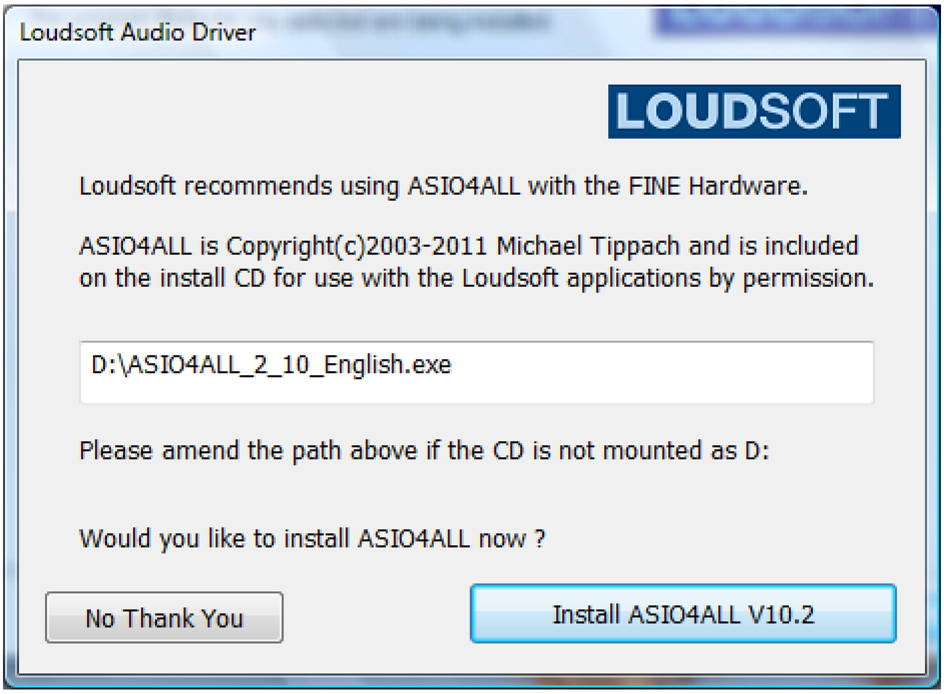
FINEQC™

Quality Control System for Loudspeakers

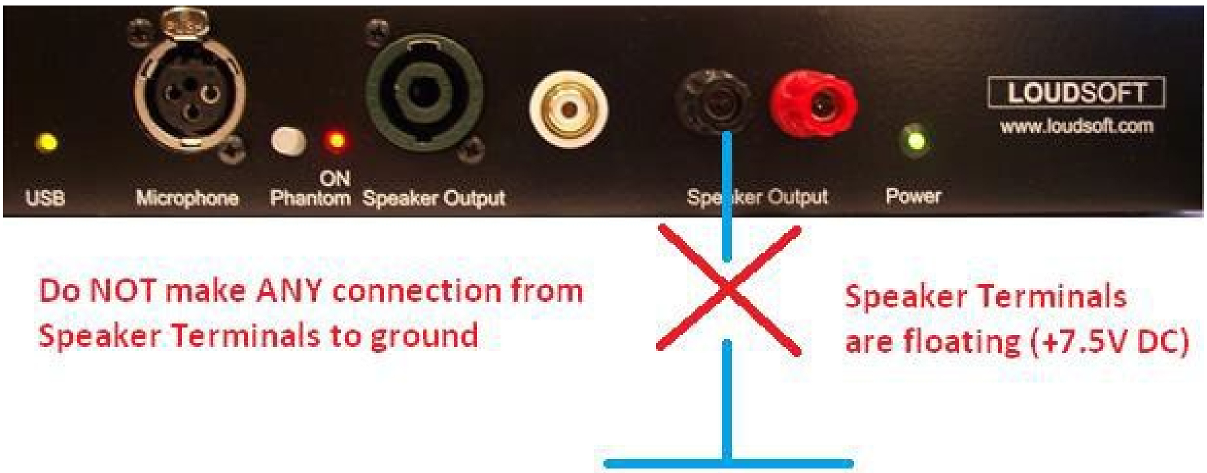
Contents

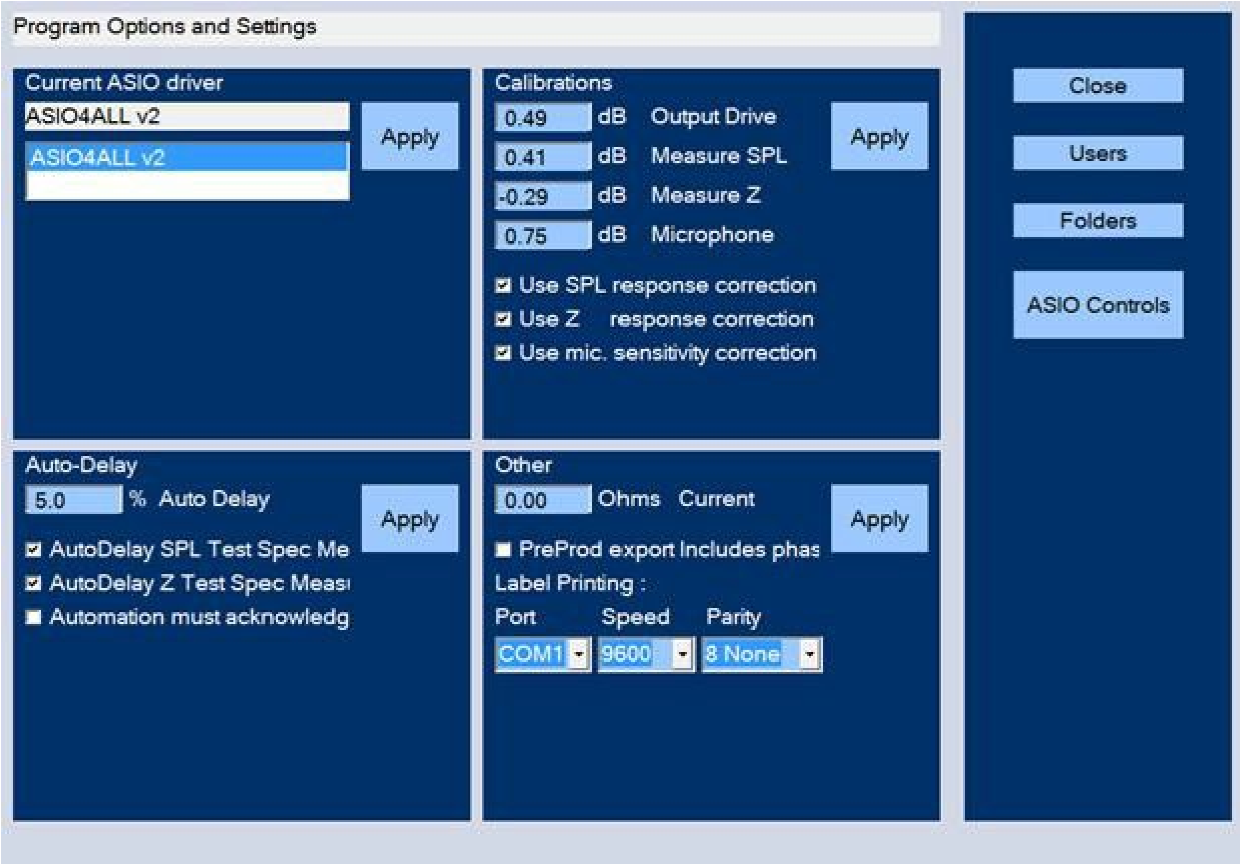
1. How to get started

1. Install the FINE QC software from the link without hardware connected.
2. You will be asked to install the ASIO4ALL driver, which is needed to work with the FINE hardware. DO NOT USE Other that version ASIO4ALL 2-11 beta2, supplied with this installation!
3. If your drive is different from D:\ then please change to your drive (E:\ or F:\ ……)



3. FIRST: Connect the power supply to the hardware box. **Make sure that the power cable is ALWAYS connected, or you may get wrong output!**
4. SECONDLY: Connect the hardware box to the computer with the USB cable
5. Start FINEQC
6. Log in as Administrator (Password is: FINELAB)
7. Press [ADMIN OPTIONS]





8. Check that ASIO4ALL is chosen
9. Press [ASIO Controls]

10. Click on the buttons to make sure that ONLY USB Audio CODEC is selected by the blue square (and NOT your normal sound card)
11. **Calibrate FINEQC. See chapter 3.**

Now the system is ready to run.

2. Login – Users

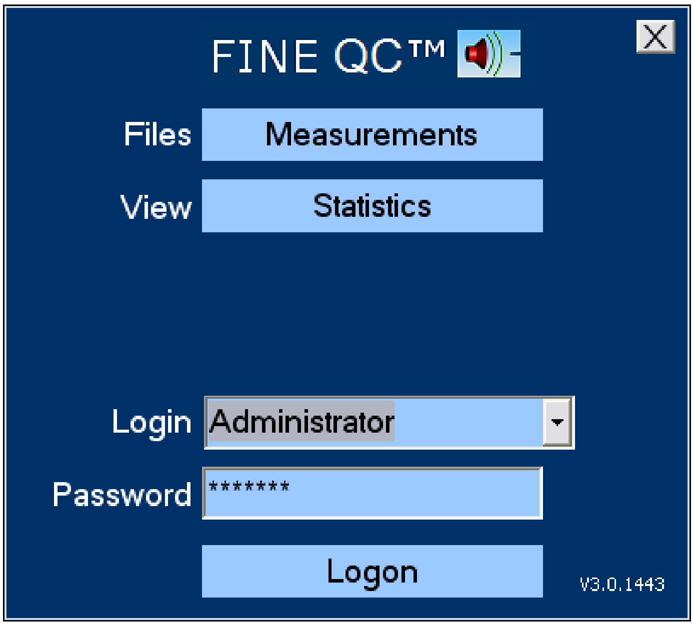
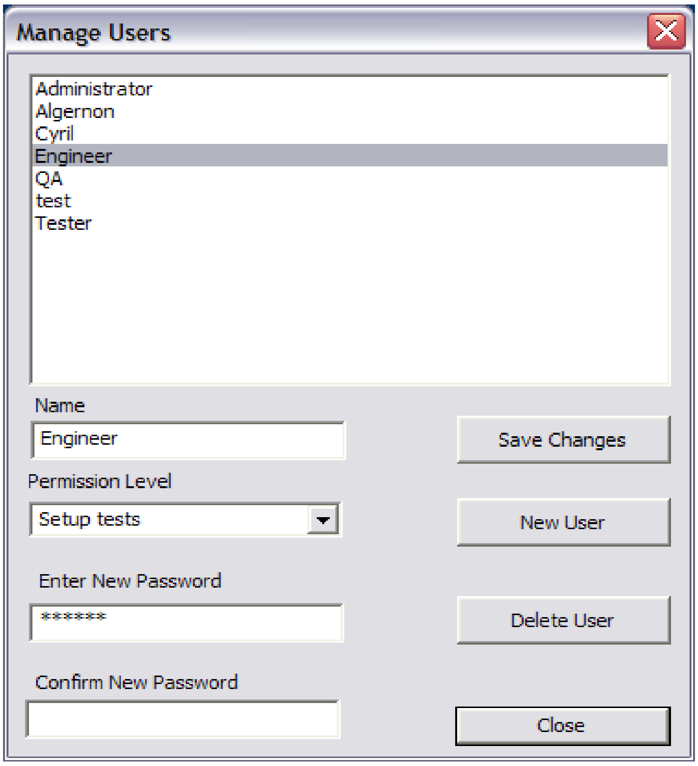


Figure 1 - FINE QC Start Screen

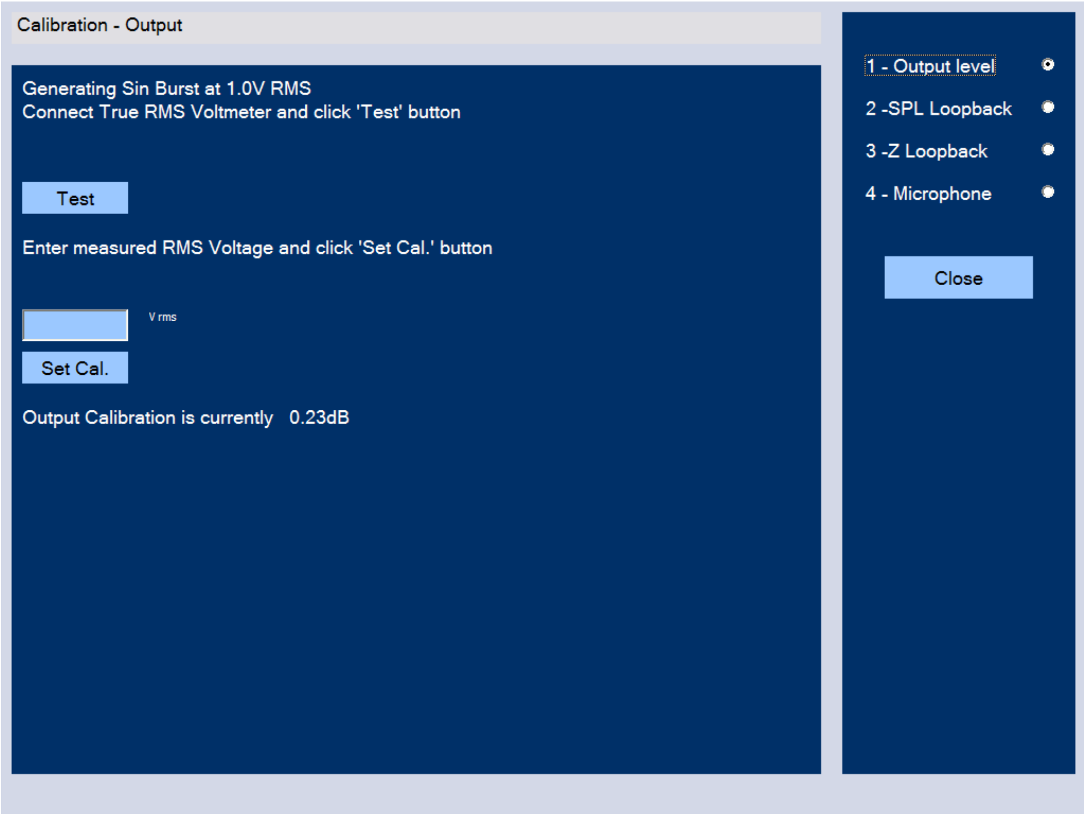
You can login the first time as Engineer without a password. To set up user profiles, you need to login as "Administrator" and go to Admin/Users. The default password is "FINELAB" (Capital letters!).

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



3. FINE QC Calibration Procedure

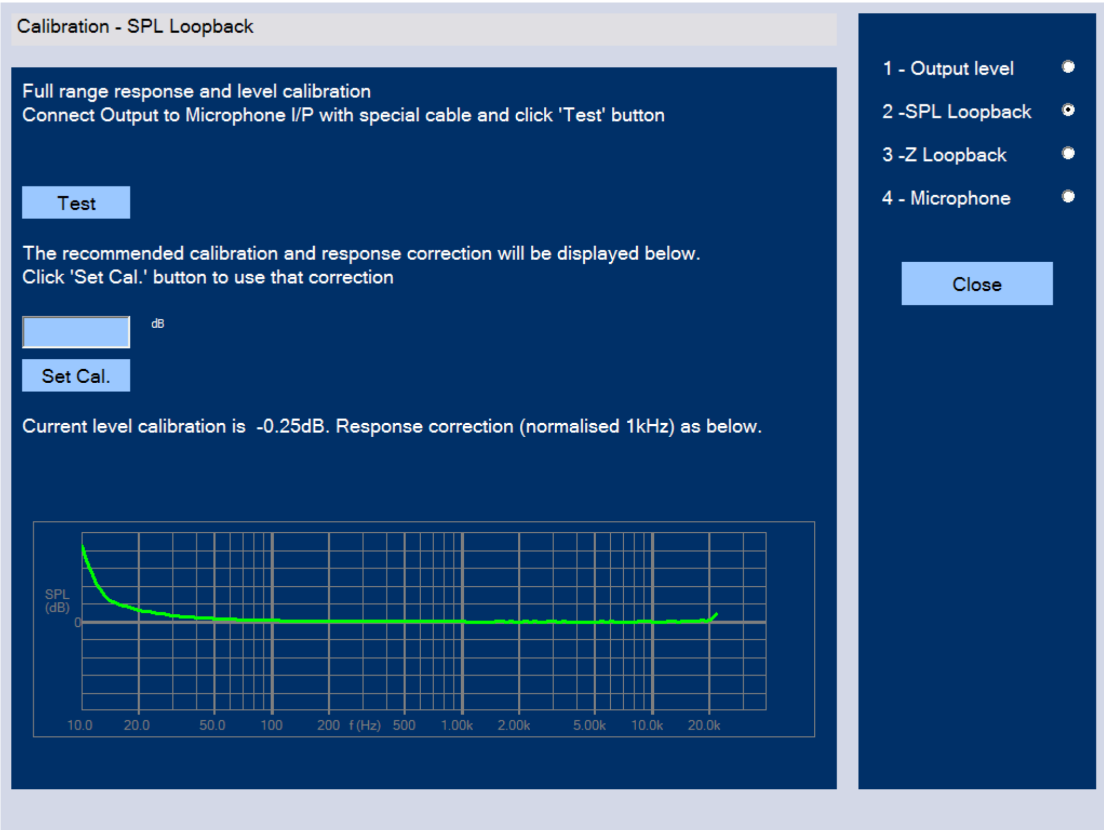
3.1. Output Level



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.

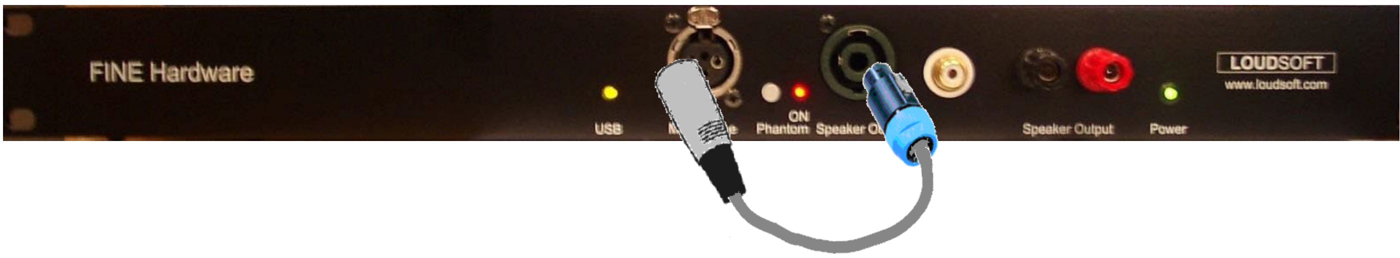
3.2. SPL Loopback Calibration



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

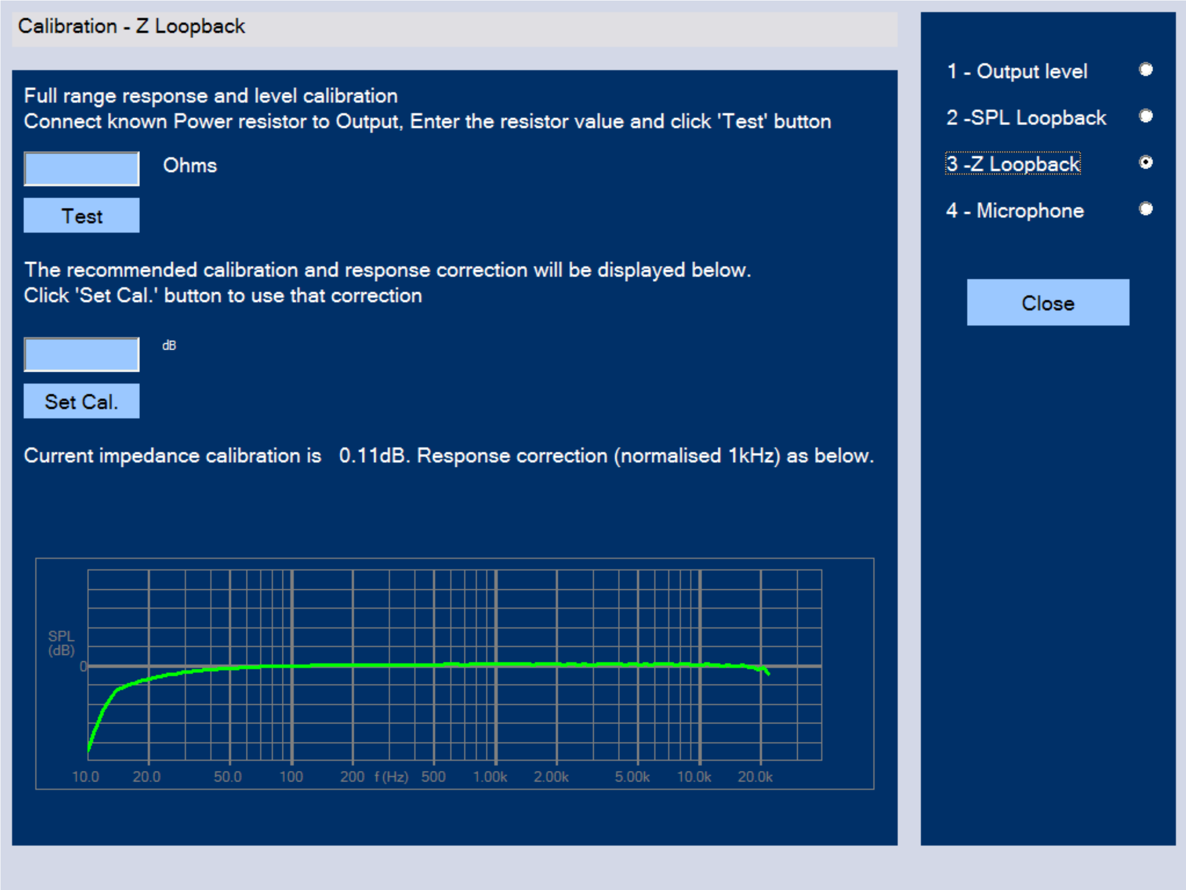
Connect the speaker output to the microphone input with the special loopback cable, which can be either Speak-on or banana plugs from the speaker output to the microphone XLR input (see the figure below) and click the ‘Test’ button.

(DO NOT leave the 48V phantom on During Calibration)



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

3.3. Impedance (Z) Calibration Using FINE Hardware

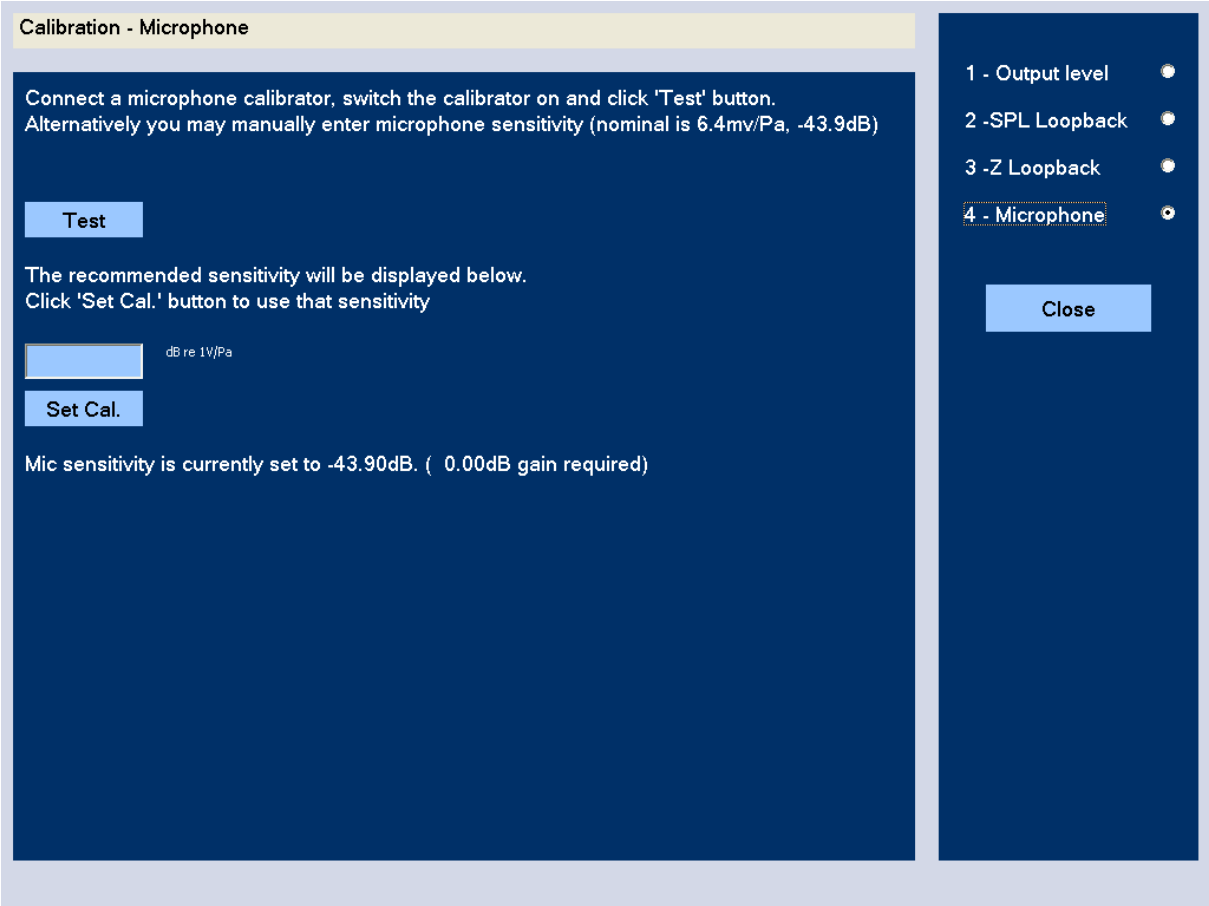


Select “3 – Z Loopback” at the upper right of the window. This is the full range response and level calibration of the impedance.

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.

3.4. Microphone Calibration



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.)

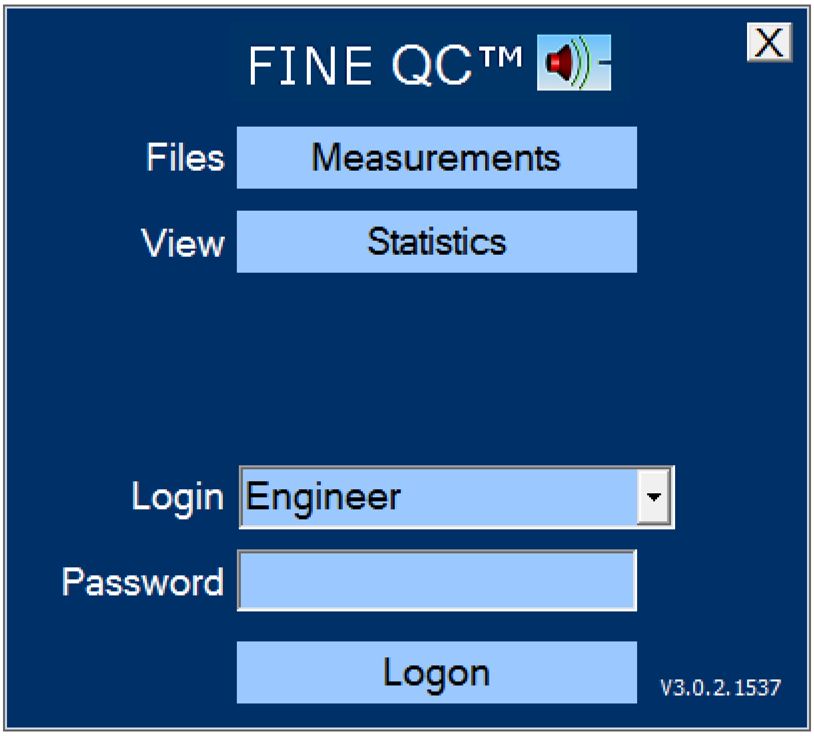
Switch on the calibrator and hold the microphone firmly (the sound from the calibrator is then barely heard).

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

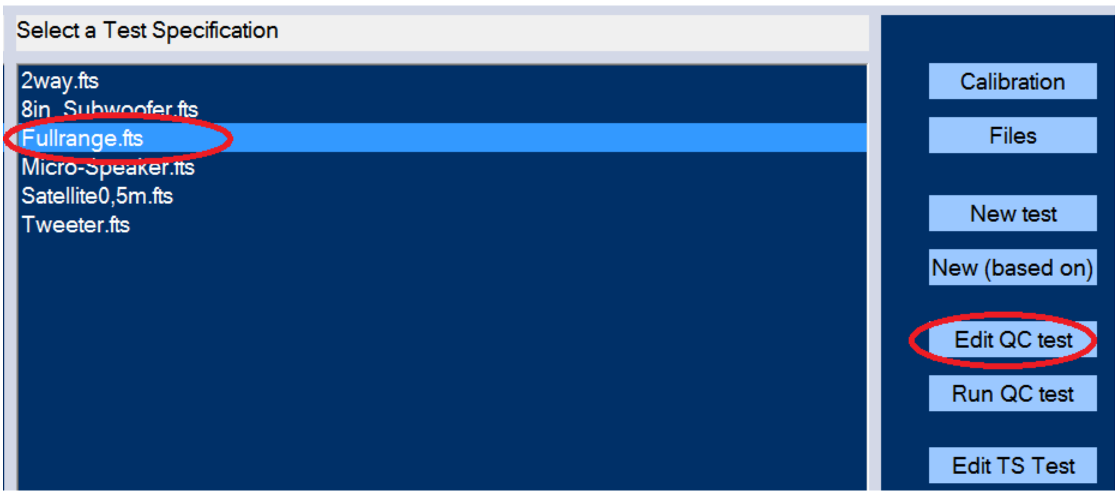
Press the "Set Cal." button to use this. The microphone calibrator must give 1 Pa (94 dB SPL).

4. How to measure in FINE QC – Quick Guide

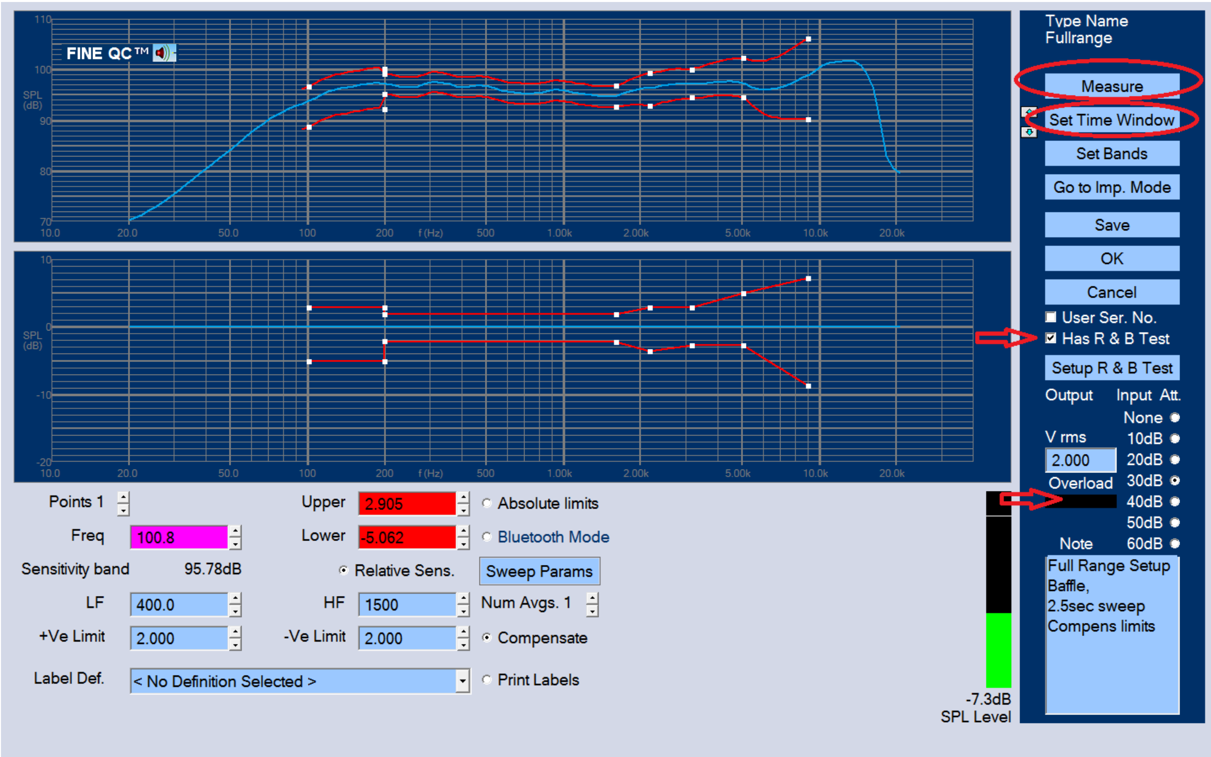
1. Start FINE QC. Select Engineer, and click on Logon.



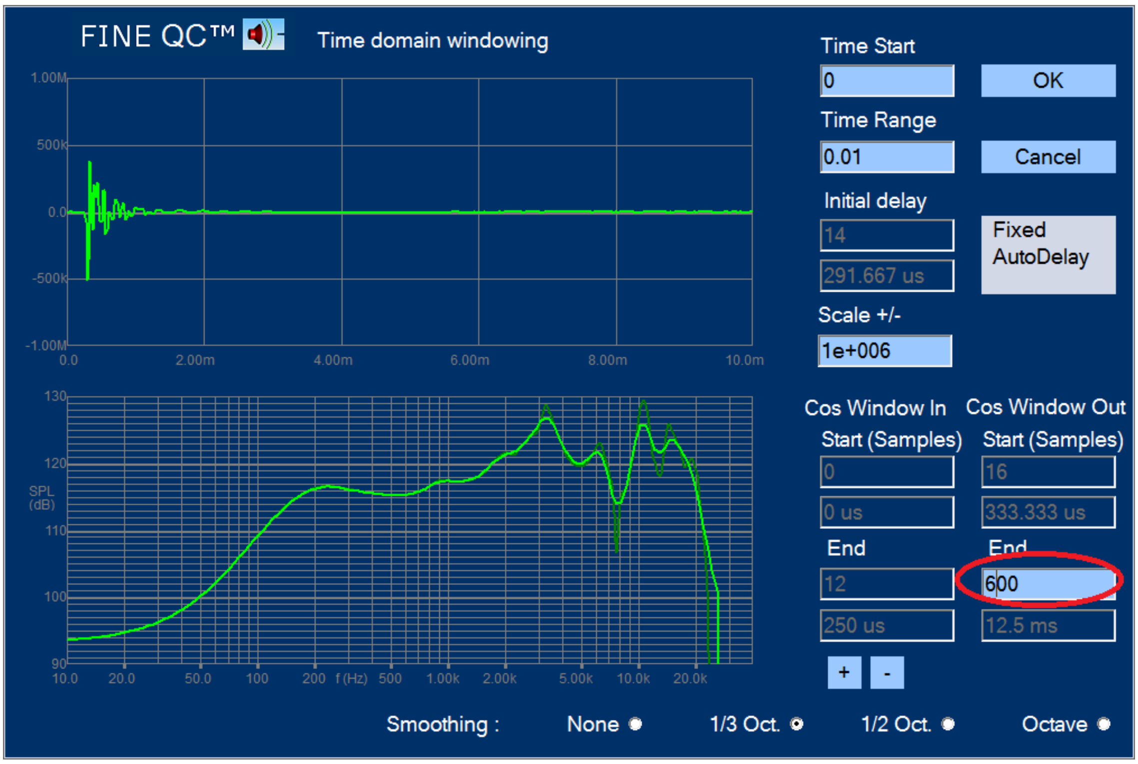
2. Select a test specification, e.g., Fullrange.fts, and then click on Edit QC test button.



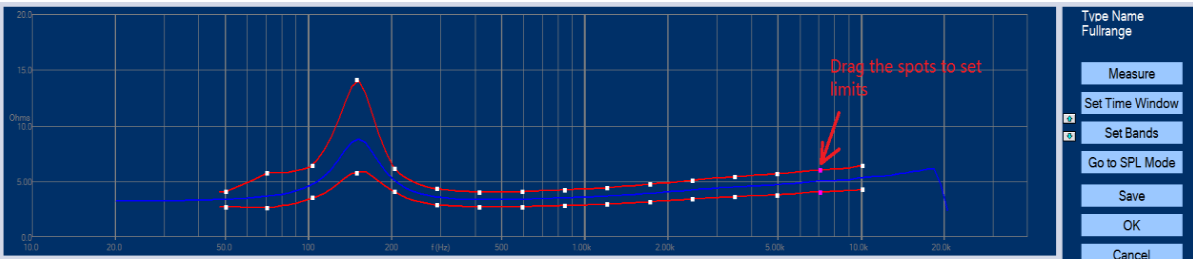
3. Let's start with a simple measurement without R&B test. Uncheck "Has R&B Test". Click on "Measure" button.



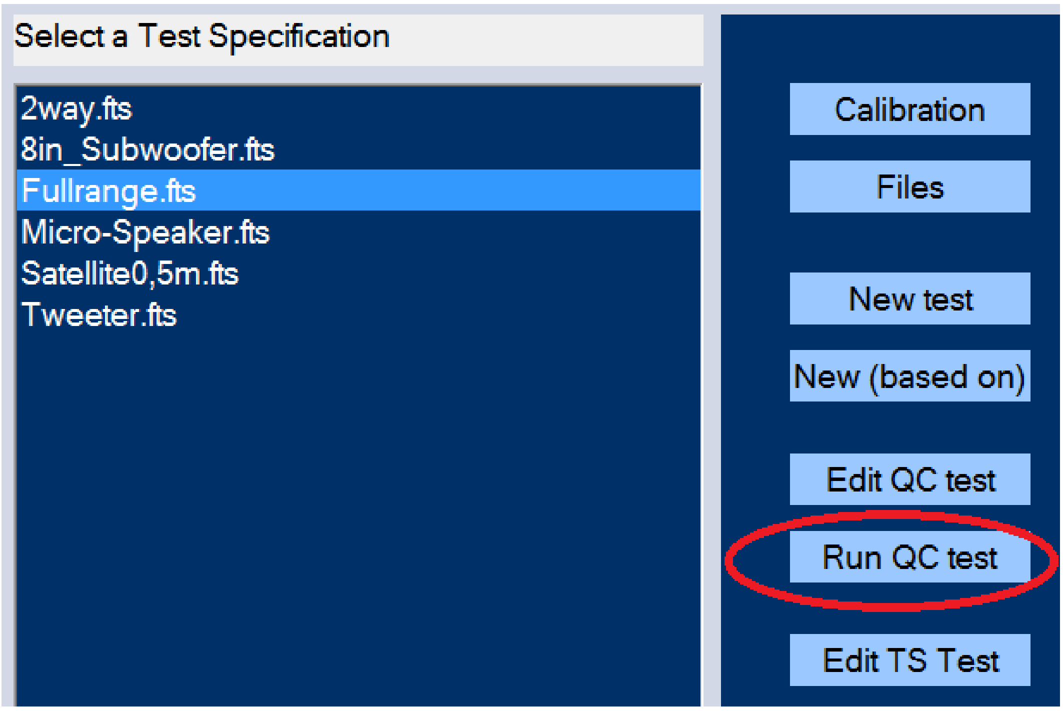
4. If the Overload bar turns red as shown in the above figure, we need to change the Input attenuation. Set the attenuator to get less than -10 dB SPL Level on the VU meter/Bar graph.
5. Click on the “Set Time Window” button and set the “End” value under “Cos Window Out” to a number that allows for a good curve for now. This can exclude reflections, see later in section 5.7. Then click on OK.



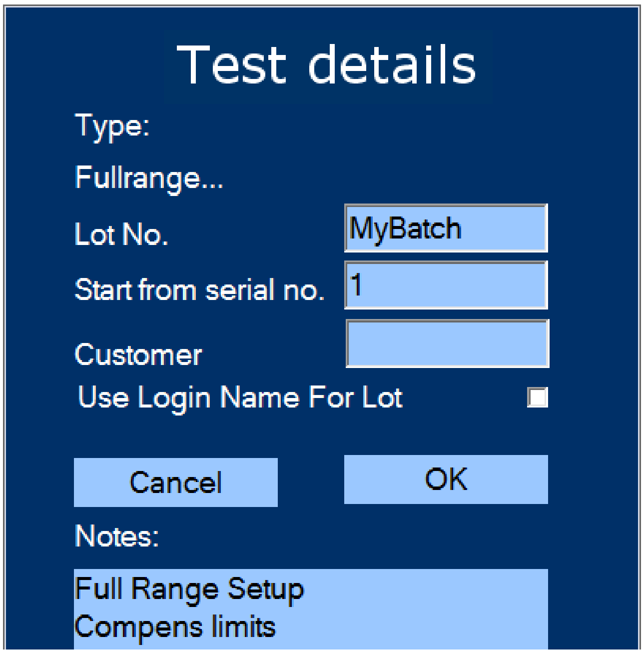
6. Click on the "Go to Imp. Mode" button, and then click on the "Measure" button. We can set the limits by dragging the white spots using mouse.



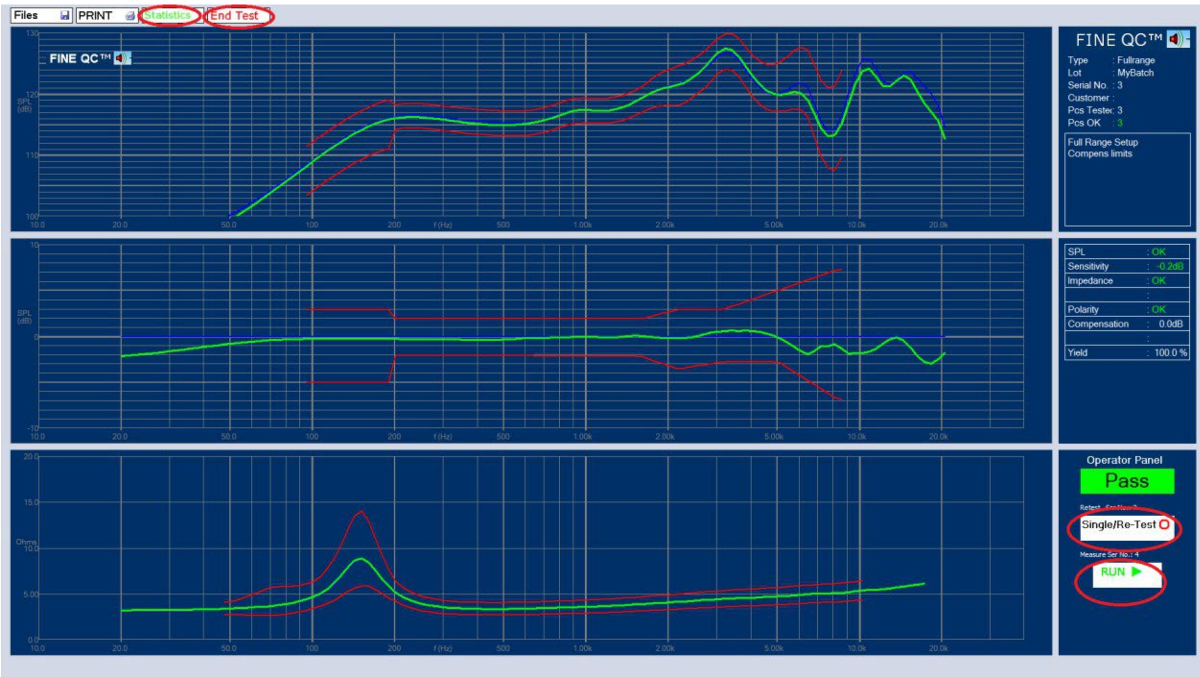
7. Click on Save button, and then, click on the "Go to SPL Mode" button.
8. Click on Save button, then click OK. The setting is done.
9. Click on Run QC test button.



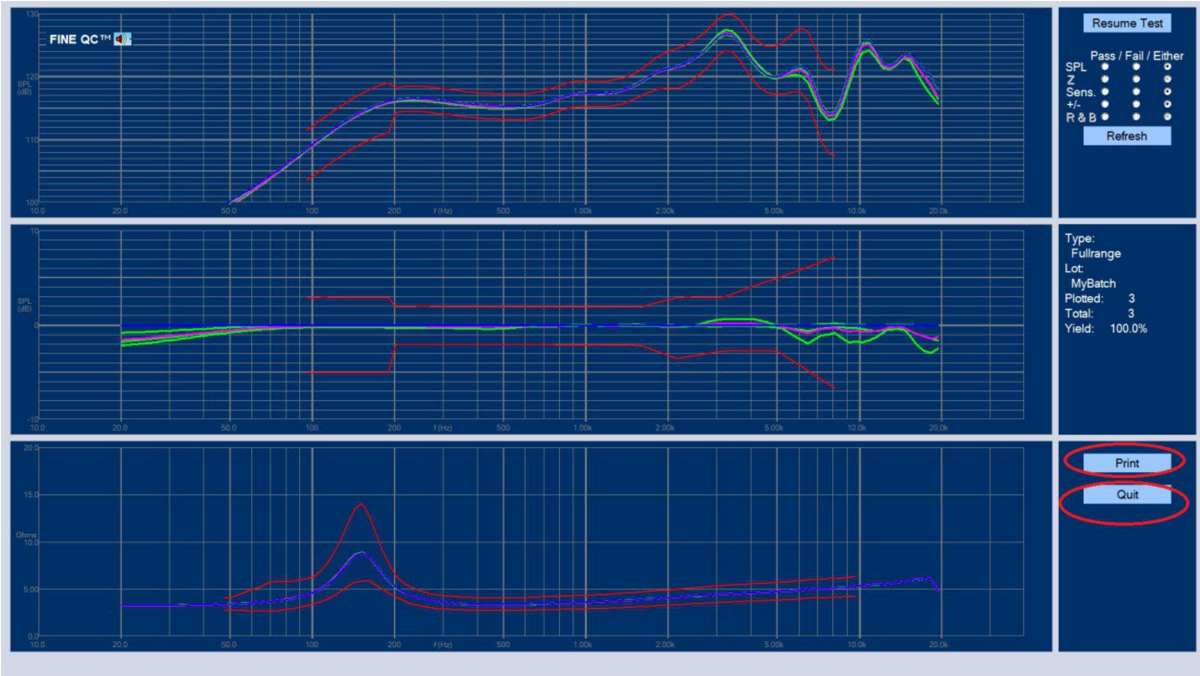
10. Fill in the texts, and then click on OK button.



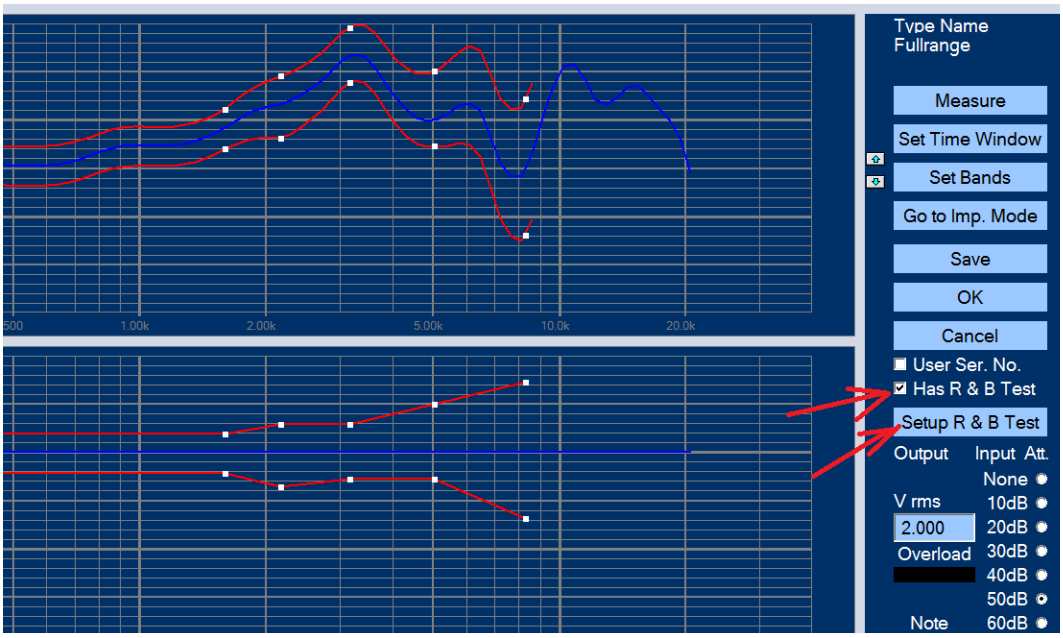
11. Click on the “Run” button to make a new test. If you want to repeat the current test, use the “Single/Re-test” button. Click on the “Statistics” button to show all the measured curves.



12. Click on the “End Test” button after all measurements have been done.
13. Click on the “Print” button to print the results. Click the “Quit” button when you want to leave.



14. To measure Rub & Buss, 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.



15. 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.

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

5. Tutorial

5.1. 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:

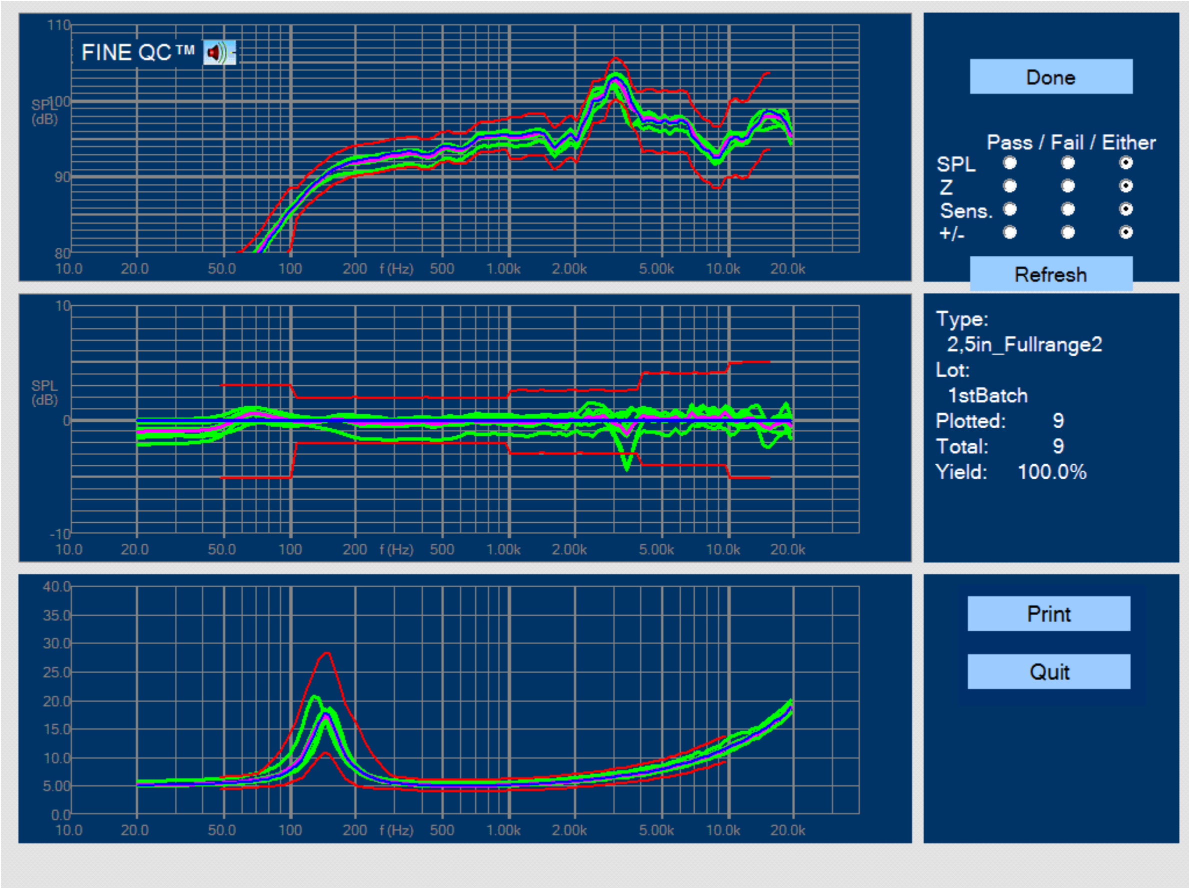


Figure 2 - Statistical Result of Previous QC Test Series

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.

5.2. QC Testing

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:

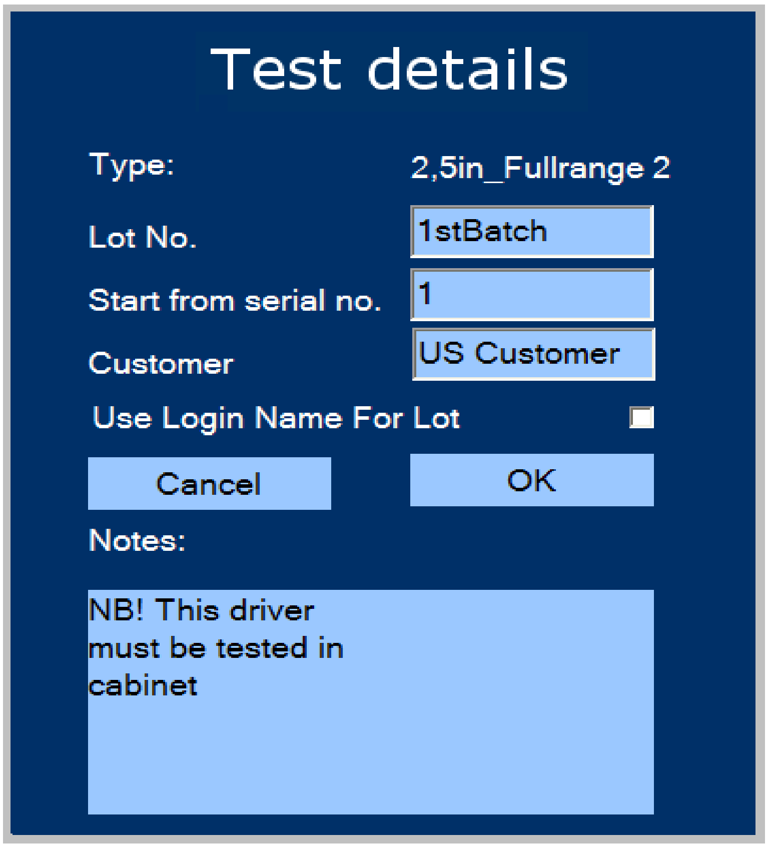


Figure 3 - FINE QC Test Details

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.

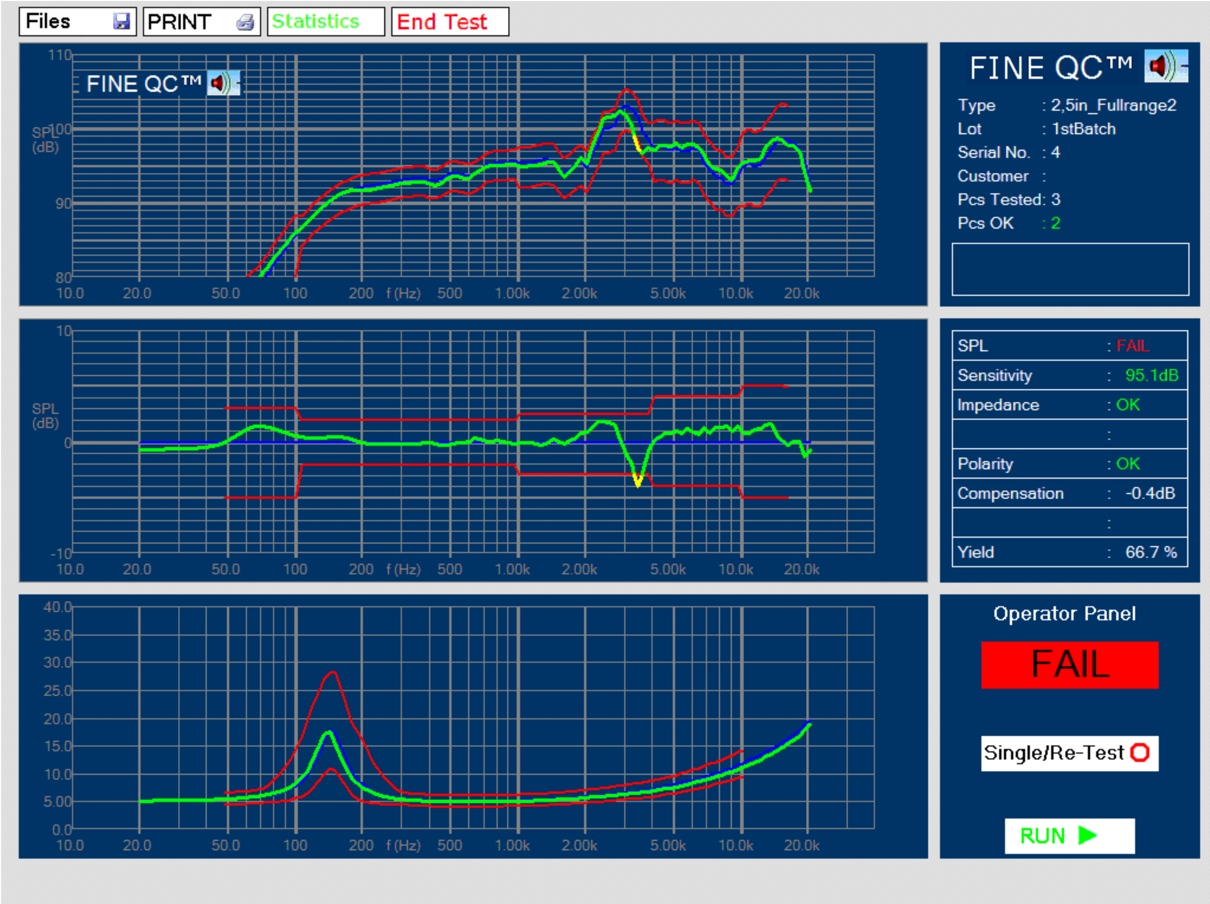
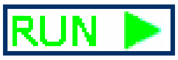


Figure 4 - FINE QC Test Display: SPL FAIL at 3.5 kHz

As a good rule, start by testing the reference driver by pressing "Single/Re-Test". After verifying that the response is close to the reference saved (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, so the tester can listen for distortion and Rub & Buzz while testing OR she can activate the powerful FINEBuzz Rub & Buzz test (see chapter 5.9). 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 when the response is outside the limits, see the example in Figure 4.

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 (see chapter 5.4). 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 page 13).

Figure 5 - Enter Serial No. (Individual) or Barcode

If you are testing individual units, you can specify to enter the serial number each time, see Figure 5. 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 and start the testing as soon as the barcode is read.

5.3. Golden Average Driver / Preproduction

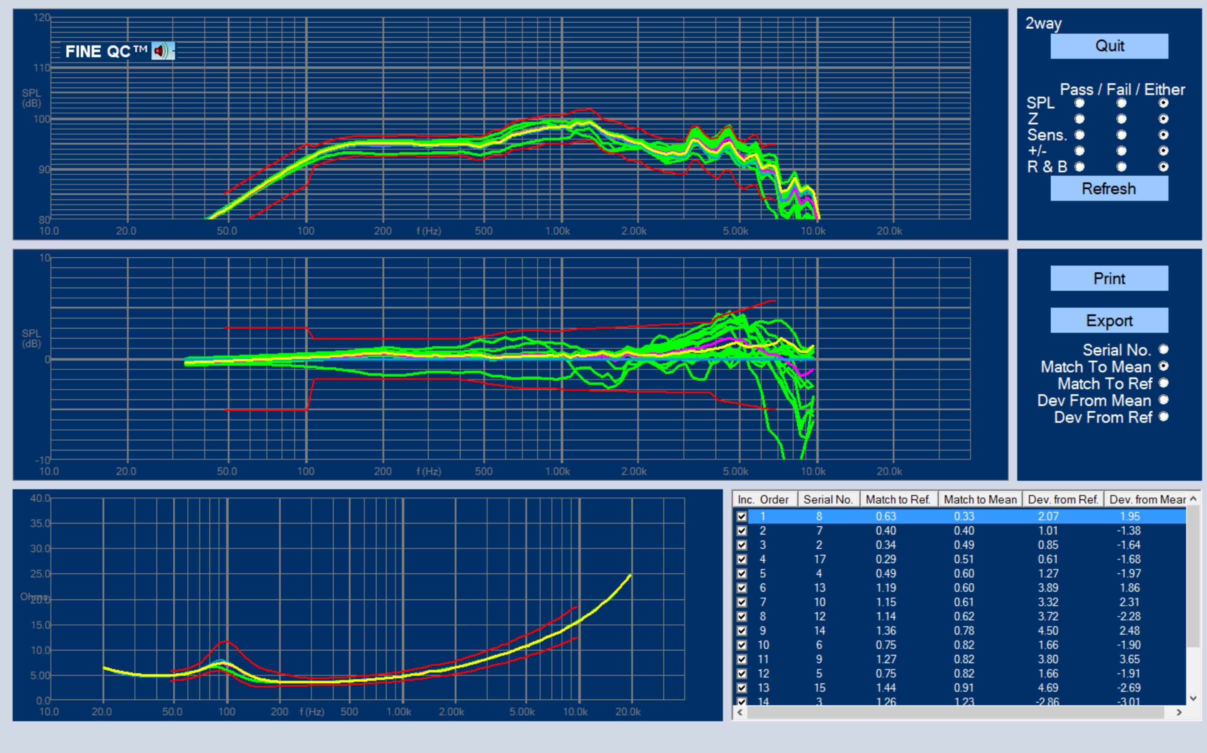


Figure 6 - Golden Average Driver Auto Finder

When starting a new production, the most important thing 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 6. 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.

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! You can even show an individual response versus reference (by de-selecting the others) and for example 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 7

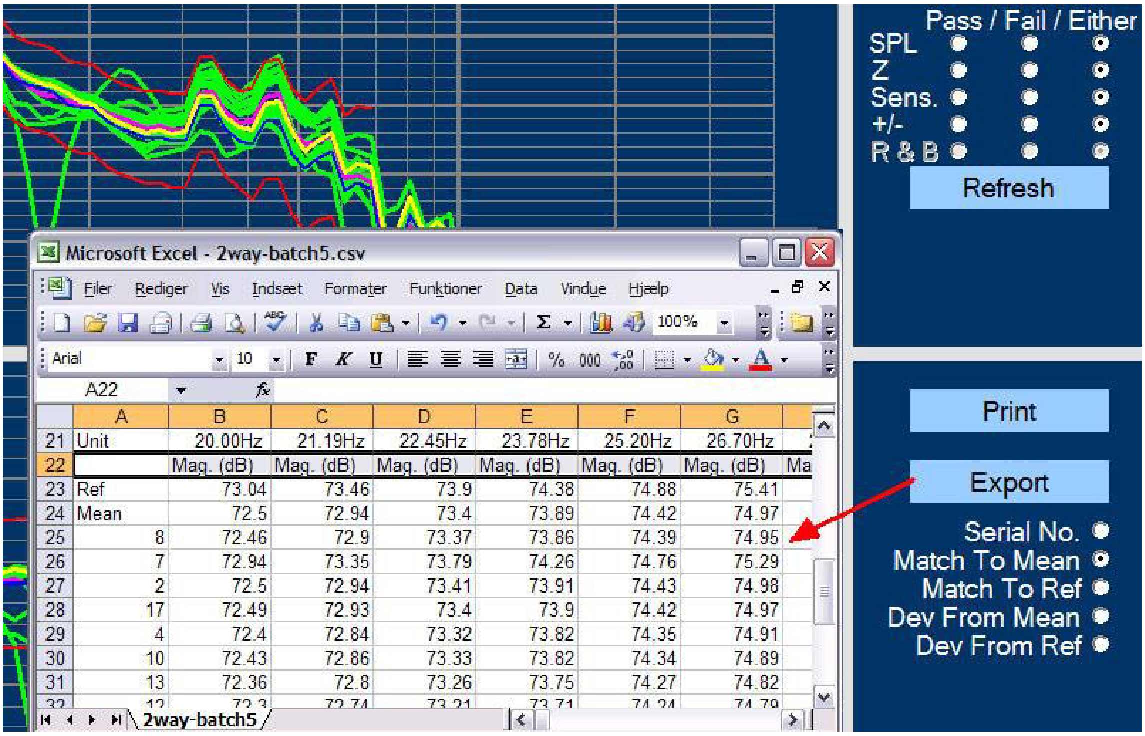


Figure 7 - Export of All Data to Excel

5.4. Edit Limits

From the statistics in Figure 1, it can be seen that the rejected responses have a dip at 3.5 kHz, but it is actually the slope of the peak, which has changed. Therefore, it makes sense to adjust the limits to allow that. Select “Edit QC test” from the menu (Figure 8):

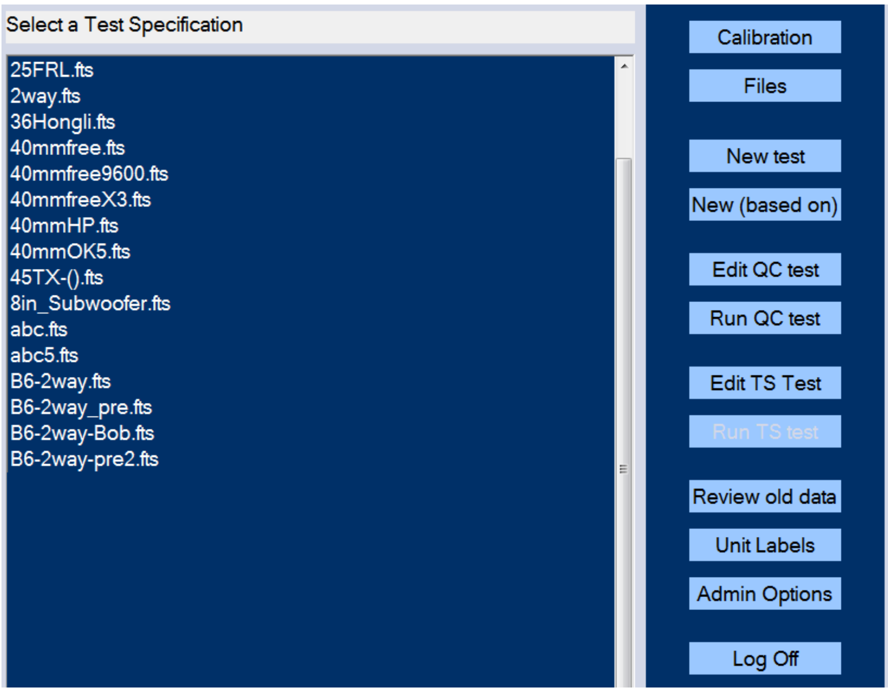


Figure 8 - Menu

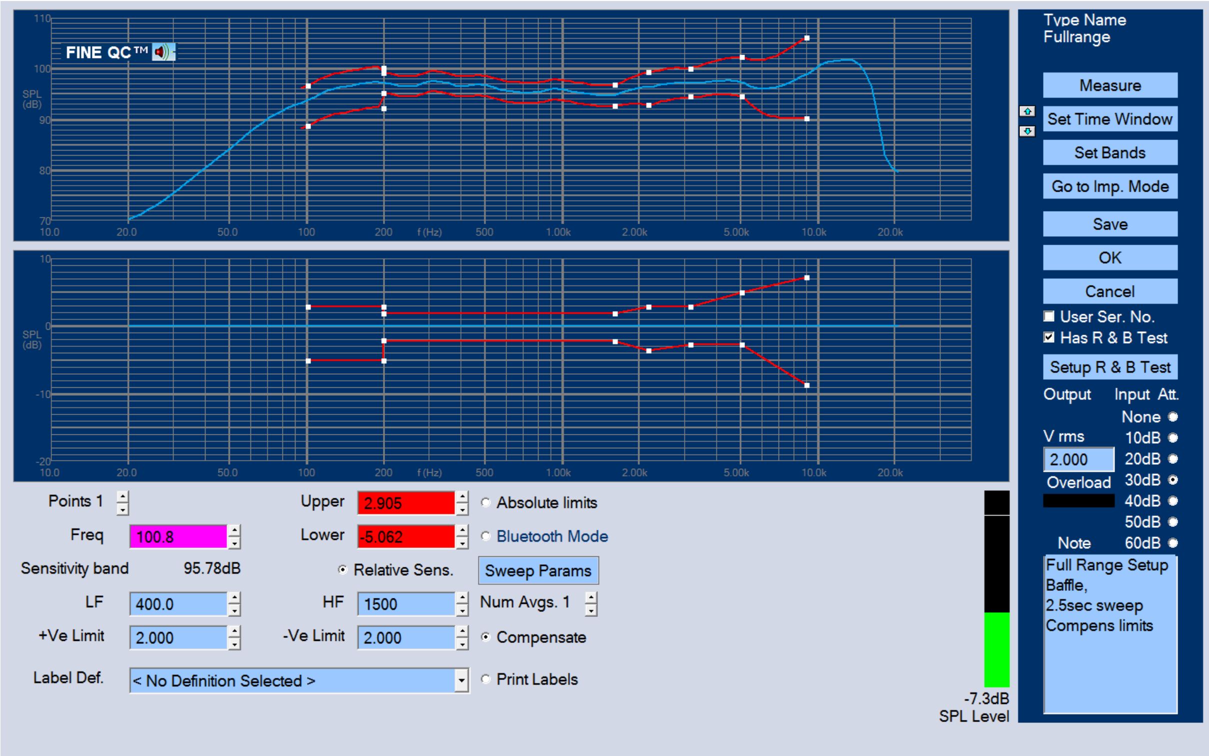


Figure 9 - Edit Limits & Sensitivity Band

The limits are broken up in ranges separated by white square points (Figure 9). 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 10:

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 9) 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 from the built-in amplifier is here set to 2Vrms, which is producing a reasonably high SPL without overloading this 2.5" full range speaker. When there is an overload (Red), see Figure 9, the attenuator should be set one or more step(s) lower.

If there is casual noise close to the test, you can specify several averages (Fig. 7). This way the test will automatically repeat the specified number of times and use the average for testing.

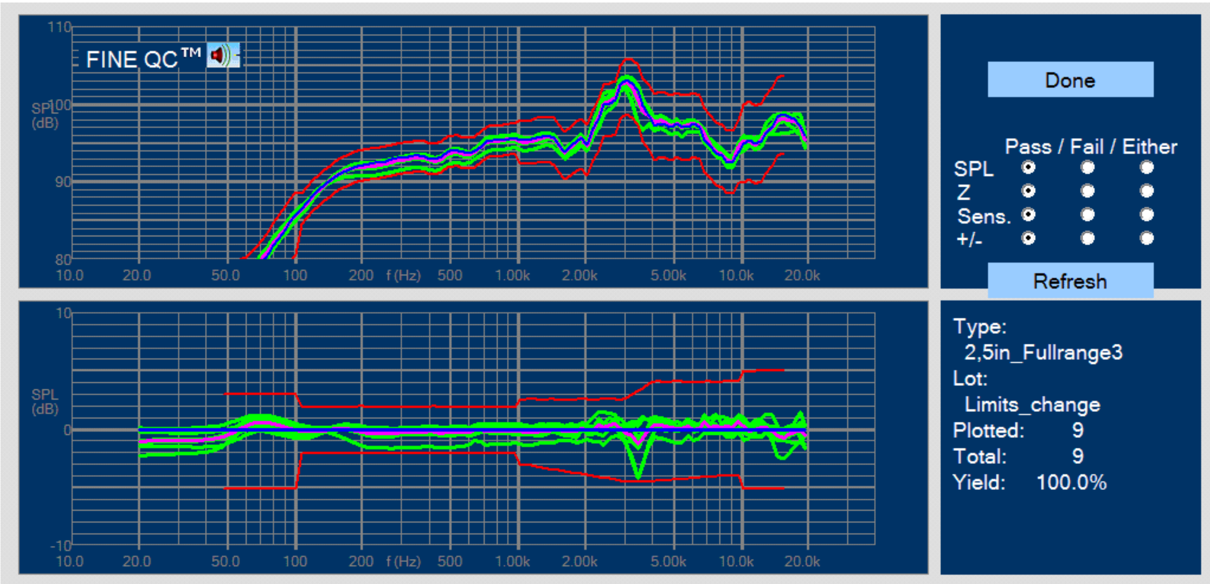


Figure 10 - SPL Statistics with Adjusted Limits

5.5. 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 11), where I first specify the file name:

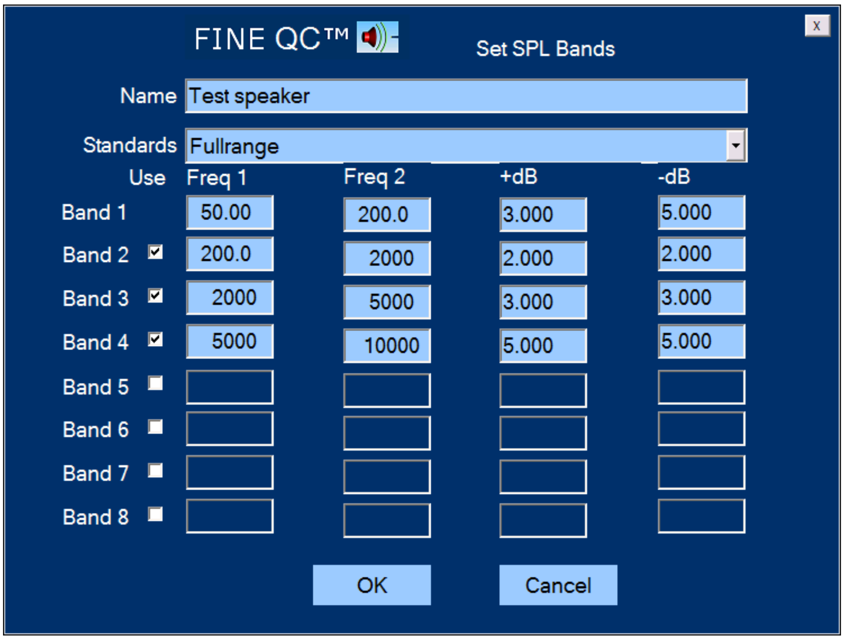


Figure 11 - Full-Range SPL Template

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.

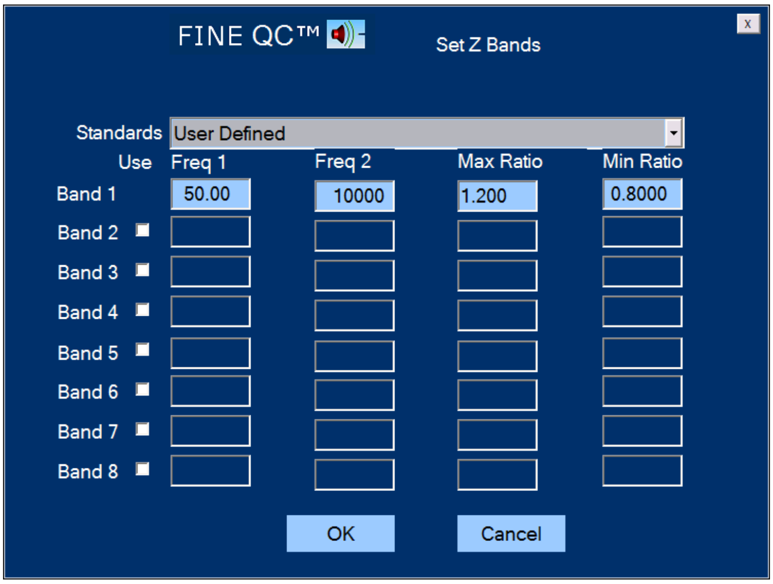


Figure 12 - Full-Range Impedance Template

After accepting the SPL limits the Impedance Template appears (Figure 12), 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 13:

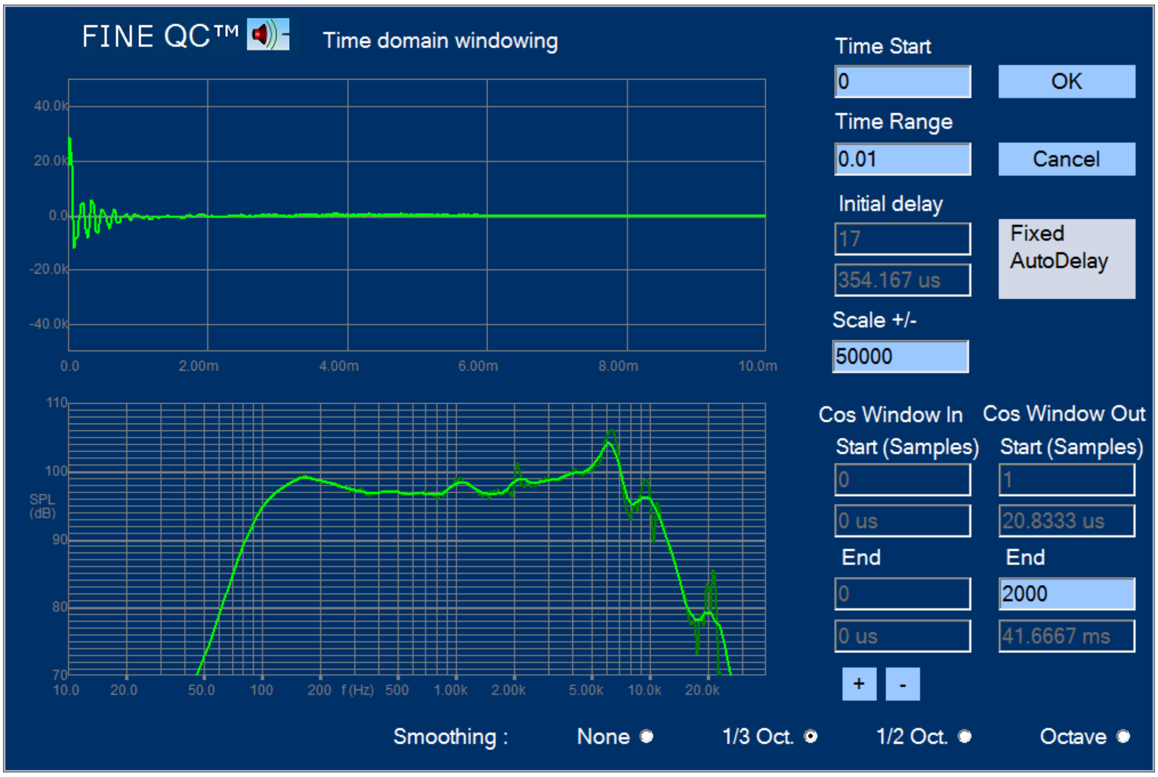


Figure 13 - Time Window Settings

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 ~0.35ms. The "Fixed Auto delay" finds this time automatically and is on by default. Hereafter the delay is fixed. Most other inputs are automatic.

Note: If you move the microphone, you must measure again and save to reset the auto delay.

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. See Figure 30.

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 14). 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.

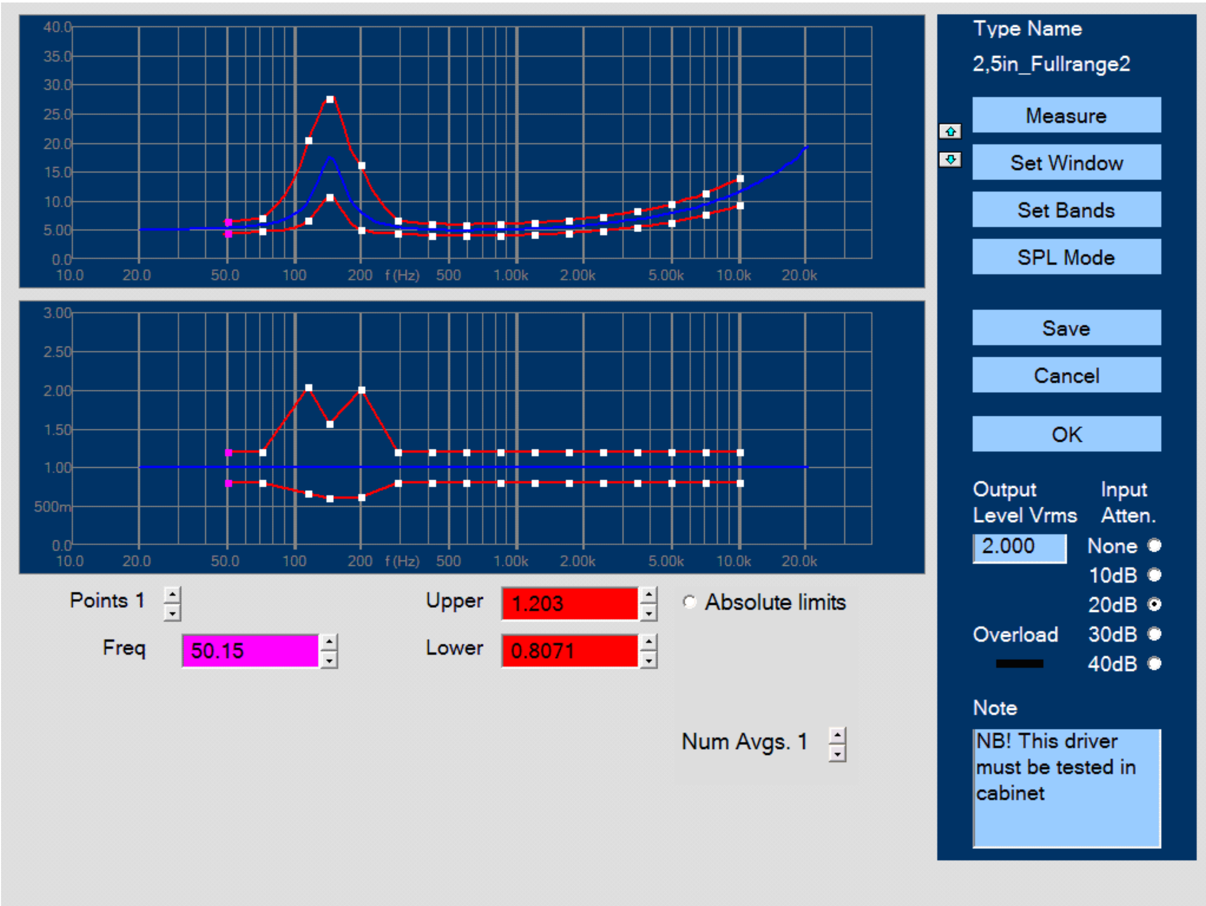


Figure 14 - Impedance Limits, Adjusted

In this window the engineer can also add a note, which will be displayed for the tester. A typical note is shown in Figure 14:

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

5.6. Set Sweep Parameters

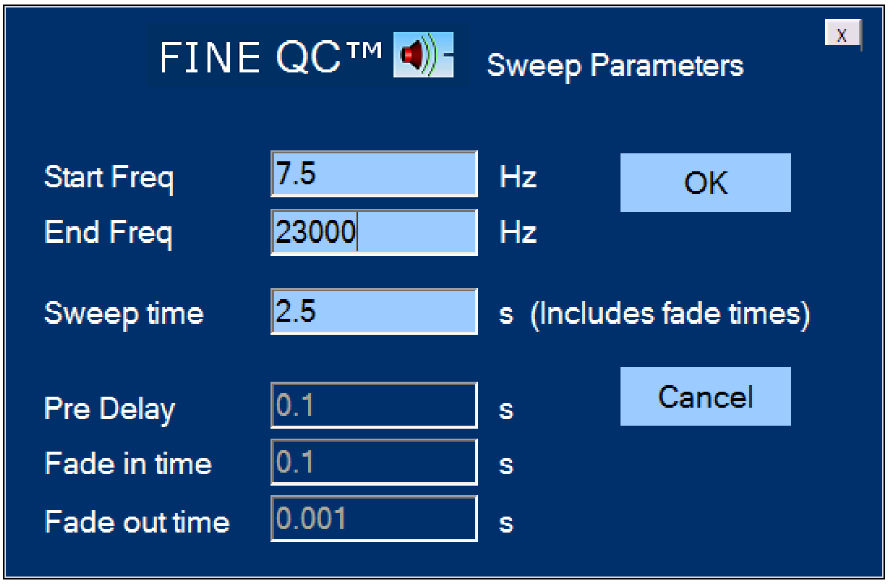


Figure 15 - Sweep Settings

The sweep can be set as shown. The sweep range should be at least ½-1 octave longer than the frequency range to be measured, but the End frequency should not exceed 23 kHz to avoid false triggering (23.9kHz is possible but not recommended). The max sweep time is 2.5 seconds. A sweep time of 0.1s is possible, but minimum 0.5 second is recommended, because short sweeps may not excite all Rub & Buzz and are more noise sensitive. For best Rub & Buzz testing use up to 2.5 second sweep time, so subtle buzzing sounds are excited.

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

5.7. Test in a Normal Room

Figure 16 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.

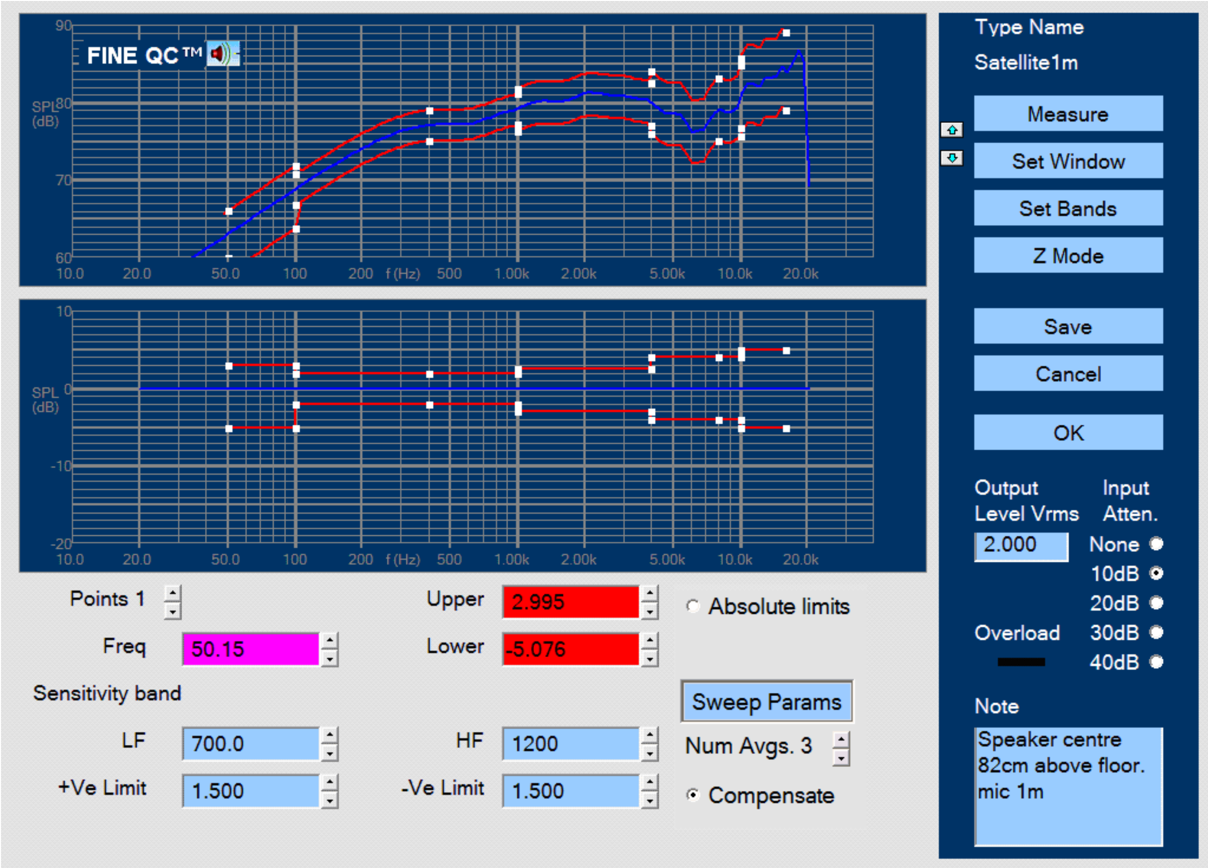


Figure 16 - Satellite Speaker Tested in Normal Room at 1m

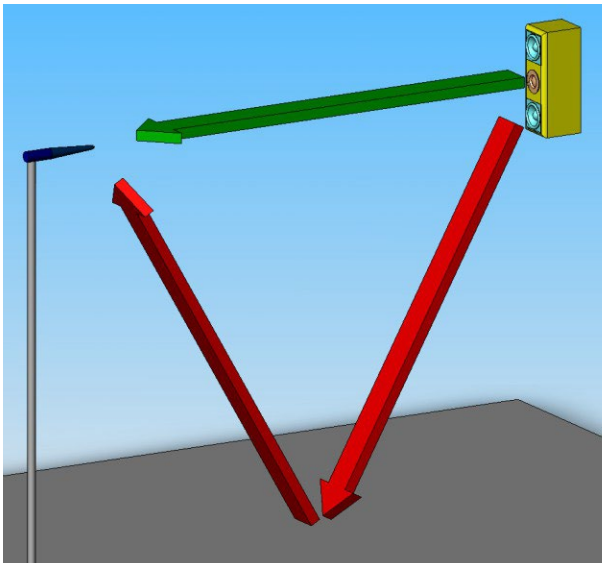


Figure 17 - Satellite Close to Floor, Red is Reflection

Figure 17 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 18. 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, Figure 17.

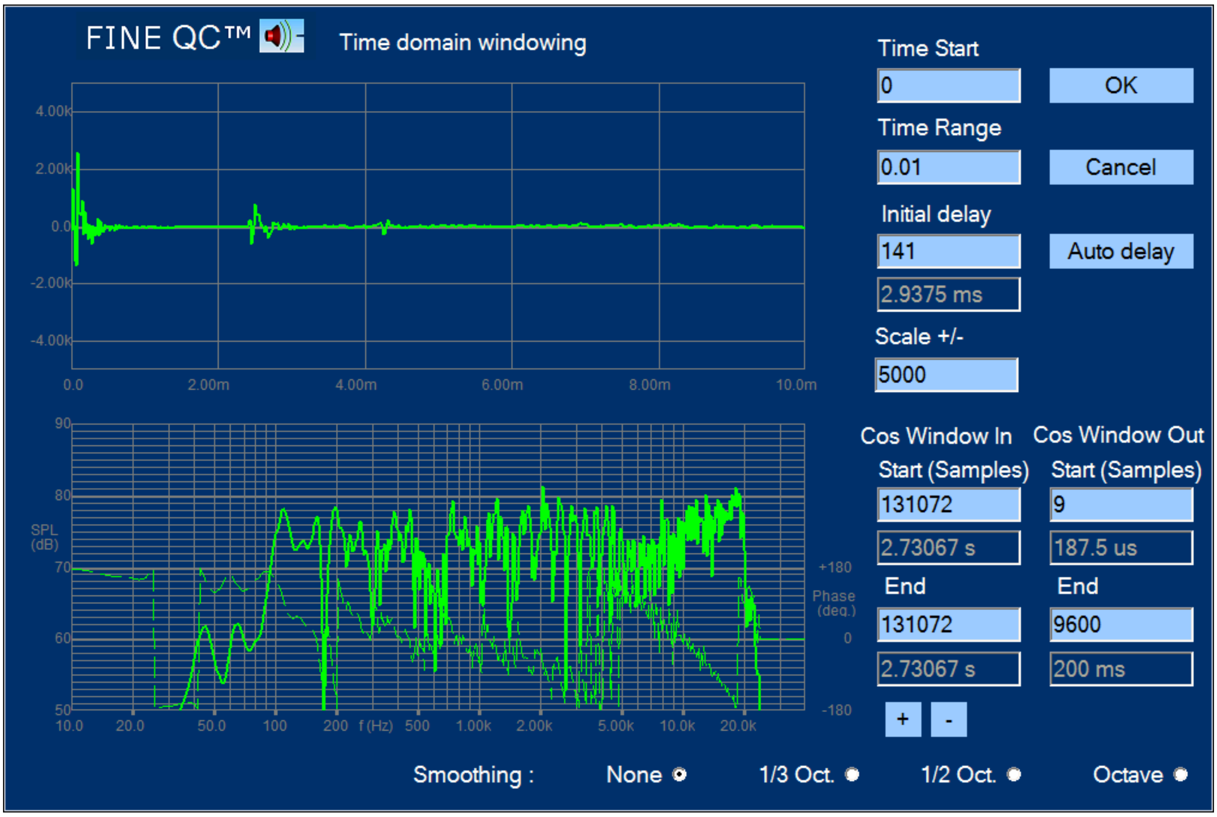


Figure 18 - Time Response of Satellite at 1m Microphone Distance and 82cm Above Floor

The short time between the two impulses is the reason for the poor low frequency response (Figure 16) 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.

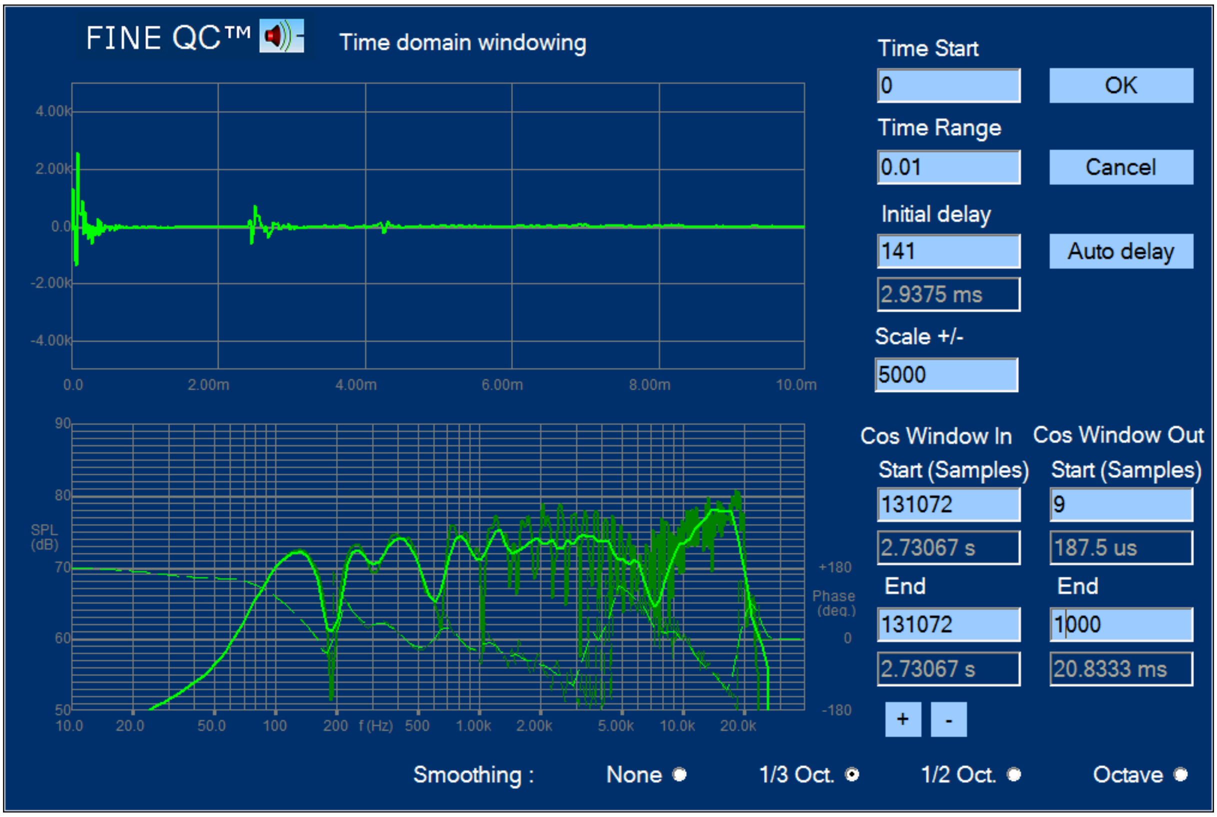


Figure 19 - 1/3 Octave Smoothing of Frequency Response (Unsmoothed in Dark Green)

The frequency response in Figure 18 is quite ragged due to the reflections. You can apply smoothing to view the response anyway as in Figure 19, where 1/3 Octave smoothing was chosen. Compared 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) 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).

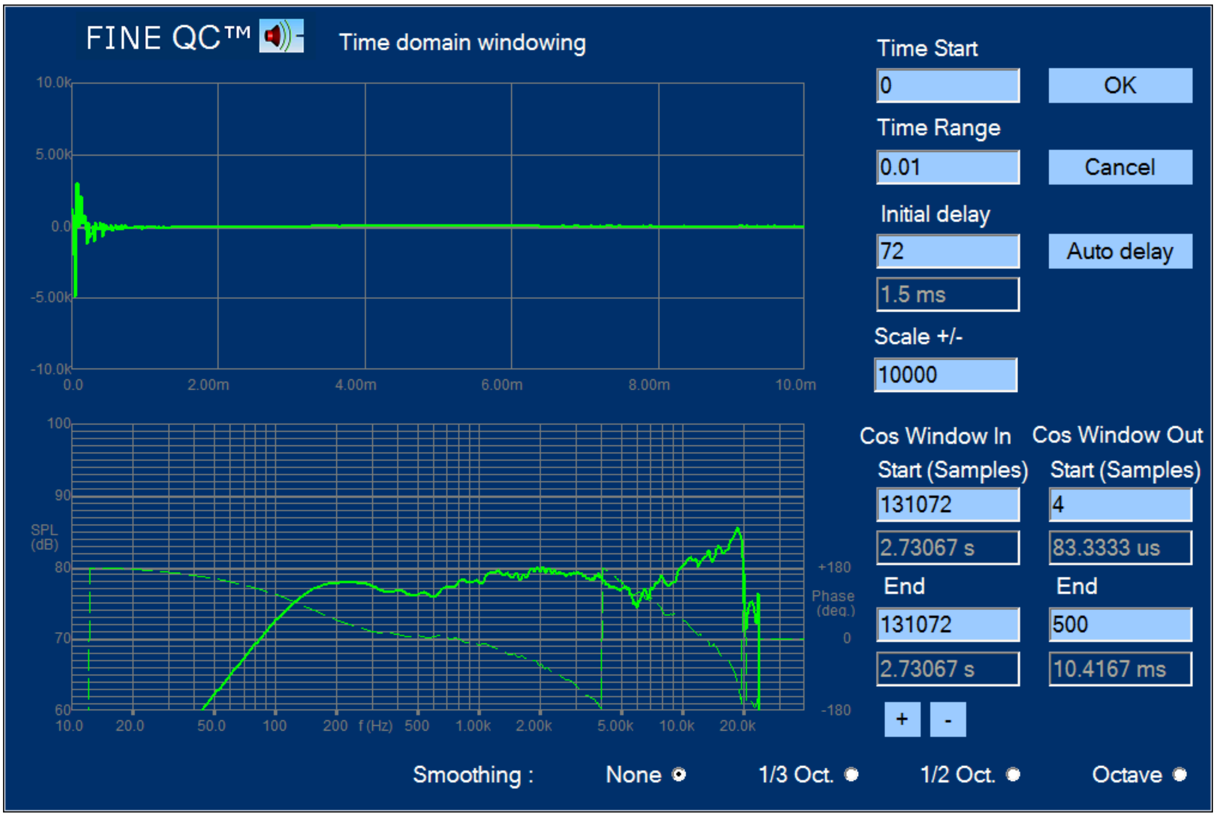


Figure 20 - Satellite and Microphone Moved up to 154cm Above Floor, Microphone Distance is 0.5m

The optimal solution, however, is shown in Figure 20, 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.

5.8. Subwoofer in Near Field

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 21, 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 22. 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.

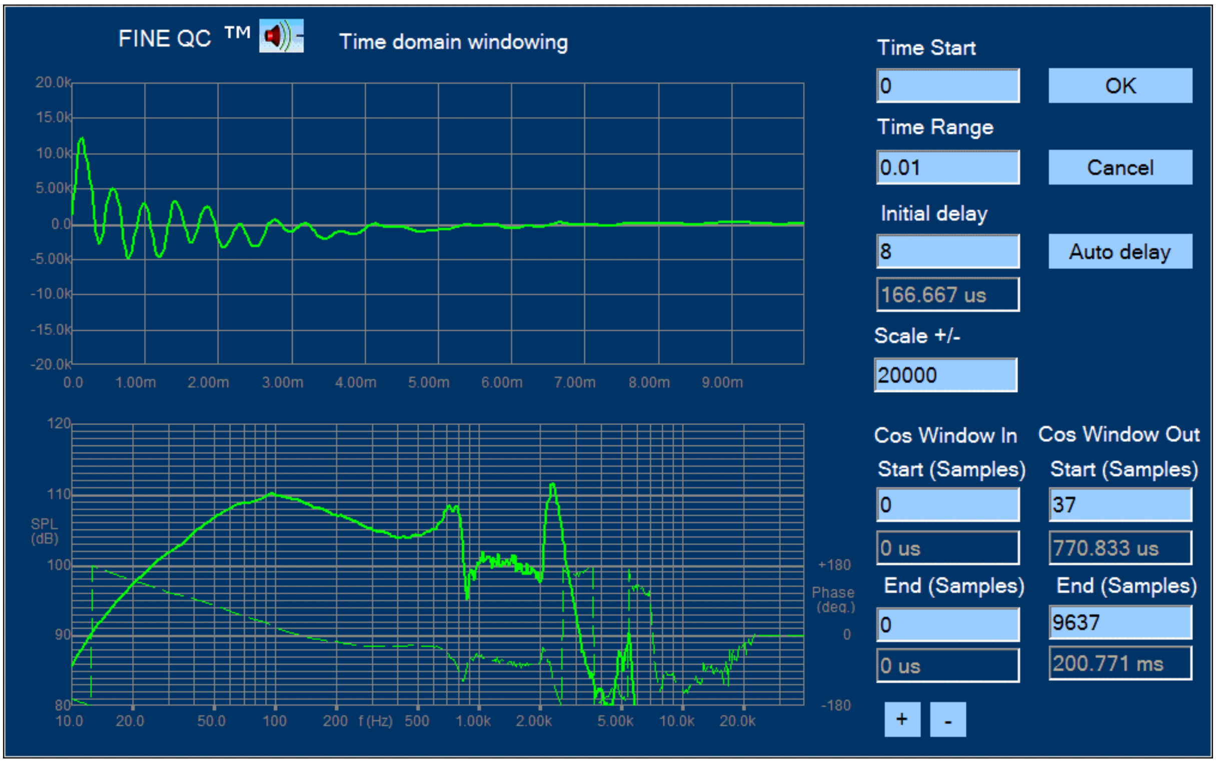


Figure 21 - 8-inch Woofer Measured in Near Field

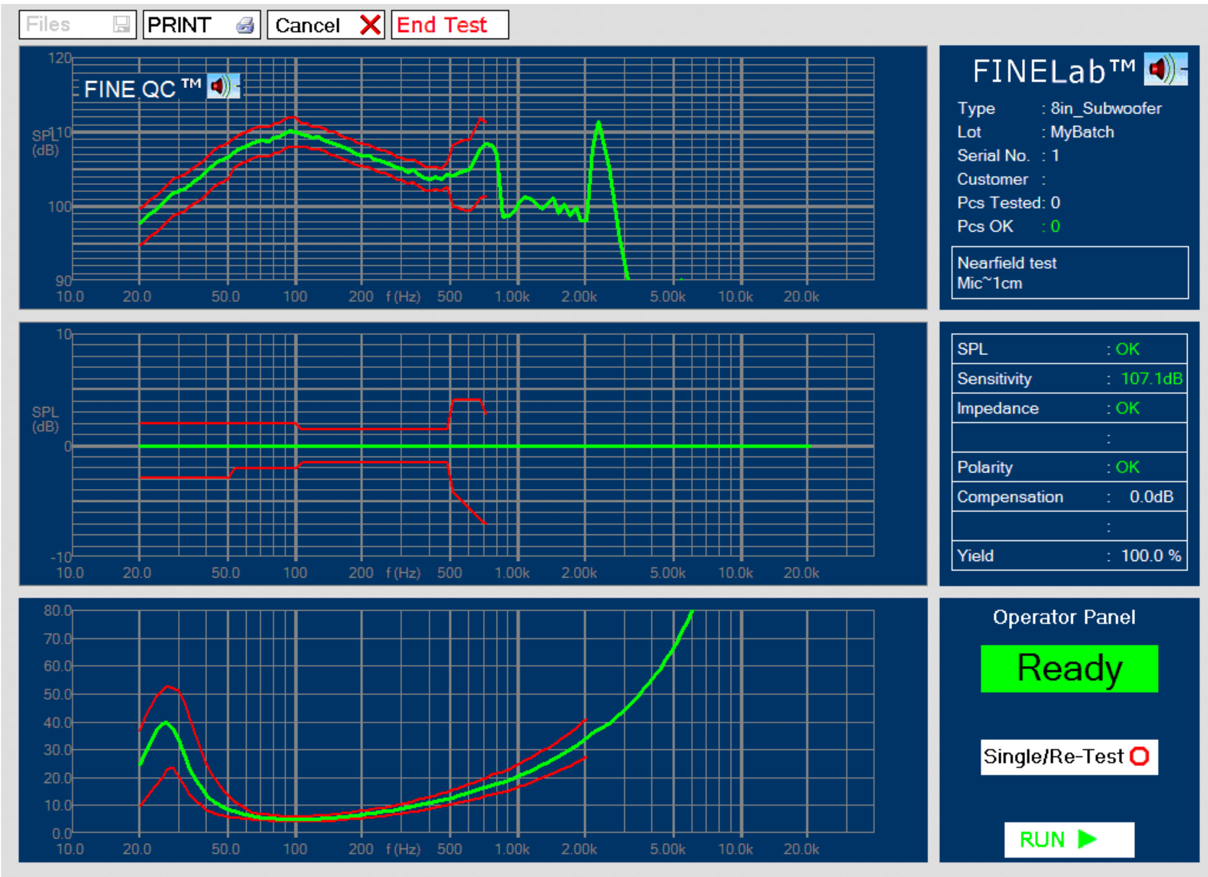


Figure 22 - 8-inch Subwoofer Test in Near Field

5.9. Rub & Buzz Setup (Incl. Micro Speakers)

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.

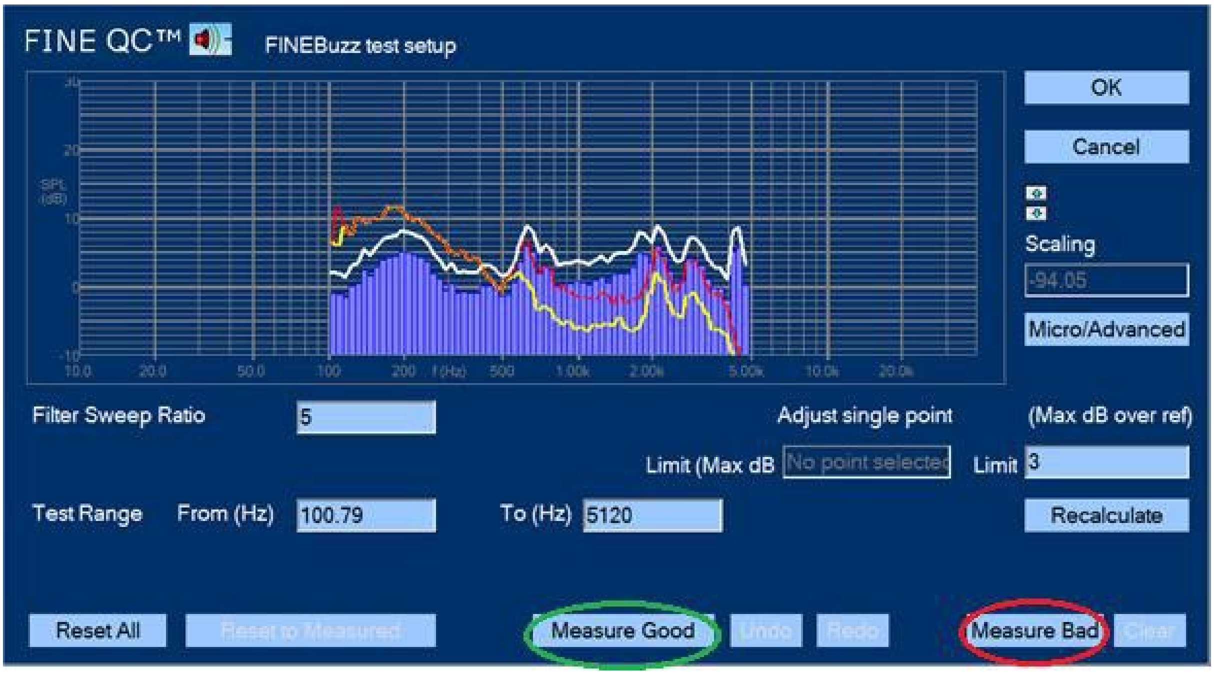


Figure 23 - FINEBuzz Setup Screen

Press "Setup R&B Test" to get Figure 23. 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).

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!)

Micro Speaker/Advanced

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

Selecting the MICRO/ADVANCED button brings up 2 choices:

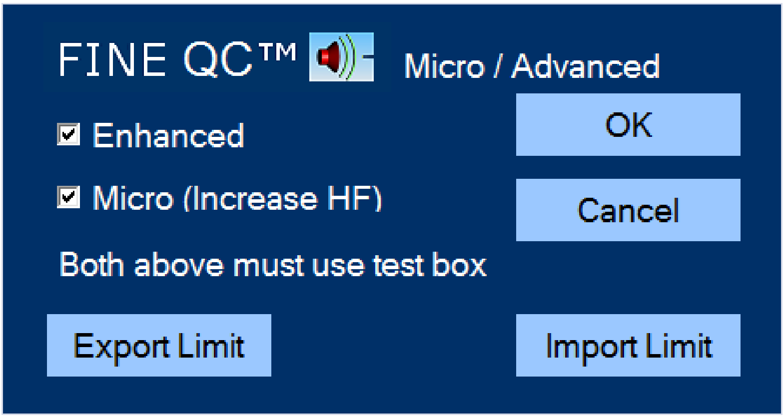


Figure 24 - Select "Micro Test" for Enhanced Rub & Buzz

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.

ALWAYS USE A TEST BOX when measuring micro speakers in production End of Line test! Then you can select "Micro Test" (Figure 24) to enhance detection of subtle Rub & Buzz.

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).

Figure 25 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.

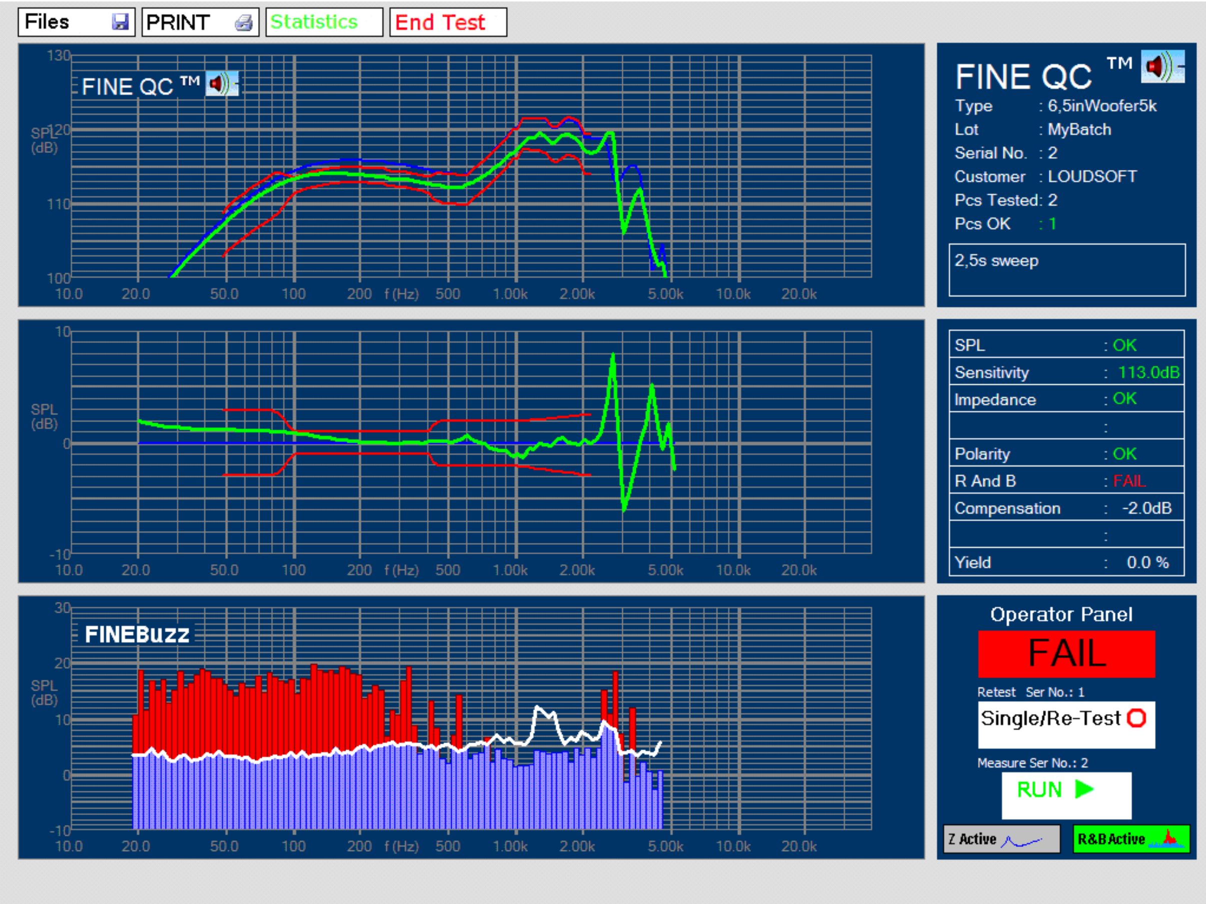


Figure 25 - 6.5-inch Woofer with Rubbing Voice Coil Found with FINEBuzz

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. In the above example, I used the 20-5kHz sweep, which further concentrates the energy in this band.

Likewise, the tweeter setup may be used to find small resonances like buzzing tinsels in tweeters. Figure 26 shows a tweeter with very subtle buzzing tinsel at 900Hz.

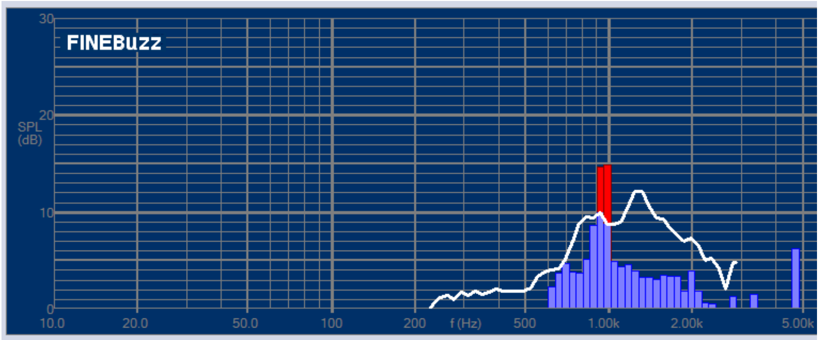


Figure 26 - Tweeter with Very Subtle Buzzing Tinsel at 900Hz

5.10. 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 27:

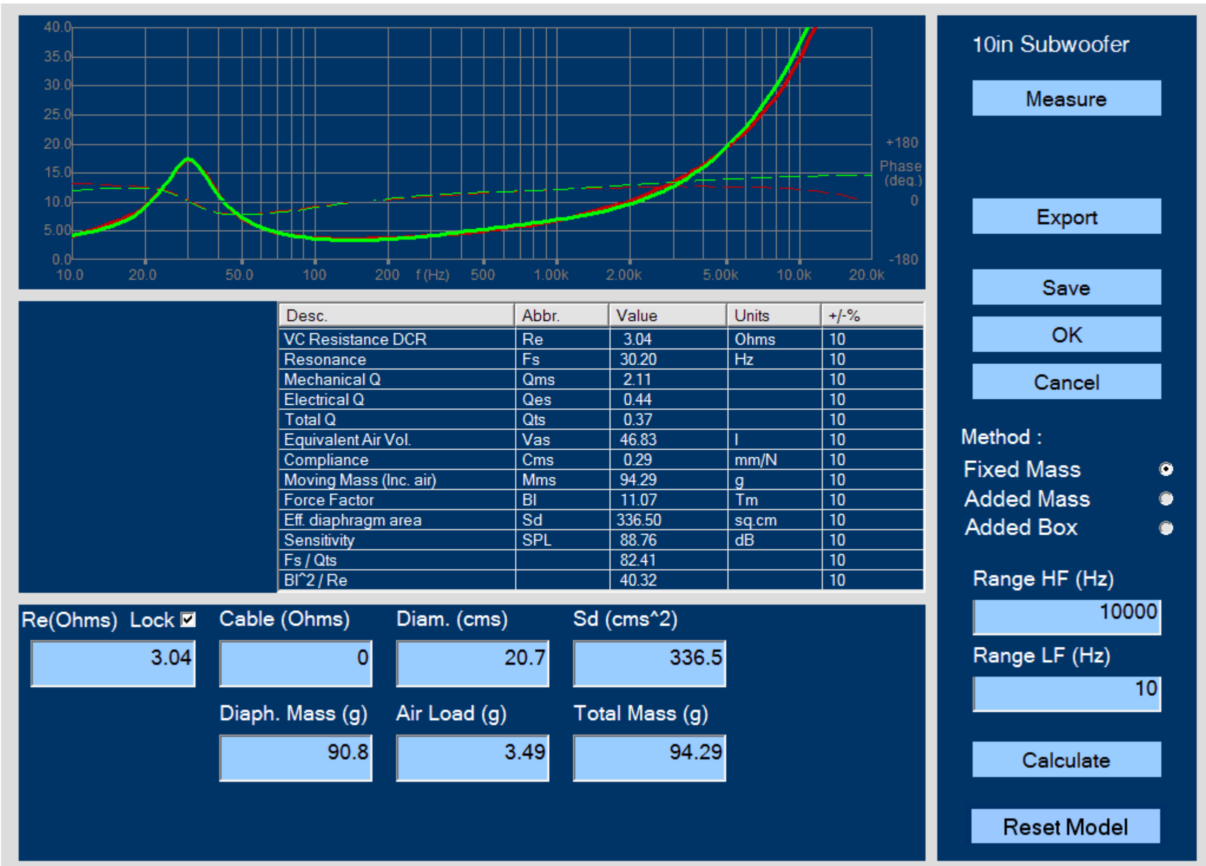


Figure 27 - TS Parameters of 10-inch Subwoofer

First I need to input the cone area Sd and Re. I choose to input the effective diameter of 20.7cm (centre 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.

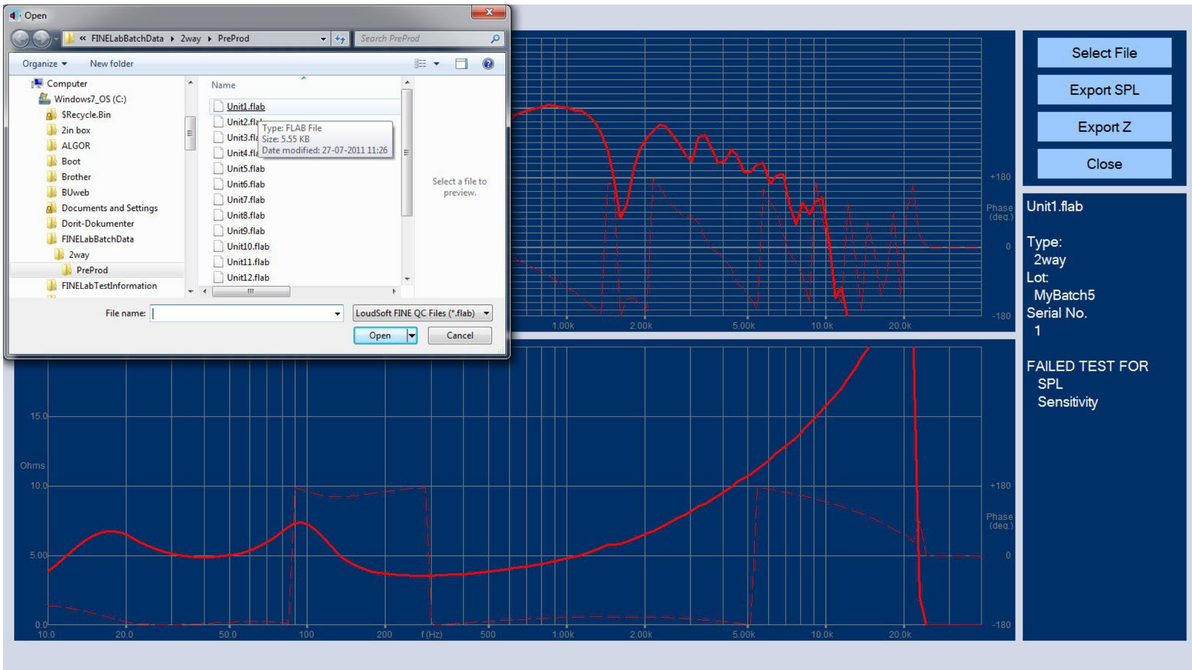


Figure 28 - File View

5.11. Typical Test Setup Procedure

In this chapter I will summarise the necessary steps in a typical test set-up:

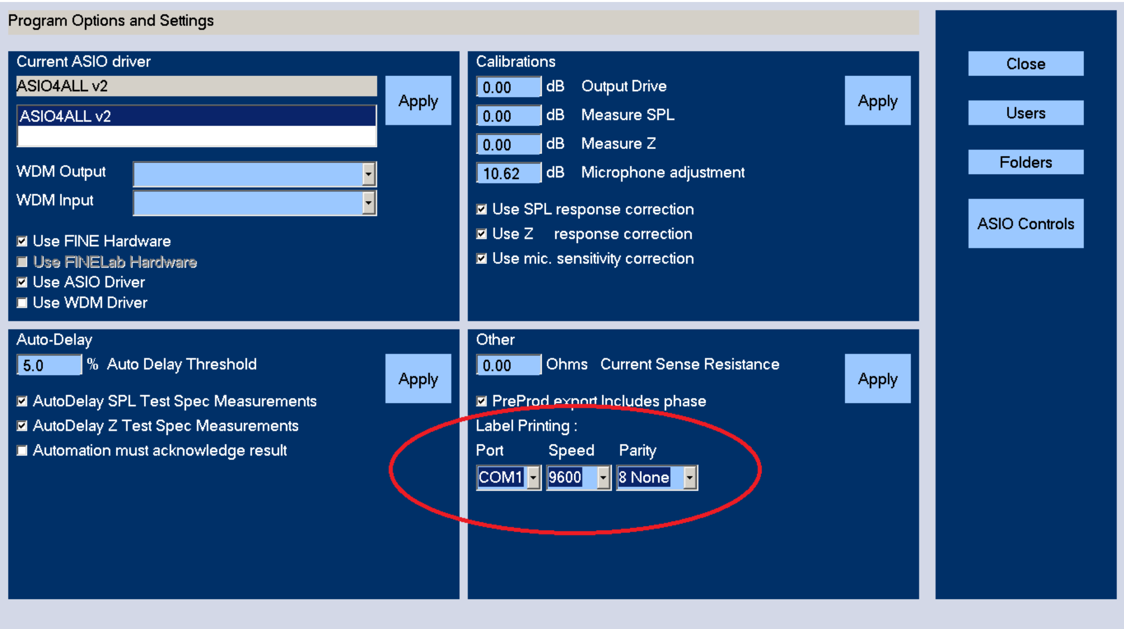
1. Log in as Engineer
2. Select a test specification as close as possible to the kind of speaker you want to test.
3. Select “New Based On” and input a name for the test
4. Specify a suitable amplifier Output Level (Vrms). Choose a level so the driver will move close to half of Xmax for woofers and around 1W or less for tweeters.
5. Press “Measure” to do the first sweep test with Input Attenuation set to: None
6. If you see the red “Overload” light, then select one step lower Input Attenuation and “Measure” again. Repeat until there is no overload
7. Press “Set Test Window” to enter the Time Domain Window
   7.1. Check that the large pulse is close to 0mS. That is normally done by the “Auto Delay”. If not adjust the “Initial Delay”. (Auto Delay is by default 5%. This can be changed in Admin. A higher number will prevent FINE QC from trigging on noise)
   7.2. The dashed curve is the acoustic phase response which will show less variation when the large pulse is close to 0mS
   7.3. Input a suitable number of samples in: (Cos Window Out / End (samples))
      7.3.1. If you are using an anechoic room or really well damped box use ~10-20mS
      7.3.2. If you are using a normal room or standard test box use ~3-10mS
      7.3.3. If you are measuring in the near field, you may use the full 200mS.
   7.4. The idea is to choose a window which will pass the decaying pulse, but avoid the reflections which arrive later (see for example Fig. 17)
   7.5. The window may extend to include some reflections in the end, because the cosine window will attenuate much towards the end
8. Select “Set Bands”
9. Choose a suitable SPL tolerance limit standard

9.1. Modify the tolerances and bands if you know how much you need
9.2. If you do not know how much you need to change the limits, then use the standard one and check the response statistics before considering changes to the limits
10. Press “Z mode” to enter the Impedance window
11. Press “Measure” to do a first impedance sweep test
12. Use the up/down arrow buttons to scale the impedance curve as necessary
13. You do not need to press “Set Window” to enter the Time Domain Window, but you can.
14. Select “Set Bands” if you want to choose standard limits, OR
15. Click and drag the white squares to suitable production limits.
16. Press “Save” when you are satisfied with the limits
17. You should now run the test file you have created with a small number of units (Test Batch) to verify your settings and limits. Press “End Test” when done and the statistics Display will automatically appear showing all the responses with your limits. You can choose to display good/rejected SPL, Impedance, Sensitivity or Polarity.
18. Select “Review Old Data” and view the Pre-Production of your Test Batch “Pre-Prod”
19. The Pre-Prod window highlights the Golden Reference (You can de-select non-typical curves).
20. Press “Edit that test” if you want to change the limits according to the statistical results

5.12. Printing Labels in FINE Q

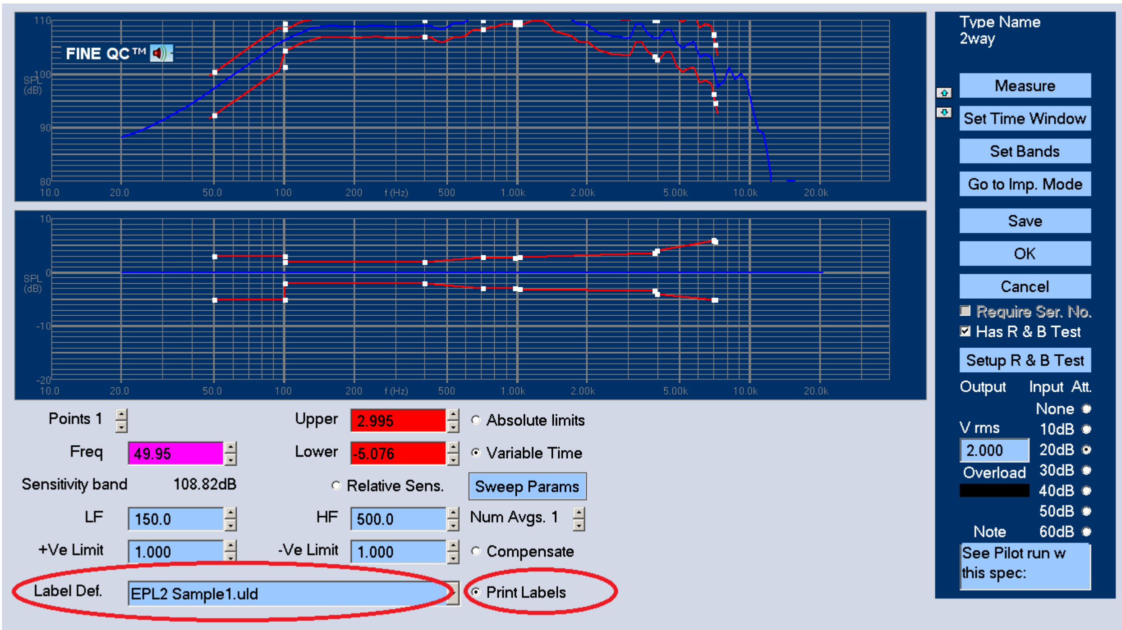
You can print labels to a standard serial matrix label printer. (Loudsoft can make customer versions to fit your specific printer or other)

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

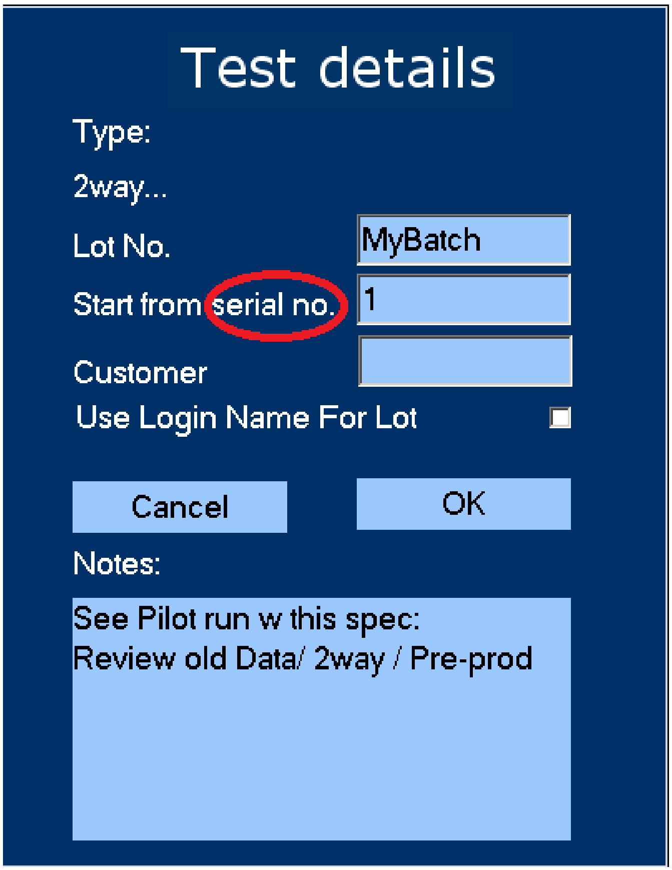


Then, define a test specification, for example, 2Way.fts. The “2Way” will be used as a type name in the label.

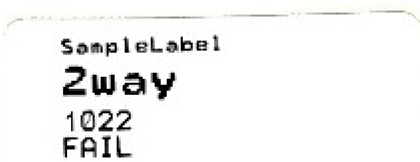
In “Unit labels” you can select a label style, as shown in the figure below. There are two more label styles, which may be chosen.” Click on “Edit QC test”, and the following window will be opened. Here you can choose “Print Labels” (last line)



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.

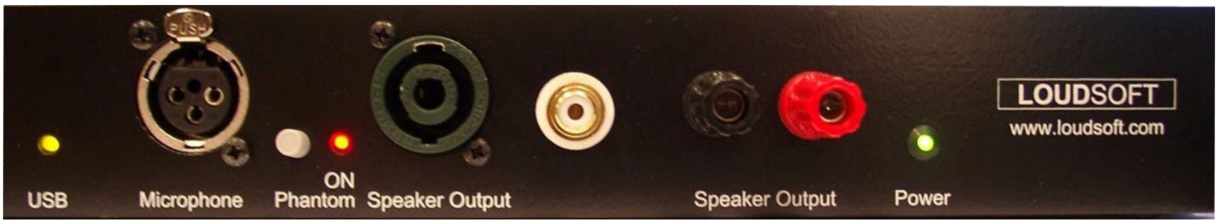


The following figure shows the label for a failed sample.



6. FINE Hardware

6.1. Front Panel



1. **USB Yellow LED**

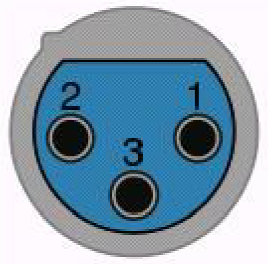
When the FINE Hardware is connected to the computer with a USB cable, the yellow USB light LED is on.

2. **Microphone input**

Phantom power (48 V) is provided for XLR type microphones, allowing you to connect a condenser microphone that requires phantom power. A red LED will indicate when phantom power is switched on.

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

Microphone/Line Input



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

Figur 1- Line Output - Phono/RCA (1/10 of Output)

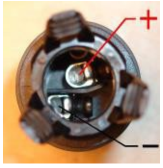
In case the built-in 25W amplifier is too small for testing your system, you can connect a larger power amplifier from the Line out RCA/Phono output on the FINE Hardware.

Note that the RCA/Phono 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 stand high power!

Amplifier output - Speakon connector / Banana connector

You can use the Speakon or banana connector to connect a loudspeaker. These are in parallel.



Figur 2 - Speakon Rear Connections

6.2. Rear Panel

1. **Power Input jack:** 15 V DC, regulated.
2. **USB Input connector:** Use a USB cable to connect the FINE hardware (Box) to your computer.
3. **USB output connector:** USB hub. Use for other USB devices. NB! This has limited power!

6.3. Main Specifications

Signal Processing

AD/DA Conversion: 24/16 bits

Sampling Frequency

AD/DA Conversion: 48 kHz

Frequency Response

SPL: 20 Hz to 20 kHz (±0.5 dB)

Impedance: 10 Hz to 20 kHz (±10%)

Nominal Input Level

XLR 0-1000 mV RMS

Interface

USB 1.0

Amplifier

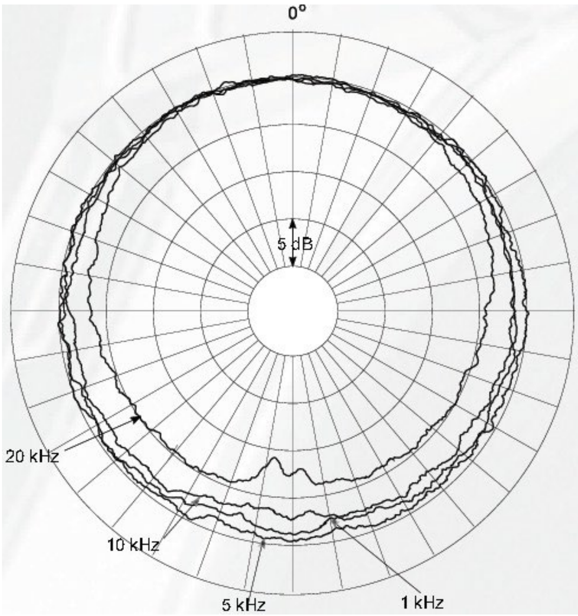
Output Power:	35 W (2 Ω load, Max THD < 1%, 1 kHz)
	20 W (4 Ω load, Max THD < 1%, 1 kHz)
Protection:	Short circuit.
	Over temperature shutdown.

6.4. Loudsoft Microphone FL1 Data Sheet

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:



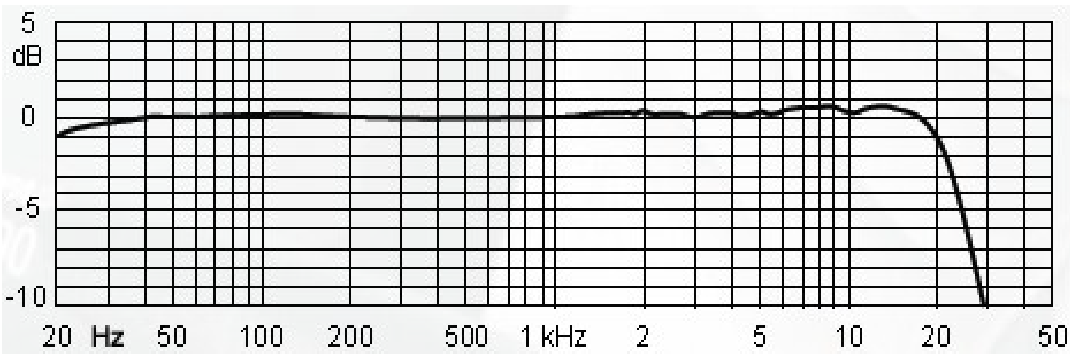
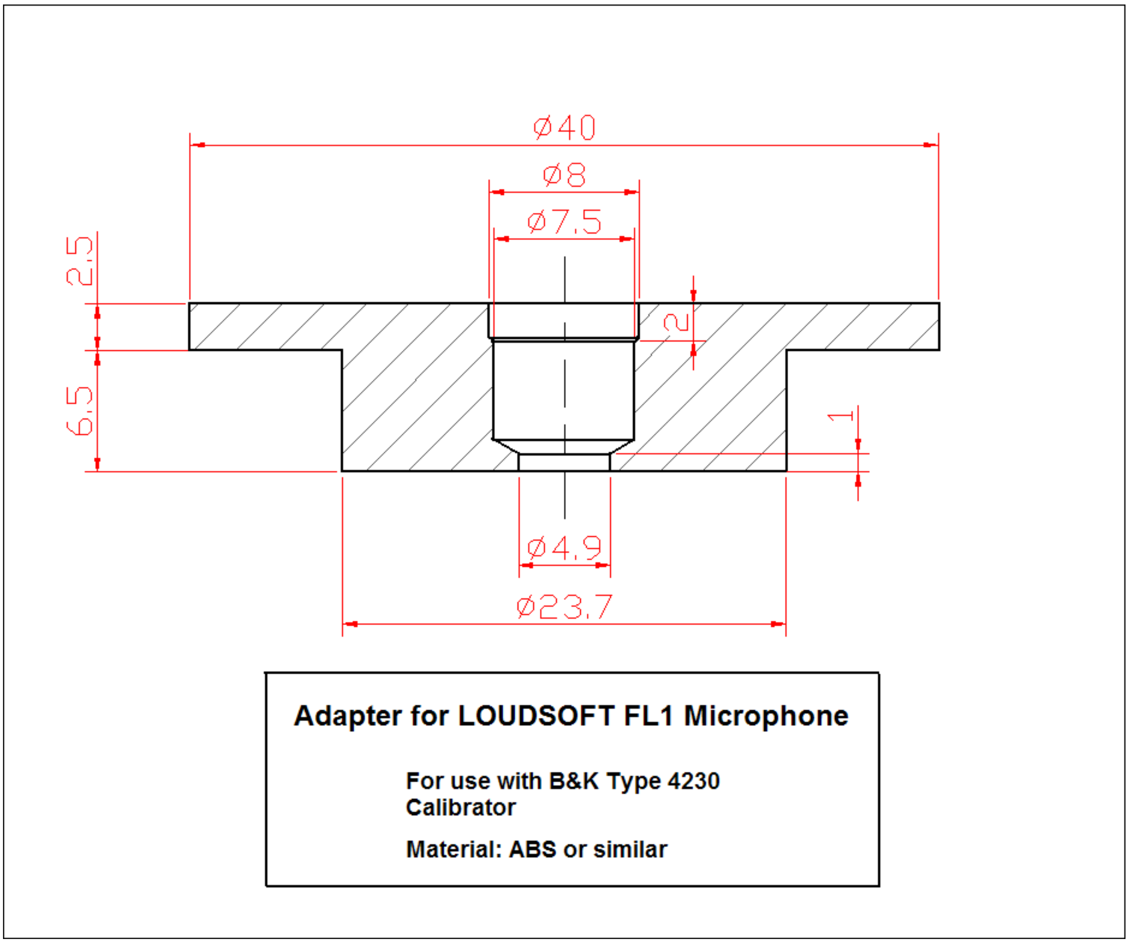


Figure 29 - On-Axis Frequency Response of LOUDSOFT Microphone FL1 in Free Field

6.4.1. Adapter for LOUDSOFT FL1 Microphone (Calibrator)



6.5. LOUDSOFT Test Box

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

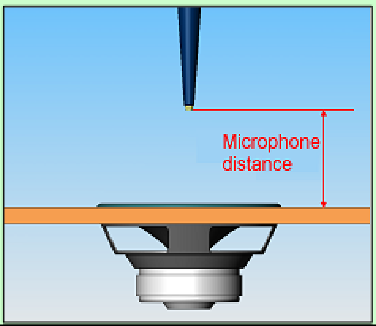
7. Frequently Asked Questions

7.1. What distance should I measure from?

Guide to QC measuring method

FINELab Application Note

Choose the type in the first column and select a measuring method, and then the recommended microphone distance can be found from the table.



Recommended Microphone Distance				
Type	In Baffle	In Test Box	In Free air	
			Normal room	Anechoic chamber/Hall
Tweeter	10 cm	10 cm	N/A	N/A
Midrange/Woofer	10 cm	10 cm	N/A	N/A
Subwoofer	< 1 cm from center of dust cap	< 1 cm from center of dust cap	< 1 cm from center of dust cap	< 1 cm from center of dust cap
Small Loudspeaker System	N/A	20 cm (mic. in line with tweeter)	0.5 m (mic. in line with tweeter) or 1 m (if room is large)	2 m (mic. in line with tweeter)
Large Loudspeaker System	N/A	N/A	0.5 m (mic. in line with tweeter) or 1 m (if room is large)	2 m (mic. in line with tweeter)

Figure 30 - Guide to QC Measuring Method

A special Test Box is designed by LOUDSOFT and can be used for testing normal loudspeaker drivers. The drawing is placed under Documents in the FINE QC installation.

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.

7.2. Where can I find the measurement files?

All measured SPL and Impedance responses are automatically stored on the PC. This makes it very easy to view these data later, see also Statistics p 15.

The measured data are stored here (default):

C:\FINELabBatchData\Batchname

The test setups are stored here (default):

C:\FINELabTestInformation\TestSpecifications

7.3. My computer is having trouble finding the FINE Hardware

If you have USB Problems with the FINE Hardware here are some tips:

- If the USB cable is plugged out, DO remember to switch off the power to the FINE hardware, and switch it on again, before you plug the USB cable in the computer again. Otherwise, Windows might not be able to detect the ASIO USB hardware.
- If a similar problem happens when restarting the computer, you can go through the following procedure to solve the problem:
    - Unplug the USB cable from the computer
    - Switch off the power to the FINE Hardware
    - Switch it on again
    - Plug in the USB cable

LOUDSOFT

www.loudsoft.com

Agern Alle 3 – 2970 Hørsholm – Denmark

Tel: (+45) 4582 6291 - Fax (+45) 4582 7242