CODA

CODA AUDIO

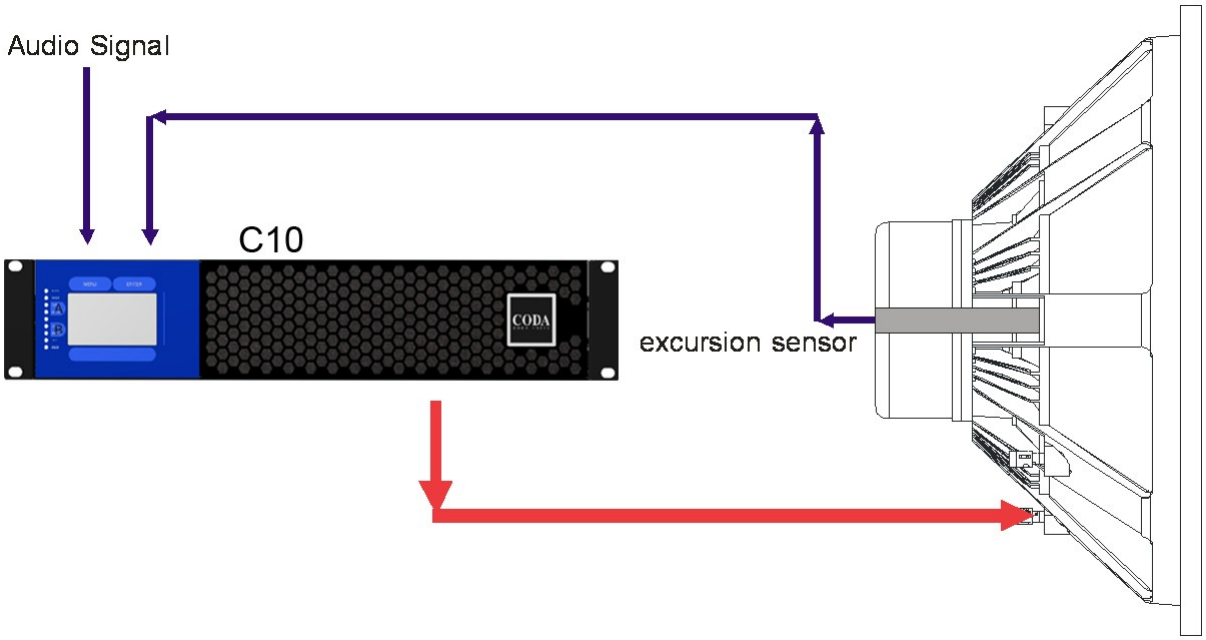
SC8 Sensor controlled subwoofer

Technical White Paper

SC8 Sensor controlled subwoofer

Description

Sensor controlled subwoofer with versatile directional characteristics (Cardio or Omni) incorporating four 18” woofers in a compact enclosure.
The drivers contain an integrated velocity sensor that measures the diaphragm movement in real time, compares it with the input audio signal and adjusts the amplifier driving voltage and/or current, correcting any driver inaccuracy. It is a self-optimizing, closed feedback-loop in which the driver confirms precisely the power it needs to accurately reproduce the original audio signal. The key advantage is a very extended and controlled response. Any distortion produced by the driver or the enclosure is instantly corrected by the feedback.



History

Although modern pro audio subwoofers are almost all port or horn loaded, the idea of feedback control in loudspeakers is not new. The first patent was applied for in 1933 by Smythe and in the early 70’s Philips developed a speaker system called Motional Feedback (MFB) which was a feedback system for HiFi woofers based on a piezo acceleration sensor. For different reasons this technology did not succeed in the HiFi market. Today some High-end HiFi companies use the MFB technology in their products (Linn, SilberSand etc).
Because of technical limitations especially at high power, the MFB technology was not suitable and has never been used in ProAudio.

The main difference between MFB and the Coda Audio sensor controlled technology is that while the MFB measure acceleration using a piezo sensor, Coda Audio utilizes a patent pending electro-dynamical sensor, measuring the velocity of the voice coil offering the following advantages:

- The piezo accelerometer is less precise especially at high excursion producing high amounts of distortion.
- Loudspeakers produce variable magnetic AC-fields depending on the position of the voice coil which is very strong in high power, high excursion pro audio drivers. The external noise sources disturb the functionality of the piezo sensor. The Coda Audio electro-dynamical sensor measures the velocity of the voice coil with a 0.1 % tolerance at 60 mm of travel. It is shielded against external noise sources and accurate even at extreme high levels.

The goal is to use a negative feedback loop to control and stabilize the loudspeaker. If the measurement sensor is not exact or the measurement is disturbed, a positive feedback will occur which will add distortion. This happens especially at high power levels when the measurement source is not exact such as piezo accelerometers.

Please see:

http://en.wikipedia.org/wiki/Negative_feedback

http://en.wikipedia.org/wiki/Positive_feedback

Processing

Conventional loudspeakers need external processing to optimize their frequency response. The minimum processing for any port or horn loaded subwoofer is:
High pass filter (HPF), Low pass filter (LPF) and one or more parametric equalizer.
While the LPF is used to implement the subwoofer to the main system the HPF is used to protect the driver from over excursion and the EQ is needed to compensate for the lower efficiency at very low frequencies.
The processing increases the group delay and alters the impulse response of the system.

The Coda Audio sensor controlled subwoofer does not need any external processing (except LPF to implement it to the main system). It is a closed loop and therefore self optimizing system in which the driver confirms accurately the power it needs to reproduce the original audio signal.

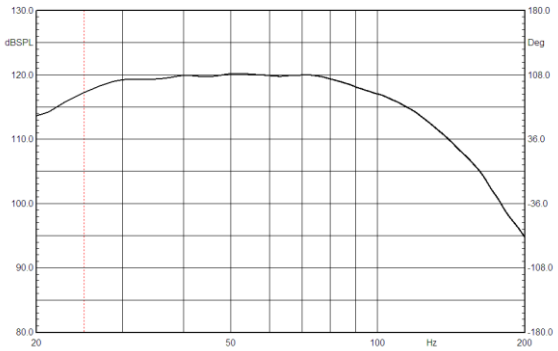
Measurements

The SC8 sensor controlled subwoofer was measured 5cm from the cabinet to avoid room reflections. Only the front 2 x 18” speakers were activated, the rear 2 x18” were switched off to minimize room influences. No processing was applied except LPF 90Hz 24dB Link/Riley.

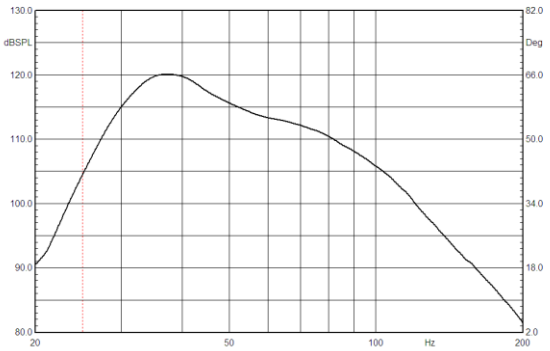
The conventional port loaded subwoofer is a high performance, large pro audio 2 x 18” subwoofer tuned at 32Hz and is measured 5cm from the port to avoid room reflections. Such a system is near the maximum of what can be achieve from conventional port loaded pro audio subwoofer. Typical processing was applied: HPF 30Hz/24dB-But, LPF 90Hz/24dB-Link/Riley PEQ 35Hz+8dB. The frequency response curve shows only the lowest frequency range which is performed by the port.

Frequency response

1.1 SC8 Sensor controlled woofer incl. LPF 90Hz 24dB Link/Riley
Frequency response measured 5cm from the loudspeaker

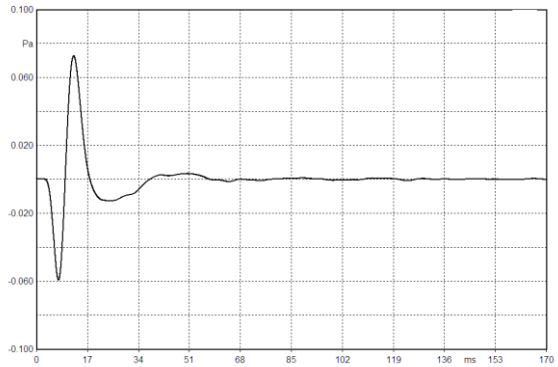


1.2 Conventional port loaded subwoofer including processing
Frequency response measured 5cm from the loudspeaker port

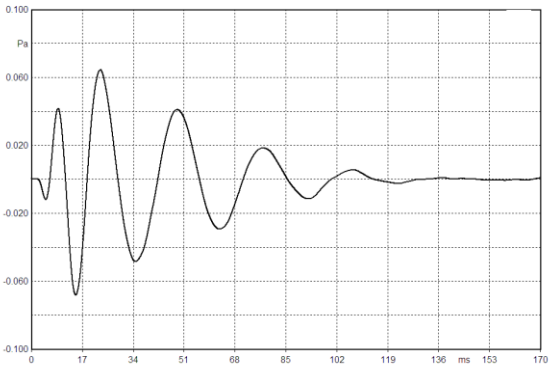


Impulse response

2.1 SC8 Sensor contr. woofer incl. LPF 90Hz 24dB Link/Riley
Impulse response measured 5cm from the loudspeaker

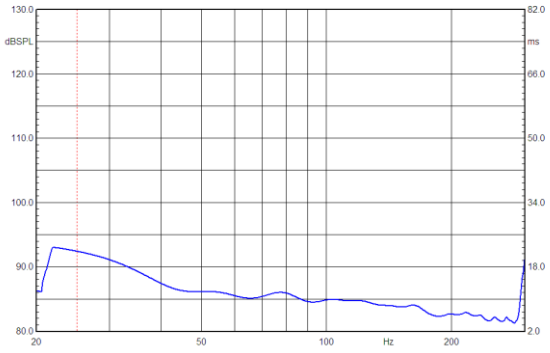


2.2 Conventional port loaded subwoofer including processing
Impulse response measured 5cm from the loudspeaker port

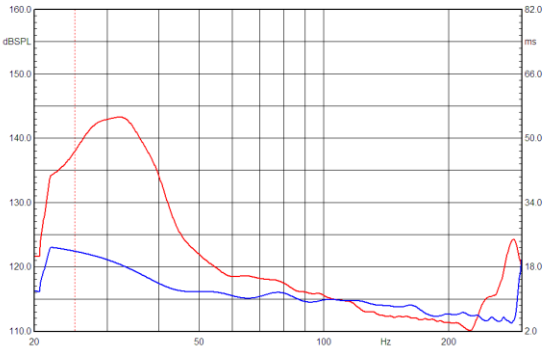


Group Delay

3.1 SC8 Sensor contr. woofer incl. LPF 90Hz 24dB Link/Riley
Group delay measured 5cm from the loudspeaker

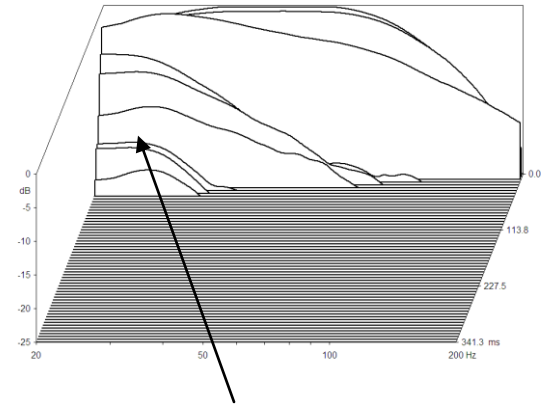


3.2 SC8 woofer vs. conventional port loaded woofer
Group delay measured 5cm from the loudspeaker port



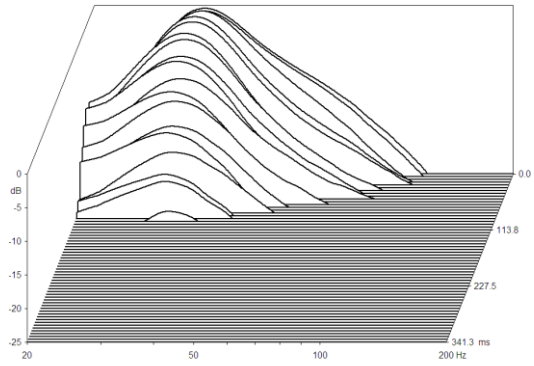
Waterfall

4.1 SC8 Sensor contr. woofer incl. LPF 90Hz 24dB Link/Riley
Waterfall measured 5cm from the loudspeaker



Note: It is difficult to measure low-frequency response of a speaker (even in an anechoic chamber), because of reflections from the environment. The SC8 waterfall measurement shows a small amount of reflections from the room at the 20Hz - 40Hz range.

4.2 SC8 woofer vs. conventional port loaded woofer
Waterfall measured 5cm from the loudspeaker port



Interpretation of the measurements

It can be seen that the feedback loop controlled subwoofer has clear advantages over conventional amplifier / subwoofer solutions.

Frequency response

The sensor controlled technology does not have a cut off frequency. While the comparator is set to optimize the system response down to 25Hz (-3dB) / 20Hz (-6dB) (Fig.1.1) It can be easily adjust for flat response down to 10Hz or even lower if needed.

The conventional port loaded cabinet is a large pro audio 2 x 18" system tuned at 32Hz and is measured 5cm from the port to avoid room reflections. Typical processing was applied: HPF 30Hz/24dB-But, LPF 90Hz/24dB-Link/Riley PEQ 35Hz+8dB. The frequency response curve shows only the lowest range which is performed by the port (Fig. 1.2). The frequency range is generally limited by the tuning frequency of the port which is the cut off frequency of such systems. Similar to horn loaded systems, port loaded subwoofers become extremely large if extended low frequency response is required. While at 36Hz both systems have the same output, the SC8 has 12dB more output at 25Hz and 23dB more output at 20Hz than a conventional system.

Impulse response

The impulse response describes the reaction of the system as a function of time. The sensor controlled system (Fig. 2.1) provides perfect impulse response while the conventional system shows increased group delay and altered impulse response caused by delayed sounds from the port (result of resonance) and the audio processing (Fig. 2.2). Such impulse response is very typical of port or horn loaded systems. The SC8 subwoofer provides very controlled impulse response assuring pure sound reproduction.

Group Delay

The sensor controlled system (Fig. 3.1) has near zero group delay in the range 42Hz-100Hz. Under 42Hz the group delay increases slightly to 8ms@34Hz and reaches its maximum of 11ms@25Hz. In fact the sensor controlled system produces the whole spectrum acoustically in the same time, because such group delay is below the limit of our perception abilities.

The conventional subwoofer (Fig. 3.2 – Red line) provides increased group delay of 44ms@34Hz. If a fast sequence of transients arises the results can be blurred with imprecise sound. With the sensor controlled subwoofer, the transients are produced with the same time liaison as the input audio signal. This means that a fast sequence of transients will be clearly audible.

Waterfall

Even if the SC8 waterfall measurement shows a small amount of reflections from the room in the 20Hz-40Hz range it repeats what we have seen already in the impulse response – very fast and clean response ensuring homogeneity and precision of sound reproduction.

The conventional port loaded subwoofer provides the typical long resonance around the tuning frequency of the cabinet and the tendency to accentuate noise/interference around the given resonance.

Conclusion

While conventional subwoofer designs are well known from years of practice, to work well enough, the sensor controlled subwoofer technology allows a vital new step forward to be taken towards a truly complete and coherent speaker system set-up, providing extended low range with flat frequency and phase response for perfect reproduction of music with exceptional accuracy and definition.

SC8 Features

- **4 x 18” extreme high output subwoofer**
- **Velocity sensors for feedback loop control**
- **Extended frequency range down to 25Hz (-3dB) / 20Hz (-6dB)**
- **Ultra low distortion**
- **Fast transient response, the upper bass and the ultra low frequency are time aligned**
- **Cardio or Omni directional mode**
- **Optional rigging hardware for flown or ground-stacked arrays**
- **Reduced truck space, reduces labor and transport costs**

Technical specifications

Type:	Sensor controlled Cardio/Omni subwoofer
Application:	High output subwoofer
Frequency response:	25Hz (-3dB), 20Hz (-6dB)
Power handling (AES/Peak):	6000W / 24000W
Sensitivity 1W/1m: [2]	106dB @ 50 Hz
Maximum output peak: [3]	150dB
Components:	4 x 18” neodymium ultra low distortion woofers 4” (101.6 mm) voice coil, 1500W (AES) each
Front:	2 x 18
Rear:	2 x 18”
Nominal impedance:	Front: 4 Ohm +-1 Rear: 4 Ohm +-2
Input connectors:	2 x Neutrik™ NL4MP
Velocity sensors output:	1 x Neutrik™ NC5FDL1
Suspension:	optional (compatible to AIRLINE LA12 Frame)
Enclosure material:	Baltic birch
Finish:	Textured Black paint
Dimensions (W x H x D):	1108 x 540 x 982 mm
Net weight SC8:	122 kg
Net weight SC8F:	135 kg including flying hardware

[4]
[2] Half-space loading
[3] Measured with pink noise 6dB crest factor

Coda Audio GmbH
Boulevard der Eu 6
30539 Hannover
Germany
www.codaaudio.com