Tonochi's Audio Room – Supplemental Info

How to Use REW

2020/04/16

How to Use Room EQ Wizard

The free PC app "Room EQ Wizard (REW)" is almost an essential tool for acoustic measurement. It makes the measurement easier, which is actually complicated. Especially, the quasi-anechoic measurement feature is very useful. You can get data just like measured in an anechoic chamber by using the feature. It helps you to know real characteristics of loudspeakers.

REW is such a powerful tool, but I was confused about its operation when I began using it. The initial setup was difficult for me in particular. I'm not a specialist of REW, though, now I can use its basic features. I've decided to document usage of REW.

The version of REW here is V5.20, beta 40.

Initial Setup

It's necessary to set up the following items before use of REW.

- Selection of input/output device(s)
- Calibration of the microphone
- Calibration of SPL meter feature

Selection of Input/output Devices

Fig. 1 shows the measurement system.
It is supposed that the input device is a USB microphone, Dayton Audio UMM-6, and the output device is a USB DAC, KORG DS-DAC-10.

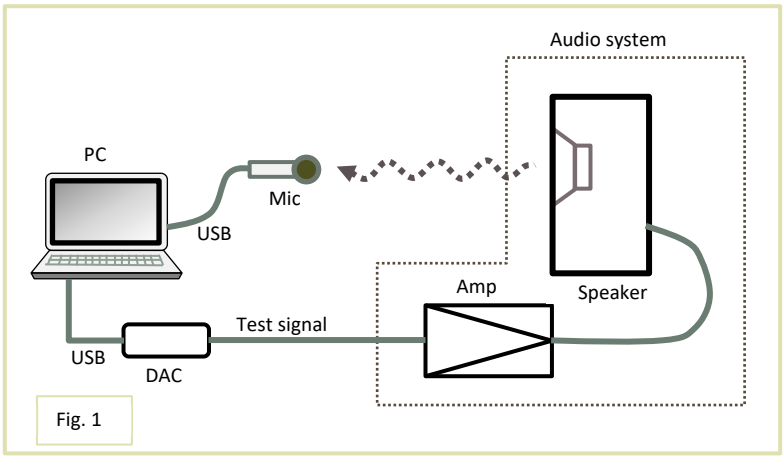

Fig. 1

Fig. 2 shows the [Preferences] dialog box where the input/output devices are set up. It is evoked by clicking [Preferences] icon on the main panel, which looks like a wrench.
Select [Soundcard] tab.
Select the driver in [Drivers] box. The options are Java and ASIO. In this case that the different devices are used for input and output, select Java. The actual devices are selected in Windows Setup. Select 'Default Device' in both [Output Device] box and [Input Device] box in this dialog. Select the sampling rate in [Sample Rate] box. The output device (DS-DAC-10) supports up to 192kHz, though, I selected 96kHz because it is enough to generate

signals up to 20kHz in very low distortion. The either channel can be chosen for the output. Set it to 'L' for the time being. The rest of the settings should be default.

There you see some calibration features like 'Soundcard calibration' and 'Levels'. They aren't applicable to my system, where the input device isn't included in Soundcard.

The actual device setting is made on [Settings] panel of Windows.
Select UMM-6 for the input device (Fig. 3).

Set the master volume to the maximum. Select UMM-6 and DS-DAC-10 for the input/output devices for REW, respectively (Fig. 4).

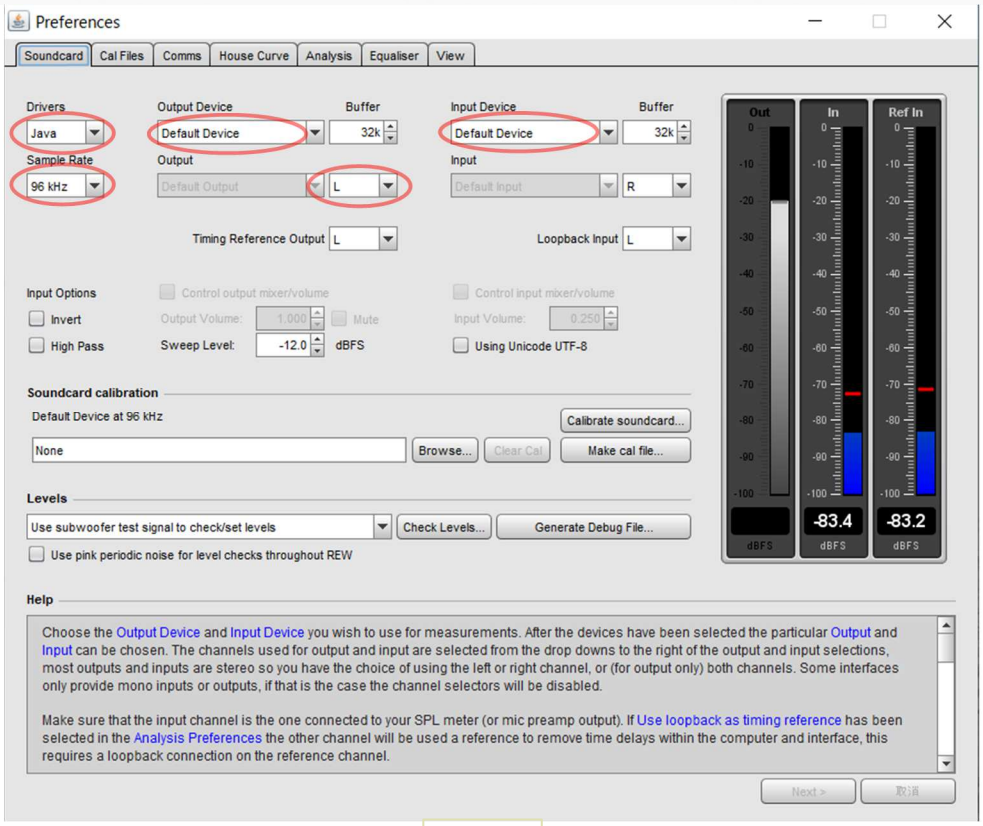

Fig. 2

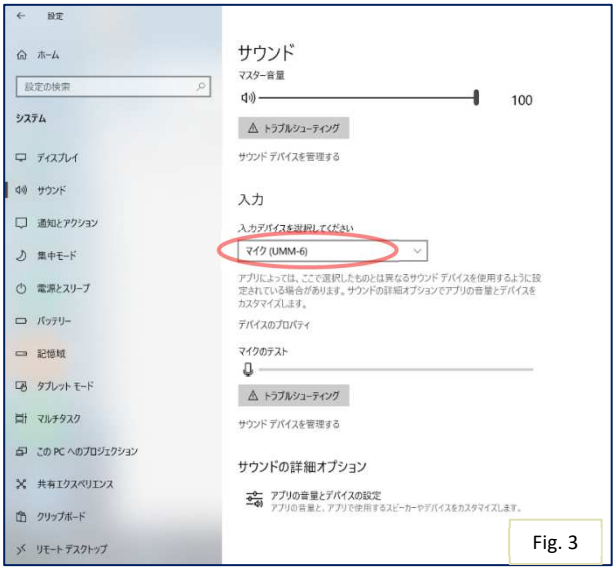

Fig. 3

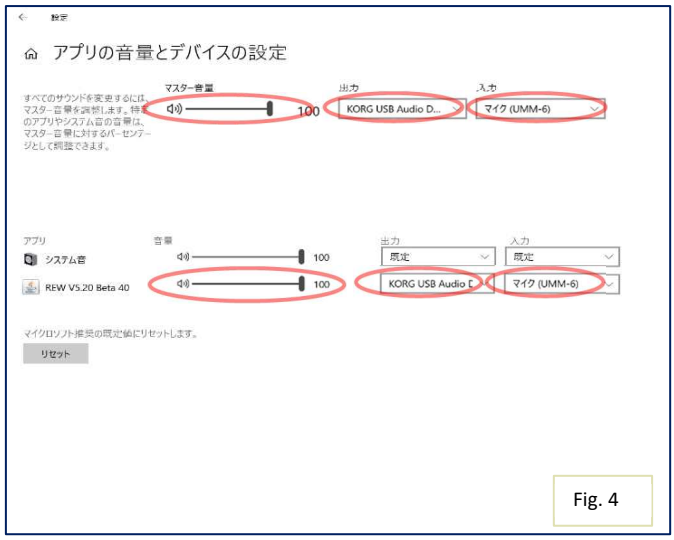

Fig. 4

Calibration of Microphone

Click [CalFiles] tab in [Preferences] dialog box. Set the calibration file of the microphone.
The characteristics of microphones are uneven, unlike pure electronic devices like USB DAC. The calibration of the mic is necessary.
Go to the website of the manufacturer (Dayton Audio), and download the calibration file. You need to type in the model number and serial number. Rename the file to your familiar name and save it to your familiar folder. Set the path to the file in [Mix cal files] box (Fig. 5).

Calibration of SPL Meter

[SPL Meter] is calibrated by using calibration signal and a real SPL meter (Phonic PAA3 for example).

Beforehand, place the mic and the real SPL meter at distance of 1m from the loudspeaker.

Click the icon of SPL Meter on the main panel of REW. The [SPL Meter] dialog box appears (Fig. 6). Click the [Calibrate] button. The [Choose Signal Source] dialog box (Fig. 7) pops up. Select [Use REW speaker cal signal] and click [OK] button. Test signal comes out of the loudspeaker, and [SPL Reading Calibration] dialog box is displayed (Fig. 8).

Adjust the volume of the amp so that the reading of the real SPL meter becomes about 80dB. Type in the reading in the dialog box and click [Finished] button.

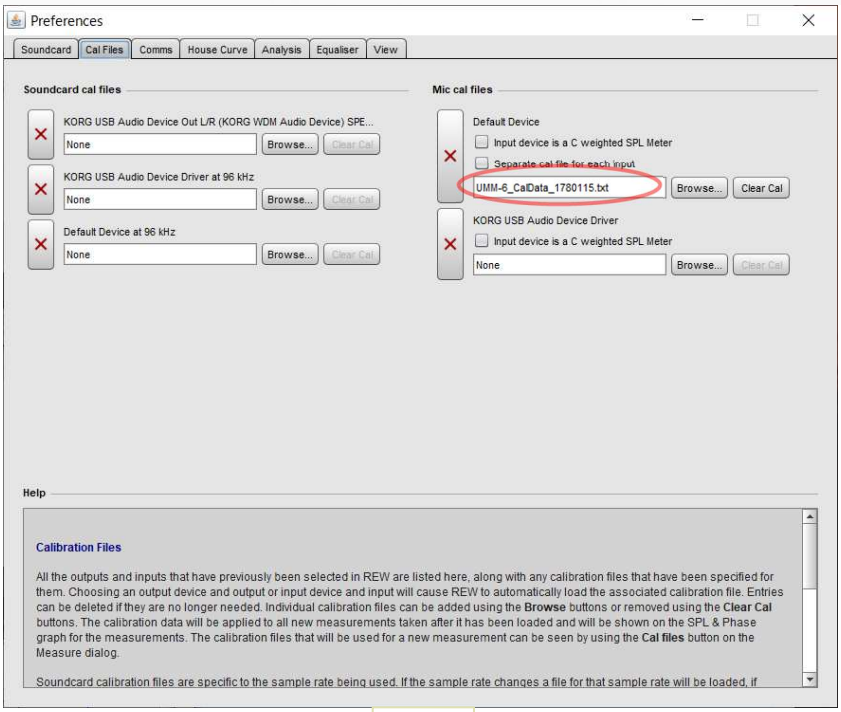

Fig. 5

This concludes all the initial settings.
The settings are saved automatically. You don't need the setup in future use.

Fig. 6

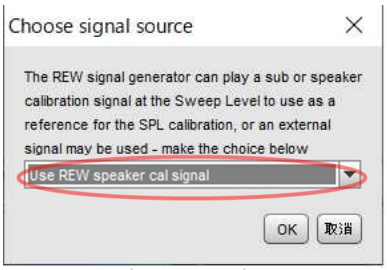

Fig. 7

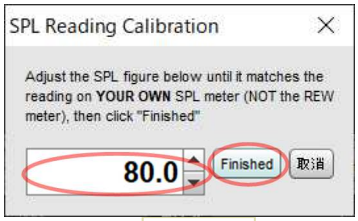

Fig. 8

Measurement of Frequency Response

The loudspeaker's particular frequency response can be measured in an ordinary room (not an anechoic chamber) by removing reflection components from the measurement data. This method is called 'quasi-anechoic measurement.'

REW offers this feature.

Preparation

Frequency response is measured in full audio band by sine wave sweeping. Actually, low-frequency and high-frequency bands are measured separately, and the full-range curve is given by merging the two data. The low-frequency band is measured in near-field and the high-frequency band is in far-field.

Calculation of the Merge Frequency

The merge frequency (f_m[Hz]) is calculated by the following equation:

$f_m = c / (2 \pi a)$

where c is sonic velocity and its value is supposed to be 345[m/sec], a[m] is the effective diaphragm radius of the loudspeaker unit (LS unit) under measurement. If the loudspeaker is multi-way speaker, a is the effective diaphragm radius of the woofer.

Position of Microphone

For the far-field measurement, the mic is placed 1[m] away from the LS unit, and it should be on the same axis as the LS unit. In case of the multi-way speaker, the mic is placed on the same axis as the tweeter.

For the near-field measurement, the distance between the mic and the LS unit (d[cm]) is calculated by the following equation:

$d = 0.11 \times a$

where a[cm] is the effective diaphragm radius of the LS unit (for multi-way speaker, the effective diaphragm radius of the woofer).

Near-field Measurement

Placement of Microphone

Place the mic at d[cm] away from the LS unit (or woofer).

Settings of REW

Click [Measure] icon on the main panel of REW. [Make a measurement] dialog box appears (Fig. 9).

Type the name of the measurement in [Name] box so that you can tell which data it is later. The name should include near-field (or NF).

Set [Range] to 20Hz (Start Freq) to 20kHz (End Freq).
The default value of [Length] is 128k, but it should be 512k for higher accuracy.

The rest of the settings should be the default values.

Click [Check levels] button, then the test signal is generated. If the SPL is too low or too high, an error message appears. Adjust the volume of the amp, and click [Check levels] button again. Repeat this till 'Level OK' is displayed.

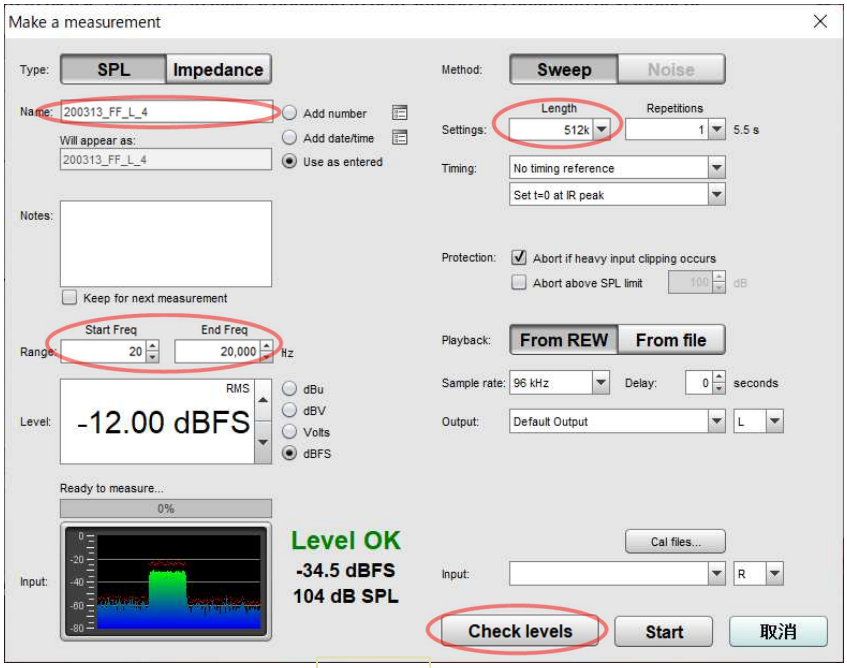

Fig. 9

Now it's ready for measurement.

Measurement

Click [Start] button. Wait till the measurement is completed staying away from the mic as possible.

Far-field Measurement

Placement of Microphone

Place the mic 1[m] away from the LS unit (or tweeter).

Settings of REW

Click [Measure] icon on the main panel of REW. [Make a measurement] dialog box appears (Fig. 9).

Type the name of the measurement in [Name] box so that you can tell which data it is later. The name should include far-field (or FF).

The rest of the settings are the same as the near-field measurement.

Click [Check levels] button. Adjust the volume of the amp as in the near-field measurement.

Measurement

Click [Start] button. Wait till the measurement is completed staying away from the mic as possible.

Removal of Reflections from the Room

Click [Impulse] button on the main panel (Fig. 10). The waveform of the impulse is displayed (Fig. 11). The waveform is resulted from inverse Fourier transform of the raw data.

Click [IR Windows] icon to open [IR Windows] dialog box (Fig. 12).

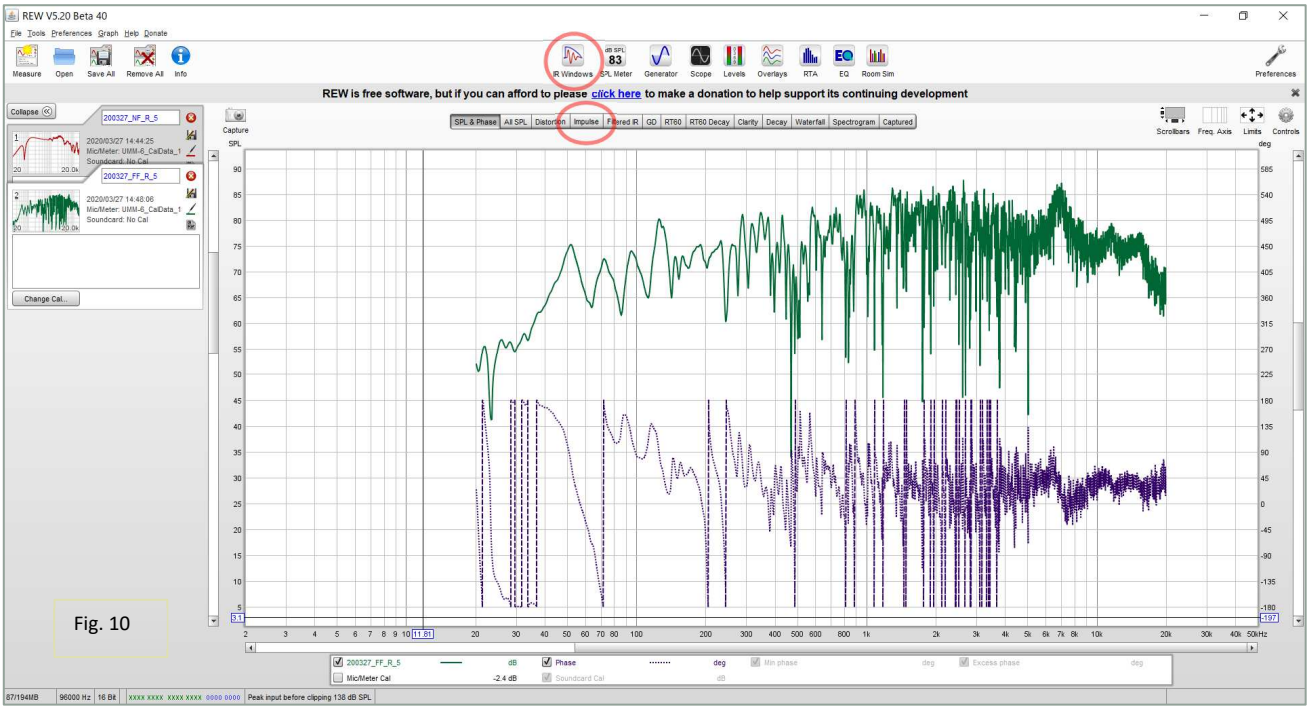

Fig. 10

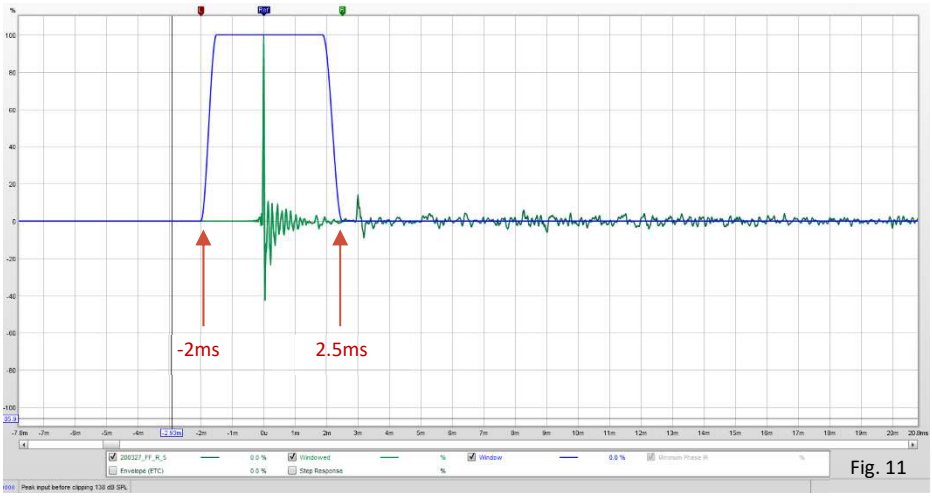

Fig. 11

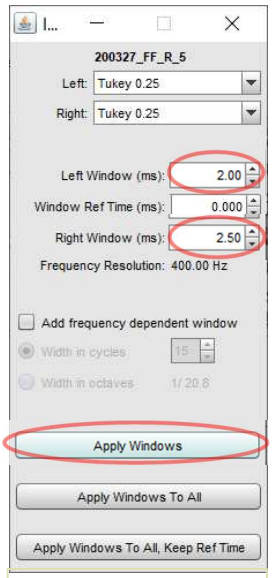

Fig. 12

Set [Left Window] box to 2.00ms. Look at the waveform of the impulse, and read the time at the end of ringing. In this example, it is 2.5ms. Type it in [Right Window] box.

Shortly after the end of the ringing, another wave comes. This is the reflection from the floor. If the reflections are outside the window, the reflections will be removed from the measured data.

You can calculate the timing of the reflection too. As shown in Fig. 13, where the height of the mic and LS unit is 1m, the path of the reflection is 1.24m longer than that of the direct sound (1.24[m] = 1.12[m] + 1.12[m] – 1[m], and the length of the reflection path can be calculated by Pythagorean theorem or trigonometric function). Suppose the sonic velocity is 345m/sec, the reflection arrives at the mic about 3.6ms later than the direct sound.
You can use the calculated value, but I recommend the way reading it from the waveform, because the sonic velocity depends on temperature and barometric pressure. And, if a wall is nearer to the direct sound path than the floor, the reflection from it reaches the mic earlier.

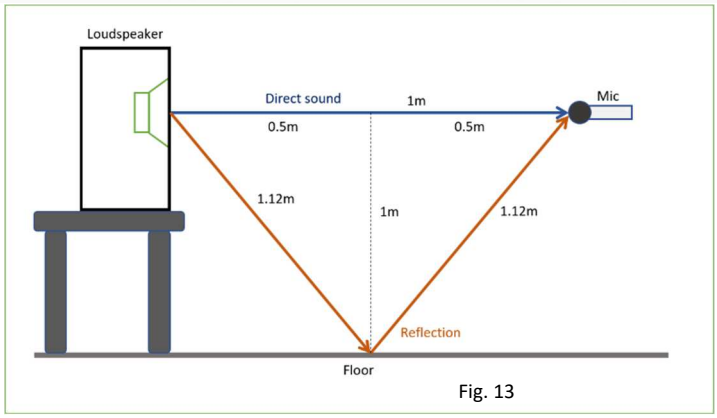

Fig. 13

After setting [Right Window] box, click [Apply Windows] button.

Merging Near-field and Far-field Measurements

Click [All SPL] button on the main panel, then [Controls] icon. The option menu is popped up. Click [Trace arithmetic] button (Fig. 14). [Trace arithmetic] dialog box is opened.

Fig. 14

Set up [Trace arithmetic] dialog box as follows (Fig. 15).

- A: The name of the far-field measurement
- B: The name of the near-field measurement
- Drop down list: Merge B to A
- At: The merge frequency (f_m) calculated above

Click [Generate] button.

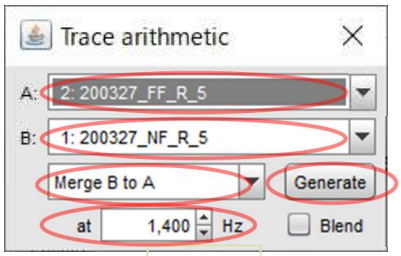

Fig. 15

Click [SPL & Phase] button. The frequency response curves are displayed. Select [1/24 Smoothing] in [Graph] menu (either 1/12 and 1/6 are OK according to your purpose).

Now the frequency response chart is completed (Fig. 16). The blue curve indicates SPL and brown one is phase.

Click [Save All] icon to save the data.

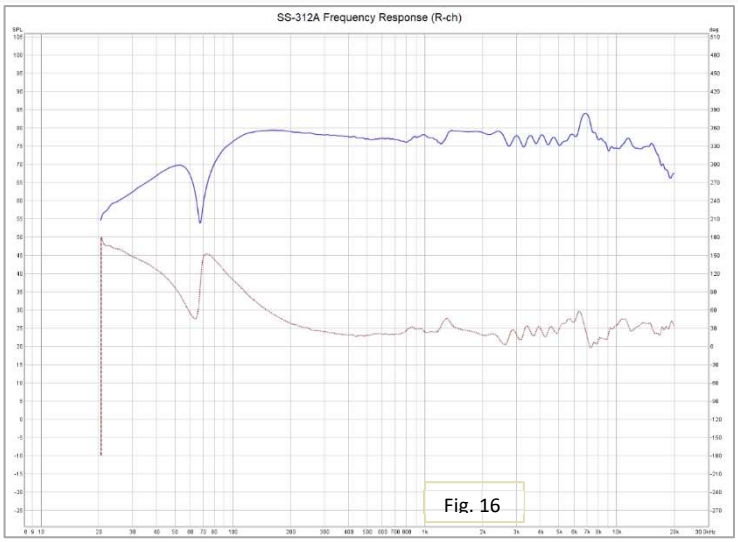

Fig. 16

Waterfall Chart

The total acoustic characteristics including the room acoustics is shown in a 3D chart.

Preparation

Place the loudspeakers according to the system design, and the microphone at the listening position.

Measurement by Using Sine Wave Sweep

Make measurement in the same method as the previous measurement described in "Measurement of Frequency Response", except the removal of reflections and the near-field measurement.

Making the Waterfall Chart

Click [Waterfall] button on the main panel. The waterfall chart is displayed (Fig. 17).

I think the default settings are effective in most cases. But, in some cases, you should change them in the parameter window popped up by clicking [Controls] icon.

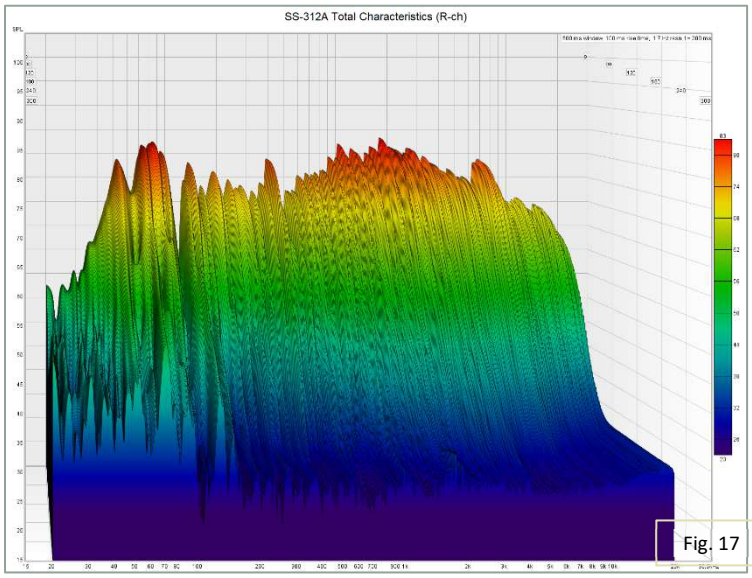

Fig. 17

Usage Note

REW has many bugs. It has been revised to fix bugs so often. You should use the latest revision.

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NOBODY Audio
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