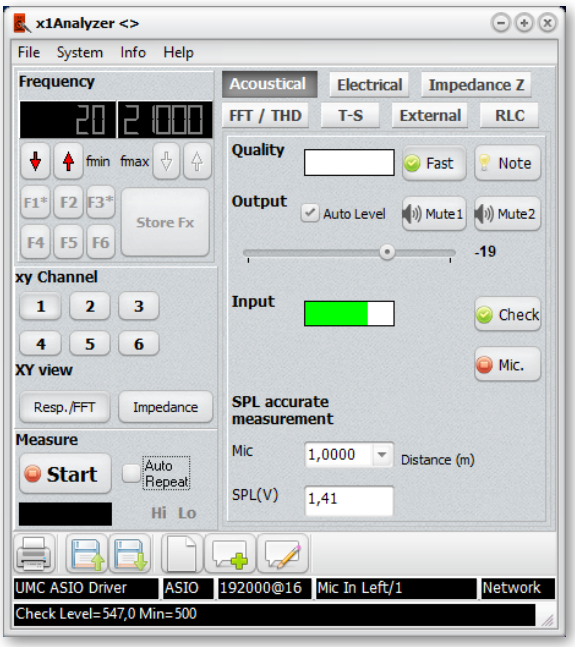
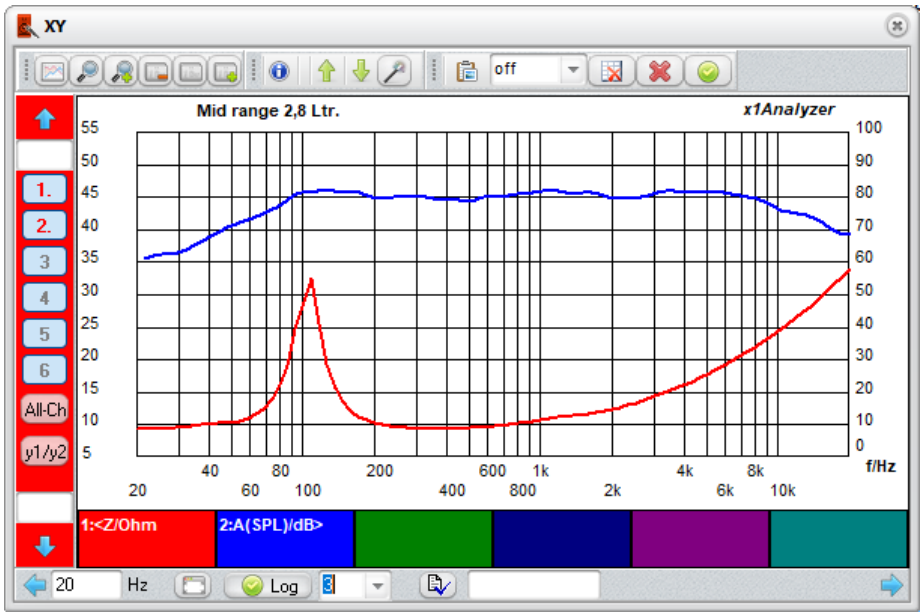




x1Analyzer

PC Audio Analyzer

STUTE Engineering

1 Key features

- Measurement range up to 90kHz@192kHz
- Compatible with commercial available USB audio interfaces and microphones
- Accurate and high repeat-ability measurements
- Very clear user interface
- Very efficient measurement analytic and presentation
- Measurement mathematics
- SPL correct measurement
- Microphone correction
- Data export to x1Designer
- Remote control via network

1.1 Software license

You need an internet connection to activate your software license. Your license can be activated up to 3 times, also on different computer. Please start the software on the target PC, before you request the license activation.

1.2 Scalable screen size

Size of “Measurement” and “XY” screen can be scaled.

1.3 Styles user interface

2 Application samples

- Assess loudspeaker driver and system issues and verify the countermeasures
- Analyze audio hardware, like audio amplifier or Bluetooth adapter
- Test loudspeaker system audio filter (cut-off, slope)
- Measure driver impedance
- Verify impedance correction circuits (RC or RLC)
- Measure driver “Thiele Small” parameter”
  - Vas, Qms, fs, SPL…
- Verify bass reflex adjustment

3 Important notes

Read this notes carefully to avoid damages of the computer, audio interface, loudspeaker driver or human ears:

- Avoid measurements above the allowed input limits of the audio interface! Measure never AC main power supply voltages! Higher voltage can damage your audio interface and computer!
- Power off connected audio amplifier for all acoustical measurements if you change audio interface settings, cable connection or before you close the software.
- Always use the latest audio interface driver version.
- The product is not suitable for children.

Note: You find more details to the allowed input voltage in the user manual to your audio interface.

3.1 Acoustical measurement

- Ensure that the audio interface is always ready for operation and is switched on for measuring operation.
- Power Off the power audio amplifier when you connect or disconnect the amplifier to the audio interface or the audio interface to the computer.
- Never disconnect the audio interface during measurement.
- For acoustical measurements: Disable the “Loudness” and tone function at your audio power amplifier. Set the each tone level to “neutral”

3.2 Tweeter and dome mid-range speaker protection

Acoustical measurement: Protect the speaker with a simple high pass filter against low frequencies of the pink noise signal. The cut-off frequency for the protection is calculated as follow:

C [µF] = 1.000.000/(4*f*3.14*Z)

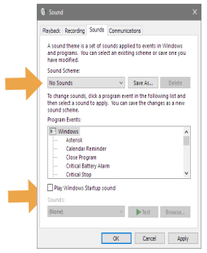
- f: Resonance frequency of the speaker
- Z: Speaker impedance (measurement or from the data sheet)

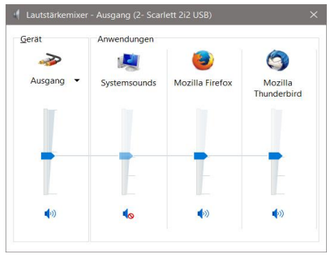
Note: The filter limits the frequency range of the speaker.

3.3 Take note

- To avoid the parallel access to the used audio interface close all other programs. Do not playback any sound/music during operation
- The PC audio mixer controls: To protect your test objects, the level will be set to 0% at the software shutdown. During operation to 100%
- Calibrate at first the system, before you execute a measurement

Disable the MS-Windows sound scheme & mute the Windows system notification sound





4 First steps

4.1 x1S Interface

The x1S is a simple passive interface with a few elements. It is needed for some measurements. You get schematic from our download page for free. More info the accessory chapter.

4.2 Preparation

4.2.1 Audio interface

- Install the latest audio interface device driver from manufacturer
- Disable the monitor function, if applicable
- Switch off the mic power supply (+48V)
- Adjust the Line In Gain for channel 1 and 2 to approx. 75%
- Adjust the Headphone output to approx. 70%
- Connect the simple measuring adapter (e.g. x1S) with your audio interface
- Connect the USB audio interface to your computer

4.2.2 x1Analyzer

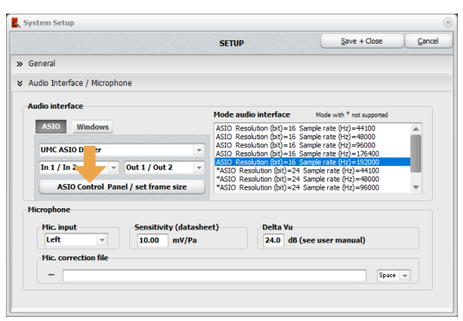
- Install the Audio Analyzer software
- Start x1Analyzer
- Open the system setup
  - Select the panel “Audio Interface”

4.2.2.1 Select an audio interface

ASIO or Windows?

Select first the audio driver type “ASIO” or “Windows”. Driver specific details to each driver type are explained in the following.

Note: ASIO is the recommended interface type.

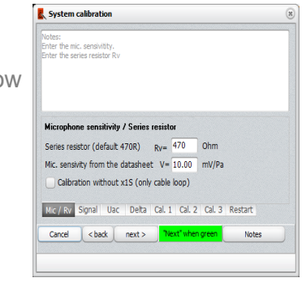


Select then the audio interface input and output. Finally the sample rate. Press “save & close” to save the settings and close the screen.

4.3 Start calibration

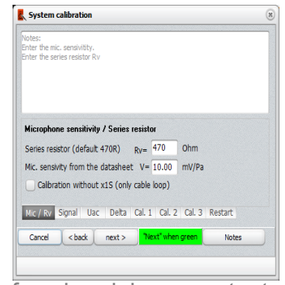
Start the calibration about the header menu System / Calibration.

4.3.1 General



- Note: You find notes at each step in the withe text box. Please follow it carefully.
- Note: Press the button “Next>” only if the rectangle ***„Next when green“*** shines green.

4.3.2 Step 1: Mic / Rv



- Enter the value of the series resistor from your measuring adapter (default 470R). x1S: Value from the schematic
- Enter the microphone sensitivity in mV/Pa (see data sheet of your microphone)
- Press the button “Next>” to open the next page

4.3.2.1 Calibration without x1S (cable loop)

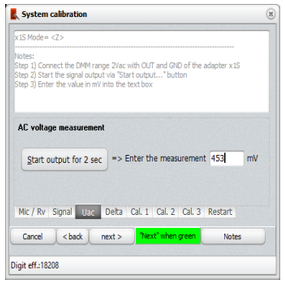
Enable the option “Calibration without x1S…” and connect the audio interface headphones output with Line input L/1 and R/2 directly (cable loop) during the calibration procedure. Ignore all messages to switch the “x1S Mode” or test resistor. Note: A SPL correct acoustical measurement is for this calibration option not possible.

4.3.3 Step 2: Signal

- Press the button „Start”
- The adjustment is successful finished, when the rectangle “Next…” displays a green background color
  - A red color indicates an error. Check the connection between measuring adapter and your audio interface
  - Increase “Headphone” level if needed
- Press the button “next>” to open the next page

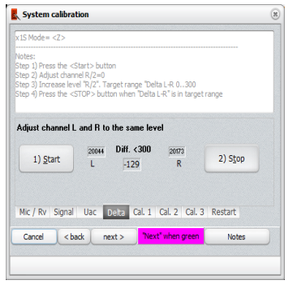
4.3.4 Step 3: Uac (Audio interface sensitivity)

- Connect a voltmeter to the “Out” and “Gnd” plug from the adapter x1S
  - Select the VAC range approx. 1V
- Press the button “Start output for 2 sec”
- Read the displayed voltage value from the voltmeter
  - Enter the value in mV in the text box. Note: The value “111” is automated entered, when the option “Calibration without…” is enabled
- Press the button “next>” to go to the next page, when “Next when green” shines green



4.3.5 Step 4: Delta

- Press the „Start“ button
- Adjust the input level for the RIGHT/2 channel to a value from less than 0..+300
  - The color of the rectangle in the top switch to green, when the value is within the allowed range
- Press the “Stop” button
- Press the button “next>” to go to the next page, when “Next when green” shines green



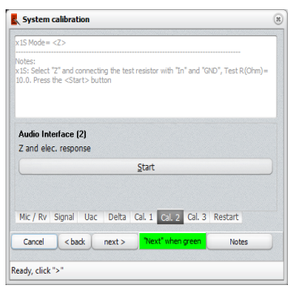
Important: Do not change the audio interface gain level for the inputs and headphone output after this calibration step!

4.3.6 Step 5: Cal 1

- The calibration step starts automatically after you press “Next” from the previous calibration step
- Press the button “next>” to go to the next page, when “Next when green” shines green

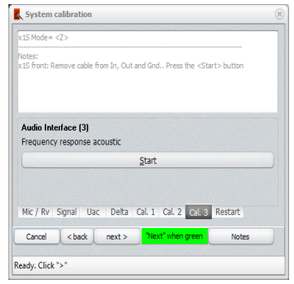
4.3.7 Step 6: Cal 2

- Connect a 10R 1% test resistor to the adapter x1S “In” and “GND”
  - Note: Not applicable, if the option “Calibration without x1S ….” is enabled
- Press “Start”
- Follow the displayed instructions.
- Press the button “next>” to go to the next page, when “Next when green” shines green



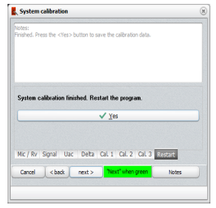
4.3.8 Step 7: Cal 3

- Press “Start”
- Press the button “next>” to go to the next page, when “Next when green” shines green



4.3.9 Step 8: Restart

Press “Yes” to start finish the calibration. The program will be re-started



The analyzer is successful calibrated.

5 Measurements

Note: Auto scale for x & y axis is set in app setup.

5.1 Acoustic frequency response (loudspeaker)

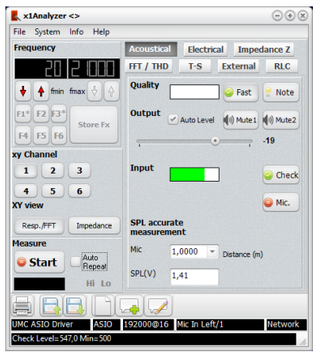
5.1.1 Measurement without SPL adjustment

Pre-condition:

- Power off the audio power amplifier!
- Connect the audio interface “headphone out” with a power amplifier input (e.g. “AUX” or “Tuner”)
- Connect the microphone with the audio interface, channel LEFT/1 (default)
- Power on the audio interface
- Power on the audio power amplifier. Set the volume to 25%. Increase it, if the level check ends with error (Input bar yellow)
- Avoid any disturbing noises during the measurement

Note: fmin/fmax adjustment is disabled. Measurement range fix is fix set to 20Hz up to 20kHz

Steps:



- Select the tab “Acoustical”
- The parameter to the acoustic response measurement is shown
- Select “Fast” for a first measuring shot
- Enable “Auto Level” and press the button “Check”
  - If the level is not sufficient, increase the volume level of your amplifier (level bar is yellow). A green bar indicates success
  - **Repeat the check, if you change the mic. distance!**
- When the level check successful ends, select the XY target channel, e.g. 1
- Execute the measurement via the button “Start”

- The XY screen views the diagram after the measuring

5.1.2 Measurement with SPL adjustment

The software is able to recalculate the measurement to a test signal voltage from 2.83V and 1m microphone distance, like in driver data sheets.

Pre-condition:

- Open the program setup / Audio Interface”
- Check/enter the correct mic. sensitivity in mV/Pa (value from the mic. data sheet)
- Enter the mic. amplifier gain in dB (see chapter setup)

Measurement of the test signal voltage:

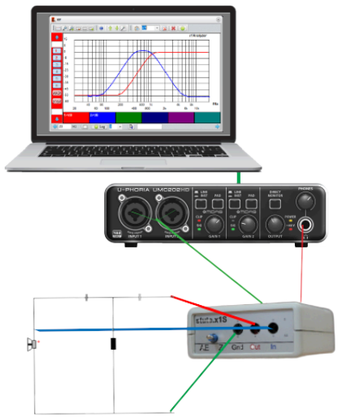
Measure with a TRMS voltmeter the voltage at the power amplifier speaker output:

- Press the button “Check” with the enabled ”Auto Level” option
- Wait until signal is ok = progress bar is green
- Disable the “Auto Level” option
- Press “Check” => A noise signal loop is heard. Measure now the AC voltage at the speaker
- Note the displayed measurement from your digital volt meter at the end of the noise signal
- Click at “Check” to stop the signal loop
- Enter the value in Volt in the text box “SPL V.”
- Enter the microphone distance in meter in the text box “Mic”

Execute the measurement:
- Execute now the SPL correct speaker measurement, press the “Start” button

5.2 Electrical frequency response (filter, amplifier,…)

5.2.1 Audio crossover



Pre-condition:

- Connect the x1S adapter to the audio interface
- Connect the audio crossover with the x1S
  - x1S: Select the mode “AE”
  - Connect your audio crossover input with “Out” and “Gnd”
  - Connect the “In” with driver (“hot” pole), e.g. the high pass output

Steps:

- Select the tab “Electrical”
- Set the “Level” to “-6dB”, select “20” points per decade
- **Disable** “**2-ch measurement**”
- Select the measurement unit “dB”

- Select the frequency range about “fmin” and “fmax” or use a frequency preset key
- Select the target channel for the XY diagram, e.g. channel 1
- Press the button “Start”
- The XY screen views the measurement

5.2.2 Amplifier

Check of audio power amplifier, pre-amplifier, mic.-amplifier, EQ, …

Important notes:

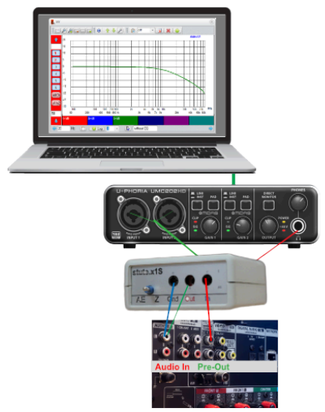
- Note the maximum input voltage of the audio interface (see audio interface manual)
- Higher voltages can damage the audio interface or the PC!
- You can only test microphone or preamplifiers or power amplifiers where the earth / - pole of the inputs and outputs is connected via low impedance. Test with a multimeter beforehand (ohm measurement). Class D amplifiers cannot be measured
- For an amplifier check with a load, use always a resistor or loudspeaker box, never a single speaker like a tweeter
- Be aware of the power amplifier gain and test signal input voltage. Limit the output level for a “suitable” speaker output
- The measurement is at your own risk

Pre-conditions:

- Select the tab “Electrical”
- Choose parameter for the electrical measurement
  - Adjust the “Level” to “-30dB”
  - Select “30” points per decade
  - Select the measurement unit, e.g. “dB” (Note: mV and µW not allowed)
- Select the frequency range about “fmin” and “fmax” or use a frequency preset key
- Select a XY target channel, e.g. chanel 1

Note: The “Mono measurement” is more accurate.

Mono measurement with x1S

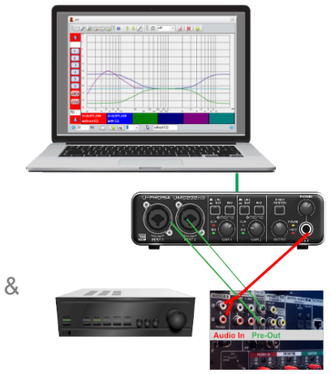


- Amplifier settings
  - Mute the speaker outputs
  - Set the amplifier output volume to approx. 10%
- Connect the amplifier with the x1S
  - x1S “Out” and “Gnd” to amplifier input, like Tuner
  - x1S “In” to amplifier “Aux Out” or “Speaker Out”
  - x1S mode “AE”
- Amplifier: Unmute the speaker outputs
- x1Analyzer
  - **Disable** “2 channel measurement”

- Press “Start” to start the measurement
- The XY screen views the measurement
- Adjust the level is needed

Stereo measurement (without x1S):

- Amplifier settings
  - Mute the speaker outputs
  - Set the amplifier output volume to approx. 10%
- Connect the audio interface with the amplifier directly
  - Connect the audio interface headphone output with the amplifier line inputs, like “CD” or “TAPE IN”
  - Connect the amplifier speaker output with the Line Inputs 1 & 2 of the audio interface
- Select the used line input at the audio amplifier
- Unmute the speaker outputs
- x1Analyzer
  - **Enable** “2 channel measurement”
  - Press “Start” to start the measurement
  - The XY screen views the measurement
  - Adjust the level is needed



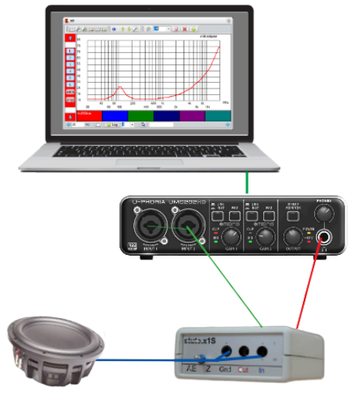
5.3 Impedance Z

Application:

- Speaker driver impedance measurement
- Z EQ circuit (RC or RLC) verification
- Crosscheck of the data from the driver data sheet
- Check the enclosure tuning or bass reflex port

Pre-condition:

- To protect a tweeter, set “fmin” to frequency >200 Hz
  - The measuring voltage depends at the used audio interface settings (e.g. 0.1V .. 0.5V)
- Connect x1S to the audio interface
- Connect the test object, e.g. speaker, with x1S
  - Select the mode “Z”
  - Connect the test object with “In” and “Gnd”



Steps:

- Select the tab “Impedance Z”
- The parameter for the Z measurement is shown
  - Select points per decade, e.g. 30

- Select the frequency range about “fmin” and “fmax” or use a frequency preset key
- Press the button “Start”
- The XY screen views the chart

5.4 FFT incl THD & frequency response

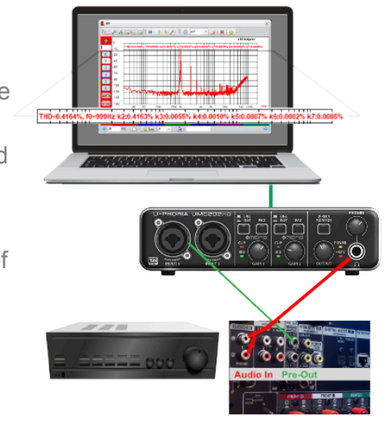
Application:

- Amplifier check (electrical)
- Loudspeaker driver / system check (acoustical)
- Analysis of an AC input signal (display the frequency spectrum)
- Distortion measurement THD and the coefficient k2 to k7
- Frequency response with white noise
- IMD measurement

Tip: With the "PEAK" option, the peak value from several measurements is displayed. The "PEAK" measurement is displayed in the selected channel +1. For channel 6 in channel 1. With the option set, only the PEAK measurement appears in the xy diagram.

5.4.1 FFT “electrical”

Pre-condition:
Attention: Note the maximum input voltage of the audio interface. Check the user manual of the audio interface for more details! High voltage can damage the audio interface or PC!



- Connect test object output to Line In 1 and/or 2 of the sound card
- Test object input
  - Internal signal source: Connect the headphone output of the sound card to the test object input
  - External signal source: Connect the output of the external signal source to the input of the test object

Tip: Alternatively, measurement via x1S, "AE" mode. Signal input then "IN" and "Gnd". See chapter frequency response electrical “Amplifier”.

Steps:

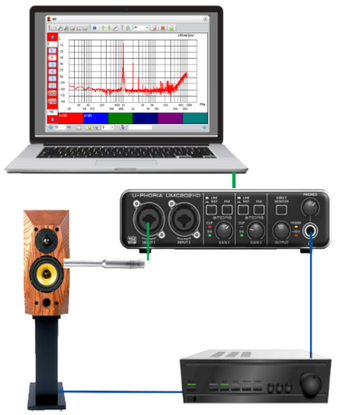
- Select the tab “FFT spectrum”
  - Adjust the FFT size, e.g to “16384”. Note: A higher number increases the frequency resolution, but need more time for processing
  - Select average, e.g “2” and FFT window, e.g. “Hanning”
  - Select the audio interface input: Line In 1/L or 2/R
- Test signal source external or internal
  - External: Start the signal output, like MP3 file
  - Internal “Test signal”
    - Enter the test signal frequency in the „fmin“ field

- Push the button „Off“. The text change to „On”
- Adjust the test signal level. Start with a low value

- Start the measurement. Press the button “Start”
- The XY screen views the frequency spectrum

Note: Use the auto scale function (XY screen or setup) , if the measurement is not shown.

5.4.2 FFT “acoustical”



Pre-condition:

- Disconnect the x1S adapter
- Enable the phantom power supply (+48V) for the mic. at the audio interface
- Connect the microphone with the audio interface, channel LEFT/1 (default, see setup)

Steps:

- Select the tab “FFT”
- The parameter for the FFT measurement is shown
  - Adjust the FFT size, e.g “16384”
  - Select Average, e.g “2”
  - Choose the FFT window, e.g. “Hanning”
- Press the button “GO”
- The XY screen views the frequency spectrum

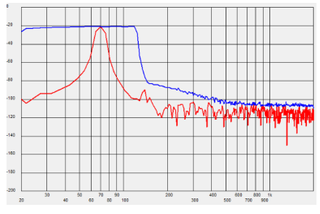
5.4.3 FFT frequency response measurement

Alternatively, you can use the FFT to measure frequency responses. The measurement signal is white noise (full frequency range) or a slow sweep signal (sliding sine wave) for frequencies up to approx. 100Hz.

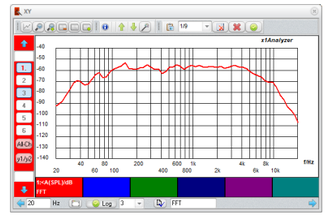
Steps:

- **Signal Sweep**
  - Activate "PEAK"
  - Repeat measurement "on" until the frequency range of the sweep signal has been fully recorded
  - Set FFT points 16384, average value 1. change as required

Sweep with low-frequency sine signal



- **Signal White noise** (e.g. in a car)
  - De-activate "PEAK"
  - Set FFT points 16384, average value 3. change as required
  - Repeat measurement "off"
  - Set in xy screen smoothing to “1/16”
- Start test signal: Internal, generator, CD, USB stick, MP3...
- Start the FFT measurement.



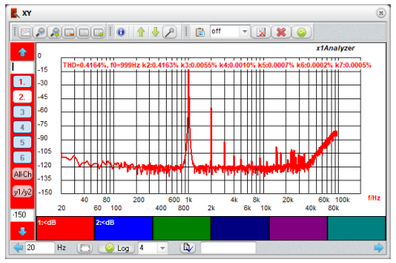
5.4.4 Distortion THD and k2 to k7

Pre-condition:

- Follow the electrical or acoustical FFT workflow
- Press the “THD” button

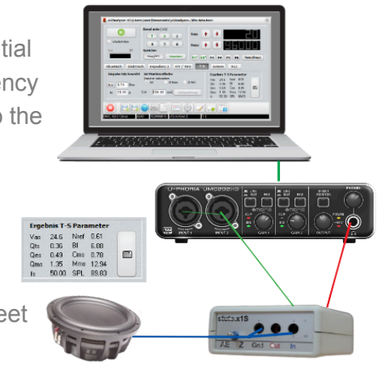
Steps:

- Press “Start”
- The fundamental frequency, THD and the distortion coefficients k2 to k7 are displayed in the xy screen



Note: Increase the FFT point quantity, if the measured fundamental frequency show a large deviates from the frequency of the test signal.

5.5 Thiele Small Parameter (Vas,Qts…)



Application: The Thiele Small (T-S) driver parameter are essential for the driver enclosure calculation and important for the frequency response or step response. But often is the T-S data different to the data from vendor data sheets. This leads into a bad sound.

- Determine the the Thiele Small (T-S) Parameter of your speaker driver
- Export the T-S data set via click into the x1Designer Loudspeaker Box Designer
- Compare the T-S data between measurement and data sheet
- Control the driver burn-in process: T-S before and after

Notes:

- Best result: Use a voltmeter to measure the DC resistor Rdc of the driver. Alternative use the “Rdc” function from the software. Connect the driver with the interface x1S. Set mode “Z”. Press the button “Rdc” (this is an approximation only)
- Best result: Pick the Sd value from the driver data sheet. Alternative calculate the size via the **“inner”** cone diameter. Select first the driver type: Woofer or Mid-Range. Enter the diameter and press “Sd calculation”

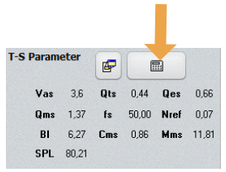
- The measurement without mass is stored in channel 1. With mass in channel 2
- Measurement only suitable for cone speakers, e.g. woofer or mid-range driver

Pre-Condition:
- The speaker driver is disassembled (free air condition)
- Small weights are needed. Typical weight values are 5…50 gram, like a AAA battery or coin cell. The weight depends at the driver size.
- The DC resistor Rdc, the cone area and the mass of the measurement weight is known
- Connect the speaker driver to x1S interface. Select the mode “Z”
- Minimize surrounding noise!

Steps:
- Select the tab “T-S”
- Input “Rdc”, the mass of the small weight and the cone area. See “notes” above
- Select the frequency range via “fmin” and “fmax” or use a frequency preset key. The range should be start be 20Hz (fmin) and ends at 4 times of the resonance frequency
- First measurement WITHOUT the mass. Press the button “Start”
- Then fix the mass at the cone, be careful! Start the second measurement.
  - For some cone types UHU Patafix is a good choice (no liability for damaged cone)
- Finally, the T-S values are displayed

Tip: Archive the measurement. “Rdc”, mass weight and the area “Sd” are stored as note into the file. A re-calculation is later with the values possible, without a new measurement.

Re-calculate the T-S data via a stored measurement



- Open a file with the T-S measurement
- Input the values “Rdc”, “Sd” and the “mass” from the XY screen header in the fields from the tab “T-S”
- Press the button “Calculate”

Share T-S data
- x1Designer requests measured T-S data to selected driver
- Copy T-S data to clipboard

5.6 Bluetooth, network audio, MP3…

In this mode, you create frequency responses for devices for which you cannot input test signals from audio interface headphone out. This includes, for example, Bluetooth audio adapters, MP3 Player, Audio network or CD players.

The test signals, e.g. MP3 files, can be played back via USB stick, CD, Bluetooth, AirPlay etc. on the target device to be tested.

Tip: You can obtain a suitable set of test frequencies in our online store.

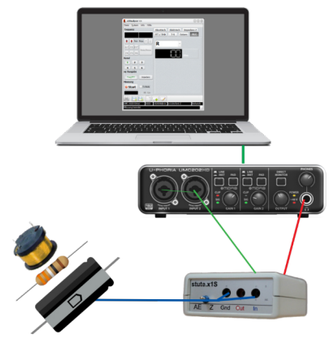
Applications:
- Test of Bluetooth audio adapter (e.g. playback test signals via your mobile phone)
- Check of network audio player (e.g. playback via NAS server and app on mobile phone)
- Check flatness or tone control function

Pre-condition:
- Connect the audio line output of the test device (e.g. Bluetooth adapter) with the line inputs from the audio interface
- Copy the test signal set your mobile device, NAS server or USB flash drive

Steps:
- Select the tab “External”
- Choose the input from the audio interface
  - “Left/1 or “Right/2”
  - **Measurement with x1S: Choose “Right/2”**
- Press “Start”
- Start then the playlist with the audio test signals
- Stop:
  - Manually: Press “Esc” from the PC keyboard
  - Automatically: Enter the highest test tone frequency in the field “fmax” as auto stop condition. Requirement: Played test frequencies in ascending order.

5.7 R-L-C components

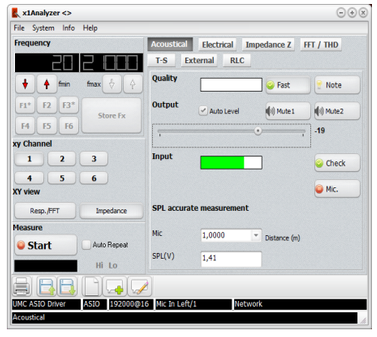
Measurement of the crossover components resistor R, coil L and capacitor C. Determine the value for components with no longer legible imprint or check the specification.



Measurement:
- Select tab “RLC”
- Choose „R“, „L“ or „C“
- x1S Interface
  - Connect the component with "Gnd" and "In“
  - Set switch to „Z“
- Press “Start”. The measured value is displayed
  - Press "Repeat" for automatically repeating measurement

6 Main functions

Measurement type

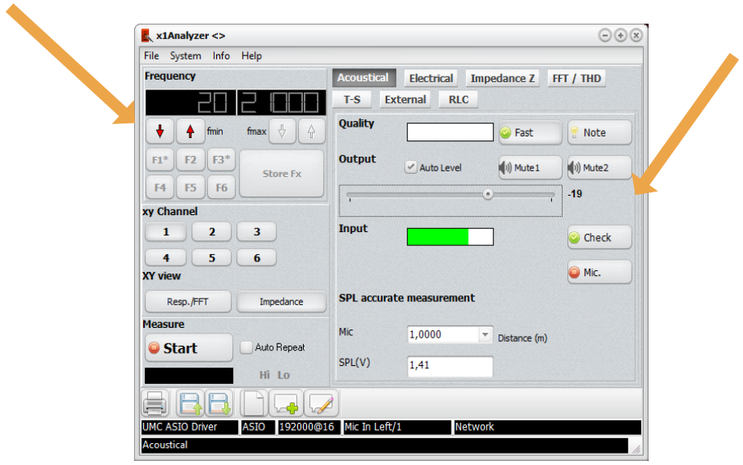


- **Acoustical**: Acoustic frequency response measurements for loudspeaker driver and loudspeaker boxes
- **Electrical**: Electric frequency response measurements for audio filter and amplifier with internal test signal source
- **Impedance Z**: Impedance measurement for loudspeaker driver or and driver with impedance correction circuit (EQ via RC/RLC). Also feasible for bass reflex port checks
- **FFT / THD**: Frequency spectral analysis of an incoming signal about the Fast Fourier Transformation plus harmonic distortion THD + coefficients k2..k7
- **T-S:** Loudspeaker driver Thiele Small parameter measurement
- **External**: Frequency response measurement with external sine signal source, e.g. MP3 test signal file set
- **RLC**: Measurement of resistor R, coil L and capacitor C, ideal for audio filter components

6.1 Screen “Measurement”

- Header: Menu “File, System, Info, Help”
- Left side “Measurement” : Frequency range, target channel, start measurement

  Right side “Type”: Measurement type & parameter



- Below: Icon bar (Print, Save…)
- Footer: Status note, settings audio interface, level remote access

6.2 Menu (header)

	Description
File	
Close	Quit program
System	
Setup	Program settings, audio interface , sample rate
Calibration	Calibrate system
Info	View program version and installation key
Help	View PDF Help from Web

6.3 Measurement (Left side)

6.3.1 Frequency fmin / fmax

Function depends on measurement type:

Messart	Beschreibung
Acoustic	Not applicable, frequency range fix
Electrical & Impedance & T-S	fmin: Start measurement at fmin in Hz, stop by fmax in Hz
FFT	fmin: Frequency Test signal, if option “Sine” is enabled. fmax without function
External	fmin: not applicable. fmax: Stop measurement, if signal is detected. See chapter „External“ too
RLC	Not applicable

Adjust fmin / fmax via:

- Up/Down buttons (red arrows)
- Input the frequency via PC keyboard
  - Click in fmin or fmax box. Input the value and press finally Enter

Frequency range presets F1..F6

Save frequently used frequency intervals (fmin/fmax). After entering fmin & fmax, press the “fmin/fmax” button and select a memory button, such as “F1.”

- An Fx key that is already assigned to fmin/fmax is marked with “*”.
- Hold the mouse pointer over a memory key for approx. 1-2 seconds to display the stored frequency interval of the key that is already in use.
- Left-clicking on a memory key recalls fmin/fmax
- Right-clicking on a memory key deletes the entry

6.3.2 xy Channel

Select here the target channel for the next measurement:

- Channel number black: not data stored for the selected “xy view” (see chapter 6.3.3)
- Channel number green: Measurement data assigned for the selected “xy view”

Automatically increase the measurement channel to the next measurement
Clicking on the text “Channel” activates the function. The text “Channel auto (+1)” is now displayed. Another click deactivates the function.

Procedure: For each subsequent measurement performed using the “Start” button, the program automatically selects the next measurement channel. When it reaches 6, it jumps back to 1.

6.3.3 XY view

The internal measurement memory can store 6 frequency responses and 6 impedance curves in parallel. This means that channel 1 can contain data for impedance and frequency response measurements. The buttons under “xy view” are used to select what is shown in the xy diagram.

- Freq/ FFT 1): Display of frequency responses from the measurement types Acoustic, Electrical, Impedance, External, FFT
- Impedance 1): Impedance chart

1) Text is **Black**: No measurements . **Green**: Measurements exists

6.3.4 Measurement

- Press the button „Start“ to start a measurement
- „Auto Repeat“ enabled: Cyclic measurements enabled. Press „Start“ to start the measurement. Disable it to stop the measurement
- Lo/Hi: Input signal high (Hi) / low (Lo)
- Value rectangle (Black): Values for measurement. Voltage in digits or current measurement frequency. Display depends on the selected measurement type.

6.4 Icon bar

A 1 2 3 4 5 6

A#	Description
1	Print chart
2	Open measurement (TES format), Import from TXT file, open TEC file (x1A mic. Correction format)
3	Save measurement (TES format), export as TXT or TEC file
4	Clear all measurements
5	Open “XY assistant ” (see matching chapter): Enter text note for the measurement channel or note for the entire measurement, mix mode display: Display of a frequency response measurement and an impedance measurement in a diagram
6	Open the tabular measurement value editor (display of frequencies and measurement values)

Note TXT” format:

- Delemiter char “;” or “Tab” character (select in the file dialog)
- The first line may contain notes on the measurement or column explanation
- Syntax: Frequency + Delemiter char + measured value
- Decimal point in the format “,” or “.”

6.5 Footer Status

A 1 2 3 4 5

6

A#	Description
1	Used audio interface
2	Used audio interface driver type
3	Used sample rate / bit depth
4	Notes to the selected measurement like x1S switch position or audio interface inputs
5	Access level for remote control (see chapter “Setup”)
6	System messages

Background color footer

- Black: Default
- Yellow: Warnings
- Red: Error messages

6.6 Module „xy assistant“

Function

- Color allocation for each XY data channel
- Text input to each channel or the total measurement
- Change scaling to the y axis 1 or 2
- Configure mixed measurement views (Z and acoustical frequency response in the same XY diagram)

Open the view via the button 

	Function
1	XY channel K1..K6 number
2	Type of measurement: AMPL ➔ Frequency response , Z➔ Impedance chart (see also #3)
3	Channel number
4	Relate measured values to the 2nd y-axis (in the XY window on the right)
5	Change the channel color. Example for the default setting 
6	Text input, e.g „Speaker A“ 

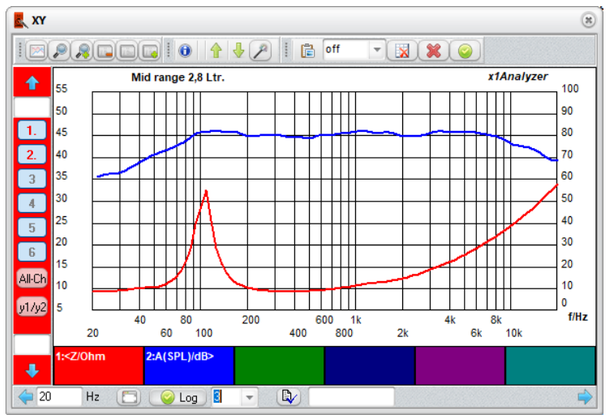
1 2 3 4 5 6

7 8 9 10

	Description
7	Set channel settings to default
8	Notes: Hidden description. Display only here
9	Header text xy screen: Description to measurement
10	Close screen

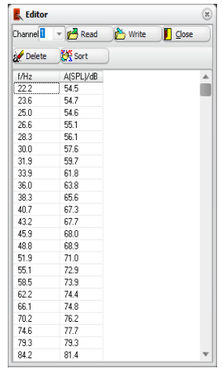
Example Z and acoustic frequency response in the same XY diagram

- XY channel 1 frequency response refer to y-axis 1, indicator “<” in the red rectangle
- Channel 2 to xy channel y-axis 2, indicator “>” in the blue rectangle



6.7 Module „Editor“

- View data pairs from the measurement
- Modify measurements
- Create measurements, new data entry (e.g. microphone correction file)

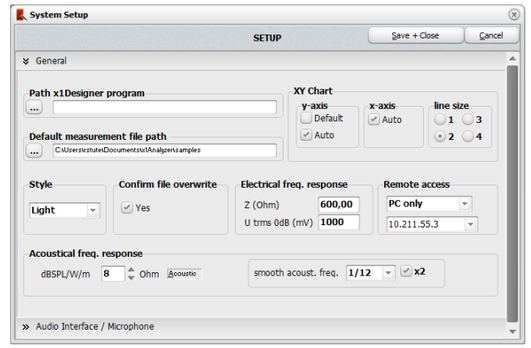


Open the view via the button 

Description:

- Channel: Select a channel number from the XY screen
- Read: Read the measurements of the selected XY channel
- Write: Write the modified data into the selected XY channel. The
- changes are displayed, when the editor is closed
- Sort: Sort the table ascending
- Delete: Erase the selected table row
  - Select a row with a mouse click in the correspondent cell

7 Setup



7.1 Page “General”

7.1.1 XY Chart

y-axis

- Default: Set the scale of the y axis to the default values after each measurement
  - Not applicable for the FFT measurement
- Auto: Set the scale of the y axis according to the measurement of the selected XY channel

x-axis

- Auto: Scale the x-axis according to the measurement of the selected XY channel

Line size

- 1..4: Line thickness of the measurement curve => 1: Thin … 4:Thick

7.1.2 Remote access

Remote access must be guaranteed for data exchange with “x1Designer” or “x1Aremote.” The following levels are available:

- Off: No access
- PC only: For transferring the T-S parameters to the selected loudspeaker in x1Designer. Prerequisite: x1Designer is installed on the same PC as x1Analyzer.
- Network: Remote control of the x1Analyzer and transfer of measurements to the “x1Aremote” app from another PC, cell phone, or tablet computer via Wi-Fi or cable network.
  - Select an IP address from your local network from the selection box.

- Prerequisite: The controlling computer with x1Aremote is located in the same local network as the PC with x1Analyzer. Guarant the access via firewall!

Note: The status bar in the main program shows the release level.

7.1.3 Acoustical freq. response

Smooth acoust. freq

Note: Smoothing of the measurement from the tab “acoustical”

- Select the level for the data smoothing: Level in 1/x octave
  - Low value for x (e.g. 1/3) => strong smoothing
  - “Off” without smoothing
- x2: Double smoothing calculation (stronger smoothing result)

Acoustical frequ. response

- dbSPL/W/m: Value for the accurate SPL calculation
- Default: 8 Ohm

7.1.4 Path x1Designer

- ‘…’: Open the file dialogue to select Loudspeaker Designer “stutex1D.exe”
  - Default path: C:\Program_Files\Stute Engineering\x1Designer…
- Text box: Displays the current file path to x1Designer

7.1.5 Default measurement path

- ‘…’: Open the folder dialogue to select the default path for the measurement storage
- Text box: Displays the current file path

7.1.6 Elec. freq. response

Note: Reference values for the measurements from the tab “Electrical”

- Z: Reference impedance for unit mW(Z) and dBm(Z)
- Utrms 0dB: Reference voltage for the unit “dBV”

7.1.7 Confirm file overwriting

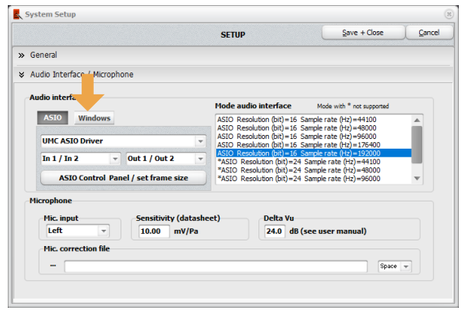
- Confirm measurement overwriting: Enable/Disable data overwriting warning messages

7.1.8 Style

Change between different user interface styles, e.g. Dark and Light. Note: A program re-start is needed to display the new style.

7.2 Page „Audio Interface“

Note: ASIO is the recommended interface type.



7.2.1 ASIO or Windows

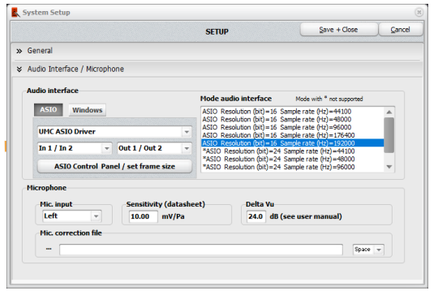
Select first the audio driver type “ASIO” or “Windows”. Driver specific details to each driver type are explained in the following.

7.2.1.1 Audio interface driver “ASIO”

Important notes:

- For a correct operation an **ASIO frame size from 1024 buffer** and above is mandatory (1024 recommended) ! Select the frame size via the ASIO panel.
  - Open the panel via the button “ASIO Control”, see below. The audio interface specific panel is displayed. You find more details in your audio interface manual
- The audio analyzer will be closed after audio interface changes. Please save first your un-stored measurements
- **Power off connected audio amplifier and disconnect test devices, if you change audio interface settings.**
- The ASIO driver control only the audio mixer functions for “Playback”. Please ensure that the mixer controls for the audio inputs “Record” are at 100%.

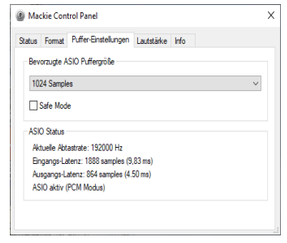
Select a ASIO audio interface



- Select an audio interface from the ASIO interfaces list
- The available “Input” and “Outputs” are listed for the interface
- Select Input and output
- Select a sample rate / resolution entry.
- The maximum measuring frequency is theoretical the sample rate divided by 2. Allowed are only the lines without a “*”

Note: The system must be re-calibrated, after changes!

ASIO Control



- Press the “ASIO Control” button to display the ASIO driver control panel (manufacturer specific)
- Change here for example the ASIO buffer size to 1024

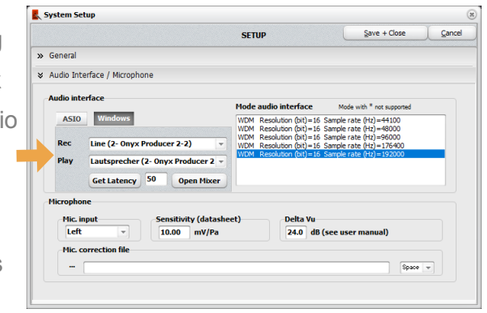
7.2.1.2 Audio interface driver „Windows/WDM“

Important notes:

- The audio analyzer will be closed after audio interface changes.
- Please save un-stored measurements
- Power off connected audio amplifier

Select a WDM audio interface

- Rec: Choose the audio interface for the recording
- Play: Choose the audio interface for the playback
  - Note: Rec & Play must be from the same audio interface
- The list “Possible settings” are updated
- Select a sample rate / resolution combination
  - ▪ Note: The maximum measuring frequency is theoretical the sample rate divided by 2
  - Allowed are the lines without a “*”



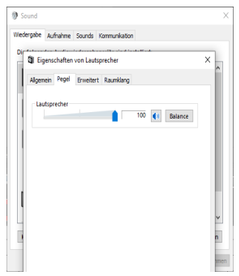
Note: After changes the system must be re-calibrated!

Get Latency

- Measure the system own latency (function also in the calibration workflow included)
- Start the measuring due to a click at the button “Get latency”
  - A signal loop due to the adapter x1S or a cable loop is needed
  - The text box displays the latency value

Windows Mixer

- Display the Windows audio interface control panel (button “Open Mixer”)
- E.g. check the audio mixer volume. Set only the mixer for the usage with x1A for “Rec” and “Play” to 100%



7.2.2 Microphone

7.2.2.1 Mic Input

- **Mic Input:** Select the default audio interface input for the microphone. Factory default is “Left/1”

7.2.2.2 Sensitivity

- Note: Input only needed for a SPL correct measurement. Enter here the sensitivity of the used microphone (mV/Pa). You get the value from the data sheet of your microphone

Note: Input only needed for a SPL correct measurement

7.2.2.3 Delta Vu

- **SPL measurement: Delta Gain**

Enter here the difference between max. “Line in” level and max. “Mic.” input level. The input is always positive and in dB. You find the information for the “line in” and ”mic. level” in your audio interface manual

Example 1	Example 2
SPECIFICATIONS Performance Specifications Microphone Inputs Dynamic Range: 106 dB (A-weighted) Frequency Response: 20 Hz to 20 kHz ±0.1 dB THD+N: <0.002% (minimum gain, -1 dBFS input with 22 Hz/22 kHz bandpass filter) Noise EIN: >-126 dB (A-Weighted) Maximum Input Level: +4 dBu Gain Range: 50 dB Line Inputs Dynamic Range: 106 dB (A-weighted) Frequency Response: 20 Hz to 20 kHz, ±0.1 dB THD+N: <0.003% (minimum gain, -1dBFS input with 22 Hz/22 kHz bandpass filter) Maximum Input Level: +22 dBu Gain Range: 50 dB	MIC/LINE/HI-Z INPUT Ch2 MIC [-60dBu~-6dBu] LINE [-40dBu~+14dBu] HI-Z [-55.5dBV~-1.5dBV]
Result: Delta gain is Line max value minus Mic max value = +14dBu minus -6dBu = 20dB	

Note: Input only needed for a SPL correct measurement.

7.2.2.4 Mic. correction file

Note: Negative values from the correction file increases the measurement value.

The mic. correction data can be imported from an ASCII file, e.g. a file from the mic. manufacturer. Alternative the data can be entered from the microphone data sheet and stored into an own created file.

8 Microphone correction

The mic. correction data can be imported from an ASCII file, e.g. a file from the mic. manufacturer. Alternative the data can be entered from the microphone data sheet and stored into an ASCII file. Also a creation via measurement with a reference microphone is possible.

Pre-Condition:

- A frequency response chart of the microphone is available (e.g. from the mic. data sheet) or a reference microphone
- The correction file values are referenced to 0dB = no correction
- **A positive peak in the mic. frequency response from the microphone must be corrected with a positive value of the mic. correction file**
- A fix offset about the complete frequency range will correct SPL errors of the microphone (e.g. due to a faulty mic. sensitivity value)

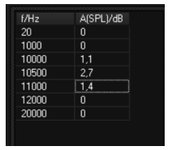
- Start your input with 20Hz. Ends with 25000Hz
  - Take over the dB value for 20000Hz also for 25000Hz
- Check the entered data in the XY screen. If needed, edit the data again
- Finally: Import the correction data in the program setup, section “audio interface”

8.1 Create a correction file

8.1.1 Manually data input via x1A internal editor

Steps:

- Open the “Editor” view
- Choose channel “1”
- Enter the correction values in the table
  - First column: frequency, second column: Correction offset
  - Mic. frequency response view a peak of 2.7dB@10500Hz => Offset 2.7dB



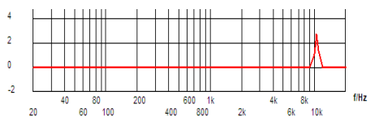
- Press “Write to XY module” and confirm the “Quit” button
- Save the data as a mic. correction file
  - Open the dialogue “Save file”
  - Enter a filename
  - Select the file type microphone correction “TEC”
  - Store the file

8.1.2 Use an ASCII editor

Enter the values for the microphone correction into a text file. Use the Windows editor “Notepad” for example. Each line contains the frequency and correction value.

Note: A first line with the column description is allowed

Example text file with the delimiter char “;”



Example ASCII file content:

Frequency;Offset
20;0.0
1000;0.0
9000;0.0
10000;1.1
10500;2.7
11000;1.4
12000;0
40000;0

8.2 Input via measurement

Pre-conditions:

- A reference microphone is available (linear frequency response expected)
- A loudspeaker box with a wide frequency range is available (e.g. 40Hz to 20kHz)
- The mic. distance/angle to the speaker and the test signal level are the same for both mic. measurements (reference and default microphone)

Steps:

- Execute a measurement “Acoustical” with the default mic. Select target channel 2
- Execute a measurement “Acoustical” with the reference mic. Select target channel 3
- Open the „xy option“ screen from the xy screen
  - Adjust both measurement at 1kHz to 0dB (see chapter appendix “XY screen”)
  - Build the difference channel 2-3. Select from the header menu „Math/Sub lin“
    - “+” channel is 2 and “-“ channel is “3” => “target” channel “1”
  - Press execute
  - The result is in channel 1
  - Erase the data from channel 2 and 3
- Open the save dialogue and select as file type “TEC mic. correction”
- Enter a file name and save the file

Finally import the file in the program setup, section “audio interface” and “Mic correction file”.

8.3 Use the mic. correction

- Open the program setup, section “audio interface”
- Choose “Mic correction file”
- Open the file open dialogue “…“
  - Select the correct file type
    - TEC
    - TXT - Set the matching delimiter char
    - **TXT- Sonarworks oder Dayton as TXT file**
  - Choose the mic. correction file
- Activate the correction in the “Acoustical” settings (main screen)
  - Press the button “Mic.” down

Note: Re-load the correction master file via the program setup, after editing!

9 Accessory

9.1 Interface x1S

For the calibration and some measurements a simple passive adapter, named "x1S", is needed. You can create it by your own. You get the schematic is for free in our download area. The adapter needs no power supply.

9.2 Cable x1S - Audio interface

Cable to connect the x1S adapter with the audio interface:

- Rear “Out” to audio interface input “L/1” and “R/2”
  - Cable 3.5mm plug Stereo to two contact 1/4" / 6.35mm Male Mono Plugs
- Rear “In” to audio interface “headphone output”
  - Cable stereo 3.5mm plug Male to 6.3mm/ 1/4" male

Measurement cable

- Front “Gnd”, “In”, “Out” : Connection to the test devices
- E.g. Cable 4mm banana jack to alligator

10 Audio interface requirements

- Audio interface sample rate 44.1kHz to 192kHz@16bit
- 2x Mono Line Input with gain knob (Hardware)
- Phones output with level knob (Hardware)
- Microphone input with phantom power supply (+48V)
- ASIO (frames >=1024) or Windows WDM driver support
- Recommendation Behringer U-PHORIA UMC202HD

11 Technical data

11.1 Acoustical frequency response

- Frequency range: 20 Hz to 20000 Hz
- SPL correct measurement

- Automatic measurement signal level adjustment
- Microphone correction, auto-smoothing after measurement
- Export to x1Designer via Network on the same PC

11.2 Elect. frequency response

- Frequency range: 20 Hz to 90000 Hz 1)
- Difference signal measurement (“2-ch mode” disabled)
- 2 channel mode: Parallel measuring of channel Left and Right
- AC input voltage range depends from the audio interface and adjustment
- 0 to 100 measuring points per frequency decade (x10)
- Measurement units: dB, dBV, mVtrms, µW(Z), dBm(Z), %
- 6 frequency range preset keys

11.3 Elect. frequency response (external)

- Frequency range: 20 Hz to 90000 Hz 1)
- Automatic recognition of the test signals
- Auto frequency calculation
- Auto measurement stop trigger via “fmax” setting
- Test signal frequency sequence not mandatory ascending

11.4 Impedance Z

- Frequency range: 20 Hz to 90000 Hz 1)
- Z range: 1 to 250 Ohm
- 30 to 90 measuring points per frequency decade (x10)
- 6 frequency range preset keys

11.5 FFT spectrum

- Frequency range: 20 Hz to 90000 Hz 1)
- 1024 to 65536 points, Window: Hanning, Hamming, Rectangle
- Average measurement from 1 to 10
- Sine test signal output 20Hz to 90kHz 1) , Level -50dB..0dB
- Frequency response

11.6 Distortion

- Frequency range: 20 Hz to 90000 Hz 1)
- Display THD and distortion coefficients k2 to k7 in % plus the fundamental frequency
- Sine test signal output 20Hz to 90kHz 1) , Level -50dB..0dB

11.7 Thiele Small parameter

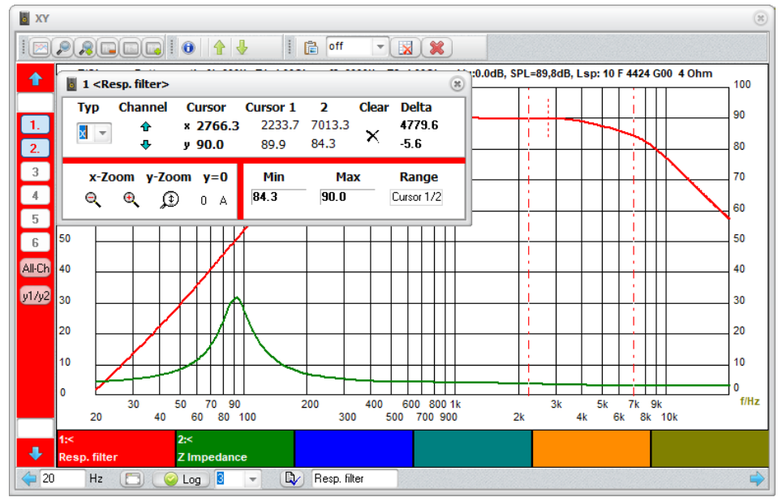
- Z measurement with a small mass
- Calculation of: Vas, Qts, Qes, Qms, fs, Nref, BL, CMS, Mms, SPL
- Export to x1Designer

11.8 R-L-C

- R: bis 100Ohm [2)]
- L: bis 20mH [2)]
- C: bis 100µF [2)]

[1)] With sample rate 192kHz. Supported sample rate from 44.1 to 192kHz. ASIO frame size >=1024.

[2)] Accuracy depends strongly on the delta level L/R from calibration. The lower the delta, the higher the measurement accuracy.



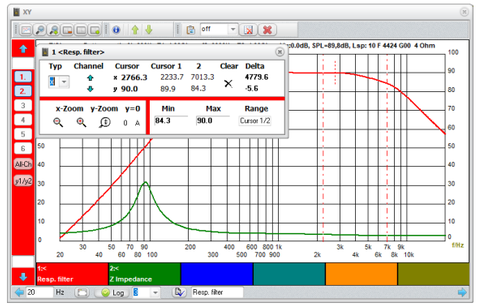
Appendix
XY screen

A XY screen

Note: The XY window is used in various software products from Stute Engineering. The diagrams or functions shown here may therefore differ.

Features:

- Parallel display of up to 6 measurements
- 2 y-axes
- x-axis linear or logarithmic
- Extensive cursor functions
- Mathematics
- Zoom and smooth the measurement curve
- Copy & Paste of the measurement curve
- Notes for measurement 1 to 6 as well as for the total measurement
- Copy measurement graph to clipboard
- Show/hide individual measurements
- Freely scalable window



A.1 Basic function

A.1.1 Identify active channel

You identify the selected channel by the background color of the channel menu on the left. The color corresponds to the channel color 1..6 from the footer of the XY window. Red means that channel 1 is selected.

A.1.2 Select active channel

Note: Many operations refer to the selected channel (active channel), such as moving curves or zooming.

- Move the mouse cursor to the corresponding channel key 1..6
- Press the right mouse button over the channel key, e.g. 1.
  - The background color changes to the channel color, in the example to red.
  - The channel is now selected (active)

A.1.3 Show/hide single channel

- Move the mouse cursor to the corresponding channel key, e.g. 1
- Click on the button to hide the channel
- Click again to show the channel again

A.1.4 Show active channel only vs. all channels

Press the "All-Ch" key once: Show active channel only. Press the "All-Ch" key again to show all channels.

A.1.5 Indicate channel with data

The channel number in red and a number with a dot after the channel number indicates that the channel contains measurement data.

A.1.6 Input notes

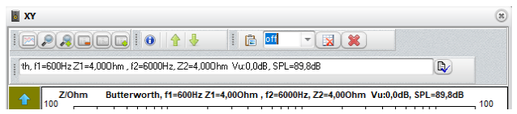
Each channel:

- Option 1 Footer:  : Enter the text related to the active channel in the text field and press the button
- Option 2 via „Tools“: Select the key from the XY icon bar. Select the "Texts" tab. Enter the text here for each channel

The text is displayed here 

Headline:

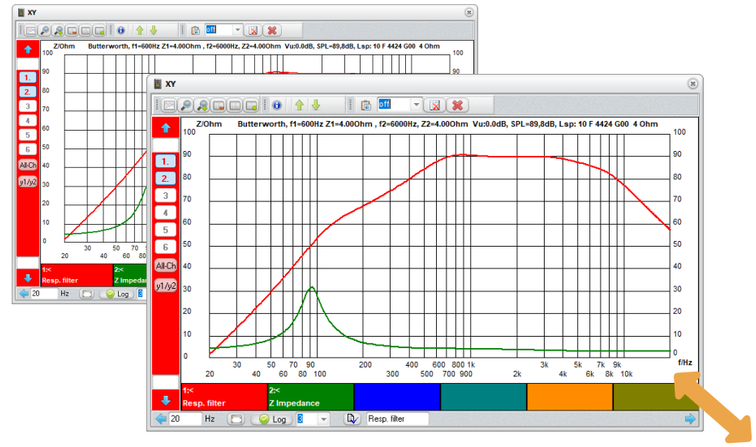
Press the button : Input the measurement headline



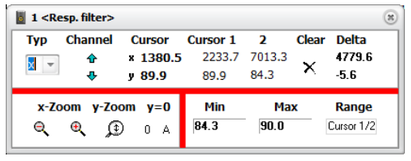
A.1.7 Re-size XY screen

The window width and height can be adjusted to your needs.

- Place the cursor on the border area of the window
- The cursor character changes
- Hold the left mouse button and drag the window to the desired size



A.2 Cursor-screen



A.2.1 View data to cursor position

- Move the mouse cursor to the measurement diagram
- Press the left mouse button
- The window Measurement data cursor appears
- Move the mouse cursor to the position of the diagram you want to read out
- Below "Cursor" the measured values to the cursor position are shown

A.2.2 View delta between Cursor 1 & 2

The difference display is helpful when analyzing the measurement data. This can be used, for example, to check the slope (dB/octave) of a crossover.

- Move the cursor to the measurement diagram
- Activate the cursor view, left mouse button
- Position the cursor on the first frequency (position 1) and press the left mouse button again, e.g. at 1kHz
- Position the cursor on the second frequency (position 2) and press the left mouse button again, e.g. at 2kHz
- The difference between cursor 1 and 2 to the x- and y-axis is displayed at "Delta":
  - Delta x = f2 – f1, Delta y= y2-y1

A.3 Main functions

A.3.1 Header

A 1 2 3 4 5 6 7 8 9 10 11 12 13 14

A#	Description
1	Display "Tools" window: Mathematical function and text input for measurement
2	Display measurement curve completely
3	"Zoom In" to the area from cursor position 1 and 2
4	Cut the trace of the selected XY channel
5	Copy trace of the selected XY channel
6	Insert trace into the selected XY channel

A#	Description
7	Text input for measurement. Display in the header for xy diagram
8	Shift active channel's trace downwards (change measured values)
9	Shift active channel's trace upwards (change measured values)
10	Copy measurement diagram to clipboard
11	Smooth active trace
12	Delete all measurements in the xy view
13	Delete active channel
14	Start measurement (only x1Analyzer)

A.3.2 Menu y-axis

	Description
	Increase scaling y maximum
	Enter the value for y Maximum. **End the input with the "Tab" key on the PC keyboard.**
1. 2. 3 4 5 6	Measuring channel 1..6: • Press key: Show/hide measuring channel • Right mouse button: Select channel as active. The background color of the menu shows the color of the selected channel (in the example red = 1).
All-Ch	Toggle: Display all channels or only the active one
y1/y2	Assign measurement data of the active channel to the y axis 1 (left) or right (2). Tip: The character "<" or ">" in the color field for each channel shows the assignment to the y axis. "<" left y-axis, ">" right y-axis
	Enter the value for y Minimum. **End the input with the "Tab" key on the PC keyboard.**
	Decrease scaling y minimum

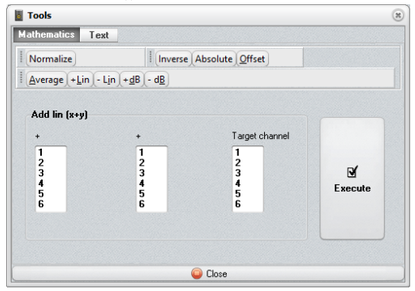
A.3.3 Menu x-axis

A1 2 3 4 5 6 7 8 9

A#	Description
1	Decrease scaling x minimum
2	Enter the value for x Minimum. End the input with the "Tab" key on the PC keyboard.
3	x Set axis to default (3 decades, log, start 20Hz)
4	Display x axis linear or log.
5	Number of decades (log only)
6	Confirm text input, see #7
7	Text input to active channel
8	Only visible with x-axis “lin”: Enter the value for x Maximum. End the input with the "Tab" key on the PC keyboard.
9	Increase scaling x maximum

A.4 Tools

A.4.1 Tab „Mathematics“



-Lin	Difference of two measurement curves. The result is displayed in the target channel: + : Select the channel number from which something is to be subtracted. - : Select the channel number to be subtracted from the "+ channel". Target channel: The result is displayed in the selected channel
-dB	Difference of two measurement curves with a dB scaling on the y-axis. The result is written to the target channel (target): Target(dB) = 20* log(10^(+channel#(dB)/20) - 10^(-channel#(dB)/20)) + : Select the channel number from which something is to be subtracted. - : Select the channel number to be subtracted from the "+ channel". Target channel: The result is displayed in the selected channel
+Lin	Addition of two measurement curves. Function similar to "Sub lin
+dB	Addition of two measurement curves. Function similar to "Sub dB
Average	Averaging of individual measurement channels: Source: Select measurement channels (e.g. 1,2 and 4). Target channel: Show result in selected channel (e.g. "5" for channel 5).

Merge (not available in x1Designer) Example: Subwoofer measurement in channel 1, front speakers in channel 2, transfer point of the measurement curves from the subwoofer to the front speakers is at 200Hz Target/TT = 1 source = 2 f=200 The result is displayed in channel 1	Assemble measurement diagram from 2 single measurements to one frequency. Target/TT : Number of the target channel with the already available measurement data to the subwoofer. Source : Number of the channel with the measurement data to the front loudspeaker f : Crossover frequency in Hz. Below f, the measurement data from the "Target/TT" channel is used and above from the "Source" channel. The result shows the channel number "Destination/TT".
Normalize Example: Level of channel 1 +3dB above that of channel 3. Level of channel 2 -5dB below channel 3. It is difficult to compare the measurements Solution: Adjust the level of the measurement curves. Calculate offset to frequency of 1kHz for all curves individually and move the measurement curves accordingly Input => channels = 1,2, reference = "3", "Applies to" = "1000".	Shift different traces to the level of the reference channel (normalize traces). The level is determined to the frequency f of the reference channel: Channel : Selection of channel numbers, e.g. channel 1 and 2. Reference channel : Number of the reference channel For value x: Frequency input (reference point for all traces)

All channels (only Absolute and Offset)	Active: The functions shown below affect ALL measuring channels. De-active: Only the SELECTED channel is changed
Offset	Shift measurement curve by the offset value Note: Channel input is not required if "all channels" is selected
Absolute Sample: Measured value from channel 1 at 1kHz 60dB. The new value (set point) should be 90dB Input: channel =“1”, “for value x” = “1000” and “set point” = 90	Shifting the measurement to a target point. The target point is given by a frequency and the set point to the frequency. Channel: Channel number For value x: Frequency to the preset value "set point". Set point : Set point/level to frequency "by x". Note: Channel input is not necessary if "all channels" is selected.
Inverse	Invert the measured values

A.4.2 Tab „Text”

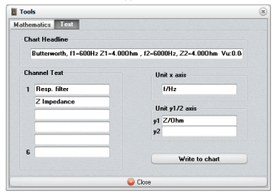
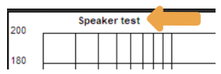
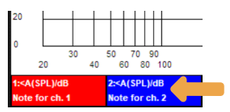


Chart headline	Headline for measurement 
Channel text	Short note to each channel 
Unit x axis	Unit x axis
Unit y1 y2 axis	Unit y1 y2 axis
Write to chart	Write headline, unit, short notes to chart

A.5 Cursor screen

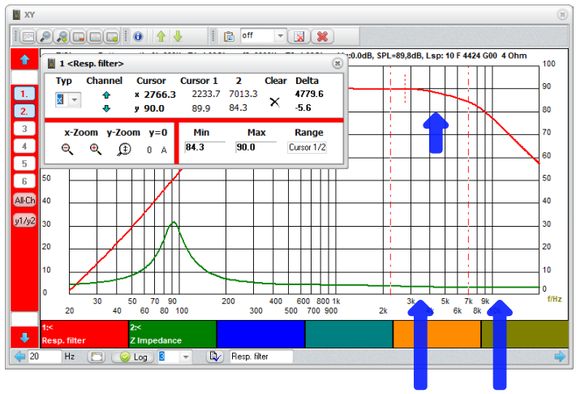
With the cursor view you can easily read and analyse the curves, such as the attenuation of a crossover (dB/octave). Vertical (x) and horizontal cursors (y) are available. To display the measurement data, a cursor in the form of a semicolon line is displayed and another window, which shows data on the cursors (cursor current pos., cursor 1 & 2).

A.5.1 Enable the cursor screen

You activate the cursor view with a mouse click (left button) in XY window. Another left mouse click sets the cursor position 1, e.g. to a certain frequency, like 100Hz. To set position 2 move the cursor to the corresponding position and press the left mouse button again, e.g. to the position 200Hz. The cursor position 2 is set. The "Cursor View" window now shows the x/y values to position 1 and 2 as well as the difference.

Another mouse click at another position deletes cursor 2 and sets cursor 1 again. You delete the cursor by closing the cursor view or button “X”.

Values to cursor position



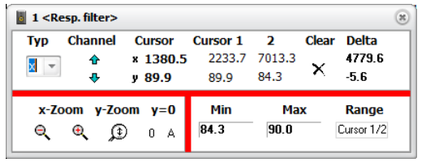
Pos. 1 Pos .2

Cursor

A.5.2 Details

A#	Description
Note	- The background color corresponds to the color of the selected channel, e.g. RED = channel 1 - The active channel (text in the frame) can also be changed here via the channel Up/Down keys
1	"x/y": switch between horizontal and vertical cursor
2	Channel: Change channel (1..6) from which the measured values are read out
3	"Cursor": Shows x & y measurement values to the cursor position of the selected channel
4	"Cursor 1": Shows x & y measurement values to the cursor 1 position of the selected channel
5	"Cursor 2 ": Shows x & y measurement values to cursor position 2 of the selected channel
6	"Clear": "x" key clears cursor 1 & 2
7	"Delta" : Shows x and y difference to cursor position 1&2 (x Pos. 2 – x Pos. 1 und y Pos 2 – y Pos 1)

A 1 2 3 4 5 6 7



B 1 2 3 4 5

B#	Description
1	"Zoom In" to the area from cursor position 1 and 2. Via function B#2 back to the entire trace (reset x-axis).
2	Show the complete measurement (reset the x-axis according to the measurement data of the active channel)
3	Fit the y-axis to the measured values to the selected measuring channel
4	0: Shift the measurement curve, that the measurement diagram of active channel at cursor position 1 receives the value "0", i.e. level 1kHz@0dB. A: Like "0", but all measurement curves are shifted
5	**Text "Cursor 1/2": (Cursor ½ set)** Shows "yMin" and "yMax" value between the cursor positions 1 and 2 (active channel). **Text "All": (Cursor ½ not set).** Shows "yMin" and "yMax" value to the whole measuring range (active channel)