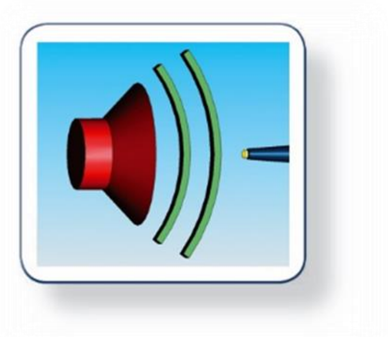
MANUAL



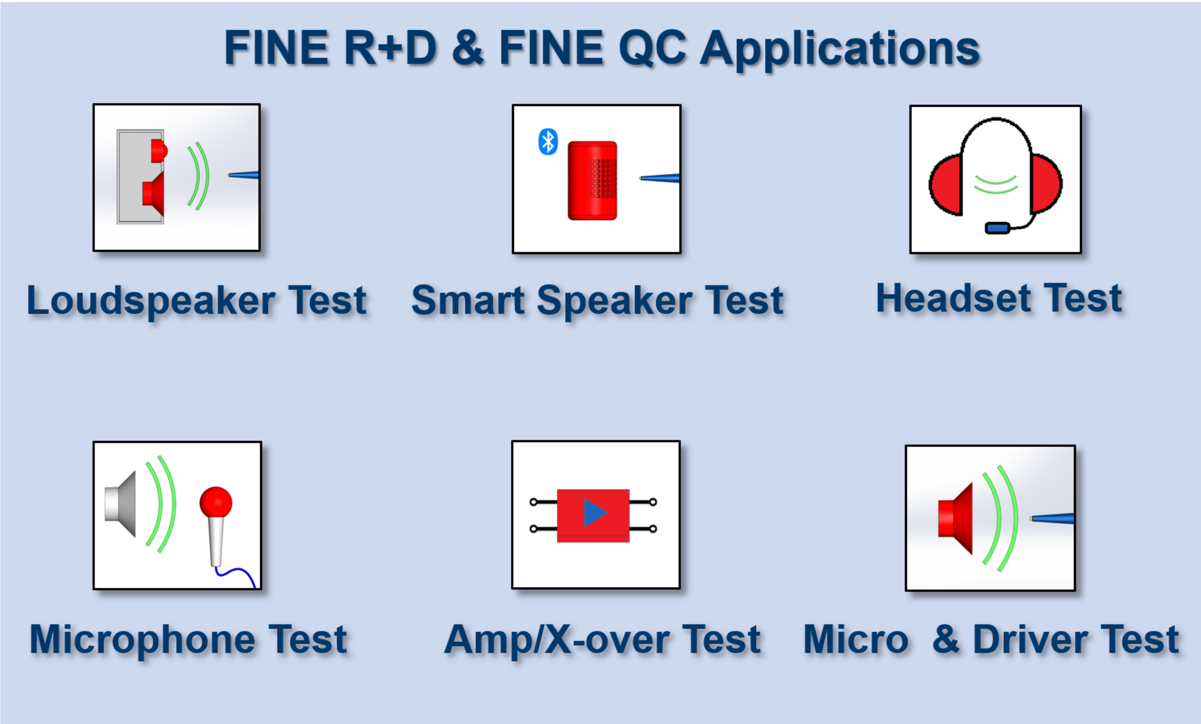
FINEQC™

Quality Control System for Loudspeakers

LOUDSOFT

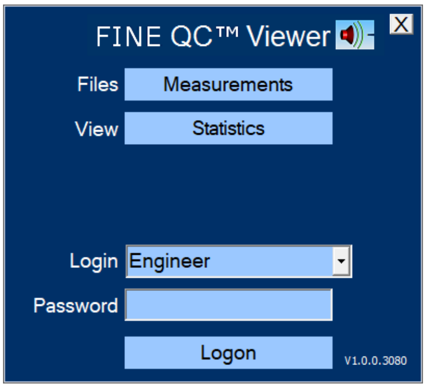
www.loudsoft.com

Contents



You can measure all these products with FINE QC

1. FINE QC Viewer / Remote setup update



The FINE QC Viewer is an independent program which can do everything FINE QC 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!

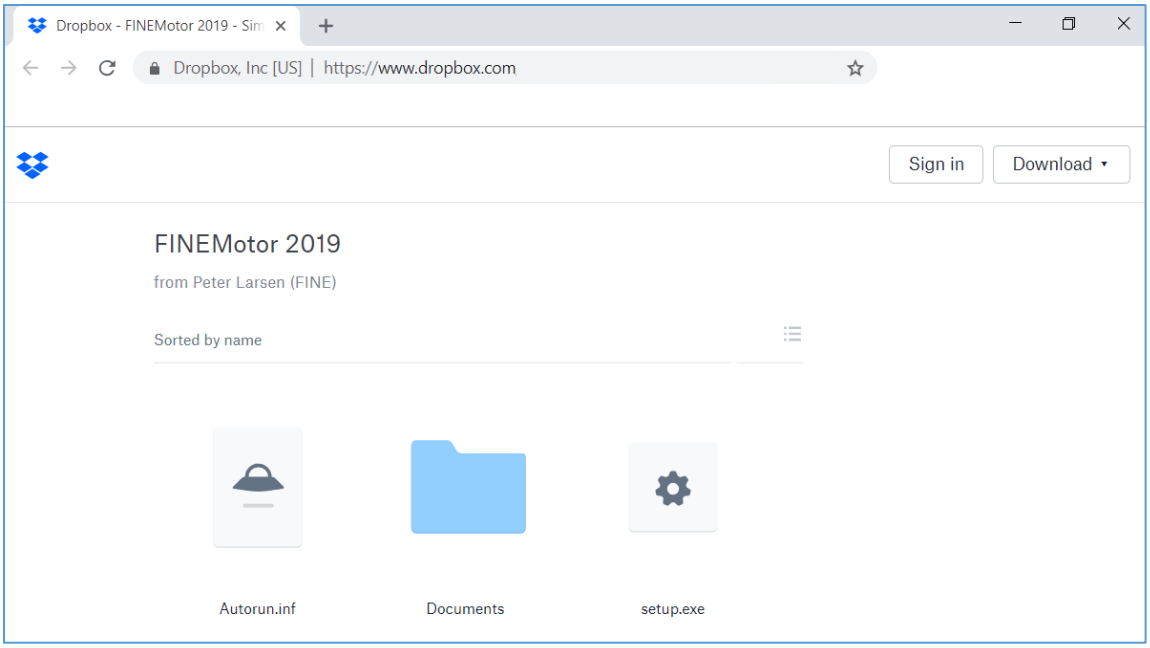
Setup Files are here: **C:\FINELabTestInformation\TestSpecifications**

Measurement data **C:\FINELabBatchData**

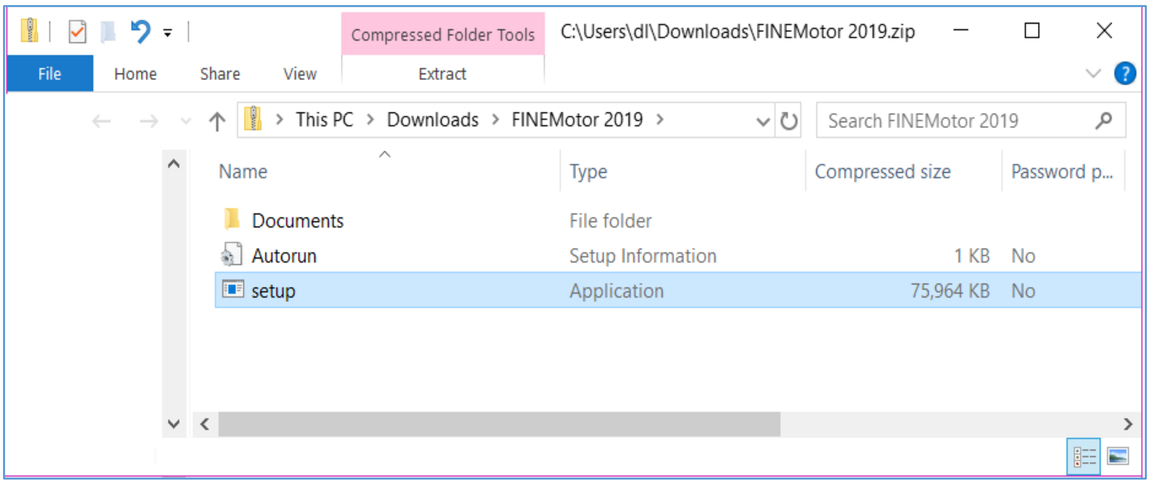
2.1 How to install the LOUDSOFT programs from a link

The computer must be connected to internet during installation.
It is possible to deactivate the program and move to another computer, and activate the software there.

- 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.

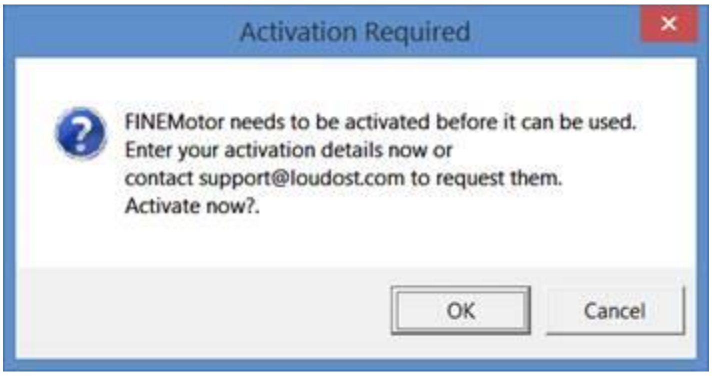


- Now find the downloaded file at the left bottom of your screen. Click on it and you will see the picture below. Click on "Setup" and follow the instructions to install the program.

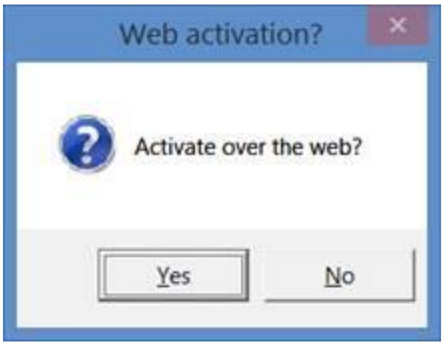


- Once the installation has finished you have to activate (and not later, because it will cause problems). The software will be usable once the activation has been completed.

- 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 PPPPPPPP

- Click OK. It is all done!

2.2 How to get started

1. If you have ordered the Automation Module you will be asked to input the separate license for this.
2. Now connect the power supply to the hardware and connect the hardware to the computer using the USB cable. Windows will automatically install a driver.
3. Start FINE QC
4. The first time you run FINE QC the software will ask for your microphone calibration data (Sensitivity), see Figure 1.
    a. Enter the microphone sensitivity from your Microphone Calibration Chart (see Figure 2). 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. 10.4

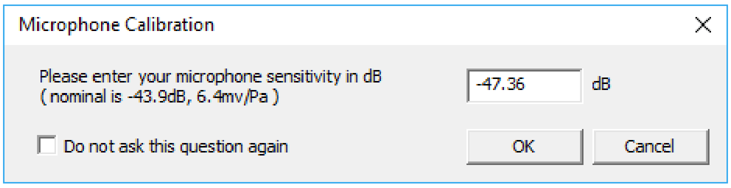


Figure 1 - Initial microphone calibration

5. The FINE QC system is factory calibrated. However, you may perform a calibration if needed (Sec. 10.4). This can improve the accuracy slightly at high frequencies.

Figure 2 - Microphone sens. charts. Left is LOUDSOFT FL1 mic. Right is GRAS 46BE mic.

Figure 3 – FINE Hardware 3

2. Login – Users

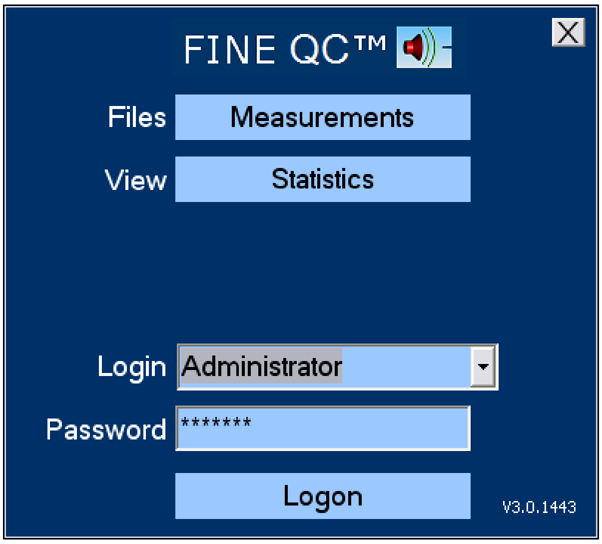


Figure 4 - FINE QC Start Screen

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].

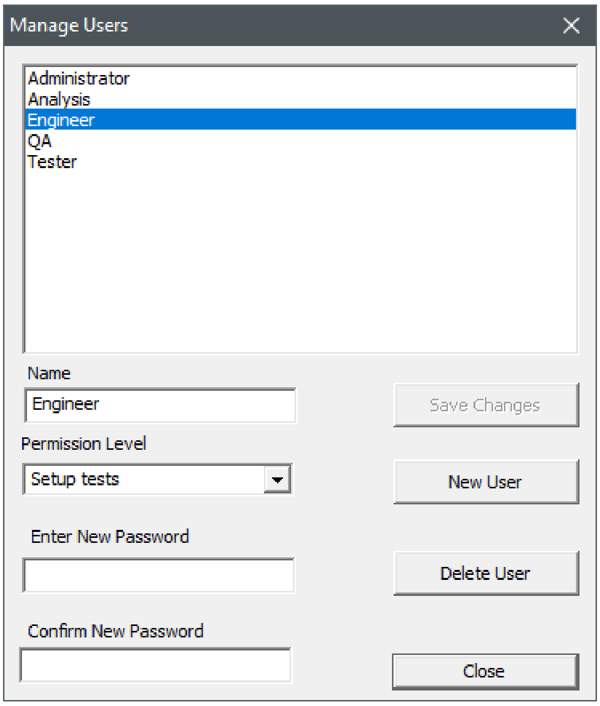


Figure 5 - Window for managing users and their permissions

3. ADMIN – Deactivation

When logged in as Administrator the [ADMIN OPTIONS] button is shown on the lower right (see Figure 26).

The ADMIN page is shown in Figure 8 below:

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

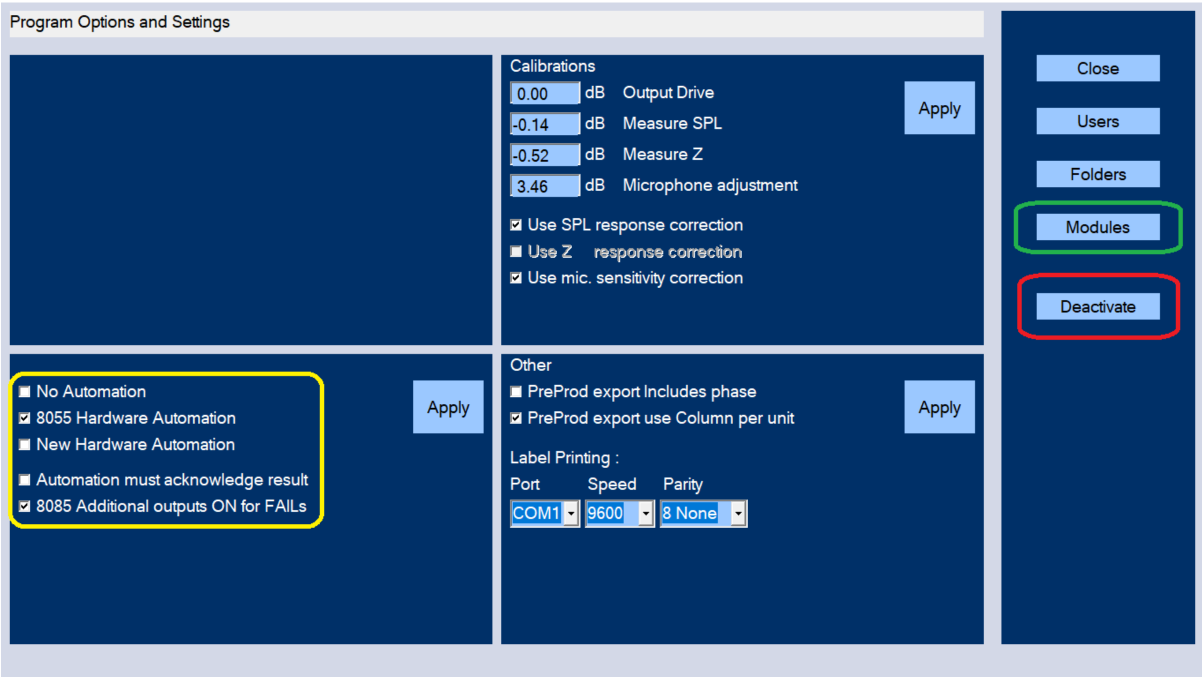


Figure 6 - ADMIN Page - Deactivation - Modules etc.

Deactivation

You can deactivate the FINE QC license by pressing the button marked in red [Deactivate] Figure 8. Then you can install the software on another PC and activate the license there using the same ID and Password as when installing FINE QC the first time.

Modules – Automation - New

The button [Modules] Figure 8 will show the installed extra modules. Here is installed the Automation Module shown in Yellow.

4. How to measure in FINE QC – Quick Guide

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

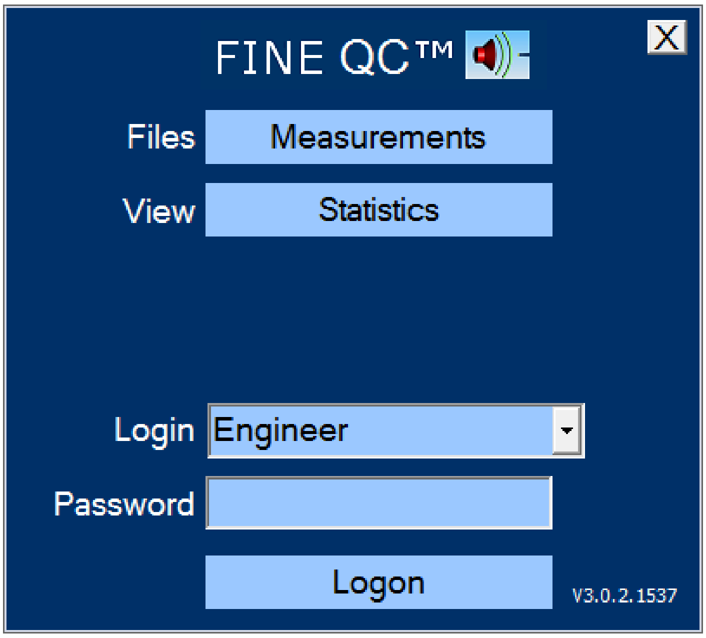


Figure 7 - FINEQC logon screen

2. Select a test specification, e.g., Fullrange.fts, 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 QC test button.

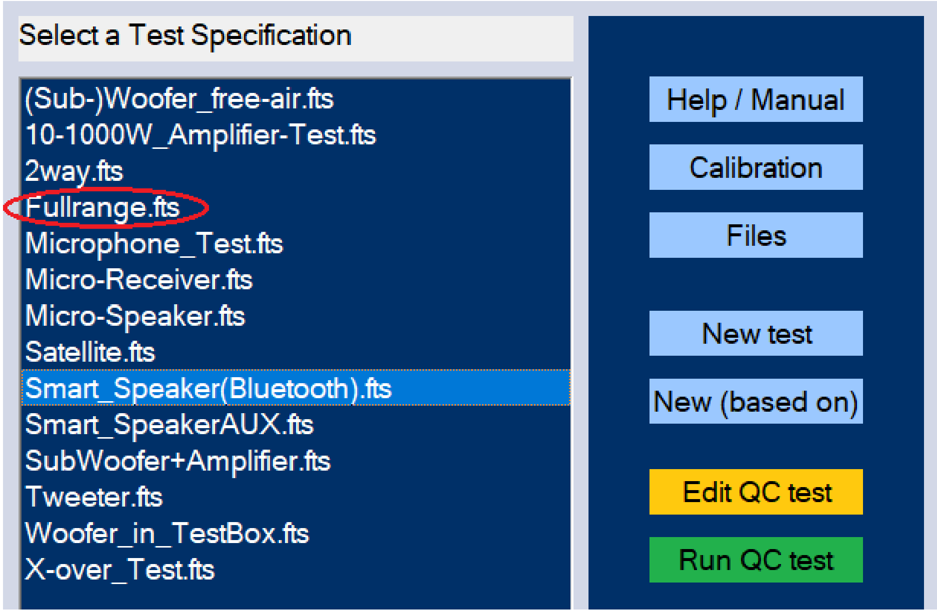


Figure 8 - Test specifications selection screen

4. Let's start with a simple measurement without R&B test. Uncheck "Has R&B Test". Click on "Measure" button.

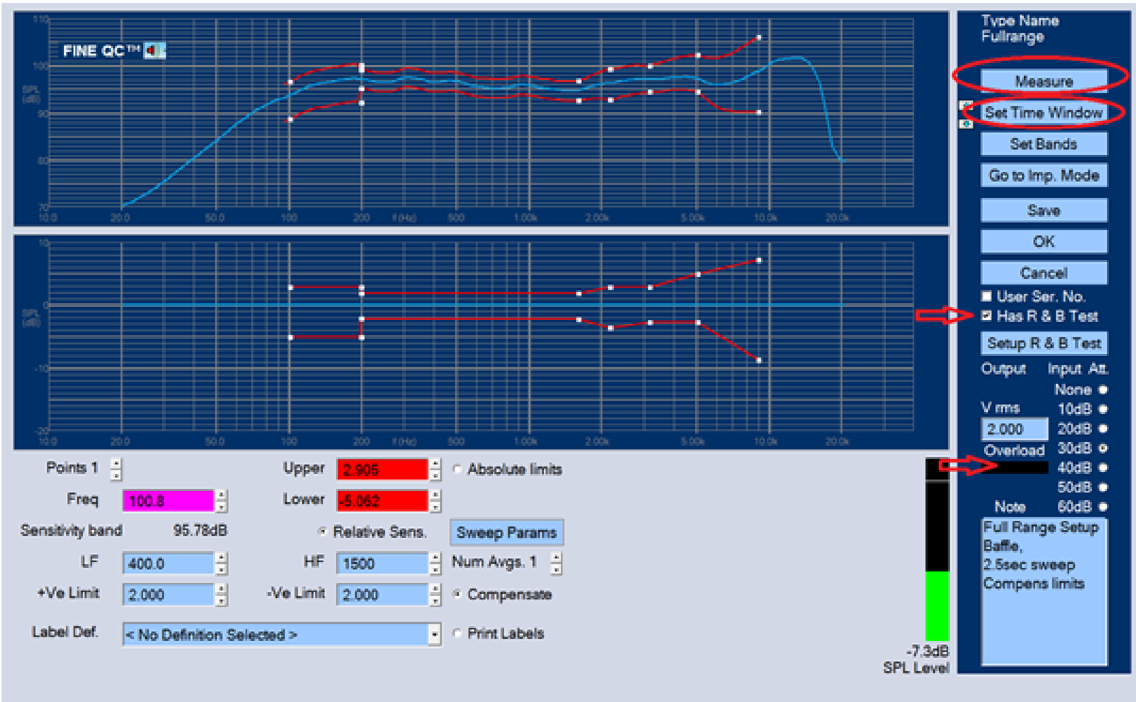


Figure 9 - Main window for editing test specifications

5. 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.
6. Click on the "Set Time Window" button, and set the "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. 4.5. Then click on OK.

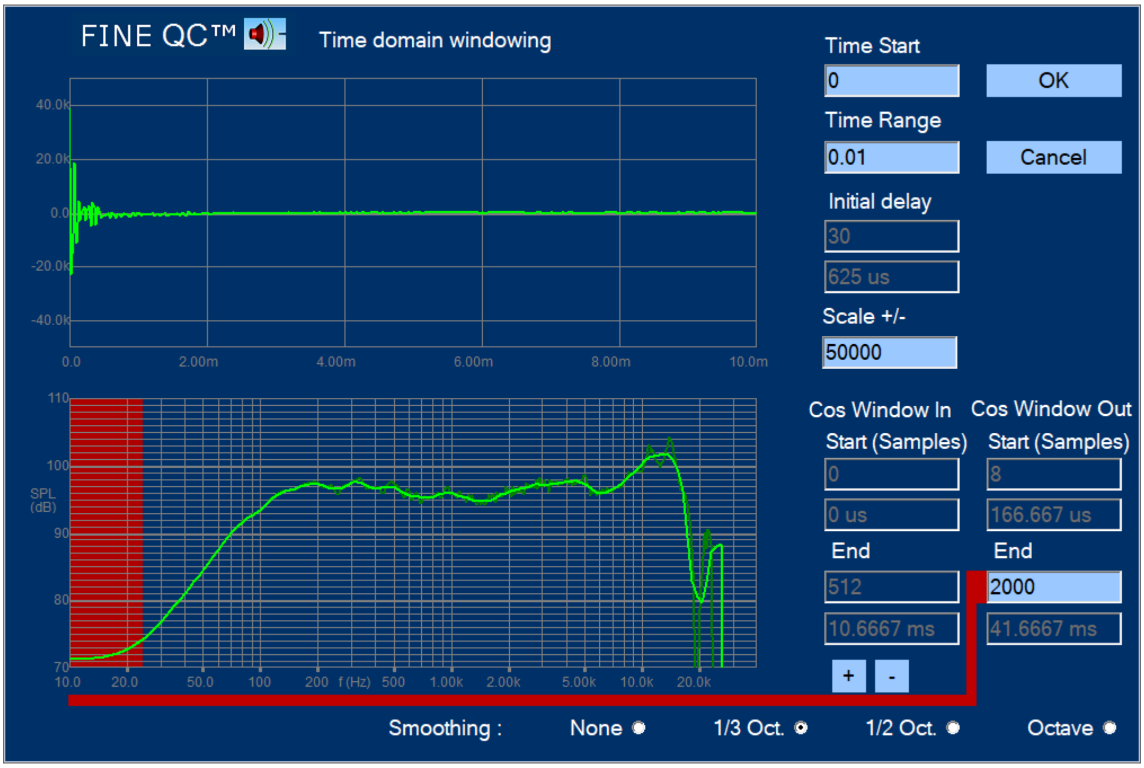


Figure 10 - Time domain windowing

7. Click on the “Go to Imp. Mode” button, and then click on the “Measure” button. We can set the limits by dragging the white spots using mouse.

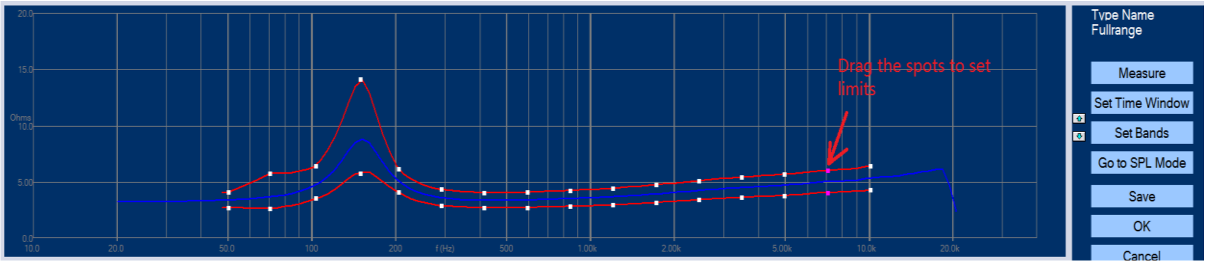


Figure 11 - It is possible to edit the limits by clicking and dragging the white dots

8. Click on Save-button, and then, click on the “Go to SPL Mode” button.
9. Click on Save-button, then click OK. The setting is done.
10. Click on Run QC test button.

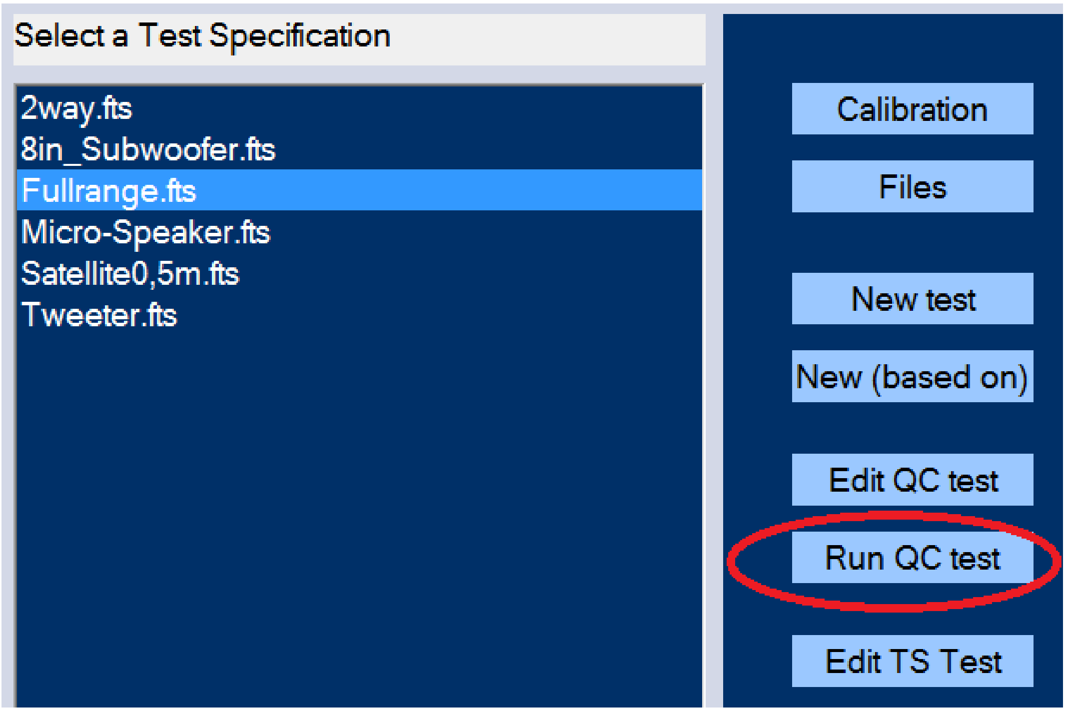


Figure 12 - When the test specifications have been set the test can be run from the main window

11. Fill in the texts, and then click on OK button.

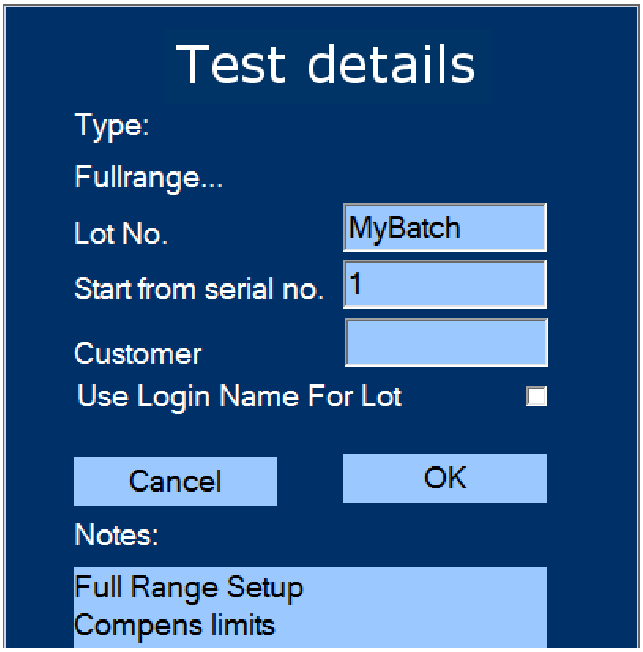


Figure 13 - The test details includes naming the batch and numbering the measurements

12. Click on the “Run” button to make a new test. If you want to repeat the current test use the “Single/Re-test” button. Click on the “Statistics” button to show all the measured curves.

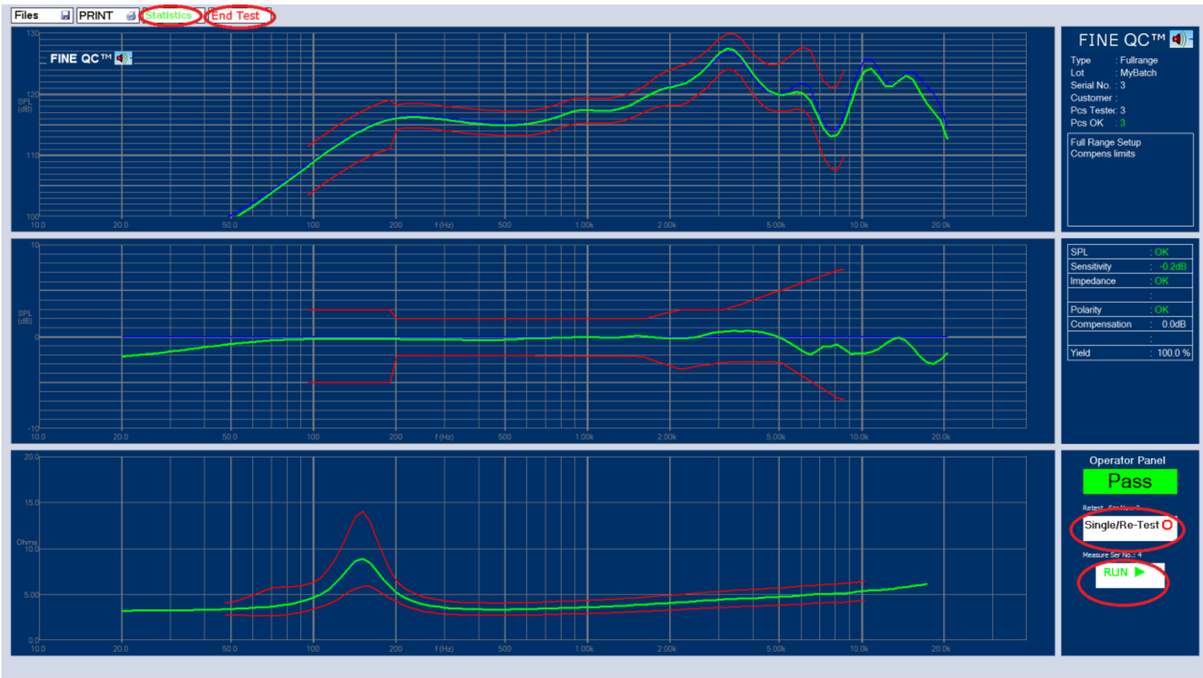


Figure 14 - In the main measuring window the frequency response, the deviation from the reference (center) and the impedance can be seen

13. Click on the “End Test” button after all measurements have been done.

14. Click on the “Print” button to print the results. Click the “Quit” button when you want to leave.

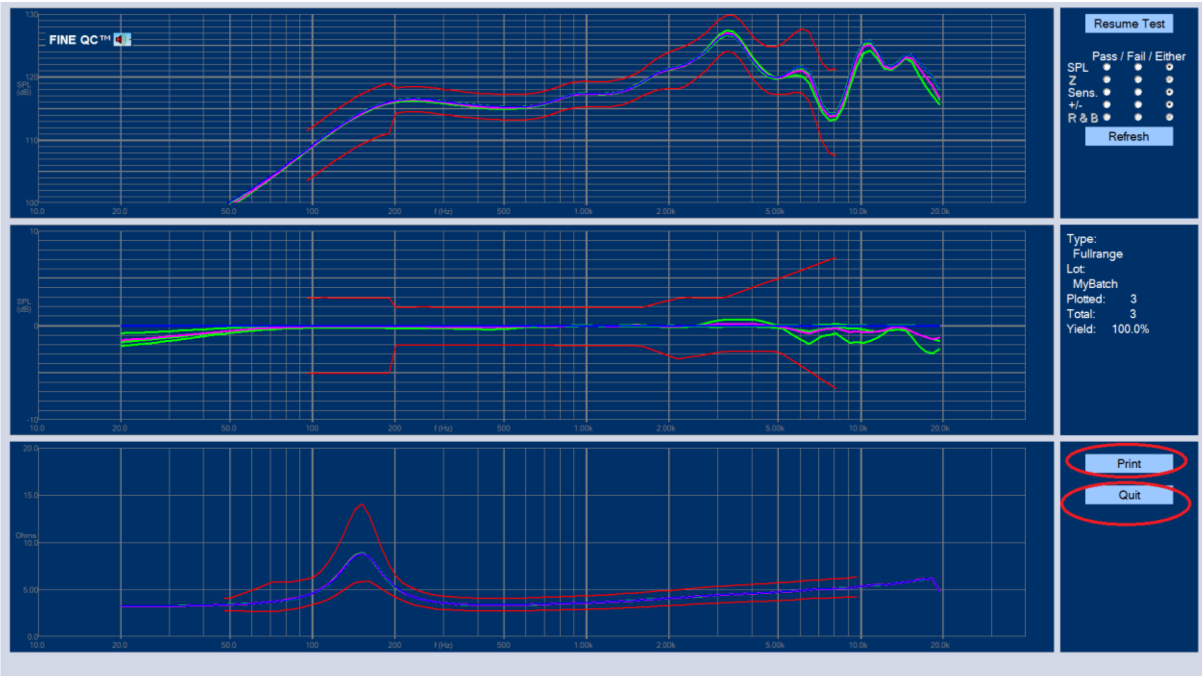


Figure 15 - When the test is done you can select what measurements you want to see and print them. You can view detailed info and responses in Pre-Prod, see Figure 18.

15. To measure Rub & Buzz, step 2 must be repeated. This time make sure that “Has R&B Test” is checked, and then click on Setup R&B Test button.

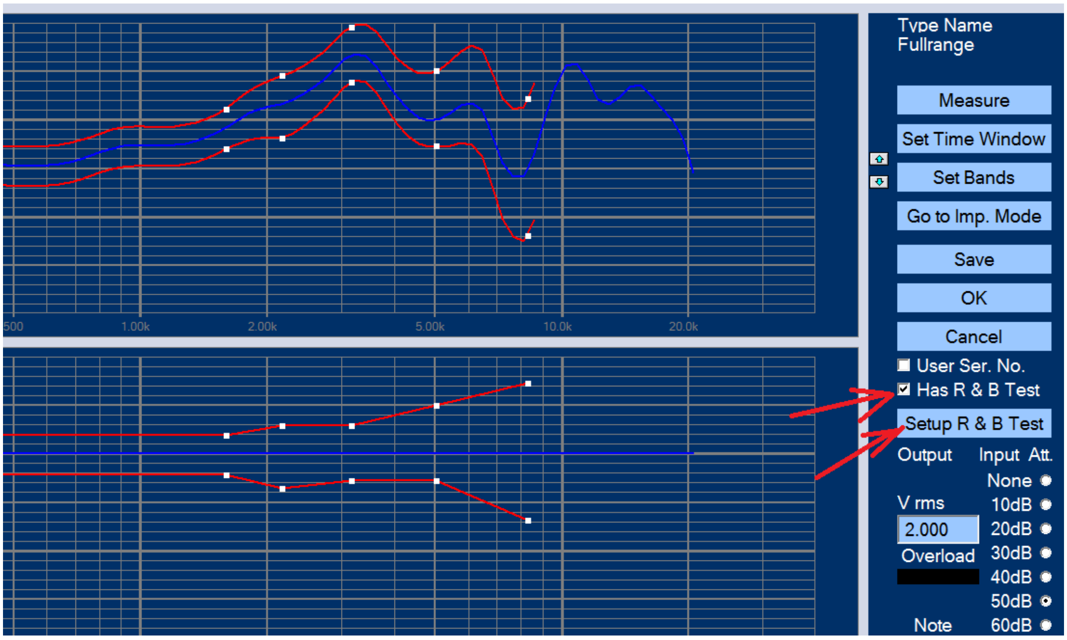


Figure 16 - FINEQC can also measure Rub and Buzz which must be specified in the specifications window

16. Click on the “Measure Good” button for units 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.

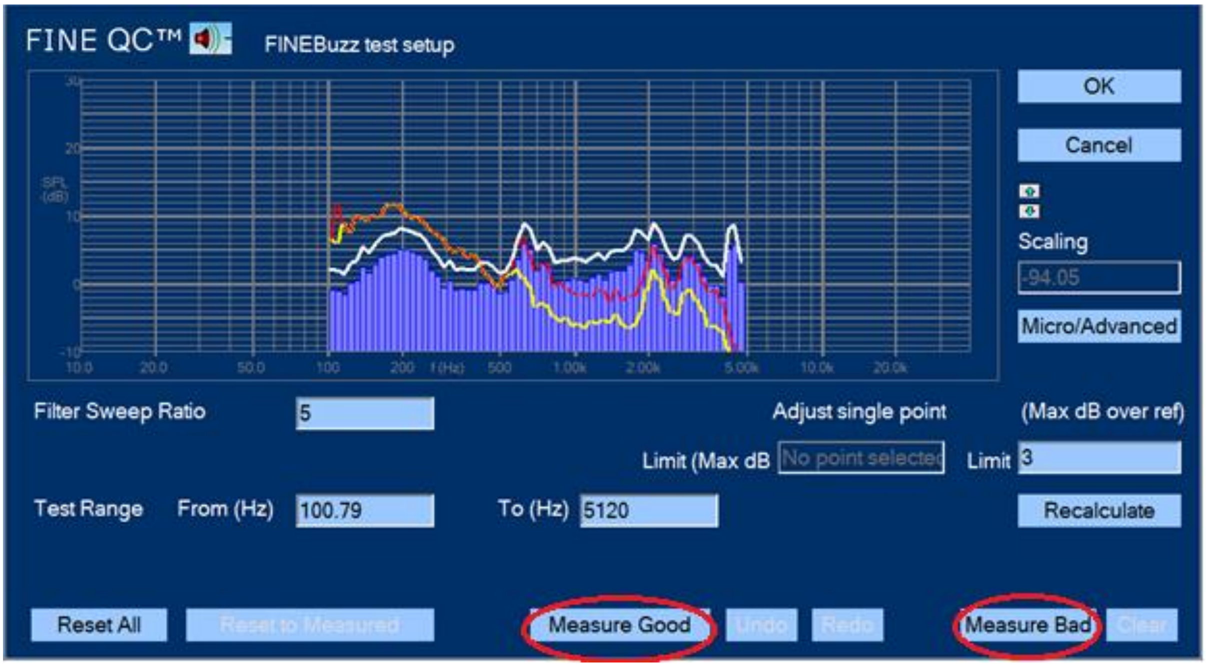


Figure 17 - The Rub and Buzz limits are defined by measuring some good and some bad drivers. FINEQC will then calculate the limits.

17. Click on OK button.
18. Click on Save.
19. Click on OK.
20. Click on Run QC Test, and then run a new QC test as described in steps 9-12.

5. Test categories and Test Specifications

Below are the default categories / Test Specifications

Press [New (based on)] for starting with these

- Amplified Subw. SubWoofer+Amplifier.fts
- Amplifier 10-1000W_Amplifier-Test.fts
- Full range driver Fullrange.fts
- Headset Use FINE QC/hp module
- Microphone Microphone_Test.fts
- Receiver Micro-Receiver.fts
- Micro speaker Micro-Speaker.fts
- Loudspeaker/Box Satellite.fts
- Smart Speaker Smart_Speaker (AUX/ Bluetooth)
- Tweeter Tweeter.fts
- Woofer Woofer_in_TestBox.fts
- Sub/Woofer (Sub)Woofer_free-air.fts
- Cross-over X-over_Test.fts

6. Tutorial

6.1. Statistics

Without logging in, all users can directly load measurement files and view statistics from automatically saved QC test series. An example is shown in the next picture, which is the result of a previous test series:

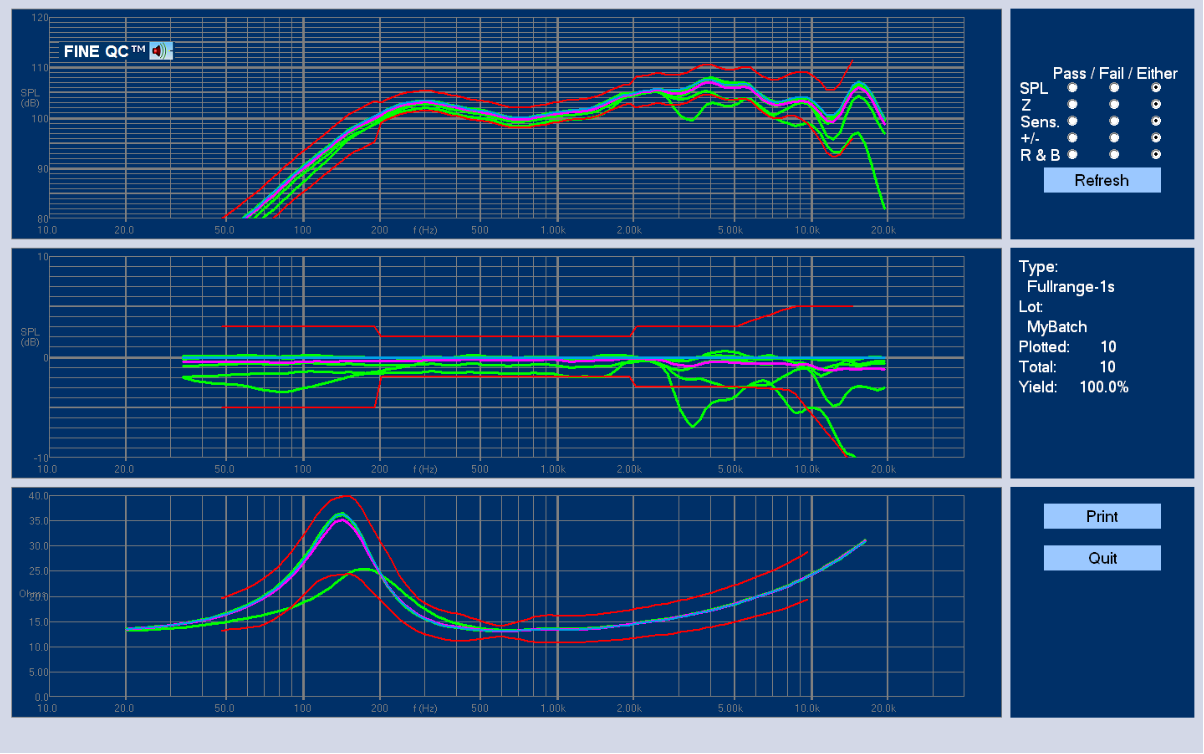


Figure 18 - Statistical Result of Previous QC Test Series

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.

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

The impedance with limits is plotted in the lower window. The average of all responses is shown as the violet curve and the reference as the blue response.

6.2. QC Testing (Drivers)

This time I log in as an engineer with my own password and select a predefined test and "Run that Test". The following screen appears:

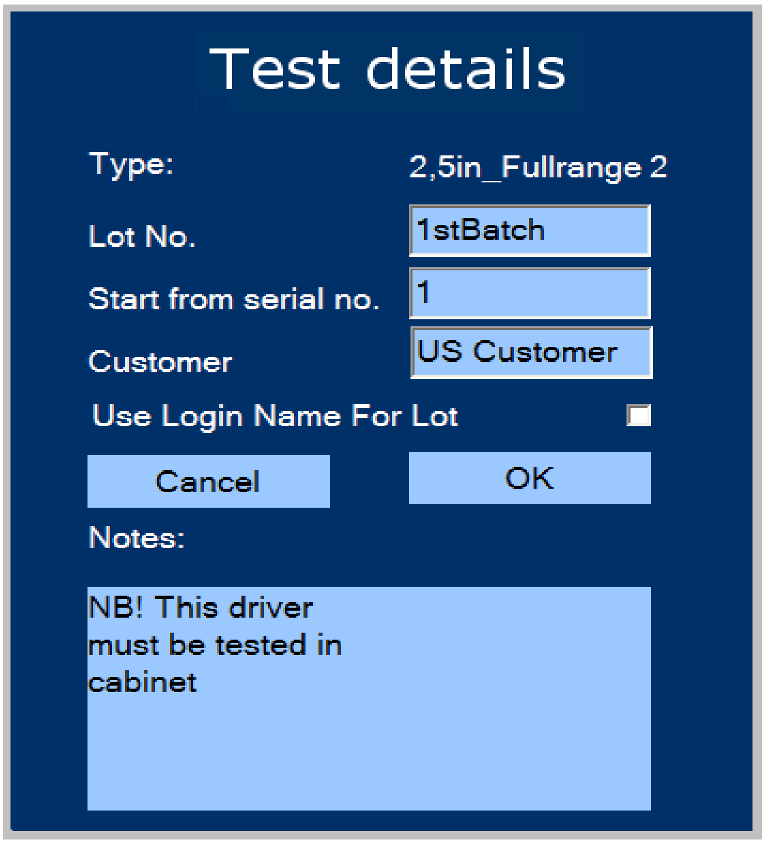


Figure 19 - FINE QC Test Details

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 QC will count up from that.

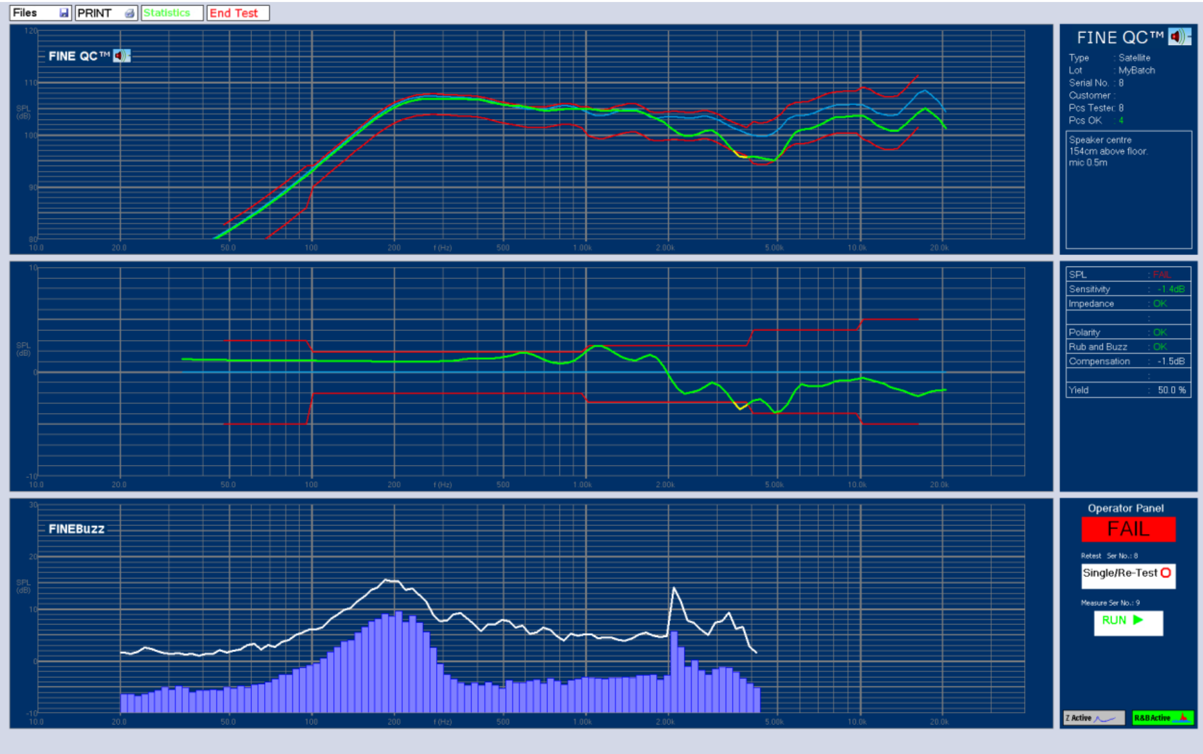
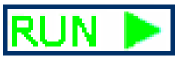


Figure 20 - FINE QC Test Display: SPL FAIL at 3.5 kHz

As a good rule of thumb start by testing the reference driver by pressing “Single/Re-Test”. After verifying that the response is close to the saved reference (a small sensitivity change of the measured response can be accepted if caused by a change in environment temperature). Say no to keeping that measurement. Then this initial reference test will not be saved in the test series.

Start by pressing the test button 

OR Space

Now the first driver is tested with a fast sine sweep. In this case the speed was chosen to be 2.5 seconds. The measured response is shown in the upper window as a green curve with the response limits in red.

If the measured response is exceeding the limits, the color changes to yellow and SPL: FAIL is reported in the right center window. The large center window is showing the measured response compared to the reference driver so is much easier to see where the response is outside the limits, see the example in Figure 15.

The sensitivity can be defined as an average over a frequency range, in this case 95.1dB (700-1200Hz). The impedance is measured with the same sweep (and current). That saves time and ensures that the level and resonance Fs is the same as in the frequency response. (A too low current may show a much higher Fs). The polarity is also checked and reported OK.

The next line is (Limits-) Compensation: This is a kind of Sensitivity Controlled Floating Limits. When active, the measured response is allowed to move within the limits as determined by the sensitivity tolerance. Finally, the actual yield of the test is calculated.

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 18).

Figure 21 - Enter Serial No. (Individual) or Barcode

If you are testing individual units, you can specify to enter the serial number each time, see Figure 21Figure 21. To do this, insert a [v] in “User Ser. No.” (Found at right under blue buttons).

This will also work when using a barcode scanner to scan the serial number. It starts the testing as soon as the barcode is read.

6.3. Golden Average Driver / Preproduction

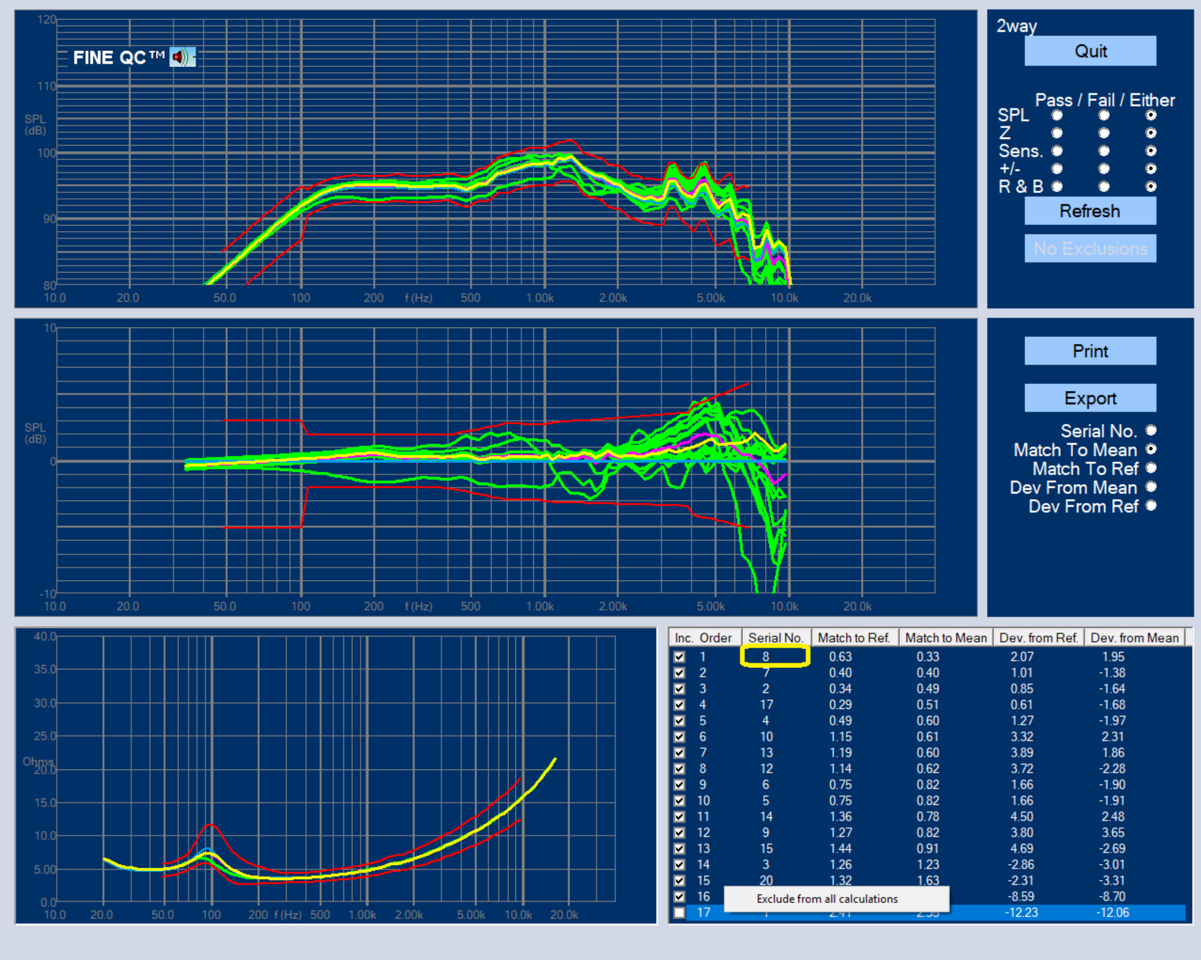


Figure 22 - Golden Average Driver Auto Finder

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.

Our pilot run consists of 17 woofers for a 2-way system which are sorted using the Preproduction feature, see Figure 22. The highlighted driver response (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 (like for example PDF995.com)

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

This example is found in: Review old Data-2way-select Pre-Prod-- Pre-Prod.

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

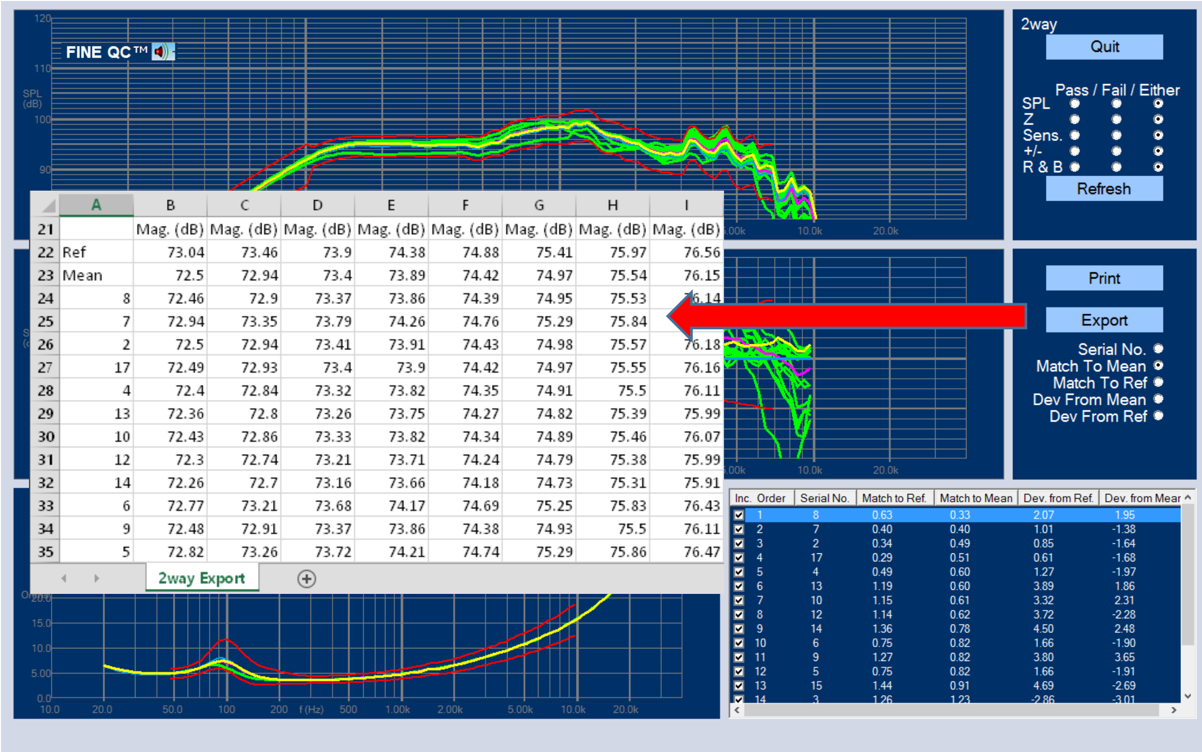


Figure 23 - Export of All Data to Excel. Choose horizontal or vertical format in Admin

6.4. Edit Limits

From the statistics in Figure 18 it can be seen that the rejected responses have a dip at 3.5 kHz, but it is actually the slope of the peak that has changed. Therefore, it makes sense to adjust the limits to allow that. Select "Edit QC test" from the menu (Figure 25):

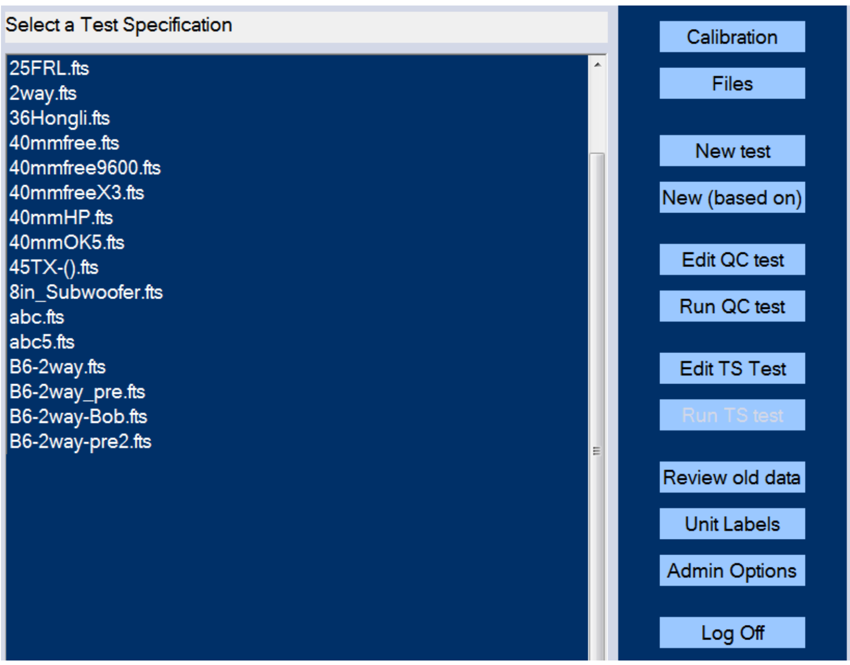


Figure 24 – Main menu

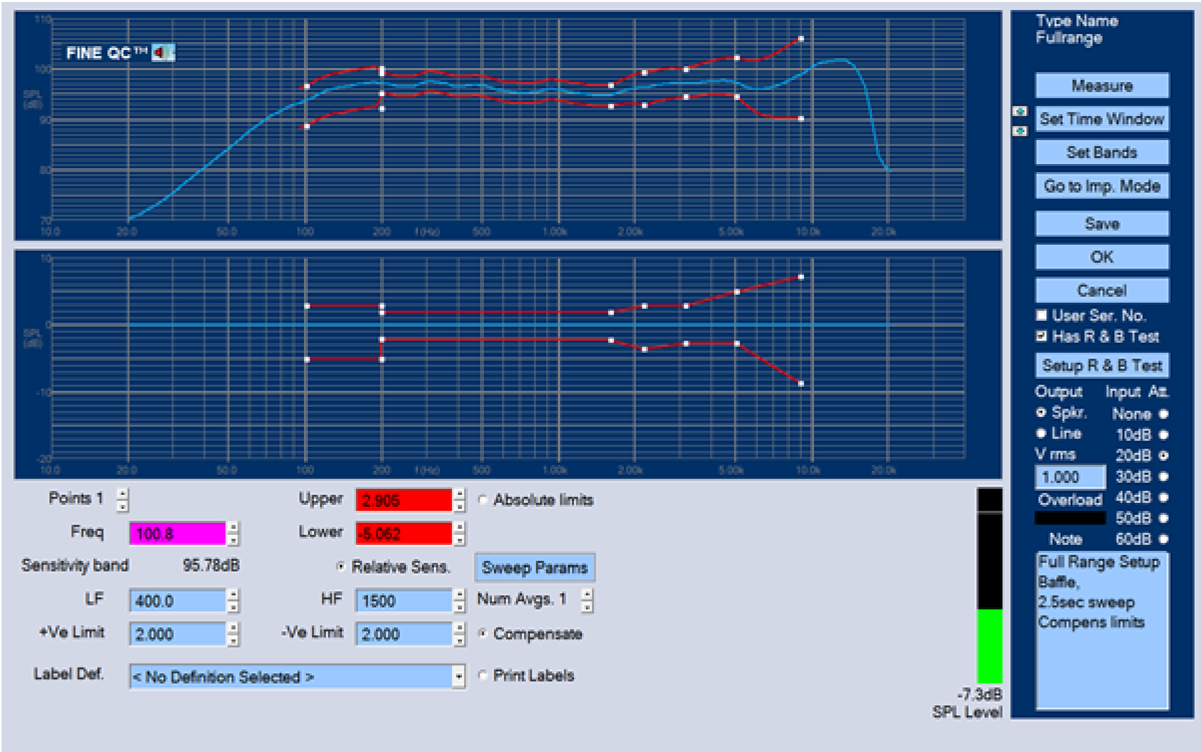


Figure 25 - Edit Limits & Sensitivity Band

The limits are broken up in ranges separated by white square points (Figure 25). These can be selected and changed individually by clicking with the mouse or by using the up/down arrows for the points. I have selected point #10 (shown in magenta when selected) and I 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.

In order to allow for the moved peak, I have lowered the frequency of point #10 to 3 kHz (2966 Hz magenta) and increased the lower limits to 4.5dB (red). A similar file is saved as 2,5inFullrange.fts and with FINEBuzz activated (R & B Test ON). After testing the batch again, we can view the statistics, Figure 26.

This time all responses are within the limits and all units passed. While the difference in the lower window seems large, the upper window shows the lower peak being close to the frequency of the peak of the reference.

Another possibility is done with the Fullrange.fts setup, where the response was smoothed to 1/3 octave before adjusting the limits to allow for the frequency variation of the 3 kHz peak.

Note that the screen (Figure 25) is also where I have specified the sensitivity range from 700-1200 Hz (blue fields), where the sensitivity is calculated as the average with a +/- 1.5dB tolerance as specified in the two lower fields (Blue). Use the “Relative Sens.” for relative sensitivity. The radio button “Compensate” is also activated, meaning that the tolerance limits are allowed to move up and down with the same tolerance. This is the most realistic way to test the frequency response limits; for example, a driver with +1dB sensitivity should be tested with the limits offset by +1dB.

The output drive level [Spkr] from the built-in amplifier is set to 2Vrms, which is producing a reasonably high SPL without overloading this 2.5” full range speaker. When there is an overload (Red), the attenuator should be set one or more step(s) lower so the - reading is less than (-10 dB)

If there is casual noise close to the test, you can specify a number of averages (Figure 25). This will automatically repeat the set number of times, using the average for testing.

Line Out

Figure 25 shows the output at right, where you can choose [Spkr] or [Line]. The Line Out is set at 100mV by default, so a connected amplifier may not overload the speaker, see Figure 50.

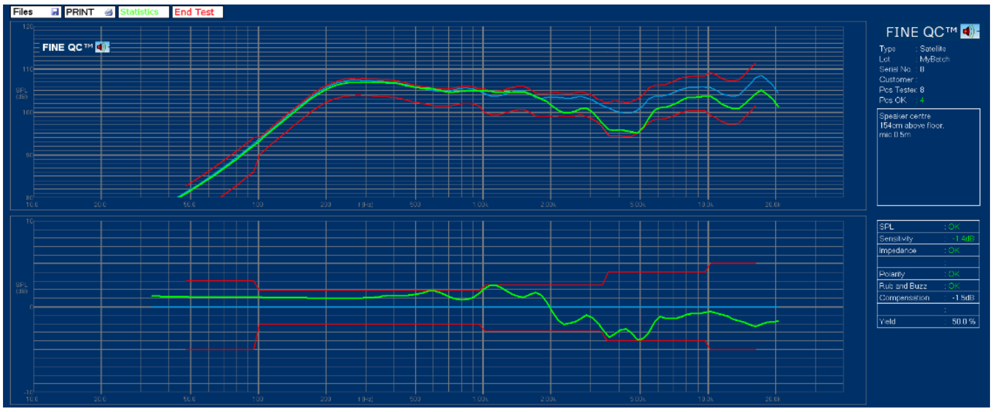


Figure 26 - SPL Statistics with Adjusted Limits

6.5. Measurements

In this chapter I will show how an entire test setup is created. I select “New” from the menu and get the following window (Figure 27), where I first specify the file name:

Figure 27 - Full-Range SPL Template

I have selected the “Full-range” standard (template) from the drop-down menu, which contains generic standard templates for the most used speakers. The 2.5second sweep time is slow enough for the tester to listen for bad sounding drivers during normal testing. However, the best is to find the Rub & Buzz using the new FINEBuzz feature, which can be set in “Edit QC Test”.

The limits can be specified in up to 8 bands; in this case the standard template is using 7 bands with +/-2dB from 100-1000 Hz, which is the stable mid-band region before break-up. The standard limits “Window” or “Mask” is opening up towards low and high frequencies, where we expect more deviation due to shifts in resonance frequency Fs and break-up at high frequencies. The user can change the limits any time if needed.

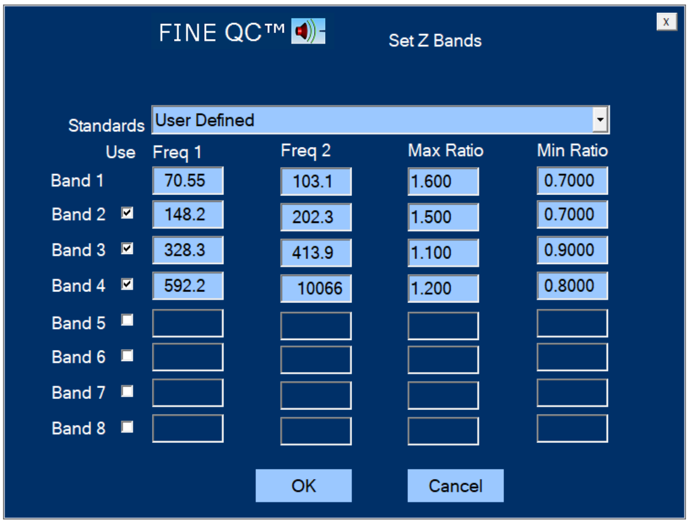


Figure 28 - Full-Range Impedance Template

After accepting the SPL limits the Impedance Template appears (Figure 28), with just one range specified from 50 to 10,000 Hz. The deviation is here defined as a ratio because we are measuring impedance. The max and min ratios are 1.2 (20%) and 0.8 (80%) which I choose to use for now. I may later need to open the limits to allow for variation of Fs.

Now I measure the speaker by clicking the “Measure” button. After the sine sweep is played the next button down is “Set Window”, which brings up the Time Domain window, see Figure 29:

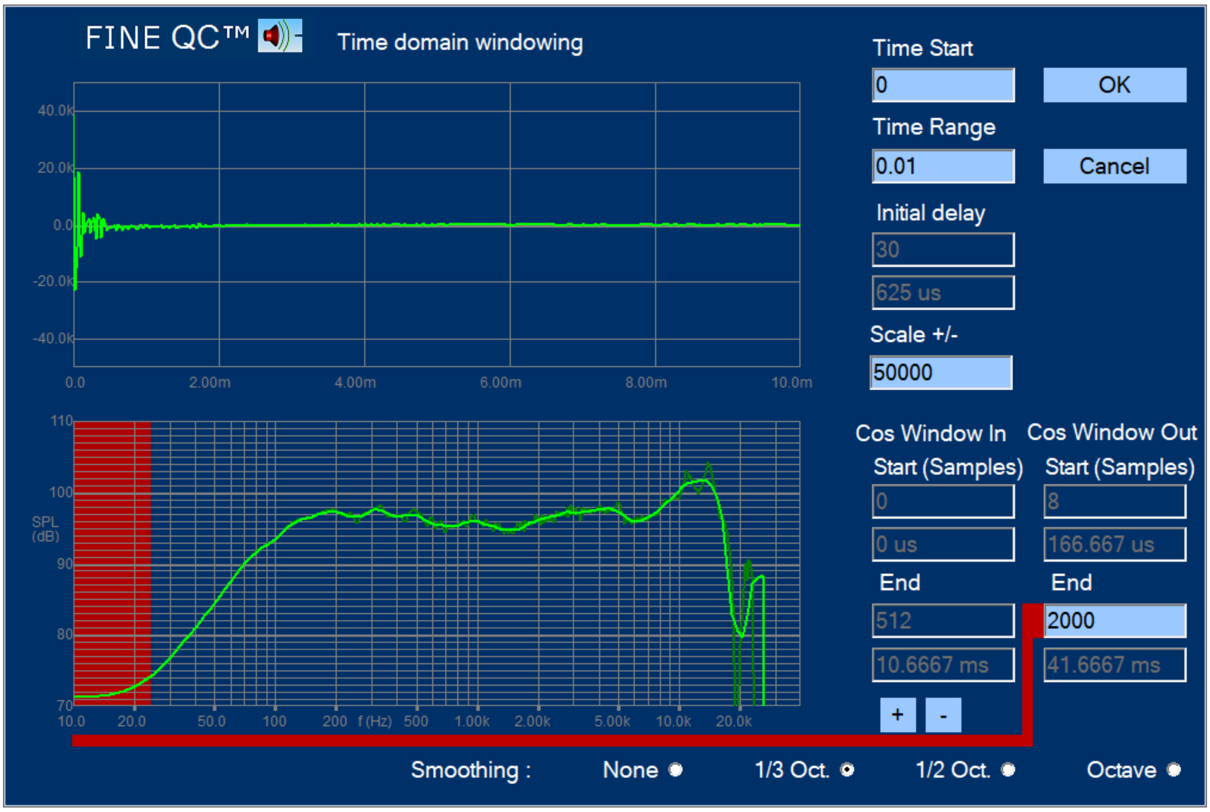


Figure 29 - Time Window Settings

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, I 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 (using the 1/f ratio) using 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 QC measurements in a well-damped closed box like the LOUDSOFT Test Box.

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).

After OK the Z Mode button is pressed to enter the impedance limits screen (Figure 30). First, I pressed “Measure” to make sure the measured curve is the actual impedance.

I have chosen to modify the pre-defined limits of ±20% around the Fs impedance peak to allow for a natural variation in production. That was done the easy way by simply clicking the white squares and dragging the limits with the mouse. Note that the limits are automatically updated in both windows when dragging.

Since the impedance measurement is purely electrical, the range and time window is already defined when the "Auto delay" is active. So, there is no need to open the "Set Window". When the limits are OK click Save.

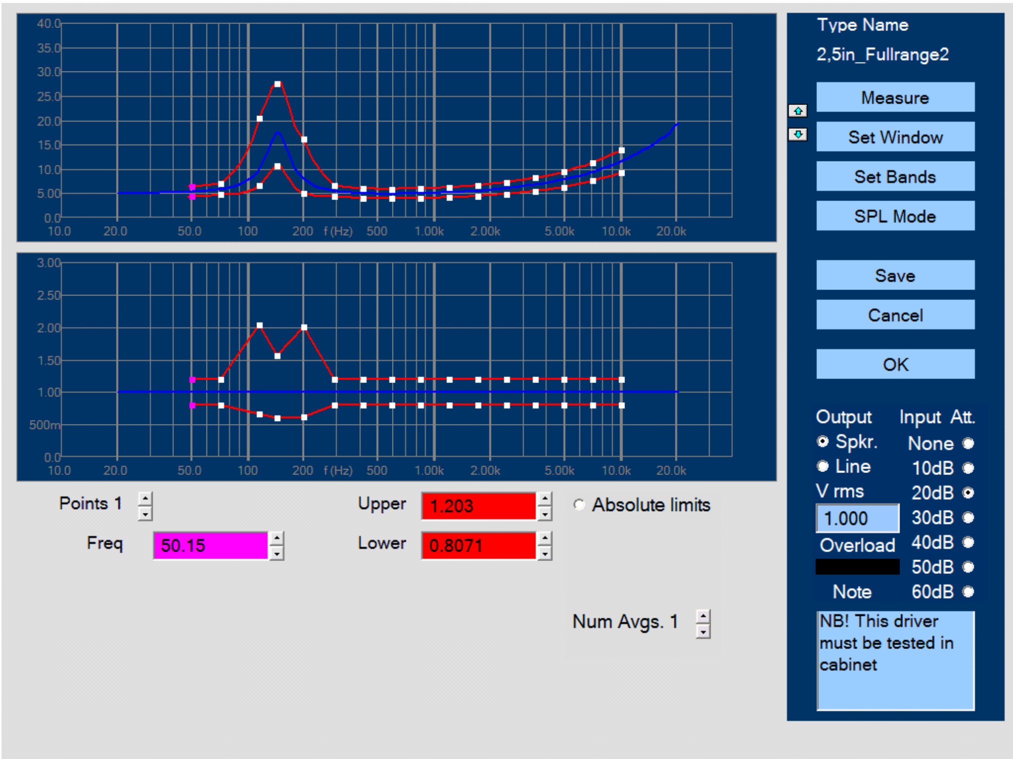


Figure 30 - Impedance Limits, Adjusted

In this window the engineer can also add a note, which will be displayed for the tester. A typical note is shown in Figure 30:

[NB! This driver must be tested in a test box]

6.6. Set Sweep Parameters

You find [Sweep params] under [Edit QC Test]. Here you can set the used sweep range and time. The main range 7.5 Hz to 23 kHz is default and can be used for everything.

We recommend using the predefined setup files, see page 13.

The max sweep time is 2.5 seconds. A sweep time of 1second is recommend for most QC 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: The sweep range should start at 7.5 Hz for woofers and < 20Hz for all other devices, ensuring that the low end is measured well. The End frequency must be 23 kHz to avoid false triggering (23.9kHz is possible, but not recommended).

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.

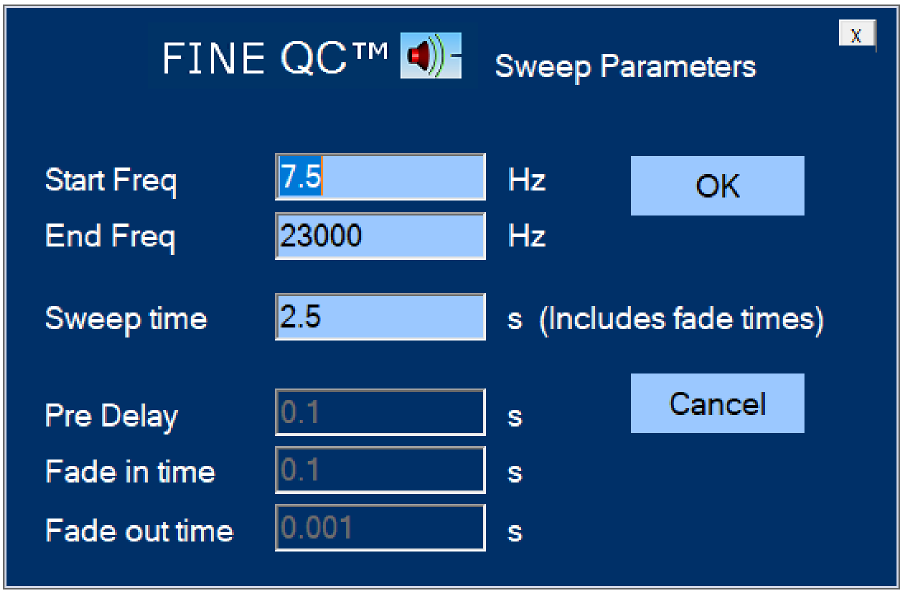


Figure 31 - Stimulus settings

6.7. Test in a Normal Room

Figure 32 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 about 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.

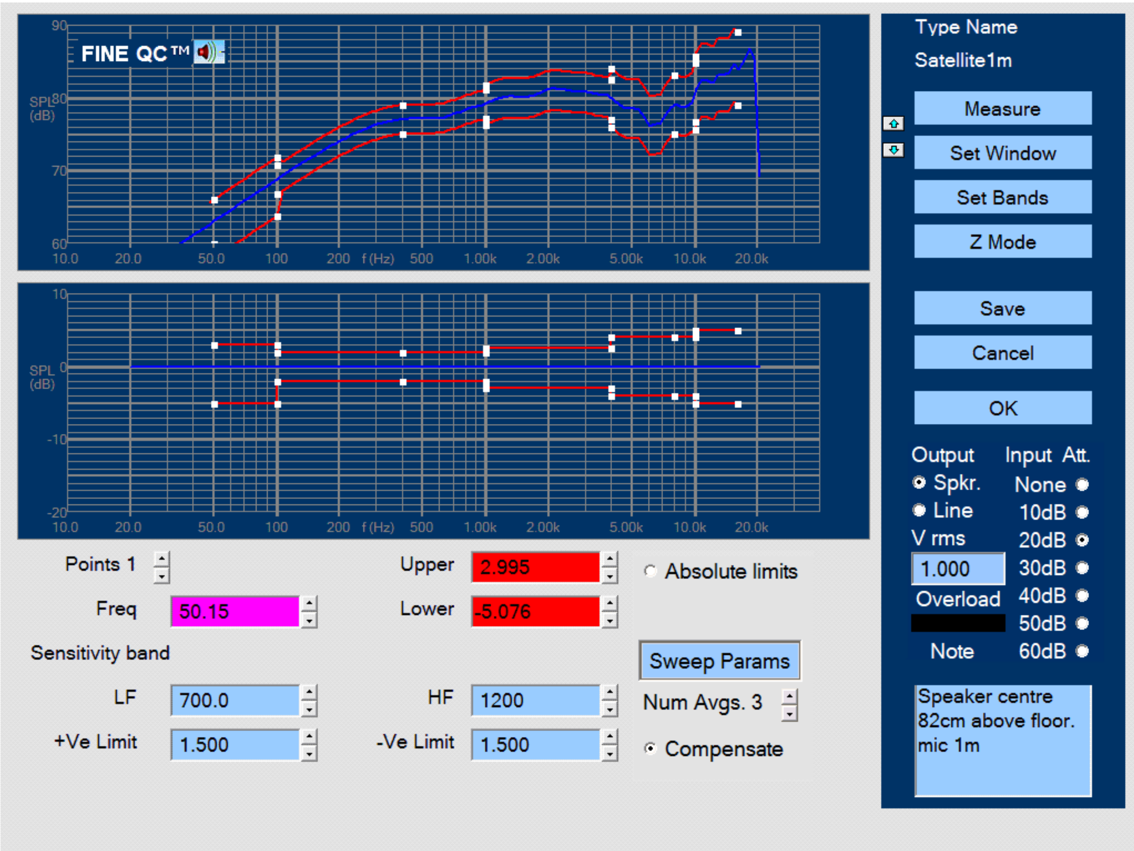


Figure 32 - Satellite Speaker Tested in Normal Room at 1m

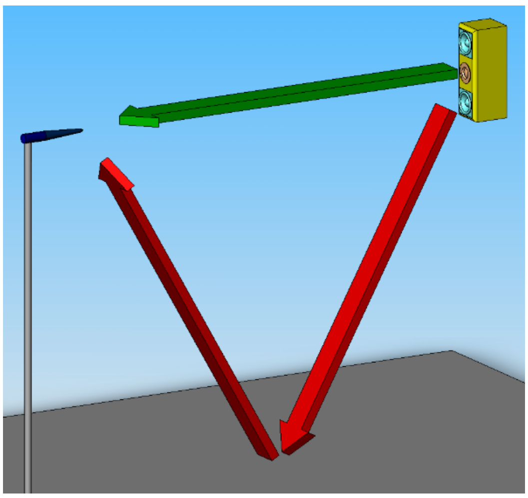


Figure 33 - Satellite Close to Floor, Red is Reflection

Figure 33 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 34. 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, which is only 82cm below the speaker and microphone, as shown in Figure 33.

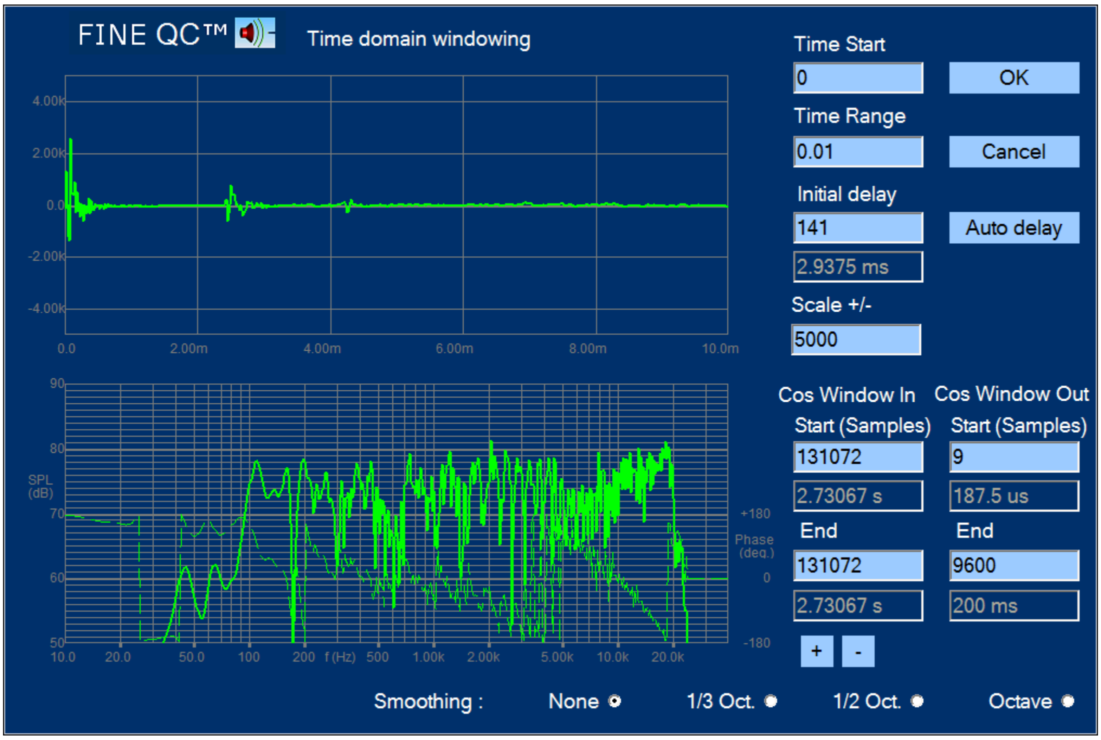


Figure 34 - Time Response of Satellite at 1m Microphone Distance and 82cm above Floor

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.

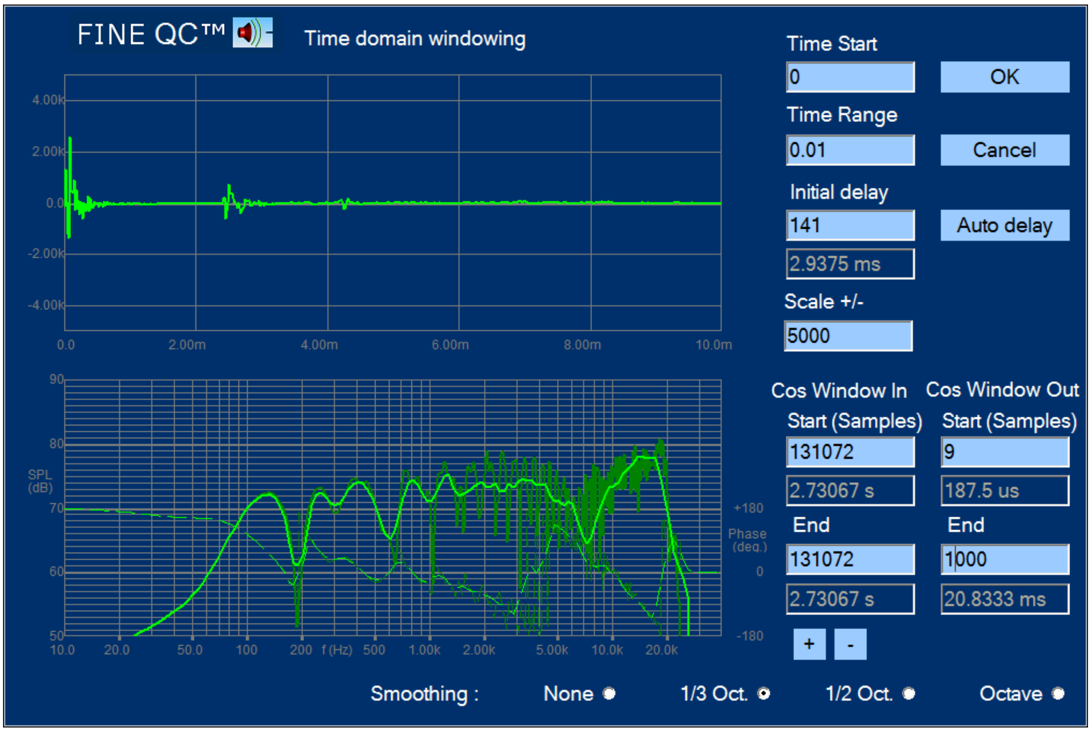


Figure 35 - 1/3 Octave Smoothing of Frequency Response (Unsmoothed in Dark Green)

The frequency response in Figure 34 is quite ragged due to the reflections. You can apply smoothing to view the response anyway as in Figure 35, 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 QC-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 QC-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).

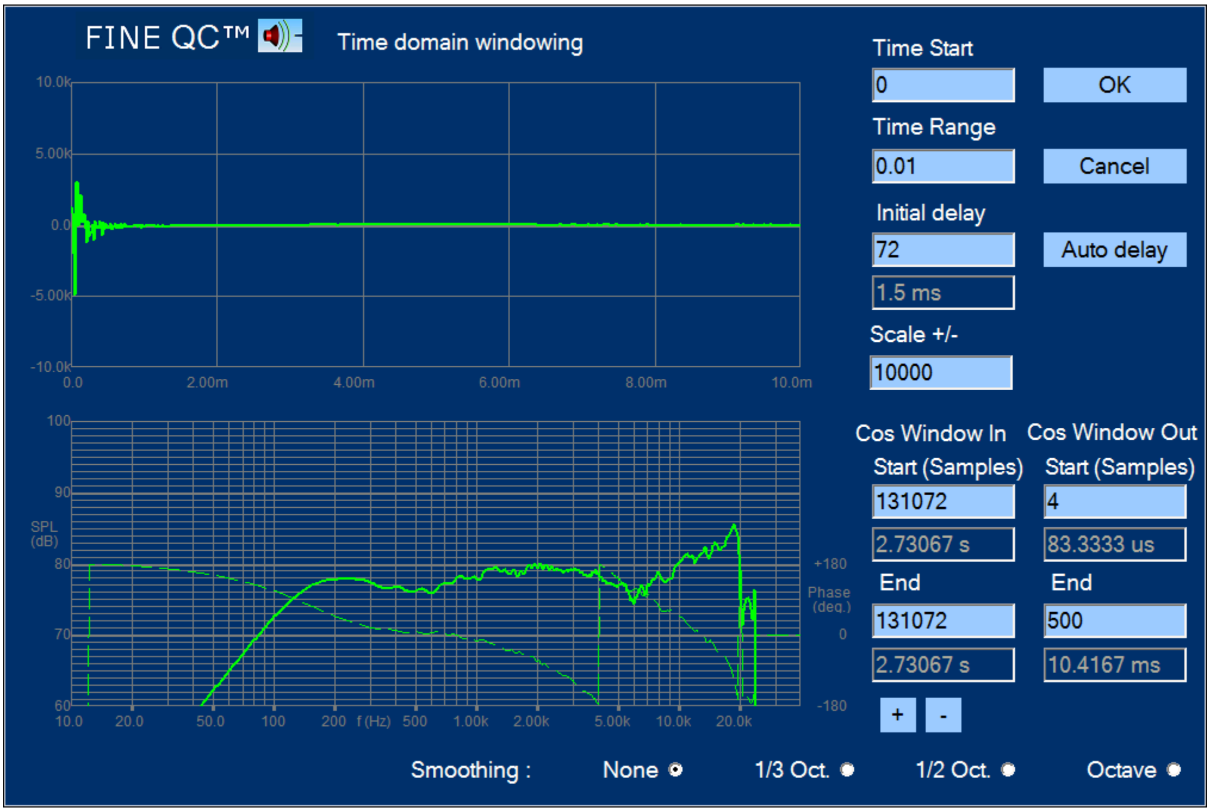


Figure 36 - Satellite and Microphone moved 154cm above floor, Microphone Distance 0.5m

The optimal solution, however, is shown in Figure 36, 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.

6.8. Subwoofer in Near Field

Use Based on: (Sub)Woofer_Free-air.fts for measuring small and very large woofers either at 1cm or say ~10cm distance for 10-18in woofers. Use the SubWoofer +Amplifier.fts setup for active/amplified subwoofers.

The final example is an 8-inch subwoofer, which I choose to measure without any baffle or cabinet, using the Near Field Measurement method keeping the microphone very close to the **center** of the cone. This method is quite powerful and will show the full low-end response as if the driver 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 LF response and sensitivity can be measured well, and the subwoofer roll off can be estimated.

The time domain response is shown in Figure 37, and no reflections are observed. In fact, I have used the default 200ms to enable measurement down below 20Hz. The final test screen for the 8-inch subwoofer is shown in Figure 38. 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.

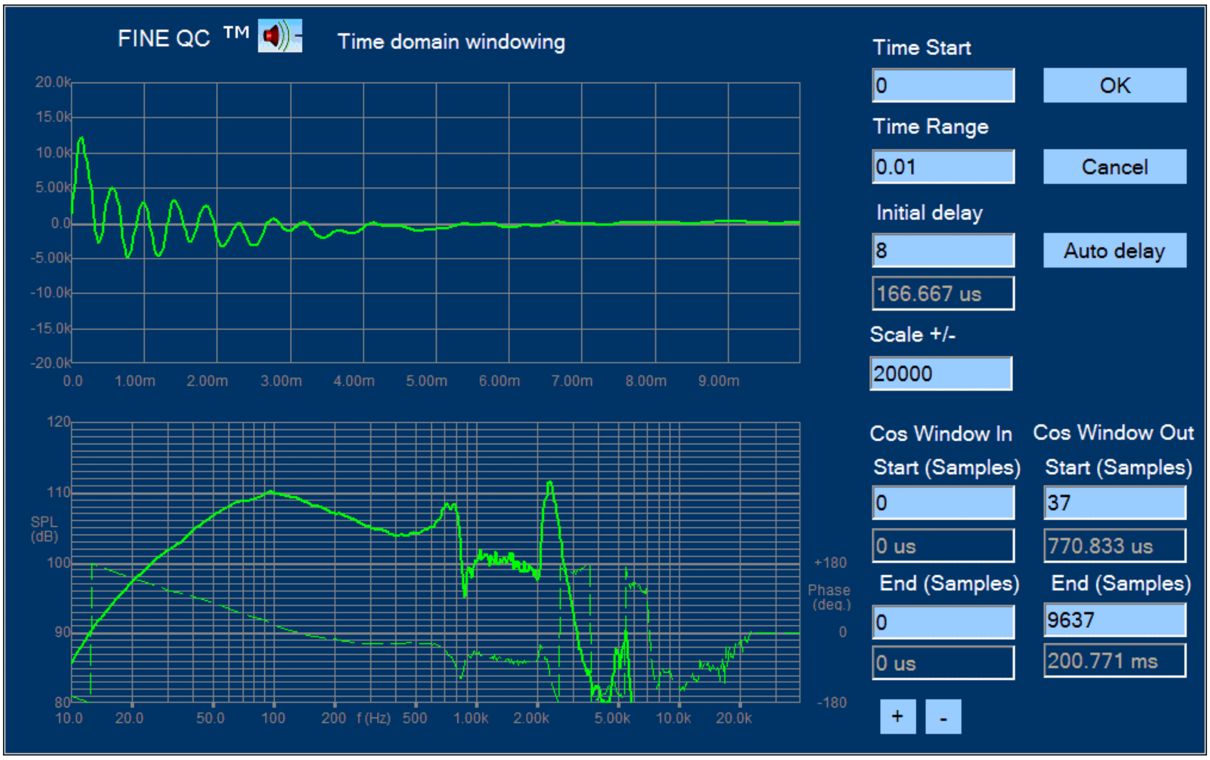


Figure 37 - 8-inch Woofer Measured in Near Field

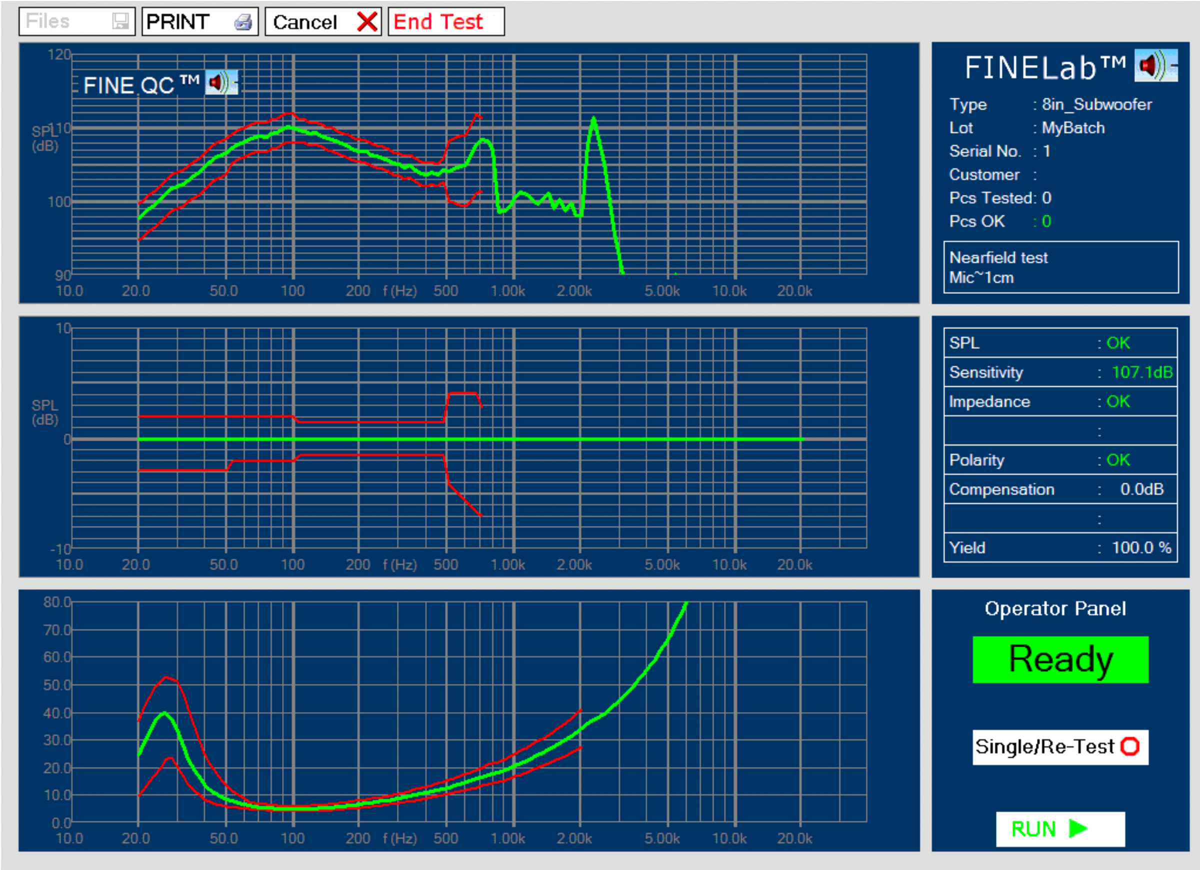


Figure 38 - 8-inch Subwoofer Test in Near Field

6.9. Rub & Buzz Setup

On the production line it is necessary to check all units 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 3rd generation FINEBuzz 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.

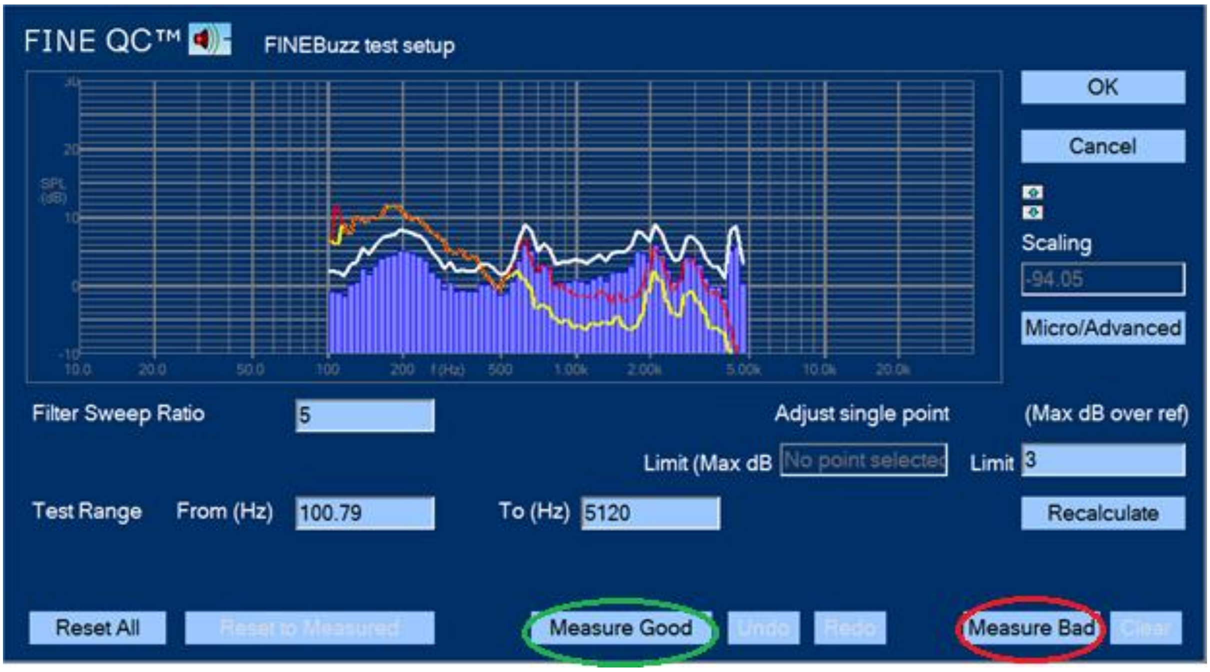


Figure 39 - FINEBuzz Setup Screen

Press “Setup R&B Test” to get Figure 39. 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.

Note: Why does the R&B (Rub & Buzz) stop 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 we can show R&B 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 40 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.

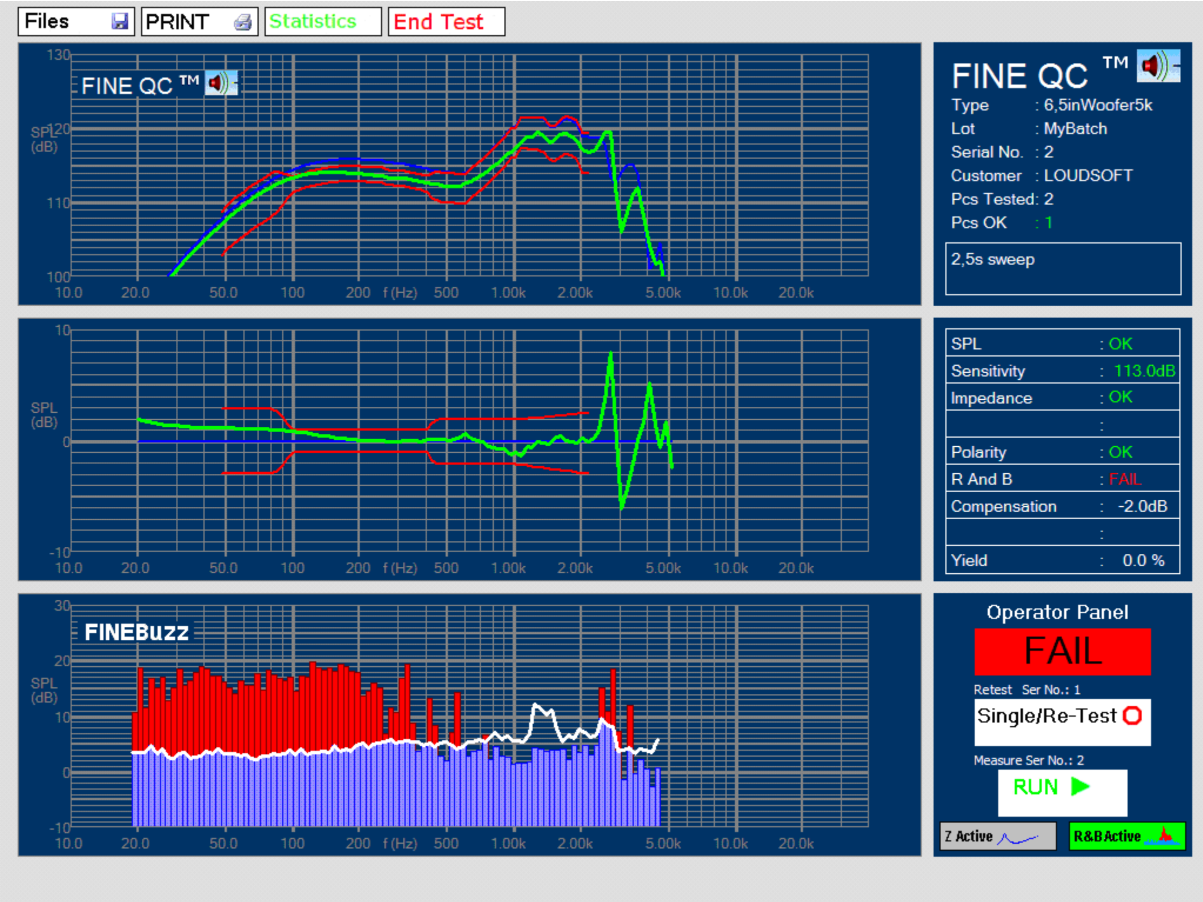


Figure 40 - 6.5-inch Woofer with Rubbing Voice Coil Found with FINEBuzz

It is possible to test Rub & Buzz in 1 second (even 0.5s is possible, but try higher first) however I recommend using the longer 2.5s 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 41 shows a tweeter with very subtle buzzing tinsel at 900Hz.

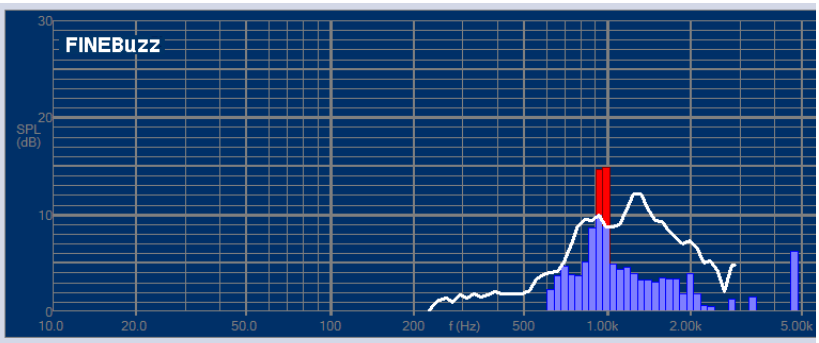


Figure 41 - Tweeter with Very Subtle Buzzing Tinsel at 900Hz

6.10. Bluetooth Testing

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

Connect a Bluetooth Transmitter to the Headphone mini-jack output (or Line Out XLR) as shown in Figure 42. 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 QC. Using a **2 second sweep** is recommended, for avoiding latency problems

Figure 42 - Bluetooth Transmitter connected to Headphone output

Automatic Rub & Buzz Limit

This new feature can save a lot of time: First measure good sounding speakers (say 5-20 pcs) by clicking the [Measure Good] button. Each will show as a yellow line, and each measurement will automatically update the maximum Rub & Buzz limit.

Note: You can undo any wrong measurement!

Then measure a few bad ones [Measure Bad], showing up as a red maximum line. Check that the red lines are clearly above the white line! Set the limit so that the white limit line is centered between good and bad measurements. The limit was in this example set as (Max dB over = 3).

Press “Recalculate” to reset the white limit. By clicking OK, you have automatically set the Rub & Buzz limit to approve the good and reject the bad units!

You can adjust the white limit line for each blue column individually by clicking it and adjusting the level with the mouse wheel, or entering the number in the field at lower right.

Note: Setting the FINEBuzz limit to a few dB requires very silent test conditions! Use a separate closed test box and avoid noise sources like air guns, fans and bumping carts and pallets.

(You can also select “Micro/’advanced” (see below). This makes the Rub & Buzz detection most sensitive. Use this function with care and always put the microphone inside a closed test box and avoid high frequency noise!)

6.11. Micro Speaker/Receiver Testing

FINE QC is ideal for measuring micro speakers or micro receivers in high speed production. A full test can be done in less than 1 sec.

Start with [Based on] Micro-Speaker.fts or Micro-Receiver.fts and measure SPL like Figure 45.

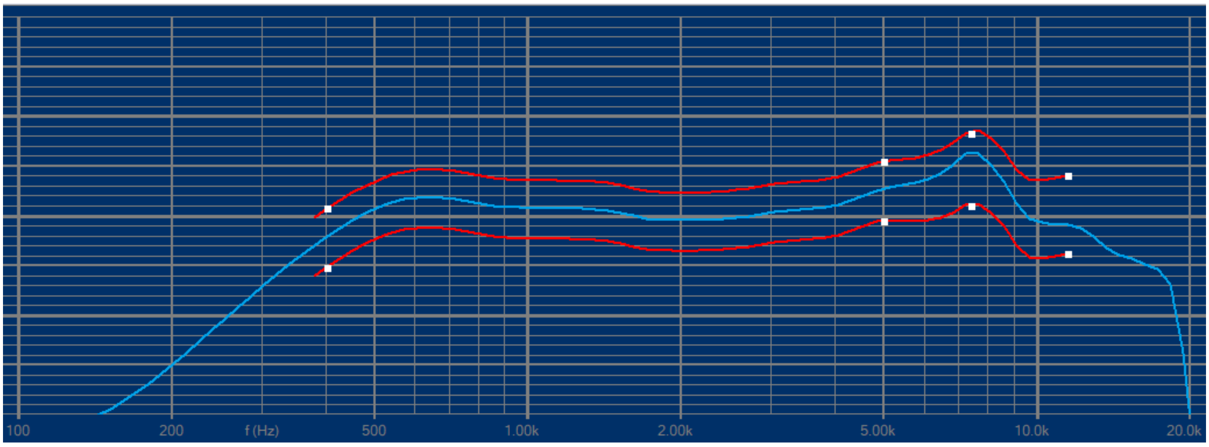


Figure 43 - Typical Micro Receiver test setup in FINE QC

WE STRONGLY RECOMMEND USING A TEST BOX when measuring micro speakers in production End of Line test! Then you can select “Micro Test” (Figure 44) to enhance detection of subtle Rub & Buzz.

Selecting the MICRO/ADVANCED button brings up 2 choices:

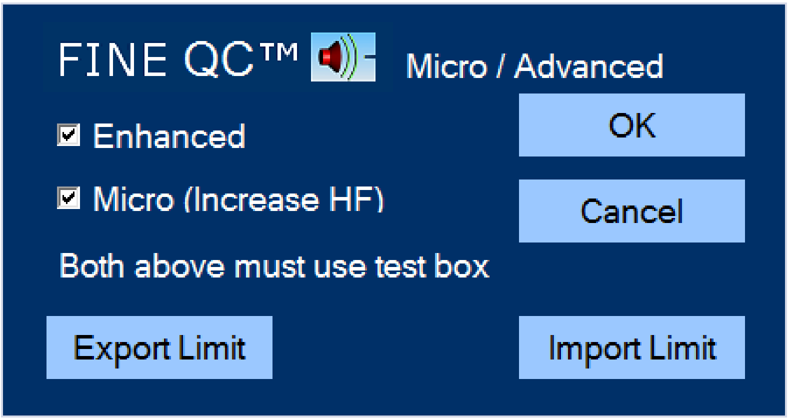


Figure 44 - Select "Micro Test" for Enhanced Rub & Buzz

1. The Enhanced option selects 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 QC testing has successfully replaced the human testing by ear.

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

6.12. Thiele / Small (TS) Parameters

Finally, I want to measure the TS parameters of a 10-inch subwoofer. Pressing “Edit TS Test” from a previously defined QC Test will show the screen in Figure 45:

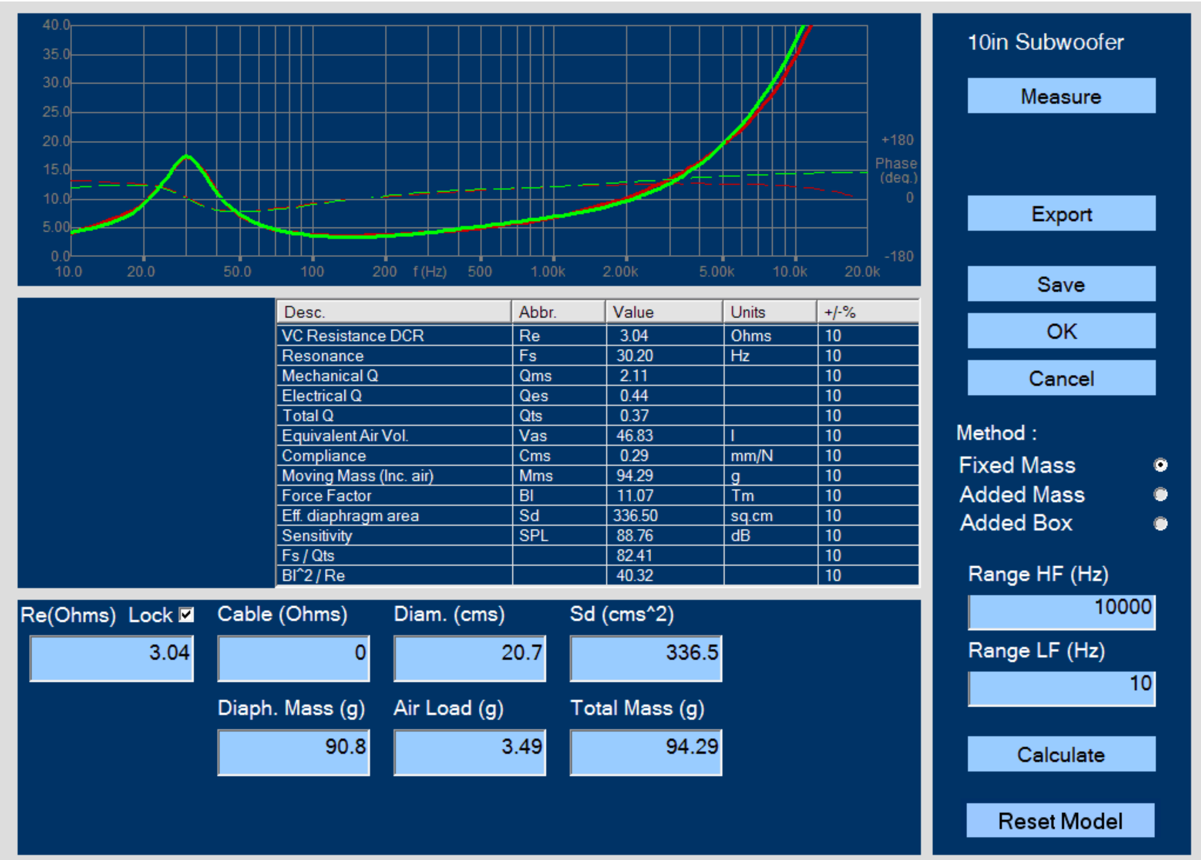


Figure 45 - TS Parameters of 10-inch Subwoofer

First, I need to input the cone area Sd and Re. I choose to input the effective diameter of 20.7cm (center of surround) and Sd will automatically be calculated. FINE QC can estimate Re from the impedance curve, but in order to get the best accuracy I have measured Re=3.04 ohms with a precise Multi-meter (DVM). That value is fixed by lock [v]. Now I press “Measure” to get the impedance curve (green).

I could choose the standard Added Mass or Added Box method, but the Fixed Mass option is much more accurate. However, I must cut a typical woofer, so I can weigh the cone + Voice Coil + half surround + half spider (including dust cap and glue etc.). This mass (Md) is entered as Diaphragm Mass which causes the air load mass (Mair) to be calculated, Md + Mair=Mms.

When the “Calculate” button is pressed, FINE QC will calculate all the TS parameters by fitting a simulated impedance curve (red) in the chosen frequency range. In this case we get a very good fit around Fs, which is important for getting accurate TS parameters. Press Reset Model if fitting is bad.

Qts is calculated as 0.37 with Fs= 30.2Hz, but we also get the sensitivity SPL= 88.76 dB/2.83V.

We must accept a large variation in Qts, because it depends strongly on Fs. Therefore, FINE QC also calculates the ratios Fs/Qts=82.41 and BL2/Re=40.32. These ratios are more important for controlling the bass response than Qts and Fs and other parameters.

Files / View

You can always open saved responses from the File menu.

The measured data are stored here (default):

C:\FINELabBatchData\Batchname

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 both SPL and impedance, both with phase.

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

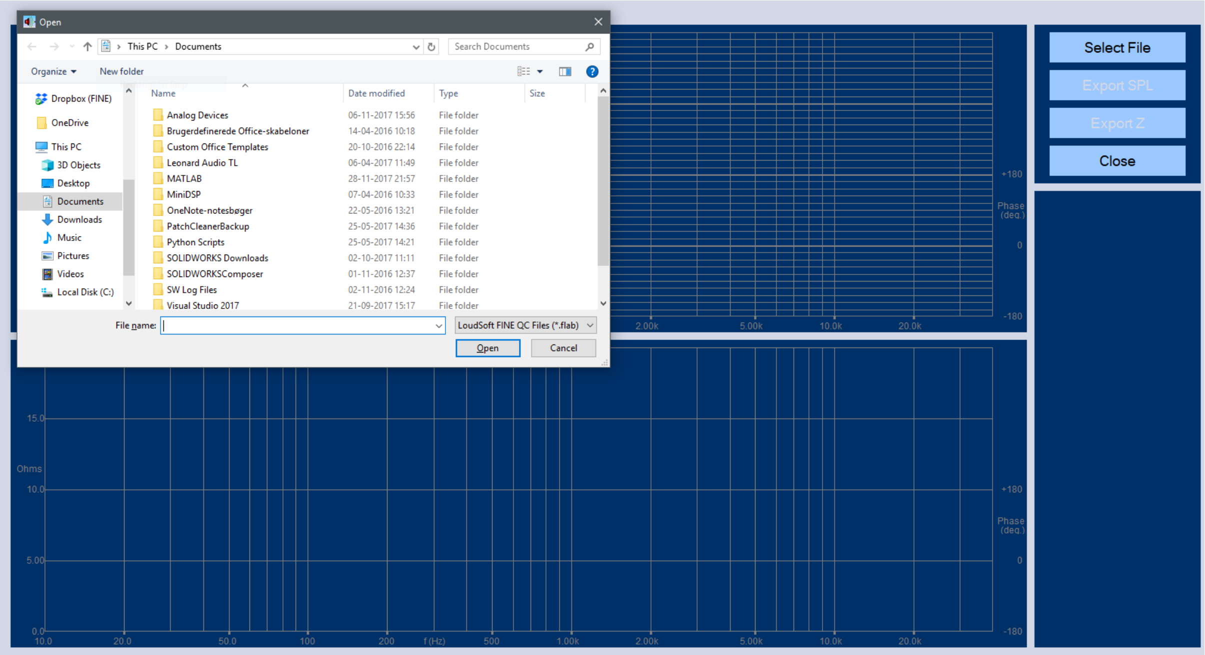


Figure 46 - File View

7. QC Test of X-over circuits

Microphone/Line Input

Pin	Function
1	Chassis ground (cable shield)
2	positive polarity terminal ("hot")
3	return terminal[2] ("cold")

Figure 47 - XLR pin layout

Figure 48 - A generic crossover

QC test of cross-over circuits:

Please connect the cross-over circuit as shown in Figure 51. You must connect resistors instead of loudspeaker drivers for QC 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!

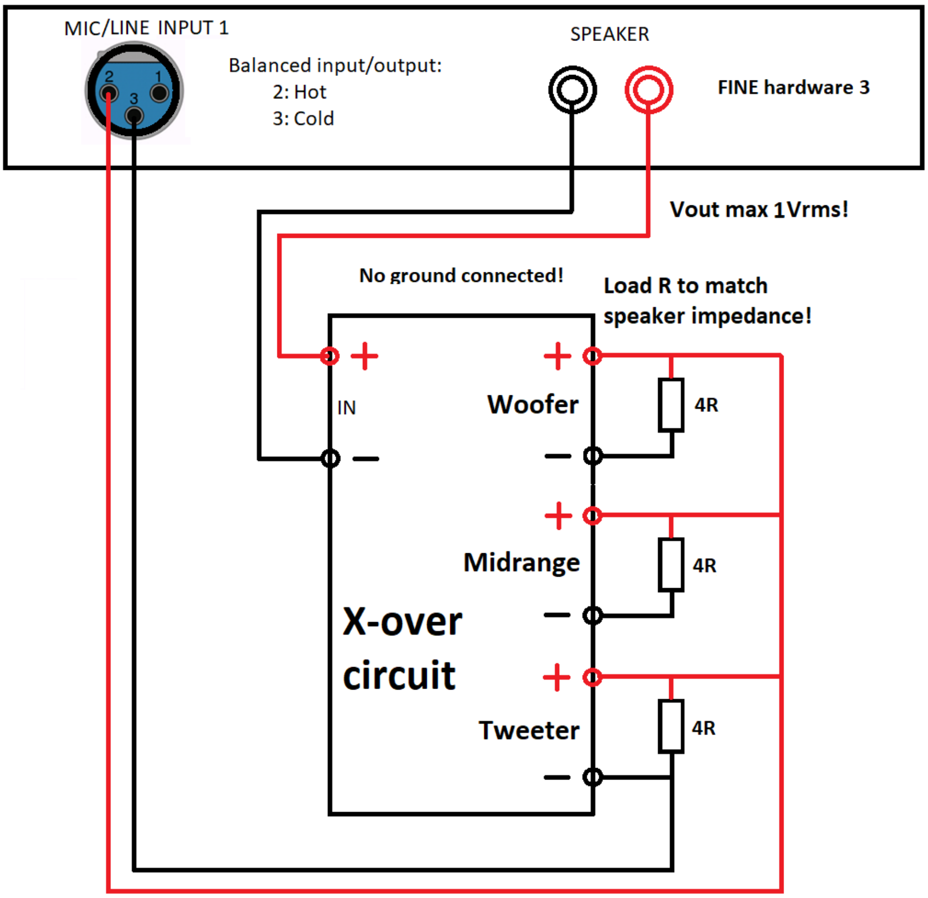


Figure 49 - QC test of X-over (Cross-over) circuit. Remember load resistors

8. 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 terminal3 (cold), see Figure 50. Then make a connection from the amplifier output to the Microphone1 input using **only** terminal 2 (Hot) and terminal3 (cold), see the diagram in Figure 50.

Select [Based on] Smart_Speaker (AUX or Bluetooth), for measuring all amplified/Smart speakers

DO NOT CONNECT TO CHASSIS/GROUND!

KEEP THE OUTPUT LEVEL LOW in order not to overload the amplifier and connected speaker! You may use the attenuator in Fig. 51 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 ~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!

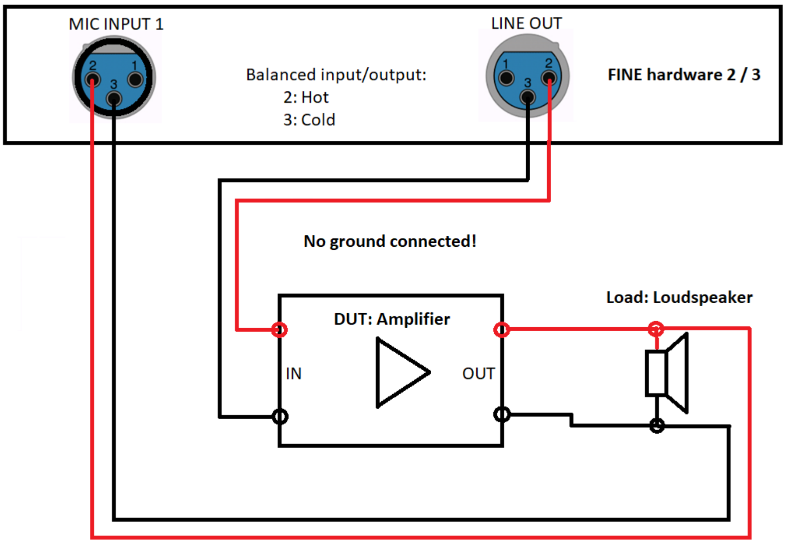


Figure 50 -- Electronics Testing: Amplifier connection diagram

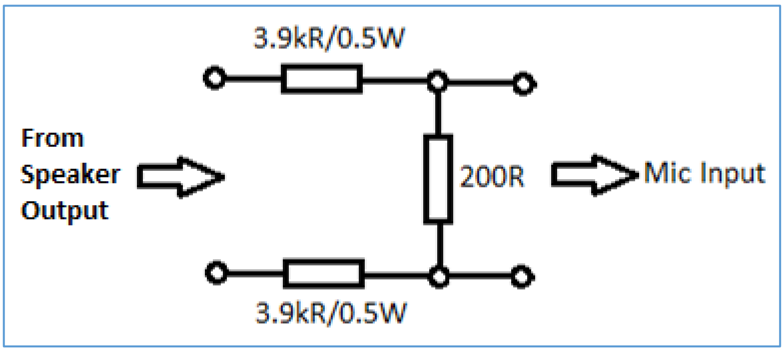


Figure 51 - Attenuator for High Power Amp Test. Max V=40V input (=400W/4R)

When you want to measure high power output from the amplifier, you must insert an attenuator as shown in Fig. 51. Connect the left side to the amplifier output.

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

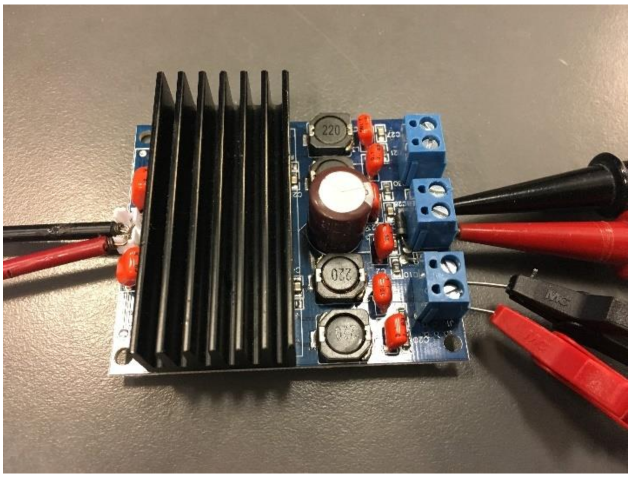


Figure 52 - Small (Class D) amplifier measured with FINE QC

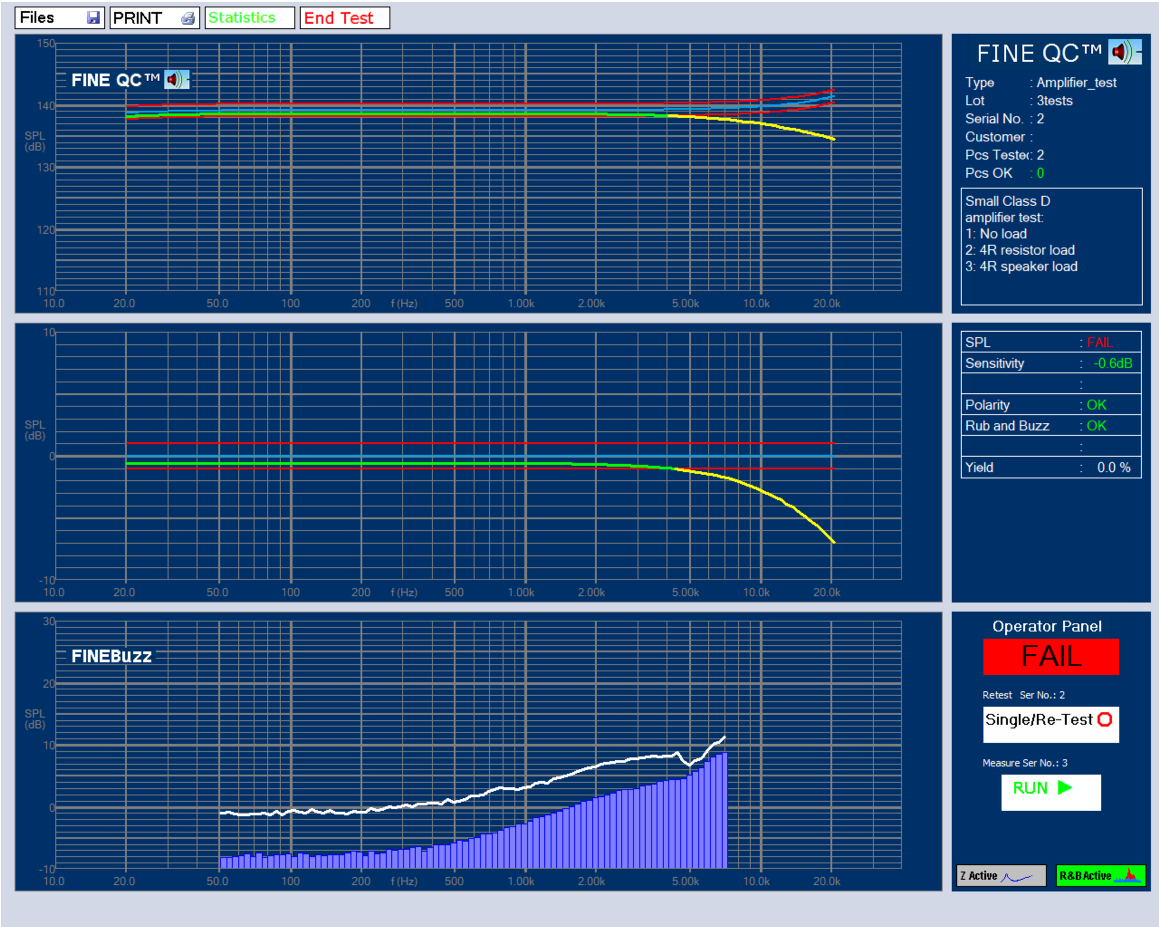


Figure 53 - Amplifier Test: #2 failed due to 4R load

The small (Class D) amplifier in Figure 52 was tested with 3 different loads: #1 (No load), #2 (4R resistor), and #3 (4R loudspeaker). Figure 53 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.

8.1. Microphone Testing

FINE QC can test microphones well. You need a good wideband speaker or speaker system. First select [Based on] Microphone_Test.fts setup and measure the frequency response using a good reference microphone, see the top curve (grey) below in Figure 54.

Then replace the microphone with the one you want to test and run the setup you have just created, see Figure 54. Now the center curve (green) is the measured response of your microphone. (This is because this center curve is relative to the reference, which was with the Reference microphone).

If your microphone has a different sensitivity than the ref microphone you can just enter this under Calibration / Microphone, but only **after** you have made the first reference measurement! (Or you can change the input test Voltage to compensate, but then do not re-measure).

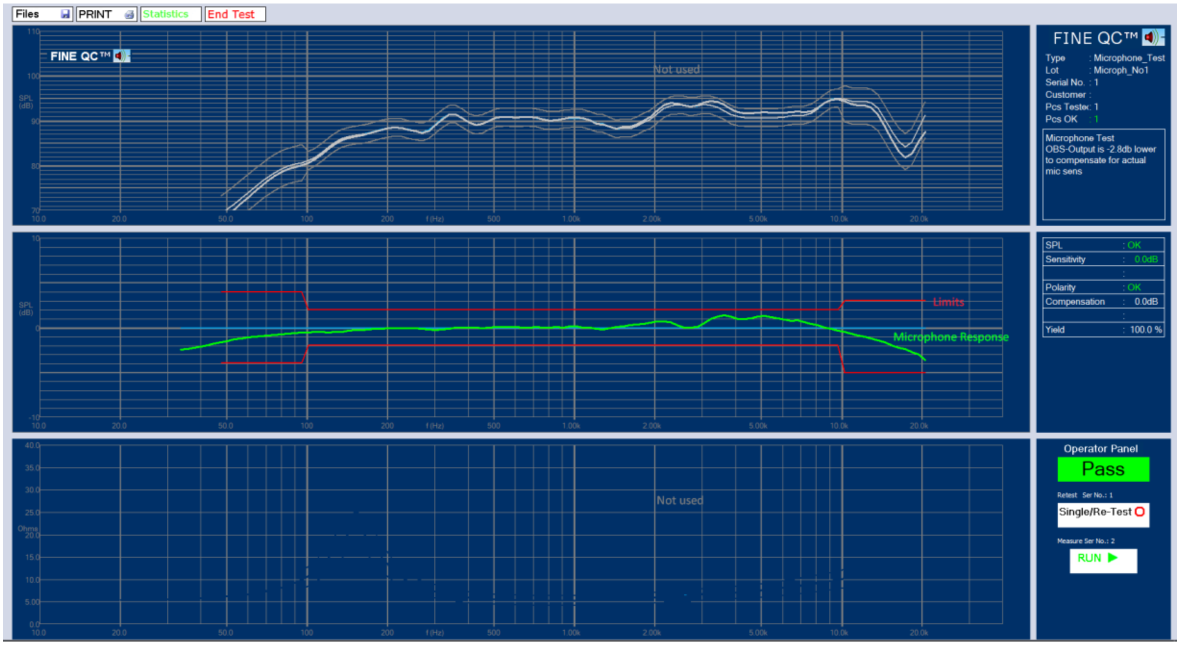


Figure 54 - Microphone response w limits tested with FINE QC

9. Printing Labels in FINE Q

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

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

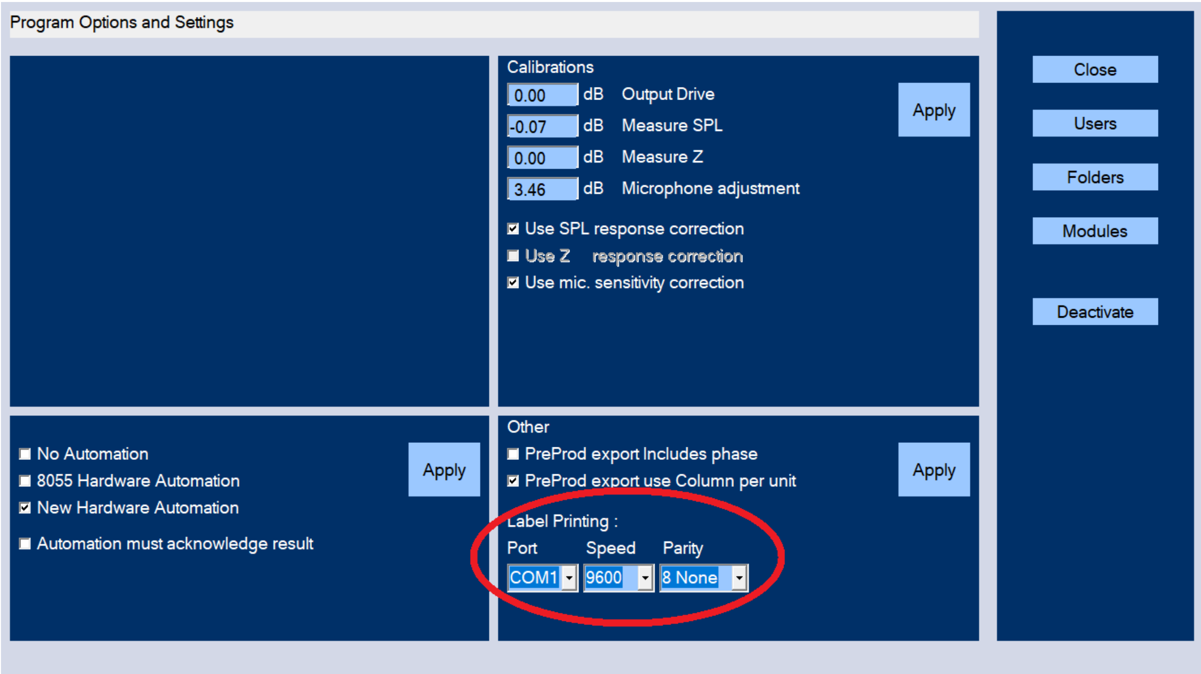


Figure 55 - The printing options can be changed in the admin panel

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

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

Figure 56 - The style of the unit labels can be changed in the "Unit Labels" menu found in the main window

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

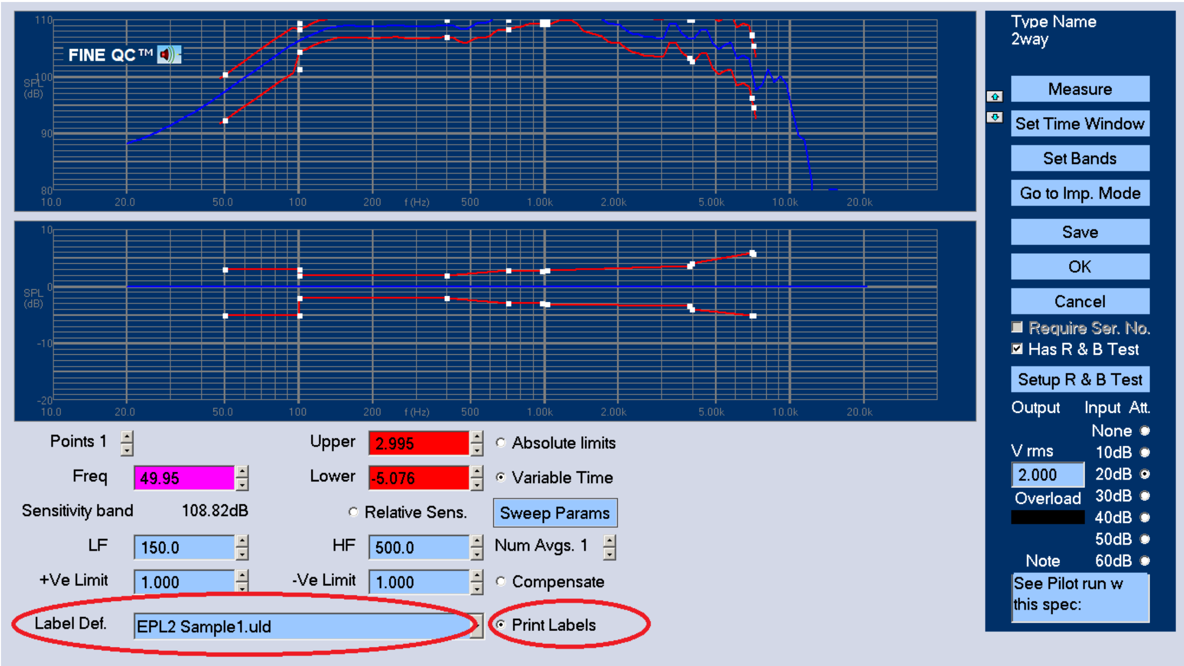


Figure 57 - The different label styles can be selected in test specifications.

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

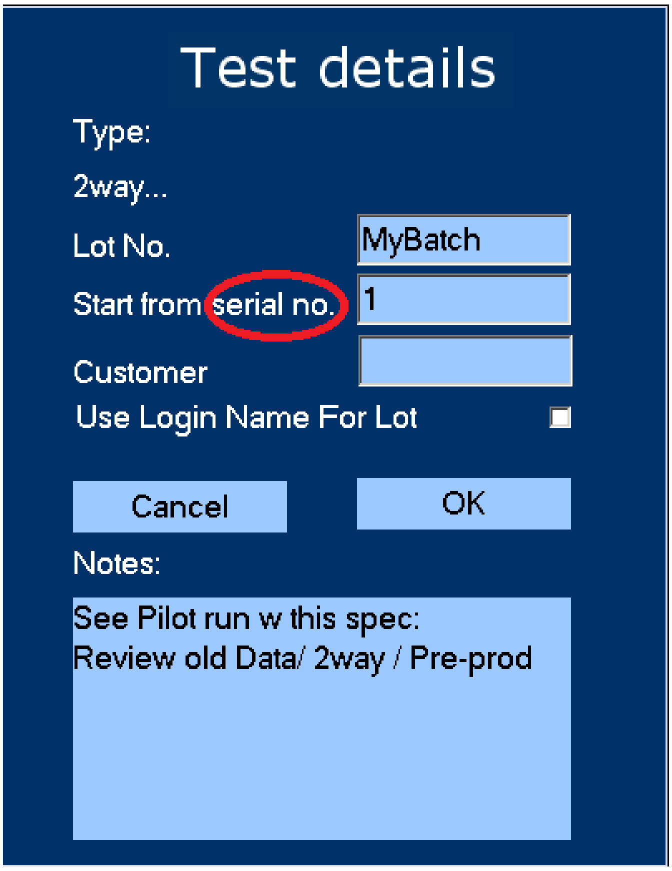
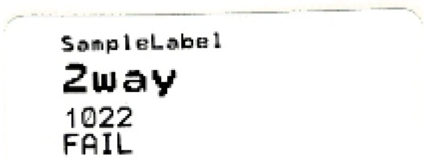


Figure 58 - It is possible to specify what serial number to start from so it fits with the production

The following figure shows the label for a failed sample.



10. FINE QC Calibration Procedure

Calibration is done from the factory. However, you can finetune FINE R+D using the calibration procedure.

10.1. Output Level

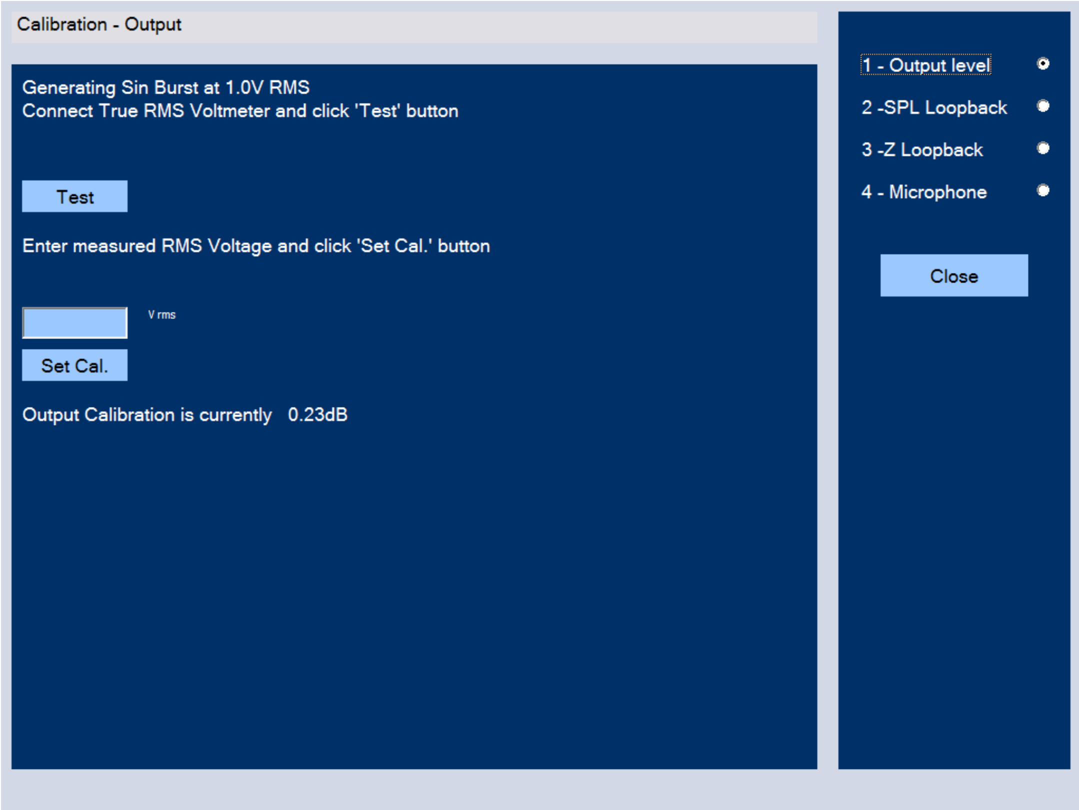


Figure 59 - The output level calibration window

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.

10.2. SPL Loopback Calibration

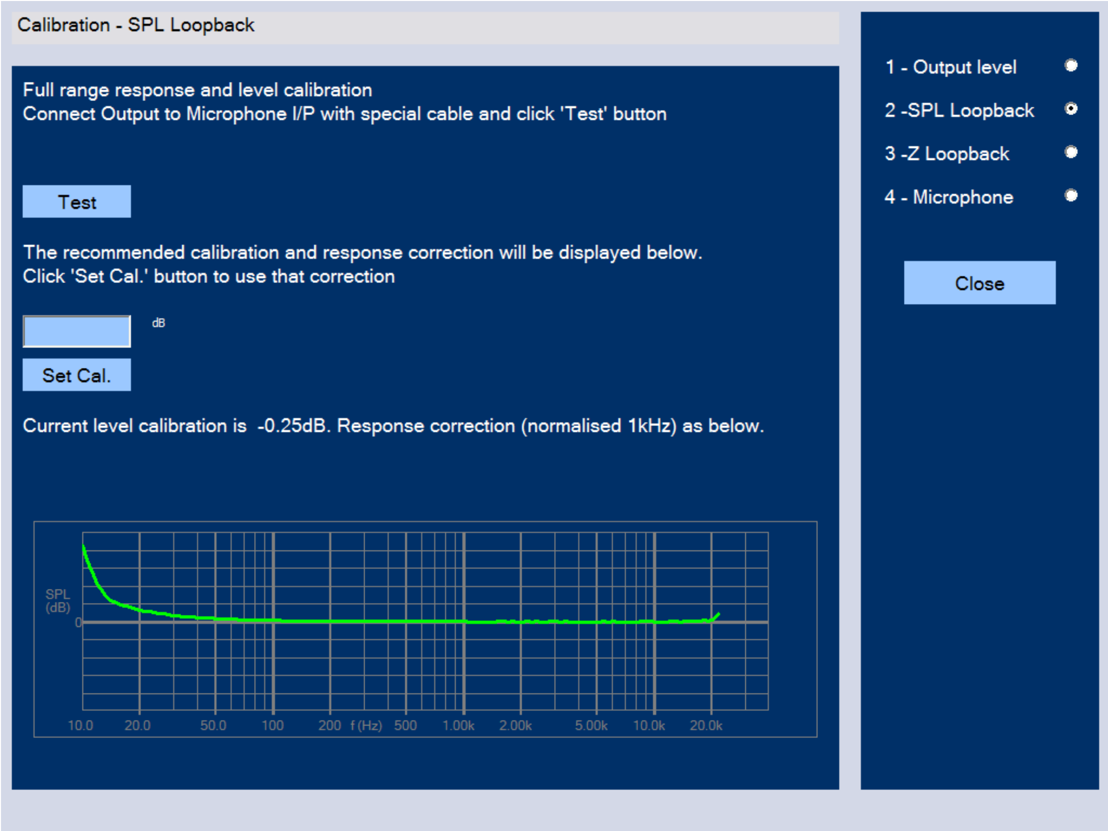


Figure 60 - The SPL loopback calibration window

Select “2 – SPL Loopback” at the upper right of the window. This is a full range response and level calibration of the SPL.

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

Figure 61 - The FINE Hardware 3

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

10.3. Impedance (Z) Calibration Using FINE Hardware

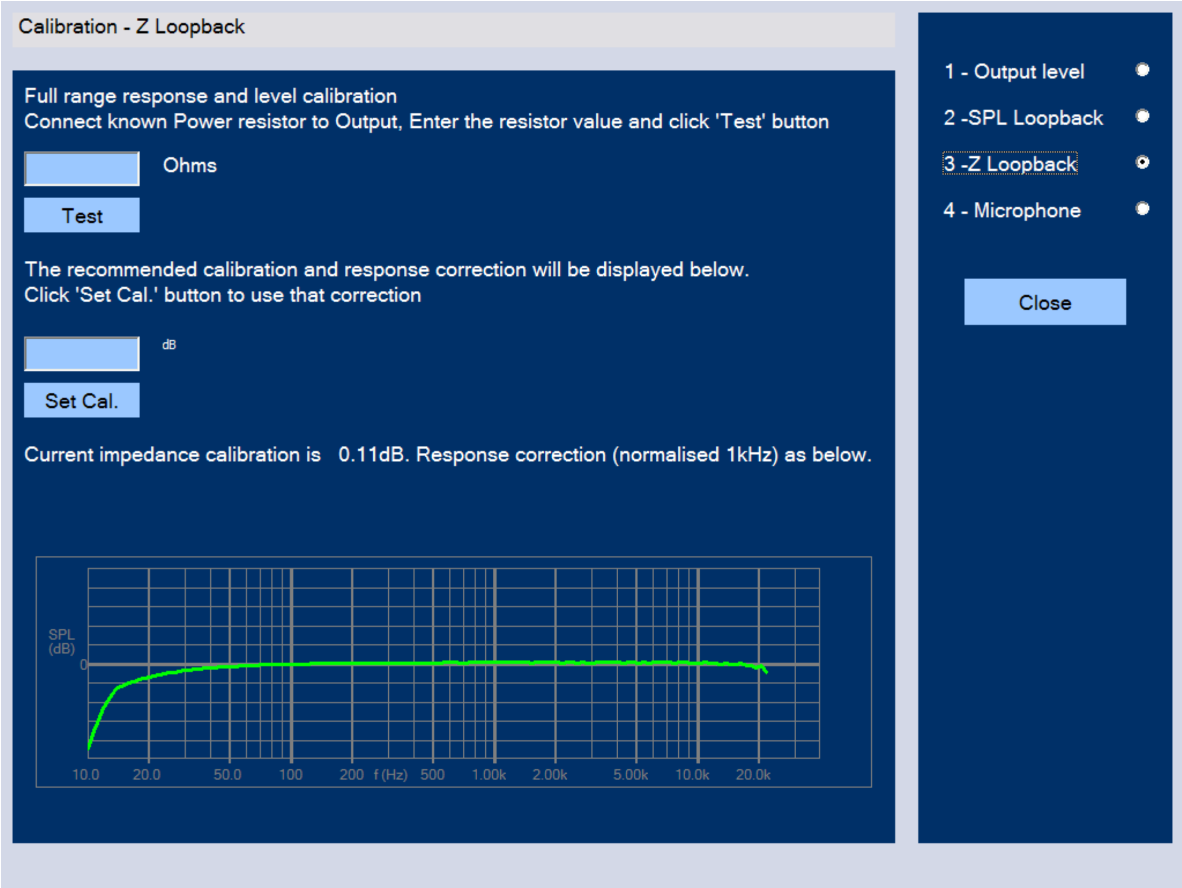


Figure 62 - The impedance loopback calibration window

Select “3 – 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.

10.4. Microphone Calibration

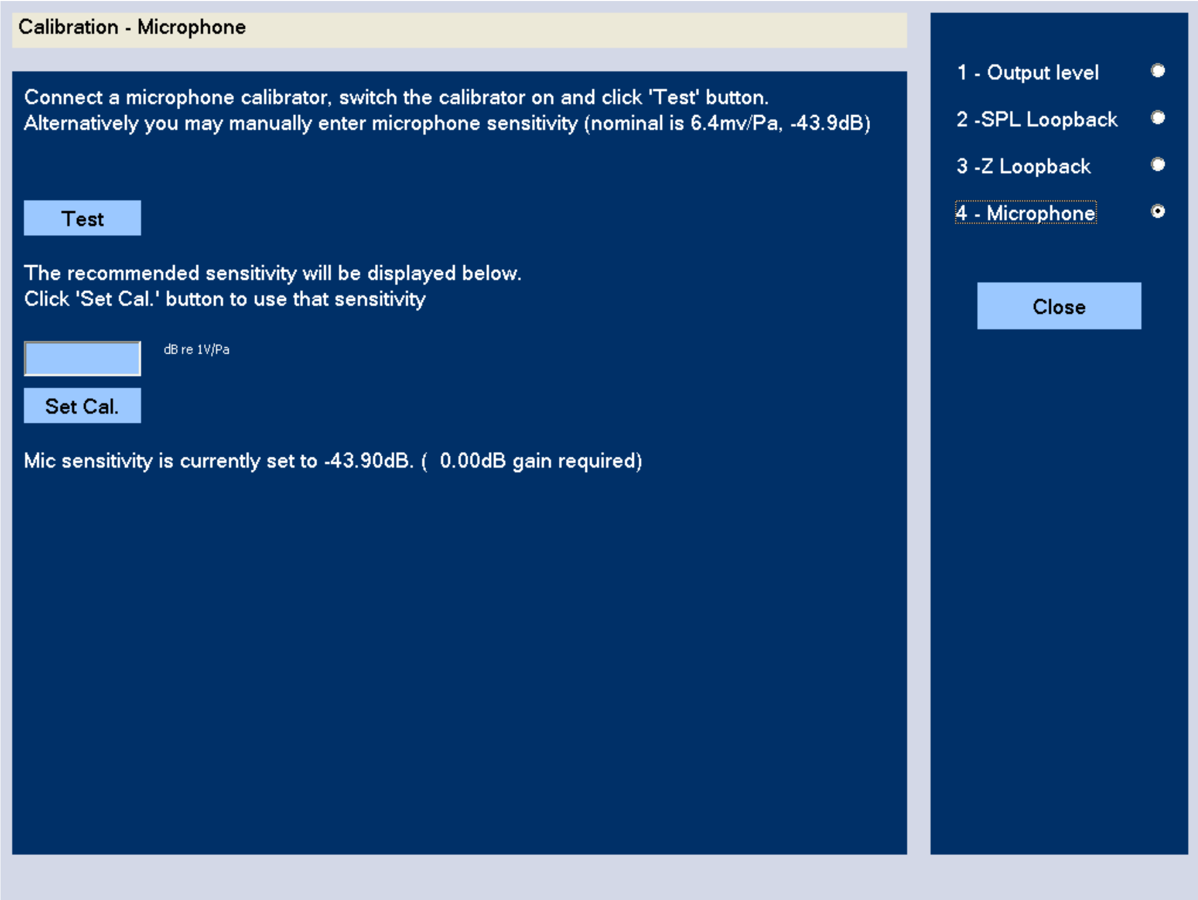


Figure 63 - The microphone calibration window

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 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).

11. FINE Hardware

11.1. Front Panel

Figure 64 - 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 TO 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 1/10 (-20dB) of the main output, so 1V nominal output will be 100mV on the RCA/Phono 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.

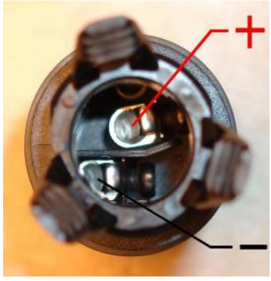


Figure 65 - Speakon Rear Connections

11.2. 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

11.3. FINE Hardware 3 Specifications

Sampling Frequency

AD/DA Conversion: 48 kHz - 24Bit

Frequency Response

SPL: 10 Hz to 22 kHz (±0.5 dB)

Impedance: 10 Hz to 22 kHz (±10%)

Mic Nominal Input Level

XLR 0-1000 mV RMS. Max input is 12V peak to peak or ~4.2Vrms

Line Output:

0 – 1500 mV

Interface

USB 2.0

Amplifier

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

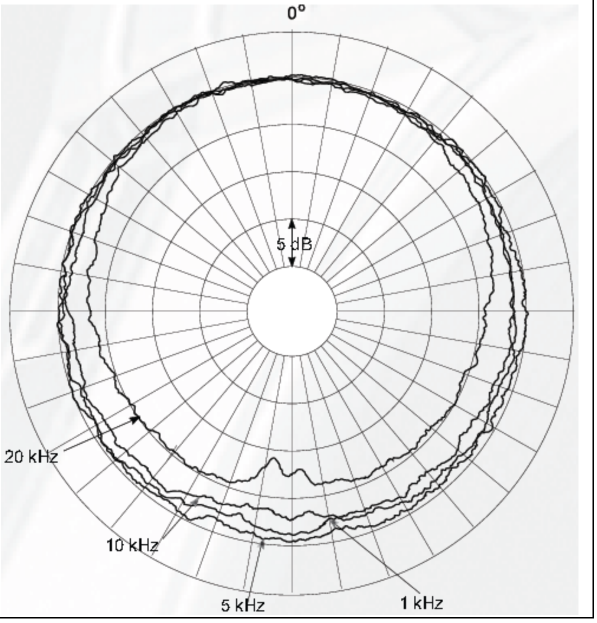
10 W (4 ohms load, Max THD<0.1%, 1 kHz)

Protection: Short circuit and over temperature shutdown

11.4. LOUDSOFT Microphone FL1 Data Sheet

Figure 66 - 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, ±2 dB:** 20 Hz – 20kHz **Sensitivity, Nominal, ±3 dB:** 6 mV/Pa; -44.5 dB re. 1V/Pa **Equivalent Noise Level, A-Weighted:** Typ. 26 dB(A) re. 20 µPa (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 Ω **Polar Pattern:** 

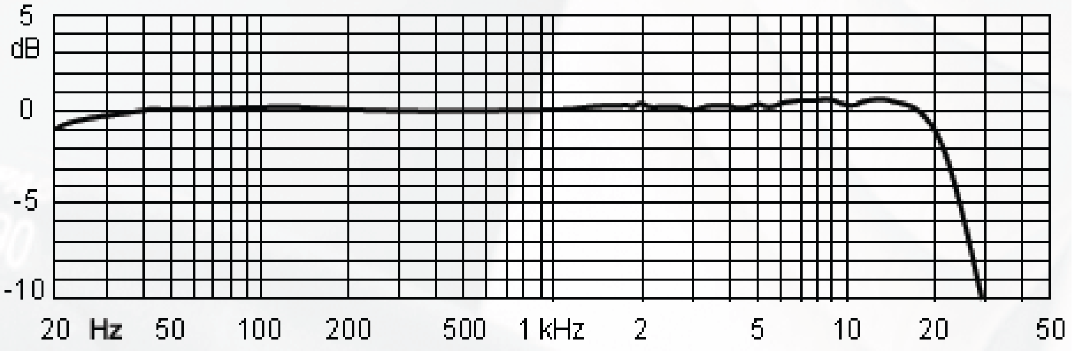


Figure 67 - On-Axis Frequency Response of LOUDSOFT Microphone FL1 in Free Field

11.5. Adapter for LOUDSOFT FL1 Microphone (Calibrator)

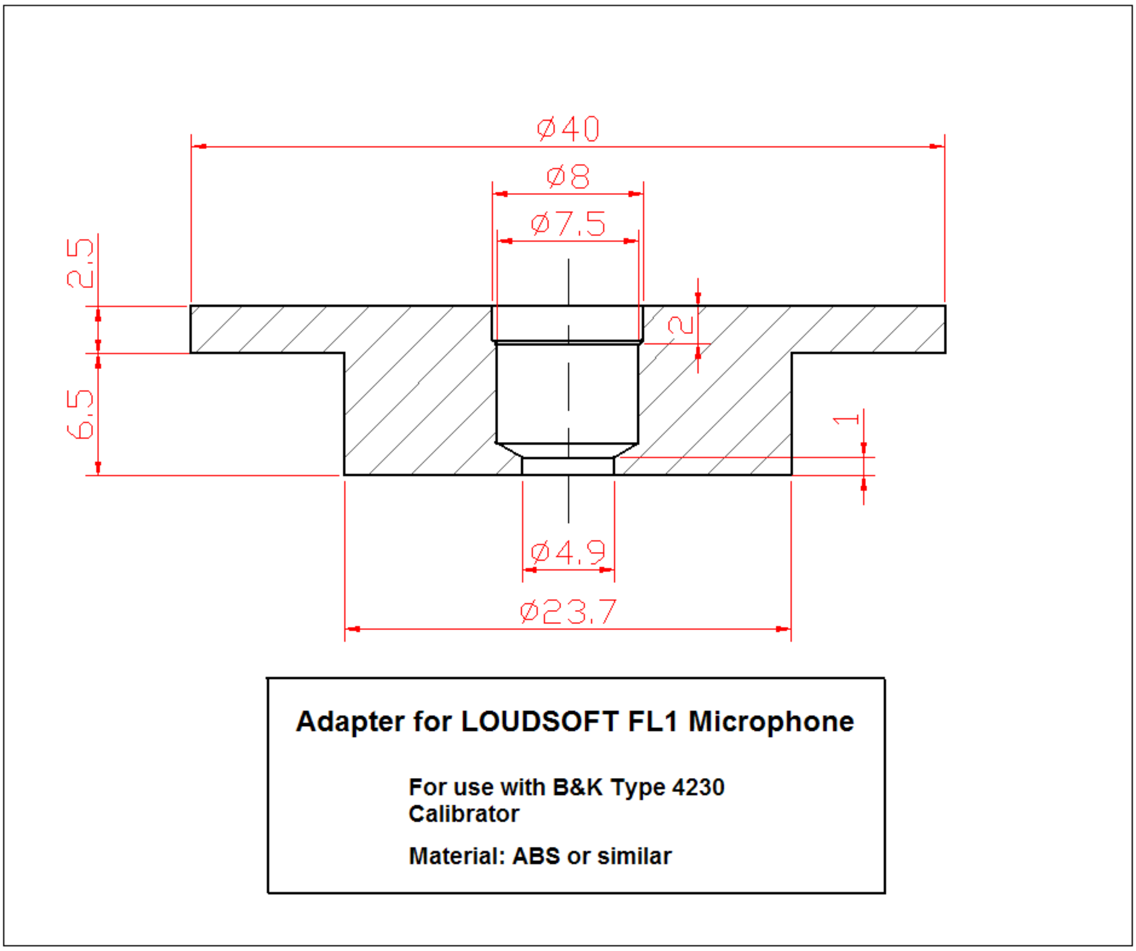


Figure 68 - Adapter for FL1 Microphone

11.6. 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 QC installation.

You can also buy the Test Boxes made in solid Aluminum directly from LOUDSOFT, see Figure 69.

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.

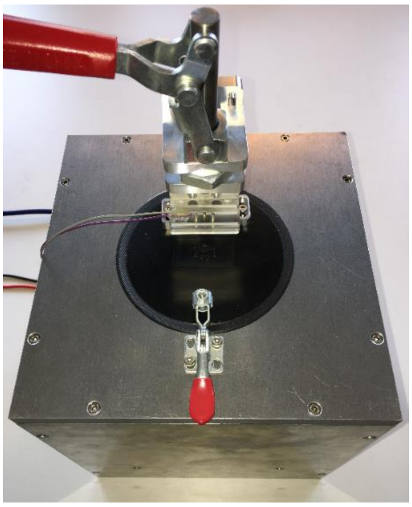


Figure 69- LOUDSOFT Aluminum Test Box –small

11.7. Automation Interface / Module

The special automation module may be installed with the normal FINE QC installation, and needs a separate license.

The automation module has 3 inputs and 3 outputs in TTL level and can communicate with an automatic speaker assembly line through the TTL I/O on the rear of the FINE Hardware3.

In addition, a special USB interface can be connected to the PC or PLC controlling the automatic speaker assembly line. Hereby control signals can be sent and received, enabling automatic sorting of all failure categories.

11.8. Conversion of old setup FTS files

The setup FTS format has changed allowing long Latencies, especially for active and Bluetooth measurements of amplified / Bluetooth speakers and amplifiers.

When opening an old FTS file, you will get this message:

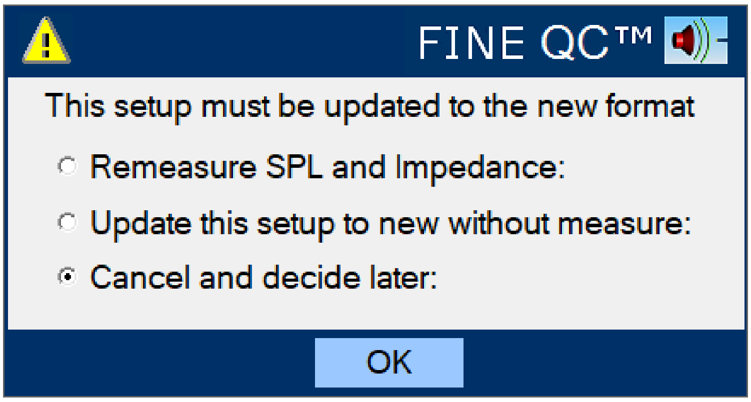


Figure 70 - Message how to update FTS setup files

If you see this message you need to update the setup FTS file. This is very easy as you can either re-measure or update using the old data.

LOUDSOFT

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