GENELEC

Small Active Monitor Technology
Genelec 8020A

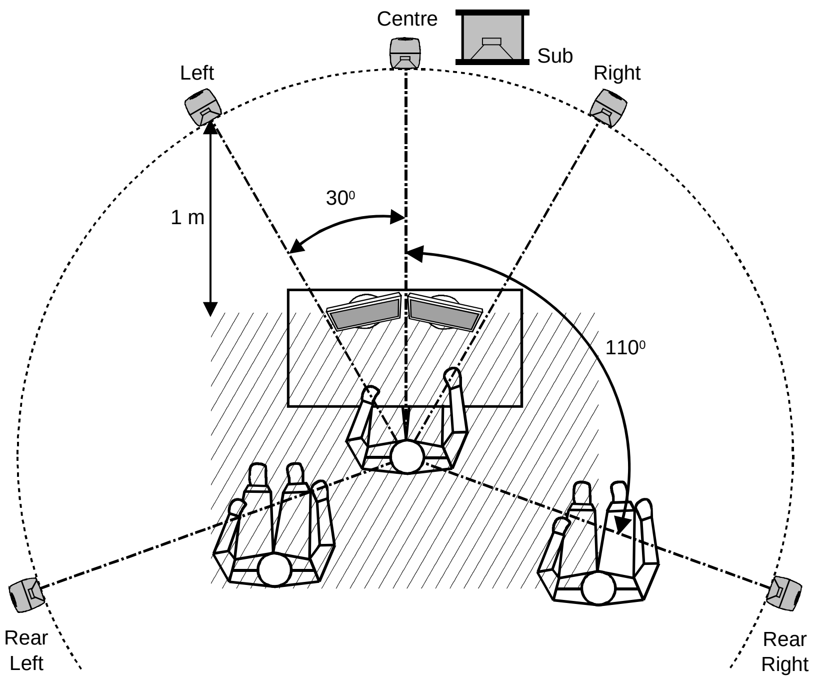
The launch of the Genelec's 8000 series monitors led to the creation of a new product category in the company's already wide range. A need was also identified for a small-sized monitoring system that could be adopted in a wide range of applications, including broadcast and post-production studios, distributed audio installations and audio/video workstations.
The R&D experience gained in the development of the 8030A, 8040A and 8050A provided unique technical solutions to create the new 8020A monitor. Genelec's Christophe Anet says the challenge was to combine small physical size and defined outer aesthetics together with outstanding technical performance and excellent functionality.

When you consider small loudspeaker performance, the first questions that come to mind concern maximum SPL and low frequency reproduction capability. Such limits are set by physical facts, but to establish realistic specifications another question should be simultaneously asked: how much SPL is really needed in these kinds of applications? It is clear that in many cases the answer would be: not very much, but still, how much is that?

Let us look at this question from a very different, non-pro-audio and especially non-rock-concert-type perspective. The interesting study of Wesley A. Bulla and James W. Hall[1] revealed that after many years of exposure, sound levels of 85 dBA for eight hours per day will produce hearing loss. It has been said that our sensory organ may tolerate greater average levels of music before damage occurs, but at the same time it seems also that audio engineers are more prone to expose themselves to higher levels of music for longer time because they find it much less disturbing than noise. Bulla & Hall conclude that the only option for an audio engineer who wishes to extend his/her career as long as possible with the customary 10 hours working days, is to monitor audio program material at conservative and safe sound levels - currently believed to be somewhere between 80 and 85 dB SPL.
Additionally, the Occupational Safety and Health Act (OSHA 2206, 1978) sets the daily 8-hour exposure limit to 75 dBA (slow response) for non-occupational fluctuating noise and 90 dBA (slow response) for industrial noise.

[1] "Daily Noise-Level Exposures of Professional Music Recording Engineers", Wesley A. Bulla, James W. Hall, 105th AES Convention, San Francisco, U.S.A., September 1998, Preprint 4792.

The established practice in multi-channel systems is to calibrate each monitor to produce 85 dB SPL at mix position. If properly applied, this is believed to keep the audio engineers' ears on the safe side [however, if all five speakers produce 85 dB SPL simultaneously, the result is 92 dB SPL for non-coherent signals. It seems that the calibration level is on the high side]. Defining



SPLs at listening positions is very practical because production environments vary a lot both in terms of acoustic treatment and listening distance. In larger rooms the distance is longer and vice-versa in smaller rooms. Most current professional monitoring systems can produce sustained levels in excess of 100 dB SPL at a few meters distance, so meeting the criteria is basically easy. However, if the SPL meter shows 85 dB SPL, it is the RMS figure integrated over a certain time period. As the music crest factor is high, the peak output capability needs to be some 10 dB higher than average RMS level.

Having this reference SPL figure and small space listening distances in mind, the 8020A maximum short term sine wave SPL output at 1 m on axis in half space, averaged from 100 Hz to 3 kHz, was set to 95 dB. This is more than sufficient for small production spaces such as OB vans or audio/video edit suites where short listening distance is a necessity.

Next question is: what is the recommended listening distance for a typical multichannel set-up and how far does the reference listening area extend?

The International Telecommunication Union[2] recommendation specifies listening arrangements for mono, stereo and multichannel audio reproduction, including the 'minimum preferred listening distances'. For stereo and multichannel reproduction the preferred minimum limit is 2 metres. The maximum preferred limits are 4 and 5 metres for stereo and multichannel systems, respectively. Figure 1 illustrates such a set-up with correct relative scale with all other elements in the sketch. It is interesting to note that with 2 metres radius and a typical production desk of 1.2 m by 0.6 m, the ITU listening area – the hatched area extending to the 'worst case' corner listening positions – only covers 1.4 m x 2.0 m. The conclusion is that only three people can work adequately within the accepted ITU listening area.

Due to room acoustics the listening position is in the reverberant field, and hence doubling the listening distance from 1 to 2 m reduces the level less than 6 dB. Despite its small size the 8020A with its 4-inch woofer and ¾-inch metal dome tweeter would still fulfil the 85 dB SPL requirement. This is not to say that larger speakers would be unnecessary, but to demonstrate what can be done with a small speaker. Larger speakers are necessary for example if we want to have a short and loud, 'impressive' session of movie effects.

[2] Recommendation ITU-R BS.1116-1: "Methods for the subjective assessment of small impairments in audio systems including multichannel sound systems", chapters 8.5.3. Two channel stereophonic reproduction, 8.5.4. Multichannel stereophonic reproduction.

So, how is it possible to squeeze such performance out of a small two-way monitor? The physics involved does not depend on enclosure size. Reproducing mid and high frequencies requires just sufficient power but at low frequencies it is always the same play between enclosure volume, cut-off frequency and efficiency. Cut-off frequency can be low if the resulting consequences of low efficiency or large enclosure are acceptable.

In Genelec's case the size was given: we were designing a small enclosure. Then there are two variables left, efficiency and cut-off frequency. Here choices have to be made again to either design a system that has wider bandwidth and which does not always need a subwoofer, or to design a system which is inherently a satellite for a sub. Our choice was the first one, the cut-off was selected to be 65 Hz (-3 dB), which dictates the maximum efficiency and hence the necessary amplifier power. Because the maximum SPL was 95 dB SPL, the thermal constraints are of minor importance while excursion and linearity are as important as in larger models. Once the choices are made, the next phase is all about optimisation - how to achieve the specified performance with minimum effort (here the word 'effort' is used in a wide sense; for example what materials to use, how much and where?). Under- and over-engineering is easy but the end result either does not fulfil the expectations or wastes resources.

As the new 8020A will be widely used in multi-channel applications, the addition of a subwoofer combined with a bass management system was mandatory. The 7050B subwoofer complements the 8020A in providing an LF response extension down to 25 Hz (-3 dB).

Genelec's chief mechanical engineer Jari Mäkinen provides an insight into the mechanical design of the 8020A: "*We start the mechanical design process from the drivers selected by our acoustic designers. They also specify cabinet volume and the very specific shape of the directivity control waveguide (DCW™). It is in fact quite challenging to bring such complex DCW™ shapes from the real prototype into the 3D model. Electronic designers give us the largest component sizes and a rough idea of the PCB dimensions. The mechanical designers then put all these parameters together in the 3D model and start to study them. In the case of the 8020A, with such a small enclosure, finding place for everything inside was quite a challenge!*"

Genelec used 3D software to study the complex acoustical shapes and curved surfaces in the design of the 8000 series monitors. This software can simulate surface appearances but you also need to test your 3D models. "*We build a lot of prototypes and test them during the design process,*" explains Mäkinen. *"First we make SLA (stereo lithography) rapid prototypes. A special machine makes plastic prototype out of our 3D-files. They are already quite accurate. With these plastic prototypes we can test the acoustic behaviour of the tweeter and the performance of the DCW™. Unfortunately plastic cabinets are too soft to test low frequency behaviour properly. Additionally, we also need a rapid prototype of the reflex port to test its air flow properties. Other rapid prototypes of specific parts might also be necessary. When we are satisfied with the design and all the parts, we make a rapid prototype of the entire cabinet in aluminium. This prototype can be played loud and all acoustical aspects verified".*

The reasons for die-casting the small monitor enclosure is to have freedom of shape, to reduce the outer dimensions and at the same time maximize internal net volume for improved LF efficiency. Aluminium is strong and solid enough even with thin walls, it is also lightweight, stiff and very easy to damp to yield a “dead” enclosure. It provides good EMC shielding and excellent heat dissipation for the power amplifiers as well.

Industrial die-casting technology uses very large moulds that can exert several hundred tons of force. The liquid aluminium (at more than 700 degree Celsius) is injected into the mould at high pressure. The aluminium part is held under pressure until it becomes solid and with the proper surface texture and is then removed and cooled in water. The casting process is fully automated but it is followed by a visual inspection of each part. The final stage is CNC machining and, if necessary, further finishing by hand. The finished part is again checked visually and with a 3D measuring device. After industrial washing the parts are powder coated to provide a strong, high quality and robust surface.

When the die-cast enclosure parts are delivered to the Genelec factory they are again checked before being assembled with all the other components and electronics. High pressure die-casting can create very accurate parts that fit together easily on the assembly line but the other side of the coin is the complicated design work involved at the beginning and high cost of the moulds.

Great care has been taken in the 8020A design to push all physical constraints to their limits to offer outstanding acoustical performance in a very small enclosure. Once again, our goal has been to exceed expectations and provide better tools for professionals.

Written by Christophe ANET, Genelec.