DATS v3 on MacOS using REW

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Overview

DATS v3 uses a TPA61111A2 (headphone) amplifier to drive the speaker under test via a 10kΩ series resistor which acts as a current source when connected to a low impedance load (good for loads under ~100Ω)

I've tested on MacOS versions: Mojave with REW V5.20 beta 47, and MacOS Big Sur with REW V5.20 beta 61

-When connected to your Mac the DATS v3 will show up as a "USB audio device" or "USB Audio Codec" depending on your OS version

I have an early DATS v3 (which I preordered in 2019), I'm not sure if more recent HW will work in the same way

DATS v3 internals

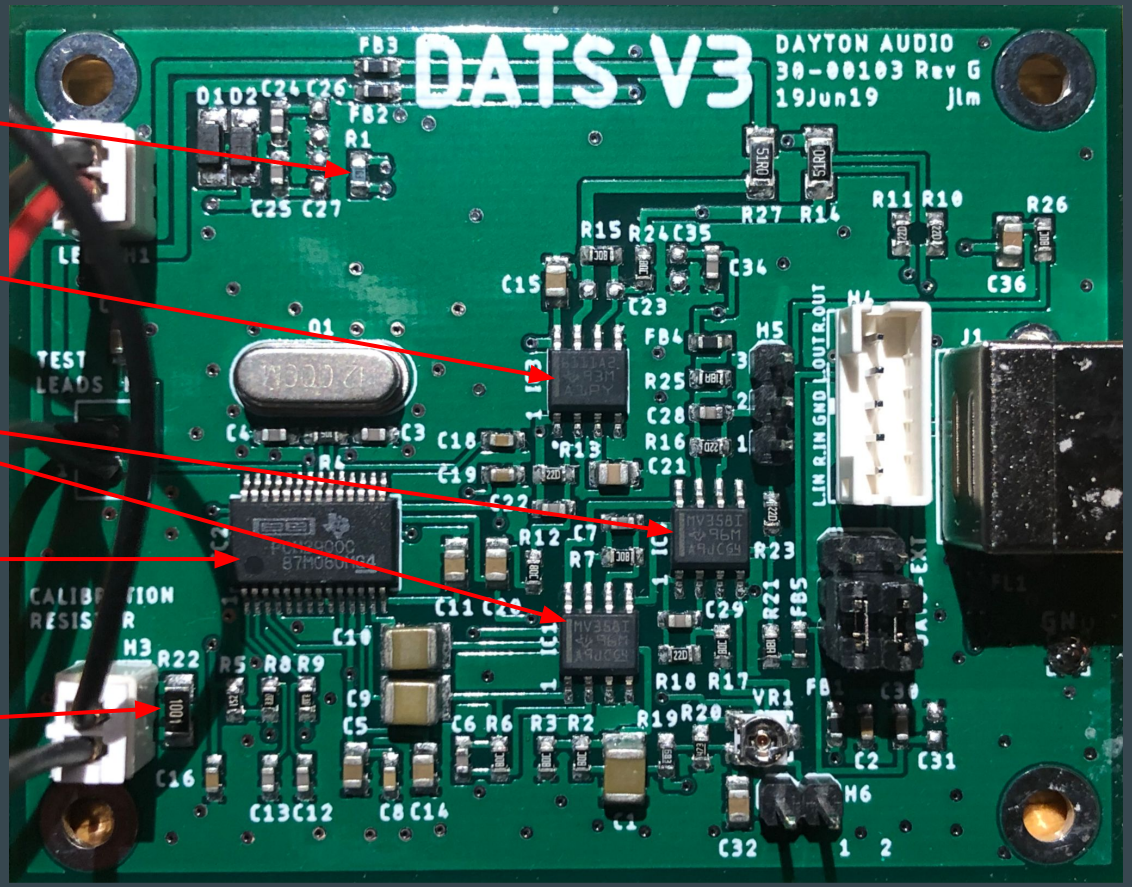
10kΩ series output resistor

TPA6111A2 150mW amp

2x LMV358 opamps

TI PCM2900 codec with USB

1kΩ precision calibration resistor

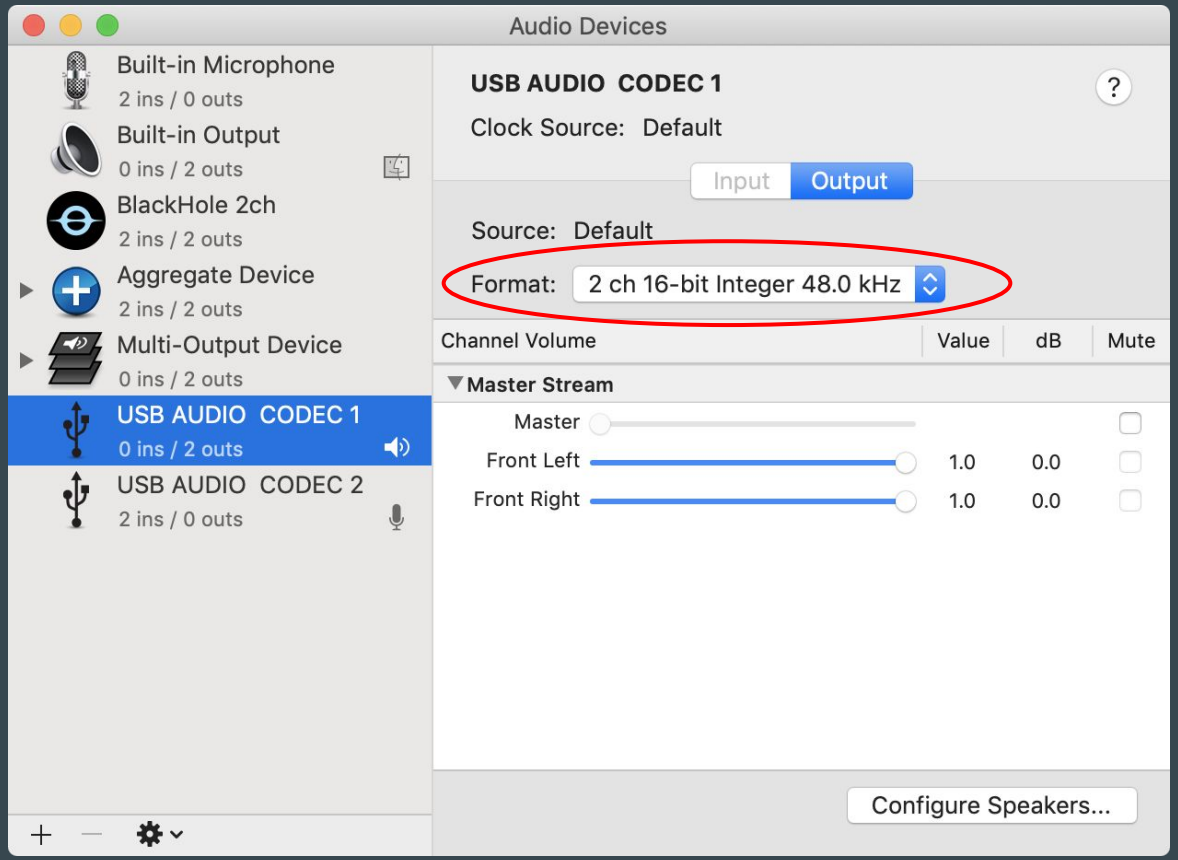


Connecting DATS v3

Using MacOS (I've tried Mojave and later) you won't need to install a driver. Using the 'Audio MIDI Setup' set the USB AUDIO CODEC 1 and 2 as your input and output devices.

If you're unsure or see different device names try plugging and unplugging the DATS v3, you'll see the named device appear and disappear off this list

Note the Format settings, make sure the sample rate and bit depth are both set to the same values. Later you'll check REW settings to make sure they all match

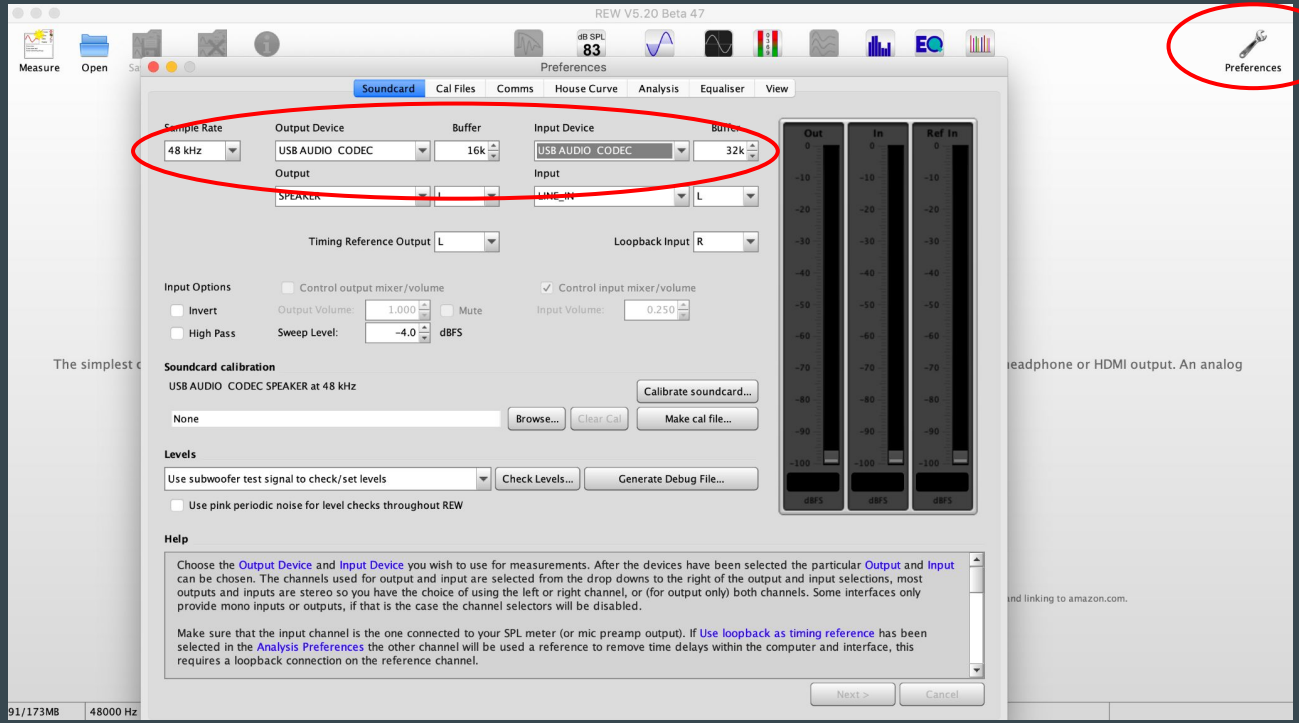


Open REW and set the preferences

In the Preferences menu select the USB AUDIO CODEC as your input and output devices.

I have trouble seeing the device if I connect DATS after starting REW.

Note the Format settings, make sure the sample rate and bit depth are both set to the same values. I've had issues running at sample rates other than 48kHz



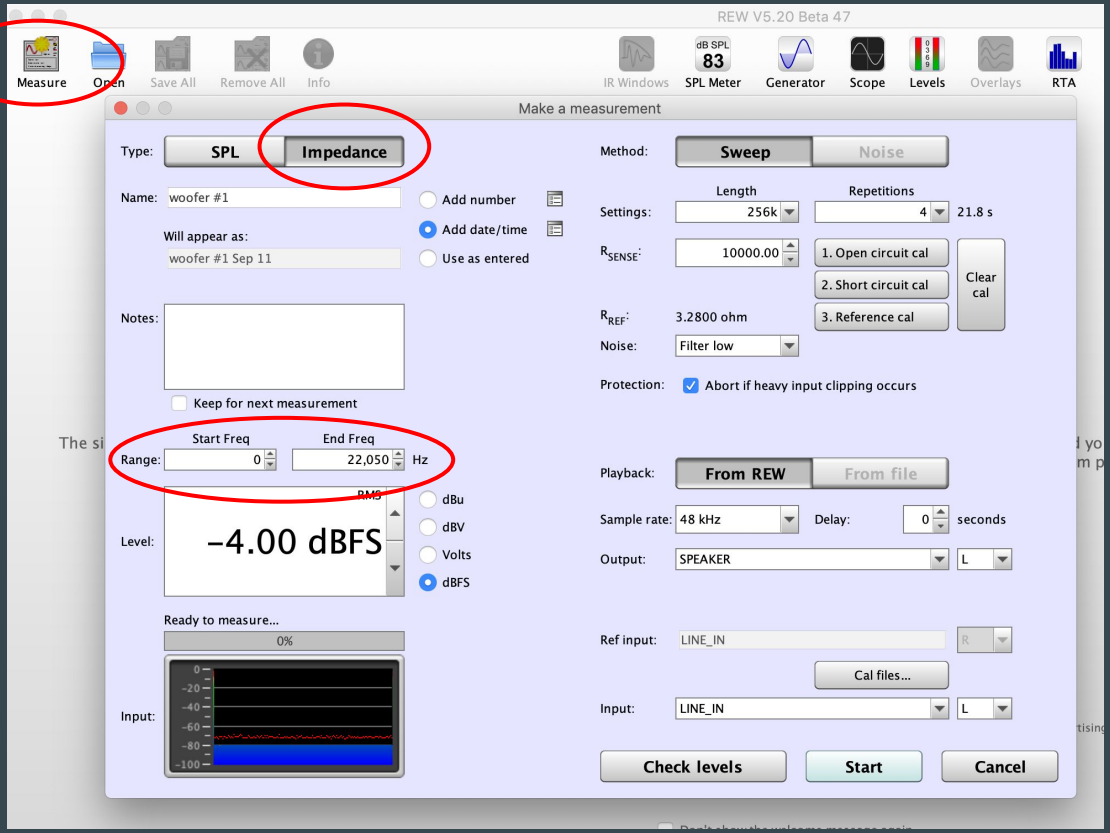
REW measurement settings

In the Preferences menu select the USB AUDIO CODEC as your input and output devices.

I have trouble seeing the device if I connect DATS after starting REW

Note the Format settings, make sure the sample rate and bit depth are both set to the same values. I've encountered issues running at sample rates other than 48kHz

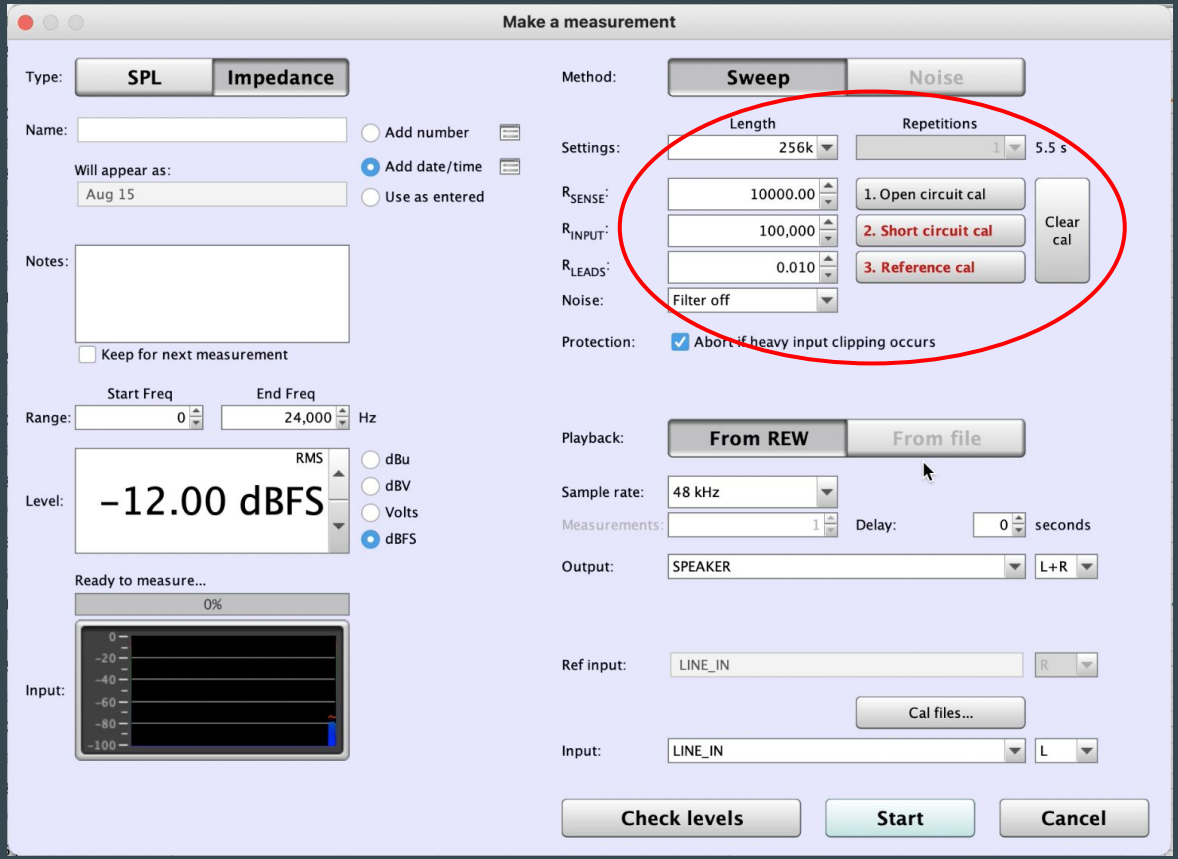
I also encounter issues when I don't begin the sweep at 0Hz



REW measurement settings

This screenshot shows the impedance calibration settings to use when first setting up REW to measure impedance using DATS v3. Enter 10kΩ for the Rsense value, 100kΩ for Rin and 10mΩ for Rleads.

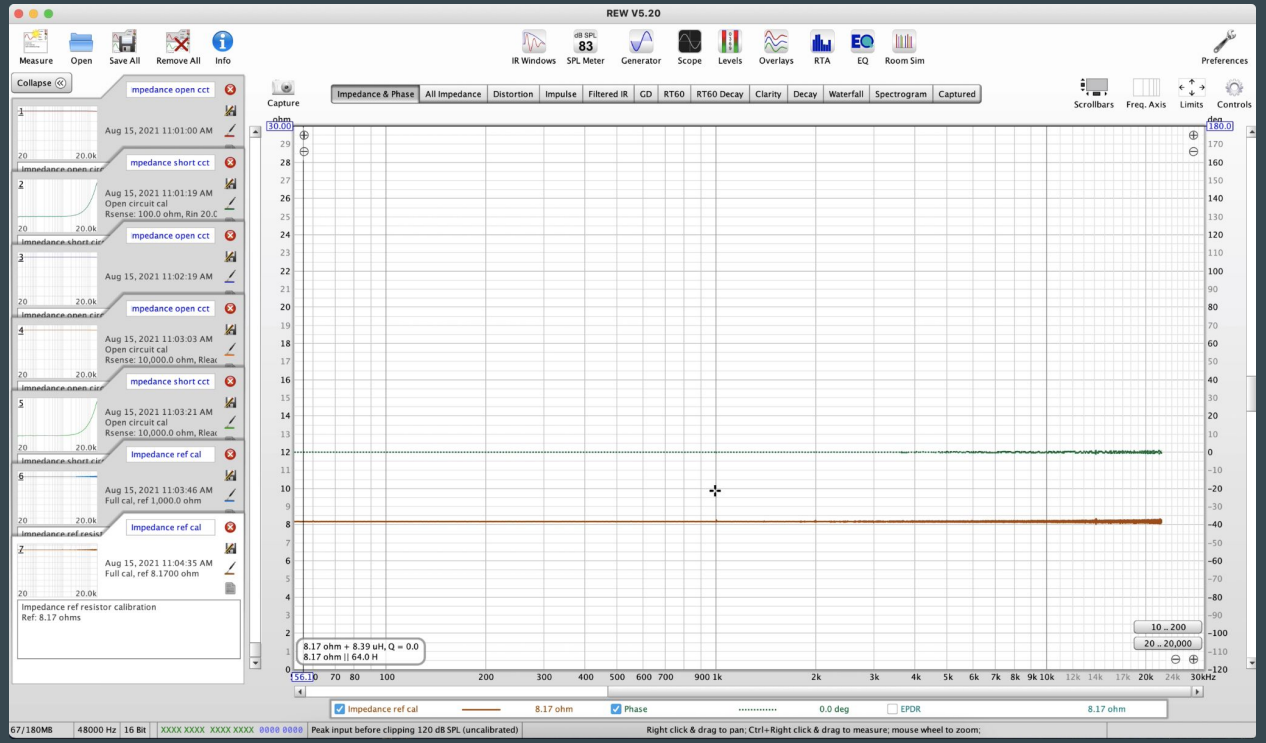
Click through the three impedance calibration steps, following the instructions. The DATSv3's built-in 1kΩ doesn't seem to work well for a reference cal value (it's too high a value compared to the 10k Rsense). I used an 8Ω resistor (actual 8.170Ω) that I measured using a 4-wire LCR meter. It's a good practice to calibrate using a value close to the DUT's expected value (or at least within an order of magnitude)



REW measurement settings

This screenshot shows the impedance measurement for a reference cal 8Ω resistor (actual 8.170Ω) that I previously measured on a 4-wire LCR meter.* For accurate results be sure to measure and calibrate at the system at a stable room temperature.

*The DER EE DE-5000 LCR meter is a low cost meter that performs 4-wire measurements with 4.5 digits of accuracy. It has a dedicated DCR mode.

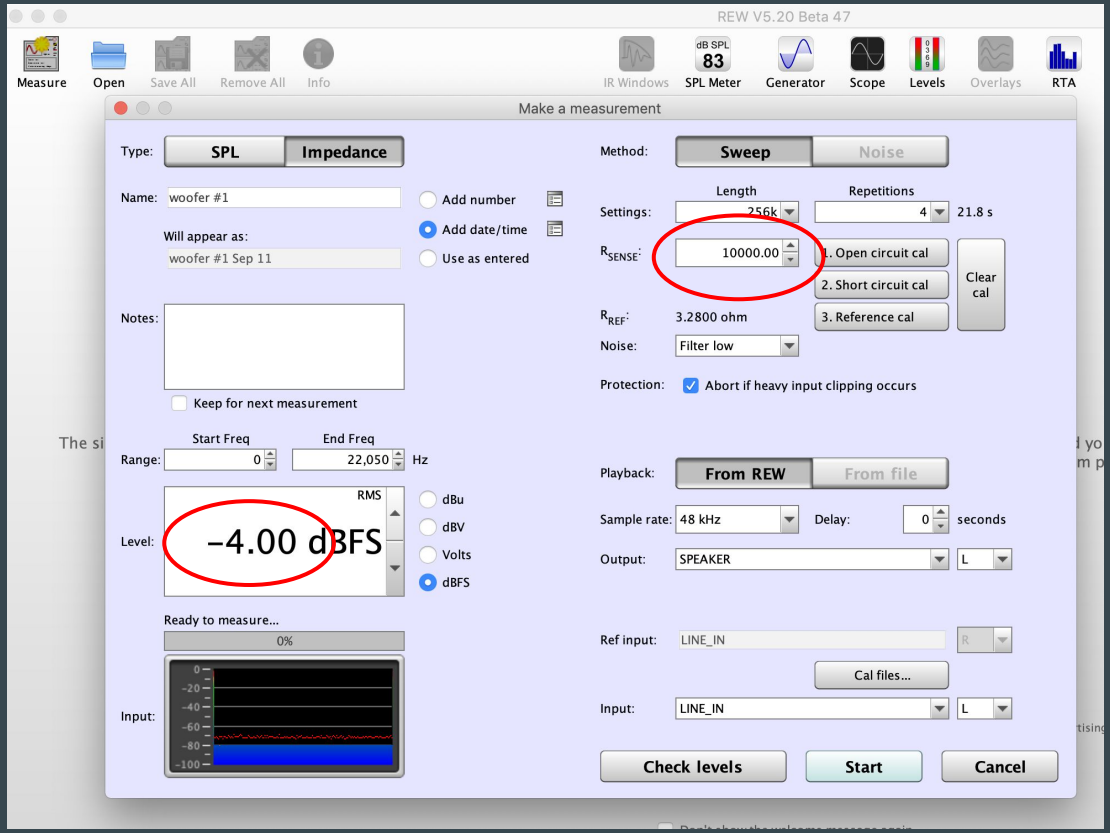


REW measurement settings

Set Rsense = 10kΩ (based on the value of output resistor R1, inside the DATSv3, see slide 3)

-4dBFS is the highest stimulus level I was able to run without clipping the measurement data, since the level changes with the load (device under test) impedance you may want

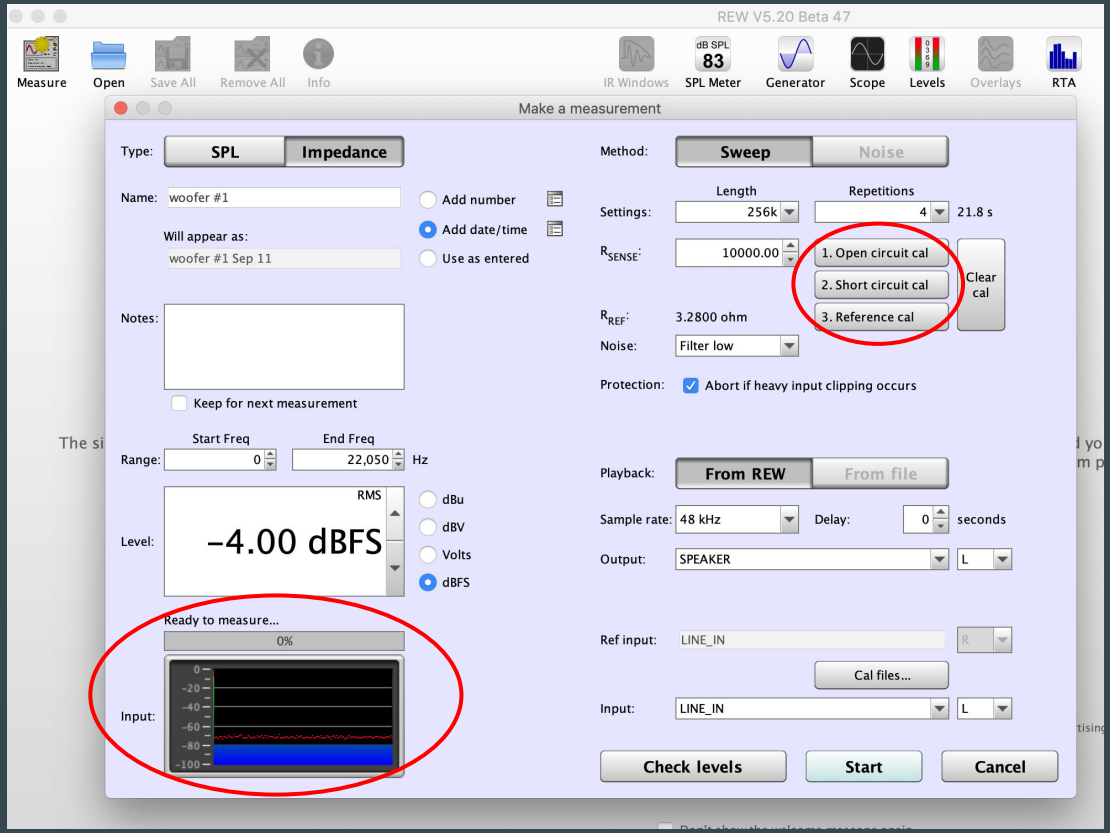
This handy window shows the real time input, it is especially handy to see if your signal is clipping



REW measurement settings

After getting the initial settings configured you'll need to click through the 3 calibration steps. On the 3rd step use a calibration reference resistor that is close in value to the lowest impedance you expect to measure (3.3 Ω is what I used, I measured the actual value [3.28Ω] on a 4-wire DMM to get at least 3 digits of accuracy)

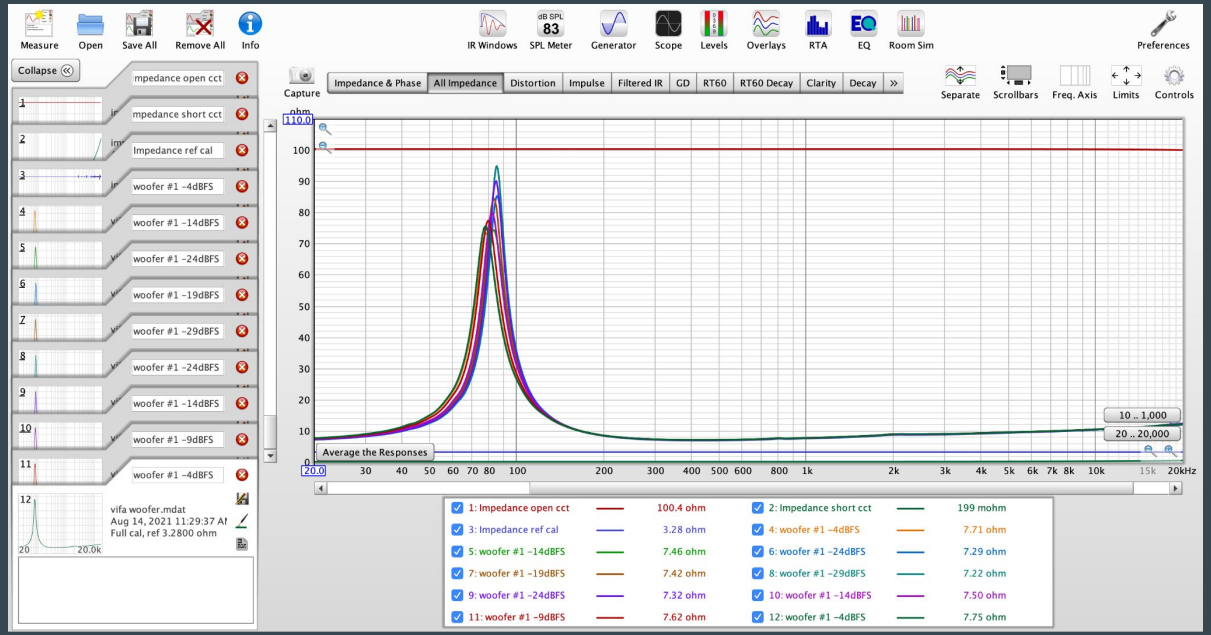
*You can see the input level in the plot window on the bottom corner After calibrating and connecting a speaker to the output you see the speaker converts acoustical signals to electrical. **For best results measure the speaker in a quiet place.** This window also shows how acoustical noise is reflected in the electrical measurement



REW impedance measurements

Unless I'm forgetting something you should be ready to measure your speaker's impedance by clicking the start button.
Here's an example of the data I collected by testing the short circuit, open circuit, a calibration resistor and a test speaker at various levels.

You can see the resonance frequency and Q change as the level changes, this is to be expected (due to the mechanical nature of the driver). A electrical test load (complex impedance) does not exhibit this difference.



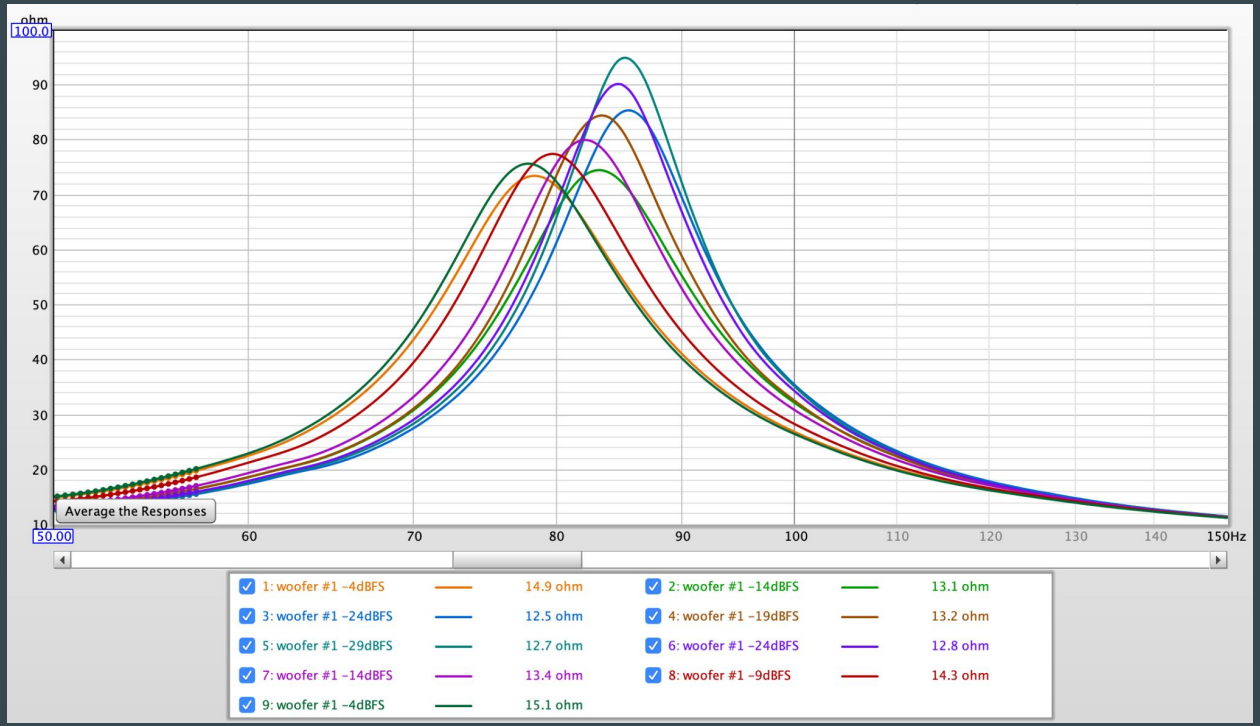
REW impedance measurements

Here's a zoomed-in view of the resonance frequency, showing 50Hz to 150Hz.

This driver's impedance peak gets close to reaching the 100Ω open circuit impedance limit, which may cause clipping or .

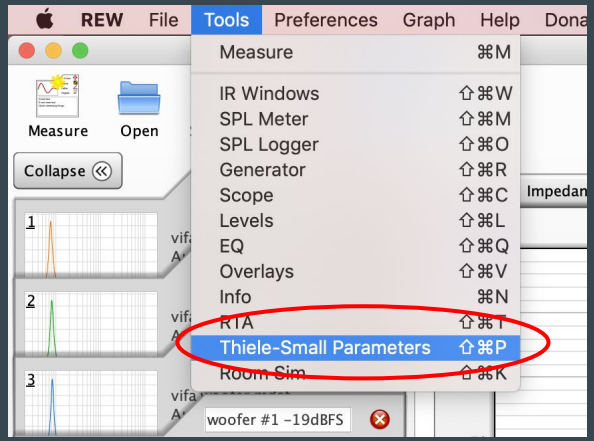
At low test levels noise becomes an issue, running multiple slower sweeps helps to average out random noise.

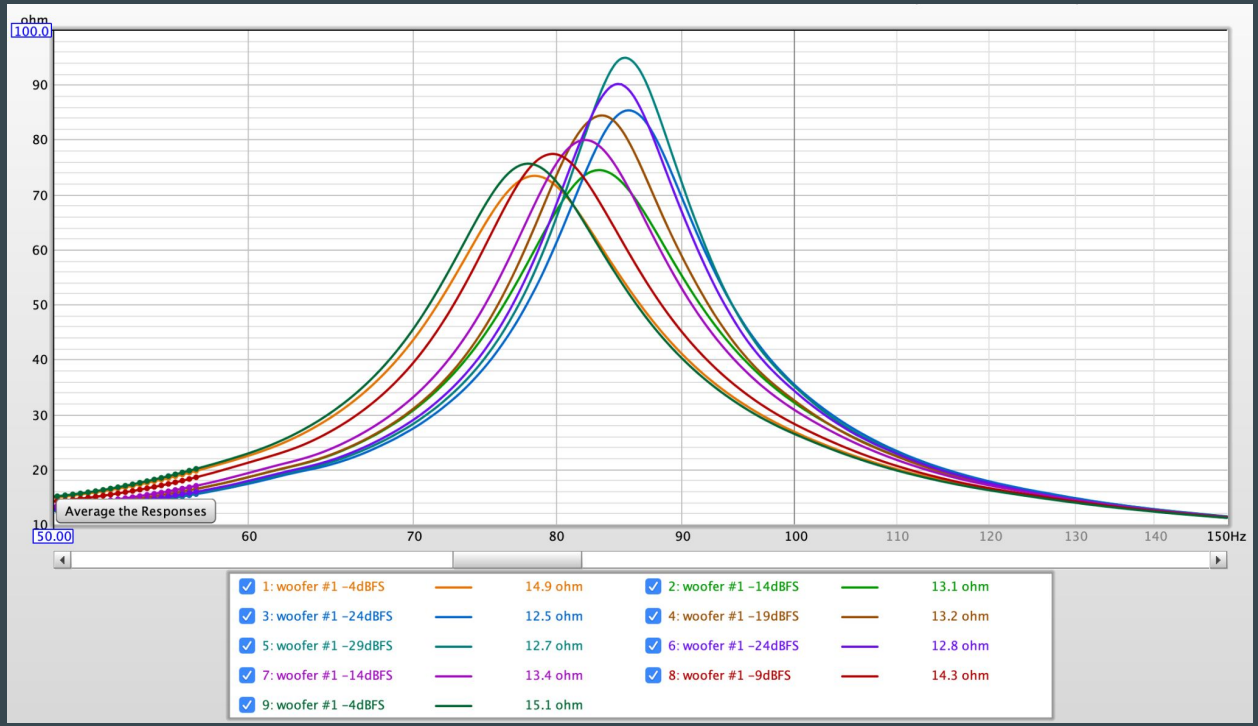
From a single impedance measurement you can pull out the Re, Fs, Qs



REW T/S Parameters

Now that the DATS v3 is setup you can use REW's excellent 'T/S Parameters tool' to calculate the driver's T/S parameters. The REW Help Index / Manual has a lot more great info

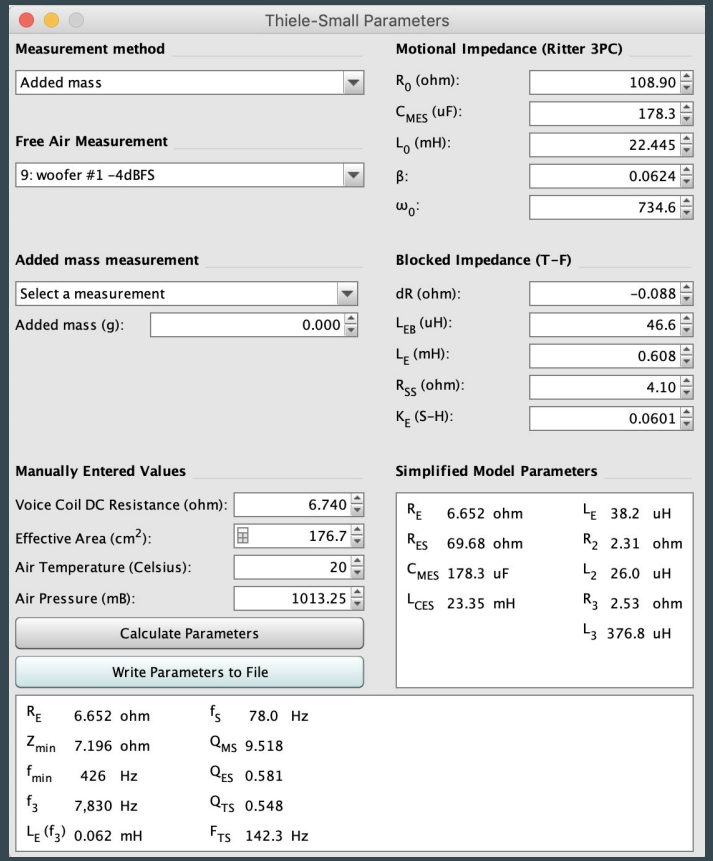




REW T/S Parameters

To calculate the T/S parameters you'll need to measure a driver in free-air then use the added mass or known volume sealed box method. You'll need to provide an accurate DC resistance (Re) for the DUT.

You can use the measured impedance at low frequency to estimate/determine the DCR of the driver. For lab-grade measurements a 4-wire DMM using continuous averaging provides sub mΩ accuracy (in a temperature controlled environment, a few degrees temp difference will cause DCR to change). This is not required for a hobbyist.

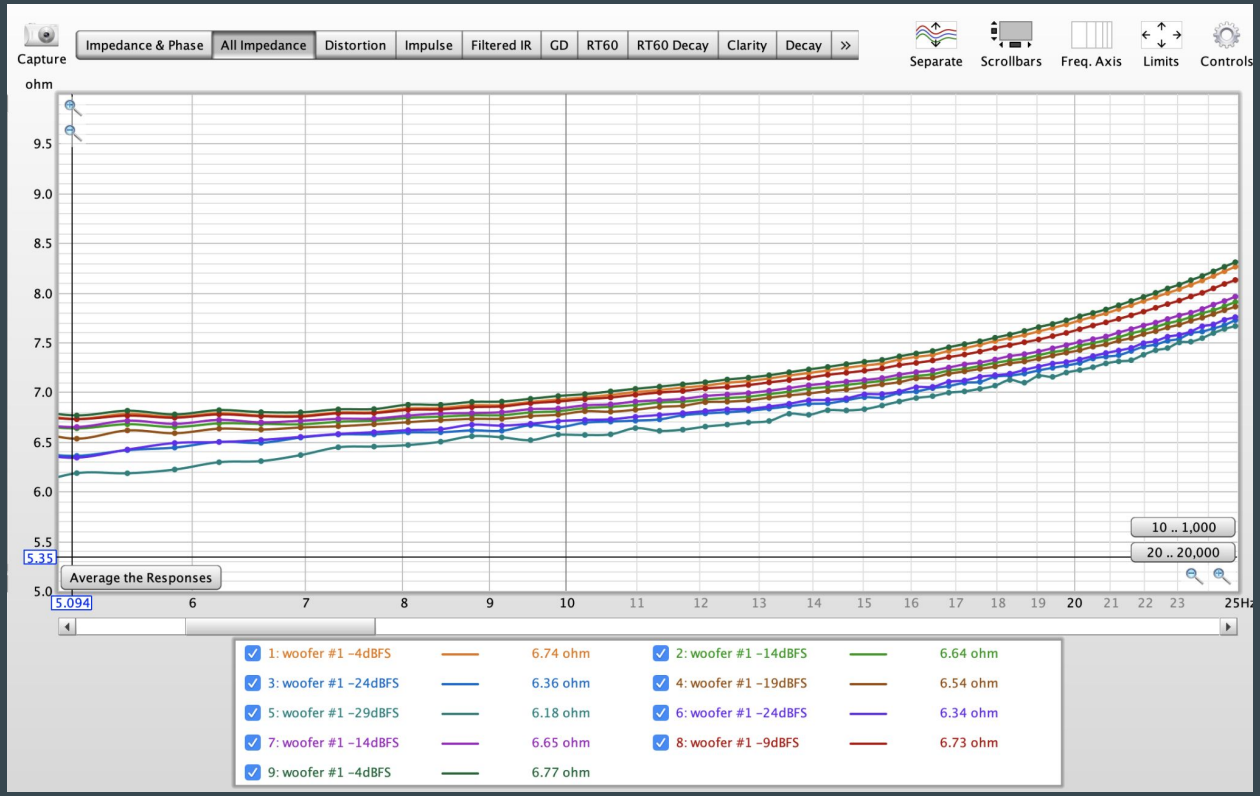


REW T/S Parameters - Determine Re/DCR

If you use the low frequency impedance as your Re value I recommend running several free-air impedance measurements and averaging over several measurements. If you see a lot of variation in the Re the signal level may be too low.

There is a lot of variation here because I used many different amplitudes. The lowest amplitude -29dBFS is too close to the noise floor and should be discarded

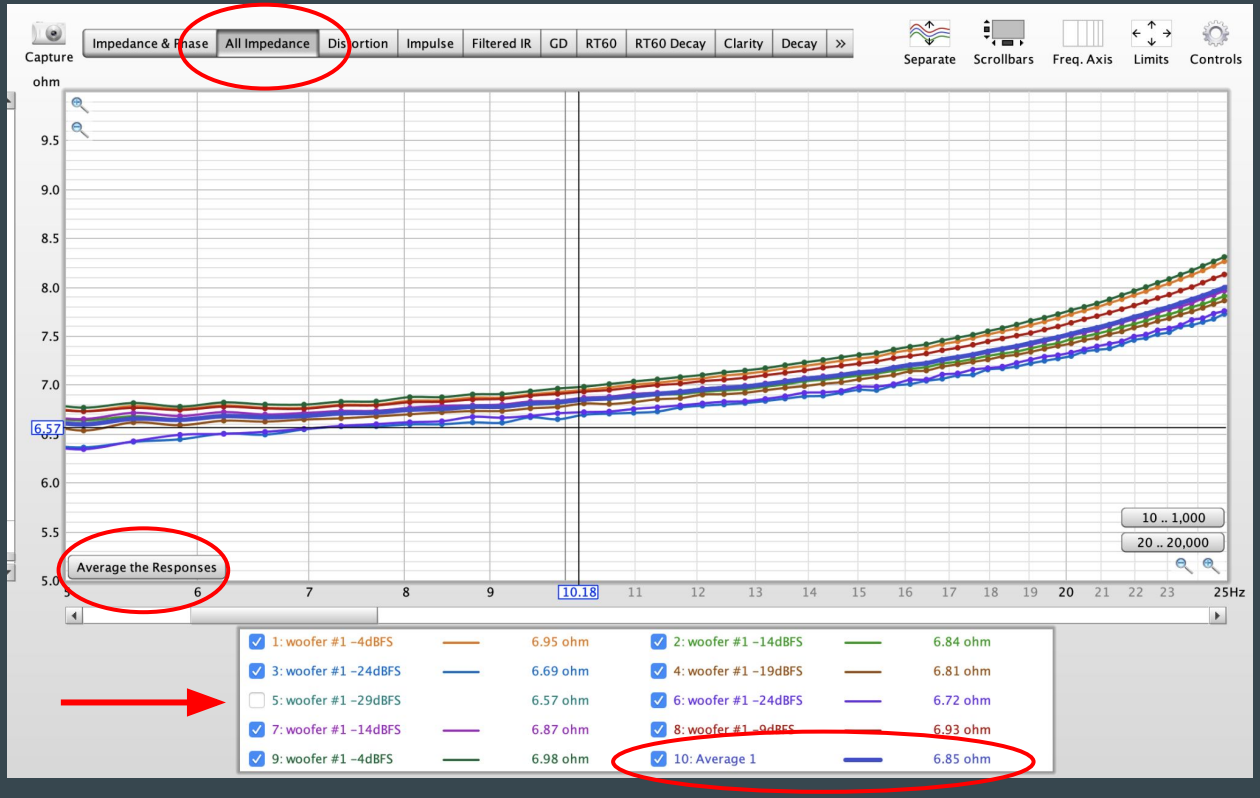
Important: The higher DCR measurements at higher amplitudes is most likely due to heating of the voice coil



REW T/S Parameters - Determine Re/DCR

After running several impedance measurements if you click on the ‘All Impedance’ tab you can see all of the plots/measurements. You can uncheck any outlier measurements, then click the ‘Average the Responses’ button which will calculates the average of the selected curves

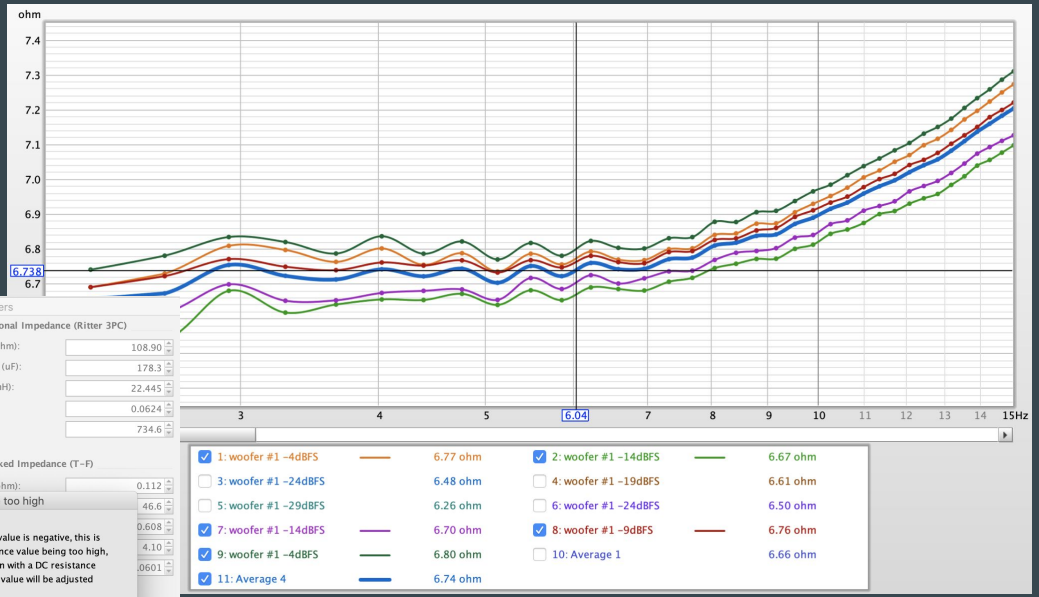
Note the x-axis scale is showing 5Hz to 25Hz

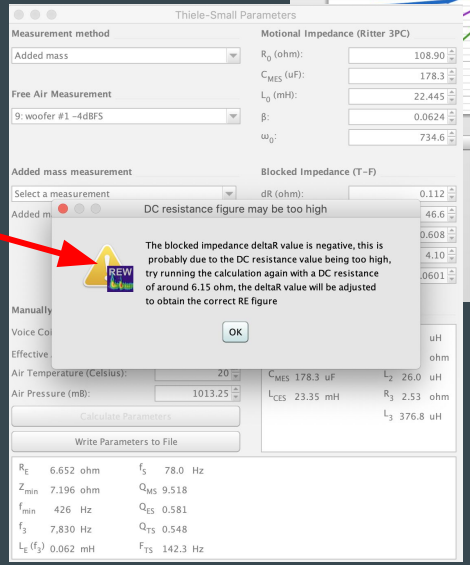


REW T/S Parameters - Determine Re/DCR

Zoomed view, showing the average. Despite the various test levels the spread across 5 measurements is only 0.15Ω (at 6Hz).

Using the average at 6Hz of 6.74Ω for the DCR/Re value will provide reasonable accuracy, but REW doesn't like it when it thinks the value is too high





REW T/S Parameters - Added Mass

For the added mass I use bluetack and form it into a ring that is placed at the edge of the dustcap (in an effort to evenly load close to the voice coil) a good target is to double the Mms (from the published parameters) to shift Fs enough to calculate a reasonably accurate Cms.

For more info on measuring the T/S parameters using REW consult the manual.