ARTA - APPLICATIONNOTE

No 9: Automatic polar measurement with ARTA

introduction

The assessment and targeted influencing of the radiation characteristics is a not insignificant goal in the development of loudspeakers. The interested reader will find a comprehensive presentation and evaluation of the interrelationships in the book by Floyd E. Toole, which is well worth reading: Sound Reproduction, Chapter 18 - Objective Evaluations [01]. Practical information on the technical preparation of the simulation of loudspeakers can be found on the homepage of Kimmo Saunisto [06].

In the ARTA Application Note No. 6 [02] the metrological recording of the radiation characteristics and various options for evaluating the measurements are shown. The construction of a simple turntable without its own drive is also included.

Those who frequently measure radiation characteristics with high angular resolution know that it is a time-consuming, stupid activity that nevertheless requires concentration on the part of the person carrying out the task, otherwise angles are quickly skipped or the measured angle and the file name do not match.

In order to facilitate these measurements, the connection of a professional turntable (Outline ET250-3D) and a DIY turntable was implemented.

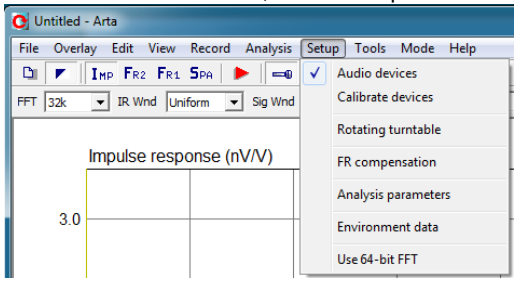
Outline ET250-3D

DIY turntable

The DIY turntable was specially developed for frequent knives in the DIY sector and self-assembly groups. Attention was paid to the reproducibility and the costs. At this point, we would like to thank Wim Huyghe (software) and Ralf Grafe (hardware), who both contributed significantly to the success of the project.

Measurements with the automatic turntable

Before the measurements, in the "Setup" menu under "Rotating turntable" you must specify the

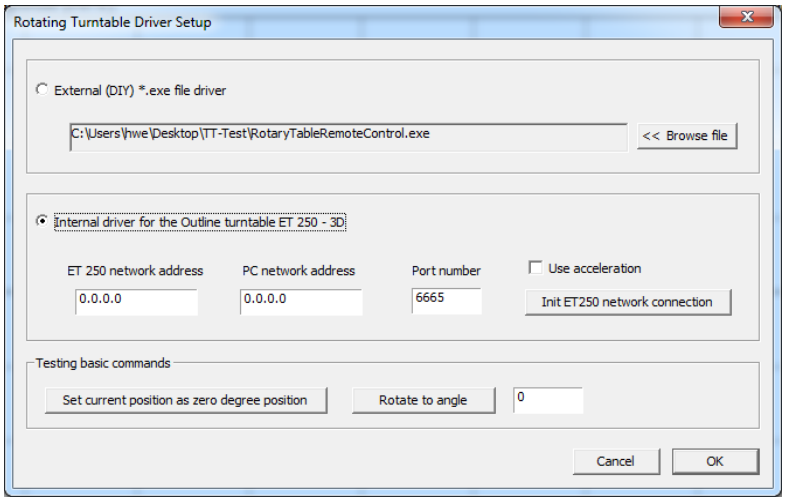


should be worked on. An external DIY turntable or the professional Outline ET 250-3D turntable are offered as options.

A) Outline rotary table ET 250-3D

If the ET 250 is selected, the IP addresses for the turntable and computer as well as the number of the port must be entered. By pressing the button

The turntable is connected with "Init ET250 network connection".



The rotation speed can be increased by activating "Use acceleration".

Before commissioning
recommended, additionally the
Consult the ET 250-3D manual.

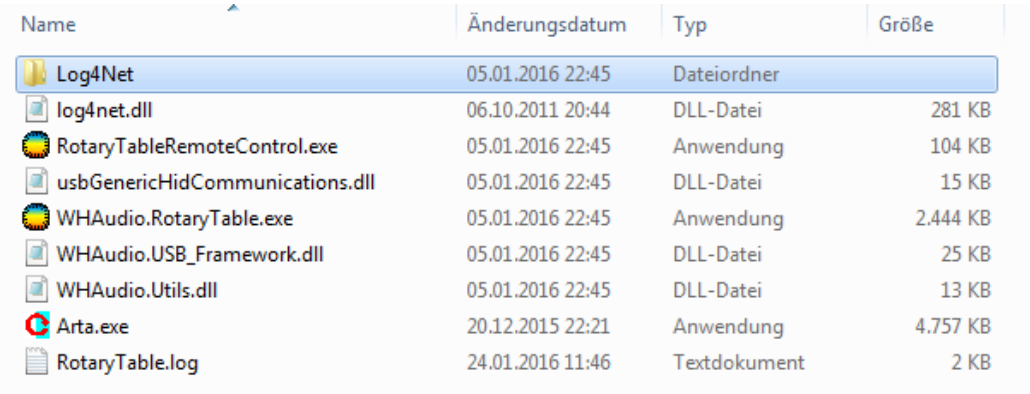
The functionality should be tested before the first measurement
become. In the “Testing basic commands” area, the zero position can be set and any angle approached
become.

B) External DIY turntable

When choosing the external DIY turntable, specify the directory in which ARTA and the control software are located. Some explanations are given below.

Software for the DIY turntable

The turntable software does not need to be installed. All you have to do is copy the files from the RemoteControlRotaryTable.zip file into the directory in which ARTA.exe is located. Below is an overview of all required files.



Name	Änderungsdatum	Typ	Größe
Log4Net	05.01.2016 22:45	Dateiordner	
log4net.dll	06.10.2011 20:44	DLL-Datei	281 KB
RotaryTableRemoteControl.exe	05.01.2016 22:45	Anwendung	104 KB
usbGenericHidCommunications.dll	05.01.2016 22:45	DLL-Datei	15 KB
WHAudio.RotaryTable.exe	05.01.2016 22:45	Anwendung	2.444 KB
WHAudio.USB_Framework.dll	05.01.2016 22:45	DLL-Datei	25 KB
WHAudio.Utils.dll	05.01.2016 22:45	DLL-Datei	13 KB
Arta.exe	20.12.2015 22:21	Anwendung	4.757 KB
RotaryTable.log	24.01.2016 11:46	Textdokument	2 KB

Preparation of the measurement

To prepare for the measurement, the turntable must be supplied with power and the connection to the computer via USB cable established.

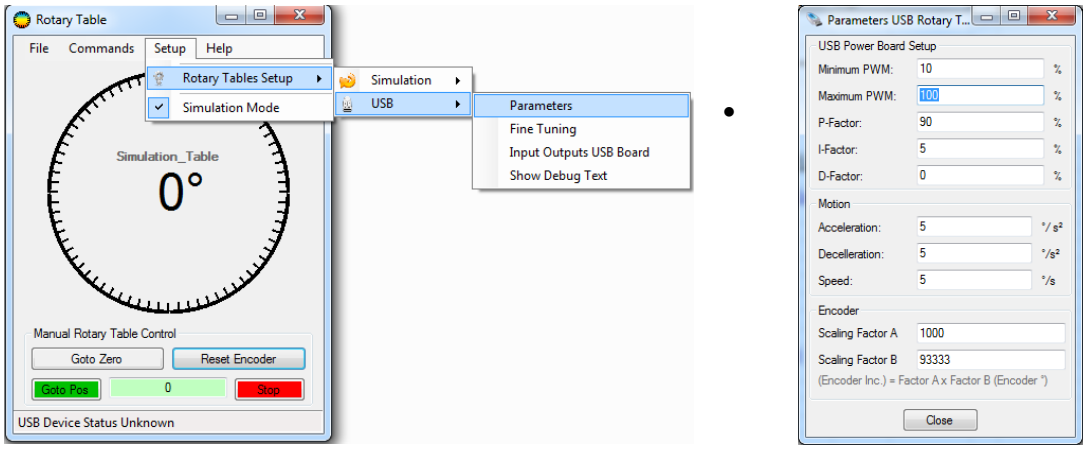
A 12V / 3A power supply unit or a 12V lead gel battery is suitable as a power supply. A fully charged 12V / 2.2Ah battery comfortably lasts a longer measurement session and also makes us independent of the power supply. Furthermore, one is freed from the annoying laying of long cables with outdoor measurements and also with measurements in the RAR.

The turntable works perfectly up to approx. 3m to 4m with passive USB extension cables. That should be enough for measurements in normal living spaces. A USB booster is required for longer distances between the computer and the turntable.

When setting up the turntable, make sure that it can rotate undisturbed. This includes that all cables to the loudspeakers can take part in the rotation. If an attachment with a support roller is used, make sure that the turning radius of the support roller is free of obstacles.

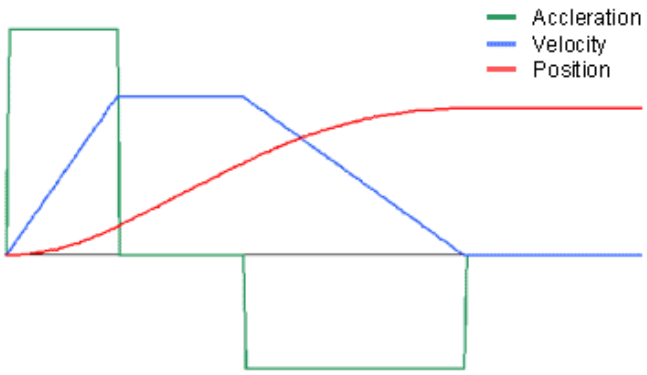
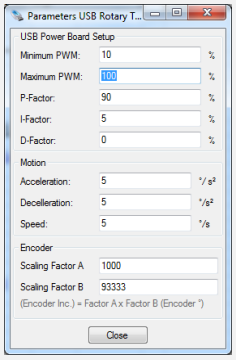
Optimization of the operating parameters and calibration of the DIY turntable

As already stated, the construction presented here is variable within wide limits. Depending on the choice of encoder, gear ratio or possibly also the pinion, appropriate adjustments are necessary. The adjustment or optimization of the operating parameters and the calibration are carried out in the program WHAudio.RotaryTable.exe.

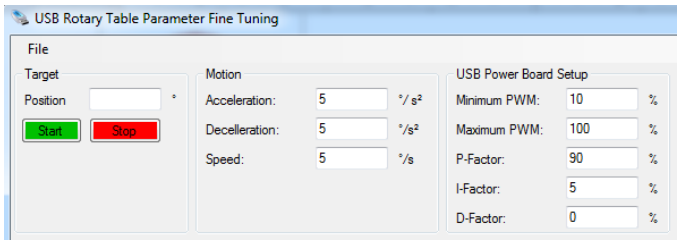


Via setup • Rotary tables setup • USB takes you to the menu item "Parameters". The operating parameters to be found there are explained below.

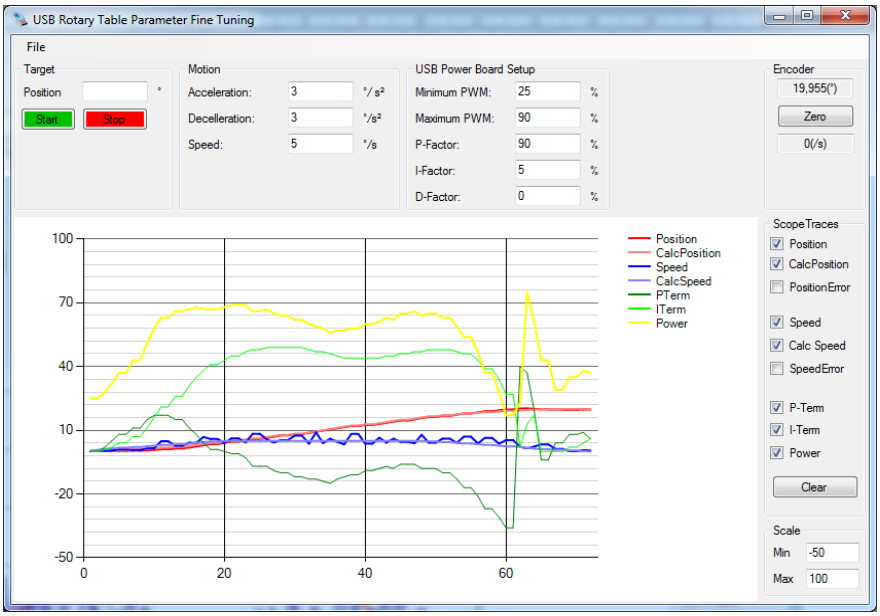
Minimum PWM **0-100%**	The power required to move the turntable. The range of values is 0% to 100%. This value is not particularly critical, even if left at zero should the turntable run properly. Determination of the correct value: The minimum and maximum PWM parameters are increased from zero until the turntable begins to move.
Maximum PWM **0-100%**	To limit the output power of the control board to the motor, it can make sense to limit the maximum PWM. The requirement can be derived from the “Fine Tuning Menu” (see below).
P-factor **0-100%**	Proportional term of the internal PID controller (Proportional - Integral - Derivative Controller) see also http://en.wikipedia.org/wiki/PID_controller). **Annotation:** The parameters shown above are suitable starting values for further optimization.
I factor **0-100%**	Integral term of the internal PID controller.

D factor 0-100%	Derivative term of the internal PID controller.
Acceleration (° / s²) Acceleration, deceleration factor and speed **Deceleration (° / s²)** To prevent abrupt acceleration / deceleration or the risk of **Speed (° / s)**	If the test object falls from the turntable, the turntable follows the movement profile shown below. 
Encoder scaling Factor A **Encoder scaling Factor B** 	The two scaling factors for the encoder determine the angular position of the rotary table. The following information must be known for the calculation: n = number of teeth on the pinion N = number of teeth of the slewing ring U = reduction of the gear motor I = number of pulses from the encoder per revolution The factor A is purely a scaling factor and can be freely selected. The calculation of the scaling factor B is as follows: Scaling Factor B = N / n • U • I / 360 = pulses / ° Example: n = 11, N = 177, U = 131.25, I = 16 Scaling Factor B = 177/11 • 131.25 • 16/360 = 93.864 p / ° Since both factors can only be integers, A = 1000 should be selected because of the better resolution (consideration of 3 decimal places). Scaling Factor A = 1 and B = 93 or, for a better resolution, Scaling Factor A = 1000 and B = 93864.

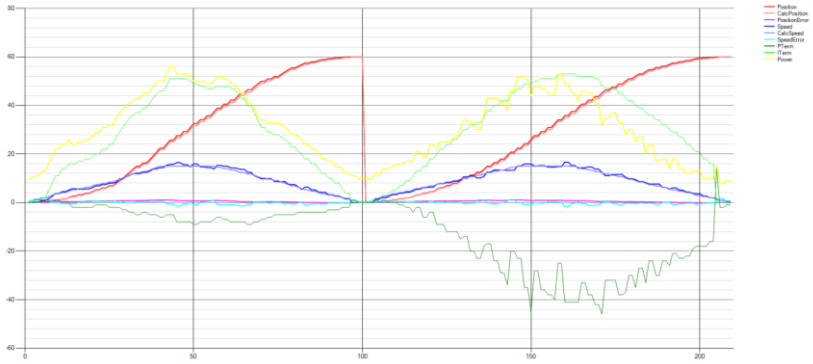
The optimization of the parameters for the respective specific version of the turntable is made possible by the **Fine tuning parameters** Menu supported. In this menu, all essential movement signals can be compared in nominal (Calc) and actual.



The effects of changes in individual parameters such as the P and I factor can be observed directly.



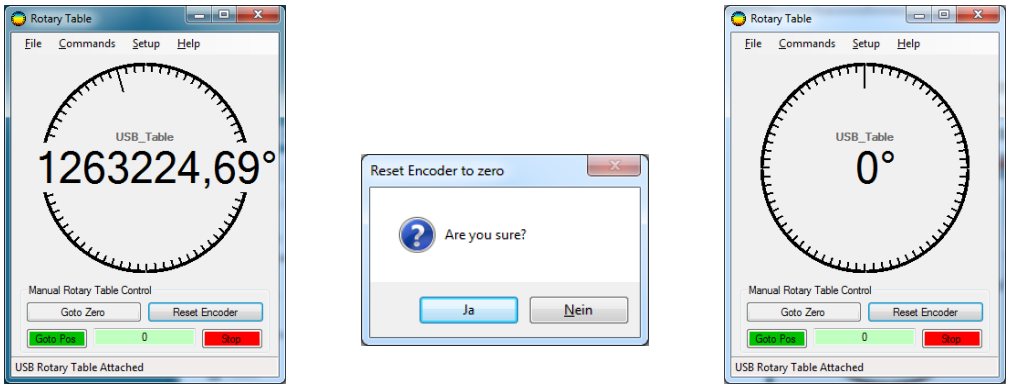
If the encoder is set to zero between two identical rotary table movements, the effects of the parameter change can be compared directly in a graphic.



calibration

After entering the basic parameters, the calibration of the turntable consists of a simple "reset encoder". After switching on the power supply and starting WHAudio.RotaryTable.exe, the following picture on the left appears. The somewhat unusual angle indication indicates that

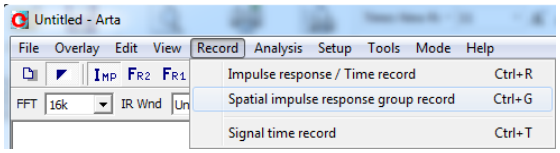
the encoder expects a reset. In principle, this can be done in any position, but should be based on any markings on the turntable (zero mark).



After the reset, the above right partial image appears. This position of the turntable is saved as a zero position until the next reset or when the power supply is switched off.

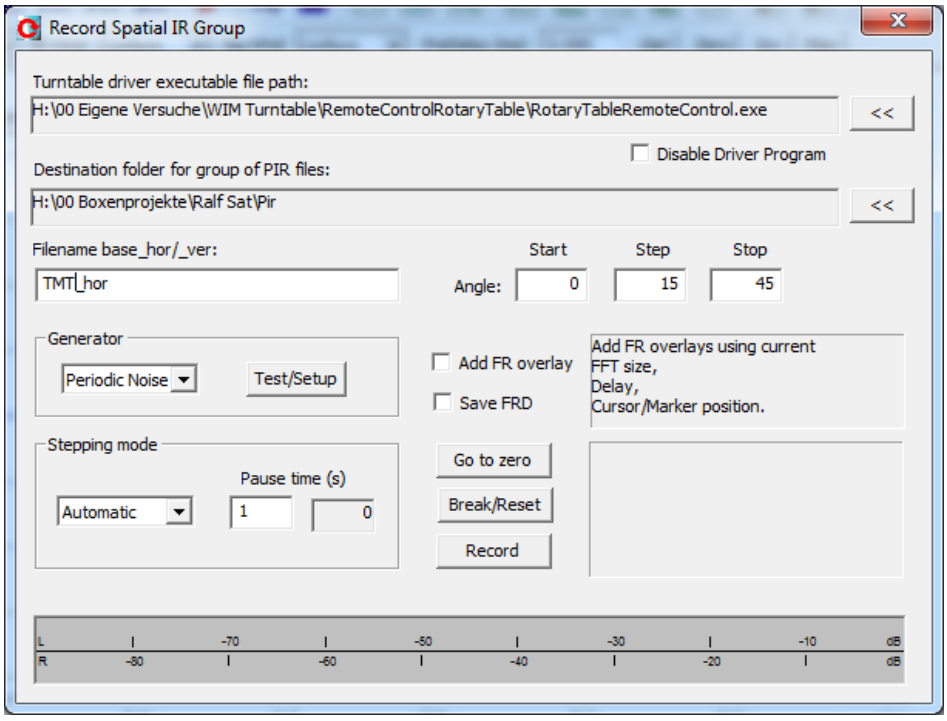
This calibration can also be carried out in the "Rotating table driver setup" menu.

Performing the measurement



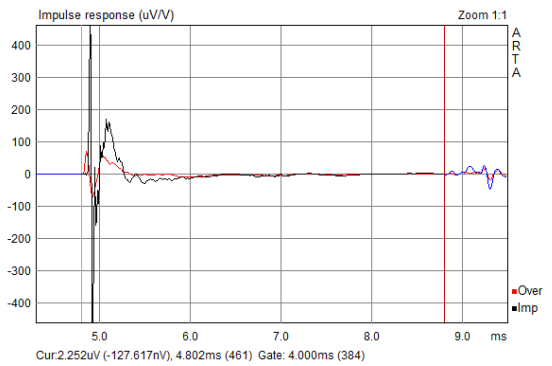
The automatic measurement by means of the turntable is with ARTA from version 1.8.5 in the menu "Record" as " **Spatial Impulse Response Group Record** " to find.

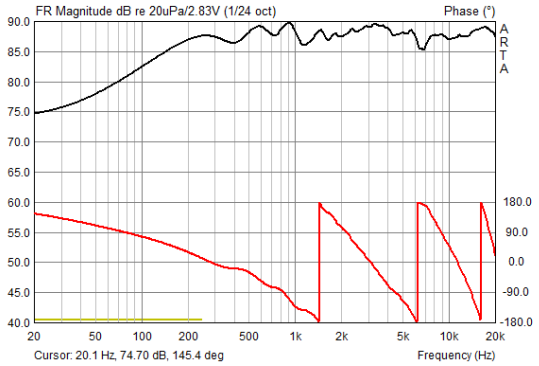
After activation, the following menu appears:



Turntable driver exe file path	Specification of the path in which the RotaryTableRemoteControl.exe program can be found. ARTA.exe must also be in this directory.
Destination folder for group pir files	The measurement files and the frd files are stored in this directory.
Filename base _hor / _ver	Base of the file name. The angle information is automatically added. WaveguideA_hor becomes WaveguideA_hor_deg0, WaveguideA_hor_deg5, etc. hor / ver stands for horizontal / vertical as additional information. Avoid digits in the base name, as this leads to errors in many simulation programs.
Start / Step / Stop	Start value / step size in degrees / stop value
Add FR overlay	If the checkbox is activated, an overlay of each measurement is saved.
Save FRD	If the checkbox is activated, the frd file of each measurement is saved (see explanation below).
generator	Selection of the measurement signal (PN, Swept Sine, MLS)
Test / setup	Opens the "Impulse Measurement / Signal Recording" menu. Automatically
Stepping mode	or manually.
Pause time	Pause between two measurements in seconds. The function is required for manual measurement because the turntable has to be moved by hand between measurements.
Go to Zero	Positions the turntable at 0 degrees. Interrupts a
Break / reset	running measurement. Starts a series of
Record	measurements.
Show Driver	If the checkbox is activated, WHAudio.TurnTable.exe remains open. Deactivates
Disable driver Program	WHAudio.TurnTable.exe for manual measurement.

If the FRD files are to be saved for further processing / simulation with third-party programs during the measurement, the measurement window must be determined before starting the measurement series. To do this, the two extreme positions of the desired measuring range are manually approached with the turntable and the cursor and marker are set in the impulse response so that neither the first impulse is clipped nor parts of the first reflection become part of the window. The following figure shows an example of the impulse responses for 0 ° (black) and 90 ° (red). It is good to see that the 90 ° pulse begins before the 0 ° pulse. Positioning based on only one measurement can lead to errors during export.

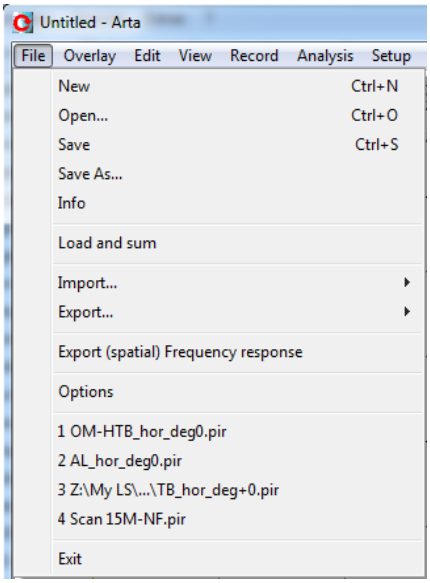




Finally, two further important points must be observed before the automatic measurement with FRD export:

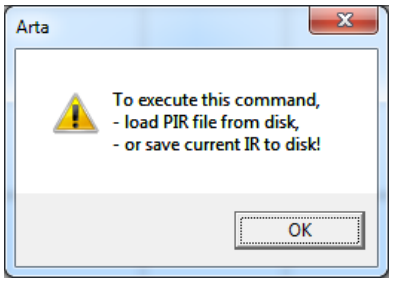
- The M + P (magnitude + phase) option must be activated in the Smoothed Frequency Response display
- In the menu "File load and import / export setup" the checkbox for "Retain cursor and marker position" must be activated. The menu can be found under File • Options.

Evaluation and export of measurements that have already been carried out

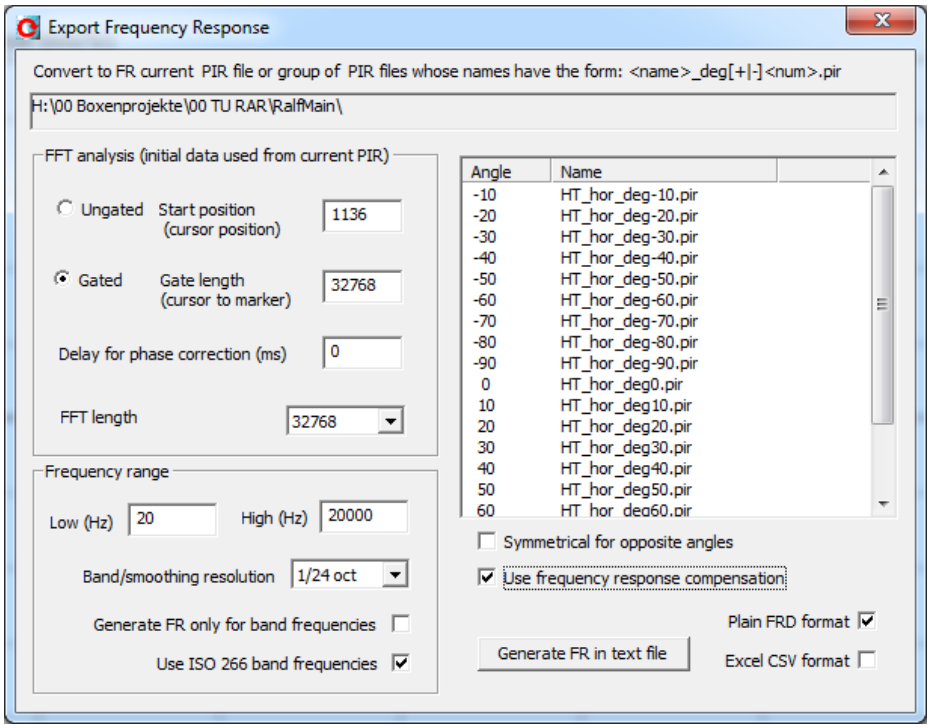


The automatic group export of polar measurements is from ARTA version 1.8.5 in the menu "File" as " **Export spatial frequency response** " to find.

After activating the menu item, the following message appears:



Please open one of the files to be evaluated or save the current file before the file export can begin.



If you have already opened one of the files from the group to be evaluated, the above menu appears. In the upper area of the menu you will find the specification of the path in which the measurement data are located (attention, observe the conventions for file names). The export files are also stored in this directory (frd, txt, csv).

If you want to use a gate for data export, please set cursor and marker before activating the export menu!

FFT Analysis (initial data used from current PIR) ungated	
	The currently open PIR file is evaluated without a gate
Gated, gate length (cursor to marker)	The currently open PIR file is displayed with the cursor and marker marked gate evaluated.
Delay for phase correction	Delay for phase correction (see also "Delay for Phase Estimation" in "Smoothed FR" menu
FFT Length	Displays the FFT length

Frequency range	
Low	Defines the lower frequency limit for the data export Defines the
High	upper frequency limit for the data export Defines the smoothing
Smoothing Resolution	
Generate FR only for band frequencies	When activated, only the band frequencies for the respective smoothing are exported (1/3 octave • 3 points / octave). Also suitable for reducing the amount of data.
Use ISO 266 band frequencies	Only band frequencies in accordance with "ISO 266: Acoustics - standard frequencies" are exported.

Symmetrical for opposite angels	When activated, the data is mirrored. Caution, do not use if measurement data with positive and negative angles are already available. When activated, the microphone
Use frequency response compensation	correction is used for the data export.
Generate FR in text file	Data is exported as a txt file Generate FR txt + Plain frd • Data is exported as
+ Plain frd format	a frd file Generate FR txt + Excel csv • Data are exported as a csv file
+ Excel csv format	

Have fun measuring!

literature

[01] Floyd Toole, Sound Reproduction - Loudspeakers and Rooms, Focal Press 2008 ARTA Application

[02] Note No. 6: Directivity Measurements

[03] ARTA Application Note No. 8: Repetitive Measurements with Script Language AutoIT ARTA Hardware &

[04] Tools, Annex 1: Construction of an automatic rotary table Operating Manual Outline ET250-3D, http://www.outlinearray.com

[05]

[06] Kimmo Saunisto: Preparation of response measurements for crossover simulation with VituixCAD, http://kimmosaunisto.net/