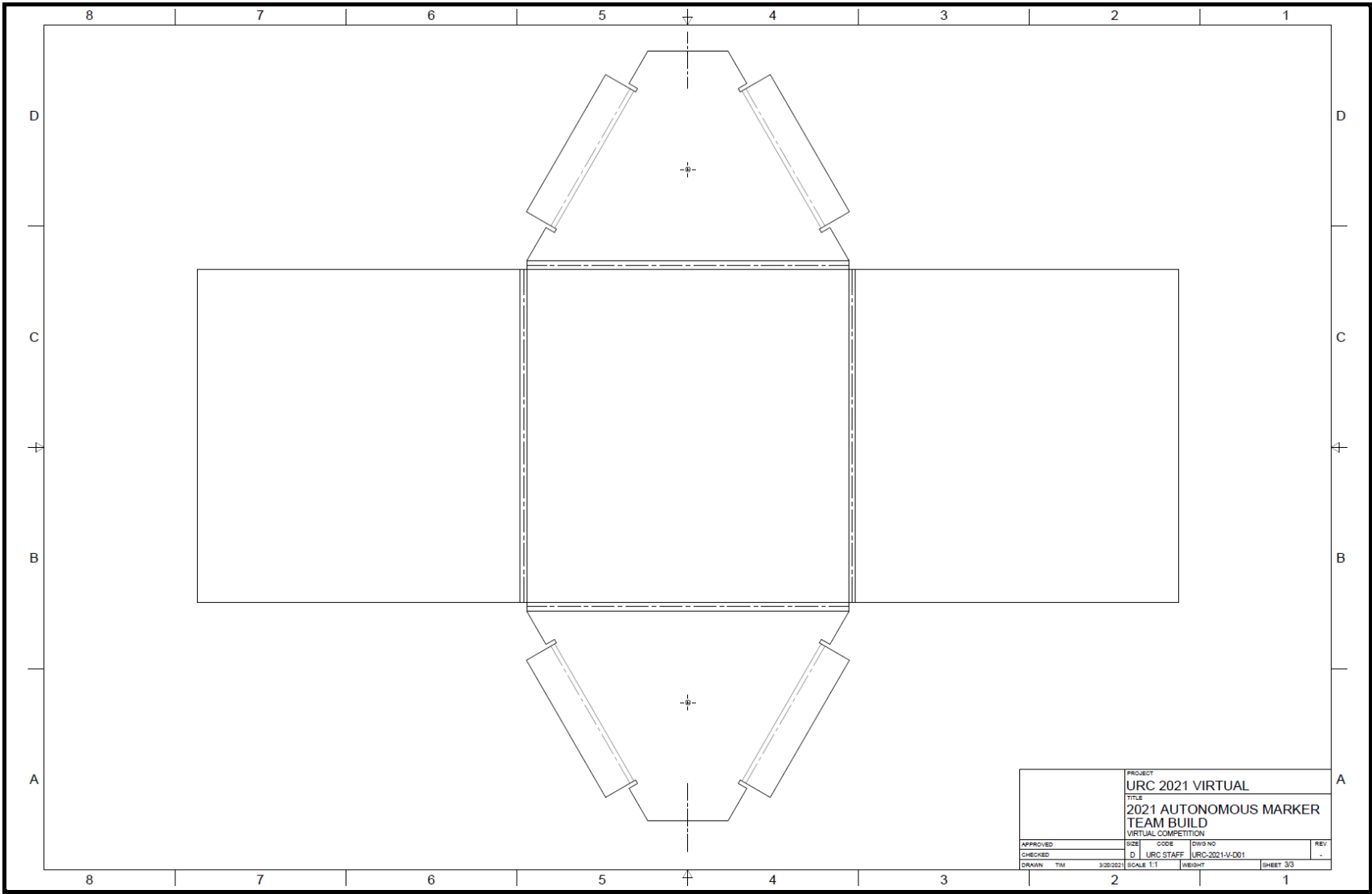


NOTES:

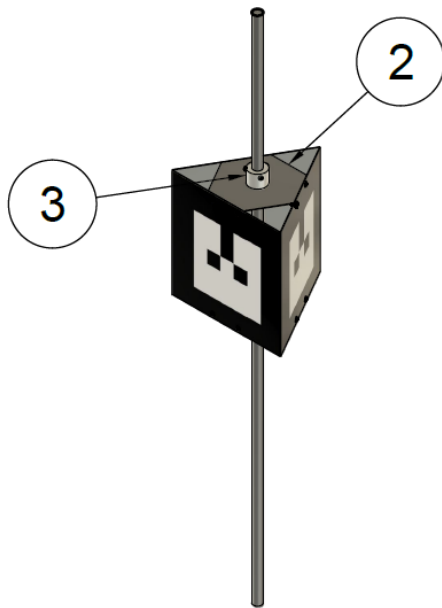
1. REFERENCE URC-2020-N-D02 FOR MARKER INSTALLATION.

AUTONOMOUS MARKER			
STAGE 1	IDENTIFIER	LEFT GLYPH	RIGHT GLYPH
	POST LEG 1	ALVAR 0	N/A
	POST LEG 2	ALVAR 1	N/A
	POST LEG 3	ALVAR 2	N/A
	GATE LEG 4	ALVAR 3	ALVAR 4
STAGE 2	IDENTIFIER	LEFT GLYPH	RIGHT GLYPH
	GATE LEG 5	ALVAR 5	ALVAR 6
	GATE LEG 6	ALVAR 7	ALVAR 8
	GATE LEG 7	ALVAR 9	ALVAR 10

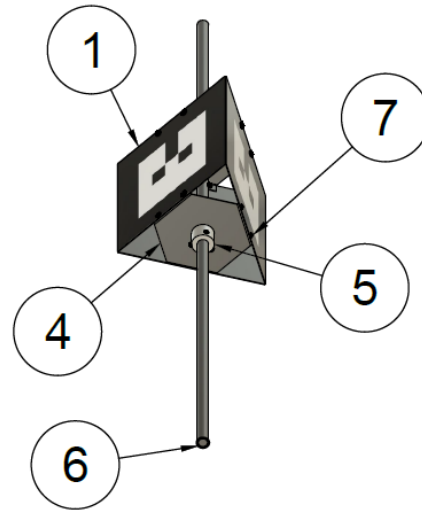
		PROJECT		
		URC 2021		
		TITLE		
		2021 AUTONOMOUS MARKER		
		TEAM BUILD		
		VIRTUAL COMPETITION		
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2021-V-D01	-
DRAWN	TIM	3/20/2021	SCALE NONE	WEIGHT
		SHEET 2/3		



PROJECT			
URC 2021 VIRTUAL			
TITLE			
2021 AUTONOMOUS MARKER			
TEAM BUILD			
VIRTUAL COMPETITION			
APPROVED		SIZE	CODE
CHECKED		D	URC STAFF
DRAWN		TM	3/20/2021
SCALE		1:1	WEIGHT
SHEET		3/3	REV
			-



TOP-DOWN VIEW



BOTTOM-UP VIEW

NOTE: ADDITIONAL BOM ITEM REQUIRED FOR FASTENERS

7	1	FASTENERS	FASTENERS
6	1		REBAR
5	1	URC-2020-N-003	CLAMP, BOTTOM
4	1	URC-2020-N-101	BRACKET ASSEMBLY, BOTTOM
3	1	URC-2020-N-003	CLAMP, TOP
2	1	URC-2020-N-101	BRACKET ASSEMBLY, TOP
1	3	URC-2020-N-002	MARKER SIDE
ITEM	QTY	PART NUMBER	PART NAME

PARTS LIST

PROJECT

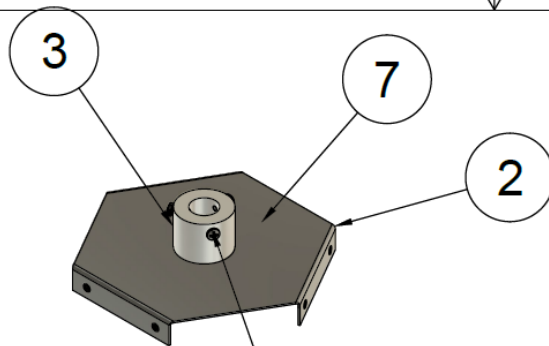
URC 2020

TITLE

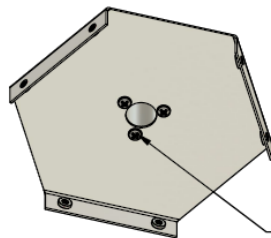
**AUTONOMOUS MARKER
PARTS OVERVIEW**

NORTH SITE

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE NONE	WEIGHT
				SHEET 1/8



INSTALL #6-32 x .375" SCREWS (3 PLACES)



INSTALL #6-32 x .375" SCREWS (3 PLACES)

NOTES:

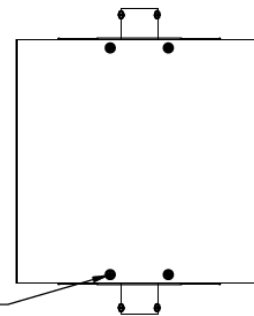
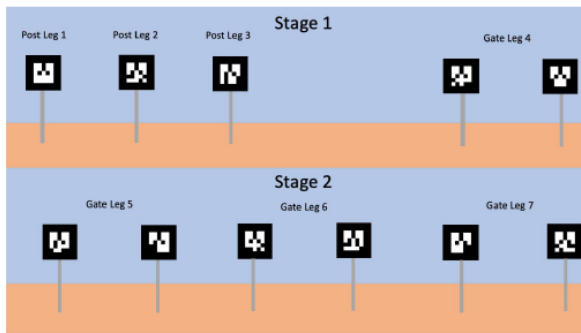
1. INSTALL SCREWS INTO HOLE, BUT DO NOT FULLY THREAD INTO THE CENTER HOLE. THESE SCREWS WILL CLAMP AGAINST THE REBAR.
2. REPEAT PROCEDURE FOR BOTTOM BRACKET AND CLAMP.

7	1	FASTENERS	
3	1	URC-2020-N-003	REBAR LOCKING CLAMP
2	1	URC-2020-N-101	MARKER BRACKET ASSEMBLY
ITEM	QTY	PART NUMBER	DESCRIPTION
PARTS LIST			

		PROJECT		
		URC 2020		
		TITLE		
		AUTONOMOUS MARKER ASSEMBLY INSTRUCTIONS		
		NORTH SITE		
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE NONE	WEIGHT
		SHEET 2/8		

ALIGN ALL GLYPHS AS
SPECIFIED IN THE URC Q&A

1



INSTALL #6-32x.250" SCREWS
(12 PLACES - 4 PER SIDE)

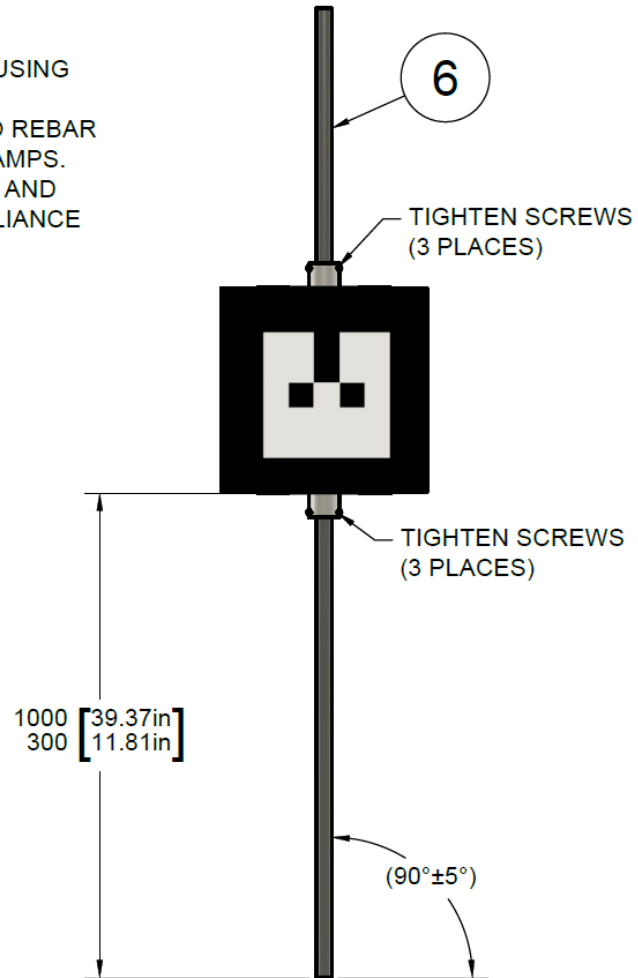
MARKER ASSEMBLY

1	3	URC-2020-N-002	MARKER SIDE
ITEM	QTY	PART NUMBER	PART NAME
PARTS LIST			

		PROJECT		
		URC 2020		
		TITLE		
		AUTONOMOUS MARKER		
		ASSEMBLY INSTRUCTIONS		
		NORTH SITE		
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE NONE	WEIGHT
			SHEET 3/8	

SITE SETUP INSTRUCTIONS

1. INSTALL REBAR INTO GROUND USING SLEDGE HAMMER.
2. ATTACH MARKER ASSEMBLY TO REBAR BY FASTENING SCREWS ON CLAMPS.
3. VERIFY HEIGHT FROM GROUND AND PERPINDICULARITY IS IN COMPLIANCE WITH RULES. REFERENCE MEASUREMENT INDICATED.



PROJECT

URC 2020

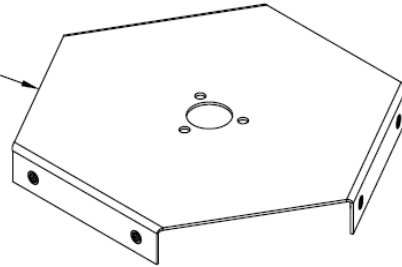
TITLE

**AUTONOMOUS MARKER
INSTALLATION INSTRUCTIONS**

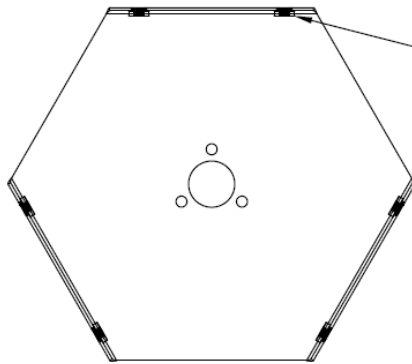
NORTH SITE

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE NONE	WEIGHT
				SHEET 4/8

1



2



BRACKET ASSEMBLY

2	6	95185A140	PEM NUT
1	1	URC-2020-N-001	BRACKET
ITEM	QTY	PART NUMBER	DESCRIPTION

PARTS LIST

PROJECT

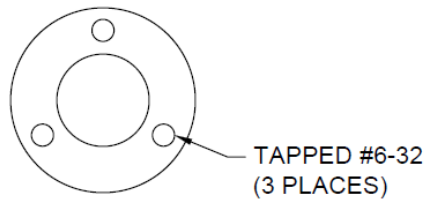
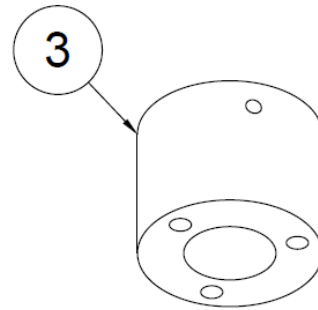
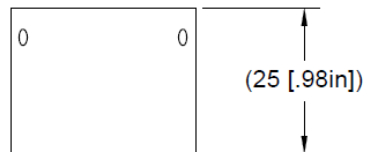
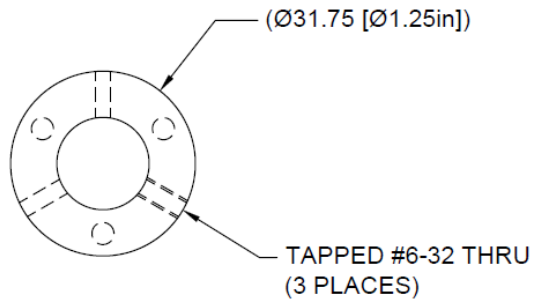
URC 2020

TITLE

BRACKET ASSEMBLY
URC-2020-N-101

NORTH SITE

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE NONE	WEIGHT
				SHEET 5/8



NOTE: DIMENSIONS CONTROLLED BY CAD MODEL

3	1	URC-2020-N-003	REBAR LOCKING CLAMP
ITEM	QTY	PART NUMBER	DESCRIPTION
PARTS LIST			

		PROJECT		
		URC 2020		
		TITLE		
		CLAMP DETAIL		
		URC-2020-N-003		
		NORTH SITE		
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A	URC STAFF	URC-2020-N-D01	-
DRAWN	TIM	12/21/2019	SCALE 1:1	WEIGHT
		SHEET 6/8		

