

Help (PDF format)

UltraVox™ XT

Version 4.0

Noldus
Information Technology

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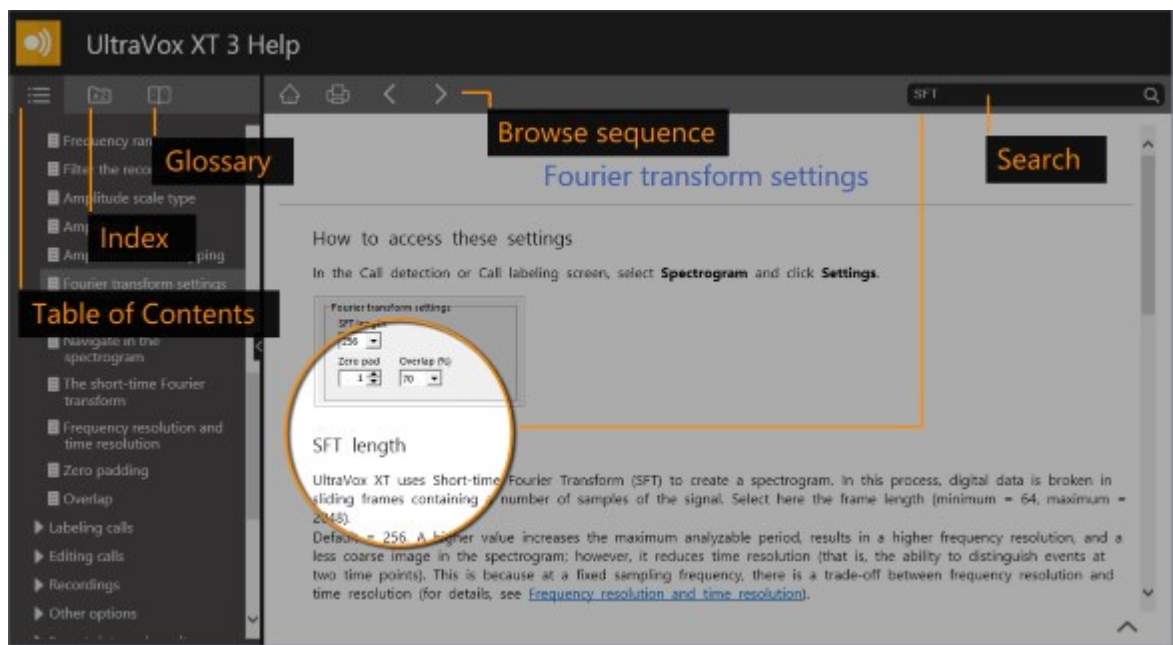
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Welcome to UltraVox XT!

Main topics and tasks

- General information on UltraVox XT 8
- What's new in UltraVox XT 10
- The main workflow 13
- Important terms 14

How to use this Help



TIPS

- If you do not see the Table of Contents on the left, enlarge the Help window or zoom out the characters (**Ctrl**+mouse wheel).
- To search for two or more adjacent words, use quotes, for example "call statistics".
- To go back to the search results after visiting one of the result pages, click the magnifying glass icon in the Search field.

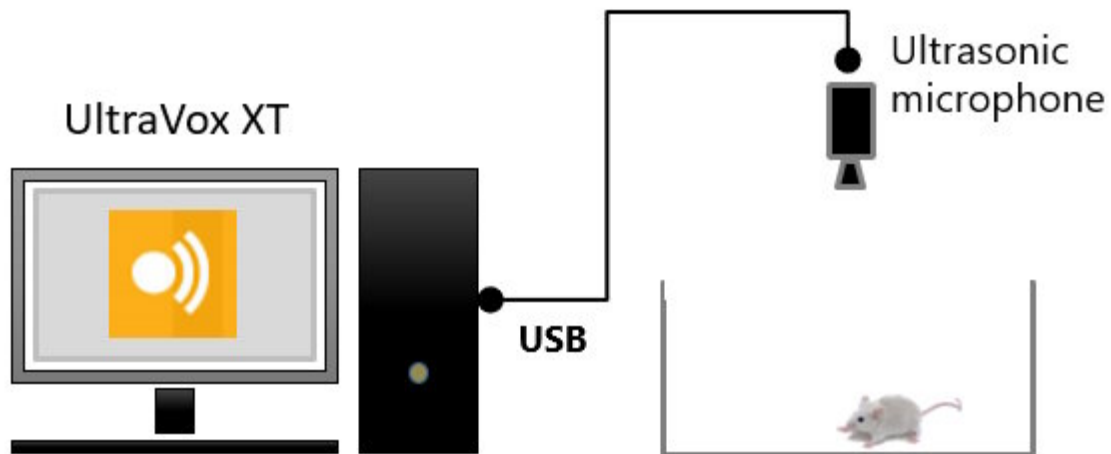


General information on UltraVox XT

What is UltraVox XT?

UltraVox XT is software for recording and analyzing sound, in particular ultrasonic vocalizations.

In the UltraVox XT system, ultrasound vocalizations of a rodent or another animal are recorded from a full-sound spectrum microphone. UltraVox XT can record and analyze sound from up to four microphones.



NOTE UltraVox XT can in principle work with standard microphones for human-audible vocalizations. However, these are not thoroughly tested and supported. You can also import audio files of WAV formats in the audible range. See System requirements

See The main workflow

Working modes: Live and Offline

Live

Connect your microphones to your computer and record sound.

See Connect the microphones and Record sound

Offline

You can analyze pre-recorded audio files.

- Import sound files (WAV).

- Import an UltraVox XT recording (UVD).

This way you can merge recordings of multiple UltraVox XT experiments, for example sound files recorded in different computers.

You can work live and offline in the same experiment. You can also export your recordings to WAV files.

What's new in UltraVox XT

Below you find the main changes in UltraVox XT 4 relative to UltraVox XT 3.2.

General

- The program code has been entirely rewritten in C++. This has resulted in a significant improvement in performance.
- The UltraVox XT software license is no longer stored on a hardware key (also known as a *dongle*). You can activate a license by importing a file that you receive from Noldus after you have purchased the license. See License activation

Interface and usability

- The interface is instantly-responsive.
- You can zoom in and out the spectrogram on both axes (time and frequency), using the mouse wheel. '
- The spectrogram can visualize up to 10 minutes intervals (previously that was 15 seconds).
- No need to re open the last experiment used: UltraVox does that for you (if you chose to do so).
- Spectrogram settings have been simplified and made more user-friendly. They are also available at **File > Settings**.
- Dynamic visualization settings: UltraVox XT 4 automatically optimizes spectrogram visualization settings based on the zoom level, ensuring great level of detail displayed efficiently. If you zoom in, the spectrogram becomes more detailed.

Recording sound

- The microphones of type Pettersson M500-384 shipped from March 2025 are automatically recognized as sound devices with a unique ID. If you wish to re-program your microphones with and ID, let us know. See Technical support
- The maximum recording duration is:
For Pettersson microphones (sample rate 384 kHz): 1 hour 33 minutes 5 seconds.
For Dodotronic microphones (sample rate 250 kHz): 2 hours 23 minutes 11 seconds.

For audible sound microphones (sample rate 44.1kHz): 13 hours 31 minutes 35 seconds.

- The difference in recording duration between microphones is due to the maximum number of bytes allowed in sound files (4294967295). This value has to be divided by the sample rate of the microphone to obtain the maximum recording time.
- When you select to stop recording automatically, the maximum recording time is 90 minutes for all microphones.

Import of audio files

- You can now import audio files that come from other experiments, which include the calls already detected. This means that you can merge data from different experiments (e.g. large number of PhenoTypers or other home cage systems).
- The import function accepts audio files of format UVD and WAV.

Sound analysis

- Call detection is now about 10 times faster.
- With parallel processing, calls across multiple recordings can be detected in parallel, drastically improving processing time and efficiency.
- You can follow the spectrogram while listening to the sound. In the Call Detection and Call Labeling screen, select **Adjust speed** to stretch the audio and listen to the sound at reduced frequency.

File management

- You can now save the data at crucial moments, for example before processing new recordings.
- An UltraVox XT 4 experiment contains the following file types: Experiment (.uvx), Recording (.uvd), Calls (.uvc).

The following file types were removed as they contained redundant or unnecessary information: .peak, .peakk, .uv1, .uv2.

- You can export data to CSV, for easy import in R, Python, Matlab, etc.

What has been removed or simplified

- In the Spectrogram settings, **Zero pad** has been removed. Analysis is done the same as with Zero pad = 1 in UV 3.2.

- In the Experiment Settings, the **ID** column for microphones has been removed. For Noldus microphones, the ID is shown in the **Microphone** column (e.g. Pettersson-M500-384-1).
- The Spectrogram settings in the preview / acquisition screen have been removed.
- In the Preferences dialog, the Acquisition settings tab (**File > Preferences > Acquisition Settings**) has been removed.
- The Report (a PDF document with call data) has been removed.
- The following file types were removed as they contained redundant or unnecessary information: .peak, .peakk, .uv1, .uv2.

The main workflow

What do you want to do?

- Create a new experiment
- Select the microphones
- Record sound
- Import sound files
- Define a call
- Search for calls
- Label the detected calls
- Calculate statistics

Learn about

- Important terms
- How to detect more calls
- UltraVox XT microphones
- Other options

Important terms

Call

In UltraVox XT, a call is any animal vocalization considered as a discrete unit. A call is either selected manually by drawing a rectangle around it or detected automatically based on a number of parameters, like the frequency minimum and maximum acceptable values.

Experiment

In UltraVox XT, an experiment is a container of one or multiple recordings. An experiment also contain microphone settings like the Gain used, and the analysis results. You can create as many experiments as you like. Normally an experiment contains recordings related to a specific experimental work.

Gain

A measure of the ability to increase the amplitude of the signal coming from the microphone. In UltraVox XT, there are two types of gain: that in the software itself and the microphone internal gain.

Independent variable

Any variable that is supposed not to vary during a recording, for example mouse strain, or day after treatment. You can use one independent variable to label recordings.

Recording

Uninterrupted record of audio in form of a digital audio file. In UltraVox XT, you can obtain a recording either from a microphone or by importing an audio file.

Sample rate

Also known as sampling frequency. This is the number of samples of a variable (in the case of sound, the signal coming from a microphone) collected in one second. The full-spectrum microphones provided with UltraVox XT have a sample rate of 384 kHz.

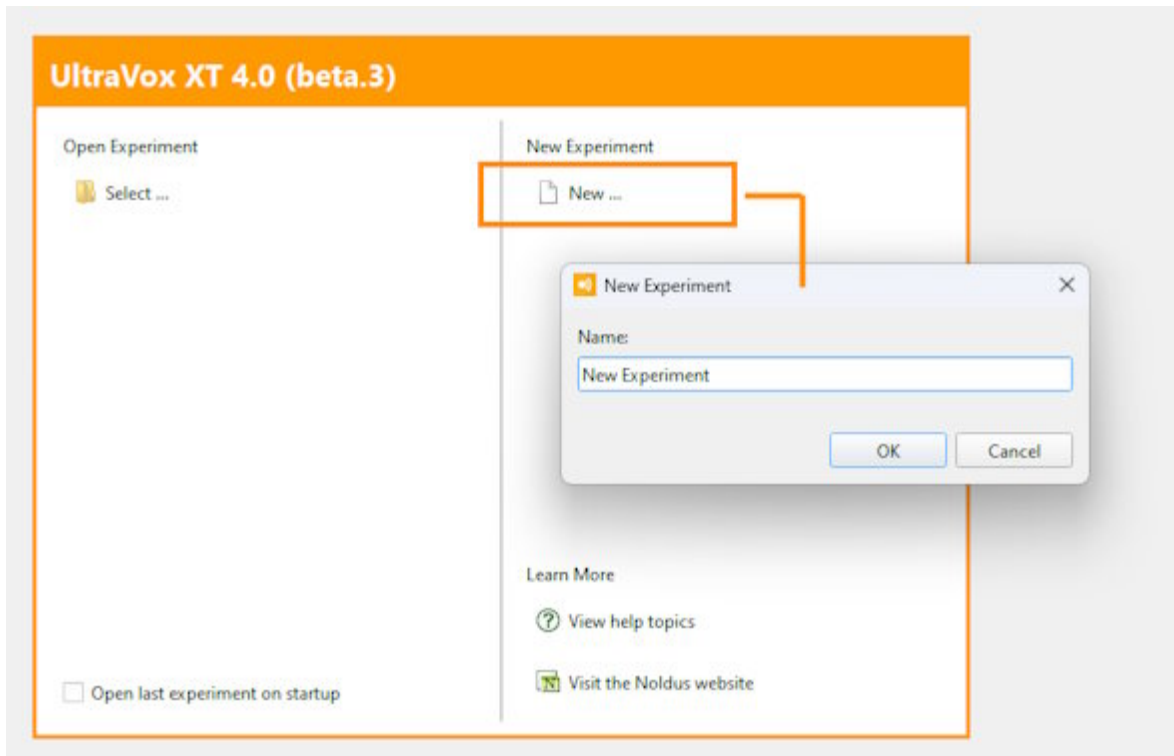
Template

In UltraVox XT, a call template is a call definition stored in such a way it can be applied to different experiments.

Create a new experiment

To create a new experiment

1. Under **New experiment**, click **New**, or choose **File > New**.
2. In the New experiment window, enter the name for your experiment.
3. Click **OK**.



The new experiment (a file with extension *.uvx) is saved in a folder with the same name as the experiment. This folder is by default located in

C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments

Notes

- If you want to save your future experiments in a different location:
Choose **File > Settings > General**. Under **Experiments location**, click the folder button and specify the new location. Then click **OK**. Next, create a new experiment. That new experiment will be saved in the new location.
- Select **Open last experiment on startup** if you want to have the last experiment already opened every time that you start the software.

Select the microphones

Aim

To choose the microphones for recording data in the current experiment.

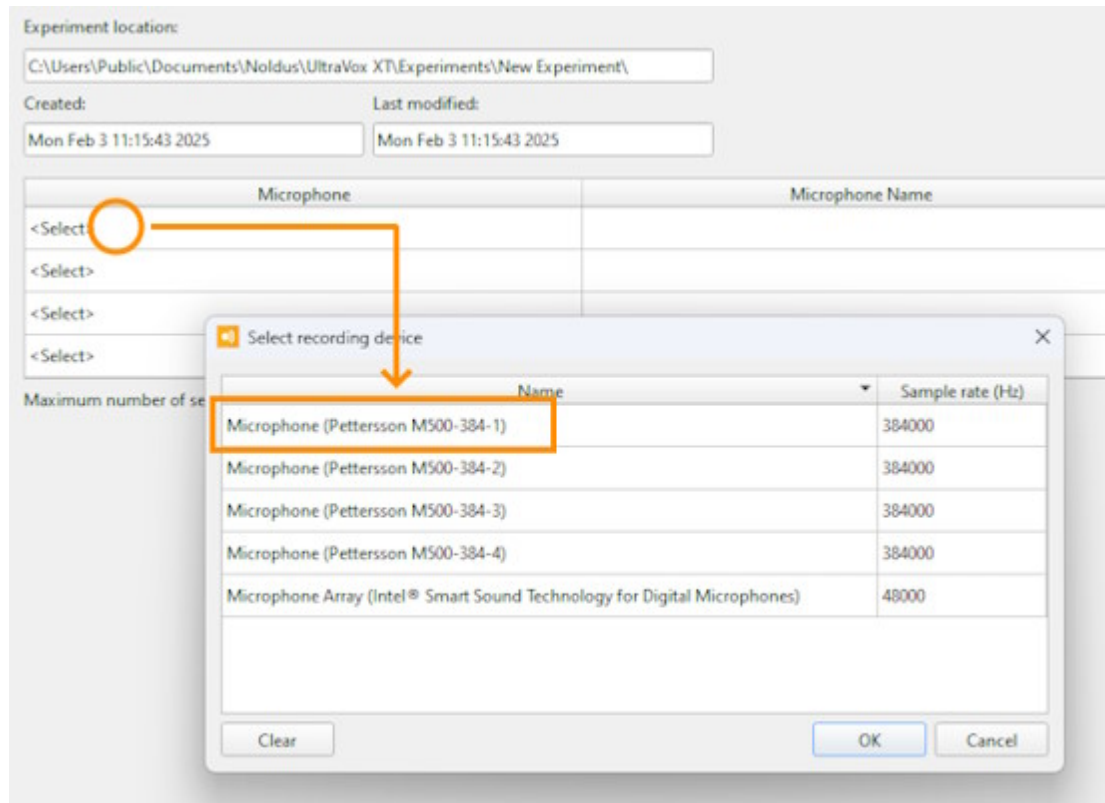
TIP Always plug the same microphone into the same USB port of the USB interface card or the USSB hub. See [Connect the microphones](#)

Prerequisites

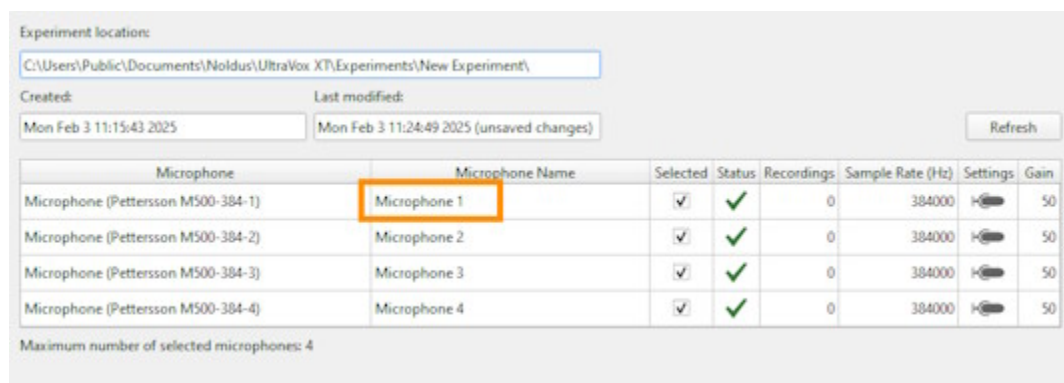
- You have created or opened an experiment. See [Create a new experiment](#)

Procedure

1. Connect the microphones you want to use.
2. Choose **Setup > Experiment Settings**.
3. Click **Refresh**.
4. In the **Microphone** column, click **<Select>**.
5. The **Select recording device** window lists the microphones currently detected. Choose a microphone and click **OK**.



6. To add more microphones, repeat steps **4-5**.
7. If you wish to modify the name of the microphones, click one of the cells under **Microphone Name** and enter a new name, e.g. *Cage 1*.



8. Next: Adjust the microphone gain in UltraVox XT.

Notes

- You cannot add a microphone that is already selected under **Microphone**.

- The **Microphone** column shows the Windows name of the microphone. For Noldus full-sound spectrum microphones, this is the friendly name of the USB device detected in the Windows manager. You cannot edit this name.

Microphone
Microphone (Pettersson M500-384-1)
Microphone (Pettersson M500-384-2)
Microphone (Pettersson M500-384-3)
Microphone (Pettersson M500-384-4)

TIP The 384-kHz microphones shipped from March 2025 have a unique ID, which makes them recognizable within the software even when connecting them to different USB ports. However, we recommend to connect each microphone to the same USB port on the USB interface card (for desktop PCs) or USB hub (for laptop PCs). Label microphones and USB ports, so you always know which microphone (and cage) is connected to which port.

- When the microphones are connected but you do not see them listed in the **Select recording device** window, click the **Refresh** button.

- The **Status** column indicates:



Device is connected and ready to use.



Device not found.

- Under **Recordings** you find the number of recordings made so far with that microphone in that experiment.

- The **Sample rate (Hz)** column shows the default sample rate:

For Pettersson microphones: 384000.

For most Dodotronic microphones: 250000.

For non-ultrasonic microphones: 44100.

- The **Settings** column specifies the microphone **Gain**. See Adjust the microphone gain in UltraVox XT



Record sound

Aim

To record ultrasonic vocalizations to a data file which can be analyzed by UltraVox XT.

Prerequisites

- Microphones are connected and selected for use in the Experiment Settings.

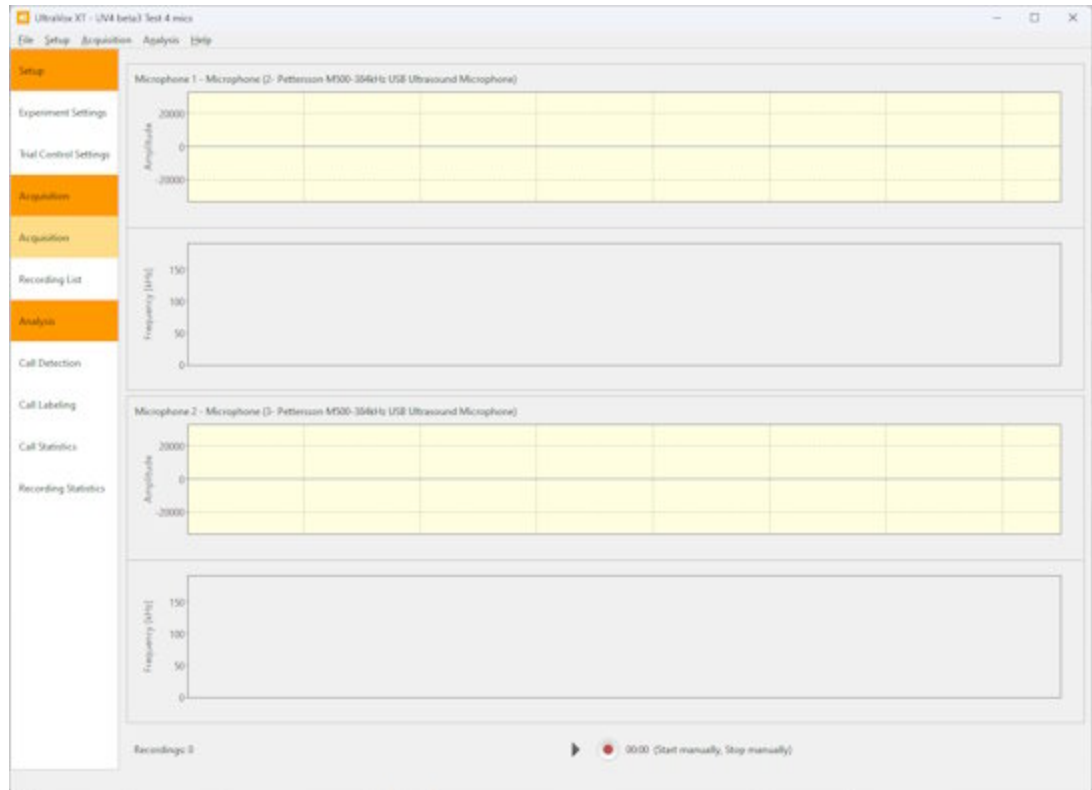


Procedure

1. Choose **Acquisition** > **Open Acquisition**. or click **Acquisition** in the Experiment Explorer.



The Acquisition screen opens.



2. Release the animals in their test environments.
3. Click the **Start display** button to visualize the input signal.

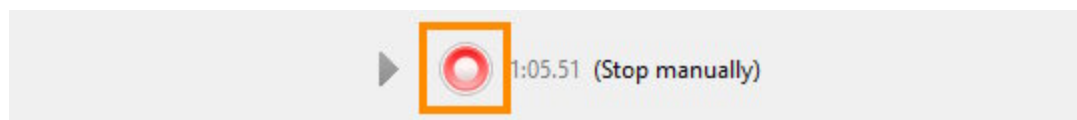


NOTE The Start display function does not record data.

4. When ready, click the **Start recording** button.



5. To stop the recording, trigger UltraVox XT with the method specified in the trial control settings, or click the **Stop recording** button.



Notes

- You can record ultrasound for up to a specific time determined by the sample rate of your microphones. See Recording sound
- To stop recording after a specific time has elapsed, in the Trial Control Settings under **Stop acquisition** choose **After ... minutes** and select the duration required. See Trigger start/stop recording
- To start and stop recording at specific clock times, use UltraVox XT in combination with the Windows Task Scheduler. See Start and stop recording at specific times
- You can also start and stop recording from external software. See Trigger start/stop recording
- In step 3, check the signal amplitude. At this point the gain should have been already optimized. If not, see Adjust the microphone gain in UltraVox XT. If the signal is too noisy, the gain may be too high. If you do not see the animal's vocalizations in the spectrogram, it may be that the gain is too low, or the microphone is too far from the animals, or that the animals do not emit vocalizations at all. See Factors affecting ultrasound recording and Eliciting vocalizations for test purposes
- Noise in the recording greatly affects the efficiency of call detection. It is very important that you minimize noise in your recording. See Experimental setup

Import sound files

Aim

To import audio files for analysis of vocalizations.

Prerequisites

- You have audio files of the following format: Windows PCM, 16 bits, Mono, with extension WAV, or audio files recorded in other UltraVox XT experiments, with extension UVD.

Procedure

1. Choose **File > Import audio files**.
2. In the **Import audio files** window, browse to the audio file you want to import.
To select multiple files, press and hold **Ctrl** down and select each file that you want to import.
3. Click **Open**.
4. Click **Recording List** to view the recording currently present in the experiment.

Notes

- Other mono formats may work, but have not been tested.
- Stereo formats are not supported. Convert the audio file to mono, then import the resulting file.

Define a call

Aim

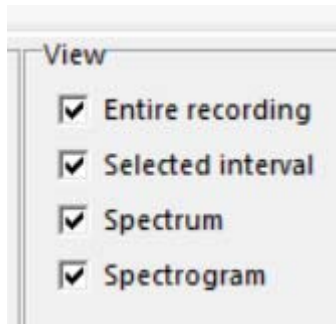
To create a call definition, which can be used to detect vocalizations automatically, based on frequency, amplitude and time parameters.

Prerequisites

- Choose **Analysis** > **Call detection**, or in the Experiment explorer choose **Call Detection**. Next, choose a recording from the list.



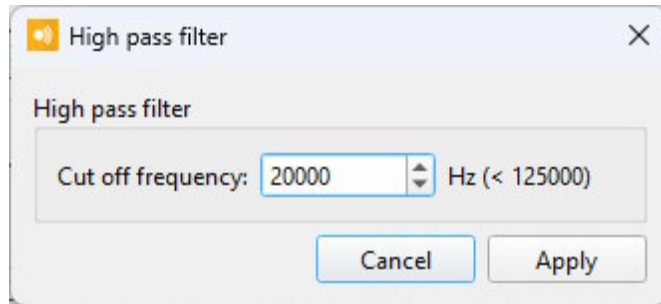
- Make sure that **Spectrogram** is selected in the **View** box.



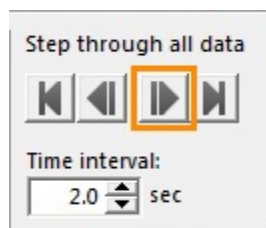
To define a call

1. Filter the signal. If you want to analyze frequencies above a threshold, under **View** click the **Filter** button.

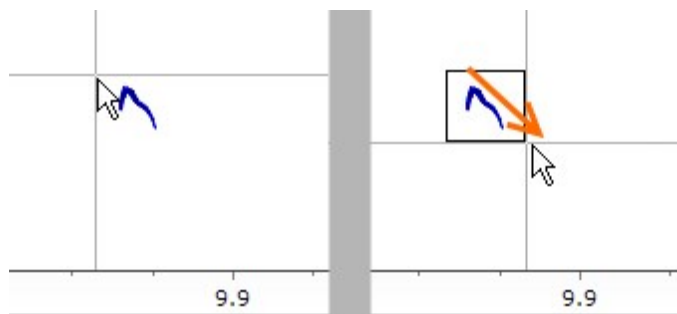
In the Filter window, enter this threshold in the **Cut off frequency** field, then click **Apply**.



2. Click the step forward button until you find a suitable call spectrogram.
OPTIONAL Adjust the **Time interval** to be visualized in the Spectrogram.



3. Drag the mouse around the call spectrogram. Make sure that all the frequencies you want to use to define the call are included.



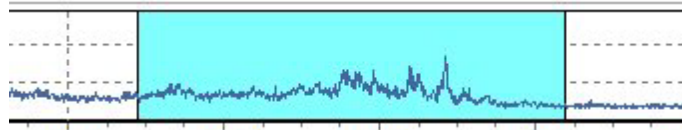
The call is highlighted and labeled with a Call name indicating the frequency range.

4. If you drag the mouse around the call, the Edit Call Definition window appears. Adjust the parameters if needed, then click **OK**.
5. Adjust the parameters to improve call detection. See How to detect more calls
6. Let UltraVox XT Search for calls.

Notes

- There are other two ways to define a call: Add a call with specific parameters and Load a call template.

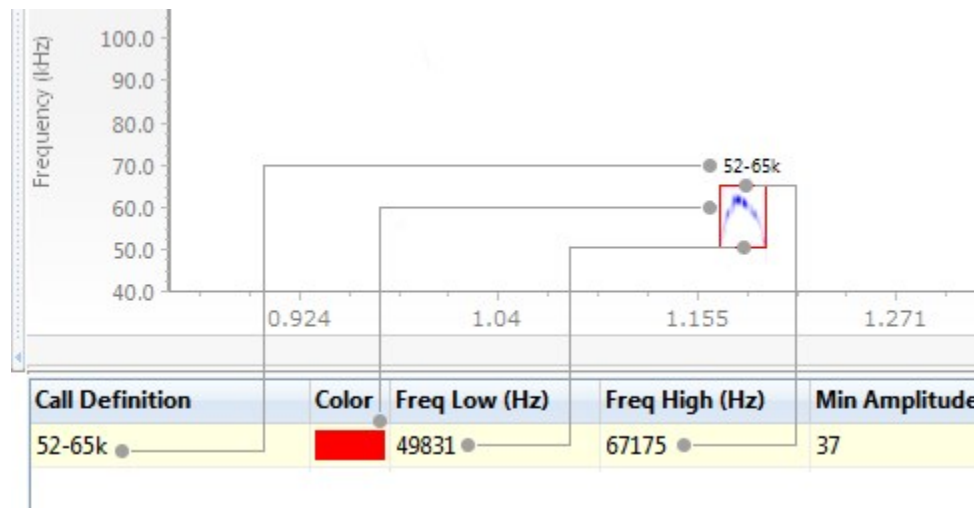
- For a better view of the calls, Zoom in/out the spectrogram.
- The Spectrum shows the frequency range selected when you select a region of the spectrogram.



- In the Call Definition list, a new row appears with the current frequency, amplitude and time parameters of the call definition.

Call Definition	Color	Freq Low (Hz)	Freq High (Hz)	Min Amplitude	Min Duration (ms)	Max Duration	Mi
52-65k	Red	49831	67175	37	23	60	10

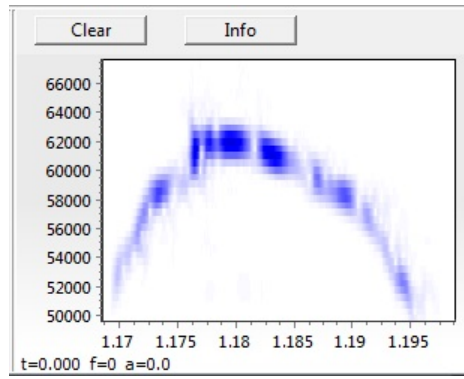
In the Spectrogram, the call is highlighted with a rectangle of the same color as that in the **Call Definition** list.



The width of the rectangle is the Minimum duration in the Call definition.

The height of the rectangle is the frequency range. You can adjust this range. See Adjust a call definition

- The call definition is given a default name based on the frequency range (for example, 52-65k).
- At the right side of the Detected Calls list, you find an enlarged spectrogram of the call.



Search for calls

Aim

To have UltraVox search for signal events that correspond to one or more call definitions. The calls found are listed under Detected Calls.

Prerequisites

You have defined at least one call definition. See Define a call.

Procedure

Click **Detect calls in this recording** to find the calls in the current recording.

Call Definition	Color	Freq Low (Hz)	Freq High (Hz)	Min Amplitude	Min Duration (ms)	Max Duration (ms)	Min Gap (ms)	Count	Add	Detect calls in this recording
46-72k		45833	71667	22	49	131	10	0	Edit	Detect calls across all recordings
									Remove	Clear calls in this recording

Alternatively, click **Detect calls across all recordings** if you want to apply the call definition(s) to all the recordings in the experiment.

- You are asked whether you want to overwrite previously-detected calls. Click **Yes**. If you click **No**, call detection is interrupted and the previous calls are kept.
- You are asked whether you want to save the experiment before starting the new call detection. Choose the action you require.

All previously detected calls are removed and the new calls appear in the list. See Detected Calls list

Notes

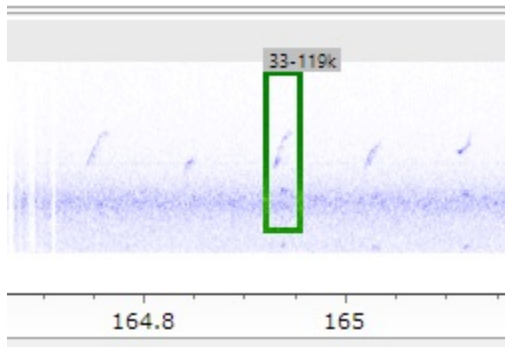
- The Detect calls function applies to all the call definitions currently present for that recording.
- See also How to detect more calls and Troubleshooting
- The **Count** column in the Call Definition list shows the number of detected calls.
- You can also save a call definition as a template, which you can use to detect calls in other recordings or experiments. See Save a call definition as a template

How to detect more calls

Keep the frequency range as narrow as possible

When you draw a rectangle around a call spectrogram, select the frequency range that covers that calls and also other neighboring calls, without selecting much empty space in the spectrogram.

Example: If the frequency range of a call definition is too large, there may be two consequences: first, you may include noise in the call definition. Second, the “empty” space in the rectangle above the call lowers the Min Amp parameter that UltraVox XT calculates for this definition. In both cases applying this definition results no calls being detected.

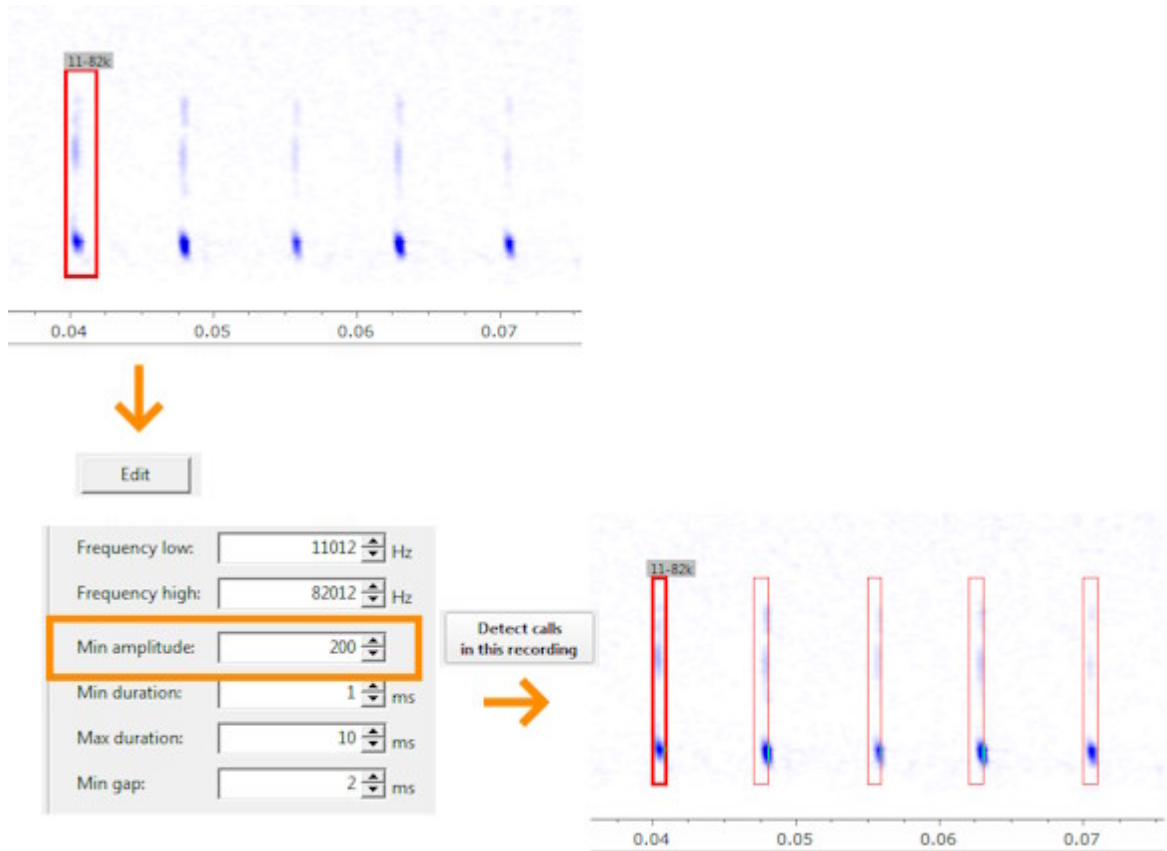


Increase the Min Amplitude parameter

If **Min Amplitude** is too low, UltraVox XT finds large regions of the spectrogram with low amplitude that do not match the rest of the call definition, like the Maximum duration. This happens particularly when the signal is noisy. In that case you get fewer calls than expected.

However, at some point the Min Amplitude value could be too high. Calls that were previously detected are no longer found. Adjust **Min Amplitude** and click **Detect calls in this recording** until the number of detected calls is maximized.

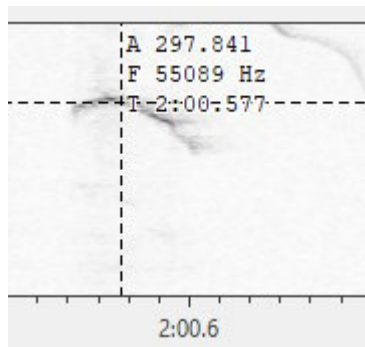
In the example below, a call definition was made by dragging around the first call in the spectrogram. Clicking **Detect calls in this recording** did not result in detection of any vocalization (top).



After increasing **Min Amplitude** from 111 to 200, all subsequent calls were detected.

Get a feel of the amplitude in a call

Hover the mouse pointer over the spectrogram of a call that is not detected yet. Check the values of amplitude **A** near the hairlines.



This way you get an idea of how the amplitude varies across the signal, and what the minimum amplitude would be required to detect similar calls.

Example: Set **Min Amplitude** quite a bit lower (2 to 5 times) than the values you see next to **A**. Click **Detect calls for this recording** and check whether that call is detected. Repeat this procedure when necessary to detect more calls.

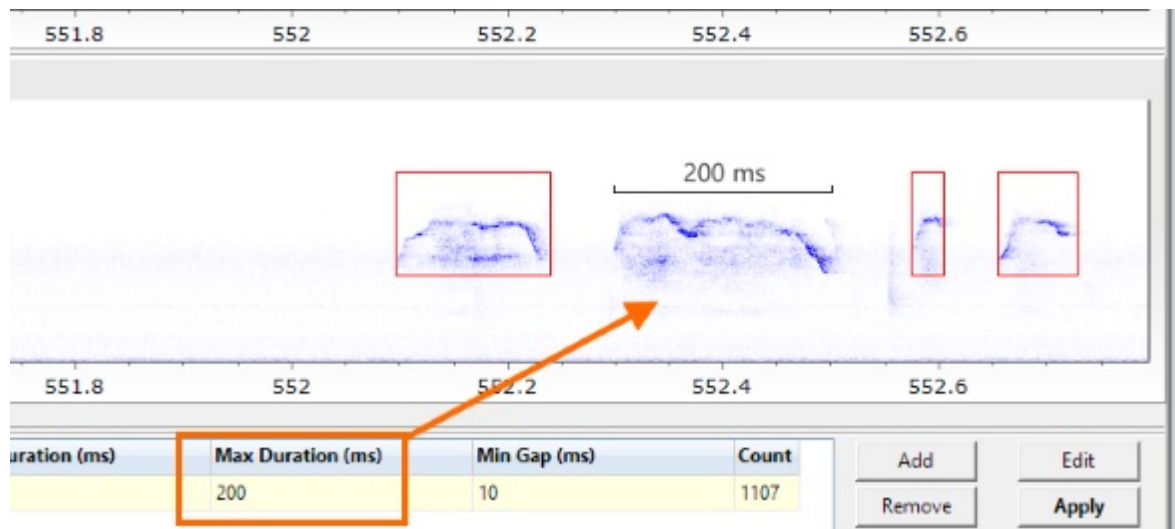
Reduce Min Duration

In general, a short Min Duration, say around 20 ms, works well for rodents.

Increase Max Duration

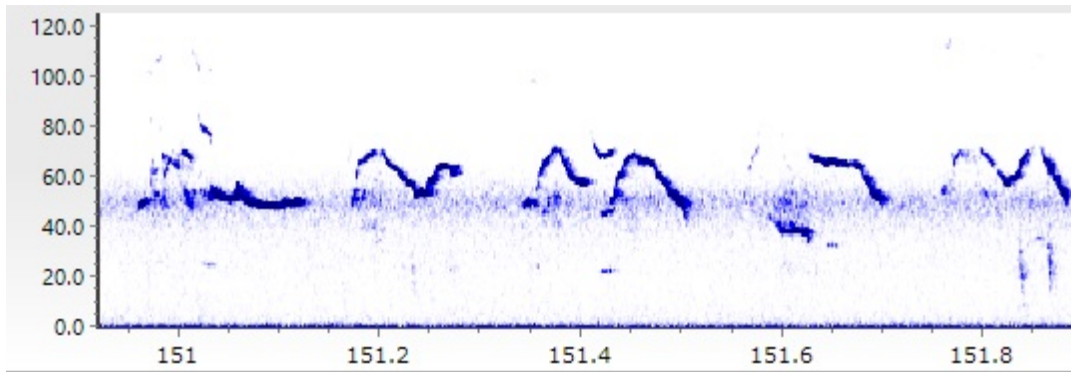
Keep Max duration high, unless you're specifically looking for calls shorter than a certain length.

In the following example, the second signal was not detected. The signal met the Amplitude and gap criteria, except for it was longer than the Maximum duration set to 200 ms. After increasing the Max duration, the signal was detected as a call.



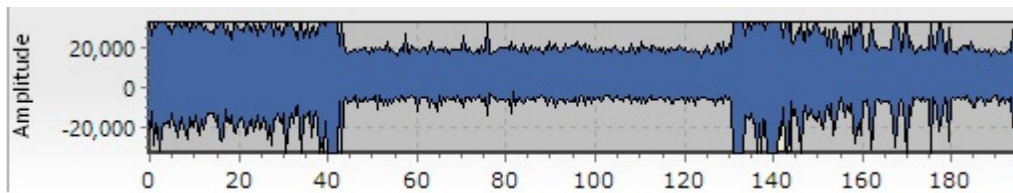
Reduce noise

Example: In the following recording, continuous noise is present around 50 KHz.

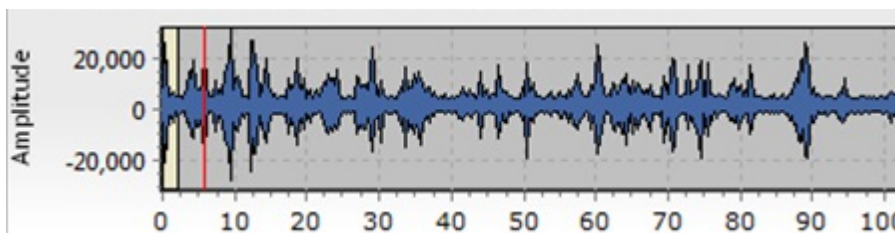


Make sure to minimize noise in your recordings; see Experimental setup.

Also check the Amplitude-time plot. If it looks like the following:



Before recording new data, adjust the microphone gain to make sure that there is a significant gap between the peaks of the signal and the margins of the plot, like here:



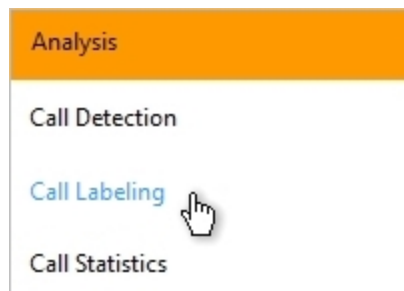
Label the detected calls

Aim

- To group the calls detected based on, for example, the shape of the call spectrogram. You can label calls with *pattern labels*.
- To add a call manually when this was not detected automatically.
- To delete a call that you do not want to analyze, or sound that was wrongly detected as a call.

Prerequisites

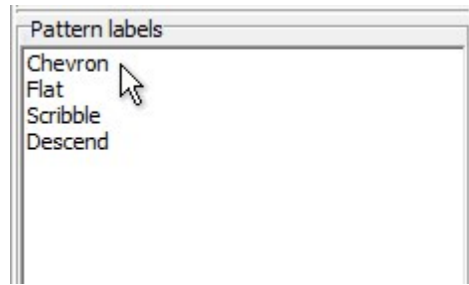
- UltraVox XT has found calls using call definitions.
- Choose **Analysis** > **Call labeling** or in the Experiment Explorer select **Call Labeling**.



- Choose a recording from the list.

To label a call

1. Do one of the following:
In the Call list, click the row for the call that you want to label.
In the Spectrogram, click within the rectangle around that call.
2. To label the call, in the **Pattern labels** list, double-click the label you require.



3. Results:

In the call list, the call is labeled and the cursor moves to the next row.

Pattern Label ...	Color
Chevron	
	

If the option **Show pattern label** is selected in the Spectrogram settings, the call is also labeled in the Spectrogram.



4. Repeat steps above to label the next calls.
5. To save the call labels, click the **Save** button.

Notes

- **IMPORTANT** Do not press **Delete** to delete a label just assigned! This will delete the whole call from your call list.

Instead, Double-click the **Pattern Label** cell so that its content is highlighted in blue, then press **Delete**.

Pattern Label ...
Chevron

- To rename the labels available or add a label, see Labeling calls.

Tips

- You can also label a call in the following way: In the call list, double-click the **Pattern label** cell, then type the first letters of the pattern you want to assign (for example: "F" for Flat). When the complete name of the label appears, press **Enter** to confirm.



- **OPTIONAL** Under **View**, next to **Spectrogram**, click **Settings** and select the option **Show pattern label** if you want to view the pattern labels next to the call spectrogram.
- To navigate through calls, you can also use the arrow keys ↑ ↓ or the **Page Up/ Page Down** keys.

Calculate statistics

Aim

- To calculate statistics for entire recordings. For example, the mean duration of calls in each recording, grouped by pattern label.
- To calculate statistics of each call. For example, the duration of each call.

To calculate statistics of entire recordings

1. Choose **Analysis > Call Statistics**.
2. Click the **Recording Statistics** tab.
3. Under **Call grouping**, choose how to group calls.

Recording statistics

Call grouping

☒ Name and pattern

☐ Name only

☐ Pattern only

☐ All calls

name.pattern

52-65k.Ascend	84-99k.Flat	84-99k.Ascend
Count	Count	Count
48	13	17

Recording statistics

Call grouping

☐ Name and pattern

☒ Name only

☐ Pattern only

☐ All calls

name

52-65k	84-99k
Count	Count
48	30

Recording statistics

Call grouping

☐ Name and pattern

☐ Name only

☒ Pattern only

☐ All calls

pattern

Ascend	Flat
Count	Count
65	13

Recording statistics

Call grouping

☐ Name and pattern

☐ Name only

☐ Pattern only

☒ All calls

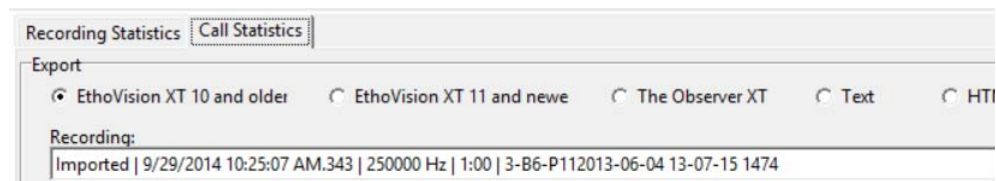
All calls
Count
78

Choose **All calls** to calculate statistics of all calls together.

4. Under **Statistics**, choose the statistics to calculate:
 - Count. The total number of calls for that group.
 - Mean duration. The mean duration of the calls (in ms).
 - SDEV duration. The standard deviation of the call duration (in ms).
 - Min duration. The minimum duration for that group (in ms).
 - Max duration. The maximum duration for that group (in ms).
 - Sum duration. The total duration for that group (in ms).
 - Mean dominant frequency. The average value of the frequency measured at the maximum amplitude for the calls in that group.
5. Choose the recordings to include in your table.

To calculate statistics of individual calls

1. Choose **Analysis > Call Statistics**.
2. Click the **Call Statistics** tab.
3. The result table is updated on your screen. Each row contains the results for one detected call.
4. Choose a recording from the Recording list.



5. In the Call Statistics table, each row contains the results for one detected call in the recording selected.

For information on the column headers, see Detected Calls list.

See also

- Export data and results

UltraVox XT microphones

Main topics/tasks

- Ultrasonic microphones supported with UltraVox XT 39
- Experimental setup 41
- Connect the microphones 43
- Microphone position 45
- Adjust the microphone gain in UltraVox XT 47
- About the microphone gain 49
- Adjust the microphone internal gain 51
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Ultrasonic microphones supported with UltraVox XT

General information

UltraVox XT has been thoroughly tested with the full-spectrum microphone Pettersson M500-384, specifically designed for recording ultrasonic vocalizations.

This microphone has a sample rate 384 kHz and can record ultrasound up to 160 kHz.



Connect the microphone

To connect multiple microphones to the PC, use a multi-port USB 3.0 interface card. See [Install the USB 3.0 interface card](#)

Alternatively, use a powered USB 3.0 hub. USB hubs that are not powered do not work with those microphones.



IMPORTANT When using 384-kHz microphones, we recommend to use a Windows 11 computer. These microphones are not recognized in Windows 8.

Notes

- The Dodotronic Ultramic 250 is not officially supported. However, short tests carried out with UltraVox XT 4 on Dell 3680 desktop with Windows 11 version 24H2 did not reveal significant issues.

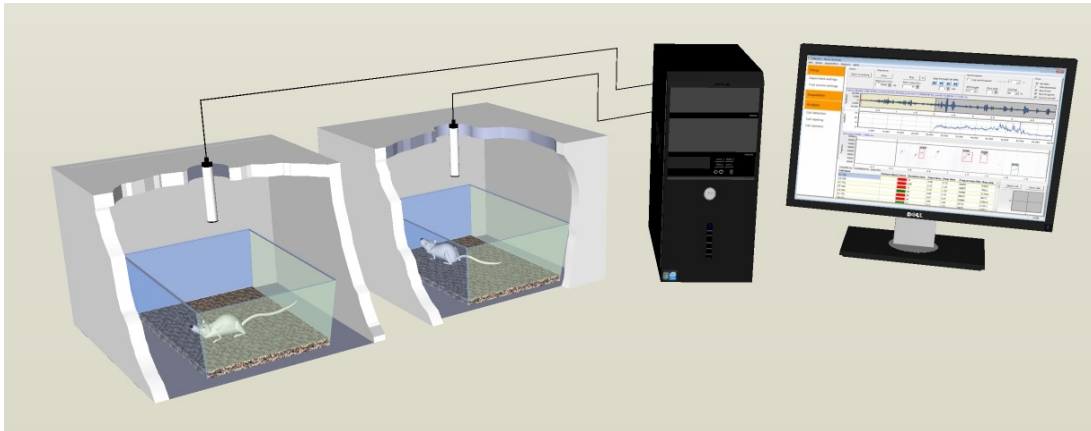
See also

- Connect multiple microphones with a USB hub

Experimental setup

Example

Home cages are placed in sound-attenuating chambers. Microphones are suspended over the home cages. Especially when not using such chambers, place the computer and monitor far from the animals because they produce ultrasound.



Factors affecting ultrasound recording

Before carrying out the actual data acquisition, make sure to run a test since several factors may affect detection of ultrasound and therefore the final result. For example:

- Fluorescent tubes.
- Computer hardware components, for example the monitor.
- Litter, such as nesting material.

Remember that all kinds of human activity produce ultrasound, and that smooth surfaces reflect ultrasound whereas "hairy" surfaces absorb it.

Be aware that the amplitude of sound being recorded is likely to vary between microphones, and at different frequencies. Keep this in mind especially when using two or more microphones at the same time. The recorded amplitude may therefore differ between microphones. Also consider that microphones are often direction-sensitive, meaning that different orientation relative to the animal introduces another source of variation in your results.

Sound-attenuating chamber

To eliminate sound interference, place both the animal and the microphone in a sound-attenuating chamber. Contact Noldus for the solutions available.

Cage materials

- Plexiglas walls of home cages reflect ultrasound and result in much background noise.
- Whenever possible, use dampening material as inner walls of the cage. This reduces reflection of ultrasound against the walls.

Cables and electronic devices

Cables and electric/electronic devices produce ultrasound. Voltage changes may occur, resulting in a change in noise levels during recording, which is also difficult to deal with. Isolate all cables and devices as much as possible.

Sound in the room

Make sure to do all tests in a quiet room. When noise (also audible sound) is detected with very high amplitude, the amplitude scale of the spectrogram is adjusted, resulting in ultrasound calls being 'drowned' in the signal, and therefore hardly visible in the spectrogram.

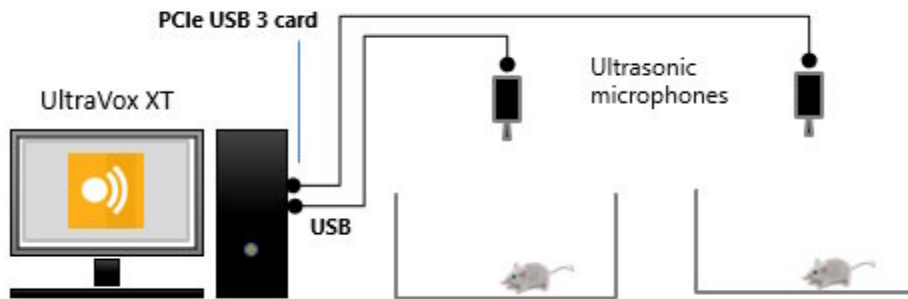
See also

- Microphone position

Connect the microphones

Connect microphones to the PC

When using 384-kHz microphones, we recommend to use a multi-port USB 3.0 interface card. See Install the USB 3.0 interface card

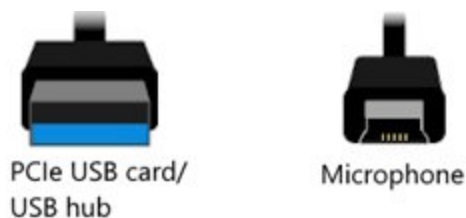


Connect the microphones using the USB cables that come with the microphones.

- Type A plug goes to the **USB 3** (recommended) port of your PC. USB 3.0 connectors and ports can be recognized by their symbols, and often also by their blue color coding.



- Type Mini-B plug goes to the microphone.



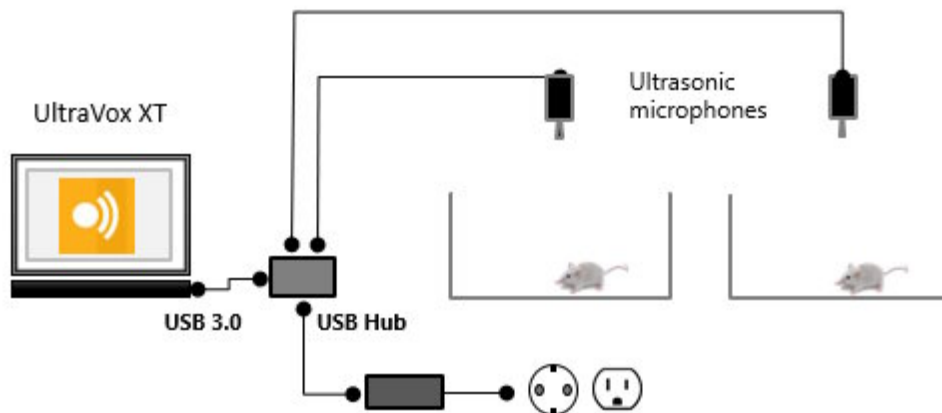
IMPORTANT Always connect the same microphone to the same USB port. If you purchased a PC together with UltraVox XT, microphones and USB ports are labeled. Always make sure that microphones are plugged into the USB ports with the matching labels.

See also Microphone position

Connect multiple microphones with a USB hub

When you work with UltraVox XT installed on a laptop, use a powered USB 3 hub.

NOTE A powered, or active, USB hub is powered through a wall outlet to bring each hub port to the same energy level as an on-system port. Non-powered, or passive, USB hubs do not have an external power source and only pull power from the computer's USB port.



Maximum number of microphones

The number of microphones that you can use simultaneously depends on your UltraVox XT license. This is specified in the UltraVox XT license.

1. Choose **Help > About UltraVox XT**.
2. Click **License Info**.
3. Next to **Number of microphones** you see how many microphones you can use simultaneously.

See Activate your license

Microphone position

Position the microphone in such a way that it receives sound optimally to minimize the effect of the position of the animal in the test environment. Here we report basic examples from the literature.

Test setups

Home cage observation

Microphones are positioned suspended 2 to 20 cm above the cage, pointing downward. Testing cages are generally placed in a sound-attenuating chamber.

Separation test for rodent pups

Pups are placed into an empty container located inside a sound-attenuating chamber. The microphone is placed through a hole in the middle of the cover of the chamber, about 20 cm above the pup.

Self-administration chamber

Position the microphone outside the chamber behind a mesh screen, if possible between the response levers at approximately head-level of the animal.

Male-female interaction (rats)

The test cage is divided in two compartments, the lower one for the male, and the upper one for the female. The microphone is attached to the divider, pointing to the lower compartment. Holes are drilled into the dividing panel to allow odor to pass to the male chamber. The diameter of the holes is smaller than the 50-kHz vocalization wavelength to sufficiently attenuate female vocalizations (Ciucci et al., *Behav Brain Res.* **182**: 284–289, 2007)

Male-male interaction (rats)

In this setup, a male rat is paired with another male and housed throughout the experiment period. Each pair is housed in a polycarbonate cage (26 cm width x 43 cm depth x 20 cm height) in an environmentally controlled rearing system where temperature and humidity are kept constant and external sound and light sources are shut out. The microphones were suspended close to the lid of the cage (Takahashi et al., *PLoS ONE* **5**(11): e14115, 2010. doi:10.1371/journal.pone.00141152010)

Eliciting vocalizations for test purposes

For optimal gain adjustment, it is important that animals produce vocalizations. To trigger vocalizations:

- *For mother-pup interaction*: separate the pups.
- *For male-male interactions (mice)*: add bedding contaminated with urine of another male in the cage.
- *For male-female interactions (mice)*: Wild-derived male mice increase the number and diversity of courtship vocalizations if they previously interacted with a female (Zala et al 2020). The exposure to a female partner or to the urine induces a clear USV response in adult male mice with previous reproductive experience (Holy and Guo 2005, Maggio *et al.* 1983; Nyby 2001, Whitney and Nyby 1979).
- *For prairie voles*: put two individuals in the cage (e.g. same-sex siblings). The frequency of vocalizations is reduced when the animals are placed in separate, side-by-side cages. For single-individual recordings, optimal distance is about 15 cm (6 in) (Stewart A.M. PhD thesis, University of Illinois at Chicago, 2012).

Relevant literature

Browse to

<https://www.noldus.com/ultravox-xt/resources>

then under **Products** click **UltraVox**.

Animal care guidelines

<http://www.animaethics.org.au/policies-and-guidelines/animal-care>

Adjust the microphone gain in UltraVox XT

Aim

With the Gain function you can adjust the amplification of the signal from the microphone.

NOTE If adjusting the microphone gain in the software does not give the expected results, you can also Adjust the microphone internal gain.

Procedure

1. Place the microphones at the top of the cage, pointing down to the middle.
2. Click the name of the microphone you want to adjust, and then click the Settings icon.



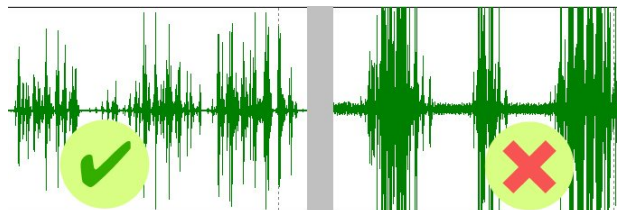
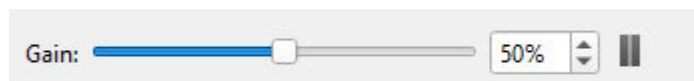
3. In the Microphone settings window, click the **Start monitoring** button.



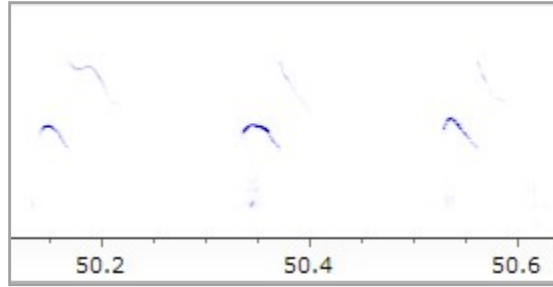
4. Results:

The Amplitude plot (top) and the Spectrogram plot (bottom) show the real-time values.

5. Move the **Gain** slider in such a way that the peak of the waveforms (almost) never cross the red shaded area of the Amplitude plot.




6. In the spectrogram, the calls should be clearly visible, provided that the subject emits vocalizations. See Eliciting vocalizations for test purposes



7. When ready, click the **Stop monitoring** button, then click **OK**.



8. The current value of gain is shown in the **Gain** column.

Settings	Gain
	22

Repeat the steps above for the next microphone.

Note

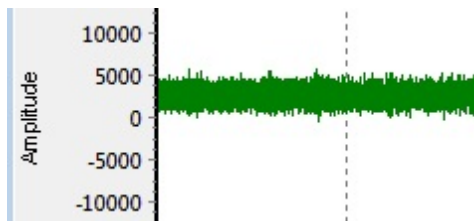
UltraVox XT stores the gain settings based on the position of the microphone in the Experiment Settings. If you select a microphone in another position (for example, you select Microphone 2 in the first row under **Microphone**), UltraVox XT will assign the gain that was last saved for that row, and will show no error message.

- To prevent confusion, always label microphones and USB ports, so you always know which microphone goes to which port.
- Connect the microphones to the corresponding USB port and click **Refresh** in the Experiment Settings.

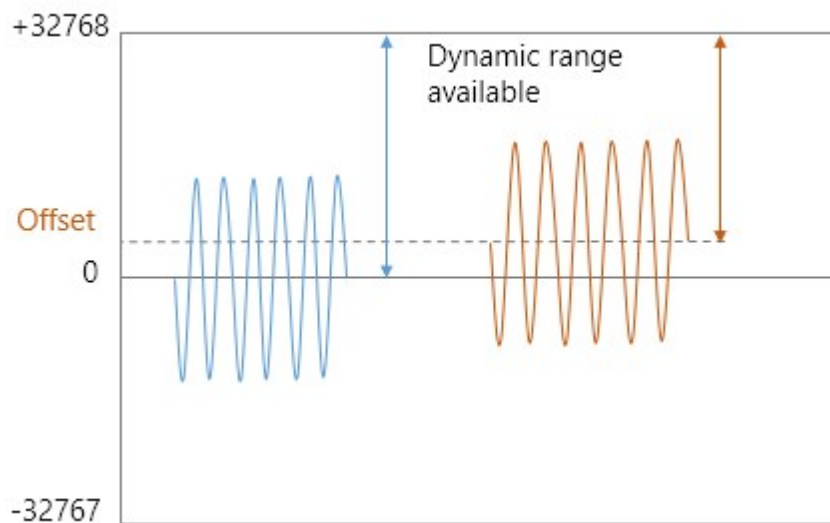
About the microphone gain

Gain and signal offset

When the gain is high, an offset may appear in the Amplitude plot, that is, the average signal is higher than zero, and the maximum values are higher than unsigned minimum values. The offset is caused by the electronics of the microphone. Therefore, increasing the gain usually results in a higher offset. However this has generally no effect on your measurements. You can reduce the offset by lowering the gain.



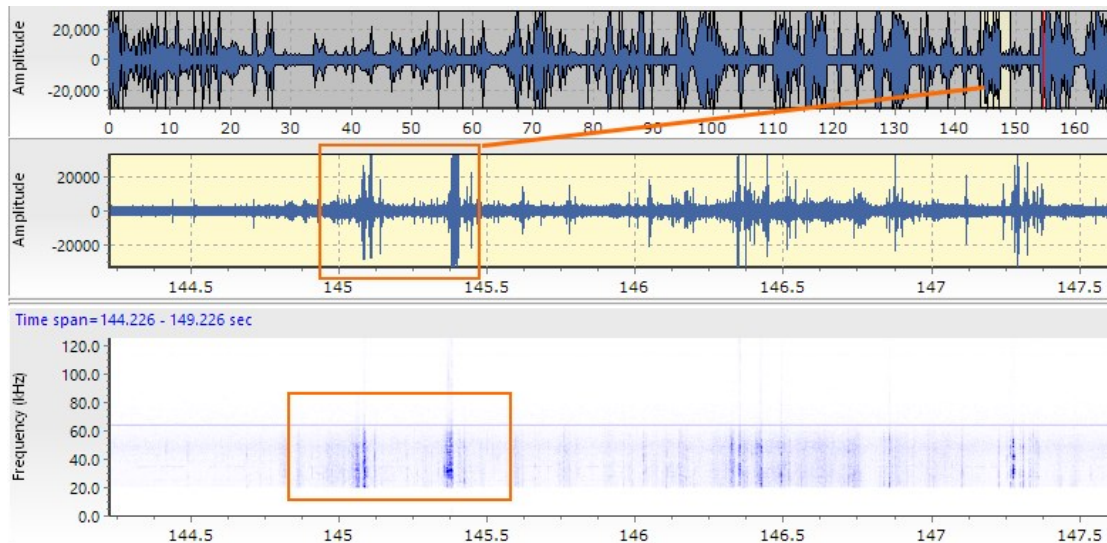
When the offset is significantly high, it can reduce the dynamic range, that is, the range of amplitudes that can be described by a digital system. In the case of UltraVox XT where audio is sampled with a 16 bit resolution, the signal can range from -32767 to +32768. If the offset is, for example, 2500, then the positive side of the signal can be from 2500 to +32768, that is, leaving an actual range of 30268.



This limitation increases the probability that loud sound exceeds the maximum possible value, generating artifacts (see below).

Gain and frequency artifacts

A high gain also produces additional high frequencies, which do not correspond to vocalizations. This occurs when the signal exceeds a lower or upper limit. The result is that the waveforms are cut off flat, or "clipped". When sound is loud, clipping produces extra frequencies that you can see in the spectrogram. For example:



When setting the microphone gain, create conditions similar to those of the actual recordings. For example, put the mouse pups at the same distance from the microphone as when you carry out the real tests.

Microphone internal gain

If the vocalizations do not appear in the spectrogram, it may be that they are covered by overall noise. To further reduce noise, for 250-kHz microphones, you can then Adjust the microphone internal gain.

Adjust the microphone internal gain

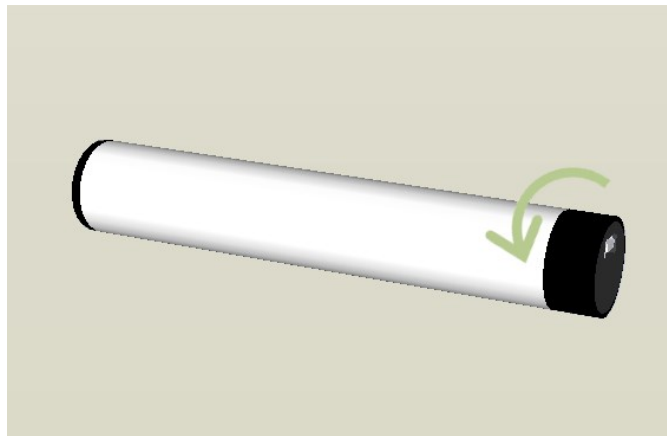
Aim

To adjust the gain of the 250-kHz microphone. Do this only when adjusting the gain in UltraVox XT does not give the expected results.

- For rough gain adjustments, adjust the microphone internal gain (see below).
- For fine-tuning the output, Adjust the microphone gain in UltraVox XT.
- See also Experimental setup and Microphone position

Procedure (250-kHz microphone)

1. Unscrew the microphone lid (connector side) and pull out the circuit board out of the aluminium cylinder.



2. Place the microphone at the top of the cage, pointing down to the middle of the cage.
3. Connect the microphone to the PC.
4. Start UltraVox XT, and choose **Setup** > **Experiment Settings**.
5. Click **Settings** for that microphone, then click the **Start monitoring** button.

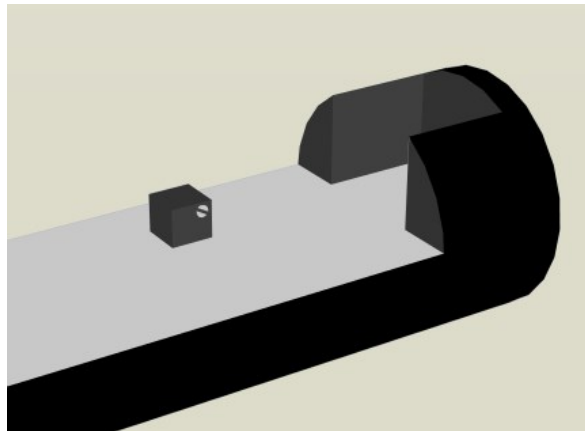


6. In the software, set the **Gain** to a low value like 20. A low value is recommended because a high software gain increases noise more than the microphone's internal gain.

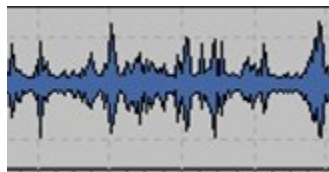
7. 'Place the microphone over the subjects. Check the waveforms on the Amplitude plot and in the spectrogram.

The vocalizations should be visualized in the spectrogram. See Eliciting vocalizations for test purposes

8. Locate the trimmer on the board. This is a small box with a tiny screw on one side.



9. Gently turn the trimmer screw: counterclockwise if the waveforms are out of scale; clockwise if the call waveforms are too narrow.
10. Test the microphone with the actual sound source. There should always be a gap between signal peaks and the minimum and maximum values of the plot.



11. When finished, click the **Stop monitoring** button and then click **OK**.
12. Put the board back in place and close the microphone.
13. For fine tuning, adjust the **Gain** value in UltraVox XT.

Repeat the procedure for the other microphones.

Notes

- The Dodotronic Ultramic 250 is not officially supported. However, short tests carried out with UltraVox XT 4 on Dell 3680 desktop with Windows 11 version 24H2 did not reveal significant issues.

- For 384-kHz microphones, we recommend not to adjust the internal gain. The trimmer inside the microphone only allows changes in sensitivity significantly larger than microphone-to-microphone sensitivity variation.
- To produce ultrasound, move a key chain in front of the microphone, at a fixed distance. However, with this method you do not calibrate the microphone to the real animal's vocalizations. See Eliciting vocalizations for test purposes
- Multiple microphones need not to have exactly the same optimal gain. For each microphone, try to find the gain that results in a clear spectrogram of calls.

Technical specifications

Microphone with sampling frequency 384 kHz

Type	Advanced electret
ADC resolution	16 bits
Max sampling frequency	384 kHz
Frequency range	10 - 160 kHz
Interface	USB 2.0, full speed, OTG/host
Connection	Mini-B USB
Anti-aliasing filter	8th order, 160 kHz
Dimensions	43 mm (1 11/16") x 114 mm (4 31/64") x 13 mm (33/64")
Weight	60 g

Microphone with sampling frequency 250 kHz

ADC resolution	16 bits
Sensor	MEMS high-sensitivity Surface Mount Wide-band Ultrasonic Acoustic Sensor
Processor	32 bit 80 MHz integrated microcontroller
Digital signal processing	8th order anti-aliasing low-pass filter
Connection	Mini-B USB
Max. sampling frequency	250 kHz
Frequency range	0 - 125 kHz
Dimensions	Length 130 mm (5 1/8") x Diam 20 mm (25/32")
Weight	50 g

Call definitions



Main topics and tasks

- Call definitions 56
- Add a call definition 58
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- Save a call definition as a template 63
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- How detected calls are sorted 67
- Explore the detected calls 68

Call definitions

Background

Call definitions are used to detect calls in your recordings. See how to [Add a call definition](#)

Call Definition	Color	Freq Low (Hz)	Freq High (Hz)	Min Amplitude	Min Duration (ms)	Max Duration (ms)	Min Gap (ms)	Count
52-65k		50000	65244	25	20	100	10	41
84-99k		70000	98650	27	17	100	10	25

The signal is detected as “call” when it fulfills the conditions set by the call definition parameters.

Call name

The name of the call definition. The same name will be given automatically to all calls detected based on that definition.

Call color

The color for this call definition (and the detected calls).

Parameters

Frequency low (Hz)

The lower frequency limit. Signals with frequency below that value are ignored.

Frequency high (Hz)

The higher frequency limit. Signals with frequency above that value are ignored.

Min amplitude

The value of amplitude below which the signal is not included in the call.

Min duration (ms)

The minimum duration of the call.

Max duration (ms)

The maximum duration of the call.

Min gap (ms)

The shortest time allowed between the stop of one call and the start of the next one. If two events matching the other parameters are found at less than the minimum gap, they are considered as one call.

See also

- Adjust a call definition

Add a call definition

There are three ways to define a call:

- Select a call in the spectrogram and Define a call
- In the Call Detection screen, click the **Add** button and enter the call parameters. See Adjust a call definition
- In the Call Detection screen, click **Edit**, then load a call template that was saved previously. See Load a call template

Adjust a call definition

Aim

At least in some cases selecting a rectangle around a call in the spectrogram does not lead to detection of similar calls as expected. For example, calls in the spectrogram that are a bit shorter than the minimum duration estimated when drawing the rectangle around a call, will not be detected.

To adjust a call definition:

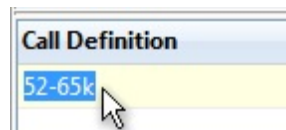
- For all parameters:

Click on a call definition in the **Call Definition** list, then click the **Edit** button. Make the necessary changes and click **OK**.

Click **Detect calls in this recording** to detect the calls with the new definition. Note that clicking this button also updates the calls detected with other call definitions.

- For the call definition name:

Double-click the cell under Call Definition and rename the frequency range if necessary (that is important especially if you change the frequency limits).



- For the frequency range:

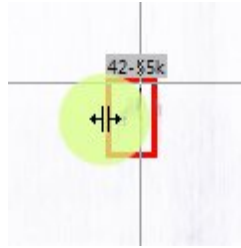
Drag the top or bottom side of the rectangle to select a higher or lower high frequency limit.



NOTE Changing the frequency limits by dragging the rectangle top/bottom sides does not result in changing the call definition name (frequency label on the spectrogram). You have to do that manually.

- For duration:

Drag the left/right sides of the rectangle to change the minimum duration of the call definition.



Notes

- Editing the frequency limits does not result in changing the call definition name (frequency label on the spectrogram). You have to do that manually (see above).
- You can save the call definition as a template to use it to search for calls in other experiments. In the **Save as template** field, enter a name for your template and click **Save**.

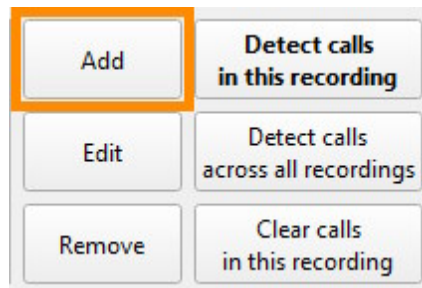
Load a call template

Aim

To apply a call definition to the current recording that was saved previously as a template, also in experiments other than that currently open.

Procedure

1. Under **Recording**, select the recording in which you want to detect calls based on an existing definition.
2. Click the **Add** button.



3. In the Edit Call Definition window, click the **Load Call Template** button.



4. Select a call template and click **OK**.
5. The Add Call Definition window is updated with the values stored in the imported template.
6. Edit the call definition (optional), then click **OK**.
7. The new call definition is appended to the Call Definition list.
8. Click **Detect calls for this recording** to detect the calls based on the call definition.

Call templates

Aim

You can use a call template to detect calls in one or multiple recordings based on information that you obtained from other recordings (or experiments).

Definition

A call template is a container of one call definition. A call template includes the following information:

- Template name
- Call name
- Color
- Frequency lower and higher limits
- Minimum amplitude
- Minimum duration (in ms)
- Maximum duration (in ms)
- Minimum gap (in ms)

What do you want to do?

- Load a call template
- Save a call definition as a template

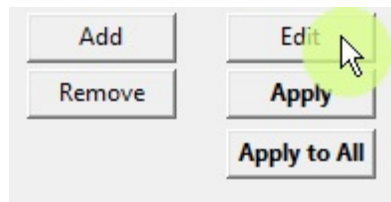
Save a call definition as a template

Aim

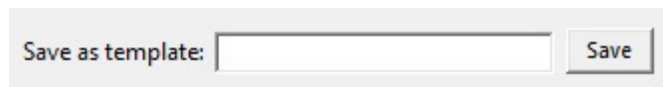
To save a call definition that can be used to detect calls in multiple experiments.

Procedure

1. Define a call.
2. When necessary, Adjust a call definition.
3. Click the call definition name in the Call Definition List, and click the **Edit** button.



4. In the Edit Call Definition window, next to **Save as template**, enter a name for that call template.



5. Click **Save**.
6. Click **OK**.

Note

The call templates are saved in the call_defs.txt file located in C:\ProgramData\Noldus\UltraVox. Do not edit this file!

Detected Calls list

Detected Calls	Color	Duration (ms)	Start Time (s)	Stop Time (s)	Freq at Max Amp	Mean Amplitude
52-65k		28	1.169	1.197	62012	170
52-65k		23	1.346	1.369	59570	163
52-65k		27	1.723	1.750	64941	247
52-65k		39	1.922	1.961	61035	148
84-99k		22	1.195	1.217	93262	139
52-65k		40	2.115	2.155	56152	170

Contents

Detected calls

The name of the call definition used to detect that call. See Call definitions

Color

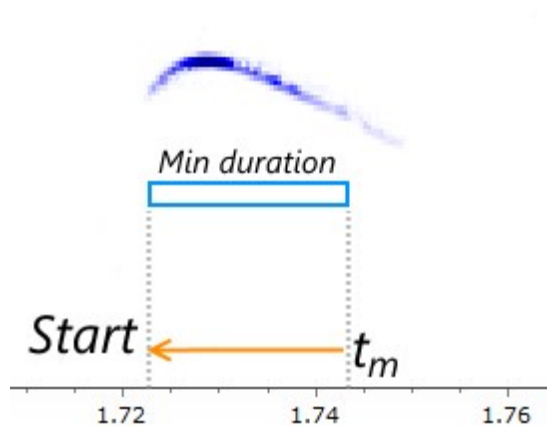
The color of the call definition the call belongs to.

Duration (ms)

Duration of the detected call. This equals Stop time – Start time.

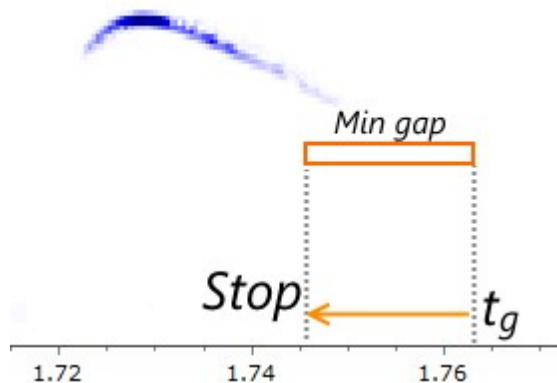
Start time (s)

The start time is back-calculated when a number of samples above the Min amplitude (set in the call definition) have been found that exceed the Min duration (set in the call definition). From this time (t_m in the figure below) the Min duration is then subtracted to obtain the Start time.

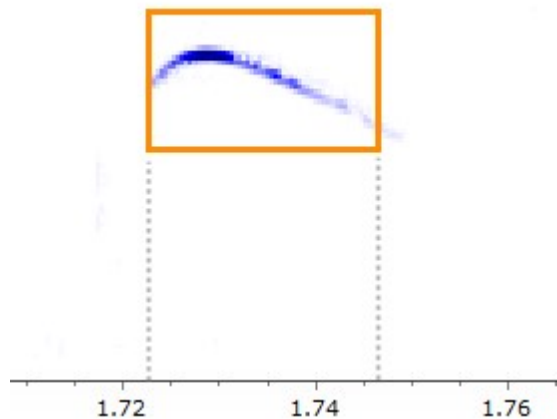


Stop time (s)

The stop time is back-calculated when a number of samples with low amplitude values (that is, below the Min amplitude in the call definition) have been found that exceed the Min gap time set in the call definition. From this time (t_g in the figure below), the Min gap time is subtracted to obtain the Stop time.



The call is then fully defined with its Start time and Stop time:



Freq at Max Amp (Hz)

The frequency at which the amplitude is the highest in that call.

Mean Amplitude

The mean amplitude of a call is calculated as the sum of the amplitude of all points inside the call rectangle with an amplitude above the specified **Min amplitude** limit (in the call definition), divided by the number of points found.

White background points in the spectrogram are generally not included as they would reduce the mean amplitude to a meaningless low value. This means also that mean amplitude is always higher than (or equal to) the Min amplitude limit.

See also


- How detected calls are sorted
- Explore the detected calls









How detected calls are sorted

In the Detected Calls List, calls are sorted first by the time interval chosen to visualize the signal, then by the call definition they originate from.

Example

The Time interval is 2 seconds. Within each 2-s interval, the calls obtained with the first call definition are listed first, then those obtained with the second call definition, etc. The orange rectangles below represent the time intervals.

Call Definition	Color
52-65k	
84-99k	

Detected Calls	Color	Duration (ms)	Start Time (s)
52-65k		28	1.169
52-65k		23	1.345
52-65k		26	1.724
52-65k		30	1.922
84-99k		22	1.195
52-65k		20	2.113
52-65k		25	2.302
84-99k		17	2.153

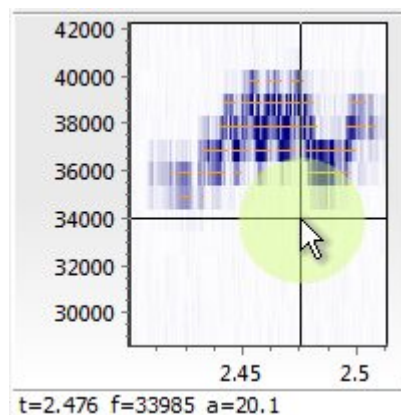
Explore the detected calls

To view information on a detected call

1. Click within the rectangle around the call in the Spectrogram.
2. In the Detected Calls list, the row for the selected call is highlighted.

To view the spectrogram of a detected call

1. Click a detected call in the Spectrogram or click a row in the Detected Calls list. The corresponding rectangle in the Spectrogram is highlighted. If the call is located in a time interval other than the current one, all plots are updated with the new interval.
2. A detailed spectrogram of that call appears at the bottom-right corner of the screen.
3. To view details of the call, move the mouse over the plot and check the values at the bottom: t (time), f (frequency) and a (amplitude).



TIP To navigate through calls, you can also use the arrow keys \uparrow \downarrow or the **Page Up/ Page Down** keys.

See also

- The Spectrogram

The Spectrogram

Main topics and tasks

- Explore the spectrogram 70
- Frequency scale 75
- Filter the recording 76
- Amplitude scale 77
- Spectrogram settings 73

Extras - Learn about

- The short-time Fourier transform 81
- Frequency resolution and time resolution 83
- Overlap 85

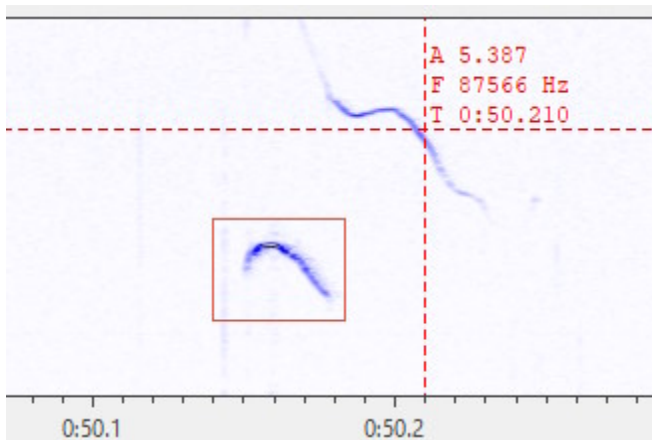
See also

- How do I report spectrogram parameters?

Explore the spectrogram

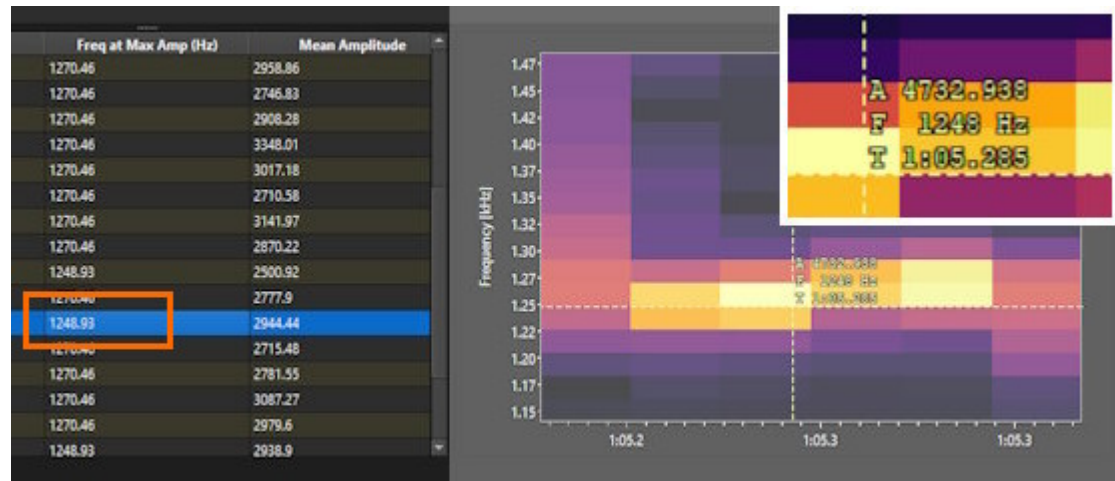
Show the time, frequency, and amplitude at a specific point

Move the cursor over the Spectrogram and look at the values on the bottom line: **t** (time), **f** (frequency) and **a** (amplitude).



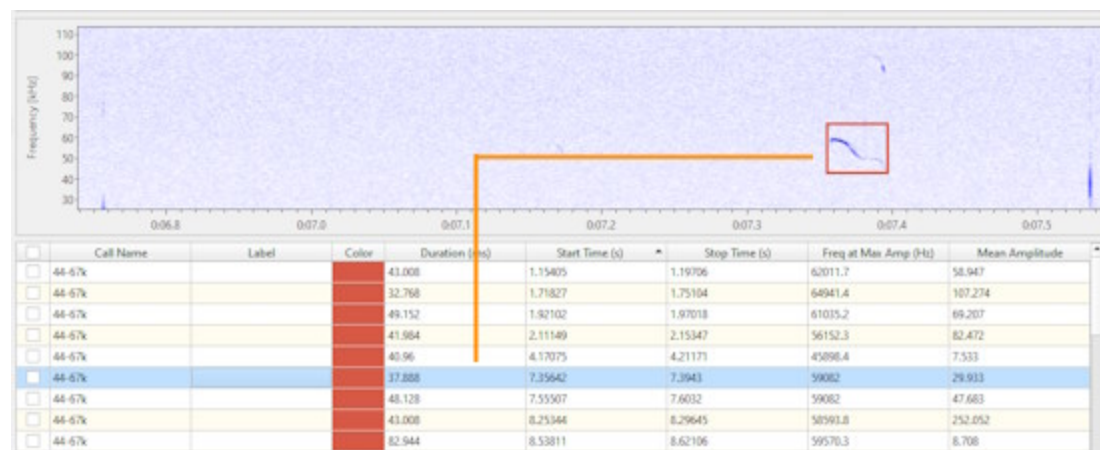
Locate the frequency at maximum amplitude

1. Click one of the rows in the Detected Calls list.
2. Take note of the **Freq at Max Amp (Hz)**.
3. Enlarge the spectrogram at the bottom-right corner of the screen.
4. Hover on the brightest (or darkest, depending on the color mapping chosen) pixel in the spectrogram. Observe the value of frequency (**F**).
5. If you move the cursor just on the lower side of the brightest pixel, you'll see the value of **Freq at Max Amp (Hz)** displayed in the Detected Calls list.



Move between the detected calls

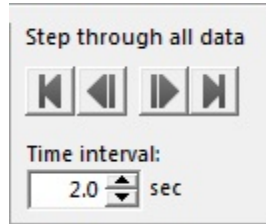
1. Click one of the detected calls either in the spectrogram or in the Detected Calls list.



2. To move through the entire recording you can also use the **Up/Down** arrow keys (to jump from call to call)
3. If you press the **Page Up/ Page Down** keys you can make longer jumps, depending on how many calls the screen can contain.

Display the next time interval

1. Click the middle buttons under **Step through all data**. Adjust the length of the **Time interval** when necessary.



Alternatively, press the **Left/Right** arrow keys to display the previous/next interval, respectively.

2. The interval is highlighted in yellow in the **Entire recording** plot. The waveform is displayed in detail in the **Selected interval** plot. See View options

Zoom in and out the axes

See Zoom in/out

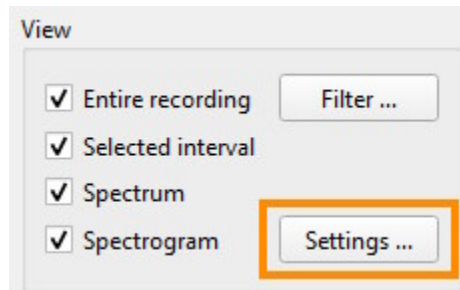
Spectrogram settings

Aim

To optimize the appearance of the spectrograms.

How to access these settings

- In the Call Detection screen or in the Call Labeling screen, under **View**, click **Settings** next to **Spectrogram**.



- Right-click anywhere on the spectrogram.

SFT length

UltraVox XT uses Short-time Fourier Transform (SFT) to create a spectrogram. In this process, digital data is broken in sliding frames containing a number of samples of the signal. Select here the frame length (minimum = 64, maximum = 2048).

A higher value of **SFT length** increases results in a higher frequency resolution and a less coarse image in the spectrogram; however, it reduces the time resolution, that is, the ability to discriminate between two events at two time points). That is because at a fixed sampling frequency, there is a trade-off between frequency resolution and time resolution (for details, see Frequency resolution and time resolution).

- The higher SFT length, the faster the processing time.
- Lower SFT length is good for wide-band spectrograms, while higher SFT length is good for narrow-band spectrograms.
- Choose a high SFT length when you are interested in an accurate measurement of the dominant frequency of vocalizations. Choose a low SFT length when you are more interested in the timing of vocalizations.
- Choose SFT length in such a way that waveform frequency resolution is smaller than the minimum spacing between the frequencies of interest.

Overlap

The **Overlap** setting determines which percentage of the frame of samples is re-used for the next frame.

Select the value you require (0 - 95%; default 50%). High Overlap percentages (90% and higher) result in the highest time resolution (that is, the ability to discriminate events at two different time points).

To speed up call detection, select a lower value. However, if you use two call definitions A and B that differ by a small range of frequencies, two calls of different type may be detected as both A or both B.

See also

- Overlap

Amplitude scale

See Amplitude scale

Frequency scale

See Frequency scale

Notes

- The Zero pad option has been removed in UltraVox XT 4. No zero padding is applied to the analysis frame, meaning that the length of the spectrum is equal to SFT length divided by 2. That is the same as Zero pad = 1 in UltraVox XT 3.
- Note that zero padding does not affect the *waveform frequency resolution*, which is the minimum spacing between two frequencies that can be distinguished. The waveform frequency resolution is always equal to $R = 1/T$, where T is the length of the original (unpadded) signal (see Frequency resolution and time resolution).

Frequency scale

Aim

To specify the minimum and maximum values of frequency shown in the spectrogram.

Procedure

1. In the Call detection or Call labeling screen, select **Spectrogram**. Right-click somewhere on the large spectrogram or click the **Settings** button under **View**, or choose **File > Settings > Spectrogram**.
2. In the window that opens, under **Frequency scale**, deselect the **auto** check box and choose the values of **Min frequency** (bottom line of the spectrogram) and **Max frequency** (top of the spectrogram) that you want to view.



Notes

- You can quickly adjust the frequency range by zooming in and out the frequency axis. Press **Ctrl** and move the mouse wheel while pointing anywhere on the large spectrogram.
- Adjusting the range of frequencies to be shown in the spectrogram does *not* filter your signals. To filter signals (for example, to remove audible vocalizations), see Filter the recording.

Filter the recording

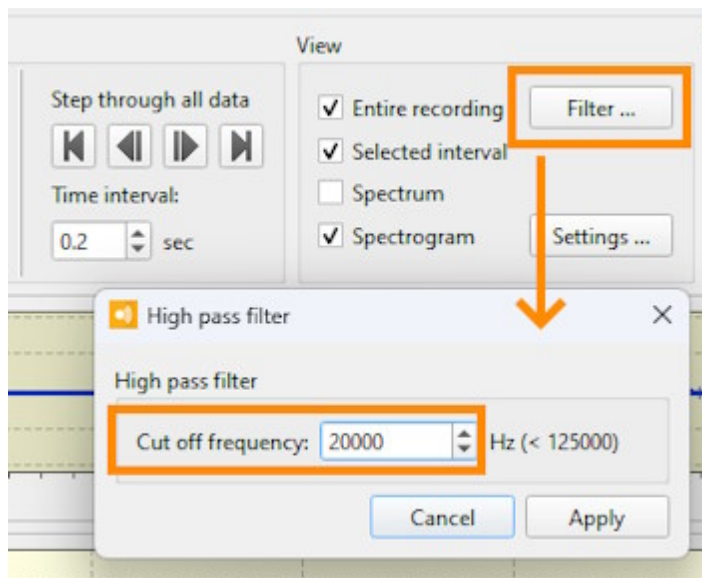
Aim

Filter the signal to display and analyze only frequencies above a specific threshold, and to eliminate noise in the audible range (up to 20 kHz).

Procedure

IMPORTANT When you filter a recording, all call definitions and calls are deleted. Make sure you apply a filter *before* you Define a call.

1. In the Call Detection or Call Labeling screen, under **View** click the **Filter** button.
2. Enter the value you require in the **Cut off frequency** field.
3. Click **Apply**.



Notes

- A copy of the unfiltered recording is kept in the Recording List. See The Recording List

Amplitude scale

Aim

Define how you want to map the values of amplitude in the spectrogram over a range of colors.

Background information

The range of values of amplitude displayed in the spectrogram is based on the minimum and maximum values in the current interval. This means that when you visualize another interval, color are assigned based on the new amplitude range.

What you choose under **Amplitude scale** does not change the range on the y-axis of the spectrogram. This is by default 0 to 124776 for 250 Hz microphones, and 0 to 191656 Hz for 384 kHz microphones. For non-ultrasound microphones, the range is 0 to 22010 Hz.

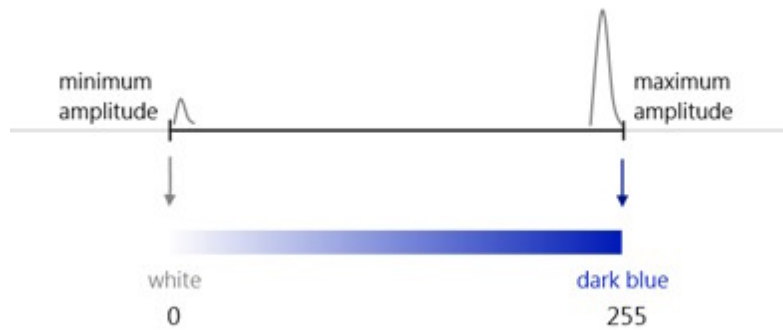
Procedure

1. In the Call detection or Call labeling screen, select **Spectrogram** and click **Settings**, or right-click the spectrogram window.
2. Under **Amplitude scale**, choose the options that you require.

Options

Linear

The option **Linear** maps the values of amplitude to color values using a linear function. In the linear scale color mapping, the minimum value of amplitude is given the “minimum” color (for example white; 0), and the maximum with the “maximum” color (dark blue; 255). The intermediate colors are calculated to vary linearly in the range [0, 255].



The linear mapping may not be optimal in the following cases:

- When the signal varies a lot in amplitude, because the color variability is limited by the values ranging from 0 to 255 a linear color mapping may not be able to discriminate between two events of different amplitude.
- When energy is concentrated in a narrow range of frequencies, there may be little variation in color within the call spectrogram, because relatively few colors are available for that narrow range. In that case some spectrogram's details may be hidden.

Log

With the Log scale color mapping, you can represent a much wider amplitude span. However, the higher the log span, the more low amplitude (including noise) is represented with "higher" colors. The Log span determines the ratio between the maximum and minimum amplitude:

$$Ls = 20 \times \log \frac{max}{min}$$

For example when choosing a Log span of 45, we obtain

$$45 = 20 \times \log \frac{max}{min}$$

Therefore

$$\frac{max}{min} = 10^{2.25}$$

Select **Log** when the signal has a high variation in amplitude, and using Linear does not result in visible variation in color between two different values of amplitudes. If you choose Log, select the span (minimum 30, maximum 350 dB). The higher this

value, the more the sound of low amplitude is represented. As a result, noise will become more evident.

Gamma

With the Gamma scale, colors are calculated based on a power law relationship, where the exponent is called Gamma ($y = x^\gamma$).

The Gamma option is similar to Log, but results in smoother spectrograms. If you choose Gamma, select the span (minimum 0.8, maximum 0.10). The value 0.8 gives results similar to linear mapping. The higher the span, the more the low amplitudes are represented. As a result, noise will become more evident.

Color map

Choose which color palette you want to use.

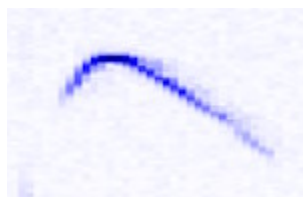
- **Grayscale.** From white (minimum amplitude) to black (maximum amplitude).



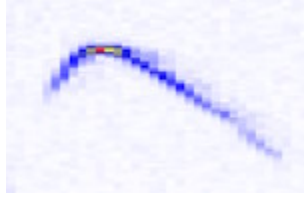
- **Inverted grayscale.** From black (minimum) to white (maximum).



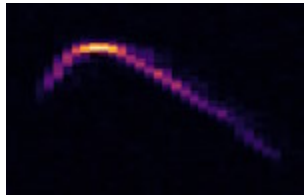
- **Blue.** From white (Minimum) to dark blue (Maximum).



- **Blue/Red.** From white (minimum) to blue, to yellow, to red (maximum).



- **Inferno**. From black (minimum) to purple, to orange, to yellow (maximum).



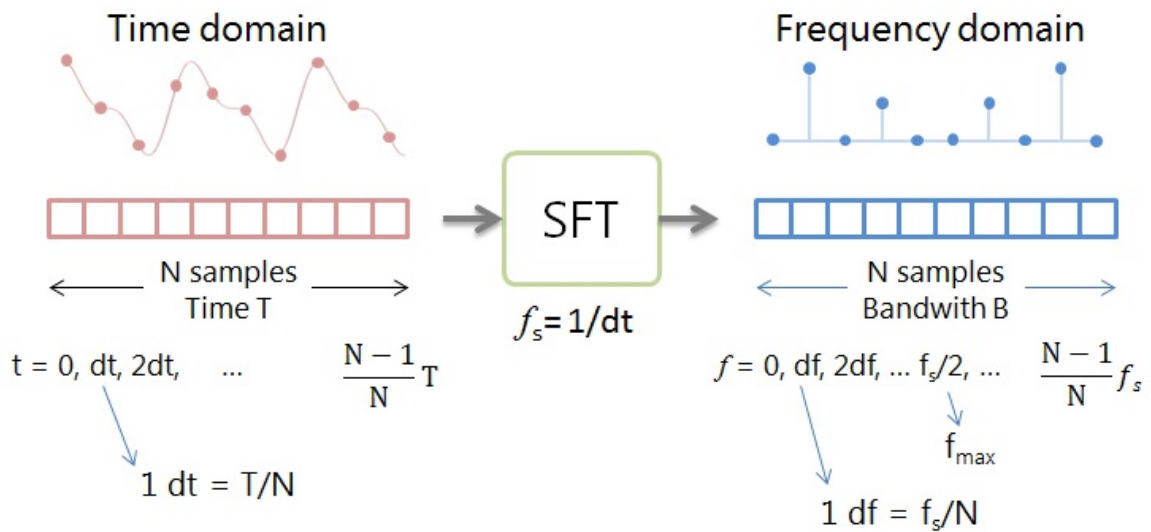
Notes

- A color palette has always 256 different scale values.

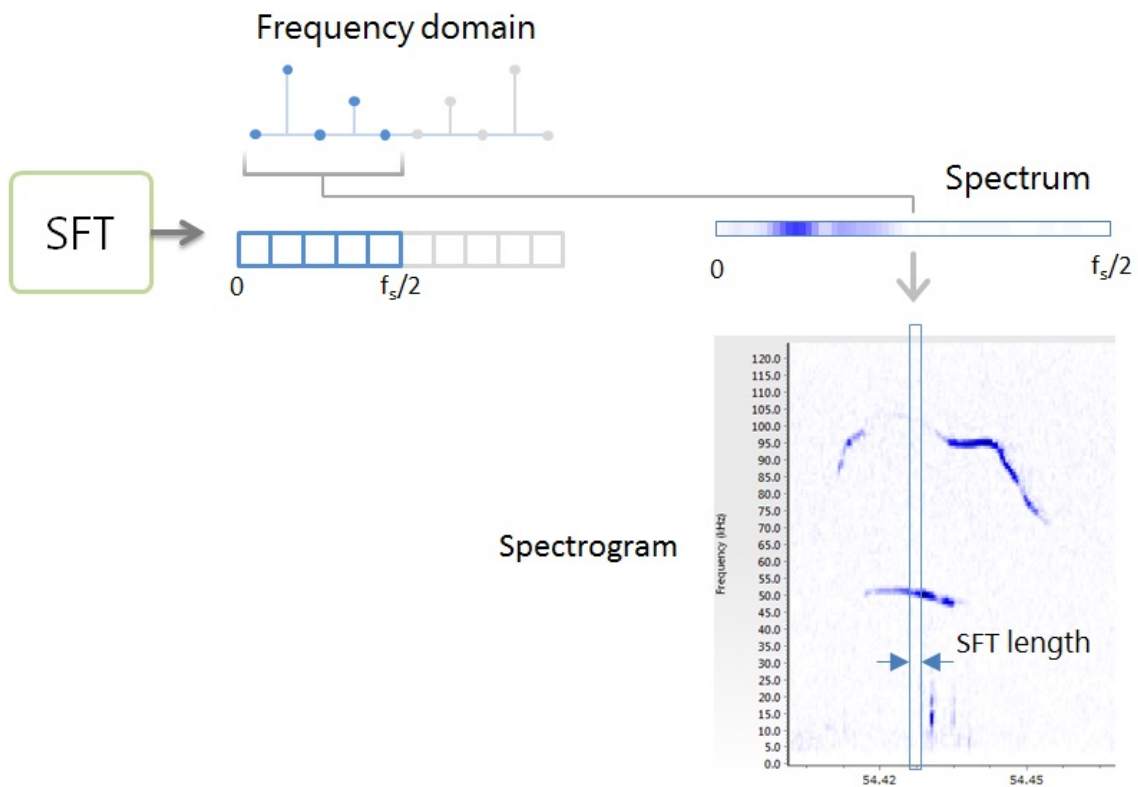
The short-time Fourier transform

The Fourier Transform is a general method to represent data in the *time domain* as data in the *frequency domain*. With discrete data such as audio sampled at a certain frequency, the Short-Time Fourier Transform (SFT) is used, where a stream of sound data is split in blocks (also called *frames*) of fixed length (N samples). Each frame is analyzed separately to produce a *spectrum*.

The basic concept underlying the SFT has to do with taking an array of N time-domain waveform samples (left) and processing those to produce a new array of frequency domain spectrum samples (right). The number of samples on the output is exactly the same as the number of samples on the input.



The length of the SFT frame (time interval T , corresponding to N samples, and a sampling frequency $f_s = N/T$) determines the spacing of the frequency bins df that can be represented in the spectrum ($df = f_s/N = 1/T$). In reality, we can only use half of the bandwidth B to represent a frequency back in the time domain. The second half of the bandwidth is alias frequencies, that is frequencies of waveforms that, when sampled, would produce exactly the same samples as the sampled signal. For this reason, the actual frequency spectrum in UltraVox XT has a maximum frequency f_{\max} equal to $f_s/2$ (f_{\max} is generally called the Nyquist frequency). Therefore, the spectrum itself is made of $N/2$ lines: $0, df, 2*df, \dots$ up to $(N/2)*df$ (see the figure below).



From the SFT Fourier transform to a frequency spectrum, and the spectrogram in UltraVox XT. You can view each spectrum as a “slice” of the spectrogram, where the value chosen for SFT length is the width of one “pixel” of the spectrogram. Note that only the first half of the frequency array (compare this with the previous picture) is used to build the spectrum.

See also

- Frequency resolution and time resolution
- Overlap

Frequency resolution and time resolution

UltraVox XT applies the Fast Fourier Transform algorithm applied to SFT, for this reason the frame length N is always a power of 2 (64, 128,..., 2048). The higher N , the smaller the frequency spacing df .

If the SFT frame is 2048 samples long, the SFT analysis gives you 2048 equally-spaced frequency bins from 0 Hz up to the sampling frequency divided by two. Increasing **SFT length** means to reduce the spacing of frequency bins according to the formula $df = \text{Sampling frequency} / \text{SFT length}$. This increases the waveform frequency resolution.

However, any timing resolution that occurs within a SFT frame is lost in the analysis, since all temporal changes are lumped together in a single frame. If **SFT length** is 2048, the frame duration is, at a sampling frequency of 384 kHz, $2048/384000 = 5.33$ ms. This means that the first spectrum is created at $t = 0$, and the next spectrum is created at $t = 5.33$ ms. Two subsequent events occurring within this time would not be distinguishable.

The following table shows the inverse relation between frequency resolution df (=sampling frequency / SFT length) and time resolution dt (=SFT length/sampling frequency), when sampling frequency is 384 kHz.

SFT length (samples)	df (=384000/SFT length) (Hz)	dt (=SFT length/ 384000 (ms)
64	6000	0.17
128	3000	0.33
256	1500	0.67
512	750	1.33
1024	375	2.67
2048	187.5	5.33

The time resolution dt is the width of the spectrogram pixel, when Overlap = 0.

If you increase the SFT length, there will be more "pixels" along the frequency axis of the spectrogram, however they are now "wider", since they represent a longer time interval; the higher the SFT, the longer this time. This relationship represents the trade-off between frequency resolution and time resolution.

See also

The following videos:

Short-time Fourier Transform and the Spectrogram

<http://www.youtube.com/watch?v=NA0TwPsECUQ>

FFT basic concepts

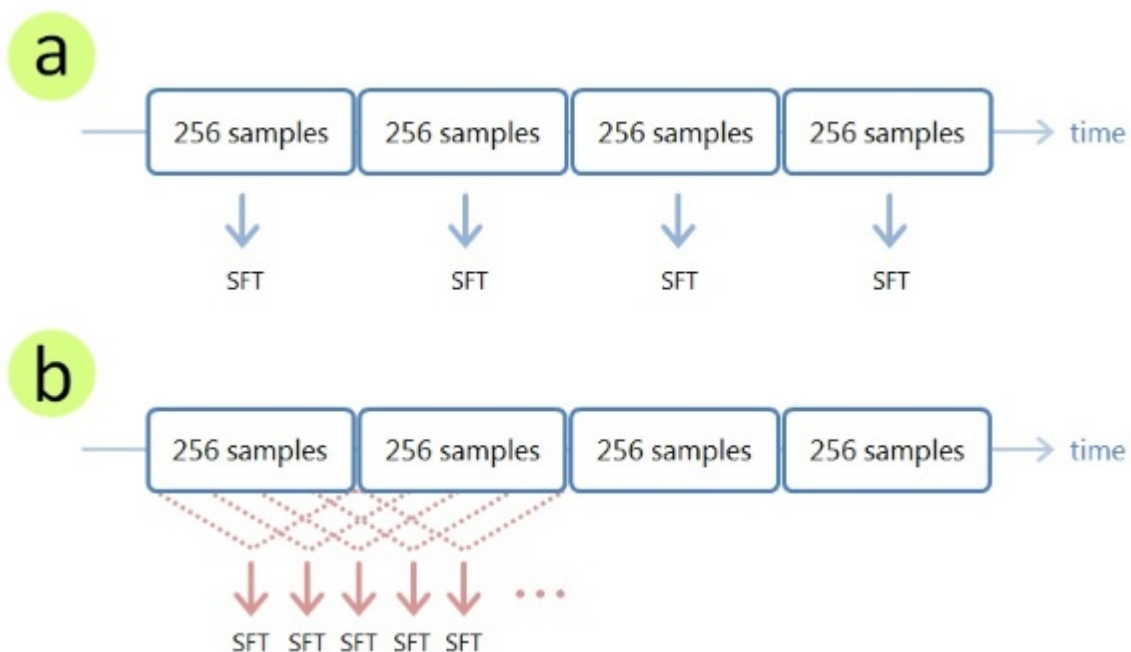
<http://www.youtube.com/watch?v=z7X6jgFnB6Y>

Overlap

What is Overlap?

Overlap is a way of improving the time resolution of the spectrogram. From what described in Frequency resolution and time resolution, the time resolution dt is equal to N/f_s , that is, the longer the SFT frame, the longer dt , the worse the time resolution. This means that events occurring within time t to time $t+dt$ fall into one "column" in the spectrogram and cannot be distinguished from each other. Overlapping helps with this, like rewinding a bit and listening again.

Below: Difference between non-overlap and overlap processing of a signal transformed into Fourier transform frames. **a)** No overlap. **b)** 75% Overlap. Note that in b) four times as many Fourier transforms are performed, increasing the time resolution by a factor of 4. SFT means Short-Time Fourier Transform.



When Overlap is used, an event that does not even last as long as one SFT frame can be "seen" (even if at reduced amplitude) in many sets of spectra that are displayed adjacent to each other. This way visibility of very short temporal variations that occur in a signal is augmented.

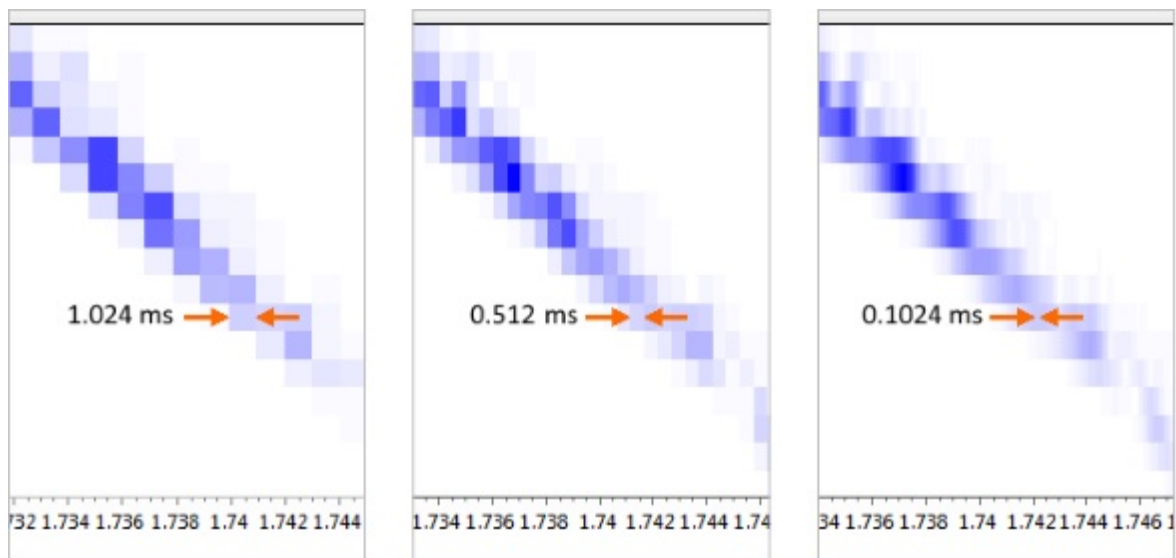
The disadvantage of Overlap is that a higher value results in longer processing time when you let UltraVox detect calls.

Effect of Overlap on your spectrogram

Overlap has an effect on the spectrogram. The width of the spectrogram pixel is:

- When Overlap (%) = 0, it is the *time resolution* dt according to the table which you can find in Frequency resolution and time resolution.
- When Overlap (%) = 50, it is 50% of the value in the table.
- When Overlap (%) = 90, it is 10% of the value in the table.

Below: Spectrogram resolution when Overlap (%) = 0 (left), 50 (middle), and 90 (right). In this example, SFT length = 256, therefore $dt = 1.024$ ms.



Labeling calls

Main topics and tasks

- Pattern labels 88
- The Labels list 89
- Enter a pattern label that is not in the Labels list 90
- Label multiple calls 91
- Replace a pattern label for multiple calls 93
- Remove labels 94

Pattern labels

Definition

A pattern label is a label that you can assign to multiple calls in order to analyze them as a group.

A pattern label is often labeled according to the shape of the call spectrogram.



Procedure

1. Choose **Analysis** > **Call Labeling**, or click **Call Labeling** on the left pane.
2. Select one of the calls in the call list.
3. Observe the spectrogram of the call that is highlighted.
4. In the **Labels** list at the bottom-left corner of the screen, double-click the name of the pattern that you want to assign.
5. The pattern name appears in the corresponding cell.

<input type="checkbox"/>	Call Name	Label	Color	Duration
<input type="checkbox"/>	45-69k			67.588
<input checked="" type="checkbox"/>	45-69k	Downward		33.791
<input type="checkbox"/>	45-69k			51.2
<input type="checkbox"/>	45-69k			49.149

6. The cursor moves automatically to the next call. You can now label the following calls. See Label multiple calls

See also

- The Labels list
- Labeling calls

The Labels list

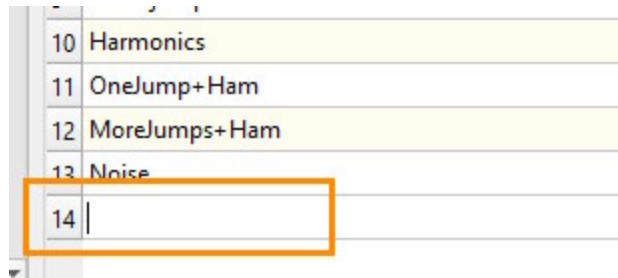
The Labels list shows the names of the call pattern labels currently available.

```
[Labels]  
lab01 = Upward  
lab02 = Downward  
lab03 = Flat  
lab04 = Short  
lab05 = Chevron  
lab06 = Wave  
lab07 = Complex  
lab08 = One jump  
lab09 = More jumps  
lab10 = Harmonics  
lab11 = OneJump+Ham  
lab12 = MoreJumps+Ham  
lab13 = Noise
```

NOTE The Labels list is used for all your experiments. You cannot create different lists for different experiments.

Add a new pattern label

1. Right-click within the Labels list, and select **Add label**.
2. A new row is appended to the list.



A screenshot of the Labels list interface. It shows a table with two columns: an index and a label. The existing rows are: 10 Harmonics, 11 OneJump+Ham, 12 MoreJumps+Ham, and 13 Noise. A new row with index 14 is being added, highlighted with an orange border and containing a text input field.

10	Harmonics
11	OneJump+Ham
12	MoreJumps+Ham
13	Noise
14	<input type="text"/>

3. Enter the label you require, then press **Enter**.

Edit a pattern label

1. Select a pattern label in the Labels list, right-click and select **Edit label**.
2. The label name becomes editable. Make the necessary changes and press **Enter**.

Delete a pattern label

In the Labels list, right-click the label and select **Delete label**.

NOTE When you delete a label, the labels of the same type assigned to calls are not deleted. If you want to delete those labels, see Remove labels

See also

- Labeling calls

Enter a pattern label that is not in the Labels list

You can label one or more calls with a pattern name that is not (yet) included in the Patterns list.

1. In the Call Labeling screen, click the row of the call you are interested in.
2. Type in a new pattern name in the **Label** cell for that call.

<input type="checkbox"/>	Call Name	Label	Color
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k	Unclear	
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		

The label is *not* included automatically in the Pattern labels list. You can also add a pattern label to the list. See Add a new pattern label

Label multiple calls

Aim

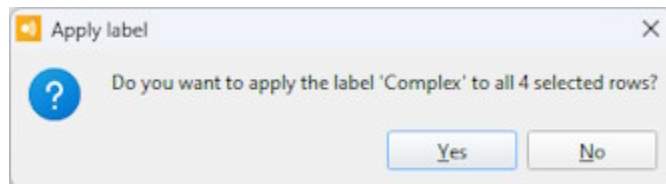
To quickly label a number of vocalizations of a specific pattern. To quickly label those calls, follow the steps below.

Procedure

1. Open the Call Labeling screen and select one recording.
2. For each call that you want to label with a specific pattern label, click the cell in the first column, so that it is marked with a check symbol ✓.

<input type="checkbox"/>	Call Name	Label	Color
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		

3. In the Labels list, double-click the label that you want to assign.
4. Click **Yes** on the message that appears.



5. Select the label you require and click **OK**.
6. The labels appear in the corresponding cells.

<input type="checkbox"/>	Call Name	Label	Color
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k	Complex	
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k	Complex	
<input checked="" type="checkbox"/>	45-69k	Complex	
<input type="checkbox"/>	45-69k		
<input checked="" type="checkbox"/>	45-69k	Complex	
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		

Replace a pattern label for multiple calls

Aim

To re-assign a pattern label to multiple calls. This is especially handy in two situations:

- When you want to assign the same pattern label to all unlabeled calls.
- When you want to replace a specific label with another one.

To re-assign a pattern label to multiple calls

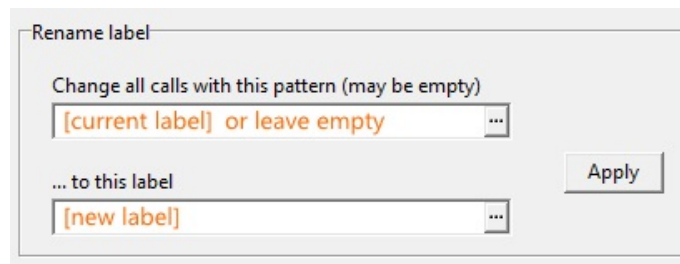
1. Click the button next to the **Pattern Label** column header.



2. In the Multi Pattern Label Editing window, under **Rename pattern label**, click the first button and in the Select pattern label window select the pattern label that you want to replace.

Leave this empty if you want to assign a label to unlabeled calls.

3. Click the second button and select the label you want to assign.

A screenshot of a 'Rename label' dialog box. It has a title bar 'Rename label'. Inside, there's a text label 'Change all calls with this pattern (may be empty)' above a text input field containing '[current label] or leave empty'. Below that is another text label '... to this label' above a text input field containing '[new label]'. An 'Apply' button is located to the right of the second input field.

4. Click **Apply**.
5. The **Pattern Label** column is updated with the new pattern label. A message shows how many calls have been labeled.

Remove labels

Aim

To remove the labels from the calls in your recordings.

Procedure (single call)

1. Double-click the **Pattern Label** cell so that its content is highlighted in blue.

<input type="checkbox"/>	Call Name	Label	Color	Duration (ms)	
<input type="checkbox"/>	45-67k			18.43	2
<input type="checkbox"/>	45-67k	Downward		22.527	2
<input type="checkbox"/>	45-67k			14.336	2

2. Press **Delete**, or right-click the label name and select **Delete**.

Procedure (multiple calls)

To remove the labels of a specific type, do the following:

1. Right-click anywhere in the call list and select **Select by label**.
2. In the second menu, select the label you want to delete.

NOTE The second menu includes the labels that are scored in the current recording.

<input type="checkbox"/>	Call Name	Label	Color	Duration (ms)	Start Time (s) ^
<input type="checkbox"/>	45-67k			29.696	4.73702
<input type="checkbox"/>	45-67k			24.576	4.90496
<input type="checkbox"/>	45-67k			24.6159	
<input type="checkbox"/>	45-67k			24.7736	
<input type="checkbox"/>	45-67k	Short		24.961	
<input type="checkbox"/>	45-67k			25.1484	
<input type="checkbox"/>	45-67k	Short			
<input type="checkbox"/>	45-67k	Flat		22.527	
<input type="checkbox"/>	45-67k			14.336	
<input type="checkbox"/>	45-67k			14.336	42.7018
<input type="checkbox"/>	45-67k	Short		12.287	43.5743

Delete Call

Select all

Select by call name

Select by label

<No label>

Flat

Short

3. As a result, all the rows that include that label are selected with a check mark.

<input type="checkbox"/>	Call Name	Label	Color	Duration (ms)
<input type="checkbox"/>	45-67k			24.576
<input type="checkbox"/>	45-67k			38.912
<input type="checkbox"/>	45-67k			17.408
<input checked="" type="checkbox"/>	45-67k	Short		55.296
<input type="checkbox"/>	45-67k			17.408
<input checked="" type="checkbox"/>	45-67k	Short		18.43
<input type="checkbox"/>	45-67k	Flat		22.527
<input type="checkbox"/>	45-67k			14.336

4. Right-click again somewhere in the call list and select **Remove label of [n] selected calls**. The number [n] indicates how many calls in that recording are labeled with the label chosen.
5. The labels are removed.

See also

- Delete calls
- Replace a pattern label for multiple calls
- To edit the list of available pattern labels, see The Labels list

Editing calls

Main topics and tasks

- Add a call manually 99
- Rename calls 101
- Adjust frequency and time boundaries in a call 104
- Delete calls 106

Select multiple calls for editing

Aim

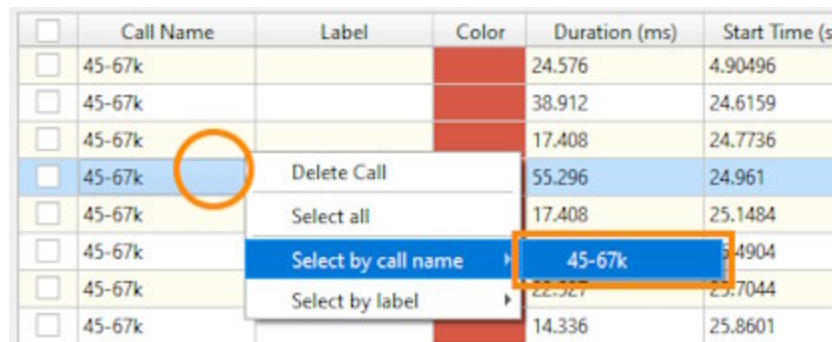
To select multiple calls for deletion, or call labeling.

Prerequisites

- Open the **Call Labeling** screen.

Procedure

- Simple manual selection. Click the check box next to each call that you want to select.
- Select by call name. Right-click anywhere in the call list and select **Select by call name**, then select one of the names available in the second menu.



<input type="checkbox"/>	Call Name	Label	Color	Duration (ms)	Start Time (s)
<input type="checkbox"/>	45-67k			24.576	4.90496
<input type="checkbox"/>	45-67k			38.912	24.6159
<input type="checkbox"/>	45-67k			17.408	24.7736
<input checked="" type="checkbox"/>	45-67k			55.296	24.961
<input type="checkbox"/>	45-67k			17.408	25.1484
<input type="checkbox"/>	45-67k				24.4904
<input type="checkbox"/>	45-67k			22.327	25.7044
<input type="checkbox"/>	45-67k			14.336	25.8601

- Select by label. Right-click anywhere in the call list and select **Select by label**, then select one of the labels available in the second menu.

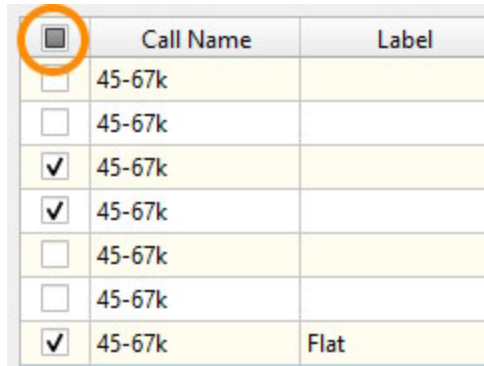
Once selected, a call can be

- Labeled - See Label multiple calls
- Deleted - See Delete calls
- Renamed - See Rename calls
- Assigned to a different pattern - See Replace a pattern label for multiple calls

Notes

To select or de-select all the calls in the Call Labeling screen, do one of the following:

- Click the first check box of the list, near **Call Name**, to select all calls. To de-select all calls, click that check box once again.



The screenshot shows a table with three columns: an unlabeled column for checkboxes, 'Call Name', and 'Label'. The first checkbox is circled in orange. The table contains eight rows of data, all with '45-67k' in the 'Call Name' column. The first four rows have empty 'Label' cells, while the last row has 'Flat' in the 'Label' cell. The checkboxes in the first four rows are: unchecked, unchecked, checked, and checked. The checkboxes in the last three rows are: checked, unchecked, and unchecked.

	Call Name	Label
<input type="checkbox"/>	45-67k	
<input type="checkbox"/>	45-67k	
<input checked="" type="checkbox"/>	45-67k	
<input checked="" type="checkbox"/>	45-67k	
<input type="checkbox"/>	45-67k	
<input type="checkbox"/>	45-67k	
<input checked="" type="checkbox"/>	45-67k	Flat

- Right-click somewhere in the call list and select **Select all** or **Select none**.

Add a call manually

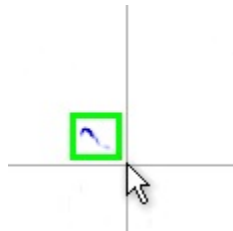
Aim

To add a call that was not detected automatically.

The call will be analyzed just as the calls detected automatically. If you want to have the new call analyzed in the same group as the other, automatically-detected calls, rename the new call with the name of those calls. See Rename calls

Procedure

1. In the Call Labeling screen, draw a box around the call spectrogram.



2. A new row is inserted. Under **Call Name**, the text **Manual** is entered automatically.

<input type="checkbox"/>	Call Name	Label	Color
<input checked="" type="checkbox"/>	45-69k		Red
<input checked="" type="checkbox"/>	45-69k		Red
<input type="checkbox"/>	Manual		Green
<input checked="" type="checkbox"/>	45-69k		Red
<input checked="" type="checkbox"/>	45-69k		Red

3. **OPTIONAL** Double-click **Manual** under Call Name and enter the name you require.

<input type="checkbox"/>	Call Name	Label	Color
<input type="checkbox"/>	45-69k		Red
<input type="checkbox"/>	45-69k		Red
<input type="checkbox"/>	45-69k		Red
<input type="checkbox"/>	45-69k		Red

4. **OPTIONAL** Assign a Pattern Label. See Pattern labels

Note

If you re-name a call with an existing call name (45-69k in the example above), the cell under **Color** is updated with the corresponding color.

Rename calls

Aim

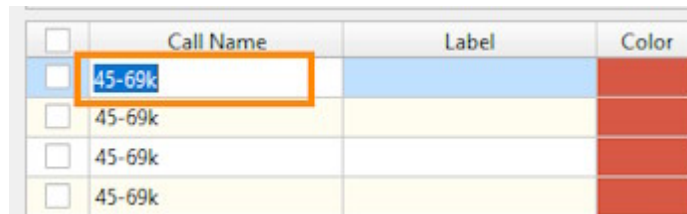
to provide meaningful names of the calls for a publication or to facilitate analysis of groups of calls across recordings and experiments.

What do you want to do?

- Rename a single call
- Rename multiple calls
- Rename the calls with a specific name
- Rename the calls with a specific label
- Rename all calls in a recording

Rename a single call

1. In the Call Labeling screen, double-click the **Call Name** cell for the call you want to rename.
2. Enter the new name for the call.



<input type="checkbox"/>	Call Name	Label	Color
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		
<input type="checkbox"/>	45-69k		

3. To confirm and stop editing, click anywhere in the call list. If you want to edit the next call name, just press **Enter**.

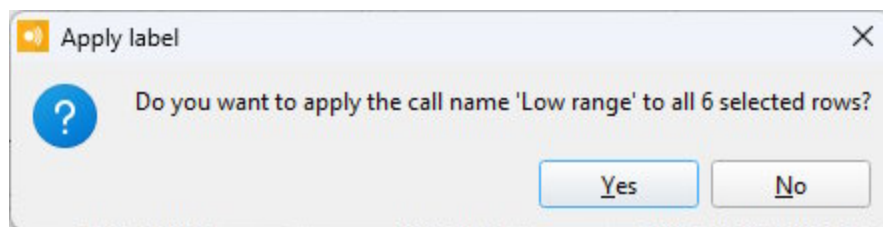
Rename multiple calls

1. In the Call Labeling screen, for each call you want to rename, select the check box in the first column. Make sure that the calls selected have the same name.

TIP If you only have one call name and you want to select all the calls, select the uppermost check box, at the left of **Call Name**.

<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		

2. Enter the new name under **Call Name** for one of the calls selected, then press **Enter**.
3. In the message dialog that opens, click **Yes** to confirm.



Rename the calls with a specific name

1. In the Call labeling screen, right-click anywhere in the call list and select **Select call by name**, then choose the name that you want to modify.
2. The rows with the chosen name are selected. Double-click the Call Name for one of those rows and enter the new call name.
3. In the message dialog that opens, click **Yes** to confirm.

Rename the calls with a specific label

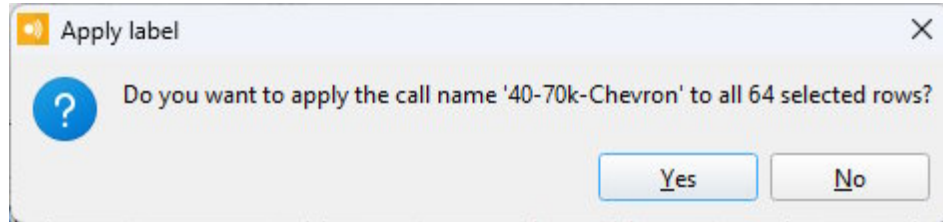
1. In the Call labeling screen, right-click anywhere in the call list and select **Select call by label**, then choose a label.
2. As a result, calls with a specific label are selected.

<input type="checkbox"/>	40-70k	Wave	
<input checked="" type="checkbox"/>	40-70k	Chevron	
<input checked="" type="checkbox"/>	40-70k	Chevron	
<input checked="" type="checkbox"/>	40-70k	Chevron	
<input type="checkbox"/>	40-70k		

3. Double-click one of those rows and enter the new name.

<input type="checkbox"/>	40-70k	Wave	
<input checked="" type="checkbox"/>	40-70k-Chevron	Chevron	
<input checked="" type="checkbox"/>	40-70k	Chevron	
<input checked="" type="checkbox"/>	40-70k	Chevron	
<input type="checkbox"/>	40-70k		

4. In the message dialog that opens, click **Yes** to confirm.



Rename all calls in a recording

1. Select the uppermost check box, at the left of **Call Name**.

<input checked="" type="checkbox"/>	Call Name	Label	Color
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		

2. Enter the new name under **Call Name** for one of the calls selected, then press **Enter**.
3. In the message dialog that opens, click **Yes** to confirm.

Adjust frequency and time boundaries in a call

Aim

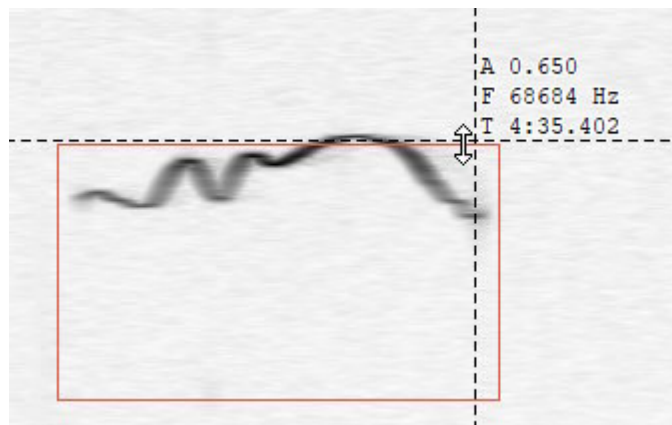
To edit the frequency and time boundaries of a call if they do not match the call spectrogram.

Do this for example when the red rectangle around a detected call does not include some weak signal that you believe it is part of that call.

Procedure

Adjust the frequency boundaries

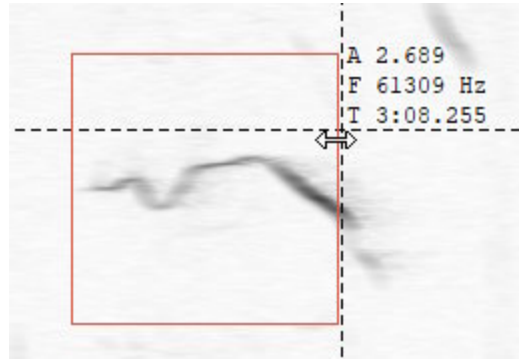
1. In the Spectrogram, hover the mouse cursor over the upper side (to adjust the High frequency boundary) or the lower side (to adjust the Low frequency boundary) of the rectangle around the call.



2. When the mouse cursor turns a double-headed arrow, drag the boundary up or down to the new position.
3. To save the changes, select **File** > **Save** or press **Ctrl+S**.

Adjust the time boundaries

1. In the Spectrogram, hover the mouse cursor over the one of the lateral sides of the rectangle around the call, depending on where you want to adjust the start boundary or the end boundary.



2. When the mouse cursor turns a double-headed arrow, drag the boundary up or down to the new position.
3. To save the changes, select **File > Save** or press **Ctrl+S**.

Notes

- When you edit the frequency or time boundaries in a call, the values reported in the call list for the corresponding call are updated.

If you adjust the frequency boundaries, you'll notice that the values **Freq at Max Amp** and/or **Mean Amplitude** will change.

If you adjust the time boundaries, you'll notice that one or more of the following values change: **Duration**, **Start Time** (or **Stop Time**), **Freq at Max Amp** and **Mean Amplitude**.

See also

- Adjust a call definition

Delete calls

Aim

To remove calls that represent noise or calls that should not be analyzed.

What do you want to do?

- Delete a single call
- Delete a selection of calls
- Delete the calls with a specific name
- Delete the calls with a specific label (or no label)
- Delete all calls in a recording
- Restore a deleted call

Delete a single call

In the Call labeling screen, right-click the corresponding row in the call list, and press **Delete Call**.

The call is removed from the call list. The corresponding spectrogram is no longer highlighted with a rectangle.

Delete a selection of calls

1. For each call you want to delete, select the check box in the first column.

<input type="checkbox"/>	Call Name	Label	Color
<input checked="" type="checkbox"/>	40-70k		
<input type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input type="checkbox"/>	40-70k		
<input type="checkbox"/>	40-70k		
<input type="checkbox"/>	40-70k		
<input checked="" type="checkbox"/>	40-70k		
<input type="checkbox"/>	40-70k		

2. Right-click anywhere in the list and select **Delete [n] selected calls** where [n] is the number of calls currently selected for deletion.

3. The calls are removed from the call list. The corresponding spectrograms are no longer highlighted with a rectangle.

To reset a selection of calls, select and then de-select the checkbox at the top of the list, at the left side of **Call Name**.

Delete the calls with a specific name

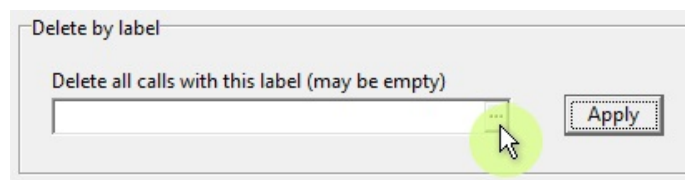
1. Right-click anywhere in the list and select **Select by call name**, then select the name of the calls you want to delete.
2. As a results, the calls with that name are selected.
3. Right-click anywhere in the call list and select **Delete [n] selected calls** where [n] is the number of calls currently selected for deletion.
4. The calls are removed from the call list. The corresponding spectrograms are no longer highlighted with a rectangle.

Delete the calls with a specific label (or no label)

1. Click the button next to the **Pattern Label** column header.

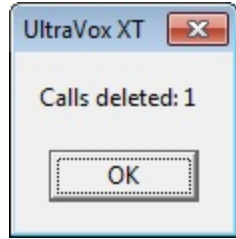


2. In the Multi Pattern Label Editing window, under **Delete by label**, click the button and select the label of the calls you want to delete.



Leave the field empty to delete all calls that currently have no label.

3. Click **Apply**.
4. The calls are deleted and a message informs you about how many calls have been removed.



Delete all calls in a recording

1. Click the button at the top of the first column and select **Tag all**.
2. Click the same button once again and select **Delete**. Click **Yes** to confirm.

Restore a deleted call

If you deleted a call unintentionally, do the following:

1. In the Spectrogram, drag a rectangle around the call spectrogram.
2. The call list shows a new row, with the text **Manual** in the **Call Name** cell. Double-click **Manual** and enter the name you require.
3. **OPTIONAL** Label the call. See Labeling calls

If you want to restore all the deleted calls, open the Call Detection screen and click the **Detect calls in this recording** button to restore the deleted calls according to the current definitions. This will not restore changes that you may have applied manually, nor will it restore the calls added manually.

Recordings

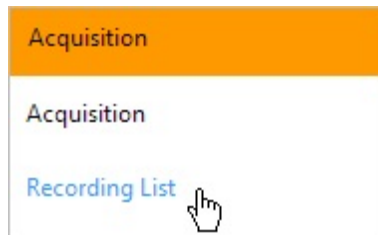
Main topics and tasks

- The Recording List 110
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The Recording List

How to access the Recording List

Choose **Acquisition** > **Recording List**.



Rec #	Microphone Name	Date	Size (MB)	Sample Rate (Hz)	Gain	Duration(ms.ms)	Calls Labeled/Detected	Filtered	Independent Variable	Delete
1	Imported	2024-11-21 16:04:59	150.18	250000	0	5:00.351	0/40		ch1-20171219-young-7-4-12d	✗
2	Imported	2024-11-21 16:04:59	150.06	250000	0	5:00.089	0/86		ch1-20171219-young-8-4-12d	✗
3	Imported	2024-11-21 16:04:59	150.28	250000	0	5:00.548	0/32		ch1-20180722-aged-6-2-12d	✗
4	Imported	2024-11-21 16:04:59	149.93	250000	0	4:59.860	0/1		ch2-20171204-aged-2-2-12d	✗
5	Imported	2024-11-21 16:04:59	150.37	250000	0	5:00.745	0/1		ch2-20171205-aged-4-8-12d	✗
6	Imported	2024-11-21 16:04:59	150	250000	0	4:59.991	0/12		ch2-20171206-aged-5-4-12d	✗

Contents

Rec

The recording number. The number is assigned by sorting the recordings first by Microphone Name, then by import/recording date.

Microphone Name

The name of the microphone used for the recording (that is specified under Microphone name in the Experiment Settings screen); or Imported if the recording is an imported WAV file.

Date

The date (year-month-day) and the time (HH:mm:ss) depend on the type of recordings:

- For microphone recordings, the date and time that the recording started.
- For imported audio files: the date and time that the file was imported.

Size (MB)

The recording file size in megabytes.

Sample Rate (Hz)

The sample rate of the microphone used for that recording, or the sample rate of the imported audio file. Common values are 250000 for 250 kHz microphones and 384000 for Noldus 384 kHz microphones.

Gain

The value of gain of the microphone used for that recording.

Duration (m:s.ms)

The duration of the recording (minutes: seconds.milliseconds).

Calls Labeled/Detected

The number of calls currently labeled and detected, separated with a "/".

Filtered

This column shows **Yes** if the recording was filtered. The cell is left empty for the original, unfiltered recordings.

Independent Variable

The value of the independent variable entered for that recording. See Independent variables

Delete

Click the symbol under **Delete** or click the **Delete** button to remove a specific recording from the experiment.

Independent Variable	Delete
ch1-20171219-young-7-4-12d	✗
ch1-20171219-young-8-4-12d	✗

Options

Also show original for filtered recordings

You find this option at the bottom of the Recording List.

☒ Also show original for filtered recordings

- Select this option to list recordings including the filtered copies.
- De-select this option to only include the filtered copies of the recordings.

Sort the Recording List

Click the column header you want to sort the list by.



Click once more to sort the Recording List in reverse order.

See also

- Independent variables
- Recording files

Independent variables

Aim

To assign labels to recordings and facilitate group analysis.

NOTE UltraVox XT does not select or group your recordings based on the labels under **Independent Variable**. Instead, use the independent variables in the exported data to filter recordings or group recordings in other software such as Excel or R.

Procedure

1. Choose **Acquisition > Recording List**. See The Recording List
2. Locate the **Independent Variable** column.

By default, the Independent Variables column is empty, unless you have imported the audio files; in that case the column shows the audio file name.

An independent variable is any variable that is supposed not to vary during a recording, and which you can use to label recordings.

For example, enter the value control or treated in each recording row.

Independent variable
control
treated
control
treated
control

Other examples:

- Phenotype (with possible values Young or Aged)
- Drug dose injected (with possible values 0.01, 0.05 mg/kg etc.).
- If you want to combine two or more independent variables, like Day and Treatment level, include the information on both variables in the single values. For example, assign a recording one of the values Control-d1, Control-d2, Treated-d1, Treated-d2 etc.

Notes

- If you add text under **Independent Variable**, the name of the corresponding UVD file and that of the UVC file are updated automatically.
- When exporting the call statistics, that value is exported together with the statistics for the corresponding recording.
- If you imported an audio (UVD, WAV) file, the file name is automatically entered as independent variable for that recording. To edit this name, double-click the corresponding cell.

Recording files

File location

Recordings are stored in the experiment folder:

C:\Users\Public\Documents\Noldus\ UltraVox XT\Experiments\ [experiment name]

To change the default experiment location, see Settings

File types

Recording (.uvd)

Each recording is saved as data file (***.uvd**). The file name depends on how the recording was created.

For recordings made with a microphone in UltraVox XT:

[experiment name]_[Microphone name]_[independent variable value]_[Date (yymmdd)]_ [time (hhmmss)]_[time(ms)]_[Gnn]_ [N]_[flt].uvd

Where

- **[Microphone name]** is the name under **Microphone name** in the Experiment Settings.
- **[Gnn]** indicates the microphone gain (for example G52).
- **[N]** is always 1 in UltraVox XT.
- **flt** indicates a filtered copy of a recording.

For recordings imported from audio files (UVD or WAV):

[experiment name]_Imported_[audio file name]_[import date (yymmdd)]_[import time (hhmmss)]_ [import time(ms)]_G0_ [N]_[flt].uvd

Where

- **G0** indicates that the gain used to record audio is unknown.
- **[N]** is always 1 in UltraVox XT.
- **flt** indicates a filtered copy of a recording.

Calls (.uvc)

A file with the same name as the recording file is created when at least one call is defined and saved.

Files of type .uvc contain the call definitions and the calls detected in a specific recording.

Notes

- If you add text in the Recording List under **Independent Variable**, the name of the corresponding UVD file and that of the UVC file are updated automatically.
- **IMPORTANT** Do not try to open and edit any of the data files mentioned above. They may get corrupted and UltraVox XT may no longer be able to analyze them.
- You can also open and play back a uvd file with Windows Media Player and with Audacity.

Other options

Main topics and tasks

- Experiment settings 118
- Trigger start/stop recording 119
- Start and stop recording at specific times 122
- Play back sound 125
- View options 126
- Zoom in/out 128
- Settings 131

Experiment settings

To access the Experiments Settings

Choose Setup > Experiment Settings.



Experiment location

Experiment location:

C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments\UV4 mouse pups\

Where the experiment is saved depends on your Settings. Each experiment is saved in a separate folder, named as the experiment.

Created / Last modified

Created: Wed Nov 27 11:33:58 2024

Last modified: Wed Nov 27 12:25:15 2024

Date and time that the experiment was created and last modified, respectively.

Microphone list

Microphone	Microphone Name	Selected	Status
Microphone (2- Petttersson M500-384kHz USB Ultrasound Microphone)	Microphone 1	<input checked="" type="checkbox"/>	✓
Microphone (3- Petttersson M500-384kHz USB Ultrasound Microphone)	Microphone 2	<input checked="" type="checkbox"/>	✓
Microphone (4- Petttersson M500-384kHz USB Ultrasound Microphone)	Microphone 3	<input checked="" type="checkbox"/>	✓
Microphone (5- Petttersson M500-384kHz USB Ultrasound Microphone)	Microphone 4	<input checked="" type="checkbox"/>	✓
Maximum number of selected microphones: 4			

Trigger start/stop recording

To access the Trial Control Settings

1. Choose **Setup** > **Trial Control Settings**.



2. Choose one of the options below for Start acquisition and Stop acquisition.

Start acquisition

- **Manually.** To start acquisition when you click the **Start recording** button in the Acquisition screen.



- **External program trigger.** Choose this option to start acquisition when a file is detected in a specific location (default: C:\ProgramData\Noldus\UltraVox\XT 4\Synch).

To test the external program trigger option, see the note below.

Choose this option to control UltraVox XT recording from EthoVision XT or The Observer XT.

Stop acquisition

- **Manually.** To stop acquisition when you click the **Stop recording** button in the Acquisition screen.



- **External program trigger** — To stop acquisition when a file is detected in a specific location (default: C:\ProgramData\Noldus\UltraVox\XT 4\Synch).

To test the external program trigger option, see the note below.

Choose this option to control UltraVox XT recording from EthoVision XT or The Observer XT.

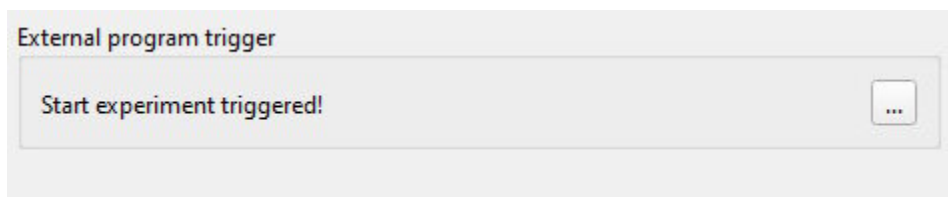
- **After ... minutes** — To stop acquisition after a fixed time has elapsed. Maximum recording time is 90 minutes. To record for longer time, stop manually or with an external program trigger. See Recording sound

Note

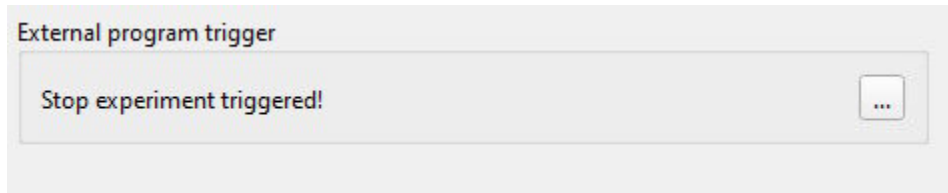
- To test the external program trigger, do the following:
Copy a text file named start.txt or stop.txt to the destination folder (default: C:\ProgramData\Noldus\UltraVox\XT 4\Synch). If you want to change this folder, click the [...] button and select the new folder path.

When the file is copied, a message appears:

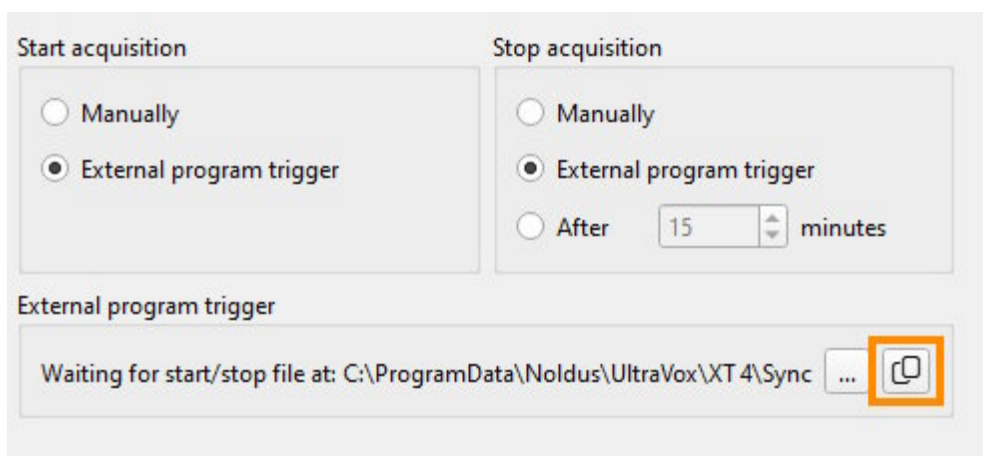
In the case you copied the start.txt file:



When you copy the stop.txt file:



- **TIP** To retrieve the current destination folder for the start/stop files. click the Copy button to copy the folder path to the clipboard.



See also

- Control UltraVox XT from other software
- Trigger settings for EthoVision XT
- Trigger settings for The Observer XT

Start and stop recording at specific times

Aim

To have UltraVox XT start and/or stop recording at specific clock times, without being in front of the computer.

Example: Start recording at 0:00 AM.

Prerequisites

- You have the UltraVox XT 4 installation package at hand.
- On your UltraVox XT computer, check that the following folder exist:

C:\ProgramData\Noldus\UltraVox\XT 4\Synch

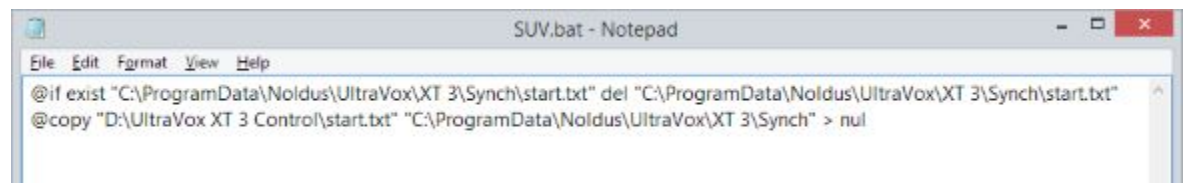
If you do not see the **Program Data** folder, in the Windows File Explorer click **View > Folder Options >** On the View tab select **Show hidden files, folders and drives**.

Procedure

Step 1 - Copy and edit the batch file that triggers UltraVox XT

With the following steps you make a batch file that copies a file "Start.txt" to a specific folder of UltraVox XT./

1. On the UltraVox XT 4 installation package, browse to **Extras**. Copy the folder **UltraVox XT 4 Control**.
2. Paste the folder to a location on your computer.
3. Right-click the file SUV.bat and select **Edit with > Notepad**.



4. On the first line, enter the following:
@if exist "C:\ProgramData\Noldus\UltraVox\XT 4\Synch\start.txt" del
"C:\ProgramData\Noldus\UltraVox\XT 4\Synch\start.txt"

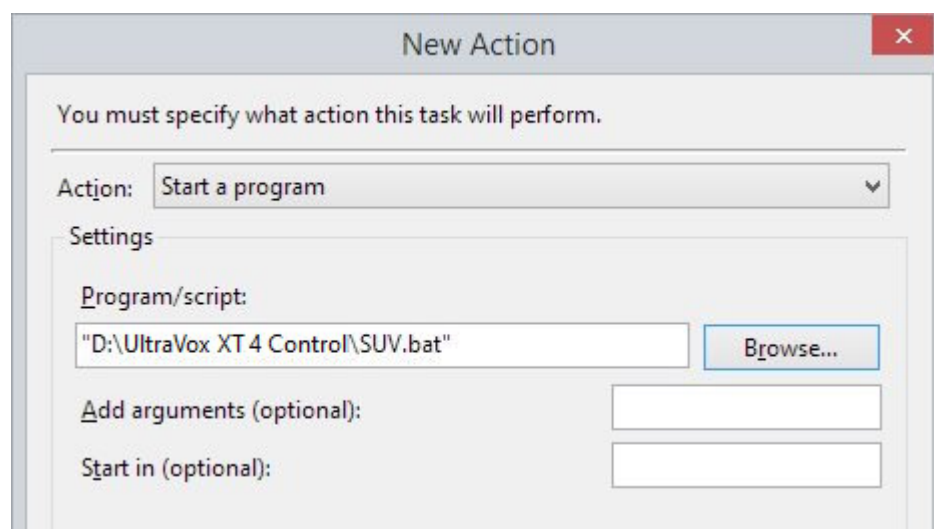
5. On the second line, enter the address of the "start.txt" file, which is located in the same folder as the SUV file. The second address is the same as that on the first line.

```
@copy "[location on your PC]\UltraVox XT 4 Control\start.txt"  
"C:\ProgramData\Noldus\UltraVox\XT 4\Synch" > nul
```

Step 2 - Program the Windows Task Scheduler

With the following steps you program the Windows Task Scheduler to start the batch file at the time required.

1. In the Control Panel, choose **System and Security** and under **Administrative Tools** click **Schedule tasks**. If you do not find this, in the Search field enter "schedule" and click **Schedule tasks**.
2. Click **Create Task** on the right panel.
3. On the General tab, give a name to the task.
4. Click the Triggers tab. Select date and time required, and whether the task should be repeated, for example each night.
5. Click the Actions tab. Click **New**, next to **Action** select **Start a program**. Click **Browse** and select the SUV file.



6. Click **OK**.

Step 3 - Activate UltraVox

1. In UltraVox XT, click **Trial Control**, and under **Start acquisition** select **External program trigger**.
2. The UltraVox XT recording screen must be open the moment that the scheduled task is activated. Therefore, before leaving the lab, in UltraVox XT

choose **Acquisition > Open Acquisition**. You do not need to click the **Start display** button.

Note

- To stop recording at a specific time, make a separate task in Windows Task scheduler. In that task, select the file SUV.bat as defined above. In the Trial Control Settings, under **Stop acquisition** select **External program trigger**.
- To control UltraVox XT from EthoVision XT, see Control UltraVox XT from other software.
- The procedure outlined above is also valid when you work with multiple microphones.

See also

- Control UltraVox XT from other software

Play back sound

Aim

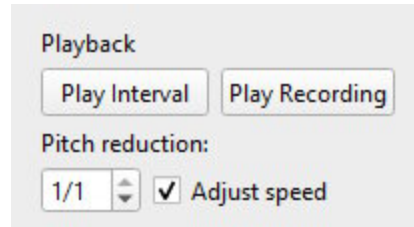
To listen to recordings converted to audible frequencies.

Prerequisites

Make sure the computer has speakers enabled.

Procedure

1. In the Call Detection or Call Definition screen, under **Playback** choose the **Pitch reduction** value (1/1 to 1/20).



1/1: No change in pitch.

1/10: Pitch reduced 10 times (e.g. from 60 kHz to 6 kHz).

2. Choose **Adjust speed** to slow down playback, so you can perceive the changes in pitch for very short calls. If **Adjust speed** is not selected, the audio file is played at normal speed.
3. Play back audio.

To play back a short section of the audio file, click anywhere within the Entire recording plot, to select an interval. Zoom in/out to adjust the length of the interval. Next, click the **Play Interval** button.

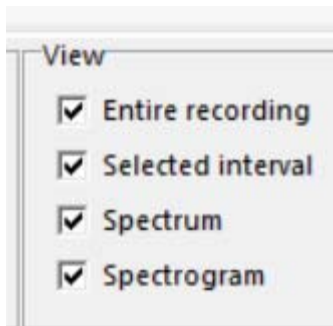
Alternatively, click a call in the call list, then click the **Play Interval** button.

To listen to the entire recording, click the **Play Recording** button.

See also

- How do I analyze audible sound?

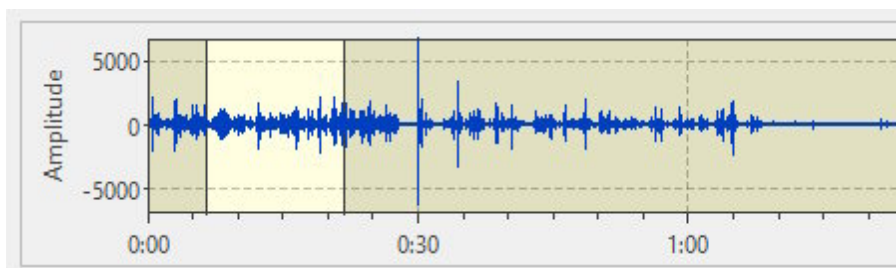
View options



Select the plots you want to display.

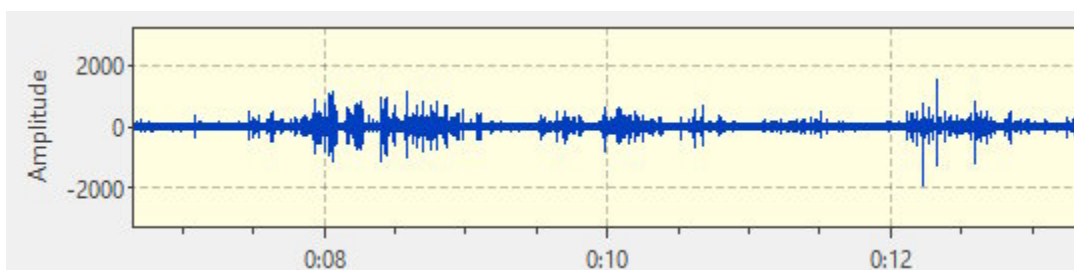
Entire recording

Displays the Amplitude-time plot for the entire recording.



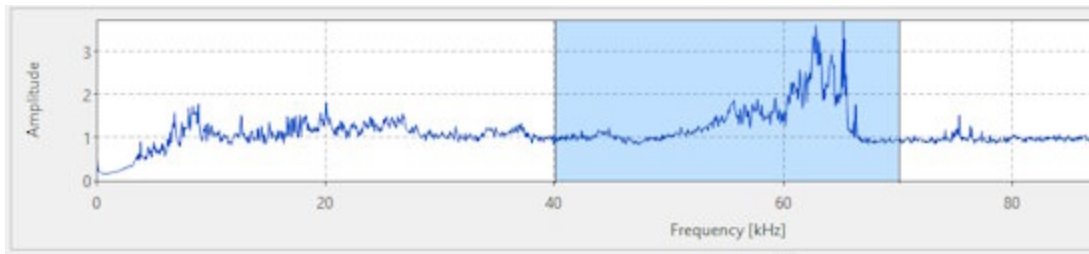
Selected interval

Displays the Amplitude-time plot for the time interval currently selected. See also [Explore the spectrogram](#).



Spectrum

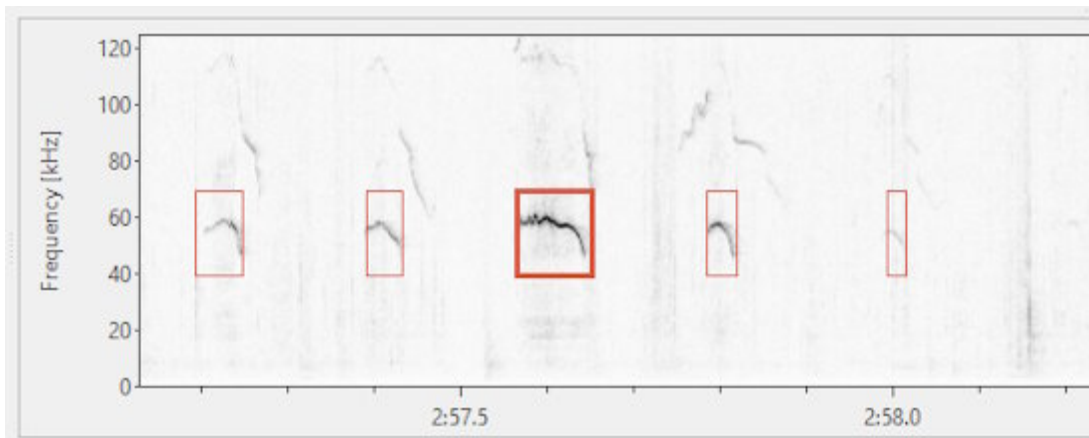
Displays the frequency spectrum for the time interval currently selected.



NOTE When you select one of the detected calls either in the Spectrogram or in the Detected calls list, part of the spectrum is highlighted in blue. This corresponds to the frequency range of the call definition that call was detected from, not the frequency range of the call itself.

Spectrogram

Displays the spectrogram for the time interval currently selected.



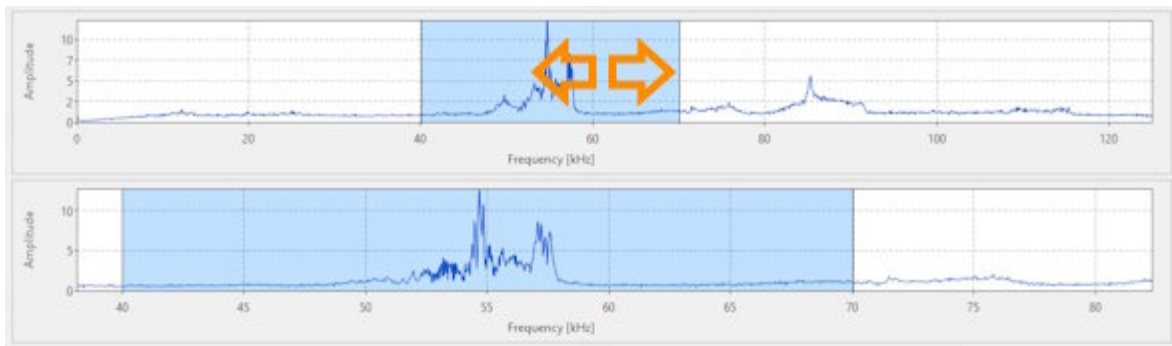
See also

- The Spectrogram

Zoom in/out

Spectrum plot

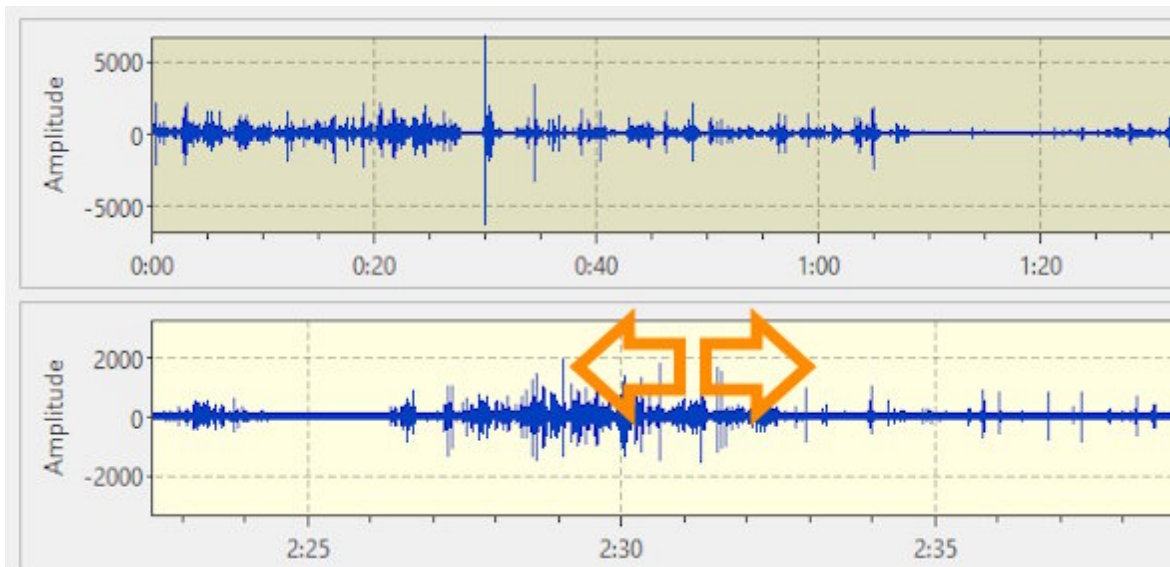
To zoom in and out the horizontal (i.e. frequency) axis, place the mouse pointer over the spectrum and roll the mouse wheel.



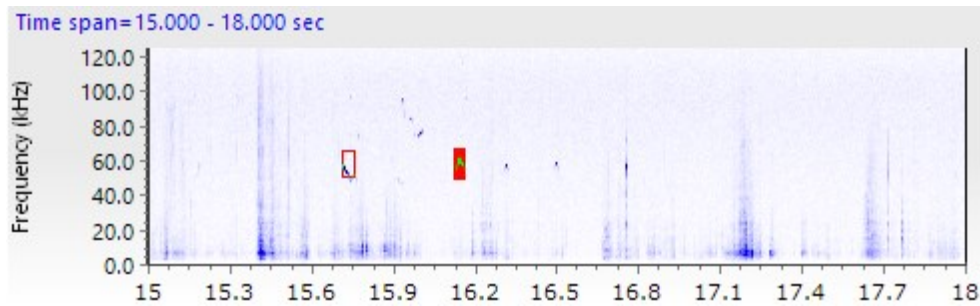
Selected interval plot

To zoom in and out the horizontal (i.e. time) axis of the Selected interval plot, do one of the following:

- Enter the length of the **Time interval** you require.
- Place the mouse pointer somewhere over the plot area (see the second plot in the figure below), then roll the mouse wheel. Note that the zoom is centered on the current position of the mouse pointer.

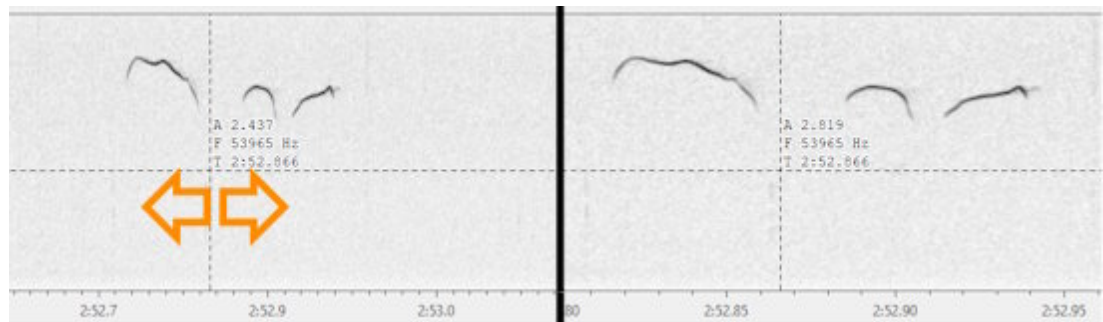


Spectrogram



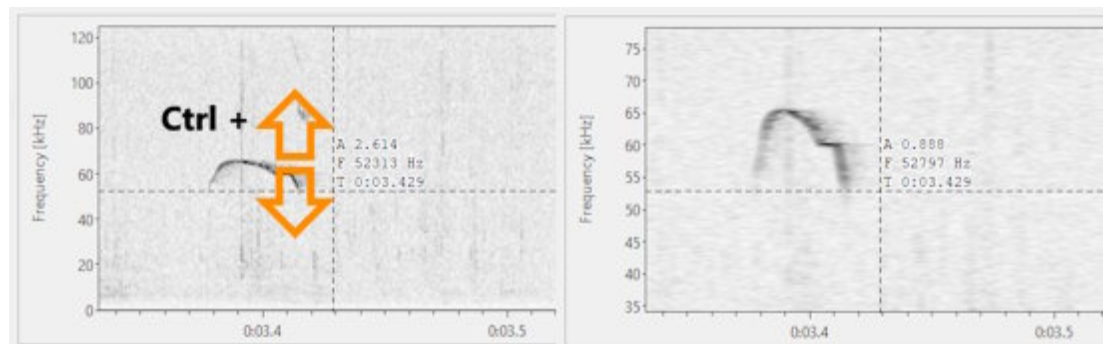
To zoom in/out the time axis:

- Adjust the value of **Time interval** at the top of the screen, or
- Place the mouse pointer somewhere over the spectrogram area (see the figure below), then roll the mouse wheel. Note that the zoom is centered on the current position of the mouse pointer.



To zoom in/out the frequency axis:

- Place the mouse pointer somewhere over the spectrogram area (see the figure below), then hold **Ctrl** down and roll the mouse wheel. Note that the zoom is centered on the current position of the mouse pointer.



- Alternatively, right-click the spectrogram area and under **Frequency scale** adjust the values **Min frequency** and **Max frequency**. Check the

spectrogram on the background. When you are happy with the zoom level, click OK.

With the **Auto** options near Min frequency and Max frequency you return to the default range determined by the microphone sample rate.

Settings

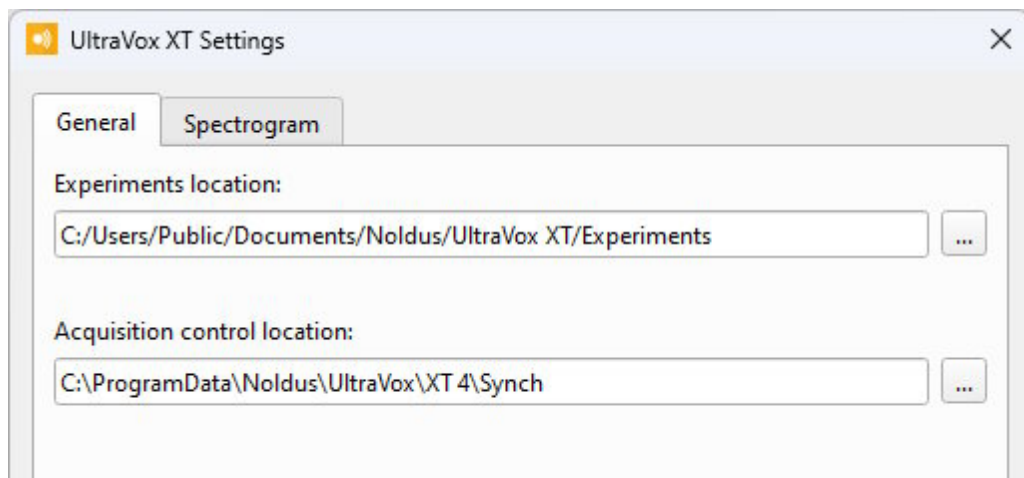
Aim

To access settings at the application level (default folder locations) and at the experiment level (e.g. the FFT settings).

Choose **File > Settings**, and click the page you require.

NOTE the Spectrogram page is only available when an experiment is open.

General page



Experiments location

All new experiments are stored in the following location

C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments

This folder is created at installation if you do not specify an alternative location.

When you create a new experiment, the software creates a sub-folder with the same name as the experiment. This folder contains all the files related to that experiment:

C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments\[**new experiment name**]

Acquisition control location

This is the folder where a file is copied in order to trigger the start/stop of recording from an external application (for example, EthoVision XT).

Default location is C:\ProgramData\Noldus\UltraVox\XT 4\Synch.

Spectrogram page

This page is only available after you have opened an experiment.

[See The Spectrogram](#)

Export data and results

Main topics and tasks

- Export recording statistics 134
- Export call statistics 135
- Export the spectrogram 138
- Export the recording as WAV file 139
- Import call data in The Observer XT 140
- Import call data in EthoVision XT 142

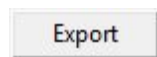
Export recording statistics

Aim

To export statistics of calls grouped according to name, or pattern label, or both. The statistics are saved to a CSV file.

Procedure

1. Choose **Analysis > Recording Statistics**.
2. Under **Call grouping**, select how you want the calls to be grouped in the table.
3. Under **Statistics**, choose which statistic to export.
4. Under **Recordings**, select the recordings you want to export and the way you want to group calls (for details see Calculate statistics).
5. Check the resulting table. When ready, click **Export**.



6. Specify the location and name of the file, and click **Save**.

Notes

- Under **Call grouping**, the option **Name and label** splits the data of a specific call name in different columns, each for a specific pattern label. The option **Name only** splits the data in columns based on the name of the calls, no matter what the call label is. The option **Label only** splits the data in multiple columns based on the label, no matter what the name of the calls is. Finally, the option **All calls** merge all calls in one group.
- The default name of the export file is:
[experiment name]_rec_stat_[date of export]_[time of export].csv.
- The default location of the export file is the **Output** folder within the experiment folder:
C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments\[experiment name]\Output.
- If a recording does not contain detected calls, the value of **Count** is 0 and the other statistics are "-".

Export call statistics

Aim

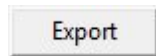
To export statistics of each call.

Procedure

1. Choose **Analysis > Call Statistics**.
2. Click the **Call Statistics** tab.
3. Under **Export**, choose the export format (see below).
4. Under **Export**, choose the recording containing the calls you want to export.

Choose one of the EthoVision XT options if you want to import the call data in EthoVision XT.

5. Click the **Export** button.



6. Repeat steps 3-5 to export more recordings.

Default file name

[experiment name]_[microphone name]_[independent variable value*]_[recording date]_[recording time (hhmmss)]_[recording time (ms)]_[Gnnn]_1_[flt].

- (*) present only if entered in the Recording List. For imported audio files, the file name is automatically added in the **Independent Variable** column of the Recording List.
- [Gnnn] is the gain used with that microphone.
- [flt] indicates that a filtered copy of the recording has been exported.
- For imported audio files, the microphone name is replaced by **Imported**.
- See Recording files for more details on file names.

Default export location

The **Output** folder of your experiment. If you did not change the default experiment location, you can find the export file in:

C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments\[experiment name]\Output.

Export file formats

EthoVision XT

This format is compatible with EthoVision XT 11 or newer. Data is saved to a *.etx file and stored as a call list.

Headers:

- Application name and date of export.
- Experiment name.
- Call file name (UVC file). See File types > Calls (.uvc)
- Microphone name, or "Imported" for imported audio files.
- Recording Date.
- Recording Start Time.
- "Time (msec)"; [Call definition 1], [Call definition 2], etc.

Data set

- The first column contains the time stamps of the start of each call, in ms.
- The second and next columns contain 0 (not a call start) or 1 (call start). Each column represents a call category (call name, or call name*pattern label). In the following example of an ETX file for EthoVision XT when opened in the Notepad, the call that started at 1.339 s is highlighted:

```
"Application";"Output produced 2024-12-13 13:50:00 by UltraVox XT 4.0 ;  
"Experiment";"UltraVox XT 4 - Sample experiment - Mouse vocalizations";  
"Call file";"UltraVox XT 4 - Sample experiment - Mouse vocalizations_Imported_Da  
"User device name";"Imported";  
"Date"; 2024-09-29;  
"Start time"; 10:25:07.343;  
"Time (msec)";"52-65k";"84-99k"  
End  
0;0;0  
1163;1;0  
1192;0;0  
1339;1;0  
1364;0;0  
1720;1;0  
1745;0;0  
1917;1;0  
1946;0;0  
2109;1;0  
2130;0;0
```


NOTES

- EthoVision XT does not import the values of amplitude and frequency of the single calls.
- Import of UltraVox XT data into EthoVision XT 10 or older is not supported.

The Observer XT

Data is saved to a *.odx file, containing the coding scheme, the call data in the form of an event log, and the link to the audio data.

NOTE The Observer XT can also import UltraVox XT XT files as external data (*.etx). Select **File > Import External Data** and choose **UltraVox XT 4 (*.etx)** as file type.

HTML

Data is saved to a html file, containing one row for each call.

The call list opens automatically in your default internet browser.

Text (.csv)

This is the format compatible with most statistics applications, such as MatLab, SPSS, R, Python etc.

```
Call;Call name;Label Label;Duration (ms);Start Time (s);Stop Time (s);Freq at Max Amp (Hz);Mean Amplitude;
1;50-65k;;29;1.16326;1.19194;61889.6;64.588
2;50-65k;;25;1.33939;1.36397;59936.5;79.143
3;50-65k;;25;1.72032;1.7449;64941.4;79.227
4;50-65k;;29;1.91693;1.9456;61157.2;75.912
5;50-65k;;20;2.10944;2.12992;57128.9;80.853
6;50-65k;;25;2.29786;2.32243;64819.3;39.017
7;50-65k;;49;7.55302;7.60218;59448.2;49.718
```

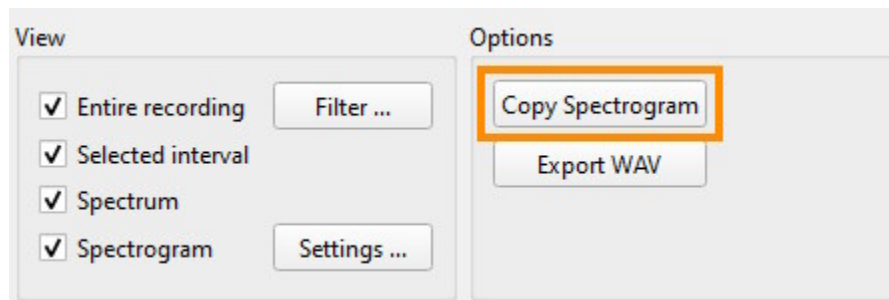
Export the spectrogram

Aim

To copy the spectrogram to another program.

Procedure

1. Open the Call Detection screen, or the Call Labeling screen.
2. Adjust the spectrogram size and zoom level if necessary, to visualize the calls at the desired level of detail. See The Spectrogram
3. Under **Options**, click the **Copy Spectrogram** button.



4. In the other program, press **Ctrl+V**.

Export the recording as WAV file

Aim

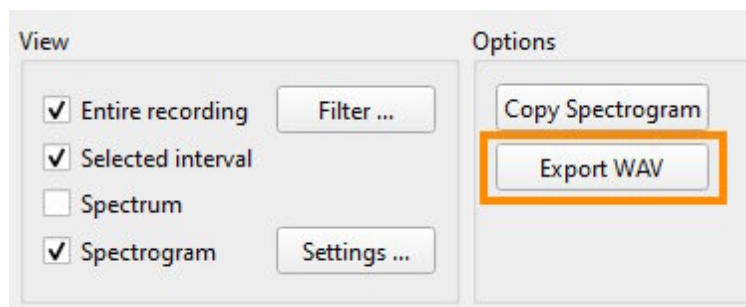
To export your recordings as sound files of WAV format. For example, to include them in a presentation or submit them to a journal as supplementary material.

Prerequisites

You have opened the Call detection or Call labeling screen.

To export a recording to a WAV file

1. Under **Recording**, select the recording you want to export.
2. Under **Options**, click the **Export WAV** button.



3. Specify a location and a name for the file.
4. Click **Save**.

Note

For a collection of mouse vocalizations, see <https://mousetube.pasteur.fr/>

Import call data in The Observer XT

To import the data

In The Observer XT, do one of the following:

- To import a recording as a separate observation: Choose File > Import > Observational Data.
- To import a recording into an existing observation: open that observation and click the **Import data button**.



Next, follow the instructions on the screen.

Coding scheme

In The Observer XT coding scheme, calls are imported as discrete events, each consisting of a state event (call name) and a modifier (pattern label).

- State events are listed in one Start-stop group named Calls. Call events with different names can be overlapping.
- If a call was labeled in UltraVox XT before exporting, the corresponding state event is attached to the modifier with the same name as the label. Modifiers are listed in a group named Pattern.

Behaviors					Modifiers		
Add Behavior group...		Add Behavior			Add Modifier group...		Add Modifier
Behavior Name			Behavior Type	Modifiers	Modifier Name		St...
Calls (Start-Stop)					Pattern (Nominal, Optional)		
52-65k	5		State Event	Pattern	Undefined		AA
84-99k	8		State Event	Pattern	Descend		AB
					Chevron		AC
					Flat		AD
					Squiggle		AE

Data in the event log

In the event log, calls are represented with two rows, one marking the call start time and one marking the stop time.

Time	Behavior	Modifier	Comment
2.113	 52-65k	Chevron	
2.133	 52-65k	Chevron	

Data visualization

When visualizing the observation, calls are shown as colored segments on the timeline. Click the + sign next to the headers to view the calls with their pattern labels.



Calls

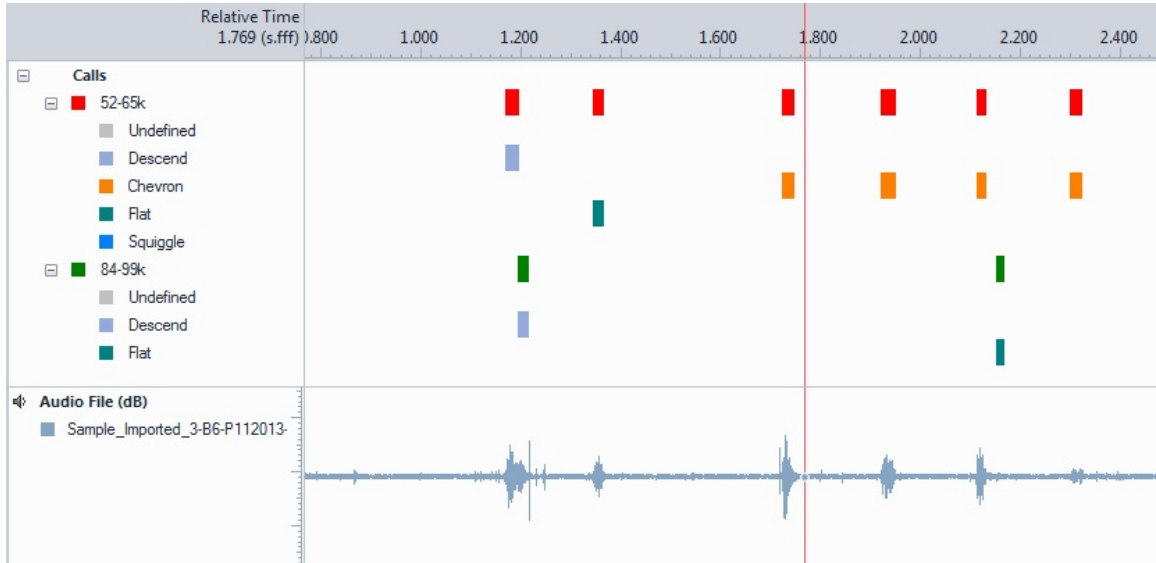


 52-65k



 84-99k

The audio data is displayed as a waveform. For more information, see The Observer XT Help.



Import call data in EthoVision XT

To import call data

1. In EthoVision XT, open the Trial List.
2. Click the **Import External Data** button.
3. Under **Files of type**, select **UltraVox XT [version number]**.
If you do not see this profile, install it from the UltraVox XT installation USB stick.
4. Select the *.etx files and click **Open**.
5. Drag the data lines from the Import External Data window to the trial you require.
6. When ready, click **Import**.

Data for each call name (or call name*pattern label) is imported and resampled as a separate dependent variable.

For more information on importing and analyzing external data, see the EthoVision XT Help.

Analysis profile

For each call type imported, the analysis profile shows two dependent variables, the **continuous** (resampled) and the **state** variable. This is a variable with discrete values 0 and 1 derived by the resampled variable.

For example, you exported calls of type 52-65 kHz (call name) labeled with "Chevron" (label name). To analyze those calls you have two options:

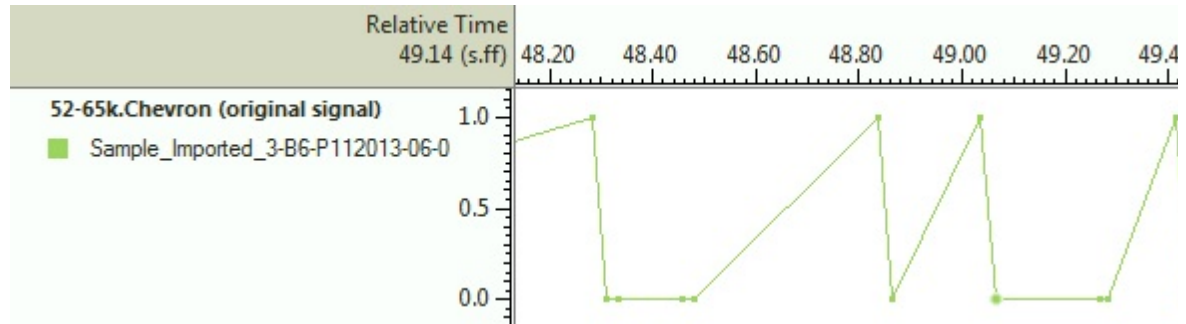
52-65k.Chevron continuous	<input type="checkbox"/>
52-65k.Chevron state	<input type="checkbox"/>

Click the button next the variable you want to analyze, and choose the type of upsampling/downsampling you require.

Integrated visualization

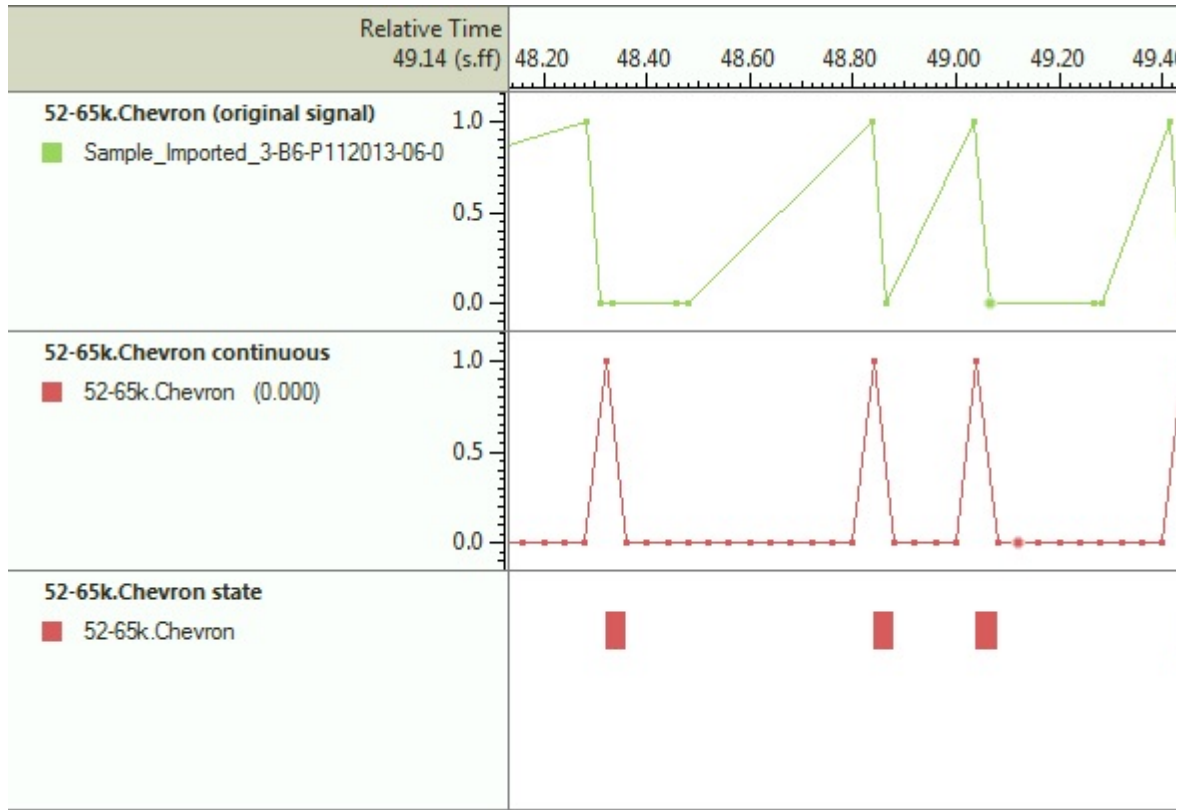
To visualize the original UltraVox call data, choose **Show/Hide > Dependent Variables** and select the **[call name*pattern label] (original signal)**.

When plotted against time, the data look like this:



Where 1 on the y-axis represent the onset of the call. The transition 1-0 represents the call end.

When visualized, the resampled variable look like this (second and third plot):



Installation

Main topics and tasks

- Install UltraVox XT 146
- Install the USB 3.0 interface card 149
- License activation 155
- End-user license agreement 160
- Acknowledgments and copyright notices 161

Install UltraVox XT

What do you want to do?

- Check the System requirements 146
- Install UltraVox XT 151
- Start UltraVox XT for the first time 153

See also

- License activation
- Installation

System requirements

If you order a complete solution from Noldus Information Technology, you will obtain one of the computers listed below or their successors, with UltraVox XT installed and ready to use.

Operating system

- UltraVox XT 4 supports Windows 11 Pro and was tested on Windows 11 Pro, version 23H2.
- Shorter tests (no recording, only import of audio files) have been performed on Windows 10 Pro, 22H2, with no issues.

Computer

Dell Precision 3680 desktop

- Processor: Intel Core i7-14700, 20 CPU cores, 3.4 GHz.
- Internal memory: 32 GB DDR5.
- Hard disks: M.2 1TB PCIe NVMe SSD.
- Graphics card: NVIDIA T1000, 4 GB GDDR6.
- Operating system: Windows 11 Pro.

Dell 3591 mobile

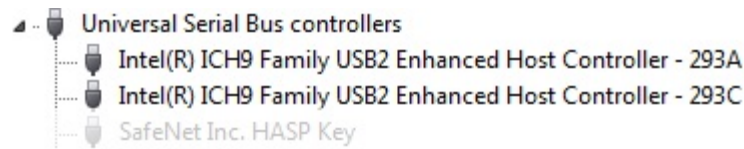
- Processor: Intel Core Ultra 7 155H vPro Essentials, 16 cores, up to 4.8 GHz
- Internal memory: 16 GB DDR5.
- Hard-disks: M.2 2280 1 TB PCIe NVMe SSD.
- Graphics card: NVIDIA RTX 1000, 6 GB GDDR6.
- Operating system: Windows 11 Pro.

USB ports

With Noldus microphones, we recommend to use USB 3.0 ports.

- For USB 3.0: the PC must have as many ports as microphones.
- For USB 2.0: the PC must have as many controllers as microphones. To check how many USB2 controllers are present on your computer, in the

Control Panel choose **System and Security** > **Device Manager**. Under **Universal Serial Bus Controllers** check the items named "USB2".



- When using 384 kHz microphones, each microphone must be connected to one USB controller. If you connect multiple microphones to USB ports which shares the same USB controller, Windows recognizes the devices but signals won't be recorded. Therefore, when using multiple microphones of this type, we recommend to use a multi-port USB 3.0 interface card (see Install the USB 3.0 interface card). Alternatively, use a powered USB 3 hub, or add a USB 3.0 card to the PC for each microphone.

NOTE A powered, or active, USB hub is powered through a wall outlet to bring each hub port to the same energy level as an on-system port.

TIP USB 3.0 connectors and ports can be recognized by their symbols, and often also by their blue color coding.



USB 3.0 PCIe interface card

UltraVox XT has been tested with the Fresco Logic U3X4-PCIE4XE111 rev 1.1 PCIe interface card to connect multiple USB 3.0 microphones. See Install the USB 3.0 interface card

Disk space

A 10-minute recording with one microphone requires:

- For 384-kHz microphones, approx. 400 MB.
- For 250-kHz microphones, approx. 300 MB.

The maximum file size, for all microphones, is about 4 GB per microphone. The maximum recording duration depends on the type of microphone.

USB 3 hub

UltraVox XT has been tested with the following USB 3 hub:

- D-link 4-port DUB-1340, with bit rate 5 Gbps.

In all cases we recommend to use a USB hub compatible with USB 3.0.

Microphones

- For ultrasonic measurements, you must use the microphones that come with UltraVox XT.
- Maximum number of microphones: 4. However, when using 384-kHz microphones and a laptop computer (Dell 7510), we recommend to use up to three microphones.

NOTE The maximum number of microphones also depends on your UltraVox XT license. See Request a license

- Standard microphones (for human audible vocalizations) have not been extensively tested with UltraVox XT. When using these microphones, the maximum sampling frequency is set to the standard 44100 Hz for human audible vocalizations. UltraVox XT will not record ultrasonic frequencies.
NOTE A third party microphone can only be used when it fully supports a 44100 Hz sample rate.
- The maximum recording duration depends on the microphones being used. See Recording sound

Sound files

You can import sound stored in WAV files (*.wav), recorded in Windows PCM format, mono, with 16-bit depth. See Import sound files

TIP If your audio files are stereo or with 32-bit depth, resample them in software like Audacity and export them as WAV files.

See also

- UltraVox XT microphones

Install the USB 3.0 interface card

Aim

To install an interface card that receives data from up to four USB 3.0 microphones.

NOTE If you ordered a computer from Noldus Information Technology when you purchased UltraVox XT and ultrasonic microphones, this card has already been installed and tested. If you bought your computer somewhere else, you will have to install the card yourself. Follow the instructions below.

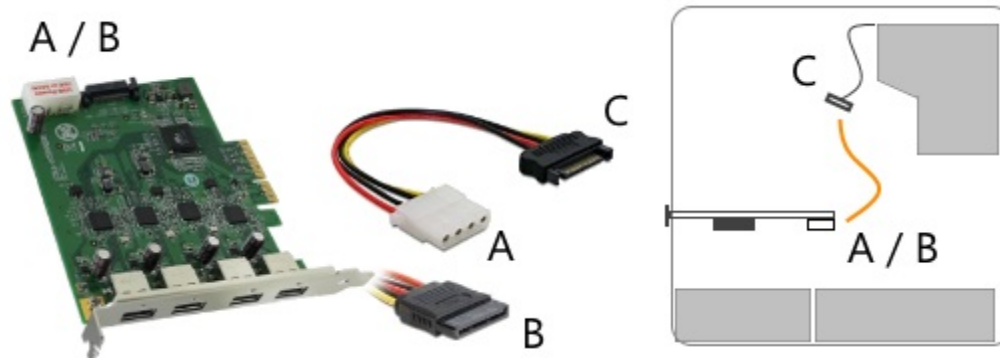
IMPORTANT UltraVox XT was tested with the following USB 3.0 interface card: Fresco Logic U3X4-PCIE4XE111 rev 1.1.



Procedure

1. Turn off your computer and all connected peripherals, such as the monitor and printer. Make sure that the computer is unplugged.
2. Remove the PC's case according to the instructions provided in the PC's user manual.
3. Select a free **PCIe** expansion slot, and remove the corresponding extension cover.
4. Unpack the USB 3.0 interface card, place it into the slot, and press it carefully into position. If the card does not fit into place easily, remove it and repeat the operation.
5. Connect the power connector on the board to one of the power supplies inside the PC. For this purpose, either use the Molex/IDE male 4-pin DC connector or the SATA male 15-pin connector that you find on the board.

Connector types vary between computers. Dell computers have a SATA 15-pin power connector. Use an adapter cable with a 4-pin female Molex/IDE DC power connector or a SATA 15-pin power connector at one end, depending on the connector on the card you use (A), and a SATA 15-pin connector at the other end (B).



6. Fix the card to the chassis and re-fit the computer's cover.

7. Connect each microphone to a USB port.

IMPORTANT Make sure that you always connect a microphone to the same USB 3.0 port. Label microphones and USB ports if necessary.

See also

- Connect the microphones

Install UltraVox XT

NOTE UltraVox XT 4 only works with a software license, not with a hardware key as it was the case for UltraVox XT 3.x.

Procedure

Download UltraVox XT from my.noldus.com

1. Browse to <https://my.noldus.com>.
2. Log in or register using the registration code on your welcome letter.
3. Click **Downloads**, then **UltraVox XT**. Under **Versions**, download the **UltraVox XT 4 - Installation Package [version number].zip** file.

Unzip the file and save the content to your PC.

Install UltraVox XT

1. Double-click the setup file with extension **exe**.
2. Under **Installation type**, select **Standard**.
UltraVox XT will be installed on C:\Program Files\Noldus\UltraVox XT 4. If you want to install UltraVox XT on another location, select **Custom** and specify there the new installation location. Note, however, that some links in the Help may not work if the software is installed in a folder other than the default one.
3. Select **I agree with the End-User License Agreement** and click **Install**.
4. Click **Close** to complete installation.

Note

- Your license of UltraVox XT determines which setup is available to you. See License activation
- If you need to install a USB 3.0 interface card on the UltraVox XT computer, see Install the USB 3.0 interface card
- The experiments will be stored by default on C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments.

If you wish to store the experiment in another folder or drive, specify the new location in UltraVox XT (**File > Settings > General > Experiments location**).

- To uninstall UltraVox XT, in the Windows **Start** menu choose **Settings** > **Apps** > **Installed Apps**, then select **UltraVox XT** and choose **Uninstall** from its menu.

See also

- System requirements

Start UltraVox XT for the first time

Prerequisites

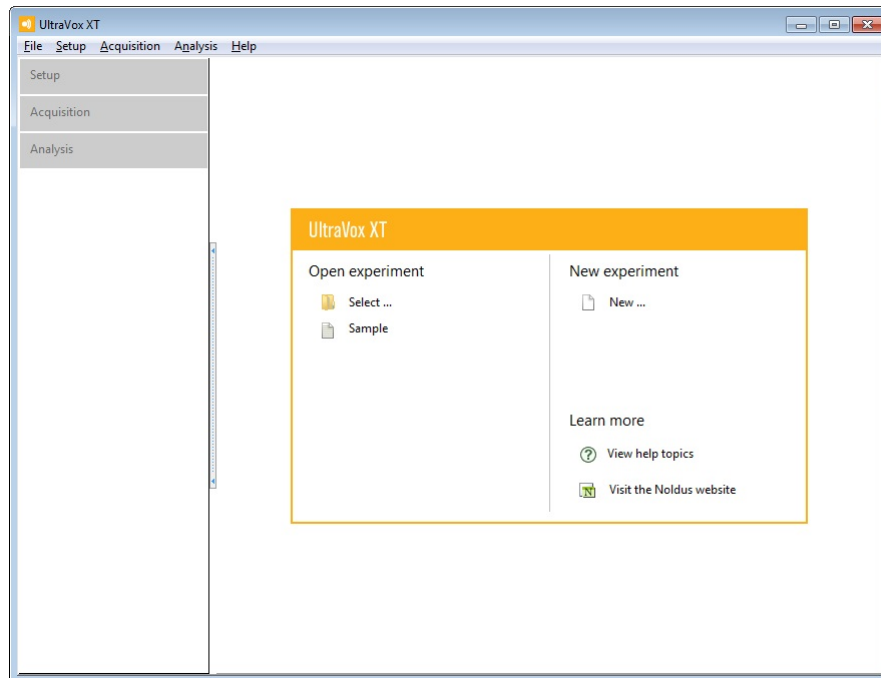
You need to have a license activation code to be able to run the full version of UltraVox XT.

Procedure

1. In the Apps screen, under **Noldus**, click the **UltraVox XT** icon.



2. Click **Import License File**. Select the UltraVox XT 4 license file (*.json) that you received from Noldus.
3. After that, the UltraVox XT start screen opens.



Next actions

- Create a new experiment
- Open an existing experiment (choose **File** > **Open**).

Note

- The Select window only lists the experiments currently stored in the experiments location. You cannot open another location.
- Click **Evaluate UltraVox XT** to open the free evaluation version. With a free evaluation version, you can only open the sample experiment that is stored on C:\Users\Public\Documents\Noldus\UltraVox XT\Experiments.
- Click **Request a License** to obtain a quotation for a UltraVox XT license.

License activation

What do you want to do?

- [Activate your license](#)

Learn about

- [Licensing options](#)

See also

- [End-user license agreement](#)
- [Acknowledgments and copyright notices](#)

Activate your license

Aim

To activate the license for a newer version of UltraVox XT.

If you have a previous version of UltraVox, the hardware key (also known as the *dongle*) associated with that version does not work with UltraVox XT 4. Please contact Noldus to purchase an upgrade to UltraVox XT 4.

Prerequisites

- You have downloaded and installed UltraVox XT from my.noldus.com.

NOTE You do not need to uninstall previous UltraVox XT versions.

Procedure

Request a license

If you already have a license file, go to the next section.

IMPORTANT Request the license from the computer you intend to use with UltraVox XT. This is because the UltraVox XT license contains information about the machine that UltraVox XT is installed on.

If your computer is not connected to the internet or you can only request a license on a different computer, in step 3 take note of the **AppID** and send it to Noldus.

1. Make sure your computer is connected with the internet.
2. Start UltraVox XT.
3. Click the **Request a License** button.
4. Fill in the necessary data:
 - **Company/Organization.**
 - **Name** and **email address** of the main user.
 - The **Number of microphones** you would like to use simultaneously.
5. Click **Send Request**. The request is sent to Noldus. After you have purchased the license, you receive a license file.
6. Activate your license (see below).

Activate your license

1. Start UltraVox XT.
2. Click **Import License File** or choose **Help > Import License File**.
3. Select the UltraVox XT 4 license file (*.json) that you received from Noldus.
4. Click **Open**.
5. A message informs you that the license has been successfully activated.

Activate an additional module

If you have UltraVox XT 4 and purchased an upgrade in order to use more microphones simultaneously, do the following:

1. Start UltraVox XT.
2. Do one of the following:
 - Choose **Help > Request License** if you do not have yet a license file for that module. After you have received a license file, activate the license (see Activate your license).
 - Choose **Help > Import License File** if you already have a license file for that module that you received from Noldus. Select that file and click **Open**.

Licensing options

	Unregistered Trial License	Registered Trial License	Full License	Classroom License
Registration needed	No	Yes ⁽²⁾	Yes	No
Price	Free ⁽¹⁾	Free	Paid	Free ⁽⁴⁾
Record audio	No	Yes	Yes ⁽³⁾	No
License duration	Perpetual	14 days	Perpetual or Subscription ⁽⁵⁾	30 days
Create new experiments	No	Yes	Yes	Yes
Open existing experiments	Only sample experiment	Yes	Yes	Yes
Sample experiment	Yes	Yes	Yes	Yes
Import files	Only sample files	Yes	Yes	Only sample files
Call detection	Yes	Yes	Yes	Yes
Export results	Yes	Yes	Yes	Yes
Export calls to EthoVision XT	No	Yes	Yes	Yes
Export calls to The Observer XT	No	Yes	Yes	Yes

(1) Unregistered Trial Licenses only work with one specific audio file included in the installation package.

(2) Registration requires user name, organization and e-mail address.

(3) One Full License supports up to four microphones.

(4) Classroom licenses are free of charge for owners of a Full License with active NoldusCare. They are recommended for teaching courses, with max. 50 seats, for 30 days. They come with a teaching package (installation instructions, background, manual, sample audio files, report template). They work with the bundled sample files only.

(5) Perpetual licenses are valid for the version purchased and remain in effect for an indefinite time. If you sign up for NoldusCare you can get major upgrades. You can

also purchase upgrades separately without NoldusCare. With a Subscription license you can always download the latest version of UltraVox XT and stay up-to-date.

See also

- License activation

End-user license agreement

Procedure

To open a PDF copy of the End-User License Agreement, do one of the following:

- Browse to the following file:
<C:\Program Files\Noldus\UltraVox XT 4\Documentation\Legal\End-User License Agreement.pdf>
- In UltraVox XT, choose **Help > About UltraVox XT > License Info > End-User License Agreement**.

Notes

- If you installed UltraVox XT on a folder other than the default one, then browse to that folder, and open
...\UltraVox XT 4\Documentation\Legal.

See also

- Acknowledgments and copyright notices

Acknowledgments and copyright notices

UltraVox™ is a trademark of Noldus Information Technology BV. UltraVox XT would not be what it is without the use of third-party software. This page lists software libraries and other software products used in UltraVox XT and where you can find license and compliance information and/or acknowledgments for that product.

The PDF of the copyright notices are stored in

C:\Program Files\Noldus\UltraVox XT 4\Documentation\Legal\Acknowledgments.

Asio

Cross-platform C++ library for network and low-level I/O programming. Version 1.32.0. Copyright © 2003-2024 Christopher M. Kohlhoff. Distributed under the Boost Software License, Version 1.0.

<https://github.com/chriskohlhoff/asio/tree/master>

https://github.com/chriskohlhoff/asio/blob/master/asio/LICENSE_1_0.txt

bb-audio

Library for recording, handling and analyzing audio files. Version 1.6.1. Copyright © 2025 Brain Builders BV.

<https://brain.builders/>

bb-license

Library for handling license restrictions. Version 2.2.0. Copyright © 2025 Brain Builders BV.

<https://brain.builders/>

ed25519

Public-key signature system used for verifying audio files and licenses.

Copyright © 2015 Orson Peters. Distributed under the zlib license.

<https://github.com/orlp/ed25519>

<https://github.com/orlp/ed25519/blob/master/license.txt>

{fmt}

Open-source string formatting library for logging. Version 11.0.2.

Copyright © 2012 - present, Victor Zverovich and {fmt} contributors.

<https://github.com/fmtlib/fmt>

<https://github.com/fmtlib/fmt/blob/master/LICENSE>

GCC

Integrated distribution of compilers for several major programming languages.

Copyright © 2023 The Free Software Foundation, Inc. This program is distributed under the GNU General Public License. Version 13.1.0.

<https://www.fsf.org>

<https://www.gnu.org/licenses>

muFFT

Library for performing the Fast Fourier Transform (FFT) in one or two dimensions.

Copyright © 2015 Hans-Kristian Arntzen.

<https://github.com/Themaister/muFFT>

<https://github.com/Themaister/muFFT/blob/master/COPYING>

nlohmann json

Class of JSON libraries used for reading license files. Version 3.11.3.

Copyright © 2013-2024 Niels Lohmann.

<https://github.com/nlohmann/json>

<https://github.com/nlohmann/json/blob/develop/LICENSE.MIT>

OpenSSL

Toolkit for general-purpose cryptography and secure communication. Version 3.4.0. OpenSSL is licensed under the Apache License 2.0.

Copyright © 2025 OpenSSL.

<https://openssl-library.org/>

<https://github.com/openssl/openssl/blob/master/LICENSE.txt>

PortAudio

PortAudio is a cross-platform, open-source C language library for real-time audio input and output. Version 19.7.0. PortAudio is licensed under MIT license.

<https://github.com/PortAudio>

<https://portaudio.com/license.html>

Qt

Qt is a cross-platform application development framework for creating graphical user interfaces. Version 6.7.3. Qt used in UltraVox XT development is licensed under a commercial license.

<https://doc.qt.io/qt-6/licensing.html>

Simpleini

Simpleini is a cross-platform library that provides a simple API to read and write ini-style configuration files. Version 4.20. Simpleini is licensed under the MIT License.

Copyright © 2006-2024 Brodie Thiesfield.

<https://github.com/brofield/simpleini>

<https://github.com/brofield/simpleini/blob/master/LICENCE.txt>

Spdlog

Spdlog is a C++ logging library. Version 1.15.0. Spdlog is licensed under the MIT License.

Copyright © 2016 Gabi Melman.

<https://github.com/gabime/spdlog>

<https://github.com/gabime/spdlog/blob/v1.x/LICENSE>

Ultravox Library

Software development kit for all UltraVox XT functionality. Version 1.1.1. Copyright © 2025 Brain Builders BV.

<https://brain.builders/>

Control UltraVox XT from other software

Aim

To start and stop recording in UltraVox XT from EthoVision XT or The Observer XT.

Example: You plan to video-track animals with EthoVision XT or record their behavior with The Observer XT and, at the same time, record ultrasound with UltraVox XT. For ease of use you want to start and stop recording with one click, in such a way the UltraVox data and the EthoVision XT/The Observer XT data are synchronized.

How it works

1. When proper communication is set between the two applications, you can start and stop recording in UltraVox XT by clicking the Start trial/Stop trial button in EthoVision XT.
2. You can then import call data into EthoVision XT for combined analysis of tracks and vocalizations. See Import call data in The Observer XT and Import call data in EthoVision XT.



Main topics and tasks

- Computer setup 166
- Trigger settings for EthoVision XT 177
- Trigger settings for The Observer XT 179
- Co-acquisition of data 181
- Import profiles 182

See also

- Start and stop recording at specific times

Computer setup

Computers

We advise to run UltraVox XT and EthoVision XT/The Observer XT on separate computers. On both computers, disable the firewall.

IMPORTANT Running EthoVision XT/The Observer XT and UltraVox XT on the same computer is not recommended. The large data transfer may cause malfunctioning in either application. Test this solution thoroughly if you want to use it. For example, check that EthoVision XT does not miss samples, or that data streams from the two applications are in sync.

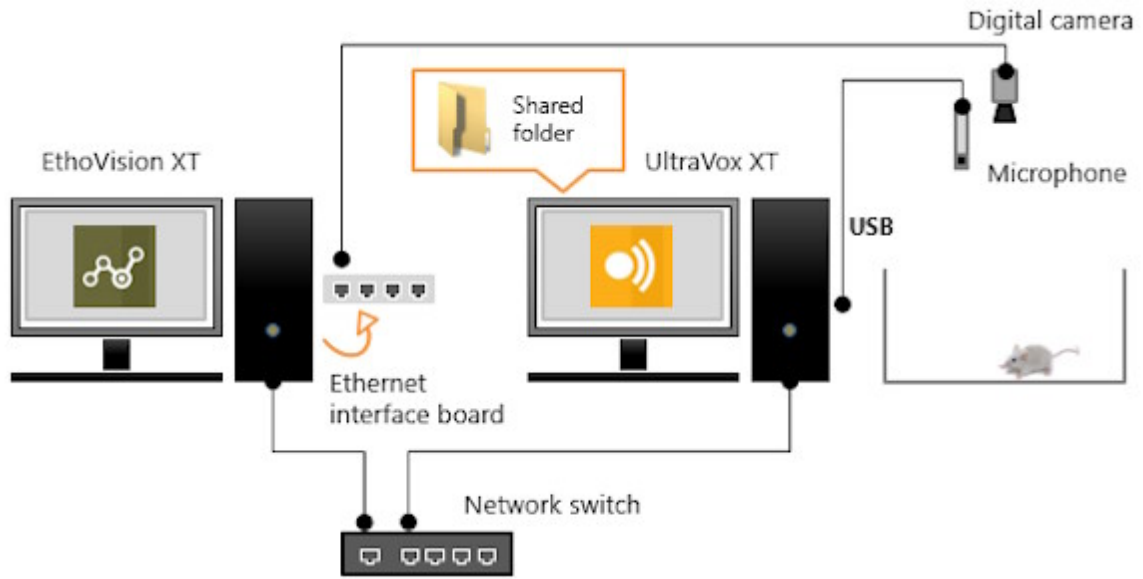
Network

The two computers should be connected to a dedicated network using a network switch. To avoid the risk of network communication delays, we recommend not to connect the computers to a larger network.



UltraVox XT computer (right) connected to an EthoVision XT or The Observer XT computer (left) through a network switch.

A typical EthoVision XT setup for one camera and one microphone would look like this:



Procedure

- Specify the IP address of the UltraVox XT PC
- Share the UltraVox XT synchronization folder
- Make a virtual drive for the EthoVision XT / The Observer XT
- Copy the UltraVox XT Control folder to the EthoVision XT/The Observer XT PC
- Edit the StartUV/StopUV batch files
- Make UltraVox XT data import easier

Specify the IP address of the UltraVox XT PC

Procedure

On the UltraVox XT computer, do the following:

1. In the Control Panel, choose **Network and Internet > Network and Sharing Center**.
2. Choose **Change adapter settings**.
3. Right-click the local network and choose **Properties**.
4. Select **Internet Protocol Version 4** and click the **Properties** button.
5. Select **Use the following IP address**.
6. Enter the IP address that is in the batch file (suggested: 192.168.0.202; this address must also be specified in the batch file).

Leave the Subnet mask and Default gateway unchanged.

Note

- We recommend to use one PC for EthoVision XT and one PC for UltraVox XT. Connect the two computers through a network switch and assign the IP addresses to enable communication. For example:

For example:

Network switch: 192.168.0.239 (Netgear GS310TP)

EthoVision XT PC: 192.168.0.201

UltraVox XT PC: 192.168.0.202

- You can assign an IP address other than specified here. However, you must enter the same address in the batch file. This address must be different from that of the EthoVision XT/The Observer XT computer. See Edit the StartUV/StopUV batch files

Next

- Share the UltraVox XT synchronization folder

Share the UltraVox XT synchronization folder

Procedure

1. With Windows Explorer, browse to C:\ProgramData\Noldus\UltraVox\XT 4\Synch.
2. If you do not see this folder, it may be hidden. See the note below.
3. Right-click and select **Properties**, then click the **Sharing** tab.
4. Click **Share** and select **Everyone**. In the context menu choose **Read/Write**.
5. Click **Share**, then **Done**.

The Synch folder can now be “seen” by the EthoVision XT/The Observer XT computer.

Next: Make a virtual drive for the EthoVision XT / The Observer XT

Note

To view hidden folders:

1. In the Windows Control Panel, choose **Appearance and Personalization**, then under **Folder Options** click **Show Hidden Files and Folders**.
2. In the window that appears, under **Hidden files and folders**, select **Show hidden files, folders and drives**.

Make a virtual drive for the EthoVision XT / The Observer XT

Aim

To make data transfer from UltraVox XT and EthoVision XT easier. Once the procedure is completed, you can easily access the UltraVox XT data and import them in EthoVision XT/The Observer XT.

Procedure

1. On the EthoVision XT PC, with Windows Explorer, right-click **This Computer** and choose **Map network drive**.
2. Choose a drive letter.
3. Select the shared Synch folder from the UltraVox XT PC.
4. Click **Finish**.

Next: Copy the UltraVox XT Control folder to the EthoVision XT/The Observer XT PC

Copy the UltraVox XT Control folder to the EthoVision XT/The Observer XT PC

Aim

To provide EthoVision XT or The Observer XT with the files necessary to communicate with UltraVox XT.

NOTE The UltraVox XT Control folder is installed automatically with EthoVision XT. Therefore, if you have EthoVision XT you do not have to follow the procedure below. Skip this topic and go to Edit the StartUV/StopUV batch files

Procedure

1. Open the UltraVox XT 4 installation package and browse to **Extras**.
2. Select the folder **UltraVox XT 4 Control**, and press **Ctrl+C**.
3. Open the following folder:
C:\Program Data\Noldus\Common\Tools
If the **Tools** folder is not present, create it.
4. Open the **Tools** folder and press **Ctrl+V**.
5. Open the folder just copied, and check that the two files SUV.bat and start.txt are present.

Next: Edit the StartUV/StopUV batch files

Edit the StartUV/StopUV batch files

Aim

To make sure that the batch file triggers UltraVox XT when activated by Noldus software.

Background information

Once activated by Noldus software, a batch file StartUV*.bat or StopUV*.bat does the following:

1. It connects with the UltraVox XT computer, and deletes any file named start.txt from the folder C:\Program Data\Noldus\UltraVox\XT 4\Synch (if present).
2. It copies the file start.txt (or stop.txt) to the folder C:\Program Data\Noldus\UltraVox\XT 4\Synch on the UltraVox XT computer.

The files start.txt and stop.txt are empty text files. Their function is to trigger UltraVox XT, provided that this is set to "external program trigger" in the Trial Control Settings. See Trigger start/stop recording

Procedure

1. Browse to C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4 Control. If this folder does not exist, see Copy the UltraVox XT Control folder to the EthoVision XT/The Observer XT PC.
2. Locate one of the *.bat batch files:
For EthoVision XT with one arena, or The Observer XT: choose **StartUV - 2 PCs** or **StopUV - 2 PCs.bat** depending on which you want to use.
For EthoVision XT with two or more arenas, choose **StartUV - 2 PCs multiple arenas.bat** or **StopUV - 2 PCs multiple arenas.bat**
3. Right-click the batch file and select **Edit with Notepad**.
4. Insert the IP address that you assigned in step Specify the IP address of the UltraVox XT PC. See the instructions below depending on what file you are editing.
5. In all cases, make sure that the path of the file start.txt / stop.txt is C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4 Control.
6. Save and close the file.

StartUV - 2 PCs.bat

Use this file in the external command for starting recording in UltraVox XT.

```
@if exist "\\IP address of UltraVox XT PC\Synch\start.txt"
del "\\IP address of UltraVox XT PC\Synch\start.txt"

@copy "C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4
Control\start.txt" "\\IP address of UltraVox XT PC\Synch" >
nul
```

Replace "IP address..." with the actual IP address of the UltraVox XT PC. Alternatively, enter the name of the PC that you find in Windows (e.g. DESKTOP-123ABC) instead of the IP address.

The batch file copies the file start.txt to the trigger folder of UltraVox XT. This starts recording in UltraVox XT.

StopUV - 2 PCs.bat

Use this file in the external command for stopping recording in UltraVox XT.

```
@if exist "\\IP address of UltraVox XT PC\Synch\stop.txt" del
"\\IP address of UltraVox XT PC\Synch\stop.txt"

@copy "C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4
Control\stop.txt" "\\IP address of UltraVox XT PC\Synch" >
nul
```

Replace "IP address..." with the actual IP address of the UltraVox XT PC. Alternatively, enter the name of the PC that you find in Windows (e.g. DESKTOP-123ABC) instead of the IP address.

The batch file copies the file stop.txt to the trigger folder of UltraVox XT. This stops recording in UltraVox XT.

StartUV - 2 PCs multiple arenas.bat

If you work with multiple arenas, use the batch file **StartUV - 2 PC multiple arenas.bat** to start recording in UltraVox XT. This way the file start.txt is sent out just one time, for Arena 1. If the arena has a different name, open the file with the Notepad and edit the name between the quotes.

```
@if exist "\\IP address of UltraVox XT PC\Synch\start.txt"
del "\\IP address of UltraVox XT PC\Synch\start.txt"

@echo off
```

```
echo %1
```

```
IF %1=="Arena 1" (
```

```
@copy "C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4  
Control\start.txt" "\\IP address of UltraVox XT PC\Synch" >  
nul  
)
```

Replace "IP address..." with the actual IP address of the UltraVox XT PC. Alternatively, enter the name of the PC that you find in Windows (e.g. DESKTOP-123ABC) instead of the IP address.

StopUV - 2 PCs multiple arenas.bat

If you work with multiple arenas, use the batch file **StopUV - 2 PC multiple arenas.bat** to stop recording in UltraVox XT. This way the file stop.txt is sent out just one time, for Arena 1. If the arena has a different name, open the file with the Notepad and edit the name between the quotes.

```
@if exist "\\IP address of UltraVox XT PC\Synch\stop.txt" del  
"\\IP address of UltraVox XT PC\Synch\stop.txt"
```

```
@echo off
```

```
echo %1
```

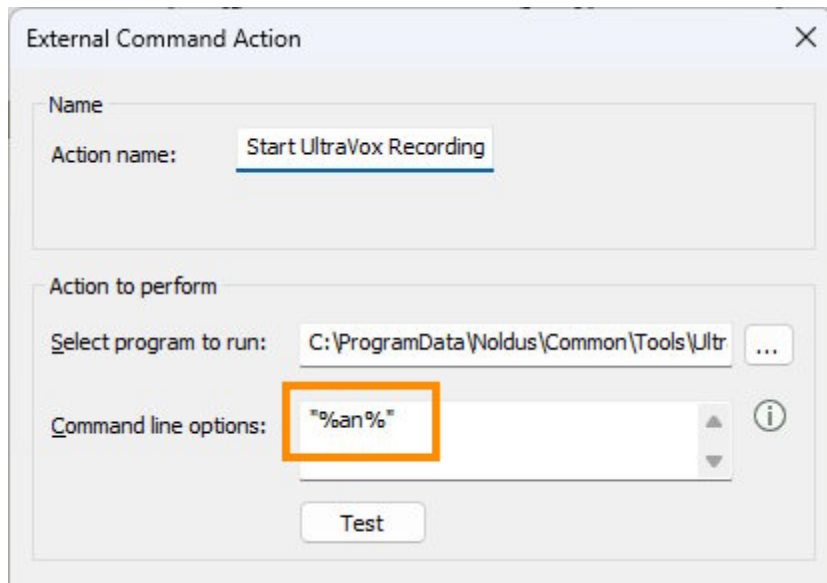
```
IF %1=="Arena 1" (
```

```
@copy "C:\ProgramData\Noldus\Common\Tools\UltraVox XT 4  
Control\stop.txt" "\\IP address of UltraVox XT PC\Synch" >  
nul  
)
```

Replace "IP address..." with the actual IP address of the UltraVox XT PC. Alternatively, enter the name of the PC that you find in Windows (e.g. DESKTOP-123ABC) instead of the IP address.

Command line options

An important point when working with multiple arenas: in the Action boxes in the Trial Control Settings of EthoVision XT, specify the Command line options: **"%an%"**, quotes included. For more information, see the EthoVision XT 18 - Trial and Hardware Control - Reference Manual.



Working with one PC

It is also possible to run EthoVision XT and UltraVox XT on the same PC. In this case use the batch files **StartUV - 1 PC.bat** and **StopUV - 1 PC.bat**. However, this solution is not supported as it may cause high workload on the memory and the processor, depending on your setup, the number of arenas and the method use for tracking. For example, Deep learning-based tracking is more demanding than Contour-based tracking. If you need install both applications on one PC, test your setup thoroughly and make sure that the proportion of missing samples in your tracks is acceptable.

Next: Make UltraVox XT data import easier

Make UltraVox XT data import easier

Aim

When importing the call statistics files from UltraVox XT to EthoVision XT/The Observer XT, a shared folder may be handy that allows to import the files directly through the network.

Procedure

1. On the UltraVox XT computer, make a general folder where you are going to place all export (*.etx) files.
2. Share this folder (see a similar procedure in Share the UltraVox XT synchronization folder).
3. On the EthoVision XT/The Observer XT computer, create a virtual drive for this shared folder (see a similar procedure in Make a virtual drive for the EthoVision XT / The Observer XT).

Next: Follow the procedure that applies.

- Trigger settings for EthoVision XT
- Trigger settings for The Observer XT

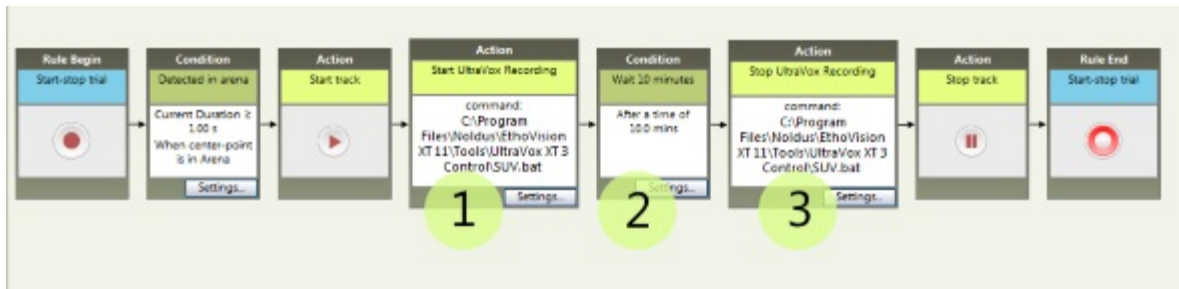
See also

- Import call data in EthoVision XT
- Import call data in The Observer XT

Trigger settings for EthoVision XT

In EthoVision XT

1. Choose Setup > Trial Control Setting > New.
2. Make a Trial Control Settings rule like in the following picture.




1 External command that runs one of the batch files StartUV*.bat. This copies the start.txt file to the trigger folder of UltraVox XT.

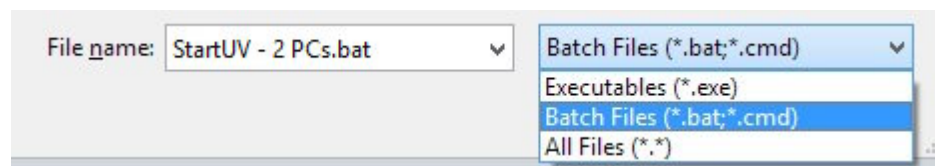
2 Time condition for waiting a fixed time (for example, 10 minutes). This determines the length of the EthoVision XT tracks and UltraVox XT recordings.

3 External command that runs one of the batch files StopUV*.bat. This copies the file stop.txt to the trigger folder of UltraVox XT.

See also Edit the StartUV/StopUV batch files

External command box (1 and 3):

1. In the Components pane, under **Actions**, choose **External command**.
2. In the External Command Action window that appears, under **Action to perform**, click the button .
3. In the Open window, choose to view **Batch Files (*.bat, *.cmd)**.



4. Select the file with extension **.bat** that you require.
5. **IMPORTANT** When you work with multiple arenas, enter **"%an%"** under **Command line options** in both External command boxes. See Command line options

6. **OPTIONAL** Under **Name**, give a name to this action box (e.g. *Start UltraVox recording* for (1), *Stop UltraVox recording* for (3)).

Time condition box (2)

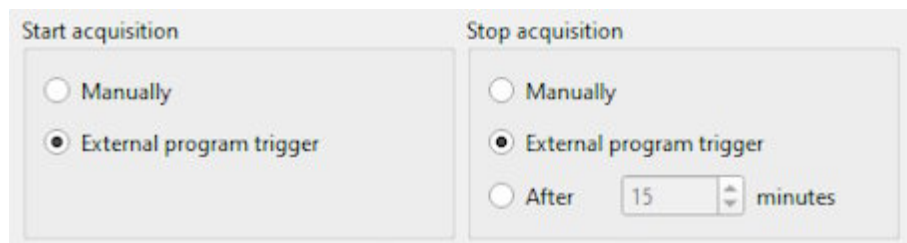
1. Click the **Settings** button.
2. Enter the time required, i.e., the duration of the recording.

See also

- **Trial Control** in the EthoVision XT Help.

In UltraVox XT

1. Choose **Setup > Trial Control Settings**.
2. Under **Start acquisition** and **Stop acquisition**, select **External program trigger**.



The screenshot shows two side-by-side panels for configuring acquisition triggers. The left panel, titled 'Start acquisition', has two radio buttons: 'Manually' (unselected) and 'External program trigger' (selected). The right panel, titled 'Stop acquisition', has three options: 'Manually' (unselected), 'External program trigger' (selected), and 'After' (unselected). The 'After' option is followed by a numeric input field containing '15' and a unit dropdown menu set to 'minutes'.

See also

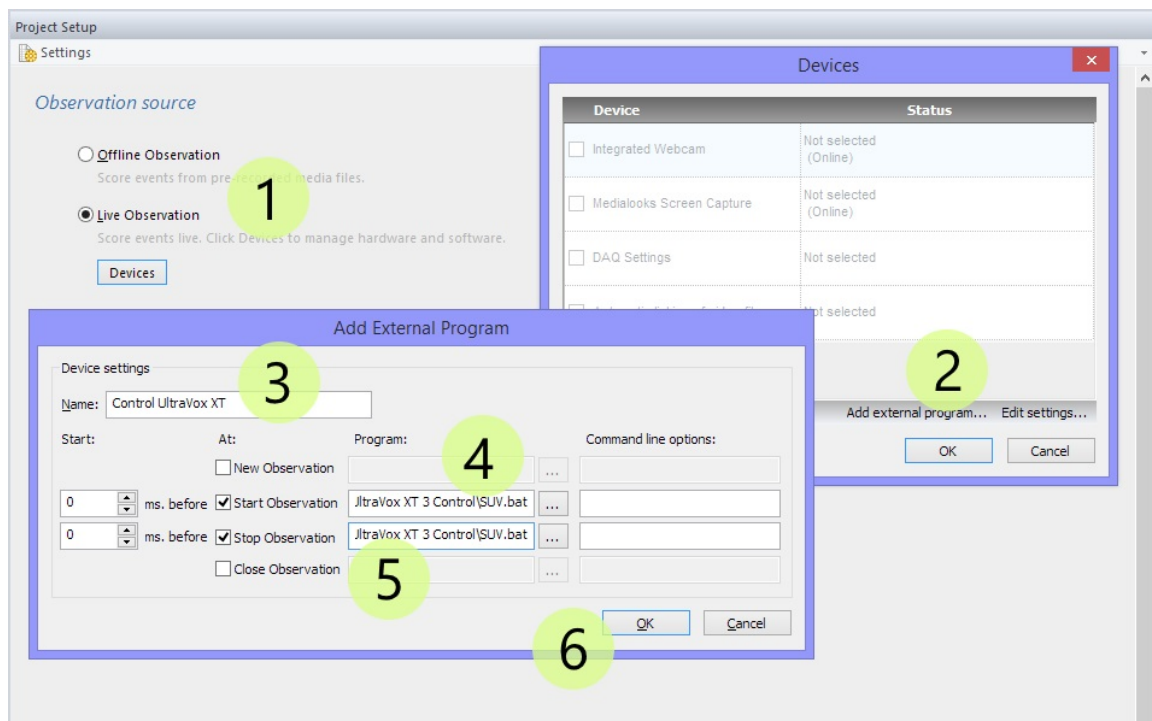
- Trigger start/stop recording

Trigger settings for The Observer XT

Prerequisites

In The Observer X, you have created a new project (**File > New**). Next, choose **Setup > Project Setup**.

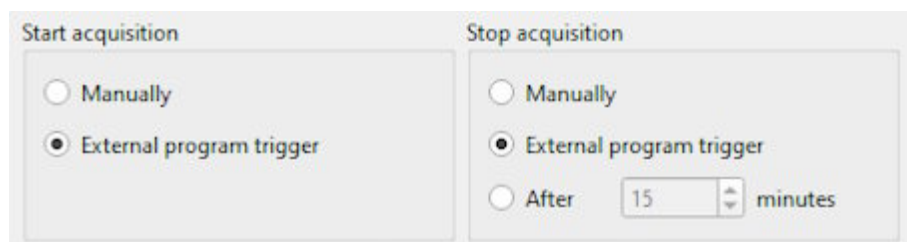
In The Observer XT



1. Under **Observation Source** select **Live**.
 2. In the Devices window that appears, click **Add external program**.
 3. In the Add External Program window, under **Name**, enter a title (for example *Control UltraVox XT*).
 4. Select **Start Observation**. Next, click and select the batch file **StartUV - 2 PCs.bat**.
 5. Select **Stop Observation**. Next, click and select the batch file **StopUV - 2 PCs.bat**.
- For how to edit the batch files, see Edit the StartUV/StopUV batch files.
6. Click **OK**.

In UltraVox XT

1. Choose **Setup > Trial Control Settings**.
2. Under **Start acquisition** and **Stop acquisition**, select **External program trigger**.



The screenshot shows a dialog box with two panels: "Start acquisition" and "Stop acquisition".

Start acquisition:

- ☐ Manually
- ☒ External program trigger

Stop acquisition:

- ☐ Manually
- ☒ External program trigger
- ☐ After minutes

See also

- Trigger start/stop recording
- Edit the StartUV/StopUV batch files

Co-acquisition of data

Aim

To acquire UltraVox XT data together with EthoVision XT or The Observer XT data.

Procedure

Follow the instructions that apply to your software (EthoVision XT or The Observer XT).

1. In UltraVox XT, open the acquisition screen.
In EthoVision XT, open the acquisition screen. In The Observer XT, create a new observation.
2. In EthoVision XT, start the trial and release the animal in the arena.
In The Observer XT, start the observation.
3. On the EthoVision XT/The Observer XT computer, the software activates the batch file. The file start.txt is sent to the Sync folder on the UltraVox XT computer. When this occurs, UltraVox XT detects the file and starts recording.
4. In EthoVision XT, after a fixed time, the trial stops automatically depending on the Time condition specified in the Trial Control rule (Trigger settings for EthoVision XT). In The Observer XT, stop the observation.
In both cases, this stops recording in UltraVox XT.
5. In UltraVox XT, detect and label the calls.
6. In UltraVox XT, export the call data to EthoVision XT or The Observer XT.
See Export call statistics
7. In EthoVision XT or The Observer XT, import the call data.

See also

- Export call statistics
- Import call data in The Observer XT
- Import call data in EthoVision XT
- Import profiles

Import profiles

EthoVision XT

To import UltraVox XT data into EthoVision XT, you must have the import profile **UltraVox 3/4**.

The import profile is installed on C:\ProgramData\Noldus\Common\Profiles.



NOTE If you do not see the C:\ProgramData folder, it may be hidden. To view hidden folders:

1. In the Windows Control Panel, choose **Appearance and Personalization**, then under **Folder Options** click **Show Hidden Files and Folders**.
2. In the window that appears, under **Hidden files and folders**, select **Show hidden files, folders and drives**.

For information on how to import UltraVox XT data, see the EthoVision XT Help.

The Observer XT

To import UltraVox XT data into The Observer XT, you do not need an import profile. Just export the call statistics in UltraVox XT in The Observer XT format (*.odx), and import the export file into The Observer XT.

Troubleshooting

Microphones

- The microphones are not recognized after restarting the computer
- Error message "Device not found"
- The Microphone name has changed

Detecting calls

- I created a call definition, but UltraVox XT detects few or no calls
- I see no vocalizations in the spectrogram
- Reduced Min Amplitude in a call definition results in fewer calls detected
- Add a call that was not detected automatically
- A call is not detected even if its amplitude is above the threshold
- There is constant noise at a specific frequency
- Call detection is very slow

Call Statistics

- Call duration is not exactly the difference between Stop time and Start time

Other

- How do I make the recording screen darker?
- How do I copy recordings and experiments?
- How do I report spectrogram parameters?
- How do I analyze audible sound?
- How do I remove the microphones from my experiment?

- The spectrogram is not aligned with the waveforms
- Error message "Unsupported WAV format"

Contact Technical Support

- Technical support

The microphones are not recognized after restarting the computer

Problem

The computer went to sleep. After restarting, UltraVox XT does not recognize the microphones.

Solution

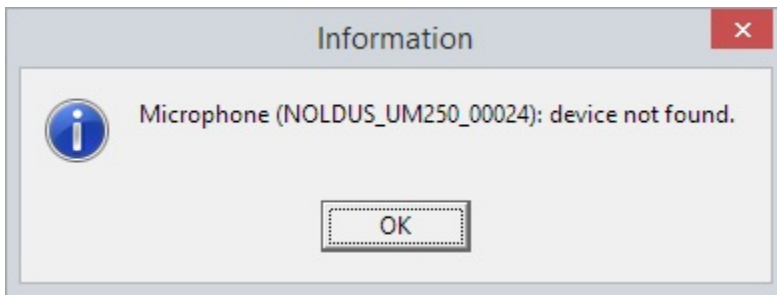
1. Disconnect and reconnect the USB cable of the hub to the same USB port of the UltraVox XT computer.
2. In UltraVox XT, open the Experiment Settings, and click the **Refresh** button.
3. If you see a cross symbol next to a microphone, click the button in the **Microphone** column and make sure to reselect the same microphone. The microphones will keep the same microphone name as before.

[Back to Troubleshooting](#)

Error message "Device not found"

Problem

After clicking the **Settings** button  for a microphone in the Experiment Settings, the following message appears:



Solution

1. Plug the microphone into the correct USB port of the PC.
2. In the Experiment Settings, click the **Refresh** button.

If the microphone was plugged in the correct port, the green symbol should appear under **Status**.

Select the check box under **Selected**.

If the microphone is not recognized, it may be that it was plugged into a USB port different from that of the previous time. Follow the procedure in The Microphone name has changed

[Back to Troubleshooting](#)

The Microphone name has changed

Problem

In the Experiment Settings, the name under **Microphone** has a number in front. For example, **Pettersson M500-384-1** changed to **2-Pettersson M500-384-1**.

Explanation/Solution

This happens when you plug the microphone into a USB port different from that used when you plugged the microphone for the first time. Close UltraVox XT and for the microphones with a name beginning with "2-", swap the USB-A connectors that go to the USB card/hub. When re-opening the software, all the microphone names should be as before (without the "2-" in front).

Even if the name under **Microphone** in the Experiment Settings changes, you can use that microphone. The name does not affect data recording. However, make sure that you know which microphone is associated with which cage. For example, label the microphones and the USB ports on your computer.

In all cases:

1. Plug the microphone into the correct USB port, then click **Refresh**.
2. Click the select button under **Microphone**.



3. Choose the microphone from the list, then click the **Settings** button to check the signal is received.



I created a call definition, but UltraVox XT detects few or no calls

Problem

After creating a call definition and clicking **Detect calls in this recording**, UltraVox XT does not detect the calls that look like the one selected to create the call definition.

Solution

In the Call Detection screen, select the call definition and click **Edit**.

Try the following:

- Reduce the frequency range (**Freq Low - Freq High**).
See Keep the frequency range as narrow as possible
- Increase **Min Amplitude**. Hover the mouse over the calls and take note of the amplitude values you see. Min Amplitude should stay below those values.

If calls that are not detected show weaker signal (lower amplitude), reduce **Min Amplitude** by steps of for example 30 or 50, and see if this improves detection.

See Increase the Min Amplitude parameter and Get a feel of the amplitude in a call
- Reduce the **Min Duration** value.
TIP Draw a rectangle around a few calls, then in the resulting call definitions look at the **Min Duration** parameter and take note of the average value. When you define the true call definition, click **Edit** and enter half of the average value as a **Min Duration**. Do not forget to delete the call definitions made before.

See Reduce Min Duration
- Increase the **Max Duration** value.
See Increase Max Duration
- Reduce **Min Gap**.
Sometimes two calls are detected as one when Min Gap is too high.

When calls have different frequency ranges, define two call definitions instead of one.

See also

- [Call definitions](#)
- [Back to Troubleshooting](#)

I see no vocalizations in the spectrogram

One simple explanation is that the subject did not make vocalizations. However, it may be that the recording is so noisy that the calls do not emerge in the spectrogram.

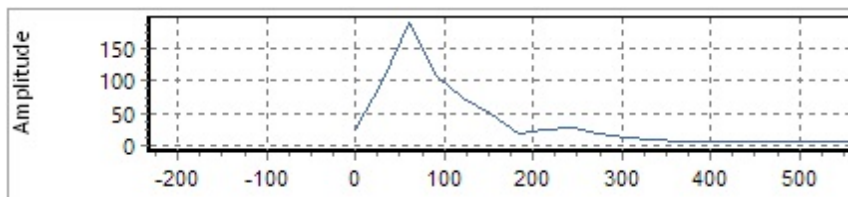
The colors displayed in the spectrogram for one event also depend on the amplitude of the signal in the surrounding interval. The same call may appear or not (or appear less evident) if another, unwanted signal like strong noise (for example, a door being closed) or constant noise from electrical appliances occurs in the interval displayed.

To find out whether there is constant noise in the signal

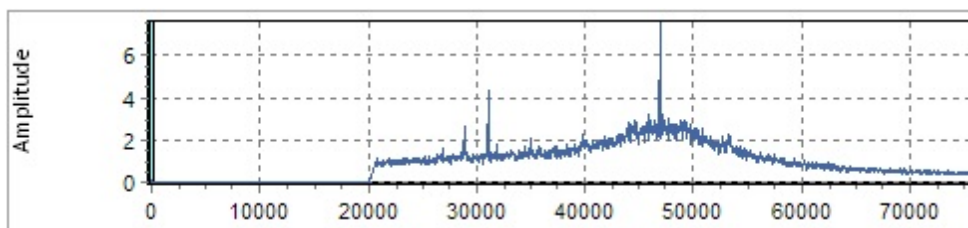
1. Under **View**, select **Spectrum**.
2. Look at peaks in the spectrum. If necessary, zoom in the spectrum. See Zoom in/out

Examples

With strong noise at 60 Hz, zoom in the left part of the spectrum.



In another example, after filtering at 20000 Hz, two peaks are visible at 32kHz and 47 kHz.



See also

- The Spectrogram
- Factors affecting ultrasound recording
- Back to Troubleshooting

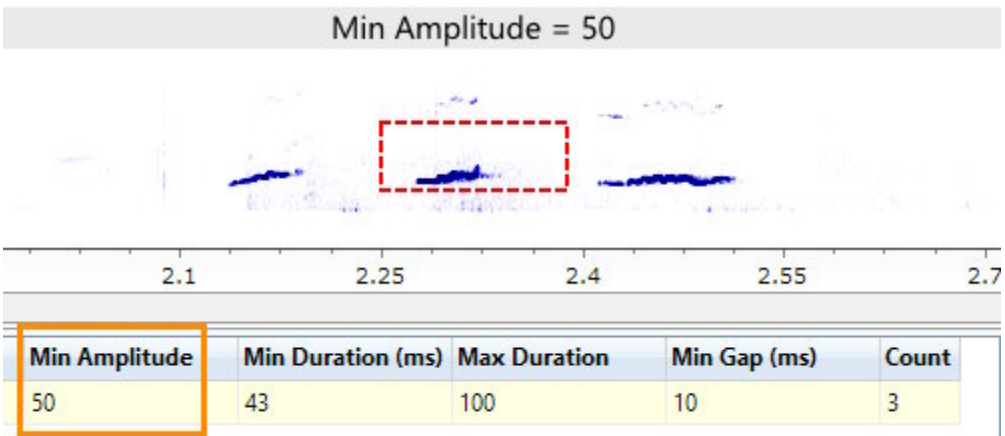
Reduced Min Amplitude in a call definition results in fewer calls detected

This result may sound counterintuitive. One may expect to detect fewer calls after *increasing* the Min Amplitude parameter, that is, after applying more restrictive criteria. In fact, more calls are often detected after increasing Min Amplitude.

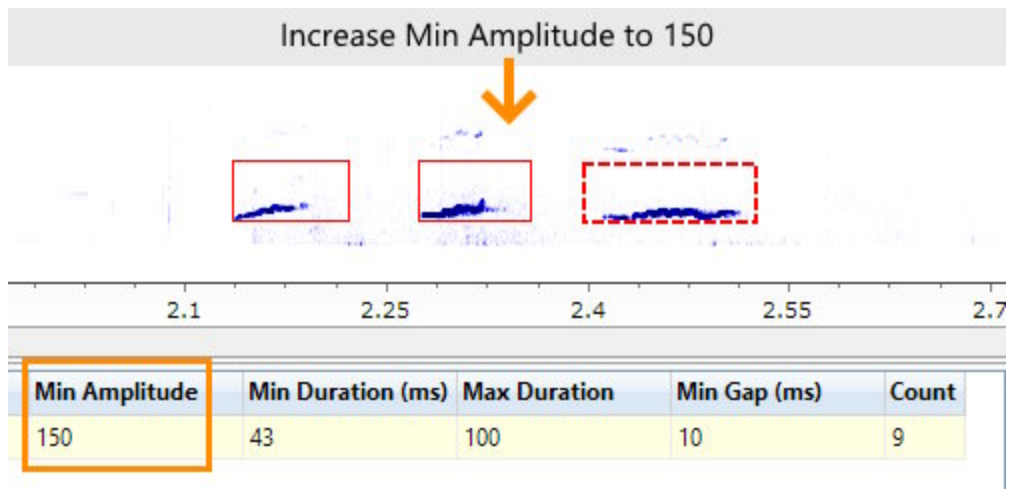
The reason is that when Min Amplitude is low, UltraVox XT captures large regions of the spectrogram that have amplitude higher than that value. But such large regions may not correspond to the other criteria in the call definition. For example, some regions may exceed Max Duration, and would not be considered as calls (figure below, top). When you increase Min Amplitude, it is more likely that (smaller) regions of the spectrogram will be found which correspond to all criteria in the call definition (bottom). This explains why when you increase Min Amplitude you begin to see more detected calls.

The figure below is an example of what could happen.

Suppose 50 is used for **Min Amplitude**. Amplitudes just above 50 are found in large regions of the spectrogram, for example that indicated with the dashed rectangle. However, the rectangle does not satisfy the other criteria set in the call definition. For example, the rectangle could be longer than 100 milliseconds, which is in conflict with the **Max Duration** setting. Therefore, the call within that rectangle is not found.



After setting a higher value of **Min Amplitude** and clicking **Detect calls in this recording**, the software finds smaller regions of the spectrogram that are above that value. This time two regions are found that match the other settings of the call definition. Therefore, two calls are detected.



The third, slightly longer call indicated with the dashed rectangle is not yet found because it conflicts with the **Max Duration** setting. It is detected after increasing **Max Duration** to for example 200 ms and clicking **Detect calls in this recording**.

See also

- The Spectrogram
- Back to Troubleshooting

Add a call that was not detected automatically

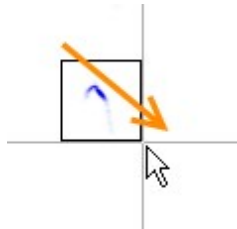
Problem

In the Spectrogram, I see vocalizations that were not detected. Further optimization of the Call definition did not help.

Solution

You can add a call manually.

1. Open the Call Labeling screen (**Analysis > Call Labeling**).
2. Draw a rectangle around the spectrogram of the call that was missed.



3. In the detected calls list, a new row appears. Double-click the **Call Name** cell for that row, and change its name from **Manual** to the one you require.

See also

- Add a call manually
- Back to Troubleshooting

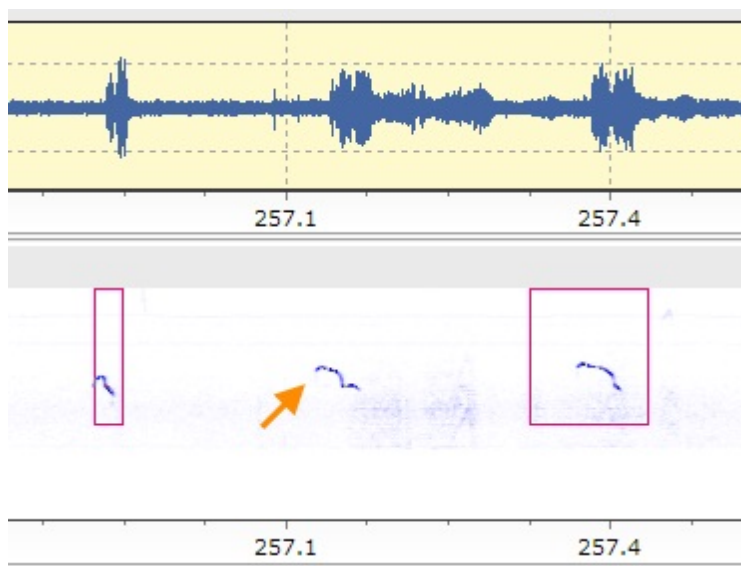
A call is not detected even if its amplitude is above the threshold

Problem

You applied a call definition and detected most calls. However, some calls that look very prominent are not detected.

Solution

In the example below, the second call is not detected even its amplitude is comparable with that other two. Some noise at the end of the call increases the time that the signal is above the **Min Amplitude** threshold, and this time is above the **Max Duration** threshold. In such cases UltraVox XT does not detect the call because the signal appears too long to match the criteria of the call definition.



You can solve this issue in two ways:

- Increase the **Min Amplitude** threshold, but check that the other calls are still detected.
- Increase the **Max Duration** threshold. If necessary, reduce the call duration in the Call Labeling screen. See Adjust frequency and time boundaries in a call

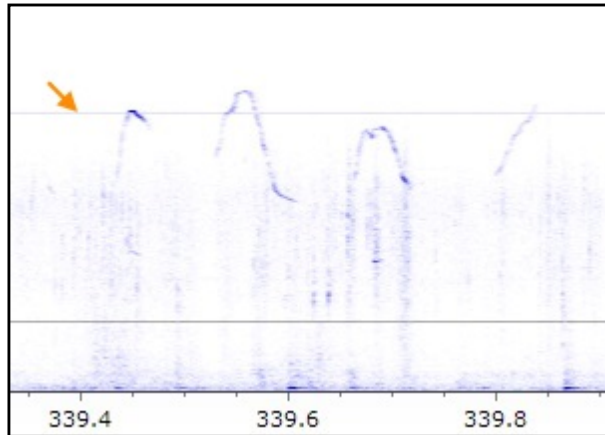
See also

- [Back to Troubleshooting](#)

There is constant noise at a specific frequency

Problem

The spectrogram shows constant, narrow-band noise. In this example, at about 70 kHz:

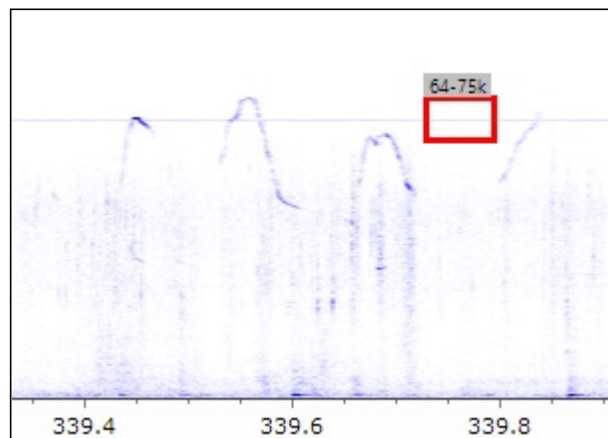


Constant noise could be due to an electronic device near the microphone, or to the microphone being defective.

NOTE Cables and electric/electronic devices produce ultrasound. Voltage changes may occur, resulting in a change in noise levels during recording, which is also difficult to deal with. Isolate all cables and devices as much as possible.

Solution

1. First, try to know what amplitude is the noise signal. Draw a rectangle around the horizontal line, without including any call.



2. A call definition is defined. Look at the spectrogram that appears at the bottom-right corner. Hover the mouse over the horizontal line and get a feel of the amplitude of that signal.

Take note of the maximum values you see.

3. Select the call definition and click the **Remove** button.
4. Draw a rectangle around a call.
5. Select the new call definition and click the **Edit** button. Set the **Min-Amplitude** parameter to a value well above the values of the noise.
6. Click **Detect the calls in this recording**.

Call detection is very slow

Problem

After clicking **Detect the calls in this recording** in the Call Detection screen, processing goes very slowly.

Solution

Right-click the spectrogram area and reduce the **Overlap**, for example to 50 % or lower.

See also

- Spectrogram settings
- Overlap

Call duration is not exactly the difference between Stop time and Start time

Problem

When examining the Call Statistics table, the value of **Duration** is not the same as one would obtain by calculating the difference between **Stop time** and **Start time**.

For example:

Duration (ms)	Start Time (m:s.ms)	Stop Time (m:s.ms)
16	3:11.685	3:11.701
117	3:11.832	3:11.949
25	3:11.965	3:11.990
37	3:12.158	3:12.195
106	3:12.391	3:12.498
86	3:12.655	3:12.741
20	3:15.332	3:15.353
10	3:15.410	3:15.420

Solution

The value of **Duration** is obtained with the difference between Stop time and Start time, using six decimals, that is, more than those you see in the table (three for both Start time and Stop time). After that, the value is rounded to the milliseconds. This is the reason why you see a discrepancy between Duration and the value expected from Start time and Stop time in the table. The result is, however, very accurate.

How do I make the recording screen darker?

If you want to reduce the brightness of the computer monitor in order to minimize the effect of light on the animals, you can run UltraVox XT in Windows dark mode.

1. Close UltraVox XT.
2. In Windows, click the Start button and choose **Settings**.
3. On the left panel, choose **Personalization**, then **Themes**.
4. Under **Themes**, choose **Windows (dark)**.
5. Start UltraVox XT.
6. To further reduce the brightness of the screen, in UltraVox XT, choose **File > Settings > Spectrogram**. Next to **Color map**, choose **Inferno** or **Inverted grayscale**.

How do I copy recordings and experiments?

If you want to copy recordings to another PC or you want to send them to Noldus Support, copy the whole experiment folder.

1. Locate the experiment folder. Each experiment is contained in a separate folder, named as the experiment itself.
2. Copy this folder and zip it.
3. Copy the zip file to another PC or send it to Noldus Support via a file transfer service.
4. On the other PC, unzip the file and copy the folder to the experiments folder.

If you want to copy recordings to another experiment, open that experiment and select **File > Import audio files**. The recordings are copied to the experiment's folder, and have extension **.UVD**.

See also

- Default experiment location in Settings
- Recording files

How do I report spectrogram parameters?

When writing a manuscript you may want to mention the spectrogram settings used in your analysis.

To access the current Spectrogram parameters, right-click the spectrogram area.

You can report the following parameters:

- **SFT length.** This is the length of the analysis window, in samples (e.g. 1024). It equals the Frame size, or Frame length, because the signal is not zero-padded in UltraVox XT 4.
- In UltraVox XT 3, you could apply zero padding. In that case the frame size was 100% if zero padding was 1, 50% if zero padding was 2, etc.
- **Window type** = Hamming (not adjustable).
- **Overlap** (%). This is the Overlap between two subsequent analysis frames.
- **Hop length.** This is not reported by UltraVox XT but may be required by reviewers. Hop length is related to overlap by the following formula:

$$\text{Hop length} = \text{SFT length} * (100 - \text{Overlap}) / 100$$

For example, if your SFT is 1024 and Overlap is 0%, each new analysis frame starts immediately after the previous one, with no overlap. So the hop length is the same as the SFT length, that is 1024. If the Overlap is 50%, the new analysis frame will be at halfway of the previous one. The hop length is therefore $1024 * 1/2 = 512$.

See also

- The Spectrogram

How do I analyze audible sound?

You can record and analyze audible sound (0-20 kHz) exactly like you would do with ultrasound. We recommend to connect a microphone that is appropriate for recording high-quality audible sound.

How do I remove the microphones from my experiment?

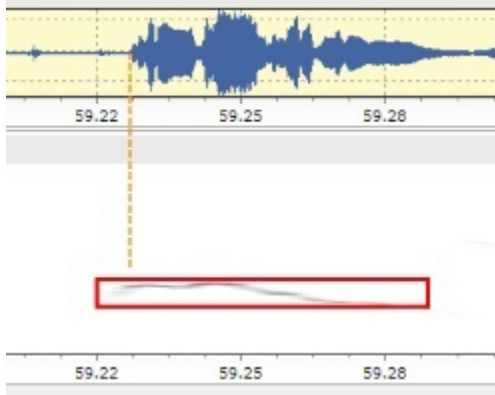
If you want to reset the Microphones list, do the following:

1. Open the Experiment Settings
2. Under **Microphone**, click the first microphone name that you want to remove.
3. In the window that appears, click **Clear**, then **OK**.
4. Repeat the steps **2-3** for the remaining microphones.

See also

- UltraVox XT microphones

The spectrogram is not aligned with the waveforms



Explanation

This is an artifact of the FFT settings. When selecting a high value of the SFT length, frequency resolution increases, while time resolution decreases. This means that with high SFT length values the onset time of a vocalization is established with less precision.

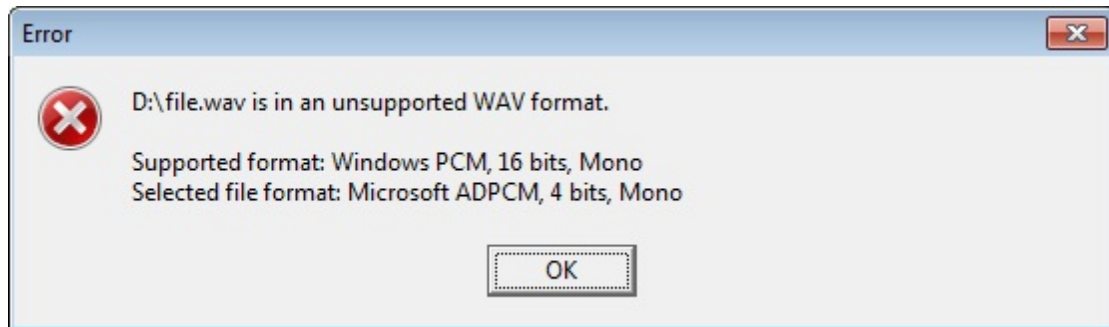
Solution

1. Right-click the spectrogram area.
2. Under **Fourier transform settings**, reduce the **SFT length**. See Spectrogram settings
3. Click **Detect calls in this recording** to update the position of the rectangle around the calls.

Error message "Unsupported WAV format"

Problem

The following message appears after trying to import one or more audio files. For example:



Explanation

UltraVox XT accepts audio files of format PCM, encoded at 16 bits and with a Mono channel.

Solution

If the audio file was recorded stereo, or encoded with 24 bit resolution, convert it to PCM WAV file format, mono, 16 bit, using an audio-editing application such as Audacity, available on the internet. Next, import the converted file in UltraVox XT.

Technical support

Noldus Online

Choose **Help > Noldus Online >**

- **UltraVox XT Home Page.** With general information on UltraVox XT, including a list of selected scientific publications.
- **MyNoldus Portal.** Click this link to access the MyNoldus portal where you can contact Support and download software and documents.
- **Noldus Academy.** Check regularly the Noldus Academy web site for training courses and tutorials about UltraVox XT and other Noldus products.
- **Get Updates and Support.** This is a direct link to the Support section of MyNoldus.
- **Check for Updates.** This is a link to the page with the most recent version of UltraVox XT.

About UltraVox XT

Choose **Help > About UltraVox XT** for information on your UltraVox XT version, the registered user, the license number and the maximum number of microphones allowed. This information is needed when you contact Noldus Support.

FAQ and Knowledgebase

If you encounter a problem using UltraVox XT or any other Noldus system, you can search through hundreds of entries in a database of questions submitted by our customers to Noldus Support with answers by our support staff.

Choose **Help > Noldus Online > FAQ and Knowledgebase**, or browse to

<https://my.noldus.com/shared>

and enter the terms you want to find.

MyNoldus.com

If you have any problems, questions, remarks or comments, please let us know. You can contact us at our support page:

my.noldus.com

We offer 24 hour support in various time zones.

License information

Before you contact my.noldus, please have the following information available. To find this information, go to the **Help** menu and select **About UltraVox XT**:

- The version number of your copy of UltraVox XT.
- The name of the registered user of UltraVox XT (click **License Info**).
- If possible, a screenshot of the window that opens when clicking **License Info**.

UltraVox XT Log file

Our Technical Support department may request a log file when answering your support question. You can locate the file in:

C:\ProgramData\Noldus\UltraVox\XT 4\log\UltraVox.txt

The log file contains errors and warnings of the most recent run of the software. If UltraVox XT crashes, do not re-start it immediately. Instead, locate and copy the log file and send it to the Technical Support department. If you restart the software, the log file is deleted so you could lose important information.

NOTE The ProgramData folder may be hidden on your computer. To view hidden folders:

1. in the Windows Control Panel, choose **Appearance and Personalization**, then under **Folder Options** click **Show Hidden Files and Folders**.
2. In the window that appears, under **Hidden files and folders** section, select **Show hidden files, folders and drives**.

Make a PC report for Support

This section is needed if Noldus Support has asked you to send a PC report for the UltraVox XT computer.

1. Download the SIW utility as indicated by Noldus Support and save it to the UltraVox XT computer.
2. Double-click on the file called **siw64.exe**.
3. Choose **File > Create Report File > HTML Report**.
4. Save the HTML file to your Desktop.
5. Send the HTML file as an e-mail attachment to Noldus Support.

NoldusCare

Your license of EthoVision XT comes with a standard service package of one year. This includes a one-year period of free technical support. With NoldusCare you make sure that you work with the latest version of your software, based on input from our worldwide customer base. Updates, upgrades and new releases are available for free. As well as update meetings, where you can discuss new features with a Noldus consultant.

For more information, see our web page

<https://www.noldus.com/nolduscare>

Other contact information

Browse to

<https://www.noldus.com/contact>