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Dynacord CXM15

Coaxial floor monitor with optional FIR processing

The CXM 15 from Dynacord, a manufacturer based in Straubing (Germany), is a 15"/1.4" box with a wedge design. The cabinet has been kept especially flat and compact so as to be as unobtrusive and easy to position as possible on stage. Despite the advent of in-ear monitoring, floor monitors are no relic of the past. On grounds of cost alone and the relatively time-consuming handling, in-ear monitoring is often not possible, and a great many performers and technicians in any case prefer classical monitoring on stage – and for a wide variety of reasons. The demands placed on the loudspeakers used on stage are very high: "unobtrusiveness" is of particular importance if the set is to remain uncluttered and the lines of sight of audience members (and cameras) unobstructed.

From an acoustic standpoint, a consistent directionality and a frequency response free from narrow-band ridges are what is required, the aim in each case being to reduce susceptibility to feedback, as – along with the polar pattern of the microphones – the performance of the monitors plays a leading role here. Depending upon the application, further factors, such as the ade-

quacy of sound pressure levels, are of greater or lesser importance. Since stage monitors are usually operated at close range – between one and three metres from the performer – the sound should as far as possible radiate from a single source.

CXM 15

For the aforementioned reasons, the CXM 15 is conceived as a coaxial two-way system. A further advantage of this construction is the reduced area of the front panel, which makes the box more compact. The two sides of the enclosure are angled at 33° and 45°, the depth of the cabinet being 329 mm. These compact dimensions for a 15" woofer indicate already that the box is not necessarily optimized for deep bass reproduction, but this is in any case not what is generally wanted in a stage monitor. The size of the enclosure is clearly here the primary consideration. Genuine deep bass reproduction on stage is only required, if at all, for the drum monitor, which can always be complemented, should the need arise, by a subwoofer or shaker.

With a weight of only 19 kg, the CXM 15 is one of the lightweights in its class and is wonderfully easy to handle. Particularly practical are the integrated gripping edges running all the way round both sides of the enclosure. The recessed side panels accommodate three Speakon sockets, the active/passive selector switch and an integrated stand adaptor. Two of the Speakon sockets are on the side with the stand adaptor and the third on the opposite side. This means that whichever way the loudspeaker is mounted, a short Speakon cable is all that is needed to run the signal from box to box. The socket for the stand reveals that the CXM 15 can naturally also be used as a 'normal' full-range box or as the top box in a small PA or even as a fill system.

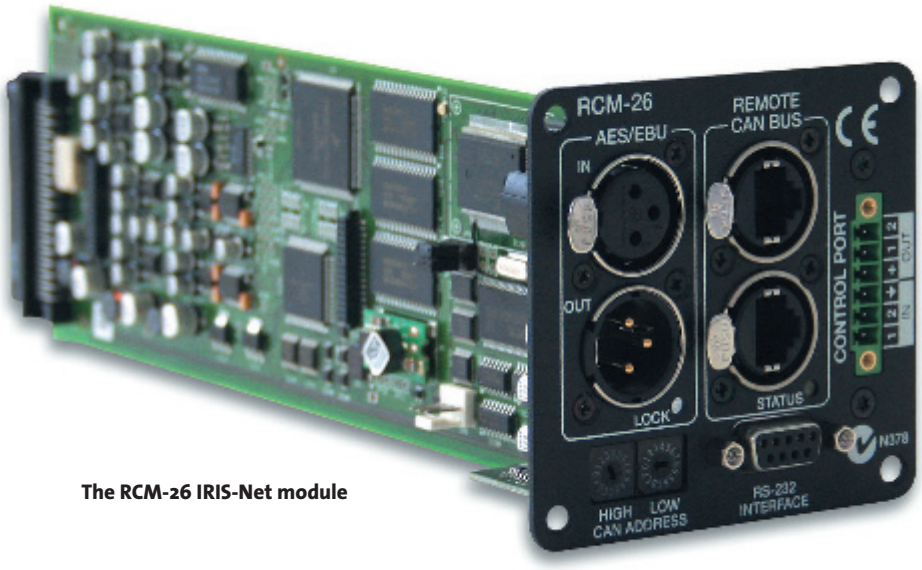
Overall, the birch plywood enclosure with its textured finish has a very robust look to it and the same goes for the equally solid front grille with its foam backing. The way the front grille is attached here, with very solid threaded screws, represents a great improvement over the screw or clamp designs you usually find. You can remove and replace the grille umpteen times here with no problems whatsoever. Depending upon the type of show, monitors on stage can be exposed to a considerable amount of dirt, so it is important to be able to clean the front panel regularly and swiftly.

When you unscrew the grille, the 15" chassis with its coaxial high frequency horn appears. The relatively large horn is positioned extremely close to the diaphragm of the 15" woofer. For the woofer, the horn functions as a type of small-volume bandpass chamber. Interference caused by the sound radiating from the woofer diaphragm reflecting back off the horn is only of relevance at very short wavelengths – in other words, at high frequencies that are in any case above the crossover frequency of 1,200 Hz. On the other hand, thanks to its size, the directionality of the horn is already so pronounced at the crossover frequency that the woofer diaphragm lying behind it is scarcely of any importance. The object of this approach is to obtain greater control of the sensitive midrange, which is otherwise always a weakness with coaxial drivers. And here, we can say at the outset, the approach has proved successful.

If you unscrew the chassis, it is easy to remove the driver with its two neodymium magnets from the box. The saving of weight that comes with the use of neodymium magnets is especially noticeable in the case of coaxial systems with two drivers in one chassis. Comparable chassis with ferrite magnets usually weigh more than the entire box does here.

Active or passive?

Once we have removed the driver, we get a clear view of the crossover: the circuit board contains two passive second-order filters – a high-pass and a low-pass – as well as a protective circuit for the tweeter. The compact circuitry on the board calculates in the manner of a simple analogue computer the RMS power received by the high-frequency driver and opens a relay whenever necessary (i.e. whenever there is



The RCM-26 IRIS-Net module

a danger of overload). The tweeter is not, however, fully switched off when this occurs but driven via two light bulbs connected in series, which offer secure protection against burnout. When the overload condition no longer exists, the bulbs are once again bypassed by the relay. A switch on the panel allows you to choose between Passive and Active modes.

In active mode, both the passive filter and the high frequency protection remain in the signal path, only the input to the passive crossover is now split so that the HF and LF can be driven separately via pins 1 and 2 of the NL4 connector. This obviates the risk of defects caused by faulty wiring. In active mode, the only thing to bear in mind is that the passive filter is already in the signal path. The crossover frequency in the active version can no longer therefore be raised significantly beyond the 1.2 kHz of the passive filter, which is in any case something best avoided. For active mode – naturally for passive mode as well – Dynacord recommends a power amplifier from its own Power H series equipped with the controller module IRIS-Net RCM-26. The H5000 power amplifier and the RCM-26 module were already the subject of a detailed test report in PRODUCTION PARTNER (Issue 10/2007) so we only need outline here those functions most relevant to the CXM 15.

IRIS-Net software and the RCM-26 module

The Intelligent Remote Integrated Supervision software platform (IRIS), which has been available now for seven years, contains the manifold control and supervision functions for Dynacord and EV power amplifiers and loudspeaker controllers equipped with their own DSP systems. Independently of any signal processing functions, the RCM-26 module adds a two-channel digital input and output in AES/EBU format, a CAN bus interface and two GPIO control and supervision connectors for external functions to the power amplifier. The networking for the remote supervision and remote control is handled by the CAN bus.

To connect to the PC, a further USB/CAN adapter is therefore needed. The UCC1 supplied for the test offers in addition to its adapter function the possibility of listening in to the signals of the connected amplifier via an audio output, which is especially practical when searching for errors.

For remote supervision, IRIS-Net offers a series of useful functions both for the power amplifiers and the connected loudspeakers. In addition to pilot-tone supervision, these allow the load impedance of the network and the prevailing thermal conditions to be checked. Another very important function is measurement of the impedance of the connected loudspeakers. Here, instead of a single reading, an entire impedance curve for the frequency range 20 Hz – 20 kHz is measured. This can then be compared with a stored tolerance mask (see Fig. 14) so that a reliable judgement can be formed as to whether the connected loudspeaker is still perfectly OK or in fact defective. With this type of measurement, you can make a reliable and at times highly specific diagnosis of most loudspeaker errors. Such a function is extremely useful for the supervision of fixed installations but even more so in the touring and rental sectors, as it makes it possible to conduct a swift and reliable check at the end of each show to make sure all the loudspeakers connected are still functioning correctly.

The RCM-26 controller in the H5000 power amplifier offers the choice of running the CXM 15 in either active or passive modes – in each case with either IIR or FIR filters. With 2 x 2.5 kW of sustainable power into 4 ohms, the H5000 naturally offers more than enough power for the operation of the CXM 15, so one can easily imagine a configuration with four boxes per channel and a total load of 2 ohms. In this case, the H5000 would deliver 3.3 kW per channel with 825 watts going to each box. The CXM 15's power handling is given as 900 watts program and 450 watts RMS, so this configuration should suit it nicely. One H5000 can power eight CXM 15s in passive mode and four in active mode.

Measured values

The connectivity of the CXM 15 with its individual LF and HF paths when set to bi-amp mode makes it easy to measure the two paths separately. What this reveals immediately is how well the two interact in the 1.2 kHz crossover zone. Fig. 1 illustrates this nicely. Despite the simple design of the passive crossover, the response when the two paths are summed is linear. Between 200 Hz and 3 kHz, the sensitivity is just under 100 dB; above 3 kHz it is around 103 dB. The fine interference structure in the high frequency range is not the fault of the driver but largely an unavoidable side-effect of the grille, as the black line showing the response when the grille is removed makes plain. Since the grille inevitably

reflects a small portion of the sound back into the horn, some interference between the waves flowing in and out is inevitable. In terms of sound, though, fine structures like these are hardly of such critical importance as to justify dispensing with a grille – least of all that of a floor monitor... Taking the mean sensitivity of 99.5 dB between 100 Hz and 10 kHz, the lower and upper 6 dB corner frequencies are found at 110 Hz and 17.4 kHz respectively. For a 15" tweeter, 110 Hz is very high for a lower boundary frequency, but this is due to the compactness of the enclosure and its use as a monitor. As soon as the box is laid on a boundary surface i.e. in its normal working position (see Fig. 3), the lower corner frequency falls to 88 Hz. Thanks to the flat cabinet construction, the much dreaded 'monitor hole' in the frequency response is scarcely discernible here. The phase response in Fig. 2 shows the high-pass characteristic of the bass reflex enclosure, with 360° of phase shift at the lower end of the frequency band and a relatively small phase shift in the area around the crossover frequency. The slight spatial displacement of the two paths seems partly to compensate for the 180° shift produced by the second order crossover. The electrical measurement of the impedance in Fig. 4 reveals the minimum impedance of 6.8 ohms as well as the 70 Hz tuning frequency of the bass reflex resonator.

All in all, what we are dealing with here is a thoroughly 'good-natured' box, from which, thanks to the secure foundation afforded by its coaxial driver, the desired results can be obtained with scant use of filters. The small 'nose' in the frequency response at 800 Hz is revealed by the spectrogram in Fig. 5 to be a resonance the causes of which could be many and diverse. Here we might be looking at an enclosure mode or perhaps a horn resonance – we cannot be sure at this stage.

The coaxial chassis with its 15" woofer and 1.4" tweeter and large horn

Directivity

In the data sheet, the nominal coverage angle of the CXM 15 is given as 60°, which due to the coaxial design and circular horn is valid for all planes. Any discrepancies could only be attributable to the enclosure and edge effects produced by it. Figures 6 and 7 show the isobar curves for the horizontal (narrow side) and vertical (wide side) planes. The nominal value of 60° as a mean value above 1 kHz is arrived at by a somewhat tortuous route. Above 8 kHz, the horn then begins to focus the sound more tightly and the radiation angle shrinks to 40° (-6 dB). Obviously you cannot expect a coaxial horn to satisfy the same demands as those imposed on comparable – and usually far larger – 15/2 boxes with individual systems, since a coaxial design necessarily involves compromises on one side or the other, though here they are balanced out well.

Maximum SPL

When measuring the maximum SPL, only the passive version of the CXM 15 was considered, since no important differences were to be expected between this and the active version. The maximum power for the series of measurements with an 185 ms sinus burst was limited to 900 watts referenced to 8 ohms. The green curve in Figure 8 is calculated from the sensitivity and the 900 watts (+29.5 dB referenced to 1 watt). In red and blue, you can see the values actually achieved with a maximum of 10% and 3% total harmonic distortion respectively. As far as 3 kHz, the 10% curve achieves with near perfect consistency the calculated maximum level, which is just beneath the 130 dB line – this, it must be said, is an outstandingly good result. At higher frequencies, the curve inevitably begins to fall away on account of the compression driver but still remains around the 120 dB mark. Also very impressive is the linearity of the maximum level curves, which indicates that the loudspeaker has no "weak frequencies".

FIR or IIR filters

The RCM-26 controller in the H5000 power amplifier offers the choice of running the CXM 15 in either active or passive modes – in each case with either IIR or FIR filters. The concomitant filter functions for all four variants are shown in Figure 9. The red and

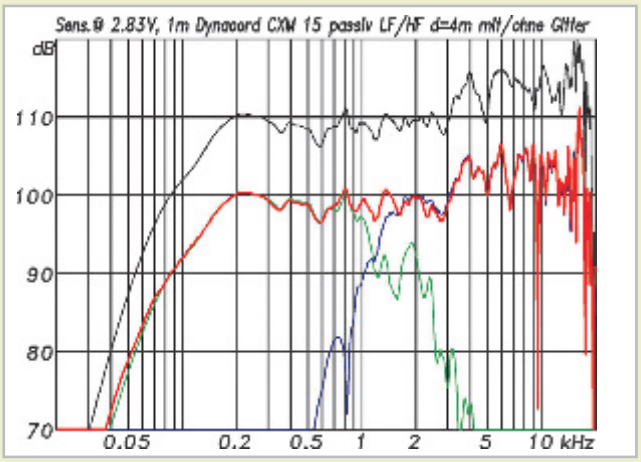


Fig. 1: The frequency response and sensitivity of the CXM 15 (red) as well as the LF (green) and HF paths (blue) with passive crossover. Moved 10 dB upwards and shown in black: the frequency response without the grille

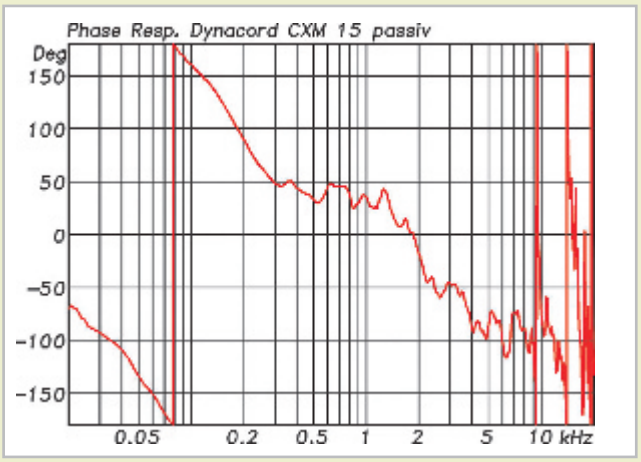


Fig. 2: Phase response of the CXM 15 in passive mode

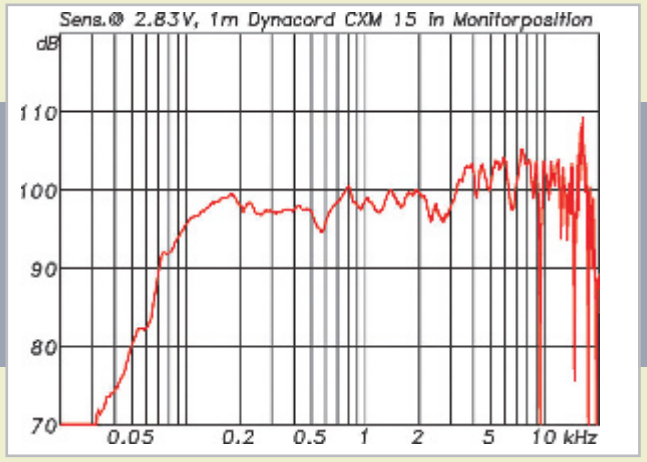


Fig. 3: Frequency response and sensitivity of the CXM 15 in floor-monitor position

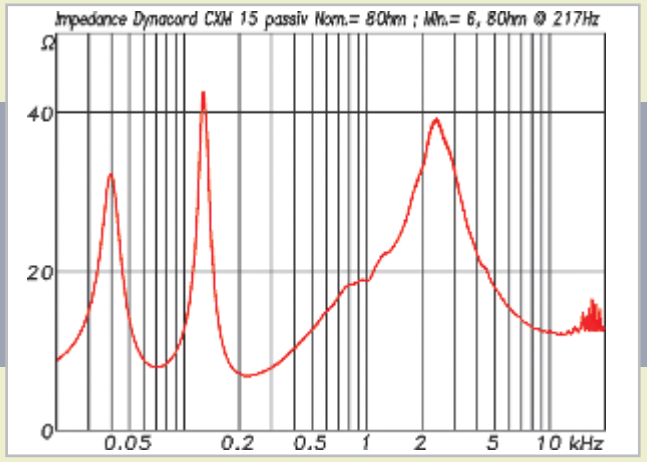


Fig. 4: Impedance curve of the CXM 15 in passive mode showing the minimum impedance of 6.8 ohms at 217 Hz and the tuning frequency of the bass-reflect resonator at 70 Hz

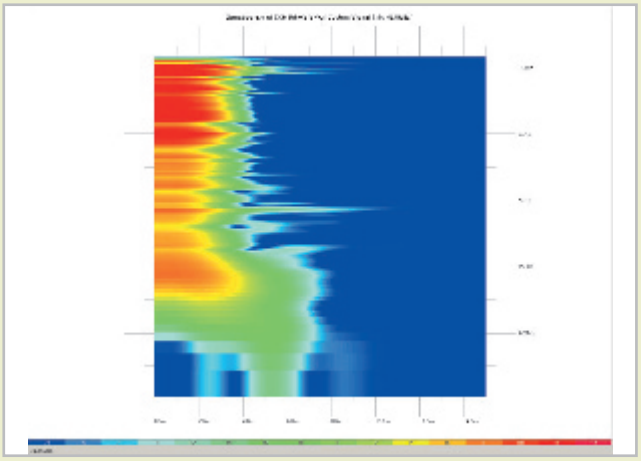


Fig. 5: The spectrogram of the CXM 15 in passive mode reveals a fairly pronounced resonance just below 1 kHz

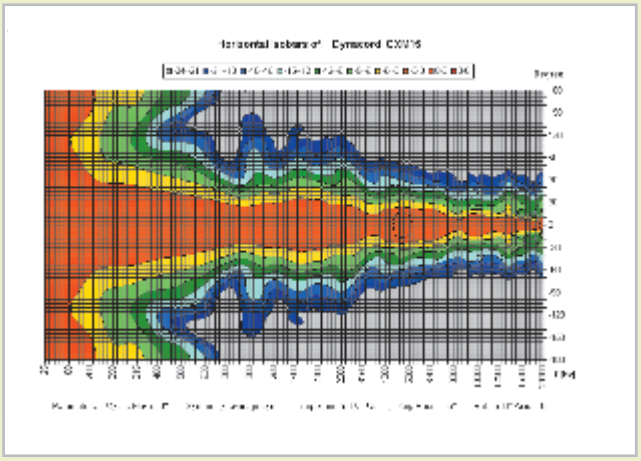


Fig. 6: Horizontal isobar curves of the 60° coaxial system

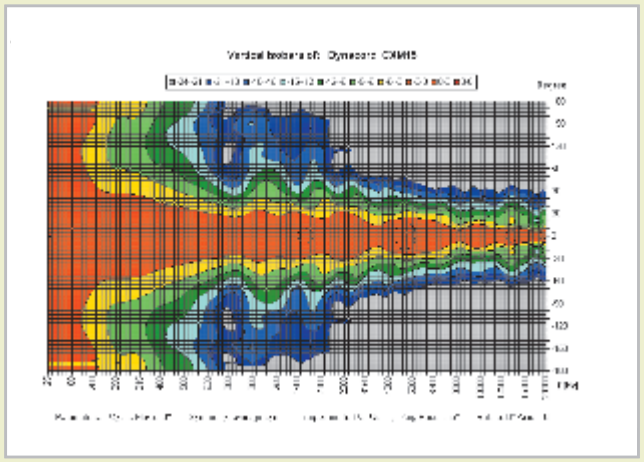


Fig. 7: Vertical isobar curves of the 60° coaxial system. Discrepancies between the horizontal and vertical curves are attributable to the shape of the enclosure

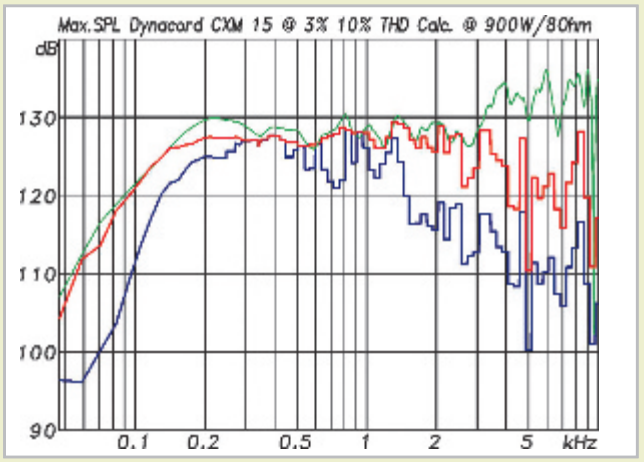


Fig. 8: Maximum level at 3 % (blue) and 10 % (red) THD along with the calculated curve (green) for the maximum supplied power of 900 W referenced to 4 ohms

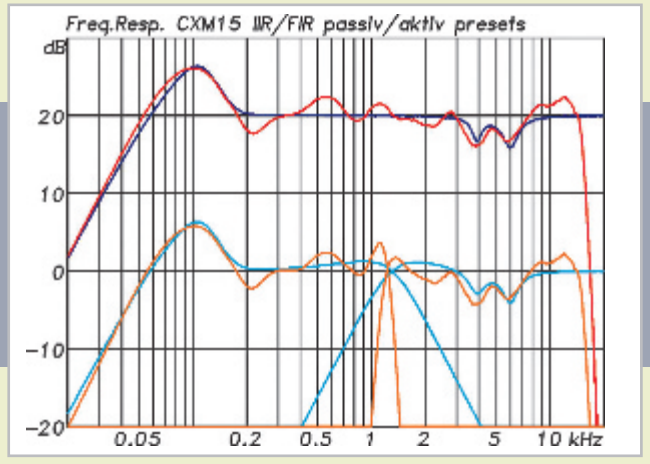


Fig. 9: Controller functions for the passive version (above) with IIR (blue) and FIR filters (red) as well as for the active 2-way version (below) with IIR (light blue) and FIR filters (orange)

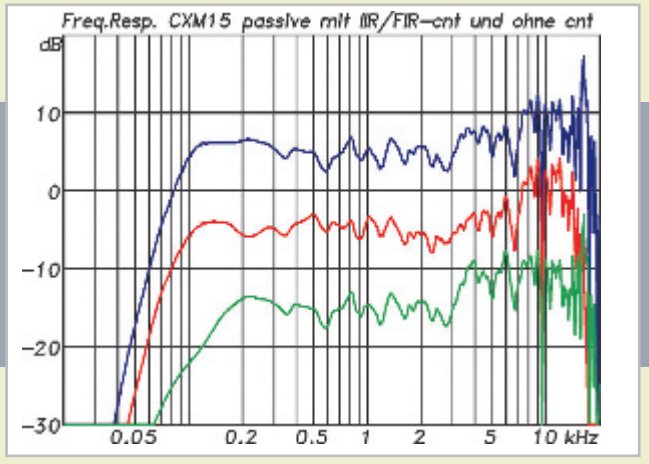


Fig. 10: Frequency response of the CXM 15 in passive mode without the controller (green) as well as with the controller and IIR (blue) or FIR filters (red)

orange curves representing the FIR variants are characterized in general by more details and in the active version considerably greater steepness.

If you look more closely at the FIR setup in the IRIS software, you will notice at once that in the lower frequency range there are an additional two IIR filters, a bell filter and a high-pass filter. These minor reinforcements are necessary because the FIR filters no longer afford sufficient resolution or frequency selectivity in this range.

Depending upon the selected number of coefficients of the FIR filters, there is an increase in the total latency of the system, which otherwise, independent of the number of signal processing functions, is 1.03 ms at a sample rate of 96 kHz and 2.3 ms at 48 kHz. With a sample rate of 48 kHz and 512 coefficients, for example, the increase in latency attributable to the presence of a FIR filter in the signal path comes to 5.3 ms when the filter is designed to be linear phase. This value can be calculated by dividing the number of coefficients by twice the sample rate – in this case, then, by dividing 512 by 2 x 48.000 1/s. At this point, it must be emphasized once again that the latency is not conditioned inexorably by the principle of the FIR filter but by the filter function itself. If the FIR filter is designed with a minimal phase function, its latency can be just as long or short as that of an IIR filter. The latency is only a by-product of the linear phase approach. What is needed, therefore, is to find a good compromise with a sufficiently short linear phase FIR filter combined with an IIR filter. The IIR filter is then used where the short FIR filter for want of frequency selectivity can no longer intervene – i.e. at the bottom end of the frequency range. This is the thinking here behind the combination of a 512-tap FIR filter and two additional IIR filters. These configurations can be nicely appraised using the IRIS-Net software (Fig. 15), in which the amplitude and phase of all the filter elements can be viewed singly and together – if necessary in conjunction with the frequency response of the loudspeakers. At the present time, as far as we know, the IRIS-Net software is the only controller software that offers such possibilities together with the measured values of the loudspeakers (see Fig. 16).

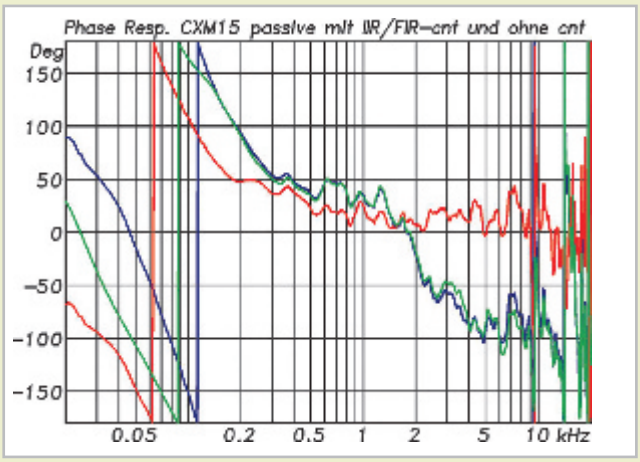


Fig. 11: Phase response of the CXM 15 in passive mode without the controller (green) as well as with the controller and IIR (blue) or FIR filters (red). With the FIR filters, a linear phase response is achieved for the medium and high frequencies

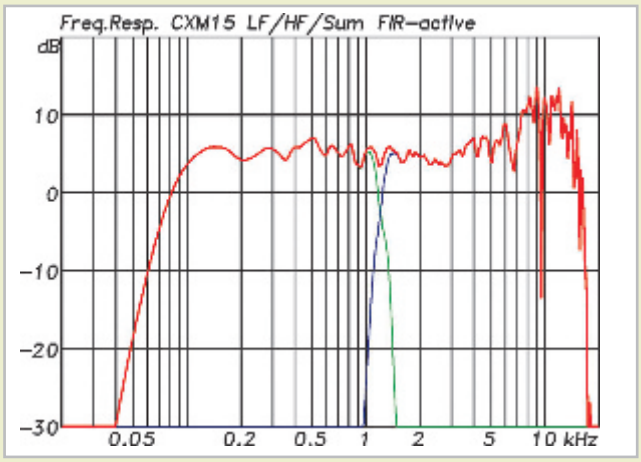


Fig. 12: Frequency response of the CXM 15 in active mode with FIR filters, with which a steep slope can be achieved

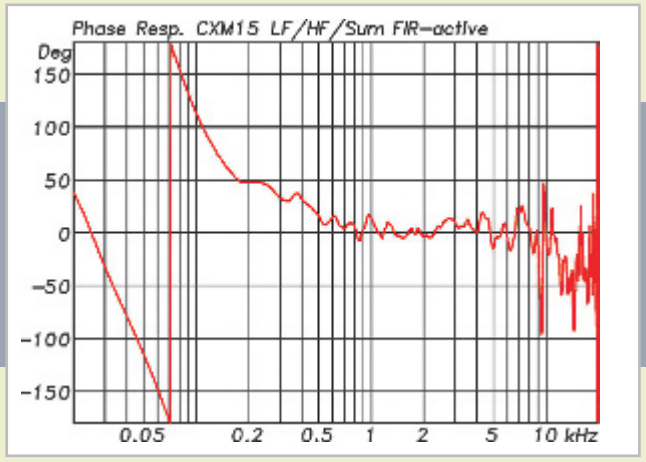


Fig. 13: Phase response of the active version with FIR filters. Despite the steepness in places, a linear phase response is even possible in the region of the crossover frequency

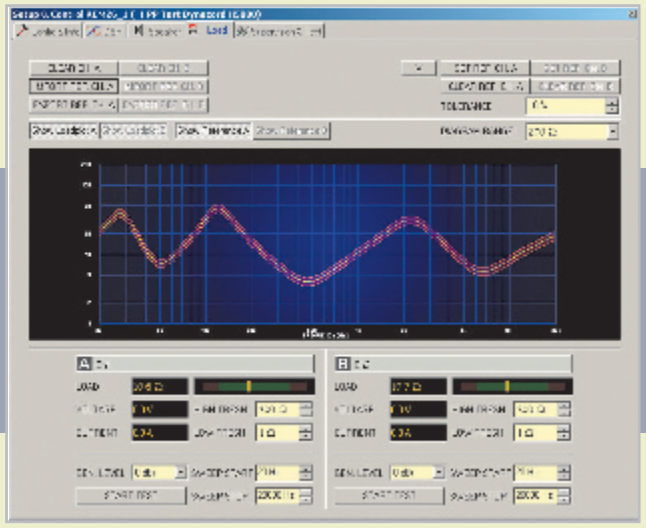


Fig. 14: The window for impedance supervision with the measured curve shown against the background of the reference range

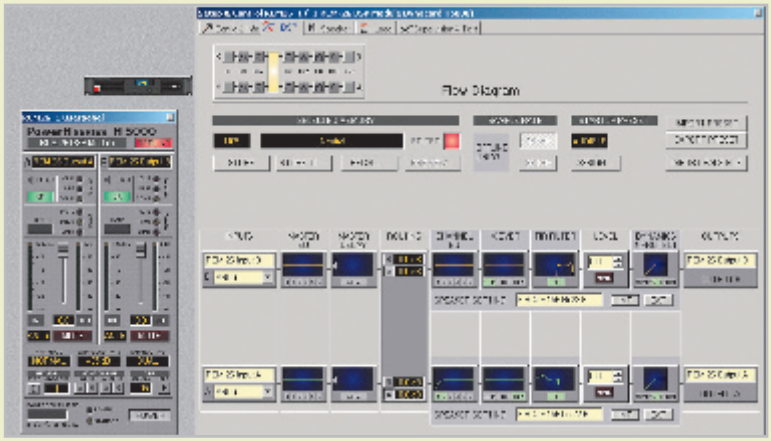


Fig. 15: Overview window in the IRIS-Net software showing the H5000 power amplifier (left) and a flow diagram of the routing and signal processing performed by the dual channel RCM-26 module

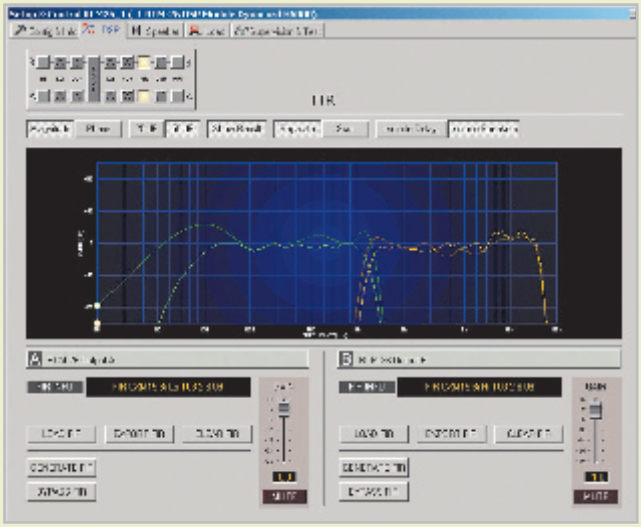
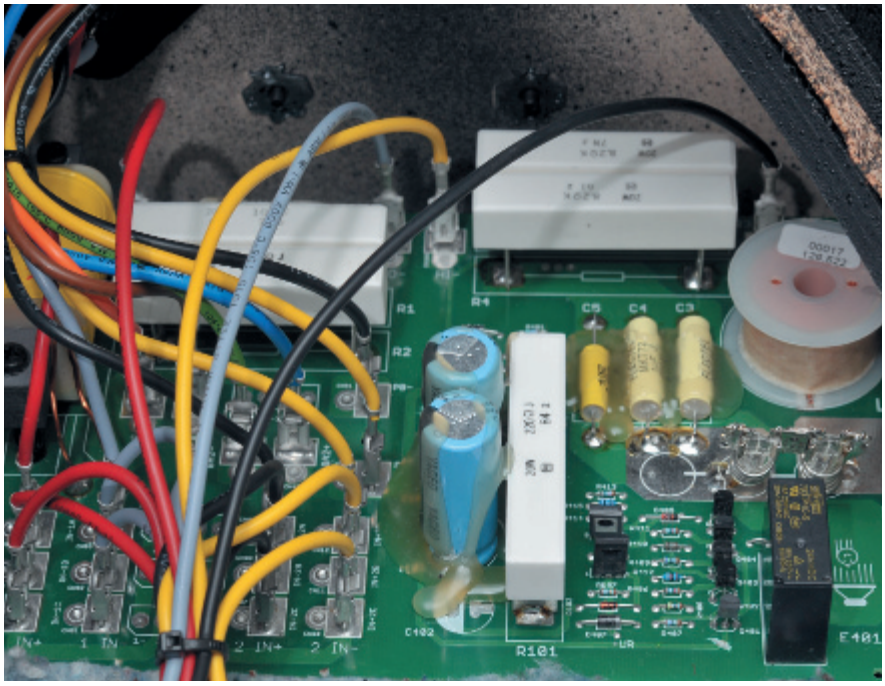


Fig. 16: FIR filter functions (thin lines) and the frequency response of the loudspeakers together with the filters. The phase response and summing functions can also be displayed



The passive crossover of the CXM 15 with (on the right) the circuitry protecting the tweeter

The software is supplied with a large library containing the measured values of many Dynacord and Electro-Voice loudspeakers.
The difficult question that arises next is which of the four controller modes to choose. Whether the monitor is driven in two-way active mode or passive is likely to be determined by economic considerations or the guidelines of the customer, so the choice boils down to that between FIR and IIR filters. Figures 10 and 11 show the amplitude and phase response of the CXM 15 in passive mode without the controller in green as well as with the controller and IIR (blue) or FIR (red) filters. In terms of frequency response, both versions with the controller thanks to the equalization achieve markedly lower corner frequencies at the bottom end. Furthermore, the frequency responses achieved with the controller are generally more linear and where there are spikes, they are less sharp. The FIR version goes into greater detail than the IIR filter. Far more marked are the differences in their phase responses, where the FIR filter in the midrange and higher frequencies achieves a linear phase whilst the IIR filter leaves the original curve of the box virtually unchanged. Summing up, one can say that the FIR filter achieves what are all in all a somewhat smoother frequency response and a linear phase response over wide frequency ranges. The advantages of the FIR filter are still more pronounced in the active version. If you look at Figures 12 and 13, an extremely steep separation between the LF and HF paths can be discerned. With conventional analogue or digital IIR filters, this would lead to pronounced phase shifts. Not so with the linear phase FIR filters, which make it possible to achieve even here a linear phase response in the medium and high frequency ranges. The FIR filters for the active mode just like the passive version introduce 5.3 ms of latency, which at the speed of sound translates to a distance of 1.8 m. This, even for a stage monitor, is perfectly acceptable. With a fully digital signal chain in which A/D and D/A conversion is performed in each case once only, a further 3 ms at most will be added, which still leaves us well inside what is generally regarded as the limit i.e. 10 ms.

Summary

The CXM 15 from Dynacord is a coaxial loudspeaker optimized from the outset for use as a stage monitor but one that is also universally applicable: this is not at all the same thing as a "multi-function box" that you can – at a stretch – also use as a monitor. The CXM 15 is for this reason very low slung, compact and light in its construction. The 15" coaxial chassis with its unusually large high frequency horn offers the ideal prerequisites for this task. The measured results are correspondingly impressive, with the very good maximum SPL values particularly praiseworthy. The fact that you can switch very quickly between active and passive modes means that the hirer can swiftly adjust the monitor system to the wishes and budget of the customer. In combination with the H5000 power amplifier and the RCM-26 controller module, there is the added option of IIR or FIR filtering
In the hearing tests, the box sounds fuller than the frequency response would at first lead one to expect. The directionality is precise with the coverage relatively strongly focussed, though the runoff towards the edges is even. Voices in particular are delivered by the CXM 15 with great clarity, which is precisely what is required from a monitor. A high degree of presence in the reproduction is often equated with "aggression" or "obtrusiveness", but this is not at all the case here. The idea of using the CXM 15 in combination with a subwoofer as a small club PA, side-fill or drum-fill is also one that appeals. Bearing in mind the quality of the performance and features offered, at around 1,900 euros the CXM 15 has to be considered good value. The 4,350 euros for the power amplifier and 795 euros for the controller module, on the other hand, may at first sight seem less so. This is only relative in the overall reckoning, however, because you can drive up to eight monitors with a single power amplifier. Since even in passive mode without a controller the CXM 15 is still a very good box, the choice exists between a very wide variety of viable configurations to match the needs and means of the user.

Text and measurements: Anselm Goertz
Photos: Dieter Stork, Anselm Goertz (2)