

**FINE**SPL™

## **Reference Manual / Tutorial**

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

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## Installation

When you have downloaded the software, right-click and select Run as ADMINISTRATOR to install on Windows XP, Vista or Windows 7. You must be connected to the internet to install. LOUDSOFT has Microsoft Authenticode Certificate so FINESPL should install easily. The software can only run on the computer where it was first installed.

## Setup

Run FINESPL from the program menu: Loudsoft/FINESPL. You can select your internal soundcard or an external in Acquisition/Soundcard, (verify it is chosen in Control/Panel/Sounds/Voice for both playback and recording). Many soundcards have a bass cut on the microphone input!

Normally you should use a good power amplifier with a flat frequency response and low output impedance, but the maximum amplifier power can be low even 10-20W. (There is no need to use a 100-1000W amplifier, because you may accidentally damage your loudspeakers).

For hardware connections see the diagrams on page 10. Note that you need a different setup for measuring impedance.

## Frequency Response / SPL Measurement

This chapter is a tutorial how to measure a normal loudspeaker. First connect the power amplifier and microphone per the "SPL Connection Diagram" page 10. Then select "New" from the menu and select the SPL tab, see Fig. 1.

Acquisition is where you define output and inputs and levels. (See View/Toolbars and Docking Windows to set which windows are active).

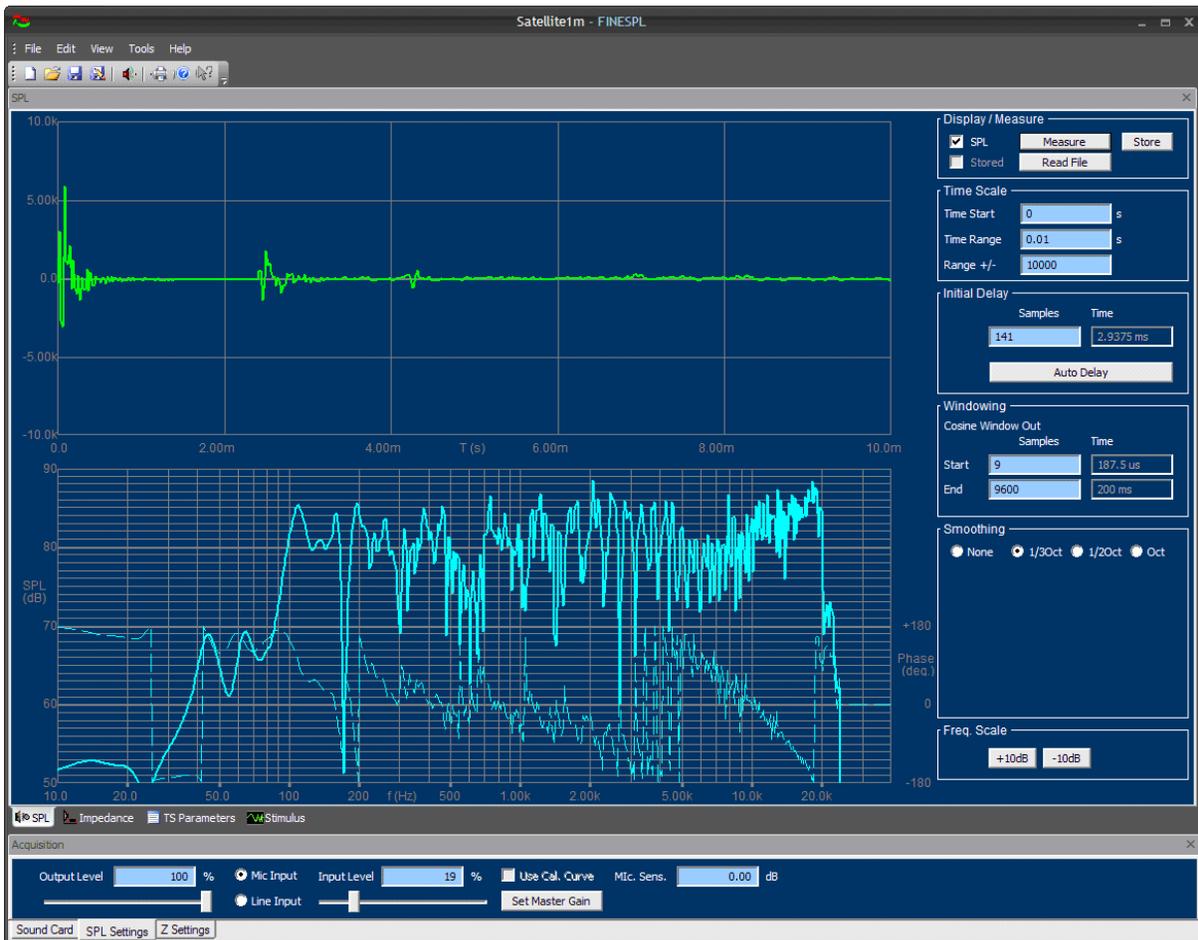
Turn the power amplifier volume up to  $\sim 1/10$  of max (say 9 o'clock on a rotary volume control) and low volume in acquisition. Now measure the speaker by clicking the (upper) "Measure" button. LISTEN for bad sound / overload. In that case turn the volume control(s) almost fully down! If the sound is still too loud / overloaded, then lower the volume control (Control Panel/Sounds/Voice).

Make sure the microphone input is selected, also in Control/Panel/Sounds/Recording/Volume. After the sine sweep is played the impulse response (using inv FFT) is shown in the upper view and the windowed frequency response below. The time scale in the right side should auto scale to show the first 10 ms of the time response.

Check that the pulse is caught at left in the Time window. This is normally the case thanks to the Auto Delay, which will catch the pulse even if your PC delays the signal several 100 ms. If the pulse is missed you may try to change the Sample number in small steps until you see the pulse just starting at left. (The Auto Delay has an amplitude threshold which is 5% of max. as default. If the program is triggered on unwanted noise spikes, you can change this setting in Properties, but only if you are really sure).

The Time domain impulse response measured 1m from a typical satellite speaker is shown in Fig. 14. The time axis automatically sets 0 at the start of the main impulse. (Which actually arrived after approximately 3ms corresponding to 1m, since the speed of sound is  $\sim 343\text{m/s}$  or  $0.343\text{m/ms}$ ). All you need is to set a value for the "Cosine Window Out/End".

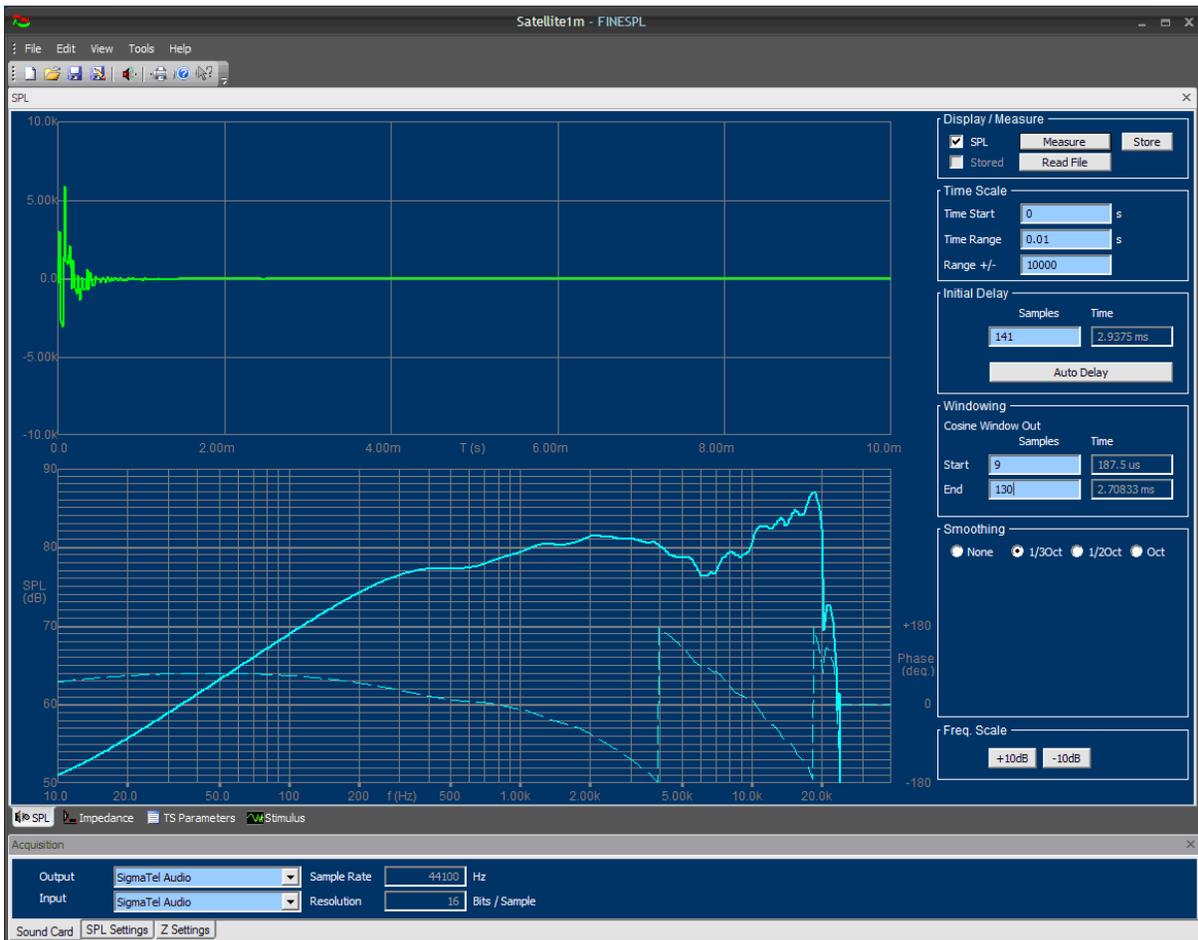
Using the default value 9600 samples / 200ms gives a very ragged frequency response Fig. 1.



**Figure 1 - Satellite measured at 1m**

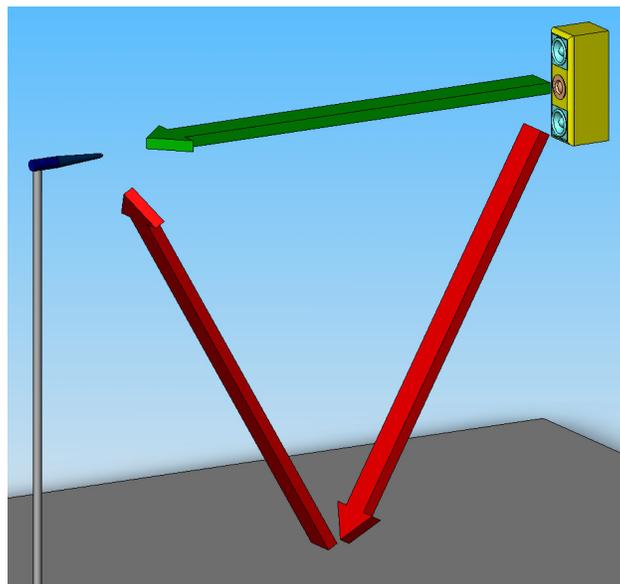
The frequency response is ragged because we have included all the reflections in the room. Therefore we can just select a lower number in “Cosine Window Out/End” to exclude all the reflections and get the “Anechoic” response.

The green Time Response also shows another strong impulse arriving already ~2.5ms after the main impulse. Therefore we can only use ~2.5-2.7ms by selecting 130 samples. This is shown in Fig. 2.



**Figure 2 – Satellite response with short time window to exclude first reflection (phase - -)**

The short time between the two impulses gives poor low frequency response because the  $1/f$  ratio with 2.5ms will only allow 400 Hz as the lowest frequency. The impulse at 2.5ms is the reflection from the floor, which in this example was only 82cm below the speaker and microphone, Fig. 3.

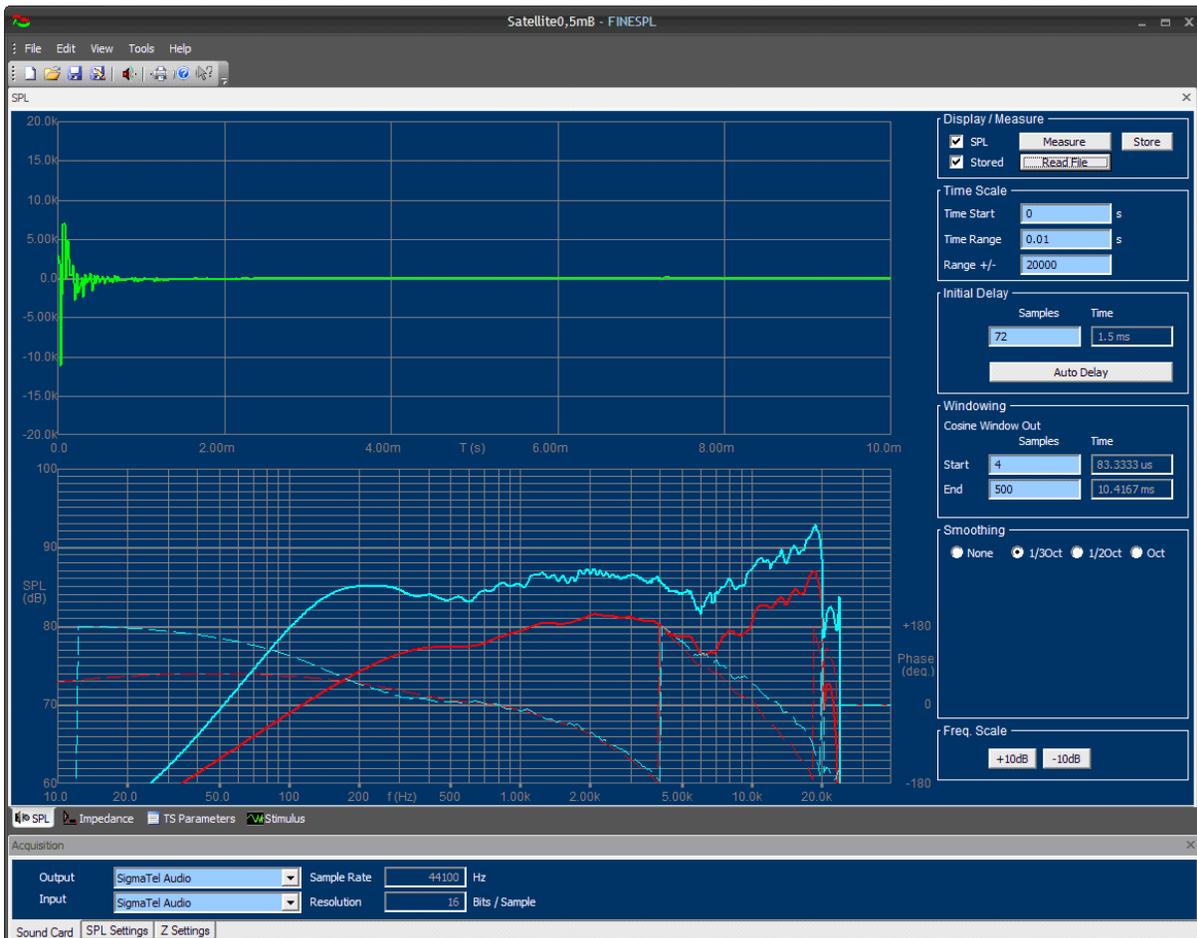


**Figure 3 -Satellite close to floor, Red is Reflection**

Fig. 3 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 (and other surfaces).

Both have been done in Fig. 4, by moving both the microphone and speaker up to 154cm from the floor and adjusting the microphone distance to 0.5m. 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.

Note the dashed lines in the SPL window are the acoustical phase responses of the corresponding SPL/ frequency responses. All FINESPL measurements are full resolution responses with phase.



**Figure 4 - Satellite measured at 0.5m and 154cm above floor (1m response=red)**

# Room Response Measurements

In case you want to measure how the loud speaker actually sounds in your room, you should include all the reflections, by using the maximum window/end.

The next example is a measurement of a very good Hi-Fi loudspeaker measured in a good listening room. The first (red) curve was measured on axis with the tweeter in the listening position. Note that the curve was 1/3 octave smoothed by selecting 1/3Oct. This response is well behaved above 1000 Hz, while the low frequency peaks and dips are caused by the standing waves in the room, Fig. 5.

In stead of the 1/3 octave smoothing you can also select 1/2 octave or even 1/1 octave smoothing. 1/1 octave smoothing will not show the room modes, but only indicate the general sound balance in the room.

The other (blue) curve was measured 30 deg off-axis. Some of the low frequency peaks have now changed to dips, indicating standing waves in the room. These two examples are well behaved room responses; however in many cases you will see much more variation in the low frequency range. FINESPL is extremely useful for adjusting your (room-) EQ and/or finding the best loudspeaker position in the room. Also furniture positions and damping material can be optimised this way.

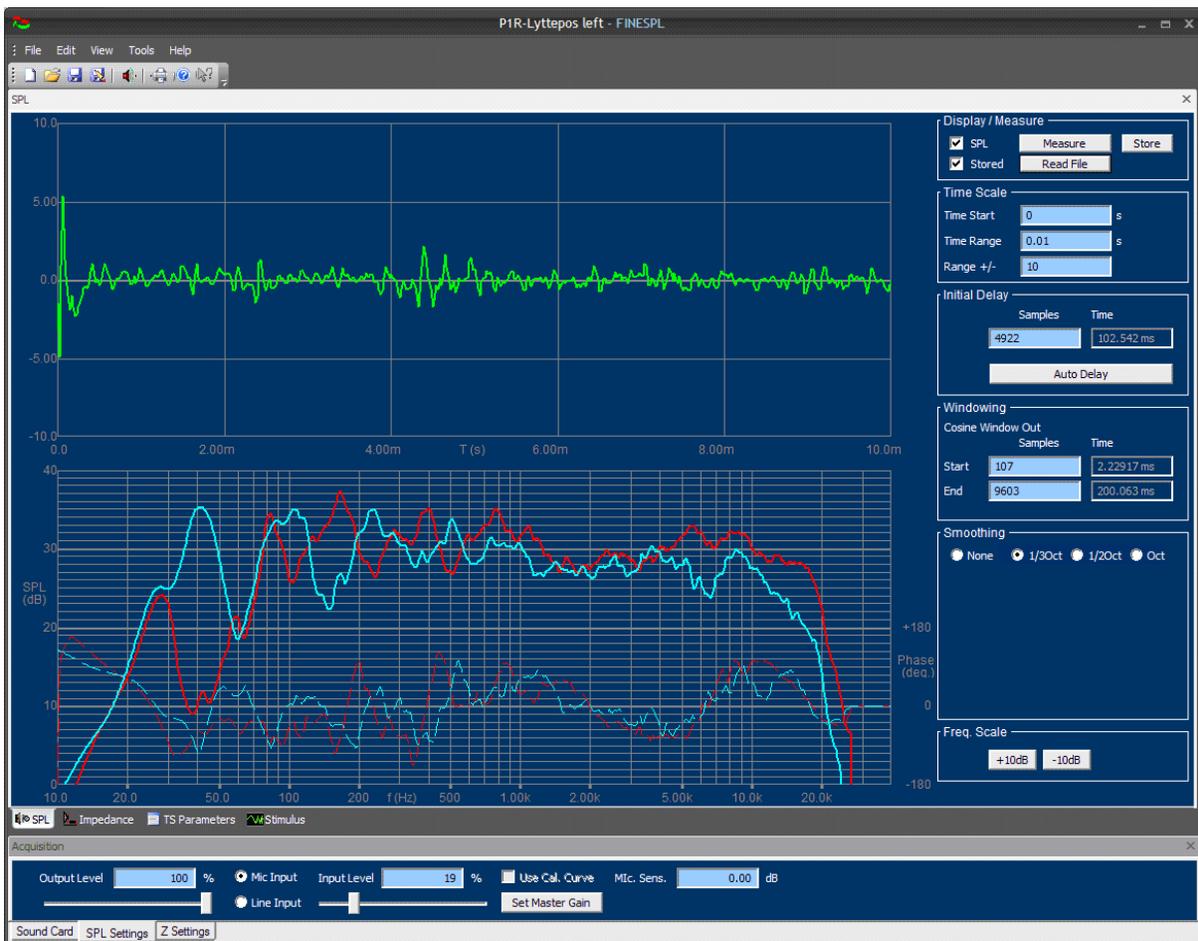


Figure 5 - Room responses measured far from loudspeaker

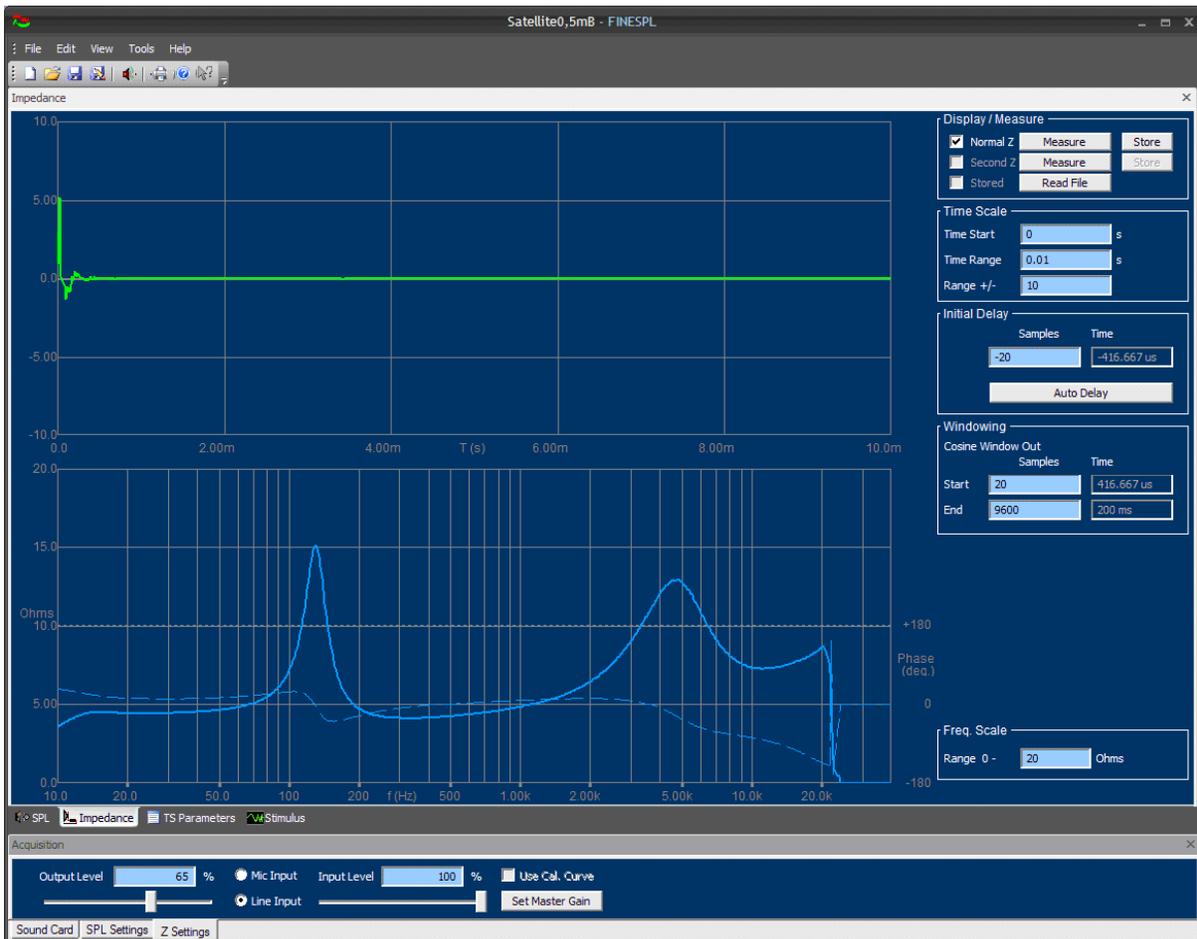
# Impedance Measurement

In order to measure loudspeaker impedance you should connect the input and output cables according to the “Impedance Connection Diagram”, see page 11. The input should be line, which is sometimes the same connector as microphone. It must be selected in Control Panel / Sound.

*Note that you need a power resistor in series with the loudspeaker (-minus terminal). This series resistor should be a low value around 1 ohm (=default). Remember to change/update the corresponding number in “Properties” if you use another value.*

Press the Impedance tab to enter the impedance screen (Fig. 6). It is a good idea to keep the amplifier volume control in the same position as for SPL measurement. Press the upper “Measure” button to measure the actual impedance curve. (The second “Measure” button is only used for Thiele/Small add mass/volume parameters)

Since the impedance measurement is purely electrical, the range and time window is already defined when the “Auto delay” is active. So in normal cases there is no need to change anything. The “Cosine Window Out/End” should be using the max (9600) always.



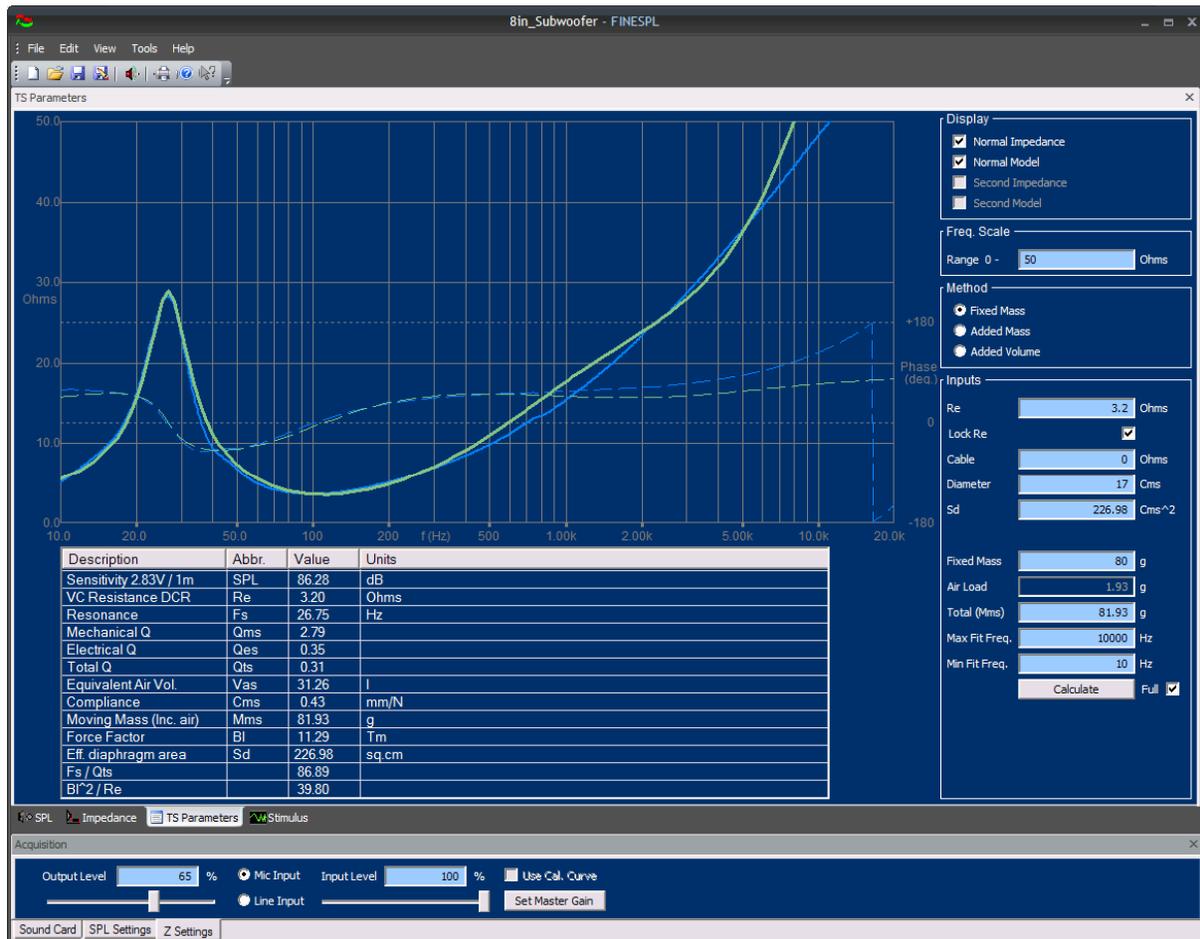
**Figure 6 – Measured Impedance with phase of Satellite**

## Thiele/Small Parameter Measurements

Here is shown how to measure the Thiele/Small parameters of an 8 inch subwoofer. Press the “TS Parameters” tab below, Fig.7.

First I need to input the cone area  $S_d$  and  $R_e$ . I choose to input the effective diameter of 20.7cm (centre of surround) and  $S_d$  will automatically be calculated. FINESPL can estimate  $R_e$  from the impedance curve, but in order to get the best accuracy I have measured  $R_e=3.2$  ohms with a precise Multimeter (DVM). That value is fixed by lock [v].

Now I press “Measure” to get the impedance curve (blue).



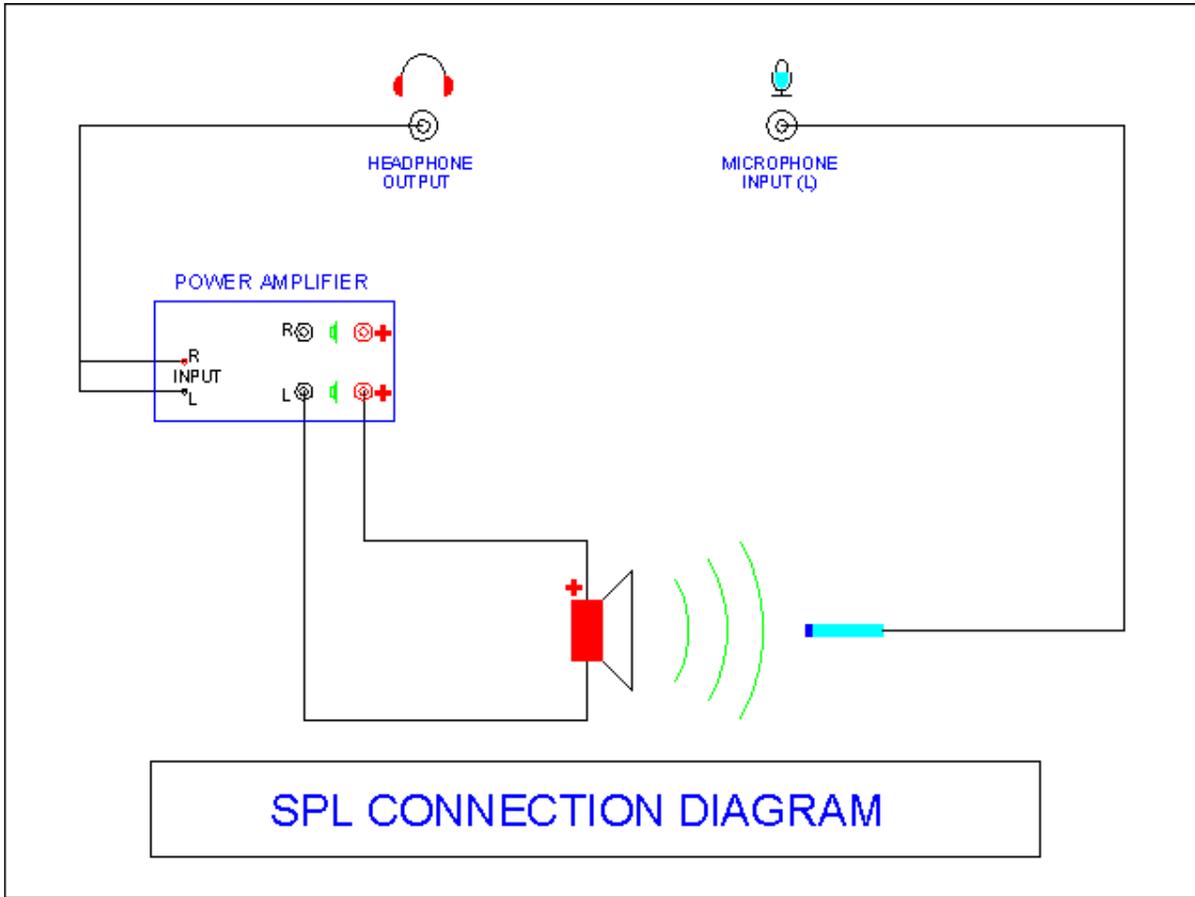
**Figure 7 – Thiele/Small Parameter measurement with Fixed Mass (alt added Mass or Volume)**

The Fixed Mass option is the most accurate method. However this requires that you know the total moving mass of cone + Voice Coil + half surround + half spider (including dust cap and glue etc.) = Fixed Mass  $M_d$ . If you know this mass from the datasheet you should enter that, which causes the air load mass ( $M_{air}$ ) to be calculated,  $M_d + M_{air} = M_{ms}$ .

If none of the masses are known you can choose the standard Added Mass or Added Box methods, which both require you to make a second impedance measurement. In those cases we end up with a total of 4 curves, 2 measured and 2 fitted.

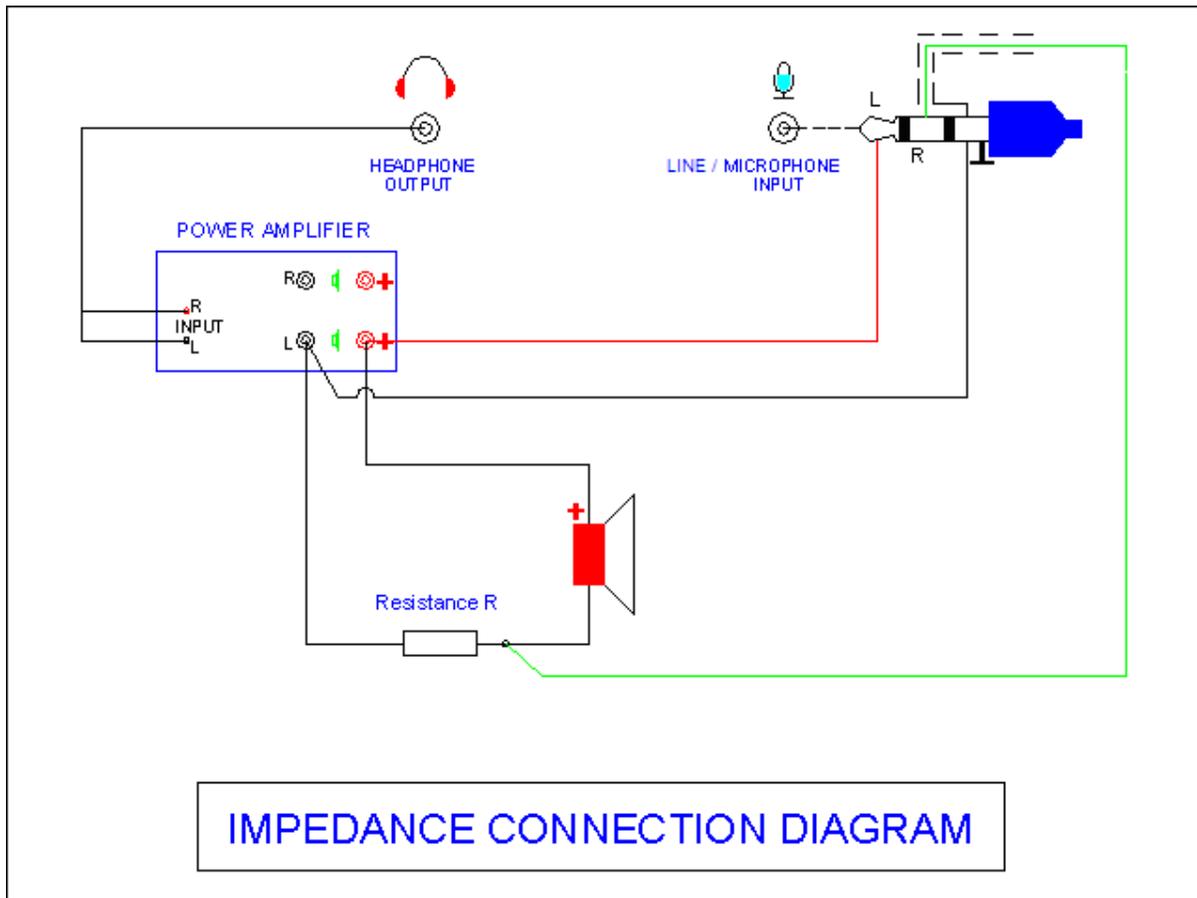
When the “Calculate” button is pressed, FINELab will calculate all the TS parameters by fitting a simulated impedance curve (green) in the chosen frequency range. In this case we get a very good fit around  $F_s$ , which is important for getting accurate TS parameters.

# Hardware Connection Diagrams



**Figure 8 – SPL Connections**

FINESPL will actually play on both left and right channels. So be sure to set the balance control to the one you want to measure, or simply disconnect the other.



**Figure 9 – Impedance Connections**

Properties	
<b>Line Colours</b>	
SPL Time curve	00ff00
SPL Freq. curve	00ffff
Show SPL unsmoothed	False
Unsmoothed SPL Freq. curve	00ff00
Stored SPL Freq. curve	ff0000
Stored SPL bold	False
Normal Z Time curve	00ff00
Normal Z Freq. curve	0080ff
Normal Model Freq. curve	80c080
Second Z Time curve	ffff00
Second Z Freq. curve	00ff00
Second Model Freq. curve	c08080
Stored Z Freq. curve	a6caf0
Stored Z bold	False
<b>SPL Acquisition</b>	
Autodelay after acquire	True
Autodelay Threshold %	5.000000
<b>Impedance Acquisition</b>	
Autodelay after acquire	True
Autodelay Threshold %	5.000000
Sensing Resistance (Ohms)	1.000000

**Figure 10 – Properties**

# SPL Interface / Inputs

The image shows a software interface for SPL measurements, divided into several sections with various controls and annotations:

- Display / Measure:** Contains checkboxes for  SPL and  Stored. Buttons include Measure, Store, and Read File. Annotations: "Press to measure" points to the Measure button; "Store response in memory" points to the Store button; "Import file for comparison curve" points to the Read File button.
- Time Scale:** Includes input fields for Time Start (0 s), Time Range (0.01 s), and Range +/- (10). Annotations: "Automatic" points to the section; "Time start (left)", "Time Range", and "Vertical Range" point to their respective fields.
- Initial Delay:** Includes input fields for Samples (4922) and Time (102.542 ms), and an Auto Delay button. Annotations: "Automatic" points to the section; "Delay samples" points to the Samples field; "Initial Delay in ms" points to the Time field.
- Windowing:** Includes input fields for Start (107) and End (9603) in Samples, and their corresponding Time values (2.22917 ms and 200.053 ms). Annotations: "Automatic" points to the section; "Window End (User Input)" points to the End field; "Start time in ms" and "End time in ms" point to their respective Time fields.
- Smoothing:** Includes radio buttons for None, 1/3Oct, 1/2Oct, and Oct. Annotation: "1/3 - 1/2 - 1/1 Octave smoothing" points to the Oct button.
- Freq. Scale:** Includes buttons for +10dB and -10dB. Annotations: "Move curve up by 10 dB" points to the +10dB button; "Move curve down by 10 dB" points to the -10dB button.

# Impedance Interface / Inputs

The screenshot shows a software control panel for an impedance interface. It is divided into several sections with various input fields and buttons. Red lines with text labels point to specific features:

- Display / Measure:**
  - Normal Z: Measure (button), Store (button)
  - Second Z: Measure (button), Store (button)
  - Stored: Read File (button)
- Time Scale:**
  - Time Start: 0 s
  - Time Range: 0.01 s
  - Range +/-: 50
- Initial Delay:**
  - Samples: -20
  - Time: -416.667 us
  - Buttons: Auto Delay
- Windowing:**
  - Cosine Window Out
  - Samples: Start (20), End (9600)
  - Time: Start (416.667 us), End (200 ms)
- Freq. Scale:**
  - Range 0 - 50 Ohms

Annotations include: "Press to measure imp curve" pointing to the Measure button for Normal Z; "Press to measure 2nd imp curve" pointing to the Measure button for Second Z; "Store response in memory" pointing to the Store button for Normal Z; "Store 2nd response in memory" pointing to the Store button for Second Z; "Import file for comparison curve" pointing to the Read File button; "Automatic" labels pointing to the Time Scale, Initial Delay, and Windowing sections; "Time start (left)", "Time Range", and "Vertical Range" pointing to the Time Scale fields; "Delay samples" pointing to the Samples field in Initial Delay; "Initial Delay in ms" pointing to the Time field in Initial Delay; "Start time in ms" and "End time in ms" pointing to the Time fields in Windowing; and "Vertical imp scale" pointing to the Range 0 field in Freq. Scale.

# TS Parameters Interface / Inputs

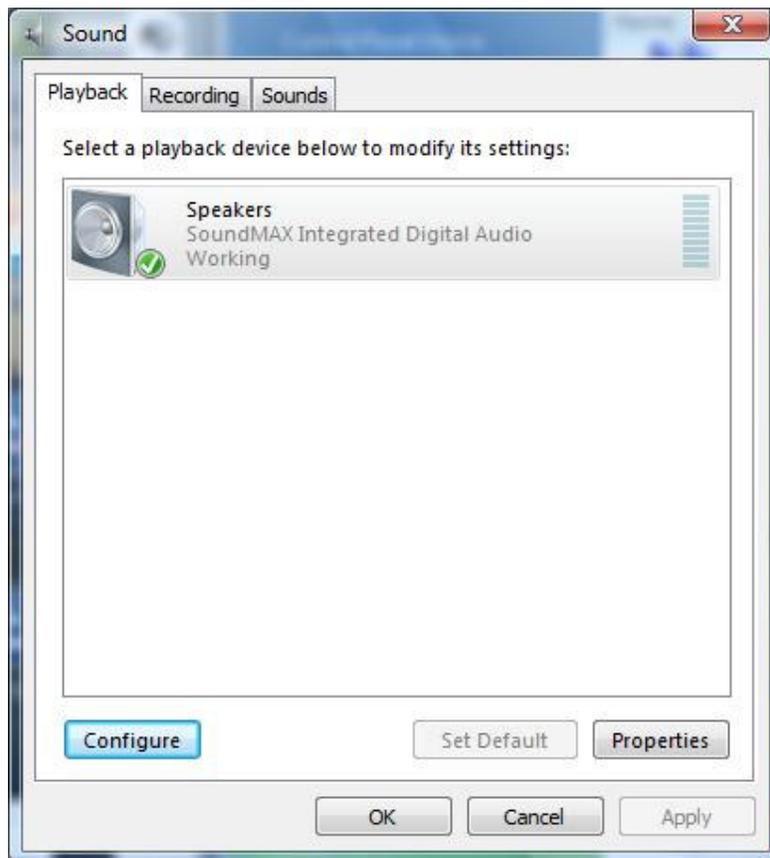
The image shows a software interface for configuring speaker parameters. It is divided into several sections: Display, Freq. Scale, Method, and Inputs. Red arrows point from descriptive labels on the left to specific controls in the interface.

- Display:** Contains four checked checkboxes: Normal Impedance, Normal Model, Second Impedance, and Second Model. Labels on the left point to these: "Display impedance curve" (Normal Impedance), "Display impedance fit curve" (Normal Model), "Display 2nd impedance curve" (Second Impedance), and "Display 2nd impedance fit curve" (Second Model).
- Freq. Scale:** A section with a "Range 0 -" label and a text input field containing "50" followed by "Ohms". A label "Vertical frequency scale" points to this section.
- Method:** A section with three radio button options: "Fixed Mass" (selected), "Added Mass", and "Added Volume". A label "Thiele/Small parameter methods" points to this section.
- Inputs:** A section with several input fields and checkboxes:
  - Re:** Text input field with "3.2" and "Ohms" label. Label: "DCR".
  - Lock Re:** Checked checkbox. Label: "Fixed DCR".
  - Cable:** Text input field with "0" and "Ohms" label. Label: "Cable resistance".
  - Diameter:** Text input field with "17" and "Cms" label. Label: "Effective cone diameter (1/2sur to 1/2sur)".
  - Sd:** Text input field with "226.98" and "Cms^2" label. Label: "Effective cone area".
  - Fixed Mass:** Text input field with "80" and "g" label. Label: "Fixed mass input (Fixed mass mode)".
  - Air Load:** Text input field with "1.93" and "g" label. Label: "Calculated air mass".
  - Total (Mms):** Text input field with "81.93" and "g" label. Label: "Total moving mass".
  - Max Fit Freq.:** Text input field with "10000" and "Hz" label. Label: "Max frequency of impedance fit curve".
  - Min Fit Freq.:** Text input field with "20" and "Hz" label. Label: "Min frequency of impedance fit curve".
  - Buttons:** "Calculate" and "Reset" buttons. A label "Calculate TS parameters" points to the "Calculate" button. A label "Reset TS parameter model" points to the "Reset" button.

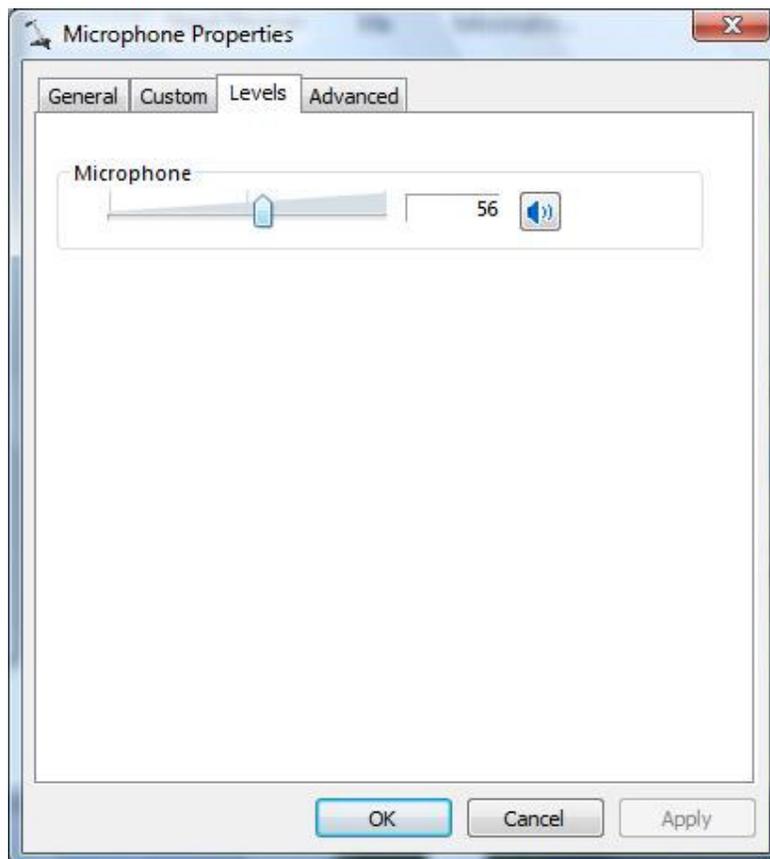
# Windows Sound Settings



**Figure 11 – Windows Vista Sound Input**



**Figure 12 – Windows Vista Sound Output**



**Figure 13 – Windows Vista Microphone Level**