

SPHEAR WIRELESS

W H I T E P A P E R



Context

In four years, the headphone market has evolved; wireless products in particular have taken an increasing market share. By developing Sphear Wireless, our aim was to push the boundaries of innovation to improve audio quality whilst integrating wireless technology.

To do this, we started with the base of Sphear, the first in-ear headphone launched by Focal in 2015 which quickly became a reference in the in-ears market for their audio quality and many advantages. With Sphear, Focal's engineers effectively revamped the design of in-ears completely, so that no compromises were made between sound and comfort. With their innovative spherical shape, the approach to the ear canal was redesigned: relieving the ear canal from extra bulk and weight. A new sound vision of in-ear headphones was born: we proved that in-ear headphones could be both comfortable and deliver quality, hi-fi sound.

However, we are always looking forward to refine our work, Sphear Wireless project was an opportunity to refine the details and go beyond the existing performance. Some customers using Sphear flagged a lack of precision in the treble, especially a "whistle" effect which could be detected around 5 kHz. Since the human ear is very sensitive to frequencies between 4 kHz and 6 kHz, any peak in this area can become very unpleasant to listen to. Consequently, we had to solve this issue. With improving sound quality being a driving factor at Focal, we took this feedback on board and strove even harder to meet our customers' expectation and satisfaction by reconfiguring our acoustic solution.



Objectives

During the development of Sphear Wireless, we set ourselves four main objectives:

- To improve acoustics, especially the precision of the treble;
- To improve comfort, so as to satisfy all ear shapes;
- To switch to wireless without losing sound quality;
- To adapt the listening depending on the external environment.

This was no mean feat for our engineers. With Sphear, we had already completely revamped the design of the in-ears to make them as comfortable as possible, without compromising on audio quality. However, we encountered some limitations from a technological point of view:

- In the case of in-ears, it is necessary to reduce the size of the ear-cup to improve comfort. But reducing the size can prove critical, as it has an impact on the acoustics, especially on reduction of the low frequencies.
- When working with small sizes, acoustic resonances can occur. Due to the lack of space, we cannot deal with the inside of the ear-cup with diffusers or absorbers (like we can with over-ear headphones, for example).

The Focal engineers therefore worked on all of these limitations to create a leading product in its sector.



Works

To achieve our various objectives, we carried out mechanics, acoustics and electronics.

1. AUDIO QUALITY

As the former technology of the speaker driver had showed some drawbacks we moved to a new driver technology by using a new membrane made from Mylar sandwiched between two layers of Polyurethane providing a perfect balance of weight, rigidity and damping. This driver uses a powerful Neodymium magnetic motor to perfectly control the movement of the voice-coil and membrane. This new technology helped to remove the resonances and extend the high frequency to deliver a detailed and transparent sound and recreate the Focal sound signature.

As all these refinements pushed us towards the smaller driver (from 7/16" (10.8mm) to 1/4" (7mm) driver) we had to find a method to bring back the dynamics and punch of the bass back.

To correct this, we had to design a very specific bass-reflex configuration tuned for low-end frequencies in a very small enclosure. A very delicate moulded plastic part with a very precise assembly process creates the aforementioned bass port. Dynamic bass and extended low-end is the result.

To conclude, thanks to the new 1/4" (7mm) Mylar-Polyurethane sandwich diaphragm technology and the new earcup with its new acoustic configuration, we improved the tonal balance and the dynamics of Sphear Wireless.



Figure 1 :
Exploded view
of Sphear Wireless elements

Figure 2 :
Transparent view
of Sphear Wireless
and its dedicated
bass port

2. NOISE ISOLATION

Soundproofing improvement was a priority, which is essential for preserving the audio qualities. Thanks to the new acoustic refinements and improved insulation, Sphear Wireless makes it possible to listen and enjoy the music in total privacy, without disturbing the people around you, but also to experience the moment fully without being annoyed by surrounding disturbances.

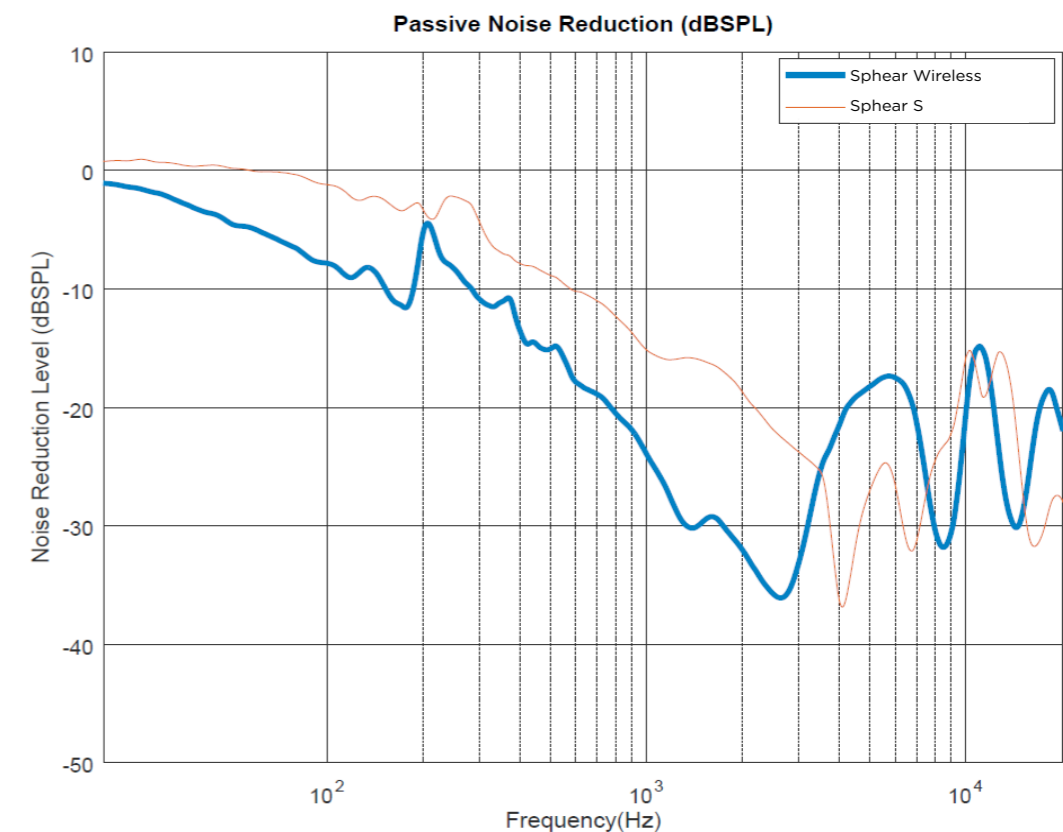


Figure 3 : Improved passive isolation in Sphear Wireless (almost 10dB in a wide range)

3. COMFORT

There are two types of in-ear headphones on the market today: earbuds and in-ears. Earbuds prioritise comfort, as they rest on the ridge of the ear and are unobtrusive. However soundproofing is often very poor, so the low frequencies are lost. In-ears, on the other hand, have excellent soundproofing and therefore good reproduction of the low frequencies, but some people find them too intrusive and uncomfortable.

We started from the work we had carried out to develop Sphear. The shape of Sphear Wireless is halfway between earbuds and in-ears since the earphones rest on the ridge of the ear whilst also having a tube that sits inside the ear canal, without being too intrusive.

To ensure they fit all ear shapes, the diameter of the ear-cups were reduced by 1/16" (1mm). That way, the headphones fit more ear sizes whilst remaining large enough to maintain their acoustic qualities.

Sphear Wireless can be worn for long periods without becoming even slightly uncomfortable inside the ear canal. We reduced the length of the tube so the headphones would be less intrusive inside the ear. The silicone or memory foam tips are more flexible and fit the ear canal better.

4. ADAPTING LISTENING TO DIFFERENT ENVIRONMENTS

Headphones have become a real accessory and are taken everywhere and anywhere. They are used indoors, in quiet settings (at home, at the office, etc.), as well as outdoors, in environments that can be very noisy (public transport, the street, etc.). External noise prevents us from hearing high and low frequencies properly. That is why Focal developed a new feature by the internal DSP of Sphear Wireless to adapt your listening to the environment, whether quiet or noisy, therefore pleasing all types of user.

The equaliser (EQ) mode includes a Neutral mode and a Loudness mode. When listening in a quiet environment, Neutral mode satisfies audiophiles looking for a sound that is faithful to the original work. To adapt to noisy ambient, Loudness mode provides a sound that is able to reproduce a better level of bass and treble.

We also recommend Loudness mode for listening at low sound levels: at low sound levels, the human ear is more sensitive to the mid-range and loses its sensitivity to high and low frequency content (Refer to the standard ISO 226:2003). This way, Loudness mode compensates for this sensation of losing the treble and bass.

5. WIRELESS AUDIO QUALITY

And last but not least, to not do any compromise, the heart of Sphear Wireless is a very reliable Qualcomm® Bluetooth® chipset which supports aptX™. The aptX® codec can transfer CD quality audio or higher (16-bit, 44.1kHz or 48kHz) over Bluetooth®. aptX™ is supported by majority of mobile devices and becoming a real standard for high quality Bluetooth® audio devices.

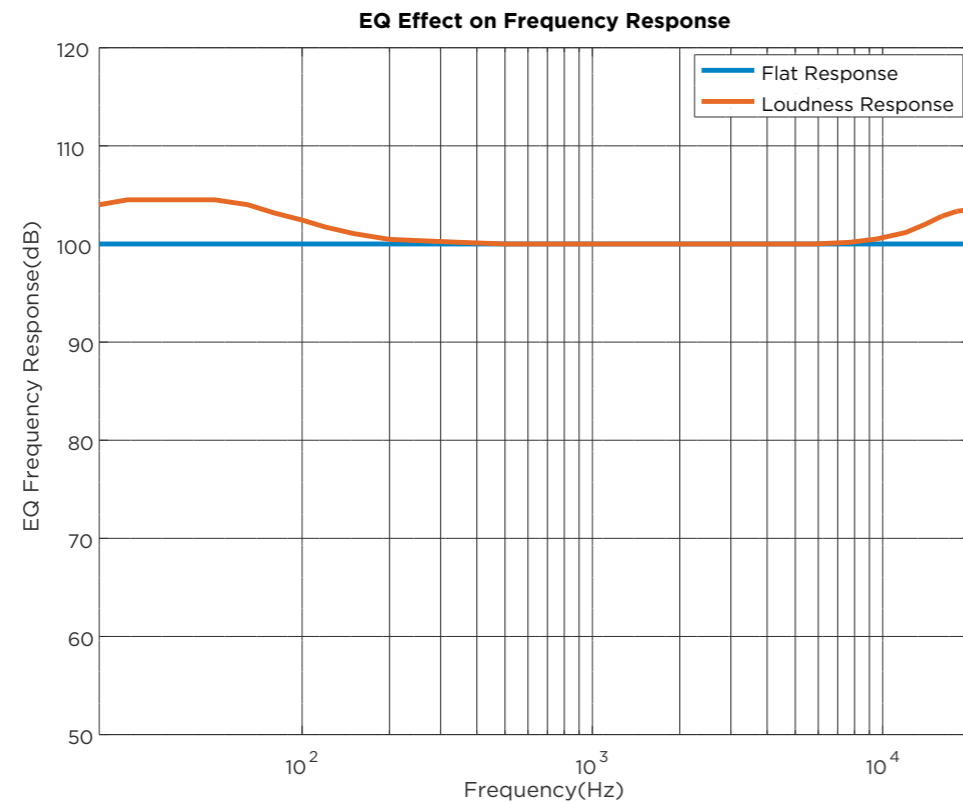


Figure 4 : Loudness vs Flat mode - Normalized DSP EQ output signal of Sphear Wireless

Results

Sphear Wireless therefore offers unrivalled audio quality for its market positioning, and is one of the best value for money products. Bluetooth® technology makes it possible to enjoy the high-definition they provide, in total freedom. They will cater to all listening requirements, whether in noisy or quiet environments, so that everyone can find their joy!





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