Near Field Measurement of Systems with Multiple Drivers and Ports

AN 38

Application Note to the KLIPPEL R&D SYSTEM

Measurement of the sound pressure output generated by loudspeaker systems are usually performed under free field condition to suppress the influence of the acoustical environment. Standing waves found at low frequencies in normal rooms but also anechoic rooms affect the sound pressure measurements in the far of a loudspeaker. A near field measurement technique may cope with the room influence but requires a complex summation of the sound pressure contributions generated by multiple drivers and/or ports (e. g. a vented speaker)j. This application note gives step by step instructions to calculate the far field response based on multiple measurements of the sound pressure transfer function in the near field of the system.

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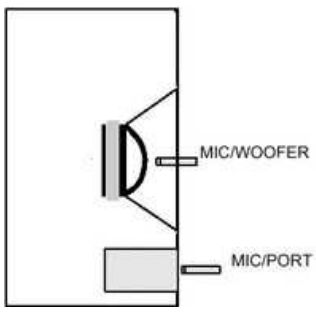
Near Field Measurement



The measurement microphone should be placed normal and as close as possible to the center of the dust cap to ensure a quasi-anechoic measurement caused by the high level differences between direct sound and room reflections. By keeping the micro-phone distance less than 11% of the effective radius a of the cone, the measurement error will be less than 1dB.

To prevent damage to the driver or the microphone, the maximum excursion should be determined first and considered while placing the microphone.

For measuring the output of the duct of a vented cabinet, the same rules as for near field driver measurement have to be applied. The microphone should ideally be placed centered and normal in the vent, flush with the system's faceplate.

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Upper frequency limit	$f_{NF\,\max}[\mathrm{Hz}] = \frac{c}{2\pi \cdot a} = \frac{5475}{a[\mathrm{cm}]}$	At higher frequencies some sound components will cause interferences in the near-field. Hence the upper frequency limit for the near-field approach is given by $ka = 1$ (k = wave number)
Summation of Near Field Response	$\underline{H}_{NF}(f) = \sum_{i=1}^{n} \sqrt{\frac{S_i}{S_1}} \cdot \underline{H}_i(f)$	The overall near field response of a vented loudspeaker can be obtained by adding the near-field response of each driver or port $H_i(f)$ weighted with their effective radiating surfaces S_i divided by S_1. This formula can be transferred to any systems featuring more than one radiator.
Scaling to Far Field	$\underline{H}_{FF} = \underline{H}_{NF} - 20\log\left(\frac{4d}{a}\right)\mathrm{dB}$ for omnidirectional radiation $\underline{H}_{FF} = \underline{H}_{NF} - 20\log\left(\frac{2d}{a}\right)\mathrm{dB}$ for hemispherical radiation	To obtain the far field response, the near field results have finally to be converted according to the sound radiation pattern. H_{FF} is the equivalent sound pressure level at a distance d, which is commonly 1 or 2 m. (a = effective radius of the driver)

Requirements

Start Up

To perform Near Field measurements the following preparations have to be made:

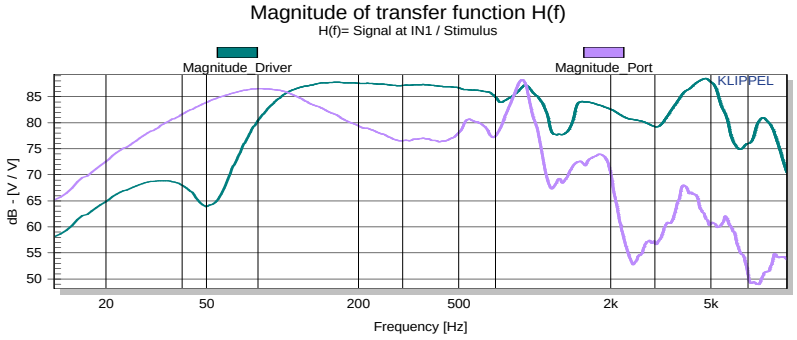
- Install the RnD Analysis Software on your computer
- Create a new object and select the *ported system* template to start the analysis
- Enter the sensitivity of the microphone in property page Input for the *TRF NearField Driver (or Port)* or use a pistonphone to calibrate the microphone.

Sound Pressure Output

Near Field SPL response

Motivation: We start with the near field response of the driver (or port) which provides an almost free field characteristic and is quite simple to measure.

How to do it: Adjust the measurement microphone normal to the driver's dust cap (or in the center of the port) and run the *TRF NearField Driver (or Port)* operation. For measuring a system with more than 2 radiators create a new *TRF transfer function* for every port or driver by duplicating the operation.



Adding to overall SPL	**Motivation:** Adding the contributions of each radiator gives the overall transfer function of the box which is almost equal with its free field measured response. **How to do it:** Select *H(f) + Total phase* in *Properties* → *Im/Export* (in *TRF NearField*) and Export them to Clipboard. Open the *Add Driver Port* Calculation, select a Curve in *Properties* → *Input* and press *Paste*. Repeat this step for the second curve. Enter the effective radiating *surfaceA* of each driver according to its *curveA* and *surfaceB* according to *curveB*. You can decide in which dimension you enter the surface of each driver, but make sure that you use the same dimension for all surfaces in this template. Click the green arrow in the dB-Lab toolbar to run the Calculation.  Within the frequency limit $f_{NF\,\max}$ this result is not corrupted by the acoustical environment and can be converted to an equivalent far field response.
Adding 3 or more radiators	You already duplicated the TRF measurement for additional measurements. For adding those to the first *Summed_Response*, we recommend to duplicate the *Add Driver Port* Calculation for each curve as well. Copy *Result.Curve.Sum* of the previous Calculation (*Properties* → *Export)* to the new *CurveA* and *H(f) and Total phase* of your TRF measurement to *CurveB.* Enter the *surfaceB* according to this Curve but leave the *surfaceA*, which is the surface of your first measured Cone.
Splicing to entire Far Field Transfer Function	It is also possible to merge the Near Field response with a Far Field measured Transfer Function to obtain a complete Response over the full bandwidth. Therefore open the Template *Merging Near / Farfield*. Copy the calculated *Sum* in *Properties* → *Export* and Paste it as *Curve_Near* in the *Splice SPL Curve* Operation. For further Information, see Application Note 39 **Merging Near and Far Field Measurements.**

More Information

Papers	M. Sanfilipo, “Audioholics Subwoofer Measurement Protocol for Subwoofer Reviews”, Part 1, Audioholics.com, 2008 J. D’Appolito, “Testing Loudspeakers”, Audio Amateur Press, Peterborough, NH, 1998 G. DellaSala, “Subwoofer Measurement Methods Continued”, Audioholics.com, 2008
Application Notes	AN39 Merging Near and Far Field Measurements

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