ARTA, STEPS, LIMP

Hardware and Tools

the Compendium
for the programs of the ARTA family

Version 1.01e, January 2011

Changes Version 1.01e

Chapter	Note to changes / additions
4.1	Erratum to Power Amp with TDA 7294
4.2	New, power amp with LM3886

CONTENTS

0 FOREWORD

This collection of hardware and tools to facilitate the measurement or in special Cases even give first. As in ARTA compendium, so here is the DIY sector in Focus, although some of the solutions presented quite professional standards withstand. You can find both ready elaborated projects, including board layout and Ideas or suggestions that are documented only in the form of sketches or photos.

It is contemplated that H & T Manual over time to constantly replenish. Suggestions and also finished posts to extensions of this manual are always welcome.

Finally, a note to the cabinet building: The replica is at your own risk.
The authors assume no responsibility for malfunctions or may be incurred Damage. Support in the reconstruction phase is not possible and also not provided. The PCB layouts can be obtained from the sources indicated in each case, finished boards only be offered if indicated.

At this point, I would not fail to extend my thanks to all contributors.
All have sacrificed many hours of their time to bring the projects so far that it here could be inserted into the collecting pot. However, my very special thanks go to Ralf Grafe and Matthias Leger, without these two "lunatics" were almost exclusively third Projects incorporated.

In the development and construction phase, the fun factor was high, but unfortunately also includes the annoying
Document it.

Enjoy the reconstruction and further development.

H. Weber and
all participating authors

0.1 General information on the reconstruction of the platinum solutions

The starting point of the following notes is the etched board.

It is recommended that the copper side with a thin layer of solder resist tarnish and Corrosion to protect when stored for long periods before drilling. The solder resist disturbing but during drilling, because it sticks, at least as long as he is not dried.

Drilling the holes

All the holes have a diameter of 0.8 mm. This is the standard size.
Exceptions are:

- 10 pin connector and voltage regulator: 1.0 mm
- Diode 1N400x: 1.0 mm
- PC terminals: 1.3 mm

Assembly

Basically equipped to "bottom-up". I.e. the smallest components first, and then the larger ones. The typical sequence is as follows:

1 Jumpers
2 Resistors and diodes
3 ICs
4 Transistors and capacitors,
5 Electrolytic capacitors
6 Voltage regulator and residual

Each board should carefully before starting to unwanted solder bridges and correct Placement be checked!

Aftercare

Is the board ready and successfully tested, it is recommended that the flux residues To remove solder and the solder resist, otherwise the acids in the flux and the solder joints the board to attack the long term. This short wash the board in so-called electro-wash, then let it dry and then protect it with a thin layer of plastic spray and preserve.

Since the least likely to want to procure the extra-expensive electric wash, it is quite well with methylated spirits. A small brush helps in small and inaccessible corners to come.

Note: The designated board layouts - and now even some more - can on the website of Ralf Grafe [10] related:

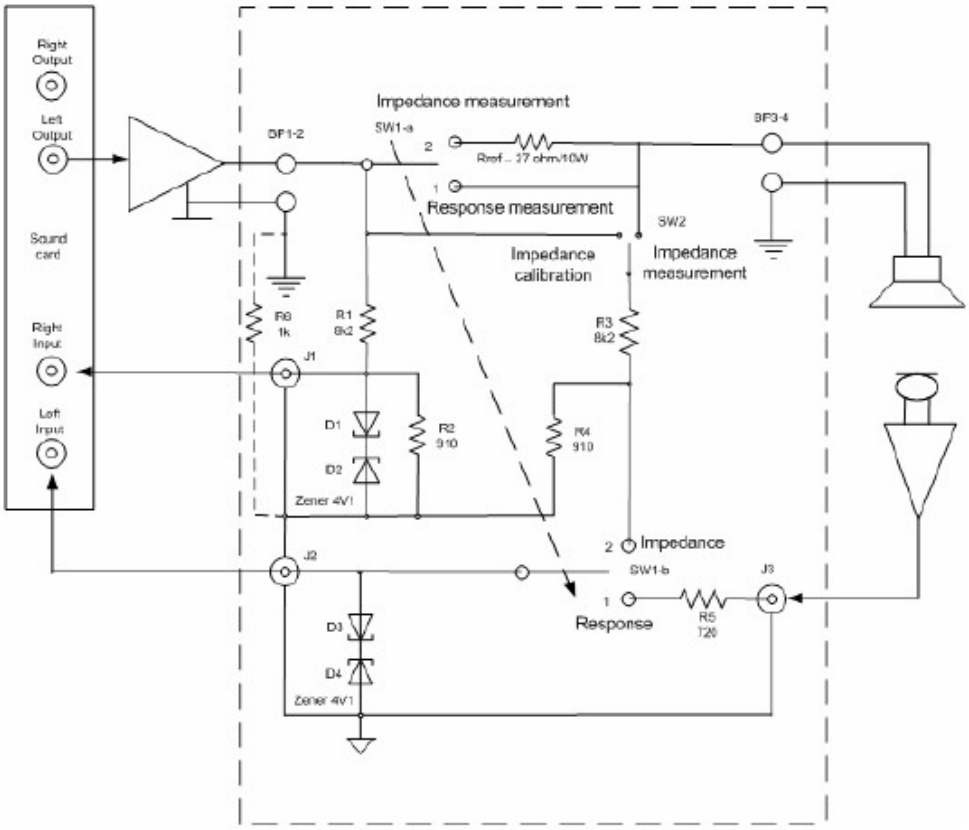
http://www.m1n1.de/html/hifi.html

In the case of sufficient demand for finished boards are also offered. Please check in individual cases.

1 The ARTA MessBox

1.1 ARTA MessBox, the original

The first ARTA MessBox is described in Application Note AN 1 from the year of 2006. There you can find all necessary information about the structure of the free wired version. For this Reason is shown here for guidance only schematic.



Note 1
Security
Security

The mass of the power amplifier and the sound card are separated by a 1k resistor. Please do not use bridge amplifier virtual ground!
The inputs of the sound card are protected by Zener diodes. The power amplifier protected as specified by the manufacturer. Make sure that the manufacturer's nominal impedance is not maintained.

Image 1.1.1: Schematic of the ARTA measurement box

1.2 ARTA MessBox, the platinum solution

Ralf Grafe

Who is in a position to be able to manufacture blanks itself, the solution is the following in question. Wiring errors should be excluded.

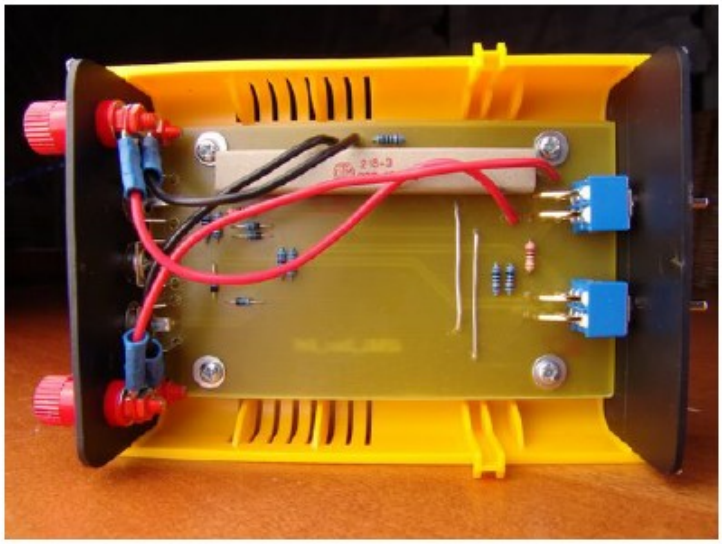


Figure 1.2.1: The solution of the platinum ARTA measurement box

The printed circuit board is one-sided, which makes the manufacture relatively easy. Figure 1.2.1 shows the view
the component side. To the speaker terminals, all components are located directly on the Board. The switches are designed both as a 2 x UM, which brings mechanical stability. The Wi- resistors 715 ohms and 910 ohms not the common E24 correspond and are thus sometimes difficult to obtain. But usually can be any resistance values by Implement parallel circuit of two resistors of the E24 series. The board is therefore deter- hen, optionally include one or two resistors. In the first case simply remains a Bestué- ckungsplatz free.

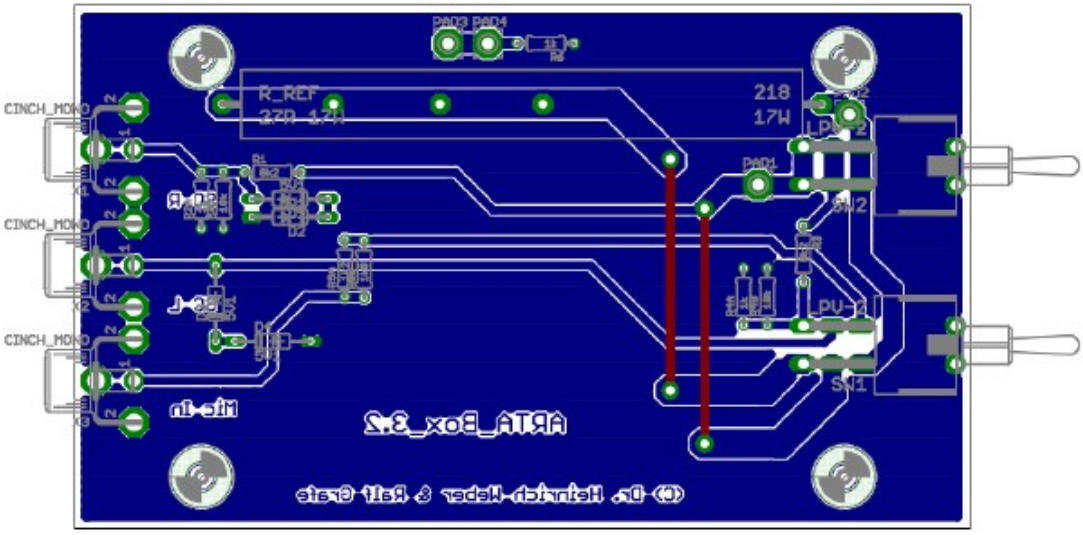


Figure 1.2.2: component side of the board for the ARTA measurement box

Finally, a look at the assembly diagram (Figure 1.1.2) and the diagram (Figure 1.1.3) from the assignment of connectors and components can be seen.

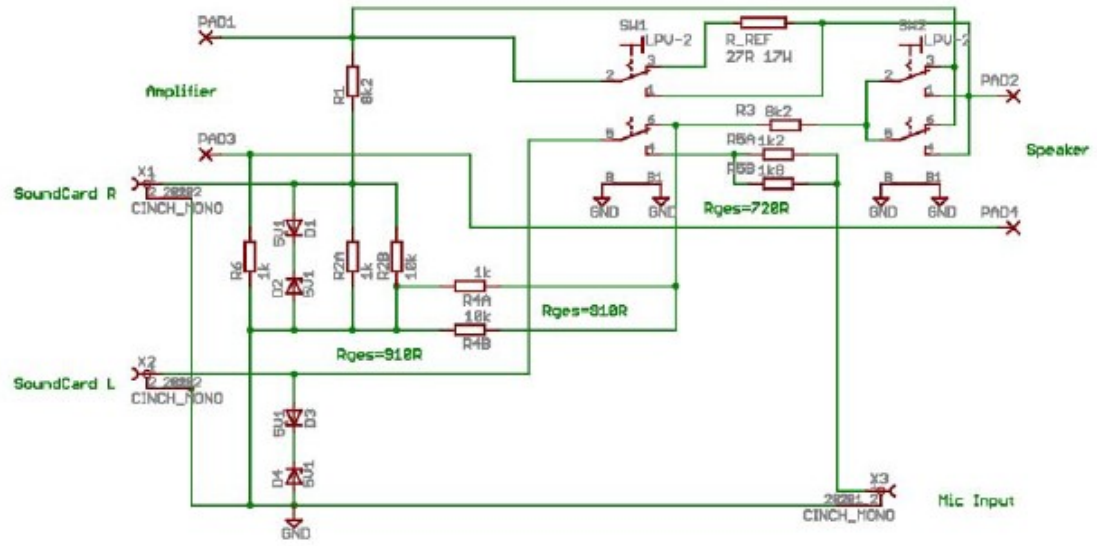


Figure 1.2.3: Schematic of the platinum solution of ARTA measurement box

Note 1: The zener diodes can both> <as well as <> be installed.
Note 2: Depending on the concern for the sound card, the values of the Zener diodes should be between 3.3 to 5.1 V (0.5 W) lie.

Image 1.2.4: When assembled, the ARTA measurement box

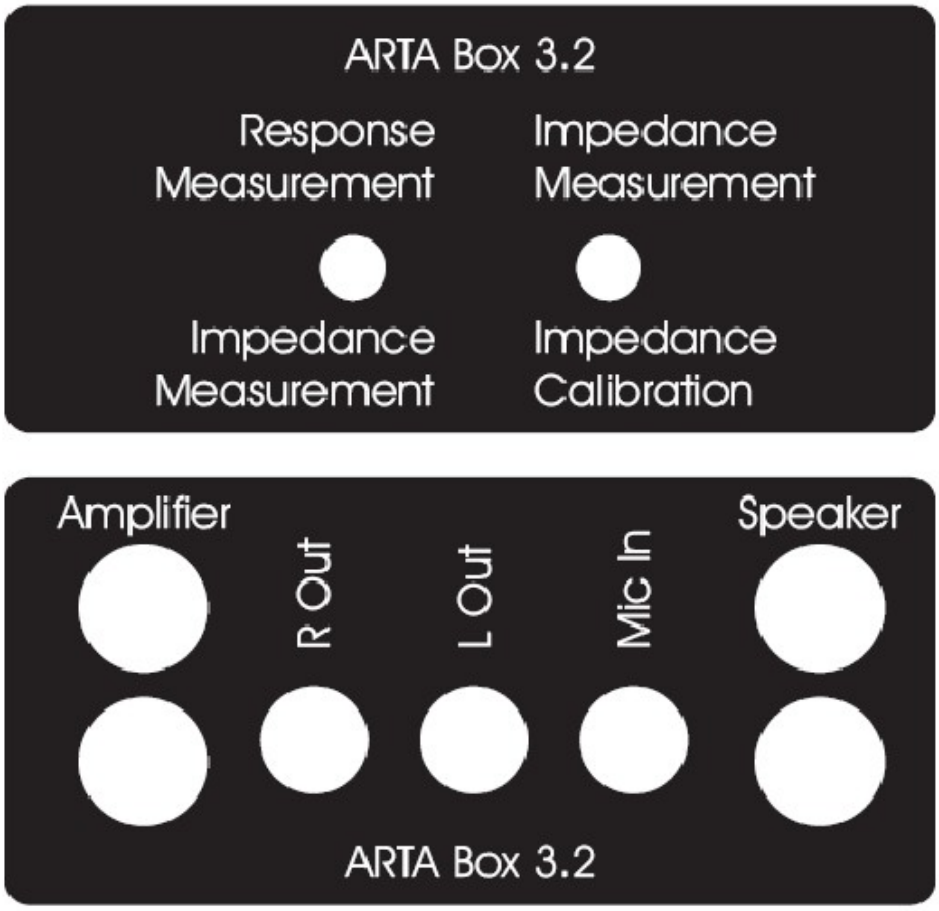


Image 1.2.5: Label template for ARTA measurement box

Number	Description	Article	Order
1		Board	ARTA Box 3
1		Plastic housing	Eurobox BL
2	SW1, SW2	Toggle switch	500 FVT MS
2	PAD3, PAD4	Black terminal post	PK 4 SW
2	PAD1, PAD2	Binding Post Red	PK 4 RT
3	X1, X2, X3	RCA socket, metal print	CBP 5
1	R Ref	Power resistor 17W	17W axial27
2	R1, R3	Resistor 8k2	
3	R 2a, R 6, R 4a	1k resistor	
2	R 2b, R 4b	10k resistor	
1	R.sup.5b	Resistor 1k8	
4	D1-D4	Zener 4.3V / 0.5W	
			ZD51

Table 1.2.1 BOM

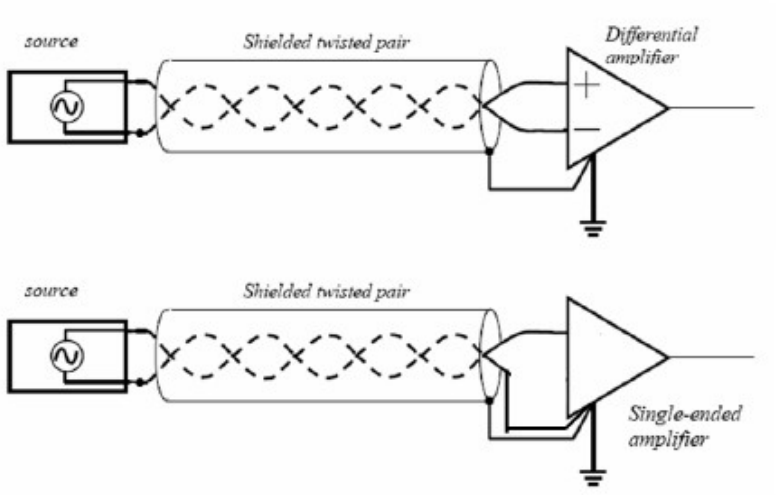
http://www.m1n1.de/html/hifi.html

1.3 Cable and pinout common connectors

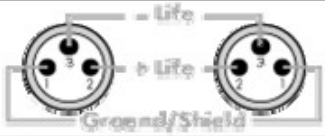
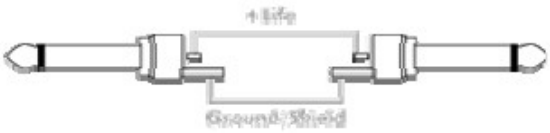
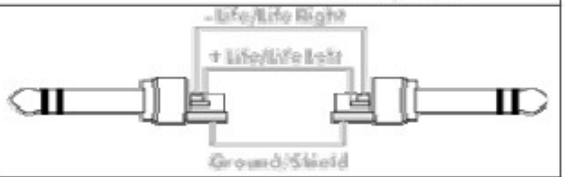
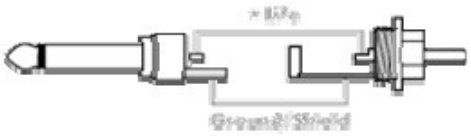
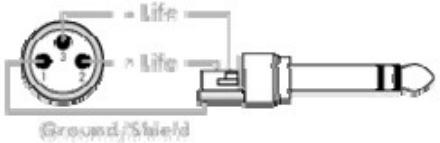
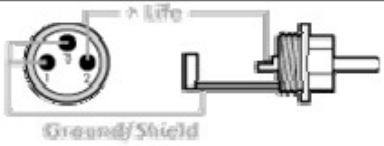
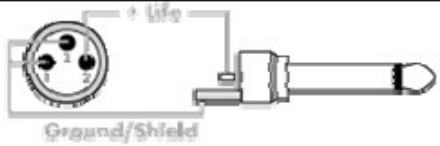
Who wants to measure small analog voltages should also pay attention to its measurement cable. Naturally suffers the transmission quality of the signal when measuring small signals with simple cables, larger distances are transmitted, as noise of any kind act on the pipes.

To counteract the mass and interference problems, the following guidelines [09] should be considered are:

- Use the shortest possible cable between the source (sensor) and measuring amplifier. Especially in the case of high-impedance sources has to be ensured.
- If possible, use double shielded cables.
- If necessary, drag an extra ground wire and connect the shielding on one side only.



- Avoid ground loops. Pay attention to the same earth potential between the measuring source and meter (sound card). Measure before with a DVM between two Ground potentials in AC and DC.
- Do not place the signal cable to pass interference (transformers, power supplies, power supply leading cable, etc.).
- If possible, disconnect the computer from the network electrically (laptop battery)
- Take advantage of the additional averaging (averaging)

Unbalanced	Symmetrical
	
	
	
	
	

JACK STEREO Housing: mass (GROUND / SHIELD) Tip: Plus (LIFE) Ring: minus (LIFE)	XLR Pin 1: GND (GROUND / SHIELD) Pin 2: positive (LIFE) Pin 3: negative (LIFE)

Image: 1.3.1: Pin assignment of connection cables

If you want to get an overview of the range of pre-configured cables,
then the "CableGuy" on the homepage of Thomann is recommended (www.thomann.de)

2 Measurement microphones and other sensors

2.1 Electret microphone capsules

Heinrich Weber

The construction of a microphone which is suitable for measurement purposes is for inexperienced DIY manageable. The most important component of the microphone is a suitable electret microphone capsule Omnidirectional. A typical representative of this category is the WM 61A Panasonic [11].
To below the important data from the specification:

Sensitivity	−35±4dB (0db = 1V/pa, 1kHz)
Impedance	Less than 2.2 kΩ
Directivity	Omnidirectional
Frequency	20–20,000 Hz
Max. operation voltage	10V
Standard operation voltage	2V
Current consumption	Max. 0.5 mA
Sensitivity reduction	Within −3 dB at 1.5V
S/N ratio	More than 62 dB

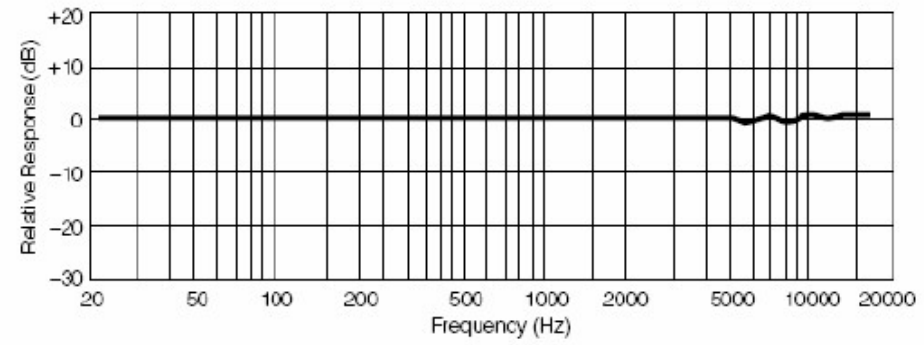


Figure 2.1.1: Panasonic WM 61A, technical data

Overall, the range of usable mic capsules on the market is manageable. One substantial part of it is listed in Table 2.1.1. The models marked with *) are unfortunately no longer available or only available as individual pieces with good luck.

Type	MCE4000	MCE 2000	WM 61	WM 60a
Frequency range in Hz	20-20000	20-20000	20-20000	20-2000
Sensitivity in mV/Pa/1kHz	5	6	18	6.3
Output impedance in ohms	2.2	2	2.2	2.2
S / N in dB	58	58	62	58
Supply in volts	1.5 - 10	1.5 - 10	1.5 - 10	1.5 - 10
Diameter mm	6	6	6	6
Length in mm	5.8	5.8	3.4	5
Manufacturer			Panasonic	Panasonic
Marketing			DigiKey	DigiKey
Order No.	Monacor	Monacor		*)
	23.3680	*)		

Type	KE 4-211-2	Pollin		
Frequency range in Hz	20-20000	50-20000		
Sensitivity in mV/Pa/1kHz	10			
Output impedance in ohms	1	1.2		
S / N in dB				
Supply in volts				
Diameter mm	0.9 to 15	1.5 - 10		
Length in mm	4.75	6		
Manufacturer	4.2	5.5		
Marketing	Sennheiser	-		
Order No.		Pollin 660 367		

Table 2.1.1: electret microphone capsules for measurement microphones

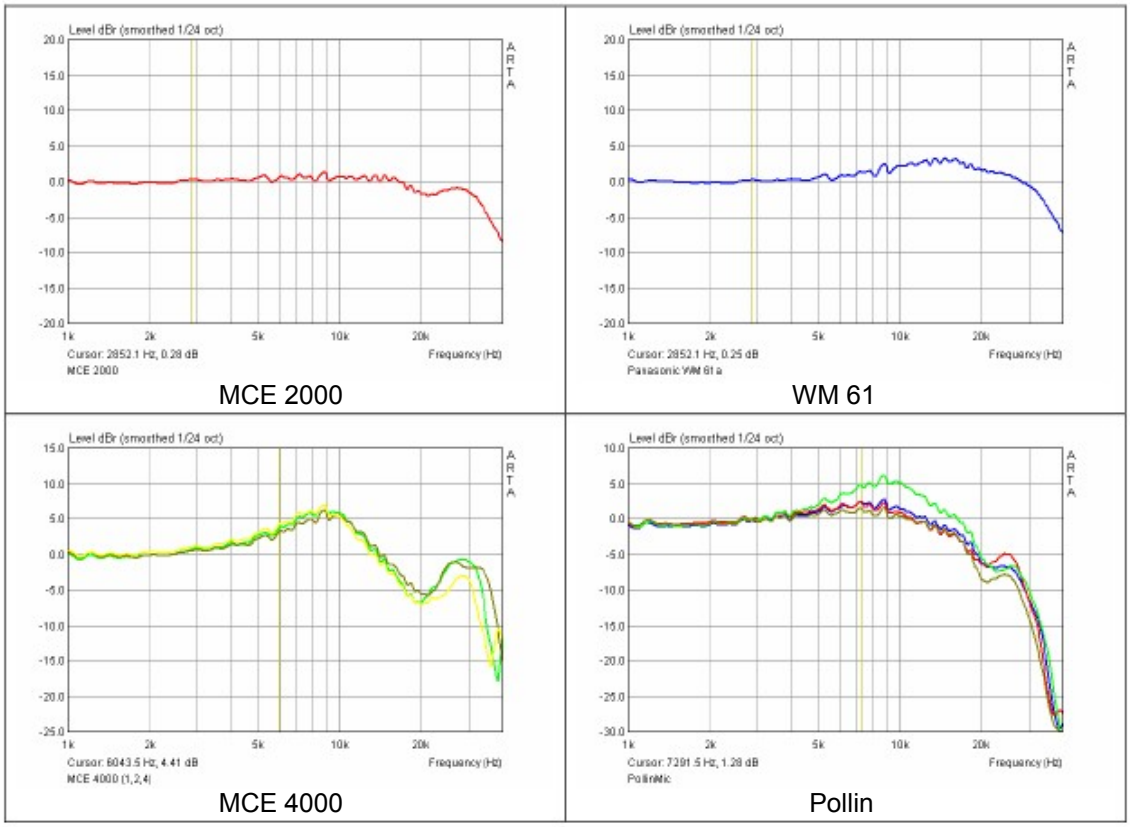


Figure 2.1.2: Deviation from the reference microphone (MK 301)

In Figure 2.1.2 the suggestion of the scattering behavior of electret microphone capsules is the example of the
Pollin capsules to see. For the purpose of giving a better impression on the distribution of Characteristic values were 10 microphone capsules from two batches measured (Figure 2.1.3). In the left part of each image is the measured frequency response of a tweeter to see in the the right-hand partial images relative deviation from a microphone capsule from the batch.

Firstly, it is clear that is always to be expected outliers, on the other hand, that Sensitivity variations of + / - 4 dB - as indicated in reputable specifications - no Rarity. So if you do not want to live with uncertainty in measurement, which should be DIY Microphone always calibrate in sensitivity and frequency response (leave). Further details can be found in the Compendium [02].

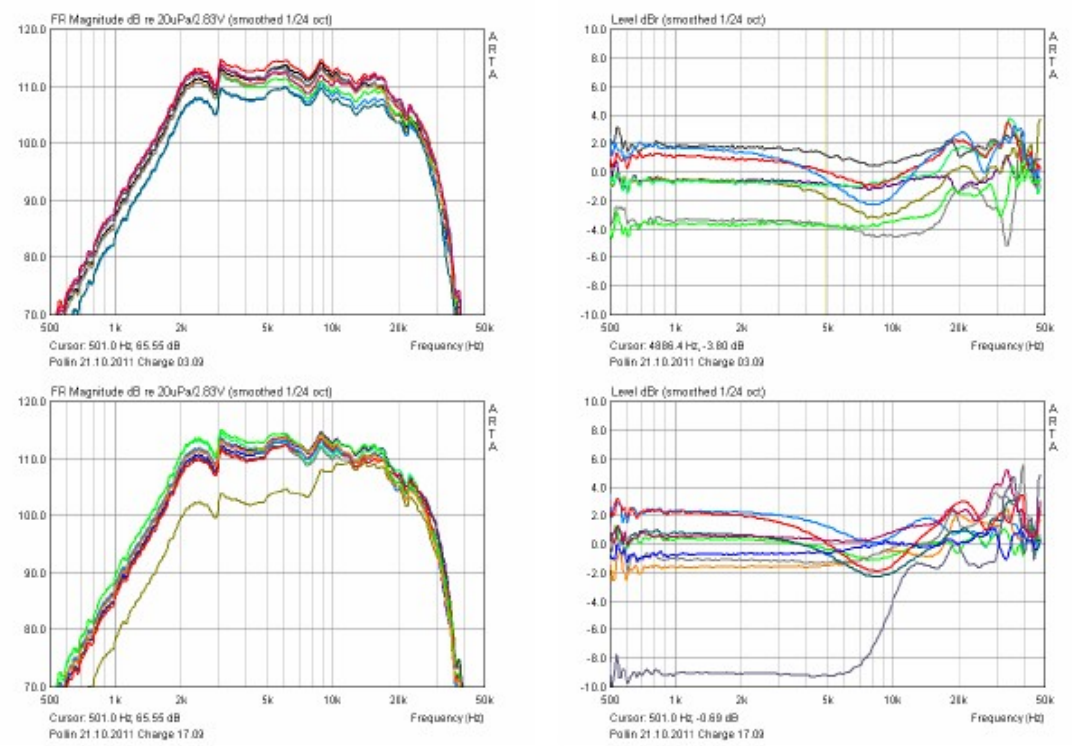


Image 2.1.3: Scattering of microphone capsules from 2 batches

Type	Sensitivity in mV/Pa @ 1kHz	Sensitivity dB re 1V/Pa	X	S	Manufacturer dB re 1V/Pa
WM61a22, 09 20,0621,07-33,53					-35.00
MCE2000 6,306,30-44,01					-44.40
Pollin6, 56 10.76 7.14 10.74 10.86 8.33 9.07 1,97-40,85					
MCE4000 4.90 6.98 5.57 4,105,39 1,22-45,37					
					-46.00

Table 2.1.2: electret microphone capsules, some measurements

2.2 A simple Electret Measurement Microphone

Heinrich Weber

If you are out of the range above a suitable microphone capsule have found
You need to build a measurement microphone only about 20 - 25 cm aluminum tube with
8mm outside diameter (available at any hardware store), a 3.5 mm stereo jack -
or better a RCA jack - and a piece of flexible cable.

The construction of the microphone is shown in Figure 2.2.1. The upper left portion of the image
are given the dimensions and pin assignment of the microphone capsule. The mean
Part describes the wiring and the right is the input circuit of the sound card to see. The
dotted boxed area in the middle part represents the microphone capsule

It should be mentioned that the sound card, the supply voltage for the microphone
must provide. So before purchasing parts please check the specification of your sound card.

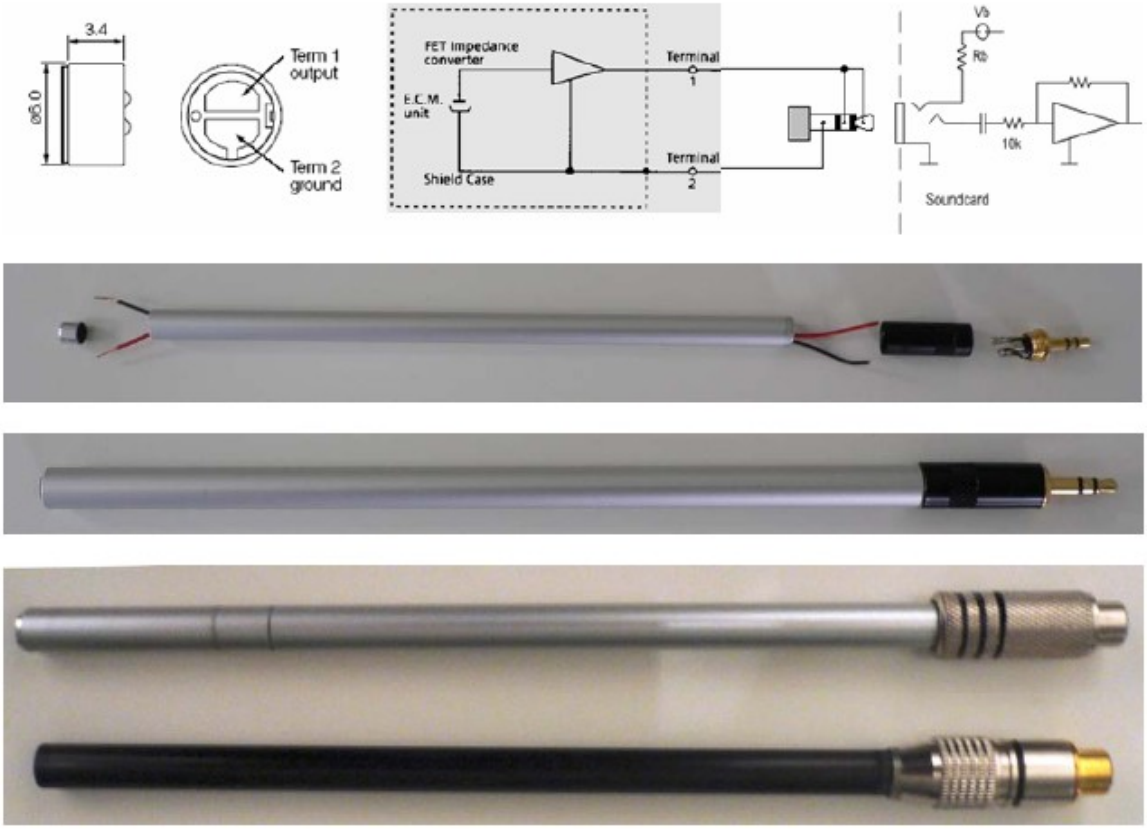


Figure 2.2.1: Development of a measurement microphone with 3.5mm jack (top) or RCA jack (bottom)

The microphone capsule should (structure-borne noise) isolated are used in the aluminum tube
(Heat shrink tubing helps a little). To fit the tube must be about 5-8 mm deep with a 7
mm drill to be drilled. If using a hand drill, please take care of
Drill canted quickly and then there is breaking or injury.

Figure 2.2.2: Measurement Microphone with DIY microphone holder

The "calibration" of the microphone can either by the tweeter method (cf. Compendium, Section 5.4.3) or by estimation to be made from those shown above Measurement results. By reading the values from the graph, a compensation file be determined, for correcting the mean deviation of the measured charge. There should be a However, be aware that significant differences occur in batch electret microphone capsules can (see section 2.1).

Nevertheless, taking into account the low use of resources (and the compensation file) obtained a "measuring microphone", which is very useful at least for first measurement experiments.

2.3 A phantom powered measurement microphone

Ralf Grafe, Goran Repanić, Heinrich Weber

In the tool box of a speaker developer a good measurement microphone is of course to Basic equipment. However, professional measurement microphones have a limitation, they are expensive.

The following is the construction of a measuring microphone is presented that the demands of DIY Should be sufficient area and - as we shall see later - are quite with finished products can measure. It is up to each mic preamps with phantom power - such as the Monacor MPA 102 - usable.

Figure 2.3.1: Finished measurement microphone (version Goran Repanić, Split)

In the circuit as used herein is a standard approach in view of the Noise performance has been optimized. Picture 2.3.2 shows the schematic and the associated parts list.

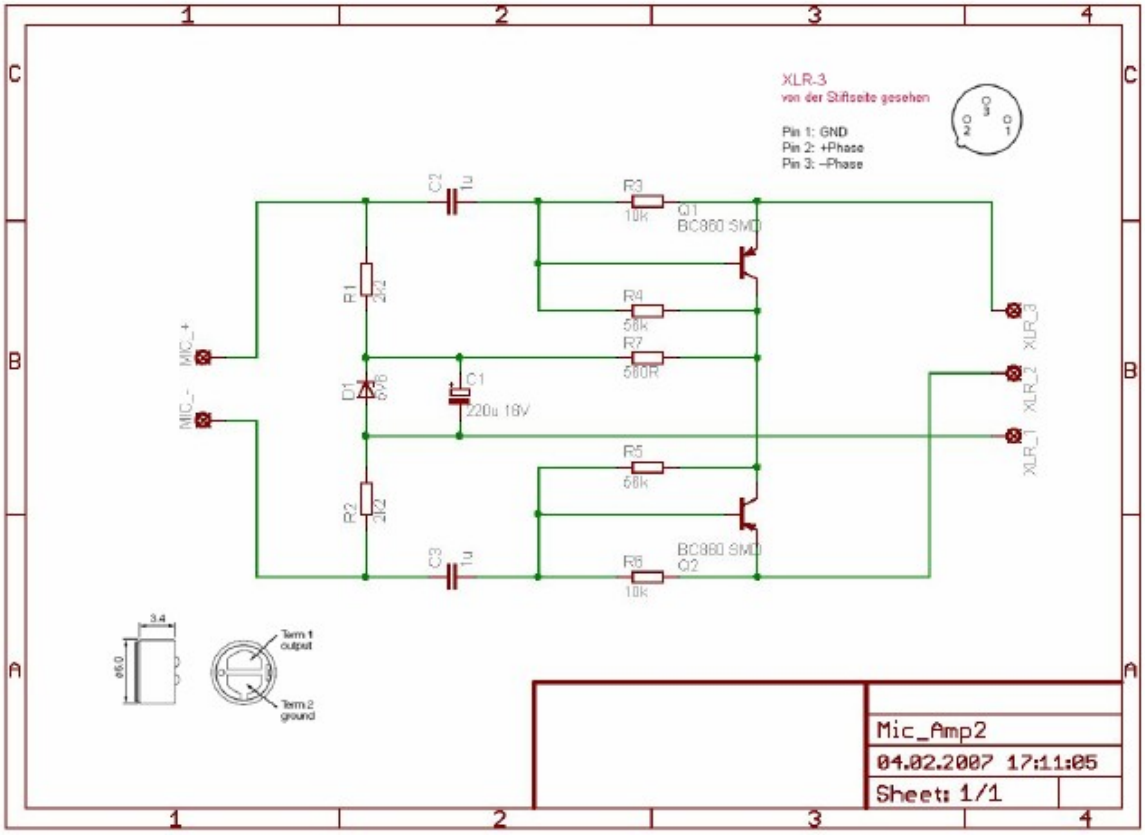
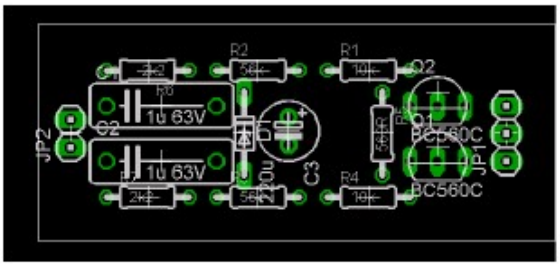


Image 2.3.2: Schematic

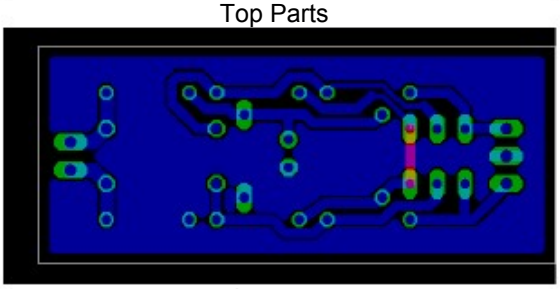
Number	Item	Description
1	M1	Panasonic WM 61A electret microphone capsule
1	C1	220 uF 16V
2	C2, C3	1 uF, see text
1	D1	5.6 V
2	Q1, Q2	BC BD 860 C and 560 C, see text
2	R1, R2	2k2
2	R3, R6	10k
2	R4, R5	56k
1	R7	560R

Table 2.3.1: Bill of

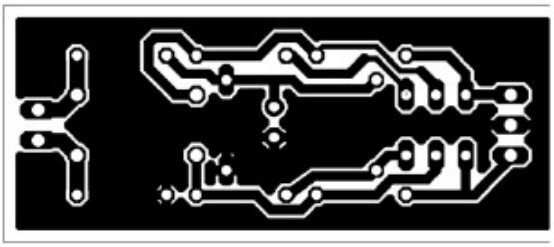
The placement plan, the layout and exposure drafts are shown in Figure 2.3.3. It layouts were developed for two variants for the experienced solderers an SMD component (here not shown) and a conventional light to-handle Description (Http://www.m1n1.de/html/hifi.html).



Top Parts



Layout



Exposure Draft

Image 2.3.3: Component scheme, layout, exposure drafts

The optimal place for the amplifier circuit is close to the microphone in the shielded Housing. Build the conventional version please make sure that on the Top of the board, the two collectors of the transistors are connected with a wire bridge need. Unlike the layout was not feasible. In the layout in Figure 2.3.3 is the red line shown.

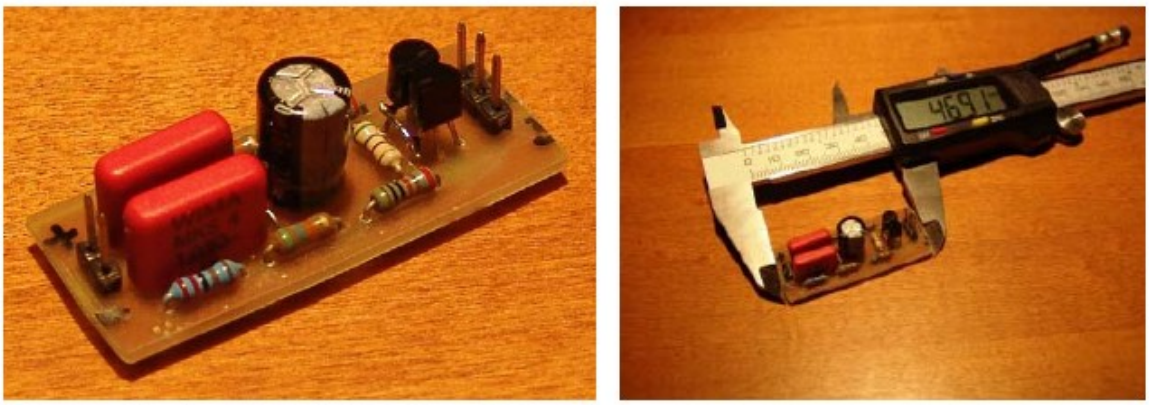


Image 2.3.4: Structure of the conventional variant

A housing which is suitable for both versions is shown in Figure 2.3.5. It consists of a Aluminum tube with 20 mm outer diameter and 2 mm wall thickness. In the remaining 16 mm inner diameter fits exactly the Pinträger the XLR connector. Becomes its mounting A hole approximately 2 mm in diameter drilled in the pipe. The exact position and Hole diameter shall be accepted on the component.

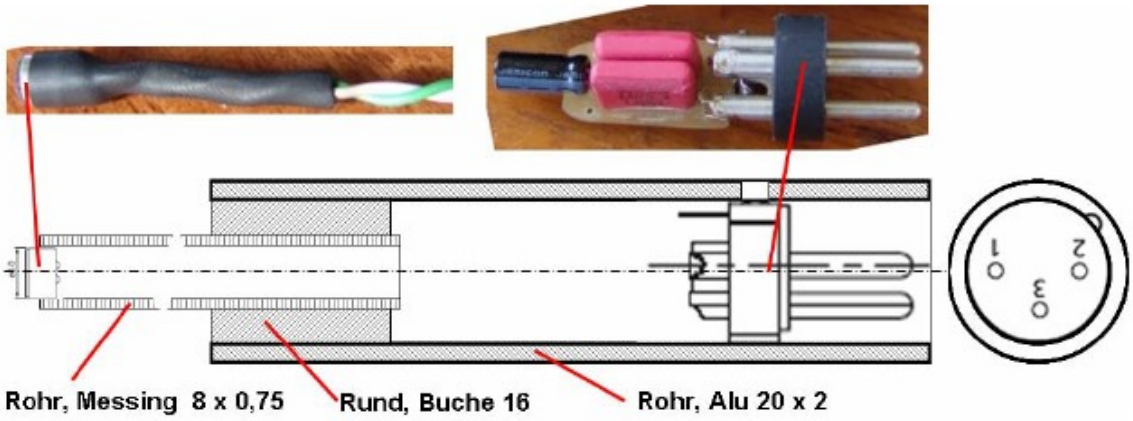


Image 2.3.5: Construction of housing

For mounting the microphone capsule is a 200 mm long brass or aluminum tube 8 mm in outer diameter used as the plug side in a piece of round wood of beech is pressed. The microphone capsule is shown after soldering the cable as shown in Figure 2.3.6 with Shrink tube insulated. When using the brass tube, the cap fits with Shrink tubing exactly to the pipe, the aluminum tube must first be approximately 10 mm deep to 6.5-7.0 mm Inside diameter to be drilled.

Picture 2.3.6: Installation of the capsule

It is important to ensure that the microphone capsule closes as exactly as possible to the tube. Already Under low or supernatants lead to changes in the frequency response [3].

Finally, the laboratory model shown here was with a professional measurement microphone MK Compared 221 Microtech Gefell [5]. The procedure is in the ARTA Application Note No. 5 [2] and described in ARTA Compendium [1].

Picture 2.3.7 shows the deviations of the laboratory sample from the frequency response of the MK 221 and are
Information about the harmonic distortion at 300 Hz at a level of 113 dB is approximately 1% THD measuring the 2% limit is reached at about 120 dB.

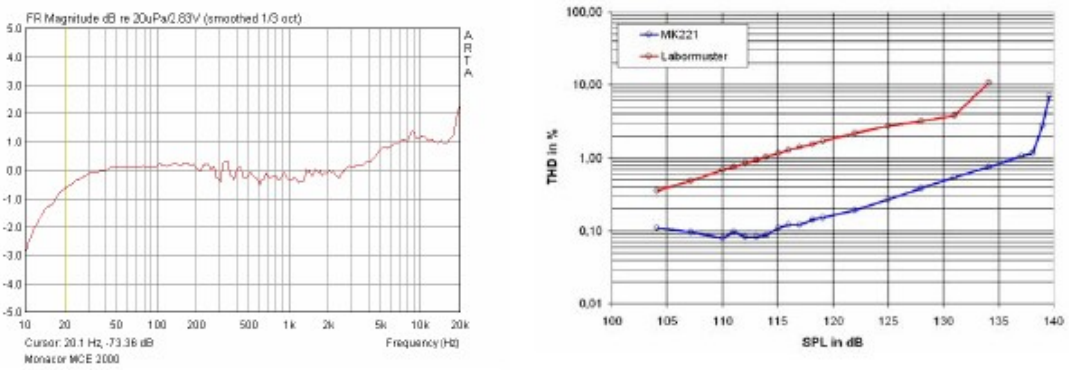


Image 2.3.7: Calibration curve of the laboratory sample and THD @ 300 Hz

2.3.7 based image becomes clear why professional measurement microphones are so expensive. The Distortions are an order of magnitude lower than in the laboratory pattern shown here. Also
The second important characteristic of a measurement microphone, the SPL is the MK 221 approx 25-30 dB higher and significantly more so in near-field distortion-free reserves.
Taking into account the resources used, the measured values are still considerable and are easily comparable with microphones of the same type.

Table 2.3.2 shows the measured values for the one shown in Figure 2.3.1 Laboratory sample from Split. The values

Sensitivity	12mV/Pa
Noise level	31dBA
THD (at 1kHz and 94dB SPL)	0.25%
THD (at 1 kHz and 114 dB SPL)	2.09%

Table 2.3.2: Technical data of the laboratory sample

calibrators were calibrated at 1 kHz and 94 dB SPL and 114 dB SPL with ARTA and a professional sound card detected.

2.4 Accelerometers

2.4.1 ACH-01

The ACH-01 is an economical, general purpose accelerometer measurement Specialties with useful features (see specifications). By using piezoelectric polymer film in ACH-01 remains the transducer affordable and also the Weight keeps up with 8 grams - including cables and connectors - within reasonable limits.

Figure 2.4.1: Accelerometer ACH01

Performance (T=25°C)	Symbol	Min	Typ	Max	Units
Sensitivity	M_o	7	9	11	mV/g
Lower Frequency Limit (1)	f_l	--	2	5	Hz
Upper Frequency Limit (1)	f_u	10	20	--	kHz
Equivalent Noise Floor 10Hz 100Hz 1kHz		 -- -- --	 130 20 6	 -- -- --	$\mu g/\sqrt{Hz}$
Dynamic Range	--	±150	--	--	g
Linearity	--	--	0.1	1.0	%
Transverse Sensitivity	M_t	--	2.0	5	%
Resonant Frequency	f_o	--	35	--	kHz
Phase Deviation (±5° Limit) (6)	θ	10	--	10,000	Hz
Supply Voltage	V+	3	--	40	Volts

Image 2.4.2: Extract from the specification of the ACH01

However, the sensor has a small problem, he is very sensitive to disturbances. One effective remedy is the shield with very thin copper foil, but at the expense increased mass and modified data (Figure 2.4.3).

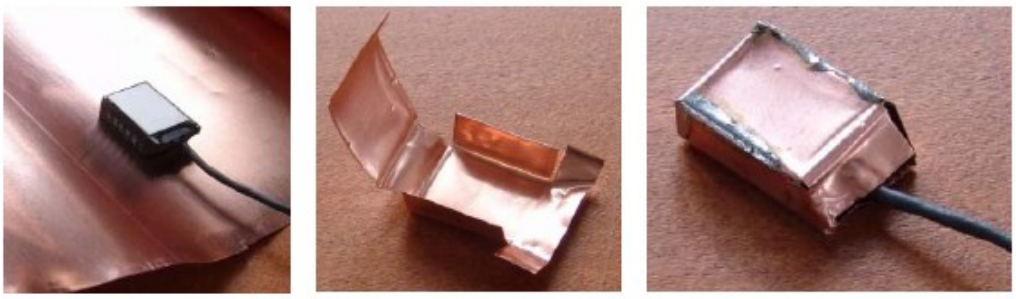


Image 2.4.3: Screening of ACH01 with copper foil

2.4.2 Amp for the accelerometer 01 ACH

Without the preamp ACH01 is not to be used. There is a Amplifier Box (IB-ACH-01) Measurement Specialties, which is specially designed for the ACH01, but also in the DIY Area you will find. Bill Waslo's homepage (http://www.libinst.com/accel.htm) is the following Refer circuit.

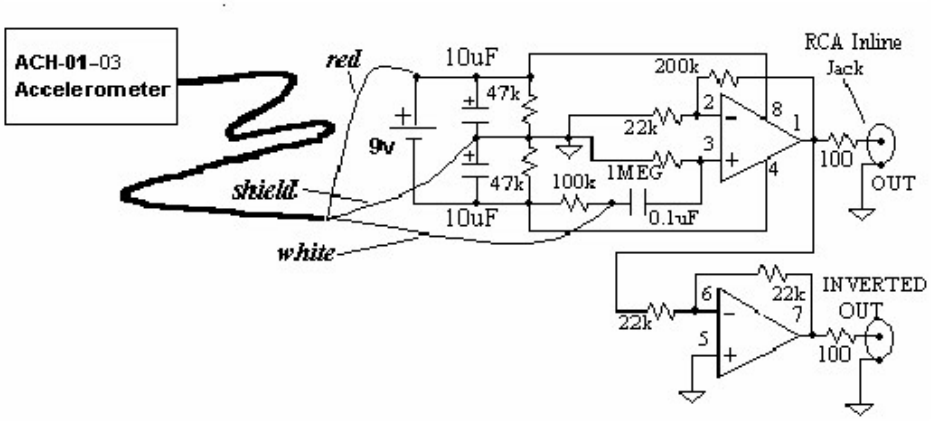


Image 2.4.4: amp for the ACH01

As an op-amp (CMOS) are TLC2272, TLC272, LMC662 LMC6482 or suitable. For Power supply reaches a 9V battery. The wiring of the sensor is as follows: Ground / screen = black, white = signal, supply 9V + = red.

Image 2.4.5: amp for the ACH01, type "crumbs"

3 Mic

3.1 Introduction

The sensitivity available on the market electret microphone capsules is between 4mV/Pa @ 1kHz and 15 mV / Pa @ 1 kHz. Picture 3.1.1 shows the output voltage of a common Microphone capsule in dependence on the level.

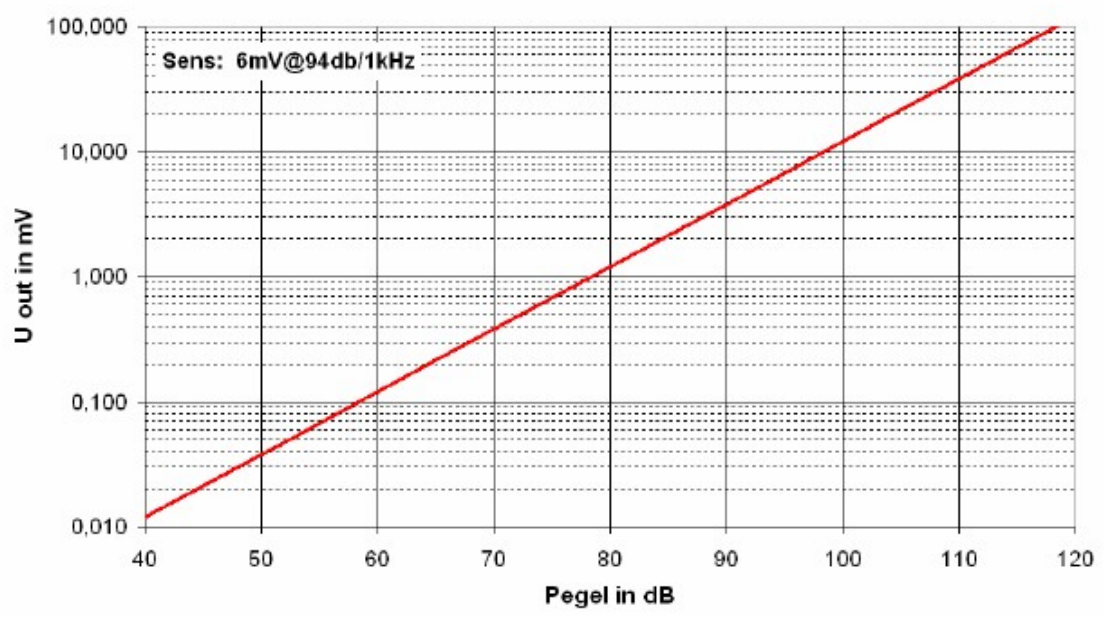


Image 3.1.1: Level-dependent power output of a standard microphone capsule

In a near-field measurement at 120 dB so we can with an output voltage of about 100 expect mV level in the range of usual free-field measurements from 80 dB to 90 dB, there are only 1 mV - 3 mV. Both levels are not sufficient for the modulation of a sound card in approximately Is the range of 1V RMS. It must therefore produces a preamplifier, the output voltage Microphone capsule lifts to an appropriate level for the sound card. Is for free-field measurements an approximate gain of 45 to 55 dB (a factor 178-562) required for near field should comply with a gain of 20 dB (a factor 10). The exact values depend of course the microphone used and the input sensitivity from the sound card.

3.2 High quality & low cost microphone

Ralf Grafe

After some experimentation (http://www.m1n1.de/html/hifi.html) with circuits for Mic, it finally came to the microphone as illustrated below, the certainly needs to fear no microphone.

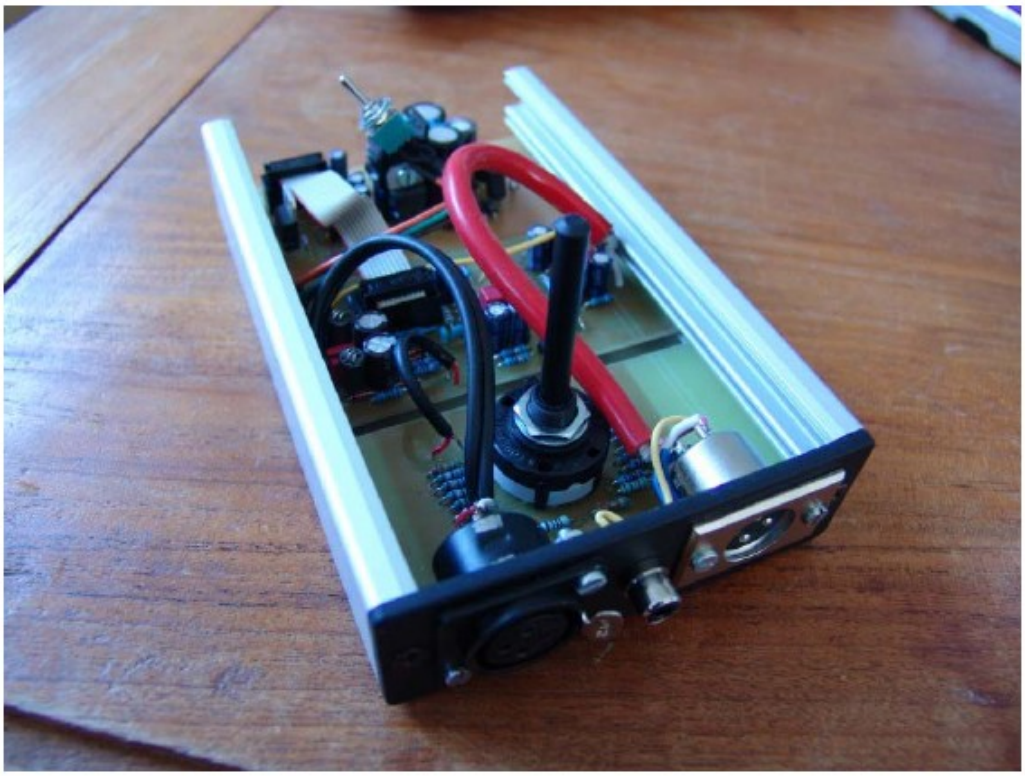


Figure 3.2.1: Rane Plus

As a basis INA163 Instrumentation Amplifier from Burr Brown is used. Concerning Noise, distortion and DC offset of the block behaves in an exemplary manner. The used SMD version is available for 5 euros from Reichelt. The data sheet can there also be obtained.

The minimum requirement for the development was an adjustable gain range of 20dB up to 65dB in 5dB steps and a phantom power. Were realized beyond another simple overload indicator, and a few little things that are explained below.

In Figure 3.2.1 and 3.3.2 image we already see all three components in one housing. These are the power supply board (left), the actual
Amplifier board (center) and the step switch board (right). That an overall gain must be paid a maximum of 65dB at a good shielding against hum, explains itself why the amplifier board sits in the middle of the aluminum case.

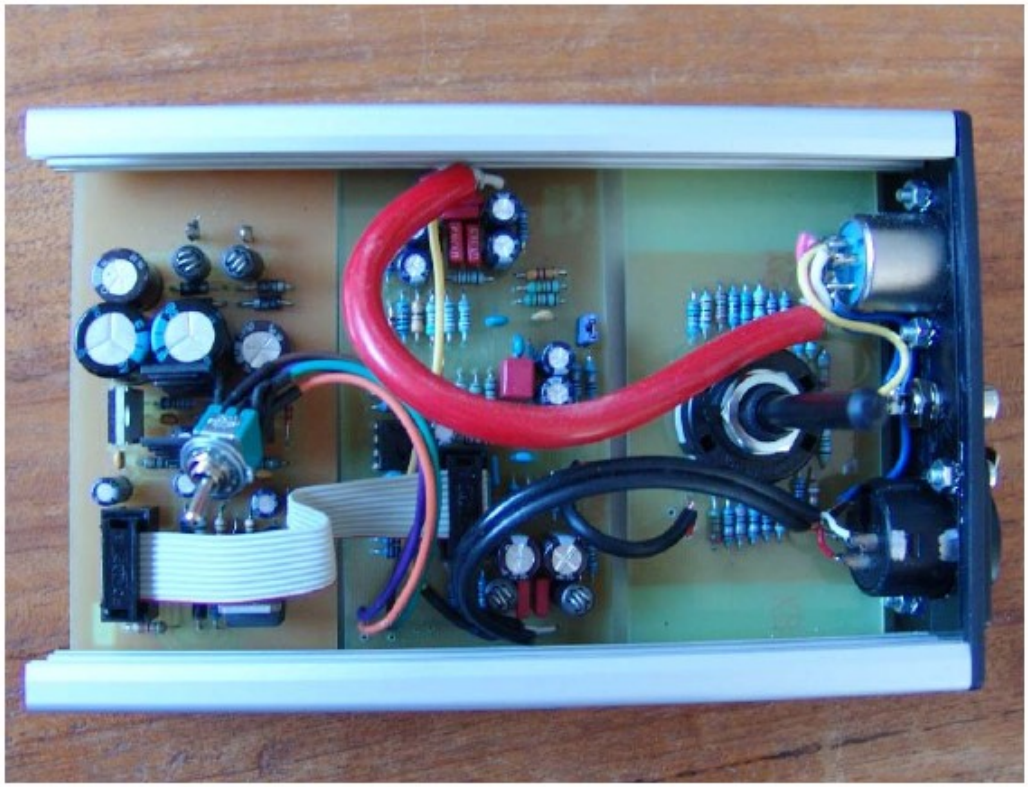


Image 3.3.2: Structure Rane Plus

The visible image in 3.3.2 toggle switch turns the phantom power on and off. There is a
A yellow LED indicator in the housing cover. Another toggle switch allows the
Switching off of the DC-Protection, if accurate measurements in the frequency range below 10Hz
should be necessary.

In Figure 3.3.3, the circuit diagram is presented. Immediately after the input filter, the RF interference
filters out and prevents the inputs of INA163, followed by the first amplifier stage. The
Gain adjustment is performed with the tap, between pins 3 and 12 of the INA
is connected. The output of the INA to find the capacitor network from C9, C10 and
C14. While C10 and C14 act as a bipolar electrolytic capacitor, C9, like their
from unwanted inductance at higher frequencies. The task of the capacitors in itself is the
Extraction of a possible DC offset of the INA so that it does not follow from the
Level is increased. As mentioned above, the DC offset is so small that, for measurements of
Frequencies this capacitor network can be bypassed under 20Hz. The
Default setting is, however, not bridged with active network.

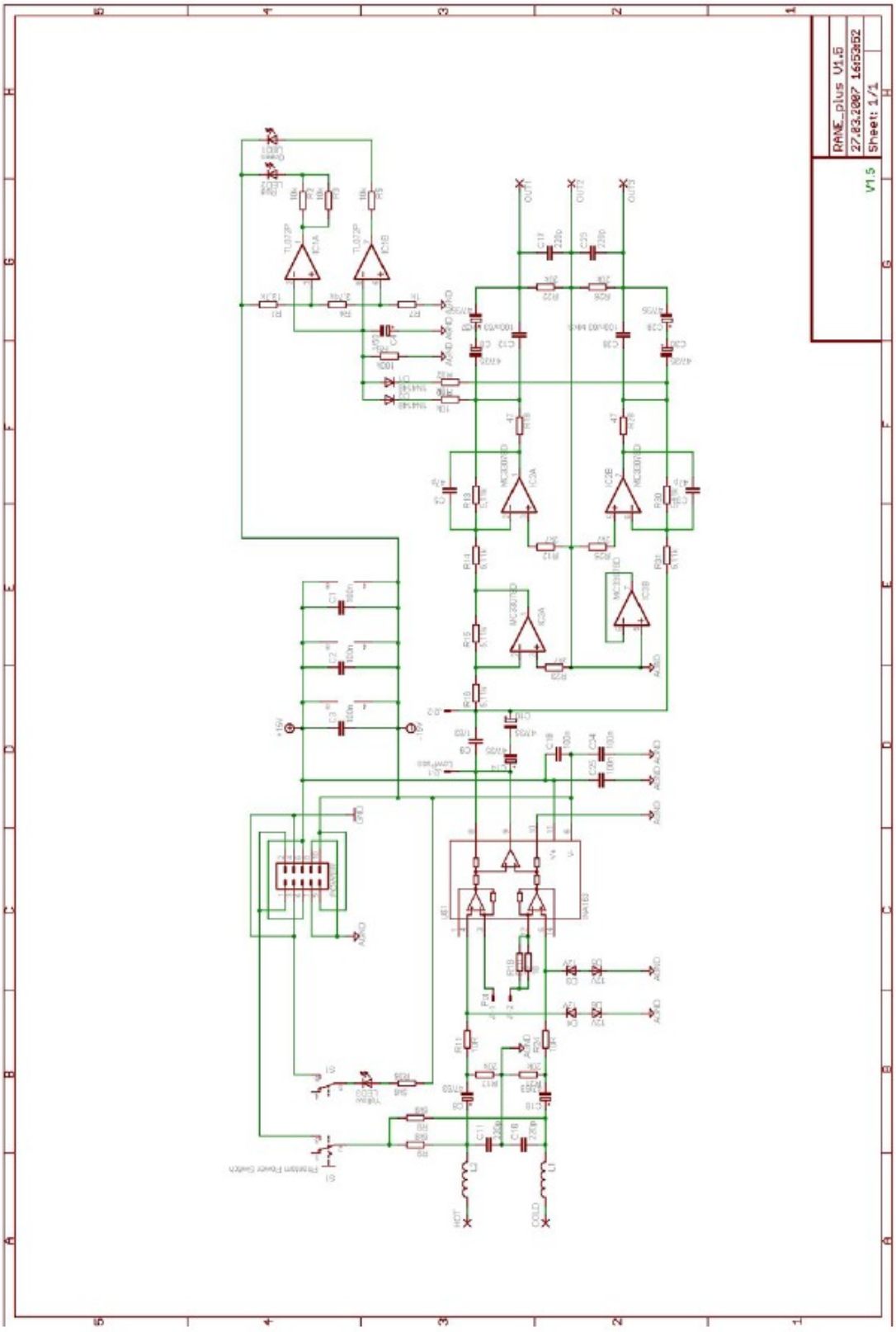


Image 3.3.3: Schematic

Below is the second stage with a fixed gain of 6dB consisting of
low-noise OP type MC33078.

The circuit diagram of the tap changer and the necessary resistance values are derived from image 3.3.1.
The rotary switch is used must be limited by means of the adjustment to 10 positions.
In the selection of the resistance values was applied to parallel connections from standard values resorted to in order to obtain more accurate values.

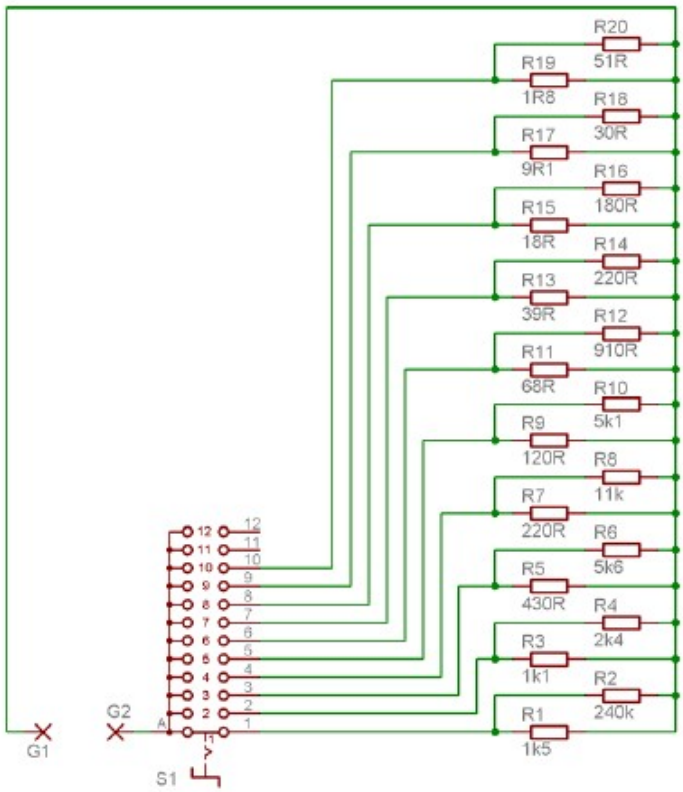


Image 3.3.1: step switch

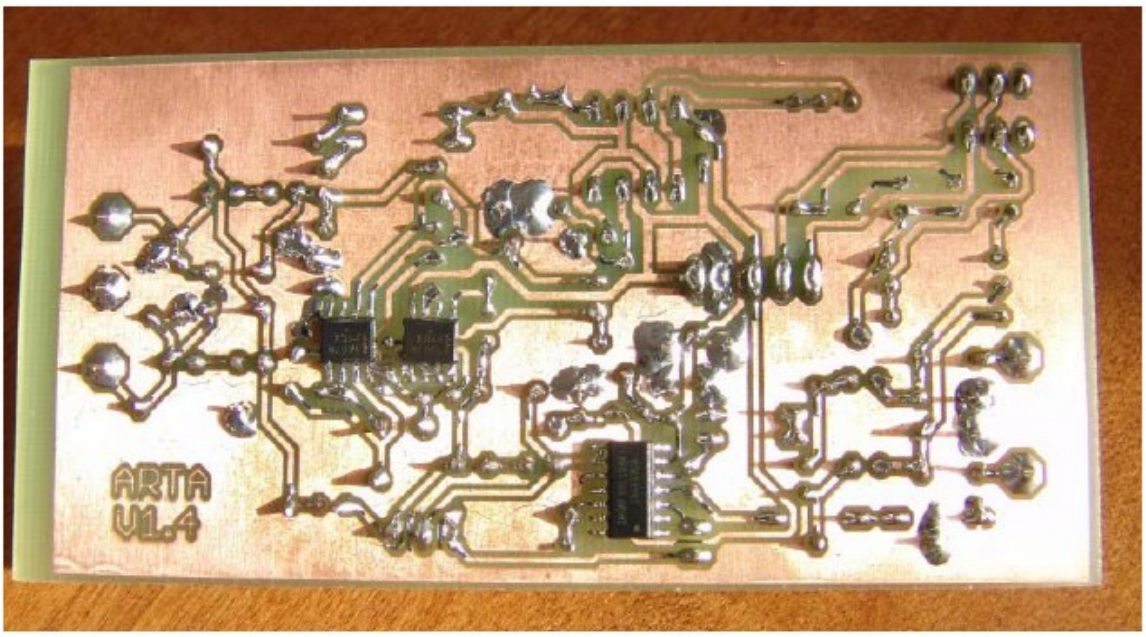


Image 3.3.2: Board Rane Plus, solder side

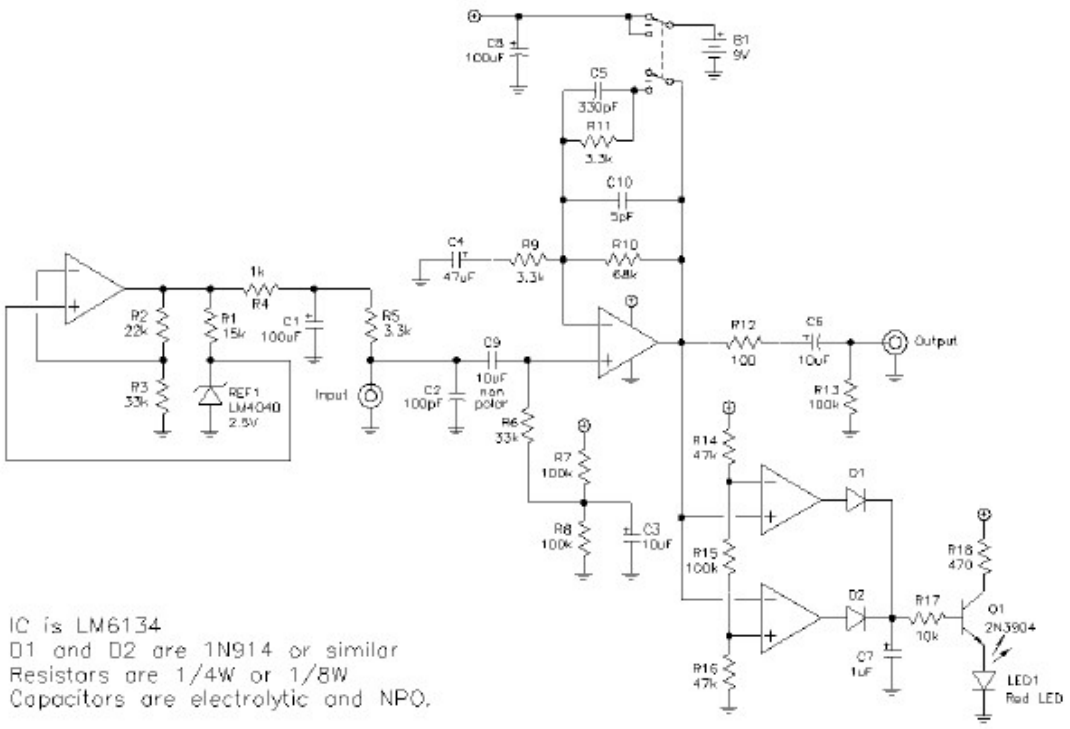
Picture 3.3.2 shows the solder side of the finished assembled board (in the older version 1.4). Good to recognize the INA163 (center) and the two MC33078 (left). All tracks have been selected wide as possible in order to ensure a relatively good reproducibility. It is important in any case, the use of so much ground plane as possible.

3.3 The Wallin mic

Heinrich Weber

In the Internet there are countless offers to mic preamps. A classic is the Preamplifier of Wallin, who now also offered by "Mad about sound" as a kit is (www.madaboutsound.com).

It is a simple op-amp circuit (see Figure 3.3.1), the normal to the Measurement operation is optimized with electret condenser microphones. Both the gain of the Near field with 6 dB and the gain for the far-field measurement with 26 dB are Designed combination with the included microphone (WM61a) practical.



Picture 3.3.1 Wallin-mic

The kit of Mad About Sound is very complete, it contains all the components as well as a matching Housing, only the microphone (WM 61A) must be ordered separately. The instructions in English is well presented and receives all required details, down to the diagram had be concerned from the Internet. The replica of the Kit should be feasible for Gelegenheitslöter. Picture 3.3.3 shows the completely assembled kit.

Contrary to the construction plan, the RCA jacks were housed within the front, the space for it is just available (See Figure 3.3.2).

Image 3.3.2: Wallin MVV

.

Image 3.3.3: Completely assembled kit (left), modified artwork (right)

Picture 3.3.4 shows the measured frequency response of the microphone preamplifier Wallin. There is a slight dependence of the bandwidth of the gain of for most measuring tasks
Speaker manufacturer but is expected to be insignificant.

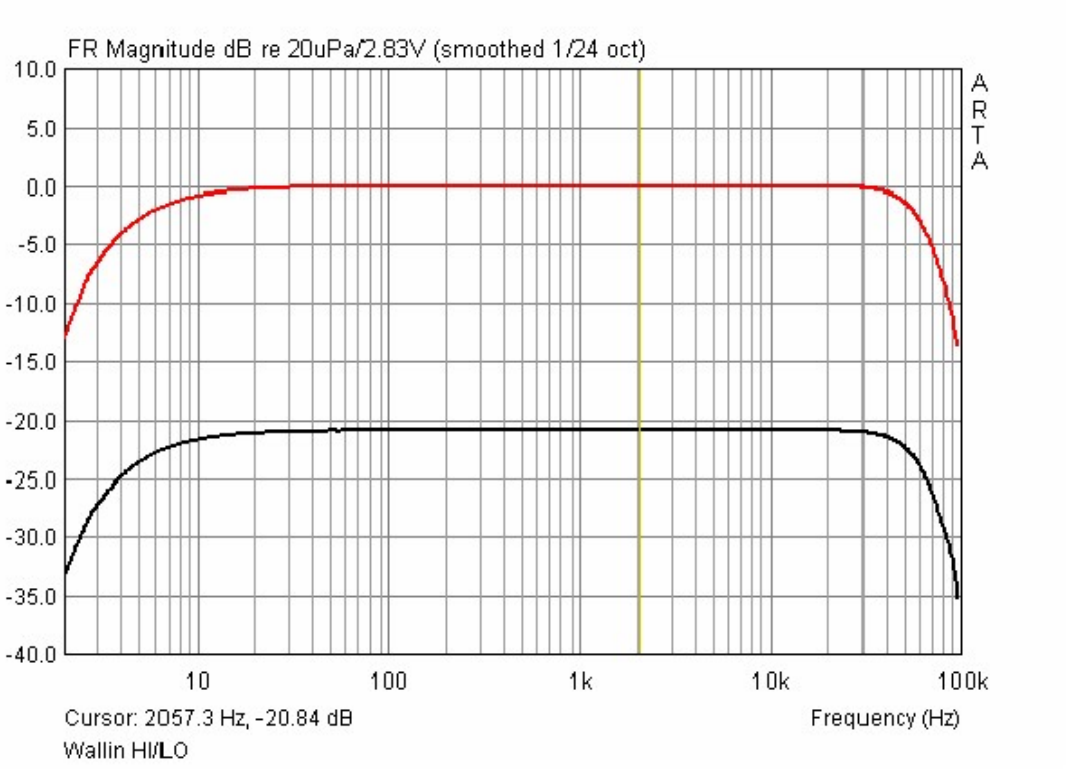


Image 3.3.4: Wallin microphone, frequency response

4 Power amplifier

4.1 High Quality Amplifier with TDA 7294

Ralf Grafe

Kits for amplifiers or power amplifiers are a dime a dozen. Most projects are
but little extreme in terms of the stated goal. This proposal is compared to super
boring, no special parts, not very big and very scalable, the desired
Terms of performance. Without transformer and heat sink without the structure shown in Figure 4.1.1
costs about 10
Euro and requires only that you can etch the PCB from itself.

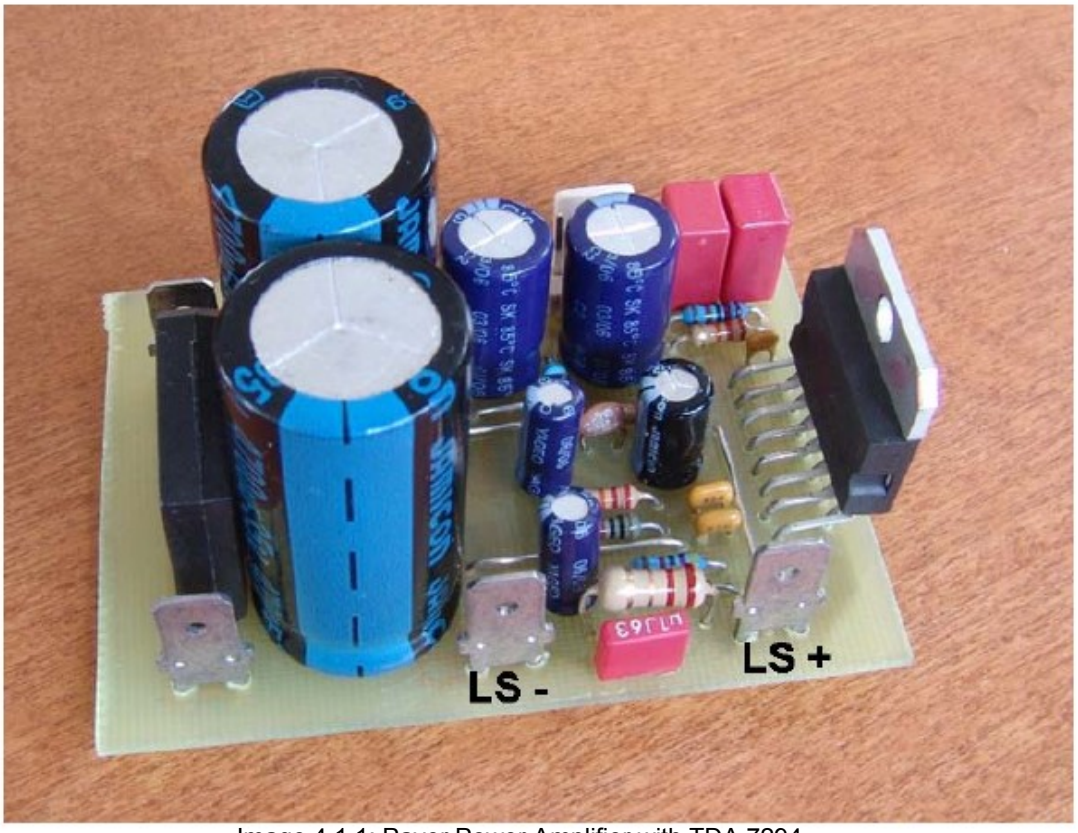


Image 4.1.1: Paver Power Amplifier with TDA 7294

The basis is the TDA7294 from SGS Thomson, a full stage, the only
few external components are required. Depending on the transformer and heatsink used
Output power up to 100W into 4 ohms possible. For details, can be found in the datasheet
Manufacturer [08}.

The IC was chosen because it has a DMOS output driver stage and otherwise by very
very low distortion and low noise shines. Many older power amp would be happy if
they would deliver as good values. But the whole also has a downside, whenever one small
Would amplify signals is to make sure that even the smallest disturbances at the entrance to
significant interference at the output lead. An unfortunate result of this IC PCB layout
inevitably to vibrate, hum, or both. To get a handle on this,
the board has a star-shaped grounding as well as various measures to
To suppress spurious oscillation. Figure 4.1.2 shows the schematic and the parts list.

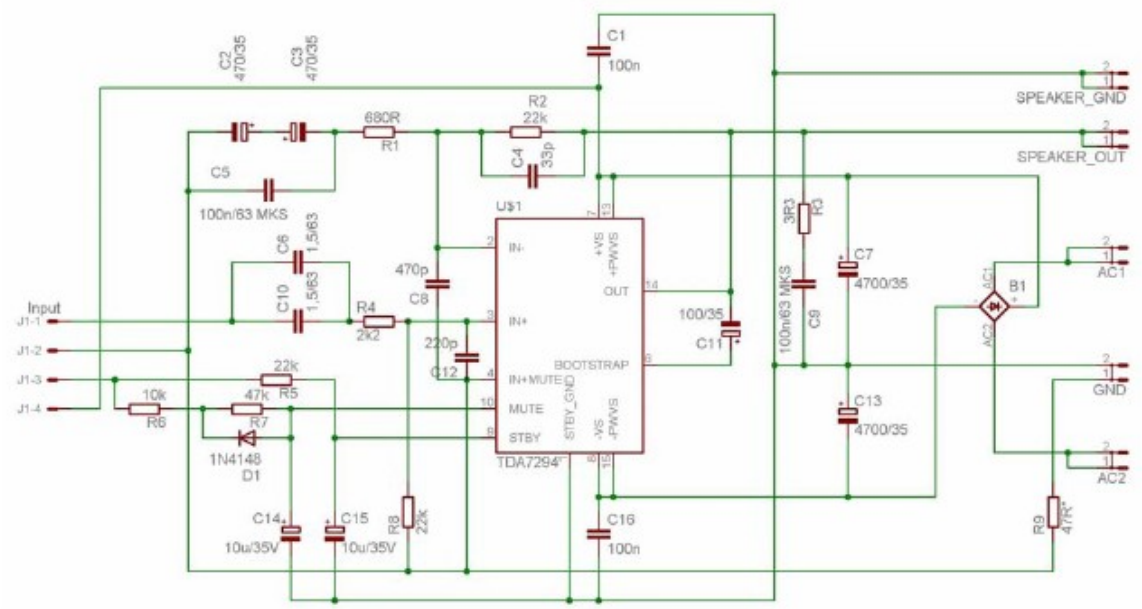


Figure 4.1.2: Schematic

As you can see in the schematic and on the board (Figure 4.1.3), there are some connectors in the middle of the board. Between the two filter capacitors of the mass point (GND) to to the center tap of the transformer is connected. The other two ac- connector located on the right and left of the rectifier called AC1 and AC2. Since- Lich are the plugs for the speaker connection. The positive terminal is adjacent to the IC, the Speaker ground terminal on the side of the board.

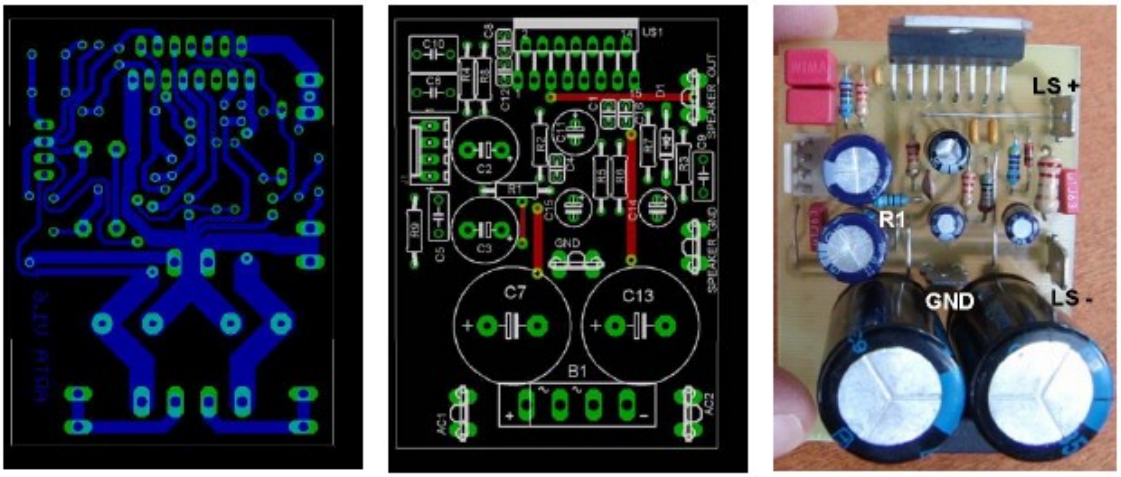
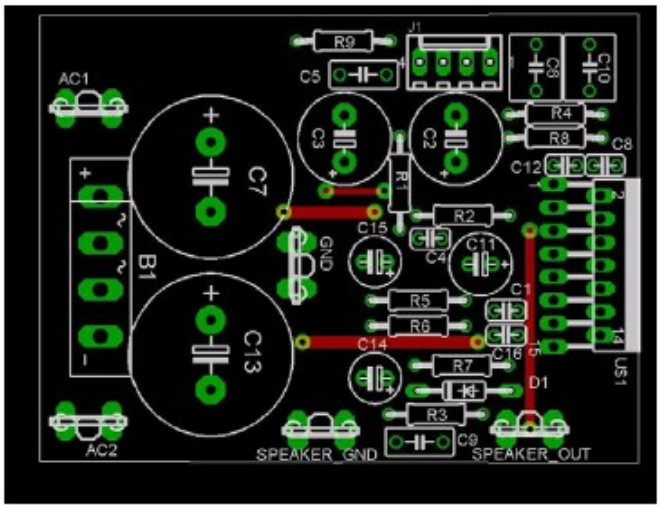


Image 4.1.3: Layout, layout plan and finished board

On the other hand, a 4 pin Molex connector is located. The order of Contacts from the top down is audio input, mass, Standby / Mute and + Ub. If you switch on the standby / mute line + Ub, you can switch on the amplifier sets to standby / mute on Mass, it turns it off. The plug is shown that all necessary signals there are available. In the assembly diagram (Fig. 4.1.3, middle) you can see the position of the components well detect. The red lines represent the jumpers

The dimensioning of components in the present case to a maximum of + / - 30V operating voltage designed. When using a transformer with 2 x 18V AC result + / - 25V
Operating voltage, resulting in a maximum output of 36W into 8 ohms or 72W into 4 ohms permits.

Assuming that the sound card is used, an output voltage of 1 volt RMS
provides a gain of G = 17 is required for full scale. This would require R1 = 22000 / (G-1) = 1375 ohms are. Nächtsliegende the resistance value of the E96 series is 1370 Ohms.



Part	Value	Package
B1	Bridge Rectifier 8A KBU8M	KBU
D1	1N4148	DO35-10
~~IC1~~	~~TDA7294~~	~~MULTIWATT 15~~
~~J1~~	~~Molex 4 Pin Connec.~~	~~6410-04~~
C1, C16	100n	C025-024X044
C2, C3	470/35V	E5-10, 5
C4	33p	C025-024X044
C5, C9	100n/63V FMD	C050-030X075
C6, C10	1.5 / 63V	C050-055X075
~~C7, C13~~	~~4700/35V~~	~~E7 0.5 to 18~~
~~C8~~	~~470P~~	~~C025-024X044~~
C11	100/35V	E2 ,5-7
C12	220p	C025-024X044
C14, C15	10u/35V	E2 ,5-6
R1	680R / G = 33 or 1K33 / G = 24.88	0207/10
R2, R5, R8	22k	0207/10
~~R3~~	~~3R3~~	~~0207/10~~
~~R4~~	~~2k2~~	~~0207/10~~
R6	10k	0207/10
R7	47k	0207/10
R9	47R (see text)	0207/10

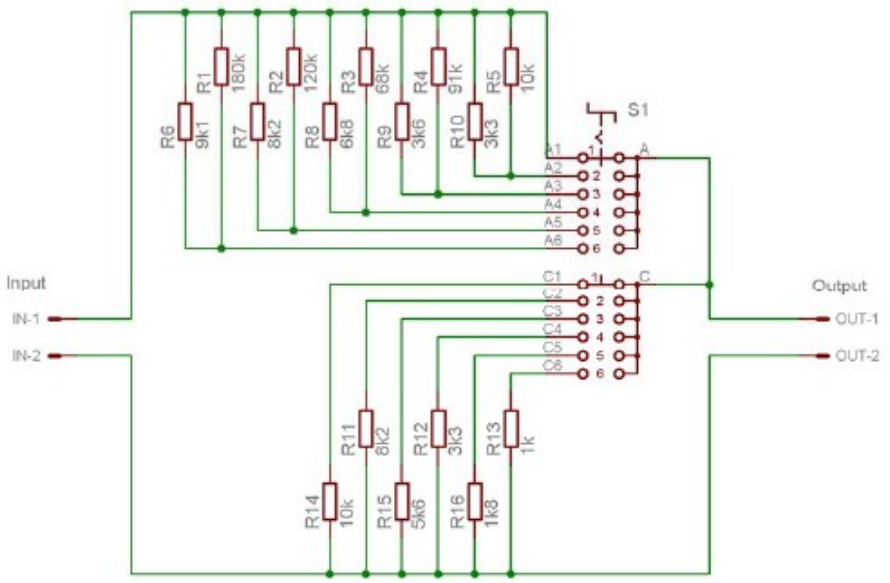
Image 4.1.4: Layout diagram and parts list

Erratum 06/2010: Attention: please capacitor C4, 33pF NOT FITTING. This is actually counteract a high-frequency oscillation tendency, but exactly the opposite is the Case. C4 leads to swings in the MHz range, because at high frequencies without proper phase More negative feedback is given.

Note 1: The resistor R9 / 47R is for a special case when it comes to
to separate the input signal ground from the amplifier ground (hum). Notwithstanding the
Schematic R9 is simply replaced here by a jumper!

Note 2: To maximize output power of the TDA 7294 is a transformer with
2 x 28V needed. Would be the withstand voltage of the filter capacitors and other capacitors
then accordingly be increased to 63V. Please check whether this is enough space on the board.

In line amplifiers, the volume is controlled by a potentiometer. It is for this
Usage also sufficient for use as a sense amplifier, however, not optimal, as
the output voltage is adjusted only by means of a reproducible tension meter.
Especially for single-channel measurements, it is important to know the respective gain or exactly
To adjust reproducible.



Phase	R Series					R parallel			G [abs]	G [dB]
1						R14	10000 22000	6875	1.00	0.00
2	R5	10000	R10	3300	2481	R11	8200 22000	5974	0.71	-3.02
3	R4	91000	R9	3600	3463	R15	5600 22000	4464	0.56	-4.99
4	R3	68000	R8	6800	6182	R12	3300 22000	2870	0.32	-9.98
5	R2	120000	R7	8200	7676	R16	1800 22000	1664	0.18	-14.98
6	R1	180000	R6	9100	8662	R13	1000 22000	957	0.10	-20.05

Image 4.1.5: Attenuator

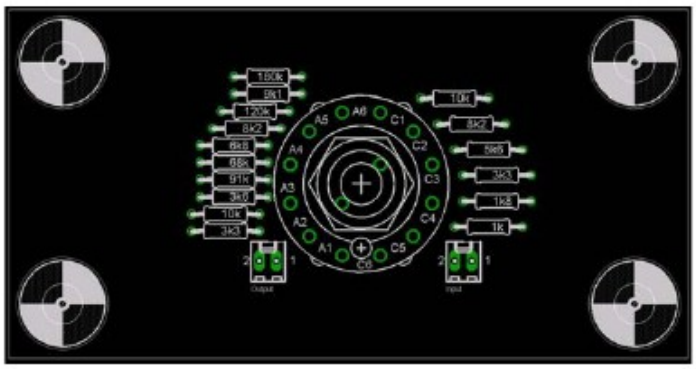


Image 4.1.6: attenuator assembly diagram

For this reason, the power amplifier to a stepped attenuator was supplemented. The resistance values for the assembly and the respective attenuation is image 4.1.5 and 4.1.7 refer to.

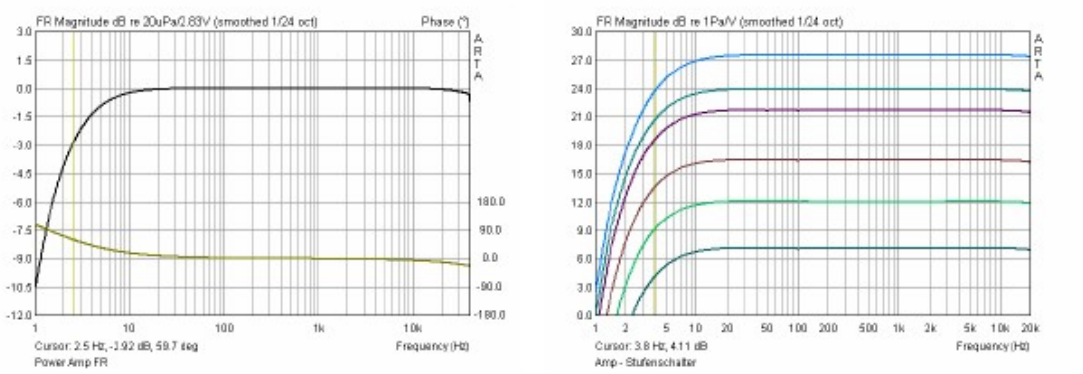


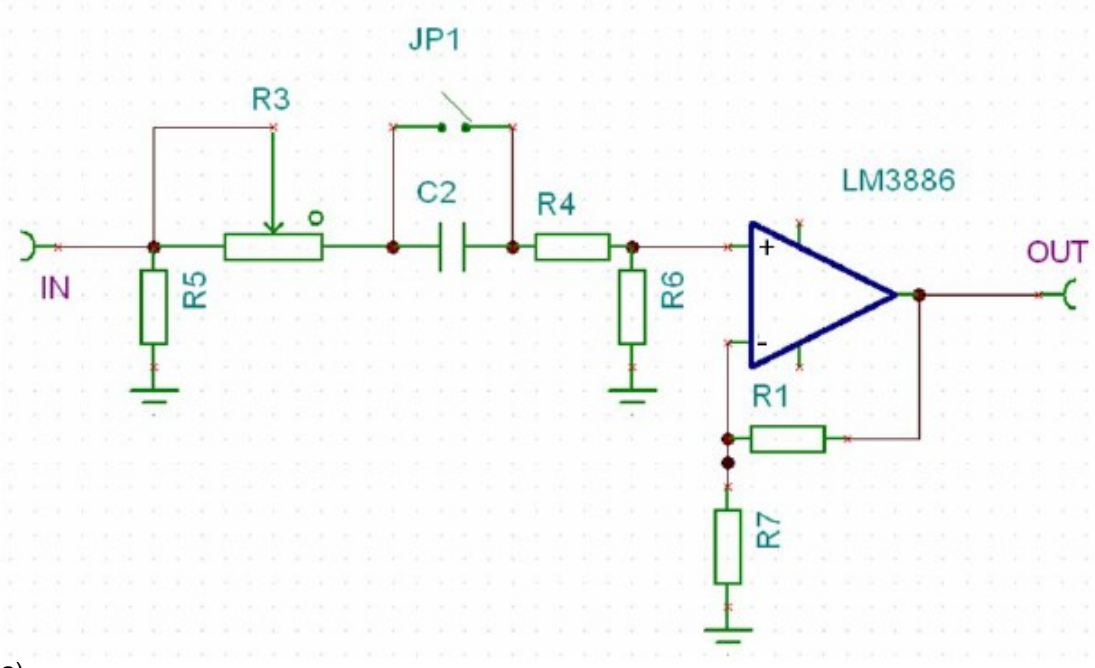
Image 4.1.7: Frequency response of the power amplifier and effect of the input attenuator

Output	> 36 W RMS, 4-8 Ω
	~ 72 W into 4 Ω max.
	~ 36 W into 8 Ω max.
	17 or 24.6 dB (R1 = 1K33)Amplification
Input Sensitivity	1.0 V RMS for 36 W into 8 Ω
	22KInput impedance
Signal-to-noise ratio	
	~ 3 Hz - 200 kHz, -3 dBFrequency response
	<0.02% reading 1W - 30W, 1kHzTHD
	<0.02% reading 1wIMD

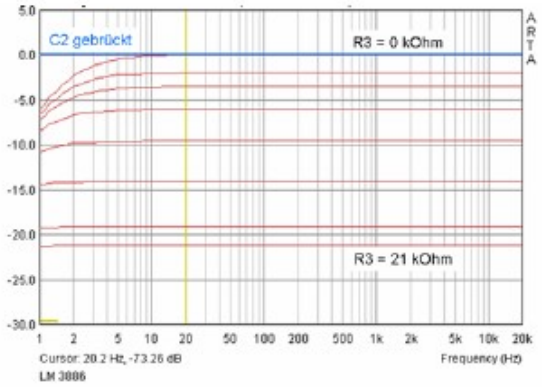
Image 4.1.8: Specification (± 25V D.C.)

4.2 High Quality Amplifier with LM 3886

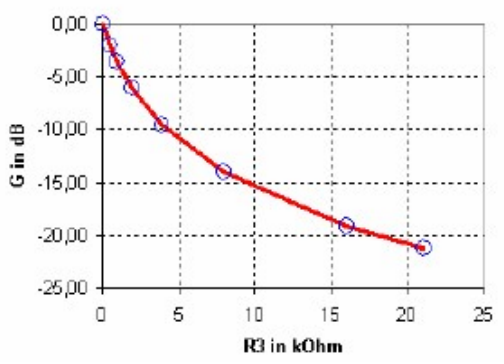
In addition to the amplifier module TDA 7294 from ST Microelectronics described in Section 4.1 enjoys the so-called National Semiconductor Overture series of great popularity.
In particular, the LM3886 (http://www.national.com/ds/LM/LM3886.pdf) is widespread and shines with excellent data. For this reason, here, a second - especially to Measurement tasks coordinated - Construction plan presented.



a)



b)



c)

4.2.1 image: a) base circuit LM3886, b) FR as f (G), c) effect of potentiometer

Since the line input of the sound card already contains most of a capacitor, C2 can bridged be (please check beforehand). The negative feedback loop does not include a capacitor as described in National's standard application of vergesehen. Both inputs see the same impedance as (R6 = R7 = 1k), which guarantee a good DC stability and a good RF frequency response. The Gain is variable between 1 and about 12th

Picture 4.2.2 shows the complete circuit diagram of the Bauvorschlages including the supply. It still lacks only a toroidal transformer with 2x18V and approx 120VA power.

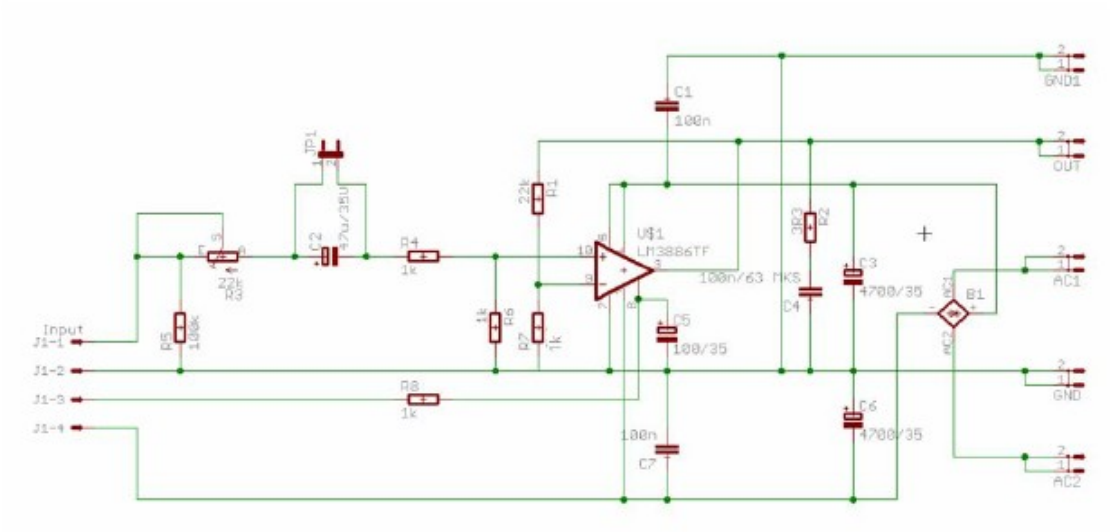


Image 4.2.2: Schematic

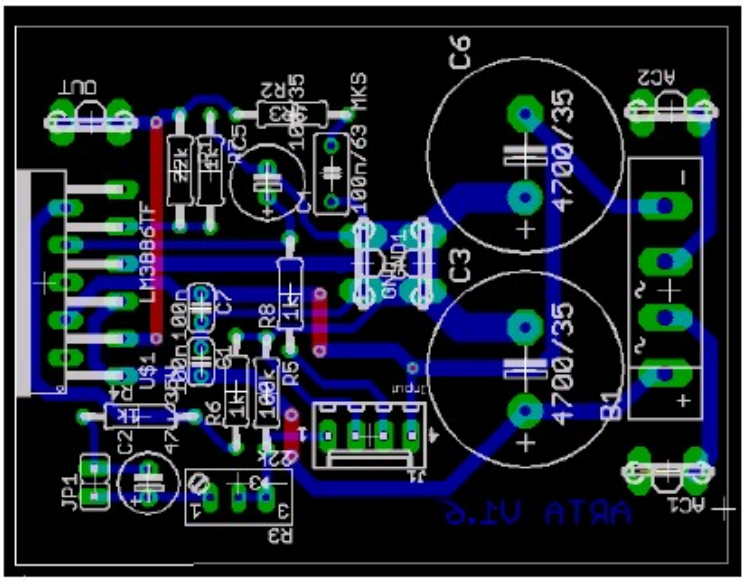


Image 4.2.3: PCB, component side

For sufficiently large boards may need to be obtained at the following address
http://www.m1n1.de/html/hifi.html.

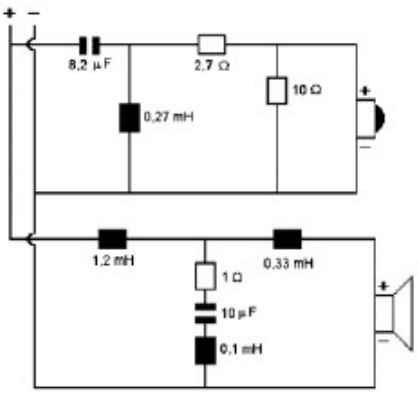
5 Tool for developing crossovers

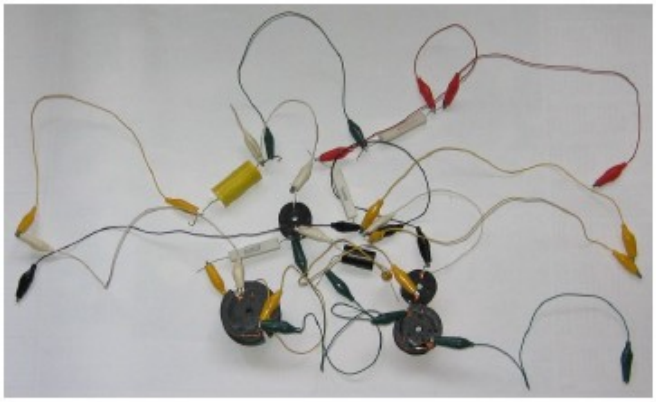
The development and metrological verification of crossovers despite effective-
full simulation and measurement programs is still a time-consuming affair. Little one
Helpers, an easier life, there are of course always welcome. Such
Techniques are presented in the following.

5.1 Development board for crossovers

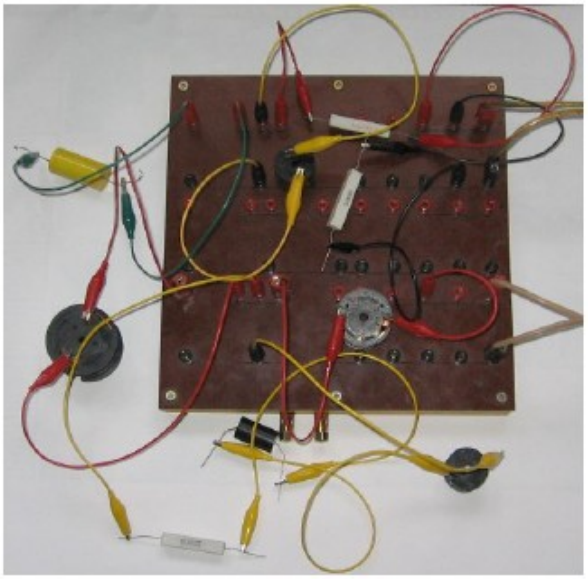
Michael Uibel

The construction of test points is usually by means of alligator clips connecting conductors.
This is very good and fast. The following could switch the alligator clip version
e.g. look like this:





The switch works, but during development it is inevitable that one is constantly
Need to replace components and possibly change the topology. With the overview it is then
quickly. You build it all apart and start from scratch.

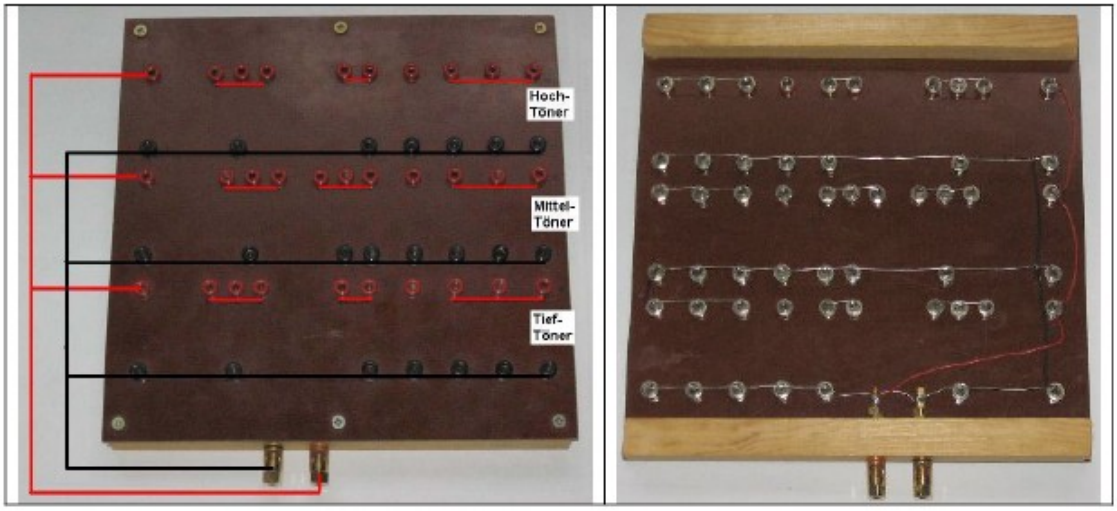


If you build the circuit on a
Crossovers development board (FWEB)
on, it looks at first glance as
chaotic. One sees this way, then
it can be seen that only the cables
must pursue and thus the position
of each component in the
Circuit can easily locate.
Changes, even changes the
Topology go quickly out of hand,
rebuild the whole crossover without in each case to
need.

Let us look for FWEB
Three-way switches at closer. It consists of
a Pertinax or epoxy plate, two
Strips of wood, some 4 mm Sockets
and a little jumper wire.

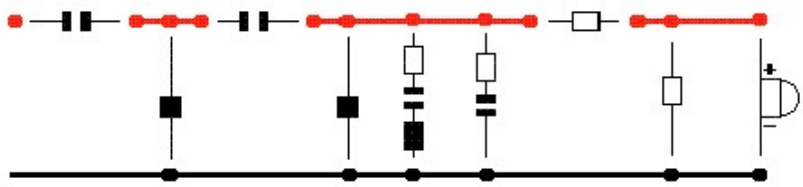
Below we can see the amp connection. Mass is applied to all black jacks. The
Positive input located on each of the first red jacks on the left. The outputs of the individual

Drivers can be found on the far right FWEB. The FWEB shown is 27 times 27 centimeters large. The rear view shows the fixed wiring.

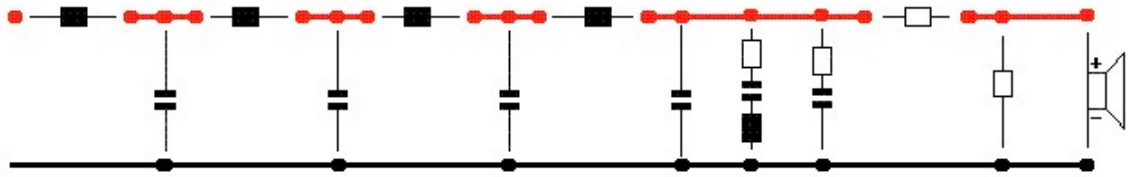


The number of required 4 mm sockets is the desired maximum configuration of the circuit dependent. A covering almost all configuration is shown below.

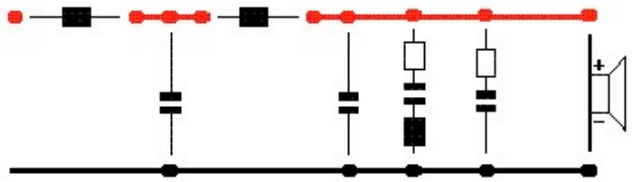
The high frequency
12 * 6 * red + black



Mid-range section
18 * 8 * red + black



LF drivers
9 * 5 * red + black



If you have several devices in series (eg LCR elements), then only the first and last device connected to the FWEB. The intermediate component is wired with alligator clip leads.

The connection stripping it establishes itself. These cuts are the alligator clip cable in half and attached to
Now the open ends a banana plug. The
You should resolder alligator clips because the crimp often provides only moderate contact.

Parts and sources in Germany

Description	Source	Order #	Price €
6 wood screws	DIY		
Wood strip	DIY		
Wire (for example NYM concealed cable)	DIY		
Pertinax 3 mm (1/3 plate, about 0.3 m2)	http://www.rediboom.de/		12.00
4mm banana socket, fully insulated, red	http://www.reichelt.de/	BB 4 RT	0.26
4mm banana socket, fully insulated, black	http://www.reichelt.de/	BB 4 SW	0.33
4mm banana plugs, screw type, cross-hole, red	http://www.reichelt.de/	BS 40SA RT	0.43
4mm banana plugs, screw type, cross-hole, black	http://www.reichelt.de/	BS 40SA SW	0.43
Connection leads with alligator clips both sides - 10 pieces	http://www.reichelt.de/	MK 612S	1.05

5.2 Course development board modifications

Heinrich Weber

In addition to the variant shown in Section 5.1, there are several other possible solutions. The The following solution is based on an idea / Published in the Klang & Ton (Http://www.klangundton.de).

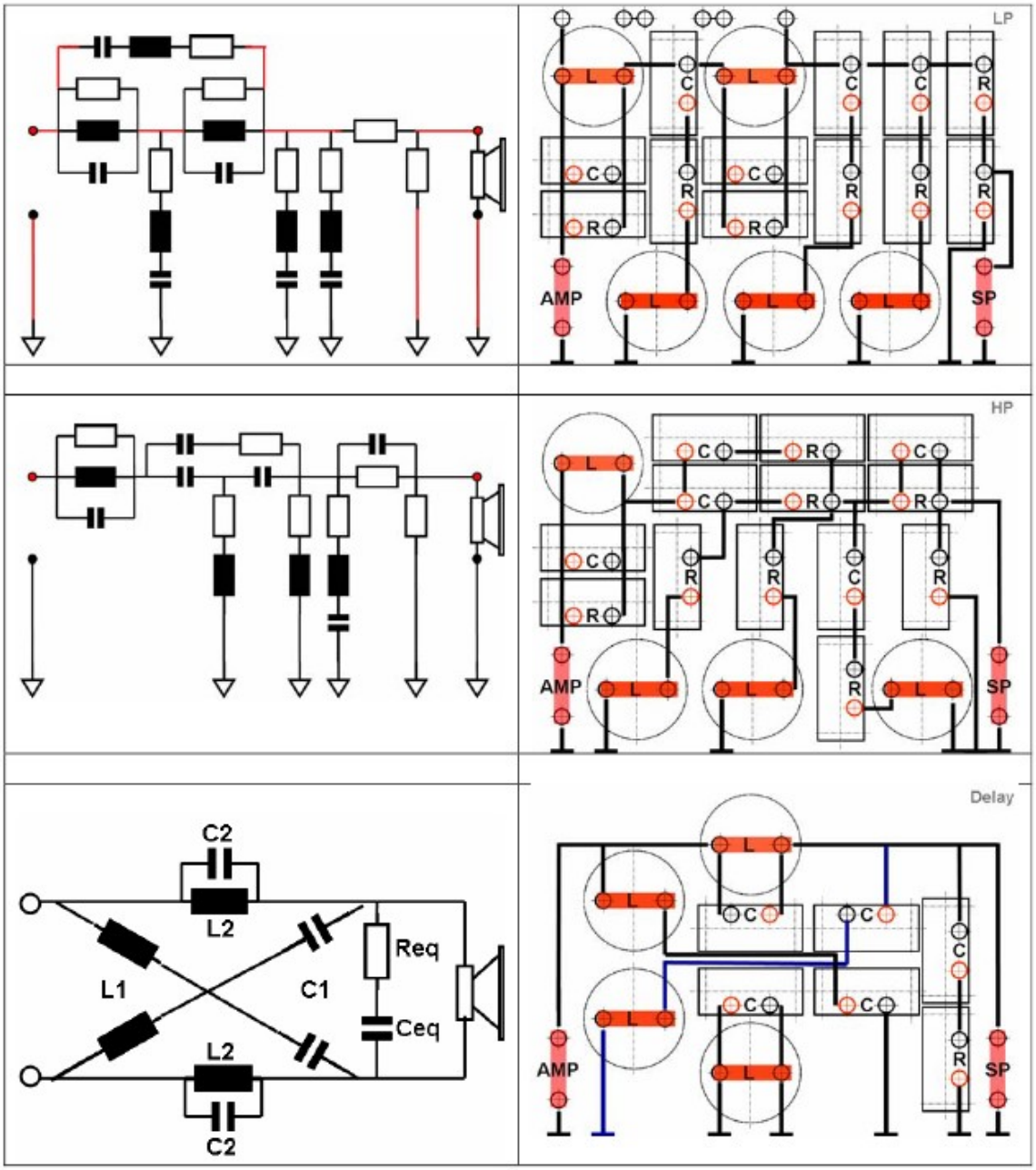


Image 5.2.1: time development board

The further expansion are no limits to the basic idea - depending on the preference for certain filter circuits - will be adjusted accordingly.

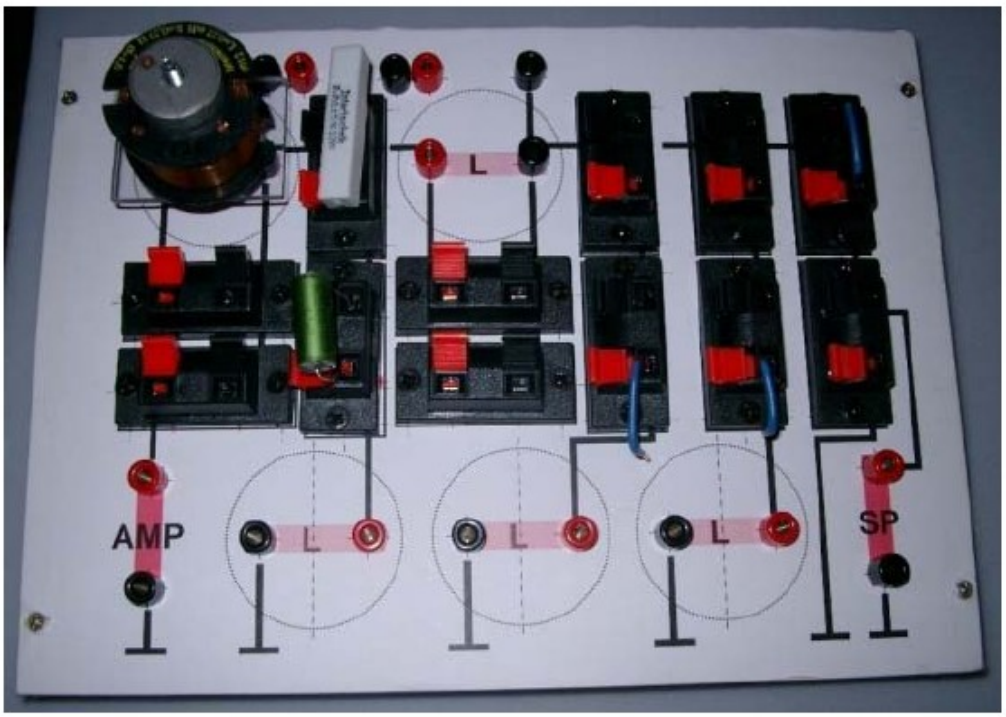


Image 5.2.2: time development board implementation

The solution shown in Figure 5.2.2 is designed to be variable coils (see Figure 5.2.3) to provided positions can be inserted.

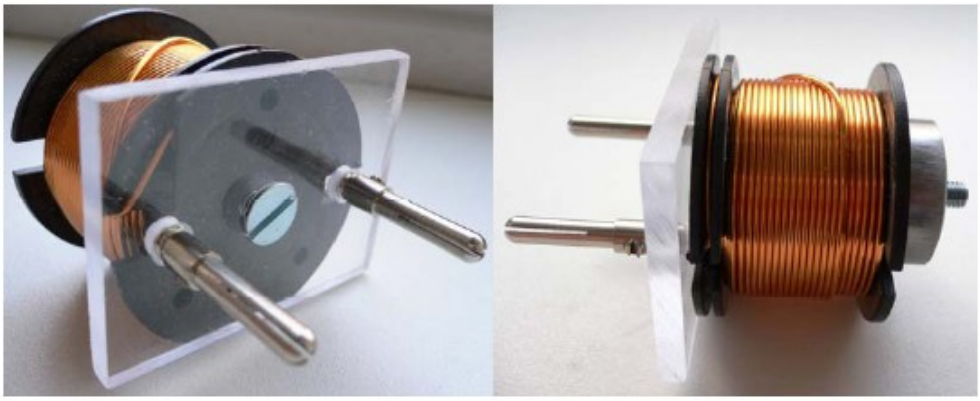


Image 5.2.3: Plug-variable coil

5.3 Variable inductors

Heinrich Weber

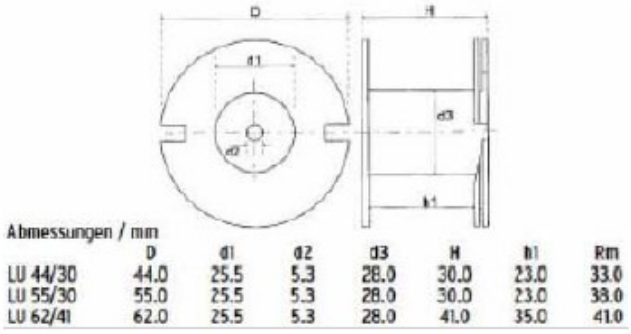
Variable coils allow the setting of almost any inductance without standard rows or closing times must be considered. The metrological optimization of crossovers is significantly accelerated, annoying reconnection or soldering is Substituted adjustment of the core. At the end of the course development process, only the vari- measure variables coils with LIMP and replace them with appropriate fixed values.

In the current Catalogs for speaker accessories you will of the principal components find for the construction of variable coils. In this example, find the products of interaction technology Application. What is needed? Well, of course, an air coil, a suitable core and Material for the adjusting device.

Regarding the core material you will quickly Fuentes dig. The inter-coil technology for Entzerrnetzwerke have a suitable soft ferrite core with 25 mm diameter and a length of 36 mm. One Hole for mounting a threaded rod for the Adjustment is already available and Fortunately, these coils are also quite inexpensive.

The core is hot glued in the coil body fastened account. After careful heating with a soldering iron (be careful so that the spool is not but melts), it should be fairly easy to remove.

Now we need air coils, into which fits our 25mm ferrite core. From the Inter-technology program are air coils with 0.95 mm and 1.4 mm wire and Air Therm Baking varnish coils suitable.



Abmessungen / mm

	D	d1	d2	d3	H	h1	Rm
LU 44/30	44.0	25.5	5.3	28.0	30.0	23.0	33.0
LU 55/30	55.0	25.5	5.3	28.0	30.0	23.0	38.0
LU 62/41	62.0	25.5	5.3	28.0	41.0	35.0	41.0

Image 5.3.1: Dimensions of the air coil with 0.95 mm wire diameter

It is important that the inner diameter d1 of the coil body is 25.5 mm. Furthermore, should the Resistance of the air coil used for the intended use in crossovers be suitable (Ri <0.5 to 0.8 ohms). Now for the practical part. First, we introduce some Measurements by LIMP to determine the effectiveness of the introduced ferrite core.

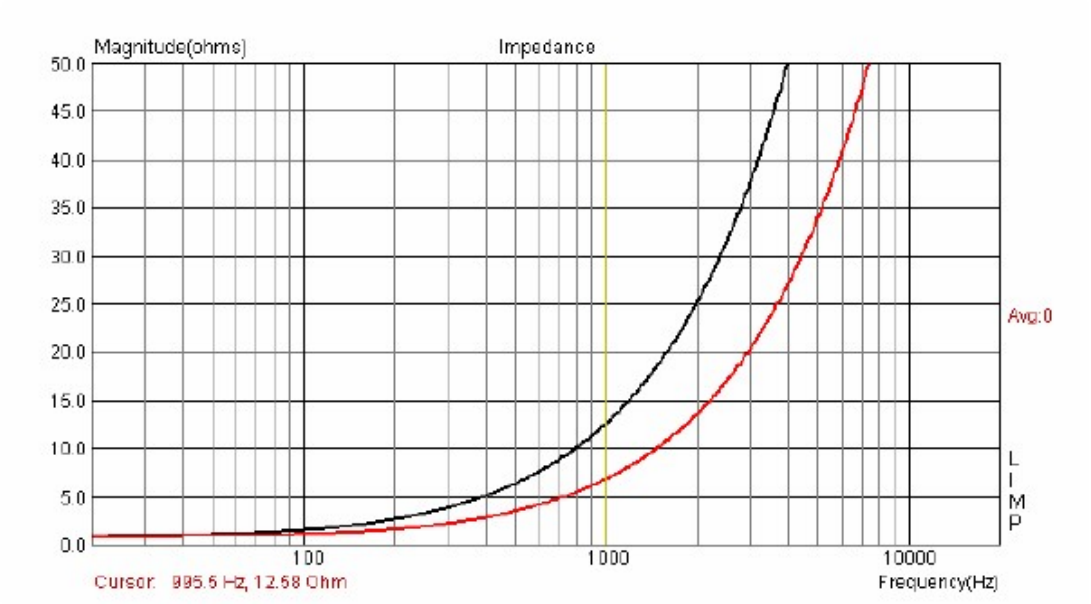


Image 5.3.2: Maximum variation range of the coil (red = no core, black core with =)

Picture 5.3.2 shows that a significant increase of the ferrite core inductor by introducing occurs. When measuring the existing coil inventory revealed that - depending on the used Air coil - can be expected with a doubling or tripling of the inductance.
As for the measuring range were not more than 1.2 mH coil available, extrapolation is higher inductances be supported by our own measurements. In Figure 5.3.3 the results of this Measurements summarized. So for example using a 2.2 mH air core coil with 0.95 and 1.0 mm wire by incorporating a ferrite core (D = 25 mm, L = 36 mm) to increase the inductance to approximately Expected 6.0 mH. If the same coil with 1.4 mm wire used, is expected to increase to about 5 mH.

L	R1,0	R1,4
0,10	**0,14**	0,08
0,12	0,16	0,09
0,15	0,17	0,10
0,18	0,22	0,11
0,22	0,23	0,13
0,27	**0,27**	0,15
0,33	0,30	0,16
0,39	0,33	0,18
0,47	0,36	0,19
0,56	0,42	0,22
0,68	**0,47**	0,24
0,82	0,52	0,26
1,00	0,60	0,28
1,20	0,65	0,30
1,50	**0,73**	0,34
1,80	0,79	0,38

With this information we can now from the Coils program offered identify those values that we need to get the desired inductance cover.

The table leftmost shows a section of the Inter-technology product range for air coils with 1.0 or 1.4 mm wire diameter. The colored arrows indicate the each active region of an inserted ferrite core.

It can be seen that e.g. a 0.1 mH air core coil of 1.0 mm wire can cover an area up to approximately 0.27 mH. So the next step was to begin at 0.27 mH and in turn would cover an area up to approximately 0.68 mH. More information can - depending on the requirements - from the Delivery program of the manufacturer of each coil are determined.

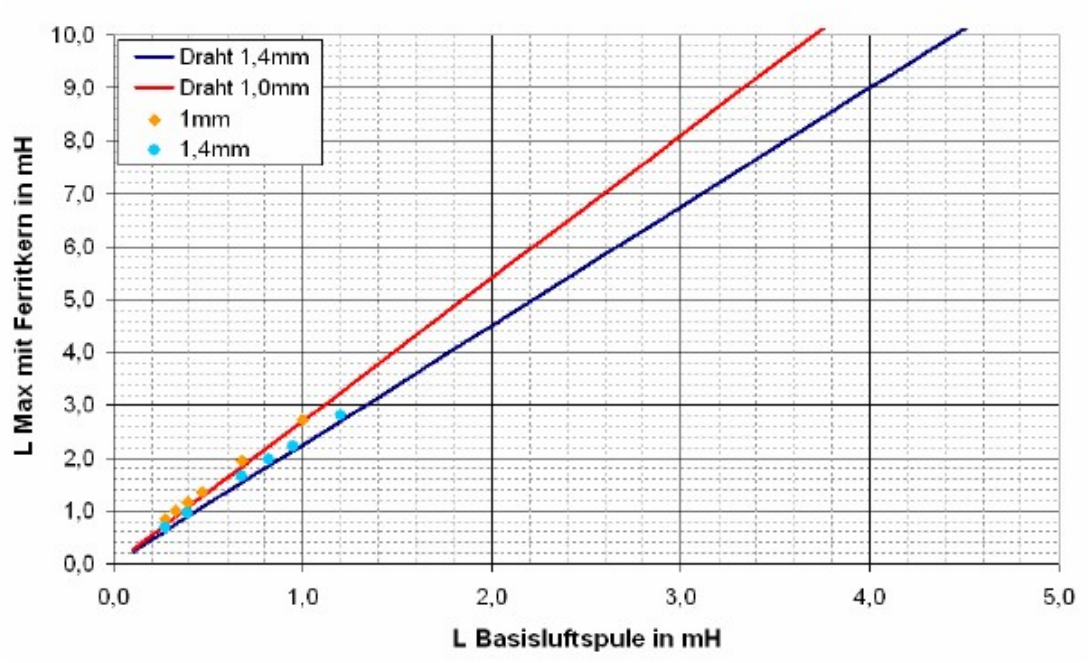


Image 5.3.3: Maximum Induktivitätserhöhung by incorporating a 36mm long ferrite core

With this information, the design of a variable inductance is very easy. For the Replica only readily available materials needed. Please use the mounting the coil and the ferrite core only brass screws. More details are the following photos found.

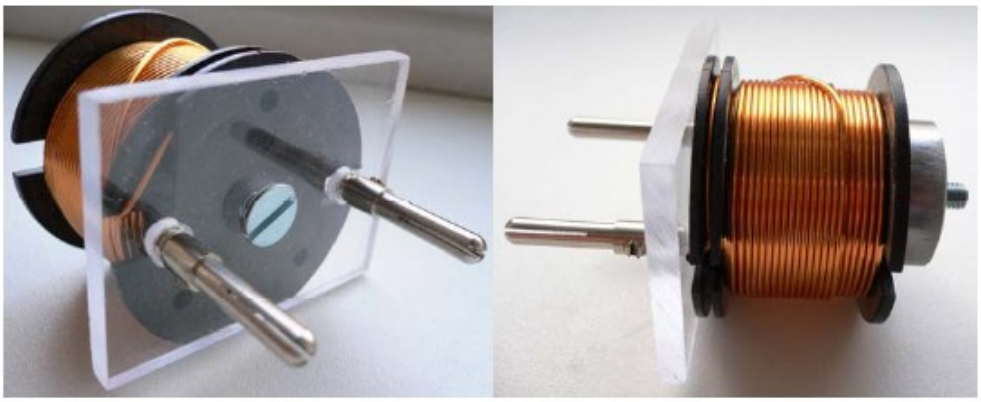


Image 5.3.4: Plug-variable coil (option 1)

Picture 5.3.4 shows a plug-in version (see also section 5.2). 5.3.5 image showing the structure of a "Normal" solution with cylindrical core.

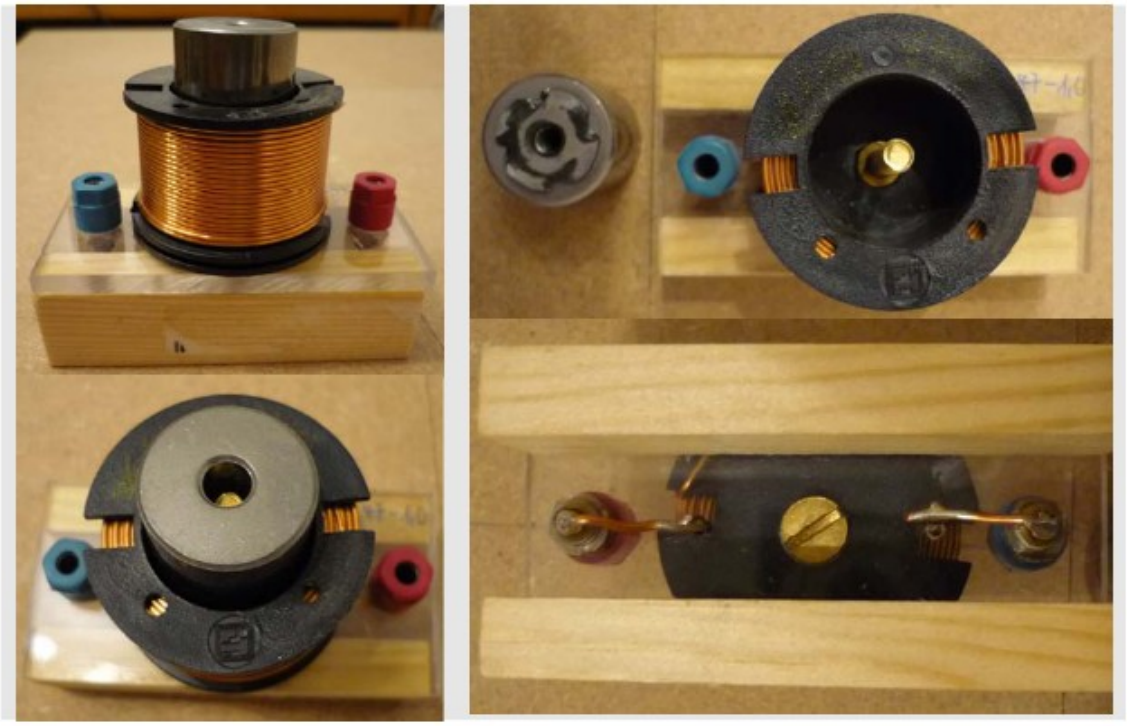
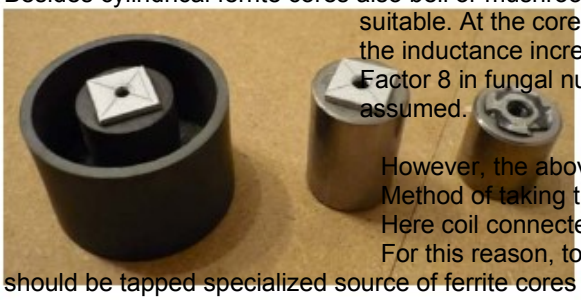


Image 5.3.5: Variable coil with a cylindrical core (Version 2)

Besides cylindrical ferrite cores also bell or mushroom seeds are very good for variable coils suitable. At the core bells shown here the inductance increases by approximately the Factor 8 in fungal nuclei by factor 3-4 assumed.



However, the above-described Method of taking the core of the Here coil connected with high losses. For this reason, to consider whether a should be tapped specialized source of ferrite cores (eg www.Tridelta.de). From Tridelta should be the core bells type C52 and both available fungal nuclei suitable (Note that fungal nuclei have only 20 mm core diameter, ie it should be a different, matching Be chosen air coil (eg LU78/30 of sintering technique).

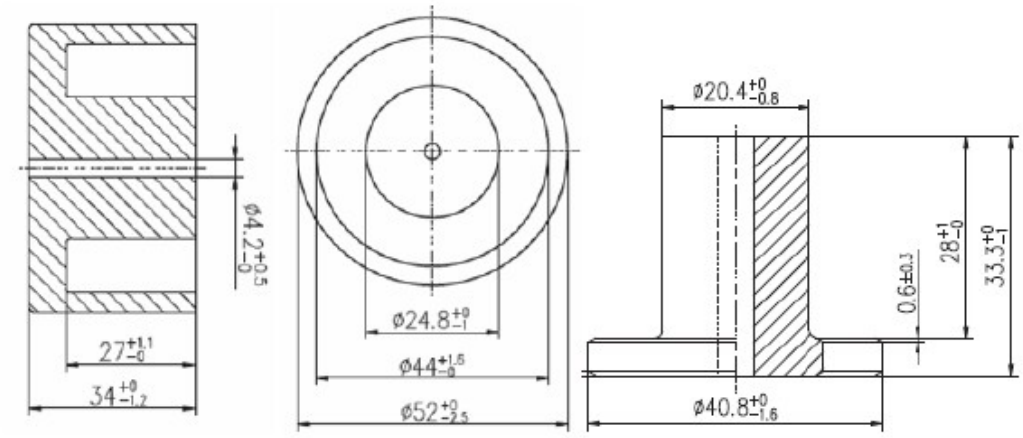


Image 5.3.6: Suitable Tridelta ferrite cores, dimensions

Image 5.3.7: Variable coil core with bells

For more information on variable construction coils can be found on the homepage of Michael Uibel (Http://www.audiocad.de/u/index.htm).

6 Tools for acoustic measurements

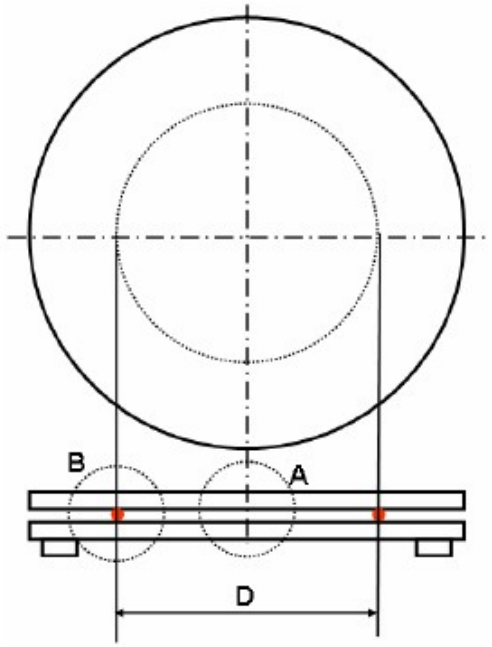
6.1 A hub for the measurement of the dispersion characteristics of Speakers

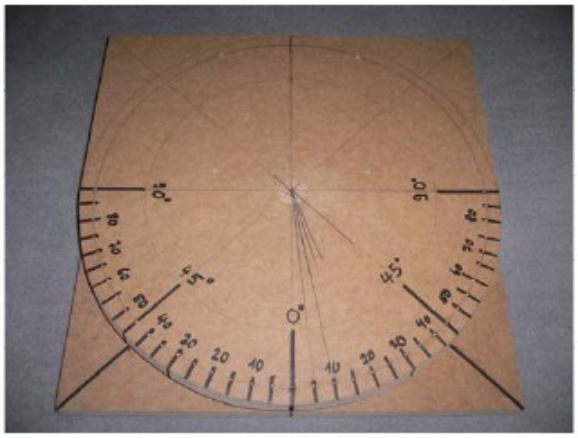
Heinrich Weber

For the reconstruction of the hub are two plates 19mm MDF, steel balls or Drawer rollers, a piece of 25mm round wood of beech and a countersunk screw with a Metal plate is required.

If the "ball bearing version" is selected, a router is required, otherwise are Jigsaw and drill sufficiently.

For the "ball bearing version" first, a groove is milled in both MDF respectively. The depth required depends on the diameter of the steel ball employed. They should be selected be that the ball is pocketed about 0.6 · radius.



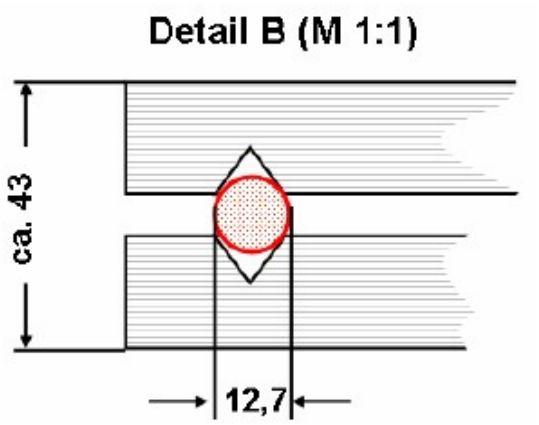


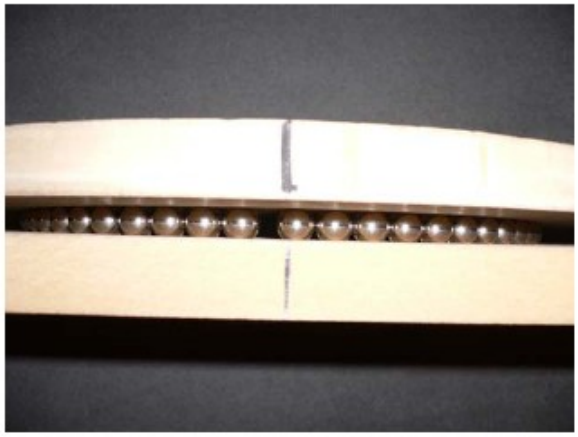
Anzahl Kugeln	D [mm]
40	161,7
50	202,1
60	242,6
70	283,0
80	323,4
90	363,8
100	404,3

The diameter of the groove should be about 2/3 the diameter of the selected disc. Is he is too small, so for heavy loads, the stability of the turntable is at risk.

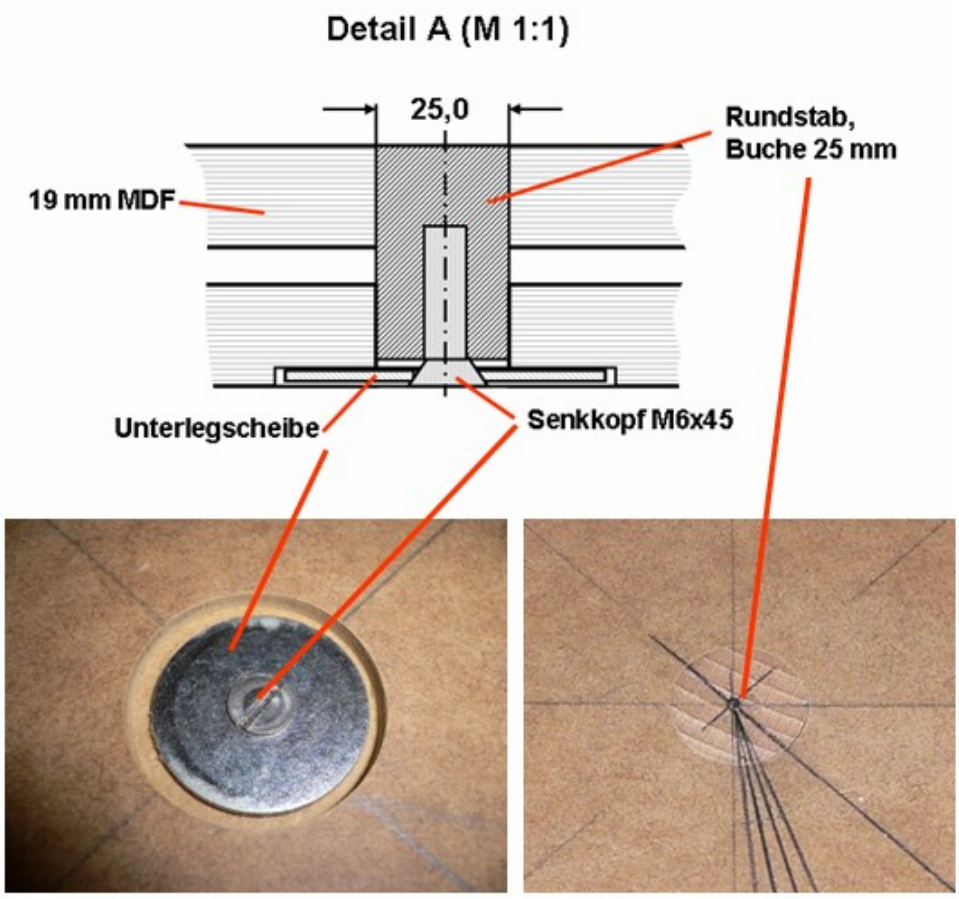
In addition, make sure that the groove diameter is chosen so that the balls the groove complete as possible without gap. Table shown above are for example used here in

Spherical diameter of 12.7 mm and a selected number of the respective balls
Diameter D of grooves.



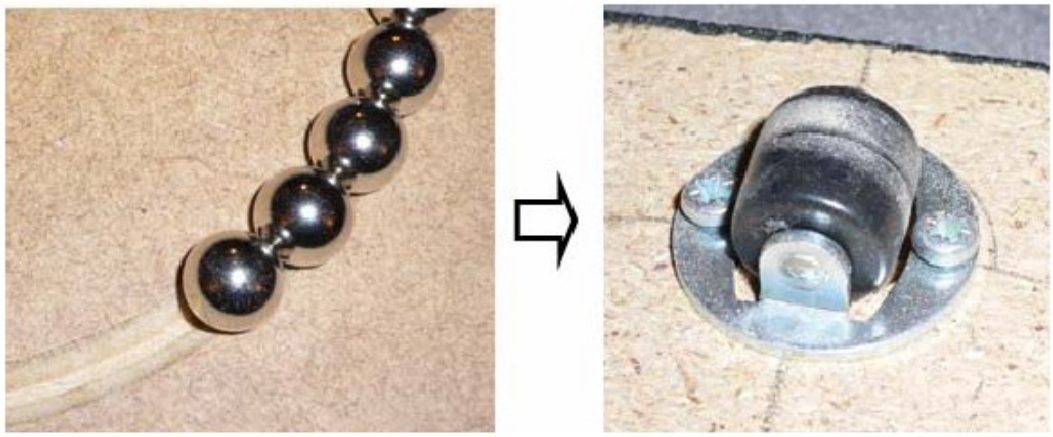


Especially important is a stable centering. This is a piece of round wood from 25 mm
Beech glued into the top MDF board. In the lower plate a guide hole as 25 mm
drilled. The sinking shown in the diagram below the washer is not
necessarily required if you example with rubber feet provide for sufficient distance to the ground.

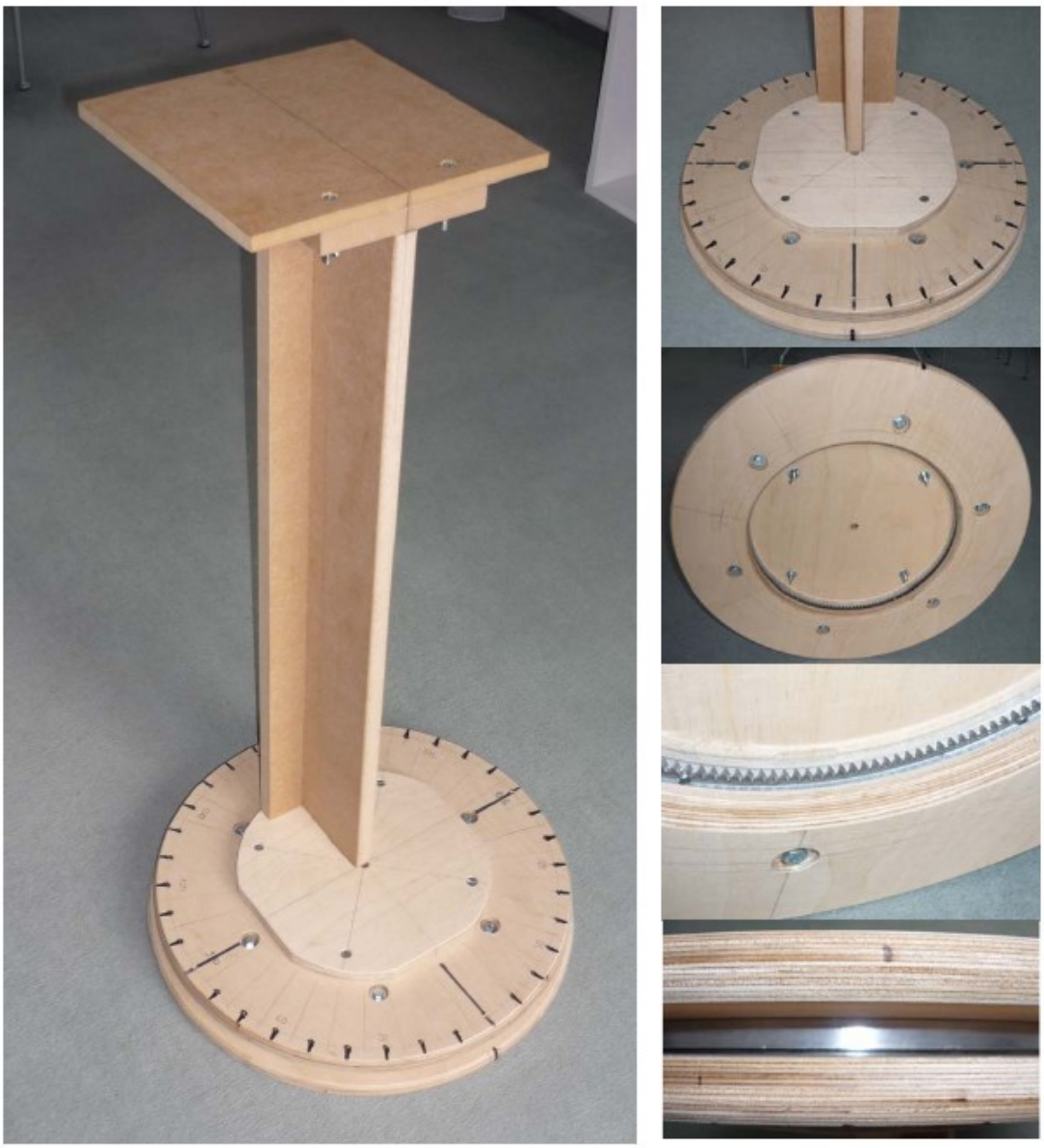


Finally, it is still only apply the angular scale (see photo). Practical is a 5 °
Classification with identification of some important angle, eg 0 °, 15 °, 30 °, 45 °.

As mentioned above, you can instead of steel balls and rollers for easy small
Drawers from the hardware store to take (see photo). In order to get enough stability, set
6-8 at least one roller on the circumference. So that the rollers can run free, a hole must
be drilled, this is just so great that the mounting screws are not material and
the rollers run freely. Make sure when mounting that the roles exactly in the direction
are aligned.



Another easy way is obtained by use of a rotary bearing / slewing ring
as shown in the following image. The bearing includes a simple toothing, and with a
matching sprocket suitable for the development of motor drive (source: ebay).



6.2 A motor-driven turntable with remote control

Ralf Grafe, Heinrich Weber

The devices described in Section 6.1 serve their purpose, but they require during measuring some physical activity. Here are two options for movement in Lazy Form presented by some photos. If you want to know more details, Please let me via PM on the Visaton Forum http://www.visaton.de/vb/)

Version 1

Nr.1: It is driven by a small stepper motor and belt. The remote
Operation is seen in the picture above right. The current version is programmed at 5 ° steps,
other values are also possible. The construction is so stable that on the base plate
other devices / holders can be attached (picture top left). The prototype is
anechoic chamber Visaton admire.

Variant 2

Variant # 2: The idea for this variation comes from Michael Lenz aka AC-SB
However (http://www.hifi-forum.de/viewthread-137-65.html), the implementation of the idea was a little modified. The drive system uses an antenna rotor (ebay, web bazaar, approx € 30.00).
The control unit can be seen in the picture above right. One should not expect miracles from the Positioning expected, but the structure for household use is always
suitable.

6.3 Construction of a dodecahedron for room acoustics measurements

Matthias Leger

What is a dodecahedron needed?

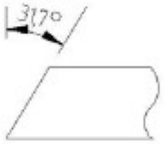
The ISO 3382 standard for the "Measurement of the reverberation time of rooms with reference to other acoustic parameters "calls for the excitation of a space, so literally," sound source spherical as possible directivity (isotropic radiator). " With its 12 surfaces is the Dodecahedron fulfilling this requirement pretty close, since each of the 12 faces its own Represents emission axis. In conventional hi-fi or PA speakers, the requirement is to an omnidirectional fulfilled only at low frequencies, the increasing concentration at high Frequencies prevents a uniform radiation in all directions and thus a uniform "illumination" of the room.

A little math around the dodecahedron

A dodecahedron is a body of twelve areas. In the present case, it is at the Surfaces at regular pentagons, so the full name of the body also "Regular dodecahedron" is.

For the construction of a dodecahedron two angles are of interest, namely, the interior angle α of the regular pentagon, and the angle β, to each other have the space.

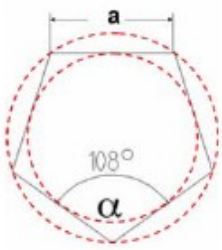
The internal angle α is 108 °, the angle β is 31.7 °



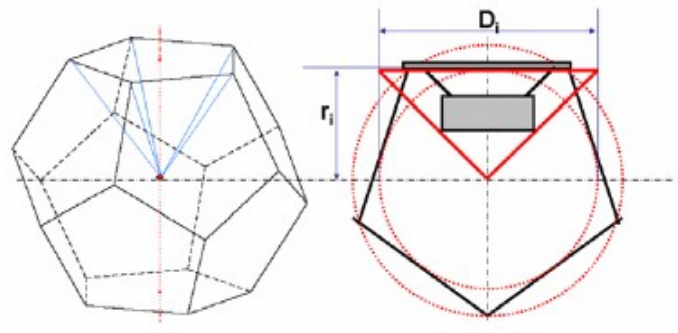
Calculate other important parameters of a dodecahedron as follows (with a = side length):

Volume	V = 0.25 (15 + 7 5) a3 a3 ≈ 7.66
Umkugelradius	$r_u = \frac{\sqrt{3}}{4}\left(1+\sqrt{5}\right)\, a \approx 1{,}40\, a$
Inner radius of the sphere	$r_i = \frac{\sqrt{5}}{20}\sqrt{50+22\sqrt{5}}\, a \approx 1{,}11\, a$

,



With the above formulas and the following outline can be determined whether the selected Speaker chassis fits into the housing.



Which speaker drivers are suitable for the construction of a dodecahedron?

In selecting suitable chassis you have to first a few thoughts about the future
Purpose make. For example, an ordinary Wohn-/Hörraum loudly with a
Encourage noise signal, it does not require expensive high-performance speakers. In professional
Copies are usually full-range speaker with external diameters of about 13-17
cm is used, then what is suitable for larger rooms.

The presented dodecahedron with very high efficiency is 10 cm full range speakers
equipped. In normal sized rooms can thus realize deafening volumes.
Even a chassis with the next smaller size (about 7-8 cm outside diameter) stocked
Dodecahedron is for the measurement of their own listening room, a sufficiently high sound pressure
. provide The following points should be taken into account in choice of chassis:

- a continuously rising slightly on axis response is to seek to the
  Counteract concentration at high frequencies. Of a dodecahedron is before
  all called for a uniform frequency response extending energy, not a smooth
  Frequency response on axis (which is incidentally not even possible, as we later
  be seen in the measurements yet)
- an upper cutoff frequency of about 10 kHz is adequate. ARTA calculates the
  Acoustic parameter space to a frequency of 8 kHz, for the evaluation of
  Room acoustics is sufficient. Due to this fact, not only
  Full-range speaker suitable for construction, but also according to principle
  broadband active agent or midrange
  the Thiele-Small parameters of the speaker should be no great
- Worry, because a meaningful vote in the tiny volume
  're practically possible, that is a high quality built and connected to a pronounced
  Overshoots in the mounting resonance frequency is practically unavoidable.
  Nevertheless speaker with a powerful drive and light membrane are in
  Preferable with regard to a good efficiency.

The sake of completeness it should be mentioned at this point that even dodecahedron in multipath
Technology are available. In that here specialized in each frequency range speaker
are used, a radiation is reached, which is very close to the ideal spherical
comes. Just think about the comparison of a converging strongly in the high frequency
Broadband speaker with the much broader radiation of a 19 or 25mm
Dome tweeter.

Construction of the housing

While you are in the planning of normal boxes on at least three dimensions
Having to worry (length, width and height), the dodecahedron setting a sufficient
Side length from - the rest is just a little math. So much for the benefits. In the
Practice, maximum precision when cutting the 12 tiles is however required, or
will be in the later joining and gluing have no joy.
With all the precision and dedication, however, you should not leave out of account the security, because
it will be impossible to avoid that one comes very close to the blade partially - is here
So caution!

As mentioned above, the presented here dodecahedron with 10 cm is large
Range speakers equipped traditional design (light paper cone, foam surround,
Small funnel).

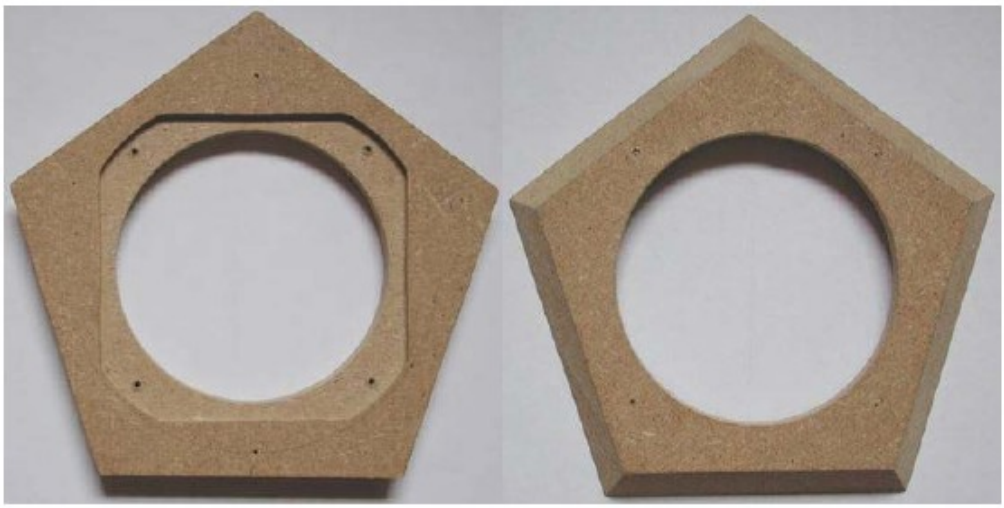
The side length of the pentagons I set to 10.6 cm. The resulting surface is then
so large that it can accommodate the speakers without trouble on the boards.
On the other hand, not much space is wasted, what of the size and weight
Dodecahedron would only drive unnecessarily high. Here, according to the motto "as large as necessary,
as

small as possible to proceed "is certainly not entirely wrong, because as mentioned earlier, is not possible housing vote in the classical sense.

The first step is to draw the outline of the pentagons exactly to the MDF at 12 (with Protractor or template). I have this sufficiently large plates of 16mm thick MDF can be cut (square) so that the subsequent steps all possible are the same and you have a clean stop for the table saw.

In the setting of the saw, it is recommended that the angle of 31.7 ° two to three tenths of a degree greater to choose, so that the plates collide when gluing on their "long" sides and ugly slots are thus avoided. After some angle with reference to both Has test cuts precisely adjusted and checked, we can start small series production.

On the side length is meticulously to ensure, if necessary, prefer one or the other boards more cut. The finished cut elements should look like, here front and Back:



As you can see, the cut and milled been here already for the chassis made. In the flush of the sinking speaker I wanted for aesthetic reasons not do without, because the cast aluminum baskets would otherwise have faced 4 mm. In this labor-intensive step you can when using steel baskets but usually without. The sawing or milling of the cuts can in principle only at the completed main dodecahedron are made, however, would be a "slip" of course particularly annoying.

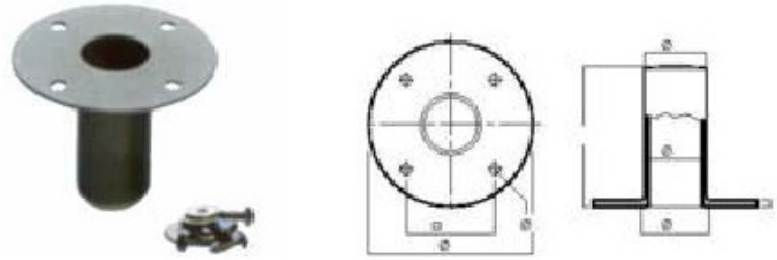
The gluing together of the elements can be done in two different ways. The left are the so-called tape method, in which the boards are held together by duct tape. After a first "dry" assembly (without glue) the pieces are finally to and removed by back, coated with glue and used again. With this technique, should be able to work fluently.

On the right, the other method, in which a simple auxiliary construction for precise setting the angle (116.6 °) is used. This is just for gluing of the first elements very useful.

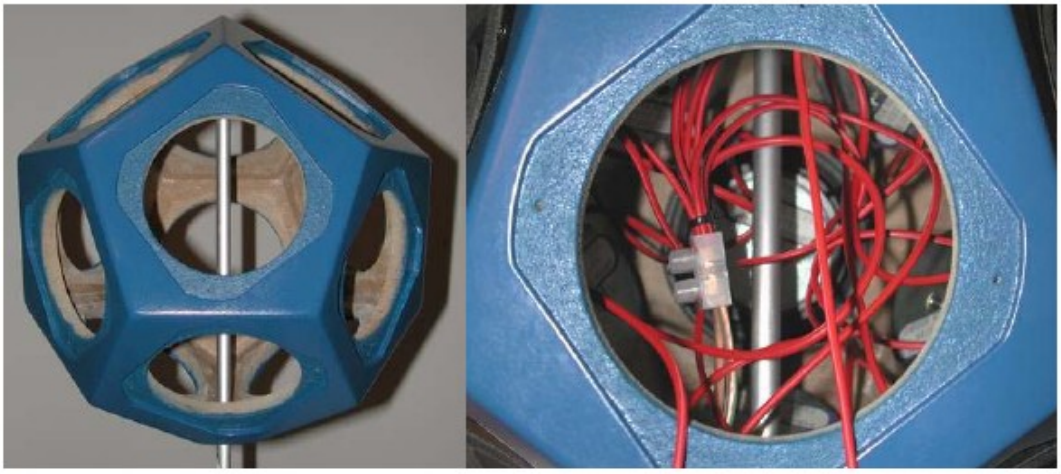
Here are two more images from the construction phase; 5/12tel dodecahedron left, to the right of final Carcass:

In the next step, any existing supernatants are ground flat and the edges are slightly rounded. It follows the first sanding with a medium grit sandpaper (about 120). To Dodecahedron, etc. later on a tripod to fix a hole in one "corner" of the Drilled by inserting a 10 mm thick aluminum tube, which at the same time as carrying out the Cable is used.

As an alternative mounting option to offer so-called high stand sleeves (see Pictures), how often they used in the PA area. Especially in severe cases are those pods in combination with a stable tripod the solution shown clearly preferable.



Left of the image pre-painted, but still bare dodecahedron. On the right, a view
the messy cabling acting. Only thing missing is the attenuation with
Cotton, except the dodecahedron is however ready and can soon loud sounds of
to give.

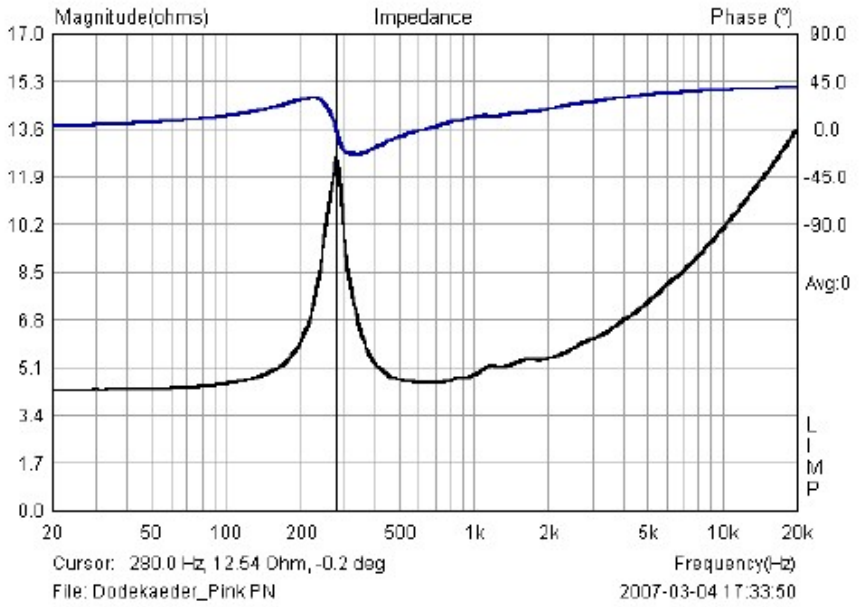


It is finished: The damping material was introduced and all speakers
connected. The correct polarity is best tested with a powerful battery, because at 12
Chassis in such a small space can easily lose track of time!

A few more words about the connection of the chassis. To amplifier-friendly impedance to
obtained (about 4 to 8 ohms), I have a combination of series and parallel circuits
selected. For this purpose, each of the three nominally achtohmigen chassis were connected in series (3x
8
Ohms = 24 ohms). These four packages of 24 ohms were then connected in parallel so that
the resulting total impedance of 6 ohms (24 ohms / 4 ohms = 6).

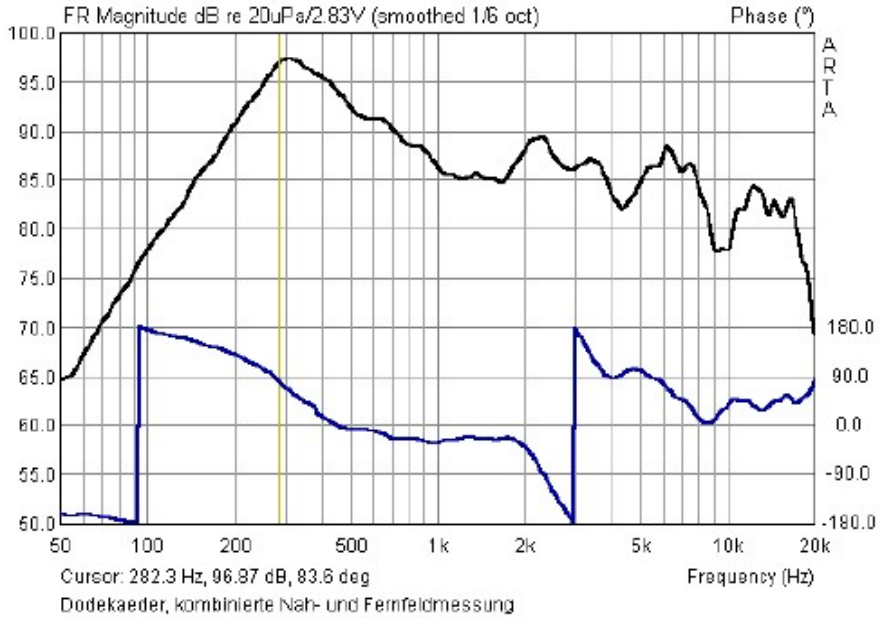
Measurements on the finished dodecahedron

In the last chapter I will present some interesting measurements. They are in the describe some ways unusual behavior of a dodecahedron closer. First, LIMP performed using an impedance measurement to check the voting body.



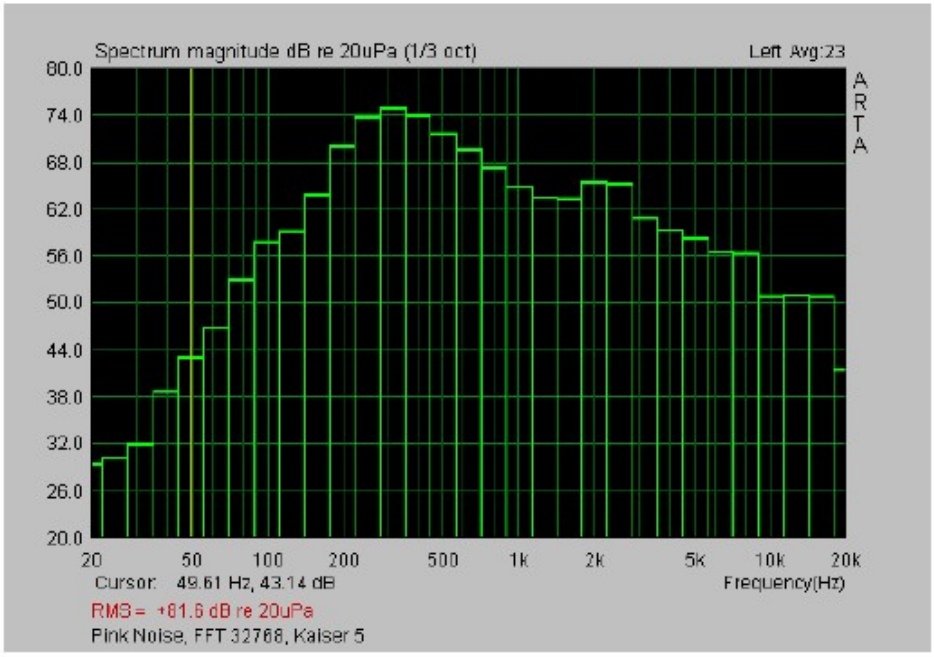
The impedance curve is primarily information about the resonance frequency in the built State (fc), but it can also have other important properties out of it read. So for example, light diaphragm resonances in the frequency range between 1 kHz and 2 kHz recognize, however, are not critical for the intended application. Furthermore, the smooth points Extending below the resonant frequency to an airtight installation of all the chassis back.

Subsequent measurement shows the frequency response of the dodecahedron. It is a combined near-and far-field measurement, which together just below 400 Hz was (recognizable by the slight offset in the phase transition). Due to the different durations of the Sound from the speakers to the measuring microphone it comes to frequency and position-dependent dips in the frequency response (interferences). The following measurements have will show, however, that the behavior of a dodecahedron with a single measurement Can describe "on the move" very inadequate.

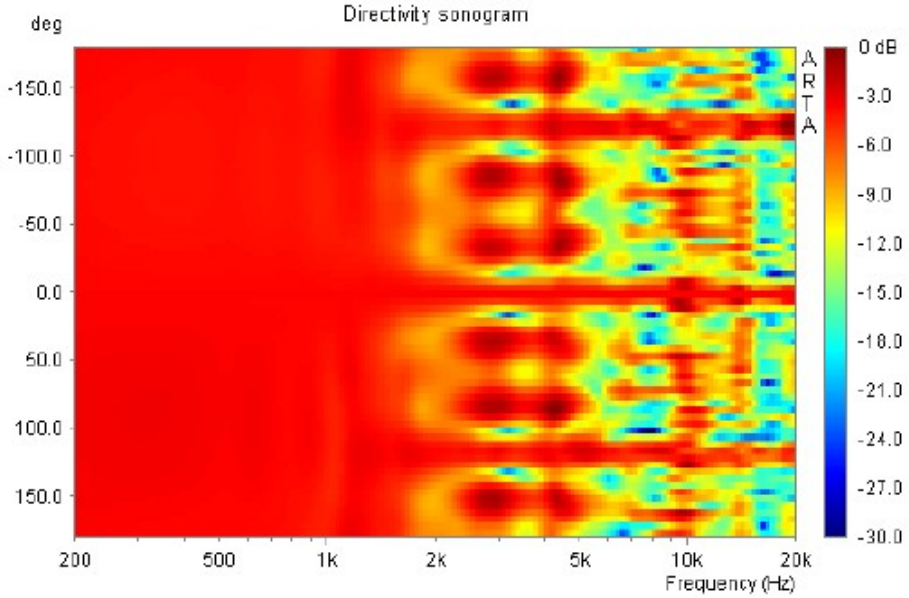


Below the resonance frequency (fc = 280 Hz) falls, the sound pressure level as a ruler pulled off with little more than 12 dB/8ve. The high quality installation (Qtc = 1.4) has a Overshoot of about 4 dB in the range of the resonant frequency to follow what envisaged in the Application, however, is problematic.

As mentioned above, a single measurement "on axis" is only very limited to evaluate the playback characteristics of the dodecahedron because the frequency response of an few degrees outside of the "axis" can clearly be different. This problem somewhat mitigate real-time analysis was conducted with great smoothing (1/3 octave) in a relatively anechoic environment performed.



The radiation characteristics of a speaker can be very descriptive in a so-called
Represent directivity sonogram. For the dodecahedron, shown below sonogram was
with an angular resolution of 5 ° measured (-180 ° to +180 °). This is a
normalized representation, that is, to be understood that all measurements are relative to the 0 °
measurements.



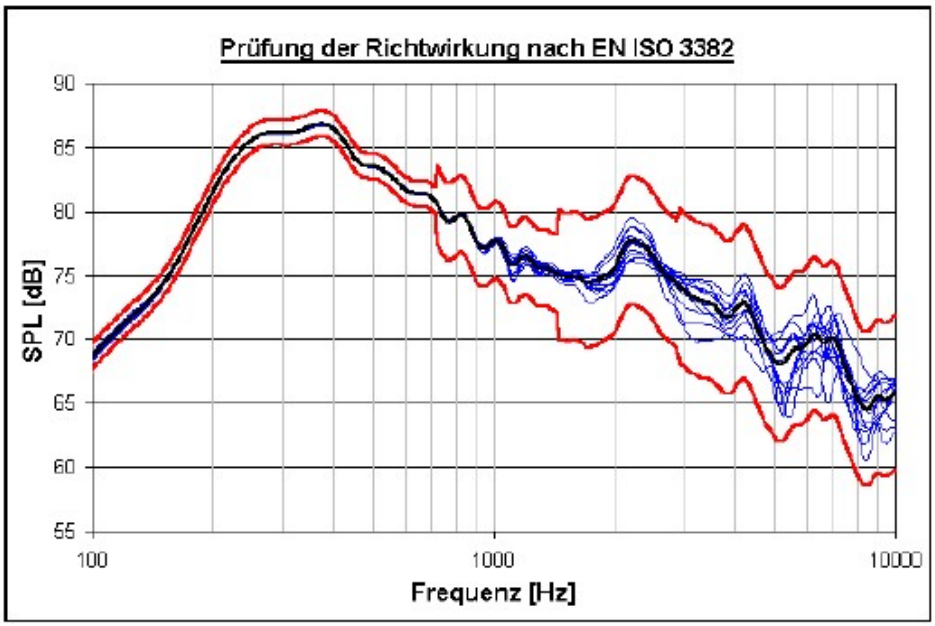
To about 2 kHz, the dodecahedron as a nearly perfect omnidirectional antenna behaves. At higher
Frequencies the influence of the interference is however growing stronger and ensures dips in
Frequency response. Another point is the bundling of the chassis. Even if the dodecahedron in 12
different directions radiates a certain directivity still persists. With a
Rotation of 360 ° occurs in the present case, three times to the situation that a chassis directly
is measured on axis. As one can see in the graph, this is at 0 °, -120 ° and
+120 ° the case.

In the first chapter of this paper the standard EN ISO was mentioned 3382nd This standard will
and the dispersion of the sound source precisely defined. Here I quote the relevant
Section of the standard:
The sound source must radiate as spherical. In the table (see below), the
maximum permissible deviations from spherical radiation given, averaged over
"Sliding" 30 ° elbow areas in an open field. If a turntable can be used in
5 ° increments to measure followed by "sliding" averaging over six neighboring
Points. The reference value is determined from a 360 ° power means in the measuring plane. The
Minimum distance between source and microphone is 1.5 m.

Frequency in Hz (octave band)	125	250	500	1000	2000	4000
largest deviation in dB	+ / - 1	+ / - 1	+ / - 1	+ / -3	+ / - 5	+ / - 6

The measurements on the directivity performed at a height of 2.5 m, the
Distance between the dodecahedron and microphone was 2 m. These measurement conditions allow
virtually
to just below 100 Hz anechoic measurements as required in the standard, which was
Measured dodecahedron in 5 ° increments, and then every 6 points from the neighboring
Mean formed (30 ° elbow areas). Similarly, as the reference value is an average of all
Measurements made (360 ° energy resources).

The following graphic shows the results. Black is the reference value (360 ° -
Energy resources), the two red lines mark the maximum permissible deviations from
Reference value (see table above) and the thin blue lines show the individual 30 ° bends.



As you can see, the dodecahedron meets the requirements of EN ISO 3382, even at the highest
Frequencies without effort. Complicating factor in this illustration that the curves do not
as were required in the standard octave band smoothed over, but that the smoothing only
1/12 octave is.

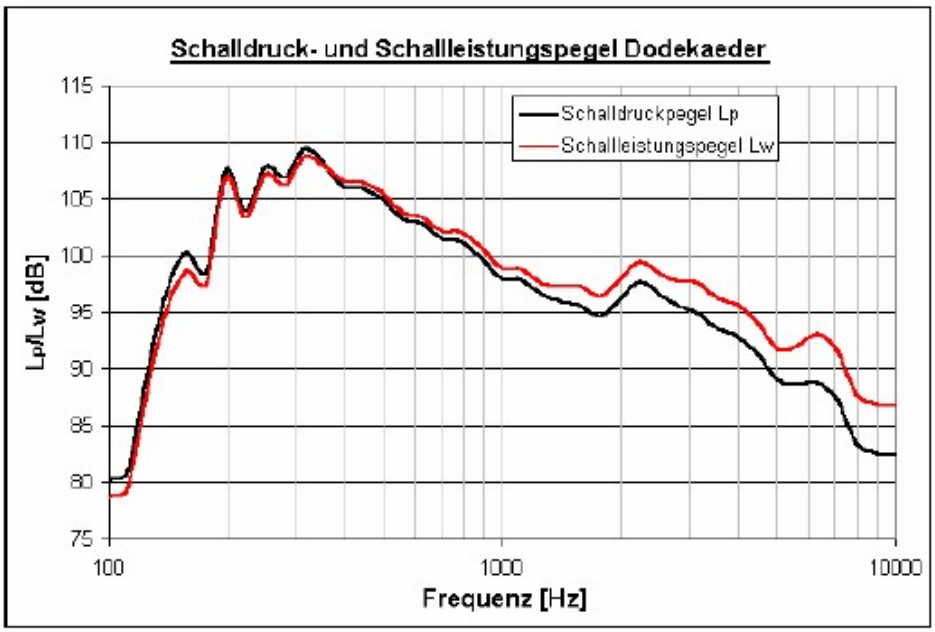
Besides the use as a sound source for room acoustics measurements provides the dodecahedron
as a sound source for reverberation chamber measurements (EN ISO 354 "Measurement of sound
absorption in
Reverberation chambers "). In the standard, it is required that the fed into the speaker broadband
must have or bandwidth limited noise signal, a continuous frequency spectrum.
The real-time analysis of the noise signal must be such that the differences in the resulting
Sound pressure level is less than 6dB in the room in adjacent octave bands. The following
Measurement is to check whether the dodecahedron satisfies this requirement. At the same time it also
Sound power level LW are recorded.

The sound power level LW calculated using the following formula:

$$Lw\ [dB] = Lp\ [dB] - 10 \cdot Log10\ (T60[s]) + 10 \cdot Log10\ (V[m^3]) - 14$$

Where:
LP [dB] = sound pressure level in decibels
T60 [s] T60 = reverberation time in seconds
V [m] = volume in cubic meters

The necessary measurement differs in one important respect from all previous:
it was deliberately in a highly reflective environment with involvement of all
Space influences performed. With such a measure, it is possible without much effort, the
total sound output of a loudspeaker to capture. Professional measurements
of this type are carried out in so-called echo chambers, in this case, however, had
cleared an empty basement room with unforgiving concrete walls to estimate the
Sound power level LW sufficient.



In the range up to about 300 Hz standing waves have a disturbing effect of the measurement space, it calls the "echo chamber" in the home's basement, but very neat. In this range fulfills the requirement of the dodecahedron EN ISO 354 without additional equalization of the Frequency response. You also want the area below the installation resonance (fc = 280 Hz) for Use measurements of the frequency response with an equalizer or controller should be under Into account the electrical and mechanical limits of the speaker are equalized.

6.4 IEC baffle

Heinrich Weber, Matthias Leger

The assessment of the speaker chassis under reproducible conditions, requires a reproducible, ie standardized test set. IEC 60268-5 describes the conditions the considerations for transferability and comparability of acoustic measurements on a Include baffle. Picture 6.4.1 shows the dimensions and the basic configuration of Standard baffle.

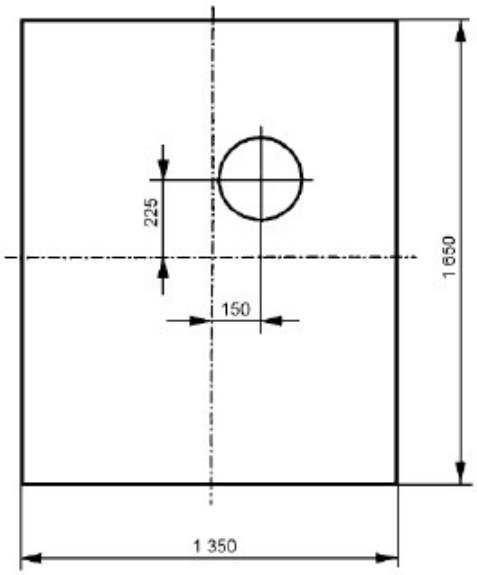


Image 6.4.1: Standard baffle acc. IEC 60268-5

Measurements were carried out under the conditions described in the standard are Although not free from foreign influences, however, to interpret well with a little practice. Further to describe the measurement conditions quickly and clearly.

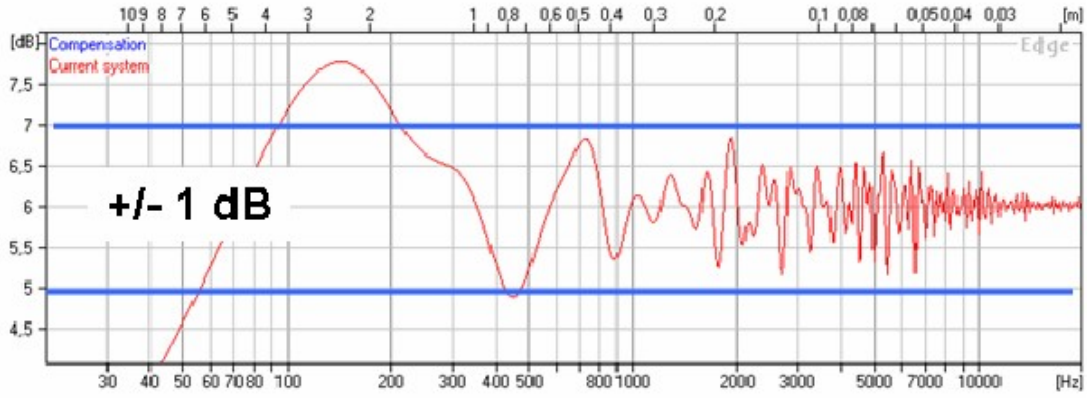


Image 6.4.2: Simulation tweeter at 1 m distance

Picture 6.4.2 shows the simulation of a dome tweeter in a standard baffle at 1 meter Measuring distance. To about 300 Hz, the influence of the baffle is in a tolerance range of + / - 1 dB.

It is further noted that both the size of the source and the distance measured effect take (see Figure 6.4.3).

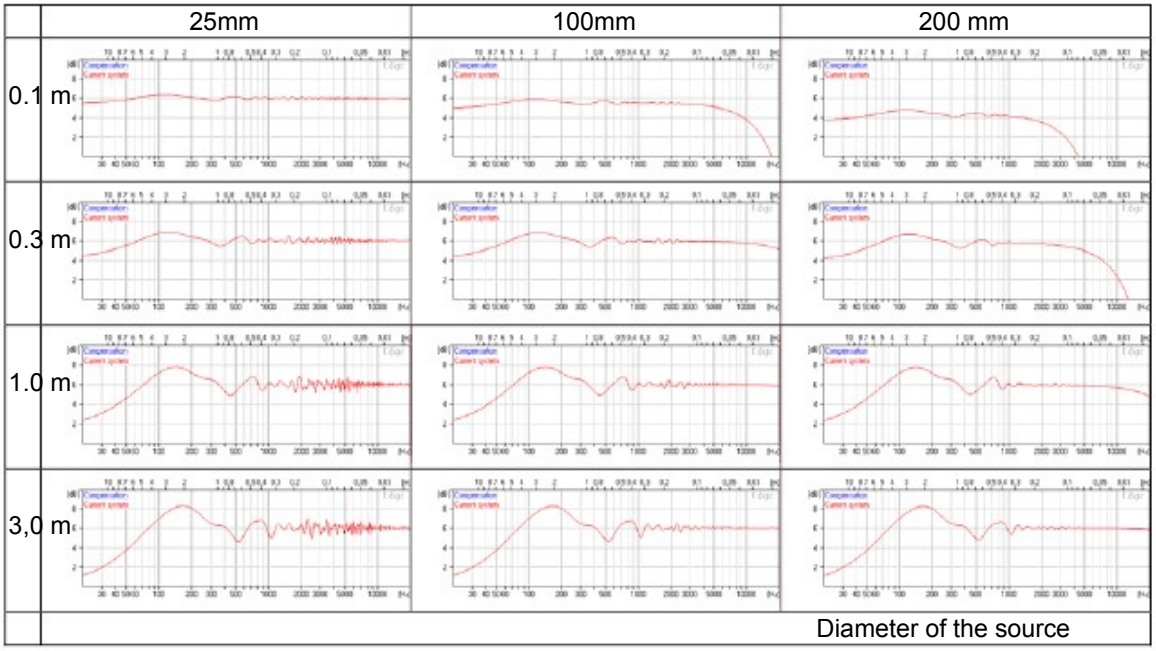


Image 6.4.3: Effect of source diameter and distance simulation

The dimensions shown in Figure 6.4.1 are not just for the field of DIY handling friendly. To the transportability and - if necessary - a space-saving To enable Staubarkeit, only a demountable solution comes into question.

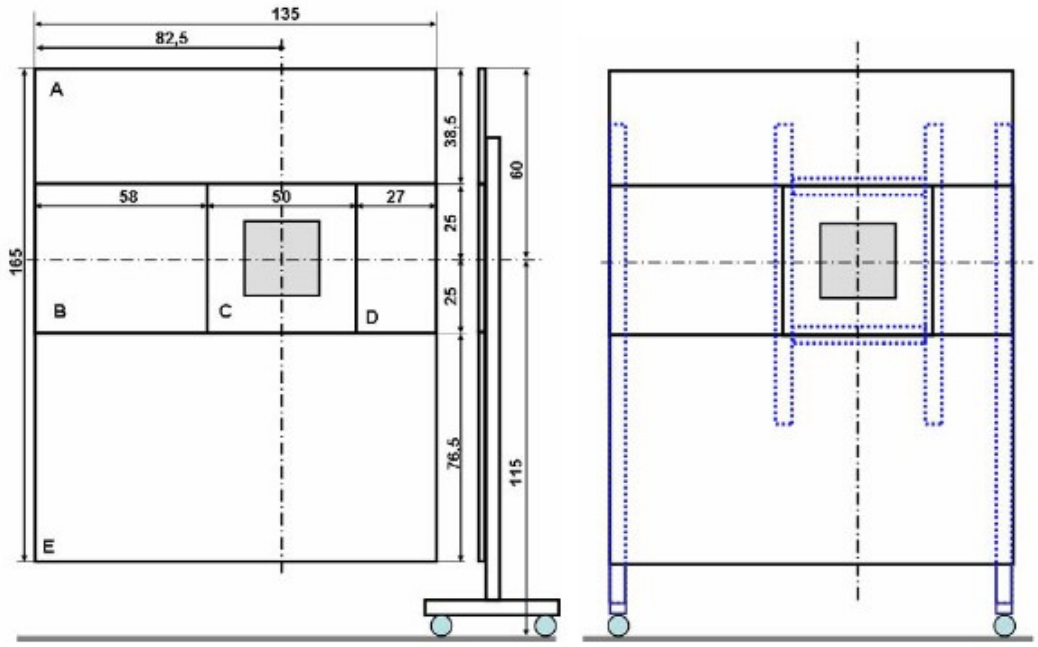


Image 6.4.4: Bauskizze a separable standard baffle

6.4.4 Image showing the construction of a mobile baffle and separable. For the construction the required materials listed in Table 6.4.1:

Number	Description	Material	Dimensions in mm
1	A	MDF 19	19 x 1350 x 385
1	B	MDF 19	19 x 580 x 500
1	C	MDF 19	19 x 500 x 500
1	D	MDF 19	19 x 500 x 270
1	E	MDF 19	19 x 1350 x 765
2	Batten		35 x 45 x 2000
4	Role		
n	Measuring insert		
		MDF 19	19 x 250 x 250

Table 6.4.1: Bill of

The image in 6.4.5 realized by Matthias Leger variant differs in the details of construction little from the Bauskizze shown above. Worth mentioning is the "backpack housing", which the rear sound capture.

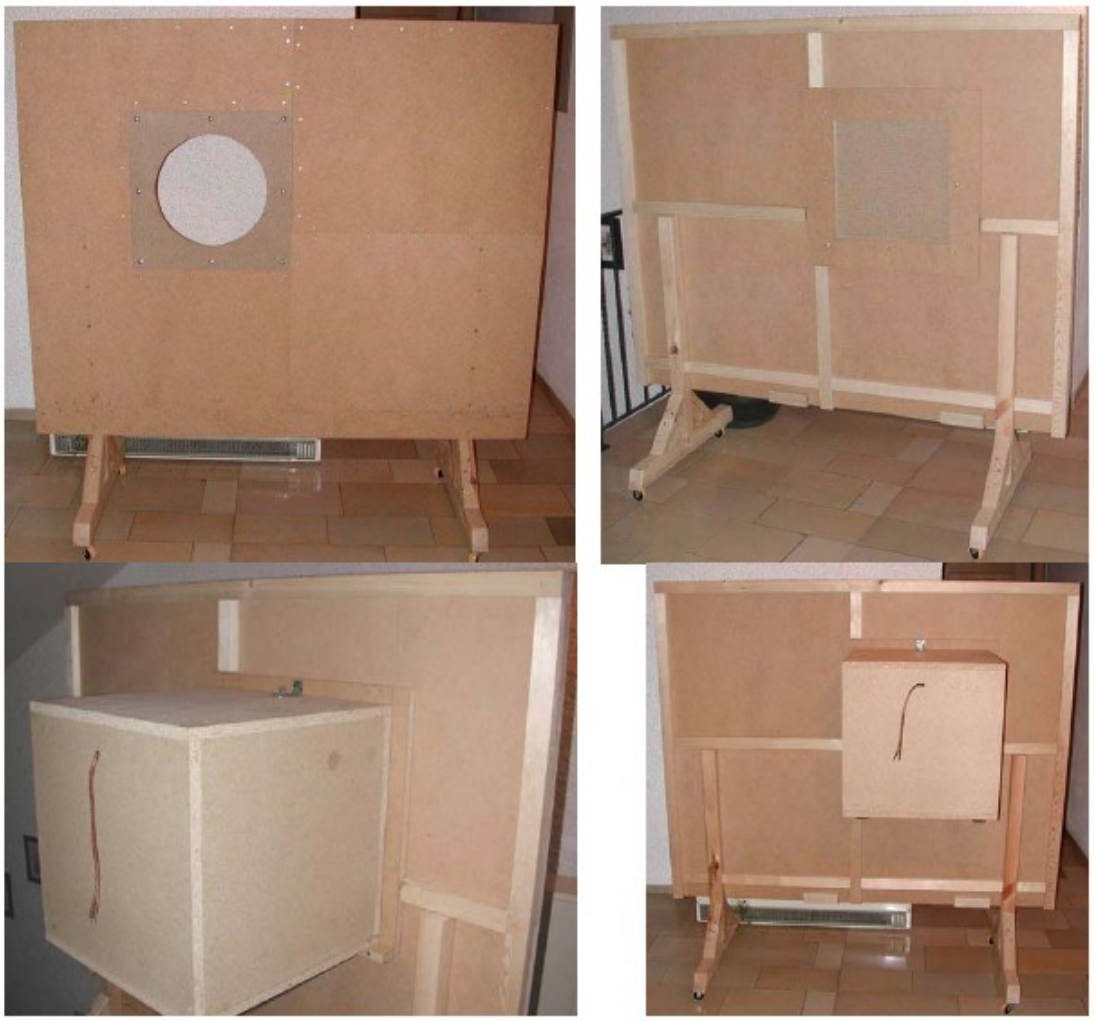
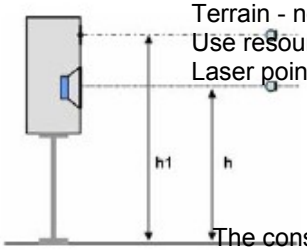


Image 6.4.5: The standard detachable baffle (Matthias Leger)

6.5 Laser Pointer Mikrofonpositioniervorrichtung

Heinrich Weber

The exact (heights) orientation of the microphone object to be measured with ruler - depending on the Terrain - not always easy. So why not an optical Use resource that is on almost every desk: A Laser pointer!



Picture 6.5.1 shows the principle: A laser pointer is in the measuring axis the microphone attached. After turning the laser pointer is the Orientation of the microphone shown directly on the membrane.

The construction of the connecting element between the measurement microphone and laser pointer is made in Figure 6.5.2. In the upper part of the design sketch of the Laser pointer introduced. The diameter 12.6 mm is such that by inserting Direction of the arrow, the pressure switch is actuated.

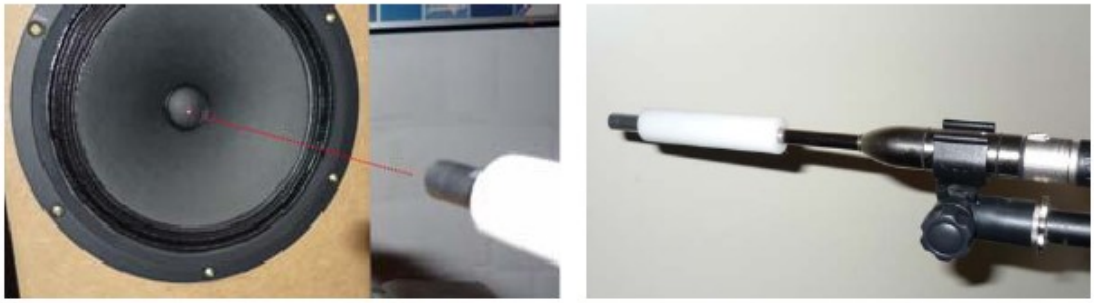


Image 6.5.1: Alignment of the microphone by laser pointer

In the lower portion (Φ 7.8 mm), the microphone is inserted. Please make constructive that the microphone by sliding can not be damaged (stop, Vent). The dimensions must be used in each course in the microphone or the laser pointer used to be adjusted.

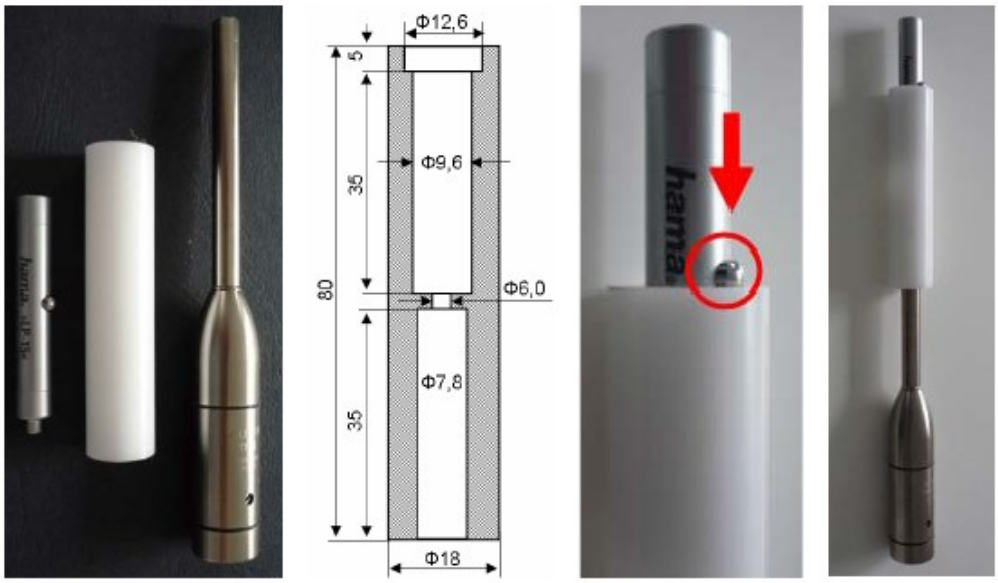


Image 6.5.2: Construction of the connecting element

7 Other aids

7.1 Speaker terminal device for measuring the TSP

Axel Ridtahler

The measurements of speaker parameters to ON Thiele & R. H. Small (TSP) based on Impedance measurements in the self-resonance (fs, Qe, Qm, Qt). A targeted mass increase the membrane performs additional weights or by installing it in a well-known housing to a resonance detuning from which we deduce further mechanical chassis parameters let (Mms, Cms, Vas WxL). These are used for calculation and design of loudspeaker enclosures required in terms of improved bass response and are basically even in the loading rich resonance valid.

Unfortunately, identifying the speaker parameters is quite prone to failure and at several measuring Passages on the same object will be always more or less large deviations tions determined. For precise determination of the parameters, it is important to have at least the output data:
DC resistance Re, membrane diameter D and the additional mass (or volume test) very accurately determined. It therefore makes no sense, the measurement results to more than specify two digits after the decimal point.

In the measurement, therefore, the membrane is vibrated - and their behavior is below be investigated. But a speaker is not only from the diaphragm and voice coil, but also from basket and magnet. And as Sir Isaac Newton (a famous English Phonetic speaker developer) said:

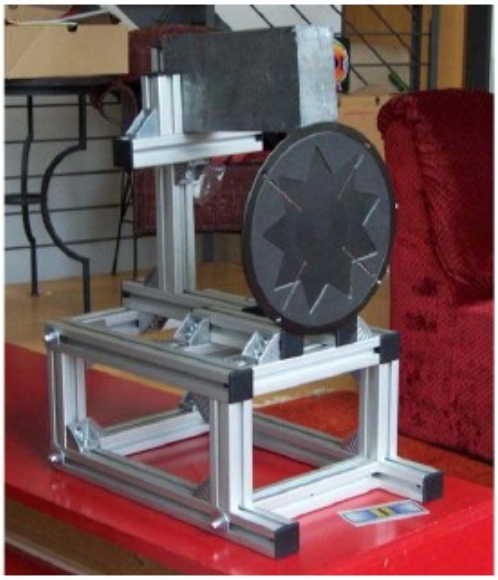
Action = reaction

Which means here that the magnet (m1 * a1) the Coil + membrane 'no less moved than the Coil + membrane '(m2 * a2) the magnet (M1 * m2 * a1 = a2). So we want only possible re-record of action, coil + membrane ', it is possible to increase the mass m1 of the loading acceleration to increase a2, m2 yes there remains the same. The forces are more in a membrane-directed and decouples the mechanical behavior of the basket or resonating table.

In practice, this is consistent, resonance-free as possible and mass-coupled mounting not very crucial, but theoretically absolutely right. Especially with measurements

tions that are subject to some additional noise interference (see above), sources of error should consistently
can be reduced.

Axel TS / P-frame is a product of the above considerations, and therefore made of aluminum Profiles assembled, very stable, virtually resonance-free, while relatively small. This can be fixed with a few simple steps on each sturdy table with clamps.
The chassis are a 12kg heavy lead block, whose supports in height adjustable bar is safely fixed and force that is deeper particularly in measurements of larger chassis and Resonance important. The high mass said reduced interactions of the membrane with the basket (Similar to a tightly bolted chassis in the housing) and avoids Resonanzeinkopp-ments in the table.



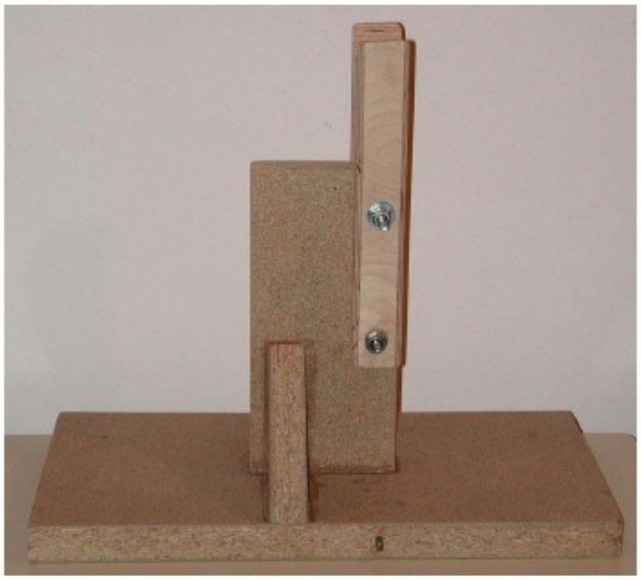
It fit the smallest to the largest tweeters and woofers exotics: a left in the picture Manger sound transducer, to the right a huge Electro Voice 30W (diameter 30 "= 80 cm)!

Matthias Leger

For so many measuring tasks, it is necessary (or at least helpful), the speaker in vertical position fix. In this paper, a simple jig presented, the replica will provide the dedicated boxes farmer no prior problems.

The basic structure is very simple: the speaker is to use a tension belt a stable base lashed. The substructure consists of a stable base and adjustable arms to accommodate different sized speaker magnets.

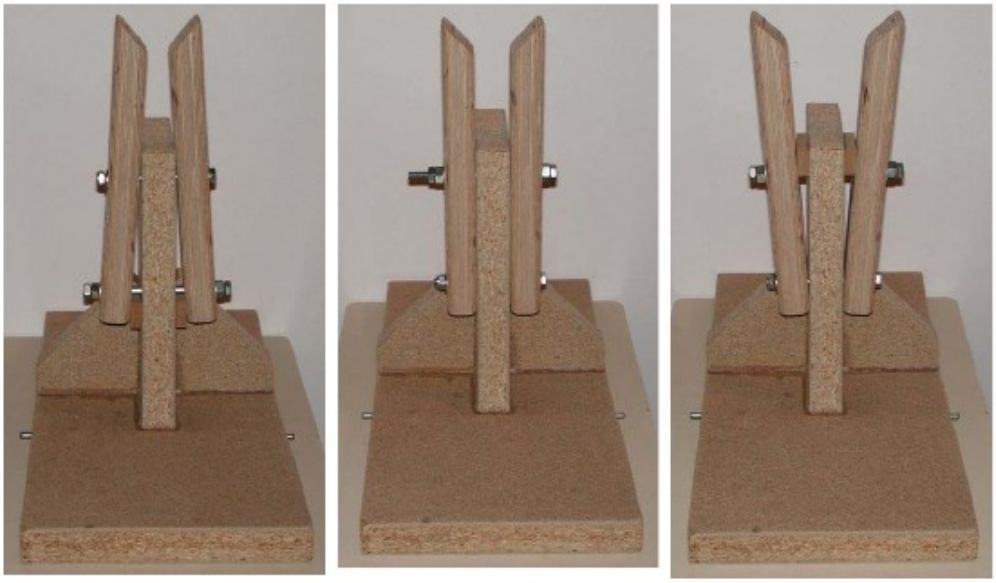
The following pictures show the construction of the clamping device. The base plate and the parts of the Base are made of 38 mm thick chipboard, against the two arms of the 36 mm Birch plywood (glued together from two plates each 18 mm). While the base plate ensure something comes oversized, stable design of the arms is due to there forces occurring (Spanngurt!) quite appropriate.



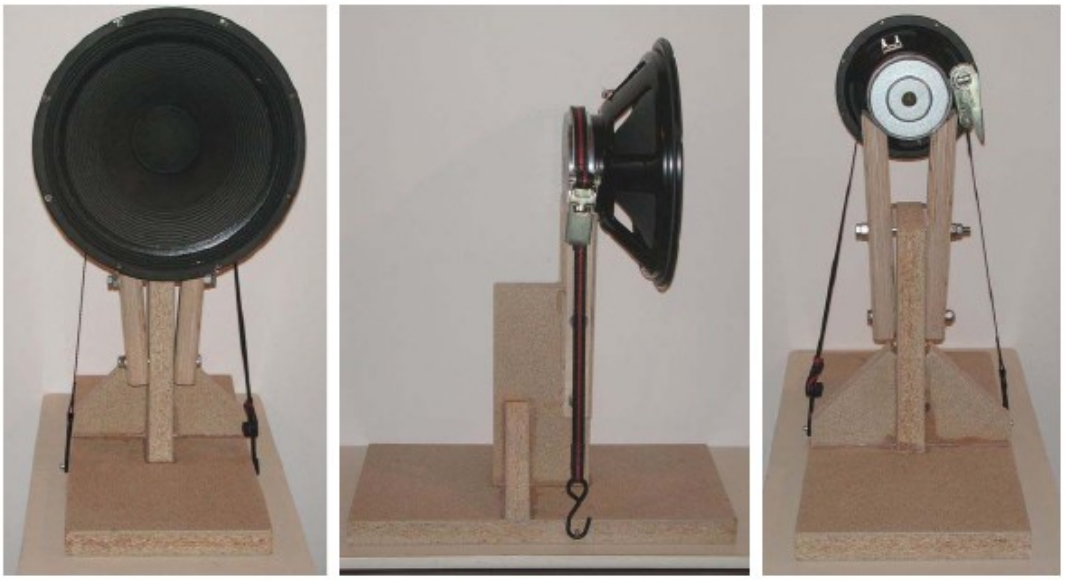
The dimensions of the base plate are presented here in the copy about 30 x 60 cm, the Height from head to toe measures a full 50 inches. With it, even huge PA with bass Magnetic diameters of 220 mm, yet sufficiently tight margins. Who, however only has to do normal large speakers, the apparatus may of course also a number of small . construct

Thus, the hook of the tensioning strap support are fixed, stable pins are in the bottom plate (or similar) involved. In this case, the problem with 10 cm long and 8 mm was measured
Steel pin released. It is also conceivable, once the strap completely around the construction around out to save yourself this step. The following pictures show both
Variants.

The distance of each other arms can by pinching small wooden blocks in many areas be varied, so that not only large but also small chassis find safe stop. The
Holes in the arms of this must of course be carried out with excess, so that the Adjust nothing stuck. The images illustrate the adjustment from small to large.



The jig in action. In the two pictures on the left with a 15 "PA Speaker, on the picture on the right with an 8 "HiFi woofer.



Heinrich Weber

The following solution uses an existing terminal device model: A clamp!
If the clamp is not intended to be permanently installed, they can - as in the picture below shown - are clamped between two grooved boards.

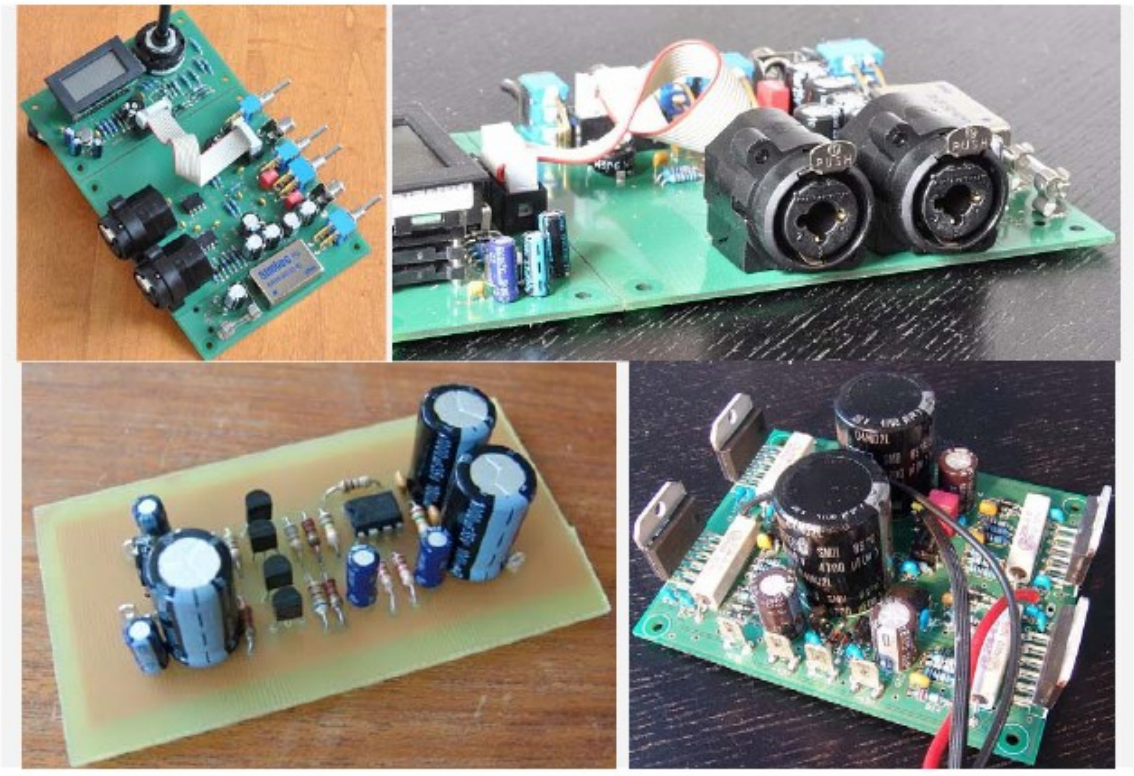


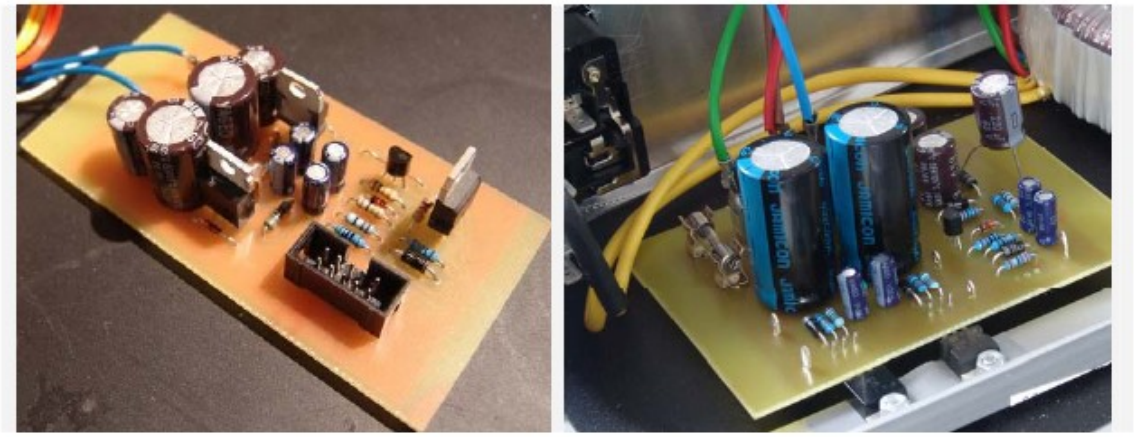

Finally it should be mentioned that the jig described here only a few of many Represents ways that you can fix speakers in a vertical position. The own Creativity knows no bounds, as always.

8 Interesting projects on the net

In addition to the projects presented here, there are more interesting - published but developments in the laboratory to see Dougie - even unpublished. More information You will find below the given links or at the following photos.

Project	Description	Board
Sound Card Measurement Interface	Measuring adapter for sound cards; http://www.m1n1.de/html/soundcard_interface.html	Yes
Monster Amp	Sound and plenty of power with 4x LM3886 http://www.m1n1.de/html/monster_amp.html	Yes
MVV Power Supply	Low-noise power supply with + / - 15V and +48 V; http://www.m1n1.de/html/mvv_powersupply.html	
ESP MVV	Microphone preamps with phantom power of ESP; http://www.m1n1.de/html/esp_mvv.html	





9 Literature and Links

[01] Mateljan, Ivo, "ARTA Manuals", Split, 2006.

[02] Heinrich Weber: A Compendium for the programs of the ARTA family

[02] AN No. 5: The ARTA Mikrofonkalibrierkammer for lower end

[03] K & T 1/05, measuring ears

[04] AN No. 4: Determination of the free-field frequency response

[05] AES2-1984 (R2003): AES Recommended Practice Specification of Loudspeaker Components Used in Professional Audio and Sound Reinforcement http://users.skynet.be/william-audio/pdf/aes2-1984-r2003.pdf

[06] IEC 60268-5: Sound system equipment - Part 5: Loudspeakers

[07] AN 4 - Measurement of Peak Displacement Xmax - Application Note to the KLIPPEL ANALYZER SYSTEM

[08] http://www.st.com/stonline/products/literature/ds/1057.pdf

[09] David Davenport: Audio Component Grounding Interconnection; http://www.diyaudio.com/forums/diyaudio-com-articles/163575-audio-component-grounding-interconnection.html

[10] http://www.m1n1.de/html/hifi.html

[11] John Conover: Using the Panasonic WM61A as a Measurement Microphone; http://www.johncon.com/john/wm61a/