

Tempo Two



DESCRIPTION

Two-way, bass-reflex loudspeaker with 18cm coated NRSC fibre glass cone midwoofer + 27mm fabric dome tweeter + wave-guide.

SPECIFICATIONS

Sensitivity • 86 dB / 2,83 volts
Impedance • 8 ohms nominal (minimum 6,2 ohms @ 200 Hz)
Frequency response • 40 - 20.000 Hz (-3dB) / 35 - 25.000Hz (-6dB)
Crossover frequency • 2100Hz / 15dB (2nd order series crossover)
Power rating • circa 55 watts RMS
Dimensions (W x H x D) • 211 x 1000 x 328 mm (without outriggers)
Weight (finished product) • 22 kg each

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[DOWNLOAD DATASHEET SEAS 27TFF / H0831](#)

[DOWNLOAD DATASHEET VISATON WG148R](#)

The loudspeaker kit contains all the components you need, even small items such as black screws for mounting the drivers, gasket sealing tape, etc. The only thing you need to obtain separately is the wood for the cabinets. The hard-wired crossovers come pre-assembled, matched and tested. The price for this DIY loudspeaker kit is EUR. 339,- each / EUR. 678,- per pair.

INTRODUCTION

The Tempo is designed as a time-aligned two-way loudspeaker, in a living-room friendly package, using cost friendly components. Great attention has been paid to optimum synergy between the drivers, cabinet and crossovers. All this results in a loudspeaker that is extremely neutral and coherent. Back in early 2003 I designed a very similar loudspeaker called [Tempo](#) so logically this loudspeaker has to be named Tempo Two. The original Tempo used exactly the same tweeter by Seas of Norway and basically the same woofer. The only difference between the midwoofers is the cone material, the old Tempo had a coated NRSC paper cone midwoofer by Vifa of Denmark, the new Tempo Two has a coated NRSC fibre glass cone midwoofer by Scan-Speak of Denmark. Other parts from which the midwoofer is made are the same and the chassis even comes off the same machines. When Vifa was taken over by an investment company in 2005, Scan-Speak bought the old Vifa factory and used the machines to produce parts for their Discovery Line of drivers. These parts were originally used for the Vifa Premium Line products. That is why, for example, the Scan-Speak 18W8434G00 has the same chassis as the Vifa PL18-WO-09-08 and the Scan-Speak D2606/920000 shows great resemblance to the Vifa PL27TG05-06. Just for fun, check out the [Vifa Premium Line Brochure 1995](#) and compare the looks of some of the tweeters and woofers from the current day [Scan-Speak Discovery](#) line of drivers.



THE DRIVERS

So the Tempo Two uses an 18cm Scan-Speak Discovery midwoofer and a 27mm Seas Prestige softdome tweeter. The tweeter is coupled to a Visaton wave-guide. A wave-guide has a couple of advantages, one being that it increases efficiency at lower frequencies which means that the electrical crossoverpoint can be chosen higher than usual and still result in a low acoustic crossoverpoint. This increases the power handling of the tweeter considerably, resulting in lower distortion levels. Another advantage of a wave-guide is that the acoustic center of the tweeter is set back a few centimeters, bringing it in line with that of the midwoofer. Seeing that time-alignment is one of the design goals of this speaker, using a wave-guide does come in handy in achieving that. The datasheets of these three components can be downloaded in the grey section at the top of this page.

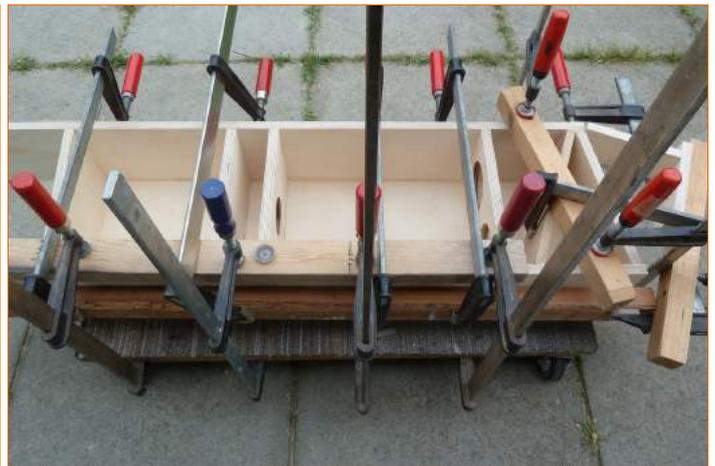




Connecting the wave-guide to the tweeter is quite straight forward. The only thing is that the screw holes on the tweeters' face-plate have to be drilled half a millimeter larger to compensate for the difference in alignment with the screw holes on the wave-guide. The correct sized screws are supplied with the wave-guide.



The cabinets are made from 18mm / 13 ply baltic birch plywood. The version I used is so called B/BB quality which means that one side is free from any imperfections, creating a nice surface that can be treated with clear varnish. The construction is so that all the bracing panels, front, rear top and bottom panels are glued between the two side panels. I cut the side panels exactly to size including the 83 / 97 degree angles. The front and rear panels were cut with a little extra length and after glueing in place, were trimmed and sanded to make a perfect fit. Don't forget to make a couple of small holes to pass the internal wiring from the drivers to the crossover compartment in the bottom of the cabinet.





Above and below the main acoustic volume of the loudspeaker are two Helmholtz absorbers, also called Helmholtz resonators. Helmholtz absorbers consist of an oscillating port connected to an air volume. The port has an acoustic mass which results from its geometry and the specific density of the air. It rests on the elastic cushion formed by the air contained in the volume behind the port. Together they form an oscillating system with a specific resonance frequency that can be easily excited and therefore can be used to damp individual eigenmodes of the main acoustic volume which develop at low frequencies. In order to make a Helmholtz resonator absorb sound, the air oscillating in the opening must be slowed down by friction. This is achieved by means of filling the volume directly behind the port with Intertechnik Sonofil acoustic damping material. For this loudspeaker I choose the port size in such a way that the length is equal to the thickness of the material, in this case 18mm. This resulted, in combination with the volume of 3,4 liters for each chamber, in a port diameter of 76mm's.

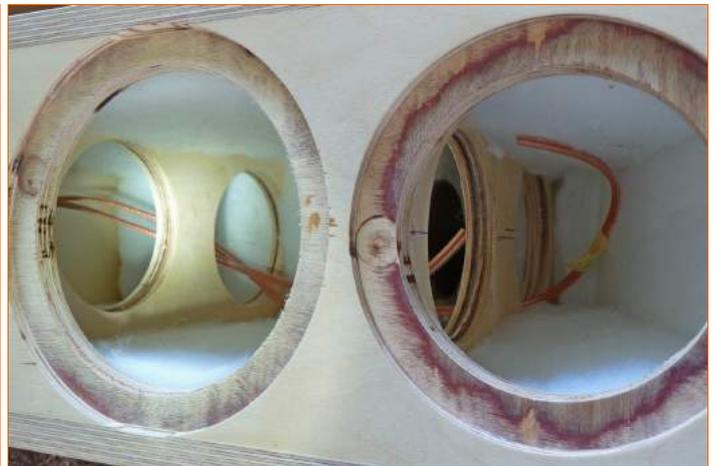
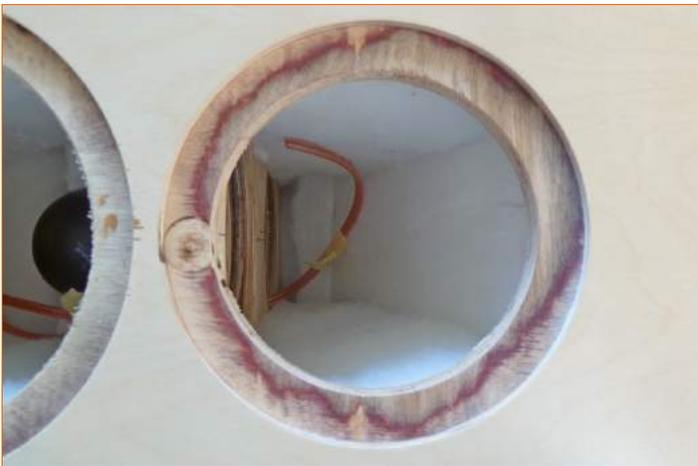


The Intertechnik Sonofil acoustic damping material must be placed in the two absorber volumes before the last side panel is glued in place. Otherwise it is not possible to evenly arrange the material around the two compartments. Seeing that the driver cut-outs were made after the cabinets were glued together I had to cover the Helmholtz ports with some old newspaper, held into place by masking tape. This keeps any dust from getting stuck in the Helmholtz absorbers. The newspaper can easily be removed afterwards via the tweeter and woofer cut-outs.





The volume in which the midwoofer and tweeter are placed is lined with a special type of polyester fibre that varies in density. One side has a higher density than the other, the higher density side is placed against the cabinet walls. No glue is needed, the polyester fibre sheets are simply held in place because they are cut slightly over-sized. Gasket sealing tape is applied to the rear of the midwoofer and the rear of the wave-guide and on the inside of the port flare. The binding-post plate is supplied with it's own air-tight seal.

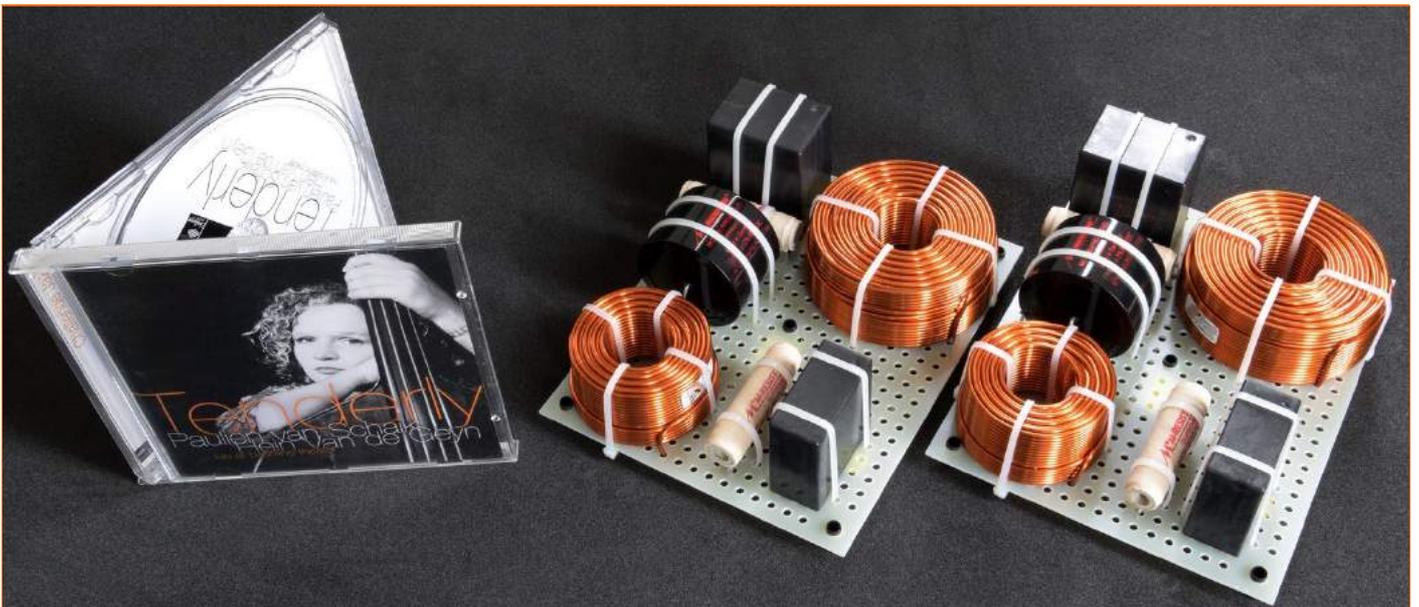


The bass-reflex ports consist of three parts: an external flare, a straight pipe and an internal flare. The pipe is cut to length so that the total length of the ports is 140mm including the inner and outer flares. The three sections are held together with gaffer tape (like I did) or for a more permanent solution, glued together with PVC glue. The completed port is held in place by means of six black allen-head screws. These are supplied with the kit as are all the screws for the drivers and for the binding-post plates.



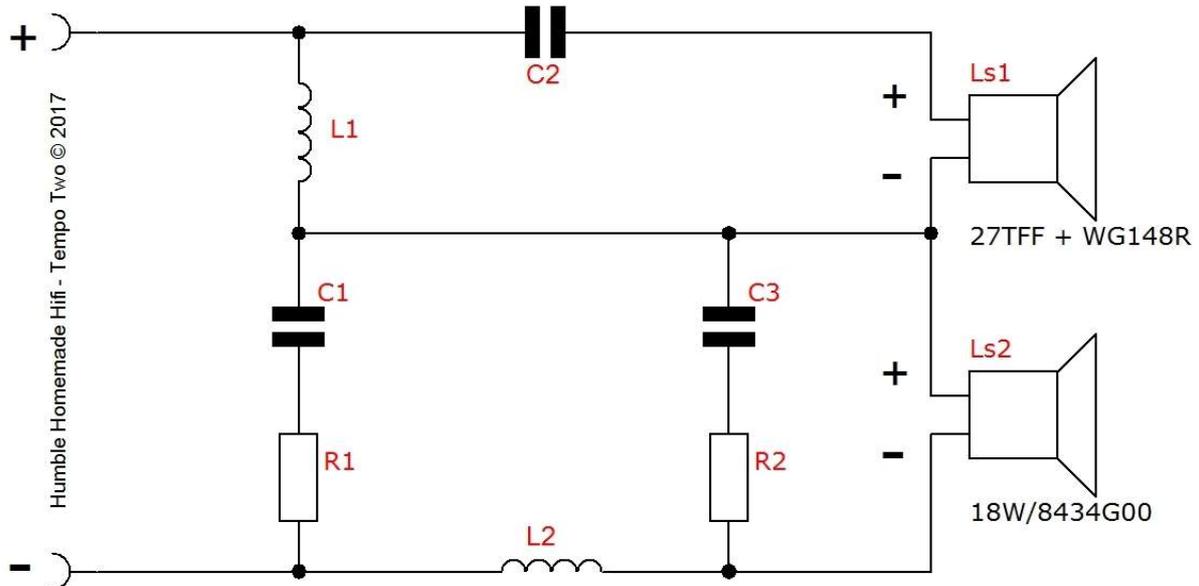
THE CROSSOVER

The crossover of the Tempo Two is, like the crossover of the original Tempo from 2003, a series crossover. Not that I was determined to design a series crossover from the start, it just turned out that in the end this crossover gave the best overall results. The Tempo Two saw many different crossovers before I came to this final version. High-order and low-order parallel networks but also series networks in different configurations.



In the schematic below you can see the configuration of this network. The tweeter high-pass function is formed by C1/L1/C2 and the midwoofer low-pass function is formed by L1/C1/L2. With a standard parallel network with three components per leg this would be a third-order network with 18dB per octave electrical slopes. In a series crossovers some of the components are shared by both drivers, in this case inductor L1 and capacitor C1. This results in slopes that are somewhere between second and third order with 15dB's per octave attenuation. The great thing about series crossovers is that there is no "overlap" nor "underlap" between the two drivers. The incoming signal is neatly distributed over the network-driver-combination without anything added nor subtracted

from the original signal. I believe this is one of the reasons why series crossovers sound so coherent, dynamic and spacious. The remaining components in the crossover are for correction purposes. Resistor R1 lowers the output level of the tweeter several dB's to match that of the midwoofer. The Zobel network consisting of resistor R2 and capacitor C3 smooths the inductive rise of the midwoofers' impedance so that the crossover see's a more constant load, even octaves above the crossoverpoint.



Inductors

L1 = Jantzen Audio 13AWG baked varnish air-core / 1,80mm wire
 L2 = Jantzen Audio 13AWG baked varnish air-core / 1,80mm wire

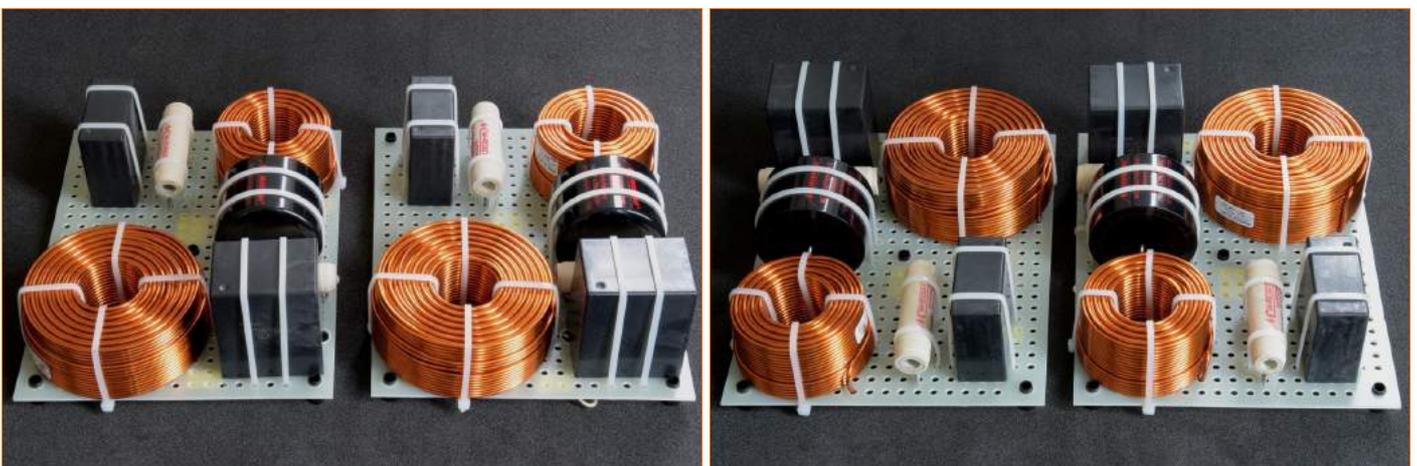
Resistors

R1 = Mundorf MResist Supreme / 20 watts
 R2 = Mundorf MResist Supreme / 20 watts

Capacitors

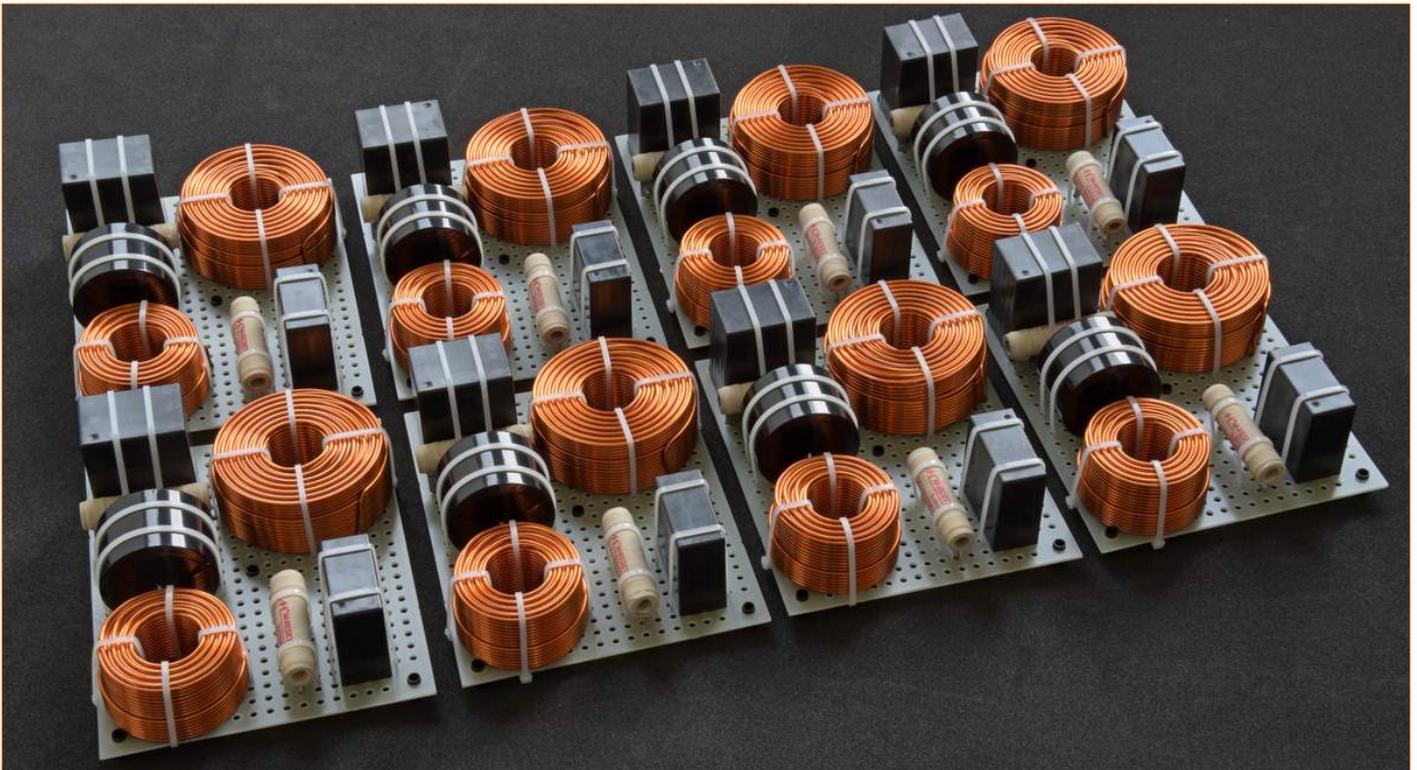
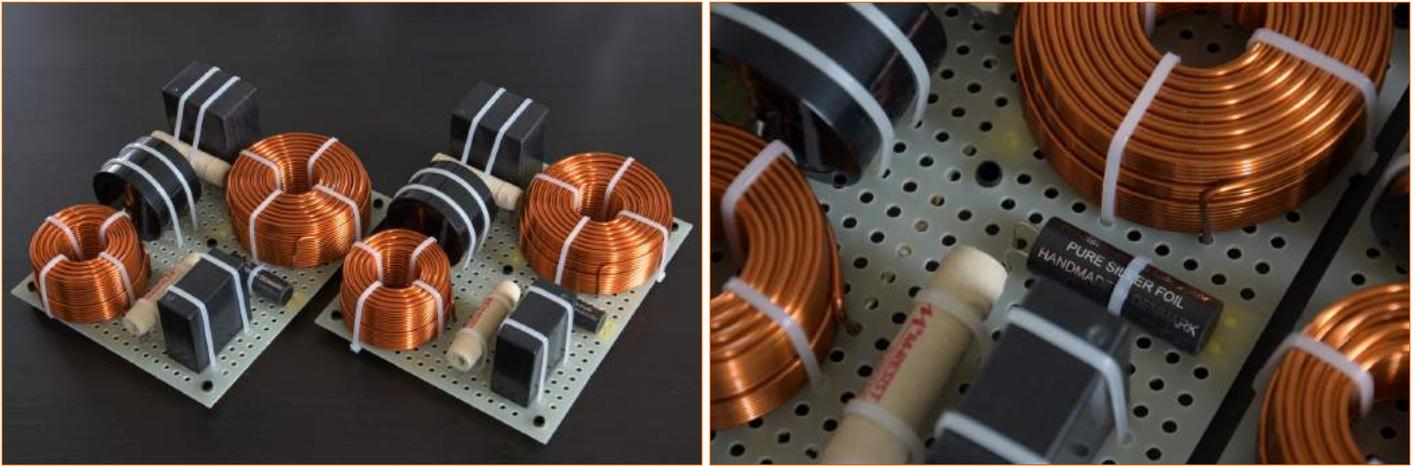
C1 = Panasonic EZPE / 1100VDC
 C2 = Mundorf Supreme EVO Oil / 800VDC
 C3 = Panasonic EZPE / 1100VDC

The quality of crossover components is very important for the overall sound of any loudspeaker. With a series crossover it is especially important as (the name suggests) the components are always in the direct series signal path of either or both of the drivers. As not to make the Tempo Two loudspeaker kit too expensive I did extensive listening tests with numerous combinations of crossover components that I believe have an extremely good price / quality ratio. This testing was done after the actual typology of the crossover and the values of the components were known. Seeing that copper foil inductors are not the cheapest around I decided to use large 13AWG (1,80mm) air-core inductors with baked varnish wire. Even for the relatively large inductor L2. Tests with much lower cost ferrite-core inductors showed a loss in spatiality and dynamics. So the choice of large gauge air-core inductors was quickly made. Choosing the capacitors was completely different story.

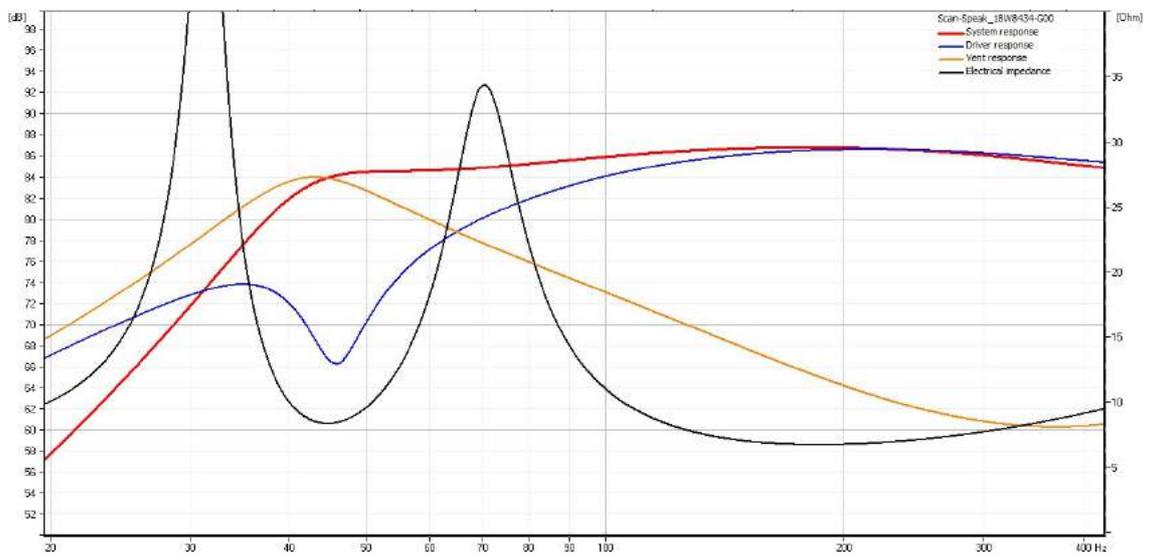


During my search for the right capacitors for the Tempo Two I came across the 1100VDC Panasonic EZPE. This capacitor is an industrial metallized polypropylene film capacitor normally used for DC filtering in solar inverters, wind power generation, industrial power supplies and inverter circuits in appliances such as air conditioners etc. For me the most important thing is that it sounds extremely neutral! In a positive way nothing stands. Seeing that the Seas 27TFF is also rather neutral I wanted to add a little bit of detail to give the overall sound of the loudspeaker a fraction more "flair". So I needed to combine the Panasonic EZPE with something that is especially good in the top end of the spectrum and also isn't too expensive. This lead me in the end to the Mundorf Supreme EVO Oil. The Mundorf added just that little bit of extra precision and richness that the Tempo Two needed. The two resistors were a no-brainer: the Mundorf MResist Supreme. Probably the best resistor available that doesn't break the bank. The result: more spatial and lush than standard MOX resistors. Below an example of the Tempo Two crossovers with Duelund

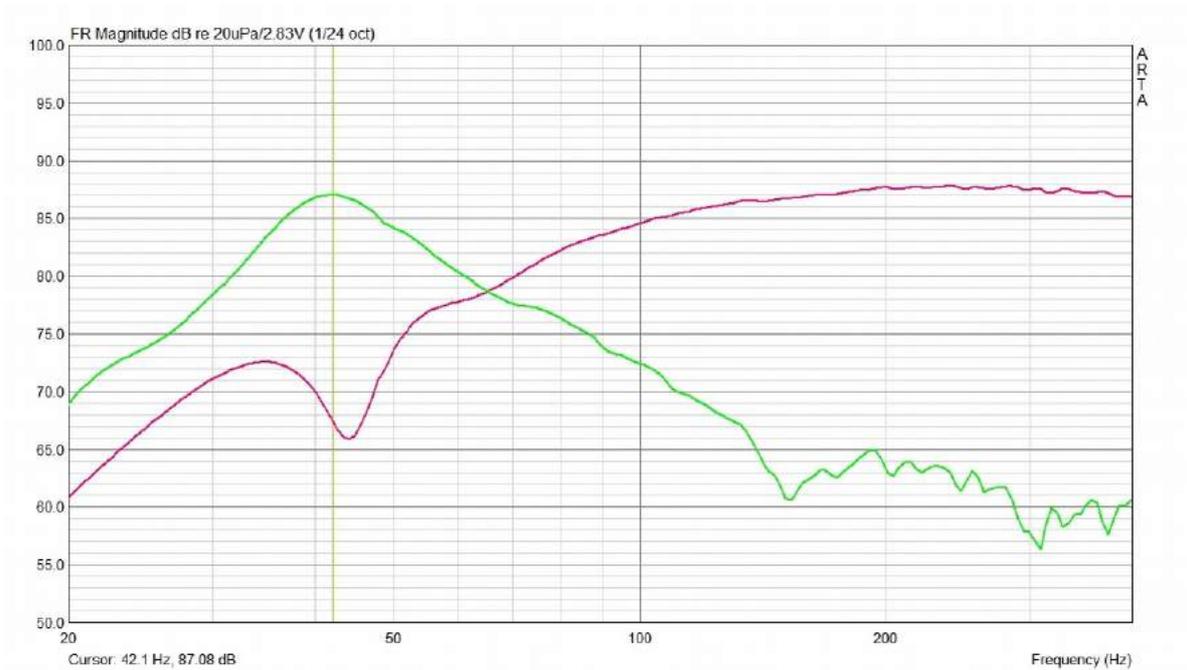
Silver Bypass capacitors.



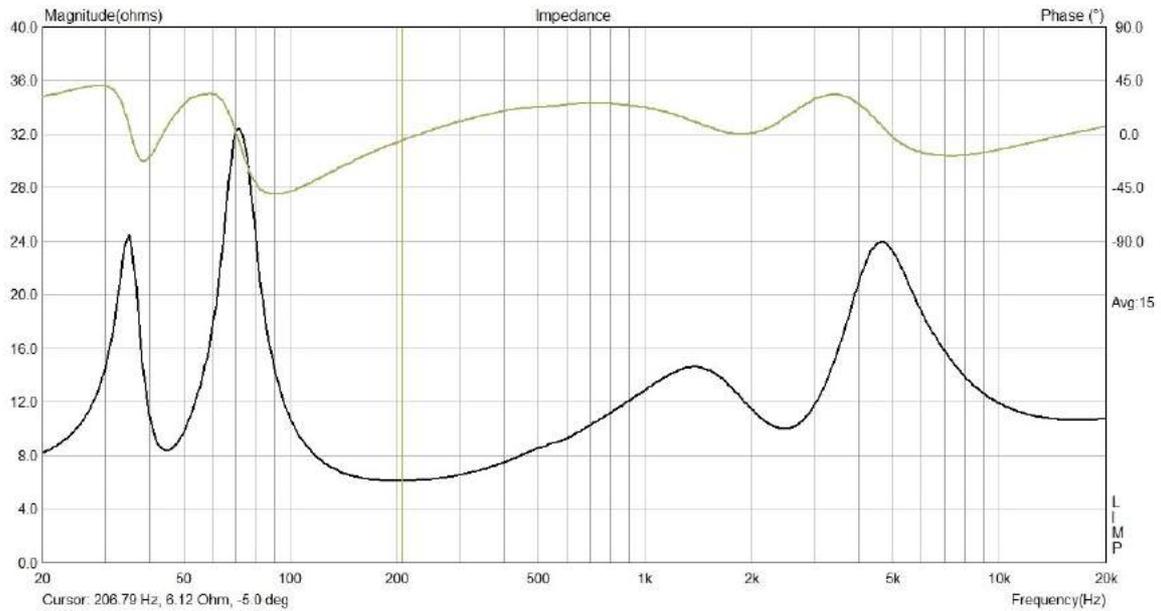
MEASUREMENTS



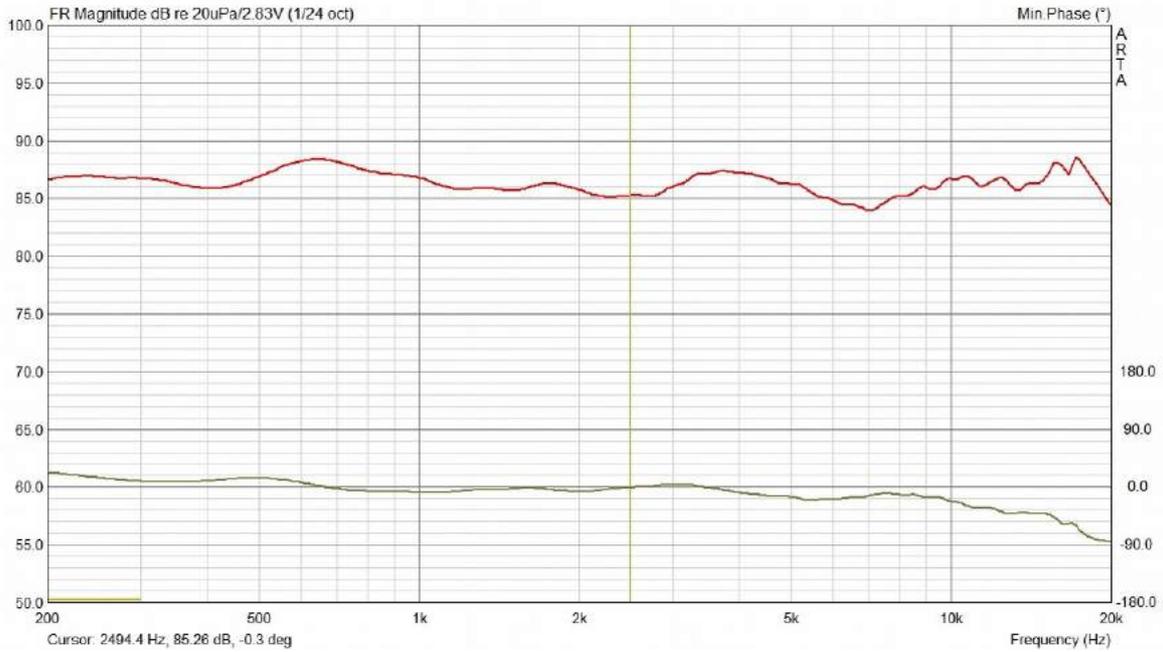
Modelled vented box woofer frequency response (blue) / port frequency response (orange) / summed frequency response (red) and corresponding impedance response (black). Range 20Hz - 400Hz; Vertical SPL scale 50dB to 100dB's; Vertical impedance scale 0 ohms to 40 ohms's.



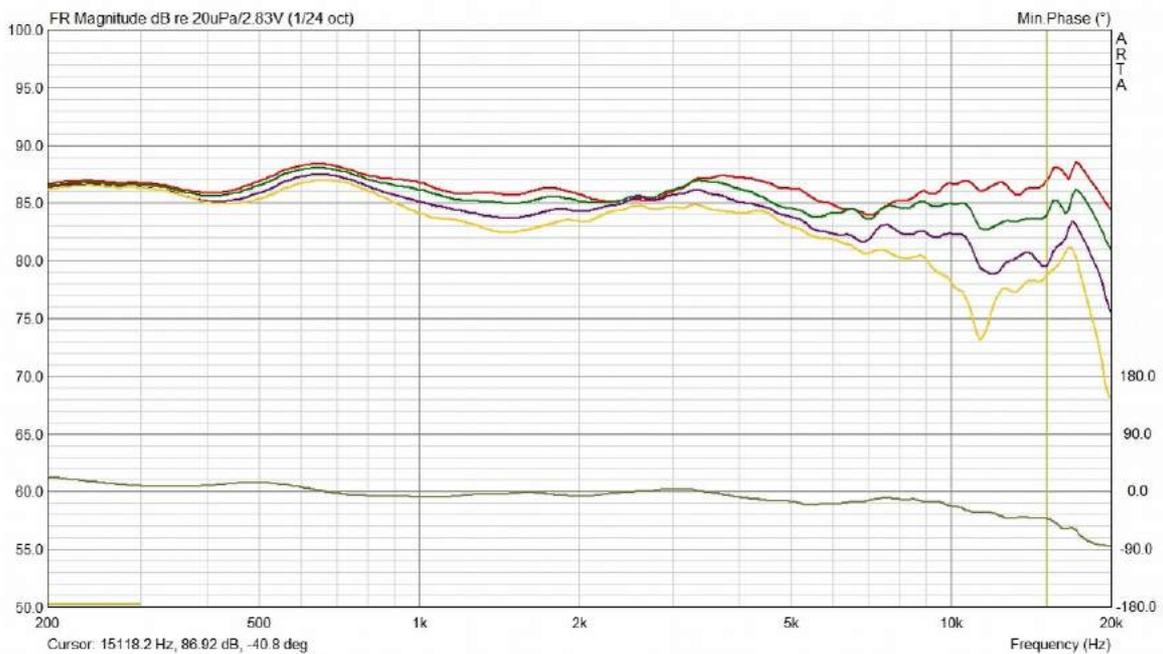
Measured vented box woofer frequency response (purple) and port frequency response (green). This corresponds exactly with the modelled response curves. Range 20Hz - 400Hz; Vertical SPL scale 50dB to 100dB's.



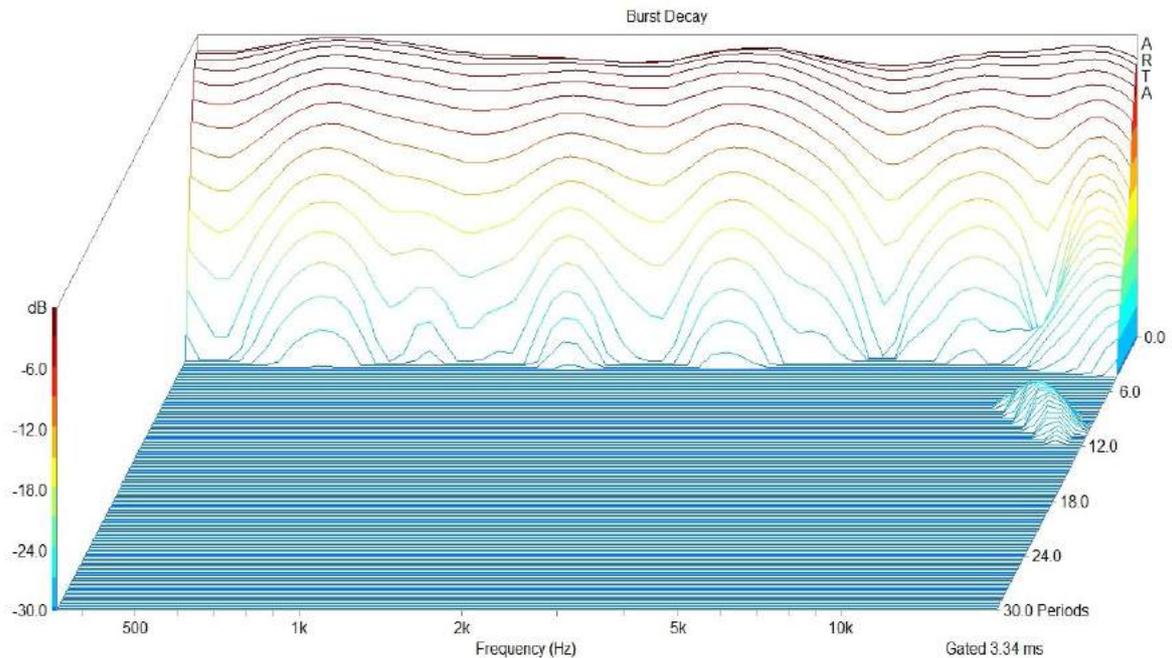
The impedance plot, with it's nominal 8 ohm impedance, shows an easy load for most amplifiers. The impedance minimum is just above 6 ohms around 200Hz. In the bass, where most current is demanded by the music, the impedance stays well above 8 ohms. The port tuning frequency can be seen at 45Hz.



The frequency measurements show a relatively smooth frequency curve that is within +/- 1,5dB for the entire range. The little ripple at around 17kHz is an attribute of the tweeter itself and can be seen in the SEAS datasheet. Off-axis the overall curve stays roughly the same, only lower in level. The wave-guide here is creating a nice constant directivity effect. By adjusting the amount of toe-in you can influence the character of the speaker slightly. The frequency measurements are taken at listening height (between the midwoofer and the tweeter) of which the red curve is on axis, green is 15 degree's off-axis, purple is 30 degree's off-axis and yellow is 45 degree's off-axis. System efficiency is very normal for a small two-way floorstanding hifi loudspeaker with around 86dB's / 2,83V.



The burst decay of the finished system shows a very smooth decay. Range 300Hz - 20kHz; Vertical scale 0dB to -30dB's; Time scale 30 periods.



LISTENING IMPRESSIONS

Extremely neutral and coherent, that is what the Tempo Two is. It doesn't matter what type of music you listen to, the Tempo Two simply plays it as it is. Bass has body, the midrange has a nice natural timbre and the treble is well defined and smooth at the same time. Spatial information is also very convincing, I guess it is due to the perfect time-alignment of the tweeter and the woofer. Things like the decay of notes in the acoustics of the recording venue are easy to follow. You will find some video's of the Tempo Two on [YouTube](#) to give you a quick impression.



Contents of the Humble Homemade Hifi DIY loudspeaker kit Tempo Two (standard version).

What customers say about the Tempo Two:

"Hello Tony, congratulations. I think you are a very talented speaker designer! The Tempo Two is a very surprising loudspeaker, very, very competent. Classical music is incredibly good, hardly any coloration, very expressive, subtle and dynamic (stopping and starting, loud and quiet). The speakers make the music far more interesting to listen to, you can hear the subtleties of the performance. My worries about the bass being too strong for my room were unnecessary, the bass is pleasantly deep but not overblown nor "one notey". The treble is also very good, cymbals sounding incredibly clear and detailed. I can now understand the description of the speaker sound on your website much better. I enjoy the Tempo Two's and their open- and subtleness. The speakers will not suit everyone, heavy metal fans beware, but I am enjoying rediscovering my CD's with all the tiny nuances that make up the music. Recording quality is clearly shown up, and well recorded songs are a joy. Once again, thanks for the speakers, a bargain!" (Chris - Wasbüttel, Germany).



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Last updated 12.1.2019