PULSE VORONOI

BY RAFAEL LOZANO-HEMMER

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GENERAL IMPORTANT INFORMATION

This short section must be read for proper operation.

PULSE VORONOI (2024)

BY RAFAEL LOZANO-HEMMER

Technique

7000 different crystals designed with a 3D Voronoi diagram, LED filaments, computers, custom-made light controllers, ARTnet DMX interface, custom-made photoplethysmography sensors, 3D printed parts, CNC aluminium plates, software written in OpenFrameworks.

Description

One cubic metre of crystal explodes into 7,000 unique but complementary shards, expelled in all directions. "Pulse Voronoi" proposes a walk through the resulting cloud of crystals, shortly after the blast. The crystals are suspended in the room, each with a warm light that glimmers rhythmically to the recorded heartbeat of a different participant from the past. Five pulse sensors placed around the room detect visitors' heartbeats which can be heard in the room and seen in surrounding lights. Every new recording of vital signs deletes the oldest one, creating a memento mori.

Operation

Please refer to Appendix I - Installation for detailed system information and wiring diagram.

1. The computers are set to stay on all the time and do a reboot at 5 am to clear their memory.

2. It is also possible to manually turn the computer(s) **ON/OFF** via their power button: starting with the secondary computer(s), then the main one.

3. The building control system (connected to the main computer via an Arduino) can also be configured to decide the artworks state (ON, Night, Cleaning Mode, Emergency Mode)

General Artwork Behaviors

Each crystal glimmers to the pulse of a different participant, which contributes to a connective arrangement. The pulse patterns or ‘choreography’ of them across the lightcrystal installation can be finely adjusted in brightness, speed and sequence using the custom software on the computer.

About every 45 seconds a “Sweep” happens during which lights are illuminated brighter starting at the floor and sweeping their way toward the ceiling. This is accompanied by a sound.

Every few minutes a “Big Bang” happens which involves the following listed behaviors and is accompanied by a rumbling sound.

- First lights on all sides of the room start being brighter.
- Then they form a thin wall of lights which sweeps towards the middle of the room. Simultaneously the lights behind the physical wall will turn off.
- After this motion ends in the middle of the room the lights will form a cube that moves around a bit before dropping from the ceiling to the floor.
- As the cube hits the floor it “explodes” outward and progressively illuminates all lights.
- After that all lights fade back to normal glimmering

Interacting with the Artwork

A participant interacts with the installation by placing its hand under one of the provided sensors. The sensor's camera reads the heartbeats by analyzing the changing skin tone of the hand placed in view. Then, a local set of crystals are ‘taken over’ and will flash only this new heartbeat for a short time, then the software assigns the beat to one crystal while all others return to their previously displayed heartbeats.

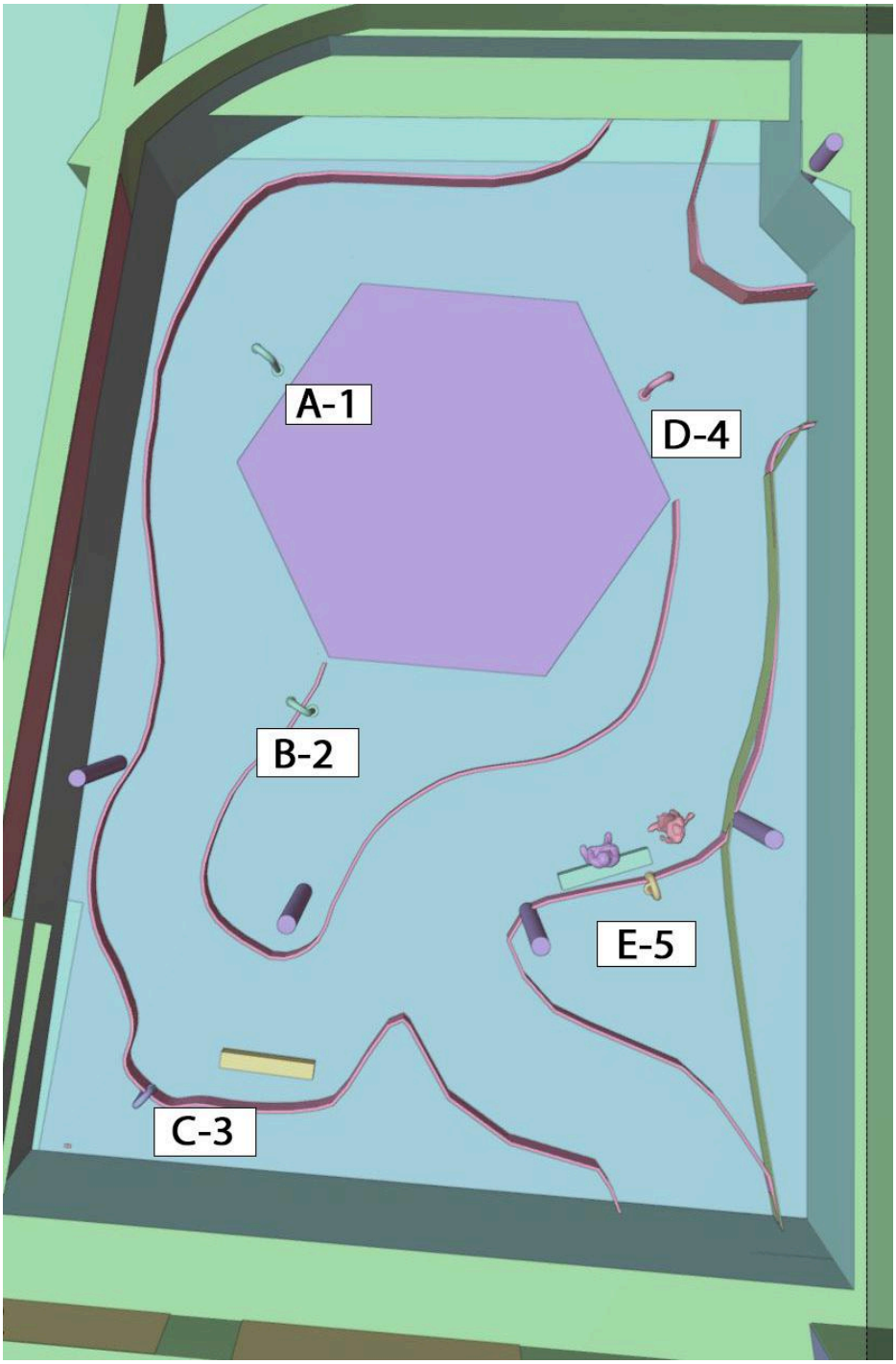
Maintenance

If it is necessary to clean the crystals use only the Swarovski approved cleaning liquid. The crystal can be placed directly in the cleaning liquid, be sure to avoid putting too much strain on the cable to prevent damage to the light element connection.

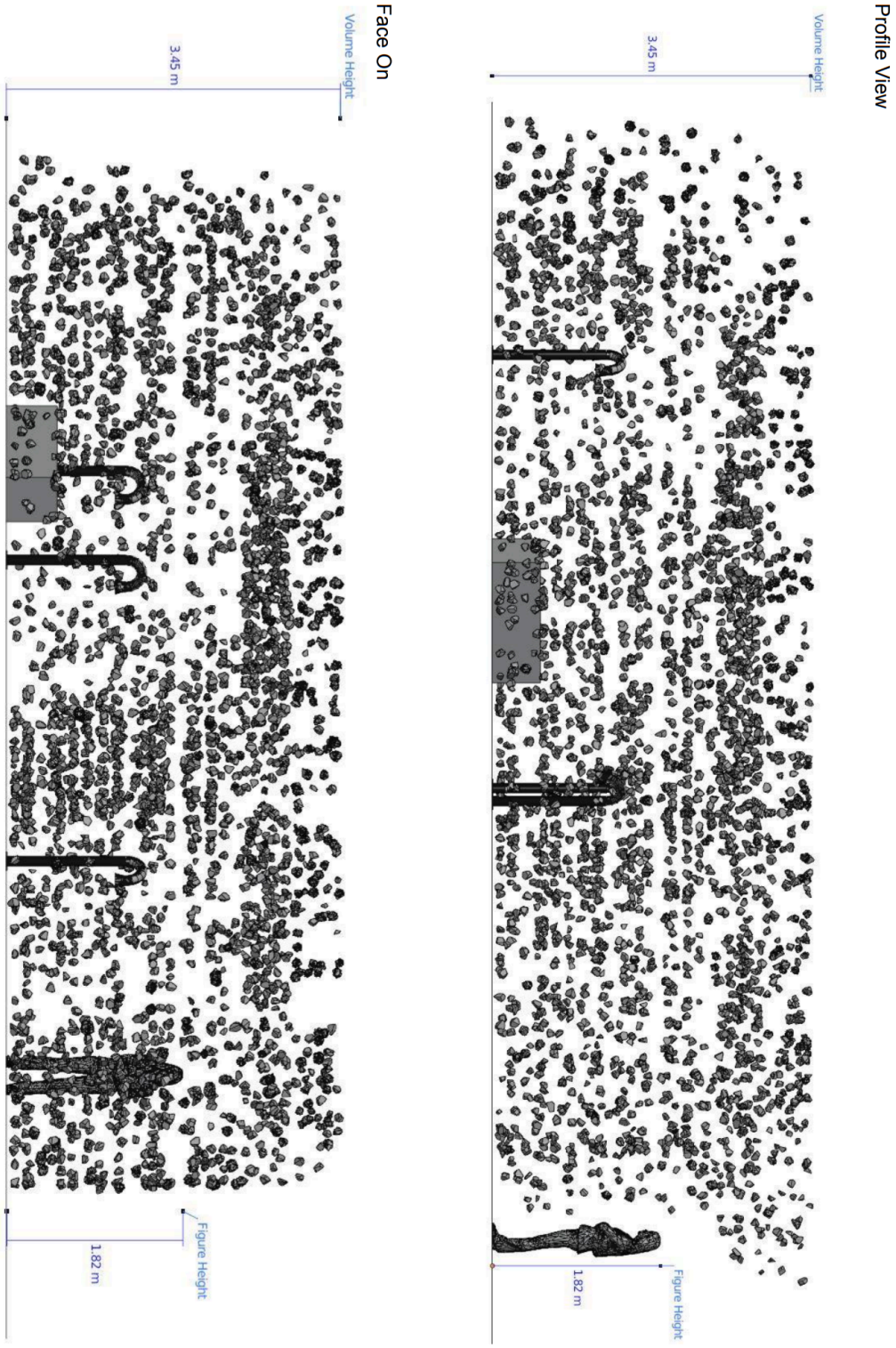
The sensor stand can be cleaned by dusting it off. Soap and water with a cotton cloth/microfiber cloth can be used to remove heavier stains.

Placement Instructions

The following diagram shows how the sensors have been arranged in the space relative to the control room. They should not be moved without first consulting the artist's studio.



The crystals in the space are suspended at different heights as seen in the rendering below.



DETAILED TECHNICAL INFORMATION

Normal Software Operation

On the ‘main’ computer two apps run continually. Both were compiled on open frameworks v 0.12.0.

- pulseTopology.app: Controls the functions of the piece and communicates with the supporting computers and the building control app.
- buildingControl.app: Receives OSC messages from the Swarovski building control and communicates them to the pulse topology app.

On the ‘supporting’ computers one app runs continually.

- rPPG: Controls the individual sensor associated with that computer and sends information to the main computer.

In addition you can access individual cameras from a local network in order to examine their functionality.

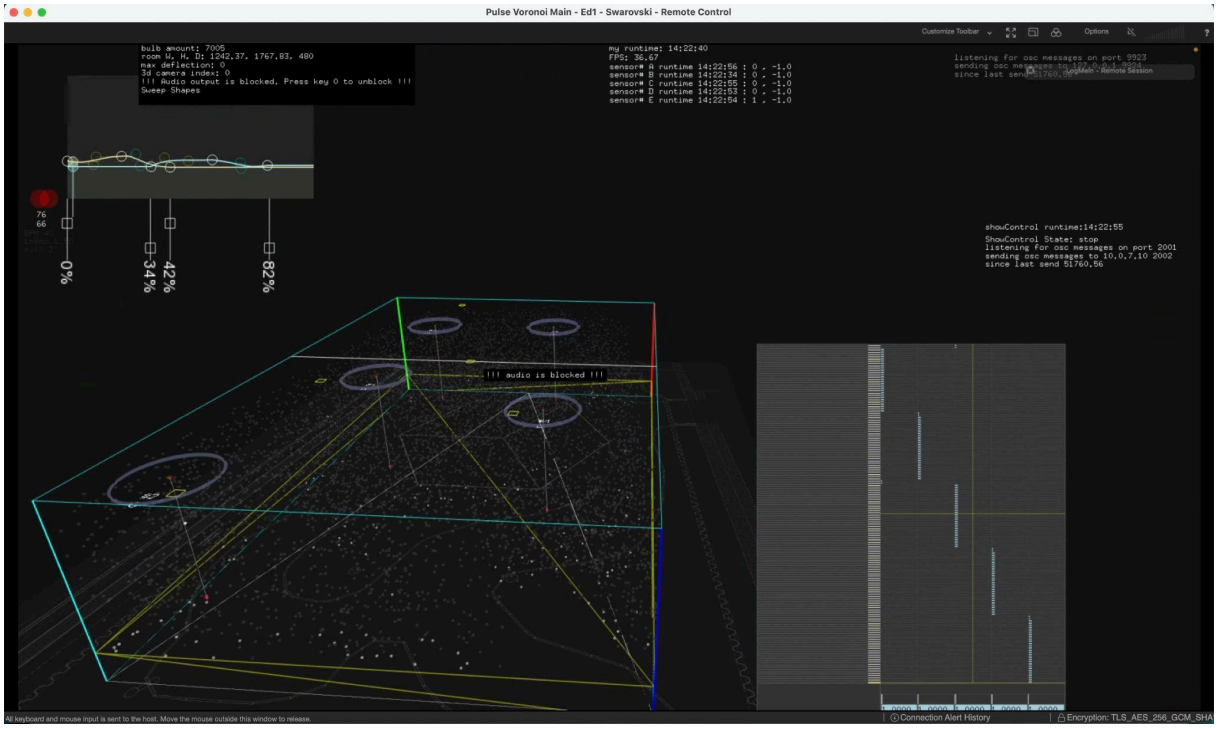
The following sections will go over the normal behavior of the two main apps, pulseTopology and rPPG. In Manual Software Calibration we will explore all of the processes mentioned here in more depth and show adjustable variables.

On all the supporting computers, the rPPG.app is scheduled to start after the computer's boot process. On the main computer, the PulseTopology.app is scheduled to start shortly after the rPPG.app. Once started, the app displays an array of white dots arranged in the same shape as the installed topology of crystals. Each dot represents one crystal.

When no person is participating all 7000 crystals pulse at the BPM of a past participant.

Each crystal has a unique x,y location and a z value defined by the predesigned topology, it is assigned to a row and column number, is assigned to a DMX universe and a specific DMX channel. When the app starts it loads data/layout/layout.csv and data/BPMs.csv file which sets up the above mentioned variables. When the app closes all BPM readings get written to BPMs.csv.

In the App you can see 1 or many circle patterns drawn inside the heart grid; each representing the location of one of the rPPG heart rate sensors. Consult the screenshot below for an image of the Pulse Topology app running well.



PulseTopology.app software

The pulsing of each light follows a predefined set of bezier curves. These curves get generated every time a new heart rate is detected and gets assigned to a light. The brightness change follows the values of those bezier curves. Depending on the BPM the curve values change fast or slow.

When a person places their hand under one of the sensors (10 cm away for best detection) a hand touch signal is sent from the rPPG.app to the PulseTopology.app. As soon as this happens the physical sensor sculpture switches from LED spot light to LED ring; warm to cold light.

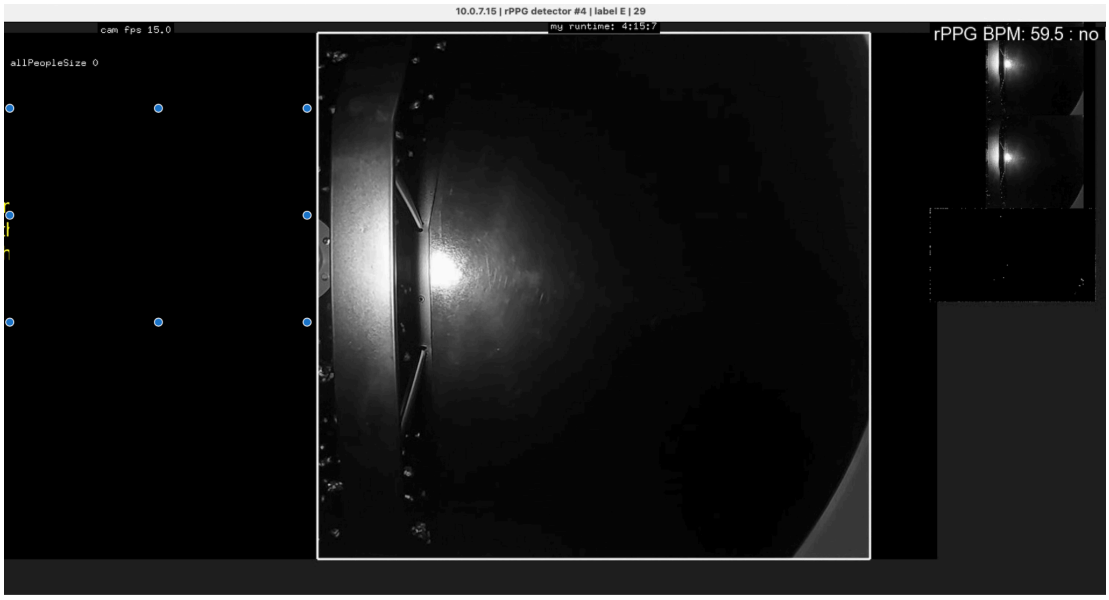
This is the start of the "population" stage.

Shortly after a small group of crystals near the sensor stop pulsing and turn to a fixed/solid brightness. It takes about 10-15 seconds until a proper BPM is measured by the rPPG.app via the sensor's built-in USB camera. Once a good BPM is acquired it is sent from rPPG.app to PulseTopoloy.app. At that moment the group of solid crystals start pulsing to the new BPM reading. This group of crystals will also stop playing their previous heart beat sound and instead the sound of the new BPM reading will become a bit louder. After a pre-defined duration more and more crystals will start pulsing in unison. The amount of crystals increases exponentially over time. Once a maximum size is reached all those crystals (which might just be a subset of the 7000+ crystals) pulse together until a hand is no longer detected by the sensor then the crystal amount decreases again. The decreasing animation does not have the sensor at its centre but a newly picked crystal. The crystal at the centre of this decreased animation will be the host for the new heart beat. The crystal containing the new heart beat will also be a bit brighter than all others.

This is the end of the "population" stage.

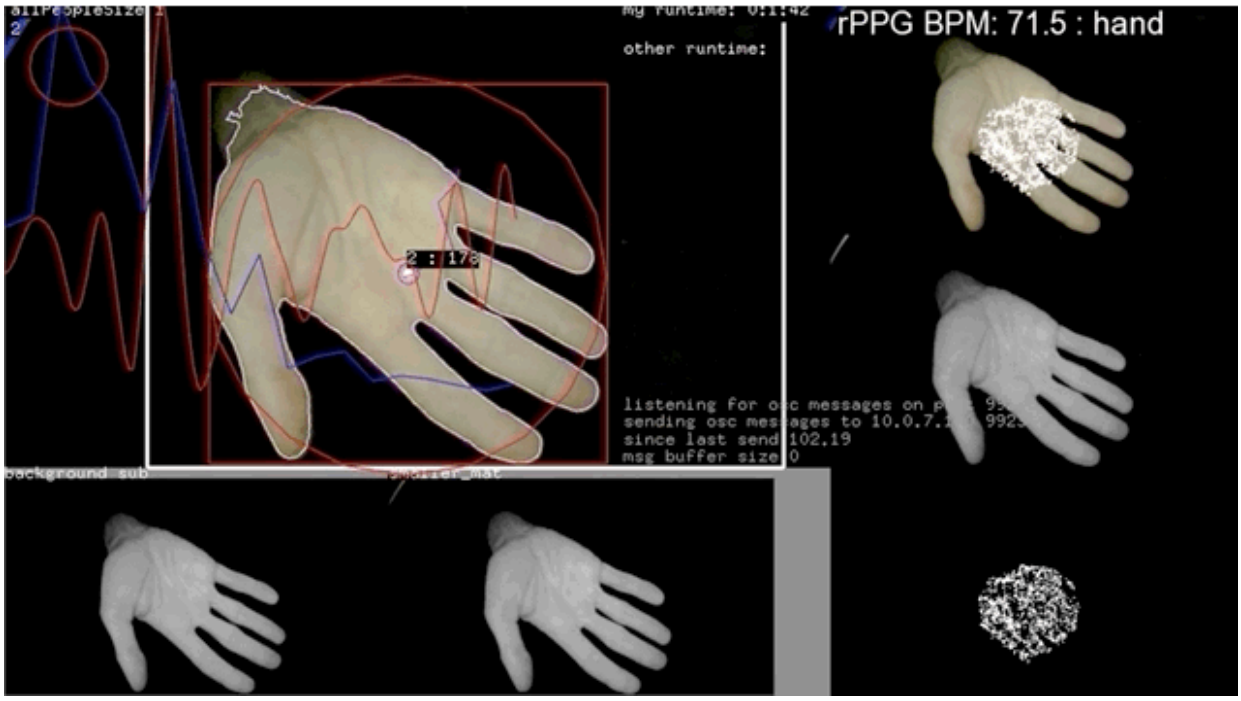
It is possible for multiple participants to activate their own heart rate sensor. As a result multiple population moments can overlap and create a more nervous behaviour.

The reaction to an hand presented to the sensor is displayed in the rPPG.app to within 3 phases - noticeable via the label at top right of display and the exposed graph while reading: at first the software detects no hand, then detects a hand and after few seconds, finally displays the detected live heartbeat live.



rPPG.app - State of the app when no hand is under it.

rPPG.app - State of the app when a new hand is placed under it.

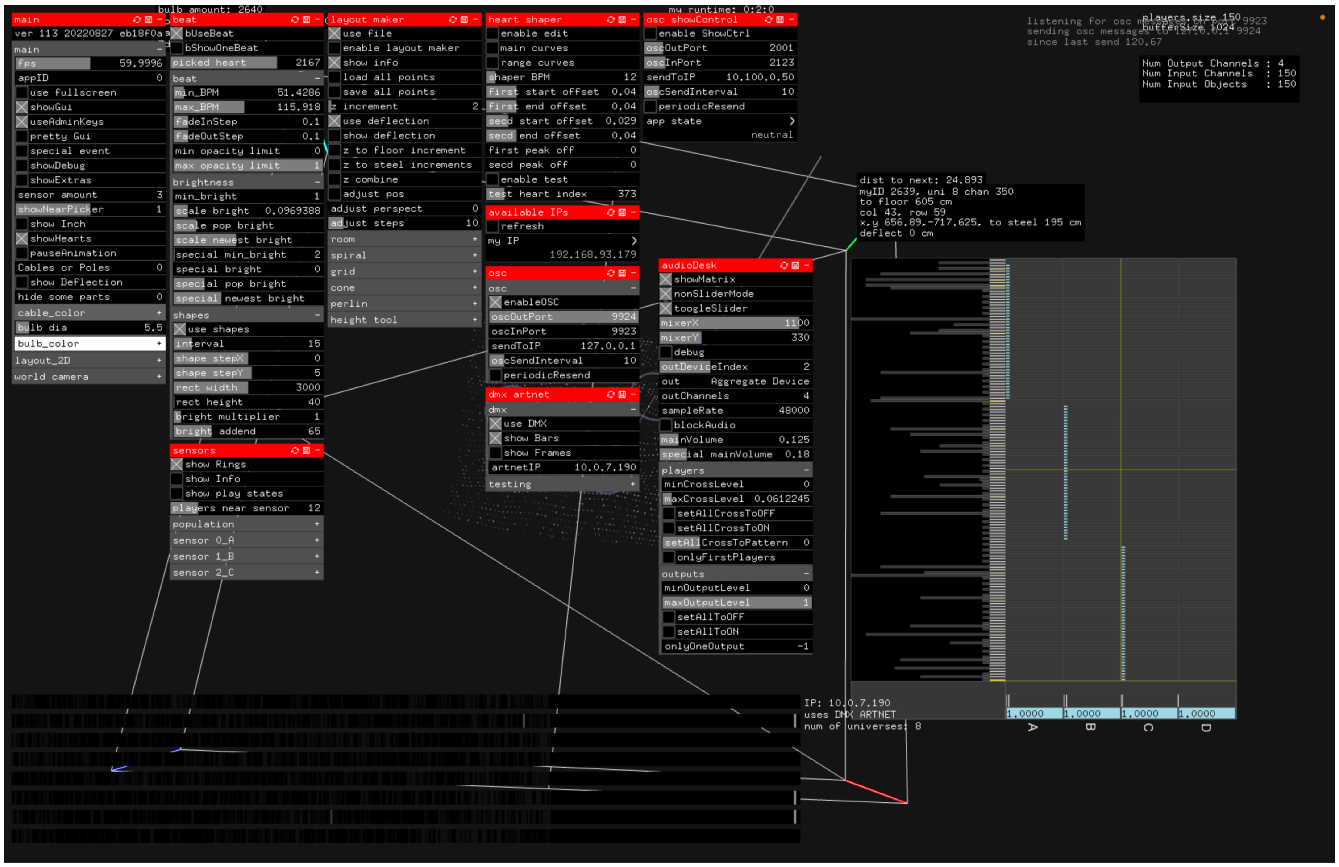


rPPG.app - State of the app when the hand's heartbeat is detected

Manual Software Calibration

pulseTopology.app

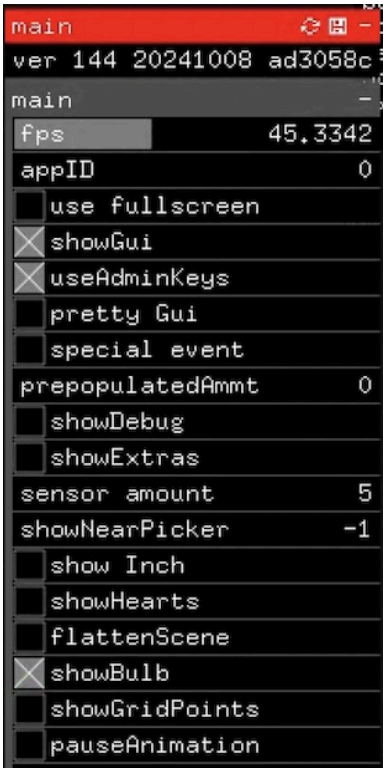
The pulseToplogy.app has a GUI function that can be accessed by pressing in the **g** key on the keyboard. **Be very careful when opening this option,** it controls everything and if the GUI is shut it will save the changes made to it. All GUI files can be found at: pulseTopology/pulseTopology/bin/data/GUIs/



PulseTopology.app with the gui visible.

The GUI is divided into subsections: a subsection name is labelled into a red or dark grey title bar and associated settings are listed under that title bar. Below, you will get information about different settings within each subsection. Only variables that you are likely to need to check or adjust will be explained. If for whatever reason the GUI values are accidentally changed, refer to a copy of the original code and these screenshots to help reset the variables.

Main



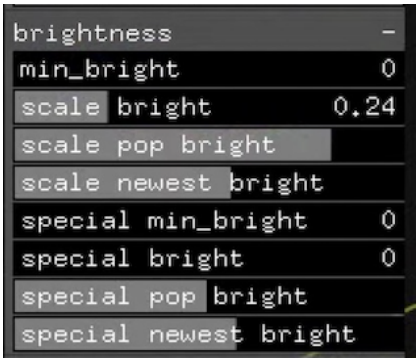
Setting	Description
appID	Set to 0. This denotes computer A. The pulseTopology.app only runs on computer A. Each rPPG and main app have their own appID.
FPS	Should be 60. Will be lower if someone is remotely connected but it should not be so severe that you see a visible change in the artwork.
special event	Should only be used when trained by Antimodular staff on how to run the piece for a special event. Can also be triggered by pressing the “s” key.
ShowNearPicker	Defines how much information about each crystal is displayed near the mouse cursor.
Sensor Amount	Set the number of sensors you are using, if there are 3 sensors then set the number to 3.
pauseAnimation	Pauses the heartbeats. Use this feature only for professional photographs of the artwork.

Beat

Variable	Description
bUseBeat	Should be selected.
min_BPM	Minimum BPM that will be saved into the artwork.
max_BPM	Maximum BPM that will be saved into the artwork.

Beat/Brightness

Setting the crystal brightness and visibility of heartbeats. Keep in mind when setting these that we never want the crystals to be fully off or too bright that they hurt to look at.

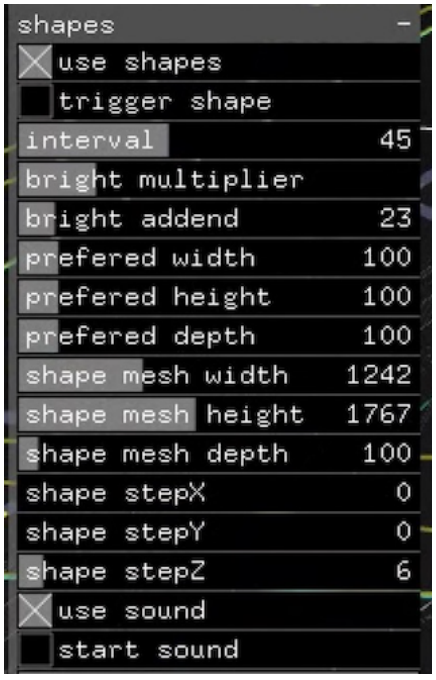


Variable	Description
bUseBeat	Should be selected.
min_bright	Minimum crystal brightness should never be 0.

Variable	Description
scale_bright	How bright a crystal can go. Should never be too bright to look directly at. Setting this to 0 would mean that the crystals never get a pulse or brightness value.
Scale pop bright	How bright the active crystals get when someone is using the sensor.
Scale newest bright	How bright the crystal that stores the last detected heartbeat is: should be different from the other crystals.
Special min_bright	Min brightness for special event mode.
Special bright	Max brightness for special event mode.
Special pop bright	How bright the crystals are when someone is using the sensor in special event mode.
Special newest bright	How bright the last saved heartbeat is for special event mode.

Beat/Shapes

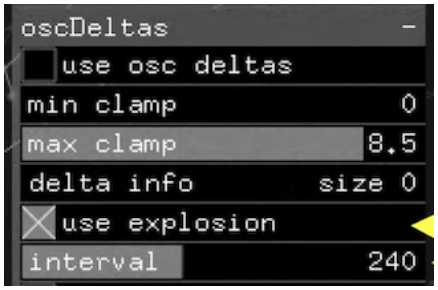
There should be an occasional sweep that goes through the artwork, the direction, size, and speed is determined by the artist. This is unique to each space.



Variable	Description
Use shapes	Should be selected. This enables the ‘sweep’ behavior every **x** seconds as set by the **interval** variable.
Interval	How often the sweep happens in seconds.
Shape stepX	Sets the x axis size; i.e. defines sweep direction.
Shape stepY	Sets the y axis sizei.e. defines sweep height.
Shape Mesh Width	Sets the width of crystals covered by sweep.
Shape Mesh Height	Sets the height of crystals covered by sweep.
Bright Multiplier	Increases the brightness of sweep.
Bright addend	Increases the brightness added to sweep.
Use Sound	Should be selected.

oscDeltas

This sets some of variables related to the big bang cube animation



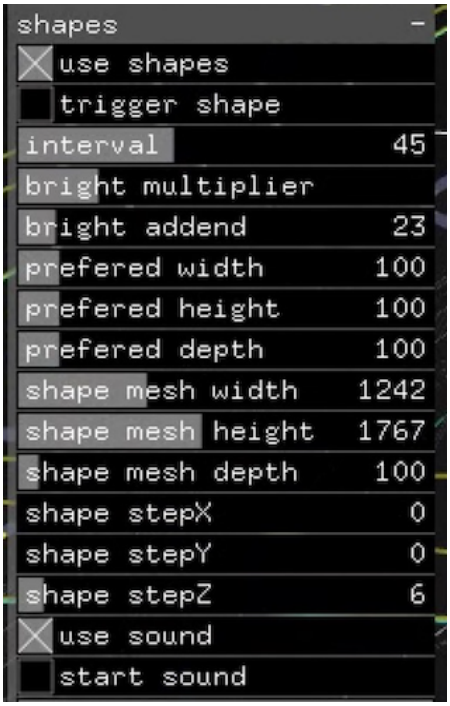
Variable	Description
Use explosion	Should be selected. This enables the ‘sweep’ behavior every **x** seconds as set by the **interval** variable.
interval	How often the explosion happens in seconds.

Sensors

For testing purposes buttons 1-6 on the keyboard can be pressed to simulate a sensor detection.

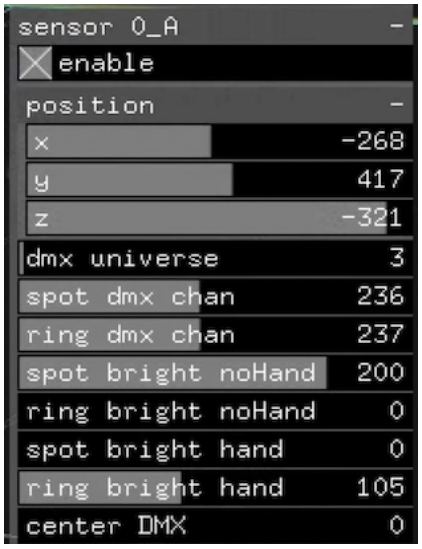
- 1 & 2 control sensor A
- 3 & 4 control sensor B.
- 5 & 6 control sensor C.
- 7 & 8 control sensor D.
- 9 & 0 control sensor E

Press 1, 3, or 5 once to select the corresponding sensor. This simulates a person placing their hand under the sensor. Then press a second time to activate it. This simulates the person's hand having been detected long enough to measure their heart rate Press 2, 4, or 6 once to deactivate the corresponding sensor. This simulates a person removing their hand.



Variable	Description
Show rings	Should be selected.
Show Info	Select when programming sensors to see more information.
Show Play States	Select to see when sensors are being activated. Helpful for determining population region and that sensors are labelled correctly.

Individual Sensor Menus

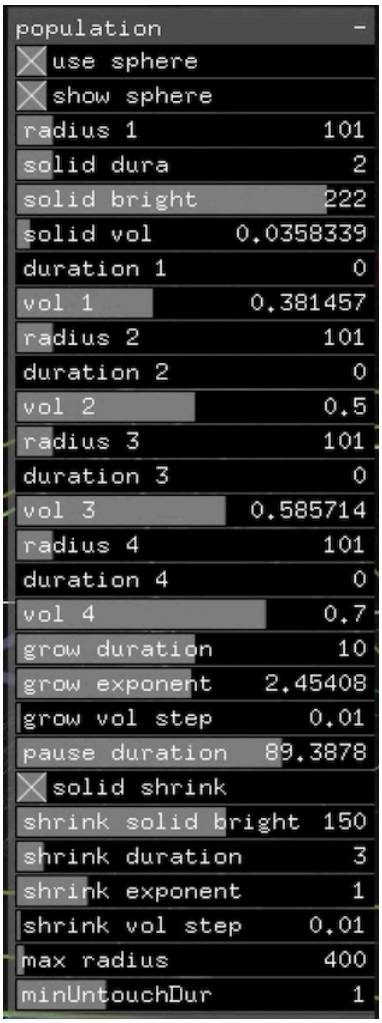


Variable	Description
Enable	Should be selected.
X	Sensor's X position in space.
Y	Sensor's Y position in space.
Z	Sensor's Z position in space.
dmx universe	Set this to the universe this sensor's LED ring and spotlight are plugged into.
Spot dmx chan	Set this to the dmx channel the spotlight has been plugged into (typically 509 or 510).
Ring dmx chan	Set this to the dmx channel the LED ring has been plugged into (typically 509 or 510).
Spot bright noHand	Turns the spotlight on when the RPPG.app does not detect a hand. It needs to be bright enough that it is visible when you walk into the space, so that people know where the interaction zones are but not so bright that it distracts from the artwork.
Ring bright noHand	Turns the ring light on when the RPPG.app does not detect a hand. should always be set to zero.

Variable	Description
Spot bright hand	Turns the spotlight on when the RPPG.app detects a hand. should always be set to zero.
Right bright hand	Turns the ring light on when the RPPG.app detects a hand. Needs to be bright enough that the sensor gets reliable readings every time a hand is seen by the RPPG.app. This value should be adjusted and tested thoroughly during the programming stage of installation.

Sensor / Population

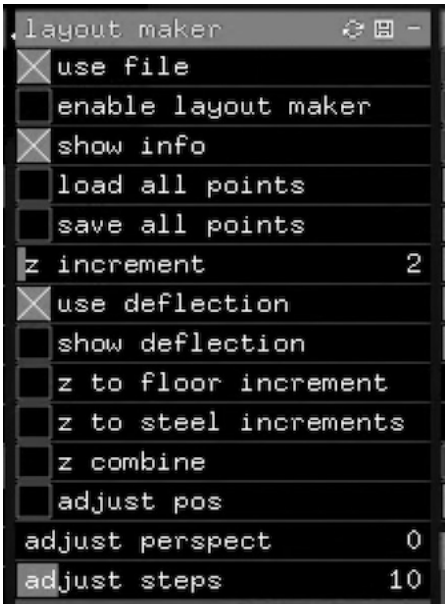
It is possible to define the first few sensor radii increases manually by setting duration1, radius 1, duration2, radius 2, etc to values larger than 0. After those radii get executed the exponential growing starts.



Variable	Description
Max radius	Adjusts the size of the sensor radius: the area that gets populated with your heartbeat when you're using the sensor.

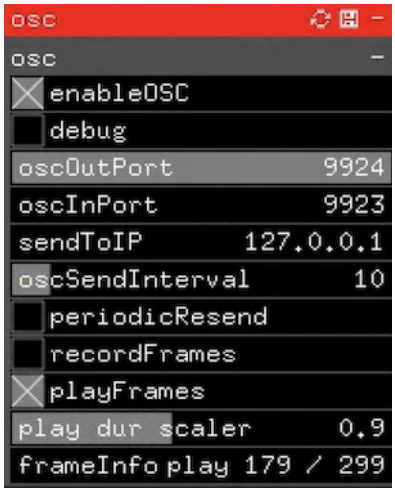
Layout Maker

Enable layout maker should ONLY be used by Antimodular to make topology design changes. This allows the software to read the layout.csv file which determines the crystal locations and dmx addresses. If you ever need to make changes to the layout.csv make a copy of the original file then change the new updated file to the name “layout.csv and put it in the correct location (mentioned above). Restart the pulseTopology app and your new csv will be loaded in.



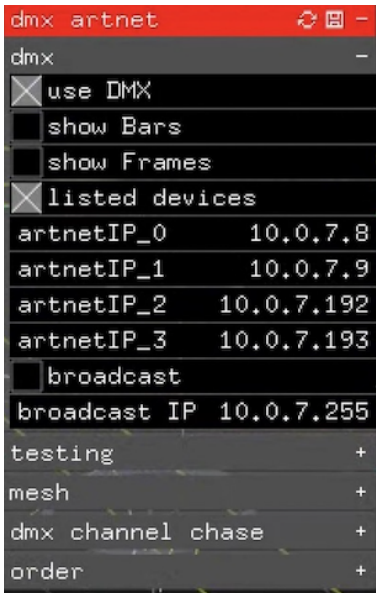
Variable	Description
Use file	Should always be selected

OSC



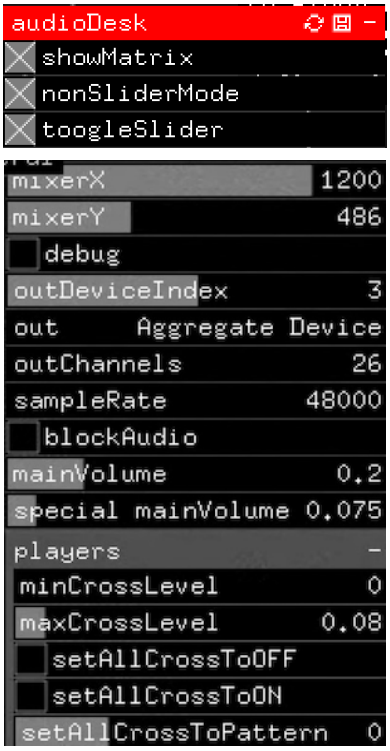
Variable	Description
enableOSC	Should be selected since the rPPG apps send data over OSC.
oscOutPort	pulseTopology.app should be set to 9924 to communicate with the different instances of RPPG.app.
oscInPort	pulseTopology.app should be set to 9923 to communicate with the different instances of RPPG.app.

DMX Artnet



Variable	Description
Use DMX	Should be selected.
artnetIP	Set to IP address of DMX device being used

Audio Desk

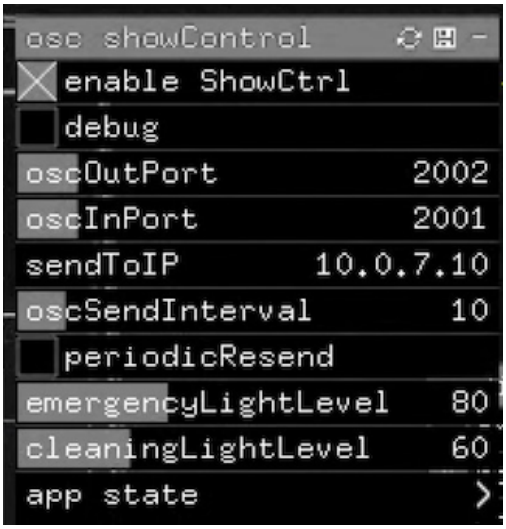


Variable	Description
Show Matri	Should be selected.
Out	Aggregate device should be selected. **Note:** The app will not open if it does not detect an Aggregate Device
outChannels	Set to 4.
SampleRate	Should be set to 48000.
mainVolume	Controls general volume of the artwork.

Variable	Description
Special mainVolume	Controls general volume of the artwork in Special mode.
minCrossLevel	Adjust this slider to increase the volume of the single heartbeat when someone is using a sensor.

Osc showControl

These variables control the app's ability to respond to the building control signals. Other than toggling the enable button on or off none of these values should ever be changed.

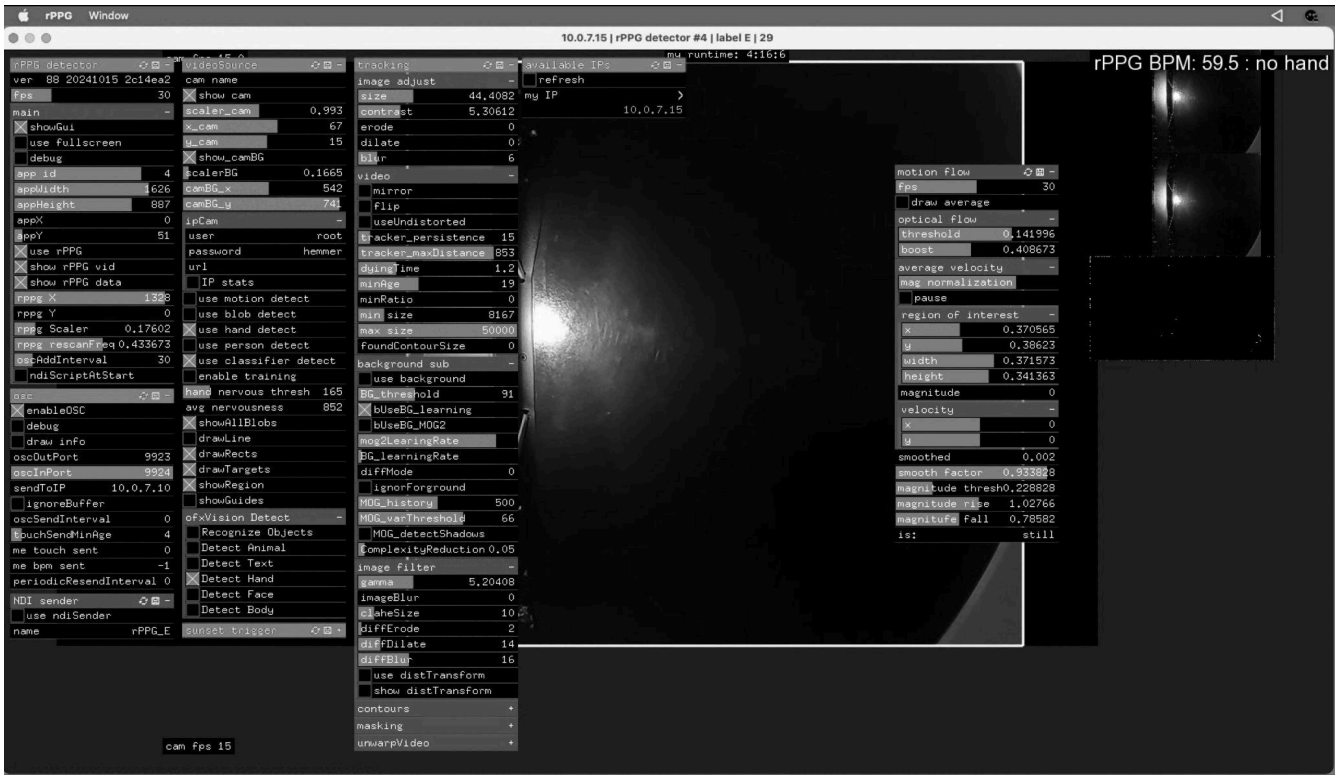


Variable	Description
Enable ShowCtrl	Enables the building control via OSC messages to control the pulse topology app stage.

rPPG.app

The rPPG.app uses coreML's vision framework and a YOLO based object detector to find a person's hand. It then selects a part of the hand and tracks this section. A keypoint racker is implemented. It then analyzes the color change over time to extract the heart rate values.

There aren't too many parameters that should need to be adjusted on site. Below are the main parameters to verify.



rPPG with the gui visible.

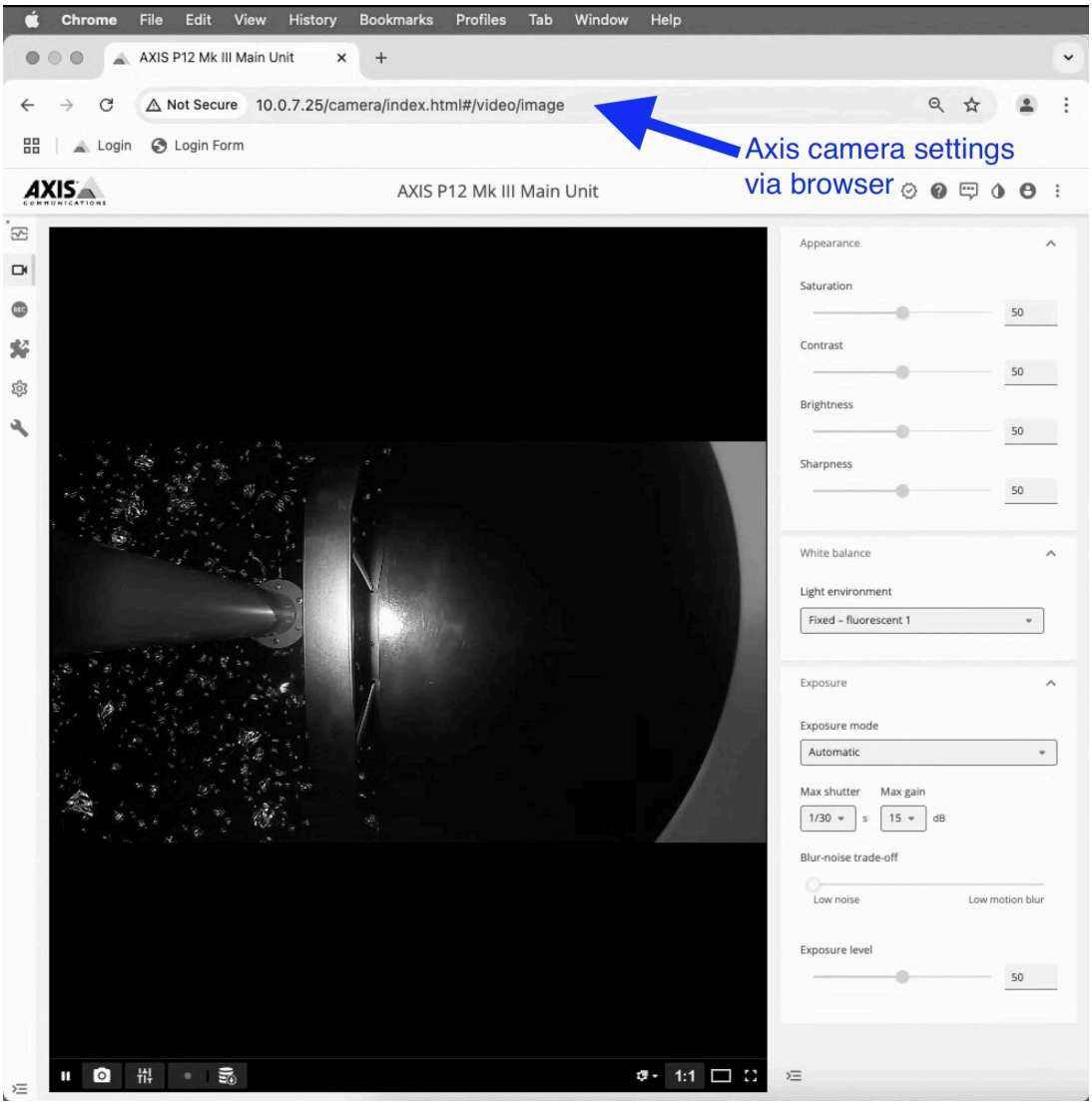
Setting	Description
rPPG detector / app id	each rppg.app needs its own app ID so the pulsetopology.app can differentiate them with their respective sensors. 0 = A, 1 = B, 2 = C
rPPG detector / use rPPG	*should always be selected*
rPPG detector / show rPPG	*should always be selected*
enable OSC	*should always be selected*
osc / oscOutPort	set to 9923

Setting	Description
osc / oscInPort	set to 9924
osc / sendToIP	set to IP address of pulseTopology.app (mac mini A)
UVC / exposureValue	sets the exposure of the camera. If this is not set correctly the sensor will not be able to detect heartbeats properly. The exposure value should be close to 1 so that the camera is very dark and you can only see the spotlight, as shown in the image below
User	Shows the axis camera login username
password	Shows the axis camera login password
url	When hovered over shows the ip and local camera url associated with this sensor.
Use classifier detect	Keep checked, allows the use of skeleton hand detection
Use classifier detect	Keep checked, also uses a hand object classifier trained on locally recorded images.
Enable training	If checked, enables the collection of hand images to train the classifier.

Networking

All computers are connected to each other via a wired LAN (local area network) connection. Typically, their IPs are set to manual IP, with an IPv4 address under the 10.0.7.x pattern, and the network mask being 255.255.255.0.

The Ethernet to DMX controllers are also connected to the same network. No other device should have any of these IP addresses. Each individual camera can be accessed on a web browser connected to the same network by visiting the url: IP_ADDRESS/camera/index.html#/video/image as seen in the screenshot below. Check the table on the next page for a complete list of all networked items and their assigned IP addresses.

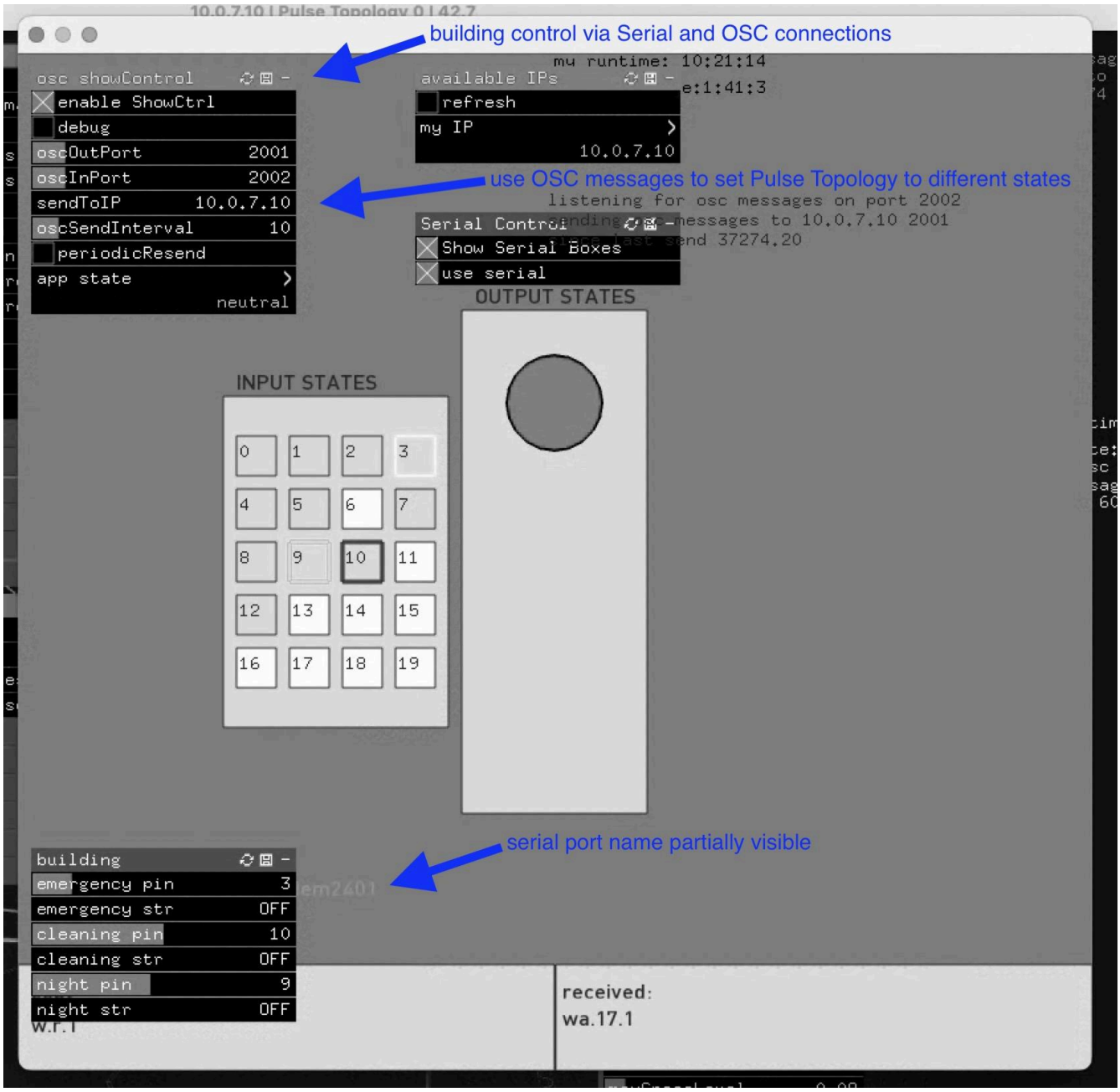


Axis camera view.

Component	IP Address	User Name	Pasword
DMX Interface 1	10.0.7.8	--	–
DMX Interface 1	10.0.7.9	–	–
Mac Mini - Main	10.0.7.10	admin	hemmer
Mac Mini - A	10.0.7.11	root	hemmer
Mac Mini - B	10.0.7.12	root	hemmer
Mac Mini - C	10.0.7.13	root	hemmer
Mac Mini - D	10.0.7.14	root	hemmer
Mac Mini - E	10.0.7.15	root	hemmer
Mac Mini - Spare	10.0.7.16	root	hemmer
Axis POE Switch	10.0.7.20	root	hemmer
Sensor A	10.0.7.21	root	hemmer
Sensor B	10.0.7.22	root	hemmer
Sensor C	10.0.7.23	root	hemmer
Sensor D	10.0.7.24	root	hemmer
Sensor E	10.0.7.25	root	hemmer

Building Control

The app that allows the main pulse topology app to respond to OSC commands received from Swarovski's building control. Do not change any of the values seen in the screenshot below. This screenshot shows the app running successfully.



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

Are all of the lights not reliably blinking to different heartbeats?

Restart the PULSE VORONOI - MAIN mac mini in the control rack using the provided keyboard. After a few minutes the app will start back up automatically and all the lights should reliably blink to different heartbeats.

Do you not see a vertical sweep going through the crystals approximately every 45 seconds?

Restart the PULSE VORONOI - MAIN mac mini in the control rack using the provided keyboard. After a few minutes the app will start back up automatically and you should see the vertical sweep. This could take up to 45 seconds to appear.

Do you not see a cube appear in the centre of the room and explode outward every 3-4 minutes?

Restart the PULSE VORONOI - MAIN mac mini in the control rack using the provided keyboard. After a few minutes the app will start back up automatically and you should see the cube. This could take up to four minutes to appear.

Is a sensor not showing the yellow spotlight when no hand is present and changing to the cool ring light when a hand is put underneath?

NOTE: During the cube explosion the sensors will NOT be responsive. If outside of this time the sensor is still not working properly.

Restart the Mac Mini associated with the sensor that is not reacting using the provided keyboard (bluetooth dongle must be switched to the USB port of the computer you need to control) , the rPPG app will start up automatically after a few minutes. Check if the problem is fixed. If not check that you can see a live camera feed through the rPPG app when someone puts their hand under the sensor. If not, verify that the camera connection is secure in the control rack.

When using the sensor do you not hear the subwoofer nearest to that sensor become louder?

Ensure the subwoofer is turned on and connected to the audio device in the control rack.

An LED is off

If an LED is off, set up the ladder in parallel to the affected LED and bring with you a spare LED and cable you know is functioning. Unplug the affected LED and replace it with the spare, if the spare turns on, then the affected LED is broken and must be replaced with the correct length of cable into the crystal in the same orientation it was placed in before.

Pulse Voronoi Master Database - refer to column “Length to Panel” and “Crystal Cable To Be Used”

First start by using a multimeter to check for the presence of an electrical short in the port.

If the spare LED did not turn on in this process, note the ID and panel of the affected LED. As an example, let’s say the ID is 1.

Go to the control box that ID 1 is plugged into and locate it. Unplug this cable, and the cable beside it, lets call it ID 2. Swap the ports that ID 1 & ID 2 are plugged into. If ID 1 now turns on, and ID 2 is now off, you know the port is dead.

If the port is dead then you must move the affected LED to the new port, find the nearest open port, located at the bottom of the rack, and place the cable in an open port. (Note: To do this you often must feed cables back through zip ties, this is a delicate process) Take a photo and a note of the port you changed it to and contact Antimodular Studios. Also write it in the NOTES section of the Pulse Voronoi Master Database so we have a record of all changes.

If the affected LED is still off, then the lead cable is broken.

The following steps are an advanced process and should only be done by someone with knowledge of electrical systems and as a last resort.

To change a lead cable you MUST unplug the lead from any controller and flag it. Once unplugged you must fish out the lead’s cable head of the affected LED. Take a new, spare barrel headed lead from the spares and cut it at 10cm from the barrel head, as well cut the head of the affected lead cable you fished out. Then using a wire stripper expose the red and the black wire’s copper and use a Wago connection to attach the spare lead head to the lead cable in the panel area.

This spliced cable should now function as intended and be ziptied for strain relief and placed back into the panelling.

A LED is too bright

Please note that the behaviour of Pulse Voronoi is that one LED per sensor saves the last heartbeat at a brighter level. Before pursuing the following steps, use all sensors to verify that the brighter LED is not an intentional feature of the artwork.

If an LED is too bright, set up the ladder in parallel to the affected LED and bring with you a spare LED and cable you know is functioning. Unplug the affected LED and replace it with the spare, if the spare turns on at a normal brightness, then the affected LED is broken and must be replaced with the correct length of cable into the crystal in the same orientation it was placed in before.

Correct lengths per ID can be found here, in the Pulse Voronoi Master Database.

If the spare LED also turned on too brightly in this process, note the ID and panel of the affected LED. As an example, let's say the ID is 1.

Go to the control box that ID 1 is plugged into and locate it. Unplug this cable, and the cable beside it, lets call it ID 2. Swap the ports that ID 1 & ID 2 are plugged into. If ID 1 now turns on at a normal value, and ID 2 is now very bright, you know the port is malfunctioning.

If the port is causing the increased brightness then you must move the affected LED to the new port, find the nearest open port, located at the bottom of the rack, and place the cable in an open port. (Note: To do this you often must feed cables back through zip ties, this is a delicate process) Take a photo and a note of the port you changed it to and send this to Antimodular VIA email or Whatsapp and we will make appropriate changes. Also write it in the NOTES section of the Pulse Voronoi Master Database so we have a record of all changes.

If this does not fix the too bright LED, it could be a programming bug and you must document the issue and send the information to an Antimodular programmer to overview and advise.

A section of lights are off

If a section of lights are off, note the area and if the issue affects a single panel, or multiple panels.

if a single panel is affected, find the ID in the corner of the affected panel and find the corresponding controller or controllers that control that panel. Check that the controller is powered. There should be a red light visible from behind the green connector blocks. If the controller is powered, assure the yellow cables on either side of the controller are plugged in correctly and the

orange and green LEDS on them are on. If they are not on, the cable may be broken and needs to be replaced.

If the cable is fine, the LED is on, and the LEDs are still dark, you may need to proceed to Reprogramming a Controller in the section below.

If multiple panels are off, find the ID in the corners of the affected panels and find the corresponding controller or controllers that control that panel. They should be all in the same bay. If they are not, document the issue and contact Antimodular.

If they are in the same bay, the issue is in relation to the titan controller or cable from it. Assure the cable is firmly set in the first dimmer of the bay, note the number on it, and then proceed to the server rack. The rack will have multiple titan 16s, find the corresponding number and assure the cable is plugged in properly to the port. Try changing out any jumper cables of a manageable length. If that does not fix the issue, you may need to replace the titan unit, or move the port to another open port of a titan, before doing either of these please document the issue and contact Antimodular.

A sensor is not reacting

If a sensor is not reacting, note the letter that corresponds with the dimmer, which can be found on the attached plan or inside the metal plate of the sensor stand. Find the Mac Mini in the server rack that has the same letter and assure it is powered on by way of indicator light and screen on the side of the server rack.

If the screen shows the mac is on, and there's no app with a camera feed on, Restart the Mac mini using the keyboard provided. The app will start up automatically after a few minutes.

If the sensor still does not react and on the computer you see no camera feed on the newly re-opened app, the camera may have gotten unplugged. Go to the affected sensor and note if the camera is still there, it should be securely glued into the housing. To remove the housing, unscrew the three hex bolts carefully until loose but not completely out, this should allow the housing to be moved and manipulated to a position you can remove it in. Ensure the micro USB is firmly plugged into the back of the camera and place the camera back into the plastic housing carefully by aligning the line on the side of the housing. It's very important you place the camera at the height it was before removing it!

If this still does not fix the sensor or the camera is missing, contact Antimodular.

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

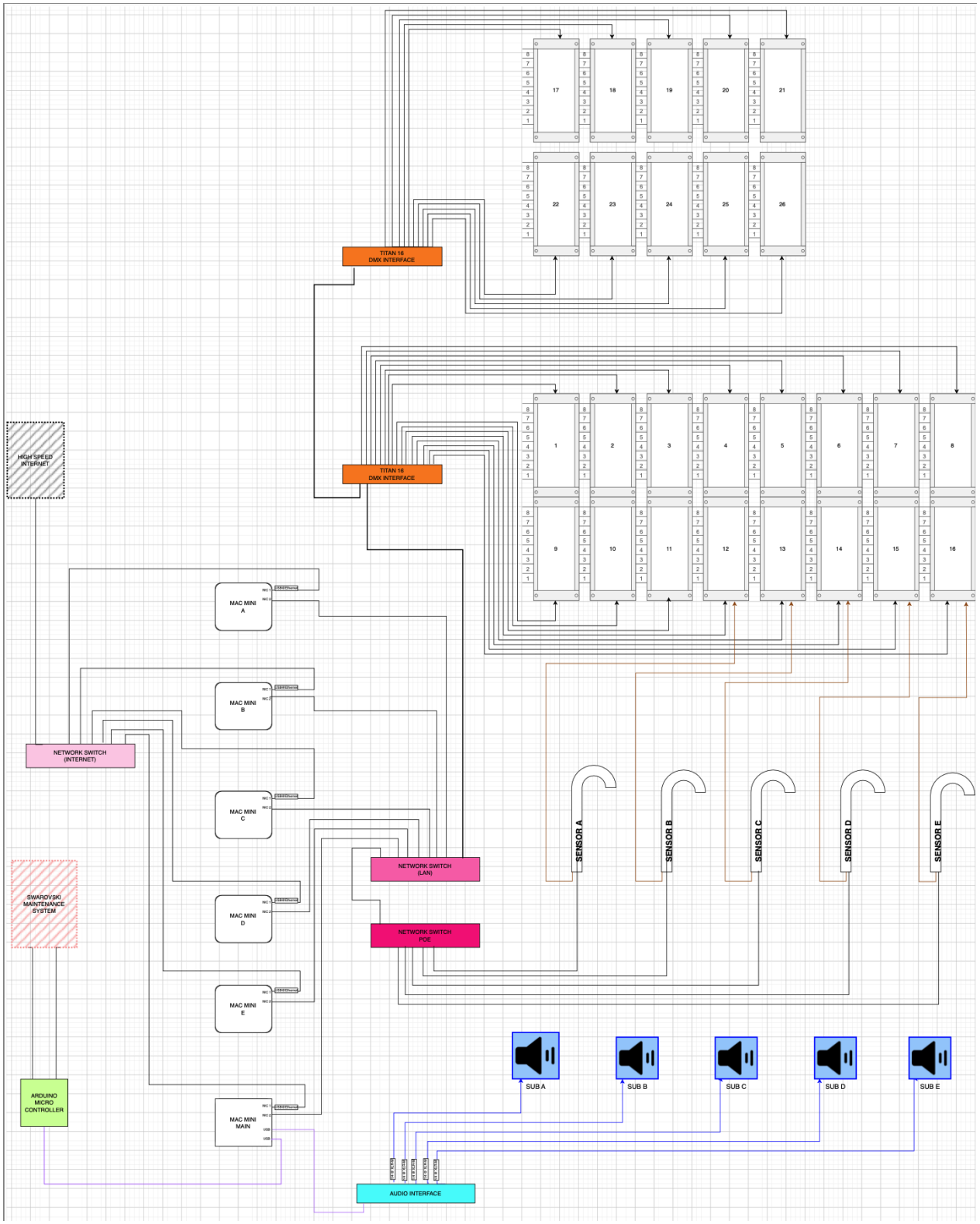
This artwork requires the following components:

Component	Description
DMX Controller(s)	Sends over the power and playback signals to the crystals.
DMX Interface	Carries the ARTNET signal to the light DMX controllers. Each port is numbered and that number corresponds to the universe number.
Lan Network Switch	Connects the computers to the DMX interface
Internet Network Switch	Supplies internet to the piece
Audio Interface	Connects the subwoofers to the main computer.
Subwoofers	Used to make the sound of heartbeats.
Camera POE Switch	Provides power to all of the cameras and connects the sensors to the lan network switch.
Camera(s)	Used to detect individual heartbeats.
Camera Cable	Carries data and power to camera and connects it to the POE switch.
Custom Sensor Frame(s)	Hosts the sensor to detect heartbeats.
Custom Sensors	Detects the heart beats of participants.
Ceiling Cable Clip	Allows the lights to be hung securely without straining the cable.
Crystal Light Assembly	LED light and cabling reacting to heartbeat, forming the light topology.
Ethernet Cabling	Interconnects the computers, the network switch and the DMX controller together to carry network communication. Also used by the USB extender to carry USB signals. Should be at least CAT5e and shielded.
Audio cabling	Connects the audio interface to the subwoofers.

Component	Description
Video cabling	Connects the main computer to the display, when exhibited. Typically using an HDMI cable.
Computer(s)	Used to run the software of the piece. Runs using Mac Mini's with OS X 13.5, M2 Chip, 8 Gb of RAM and 256Gb of SSD.

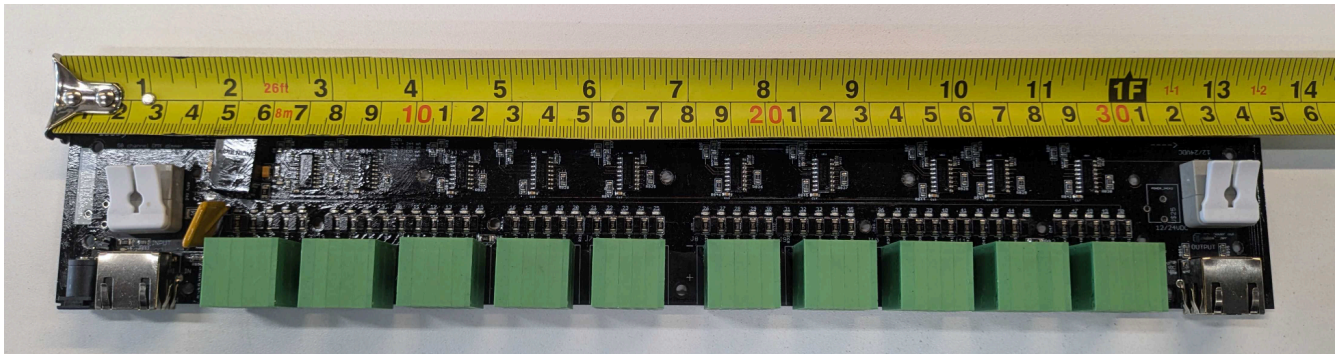
Wiring Diagrams and Connections

General Wiring diagram of the piece.



APPENDIX II - TECHNICAL DATA SHEETS

DMX Controllers



Receives Artnet data in an input and an output RJ45 port, translates this data to 50 ports. 12V power through a lever connector on the left side and distributes power through 5 pin push pin connections Note: As well, on the left side is an outboard barrel jack, to use this you MUST unplug any power supply from the lever ports. Each port outputs 1 DMX channel.

While 1 port is 1 channel, each group of 5 channels are controlled by 1 chip and if issues appear in 1 of the 5 ports, they will soon travel to one or more of the others on that chip.

The output current for the single LEDs such as the ones used in Swarovski should be low

Uses the Hi512D 5 chip to control addresses.

Component	Description
1x RJ45 DMX512 input and 1x RJ45 DMX512 output	Receives and daisy chain the DMX signal to the next light controller on the same universe.
Power input	12VDC/5A/60W Power inlet for light controller.
10x 10 push lever 12V connections	Connect to lights and carry over data and 12V signals.
Main PCB	Hosting all components: the whole being referred to as a light controller.

Each controller is controlling 50 lights each with 1 address per light. A single controller gives out 50 addresses. The maximal number of controllers linked to a universe should be 8, for a maximal number of 400 addresses, even if an universe could contain a maximum of 512

addresses. That limitation has been decided for safety reasons. Even if you are not using every port of a controller it will react as if using a total of 50 addresses.

Each controller's port has been labelled with the crystal ID connecting to the port. The correct port # for a specific cable/light is denoted on the power cable label.

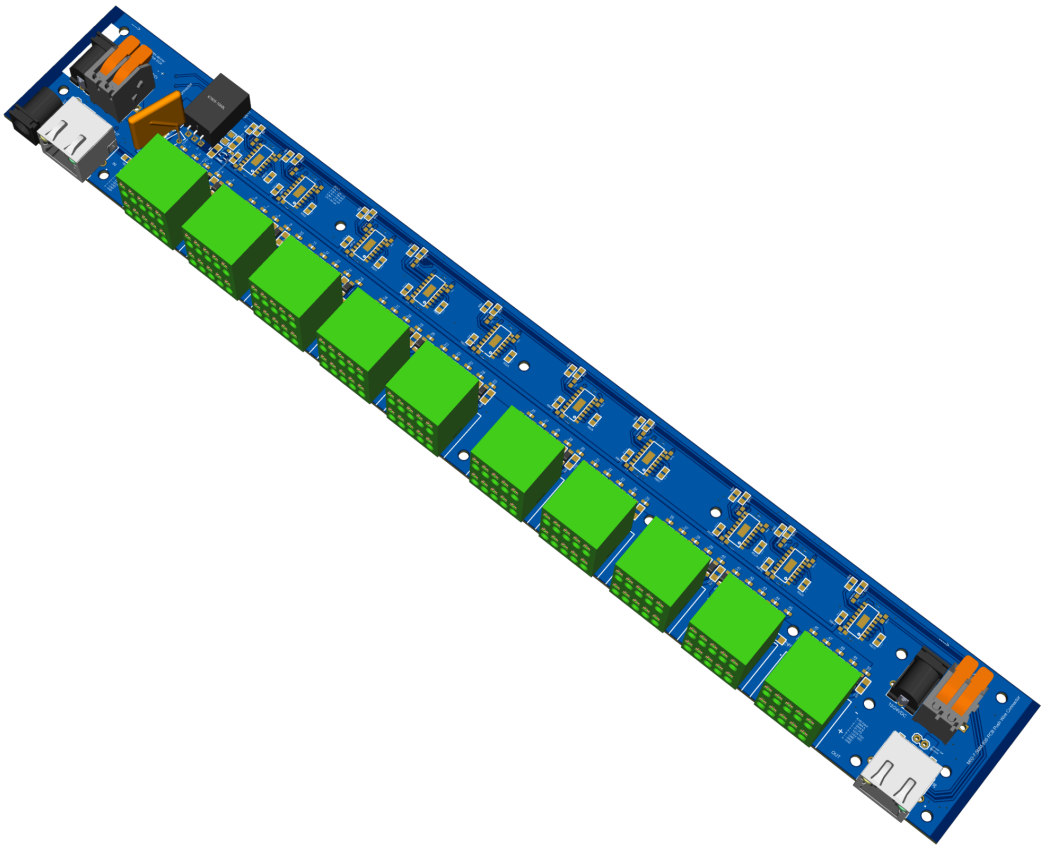
The data for the controllers will be received by the DMX512 IN port. The IN port is located next to the 12v power input, while the OUT port is on the far side of the controller. The first controller of a universe will always receive the data first, connected via the DMX controller's OUT port and the crystal controller's IN port. Then, we daisy chain from the first light controller to the second one, connected via the first controller's OUT port and second controller's IN port. Then will then feed to the next controller in the order from its output.

The power then is plugged in by way of an IEC plug on the back of the controller, and can be toggled by a powerswitch.

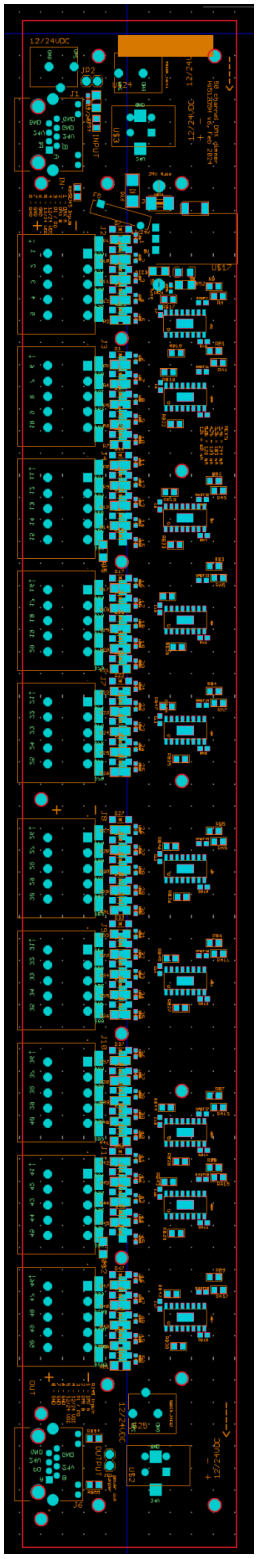
NEVER COVER UP THE VENT AT THE BACK OF THE METAL BOX

Speaker Controller's Main PCB

The main PCB has been designed by the studio. The latest version of such PCB is labeled as Hi512D5H v6 - Feb 2024. The main PCB is controlling the power feed to the speaker's power line and, by extension, their on/off state. The board has 10 onboard chips, each controlling 5 outputs for a total of 50 channels.



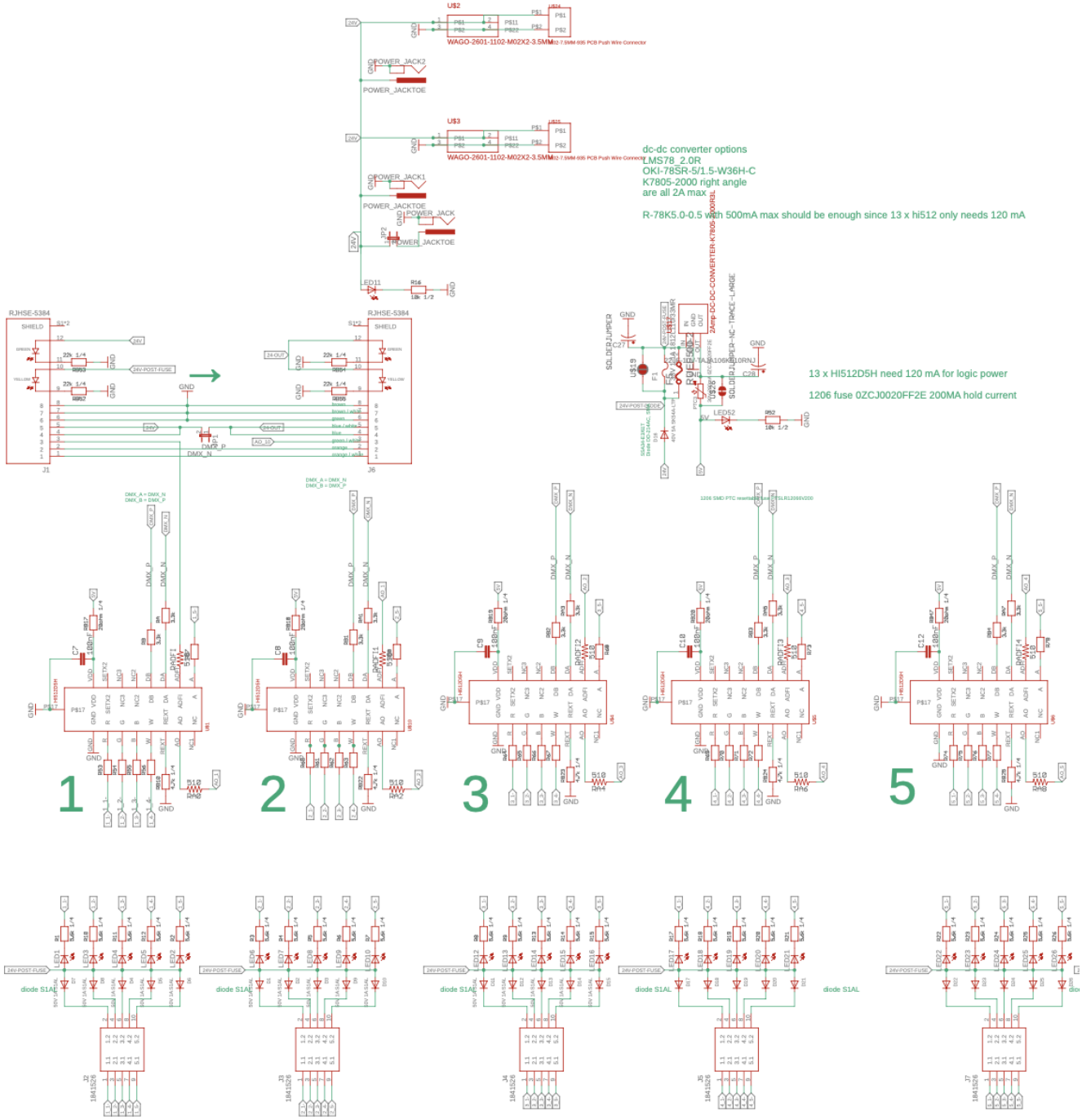
Main PCB

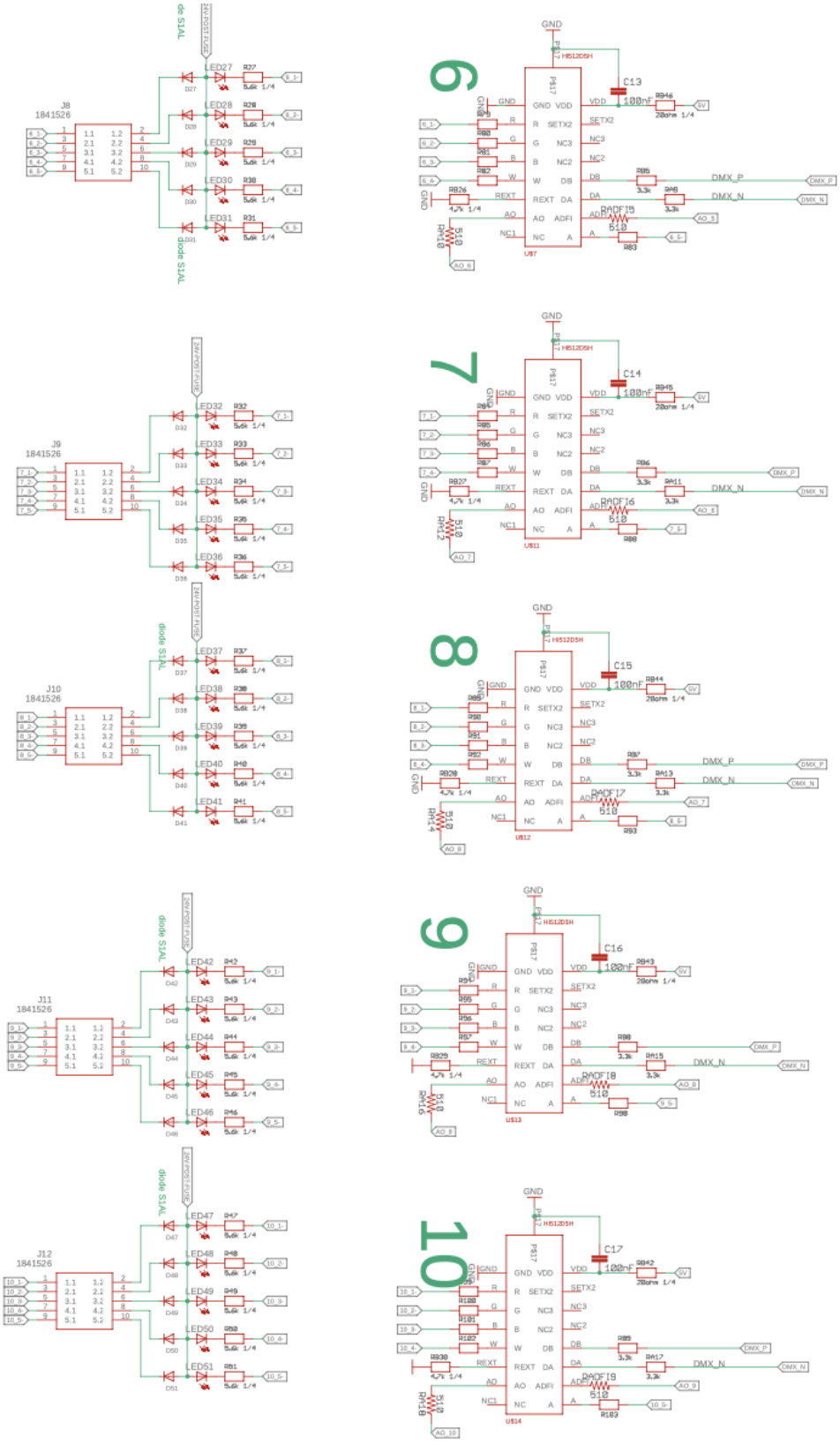


Board circuitry

Schematics

For ease of viewing the schematics have been broken up into sections of five




J8
1841526
LED27
LED28
LED29
LED30
LED31
diode S1AL
J9
1841526
LED32
LED33
LED34
LED35
LED36
J10
1841526
LED37
LED38
LED39
LED40
LED41
J11
1841526
LED42
LED43
LED44
LED45
LED46
J12
1841526
LED47
LED48
LED49
LED50
LED51
9
10
GND
C13
C14
C15
C16
C17
100nF
DMX_P
DMX_N
RADF15
RADF16
RADF17
RADF18
RADF19
510

Speaker Controller's Power supply

The power for the unit comes from a class 2 power supply. We can recommend the following unit for this artwork. That said, other units could be used, here are the most important specs for this unit:

Specification	Details
Manufacturer	Meanwell
Model Number	LPV-60-12
DC Voltage	12V
Rated Current	5A @ 12VDC / 1.2A @ 115VAC / 0.7A @ 230VAC
Rate Power	60W
Output plug	Barrel connector Inner diameter: 2.1mm Outer diameter: 5.5mm Barrel length: 11mm Polarization: Positive center, negative sleeve

Labeling of Crystal Power Cables

The crystal light's extension power cables (from a dimmer to a position near the crystal tether point) will all have a unique label at both ends, near the barrel connectors. This cable lists specific info regarding the patching for every crystal.

Please refer to the bulb and crystal cables sheet provided to get the relevant info for each crystal: the sheet takes in consideration the label inscription, and gives the proper patching information used during the installation.

The labels read as such:

Group client # - Panel ID | Crystal ID DMX Universe - Dimmer Pack Port #
bad good good bad bad

Eg: 000-A7|0002 04-003

Component	Description
Group client #	Wasn't used.
Panel ID	Refers to the panel where the cable heads to.
Crystal ID	Refers to the crystal ID in the system.
DMX Universe	Refers to the DMX universe to which the crystal should have connected to. Please refer to the sheet for the proper value.
Dimmer Pack Port #	Refers to the dimmer port number to which the crystal would have connected to. Please refer to the sheet for the proper value.

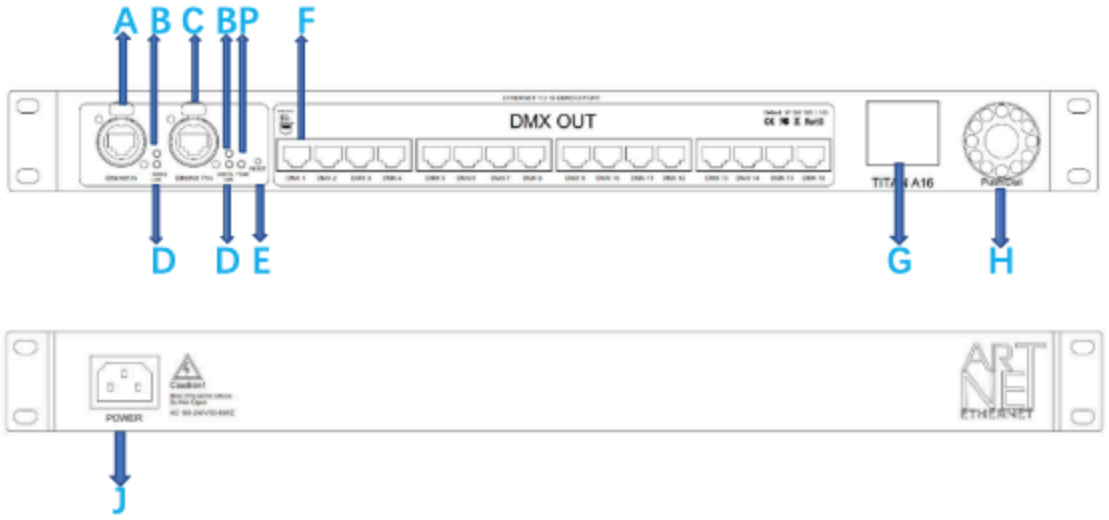
DMX Interface

The following table shows important characteristics of this converter, the images after give detailed explanations on its pinout and how to configure the device.

Specification	Details
Manufacturer	Colordreamer
Model	TITAN A16
Input Voltage	100-240VAC50/60Hz
Power Consumption	5W
Network Protocols	Art-Net via ethernet
DMX Outputs	16X512 DMX Channels
Ethernet	RJ45
Default IP	192.168.1.100
Default Subnet	255.255.255.0
Connector	RJ45
Dimensions(LXWxH) Body	44.0 × 13.6 x 4.4 cm

Connectivity

(Titan A16)



A: RJ45 Ethernet in Port
B: Status LED for Ethernet Activity
C: RJ45 Ethernet thru port
D: Status LED for Ethernet Link
E: Reset Button
F: DMX Outputs
G: Oled Screen
H: Push/Dial button
J: Power Socket
P:Status LED for Power

Description of Status LED:

E: Status LED for Power

Status	Description
Powered Off	Power cable not connected. The device has no power
Permanently Green:	Connected to Power. Power is on.

D: Status LED for Ethernet Link

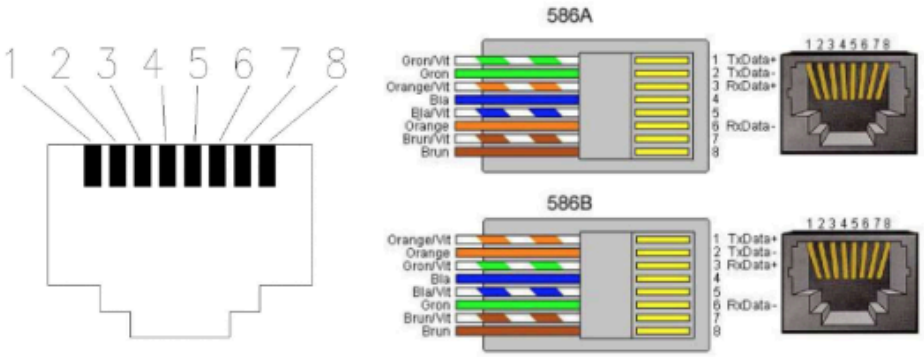
Status	Description
Powered Off	Ethernet not connected
Permanently Red:	Connected to ethernet

F: Status LED for Ethernet Activity

Status	Description
Powerer Off	No data received over ethernet
Permanently Green or Blinking Green	Communicating over Ethernet. Receiving data over ethernet

3-Pin And 5-Pin XLR Connector Layout

RJ45 Connector Layout

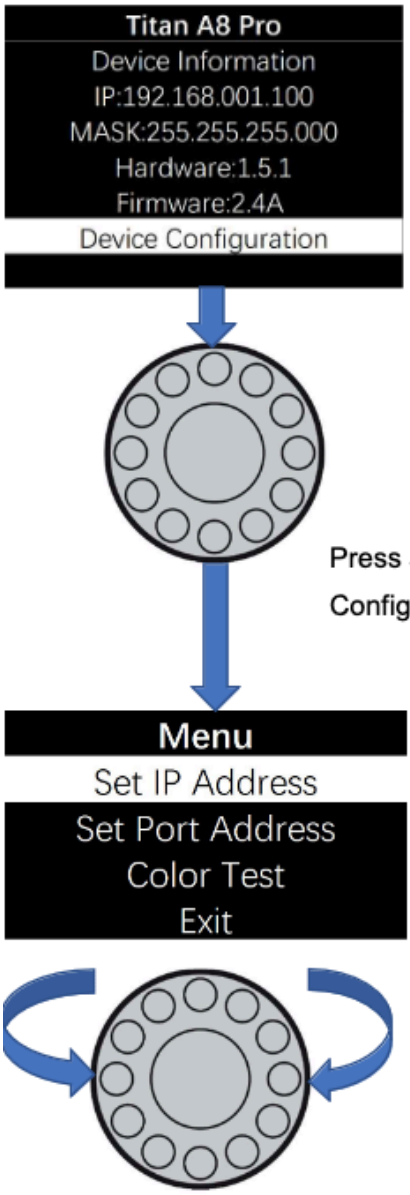


1: DMX+ 2: DMX- 7: Ground

Device Configuration Through onboard Screen and Push/Dial button

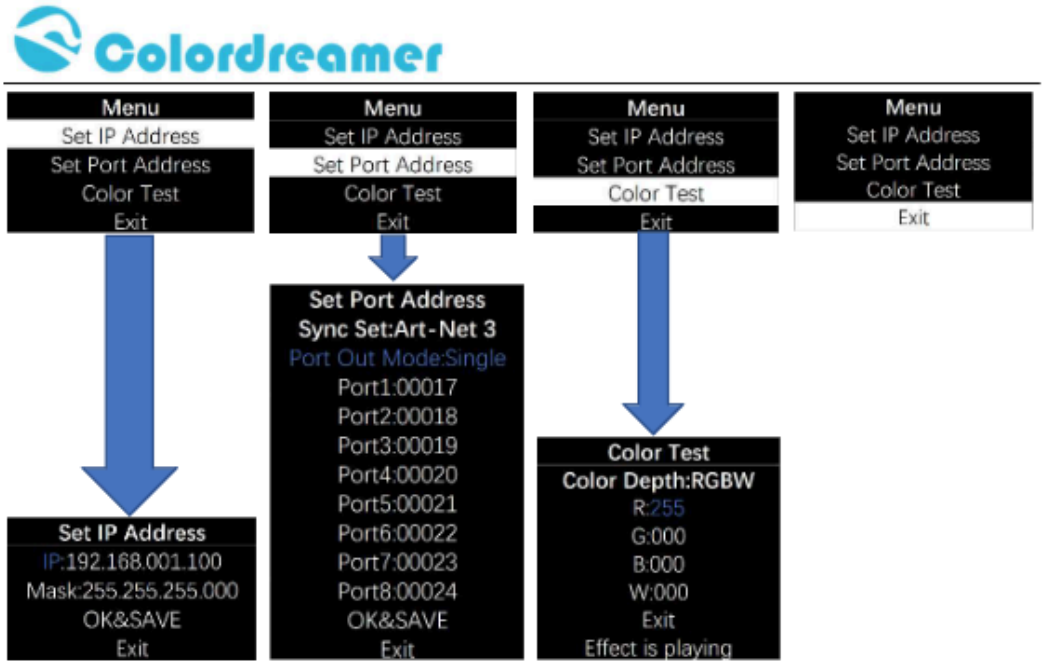
Standby Screen:

When you are not performing a task within a menu, Titan A8 or Titan A16 will display device information as below.



Press and release the rotary dial to enter the Device Configuration Menu.

Rotate the dial clockwise or counterclockwise to move between the highlights.
Press and release the dial to enter the page of highlight



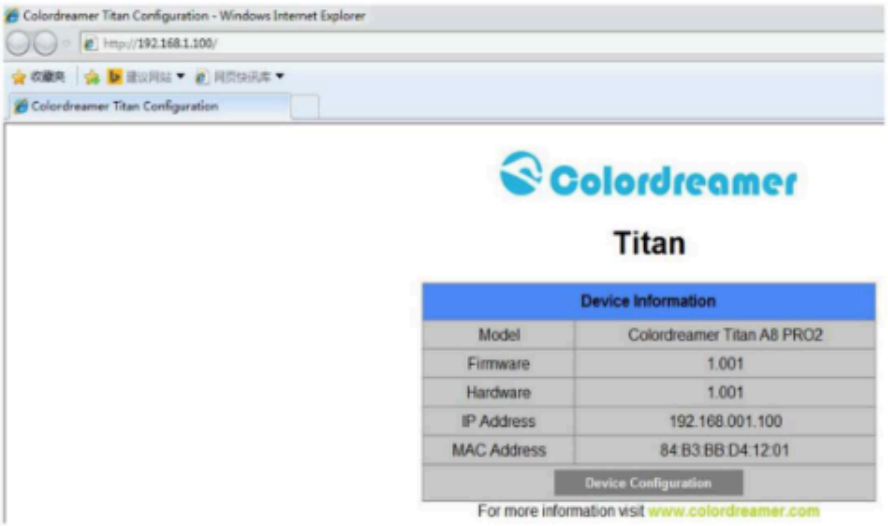
Rotate the dial to move the highlighted cursor between options within the page
When the highlighted cursor is over the required option, press and release the dial
Rotate the dial to change the value of the option.
Press and release the dial to fix the chosen value of the option.
Remember to press “OK&SAVE” to confirm your setting.
Press “Exit” to come back Main Menu.

Notes:

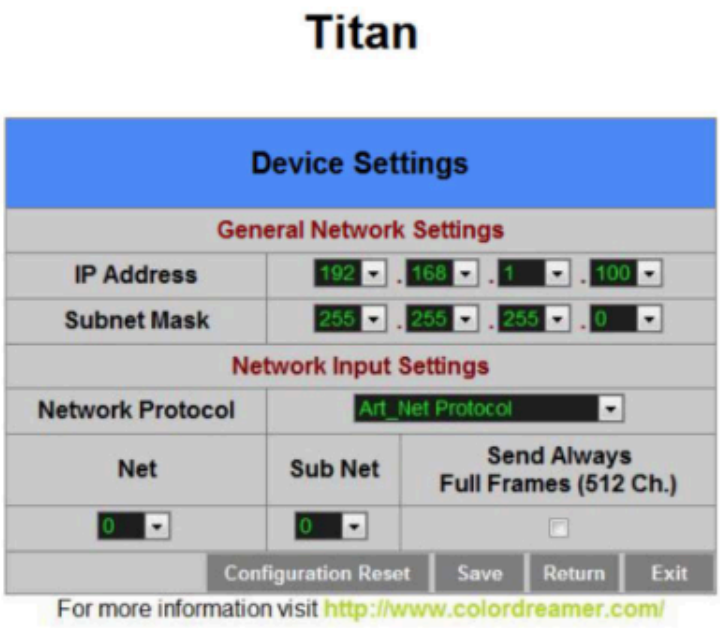
1: In the page “Set Port Address”, Sync Set can be Art-Net 3 or Art-Net 4
2: User can use Color Test Page to test your led fitting when software is not ready.
Color DepthW/RG/RGB/RGBW
R: a value between 0-255 G: a value between 0-255
B: a value between 0-255 W: a value between 0-255

Device Configuration Through a Web Browser

You can access all settings and information of Titan Artnet Controller by using the built-in web configuration tool.
Step 1) Connect Titan Artnet Controller and your computer to the same network.
Artnet Controller Default IP 192.168.1.100
Step 2) Assign correct network settings for your computer in the operating system. (Recommended default settings:
IP address 192.168.1.XXX/ Subnet mask 255.255.255.0)
Step 3) Open your web browser and enter the IP address of Artnet Controller 192.168.1.100
Step 4) The web configuration tool will be launched.



Step5)You can change IP address and save this configuration



Step6) After saving all setting,reboot the system to apply the new setting.after reboot,this window will be closely automatically.

Titan

For more information visit www.colordreamer.com

Reset to Factory Default Settings

Step 1) Disconnect the device from power.

Step 2) Use a suitable tool to press the reset button.

Step 3) Continue to press the reset button and connect to power again.

Step 4) Continue to press the reset button and wait until all status LEDs of the device flash repeatedly or wait 5 seconds.

LAN Network Switch

Specification	Details
Manufacturer	D-Link
Model Number	DGS-1016D
Output Ports	RJ45
Number of Output Ports	16
Dimensions (W x D x H)	28.0 x 12.5 x 4.4 cm
Max Power Consumption	10.07W
Power Supply	AC : 100 ~ 240 V
Switching Capacity	32Gps
Max Packet Forwarding Rate	23.8 Mpps

Internet Network Switch

Specification	Details
Manufacturer	Tp-Link
Model Number	TL-SG108E
Output Ports	RJ45
Number of Output Ports	8
Dimensions (W x D x H)	6.2 × 4.0 × 1.0 in (15.8 × 10.1 × 2.5 cm)
Max Power Consumption	3.68 W (220 V/ 50 Hz)
Power Supply	External Power Adapter(Output: 5 VDC/ 0.6 A)
Switching Capacity	16Gps
Max Packet Forwarding Rate	11.9 Mpps

Audio Interface

Specification	Details
Manufacturer	Presonus
Model Number	Quantum 2626
Connectivity port	Thunderbolt
Power	12 VDC, External Power Supply
Dimensions	17.8 L x 19 W x 4.4 H (cm)
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

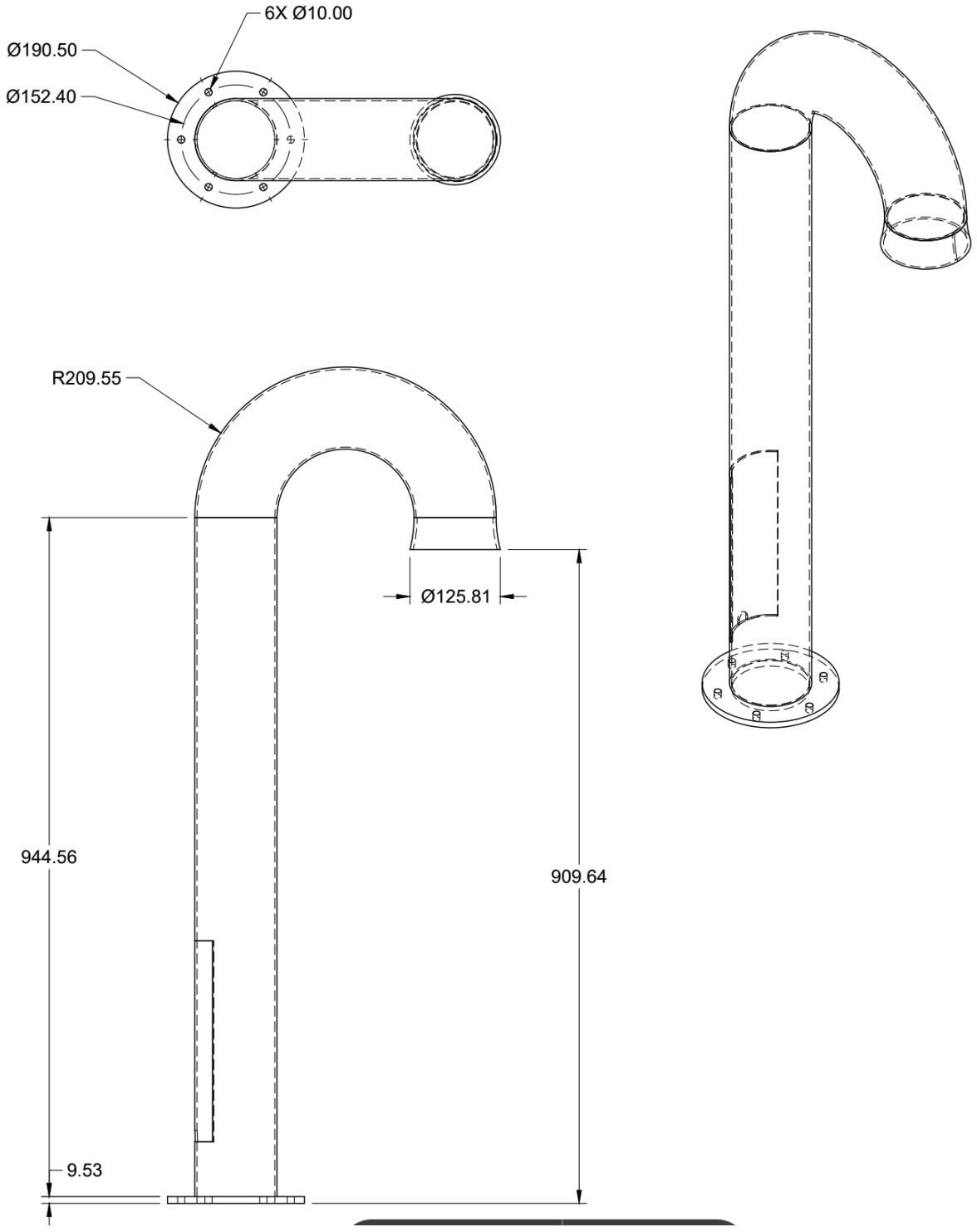
Subwoofers

Specification	Details
Manufacturer	QSC
Model Number	KS118
Configuration	Direct Radiating
Amplifier	Class D 3600 W (Peak)
Connectors	2 × locking XLR/F ¼ inch combo 2 × XLR/M (Loop-thru Output) 1 × locking IEC power connector
AC Power Input	Universal power supply 100 – 240 VAC, 50 – 60 Hz
Ac Power Consumption	100 VAC, 3.6 A / 120 VAC, 3.0 A / 240 VAC, 1.7 A
Dimensions	64.0 × 52.0 × 78.5 cm
Net Weight	56.5 kg

Camera POE Switch

Specification	Details
Manufacturer	Axis Communications
Model Number	T8508
Dimensions	22.0 W x 24.2 D x 4.4 H (cm)
Throughput	14.9 Mpps
Switching capacity	20 Gbps
MAC table	8 K
PoE Class	2x RJ45 Gigabit Ethernet WAN
Outputs	PoE ports
Inputs	8x RJ45 Gigabit Ethernet PoE+ (30 W, 802.3at)
Supported Protocol	DHCP Server, IPv4, IPv6
Input Power	100 to 240 VAC, 50 / 60 Hz

Custom Sensor Frame



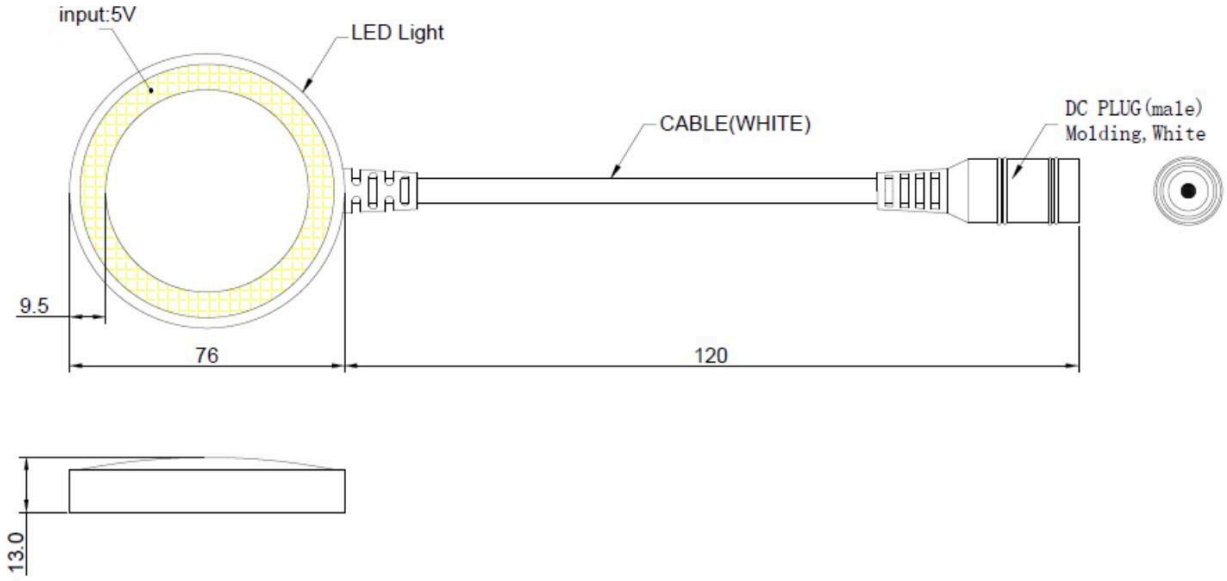
Custom Sensor

The sensor contains the following elements:

- LED Ring Light;
- LED Spot Light;
- Camera;
- Camera Cable.

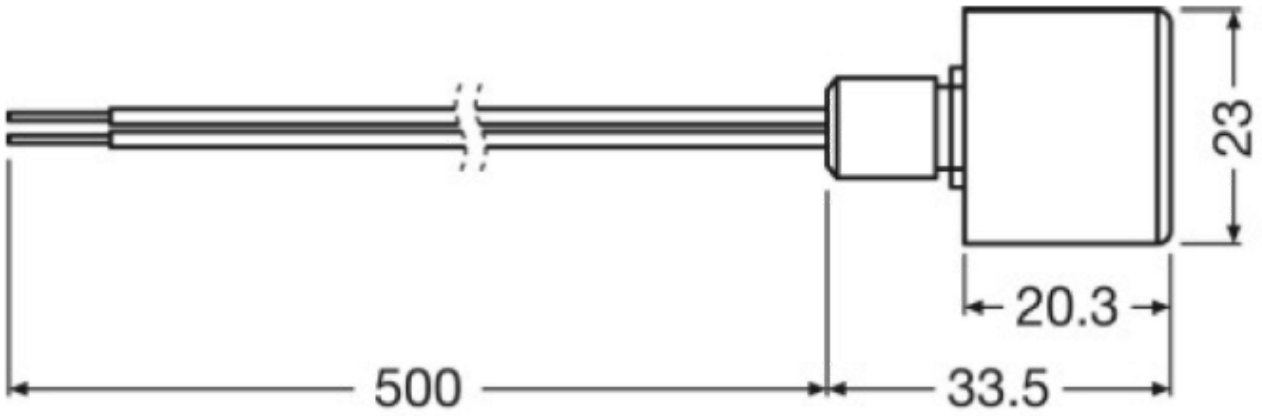
Each of these components is detailed in the following sections.

Ring Light



Specification	Details
Manufacturer	AdaFruit
Model Number	MODEL 4433
Light Tone	Cool

Spot Light



Specification	Details
Manufacturer	OSRAM
Model Number	DE1 -W4F-830-G3 Osram DRAGONeye
Color Temperature	3000k
Emitting Color	Warm White
Energy Consumption	2kWh/1000h
Nominal wattage	1W
Nominal beam angle	15 degrees

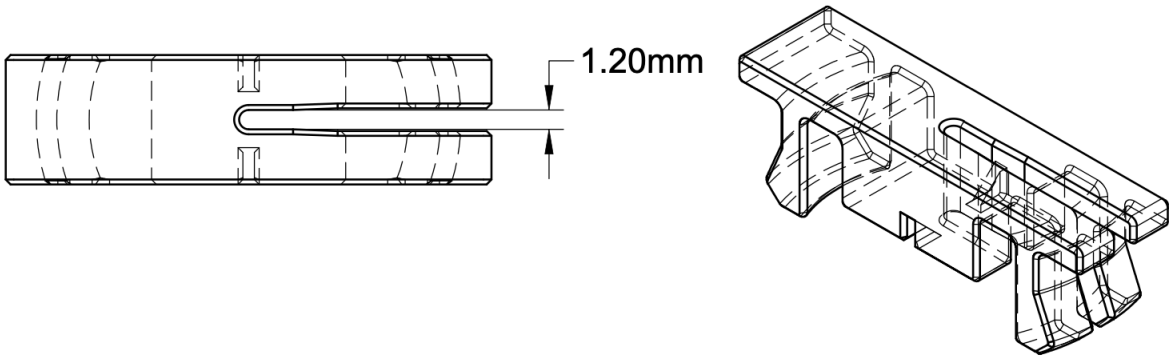
Camera

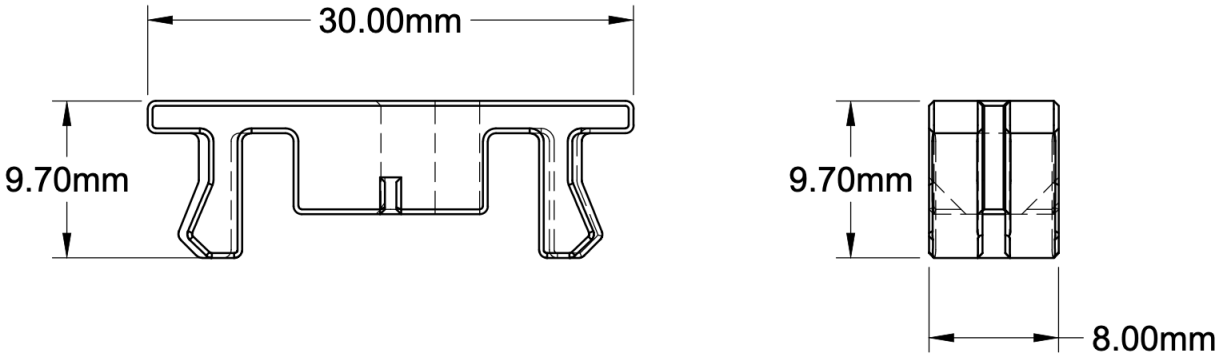
Specification	Details
Manufacturer	Axis Communications
Model Number	P1245 Mk II
Image Sensor	1/2.9” progressive scan RGB CMOS Pixel size 2.8 µm
Resolution	1920 x 1080
FPS	25/30
Focal Length	2.8mm
Horizontal field of view	111 degrees
Vertical field of view	61 degrees
Lens mount	M12
Power	Power over Ethernet
PoE Class	2

Camera Cable

Specification	Details
Manufacturer	Axis Communications
Model Number	F7301
Length	1m
Ports	Male RJ45, male micro-usb

Cable Clips





Crystal Light Assembly

The crystal lights contain the following elements:

- LED;
- Custom fabricated LED tooth;
- Crystal body;
- Crystal power cable.

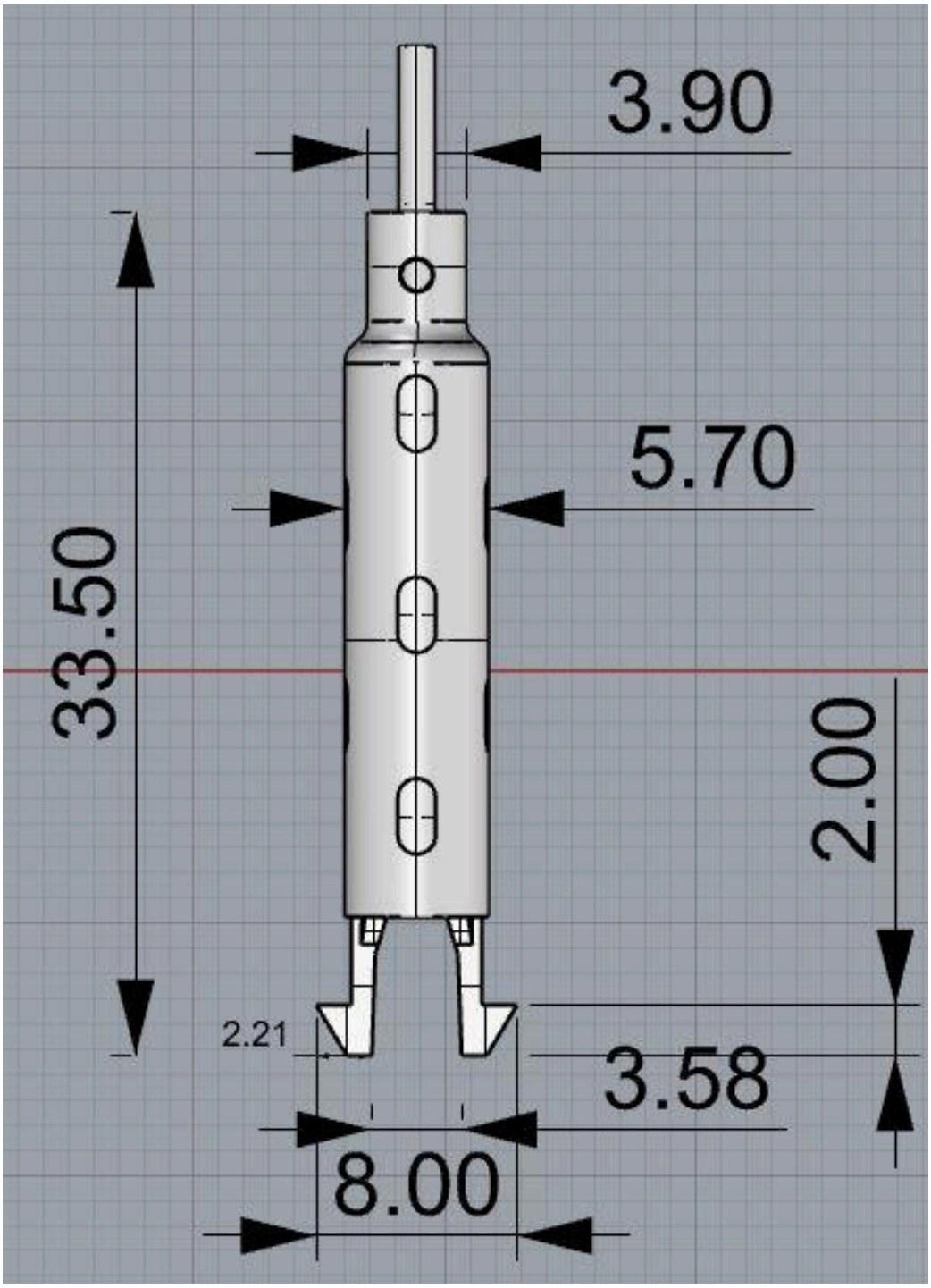
Each of these components is detailed in the following sections.

LED

Specification	Details
Light Color	Warm
Power Supply	12V/5A

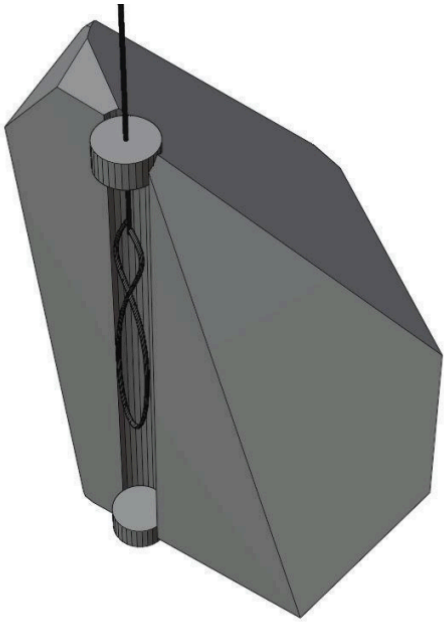
Custom LED Tooth

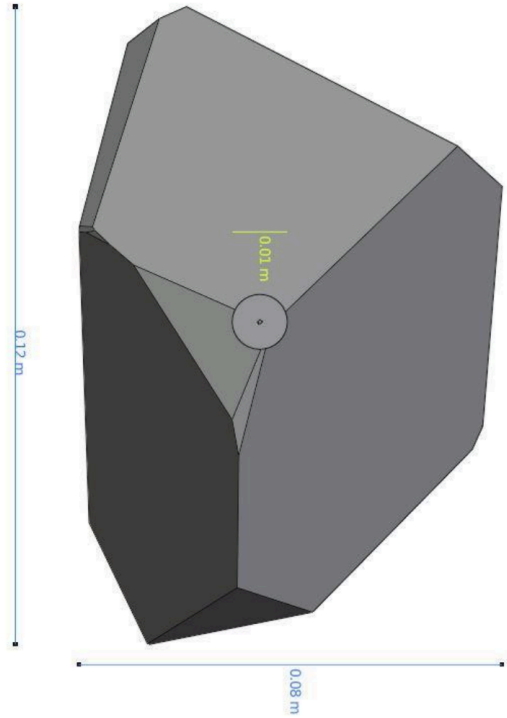
This holds the crystal to the cable and LED assembly. Fits over the LED and cable end.

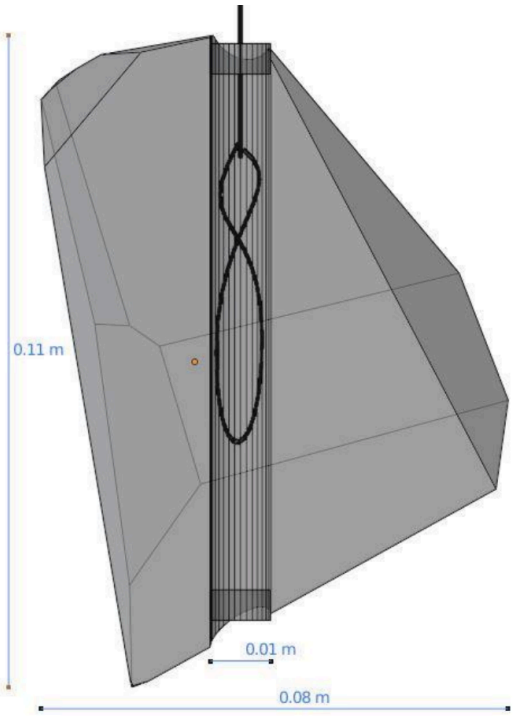


Crystal Body

Each Crystal body will have slightly different dimensions but the imaged below show an example crystal and how the LED tooth and LED are secured inside.







Crystal Power Cables

The crystal light's power cables will all have a unique label near their barrel connector. This cable shows the cable drop length from ceiling to the crystal.

Please refer to the bulb and crystal cables sheet provided to see which length coincides with the crystal ID you're referring to.

APPENDIX III - REPAIR

Reprogramming a Controller

The Glimmerdimmer runs on the Hi512D chip with 5 pinned outputs. These chips control the dimming of the LEDs in a clean and consistent manner that reacts to DMX 512 input.

If a controller ever needs to be replaced or reset, you will need to reprogram the Hi512D chip on the controller to match the settings and functionality of the piece as a whole. To do so you will need to use the BL-321, there are other controllers that can interface with the Hi512D chip but this unit is our recommendation.

First familiarize yourself with the BL-321 unit.

The left side of the unit has the power on switch, a SD card port for firmware updates, and a USB C port for charging the unit. Switch the power on.

The screen of the unit is backlit, it will open to a page titled “Addressing Device” with several options as seen in the screenshot below.

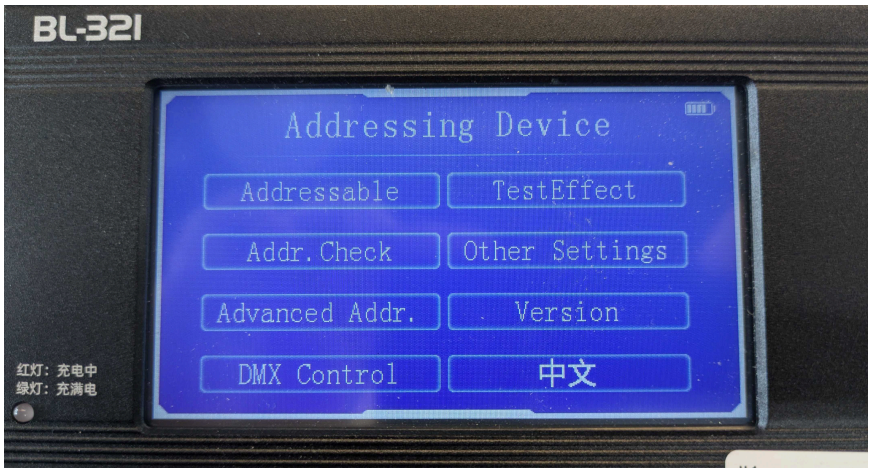


Photo of the initial screen on the BL-321.

The following table explains the functionality of each of these buttons.

Options	Details
Addressable	The basic addressing format, safest to use as it will only effect the DMX address
TestEffect	A testing interface to test the lights DMX functionality, not often used.

Addr. Check	A testing interface to test the lights DMX address, good to use to confirm from programming
Other Settings	Do not use, not applicable to our system
Advance Addr.	Advance programming, needed for reprogramming of a unit.
Version	Firmware version, note this if ever talking to a tech about an issue with the BL-321 or reprogramming
DMX Control	Do not use, not applicable to our system
Language	Only available options are Mandarin Chinese and English

In order to reprogram an entire unit you will need to use the Advanced Addr. option. First make sure that nothing is plugged into the BL-321. Then open the “Advanced Addr” option and apply exactly the settings seen in the following table.

Settings	Value
GAMMA	2.5
GAMMASmooth	Open
RefreshRate	16kHz
NoSignal	LastFrame
AutoAddress	Close
StepValue	1
FieldMode	5
PortDelay	Ons
ColorR	255
ColorG	255
ColorB	255
ColorW	255

ColorA	255
CurrentR	11
CurrentG	11
CurrentB	11
CurrentW	11
CurrentA	11

Once all these are set, press the Return icon at the top left corner of the screen and check the box next to Param. Set.

Next open Addr. Set You should see a screen that looks like the image below. Make sure that your settings in the top row are set to be the same as the ones in the image. The “Lights” and “Amount” setting will change automatically, do not touch either yourself. The “Start Add” number must be set to the address of the unit you are replacing or reprogramming. This address should be indicated on a label after the Box ID. Please match it exactly.

Once set, press the Return icon at the top left corner of the screen and check the box next to Addr. Set.

On the right side of the BL-321 is a port for an orange terminal block, green terminal block, and RJ45. You can plug the Cat6 RJ45 jumper into the RJ45 port. If you do this please put a power termination board at the other end of the RJ45 jumper to assure no POE from the controller enters the BL-321. This method can be seen in the image below

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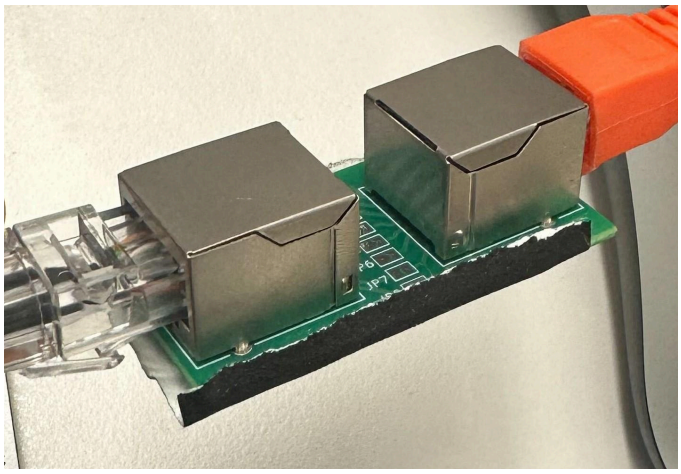
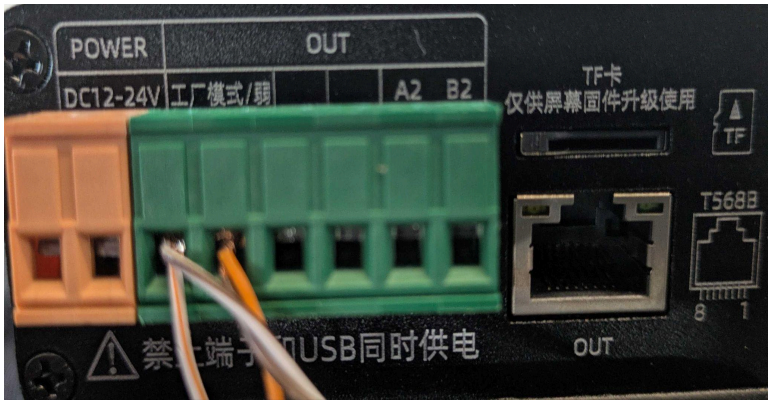


You may also use a cut RJ45 cable and plug the orange white and orange cables directly into the green terminal block's first and second port respectively. (First port denoted by A1, and closest to the orange terminal block)

This method does not require you to use the power termination board and can be seen in the image below.



After choosing one of the above methods you can now plug the RJ45 into the DMX in port of a controller while the controller is powered on. With both boxes checked, press SendData. The board of the buttons will disappear and all options will be unpressable during the reprogramming process. **DO NOT REMOVE POWER FROM THE CONTROLLER OR BL-321 AT THIS TIME**

Once this process is complete the dimmer has successfully been reprogrammed.