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Test Signals for Setting up Subwoofer-based Systems

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1. Introduction

Neumann loudspeakers will give their best acoustical performance when they have been set up correctly. The performance of a loudspeaker changes when it is placed into an acoustical space. Some of these changes can be corrected using the acoustical controls built into the loudspeaker. Some of the changes cannot be equalized and require a change of location or some form of acoustical treatment added to the room.

To help set up the loudspeakers some (.mp3 formatted) audio test signals have been prepared. The test signals and their appropriate use are described and each test signal can be downloaded by clicking on the link.

Some of the test procedures described below require two people: one to adjust the controls on the subwoofer and the other sitting in the listening position.

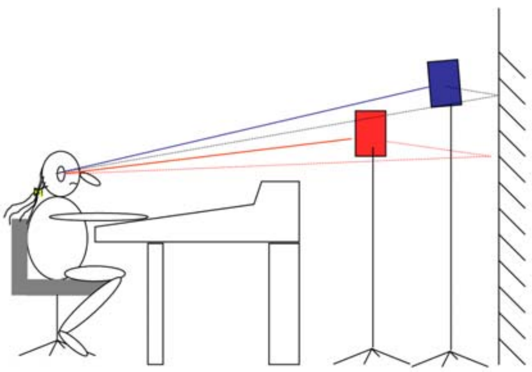
2. Positioning the Loudspeaker and Subwoofer Cabinets in the Room

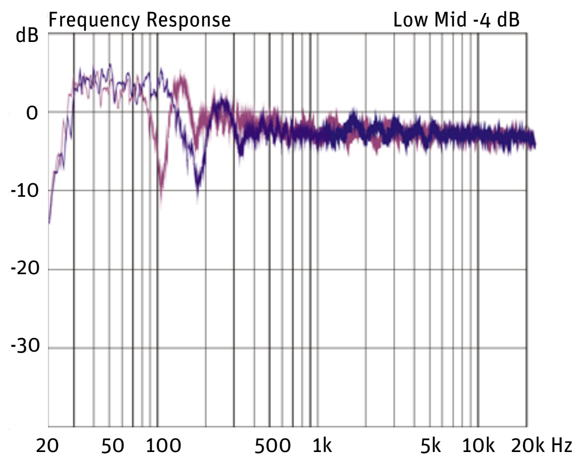
Before setting the relative levels and phase of the loudspeakers and subwoofers, correctly position them within the room and then adjust the equalizer controls to compensate for that positioning. The acoustical controls of the loudspeakers should be set according to their instruction manuals.

Positioning the loudspeakers and subwoofers

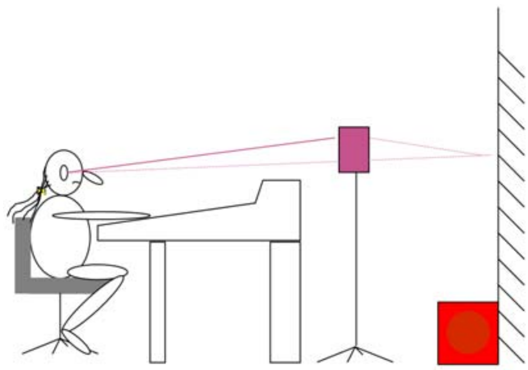
Subwoofers are typically positioned close to a wall (<60 cm or 2 ft) to avoid cancellations in the passband, and located between the front left and right loudspeakers to avoid localization. To reduce the chance of inefficient coupling and a consequent loss of SPL, ensure that the front of the subwoofer (driver and ports) is not located exactly at the center of any axis of the room.

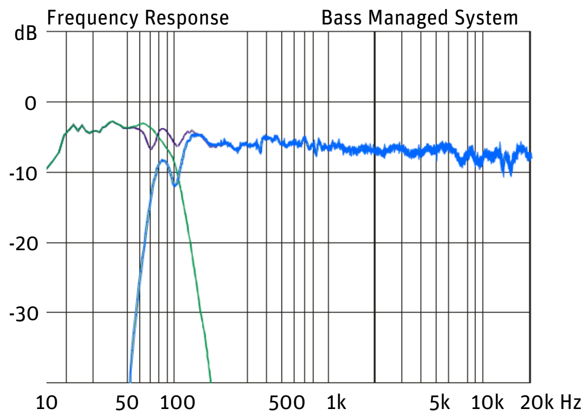
The loudspeakers should be positioned sufficiently far away from the wall to avoid an audible notch in the frequency response caused by reflections from the wall behind the loudspeaker. The diagram below shows this effect. The listener hears the direct sound (solid line) and the reflected sound (dotted line). The reflected sound is 180° out of phase when it arrives back at the loudspeaker and this causes destructive interference. Depending on the solidity of the wall (greater effect seen for heavier walls), a dip at a frequency where the distance to the wall is a quarter of the wavelength can be seen (dip at 180 Hz in the blue example below). An alternative is to place the loudspeaker next to the wall and compensate the loading with the **Bass** control.





Increasing the distance of the loudspeaker from the wall increases the affected wavelength and therefore decreases the affected frequency (red example above). The loudspeaker should be positioned sufficiently far from the wall to locate this frequency below the loudspeaker/subwoofer crossover, so that any cancellation will be compensated for by the subwoofer.





It is important that the loudspeakers are correctly positioned before setting the level and phase controls on the subwoofer, as any later change in position will require the level and phase to be readjusted.

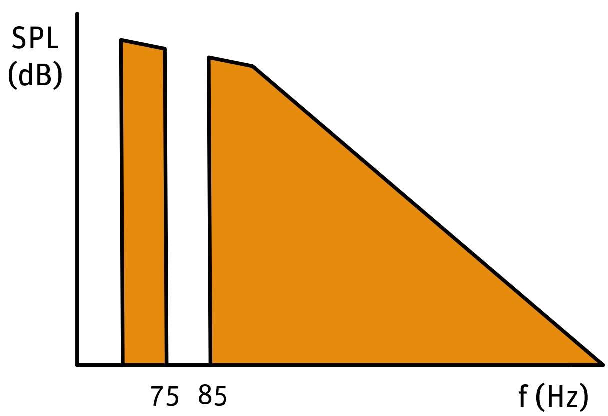
Setting the subwoofer's acoustical controls

The in-room response of the subwoofer can be checked using the range of test tone tracks from 15 to 90 Hz:

- While sitting in the listening position, start at 90 Hz and gradually decrease the frequency, listening carefully for any changes in the sound level. It is likely that there will be peaks at certain frequencies, caused by constructive interference or strong resonances.
- Increases in level below 35 Hz can be corrected using the **Low Cut** control. Adjust it so that this very low region sounds to be at the same level as the rest of the response.
- For increases in level above 35 Hz, play a tone at the problem frequency, and switch the parametric equalizer on. Set the **Q** to its maximum value, 8, and the **gain** to its minimum value, -12dB. Adjust the **frequency** control to focus on the centre frequency of the peak. Then adjust the **Q** and the **gain** in order to give an overall flat sounding frequency response in this area.
- If there is a decrease in level rather than a peak, the equalizer can be used to increase the offending frequency in the same way.

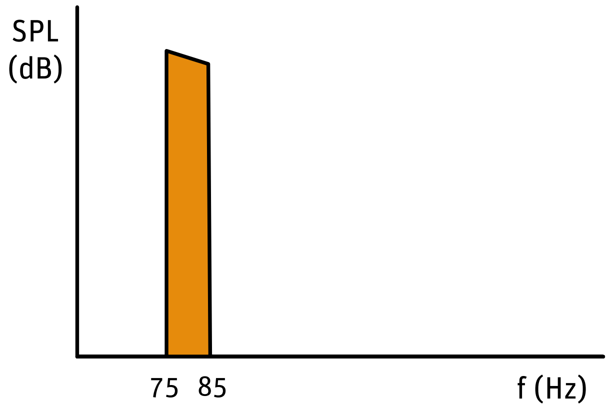
3. Pink noise from 60 Hz upwards, with a 10 Hz wide cut centered on 80 Hz

This test signal "**01 - Pink noise with 80Hz cut.mp3**" is used to set the level of a subwoofer relative to the level of a main loudspeaker. Play the test signal through the loudspeaker/subwoofer combination and repeatedly enable and disable the subwoofer using the Bass Management control. Adjust the level of the subwoofer until the level of bass energy does not change whether the subwoofer is disabled or not. Repeat this process for each loudspeaker/subwoofer combination in the system, but this time adjust the level of the loudspeaker not the subwoofer.



4. Pink noise from 75 – 85 Hz

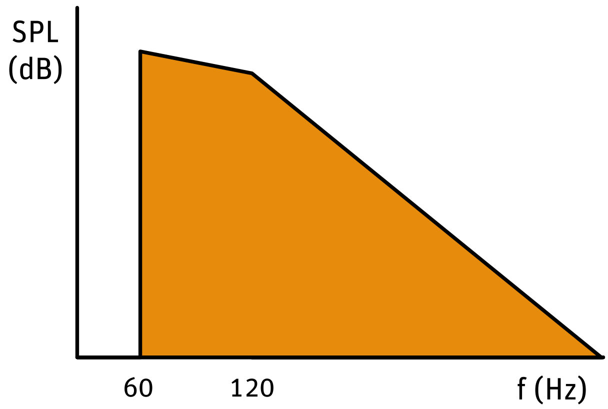
This test signal "**02 - Pink noise 75Hz-85Hz.mp3**" is used to set the phase of a subwoofer relative to a main loudspeaker. Play the test signal through the loudspeaker/subwoofer combination and adjust the phase controls (0°, 45°, 90°, and 135°, with and without the 180° switch) on the subwoofer until the lowest level is observed at the listening position. The level can be measured using a microphone and mixing console metering, a sound level meter, acoustic test equipment, or simply listen to it. Once the worst case has been found, flip the 0°/180°switch to the other setting. Verify that the setting is appropriate by repeating this process for each loudspeaker/subwoofer combination in the system.



5. Pink noise 60 – 120 Hz

This test signal "**03 - Pink noise 60-120Hz.mp3**" is used to verify the settings resulting from the above two procedures. It can reveal problems at the crossover frequency. When the bass management in the subwoofer is disabled, there should be no significant audible difference in the level of pink noise sound. If there is a difference in level, the above two level and phase procedures should be repeated. There will always be a small difference in tonality when the bass management is enabled or disabled as the loudspeaker and subwoofer will have different coupling to the room due to their different locations.

Additionally, when played loud, this test signal can be used for testing for rattles in the room. Find the source of the rattle and stop it by adding damping material, tightening up the screws, or applying (duct/gaffer) tape.

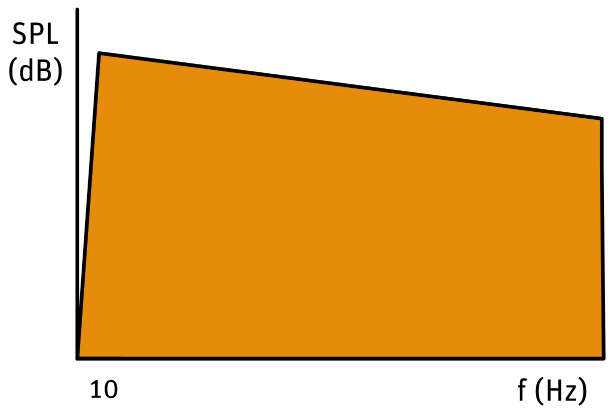


6. Broadband pink noise

Pink noise has equal power in each octave so the power density decreases at a rate of 3 dB per octave. The spectrum of pink noise is similar to that of the long-term average of typical music signals, and is more “loudspeaker-friendly” than white noise.

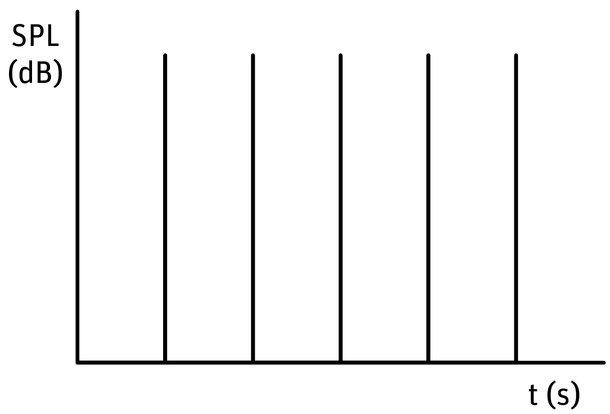
This test signal “**04 - Pink noise.mp3**” is very good at revealing tonal differences between loudspeakers or subwoofers located in different positions in the room or between different loudspeakers or subwoofers. Ideally the sound should be the same from each loudspeaker or subwoofer in the system.

It is also possible to hear the additional bass extension of the system when the bass management in the subwoofer is enabled.

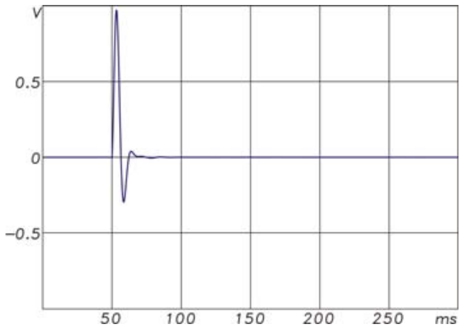


7. Low-passed Dirac impulse train

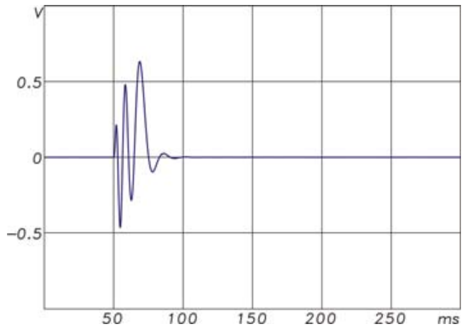
An impulse is ideally infinitely narrow and infinitely tall. A Dirac impulse is a digital representation of an impulse and looks like this: 1 0 0 0 0 0 0 0. A Dirac impulse train is a set of equally-spaced Dirac impulses and looks like this: 1 0 1 0 1 0 1 0. This signal is then low-pass filtered so it can be used to reveal problems such as 360° phase difference.



In some situations it is possible for the main loudspeaker and subwoofer to be in-phase at the crossover frequency, but have a delay between them of one or more cycles at the listening position. This causes impulsive sounds to be smeared in the time domain. The following plots show a low-pass filtered Dirac impulse with and without a one cycle delay at 80 Hz (12.5 ms) between the loudspeaker and subwoofer at the listening position.



Impulse response with no delay



Impulse response with 12.5ms (80 Hz) delay between the loudspeaker and subwoofer

This test signal "**05 - Low passed Dirac impulse train.mp3**" can be used to identify if there is a 360° phase change between the loudspeaker and the subwoofer. To overcome this audible problem, reduce the difference in the distances of the loudspeaker and subwoofer cabinets from the listening position, and then set the phase and level using the first two test signals shown above.

8. Kick drum track

This test signal "**06 - Kick drum.mp3**" can be used in the same way as the low-pass filtered Dirac impulse train. It is a real-world version of the artificial low-pass filtered Dirac impulse train presented above. It is additionally useful for observing the low frequency transient performance of the subwoofer and for listening for rattles in the room.

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Version: 03
Date: 5-May-2011
Language: English