OTTOsonics

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Rojin Sharafi

Artistic Director

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Tangible Music Lab University of Arts Linz

Contents

OTTOsonics

open platform for immersive sound

- a collaboration between the OTTO Kulturgenossenschaft Ottensheim and the University of Arts Linz

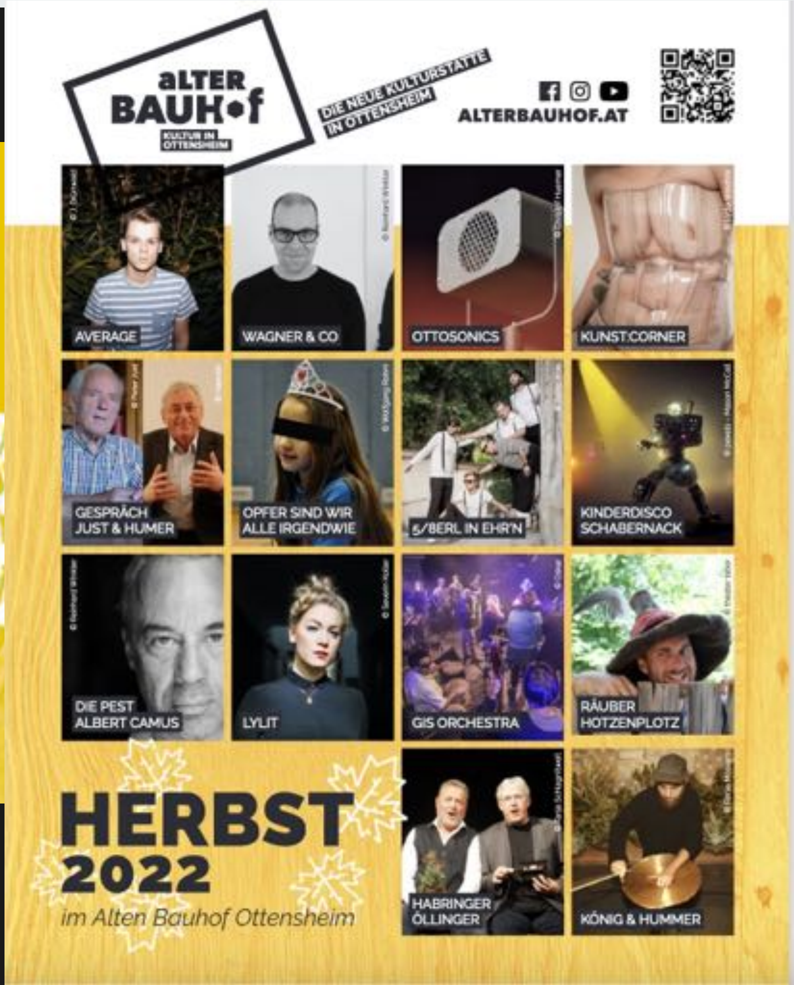
- a collective of sounds-artists, developers, sound engineers



Project goals

- make immersive audio formats accessible to sound and performance artists, as well as cultural and educational institutions, and to facilitate their use in the arts and culture

- address barriers to incorporating immersive sounds in all disciplines of arts and performances, to exchange technical and creative methods from production to implementation, and to share artistic and technological know-how across the field of acoustic and electronic music



ALTER BAUHOF
KULTUR IN OTTENSHEIM
DIE NEUE KULTURSTÄTTE IN OTTENSHEIM
ALTERBAUHOF.AT
AVERAGE
WAGNER & CO
OTTOSONICS
KUNST:CORNER
GESPRÄCH JUST & HUMER
OPFER SIND WIR ALLE IRGENDWIE
5/BERL IN EHR'N
KINDERDISCO SCHABERNACK
DIE PEST ALBERT CAMUS
LYLIT
GIS ORCHESTRA
RÄUBER HOTZENPLOTZ
HERBST 2022
im Alten Bauhof Ottensheim
HABRINGER ÖLLINGER
KÖNIG & HUMMER


Tech Goals

- High Density Speaker array (15 degrees separation in 3D)
- Ambisonics: 4th-5th order
- Speaker Arrays
- WaveFieldSynthesis
- Sound Virtualization for Theather and popular music genres.
- Compatibility with VR, gaming productions, etc.

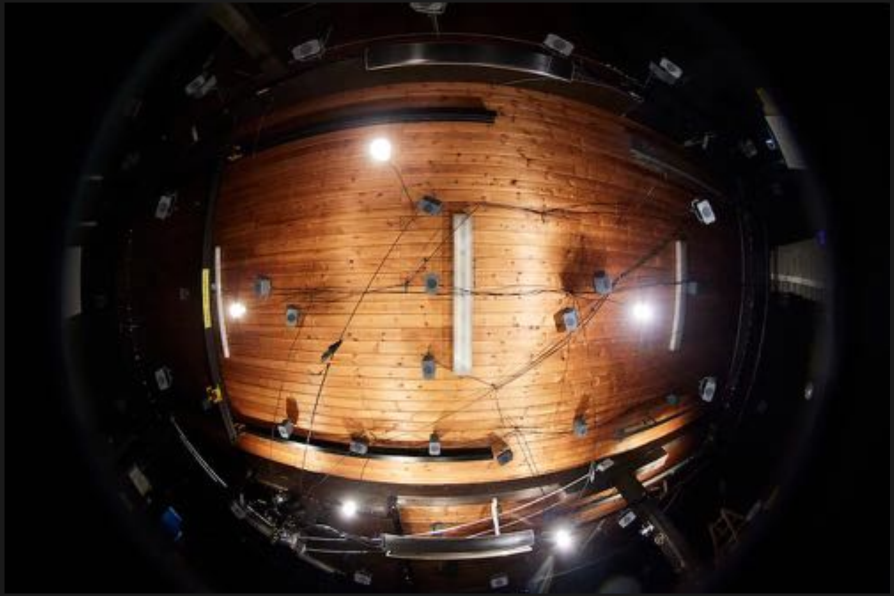
Speaker Layouts until the moment

Alter Bauhof:

- 36-channel dome (10 at -30°, 10 at 0°, 10 at 30°, 5 at 60°, 1 at 90°, 6m diameter, 3 studio subwoofers)
- 22-channel rectangle (10x12m) with 4 speakers/channel and 3 18″subs.
- 20-channel ceiling speakers (4 x 5 grid)
- 4x line array with 6 speakers

Tangible Music Lab:

- A 23.1 speakers dome: 2.5 meters radius: 12 speakers at 0°, 6 speakers at 30°, 4 speakers at 50°, 1 speaker at 90° plus 1 subwoofer.



Problems to solve

1. Develop affordable, open hardware (speakers, amps, mounting and wiring solutions)

2. Provide software solutions for controlling the system

3. Enable transfer of technical knowledge, artistic methods, designs and building instructions

4. Encourage artists and small cultural associations to use immersive audio technologies

   Create a network of artists and compatible live venues

Loudspeaker design

demands, constraints, wishlist

- modular, adaptable, should allow for different setups

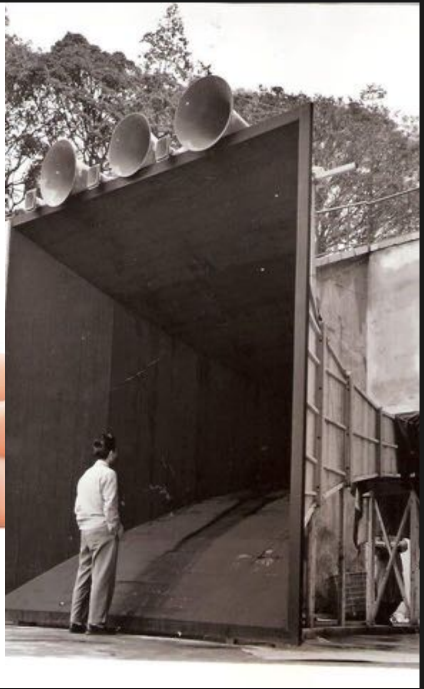
- quick and easy to set up, lightweight, including solution for hanging / mounting

- affordable

- open for others to recreate and further develop

- high audio quality (distortion, frequency response, noise, dispersion, phase alignment, ...)

- high sound pressure



What types of speakers are there? What best fits this list?

Studio monitors

2 or 3-way speakers, linear frequency response, expensive, not modular, heavy, too sensitive for live applications with high dynamics

Home theatre systems with subwoofers and satellites

well suited for immersive audio applications, high crossover frequency to allow for small size, not enough sound pressure

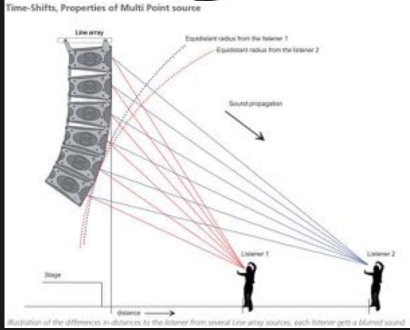
What types of speakers are there? What best fits this list?

PA speakers with compression drivers

loud, wide dispersion but low resolution in higher frequencies, can be harsh sounding, heavy, not modular

Line Sources / Line Arrays

modular, heavy, expensive, sound quality similar to PA speakers, low vertical and high horizontal dispersion, efficient (low energy loss over distance)



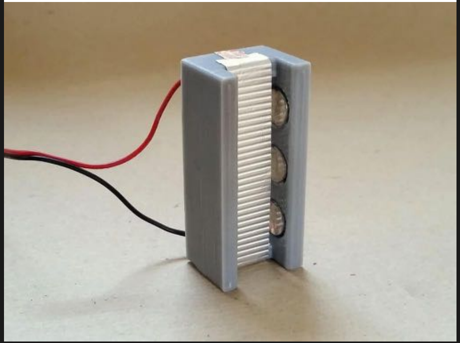
What types of speakers are there? What best fits this list?

Coaxial speakers

not modular, need passive or active crossovers, heavy, not available in smaller sizes (6" min)

Ribbon speakers / AMT speakers

wide dispersion in higher frequencies, sound pressure limited, 2-way system needed



Our solution (so far)... a single, passive 4" speaker in a 3D-printed chassis

- single frequency band, no phasing, no crossover needed, easy to build

- lower frequency dropout at 120 Hz - subwoofer needed, directional hearing not impaired

- modular - line source by stacking them on top of each other to achieve higher sound pressures

- 91dB / speaker, with a low cut a bit more, +6dB when doubling the number of speakers

- impedance of 16 Ohm allows connecting multiple speaker in parallel

Our solution (so far)... a single, passive 4" speaker in a 3D-printed chassis

- light - speaker with neodymium magnet (270g) + chassis (300g), no components other than the speaker and 2 speakon sockets needed

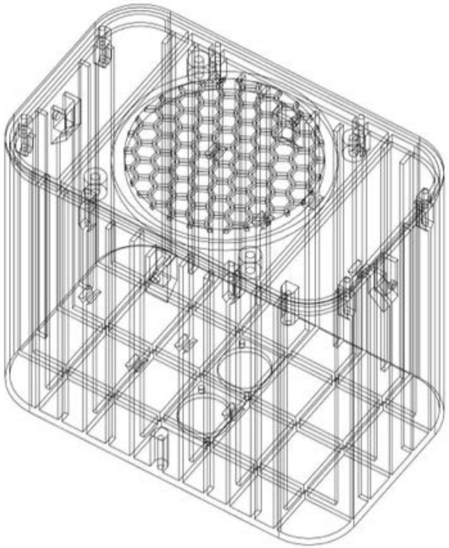
- tight dispersion pattern in higher frequencies can be counteracted by using 2 or more speakers angled to each other

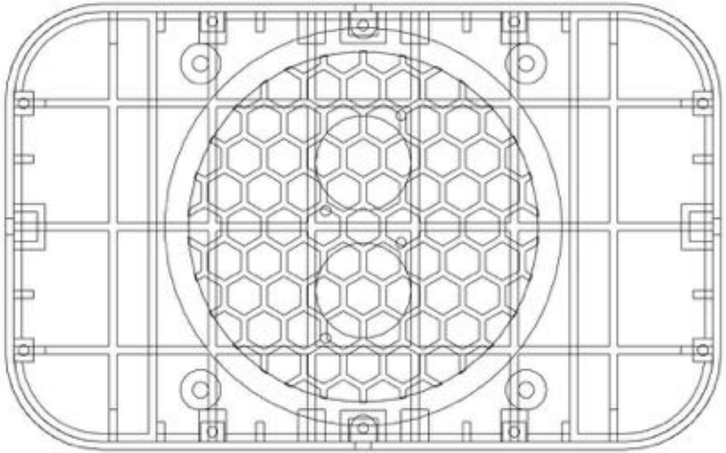
- affordable - 25,- / speaker including printing material

- open and customizable design

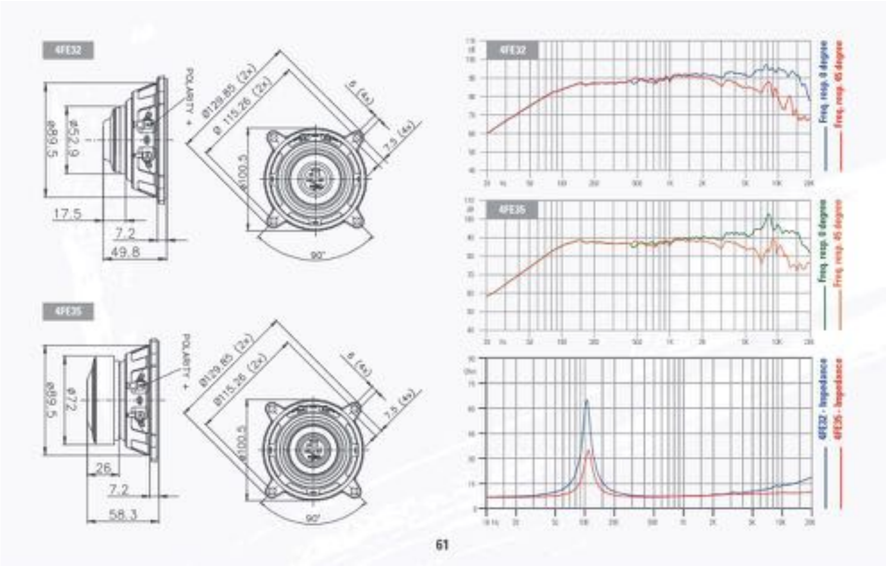
- mid scoop (necessary with full range speakers) can be implemented within the software, additional equalization possible

Chassis design for a Faital 4FE32 4" Full Range speaker

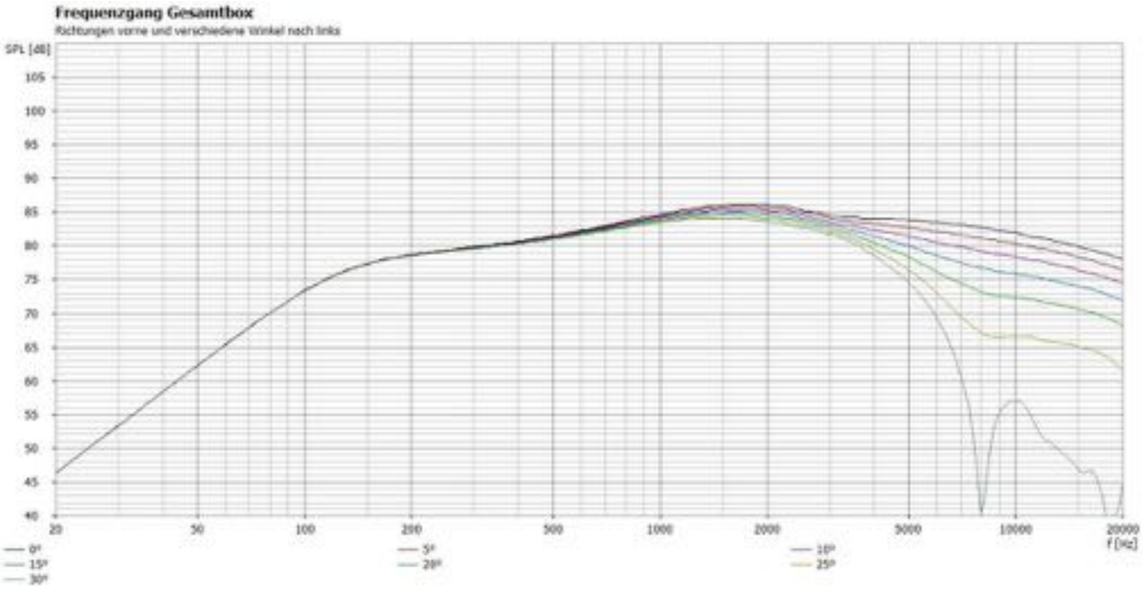




Chassis design for a Faital 4FE32 4" Full Range speaker



Frequency response simulation in a closed chassis using Boxsim

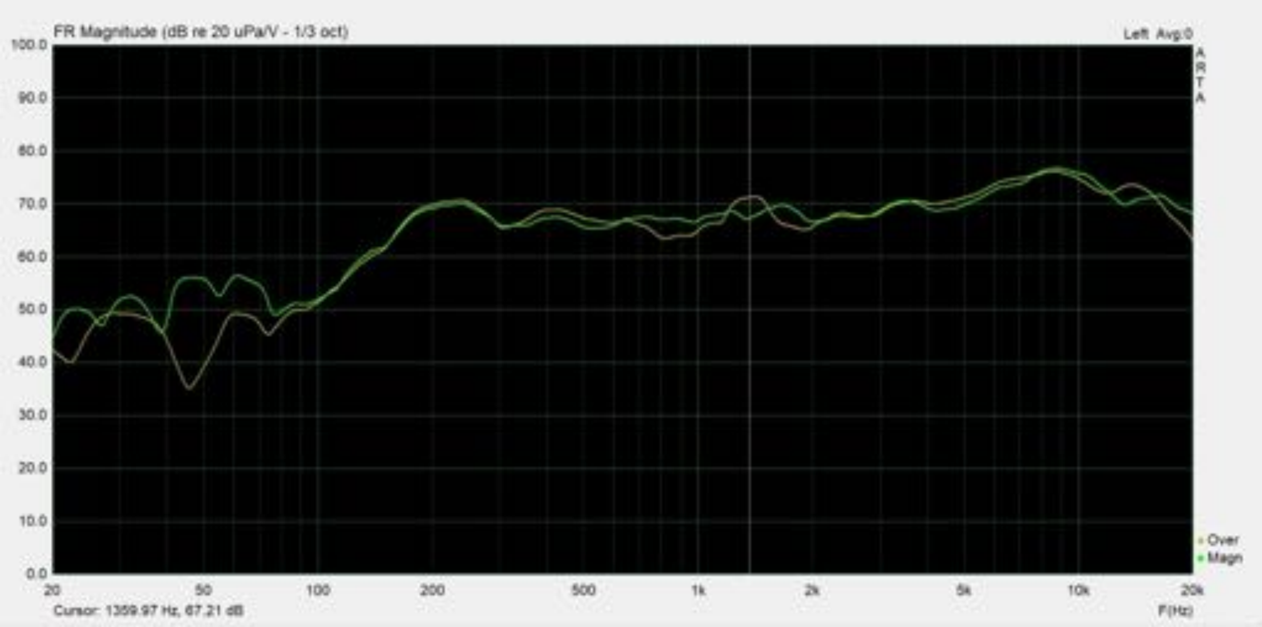


speaker is best suited for a closed chassis (see Thiele & Small parameters, Qts 0.6)

- Volume of at least 2.8 litres is needed

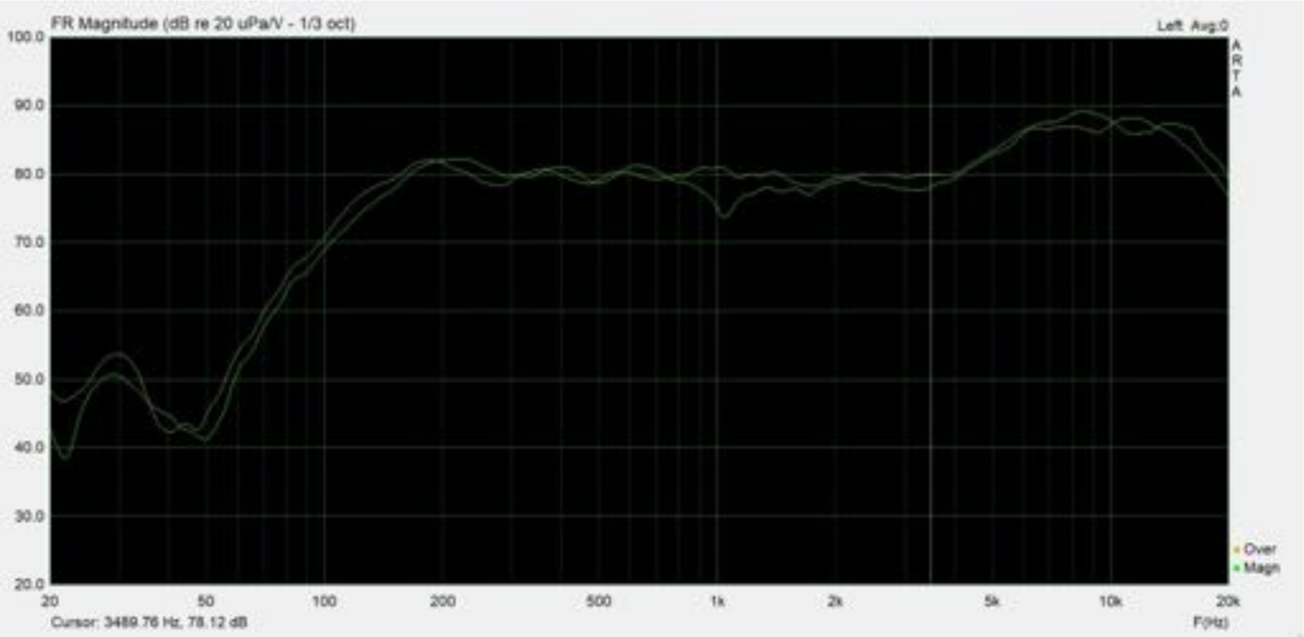
Acoustic measurement using a frequency corrected dbx measuring mic and ARTA software

10mm birch plywood vs 2mm PLA



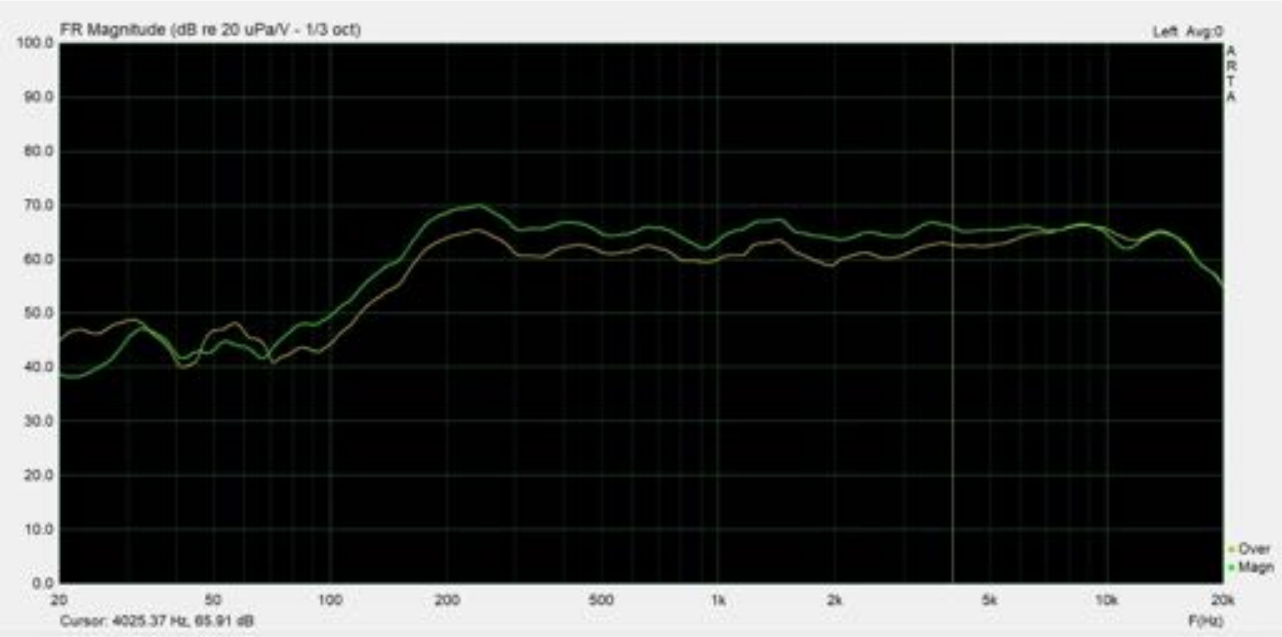
Acoustic measurement using a frequency corrected dbx measuring mic and ARTA software

2 l vs 2.8 l



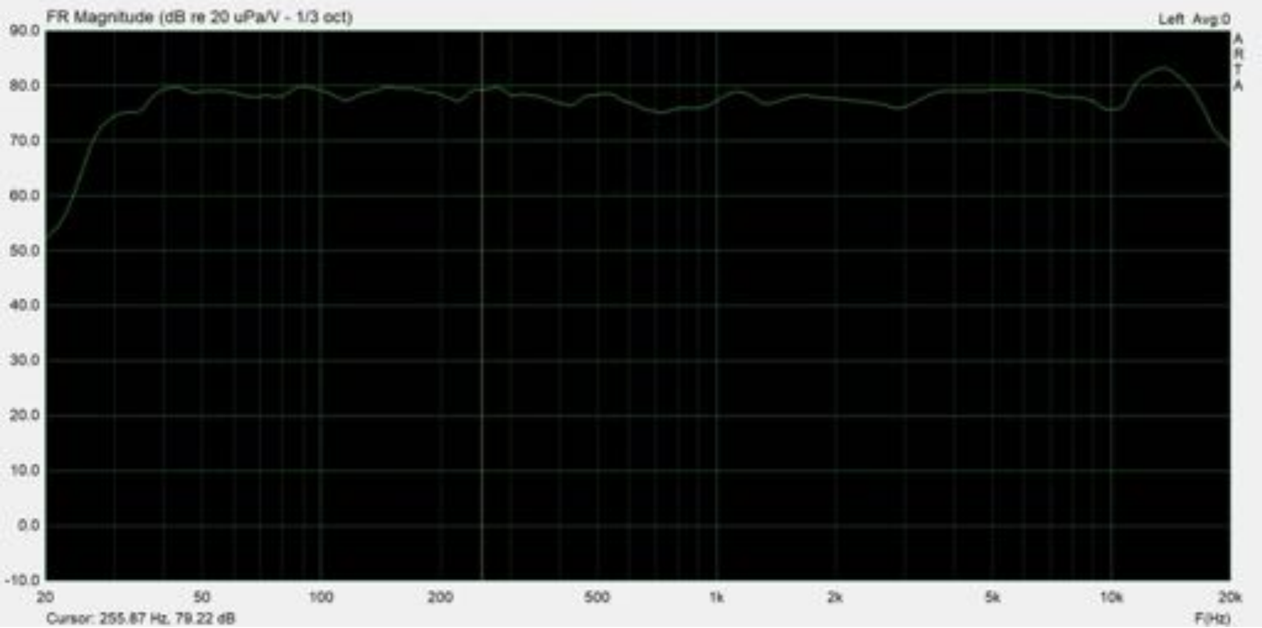
Acoustic measurement using a frequency corrected dbx measuring mic and ARTA software

single speaker vs 2 speakers at 45°



Acoustic measurement using a frequency corrected dbx measuring mic and ARTA software

single speaker with mid scoop and subwoofer



Additional **speaker design considerations**

- dimensions (length, width, height) should not be multiples of each other

- as a line source speakers must be close to each other

- light material (PLA) must be reinforced to avoid resonances, inner structure and struts needed

- mounting points at all sides (center of mass on the sides, center of membrane on top and bottom)

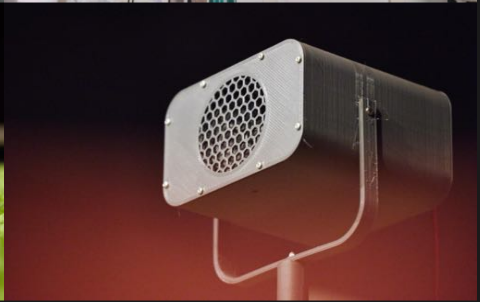
- protection of the membrane

- no supports needed for printing

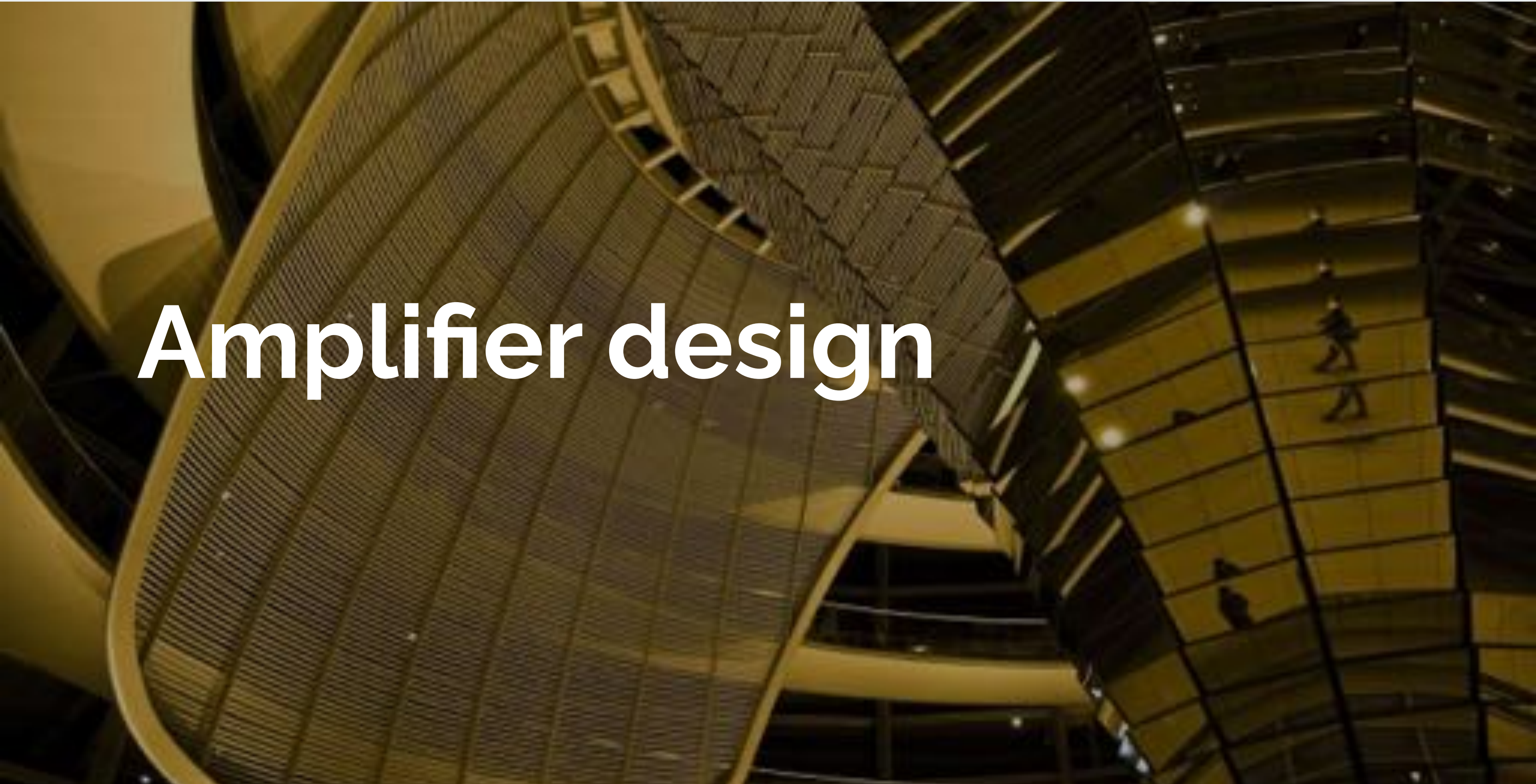
Mounting options





Amplifier design



demands, constraints, wishlist

- balanced inputs (D/A converters have balanced outputs)

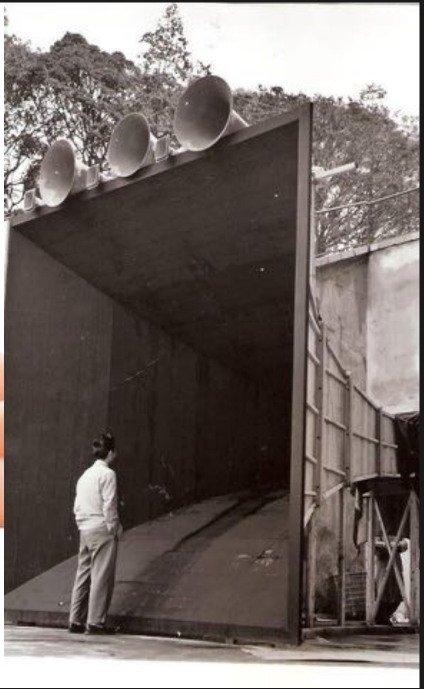
- low cut filter for protection with a bypass option

- option for bridging the inputs eg. when used as a line array with stereo signals

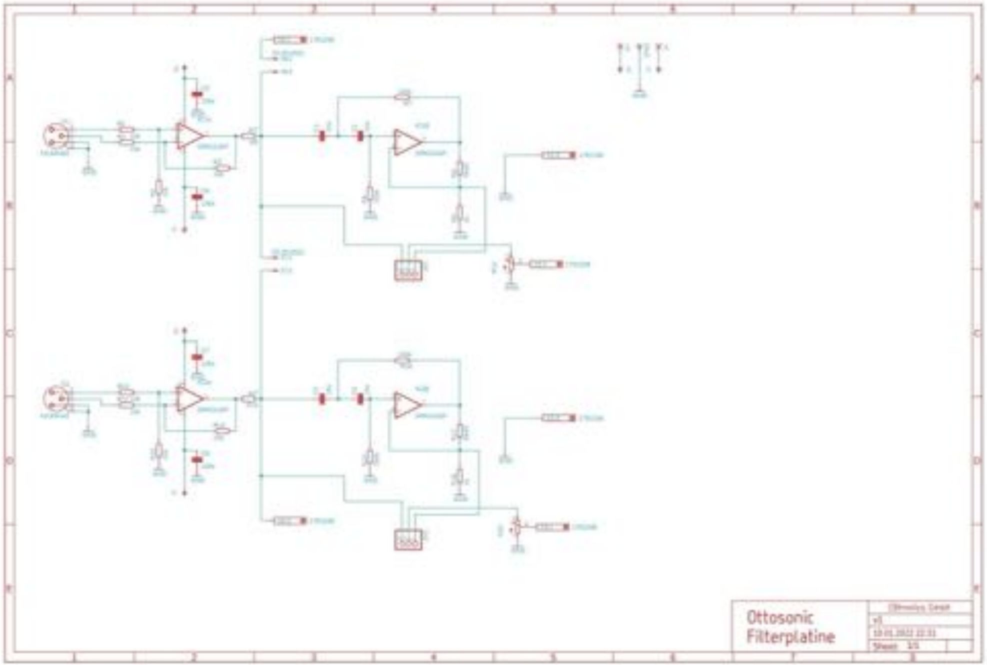
- poti for calibration the level of each channel

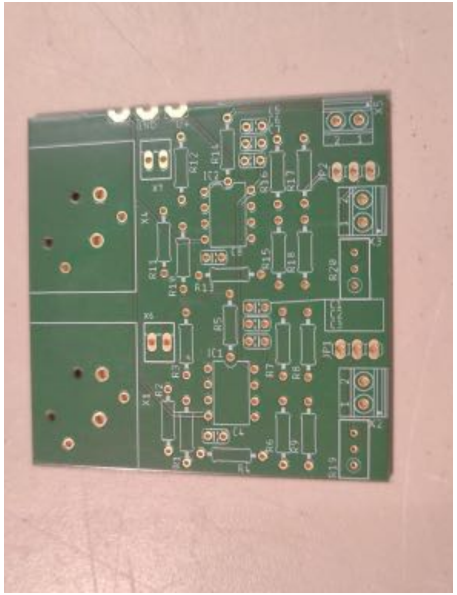
- low distortion, high power, low signal/noise ratio, linear FR

- affordable components



OPA2134 for unbalancing and filtering





tda7294 for amplification


SGS-THOMSON
MICROELECTRONICS
TDA7294

100V - 100W DMOS AUDIO AMPLIFIER WITH MUTE/ST-BY

- VERY HIGH OPERATING VOLTAGE RANGE (±40V)
- DMOS POWER STAGE
- HIGH OUTPUT POWER (UP TO 100W MUSIC POWER)
- MUTING/STAND-BY FUNCTIONS
- NO SWITCH ON/OFF NOISE
- NO BOUCHEROT CELLS
- VERY LOW DISTORTION
- VERY LOW NOISE
- SHORT CIRCUIT PROTECTION
- THERMAL SHUTDOWN

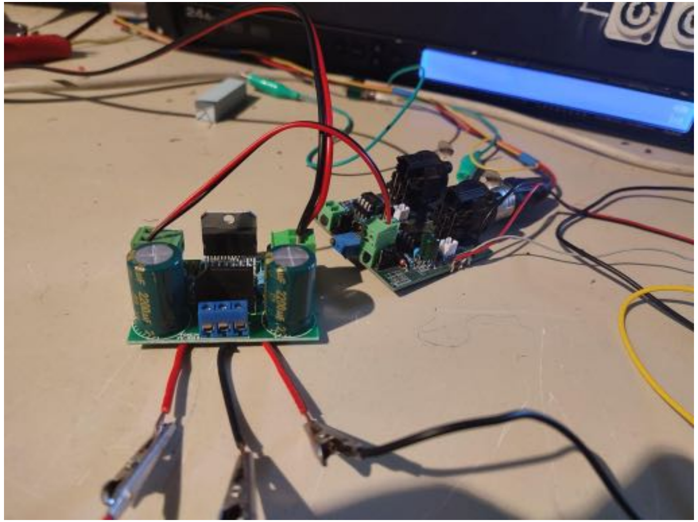
MULTIPOWER BCD TECHNOLOGY

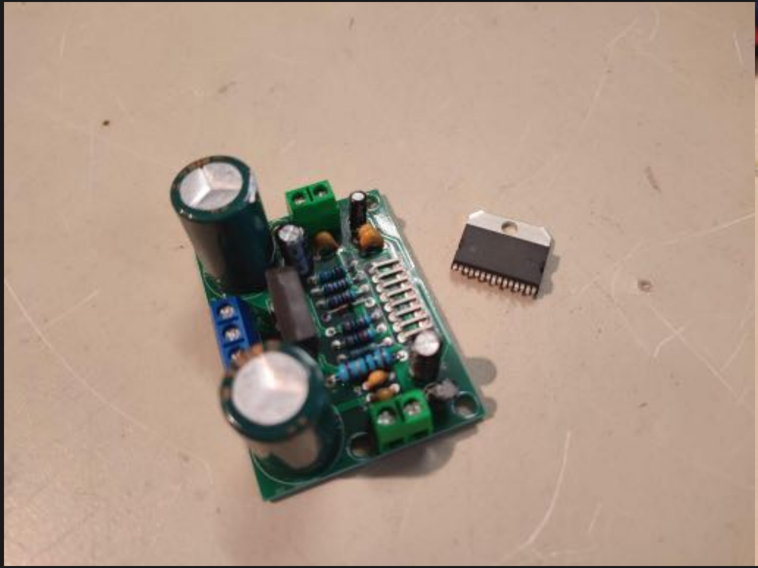
Multiwatt15
ORDERING NUMBER: TDA7294V

DESCRIPTION

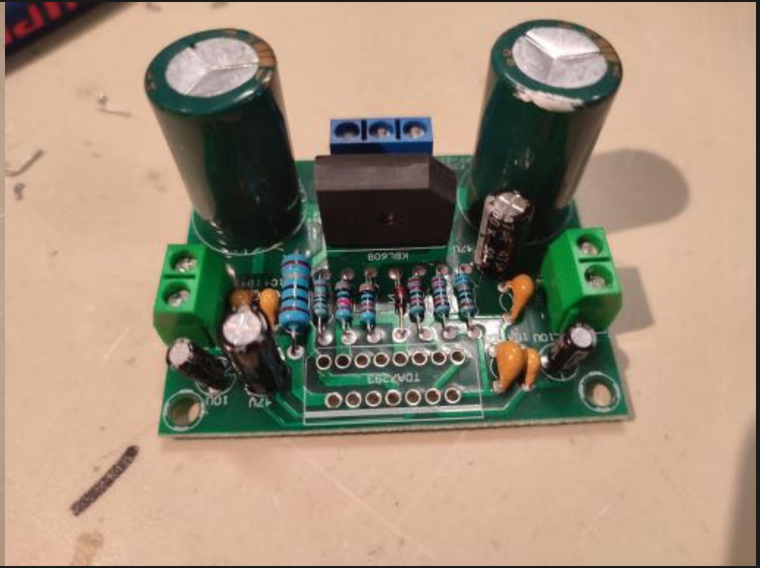
The TDA7294 is a monolithic integrated circuit in Multiwatt15 package, intended for use as audio class AB amplifier in Hi-Fi field applications (Home Stereo, self powered loudspeakers, Top-class TV). Thanks to the wide voltage range and to the high out current capability it is able to supply the highest power into both 4Ω and 8Ω loads even in presence of poor supply regulation, with high Supply Voltage Rejection.

The built in muting function with turn on delay simplifies the remote operation avoiding switching on-off noises.





defective IC



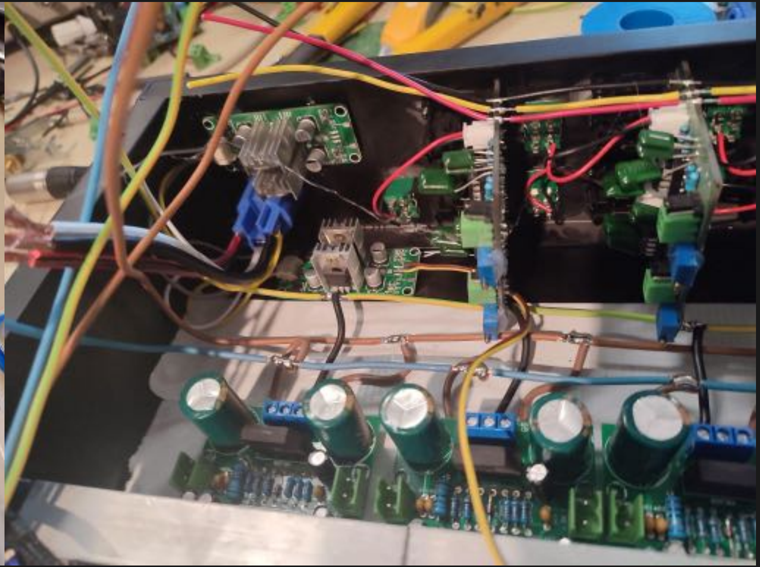
board cleaned for a new IC

mass production

7294s on radiators

front and back plates

amp layout with heat dissipation



input filters

voltage regulators for input filters
and cooling fans

costs for a 24 channel system - speakers & amps
(without D/A converters)

Input PCBs	€ 2.52	12	€ 30.24
tda7294	€ 3.68	24	€ 88.32
board with tda7293	€ 3.50	24	€ 84.00
Faital 4FE32	€ 16.20	24	€ 388.80
PLA	€ 8.00	24	€ 192.00
Speakon sockets	€ 0.20	72	€ 14.40
voltage limiter 15V	€ 2.70	2	€ 5.40
limiter 12V	€ 2.70	3	€ 8.10
OPAs	€ 0.47	24	€ 11.28
XLR sockets	€ 0.66	24	€ 15.84
resistors, capacitors			€ 20.00
power supply	€ 80.00	4	€ 320.00
19" chassis	€ 40.00	3	€ 120.00
radiators	€ 4.00	8	€ 32.00
			€ 1,330.38

Audio Architecture

Audio Over Ethernet

- audio network architecture (one cable controls all channels)

- low latency and hundreds of channels

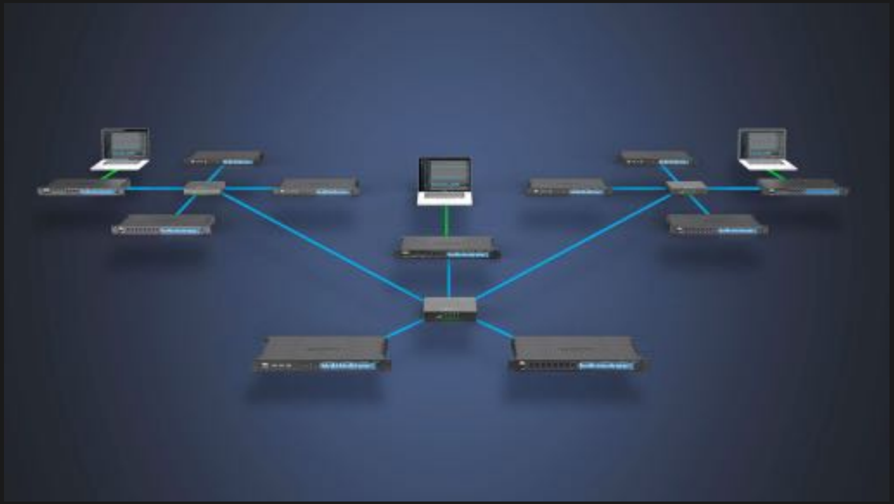
- less cables between interfaces and standardized (ethernet)

- Browser-based control and WIFI options.

- HUGE channel matrix

- highly specialized (costly) hardware

- compatibility with other protocols and hardware



AVB and DANTE

- Dante (2003) is licensed (by Audinate), manufacturers pay a fee to use the technology. AVB is an open standard (manufacturers are not required to pay a fee to use it) developed by the IEEE.

- Dante control software not easy to setup and use compared to AVB

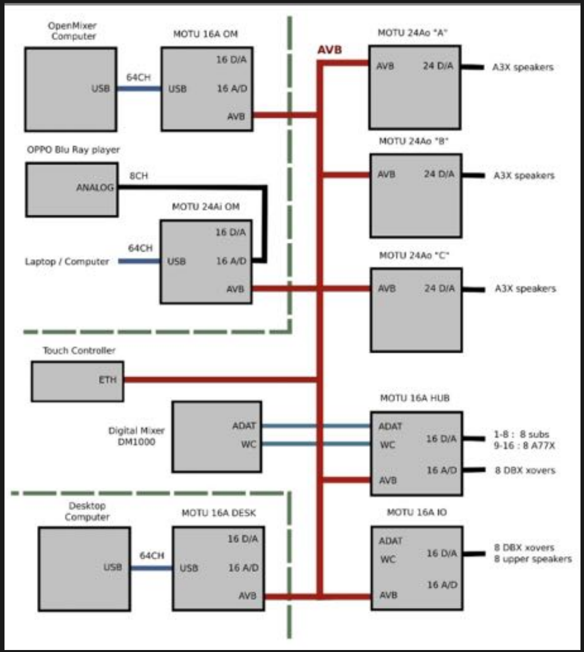
- AVB: Lower industry take up until the moment

- Dante-devices can have a secondary port. In the event of a network failure, the system automatically switches to the secondary network, making Dante a better choice for mission-critical applications.

- AVB offers possibilities to extend its hardware and software: OSC control + Http servers, etc

- Both require expensive extensions to interface typical Yamaha and Allen&Heath mixers

OTTOsonics solution: MOTU AVB



CCRMA 3D Studio System

We followed the documented experiences of CCRMA and Rhode Island University

costs for a 24 channel system - speakers & amps & AVB & Subw

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board with tda7293	€ 3.50	24	€ 84.00
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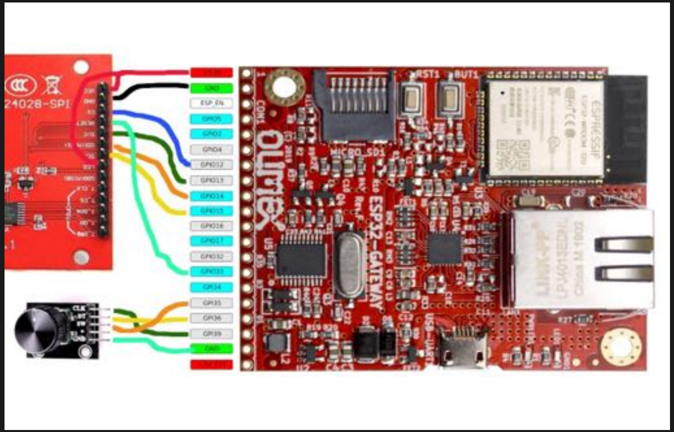
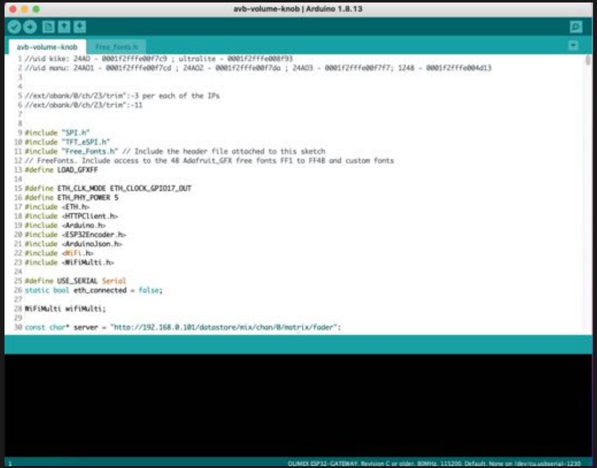
power supply	€ 80.00	4	€ 320.00
19" chassis	€ 40.00	3	€ 120.00
radiators	€ 4.00	8	€ 32.00
MOTU 24AO	€1000	1	€1000
Subwoofer	€300	1	€300
			€ 2,630.38

A custom volume controller (using a ESP32)





https://github.com/ultranoise/MOTU_AVB_ESP32_Controller

Our experience with AVB

- Easy setup: install the drivers and connect.

- Transparent workflow.

- Until 64 channels: quite easy with USB

- More than 64 channels -> thunderbolt + adapters. An expensive adapter is needed for ethernet audio from MacBooks.

- Each MOTU interface has very different I/O specifications, it is necessary to purchase a few of them for various uses.

- MOTU offer drivers for Mac and Win only.

Student at Tangible Music Lab 23.1 system

SOFTWARE WORKFLOW

live inputs

recorded audio

DAW - Reaper
(until 64 ch per track)

IEM Plug-in Suite

Ambisonics VST Suites

OTTOsonics

Upcoming events (Autumn 2022):

Sept 11th-17th OTTOsonics Residency with Stefan Juster and Robert Schwarz

Sept 17th and 18th OTTOsonics Festival

Sept 30th Opfer sind wir alle irgendwie, Theater asozial

Oct 13th Klimazone, Theater phönix

Oct 24th-30th OTTOsonics Residency with Amelie Nilles

Etc…

Practical session