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TW Audio T24N and B30

The second generation of the TW Audio classic has been completely reworked and equipped with state-of-the-art drivers

TW Audio – named after its founder and now co-managing director, Tobias Wüstner – is celebrating its tenth birthday in 2014. Not only was the top part/subwoofer combination of T24 and B30 one of the first speakers in the TW Audio range ten years ago, it has been able to remain part of it, unchanged, to the present day. According to Tobias Wüstner, several thousand models of the T24 top part alone have been sold over the years, and the box continues to enjoy ongoing popularity. The T24 thus fortunately never shared the same fate as many other known horn systems, which today eke out a miserable existence behind the line arrays (or have completely disappeared from the market).

How could this be, even though TW Audio's range naturally also includes line arrays in the form of the VERA series? It may be due to the good performance despite an extremely compact design. Weighing "just" 46 kg, the original T24 has always been a lightweight compared to the "100 kg plus" offered by some other manufacturers. The T24 thus escaped this extinction phase and without any doubt: there are still many areas in which classic horn systems are equal or even superior to line arrays. When we think about several top 40 bands, club concerts, fittings, smaller dance floors or monitoring systems on large stages, the horn top is always the first choice.

A lot of work has gone into speaker chassis development in recent years – the drivers have become lighter, more resilient, and better in general – and it is only logical to modernise and upgrade the tried-and-tested T24 design. The T24 is therefore currently being presented at the Prolight + Sound 2014, in its new, locally tested T24N version.

T24N for "new" or neodymium

Externally, an expert eye is needed to distinguish the T24N from the original T24, with only the slightly more rounded rear side giving it away. But lifting up the box reveals another significant distinction. 33 instead of 46 kg is a crucial difference when it comes to transporting and even setting up a top on one's own.

The weight was primarily reduced by using neodymium drivers for the two 12" chassis and the compression driver.
All drivers are made by Italian manufacturer B&C, and are not freely available custom-made models. The tweeter is based on B&C's 3" titanium models, and the bass reflex construction for the woofers is another innovation. The large horn area now has four openings, which work as resonators, increasing the box's frequency response by over 6 dB to between 70 and 100 Hz, and even have an impact up to 200 Hz, which is particularly important for full-range operation. The two 12" chassis operate on a large horn, whose opening takes up the entire front of the box. Both drivers are equipped with a phase plug, designed for the top chassis in the form of the tweeter.
The entire tweeter unit is mounted onto the box's baffle on four metal slats, and can be easily removed by undoing the four screws. This last step is relevant because the tweeter horn is rotatable and exchangeable: there is a 60 × 40 and a 90 × 50-degree version.
The T24N's cabinet comprises two halves: The front section with internal front panel contains the horn with the 12"drivers attached from the rear. The back section is a case shell added for bulk. If the 12" drivers need to be serviced, the rear case section is thus simply removed to provide free access to the drivers.
The two woofers are 8-Ohm chassis, which work electrically parallel as a 4-Ohm unit. The box can be set for passive or active operation using a solid switch at the back. Both are connected via the NL4 bushing. From a performance perspective, a T24N top goes perfectly with two B30 subwoofers (8-Ohm systems), meaning a power amplifier can be optimally utilised with two subs and one top.
The active operation option has been introduced to TW Audio by international customers, and is therefore also available.

Accessories

The T24N is identical to the T24 in size, meaning existing accessories can continue to be used. And there are plenty of them. Starting with the dolly – suitable for T24N and B30 -, to protective covers, cases, small and large flying frames, to a solid swivel bracket with which the T24N can either be mounted on a stand or attached to a truss. Complex clusters can be built using the relevant accessories, and tops can be arrayed clustered vertically and also horizontally at 45-degree angles. So nothing has been spared here, and this comes as no surprise, given thousands of the boxes have proven their worth in harsh conditions for the last ten years. In terms of power amplifiers, TW Audio recommends the Powersoft K DSP series or the Lab.gruppen PLM series. TW Audio's systematic concept means it supports both platforms with compatible system presets. The test unit was supplied with a Powersoft rack with two K3-DSP amplifiers. Further details to come.

Measurement values

When it comes to measurement values, we usually start with the impedance curves. In addition to the values for nominal impedance by standard, minimum and similar, it also provides information on the speaker itself, e.g. the tuning frequency of the bass reflex cabinet, driver resonances, and even when the tweeter's membrane starts to

The T24N HF-horn can be rotated as an entire unit, or replaced by the alternative 90 × 50 horn; the openings on the sides of the large horn are bass reflex ports

Frontal box links enable intermediate angles to be set, and even larger horizontal/vertical clusters to be formed

The swivel bracket allows the T24N to be mounted on a stand or attached to a truss

show partial vibration. Figure 1 shows three curves relating to this for the T24N – the LF and HF branches in active mode, and the entire box in passive mode. The minimum for the LF path and the passive box is at 3.3 Ohm, right on the tuning frequency of 73 Hz. It is thereby still safely within the 20-percent standard tolerance range.

The tweeter is shown as an 8-Ohm system. In its sphere of operation over 250 Hz, the minimum here is a completely uncritical 8.1 Ohm. The driver resonance is 473 Hz, and the first partial vibrations only start appearing from13.4 kHz upward.

The T24N's frequency responses were initially measured in the active version. Figure 2 shows the individual measurements for the LF and HF paths. They each have two curves – for the 60 × 40 and 90 × 50 versions. The angle of radiation is changed purely by replacing the tweeter's horn. But there is still a small impact on the woofer, as the two horns have different external designs, meaning the phase plug also changes slightly for the upper woofer.

The 90 × 50 tweeter horn is approx. 1.5 dB lower than the 60 × 40 in terms of sensitivity.

The correlation is also plausible, as the same driver in the 90 × 50 version distributes its acoustic output over a much larger spatial angle than the 60 × 40. It must be noted that the two tweeter curves are measured for 2 V / 1 m. The 1 W / 1 m sensitivity is thus 3 dB higher, sitting between 1 and 10 kHz at a mean of 109 dB. This sort of figure is as expected for a compression driver with a 3" membrane. It has to be mentioned that for the curve for the higher frequencies all measurements were taken with the front grill. Without this grill, the curve would have been noticeably smoother above 5 kHz. Grills create reflections, which run back into the horn, where, coupled with the direct sound, they cause interference expressed as undulations in the frequency response.

The 2 × 12" woofer unit is truly spectacular. Its sensitivity continually rises from an initial 98 dB at 100 Hz to 110 dB at 1 kHz. Apart from the actual values, the main surprise is the evenness of the curve. Filtering can thus be relatively modest, and we see clear evidence of largely low-resonance behaviour.

The integrated passive crossover brings both paths together very simply, with the crossover limited to high and low-pass functions. All other filtering then takes place in the controller, where it can be performed without loss. The advantage of passive operation compared to the fully active solution lies in the wiring and in the fact that it spares the need for another amplifier channel.

For most users, the passive separation of the T24N will be the first choice, which is why only this version is described in more detail below. The crossover function for fully active operation has largely approximated the passive crossover to cause the least possible change to the radiation in the transition zone.

B30 subwoofer

TW Audio recommends the B30 subwoofer for the T24N, and this product is offered in the PA-SYS-ONE set at a ratio of 2:1. Reworked two years ago, the B30 is equipped with two particularly strong 15" chassis by Eighteen Sound. The two drivers with rubber surrounds are arranged on the V-shaped, inward-running sound panels in a space-saving manner. The bass reflex port is situated in the centre of the box itself. The V-shape additionally creates a type of horn stump, which has a favourable effect on the radiation. The inverse assembly with the magnets facing outwards enables optimum driver cooling, as the waste heat can escape more easily compared to inside mounted magnets.

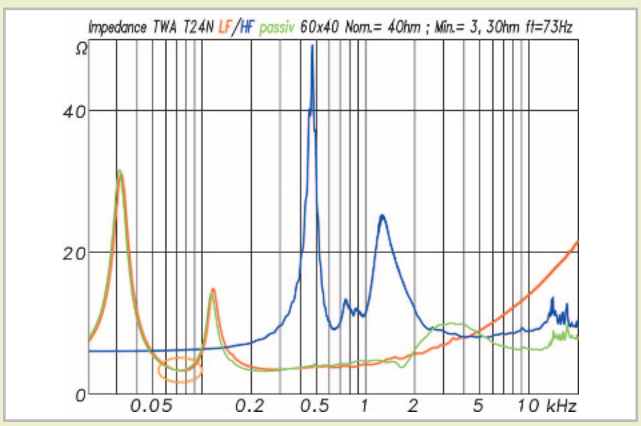


Fig. 1: Impedance measurements of the T24N in passive mode (green) and active mode with separate curves for woofers (red) and compression driver (blue). The tweeter is an 8-Ohm system. The woofer unit works with two parallel 8-Ohm drivers as a nominal 4-Ohm system. The bass reflex tuning is at 73 Hz.

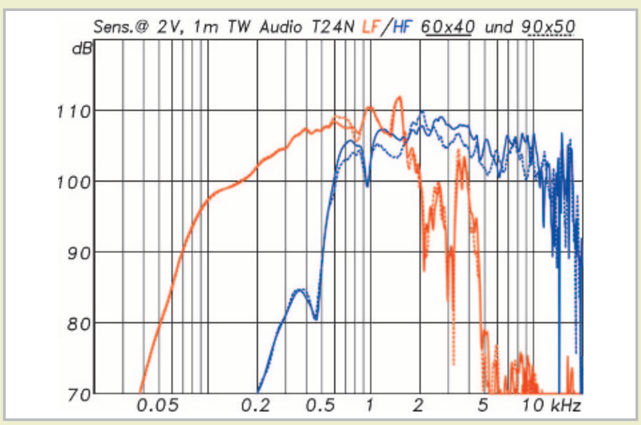


Fig. 2: Frequency responses and sensitivity for the LF (red) and HF path (blue) in the T24N with 60 × 40 horn. The dotted curves represent the 90 × 50 version. The sensitivity for all curves is based on 2 V / 1 m. The 1 W / 1 m value for the HF path as an 8-Ohm system is thus 3 dB higher. All measurements are taken with the front grill.

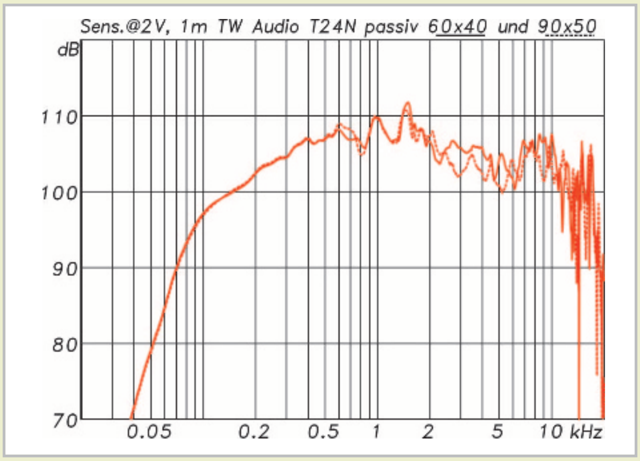


Fig. 3: Frequency responses and sensitivity for the T24N with passive crossover in the 60 × 40 and 90 × 50 (dotted) version

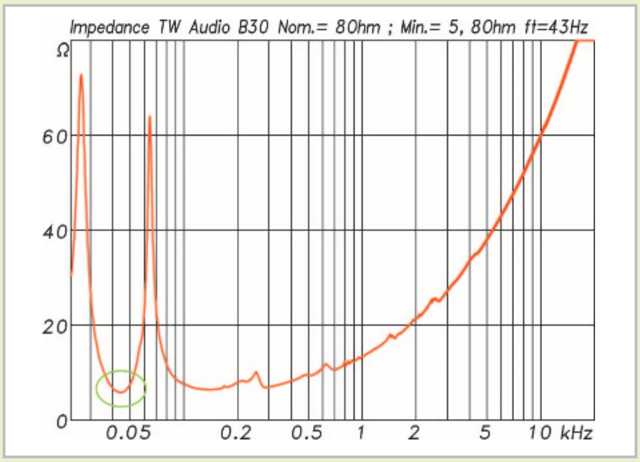


Fig. 4: B30 impedance curve: Both 16-Ohm drivers are connected parallel to an 8-Ohm system, the bass reflex system is tuned to 43 Hz

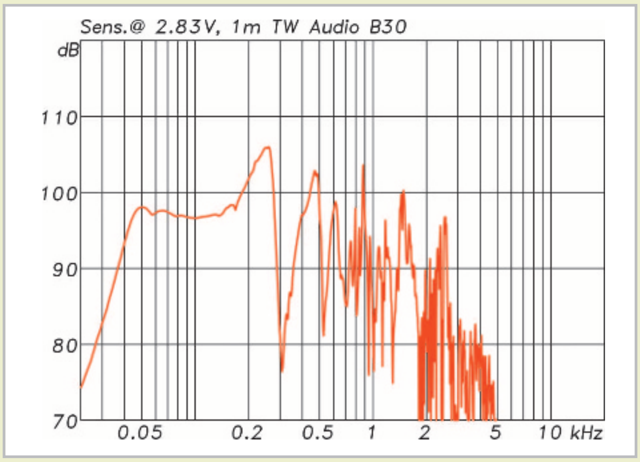


Fig. 5: B30 frequency response and sensitivity. Between 50 and 100 Hz, the average sensitivity is 97.2 dB; in terms of this, the lower edge frequency (–6 dB) is 38 Hz.

In terms of dimensions, the B30 measures 706 × 446 mm at the front (like the T24), with a depth of 800 mm. It similarly weighs a very reasonable 39 kg. The side and back of the cabinet each have two grips, making it easy to handle. A dolly, also suitable for the T24N, can be fastened to the front. The B30 has solid feet, enabling upright or flat assembly. Each of the opposite sides has a suitably deep recess where the feet of another B30 or T24N can lock in to provide stable support during stacking.
The impedance curve in Figure 4 shows an 8-Ohm system with a minimum impedance of 5.8 Ohm at a tuning frequency of 43 Hz. Two B30 subs are typically operated on one amplifier channel.
The frequency response is where the B30 really shows what it's made of: An average sensitivity of 97.2 dB is achieved between 50 and 100 Hz, while the lower edge frequency of 38 Hz is pretty deep for a 15" subwoofer. Combined with a programme power of 2 kW (1 kW limiting continuous thermal withstand power), two B30s can, with a 4-kW amplifier, achieve a theoretical maximum of 136 dB. More information on this can be found in the section on maximum levels and distortion values.

Controller and amping

The test system was equipped with the relevant standard amp rack with two Powersoft K3-DSPs. Each amplifier channel has up to 3.3 kW at 4 Ohm, depending on the signal's crest factor. The integrated DSP system, coupled with the Armonia software, provides extensive filter and limiter functions, as well as all kinds of system monitoring options. In addition to the IIR and FIR filters, the DSP also offers the Raised Cosine Filter, which enables particularly detailed adjustment of almost any given filter curve. Further details on this can be found in the K3-DSP test report in PRODUCTION PARTNER, 4/2011 edition.
The K3-DSP power amplifiers contain setups for the active and passive versions of the T24N. Both variants then, in turn, have their own separate variants with (cut) and without (full-range) additional subwoofers. Figure 6 shows the relevant filter curves, together with the curve of the B30 setup. There is also the option of operating the T24N in full-range mode with subwoofer, raising the level from 60 to 200 Hz, which may be beneficial in certain cases or for certain setups.

Overall system

Figure 7 shows the overall performance of the speaker and controller. In full-range mode (red curve), the T24N reaches down as far as approx. 70 Hz, whereby the box also does well without a subwoofer when the output is not excessively bassy. If the T24N is used in cut mode, coupled with the B30, the frequency response is extended a crucial further octave down. This of course results in significant gains in maximum level (see also Figure 15). When it comes to the phase response (Figure 8), the T24N acts as expected with and without B30. Each separation and each electrical high-pass filter causes a 360° phase rotation. It is also worth remembering that a transition is not just about each electrical high-pass and low-pass function, but also the speaker's acoustic

B30 subwoofer with two Eighteen Sound 15" drivers. The bass reflect port is in the middle, between the two drivers inside the box. The high-performance drivers are fitted with neodymium magnets and flow-optimised baskets.

function. A 2nd-order electric low pass coupled with the relevant speaker can thus also result in a 4th-order low pass. For the T24N, this is the transition between tweeter and woofer at 360°, the box's acoustic high-pass behaviour at 360°, and the relevant electronic 4th-order high-pass filter. Subwoofers add a further 360°C for the transition from top to sub.
The delay curves in Figure 9 also differ accordingly.
The spectrogram in Figure 10 shows a good result overall with the T24N and B30 combination. There are very few resonances in the 1-to-2 kHz range and at the far top of the transition zone, where the partial vibrations of the tweeter membrane inevitably start. The post-oscillation below 100 Hz is due to the rise in group delay.

Directivity

If all the T24N variants were to be covered by directivity measurements, there would be 16 test series in total. There are the active and passive variants, each with a 60 × 40 and 90 × 50 horn, and both in the rotated horn variant as 40 × 60 and 50 × 90. The high flexibility in radiation should be particularly important to the installation market, where the speakers need to adapt as accurately as possible to local conditions. According to Tobias Wüstner, a weatherproof T24N model for stadium use is already under construction. The differences between the actively and passively separated versions are rather marginal in terms of directivity, as the X-Over functions of the active crossover have been adapted to those of the passive crossover wherever possible. We thus limited ourselves to the passive version in the most important variants 60 × 40 and 90 × 50 for the test.

In all cases, the tweeter horn fulfils its task correctly, without any problem. With the relatively high transition frequency in the 1.6 kHz range, the 2 × 12" unit displays greater bunching than the tweeter unit, which is particularly noticeable for the 90 × 50 horn and vertical level, due to the larger spread of the two 12" driver. A huge plus point is the complete omission of interference effects. The "almost" coaxial arrangement means no level has angle-dependent phase differences, which otherwise typically cause interference at the vertical level.

Maximum level and distortion values

A maximum level test with sine bursts for 3 % and 10 % distortion limits was initially conducted to measure distortion. It rates the harmonic components k2 to k9. The measurement algorithm increases the level until the relevant distortion limit value of 3 % or 10 % is reached. A performance limit for the speaker or, as in this case, the detection of a limiter in the system, can be set as a third abort criterion. Figure 15 shows the result with the blue curve for maximum 3 % distortion and the red curve for the 10 % limit. At the point where both curves meet, the distortion limit values were not reached before the internal limiter in the K3-DSP amplifiers stopped the measurement. The dotted curves were measured with a combination of T24N and two B30 subwoofers. Except for 1–2 dB, the red curve for the top parts approximates the theoretical maximum value, which is calculated based on sensitivity and the maximum output permitted by the limiters. When it comes to the T24N, the limiters in the K3 are set for a sine

System amp rack with two Powersoft K3-DSP amplifiers. Two stacks, each with 2 x B30 and 1 x T24N, are operated with one rack as standard, though the design enables the use of up to four stacks (4 x T24 + 8 x B30, all channels 2 Ohm)

signal in such a way so as to ensure 63.6 Veff as a maximum, corresponding to an output of 1 kW at 4 Ohm, which results in a 30 dB level increase compared to the 1 W/1 m sensitivity.
The figures for the two B30s are as follows: The sensitivity of an individual B30 is 97.2 dB plus the 3 dB gained by the acoustic coupling of two subwoofers. The K3 amplifier can provide a maximum output of 2.8 kW for the duration of the sine bursts, corresponding to a theoretical level increase of 34.5 dB. The average value of the 10 % curve is only 1.5 dB lower, between 50 und 100 Hz with an average 133.2 dB, allowing amplifiers, limiters and speakers to perfectly complement one another.
The second test for non-linear distortion uses a multi-sine signal to analyse the distortion. The signal consists of 60 sine signals with a random phase, and is weighted as per EIA-426B based on average musical spectrum. The signal has a crest factor of 12 dB, and is therefore also very similar to a normal music signal.
The green curve in Figure 16 shows the frequency weighting of the measurement signal. The blue lines or 1/6 octave band cumulative curve show the signal transmitted by the speaker. The red lines and cumulative curve only contain the distortion percenta-

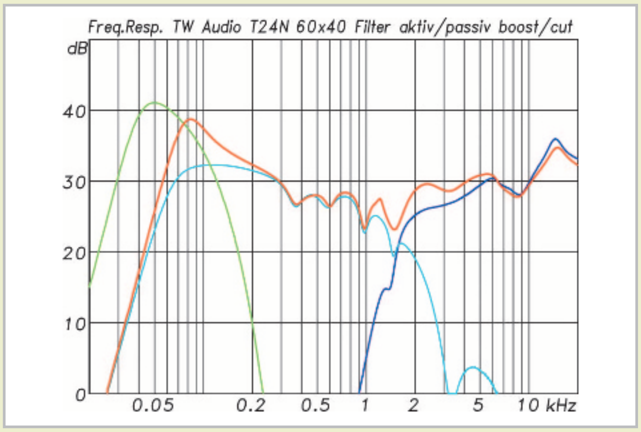


Fig. 6: Controller functions of the K3-DSP power amplifiers. Pale and dark blue for T24N active operation with low-cut. Red for the passive variant without low-cut. Green for the B30 subwoofer filter.

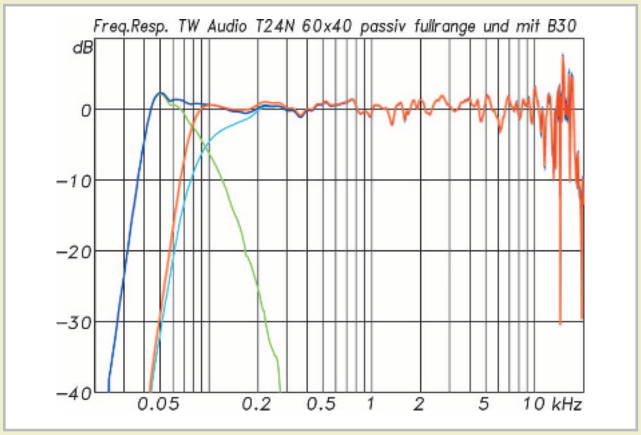


Fig. 7: Frequency responses for the system with controller. Red for the T24N in full-range mode and pale blue for low-cut when combined with subwoofer (green). Without a subwoofer, the T24N can be used down to 70 Hz. The B30 takes the transition zone one octave lower. All curves are based on the T24N in passive mode.

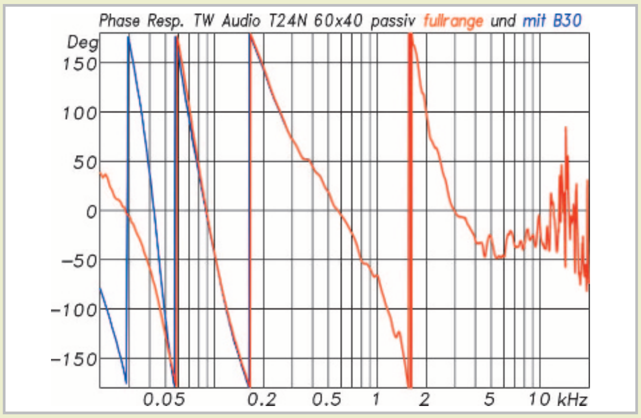


Fig. 8: Phase responses for the T24N full-range (red) and with B30 subwoofer (blue). There is a 360° phase rotation for each X-Over point, as well as for the electrical/acoustic high passes.

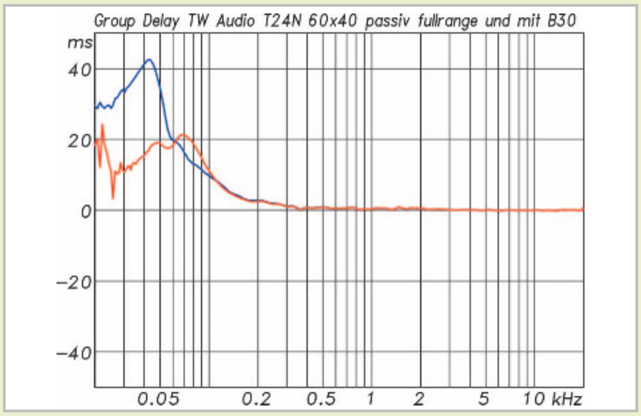


Fig. 9: Group delay for the T24N full-range (red) and with B30 subwoofer (blue). With a subwoofer, the phase rotations increase in the bass range, and the delay curve rises accordingly.

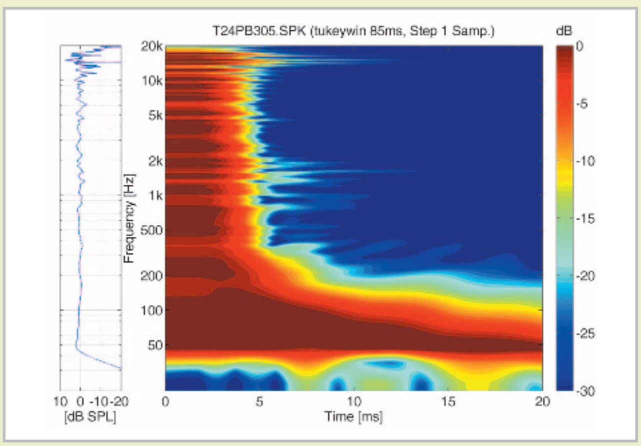


Fig. 10: Spectrogram of the T24N and B30 combination. There are some small resonances between 1 and 2 kHz. Above 13 kHz, we can see tweeter membrane resonances and reflection from the horn mouth / front grill.

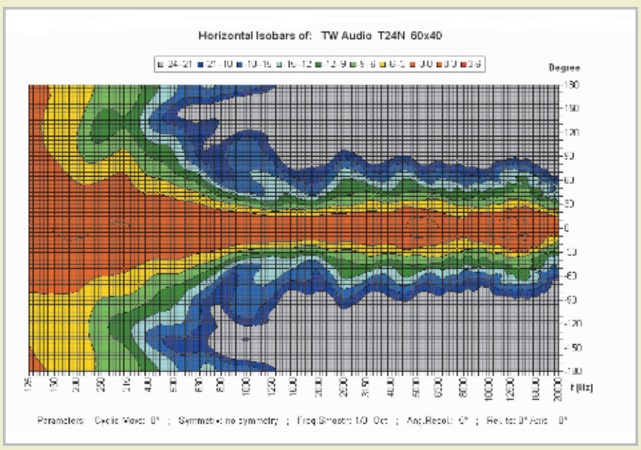


Fig. 11: Horizontal isobars for the passive version of the T24N with 60 × 40 horn. The 60° is achieved upwards of 800 Hz. The isobars narrow down slightly between 1 and 2 kHz.

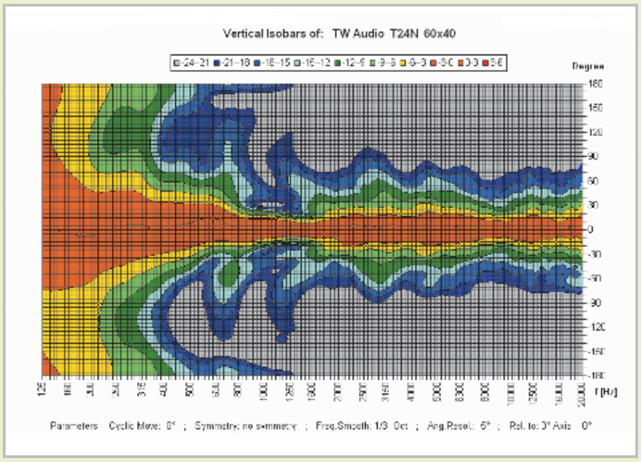


Fig. 12: Vertical isobars for the passive version of the T24N with 60 × 40 horn. The 40° is largely upheld by the tweeter horn. The 2 × 12" unit causes more bunching in the middle.

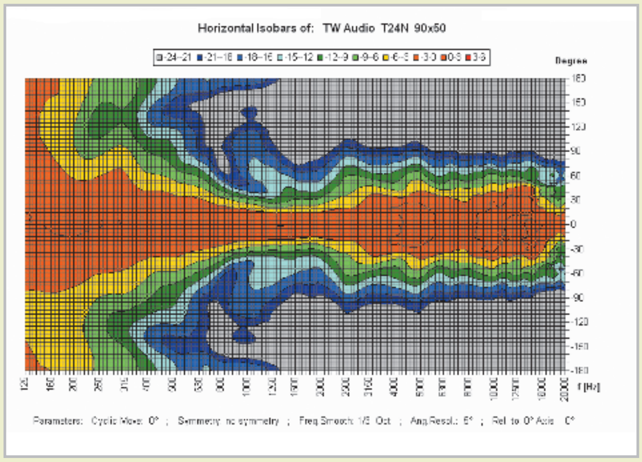


Fig. 13: Horizontal isobars for the passive version of the T24N with 90 × 50 horn. The constriction in the affects optically stronger here compared to the 90° tweeter.

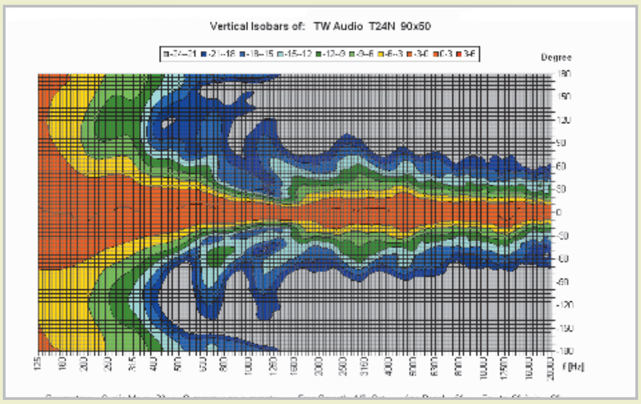


Fig. 14: Vertical isobars for the passive version of the T24N with 90 × 50 horn

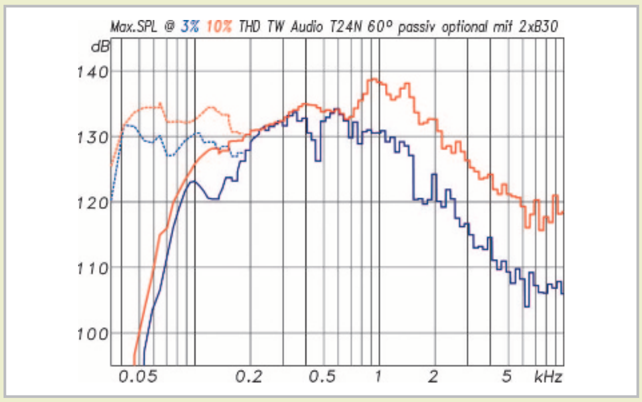


Fig. 15: Maximum level for 3 % (blue) and 10 % (red) distortion limits for a T24N in full-range mode and with two B30 subwoofers. The subs perfectly complement the top. There are no weak areas in the curve.

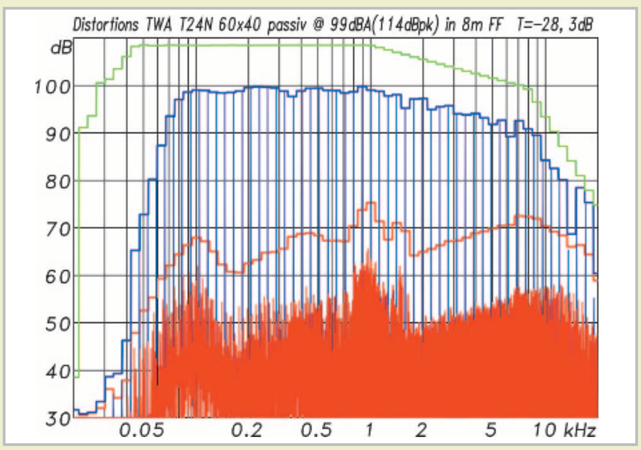


Abb. 16: Intermodulation distortion for a Leq of 99 dBA at a distance of 8 m. A multi-sine signal with EIA-426B spectrum (green) and 12 dB crest factor was used as a stimulation signal. The red represents the distortion components which make up 4 %. The peak level measured for this, based on a distance of 1 m, was 132 dB.

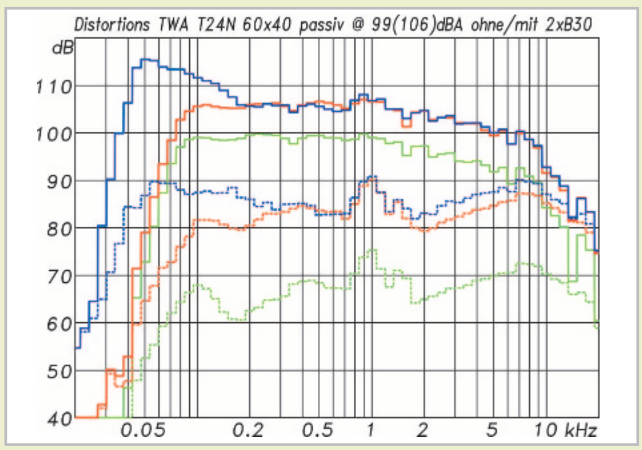


Fig. 17: Measurement of total distortion for:
Green: T24N at 99 dBA / 8 m 132 dBpk / 1 m
Red: T24N at 106 dBA / 8m 139 dBpk / 1 m
Blue: T24N with 2 × B30 at 106 dBA / 8 m

ges consisting of harmonic distortion and all intermodulation distortion.

The measurement is typically performed for a standard useful signal level, approximating a real operational situation. A level of 99 dBA at a distance of 8 m under open-air test-site conditions was set for the T24N. The level here is an LAeq (energy-equivalent continuous sound level), and the linear weighted level is approx. 3 dB higher. 12 dB must again be added for the maximum value. This means a 114 dB peak level at a distance of 8 m for the T24N, corresponding to 132 dB at a distance of 1 m. At –28.3 dB (4 %), the total distortion measured was very low.

But the box has certainly not reached its limit yet. The level was raised further for the curves in Figure 17, starting with the 99-dBA measurement at a distance of 8 m. The green curves once again show the trend of the overall level (solid curves) and distortion percentages (dotted curve) from Figure 15. Controlling the amplifier until the limiters are set (red curves) raises the level by 7 dB to 106 dBA Leq at a distance of 8 m, and 139 dB Peak at a distance of 1 m. In this case, the distortion percentage then remains at an acceptable 10 %.

The blue curves in Figure 17 were also measured for 106 dBA, but with the addition of two B30s. Below 150 Hz, the level rises as expected, without increased distortion. Quite the opposite, in fact – the values actually drop. But another phenomenon is observed by the by: Adding the subwoofers only increases the distortion values by 2–3 dB in the tweeter's sphere of operation, though there is unfortunately still no explanation for this. It could be electrical or acoustic phenomena which caused the distortion in currently very high low-frequency sound pressure to rise slightly in our type of construction.

Listening test

The listening test involved building a stereo set consisting of a B30 subwoofer and a T24N top on each side in the measuring room. Despite the rather unrealistic boundary conditions, the tonal behaviour can be evaluated very well here due to the lack of spatial influences. Another advantage – also generated by the room's lack of diffuse field – is the possibility of being able to listen at a very loud volume, without this level becoming unpleasant. The listening distances in the low-reflection room are typically 6–8 m.

The T24N was initially heard full-range without subwoofers. The bass reproduction was pleasingly strong, meaning that, depending on the music, nothing was missed unless there was a direct switchover. With a subwoofer, the system was really amped up, producing a high-end sound with the dynamism of a live performance. At this point, it was pure enjoyment, and even critical ears were unable to find any points of criticism. Many different samples were listened to, and every person present could clearly envisage the purposes for which the systems were best suited: Club concerts, marquee events, DJ gigs, voice amplification for speeches over long distances, and all kinds of installations ...

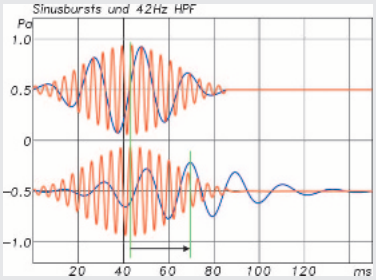
Particularly striking were the system's sound, which remained pleasant even at very high levels, and tonal balance.

Summary

With the T24N as the successor to the T24, which has proven its dominance over the last ten years, TW Audio has achieved more than merely a model upgrade. The extremely compact, significantly lighter (thanks to neodymium drivers), full-range-compatible, completely horn-loaded top is the epitome of speaker design in every respect. There is now also the alternative 90 × 50-degree horn and the serial switchover option between passive and 2-way active operation. Everything about it, even on top of the tonal and metrological performance, is top class. The workmanship is excellent, the accessories are plentiful, and the speaker top and subwoofer are well designed and genuinely easy to use. So it's easy to see that the new T24N, coupled with the B30 subwoofer (reworked two years ago) and the Powersoft or Lab.gruppen system amp racks, will be successful for many more years to come.

Phase rotation and group delay

Contrary to what is often misreported, intense phase rotations and a rise in group delay do not mean that low frequencies are reproduced too late. They instead cause a delay in a frequency group's energy focal point. Our simulation explains this using two sine bursts: At the top are two original signals, and at the bottom are both signals after being transmitted through a high-pass filter. The blue sine burst with the lower frequency peters out, and its energy focal point shifts clearly backwards. The red burst, on the other hand, remains virtually unchanged. This time difference in energy focal points, resulting from the transmission through the system, corresponds to the group delay difference between these two frequencies.



Two sine bursts in the original (top), which are transmitted down to the low frequencies (bottom) through a system with increased group delay. The energy focal point of the lower-frequency blue burst shifts by an amount equivalent to the system's group delay difference (green lines)

Text and measurements: Anselm Goertz
Pictures: manufacturer