# Measuring a speakers' frequency response using the FPS3010 interferometric sensor

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Only recently, attocube released the new FPS3010, which is even more integrated and automated as previous versions. Here, the FPS3010 (see Figure 1) was used to measure the displacement of a speakers' membrane to characterize its frequency response. The setup is shown in Figure 2.

The new FPS3010 has outstanding properties such as a measurement bandwidth of 10 MHz. At the same time, the alignment restrictions for the optical sensor are relaxed, due to a large acceptance angle of +/- 0.4°. This makes the FPS3010 usable in a wide range of applications. The standard version is equipped with three sensor channels for the detection of e.g. linear movement together with pitch and yaw or 3D motion.

In detail, the signal flow for one channel in the FPS3010 is as follows: the laser beam, stabilized at a wavelength of $\lambda$ = 1535 nm, is passing through the attached single mode fiber into a collimator arrangement (the sensor unit), thus forming a collimated beam of about 1.6 mm diameter that is directed here onto the bare aluminum membrane of a commercially available loud speaker. The reflected light is coupled back into the fiber and routed onto a detector in the FPS3010 device. Note that the sensor head is completely passive; only an optical fiber is required for the connection of the sensor head to the controller. Therefore the sensor is suitable for e.g. high electromagnetic field applications as can be found in synchrotrons. Moreover, heating is completely relocated into the remote electronic setup. Hence, the FPS3010 is the ideal choice for vacuum or low/high temperature applications.

In the controller, the signal is split into a low pass filtered direct signal and a 90° phase shifted demodulated signal, enabling quadrature detection for the amount of movement and its direction. These signals are visualized by an application running on standard PCs and IPads, yet can also be routed through real time AquadB and high-speed serial outputs (HSSL), enabling higher OEM integration. For the measurement of the membrane's frequency response, a swept sine wave signal was applied to the membrane covering the full frequency range of 10 Hz to 20 kHz and the displacement was recorded in a sampling frequency of 44.1 kHz. The maximum displacement amplitude of the membrane was about 10 µm in the resonance peaks (at roughly 550 and 700 Hz). By Fourier-transforming the resulting time-dependent signal, one obtains the normalized frequency response as shown in Figure 3. A double peak structure can be seen that may arise from a beating effect of two resonances in the system, as well as a drop in amplitude at about 1500 Hz.


**Figure 1:** *The real-time displacement FPS3010 sensor equipped with 3 channels using single mode fibers and compact sensor units.*

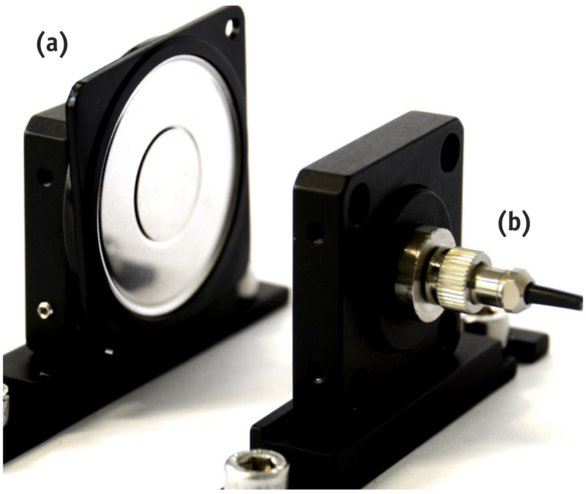


**Figure 2:** *Photo of the setup used for the experiment. The speaker (a) is mounted on the left. The sensor head (b) consists of the optical fiber and a collimation lens in a holder.*

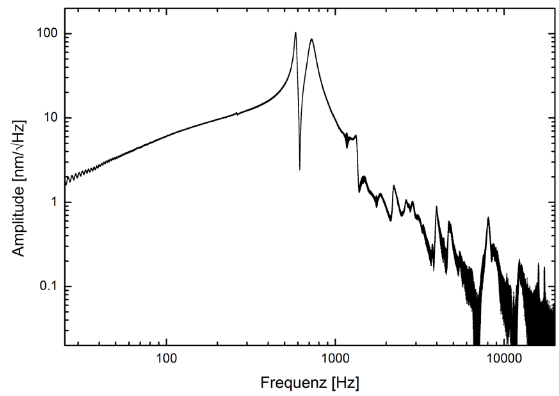


**Figure 3:** *Measured frequency response of the speaker used in these tests showing a clear double-peak resonance.*