Use Acourate FIR filters with miniSharc from miniDSP-Ltd.

A Software Package to use miniSharc as a high-quality Room Correction Device (DRC)

This documentation is more in depth than the Readme.md file. It explains how to test and run the Software Package and gives some insight how it works and what results are achieved.

Prerequisites

To run the software package on your Windows-10 PC you have to…

- … download Scilab 6.0.2 and installed it on your PC.
- … download this software package from GitHub.

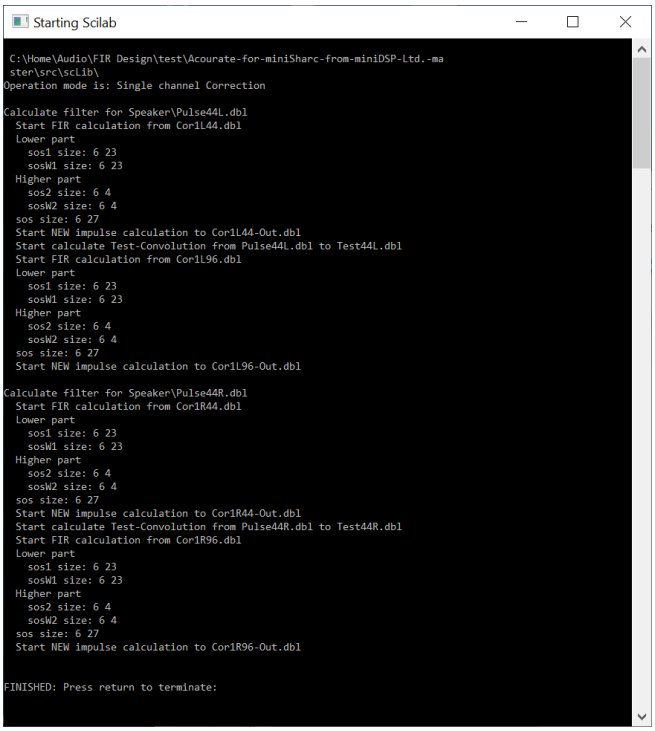
To calculate room correction filters for miniSharc you have to…

- … license the Acourate® Software.
- … read some tutorials.
- … be able to perform room measurements and calculate room correction filters with Acourate.
- … own a miniSharc Kit and the according Plugin.

Testing the Software Package

- Download the Software Package and unzip it into any folder.
- Open the folder `example`
- Doubleclick the script `!Run_Excample.cmd`

There may come up some warnings before the script got executed. Just ignore them and run the script.
You would see the following output:



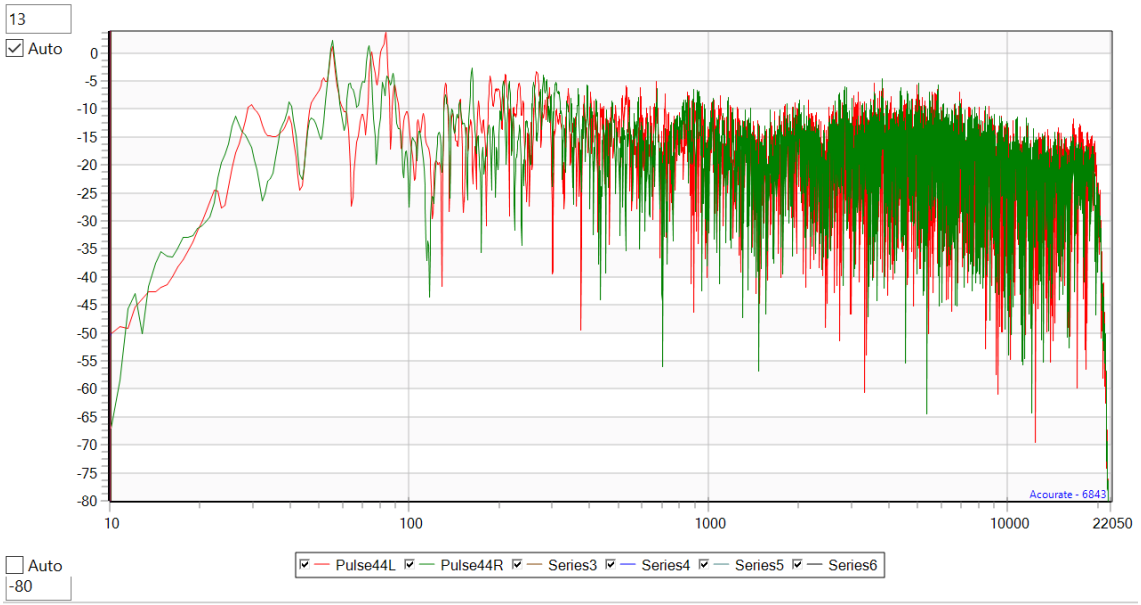
Now press `return` and the window will disappear. In the `example` folder some new files appeared.
If you see the file `!MiniSharc-Config.xml` anything is fine.

How it works

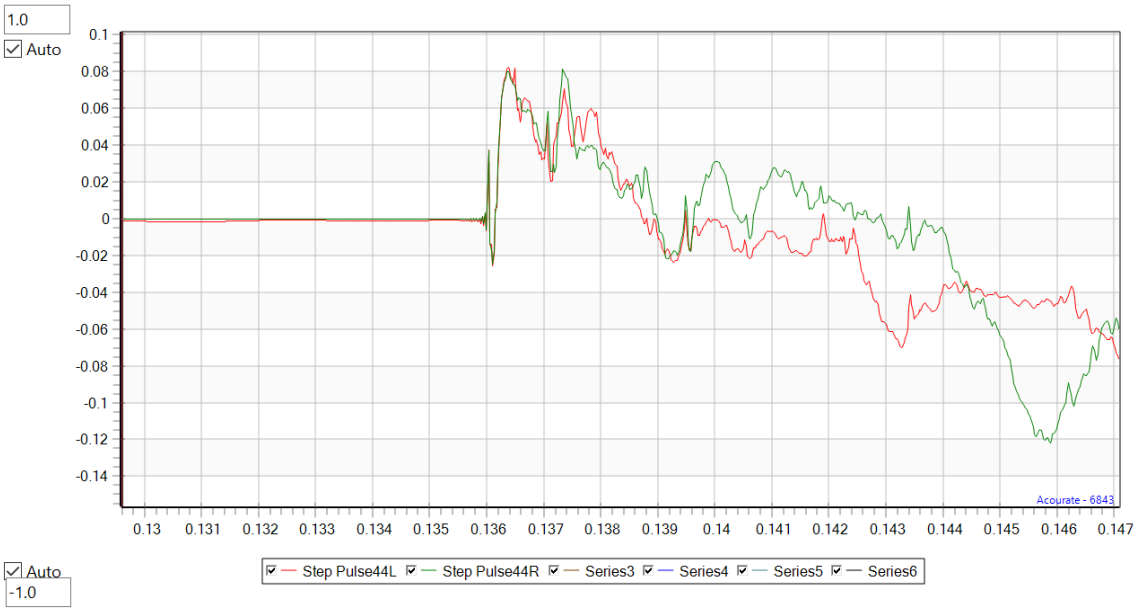
Files in the `example` Folder

The `example` folder is a copy of an Acourate workspace. The files and their meaning:

- `Pulse44L.dbl` and `Pulse44R.dbl` are the result of a room measurement done with the logsweep recorder of Acourate with a sample rate of 44,1kHz. To use this sample rate for the measurement is mandatory!

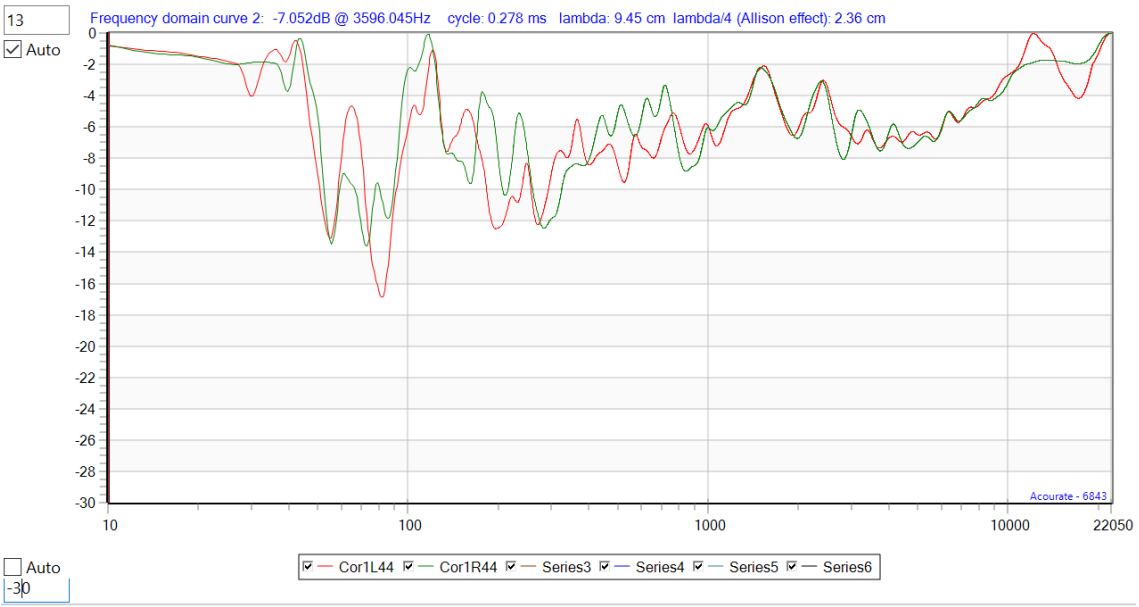


A look at the step response (below) shows us, that some phase correction is necessary to integrate the woofer into the step. Currently it is a bit delayed after the peak of the tweeter.

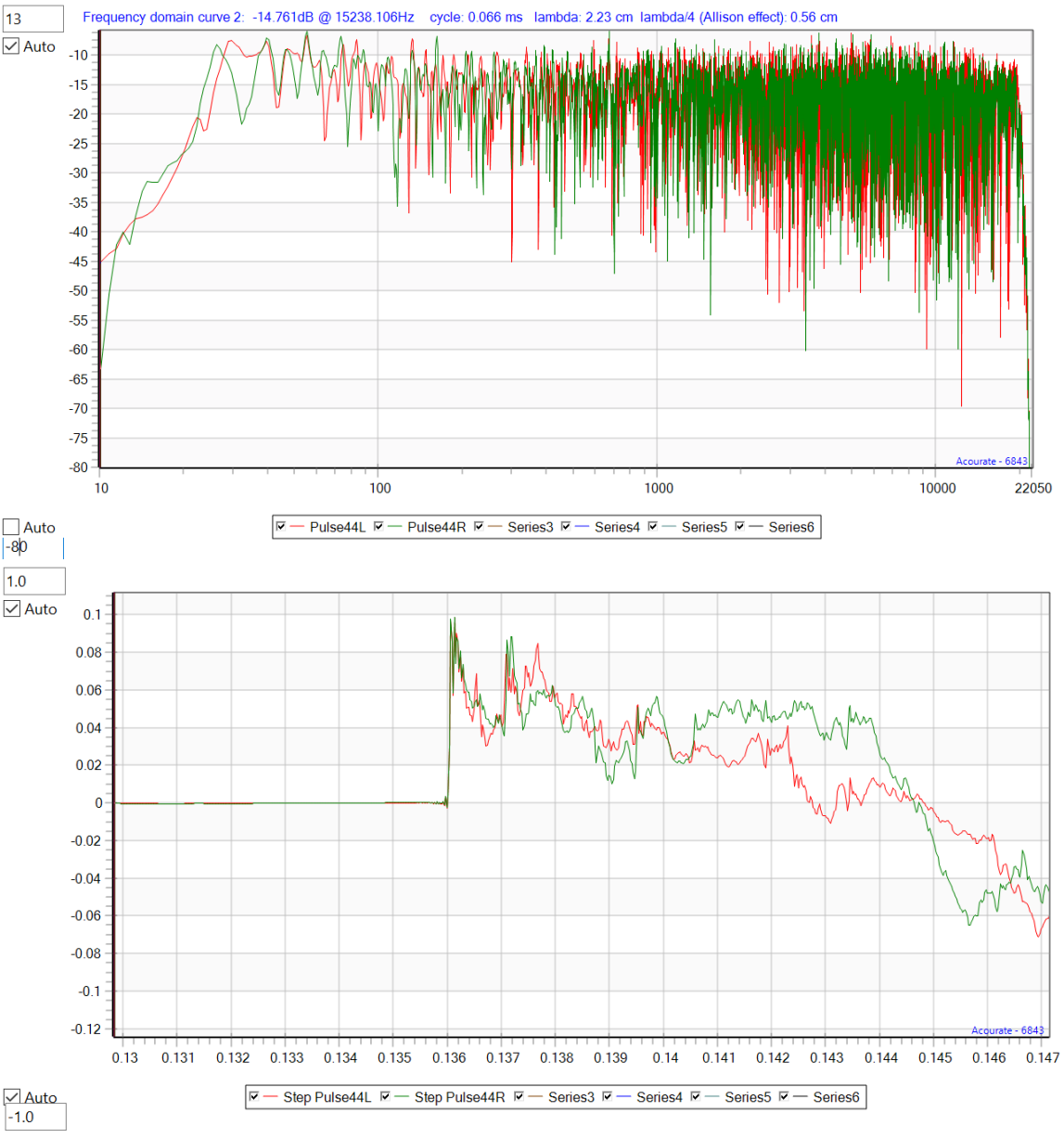


- `Cor1L44.dbl`, `Cor1R44.dbl`, `Cor1L96.dbl` and `Cor1R96.dbl` are the FIR correction filters Acourate creates when filters for 44.1kHz and 96kHz are calculated. Having all four files is mandatory because the miniSharc operates at 96kHz.

This is the way the Acourate correction looks like. It is somehow a flattened mirror of the measurement:



- In the subfolder `TestConvolutionon` the files `Pulse44L.dbl` and `Pulse44R.dbl` can be found that show the result after the correction was applied to the measurement.
  As easily can be seen the result is much better in the frequency and the time domain.



Requirements

The miniSharc offers a lot of IIR filters and some few FIR capabilities.

In the PEQ sections of the input there are 10 Bi-Quads available for each channel. At each output there are 10 Bi-Quads available in the PEQ section, 8 Bi-Quads in the Xover section and when using only two output channels (what we do here) there are FIR filters with a maximum of 1682 Taps available. Together we have 28 Bi-Quads and a FIR filter with 1682 taps.

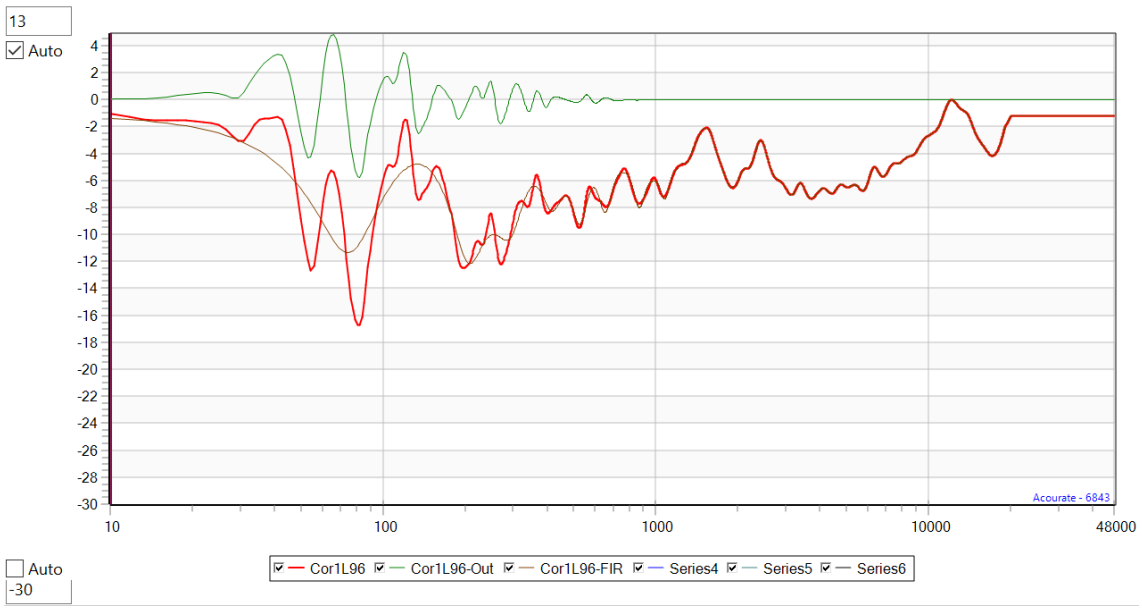
Now the requirement is, to approximate the 64k long FIR filter Acourate calculated with these elements. Therefore, we compute 27 Bi-Quads and a 1682 Taps log FIR filter for each channel, right and left. The Bi-Quad coefficients will be spread over all the available sections in the miniSharc. All IIR sections of miniSharc are operated in 'advanced' mode.
In each PEQ section of the inputs, EQ1 is configured as a LOW_SHELF to be able to adjust bass performance in real time adapting the taste of the listener. Just change the gain of EQ1s for that.

Running the Software Package

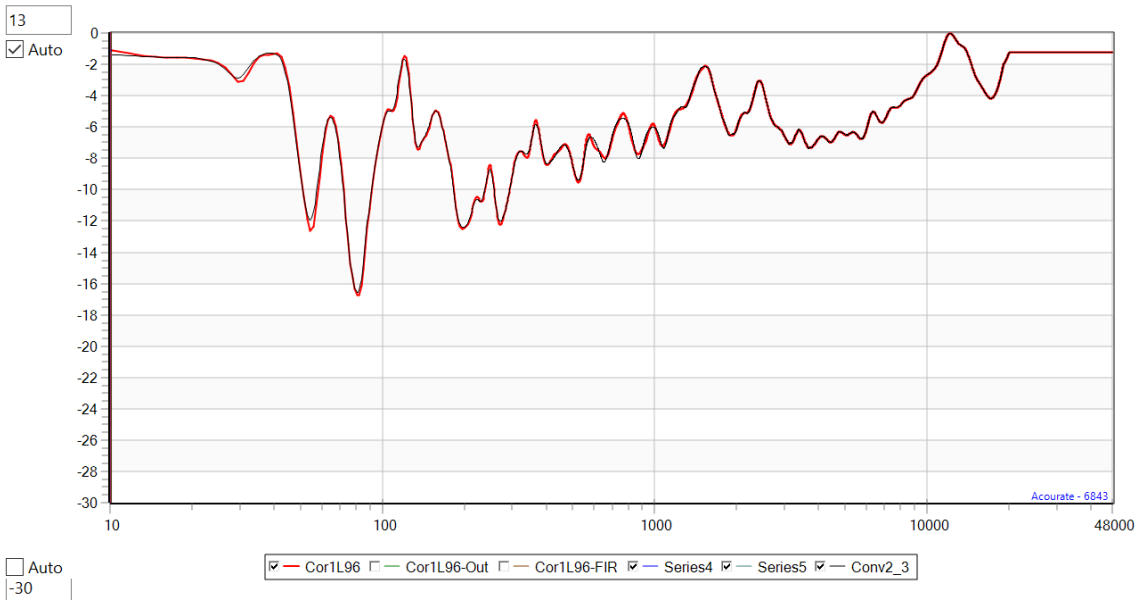
The Software package is started with the cmd-file `!Run_Example.cmd`. This file simply starts Scilab with the name of the Scilab script `Calculate_miniSharc_Filters.sce` as a parameter.

Beginning with the 96kHz correction files `Cor1L96.dbl` and `Cor1R96.dbl` the script calculates four output files. The FIR parts are in `Cor1L96-FIR.dbl` and `Cor1R96-FIR.dbl` and the IIR parts - as result of the 27 Bi-Quads - are in `Cor1L96-Out.dbl` and `Cor1R96-Out.dbl`.

As easily can be seen the approximation nicely works. The 1682 Taps FIR-Part (brown) is quite good down to 400Hz. Here the IIR part (green) gets in and performs the amplitude correction that the FIR can't do caused by its limited length.

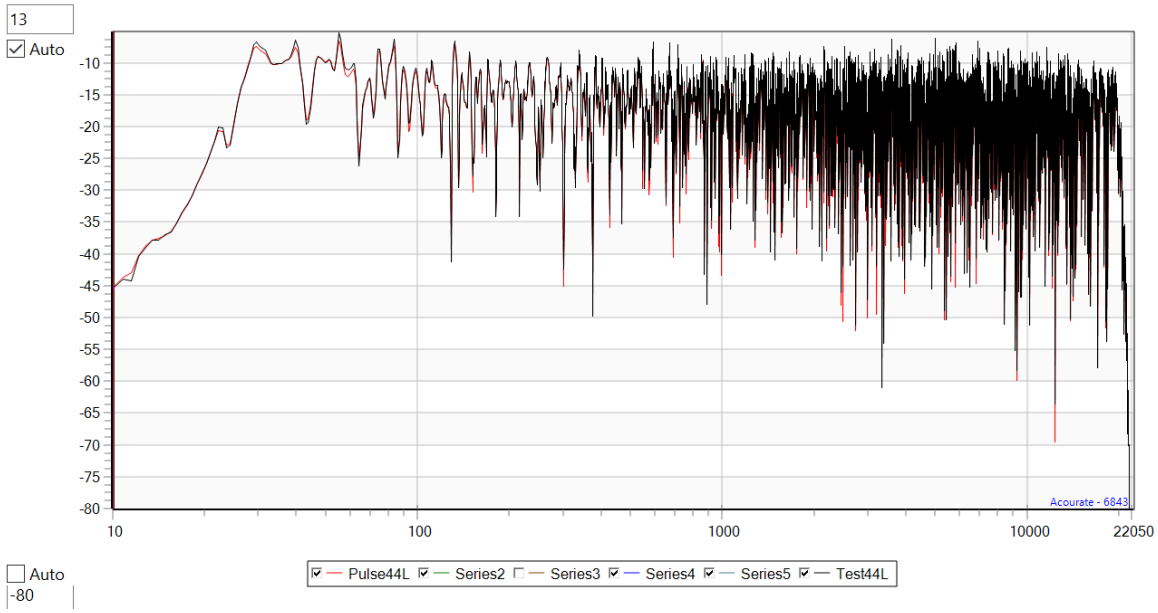


Convolving the FIR part and the IIR part you see (black) that there is nearly no amplitude difference compared to the Acourate correction (red).

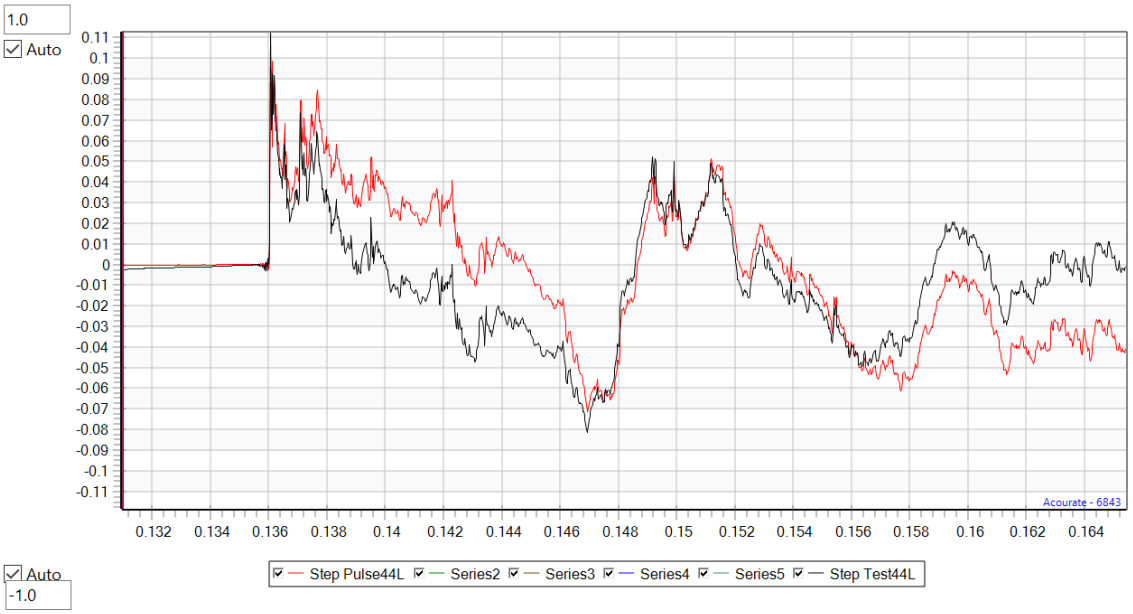


From these first results the files `Test44L.dbl` and `Test44R.dbl` were created in the subfolder `TestConvolutionon` to be able to compare the result after the correction.

In comparison to the TestConvolution files Acourate creates, the difference in amplitude is negligibly small. An overall amplitude difference (6dB) in the TestConvolution is visible that is corrected in the slide below.



Comparing the step response of the TestConvolution you see that also with miniSharc the woofer is perfectly integrated. Only at the lowest frequencies the phase correction of the Acourate FIR filter (red) has a small advantage against the IIR/FIR combination that was calculated (black).



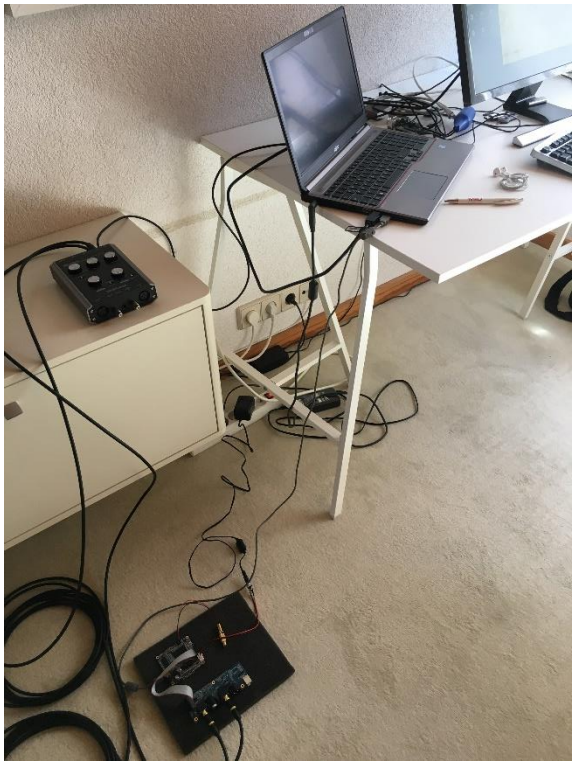
Next the file `src/!MiniSharc-Default.xml` is read, the calculated filters are filled in and the result is saved in `example/!MiniSharc-Config.xml`. This file can be loaded into the miniSharc 8x4 96kHz plugin and got synchronized with the miniSharc.

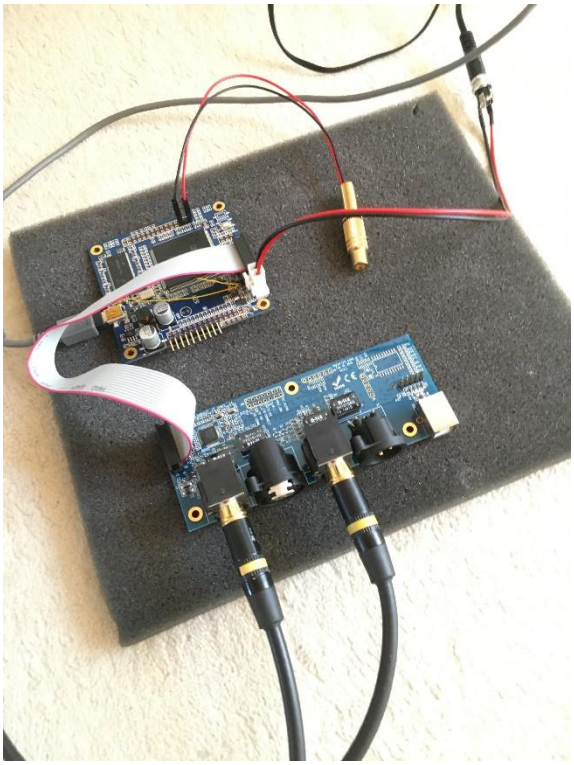
The display of the filter sections in the miniSharc plugin look quite strange but are correct.
Below we see: Input PEQ I2S 1, Output Xover 1, Output FIR 1, Output PEQ 1 (left to right, up to down).

Verifying the result by measurement

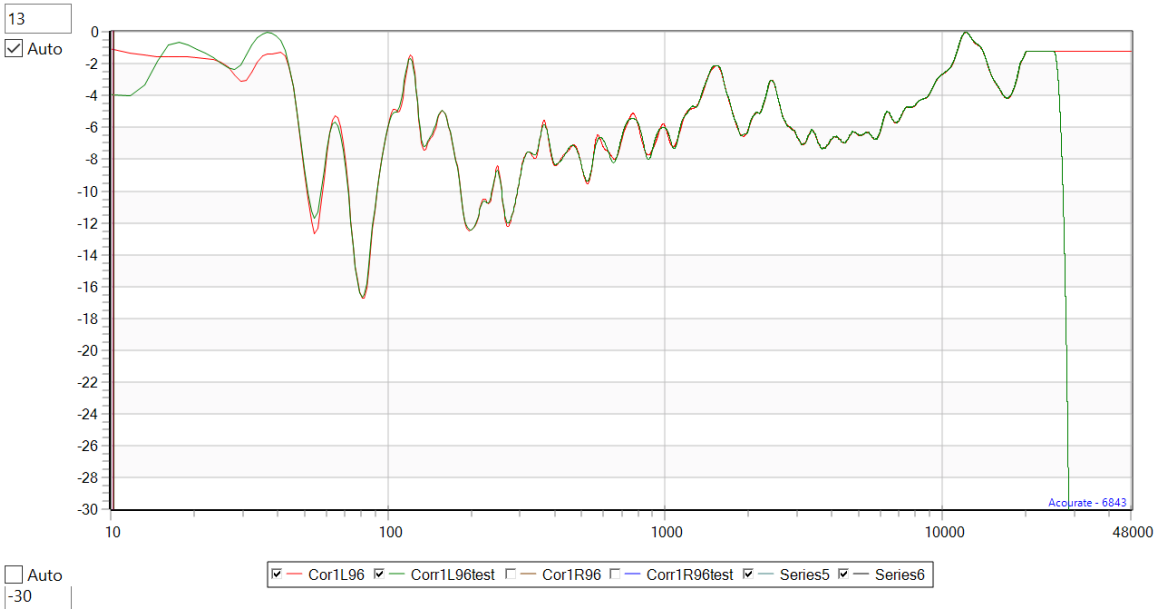
To verify that all the computations were OK I built up a testbed for the miniSharc. At my PC I run a Tascam US-144 MK II audio interface that has 96kHz ability and a digital in- an output.

I equipped the miniSharc with the DIGI-FP digital interface and connected the digital output of the US-144 with the digital input of the DIGI-FP and vice versa.





Next, I took a measurement with Acourate logsweep recorder and compared it with the FIR correction filter Acourate provided. It behaves as expected despite some few difference (<1dB) below 40Hz.



Summary

Transforming FIR filters to a FIR/IIR combination for miniSharc is not an easy task. But with this I proofed, that the miniSharc platform can be successfully used as a very well performing Room Correction Device for a low price with perfect amplitude correction and a nearly perfect phase correction. And it sounds stunning 😉 😉 😉