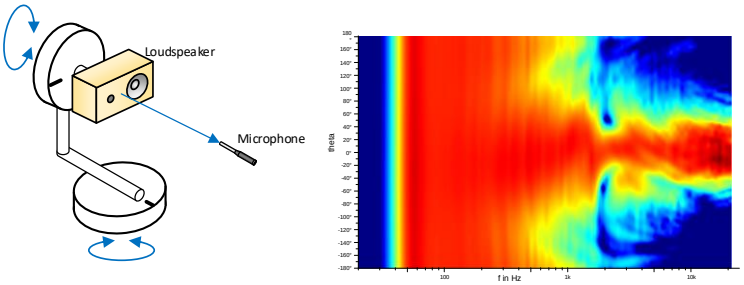
Directivity Measurement with Turntables AN54

Application Note to the KLIPPEL ANALYZER SYSTEM (Document Revision 1.6)

FEATURES

- Polar measurement in far field
- CEA2034 measurement
- Fast, automatic measurement
- Integrated in Klippel measurement system



DESCRIPTION

Fast and automated measurement of the directivity pattern of a loudspeaker is one of the most important features in the field of acoustics. The POL Module enables the user to measure the directivity of a sound source (e.g. a loudspeaker) using the TRF Module of the KLIPPEL R&D System. The user may choose between a one- or two-dimensional setup which presents the results in polar or balloon plots. The measured data can be analyzed in the visualization software exported to VACS, a program for viewing and post processing all kinds of acoustical data.

This Application Note gives step-by-step instructions on how to perform a measurement with a loudspeaker to obtain its directivity pattern using the POL and TRF Module of the KLIPPEL R&D System. It describes the hardware setup and gives valuable hints on how to obtain and interpret results. Furthermore, it is shown how the user may modify the setup to use other Modules than the TRF Module.

CONTENT

1 Requirements

1.1 Hardware

Required Hardware	• Klippel Analyzer 3 or Distortion Analyzer 2 • One or two turntables according to your own requirements • Microphone • PC
Setup	The hardware shall be connected the way you are used to perform a TRF. Please arrange the turntable(s), loudspeaker and microphone as shown in Figure 1:

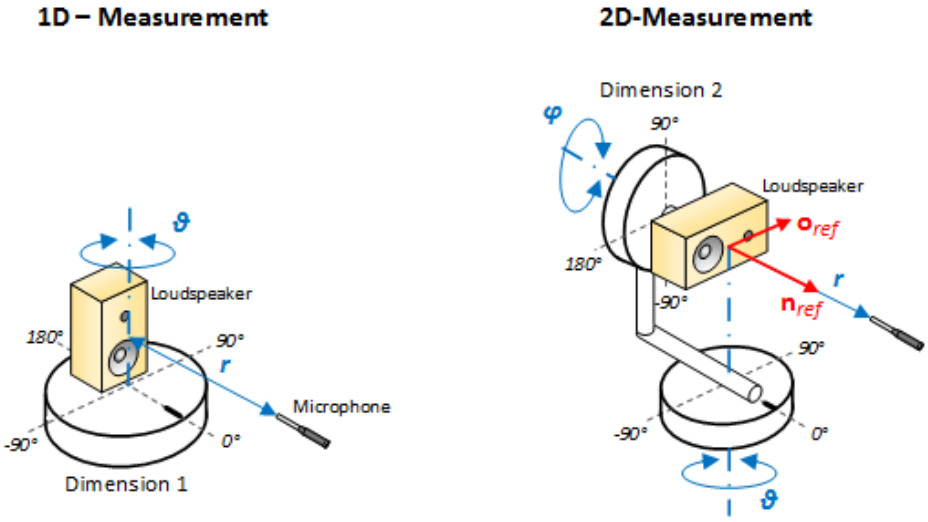


Figure 1: Hardware setup for the POL Module

The turntable 1 at the bottom is used as polar (ϑ-) axis. In the two dimensional setup a second turntable 2 for the circular (φ-) axis is arranged perpendicular to turntable 1.

The microphone needs to be positioned at the polar position of ϑ =0°. The loudspeaker driver should point into this direction as well. The position of the loudspeaker or device under test is the center of the turntable 1 (center of used coordinate system as well). Thus, r_{mic} is defined as the distance between the microphone and this center point of turntable 1. Please make sure that the distance r_{mic} does not change during the measurement.

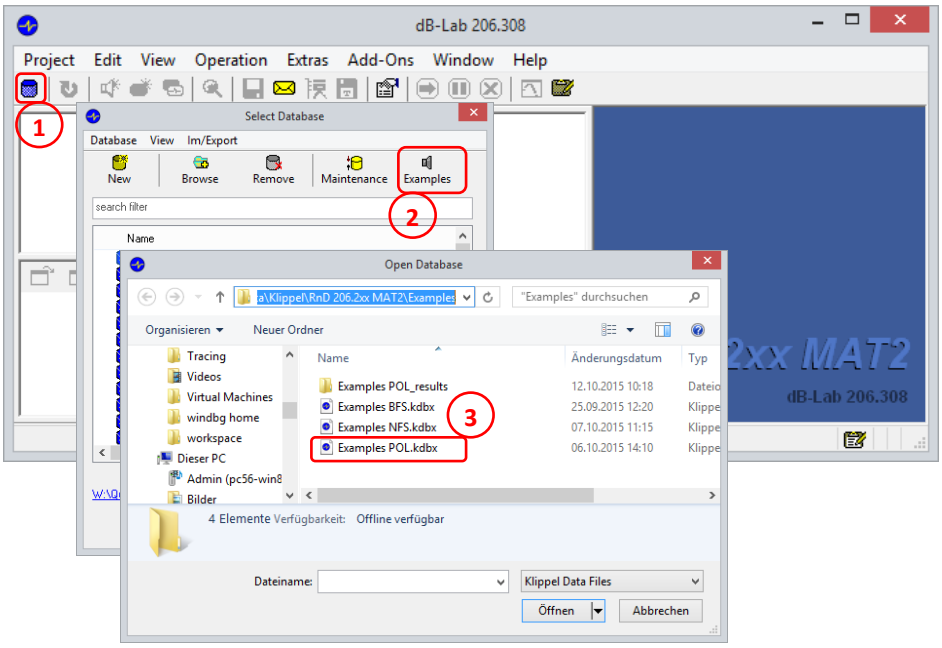
1.2 Software

Requirements	• dB-Lab • Robotics • POL – Polar Far Field Measurement – Software Module • TRF - Transfer function – Software Module • VACS Visualization Software [1] (Optional)

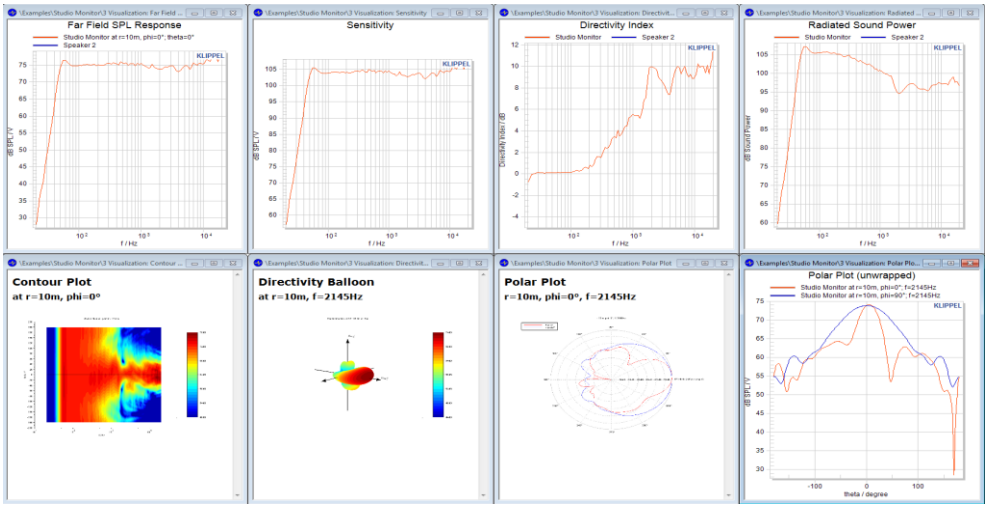
2 Viewing Example Measurement

Open Example Database

Open the Database selector, klick on *Examples*, and open the *Examples POL.kdbx* database. This Database shows a sample database.



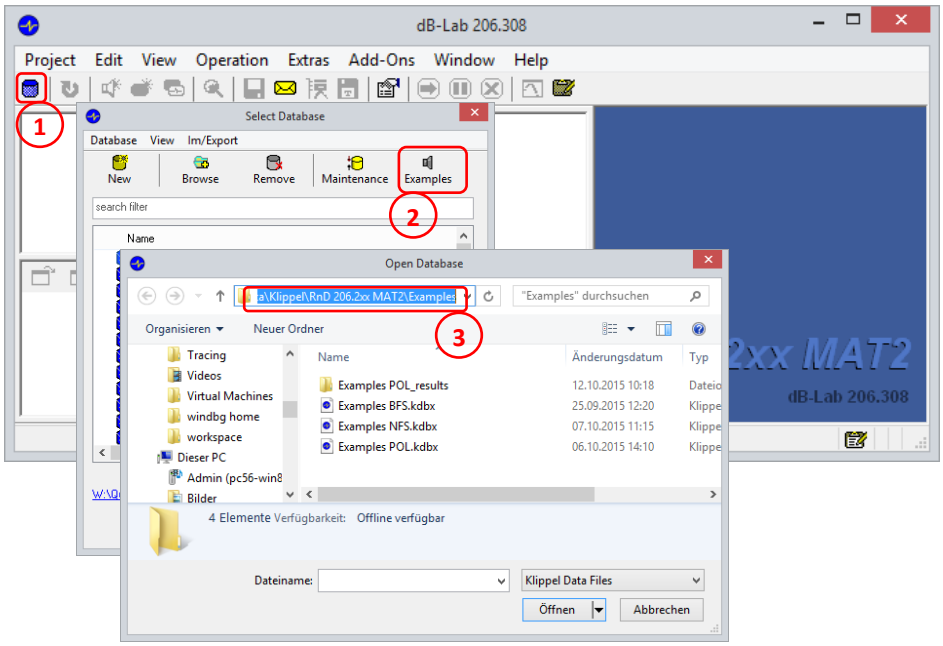
Select the operation Visualization to see the measurement results.



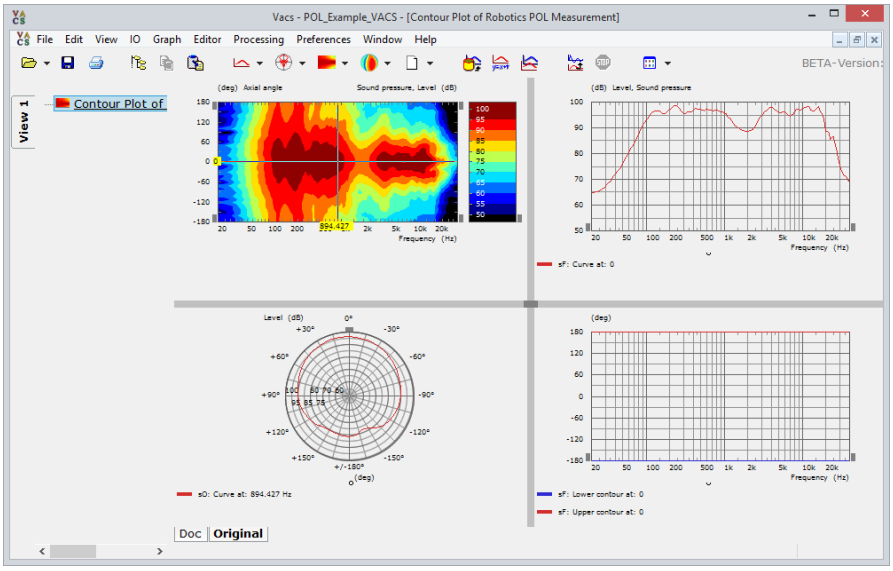
The analyze measurement data interactive run the operation.

Open Example in VACS

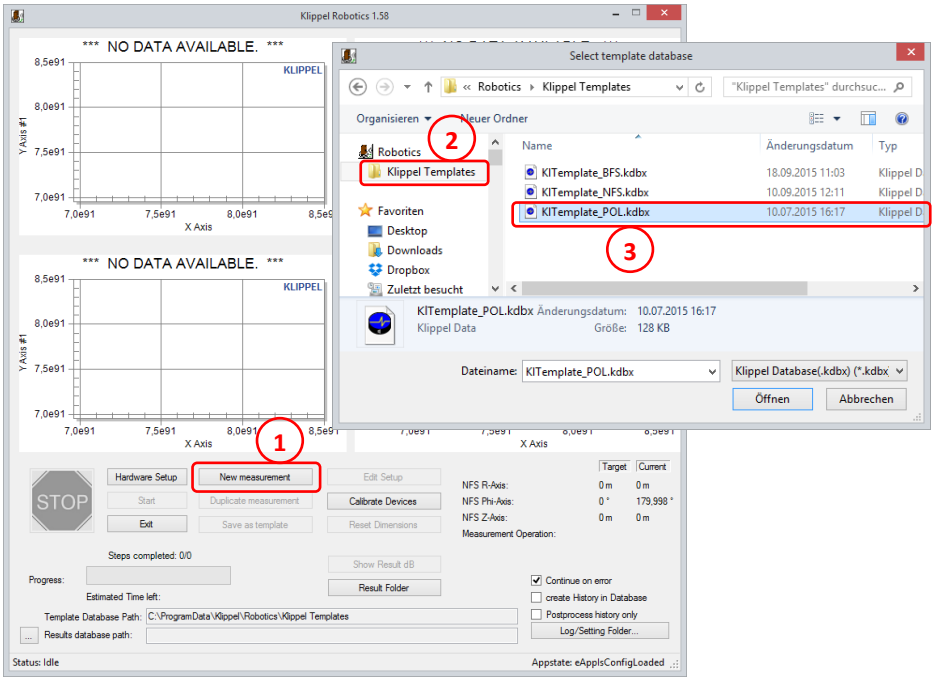
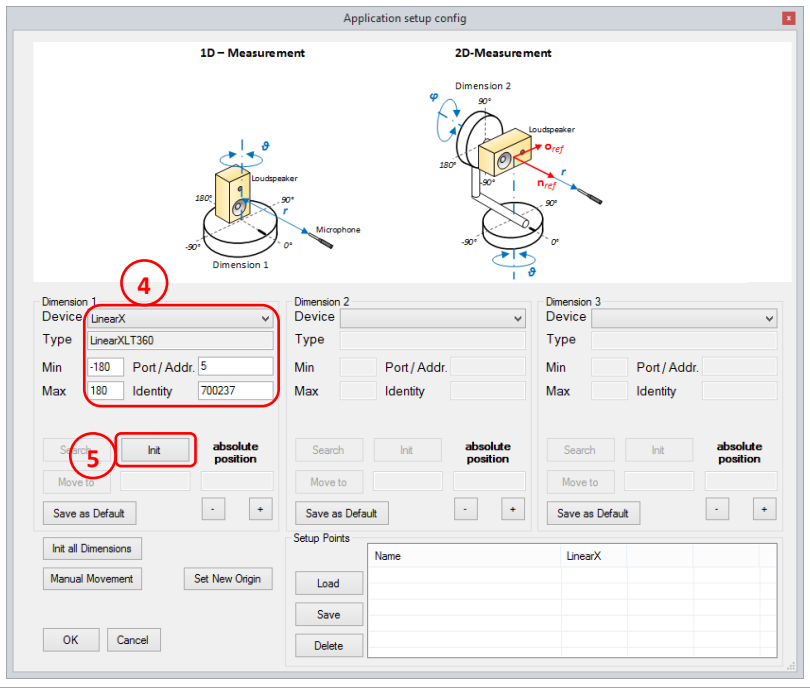
Open the Database selector, klick on *Examples*, copy the path and open it in the explorer. This folder includes the measurement data as ASCI data. And a sample VACS file [1].



Install VACS [1] to open and view the data in VACS.

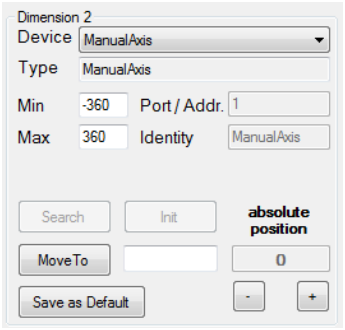


3 Conducting a polar measurement

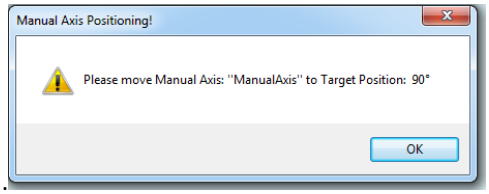
Getting started	Start Robotics Software and set up a new POL measurement. Klick on *New measurement* and select the *KlTemplate_POL.kdbx* Template file 
Hardware Setup	Select the hardware for *Dimension 1*, if you want to do a 1-dimensional measurement, or *Dimension 1* and 2 if you want to do a 2-dimensional measurement. *Dimension 1* corresponds to the turntable that performs the axial movement (φ-direction) and *Dimension 2* to the turntable that performs the polar movement (ϑ-direction). Select a blank device for all non-used dimensions, to avoid unwanted movement. Enter the port for the device (for most devices this is the used COM port). Please read the Robotics Manual [2] for further reference on the port selection. Click on *Init*, to initialize the device. You can now move the turntable, by entering an angle and clicking *Move to*. 

Manual Axis:

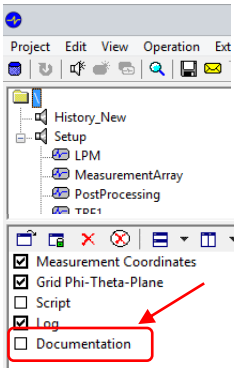
Especially the measurement of the CEA2034 spinorama requires the scanning of 2 polar scans. If only 1 turntable is available for the measurement, the rotation of the second axis (phi angle) can be performed by hand. To do this, please select in the hardware setup for dimension 2 the ManualAxis.



During the scan the Robotics Software will pop up a message box, when a manual positioning of the speaker is required.



Adjust Measurement Setup



Open the measurement setup, by clicking on the Edit Setup Button in the main window. dB-Lab will open with the Measurement Database.

Select the Measurement Operation *Setup/MeasurementArray* to configure the driving Job:

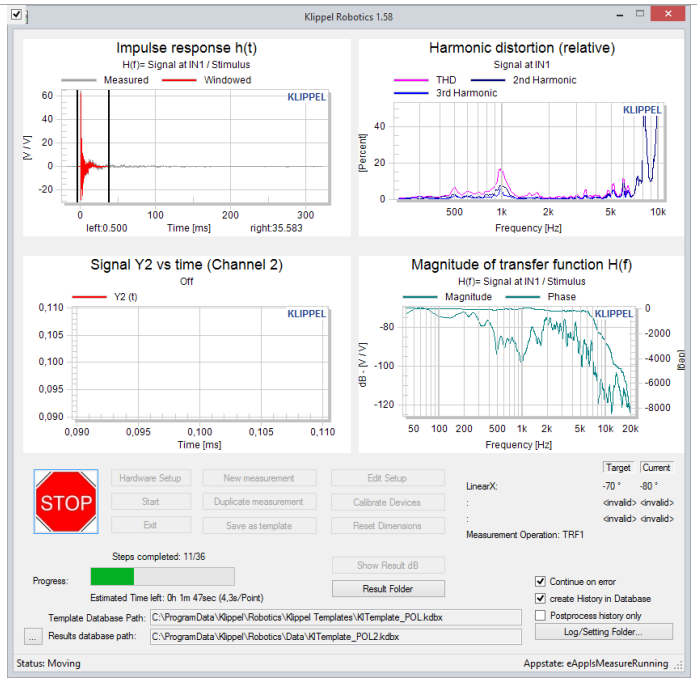
Define the measurement grid using the input parameters. You find the detailed description of the parameter in the "Documentation" window.

Select the Operation *TRF1* and adjust the parameters, as intended. Setup the Measurement Bandwidth, Measurement Voltage, windowing etc. Please find further Information in the TRF Manual [3]

Start Measurement

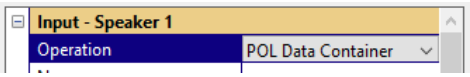
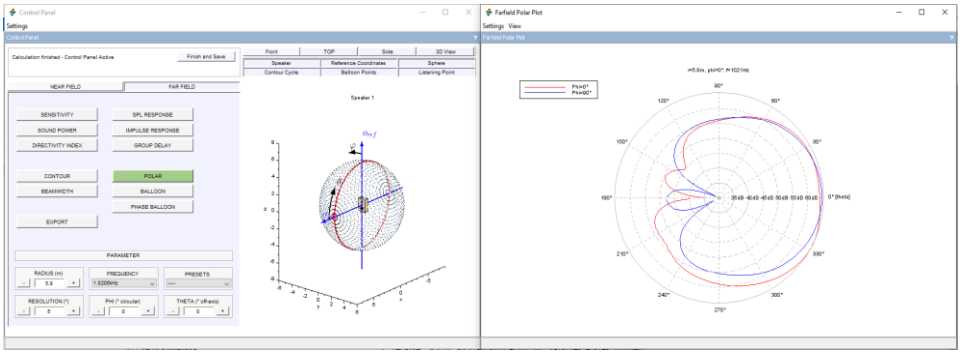
Before you start the measurement, please check the Checkbox *create History in Database*. The software will now keep a copy of every measured TRF operation for future reference.

Start the measurement and wait until it is finished. During the measurement the four diagrams in the Robotics main window will be updated after each measurement. This way you can have an online-view onto your measurement results.



The measurement can be interrupted at any time, simply by pressing the *STOP* button. It can be continued afterwards by clicking the *Resume* Button

4 Viewing Results

Results in dB-Lab	After the end of the measurement task press the button Show Result dB. The software dB-Lab will open and you can continue with the Visualization.
Data Container	The database include the operation 'POL Data Container', where all measured curves are stores. To continue with the specific processing please select in the properties window the Export-format (e.g. CEA2034, Visualization) and the curve, which should be analyzed.
NFS Visualization	The visualization module of the Nearfield Scanner System can be used for the analysis of POL data as well. To do this, link the POL Data Container in the Properties Window.  Running the operation will open an interactive control panel to analyze the data. 
CEA2034	A special measurement task of the POL module is the CEA2034 measurement, which requires two POL scans. To calculate the specified curves from the standard automatically, the CEA2034 operation can be used. After running the operation the dB-Lab Result window shows the specific CEA2034 curves.

	
Export Results to VACS	To view your data in VACS perform the following steps: Select in the Data Container the export format "VACS ASCII" and define the result path. After Running the data container, the exported curves from the results folder can be loaded into VACS, by using the Import functions.

5 Input Parameters

This section explains the input- and output-parameters of the operations *MeasurementArray* and *PostProcessing* operation. All input parameters are shown and edited in the property page.

5.1 MeasurementArray

Parameter	Type	Description
Measurement Operation		The POL Modules can be operated multiple measurement operation. (e.g. TRF with variable Settings)
Update Database	button	Pushing the button will update the list of measurement operations
Select Operation	list	List to select an operation, which should be added to the Operation List
Add Operation to List	button	By pressing the button the Selected Operation will be added to the Operation List
Operation List	list	List of operation which are performed at each measurement point.
Repeat Measurement	number	If Parameter is activated the measurement operation will be repeated by the specified number of repetition
Scanning Dimensions	select list	Parameter to select the Scanning dimension. 1D (Polar) - measurements with 1 turntable 2D (Balloon) - for a balloon measurement with 2 turntables.
Measurement Distance		
Radius *r*	number	Parameter define the measurement distance in meter. The radius r specifies the distance from the center of the turntables (Point of Rotation) to microphone position
Dimension 1: Polar Angle Theta		The dimension of the 1st turntable is specified as the polar angle theta. It defines the off axis angle.
Theta Maximum	number	Upper Limit of the theta scanning range

Theta Resolution	number	Step size of theta scanning range
Theta Minimum Turntable	number select list	Lower limit of the theta scanning range Parameter specifies the measurement setup. The turntable can either rotate the loudspeaker or move the microphone.
Dimension 2: Circular Angle Phi		The dimension of the 2nd turntable is specified as the azimuth angle phi. It defines the circular angle.
Phi Maximum	number	Upper Limit of the phi scanning range
Phi Resolution	number	Step size of phi scanning range
Phi Minimum	number	Lower limit of the phi scanning range
Turntable	select list	Parameter specifies the measurement setup. The turntable can either rotate the loudspeaker or move the microphone.
Manual Definition	number	For a one dimensional scan the phi angle can be defined by hand, using this parameter.
Grid Options		
Consider Hysteresis	boolean	☐ not checked: The movement path will be optimized. ☑ checked: The play of the motor is compensated by moving the turntable always in the same direction.
Remove Redundant Point	boolean	☐ not checked: points at the poles are measured multiple times ☑ checked: points at the poles are only measured once

5.2 Postprocessing		
Setup Parameter - Get	list	The Parameter Get define the Parameters and Curves, which should be extracted from the measurement operation. They can be freely defined by using the following syntax: ***Extraction of Curves:*** myCurve= '<Operation>#CURVE#<Chart>#<Curve Name>' ***Extracting of Setup Parameter:*** mySetup ='<Operation>#SETUP#<Parameter 1>,<Parameter 2>…' ***Extracting of Result Parameter:*** myResults='<Op.>#RESULT#<Parameter1>,<Parameter2>,…' ***Special Commands for TRF Operation:*** *Extraction of the Measured Impulse Response:* myImpulseResponse = 'TRF*#TRF_GetImp';
All other input parameters in the *PostProcessing* operation are internal and automatically filled by the Robotics software. For further information take a look at the Robotics Manual.		

6 References

[1]. VACS - Visualizing Acoustics Software http://www.randteam.de/VACS/Index.html
[2]. Manual Robotics
[3]. Manual TRF

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
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