

DATS v3 on MacOS using REW

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Overview

DATS v3 uses a TPA6111A2 (headphone) amplifier to drive the speaker under test via a $10\text{k}\Omega$ series resistor which acts as a current source when connected to a low impedance load (good for loads under $\sim 100\Omega$)

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

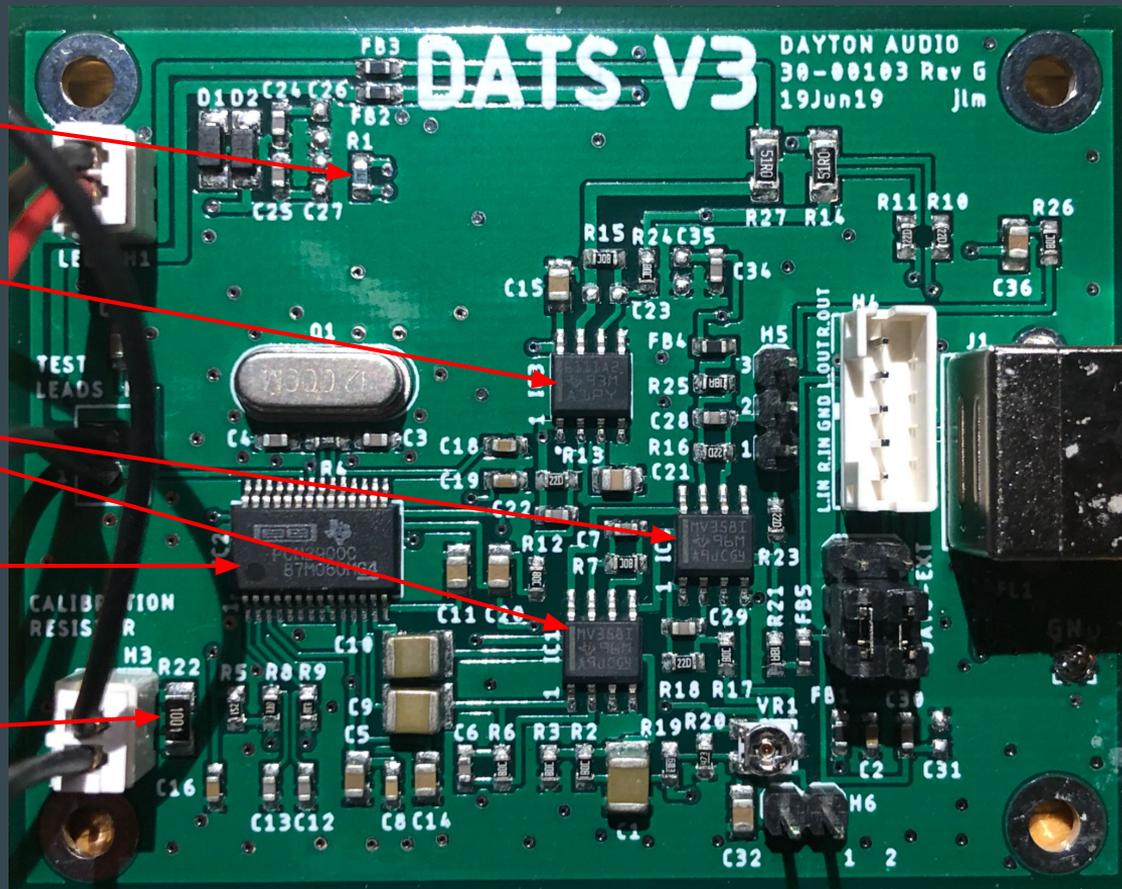
10k Ω series
output resistor

TPA6111A2
150mW amp

2x LMV358
opamps

TI PCM2900
codec with USB

1k Ω precision
calibration
resistor

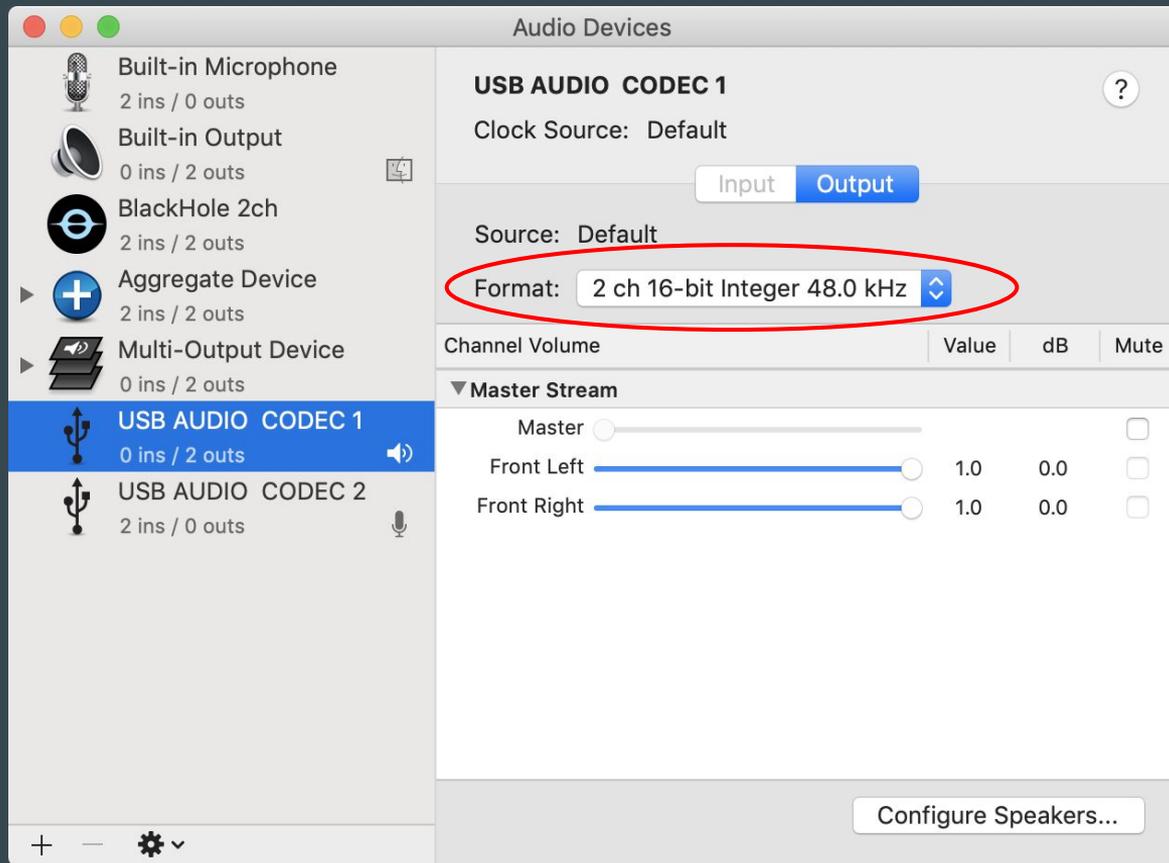


Connecting DATS v3

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

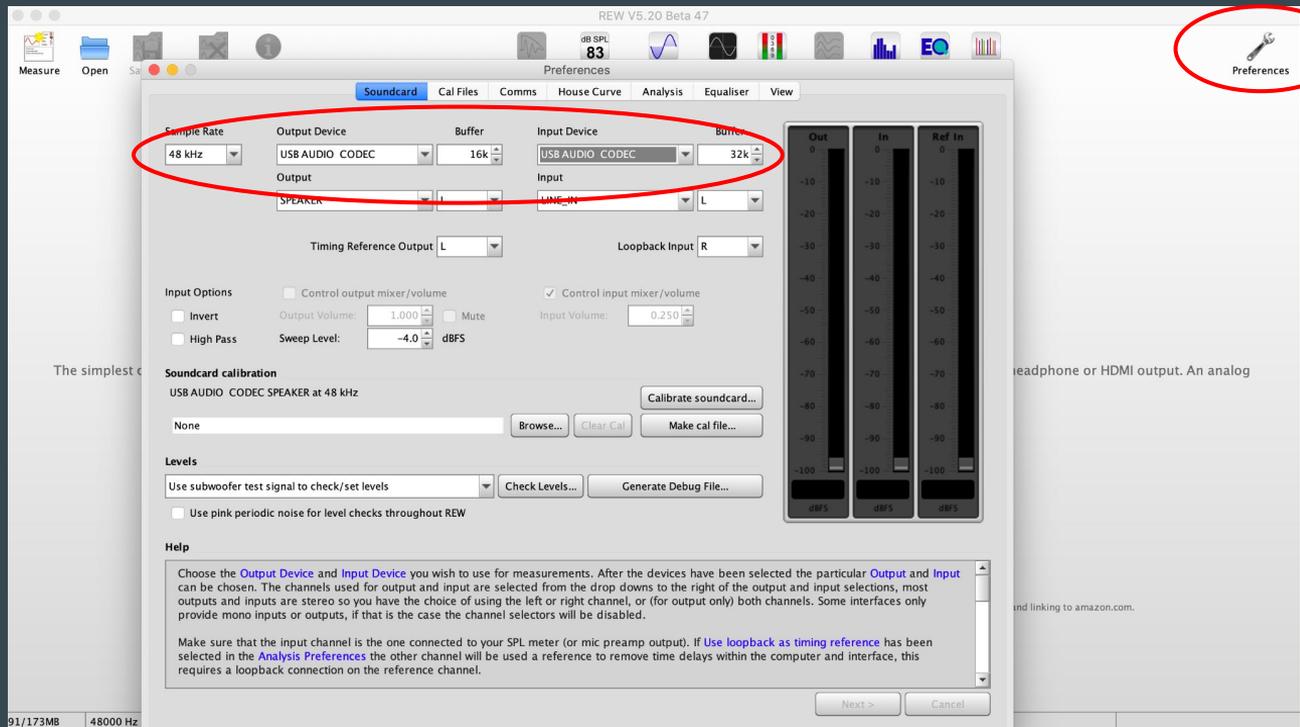


Open REW and set the preferences

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 10k Ω for the R_{sense} value, 100k Ω for R_{in} and 10m Ω for R_{leads}.

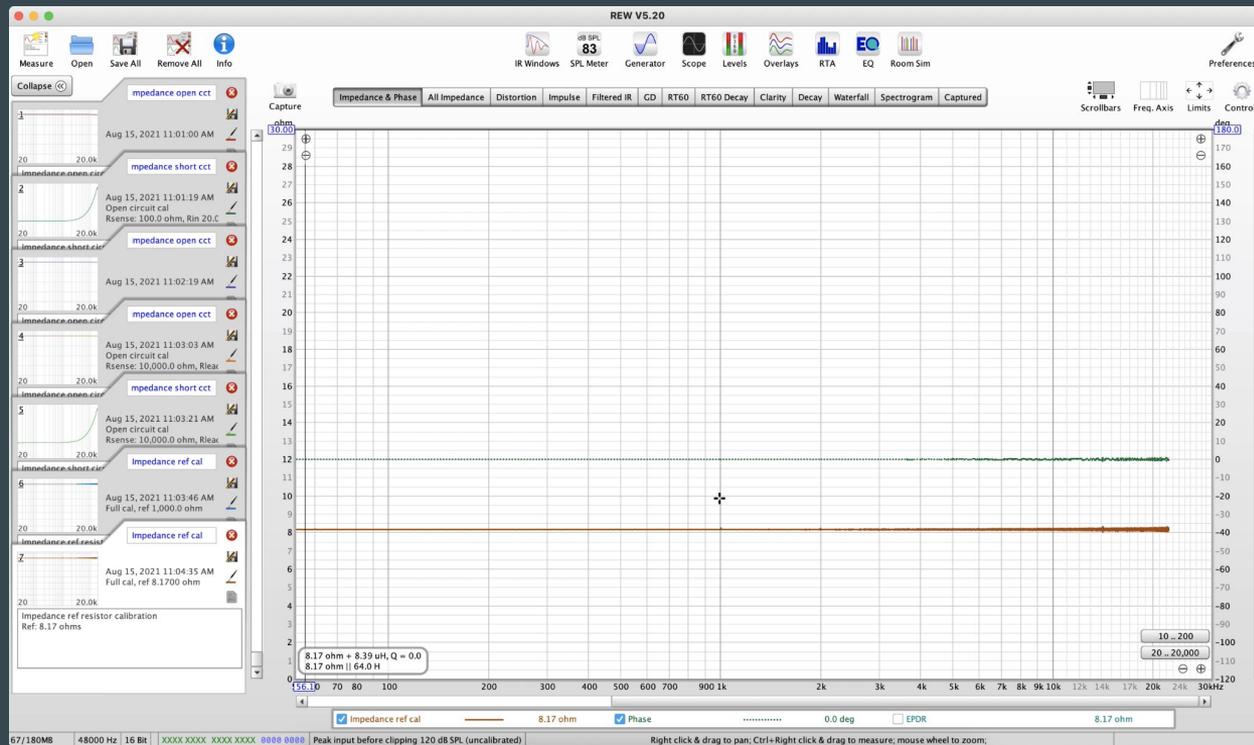
Click through the three impedance calibration steps, following the instructions. The DATSv3's built-in 1k Ω doesn't seem to work well for a reference cal value (it's too high a value compared to the 10k R_{sense}). I used an 8 Ω resistor (actual 8.170 Ω) that I measured using a 4-wire LCR meter. It's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

The screenshot displays the 'Make a measurement' dialog box in REW. The 'Type' is set to 'Impedance'. The 'Method' is 'Sweep'. The 'Settings' section includes 'Length' (256k), 'Repetitions' (1), and '5.5 s'. The 'RSENSE' is 10000.00, 'RINPUT' is 100,000, and 'RLEADS' is 0.010. The 'Calibration' section shows three steps: '1. Open circuit cal', '2. Short circuit cal', and '3. Reference cal'. The 'Level' is set to -12.00 dBFS. The 'Ready to measure...' progress bar is at 0%. The 'Input' is LINE_IN.

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 $R_{sense} = 10k\Omega$ (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 V5.20 Beta 47

Measure Open Save All Remove All Info IR Windows SPL Meter 83 Generator Scope Levels Overlays RTA

Make a measurement

Type: **SPL** Impedance

Name: woofer #1 Add number Add date/time Use as entered

Will appear as: woofer #1 Sep 11

Notes:

Keep for next measurement

Start Freq: 0 End Freq: 22,050 Hz

Level: **-4.00 dBFS** dBu dBV Volts dBFS

Ready to measure... 0%

Input:

Method: **Sweep** Noise

Settings: Length: 256k Repetitions: 4 21.8 s

R_{SENSE} : 10000.00 1. Open circuit cal 2. Short circuit cal 3. Reference cal

R_{REF} : 3.2800 ohm

Noise: Filter low

Protection: Abort if heavy input clipping occurs

Playback: **From REW** From file

Sample rate: 48 kHz Delay: 0 seconds

Output: SPEAKER L

Ref input: LINE_IN R

Cal files...

Input: LINE_IN L

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 [3.28 Ω] 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

The screenshot shows the 'Make a measurement' dialog box in REW V5.20 Beta 47. The 'Type' is set to 'SPL' and 'Method' to 'Sweep'. The 'Name' is 'woofer #1'. The 'R_SENSE' is 10000.00 and 'R_REF' is 3.2800 ohm. The 'Level' is -4.00 dBFS. The 'Input' plot shows a signal level around -80 dBFS. The 'Cal files...' button is highlighted with a red circle.

Measure Open Save All Remove All Info IR Windows SPL Meter 83 Generator Scope Levels Overlays RTA

REW V5.20 Beta 47

Make a measurement

Type: **SPL** Impedance

Name: woofer #1 Add number Add date/time Use as entered

Will appear as: woofer #1 Sep 11

Notes:

Keep for next measurement

Start Freq: 0 End Freq: 22,050 Hz

Level: -4.00 dBFS dBu dBV Volts dBFS

Ready to measure... 0%

Input:

Method: **Sweep** Noise

Settings: Length: 256k Repetitions: 4 21.8 s

R_SENSE: 10000.00 1. Open circuit cal 2. Short circuit cal 3. Reference cal Clear cal

R_REF: 3.2800 ohm

Noise: Filter low

Protection: Abort if heavy input clipping occurs

Playback: **From REW** From file

Sample rate: 48 kHz Delay: 0 seconds

Output: SPEAKER L

Ref input: LINE_IN R

Cal files...

Input: LINE_IN L

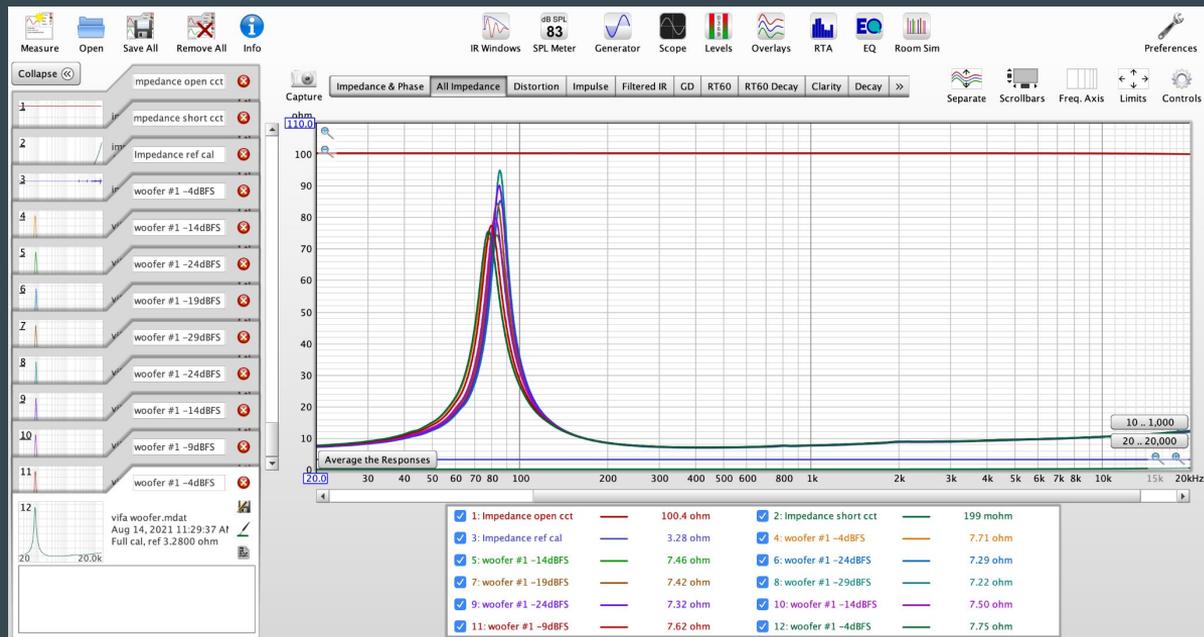
Check levels Start Cancel

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 .

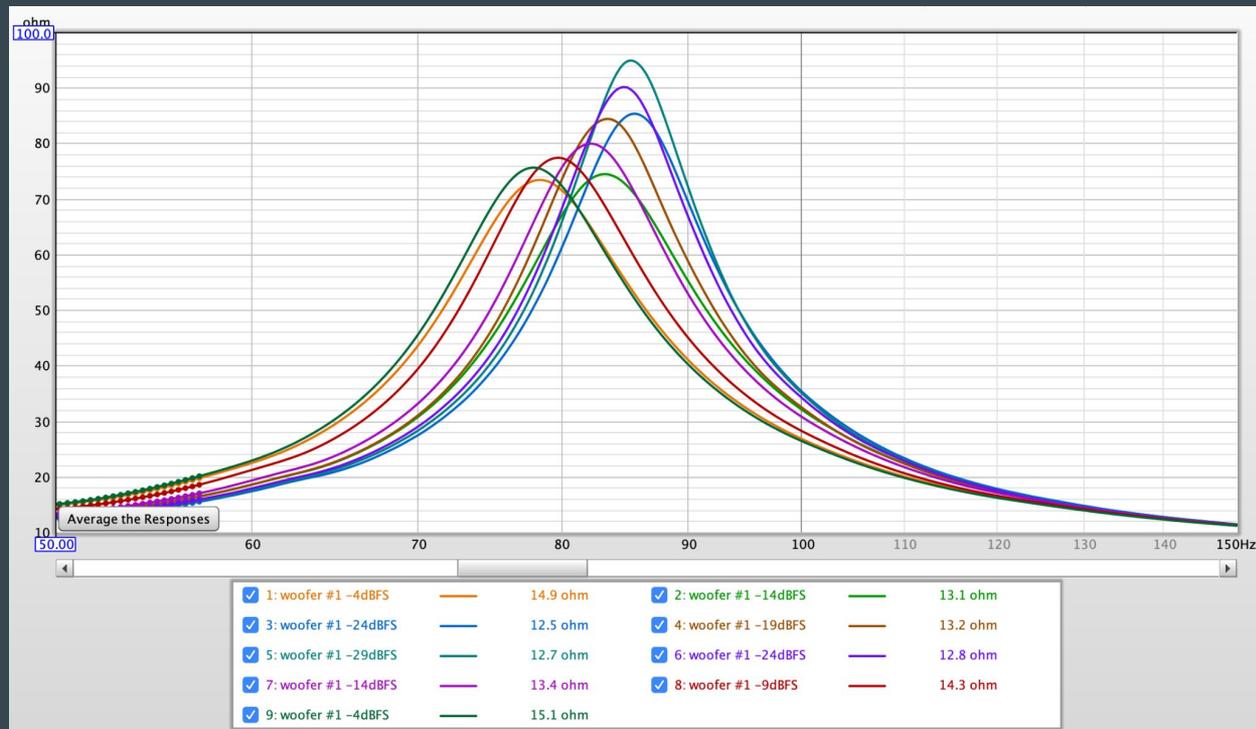
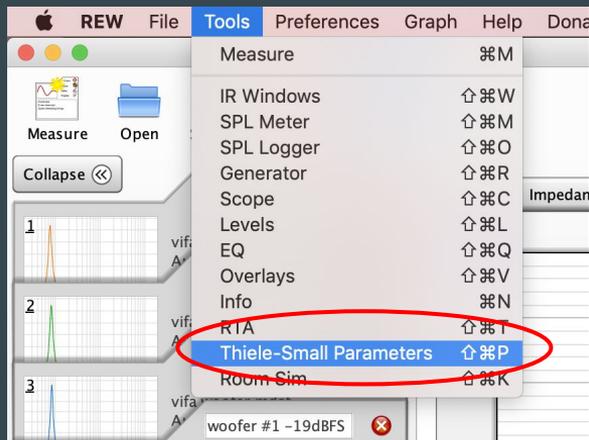
At low test levels noise becomes an issue, running multiple slower sweeps helps to average out random noise.

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 (R_e) 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 m Ω accuracy (in a temperature controlled environment, a few degrees temp difference will cause DCR to change). This is not required for a hobbyist.

Measurement method
Added mass

Free Air Measurement
9: woofer #1 -4dBFS

Added mass measurement
Select a measurement
Added mass (g): 0.000

Manually Entered Values
Voice Coil DC Resistance (ohm): 6.740
Effective Area (cm²): 176.7
Air Temperature (Celsius): 20
Air Pressure (mB): 1013.25

Motional Impedance (Ritter 3PC)
R₀ (ohm): 108.90
C_{MES} (uF): 178.3
L₀ (mH): 22.445
β: 0.0624
ω₀: 734.6

Blocked Impedance (T-F)
dR (ohm): -0.088
L_{EB} (uH): 46.6
L_E (mH): 0.608
R₅₅ (ohm): 4.10
K_E (S-H): 0.0601

Simplified Model Parameters

R _E 6.652 ohm	L _E 38.2 uH
R _{ES} 69.68 ohm	R ₂ 2.31 ohm
C _{MES} 178.3 uF	L ₂ 26.0 uH
L _{CES} 23.35 mH	R ₃ 2.53 ohm
	L ₃ 376.8 uH

Calculate Parameters
Write Parameters to File

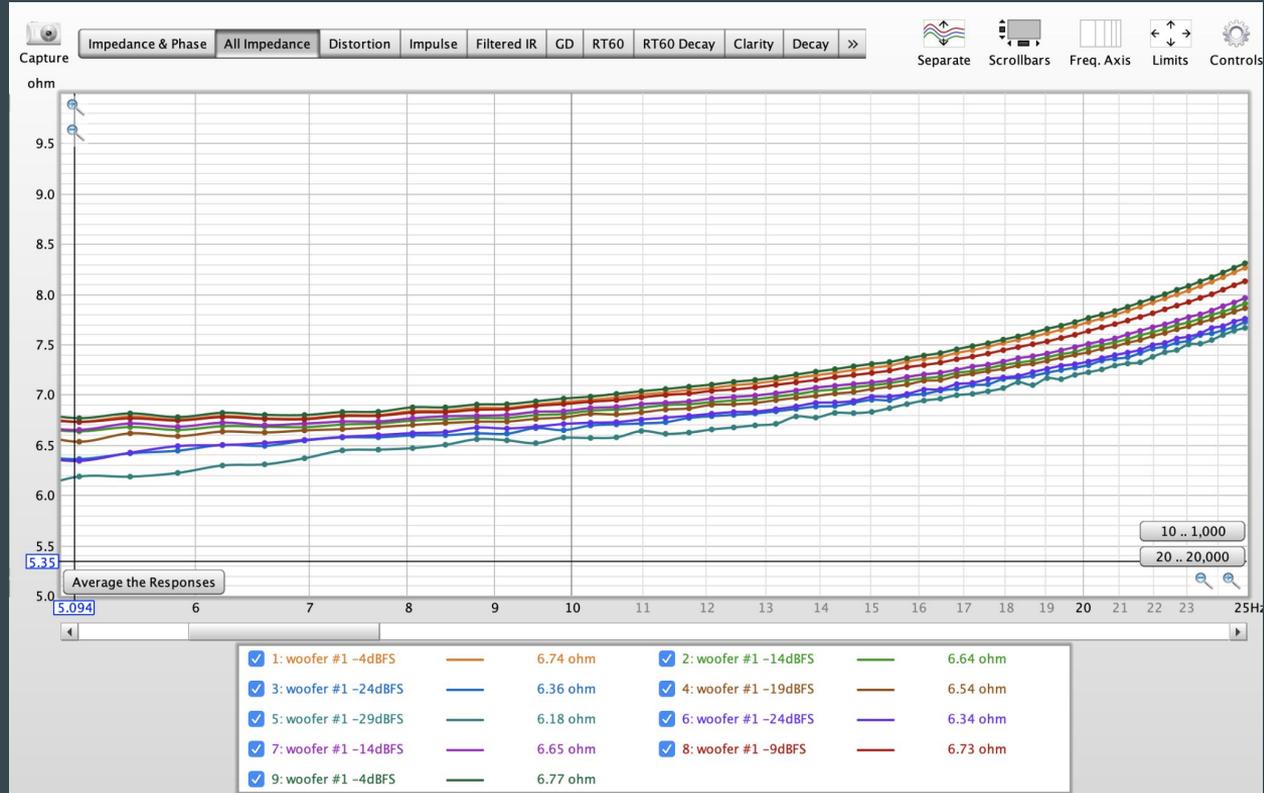
R _E 6.652 ohm	f _S 78.0 Hz
Z _{min} 7.196 ohm	Q _{MS} 9.518
f _{min} 426 Hz	Q _{ES} 0.581
f ₃ 7,830 Hz	Q _{TS} 0.548
L _E (f ₃) 0.062 mH	F _{TS} 142.3 Hz

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

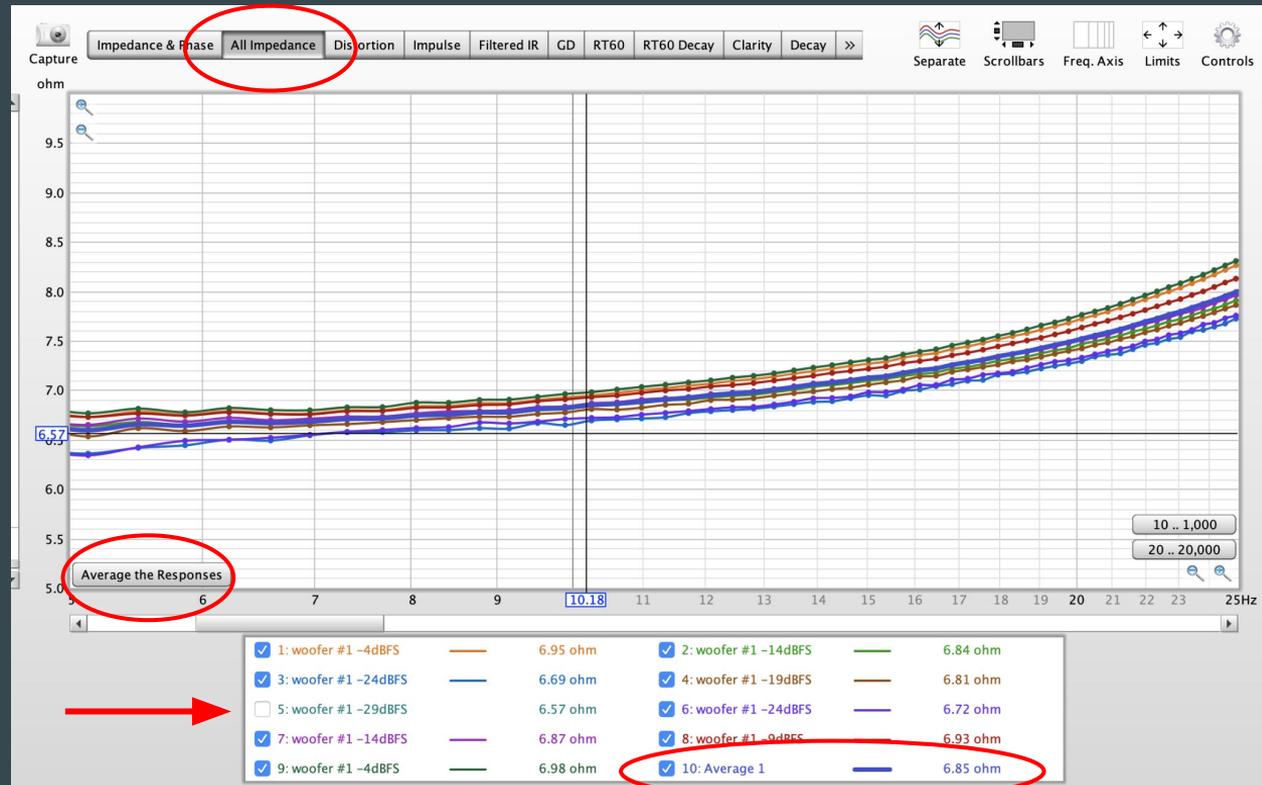
Important: The higher DCR measurements at higher amplitudes is most likely due to heating of the voice coil



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 calculate the average of the selected curves

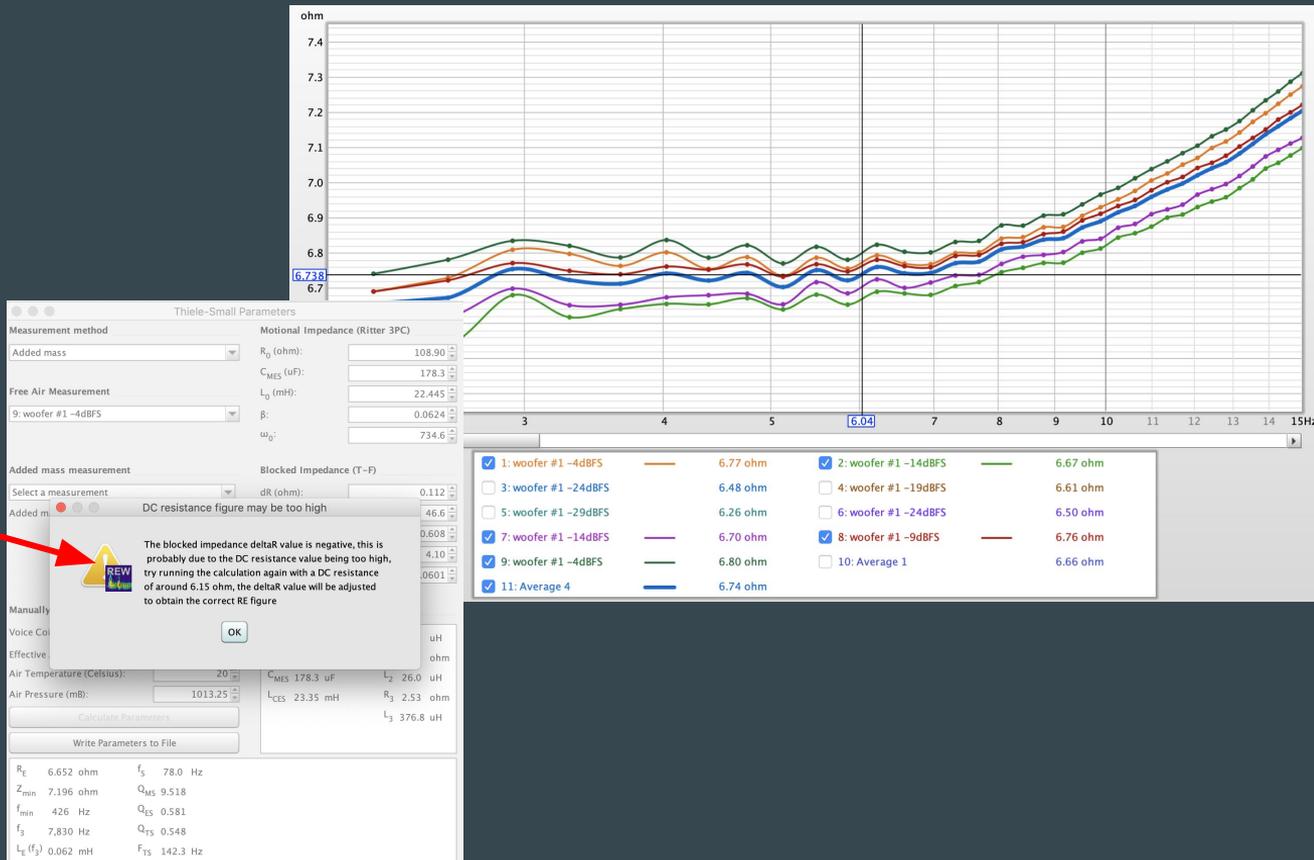
Note the x-axis scale is showing 5Hz to 25Hz



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.

