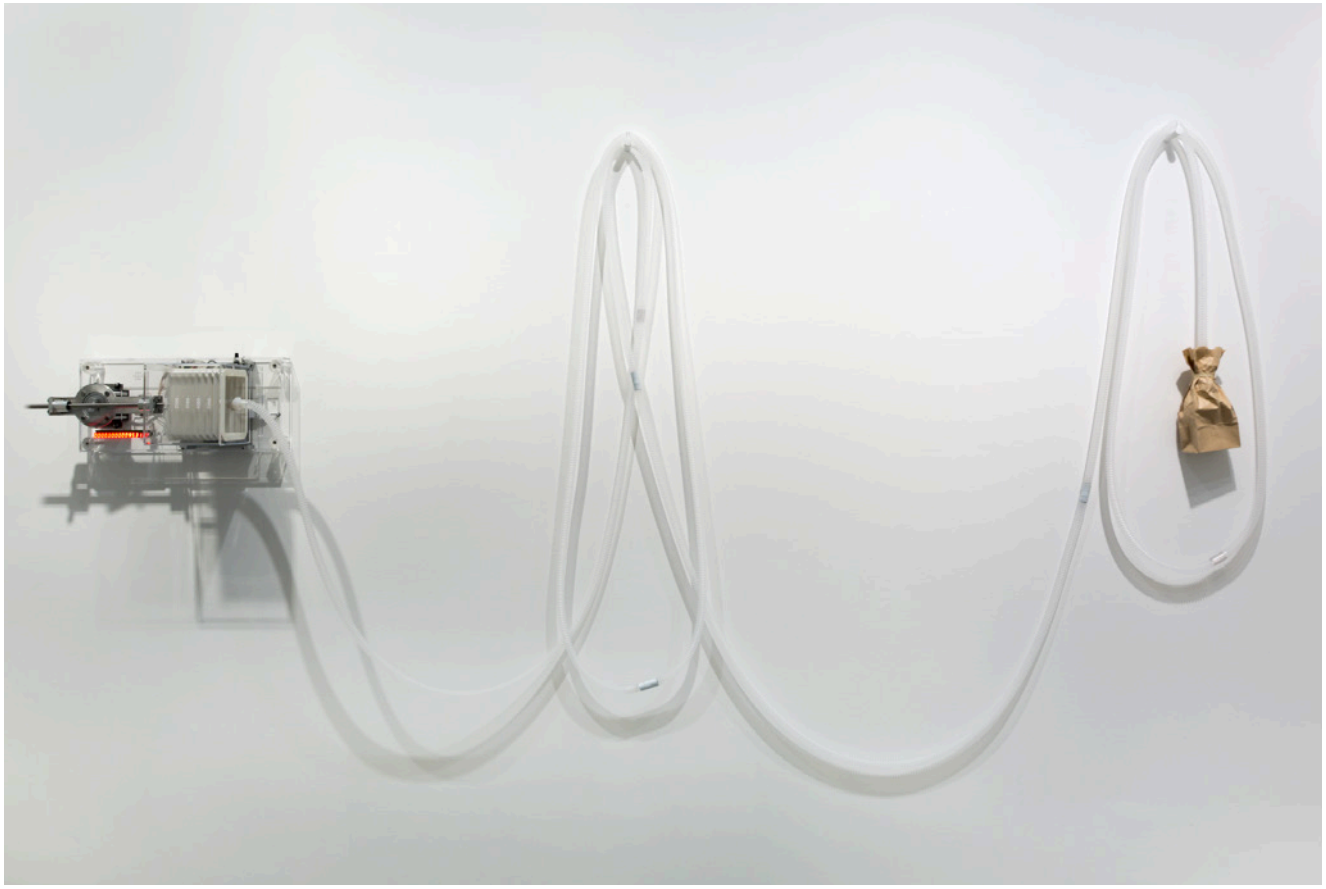
LAST BREATH

BY RAFAEL LOZANO-HEMMER - ACRYCLIC SHEET VERSION



Version: 2025-04-24

TABLE OF CONTENTS

GENERAL IMPORTANT INFORMATION

This short section must be read for proper operation.

LAST BREATH (2012)

BY RAFAEL LOZANO-HEMMER

Technique

Motor, bellows, acrylic, digital display, custom circuitry, arduino processor, respiration tubing, brown paper bag, and video documentary.

Description

“Last Breath” is an installation designed to store and circulate the breath of a person forever. The piece consists of a small brown paper bag which inflates and deflates automatically thanks to motorized bellows similar to those found in artificial respirators in hospitals. The apparatus hangs on a wall and is activated 10,000 times a day, the typical respiratory frequency for an adult at rest, including 158 sighs. Each stroke of the machine advances a digital counter that beeps. The breath circulates between the bellows and the paper bag through a ribbed transparent plastic tube that emits a faint and hypnotic low sound. The tube can be as large as necessary to either hang the bag right beside the piece, on the same wall, or to create a labyrinth on the ceiling of the exhibition that ends with the bag suspended in the middle of the room. The brown paper bag makes a rhythmic crushing sound as it inflates and deflates. As a biometric portrait, the piece requires careful curation, and the question of who gets stored should be in itself an interesting debate. The portrait should work as a living memorial of a senior respected artist, ideally a poet, singer or dancer. A small video of the person blowing into the bag is exhibited beside the apparatus.

The first copy of the piece stores the breath of Cuban singer Omara Portuondo. The piece is currently on tour but eventually will be exhibited by the National Museum of Music in Cuba: after she dies people will be able to visit her "Last Breath" there. The second copy of the piece has the last breath of American Avant-Garde composer and accordionist Pauline Oliveros, developer of the concept of “Deep Listening.” Oliveros died on Nov 24, 2016, but her breath continues circulating in this biometric portrait. The third copy is owned by Musée des Beaux-Arts de Montréal which stores French Canadian writer and poet Nicole Brossard’s breath. The fourth copy stores the breath of Finnish actor Seela Sella, owned by the EMMA Museum. The breath of Ecuadorian writer and poet Efrain Jara Idrovo was stored for the Bienal de Cuenca. The sixth copy stores the breath of Nigerian writer and poet Wole Soyinka.

Dimensions and Weight

The apparatus is approximately 60 x 26 x 26 cm when the bellows is contracted, 72 x 26 x 26 cm when expanded and weighs about 13 kg. The air tube can measure up to 17 m long when all hoses are in use.

Operation

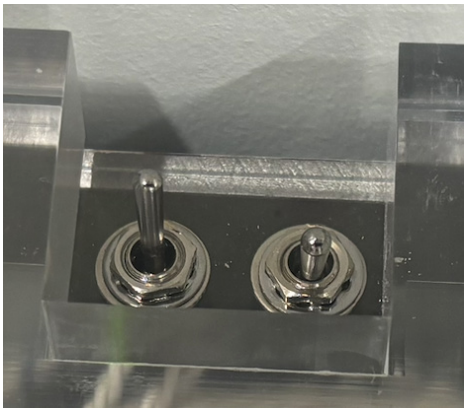
Please refer to Appendix I - Installation for detailed system information and wiring diagram.

1. Connect the piece to electrical power. The artwork runs on either 120 Volts or 240 Volts (50-60Hz).

2. To start the piece turn the On/Off switch (Right) to ON position (away from the wall). At startup the LED counter will show a series of zeros: it will start counting after the homing sequence.

3. The piece should beep every breath. This said, the beeping can be turned On and Off by flicking the left switch away from the wall (On) or towards the wall (Off).

4. To shutdown the artwork turn the On/Off switch (right) to Off. The breathing mechanism will stop and the counter will turn off, while the air will stay safe inside the bellows, air hoses and the paper bag. The artwork will remember the last breath given. Unplug the power to stop any current consumption.

The Apparatus buttons' color may differ between versions. Most *editions of the piece use switches that have colored caps as seen in the image above on the left. While other versions have both switches use no caps as seen on the image above on the right. For clarity, positions (left and right) instead of colors are used in the description below.*

General Artwork Behaviors

The apparatus hangs on a wall and is activated 10,000 times a day, the typical respiratory frequency for an adult at rest, including 158 sighs. Each stroke of the machine advances a digital counter that beeps. The breath circulates between the bellows and the paper bag through a ribbed transparent plastic tube that emits a faint and hypnotic low sound. The tube can be as large as necessary to either hang the bag right beside the piece, on the same wall, or to create a labyrinth on the ceiling of the exhibition that ends with the bag suspended in the middle of the room. The brown paper bag makes a rhythmic crushing sound as it inflates and deflates.

Maintenance

To clean the apparatus, use soft and non-abrasive microfiber cloth, like the TAP's microfiber cloth, to dust the artwork. If a deeper cleanup is needed, use the Novus plastic polish cleaning products combined with the microfiber cloth. If your edition has vinyl stickers applied to the bellows casing, pay attention to not rub them too harshly.

The air hoses should be dusted with a microfiber cloth, or even a feather duster or a hand duster (like a Swiffer). The paper bag should be dusted with the use of a compressed air can.

We recommend cleaning-up the artwork every two weeks, when exhibited. This said, the artwork may need to be cleaned at a faster pace, if the exhibition space tends to get dusty more quickly.

Placement Instructions

The piece should be hung by the four corner screws vertically centered at 1.6m (63") from the ground: placing the lower edge at 147.3cm (58") from the floor **(*** note that since each edition could be slightly different, always double check the final position of the apparatus before setting up your anchors on the wall ***)**. The apparatus weighs about 13 kg and a proper anchoring system should be chosen according to the wall material.

A template for drilling the anchor holes might have been provided by the artist studio to help hang the piece properly.

To mount the main unit on the wall only four 3-4" screws (75-100mm) are required. Ideally the screws will be made of 18-8 Stainless Steel, size 14, to fit but not damage the acrylic holes. One on each corner through the Acrylic pillars (or full Acrylic sheet). For drywall proper wall anchors should be used.

When **first installing the artwork**, the air will be contained in the paper bag and the bellows will be collapsed to its smallest size. *Please refer to the Wiring Diagram for visual reference and proceed with the following steps*:

1. **Prepare the tubes:** expand the tubes fully (a minimum of 5 and a maximum of seven should be used), and connect them together using the tube coupling.
2. **Attach to the apparatus:** connect the assembled tubes to the apparatus via the air hose fitting.
3. **Inspect the rubber band**: if the rubber band securing the paper bag to the bag-to-tube coupling seems loose, dry or compromised, tighten it or replace it with a new one.
4. **Remove the bag shipping cap:** carefully remove it from the bag-to-tube coupling.
5. **Complete the connection:** attach the assembled tubes to the bag-to-tube coupling.

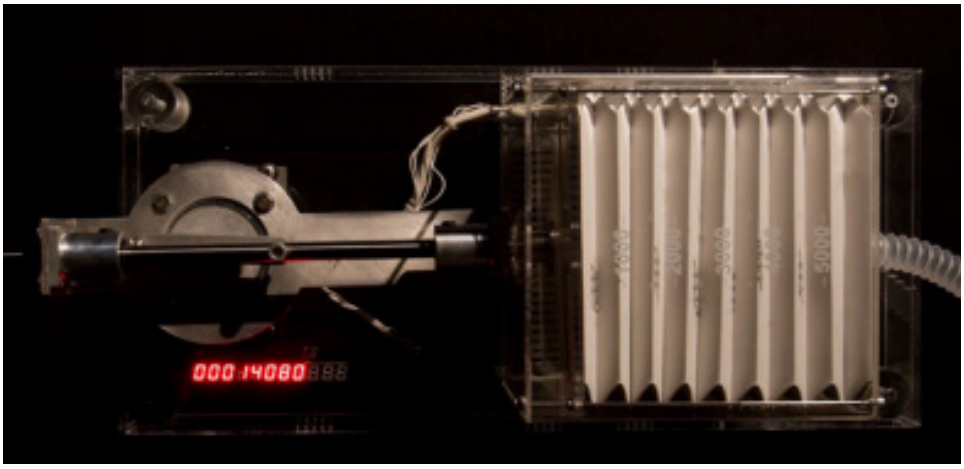
The tubing can be coiled and hung from the very same wall - or surrounding wall(s) - so the bag is close to the apparatus or slightly further away from it. When hung from the wall, the use of

thin metal hooks having a color close to the wall color, or to the air tubing is preferred. Another way to install the bag is to hang it from thin nylon threads around the room so that the paper bag is in the middle of the exhibition area. When this option is chosen, you may want to protect the area so people don't touch the tubing or the paper bag: this is up to your standards, but in no case should we have massive stanchions blocking the whole space, such elements must remain discrete and elegant . If unsure on how to display the tubing please contact the artist studio.

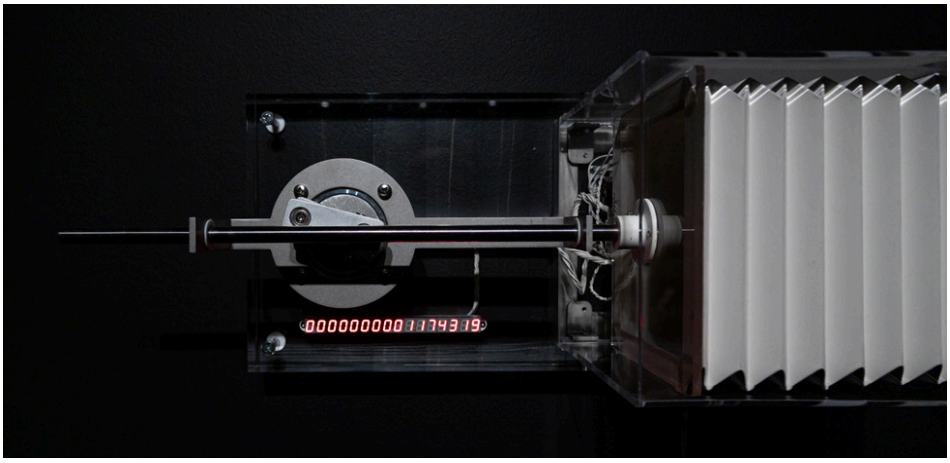
The white power cable powering the artwork should ideally be plugged in directly below into a power outlet that is similar to those normally in the Museum. We want to show the risk that anyone could potentially unplug the work with the implication this would stop the breath circulating.

A documentary video is provided with the artwork. This documentary video shows the moment when the person associated with the last breath contained within the apparatus did blow their last breath in the paper bag. This video should be displayed with the artwork, within a playback device placed nearby. The device used to playback the video and its exact placement should be discussed with the artist before installation.

After following all these steps & powering on the apparatus, monitor the piece for a few minutes to ensure the breath is circulating properly and there are no unexpected noises coming from the apparatus. Pay special attention that you don't hear any pieces scratching or creating friction. If anything seems out of the ordinary please power off the piece, refer to the Preliminary Troubleshooting Steps, and call the artist studio if further assistance is needed.



Early versions of the work use acrylic pillars on the four corners of the acrylic assembly. Please refer to the original Last Breath manual for more details about this version.



Newer versions of the work use a full acrylic sheet, drilled in the four corners.

DETAILED TECHNICAL INFORMATION

Normal Software Operation

Last Breath runs on a custom programmed microcontroller device. Early editions used an Arduino Pro Mini, while later editions used a Teensy 4.0 microcontroller. The software is written in C++ using the Arduino framework. The software will begin to run immediately once the piece is switched on. The microcontroller will initiate an initial homing sequence that may take one to two cycles of the motor arm. After this initial sequence the mechanism will move continuously and the 7 segment display will update its counter with each breath cycle.

In latest versions, it is possible to manually reset the breath count by editing the onboard SD card as described in APPENDIX III - REPAIRS AND ALTERATIONS. No other features of the artwork are adjustable from the software.

Preliminary Troubleshooting Steps

If after a long period of time you hear a slight clicky sound

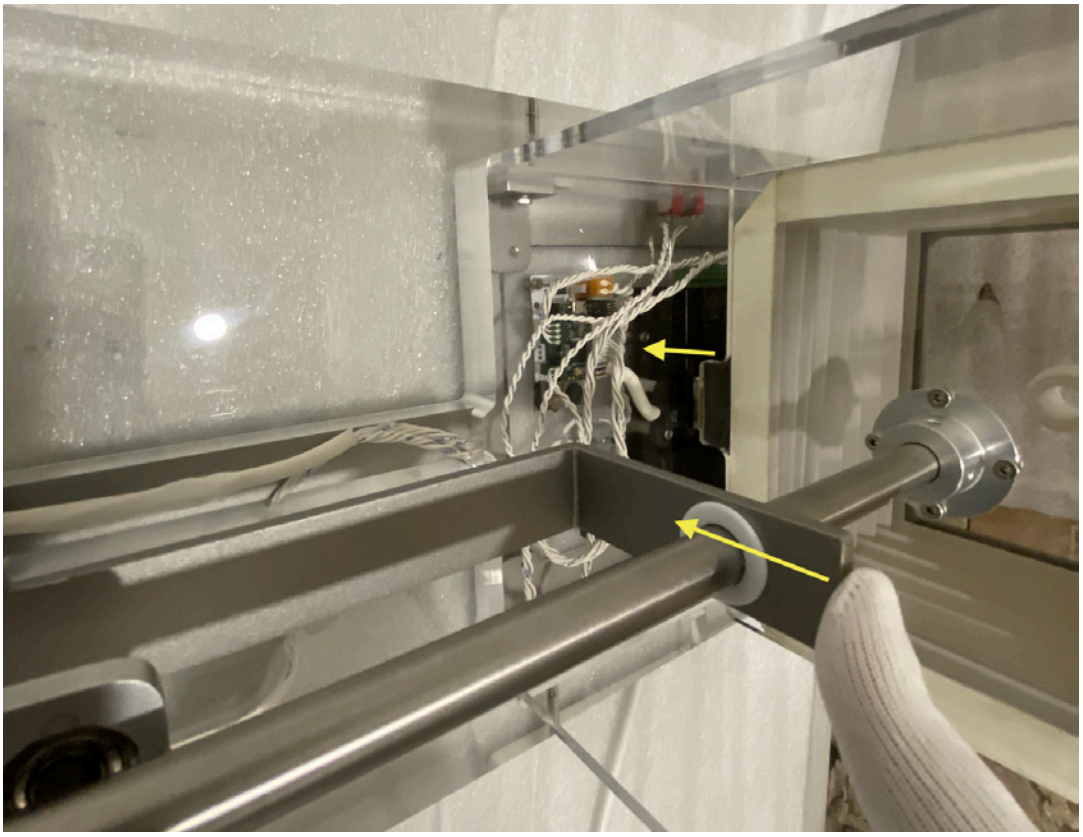
The lever mechanism needs some light maintenance: view Securing the shaft head screws section for details.

If after unpacking and installation, the counter does not increment after the bellows move with each breath, the magnet spacing on the bellows may need to be adjusted.

First see if the hall sensor lights up with a faint red light when the magnet passes over it.

If it does light up, but nothing counts up, the issue is either because the piece is still in the homing phase, or it's having an electronic issue. In this case try restarting the piece.

If it does not light up, it's likely because the magnet is not close enough. To confirm if that's the case, press the right hand side of the Frame Motor and Rod Support towards the base block while the bellows is moving to get the pusher plate and the magnet closer to the hall sensor: be careful to avoid scratching the base block. Only touch the piece if you are wearing art handler gloves to avoid staining it. See image below as reference.



If the counter increments when a slight pressure is applied, this confirms the magnet needs to be adjusted. **Before proceeding to the following, please reach out to the studio to discuss the situation,** as there are a lot of details to watch out for and the artwork could be harmed in the process.

To adjust, first turn the piece off, then loosen the 4 screws around the Stepper motor: the whole arm assembly will move, the acrylic push plate will touch the bellows shroud, and it would need to be carefully held in place with an even gap all around while re-tightening the 4 screws, starting with those closest to the magnet. Once everything is secure, run the mechanism manually to ensure the acrylic or magnet is not rubbing against the sides. Switch it on and verify if the Hall sensor is now being activated.

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

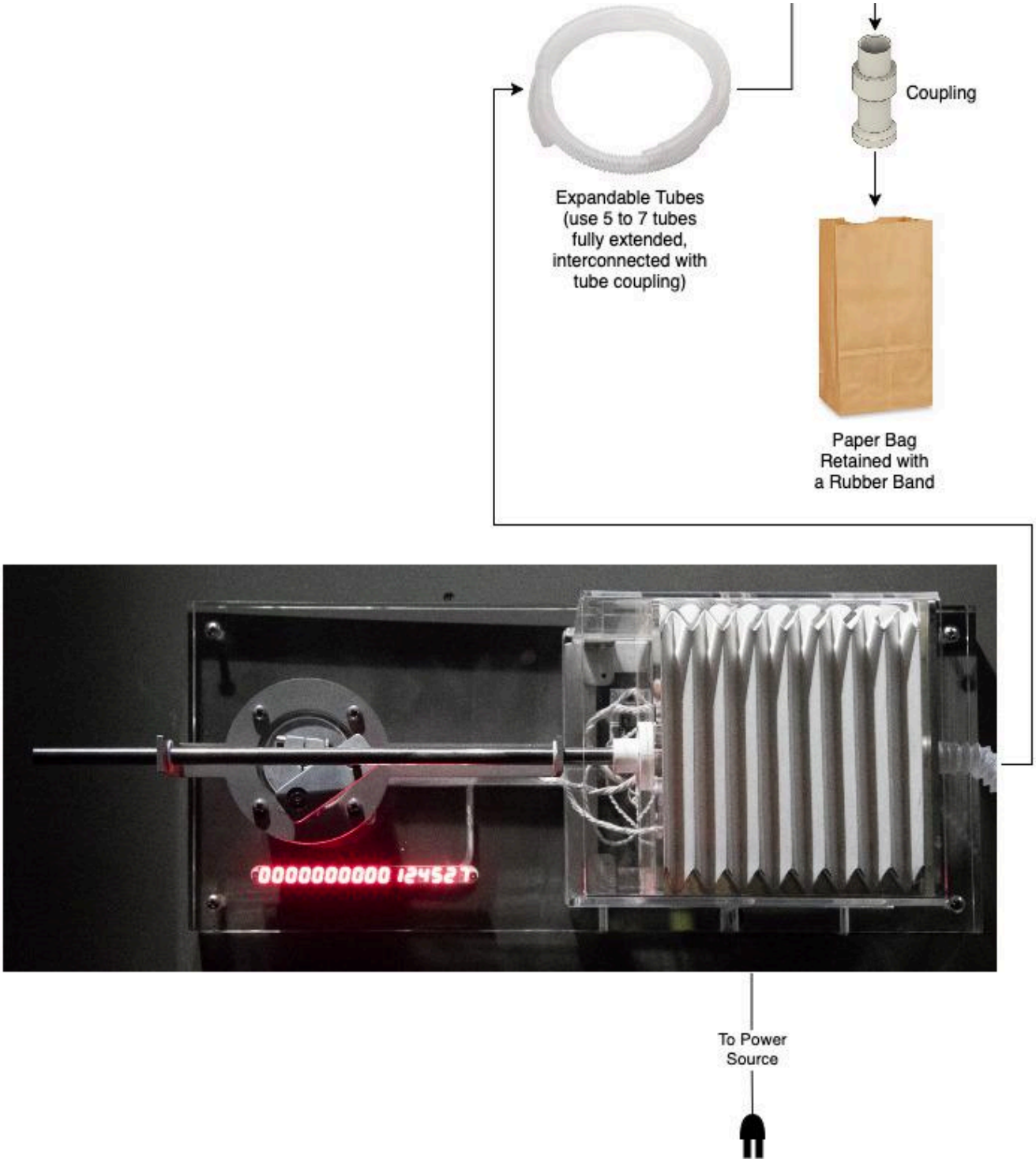
APPENDIX I - INSTALLATION

Description of Components

This artwork requires the following components:

Component	Description
Breathing Apparatus	Custom Acrylic case containing the bellows and electrical components of the piece.
Electrical Components	Within the apparatus, controls the bellows and their behaviour.
Other Hardware - Kraft Paper Bag	A paper bag that is inflated and deflated by the apparatus and air hoses.
Other Hardware - Expandable Tube	Carries the breath from the apparatus to the Kraft paper bag.
Other Hardware - Rubber Band	Neutral colored rubber band to secure the paper bag to the air hose.
Other Hardware - Video Playback Device	Used to playback the video recording of the person's last breath contained in the artwork.

Wiring Diagrams and Connections



Refer to the Technical Data sheets for more information about the different components.

APPENDIX II - TECHNICAL DATA SHEETS

Breathing Apparatus

The acrylic, metal and mechanical components that comprise the main structure of Last Breath. The breathing apparatus also contains the electrical components, which are described in a different section.

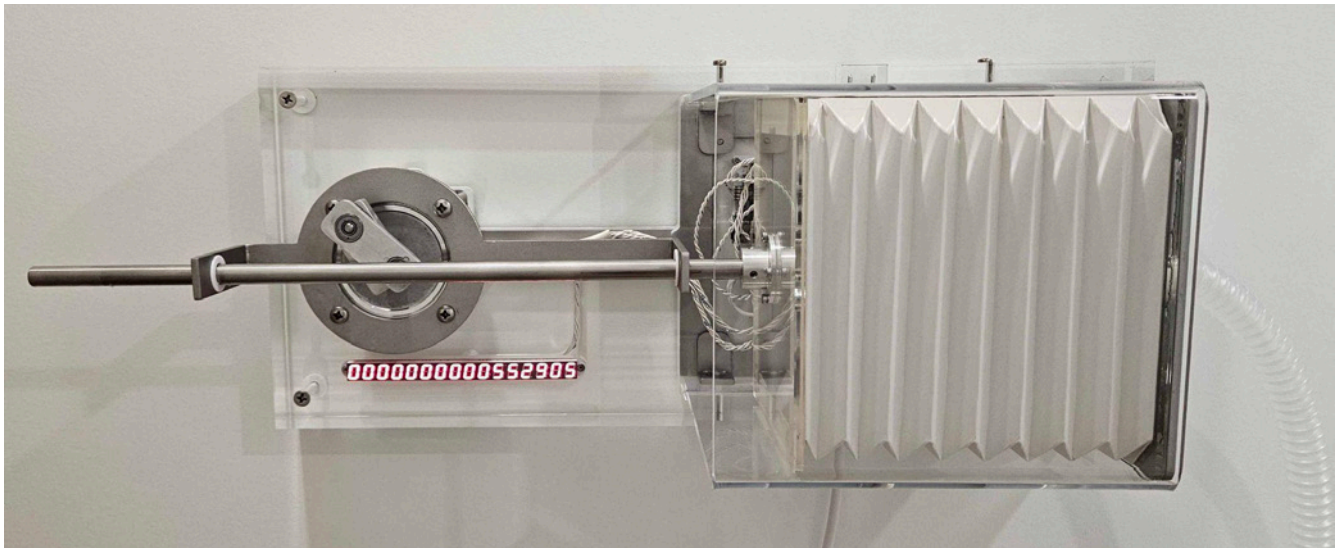


Image for representation only, the edition you have in hand might slightly differ from this image.

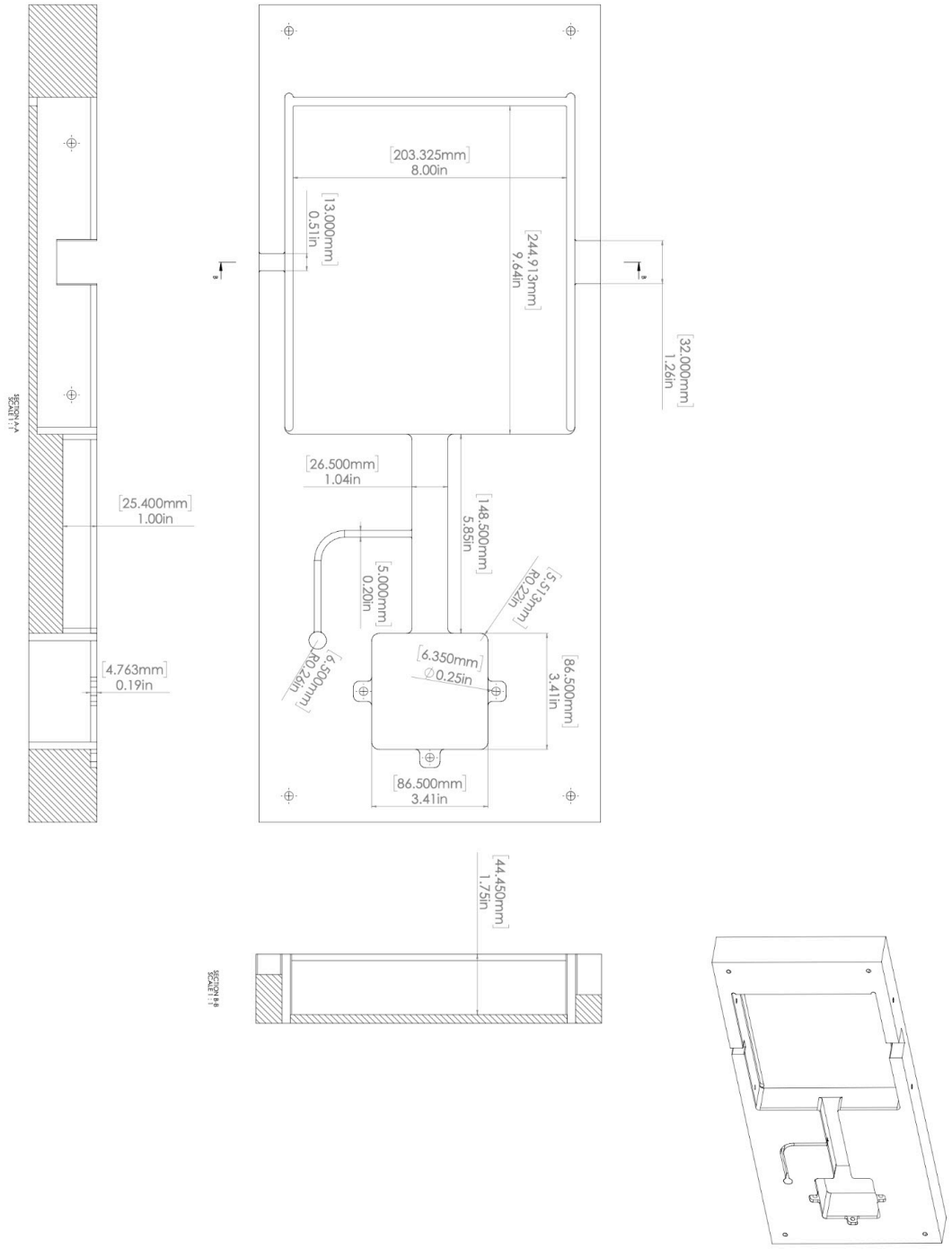
Bill of Material

Component	Quantity	Manufacturer	Part Number
Acrylic Base Block	1	Custom Made	
Acrylic Pusher Plate	1	Custom Made	
Vinyl Sticker	1	Custom Made	
Acrylic Bellows Case	1	Custom Made	
Acrylic Electronics Plate	1	Custom Made	
Acrylic End Cap Plate	1	Custom Made	
Housing Shim A	2	Custom Made	
Housing Shim B	2	Custom Made	
Frame Assembly			
Frame Bottom Plate	1	Custom Made	
Frame Bellows End Cap Plate	1	Custom Made	
Frame Corner Tabs	1	Custom Made	
Frame Tabs	1	Custom Made	
Frame Motor and Rod Support			
Frame Motor Support	1	Custom Made	
Frame Rod Support	1	Custom Made	
Rod (modified)	1	McMaster-Carr	6061K53
Crankshaft	1	Custom Made	
Bearings and Lever	1	Custom Made	
Bellows Wall Junction	1	Custom Made	
Air Hose Fitting	1	Custom Made	
White Bellows	1	Nabell	ATMR-PF-032812
Light Duty Dry-Running Flanged Sleeve Bearings (alternative in PTFE possible)	2	McMaster-Carr	6389K418 (alternative: 2706T24)
Tapered Heat-Set Inserts (Motor)	4	McMaster-Carr	4180A363
Motor Screws (Front)	4	McMaster-Carr	90116A311
Motor Screws (Back)	7	McMaster-Carr	92095A238
Stepper Motor Standoffs	4	Custom Made	
Bellows Case Screws	4	McMaster-Carr	90116A267
Bellows Case Washers	4	McMaster-Carr	90965A160
Bellows Case Hex Nut	4	McMaster-Carr	94150A340
Electronic Plate Mounting Screws	4	McMaster-Carr	97654A205
Electronic Mounting Screws	12	McMaster-Carr	90116A161 / 90116A155
Electronic Mounting Hex Nut	12	McMaster-Carr	91828A211

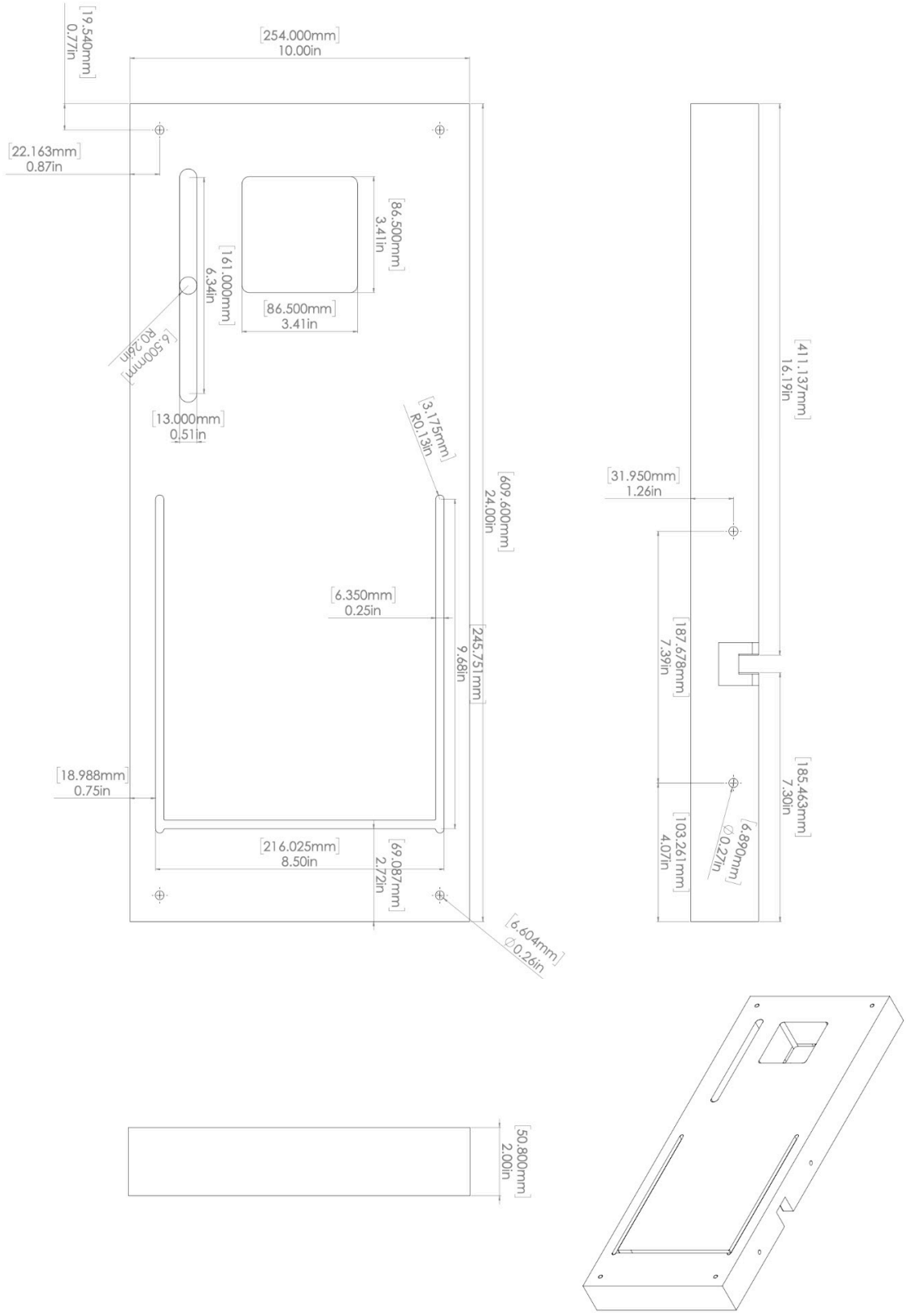
Base Block

Made of transparent acrylic. Forms the main base of Last Breath. The measurements and cuts slightly fluctuate within different iterations, please refer to your physical edition to confirm its exact dimensions.

Front

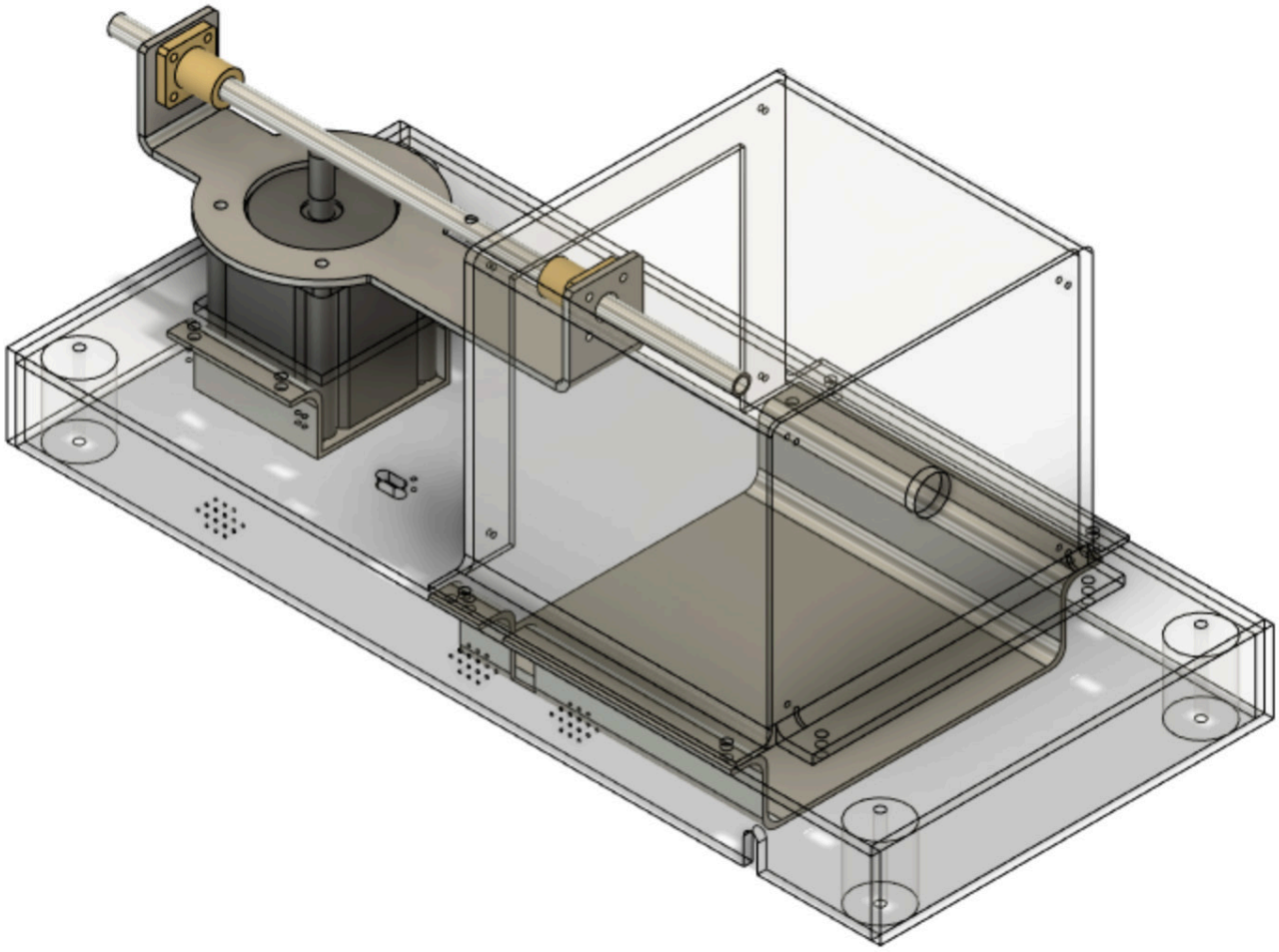

[203.325mm]
8.00in
[13.000mm]
0.51in
[244.913mm]
9.64in
[32.000mm]
1.26in
[26.500mm]
1.04in
[148.500mm]
5.85in
[5.000mm]
0.20in
[6.500mm]
R0.26in
[6.350mm]
∅0.25in
[86.500mm]
3.41in
[25.400mm]
1.00in
[4.763mm]
0.19in
[44.450mm]
1.75in

Back


19.540mm
0.77in
254.000mm
10.00in
22.163mm
0.87in
86.500mm
3.41in
161.000mm
6.34in
86.500mm
3.41in
6.500mm
R0.26in
13.000mm
0.51in
3.175mm
R0.13in
609.600mm
24.00in
6.350mm
0.25in
245.751mm
9.68in
18.988mm
0.75in
216.025mm
8.50in
69.087mm
2.72in
6.604mm
Ø0.26in
411.137mm
16.19in
31.950mm
1.26in
187.678mm
7.39in
185.463mm
7.30in
103.261mm
4.07in
6.890mm
Ø0.27in
50.800mm
2.00in

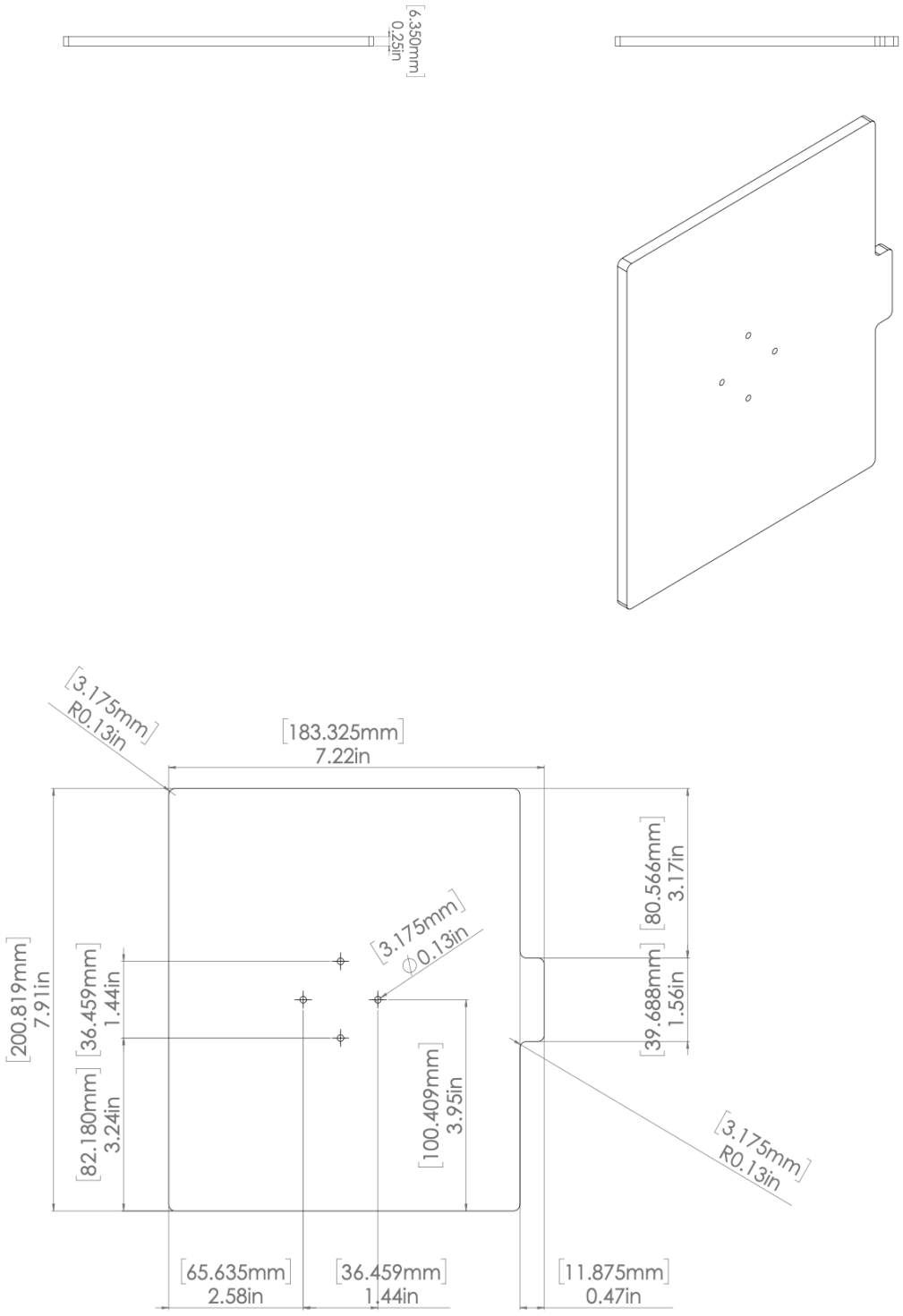
Earlier version

In the earlier editions, the Base Block was a Plexiglass assembly done with a front sheet, 4 sides, and 4 pillars glued together. The measurements and cuts slightly fluctuate within different iterations, please refer to the original Last Breath manual and your physical edition to confirm its exact dimensions.



Pusher Plate

Made of transparent acrylic. Connects to the steel rod to push the bellows. A magnet is glued onto the short edge of the acrylic plate.



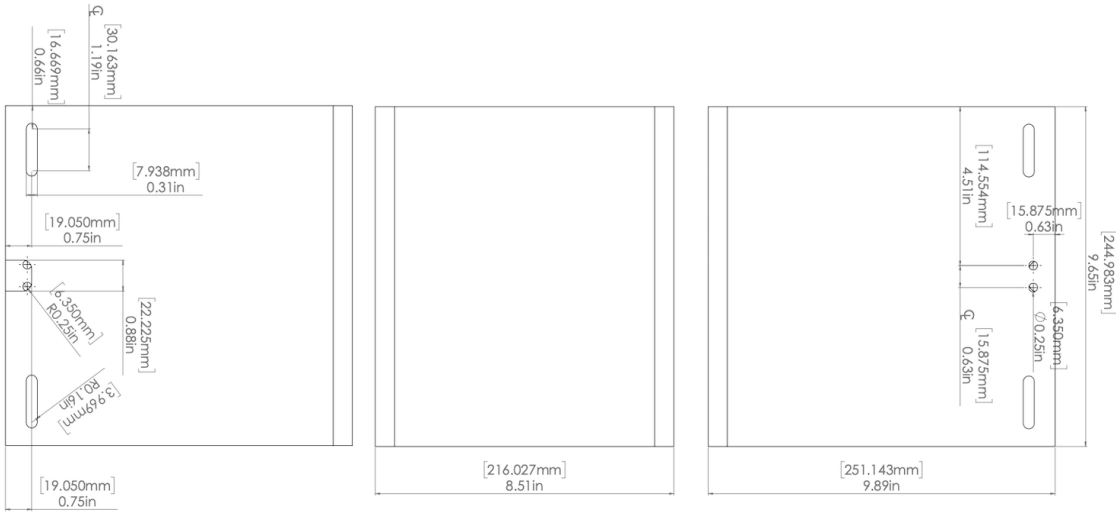
Magnet

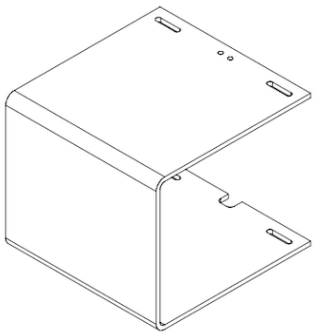
A Neodymium Magnet High-Temperature glued to the edge of the pusher plate using VHB tape as shown in the next picture.

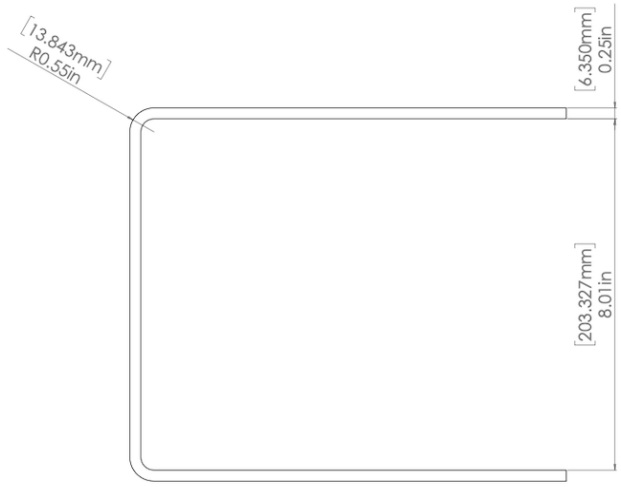
Specification	Details
Thickness	0.1”
Width	¼”
Length	1”
Source	McMaster-Carr
Model	5848K68

Bellows Case

Made of transparent acrylic, covers and protects the bellows.

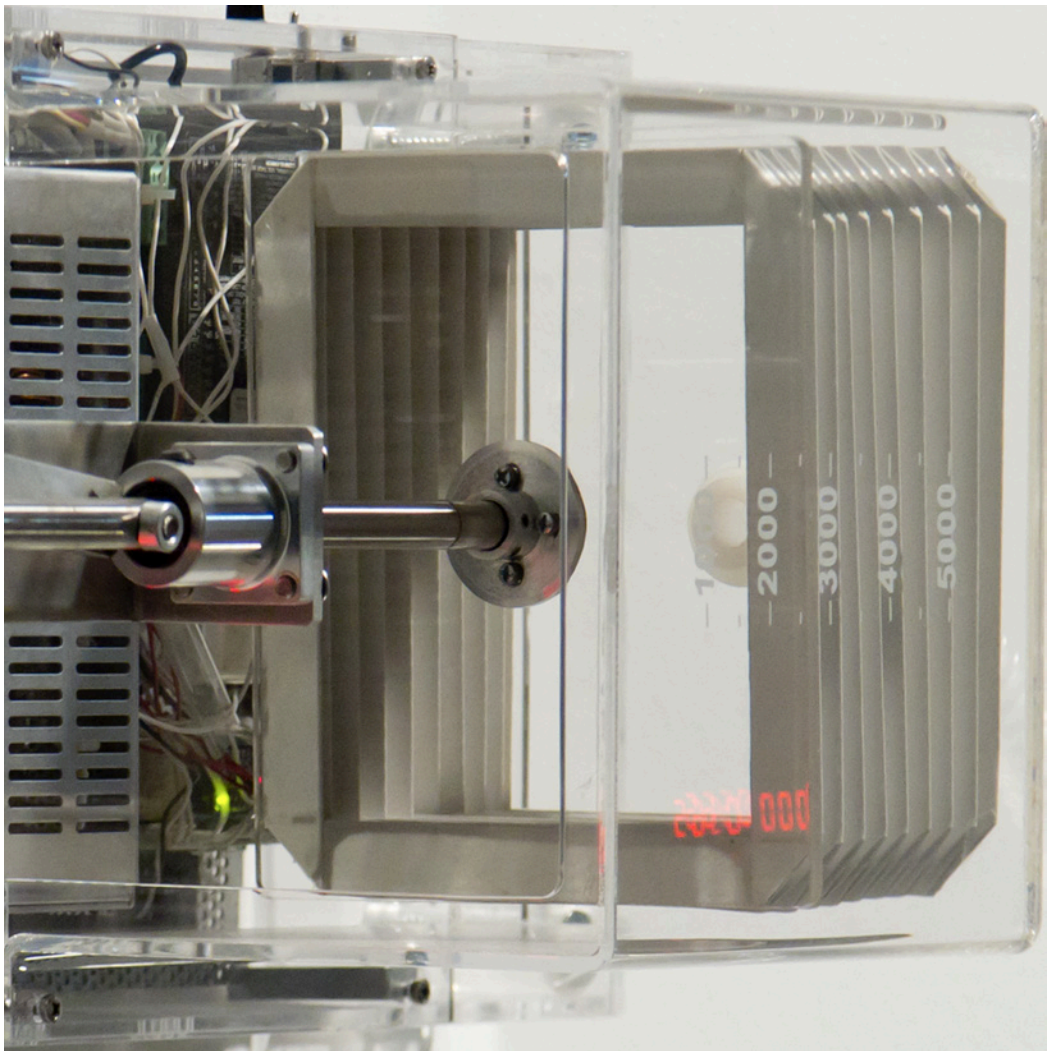






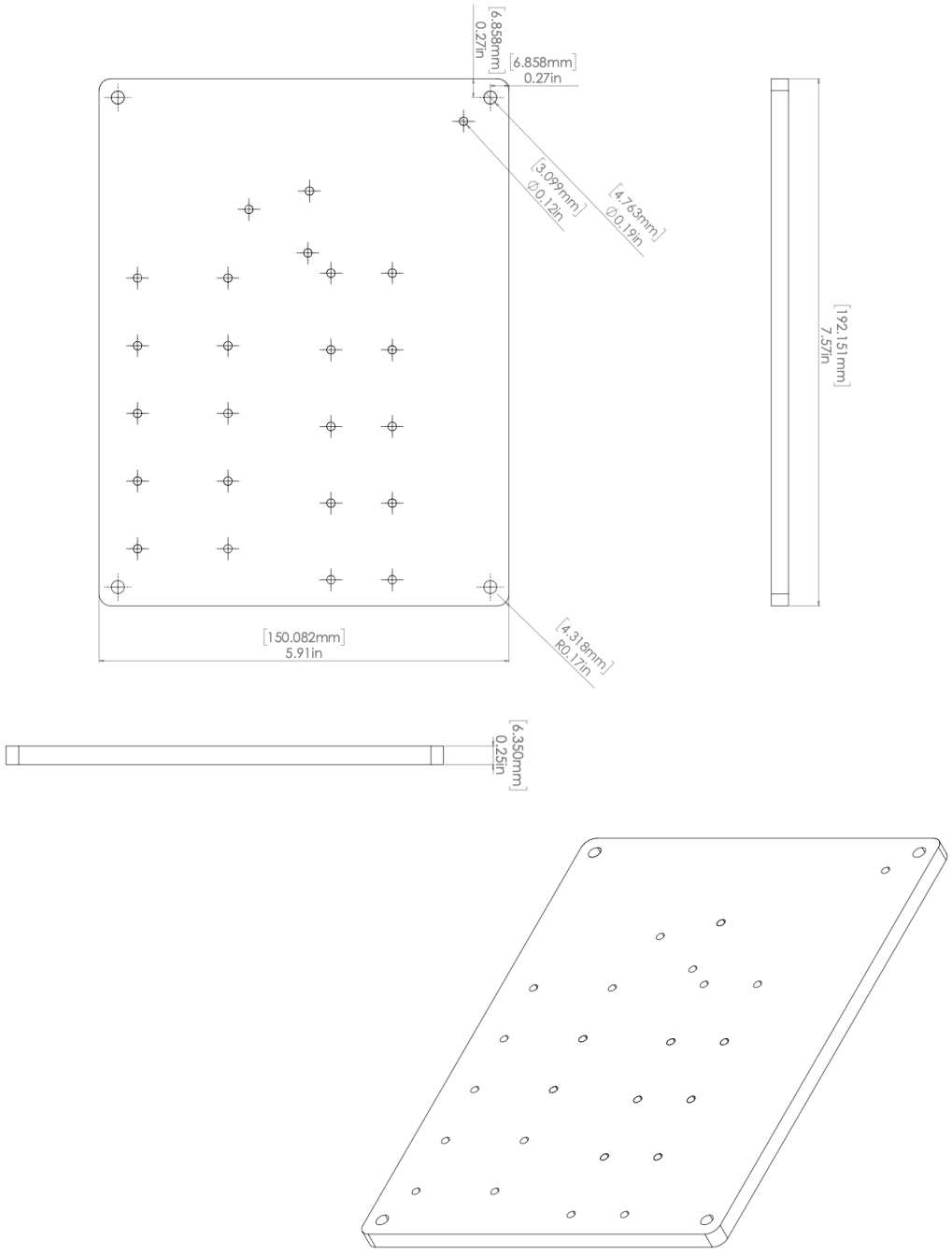
Vinyl Sticker

In first editions of the artwork, the bellows case had white vinyl stickers applied on it, showing the volume of air contained in the bellows, in its current position: from 1000 to 5000 as shown below. Note the artist decided, in the late editions, to not install these decals.



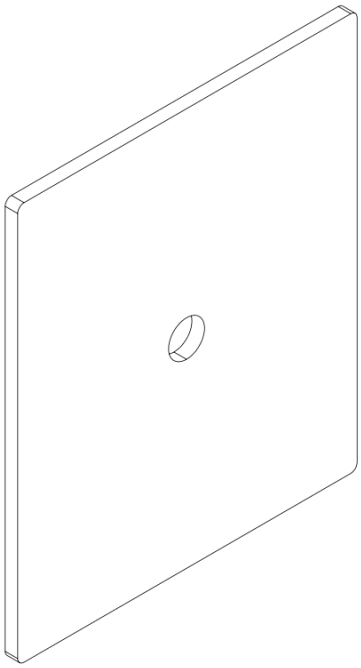
Electronics Plate

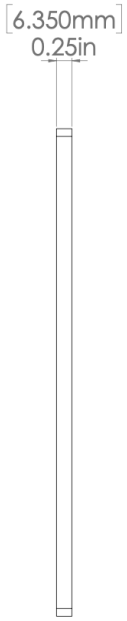
Made of transparent acrylic. Supports the electronic components that control the motor and display. In previous editions of the piece different methods of attaching the electrical components were used, including double sided-glue, tie wrap, screws and nuts, etc. At the time of writing this manual, the preferred method is screwing the electrical components in place using the screws noted in the Electrical Components: Bill of Material.

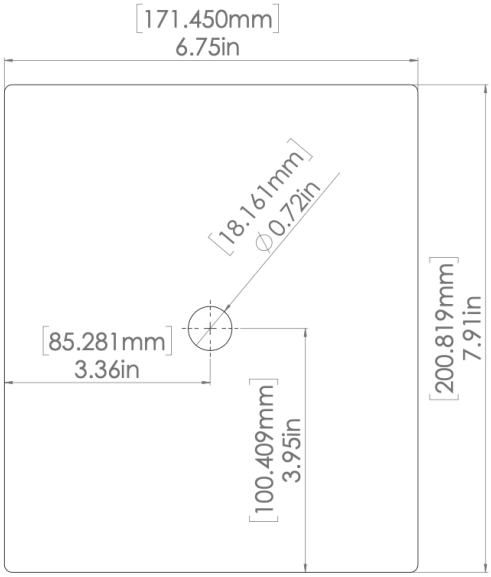


End Cap Plate

Made of transparent acrylic. Connects the air hose to the bellows chamber allowing air to be pushed into the paper bag.



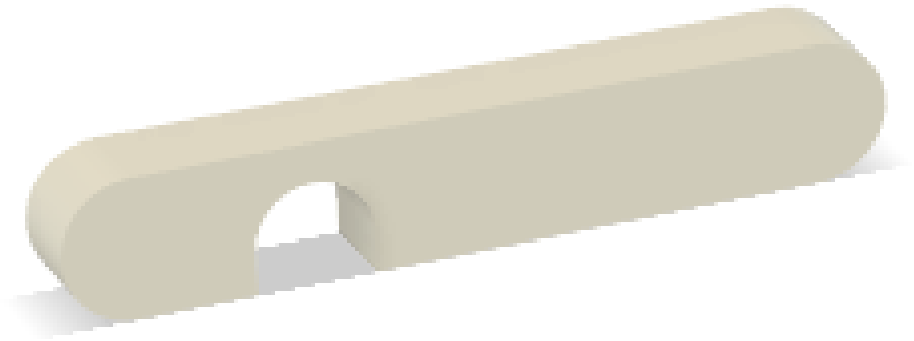




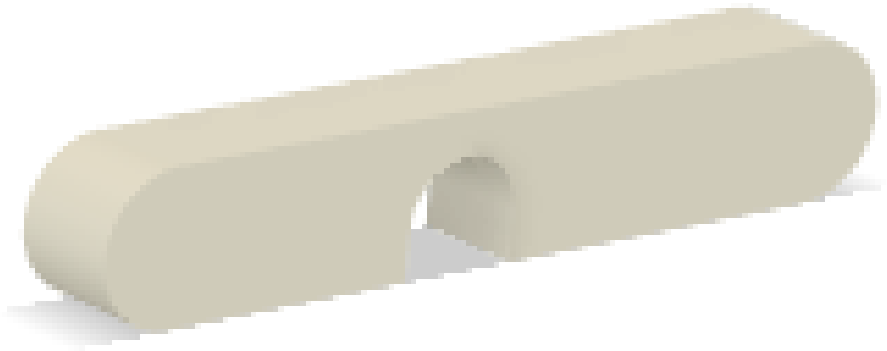
Housing Shims

There are 4 shims used to secure the Bellows Case to the Base Block and to the Frame Bottom Plate. These exist in 2 different pairs (Shim A and Shim B) and are 3D printed in white matte PLA. They sit in the slotted holes of the bellow case, precisely positioning and keeping it in place.

The Shim A is installed closer to the stepper motor. A step file is typically included in the provided USB key.

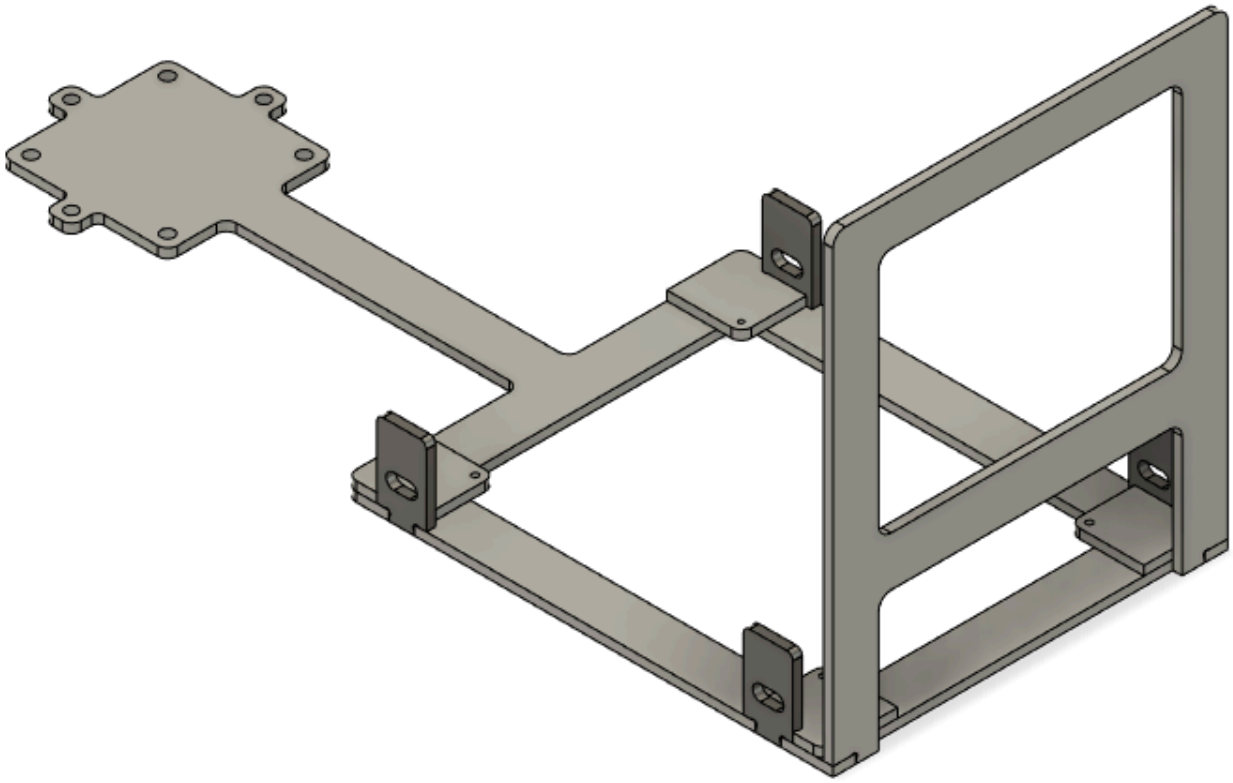


The Shim B is installed closer to the air hose fitting. A step file is typically included in the provided USB key.



Frame Assembly

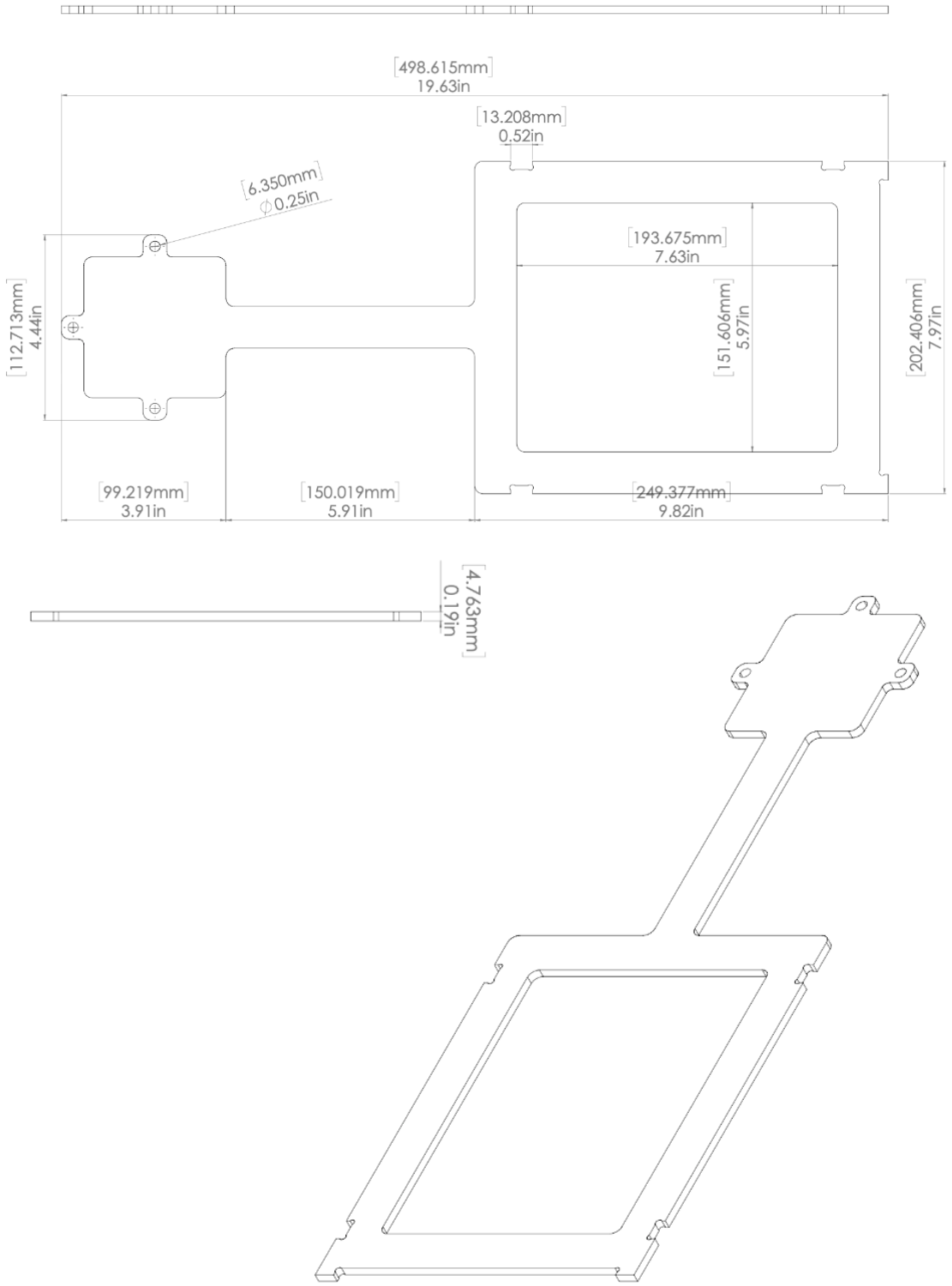
The frame assembly is made by welding the Frame Bellows End Cap Plate, four Frame Corner Tabs and four Frame Tabs together. The different mentioned elements are described in the next pages.



3D view of of the Frame assembly

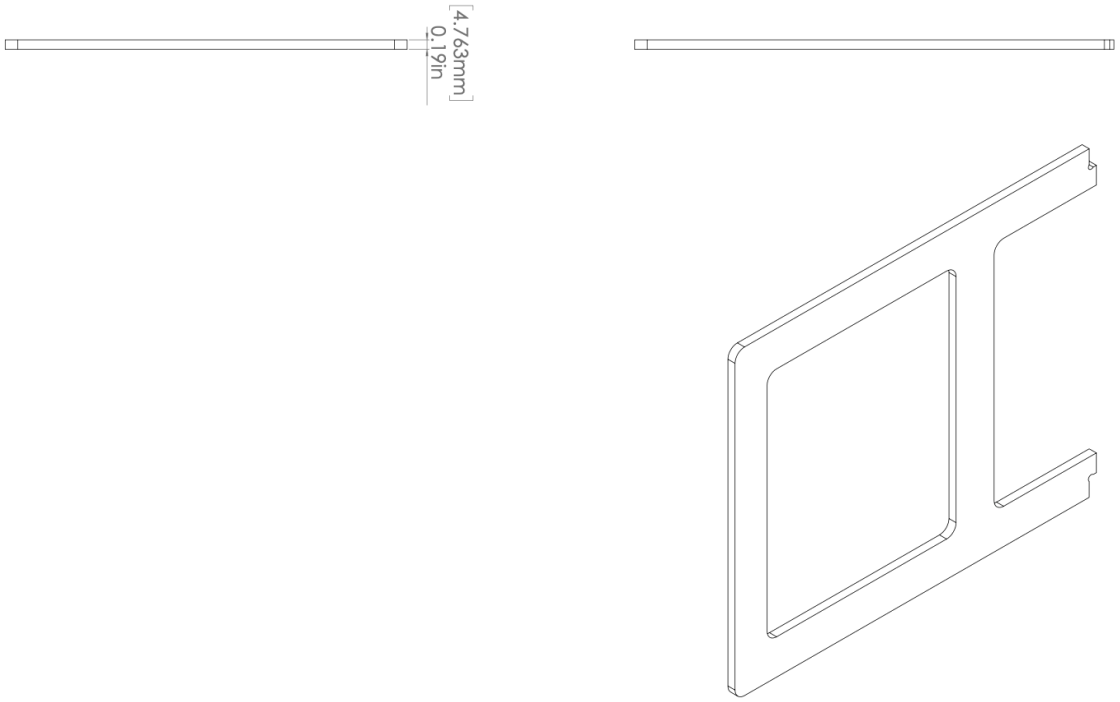
Frame Bottom Plate

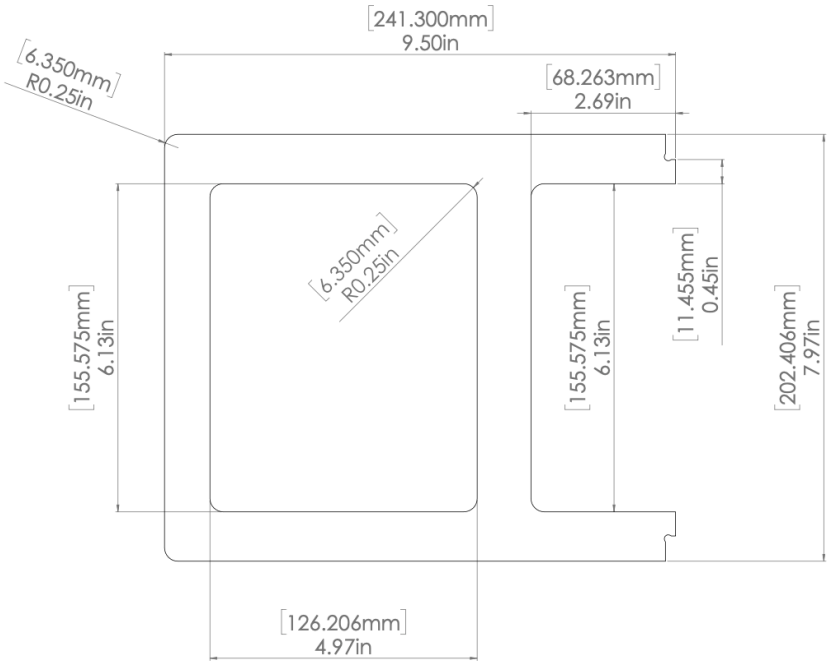
Custom machined from stainless steel powdercoated light grey. Placed inside the Base Block.



Frame Bellows End Cap Plate

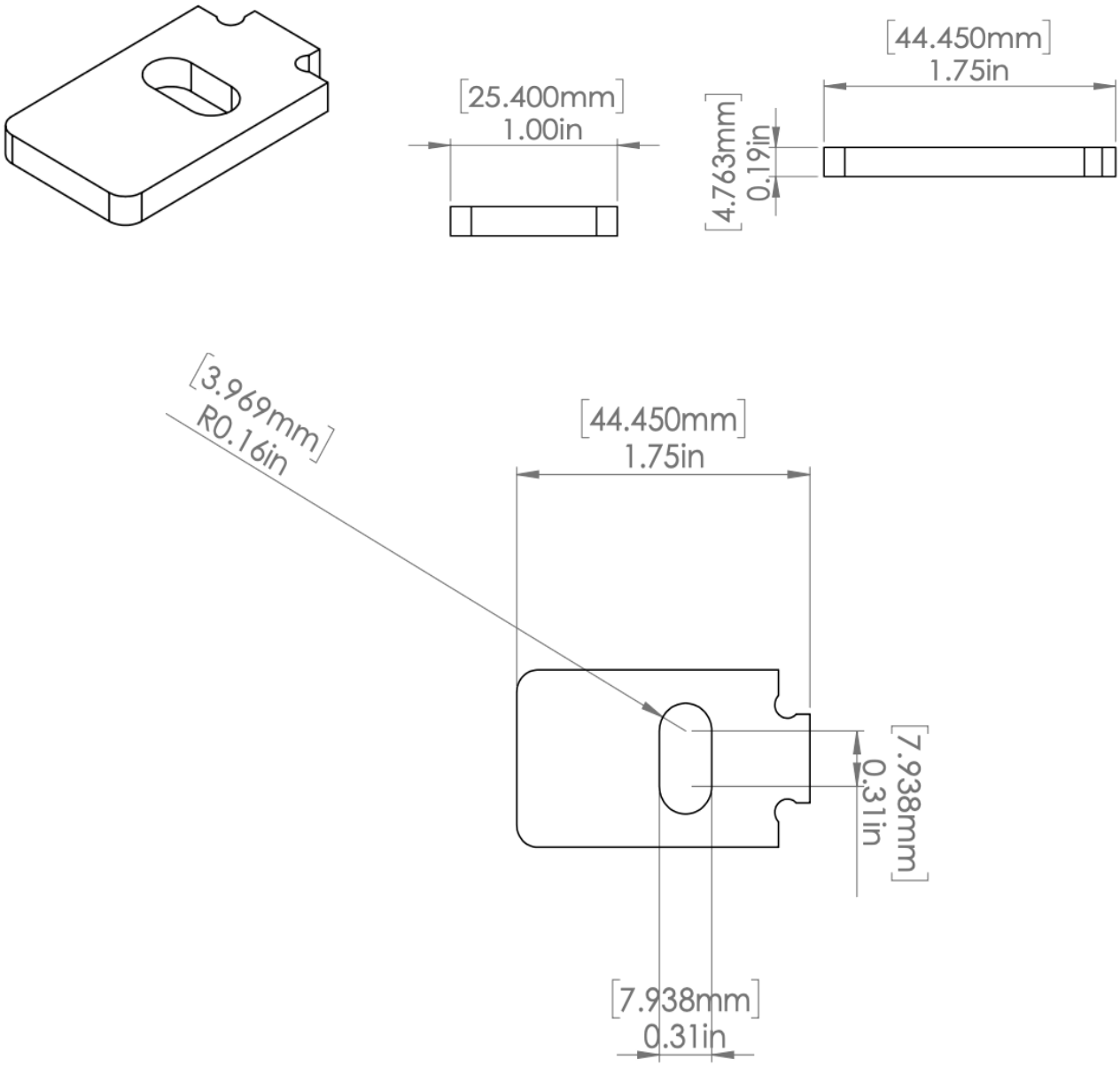
Custom machined from stainless steel powdercoated light grey. Welded to the Frame Bottom Plate. The End Cap Plate has been glued onto this Frame Bellows End Cap Plate with 3M VHB tape.





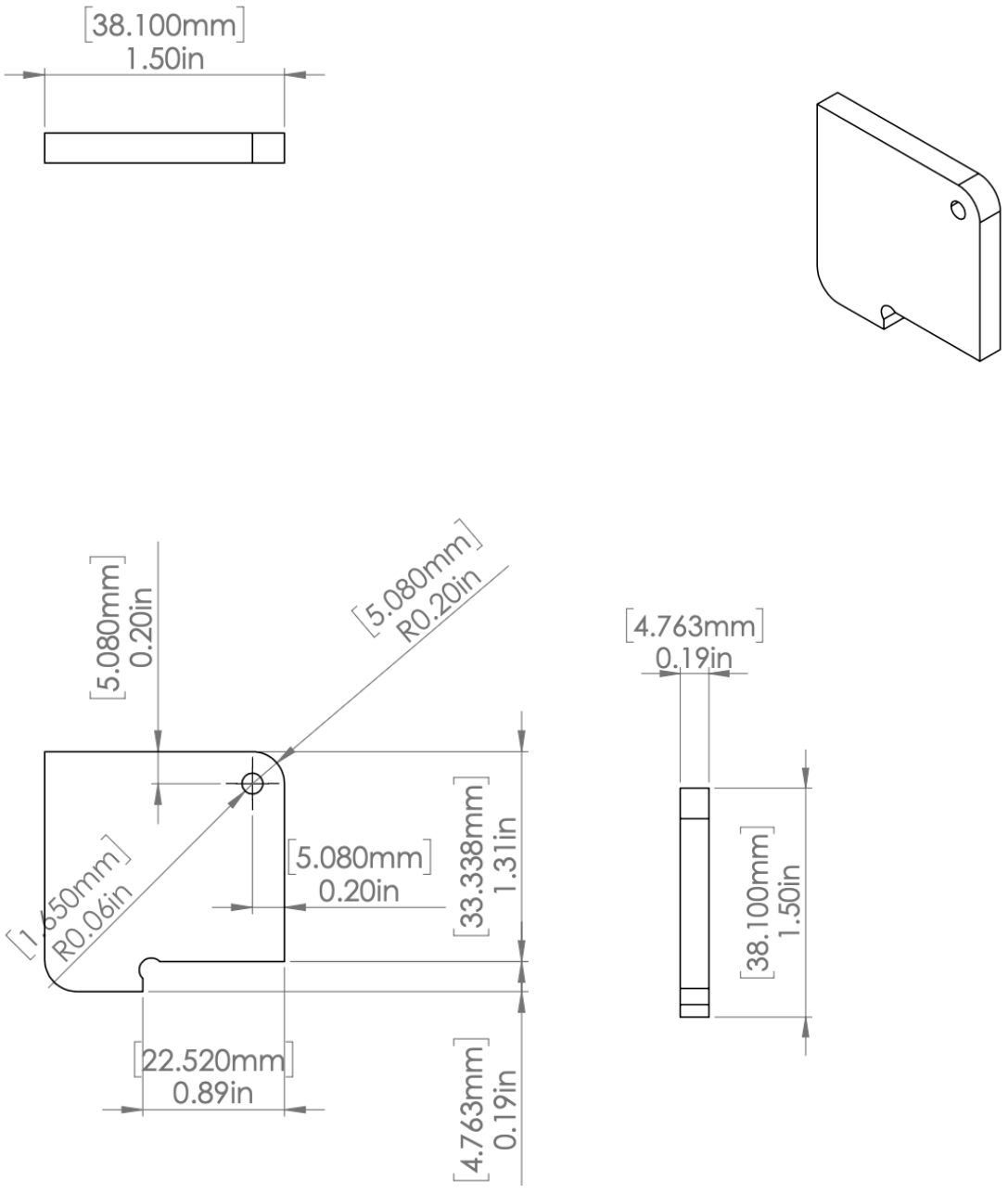
Frame Corner Tabs

Four custom machined from stainless steel powdercoated light grey, used to reinforce the corners of Last Breath. Welded to the Frame Bottom Plate.



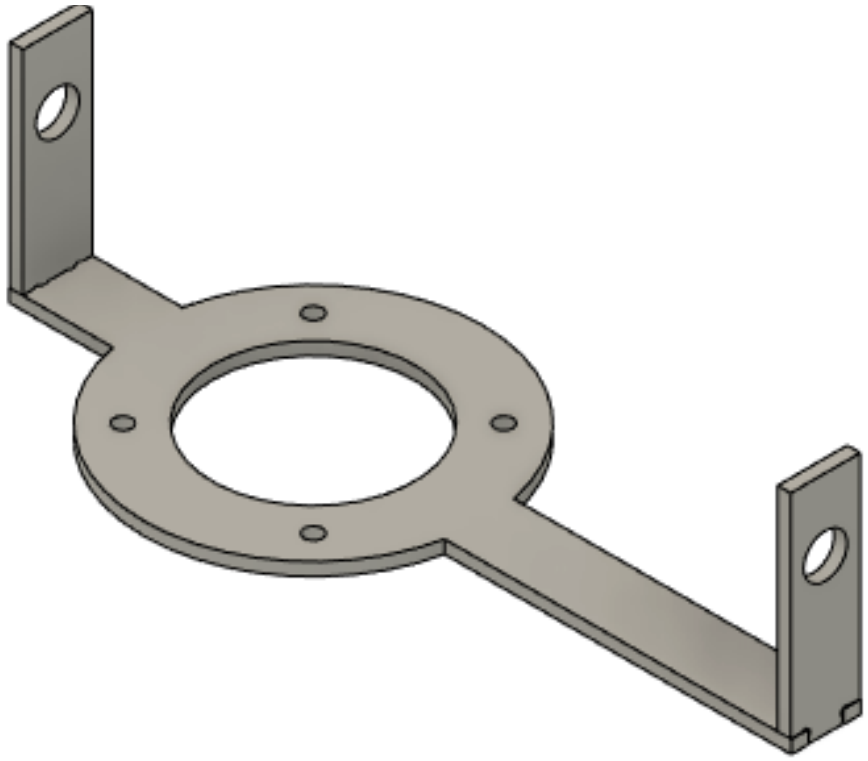
Frame Tabs

Four custom tabs machined from stainless steel powdercoated light grey, used to support the frame of Last Breath. Welded to the Frame Bottom Plate.



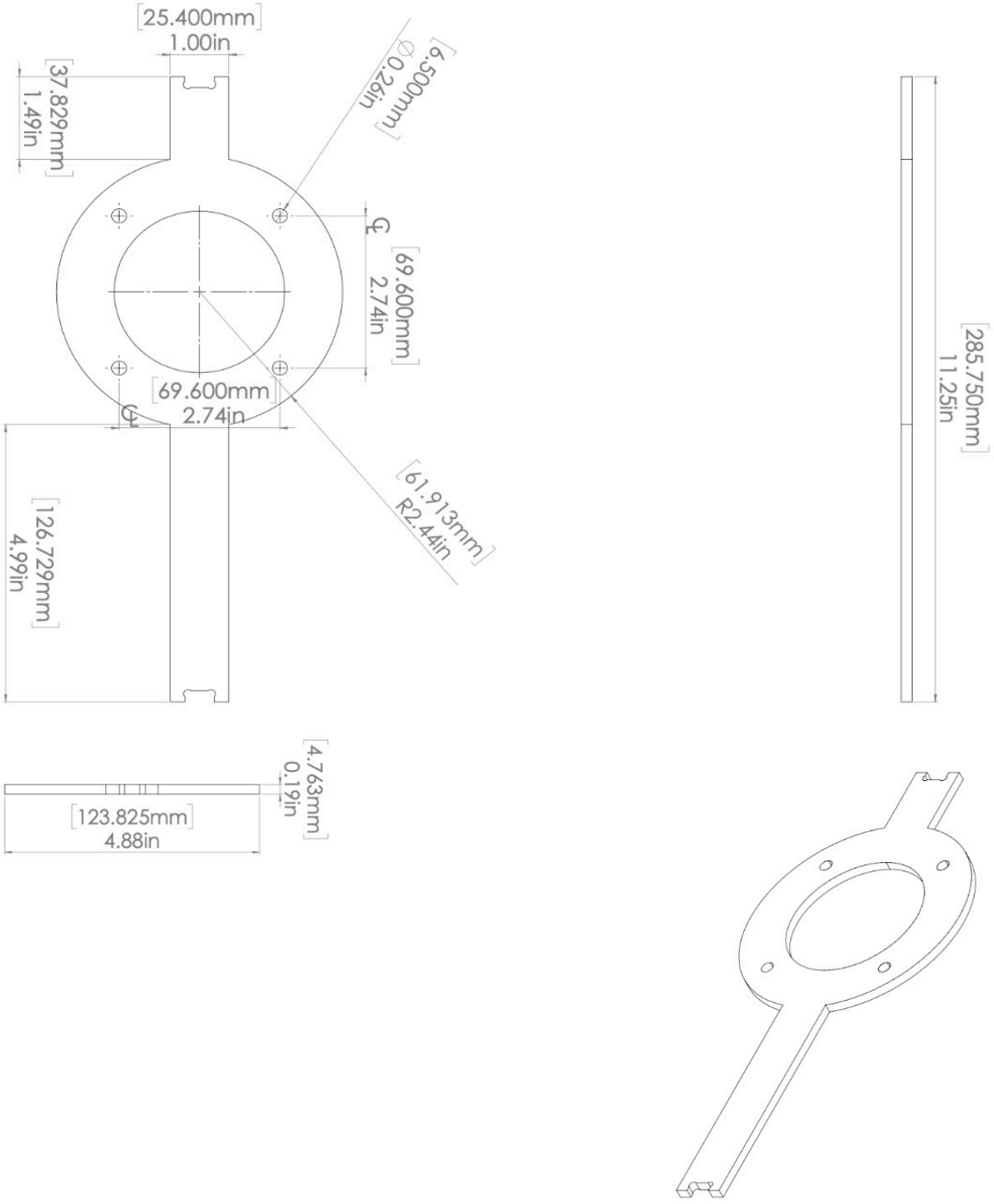
Frame Motor and Rod Support

Custom machined from stainless steel powdercoated light grey. Used to support the stepper motor and align the rod in the right axis. Three parts are welded together to make this assembly: the Frame Motor Support and two Frame Rod Supports.

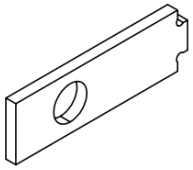


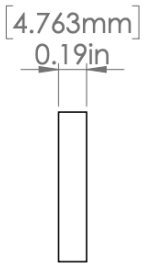
3D view of the Frame Motor and Rod Support assembly

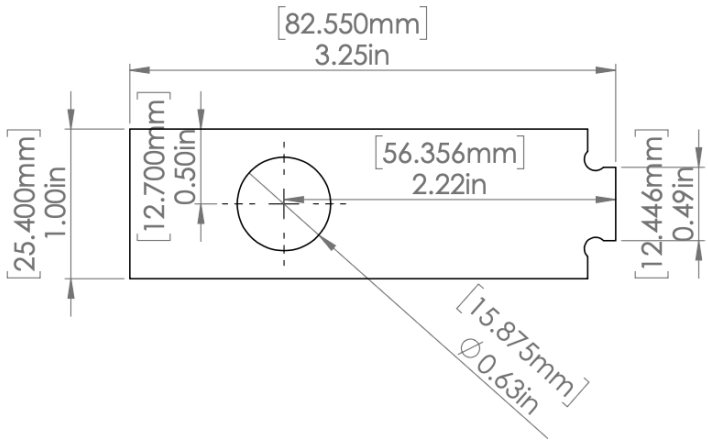
Frame Motor Support



Frame Rod Support

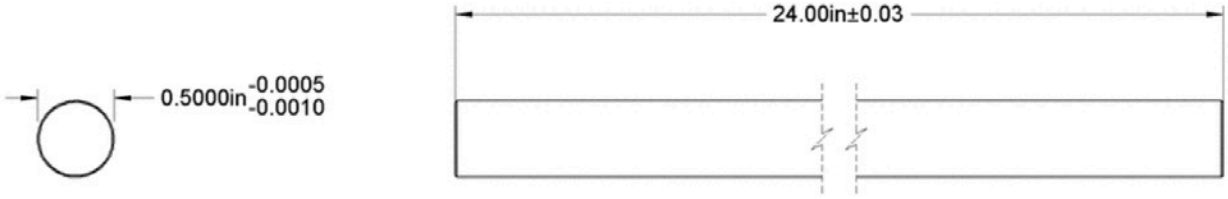






Rod

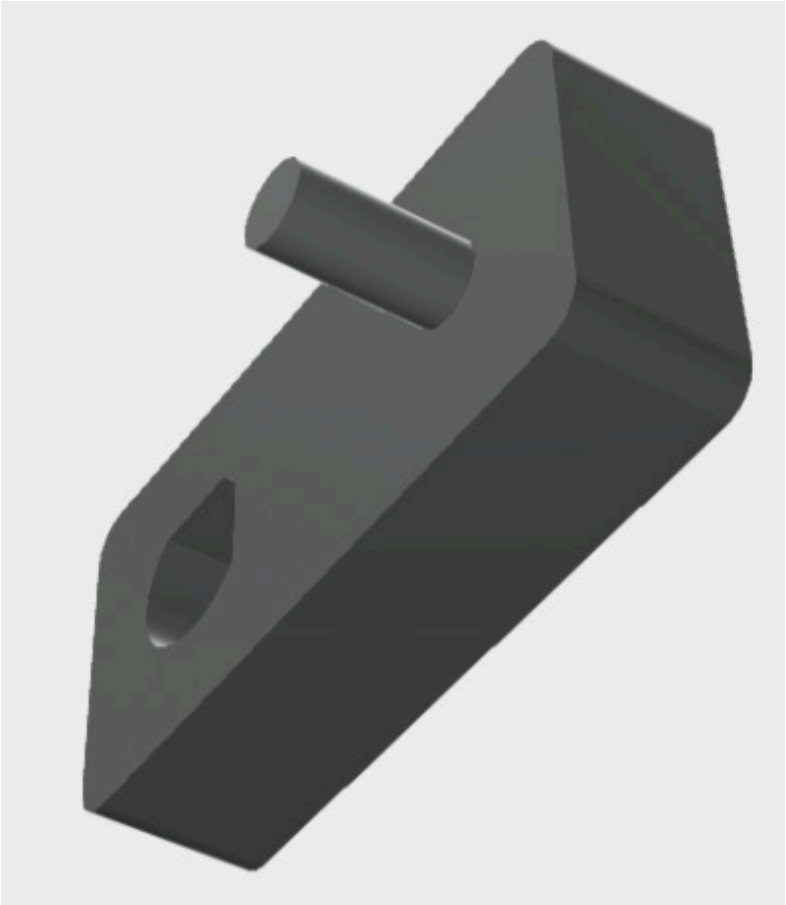
A custom machined peg is added to this off the shelf component. Details of this can be found in the provided digital assembly model contained within the USB key provided with your edition.



Specification	Details
Material	Carbon Steel
Length	24 in
Diameter	½ in
Edge Type	Chamfered
Hardness	Rockwell C60

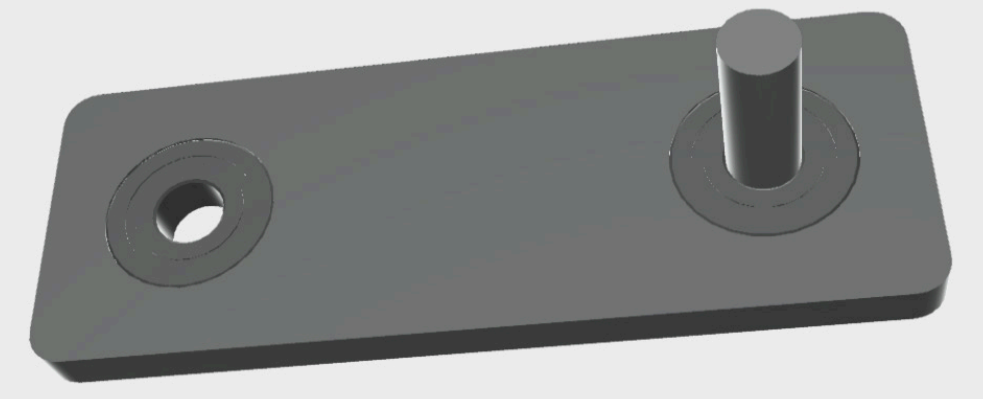
Crankshaft

Custom machined from brushed aluminum, this part is secured to the Stepper Motor with the use of an M3 set screw, and is connected to the Bearings and Lever by a ¼" steel pin, pressfitted in the crankshaft. Details of this can be found in the provided digital assembly model contained within the USB key provided with your edition.



Bearings and Lever

Some custom assembly was performed on the off the shelf parts. Connected to the Crankshaft by a pin. Details of this can be found in the provided digital assembly model contained within the USB key provided with your edition.

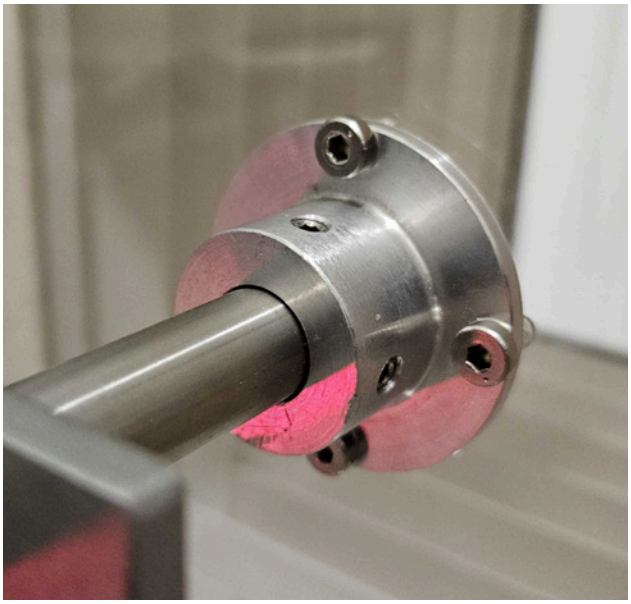


The two bearings in use are acquired from McMaster-Carr, model 6138K54, and their main specs are as follows:

Specification	Details
Trade Number	R4-2Z
Load Direction	Radial
Seal Type	Shielded
Inner Ring Type	Standard
Ball Bearing Type	Standard
Shaft Type and Diameter	Round ¼”
ID Tolerance	-0.0003” to 0”
Width	0.196”
Ring and Ball Material	440C Stainless Steel
Cage and Shield Material	304 Stainless Steel
Radial Load Capacity	260 lbs

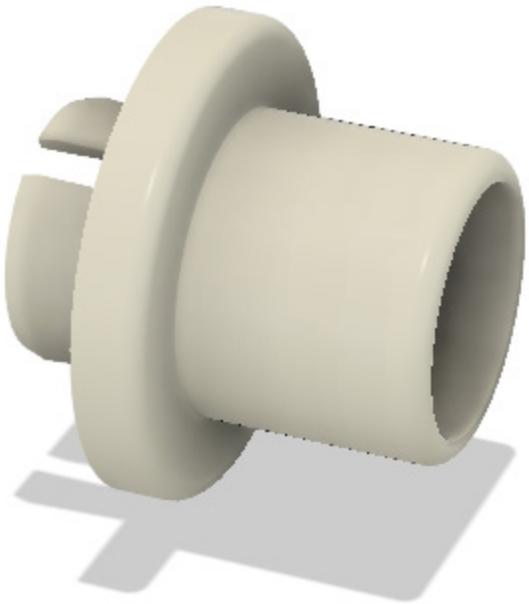
Bellows Wall Junction

Used to attach the shaft to the bellows back plate. In previous versions this part was machined from Aluminium as seen in the image on the left below. At the time of writing this manual it is 3D printed with PLA matte white material as seen in the image on the right below. A step file is typically included in the provided USB key.



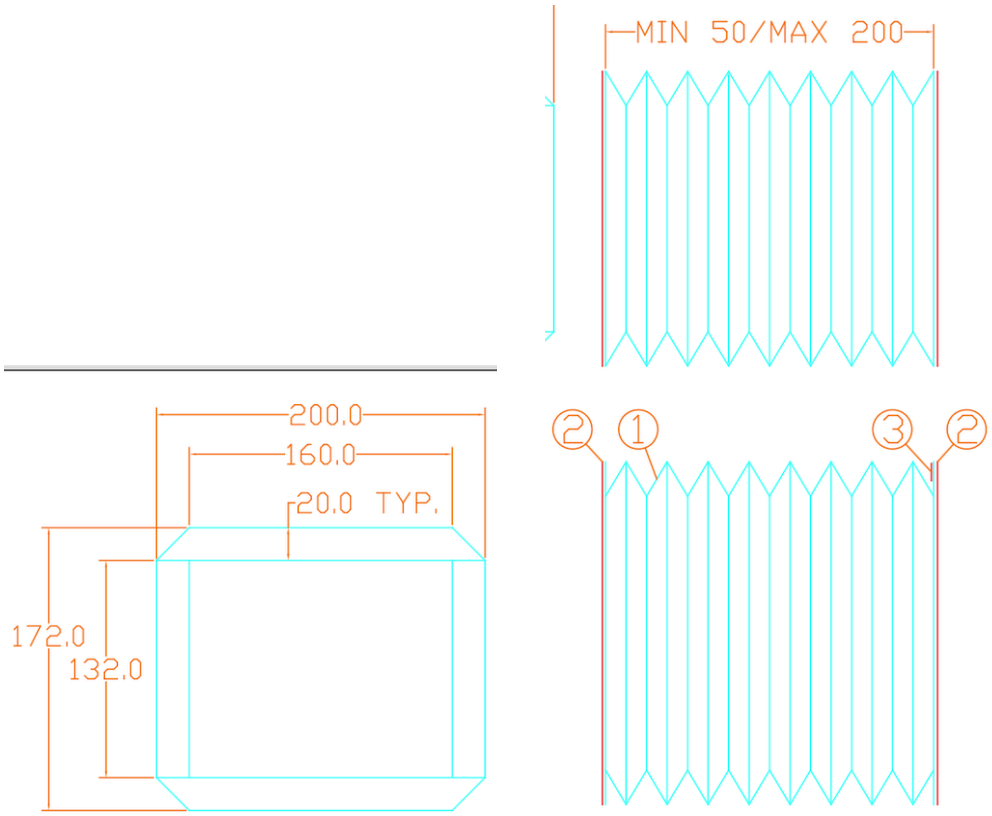
Air Hose Fitting

Connects the air hose to the bellows front plate. In previous versions this was made with nylon. At the time of writing this manual they are made out of PLA matte white material. A step file is typically included in the provided USB key.



White Bellows

Used to push air into the paper bag. The surface is polyurethane coated nylon, the core is polymer film and the back is polyurethane coated nylon. Double sided tape on either end of the bellow is used to secure it to the acrylic plates.

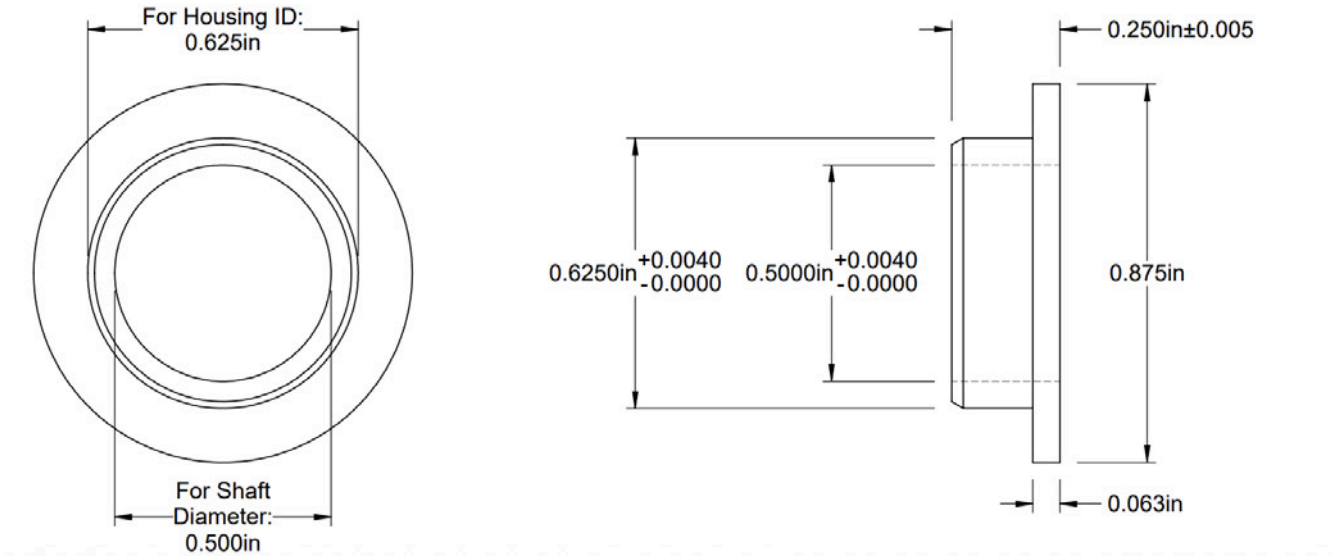


TOLERANCES NOT OTHERWISE SPECIFIED	DIMENSIONS ARE IN METRIC/[ENGLISH]
6 & Under ± 0.1 30 & Under ± 0.2 120 & Under ± 0.3 315 & Under ± 0.5 Over 315 ± 0.8	PITCH=20
	OPEN PITCH=25
	FOLDS/BLOCK=8
	BLOCKS=1
	TOTAL FOLDS=8

REV.	DATE	BY	COMMENT
REL	03/28/12	JED	RELEASE
REVA	02/25/14	HMR	CHANGED CORE MATERIAL FROM PET4 TO PET 10

Dry-Running Flanged Sleeve Bearings

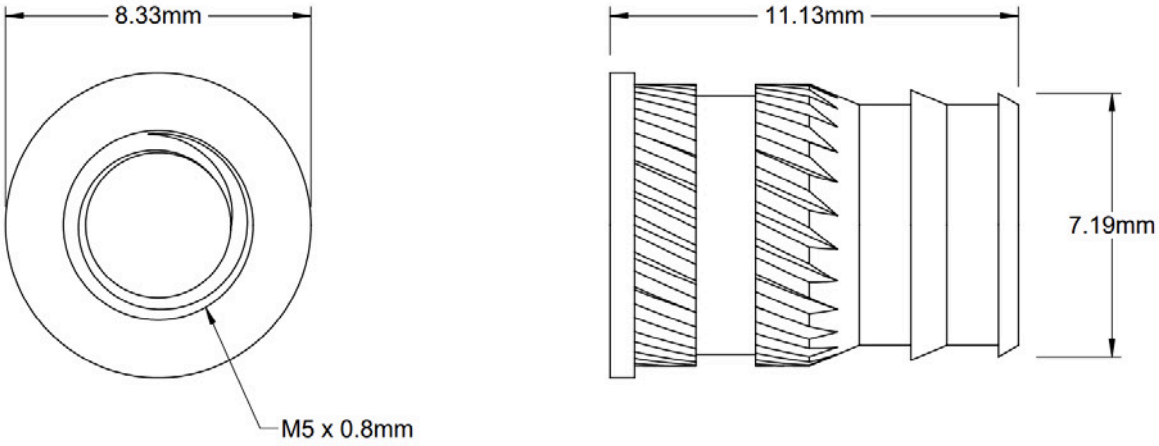
This element is used in order to center the rod within the Frame Rod Support, ensuring smooth linear movement of the rod and preventing friction, residues and noise. Generally in nylon, a PTFE option could also be used, with units having more friction between the rod and the rod support. A precise press-fit between the bushing, the support, and the rod is essential for quiet, low-friction operation without the need for lubrication.



Specification	Details
Source	McMaster-Carr
Model	6389K418 (or 2706T24)
Material	Nylon Plastic (or PTFE)
Shaft diameter	½ in
Color	White

Tapered Heat-Set Inserts for Plastic

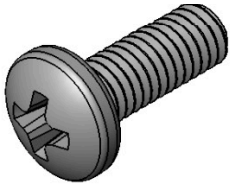
Used to help secure screws in the Base Block, for the Frame Bottom Plate assembly.

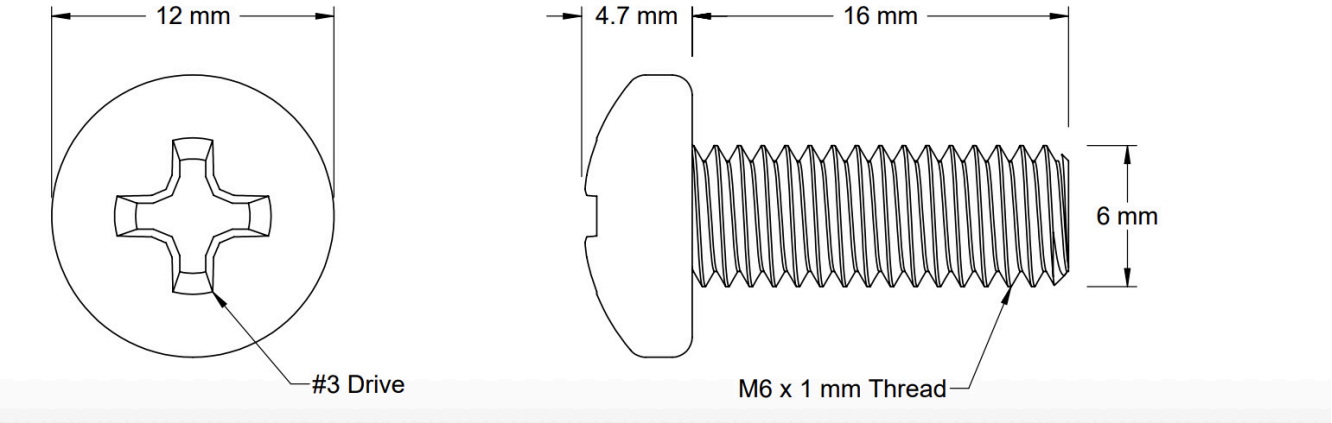


Specification	Details
Material	Brass

Motor Screws (Front)

Secures motor to the Frame Motor and Rod Support.

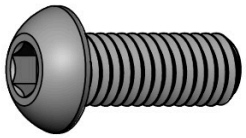


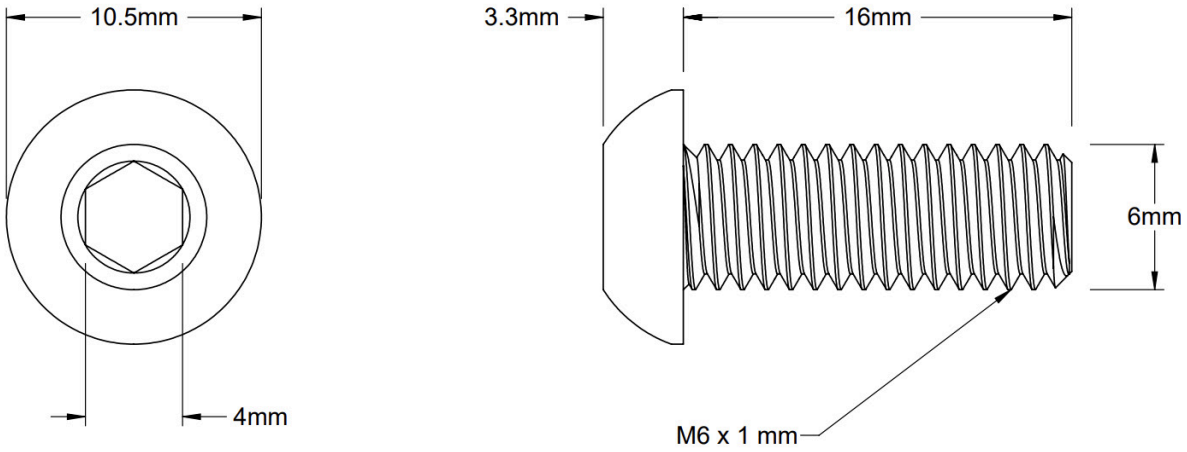


Specification	Details
Material	316 Stainless Steel
Thread Size	M6

Motor Screws (Back)

Secures to the Frame Bottom Plate.





Specification	Details
Material	Passivated 18-8 Stainless Steel
Thread Size	M6

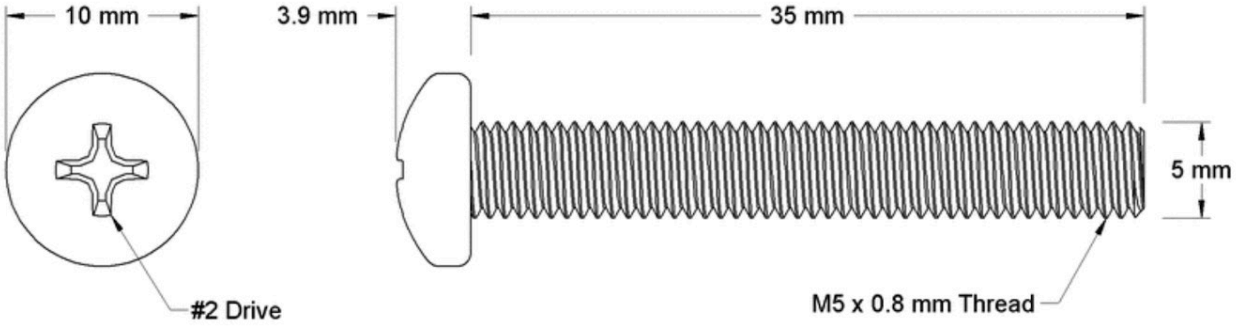
Stepper Motor Standoffs

Custom machined from aluminum and used to secure the Stepper Motor to the Frame Bottom Plate.

Specification	Details
Material	Aluminum
Tap Thread Size	M6
Length	85.725 mm (3 ⅜”)
Outer Diametre	9.525 mm (⅜")

Bellows Case Screws

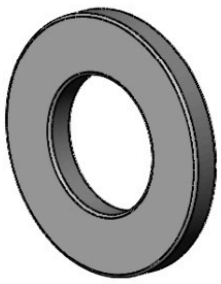
Used to secure the Bellows Case and the Frame Assembly (Frame Corner Tabs) and the Base Block.

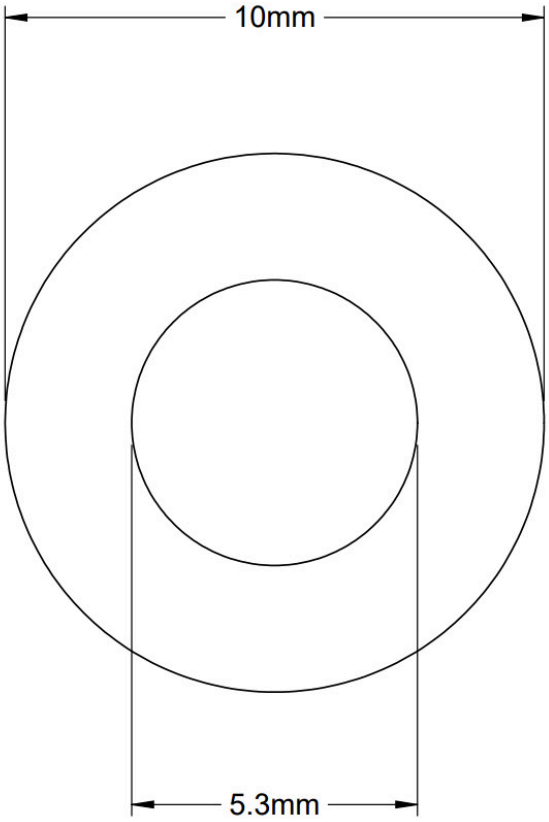


Specification	Details
Material	316 Stainless Steel
Thread Size	M5

Bellows Case Washers

Used to secure the bellows case to the Base Block.

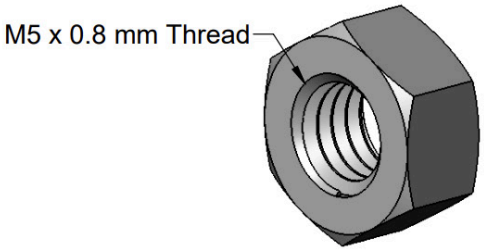


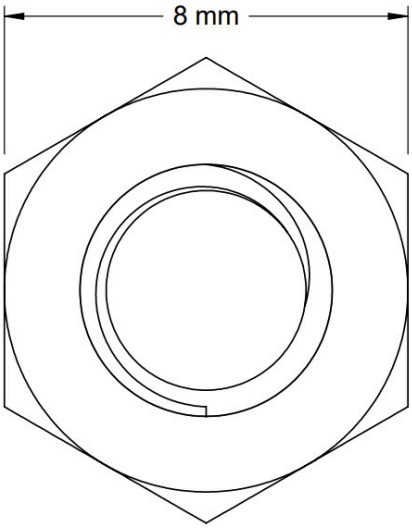


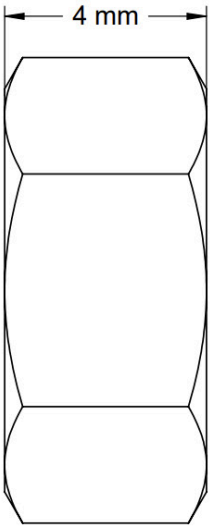
Specification	Details
Material	316 Stainless Steel
Thread Size	M5

Bellows Case Hex Nut

Used to secure the bellows case to the Base Block.



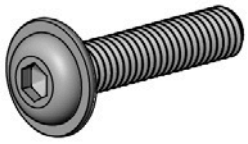


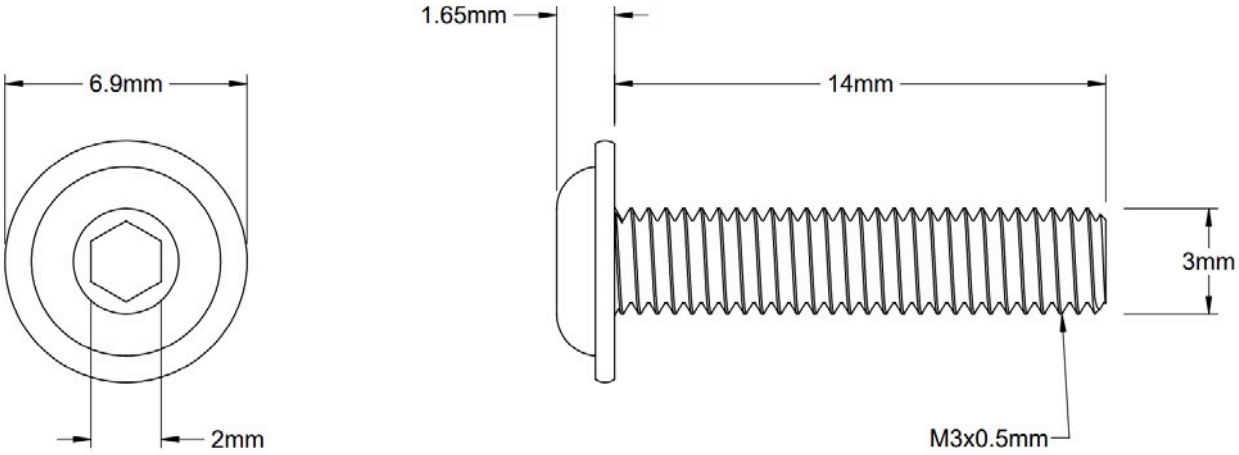


Specification	Details
Material	316 Stainless Steel
Thread Size	M5

Electronic Plate Mounting Screws

Mounts the Frame Assembly (Frame Tabs) to the Electronic Plate.

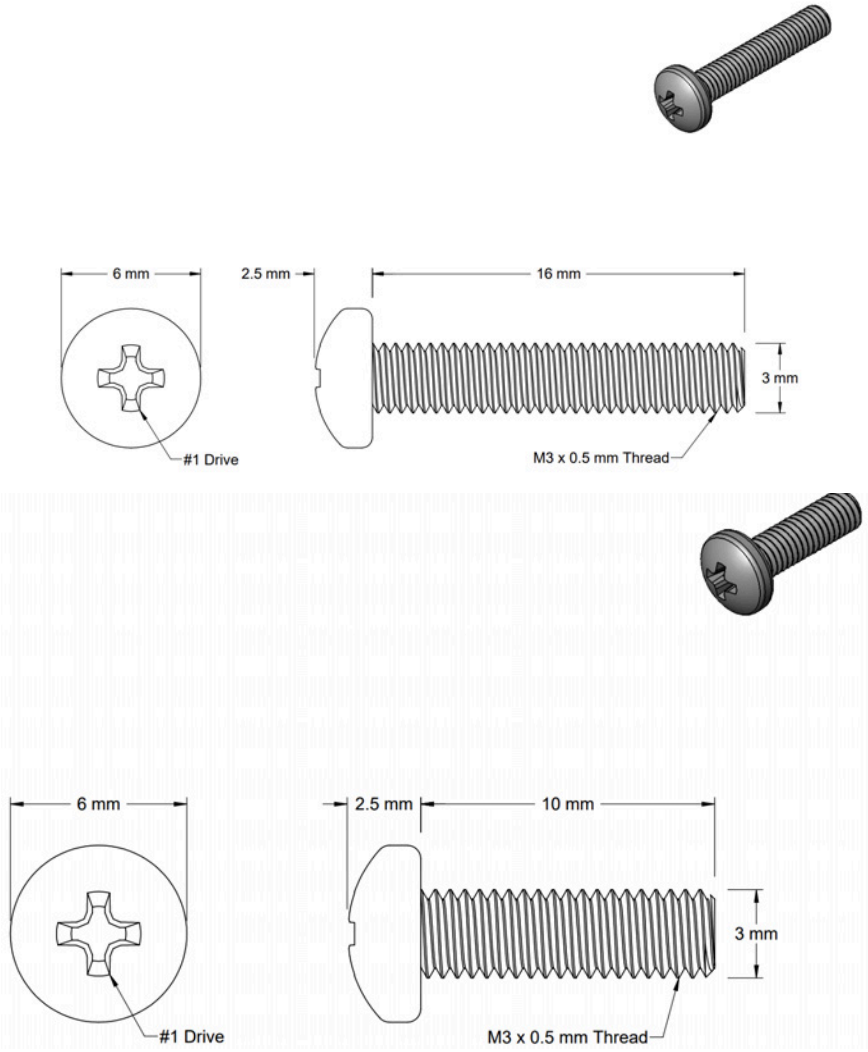




Specification	Details
Material	18-8 Stainless Steel
Thread Size	M3

Electronic Mounting Screws

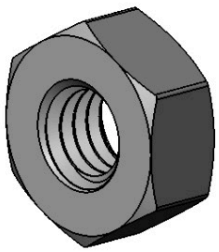
Mounts the Electrical Components to the Acrylic Electronic Plate. Two models may coexist within the edition assembly.

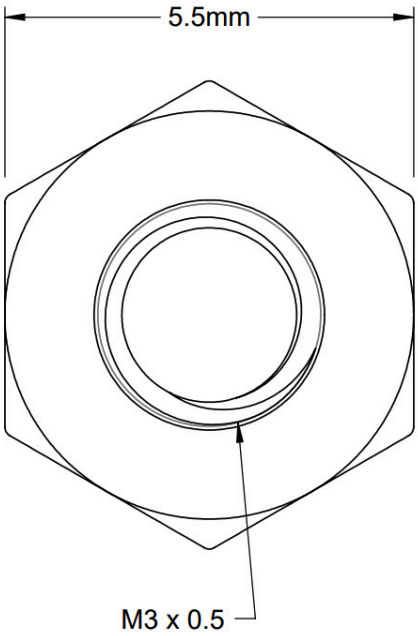


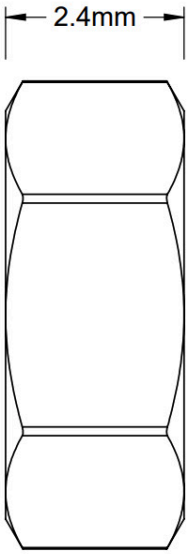
Specification	Details
Material	316 Stainless Steel
Thread Size	M3
Manufacturer	McMaster-Carr
Models	90116A161 / 90116A155

Electronic Mounting Hex Nut

Mounts the electronic plate to the Base Block.



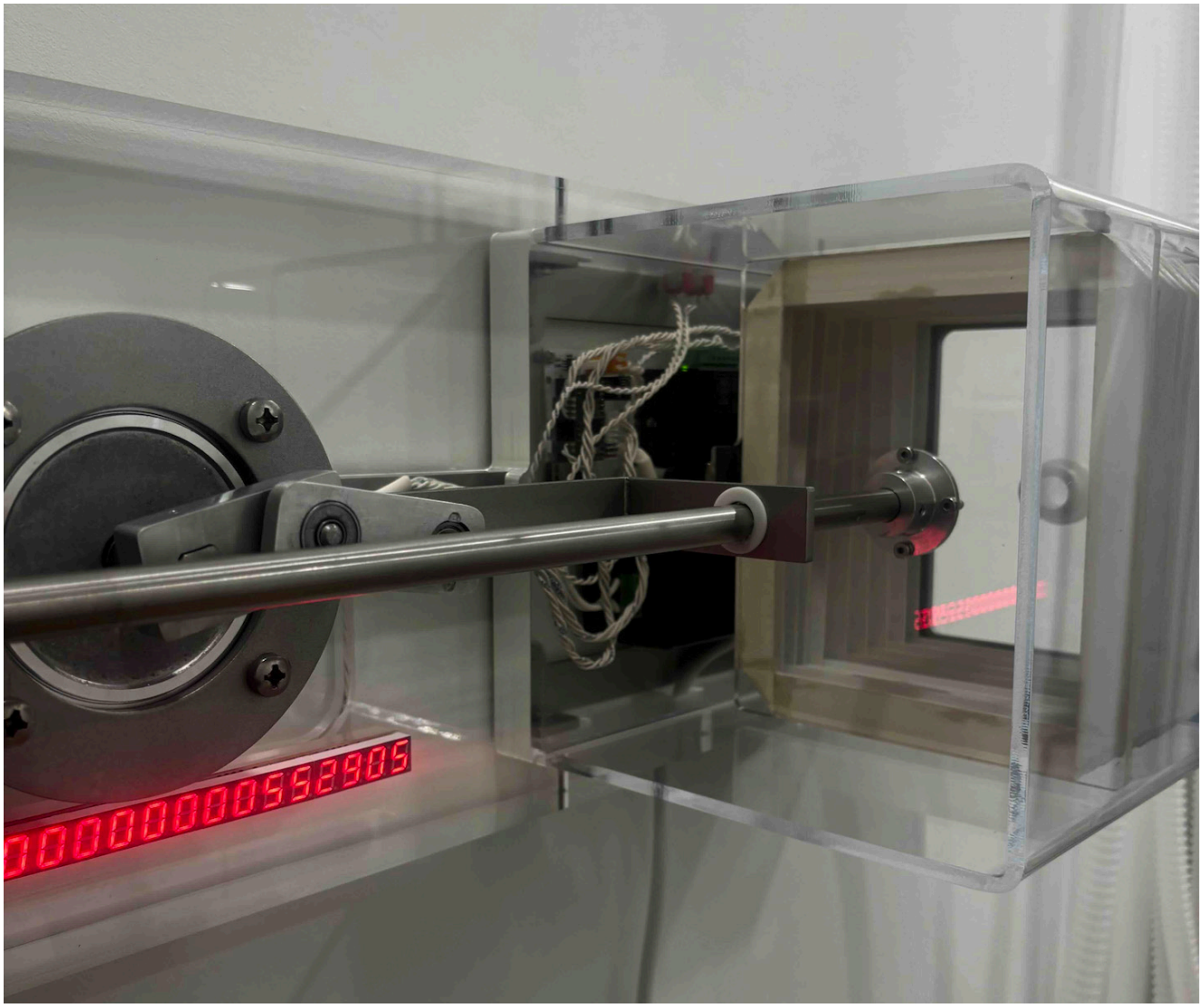


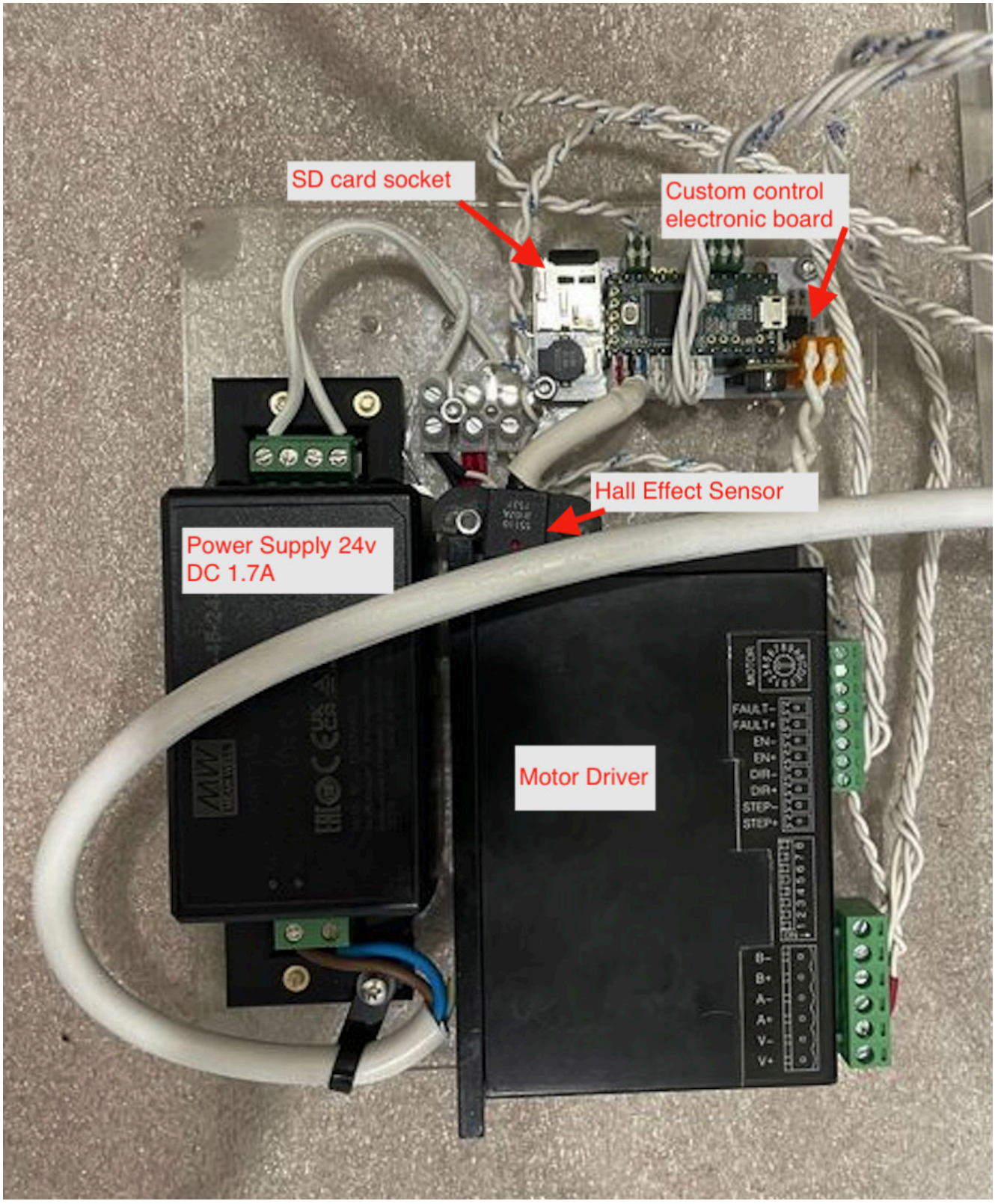


Specification	Details
Material	18-8 Stainless Steel
Thread Size	M3 x 0.5 mm

Electrical Components

The electronic components are nested within the breathing apparatus and can only be accessed from the back by removing the electronics plate that supports them.

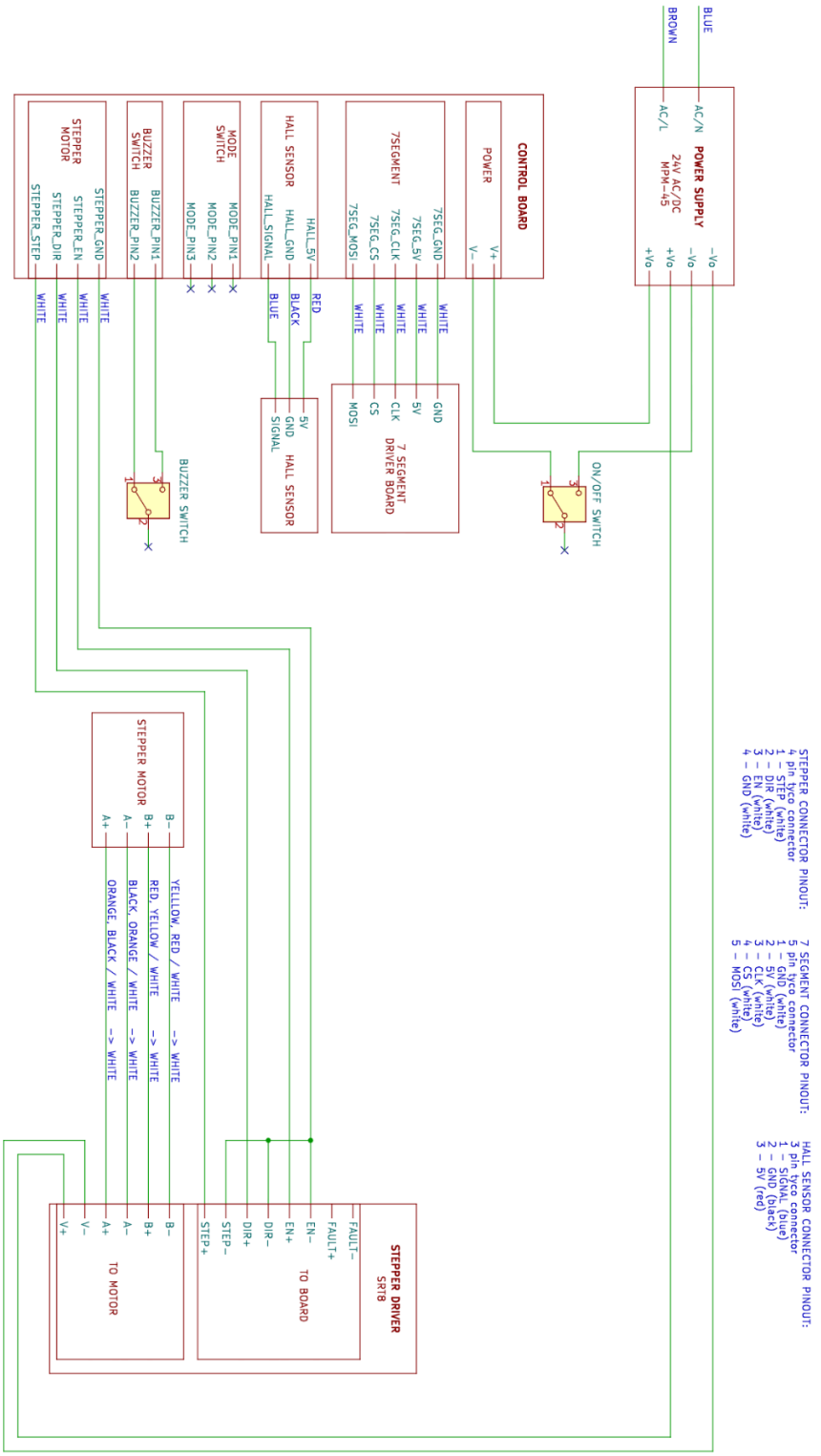


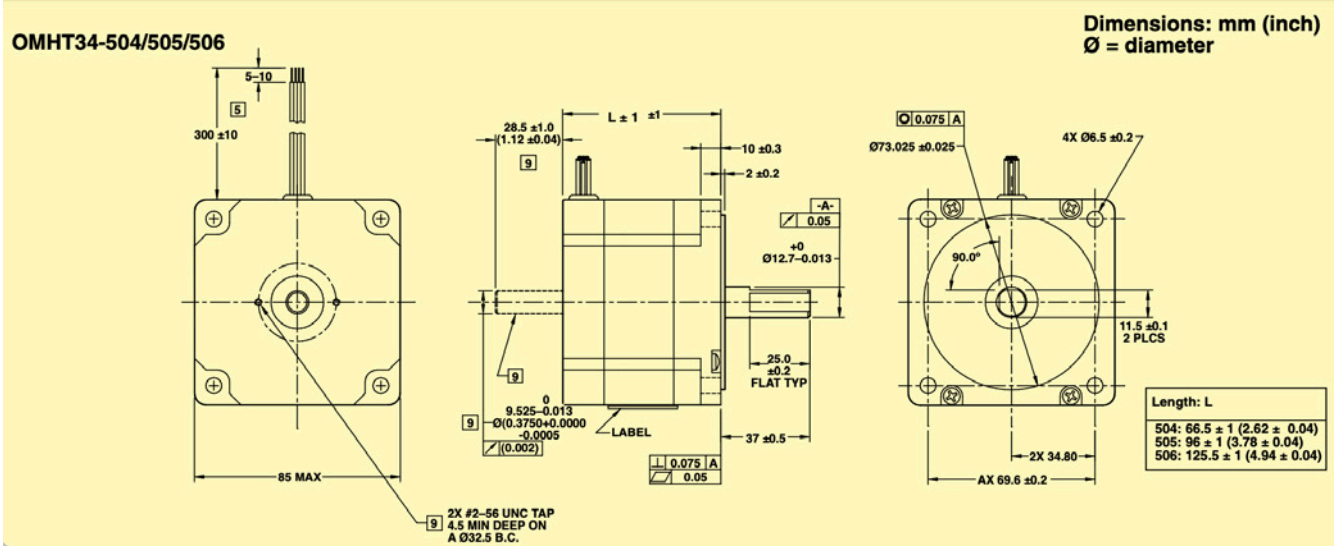

SD card socket
Custom control electronic board
Hall Effect Sensor
Power Supply 24v DC 1.7A
Motor Driver

Bill of Material

Component	Quantity	Manufacturer	Part Number
Stepper Motor	1	Omega	OMHT34-505
Stepper Motor Driver	1	Omega	STR8
Seven Segment Display	4	Lite-On	LTC-4727JR
Custom Display Driver	1	Custom Made	
Hall Effect Sensor	1	Little Fuse	55100-3H-04-A
Miniature Rounded Toggle Switch	2	McMaster-Carr	7347K14
Power Supply	1	MeanWell	MPM-45-24ST
Custom Control Electronic Board	1	Custom Made	

Schematics / Interconnection between Components

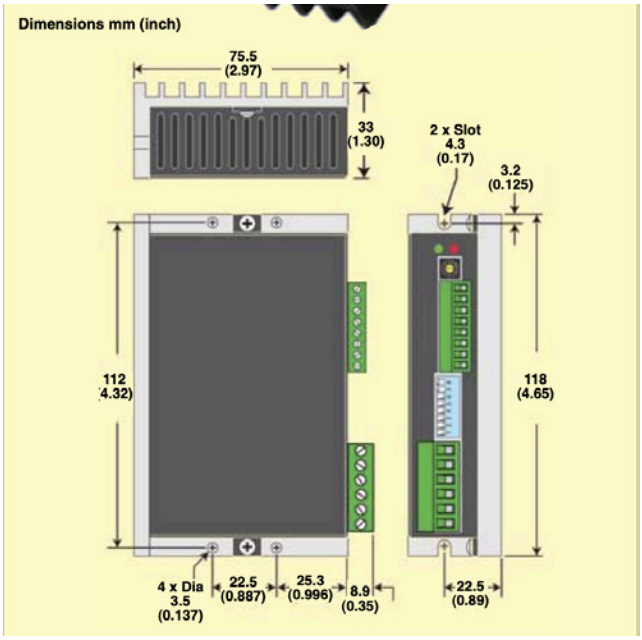




Specification	Details
Length	96 mm
Holding Torque	849 oz
Step Angle	1.8 deg
Volts	2.97
Amps	4.5
Ohms	0.66
Rotor Inertia	10.8 Oz-In (squared)
Motor Weight	2676 g

Stepper Motor Driver

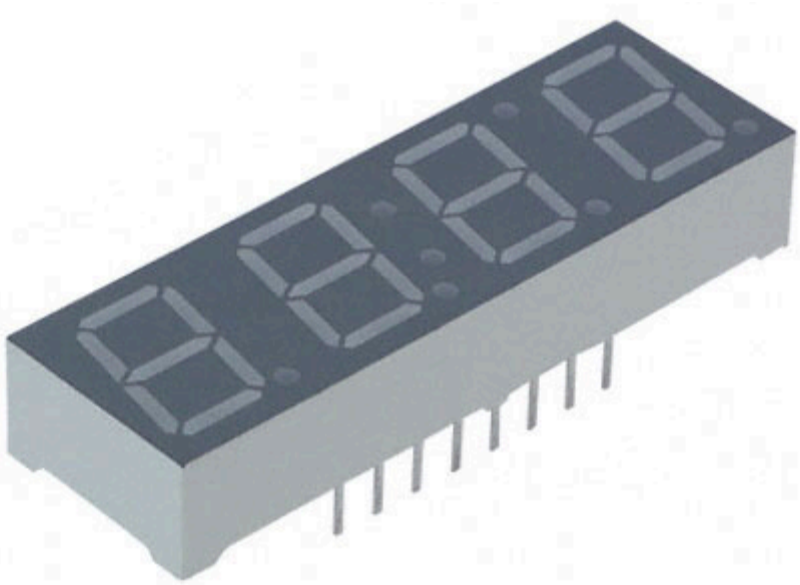
This driver allows for electronic damping, microstepping and microstep emulation, step and direction inputs, cw pulse/ccw pulse operation, idle current reduction and selectable digital input filter.



Specification	Details
Voltage Supply	24~75VDC
Current Range	2.35 to 8.0 A/phase, peak of sine

Seven Segment Display

Four units are used in the assembly of the work.



PIN CONNECTION

NO	CONNECTION
1	COMMON CATHODE DIGIT 1
2	COMMON CATHODE DIGIT 2
3	ANODE D
4	COMMON CATHODE L1,L2,L3
5	ANODE E
6	COMMON CATHODE DIGIT 3
7	ANODE DP
8	COMMON CATHODE DIGIT 4
9	NO CONNECTION
10	NO PIN
11	ANODE F
12	NO PIN
13	ANODE C,L3
14	ANODE A,L1
15	ANODE G
16	ANODE B,L2

FEATURES

* 0.4inch (10.0mm) DIGIT HEIGHT.
* CONTINUOUS UNIFORM SEGMENTS.
* LOW POWER REQUIREMENT.
* EXCELLENT CHARACTERS APPEARANCE.
* HIGH BRIGHTNESS & HIGH CONTRAST.
* WIDE VIEWING ANGLE.
* SOLID STATE RELIABILITY.
* CATEGORIZED FOR LUMINOUS INTENSITY.

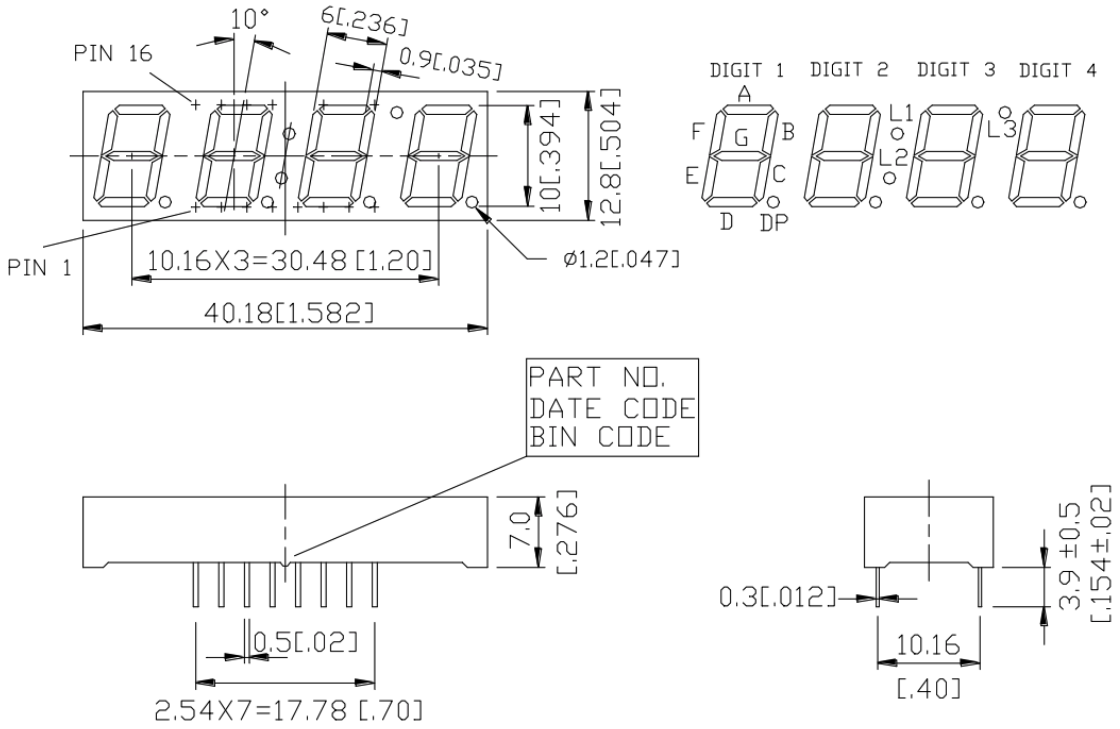
DESCRIPTION

The LTC-4727JR inch (10.0 mm) digit height quadruple digit seven-segment display. This device utilizes AlInGaP super red LED chips, which are made from AlInGaP on a non-transparent GaAs substrate, and has a gray face and white segments.

DEVICE

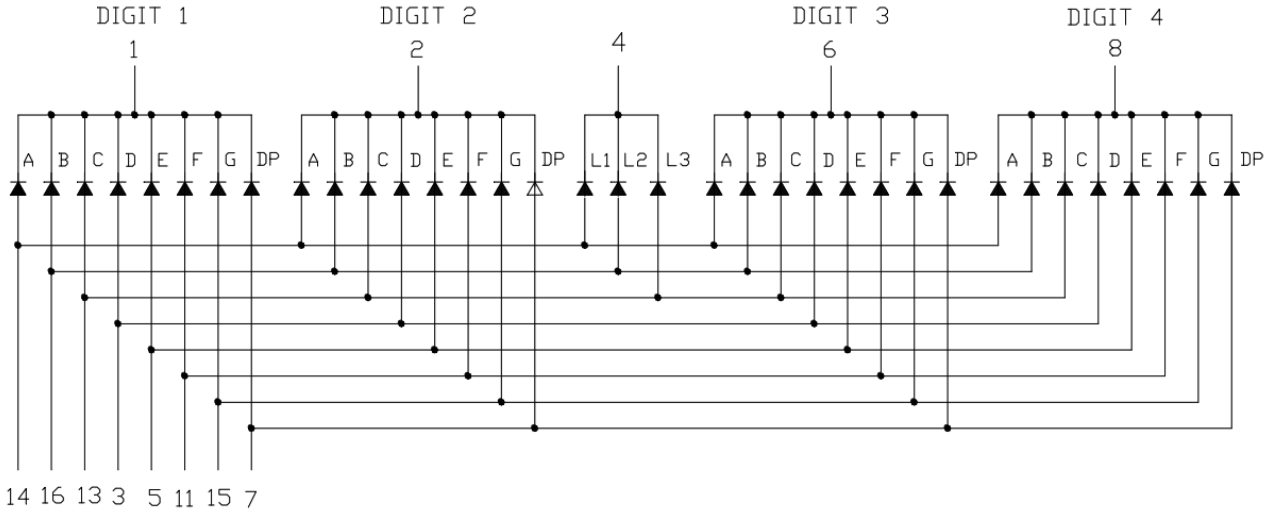
PART NO.	DESCRIPTION
AlInGaP Super Red	Multiplex Common Cathode
LTC-4727JR	Rt. Hand Decimal

PACKAGE DIMENSIONS



NOTES: All dimensions are in millimeters. Tolerances are± 0.25 mm (0.01“) unless otherwise noted.

INTERNAL CIRCUIT DIAGRAM



ABSOLUTE MAXIMUM RATING AT Ta=25°C

PARAMETER	MAXIMUM RATING	UNIT
Power Dissipation Per Segment	70	mW
Peak Forward Current Per Segment (1/10 Duty Cycle, 0.1ms Pulse Width)	90	mA
Continuous Forward Current Per Segment Derating Linear From 25℃ Per Segment	25 0.33	mA mA/℃
Reverse Voltage Per Segment	5	V
Operating Temperature Range	-35℃ to +85℃	
Storage Temperature Range	-35℃ to +85℃	
Solder Temperature: max 260℃ for max 3sec at 1.6mm below seating plane.		

ELECTRICAL / OPTICAL CHARACTERISTICS AT Ta=25°C

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CONDITION
Average Luminous Intensity	I_V	320	975		μcd	I_F=1mA
Peak Emission Wavelength	λp		639		nm	I_F=20mA
Spectral Line Half-Width	Δλ		20		nm	I_F=20mA
Dominant Wavelength	λd		631		nm	I_F=20mA
Forward Voltage Per Segment	V_F		2.0	2.6	V	I_F=20mA
Reverse Current Per Segment	I_R			100	μA	V_R=5V
Luminous Intensity Matching Ratio	I_V-m			2:1		I_F=1mA

Note: Luminous intensity is measured with a light sensor and filter combination that approximates the CIE (Commision Internationale De L'Eclairage) eye-response curve.

TYPICAL ELECTRICAL / OPTICAL CHARACTERISTIC CURVES

(25°C Ambient Temperature Unless Otherwise Noted)

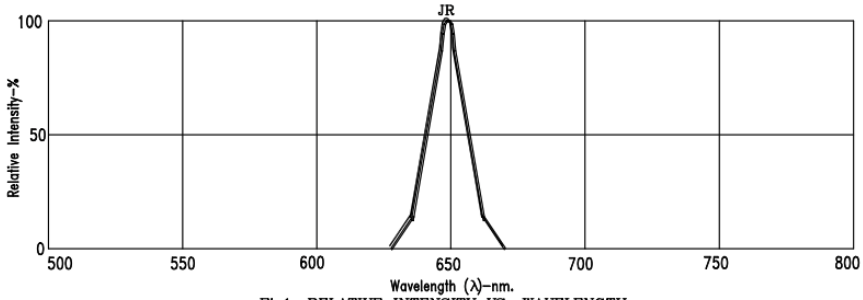


Fig1. RELATIVE INTENSITY VS. WAVELENGTH

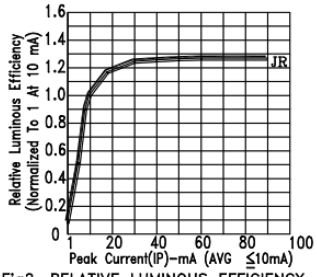


Fig2. RELATIVE LUMINOUS EFFICIENCY (LUMINOUS INTENSITY PER UNIT CURRENT) VS. PEAK CURRENT

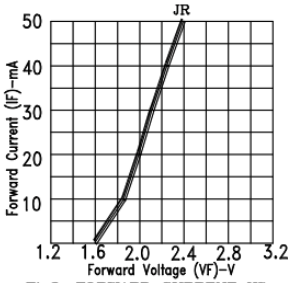


Fig3. FORWARD CURRENT VS. FORWARD VOLTAGE

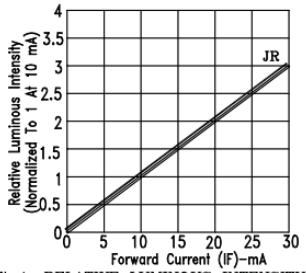


Fig4. RELATIVE LUMINOUS INTENSITY VS. FORWARD CURRENT

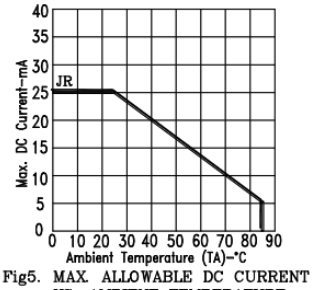


Fig5. MAX. ALLOWABLE DC CURRENT VS. AMBIENT TEMPERATURE.

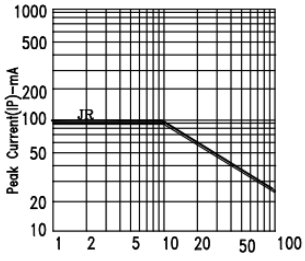
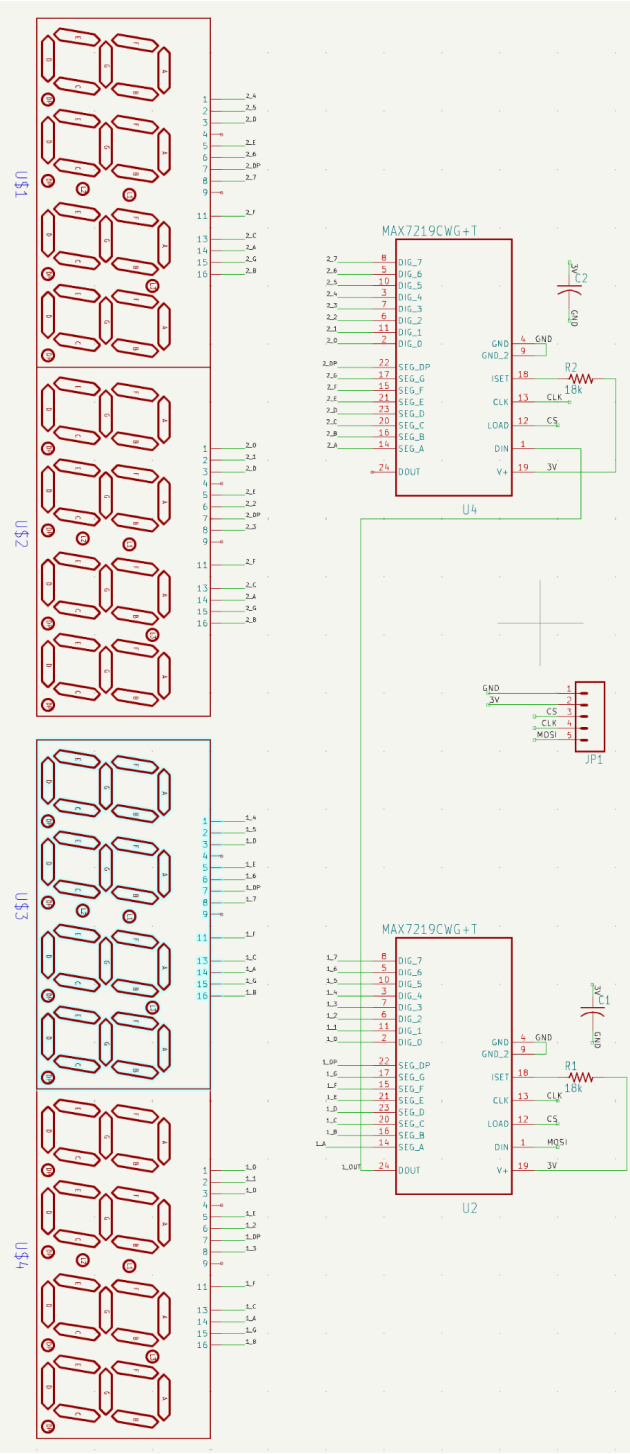


Fig6. MAX. PEAK CURRENT VS. DUTY CYCLE % (REFRESH RATE 1KHz)

Custom Display Driver

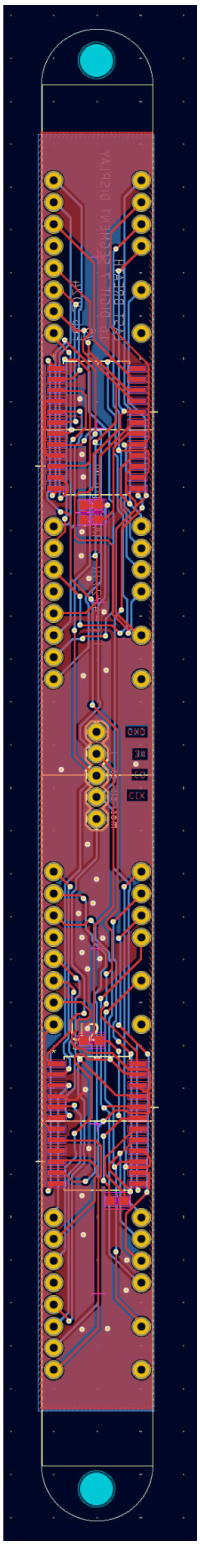
Allows the piece to control several seven segment displays as one.

Schematics



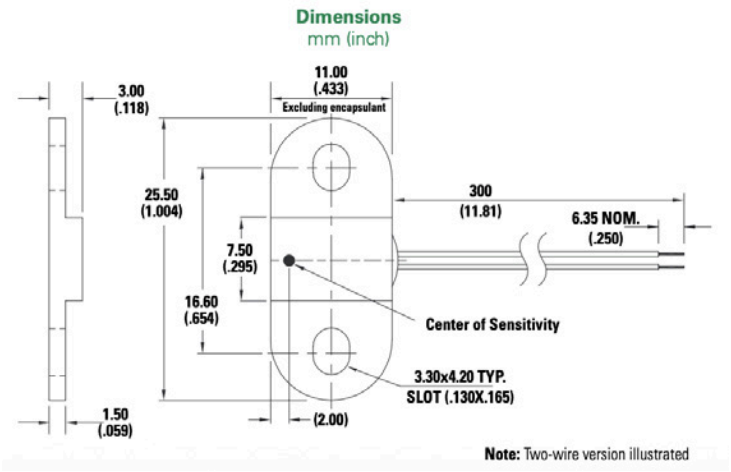
Board

The PCB board in use at the time of this manual writing is labeled “Last Breath 16 Digit Segment Display V6 Feb 2024”. This component version may differ from one edition to another.

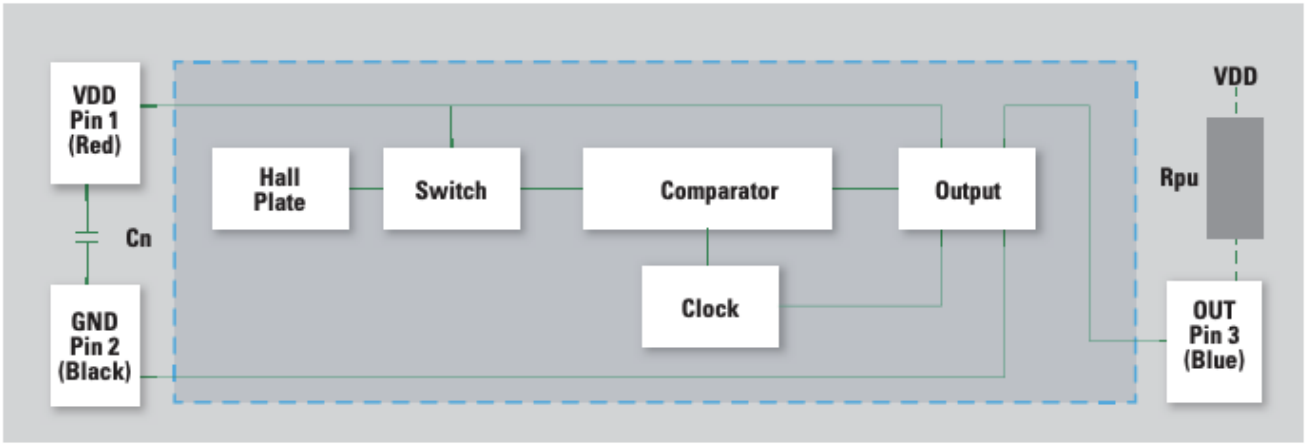


Hall Effect Sensor

The Hall sensor should be in contact with the Base Block; its placement is very delicate and crucial to the functionality of the piece.



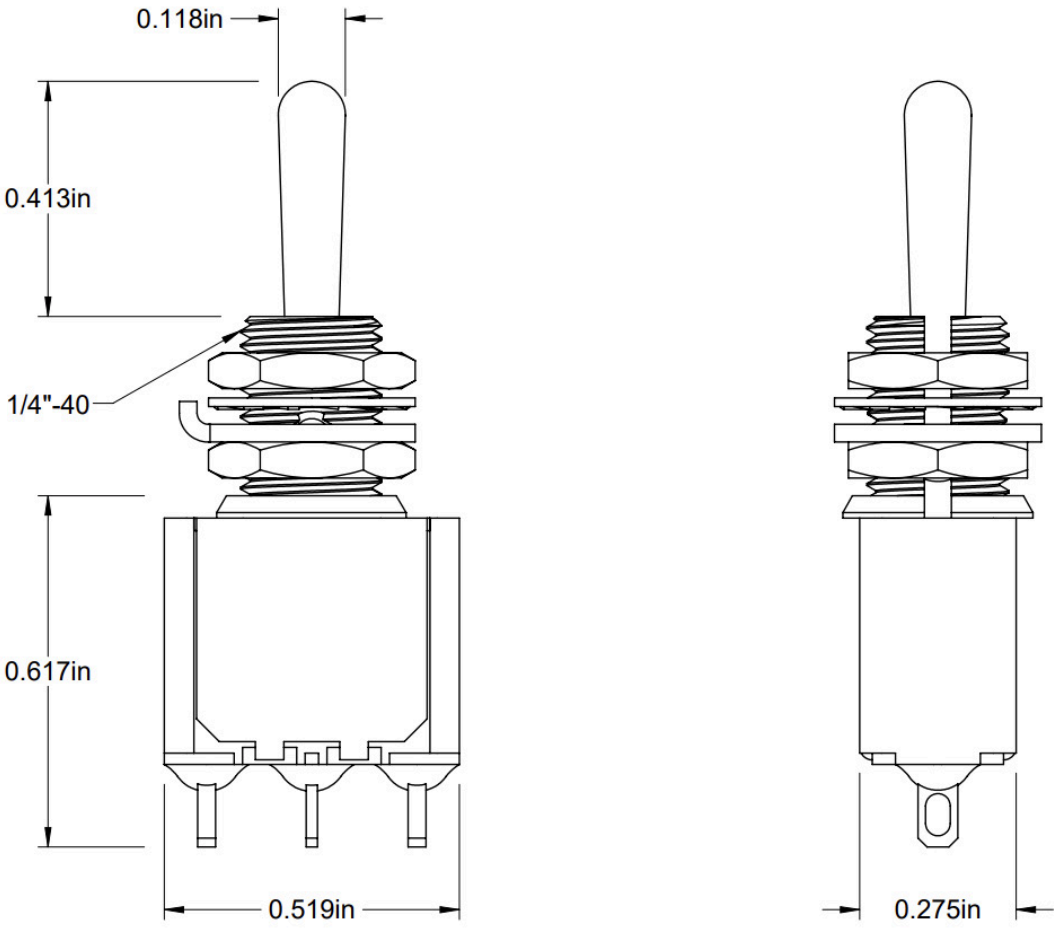
Three-wire Version



Specification	Details
Sensativity	55 (Gauss)
Activation Distance	19 mm
Current Consumption	1.1 to 2.4 mA
Output Current	25 mA
Supply Voltage	2.7 to 24 V

Miniature Rounded Toggle Switch

Used to control the sound and power to the piece. In most editions, the toggle switch's pin is covered with a rubber sleeve, one white colored, the other red colored. Some editions have no rubber sleeve, exposing the natural metal of both toggles.



Specification	Details
Number of positions	2
Number of terminals	3
Industry Designation	SPDT
Position Designation	On-On

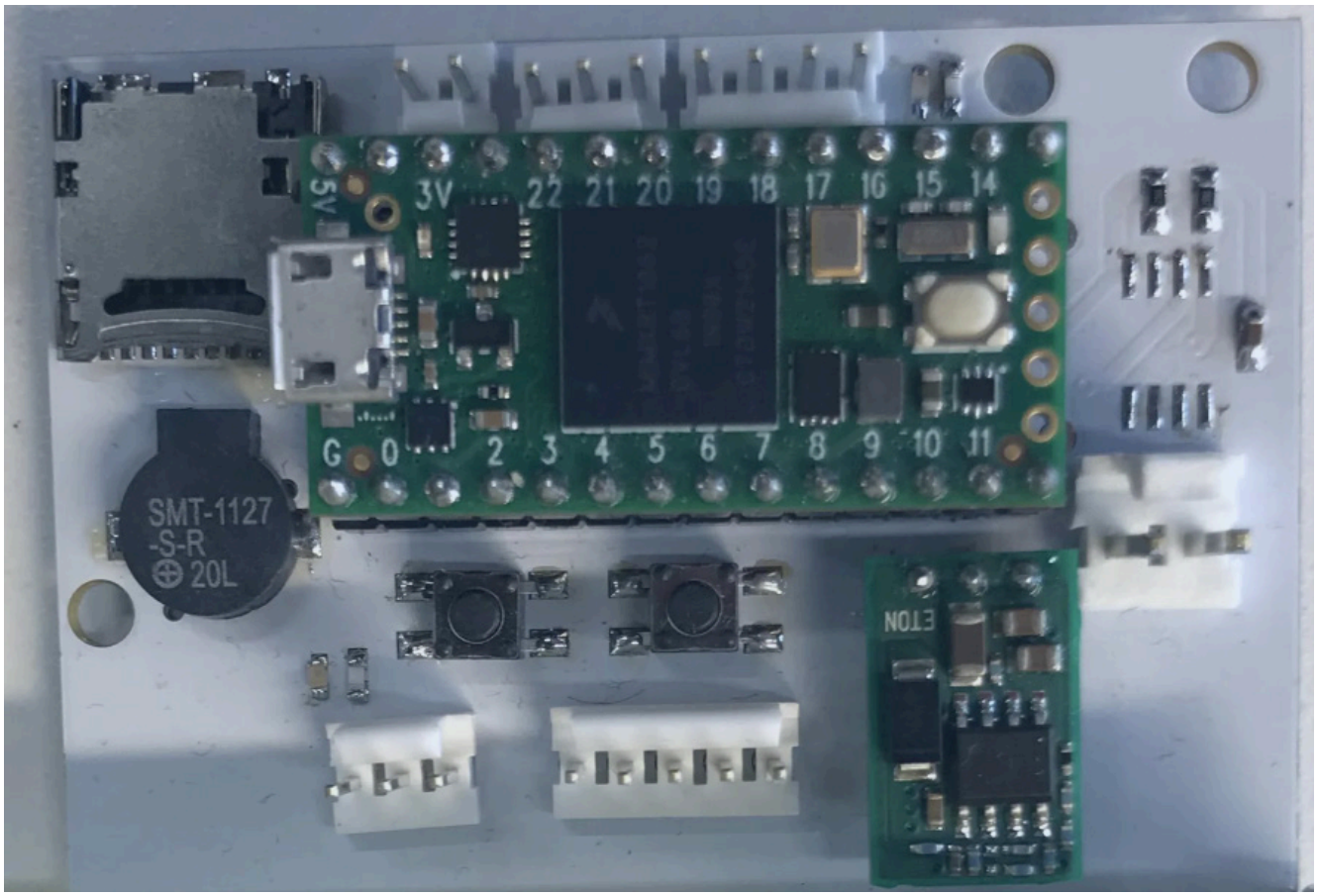
Power Supply

Different power supply models have been used in the different editions, all of them outputting about the same wattage under 24VDC. At the time of writing this manual, this Mean Well MPM-45-24ST Class 2 unit was the most common and most preferred.

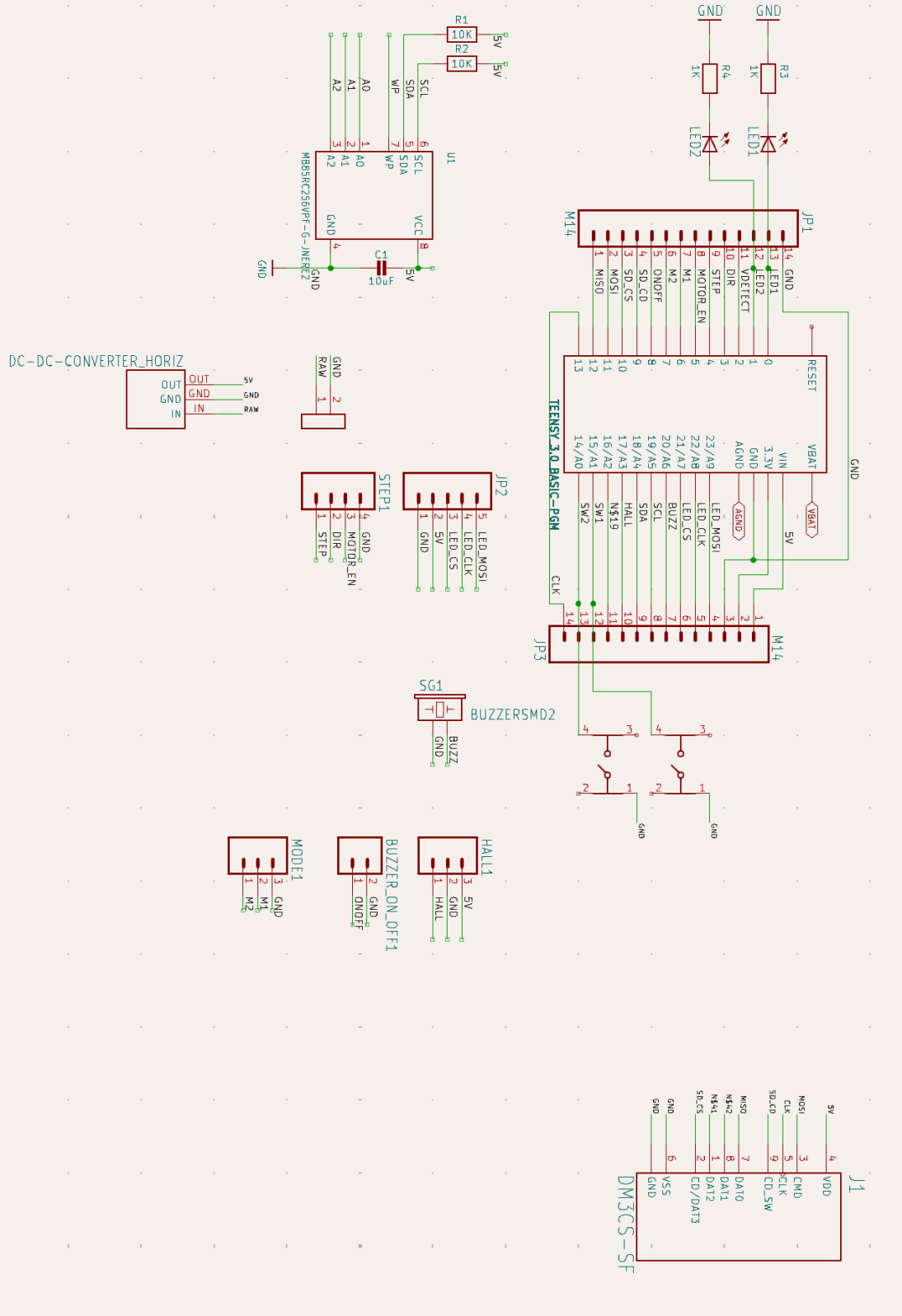
Specification	Details
Output	24VDC at 1.88A, 45 W
Input	Up to 1.2A, under 100 - 240 VAC
Dimensions	10.9 x 5.2 x 3.35 cm (LxWxH)

Custom Control Electronic Board

Allows the piece to control the number of breaths and sounds made by the piece. Shape and look may differ from one edition to another.

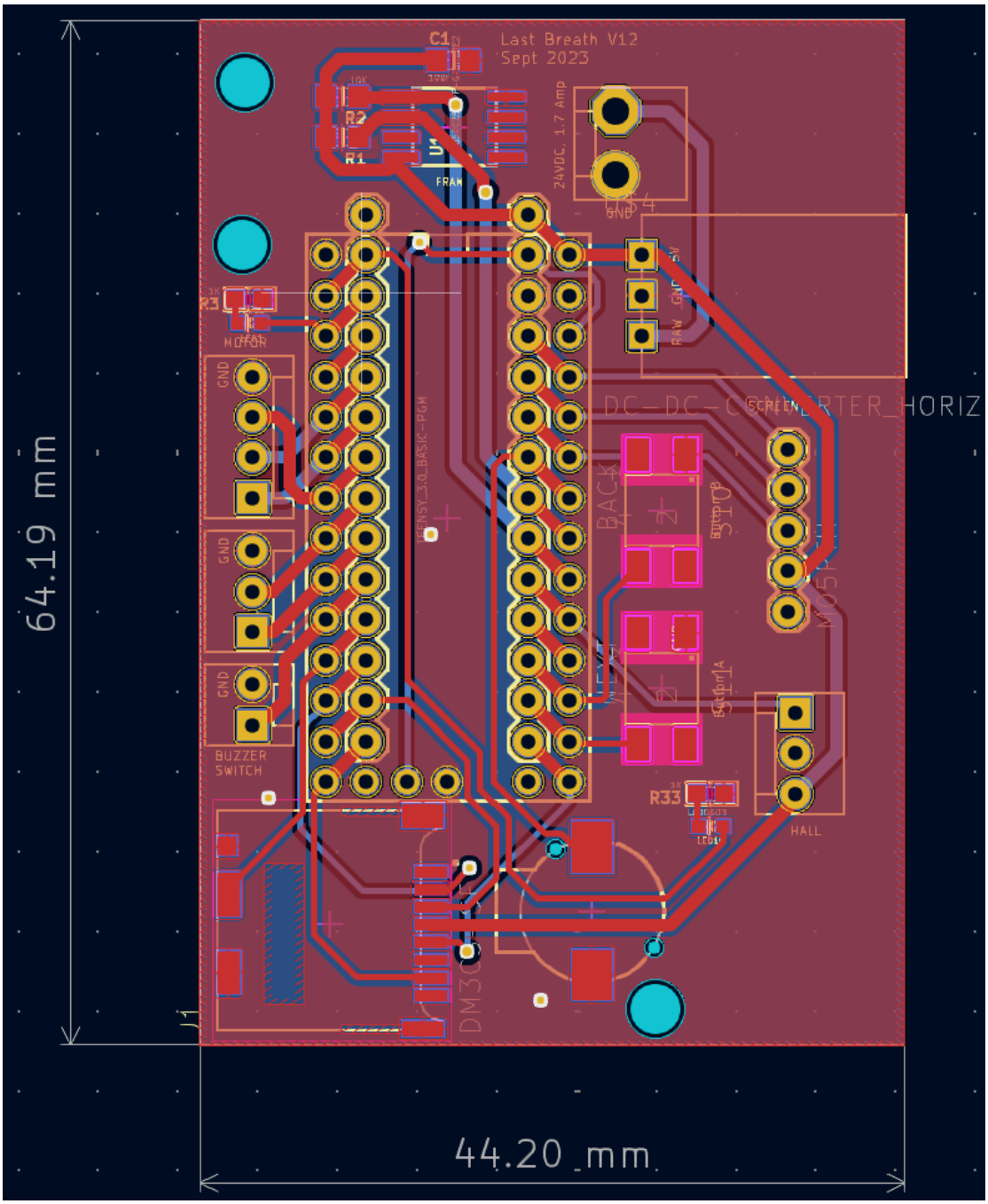


Schematics


GND
GND
R1
10K
5V
R2
10K
5V
R4
1K
R3
1K
LED2
LED1
JP1
M14
U1
MB85RC256VPF-G-JNERE2
C1
10uF
DC-DC-CONVERTER_HORIZ
OUT
GND
IN
5V
GND
RAW
STEP1
JP2
TEENSY_3.0_BASIC-PGM
JP3
M14
SG1
BUZZERSMD2
MODE1
BUZZER_ON_OFF1
HALL1
J1
DM3CS-SF

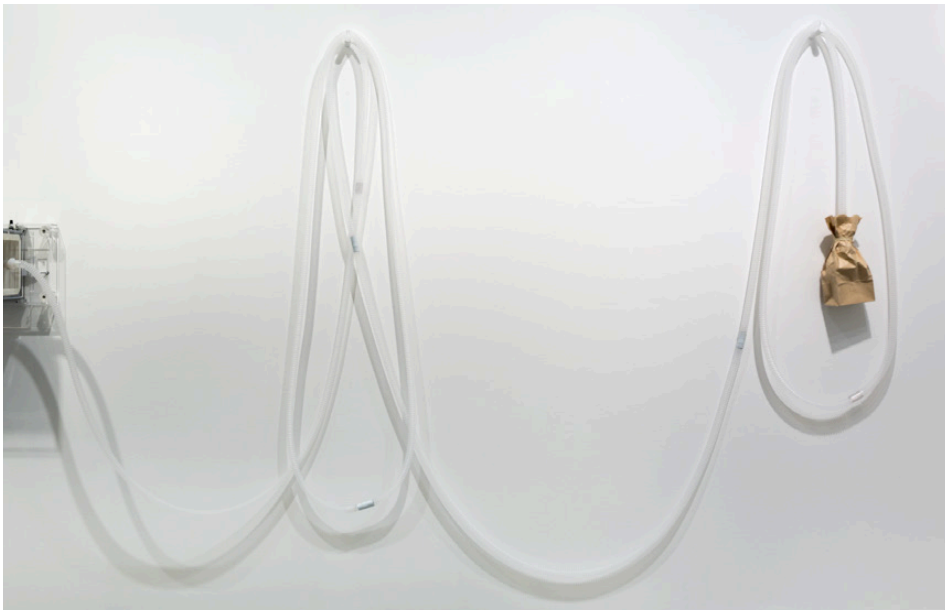
Board

The PCB board in use at the time of this manual writing is labeled “Last Breath v12 Sept 2023”. On any edition, this component may differ from this version.



Other Hardware

The other hardware components used in the artwork which are apart from the breathing apparatus: the air hose system, the paper bag, the hanging system and the playback device.



Bill of Material

Component	Quantity	Manufacturer	Part Number
Expandable Tube	7	Dispomed	940-F22108INSS02
Tube Coupling	7	Custom Made	
Tube Hooks	2	Variable	
Bag-to-Tube Coupling	1	Custom Made	
Rubber Band	1	Variable	
Kraft Paper Bag	1	Pack Plus Converting	FB-NP-5P13
Bag Shipping Cap	1	McMaster Carr	9545K15
External Display	1	Variable	

Expandable Tube

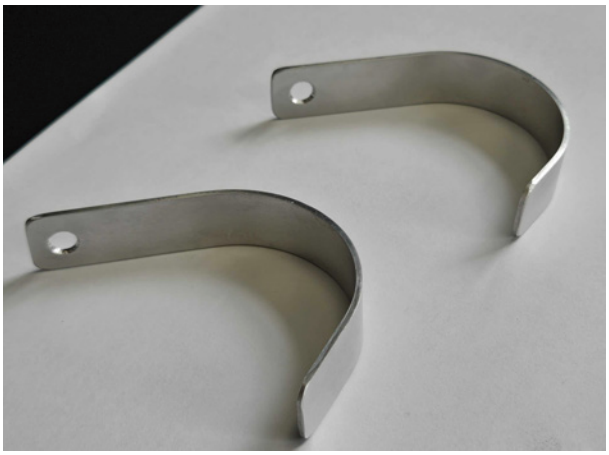
Specification	Details
Color	Transparent
Material	Polyurethane
Inner Diameter	22 mm at tube's end
Length	245 cm per tube, when expanded

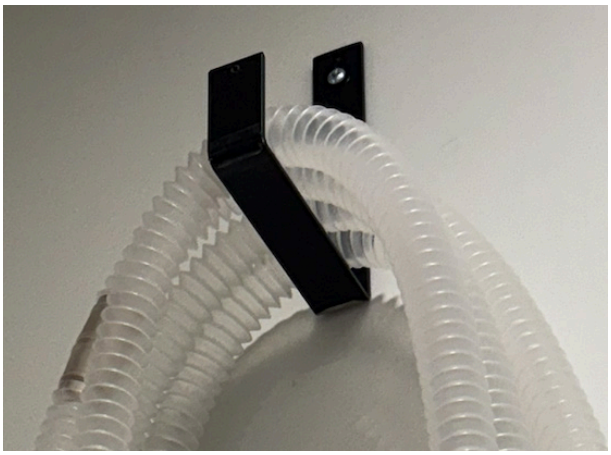
Tube Hooks

The preferred method to hang the expandable tube is to hang it from thin metal hooks having a color close to the wall color, or to the air tubing. Alternatively, it can also have a stainless color which recalls the apparatus mechanism. So far, we have used curved hooks, straight hooks, hooks with a retaining tab, L-shaped screwable metal pins of a similar size.

Another way to install the bag and tube is to suspend them from the ceiling using thin nylon threads around the room.

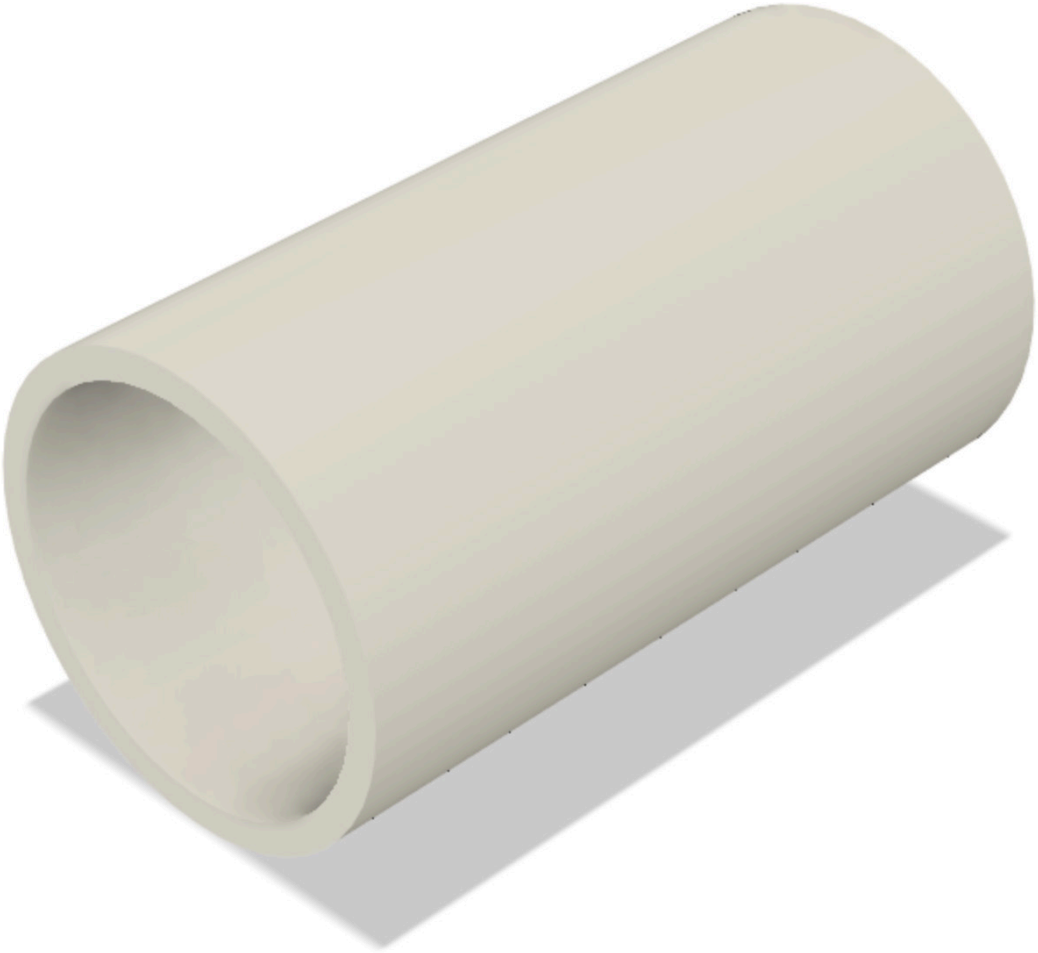
The following images show some examples of hook shapes used to hang the tubes over different exhibitions.





Tube Coupling

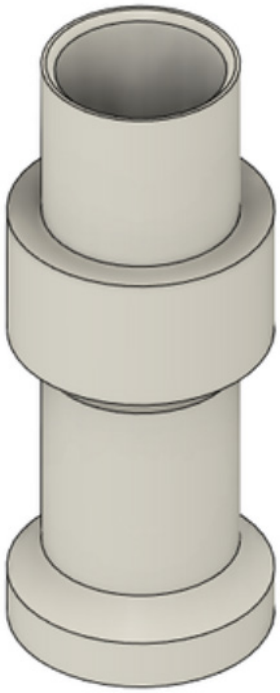
Made originally out of white colored PVC cutouts, the studio then moved to 2 different options: a polyethylene transparent tube cutouts - without inscription - or 3D printed white matte PLA. A step file is typically included in the provided USB key.



Specification	Details
Color	Transparent (polypropylene) or matte white (PLA)
Material	Polyethylene or PLA
Length	4 cm
Inner Diametre	15 to 19 mm, bigger being better for ai flow
Outer Diametre	22 mm

Bag-to-Tube Coupling

At the time of writing this manual this is made out of PLA matte white material. A step file is typically included in the provided USB key. Previous editions of the artwork used a round ethafoam cylinder with a hole in the center for this purpose.



Rubber Band

This secures the bag to the tubing. In the past, the atelier used tan colored natural rubber bands. The circumference of the rubber band should be around 16 to 25cm and the width should be between 3 to 7mm. The rubber band is usually twisted a few times around the paper bag and tube coupling element to ensure a tight connection.

In the past, the atelier used #64 rubber bands (6.4mm in width, 18cm of circumference) from the company Staples, bought in 99 gram bags, but other brands can do the trick.

Note the rubber bands will dry over time and periodic verification is useful to inspect the rubber band dryness and call for a replacement, before the bag gets loose on the coupling part.

Image as reference, brand and model may differ.

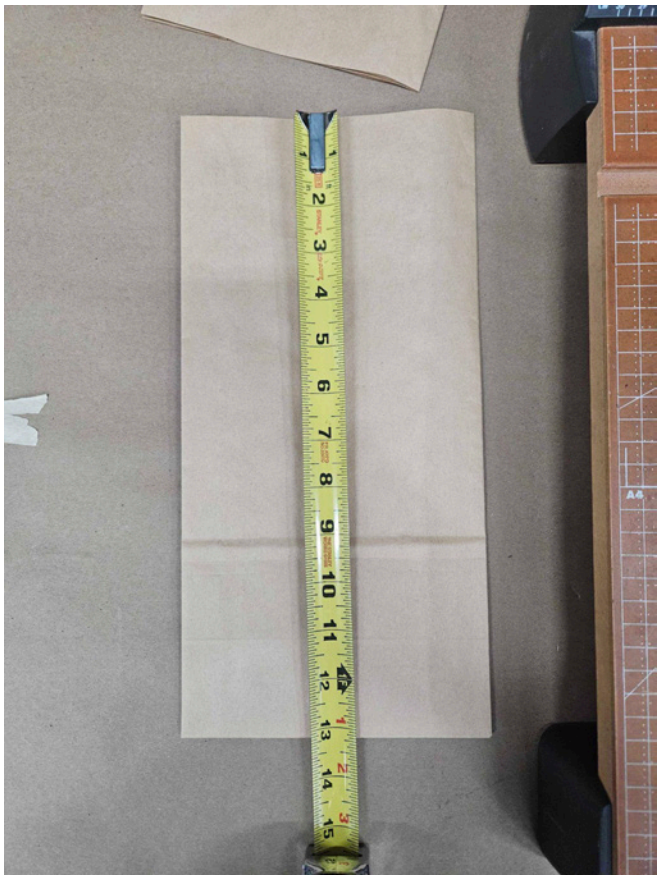
Kraft Paper Bag

The Kraft paper bag used in this artwork should measure 16.5 x 10.2 x 33 cm / 6 ½ x 4 x 13 ½ inches, (WxDxH). It must have a brown 'lunch bag' color and it is lined internally with PLA.

The studio used to purchase this item from the manufacturer Tenka (model APGS5P13-TN), while cutting out the tin tie from the bag.

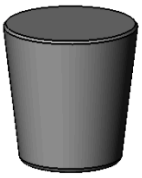
At the time of writing this manual, the studio uses the model FB-NP-5P13 from the manufacturer Pack Plus Converting, measuring 16.5 x 10.2 x 45.5 cm / 6 ½ x 4 x 18 inches, (WxDxH). It is then cut to a height of 33cm (13 ½ inches).

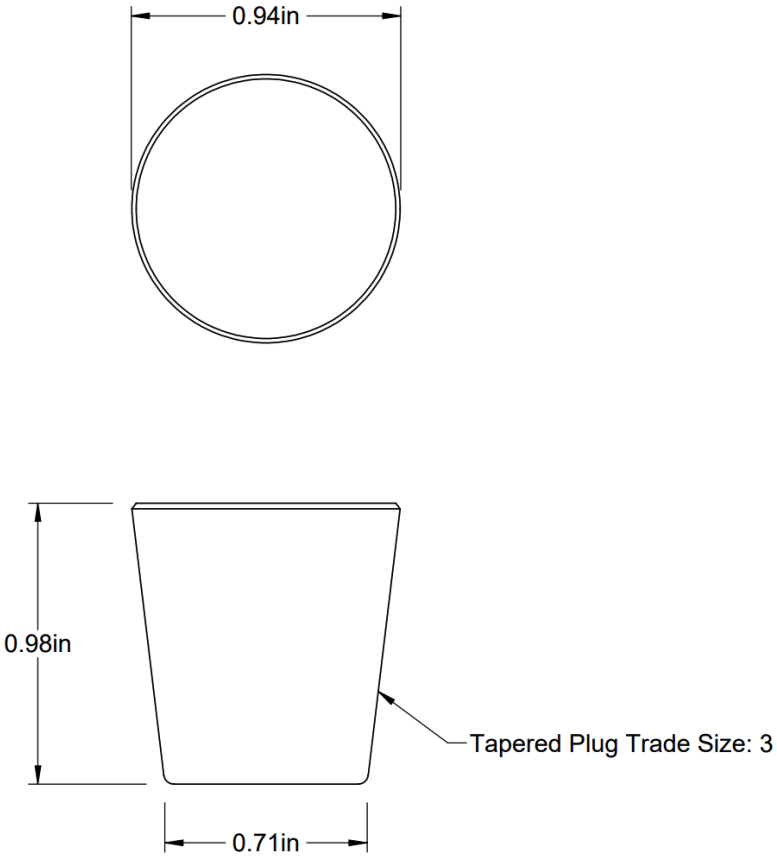
The original paper bags measured 7 x 12.5 x 30 cm (WxDxH) / 3 x 5 x 12.5 inches. A tin tie was present on the edge of the bag opening and removed before use. During the few first exhibitions, these bags developed visible wear and tear and exacerbated the stress placed on the bellows. To mitigate this a bag with a larger volume was selected.



Bag Shipping Cap

This is used to close the Bag-to-Tube Coupling opening while the artwork is stored in transit. Different types of material (metal, cork, PLA, etc.) and shapes were provided over time, but the following version should work with every edition.





Specification	Details
Color	Black
Material	SBR (rubber)

Video Playback Device

The method of displaying the accompanying video should be discussed with the artist studio prior to installation.

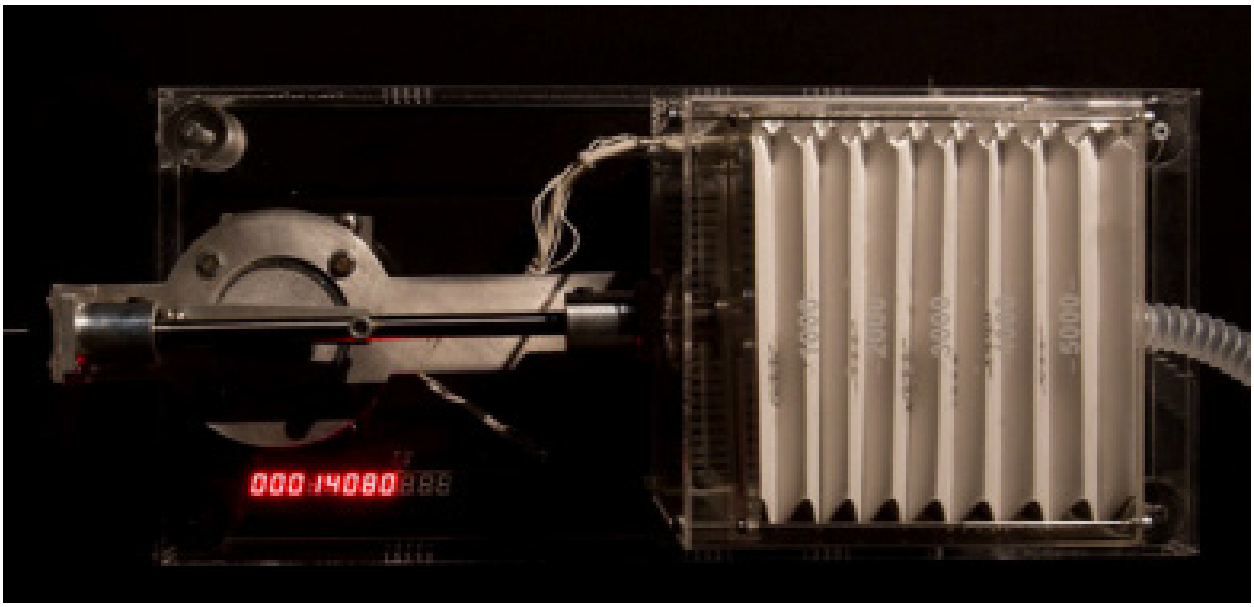
In previous versions a Windows Surface Pro tablet (with disabled touch screen) running VLC was used, while being enclosed into a metal frame to make it look like a regular monitor, with a diagonal of about 9". However the display could be another tablet system, a monitor or even a projection with a playback device. The documentary video resolution should be adapted to the playback device resolution.

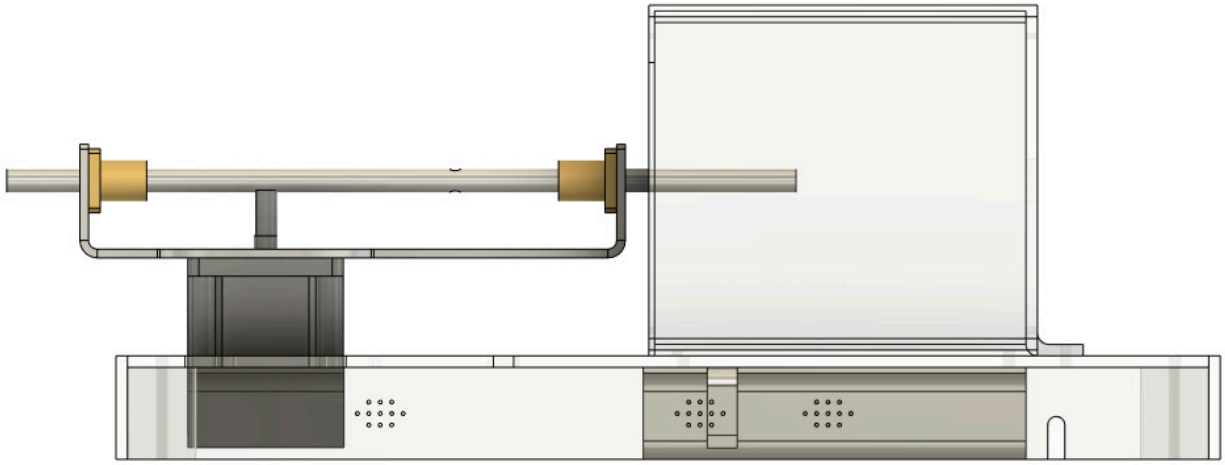
When a display is in use, you should consider the viewing angles spec of the desired device to ensure it will allow people to see it from different perspectives. The ideal is to use a display that allows 178-180 degrees from any direction. As per display size, the rule of thumb would be to have a conspicuous display slightly aside from the breathing apparatus, to give the main focus to the apparatus. You should also take in consideration the resolution of the provided video to be played back.

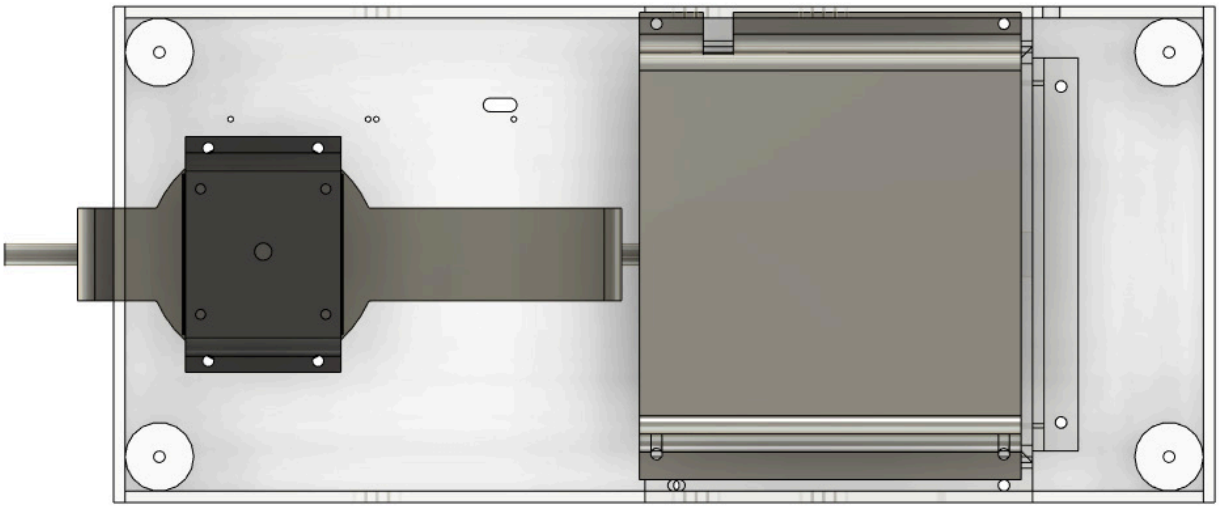
Pictured here: Omara Portuondo's Last Breath video played back in a Windows Surface Pro 3.

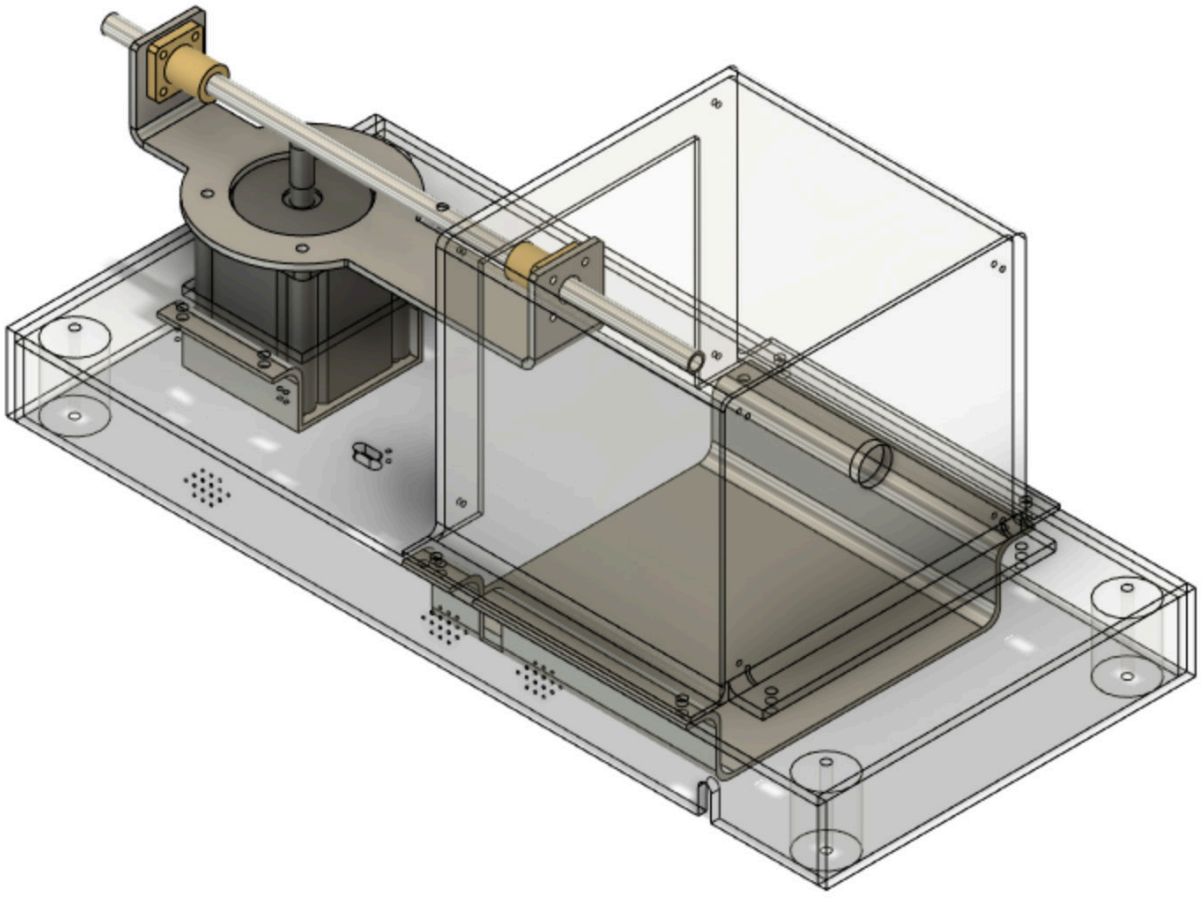
APPENDIX III - PLAN VIEWS AND DRAWINGS

Early versions of the work use acrylic pillars on the four corners of the acrylic assembly, a maintenance button, different bushing and slightly differed in assembly. Please refer to the original Last Breath manual for more details about this version.

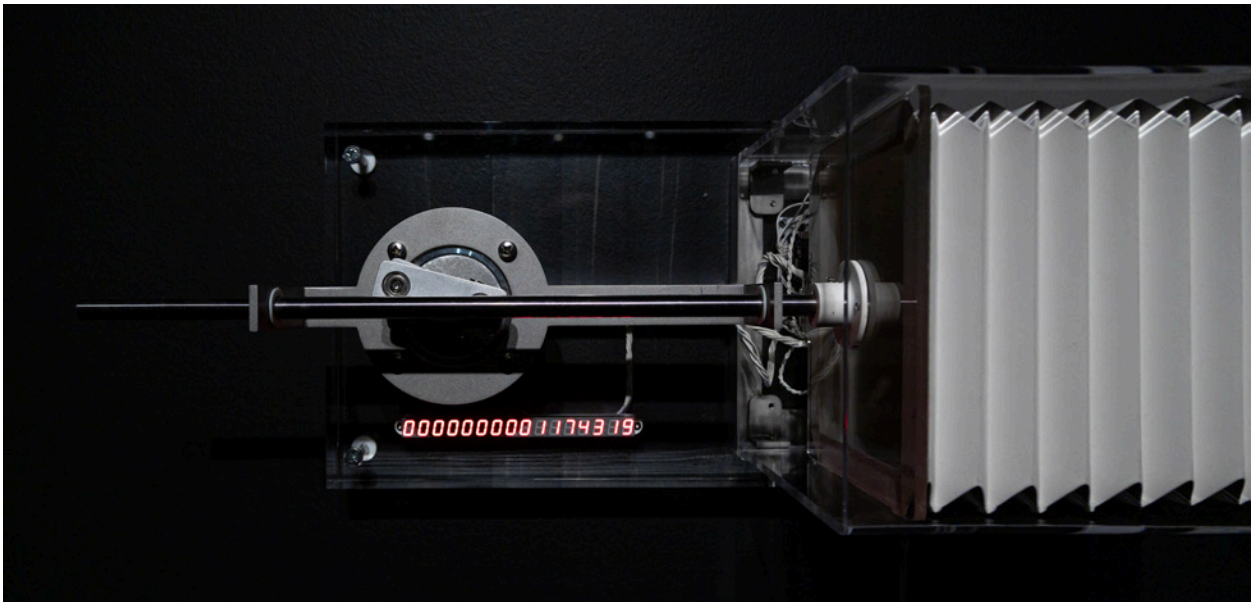


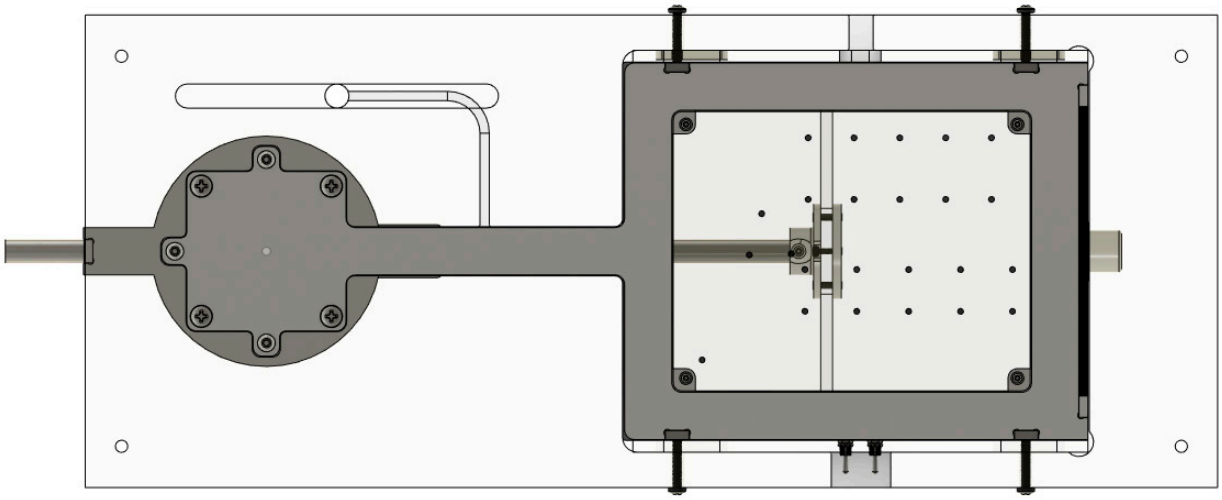


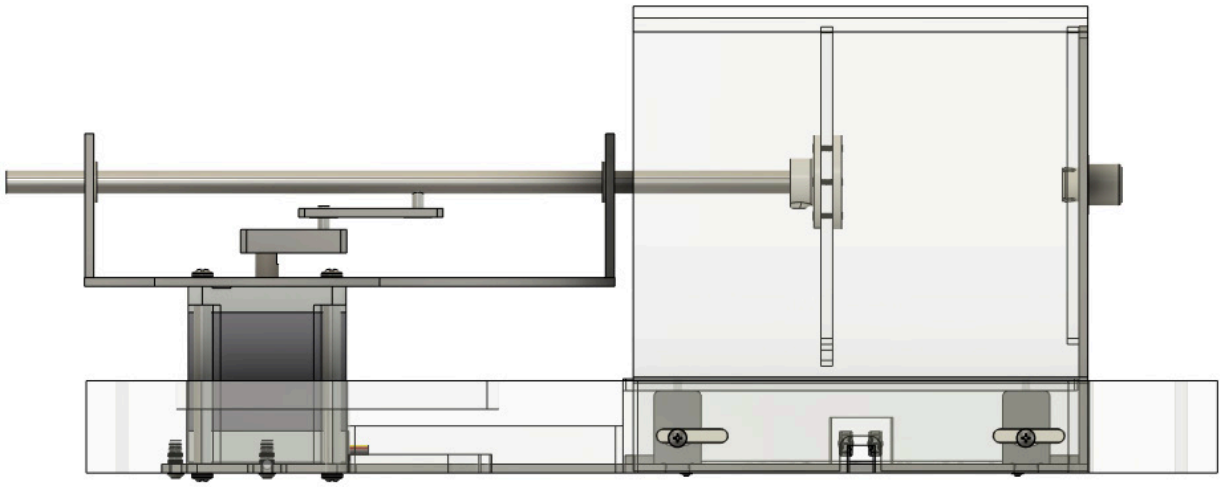


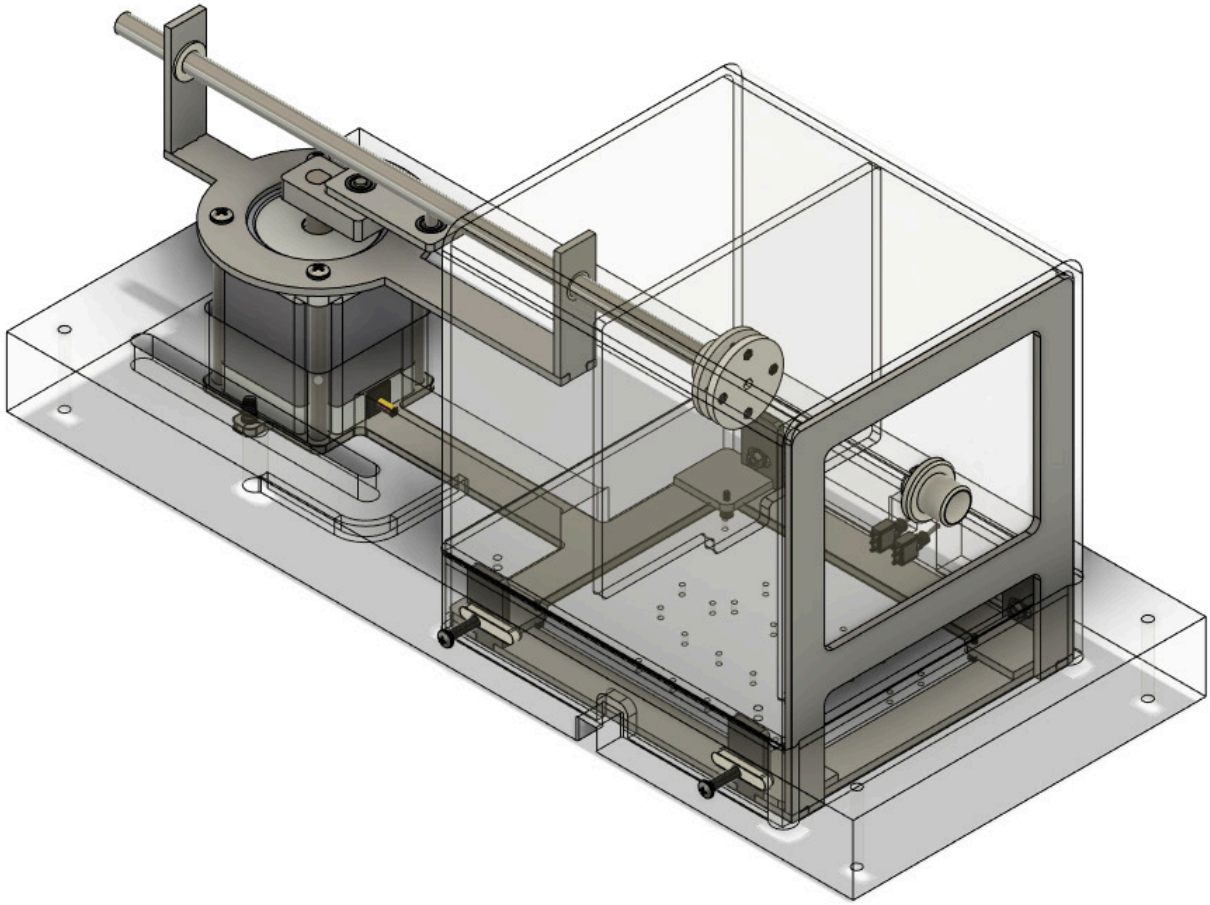


Newer versions of the work use a full acrylic sheet, drilled in the four corners.









APPENDIX IV - REPAIRS AND OTHER MANIPULATIONS

Securing the shaft head screws

For every socket head screw in the center of each shaft, apply some thread locking liquid and screw the parts back again immediately after the application.



Be careful not to put thread locking liquid on the bearings.

Changing the paper bag which contains the last breath

To change the air or replace the bag, turn off the piece when the rod is extended at the furthest point outside of the apparatus, to keep the maximum of air inside the machine. If you can't perfectly achieve this, you could move the mechanism manually to deflate the bag and inflate the bellows. Unplug the apparatus from its power source.

Unplug the tube from the air hose fitting on the apparatus and put a cap in the apparatus' air hose fitting. The breath is now safe inside the apparatus.

The bag can now be changed to a new one: unplug the bag-to-tube coupling adapter from the air hose assembly and remove the old bag with its rubber band from the tube coupling. Then attach the new bag (see Appendix II - Technical Datasheets: Kraft Paper Bag) to the coupling adapter using the rubber band. Remove the cap from the hose fitting, and reattach all the tubing to the air hose fitting.

Changing the breath count

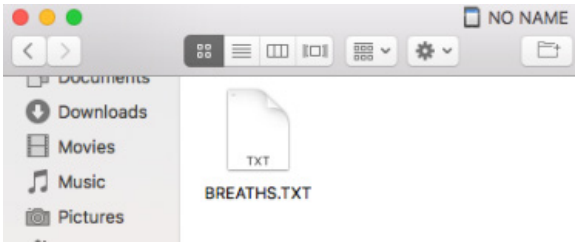
If the displayed number of breaths is not correct, you can change it to a specific value by doing the following. **At the end of the process, if the display shows an error message it means the file was not formatted in the right way. Make sure there are no spaces or capital letters on the file.**

1. Unscrew the M4 socket screws from the back and delicately open the electronics back plate. Be careful not to pull on the wires.

2. Take the micro SD card out of the socket by pushing into it until you hear the spring action releasing the card.

3. Put the card in a memory card reader with or without the SD card adapter included with the piece and plug it to a computer.

4. In a plain text editor (textEdit on Mac or Notepad on Windows) open the file BREATHS.txt as seen in the image below.



5. In the file you will see three lines: the header, the number corresponding to the right part of the display (the lower 8 digits of the number), and the number corresponding to the second part of the display (the higher 8 digits of the number).

6. First, edit the header from machine to human. Then change the next two lines to the desired number.

7. Save the file and put the SD card back in the socket.

8. Turn on the machine again and the display will show the new number. The number will be recorded on the on-board memory.

APPENDIX V - PACKING

Due to the different crating solutions used over time, the following information is an attempt at giving you the general sense for preparing the artwork for storage or shipment.

Before unmounting the artwork from the wall, inspect all the elements in use.

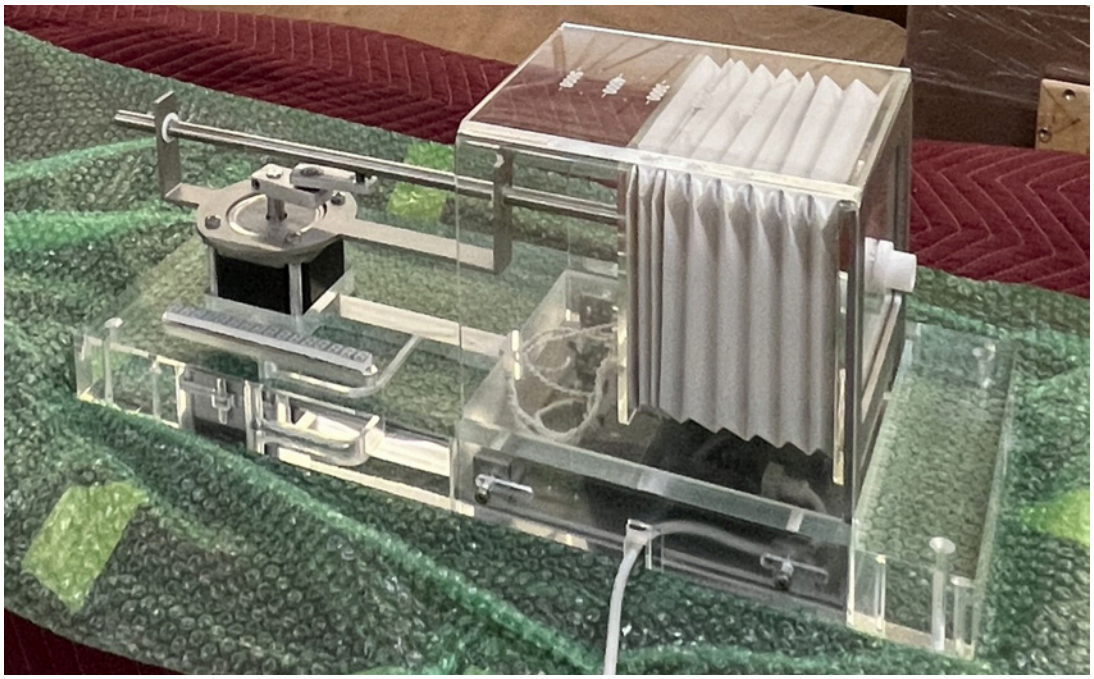
If the paper bag is showing traces of wear and tear, you might want to seize the opportunity to replace the paper bag prior to removing the artwork from the wall and packing the artwork.

Before dismantling the parts, ensure the apparatus gets stopped while the rod is retracted inside the Acrylic Bellows Case, in order to take the least amount of space and push most of the air within the paper bag.

Securely store the inflated paper bag, use the provided bag shipping cap to close it, disconnect the air hoses and retract them, keep the unused paper bags folded and stored together. Do not cap the bellows' Air Hose Fitting, air pressure changes may damage and rupture the bellows during travel.

In some packing versions, enough space is available on the right side of the device (air output of the bellows) to store the retracted air hoses and their fittings, while the bags should be folded and stored flat in the case before putting the main device. In other versions, the folded bags and the retracted air hoses are stored in a fabric pouch concealed in the crate lid, with other accessories (gloves, cleaning supplies, etc).

The acrylic is highly prone to scratching and should be handled with care, using only non-abrasive materials to prevent surface damage. More detailed instructions should come with the specific edition you have on hand.



Position in which the Apparatus should be stopped for storage.