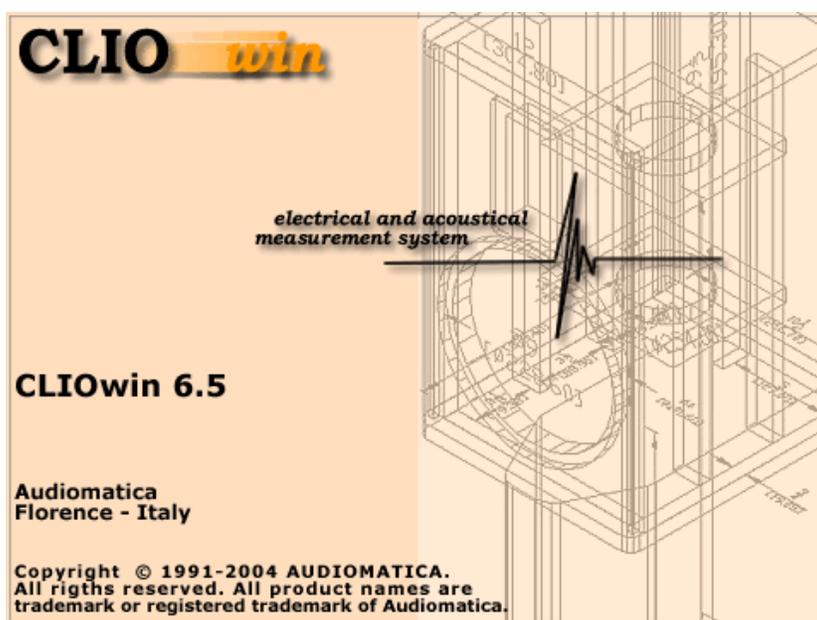


CLIO

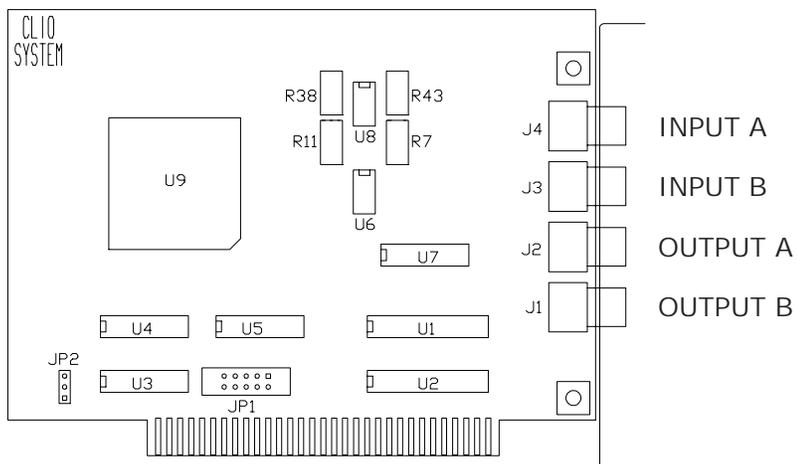
ELECTRICAL & ACOUSTICAL TESTS



User's Manual

Version ISA





The **CLIO** HR-2000 ISA PC board

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Edition 6.51 ISA, March 2004

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1 INTRODUCTION

1.1 ABOUT THIS MANUAL

This User's Manual explains the CLIO system hardware and CLIOwin software. All software versions are covered, please note that CLIOwin software is designed to operate in conjunction with the supplied hardware. If this hardware is absent or the serial numbers do not correspond then CLIOwin will operate in **demo mode** only.

1.1.1 WHAT THIS USER MANUAL DOES COVER

The CLIO System is a complete electro-acoustic analyzer. There are thousands of books on many of the topics that CLIO handles as a measurement system. The simple definition of Frequency Response could be extended to a book itself. This User Manual is intended only as a **guide** to allow the user to quickly become efficient in using the CLIO system, its user interface, its hardware features and limits. Every topic is handled through real life examples with dozens of actual measurement being presented for clarity. It is therefore a HOW TO manual; WHY is left to the reader to explore through other literature and should be considered as essential reading. There is however reference [1], 'Testing Loudspeakers' by Joseph D'Appolito, which, in our opinion, is the perfect complement of what is covered here. Anyone who feels that WHY and HOW is strongly related should seriously consider buying this wonderful book.

1.2 GENERAL CONDITIONS AND WARRANTY

THANKS

Thank you for purchasing your CLIO system. We hope that your experiences using CLIO will be both productive and satisfying.

CUSTOMER SUPPORT

Audiomatica is committed to supporting the use of the CLIO system, and to that end, offers direct support to end users. Our users all around the world can contact us directly regarding technical problems, bug reports, or suggestions for future software enhancements. You can call, fax or write to us at:

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AUDIOMATICA ON-LINE

For any inquiry and to know the latest news about CLIO and other Audiomatica's products we are on the Internet to help you:

AUDIOMATICA website: www.audiomatica.com
CLIOwin website: www.cliowin.com
E-MAIL: info@audiomatica.com

AUDIOMATICA'S WARRANTY

Audiomatica warrants the CLIO system against physical defects for a period of **one year** following the original retail purchase of this product. In the first instance, please contact your local dealer in case of service needs. You can also contact us directly as outlined above, or refer to other qualified personnel.

WARNINGS AND LIMITATIONS OF LIABILITY

Audiomatica will not assume liability for damage or injury due to user servicing or misuse of our product. Audiomatica will not extend warranty coverage for damage of the CLIO system caused by misuse or physical damage. Audiomatica will not assume liability for the recovery of lost programs or data. The user must assume responsibility for the quality, performance and the fitness of Audiomatica software and hardware for use in professional production activities.

The CLIO SYSTEM, CLIOwin and AUDIOMATICA are registered trademarks of Audiomatica SRL.

REGISTRATION CARD

AUDIOMATICA REGISTRATION CARD
(EMAIL OR FAX TO US)

CLIO SERIAL NUMBER: _____

SOFTWARE VERSION: _____

PURCHASE DATE: _____

NAME: _____

JOB TITLE: _____

COMPANY: _____

ADDRESS: _____

ZIP OR POST CODE: _____

PHONE NUMBER: _____

FAX NUMBER: _____

E-MAIL: _____

2 THE CLIO SYSTEM

Depending on the hardware options that have been purchased, the CLIO system consists of the following components:

- The HR-2000 PC board
- The MIC-01 or MIC-02 (also **Lite**) microphones
- The PRE-01 microphone preamplifier
- The ClioQC Amplifier & Switch Box

In the next few pages we will describe each component and give its respective technical specifications.

NOTE: Audiomatica reserves the right to modify the following specifications without notice.

2.1 THE HR-2000 PC BOARD



The HR-2000 board will fit in an IBM (or IBM-compatible) Personal Computer and will perform the A/D and D/A interfacing with the outside world. The board requires a standard 8-bit half-size **ISA slot**. The audio connections are made via four RCA plugs; the lower two are outputs, and the upper two are inputs (see Fig. 2.1). Two adaptor cables with alligator clips are supplied with the board (not in the **Lite** version), and can be used to connect to speaker or component terminals when performing measurements.

2.1.1 TECHNICAL SPECIFICATIONS

GENERATOR

Type: Two-channel 16-bit sigma-delta D/A converter
Frequency range: 1 Hz–22 kHz (+0/–1 dB)
Frequency accuracy: better than 0.01%
Frequency resolution: 0.01 Hz
Output impedance: 100 ohms
Max. output level (sine): 12 dBu (3.1 Vrms)
Attenuation: +12 to -64 dBu in 0.1 dB step + mute
THD+Noise (sine): 0.015%

ANALYZER

Type: Two channel 16-bit sigma-delta A/D converter
Input range: +30 to –40 dBV
Input impedance: 64 kohm
Phantom: 8.2 V (5.6 kohm mic input impedance)

MISCELLANEOUS

Sampling frequencies: 51.2 kHz, 25.6 kHz, 12.8 kHz, 6.4 kHz, 3.2 kHz and 1.6 kHz
Card type: 14 cm, 8-bit PC ISA slot card
Card connections: Four RCA plugs
Adaptor cables to speaker terminals (not supplied in Lite version)

2.2 THE MIC-01 MICROPHONE



The MIC-01 microphone is an electret measuring microphone that is particularly well suited to be used in conjunction with the other components of the CLIO system. It is furnished with its own stand adaptor and a calibration chart reporting the individually measured sensitivity, all fitted in an elegant case. Its long and thin shape renders it ideal for anechoic measurements. Because its frequency response is very flat over the entire audio band, no particular correction is usually needed.

2.2.1 THE MIC-02 MICROPHONE



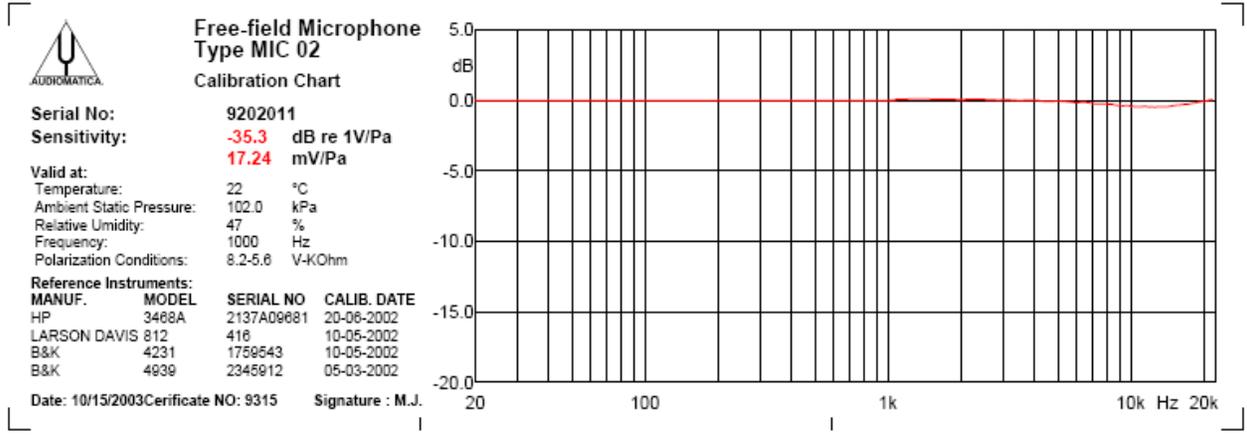
The MIC-02 microphone is functionally identical to MIC-01. It differs only in the fact that its length is 12 cm instead 25 cm. The MIC-02 is more practical to handle and to work with, and is ideal for measurements in a reverberant environment.

2.2.2 TECHNICAL SPECIFICATIONS

MIC-01

Type:	Condenser electret
Accuracy:	± 1 dB, 20 Hz to 10 kHz ± 2 dB, 10 kHz to 20 kHz (direct field)
Maximum level:	130 dB SPL
Dimensions:	8 mm diameter, 25 cm long
Accessories:	wooden case, 2.7 m cable, stand adaptor
MIC-02:	Same as MIC-01, but 12 cm long.

2.2.3 THE MIC-01 (OR MIC-02) FREQUENCY CALIBRATION DATA



The microphones MIC-01 and MIC-02 can be furnished with (or be submitted for) a frequency calibration certificate. This document, along with numerical data on floppy disk, is released by Audiomatica and specifies the frequency behaviour of the single microphone under test. The file data can be used with the CLIOwin software (see 5.4.5).

2.2.4 THE MIC-01 (OR MIC-02) LITE MICROPHONE

In the **Lite** version of MIC-01 and MIC-02 the accessories (wooden case, 2.7 m cable and stand adaptor) are not supplied.

2.3 THE PRE-01 MICROPHONE PREAMPLIFIER



The microphone preamplifier PRE-01 has been designed to match Audiomatica's microphones MIC-01 and MIC-02. It is particularly useful when the microphone has to be operated far from the analyzer or when weighted measurements are needed. PRE-01 powers the microphone connected to its input with an 8.2V phantom supply and adds a selectable weighting filter (A or B or C); also available there is a 20 dB gain stage. The unit is operated with two standard 9V batteries or with an external DC power supply. PRE-01 substitutes the 3381/A preamplifier.

2.3.1 TECHNICAL SPECIFICATION

Frequency response:	7Hz ÷ 110kHz (-3dB)
Weighting filter:	A, B, C (IEC 651 - TYPE I)
Phantom power supply:	8.2V (5600 Ohm)
Gain:	0 & 20dB (INTERNAL SETTINGS)
Input impedance:	5600 Ohm
Output impedance:	100 Ohm
Maximum output voltage (@1kHz):	25 Vpp
THD (@1kHz):	0.01%
Input noise (@20dB gain):	7uV LIN, 5.3uV A
Drive capability:	±7mA
Batteries duration:	>24h (alkaline cells)
Size:	12.5(w)x19(d)x5(h)cm
Weight:	900g

2.3.2 USE OF THE PREAMPLIFIER

The MIC-01 or MIC-02 microphone cable has to be connected to the preamplifier input while the preamplifier output has to be connected to the analyzer input. The unit is switched on with the POWER switch, while the TEST push-button controls the state of the unit; when pressing it, if the led light is on then the unit operates correctly, otherwise not: either the batteries are low or the external power supply is not connected. The FILTER switch inserts the weighing filter. To choose the desired weighting filter type and to set the amplifier gain you have to modify the internal settings as described later.

NOTE: if the 20 dB gain stage is inserted the overall sensitivity (microphone + pre) is 10 times higher. For example if your microphone has a sensitivity of 17.1 mV/Pa and you preamplify it of 20 dB then you get a sensitivity of 171 mV/Pa.

2.4 THE QCBOX MODEL 4 AMPLIFIER & SWITCH BOX



The QCBOX Model 4 amplifier and switch box is of invaluable help when configuring an automatic or manual quality control setup and even in everyday laboratory use. Its main feature is the possibility of **internal switching** that permits the measurement of the impedance and frequency response of the loudspeaker connected to its output sockets without changing the loudspeaker wiring; it is also possible to choose one among four inputs for the response measurements; the internal switching is under software control via the parallel port of the PC. A dedicated output, ISENSE, allows impedance measurements in constant voltage mode as well voice coil current distortion analysis. A dedicated input permits an external foot pedal switch to be connected and trigger QC operations.



2.4.1 TECHNICAL SPECIFICATIONS

Inputs:	Four line/microphone inputs with selectable phantom power supply (8.2V) One TTL input for external trigger
Functions:	TTL controlled internal switches for impedance measurements
Output power:	50W (80hm) with current sensing
THD (@1 kHz):	0.004 %
Dimensions:	23(w)x23(d)x4(h)cm
Weight:	1.4kg
AC:	90 ÷ 240V

3 CLIO INSTALLATION

3.1 MINIMUM PC CONFIGURATION

The CLIO PC board running the CLIOwin software can be fitted in any IBM (or compatible) personal computer with the following minimum system requirements:

- Pentium processor (suggested minimum 133 MHz)
- one free 8-bit or 16-bit half-size ISA slot
- 32 MB RAM
- 800x600 256 color video adapter
- Microsoft Windows 95, 98, or ME (Millennium Edition)
- Microsoft Internet Explorer 4.01
- Adobe Acrobat Reader 4

3.2 HARDWARE INSTALLATION

Note: we strongly suggest you to read all this chapter before proceeding with the hardware installation. Infact, should you need to change the jumper settings to reflect system resources availability then you should repeat this installation!

To install the CLIO board in your computer you should follow the instructions presented below:

- 1) Disconnect the mains power cable from the PC.
- 2) Open the computer cabinet.
- 3) With the motherboard in front of you, identify a free 8-bit (or 16-bit) **ISA** slot. Note that it is preferable to install the CLIO board as far away as possible from the video adapter.
- 4) Insert the CLIO board in the slot and screw it down firmly.
- 5) Close the cabinet.
- 6) Reconnect the mains cable and switch the computer on.

At this point the CLIO board hardware installation is finished.

3.2.1 SOME MORE WORDS ABOUT THE HR-2000 CARD

The CLIO HR-2000 PC board is an ISA legacy hardware. This means:

- 1) CLIO needs, to operate, to be physically installed in a 100% compliant ISA slot.
- 2) Provided an ISA equipped computer meeting the minimum requirements given before, CLIO can operate with any kind of processor, no matter how fast or new this processor is. ISA compatibility, which is a well recognized industry standard, guarantees CLIO's functionality.
- 3) As the word 'legacy' implies, and as it is needed with all other ISA devices, the installation in a Windows environment will go through some manual actions and man-to-machine interactions, at least for changing the on-board jumper and, when needed, for inspecting and modifying the computer BIOS settings. It is not possible to have a 100% automatic and hassle-free installation since Windows is not able to modify these settings.

3.2.2 PC SYSTEM RESOURCES REQUIRED

Before proceeding with the software installation please take note of the following requirements.

The CLIO systems needs the following PC system resources:

- 1) The exclusive usage of DMA channels number 1 and 3.
- 2) A free I/O Address range selectable between the two possible: 300 HEX (using 300-304 range) or 310 HEX (using 310-314 range)

No IRQ is needed.

It is possible to configure the I/O address of the CLIO board, by means of the JP2 jumper, in order to avoid conflicts with other boards that are installed in your computer. Refer to Fig.3.1 where you can see the two possible positions of JP2. The I/O space used by CLIO is five bytes wide, and starts at the base address that has been selected (i.e. 300-304 HEX if the 300 HEX choice has been made). The situation depicted in Fig.3.1a is the factory default.

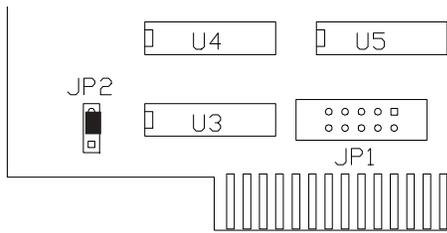


FIGURE 3.1a – I/O address 300 HEX

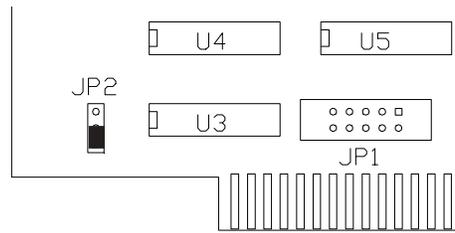


FIGURE 3.1b – I/O address 310 HEX

Jumper JP1 has no effect either on the installation or the current software functionality; it has to be left as factory shipped.

3.3 SOFTWARE INSTALLATION AND HARDWARE REGISTRATION

This paragraph deals with **software installation** and **hardware registration**. Please note that these two steps are distinct and separate; while the first is carried out simply running an automatic procedure the second is a manual procedure that requests you to interact with the Windows operating system.

The CLIOwin software is provided either on its own CD-ROM or, in electronic format, as a single, self-extracting, executable file.

Figure 3.2



In the first case the CD-ROM root will contain a file named **setup.exe** while in the second the file will be named with your system's serial number (**41947124.exe** as in Fig. 3.2); click on these files to start the software installation as in Fig.3.3.

The procedure is completely automatic and will only request you to accept the Software End User's License Agreement and input some information in order to correctly install CLIOwin; the software installer will also check your operating system version and, in certain cases, will request you to restart Windows in order to finalise the installation.

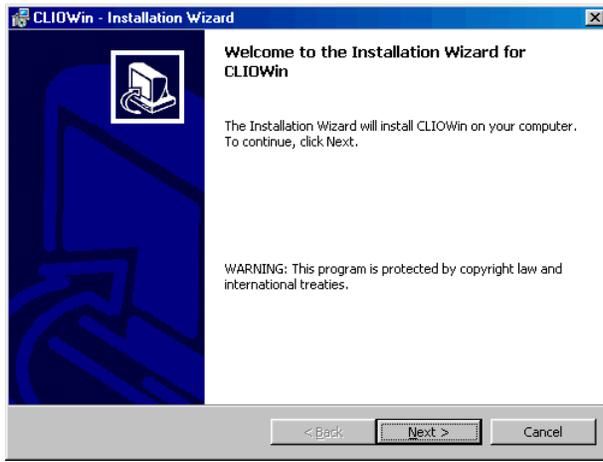


Figure 3.3

After completing successfully this procedure you are ready to go for the hardware registration of your CLIO board. Take note of the installation directory of CLIOwin (usually C:\Program Files\Audiomatica\ClIowin).

Please don't run CLIOwin now! The software is already installed but your CLIO hardware has not been registered with Windows yet. You would surely obtain an error message and your software won't run correctly.

The procedures described refer directly (and are described with examples and figures) to the Windows 98 SE operating system, English version; they can be applied with only minor modifications and appropriate translations to all the other OS and languages.

Let's first inspect the availability of your PC system resources:

Click with the **right** mouse button on the 'My Computer' icon on the Windows desktop. Then click 'Properties' and select the 'Device Manager' tab as in Fig. 3.4.

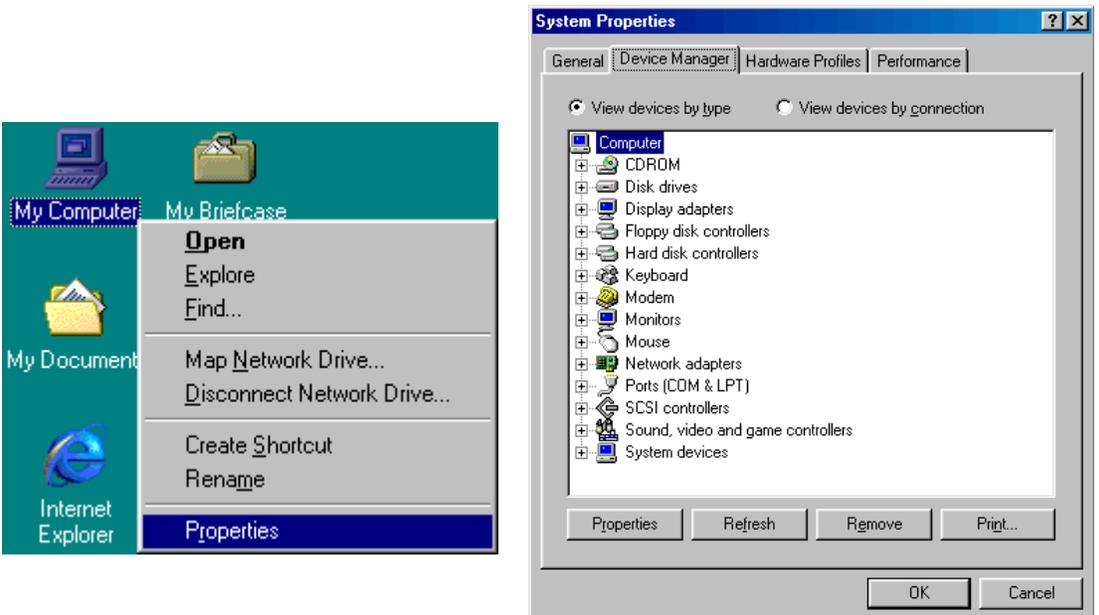


Figure 3.4

Double click on 'Computer'. The Computer properties dialog box appears. Select Direct Memory Access (DMA). Then Select Input/Output. Refer to Fig.3.5.

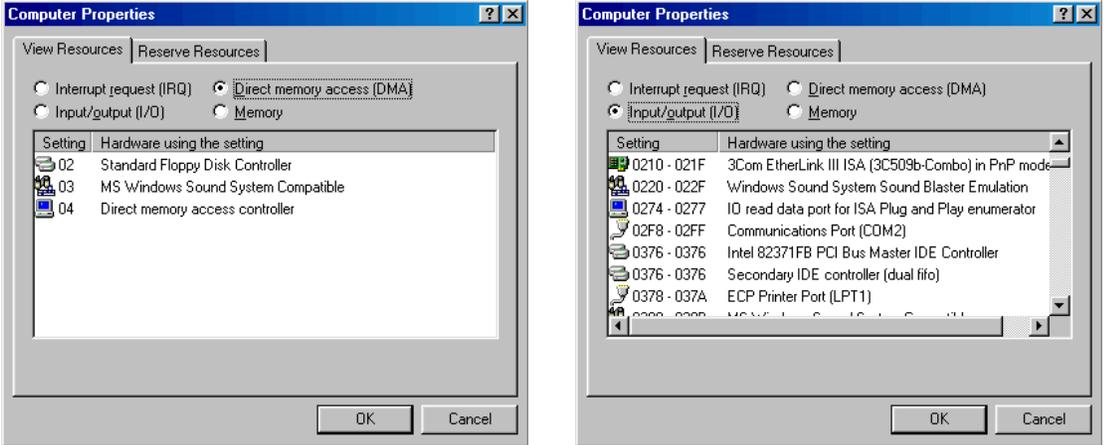


Figure 3.5

The two panels above are of fundamental help since they let you understand what other hardware may conflict with the CLIO board. As said in 3.2.2 CLIO needs DMA channel 1, DMA channel 3 and I/O at either 300Hex or 310Hex. In the example of Fig. 3.5 you can see that I/O is free but DMA channel 3 is taken by an MS Windows Sound System Compatible card: this is a conflict! And you must resolve it otherwise your CLIO hardware will not work.

Resolving a conflict means to free the resources that CLIO needs; when the conflict is hardware you usually need to act manually on the conflicting peripheral and try to reconfigure it, assigning different resources to it. In the example above, you may try to assign DMA channel 0 to the MS Sound System (if supported). If you cannot find a way to resolve the conflict you are obliged to disable or remove it. Sometimes there are what we can call 'apparent' conflicts with some sort of Device Drivers (like legacy sound blaster emulators) or with particularly smart hardware; in these cases Windows does the job for you and, as soon as it finds the CLIO card requesting for certain resources, will free them and be able to configure the other driver or hardware.

In any case you have to go through the 'Add New Hardware Wizard' and try to register CLIO with Windows. Follow this procedure; enter the Control Panel from the Start Menu and then run the Add New Hardware Wizard, as in Fig.3.6.

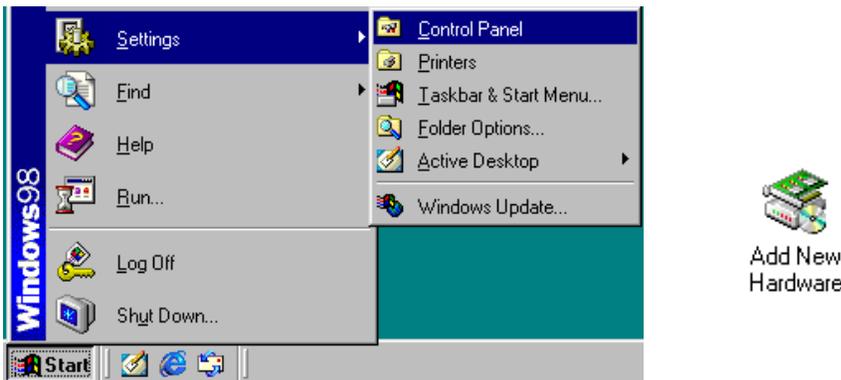


Figure 3.6

The Wizard will first try to locate the Plug&Play Devices in your system. Choose 'No, the device isn't in the list'. At the following prompt choose 'No, I want to select the hardware from a list'.

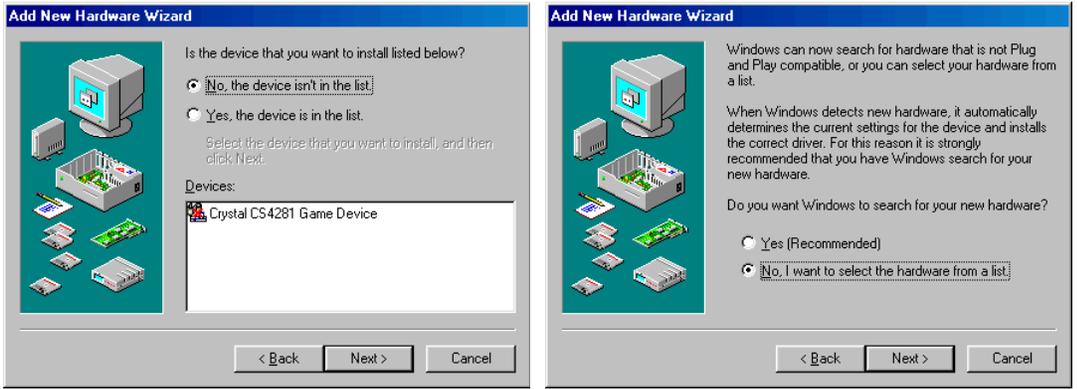


Figure 3.5

Select 'Sound, video and game controllers' from the Hardware types list. Then click Next. Then Press the 'Have Disk...' button.

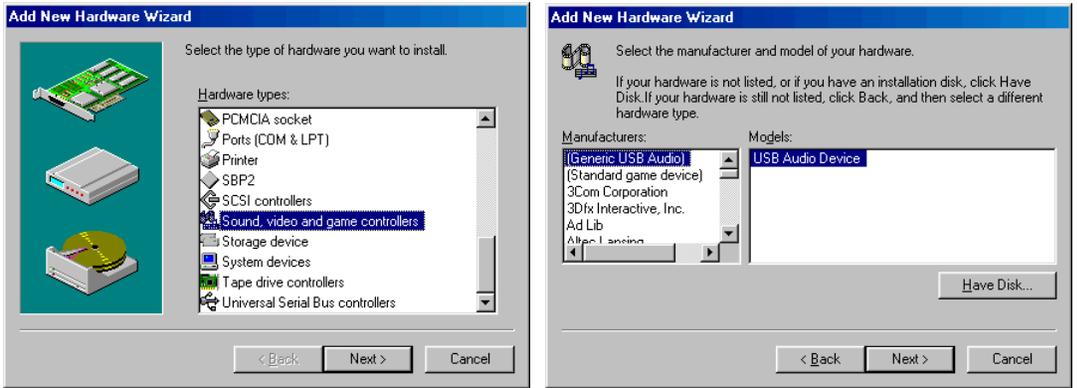


Figure 3.6

Press the "Browse..." button. Select the 'C:\Program Files\Audiomatica\Cliowin' folder (or the installation directory you chose). Choose the **clio.inf** file.

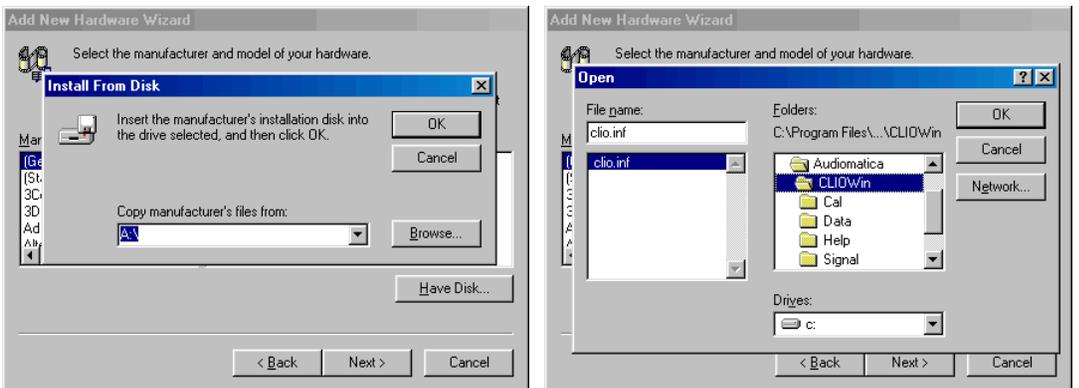


Figure 3.7

Choose the 'Clio HR-2000' hardware and follow the instruction. Windows will now tell you if it was able to assign CLIO the requested resources.

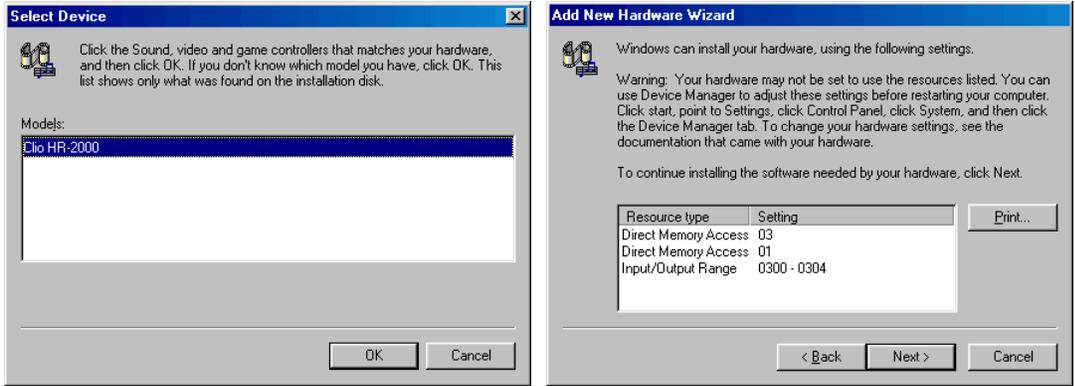


Figure 3.8

In case of success you will receive a message like the one in Fig. 3.8. Windows will then complete the procedure and restart your PC.

Only then you can consider the installation completed and run CLIOwin. Skip the following paragraph and proceed using CLIO for the first time.

Should you receive a warning message you need to suffer a little more... Windows may tell you that it cannot assign CLIO the requested resources and indicate you what hardware is conflicting. At this time you have to through again the procedure described in this paragraph after Windows has rebooted. Take note of all messages that Windows tells you; keep in mind that you can configure your CLIO card by moving the JP2 in order to select one of the two possible I/O ranges. Read the following chapter for a more detailed discussion of possible conflicts.

3.3.1 CAUSES OF CONFLICT

The causes of conflict may be divided in two main categories: peripherals integrated on your main PC board or add-on cards inserted in your mainboard's ISA expansion slots. It is very unlikely that a PCI expansion card is conflicting with CLIO. To troubleshoot your installation you need to locate the conflicting hardware and either reconfigure, disable or remove it.

The **on-board** conflicting integrated peripherals may be:

- 1) Parallel ports configured in ECP mode
- 2) Infrared serial ports
- 3) Audio subsystems

To check if any on-board peripheral is conflicting you have to access your PC's BIOS settings. This is usually accomplished pressing a particular key or sequence of keys while your PC is booting; any PC is telling the user which is the correct key to press to enter BIOS: the most common is the 'Del' key but you may need to press 'F2' or a different one.

When inside BIOS you should locate a menu like 'INTEGRATED PERIPHERALS' inside which there are listed the peripherals present and their settings.

The conflicting ISA **add-on** cards may be:

- 1) Sound cards

- 2) Network cards
- 3) Expansion parallel ports
- 4) SCSI controllers

The main difference with the preceding case when an on-board peripheral was conflicting is that an expansion card may be, for testing purposes, physically removed. This is a quick way for isolating the cause of problems and assessing CLIO's functionality.

In our experience the vast majority of conflicts are generated by:

- 1) On-board parallel ports configured in ECP mode using DMA channel 1 or 3.
- 2) ISA sound cards or on-board audio subsystems using DMA channel 1 or 3.
- 3) ISA network cards using I/O address 300.

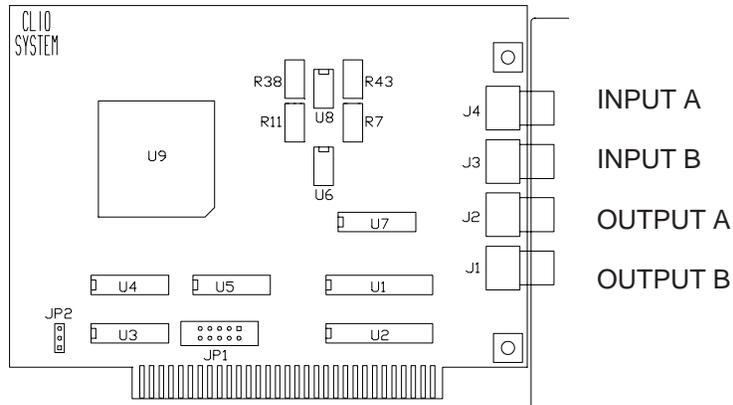
3.4 RUNNING CLIOWIN FOR THE FIRST TIME

If you have completed the preceding installation procedure, you are ready to run CLIOWin!

The steps hereafter described will guide you through a complete verification of the system performance and operation.

3.4.1 INITIAL TEST

Please, take some time to familiarize with your CLIO board and its four RCA plugs. The two upper ones are the input (**A** and **B**), while the lower twos are the output (**A** and **B**).



The board has to be connected as depicted in Fig. 3.9 (with input **A** and output **A** short-circuited); **do not change** this connection throughout all the tests described in this section.

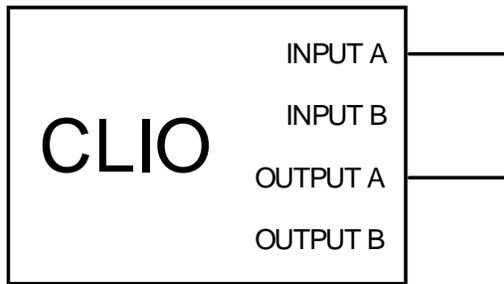


Figure 3.9

From the **Start Menu** choose **Programs**, then **CLIOwin** and click on the CLIOwin icon.



The program should start smoothly and present the main desktop (see 5.3); should it display an error message take note of it and go to the troubleshooting section.

Let's now execute our first test measurement: play and capture an 1kHz sinusoid. Click on the generator icon  to play the 1kHz sinusoid (it's the default signal). Then press the **F4** keystroke to invoke the Multi-Meter as in Fig.3.10.

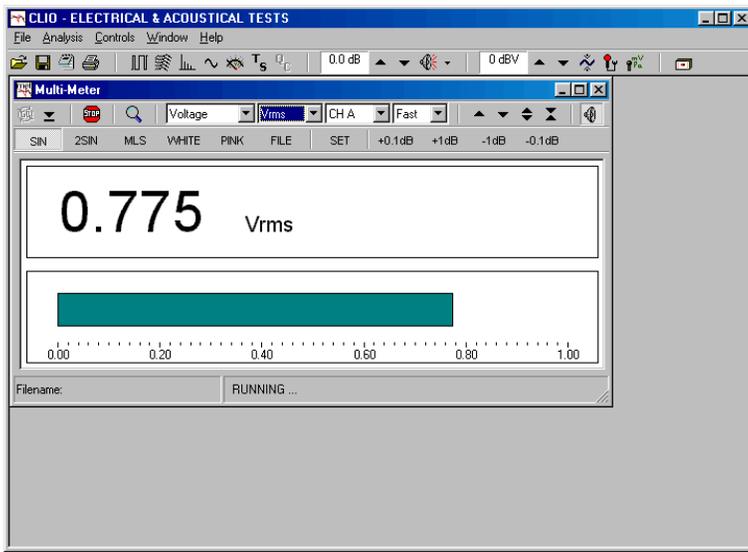


Figure 3.10

If everything is OK you should obtain a reading of circa 0.77V (-2.2dBV) which is the default output level of a sinusoidal signal.

To conclude your initial test execute the calibration procedure described in the following section.

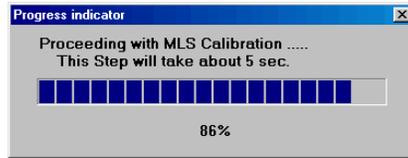
3.5 SYSTEM CALIBRATION

This section describes how to perform the system calibration.

Connect Output A with Input A, referring to Fig.3.9.

Be sure that, any time you perform a calibration, the system has warmed up for, at least, 15/20 minutes.

Select **Calibration** from the **File** menu (6.3.5); answer **yes** to the initial prompt; this will run an automatic procedure that will last several minutes. The calibration procedure is completely automatic and several progress indicators will accompany all the executed measurements. At the end of it your CLIO system should be calibrated and ready to execute measurements.



At the end of the calibration process it is always mandatory to verify the calibration itself; this is done by two simple measurements as described in the following section.

3.5.1 CALIBRATION VALIDATION

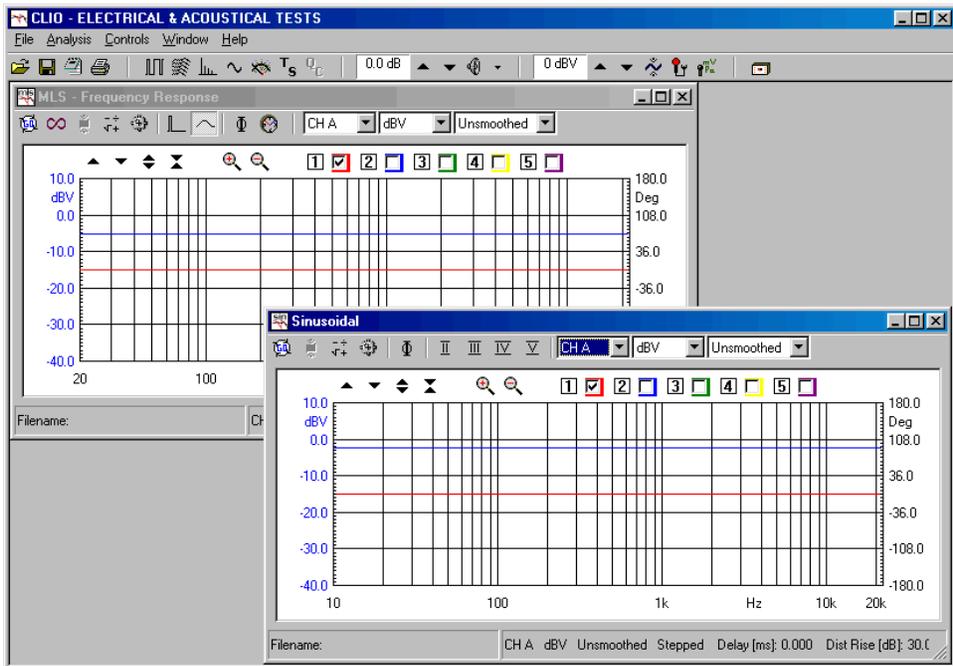


Figure 3.11

To verify the calibration first check that the generator output level is set to 0dBu (refer to 5.4.2 for details).

Then click on the MLS button  to invoke the MLS control panel. Press the Go  button to execute an MLS frequency response measurement; after about **1 second** you should obtain the desired result, a straight line (blue) as in Fig.3.11. You can click on the graph and inspect the amplitude of the measured signal: you should obtain a reading around

-5.2dBV, this is the correct output level of the MLS signal with the generator output set to 0dBu.

Then click on the Sinusoidal button  to invoke the Sinusoidal control panel as in Fig.3.11. Press the Go  button to execute a Sinusoidal frequency response measurement; after about **3 seconds** you should obtain the desired result, again a straight line (blue) as in Fig.3.11. You can click on the graph and inspect the amplitude of the measured signal: you should obtain a reading around -2.2dBV, this is the correct output level of the sinusoidal signal with the generator output set to 0dBu.

To assess a 100% correct calibration you need also to inspect phase responses of both measurements. To do this press the phase button  and verify that you obtain a straight line (red curves in Fig.3.11) also for phase responses; the readings in this case should be around zero degrees in both cases.

3.6 CLIO SERIAL NUMBER AND DEMO MODE

Each CLIO system has its own **serial number** which plays an important role since the CLIOwin software is hardware protected and relies on a correct serialization in order to run.

If the CLIOwin software doesn't find an HR-2000 board installed with a correct serial number gives a warning message and enters what is called a **DEMO mode**; in this way it is possible to run CLIOwin also in a PC where there is not installed the CLIO hardware and perform postprocessing and other off line jobs.

To find the serial number of your CLIO system refer to Fig.3.12 below, inspect the HR-2000 PC board and read the number written on the black square chip (U9) right in the center of the board itself. Please take note of this number and always tell it to Audiomatica when requesting assistance or upgrading software.

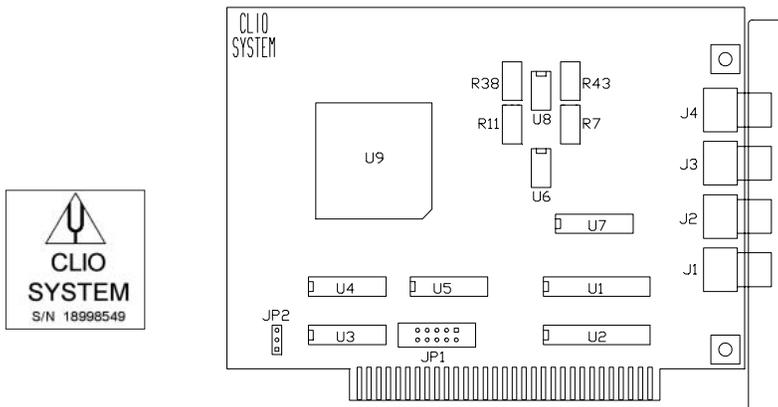


Figure 3.12

4 TROUBLESHOOTING CLIO INSTALLATION

To receive assistance please contact Audiomatica at info@audiomatica.com or connect to our website www.audiomatica.com.

5 CLIOWIN BASICS

5.1 INTRODUCTION

This chapter gives you the basic information about CLIOwin and the related hardware and how to connect and operate it; then you should refer to the various measurement specific chapters to go into more details of single measurements. Chapter 6 deals with other general functionality of CLIOwin.

Here you will find information about:

- **Help**
- **Main desktop, toolbar and menu**
- **Shortcuts**
- **Generator, Input and Output, Microphone**
- **Amplifier&SwitchBox, Turntable**
- **Connections**

5.2 GETTING HELP

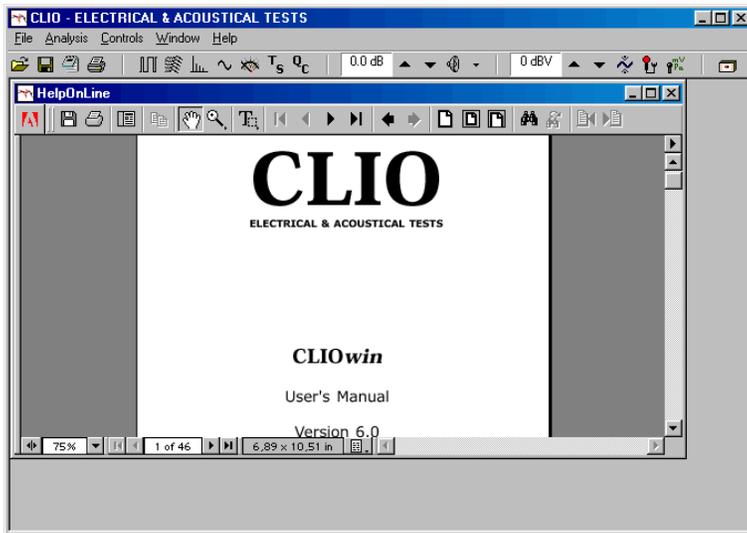


Figure 5.1 CLIOwin Help On-Line

To request the CLIOwin on-line help press **F1**. The on-line help screen (Fig. 5.1) should appear and the context-sensitive search should locate the page appropriate to the currently active menu, dialog or control.

*Note: in order for the CLIOwin help to work you should have installed **Adobe Acrobat Reader** (ver. 4 or later) in your system. The CLIOwin CD-ROM contains a correct version of this utility. Refer to Adobe (www.adobe.com) for any ulterior information.*

The CLIOwin help can be invoked also from outside CLIOwin; to do this go to the Start Menu, then Programs, then Cliowin and then click on 'CLIOwin Help'; in this way Acrobat will let you read and print this User's Manual.

If you are not familiar with Acrobat, please spend some time to familiarize with its capabilities, controls and navigation buttons.

Another way to obtain help is through the Help Menu (see 5.6.5) which gives you the possibility to view also the on-line resources available in the Audiomatica and CLIOwin websites.

5.3 CLIOWIN DESKTOP

The CLIOwin desktop presents itself as in Fig. 5.2 and gives you access to the main menu and the main toolbar.

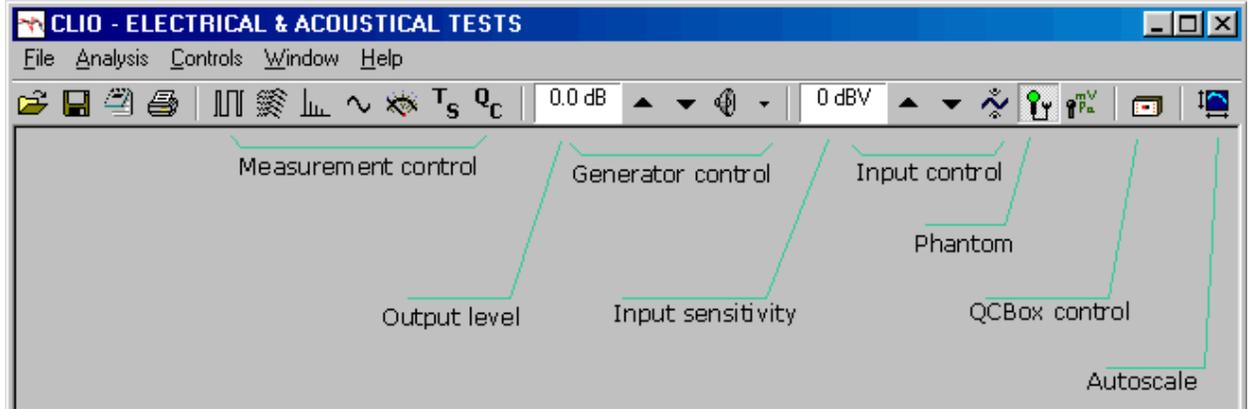


Figure 5.2 CLIOwin Desktop

Inside the main toolbar you may locate several distinct functional area; starting from left to right we have file and print functions, the measurement control, the generator control and display of the output level, the input control and display of input sensitivity, the control for external hardware (ClioQC Amplifier&SwitchBox etc.). Follows a description of all the controls inside the main toolbar.

Refer to Section 5.6 for a detailed view inside the main menu.

5.4 MAIN TOOLBAR

Please refer to Chapter 6 for information about file and print functions.

5.4.1 MEASUREMENT CONTROL

Clicking on these toolbar buttons it is possible to interact and display each measurement control panel; if the control panel is closed then it will be initialized and shown, otherwise it will be simply activated, in respect to the previously active one which will be deactivated.

The same functionality will be obtained with the relative **shortcuts** or making a selection inside the Analysis Menu (see 5.6.2); a third way is to select a window through the Windows Menu (see 5.6.4).

 Enters the MLS Analysis control panel.

 Enters the Waterfall control panel.

 Enters the FFT Analysis control panel.

 Enters the Sinusoidal Analysis control panel.

 Enters the Multimeter control panel.

 Enters the Thiele&Small Parameters control panel.

 Enters the Quality Control Processor.

5.4.2 GENERATOR CONTROL

CLIO's generator can be controlled from the dedicated toolbar buttons and dialogs; another powerful way to manage it (interactively with a level measurement) is from within the Multi-meter control panel, which can be invoked with the **F4** shortcut. Refer to section 8.3.1 for details.

output level display & control buttons

Displays the actual output level (in dBu) of the internal generator. This level is valid for both output channels. It is possible to modify it in **1dB steps** pressing the ▼ (or **F7**) and ▲ (or **F8**) buttons. If the **Shift** key is pressed simultaneously then the steps are of **0.1dB**.

 Switches on and off the generator.

To immediately **kill** the generator it is possible to use the **ESC** key.

If you wish to receive a message (Fig.5.3) before playing check **PromptOnPlay** in the generator drop down menu (see right below).

Clicking on the small arrow aside the button the generator drop down menu is invoked; from there it is possible to choose the output signal to be generated.

The default signal at startup is a 1kHz sinusoid.



Figure 5.3

generator drop down menu

Note: this drop down menu will appear also clicking the SET button within the Multi-meter control panel (8.3.1).

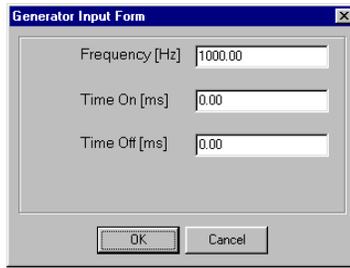
It is possible, from here, to define three kinds of signals or choose from a signal file list. Once you have defined the signal you want to play, then you will control generation simply with the toolbar button . The signal will remain defined until next user definition. The default signal is a 1kHz continuous sinusoid.

Check **PromptOnPlay** if you want to be prompted (Fig5.3) before the generator starts playing.

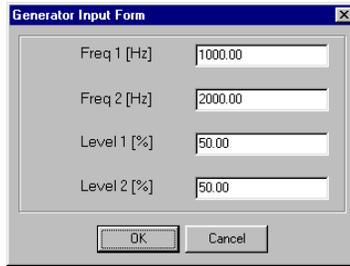


Figure 5.4 Generator drop down menu

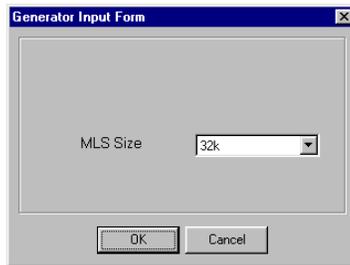
It is possible to generate the following signals:
(Bursted) sinusoid; you can input the sinusoid frequency; if you leave Time On and Time Off at zero the signal is continuous.



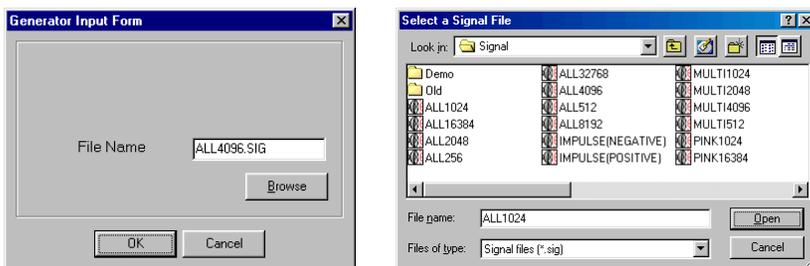
Two tones signal; you can input each tone frequency and relative level.



MLS sequence; you may choose among different sequence lengths.



Signal file; you may choose from the available list of signal files.



5.4.3 INPUT CONTROL

input sensitivity display & control buttons

Displays the actual input sensitivity (in dBV) of the instrument, i.e. the voltage level beyond which the board saturates. It is possible to modify it in 10dB steps pressing the ▼ (or **F9**) and ▲ (or **F10**) buttons.

 Selects the Autorange mode. When in autorange the input sensitivity is automatically adjusted by the instrument to achieve the optimum signal to noise ratio.

5.4.4 MICROPHONE CONTROL

 Switches the phantom power on and off. This 8.2V supply is needed to operate Audiomatica's microphones MIC-01 and MIC-02.

 Enters the Microphone Sensitivity dialog box.

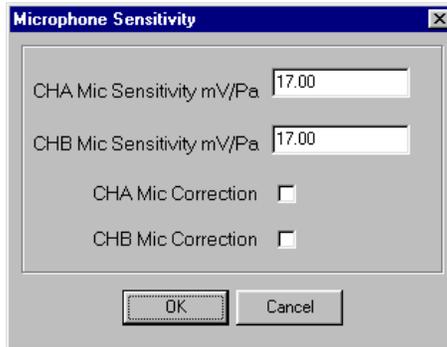


Fig.5.5 Microphone sensitivity dialog

When taking acoustical measurements, the readings and the scales will be in Pascals (Pa or dB SPL). In this case, the software will assume that you are measuring a pressure quantity and it therefore needs to know a conversion factor that defines the voltage produced by the microphone when it is measuring a certain pressure. This conversion factor is usually the sensitivity of the microphone (as found in the microphone's calibration chart) or the sensitivity of the microphone + preamplifier chain of equipment. When working with the CLIO system there are two possible cases:

- you are using the microphone MIC-01 or MIC-02, so it is necessary to input the sensitivity of the microphone (in mV/Pa).
- you are using the PRE-01 preamplifier, it is necessary to know its internal gain; if it is 0dB then input the microphone sensitivity, if it is +20dB then input the microphone sensitivity multiplied by 10.

NOTE: It is necessary to input two separate sensitivities, one for channel **A** and one for channel **B**. When it is selected the **A-B** balanced input configuration (see 5.7.1) the software will use the channel **A** sensitivity.

Please refer also to 8.4.1 where it is described a procedure for assessing the sensitivity of the microphonic chain using an acoustic calibrator capable of producing 94dB SPL.

It is also possible to activate the Microphone Correction check boxes; if activated the software will correct the measured curve according to the data stored in the "MICA.CAL" and "MICB.CAL" files one for each input channel.

The example below shows a sample text file created to store the microphone frequency response:

Freq	dB	Phase
1000	0	0
4000	0.25	0
8000	0.33	0
10000	0.5	0
15000	1.75	0
20000	2.5	0

NOTE: This correction will take effect in the MLS and Sinusoidal measurements only.

5.4.5 AUTOSCALE

 Enables autoscale. When autoscale is active the software, during measurements, determines optimum Y-scale settings.

5.5 EXTERNAL HARDWARE CONTROL

 Enters the External Hardware Controls dialog box. This dialog box performs controls over some external hardware connected to the computer parallel port. It is possible to choose the parallel port to use and then enter the available control panels.

The following figure illustrates the parallel port bits and how they are used by CLIO.

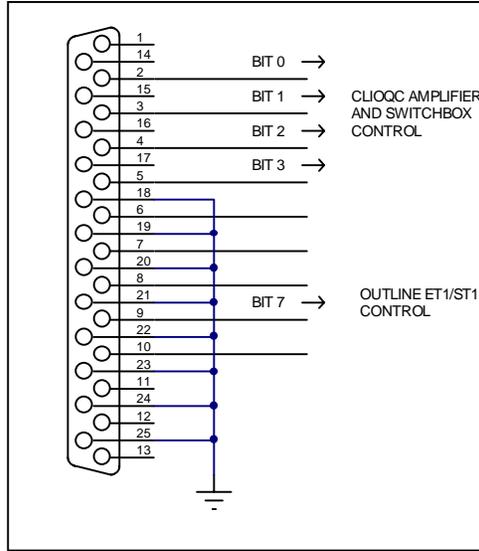


Fig.5.6 Parallel port control signals

5.5.1 CONTROLLING THE CLIOQC AMPLIFIER & SWITCHBOX

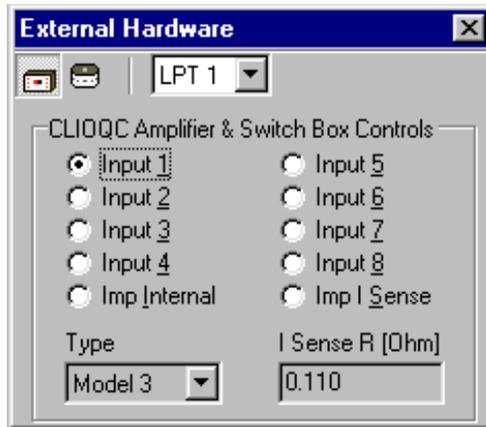


Fig.5.7 CLIOQC Amplifier&Switchbox control panel

This control panel helps you when you are operating the CLIOQC Amplifier&SwitchBox.

You may choose the Amplifier&SwitchBox model and set the value of the internal sensing resistor to obtain maximum precision during impedance measurements (for this please refer to chapter 13).

These controls are self-explaining; they are also treated in the unit's user's manual and, in this manual, everywhere else the amplifier and switchbox is used.

5.5.2 CONTROLLING A TURNTABLE

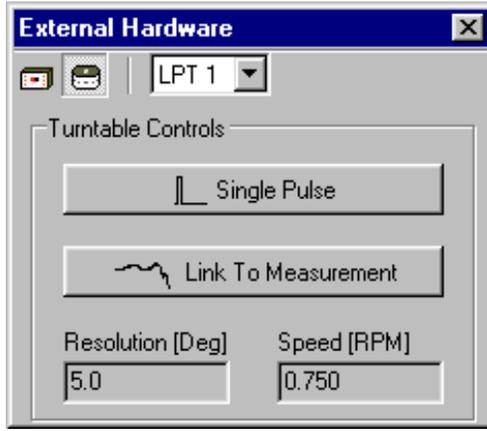


Fig.5.8 Turntable control panel

This control panel helps you when you are operating a turntable; the information given here apply to the control of the **Outline ET/ST Turntable**; they can be adapted to any other device.

The turntable control is achieved with **Bit 7** of the parallel port output bits, as showed in Fig.5.6. The turntable should be connected to the parallel port of the computer by means of a cable defined as follows:

```
PC side DB25 male                ET/ST side DB9 male
Pin 9 <-----> Pin 2
Pin 22 <-----> Pin 4
All other pins unconnected
```

The cable should be connected as in the following figure.

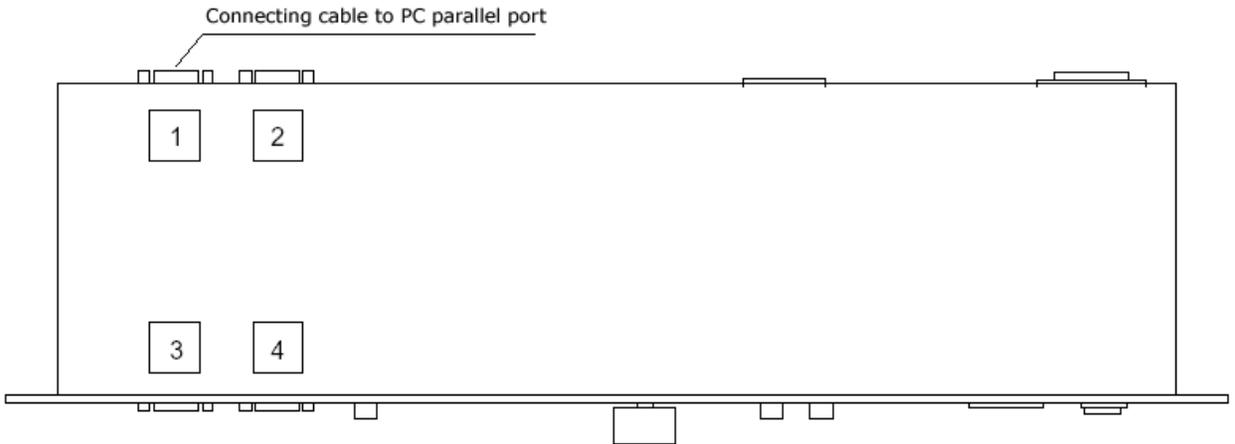


Fig.5.9 Outline ET/ST Turntable connections

Inside the Turntable control panel it is possible to set its **Resolution** (in degrees) and **Speed** (in rotations per minute); the combination of these settings give the software indication about how much time to wait after the controlling pulse is output.

We have two controlling buttons defined as follows:

Single Pulse It is used to give a single manual triggering pulse to move the turntable to the next position.

Link To Measurement When pressed enables the software to move the turntable at the end of an executed measurement; works only with the MLS and Sinusoidal control panels. Refer to chapter 12 for an example of how to use this feature during polar measurements.

5.6 MAIN MENU AND SHORTCUTS

Read carefully this section which gives you a comprehensive list of all the menu and shortcuts active within CLIOwin. Shortcuts, i.e. keystrokes that you can press to obtain a certain action, will save you time and increase your productivity.

Refer also to Chapter 7 to learn the measurement interface and associated shortcuts. Note that the measurement specific (MLS submenu, FFT submenu) menu are active only when the measurement control panel is open and selected.

5.6.1 FILE MENU

Please refer to Chapter 6 for a detailed explanation of the File Menu.



Fig.5.10 File Menu

F3 Saves a measurement file relative to the active control panel.

F2 Loads a measurement file relative to the active control panel.

ALT+F2

Enters the Autosave Settings dialog box (see 6.3.1).

SHIFT+F2

Exports the active measurement as an ASCII file.

CTRL+F2

Exports the active measurement as a Windows Enhanced Metafile.

ALT+P

Prints the active measurement.

F6 Enables/disables the AutoScale function (see 5.4.5).

5.6.2 ANALYSIS MENU

The Analysis menu gives you a powerful way to access measurement menu and menu functions through the keyboard. Here we present you all the available menu and shortcuts; refer to the chapters specific to each measurement for details about it.

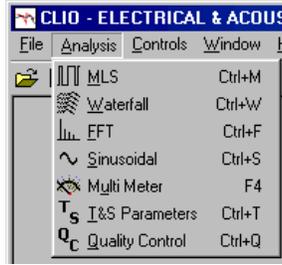


Fig.5.11 Analysis Menu

CTRL+M

Enters the MLS Analysis control panel.

CTRL+W

Enters the Waterfall control panel.

CTRL+F

Enters the FFT Analysis control panel.

CTRL+S

Enters the Sinusoidal Analysis control panel.

F4

Enters the Multimeter control panel.

CTRL+T

Enters the Thiele&Small Parameters control panel.

CTRL+Q

Enters the Quality Control Processor.

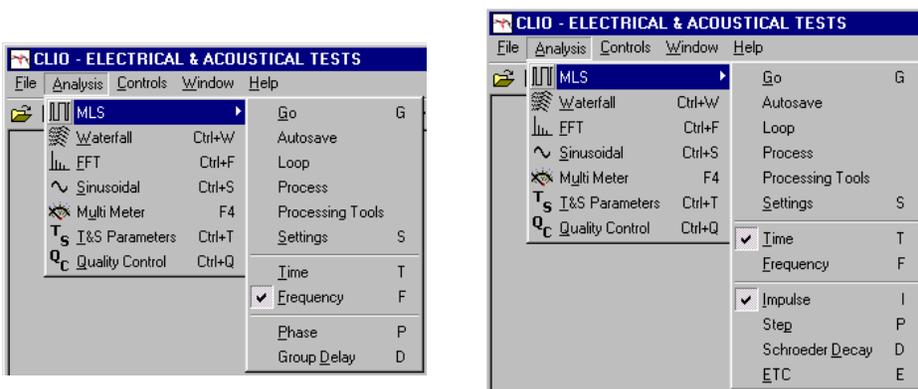


Fig.5.12 MLS Submenu

G Starts an MLS measurement. Equivalent to 

S Enters the Settings dialog box. Equivalent to 

T Enters the MLS Time domain. Equivalent to 

F Enters the MLS Frequency domain. Equivalent to 

And, when in Frequency domain

P Displays Phase. Equivalent to 

D Displays Group Delay. Equivalent to 

And, when in Time domain

I Displays Impulse Response. Equivalent to 

P Displays Step Response. Equivalent to 

D Displays Schroeder Decay. Equivalent to 

E Displays Energy Time Curve. Equivalent to 

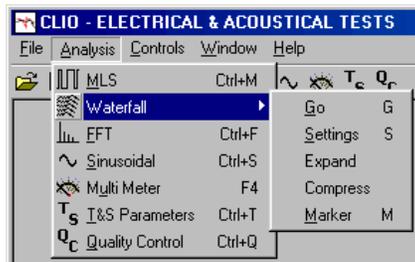


Fig.5.13 Waterfall Submenu

G Starts a Waterfall processing. Equivalent to 

S Enters the Settings dialog box. Equivalent to 

M Invokes marker. Equivalent to 

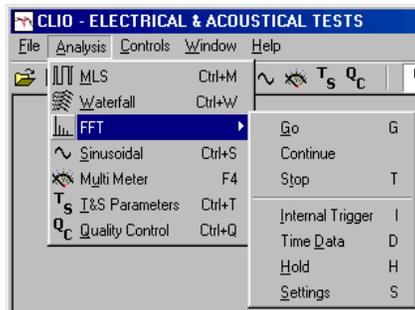


Fig.5.14 FFT SubMenu

G Starts an FFT measurement. Equivalent to 

T Stops the FFT measurement. Equivalent to 

I Sets the Internal Trigger mode. Equivalent to 

D Invokes the Time Data display. Equivalent to 

H Enables the Hold function. Equivalent to 

S Enters the Settings dialog box. Equivalent to 

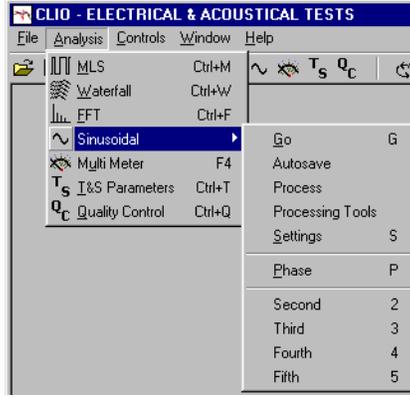


Fig. 5.15 Sinusoidal Submenu

G Starts a Sinusoidal measurement. Equivalent to 

ESC

Immediately stops a Sinusoidal measurement.

S Enters the Settings dialog box. Equivalent to 

P Displays Phase. Equivalent to 

2 Displays second harmonic. Equivalent to 

3 Displays third harmonic. Equivalent to 

4 Displays fourth harmonic. Equivalent to 

5 Displays fifth harmonic. Equivalent to 

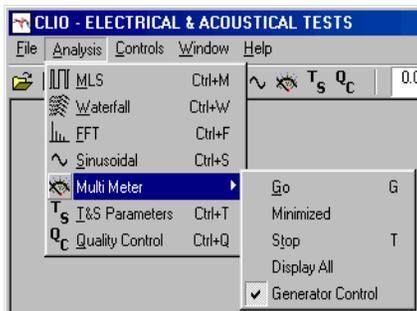


Fig. 5.16 Multi-meter Submenu

G Starts a Multi-Meter measurement. Equivalent to 

T Stops the Multi-Meter measurement. Equivalent to 

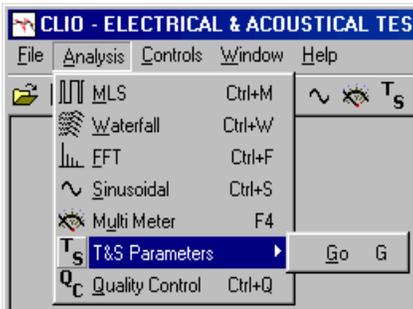


Fig. 5.17 T&S Parameters Submenu

G Starts a T&S Parameters calculation. Equivalent to 

5.6.3 CONTROLS MENU

The Controls Menu is the heart of your CLIO hardware; learn in detail how to access hardware control through the keyboard. Refer also to 5.4.2, 5.4.3, 5.4.4 and 5.5.

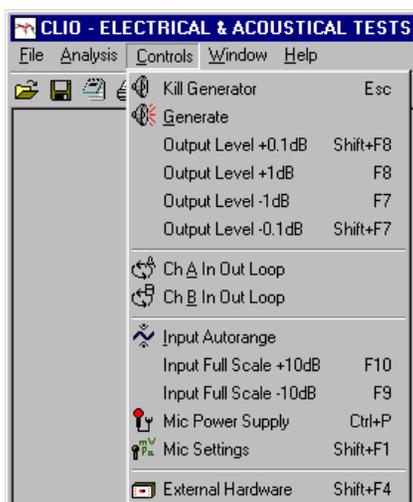


Fig. 5.18 Controls Menu

ESC

Immediately kills the generator. Equivalent to releasing 

SHIFT+F8

Increases the output level of 0.1dB. Equivalent to SHIFT+ 

F8 Increases the output level of 1dB. Equivalent to 

F7 Decreases the output level of 1dB. Equivalent to 

SHIFT+F7

Decreases the output level of 0.1dB. Equivalent to SHIFT+ 

F10

Increases the input acceptance of 10dB. Equivalent to 

F9 Decreases the input acceptance of 10dB. Equivalent to 

CTRL+P

Switches on and off the microphone power supply. Equivalent to 

SHIFT+F1

Enters the Mic settings dialog. Equivalent to 

SHIFT+F4

Enters the External Hardware control panel. Equivalent to 

5.6.4 WINDOWS MENU

The Windows Menu helps you manage all opened windows (i.e. measurement control panels) in a standardized way. You can Tile or Cascade the open windows or access each one directly.

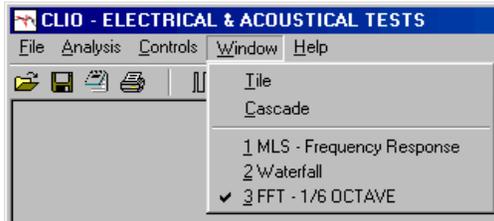


Fig. 5.19 Windows Menu

5.6.5 HELP MENU

From the Help Menu you can access all the available help resources installed in your computer or available directly from Audiomatica over the internet.

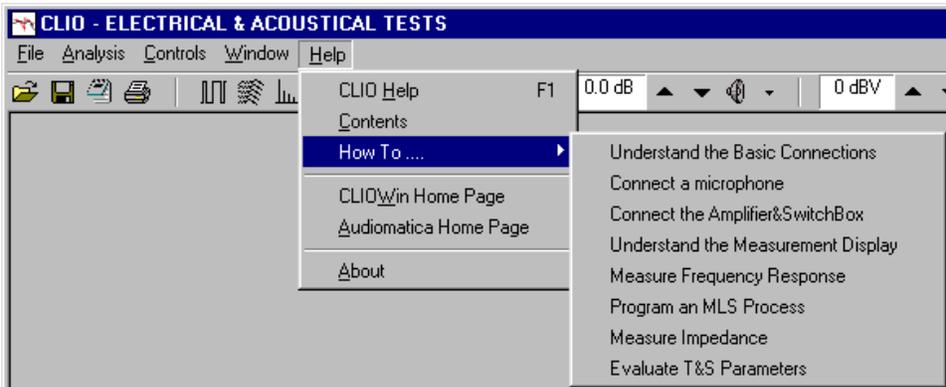


Fig. 5.20 Help Menu

F1 Invokes the On-Line Help.

5.7 BASIC CONNECTIONS

In order to correctly interface CLIO with the outer world you should always keep in mind the following electrical specifications:

MAXIMUM INPUT VOLTAGE:	+30 dBV (89.5 V peak-to-peak)
MAXIMUM OUTPUT VOLTAGE:	+12 dBu (3.1 Vrms) (sine)
INPUT IMPEDANCE:	64 kohm
OUTPUT IMPEDANCE:	100 ohm

5.7.1 CONNECTING THE HR-2000 BOARD

The CLIO board has four RCA plugs that are used to connect it with the outside world (Fig. 5.21). The lower ones, J1 and J2, are the two output, while J3 and J4 are the input. The board is stereo and can simultaneously process two I/O channels which are named channel **A** and **B**. The output of channel **B** is driven in parallel with channel **A** output.

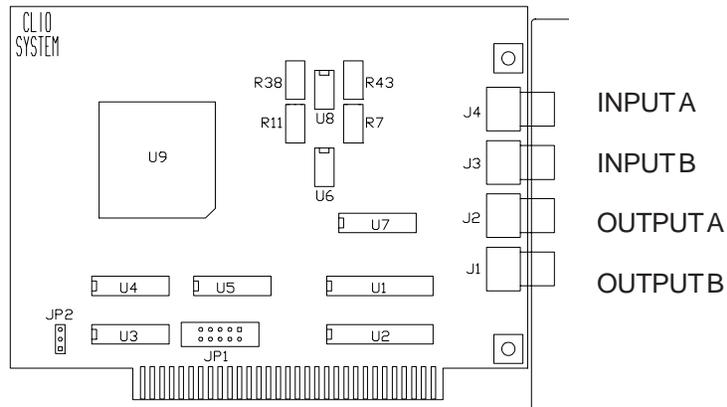


Figure 5.21

The software is able to analyze either the signal present at channel **A** or channel **B** input in an unbalanced configuration or the combined **A-B** signal thus realizing a **balanced** input configuration (Fig. 5.18); in the first case the input connection can be realized with one simple RCA cable while in the latter case it is mandatory to realize a balanced probe that will connect channel **A** input (used as the positive or "hot") to the first measuring point, channel **B** input (used as the negative or "cold") to the second measuring point and ground.

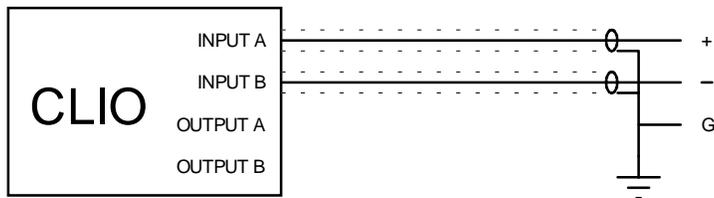


Figure 5.22

WARNING: Both CLIO inputs and outputs are referred to a **common measuring ground**. When you are making measurements in the normal configuration (channel **A** or **B** unbalanced), one of the two measuring points **MUST** be at ground potential! Problems may arise if one tries to use amplifiers with floating outputs; the connection with CLIO could cause damage to such an amplifier. Use the channel **A-B** balanced connection in such cases.

Unless you are executing impedance measurements with the **Internal Mode** selected, one of CLIO outputs will usually be connected to an external power amplifier that will drive the loudspeaker, electronic apparatus, or other system under test.

The output of the system under test will be connected to one of the CLIO input.

5.7.2 CONNECTING A MICROPHONE

For acoustical measurements, you will connect a microphone (optionally followed by a preamplifier or power supply) to CLIO's input channel.

When using a MIC-01 or MIC-02 microphone it is possible to connect it **directly** to CLIO's input; remember, in this case, to switch the phantom voltage on pressing the phantom button . It is good practice to wait a few seconds before taking measurements as the microphone's output stabilizes.

If the measuring point is far from the PC, always lengthen the connection between the preamplifier and CLIO. Make sure that you never use microphone cable that is longer than the one that has been supplied.

In Fig. 5.23 we see the typical test setup for performing acoustical measurements of a loudspeaker. Please **note** this schematic diagram, drawn in the assumption of using one Audiomatica microphone MIC-01 or 02 directly connected to CLIO input; the output of the power amplifier is connected to the loudspeaker with an inversion in cables polarity; this compensates the fact that **MIC-01 and MIC-02 microphones are phase inverting** (as almost the vast majority of measuring microphones found in the market); when making polarity measurements always cure the measuring chain in this respect considering that the CLIO hardware itself is NON-INVERTING and that all calibrations are usually made under this assumption: any external device like amplifiers, microphones, accelerometers, preamplifiers etc. has to be carefully checked.

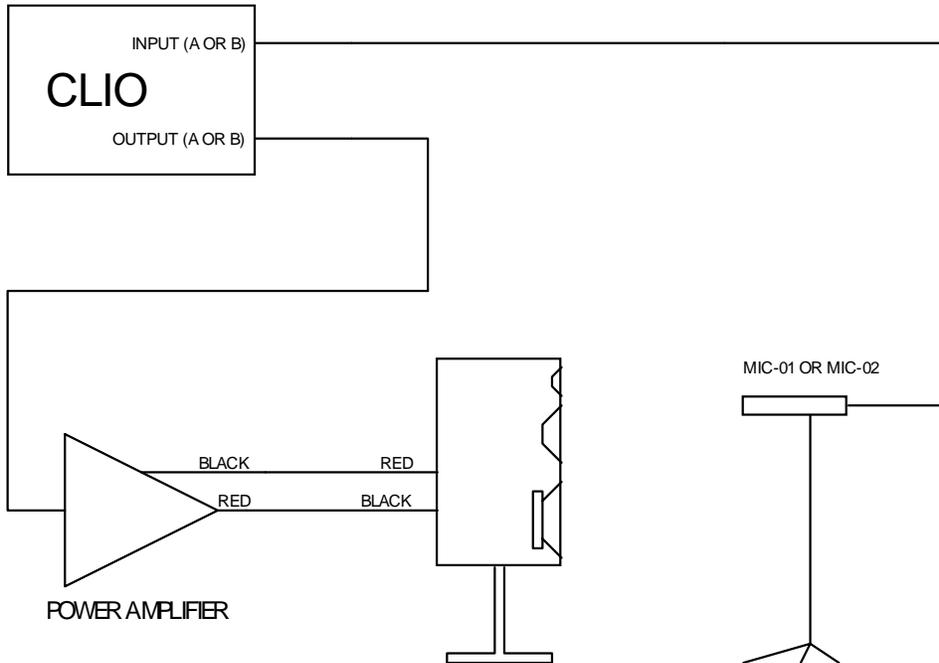


Figure 5.23

5.7.3 CONNECTING THE CLIOQC AMPLIFIER&SWITCHBOX

Fig.5.24 and Fig.5.25 show the connections of a CLIOQC Amplifier&Switch Box to CLIO.

In Fig.5.24 the unit has its internal switcher set for response measurements.

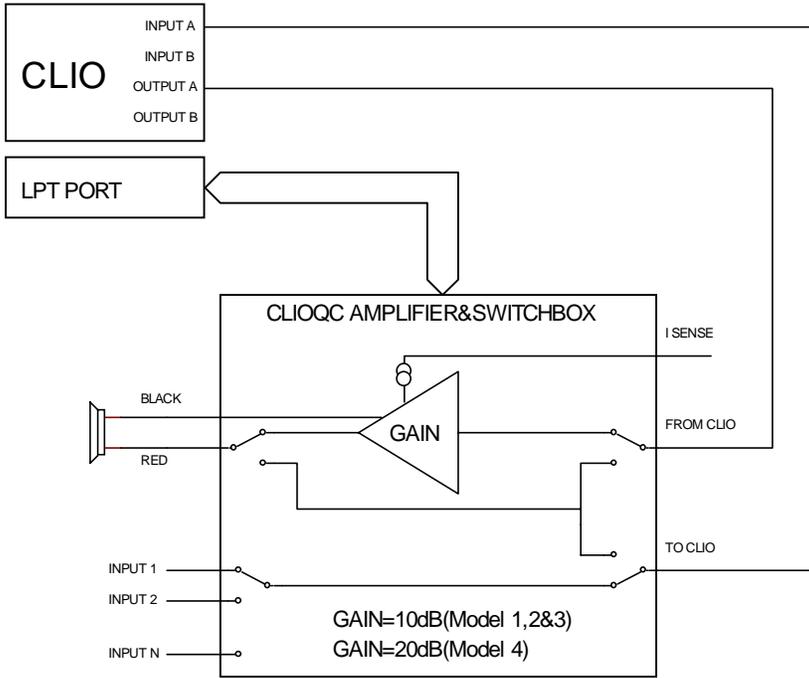


Figure 5.24

In Fig.5.25 the unit has its internal switcher set for impedance measurements (using Internal Mode; refer to Chapter 13 for details).

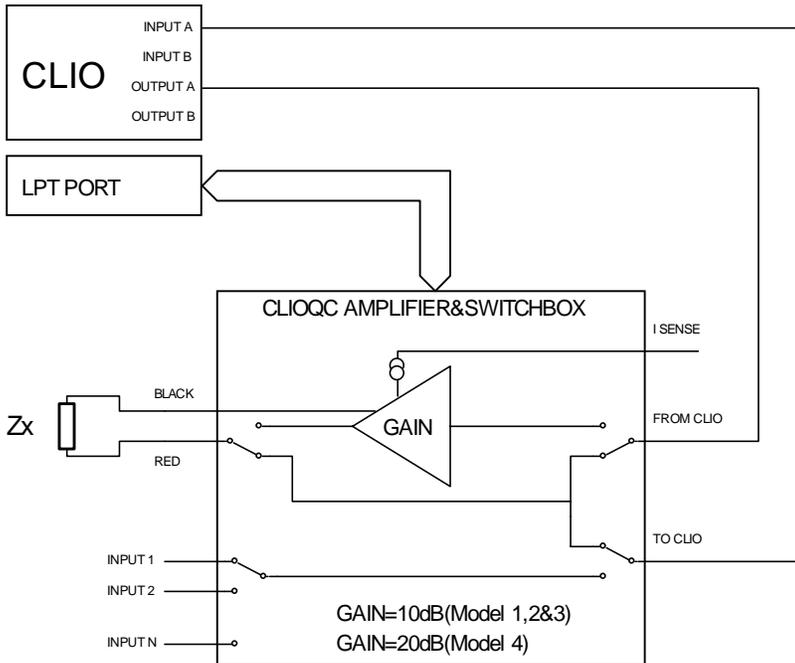


Figure 5.25

6 SYSTEM OPERATIONS AND SETTINGS

6.1 INTRODUCTION

This chapter completes the introduction to CLIOwin started in Chapter 5.

Here you will find information about:

- Files extensions
- File operations
- Printing
- Exporting data
- Exporting graphics
- Calibration of CLIO
- Software setup
- Startup options
- Measurements settings

6.2 REGISTERED FILE EXTENSIONS

CLIOwin registers, during its installation, several file extensions which will let you easily find a file done during your work. Browsing your hard disk you will then encounter the icons that we are going to describe.



MLS frequency response data files.



MLS impedance data files.



MLS process files.



Waterfall data files.



FFT and RTA data files.



Sinusoidal frequency response data files.



Sinusoidal impedance data files.



Sinusoidal process files.



Multi-meter data files.



T&S parameters data files.



Signal files.

When you find a CLIOwin data file it is possible to invoke the program simply clicking on the file itself; if CLIOwin is open it will load the file in the appropriate menu and display it, if it is closed it will also be launched.

It is possible to run only a single instance of CLIOwin.

6.3 FILE MENU AND MAIN TOOLBAR BUTTONS

Fig. 6.1 shows the File menu and the Export submenu. Refer to 5.5.1 for the shortcuts active.



Fig.6.1 File Menu

6.3.1 LOADING AND SAVING FILES

 Loads a measurement file relative to the active control panel. It is important to note that it is possible to load more than one data file type from the following menu:

- **MLS** loads frequency response files (*.mls) and impedance response files (*.mlsi)
- **FFT** loads FFT files (*.fft) and CLIO4 RTA files (*.rta)
- **Sinusoidal** loads frequency response files (*.sin), impedance response files (*.sini), CLIO4 sinusoidal frequency response files (*.frs) and CLIO4 impedance response files (*.imp).

You can select the desired file type from the 'Files of type' drop down inside the Open dialog box.

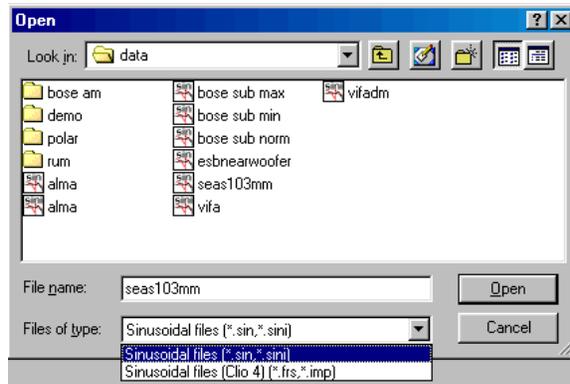


Fig.6.2 Open dialog

 Saves a measurement file relative to the active control panel. It is important to note that the following menu save more than one data file type:

- **MLS** saves frequency response files (*.mls) and impedance response files (*.mlsi)
- **Sinusoidal** saves frequency response files (*.sin) and impedance response files (*.sini)

The extension is automatically chosen by CLIOwin.



Invokes the Autosave Settings dialog. It is possible to define the autosaving rules that will be followed by the measurements capable of this feature (MLS and Sinusoidal).

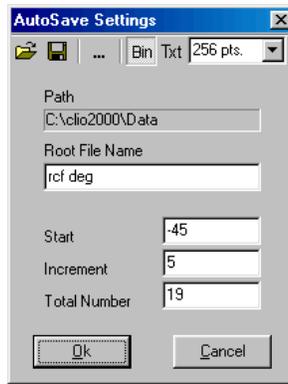


Fig.6.3 Autosave settings

There are four settings which serve to define the autosave file name:

Path defines the folder where the file will be saved; it is possible to choose it clicking on the browse for folder button (...). In Fig.6.3 we see path defined as c:\clio2000\data

Root File Name defines the part of the file name that will not change during autosave; in Fig.6.3 it is 'rcf deg'.

Start defines the initial number appended to the root. This number will always be multiplied by 100 to give space for two decimals management. Numbers are appended with spaces. In Fig.6.3 start is -45; this will define the first autosaved file name as 'c:\clio2000\data\rcf deg -4500'

Increment defines the increment to be given to the autosaved file names. In the example of Fig.6.3 the second autosaved file will be named 'c:\clio2000\data\rcf deg -4000'

Total Number defines the number of autosaved files after which the process is automatically ended

It is possible to choose to save in the standard binary file format (Bin) and/or to export in text format (Txt) (see also 6.3.3); the drop down chooses number of export data points for MLS files.

It is possible to save (and load) these definitions in particular files called Autosave Definition Files (*.asd).

 Enters the Notes dialog where it is possible to input comments to be saved with the actual measurement and inspect other measurement information. Check boxes enable for printing notes and exporting notes to graphics files.

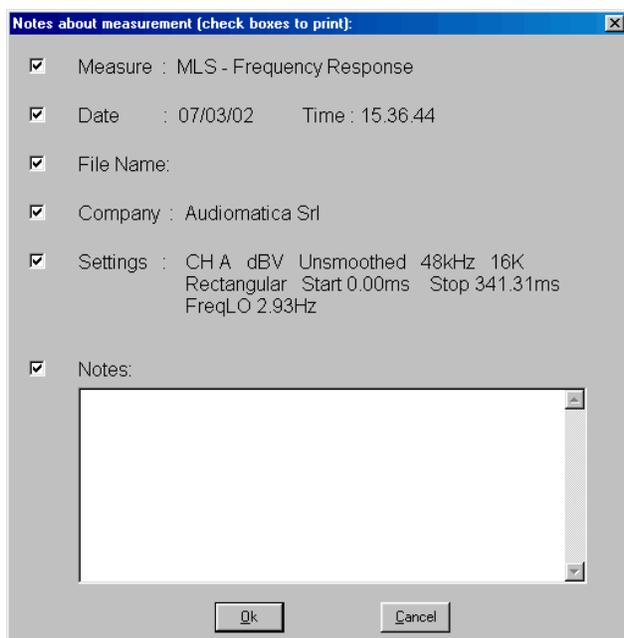


Fig.6.4 Notes dialog

6.3.2 PRINTING

 Prints the current active measurement. The definition of printing colors is done with the Setup dialog, see 6.3.5.

6.3.3 EXPORTING DATA

File > Export > Data

CLIOwin is able to export the currently active measurement in an ASCII file (*.txt).

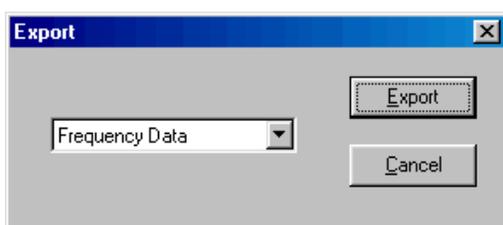


Fig.6.5 Export dialog

Performing this choice you will be prompted by the Export dialog. Depending on the measurement menu you are working with, it will be possible to choose different data for export. Here is a list of the possibilities, menu by menu:

MLS > Display Frequency Data

The program will export the frequency data as they are displayed on the screen, with resolution variable from 256 to 2048 points, regardless the current MLS size.

MLS > FFT Frequency Data

The program will export the frequency data with the resolution of the current MLS size.

MLS > Time Data

The program will export the acquired impulse response or active post process.

FFT > Display Frequency Data

The program will export the processed frequency data as they are displayed on the screen, with its internal resolution of 2048 points, regardless the current FFT size.

FFT > FFT Frequency Data

The program will export the processed frequency data with the resolution of the current FFT size.

FFT > Last FFT Data

The program will export the last calculated FFT frequency data with the resolution of the current FFT size.

FFT > Last Time Data

The program will export the last captured time data with the resolution of the current FFT size.

Sinusoidal > Frequency Data

The program will export the acquired frequency data with their fraction of octave frequency resolution.

Sinusoidal > Frequency Data + Harmonics

As above plus harmonics data.

T&S > T&S Parameters

6.3.4 EXPORTING GRAPHICS

File > Export > Graphics

CLIOwin is able to create **enhanced metafiles** (*.emf) or **bitmaps** (*.bmp) of the currently active measurement. The graph is drawn using the same color of printouts; you can define them with the Setup dialog, see 6.3.6.

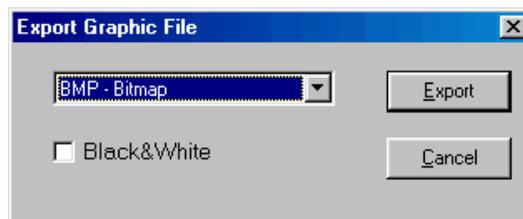


Fig.6.6 Export Graphics dialog

When exporting bitmaps check the Black&White box to greatly reduce the size of the generated file, while losing color information.

6.3.5 CALIBRATION

File > Calibration

This option will perform a calibration of your CLIO hardware. Please refer to paragraph 3.5 and follow the procedure described.

In order to determine, at any given time, if it is necessary to calibrate CLIO do the following:

- Let the system warm up
- Proceed to perform the verification described in 3.5.1
- Consequently decide whether or not to calibrate

The result of the measurement may vary in some way from the time we calibrated because of many small changes in measurement conditions, including changes in the atmospheric conditions, the season, and the mains voltage.

Note: the CLIO hardware is highly precise and stable and, under normal operating conditions, does not require frequent calibrations.

Always perform a calibration if:

- You reinstalled CLIO in a different computer
- You installed a software upgrade

6.3.6 SETUP

File > Setup

This option gives you access to the setup dialog (Fig. 6.7), where you can define the following:

- Screen Colors
- Print (and graphics export) colors
- Screen line width
- Print (and graphics export) line width
- The Company Name which will appear in all printouts.

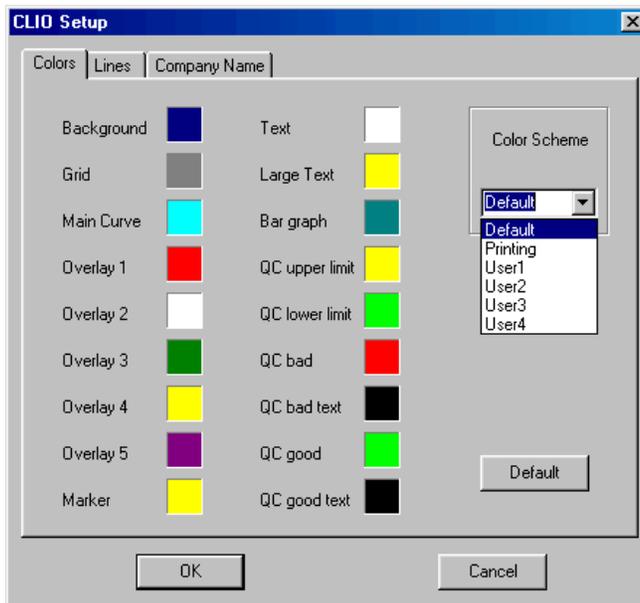


Fig. 6.7 Setup dialog

Apart from the Default color scheme, which is not changeable, it is possible to define up to 5 color schemes, User1, User2, User3, User4 and Printing.

The **Printing** color scheme, as the name implies, will affect your printouts (and exported graphic files) and, if selected, will let you preview, on your screen, how they appear.

When defining a color scheme you may press the default button which will load the Default scheme for your reference.

File > Setup>QC

From this tab (Fig.6.8) it is possible to select the **serial port** used, inside QC, to control external RS-232 devices.

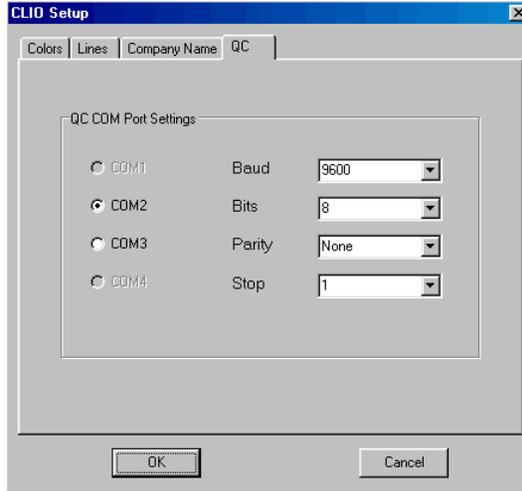


Fig.6.8

6.3.8 STARTUP OPTIONS AND GLOBAL SETTINGS

You can start CLIOwin directly clicking on the **cliowin.exe** executable that is saved in the installation directory (usually C:\Program Files\Audiomatica\ClIowin); you may access CLIOwin either from **Start Menu > Programs > Cliowin** or creating a shortcut on your Desktop.

A second way to run CLIOwin is to click on a registered file; in this way you will not only run the program but also load the file into the appropriate measurement menu.

CLIOwin relies, during startup, on a configuration file named **clio.stp** which resides in the installation directory.

This file is written each time the program ends and saves several settings that will be reloaded and reconfigure your system.

Among them we find:

- generator output level (see 5.4.2)
- input sensitivity (see 5.4.3)
- phantom power supply state (see 5.4.3)
- autorange state (see 5.4.3)
- microphone settings (see 5.4.4 and 7.4.1)
- CLIOQC Amplifier&SwitchBox settings (see 5.4.5)
- color scheme and other setup settings (see 6.3.6)
- main window state
- multi-meter generator control state (see 7.2.1)
- global reference level (see 7.3.3)
- autoscale state (see 5.4.5)

Note: It is possible to return the system to its initial default state (after installation) deleting the clio.stp file.

6.3.9 SAVING MEASUREMENT SETTINGS

Measurements settings can be saved from within the MLS, FFT, Sinusoidal and Waterfall menu; to do this simply check the Save Settings box in the Settings dialog of each menu (Fig.6.9); refer to chapters 9, 10, 11 and 12 for details on settings.



Fig.6.9 Save Settings check box

Settings are saved in the **mls.stp** (MLS), **sin.stp** (Sinusoidal), **fft.stp** (FFT) and **wtf.stp** (Waterfall) files inside the installation directory.

Upon finding one of these files CLIOwin will reset the corresponding menu to the saved settings.

7 COMMON MEASUREMENT INTERFACE

7.1 INTRODUCTION

This chapter deals with the graphical user interface which is used to display and manage the measured curves within all CLIOwin frequency measurement menu. In particular this Common Measurement Interface (CMI) is used by the FFT, MLS and Sinusoidal menu. The understanding of CMI behavior and capabilities is very important to use CLIOwin at its best.

7.2 UNDERSTANDING THE DISPLAY IN FRONT OF YOU

Fig. 7.1 explains the main objects found in a frequency response measurement display.

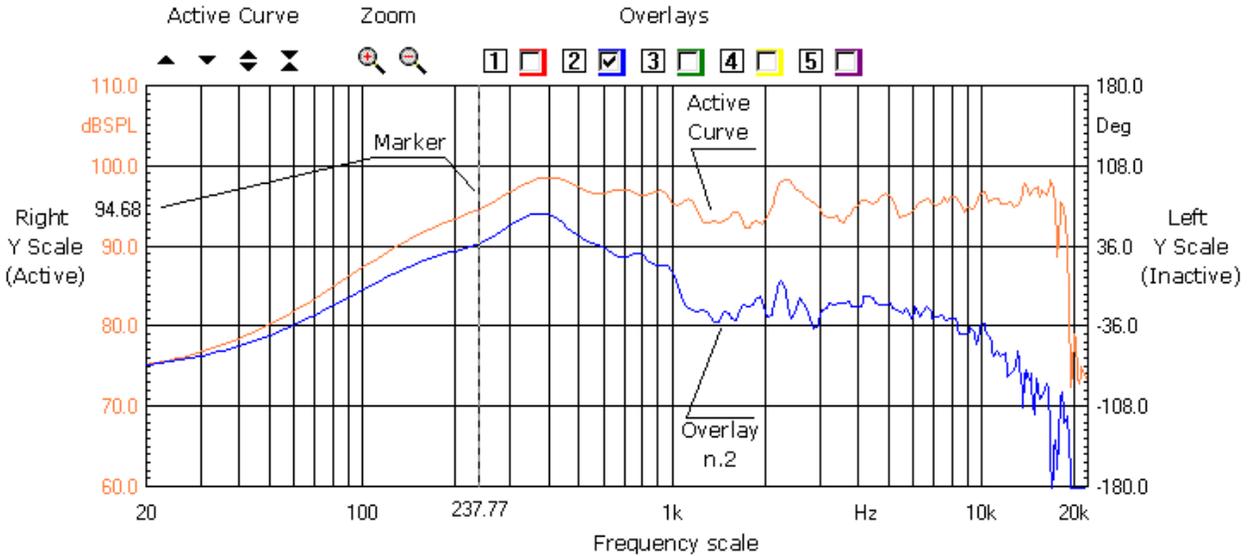


Figure 7.1

Inside the graph you find the **active curve** which reflects an executed (or loaded from disk) measurement, up to five **overlays curves** which are stored by the user and can be switched on and off interactively, the **marker** which is activated clicking with the mouse in the graph area.

Above the graph itself we find several buttons and checkboxes which divide in three main categories: active curve, zoom and overlays management.

Aside and below the graph we find the Y Scales, the Frequency (or Time) Scale and Marker Indicators. One of the two Y scales is of the same color of the active curve and refers to it. The marker indicators give the user the reading of the active curve.

The objects described may, from case to case, not all be present at the same time, as in the case of Time Data display in the FFT menu. The frequency (or time) scale may be logarithmic or linear. A particular representation is the MLS time domain which will be discussed later in 7.5.

It is possible to have two graphs in the same control panel (see FFT). In this case one is referred as active after you have clicked on it.

To change the colors of the screen, active curve and overlays refer to section 6.3.6.

7.3 BUTTONS AND CHECKBOXES

▲ Moves (shifts) the active curve upward.

▼ Moves (shifts) the active curve downward.

◆ Expands (magnifies) the active curve; it also changes the Y scale respectively.

⌵ Compresses (reduces) the active curve; it also changes the Y scale respectively.

🔍 Zooms the active curve in; it is possible to execute multiple zoom in actions.

🔍 Zooms out the active curve completely i.e. returns to the default initial zoom state.

1 Stores the active curve into overlay 1. It also displays overlay 1.

2 Stores the active curve into overlay 2. It also displays overlay 2.

3 Stores the active curve into overlay 3. It also displays overlay 3.

4 Stores the active curve into overlay 4. It also displays overlay 4.

5 Stores the active curve into overlay 5. It also displays overlay 5.

Switches on and off the respective overlay. It also shows the color of the overlay.

7.4 HOW TO ZOOM

1) Click on the Zoom+ 🔍 button.

2) Position the mouse and PRESS the left mouse button at the beginning of your selection and **maintain the mouse button pressed**. Don't just click otherwise you get a warning message!

3) With the mouse button pressed move the mouse until the second selection point.

4) Only now release the left mouse button.

Be careful: you must have the button pressed from point 2) to point 4)!

7.5 SHORTCUTS AND MOUSE ACTIONS

The following keystrokes and mouse actions are active:

up arrow

equivalent to ▲ on the active graph

Shift+up arrow

equivalent to ◆ on the active graph

down arrow

equivalent to ▼ on the active graph

Shift+down arrow

equivalent to ⌵ on the active graph

mouse click

activates the graph; useful when more than one graph is present (see FFT)

mouse left down

activates the marker

mouse left drag

moves the marker

mouse wheel up

equivalent to ▲

mouse wheel down

equivalent to ▼

7.6 THE MLS TIME DOMAIN DISPLAY

When entering the MLS time domain you will find a slightly different display (Fig. 7.2).

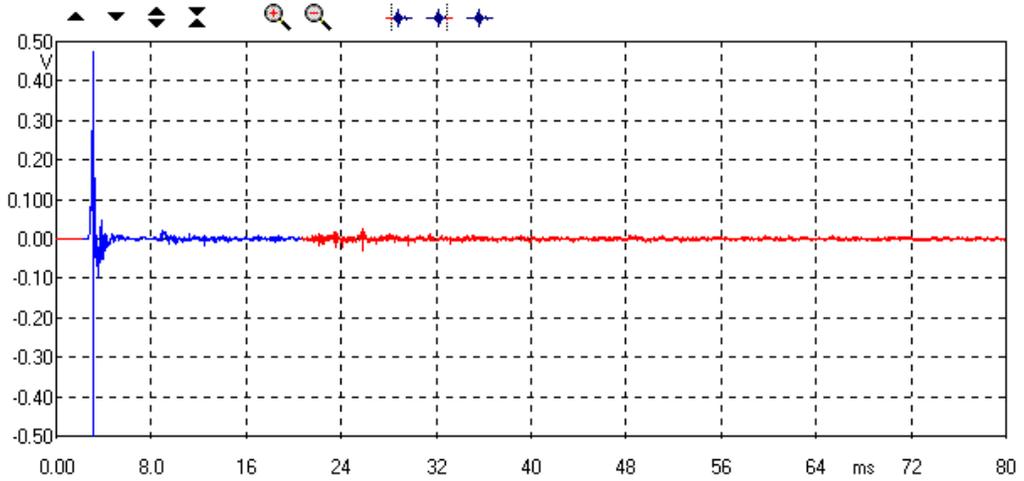


Figure 7.2

In this case there are no overlays. It is also possible to **select** a portion of the active curve by means of three particular buttons. The selected portion of the active curve is identified by a **start** and **stop** point and is draw in a different color from the unselected portion.

 Defines the start point of the selection.

 Defines the stop point of the selection.

 Returns the curve to a completely unselected state.

8 MULTI -METER

8.1 INTRODUCTION

The Multi-meter is an interactive, real-time, measuring instrument.

It gives CLIOwin the functionality of a:

- Sound level meter (dBSPL, dBA, dBC)
- Millivoltmeter (V, dBV, dBu, dBr)
- Frequency counter (Hz)
- Distortion meter (% , dB)
- L-C-R bridge (H, uF, Ohm)

Recallable simply pressing **F4**, the Multi-meter has also the capability of **controlling the generator** and of **capturing the global reference level**; thus it can be considered the heart and control center of CLIO; it is rare that you enter CLIOwin and don't use the Multi-meter, the information and controls available here are of invaluable importance during the normal operation of the whole instrument.

8.2 MULTI -METER CONTROL PANEL

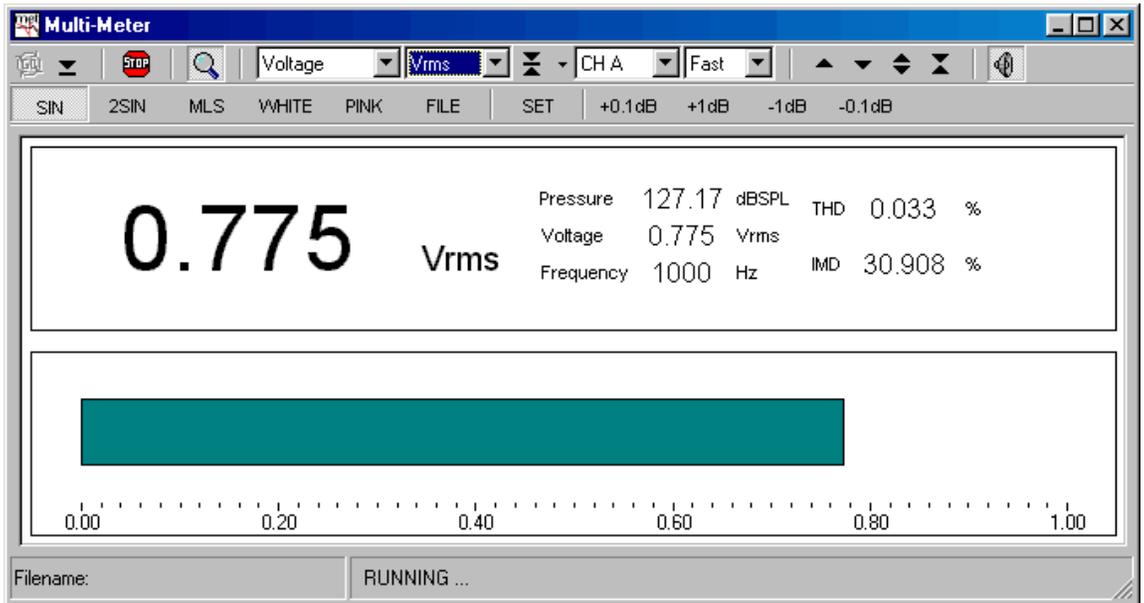


Figure 8.1 Multi-meter control panel

8.2.1 TOOLBAR BUTTONS

 Starts the measurement.

 Permits execution with the control panel in a minimized state. Only a small stay-on-the-top display remains visible. See 8.3.2.

 Stops the measurement.

 If pressed displays all measured parameters.

 Captures the actual reading of the multi-meter as the global reference level (or microphone sensitivity); refer to 8.3.3 and 8.5.1 for details.

 Control the scale of the meter bar graph.

 Enables/disables the generator control toolbar (see 8.3.1); this setting is saved within CLIOwin global settings.

8.2.2 TOOLBAR DROP DOWN LISTS

parameter

Selects the parameter to be measured.

unit

Selects the measurement unit.

channel

Selects the input channel.

integration

Selects between fast (125ms) and slow (1s) integration. Not applicable to the LCR meter.

8.3 USING THE MULTI-METER

The first application of the Multi-meter has been described in section 3.4.1 when CLIOwin was started for the first time. This was a simple generation of a 1kHz sinusoid (0dBu output level) and relative level capture with the Multi-meter. You can continue the measurement described to familiarize better with the instrument. Pressing the magnifier will let you inspect all the parameters that the Multi-meter measures in parallel (Fig.8.1); changing the selected parameter will bring it in foreground; for any parameter it is possible to choose different units, for example THD can be shown in percentage or in dB; then you can select the input channel and the integration. This last parameter (**integration**) affects the measurement rate, since the integration **fast** assumes **125ms** of exponential averaging while the integration **slow** assumes **1s** of exponential averaging. The program approximates these constants trying to measure the computer speed and varying the number of averages calculated.

The rest of the paragraph deals with other applications of the Multi-meter.

8.3.1 CONTROLLING THE GENERATOR

It is possible to control the generator by means of the dedicated main toolbar button

 in a way as an on-off switch works; please refer to 5.4.3 for details. Here it is possible to control the generation of single signal types and quickly pass from one to another. When the generator control toolbar is active the following buttons are available:

SIN

Generates the currently defined sinusoid. The default sinusoid is 1000Hz continuous.

2SIN

Generates the currently defined two tones signal. The default is 1000Hz + 2000Hz, 50% each.

MLS

Generates the currently defined MLS sequence. The default is a 16383 MLS sequence.

WHITE

Generates a white noise signal. It plays the **white.sig** file.

PINK

Generates a pink noise signal. It plays the **pink13.sig** file.

FILE

Generates the currently defined signal file. The default is the **all4096.sig** file.

SET

Enters the generator drop down menu to define the signals played by the various buttons. See 5.4.3 for details.

+0.1dB

Increases the output level by 0.1dB. Equivalent to **SHIFT+F8** or **SHIFT+▲** main toolbar button.

+1dB

Increases the output level by 1dB. Equivalent to **F8** or the **▲** main toolbar button.

-1dB

Decreases the output level by 1dB. Equivalent to **F8** or the **▼** main toolbar button.

-0.1dB

Decreases the output level by 0.1dB. Equivalent to **SHIFT+F8** or **SHIFT+▼** main toolbar button.

8.3.2 THE MINIMIZED STATE

It is possible to operate the Multi-meter in what we call a 'minimized' state. Pressing the relative button the control panel collapses and, in its place, remains a **stay-on-the-top** display as in Fig.8.2.



Figure 8.2

This operating mode is very useful; as an example suppose you want to measure the

total harmonic distortion of a sinusoidal signal while displaying also its frequency content. To do this lets invoke the FFT and Multi-meter control panels together; then press the Go button in FFT, this will start both measurements (see also 8.6 about this); inside the Multi-meter select the THD parameter and then press the minimized button. You should obtain a measurement situation like the one in Fig.8.3. In this figure we were acquiring directly the output of CLIO while generating a 1kHz sinusoid at 0dBu.

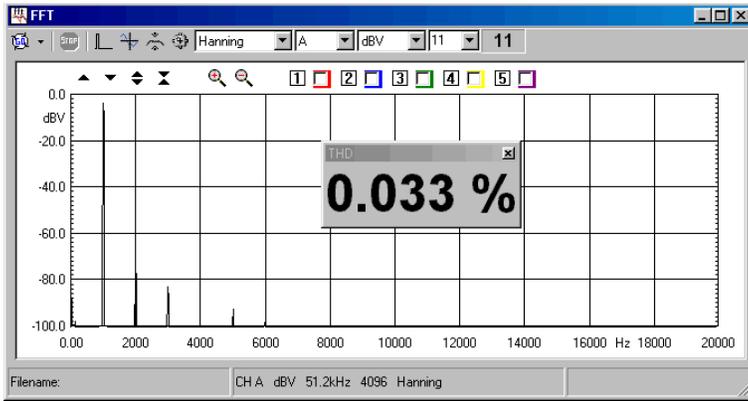


Figure 8.3

8.3.3 CAPTURING THE GLOBAL REFERENCE LEVEL

Let's see now how to capture a level to be the reference for other measurements. Once this is done then the subsequent measures done in all the instrument, with the units **dBRel** selected, will refer to it. As an example we go back to the procedure described in 3.5.1 which aims at validating a calibration. This is substantially the measurement of the frequency response of the CLIO board itself which is, when calibrated, a straight line; as said in the cited procedure the acquired level of such a measurement is -5.2 dBV. Let's see a practical way to acquire this level in order to refer future measurements to it. Maintain the instrument connected as in Fig.3.9, with input **A** and output **A** short circuited. Press the MLS button to start generating the MLS signal (the same that MLS uses during its operation). Press Go to start acquiring this signal, you should read circa 0.54V. Select also the Slow integration as the MLS signal is a wide band noise. While the measurement is running press the  button; answering yes to the warning message you'll set the global reference level. To inspect the captured value press the button's drop down menu. You should see the situation in Fig.8.4.

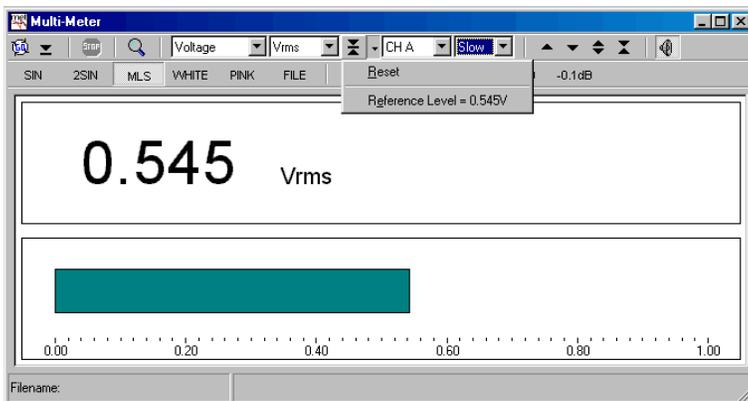


Figure 8.4

The drop down tells you what is the actual global reference level. If you want to restore the default , which is 1V, just choose **Reset**. Should you choose now, as reading units, **dBRel** expect to read **0dBRel**!

But let's go to the MLS control panel and see how we can reference frequency response measurements. Open the MLS control panel and simply choose dBRel as units. Then execute the measurement. You should obtain the situation of Fig. 8.5; as general tendency is always a straight line but the reading, now, is circa 0dBRel.

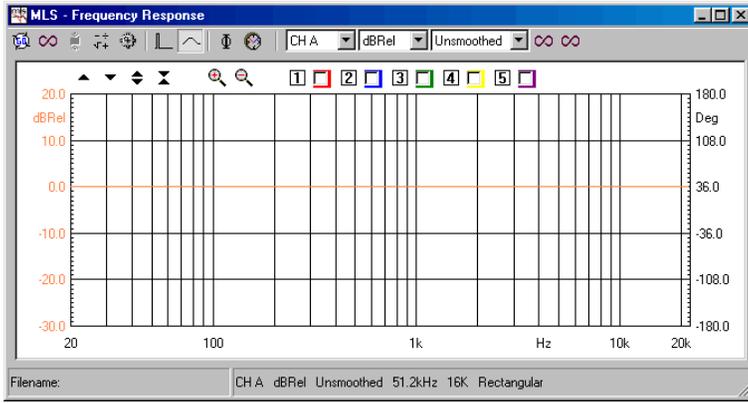


Figure 8.5

8.4 THE SOUND LEVEL METER

Selecting **Pressure** as measured parameter gives your Multi-meter the functionality of a Sound Level Meter. Three units are available: dB SPL, dBA and dBC. **dB SPL** is a direct reading of the sound level, relative to the reference pressure of 20uPa. Remember that CLIOwin needs to know your microphone sensitivity to correctly execute this measurement (see 5.4.4). **dBA** and **dBC** are frequency weighted measurements and are usually requested to assess, for example, environmental noise or any human related annoyance. In these two cases the program postprocess the measurement, applying the appropriate frequency filter as described in IEC-651 norms.

8.4.1 CAPTURING THE MICROPHONE SENSITIVITY

When measuring pressure, it is possible to calibrate your measuring chain if you have available a pressure reference like an acoustic calibrator. **It is possible to calibrate both channels.**

In this situation, in fact, the  button, if pressed, will prompt the instrument to capture a pressure reading as reference for the reading channel; it also expects that the reference pressure level at its input is **94dB**, as furnished by the vast majority of acoustic calibrators. As result of this procedure the program will calculate the sensitivity, in mV/Pa, of the microphonic front end, and store it in the CLIOwin settings.

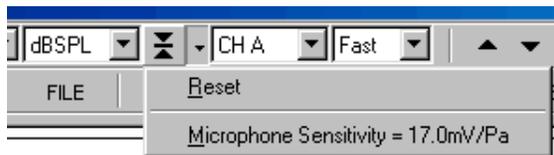


Figure 8.6

If you press the button's drop down you see reported the actual Microphone sensitivity. In this case, differently from the case of Voltage measurements, the default quantity is 18 mV/Pa, which is a rough average or Audiomatica's microphones MIC-01 and MIC-02 sensitivity. Let's see how to capture the channel **A** microphone sensitivity. In Figure 8.7 you see a Bruel&Kjaer 4231 acoustic calibrator fitted to a MIC-02 microphone.



Figure 8.7

With the Multi-meter running, fit the calibrator in place and switch it on. Wait some second for the measurement to stabilize. Then press the  button. You will receive the prompt in Fig.8.8.



Figure 8.8

Be advised that, answering yes, you will affect all pressure measurements executed with input channel A. You can inspect the newly acquired sensitivity entering the microphone sensitivity dialog (see 5.4.4).

8.5 THE LCR METER

This is a particular operating mode of the Multi-meter that gives you the possibility of measure inductors, capacitors and resistors. This measurement is an **impedance measurement** and is carried out in the **Internal Mode**; please have Chapter 13 as a reference for what concerns impedance, related connections and operations.

In this mode the Multi-meter takes control of the generator and, when the measurement is started, outputs a series of sinusoids of variable frequency in order to find the best one to carry out the measurement. The output frequency can be displayed (with the magnifier button) together with the measured parameter.

8.5.1 MEASURING AN INDUCTOR

Measuring an inductor is as easy as connecting it as in Fig.8.9 and pressing Go. The most critical factor influencing this test are connections; as with all impedance measurements, if you use pin-to-alligators cables put a great care in avoiding false contacts which may arise if terminals are oxidized or alligators loose their bite.

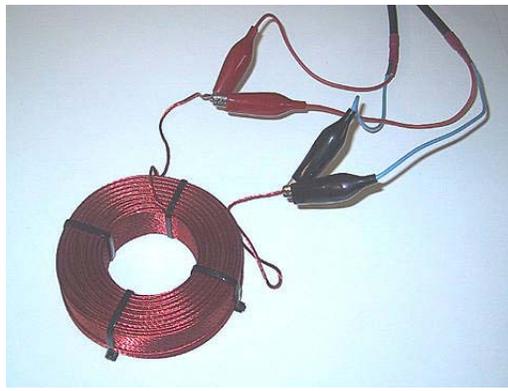


Figure 8.9

In a few seconds the measure stabilizes to the final result shown in Fig. 8.10. This was a 4.8H nominal inductor; the panel shows also the test frequency that, in this case, is 2510Hz. The same procedure should be carried out when measuring resistors or capacitors.

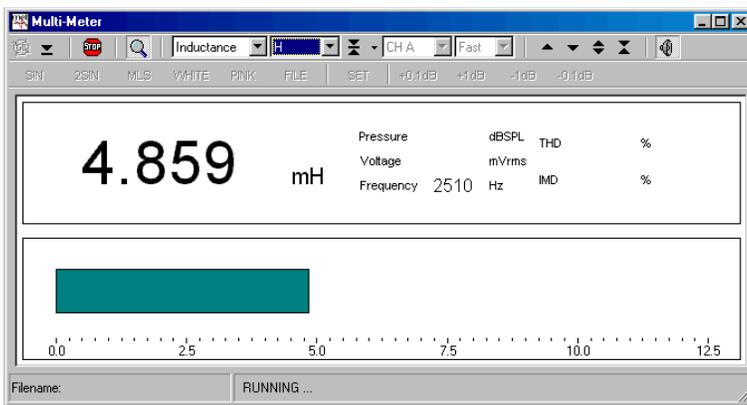


Figure 8.10

8.6 INTERACTION BETWEEN THE MULTI-METER AND FFT

The Multi-meter uses the same capture and processing units as the FFT control panel. To perform a measurement it programs the FFT routines (changing FFT settings to match its needs) and then effectively starts an FFT measurement in background.

The two panels can be opened and can work together but FFT always acts as **master** while Multi-meter as **slave**. In this situation the Multi-meter window's title is changed to '**Multi-Meter (FFT slave)**' to reflect this new state; the **Go and Stop buttons are disabled** as you operate the slave panel from inside FFT, starting and stopping the reading with the FFT's Go and Stop buttons; **the input channel follows the FFT one** while **the integration setting become meaningless**; this is because the user's has control over FFT averages which precisely define the measurement integration. Nevertheless, during slave operation, it is possible to select the displayed parameter and its unit. It is not possible to select LCR operation as LCR meter uses different measurement capabilities.

As soon as the FFT control panel is closed it releases Multi-meter from the slave state; then Multi-meter is ready from stand-alone operation and is fully functional as described above.

9 FFT AND RTA

9.1 INTRODUCTION

By selecting the FFT command from the main menu bar, it is possible to carry out Fourier analysis of the input signal to determine its frequency content using the Fast Fourier Transform (FFT).

The processed data can be displayed as narrowbands or 1/3 (or 1/6) octave bands, turning the instrument into what is generally called a real-time analyzer (RTA).

The ability to process two channels simultaneously, to select the appropriate sampling frequency and the possibility of triggering with respect to the generated signal make this control panel a flexible and valuable instrument. Finally, there is also a very useful facility to quickly and easily swap back and forth between the time and frequency domains.

9.2 FFT CONTROL PANEL

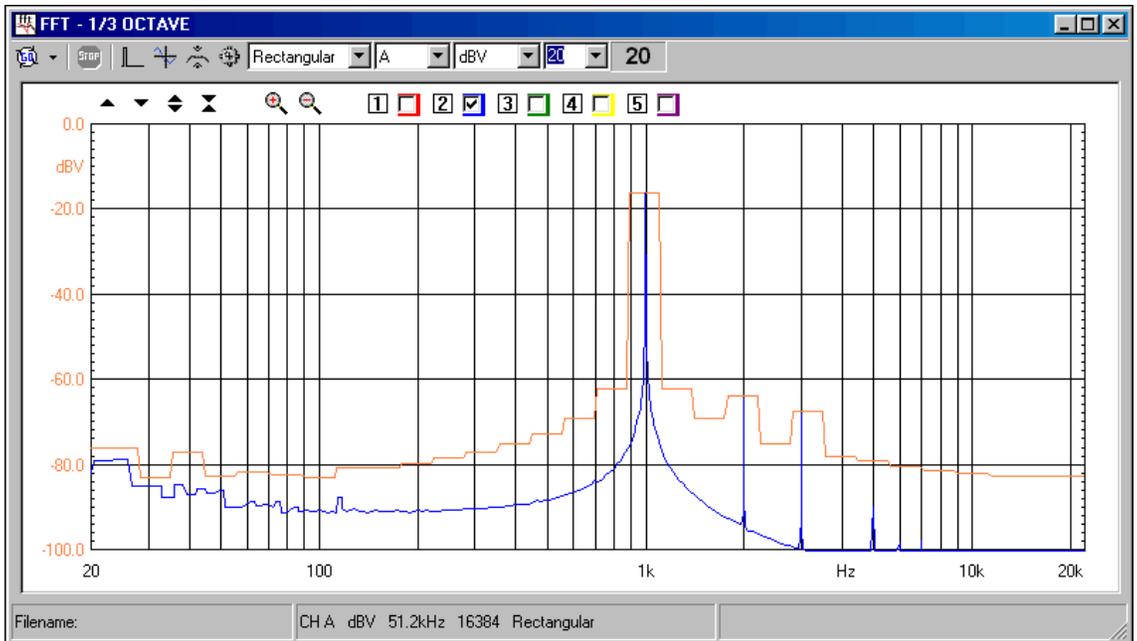


Fig. 9.1 The FFT control panel

Fig. 9.1 shows the FFT and RTA control panel. Follow a description of the FFT control panel toolbar and settings.

RTA operation is obtained simply by selecting the appropriate frequency axis property (either 1/3 or 1/6 of octave) within the FFT settings dialog (see 9.3). When operating as RTA the FFT window's title is changed (as in Fig.9.1) in 'FFT 1/3 OCTAVE' or 'FFT 1/6 OCTAVE'.

For a detailed description of the graphical display (common also to other measurement control panels) and its capabilities please refer to Chapter 7. For a description of the available shortcuts please refer to section 5.5.2.

9.2.1 TOOLBAR BUTTONS

-  Starts an FFT or RTA measurement. Pressing the drop down menu it is possible to select the **Continue** switch. In this mode the measurements is not started from blank but accumulates with the previously stopped one; see Averaging (9.6) for details.
-  Stops the current measurement.
-  Selects Internal Trigger operation. When pressed the acquisition is triggered by the generated signal.
-  Activates the Time Data display.
-  Enables the Hold function. Depending on the setting entered in the FFT Settings dialog box, it is possible to hold either the minimum or maximum value per frequency point.
-  Enters the FFT Settings dialog box.

9.2.2 TOOLBAR DROP DOWN LISTS AND DISPLAY

data window

Selects a weighting data window among the following:

- Rectangular (no window)
- Hanning
- Hamming
- Blackman
- Bartlett (triangular)
- FlatTop

channel display

Selects the input channel or function to display.

Y scale units

Selects the measurement units.

target averages

Inputs the total number of averages. Averaging is controlled by the setting in the FFT Settings dialog; see Averaging (9.6) for details.

number of averages display

Displays the number of the actual average; this number increases during the measurement unless, while in exponential averaging, the target has already been reached; see Averaging (9.6) for details.

9.3 FFT SETTINGS DIALOG

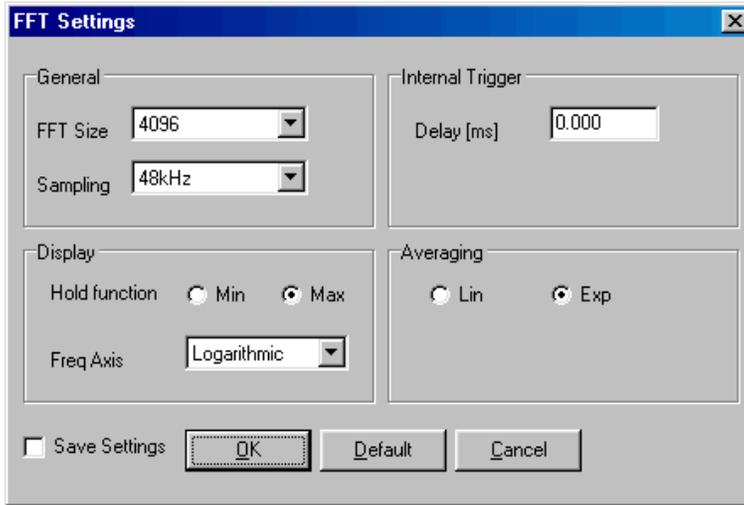


Fig. 9.2 The FFT settings dialog box

FFT Size

Selects the number of samples acquired and processed by each FFT. It is possible to choose a size between 256 and 65536 points.

Sampling

Selects the sampling frequency.

Hold Function

Selects either Min or Max hold function. This functionality is activated by the relative toolbar button.

Freq Axis

Selects among four possible FFT or RTA operating modes:

- Linear frequency axis (narrowband)
- Logarithmic frequency axis (narrowband)
- 1/3 Octave filtered (RTA)
- 1/6 Octave filtered (RTA)

Delay

Permits the input of the desired processing delay (in ms) when in Internal Trigger mode. See 9.7 for details.

Averaging

Selects either linear or logarithmic averaging; see Averaging (9.6) for details.

9.4 FFT AND RTA OPERATION

The FFT and RTA measurements (and also Multi-meter ones, see Chapter 8) differ from MLS and Sinusoidal ones in the fact that they are interactive, the user has control over measurement time and generated stimuli. You may obtain from them only answers about unknown signals, without any care for generating a stimulus; or you may leave to others this job, like when you measure an audio chain relying on the test signals contained in a CD-ROM. One effect of this is that, strictly speaking, FFT measurements may lead to less precise results if compared to other techniques; the possibility of injecting a synchronous MLS sequence at the beginning of the same audio chain mentioned before is surely a better approach even if, in the vast majority of cases, unfeasible.

FFT and RTA power depends not only on the measurements settings themselves but also on the **generated signals**.

CLIOwin adds the possibility of **internal trigger** (and relative **delay**) i.e. triggering with respect of the generated signal thus obtaining a synchronous capture. Let's see how a measurement presented in section 11.4 was done; please refer to figures 11.9, 11.10 and 11.11. We have an acoustical measurement of a tweeter, done stimulating it with a 2kHz 10ms tone burst (see 5.4.2 for details about programming a bursted sinusoid); the FFT measurement is done in internal trigger; Fig. 11.9 shows the analysis and the captured time data that clearly show the flight time from the tweeter to the microphone; Fig. 11.9, even if the analysis is not our final target, show the power of synchronous acquisition which permits to display the arrival delay of sound to the microphone. To obtain the desired result, as explained in 11.4, it is necessary to remove the flight time plus the device settling time; this can be easily accomplished setting the internal trigger delay, in FFT settings, to 1.5ms; the final result shown is shown in 11.11 and permits the identification of the device harmonic distortion. To proceed further one could vary the stimulus amplitude and test the distortion of the tweeter at different amplitudes; using bursts prevents also the damage of the unit as the overall power delivered to it rather low and a direct function of the duty cycle of the burst itself.

Other useful signals are **noises** and **multitones**. The predefined signal file is the **all4096.sig**; you can play it pressing the FILE button from the Multi-meter panel, or choosing it from the list of signal files. As its name suggests this multitone signal is done adding 4096 sinusoids of the same amplitude which frequencies exactly fall inside an FFT frequency bin; for a sampling frequency of 51200Hz a frequency bin in a 4096 points analysis is a multiple of 12.5Hz; for a sampling frequency of 48000Hz a frequency bin in a 4096 points analysis is a multiple of 11.71875Hz. This particular signal should be employed, for maximum performances, when analyzing a system with a 4096 points FFT; should you change FFT size, you should change stimulus too. Using this signal it is possible to assess the frequency response in a single FFT acquisition without the need for any averaging. Among noises we find the **pink noise** that is required when taking RTA measurements. CLIOwin has several pseudo-random pink noises (like **pink16384.sig**) that are filtered versions of an MLS sequence. Use this stimulus when executing RTA measurements, due to its pseudo random nature permits RTA analysis that settle in a fraction of time with respect to analysis done with true pink noise. Choose the file with the name matching the length of the FFT used; for a 16K RTA use the pink16384.sig signal.

The main application of RTA analysis is in assessing the quality of an audio installation (from the placement of the speakers in a listening room to the overall sound quality of a car stereo system). In these case it is often used the pink noise as stimulus. If you are not using CLIO as the source of such a stimulus be sure to use a good one; you may

find several audio generators that do the job, but they are usually expensive; a good choice is to use a recorded tracks of one fo the various test CDs available; in this case not all the CD-ROM readers may furnish adequate results as appears from the graph in Fig.9.3

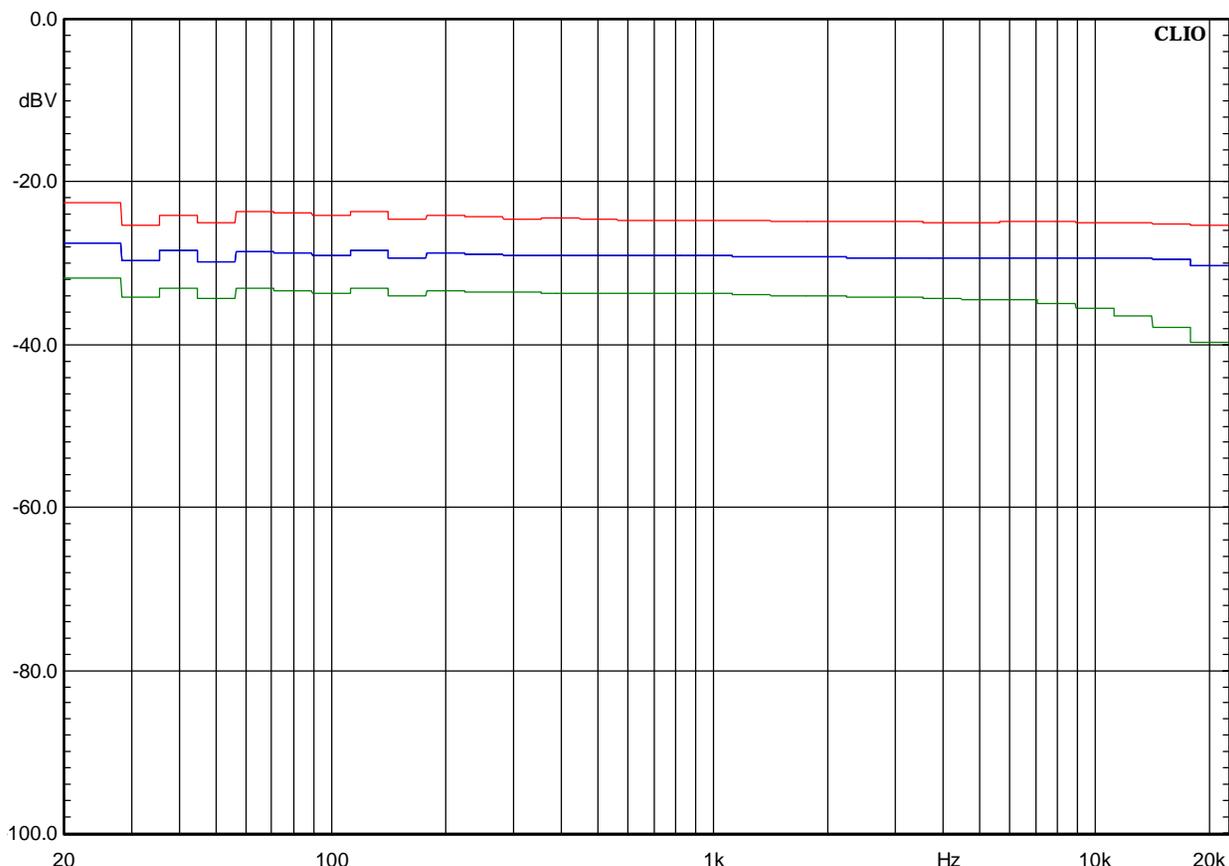


Figure 9.3

All three graphs represent true analog pink noises, they are played at 5dB different level for clarity. The upper (red) is the output of an Audio Precision System One generator; the second (blue) is the pink noise of track 4 of the Stereophile Test CD played by a Philips CD692 CD player, the third is the same track of the same test CD output by the computer where I'm writing right now (Pioneer DVD Player plus Crystal Sound Fusion PCI Audio).

When taking RTA measurements use, at least, 16K FFT size if you want to cover the entire 20-20kHz audio band; using lower sizes results in octave bands not present as no FFT bins fall inside them.

9.5 AVERAGING

Averaging plays a very important role in FFT and RTA analysis. It is vital when analyzing signals buried with noise. It is also important when taking spatially averaged measurements. CLIOwin has flexible averaging capabilities. Averaging basically means adding and dividing for the number of additions made. To start an averaged FFT measurement you need to set a number bigger than one in the Target Average drop down; otherwise you have a continuously refreshing single measurement that will continue until the Stop button is pressed. It is possible to choose between **linear** and **exponential** averaging. The instrument behaves differently in the two averaging modes. In linear averaging the measurement is continued until the target is reached, then it automatically stops. What you got is exactly what we just explained. In exponential averaging the measurement never stops. When the target is reached the averaging continues relying on a mathematical formula which discards the oldest acquisitions and gives more and more importance to newer ones. The exponential averaging is the default one.

As an example Fig. 9.4 compares a single 1kHz sinusoid FFT analysis and 100 averages one.

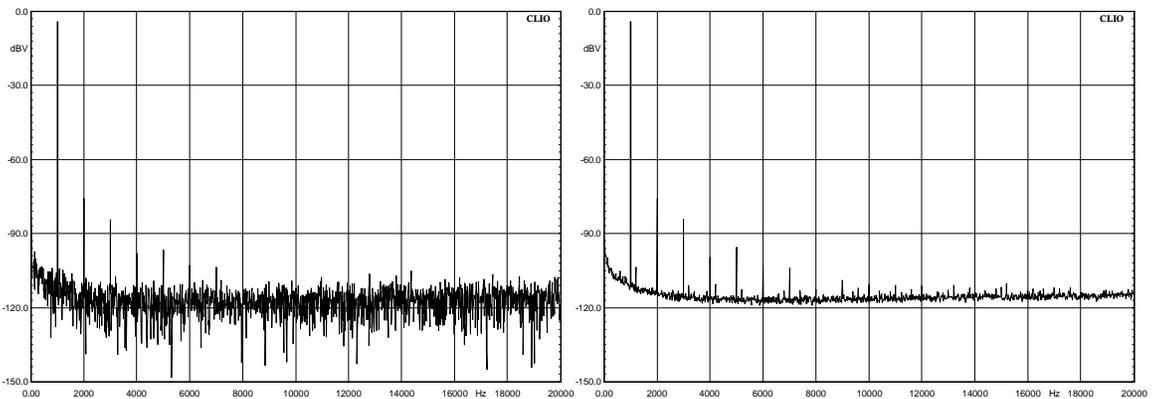


Figure 9.4

This is a classical example of signal buried with noise: the sinusoid's 9th harmonic is clearly visible after 100 averages, but invisible for a single acquisition.

Another important feature, when averaging, is the possibility of **continuing** averaging after a measurement is stopped, has reached its target or a previous measurement has been loaded from disk. CLIOwin has this capability when selecting continue in the drop down menu available aside the Go button (Fig.9.5).



Figure 9.5

Selecting the continue option allows, as an example, for spatially averaged measurements. Fig. 9.6 shows two 1/3 octave RTA measurements of a small HT satellite at listening position: the black one is a single 10 averages measurement taken on axis; the red one is, instead, built, using the continue option, adding a total of eleven 10 averages measurements taken moving from -25 degrees left to +25 right of the speaker itself.

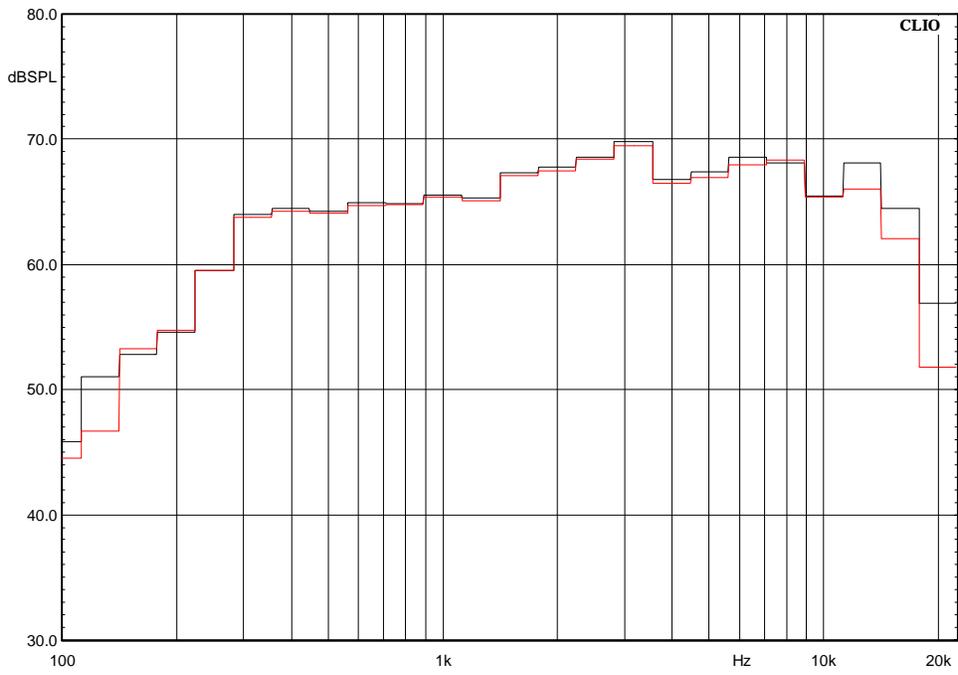


Figure 9.6

9.6 TIME DATA DISPLAY (OSCILLOSCOPE)

The time data (Fig. 9.7) is an ancillary display to an FFT or RTA executed measurement. Here we see a 100Hz sinusoid captured and analyzed with a 16K FFT.

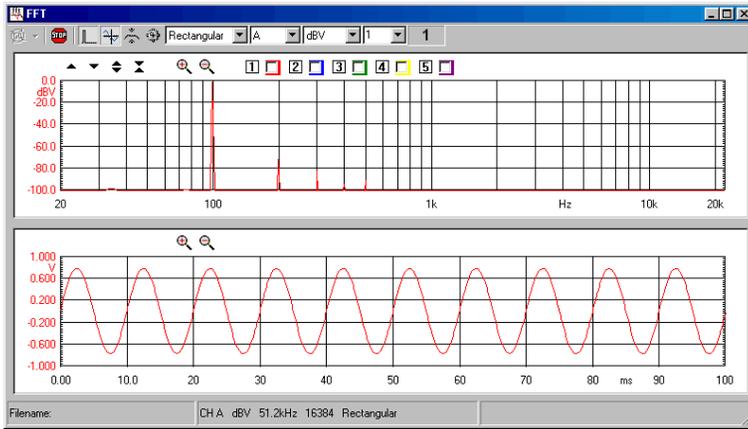


Figure 9.7

The time data display has a number of particular features that allow, **out of user control**, for automatic scale adjustment and triggering of the displayed signal.

The time information displayed are the processed data only. The user can zoom in and out these data but it is not possible to display more than one acquisition area. Fig. 9.8 shows this effect; the same 100Hz sinusoid as before seems now truncated; this means only that we reached the maximum displayable data, in case of a 16K FFT @ 51200Hz sampling this is exactly 320ms.

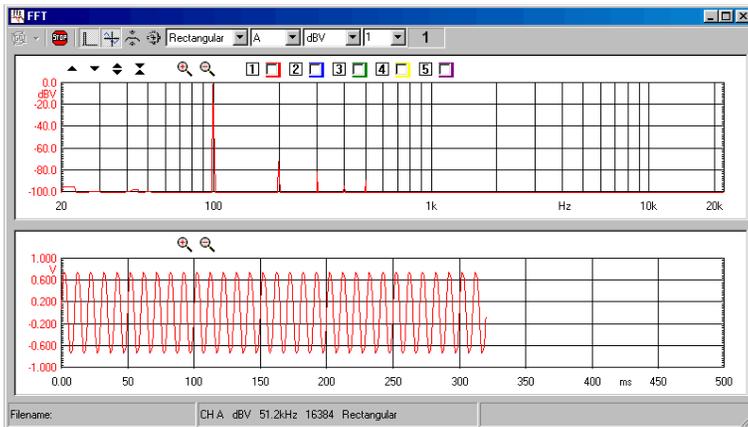


Figure 9.8

9.7 FFT AND MULTI-METER

There is a close interaction between FFT and Multi-meter operations. The two measurements share the same acquisition and processing core. Should they operate together the FFT control panel acts as **master** while Multi-meter follows as **slave**. In this situation, among other peculiarities, the Go and Stop buttons of the Multi-meter are disabled; if an FFT acquisition is started then the Multi-meter runs as well, the same when you stop the measurement. More on this in section 7.6.

10 MLS

10.1 INTRODUCTION

MLS Analysis, MLS stands for Maximum Length Sequences, is a powerful well established technique that allows carrying out analysis of linear systems recovering the **Impulse Response** of the device. It is therefore a Time based analysis. Frequency domain information is obtained calculating the Fast Fourier Transform, hereafter FFT, of the impulse response. As the crucial piece of information is in the time domain, MLS is particularly well suited for recovering the anechoic sound pressure response of a loudspeaker. i.e. the frequency response of a loudspeaker as if it were positioned in an anechoic room, while carrying out the measurement in a normal room. Important as well MLS allows complete evaluation of room acoustic parameters. Within this Menu user will be able to switch from time domain to frequency domain and backward, using the powerful post processing tools CLIO gives. This allows getting very sophisticated and complete information of any electro-acoustic device. Both the theory behind all this and the amount of parameters that affect the measurement results make this Menu probably the most complicate to use. We will skip theory completely and after a concise description of whole User interface will deal with real life applications.

10.2 MLS CONTROL PANEL

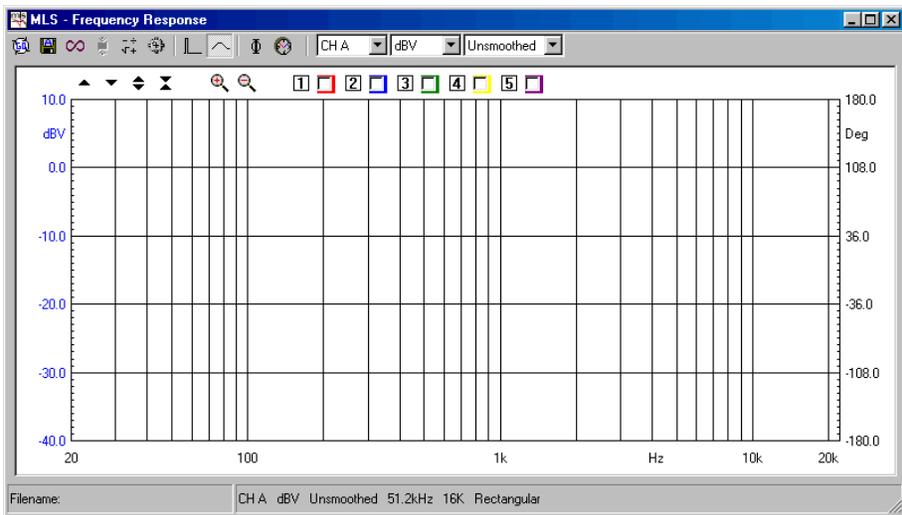


Figure 10.1

10.2.1 TOOLBAR BUTTONS

 Starts an MLS measurement.

 If pressed the measurements will be autosaved. The current autosave definitions apply; see 6.3.1 for details.

 Selects the Loop mode. When in Loop mode the MLS measurement is automatically repeated until the users presses a keystroke or releases the button. If Autosave is active the loop mode ends after the total files to be autosaved are done.

 When an MLS measurement is taken, automatically applies the selected post-process.

 Enters the MLS Process dialog box.

 Enters the MLS settings dialog box.

 Enters Time domain.

 Enters Frequency domain.

 Displays phase.

 Displays group delay.

10.2.2 TOOLBAR DROP DOWN LISTS

input channel

Selects the input channel configuration.

Y scale unit

Selects the measurement units. It is possible to select Voltage (dBV, dBu, dBRel) or Pressure (dBSPL) or Impedance (Ohm).

smoothing

Activates a frequency smoothing of the active curve. This smoothing effect will allow for a better appreciation of the general features of the response curve. The smoothing algorithm that is employed averages all values within a fraction-of-octave band surrounding each analysis frequency.

10.2.3 MLS SETTINGS DIALOG

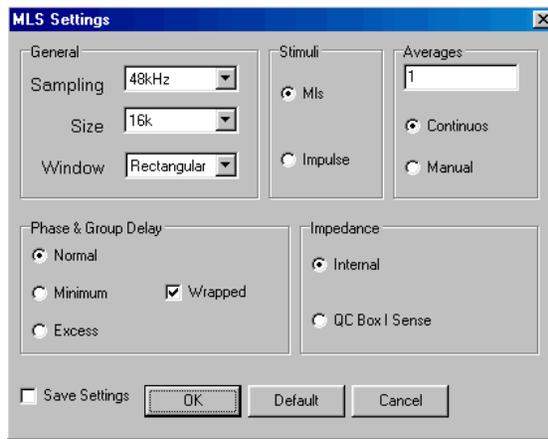


Figure 10.2

sampling

Selects the measurement sampling frequency.

size

Selects the size of the MLS sequence.

window

Selects the appropriate kind of window for analyzing time data. It is possible to select between a rectangular, Hanning or Blackman window; the last two can be **full** or **half sized**. NOTE: These windows are applied to the time portion to be transformed with FFT. If the start point is near the impulse **full windows** will null the most important part of the time response (due to their rise time). To evaluate the effects of a data window refer also to Chapter 9, and FFT measurements in general.

stimuli

Selects the kind of stimulus used for the measurement of the impulse response.

averages

Controls the averaging mode of operation. The measurement will be repeated and averaged the number of times set, therefore obtaining a better signal-to-noise ratio at the expense of reduced measurement speed. **Continuous** performs the number of averages in the shortest time without waiting. **Manual** waits the user to press any key between each measure; it is useful, for example, in averaging different microphone positions.

phase & group delay

Used to select how phase (group delay) response is obtained.

Normal displays the measured phase (group delay) curve referring to the selected time domain data.

Minimum calculates and displays the phase (group delay) curve, related to the current modulus curve, in the assumption of minimum phase behaviour (i.e. the Hilbert transform of the log magnitude).

Excess calculates and displays the phase (group delay) curve as the difference between the Normal and the Minimum ones.

It is possible to display phase data **wrapped** at ± 180 degrees boundaries or **unwrapped**.

impedance

When taking impedance measurement refers either to the **internal** impedance mode or to the **I Sense** feature of the CLIOQC Amplifier&SwitchBox Model 2 and 3.

10.2.4 MLS POST-PROCESSING TOOLS

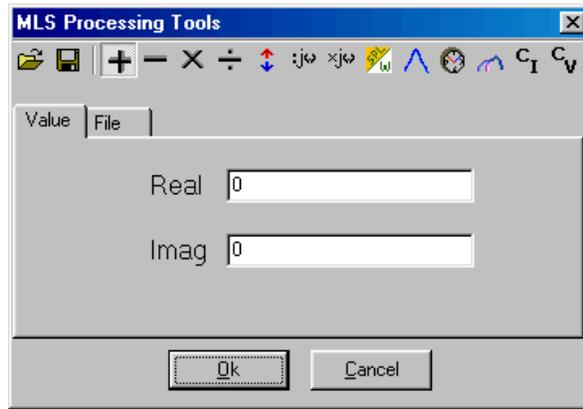


Figure 10.3

 Loads an MLS process.

 Saves an MLS process.

 Adds a data value or compatible file to the current measurement.

 Subtracts a data value or compatible file to the current measurement.

 Multiplies the current measurement by a data value or compatible file.

 Divides the current measurement by a data value or compatible file.

 Shifts the current measurement by a dB value.

 Multiplies the current measurement by complex frequency.

 Divides the current measurement by complex frequency.

 Uses a reference measurement file taken at speaker terminals to calculate 1m sensitivity in dB SPL/W. The reference file should have dBV Y units while the one in memory should be in dB SPL.

 Process the current measurement with an octave band filter. It is possible to input the midband value and the filter bandwidth.

 Temporally shifts the current measurement by a ms value. Affects phase response.

 Merges the current measurement with the part below the selected transition frequency of a selected compatible file.

 Combines the actual measurement and the selected file to obtain a constant current impedance measurement. Both files should be in dBV.

 Combines the actual measurement and the selected file to obtain a constant voltage impedance measurement. Both files should be in dBV.

10.4 IMPULSE RESPONSE CONTROL PANEL

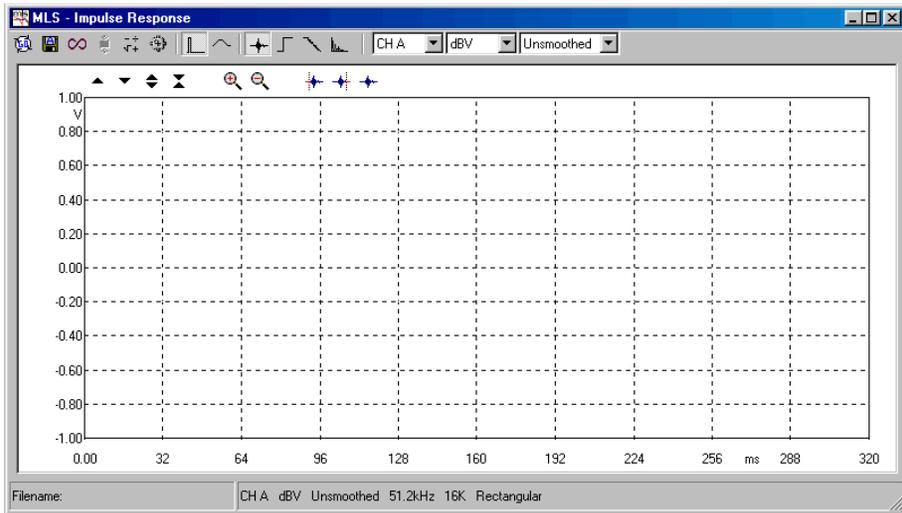


Figure 10.4

10.4.1 TOOLBAR BUTTONS

The following toolbar buttons differ from frequency domain control panel:

 Displays Impulse Response.

 Displays Step Response.

 Displays Schroeder Decay.

 Displays Energy Time Curve (ETC).

Also the following buttons inside the measurement area are peculiar of this control panel. See Chapter 7 for other information.

 Selects the starting point of the measurement window.

 Selects the end point of the measurement window.

 Restores the default state of the measurement window thus selecting all the acquired points for analysis.

10.4 MEASURING FREQUENCY RESPONSE

In a step by step process we will deal with any single aspect that affects MLS measurements results. At first we deal with electrical measurements, leaving acoustical as the last steps.

10.4.1 MEASUREMENT LEVEL

Opening the MLS menu for the first time you will see a graph which has frequency on its X-axis. Despite the mother of all information is in the time domain here, this approach, in our opinion, greatly simplifies a step by step approach. In fact user can at first completely ignore most of the settings we encountered in the previous paragraphs and get the most intuitive piece of information, that is the Frequency Response of a device under test. Our first step will be measuring the response of an "A" weighting filter. All the settings are left in their default state; we will take care on measuring level only. Ours is not a power device, is not a loudspeaker, so we think it cannot be damaged with an output set to 0dB (-5.21dBV with MIs signals). We connect CLIO output A with the device input, CLIO Input A with the device output, we enable input auto-range and click the Go button. As result we get Fig.10.5

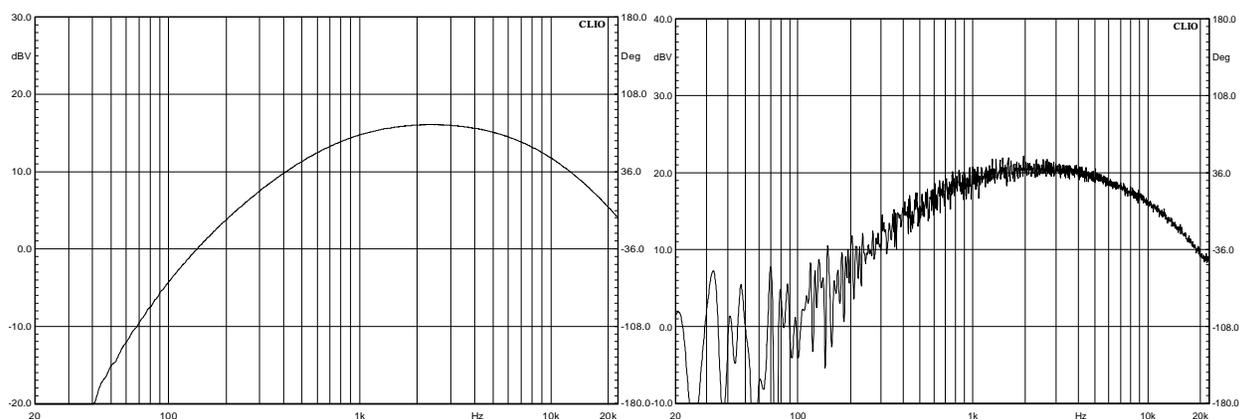


Figure 10.5 and 10.6

The curve reaches 16dBV (6.3V) at 2.5kHz, which is a quite high level for our device. Looking for trouble, we increase CLIO output to +6dB and measure again obtaining Fig.10.6. The device went into saturation; in more emphatic terms it is not linear any more. The whole MLS process works on the assumption the device is linear. If this is not the case, is not easy for inexperienced user to understand what is going on just by inspecting the results. Checking the measuring level is important, especially when the gain of the device under test is unknown. You should use the Multi-Meter and the MLS signal to accomplish this.

10.4.2 MLS SIZE

The MIs Size is the number of points that defines the MLS sequence. In terms of generating a digital signal these are the numbers of samples before the signals is started again from the beginning. CLIO handles MLS sizes from 4k to 128k. These terms are inherited by the computer world and are somehow imprecise. The real size is the nearest power of 2, the 4k being 4096 points and the 128k 131072 points long (one less!). The first important consequence of setting the MIs size is the length of the Impulse Response recovered which is always as long as the MIs itself. From the user point of view what matters is how long this impulse is in terms of seconds. This in turns depends also on the Sampling Frequency set. It is easily calculated as the size divided by the sampling frequency. The default is 16k and 51200Hz, that is $16384/51200=0.32$ seconds. We will

deal with this in more detail later. Here is enough to say that CLIO uses this size also for the FFT. This is important as the frequency resolution you get is calculated as the sampling frequency divided by the FFT size. Again for the default settings this is $51200/16384=3.125\text{Hz}$. This is already a high resolution. However thinking in terms of octave or fraction of octave, which are the terms of a logarithmic frequency axis, 3.125Hz is around $1/2218$ of an octave at 10kHz while is around $1/3$ of an octave at 10Hz .

Again one example is better than one thousand words. We will measure a twin T notch filter, probably the most demanding situation for frequency resolution with two sizes, 8k and 64k , and two centre frequency, 10kHz and 63Hz . Results are in Fig.10.7.

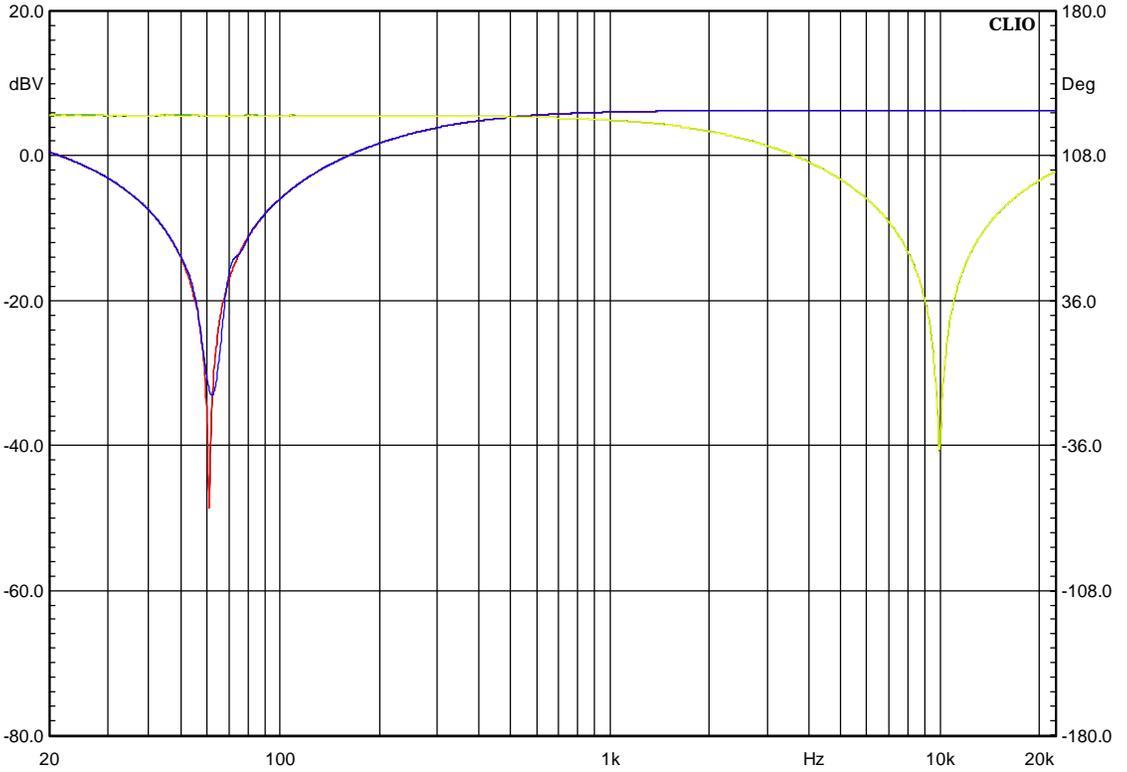


Figure 10.7

Interestingly, the measurements are four but we can see only three curves. In fact the 8k size gives by far enough resolution at 10kHz and the relative curve is completely hidden by the 64k one. At 63Hz instead the 64k curve, red, differs from the 8k , blue. We have seen that there is another parameter involved here, which is sampling frequency. While experimenting with it, we will also make our first impedance measurement. We will use CLIO internal mode. This is again the default setting, so all we have to do is to change the Y scale unit to Ohm. We are going to measure a big $15''$ professional woofer using 51.2kHz and 6.4kHz leaving size at 16k . The output level is set at $+12\text{dB}$. Fig.10.8 and 10.9 shows the results.

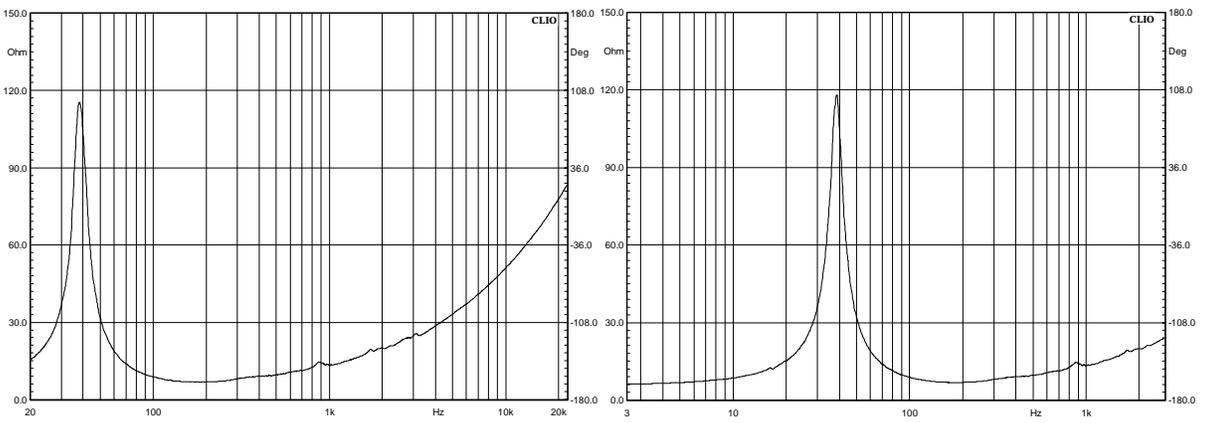


Figure 10.8 and 10.9

The first relevant difference is the frequency range. In the 6.4kHz sampling rate both sides of the resonance are completely visible. Thiele and Small parameters derived with these settings are more accurate. This is especially true if, using the added mass technique, F_s is further lowered. But, more important, the impedance at F_s , is 115 ohm at 51.2kHz and 118Ohm at 6.4kHz.

10.4.3 ACOUSTIC FREQUENCY RESPONSE

Up to now we measured using CLIO and simple cables. Now we are going to deal with acoustic measurement. The time domain will be an essential part of our interest. Furthermore we need to add two external devices, a microphone and a power amplifier. Connections are shown in Fig.10.10.

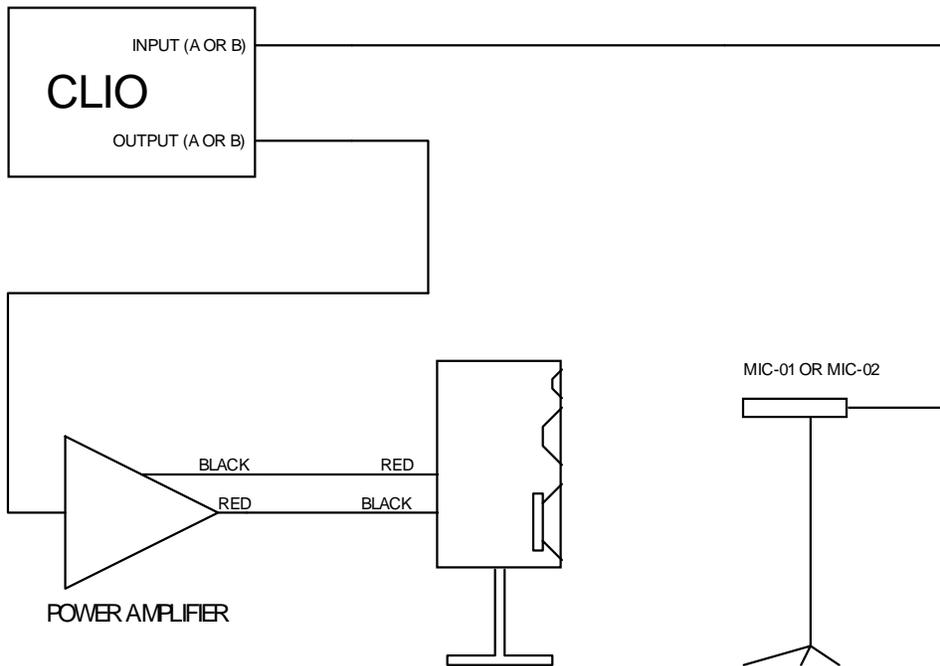


Figure 10.10

Please note that the connections from the amplifier to the speaker are inverting polarity. This is on the assumption that the amplifier is non-inverting, most are so, and you are using Audiomatica Mic-01 or Mic-02, which does invert polarity. Most Measuring Grade Microphone invert polarity. Remember that inverting polarity do not change the frequency response. It does change phase response. Fig.10.11 shows how we placed the microphone respect to the speaker and both respect to the floor.

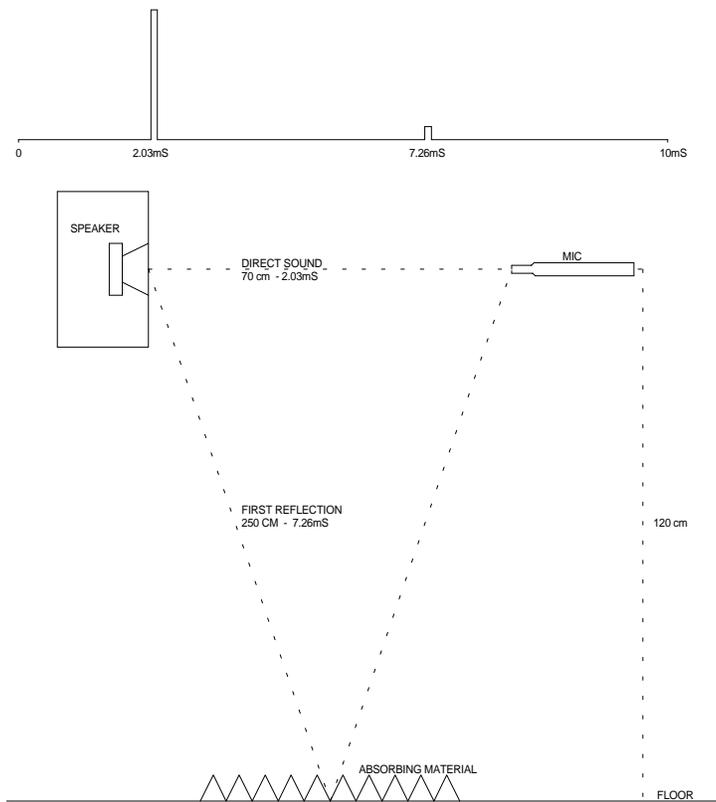


Figure 10.11

Any other reflecting surface is farther than the floor. If the microphone is directly connected to the CLIO board **remember to switch the microphone power supply on**. Also, **very important**, remember to type in the correct microphone sensitivity in the microphone Dialog Box. The last item is crucial for setting the correct measurement level. We already dealt we level before. Here things are more dangerous. Supposing the amplifier used has a gain of 30dB, a common value, leaving CLIO output level to 0dB will cause the amplifier to deliver the equivalent of circa 40W/80ohm continuous. If the amplifier handles this power you will for sure burn your tweeter. If the amplifier is of lower power it will saturate and burn your tweeter even faster. To avoid this embarrassing event, do as follow: enable CLIO input auto-range, open the Multi-Meter and select Pressure from the Parameter Drop Down. You will get the reading of your environmental noise. Fig.10.12 shows ours, we hope yours is lower.

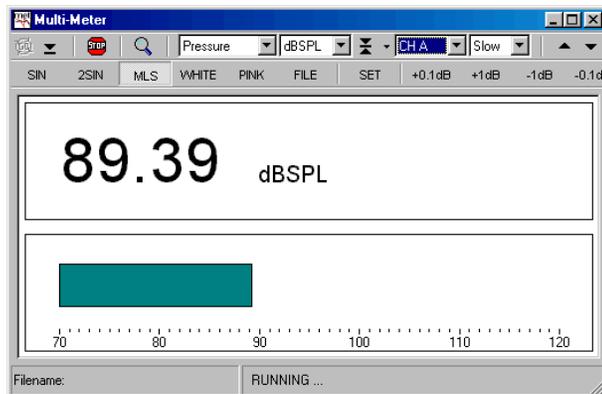
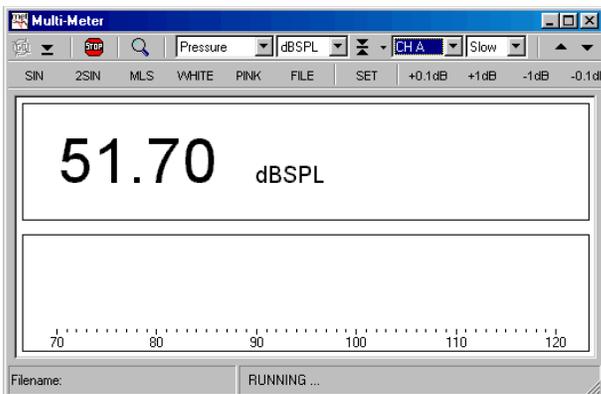


Figure 10.12 and 10.13

Now set CLIO output level to a very low value, -30 to -40dB. Start the MLS signal and increase CLIO output level until you read 85 to 90 dB SPL as in Fig.10.13. This holds if you placed the microphone 70cm to 1m distant from the speaker. Now go back to the

MLS Menu, select dB SPL as Y scale unit and finally click on Go. The speaker we are testing is a glorious Rogers LS3/5A, year 1978. Fig.10.14 shows our result.

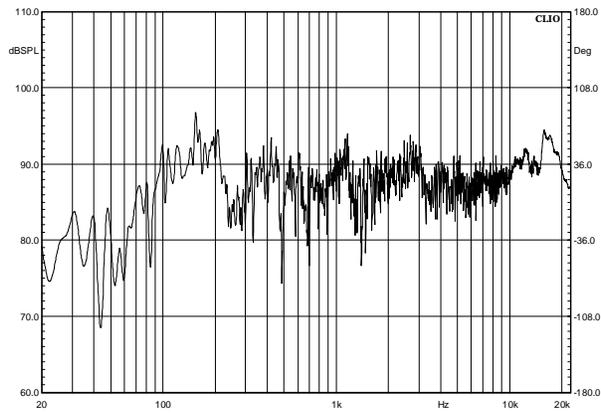


Figure 10.14

What you see is the speaker plus the room where we take our measurement, which is far from being anechoic. It is time to inspect the time domain. Clicking on the Time Domain button we get Fig.10.15 and, Fig.10.16, once we zoomed to the first 11ms and expanded the y scale.

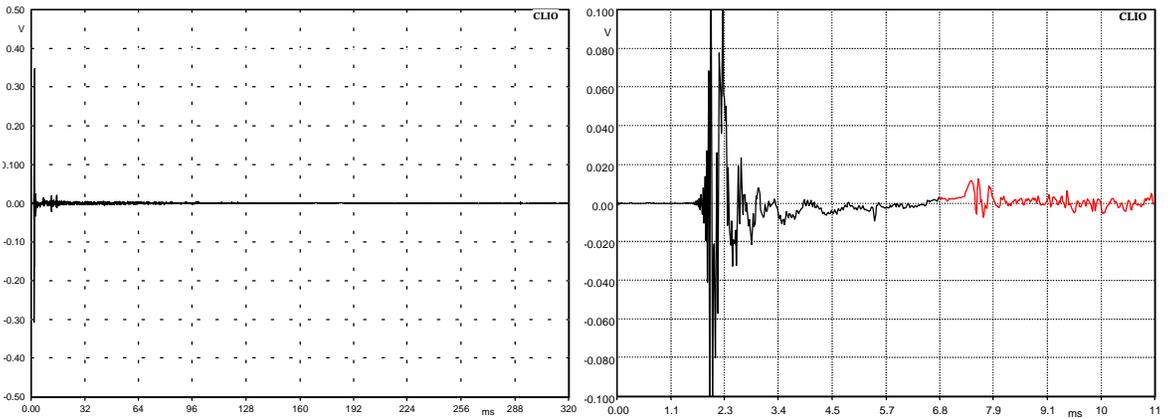


Figure 10.15 and 10.16

We did also another very important thing. At 7.3ms is visible the first reflection due to the floor and expected from Fig.10.11. We set the marker at 6.8ms, which is just before the first reflection, and set the Stop Window there (see Chapter 8.5). CLIO will set to 0 all the values of the impulse response after 6.8ms before FFT is executed. In this way we simulate a reflection free environment. Clicking on the Frequency Domain Button we obtain Fig.10.17.

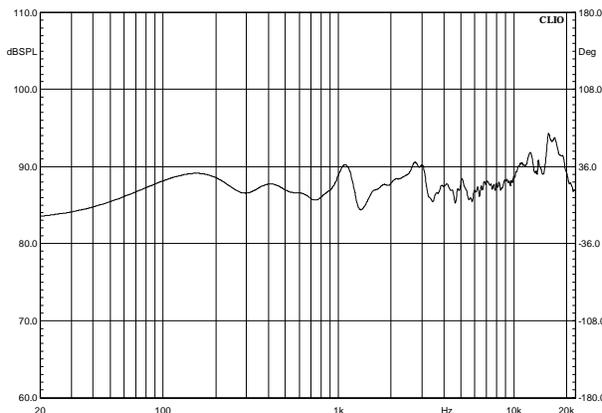


Figure 10.17

Now things look much better and this is the almost anechoic response of the speaker. Almost means that nothing comes for free. The low frequency part of the response seems quite optimistic for such a little speaker. The price we paid in setting to 0 the impulse tail is that we lost information on the lower part of the spectrum. The transition frequency between meaningful and meaningless data is calculated as 1 divided by the selected impulse length. In our case we selected a 6.8ms long impulse. $1/0.0068=147\text{Hz}$ right? Wrong. We have the first 2 ms of the impulse, which is the time of sound flight that does not carry any information. We could have selected the impulse as in Fig.10.18 without affecting the frequency response at all. Phase response would have been greatly affected.

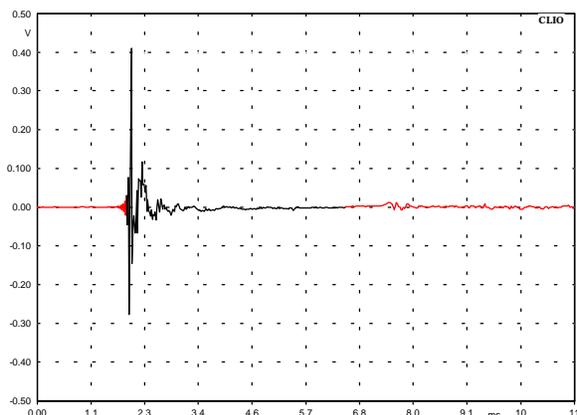


Figure 10.18

The right calculation is $1/(0.0068-0.002)=208.33\text{Hz}$. In our room the smallest dimension is floor to ceiling. This is indeed the most frequent case. This dimension is however 4m. The best location for the speaker would have been at 2m both from the floor and the ceiling. The second consideration is microphone distance. The highest it is, more is the useless part of the impulse you have to subtract. In practice we do not encourage distance below 70cm for complete speaker measurement and you should increase to 1m for bigger ones. However single driver measurement can take advantage from a reduced distance.

10.4.4 PHASE & GROUP DELAY

We used the term "Frequency Response" to refer to graphics the kind of Fig.10.5 and Fig.10.8. Frequency is in the x-axis in both figures. The units that respond to frequency, y-axis, are Volt and Ohm, respectively. Both of them are complex quantities (have real and imaginary part) and their **magnitude** is shown. Doing this we obtained a very useful piece of information but we lost the original data (infinite numbers of different real and imaginary part can lead to the same magnitude). How this information loss will affect your life depends on what you are going to do with these graphs, or, better, which was the original question you were trying to answer. Referring to Fig.10.5. A reasonable question could have been: how much does "A" filter attenuate signal at 100Hz in respect to 1kHz? You go trough the graph with the marker and answer 19.3dB. If you have the IEC 651 norm you can go to the "A" filter specs and you will find this attenuation should be 19.1dB +- 0.5dB for type 0 devices. End of your job. Lets now pose another question referring to Fig.10.8: how much a 10kHz tone would be attenuated if we wire a 10 ohm resistor in series with that woofer? We are simply not able to give the correct answer. We need another piece of information, which is **PHASE**. Fig.10.19 is the same measure of Fig.10.8 with phase curve overlaid. To obtain it we just stored the magnitude curve and clicked on the phase button.

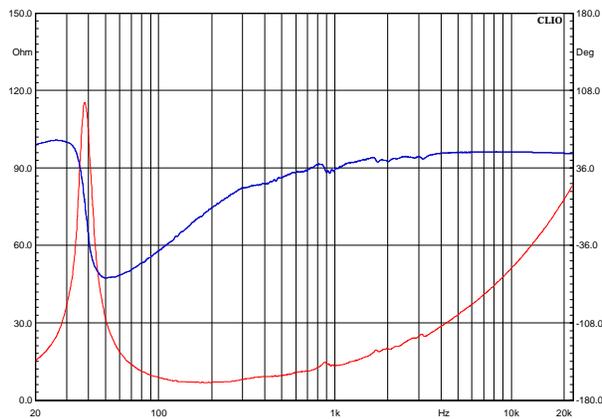


Figure 10.19

To acoustic devices the same principles applies. Fig.10.20 shows the magnitude response of woofer and tweeter in a box without cross-over network.

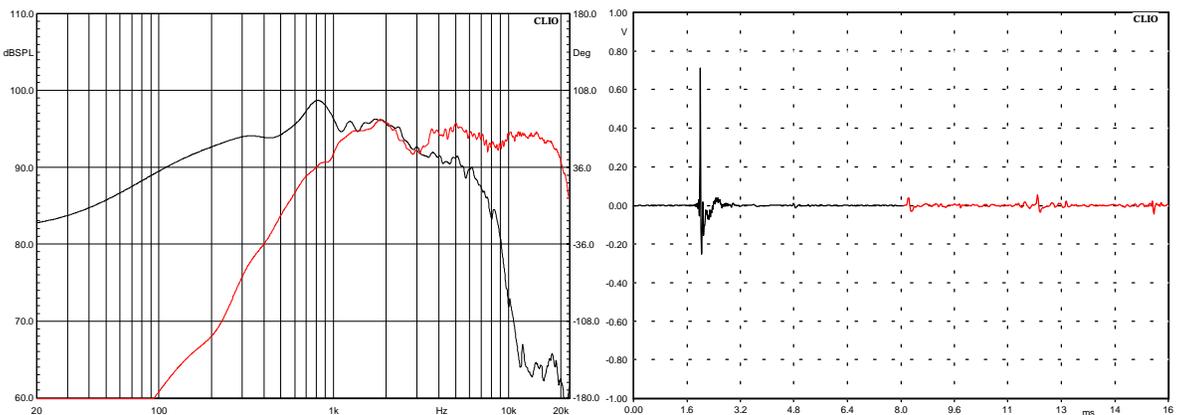


Figure 10.20 and 10.21

The two measurements were taken from the same microphone position. Should we ask ourselves which is the summed output we could not answer from the magnitude data alone. Unfortunately acoustic phase is not so easy to handle as electric phase. We are going to base our example on the tweeter, whose impulse response and window settings are in Fig.10.21. Procedure for woofer would be exactly the same.

We will take this opportunity to introduce the use of the Wrapped Check Box. Figures 10.22 and 10.23 shows the tweeter phase curve, unwrapped and wrapped.

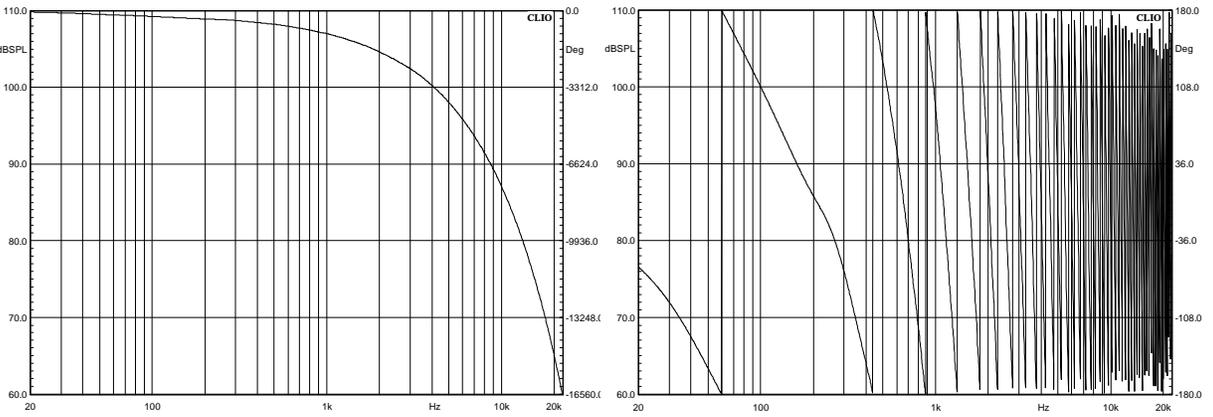


Figure 10.22 and 10.23

Reader might wonder if these figures are correct at all and if they have same usefulness, at least visually. Well, the curves are absolutely correct; their visual usefulness is zero for the wrapped curve and low for the unwrapped. Difficulties in getting simple visual information from these curves arise because they are the sum two effects. The first one is the device own phase response. The second is the time of sound flight. The latter does affect the curves much more than the first one, completely burying it. The good news is that it is often possible to separate these two effects. However, bad news, this is not an easy task. Trying to explain it, without going in heavy math, is very difficult. The bibliography in this user manual should be considered as integral part of it here. Within CLIO the time of flight can be removed in several different way, with different degree of accuracy. The most accurate is also the most complicated and is how we are going to proceed. Fig. 10.24 introduces us to **Minimum Phase**, which is the hearth of the whole procedure.

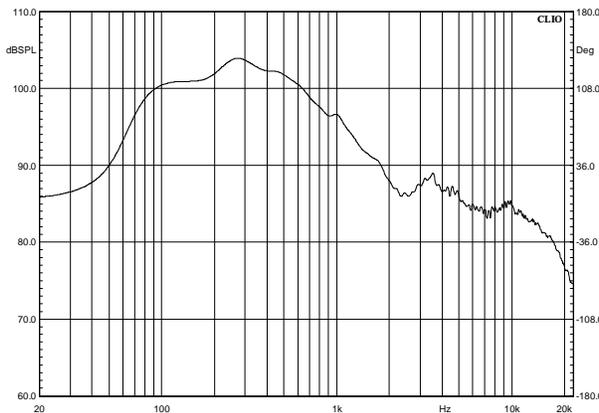


Figure 10.24

We obtained it selecting minimum phase in the MLS Setting and calculating the phase again. Certain well-behaved systems are defined as Minimum Phase. In these, the phase response can be obtained from the magnitude response by calculation. Another kind of phase (we promise is the last one), is **Excess Phase**. This is the algebraic difference between true phase, as in Fig. 10.22, and minimum phase. It is exactly what we need to separate the time of flight from the device own phase response. We wont use excess phase directly here but a post process of it, **Excess Group Delay**. Fig. 10.25 is the excess group delay of our tweeter vs. frequency.

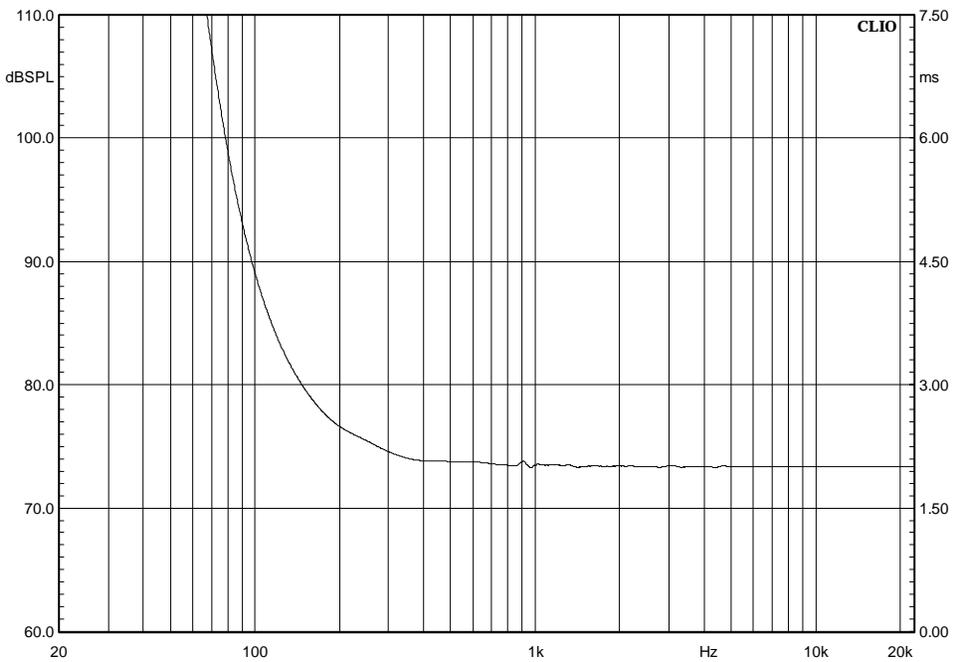


Figure 10.25

It was obtained selecting Excess in the Setting Dialog and clicking on the Group Delay button. This graph represents the distance of the sound source from the microphone vs. frequency. As long as the distance is constant the system is minimum phase and we are in presence of a well defined acoustic centre. Recall from previous paragraphs that we have reliable data down to 200Hz because of the time windows. As we deal with a tweeter we will consider the 2k-20k frequency range where the marker reads a constant 2.01ms. We will use this value to operate a time shift that removes the time of sound fly. This is accomplished from the Processing Tools Dialog, selecting Time shift and typing the value we found as in Fig.10.26.

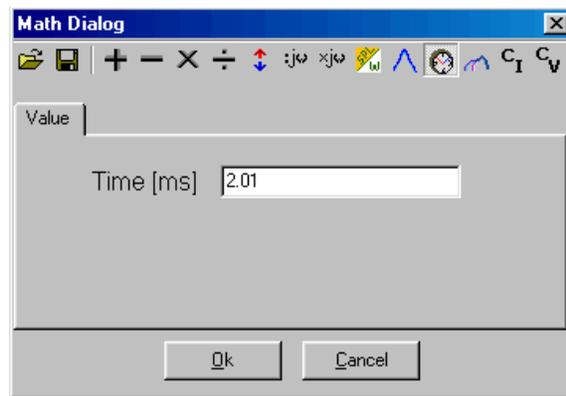


Figure 10.26

Clicking Ok we can finally display the processed phase, minimum phase and magnitude response of our device in Fig.10.27. We used the term "processed phase" here and this is not casual.

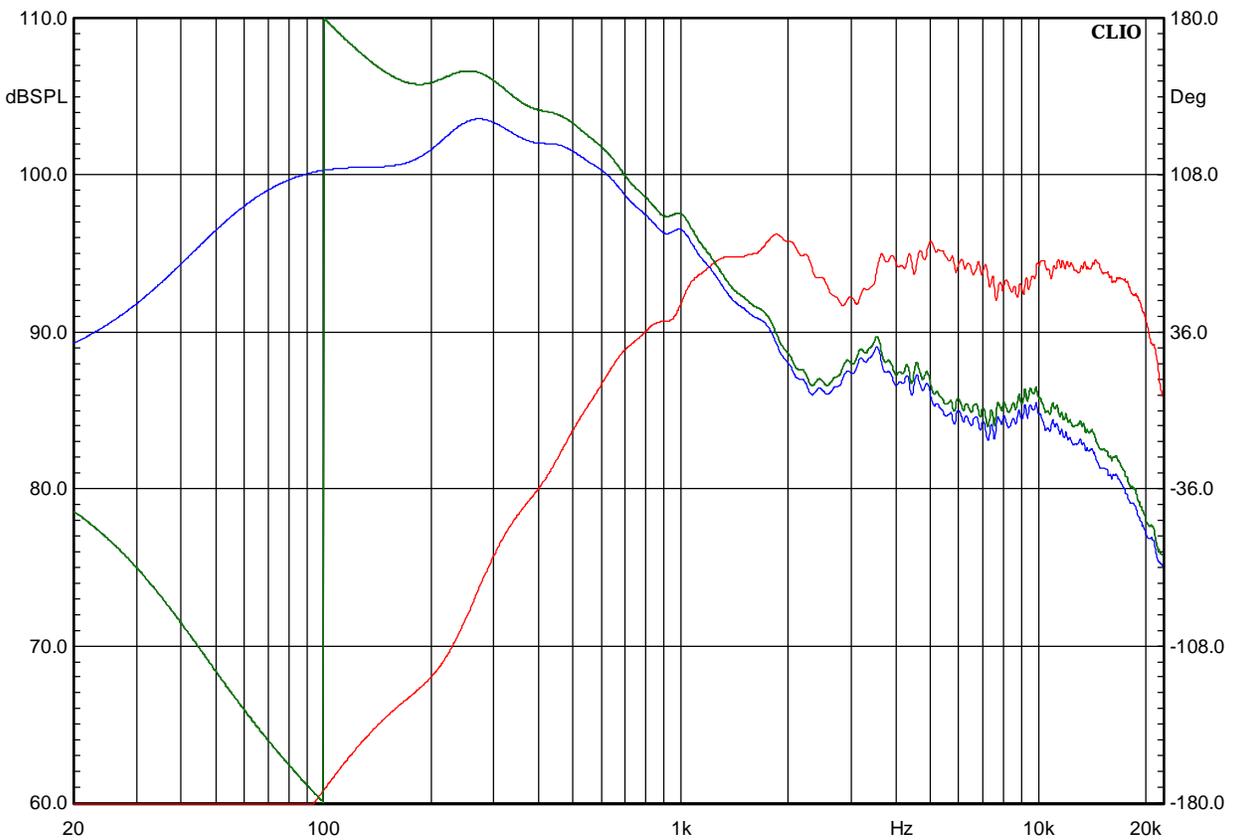


Figure 10.27

To terminate this difficult paragraph we will summarise what we did with some comments. Measuring acoustic phase response is often far from a "press a button and get it" procedure. We went through several phase plots, all looking different but, this is an important point, all correct. It is common to identify the processed phase as the true one only because it looks better. It is important to stress that the true phase is that of Figures 10.18 and 10.19. CLIO, intended as a computer based instrument, can, as we will see later, easily calculate the summed response of woofer and tweeter after their are taken separately but with the same microphone position. What we did with our complicated procedure was to obtain a response as if the microphone would have been exactly in the acoustic centre of the driver. The most obvious application is to furnish data to cross-over CAD.

10.5 OTHER TIME DOMAIN INFORMATION

CLIO gives, aside the impulse response we already dealt with, three more time related post processing, which are ETC, Step Response and Schroeder Plot. The last is room acoustic oriented and we will handle it later with a T60 calculation example. ETC and Step Response are shown here, Fig.10.28 and 10.29; they are relative to the system of Fig.10.15.

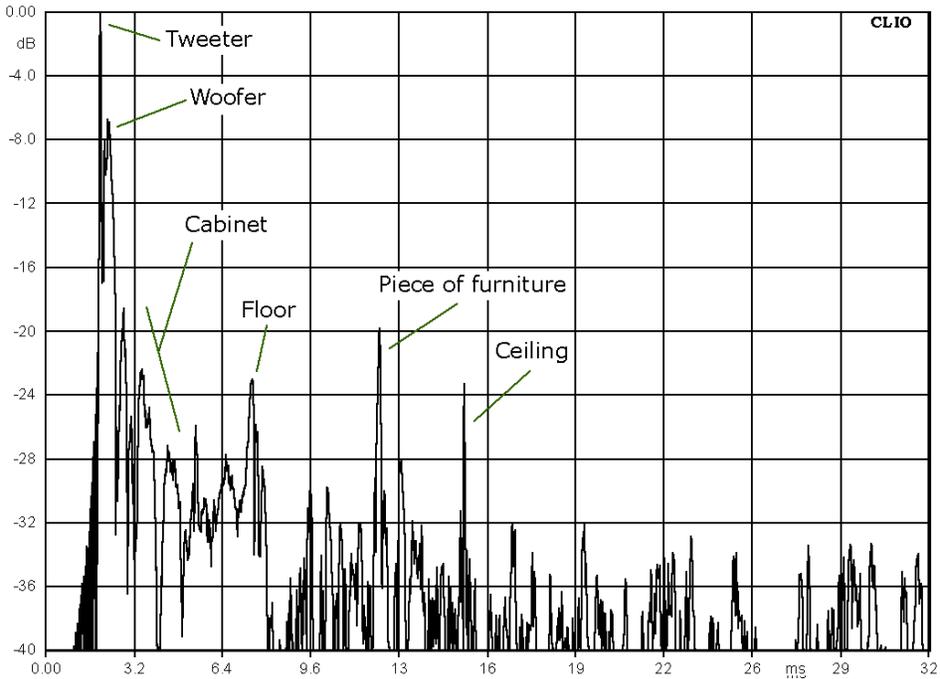


Figure 10.28

Interpretation of ETC, aside most obvious things which are labelled inside the figure, requires some theoretic digressions beyond the scope of this user manual as the topic is still debated.

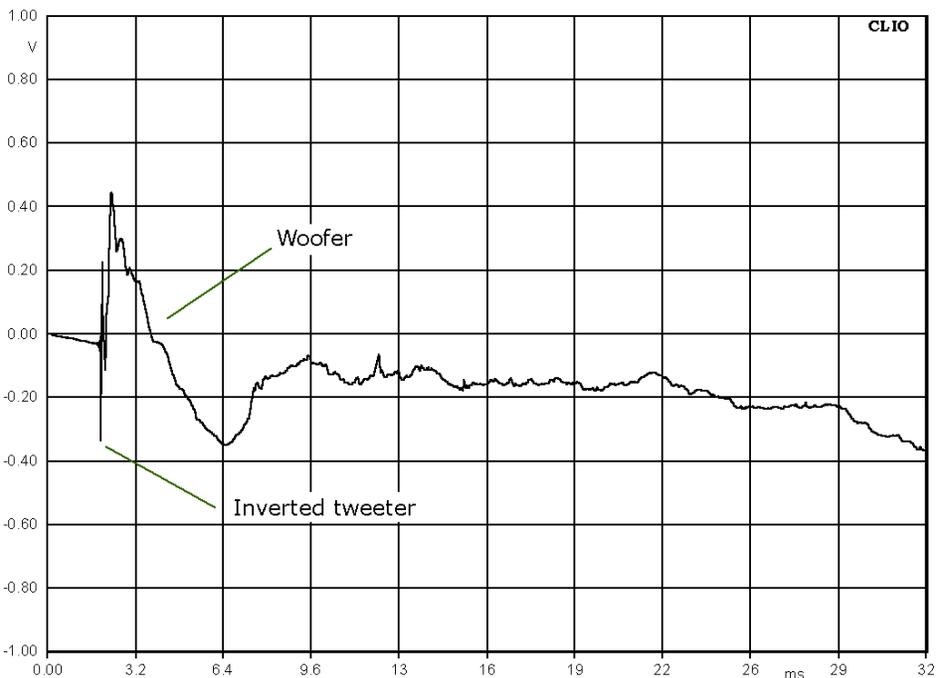


Figure 10.29

Step response is very useful to identify differences in arrival time between drivers as well as their polarity.

10.6 PROCESSING TOOLS BY EXAMPLE

CLIO has powerful processing tools that can be helpful in several circumstances. We saw the basics at the beginning of this chapter. It was just a brief description of the kind "press this to do that". Here we are going to use some of them in practice. Some general rules applies to group of them as the four basic operation. You can add, subtract, multiply and divide the data in memory either wit a single complex value or with a **compatible file**. Compatible means that it must be a file with the same basic settings as the one in memory. Y-scale must also be the same that is you cannot add dBV with Ohm. The use Load Process and Save Process, will become clearer along the examples. The Add and Sub functions are most used among files. We will use them to obtain the sum and difference of the woofer and tweeter of Fig.10.20. Results are in Fig.10.30 where the sum is in red and the difference in blue. This are useful plots to start with during a cross-over design. Interesting enough is the big notch in the sum curve, something not easy to imagine from the magnitude response.

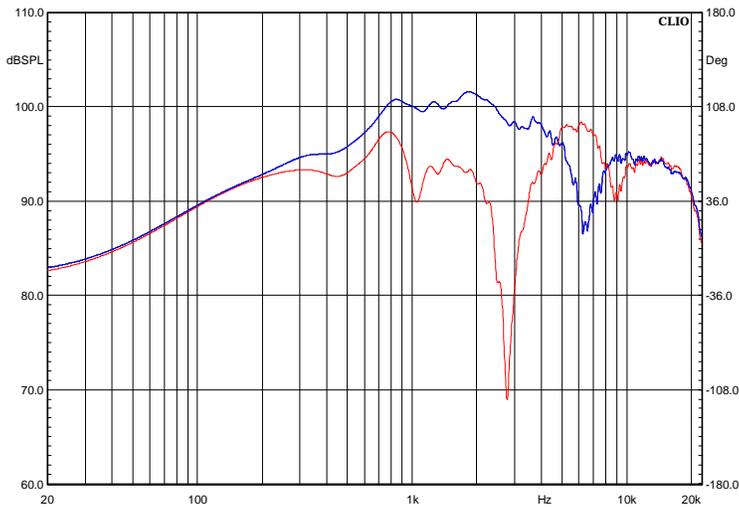


Figure 10.30

The divide function, in its most classical use, allows to show a magnitude response as transfer function with another measurement. Suppose you want to evaluate how the grid affects the frequency response. We will use as reference the response of Fig.10.17, which has been taken with the grid in place. We remove it, take another measurement, and perform a division by file with the grid in place. We remove it, take another measurement, and perform a division by file with the data of the reference. Result is in Fig.10.31.

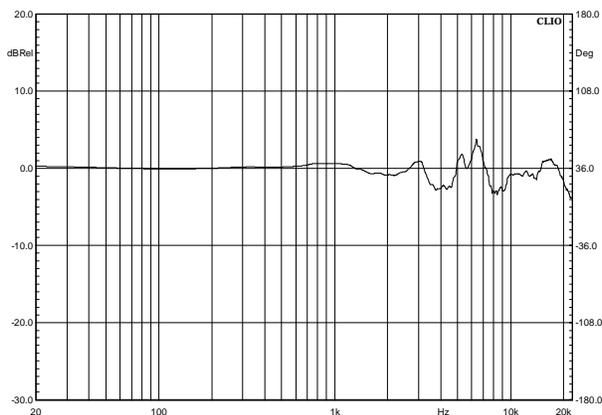


Figure 10.31

Note that the y-scale has been automatically changed to dBRel. This is a good point to introduce the use of Load and Save process together with the Automatic Processing

button. Any process you execute can be saved to disk and will have "mpro" extension. This allows to recall any value or file path later on by loading this file again. Suppose you have a little production of ten speakers you want to test against a previous produced reference you know is fine. You just have to define and save a process that divide current data with the reference. Testing a device against itself should produce a flat line, within the frequency range of the device, and this should be checked before saving the process. When you need to check your little batch you just recall your process. This will activate the Automatic Process button. When this button is down any subsequent measurement is processed before it is displayed. The next process we will consider is the **dB SPL/Watt**. It requires a file and an impedance value and allows to obtain a frequency response plot referred to 1W at the speaker terminal whatever is the real measurement level. To make this possible an electrical measurement at the speaker terminal (power amplifier output) must be taken, with dBV as y-scale, and used as reference file. A value of impedance is also necessary that allows Clío to convert voltage to power. We will go through the entire procedure using the tweeter of previous examples. As what we are looking for is the response in 1W-1m condition we have to move the microphone to 1m from the tweeter (it was at 69.14cm). The 1m condition can be set directly with a meter. Fig.10.32 shows the 1m measure in black and the previous one in red. Level at speaker terminal is unchanged. The average difference 3.3dB.

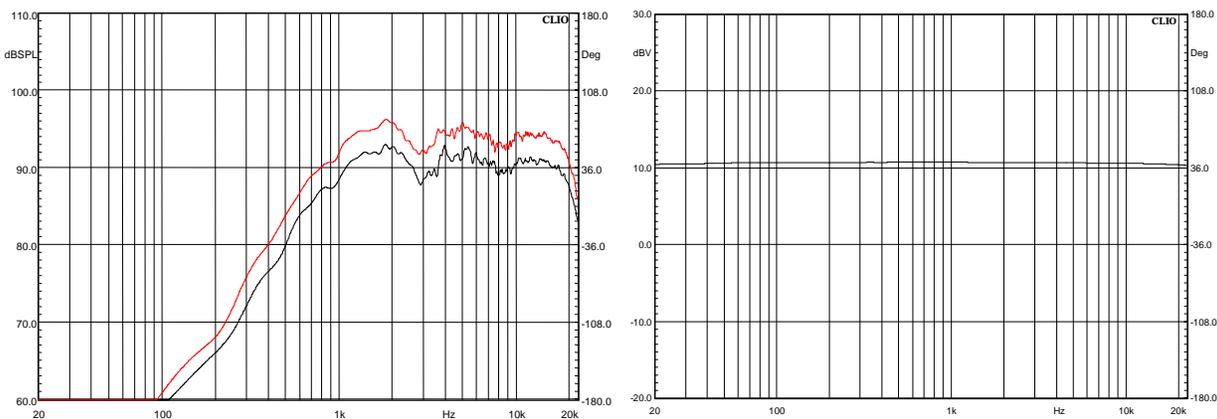


Figure 10.32 and 10.33

We now connect Clío input to the speaker terminals, change the y-scale to dBV, **do not change** Clío output level and obtain Fig.10.33. This is a nearly flat line that indicates us the voltage delivered to the speaker. Remember to save the measurement to disk. It is worth to point out that deviation from linearity in this curve due to the power amp or cable would be compensated by this procedure. Now we reload the response at 1m, go to the Process Dialog that will appear as in Fig.10.34.

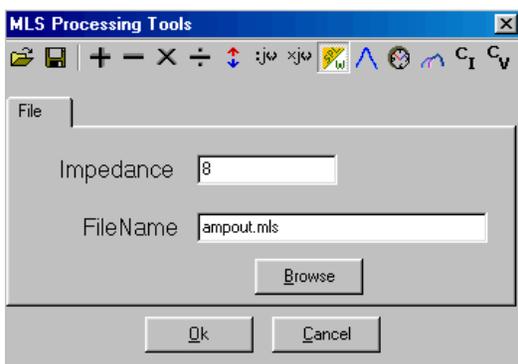


Figure 10.34

We set the impedance to 8 ohm as this is the nominal impedance of the tweeter. Clicking Ok we obtain Fig.10.35, which is the final result.

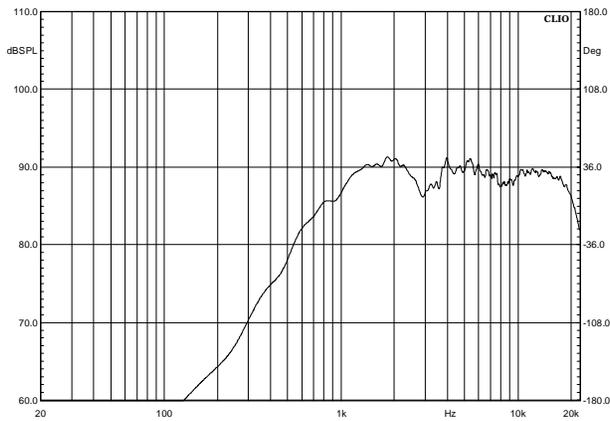


Figure 10.35

Our last example will cover the **merge function**. When we measured the system of Fig. 10.17 we stated that the lower frequency limit that had to be considered reliable was 208Hz. We can easily overcome this limit taking another measurement with the near-field technique and merge the result with the data of Fig.10.17. Doing near-field measurement you should readjust the output level so that the maximum sound pressure does not exceed 110dB SPL as this prevent Microphone overload problems. Fig.10.36 shows both the near-field and far-field response. Notice the big level difference. To merge them the far-field should be the one in memory. Fig.10.37 shows the Merge Dialog with a transition frequency set to 350Hz.

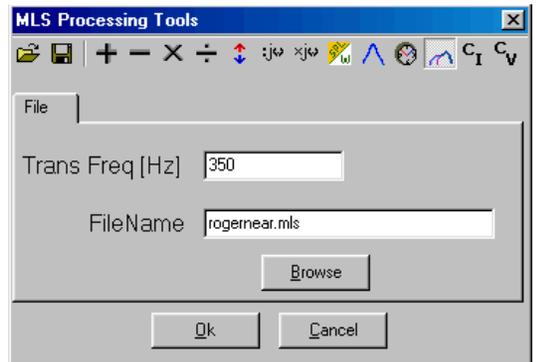
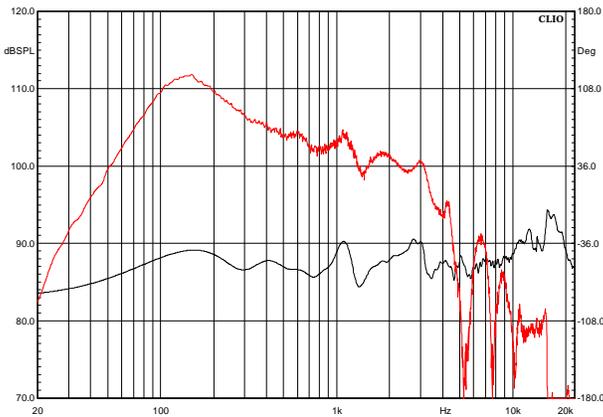


Figure 10.36 and 10.37

Fig.10.38 shows the merged response. Notice that the near-field measurement level has been scaled to the far-field one. Two very important functions, **cv function** and **ci function**, are explained in Chapter 13 as they are impedance tools.

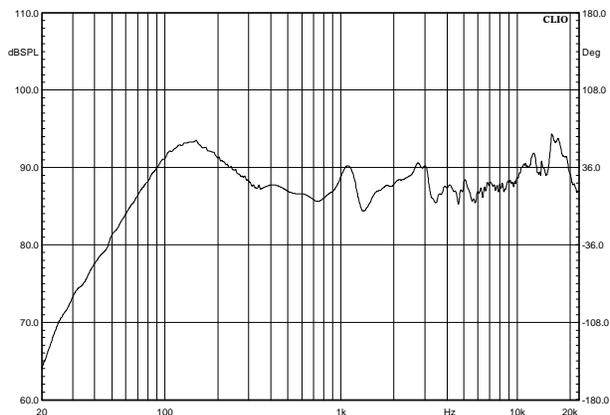


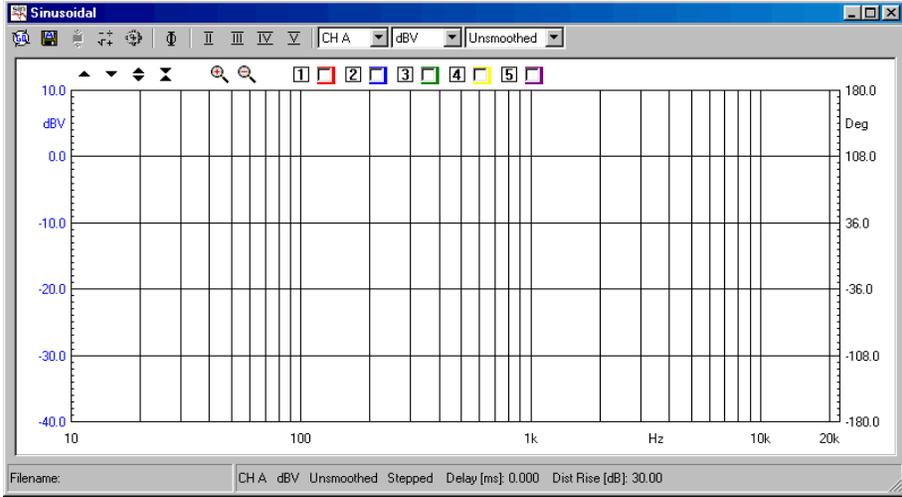
Figure 10.38

11 SINUSOIDAL

11.1 INTRODUCTION

Within Sinusoidal, it is possible to carry out Frequency Response Analysis, Impedance Analysis and Distortion Analysis. As should be obvious the stimuli used is a Sinusoidal signal, stepped swept within user defined Frequency limits. Although Sinusoidal steady state analysis is among the oldest and more traditional kind of measure, CLIO merges the reliability of this well known technique with the power of advanced DSP. The completely programmable Gating feature allows to add quasi-anechoic Frequency Response capability.

11.2 SINUSOIDAL CONTROL PANEL



11.2.1 TOOLBAR BUTTONS

 Starts the sinusoidal measurement.

 If pressed the measurements will be autosaved. The current autosave definitions apply; see 6.3.1 for details.

 Automatically applies the defined post-process after the measurement has been taken.

 Displays the phase response instead of modulus response.

 Enters the Sinusoidal Post-Process Dialog, described below.

 Enters the Sinusoidal Setting Dialog, described in detail below. It is the heart of the whole menu and should be thoroughly understood before pressing Go.

 Displays second harmonic distortion, risen the amount of dB defined in the Setting Dialog.

 Display third harmonic distortion, risen the amount of dB defined in the Setting Dialog.

 Display fourth harmonic distortion, risen the amount of dB defined in the Setting Dialog.

 Display fifth harmonic distortion, risen the amount of dB defined in the Setting Dialog.

All the distortion buttons are disabled when Ohm is selected as y scale unit.

10.2.2 TOOL BAR DROP DOWNS

input channel

Selects the input channel configuration. See 5.6 for details.

Y Scale units

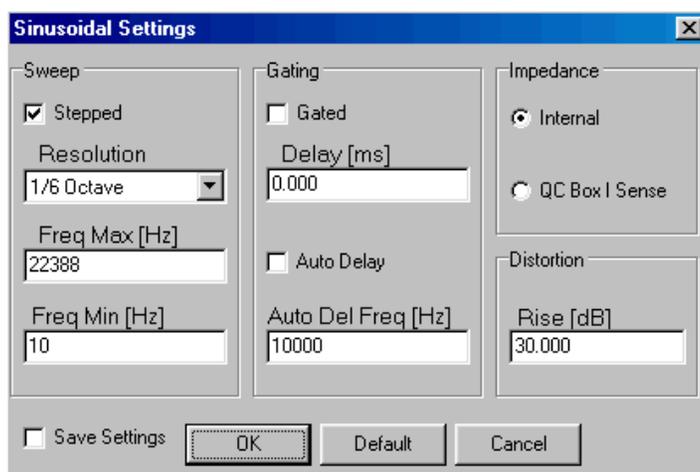
Selects the measurement Y scale unit. Possible choices are dBV, dBU, dBRel as Voltage units, dB SPL as pressure unit, Ohm as impedance unit. dBV and dBU refer the 0 dB on the scale to 1 V and 0.775 V, respectively. dBRel refers the 0 dB on the scale to the value set within the MULTI-METER. dB SPL switches the system to work in pressure mode. A conversion from Volts to Pressure is accomplished, based on the Microphone sensitivity set in the dedicated Dialog. Once the measure is taken the conversion is done and all the internal data are stored in Pressure. This means that further changes to Microphone sensitivity do not affect in memory or saved measurements. Ohm switches the system to convert the measurements in Ohm basing the conversion on the Impedance Mode Settings available in the Settings Dialog. Again, once the measure has been taken data are immediately converted.

Smoothing

Allows to select a Frequency smoothing of the active curve. The smoothing algorithm averages all the value within the selected fraction of octave band, surrounding each analysis Frequency. It is a non destructive post process that can be applied or

removed at any moment after the measurement has been taken.

11.2.3 SINUSOIDAL SETTINGS DIALOG



It is undoubtedly the most important User Interface of the entire Menu. Here the single action of every control is considered. Theoretical and practical effects on the subsequent measurement are considered later.

Sweep Settings

Stepped Check Box

Lets the user choose between continuous or stepped Logarithmic Sweep. Continuous sweep is faster but, therefore, should be used only if its clear to the user how this affects the measure.

Resolution Drop Down

Lets the user choose between five different Frequency resolutions. It affects the measurement execution time, whatever are the other settings.

Freq Max Edit Box

Lets the user define the highest Frequency of the Sweep. This is also the starting measurement Frequency. The highest value accepted is 22388 Hz. The value should also be one octave higher than the Minimum Frequency.

Freq Min Edit Box

Lets the user define the lowest Frequency of the Sweep. This is also the end measurement Frequency. The lowest value accepted is 10 Hz. The value should also be one octave lower than the Maximum Frequency.

Gating (Acquisition) Settings

Gated Check Box

Lets user enable the gating acquisition mode. Checking it will automatically disable the Stepped Check Box and check it. That is, Gated Measurements are always carried in Stepped Mode.

Delay Edit Box

Lets user define the delay, in ms, applied between the signal generation and its acquisition. When different than 0 it is active, even when gating is not checked, if

Stepped is also not checked. Typical use, when gated is checked, is quasi anechoic Frequency Response Analysis where it removes the sound time of fly between Speaker and Microphone. Alternative use, with gated not checked, might be removing the delay between the play and recording head in a three heads tape recorder as well as any digital processor that introduce delay in the signal path. When the settings are Not Stepped and Not Gated the delay value is reset automatically to 0; CLIO introduces a large delay anyway between start of generation and acquisition. The highest Delay value accepted is 320ms.

Auto Delay Check Box & Auto Delay Frequency Edit Box

If Auto delay is checked, when delay is handled, see above, CLIO tries, using the Frequency settled in the Edit Box, to determine the delay automatically. The value found is displayed in the Delay Edit Box; reopening the Settings Dialog after the measurements has been taken allows to visualise it.

Impedance Settings

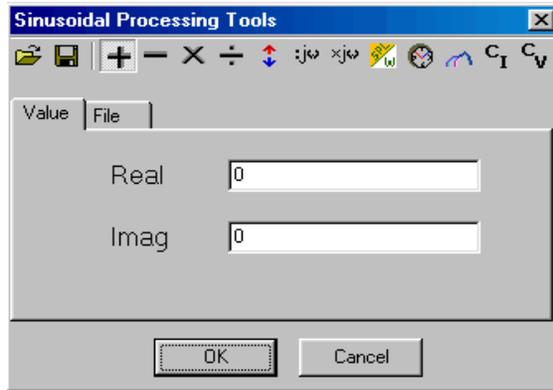
A two position Radio Button allows to choose between Internal Mode and QC Box I Sense Mode. The latter, requires the QC Box Unit Model 2 or Model 3. See Chapter 13 'Measuring impedance and T&S parameters' for details about connections and more.

Distortion Settings

An Edit Box allows to type in the value, in dB, used by the graphical routines to rise the display of the distortions curves. Only the display of the curve is affected. The marker readings continue to display the real value which, if the rise value is different than 0, differs from the curve position.

11.2.4 SINUSOIDAL POST PROCESSING TOOLS

The POST PROCESSING Dialog gives access to very powerful tools that, once defined, can be saved, reloaded and automatically be applied to every executed measurement.



 Loads a Sinusoidal process.

 Saves a Sinusoidal process.

 Adds a data value or compatible file to the current measurement.

 Subtracts a data value or compatible file to the current measurement.

 Multiplies the current measurement by a data value or compatible file.

 Divides the current measurement by a data value or compatible file.

 Shifts the current measurement by a dB value.

 Multiplies the current measurement by complex frequency.

 Divides the current measurement by complex frequency.

 Uses a reference measurement file taken at speaker terminals to calculate 1m sensitivity in dB SPL/W. The reference file should have dBV Y units while the one in memory should be in dB SPL.

 Temporally shifts the current measurement by a ms value. Affects phase response.

 Merges the current measurement with the part below the selected transition frequency of a selected compatible file.

 Combines the current measurement and the selected file to obtain a constant current impedance measurement. Both files should be in dBV.

 Combines the current measurement and the selected file to obtain a constant voltage impedance measurement. Both files should be in dBV.

11.3 A BRIEF DESCRIPTION ON SETTINGS EFFECTS

11.3.1 STEPPED VS. NOT STEPPED

Although Measuring speed increases, use of a not stepped sweep can adversely affect measuring results in several circumstances. As an example that should make clear also other situation, let's see what happens measuring the impedance of a woofer in Internal or Constant Current Mode. Please refer to Measuring Impedance for more information on this topic. In both conditions the loudspeaker is driven from a high impedance source and its damping is only mechanical. Fig.11.1 shows a 6" woofer, driven by a 100Ohm output impedance generator delivering a sinusoidal burst 200ms long, at its resonance frequency. When the excitation stops, the device continues to move, and therefore produce back electromotive force voltage for more than 50 ms. Something very similar happens at start-up. In this situation, if CLIO is set in not stepped mode, it will acquire the previously played frequency together with the actual.

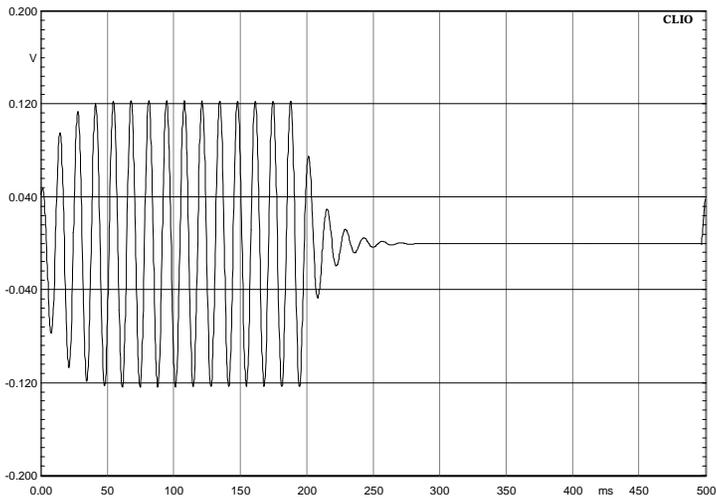


Figure 11.1

Fig.11.2 shows the same driver impedance taken both in stepped (black) and not stepped mode (red). The not stepped curve is simply wrong. Conclusion: use always stepped mode if the behaviour of the device to be measured is unknown.

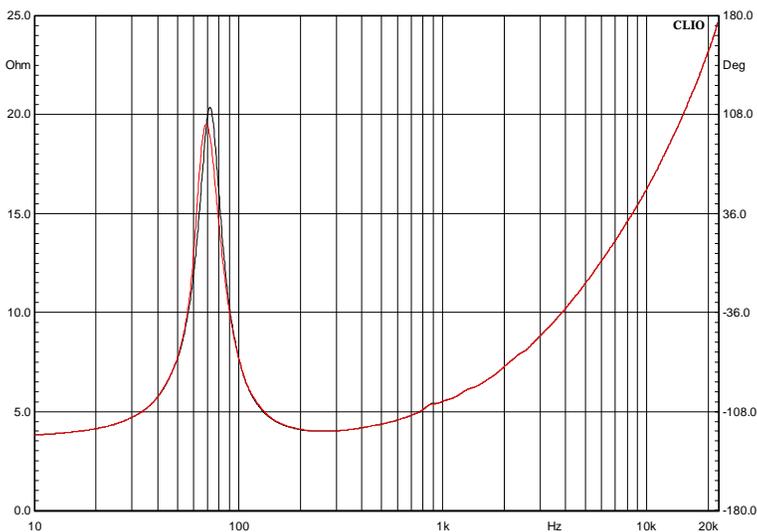


Figure 11.2

11.3.2 FREQUENCY RESOLUTION

Here the lowest resolution the fastest is the measuring time. Impedance measurements are again a powerful setup to exploit problems. Fig.11.3 shows two impedance taken from the same 16" woofer with 1/24 octave resolution (red) and 1/6 octave resolution (black). Deriving T/S Parameters from the black curve would lead to serious errors. This is an extreme case, a huge woofer with high Qms. Different curve shapes can be accurately quantified even with 1/3 octave resolution.

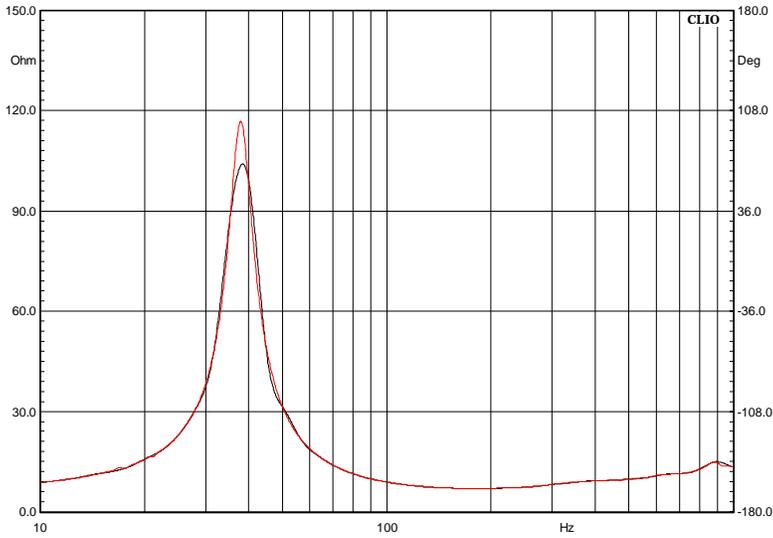


Figure 11.3

11.3.3 GATING

Enabling Gating allows quasi anechoic Frequency Response to be carried out in normal environments, with obvious and less obvious limitation. Regarding the geometrical environment required, Sinusoidal analysis does not differ from what has been said about MLS. Nevertheless the latter give a much more intuitive approach. It is strongly suggested to become very familiar with quasi anechoic measurements using MLS before dealing with gating. What follows is a brief description of the parameters involved. We are going to use some figures to help our intuitive grasp. Fig.11.4, repeated from the MLS chapter, show a typical setup, while Fig.11.5 shows what really happens, using as stimuli a 20ms 1kHz Sinusoidal Burst.

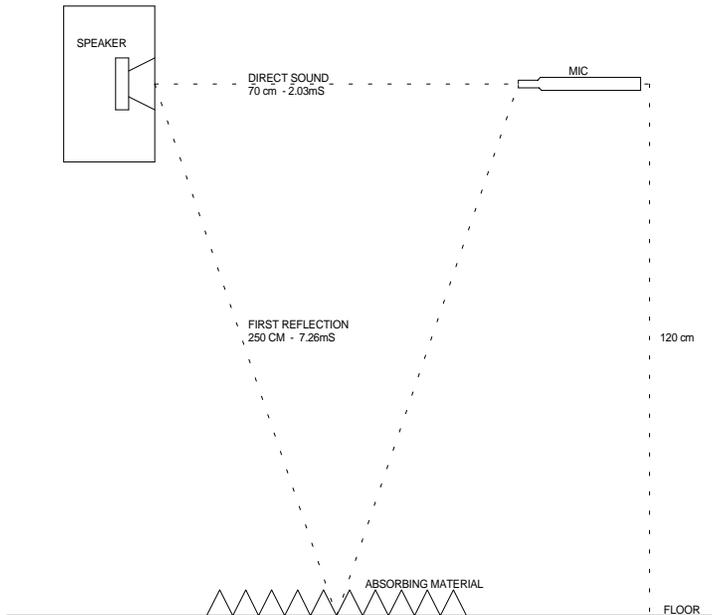


Figure 11.4

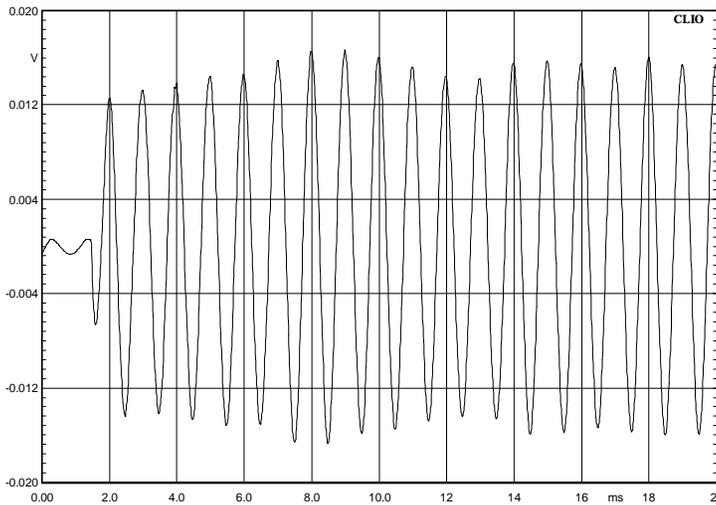


Figure 11.5

The time of sound fly is clearly visible at the beginning, roughly 1.3ms. This is the value users should input in the Delay Edit Box. Thereafter is a short time the device takes to start. This is usually short enough to not affect amplitude evaluation but adversely affect distortion measurements. At 7 and 8 ms, where there are two consequent sinusoid positive peak, a level increase is clearly visible. This is the effect of the first reflection (floor); it affects amplitude evaluation which therefore should have stopped before. The time the system evaluate the signal is usually defined as Meter On time. This is

automatically set by CLIO around the value of 6 ms, as long as the Frequency involved is high enough to allow this. In Fig.11.6 Excel plots the Meter On Time Vs Frequency CLIO uses.

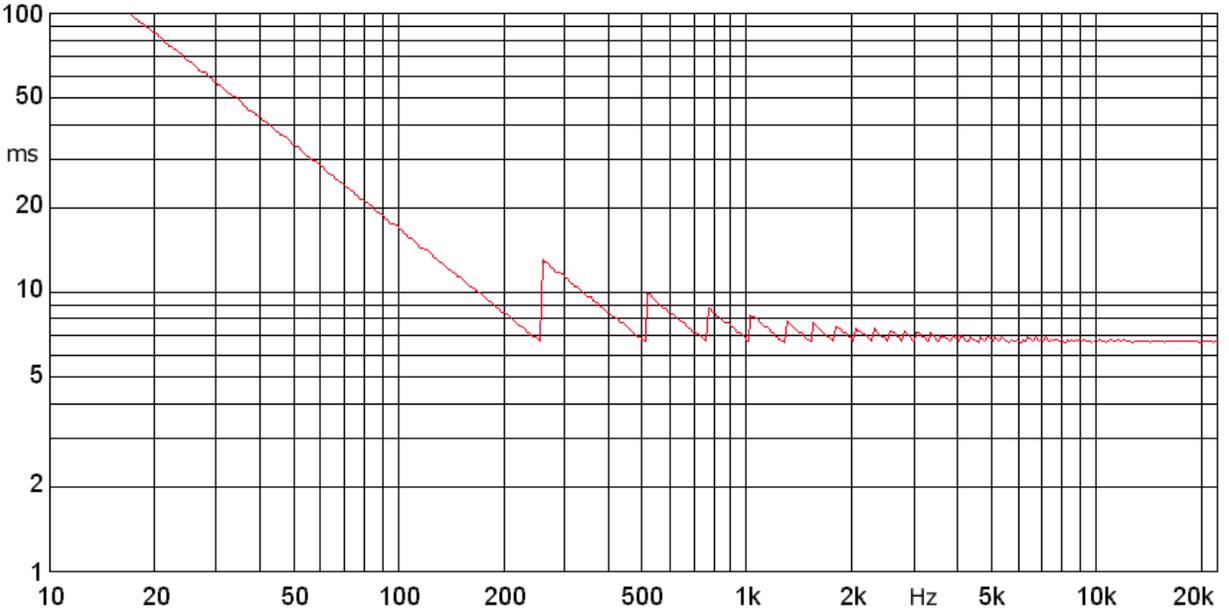


Figure 11.6

Users should use this graphic to determine the lowest Frequency that has been measured in anechoic state. Using a fixed predefined Microphone and Loudspeaker location makes all these parameters easier to define in routine measurement processes. But for new situation its very advisable to run an MLS and have a look at the impulse response obtained. Fig.11.7 shows the labels of the corresponding data to be input as gating parameters.

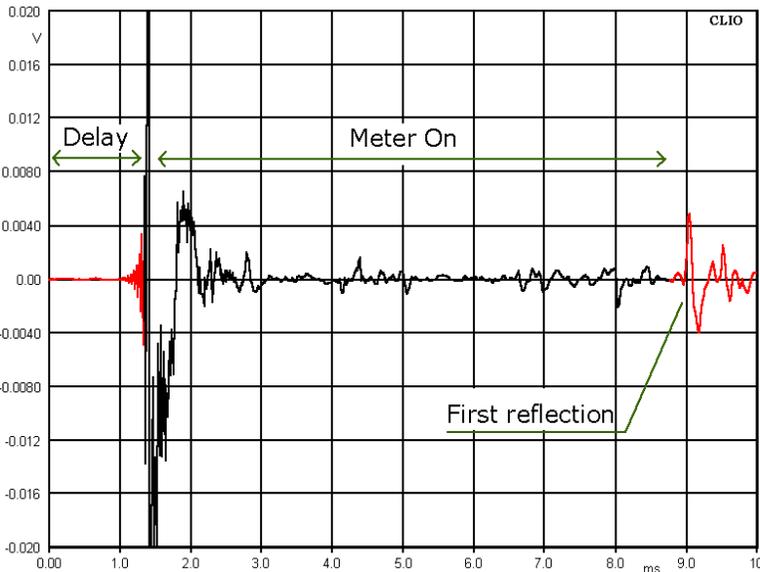


Figure 11.7

11.4 DISTORTION AND SETTINGS

Sinusoidal stimuli allows CLIO to evaluate distortion in its single harmonic contribution. If not Set in Impedance Mode, CLIO always evaluate harmonics from second to fifth and allows display each one separately via its own push buttons. While it is straight to have meaningful distortion figure of electrical devices, measuring Loudspeaker distortion, in normal environments (without anechoic chamber) is not trivial. We will give only some advise here, relaying on examples, as the topic is far beyond the scope of this User Manual. To do this we will use CLIO's FFT Menu in quite an advanced way. Distortion evaluation is adversely affected by several parameters; Two are the most important.

Noise

50 dBSPL of ambience noise, a common figure, usually does not affect Amplitude evaluation which is usually carried out at an average level of 90dBSPL. This is particularly true using CLIO Sinusoidal Analysis capability which, by means of DSP filtering, allows exceptional S/N Ratio. Unfortunately evaluating 1% distortion means looking for signals that are 40dB lower than the 90dBSPL mentioned above, in the same magnitude order of environment noise.

Gating Effects

Device settling time, not perfect delay removal and reflections arriving within the sampling time (Meter On) seriously affect distortion measurements, creating artifacts.

It is advisable to perform a noise evaluation using FFT Analysis. Fig.9 shows two curves, the first (red) is obtained with the Max Hold function, the second (black) with Min Hold.

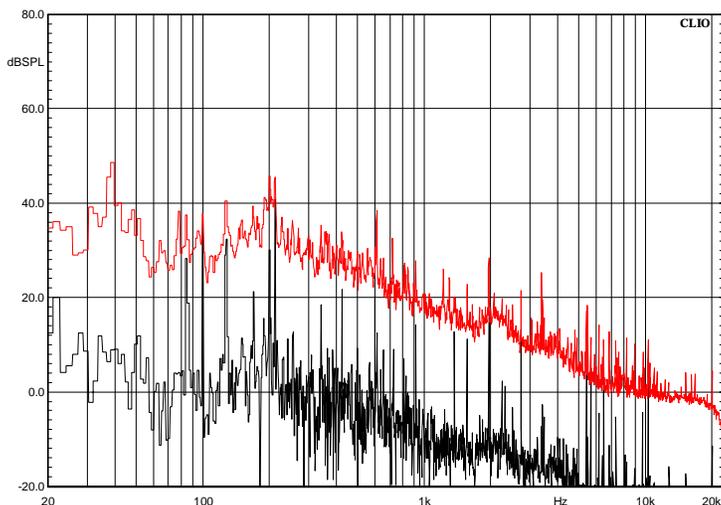


Figure 11.8

The first, a sort of worst case, should be taken as the reference lower distortion floor once risen 10dB at least. The second is useful to identify pure tones in the noise spectrum; these are likely to produce both distortion increase as well as cancellation artifacts. In our case this tones are caused by more than 20 different computer fans, spread everywhere in the room. Supposing we carry a distortion analysis at an average 90dBSPL, residues below 1% are difficult to evaluate up to 600Hz, things going much better at higher frequencies. Remember that the frequency axis should be referred to the harmonic we are looking for, not to the fundamental. The obvious solution to overcome noise is increase level. One way is to put more voltage at the Loudspeaker terminals; unfortunately this increase distortion by its own even if it provide important information regarding the device. The second way is to narrow the Microphone to Loudspeaker distance. The next figures, dealing with Gating Effects, refer to a

Microphone 11.5cm (4.5") in front to a good quality tweeter. FFT size is set to 512 points, the equivalent of 10ms Meter On at 51200Hz sampling rate. Fig. 11.9 shows the effects of a wrong delay in capturing a 2kHz 10ms tone burst. All harmonics are buried below the effects of this wrong set.

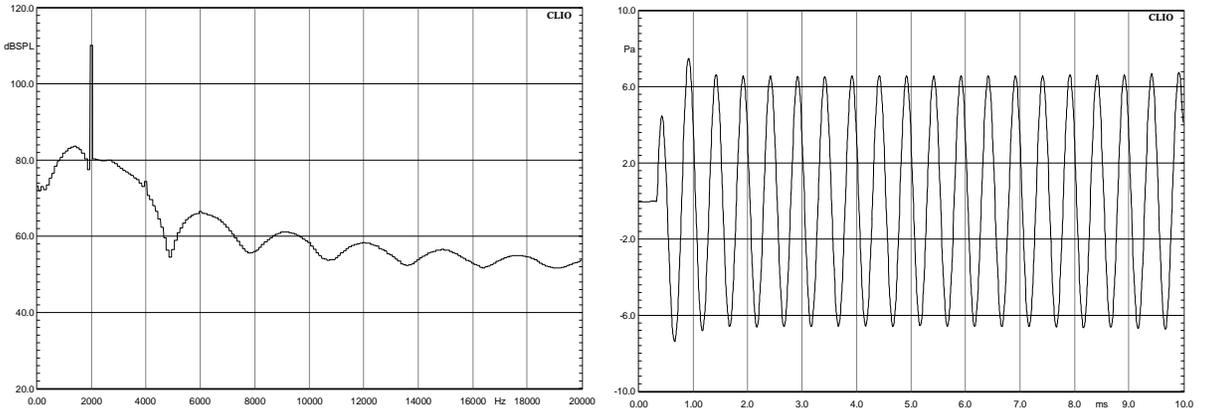


Figure 11.9

Fig. 11.10 shows the effects of the device settling time as the delay is now correctly set to 0.35ms. 40dB down harmonics (1% distortion) should be visible now. As the tweeter perform better than this what we see is the second harmonic cancelling the broad spectrum caused by the device settling time.

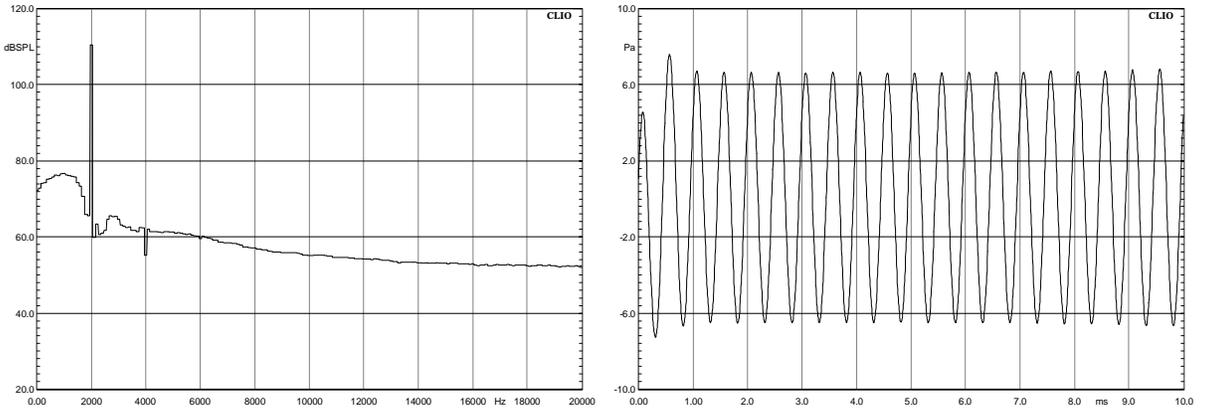


Figure 11.10

Fig. 11.11 shows the spectrum when the delay has been set to 1.5ms. The third harmonic, 64dB (0.06%) below the fundamental is clearly visible.

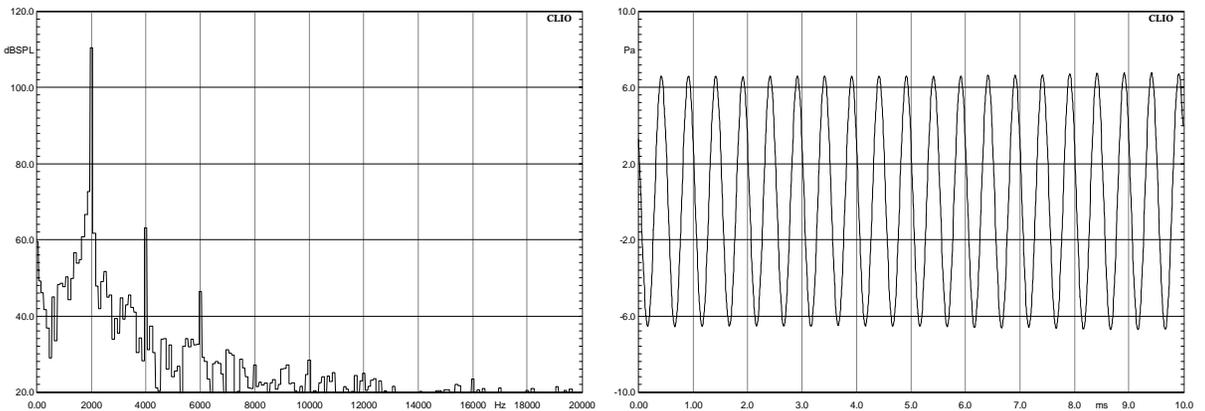


Figure 11.11

Finally Fig.11.12 shows the distortion analysis carried out with the same microphone distance as in the past examples and the gating delay set to 1.5ms with the auto delay option disabled. Fundamental is red, second harmonic (+ 30dB) blue and third harmonic (+ 30dB) green.

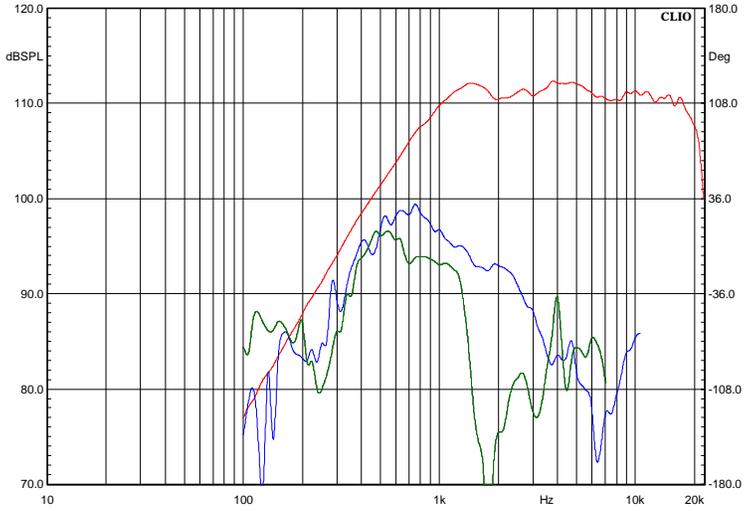


Figure 11.12

12 WATERFALL

12.1 INTRODUCTION

The Waterfall post processing routines give CLIOwin the possibility of making 3-D plots adding a third dimension (usually time) to classical amplitude-frequency graphs.

CLIOwin permits the following 3-D types of waterfall:

- **Cumulative spectral decay (CSD)**
- **Energy Time Frequency (ETF)**
- **File display (used for polar representation)**

12.2 WATERFALL CONTROL PANEL

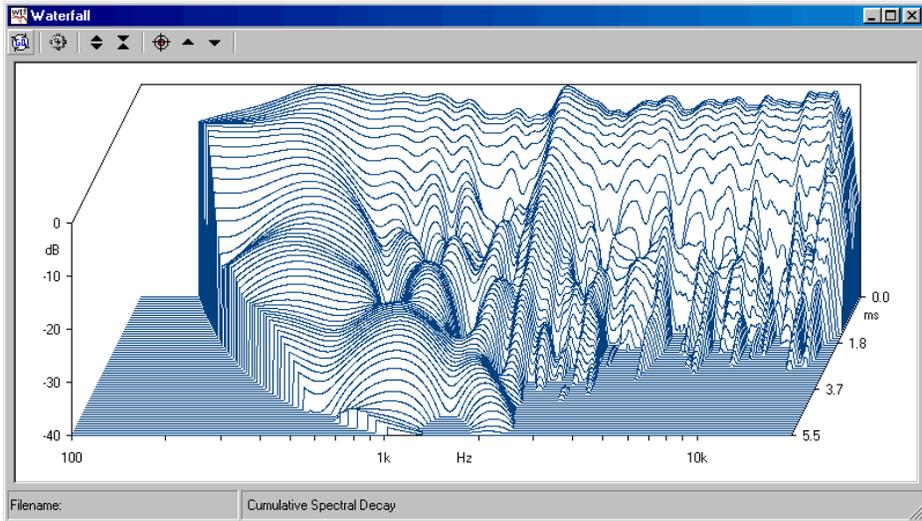


Figure 12.1

12.2.1 TOOLBAR BUTTONS

-  Starts a waterfall calculation.
-  Enters the Waterfall settings dialog. See 12.2.1.
-  Expands the waterfall display changing its Y scale. Three ranges are available 20, 40 and 80dB.
-  Compresses the waterfall display changing its Y scale. Three ranges are available 20, 40 and 80dB.
-  Enters the Marker mode (see Fig. 12.5). In this operating mode it is possible to inspect the single data points of each waterfall slice clicking and dragging the mouse.
-  When in marker mode, moves the selected waterfall slice backwards. The same action is obtained with the **Up-Arrow** keyboard shortcut.
-  When in marker mode, moves the selected waterfall slice forwards. The same action is obtained with the **Down-Arrow** keyboard shortcut.

12.3 WATERFALL BASICS

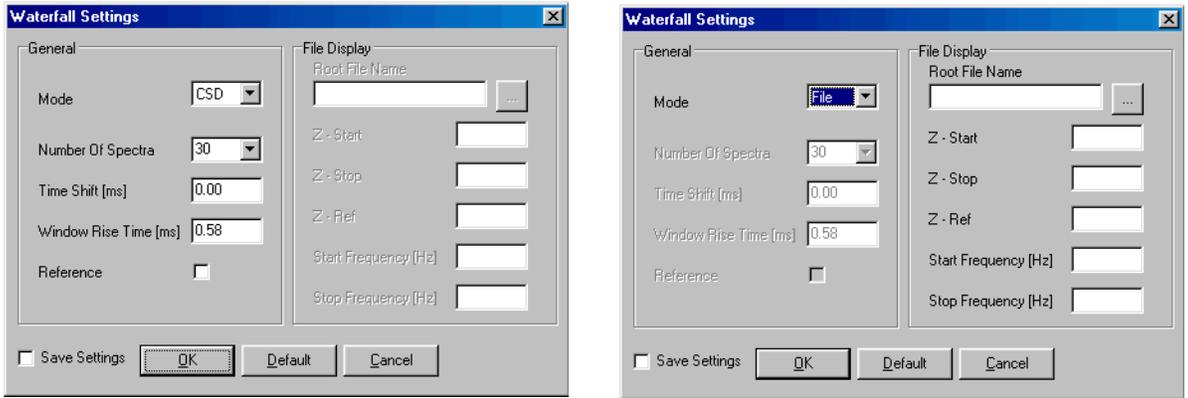


Figure 12.2

Within the waterfall settings dialog (Fig. 12.2) it is possible to configure many waterfall parameters. But, since the calculation relies on externally available data, it also **captures some settings** from the data source itself. When executing CSD and ETF waterfalls the data source is the MLS control panel, when displaying files the data source is, obviously, the set of files. It is possible to save and load from disk executed waterfalls.

One automatic setting is **Y scaling**. The waterfall amplitude scale is always dB relative; the routine try to evaluate the maximum value within all the data to be represented and references all other values to this.

The first setting encountered is **Mode** that selects between the available modes: CSD, ETF and File. Follow a basic introduction to the three different modes.

12.3.1 CSD AND ETF MODES SETTINGS AND OPERATION

Number of Spectra

Selects the number of data slices to display.

Time Shift (ms)

Selects the time between two consecutive spectra.

Window Rise Time (ms)

Selects the rise time of the data selecting window. Valid only for CSD.

Reference

If checked the waterfall spectra will be reference to the rearmost one.

As already said, the data source for a CSD or ETF waterfall is the MLS control panel; when in these modes, the Go button becomes active only if there is an MLS measurement active, i.e. just executed or loaded from disk. The waterfall captures the following MLS settings: **frequency range**, if MLS has a zoomed curve than waterfall will take the selected zoom as frequency range to display; **smoothing**, the current MLS smoothing factor is also applied to the calculated data slices; **start time**, the Start Window value selected in the MLS impulse response represents time zero for the waterfall; **stop time**, the Stop Window value selected in the MLS impulse response represents the last processed CSD slice unless a different Time Shift has been selected.

You can interactively switch between the MLS and Waterfall control panels to change the MLS settings that affect waterfall.

CSD (**Cumulative Spectral Decay**) is intended primarily for anechoic loudspeaker

evaluation; in this case only the data between the start and stop time is analyzed; each successive slice considers time data from its relative start time (the rearmost, at time zero, has start time equal to the start window of MLS) to the fixed stop time, the data being windowed by a particular time window with a smoothed rising edge (see literature for a discussion about this). Normal values for the Window Rise Time lie within 0.1 and 0.6ms. In CSD mode, should the Time Shift value be left at zero, the routine will automatically calculate it, spacing the selected Number of Spectra in the interval defined by start and stop times; if Time Shift is forced by the user be sure to set it small enough to permit the last spectra to be calculated; if the fixed stop time is passed, then the calculation defaults as in case of zero Time Shift.

When representing a CSD the program automatically hides the low frequency part of the spectra that has become unreliable due to the time-frequency uncertainty principle.

ETF (**E**nergy **T**ime **F**requency) is intended for room acoustic evaluation; in this case all MLS data starting from the start time are computed; then, successive slices are calculated moving their initial point of the Time Shift value.

12.3.2 FILE DISPLAY MODE SETTINGS AND OPERATION

Root File Name and browse button

Name of one file within the set to be displayed. Pressing the associated button it is possible to browse the disk and choose the file.

Z-Start

Value associated to the first (rearmost) file.

Z-Stop

Value associated to the first (foremost) file.

Z-Ref

Value associated to the file to be taken as reference.

Start Frequency

Start frequency of the waterfall.

Stop Frequency

Stop frequency of the waterfall.

File display mode is a powerful way for synthesizing a large number of measurements in a single 3-D graph. This mode allow the representation of the **polar response** of a loudspeaker taken as successive frequency responses saved in files.

In order to identify the set of files it is important that all of their names follow a particular syntax, that give certain information to the processing routines.

The syntax follows: **<NAME><UNITS><VALUE*100>.MLS**.

NAME is a common file name, UNITS are the common measurement units (to be displayed in the graph as Z axis label) and VALUE is a unique value identifying the single file; these quantities needs to be separated by **spaces**, it is possible to give negative numbers to VALUE. For example '**mydriver deg -250.mls**' is a valid file name: as the name tells it is a measurement named **mydriver** with units **deg** taken at **-2.5** (250 divided by 100) units value.

It is possible to identify one file within the set as reference with the Z-ref value; all calculations will then be made referenced to it.

Please refer to 12.5 for an example.

12.4 MAKING A CUMULATIVE SPECTRAL DECAY

A cumulative spectral decay starts from an MLS measurement in memory. Suppose we have an anechoic frequency response of a medium sized pro speaker (12" midbass and horn compression driver) as in Fig.12.3 and 12.4.

Let's first inspect its impulse response and select a reflection free part of it. This data will characterize both the MLS quasi-anechoic response and the waterfall postprocess; selecting the start and stop window points we give the two first information to waterfall: zero time will be referenced to the start window instant, the Z axis will range exactly the difference between stop and start window points (unless a Time Shift is chosen).

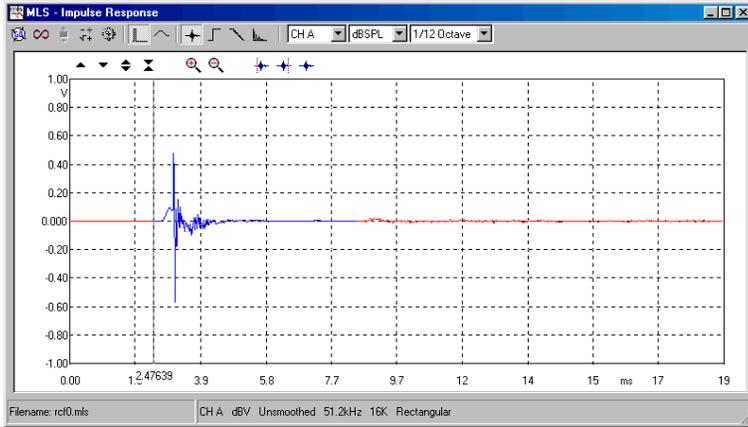


Figure 12.3

Going to frequency domain we zoom our measurement between 200 and 20000Hz, and apply 1/12 octave smoothing as in Fig. 12.4. As said before these parameters will be valid for the waterfall now! We are ready for a waterfall now!

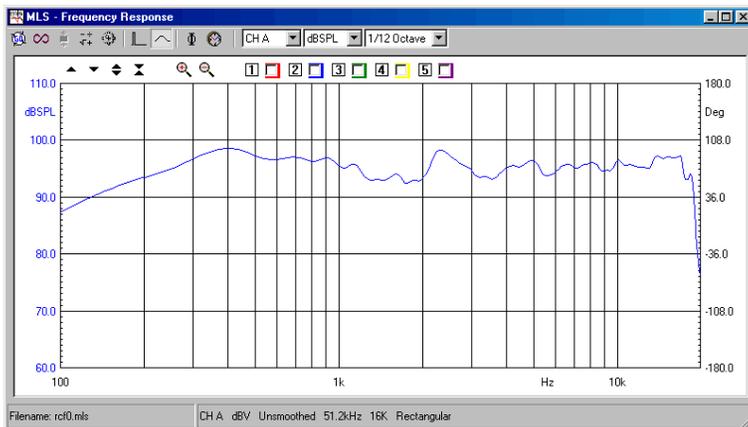


Figure 12.4

Let's invoke the waterfall control panel. The Go button should be enabled. Press it, you should obtain a waterfall like the one in Fig. 12.5.

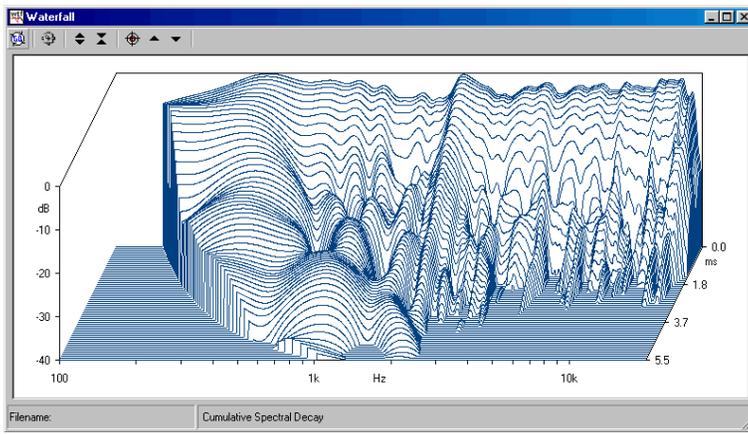


Figure 12.5

One powerful way to inspect a waterfall is to enable its marker. Press the  button. The display should change as in Fig. 12.6. It is very easy to locate frequency zones where the decay 'suffers', like the peak around 2200Hz. After placing the cursor on it is quickly possible to move back and forth the calculated slices by means of the up and down keyboard arrows.

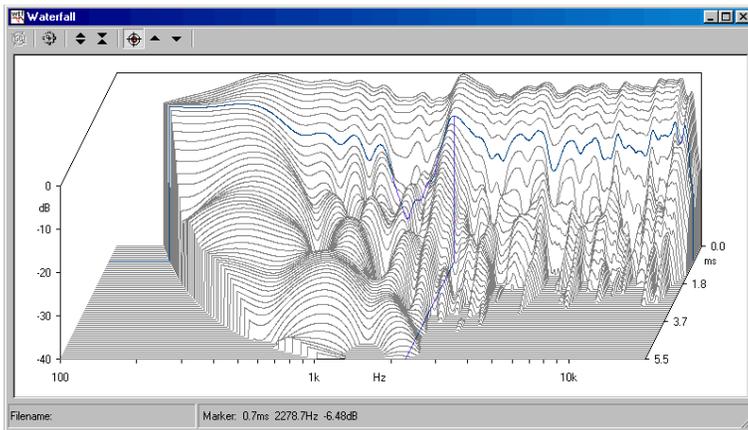


Figure 12.6

Let's now change the CSD aspect. Go to the waterfall settings dialog and input 0.1ms Time Shift. After recalculating it you obtain the plot in Fig.12.7; as you notice now the slices are closer in time, decaying modes are more evident. Since the time span chosen for this waterfall was about 6.1ms the maximum allowed Time Shift you could input was around 0.2ms (considering 30 spectra as this was the case).

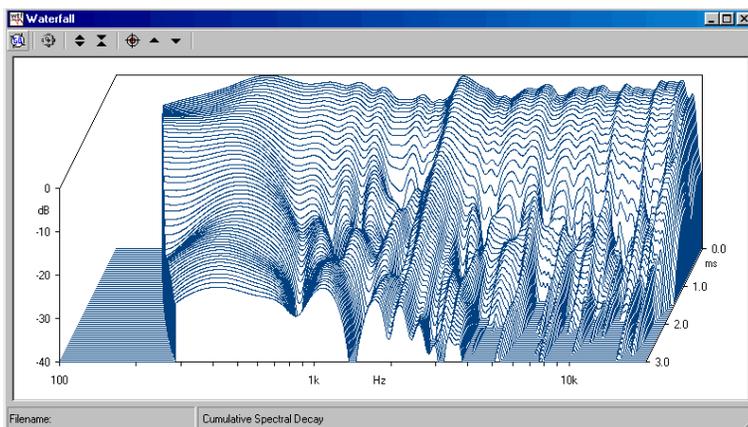


Figure 12.7

Let's now change the CSD aspect again. Go to the waterfall settings dialog and check the Reference box. After recalculating, you obtain the plot in Fig.12.8; as you notice now the slices are referenced to the first one (the rearmost); decays of different frequency regions can now be more easily compared. Now change the Windows Rise Time from the default 0.58ms to 0.1ms and recalculate the CSD. The result is given in figure 12.9.

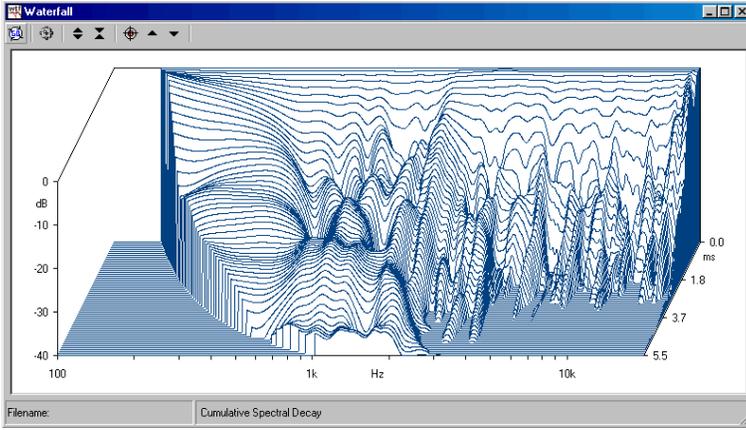


Figure 12.8

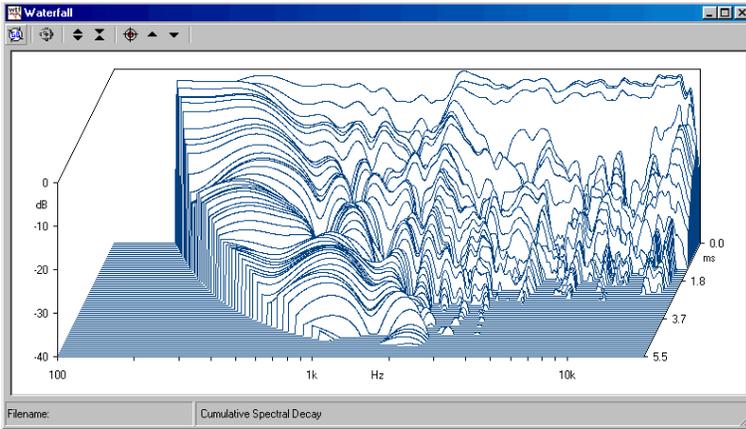


Figure 12.9

12.5 MEASURING AND REPRESENTING LOUDSPEAKER POLAR DATA

Suppose now we want to measure and give a graphical representation of the polar response of the same speaker analyzed in 12.4. We need to measure its anechoic frequency response, at various angles, with MLS and save the files following the rules given in 12.3.2. We will use a turntable (Outline ET/ST), under CLIOwin's control, and the automation possible within the MLS control panel.

12.5.1 PREPARING THE MLS CONTROL PANEL

For this test we would like to measure the speaker from -60° to $+60^\circ$ (in intervals of 5°) relative to its front baffle.

The MLS measurement should be set in a particular way in order to automatically acquire the responses at various horizontal angles. **To do this we will use the autosave function, the loop mode and the link to the turntable control.**

Let's start from setting the autosave function. Pressing **Alt-F2** we recall the Autosave Setting dialog (fig.12.10); here we input the desired filename ('rcf deg'), start (-60) increment (5) and total (25) values.

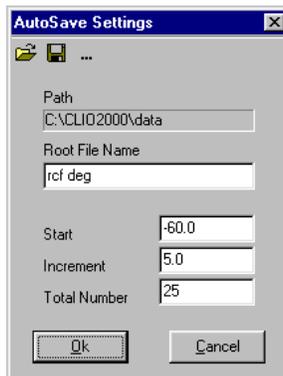


Figure 12.10

The MLS menu is now ready to start taking measurements; we only need to properly set the turntable and its control.

12.5.2 PREPARING THE TURNTABLE

We consider that the Outline turntable is properly connected to your PC (refer to 5.5.2 to have details). To prepare for this measurement session you need to:

- 1) Manually set the front selector labeled 'Deg Step' to 5° .
- 2) Rotate counterclockwise the turntable until you reach the desired start position: as we want to start from -60° position it at 300° .
- 3) Recall the turntable control dialog (Fig.12.9), set Resolution at 5° , Speed at 0.75 RPM and press Link To Measurement

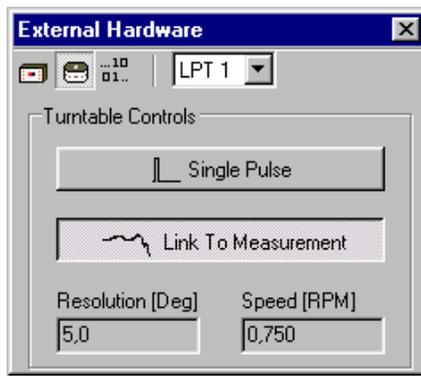


Figure 12.11

12.5.3 TAKING THE MEASUREMENTS

You are now ready to begin the measuring session. We suggest you to take one first measurement (with the speaker in place over the turntable) to verify all the parameters, especially viewing the acquired impulse response and setting the start and stop values of the measurement window. These values will be applied to all the measurements taken; consider, in this respect, the problem of the trajectory of the acoustic center of the speaker during the rotation.

The last thing to do is to activate Autosave and Loop; to do this we press the corresponding toolbar buttons (Fig.12.12).

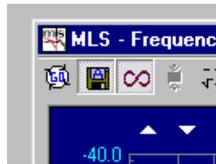


Figure 12.12

Press Go. After each MLS measurement is taken you will see the turntable rotating and CLIOwin waiting for a time sufficient for the turntable to stabilize before automatically take the next measurement. Should this time not be sufficient you have to reset the turntable speed value accordingly. The autosave function will refresh the filename after each measure (Fig.12.13).



Figure 12.13

After the 25 measurements are taken the session should end while the autosave and loop buttons reset.

12.5.4 REPRESENTING POLAR DATA WITH A WATERFALL

To represent the measured data we need to enter the Waterfall Settings dialog, select the File Display mode and then press the browse button. Entering our data directory we find the situation in Fig.12.14:

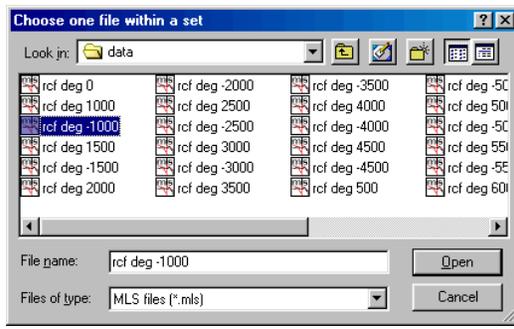


Figure 12.14

The set of files is composed by 25 files; it is sufficient to choose one of them. It is now important to give the initial and last files for display, this is done with the Z-start and Z-stop values to be input as in Fig.12.15. We chose to display only responses from -40° to +40°.

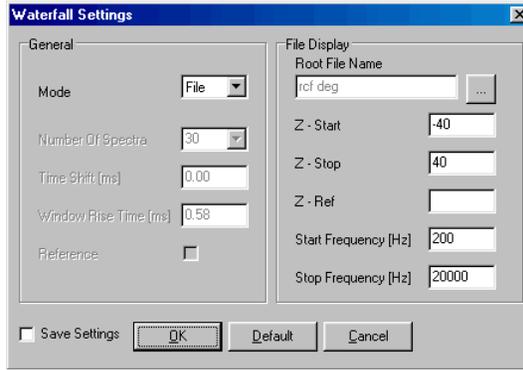


Figure 12.15

We are, at last, ready for the waterfall. The result is in Fig. 12.16.

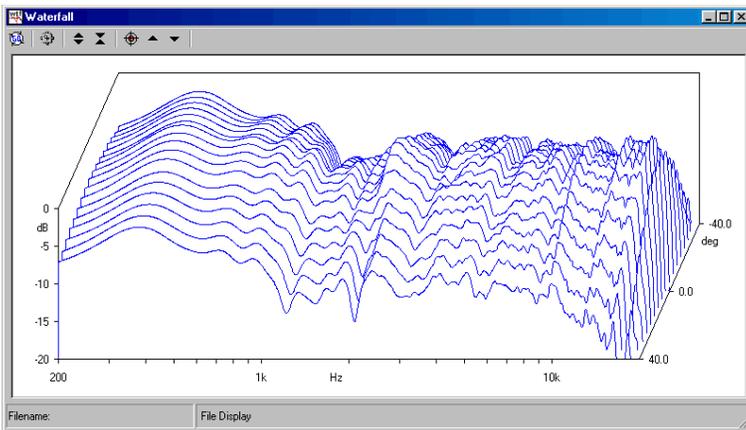


Figure 12.16

Treating polar data we may be more interested in referencing the graph to the response that our speaker shows on-axis. This is easily done inputting the relative value in the Z-ref box inside the waterfall settings (Fig.12.17).

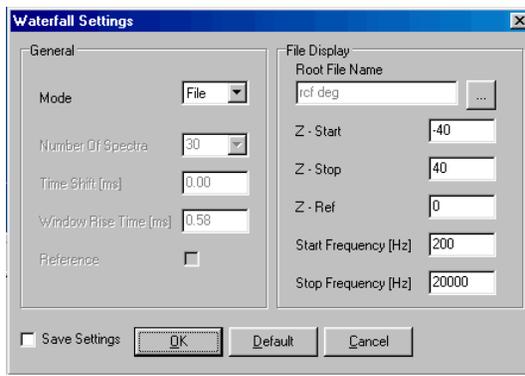


Figure 12.17

The final result for our polar data waterfall is in Fig.12.18; the response at 0 degrees is now flat and our plot identifies perfectly the behavior of the speaker, putting in clear evidence frequency zones where the polar response is acceptable and others where it is not.

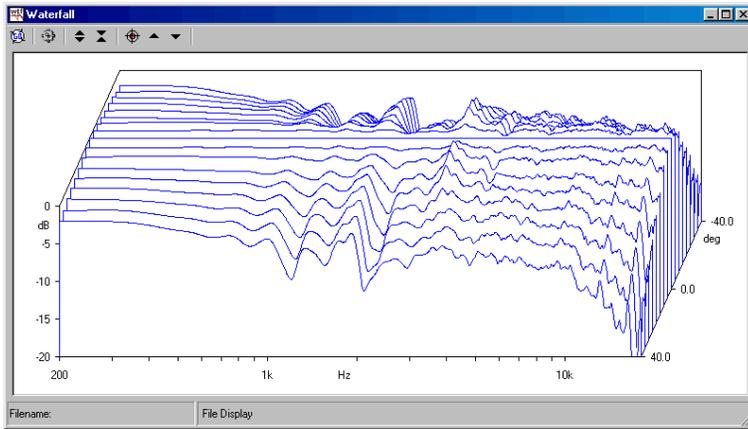


Figure 12.18

13 MEASURING IMPEDANCE AND T&S PARAMETERS

13.1 INTRODUCTION

This chapter deals, before going in the Thiele and Small Parameters Menu description, with impedance measurements in general. CLIO performs impedance vs. frequency measurements both from within the MLS and the Sinusoidal Menu. You will find specific information in the relative Chapters. Both are relevant to what we will explain now. Here we explain connections, principles and other topics that apply to both menus. Differences and choice criteria are also covered.

13.2 GENERALS

Whatever the stimuli, CLIO sees a voltage at its input. Impedance is obtained by a suitable post process, which changes upon how user decides to perform the measurement. Four methods are available. Two of them, **Internal** and **I Sense**, were already found in the Settings Dialog, both in MLS and Sinusoidal. We will start with these, leaving **Constant Voltage** and **Constant Current** to later on. The last two methods derive their name from the description of what is going on during the measurement; they were the standard before automatic computer based Measuring Systems. **Internal** and **I Sense** are faster, require only one measure, it is easier to handle the connections needed.

13.3 INTERNAL MODE

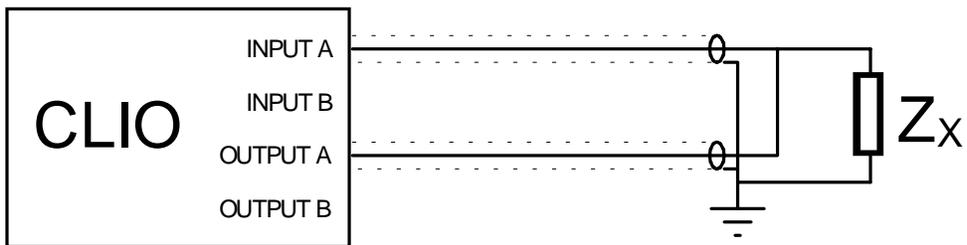
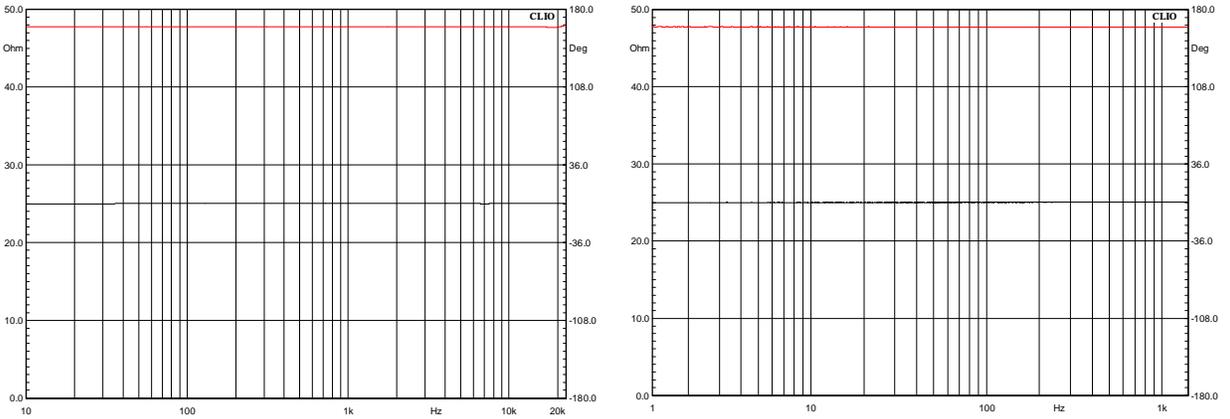


Figure 13.1

In principle, Internal mode is very similar to **Constant Current**. Takes advantage on the knowledge CLIO has of its own output level and output impedance (100 Ohm 0.1%). In fact, this value is lower than what should be used for true Constant Current procedure. Veterans should not worry; Even if the resistor value is on the same order of magnitude of the device you are going to measure instead of 10 times higher as usually advised, no errors occurs as CLIO is able to acquire and evaluate the signal at device terminals as complex (real and imaginary). Fig.13.1 shows the connections for measuring Impedance in Internal mode. Only two cables (pin-to-alligators like the one in the photo) are needed, without any other external active or passive device.



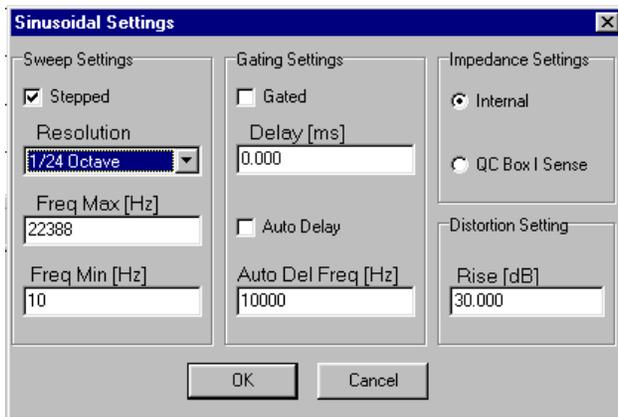
If you are novice in using CLIO or to impedance measurements in general use this mode; also do not start measuring loudspeaker impedance immediately. Get a 22 to 100 Ohm resistor, possibly 1% tolerance, and make your experience with something you can expect the results you should get. Here are two examples both with Sinusoidal and MLS. Before you press go, remember to set the Y scale to Ohm. We choose a 47 Ohm resistor. The modulus should be very close to the resistor value (red curve) and phase, important as well should be very close to 0; All this must happens in the entire frequency range. Notice that Fig.13.3, which refers to MLS, extends low frequency limit to 1Hz while Sinusoidal, Fig.13.2, stops at 10Hz which is the lowest possible. If you are not getting similar results do not proceed with a loudspeaker impedance measurement. You would only add problems we will see soon to a not working procedure. Even in internal mode CLIO's output level is left to the user. We set it at +10 here as resistors are, hopefully, the most linear devices we can get. As we had very comfortable results lets proceed with a Loudspeaker.



Figures 13.2 and 13.3

13.3.1 MEASURING IMPEDANCE OF LOUDSPEAKERS

We will start with a 5" woofer using Sinusoidal, **our preferred choice**, with the following Settings.



Aside frequency range, which can be changed without side effects, those above are problems free settings for impedance measurements. We will experiment a little, pointing out difficulties that might arise. Lets start with output level, which is a sensitive topic.

13.3.2 SETTING THE RIGHT LEVEL

The five curves of Fig.13.4 are taken at 5 different output levels, ranging from 10dBu to -10dBu in 5dB steps. The red curve refers to +10dBu, the blue to +5dBu, the remaining are substantially overlapped.

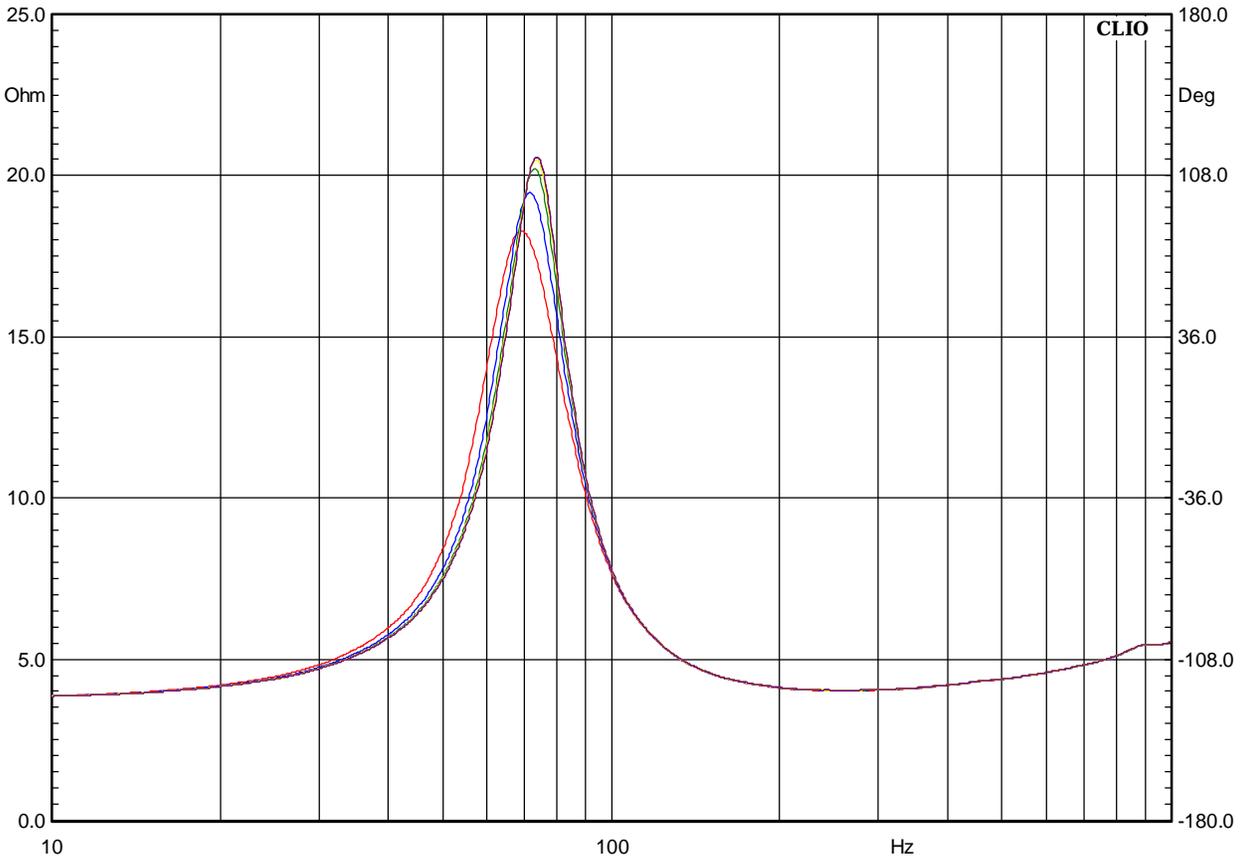


Figure 13.4

It turns out that going from linear device to loudspeakers makes the life harder even if, probably, more interesting. Deriving the principals TS Parameters from the five curves yields to Table 13.1

	Fs	Qms	Qes	Qts
+10dBu	69.244	3.105	0.609	0.5094
+5dBu	71.63	3.6461	0.6643	0.5619
0dBu	72.9912	3.986	0.695	0.5920
-5dBu	73.5429	4.1663	0.7147	.61
-10dBu	73.82	4.227	0.7218	0.6166

Table 13.1

Values from 0dBu to -10dBu are in optimum agreement and this set the maximum level to be used to 0dBu. Interestingly enough, **Internal Mode** is the less sensitive to output level. We will go further on this topic relaying on CLIO being a complete and powerful audio measuring system. Without changing connections we will use CLIO's FFT and Signal Generator to evaluate the distortion current at resonance at 10dBu. Fig.13.5 shows the spectrum in this condition. The second harmonic is 56dB lower than the fundamental, which is 0.158% distortion. Even at 10dBu we are by far in the linear region of the loudspeaker motor. However what we have seen above, clearly states 10dBu are a quite high level for this device.

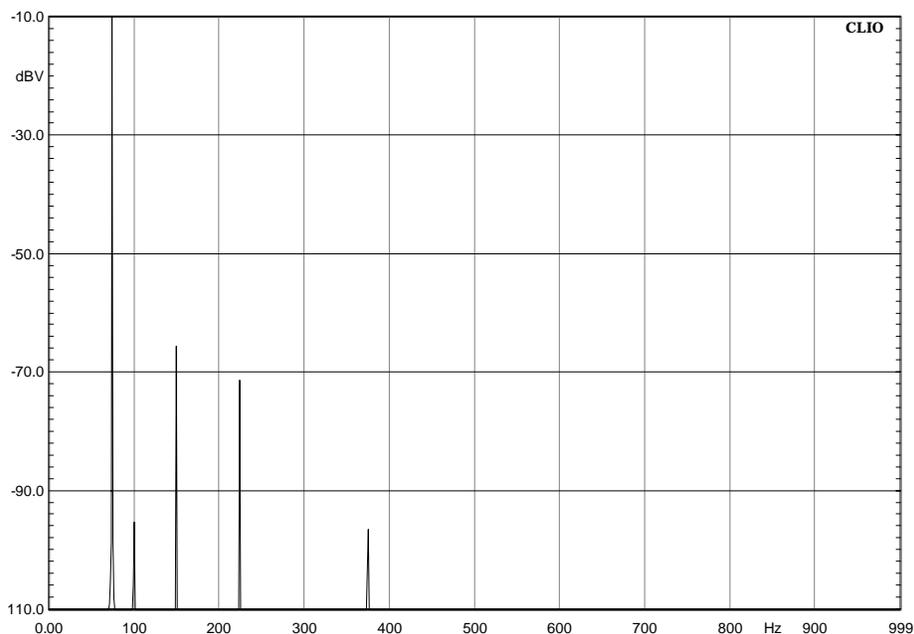
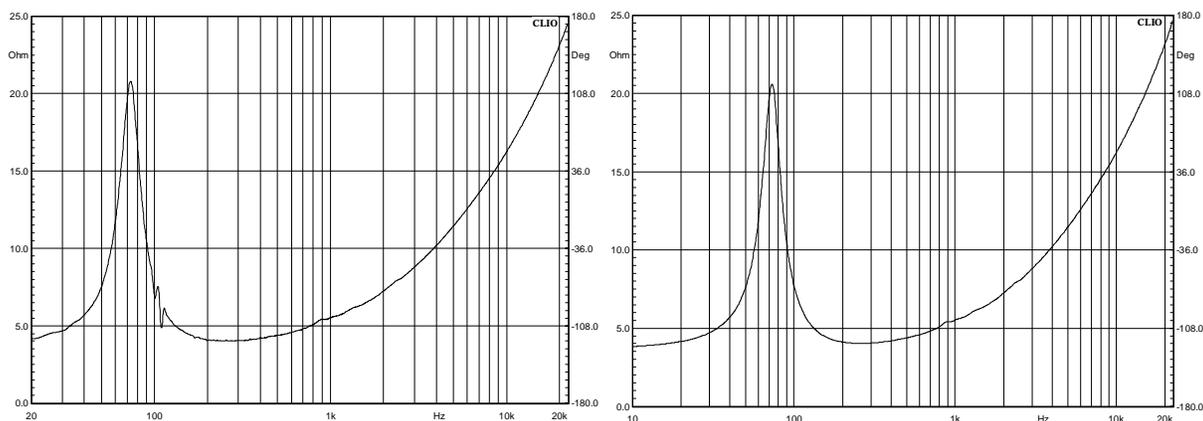


Figure 13.8

Reader could be tempted to determine absolute quality of the device by means of this procedure. While he or she may be right, a lot of experience is needed. One important parameter, for reliable comparison among devices, is the value, in VRMS, at the speaker terminals at resonance. It is shown from FFT as -10dBV that are 0.316VRMS.

13.3.3 DEALING WITH ENVIRONMENTAL NOISE

The next problem in measuring loudspeaker impedance is noise. Transducers do their job in both directions and noise will appear as voltage exactly where CLIO's input is connected. To evaluate the problem we deliberately produced a disturb generating a 110Hz single tone causing 58 dB SPL at the speaker cone. We took two impedance curves in this condition one with MLS the second with Sinusoidal. Both were taken at -10dBu, a value that gained our favour before. Results are in Fig.13.6 for MLS and Fig .13.7 for Sinusoidal.



Figures 13.6 and 13.7

This is one reason why we prefer sinusoidal analysis to measure impedance.

13.3.4 DEALING WITH VIBRATIONS

The last enemy we consider are external vibrations.

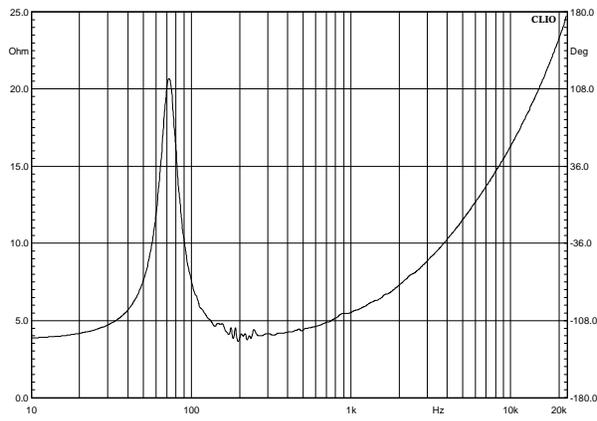


Figure 13.8

Fig.13.8 is an impedance curve taken with the loudspeaker disposed on a computer table, on one of those appendices that may be set up or down upon needs. This stuff clearly resonates, excited by the loudspeaker, around 200Hz. No matter how good the loudspeaker is fixed to a structure if this does move by itself. Usually there is no need to fix anything as long as you are using a stable, non-resonating structure.

Up to now we dealt with Internal Mode. We will briefly go through the other modes; problems found up to here will remain the same or worsen from here on.

13.4 I SENSE

Requires Audiomatica CLIOQC Amplifier and Switch Box model 2, 3 or 4. It is a simplified Constant Voltage method. Simplification arises as both device gain and sensing resistor (around 0.1 Ohm) is known. Fig.13.9 shows the CLIOQC Software Control Dialog Box. I Sense should be selected.

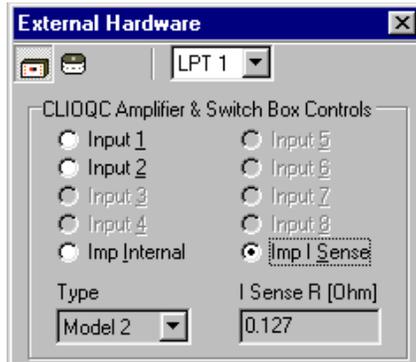


Figure 13.9

Fig.13.10 shows required connections.

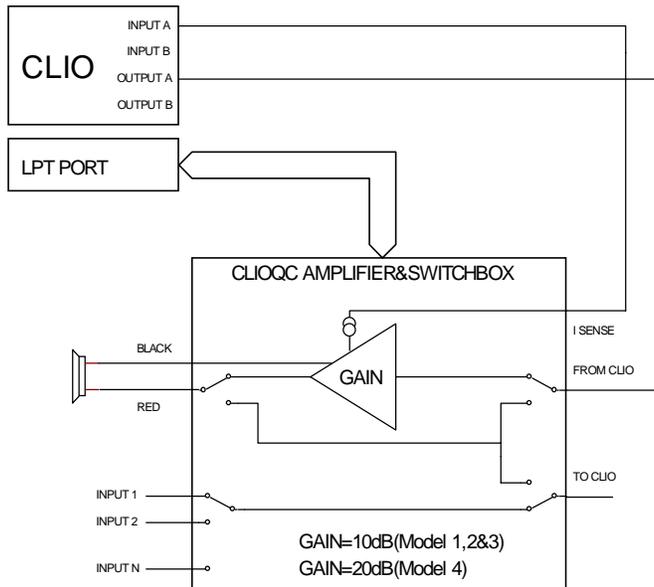


Figure 13.10

Before proceeding, whatever in MLS or Sinusoidal, remember to go in the Settings Dialog and select I Sense under Impedance. CLIO's output level has to be set to a much lower level than in Internal Mode. We have seen before that with 10dBu out we had 0.316V at speaker terminals at resonance. Should you let this level you would have 7.75V at any Frequency! -20 to -30 dBu are reasonable output level to start with. The CLIOQC Amplifier gain is 10dB(Model 2&3) or 20dB(Model 4); it therefore multiply CLIO's output by 3.16(Model 2&3) or 10(Model 4). As the output impedance is close to 0 no further attenuation occurs once the speaker is connected. Finally we deal with measuring accuracy in this case. The sensing resistor value has been stated as around 0.1 Ohm. It is very difficult to keep such a low value within a reasonable tolerance and therefore the real value is going to change between units. The default value that comes is 0.127 Ohm. User can further adjust this value using a reference resistor of known value in the 10 Ohm range (the real value can be eventually measured with high accuracy using internal mode). Simply take an impedance measurement of the known resistor and adjust the I Sense value displayed multiplying it by the ratio between the know resistor value and the marker reading at 1kHz. Example: known resistor value 10 Ohm, reading

at 1kHz 9.3 ohm, I sense value 0.127 Ohm. Multiply 0.127 by 1.075268817, obtain 0.13655914, input this new value and check everything performing a new measurement.

13.5 CONSTANT VOLTAGE & CONSTANT CURRENT

These were the standard approaches to measure impedance with traditional set of instruments. We will skip further theoretical discussion and go directly on how CLIO implements them. These methods both require two external components, a reference resistor of suitable and know value (where known means better than 1% tolerance) and a power amplifier. They also require two measures to be taken one after the other, changing connections in between. CLIO, by means of its processing tools can speed up things a lot but the whole procedure remains quite complicate. Whatever you are going to use MLS or Sinusoidal, all the measurement should be performed in Volts (the Y Scale should be dBV).

13.5.1 CONSTANT VOLTAGE

Proceeding step by step we are going to create two files, one named "reference", the second named "device". The two measurement files must have identical settings and identical CLIO's output level. We choose a sensing resistor, R_s , of 1 ohm 1%. Fig.13.11 shows connections for creating the reference file. The level you choose now is the total measuring level.

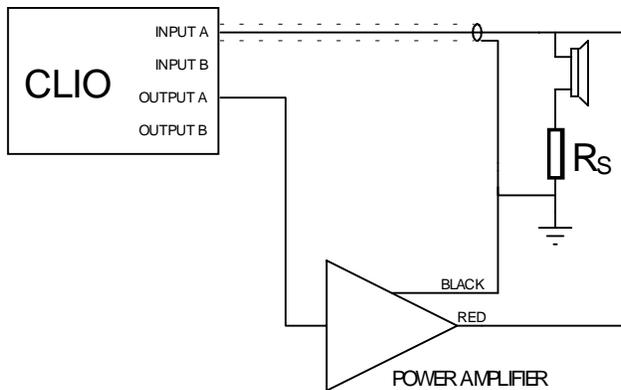


Figure 13.11

The reference measurement is shown in Fig 13.12. As expected the output of the amplifier appears as a straight line. Should not be so, this would not be a problem as the whole procedure compensate for any deviation in the frequency response. More interesting is the absolute level. As R_s value is small, this level appears nearly unchanged to the speaker. We read -12dBV that translate in 250mV.

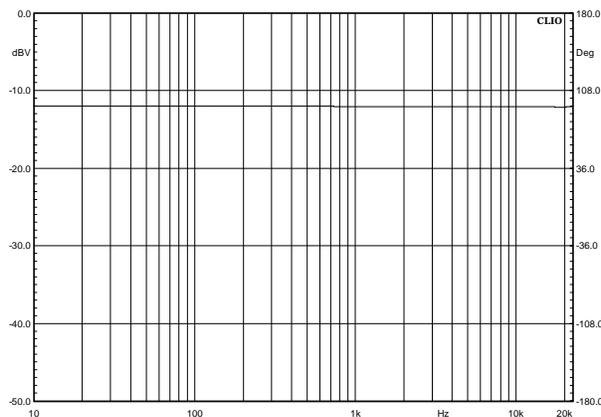


Figure 13.12

Lets proceed now with the device measurement. Connections need to be changed as in Fig. 13.13. We are going to measure now the voltage across R_s , which is proportional to the current in the device. Leaving anything in the Sinusoidal menu as it was for the previous measurement we obtain Fig.13.14. It seams a strange shape if you are not used to. But in fact we are measuring Current here and, Voltage being constant, it decreases at resonance.

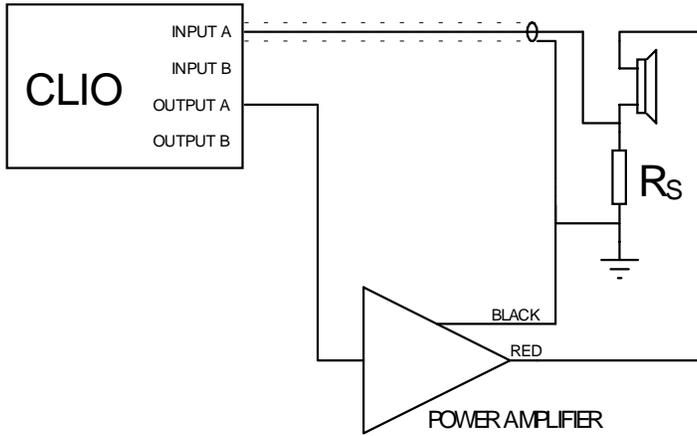


Figure 13.11

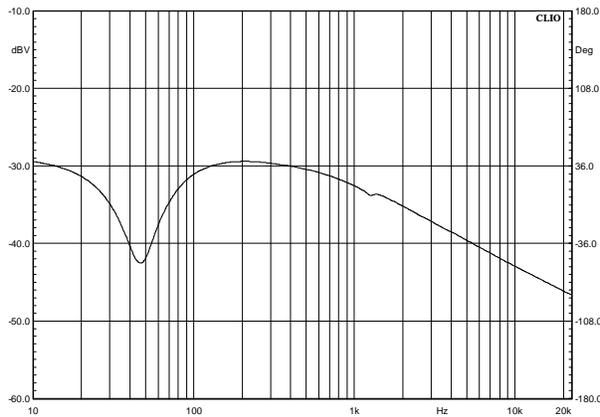
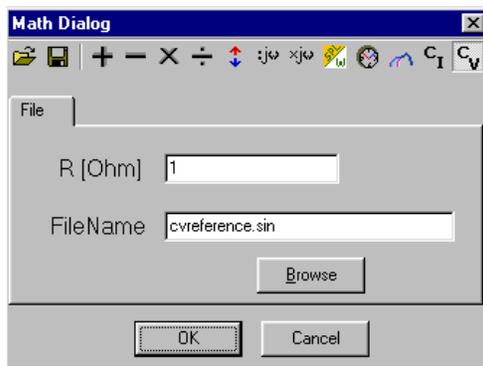


Figure 13.14

What we do from now on is just post processing. Leaving the last measure in memory, open the Processing Tools Dialog from within Sinusoidal (MLS has the same), select the CV icon and input the data you should know.

The Ohm value is that of the Sensing Resistor while in the edit box you see the name of our previous file, cvreference.sin, added by its own path which could be different in your case.



Pressing Ok we get Fig. 13.15 which is our final result. Note that the Y Units have been changed to Ohm. This result is only in memory and should be saved now for further use.

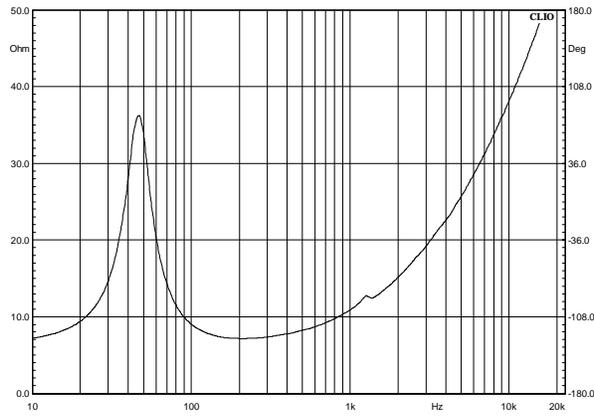


Figure 13.15

13.5.2 CONSTANT CURRENT

We will go quicker now as its very similar to what we have just seen. Connections for creating the reference are the same, please refer to Fig. 13.11. Again everything should be left unchanged between creating the reference and the device files. The big difference from before is the output level. We choose here a 1Kohm resistor. This will attenuate a lot the signal at loudspeaker terminal. Fig.13.16 shows the reference measurement.

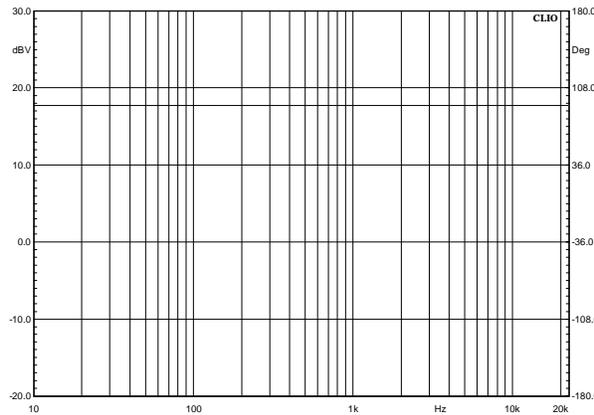


Figure 13.16

We have a straight line again; notice the level has become 17dBV now. We change connections, accordingly with Fig.13.17, and nothing else.

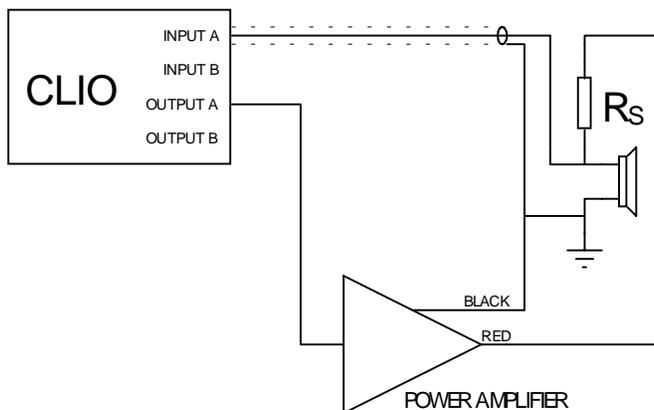


Figure 13.17

The figure shows us we are going to measure the voltage across the device. Therefore the next graph, Fig.13.18, will give us detailed information regarding the measuring level.

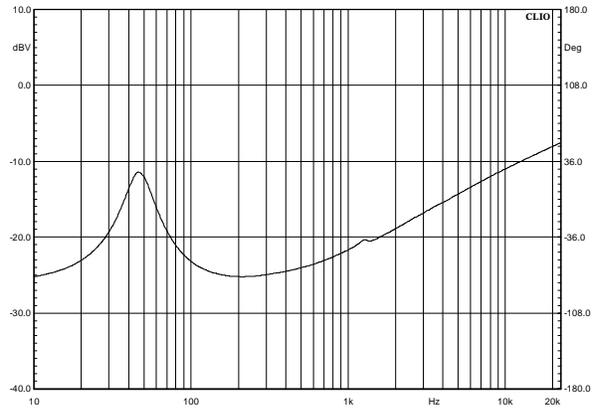
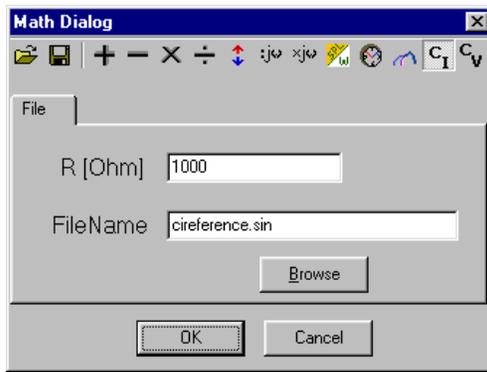


Figure 13.18

The level is low enough not to worry us and we proceed with our post process as before. Instead of the CV button CI should be selected.



Finally Fig.13.19 shows the process result.

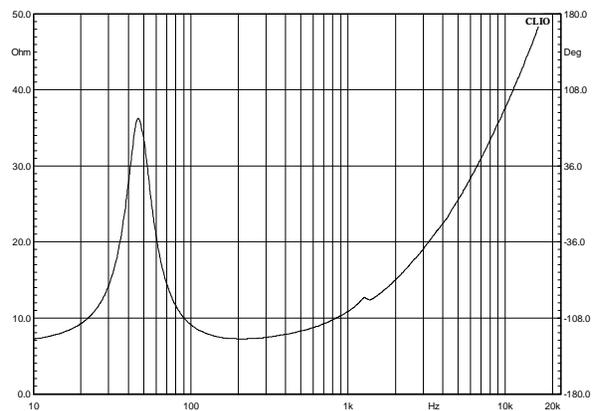


Figure 13.19

13.6 IMPEDANCE: SINUSOIDAL OR MLS

Up to now we have nearly only used Sinusoidal to perform Impedance Measurements. When MLS has been used, it was to point out problems. We also stated Sinusoidal is the preferred choice. Inexperienced user might ask why the MLS Menu has impedance measuring capability at all. In fact MLS yields to accurate Impedance Measurements. It is, however, less prone to forgive errors and/or measuring set-up problems of any

kind. Users, however, should always take the maximum effort to avoid these situations anyway. Furthermore MLS has several advantage over Sinusoidal. The most evident is execution time which is one order of magnitude better, even using big sizes, which, by the way, is always advisable. It can measure down to 1Hz while Sinusoidal stops at 10Hz. Its high sensitivity to even weak non-linearity can be used to reveal even small rub&buzz problems, directly from the impedance measure. We advise to use Sinusoidal for the first experiences. After everybody will be able to get an opinion on personal basis.

13.7 THIELE & SMALL PARAMETERS

13.7.1 INTRODUCTION

CLIO handles Thiele and Small Parameters, hereafter TS, as a post process of impedance measurements. Three options are available for data source, selected by the Data Origin Drop Down Control: Sinusoidal Impedance Data, MIs Impedance Data, File Data, the last created with either of the previous. There are no conceptual differences between File and the first two options, aside where the data resides. Choosing Sinusoidal or MIs, user should have one of these measurements in memory while the File Data option will prompt for file selection. Impedance measurements are therefore central topic and the previous paragraphs are an essential background. To get the full set of TS, two impedance curves are needed. The first is the loudspeaker free air impedance, the second, the impedance obtained either with Delta Mass or Delta Compliance method. The first consists in adding a suitable Known Mass to the Loudspeaker cone, the latter in loading the cone with a Known Volume.

13.7.2 T&S PARAMETERS CONTROL PANEL

Manufacturer:						
Model:						
Date:						
F_S	0.0000 Hz	V_{AS}	0.0000 L	R_E	0.0000 Ω	
Q_{MS}	0.0000	Q_{ES}	0.0000	Q_{TS}	0.0000	
$B \cdot l$	0.0000 T·m	dB_{SPL}	0.0000	S_D	0.0000 m^2	
C_{MS}	0.0000 mm/N	M_{MS}	0.0000 g	R_{MS}	0.0000 Ω_M	
C_{AS}	0.0000 m^5/N	M_{AS}	0.0000 kg/m^4	R_{AS}	0.0000 Ω_A	
C_{MES}	0.0000 μF	L_{CES}	0.0000 H	R_{ES}	0.0000 Ω	
R_{AT}	0.0000 Ω_A	R_{MT}	0.0000 Ω_M	M_{MD}	0.0000 g	
Z_{MIN}	0.0000 Ω	Z_{MAX}	0.0000 Ω	Z_{AVG}	0.0000 Ω	
η_0	0.0000 %	L_{1kHz}	0.0000 mH	L_{10kHz}	0.0000 mH	

The User Interface is quite simple with three Buttons, one Drop Down and one Check Box.

 Starts a T&S Parameters procedure. See 13.7.3 for details.

 Delta mass T&S Parameters calculation. See 13.7.3 for details.

 Delta compliance T&S Parameters calculation. See 13.7.3 for details.

The Drop Down allows selecting the data origin as described in the introduction. The MSE Check Box, when checked, enables a Minimum Square Error routine while calculating TS Parameters; more on this later. Aside information regarding the device tested the Control Panel displays 27 parameters. Here is what they are.

13.7.3 GLOSSARY OF SYMBOLS

F_s	Resonant frequency of driver including air load
V_{AS}	Volume of air having the same acoustic compliance as driver suspension
R_E	DC electrical resistance of voice coil
Q_{MS}	Q of driver at F_s considering mechanical losses only
Q_{ES}	Q of driver at F_s considering electrical resistance only
Q_{TS}	Q of driver at F_s considering all driver losses
$B \cdot l$	Motor strength, product of B times l
dB_{SPL}	Acoustic pressure produced by the driver at 1m when driven by 2.83 V
S_D	Effective surface area of the driver cone
C_{MS}	Mechanical compliance of driver suspension
M_{MS}	Mechanical mass of driver cone assembly including air load
R_{MS}	Mechanical resistance of driver suspension losses
C_{AS}	Acoustic compliance of driver suspension
M_{AS}	Acoustic mass of driver cone assembly including reactive air load
R_{AS}	Acoustic resistance of driver suspension losses
C_{MES}	Electrical capacitance representing the driver total moving mass
L_{CES}	Electrical inductance representing the driver mechanical compliance
R_{ES}	Electrical resistance representing the driver mechanical losses
R_{AT}	Total acoustic resistance of driver
R_{MT}	Total mechanical resistance of driver (suspension losses + electrical reflected)
M_{MD}	Mechanical mass of driver cone assembly excluding air load
Z_{MIN}	Minimum impedance in the frequency range above F_s
Z_{MAX}	Impedance at F_s
Z_{AVG}	Average of impedance modulus over the measured frequency limits
η_0	Efficiency

$L_{1\text{kHz}}$ Inductance at 10kHz

$L_{10\text{kHz}}$ Inductance at 10kHz

13.7.3 TS STEP BY STEP

Getting TS requires two impedance measurements. As we will use both methods we need three, the first relative to the driver in free air, the second to the driver with a known mass (delta mass) added to the cone, the third to the driver loaded with a known volume (delta compliance). Fig. 13.20 shows the results of the three measurements, overlaid in one single graphic.

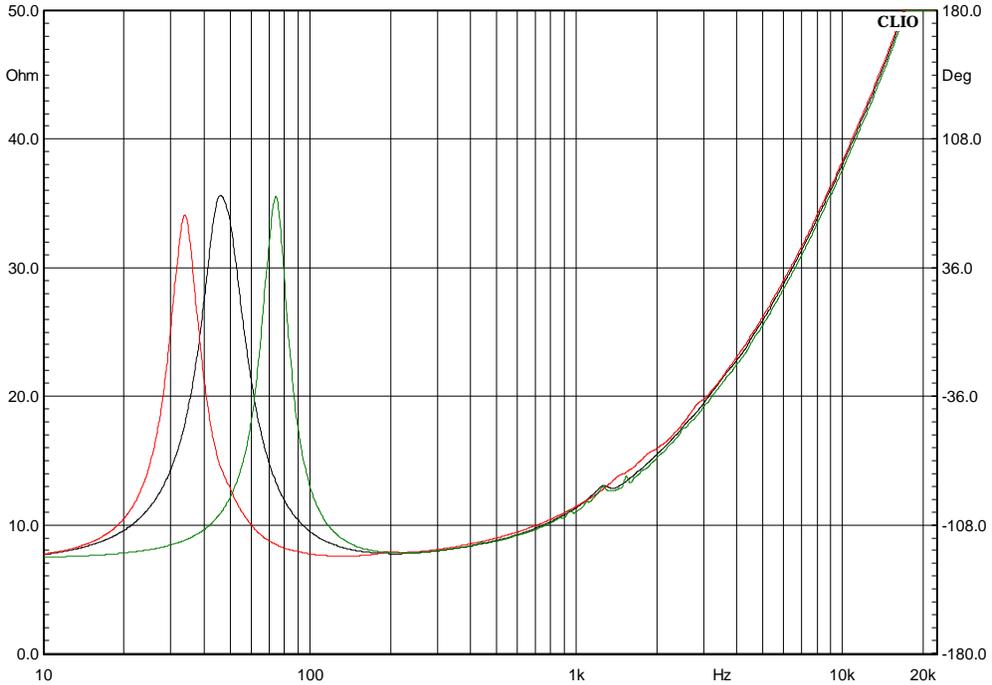
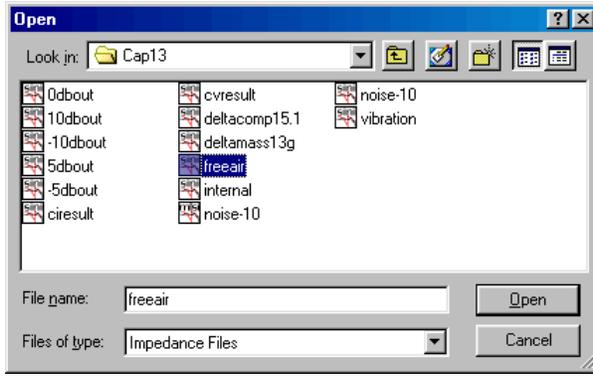


Figure 13.20

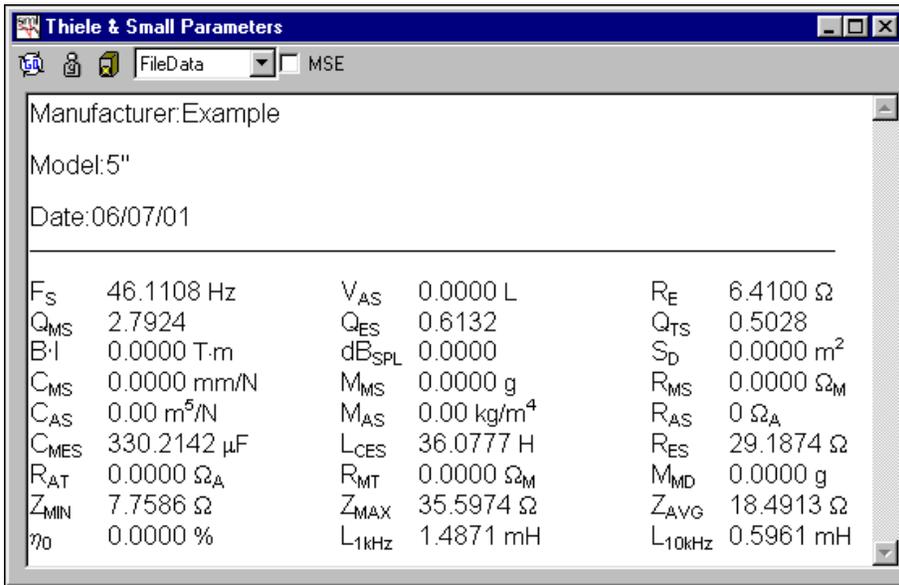
The black curve refers to free air, the red to delta mass, the green to delta compliance. As you can see adding a Mass determines lowering F_s while loading the cone with a closed volume will increase F_s . Always check this is the case to avoid errors in the post processing routine. As deriving TS parameters can be performed at any successive time after the impedance measurements has been taken, we suggest to save them with meaningful names as well as to use the Notes Dialog to store the measuring conditions as mass weight and/or volume. The last step before pressing Go in the TS dialog is to measure both the voice coil DC resistance and the effective cone diameter in millimeters. In this example they are 6.41 Ohm and 133mm. Finally we select File Data as data origin and pressing Go we get the following prompt Dialog

Manufacturer	Example
Model	5"
Re [Ohm]	6.41

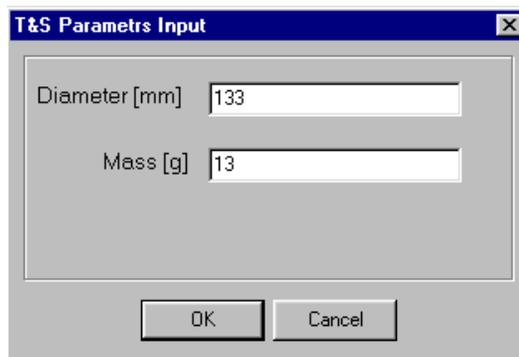
After right values have been typed in clicking Ok we will prompt for the file name. The file required here is the free air impedance measurement.



Opening the file we get this partially filled TS parameters screen.



Now we can save this result for later use or proceed immediately for the missing parameters. Notice that the two Buttons for Delta Mass and Delta compliance that were disabled before are now enabled. We Click on the Delta Mass Button, type in the required values



and, finally, after we have choose the impedance file obtained with the added mass, we get our completely filled TS parameters screen

F_S	46.1108 Hz	V_{AS}	21.0957 L	R_E	6.4100 Ω
Q_{MS}	2.7924	Q_{ES}	0.6132	Q_{TS}	0.5028
$B \cdot l$	6.7891 T·m	dB_{SPL}	87.3024	S_D	0.0139 m ²
C_{MS}	0.7827 mm/N	M_{MS}	15.2204 g	R_{MS}	1.5792 Ω_M
C_{AS}	1.51E-7 m ⁵ /N	M_{AS}	78.86 kg/m ⁴	R_{AS}	8182 Ω_A
C_{MES}	330.2142 μ F	L_{CES}	36.0777 H	R_{ES}	29.1874 Ω
R_{AT}	45437 Ω_A	R_{MT}	8.7699 Ω_M	M_{MD}	14.2936 g
Z_{MIN}	7.7586 Ω	Z_{MAX}	35.5974 Ω	Z_{AVG}	18.4913 Ω
η_0	0.3238 %	L_{1kHz}	1.4871 mH	L_{10kHz}	0.5961 mH

Now we can save our complete results and proceed with the Delta Compliance. The free air derived data are already in memory and we can deal with the last part of the procedure only, which is nearly the same as before. We will be prompted for volume instead of weight. Obviously the file we have to choose is relative to the driver loaded with a known volume (15.1 liters in this case). Here we show the results for the delta compliance method. The two sets of data do agree pretty well.

F_S	46.1108 Hz	V_{AS}	23.8935 L	R_E	6.4100 Ω
Q_{MS}	2.7924	Q_{ES}	0.6132	Q_{TS}	0.5028
$B \cdot l$	6.3793 T·m	dB_{SPL}	87.8432	S_D	0.0139 m ²
C_{MS}	0.8865 mm/N	M_{MS}	13.4381 g	R_{MS}	1.3943 Ω_M
C_{AS}	1.71E-7 m ⁵ /N	M_{AS}	69.62 kg/m ⁴	R_{AS}	7224 Ω_A
C_{MES}	330.2142 μ F	L_{CES}	36.0777 H	R_{ES}	29.1874 Ω
R_{AT}	40116 Ω_A	R_{MT}	7.7430 Ω_M	M_{MD}	12.5113 g
Z_{MIN}	7.7586 Ω	Z_{MAX}	35.5974 Ω	Z_{AVG}	18.4913 Ω
η_0	0.3667 %	L_{1kHz}	1.4871 mH	L_{10kHz}	0.5961 mH

13.7.4 USING MSE (MINIMUM SQUARE ERROR)

With this option checked, TS parameters are calculated in a more sophisticated way. Basically the parameters obtained in the standard way are used to derive the starting values for the equivalent electric circuit model. These values are then changed slightly around the initial value until the best fit between the calculated and measured impedance curve is found, in a large frequency range around resonance. This procedure works fine and gives accuracy advantage if the driver impedance fit the Thiele and Small model pretty well. Unfortunately this is not always the case. Should the user encounter such cases (if the parameters obtained with and without MSE differ substantially) he/she must be warned that the entire concept of TS parameters has loosen its usefulness. This often happens with tweeters, woofer whose impedance has been measured at high level, defective devices.

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