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1 General

1.1 Startup tips

1.1.1 What are the PC requirements?

If WinMLS is to be used for post-processing measurements, at least a 400 MHz PC with 64 Mb RAM is recommended. This is because a slower PC will give a slower performance on plotting large amounts of data and for computing room acoustics parameters. However, the speed of the plotting can effectively be increased, see the chapter How to speed up the plotting.

1.1.2 What is the easiest way of performing a measurement?

This is done by first loading a setup that contains the wanted settings (see the chapter below for more details).

Start the measurement by clicking on the  button (or from **Measurement->Start Measurement**). If you want to cancel the measurement before it is finished, click the red stop sign (alternatively **Esc** or **Measurement->Cancel Measurement**).
You can test the output level from **Measurement->Test Current Levels**.

1.1.3 What is a setup and how to use it?

All the settings in WinMLS are saved in setups. There are two setups, one for measurement settings and one for post-processing settings (e.g. plot settings, such as x-axis type). Some setups have been made for you, but you can modify these and save your own setups.

Setups can be loaded and saved from the **Setups Toolbar** (can be turned on/off from the **View** menu). Note that the icon to the right of the setup name turns red if a setting has been changed. The changes can be saved by clicking on the icon that turned red.
When you load a measurement setup, the post-processing setup associated with this setup will be loaded.
It is also a link toggle. If this is turned on, you will always save the post-proc. setup whenever the measurement setup is saved.

Measurement setups can also be loaded and saved under **Measurement-> Measurement Setup.** Post-processing setup can be loaded and saved under **Plot-> Post-processing Setup**.

1.2 Standard Windows

The software has a standard windows interface and is written in Visual C++.

1.2.1 What does "**->**" mean?

The symbol -> is used for menus, e.g. **File->Insert in Active Group...**, means that you are to select the item **Insert in Active Group...** under the **File** menu.

1.2.2 What is a "toolbar" and how to use it?

WinMLS makes extensive use of toolbars. A toolbar can be made visible and used all of the time in contrast to a standard dialog box. It is useful for checking settings and allows a fast change of the settings (no dialog box needs to be opened). All the settings in the toolbars can also be done from a standard dialog box (except for the Measurement settings toolbar), so the purpose of the toolbars is to increase the user friendliness. A toolbar can be placed anywhere on the screen, but if it is desired to use as much as possible of the screen to display the graph(s) then the toolbar can be removed. The toolbars are turned on/off from the **View** menu. From the **View** menu you see all available toolbars. Note that the toolbar on/off status and position is saved in the post-processing setup.

1.2.3 How to get a quick explanation of the buttons and menus?

Place the mouse pointer on top of the button/list box or menu item you want to be explained. The explanation text will appear in the status bar at the bottom. For the toolbars, a short version of the explanation will appear as a tooltip just beside the mouse pointer.

1.3 Important Terms

These terms are important for the understanding and usage of this FAQ and WinMLS.

1.3.1 What is a **measurement group**?

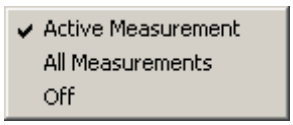
This is what we call the document or window in WinMLS. A window can contain several measurements that can e.g. be plotted on top of each other. To add measurements to the window, either use **File->Insert in Active Group…** or perform a measurement.
It is possible to have more than one window open in WinMLS. **File->New Group** opens an empty new window. **File->Open...** will open a measurement in a new window, and not in the current window. A common beginner mistake is to insert a measurement using **File->Open …** instead of using **File->Insert in Active Group…**.

1.3.2 What is an **active measurement**?

You can have several measurements in a window (called measurement group as described above). One of these measurements is called the active measurement. When performing or inserting a new measurement, this will become the active measurement.
The active measurement is used in several ways

- **File->Save Active Measurement As.…** will save the active measurement

- **Measurement->Measurement Information...** will display information about the active measurement.
- If auto-refresh is enabled in "active measurement" mode (**Plot->Auto Refresh** is set as shown in the figure below,



  the curve belonging to the active measurement will be refreshed when changes in the plot settings are made.

1.3.3 What is an **Active plot**?

WinMLS can display one plot or two plots in a window. If only one plot is displayed, this is always the active one. If two plots are displayed, you can click on one of the plots to set as active. A thin frame is drawn around the active plot.

1.3.4 What is channel 1 and channel 2 on the sound card?

WinMLS sometimes refers to channel 1 and channel 2 on the sound card. Channel 1 is the same as the *left* channel and channel 2 is the same as the *right* channel.

1.3.5 What is a transducer?

A transducer is a device for transforming a quantity to another quantity. An example is a microphone, which transforms sound pressure to voltage. Another example is a loudspeaker that transforms a voltage to sound pressure.

1.3.6 What is a sound card?

General term for hardware (A/D-D/A) used for performing the measurements. Sound cards can be built-in (they are not on a separate "card") and USB. Calling a USB sound device or a built-in sound device for a *sound card* does not make much sense, but it is common practice so we will still use this term for all sound devices.

1.3.7 What is an impulse response?

When measuring a single input-single output linear system, such as a loudspeaker, the impulse response is defined as the output signal resulting from a short pulse input signal. The input signal pulse should theoretically be infinite short, this is called a Dirac pulse.
The impulse response completely describes a linear system, it is quite intuitive (e.g. a hand-clap in a room will give the impulse response of the room), and the phase and magnitude frequency response can be calculated from the impulse response. Because of this and because a MLS measurement gives the impulse response as the result, the data from a MLS measurement is saved in time domain as an impulse response.

1.3.8 What is MLS?

MLS stands for Maximum Length Sequence. When the MLS measurement method was first introduced, the maximum length sequence was generated using shift registers. By connecting the shift registers in a special way it was found that a Maximum Length Sequence could be generated. This was the longest sequence that could be made before it repeated itself. If the number of shift registers is N the length of the sequence is 2^N - 1. The MLS signal can be used to measure any type of LTI (Linear Time Invariant) system, therefore nowadays Maximum Length Sequence measurements are used in different fields in addition to acoustics.

The MLS method gives the impulse response of the measured system using cross-correlation between input and output signals. The impulse response can be easily windowed in the time domain. Using windowing, reflections (e.g. from the walls of the a room) may easily be removed from the frequency response. Using this feature it is possible to simulate the frequency response of a loudspeaker measured in an anechoic room.

The number of averages determines how many times the MLS is repeated during the measurement. The reason for averaging is that it will decrease uncorrelated noise and thus increase the quality of the measurements. For each time the number of averages is doubled, the signal-to-noise ratio is theoretically increased with 3 dB. Note that the total measurement time increases when the number of averages increases. Be also aware of that if the system you are measuring is somewhat time-variant, a long measurement time is not good. An example of a time-variant system is a concert hall where people are running around. Try to avoid measuring during such situations. For room acoustical measurements, a measurement time of more that 60 seconds is seldom necessary.

Electrical or mechanical systems are usually very little time-invariant, so the long measurement times are seldom a problem.

The MLS technique has many advantages when compared with other methods of measuring the response of a system. The MLS has a flat spectrum (contains equal amount of all frequencies. The DC component is rejected and may not be measured. The signal-to-noise ratio of a MLS measurement is high and may be increased by increasing the total measurement interval. The measured distortion of the system is spread throughout the computed impulse response as spurious peaks. Every MLS sequence has his own characteristic distortion pattern. Measuring the same system with different sequences may be used to detect the distortion.

1.3.9 What is a transfer function?

When measuring a single input-single output linear system, such as a loudspeaker, the transfer function is the FFT of the impulse response (do not take this as a definition, more an indication).

1.4 Shortcut keys

Some shortcut keys are supported. Requests for new shortcuts are welcomed.

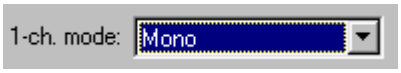
Ctrl+"G"	**Measurement->Start Measurement**
ESCAPE	**Measurement->Cancel Measurement**
Ctrl+"T"	**Measurement->Test Current Levels**
Ctrl+"F"	**Measurement->General Frequency Domain Settings…**
Ctrl+"W"	**Time data window settings for active measurement**
F5	**Display the settings for the active plot type**
Ctrl+"A"	**File->Save Active Plot As…**
Ctrl+"I"	**File->Insert in Active Group...**
Ctrl+"N"	**File->New Group**
Ctrl+"O"	**File->Open...**
Ctrl+"P"	**File->Print Active Plot**
Ctrl+"S"	**File->Save Active Measurement As…**
Ctrl+"L"	**View->Volume and Input Level(s) Dialog**
Ctrl+INSERT	**Edit->Copy to clipboard…**
Ctrl+"C"	**Edit->Copy to clipboard…**
Ctrl+"M"	**File->Save Active Measurement->As Meas Sys Corr File…**
Ctrl+Alt+"C"	**File->Save Active Measurement->With Filename <_ActiveMeas_>…**

2 Troubleshooting

2.1 An error message is given when trying to perform a measurement, why?

2.1.1 The sound card does not support stereo full duplex

If you have a mono full duplex sound card (this is the case for some older sound cards, but very unlikely if your sound card is new), then go to **Measurement->Sound Card Settings** and make sure **1-ch mode** is set according to the figure below:



2.2 My measurements look too good, why?

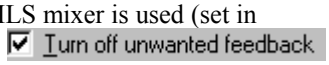
This may be because somehow the output signal may be directly connected to the input (the sound card may be defective or badly constructed). This has been reported for an early version of SoundBlaster 128, SB128PCT (CT4700). However, the SB128 PCI (CT4810) has been reported to not have this problem.

2.3 When changing the preferred sound device in windows multimedia properties, WinMLS does not work properly, how to fix this?

WinMLS uses a device number for identifying the sound devices. When changing the preferred device in multimedia settings this number will change, this will affect the WinMLS device settings. Therefore, make sure

to first set the preferred device in multimedia settings. Then to go to **Measurement->Sound Card Settings** and make sure the correct input device and output device is chosen.

2.4 There is feedback during the measurement, how can it be turned off?

You may experience feedback when connecting speakers and microphones to your sound card. This is because the sound card may patch the signal present on the input to the output. If the WinMLS mixer is used (set in **Measurement-> Sound Card Settings…**), this should be avoided by making sure 

is checked under **Advanced Settings** in **Measurement->Sound Card Settings…**.
If the WinMLS mixer is not used, the feedback is not just annoying but can affect the measurements as well, Feedback is detected as false echoes in the impulse response and as comb filtering in the frequency response. The unwanted feedback can be turned off using the Windows sound card mixer. The setting in the Windows sound card mixer that gives the feedback has different names depending on the sound card. If you mute all inputs and outputs that you are not using for the measurement signals the feedback should be damped. See the chapter **If your Sound Card does not support the WinMLS Mixer** in the **WinMLS2000 User's Guide** for more information.

2.5 Why does a small change the in volume settings in the WinMLS give no effect?

If the WinMLS mixer is calibrated (see **Measurement->Hardware Calibration...**), a change in the volume setting will give effect since the calibration procedure has detected the level steps. However, if the mixer is not calibrated, the sound card level steps have not been detected, and slight changes in volume may not be supported. There should be at least 16 different levels and maximally 65535 levels of volume to choose from.

3 Plotting and post-processing

3.1 Plotting – general information

Some general plot-settings are found on the standard toolbar to the right of the red stop sign. Important settings are found on **Plot Toolbar** (initially situated at the bottom). From the **Plot Toolbar** you can do all kinds of zooming, choose plot type, choose number of plots to be displayed (1 or 2) and open the settings dialog box for the active plot type.

3.1.1 How to plot a measurement?

If a measurement is performed, inserted or opened, it will be plotted automatically if the check box **Perform plotting** is turned on in **Measurement->Measurement Tasks...**.

3.1.2 How to display two plots simultaneously, e.g. the upper plot displaying frequency response and the lower phase response?

You can choose to have one or two plots in a window from the **Plot->Select Plot Type(s) /Measurement(s)...**, or use the  button on the **Plot Toolbar**.

3.1.3 What does **active plot** mean and how is it set?

See What is an **Active plot?**

3.1.4 How to set the plot type (to e.g. phase response) and determine what measurement is to be plotted?

All this can be done from the **Plot Toolbar** and the **Measurement Selection Toolbar**: The type of plot is determined from the list box list in the plot toolbar (**View->Plot Toolbar**). The "active" measurement is set from the list box in the measurement selection toolbar (**View->Measurement Selection Toolbar**).

If you do not wish to use the toolbars, from **Plot->Select Plot Type(s)/Measurement(s)....** you can select the type of plot and the measurement you wish to plot assuming that the measurement has been inserted into the active window (This can be done from **File->Insert in Active Group...**). Changes in this dialog box will immediately apply to the active plot even though **Plot->Auto Refresh** is set in **Off** position.

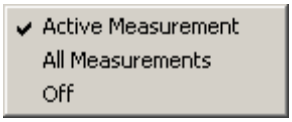
3.1.5 How to access the settings for the plot type?

If two plots are displayed, first set the plot you want to access the settings for as active by clicking in it. Then type the **F5**-key or click the rightmost button on the **Plot Toolbar** or simply double click in the plot. The settings can also be accessed from the menu; **Plot->Plot Type Settings**. A dialog box will appear displaying the settings for the plot type. *All* settings (except layout settings) will be available from this dialog box. Note that the button

displays the settings for all the frequency domain plot types. If a setting in this dialog box is changed, it will thus affect all the frequency domain plot types in the active window.

3.1.6 If a setting is changed for the displayed plot-type, how are the curves belonging to the plot updated?

This is done automatically, the choices are as shown below:



- If **Plot->Auto Refresh->Active Measurement** is selected, the curve belonging to the active measurement will be updated automatically if any changes in settings are being made.
- If **Plot->Auto Refresh->All Measurements** is selected, all curves are updated automatically if any changes in settings are being made (see comment below).
- If **Plot->Auto Refresh->Off** is selected, no curves will be updated. Auto-refresh can also be turned off with the  button.

Refresh can also be done manually using:

- **Plot->Refresh** - refreshes the curve belonging to the active measurement
- **Plot->Refresh All** or  refreshes the curve belonging to the active measurement (see comment below).

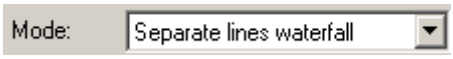
Note that **Plot-Refresh All** and **Plot->Auto Refresh->All Measurements** will refresh only the most recent curve of each measurement in the active plot. This means that if you have plotted several curves from the same measurement, these will not be refreshed.

3.1.7 How to change y-axis scaling?

The y-axis scaling can be changed, e.g. from **Linear** to **dB** of plot type **Time Data (Impulse Response)**.
If two plots are displayed, make the plot you want to change the scaling of active by clicking in it. Then click  (or **F5**) to open the active plot type settings. Then at the upper part of the dialog change the content of the **Y-Axis** list box. 

3.1.8 If waterfall is plotted, how to read the waterfall slice values using the cursor?

This is only supported if the waterfall layout mode is **Separate lines waterfall** as shown below.



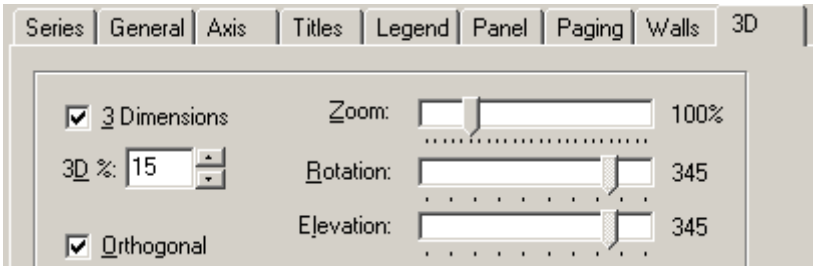
This is set from the waterfall plot type settings (found by double-clicking in the plot, by typing **F5**, or **Plot->Plot Type Settings->Waterfall…**).

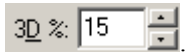
On the right part of the **Frequency Plots Toolbar**, the buttons  and  can be used to mover upwards and downwards and select the slice. The selected slice from which the values are read from is plotted in green.

3.1.9 If there are many lines in the waterfall plot, how to space the lines less close together?

The lines can be spaced too far apart if there are many lines in the plot. If the waterfall layout mode is **Separate lines waterfall** this can be the case; the z-axis may disappear into the distance and the plot gets very flat in the y-axis.

This can be solved from **Plot->Chart Settings for Active Plot...**, select the **3D** tag as shown below.



One method is to change the z-axis density, this is done in 

.

Another method is to turn off 

and change the **Rotation** and **Elevation** values.

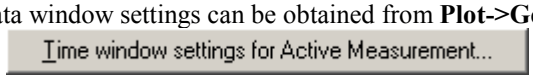
Selecting another layout mode can also solve this problem. In **Plot->Plot Type Settings->Waterfall** select **Waterfall** or **Surface** in the layout mode list box.

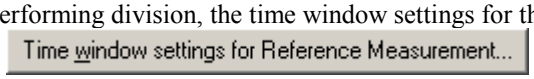
3.1.10 When plotting waterfall, how to select the start point?

The start point is set by start of the time data window. See below on how to set this.

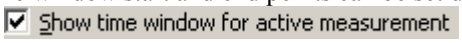
3.1.11 How to set the time data window when plotting in frequency domain? (determine part of the time data to be used when transforming to the frequency domain)?

The time data window determines the part of the time data to be used when transforming from time domain to the frequency domain. Three ways of setting the time window this will here be described.

- The time data window settings can be obtained from **Plot->General Frequency Domain Settings…**, click on the 

button found in the upper left part of the dialog box.
If you are performing division, the time window settings for the reference measurement are obtained by clicking the 

button found in the lower left part of the dialog box. If you need faster access to these settings, they are found clicking  and  on the **Frequency Plots** toolbar (**View->Frequency Plots Toolbar**).

- If the **Time Data** Plot type is displayed, the window start and end points can be set directly by clicking and dragging with the mouse. To do this, 

must be checked in the time data plot type settings (**Plot->Plot Type Settings->Time Data…**). Some might find it difficult to do this since the mouse pointer has to be exactly on top of the vertical line that is to be moved. If you find it difficult to use the mouse for doing this, the fast method explained below may be useful.
- Another way of setting the window directly is by using the **Time Window** toolbar (**View->Time Window Toolbar**). If a change is made and auto-refresh is on, the plot will be automatically updated with the new settings. After typing a value, click **Enter** to validate.

3.1.12 How to speed up the plotting?

If fast plotting is required, first make sure you are using **Fast Line** as line type. This can be set at the bottom of **Plot->Advanced Plot Settings...**, in the **Curve type** list box.

Note that these settings apply for the active plot type only.
The plotting speed can be additionally improved using two methods. The first method has no side effects and has a great effect on the speed; it is simply to set the curve width to size 1. If it is not set to width 1, the plotting is much slower. Set the width in **Plot->Default Curve Styles...**, this will apply to all plot types. Make sure that all the curves in the dialog box have width 1. Also at the bottom of the dialog box, make sure that **Display active curve with width** is set to 1.

The other method gives very efficient plotting for large amounts of data, e.g. for large ***.wav**-files. From **Plot->Advanced Plot Settings…** check ☐ Plot only each . If this setting is on, the points in between the points plotted are simply skipped independent of what part of the curve is displayed. This will affect all the plot-types originally having more elements than the maximum limit. Please note that the skipped points will not appear when zooming in, therefore it is *not* recommended to use this option on a fast PC. The plotting range can also be limited by checking ☐ Plot points only in the range: .

3.1.13 Where are the cursor values (x,y) in the plot displayed?

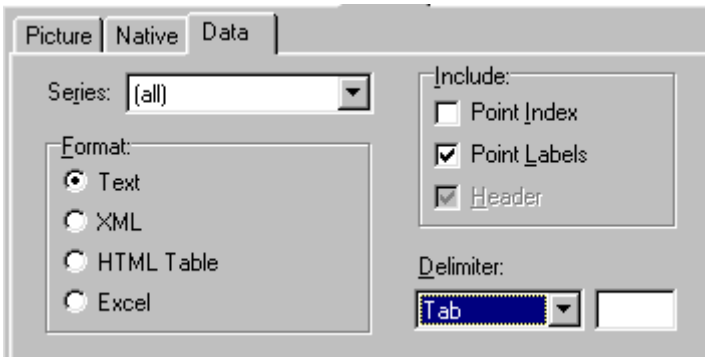
The position of the mouse pointer relative to the curve of the active measurement is written to the **Status Bar** (at the bottom right). Using this you can read out the values of the active measurement curve.
Note that if you have plotted several measurements it is the one belonging to the active measurement that is displayed.

3.1.14 Where is the wavelength displayed?

When a plot type has frequency as x-axis the wavelength is displayed in the status bar to the left of the x and y-values (see above).

3.1.15 How to save the data in the plot?

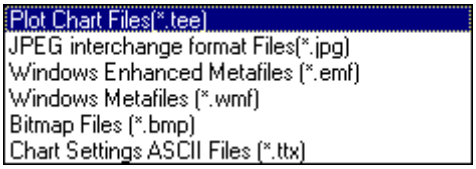
The data in the active plot can be exported to **.txt**-file in **File->Save Data in Active Plot As…**.
A method that gives access to advanced settings is found in **Plot->Chart Settings for Active Plot...**, click the **Export** tag, then click the **Data** tag. The dialog box will then show the settings below.



In the **Series** list, it can be chosen if all or just one series is to be exported.

3.1.16 How to save the plot as a picture?

The active plot is saved to a picture format in **File->Save Active Plot as…**. From this dialog box, several formats can be selected as shown below.



If the **.tee**-format is selected, the file can be opened by WinMLS later and changes can be made, but a disadvantage is that the size can get large if the plot consists of large amounts of data.

Ctrl+C or **Edit->Copy to Clipboard** will copy the active plot to clipboard.

A method that gives access to more advanced settings is found in **Plot->Chart Settings for Active Plot...**, click the **Export** tag. The dialog box will then show the settings below.

From the figure above, we see that it is possible to set the quality and size when saving as **.jpg**-file.

3.1.17 How to view and manipulate the data of the plotted curves?

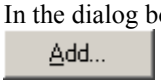
The plotted data can be viewed and manipulated from **Plot->Chart Settings for Active Plot...**, click on the **Data** tag. Note that you can increase the size of this dialog box, which is convenient you want to inspect curves with large amounts of data.

3.1.18 Why are plot toolbar axes limits not updated when a plot is zoomed or scrolled?

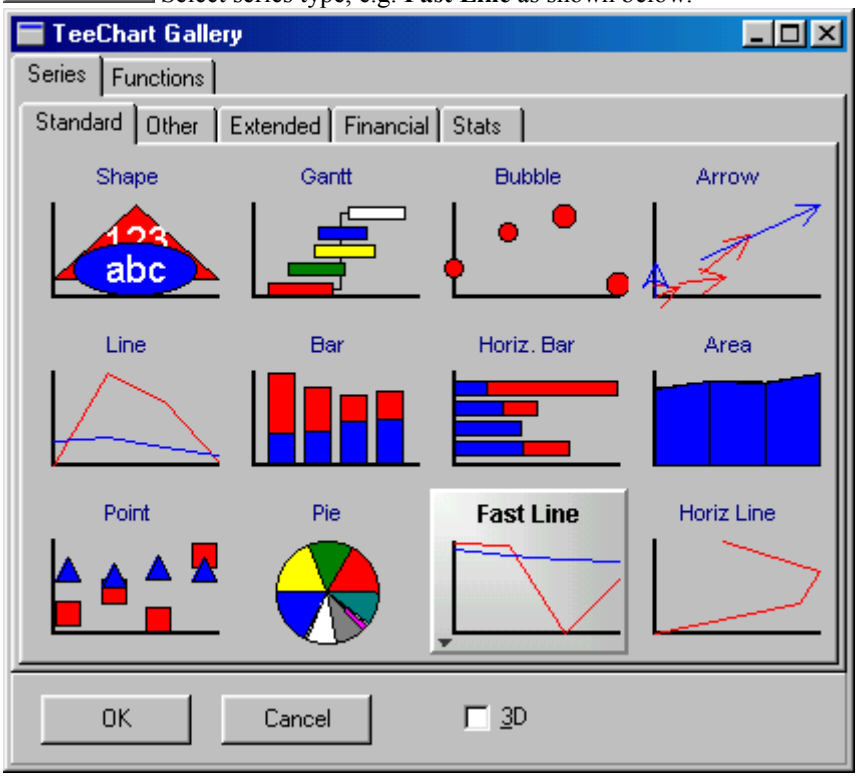
Normally the x- and y-axis limits will be updated when zooming or scrolling, but if you have two plots visible and are zooming/scrolling in the plot that is *not* active, then they will not be updated since they will display the values of the active plot.

3.1.19 How to make calculations, such as average and difference on plotted curves?

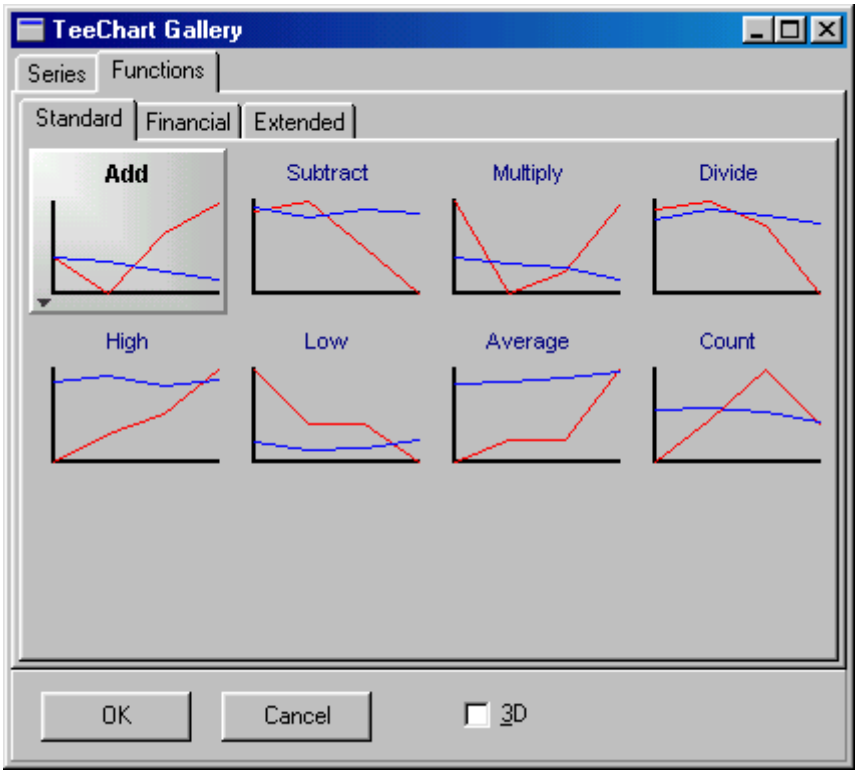
First plot all the curves you want to perform calculation on and go to **Plot-> Chart Settings for Active Plot...**. In the dialog box, you will see the list of the plotted curves/series. Generate a new curve/series by clicking



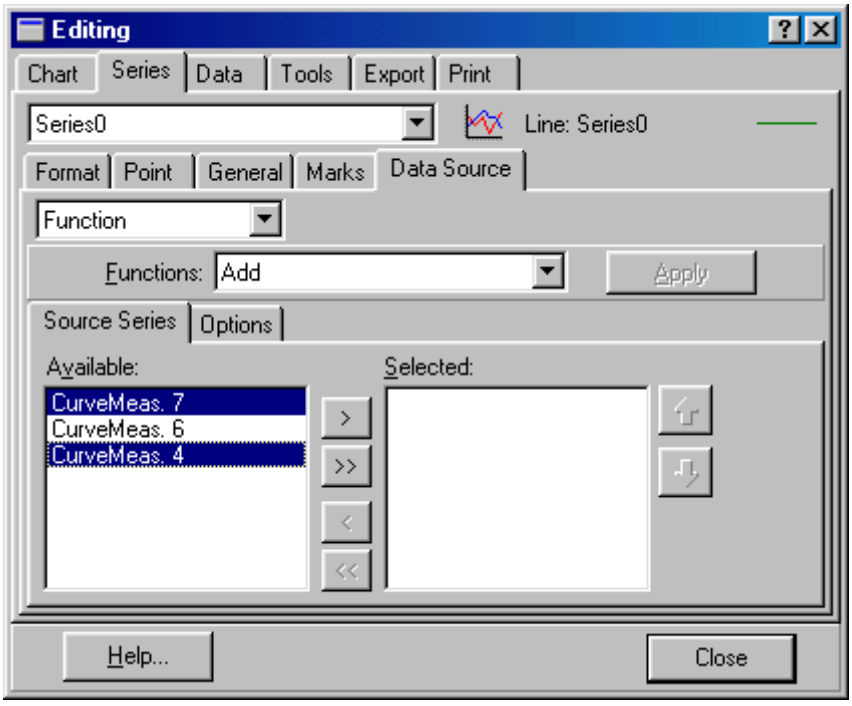
Select series type, e.g. **Fast Line** as shown below.



Click on the **Functions** tag in the upper part of the dialog box. You can select from three tags containing different mathematical functions, **Standard, Financial** and **Extended**.



Double-click on the type of mathematical function you want, e.g. **Add** (see above). You will then go to the series properties (see below).



In the **Source Series** part, mark the series you wish to do the computation on (in the figure above **CurveMeas. 7** and **CurveMeas. 4** have been marked).

Now use  to move them to the **Selected:** list. If you want to move all measurements, then use  .

When this is done, click  to exit the dialog box. You will now see the new series in the plot.

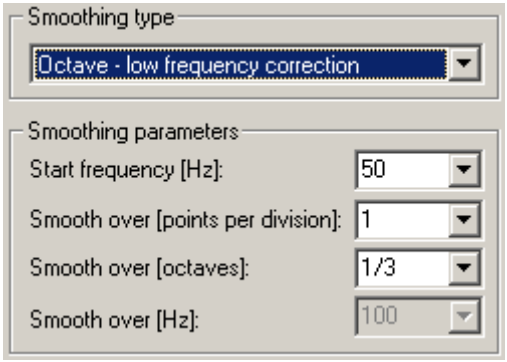
You can change the title of the new series by clicking  in **Plot->Chart Settings for Active Plot...**. How to save the data in the plot to a ***.txt**-file is also described in this FAQ.

3.1.20 How to plot a transfer function (e.g. room or loudspeaker measurement) in octave or third-octave bands?

The energy or power can be plotted in octave or third-octave bands if **Frequency response/Spectrum** is selected as plot type.

Click **F5** to display the plot settings dialog box. Make sure that **Use Smoothing (or integration)** is checked as shown in the figure below. Click on the **Settings…** button also shown in the figure below.

In the new dialog box, select smoothing type as shown below (it will plot 1/3-octaves starting from 50 Hz).



Click OK to exit the dialog boxes.

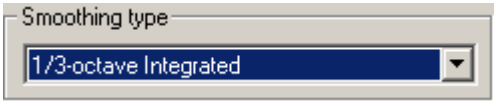
3.1.21 How to plot spectrum in octave or third-octave bands?

The easiest way is to load the setup called **QuasiRealTimeAnalyzer**. Below it is described more in detail how it can be done without loading the setup. This is not intended to be used for transfer function measurements, since it will give a 3 dB/octave bias because of the integration explained below.

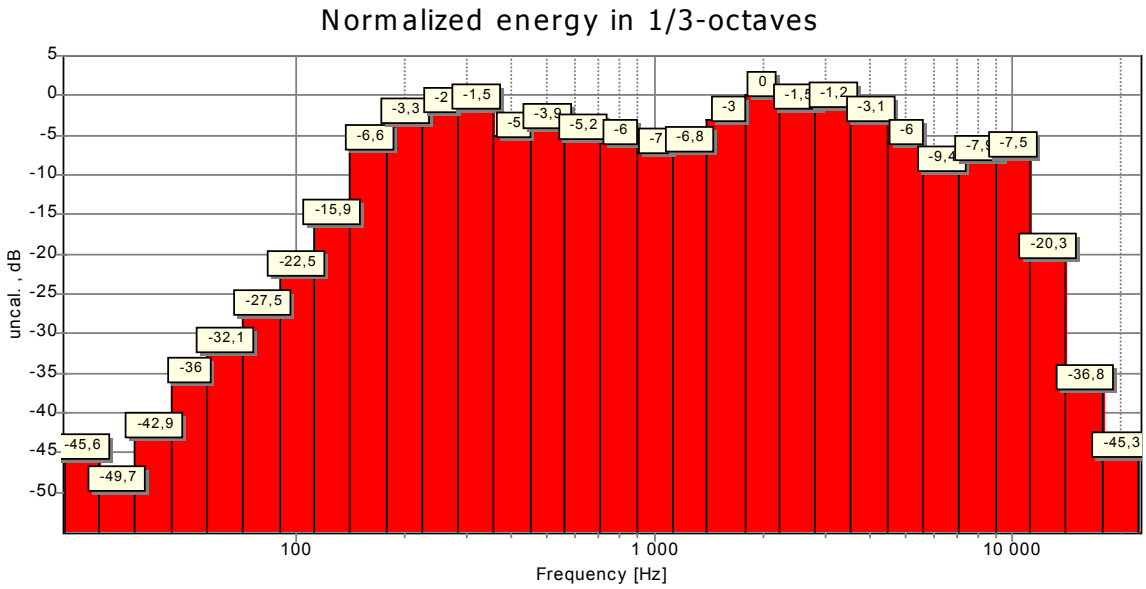
The energy or power can be plotted in octave or third-octave bands if **Frequency response/Spectrum** is selected as plot type. In **Plot->General Frequency Domain Settings...** select the scope mode to one of the below.

Click **F5** to display the plot settings dialog box. Make sure that **Use Smoothing (or integration)** is checked as shown in the figure below. Click on the **Settings…** button also shown in the figure below.

In the new dialog box, select smoothing type as shown below (or select the **1-octave Integrated** option).



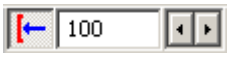
Click OK to exit the dialog boxes.
An example of 1/3 octave normalized energy is displayed in the figure below.



In this figure, we have used curve type **Histogram** to get the bars (can be set in the bottom of the **Plot->Advanced Plot Settings…** dialog box). For information about how to display the values for each point, read the chapter **How to change the curve style (color, type and width)?**

3.1.22 How to validate numbers typed in the **Plot Toolbar**?

If values are entered to this toolbar, they must be validated clicking **Enter** if the auto-zoom button is turned on as shown below.



3.2 Plot Chart Settings

The features below are found in **Plot->Chart Settings for Active Plot...** or from the  button on the standard toolbar. Note that in this dialog, the plotted curves are called *series* and the plot settings are called *chart* settings. When there are two plots visible, we have two plots, and one chart setting for each of them. The chart has many possibilities, far from all are covered here. But when first starting to use it, it should be quite intuitive to explore the possibilities.

3.2.1 How to change the curve type?

When installing WinMLS, the default curve type is set in **Plot->Plot Options…** as shown in the figure below.

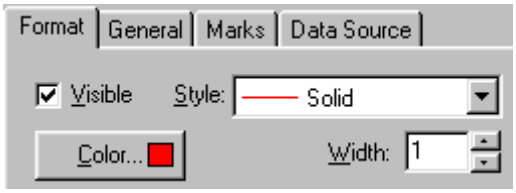
To change the curve type without changing the default curve type, in **Plot->Chart Settings for Active Plot...**, click on  to. For an explanation see the documentation under **Plot->Plot Options…**.

3.2.2 How to change the curve style (color, type and width)?

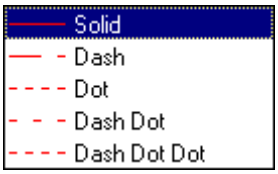
The defaults curve style can be changed in **Plot->Default Curve Styles…**. The changes will apply when plotting a new measurement. To update the current curves, select **Plot->Refresh All**.
If you want to keep the default curve styles but just want to change the curve styles in the current plot, then it can be changed directly from **Plot->Chart Settings for Active Plot...**.
If you want to change the color only, click on the curve to the left of the series title, the red horizontal line shown in the figure below.

(You can do the same thing from the List of Curves toolbar, **View->List of Curves Toolbar**).

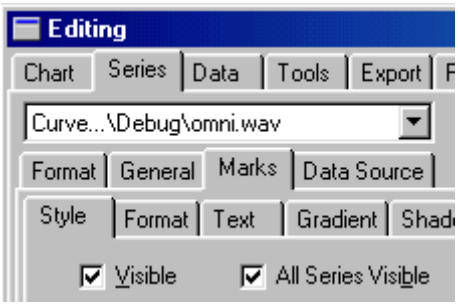
If you want to display the style settings, double-click on the curve title (**CurveMeas. 1** shown in the figure above). If the curve type is **FastLine**, the settings shown below will be displayed.



From the Style list the options shown in the figure below can be selected. These are especially useful if plotting several lines and colors are not allowed. Note that if the curve width is larger than 1, the style can only be solid.



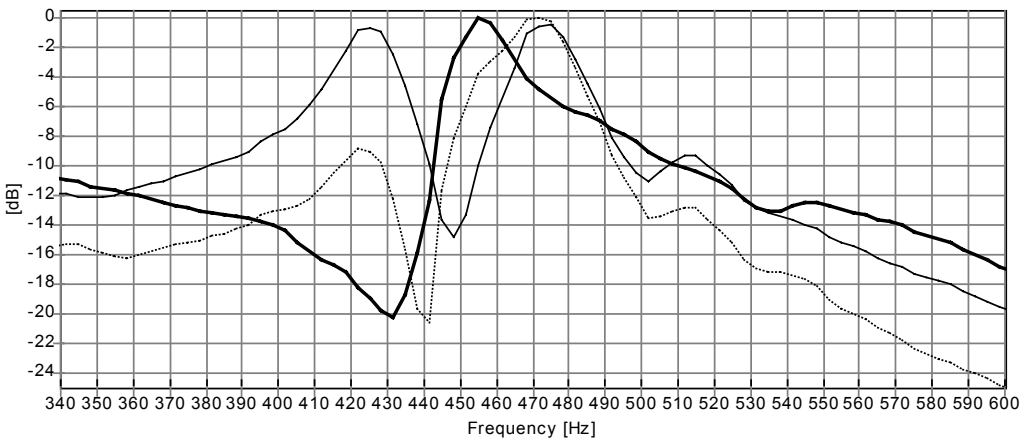
To display the value for each point, **marks** must be set to visible. This is set from **Plot-> Chart Settings for Active Plot...** as shown in the figure below. First select the series, then the **Marks** tab. In the **Style** tab, make sure **Visible** is checked.



3.2.3 How to plot figures in black and white only (e.g. for publishing)?

Sometimes figures in color are not accepted, e.g. for publishing articles in journals. If this is the case, it is recommended to load the post-processing setup file named **BlackNWhite** (found on the **Setups Toolbar**). This setup will make sure that the background is white and the plotted curves are in black. If several curves are plotted, some curves are plotted dashed and dotted. The defaults for this are set in **Plot->Default Curve Styles…**.

If you are to change the curve style, please see How to change the curve style (color, type and width)?. An example of a plot in black and white made using WinMLS is shown below.



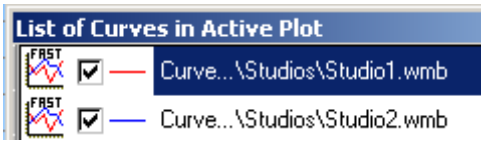
The plot can be saved from **File->Save Active Plot As…**. If saved in the **.tee**-format, it can be opened again using WinMLS, this is useful if formatting adjustments are to be made later.

3.2.4 How to change the order of curves?

From **Plot-> Chart Settings for Active Plot...**, the order can be changed by clicking and dragging. Note that the curve at the *end* of the list is the *upper* curve displayed in the plot. You can also change the order from the **List of Curves Toolbar** (**View->List of Curves Toolbar**).

3.2.5 How can I delete a single curve?

From **Plot->Chart Settings for Active Plot...**, click on the curve(s) to be deleted and click the delete button or delete key.
You can also do it from the **List of Curves Toolbar** (**View->List of Curves Toolbar**) as shown below.



Mark the curve(s) you want to delete by clicking on the curve name(s). Use **Shift** or **Ctrl** if you want to mark several curves. Then use the **Delete** key to delete the marked curves.

3.2.6 How to choose between plotting several curves and a single curve?

If **Plot->Hold plotted curves** is turned on, the new curve plotted will be added to the existing curves. If it is turned off, the existing curves will be deleted when a new curve is plotted.
Plot->Hold plotted curves is also available on the standard toolbar as the  button.

3.2.7 How to display one single curve as **Solo**?

When there are several curves in the plot, it is sometimes useful to display only one of the curves temporarily without deleting the others. This can be done with the 

button on the toolbar, or from **Plot->Solo Active Measurement**.

When **Solo** is on, only the active curve is active and displayed and the other curves will not be visible in the plot, only in the legend. If **Solo** is turned off, all curves that were displayed when **Solo** was turned on will be displayed again.

3.2.8 When printing a plot, why is the plot squeezed to the left corner?

This is probably because the legend is displayed. The legend may be turned off using the  toggle on the **Standard Toolbar**. The legend may also be moved inside the plot, see below on how to do this.

3.2.9 How to add legend, displaying a list of the curves that are in the plot?

Turning on the  toggle on the **Standard Toolbar** adds legend. If you want to set the legend formatting or position, the legend settings are found in **Plot->Chart Settings for Active Plot...**, select the **Legend** tag. Note that a check box for determining if the curve is to be displayed in the plot, or not, can be added or removed from the legend. See below for more information about this.

3.2.10 How to “turn off” a single curve from the plot without deleting it?

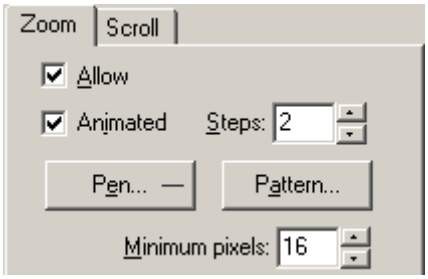
When there are several curves in the plot, it is sometimes useful to temporarily set one of the curves inactive without deleting it. WinMLS offers several ways of doing this:
In **Plot->Chart Settings for Active Plot...** all the available curves are displayed, they are shown in the plot only if the check box is checked. The list is displayed in the **List of curves Toolbar** (**View->List of Curves Toolbar**).
It can also be done very efficiently by turning on the legend button on the standard toolbar. The legend settings are found from **Plot->Chart Settings for Active Plot...**, select the **Legend** tag. Then turn on the check box named **Check boxes**.

3.2.11 How to zoom the plot using the mouse?

If the mouse zooming is turned on (see below) this can be done. To zoom *in*, drag a rectangle from *upper left* to *lower right*. Note that this is the *only* way to zoom in if using the mouse. If you drag a rectangle any other way this does zooming *out*.
Zooming can also be done very efficiently by the **Plot Toolbar**. Note that in certain cases, if the plot is to be zoomed out, the mouse zooming will not zoom enough. Then click on the **Autoscale all** button on the **Plot Toolbar** (**View->Plot Toolbar**).

3.2.12 How to access zoom options, e.g. to turn the mouse zooming on/off ?

From **Plot->Chart Settings for Active Plot...**, select the **General** tag, then select the **Zoom** tag as shown below.



The mouse zooming can be set from the **Allow** check box. Note that the "animated" setting will do the zooming in steps; this is a nice visual effect, but is not recommended on a slow PC. The **Minimum pixels** edit box determines the minimum size of the rectangle drawn by the mouse to obtain zooming (if the rectangle is smaller, no zooming will be performed). The **Pen** and **Pattern** buttons can be used to display the zoom rectangle area in different ways.

3.2.13 How to scroll the plot using the mouse?

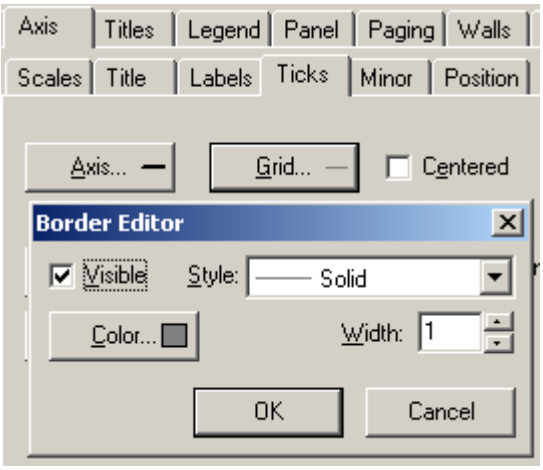
Clicking on the right mouse button and drag will do scrolling if scrolling is enabled.

The type of scrolling (on/off/vertical/horizontal) can be set. Under **Plot->Chart Settings for Active Plot...**, select the **General** tag, then select the **Scroll** tag, then mouse zooming can be set from the **Allow Scroll** radio buttons.

3.2.14 How to turn on and modify gridlines

Gridlines can be turned on/off from a button on the standard toolbar. Note that when the **Plot->Chart Settings for Active Plot...** dialog is opened, the current gridlines are displayed even if they are turned off. Note also that if the plot type is **Frequency response/Spectrum**, **Phase response/Function**, **Group delay, Waterfall** or **Levels** and if the x-axis is logarithmic, some of the gridline settings are not user changeable.

The gridline settings depend on the setup that is used. The gridlines can even be turned off in the setup. To turn on or modify the gridlines; in **Plot->Chart Settings for Active Plot...** select the **Axis** tag. Then select the axis from the list (**Left Axis** or **Bottom Axis**). Click on the **Ticks** tag. Finally click on the **Grid…** button and turn on the **Visible** check box.



Minor gridlines are available from the **Minor** tag, found at the right side of the **Ticks** tag.

3.2.15 The y-axis labels show only zeros, how to change this?

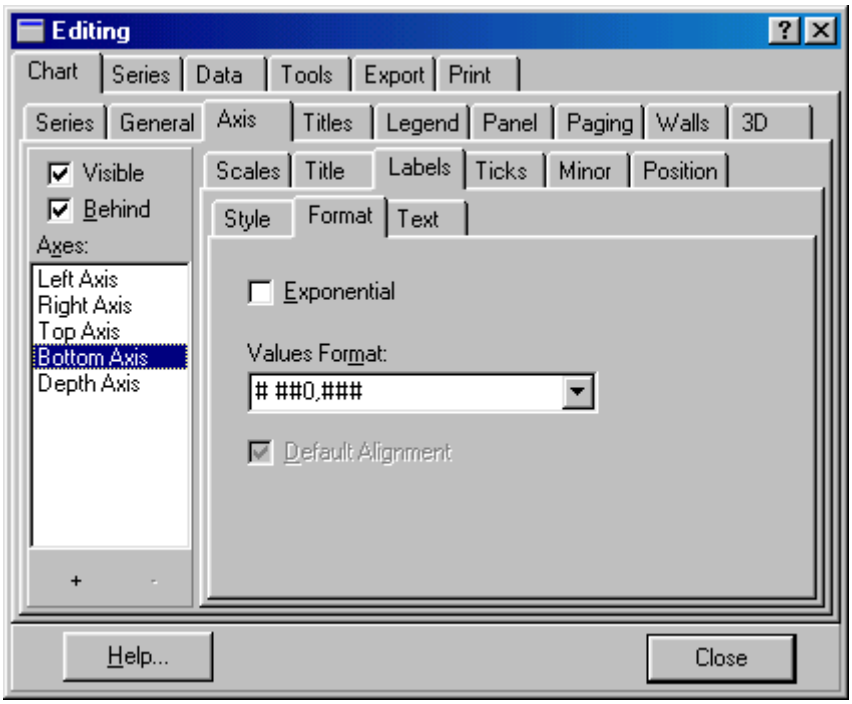
The axis labels resolution has to be set. See below on how to do this. You have to make sure to set it for the **Left Axis**. If you select the exponential format this problem should be solved.

3.2.16 How to set the axis labels format?

As examples on setting the format, we will first show how to set the axis labels resolution, then the labels increment.

3.2.16.1 How to set the axis labels resolution?

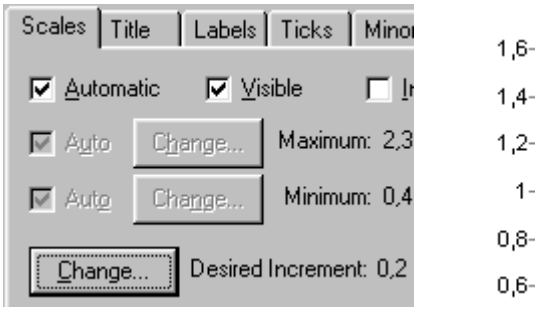
A problem can be that the resolution of axis value numbers (now 3 decimals) should be switched to an auto-function, because mostly 3 decimals is not necessary, sometimes it is too little. Using an exponential format can solve this. How the format is set will be shown.
From **Plot->Chart Settings for Active Plot...** click on the **Axis** tab. Select the desired axis, found on the list to the left, e.g. **Bottom Axis**. Then click on the **Labels** tab, and finally on the **Format** tab (see figure below).



The **Values Format:** list box has a list of used formats. You may also type your own format. To the left in the dialog box you see a list of the axes. Select the axis you want to change the format of ("left" is the y-axis and "bottom" is the x-axis).

3.2.17 How to set the axis labels increment?

This is useful if you for example want to plot the magnitude frequency response using axis labels with an increment of 5 dB/div for comparing with printouts from other measurement systems.
We will show how you can force WinMLS to label the selected axis using a specified increment. From **Plot->Chart Settings for Active Plot...**. click on the **Axis** tab. Select the axis you want to modify (**Left axis** or **Bottom Axis**) in the left corner of the dialog box. Then click on the **Scales** tab (see figure below). Click on the Change... button found at the bottom of the figure below. In the new dialog box, type the desired increment using *comma* as separator and click OK. If you type "0,2", the **Desired Increment** will be set to 0,2 as shown in the figure below.



Note that the selected increment will only be displayed if there is enough separation between the labels. This should not be a problem, but by clicking the **Labels** tab shown in the figure above the separation can be set in percentage:

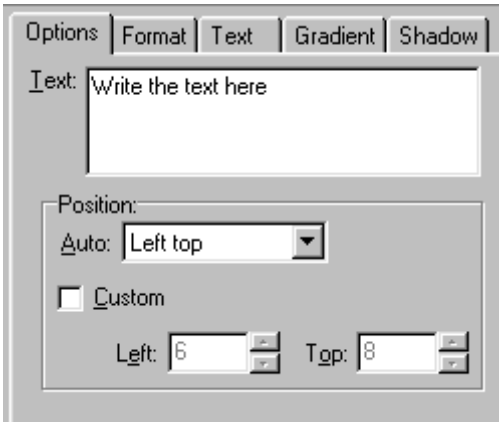
3.2.18 How to display the numerical values of the Magnitude Frequency Response Guidelines?

When **Frequency Response/Spectrum** is selected as the active plot type, it is possible to add guidelines. This can be done by clicking  to open the settings dialog. Then click on the guidelines Settings... button. From this dialog, the numerical values can be turned on/off using 

.
To display the numerical value of these lines can also be done in the legends:
In **Plot-> Chart Settings for Active Plot...**, click the **Legend** tab. In the **Legend Style** list box choose **Last Values**. This means that the last value of the series will be displayed in the legend. Since the guidelines are linear this is the value of the guideline. Turn the guideline on in the **Visible** check box at the upper left in the dialog box.

3.2.19 How to add a text box to the plot?

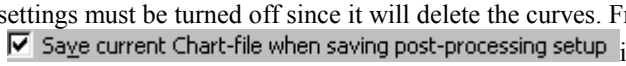
In **Plot->Chart Settings for Active Plot...**, click on the **Tools** tag. Then click on the **Add…** button. From the list select **Annotation** and click on the **Add** button. A text field as shown in the figure below will be displayed. Type the text in the field, and below the text field the position can be set.

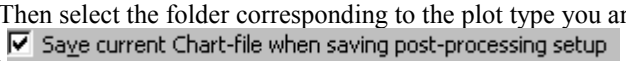


3.2.20 How to add a cursor (cross) that follows a curve?

In **Plot->Chart Settings for Active Plot...**, click on the **Tools** tag. Then click on the **Add…** button. From the list select **Cursor** and click on the **Add** button. From the **Series:** list box, select the curve you wish the cursor to follow. Turn on the **Snap** and **Follow mouse** check boxes. Click **Close** to exit the dialog box.
Note that if you selected the active measurement, the cursor values are displayed at the **Status Bar**.

3.2.21 How can curves in the plot remain so that they are there when the program is restarted or a new window is opened?

Do this if you want to start up the program with one or several reference curves present.
The automatic save of the Plot Settings settings must be turned off since it will delete the curves. From **Plot->Advanced Plot Settings…**, make sure 

is not checked. If the layout settings are saved manually from the **Save** or **Save As…** button in the same dialog box (**Plot->Advanced Plot Settings…**), the curves will be deleted. To avoid this happening, perform the saving to the *.tee-file from **File->Save Active Plot As…**. Find the folder where WinMLS is installed and select the folder named **Chart**. Then select the folder corresponding to the plot type you are currently using.
Note that when 

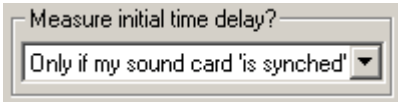
is not checked, temporary .tee-files are not saved. This means that the settings that belong to the Plot Settings will not be saved when the program is exited or on **File->New Group**.

4 Measurement

4.1 How to perform a 1-channel measurement (MLS) using WinMLS?

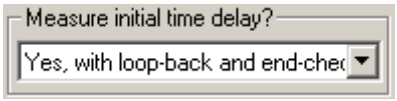
This is explained in the WinMLS2000 User's Guide, see the chapter 'The First Measurements". If you are in a hurry, a short description is given below.

This explains how a 1-channel measurement in loop-back mode can be performed with a loudspeaker and a microphone. (If you do not need to measure the distance between the microphone and loudspeaker, or if your sound card is synchronized, you do not need to measure in loop-back mode. Then you do not have to connect the output right channel to input in *right* channel, and make sure



is set in in **Measurement->Sound Card Settings**).

Measurement preparation:
Connect a speaker to output left channel. Connect a microphone to input left channel. Connect the output of right channel to input right channel. Make sure



is checked in **Measurement->Sound Card Settings**. The 'end-check' will notify you if gaps has occurred during the measurement an thus made the result wrong.

Measurement procedure:

Click the 

button in the standard toolbar. A synchronization signal is first sent through the right channel output. The synchronization signal is recorded and is used to find the correct initial time delay.
Then the MLS signal is played on left channel output, through the speaker. The signal is recorded at the left channel input where the microphone is connected.
After the measurement signal is finished playing in left channel, the synchronization signal is played once more on the right channel output. This synchronization signal is compared against the first synchronization signal and the time difference is computed. The purpose of this is to check that there has been no gaps in the playback or record. Gaps may occur if the PC was busy with other things during the measurement.
If no error has occurred, the system impulse response is found using cross correlation. The delay of the measurement system (pipeline delay in sigma-delta converters) is added in order to get the whole system response (the default is 40 samples, but this can easily be measured for the specific sound card by doing a loop-back measurement of the sound card).

It is possible to correct for the influence of the measurement system (sound card). This is done by first doing a loop-back measurement of the measurement system only. This measurement is then deconvolved with the actual measurements. Measuring the measurement system with system correction turned on will give a Dirac pulse (value 1 at the first sample and value ~0 at the other samples). This will give a flat magnitude and phase frequency response.
If this correction is *not* done, there will be an extra time delay usually of about 1 ms (40 samples or ~0.3 meter) because of the sound card delay.

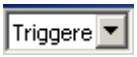
It is further possible to perform 2-channel measurements (measure two system responses in one measurement) using the same loop-back technique. This is covered in the WinMLS User's Guide.

4.2 How to check that my sound card measurement is correct?

Measurements of several sound cards/cards are found in the WinMLS sub folder Measurements/SoundCards. Plot your measurement and compare with one of these (use **File->Insert in Active Group...** to insert one or more of the sound card measurements).

4.3 How to perform a triggered measurement?

This instruction assumes that you have been using WinMLS, if not please read the start of the Measurement chapter.
On the **Measurement Selection Toolbar**, set the measurement mode to **Triggered, no excitation (scope)** as shown below



On the **Measurement Settings** toolbar, make sure that the number of averages is set to 1, as shown to the right in the figure below.

Set the sequence order to a length that corresponds to a larger length than the signal you are to record. If you use 16, as shown above, the measurement length is 1.365 sec.

In **Plot->General Frequency Domain Settings...** set scope mode to

Now make sure the input level is set high enough, but not overloaded. Do this by selecting **Measurement->Test Current Levels** and "play" the signal that is to be use for the measurement.

Finally, perform the measurement (**Measurement->Start Measurement**).
Note that it takes a while before the recording starts, at the left part of the **Status Bar** you will be notified when it is started.

4.4 How to calibrate the input of the measurement system?

The purpose of calibrating the input is to be able to measure absolute level (input level absolute calibration) and to obtain the true transfer function gain independent of the level of the WinMLS mixer input (relative calibration of mixer). The calibration can be done in different ways dependent on the features of the sound card (e.g if the sound card supports the WinMLS mixer or not) and the type of measurement you intend to perform. For some sound cards, e.g. VXPocket, a measurement setup file will be available with nominal calibration settings.

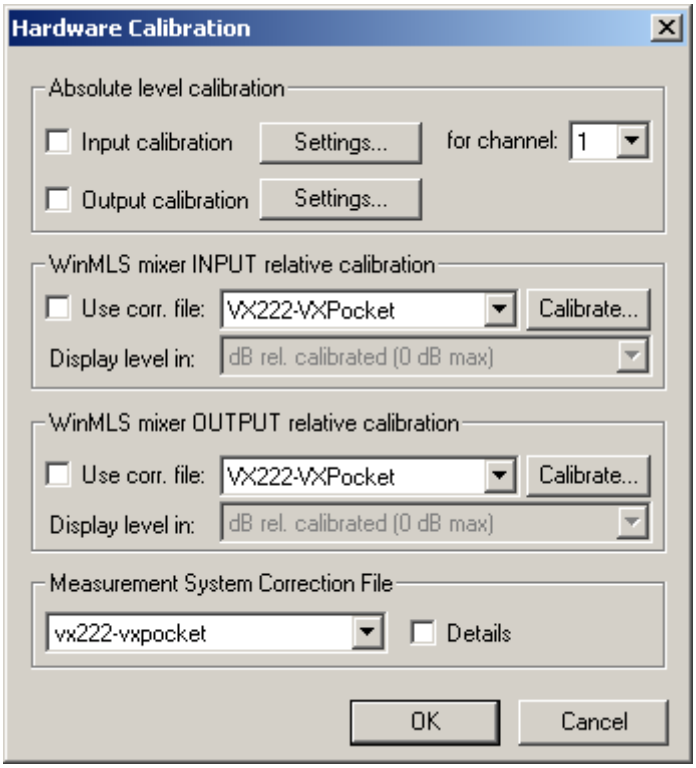
If the sound card input and output is calibrated, a MLS measurement should give an amplification of 0 dB for a loopback measurement (input directly connected to output). If also the mixer is relatively calibrated, this should be independent of mixer settings.

4.4.1 How to perform relative calibration of mixer input levels?

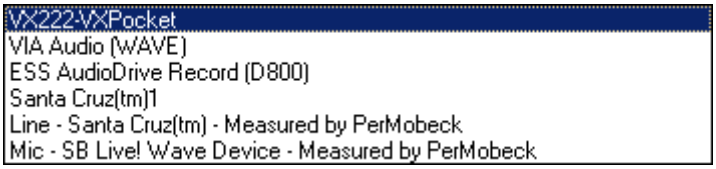
The WinMLS mixer controls the analog input and output amplifier of the sound card (some sound cards do not have a Windows mixer, and some cards have a mixer that can not be controlled by WinMLS). The relative

calibration will generate a file containing the gain steps for the mixer, this file is used for correction when the mixer gain is changed. So when a relative calibration has been done for the WinMLS mixer, changing the volume of the WinMLS mixer input will *not* affect the level of measurement.

To activate relative calibration for the mixer, go to **Measurement->Hardware Calibration**.



In the dialog box shown above under **WinMLS mixer INPUT relative calibration** make sure  is checked. To the right of this check box, you can select the correction file to be used from a list of files.



If you are using the sound card VXPocket or VX222, we recommend that you use the file VX222-VXPocket instead of generating a correction file.

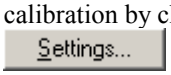
To generate a new correction file, click the  button. This calibration procedure may take some minutes, all the gain steps of the mixer will be tested and measured. When finished, we recommend that you test the results by performing some measurements with different WinMLS input volume settings. This can be done by measuring the sound card loopback (input connected to output), plotting the frequency response (**Frequency Response/Spectrum**). Making sure that all the measurements have exactly the same level. Especially the lowest mixer levels should be tested since these may be influenced by noise. It is possible to edit the values by opening the calibration file e.g. using the Windows **Notepad** (it is a text file).

If your sound card supports 24 bits, the use 24 bits for recording to get the best results (in **Measurement->Sound Card Settings** set **Input number of bits:** to 24). If you are doing a 2-channel measurement, the relative calibration for both channels is done using the same correction file. The mixer steps for channel 1 should be equal to channel 2, but we recommend that you test this.

4.4.2 How to perform absolute calibration of input level?

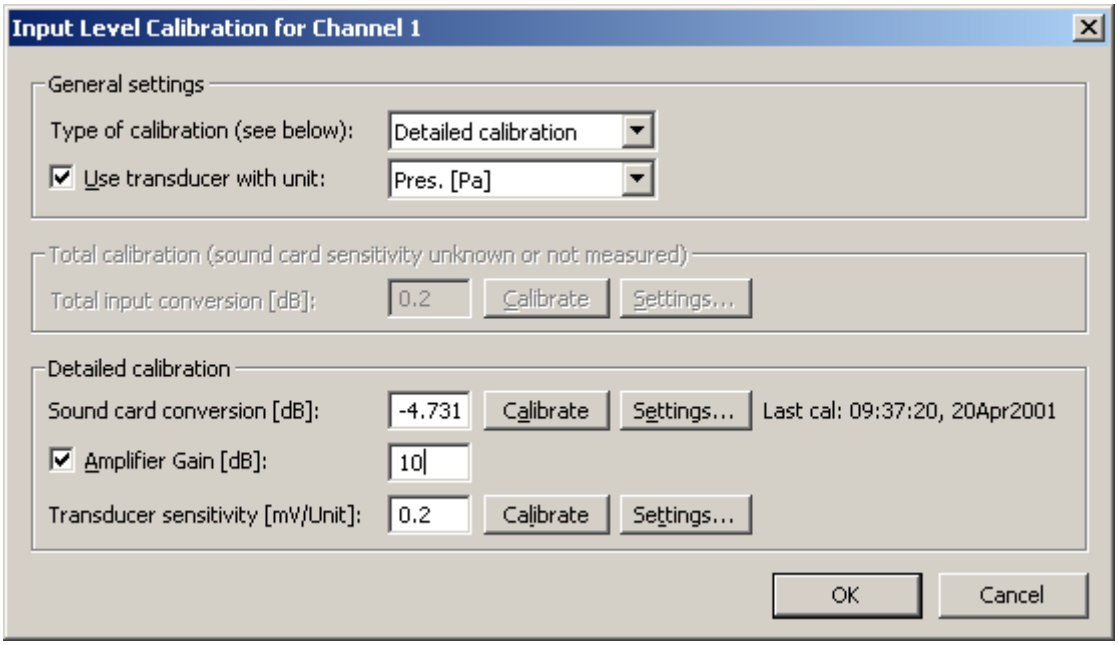
The purpose of the calibration is to be able to measure the absolute quantity, e.g. voltage or sound pressure level (SPL). To activate input calibration, go to **Measurement->Hardware Calibration**. In the dialog box, enable the

calibration by checking 

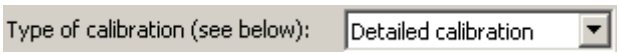
. To perform a new calibration or view the settings, click on the 

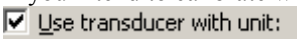
button. Make sure the channel number to the right of the button is set to 1 if you are doing the calibration for one channel measurement. For a multi-channel measurement, each channel has to be calibrated, the procedure is the same as for calibrating channel 1. In the following we describe the procedure for calibrating channel 1.

After clicking the **Settings...** button shown above, the **Input level calibration for channel 1**dialog box will be displayed.



In this dialog box, the upper list box determines if you want to calibrate the whole measurement chain in one operation (**Total calibration**), or calibrate each part of your measurement system (**Detailed calibration**) as shown below.



If you intend to calibrate with a transducer (e.g. a microphone) connected to the input, the check box 

must be checked. In the list box to the right of the check box, specify the type of transducer. A microphone would get **Pres [Pa]**. By doing this you will get the correct units during calibration and the correct units on the left axis (y-axis) when plotting measurements.

Make sure that the input and output volume is not too high because this will give clipping of the input signal. It should not be too low either, because this may give unreliable results due to background noise.

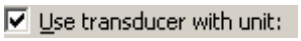
Note that if you are using the VXPocket or VX222, there is a special gain setting in the sound card mixer under **Advanced Input** that can be used to switch the input from Line to Microphone (see the Tested Sound Cards file).

4.4.2.1 How to perform "Total Calibration"?

The purpose of this type of calibration is to calibrate the whole input chain in one operation. This calibration is fast and simple. However, if you are using WinMLS both for electrical measurements and measurements where you are using a transducer (e.g. a microphone) or a pre-amplifier with changeable gain, we recommend that you instead use the **Detailed Calibration** (see next chapter).

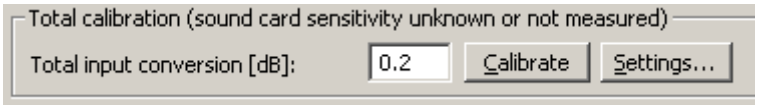
If you are not already in the **Input level calibration for channel 1**dialog box, go there (**Measurement->Hardware Calibration**, click **Settings…** to the right of the **Input calibration** check box.

First make sure that the list box named **Type of calibration** at the top of the calibration dialog box is set to **Total Calibration**.

Right below, make sure that you have checked 

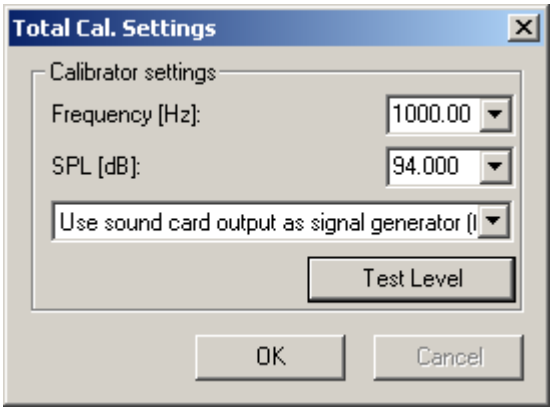
if you are using a transducer. Select in the list box the unit of the transducer you are using (for a microphone this would be **Pres [Pa]**).

The settings for the total calibration are shown below:



Click the 

button to view the **Total Cal. Settings** dialog box.

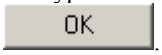


From here you can set the level and frequency for the calibration, and choose if you want to use an external signal generator or use the sound card output as signal generator. Using the sound card output should be fine as long as you have something to measure the signal level with (the measured level is used as the reference level), e.g. a voltage meter if you are doing an electrical calibration.

If you are to connect a signal generator or a calibrator to the input, choose **Use external signal generator** in the list box. Type the signal generator/calibrator frequency and level in the edit boxes.

If you are to use the sound card output as signal generator choose **Use sound card output as signal generator (full scale output)** in the list box. Select the frequency, 1000 Hz should be fine for most purposes. Then the output signal must be measured with an external device in the unit you wish to do the calibration for. Use a voltage meter if you are doing an electrical calibration and a SPL meter if you are calibrating a microphone using a loudspeaker. The 

button should be clicked to test the levels (**End level test** can be clicked to stop the playback of the calibration signal). After the 

button is clicked, measure the level using the external device. Type the measured level in the dialog box below the frequency setting and exit the dialog box by clicking 

.

Make sure that you have connected the calibration signal to the correct input channel (channel 1 is left).

Now click the 

button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the **Calibrate** button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a

sinusoidal excitation signal?). Please note that if you repeat the calibration, the number may not seem to be changed, but if the date is updated, this is probably because exactly the same number is written.

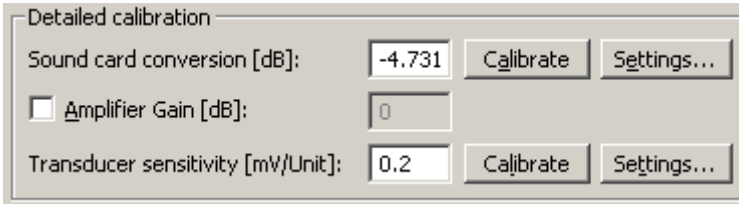
If  is checked, it is assumed that you are using a transducer when doing the level calibration. Note that if this check box is turned off, no warning will be given that you should redo the calibration. If you are going to do a measurement later without using the transducer, a new calibration must be performed.

4.4.2.2 How to perform "Detailed Calibration"?

The advantage of doing the detailed level calibration is that you can, without doing any new calibration, switch between doing an electrical measurement, measure with pre-amplifier and measure with transducer.

If you are not already in the **Input level calibration for channel 1**dialog box, go there (**Measurement->Hardware Calibration**, click **Settings…** to the right of the **Input calibration** check box. Make sure that the list box named **Type of calibration** at the top of the calibration dialog box is set to **Detailed Calibration**.

The group box **Detailed calibration** contains the settings for this calibration type.

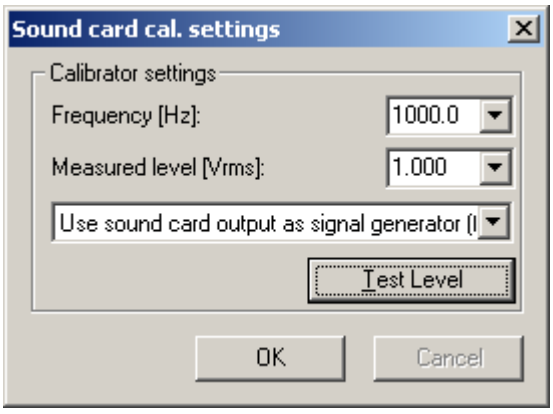


First determine what type of calibration you need. It is possible to calibrate the sound card and the transducer sensitivity. The pre-amplifier gain can also be specified.

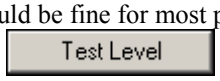
If you want to determine the amplification of the pre-amplifier, we suggest that you do this manually by plotting the frequency response of the measurement system with and without the pre-amplifier. Note that the sound card calibration and the pre-amplifier gain and status (checked/unchecked) must be correct in order to get a correct calibration of the transducer sensitivity.

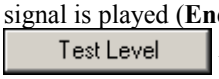
4.4.2.2.1 Sound card conversion calibration

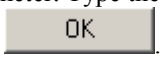
Start by calibrating the sound card, since the transducer calibration is dependent on the sound card sensitivity. Click the  button to the right of the **Sound card conversion [dB]** to display the settings.



From this dialog box you can set the level and frequency for the calibration, and choose if you want to use an external signal generator or use the sound card output as signal generator. Using the sound card output should be fine as long as you use a voltage meter to measure the RMS voltage.
If you wish to use an external signal generator, choose **Use external signal generator** in the list box. Type the signal generator/calibrator frequency and RMS voltage in the edit boxes.

If you are to use the sound card output as signal generator choose **Use sound card output as signal generator (full scale output)** in the list box. Select the frequency, 1000 Hz should be fine for most purposes. Then the output signal must be measured with a voltage meter. If you click the 

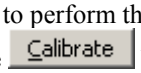
button, the output signal is played (**End level test** can be clicked to stop the playback of the calibration signal). After the 

button is clicked, measure the level using the voltage meter. Type the measured level in the dialog box below the frequency setting and exit the dialog box by clicking 

.

Make sure that you have connected the calibration signal to the correct input channel (channel 1 is left).

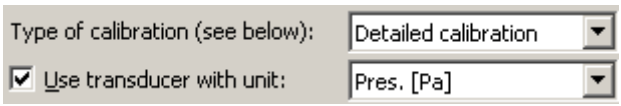
Now click the 

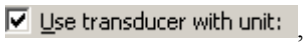
button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the 

button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a sinusoidal excitation signal?). Please note that if you repeat the calibration, the number may not seem to be changed, but if the date is updated, this is probably because exactly the same number is written.

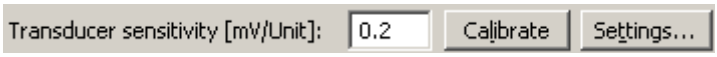
4.4.2.2.2 Transducer sensitivity calibration

Before you start calibrating your transducer you must make sure the sound card sensitivity and amplification gain and status (checked/unchecked) is correct. Therefore we recommend that you calibrate the sound card sensitivity (see above) before calibrating the transducer sensitivity.



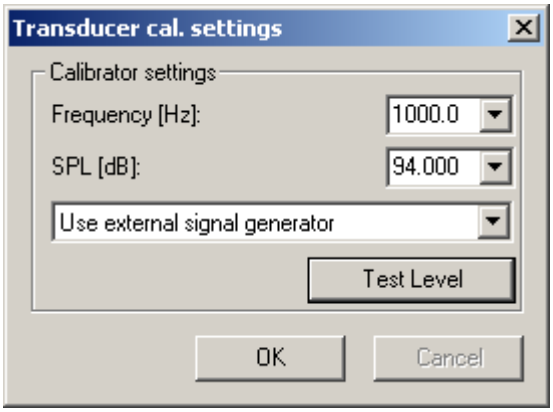
Start the calibration preparation by checking 

, and select in the list box the unit of the transducer you are using (for a microphone it would be **Pres [Pa]**).



Click on the 

button shown above to the right of the **Transducer sensitivity** to display the settings.



From this dialog box you can set the level and frequency for the calibration, and choose if you want to use an external signal generator or use the sound card output as signal generator. Using the sound card output should be fine as long as you have a device for measuring the level.
If you are to connect a signal generator or a calibrator to your input chain, choose **Use external signal generator** in the list box. Type the signal generator/calibrator frequency and level in the dialog box.

If you are to use the sound card output as signal generator choose **Use sound card output as signal generator (full scale output)** in the list box. Select the frequency, 1000 Hz should be fine for most purposes. Then the output signal must be measured in the transducer unit (e.g. SPL) using an external device. Use a SPL meter if

you are calibrating a microphone using a loudspeaker. If you click the Test Level button, the output signal is played (**End level test** can be clicked to stop the playback of the calibration signal). After the Test Level button is clicked, measure the level using the voltage meter. Type the measured level in the dialog box below the frequency setting and exit the dialog box by clicking OK.

Make sure that you have connected the calibration signal to the correct input channel (channel 1 is left).

Now click the Calibrate button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the Calibrate button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a sinusoidal excitation signal?). Please note that if you repeat the calibration, the number may not seem to be changed, but if the date is updated, this is probably because exactly the same number is written.

4.5 How to calibrate the output of the measurement system?

4.5.1 How to perform relative calibration of mixer output levels?

The purpose of calibrating the output is to be able to obtain the true transfer function gain independent on the level of the WinMLS mixer output (relative calibration of mixer). The calibration can be done in different ways dependent on the features of the sound card (e.g if the sound card supports the WinMLS mixer or not) and the type of measurement you intend to perform. For some sound cards, e.g. VXPocket, a measurement setup file will be available with nominal calibration settings.

The procedure for calibrating the output mixer is equal to the procedure for calibrating the input mixer, so please follow the procedure How to perform relative calibration of mixer input levels?.

4.5.2 How to perform calibration of absolute output level?

To calibrate the *output* of the measurement system is very similar to calibrating the *input*. If you choose to use the sound card input to measure the levels during the output calibration, it is required that the input is calibrated first. Therefore we strongly recommend that you *do the input calibration before doing the output calibration*.

Make sure that the input and output volume is not so high that it gives clipping of the input signal or so low that the calibration gets unreliable.

Note that if you are using the VXPocket or VX222, there is a special gain setting in the sound card mixer under **Advanced Input** that can be used to switch the input from Line to Microphone (see the Tested Sound Cards file).

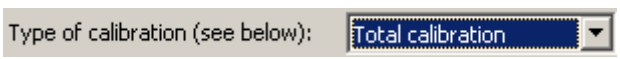
First determine if you are going to do total calibration or detailed calibration.

4.5.2.1 How to perform "Total Calibration"?

The purpose of this type of calibration is to calibrate the whole output chain in one operation. We recommend that you instead use the **Detailed Calibration** (see below) if you are using WinMLS both for electrical measurements and measurements where you are using a transducer (e.g. a loudspeaker), or if you are using an amplifier with changeable gain.

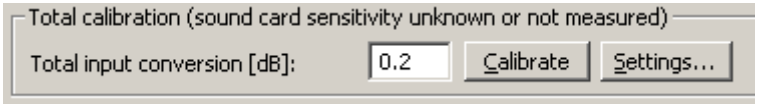
If you are not already in the **Input level calibration for channel 1**dialog box, go there (**Measurement->Hardware Calibration**, click **Settings…** to the right of the **Input calibration** check box.

First make sure that the list box named **Type of calibration** at the top of the calibration dialog box is set to **Total Calibration**.

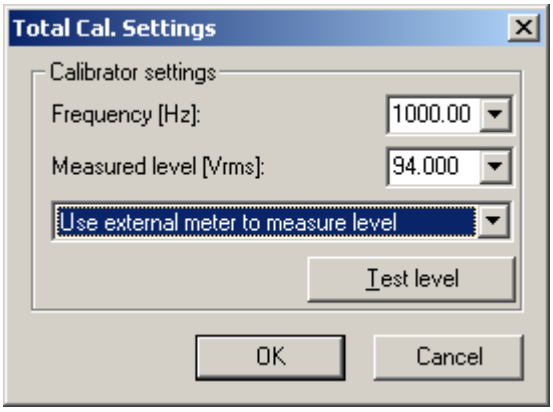


Right below, make sure that you have checked Use transducer with unit: if you are using a transducer. Select in the list box the unit of the transducer you are using (for a microphone this would be **Pres [Pa]**).

The settings for the total calibration are shown below:



Click the Settings... button to view the **Total Cal. Settings** dialog box.



Type the desired signal frequency and level in the dialog box. 1000 Hz should be fine for most purposes. From here you can also set the level, and choose if you want to use an external meter or use the sound card input to measure the output level. Using the sound card input for measuring the output level is fine if you have calibrated the input.

If you are to use an external meter to measure the output level, choose **Use external meter to measure level** in the list box. Then measure the output level on channel 1 (left) using the external device after clicking the Test Level button. Type the measured level in the dialog box below the frequency setting (you are also asked to enter the level during the actual calibration, the level you have typed now will show as default).

If are to use the sound card input to measure the level, select **Use soundcard input to measure level**. The sound card input will now measure and determine the level automatically, no number to be typed, but you must be sure that the sound card input is calibrated properly and that it is connected to input channel 1 (left).

Now click the Calibrate button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the **Calibrate** button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a sinusoidal excitation signal?). Please note that if you repeat the calibration, the number may not seem to be changed, but if the date is updated, this is probably because exactly the same number is written.

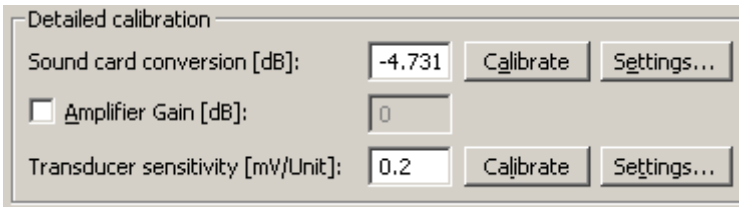
If ☑ Use transducer with unit: is checked, it is assumed that you are using a transducer when doing the level calibration. Note that if this check box is turned off, no warning will be given that you should redo the calibration. If you are going to do a measurement later without using the transducer, a new calibration must be performed.

4.5.2.2 How to perform "Detailed Calibration"?

The advantage of doing the detailed level calibration is that you can, without doing a new calibration, switch between doing an electrical measurement, measure with amplifier and measure with transducer.

If you are not already in the **Input level calibration for channel 1**dialog box, go there (**Measurement->Hardware Calibration**, click **Settings…** to the right of the **Input calibration** check box. Make sure that the list box named **Type of calibration** at the top of the calibration dialog box is set to **Detailed Calibration**.

The group box **Detailed calibration** contains the settings for this calibration type.



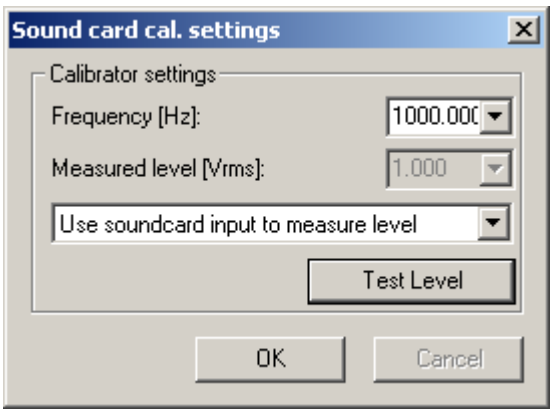
First determine what type of calibration you need. It is possible to calibrate the sound card and the transducer sensitivity. The pre-amplifier gain can also be specified.

If you want to determine the gain of the amplifier, we suggest that you do this manually by plotting the frequency response of the measurement system with and without the amplifier. Note that the sound card calibration and the amplifier level and status (checked/unchecked) must be correct in order to get a correct calibration of the transducer sensitivity.

4.5.2.2.1 Sound card sensitivity calibration

Start by calibrating the sound card, since the transducer calibration is dependent on the sound card sensitivity.
Start by calibrating the sound card, since the transducer calibration is dependent on the sound card sensitivity.
Click the 

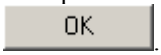
button to the right of the **Sound card conversion [dB]** to display the settings.



From this dialog box you can set the frequency and level for the calibration, and choose if you want to use an external meter or use the sound card input to measure the output level. Type the desired signal frequency and level in the dialog box. 1000 Hz should be fine for most purposes. Using the sound card input for measuring the output level is fine if you have calibrated the input.

If you are to use a voltage meter to measure the output level, choose **Use external meter to measure level** in the list box. Then measure the output level on channel 1 (left) using the voltage meter after clicking the 

button. Type the measured level in the dialog box below the frequency setting (you are also asked to enter the level during the actual calibration, the level you have typed now will show as default).

If are to use the sound card input to measure the level, select **Use soundcard input to measure level**. The sound card input will now measure and determine the level automatically, no number to be typed, but you must be sure that the sound card input is calibrated properly and that it is connected to input channel 1 (left). Exit the dialog box by clicking 

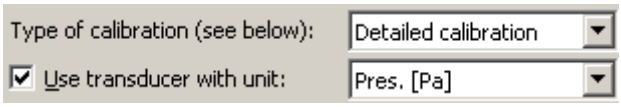
.

Make sure that you have connected the calibration signal to the correct input channel (channel 1 is left).

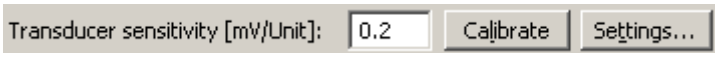
Now click the Calibrate button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the Calibrate button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a sinusoidal excitation signal?). Please note that if you repeat the calibration, the number may not seem to be changed, but if the date is updated, this is probably because exactly the same number is written.

4.5.2.2.2 Transducer sensitivity calibration

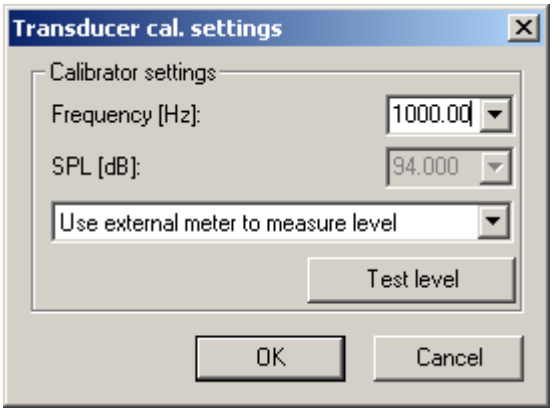
Before you start calibrating your computer you must make sure the sound card output sensitivity and amplifier gain and status (checked/unchecked) is correct. Therefore we recommend that you calibrate the sound card sensitivity (see above) before calibrating the transducer sensitivity.



Start the calibration preparation by checking Use transducer with unit:, and select in the list box the unit of the transducer you are using (for a loudspeaker it would be **Pres [Pa]**).



Click on the Settings... button to the right of the **Transducer sensitivity** to display the settings.



From this dialog box you can set the level and frequency for the calibration, and choose if you want to use an external signal generator or use the sound card output as signal generator. Using the sound card input for measuring the output level is fine if you have calibrated the input.

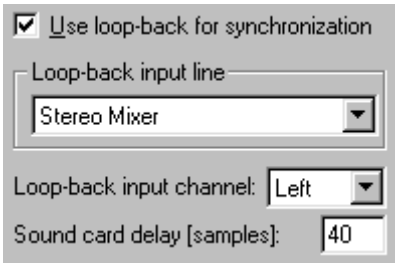
If you are to use an external meter to measure the output level, choose **Use external meter to measure level** in the list box. Then measure the output level on channel 1 (left) in the transducer unit (e.g. SPL) using the external device. Use a SPL meter if you are calibrating a loudspeaker. Measure the level after clicking the Test Level button. Type the measured level in the dialog box below the frequency setting (you are also asked to enter the level during the actual calibration, the level you have typed now will show as default).

If are to use the sound card input to measure the level, select **Use soundcard input to measure level**. The sound card input will now measure and determine the level automatically, no number to be typed, but you must be sure that the sound card input is calibrated properly (considering if you are using amplifier and transducer on the input) and that it is connected to input channel 1 (left).

Now click the Calibrate button to perform the calibration. After the calibration is performed, the number to the left and the date to the right of the Calibrate button will be updated with the new settings. Now you can do a measurement to test if the calibration is correct. You can use sinusoid as excitation signal (see How to use a sinusoidal excitation signal?).

4.6 How to measure the initial time delay (the distance between the loudspeaker and the microphone)?

Sound cards do not usually have synchronized inputs and outputs, this means that something has to be done to find the correct initial time delay. An exception is the Card Deluxe, Siena and Vxpocket/VX222 sound cards, read more about how to do it for those cards in the document "Tested sound cards".
To measure the correct initial time delay, WinMLS has the possibility of using a synchronization signal. This option can be turned on in **Measurement->Sound Card Settings** as shown below.

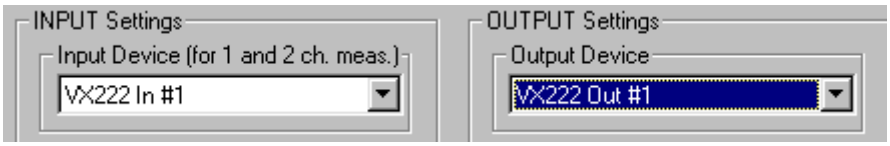


Read more about this in the **User's Guide**. Note that this procedure will not correct for the delay of the sound card (~40 samples). To do this, you must perform a measurement system correction as described below.

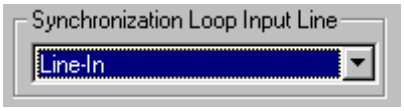
4.6.1 Why is the synchronization signal not strong enough?

The first thing would be to try to increase the mixer synchronization input and output level. The settings in the suggestions below are found in **Measurement->Sound Card Settings**.

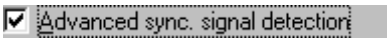
1. Check that the cables are connected properly.
2. Check that you have chosen the right audio devices



3. Check that you have chosen the right sync line



4. If nothing above helps, try to turn on the check-box:



This will not work on older PC's with bad performance.

4.7 How to correct for the influence of the measurement system?

In some cases it is important to be able to correct for the influence of the measurement system, e.g. when the exact phase is desired. How to correct for the influence of the sound card will now be described, if you want to include more e.g. an amplifier in the correction, the procedure is similar. If you use the sound card VXpocket (or VX222) calibration files have already been made, and you may use the existing files instead of measuring your own. Then you can go directly to the last part of step 2 below.

4.7.1 Step 1

Perform a measurement of the measurement system only, e.g. a loop-back measurement of the sound card.

Use sequence order 14 and 32 averages or more. Make sure the  button on the **Measurement Settings Toolbar** is turned off.
If you do not know the sound card delay, make sure **Measure with synchronization signal** is turned off in **Measurement->Sound Card Settings**.

4.7.2 Step 2

Save the measurement.

It may be done manually from **File->Save Active Measurement As...** and using the folder **Measurement System Correction** which is a sub-folder of the folder where WinMLS was installed. Select the extension **.wmb** and the name:
<Name><Multi-channel measurement tag><Channel #>_Fs<Sampling Frequency as integer>.

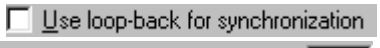
For example a 1-channel measurement with sampling frequency 44100 Hz measured using the name of the sound card VXPocket will be **VXPocket_ch1_Fs44100.wmb.**

The fastest way of doing this procedure is by doing it automatically using **File->Save Active Measurement->As Measurement System Correction File…**. Then the active measurement will be set as the correction file using the short name **activemeas**.

When the file is saved according to this, the first part of the filename will be added in **Measurement->Hardware Calibration** under the list box in "**Measurement system correction filename**". Select this name in the list box.

4.7.3 Step 3

Turn on the measurement system correction button  on the **Measurement Settings Toolbar**.

If you have check-marked 

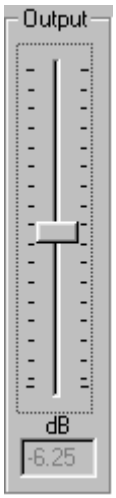
in **Measurement->Sound Card Settings**, make sure the time delay 

is set to the correct sound card delay (this can be found by plotting the impulse response of the sound card using samples as x-axis).

4.8 How to do get logical filename suggestions of when performing several measurements?

Before starting the measurement series, go to **Measurement->Defaults for Saving...** There select the folder you want the measurement to be saved as, and the name. You may also write comment and title. Type the number of measurements you are to perform in the autoname generator range.
For example, if the range is 1-3 and the default filename is "Meas". The suggested name for saving the first three measurements will be
Meas_1.wmb, **Meas_2.wmb**, **Meas_3.wmb**
Then when saving the forth measurement, the **Defaults for Saving** dialog box will automatically appear, and you may write a new default filename.

4.9 How to get fine resolution on the WinMLS mixer slider?



Some sound cards have mixers with very high resolution, e.g. VXpocket has a range of more than 80 dB and 0.25 dB per step, which gives many steps. The WinMLS mixer input and output level slider can be set using the mouse, but moving only one step may be difficult with the mouse. To move one step at a time, first click on the slider to set it active (a dotted border around the slider tells that it is active, see the figure to the right). Then the up and down arrows on the keyboard will move the slider.

4.10 How to use a sinusoidal excitation signal?

Set **Sinusoid** as measurement mode in the **Measurement Selection Toolbar** as shown below.

Since WinMLS was designed for MLS measurements, the length of the sinusoid is set by the **Sequence Order** and **Averages** on the **Measurement Settings toolbar**. The relative level and frequency of the sinusoid is set in **Measurement->Sinusoid settings…**, but the frequency is adjusted so an integer number of periods fit into the sequence length specified. Because of this, averaging can be used. If the sinusoidal signal is to be played back for a long period, use either several averages or use **Measurement->Test Current Level(s)**.

4.11 What format is recommended for saving measurement data?

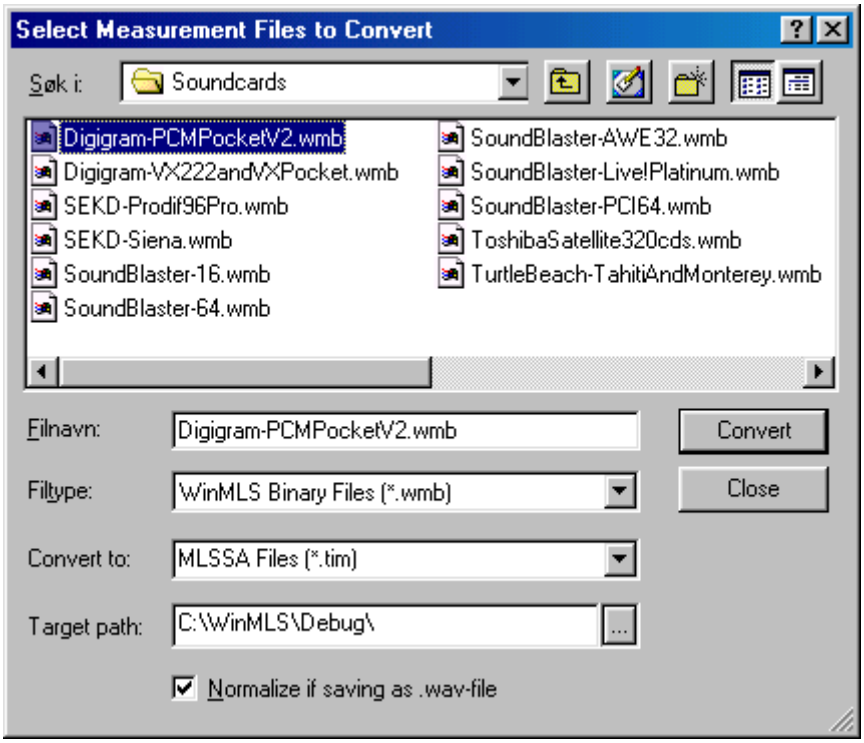
When installing WinMLS, the **.wmb (WinMLS binary files)** is the default format and it is recommended since it contains all information about the measurement.

The other formats are mostly meant for exporting purposes.

The **.wav**-format will also have stored the information, but it may cause problems because of the normalization option (can be set in **Measurement->Defaults For Saving…** or **File->Convert Measurement(s)…**). Note that **.wav**-normalization will change the scaling, and if normalization is not used when saving as .wav, the quantization noise is usually large.

4.12 How to convert a measurement file, e.g. of extension .wmb to .wav?

This is done from **File->Convert Measurement(s)**. Several measurements can be converted by selecting the ones to be converted in the dialog.

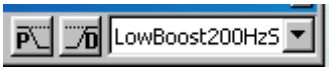


4.13 How to improve signal-to-noise ratio for low frequencies?

It is possible to pre-filter the MLS sequence. This method can be used to boost frequencies that has poor signal-to-noise ratio. See below how this can be done

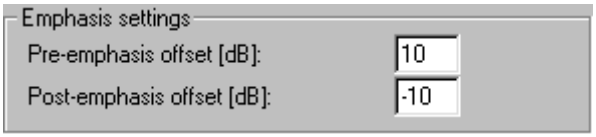
4.14 How to add pre-filtering (emphasis) to the excitation signal (MLS)?

Both pre- and de-emphasis (Pre/Post-filtering) is available as buttons on the **Measurement Settings Toolbar**.



Currently one type of filter is available (**LowBoost200HzShelvingFirstOrder**), it will boost the frequencies below 200 Hz with 20 dB using a first order filter. This is useful for measuring in environments where the low frequency background noise is greater than the high frequency background noise, which is the case for most rooms.

The gain of the emphasis can be set under **Measurement->Advanced Settings...**.



4.14.1 How to generate your own filter?

Custom filter can be made using Matlab or by contacting us. The filter coefficient file format is the same as the Matlab mat-format, but change the extension name from **.mat** to **.emp**. To save filter coefficients in Matlab (assuming the a and b coefficients have been generated), the following algorithm can be used:
save filtercoeffs.mat a b
change the extension of the file from .mat to .emp.
copy the file to the "Filters"-folder under the WinMLS-folder.

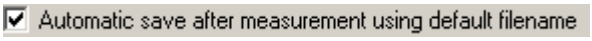
4.15 How to access a measurement from memory?

The measurements that are in memory are found on the **Measurement Selection Toolbar**. Clicking the  button, all the measurements that are not plotted will be deleted. Note that even if no measurements are plotted, the reference and the active measurement in upper and lower plot will not be deleted.

4.16 How to run WinMLS as batch or from Matlab?

If you have a registered version of WinMLS you can see how to run WinMLS form batch by opening MS-DOS and go to the WinMLS folder. To display the help text type:
winmls /h
The function **loadimp.m** found in the WinMLS folder may be used to read **.wmb** or **.wmt** files into Matlab.

WinMLS [/M MeasSetupfile] [/R] [/F FileName]
/M: MeasSetupfile is the short name of a measurement setup to load.\n"
/R: If RunAndExitAfterMeas is set then the measurement start immediately and exits afterwards
/F: Filename is the name of a file to save
/H: Show this help

Example: **WinMLS /M LSP_Setup /F LSP_Filename /R\n**
This example will load the settings in the measurement setup file **LSP_Setup**, perform a measurement and save the result as **LSP_Filename** before it exits.
Note that in order to automatically save the measurement, 

has to be checked in **Measurement->Measurement Tasks...**.

4.17 Can a given setup be automatically called using DOS switches?

Yes, this is possible, see the chapter above. This feature can be used to load the same settings each time WinMLS is opened. If no measurement setup is specified, WinMLS will open with the settings it had when it was closed the last time it was used.

4.18 What is the highest sampling rate available (important for e.g. scale modeling in room acoustics)?

At the moment the highest sound card sampling rate is 96 kHz, which means that it is impossible to get results above 48 kHz. In a few months we have been promised that a high quality card capable of 192 kHz will be available, this will increase the frequency range up to a limit of 96 kHz.

4.19 Can multi-channel measurements (>2 channels) be performed using WinMLS?

WinMLS is capable of measuring up to 24 channels simultaneously. The number of channels is limited by the hardware. Please contact us if you are interested in a multi-channel (>2) measurement system.

5 Room Acoustics

Refer to the **Room Acoustics User's Guide** for additional information.

5.1 How to measure room acoustics?

When using WinMLS for measuring room acoustics, it is recommended that a room acoustics setup is loaded for performing the measurements. These can be loaded and saved from the **Setups Toolbar** (can be turned on/off

from the **View** menu), or from **Measurement->Measurement Setup...**. When the setup is loaded, you can click the **GO** button on the standard toolbar to start the measurement or **File->Insert in Active Group...** to insert a measurement.
On the **Room Acoustics** menu, you can create your own settings for displaying the room acoustics parameters. These settings can be saved in the post-processing setup file.

5.2 How are room acoustics parameters presented?

Room acoustics parameters can be presented either in a grid or in a plot. If you want to display several parameters, use the grid. If you want to display one single parameter (e.g. reverberation time) you can use either the grid or the **Room Ac. Parameters** plot type (Can be set from the **Plot Toolbar** or **Plot->Select Plot Type(s)/Measurement(s)....)**. See below on how to do this. If you plot the parameters using this plot-type, it is possible to plot several measurements for easy comparison.

5.3 How can the Room Acoustics Parameters Grid be copied to a spreadsheet (e.g. Excel)?

This can be done first by computing the parameters to a grid (see above).
If you have problems, note that inserting in Excel from WinMLS acoustics parameter clipboard does not work if "**,**" and not "**.**" is selected as decimal divider.
The reason is that Excel interprets what is in the cells dependent on the global Windows settings. If "**.**" Is the decimal divider, it works fine. It can be set from the windows **Control Panel**, select **Regional and Language Options**. Click the **Customize…** button. As **Decimal Symbol**, select "**.**".

5.4 Plotting: How to compute and plot room acoustics parameters such as reverberation time?

The room acoustics parameters, e.g. reverberation time and clarity, are available in a plot type called **Room Ac. Parameters**. This plot type has like the other plot types a **Settings** dialog box (can e.g. be accessed by double-clicking in the plot). From this dialog box, the type of parameter to be plotted is selected. Note that only a few settings are available in this dialog box, the rest of the settings are taken from **Room Acoustic->Calculation Options…** and **Room Acoustics->Parameter Settings...**.

5.5 How to specify two measurements for computing room acoustics parameters?

Two measurements are to be used to calculate parameters such as IACC and LF. When doing this, the primary measurement (omni-directional mic.) is the active measurement in the upper plot and the secondary measurement (figure-of-eight mic.) is set to be the active measurement in the lower plot. If only one plot is displayed and not two, the active measurement in the lower plot is found in the **Measurement Selection Toolbar** or in **Plot->Select Plot Type(s)/Measurement(s)....**. We recommend using this toolbar shown below to check that you have got the right impulse responses.

5.5.1 Limitations when plotting parameters needing two measurements

Only signal-to-noise ratio for primary impulse response is displayed in the *plot* in case two impulse responses are used in computing the parameter. In the grid, both signal-to-noise ratios are displayed.

If you intend to plot room ac. parameters in the lower plot, the active measurement in the lower plot is used as primary measurement and if two measurements are needed to calculate the parameter, then this will give an error message. Instead, perform the plotting in the upper plot when parameters needing two impulse responses are to be plotted.

If plotting is performed in the upper plot, there is still a problem if several curves are plotted and **Plot->Refresh All** is selected. Each curve will not remember what was used as secondary measurement when it was plotted, therefore the active measurement in the lower plot will be as secondary plot when refreshing all the curves.

5.6 Numerical display: How to compute and display room acoustics parameters in a grid?

First a measurement has to be active in the plot (upper plot if two plots are displayed). Do this by performing a measurement (**Measurement->Start Measurement**) or inserting a measurement (**File->Insert in Active Group...**).
When a measurement is active in the plot, the name of it will be displayed in the WinMLS title and also in the **Measurement Selection Toolbar**.

5.6.1 What about parameters that need two measurements (impulse responses) to be computed?

Some parameters need two impulse responses to be computed. The number and type of microphones to be used is set from **Room Acoustics->Calculation Options** in the **Microphone type(s)** list box. If a type that uses two microphones is selected, it needs two measurements, a primary and a secondary. The primary measurement is taken from the upper plot and the secondary measurement is taken from the lower plot. These measurements are displayed in the **Measurement Selection Toolbar**, and can easily be changed from this toolbar as well.

5.7 How to compute one parameter only, e.g. reverberation time?

A single parameter can be plotted using the plot type **Room Ac. Parameters**, it can also be displayed in the grid as described below.
In **Room Acoustics->Parameter Settings...** the type of parameters to be displayed can be selected. By using the check boxes, the user can determine which parameters to be computed. If only reverberation time is to be displayed, make sure that all check boxes, except reverberation time (T30) are turned off.

5.8 How to export the computed parameters from the "Room acoustics parameters" grid?

When **Room Acoustics->Display Selected Parameters** is selected, room acoustics parameters are displayed in a grid. To copy the parameters to clipboard, use the **Copy to clipboard** button below the grid. This will copy the marked numbers. If no numbers are marked, it will copy all parameters. Note that you can mark a column by clicking at the upper part of the column.

5.9 How to change the bandwidth, e.g. obtain the reverberation time of the broadband measurement?

The bandwidth is set from **Room Acoustics->Calculation Options** in the **Bandwidth** list box.

5.10 How to display room acoustics parameters automatically after performing a measurement or inserting measurement file(s)?

At the bottom part of **Measurement->Measurement Tasks**, there is a check box called **Display selected room acoustics parameters** check box. If this is on, room acoustics parameters will be displayed in a grid and/or written to text-file when a measurement is performed or when one or several measurement files are inserted using **File->Insert in Active Group...**.

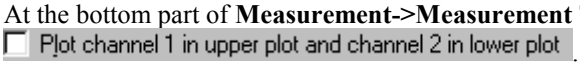
5.11 How to automatically compute room acoustics parameters from several measurements?

At the bottom part of **Measurement->Measurement Tasks**, there is a check box called **Display selected room acoustics parameters**. If this is turned on, then room acoustics parameters are being computed and displayed to a grid when measurement files are inserted using **File->Insert in Active Group...**. (If **Room Ac. Parameters** is selected as plot type, the selected parameter will be displayed in the plot as well. Note that this will reduce the speed, since the computation will be performed twice.) **File->Insert in Active Group...** will insert all marked measurement. To mark several measurements, hold the <**Ctrl**> key while clicking on the measurements that are to be inserted. <**Shift**> can also be used to mark a group of measurements.

5.12 How to average or doing other calculations on room acoustics parameters obtained from several measurements?

This can be done from the **Room Ac. Parameters** plot type. On how to do this see the question "How to make calculations, such as average and difference on plotted curves?"

5.13 Is there a way of automatically sending measurement channel two to the lower plot or insert measurements in both upper and lower plot in one operation.

At the bottom part of **Measurement->Measurement Tasks...**, there is a check box that will do this called 

. If it is checked and a multi-channel measurement is *performed*, channel 1 will be plotted in the upper plot and channel 2 will be plotted in the lower plot. Make sure you are viewing two plots, if you only have one plot, channel two will not be displayed.
If several measurements are inserted using **File->Insert in Active Group…**, the first measurement will be displayed in the upper plot, the second will be displayed in the lower plot, the third will be displayed in the upper plot, and the forth in the lower, and so on… This is useful when computing the room acoustics parameters that need two measurements.

At the bottom part of **Measurement->Measurement Tasks...**, make sure 

is checked. If it is checked and a multi-channel measurement is *performed*, channel 1 will be plotted in the upper plot and channel 2 will be plotted in the lower plot. Make sure you are viewing two plots, if you only have one plot, channel two will not be displayed.

If several measurements are inserted using **File->Insert in Active Group…**, the first measurement will be displayed in the upper plot, the second will be displayed in the lower plot, the third will be displayed in the upper plot, and the forth in the lower, and so on… This is useful for computing room acoustics parameters that need two measurements. Note that you may select measurements in any order by clicking on the measurement files in the **File->Insert in Active Group…** dialog.

6 Various Applications

6.1 How to measure loudspeaker frequency response?

To measure the frequency response of a loudspeaker, no level calibration has to be performed. Load the setup named **LoudspeakerMeas** from the Setups Toolbar (usually situated at the lower right corner, can be found from **View->Setups Toolbar**). Perform a measurement (**Measurement->Start Measurement**) with a microphone connected to the input (left channel) and the loudspeaker connected to the output (left channel).

6.2 How to use WinMLS as a level meter for measuring SPL values in octave, 1/3 octave, dBA?

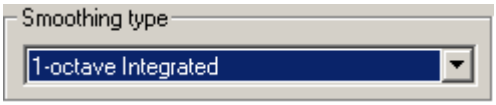
Tests comparing WinMLS with a sound level meter showed good agreement, but for measuring dBA the input measurement chain must be calibrated. The easiest way of doing this calibration is if you have a microphone and a calibrator. For how to do this, see How to perform "Total Calibration"?
If you have a microphone with a known sensitivity, you may also use this and calibrate the rest of the input chain. For how to do this, see Sound card conversion calibration.

To perform the measurement, first load the setup **QuasiRealTimeAnalyzer** (can be done e.g. from the **Setups Toolbar**). As default, the plot 1/3-octave Power Spectrum is selected.

6.2.1 How to display in octaves?

1-octave Power Spectrum can be set by first clicking in the plot, then type F5 to open the plot type settings. Then click the **Settings...** button shown below.

In the Smoothing/Integration Settings dialog box, select 1-octave Integrated as shown below



6.2.2 How to display in dBA?

To display the dBA level, the plot type has to be changed from **Frequency Response/Spectrum** to **Levels**. This can be done from the **Plots Toolbar** normally situated at the bottom.

6.2.3 How to display several measurements (e.g. for comparison and for saving the data)?

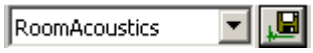
This is done the same way as with other types of measurements, if Plot->Hold Plotted Curves is checked (same as the  button), a new measurement will be added. This is very nice for comparison, especially when plotting dBA values. The plotted data can be saved as text-file using **File->Save Data in Active Plot As...**.

6.3 How to measure speech transmission indexes STI or RASTI?

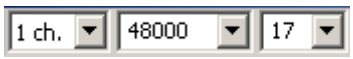
STI or RASTI can be measured using WinMLS. The software has previously been tested against MLSSA's RASTI calculation and recently against the B&K Speech Transmission Meter. The agreement was good. Currently the sound card must be able to preform a MLS measurement. Please check this by going through the procedure described in the chapter *Loop-back measurement of the sound card* in the *WinMLS2000 Users Guide*.

It is also recommended that you read and use the *Speech transmission indices* chapter in the *Room Acoustics User's Guide* and use that as a reference when reading this. Below the steps for setting up and measuring STI and RASTI is given.

1. *Load measurement settings for room acoustics measurement*

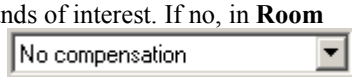
   Select the measurement setup named Room Acoustics 

   from the Setups Toolbar (initially situated at the bottom right). It will load the initial settings that we will slightly modify.
   If you are measuring in a reverberant room, having a reverberation time larger than one second, in the Measurement Settings Toolbar (**View->Measurement Settings Toolbar)**, set the sequence order to 17 as shown to the right in the figure below

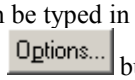
2. *Select RASTI or STI as plot type.*
   In **Plot Toolbar** (initially situated at the bottom), select plot type **Room Ac. Parameters**
   

   . Click in the plot to make it active and click **F5** to access the plot-type settings. Then select RASTI or STI as shown below
   

3. *Determine if noise compensation is to be used.*
   Find out if your STI/RASTI measurement has to take the background noise into account. It should be done if the speech-to-noise ratio is less than 15 dB in the octave bands of interest. If no, in **Room Acoustics->Parameter Settings...** select the compensation option. 

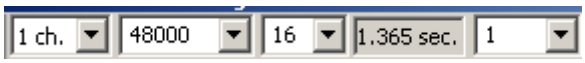
   and skip the next point. If yes, read the next point.

4. *Find background noise level for noise compensation.*
   There are two options for compensating for the background noise as explained below.

   The options *Compensation (noise fixed)* assumes that the background noise is measured. One advantage is that this method can be used in cases where the background noise is very high (averaging can be used to increase the signal-to-noise ratio). Another advantage is that it is not needed to calibrate the WinMLS input chain. The background noise level can be measured using an octave band level meter. The octave band values can be typed in by first going to the lower left part of the **Room Acoustics->Parameter Settings...**. The 

   button opens up a new dialog box where the necessary data can be entered.

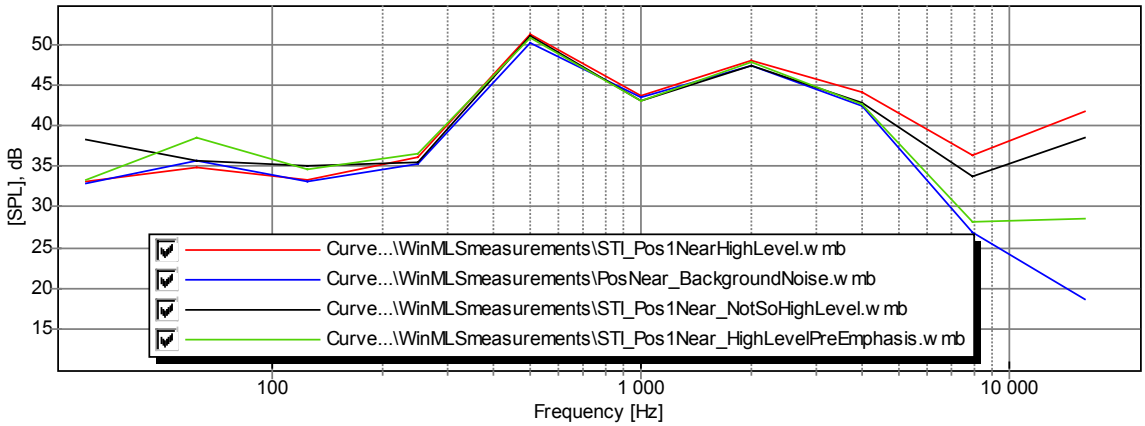
   The option *Compensation (noise updated automatically)* computes the background noise from the measured impulse response with WinMLS. In order to do this, the input chain (including the microphone) must be calibrated. The easiest way of doing this is to use a microphone calibrator with known frequency and level. The calibration is also possible to do without a calibrator. See How to perform absolute calibration of input level? and perform one of the methods of calibration described there.
   Please note that this option should not be used on measurements performed using averaging since the averaging will reduce the effect of the background noise. Therefore, in the Measurement Settings Toolbar (**View->Measurement Settings Toolbar)**, set the number of averages to 1 as shown to the right in the figure below

   On the same toolbar, make sure that the De-emphasis is turned off as shown: 

   . This is because the de-emphasis will influence the calculation of the background noise. The Pre-emphasis can be left turned on, it will reduce the treble output and reduce the chance for distortion. Distortion gives spurious peaks in the MLS signal which will artificially increase the calculated background noise for higher frequencies. An example is shown in the figure below where the blue curve is the sampled

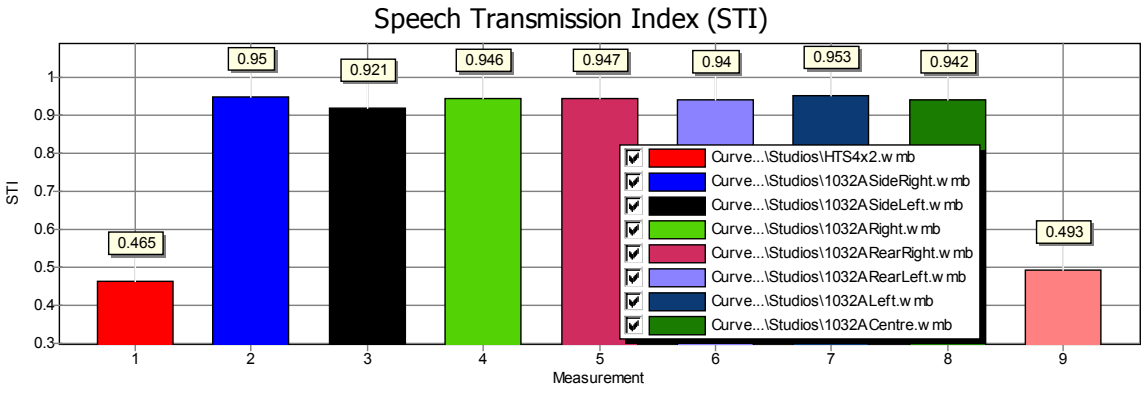
background noise in octave band, the green curve is the computed background noise from an MLS measurement using pre-emphasis, the red curve is a MLS measurement with high level and the black curve is a MLS measurement with not so high level. From this we can see that using pre-emphasis gives the best estimation of the background noise.



When finished, save the measurement settings using the button in the Setups toolbar (**View->Setups Toolbar).**

5. *Perform the measurement*
   Connect the loudspeaker to the sound card output (left channel) and the microphone to the sound card input (left channel). Place the loudspeaker in the position of the "speaker" and the microphone in the position of the "listener".
   Select Measurement->Test Current Levels and set the output level properly. If you are unsure, try measuring with different levels and see what gives the best result.
   Click the GO button (or **Measurement->Start Measurement**) to perform the measurement.
   If you want measurements to be automatically repeated, in **Measurement->Measurement Tasks...** make sure ☐ Automatic start of new measurement after successful measurement is checked.

6. *Displaying the results*
   The results will be plotted as bars as shown in the figure below. In this figure the values for several measurements are plotted and the legend moved from its default position in the right corner.



These results can also be saved to a text-file from **File->Save Data in Active Plot As...**. The data is organized in two columns, the first contains the measurement names, the second the RASTI or STI values.
If you only want to show only one RASTI/STI value in the plot, make sure **Plot->Hold Plotted Curves** is not checked when plotting a new curve.

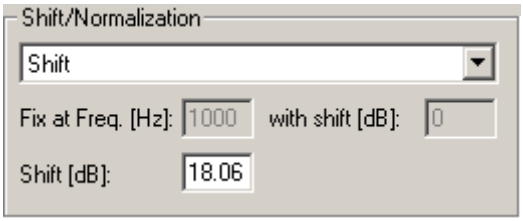
6.4 How to measure loudspeaker impedance?

Impedance is, according to Ohms law, defined as voltage divided by current. The current is found by measuring the voltage over a resistor **R** with known resistance. Use a resistor that can handle a power signal, a power resistor of 8 Ohm can be suited.
Place the resistor in series with the loudspeaker and measure the voltage over the loudspeaker $\mathbf{V_{LSP}}$ and the voltage over the resistor $\mathbf{V_R}$. The input impedance is give by:

$$\mathbf{Z_{LSP} = V_{LSP} / I = R * (V_{LSP} / V_R)}$$

Load a setup for doing a MLS measurement, e.g. the setup named LoudspeakerSetup (can be done from the **Setups Toolbar**). Now we have performed the two measurements we want to do the division. How to do this is described in How to find the level difference of two measurements as function of frequency?

To obtain the correct impedance scaling, in the **Plot->Plot Type Settings->Frequency Response/Spectrum** dialog box, in the group box **Shift/Normalization of magnitude,** make sure **Shift Magnitude** is selected in the list box as shown below.



Below the list box there is a **Shift [dB]:** edit box. Here type the resistance of the resistor. Note that you have to convert it to decibels, that is 20*log10(resistor value). A resistor value of 8 Ohms gives a dB value of 18.06 as shown in the figure above.
Impedance is a linear value. Therefore, in the same dialog box, set the y-axis scaling to linear as shown below.

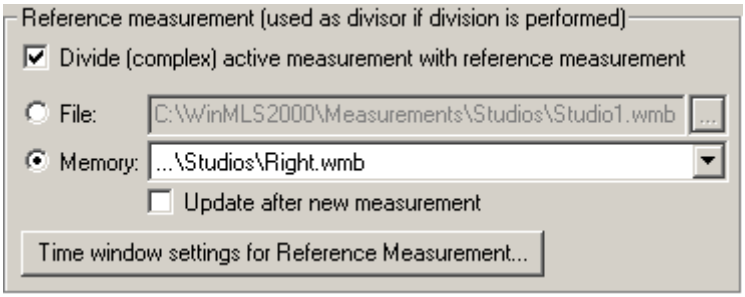
6.5 How to find the level difference of two measurements as function of frequency?

Perform or insert the two measurements you want to see the difference between. Select **Frequency Response - Spectrum** as plot type and one of the measurements as active measurement. This can be done in the **Measurement Selection Toolbar** or in **Plot->Select Plot Type(s) and Active Meas.**

The other measurement must then be set as reference measurement. This is most easily done from the **Measurement Selection Toolbar** also. First make sure the  button is checked, It makes the rightmost list box display the reference measurement if this is taken from memory. (If  is checked, the list box will not display the reference measurement but the measurement in the lower plot). Select the desired reference measurement from this list box. In the figure below, the measurement **Left** is the reference measurement and **Right** is the active measurement.

If the list box is disabled, please do as described below.
Finally perform the division from the **Frequency Plots** toolbar by clicking the  button.

Setting the reference can also be done from the lower part of **Plot->General Frequency Domain Settings...** dialog box. The “reference measurement” part of the dialog box is shown below.



Make sure  is checked. The in the list box below, select the desired "divisor" measurement (**Right** is selected in the example above). If you want to window the measurements, click  . It should be checked that the window settings are equal for the two measurements. When the dialog box is exited with  you should now see the level difference between the measurements as function of frequency.

6.6 How to find the level difference between stereo speakers?

Do as the chapter above using a measurement of left speaker as the active measurement and a measurement of the right speaker as the reference measurement.

6.7 Violin Acoustics

6.7.1 Is it possible to process the impulse excitation using the constant Q transform (CAS Journal, Nov.93, p.1-4)?

The constant Q-transform is similar to octave band smoothing of the frequency response. Please see the chapter "Smoothing or Integration" in "Menus and Dialog boxes.pdf" on how to use this.
The other issues described in the CAS Journal article referred to above is only valid for periodic signals, and not for an impulse response. Ideally the Q-transform is performed using time-windows of increasing size for low frequencies. This feature is not directly supported in WinMLS, but tests using time-windows of different sizes did not show significant improvement using this method.