



TW-Audio 15/2 Top with Subwoofer

A compact passive FOH and monitor PA-system
Made in Germany

In 2004 Tobias Wüstner has founded TWAUDIÖ in the southern German town of Ludwigsburg. Ever since he has been successfully developing professional sound systems at premium quality.

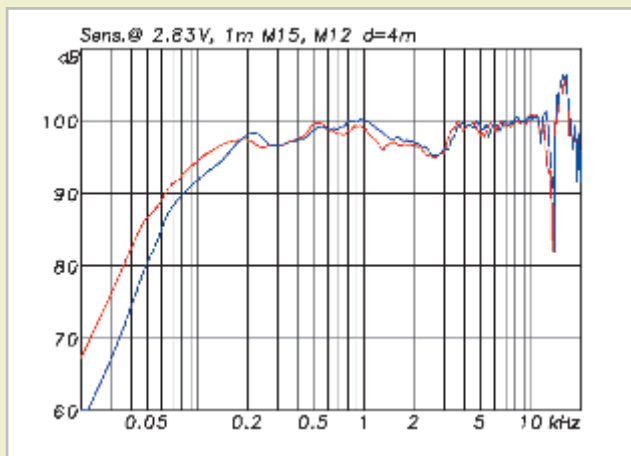
Well known in the business for quite some time, Tobias Wüstner has worked as sound engineer, run a PA Rental Company and developed loudspeakers for several manufacturers since late 80's.

Similar to other developer careers, it was a logical step for Tobias Wüstner's to establish his own company to development and manufacture integrated sound solutions.

With TWAUDIÖ he has grown a company with the clear mission to develop and manufacture customer-oriented products at superior quality and performance. TWADUIÖ is taking a very serious business approach, which is reflected in extensive product development and investments in latest testing technologies that exceeds common standard of most manufacturers.

As an example TWAUDIÖ horns are developed by using BEM simulations and are optimized to the shape of drivers wavefront output.

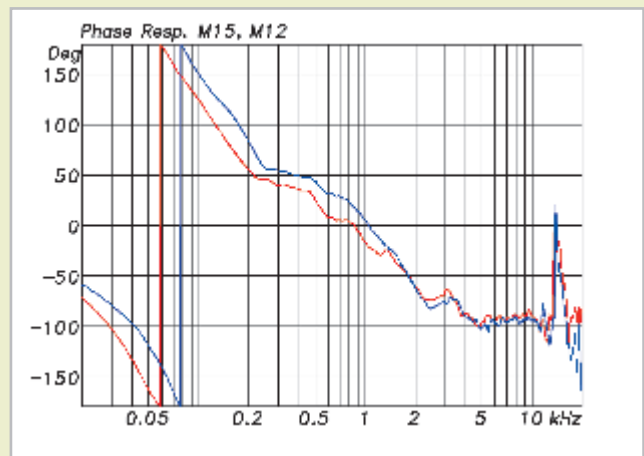
The current TW-Audio product range includes the M-series with the B15 subwoofer, the entirely horn-loaded 2 x 12" top T24, the 2 x 15" sub-



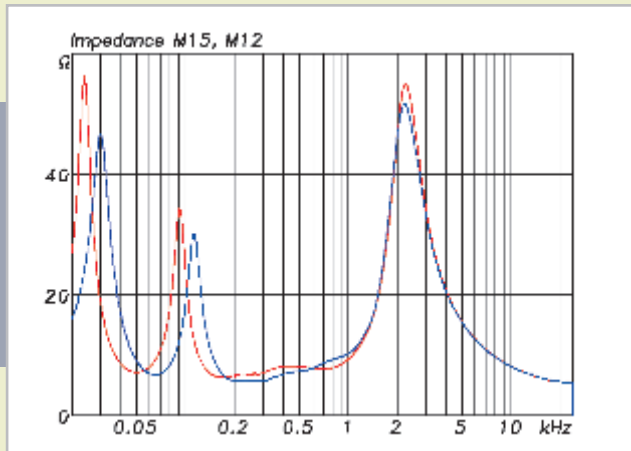
Pict. 1: Frequency response with sensitivity of M15 (red) and M12 (blue)

Sensitivity 100 Hz – 10 kHz: M15: 97.7 dB, M12: 97.8 dB

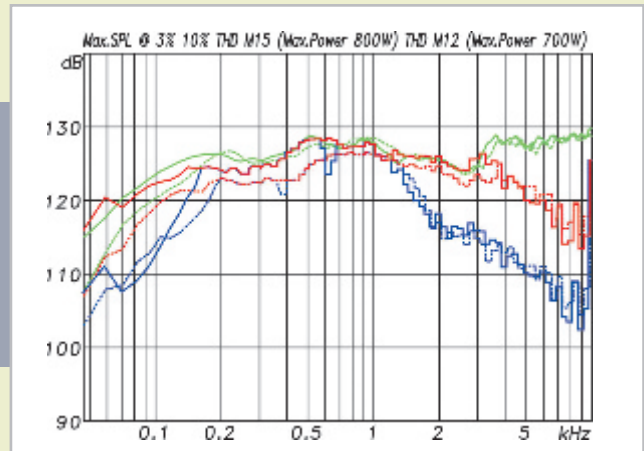
Sensitivity 50 Hz – 100 Hz: M15: 91.0 dB, M12: 87.4 dB



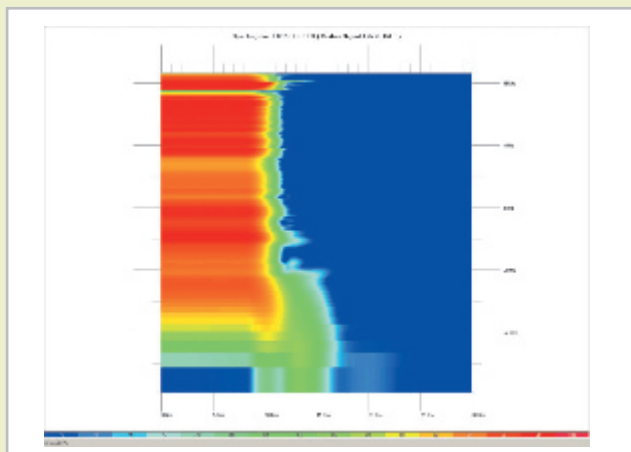
Pict. 2: Phase response of M15 (red) and M12 (blue). As expected, the curves are almost identical except for a small difference in the low area, since the M12 has a slightly higher cut-off frequency compared with the larger M15.



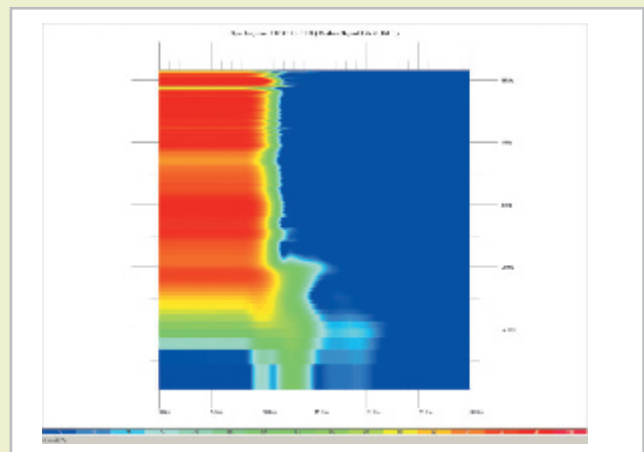
Pict. 3: Impedance chart of the M15 (red) and the M12 (blue). The higher tuning of the bass reflex resonator in the M12 to a frequency of 65 Hz as opposed to 50 Hz in the M15 can clearly be recognised. The impedance lows are at 6.3 Ω (M15) and 5.6 Ω (M12).



Pict. 4: Maximum level at max. 3% (blue) and max. 10% (red) THD as well as calculated maximum level as a result of sensitivity and maximum load for the M12 in dashed lines for the M12 and continuous lines for the M15.



Pict. 5: Spectrogram of the M15 with a very straight decay pattern almost free of resonances. The tweeter is especially exemplary.



Pict. 6: Spectrogram of the M12.



The 15" driver of the TW-Audio B15 is a custom-made unit by Eighteen-Sound with very large linear movement and Neodym magnet.

woofer B30 and the recently introduced line-array VERA 10 as 90° and 120° version. TWAUDIO also provides the specially developed ASID / Hoellstern four-channel system amplifier Delta12.DSP with integrated speaker-management (24 Bit / 96 kHz) and up to 12 kW power. The system setups can be switched and edited via PC. Alternatively there is the possibility to use any amp with internal or external controller – suitable parameter lists are available.

M-Series

The „M“ of the M-Series stands for „multi-functional“ and describes the application range of the models M8, M12 and M15. The speakers are designed for use in front-line sound for smaller locations and as monitor system on the floor, as drumfill or sidefills on large stages. The M-Series can also be seen in different positions in fixed installations or typical club setups.

As the names suggest, the three models are fitted with 8“, 12“ or 15“ LF speakers, which are matched for the highs by a 1“ HF-horn (90 x 60) in the M8 and with a 1,4“ horn (75

x 50) in the M12 and the M15. The separation is done with integrated passive crossovers in all cases. These are designed to handle the system equalisation in addition to the actual crossover function, enabling the speakers to be used with any amplifier even without an additional external controller. The alternative to this would be a pure crossover function based on passive elements combined with system equalisation in a system controller ahead of the power amp. This approach, with its most famous representation probably being the Nexo PS15, has several advantages from a technical point of view, but restricts the flexibility to a certain degree, since using the additional controller can not be avoided. However, for the M-series Tobias Wüstner decided to use the first concept, a complete passive filtering.

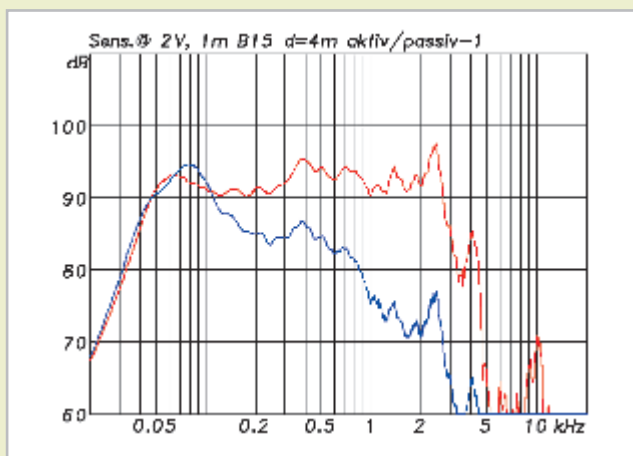
M15

The M15 is a typical representation of the 15/2 class in a universal cabinet, making the speaker useable for normal standing use as well as a floor monitor with two dif-

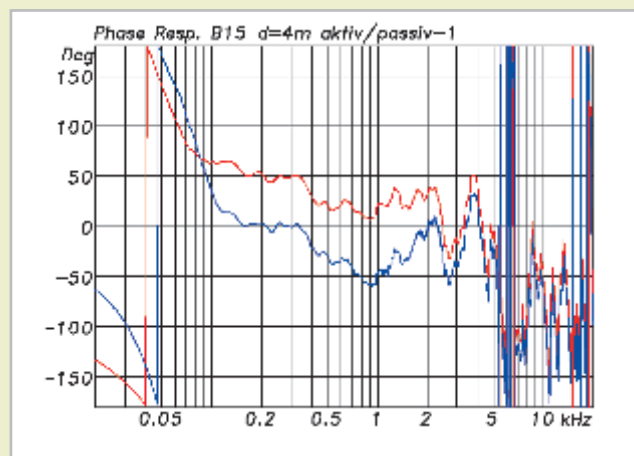
ferent angles of 50° and 70°. For use as symmetrical floor monitors there are left and right versions. The bottom plate features the obligatory mounting socket for a stand as well as an air cargo rail (there is one on the top too) and a grip. A mounting bracket to be attached to the air cargo rails is available as an accessory. The electrical connection is done via NL4 connectors, of which two are sunk in the floor, enabling the connection of the Speakon plug and the cable without risk of breakage. The cabinets are conventionally made from multiplex (15 mm) and protected with a solid 2 mm steel grille with a foam covering. In addition a special coating material, qualifying them as waterproof, covers the membranes of the conical speakers. With a weight of 26 kg the M15 is neither very heavy nor light in this class, but can definitely still be handled well by one person alone.

M12

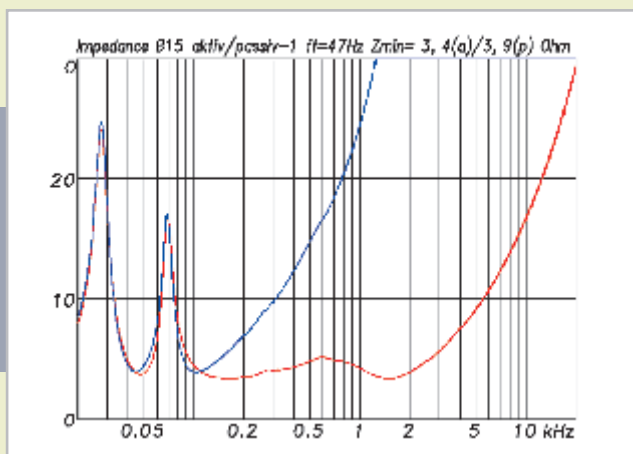
The M12 with 20.5 kg is quite a bit lighter and a bit more compact. The features are identical with the M15 except for the LF-



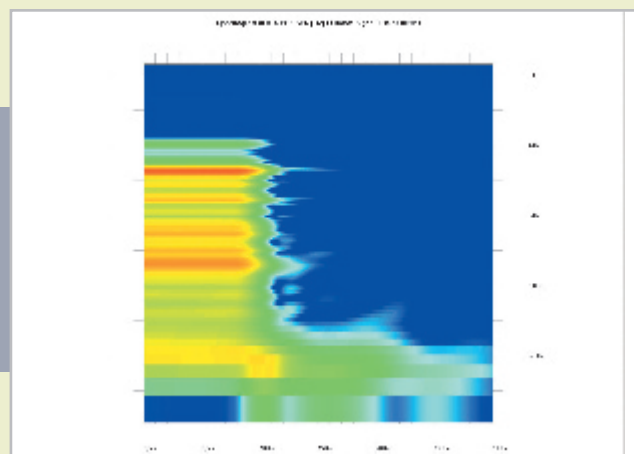
Pict. 7: Frequency response with sensitivity of the B15 in active mode (red) and with passive lowpass-filter (blue) for a combination with M15 or M12. The medium sensitivity is at 92.3 dB (active) or 93.0 dB (passive) between 50 Hz and 100 Hz.



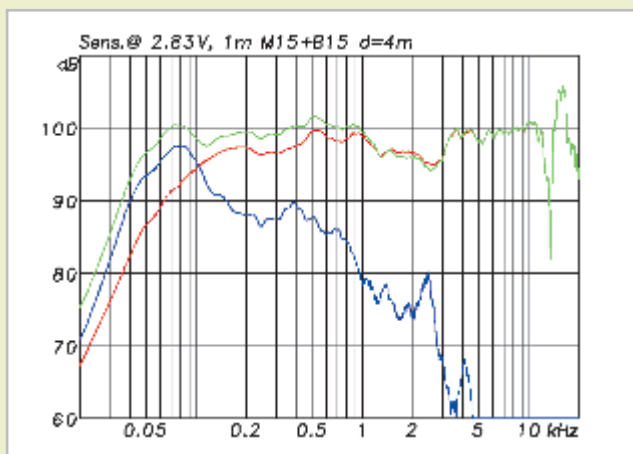
Pict. 8: Phase response of the B15 in active mode (red) and with passive lowpass-filter (blue).



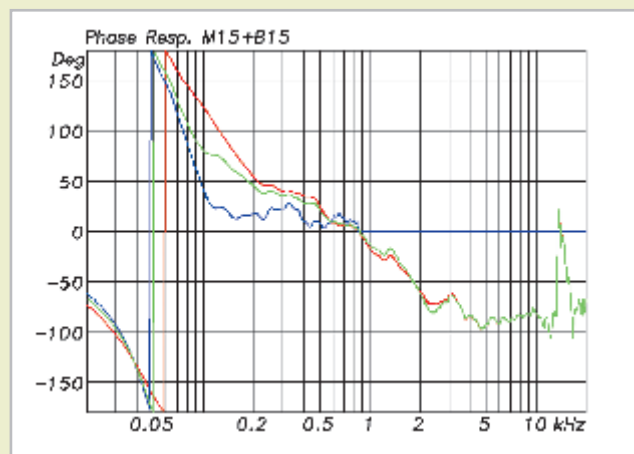
Pict. 9: Impedance chart of the B15 in active mode (red) and with passive lowpass-filter (blue). The tuning frequency is at 47 Hz and the impedance minima are at 3.4 Ω (active) and 3.9 Ω (passive).



Pict. 10: Spectrogram of the B15 in active mode. A first small resonance is at 380 Hz and therefore far outside of the frequency range envisioned.



Pict. 11: Frequency response of the M15 (red), the B15 with passive lowpass-filter (blue) and the combination of both systems (green). The sensitivity is referenced here to 2.83 V and therefore to a nominal impedance of 8 Ohm.



Pict. 12: Phase response of the M15 (red), the B15 (blue) with passive lowpass filter and the combination of both systems (green). Under these circumstances top and subwoofer are matched well for a passive combination in the crossover range.

driver which is a 12" unit in this case and is made by Italian manufacturer Eighteen-Sound like all other driver components. The conical speaker of the M12 and M15 are modified standard models, the bass chassis of the B15 is a custom build unit. The HF-units in the M12 and M15 are completely identical, which also applies to their test measurements in combination with crossover and LF-speaker, enabling both models to be used together without causing phase problems. The HF-driver, a 1.4" type by Eighteen-Sound works through a 75 x 50 degree horn with a square opening and mounting plate, so it is easy to mount it in a position turned by 90° when necessary. The distinctive feature of the HF-unit is that the horn form is optimised with the „Boundary Element Method“ (BEM) to the driver used. To do this, the waveform coming from the driver is first scanned in high resolution with a tiny 1/8" microphone and a special xy-table and then used as the base for calculating the spread of the wave in the horn. The optimal horn form for the planned dispersion character under the given constraints like lower cut-off frequency, size of the horn opening and length is then done through the BEM-optimisation without a protracted construction of prototypes and several iteration steps. The horn length should be as short as possible to avoid distortion, which can of course sometimes be detrimental to the dispersion character aimed for – and then a good compromise has to be found, which is also very fast with the BEM method. The base for all these calculations are based on research activities of Dr. Michael Makarski at the German university RWTH Aachen and has been consolidated in his 2006 doctoral thesis and have become quite popular with speaker designers since then.

Subwoofer B15

In addition to the M-series there is the subwoofer B15 with 1 x 15" in a bass-reflex cabinet with the very compact size of 506 x 440 x 560 mm (H x W x D) and a weight of only 23 kg, which can be placed directly under a M15. Of course it can also be combined with the M12 and the M8, but in these cases the front sizes do not fit perfectly. For such a combination we automatically



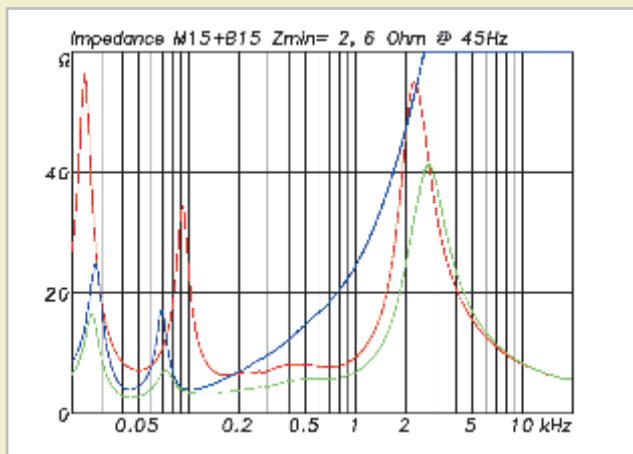
The two NL4 connectors are recessed in the bottom, so Speakon plug and cables can be protected from breaking.

think of a controller with two power amps in active use. We have learned from experience that everything else would be a rather half-hearted compromise since top and subwoofer can hardly be matched with a passive crossover in this frequency range due to the especially pronounced impedance fluctuations found here. Those who know Tobias Wüstner even a little bit will know that bad compromises are not his thing at all. He therefore spent a lot of effort on finding a solution enabling a simple combination with the subwoofer without having to accept the mentioned disadvantage. Therefore the B15 can be configured in three ways:

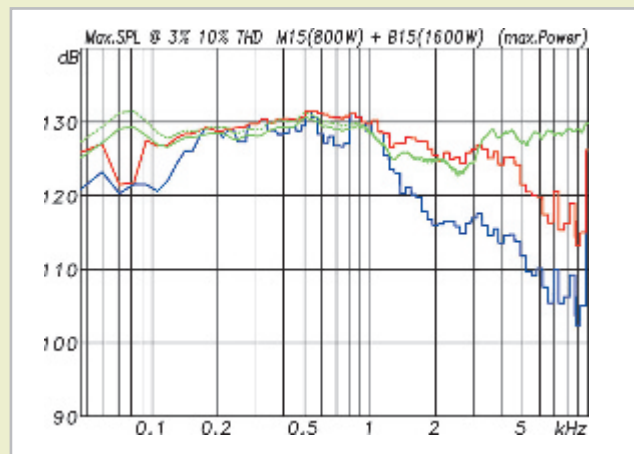
- 1.Active mode without crossover with external controller
- 2.Passive mode with low-pass filter for the B15; the top is used in parallel without filtering in this case

- 3.Passive mode with low-pass filter for the B15 and high-pass filter (150Hz, 12 dB / Oct.) for the top

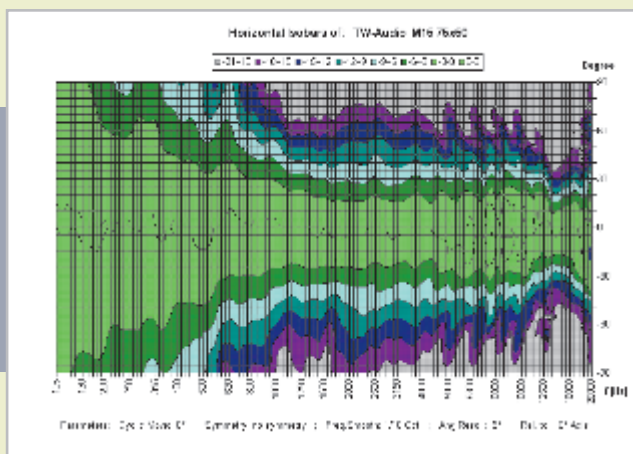
The first variant can of course be used with any combination, the second choice is optimised for the large tops M12 and M15 and the third one is for the small top M8. The LF-unit of the B15 works in support of the LF-units of the M12 or M15 and therefore does not take over the bass range completely as would be the case in active mode. Since the chassis of the B15 is optimised for the bass range and can therefore be driven harder than the woofers in the tops while mainly being aimed at the frequency range below 100 Hz, it was designed as a 4 Ohm system in contrast to the 8 Ohm tops. The consequences are simple and effective: the B15 taking on twice the power in comparison to the parallel top in its range leads to a very harmonic combination as will later be



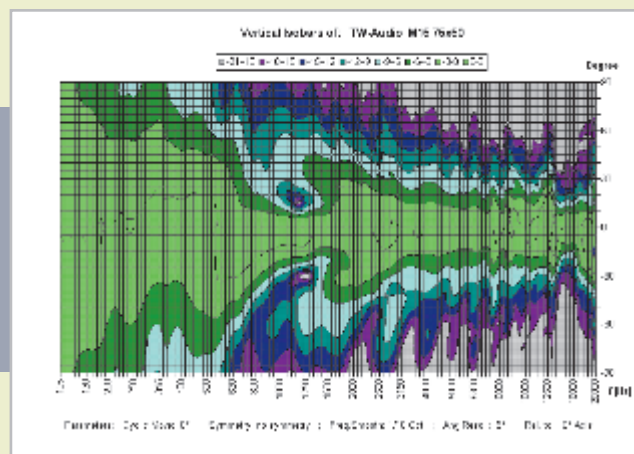
Pict. 13: Impedance chart of M15 (red), B15 with passive lowpass-filter (blue) and the combination of both systems (green). In a simple parallel combination there is a impedance minimum of 2.6 Ohm for the combination of M15 top and B15 subwoofer.



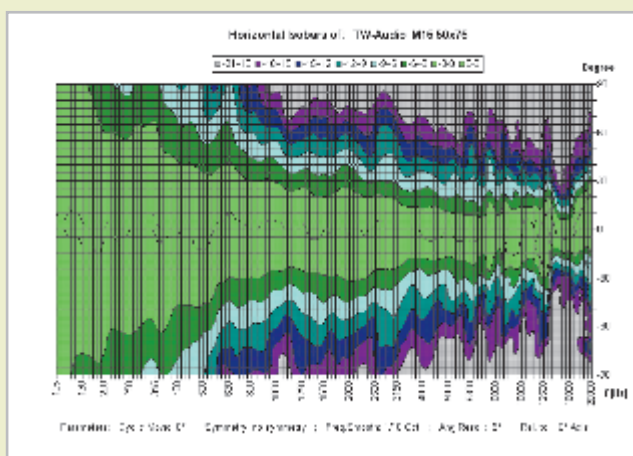
Pict. 14: Maximum SPL at max. 3% (blue) and max. 10% (red) THD as well as maximum SPL calculated from sensitivity and power load (green) for the combination of M15 and B15. The maximum output power was referenced to 800 W into 8 Ohm, so that the M15 was driven by 800 W and the B15 as a 4 Ohm system was driven by 1600 W at the most.



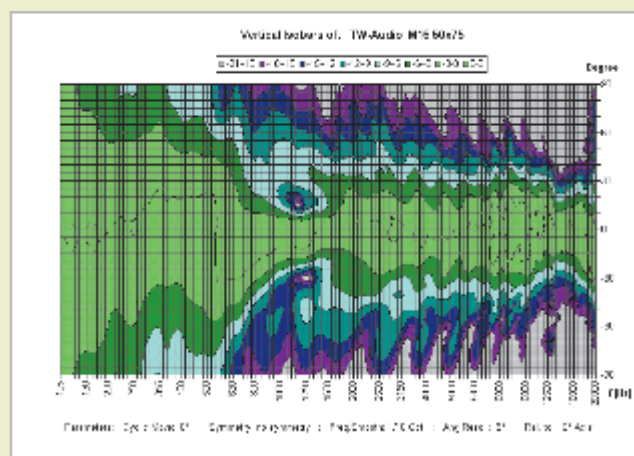
Pict. 15: Isobarics in the horizontal plane for the M15 with the HF horn in the standard position for a dispersion angle of 75° x 50°.



Pict. 16: Isobarics in the vertical plane for the M15 with the HF horn in the standard position for a dispersion angle of 75° x 50°.



Pict. 17: Isobarics in the horizontal plane for the M15 with the HF horn turned (typical for use as a floor monitor) for a dispersion angle of 50° x 75°.



Pict. 18: Isobarics in the vertical plane for the M15 with the HF horn turned (typical for use as a floor monitor) for a dispersion angle of 50° x 75°.

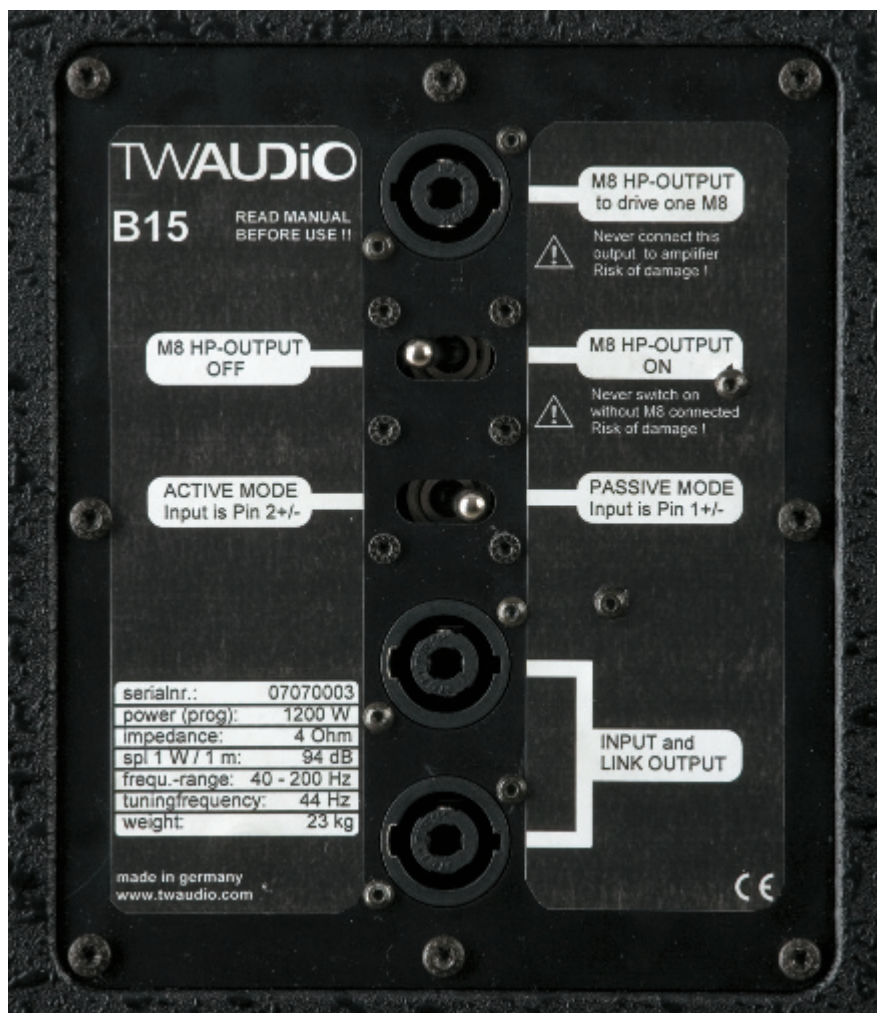
shown by the test results. The low-pass filter in the subwoofer was designed as a simple filter of the first degree with 6 dB/Oct. which is supported by the characteristic of a fast fall-off to the higher frequencies of the LF-speaker in the B15.

The B15 is fitted with grips, feet, 15mm multiplex cabinet, foam coated metal grille etc. like the M-series tops. Then there is an optional protective cover and a dolly that can be fitted to the front. The 15" driver is a custom unit by Eighteen-Sound with an especially large linear movement and neodymium magnet.

Measurements of the M12 and M15

We tested the two tops M12 and M15 as well as the subwoofer B15 alone and in a passive combination with the M15, which should be typical for drumfill or sidefill applications or a small club PA. Pictures 1 to 4 first show the usual measurements for the tops M12 and M15. As expected, the frequency response above 200 Hz hardly differs. Below 200 Hz the lower tuned M15 can benefit from its size advantage with about 3 dB more in sensitivity. On average the speakers reached a sensitivity of almost 98 dB referenced to 2,83 V/1m between 100 Hz and 10 kHz, a typical value for 15/2 or 12/2 speakers of this category. The phase response in picture 2 shows almost identical performance for both tops with just some small differences in the bass range caused by the higher low cut-off frequency of the M12 (99 Hz compared to 75 Hz of the M15). The phase response itself is almost minimal, 360° caused by the high-pass function at the lower end and an additional 180° caused by the crossover function. HF and LF speakers delay times are tuned well to each other so that there is no flutter in the phase response in the area of the crossover frequency.

In picture 3 the impedance is charted for M12 and M15, reflecting very well the tuning frequencies of the bass reflex cabinets by the point of the minima between the two maxima. The larger M15 is tuned to 50 Hz and the M12 to 65 Hz. The absolute impedance minimum is at 6.3 Ohm for the M15 and at 5.9 Ohm for the M12. Both values are not exactly to the current norm



The subwoofer B15 can be configured in three way. The photo shows a connection panel of a pre-production model still fitted with stickers.

anymore (maximum of 20% below nominal impedance) but quite within the acceptable area for modern amplifiers. Problems can only occur in 2 Ohm use, i.e. four speakers connected in parallel to one power amplifier channel, when the impedance partially falls significantly below 2 Ohm, something that should hardly occur from the view of the amplifiers taking into account cable resistance etc. The decay characteristic is exemplary for both models. The spectrograms in pictures 5 and 6 show a perfect HF unit, a hardly noticeable frequency crossover and a LF system with only a few, small and completely harmless resonances. For example there is a slight resonance at 500 Hz shown for the M15 which can also be seen as slight rise in the frequency chart and which is probably be

caused by the cabinet. Overall the decay characteristic of both speakers is so good that they compare well to the best of studio monitors tested in our sister publication SOUND & RECORDING.

Measurements of the B15

The subwoofer B15 was looked at both in the version for passive combination to the top with the integrated low-pass filter as well as completely without passive filtering for active mode. The pictures 7 to 9 show frequency and phase response for both versions. The frequency response without filter (red curve) shows the B15 not getting noticeably louder to the middle frequencies, which often occurs in other cases, instead keeping the sensitivity value of about 93 dB within the whole frequency

range to 3 kHz, before quitting without trouble. This quality is needed to enable the use of a passive 6 dB crossover as a low-pass filter to couple with a top, since the speaker does not work against the crossover function. The second blue curve shows the behaviour with a passive low-pass filter activated. The matching phase charts are found in the same colours in picture 8. The additional passive filter of 1st degree rotates the B15 phase 90° further to the given 360° as a result of the bass reflex cabinet design. The cabinet tuning frequency is at 47 Hz as shown by the impedance characteristics in picture 9. The spectrogram of the B15 shows no anomalies and the speaker could actually be used up to 1 kHz if so desired, which is quite unusual for a subwoofer. The minima of the impedance charts are at 3.4 Ohm (active) and 3.9 Ohm (passive with filter) and are therefore completely unproblematic for a speaker of nominal 4 Ohm as well as adhering completely to the norm. The relevant value in this context for the B15 is the quoted sensitivity in the frequency response for 2 V equivalent to 1 W into 4 Ohm.

Passive combination of M15 and B15

Now we are interested in the interplay of B15 with the tops in passive combination. The probably most popular combination should be the B15 with the M15 top, which we shall look at more closely in the following. As a start, picture 11 shows us the frequency responses of the M15 and the B15 with the B15 being driven with a passive low-pass filter. The sensitivity in this chart is referenced to 2.83 V and therefore to the nominal impedance of 8 Ohm of the M15 top. The B15 as a 4 Ohm system is shown 3 dB louder than in the 1W/1m chart in picture 7 because of this – but this is right referenced to the parallel use with the same source voltage for both systems. The summed function of both systems is shown in the green curve in picture 11, which now shows an average sensitivity of 98.7 dB (100 Hz to 10 kHz) referenced to 2.83 V and a lower cut-off frequency (-6 dB referred to 98.7 dB) of 38.8 Hz. The upper cut-off frequency is above 20 kHz. These values are very convincing in any case. Combined

with the very smooth transition from the subwoofer to the top the whole setup can be called an outstanding combination taken into account a simple passive crossover. The phase graphs with the same colours in picture 12 confirm this. Of course the phase transition is not as perfect as one that could be reached with an active crossover or even a digital controller with all its filter possibilities, but this could not be expected from a simple passive crossover in such a difficult frequency range. The frequency range for the crossover from subwoofer to top is difficult both because of the low frequencies which need large component values with high voltages and strong currents at the same time and on the other hand because of the pronounced impedance fluctuations in this frequency range, which make life tough for a passive crossover.

Picture 13 shows all the relevant impedance curves of the M15 top (red), the B15 subwoofer (blue) and the parallel combination of both systems in green. The impedance minimum for the parallel connection is 2.6 Ohm at 45 Hz. In this constellation the B15 takes on twice the power that goes into the M15, which fits the load capacities and matches the speakers levels to each other. The straight passive combination of M15 top and B15 sub therefore is as simple as it is elegant and effective and it is economic as well since only one amplifier channel and no controllers are needed.

Maximum levels

Looking at the maximum levels we have to observe three setups: M12 and M15 each in fullrange mode in picture 4 and the passive combination of M15 and B15 in picture 14. The highest power allowed for the tests was the program power value from the data sheet, 700 W for the M12, 800 W for the M15 and the combination of M15 and B15. Since all power value were referenced to 8 Ohm nominal impedance, this meant 1600 Watt maximum power for the B15 bass speaker with 4 Ohm driven in parallel with the M15. The following table sums up the median SPL values measured at a maximum of 10% THD at a distance of 1m for both frequency ranges 50 to 100 Hz (bass) and 100 Hz to 10 kHz.

Typ	M12	M15	M15+B15
Max.			
Power [W]	700	800	800+1.600
SPL @			
10 % THD 50–100 Hz	108,7	119,4	125,1
Calc. Max.			
SPL 50–100 Hz	113,4	119,4	129,4
SPL @			
10 % THD 100–10k Hz	122,9	124,4	126,7
Calc. Max.			
SPL 100–10k Hz	126,2	126,7	128,1

The second value quoted is in each case the calculated maximum based on sensitivity and the maximum power. In the range from 100 Hz to 10 kHz the values are quite near to each other as could be expected. The advantages of the larger membrane of the 15" driver or the combination with the subwoofer only really show up below 100 Hz., where with the combination M15 + B15 reaches impressive 125 dB. This combination therefore clearly qualifies as a serious mini-PA for small clubs and similar locations. This compact set should also fill high expectations (in the sense of deep bass and high levels) of drummers as a drumfill.

Directivity

In the final part of the tests we had a look at the directivity of the tops. Only the M15 is shown, since the M12 with the same tweeter behaves almost the same way. Both tops offer the possibility to fit the horns turned by 90°, offering the versions 75 x 50 and 50 x 75.

Horizontal and vertical isobarics are shown in pictures 15 to 18. Looking first at the „normal“ configuration 75 x 50, the horizontal curves are convincing with their absolute perfection. Only above 13 kHz there is a little break-up of the beautifully straight isobaric, since the wave front from the driver begins to break up a bit here. This effect can be recognised in the frequency response from the sharp dips and peaks above 13 kHz. The nominal 75° for the horizontal plane are just adhered to from 1 kHz upwards. In



The TW-Audio M15 can be used both in normal standing position and as floor monitor with an angle of 50° or 70°.

the vertical plane things are not that straight because of the unavoidable interference effects. Due to the bigger projector plane the opening angle narrows a bit around the 1 kHz octave (low and high sectors working together here). From 1.6 kHz upwards the HF horn takes over almost completely leading first to a widening before reaching the nominal 50° from 3 kHz upwards.

The compact HF horn does not reach the desired high focussing to 50° at lower frequencies. For the version with the horn turned to 50 x 75 things are quite similar with switched roles. Overall the M15 can therefore be attested an exemplary and very well mannered directivity behaviour.

Listening test

For our listening test the TW-Audio speakers were first used as a typical satellite

system in passive mode, driven by one QSC PL380. The first trial with well-known CDs created a homogenous and room-filling sound picture with pleasing highs. The bass sector was precise and in the right relation to the top, so we have to attest TW-Audio that the passive mode turned out excellent. Only sound conserves made extremely for massage of internal organs would necessitate using an EQ to make the overall result a bit thinner and audience-friendly, because the B15 can be very powerful in spite of its tiny size.

Depending on the room and the task the top M15 can shine with its full range suitability without help from a subwoofer. Recorded music playback is excellently handled in the style of a very good studio monitor, as are speech and vocals.

The speakers make the day relaxed for a FOH engineer, who might just need a minimal bit of EQ for special taste to be able to

fully concentrate on the performance on stage.

This finely tuned performance also commends the M15 for monitor use and it was convincing in this case, used for example for vocals with and without keyboards or full band with a loud drummer. The passive combination M15/B15 results in a very compact, easily usable drumfill which can be fitted in even on crowded stages and satisfies the musician who rarely hears his instrument with a deep kickdrum etc. at high levels.

Finally the TW-Audio combination had to prove itself as FOH-PA for a small club gig. To test playback quality and possible sound level once again in this environment, the complete drumset was miked up on the spot – and everyone was pleased by the homogenous and powerful projection except for the club owner (understandably). Therefore the concert was done with

two M15, without support from the subwoofer, without further interference by the club owner and it was completely convincing.

Conclusion

The new M-Series by TW-Audio with the matching subwoofer B15 is based on cutting-edge

Chassis combined with horns and crossover that are the results of new design- and simulation-tools. The test results show how exact a development can be done with these. Almost perfect test results in all areas combined with a professional enclosure and perfect finish add up to a great overall impression without weaknesses. The combination of M15 and B15 stands out positively, since they work together to a rarely reached degree even in the simple passive version. The passive match of the tops with the subwoofer B15 is therefore more than

just a compromise, making the combination highly attractive especially in the sense of the price-performance ratio. Overall all component prices of the M-Series can only be called very reasonable – even though they are completely „Made In Germany“.

In our listening tests the TW-Audio components convinced with a homogenous, powerful playback of recorded music and live music. The M15 is able to make life tough for similar speakers in a rental rack not just because it does not need a control-

ler. TW-Audio shows that external controlling does not have to be necessary in combination with subwoofers and this suggests the passive combination M15/B15 for events on short notice and with small budgets. Of course this combination can also be used in active mode the same efficient way like in passive mode.

◆ Text and tests: Anselm Goertz, Udo Klinkhammer
Translation: Alex Merck
Photos: Dieter Stork

Type	Size (H x W x D, mm)	Weight	Power
M8	400 x 240 x 240	10.5 kg	400 W/8 Ohm
M12	604 x 360 x 374	20.5 kg	700 W/8 Ohm
M15	706 x 440 x 374	26.0 kg	800 W/8 Ohm
B15	506 x 440 x 560	23.9 kg	1,200 W/4 Ohm
data			

TWAUDIO™

charming powerful

TWAUDIO – simply great sound

What can one expect from a speaker system with only 50 cm width and 16,9 kg weight, certainly rigging gear included? Well, an innovative and groundbreaking new development, designed from pro's for pro's. A product that challenges but then inspires you to think beyond limits. At least if it comes from TWAUDIO. **VERA 10**