Near Field Measurement of Systems with Multiple Drivers and Ports

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). 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.

CONTENTS:

Terms and Definitions ................................................... 1
Requirements ................................................... 2
Sound Pressure Output ................................................... 2
More Information ................................................... 3

Terms and Definitions

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.
### Near Field Measurement with Multiple Drivers and Ports

#### Upper frequency limit

\[
f_{NF\,\text{max}} [\text{Hz}] = \frac{c}{2\pi \cdot a} = \frac{5475}{a [\text{cm}]}
\]

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

\[
H_{NF}(f) = \sum_{i=1}^{n} \sqrt{\frac{S_i}{S_1}} \cdot H_i(f)
\]

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

For omnidirectional radiation:

\[
H_{FF} = H_{NF} - 20 \log \left( \frac{4d}{a} \right) \text{dB}
\]

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.

For hemispherical radiation:

\[
H_{FF} = H_{NF} - 20 \log \left( \frac{2d}{a} \right) \text{dB}
\]

#### 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 portable 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 $H(f) + \text{Total phase}$ in Properties $\rightarrow$ Im/Export (in TRF NearField) and Export them to Clipboard. Open the Add Driver Port Calculation, select a Curve in Properties $\rightarrow$ Input and press Paste. Repeat this step for the second curve.

Enter the effective radiating surface $A$ of each driver according to its curve $A$ and surface $B$ according to curve $B$. 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 $\rightarrow$ Export) to the new Curve $A$ and $H(f)$ and Total phase of your TRF measurement to Curve $B$. Enter the surface $B$ according to this Curve but leave the surface $A$, 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 $\rightarrow$ 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.

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**More Information**

**Papers**


**Application Notes**

AN39 Merging Near and Far Field Measurements