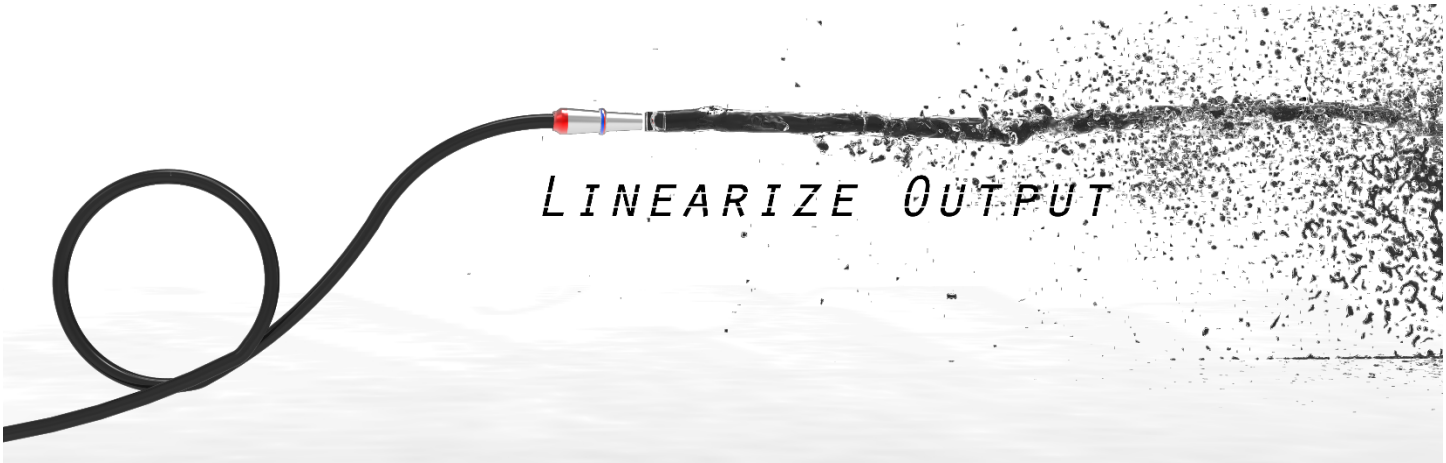


Filter Hose

User Guide v 2.1

HX Audio Lab

Contents

Feature

- ✓ Easy and quick to create FIR filter based on a measurement or a user defined input
- ✓ Create mixed, linear-phase and minimum-phase FIR filters
- ✓ Multi-Zone Time Windows to clean input impulse response
- ✓ Compatible with EASERA, Systune, ARTA, and Monkey Forrest binary file formats
- ✓ Compatible with EASERA, Systune, ARTA, Room EQ Wizard, HOLM Impulse, FuzzMeasure and Smaart ASCII file formats
- ✓ Target presets: flat magnitude only (linear or minimum phase filter), flat phase only, flat magnitude & flat phase and minimum phase.
- ✓ User defined filter and user defined target curve
- ✓ Export filter coefficient in *.csv, *.wav, MiniDSP's *.txt
- ✓ Numerical data format converter, including freq-mag-phs and freq-real-imag
- ✓ Flip polarity on the input or filter
- ✓ Smart smoothing algorithm for the input data
- ✓ Manual frequency domain data input
    - RTA data
    - Log-spaced frequency domain data
    - Sample rate conversion
    - Incomplete transfer function
    - User's own creation of a frequency/phase response curve

Note: we acquire the owner's permissions to implement the binary files loading compatibility.

Compatibility and Known Issues

Windows XP, Vista, 7, 8 and 10

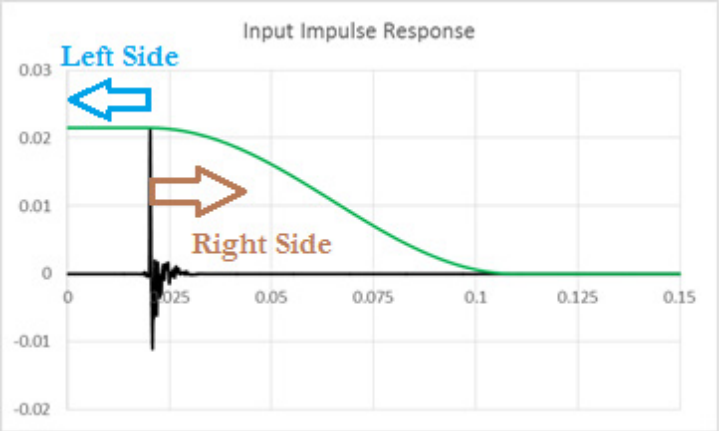
Region and Language of the Operating System: English (USA)

Requires Framework 4.0 Client

Recommended display resolution: 1280 x 800 or higher

Application Notes

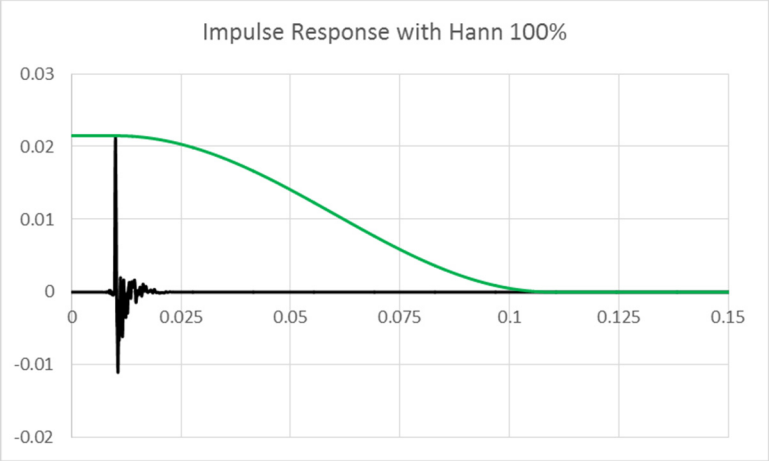
- ✓ Output and filter sample rates depend on the input sample rate. If needed, sample rate conversion can be done from manual input data (under advance menu).
- ✓ Windowing for input impulse response [abbreviated as IR from here forward], including multi-zone time windows [abbreviated as MZTW from here forward], is performed at the right half side only with IR peak auto detect.

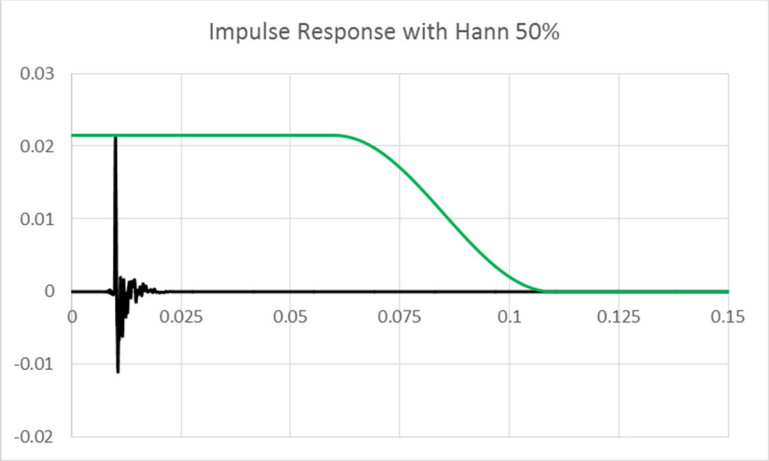


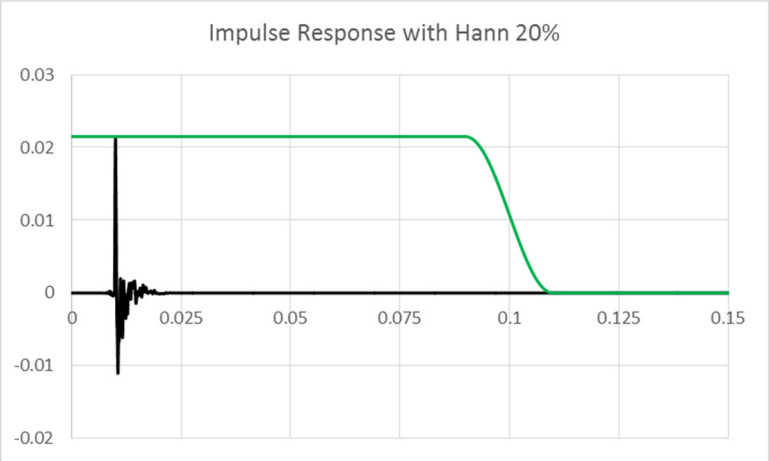
  - MZTW starts at 0.5ms [short] and 1ms [medium & long] after the IR peak.
  - Hann 50% window always start at the IR peak.
  - The left half side of the window is rectangular.
- ✓ MZTW suggested applications:
  - *Long:* Fits perfectly to clean up a ground plane measurement in a very large room or outdoor area. For venue tuning application, this allows early reflections to be included in the IR.
  - *Medium:* For general use.
  - *Short:* For creating loudspeaker correction where good measurement is not possible due to limited room size. Smoothing is likely needed after windowing is applied.
  - *Room:* For creating room compensation EQ, where the minimum length of the window at high frequency is 20ms (>5000Hz), and wider at lower frequencies. This window will include early reflections.
- ✓ Maximum filter tap depends on the input IR length (N) unless the filter is loaded from step 2.
- ✓ Wave file export is fixed @ 8, 16 and 24 bit and float @ 32 and 64 bit. *Filter gain may change due to normalization.*
- ✓ User defined target and user defined filter utilize biquad filter input parameters.

Notes cont'd

- ✓ Windowing percentage illustration and comparison
  Hann, impulse peak @ 10ms, window length = 100ms

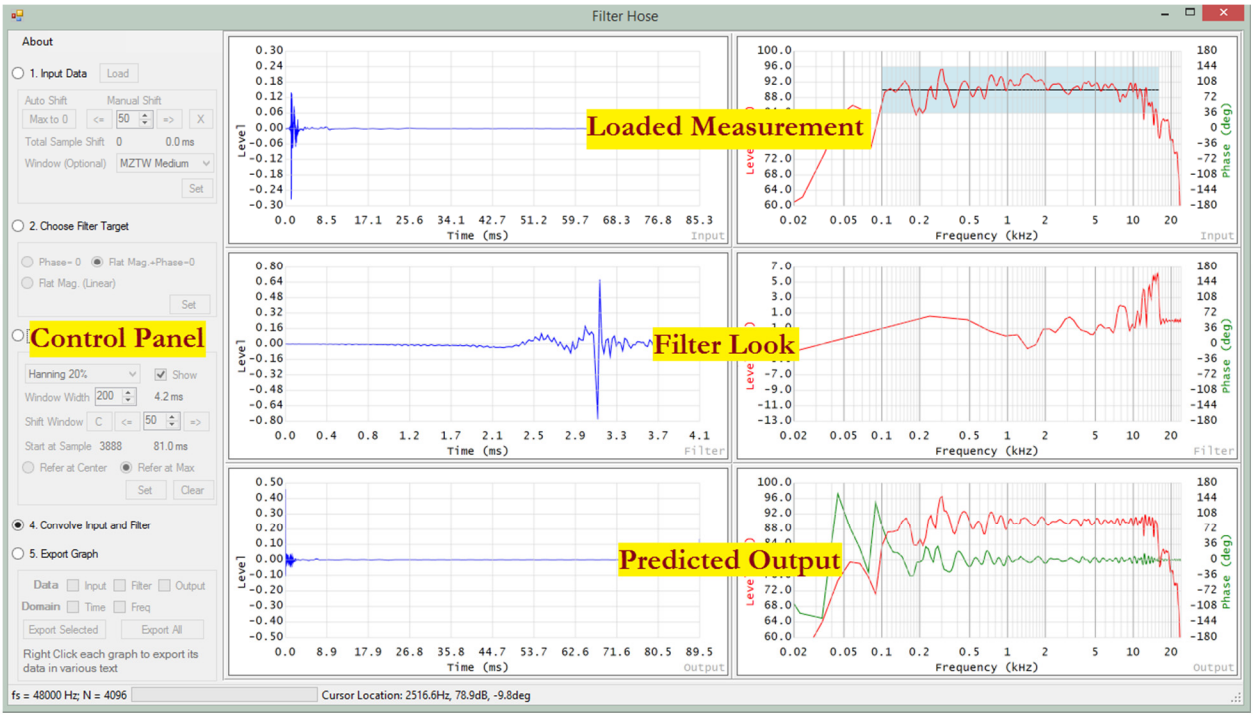


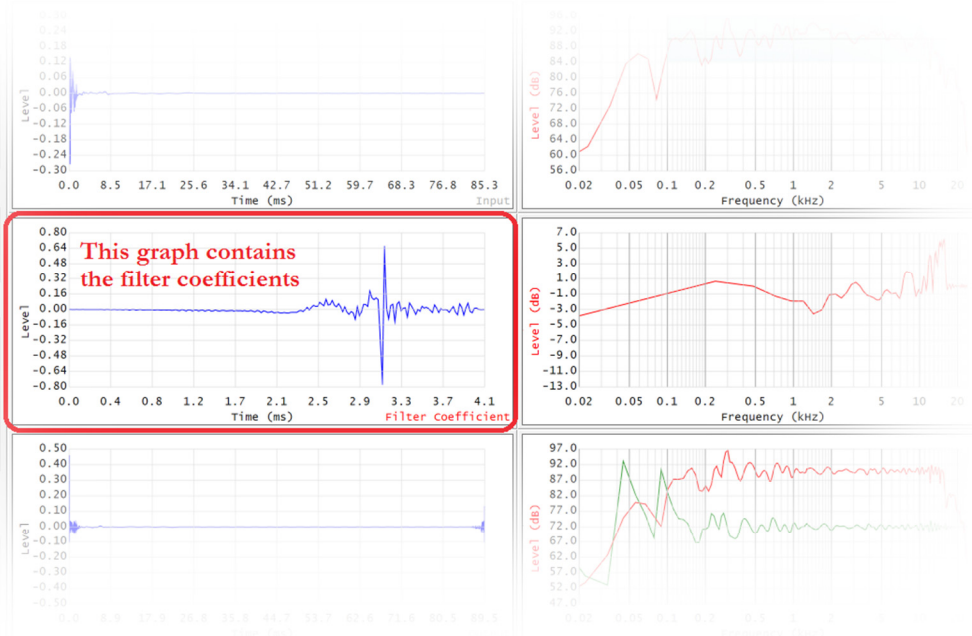




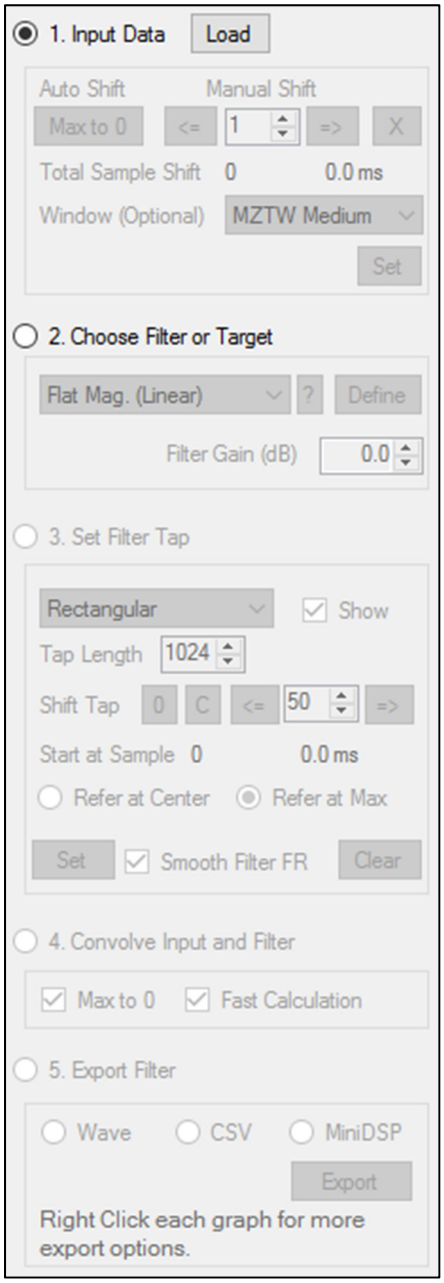
Navigation

Understanding Filter Hose User Interface



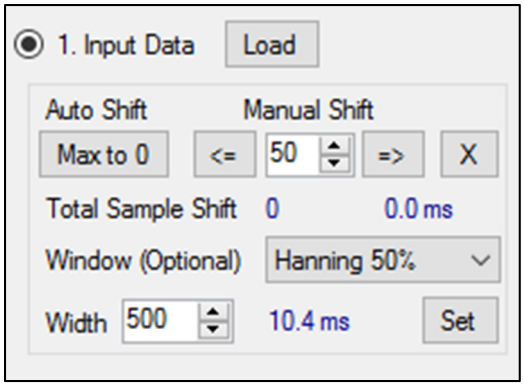


The Five-Step Control Panel



1. <u>Input Data</u>
   Direct load measurement data and provide basic editing such as windowing and cyclic shift. Manual data input can be done via Advance menu – Manual Input Data.
2. <u>Choose Filter or Target</u>
   Choose from several target presets, or define your own target curve/filter.
3. <u>Set Filter Window</u>
   Define the FIR tap length and provide basic filter's time domain editing.
4. <u>Convolve Input and Filter</u>
   Calculate the convolution of input IR and filter.
5. <u>Export Filter</u>
   Export FIR filter shown in the filter coefficient graph (middle left graph).

First Step



Click **Load** button to load measurement file directly (no changes on the original data).

Max to 0 button will cyclic shift the IR so its peak is at 0ms. Please note that the impulse should not be cut off at 0ms for proper calculation of the predicted output (step 4). Use Manual Shift to make sure the whole IR is located after 0ms.

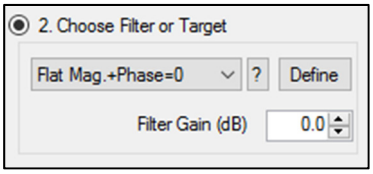
Manual Shift will cyclic shift the IR based on the selected interval (in sample). If the left side of IR is cut off at 0ms, it needs to be shifted to the right. The **X** button will clear all shift performed by Filter Hose.

Window (Optional) drop down list contains five different windows to clean up the input IR. Please see the Notes section of the user guide (page 3) for more information. If Hanning 50% is chosen, user is able to define the total window width, relative to the IR peak. The **Width** input value is in sample.

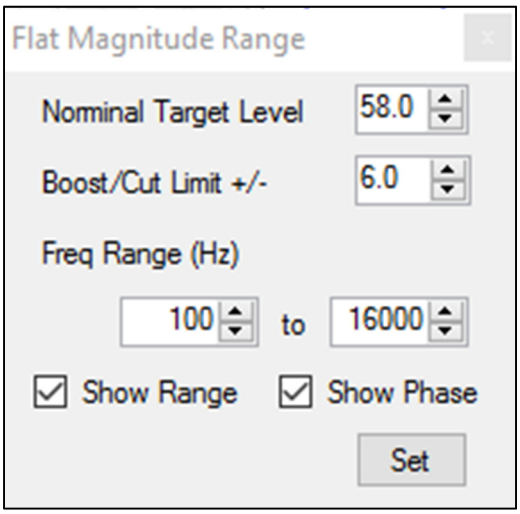
Please click **Set** button to apply the window.

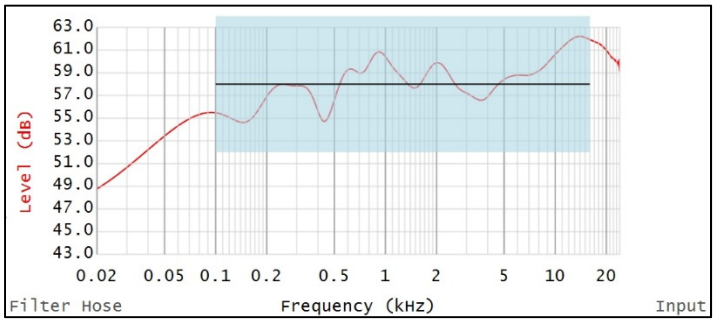
Second Step

Filter Hose provides several targets:



Phase = 0 will flatten the phase response of the input data close to 0 degree. Ideally, the magnitude is unchanged, but depending on the property of the filter, it may be affected.
Flat Mag. + Phase = 0 will flatten the magnitude and phase of the input data close to a flat line and 0 degree respectively. The actual result depends on the property of the filter.
Flat Mag. (Linear) will flatten the magnitude of the input data. Ideally, the phase is unchanged, but depending on the property of the filter, it may be affected.
Phase = Min. will create minimum phase from the input data based on its magnitude. Ideally, the magnitude is unchanged, but depending on the property of the filter, it may be affected.
Flat Mag. (Min. Phase) will flatten the magnitude of the input data. The filter is a minimum-phase FIR filter.
User Defined Filter and Target create custom FIR filter. This will be explained in the other section of the user guide.
Load from *.csv allows user to load a .csv file as is.
Filter Gain changes the nominal level of the FIR filter.



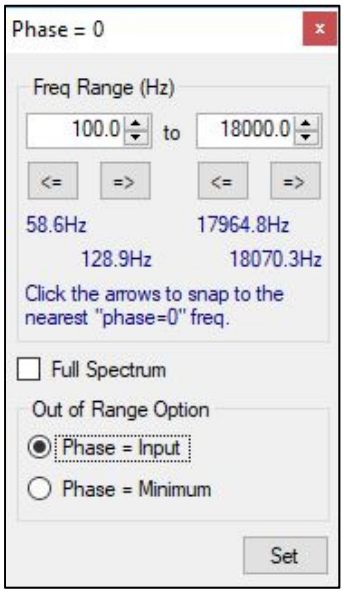


If **Flat Mag. + Phase = 0**, **Flat Mag. (Linear)** or **Flat Mag. (Min. Phase)** is selected as the filter target, **Flat Magnitude Range** window will pop-up.

Magnitude response will be flattened to the **Nominal Target Level** as long as it is within the **Boost/Cut limit**. Please make sure the light blue rectangle covers your desired magnitude range before clicking **Set Target**. If the Y-axis is in dBFS, user may input a negative value in the nominal target level box.

Start Freq and **End Freq** determine the frequency range to flatten.

All parameters are visualized as a black line and a light-blue rectangular, overlapping the magnitude response curve.



If **Flat Mag. + Phase = 0** or **Phase = 0** is selected as the filter target, **Phase = 0 Range** window will pop-up.

Start Freq and **End Freq** determine the frequency range for the target phase = 0.

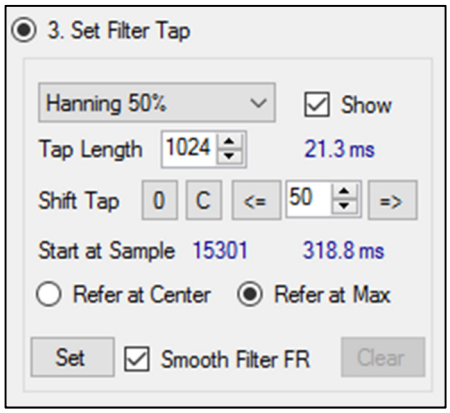
Out of Range Option determines the target phase for the extreme low (0 Hz – start freq) and extreme high (end freq – Nyquist frequency). User is able to choose minimum phase **(Phase = Minimum)** or original phase **(Phase = Input)**.

Full Spectrum will input 0Hz and Nyquist frequency in the start/end freq range. This option will ignore **outside range** phase target since the whole spectrum target phase will be 0 deg. Note: Prior to v1.3, Filter Hose always calculate the whole spectrum for Phase = 0 target.

In v2.1 and newer, user can find **left/right arrows** under the start/end freq range input box. These arrows automatically find the nearest phase = 0deg (or phase approaches to 0deg) from the input data. For example, the left picture shows that a user intends to flatten the phase from 100Hz. However, the phase is not 0deg at 100Hz. Continuing with this may not result in a good FIR filter. User can use the arrow to find the phase = 0 location, in this example either starts at 58.6Hz or 128.9Hz. If user is not satisfy with the automatic finding, user can change the input frequency value, in this example lower than 58.6Hz or above 128.9Hz. The finder will automatically find new frequency points.

Third Step

The most important step to create an FIR filter



The **Window** drop down list contains several window presets to taper the filter's front/end tails.

Show check button will toggle the tap selection area display on and off.

Tap Length determines the filter's tap length. The input value is in sample.

Shift Tap will cyclic shift the filter's IR. The input value is in sample.

0 button will locate the window's starting point at the first sample of the calculated filter's IR. This is useful to create minimum phase FIR filter.

C button will center the tap selection to the peak of the impulse.

Note: Selecting appropriate tap location is the most important step of creating FIR filter. Failure to do so will result in a dysfunctional FIR filter.

Select **Refer at Center** to use the center of the tap area as the left and right window dividing point.

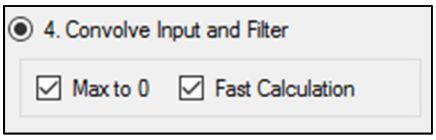
Select **Refer at Max** (default) to use the peak sample of the tap area as the left and right window dividing point. This is the recommended choice for general use.

Check **Smooth Filter FR** to lengthen the filter's N so that the frequency response display is smoother (finer frequency resolution curve).

Set button will apply the window and tap selection to finalize the FIR filter. Click **Clear** button if the user wishes to experiment with other settings.

Technical Note: If the FIR filter contains a processing delay (ie. the peak of the filter is far from 0ms), the filter's phase response will likely drop and contain a lot of wraps.

Fourth Step



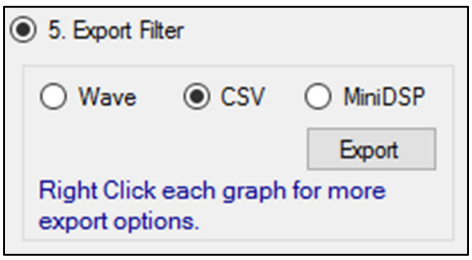
This step convolves the input IR and the filter's IR in the time domain. Then, the frequency response is calculated using DFT/FFT, based on the new calculated IR. **Note: DFT requires significantly longer process time if input IR and/or filter has N larger than 8192.**

To use FFT, please select **Fast Calculation (**by default). To use DFT, please unselect **Fast Calculation** (more accurate result). FFT or DFT choice only affects the frequency domain data.

If **Max to 0** checkbox is selected, the peak of IR will automatically cyclic shifted to 0ms (default).

Tip: If one needs to cyclic shift the calculated output, please save it as .csv file and reload it in the step 1.

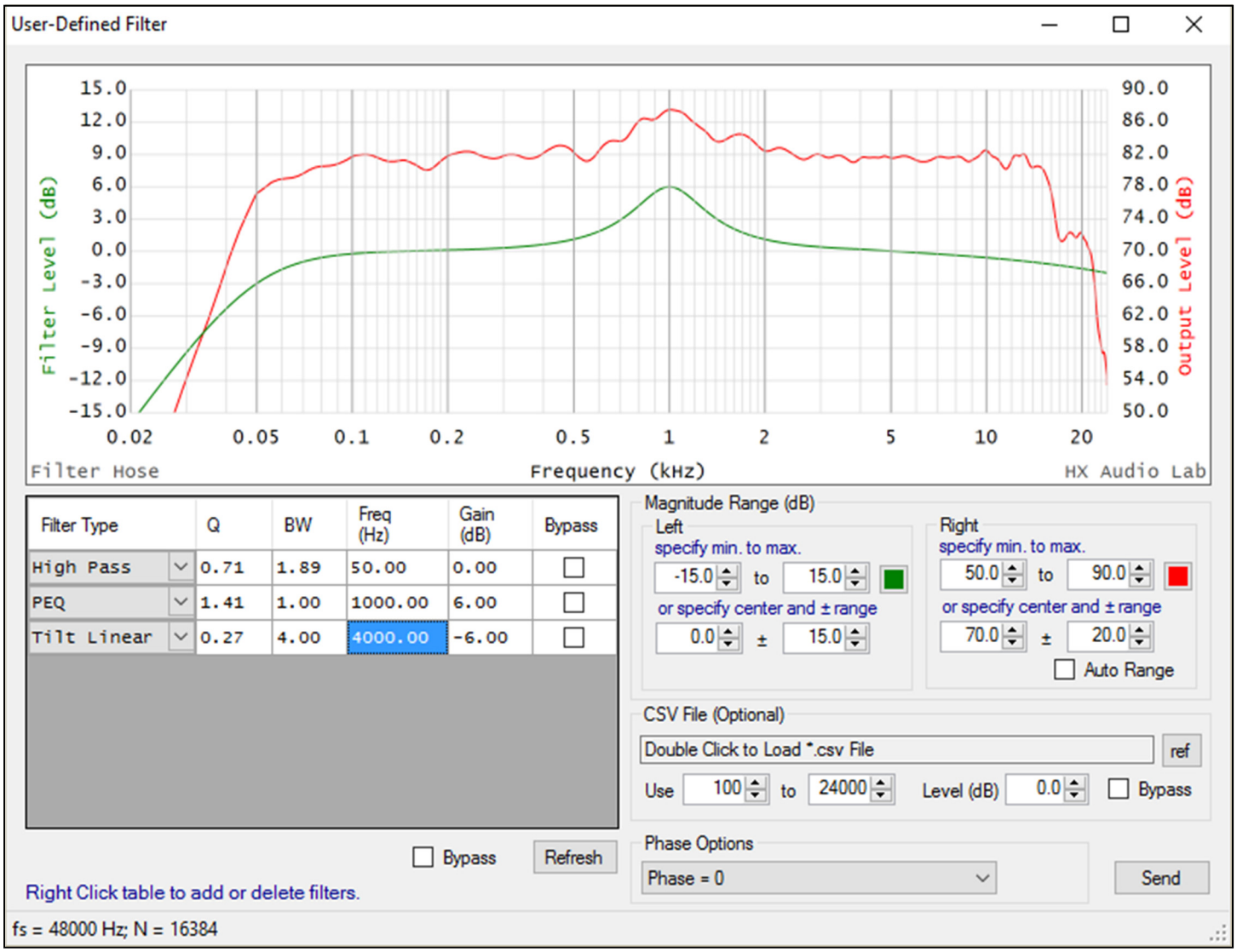
Fifth Step



This step allows user to export the filter coefficients. User can also export the filter by using right click on the filter coefficient graph (middle left graph).

User Defined Filter

User is able to define a filter/EQ curve based on .csv file load, biquad filter input or other controls.

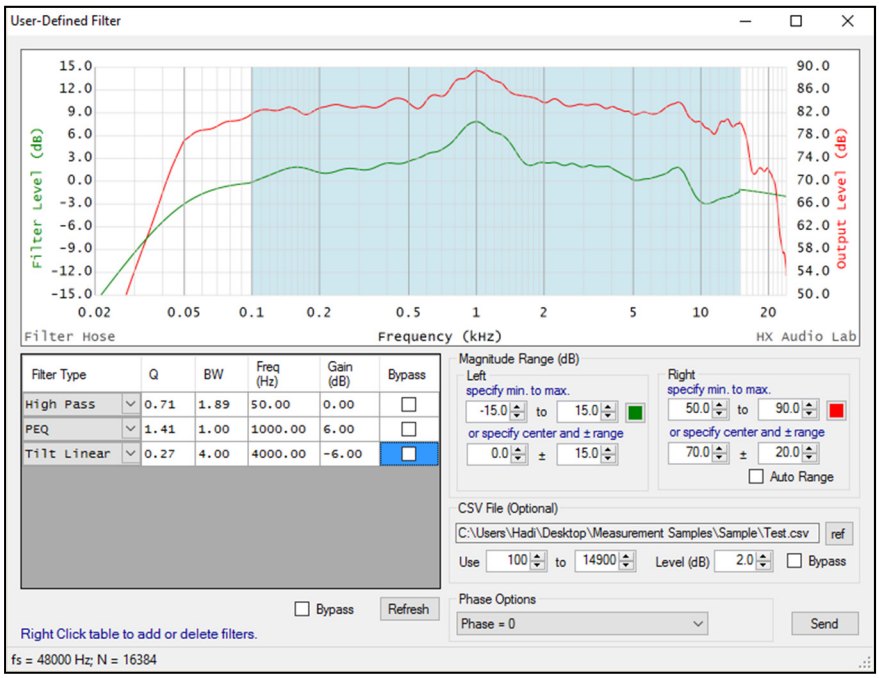


The green curve shows the magnitude of user defined EQ and the red curve shows the magnitude of the predicted output. User is able to edit the table on the left by defining biquad input or other available filter to create the EQ. Please always click **Refresh** button (or hit enter) to refresh the graph after performing any edits. Use **right-click** on the table area to add/remove filters. To change the graph color, please click on the color button on the right of the min/max value.

Phase Options define the final FIR filter's phase. There are four options:

1. Phase = 0
   Creates an FIR filter with phase = 0. This will ignore the biquad minimum phase filters from the table.
2. Phase = Min.
   Creates a minimum phase FIR filter. This option will calculate a minimum phase from the loaded csv file.
3. Use CSV phase, table phase = 0
   Combines the loaded csv file with the filters defined in the table and set the phase from the table to 0.
4. Use CSV phase, table phase = Min.
   Combines the loaded csv file with the minimum phase filters defined in the table. Note: Selecting non-minimum phase filter will result in a mixed-phase filter.

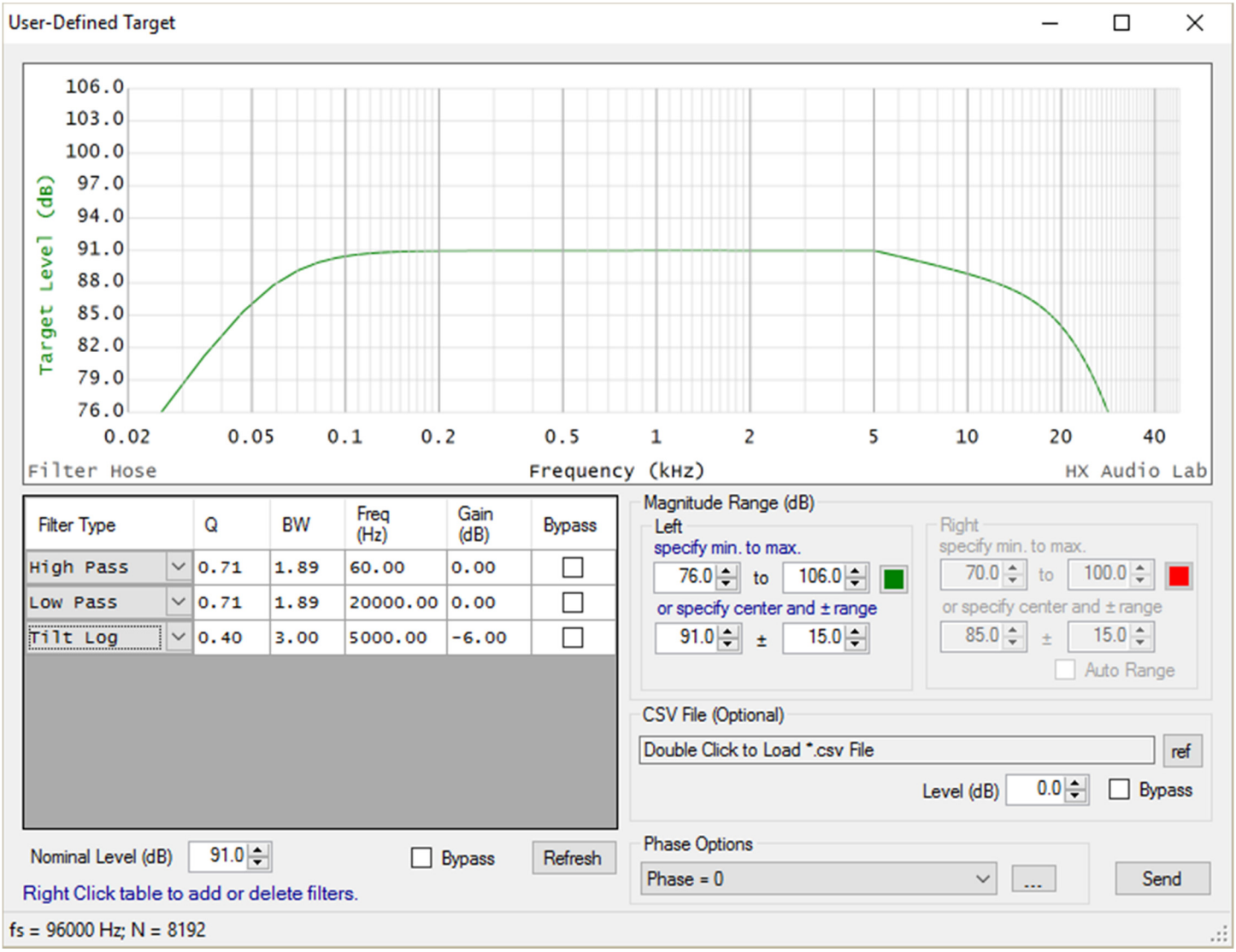
For a certain selection, user is able to define the magnitude range of the loaded .csv file. The graph will show the selected range in the blue rectangle as shown in the picture below.



<u>Note: loading .csv file in user defined filter window requires a same N length with the loaded measurement. Filter Hose will automatically shorten/lengthen the .csv file.</u>

User Defined Target

User is able to define a target curve. The step 4 frequency response will likely result closely with the defined target curve in the this window (depending on the step 3 editing) unless user selects filter phase = 0 or filter phase = Min.



The **nominal target level** is always calculated based on the input. Please make sure to adjust the nominal target level first prior modifying the table.

Phase Options define the target curve's phase response, or assign a certain phase characteristic to the created FIR filter (target curve is used for magnitude correction only). There are six options:

1. Phase = 0
   Creates a target curve with phase = 0.
2. Phase = Min.
   Creates a target curve with minimum phase response.
3. Use CSV Phase, Table Phase = 0
   Combines the loaded csv file with the curve defined from the table (phase = 0).
4. Use CSV Phase, Table Phase = Min.
   Combines the loaded csv file with the curve defined from the table (phase = Min.).
5. Phase = Input (Filter Phase = 0)
   Creates an FIR filter with phase = 0, with the target magnitude curve defined in the table, CSV file or combination.
6. Filter Phase = Min.
   Creates a minimum phase FIR filter, with the target magnitude curve defined in the table, CSV file or combination.

<u>Note: loading .csv file in user defined filter window requires a same N length with the loaded measurement. Filter Hose will automatically shorten/lengthen the .csv file.</u>

Available Filter Types

To define a frequency response curve in user defined window and user defined target, user is presented with several options:

1. Biquad high pass filter (HPF)
   User is required to define the frequency and Q/bandwidth.
2. Biquad low pass filter (LPF)
   User is required to define the frequency and Q/bandwidth.
3. Biquad high shelf (HS)
   User is required to define the frequency, gain and Q/bandwidth.
4. Biquad low shelf (LS)
   User is required to define the frequency, gain and Q/bandwidth.
5. Biquad all pass filter (APF)
   User is required to define the frequency and Q/bandwidth.
   This is a non-minimum phase filter.
6. Parametric EQ (PEQ)
   User is required to define the frequency, gain and Q/bandwidth.
7. Tilt Log
   User is required to define the start frequency (lower limit), gain and bandwitdh (how many octave up?).
   Example: if user wishes to have a -3dB spectral tilt from 5000Hz – 15000Hz, input the parameters as follow:
   Frequency = 5000Hz
   Bandwidth = 3 octaves (Note: 15000Hz is three octaves higher from 5000Hz).
   Gain = -3dB.
   This is a non-minimum phase filter.
8. Tilt Linear
   User is required to define the start frequency (lower limit), gain and bandwitdh (how many octave up?).
   Please see the example from number 7 above.
   This is a non-minimum phase filter.

<u>Note: each biquad filter is a second order filter.</u>

Mouse Navigation on Each Graph

- ✓ **Left-Click on graph**:
  Shows the cursor location.
- ✓ **Right-Click:**
  Shows the export menu, graph setup, peek window and other options.
- ✓ **Control Right-Click:**
  Pops up the graph property window.
- ✓ **Control Left-Click + drag:**
  Horizontal zoom in.
- ✓ **Shift Left-Click + drag:**
  Vertical zoom in
- ✓ **Double Left-Click:**
  100% zoom out and activate the auto range.

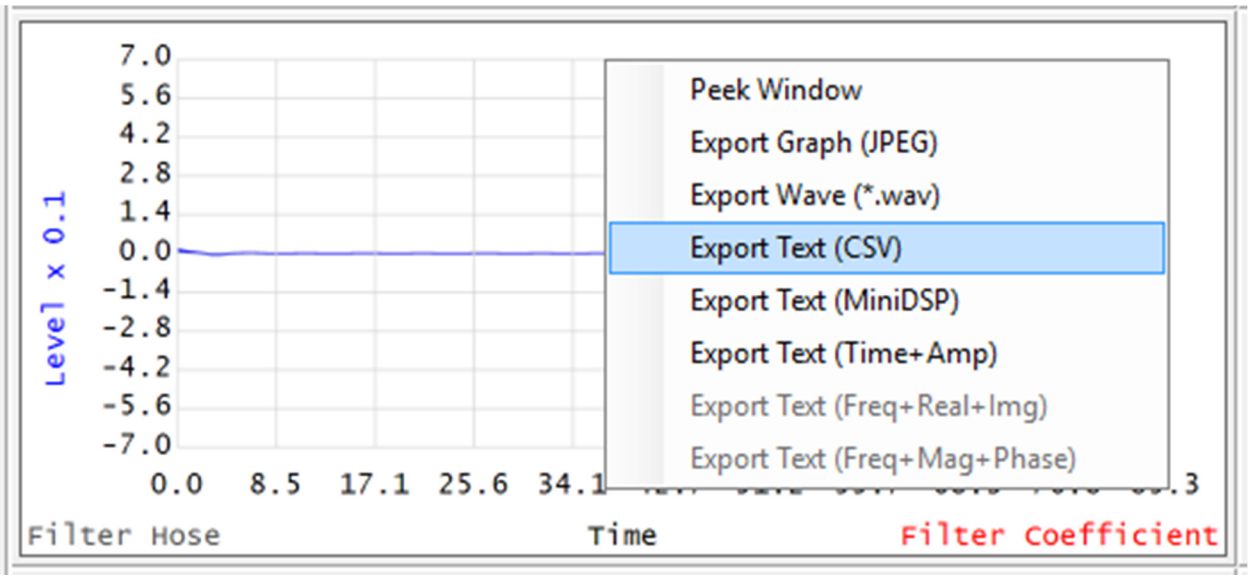
Peek Window

Larger window (twice larger) for each graph is available, user can access peek window by right clicking each graph and select peek window option. The data in the peek window is not affected if changes are made in the main Filter Hose window. The size of the peek window depends on the original graph size.

User is able to export the peek window's graph by using right-click on the peek window graph and select export picture. User is also able to rename the peek window's name. The peek window's name is not included in the exported picture, however this function helps user to keep track what data is shown in a peek window, especially if multiple peek windows are opened.

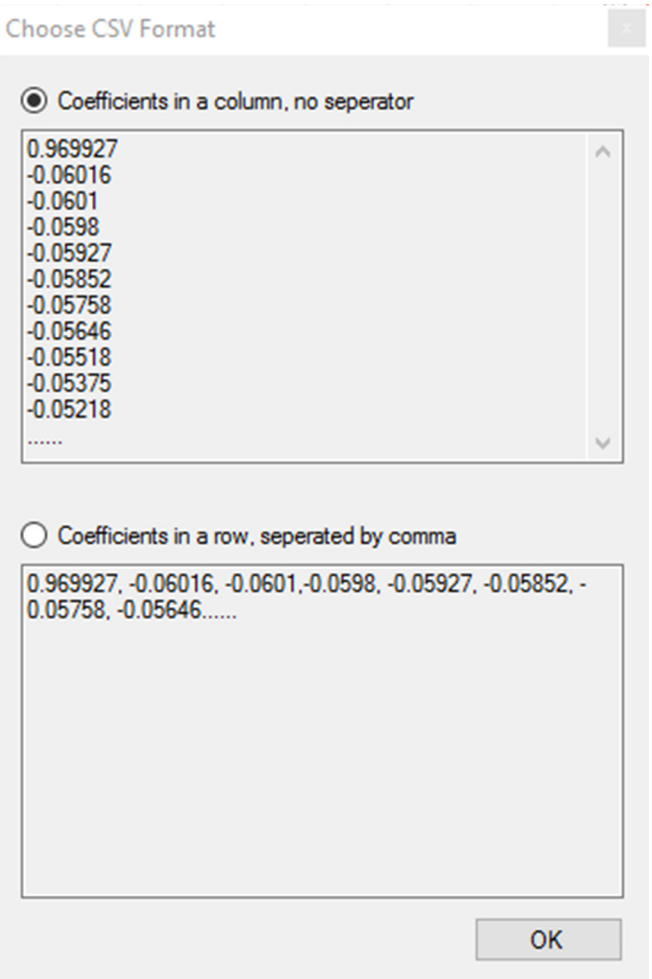
Exporting FIR values

User can export FIR filter coefficient from step 5 or right-click on the time-domain filter graph (middle left graph - as shown below).



Filter Hose .csv File Format

The .csv file format that Filter Hose recognizes (export and import) follows the following screenshot.



Manual Time Domain Data Input

If a software exports a time domain data ASCII file (.txt or .csv) that is not recognized by Filter Hose, user can manually edit the data in the notepad or excel to include only the IR's amplitude data, and format it in a column with no separator or in a row separated by comma. Then save it as a .csv file. User can also rename a .txt file to a .cvs file. This enables a flexibility to manually input time domain data to Filter Hose. This is also explained in the sub chapter importing a filter transfer function at the end of the user guide.

Known Hardware Compatibility

Coefficients in a column is recognized by DSP such as QSC Q-sys, Marani Audio, Symmetrix, DFM Audio.

Coefficients in a row, separated by comma is recognized by DSP such as Biamp Tesira.

The above examples were tested in 2018 and may changes in the future. Please always check with your DSP manufactures. Should you find a DSP input format that is not recognized by Filter Hose export function, please contact us.

Advance Menu

In Filter Hose v1.2 and newer, advance menu is introduced.

Send Filter to Input

When a filter is already generated, this function enables user to send the filter (time domain) to the data input. This is useful when creating a mixed phase FIR filter. A similar way can be done by saving the filter as a .csv file and loading it to the data input. Please see the section on Importing a Filter Transfer Function in this user guide. The FT reference is automatically set to 1.

Half Input N

This function shorten the data input N by eliminating the last half samples and the function works for N > 1024. Please make sure the impulse is not chopped incorrectly by shifting the peak to near beginning/0ms.

Tips on shortening Input N

Several softwares (such as room EQ wizard) collect long impulse response and may cause Filter Hose "not responding". To shorten the data input, please follow the steps below

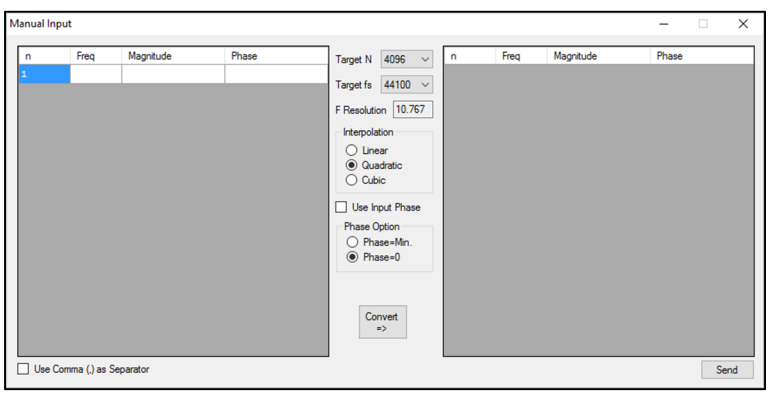
1. Load a data (assuming N > 64k).
2. Click on Max to 0
3. Cyclic move the impulse at least 50 samples to the right (to avoid the impulse getting chopped).
4. Use Advance – Half Input N function about two or three times to shorten the impulse length.

It is recommended to work with impulse response with N <= 16k to avoid slow response of the program.

Smooth Input

This function will smooth the input data to approximate 1/3, 1/6 or 1/12 octave smoothing.

Manual Input Data



Clicking this function will pop-up a new window as shown on the left. This window enables user to:

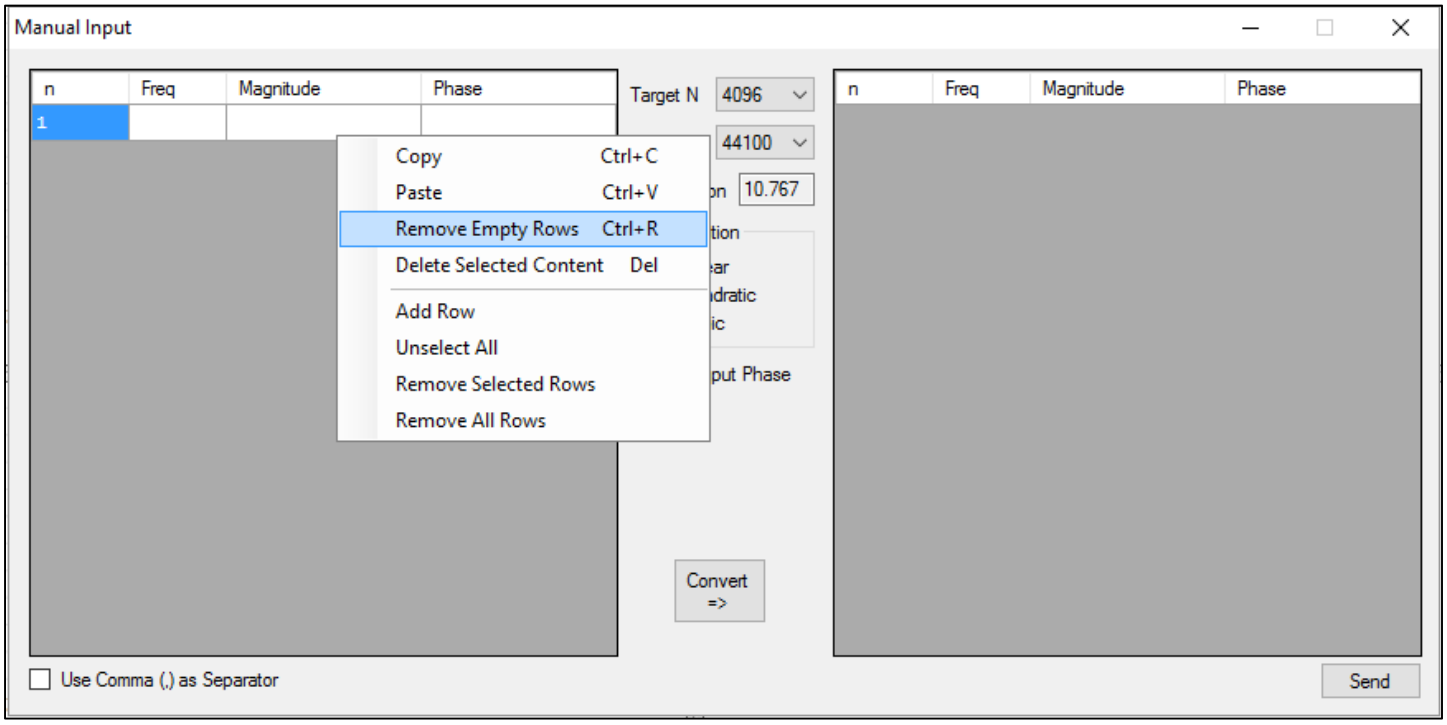
- ✓ Load an RTA data
- ✓ Load a log-spaced frequency domain data
- ✓ Do a sample rate conversion
- ✓ Load an incomplete frequency domain data

The user input is located on the left table. User is able to copy-paste text/ASCII data from notepad or Excel or other similar software. It accepts log or linear frequency domain data, including incomplete transfer function.

By unchecking **Use Input Phase**, Filter Hose offers two options on how the phase will be generated: minimum phase (calculated from the magnitude data) or phase = 0 deg. This step is required to create a phase curve from RTA data, or if user wish to overwrite the current measured phase data.

Please define the target sample rate (fs) and N before clicking **Convert**. The new data set will be transferred to the main Filter Hose window by clicking **Send.**

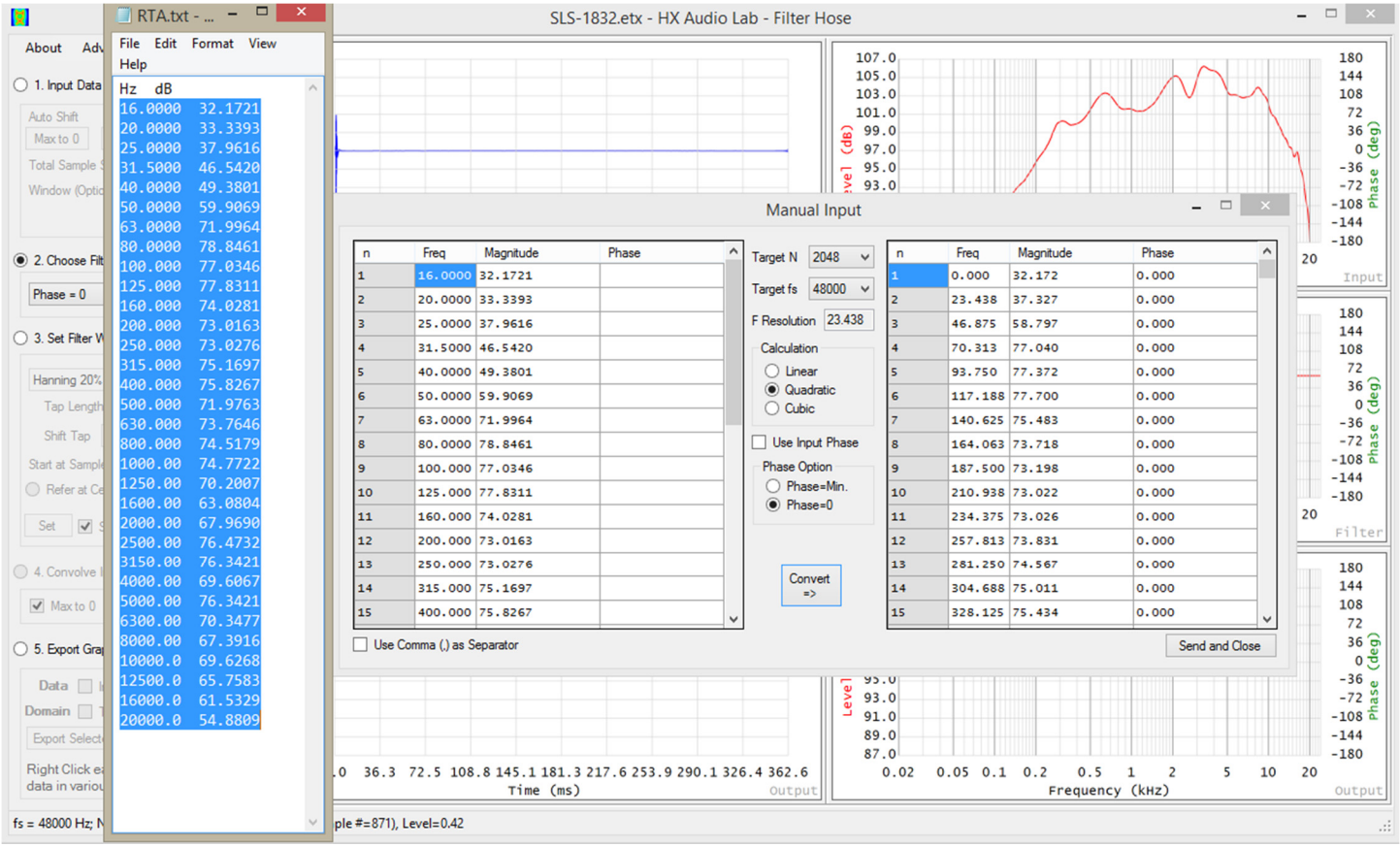
The pasted data on the left table may contain rows that are not acceptable to Filter Hose. Please use right click on the row to perform editing. Several table editing options can be seen below.



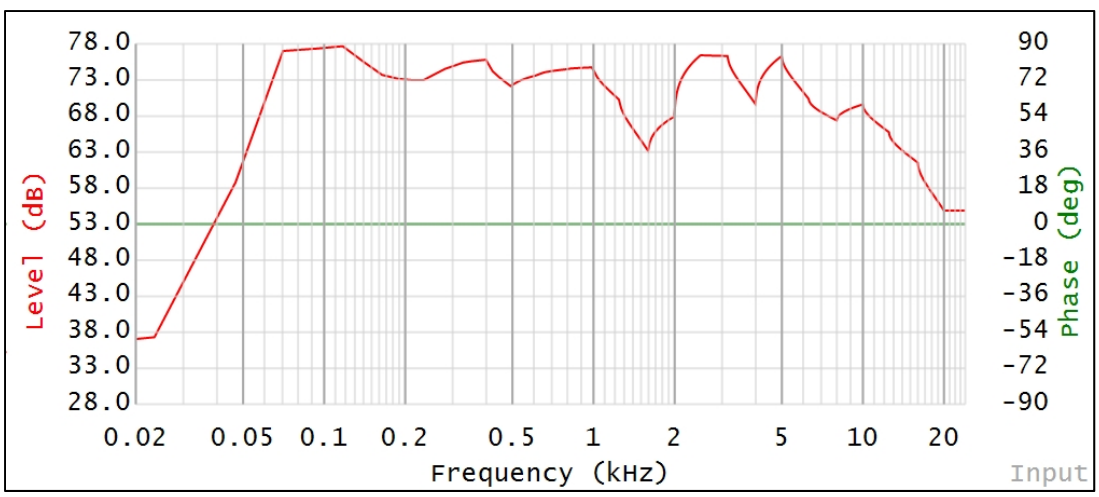
Note:

1. ***Target N refers to time domain data N, therefore the data in the right table will contain <u>half</u> of the selected target N value.***
2. ***Manual input <u>always</u> perform interpolation/extrapolation to create a new (linear frequency) data set. To import the data without any changes, please use the direct load button (Step 1 from the main window).***
3. **User is able to create her/his own frequency/phase response by inputting the value in each row manually.**
4. **Please refer to HX Audio's article: [Creating Earthworks Mic Compensation in EASERA and Systune using Filter Hose] for an application example of the manual input where user inputs an incomplete data and customizing a lower frequency curve manually.**

Manual Input Example – Loading an RTA data

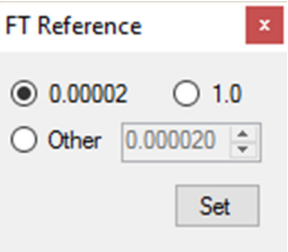


An RTA data is copy pasted from notepad. The data is transferred without phase information, and filter hose is inputting phase = 0. To do this, please unclick **Use Input Phase** and select the desired option. The input result can be seen below (48kHz sample rate, N=2048).



Set FT Reference

User is able to define a reference value for the Fourier transform. This will affect the level in the frequency response.



If send filter to input is clicked, the FT reference is automatically set to 1. After changing the FT reference, user shall reload the input file.

Set IR CSV Format

Filter Hose recognizes two different csv file format import/export. This is explained under *Filter Hose .csv File Format* sub chapter.

Flip Input Polarity

Flips the polarity if the input.

Flip Filter Polarity

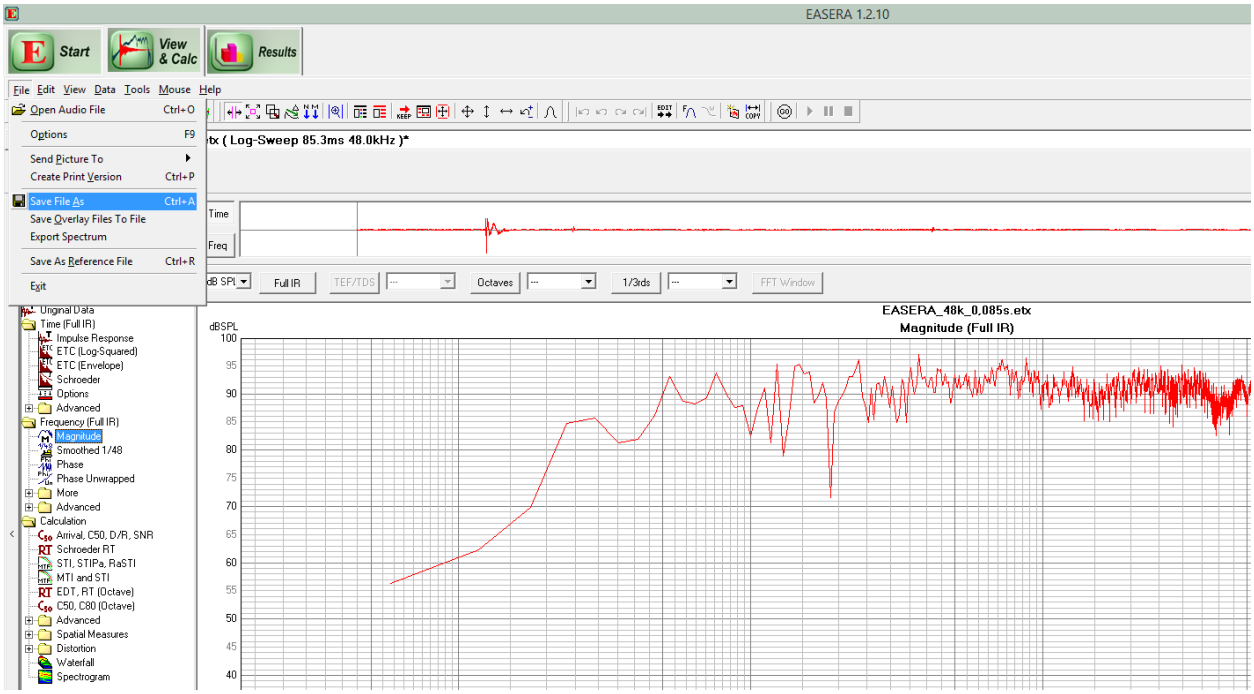
Flips the polarity of the filter. This function is active after a filter is created.

Direct Import ASCII Measurement Files

<u>Direct load only accepts 2^n measurement data length</u>.

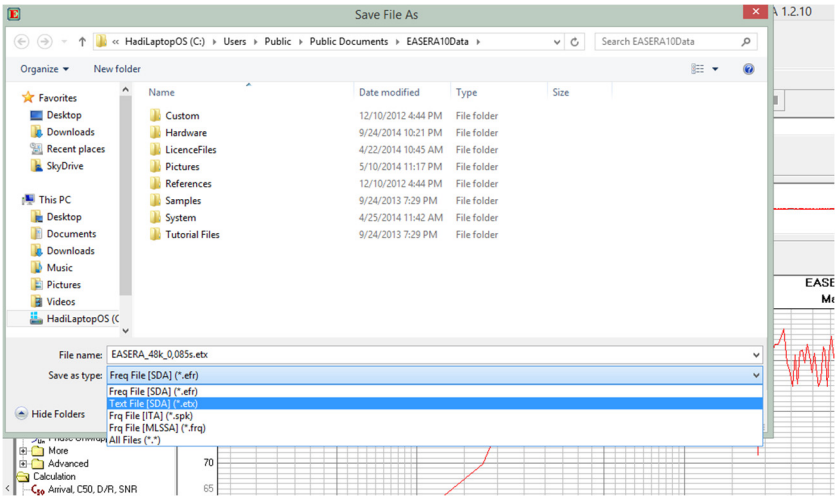
EASERA .etx file (Tested using v1.2.13)

Filter Hose is able to load time and frequency domain EASERA .etx files. The example below is in frequency domain.



Click **Magnitude** on the left panel

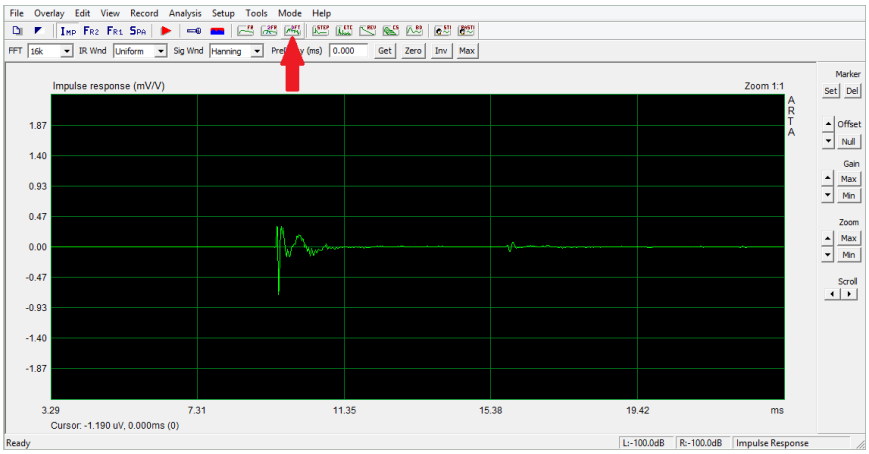
Click **File** – **Save File As**



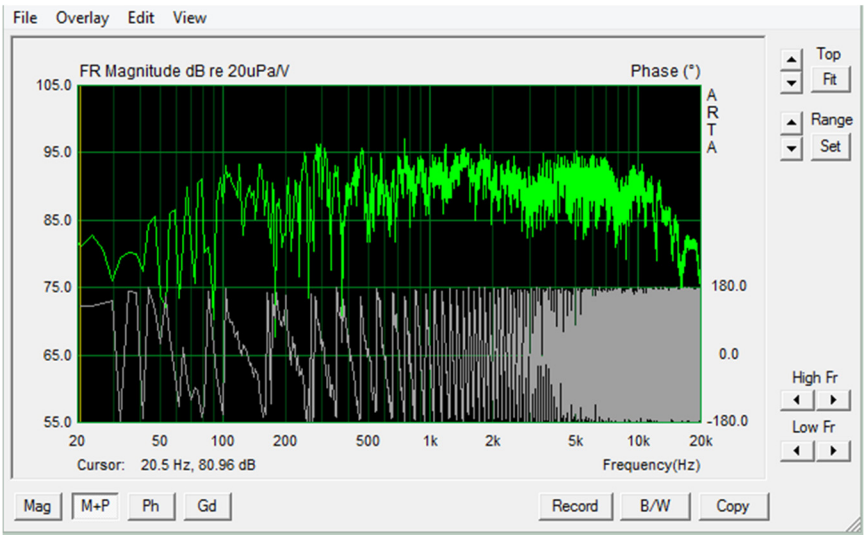
Select Text File *.etx from the drop down menu

ARTA .txt file (Tested using v1.8.5)

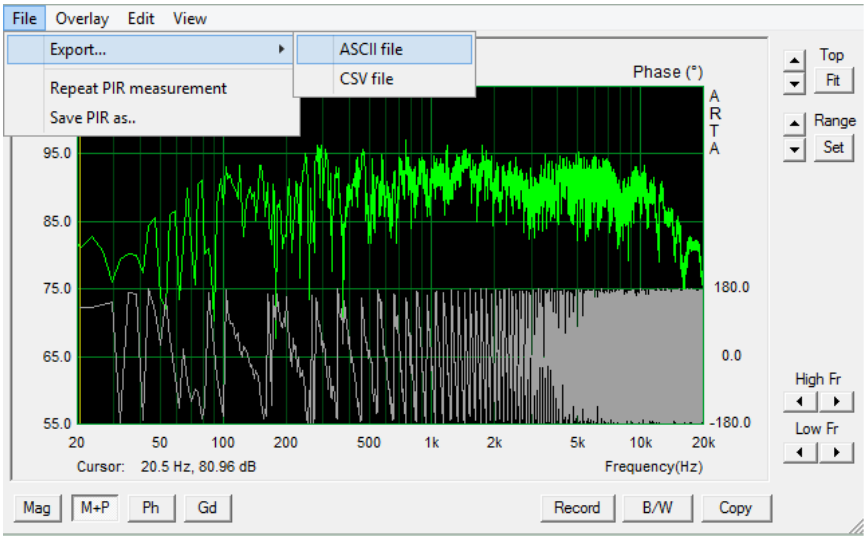
Click **DFT** (unsmoothed FR)



Make sure magnitude and phase are both shown by clicking **M+P** button

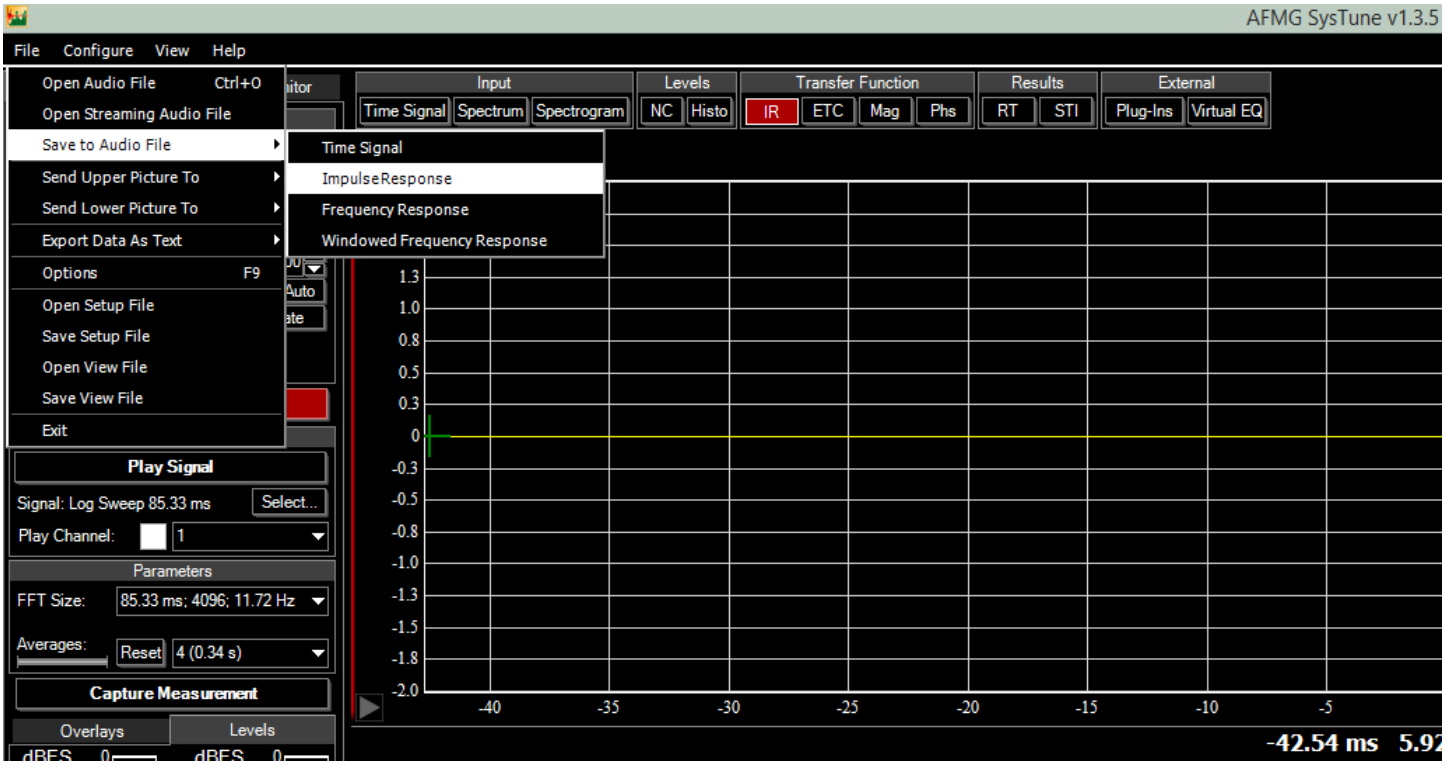


Click **File** – **Export** – **ASCII file**

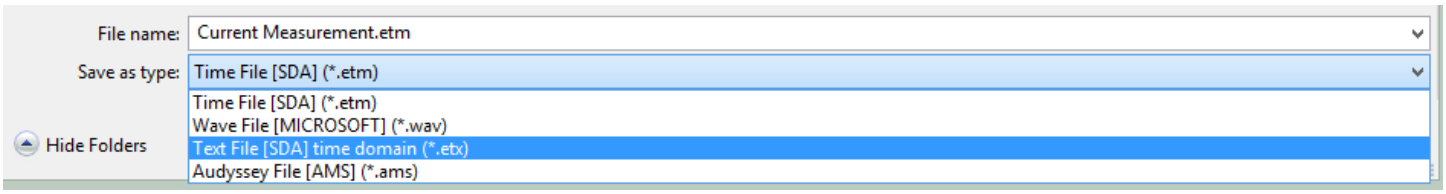


Systune .etx file (Tested using V1.3.7)

Click **File – Save Audio As – Impulse Response** to create an .etx file from Systune. We recommend using Systune's time domain etx data format.



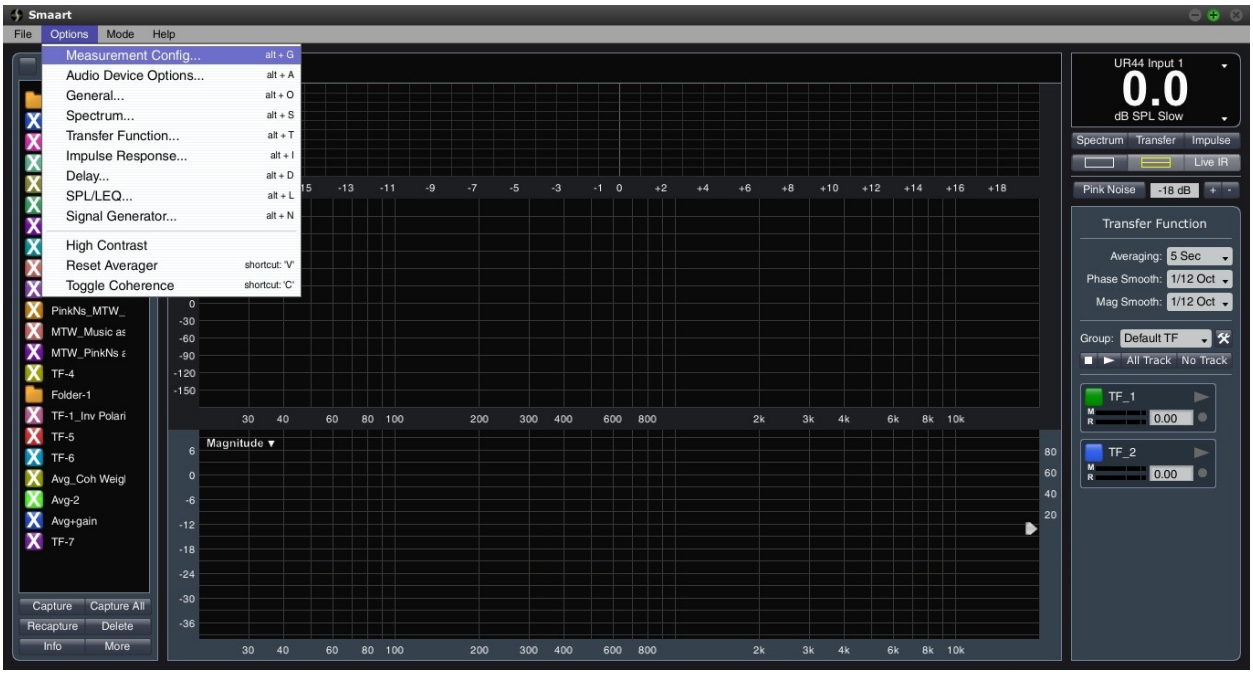
From the file dialog, select *.etx.

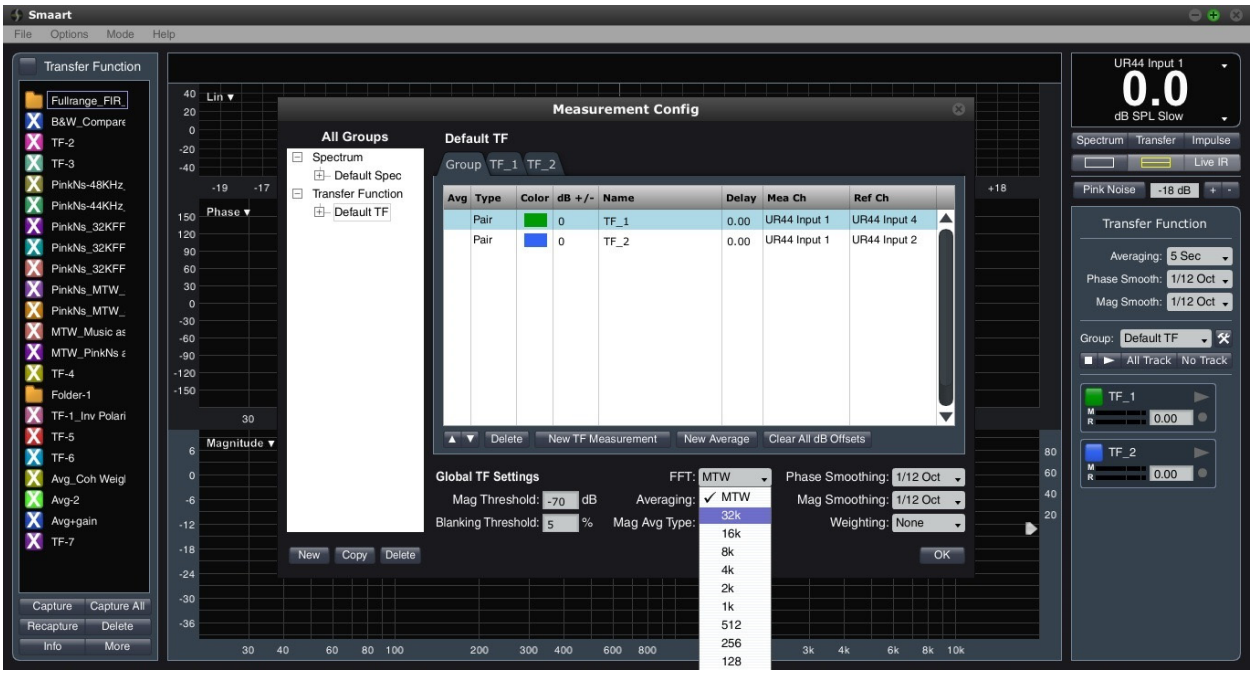


In Filter Hose, please use EASERA *.etx file type to import the file.

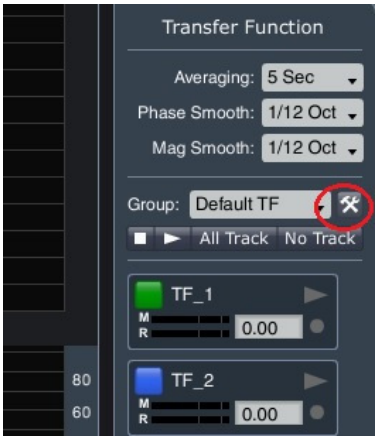
Smaart 7 .txt file (Tested using v7.5.2)

Click **Measurement Config** and switch the MTW to a FFT size.





Another way to open **Measurement Config** is to press the tool button as shown below:



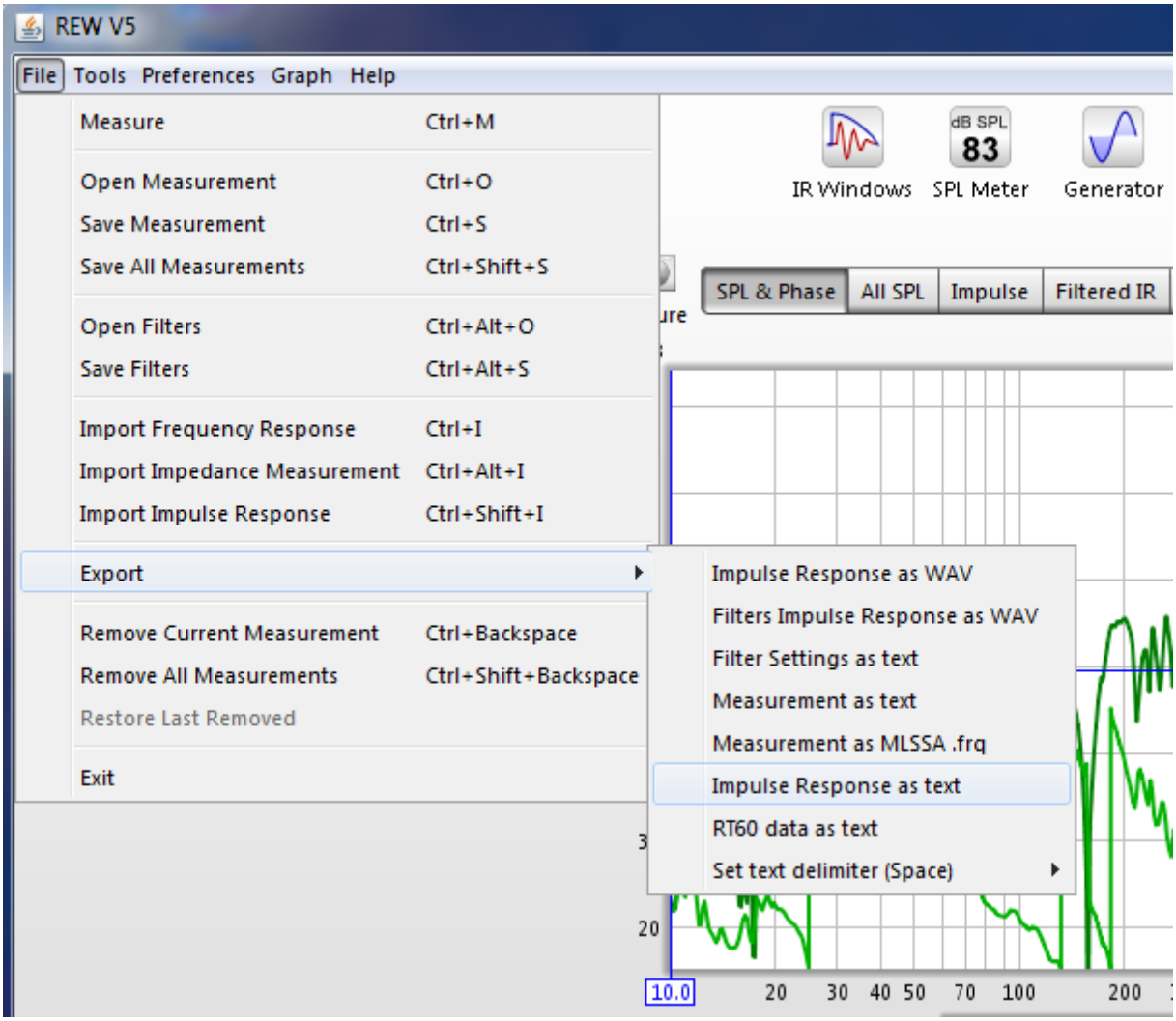
Click **More** – **Copy to ASCII**

The values are stored in the clipboard. Open Notepad to paste in the values, and save as a new text file (*.txt).

Room EQ Wizard/REW (Tested using v5.12)

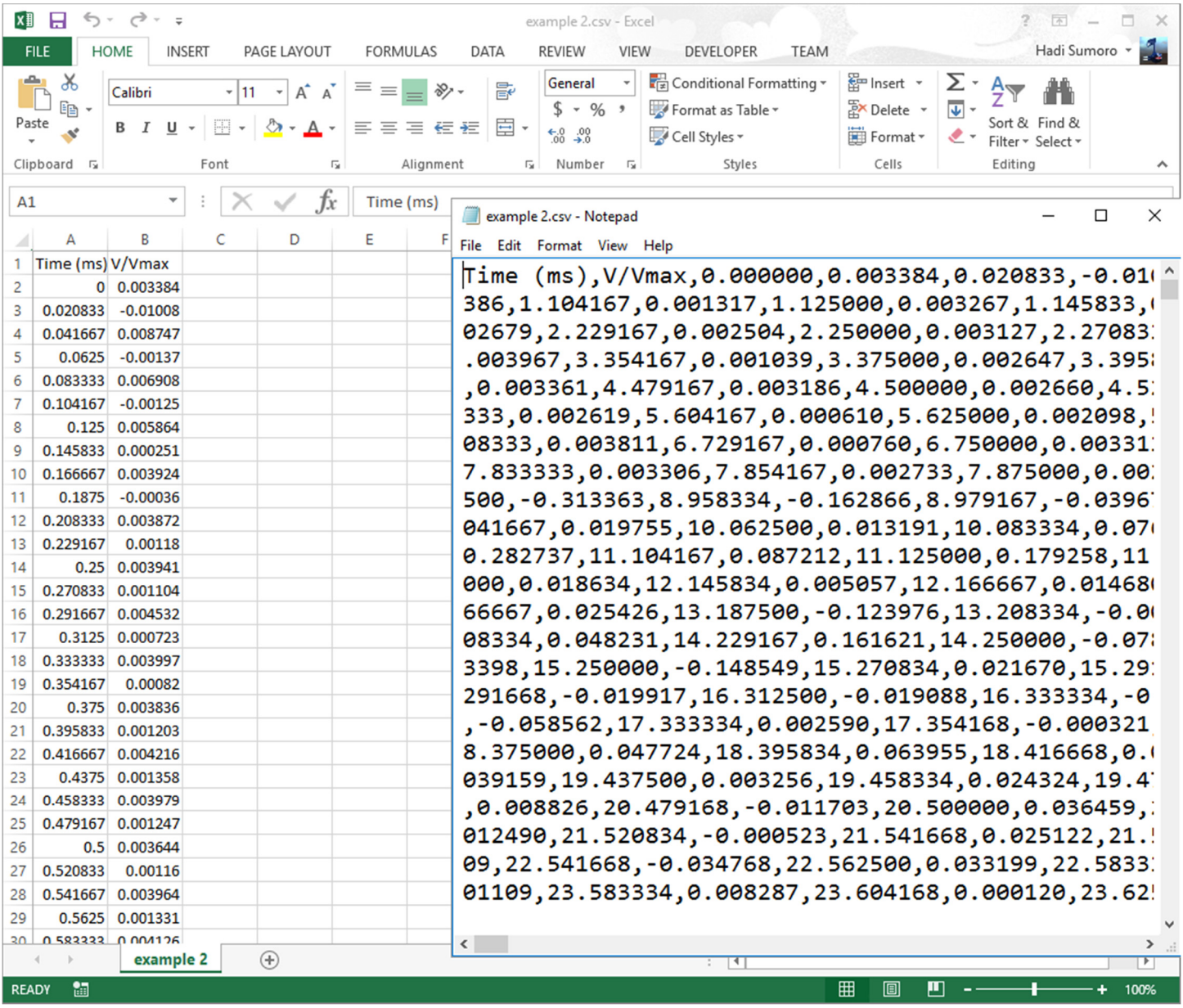
Click **File – Export – Impulse Response as text** to create a compatible txt file for Filter Hose use.

Please note that REW impulse length is default to N > 64k. Upon loading the txt file to Filter Hose, it is recommended to use **Advance – Half Input N** to shorten the impulse length at least to N <= 16k. Please see "Tips on Shortening Input N" section in the user guide.



FuzzMeasure

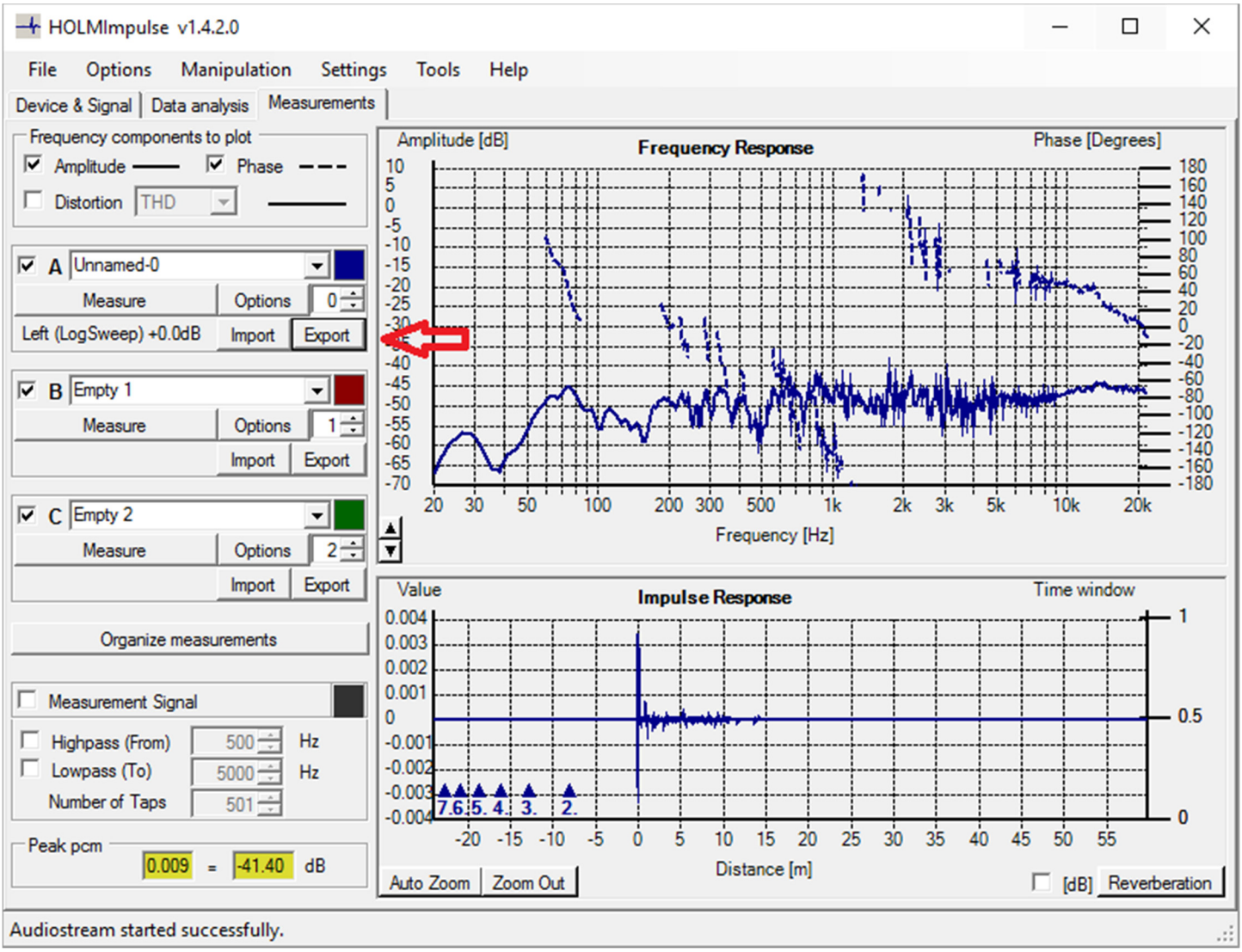
Filter Hose accepts FuzzMeasure time domain data export (.csv file). Please make sure the exported csv file contains the time (ms) and amplitude of the impulse response as shown below (opened in Excel and NotePad).

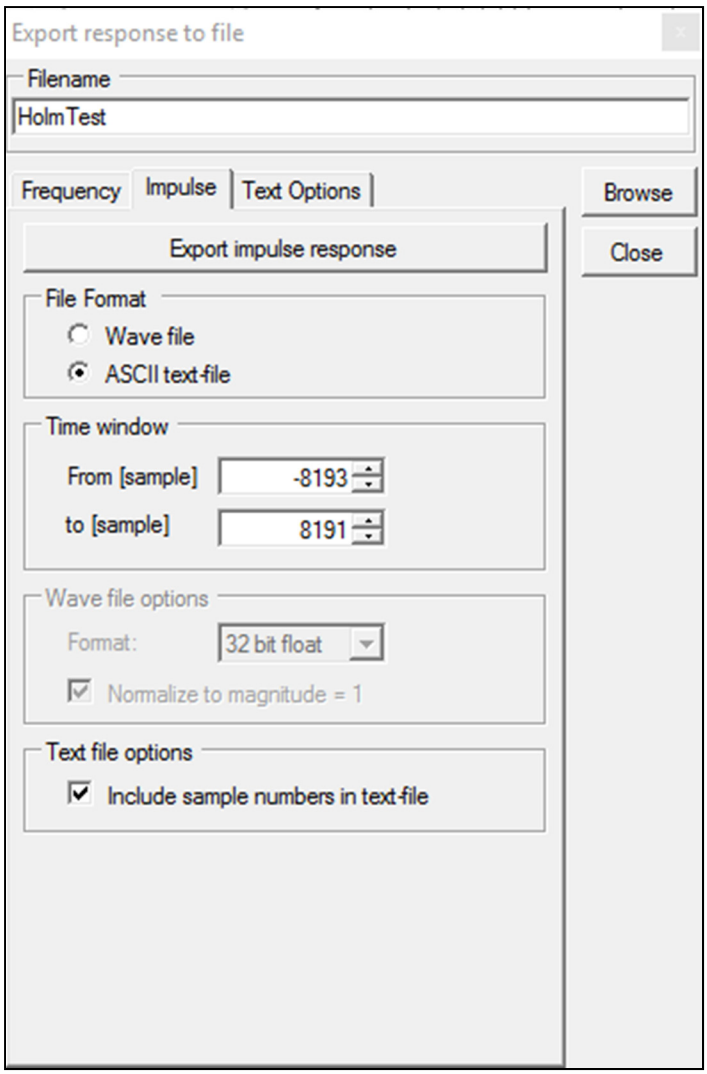


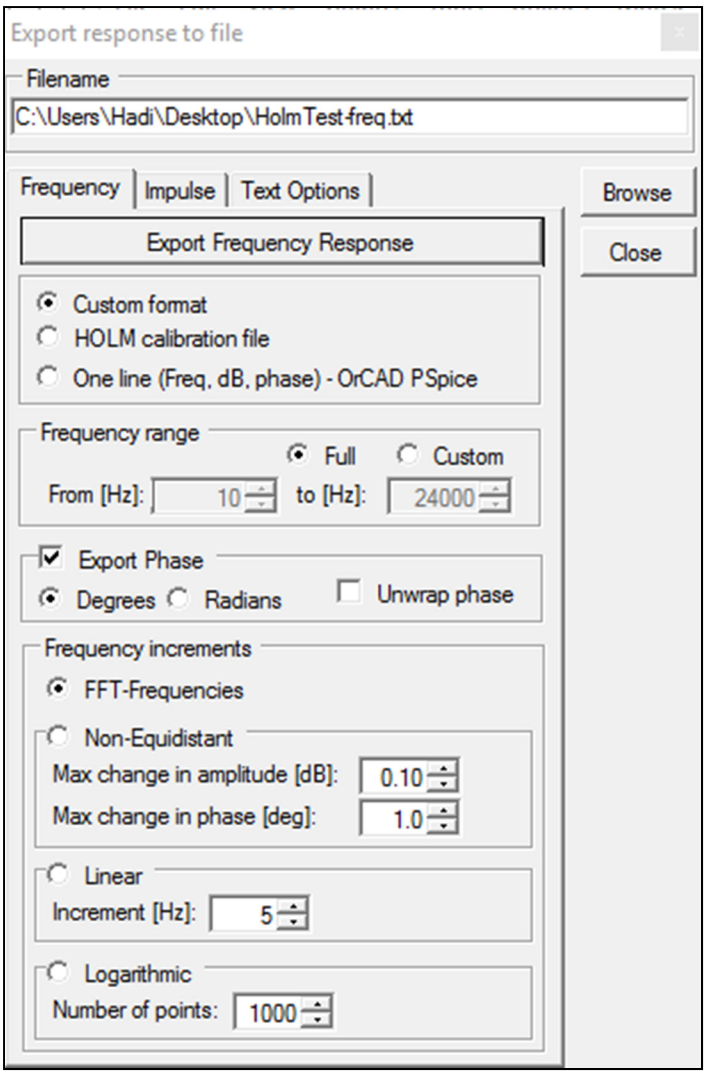
Time (ms)	V/Vmax
0	0.003384
0.020833	-0.01008
0.041667	0.008747
0.0625	-0.00137
0.083333	0.006908
0.104167	-0.00125
0.125	0.005864
0.145833	0.000251
0.166667	0.003924
0.1875	-0.00036
0.208333	0.003872
0.229167	0.00118
0.25	0.003941
0.270833	0.001104
0.291667	0.004532
0.3125	0.000723
0.333333	0.003997
0.354167	0.00082
0.375	0.003836
0.395833	0.001203
0.416667	0.004216
0.4375	0.001358
0.458333	0.003979
0.479167	0.001247
0.5	0.003644
0.520833	0.00116
0.541667	0.003964
0.5625	0.001331
0.583333	0.004126

Holm Impulse (Tested using v1.4.2.0)

Filter Hose accepts time and frequency domain data export from Holm Impulse.







Please follow the setup in the left screenshot for time domain export or the right screenshot for frequency domain export.

The .txt file shall look like the pictures in the next page.

HolmTest-freq.txt - Notepad

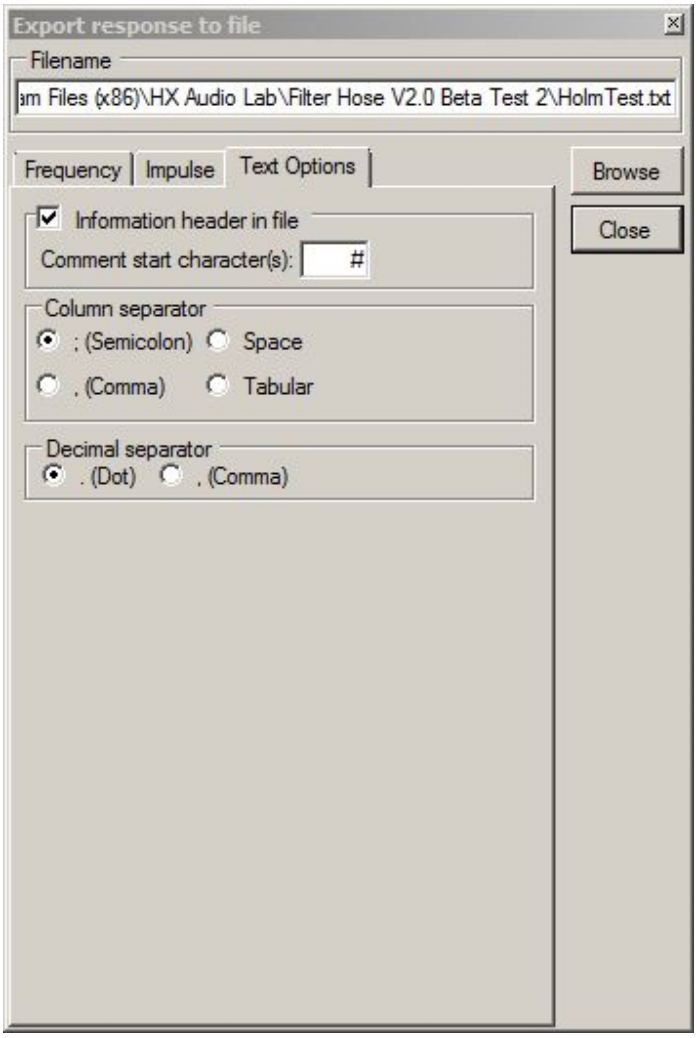
File Edit Format View Help

```
#
# Measurement exported using HOLM Acoustics
software
# http://www.holmacoustics.com
#
# Note: Unnamed-0
# Number of samples: 16384
# Samplerate: 48000
#
# All discrete frequencies are included
#
# Frequency [Hz]; Amplitude [dB]; Phase
#
0;-107.3349221;0
2.9296875;-78.2020589123;33.451432286
5.859375;-76.6466231685;-93.5699968278
8.7890625;-68.4545615704;-174.478481173
11.71875;-69.8254675324;131.103658034
14.6484375;-76.1489305361;90.1415173229
17.578125;-79.5758727592;157.60608961
20.5078125;-65.3711177742;-167.647698387
23.4375;-59.0231536476;154.266571843
26.3671875;-57.0922084688;117.572042643
```

HolmTest-time.txt - Notepad

File Edit Format View Help

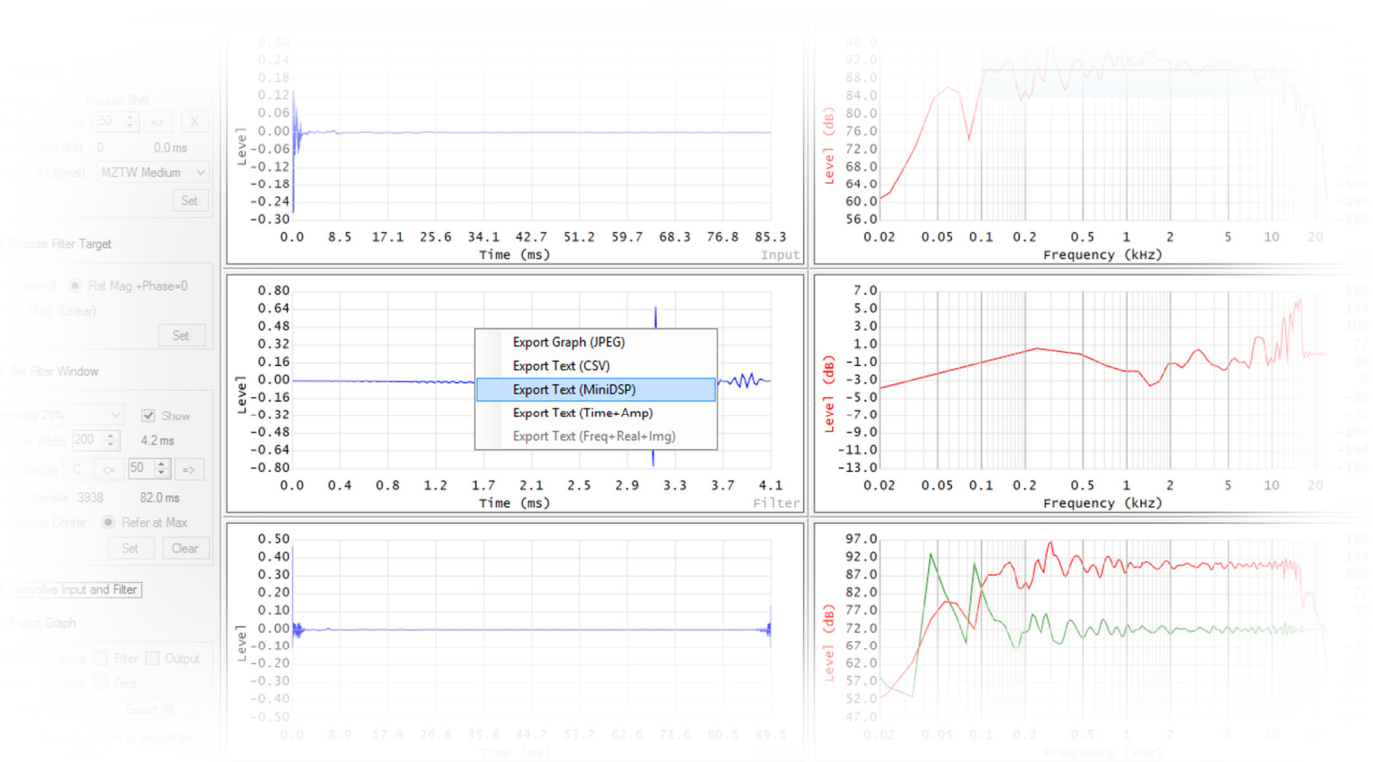
```
#
# Measurement exported using HOLM Acoustics
software
# http://www.holmacoustics.com
#
# Note: Unnamed-0
# Number of samples: 16384
# First sample number in file: -8193
# Last sample number in file: 8191
# Samplerate: 48000
#
#
## sample; Amplitude
-8193;0
-8192;0
-8191;0
-8190;1.4602345869e-007
-8189;-2.73310834602e-007
-8188;3.75723148163e-007
-8187;-2.00377491522e-007
-8186;6.96526195308e-008
-8185;-2.26586327537e-007
-8184;2.88144984314e-007
```



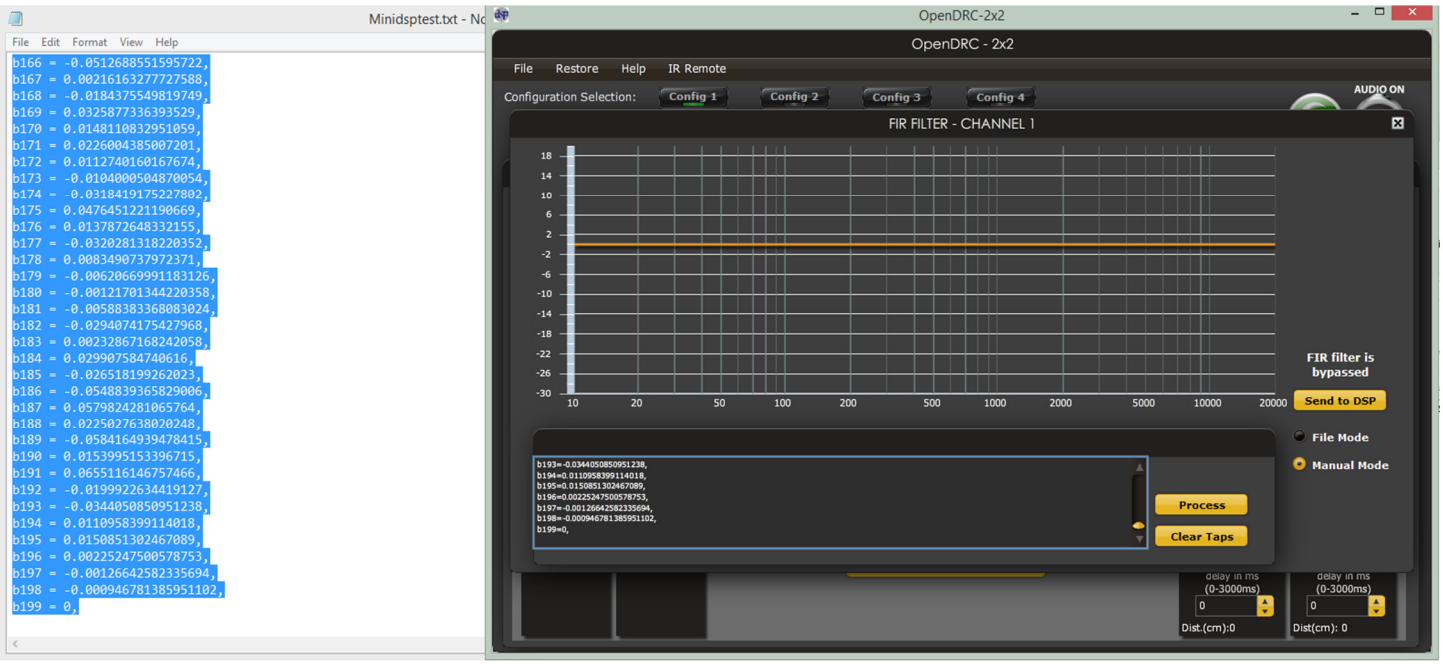
Export to MiniDSP

Filter Hose is able to export coefficient to MiniDSP OpenDRC plugin.

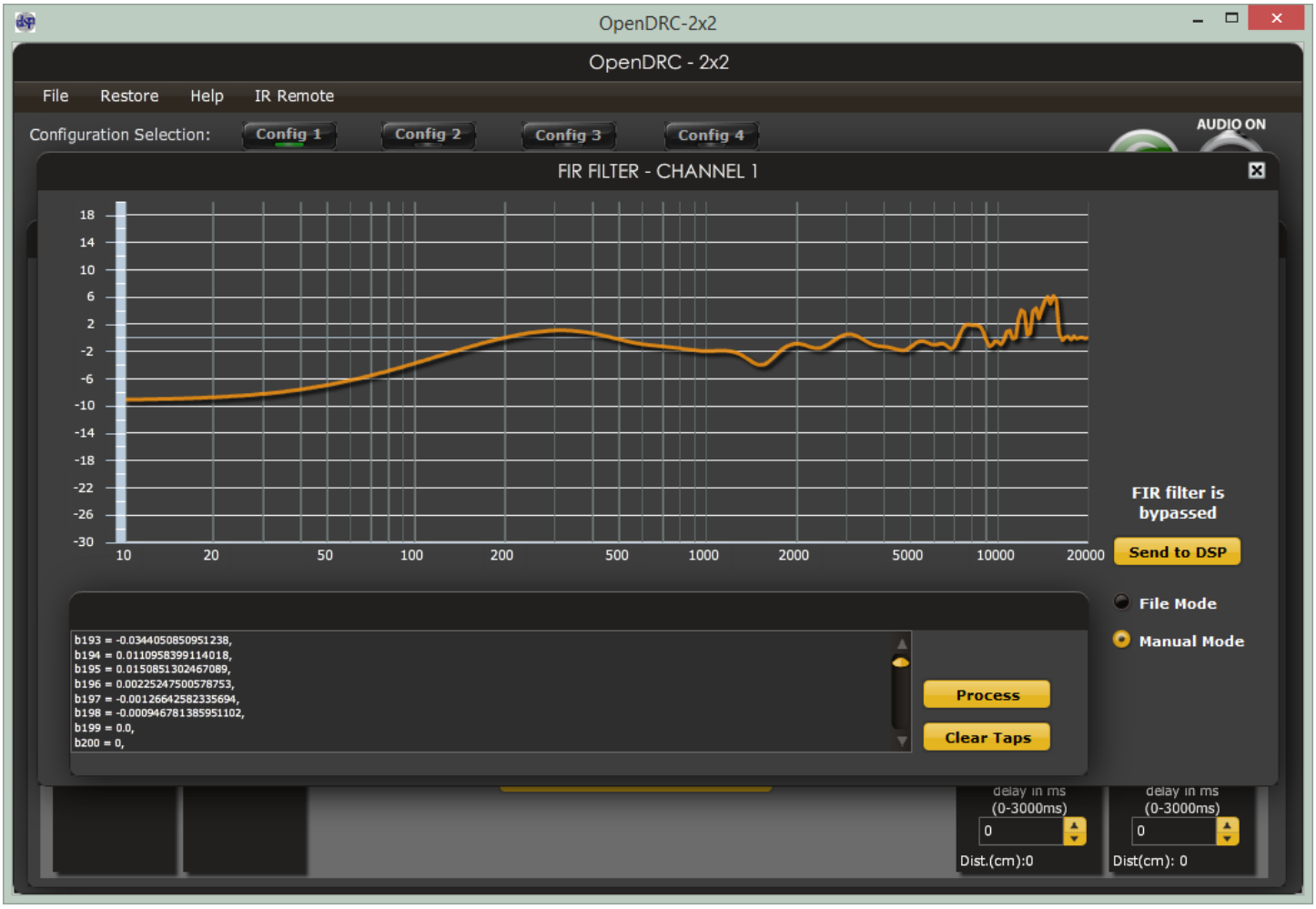
Right-click on the time-domain filter graph and select **Export Text (MiniDSP)**.



Open the text file in Notepad; copy all text to MiniDSP input. Please make sure that MiniDSP is in manual mode and its previous filter taps are cleared (click **Clear Taps** button).



Click **Process** and **Send to DSP**.



Importing a Filter Transfer Function

General Information

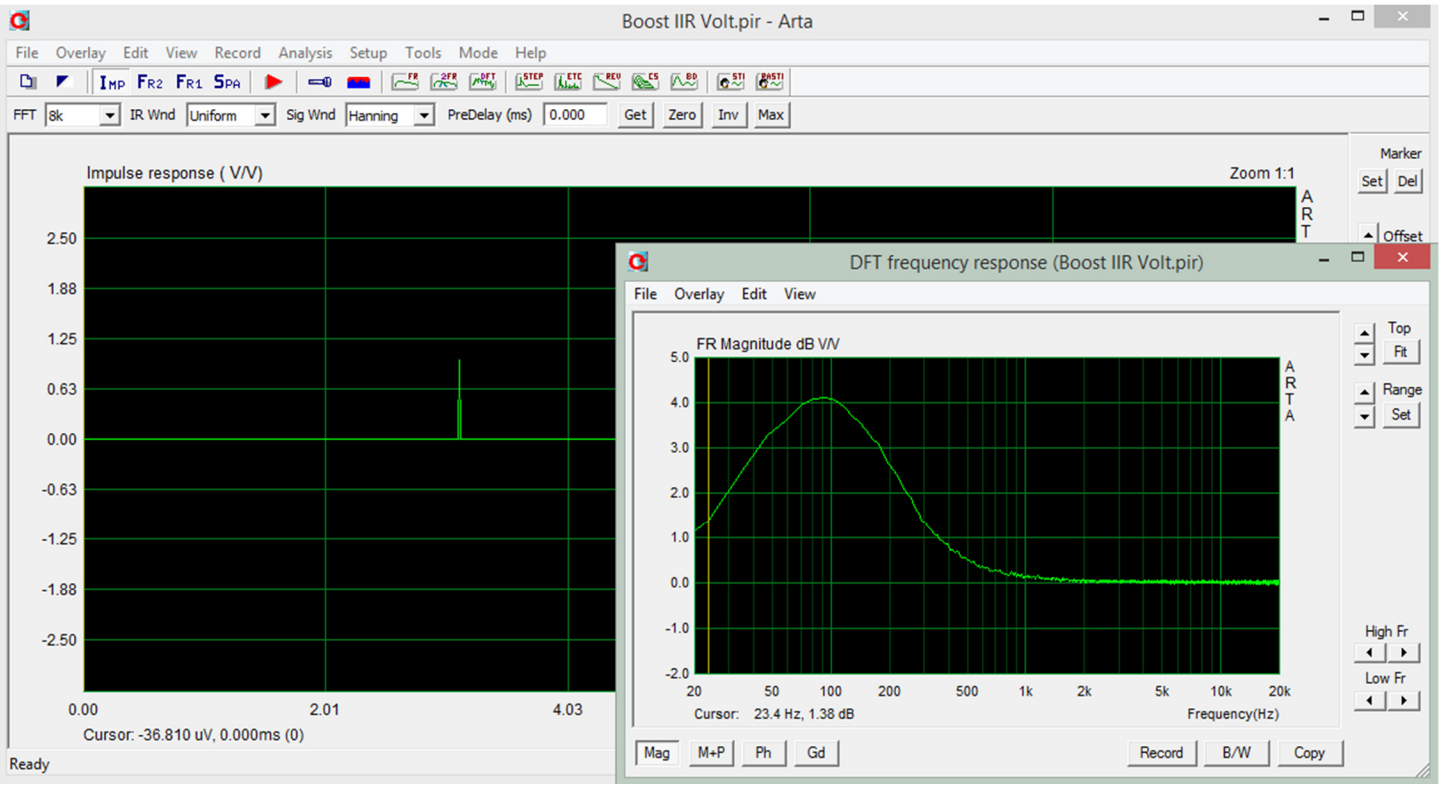
In Filter Hose v1.2 and higher, it is possible to import a .csv file in step one or step two. Step one will import .csv file and will extend the length to the next 2^n value or more. Sample rate will be asked when a .csv file is loaded. Step two will import .csv as is, assuming the sample rate matches the loaded measurement (step one).

In version 1.3 and newer, manual frequency domain data input is introduced. User is able to use this function to perform the above procedure using frequency domain data.

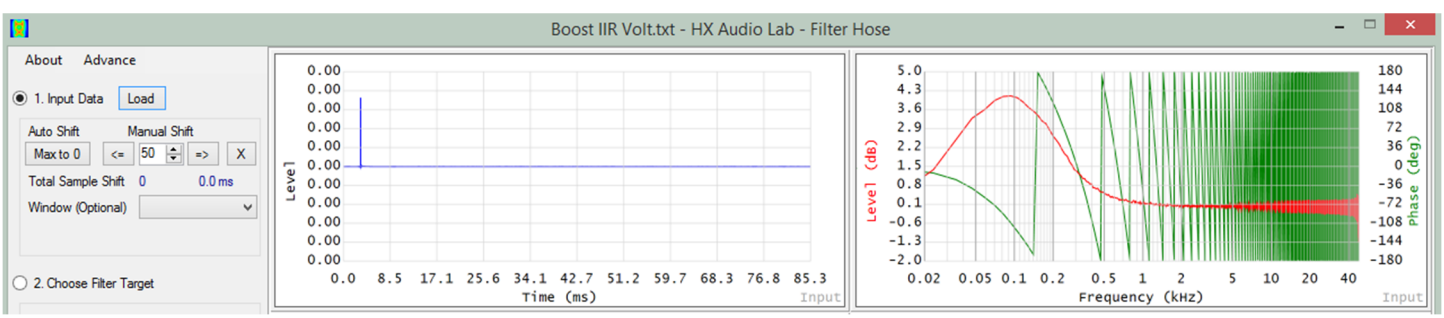
Loading a Filter Transfer Function Measurement

To load a filter transfer function measurement to Filter Hose, it is recommended to use a time domain data. Please follow the example below.

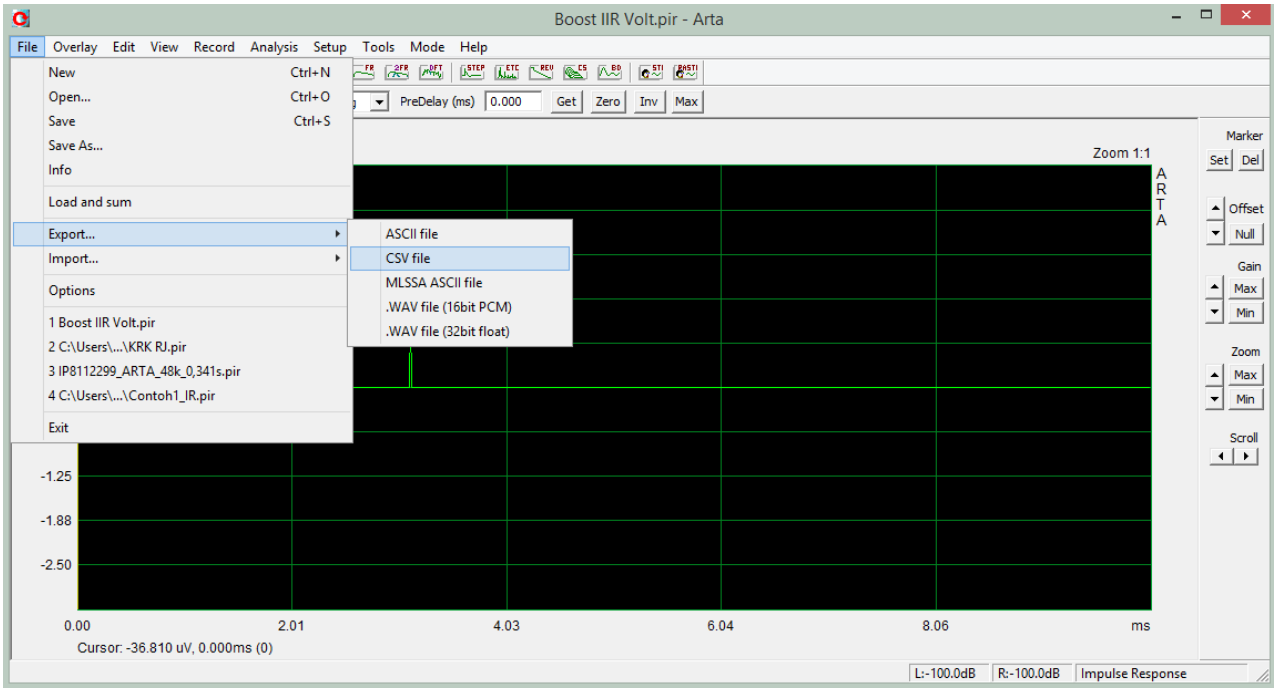
1. ARTA is used to measure a transfer function of a digital loudspeaker management system. The transfer function contains only low frequency boost centered at 90Hz as shown below.



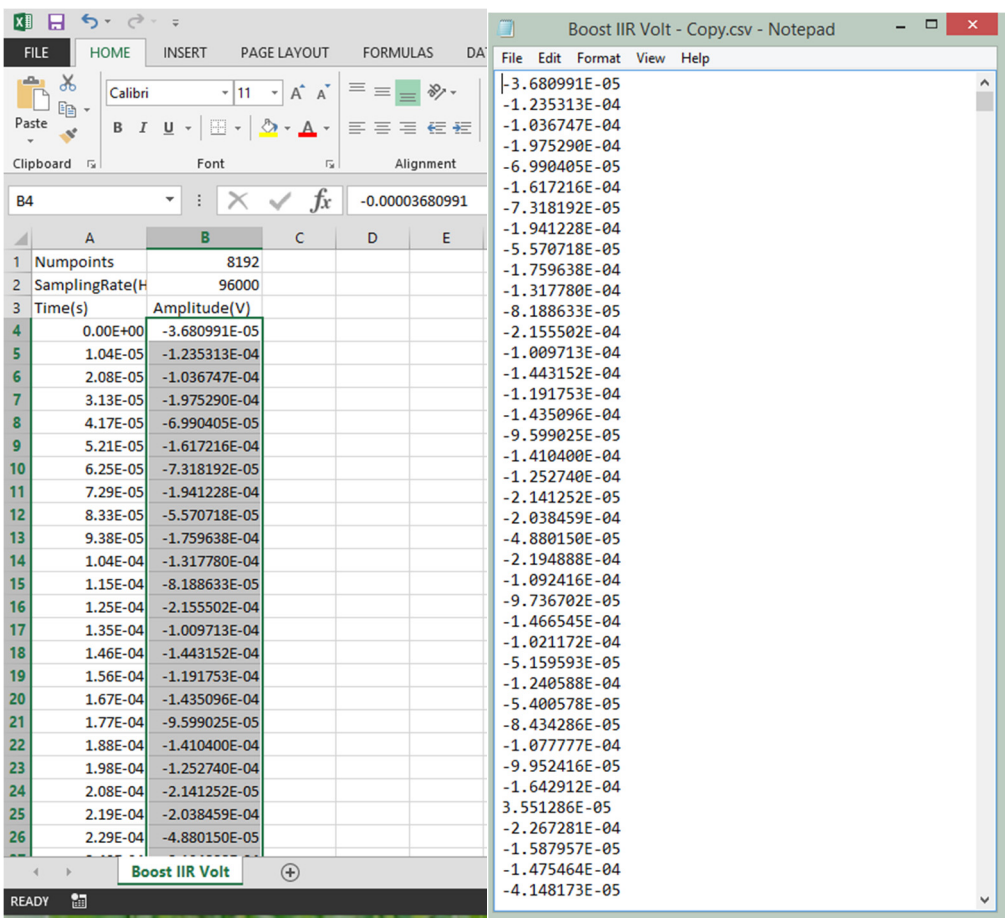
2. When the filter is exported from ARTA, the ARTA .txt file contains frequency domain data. If it is loaded to Filter Hose under ARTA (.txt), it will result incorrect time domain data. Note the Y-axis is all 0.



3. To do this correctly, it is recommended to export the time domain data from ARTA as shown below.



4. Open the exported ARTA .csv file (time domain) and select the amplitude column only. Copy paste the value to a new .txt file (such as using NotePad) and then rename the .txt to .csv as shown below. Note: .csv is basically a .txt file format.



5. Use Load Filter (.csv) option from Filter Hose to open the filter, choose the appropriate sample rate and desired extended N. The graph below matches the graph shown under step 1 of this tutorial.