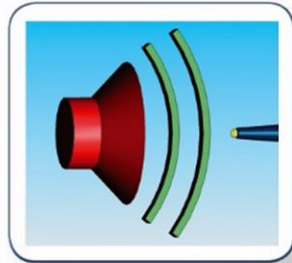


# MANUAL



## FINEQCX™

### Quality Control System



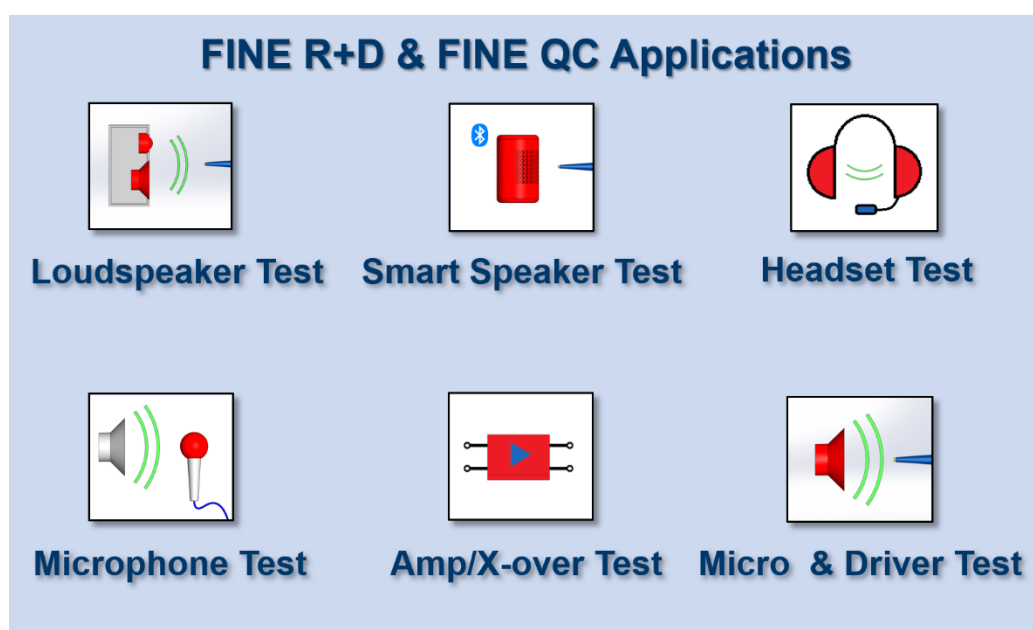
**LOUDSOFT**

[www.loudsoft.com](http://www.loudsoft.com)

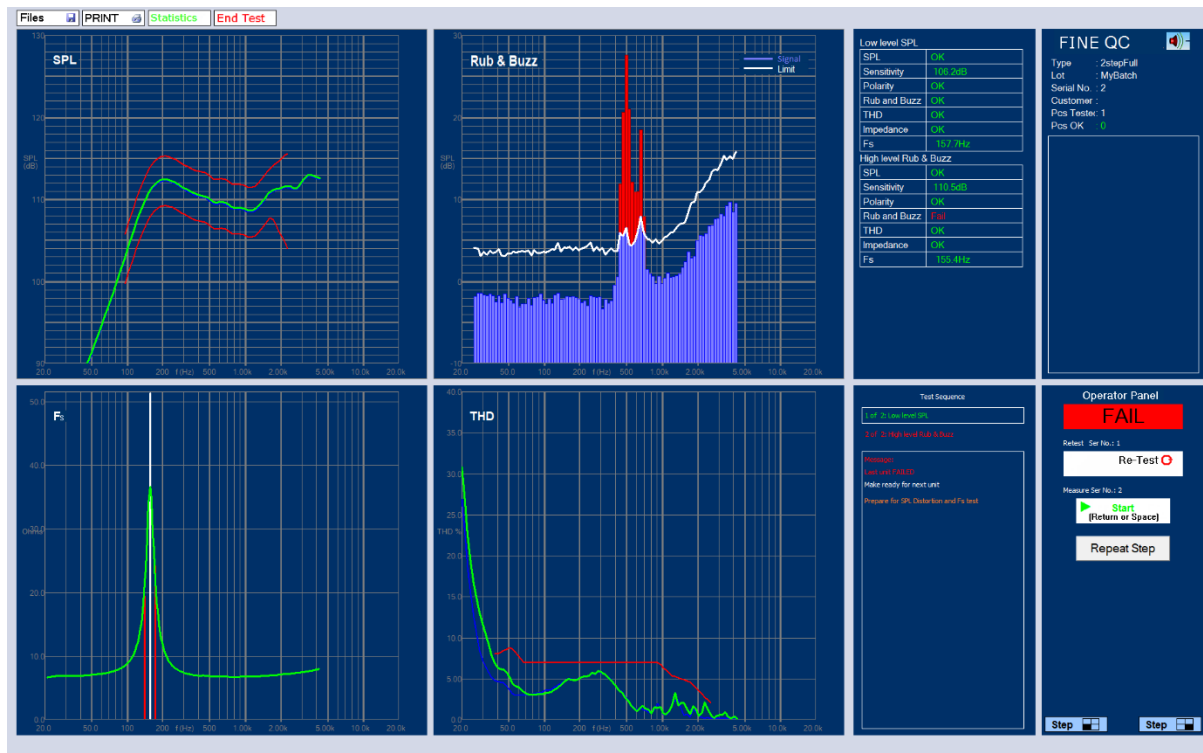
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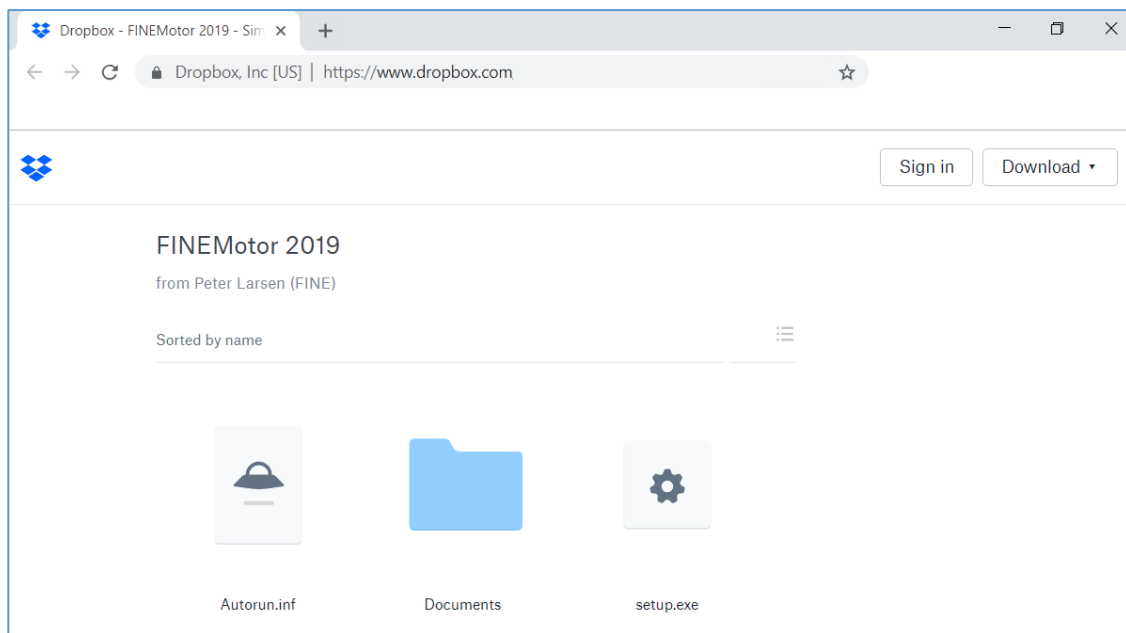
**You can measure all these products with FINE QCX**



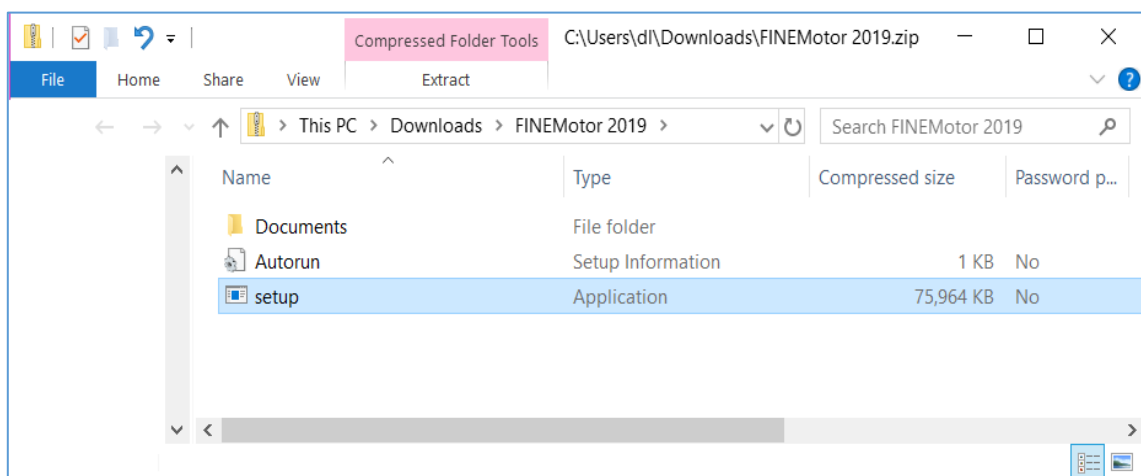
## 1.1 How to install the LOUDSOFT programs from a link

**The computer must be connected to internet during installation.**

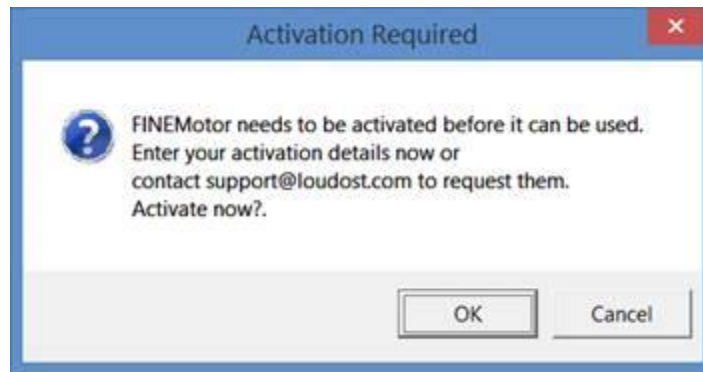
- When you click on the license link, you must download the program. Click on "Download" at the top right corner of your screen. Make sure to save it, you might need it later. We change the links from time to time for security.



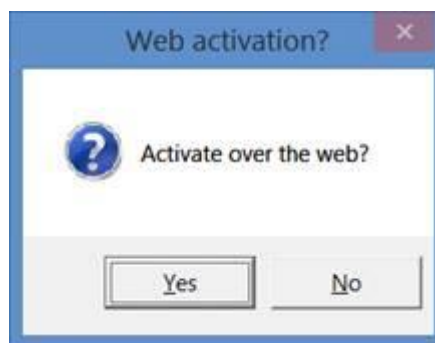
- Now find the downloaded file at the left bottom of your screen. Click on it and you will see the picture below. Click on “Setup” and follow the instructions to install the program.



- Click OK on the first dialog



- Click YES on the second dialog



- Fill in your license ID and password in next dialog. Your License ID is XXXXXXXX, and your password is PPPPPPP



- Click OK. It is all done!

## 1.2 How to get started

1. If you have ordered special Modules like Automation Module, you must activate the separate license for this, see section 1.3.
2. Now connect the hardware to the computer using the USB cable. Windows will automatically install a driver.
3. Start FINE QCX
4. The first time you run FINE QCX the software will use the **Default microphone sensitivity** (12.5mV/Pa, -38 dB re 1V/Pa) for all 3 microphone inputs. Therefore, the SPL will not be correct until you enter the correct sensitivity numbers for your actual microphones.
  - a. You should go to Calibration and click on microphone # 1. Then please enter the sensitivity from your Microphone Calibration Chart (see Figure 1). Note this is a negative number, i.e. -47.33 dB
  - b. If you have no calibration data, you can calibrate your microphone using a calibrator, see Sec. 9.4
  - c. Repeat above for all 3 microphones if applicable.

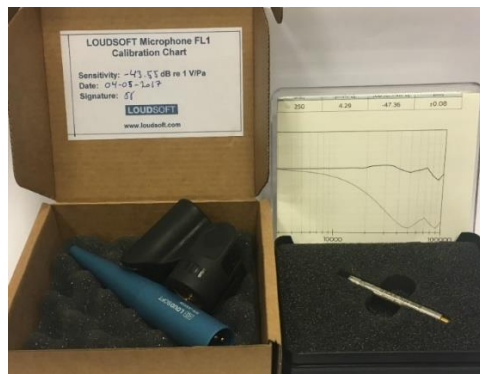


Figure 1 - Microphone Sens. charts. Left is LOUDSOFT FL1 mic. Right is GRAS 46BE mic.

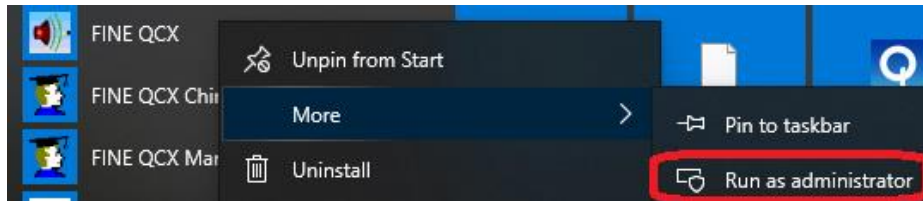
5. The FINE QCX system is factory calibrated. However, you may perform a calibration if needed (Sec. 9.4). This can improve the accuracy slightly at high frequencies.



Figure 1 – FINE Hardware 3

### 1.3 Install / Activate Modules

Run FINE QCX as administrator (FINE Hardware3 must be connected)  
Figure 2



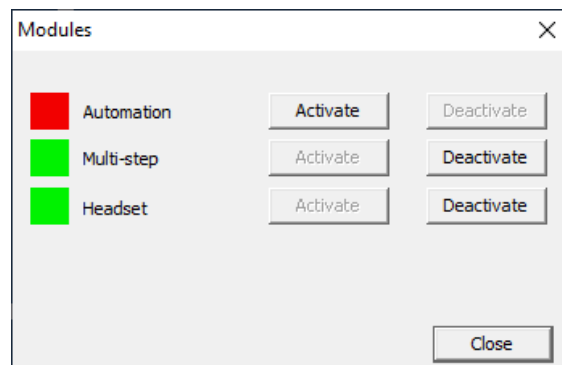
**Figure 2 - Run as administrator for installing modules**

Start FINE R+D as Administrator

Press [Help]

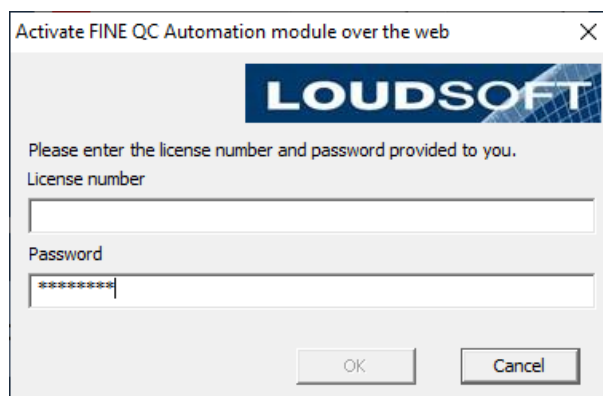
Press [Modules]

Press [Activate] for the **Module** you want to activate (Figure 3)



**Figure 3 - Activation of Modules**

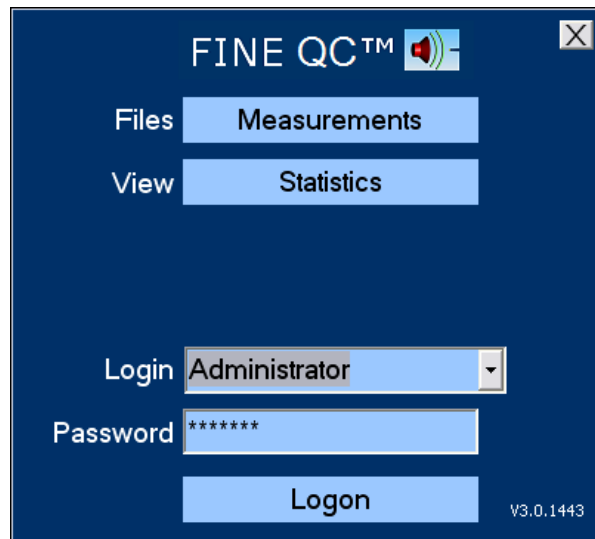
Enter License number and Password as received from LOUDSOFT (Figure 4)



**Figure 4 - Enter License number and Password**



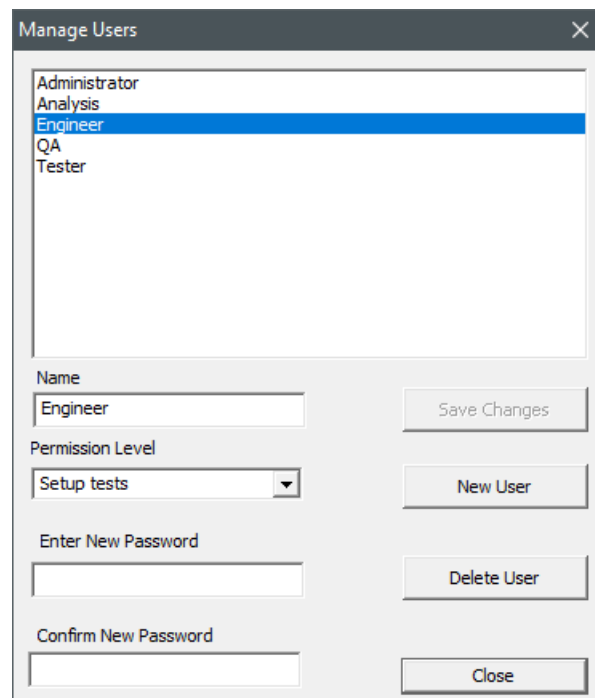
## 1.4 Login – Users



**Figure 5 - FINE QCX Start Screen**

You can login the first time as Engineer without a password. To setup user profiles, you need to login as “Administrator” and go to Admin/Users. The default password is “FINELAB” (Capital letters!).

There are 4 default user levels: Administrator/Engineer/QA/Tester. Each has limited access, except the Administrator. You can setup User Passwords and change all as Administrator: [Admin Options/Users].



**Figure 6 - Window for managing users and their permissions**

## 1.5 ADMIN – Deactivation

When logged in as Administrator the [ADMIN OPTIONS] button is shown on the lower right (see Figure 9).

The ADMIN page is shown in Figure 7 below:

*(Note that no ASIO drivers are needed with new FINE Hardware3!)*

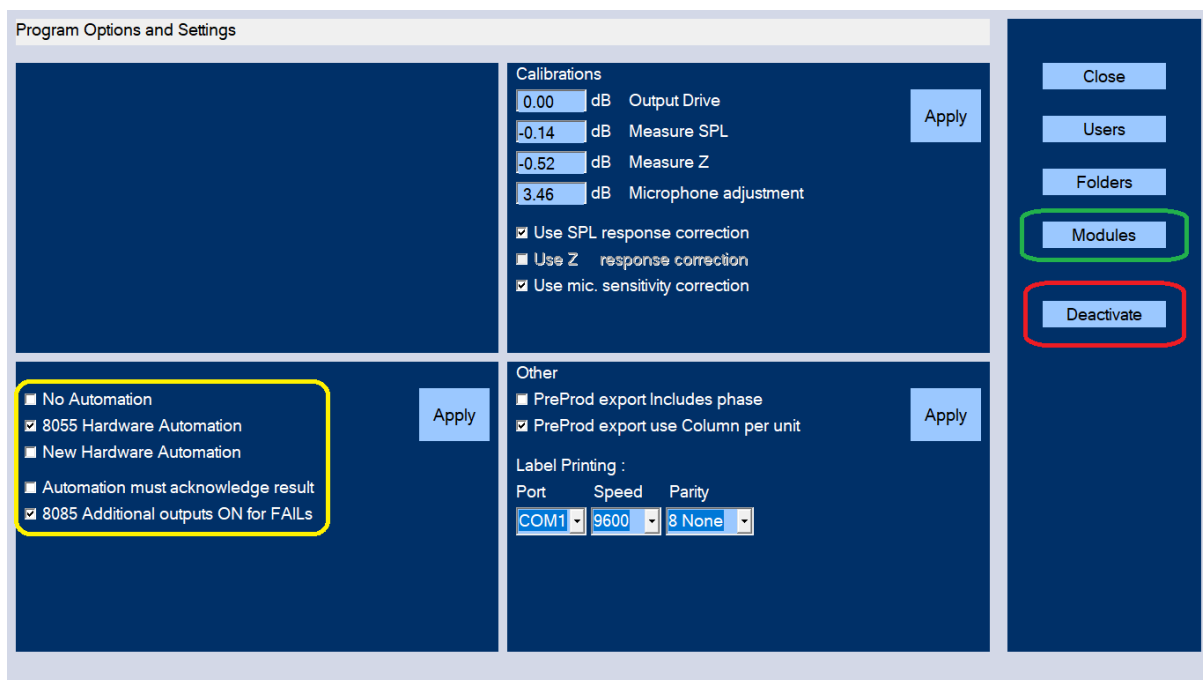


Figure 7 - ADMIN Page - Deactivation - Modules etc.

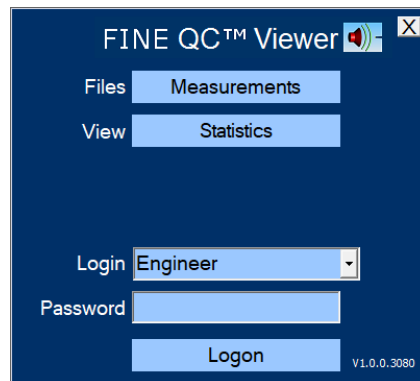
## Deactivation

You can deactivate the FINE QCX license by pressing the button marked in red [Deactivate] Figure 7. Then you can install the software on another PC and activate the license there using the same ID and Password as when installing FINE QCX the first time.

## Modules – Automation - Other

The button [Modules] Figure 7 will show the installed extra modules. Here is installed the Automation Module shown in Yellow.

## 1.6 FINE QCX Viewer / Remote setup



The FINE QCX Viewer is an independent program which can do everything FINE QCX does, except measure! It needs a separate license.

This program is ideal for remote updating of setup files, checking statistics etc. You can even do this from your office or in another country!

Setup Files are here: **C:\FINEQCXTestInformation\TestSpecifications**

Measurement data **C:\FINEQCXBatchData**

## 2. How to measure in FINE QCX – Quick Overview

1. Start FINE QCX. Select Engineer, and click on Logon.

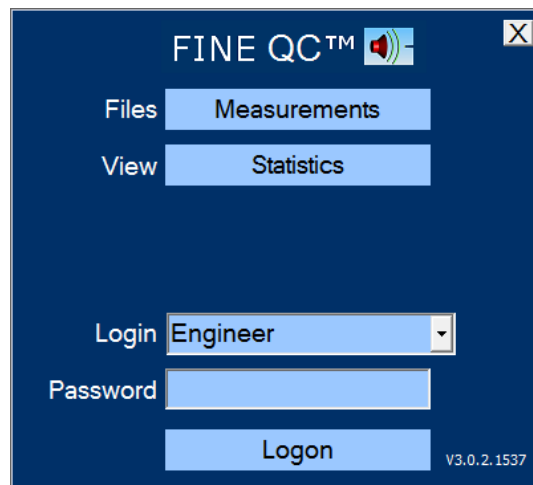


Figure 8 - FINEQCX logon screen

2. Let's start with a simple measurement with only 1 step: Fullrange.ftx, and then click on **[New (based on)]** button. This way you create a new setup with your **chosen name**, and don't overwrite the existing.
3. Edit QCX Stepped test button. (Fig. 9). This is also for tests only containing one step.

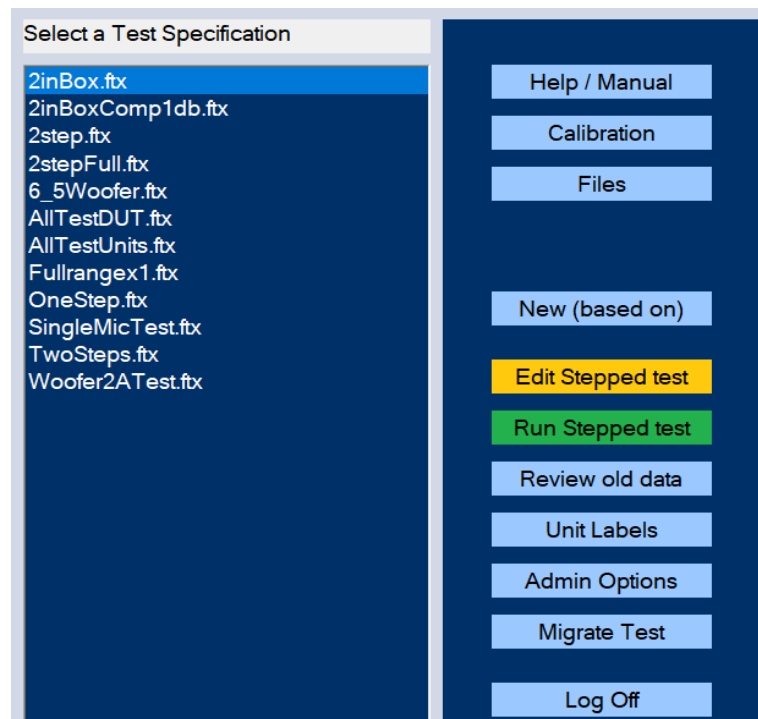
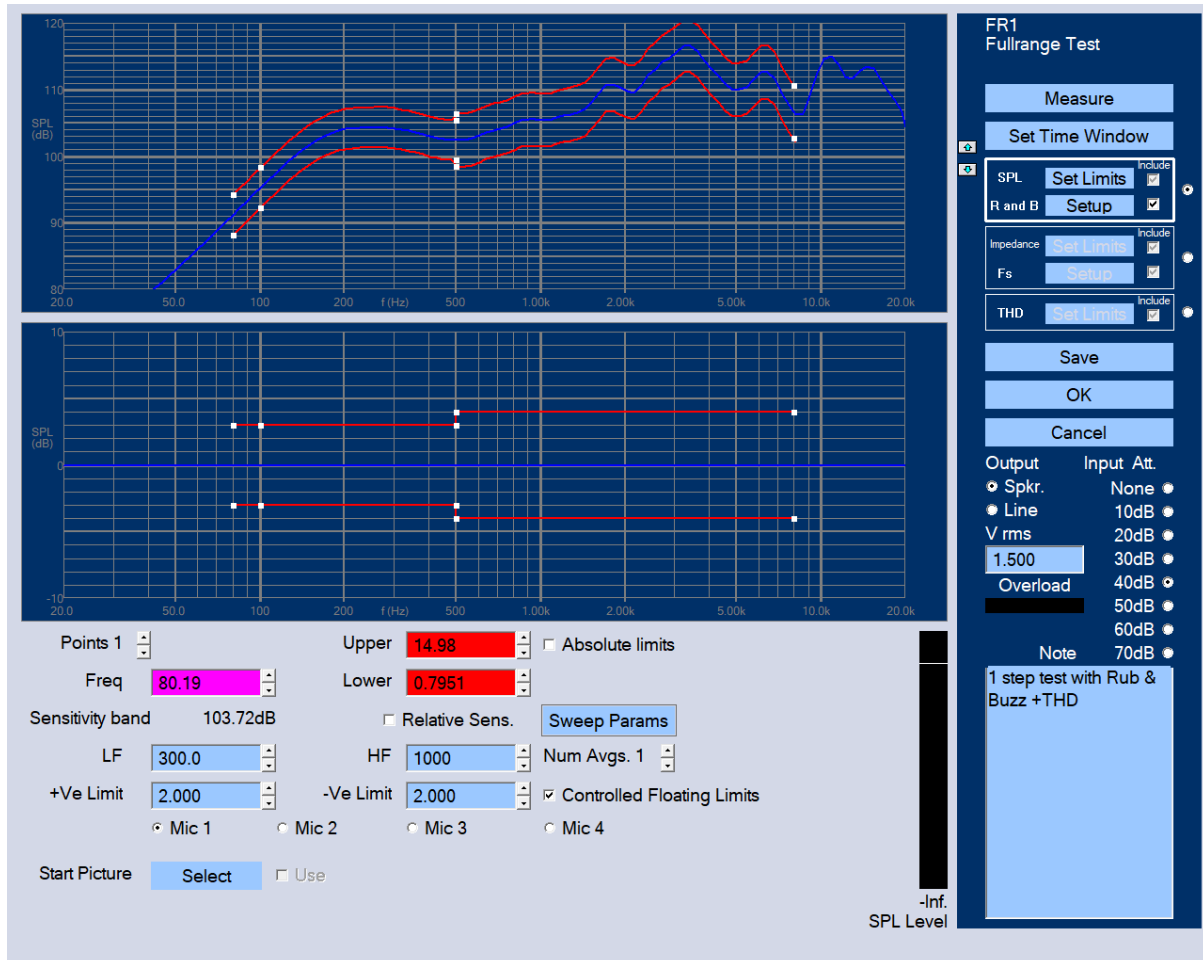


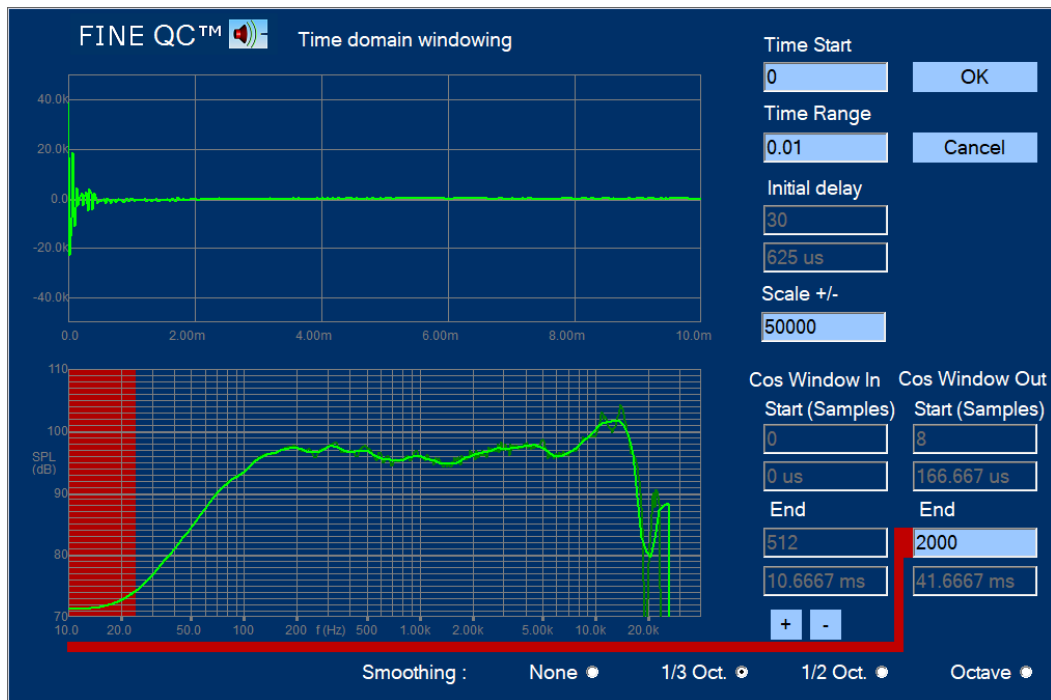
Figure 9 - Test specifications selection screen

4. Then click on “Edit Step” and set a low Voltage, say 1V (lower right)
5. We will go through the buttons at right from the top, starting by the “Measure” button.  
(Set Limits and R and b are bypassed for now).



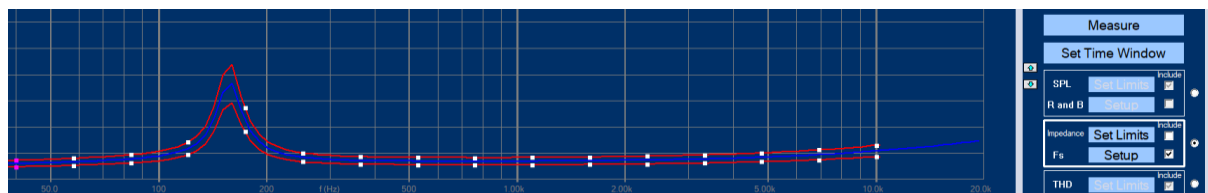
**Figure 10 - Main window for editing test specifications**

6. If the Overload bar turns red, we need to change the Input attenuation. Set the attenuator to get less than -10 dB SPL on the VU meter/Bar graph.
7. Click “Set Time Window” button, and set “End” value under “Cos Window Out” to a number that allows for a good curve for now. This can exclude reflections, see later in Sec. 4.3. Then click on OK.



**Figure 11 - Time Domain windowing**

8. Now move focus down and select the "Imp. / Fs" buttons, and then click on the "Measure" button again to measure the impedance. We can set the limits by dragging the white spots using mouse. (You may edit and set the Fs Setup, but you could do that later).



**Figure 12 - It is possible to edit the limits by clicking and dragging the white dots**

9. We will bypass the THD for now.
10. Click on Save-button, then click OK. The setting is done. Click OK and get back to Test specs.
11. Next, we should run our test. Click on the green **Run Stepped test** button. (see Fig.9)
12. Click the [v] to bypass filling in the texts, and then click on OK button.

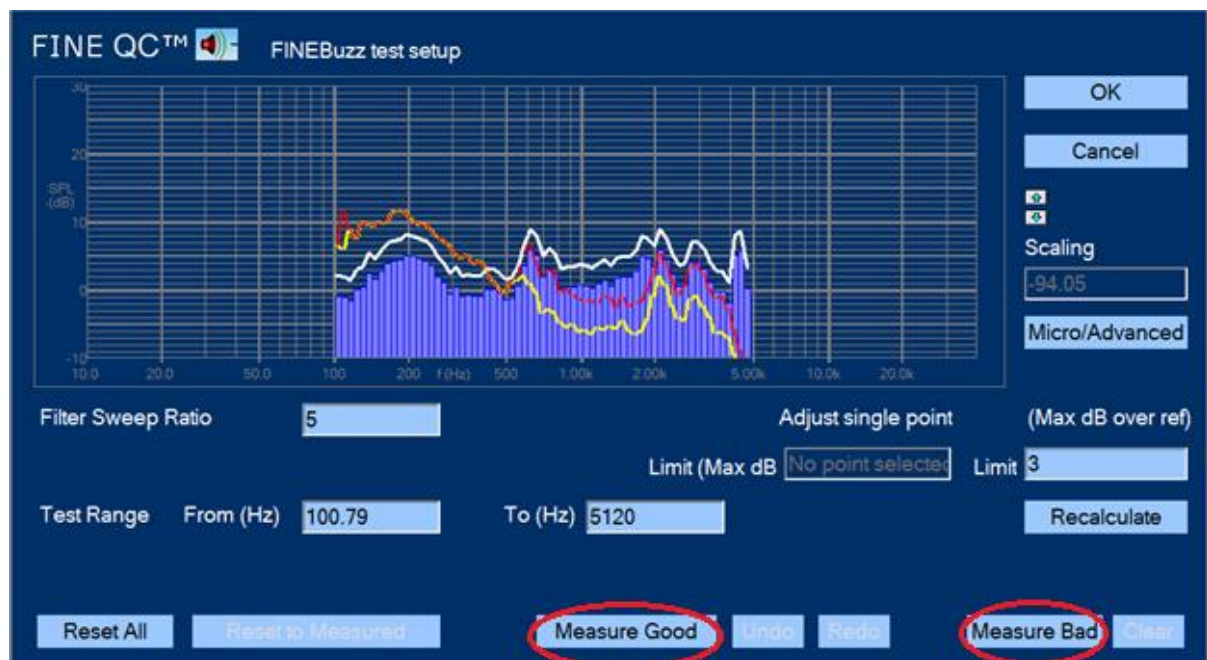
**Figure 13 - The test details includes naming the batch and numbering the measurements**

13. Click on the “Start” button to run the test. Or you can press “Enter” or the Spacebar.
14. If for some reason you need to repeat the current test use the “Single/Re-test” button.
15. In the lower right corner (See step buttons lowest in Fig.14) you can View Impedance, or SPL Difference (=Difference from Reference).

**Figure 14 - Select Bottom View buttons**

16. Click on the “End Test” button after all measurements have been done.
17. When the test is done you can select what measurements you want to see and print them. You can view detailed info and responses in Pre-Prod, see section 4.2

18. To add measuring Rub & Buzz and THD, press Edit Stepped test again, and press and set R and B Setup Fig. 15.



**Figure 15 - The Rub and Buzz limits are defined by measuring some good and some bad drivers. FINEQCX will then calculate the limits.**

19. Click on the “Measure Good” button for drivers you want to approve. Then, you may provoke some rub & buzz by putting your finger on the diaphragm of the speaker unit (or connect a speaker unit that has R&B problem), and click on the “Measure Bad” button. This will show a red curve, normally higher than the limit.
20. Click on OK button.
21. Open the THD (Fig. 16). Press Setup and enter some limit bands in %.



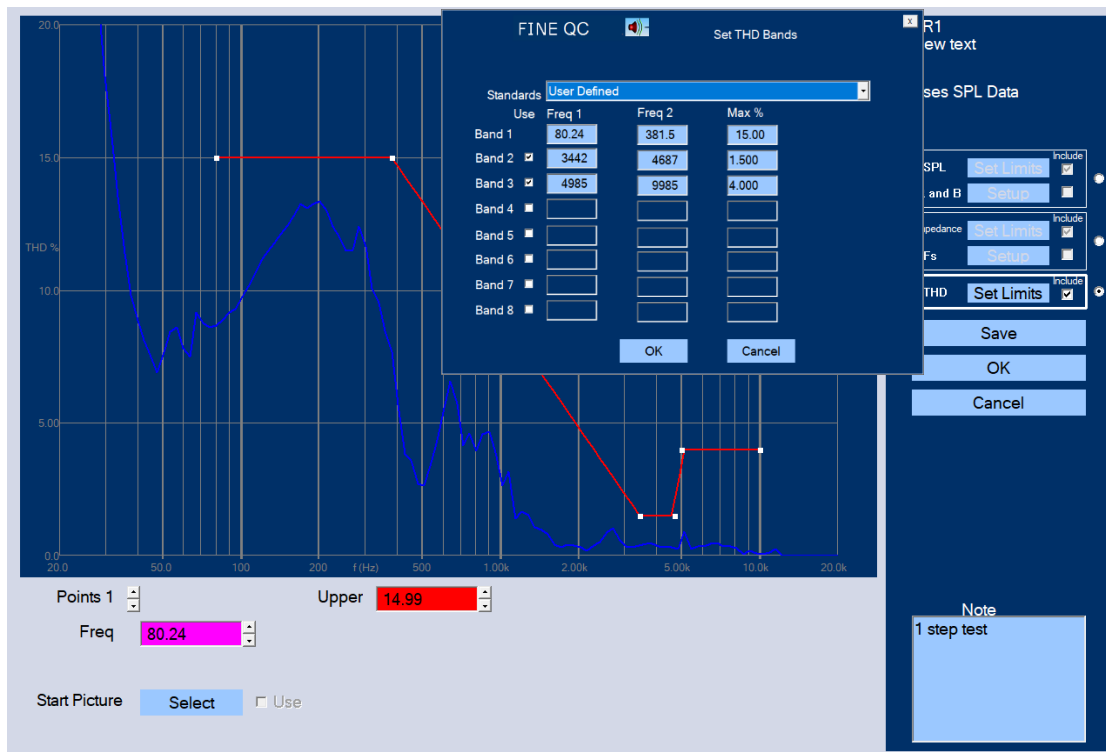


Figure 16 - THD Setup. Enter limits from THD Bands or dragging white points

22. Click on Save.
23. Click on OK.
24. Click on Run QCX Test, and then run a new QCX test as described in steps 11-16.

Fig.17 shows a typical test picture of full test in 1 step.

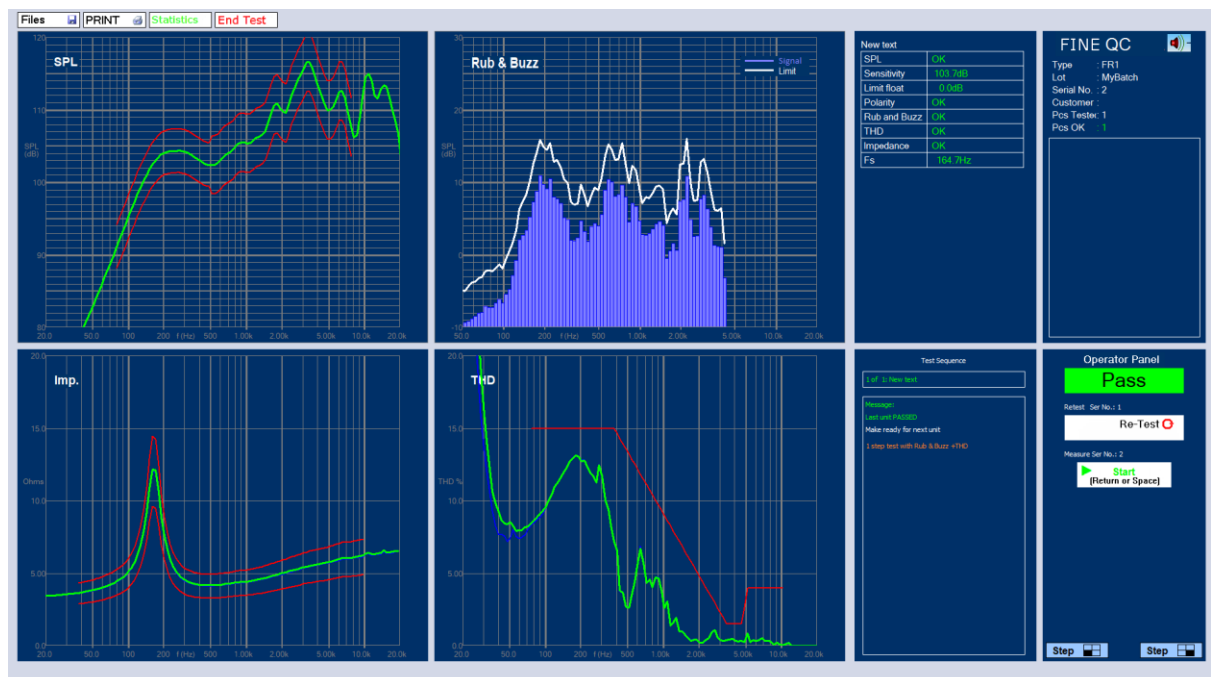


Figure 17 - FINE QCX: SPL, Imp, Rub & Buzz and THD in one step

### 3. Default Test Specifications / Test Categories

Below are the default Test Specifications / Test Categories /

Press [New (based on)] for starting with these (avoids overwriting the default files)

- Subwoofer SubWoofer.ftx (including Amplified subs)
- Amplifier Amplifier\_Test.ftx
- Full range driver Fullrange.ftx
- Headset Headset.ftx
- Microphone Mic\_Test.ftx
- Receiver Micro-Receiver.ftx
- Loudspeaker/Box Speaker-Far\_Near.ftx
- Smart Speaker BT-Speaker.ftx
- Tweeter Tweeter.ftx
- Woofer Woofer\_TestBox.ftx
- Cross-over X-over\_Test.ftx
- 

### 4. Testing / DUTs (Device Under Test)

Testing DUTs (Device Under Tests). Logging in as an engineer with own password and “Run that Test”. The following screen appears:

**Test details**

Type: 2,5in\_Fullrange 2

Lot No. 1stBatch

Start from serial no. 1

Customer US Customer

Use Login Name For Lot ☐

Cancel OK

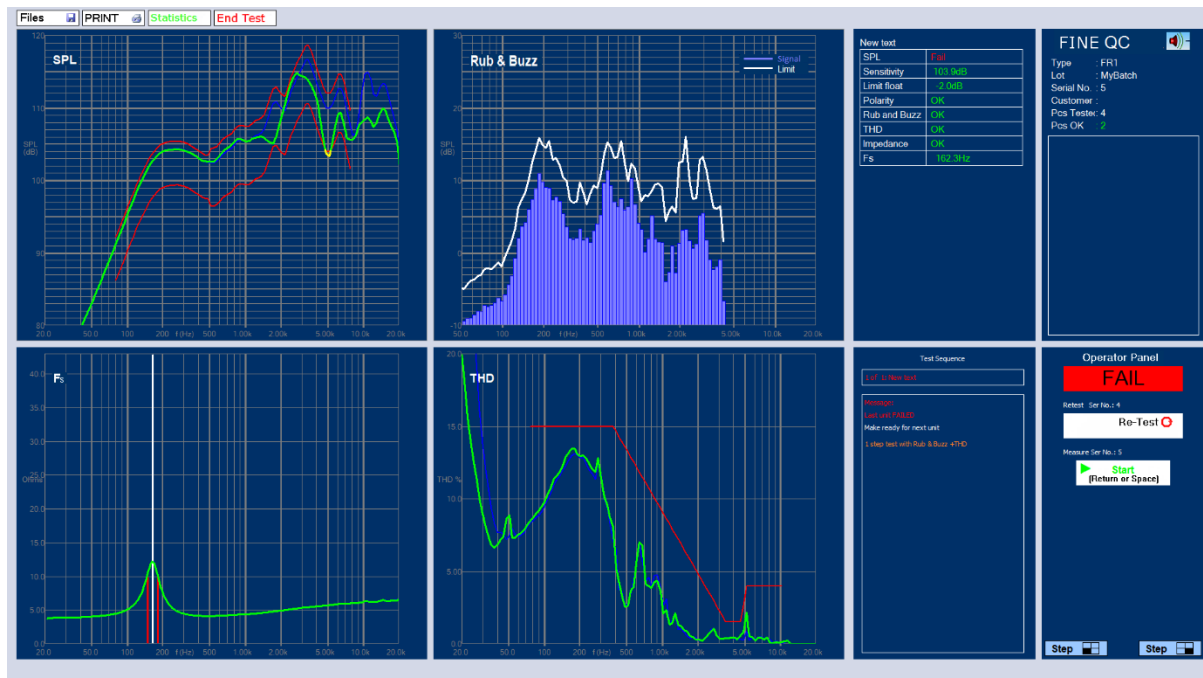
Notes:

NB! This driver must be tested in cabinet

Figure 18 - FINE QCX Test Details

After filling in the batch number and customer name this series will start with #1 and automatically count up as you test. If you enter the last tested number instead, FINE QCX will count up from that.

Start by pressing the  test sweep button OR Space.



**Figure 19 - FINE QCX Test Display: SPL FAIL at 5 kHz**

Fig. 20 shows the measured frequency response with red limits upper left. In this case the green curve turns yellow at 5 kHz causing FAIL, because the response is outside the lower limit. This is also reported as SPL Fail in the first line of the Test results (3rd column).

The next result line reports the absolute Sensitivity 103.9 dB measured as average over a defined frequency band. (Relative sensitivity is also possible, see section 5.2).

The next result Limit Float, is short for Controlled Floating Limits. This is explained in detail in section 5.2, but means that the limit can be allowed to move some dB for checking if the response fits inside the limits. The actual level is measured with the (average) Sensitivity, see above.

The measured impedance with limits is tested OK as shown in results. The impedance curve can be viewed by the lower right buttons, also shown in Fig. 14. Polarity OK is also in results.

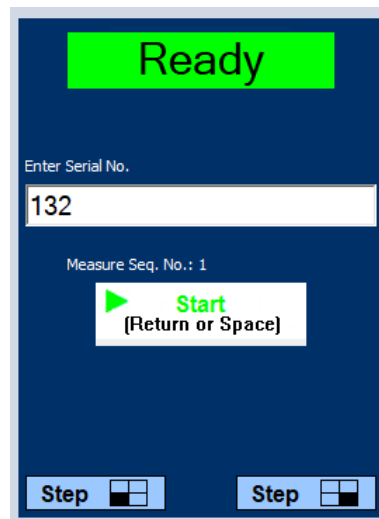
Rub & Buzz is shown center. The blue columns are below the white limit, which was defined as Good (enough), because the acceptable DUTs don't have to be absolutely perfect, see section 5.8. This is using the world leading FINEBuzz algorithm which is verified to fully replace human listening.

Below that THD is shown, which in this case below the red limit line. Note that in contrast to Rub & Buzz, THD is not useable for deciding if the sound quality is OK (See [https://www.loudsoft.com/papers/ Fast Rub & Buzz Testing](https://www.loudsoft.com/papers/Fast%20Rub%20&%20Buzz%20Testing)).

The lower left shows the impedance peak representing the resonance frequency  $F_s$  of a driver.

You can re-test the reference unit any time by pressing “Single/Re-test”. Then you should answer “No” to overwrite, thereby keeping the serial numbering.

As soon as “End Test” is pressed, the Statistics of the series is displayed and the user can view rejects etc. (see Figure 21).



**Figure 20 - Enter Serial No. (Individual) or Barcode**

If you are testing individual units, you can specify to enter the serial number each time, see Figure 20. To do this, insert a [v] in “User Ser. No.”, see Fig. 27.

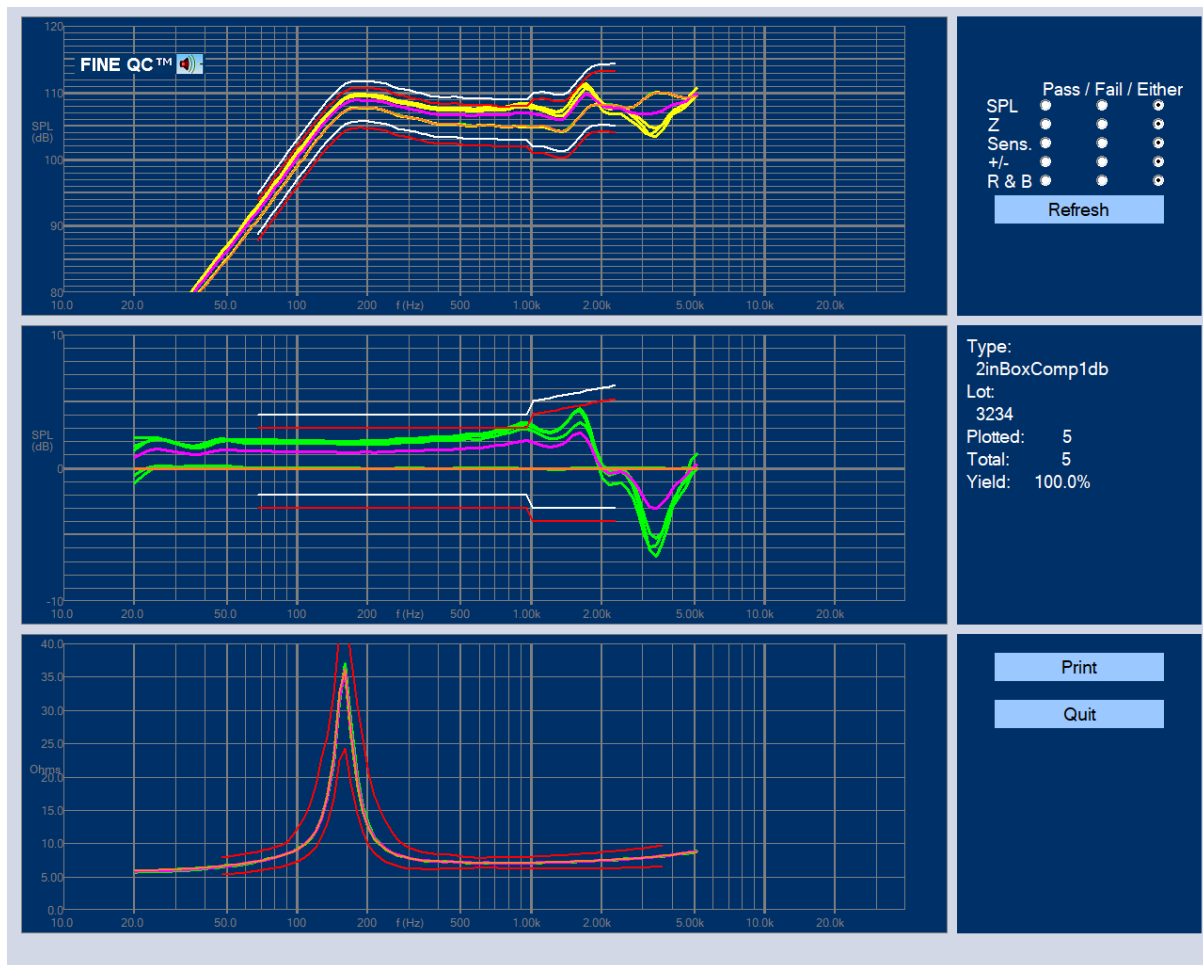
This will also work when using a barcode scanner to scan the serial number. Scanning the barcode will start the testing.

## 4.1 Statistics (Auto-saved)

Pressing the Statistics button while still in the middle of a test batch will display the Statistics of the (so far) tested DUTs

That is also possible without logging in, all users can directly load measurement files and view statistics from automatically saved QCX test series. Files: Measurements (C:\FINEQCXBatchData\ --)

Fig. 21 shows an example of the Statistics for a few DUTs.



**Figure 21 - Statistical Result of small QCX Test Series**

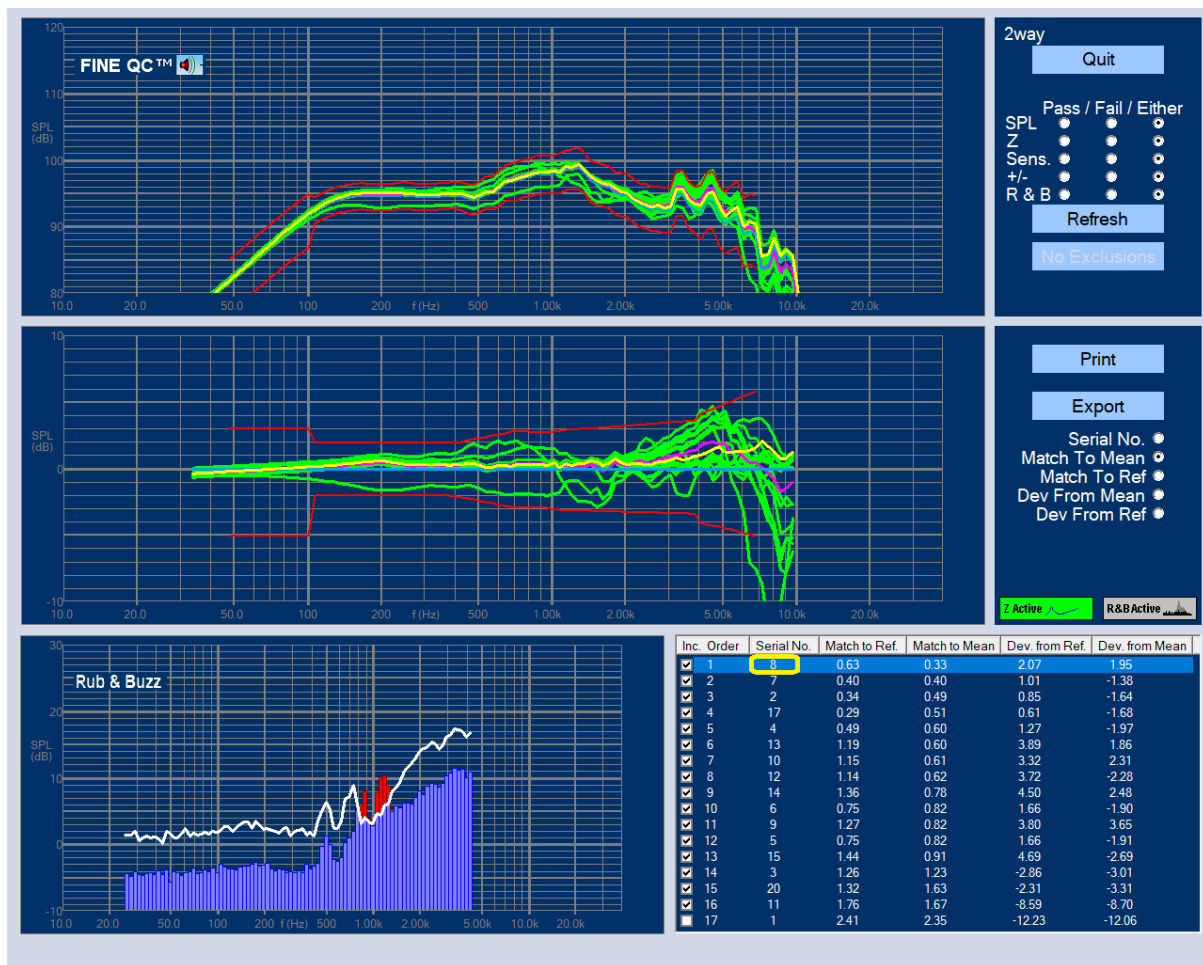
The frequency responses of all units tested are shown in the upper window as green lines, with the tolerance limits shown in red. The average of all responses is shown in violet; however, you can select to view all Pass or Fail for SPL, Impedance, Sensitivity or Polarity as you wish plus getting the test yield for each. (See also Enhanced Statistics in Pre-Prod, section 4.2).

The center window shows the same responses as above, but now plotted relative to the reference (orange). For example, a change in sensitivity is very easy to see this way.

The impedance curves with limits is plotted in the lower window. The average of all responses is also shown as the violet curve, which here is on top of the other curves.

If Controlled Floating Limits is used, these are shown in white. The yellow/green curves in Fig. 21 does fit inside the (floating) white limits, and are OK for SPL, however they eventually failed because the sensitivity was outside the (+/- 1dB) limits

## 4.2 Enhanced Statistics / Golden Average DUT



**Figure 22 – Enhanced Statistics + Golden Average Driver Auto Finder**

After finishing a batch, you can view the Enhanced Statistics. Especially when starting a new production, the most important is to find the unit which is closest to the average of the good units, so it can be used as reference.

Here a pilot run consists of 17 woofers for a 2-way system which are sorted using the Enhanced / Preproduction feature, see Figure 22. The highlighted driver response (blue/yellow) is serial no.8 in the table and is the best match to the average i.e. the *Golden Average Unit*.

Actually driver no. 17 was deselected in the table because that response was considered non-typical and should not disturb the average. (Right-click can exclude from calculations).

Should it be necessary to find a similar reference driver later it can be found by selecting “Best Match to Reference”.

*Note: You can also use this feature to match drivers or speaker systems! And show an individual response versus the reference (by de-selecting the others). Or print this or make a PDF document by printing to a PDF printer.*

The matching is using the frequency range of the red limits. You may choose to see the max deviation instead.

The corresponding Rub & Buzz curve is shown lower left. This way you can see all responses from a large batch, including Rub & Buzz. (The shown Rub & Buzz curve is here from another driver).

All the SPL data can be exported to a \*.csv file to Excel, see Figure 23.

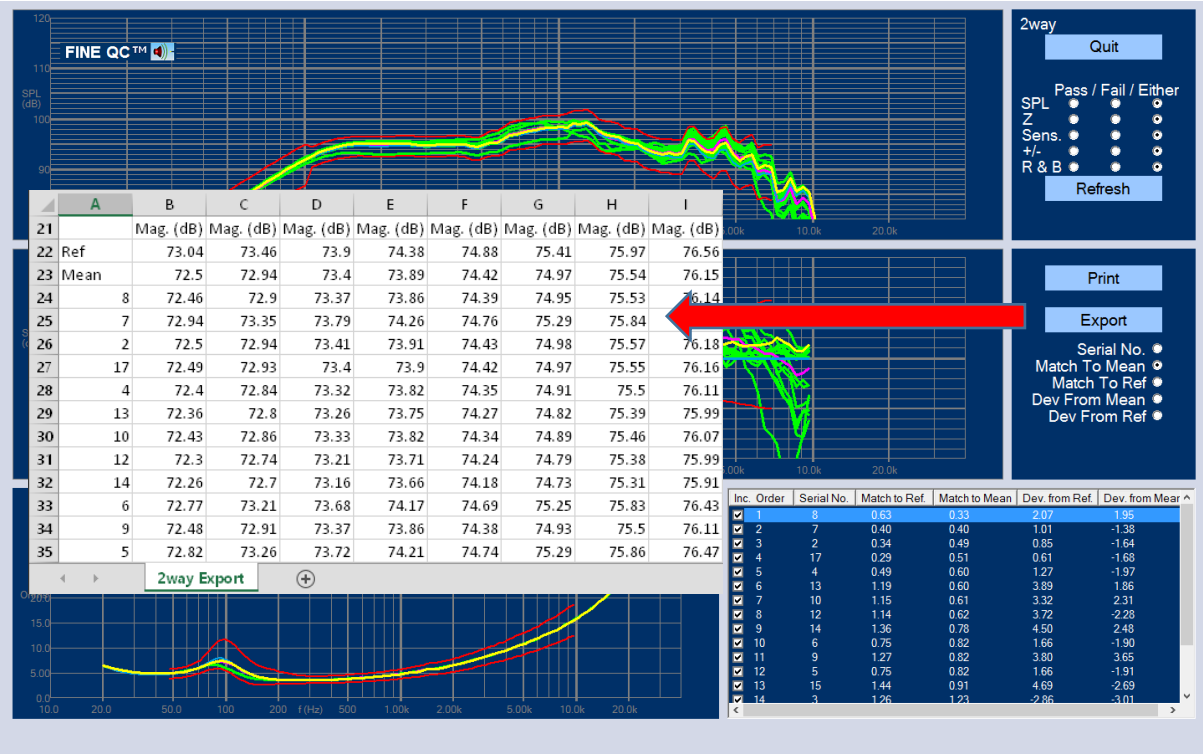
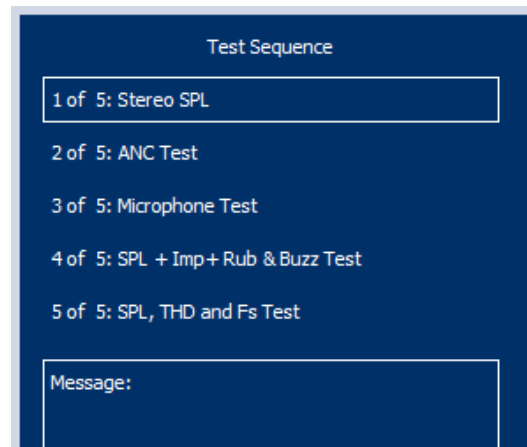


Figure 23 - Export of All Data to Excel. Choose horizontal or vertical format in Admin

# Test Setup

## 5.1. Define Test Elements

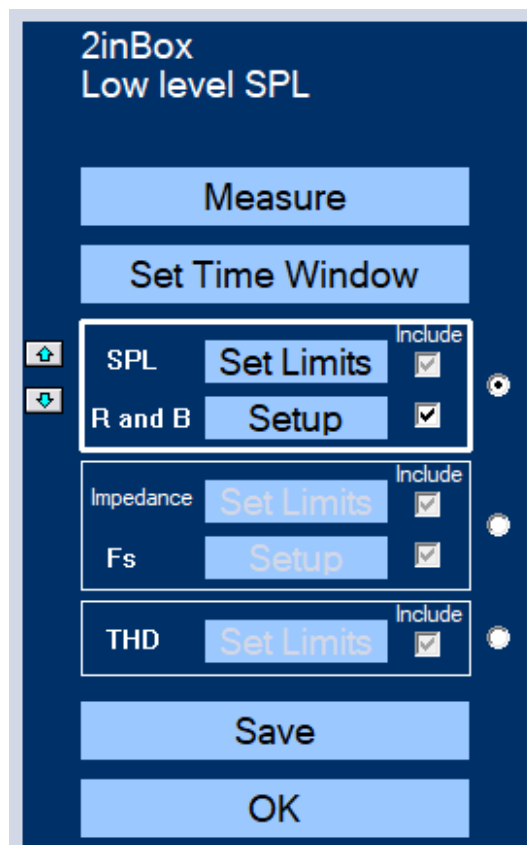
A test sequence can have many steps. Fig. 24 shows 5 steps.



The screenshot shows a window titled "Test Sequence" with a dark blue background. It contains a list of five steps, each in a white box with a blue border. The steps are: "1 of 5: Stereo SPL", "2 of 5: ANC Test", "3 of 5: Microphone Test", "4 of 5: SPL + Imp+ Rub & Buzz Test", and "5 of 5: SPL, THD and Fs Test". Below the list is a white box with a blue border labeled "Message:".

Figure 24 - Test Sequence with 5 steps

Each step can contain all the elements shown in Fig. 25

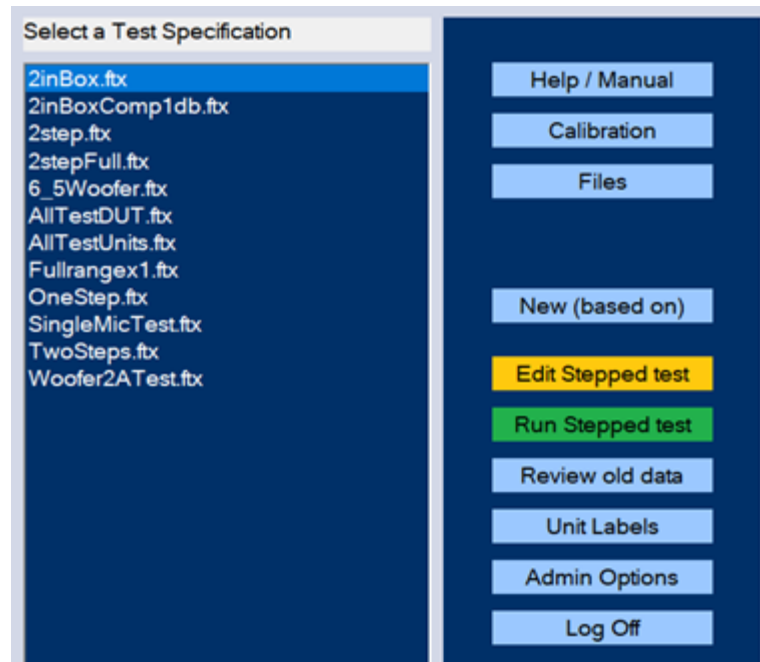


The screenshot shows a window titled "2inBox Low level SPL" with a dark blue background. It contains several sections of controls. At the top are two large blue buttons: "Measure" and "Set Time Window". Below these are three groups of controls, each with a "Set Limits" button and a "Setup" button. The first group is for "SPL" and "R and B", the second for "Impedance" and "Fs", and the third for "THD". Each group also has an "Include" checkbox with a checkmark. To the left of the first two groups are up and down arrow buttons. At the bottom are two large blue buttons: "Save" and "OK".

Figure 25 - Edit Stepped Test



## 5.2. Setup Test / Edit Limits



**Figure 26 - Test specifications selection screen**

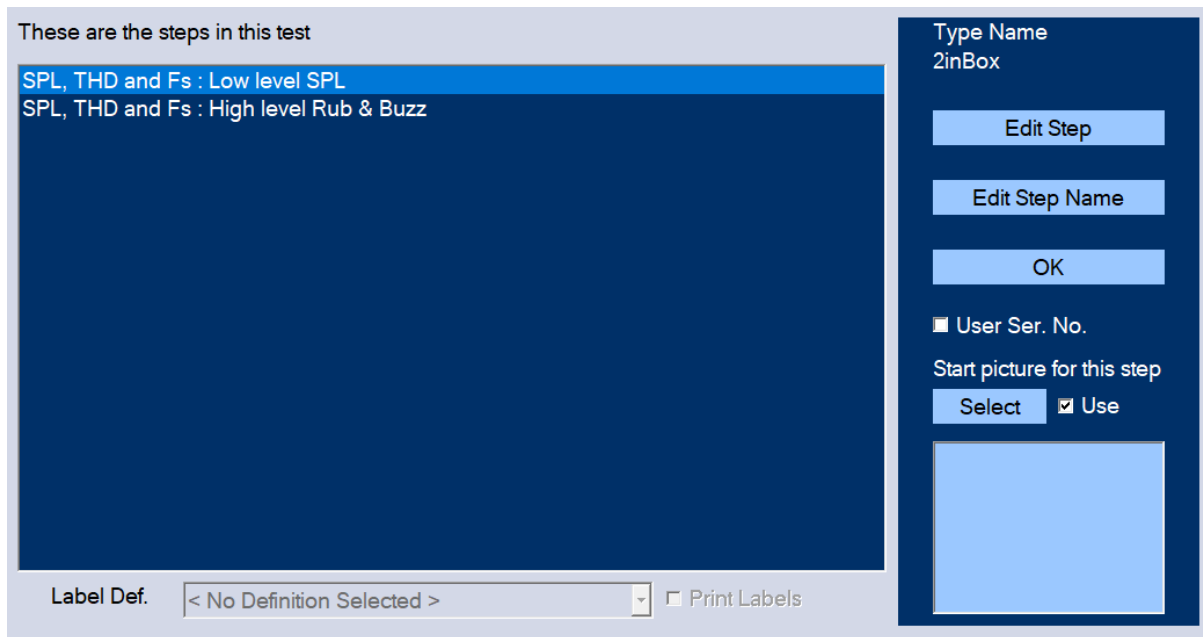
When making a new setup you should select a similar Test spec and press [New (based on)]. Fig. 25. Some of these predefined tests have as many steps as needed.

Or you can edit an existing Test spec by pressing [Edit Stepped test] even if you only need one step. Next you get the screen like Fig. 26.

Select which step you want to edit, if you have selected a multi-step test spec. Now you can continue with Edit Step Fig. 27, or Edit this step name.

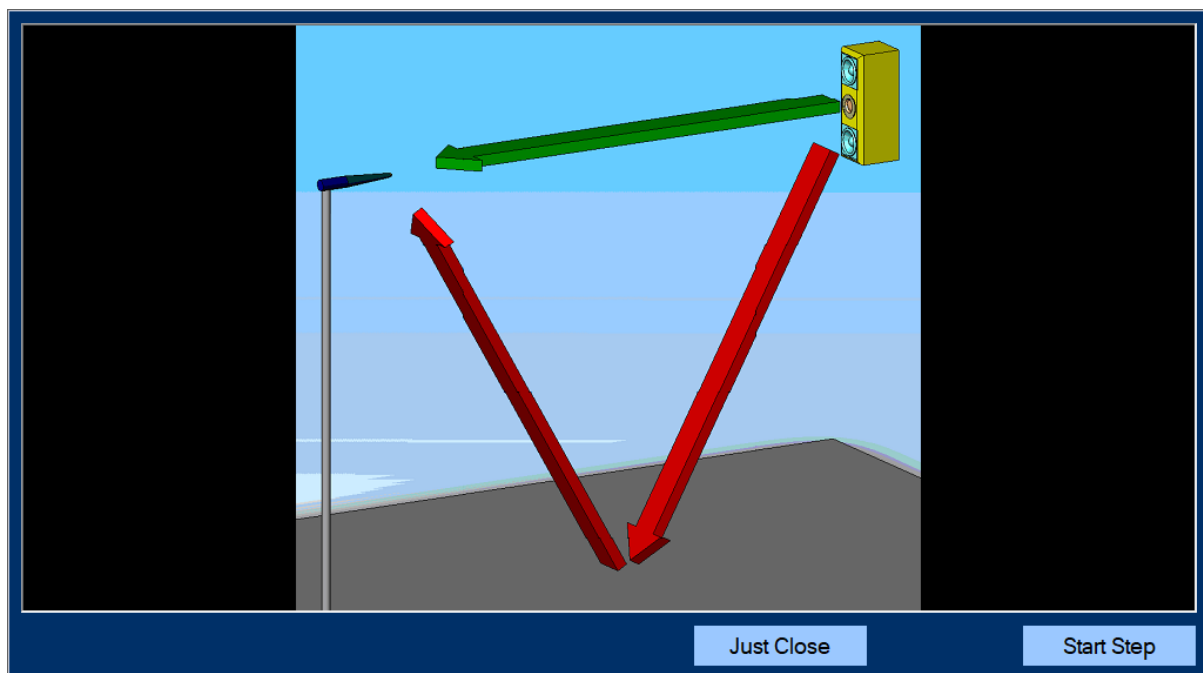
On this page you may also select the option for User Serial Number input, which will prompt for entering individual serial numbers (Fig. 20).

On the same page you can also activate printing a predefined label, see section 8.



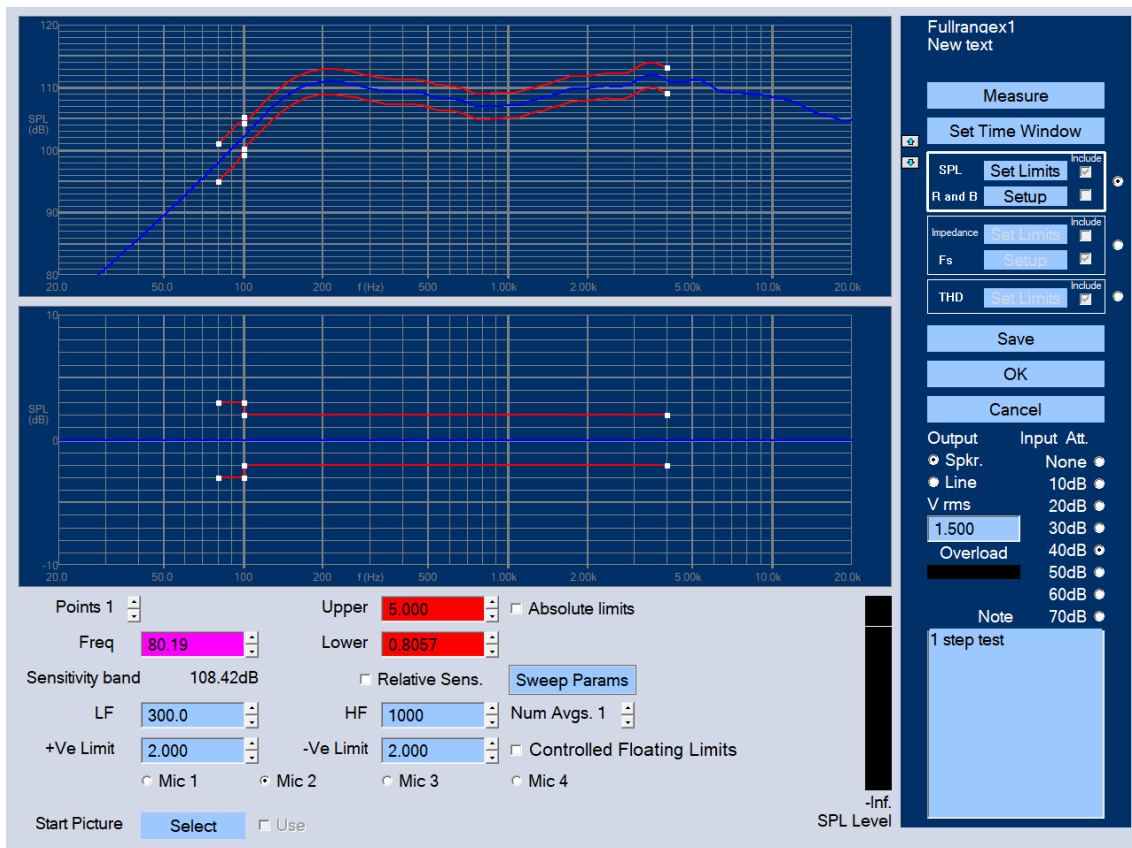
**Figure 27 - Set Serial Number option and Label printing**

#### 4.1. Insert picture / Instructions during Test




**Figure 28 - Select a picture or Instructions to be inserted in the test**

You can also in the same screen (Fig. 27) insert a picture, and/or instructions to the operator during testing. This is very useful for directions regarding for example switching outputs or similar at a specific point in the test sequence.



**Figure 29 - Edit Limits & Sensitivity Band: Edit Step**

*Note: Choose items by “Radio” buttons* 

You should start from the top, and select the items you need [ v ]. All items will be explained in the following:

Start by selecting Spkr or Line output and set the output voltage (Vrms) fig. 27. The Line Out is set at 100mV by default, so a connected amplifier may not overload the speaker. Then be sure to select one of the Microphones #1 - #3 (Mic #4 is included in the headphone socket).

You may use different microphones in other steps, for example placing a microphone close to the rear (port) of a speaker cabinet.

The Sensitivity Band (lower left) should be set for calculating the average sensitivity over a defined frequency band, in this example 108.42dB. Set the actual band by specifying the two

frequencies (here 300 – 1000 Hz) and a tolerance (here +/- 2dB). You can also select Relative sensitivity from the reference (= 0 dB).

Press [Measure] to start the sweep. Or if you need to select a different sweep, press [Sweep params] (lower center), see next.

*Note: The Limits (incl Controlled Floating Limits) are explained in section 5.5 Set SPL Limits*

## 4.2. Set Sweep Parameters

You find [Sweep params] under [Edit Step] Fig. 27. Here you can set the used sweep range and time. The main range 20 Hz to 20 kHz is default and can be used for everything.

We recommend using the predefined setup files, see section 3. You can also set a limited test range, for example from 20-5000 Hz for a woofer, or 500-20kHz for a tweeter.

The max sweep time is 2.5 seconds. A sweep time of 1second is recommend for most QCX testing. For best Rub & Buzz testing use 2.5 second sweep time, so subtle buzzing sounds are excited.

(0.1s sweep time is possible, but minimum 0.5 second is recommended, because short sweeps may not excite all Rub & Buzz and are more noise sensitive)

*Note 1: When the measuring range for example is set from 20Hz to 20 kHz, the actual sweep starts at 7.5 Hz and ends at 23 kHz for improved accuracy.*

*Note 2: USE 2 SECONDS SWEEP TIME for amplified and Bluetooth devices for avoiding Latency problems!*

*Note 3: The sweep changes are not fully active until save and Edit again or Run.*

# FINE QC

 Parameters

Start Freq  Hz

End Freq  Hz

(Sweep will be from 7.5Hz to 23000.0Hz for improved accuracy)

Sweep time  s (Includes fade times)

Pre Delay  s

Fade in time  s

Fade out time  s

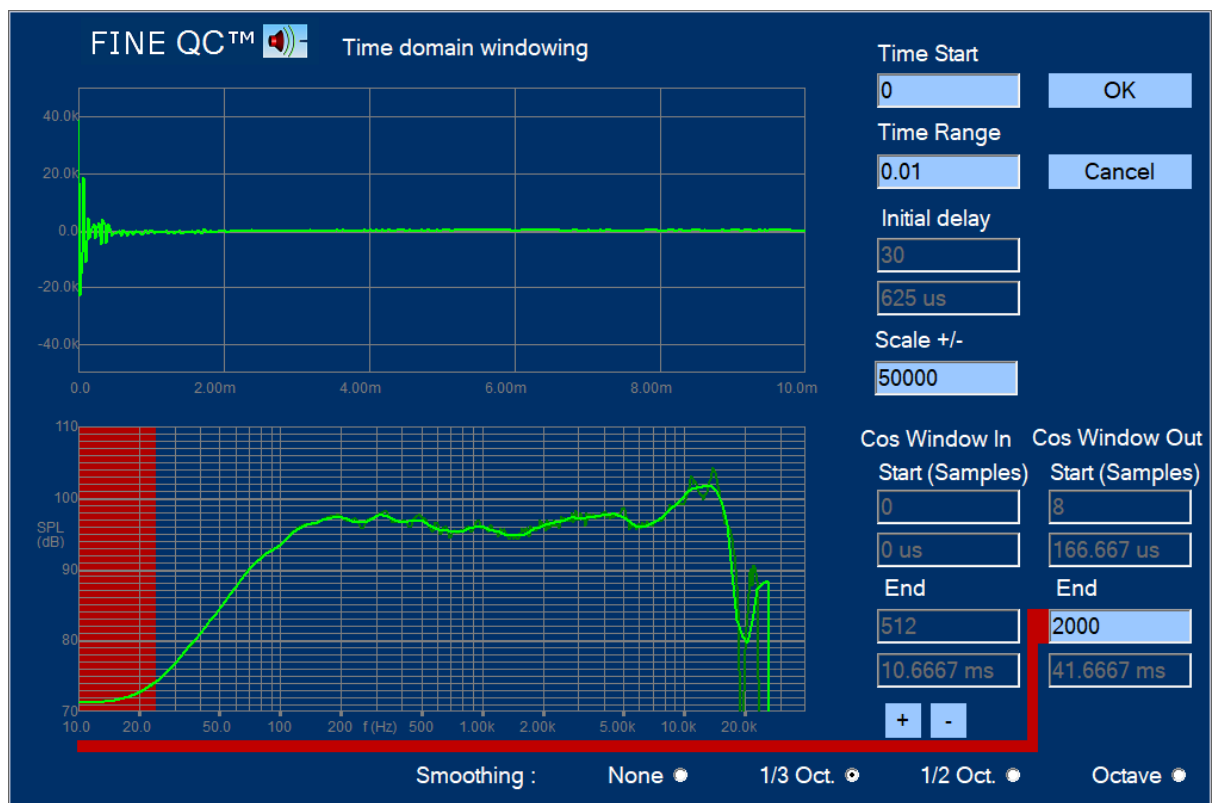
OK

Cancel

**Figure 30 - Stimulus settings**

If the Overload bar turns red, you need to change the Input attenuation. Set the attenuator to get less than -10 dB SPL on the VU meter/Bar graph

## 4.3. Set Time Window



**Figure 31 - Time Window Settings**

The impulse response is shown in the upper half and the windowed frequency response below. The upper buttons are automatically scaling the impulse response. The time before the impulse is arriving is called the “Flying Time”, which is the travel time (in air) from the

speaker cone (or actually the voice coil) until it reaches the microphone, here being ~0.63ms. The precise “Minimum Phase trigger” finds this time automatically and is on by default. Most other inputs are automatic.

*Note: If you move the microphone, you should measure again and save to reset the response.*

Therefore, we only need to care about the end of the impulse, which is indicated in the lower right field: Here was chosen 41.7mS (2000 samples) corresponding to ~25Hz (Shown in red- using the 1/f ratio) with the standard cosine/Hann window (Cos window Out).

41.7mS is a long time, but is useable in this case because a large well damped test box was used with the microphone at ~12cm distance.

*Note: We strongly recommend doing driver QCX measurements in a well-damped closed box like the LOUDSOFT Test Box (See section 11.6 LOUDSOFT Test Boxes)*

After choosing 1/3 octave smoothing the final windowed frequency response is useable from about 50Hz, showing good response from 100 Hz and almost up to 20 kHz (the unsmoothed response is shown in dark green).

## 4.4. Set SPL Limits

The limits are broken up in ranges separated by white square points (Figure 29). These can be selected and dragged individually by clicking with the mouse or by using the up/down arrows for the points. You can either just drag and move the point, or use the upper and lower fields (Red) to change the frequency and dB deviation from the reference.

| Standards    | Use                                 | Freq 1 | Freq 2 | +dB   | -dB   |
|--------------|-------------------------------------|--------|--------|-------|-------|
| User Defined |                                     |        |        |       |       |
| Band 1       | <input checked="" type="checkbox"/> | 100.4  | 199.1  | 3.000 | 5.000 |
| Band 2       | <input checked="" type="checkbox"/> | 199.1  | 1594   | 1.900 | 2.100 |
| Band 3       | <input type="checkbox"/>            |        |        |       |       |
| Band 4       | <input type="checkbox"/>            |        |        |       |       |
| Band 5       | <input type="checkbox"/>            |        |        |       |       |
| Band 6       | <input type="checkbox"/>            |        |        |       |       |
| Band 7       | <input type="checkbox"/>            |        |        |       |       |
| Band 8       | <input type="checkbox"/>            |        |        |       |       |

**Figure 32 - Full-Range SPL Template**

The limits can be specified in up to 8 bands; for example, using +/-2dB from 100-1000 Hz, which is the stable mid-band region before break-up. Then you may set another band and open it by dragging towards low and high frequencies, where we expect more deviation due to shifts in resonance frequency  $F_s$  and break-up at high frequencies (Fig. 32). The user can change the limits any time if needed.

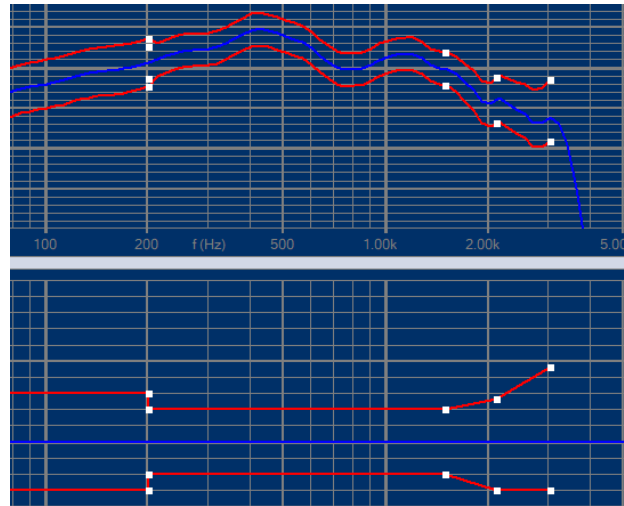


Figure 33 - Example of dragged limits 2-3 kHz

## 4.5. Rub and Buzz Setup: FINEBuzz

On the production line it is necessary to check all DUTs for bad sound. The frequency response and impedance of a driver or system may well be within limits but can unfortunately still sound bad, for example due to a rubbing voice coil or a rattle from the cabinet.

The world leading FINEBuzz algorithm is verified to fully replace human listening. Now in 3rd generation this detection method is based on the latest Danish research on hearing mechanisms, and uses an enhanced new algorithm to find the annoying sounds, which cannot be detected with conventional methods like THD, high harmonics or IM distortion. The new method is extremely sensitive and can detect even the smallest buzzing tinsel in a tweeter.

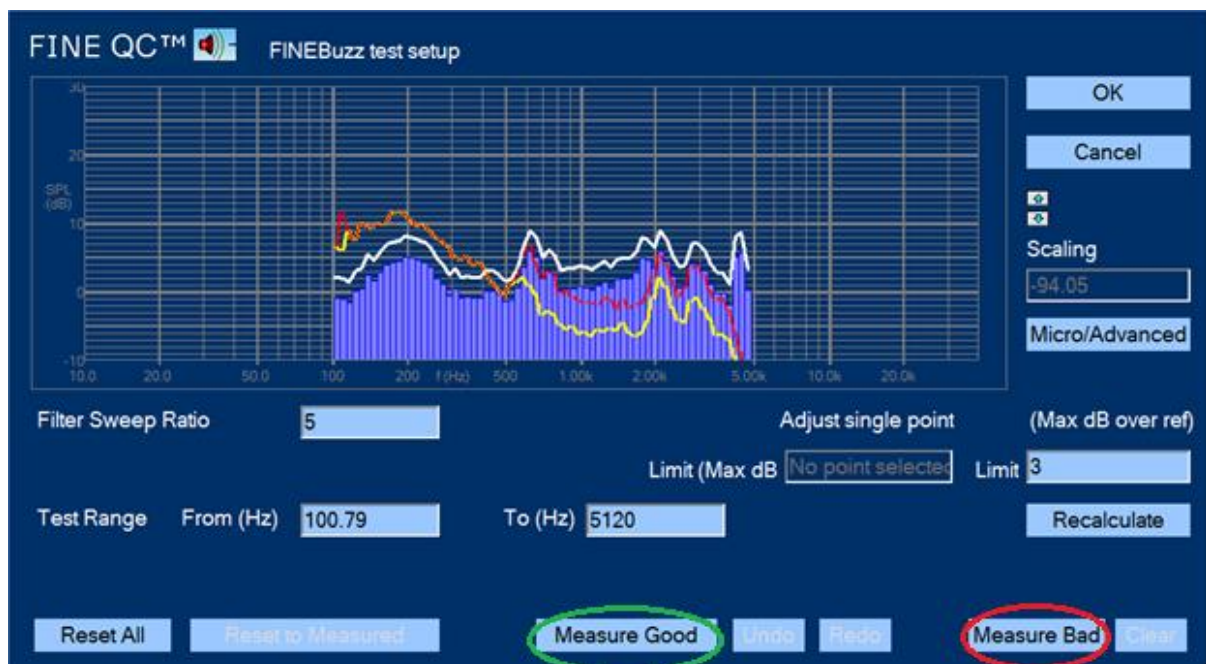


Figure 34 - FINEBuzz Setup Screen

Press “Setup R&B Test” to get Figure 34. The rub and buzz is normally concentrated at low frequencies where the driver excursion is high. These annoying sounds contains high impulses where the ear is most sensitive, especially around 1- 3 kHz. FINEBuzz has a sweeping filter to pick up the rub and buzz, which is normally set to a ratio of 5 (5x test frequency) or higher. Ratio 5 is generally recommended for most drivers and systems.

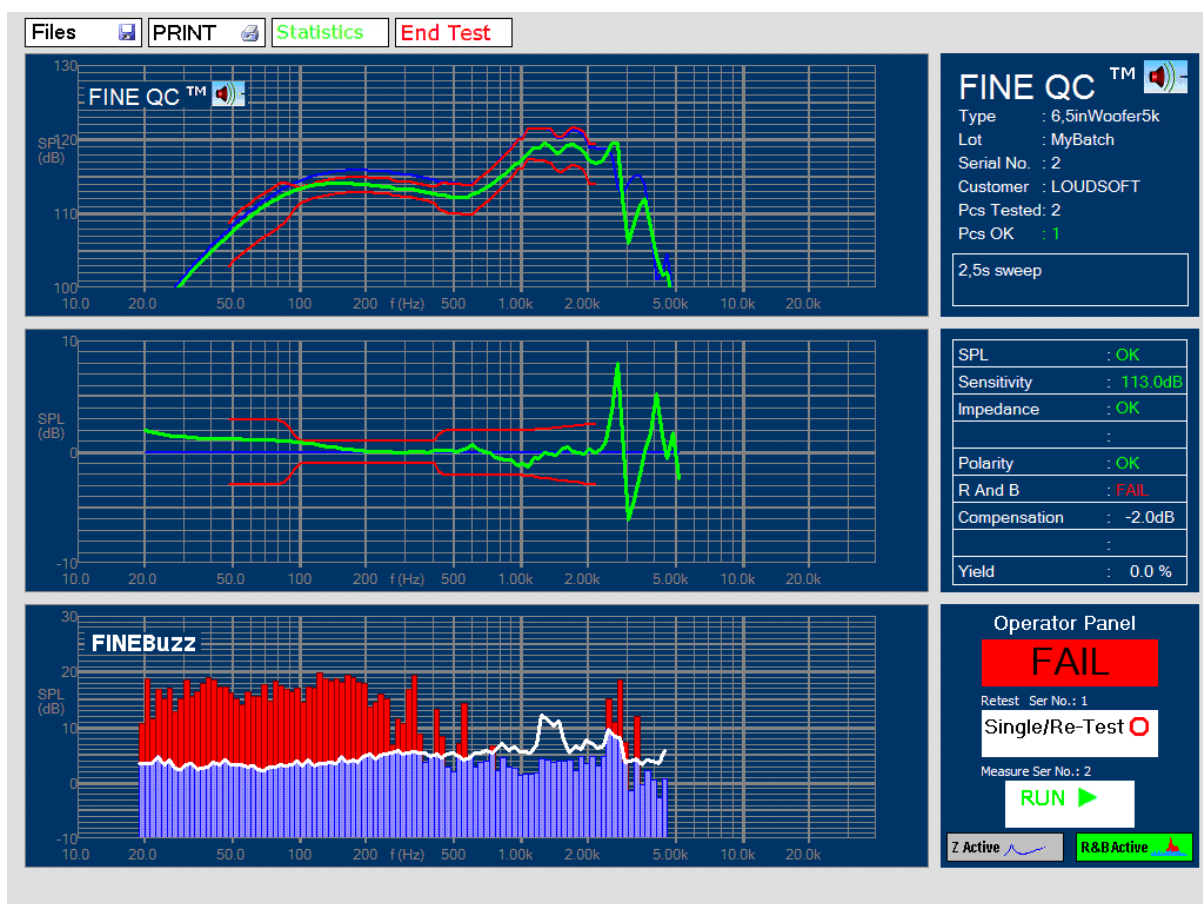
The Rub and Buzz limits are defined by measuring some good and some bad DUTs. FINEQCX will then calculate the limits. This means that you can select Good DUTs that are just good enough.

*Note: Why is the R&B (Rub & Buzz) only shown up to around 5 kHz? The highest measure frequency is ~23 kHz (~48 kHz/2), and we have set the sweep ratio to 5 here. This means that actual Rub & Buzz up to 23 kHz is displayed up to (23/5 kHz) ~4.6 kHz.*

*Lowering the sweep ratio to 3 enables you to see R&B up to 7.7 kHz, which is good for tweeters or full ranges, however being less sensitive for R&B at low frequencies.*

*(You can actually set a much higher frequency, but then you will mostly see noise in the high range).*

Figure 35 shows a woofer which failed due to a rubbing voice coil, indicated by the red columns where the rub and buzz is above the white maximum line.



**Figure 35 - 6.5-inch Woofer with Rubbing Voice Coil Found with FINEBuzz**

It is possible to test Rub & Buzz in 1 second (even 0.5s is possible, but try higher first) however we recommend using a longer sweep, because a fast sweep may not contain



enough energy to find very small resonances. Using a **2 second sweep** is recommended for amplified and Bluetooth products for avoiding Latency problems.

Likewise, the tweeter setup may be used to find small resonances like buzzing tinsels in tweeters. Figure 36 shows a tweeter with very subtle buzzing tinsel at 900Hz.

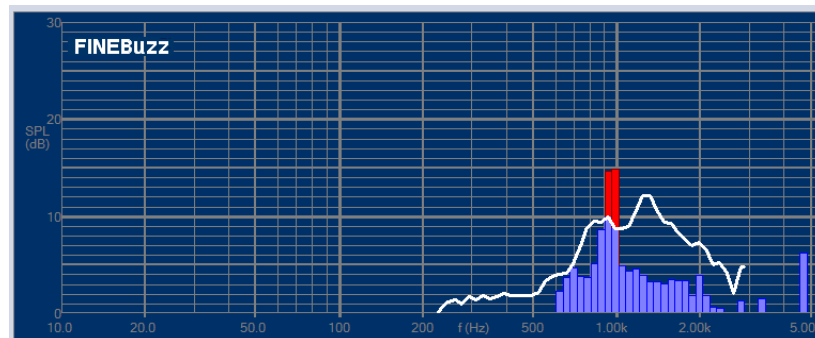


Figure 36 - Tweeter with Very Subtle Buzzing Tinsel at 900Hz

## 4.6. Set Impedance Limits

Selecting the Impedance brings up the Impedance Edit window Fig. 36.

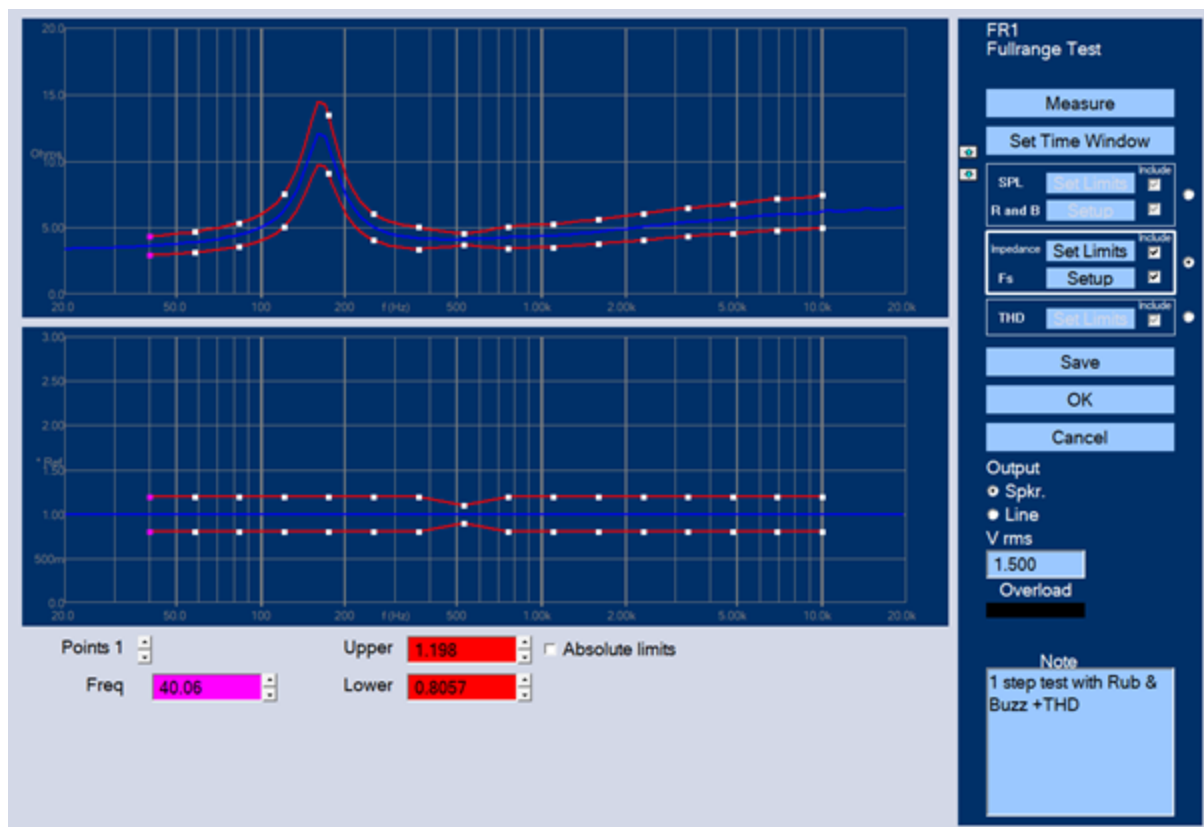


Figure 37 - Set Impedance Limits

The limits were set by selecting Set Limits, and setting just one range, for example from 40 to 10,000 Hz, see Fig. 37. However, the limits were minimized to +/-10% at 500Hz,

while the max and min ratios are 1.2 (20%) and 0.8 (80%) were chosen for all other frequencies. You may open the limits around  $F_s$ , after testing a pilot series. I may later need to open the limits to allow for variation of  $F_s$ , see Pre-prod in section 4.2.



Figure 38 - Impedance Limits Setup

4.7. Setup  $F_s$  Limits

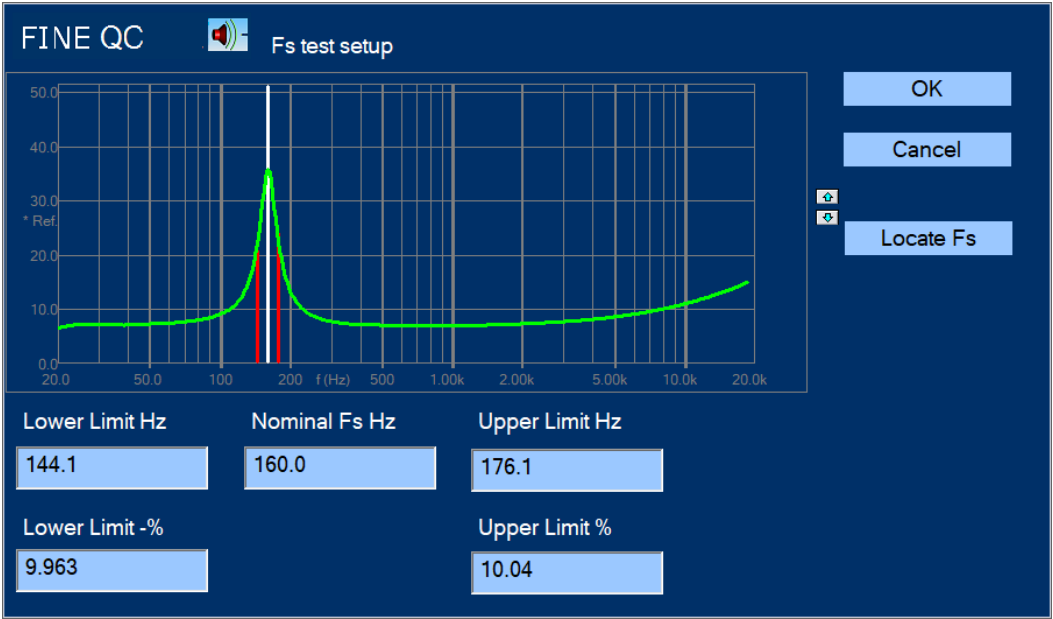


Figure 39 -  $F_s$  (Resonance) Test Setup

Also, in Impedance you can select  $F_s$  test. This feature will find the actual (Driver resonance)  $F_s$  by finding the peak in the impedance curve. Use the [Locate  $F_s$ ] to find the peak. You may have to input the approximate frequency in some cases, and then use the [Locate  $F_s$ ] again.

### 4.8. Set THD limits

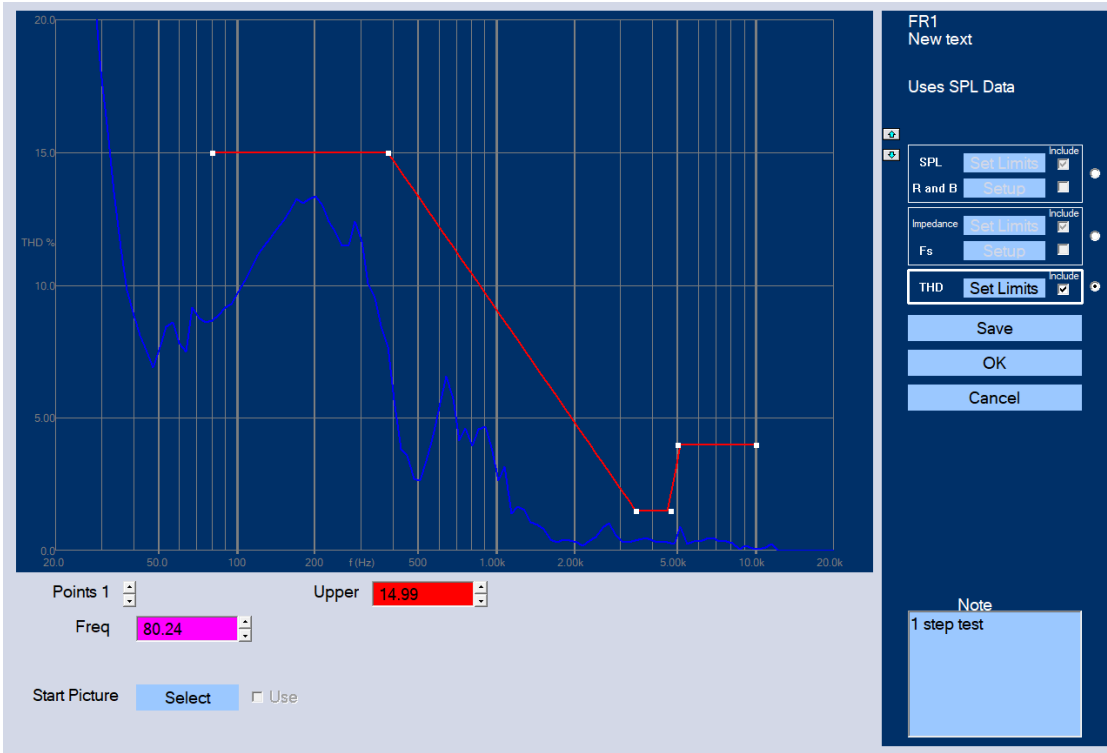


Figure 40 - Set THD Limits

The THD is calculated already from the same SPL sweep. You can set limits in the usual way in bands Fig. 40, and the (white) points can be dragged as you need.

THD may be required by standards, however please note that in contrast to Rub & Buzz, THD is not useable for deciding if the sound quality is OK (See <https://www.loudsoft.com/papers/> Fast Rub & Buzz Testing).

For deciding if the sound quality is OK you should only trust FINEBuzz.



Figure 41 - Set THD limits in bands

## 4.9. Test in a Normal Room

Figure 42 shows the response of a satellite speaker tested at 1m in a normal room with the microphone in line with the tweeter, which is the normal listening axis. The tweeter of the speaker was only 82cm above the floor. Note that the low-end response is limited around 300Hz. This is unfortunately not the true response, but the result of a poor measurement.

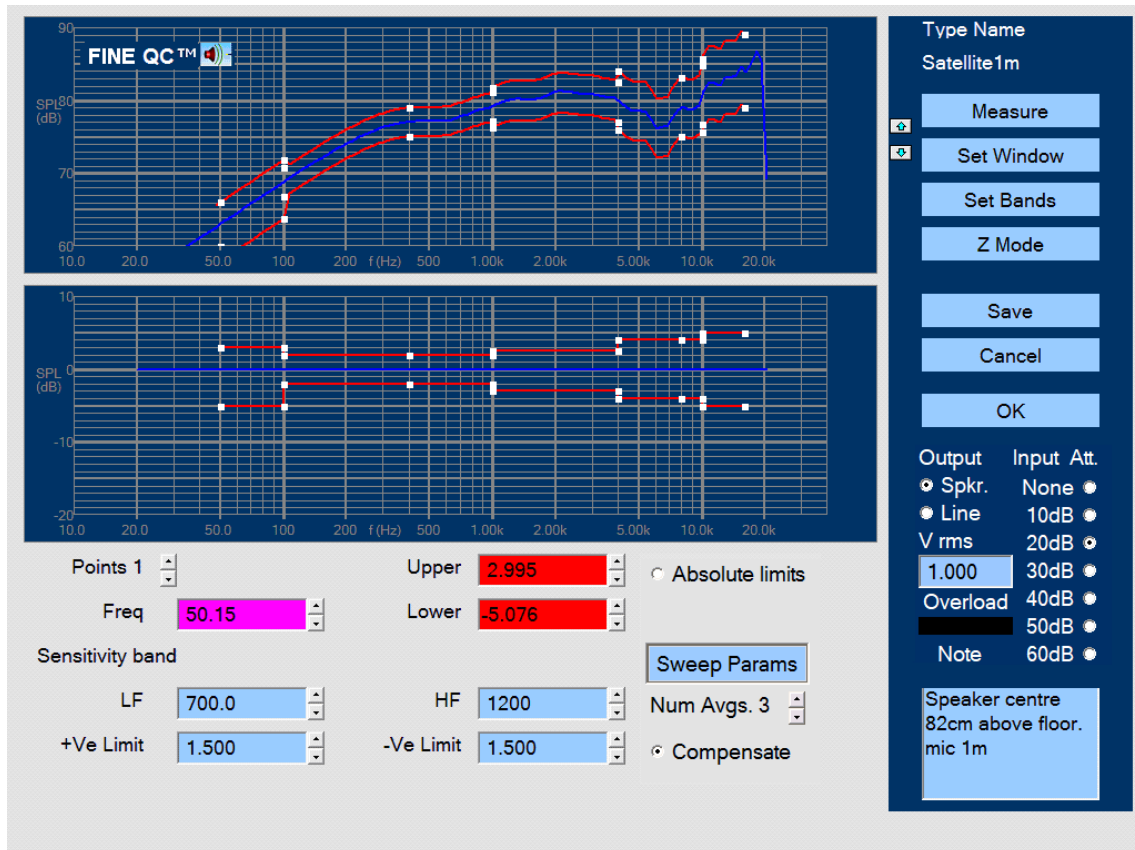


Figure 42 - Satellite Speaker Tested in Normal Room at 1m

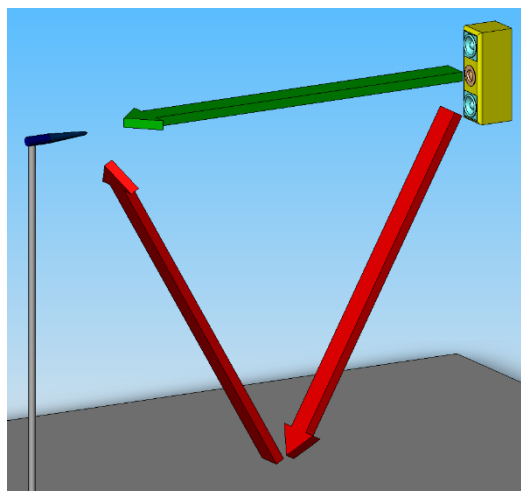
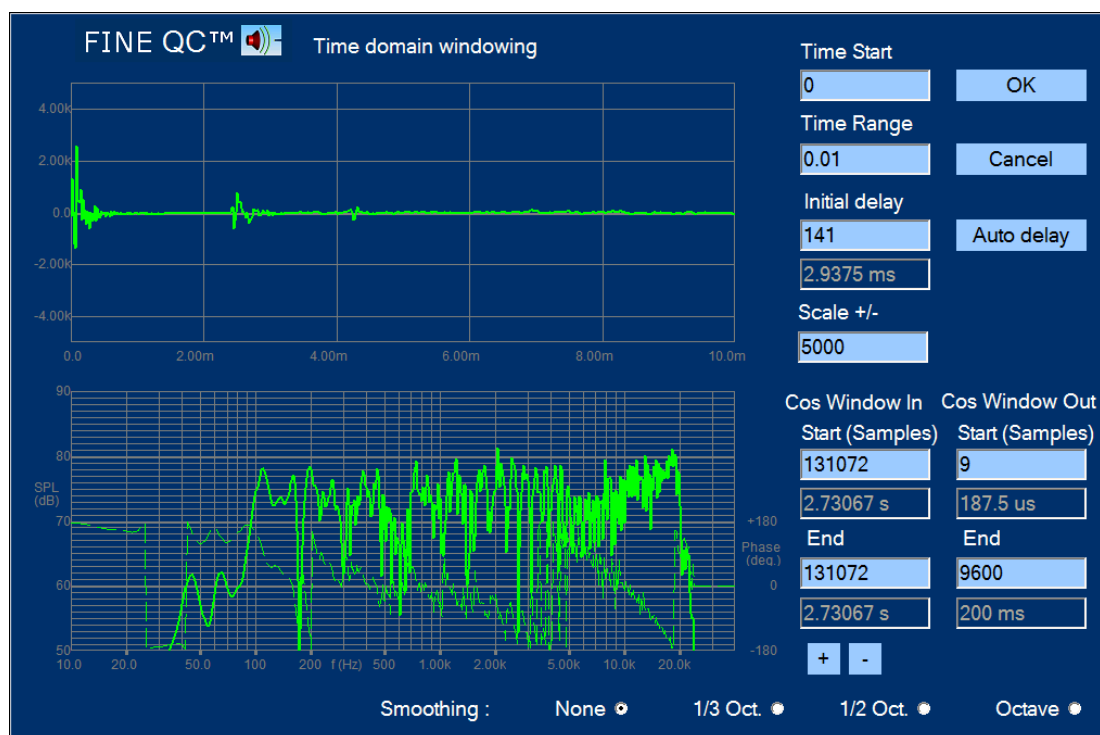


Figure 43 - Satellite Close to Floor, Red is Reflection

Figure 43 is illustrating the problem where the reflection from the floor is too close to the main signal, because there is little difference between the direct distance (green arrow) and the reflection path (red arrows). We can do two things to improve that: Move the microphone closer to the speaker and/or move both speaker and microphone further away from the floor (or other surfaces).

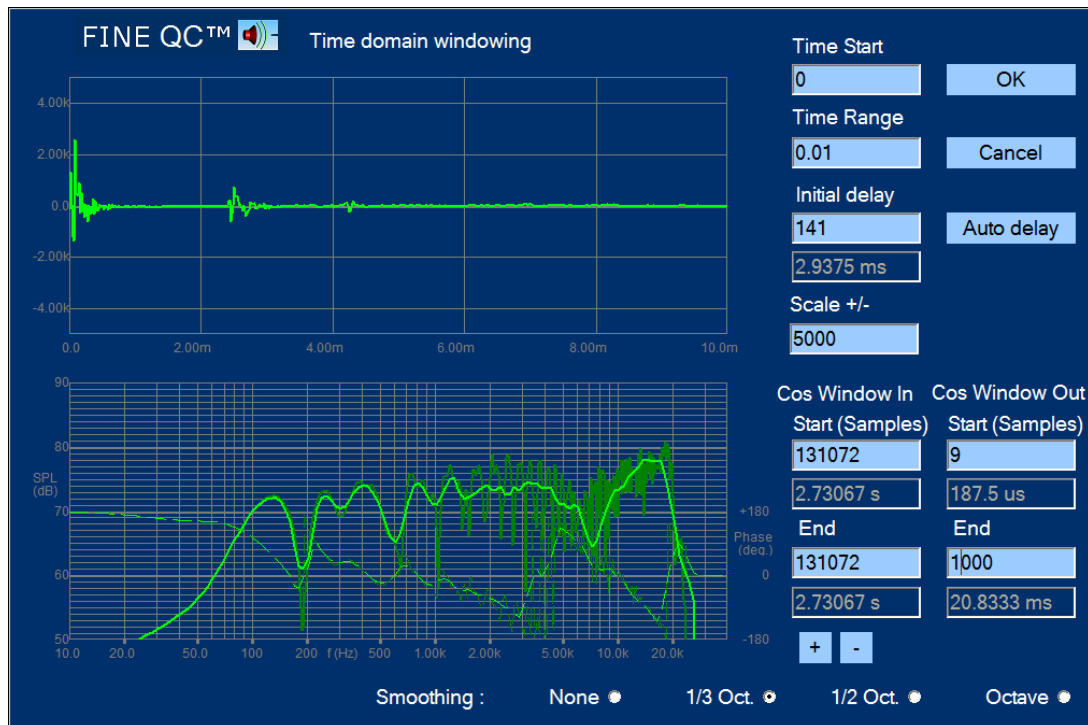
The Time domain impulse response of the satellite is shown in Figure 44. The main impulse is arriving after approximately 3mS corresponding to ~1m (the speed of sound is ~343m/s or 0.343m/mS).

However, you can see another strong impulse arriving already about 2.5ms after the main impulse. That is the reflection from the floor (red arrow in Fig. 43), which is only 82cm below the speaker and microphone, as shown in Figure 43.



**Figure 44 - Time Response of Satellite at 1m Microphone Distance and 82cm above Floor**

The short time between the two impulses is the reason for the poor low frequency response. Using the 1/f ratio the 2.5ms will only allow 400 Hz as the lowest frequency. Since we are using a cosine window, we may extend that to 2.7-3mS, but that does not really help.

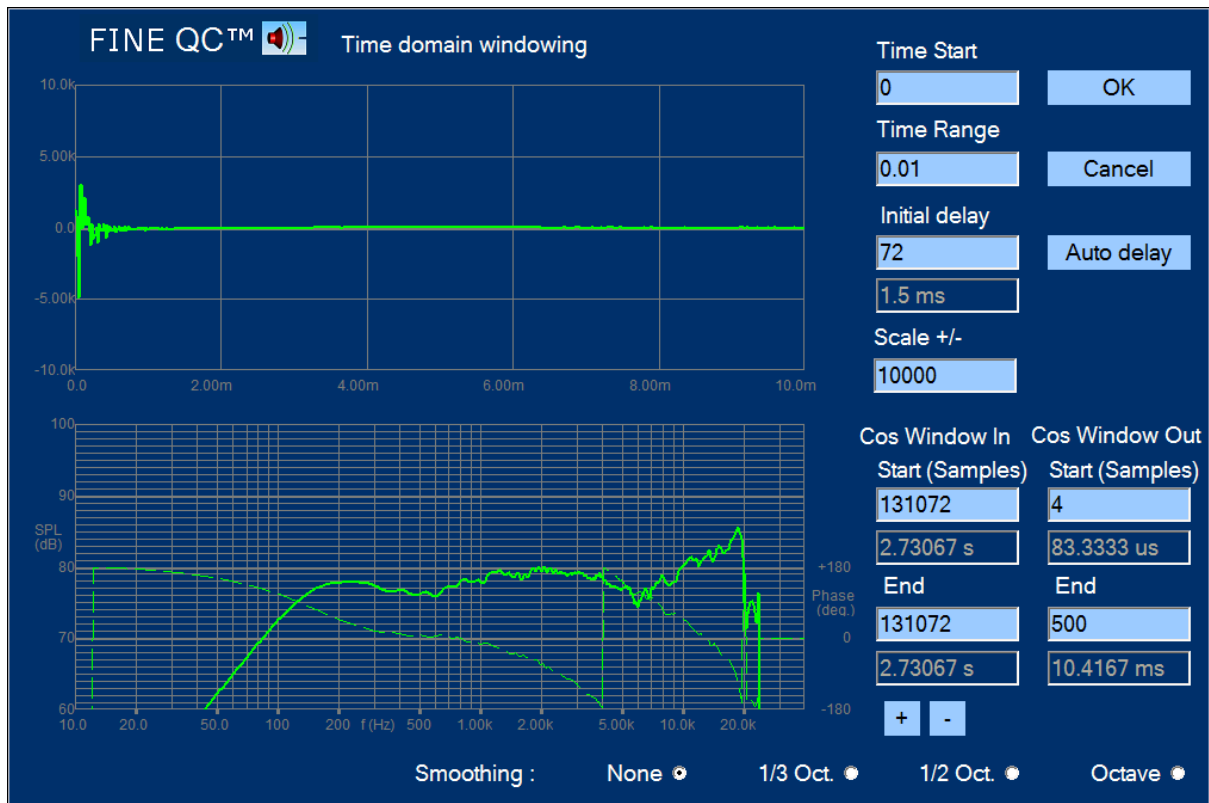


**Figure 45 - 1/3 Octave Smoothing of Frequency Response (Unsmoothed in Dark Green)**

The frequency response in Figure 44 is quite ragged due to the reflections. You can apply smoothing to view the response anyway as in Figure 45, where 1/3 Octave smoothing was chosen. Comparing with the unsmoothed response which is shown behind (dark green), you can still see the dips in the response at low frequencies, but it is possible to use such a (bad) response for QCX-testing.

The dips and peaks can be leveled out by further smoothing up to 1/1 Octave, but that is not recommended, because you also hide most of the response problems you want to measure in the QCX-test.

*Note: You can use the smoothing feature for room measurements, by including all reflections. Set the Cos End to max (~9600/200ms) and select for example 1/3 Octave smoothing. This way you can measure the actual response at the listening position or anywhere in the room, to estimate the room modes. This is particularly useful for positioning of loudspeakers and/or applying damping or room equalization (EQ).*



**Figure 46 - Satellite and Microphone moved 154cm above floor, Microphone Distance 0.5m**

The optimal solution, however, is shown in Figure 46, where both the microphone and speaker has been moved up to 154cm from the floor (the distance to the other walls and ceiling was equal to or greater than 154cm). Because the speaker is having the drivers quite close it was safe to adjust the microphone distance to 0.5m. Due to these precautions, this time we get the reflections much later and can use a window of 10.4ms. Therefore, we get the real low frequency response of the satellite, starting from approximately 150 Hz.

## 4.10. Subwoofer in Near Field

Use Based on: Subwoofer.fts for measuring small and very large woofers either at 1cm or say ~10cm distance for 10-18in woofers. The same setup can be used for active/amplified subwoofers by selecting Line Output. Then connect the Line out to the amplifier input.

This example is an 8-inch amplified subwoofer, which was measured using the Near Field measurement method keeping the microphone very close to the **center** of the cone fig. 47. This method is quite powerful and will show the full low-end response as if the speaker was placed in a very large baffle (~infinite baffle). The only drawback is that the response is only valid at low frequencies (below break-up). The -1dB limit is around 500 Hz for an 8-inch woofer, so the subwoofer response and sensitivity can be measured well, and if measuring a subwoofer driver, the roll off can be estimated.

The time domain response is shown in Figure 47, and no reflections are observed. In fact, the full default 200ms was set to enable measurement down below 20Hz. A test screen for a 8-inch subwoofer driver is shown in Figure 48. The limits are tight from 100-500 Hz which is the piston range before break-up. The sensitivity is measured as an average from 100-400Hz.

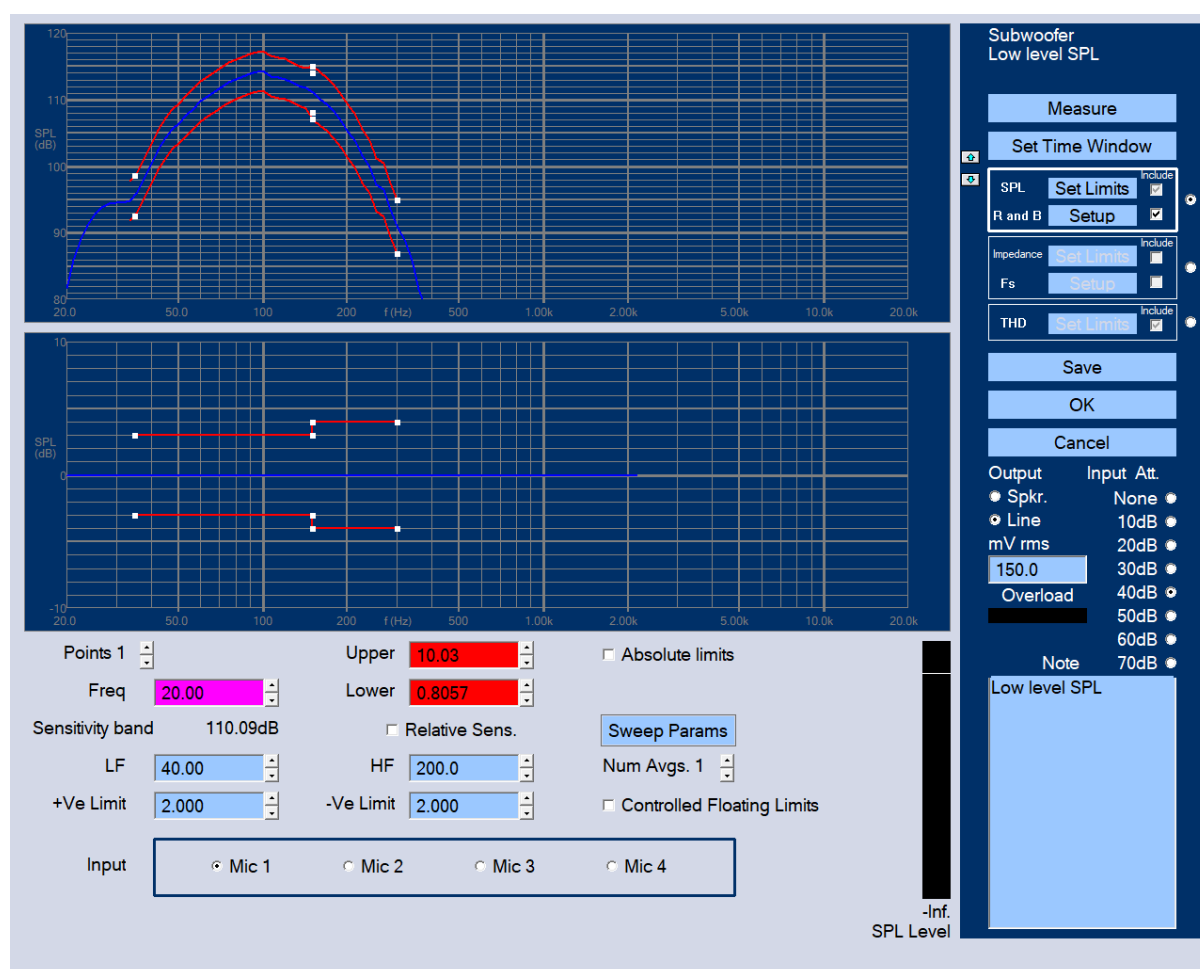


Figure 47 – Amplified Subwoofer Measured in Near Field



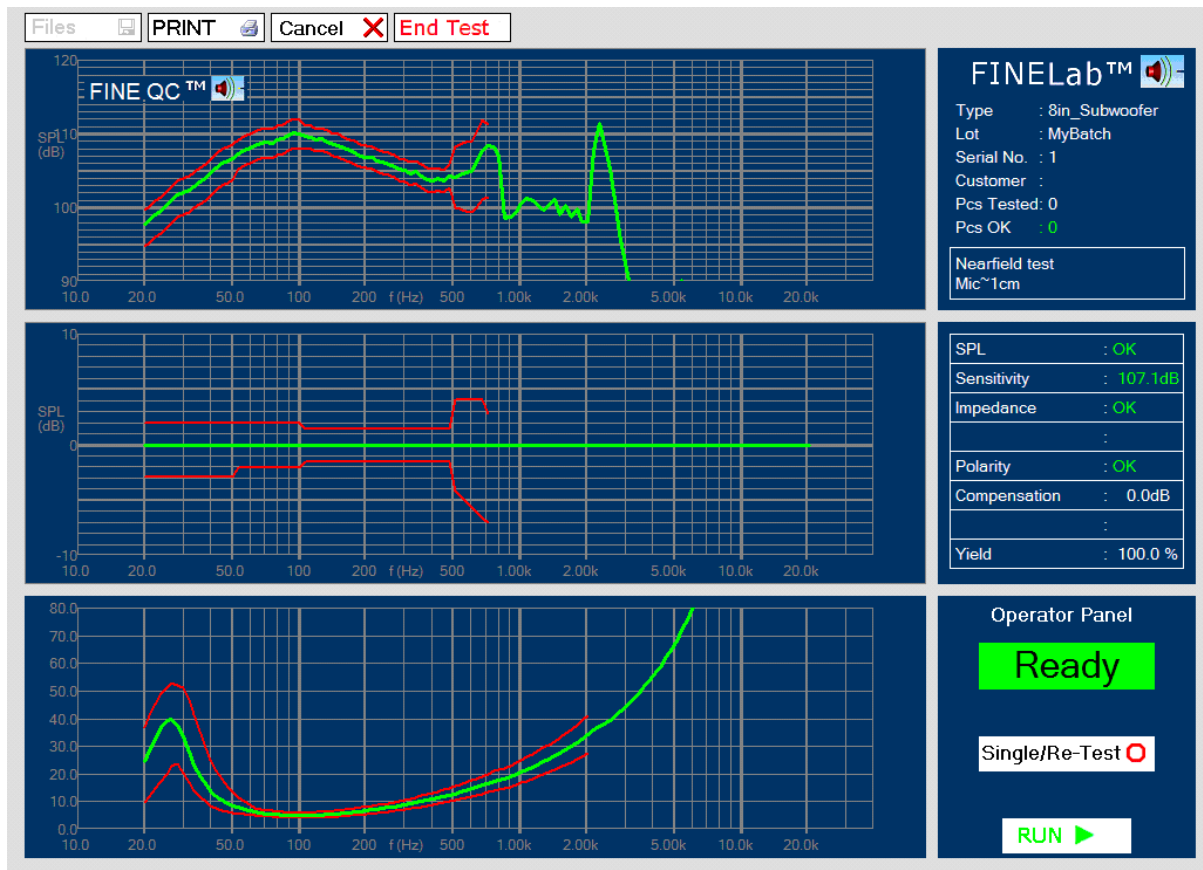


Figure 48 - 8-inch Subwoofer Test in Near Field

## 4.11. Smart Speakers / Bluetooth Testing

Smart speakers like wireless Bluetooth Speakers used to be difficult to test at the Production Line because of the latency problem. The new FINE QCX hardware generation does not have this problem and you can measure Bluetooth devices just like normal speaker systems.

Use Based On, and select BT-speaker.fts. Then connect a Bluetooth Transmitter to the Headphone mini-jack output (or Line Out XLR) as shown in Figure 49. You must first select pairing and wait for that to happen. Thereafter you can test as normal. The accuracy of the Bluetooth test is very close to the normal high accuracy of FINE QCX. Using a **2 second sweep** is recommended, for avoiding latency problems.

Rub & Buzz testing is recommended for good sound test, while THD is not recommended. (see also section 4.8)

*Note: We recommend the Avantree Audicast for low latency Bluetooth measurements.*

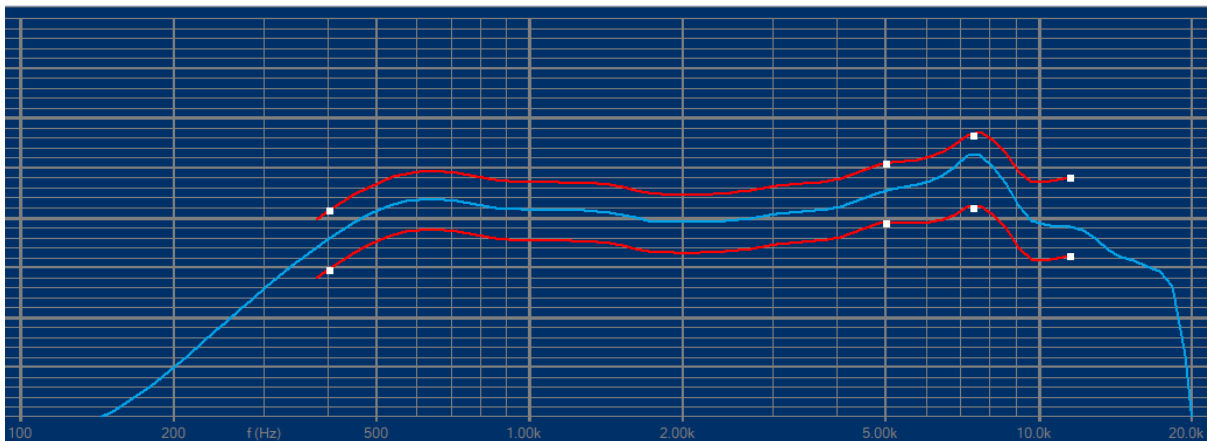


**Figure 49 - Bluetooth Transmitter connected to Headphone output**

## 4.12. Micro Speaker/Receiver Testing

FINE QCX is ideal for measuring micro speakers or micro receivers in high speed production.

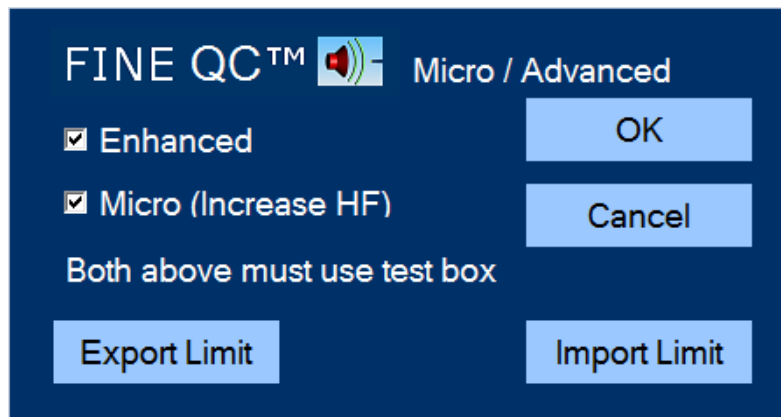
Start with [Based on] Micro-Receiver.fts and measure SPL like Figure 50.



**Figure 50 - Typical Micro Receiver test setup in FINE QCX**

WE STRONGLY RECOMMEND USING A TEST BOX when measuring micro speakers in production End of Line test! You also select “Micro Test” (Figure 51) to enhance detection of subtle Rub & Buzz.

Selecting the MICRO/ADVANCED button brings up 2 choices:



**Figure 51 - Select "Micro Test" and "Enhanced" for most sensitive Rub & Buzz test**

1. The Enhanced option is the most sensitive, and uses the new extremely sensitive 3rd generation FINEBuzz Rub & Buzz method.
2. The Micro option will increase focus on the high frequencies to catch subtle Rub & Buzz often found in micro speakers.

Extensive testing with 1000s of micro speakers in Chinese factories has verified that FINE QCX testing has successfully replaced the human testing by ear.

*Note: LOUDSOFT has designed special test boxes to be used for End of Line QCX testing in production both for large, medium and micro speakers. Drawings are available from the FINE QCX installation (Documents).*

### 4.13. Files / View

You can always open saved responses from the File menu fig. 52.

The measured data are stored here (default):

**C:\FINEQCXBatchData**

Each test batch is saved in a folder with the name of the batch. The measured SPL of ALL tested drivers are automatically saved. You can open the files and view SPL and impedance.

The best way to view measurements are the Enhanced Statistics, section 4.2, where you can find the Golden average DUT and match all tested DUTs.

From here responses can be exported in the \*.lab format used in all LOUDSOFT software. This way you can import measured responses into FINECone, FINE R+D, FINEBox etc.

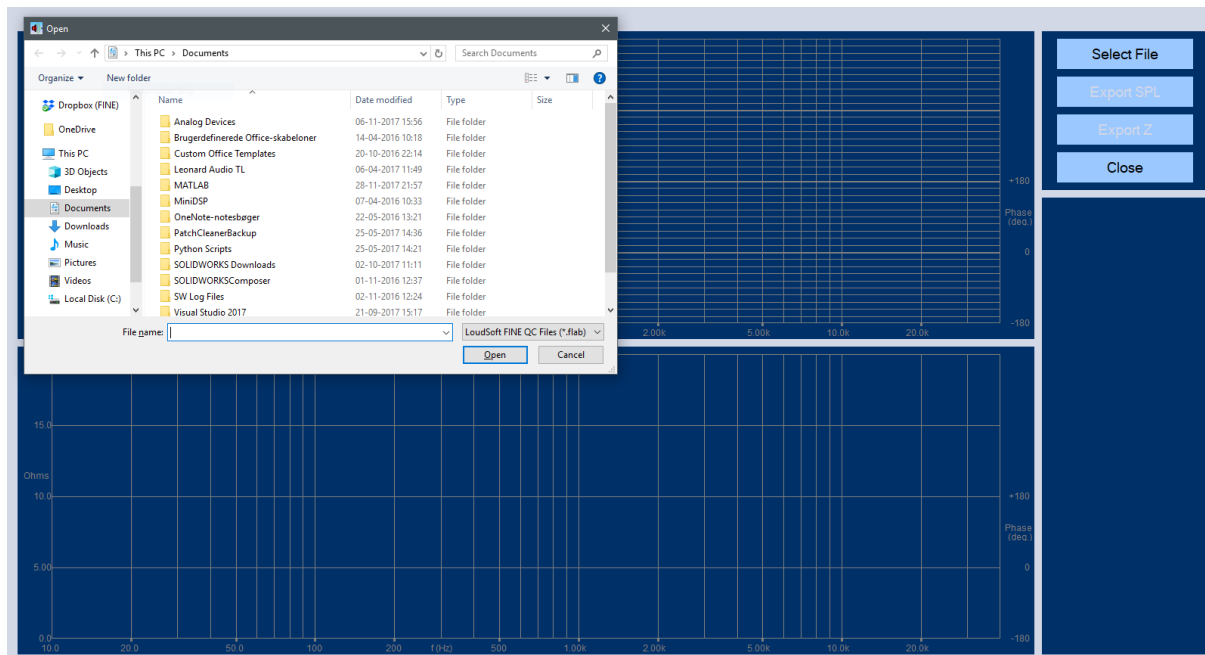


Figure 52 - File View

## 5. QCX Test of X-over circuits



Figure 53 - A generic crossover

### QCX test of cross-over circuits:

Please connect the cross-over circuit as shown in Figure 55. You must connect resistors instead of loudspeaker drivers for QCX check. Only then you can measure the total x-over voltage and valid impedance curves.

*Note: The total measured voltage curve will be different from the curve measured with real loudspeakers as these have varying impedance curves!*

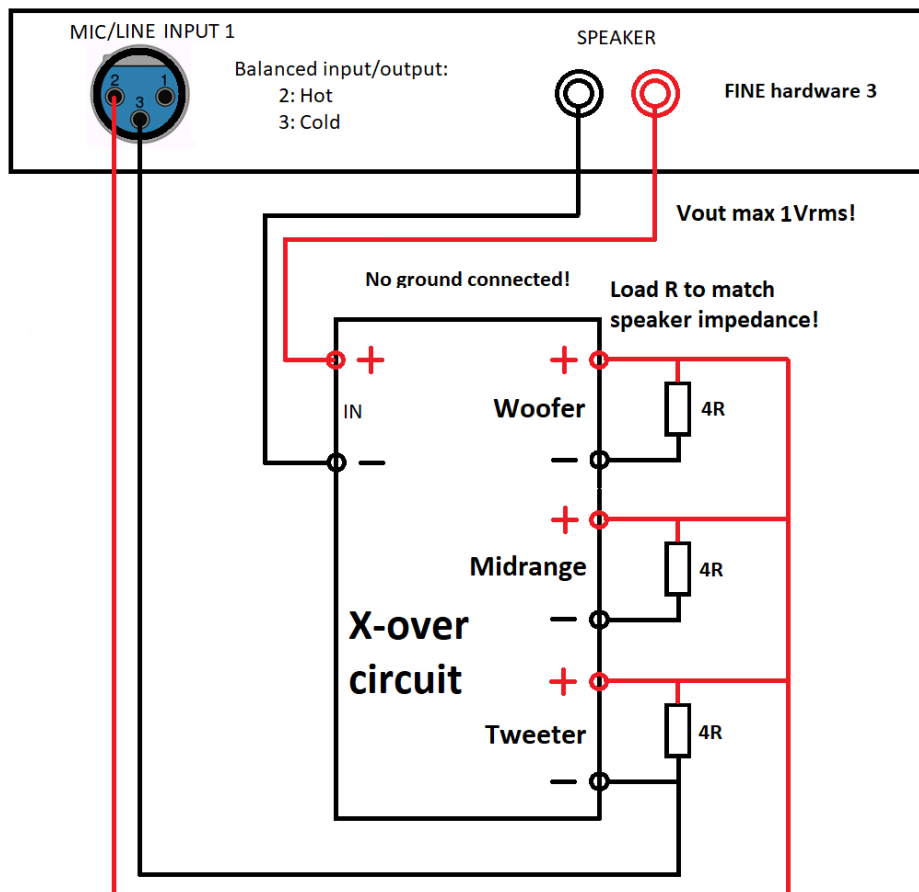


Figure 54 - QCX test of X-over (Cross-over) circuit. Remember load resistors

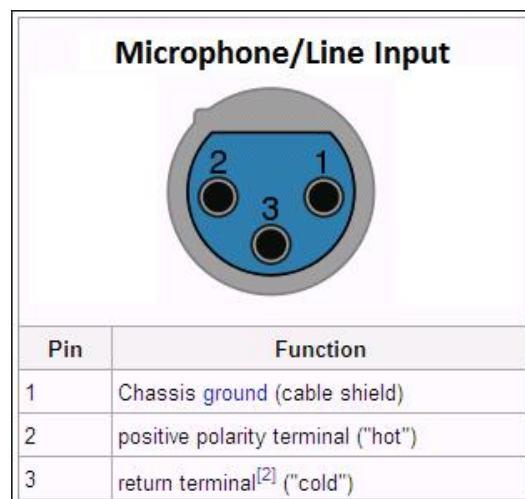


Figure 55 - XLR pin layout

Fig. 55 shows the internal pin connections in the XLR connector used in the 3 Mic/Line inputs.

## 6. Measuring Amplifiers and Electronics

Electronic measurements of amplifiers and other electronics is quite easy with the advanced FINE Hardware3. Just connect the amplifier input to the balanced Line Out XLR, using **only** terminal 2 (Hot) and terminal 3 (cold), see Figure 56. Then make a connection from the amplifier output to the Microphone1 input using **only** terminal 2 (Hot) and terminal 3 (cold), see the diagram in Figure 56.

Select [Based on] Amplifier\_Test.fts, for measuring all amplifiers and electronics. If the device is wireless / Bluetooth you can test normally, but see section 4.11 regarding BT testers.

DO NOT CONNECT TO CHASSIS / GROUND!

KEEP THE OUTPUT LEVEL LOW in order not to overload the amplifier and connected speaker! You **must** use the attenuator in Fig. 57 for high voltages, max  $V=40V$  ( $=400W/4R$ ).

Fortunately, the Line out signal is 100mV by default, which you can then change after considering the amplifier gain. Normal gains are around 30dB, causing  $\sim 3V$  output for 100mV input.

You can also measure unbalanced using the Hot (2) for signal and the Cold (3) for return (ground) terminals in the XLR connector. DO NOT CONNECT TO CHASSIS / GROUND!

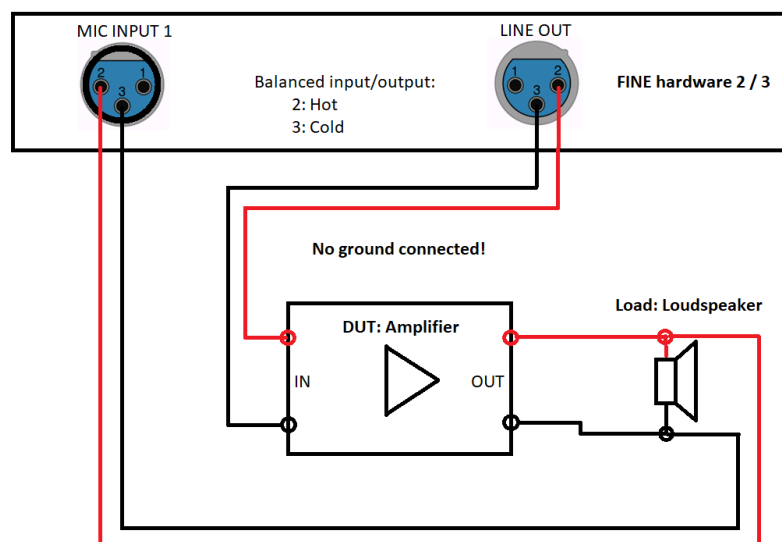
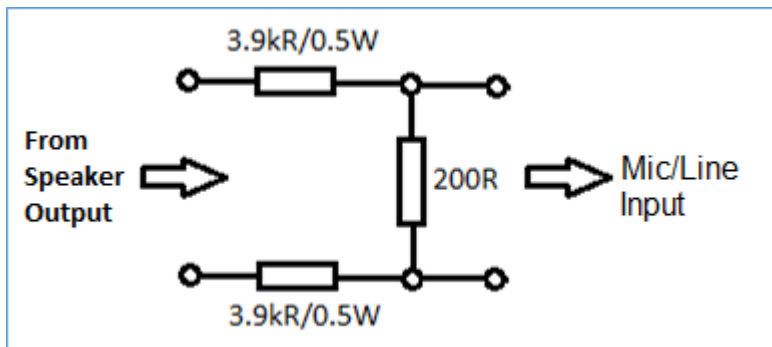


Figure 56 -- Electronics Testing: Amplifier connection diagram

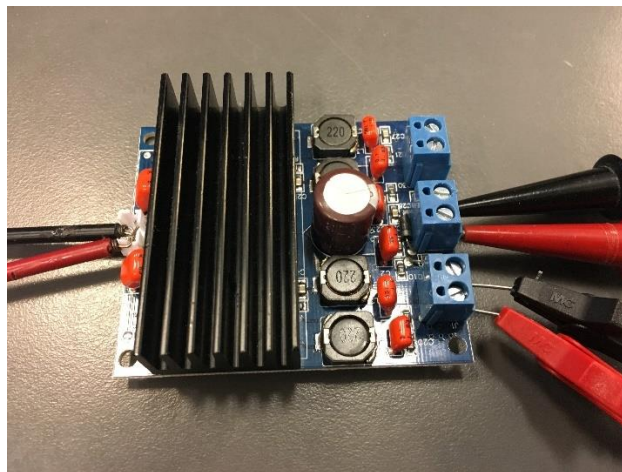


**Figure 57 - Attenuator for High Power Amp Test. Max V=40V input (=400W/4R)**

When you want to measure high power output from the amplifier, you must insert an attenuator as shown in Fig. 57. Connect the left side to the amplifier output.

This simple circuit is balanced and attenuates approximately 40x (~32 dB).

Max Voltage =40V input (=400W/4R)



**Figure 58 - Small (Class D) amplifier measured with FINE QCX**

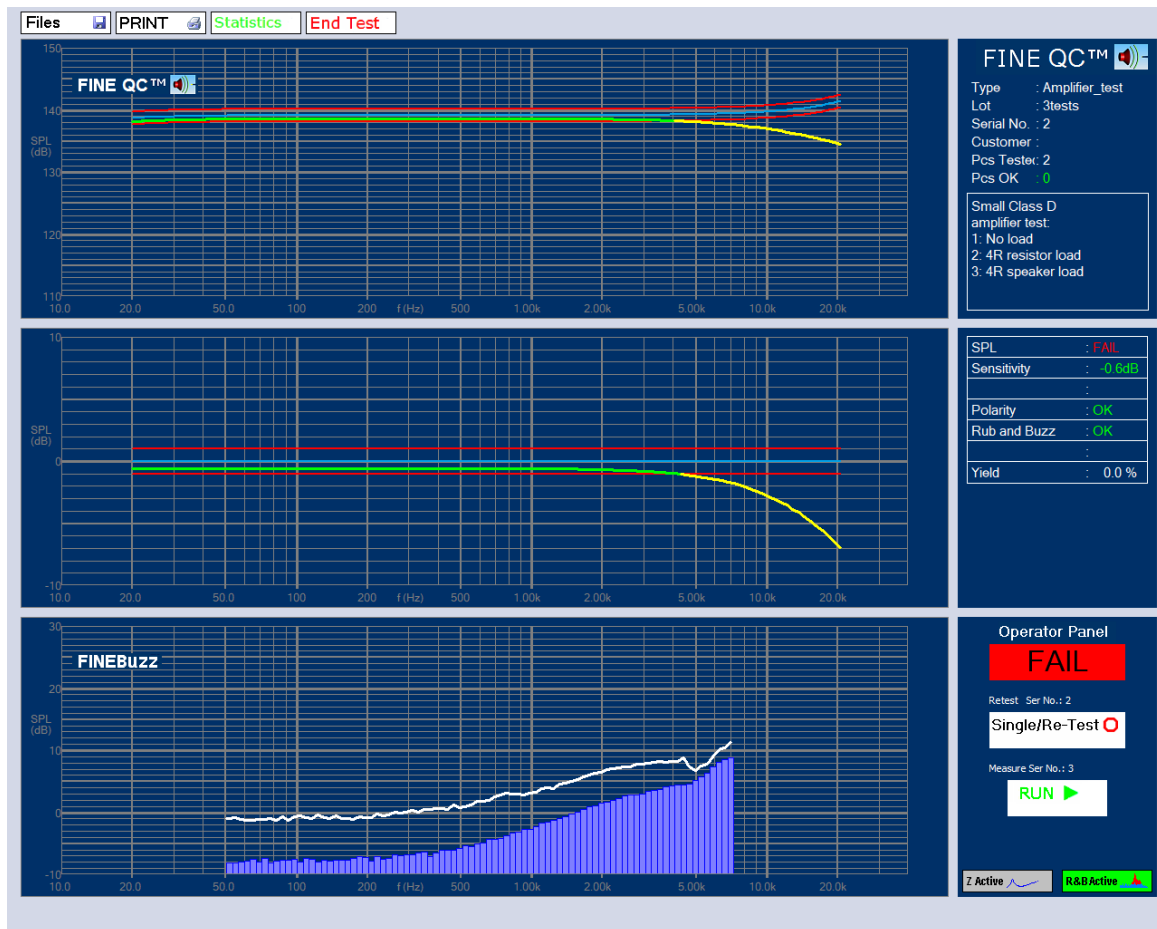


Figure 59 - Amplifier Test: #2 failed with 4R load

The small (Class D) amplifier in Figure 58 was tested with 3 different loads: #1 (No load), #2 (4R resistor), and #3 (4R loudspeaker). Figure 59 shows #2 test, which failed because the 4R load changed the frequency response. #3 was also different due to the 4R loudspeaker load (not shown). Testing amplifiers with real loudspeaker loads is very important and revealing.

## 6.1. Microphone Testing

FINE QCX can test microphones fast and easy. You need a good wideband speaker or speaker system. First select [Based on] Mic\_Test.ftx setup and measure the frequency response using a good reference microphone, (Blue Ref curve in Figure 61).

The frequency response of the wideband speaker using the Reference microphone is shown in the center window. This response is now used as reference (flat blue curve) in the upper window. This way we measure the Difference from the REF microphone. The sensitivity was specified as Relative (from Ref).

Run the test with the microphone(s) you want tested, see Figure 61. Now the green curve is the measured response of your microphone with limits. Sensitivity was -1.2dB, while the curve was using Controlled Floating Limits.

Rub & Buzz was also measured, which is a better indicator for good sound than THD.



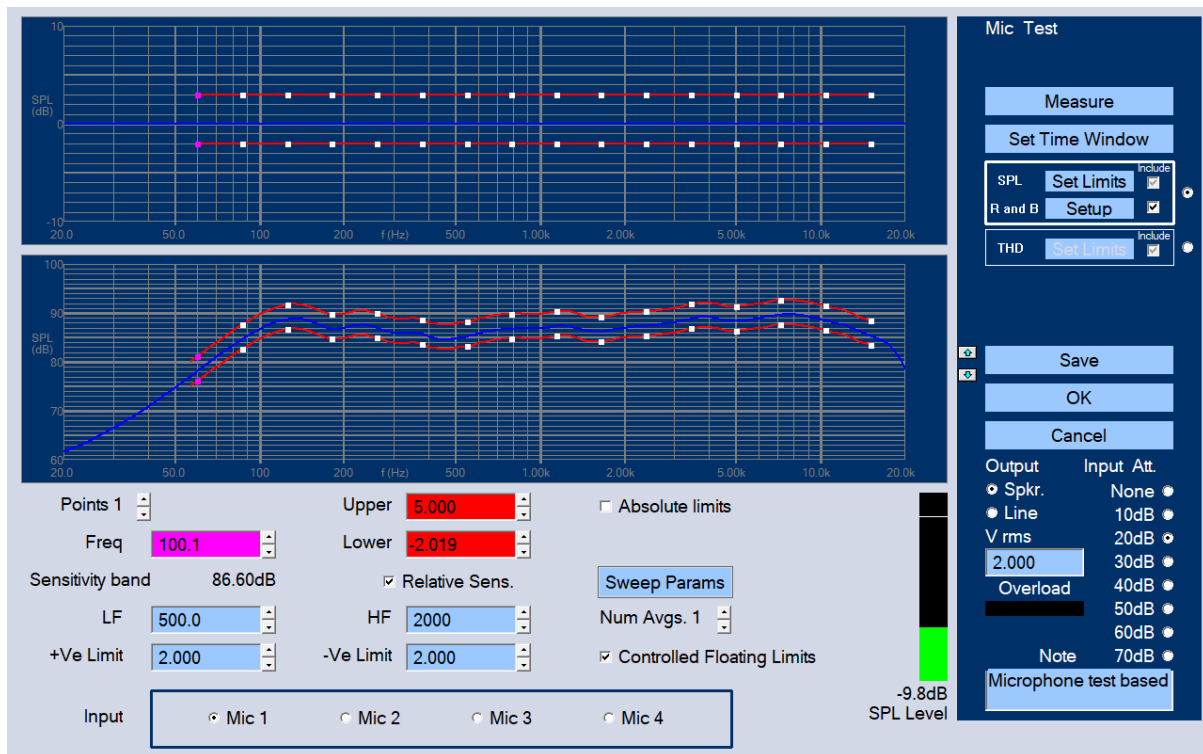


Figure 60 - Microphone Test setup based on REF microphone

After finishing test a large batch of microphones you can view ALL measured curves and average etc. in Statistics after the test.

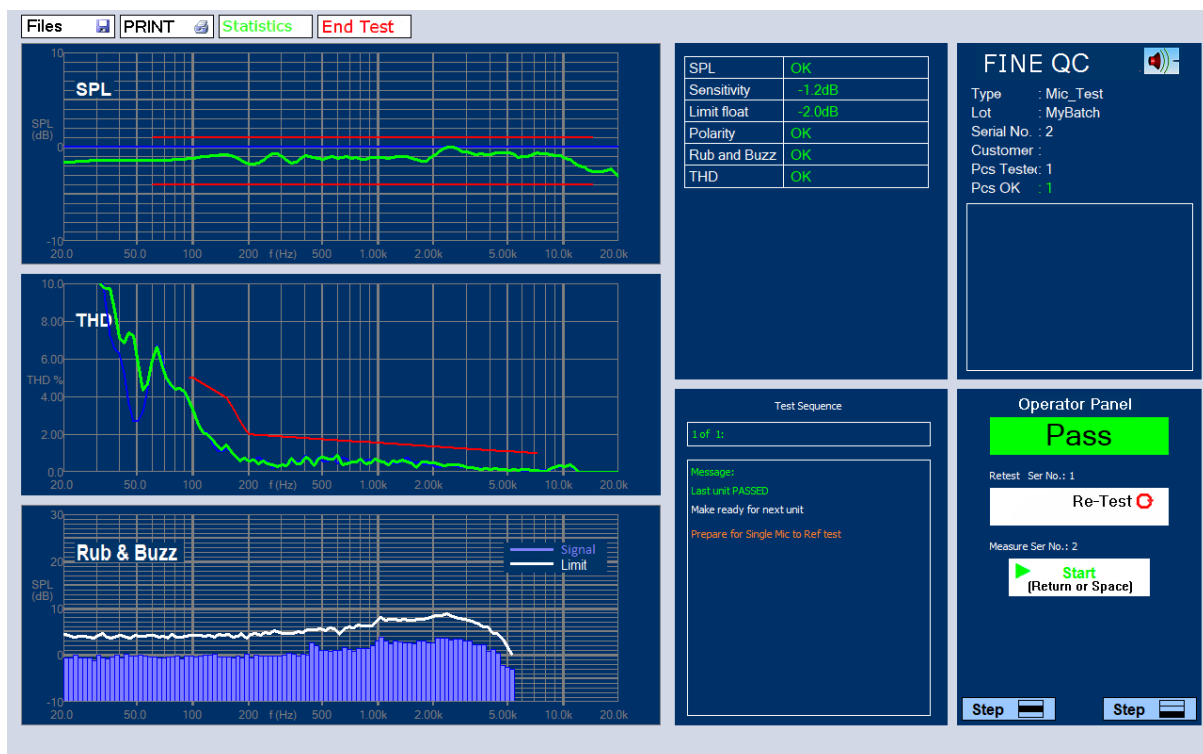


Figure 61 - Microphone tested with FINE QCX. SPL was OK and Sensitivity -1.2dB

## 7. Add-on Modules

### 7.1. Automation Module

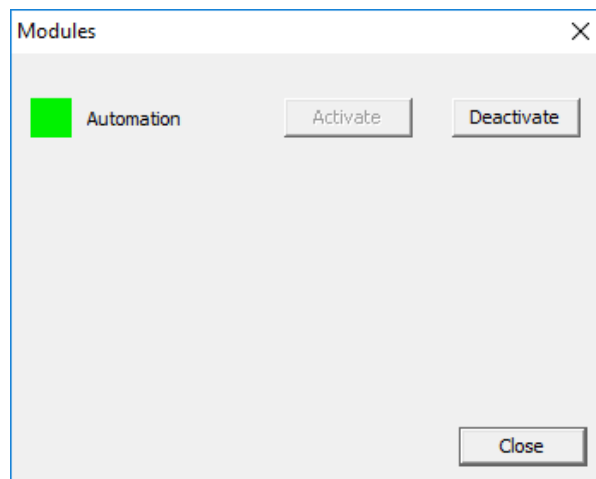
The new automation module makes it possible to run the EOL (End of Line) QC-test fully automatically.

With the Extension I/O Interface Card (see next chapter) the software can automatically sort rejects in all possible failure-groups. Statistics for every unit tested is always saved automatically.

#### A. Installation/Setup

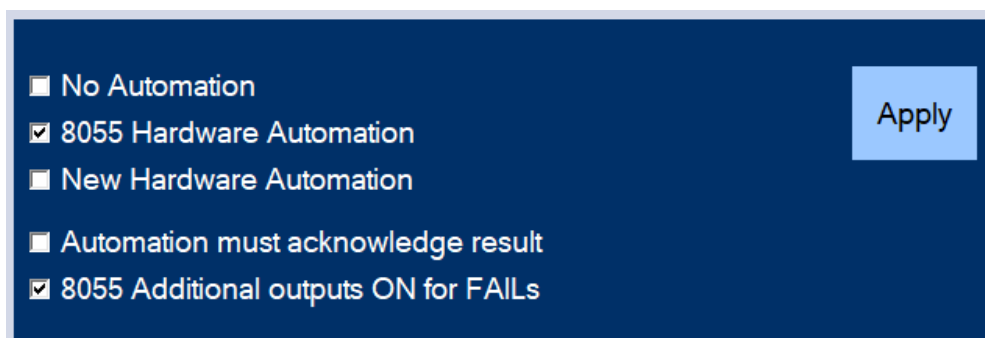
This module has a separate license, which should be activated over the internet like all other Loudsoft software.

Run the PC as administrator, then start FINE QC and Log on as Administrator (see manual) and press the Admin button:



Pressing the button Modules will show the installed modules, here the Automation module is installed and activated.

At left is shown the Automation options:



only ON LED

- A. Here you can select New Hardware Automation, or
- B. 8055 Automation (Extension I/O card - see next).

The 8055 Additional outputs ON for fails, means that the LEDs will be ON when there is a failure, which is normally preferable.

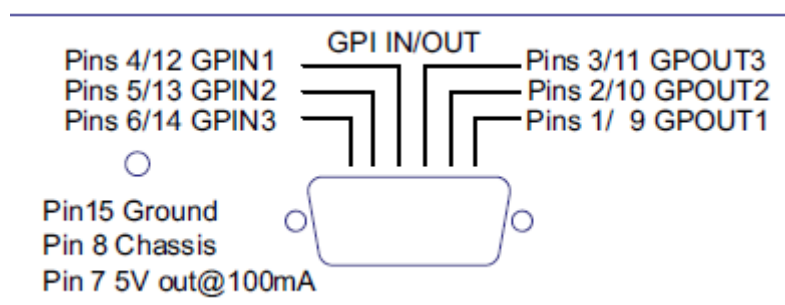
The Automation has I/O (Input/Output) TTL communication through the 15-pin D connector located on the back of the FINE Hardware 3.

### 15-pin D Inputs:

- GPI IN1      Shorting pins 4 and 12 will start the QC test
- GPI IN2      Shorting pins 5 and 13 will Re-Test the current unit, keeping the same serial number
- GPI IN3      Shorting pins 6 and 14 will acknowledge result. For the Assembly Line electronics to signal that all is ready for next test. The last option [ ] "Automation must acknowledge result" must be set.

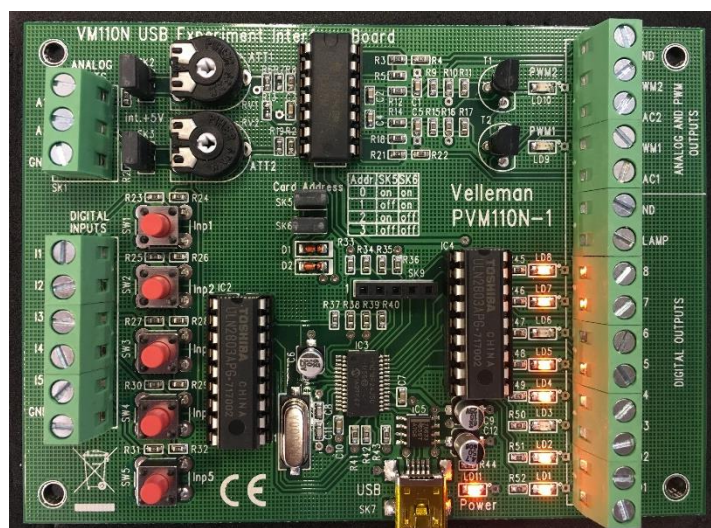
### 15-pin D Outputs:

- GPOUT1      Pins 1 and 9 are shorted, unit is OK. FINE QC is ready for next test
- GPOUT2      Not used.
- GPOUT3      Pins 3 and 11 are shorted, showing the unit was rejected.



## B. Extension I/O Interface Card K8055 / VM110

Adding the extension I/O card makes it possible to sort rejects in all possible failure-groups automatically. Statistics for every unit tested is always saved automatically and can be viewed later for analysis.



## C. Installation of K8055 / VM110 USB Interface Board

First, you will need to plug your K8055 / VM110 card into an available USB (1.1/2.0) port on your computer, so Windows will detect this new device and install the hardware driver (automatically).

The software package contains a standalone demo application K8055 Demo.exe, allowing you to be able to test your board. The demo application is located in the **\Demo** folder of the software package. When installed the K8055 Demo can be run from Programs. (The file **K8055D.DLL** from the folder **\Demo** must be copied to the same directory as the Demo).

The K8055 interface board has 5 digital input channels and 8 digital output channels. In addition, there are two Analog inputs, two Analog voltage outputs and two PWM (Pulse Width Modulation) outputs with 8 bits resolution.

All communication routines are contained in the Dynamic Link Library K8055D.DLL.

## D. Automatic Failure Sorting Signals (LED's ON for failures)

| Result        | Output LED's Failure indication |
|---------------|---------------------------------|
| Test OK       | LED3 ON                         |
| RB            | LED#4 + LED#7 ON                |
| SPL           | LED#4 + LED#6 ON                |
| Imp           | LED#4 + LED#8 ON                |
| Polarity      | LED#4 + LED#5 ON                |
| Sensitivity   | LED#4                           |
| No connection | LED#4 + LED#2 ON                |
| THD           | LED#4 + LED#9 ON                |
| Fs            | LED#4 + LED#10 ON               |

LED#1 ON indicates system is ready to measure

## E. Optional programming the K8055 / VM110 USB I/O Board

The K8055 / VM110 USB Interface Board comes with a library (DLL) that can be used to communicate with the board in any programming language. The software package includes examples on how to use this DLL in some of the most popular programming languages.

At this time the following programming languages / environments are supported:

- Microsoft Visual Basic 2008 Express Edition
- Microsoft Visual C++ 2008 Express Edition
- Microsoft Visual C# 2008 Express Edition
- Microsoft Visual Basic 6.0
- Microsoft Excel VBA
- Borland Delphi 5
- Borland C++Builder 6
- Bloodshed Dev-C++

## F. Rear GPI/O D-connector

GPIN's short circuit current < 150  $\mu$ A

GPOUT's are using optically isolated solid-state relays at TTL level (5V)

- Maximum RON 5  $\Omega$
- Load voltage 60 V
- Load current 100 mA

## 7.2. Test Steps / Test Sequence

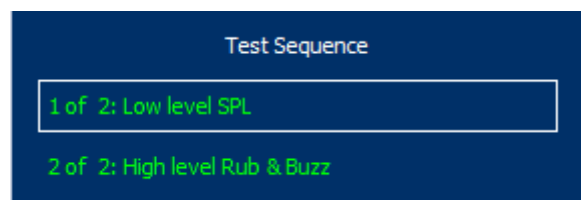


Figure 62 - Test Steps in Sequence

The Multi-step / Sequence Test Module makes it possible for example to test the same DUT at low and high levels using different microphones. More complex testing is also possible. See Fig. 24, which has 5 steps, including stereo test and microphone testing.

Fig. 62 shows results from a 2-step test, where the second step includes High level Rub & Buzz.

| Low level SPL         |         |
|-----------------------|---------|
| SPL                   | OK      |
| Sensitivity           | 106.0dB |
| Polarity              | OK      |
| Rub and Buzz          | OK      |
| THD                   | OK      |
| Impedance             | OK      |
| Fs                    | 157.7Hz |
| High level Rub & Buzz |         |
| SPL                   | OK      |
| Sensitivity           | 110.4dB |
| Polarity              | OK      |
| Rub and Buzz          | OK      |
| THD                   | OK      |
| Impedance             | OK      |
| Fs                    | 155.4Hz |

**Figure 63 - Results from 2 step Test**

### 7.3. Additional Modules

LOUDSOFT will continue developing new modules for the FINE QCX system. Already planned is a Digital S/PDIFF module.

## 8. Printing Labels in FINE QCX

You can print labels using a standard serial matrix label printer. (LOUDSOFT can make customer versions to fit your specific printer or other)

Go to “Admin Options” (Password: FINELAB) and select the right Port, Speed, and Parity, see Fig.

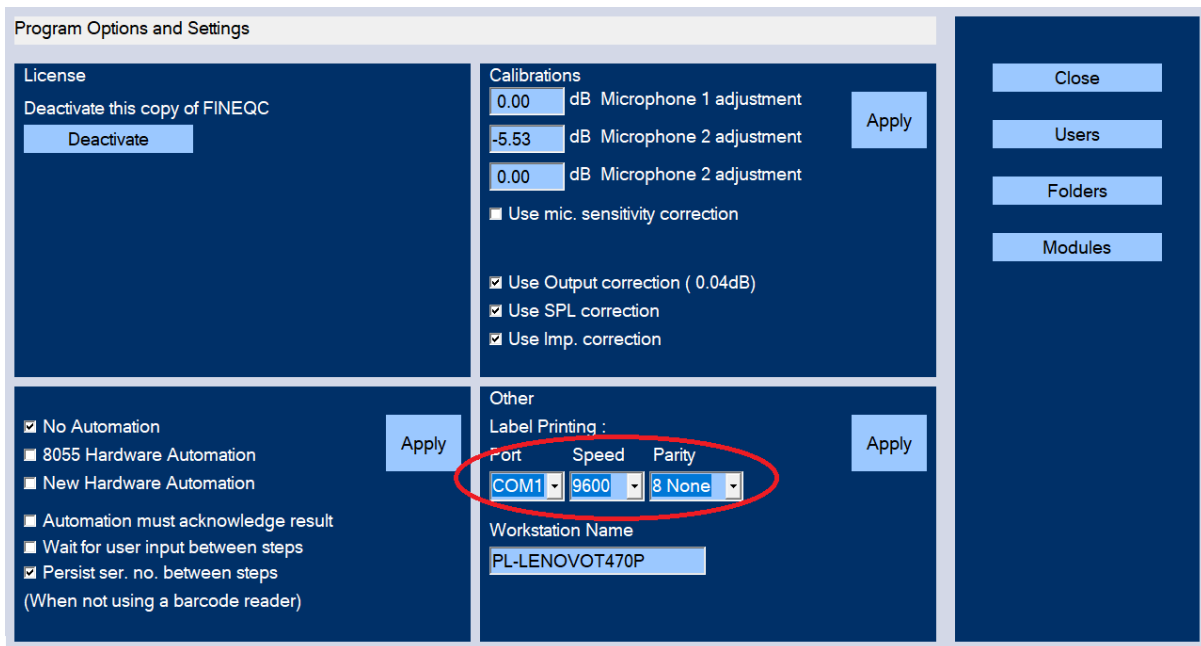


Figure 64 - The printing options can be changed in the admin panel

**Note:** Please use a Zebra type label printer, RS232 (COM1 -4), set in admin

Then, define a test specification, for example, 2Way.fts. Then “2Way” will be used as a type name in the label.

In “Unit labels” you can select a label style, as shown in Fig. 9. There are two more label styles, which may be chosen.” Click on “Edit QCX test”, and the following window will be opened. Here you can choose “Print Labels” (last line)

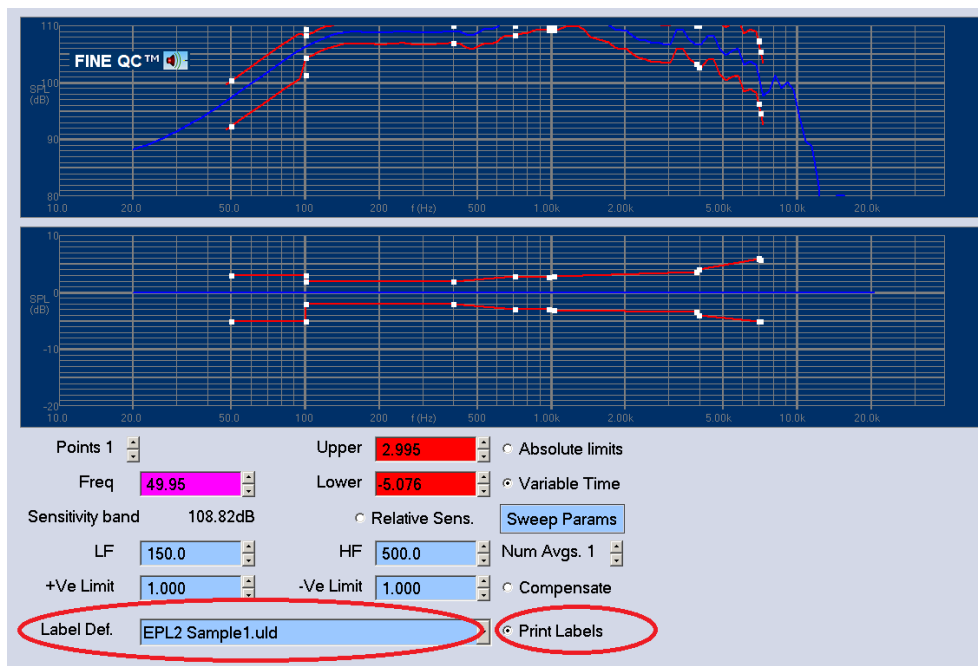


Figure 65 - The different label styles can be selected in test specifications.

After “Save”, it is ready for “Run QCX test”. In the figure below, the starting serial no. will be input by the operator. The number on label will start from this number.

The following figure shows the label for a failed sample.

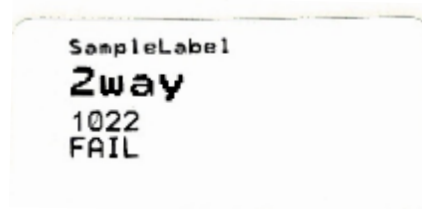


Figure 66 - Example of printed label

## 9. FINE QCX Calibration Procedure

Calibration is done from the factory. However, you can finetune FINE QCXD using the calibration procedure. Select Calibration from the main menu.

### 9.1. Output Level

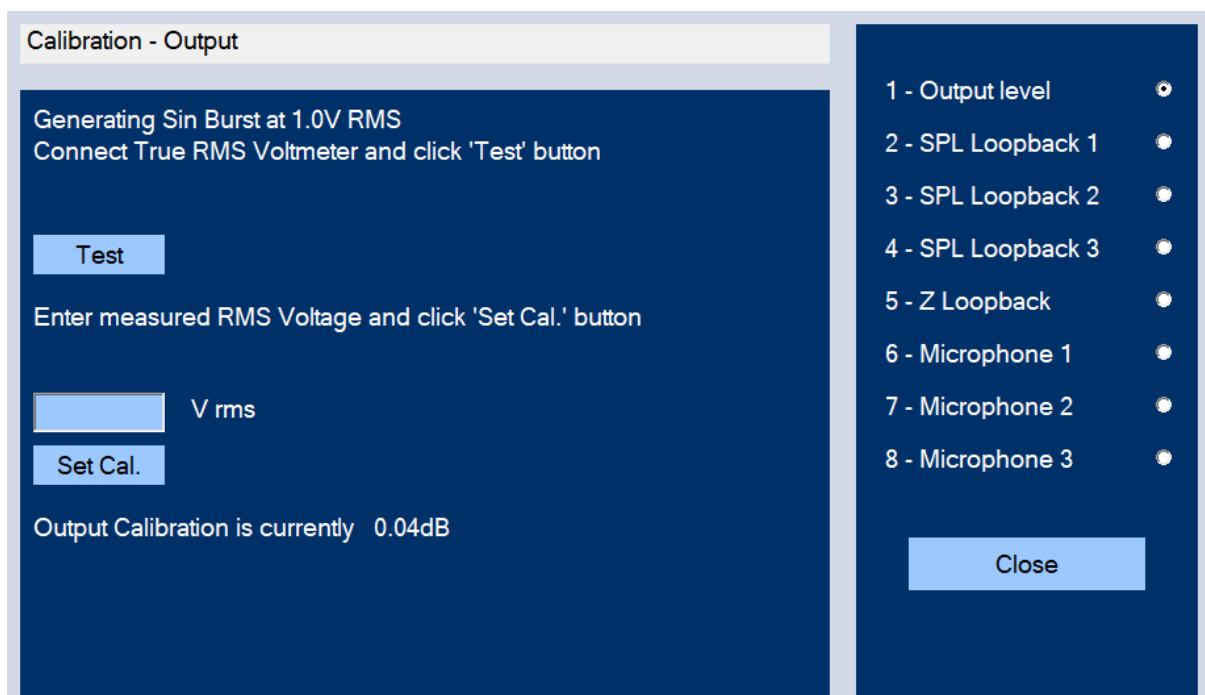


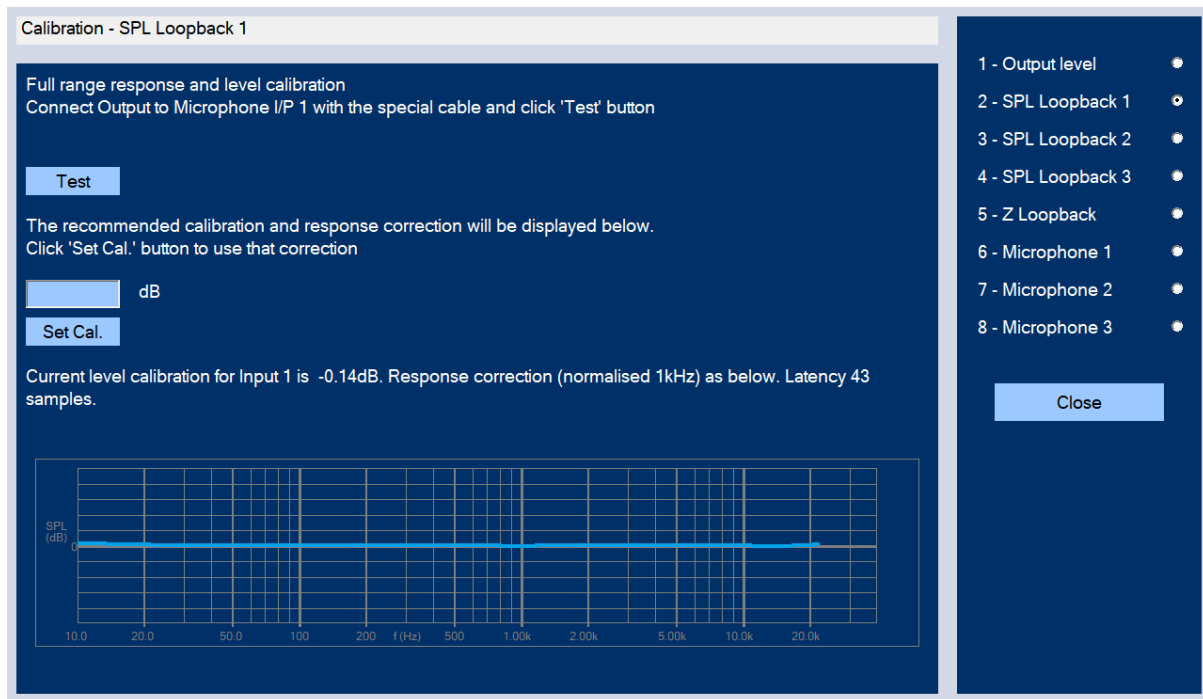
Figure 67 - The output level calibration window



Connect a True RMS Voltmeter to the output of FINE Hardware, then click the “Test” button.

An RMS Voltage around 1V RMS should be measured on the Voltmeter. Enter the measured RMS Voltage in the empty field “[ ] V rms” and click “Set Cal.” button. The calibration of the output level is now done.

## 9.2. SPL Loopback Calibration



**Figure 68 - The SPL loopback calibration window**

Select “2 – SPL Loopback” (1-3) at the upper right of the window. This is a full range response and SPL level calibration of each input.

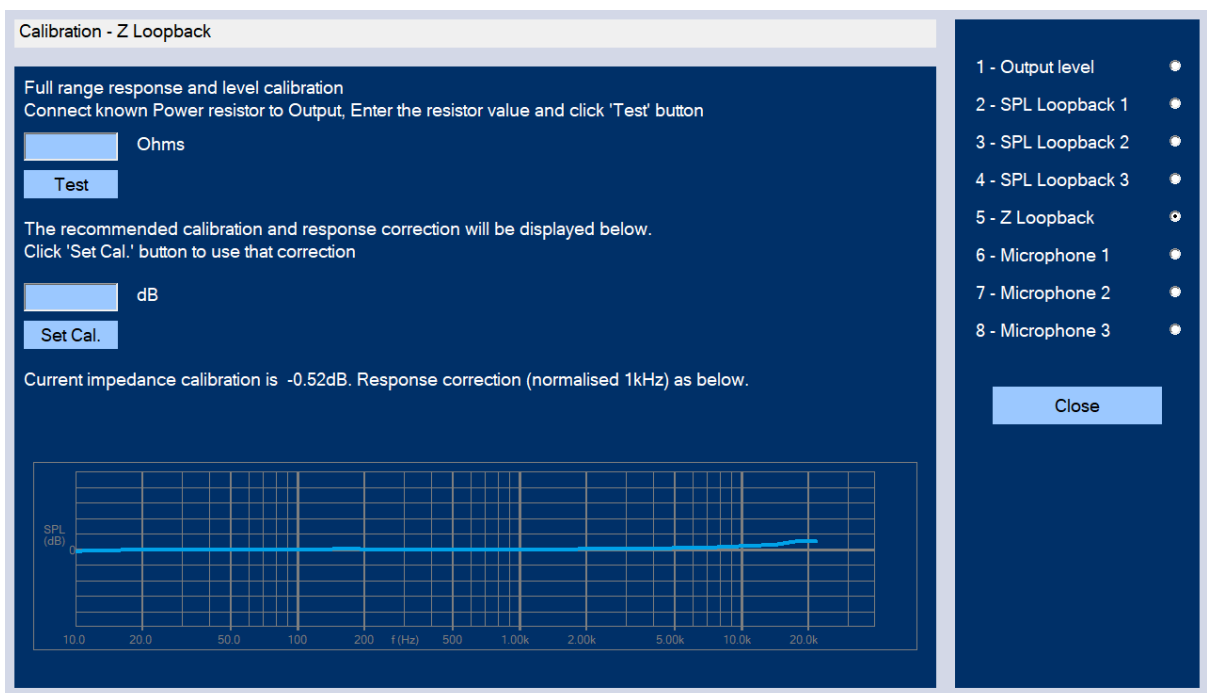
Connect the speaker output to the microphone input with a special loopback cable, which can be either Speak-on or banana plugs from the speaker output to the microphone XLR input (see the Figure 68 below) and click the ‘Test’ button. (You may leave the 48V phantom on, as the input is balanced and ac-coupled)



**Figure 69 - The FINE Hardware 3**

After the recommended calibration and response correction is displayed, click “Set Cal.” button. Now the SPL loopback calibration is finished.

### 9.3. Impedance (Z) Calibration Using FINE Hardware



**Figure 70 - The impedance loopback calibration window**

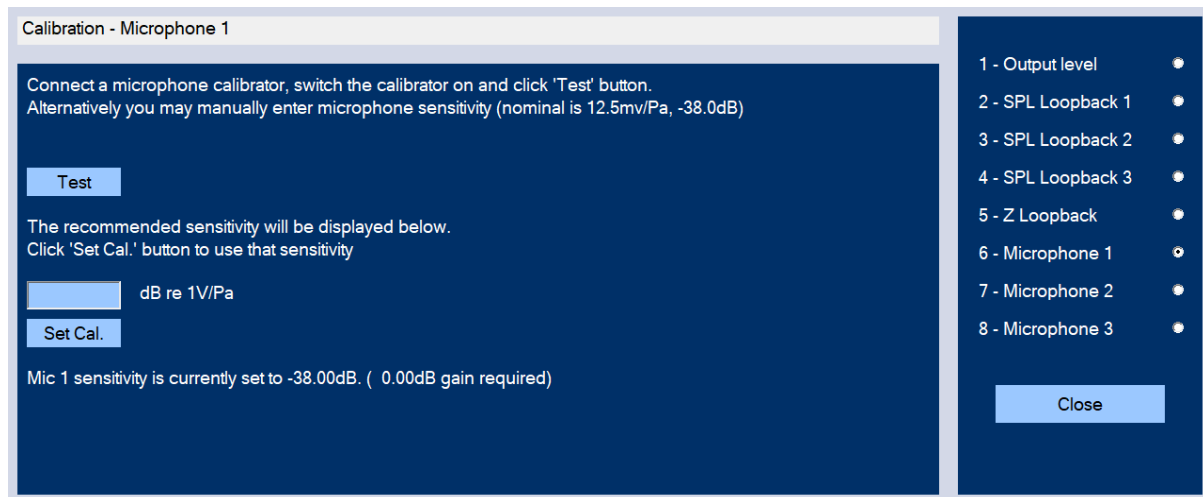
Select “5 – Z Loopback” at the upper right of the window. This is the full range response and level calibration of the impedance.

Do the following steps to calibrate the impedance:

1. Take a 4 ohms 5W resistor (or closest available)
2. Measure the resistor with an accurate Low Ohms Digital Multimeter. The value should have two decimals, e.g. 4.31 ohms.

3. Connect the resistor to the speaker output (You may include your cables to make a more accurate calibration). Enter the measured resistor value in the empty field “[       ] Ohms” and click “Test” button.
4. After the recommended calibration and response correction are displayed, click “Set Cal.” button. The calibration is finished.

## 9.4. Microphone Calibration



**Figure 71 - The microphone calibration window**

### **A) Calibration using microphone data:**

The microphone sensitivity can be found from the LOUDSOFT Microphone Calibration Sheet supplied with the microphone.

Enter the microphone sensitivity value in the empty field “[       ] dB re 1V/Pa”, and click “Set Cal.” button. Now the calibration is done.

### **B) Calibration using a microphone calibrator:**

This is the most accurate method. Place the microphone on the calibrator using an adaptor. (See the attached sketch in section 10.5 showing an adaptor for the LOUDSOFT FL1 microphone.)

Switch on the calibrator and hold the microphone firmly (the sound from the calibrator is then barely heard).

Press the test button and the measured microphone sensitivity is displayed.

Press the “Set Cal.” button to use this. The microphone calibrator must give 1 Pa (94 dB SPL).

## 10. FINE Hardware 3

### 10.1. Front Panel



Figure 72 - The front panel of the FINE Hardware 3

#### 1. USB Yellow LED

When the FINE Hardware is connected to the computer with a USB cable, the yellow USB light LED is on.

#### 2. Microphone input(s)

Phantom power (48 V) is provided for XLR type microphones, for connecting condenser microphones that requires phantom power. A red LED will indicate when phantom power is switched on. GRAS and other (CCP) microphones can be connected using a special adapter, supplied by LOUDSOFT.

NB: REMEMBER TO SET THE PHANTOM 48V SWITCH ON WITH THE LOUDSOFT FL1 MICROPHONE!

#### 3. Headphone Output

Stereo headphone output by separate headphone amplifier. The signal is same as Line out.

#### 4. Line Out

In case the built-in 25W amplifier is too small for testing your system, you can connect a larger power amplifier from the Line out XLR output on the FINE Hardware.

Note that the Line Out level is by default 1/10 (-20dB) of the main output, so 1V nominal output will be 100mV on the Line output. If for example your power amplifier has a gain of 30dB, then 1V nominal output will produce  $1V -20dB +30dB = 3.16V$  from your power amplifier.

*NB: Do not use high output for a full range system with Tweeters/HF units, as these units cannot accept high power!*

#### Amplifier output - Speakon connector / Banana connector

Use the Speakon or banana connector to connect a loudspeaker. These are in parallel.

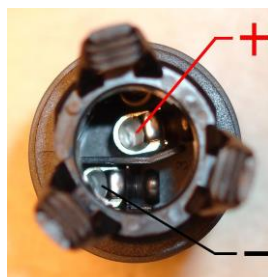


Figure 73 - Speakon Rear Connections

## 10.2. Rear Panel

- **Power Input:** 110-230 V AC
- **USB Input connector:** Use a USB2 cable to connect the FINE hardware (Box) to your computer.
- **TTL input/output:**  
For automation. 3 inputs and 3 outputs in TTL level. Used with Automation module section 7.1

## 10.3. FINE Hardware 3 Specifications

### Sampling Frequency

AD/DA Conversion: 48 kHz - 24Bit

### Frequency Response

SPL: 10 Hz to 22 kHz ( $\pm 0.5$  dB)

Impedance: 10 Hz to 22 kHz ( $\pm 10\%$ )

### Mic Nominal Input Level

XLR 0-1000 mV RMS. Max input is 12V peak to peak or  $\sim 4.2V_{rms}$

### Line Output:

0 – 1500 mV

### Interface

USB 2.0

### Amplifier

Output Power: 35 W (1 ohms load, Max THD $<0.1\%$ , 1 kHz)

10 W (4 ohms load, Max THD $<0.1\%$ , 1 kHz)

Protection: Short circuit and over temperature shutdown

## 10.4. LOUDSOFT Microphone FL1 Data Sheet



Figure 74 - The LOUDSOFT FL1 microphone

The LOUDSOFT FL1 is a high-quality microphone made in Denmark. The gold-plated diaphragm and a double-vent protection system ensures the highest durability in production environments.

**Directional Characteristics:**

Omni-directional

**Principle of Operation:**

Pressure

**Cartridge Type:**

Pre-polarized Condenser

**Power Supply:**

48 V Phantom Power

**Frequency Range,  $\pm 2$  dB:**

20 Hz – 20kHz

**Sensitivity, Nominal,  $\pm 3$  dB:**

6 mV/Pa; -44.5 dB re. 1V/Pa

**Equivalent Noise Level, A-Weighted:**

Typ. 26 dB(A) re. 20  $\mu$ Pa (Max. 28 dB(A))

**S/N Ratio, re. 1 kHz at 1 Pa (94 dB SPL):**

68 dB(A)

**Total Harmonic Distortion (THD):**

< 1 % up to 123 dB SPL Peak

**Polarity:**

Inward Movement of Diaphragm Produces  
Positive Going Voltage on Pin 2

**Cable Drive Capability:**

Up to 300 m (984 ft.)

**Connector:**

3-pin XLR (Standard P48)

**Dynamic Range:**

Typ. 97 dB

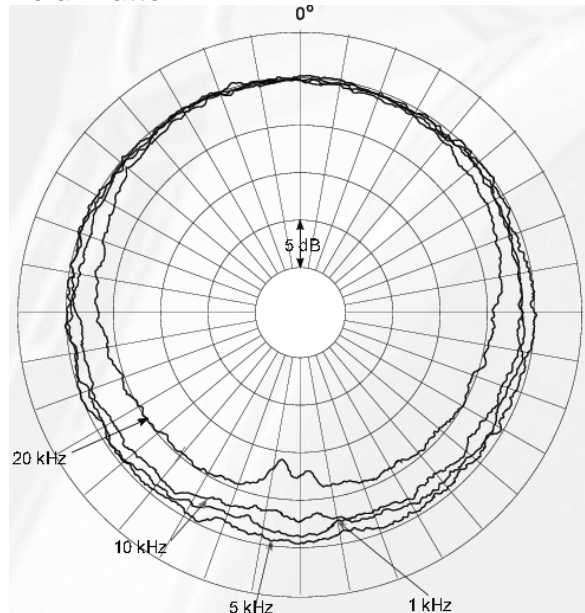
**Max SPL, Peak Before Clipping:**

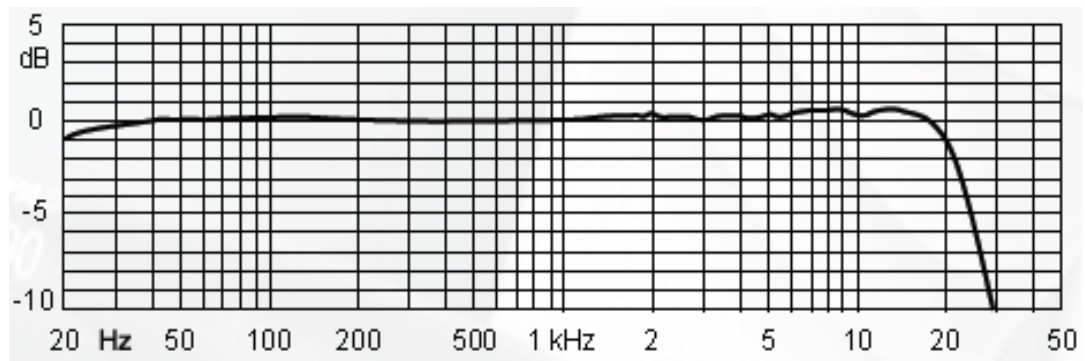
144 dB

**Output Impedance:**

< 40  $\Omega$

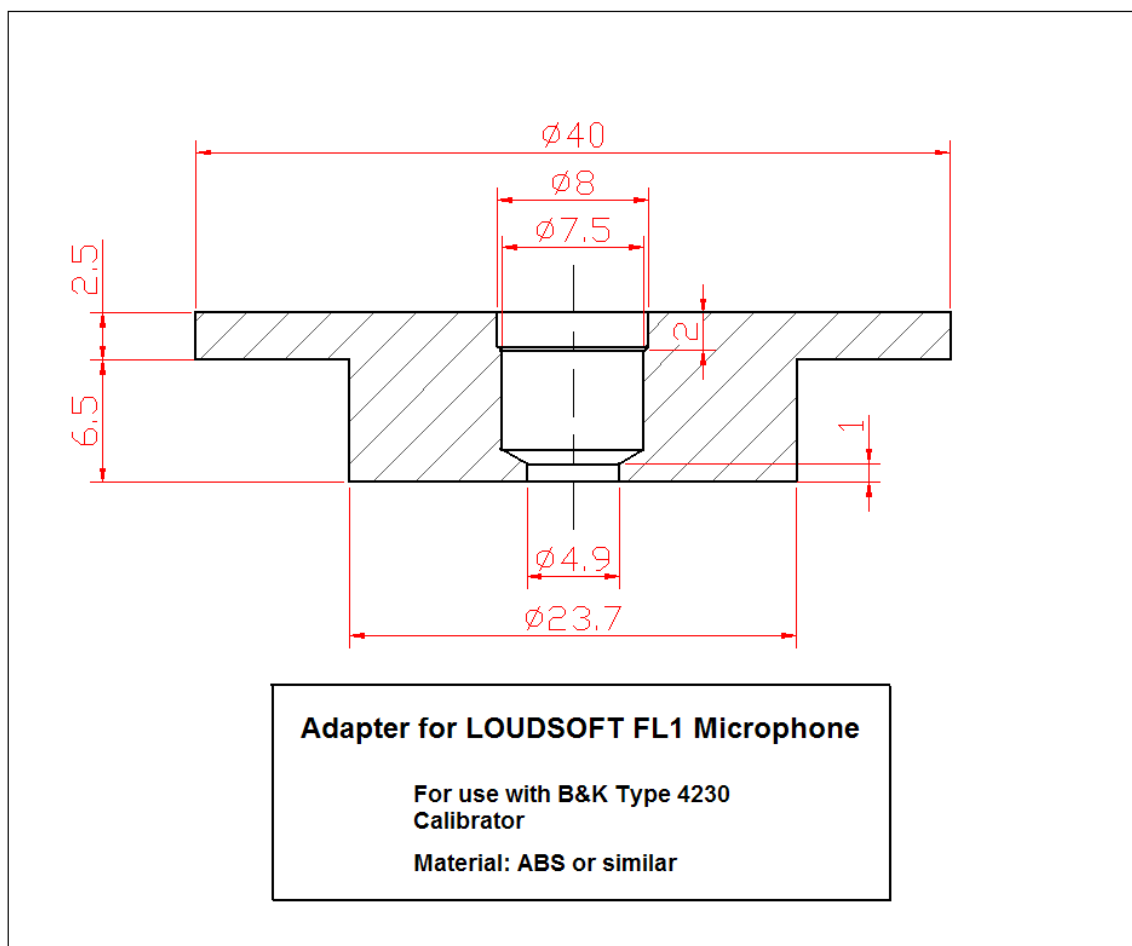
**Polar Pattern:**





**Figure 75 - On-Axis Frequency Response of LOUDSOFT Microphone FL1 in Free Field**

## 10.5. Adapter for LOUDSOFT FL1 Microphone (Calibrator)



**Figure 76 - Adapter for FL1 Microphone**

## 10.6. LOUDSOFT Test Boxes

3 different special Test Boxes are designed by LOUDSOFT and can be used for testing normal loudspeaker drivers and micro speakers and headphone drivers etc. The drawings are placed under Documents in the FINE QCX installation.

You can also buy the Test Boxes made in solid Aluminum directly from LOUDSOFT, see Figure 77.

For testing loudspeaker systems use a separate test booth/room. Be sure to keep high frequency noise away from the test, especially air guns and heavy bumping carts and pallets.

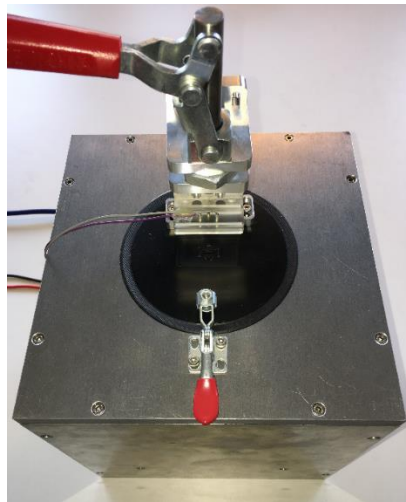


Figure 77 - LOUDSOFT Aluminum Test Box –small



[www.loudsoft.com](http://www.loudsoft.com)