

Tutorial: Measurement of Reverberation Time with MLS

Requirements

- WinAudioMLS plus reverberation plug-in
- Signalgenerator (PRO)
- Measurement microphone and pre-amplifier
- Loudspeaker with amplifier
- Optional 1/3 octave filterbank plug-in

Features

- Broadband calculation of reverberation time
- Optional 1/1 and 1/3 octave resolution
- Room impulse response measurement with MLS
- Export and import of room impulse responses via .wav files
- Plot of energy decay curve (Schroeder plot)
- Configurable to measure RT60, RT30, EDT (Early Decay Time) and others
- Selection of average range directly at the Schroeder plot using mouse

Definition

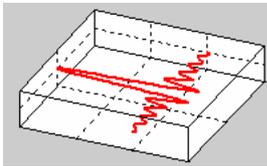
The reverberation time is one of the most important parameters in room acoustics. This parameter indicates the time after the acoustic energy inside a room is below a certain threshold after switching off the sound source. RT60 is widely used, which is defined to be the time after the acoustic energy is below -60dB .

Measurement

You can measure the room impulse directly with an excitation using a short impulse e.g. a shot. WinAudioMLS uses a more sophisticated approach. It uses MLS to calculate the room impulse response using cross-correlation. This approach is highly immune against noise and requires less signal level. Therefore you can use smaller loudspeakers or amplifiers, which makes it ideal for mobile measurements.

From the room impulse response WinAudioMLS calculates the energy decay curve. This curve is the basis for the reverberation time.

Under normal condition the signal level for a decay of 60dB (RT60) is too low to be distinguished from the noise. Therefore the slope is calculated from the initial decay and the decay to e.g. -60dB is extrapolated. You can freely define the part of the Schroeder plot for reverberation time calculation e.g. -10dB to -25dB . You can easily modify the parameters for RT30, EDT or others. With its filterbank you can display the reverberation time with 1/1 and 1/3 octave resolution.



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Alternatively you can calculate the reverberation time from an imported impulse response (via .wav) file.

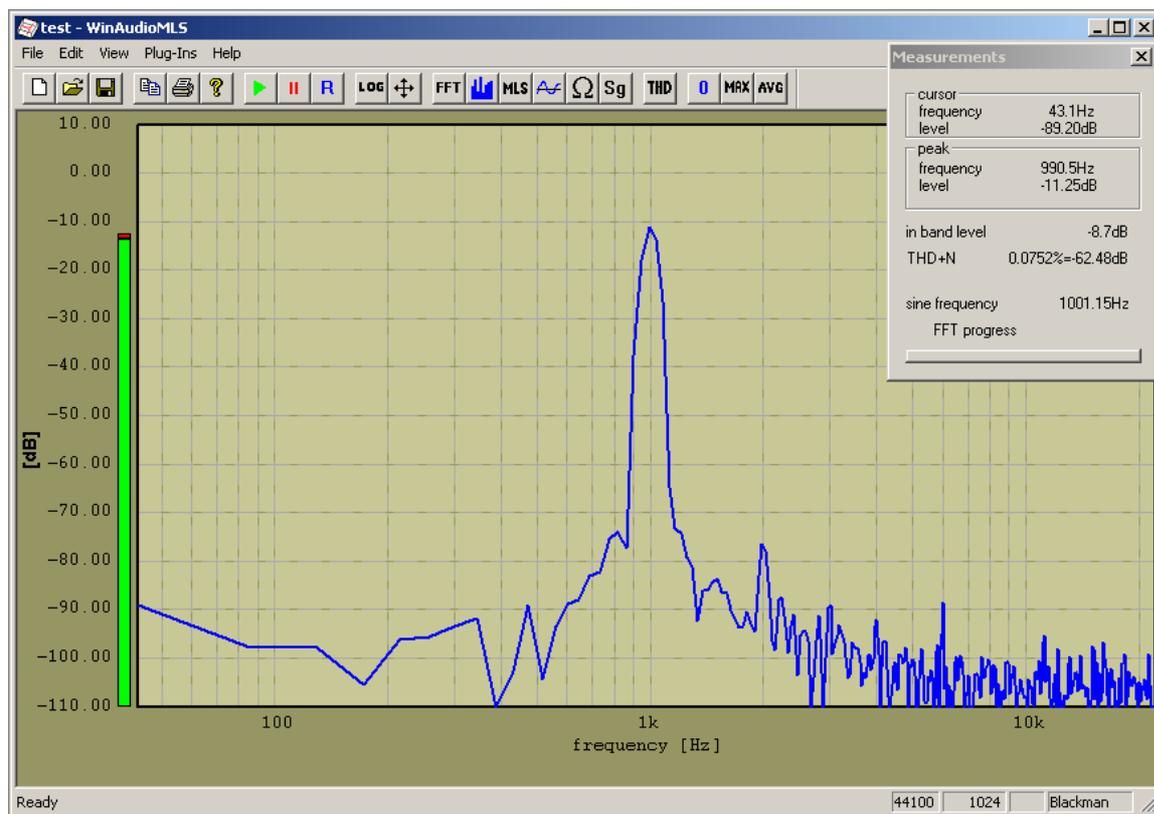
Setup

Connect the amplifier and loudspeaker to the output of the soundcard.
Microphone and optional pre-amplifier must be connected to the input.

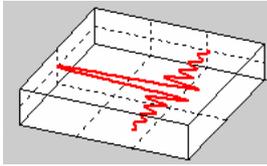
Procedure

WinAudioMLS contains a rich set of features and parameters to configure a measurement. To simplify this process, we integrated wizards that use typical settings to get quick results. Experienced users can override these default settings.

1. Connect all equipment
2. Start the signal generator using its default settings. You should here a sine with 1kHz. Please note that too high levels can easily destroy your valuable equipment.
3. Start the analyzer (WinAudioMLS). You should see the base frequency with a similar plot like the following



These steps are used to verify your setup. You can omit these and use the wizard directly.



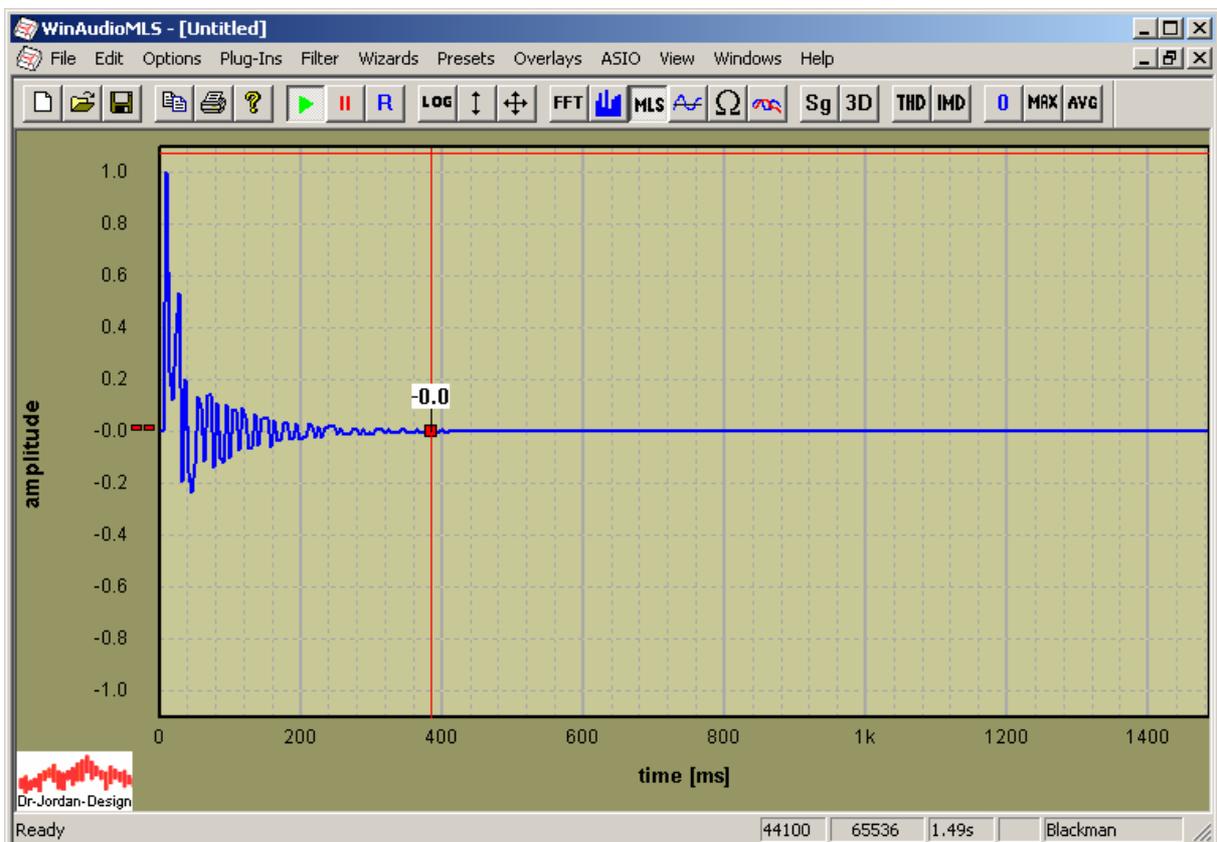
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4. Start the reverberation wizard.

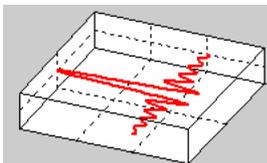
This wizard configures both the analyzer and generator for a typical setting which is suitable for many rooms. You will hear a signal, which is similar to noise. The analyser will show the energy decay curve and the broadband reverberation time. The measurement is correct if you see a linear decay.

Example

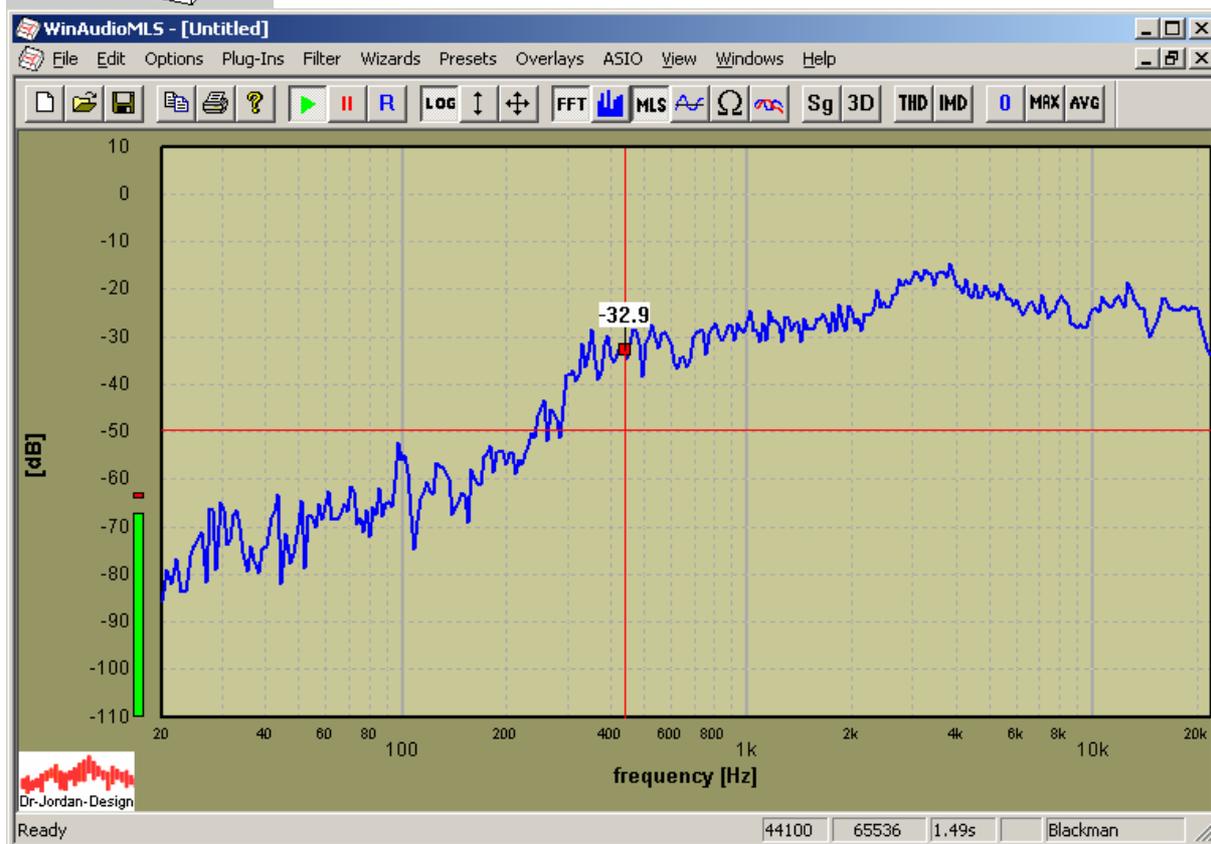
The following picture shows the room impulse response of a small concert hall.



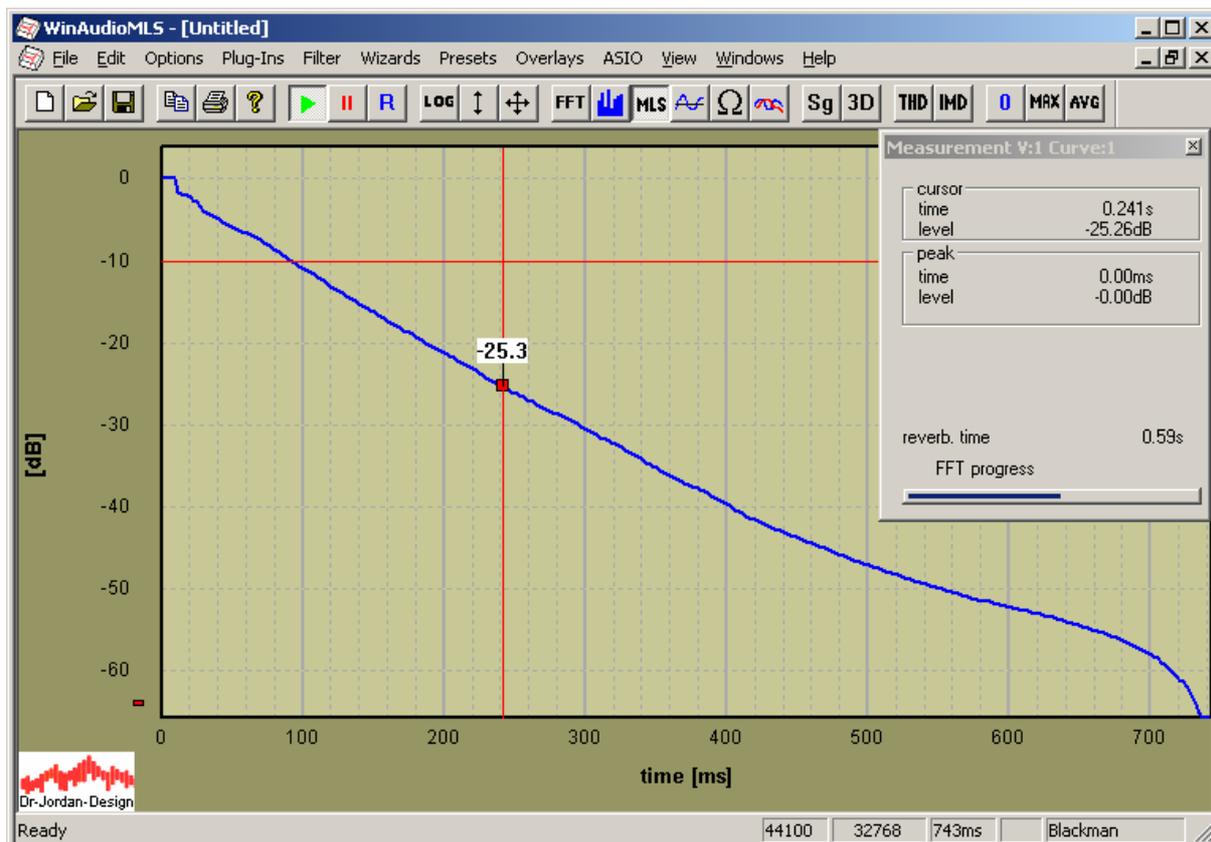
You can also view the frequency response.

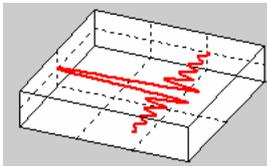


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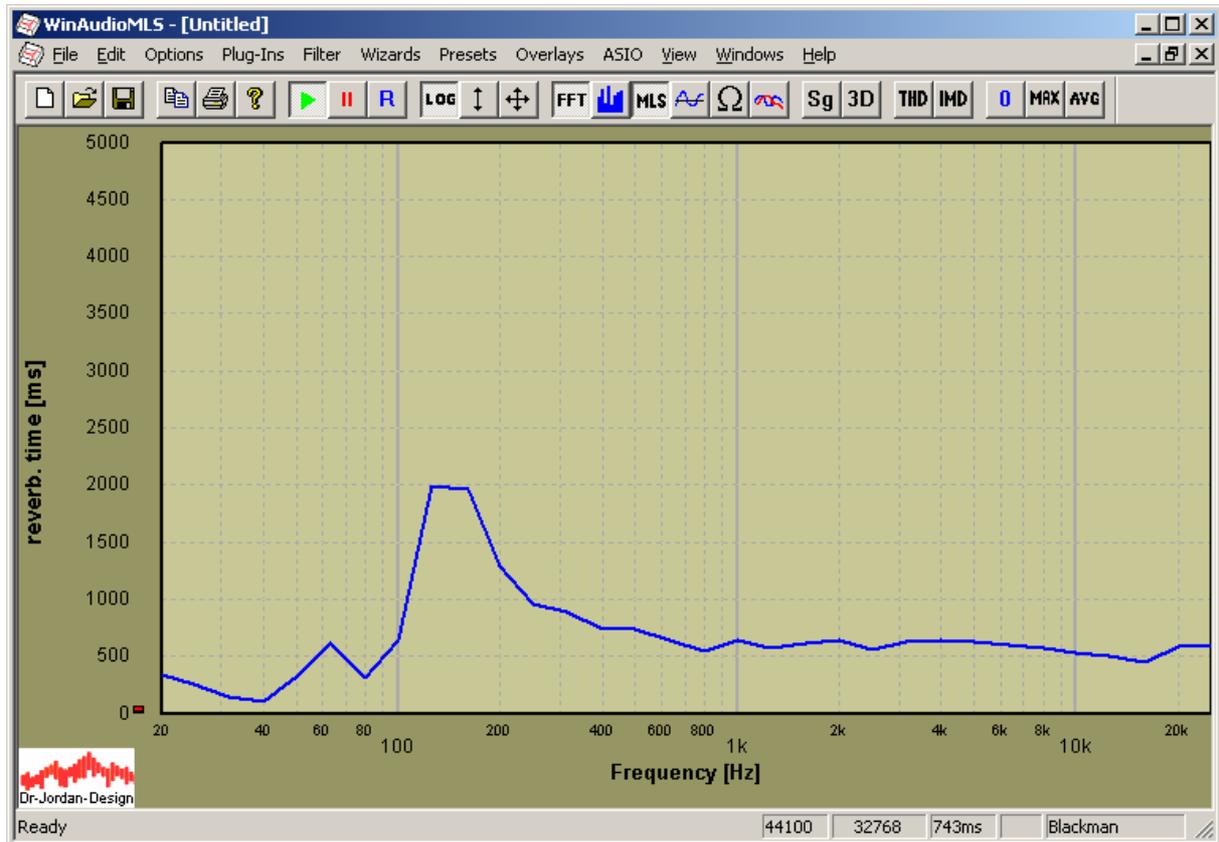
WinAudioMLS calculates the energy decay plot from the impulse response. You can clearly see the linear decay. For this example the reverberation time is 600ms.





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You can also plot the reverberation time with 1/1 octave or 1/3 octave resolution.

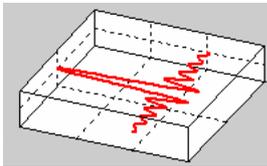


For further analysis or documentation you can view and export the measurement results (view->Show results)

The Results dialog box displays a list of frequency and reverberation time measurements. The data is as follows:

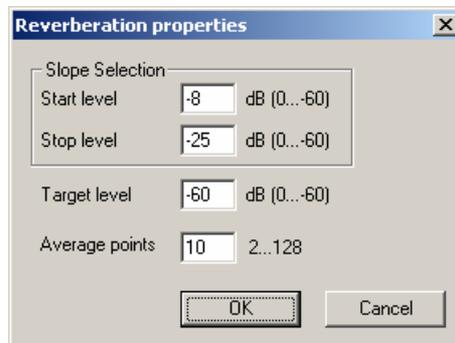
Frequency [Hz]	Reverberation Time [ms]
20.0Hz	389.28ms
25.0Hz	312.44ms
31.5Hz	199.76ms
40.0Hz	204.88ms
50.0Hz	386.71ms
63.0Hz	840.02ms
80.0Hz	486.59ms
100.0Hz	1021.85ms
125.0Hz	2171.75ms
160.0Hz	1931.01ms
200.0Hz	1226.73ms
250.0Hz	939.90ms
315.0Hz	870.75ms
400.0Hz	781.11ms
500.0Hz	747.82ms
630.0Hz	627.45ms
800.0Hz	565.99ms
1000.0Hz	606.96ms
1250.0Hz	604.40ms
1600.0Hz	624.89ms
2000.0Hz	653.06ms

Configuration



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You can configure the calculation of reverberation time in a flexible way. The following picture shows the dialog box with default settings.



You can freely select the part of the slope for calculation with a start and stop level. In addition you can define the number of values, which will be used for averaging (linear regression).

WinAudioMLS can calculate the target value for RT60, RT30 or any other value. In this example we average 10 values from the range of -8dB to -25dB to calculate the reverberation time to -60dB .

Please note, that you can select the range of the slope graphically with the mouse directly at the decay curve.

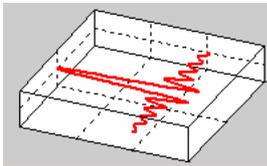
Graphical selection

You can define the area for averaging directly with the mouse. With this feature you can interactively analyse the change of reverberation time in different areas of the curve.

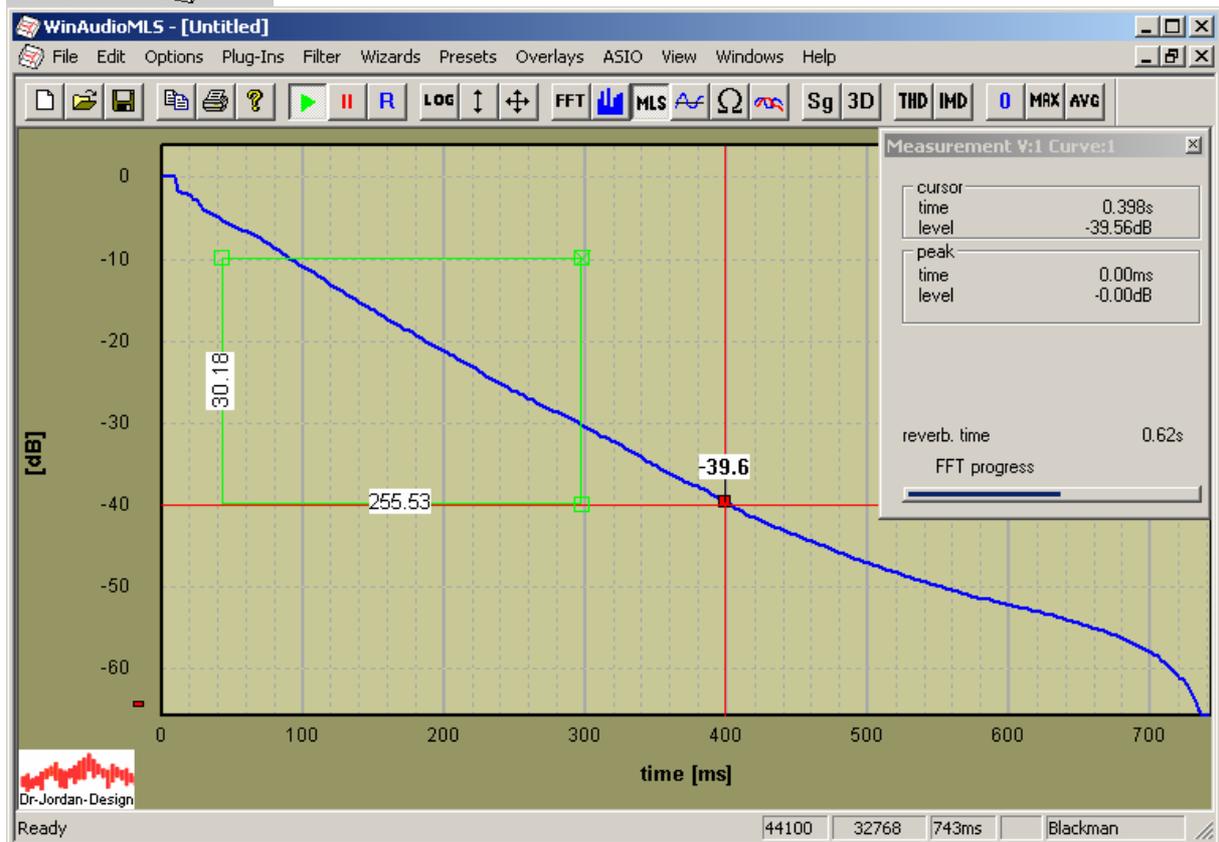
With a double click on the graphic area you can create a measurement rectangle. This rectangle defines the start and stop level. You can move or resize it with the mouse.

WinAudioMLS automatically updates the reverberation time.

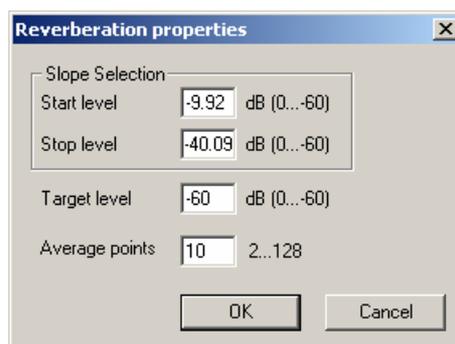
The following example shows a selection between -10dB and -40dB .



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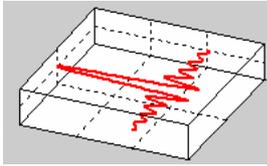


The rectangle defines the start and stop level. These values are transferred to the configuration dialog box.



Notes

For automatic adjustment of the signal generator you will need the PRO version.
A graphical plot of the reverberation time with 1/3 octave resolution requires the filterbank plug-in.



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Checklist

- Did you connect the loudspeaker, amplifiers, microphones correctly?
- Are the mixer settings of your soundcard correct?
- No component of the signal chain shall be overdriven.
- Change the position of loudspeaker and microphone. The measurement works only for diffuse reflections.