Strøm

Tue S. Dissing

Feb 02, 2023

DOCUMENTATION SECTIONS

The *Strøm* open source speaker project have been started with the main goal of creating a fully functional “streaming speaker”, but as an open sourced product. One that you can choose to buy fully built and tested, or choose to built it yourself.

CHAPTER

ONE

REQUIREMENTS

The main goal of the *Strøm* open source speaker project are to create a fully functional and open source "wifi speaker".

1.1 The Speaker concept

The primary features of the *Strøm* speaker are:

- Minimalistic design language
- Playback via Spotify Connect and Bluetooth
- Wall mountable
- Sustainable materials
- Open Source

Making it a modern, minimalistic and fully capable speaker.

1.2 Design Goals

The following parameters are used as design goals. These are not *hard* requirements, but reflects the ideal characteristics of the final speaker.

1.2.1 Sustainability

It is important to use materials that are produced and sourced using sustainable methods, as well as using sustainable productions methods of the speaker itself. A non exhaustive lists of considerations:

- The cabinet must primarily be made out of wood
  - like MDF and plywood
- No plastic
- Built to be repairable

Making a 100% sustainable active speaker is, however, not 100% realistic as there isn't any fully sustainable PCB's. At least not readable available.

1.2.2 Cabinet

The design of the cabinet must reflect a minimalistic design approach. This means a small physical form factor and a minimalist visual appearance. A non exhaustive lists of considerations:

- Small form factor
- Shallow cabinet for better on-wall placement
- Ultra mat finish of the cabinet
- Cloth covered drivers

1.2.3 Acoustics

With this project it is not the goal to create another boombox, with over attenuated lows (bass) and highs (treble) as this will quickly result in listening fatigue. This is also called a smiley face curve.

However a slight bass boost at lower SPL levels to accommodate for the non-linear human hearing will make the speaker sound natural at lower sound pressure levels (SPL). This boost should be less pronounced at higher SPL levels; the dynamic part of this requirement can become hard to realize, but it will make for a much more appealing listening proposition. A non exhaustive lists of further considerations:

- Max SPL of 100dB
- Frequency range: 80Hz - 17kHz; $\pm$3dB
- Reasonable flat response; within $\pm$4dB
- High speech intelligibility
- SPL dependent bass boost to match the nonlinearity of the human hearing

Below each of the technical design goals are unwrapped to explain what they mean and how the voicing process is used to implemented these requirements.

High maximum SPL

SPL (Sound Pressure Level) is a measure of "how loud" a sound is. And the maximum SPL of a speaker tells something about how loud a speaker is capable of playing.

Usually the SPL is measured at a distance of one meter [m]. The unit of SPL is decibel [dB].

The Strøm speaker isn't a large speaker, but it should still be a capable speaker. A speaker that is capable of "playing loud". But as this can be hard to quantify as the perception of "loud" various a great deal from person to person. It is also highly affected by the distance between the speaker and the listener as well as it's placement in the room. And finally this perception is impacted by any audible distortion from the speaker. The higher the distortion, the higher the SPL is perceived.

So instead of stating that the speaker must play "loud", a quantifiable number is needed.

We also want to add a few more limitations to this design goal. The maximum SPL should:

- be reachable "anywhere" on the frequency band,
- without reaching the mechanical limits of the driver,
- and should avoid clipping

We have settle on **100dB of maximum SPL** for this small speaker. This will be more than sufficient for most small and medium sized rooms. The implementation of this requirement will affect (limit) the frequency response of the speaker. Most drivers can play down to 20Hz, but maybe not at great volume. So by limitting the frequency band we can push the drivers to higher SPL levels.

Frequency response

It should be pleasent to listen to this speaker and at the same time you should be able to get an "audio experience". So no smiley curve frequency response, nor overly exaggerated lows; i.e. this is not a boom box. We are looking to implement a "hi-fi" speaker with fairly linear frequency response.

A requirement of a linearity within $\pm$4dB isn't perfect, but it is a pretty decent middle ground.

The better the low range extension a speaker can achieve, the more of the audio frequency range it is capable of reproducing and the more "convincing" this speaker will sound.

As small drivers are used, subwoofer levels of extension are hard to come by, so a compromise is needed. By setting the targeted -3dB point at 80Hz, this speaker will not be a bass monster, but the bass it will reproduce will be crips and undistorted.

When placed on a wall even lower frequency extension will be possible at the same (or higher) SPL.

1.3 Drivers

In order to fulfill the requirements of a small form factor speaker, shallow drivers are needed. This makes it possible to minimize the overall depth of the cabinet.

Only a few really larger shallow drivers exists, which also tends to be rather expensive. They usually deliver good performance, but most of them are considered to be too expensive for this project. In stead of using one large driver, 4 miniature full range transducers are targeted instead. This makes it possible to decrease the overall depth of the cabinet.

The following drivers are used:

- 2.5" full range driver: *SB65WBAC25-4*.

CHAPTER

TWO

USER DOCUMENTATION

2.1 Maintenance

2.2 User Manual

2.3 Voicing of the *Strøm* speaker

Note: One important aspect of developing a speaker are to tune the frequency response, as well as to ensure that the drivers isn't driven over their capabilities. It is here the sound of the speaker is developed.

This process is called **voicing**.

The voicing of a speaker consists of several steps and this *howto* will try to outline a few of them. The following topics will be covered below:

- Voicing goals
- Measurements
- Adjusting the response

2.3.1 Voicing goals

With the Strøm speaker several design goals have been defined (see more in the *Requirements* section) and those related to sound reproduction should – where applicable – be implemented through the voicing process.

The following acoustic design goals have been set for the speaker:

- Max SPL of 100dB
- Frequency range: 80Hz - 17kHz; ±3dB
- Reasonable flat response; within ±4dB
- High speech intelligibility
- SPL dependent bass boost to match the nonlinearity of the human hearing

Most of these design goals can be asserted using various measurement techniques.

2.3.2 Measuring the speaker

What you need to measure the speaker:

- A measurement microphone like the UMIK-1 (or similar)
- Assembled cabinet with drivers
- External amplifier
- Laptop (or similar) with Camilla DSP installed.
- Room EQ Wizard (REW)

In order to measure the speaker, make sure that you can *"answer yes"* to all of the above bullets.

What do we want to measure?

With `REW` it is possible to measure a large suite of things, but bare in mind, that this program is initial created to measure rooms and not speakers. We will use `REW` to perform the following measurements: * frequency response * phase response * impulse response

Frequency and phase response

We do not have easy access to an anechoic chamber, but that doesn't mean that we can't produce some useful results. And for this speaker we actively rely on the walls and boundaries to increase our bass response. So a measurement "in place" isn't actually that bad.

We have placed the microphone within 10cm from the baffle to limit the impact of reflections.

Here's the speaker measured before voicing. A single 8th order high pass (HP) filter have been added at 45Hz to protect the driver (from exceeding X_{max}).

The frequency and phase response are depicted. It is worth noting that the results haven't been normalize, resulting in that the measured dB can't be related to anything (other than other measurements using the same setup).

2.3.3 Adjusting the response

As a developement workflow I am using the great HEnquist/camilladsp project. This makes it possible to specify the filter banks as a simple YAML config file. For the initial 80Hz target tuning this file have been used: voicing/voicing-80hz-target.yaml.

As we can't make the bass higher – without additional X_{max} of the driver - we need to lower the rest of the frequency response. This will lower the overall efficiency of the speaker, but result in a much more linear frequency response. See the below graph for a measurement of the inital filters applied to the signal chain.

The result isn't perfect but a really good starting point (and a good sounding one of that) which proves that these little drivers are pretty capable in this little cabinet.

CHAPTER

THREE

REPAIR

CHAPTER

FOUR

END OF LIFE

CHAPTER

FIVE

SPEAKER PARTS AND ASSEMBLY

The speaker cabinet are constructed from MDF, as this material is well suited for this type of application. Both the low internal damping, as well as the ease of processing, of this material makes it a good choice for constructing speaker cabinets.

To minimize the overall volume of the cabinet, a sealed construction is chosen. Each driver, does in fact, have its own internal cabinet. This is done to minimize the internal interference between the drivers; hence limiting interference artifacts.

Each speaker part have its own unique ID to make it easier to identify the correct part. Externally sourced parts will likely also have a SKU or similar.

5.1 Speaker parts

5.1.1 Drive-in Nut

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *M3 Screw; 0376 3 5*
Parts ID: 6C27ST
Product link: Würth 0376 3 5

Parts Description

To ensure proper mounting of the speaker drivers, they are fastened using these screws and the already mounted drive-in nuts.

Please see the tables below for dimensions.

Table 1: Physical requirements

Screw type	Outer dimensions	Thread
Drive-in nut	5mm x 13mm	M3

5.1.2 M3 driver mounting screw

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *M3 DIN7985 screw; 004648 316*
Parts ID: 3A4RA6
Product link: Würth 004648 316

Parts Description

To ensure proper mounting of the speaker drivers, it's not enough to just drive the screws into the MDF of the baffle. We need mounting hardware to ensure that the drivers remain in place. A set of *Drive-in nuts* are mounted on the backside of the *baffle*. These screws are fasted into the nuts, holding the drivers in place.

Please see the tables below for dimensions.

Table 2: Physical requirements

Type	Outer dimensions	Thread
M3 metal screw; black	6mm x 16mm	M3

5.1.3 PCB Standoffs

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *PCB Standoff; 0968 000310*
Parts ID: 3A4RA6
Product link: Würth 0968 000310

Parts Description

The PCB are mounted inside the main cabinet. There are dedicated support for this on *cabinet layer 1*. here a set of drive-in nuts are mounted. Using a set (of four) PCB standoffs the PCB are securely mounted to the cabinet. This provides sufficient space on both sides of the PCB.

Please see the tables below for dimensions.

Table 3: Physical requirements

Type	Outer dimensions	Thread
Steel PCB standoffs	6mm X 16mm	M3

5.1.4 Amplifier Module

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Amplifier module*
Parts ID: 9X6S29

Part description

The amplifier module is a generally available, but custom, PCB design which are base upon the popular Espressif ESP32 platform.

This is combined with an audio amplifier from Infineon. The MA12040P is a strong candidate.

Sourcing

Todo: sourcing of this module are still TBD.

5.1.5 Back Panel

Parts information

See the below for a quick overview of the naming and ID information of this part.

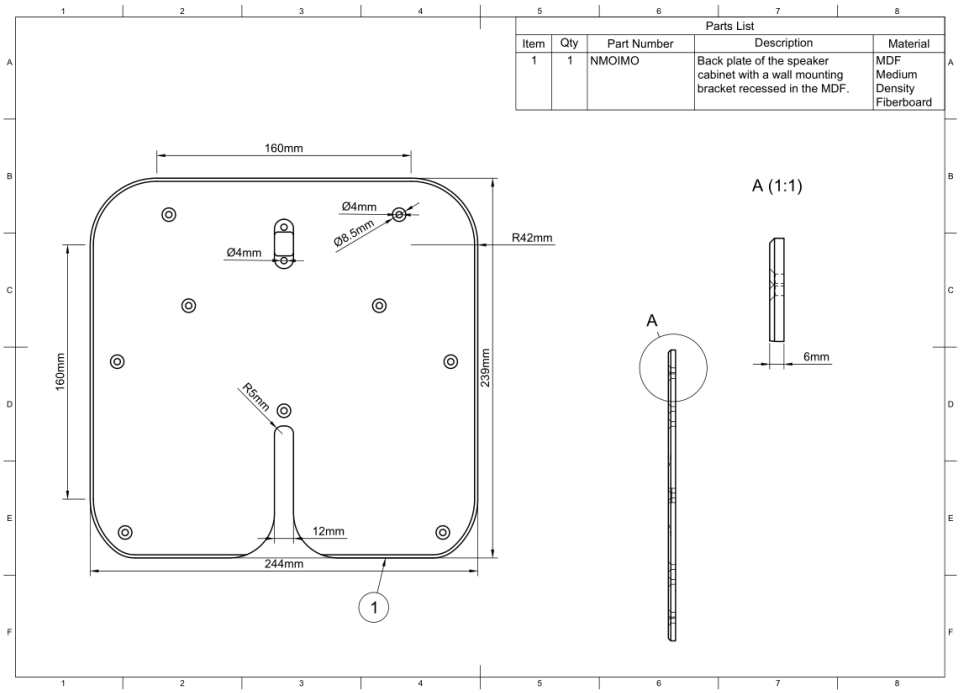
Part name: *Back Panel*
Parts ID: NMOIMO
Material: 6mm, MDF

Part description

The cabinet back panel are the bottom layer in the complete cabinet. This part makes an air tight fit to the rest of the cabinet, sealing the enclosure.

Four counter sunk screw holes – one in each corner – are created in this part for easy assembly.

To ensure a close distance between the back panel and the wall, when wall mounted, a bracket needs to be recessed into this part. This bracket must be fastened with two wood screws.



Finish

To create a small visual seperation between the wall and the speaker, the back panel must be of a dark color. Preferably black. The most important part of the back panel to finish with a black tint, are the 45° angled sides.

Warning: Depending on the requirements with regards to MDF degassing, this cabinet part only needs limited finishing, or a full pain job.

Downloads

Download the drawing as a PDF `back-panel-drawing.pdf`.

Download the CAD file in .STEP format `back-panel.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.6 Cabinet Baffle

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Baffle*
Parts ID: 47TTHC
Material: 12mm, MDF

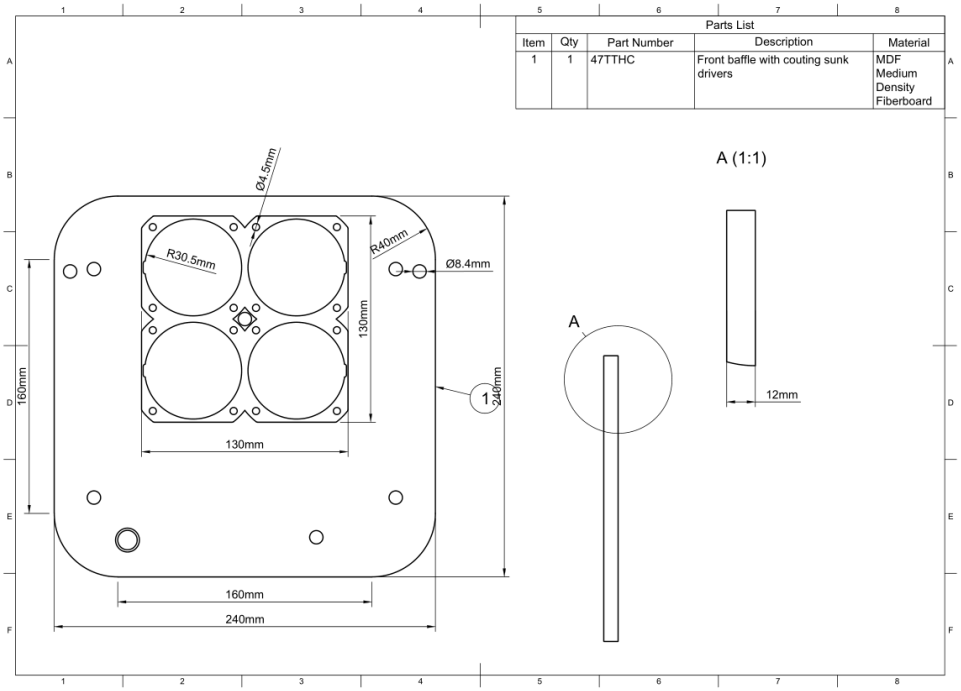
Part description

The baffle are where the speaker drivers are mounted. They are counting sunk into the baffle, so the top of the driver matches the top of the baffle. For each driver four screw holes are made to fasten the driver to the baffle.

Three assembly-guiding holes are also cut in to the baffle. This helps aligning the different layers with each other.

See also:

For further details about the assembly, take a closer look at the *assembly description*.



Todo: Add feature to ensure proper mounting of the *soft top frame* to the baffle.

Finish

The top of the baffle must be finished with a paint, complementary to the hue of the *soft top fabric*. If the fabric are of a light hue, then a white paint must be applied – RAL9010 for instance – and when are darker hue of fabric are used, then a black finish must be applied – something like RAL9005 will suffice.

The surface finish of the paint are allowed to be a rough and matte finish, as the top of baffle are covered by the soft top fabric under normal operation.

Warning: Depending on the requirements with regards to MDF degassing, this cabinet part only needs limited finishing, or a full pain job.

Downloads

Download the drawing as a PDF `baffle-drawing.pdf`.

Download the CAD file in .STEP format `baffle.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.7 Dowels

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Dowels*
Parts ID: OOWEOE
Material: *8mm, wood*

When assembling the cabinet dowels are needed for easy alignment of the different layers.

Parts description

These woods dowels comes in many assortments, lengths and diameters. For this project the following dimensions dowels are needed:

Table 4: Physical requirements for dowels.

Material	Diameter	length
Wood	8mm	40mm

An example of such as dowel are this one from HABO: 63009.

5.1.8 Full Range Driver

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Driver; SB65WBAC25-4*
Manufactor: SB Audience
Manufactor ID: SB65WBAC25-4
Parts ID: 7SQ7QH
Product link: SB Audience SB65WBAC25-4

Parts Description

This is the full range driver used in this project. For each speaker a total of four drivers are needed.

These drivers are primarily chosen for their extremely small height – of only 38mm overall height – and for their relative high power handling of 20W.

Sourcing

Todo: sourcing of this module are still TBD.

Downloads

Download the driver specification as a PDF `2.5in SB65WBAC25-4.pdf`.

5.1.9 Cabinet Layer 1

Parts information

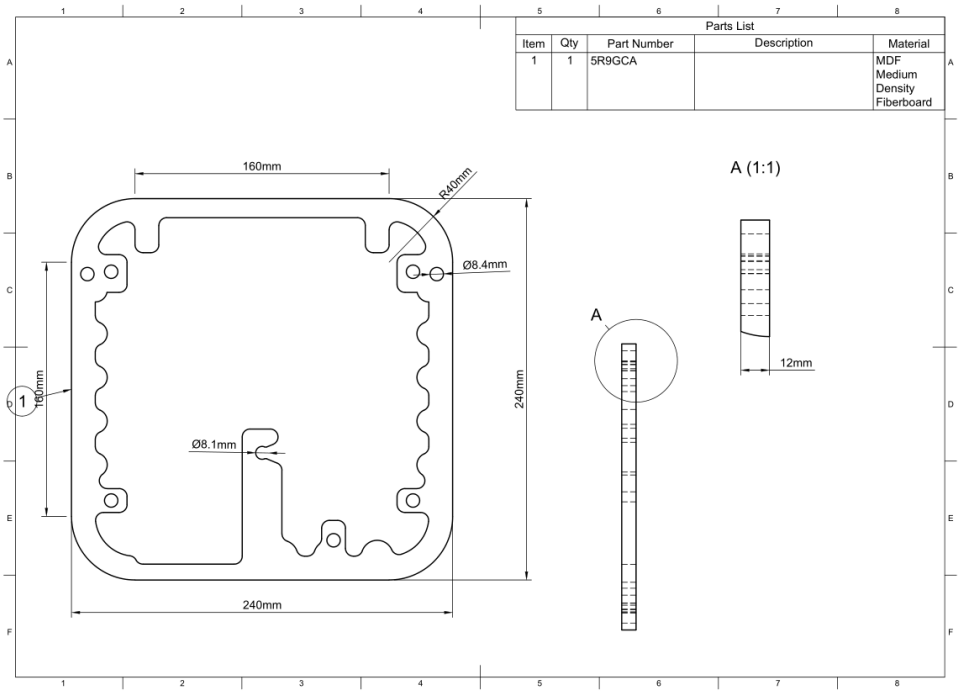
See the below for a quick overview of the naming and ID information of this part.

Part name: *Cabinet layer 1*
Parts ID: 5R9GCA
Material: 12mm, MDF

Part description

This is the first layer of the cabinet, connecting directly to the baffle. To make room for the DC barrel power plug and it's wires, a mounting hole and a tapering slot are cut. This helps guide the DC power cables from the DC socket.

The three larger holes (Ø8,4mm) are for dowels, used for aligning the three layers during cabinet assembly.



Finish

This part doesn't require any finish.

Downloads

Download the drawing as a PDF `cabinet-layer-1-drawing.pdf`.

Download the CAD file in .STEP format `cabinet-layer-1.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.10 Cabinet Layer 2

Parts information

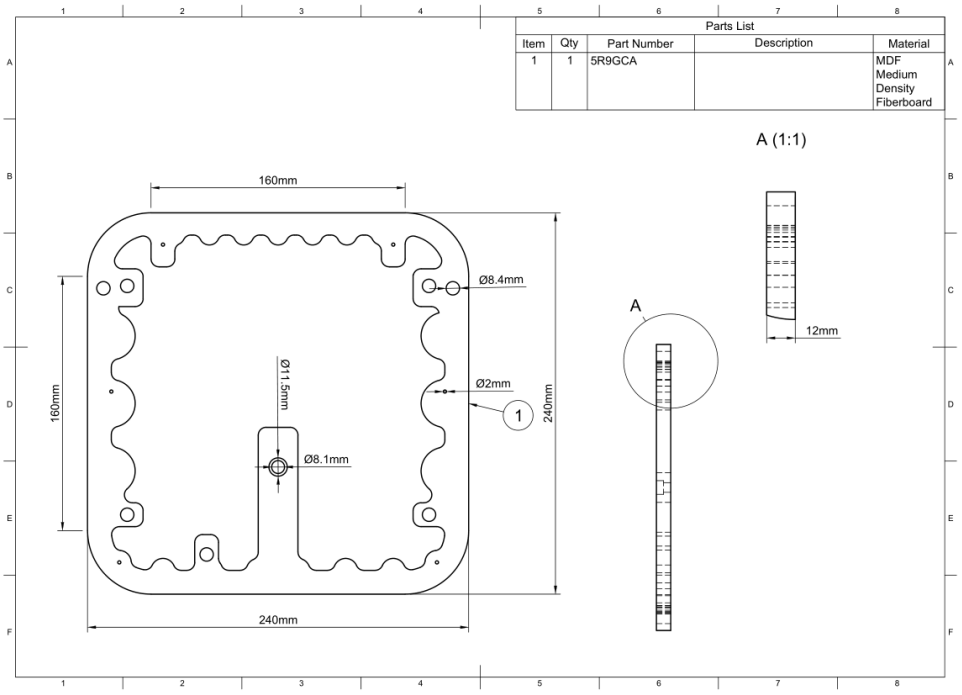
See the below for a quick overview of the naming and ID information of this part.

Part name: *Cabinet layer 1*
Parts ID: 5R9GCA
Material: 12mm, MDF

Part description

This is the middle layer of the cabinet. To make room for the DC barrel power socket, a matching DC socket mounting hole is cutout. Half of this hole are counter sunk at a wider diameter (Ø11,5) to accommodate for the wider diameter of the DC plug itself - to ensure that this plugin can be fully consealed within the cabinet (for on wall placement).

The small holes (Ø2mm) are used when mounting the back plate to the main cabinet. The larger holes (Ø8,4mm) are for dowels, used for aligning the three layers during cabinet assembly.



Finish

This part doesn't require any finish.

Downloads

Download the drawing as a PDF `cabinet-layer-2-drawing.pdf`.

Download the CAD file in .STEP format `cabinet-layer-2.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.11 Cabinet Layer 3

Parts information

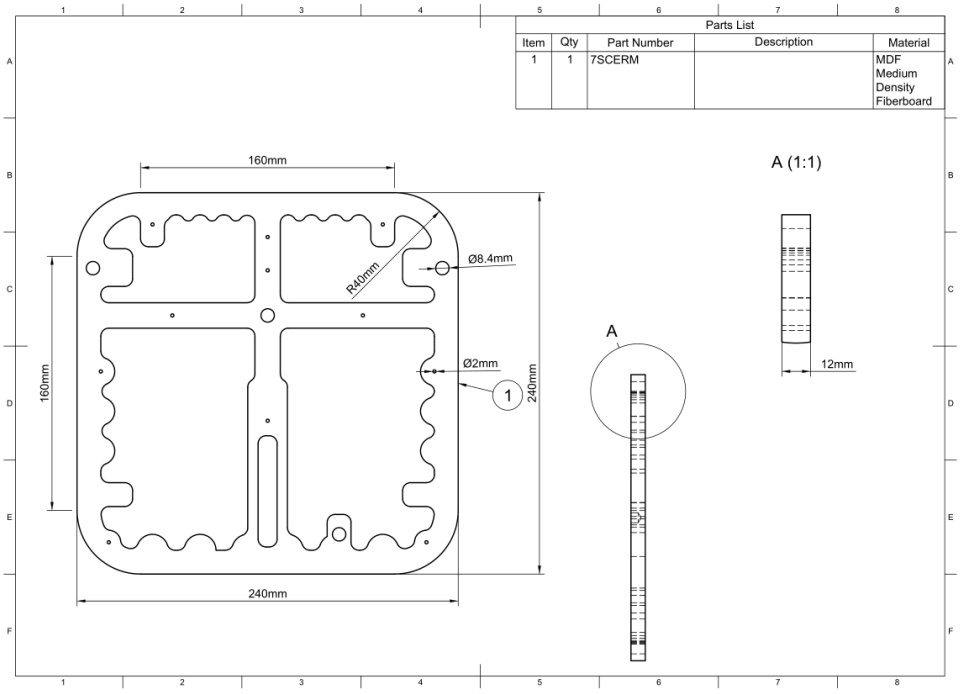
See the below for a quick overview of the naming and ID information of this part.

Part name: *Cabinet layer 1*
Parts ID: 7SCERM
Material: 12mm, MDF

Part description

This is the third layer of the cabinet - counting form the baffle. Here a large keyhole slot a cut to make room for the DC jack, an L-bracket adaptor and a little wire. All in all to make sure that the power connections are consealed when mounted to a wall.

The small holes (Ø2mm) are used when mounting the back plate to the main cabinet. The larger holes (Ø8,4mm) are for dowels, used for aligning the three layers during cabinet assembly.



Finish

This part doesn't require any finish.

Downloads

Download the drawing as a PDF `cabinet-layer-3-drawing.pdf`.

Download the CAD file in .STEP format `cabinet-layer-3.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.12 Power Brick

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Power brick; GST60A18-P1J*
Parts ID: WVOAE2
Product link: Mean Well GST60A18-P1J

Parts Description

When creating an active speaker, it will need power. For this project we have settled on a barrel styled *power plug*. These type of power supplies readable available are relatively inexpensive, but not any old power supply will do. There's are few requirements that is required to be met. Please see the tables below for further details.

Table 5: Electrical requirements for the power brick

Mains range	Output Voltage	Output Wattage
100V - 240V	18V	60W

Table 6: Physical requirements

Plug type	Plug dimensions	Cable length
Barrel, male	5,5mm x 2,1mm	>=1,5m

Sourcing requirements

Warning: When sourcing a power brick (power supply), it is really important that set power supply is CE approved, as well as RoHS compliant. Therefore only approved power supplies must be used and supplied to the end customer.

Currently the only **approved** power supply is this one from Mean Well: GST60A18-P1J.

5.1.13 DC Power Socket

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *DC power socket*
Parts ID: I6C3Q5
Manufactor: Tensility
Manufactor ID: 50-00541
Product link: Tensility 50-00541

Parts Description

In order to maintain an airtight cabinet we have taken a bit of a different approach to the DC socket. In fact this socket is a overmold jack. We are then using the cabinet as the overmold.

How this socket are integrated in the cabinet are described in detail in the *assembly description* as well as in the description of layer *2* and *3*.

Todo: the assembly section needs to be updated.

Sourcing

Todo: sourcing of this module are still TBD.

Downloads

Download the specification as a PDF `50-00541.pdf`.

Download the CAD file in .STEP format `50-00541.step`.

5.1.14 Soft Top Fabric

Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Soft top cloth*
Parts ID: 0NGII0
Material: Jersey fabric

5.1.15 Soft Top Frame

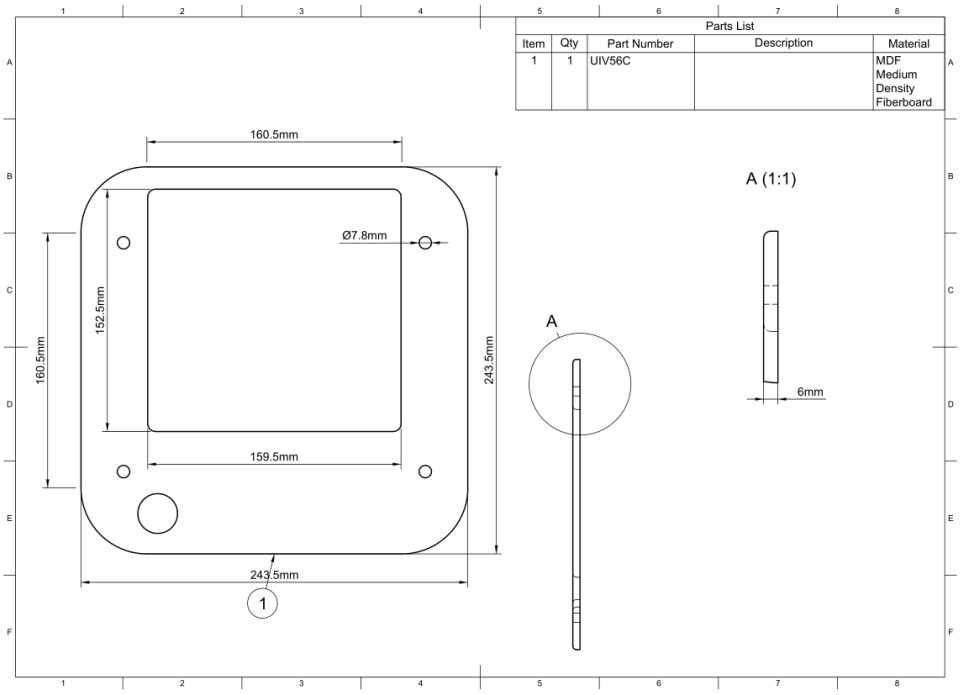
Parts information

See the below for a quick overview of the naming and ID information of this part.

Part name: *Soft top frame*
Parts ID: UIV56C
Material: 6mm, MDF

Part description

The soft top frame holds the fabric that covers the drivers. This is a simple part. The soft top frame are friction fit to the pretuding dowels in hte baffle of the main cabinet. This ensures a tight fit of the frame but at the same time allow for its removal in case of service or repair.



Finish

This part is painted black to match the shadow created where the drivers are located. It is important to lightly sand this part after painting, as the raised grain can in fact tare any fragile fabric.

Downloads

Download the drawing as a PDF `softtop-drawing.pdf`.

Download the CAD file in .STEP format `softtop.step`.

Fusion 360 Source Files

The model is developed in Fusion 360. To access the original Fusion 360 source files, follow the link below.

Access source files

5.1.16 Generate a parts ID when adding a new part

To generate a ID for a part, follow the below example. The following tool is used: Short UUID.

```
suid -l 6 -d utils/uuid-dict.json
```

Please note that a simplified dictionary have been used to ensure only uppercase characters are used.

5.2 Cabinet Assembly

Todo: Still missing these sections:

4. linoleum
5. drivers
6. back panel
7. soft top

5.2.1 Assembling the main cabinet

The main cabinet is assembled using the following 5 parts:

- Cabinet Layer 1
- Cabinet Layer 2
- Cabinet Layer 3
- Dowels
- DC Power socket

Each of the three cabinet layers are glued together using standard indoor wood glue. To easily lineup the individual layers with each other, a set (3) of guide holes are bored in each layer. These are for the dowels.

Following the steps below to assemble the main cabinet.

1. Start with layer 1 and place it, so the cable ducts and layer numbering faces downwards
2. Add wood glue to the guide holes and mount the dowels inside them. Make sure that go all the way through, but do not pertrude further than the face of this layer - otherwise the back panel can't be mounted correctly.
3. Now we are ready to add the second layer.
    a. Apply glue to layer 1 in order to the second layer to adhere to it.
    b. Now take layer two and ensure that the layer identification holes faces up.
    c. Add glue to the guiding holes and place it over the dowels and press down. Make sure to press the layer all the way down so it mates with layer 1.
4. The third layer can now be mounted. This is done in the same way as in point **3** above.
5. Clamp all the layers firmly together and let the glue set.
6. Finally we can mount the DC power socket. This is down with a couple of screw.

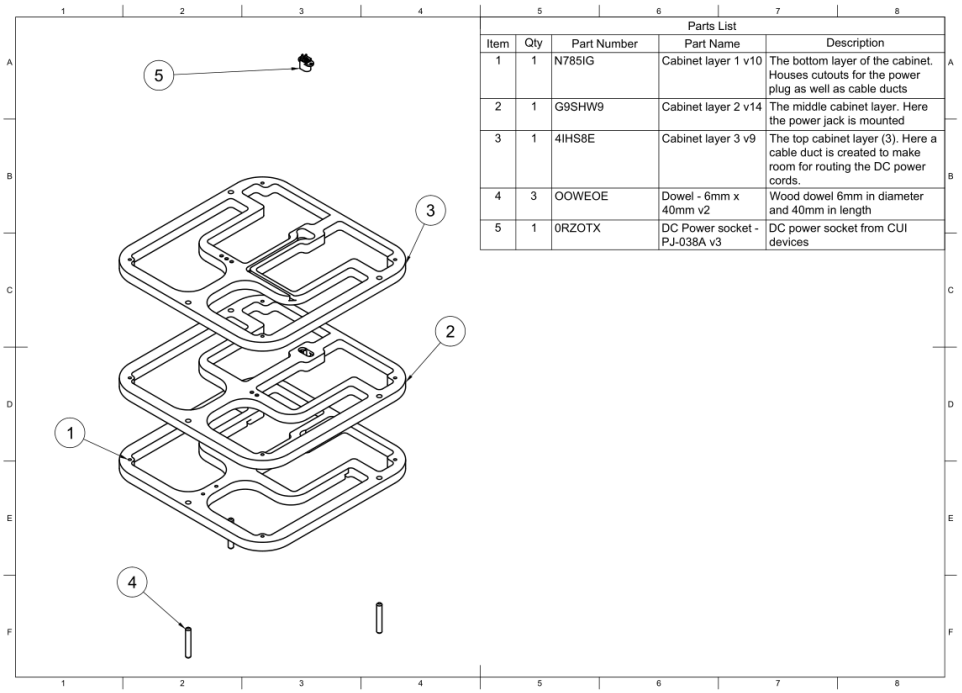


Fig. 1: Exploded view of all the parts needed to assemble the main cabinet.

a. Add some hot glue over the wires, to ensure they do not come off. We are encapsulating this socket inside the cabinet, so we do not want any faults.

b. Place the wire harness in the cable duct and secure it with hut glue.

The main cabinet are now ready for the next stage: *mounting the baffle*.

Assembly video

To make it more clear how all these parts comes together, a short video showing an exploded view of the speaker can be found below. This highlights how all the parts fit together with each other.

https://youtu.be/-KRVnBKZZOo

Downloads

Download the drawing as a PDF `main-cabinet-assembly.pdf`.

5.2.2 Mounting the baffle

The baffle and the main cabinet are now ready to be mated.

- Baffle
- Main cabinet assembly

The baffle needs to be mated to the main cabinet. This is a relatively simply process, but first it needs to finished.

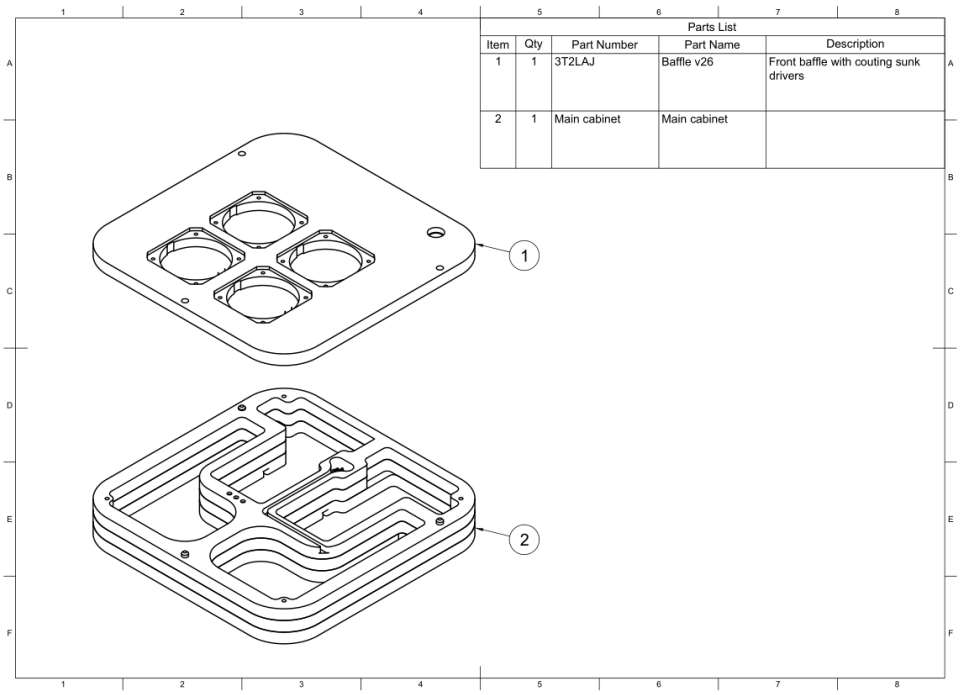


Fig. 2: Exploded view of all the parts needed to mount the baffle to the main cabinet.

Following the steps below to mount the baffle to the main cabinet.

1. Start by finishing the top of the baffle - see parts description for additional details.
2. Add glue to the main cabinet and place the baffle on the main cabinet, using the dowels guide holes for proper placement.

a. The top of the dowels should pertrude about 6mm out of the main cabinet. Enough to properly align the baffle on the cabinet.

3. Clamp down the parts while the glue sets.

Assembly video

To make it more clear how all these parts comes together, a short video showing an exploded view of the speaker can be found below. This highlights how all the parts fit together with each other.

https://youtu.be/6zH1YJoNRr8

Downloads

Download the drawing as a PDF `mounting-the-baffle.pdf`.

5.3 Cabinet construction

To ensure an easy assembly of the speaker cabinet, a sandwish construction is used. This makes it easy to construct the different layers and, at the same time, simplifying the construction of this semi complex cabinet. This also makes it possible to machine all the individual layers on a CNC. This comes in handy when utilizing decentrilized manufactoring.

Further details on the cabinet assembly can be found in the *assembly section*.

CHAPTER

SIX

THE SOFTWARE PLATFORM

This speaker is capable of playing audio through *Bluetooth* and *Spotify Connect*, as well as other sources. All of this are handled by the software platform called Euphonium. This is a separate project on GitHub and it can be used for other types of platforms. Not just this ESP32 based setup. Read more in this projects documentation.

6.1 Bluetooth

> *"A short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances"*
>
> —Wikipedia

6.2 Over The Air (OTA) Updates

6.3 Spotify Connect

> *"Listen on your speakers or TV, using the Spotify app as a remote."*
>
> —Spotify

6.4 Web Radio

There's integration to web radio playback, making it easy to select most online available web radios.

Simply search in the UI, for your favorite station and select play.

CHAPTER

SEVEN

CONTRIBUTION GUIDELINE

The following document describes how to contribute to the STRØM 1.0 project.

7.1 Contributing to Stroem (Open Source Speaker)

We're glad you're considering contributing to Stroem! Whether you're a first-time contributor or a seasoned open source veteran, we're here to help make your contribution experience as smooth and enjoyable as possible.

Please note that this is an open source speaker project, so some contributions may require specialized knowledge or equipment. We appreciate any and all contributions, big or small, and are here to help you get started.

7.1.1 Getting Started

1. Before you start, make sure you have a GitHub account. If you don't have one, sign up for free here.
2. Take a look at the existing issues to see if there's anything you'd like to work on. If you have an idea for a new feature or improvement, feel free to open a new issue to start a discussion.
3. If you're ready to start coding or working on hardware, fork the repository and clone it to your local machine.
4. Make your changes and test them thoroughly.
5. When you're ready to submit your changes, create a pull request. Make sure to include a clear and concise description of what you've done and why.

7.1.2 Code of Conduct

At Stroem, we believe in creating a welcoming and inclusive environment for all contributors. We follow the Contributor Covenant Code of Conduct, which outlines our expectations for behavior and the consequences for unacceptable behavior.

7.1.3 Help and Support

If you need help or have any questions, feel free to reach out to us by opening an issue or joining our community chat. We're here to help and will do our best to support you in your contribution journey.

Thanks for considering contributing to Stroem! We can't wait to hear what you'll add to this amazing open source speaker project!

CHAPTER

EIGHT

PROJECT LICENSING

The STRØM 1.0 project consists of several open source projects. One for the software platform, one of the hardware (PCB) and this project.

The license listed below only covers what is committed to this GitHub repository: LydByDissing/stroem. The other projects are licenced seperately.

You can read the licens below or in the GitHub repo: LydByDissing/stroem/LICENSE.

8.1 The CC BY-SA 4.0 license

Attribution-ShareAlike 4.0 International

===

Creative Commons Corporation ("Creative Commons") is not a law firm and does not provide legal services or legal advice. Distribution of Creative Commons public licenses does not create a lawyer-client or other relationship. Creative Commons makes its licenses and related information available on an "as-is" basis. Creative Commons gives no warranties regarding its licenses, any material licensed under their terms and conditions, or any related information. Creative Commons disclaims all liability for damages resulting from their use to the fullest extent possible.

Using Creative Commons Public Licenses

Creative Commons public licenses provide a standard set of terms and conditions that creators and other rights holders may use to share original works of authorship and other material subject to copyright and certain other rights specified in the public license below. The following considerations are for informational purposes only, are not exhaustive, and do not form part of our licenses.

```
Considerations for licensors: Our public licenses are
intended for use by those authorized to give the public
permission to use material in ways otherwise restricted by
copyright and certain other rights. Our licenses are
irrevocable. Licensors should read and understand the terms
and conditions of the license they choose before applying it.
Licensors should also secure all rights necessary before
applying our licenses so that the public can reuse the
material as expected. Licensors should clearly mark any
material not subject to the license. This includes other CC-
licensed material, or material used under an exception or
limitation to copyright. More considerations for licensors:
wiki.creativecommons.org/Considerations_for_licensors

Considerations for the public: By using one of our public
```

(continues on next page)

(continued from previous page)

```
licenses, a licensor grants the public permission to use the
licensed material under specified terms and conditions. If
the licensor's permission is not necessary for any reason--for
example, because of any applicable exception or limitation to
copyright--then that use is not regulated by the license. Our
licenses grant only permissions under copyright and certain
other rights that a licensor has authority to grant. Use of
the licensed material may still be restricted for other
reasons, including because others have copyright or other
rights in the material. A licensor may make special requests,
such as asking that all changes be marked or described.
Although not required by our licenses, you are encouraged to
respect those requests where reasonable. More considerations
for the public:
wiki.creativecommons.org/Considerations_for_licensees
```

==========

Creative Commons Attribution-ShareAlike 4.0 International Public License

By exercising the Licensed Rights (defined below), You accept and agree to be bound by the terms and conditions of this Creative Commons Attribution-ShareAlike 4.0 International Public License ("Public License"). To the extent this Public License may be interpreted as a contract, You are granted the Licensed Rights in consideration of Your acceptance of these terms and conditions, and the Licensor grants You such rights in consideration of benefits the Licensor receives from making the Licensed Material available under these terms and conditions.

Section 1 – Definitions.

a. Adapted Material means material subject to Copyright and Similar Rights that is derived from or based upon the Licensed Material and in which the Licensed Material is translated, altered, arranged, transformed, or otherwise modified in a manner requiring permission under the Copyright and Similar Rights held by the Licensor. For purposes of this Public License, where the Licensed Material is a musical work, performance, or sound recording, Adapted Material is always produced where the Licensed Material is synched in timed relation with a moving image.

b. Adapter's License means the license You apply to Your Copyright and Similar Rights in Your contributions to Adapted Material in accordance with the terms and conditions of this Public License.

c. BY-SA Compatible License means a license listed at creativecommons.org/compatiblelicenses, approved by Creative Commons as essentially the equivalent of this Public License.

d. Copyright and Similar Rights means copyright and/or similar rights closely related to copyright including, without limitation, performance, broadcast, sound recording, and Sui Generis Database Rights, without regard to how the rights are labeled or categorized. For purposes of this Public License, the rights specified in Section 2(b)(1)-(2) are not Copyright and Similar Rights.

e. Effective Technological Measures means those measures that, in the absence of proper authority, may not be circumvented under laws fulfilling obligations under Article 11 of the WIPO Copyright Treaty adopted on December 20, 1996, and/or similar international agreements.

f. Exceptions and Limitations means fair use, fair dealing, and/or any other exception or limitation to Copyright and Similar Rights that applies to Your use of the Licensed Material.

g. License Elements means the license attributes listed in the name of a Creative Commons Public License. The License Elements of this Public License are Attribution and ShareAlike.

h. Licensed Material means the artistic or literary work, database, or other material to which the Licensor applied this Public License.

i. Licensed Rights means the rights granted to You subject to the terms and conditions of this Public License, which are limited to all Copyright and Similar Rights that apply to Your use of the Licensed Material and that the Licensor has authority to license.

j. Licensor means the individual(s) or entity(ies) granting rights under this Public License.

k. Share means to provide material to the public by any means or process that requires permission under the Licensed Rights, such as reproduction, public display, public performance, distribution, dissemination, communication, or importation, and to make material available to the public including in ways that members of the public may access the material from a place and at a time individually chosen by them.

l. Sui Generis Database Rights means rights other than copyright resulting from Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases, as amended and/or succeeded, as well as other essentially equivalent rights anywhere in the world.

m. You means the individual or entity exercising the Licensed Rights under this Public License. Your has a corresponding meaning.

Section 2 – Scope.

a. License grant.

```
   1. Subject to the terms and conditions of this Public License,
      the Licensor hereby grants You a worldwide, royalty-free,
      non-sublicensable, non-exclusive, irrevocable license to
      exercise the Licensed Rights in the Licensed Material to:

        a. reproduce and Share the Licensed Material, in whole or
           in part; and

        b. produce, reproduce, and Share Adapted Material.

   2. Exceptions and Limitations. For the avoidance of doubt, where
      Exceptions and Limitations apply to Your use, this Public
      License does not apply, and You do not need to comply with
      its terms and conditions.

   3. Term. The term of this Public License is specified in Section
      6(a).

   4. Media and formats; technical modifications allowed. The
      Licensor authorizes You to exercise the Licensed Rights in
      all media and formats whether now known or hereafter created,
      and to make technical modifications necessary to do so. The
      Licensor waives and/or agrees not to assert any right or
      authority to forbid You from making technical modifications
      necessary to exercise the Licensed Rights, including
      technical modifications necessary to circumvent Effective
      Technological Measures. For purposes of this Public License,
      simply making modifications authorized by this Section 2(a)
      (4) never produces Adapted Material.

   5. Downstream recipients.

        a. Offer from the Licensor -- Licensed Material. Every
           recipient of the Licensed Material automatically
```

(continues on next page)

(continued from previous page)

```
          receives an offer from the Licensor to exercise the
          Licensed Rights under the terms and conditions of this
          Public License.

       b. Additional offer from the Licensor -- Adapted Material.
          Every recipient of Adapted Material from You
          automatically receives an offer from the Licensor to
          exercise the Licensed Rights in the Adapted Material
          under the conditions of the Adapter's License You apply.

       c. No downstream restrictions. You may not offer or impose
          any additional or different terms or conditions on, or
          apply any Effective Technological Measures to, the
          Licensed Material if doing so restricts exercise of the
          Licensed Rights by any recipient of the Licensed
          Material.

   6. No endorsement. Nothing in this Public License constitutes or
      may be construed as permission to assert or imply that You
      are, or that Your use of the Licensed Material is, connected
      with, or sponsored, endorsed, or granted official status by,
      the Licensor or others designated to receive attribution as
      provided in Section 3(a)(1)(A)(i).
```

b. Other rights.

```
   1. Moral rights, such as the right of integrity, are not
      licensed under this Public License, nor are publicity,
      privacy, and/or other similar personality rights; however, to
      the extent possible, the Licensor waives and/or agrees not to
      assert any such rights held by the Licensor to the limited
      extent necessary to allow You to exercise the Licensed
      Rights, but not otherwise.

   2. Patent and trademark rights are not licensed under this
      Public License.

   3. To the extent possible, the Licensor waives any right to
      collect royalties from You for the exercise of the Licensed
      Rights, whether directly or through a collecting society
      under any voluntary or waivable statutory or compulsory
      licensing scheme. In all other cases the Licensor expressly
      reserves any right to collect such royalties.
```

Section 3 – License Conditions.

Your exercise of the Licensed Rights is expressly made subject to the following conditions.

a. Attribution.

```
   1. If You Share the Licensed Material (including in modified
      form), You must:
```

(continues on next page)

(continued from previous page)

```
       a. retain the following if it is supplied by the Licensor
          with the Licensed Material:

            i. identification of the creator(s) of the Licensed
               Material and any others designated to receive
               attribution, in any reasonable manner requested by
               the Licensor (including by pseudonym if
               designated);

           ii. a copyright notice;

          iii. a notice that refers to this Public License;

           iv. a notice that refers to the disclaimer of
               warranties;

            v. a URI or hyperlink to the Licensed Material to the
               extent reasonably practicable;

       b. indicate if You modified the Licensed Material and
          retain an indication of any previous modifications; and

       c. indicate the Licensed Material is licensed under this
          Public License, and include the text of, or the URI or
          hyperlink to, this Public License.

  2. You may satisfy the conditions in Section 3(a)(1) in any
     reasonable manner based on the medium, means, and context in
     which You Share the Licensed Material. For example, it may be
     reasonable to satisfy the conditions by providing a URI or
     hyperlink to a resource that includes the required
     information.

  3. If requested by the Licensor, You must remove any of the
     information required by Section 3(a)(1)(A) to the extent
     reasonably practicable.
```

b. ShareAlike.

```
In addition to the conditions in Section 3(a), if You Share
Adapted Material You produce, the following conditions also apply.

  1. The Adapter's License You apply must be a Creative Commons
     license with the same License Elements, this version or
     later, or a BY-SA Compatible License.

  2. You must include the text of, or the URI or hyperlink to, the
     Adapter's License You apply. You may satisfy this condition
     in any reasonable manner based on the medium, means, and
     context in which You Share Adapted Material.

  3. You may not offer or impose any additional or different terms
```

(continues on next page)

(continued from previous page)

```
     or conditions on, or apply any Effective Technological
     Measures to, Adapted Material that restrict exercise of the
     rights granted under the Adapter's License You apply.
```

Section 4 – Sui Generis Database Rights.

Where the Licensed Rights include Sui Generis Database Rights that apply to Your use of the Licensed Material:

a. for the avoidance of doubt, Section 2(a)(1) grants You the right to extract, reuse, reproduce, and Share all or a substantial portion of the contents of the database;

b. if You include all or a substantial portion of the database contents in a database in which You have Sui Generis Database Rights, then the database in which You have Sui Generis Database Rights (but not its individual contents) is Adapted Material, including for purposes of Section 3(b); and

c. You must comply with the conditions in Section 3(a) if You Share all or a substantial portion of the contents of the database.

For the avoidance of doubt, this Section 4 supplements and does not replace Your obligations under this Public License where the Licensed Rights include other Copyright and Similar Rights.

Section 5 – Disclaimer of Warranties and Limitation of Liability.

a. UNLESS OTHERWISE SEPARATELY UNDERTAKEN BY THE LICENSOR, TO THE EXTENT POSSIBLE, THE LICENSOR OFFERS THE LICENSED MATERIAL AS-IS AND AS-AVAILABLE, AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE LICENSED MATERIAL, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHER. THIS INCLUDES, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT, ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OR ABSENCE OF ERRORS, WHETHER OR NOT KNOWN OR DISCOVERABLE. WHERE DISCLAIMERS OF WARRANTIES ARE NOT ALLOWED IN FULL OR IN PART, THIS DISCLAIMER MAY NOT APPLY TO YOU.

b. TO THE EXTENT POSSIBLE, IN NO EVENT WILL THE LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY (INCLUDING, WITHOUT LIMITATION, NEGLIGENCE) OR OTHERWISE FOR ANY DIRECT, SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY, OR OTHER LOSSES, COSTS, EXPENSES, OR DAMAGES ARISING OUT OF THIS PUBLIC LICENSE OR USE OF THE LICENSED MATERIAL, EVEN IF THE LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSSES, COSTS, EXPENSES, OR DAMAGES. WHERE A LIMITATION OF LIABILITY IS NOT ALLOWED IN FULL OR IN PART, THIS LIMITATION MAY NOT APPLY TO YOU.

c. The disclaimer of warranties and limitation of liability provided above shall be interpreted in a manner that, to the extent possible, most closely approximates an absolute disclaimer and waiver of all liability.

Section 6 – Term and Termination.

a. This Public License applies for the term of the Copyright and Similar Rights licensed here. However, if You fail to comply with this Public License, then Your rights under this Public License terminate automatically.

b. Where Your right to use the Licensed Material has terminated under Section 6(a), it reinstates:

```
   1. automatically as of the date the violation is cured, provided
      it is cured within 30 days of Your discovery of the
      violation; or

   2. upon express reinstatement by the Licensor.

 For the avoidance of doubt, this Section 6(b) does not affect any
```

(continues on next page)

(continued from previous page)

```
right the Licensor may have to seek remedies for Your violations
of this Public License.
```

c. For the avoidance of doubt, the Licensor may also offer the Licensed Material under separate terms or conditions or stop distributing the Licensed Material at any time; however, doing so will not terminate this Public License.

d. Sections 1, 5, 6, 7, and 8 survive termination of this Public License.

Section 7 – Other Terms and Conditions.

a. The Licensor shall not be bound by any additional or different terms or conditions communicated by You unless expressly agreed.

b. Any arrangements, understandings, or agreements regarding the Licensed Material not stated herein are separate from and independent of the terms and conditions of this Public License.

Section 8 – Interpretation.

a. For the avoidance of doubt, this Public License does not, and shall not be interpreted to, reduce, limit, restrict, or impose conditions on any use of the Licensed Material that could lawfully be made without permission under this Public License.

b. To the extent possible, if any provision of this Public License is deemed unenforceable, it shall be automatically reformed to the minimum extent necessary to make it enforceable. If the provision cannot be reformed, it shall be severed from this Public License without affecting the enforceability of the remaining terms and conditions.

c. No term or condition of this Public License will be waived and no failure to comply consented to unless expressly agreed to by the Licensor.

d. Nothing in this Public License constitutes or may be interpreted as a limitation upon, or waiver of, any privileges and immunities that apply to the Licensor or You, including from the legal processes of any jurisdiction or authority.

===

Creative Commons is not a party to its public licenses. Notwithstanding, Creative Commons may elect to apply one of its public licenses to material it publishes and in those instances will be considered the “Licensor.” The text of the Creative Commons public licenses is dedicated to the public domain under the CC0 Public Domain Dedication. Except for the limited purpose of indicating that material is shared under a Creative Commons public license or as otherwise permitted by the Creative Commons policies published at creativecommons.org/policies, Creative Commons does not authorize the use of the trademark “Creative Commons” or any other trademark or logo of Creative Commons without its prior written consent including, without limitation, in connection with any unauthorized modifications to any of its public licenses or any other arrangements, understandings, or agreements concerning use of licensed material. For the avoidance of doubt, this paragraph does not form part of the public licenses.

Creative Commons may be contacted at creativecommons.org.

CHAPTER

NINE

TODO LIST

Todo: Still missing these sections:

4. linoleum
5. drivers
6. back panel
7. soft top

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/assembl
line 6.)

Todo: sourcing of this module are still TBD.

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/parts/am
module.rst, line 18.)

Todo: Add feature to ensure proper mounting of the *soft top frame* to the baffle.

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/parts/ba
line 27.)

Todo: sourcing of this module are still TBD.

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/parts/dri
line 25.)

Todo: the assembly section needs to be updated.

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/parts/po
socket.rst, line 24.)

Todo: sourcing of this module are still TBD.

(The original entry is located in /home/docs/checkouts/readthedocs.org/user_builds/stroem/checkouts/latest/docs/source/speaker/parts/po
socket.rst, line 29.)

CHAPTER

TEN

CHANGELOG

Read on below to get a high level *Introduction to the project* as a whole.

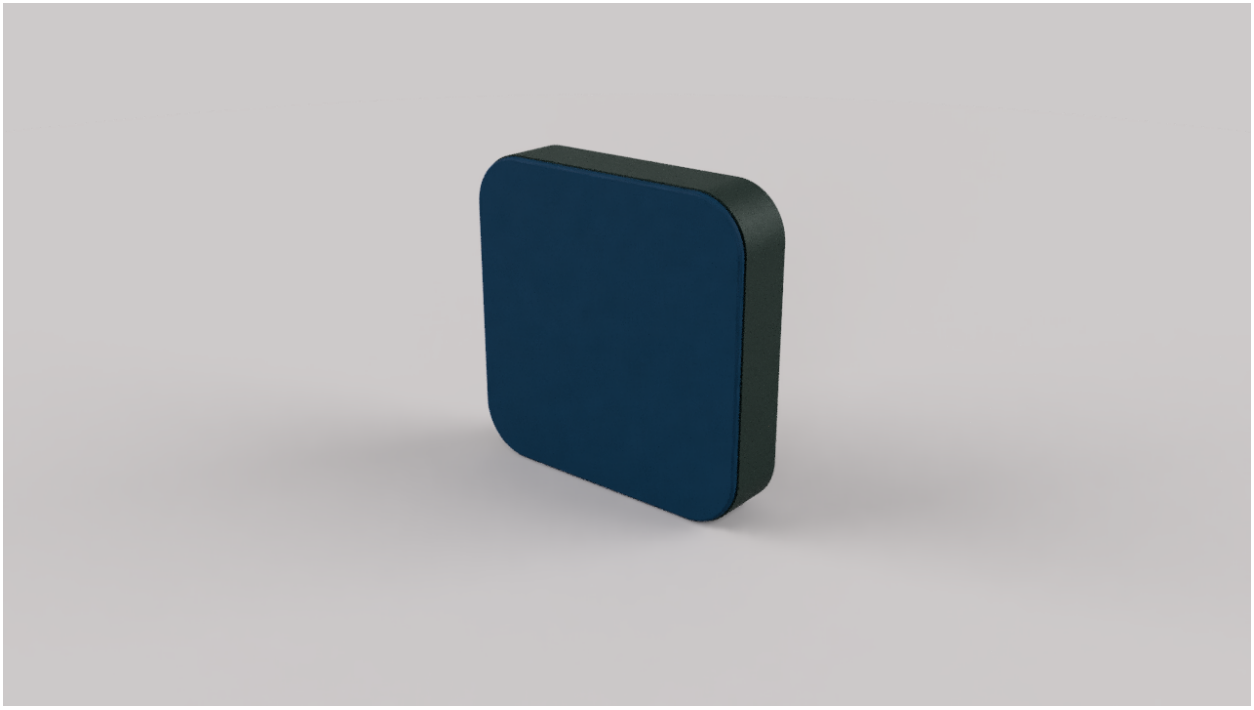


Fig. 1: Strøm speaker in conifer linoleum and blue fabric on the soft top.

CHAPTER

ELEVEN

INTRODUCTION TO THE PROJECT

The primary features of the *Strøm* speaker are:

- Minimalistic design language
- Playback via Spotify Connect and Bluetooth
- Wall mountable
- Sustainable materials

Making it a modern, minimalistic and fully capable speaker.

11.1 Motivation for starting the STRØM 1.0 project

11.2 Project goals

11.3 Project history

Initially started as an OPEN!NEXT demonstrator project in December 2021. The project was started by Tue Dissing.

11.4 Contributing to the project

Interested in contributing to the project? Then please take a quick look at the contribution guideline beforehand. You find the contribution guide *here* and in the GitHub repo as well: LydByDissing/stroem/CONTRIBUTING.md.

11.5 Last updated

The mainline documentation have last been updated at 2023-02-02.

CHAPTER

TWELVE

LICENSE

This project is licenced under the *Creative Commons ShareAlike 4.0 license*.