



Showerloop Kit 2019

Manual version 01

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1. LINKS AND RESOURCES

showerloop.org	This is website
showerloop.org/research	Original bachelor's thesis'
showerloop.org/diy	Instructions and design files for Showerloop
showerloop.org/store	This is where you can purchase parts
showerloop.org/community	Community site
on Facebook	facebook.com/showerloop
on Youtube	youtube.com/channel/UCaTOqjcOmjvOxqlp348tH4A
on Vimeo	vimeo.com/user56408233
on Reddit	www.reddit.com/r/showerloop
Fablab.aalto.fi	Aalto FABLAB Digital Fabrication Laboratory. None of this would be possible without the help of Aalto Fablab!!!!
Turbiini Startup Accelerator	A startup center in Vantaa, Finland which has graciously provided us with office space to work on Showerloop and other sustainability projects.
AIRO Island RY	Our soon to be production facility is hosted by A.I. Robotics Island RY. While Showerloop isn't specifically in the field of A.I. we're working with digital fabrication tools like CNC machines and 3D printers with the goal of educating Finns and the world about the opportunities that lie in these but amazing technologies, especially when shared.
OSCEdays	Open Source Circular Economy days 2015 in Helsinki is where we presented Showerloop to the open source community for the first time. Jason was also one of the organizers of the event that year and in 2016.
POC21.cc	Proof of Concept 21. An innovation camp in 2015 that helped Showerloop get some international fame.
Instructables.com	https://www.instructables.com/id/Showerloop/ . The POC21 prototype.
Helsinki Fashion Week	This version Showerloop KIT18 was presented at the HFW2018.
GreenTech Awards	We won the Gallileo Wissenpreis GreenTechAward, Berlin 2017. We also got a business loan from the one and only Rea Garvey.



Showerloop at the Helsinki Fashion Week 2018

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3. SAFETY INSTRUCTIONS

- READ this before using !!!

Please read these instructions carefully before using ShowerLoop. The instructions contain important information which will help you understand the limitations of the technology and also help you get the best out of the system and ensure safe and proper installation, use and maintenance. Keep this manual close so you can always refer to it for j

- The filter captures particles and dirt inside it, the **backwash system** may help flush out these things but the point is that it doesn't just magically purify water with any contaminants. It was specifically designed for use in showers.
- A short, non-looping or pre-wash is preferable before activating the loop to reduce the overall load on the system and to remove particles, oils, and dirt from the body and therefore from entering the system extending the life of the filtrate (filter material).
- **Ultraviolet (UV) light** can be dangerous. **Never stare at it directly** without eye protection or expose it directly to your skin. The UV lamp has an operating time of 6000 hours (of continuous operation) before it's output is reduced by 20%. As a precaution, it is advised to **change the lamp** after **2 years or 600 hours** of operation as lamp usage is likely intermittent and the turning on and off of the lamp will reduce its capacity sooner. Once a suitable sensor becomes available we can reliably determine the lifetime of the lamp.
- **Test the GFCI** (Ground Fault Circuit Interrupter) on a **monthly** basis. When the system is connected to 220V AC power but not ON, Press the [T] button and everything should switch off.
- **Check** the cable glands, electrical boxes, and switches **for leaks, holes, water moisture** or anything abnormal.
- **Check** the **pump** on a **monthly** basis (according to the manual) but at least open the pump and service it each time the filter is changed (or after flushing the filter).
- **Always use a pre-filter** before the pump. Any debris will clog the pump and damage it. IT won't go off automatically and the friction can cause overheating and possibly even fire.
- **Stop the pump** when **switching modes** if possible.
- When **activating** the system for the **first time** the AC will release lots of dust and it should NOT be recycled. **Flush the system** like a normal shower - clear water IN and all water to DRAIN / WASTE WATER for **5-10 minutes/ 50-100 liters**. After this, the filter may release dust every now and then (especially when tightening the filter). As long as the particles are small they will not be a problem for the filter and the trace amounts of carbon are not dangerous if consumed.
- **Don't operate** unless you are nearby (at least for the first 10 hours of operation, reset after maintenance).
- **If WET, ONLY** use the **SWITCHBOARD** and **ON/OFF button** on the power box.
- Attach a **power consumption meter** / Timer between the power plug and wall socket to measure the operating time of the Filter.
- Log use of the system (see appendix) and **report back to Showerloop Headquarters...**

4. BOM / COMPONENT LIST

Below is a link to our component list, this includes some specifications and known suppliers. Prices may vary as well as the products. If you're looking for something on ebay and the link is no longer valid try searching for the full name listed.

[Showerloop Component List](#)

5. SPECIFICATIONS

5.1. DIMENSIONS Minimum dimensions

X	WIDTH	500 mm (440 mm smallest)
Y	HEIGHT	1800 mm (1440 mm smallest)
Z	DEPTH	250 mm (230 mm smallest)
Total system weight		35 kg
Total package weight with extra parts		42 kg

XXXPICTURE OF THE WHOLE SYSTEM HERE!XXX

*** See component list for dimensions and weights of individual parts ***

*** See 3d model for design files ***

5.2. WATER CONSUMPTION

PREWASH	1-5 L?
SHOWERLOOP	10 L
BACKWASH	0-5 L

A water and power savings calculator was developed by <http://david.mercereau.info/>
<http://showerloopcalculator.zici.fr/en>

5.3. POWER CONSUMPTION

PUMP	40W	12VDC 8A maximum (10A fuse) 100W max. Operating power.
VALVES	0.24W	5-24VDC 0.02A
RELAY MODULE	-	5-12VDC
SWITCHES	-	5-12VDC
AC/DC TRANSFORMER	150W	220VAC to 12VDC
UV	30W	220VAC or 12VDC
HEATER & HEAT LOSS	3000W 14A	220VAC or

Nominal operating power is 150 W max without heating or 60 minutes is 0.150kWh

10-minute shower ~1.3 kWh

30-minute shower 2 kWh

A water and power savings calculator was developed by <http://david.mercereau.info/>
<http://showerloopcalculator.zici.fr/en>

5.4. REPLACEMENT OF FILTERS & OTHERS

SHOWER DRAIN FILTER DAILY

PREFILTER WEEKLY - MONTHLY, INSPECTION, MONTHLY CLEANING. REPLACE AFTER 150 showers

PUMP	MONTHLY INSPECTION & CLEANING (see Pump manual)
SAND FILTER	2-5 MONTHS
AC FILTER	2-5 MONTHS
UV LAMP manual)	1000 hours operating time but rated for 8000 hours continuous operation (see UV manual)
HEATER	6-12 MONTHS INSPECTION (see Heater manual)

Note: filter lifetime is still in need to wide scale testing. Most results are estimations based on empirical data from our lab tests and tests with a single showerloop in household conditions. The water from Southern Finland where the hardness of water ranges from 3.0 to 4.5 dH and water quality is good.

6. MATERIALS & CARE

6.1. THOUGHTS ON MATERIAL SELECTION, LONGEVITY AND PRODUCT LIFECYCLE

ShowerLoop is a work in progress. Components and materials had been selected in the last 5 years (2012-2017) carefully and under a tight budget. The limitation in resources has been the principal reason why ShowerLoop develop process has taken longer than expected. In consequence, materials had been choose base on longevity, price, availability and utility = sustainability. It's likely that every component could be replaced with something more sustainable, effective, simpler, prettier and cheaper.

Additionally, we limit the suppliers to commonly available hardware stores in Finland which have slightly smaller selections than those in mid-Europe. ShowerLoop applies the Open Source principals, so parts can be interchanged with what is available locally.

That said, many alternatives have been attempted with almost every component and material available, making this last design the best of the best so far. In order to speed up the developing process, we relay in more users fabricating/modifying their own ShowerLoops. We encourage you to find good and sustainable components, as well as suppliers that would allow Showerloop builders to collaborate and ultimately make a super sustainable shower.

6.2. VERSIONS.

Show some pictures

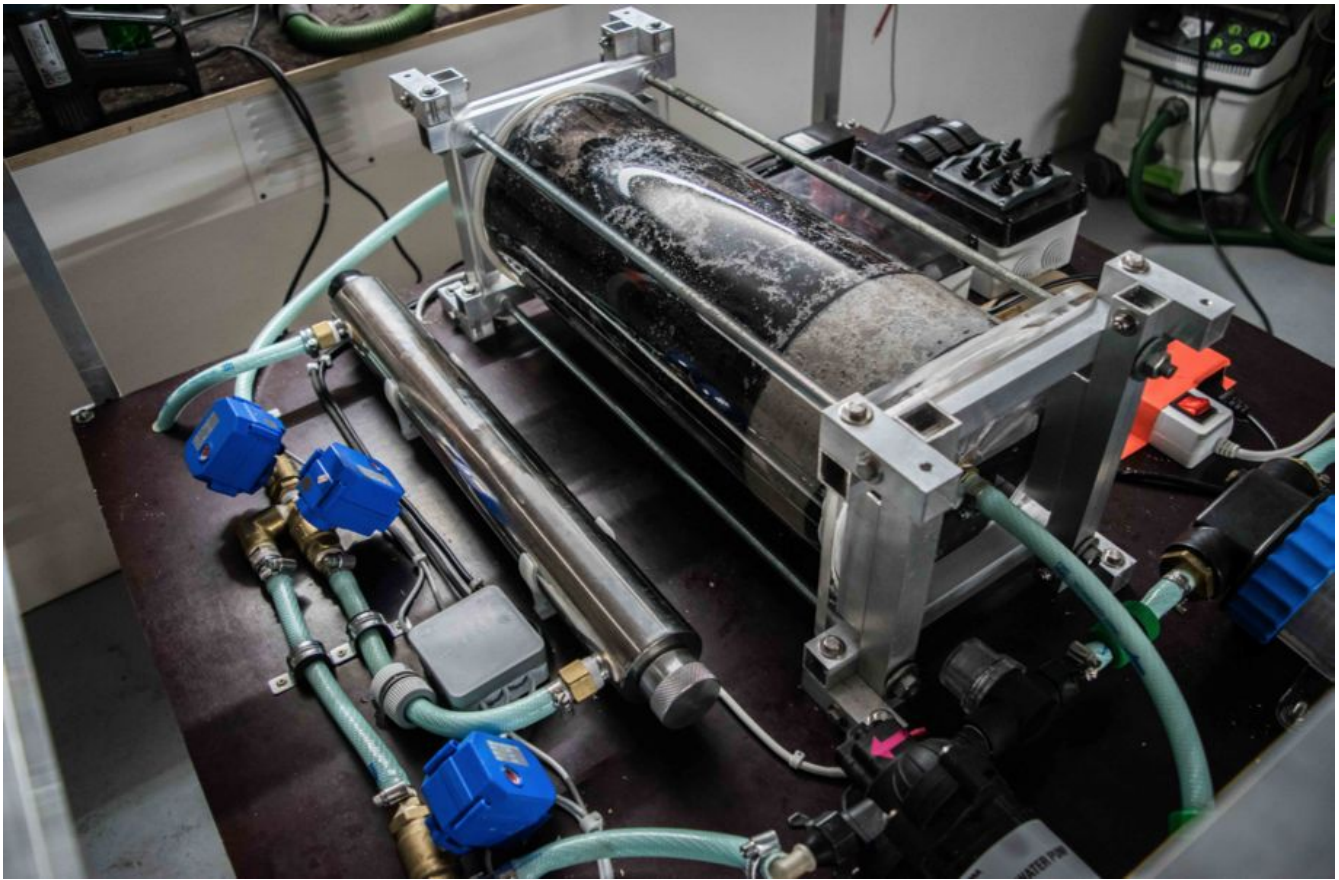


fig. 1: Showerloop assembled in Hamburg at n55 in 2016. Designed by Jason and Eduard Kobak, assembled by Jason and Timm Wille. Still my favorite one visually and for it's 1m2 XYZ city structure format, however, it doesn't have the passive drainage possibilities of future models.



fig. 2: Showerloop at Helsinki Design Museum as part of the Enter and Encounter exhibit on the

next 100 years of Finnish Design. Designed by Jason Selvarajan collaborating with Juha Kivekäs (for the shell) using [Xplision](#). The water flow visualization was made with the help of Niklas Pöllönen. This version had all existing components but in a compact form.

fig. 3: Showerloop KIT exhibit at Aalto Fablab Re-Opening Event 2017, Aalto University, Espoo.

7. WHAT IS SHOWERLOOP?

Showerloop is a water filtration system made principally for Showers, allowing you to take showers at a reduced environmental and economic cost. It requires 10 liters of water for a shower of any length* while reducing the amount of energy needed for a nice and warm shower.

How it works is not a mystery! basically, it captures water from the drain which gets sucked through an initial particle filter by the pump before it's pumped through a fabric, sand and activated carbon filter to remove particulates and organic compounds like oils and sweat. The carbon has millions of tiny pores that capture suspended solids and can even trap molecules making the water crystal clear or pure, for the next step - ultraviolet sterilization, to be effective.

The ultraviolet sterilization is done by The UV lamp, it emits UV-C light radiation which breaks up the DNA of bacteria thus sterilizing it. After this, the water can be recycled/reused. Neither term is accurate as recycling is generally more like downcycling. Reusing also is a bit incorrect as a term since the water has been upcycled from it's 'dirty' state. (returning the water as close as possible to its original form with the low-tech materials used). Re-upcycled? UpUsed? Temperature can be maintained with a resistive heater and thermostat to automatically maintain water temperature, though solar heating would be preferable and gas heating is a good option in some circumstances.

The system also uses a series of electro-mechanical ball valves and piping to allow multiple shower modes: Showerloop, **bypass** (which skips the filters), **backwash or back-flush** (to clean the filter), **pee** mode / direct to drain and finally system drain - this allows all the water to be drained from the system after each shower. The blue-grey water can also be stored and used for washing clothes or flushing the toilet. The system runs mostly on 12VDC power except for the UV and heater, though it's possible to have a completely 12V off-grid ready system. Still under development are 1. research on removing soaps and oils, 2. making the shower smarter using sensors, microcontrollers and adding connectivity and programmability to the system, not to mention the 3. overall design, usability, and production process.

Showerloop was officially started as a Bachelor's thesis project in 2012 (though proposed in class on thermodynamics and a business competition in 2010 and). Research on filter dimensions and purification/sterilization were the main facets of the research which can be found here:

<https://www.theseus.fi/handle/10024/76148>

8. OPERATING PRINCIPLE AND GENERAL SPECS

8.1. TAKING A LOOP SHOWER

The process of taking a shower is as follow:

- Check that all **valves** are in **OFF**-position (down)
- Check The **pump** is switched to **zero** (counterclockwise)
- Turn ON** the system from the control box by **rotating** the RED '**emergency switch**' button
- Set** the desired heating **temperature** on the thermostat if it's is available
- Activate the **Showerloop mode** on the switch panel. Normally by **activating valves 2,4 and 5**.

Initially, it is recommended to run the shower in 'pee' mode at least once before taking your first shower in order to remove loose filter particles out of the system and not back into the filter.

Afterwards begin to fill the shower with water from your water source of choice. Hot water is preferred. Turn on the pump on the control box (button above the stop button) and adjust the flow on the dial. stop adding water once around 10 liters has been added to the system. You should have a continuously looping shower now. See the troubleshooting section if things don't look normal at this point.

Step into the shower and enjoy. When you are ready to step out of the shower and turn off the pump. Change the mode into Backwash mode and turn the pump on again. This will pump water into the drain but backwards through the filter rinsing it off a little.

Open all the valves but shut off all other devices since you don't need them any longer. This will Drain the system of excess water and prepare it for the next shower. After the whole system is drained the system can be shut down. Keeping the system powered to allow for drainage uses a marginal amount of energy (maximum 15 W, though likely it's more like 1,5 W).

The system can also be drained faster by using the pump to build up a pressure in the filter. By closing the output valve but this would require some practice as it's a manual operating.

Getting wet and washing off main dirt particles and possibly applying shampoo. Shampoo and conditioner can also be applied at the end of the shower if possible.

*Draining and cleaning the filter will be automatic in the next model. a prewash or navy shower.

8.2. MODES

DIRTY WATER IN > PRE-FILTER > PUMP > VALVES > FABRIC FILTER > SAND FILTER > ACTIVATED CARBON FILTER > VALVES > UV > HEATER > SHOWER HEAD > YOU > <start again>

There must be sufficient water in the system (7-10 liters) to fill the system.

Water is prefiltered, pumped to the filter, filtered, sterilized/purified in the UV lamp and reheated before being looped.

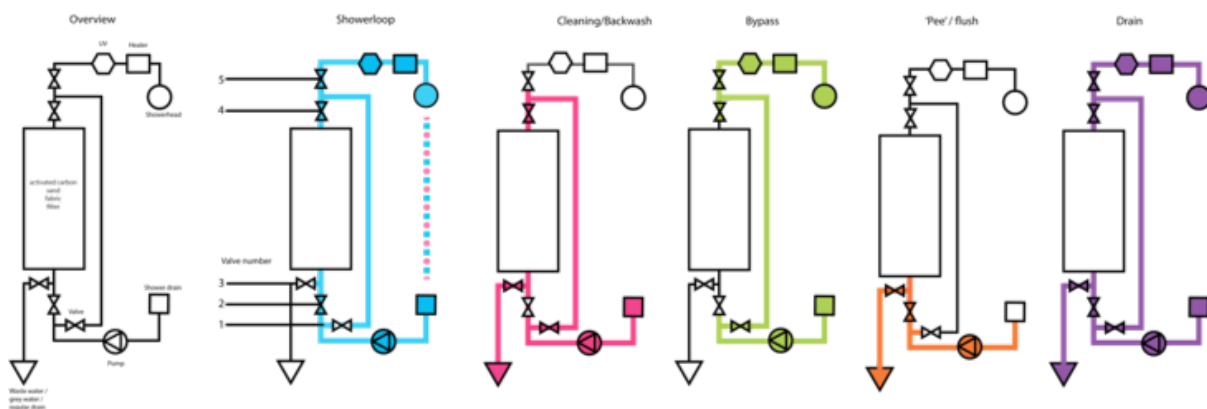


fig. 4: Schematic 555

8.2.1. Prewash

Ideally, in this mode, you will take the initial shower before activating Showerloop mode to reduce the load on the filters. A pre-wash or navy shower is recommended, essentially taking a really quick shower. Getting wet and washing off main dirt particles and applying shampoo and soap.

8.2.2. ShowerLoop

: PUMP, UV, HEATER, V2, V4, V5

The main mode used to enable the filtering and reuse of shower water.

8.2.3. Backwash

: PUMP, V2, V3, V5

Run this until no water goes out the drain pipe/ the motor has run dry for a moment.

Then run Pee/Flush mode: PUMP, V2, V4

To evacuate all the water left in the system.

8.2.4. Bypass

: PUMP, V1, V2, V5

Run this until no water goes out the drain pipe/ the motor has run dry for a moment.

Then run Pee/Flush mode (see: [Pee / Flush](#))

To evacuate all the water left in the system.

8.2.5. Pee / Flush

: PUMP, V1, V3, V4

Run this until no water goes out the drain pipe/ the motor has run dry for a moment.

Then run Pee/Flush mode: PUMP, V2, V4

To evacuate all the water left in the system.

8.2.6. Drain

: V1, V2, V3, V4, V5

This is, unfortunately, a little bit cumbersome of a process and will be automated. Leave the valves open for 10-30 minutes after you have taken a shower to allow for the filters and pipes to empty of water. For this reason, it's good to allow for water to drain passively from the system by connecting devices

9. ASSEMBLY INSTRUCTIONS.

9.1. ORDER

Figure out how you want all the components to be laid out. Lay them out on the ground or on the backboard you intend to use.

Considerations:

The Sand/Active Carbon Filter should be upright with the current design (carbon level on the top of sand). It should run sideways but some important features may be missing: the ability to push bubbles out of the system and filter and passive or gravity draining. So water should always be flowing upwards or sideways (though a slight angle is recommended).

9.2. SECTIONS:

9.2.1. Pre-filter and pump:

The pre-filter and pump intake should be aligned. It doesn't matter if it comes from the left or right but make sure the orientation on both the pump and the prefilter are correct. Look for the arrows showing the direction of water flow. Ideally, both are positioned at the bottom of the Showerloop. It's not recommended to use angled pipe connectors with filters.

9.2.2. Valves :

Can be split into the top and bottom assemblies.

- Top Assembly: Valves I and II.
- Bottom Assembly: Valve III, IV, V.

Use 5-7 rounds of Teflon tape. This part is a little tricky because with the connectors we are using there's no way to ensure the orientation, except for trial and error. Using plumbing style connections (like with the POC21 version) it's a little easier.

9.2.3. Filter:

The main filter (sand/active carbon) should be installed in the middle of the Showerloop, preferably located over the pump and pre-filter. The orientation of the filter is based on the internal material. The sand is located in the bottom of the filter and the active carbon on the top of the filter. The bottom of the filter is connected to T-branch, located between valves V3 and V4. The top of the filter is connected to the valve V2.

9.2.4. Uv:

Uv is located on top of the showerloop, over the main filter. The recommended installation angle is 45°. The lower connector is connected to the Valve V1. The top connector is connected to the shower head.

Heater

10. PARTS / COMPONENTS / BOM .

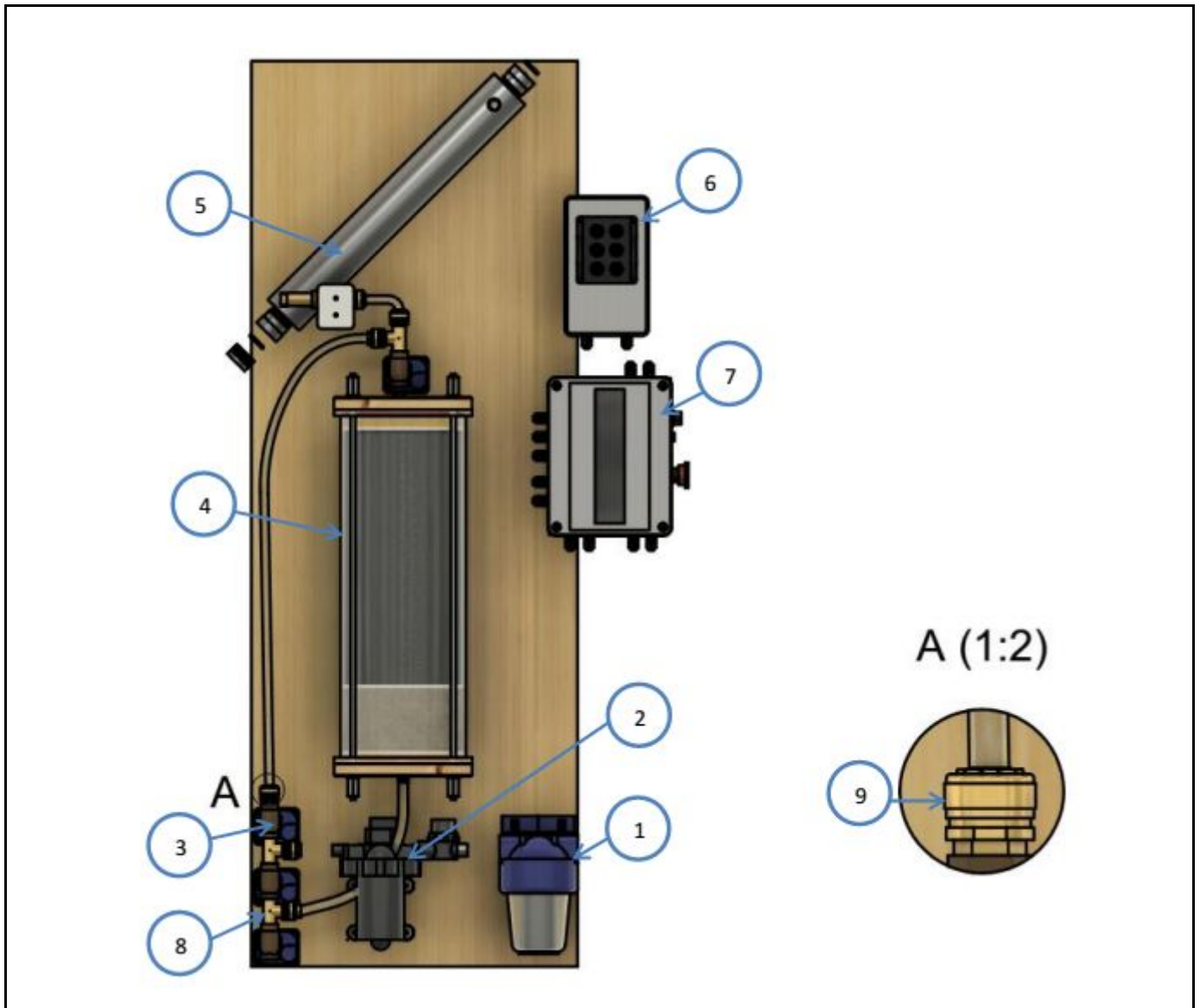


fig. 5: General assembly diagram.

List of components:

Det nr.	Qty.	Name	Ref. number
1	1	PRE_FILTER	LOOP-057
2	1	PUMP	LOOP-046
3	5	VALVE	LOOP-060
4	1	MAIN_FILTER	LOOP-001 - LOOP-009
5	1	UV	LOOP-052
6	1	CONTROLLER	

7	1	ELECTRIC PANEL	
8	3	FITTERS	LOOP-022
9	10?	CONNECTOR	LOOP-017

10.1. PREFILTER.

The first prefilter stage is the drain itself. This is the first and best line of defense to keep the Showerloop in working order for as long as possible. The drain will keep big size external elements/particles out of the system.

The second stage of the Prefilter is a KIT (as shown), it contains a filter that can be replaced when needed. An easy visual inspection will tell you whether is time to change it (for more info check Maintenance chapter). The kit includes a support, we recommend it for an easy installation and maintenance.

The KIT pre-filter is placed before the pump to capture large particles and prevent them from clogging up the pump and hoses.

The prefilter should be placed horizontally with the transparent chamber facing down and accessible so that you can clean and replace the filter.



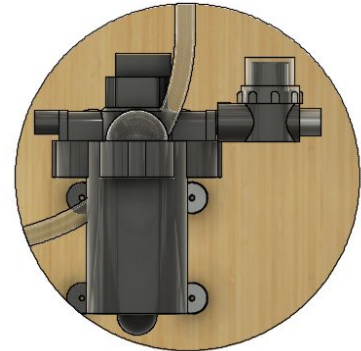
NOTE the orientation of the filter. There should markings for IN and OUT (outside of the filter to the center and then up and out). Also, make sure that there isn't anything there.

Use Teflon tape or hemp fiber to seal the connections. L-bends, Male, Barbed connectors can be used.

10.2. PUMP.

The pump is a crucial part of the system, it is the device that ensures the circulation of the water throughout all the components. There are definitely many options to choose from, but through our experience, a self-priming water pressure pump does the job quite well, it should cost at least 60 dollars/euros.

The Pump should be placed after the pre-filter and connect to the T-pipe located between valve V4 and V5. This ensures a good operation of the ShowerLoop modes. It is better to orient the motor housing facing down (as illustration ##) or horizontal so it can be inspected and clean easily. For more information consult the self-priming water pressure pump manual:

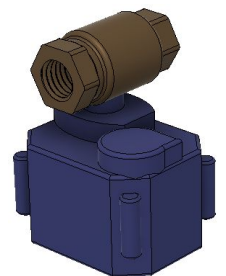


SEE SELF-PRIMING WATER PRESSURE PUMP MANUAL

<https://docs.google.com/document/d/1uYXiMgoutgsRaZN4cyekOJQvDxBk9fcLM-2BmzSxSco/edit?usp=sharing>

10.3. Valve.

The motorized ball valves are used in combination to activate the various showerloop modes by opening and closing in specific combinations. Ball valves are nice because of their low resistance as the diameter inside the valve is about the same as the hose in a straight line. Solenoids can also work but they generally only flow in one direction, have high resistance, and draw much more power (watts compared to fractions of a watt).



Valve power

On at 6.4V (very slow and weak though)

0.02A

.122 watts per valve

It goes off at 4.5V or less

0.02 A

[LINK to the valve documents!!!](#)

10.4. FILTER.

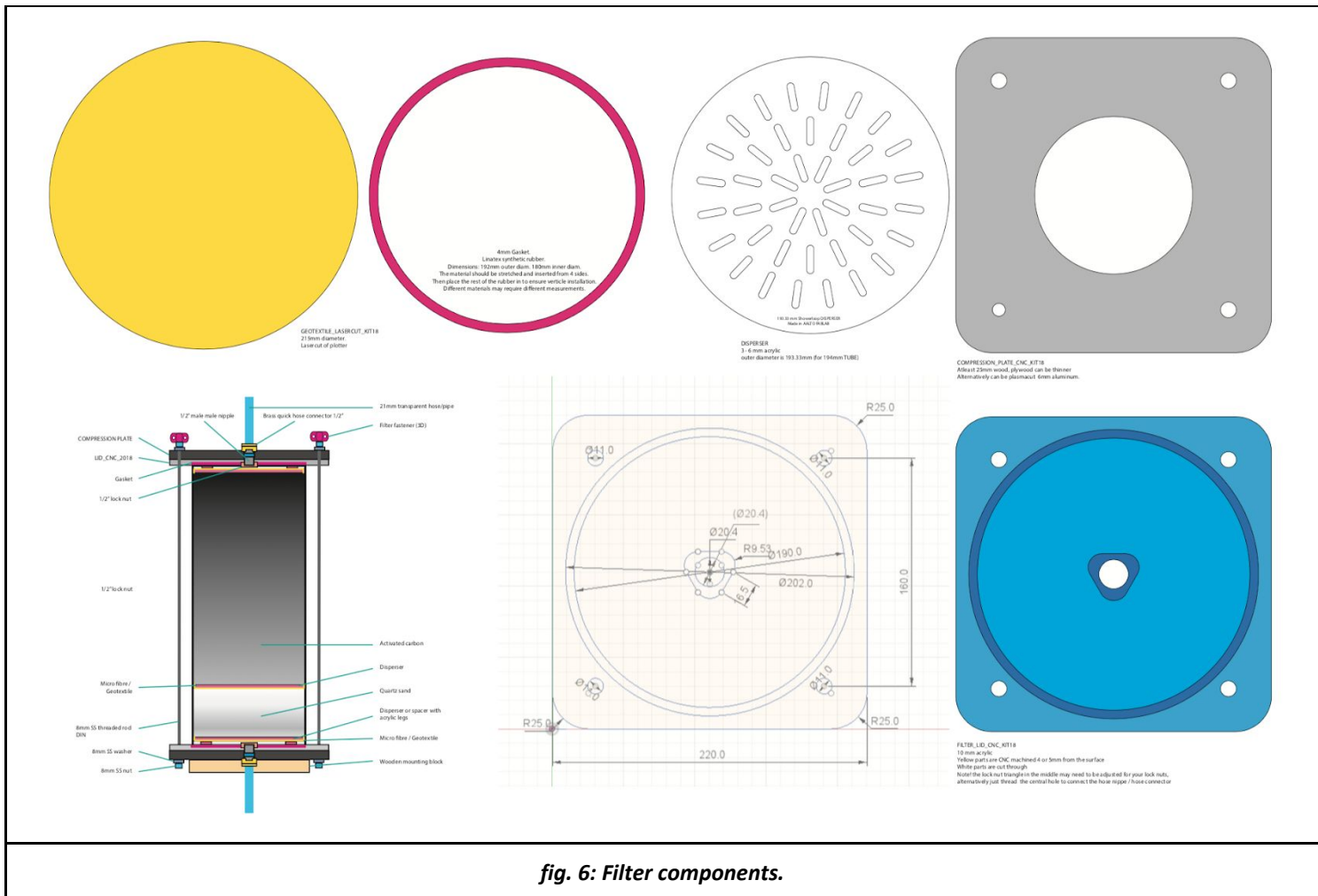


fig. 6: Filter components.

Link to the design files above.

<https://drive.google.com/open?id=1l7l9SxWHhkKq-GCmqPPQ-lw2lWYjYr0T>

SEE FILTER MANUAL

https://docs.google.com/document/d/1bDM_z5XQPu2OrFVX3QQyj3mfffK_Ft_ffbqZrGkTmbY/edit?usp=sharing

10.5. UV LAMP

ULTRAVIOLET IRRADIATOR

SEE UV MANUAL

10.6. HEATER.

SEE HEATER MANUAL

https://docs.google.com/document/d/1e7N5EUpV_W2SX7Yeydl1DjIKlWVAsMepUFc0gqwdvY/edit?usp=sharing

10.7. PIPE FITTINGS.

Everything has been standardized to use 1/2" BSP (British standard pipe) threads for connecting hoses, valves, pumps, UV, you name it. 3/8" inch might work but I haven't used it much. Also 3/4" and 1" connections may also

work better to reduce the overall pressure in the system but I have my doubts they would offer significant improvements. 1/2" is a good size because it's common with gardening equipment, is inexpensive and has a good range of quality and standard parts with decent prices. Permanent fixtures with copper/ss pipe or PEX tubing will for sure work but I haven't been able to test them out thoroughly. Since they are an industry standard I see no problems with them except their larger size and cost.

10.7.1. Plastic quick fit hose connector.

This is standard for connecting 2 hoses together. It's easy to install and very reliable (no leaking) without the need for tools as it tightens by hand is sufficient. These can be found in any gardening section in a decent hardware store though they cost a lot compared to finds on Ebay.



fig. 7: Plastic fitting connector.

10.7.2. Brass quick hose connector.

This component took a while to find but it's fantastic. Really should be available everywhere. It's got the 1/2" female thread which can also connect to a male-male connector to have both orientations.

DIAGRAMS

Brass T

Brass Male - Male

Brass Male - 1/2" barbed connector

10.7.3. Other options.

PEX tubing

... copper ...

10.8. ELECTRONICS .

COMPONENT 6 AND 7 IN THE ASSEMBLY DRAWING LIST !!!

This is technically outdated, but also a simplified version of the switchboard/power box combination. Instead of using a relay module and trigger each device from it, the switchboard directly triggers the valves and via the minimalistic power box on the right triggers a relay for the pump, UV, and heater. The output from the switchboard is all 12V DC while the output from the power box is 220V AC for the UV and Heater and 12V DC for the pump. The reason this was replaced with the Relay module is that it was both less expensive to produce at small quantities and also provides a visual feedback for the devices. When the device is triggered via the switch a RED LED turns on to show that the RELAY is CLOSED. Wiring the relay module is also simpler.

diagram of how the relays work

WHERE IS THE 3D MODEL?

WHERE IS THE CAM FILE?

Attachments? Links?



fig. 8: Plastic fitting connector.

10.8.1. Backboard size 30x50 plywood 3-6mm

Cut the plywood. Round the edges if desired. Lacquer or varnish.

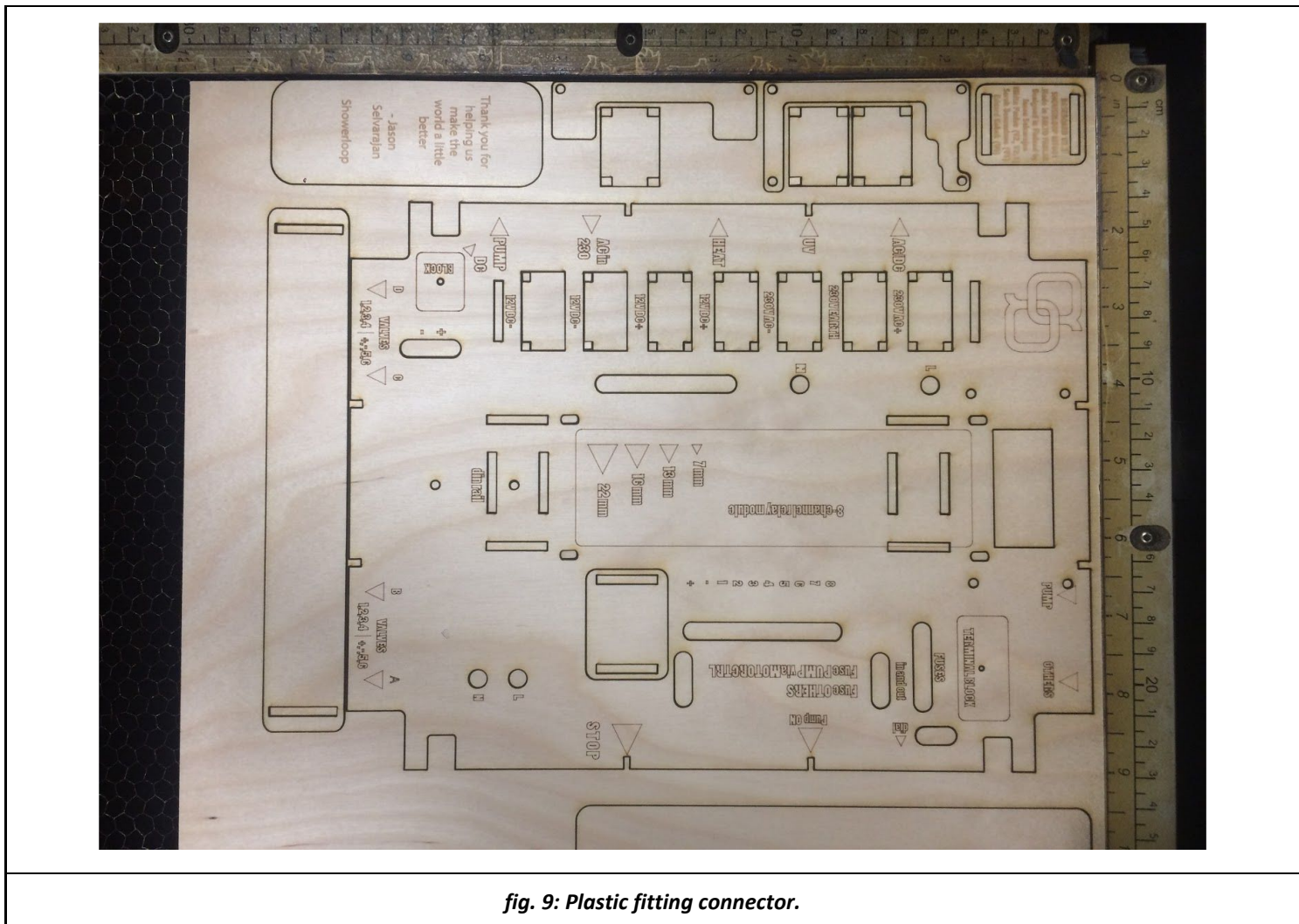


fig. 9: Plastic fitting connector.

Laser cut baseboard for power box. Plastic may be the better option as wood will likely warp from the humidity and changing temperatures. Hopefully, if the box leaks the wood will reveal it. Acrylic is an available alternative but possibly less sustainable.

Complete baseboard includes 17 pieces, mainly used for organizing electronics during assembly. To help with assembly, we have marked components' positions on the board itself, such as position for a relay unit or cable through-holes.

Fig. 11: the front end of the completed baseboard

Fig. 12: backend of completed baseboard

Use two holders to attach cable organizer (marked with text) to the marked location (Fig. 11). Do not apply force, since pieces are fragile to break.

Remove a DC-motor regulator from the protective case. Attach holders (Fig. 13) to the DC-motor regulator before attaching regulator to the baseboard. The smaller holder is located on top of the bigger one (Fig. 14). Attach the component to the baseboard with four M3-screws and nuts as shown in Fig. 15 and 16. Turn the baseboard around marking text facing up.



Fig. 13: DC-motor regulator holders



Fig. 14: Holders pre-installed to the DC-motor regulator

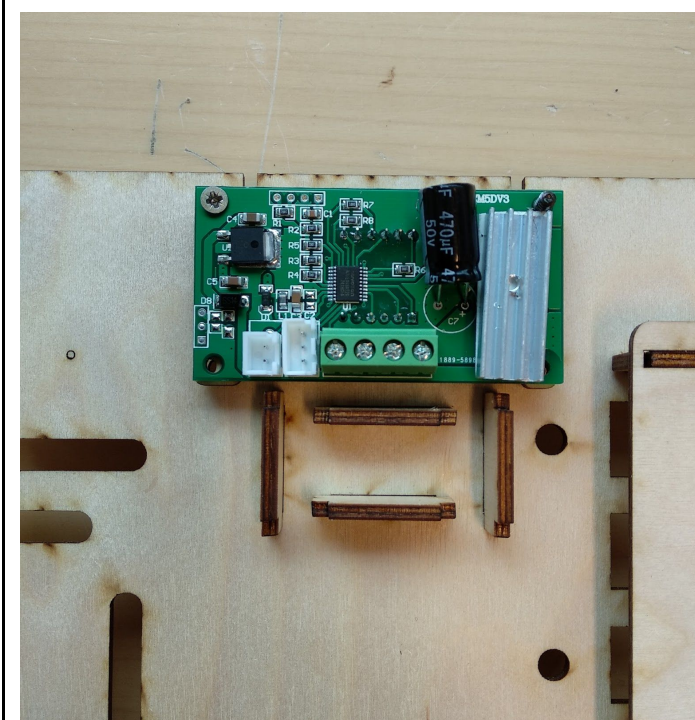


Fig. 15: Installed DC-motor regulator to the baseboard (back)

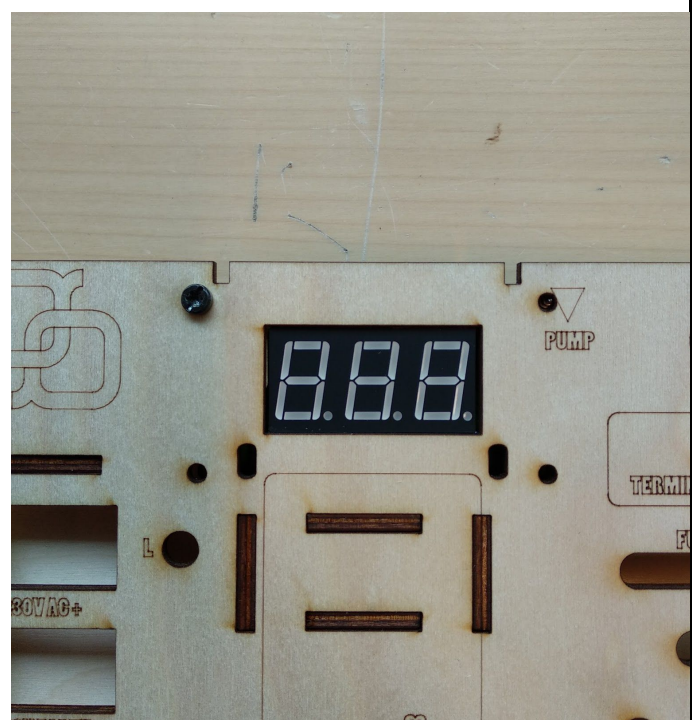


Fig. 16: Installed DC-motor regulator to the baseboard (front)

Proceed with electronics' assembling.

LASER CUTTABLE FILE

<https://drive.google.com/open?id=1O1YaiM63p1VlhiQVy5KYs1pycWCMKvNk>

10.8.2. Power Box / Relay Box

The purpose of the power box is to house the high voltage electronics and to separate them from the user while they are in the shower. Water and electricity can be an intimidating combination even though it's done all the time with washing machines, dishwashers, and jacuzzis. In Finland, we casually through streams of water at electrical resistors while naked in the sauna.

LIST of components:

Det nr.	Qty.	Name	Ref. number	Comments
1	1	POWER BOX	LOOP-028	
2	1	BACKBOARD	LOOP-029	
3	1	RELAY MODULE	LOOP-032	
4	7	TERMINAL BLOCK (5 pin)	LOOP-033	
5	4	TERMINAL BLOCK (2 pin)	LOOP-034	Use 2 x 2 pin as one 4 pin
6	1	MOTOR CONTROLLER	LOOP-035	Incl. switch and control buttons
7	1	FUSE 10A	LOOP-036	
8	1	FUSE 1A	LOOP-037	
9	1	GROUND FAULT PROTECTOR	LOOP-040	
10	1	CIRCUIT BREAKER	LOOP-041	
11	1	KILLER SWITCH	LOOP-113	
12	11	CABLE GLAND	LOOP-038	PG7, 7 x white, 4 x black
13	1	DIN RAIL	LOOP-114	
14	1	AC/DC CONVERTER	LOOP-062	

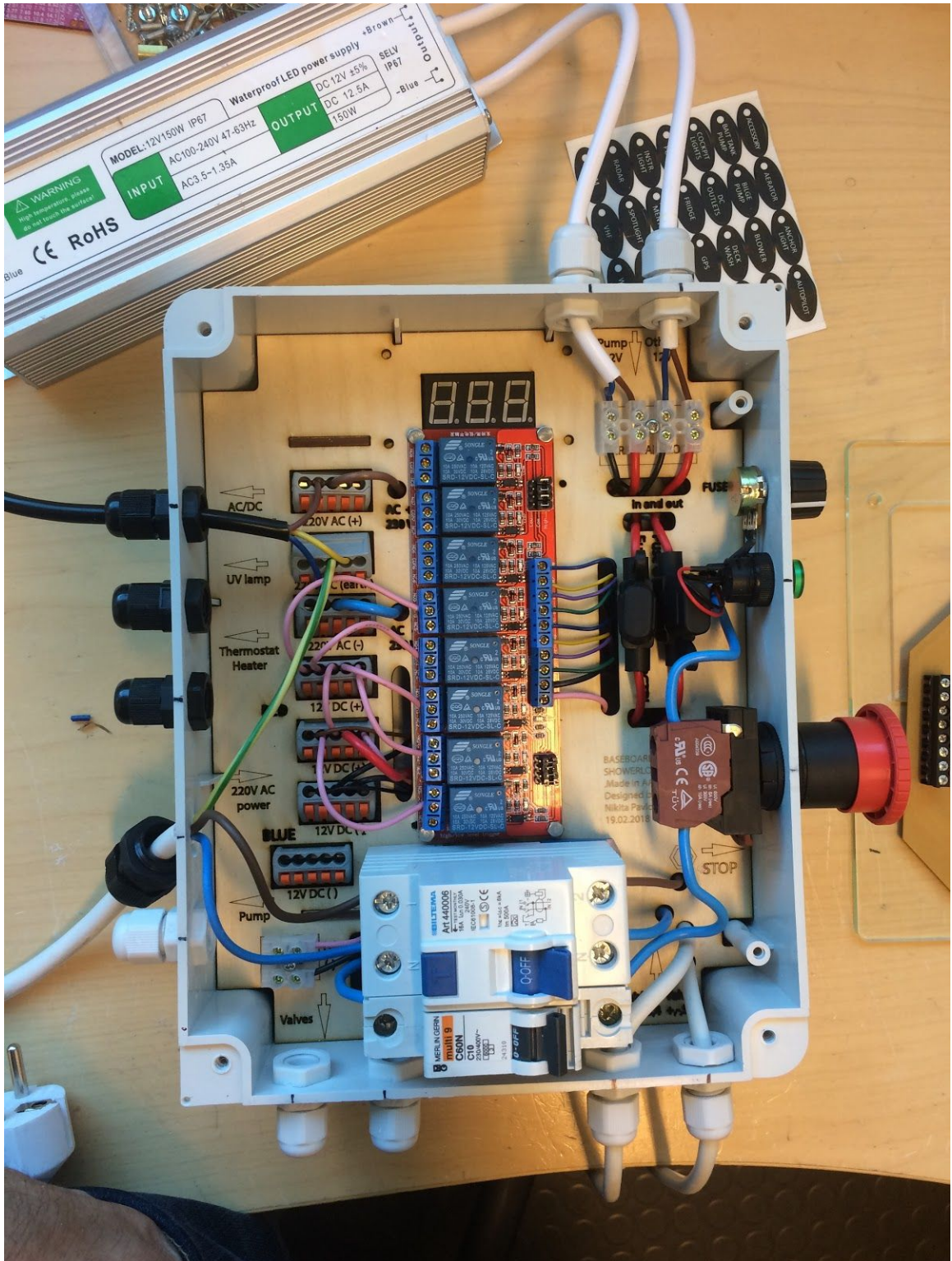
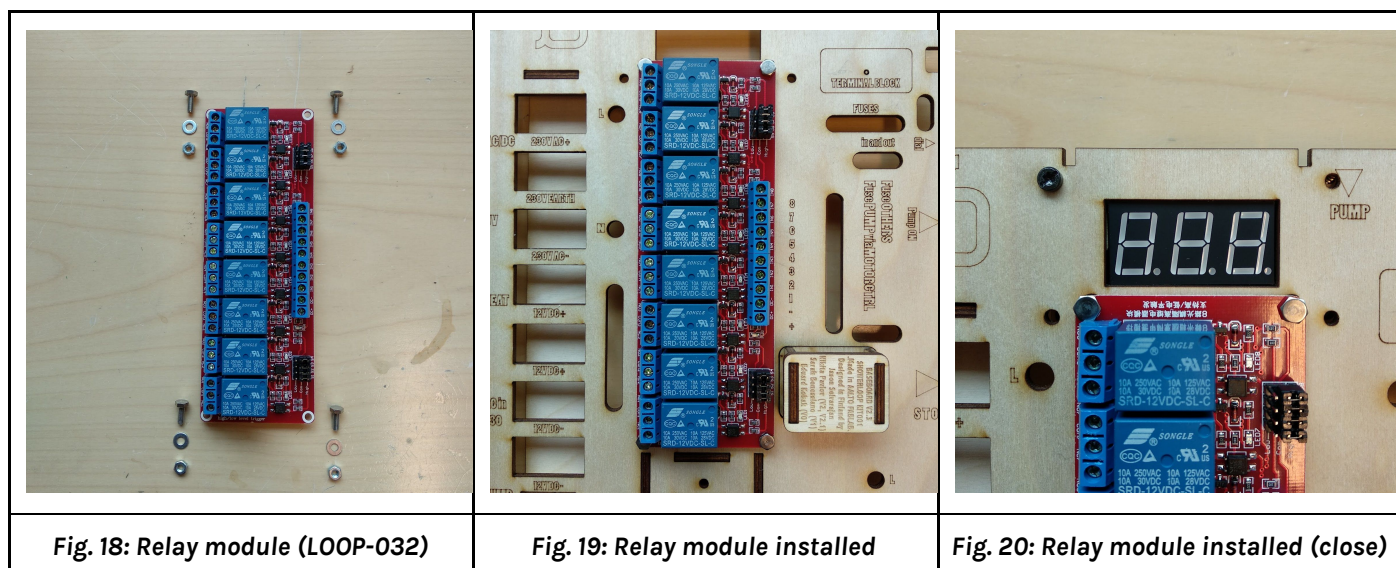
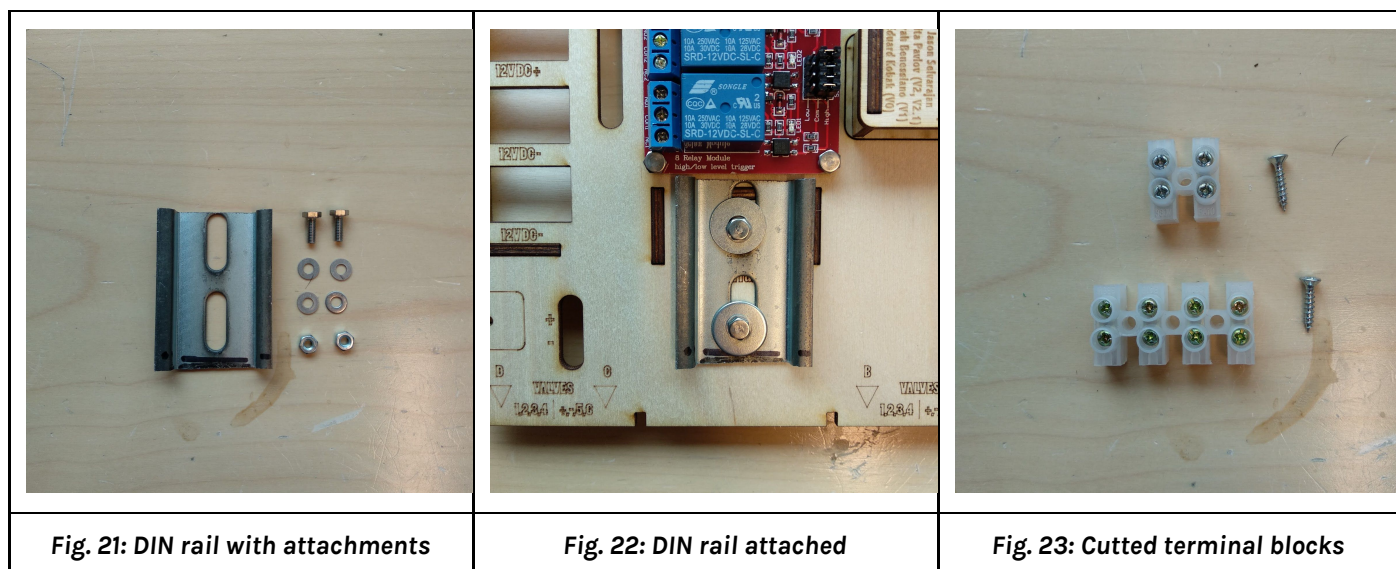


fig.17: Plastic fitting connector.

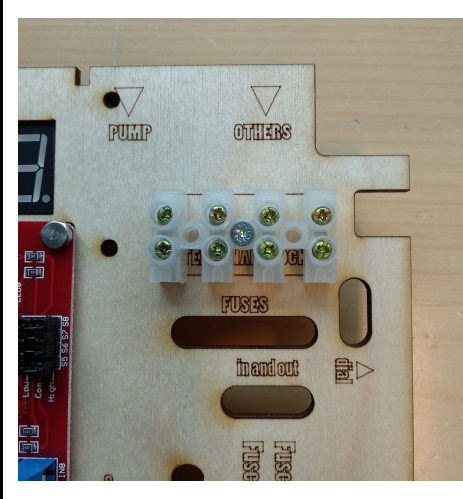
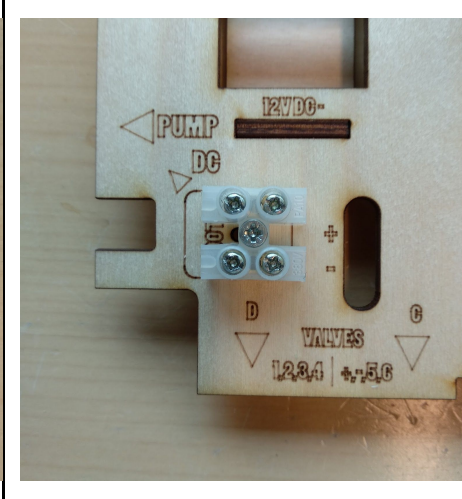
Begin assembly by attaching relay module (1.) to the baseboard (Fig. 18). The location for a relay module is marked on the baseboard in the middle. The relays should be facing left towards terminal block location (Fig. 19). Secure the relay module with four M3-screws and M3-nuts (Fig. 20). Try not to bend the relay module, as it may break.



Secure the DIN rail (13.) to the baseboard (Fig. 21). The location for a DIN rail is marked on the baseboard, located under the relay module location. Use two M3-screws and -nuts, in addition to washers. The DIN rail should be located directly under the relay module in addition to touching it (Fig. 22).



Attach terminal blocks (5) to the baseboard (Fig. 23). Use M3 wooden screws to secure terminal blocks. The 4-pin terminal block is used for connecting AC/DC converter to the fuses. Terminal block is located in the right-top location of the baseboard (Fig. 24). Remaining 2-pin terminal blocks are used for DC-power connection. A 2-pin terminal block for controlling DC-pump is located in the left-down location of the baseboard (Fig. 25). Another 2-pin terminal block is located next to the relay module and fuses (Fig. 26).

		<p>Need pic.</p>
<p>Fig. 24: Terminal block for Fuses</p>	<p>Fig. 25: Terminal block for DC-motor</p>	<p>Fig. 26: Terminal block for Switch Panel</p>

Install Ground Fault Protector (9) and Circuit Breaker (10) to the DIN rail (13). Ground Fault Protector should be located on top of Circuit Breaker. The 1-pole of the Ground Fault Breaker should be facing left while 2-pole should be facing right. The Circuit Breaker should be installed such way, that the text written on both components should be easily read without turning baseboard.

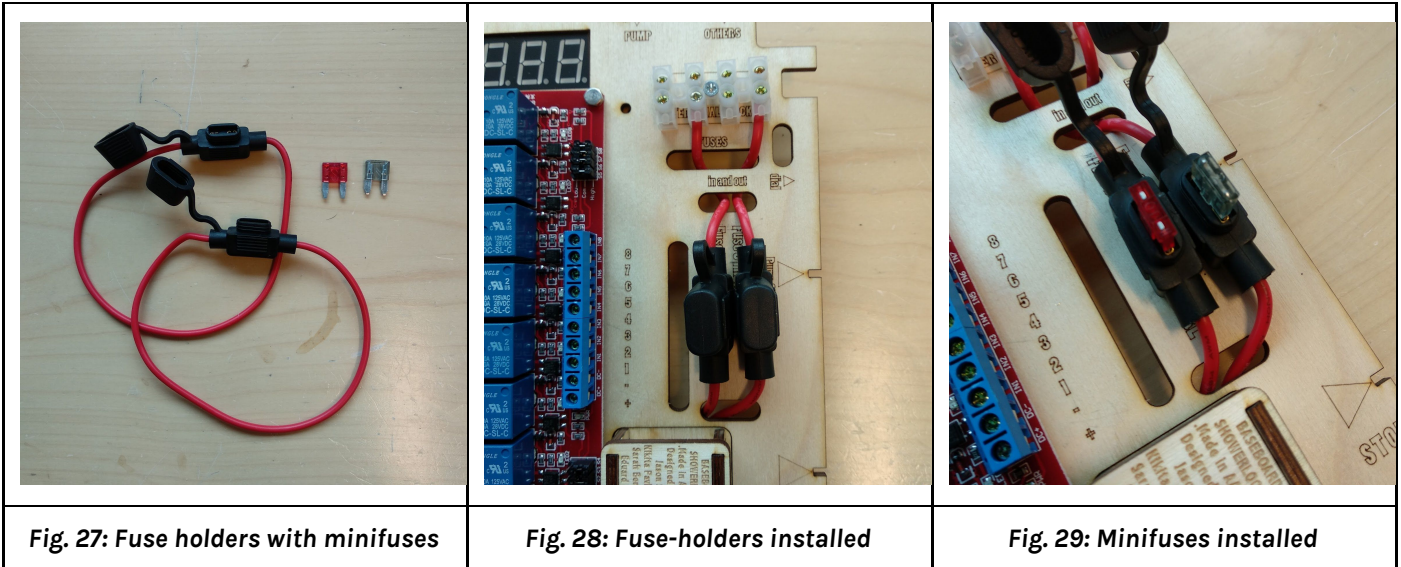
10.8.2.1. WIRING...

The process includes wiring AC and DC components. The wiring also includes adding additional components, such as Killer Switch, Fuses, Terminal Blocks, and Pump Controller switches.

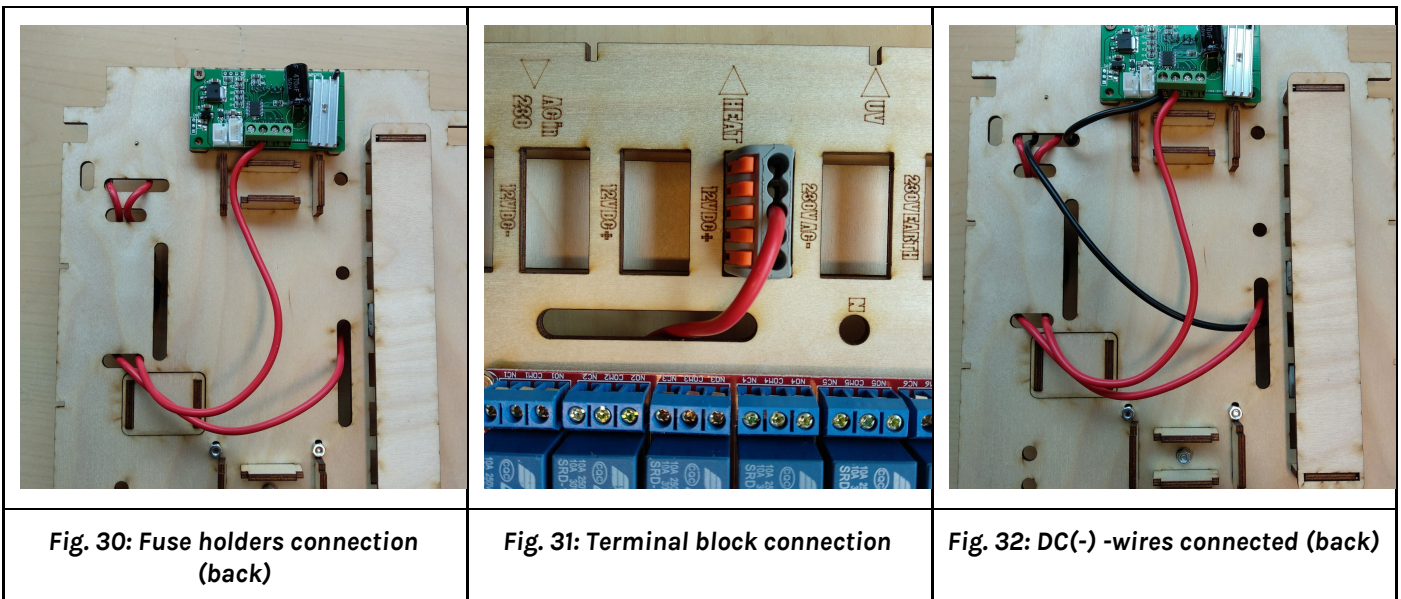
General wiring rules are included in the process, covering color pattern for AC/DC components. AC-wiring includes usage of blue, brown and green/yellow wires, where DC-wiring includes red and black wires.

Begin with wiring AC components. Based on standard IEC 60466, phases are brown & neutral is blue. AC Power Cable is connected to Ground Fault Protector (9.). Phases (brown) is connected to the pin 1 of Ground Fault Protector and Neutral (blue) is connected to the N-pin on the same side. The pin 2 of Ground Fault Protector is connected to the Circuit Breaker (10.) by the Phase (brown) wire. The wire is routed between components on the other side of the baseboard. To secure wiring use 2.5mm² terminal crimps (LOOP-074).

Connect the unplugged end of Circuit Breaker to the Killer Switch (11.) with Phase (brown) wire. From Killer Switch the Phase (brown) wire is connected to the Terminal Block marked with 220 AC(+). The wire should be routed through the back of the baseboard. The Neutral (blue) wire is routed from Ground Fault Protector's (9.) pin N to the Terminal Block marked with 220 AC(-). The Power Cable's Ground is connected to the Terminal Block marked with 220 AC(grnd).



Connect Fuse Holders (Fig. 27) to the Terminal Blocks located in the top right of the baseboard. To keep Fuse Holders secured on a baseboard, reroute wires as shown in figure 18. Install 10A Fuse (7.) to the left Fuse Holder and 1A Fuse (8.) to the right Fuse Holder (Fig. 29). On the back side of baseboard, the Fuse Holder with installed 10A Fuse is connected to the Motor Controller (Fig. 30). The Fuse Holder with installed 1A Fuse is rerouted to the Terminal Block marked 12V DC+ on the front side of the baseboard (Fig. 31). From previously connected Terminal Block reroute ground wiring (black) parallel to the Fuse Holders. 10A Fuse Holder -related wire is connected to the Motor Controller (6.) and 1A Fuse Holder -related wire is connected to the Terminal Block marked 12V DC- (Fig. 32).



Jump wire two 12V DC+ marked Terminal Blocks together. Connect both 12V DC+ Terminal Blocks to the Relay Module's(3.) COM-ports 1 ... 5. Use 1.5mm² terminal crimps (LOOP-074) to secure wiring to Relay Module. Jump wire two 12V DC- marked Terminal Blocks together.

Connect Relay Module's Pin DC+ to the Terminal Block marked 12V DC+, and Pin DC- to the Terminal Block marked 12V DC-. Reroute two DC wires from Motor Controller (Fig. 33) to the Terminal Block located in the lowest left side of the baseboard marked Pump (Fig. 34).

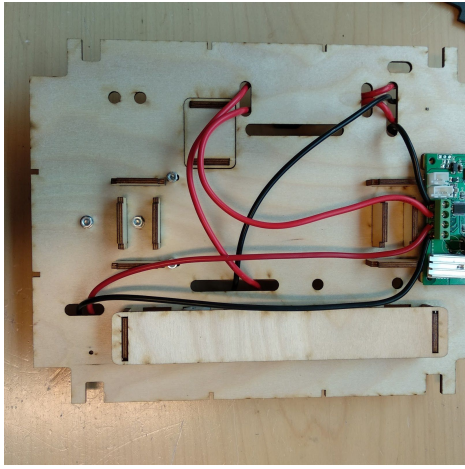


Fig. 33: DC -wiring (back)

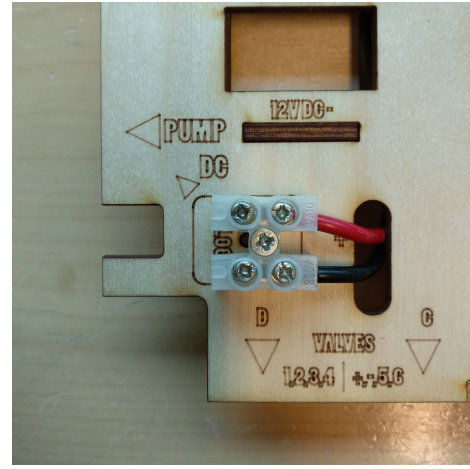


Fig. 34: Pump terminal block wired

10.8.2.2. ASSEMBLY...

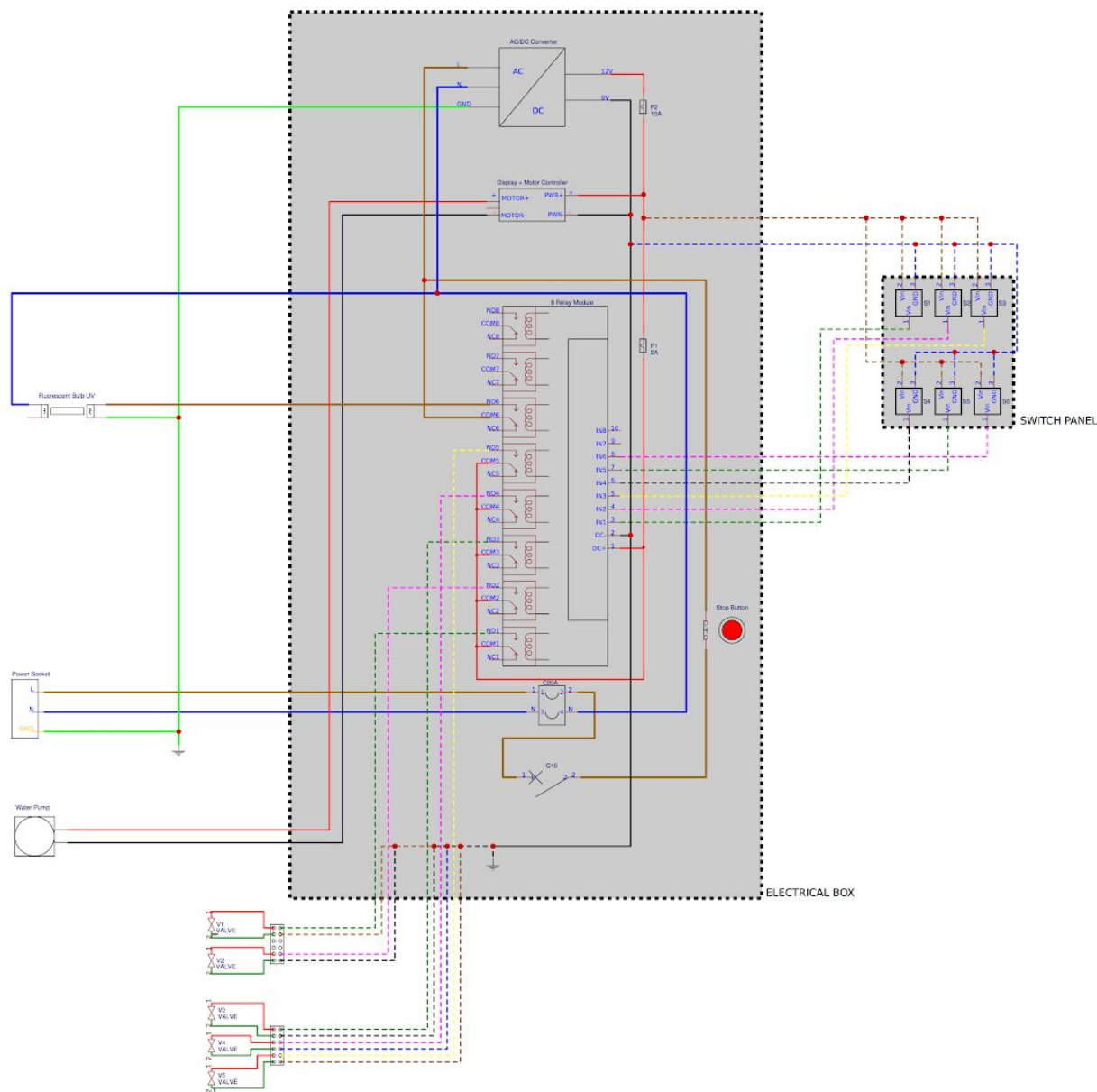
Begin assembly by connecting Switch and Speed Controller to the Motor Controller (6.) Use picture [XX] as a reference. (note: secure Switch Controller to the Power Box (1.) before connecting to the Motor Controller and use O-ring.) Place assembled Baseboard inside the Power Box. The arrow markings should match the position of power box's through-holes, which indicates the correct installation position.

Attach O-rings (LOOP-039) to each Cable Gland (12.). Install and fast secure Cable Glands to the Power Box in marked location (note: black-colored cable glands are used for AC-components, while white-colored are used for DC-components). Don't apply force while securing cable glands, as it may break O-rings. Secure Killer Switch to the marked location.

Attach AC/DC Converter (14.) to the Power Box. The AC-side cable is connected appropriately to the Terminal Blocks (AC+, AC- & GND) located on the baseboard. Two DC-side cables are connected to the terminal blocks together with Fuse Holders: brown cable is connected with the red one and blue cable with the black one (note: you can check the polarity of cables marked on the Converter itself).

Attach UV-light Converter to the Power Box. Cables are connected appropriately to the Terminal Blocks located on the baseboard.

Connect 3-wire Power Plug Cable (LOOP-065) to the Power Box. Peel off protective skin to expose internal wires. Before connecting wires, ensure that ground wire is the longest of all three wires. We recommend cutting ground wire at least 200mm. longer than other wires. Secure wires inside the Power Box. Both phase (brown) and neutral (blue) are connected to the Ground Fault Protector (9.) in the marked sockets. The ground is connected to the Terminal Block marked 220 AC(grnd).



	AC/DC Transformer		Protection Switch		Power Source		12V (DC+)
	Motor Controller + LCD Display		Circuit Breaker		Terminal Block		GROUND (DC-)
	Switch		UV Lamp		Valve		LIVE (AC)
	STOP Button		DC Pump		Fuse		NEUTRAL (AC)
							GROUND (AC)
							DC/LOW POWER
							DC/LOW POWER
							DC/LOW POWER
							DC/LOW POWER
							DC/LOW POWER
							DC/LOW POWER
							DC/LOW POWER

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fig.35: Electric Diagram.

10.8.3. Switch panel / Control panel

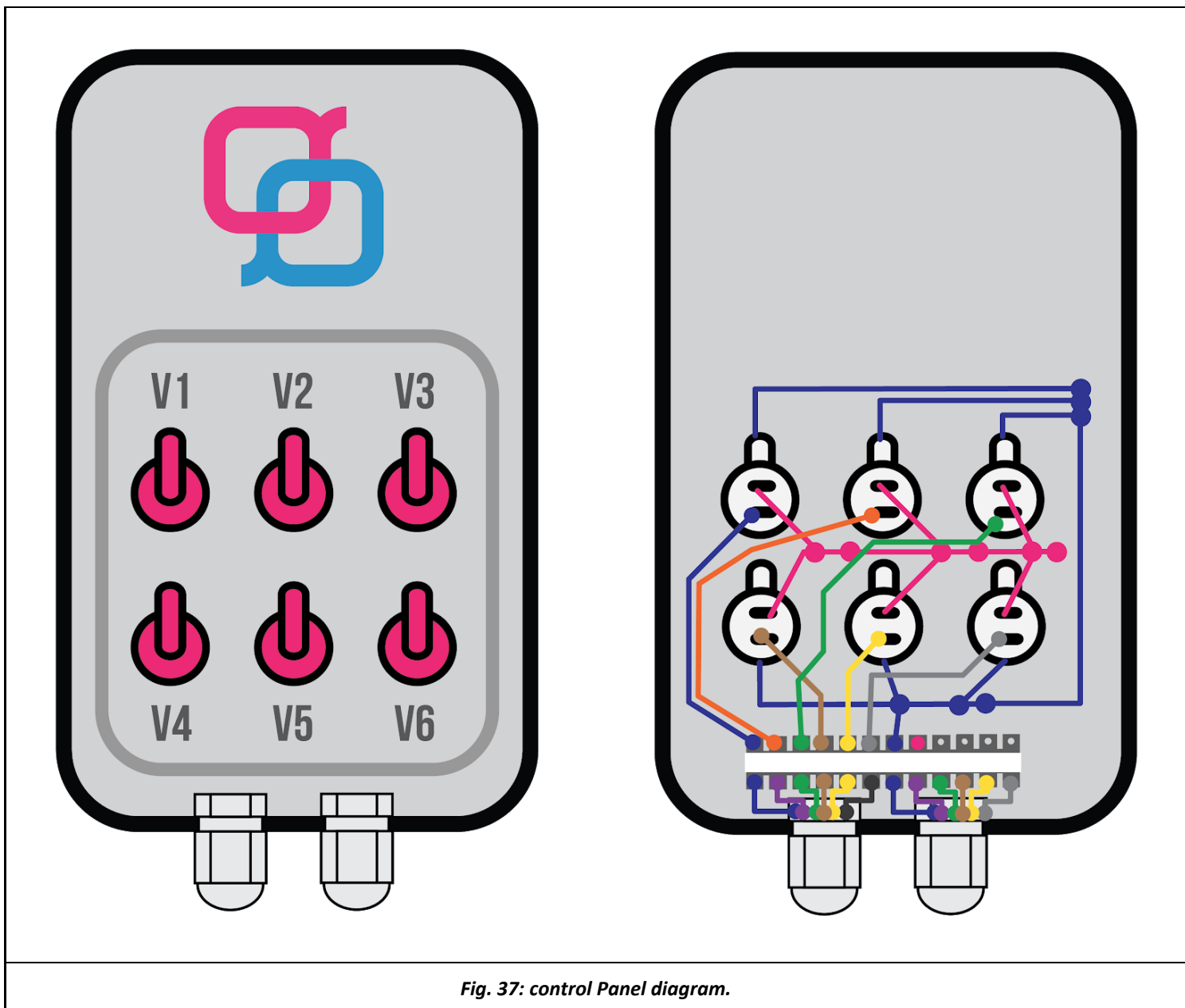


Fig. 37: control Panel diagram.



Fig. 39: Switch and Control Panels.

Top left: AC/DC transformer 150W DC output. Left: Power Box, Right: Switch panel. Right, right: prototype Showerloop mode diode module. LEFT: DIMENSIONS FOR THE 6X TOGGLE SWITCH PANEL (originally for the Motonet/seaworld one, but also works with Biltema)
 RIGHT: Dimensions for the boat rocker switch (mm). >Snug fit<

The Control Panel is pretty simple.



input is 12V DC power + and -

The switches open and close the circuit. Each switch has 3 connections,

- 1: +/PWR/VCC/positive
- 2: -/ground/negative
- 3: ACC/accessory/signal

There's a common power cable for all switches and a common ground. The ACC or signal is what's connected to the INPUT of the relay module to power each device.

It could be even simpler with a common ground for everything and the power working as the signal cable and going directly to the device.

This doesn't happen for 2 reasons. First a switch with an LED needs to have 3 connections so the power of the device isn't going directly through the LED, secondly, and more importantly, the switches are used to activate relays and therefore separate the power of the device from the circuit that the user can come into contact with while in the shower. E.g. imagine the 220V heater connecting to the wall socket and all you have is a on/off switch to activate it. If the switch was not properly insulated the current could pass through you and cause electric shock (this is bad). Instead now only low voltage and low current 12V DC 0.01 A power can come into contact with the user.

10.8.3.1. WIRING & ASSEMBLY....

For Control Panel the wiring and assembly simultaneously. Begin the assembly by attaching Switch Board (LOOP-044) to the cover case of Switch Panel (LOOP-043). Remember to attach silicone gasket between switch panel and cover case to remain IP-protectivity. Use four M3 screws and nuts to secure switch panel. Detach all fuse holders from the switch panel.

Cut six approx. 200mm. long wires. Use a crimp tool to attach Female Spade Crimps to each cable from one side. Connect wires by crimps to the switch panel.

Install the 8-pin terminal block inside the Switch Panel Housing (LOOP-043) and secure with the screw to the case bottom. Attach two PG7 Cable Glands (LOOP-038) with O-rings to the holes drilled in switch panel housing.

Use two 5-meter long, 6-wires Cables (LOOP-066) to connect Power Box to the Control Panel. Peel off protective skin (approx. 100mm. length) to expose internal wires from both sides of the cable. Connect the cable to the terminal block located inside the Switch Panel as shown in the diagram [XX].

When all components are connected, close the case of Switch Panel and secure it properly with four screws included with the case. Connect two previously used 6-wires Cables (LOOP-066) to the Power Box. Push cable through two Cable Glands marked **A** & **B**. The marking on the baseboard provides you an information for each switch controlling each valve. Using diagram [XX] as reference connect wires to the relay module and the terminal block accordingly.

10.8.4. Testing.

Before begin testing, make sure that:

- the Emergency Stop Switch is pressed down
- both Ground Fault Protector and Circuit Breaker are switched off
- check for unplugged cables, especially attached to the AC-powered components
- make a visual inspection of all cables' and wires' insulation for exposed copper
- don't touch any visible components while the electronics are powered on (!)
- don't plug or unplug any components/cables/wires while the electronics are powered on (!)

Plug the power cord to the wall socket. Turn the Ground Fault Protector and Circuit Breaker on. Release the Killer Switch. The Relay Module's LED should turn on.

Test the Pump Switch, by pressing it. The LCD display should turn on and 0-value should be printed. Turn the Pump Speed controller in both directions, while the number on LCD display should be changed between 0 ... 100.

Test all switches in the Switch Panel by turning them on and off. The LEDs on Switch Panel should turn on for each switch, while LED on Relay Board should turn on accordingly.

Test emergency shutdown by hitting Killer Switch. All LEDs should be shut down immediately. Test the functionality of Ground Fault Protector by pressing T-button located on the component. The switch should release immediately and the power should turn off.

End testing by pressing the Killer Switch on and unplug the power cord from the wall socket. After a little moment, you may begin connecting Power Box to the Showerloop.

10.8.5. connectors / electrical fittings..

10.8.5.1. JUNCTION BOXES

10.8.5.2. PG7

10.8.5.3. PG11

10.8.5.4. AWG/EU electrical cables

Amps

10.8.5.5. STANDARDS

AWG/EU electrical cables

IP Classifications

7. 11. Q&A



“... why is it necessary to discard the water after use? As in why couldn't the same water be used to shower over and over multiple (hundreds?) of times since it's being purified with each pass?

Best, Frank

> Hey, I'm sure the water can be reused but I'm not sure how often so I don't want to advertise it until I've been able to test and verify the results, something that's been very difficult to do since graduating from university and losing access to the various laboratories that I had at my disposal.

The thing I'm concerned about is still water. Generally, bacteria will begin to form no matter what you do and if there are trace nutrients in the water, which there are, biofilm would start to form on the surface layer/walls of the storage tank. That said I think running the shower X times a day/week/month when not in use would remedy the situation. Also, I think if it's necessary a ceramic filter (much like a membrane filter) and or bubbling ozone through the water would act to sterilize the water. UV would also work but we don't have a holding tank for the water and it's safer/better to use various methods of sterilization to make it super safe/secure one system goes down or isn't sufficient to deal with some kinda superbug. Chlorine may work but only so and so since it evaporates and would consume the Activated carbon, also I want the system to run on its own without the need for chemicals.

The best long-term option would be solar thermal heating and desalination. Storage tanks for both hot, cold and process or grey water. This way the system runs basically passively. All you need to do is clean the system every now and then. Solar and batteries as storage. The point of the hot water storage is to act as a battery. Maybe a Stirling engine or Peltier elements could work to convert some of it into electrical energy. Is there a loss when it's hot on one side (the hot water tank) and cold (room temp/outdoor temp) on the other side. Wouldn't that be really efficient? or if the efficiency is only like 20% then we're losing 80% of the heat energy to outside. And you need a lot of surface area. Then again maybe a container designed like a heat exchanger/heater could do everything. It would need a way to get cleaned maybe. Maintenance would always be good - but there's a loss in structural strength and simplicity... and of course, there's always wood ovens and stuff like that.

RESOURCES

8. 12. TROUBLESHOOTING

What to do when...

Everything is on but the water isn't coming out

- Check that all devices have power.

Pumps not working

13. APPENDIX TOC

14. Showerloop Usage LOG.

Date	User	Duration (minutes)	Water used (liters)	Power used (kW)	Notes Sound, smell, behavior, did it change, what did you to do fix it
21.7	testing	5 hours?	50 flushing	?	errors.
22.7	More testing				

15. REFERENCES, SOFTWARE & OTHER MANUALS

Tutorial: How to crimp connectors, strip wire and use heat shrink. Mjloron on youtube.

<https://www.youtube.com/watch?v=kjSGCSwNuAg>

Common plumbing parts with names and pictures

<http://www.merikarvianlviuote.fi/en/products/products/>

Software we use and Open Source alternatives

Fusion360(3d models, CNC, printing)

Cura

Prusa Slicer

Tinkercad

OpenSCAD

FreeCAD

SolveSpace

Adobe Illustrator

Gravit Designer

Inkscape

Keynote

Google Docs

Eagle (board design)

KiCAD

Easy EDA (circuit diagrams)



16. Link to the scanned documents here:

MANUALS for other products

16.1. ShowerMagic : A Hygienic and Eco-Efficient Real Time Greywater Reuse System for Showers

Selvarajan, Jason; Holland, Keiran (2013)

<https://www.theseus.fi/handle/10024/76148>

TESTING FACILITY FOR A WATER RECYCLING SHOWER Master's thesis

Eduard Kobak (2013)

<https://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/22156/Kobak.pdf?sequence=3>

16.2. Testing the Efficacy of The Prototype Water Purification System for Shower Water

Mishra, Anup (2015)

<https://www.theseus.fi/handle/10024/92876>

16.3. Testing different combination of personal cleaning products against activated carbon for Showerloop shower water purification system

K.C., Gaurab (2017)

<https://www.theseus.fi/handle/10024/92876>