

SHADOW TUNER

BY RAFAEL LOZANO-HEMMER



Version: 2025-04-08

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GENERAL IMPORTANT INFORMATION

This short section must be read for proper operation.

SHADOW TUNER (2023)

BY RAFAEL LOZANO-HEMMER

Technique

spherical LED display, depth cameras, amplifiers, speakers, custom powdered coated stainless steel base, custom softwares, sound card, video controller, computer.

Description

An animated image of the Earth rotates with its poles parallel to the ground on a custom circular display. People's movements are tracked and reflected on the sphere as black shadows as they move around it. As shadows cover different cities, they automatically trigger live, local radio stations from those locations, thus creating a global polyphonic tuning device.

Operation

Please refer to APPENDIX I - Installation for detailed system information and wiring diagram. Note the artwork must be connected to the internet via WiFi to successfully record radio stations live streams from their web source.

1. To turn the piece **ON** after power has been fully cut, flip the Smart Power Bar's On/Off button on the West side of the piece's base cladding to the off position, then to the on position. See Placement Instructions for information on identifying which side is West.
2. Once you have turned the piece **ON**, the piece should start automatically after about 5 minutes. Be patient; once you see the display illuminate, wait another minute for the softwares to start up.
3. To turn the piece **OFF**, using a keyboard connected to Computer A press the key 'P' and '0' (Zero) at the same time.
4. Please wait until the display and computers have finished their shutdown routine and have cooled down before turning the piece **ON** again. At minimum, this should be after waiting at least 5 minutes.
5. This piece has an automatic start up time and shutdown time each day: please refer to your maintenance sheet for further precisions. This can be modified, as explained later on in this manual.

General Artwork Behaviors

At rest the screen displays a globe. The globe is rotating counterclockwise and no audio is being emitted.

Interacting with the Artwork

When someone interacts with the piece by walking around it their silhouette should appear as a black shadow on the globe following their movements. A white line on top of their silhouette will determine which radio stations are activated and multiple stations will play at once.

Maintenance

Always use gloves when you manipulate the artwork to avoid having to clean it. Do not use Windex, soap, or lint-free cloths on the LED surface. Instead, whenever dust is visible, use compressed air dusters designed for computer equipment.

The metal outer casing can be cleaned with a regular all-purpose cleaner. Do not use harsh cleaners or rough sponges. If some stains persist small amounts of isopropyl alcohol may be used without being a risk to the powder coating.

We recommend dusting the general space where the computers are, and specifically dusting the fans on the computers every 6 months using a compressed air duster or feather duster. Once a year we also recommend opening the casing on the computer and dusting the entire internal system using a compressed air duster.

Placement Instructions

The piece needs to have at least 1 meter on either side of the stand clear of any objects so that viewers can walk around the piece easily. The exact amount of space around the piece will vary based on the installation location and should be discussed with the artist before installing. The piece weighs 140 kg or approximately 300lb so a hoist will be necessary; this piece cannot be moved by hand. The piece can be run on a single 15A 120V circuit.

Each side is uniquely labeled as North, East, South, and West with labels internal to the panels. The fan side of the stand is considered North. If the piece is placed in a space near a wall the fans should face towards the wall away from the area with the most foot traffic. If in doubt about which side of the stand you are facing you can also check behind the depth sensor for that side which should have a clear label.

If instructed by the artist to adjust the angle of the depth sensors please read the [Aligning the Depth Sensors](#) section before doing so.

DETAILED TECHNICAL INFORMATION

Normal Software Operation

Shadow Tuner uses four custom softwares running on two separate computers.

1. Shadow Tuner Computer A

Runs the depth sensor capture, audio player and video output. Three softwares run in parallel.

- *Shutdown*: Allows the computers to shutdown gracefully and on a schedule. Runs on Python 3.13.
- *Shadow_GraphicsTracking_multipleblobs*: Controls the graphics and detection. Runs on Touchdesigner 2023.11340.
- *Shadow_AudioPlayer*: Controls which audio is playing. Runs on Touchdesigner 2023.11340

2. Shadow Tuner Computer B

- *ShadowTunerDownloader*: Handles audio downloading and audio parsing. The software analyzes audio to determine what is and is not speech, saves this info, and relays it to the computer A through a network connection. It was created using Python 3.11 in a CUDA 12.1 environment.

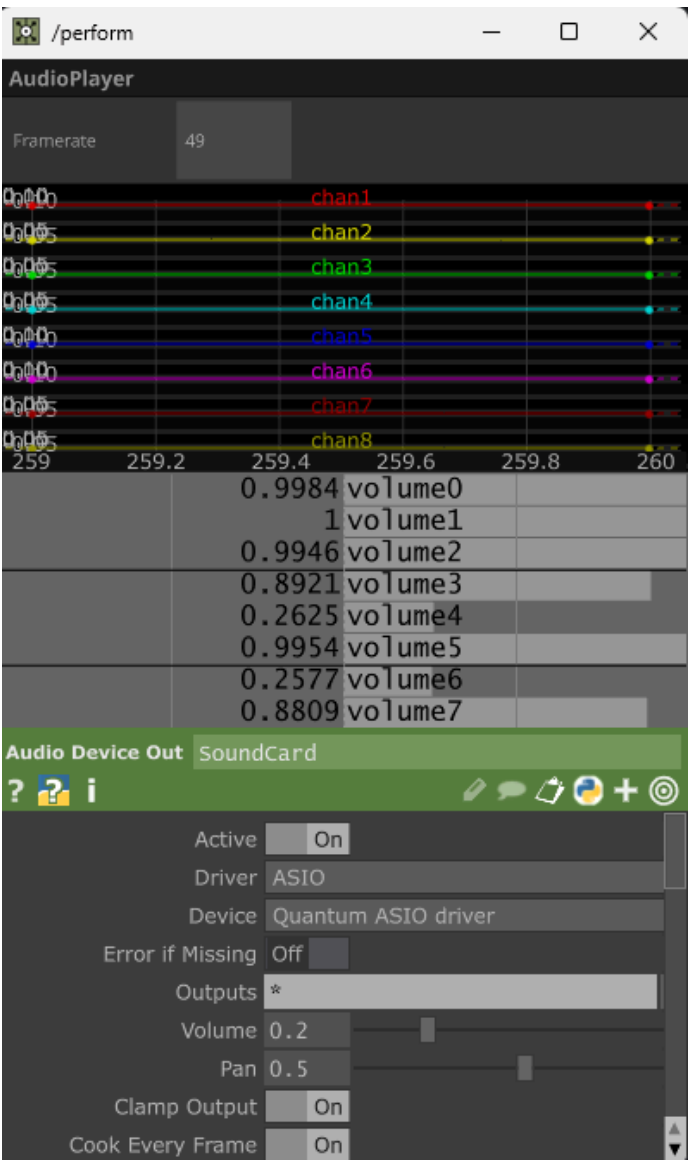
Manual Software Calibration

Computer A

The following sections break down the softwares running on this computer and what user interactions are available.

Shadow_AudioPlayer

The app opens automatically when the computer starts up. A well functioning app will look like the screenshot below, it will quickly get hidden behind the second app to prioritize graphics.



This table shows the variables and their functions available in this app. These variables should not be changed without first consulting the studio. They are for diagnostic purposes only.

Setting	Description
Framerate	Indicator of computer's performance. Aim for around 30 consistently.
Chan 1-8	This shows the audio wave going to the speakers 1 to 8. Can be used to confirm that audio is being transmitted.
Volume 0-7	This is an indicator that a blob is detected. No blob turns the volume of the channel to 0.
Audio Device Out	Showing selected drivers for the Sound Card. No change should be done here.

Shadow_GraphicsTracking_multipleblobs

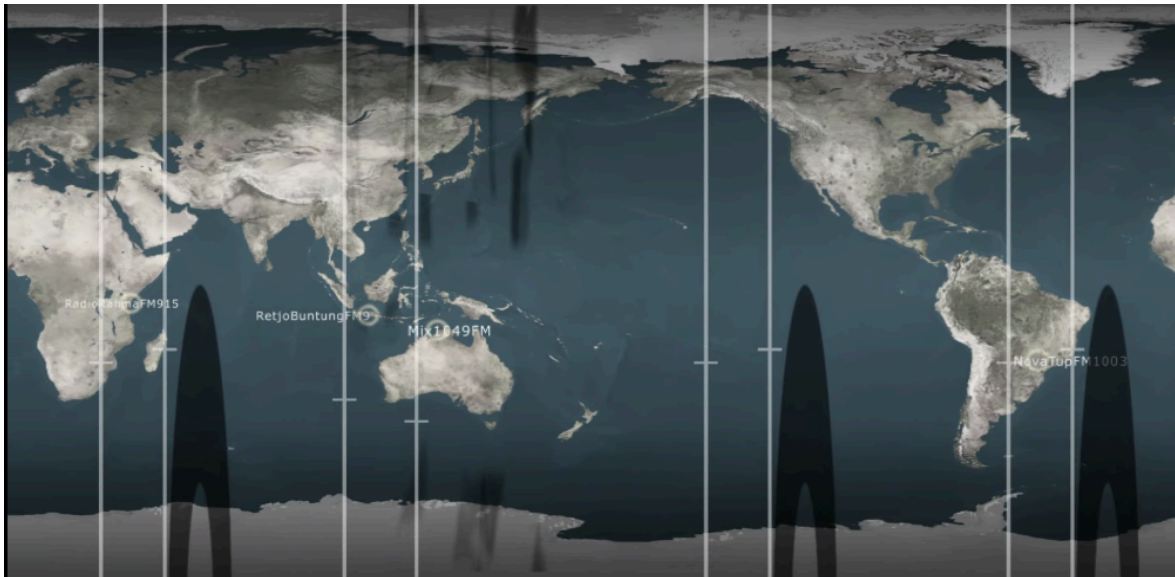
This app will start up automatically after the Shadow_AudioPlayer software. Note that an autocalibration (background subtraction) happens in the software when turning on. This will also happen if there is no interaction for 50 seconds.

In this software depth sensors are referred to with numbers 1-4. Consult the [Depth Sensor](#) section for information on the depth sensor labeling system.

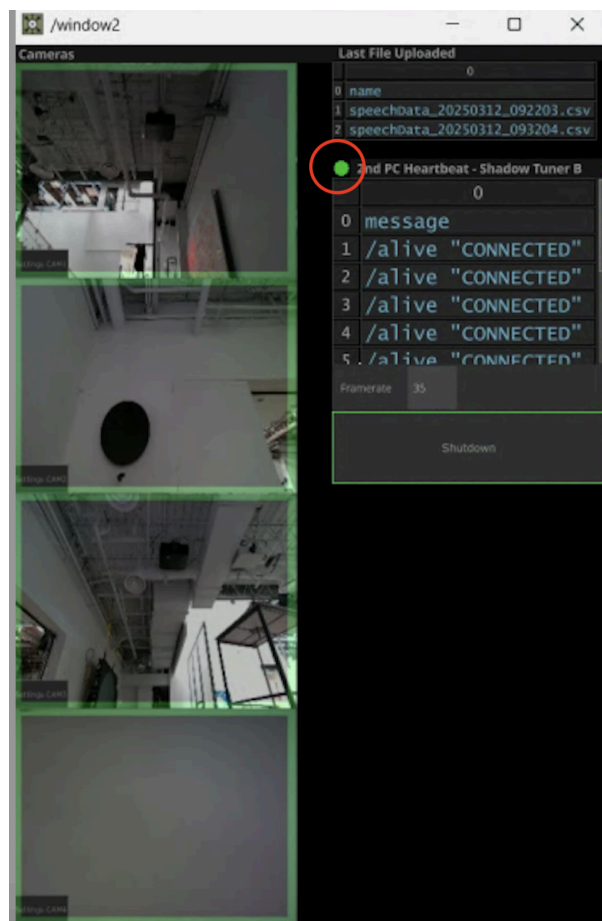
The following keyboard shortcuts are available to the user when within this software.

- Arrow UP: Raises volume by 10%. A visual output will show the level on the sphere
- Arrow DOWN: Lowers volume by 10%. A visual output will show the level on the sphere
- Arrow RIGHT: Raises brightness by 10%. A visual output will show the level on the sphere
- Arrow LEFT: Lowers brightness by 10%. A visual output will show the level on the sphere
- P + 0: By pressing P and Zero at the same time, you are triggering the shutdown command to the piece. This is only needed if the piece needs to be off inside of a normal working schedule.
- S : Save parameters
- G : Opens a debug menu, this can be closed by pressing G again

The following image is the app running normally.



The menu accessed by the 'g' key can be seen in the screenshot below.



This table shows the variables and their functions available in this app. These variables should not be changed without first consulting the studio. They are for diagnostic purposes only.

Setting	Description
Depth Sensors	The left panel shows the individual depth sensor feeds. A yellow or red border would mean something is wrong with the depth sensor connection. A green border means the signal is good. A small button in the bottom left corner allows access to more settings.
Last File Uploaded	The name showing here is the last file updated. The date appears in the name of the file and is a good indicator that the piece behaves correctly. An old date would mean files are not getting updated. The files are getting updated every time the piece has run for multiple hours. So, if the piece runs everyday, the date should reflect a maximum of 'a day prior'.
2nd PC Heartbeat	This receives OSC messages from Shadow Tuner computer B. Messages give information on connectivity between computer and network status. If this list doesn't get updated, this would mean the 2nd PC is not communicating properly with the main computer. Every time the piece starts, this list gets cleared off, so no information would signify a connectivity problem. A small green circle, visible circled in red in the screenshot above, is flashing every time it receives a message from the 2nd PC.
Framerate	Indicator of computer's performance. Aiming to stay above 30.
Shutdown	This button can be pressed to trigger a shutdown on the whole piece outside of scheduled hours. The keyboard shortcut p+0 (zero) would also trigger that.

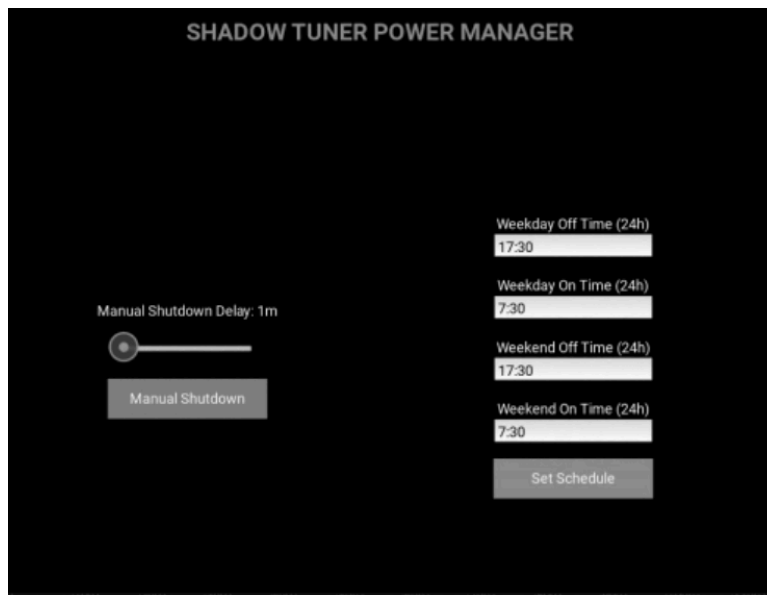
Shutdown

This app manages shut-down with the smart power bar after being triggered by the `Shadow_GraphicsTracking_multipleblobs` GUI / key command. It is also where you schedule different start-up / shut-down times. These variables should not be changed without first consulting the studio.

It exposes the following variables.

Setting	Description
Manual Shutdown Delay	This changes the scheduled delay between the computers shutting down and the power bar cutting power. There is no need for this to be adjusted.
Weekday Off Time	The time for the piece to turn off for weekdays (Mon-Fri)
Weekday On Time	The time for the piece to turn on for weekdays (Mon-Fri)
Weekend Off Time	The time for the piece to turn off for weekends (Sat-Sun)
Weekend On Time	The time for the piece to turn on for weekends (Sat-Sun)
Set Schedule	Updates the schedule based on the text inputs.

The app can be seen in the following screenshot

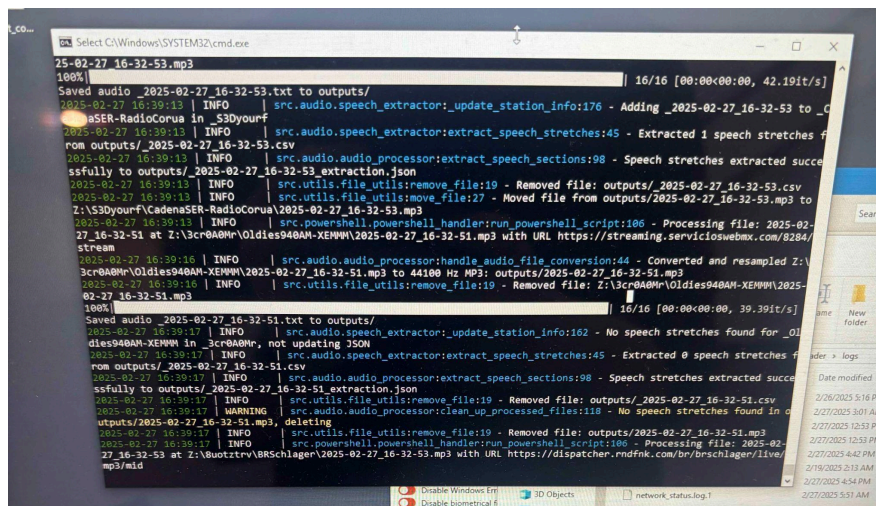


Computer B

The following sections break down the software running on this computer and what user interactions are available.

ShadowTunerDownloader

There is no user interface for this app and it should not need to be specially configured or adjusted once installed. If running properly the app will create a terminal window as seen in the screenshot below. There should be new lines appearing every few seconds if you watch it.



For advanced debugging purposes this software also creates three log files which can be found in the 'logs' directory in the project root. These can be read to gain information about how the app is functioning.

- software logs: Stores information about what was just downloaded, where did it get moved, etc). This has a current log (application.log) and three rotated out, previous logs.
- harddrive_status log: lists whether the app is currently using the primary (remote) drive or the secondary (local) drive. This has a current log and one rotated out log
- network_status log: lists whether the app is currently connected or disconnected from the internet (which it monitors by pinging Google servers). This has a current log and one rotated out log

Networking

To ensure best functionality of the piece Computer B has a special network policy configuration that must remain in place. For clarity this process will be detailed here. The configuration is stored within the Windows software GPEdit, which can be accessed by typing the name “gpedit” into the start menu and hitting enter. Within GPEdit the path Computer Configuration > Administrative Templates > System > Logon has had the "Always wait for the network at computer startup and logon" parameter enabled.

Similarly Computer A has had its Anaconda environment set to have its “Quick Edit” feature turned off.

In addition static IP's have been applied to the computers. These configurations should remain in place.

- Computer A:
 - Ethernet 1 (connecting to Computer B): **10.0.0.101**
 - Ethernet 2 (connecting to Smart Power Bar) : **11.0.0.120**
- Computer B: **10.0.0.102**
- Power Bar : **11.0.0.190**

Remote Access to Artwork's Computer

There is a software installed on the computer running this artwork that allows the studio to connect remotely to the artwork. This feature is helpful when you require assistance from the studio, as we can remotely connect to it, do a quick inspection, and do a debugging session of your components, if needed. In order to enable this feature, the computer has to be connected to the internet at all times. Depending on the computer's operating system (Windows 7/8/10/11, OSX), the procedure to set the computer online will vary. Please look online for tutorials, if necessary.

Preliminary Troubleshooting Steps

After flipping the on switch, nothing seems to happen.

Refer to [Removing the side cladding](#) section and follow the instructions for safely removing the cladding. Ensure both computers are receiving power correctly: its power LED should turn On/Off when the computer switches On/Off. Ensure the power cable connects firmly to the port and to the power source.

If the LED for a computer is not lighting up when pressed, ensure that all cable connections are secured. Refer to the [Wiring Diagrams and Connections](#) section to see how things should be properly connected.

The piece is on but the screen is dark.

Refer to [Removing the side cladding](#) section and follow the instructions for safely removing the cladding. Try using a different video output port on the computer. We recommend switching to the Display Port if not already in use.

One pixel is not working

See the process detailed in [Repairing a single damaged pixel](#) section.

The sound is not coming out

Refer to [Removing the side cladding](#) section and follow the instructions for safely removing the cladding. Then first check that the audio interface is properly connected to the computer, verify connections by referring to the [Wiring Diagrams and Connections](#) section if necessary. If this does not resolve the issue check the connections for the amplifiers and speakers in use. If the problem still persists, restart Computer A.

If you suspect an individual speaker is broken follow the guide in [Replacing a Speaker](#) section.

The piece doesn't track visitors

Confirm that each depth sensor is not obstructed. If the view for a depth sensor is not viewable in the GUI as described in [Manual Software Calibration: Shadow Tuner Computer A](#). Refer to [Removing the side cladding](#) section and follow the instructions for safely removing the cladding. Check that the affected depth sensor is properly connected by referring to the [Wiring Diagrams and Connections](#) section. If you suspect an individual depth sensor is broken follow the guide in [Replacing a Depth Sensor](#) section.

The graphics are stretched weirdly on the sphere

A resolution parameter might have been changed, contact the studio before attempting to change any other values in the software.

The top LED panel of the sphere seems misaligned

Follow the guide in Aligning the Top LED Panel section.

A significant part of an LED panel is damaged

Follow the guide in Replacing an LED Panel section.

Troubleshooting Assistance

Prior to contacting the Antimodular Studio with a problem about your artwork, please ensure that you went through the preliminary troubleshooting steps outlined in the previous section.

The troubleshooting process will vary depending on the problem. In order to make the process easier, it is recommended that you collect and send the following information to the studio:

- Date and time when the problem first happened;
- Description of the problem;
- Actions taken so far and conclusions;
- Detailed photographs (or videos) displaying the problem;
- Detailed photographs (or videos) of the suspected faulty component;
- Detailed photographs (or videos) of the whole artwork and its surroundings;
- Personnel involved.

Support (Contact Us)

If you would like support for the piece, please feel free to call Lozano-Hemmer's studio in Canada:

Antimodular Research
4462 rue Saint-Denis
Montréal, Québec, Canada
H2J 2L1
Tel 1-514-597-0917
info@antimodular.com
www.antimodular.com

APPENDIX I - INSTALLATION

Description of Components

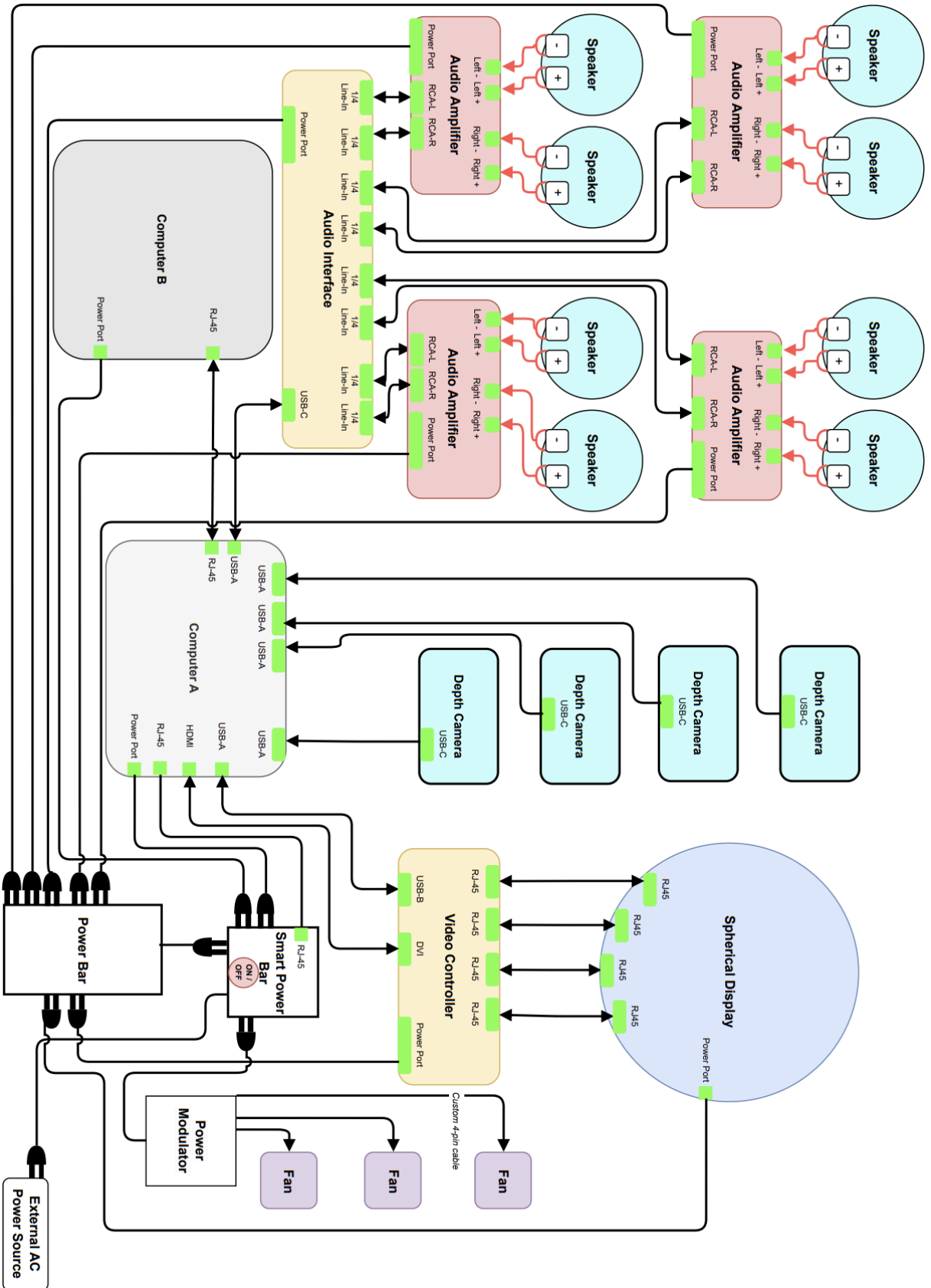
This artwork requires the following components:

Component	Description
Custom Spherical Display	Circular display with an approximate diameter of 0.8 m, mounted on a stand.
Stand	A custom created stand for the piece, houses the electronics used to control the piece.
Video Controller	Controls the sphere and sends image data from the computer to its pixel panels.
Video Cable	Used to connect the video controller to Computer A. Usually HDMI to DVI.
Computer A	Computer responsible for controlling the video and audio players and depth sensor capture.
Depth Sensor Cables	Connects the depth sensors to the computer. Usually a USB-C to USB-A cable.
Depth Sensors	Track viewers of the piece.
Thunderbolt Cable	Thunderbolt 3 cable, connecting the audio interface to the computer.
Audio Interface	Connects the computer to the amplifiers in use.
Audio Cables	Connect the audio interface to the audio amplifier. Usually a ¼ Line in to RCA cord.
Amplifiers	Boost the sound level from the computer to the individual speakers.
Speaker Cables	Connects the speakers to the amplifiers. Uses black 2/16 AWG speaker cable, terminated with banana plugs.
Speakers	Plays the audio associated with each radio station.
Fans	Keep the internal electronics cool.
Power Modulator	Supplies power to the three internal fans from one outlet.
Power Modulator Power Supply	Supplies power to the fans power modulator.

Component	Description
Computer B	Computer responsible for downloading audio files.
Smart Power Bar	Allows the computer to coordinate a graceful shutdown of the piece.
Ethernet Cabling	Interconnects the computers and allows computer A to control the smart power bar. Also used to connect the sphere to the video controller.
Wireless Keyboard	Necessary to force an unscheduled shutdown of the piece or change its schedule. Can also be used to debug or troubleshoot the piece.
External display (optional)	Not necessary but can be used to debug or troubleshoot the piece.

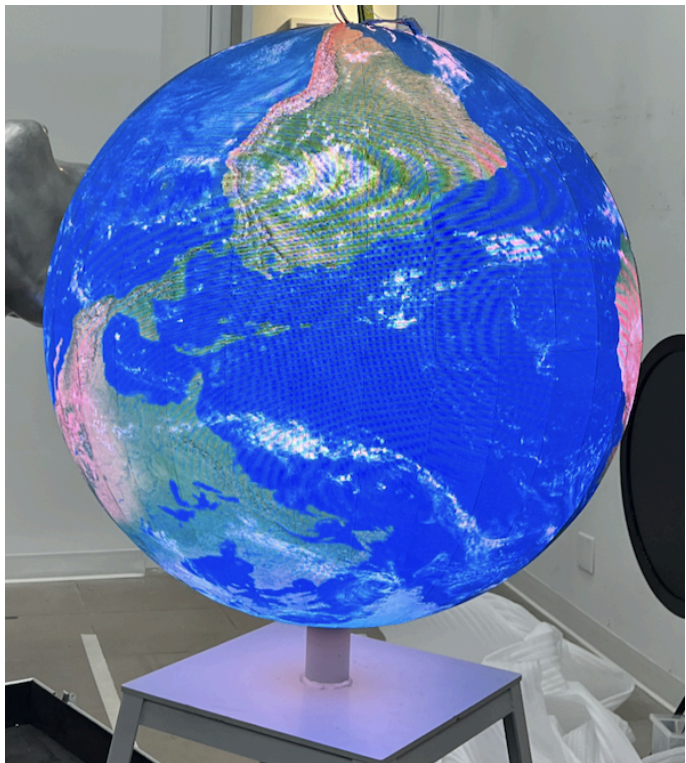
Wiring Diagrams and Connections

The diagram on the following page details the connections used in the piece. When attempting to reconnect any of the components mentioned in this diagram be sure to respect the labeling system in place. I.E if replugging speaker six be sure to use the cable labeled 'speaker 6'. Similarly the depth sensors use the cardinal direction system for their labeling. Consult the Depth Sensor section for information on the depth sensor labeling system and Speakers section for information on the depth sensor labeling system.



APPENDIX II - TECHNICAL DATA SHEETS

Custom Spherical Display



Specification	Details
Manufacturer	Shenzhen Toosen Optoelectronics Co
Model Number	P1.25 indoor LED Ball Screen
Diameter	0.8 m
LED Screen Square Meters	2.011
Pixel Density	640,000 pixels per square meter
Refresh Rate	3840 Hz
Weight	70kg
Average power consumption	603.3 W
Max power consumption	1206.6 W
Video Controller	MB6S Mooncell

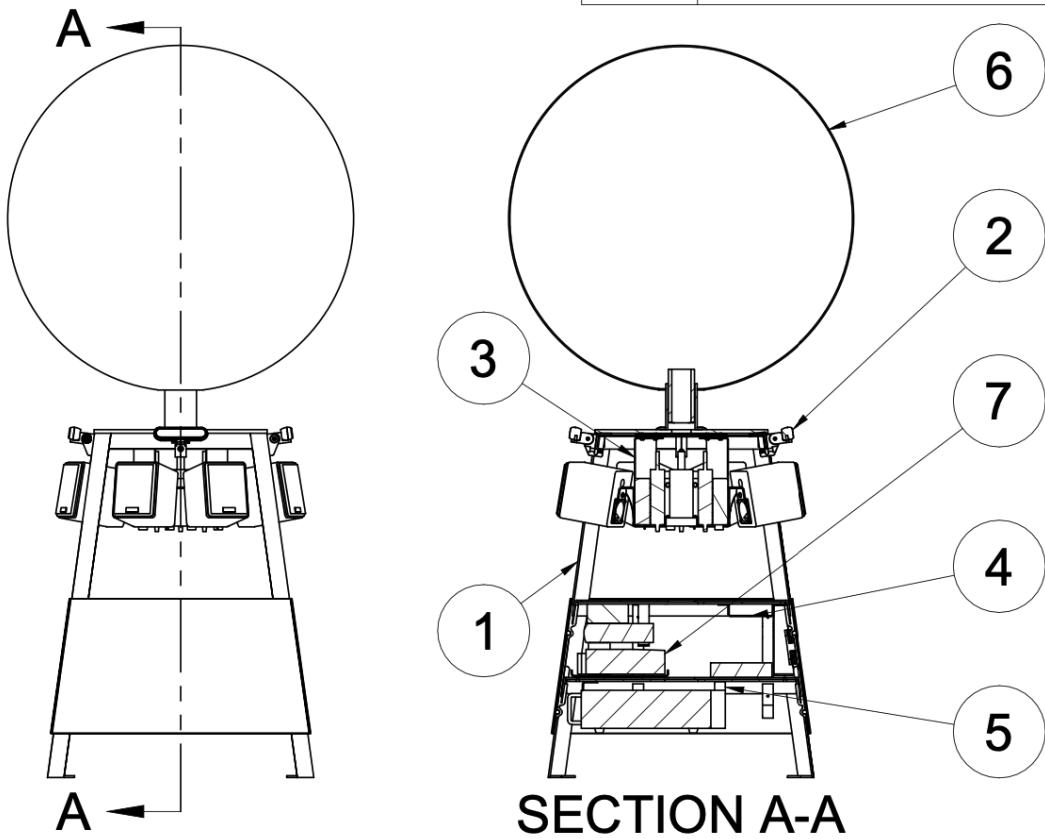
Stand

Overall Bill Of Material (BOM)

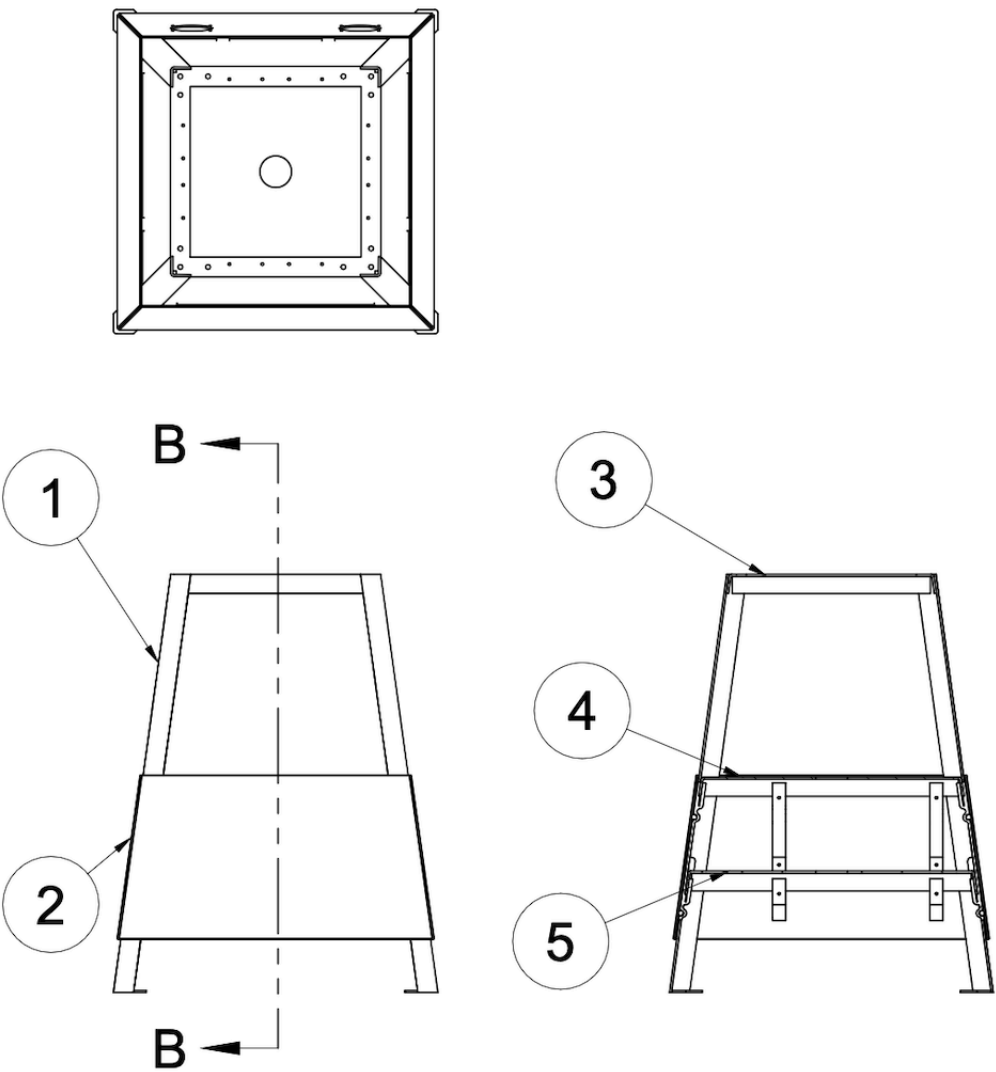
Although they are mentioned for clarity in the below diagram this section will not go over the electronic components housed within the sphere. That information is covered in the Wiring Diagrams and Connections section and other technical datasheets within this same appendix.

The stand should not be altered in any way or have anything removed from it except for the removable cladding when appropriate.

ITEM	PART NUMBER
1	BASE
2	CAMERAS
3	TOP INNER STRUCTURE
4	MIDDLE INNER STRUCTURE
5	LOWER INNER STRUCTURE
6	SPHERE
7	ELECTRONIC COMPONENTS



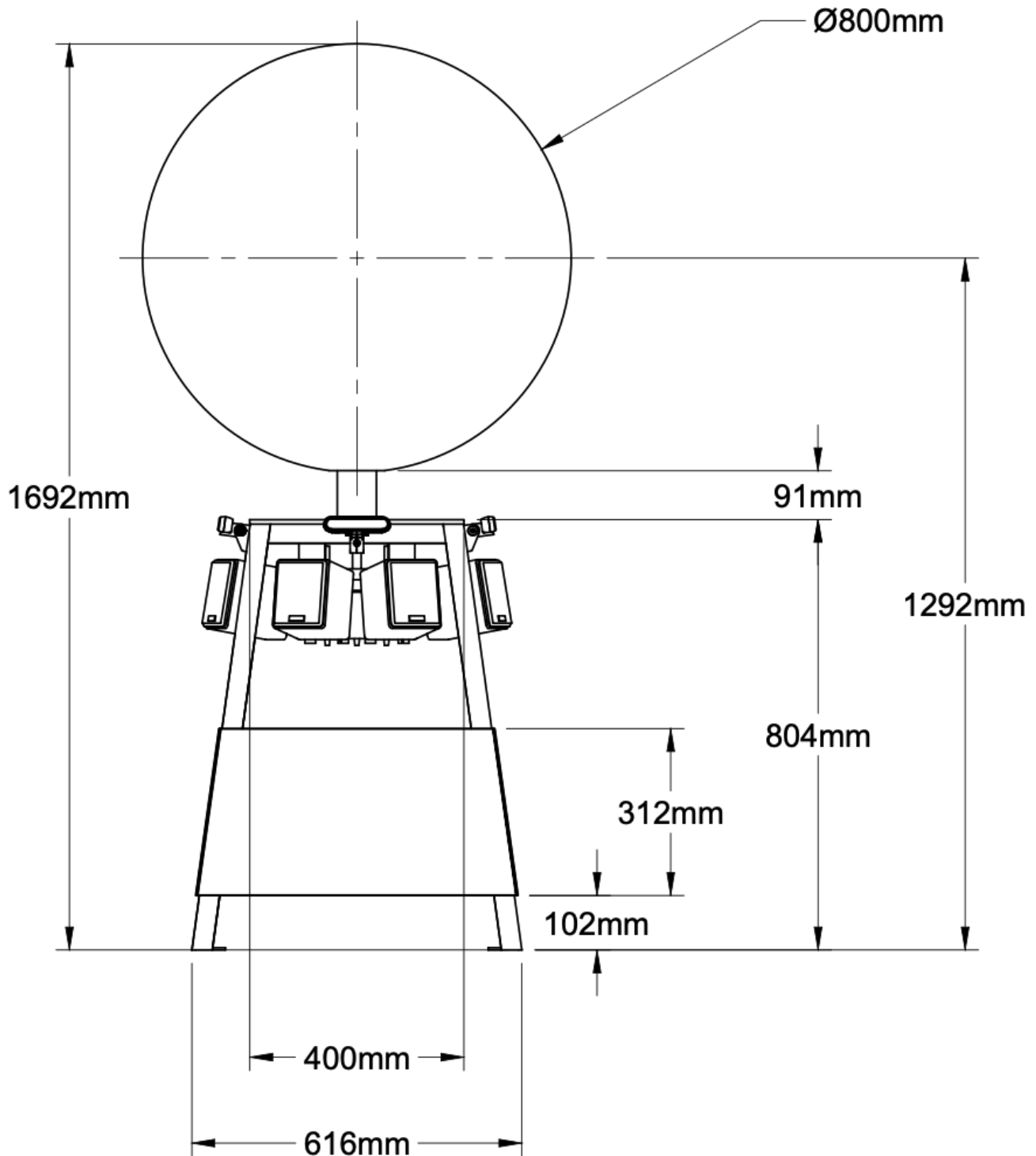
Base



Part	Quantity	Material
1- Legs	4	Stainless steel
2- Cladding (North unit has two fan holes in it, the three others are solid)	4	Aluminum 5052 H32
3 -Top Shelf	1	Stainless steel
4- Middle Shelf	1	Stainless steel
5- Lower Shelf	1	Stainless steel

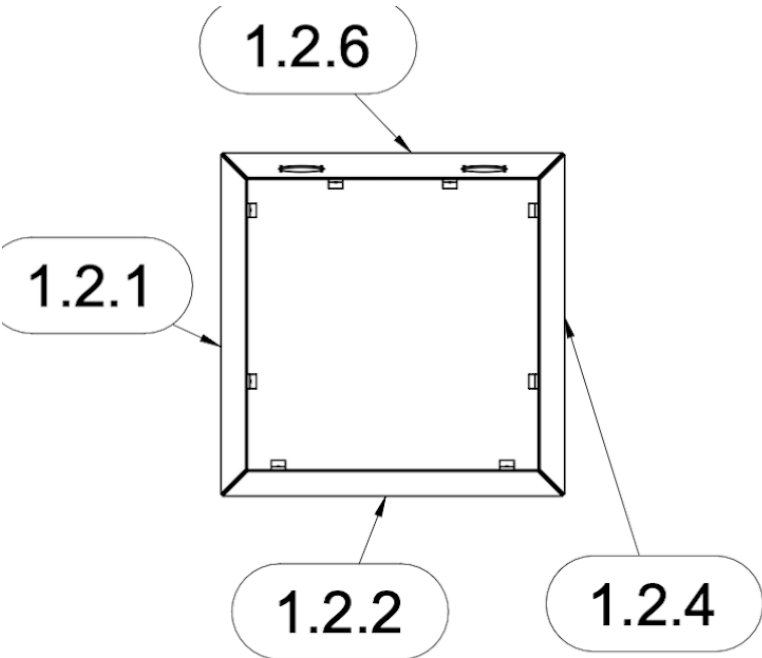
Manufacturer Constructed Base

This section is composed of the parts in the previous diagram labeled “Legs, Top Shelf, Middle Shelf, and Lower Shelf”. The finish is powdercoated satin black.

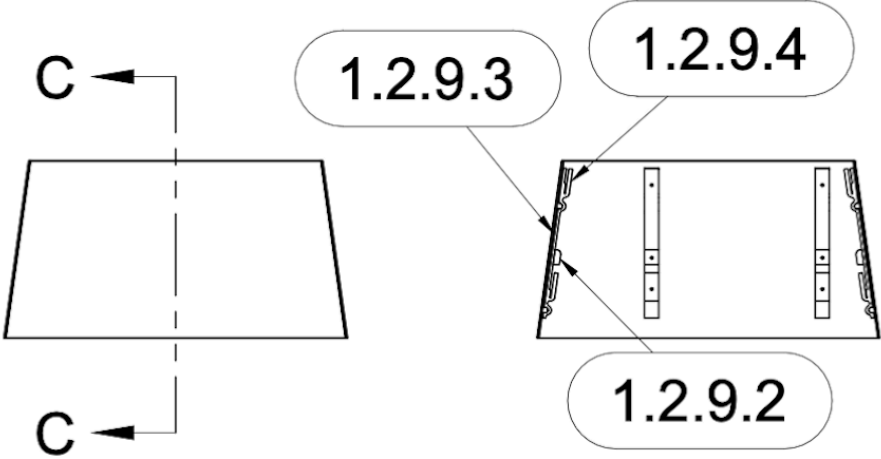


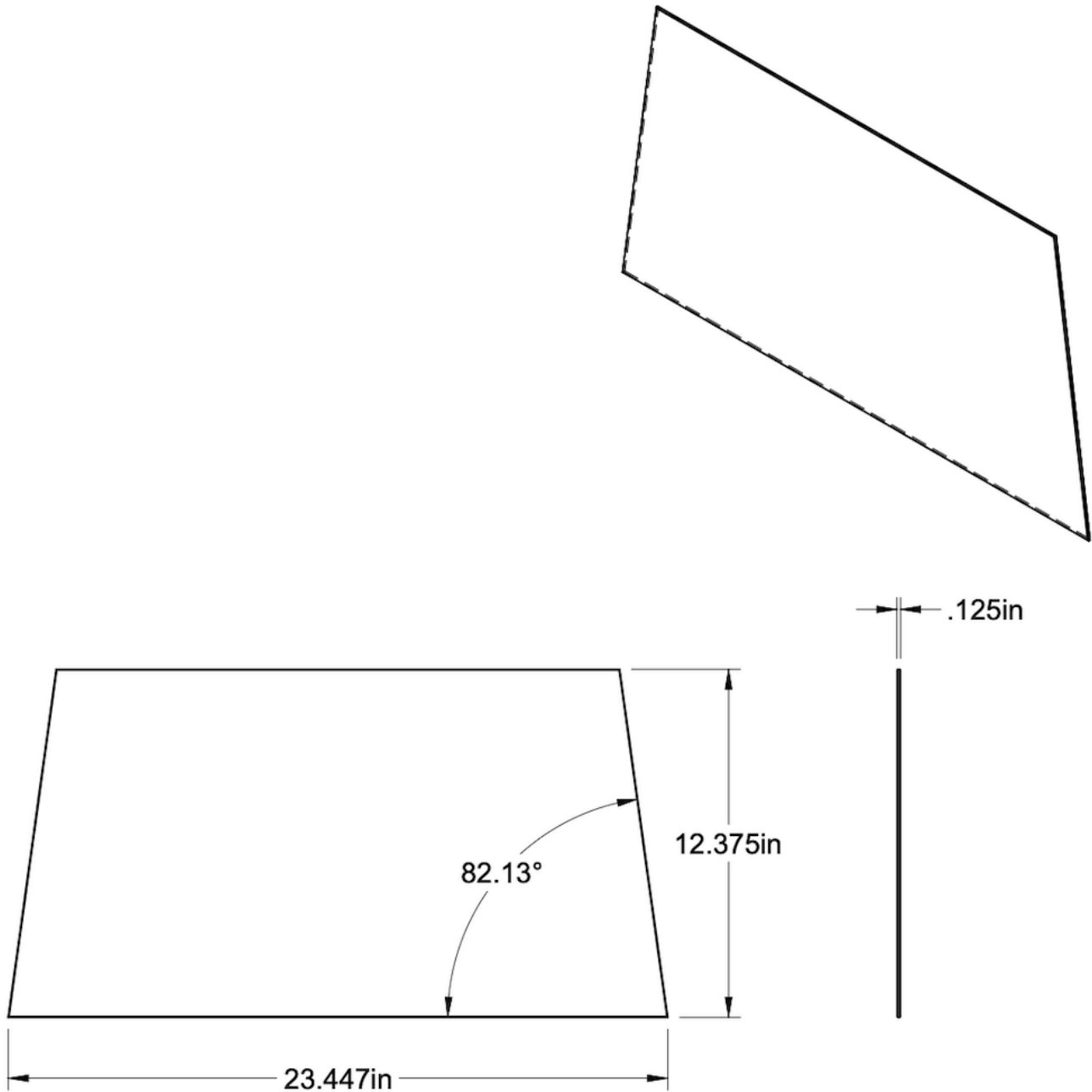
Cladding

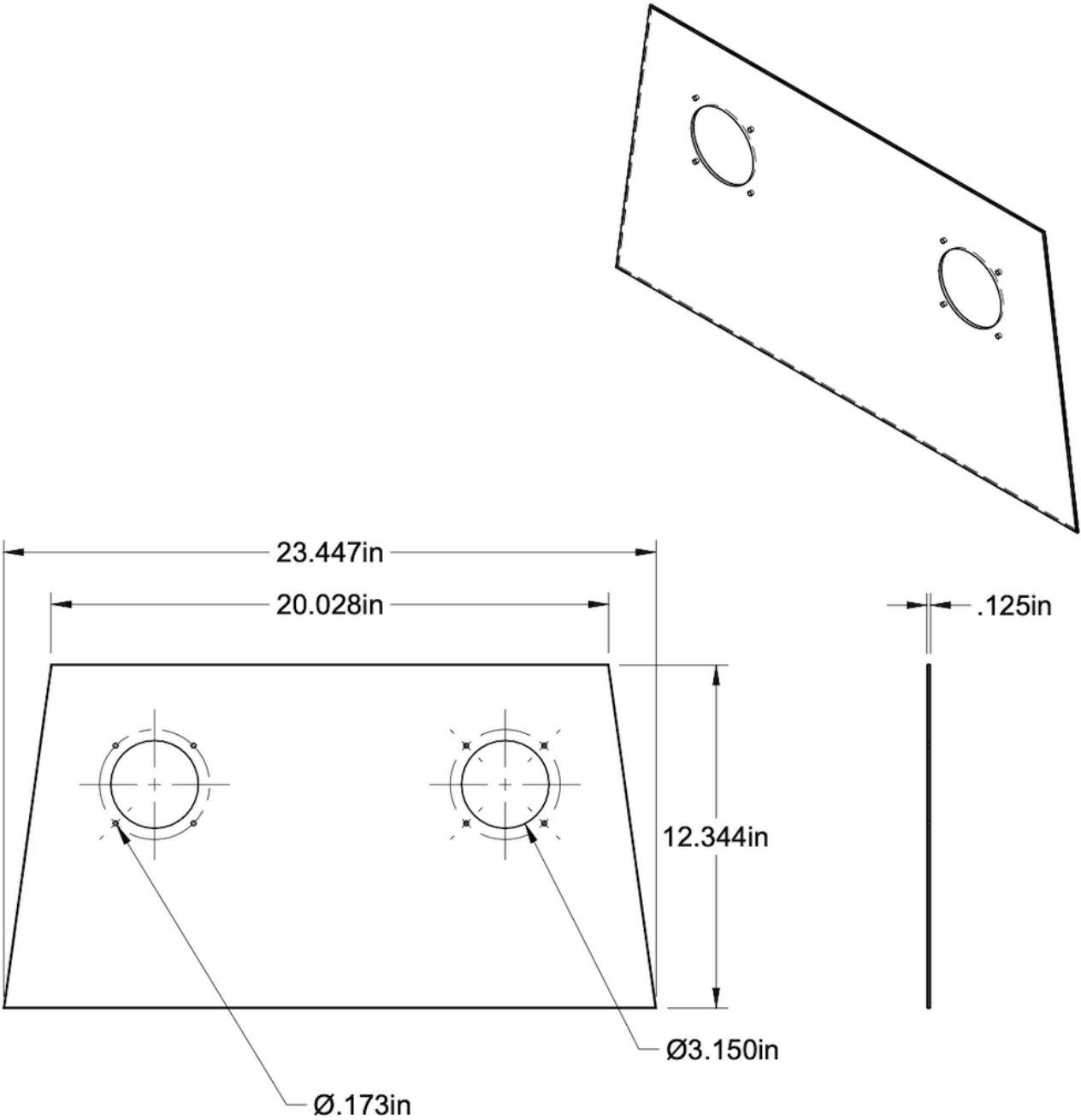
The North Cladding has fan holes whereas the South, West and East cladding do not. On the other hand, the West Cladding has a hole cutout to give access to the Smart Power Bar. In addition the locking and clip-on mechanisms mentioned in the diagram below have been epoxied on by hand in the artist studio. If repair on these parts is necessary please contact the studio.



1.2.1	CLADING W
1.2.2	CLADING S
1.2.4	CLADING E
1.2.6	CLADING N WITH FANS
1.2.9	CLADING_MOUNTING POINT V4
1.2.9.2	LOCKING BLOCK
1.2.9.3	CLIP ON CLADING
1.2.9.4	CLIP ON STRUCTURE







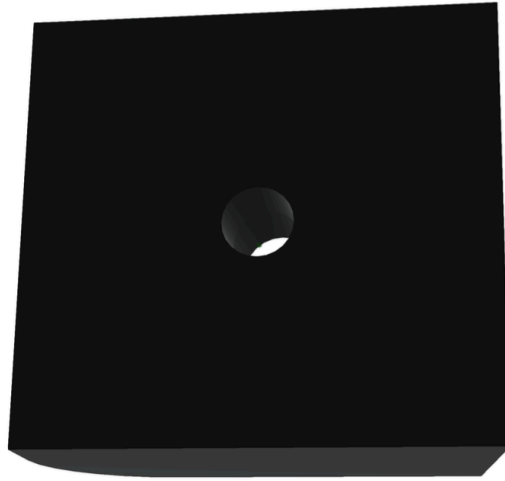
Cladding Locking Mechanism



Part	Quantity	Material
Locking Block	8	Bambulab PLA Mat Black
Clip on Cladding	8	Bambulab PLA Mat Black
Clip on Structure	8	Bambulab PLA Mat Black

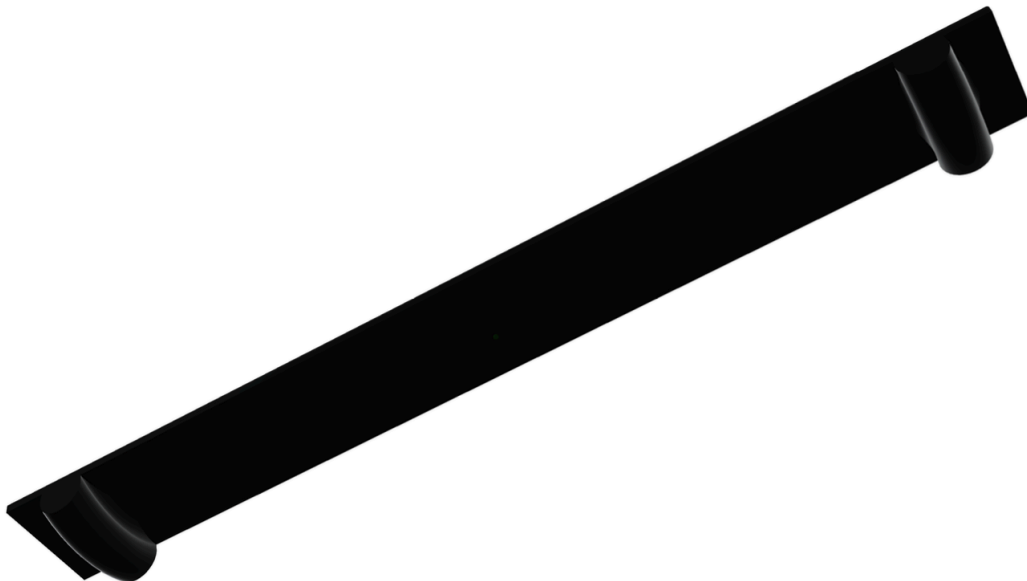
Locking Block

A complete step file for this piece is included in the provided USB.



Clip on Cladding

A complete step file for this piece is included in the provided USB.



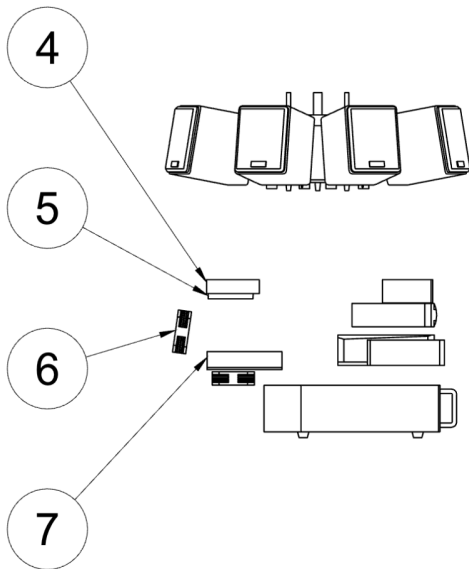
Clip on Structure

A complete step file for this piece is included in the provided USB.

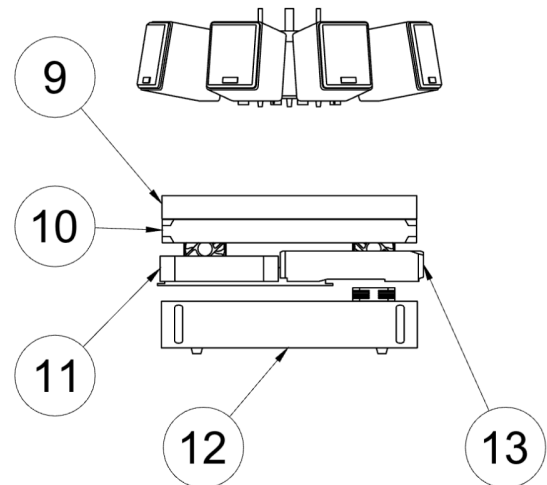


Electronic Components' Location within the Base

Within the base, the electronic components would be arranged within specific subsections, Here's how the major components would be placed.



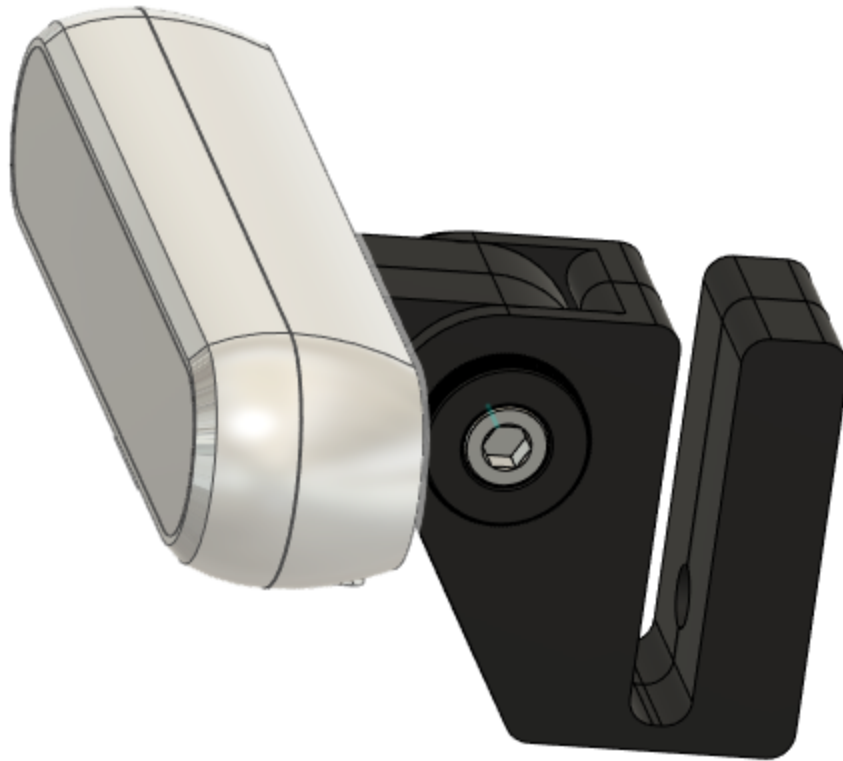
Viewed from the West



Viewed from the South

Part	Location
Speakers	Top Inner Structure
Amplifiers and their power supplies	Top Inner Structure
4- Asus ROG NUC power supply	Middle Inner Structure
5- Intel NUC Enthusiast power supply	Middle Inner Structure
7- Smart Power Bar	Middle Inner Structure
9- Power distribution bay	Middle Inner Structure
10- Audio Interface	Middle Inner Structure
11- Computer B (Intel NUC Enthusiast)	Middle Inner Structure
12- Video controller	Lower Inner Structure
13- Asus ROG NUC	Middle Inner Structure

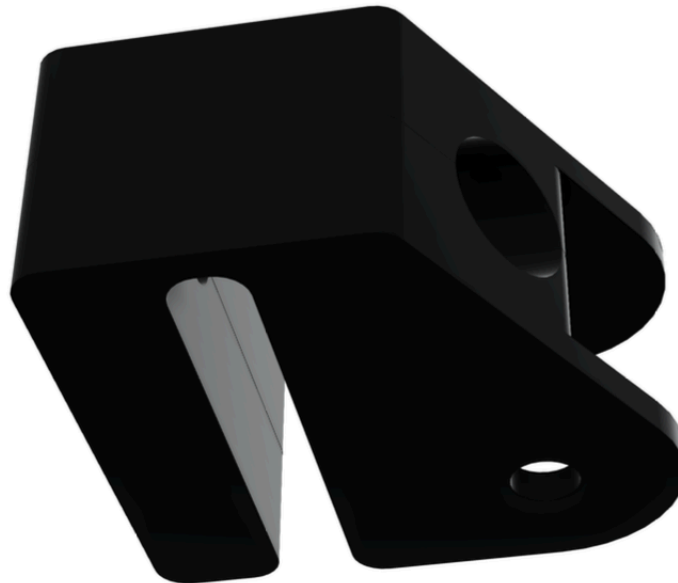
Depth Sensors (Cameras) - Mounting Method



Part	Quantity	Material
Clamp	4	Bambulab PLA Mat Black
Pivot	4	Bambulab PLA Mat Black

Clamp

A complete step file for this piece is included in the provided USB.



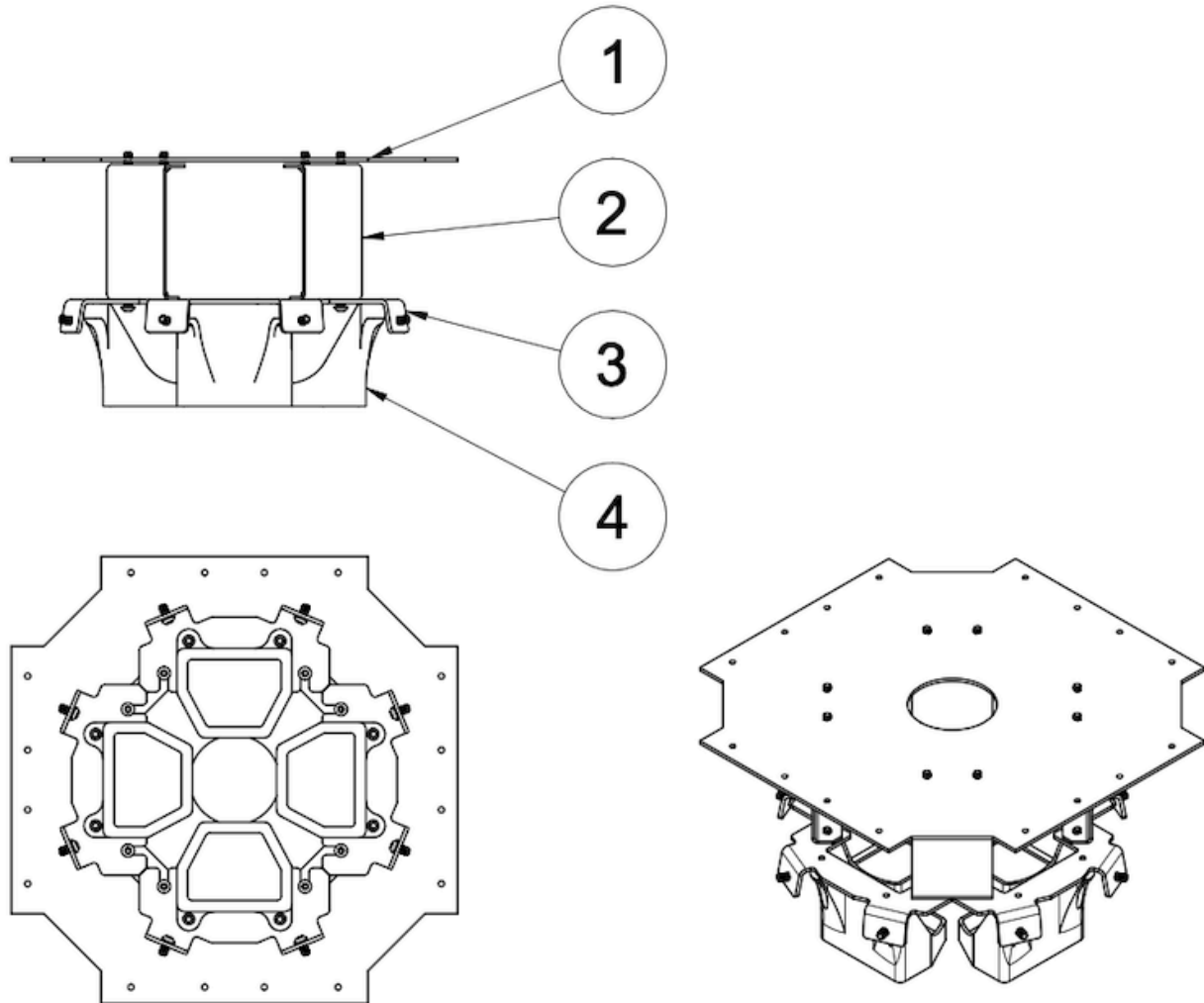
Pivot

A complete step file for this piece is included in the provided USB.



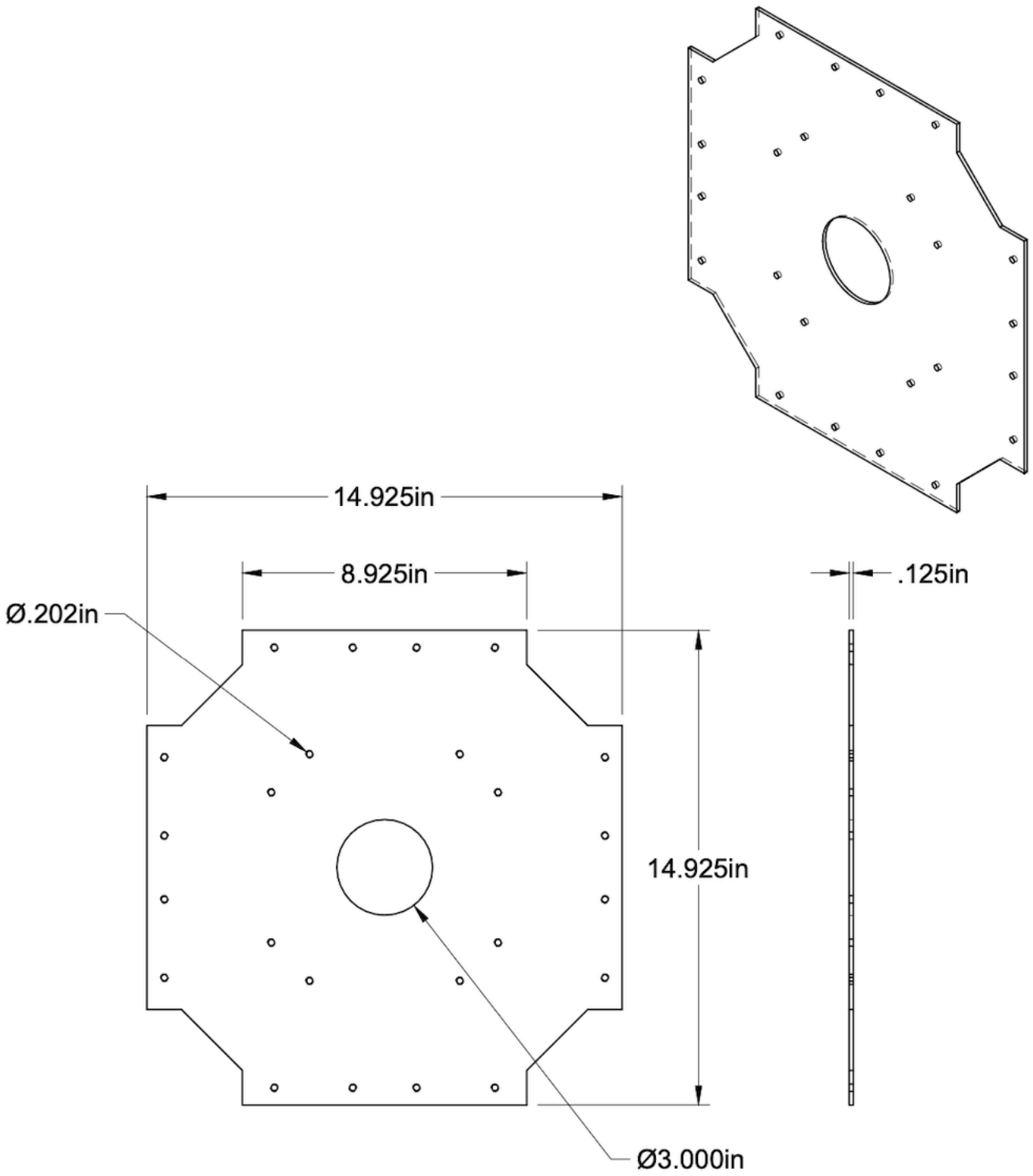
Top Inner Structure

The top inner structure hosts many electronic components, namely the speakers, the amplifiers and their power supplies.



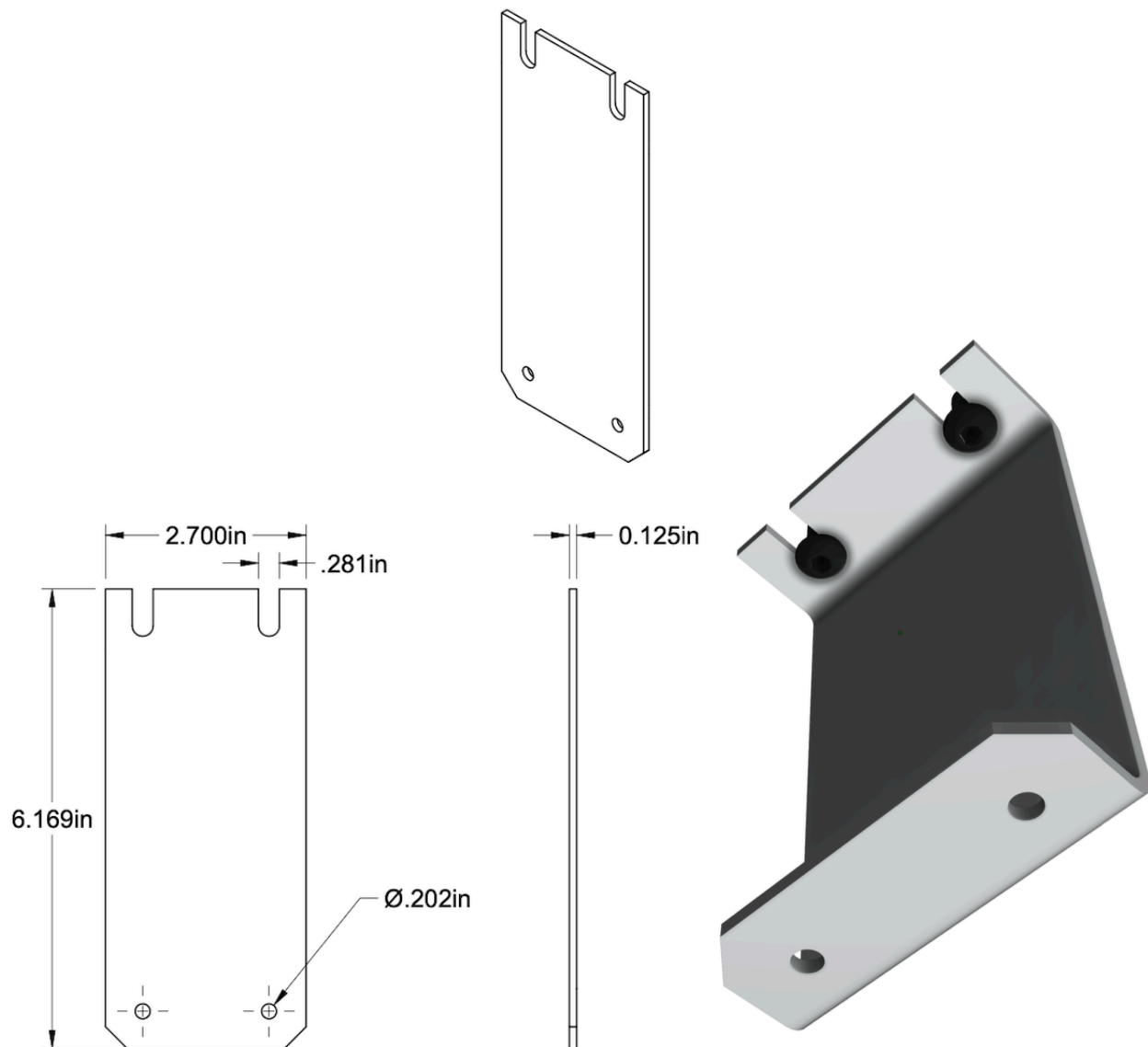
Part	Quantity	Material
1- Inner Base Plate	1	Aluminum 5052 H32
2- Reach Down Support	6	Aluminum 5052 H32
3- Speaker Angled Bracket	6	Aluminum 5052 H32
4- Amp and PSU Support	4	Bambulab PLA Mat Black

Inner Base Plate



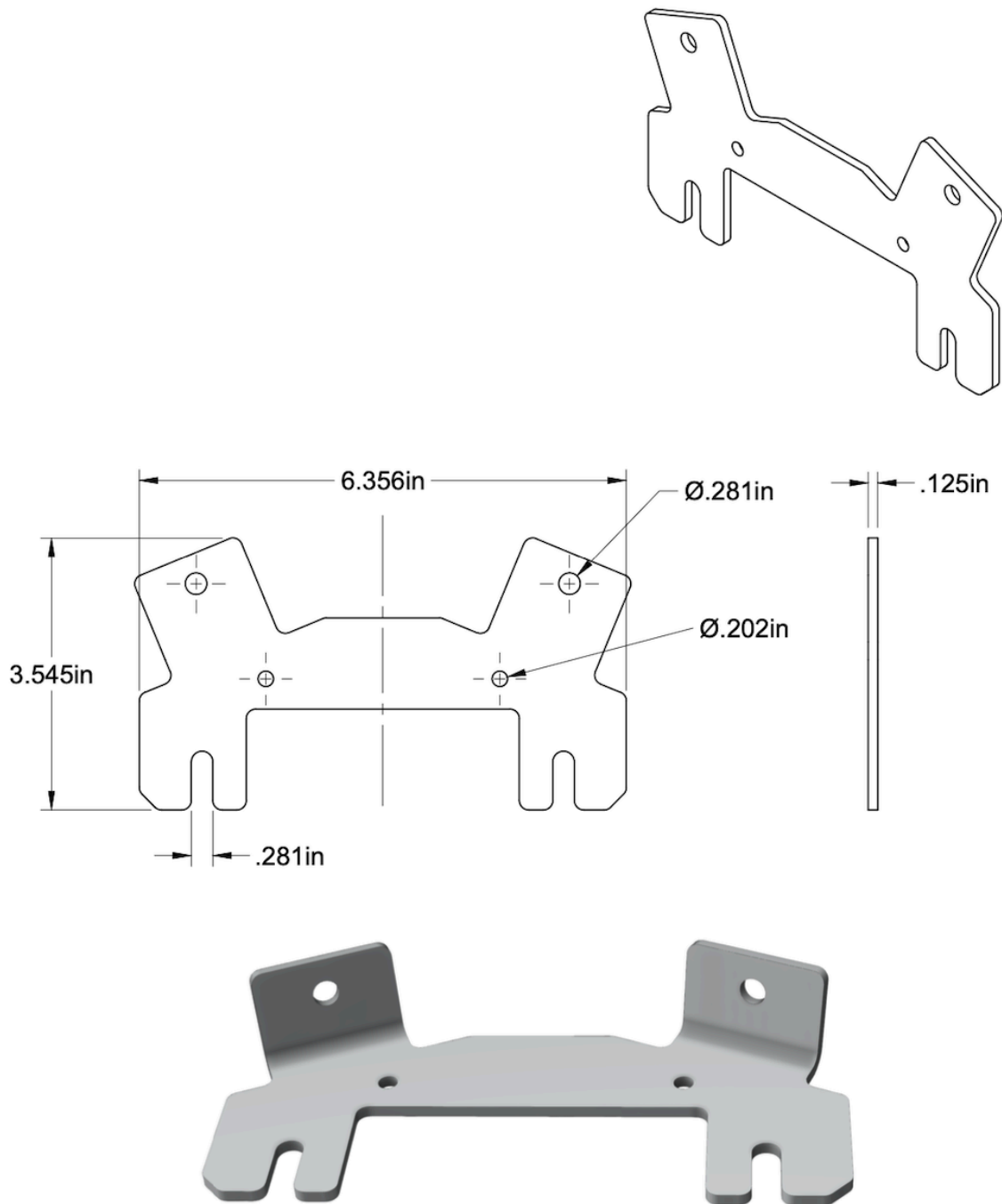
Reach Down Support

Both bending angles are 90 degrees.



Speaker Angled Bracket

Both bending angles are 100 degrees.



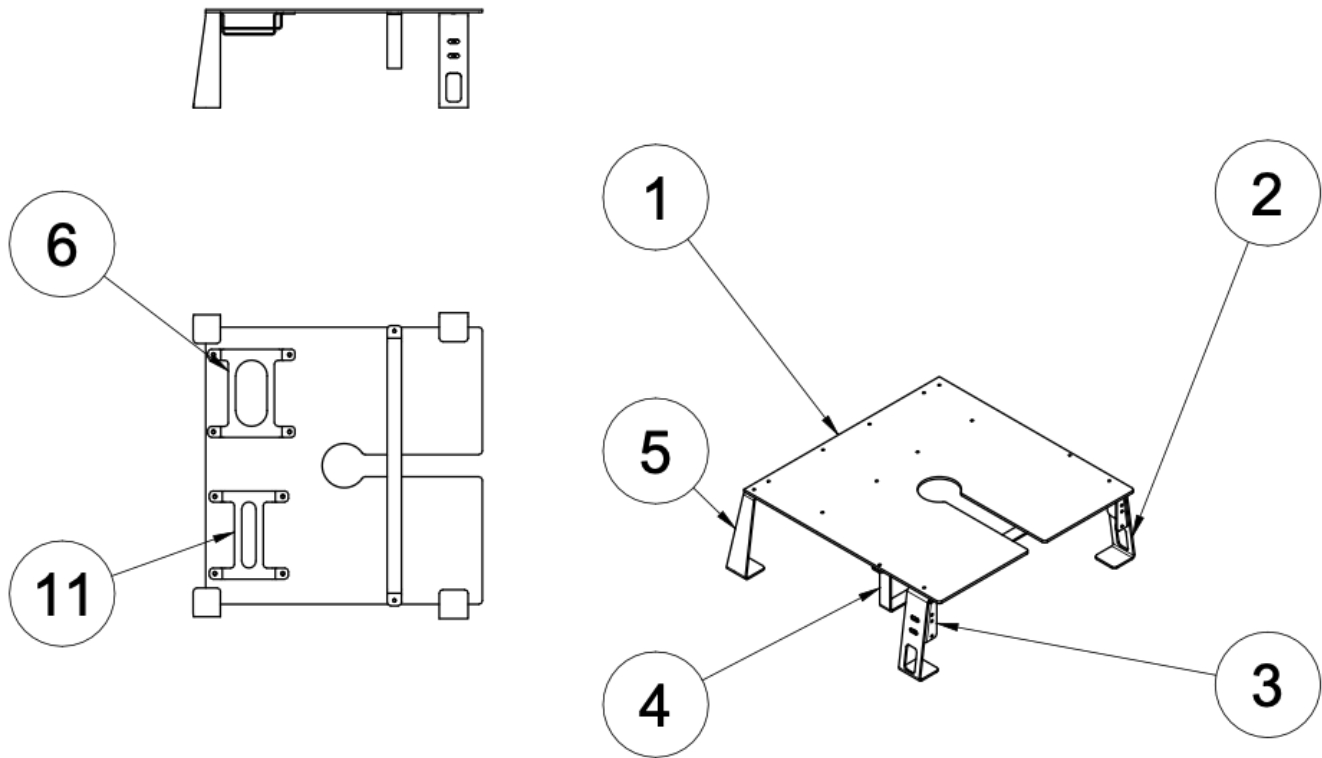
Amp and PSU Support

A complete step file for this piece is included in the provided USB.



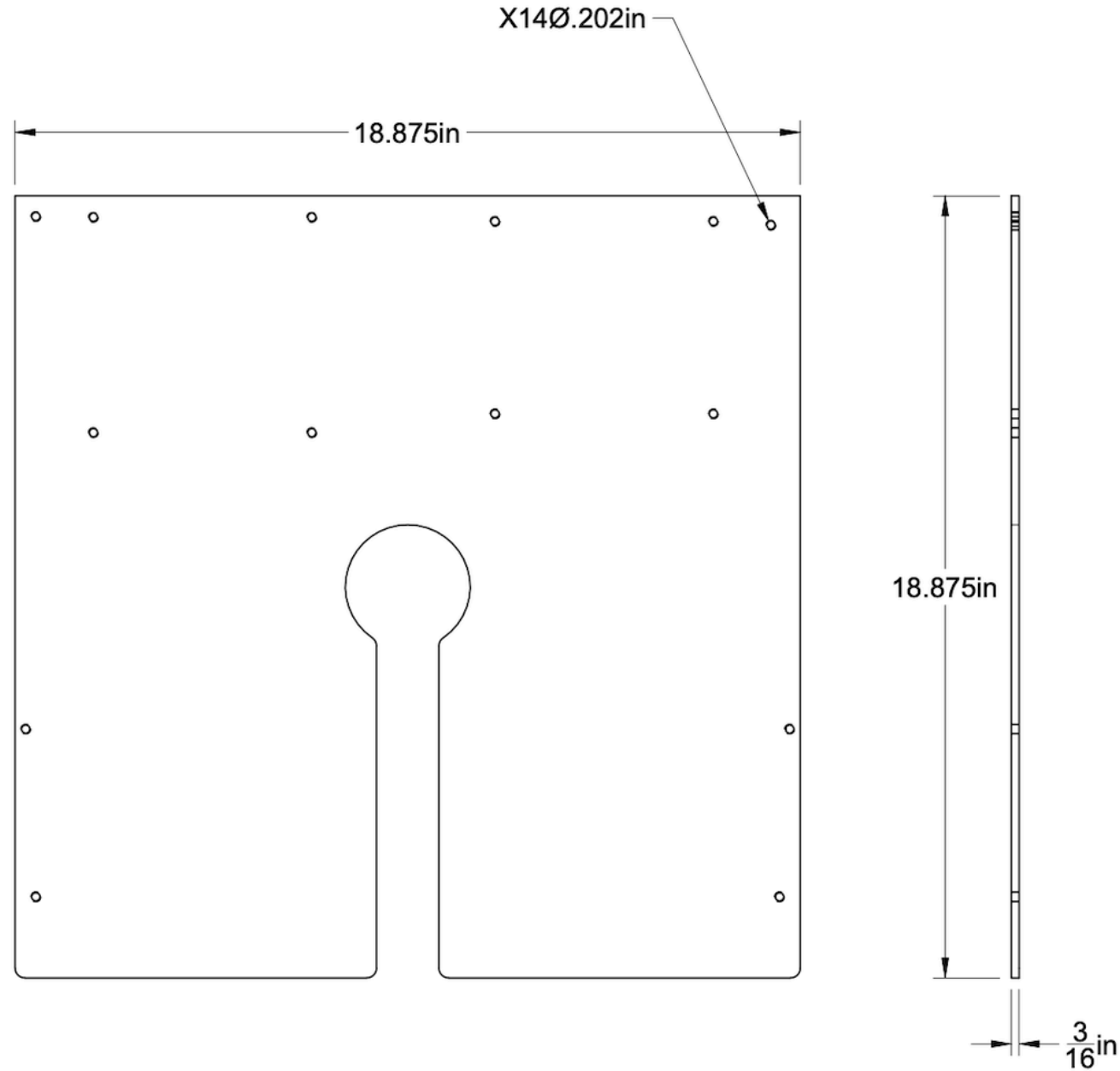
Middle Inner Structure

The middle inner structure hosts many electronic components, specifically the computers' power supplies, the audio interface and a power distribution bay. Under the inner structure element, within the space area, we will retrieve a Smart power bar, the fans' power modulator and the fans power supply.



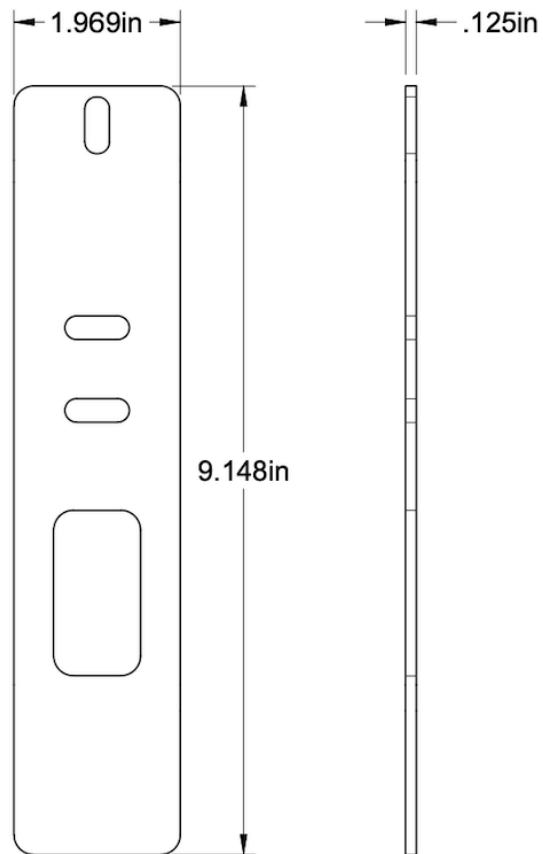
Part	Quantity	Material
1- RLH_006 Ceiling Plate	1	Aluminum 5052 H32
2- RLH_008 Front Leg	2	Aluminum 5052 H32
3- RLH_007 U1 Mount	2	Aluminum 5052 H32
4- RLH_011 Soundcard Support	1	Aluminum 5052 H32
5- RLH_012 Back Leg	2	Aluminum 5052 H32
6- RLH_010 PSU Bracket 02	1	Aluminum 5052 H32
11- RLH_009 PSU Bracket 01	1	Aluminum 5052 H32

Ceiling Plate

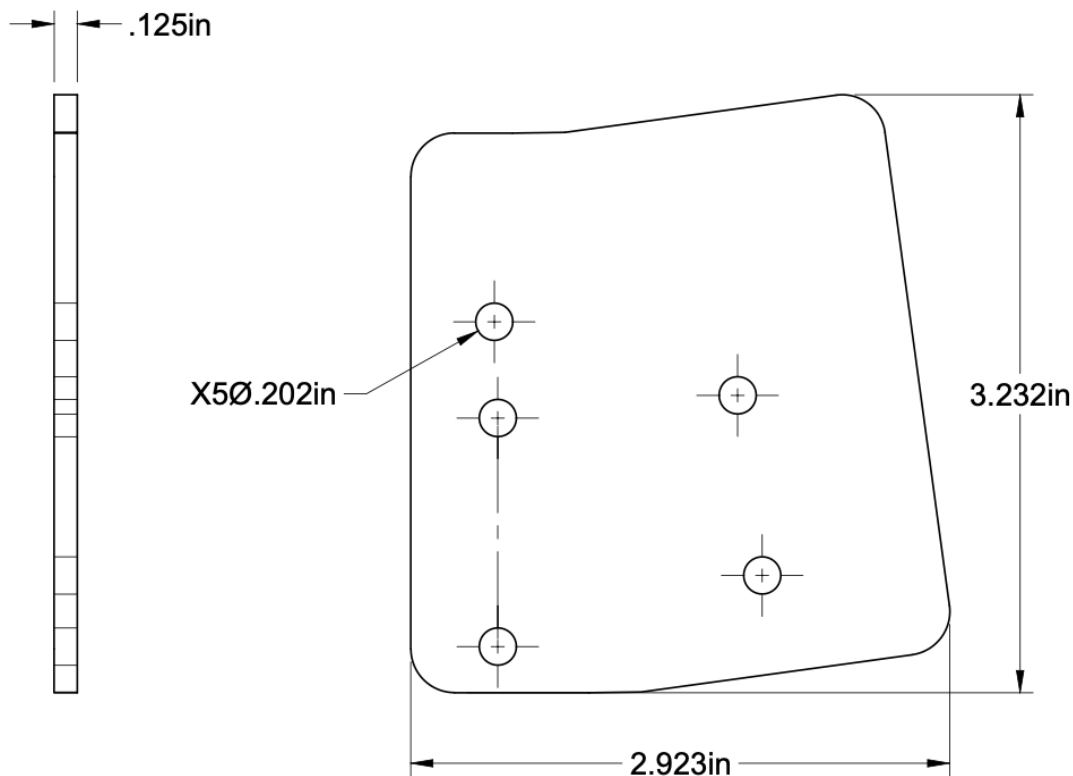


Front Leg

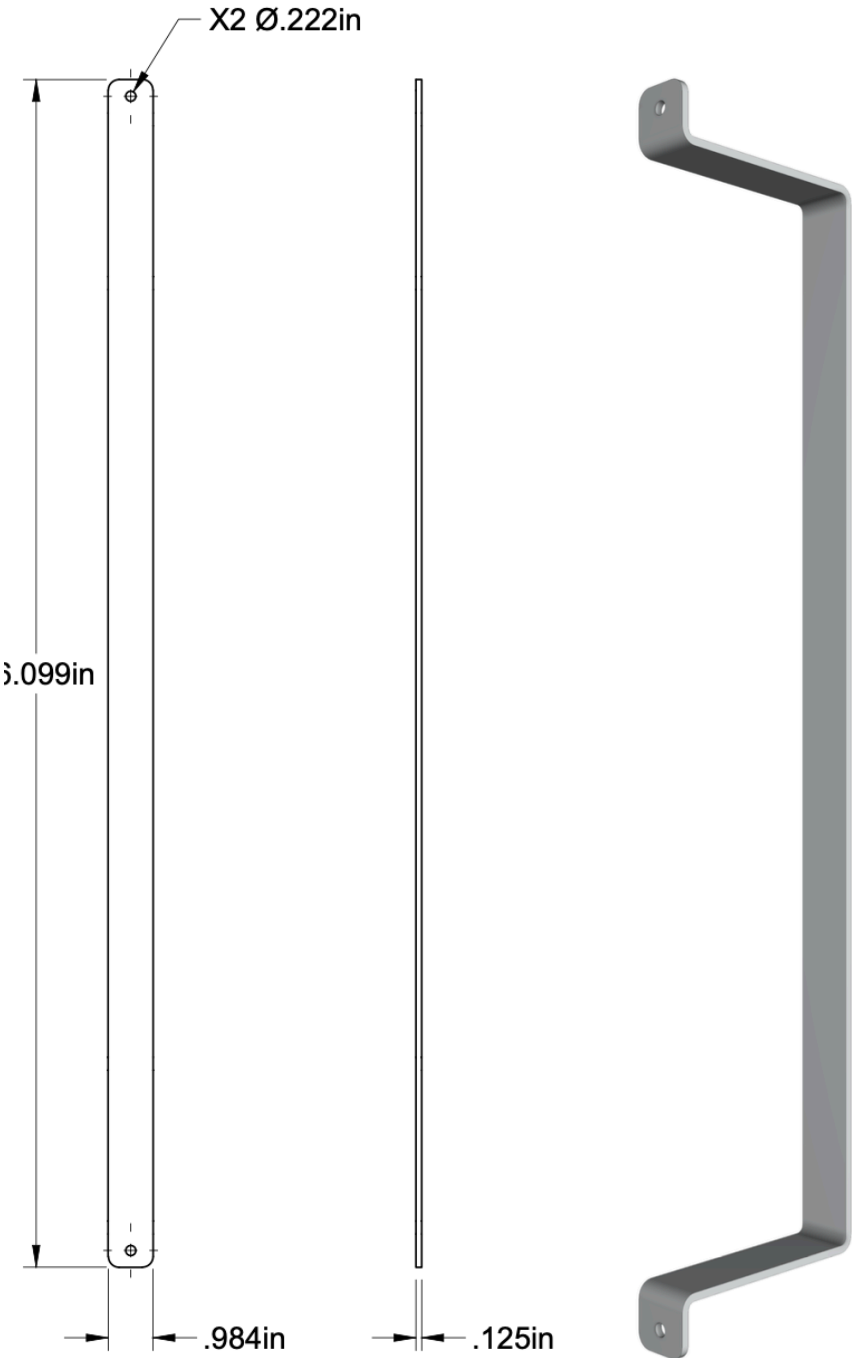
The large bend is 82.2 degrees and the smaller bend is 97.8 degrees.



U1 Mount

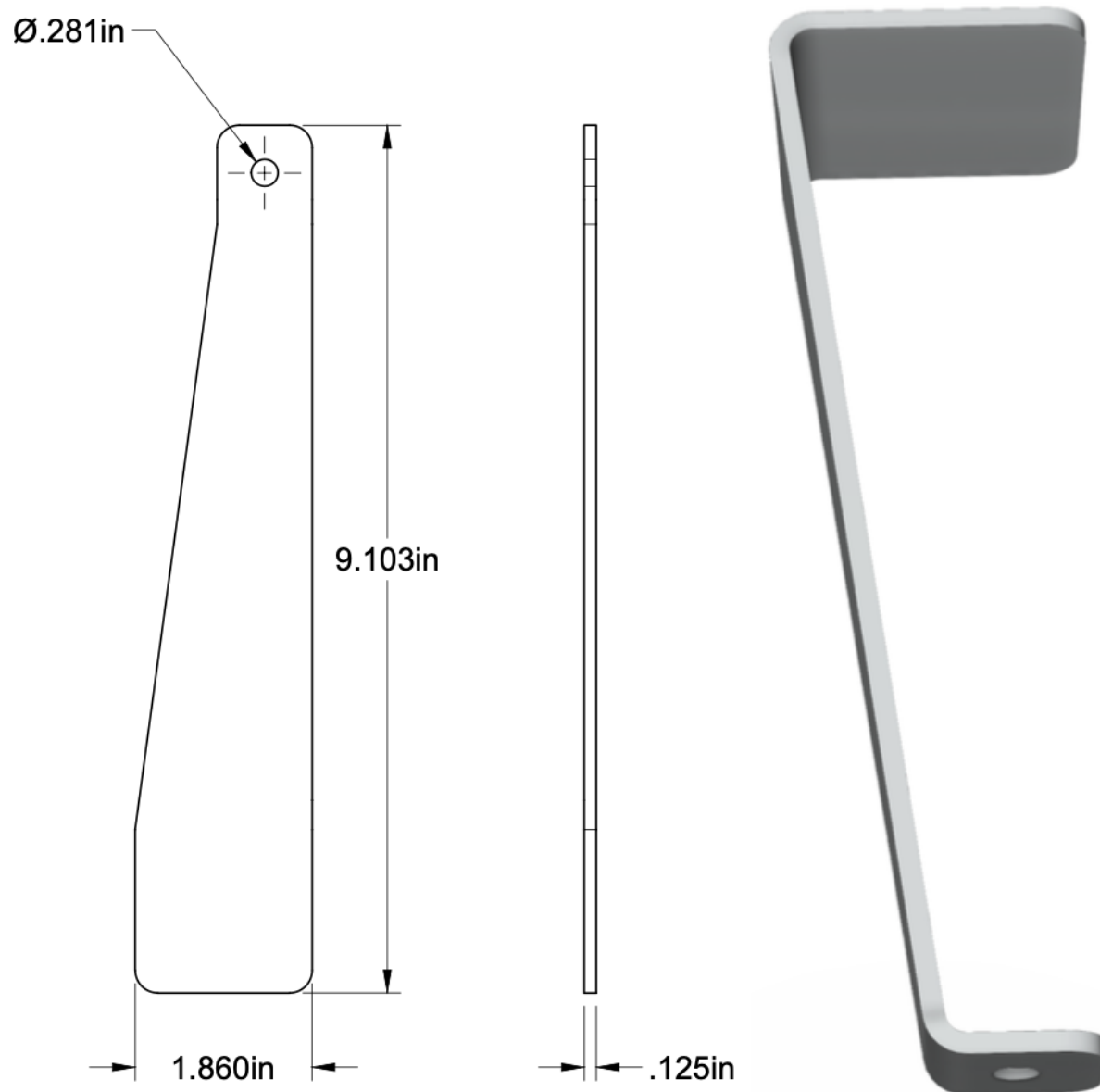


All angles shown are 90 degrees.



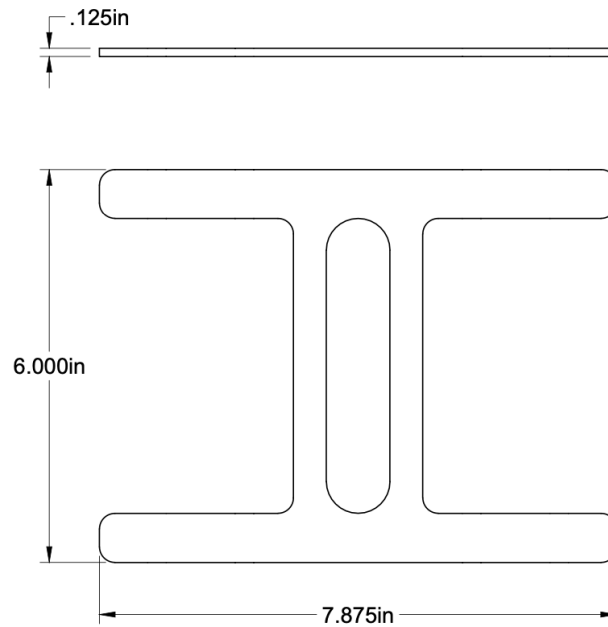
Back Leg

The large bend is 82.2 degrees and the smaller bend is 97.8 degrees.



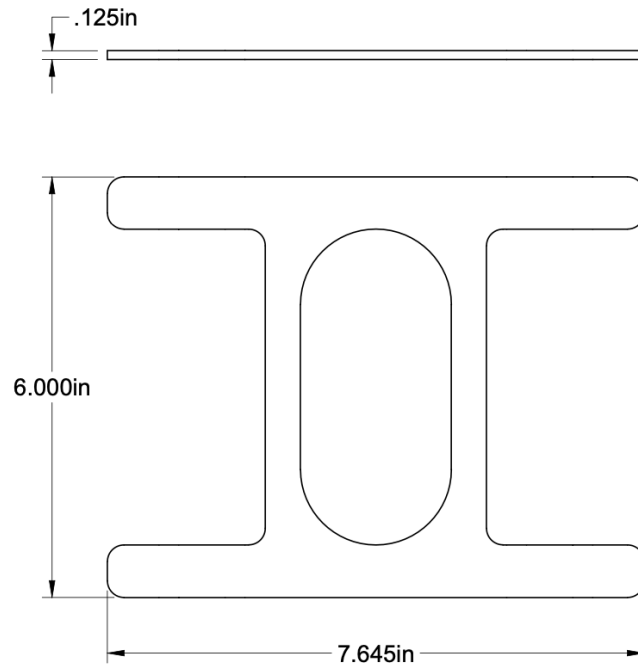
PSU Bracket 01

All bends shown are 90 degrees. This bracket secures the computer A's power supply.



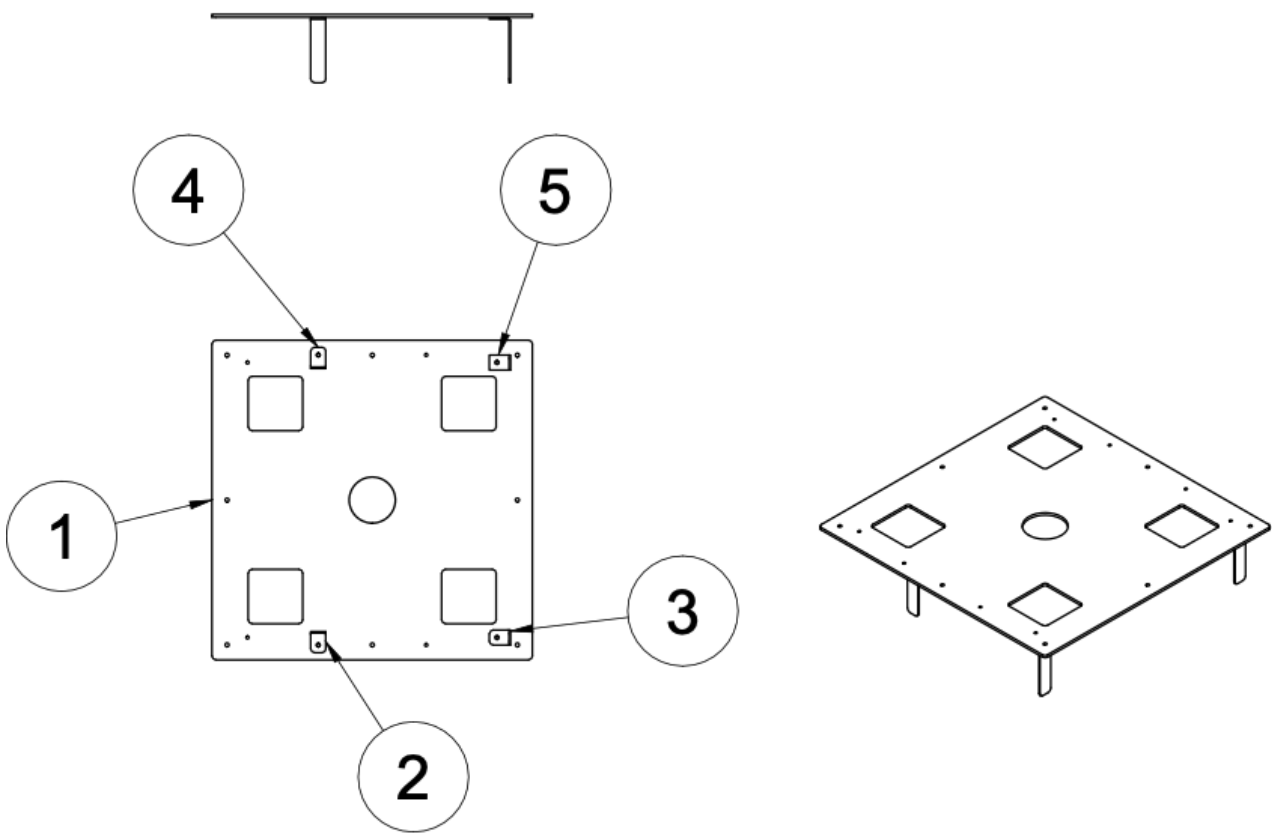
PSU Bracket 02

All bends shown are 90 degrees. This bracket secures the computer B's power supply.



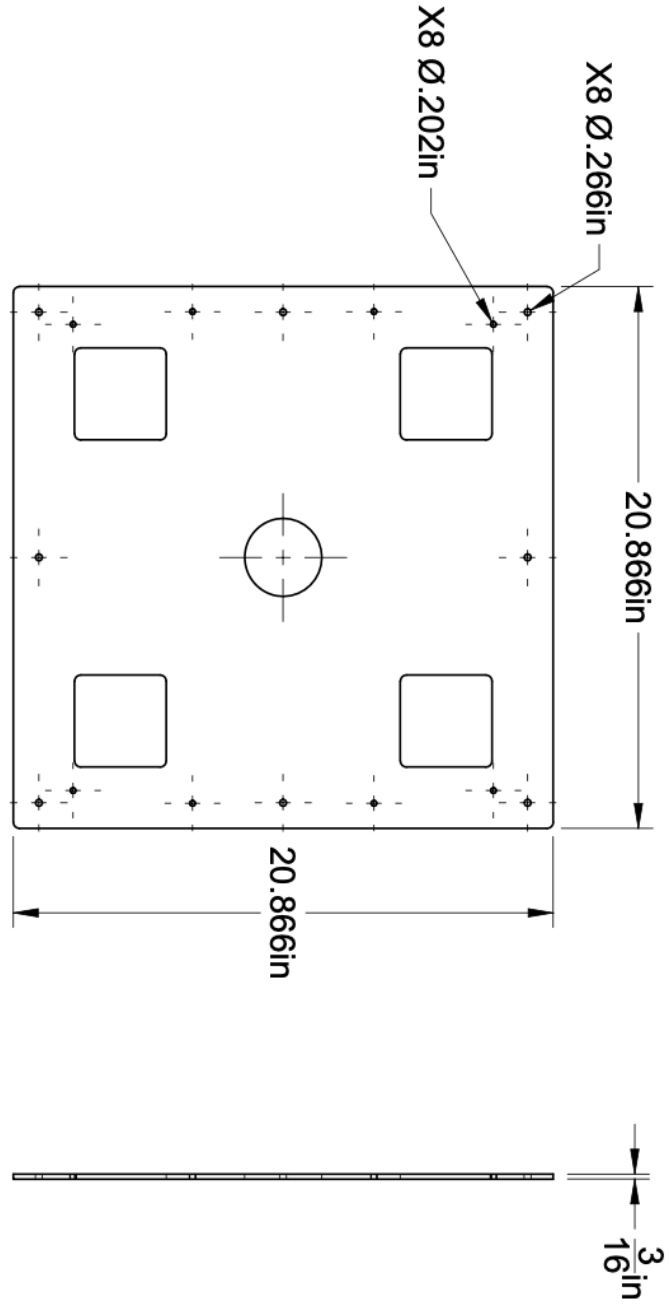
Lower Inner Structure

The lower inner structure hosts the artwork's video controller.



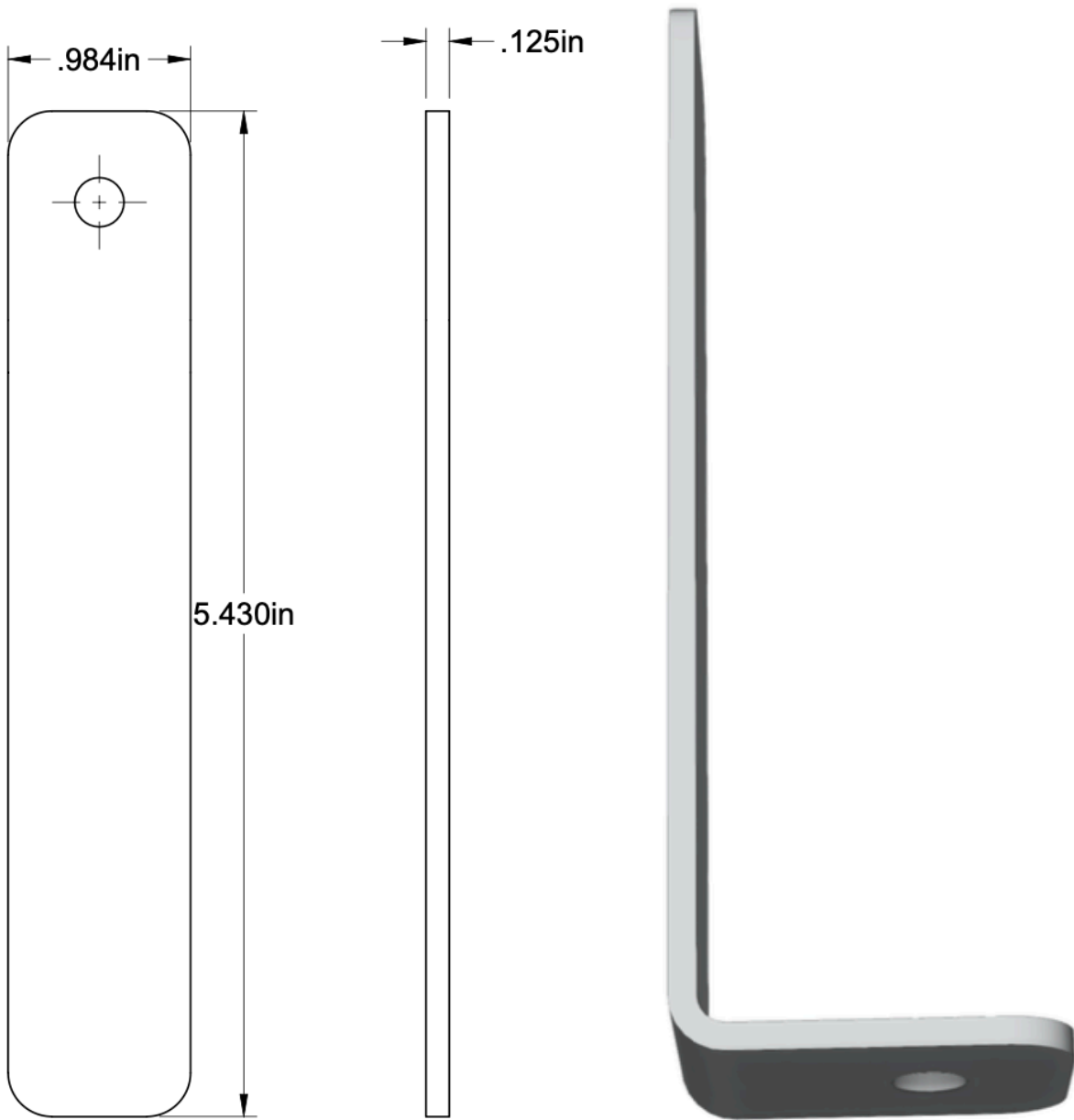
Part Number	Quantity	Material
1- RLH_013 Top Plate	1	Aluminum 5052 H32
2 to 5 - RLH_014 Video Controller Front Bracket	4	Aluminum 5052 H32

Top Plate



Video Controller Front Bracket

The piece is bent at 90 degrees.



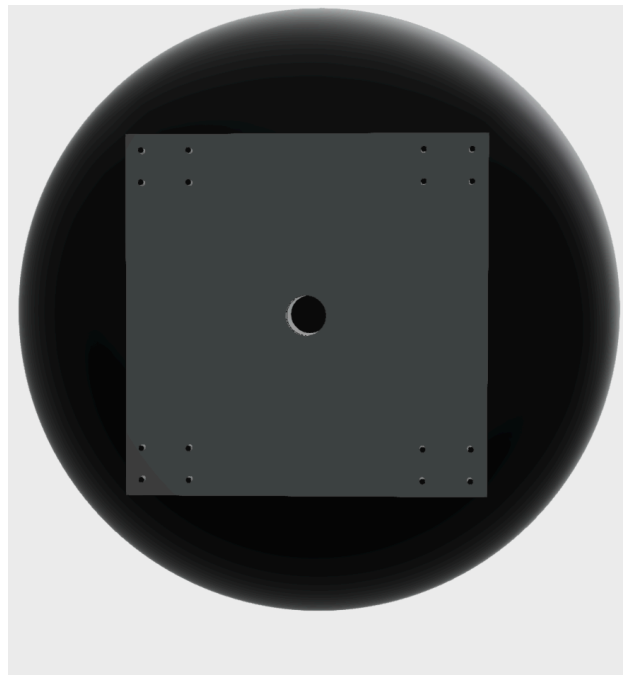
Sphere Support

The support comes as one piece (pole, plate and sphere skeleton), made by the sphere's manufacturer and the sphere is welded to this support system. Height measurement can be found under Stand - Base, under Manufacturer Constructed Base's subsection. The system for securing the support to the rest of the base are three 1/4-20 screws in each corner. A fourth screw closer to the hole in the center on the four corners is not connecting the support to the rest of the stand.

The sphere support should not be disconnected from the base, unless discussed with the studio's team.



View of the support from the front.



View of the support from the bottom.

Video Controller

The video controller relays the video feed from the dedicated computer to the sphere. It is located under the lower shelf of the base, assembled within the lower inner structure.

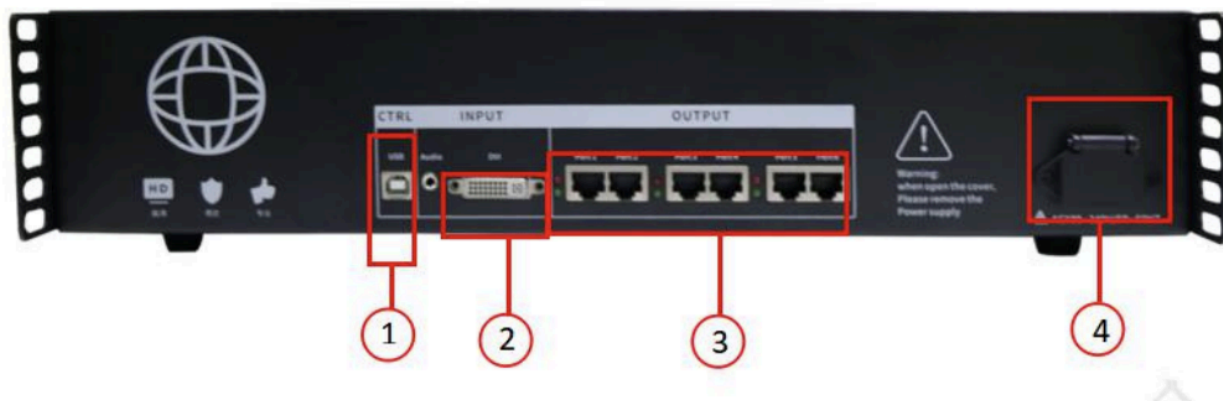
Specification	Details
Manufacturer	Shenzhen Mooncell Electronics Co., Ltd
Model Number	MB6S
Power Supply	AC-100-240V-50/60HZ AC
Dimensions	436 x 300.2 x 88.9 centimetres



Front Panel Illustration

Front Panel Illustration		
#	Name	Illustration
1	ON/OFF	Power ON/OFF
2	Indicator	The operating status indicator of the controller

Backside Panel



Backside Panel Illustration

Input Interface

#	Name	Illustration
2	AUDIO	3.5mm AUDIO INPUT Port
3	DVI	DVI Video Signal Input Port

Output Interface

#	Name	Illustration
4	Gigabyte Ethernet Port	<ul style="list-style-type: none"> ◆ OUT1-OUT6: Output Ethernet Ports 1-6 ◆ 650 thousand pixels for 1 network port ◆ it supports network port loop backup.

Control Interface

#	Name	Illustration
1	USB (B TYPE)	to get it connected to the software on the PC to communicate.

Power Interface

#	Name	Illustration
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5	AC Power Port	AC-100-240V-50/60HZ AC Power Port
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Computers

Both computers are nested between the bottom and the middle shelf within the base, sitting on the lower shelf. Their power supplies are located within the same area of the base, secured PSU bracket within the middle inner structure.

Computer A controls the audio and video output for the piece.

Specification	Details
Manufacturer / Model	Asus ROG NUC14SRK
Processor	Intel Core Ultra 7 155H
RAM	16 GB
Graphics Card	NVIDIA Geforce RTX 4060
Storage	500 GB SSD
Operating System	Windows 11
Dimensions	27 x 18 x 6 centimetres

Computer B controls the downloading software.

Specification	Details
Manufacturer / Model	Intel Nuc Enthusiast NUC11PHKi7C000
Processor	Intel Core i7-1165G7 2.80 GHz
RAM	32 GB
Graphics Card	NVIDIA Geforce RTX 2060
Storage	1 TB SSD
Operating System	Windows 10
Dimensions	22.7 x 14.5 x 4 centimetres

Depth Sensors

The depth sensors attach to the outer top edges of the base. They're held in place using custom made brackets described under the [Depth Sensors \(Cameras\) - Mounting Method](#) section and can be located like represented in the section [Stand - Base](#), under Manufacturer Constructed Base's subsection.

This stereoscopic depth sensor detects the elements in space in front of the display and can return the distance of such elements from the sensor. The artwork's software will require that exact device to be used. Future versions might rely on different sensors: here are the minimal specs to match or improve for an easier migration process.



Specification	Details
Manufacturer / Model	Intel RealSense D455
Resolution	Up to 1280 x 720, up to 90 fps
Tracking range	60 cm to 600 centimetres
Depth Field of View	87 degrees (horizontal) X 58 degrees (vertical)
USB Standard	3.0
Mounting Point	¼-20 UNC thread
Dimensions (W x H x D)	124 x 29 x 26 mm

All cables and connections to the computer have been labelled to make preserving the connections established in the artists studio easier. The depth sensors have been labelled as cardinal directions and numbers externally and have an internal ID assigned by RealSense. We record each of these below.

If there is ever a need to replace a depth sensor please first consult the [Replacing a Depth Sensor](#) section.

Cardinal Direction	Number Assignment	Internal ID
North	3	213522252390
East	4	213522250473
South	1	213522253928
West	2	035322250690

Audio Interface

The audio interface is mounted between the bottom and the middle shelf within the middle inner structure.



Specification	Details
Manufacturer	Presonus
Model Number	Quantum 2626
Connectivity port	Thunderbolt
Power	12 VDC, External Power Supply
Dimensions (W x H x D)	19 x 4.4 x 17.8 centimetres
Digital Audio Bit depth	24 Bits
Digital Audio Dynamic Range	(115 db (A-weighted))
Line Output Connection Type	¼ TRS Female
Line Input Impedance	10k Resistance
Main And Line Outputs Output Impedance	51 Resistance

power Thunderbolt

channels 1 to 8



Amplifiers

The four amplifiers and their power supplies (PSU) are mounted within the top inner structure of the stand. It is supported by the custom 3D-printed Amp and PSU Support Bracket. Information about that bracket can be found in the [top inner structure](#) section, under the Amp and PSU Support subsection.



Specification	Details
Manufacturer	Fosi Audio
Model Number	V1.0B
Chip Set	TPA3116
Output Power	50W x 2 channels @ 4Ω
Terminating Impedance	2Ω-8Ω
Input Mode	RCA
Output Mode	Passive Speakers
Frequency Range	20Hz - 20kHz (±1dB)
Input Sensitivity	≤ 280mV
Dimensions	4.13 x 3.54 x 1.38 “
DC Input Range	12-24V
Power Supply	19V 4.74A

Speakers

The speakers are installed between the top and the middle shelf, within the top inner structure of the base and the mourning method is described in the section Stand - Base, under Manufacturer Constructed Base's subsection. The speaker's mesh screen must be exhibited with the artwork.

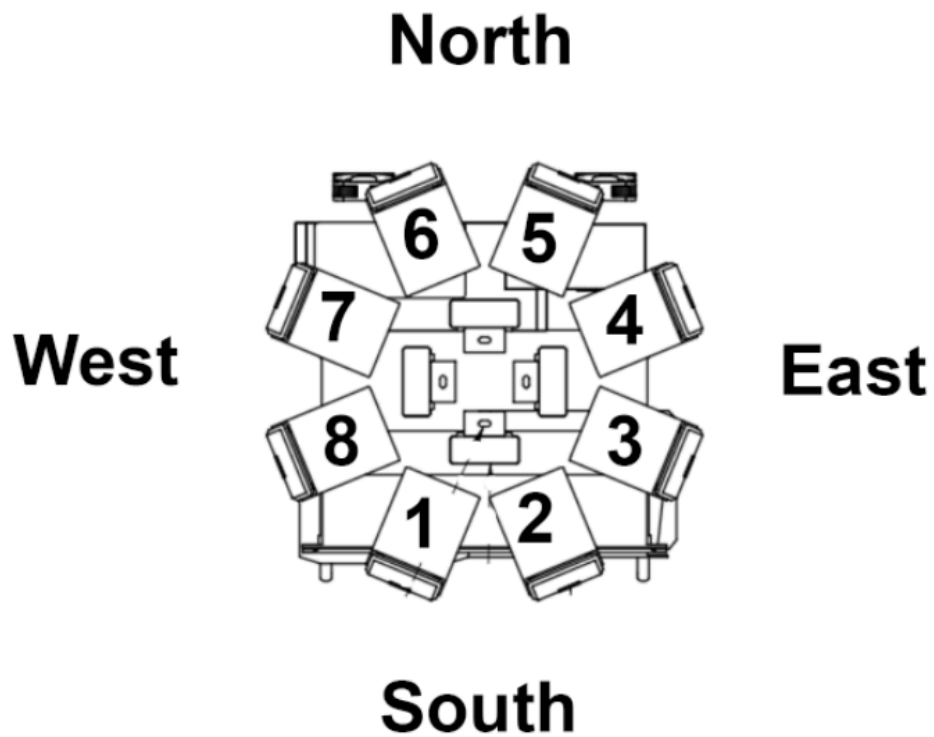


Specification	Details
Manufacturer	Micca
Model Number	COVO-S Compact
Power Handling	50W Max (Each)
Impedance	Impedance: 6-8 Ohms
Dimensions (W x H x D)	13 x 13.2 x 10.7 centimetres
Frequency Response	Frequency Response: 90Hz-20kHz (Typical In-Room)

All cables and connections to the computer have been labelled to make sure we preserve the order of how things are plugged. The speakers have been labelled as numbers. Speakers are

labelled from 1-8 corresponding to the 8 outputs of the Audio Interface. The diagram below shows the speaker's relationship to the cardinal sides.

If there is ever a need to replace a speaker please first consult the [Replacing a Speaker](#) section.



Fans

The 3 fans maintain a decent airflow within the closed part of the base to prevent the electronic components from overheating. Two of these are mounted on the base's north cladding, while the other is mounted under the base's lower shelf.



Specification	Details
Manufacturer	Noctua
Model Number	NF-A8
Dimensions	80 x 80 x 25 millimetres
Noise Level	17.7 dB(A)
Voltage Range	12V
Maximal Input Power	0.96W

Power Modulator

The power modulator is installed onto the inside part of the base's North cladding, in such a way its knob is easily controllable.



Specification	Details
Manufacturer	Noctua
Model Number	Na-FC1
Dimensions	21 x 25 x 48 millimetres
Voltage Range	5-12V

Power Modulator Power Supply

The power modulator power supply is located between the middle and the bottom shelves, within the base.



Specification	Details
Manufacturer	Noctua
Model Number	NV-PS1
Output Connector	5.5mm (outer diameter) / 2.1mm (inner diameter) barrel with NA-AC10 4-pin PWM adaptor cable
Input Voltage	90~264 VAC
Output	2A @ 12VDC

Smart Power Bar

The smart power bar rests on the lower shelf, within the base. Its On/Off rocker switch is used to control the power to the whole artwork, please refer to Operation for more details.



Specification	Details
Manufacturer	Digital-loggers
Model Number	Pro Switch
Dimensions	13 x 5.8 x 1.6"
Ethernet Interface	10/100 autosensing, Static IP, TCP port selectable, 8 pin RJ-45 w/ internal FCC filtering
Outlet Switching	8 individually switched circuits, 2 unswitched (always on)
Power Supply Rating	90-240V, AC/DC Autosensing
Weight	4.3 lb, 1.95 kg

APPENDIX III - REPAIRS AND OTHER MANIPULATIONS

Repairing a single damaged pixel on a panel

You may need to reseat or replace a single pixel on a panel if it stops transmitting in a certain light range or if it is otherwise visibly damaged.

Gather the materials listed below.

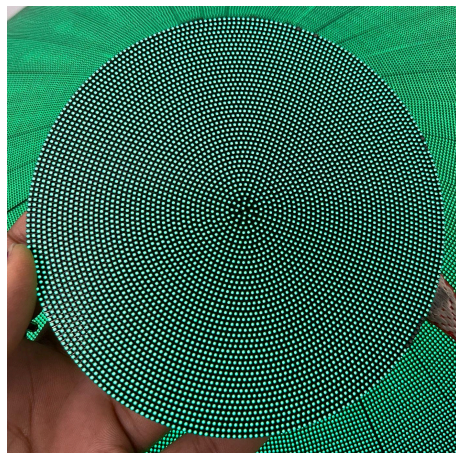
- Gloves to prevent damaging or marking the sphere
- Kapton tape
- Hot air station for desoldering with narrow attachment
- Needle nose pliers

1. Wait until the sphere has fully cooled.

Once a damaged pixel has been identified, turn the sphere off for at least one hour before attempting to repair anything. The panels should be cool to the touch before you attempt to remove them. Failure to wait until the sphere has fully cooled down can result in multiple pixels being damaged during the repair process.

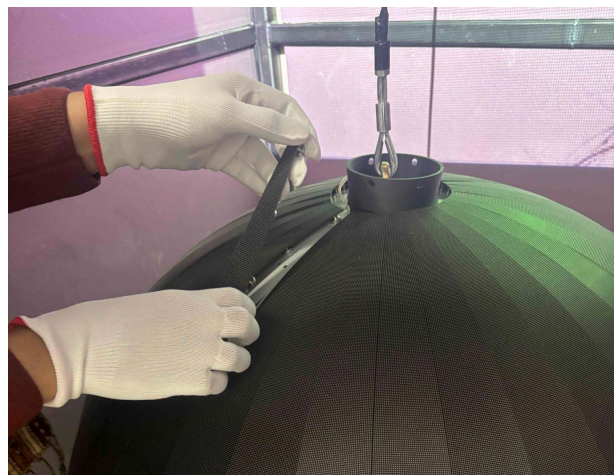
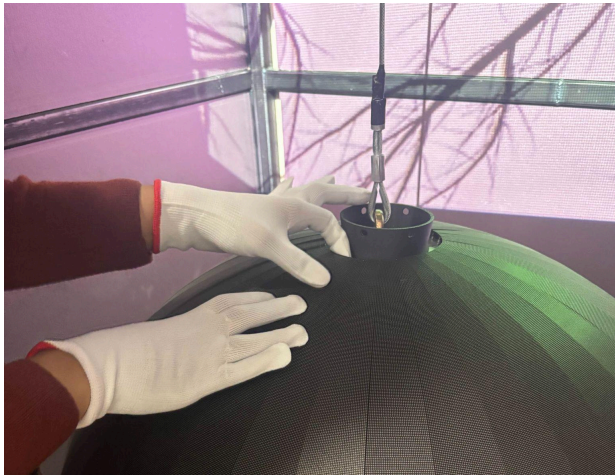
2. Remove the top circular panel.

Put on thin cotton gloves before beginning the panel removal process. The very top of the sphere will have a circular LED panel as seen in the image below. This panel must be removed first before removing any other panels in the sphere. Remove the panel by firmly getting under the edge and gently pulling upwards until the magnets holding it in place disengage. There will be two wired connections to the panel that you should gently disconnect. Place the removed panel on some sort of padding to avoid scratching and take care to not allow the wires connected to the sphere fall into the gap in its center as they're quite difficult to fish out again.



3. Remove the panel that has the damaged pixel.

In order to access the panel that has the damaged pixels you must begin from the top of the sphere and work your way down. For example if a center panel has a damaged pixel you should identify the panel immediately above it and remove that first in order to give yourself enough room to safely remove the center panel. The images below illustrate the process of removing a panel that was explained in the previous step. Again be sure to wear gloves and avoid having the cables of the removed panel fall back into the sphere. Place any removed panel on some sort of padding to avoid scratching.

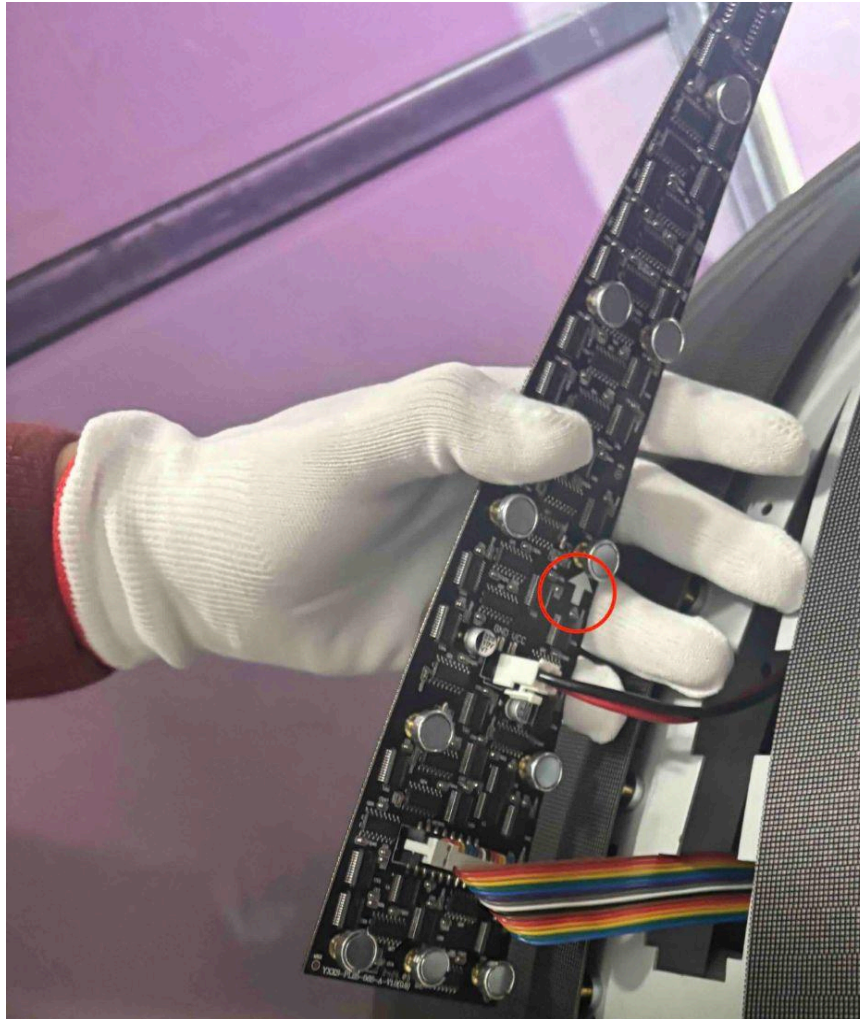


4. Reseating or replacing the damaged pixel.

Cover the leds surrounding the area with heat resistant tape like kapton. Set the hot air station to 300-350, use as narrow an attachment as possible and blow the hot air onto the led in small circular motions. Use needle nose pliers to reseat or remove and replace the damaged leds as necessary. Let the pixels fully cool back down for at least an hour before removing the tape and placing the panel back.

5. Placing the panel back.

Again while wearing gloves put the panel back in place, engaging the magnets slowly and carefully. Most panels will have an arrow pointing upwards as seen in the image below, be sure that this is the orientation that you place the panel back in.



Replacing an LED Panel

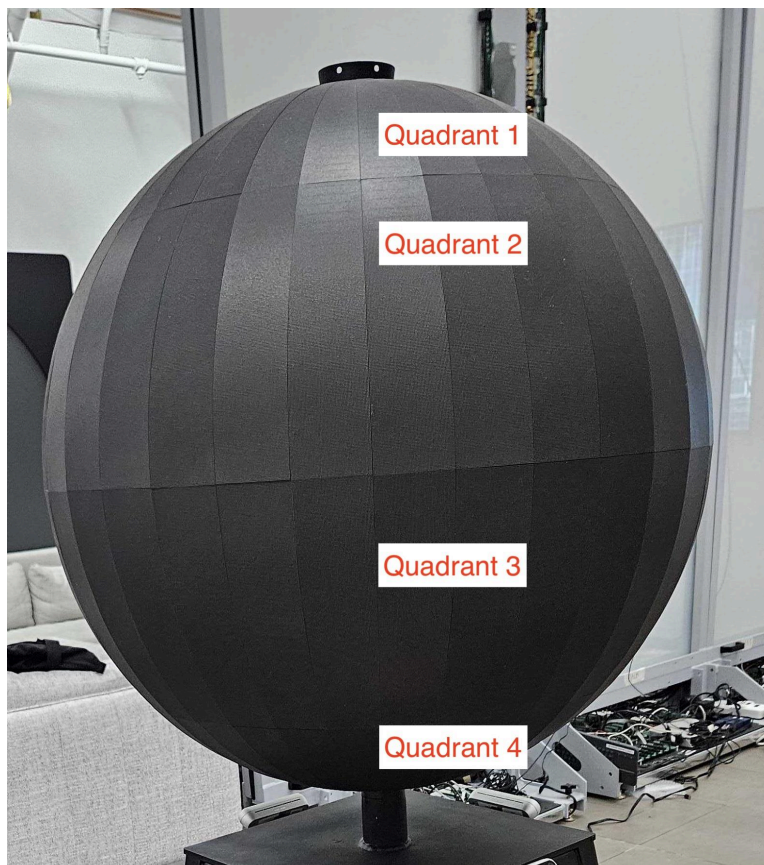
You may need to replace a panel if many pixels are damaged or you don't have a qualified technician who can perform the steps described in the [Repairing a single damaged pixel](#) section.

Gather the materials listed below.

- Gloves to prevent damaging or marking the sphere.
- Replacement panel, please refer to the packing list for stock availability.

1. Identifying the appropriate spare panel

The image below shows the terminology this appendix will use to refer to the four types of panels available. Each quadrant has its own panel with slightly different characteristics. It's important to replace one panel with another from its same quadrant.

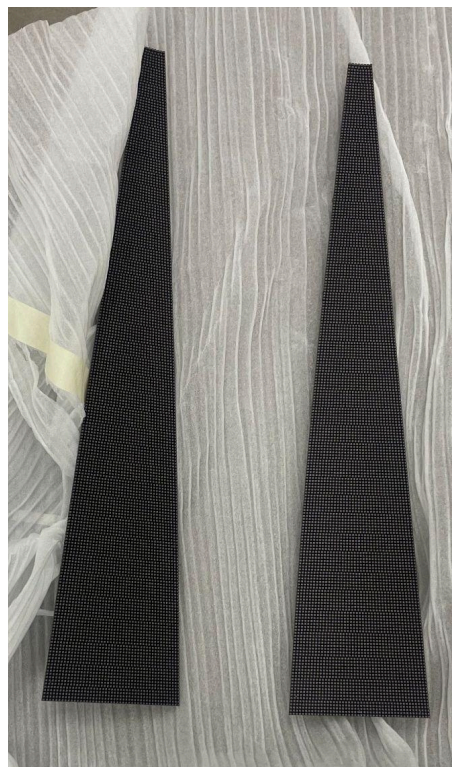


Panels belonging to quadrant one and four look very similar to each other when out of the sphere, as do panels belonging to quadrants two and three.

You can tell a panel is meant for quadrant one because it will have an arrow on its inside pointing upwards as seen in the section before: [Repairing a single damaged pixel](#). A panel for quadrant four will not have an arrow.

Panels in both quadrant two and quadrant three have internal arrows pointing up. You can tell if a panel is meant for quadrant two or three by holding the panel with the arrow pointing upwards. Take note of the size of the top of the panel compared to the bottom. If the top is smaller than the bottom it is from the second quadrant. When the top is bigger than the bottom it is from the third quadrant.

The images below show panels from quadrants two and four respectively.



2. Swap the panel

Once you have used the information above to identify a compatible spare follow the instructions 1-5, skipping step four in the [Repairing a single damaged pixel](#) section.

Aligning the top LED Panel

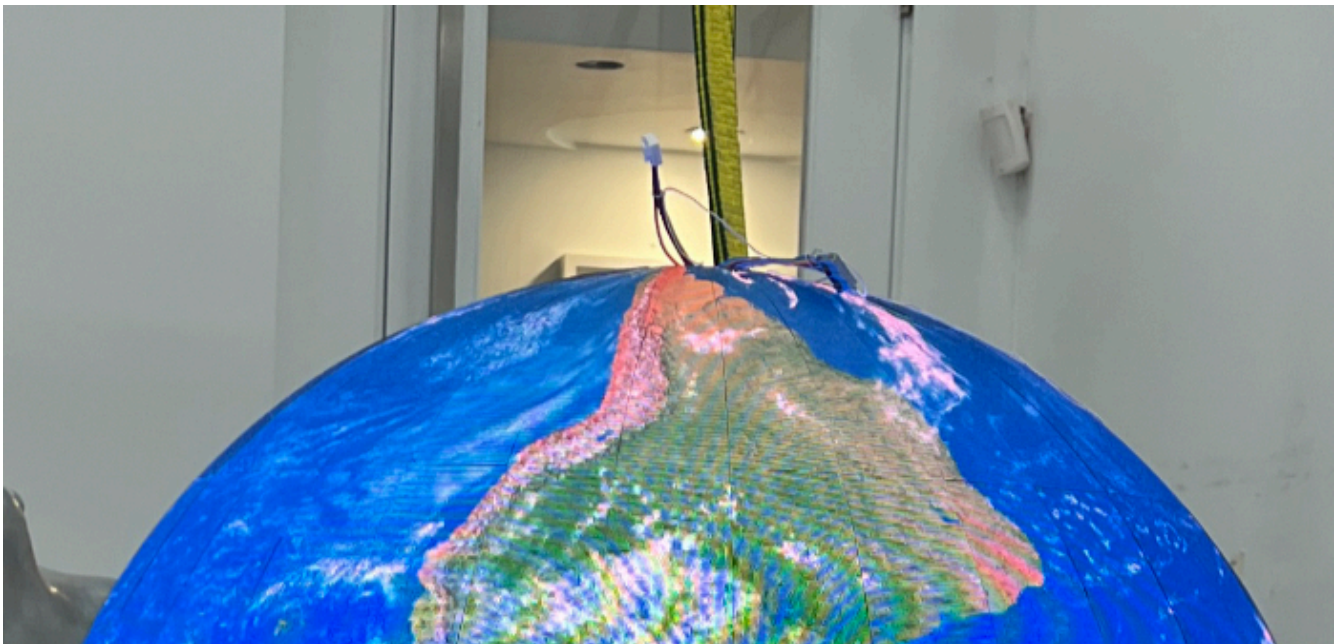
You may need to slightly realign the top LED panel if it moves significantly.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand.

1. Remove the panel

Follow the instructions 1-3 in the [Repairing a single damaged pixel section](#). The north side of the panel should be clearly labeled, align this carefully with the north side of the stand (where the fans sit) until the pixels align up well. Reseat as many times as necessary to achieve good alignment as seen in the image below.



Removing the side cladding

You may need to remove a panel to access the electrical components inside the stand when troubleshooting something.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand.
- Thin foam on which to place a panel once removed.

1. Identify the panel to remove

Each side is uniquely labeled as North, East, South, and West with labels internal to the panels. From the outside the fan side of the stand is considered North. If unsure of which side to remove, begin with the North side.

2. Remove the panel

To remove an individual panel, pull the panel outward from its clip. The clips are located in each corner of the panel.

3. Place the panel safely on protective foam

Consult the image below to see an example of a well placed panel.



When ready to put the panel back in place, consult the next section: [Re-Installing the side cladding](#).

Re-Installing the side cladding

After removing a panel you will need to re-install it.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand.

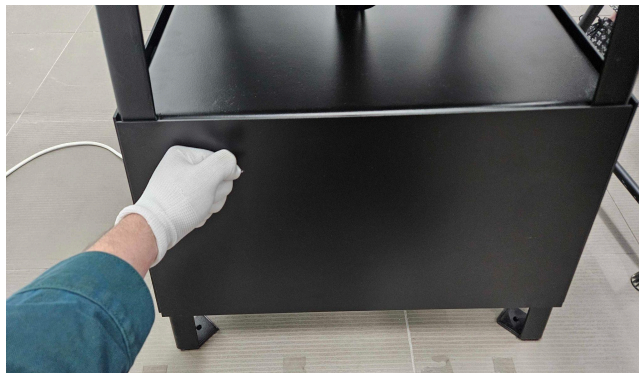
1. Properly align the panel

To reinstall, align it with the clips as seen in the image below. The clips are located on all four corners of the piece.



2. Properly align the panel

Push the panel back into place, ensuring even pressure is applied inward at all four clipping points to fully secure it. Consult the image below as an example. If the panel does not clip in, move it from left to right to ensure it is properly lined up. Press right over each clip to ensure they're in.



Aligning the Depth Sensors

Note: This adjustment requires recalibration in the software. The depth sensors should only be repositioned if approved by the artist.

You may need to align the depth sensors to work within a space on certain installations. If instructed to by the artist follow these instructions to properly align them. We shouldn't readjust the depth sensor unless the piece is exhibited in a narrower or wider space. It would leave more or less space above your head when you are close to the sphere. This is needed to filter the depth, physical adjustment needs to be reflected in software to make the 'depth filter' accurate.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand/ depth sensors.
- A 3/16" Allen key.
- A digital level, mobile app, or a protractor.
- An external display
- The wireless keyboard provided in the piece.
- Video cable to connect external display.

1. Removing the side cladding

Follow the previous section: Removing the side cladding instructions on how to safely remove the cladding and gain access to Computer A.

2. Attach an external display.

Set a small external display up so you adjust the software as needed.

3. Loosen the bracket

Now loosen the thumb screw accessible on either side of the depth sensor brackets. If the screw is tighter than hand-tight, use your Allen key.

4. Pivot the depth sensor

Pivot the depth sensors to the desired angle using a digital level, mobile app, or a protractor, ensuring alignment with the structure and the depth sensor face. See the image below for an example of using an app to properly measure the angle of the depth sensor.

If the artwork is exhibited in a space where the interactive area around the work is located in the 1 to 1.5m range (40 to 50"), the sensors should be set to a 32° angle. If the interactors are further away from the artwork, the sensors might need to be less angled compared to the ground.



5. Secure the depth sensor

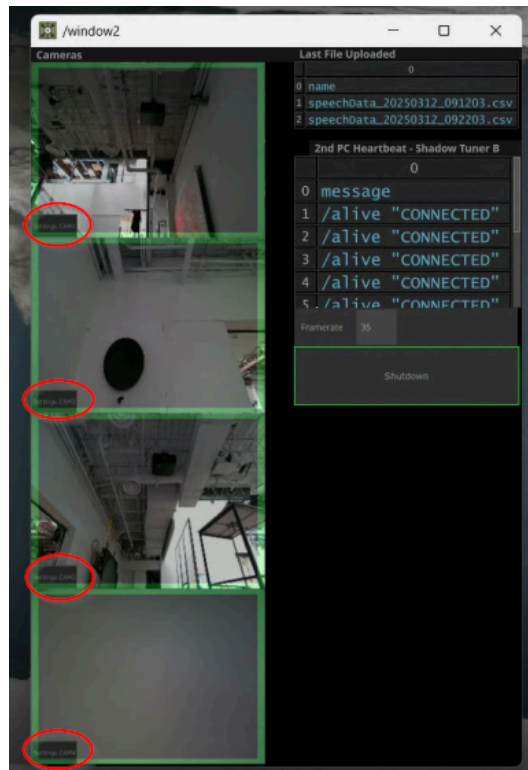
Once positioned correctly, securely tighten the thumb screws.

6. Access the software menu

In `Shadow_GraphicsTracking_multipleblobs` press the 'g' button to open the menu.

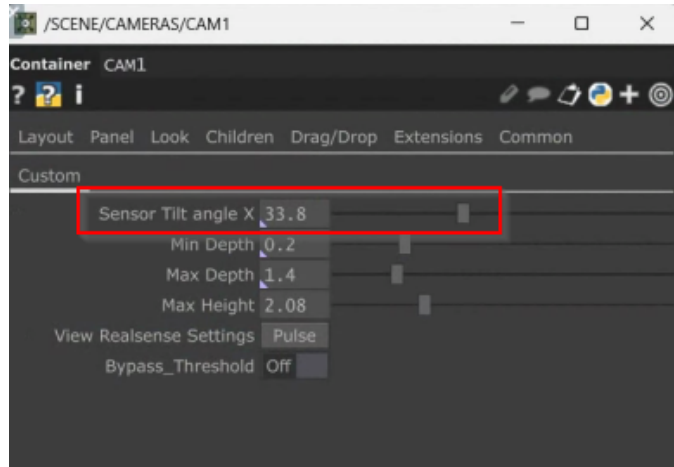
7. Access the depth sensor's menu

For each depth sensor being adjusted, click the bottom left corner button named 'Settings Cam', this will open a new menu. These buttons can be seen in the screenshot below.



8. Adjust appropriate variable

The first field of the menu is called 'Sensor Tilt Angle', change it to the actual angle in use. This variable can be seen in the screenshot below.



9. Save and Exit

Press 'S' to save the parameters. The depth sensor menu can be closed by pressing the X button at the top.

10. Re-Installing the side cladding

Follow the previous section: [Re-Installing the side cladding](#) instructions on how to safely replace the cladding. Be sure to remove the video cable and external monitor in use before doing so.

Replacing a Depth Sensor

You may need to replace a depth sensor if one fails. When replacing a depth sensor be sure to label it to match the depth sensor you are removing. Consult the [Depth Sensor](#) section.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand.
- New depth sensor of same make and model as old depth sensor.

1. Remove the faulty depth sensor

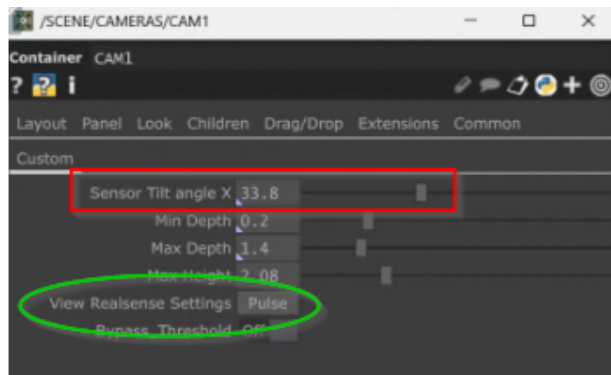
Unscrew the existing depth sensor from its supports and place it gently aside.

2. Replace the faulty depth sensor with a depth sensor of the same make and model

Screw it firmly into the same supports the old depth sensor used and plug in the old depth sensor's cable. Restart the piece and see if the depth sensor connects automatically on startup. Be careful to not change the angle of the depth sensor's bracket when doing this.

3. If the depth sensor is still not recognized, remove the cladding

Follow the previous section: [Aligning the Depth Sensor](#) steps **1-2**, and **6-10**. Instead of adjusting the depth sensor's tilt angle however, select the appropriate id from the drop down menu circled in green in the screenshot below.



Replacing a Speaker

You may need to replace a speaker if one fails. When replacing a speaker be sure to label it to match the speaker you are removing. Consult the [Speakers](#) section.

Gather the materials listed below.

- Gloves to prevent damaging or marking the stand.
- New speaker of the same make and model as the old one.

1. Remove the faulty speaker

Unscrew the existing speaker from its supports and place it gently aside.

2. Replace the faulty speaker with a speaker of the same make and model

Screw it firmly into the same supports the old speaker used and plug in the old speakers cable. You should not need to access the internal electronics or remove the cladding for this process.