Technical Note

SyncBox and The Observer XT

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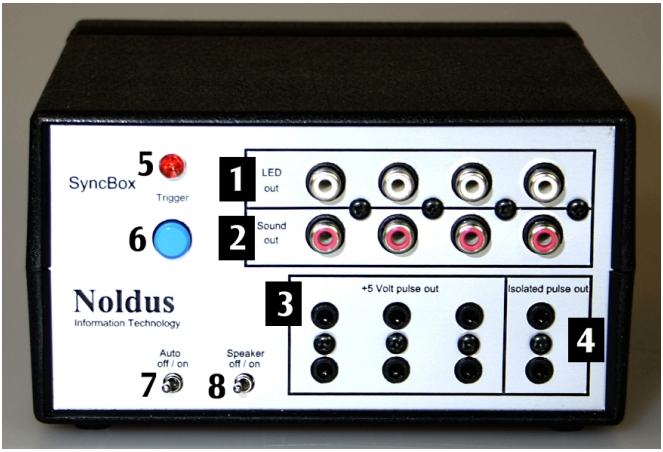
1 The SyncBox



INTRODUCTION

When you use The Observer XT as part of a complex lab setup, it is necessary that the observational data from The Observer XT and external data from other applications/devices play back as synchronized as possible. Such a complex setup might consist of (depending on your type of research):

- The Observer XT — to record a participant's behavior.
- One or more cameras and the MediaRecorder software — to create one or more digital video files.
- An eye tracking system — to monitor the point of gaze of a test subject when testing a website or software.
- One or more data acquisition systems — to measure, for example, heart rate or galvanic skin response.

Synchronize the data sets

One way to achieve simultaneous playback of observational and external data is to start external applications from within The Observer XT as External Programs at the start of an observation (page 22). However, most applications take some time to start which results in a delay between the start of the observation in The Observer XT and the start of the external application (see Figure 1).

Use the SyncBox to determine the delay

The SyncBox is a device that has been developed to determine this delay. Once you know the delay for a specific external application, you can set this in The Observer XT, so the start of the observation and the start of the external application are synchronous (see Figure 1).

In general, you can determine the difference in offset between The Observer XT and external applications/devices by using one of the following methods:

- At the start of an observation in The Observer XT, record one signal in all applications/devices and a synchronous time stamped trigger comment in The Observer XT — For example, record a visual and/or auditory cue for video or a pulse in the physiological data signal.

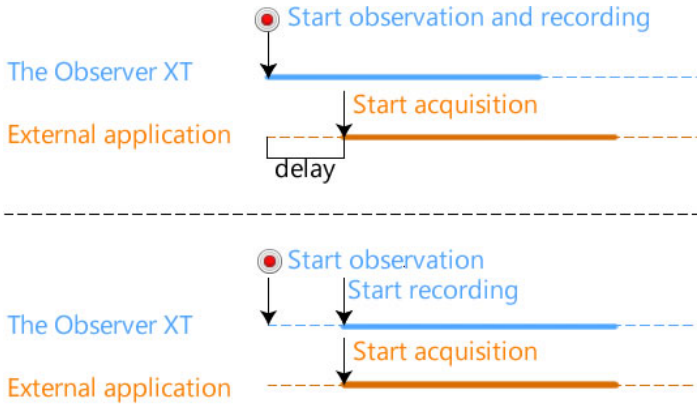


Figure 1 *Schematic overview of the result of using the SyncBox. The top picture shows the delay in starting up of the External application. This delay is determined using the SyncBox. The bottom picture shows that, when this delay is taken into account, Start of recording in The Observer XT and Start data acquisition in the External application are now synchronous.*

Afterwards, the difference in offset between The Observer XT and other applications/devices can be determined and set in The Observer XT.

- Record a series of signals in all applications/devices at fixed intervals during an observation and a synchronous time stamped trigger comment in The Observer XT — This might be necessary for long observations when you expect the different computer clocks to start running asynchronously. Afterwards, you can determine the difference in offset between The Observer XT and the other applications/devices at the start and end of the observation and correspondingly stretch the external data. You can only stretch external ASCII data, not video data.

Notes

If you have MediaRecorder 2.5 or higher, and start video recording together with a live observation in The Observer XT, you do not need to measure the delay between The Observer XT and MediaRecorder video.

In this case The Observer XT takes care of correcting for this delay when importing the video files. For more information, see The Observer XT Help, and the MediaRecorder Help.

HOW THE SYNCBOX WORKS

The SyncBox is triggered by The Observer XT to send out different types of signals at exactly the same time to one or more external applications, based on the clock of The Observer XT computer. Simultaneously, a time stamped trigger comment is recorded in The Observer XT (see Figure 6 on page 14). After import of the different data streams into The Observer XT, you can use the trigger comment and the recorded signals to manually synchronize the observational and external data. By doing this, you can determine the difference in offset and set this in The Observer XT as a delay. Subsequently, an observation and external applications will start synchronously. Furthermore, when you trigger the SyncBox to send out a series of signals during a longer period of time, you can use these multiple trigger events to correct for your (long) observation and the external applications/devices running out of sync.

Use the SyncBox before you actually start acquiring data. Create a SyncBox project in The Observer XT, carry out a test observation while The Observer XT triggers the SyncBox to send out its signals and determine the difference in offset between the trigger comment(s) in the observation and the external applications/devices. These differences in offset can then be used in the 'real' observation to correct these offset differences.

COMPONENTS OF THE SYNCBOX

The SyncBox system consists of the following components:

- SyncBox — Contains a Power in, a COM in, X-keys out (2x), LED out (4x), Sound out (4x), TTL direct out (6x), TTL opto-isolated out (2x), a Trigger button, an Auto off/on switch and a Speaker off/on switch (see Figure 2).

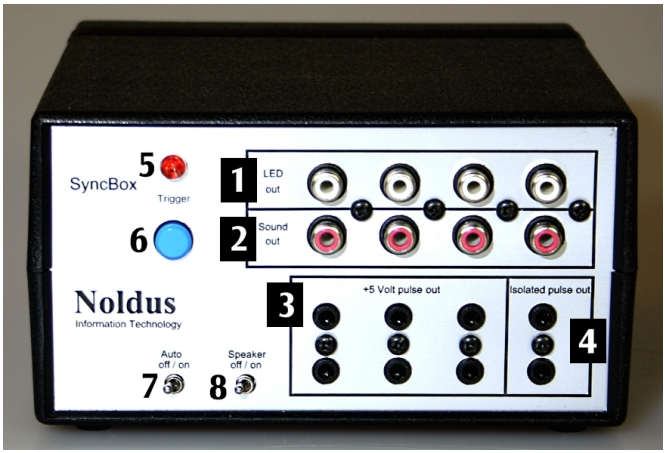


Figure 2 *Front panel of the SyncBox. 1=LED outputs, 2=Sound outputs, 3=TTL direct outputs, TTL isolated outputs, 5=LED light, 6=test trigger button, 7=Auto on/off switch, 8=Speaker on/off switch.*

- Power supply (2x) — You can either use the 5V VDC 'medical' power supply or the USB-to-5V supply cable to get power from a PC (see Figure 3).

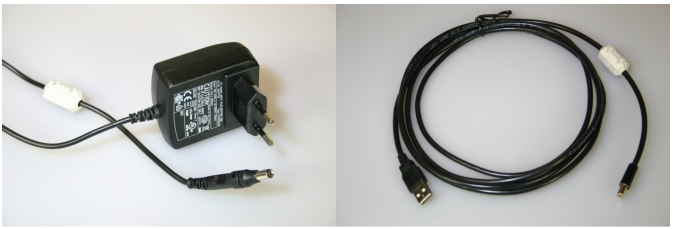
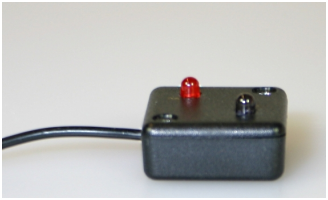
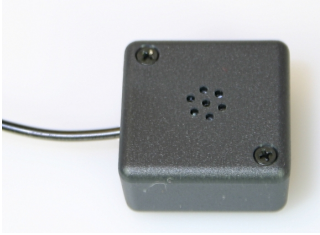


Figure 3 *Power supplies of the SyncBox. The left picture shows the 5V VDC power supply, the one on the right the USB-to-5V supply cable.*

- COM cable — To connect the COM port of the SyncBox to the COM port of the The Observer XT PC (or the USB-to-COM converter).
- LED box — A box with a red and infrared light connected to a cable (length: 5 m) with a white RCA plug at the end.



- Sound box — A box with a small speaker connected to a cable (length: 5 m) with a red RCA plug at the end.



- Line-in cable — A cable with an RCA plug on one end and a stereo 3.5 mm phone plug on the other end (see Figure 4). This cable connects a Sound output of the Syncbox with the line-in of a PC or amplifier.
- TTL cable — A cable (length: 5 m) with a 3.5 mm phone plug on one end. The white '-' wire and brown '+' wire can be connected to a plug suitable for your data acquisition system (for example, a phone plug, a RJ-11 jack).
- X-keys USB cable - A USB-A-B cable that connects the X-keys outputs to a USB port on a test PC (see Figure 4).

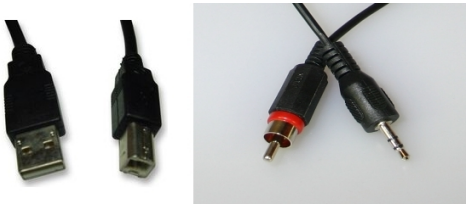


Figure 4 *The USB-A-B cable (on the left) and the Line-in cable.*

HOW TO INSTALL THE SYNCBOX

The SyncBox gets its power (5 VDC) from the provided power supply or from the USB port of a computer via the supplied USB-to-5V cable (see Figure 3). All signals are functional once you plug in the power supply.

USING THE SYNCBOX SIGNALS

The SyncBox can send out the signals mentioned below. Which signal you use depends on the application or device you send the signal to.

The LED signal

A LED signal is a light signal. There are 4 LED signal outputs and one LED light on the SyncBox itself (see Figure 2). The LED signal is sent via an RCA connector to a LED box with a red and infrared LED light (see picture on page 8).

Connect the RCA connector of the LED box to one of the LED signal outputs.

Use the LED signal when you use a camera; record the LED signal as a visual cue in a video recording.

The sound signal

The Sound signal is an audio signal (audio frequency: 2.3 KHz). There are 4 Sound signal outputs. The Sound signal is sent via a RCA connector to a Sound box with a speaker. Alternatively, the sound signal can be sent to the Line-in of a PC or other equipment.

You can also hear the Sound signal through the internal loudspeaker on the SyncBox when the Speaker switch is set to **On**.

Connect the RCA connector of the Sound box to one of the Sound signal outputs or connect the RCA connector of the Line-in cable to one of the Sound outputs.

Use the Sound signal when you use audio equipment; record the Sound signal as an auditory signal in an audio file.

When you use a microphone to record the Sound signal, make sure you place the Sound box as close to the microphone as possible so the sound travels the shortest distance possible.

The TTL direct pulse

The TTL direct pulse is an electrical signal (Max.: DC levels: <+1 Volts and >+3 Volts). There are 6 TTL direct pulse outputs. The TTL direct pulse is sent via a TRS connector (or phone plug / jack plug) to a DC input on a data acquisition system.

Connect the 3.5 mm phone plug of the TTL cable to one of the TTL direct pulse outputs. The type of connector that you need to attach to the other end of the cable depends on the type of input on your data acquisition system.

Use the TTL direct pulse signal when you use a data acquisition system; record the signal as a marker in the data file.

We recommend using the synchronization signal when acquiring physiological data, rather than the TTL pulse. The synchronization signal enables you to automatically synchronize your observational and physiological data. See The Observer XT Help how to use this signal.

Use the TTL direct pulse in case the sensors on your subject are wirelessly connected to the data acquisition system.

The TTL opto-isolated pulse

The TTL opto-isolated pulse is an electrical signal. There are 2 TTL opto-isolated outputs. This TTL pulse signal is optically isolated from the SyncBox electronics and all connected devices (see Figure 5).

Connect the 3.5 mm phone plug of the TTL cable to one of the TTL opto-isolated pulse outputs. The type of connector that you need to attach to the other end of the cable depends on the type of input on your data acquisition system.

Use the TTL direct pulse signal when you use a DAQ system; record the signal as a marker in the physiological data file.

We recommend using the synchronization signal when acquiring physiological data, rather than the TTL pulse. The synchronization

enables you to automatically synchronize your observational and physiological data. See The Observer XT Help how to use this signal.

Use the TTL opto-isolated pulse in case the sensors on your subject are connected through wires to the DAQ system. The opto-isolated pulse is to prevent that a high voltage could be applied to a subject attached to the data acquisition system, in the unlikely case that the SyncBox might malfunction.

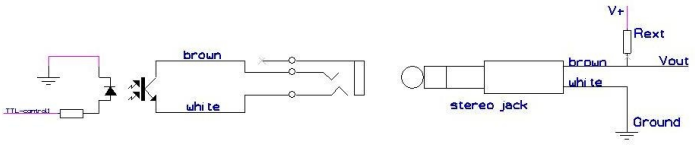


Figure 5 *Electrical scheme of the TTL opto-isolated output and the connected phone plug.*

The keycode signal

The keycode signal sends out a pre-programmed keyboard key. There are 2 keycode signal outputs (via the X-keys device).

The X-keys device is a keyboard simulator that can send out any keystroke. The X-keys device in the SyncBox sends out a "t". Please contact support@noldus.nl when you want the SyncBox to send out another character than the "t".

Connect the X-keys USB cable between one of the X-keys outputs and a USB port on a PC you want to send the signal to.

A green light above the output indicates that the port is active.

Use the Keycode signal when you use an application that records keystrokes or captures the screen of the test computer:

- Screen capture software — Use the Keycode signal to record a "t" in Notepad. While the software captures the screen, simply open Notepad and the character "t" appears in the screen capture when the SyncBox sends the Keycode signal.
- Eye tracking system — Use the Keycode signal to record a "t" in Notepad. While the eye tracking system captures the screen, simply

open Notepad and the character "t" appears in the screen capture when the SyncBox sends the Keycode signatl.

2 Working with the Syncbox

Use the SyncBox before you actually start acquiring data. Create a SyncBox project in The Observer XT, carry out a test observation while The Observer XT triggers the SyncBox to send out its signals and determine the difference in offset between the trigger comment(s) in the observation and the external applications/devices.

WORKFLOW

Working with the SyncBox involves the following basic steps:

1. Determine what type of signals you want to send out with the SyncBox (see Figure 6 below and SyncBox signals on page 10).

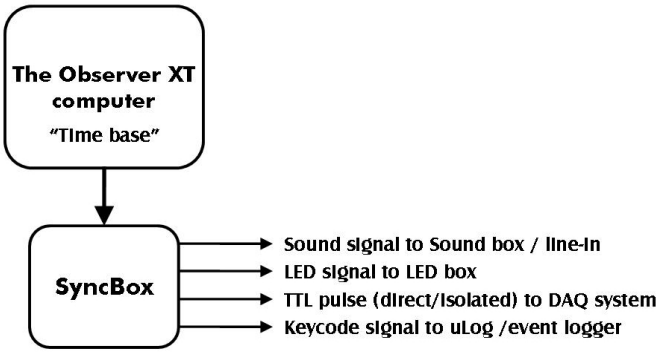


Figure 6 *Schematic overview of the different types of signals that can be sent out with the SyncBox.*

2. Set up all the necessary connections (see page 10) and make sure you are able to record the signals. For example, the LED box should be visible in the camera view, you should have started a test observation in The Observer XT, etc. Set up The Observer XT for triggering the SyncBox.
3. Start an observation and, simultaneously, all external applications as External Programs in The Observer XT. During the observation The Observer XT triggers the SyncBox to send out one or more signals (see page 15).
4. Stop the observation and the external attpplications, and import all data into The Observer XT.
5. Manually synchronize the observational and external data in order to be able to determine the difference in offset (see page 24).
6. Once you know this difference in offset for a specific application, simply set this delay in The Observer XT next time you start this application from within The Observer XT simultaneously with the start of an observation. As a result, the start of the observation and the external application are now synchronous.

TRIGGERING THE SYNCBOX

You use The Observer XT to trigger the SyncBox to send out signals. You can set the interval between consecutive trigger pulses in The Observer XT.

Make sure the SyncBox is connected to the The Observer XT PC via the COM port and the Auto on/off switch on the SyncBox is set to off.

See Troubleshooting on page 18 to read more about the **Auto on/off** switch.

Before you start triggering the SyncBox:

- Make all the necessary connections (see above) and make sure the signal(s) can be recorded by the appropriate applications/devices.

  After you have made all connections you can check whether signals are sent out properly by pressing the blue **Trigger** button on the SyncBox.

- In The Observer XT, before you start an observation, make sure you have added all external applications as External Programs in the **Observation source**. This way the external applications are started when you start an observation.

To start triggering the SyncBox to send out signals, do the following:

1. Make sure to close all unused programs; variable processor load may cause the delay to vary in the start-up of some applications.
2. In The Observer XT, open a SyncBox project.
3. Under **Observation source**, make sure you select **Live Observation**.

   You should not select **DAQ settings** when you want to use the SyncBox. If you do so, the SyncBox settings (see the next step) are grayed out.
4. Create a new observation.
5. Click **View Settings** on the far-right of the tool bar of the observation, select **SyncBox**.
6. In the **SyncBox Settings** window, select the **Enable SyncBox pulse** box. Next, set the following:
   - **Output port** — Select the COM port that connects the The Observer XT PC to the SyncBox. Usually, this is the default COM1. However, if you use a Noldus USB-to-COM converter because you run The Observer XT on a laptop without a COM port, you should select another COM port - selecting the correct COM port results in the SyncBox internal speaker to playback a sound (if switched on).
   - **Pulse interval** — Enter a value between 1 and 3600 seconds.
7. Press **OK**.

   If you carry out another action in The Observer XT after making the SyncBox settings, you need to go back to step 5 to re-do these.

8. Start the observation.

   As soon as the observation starts, all external applications are also started and the first trigger pulse is sent to the SyncBox. Synchronously a trigger comment is logged in the event log in The Observer XT, with the format: Pulse <Absolute Time Stamp Scoring hh:mm:ss.fff> - <Counter>.

9. Stop the observation after the required number of pulses (see below) have been sent.

You can now determine the difference in offsets by manually synchronizing the observational and external data (see below).

How many pulses should I use?

Send *two* trigger pulses at the start of an observation in the following case:

- You carry out a short observation (< 60 minutes) — In this case it is unlikely that the The Observer XT computer and the external computer start running out of sync during an observation, so you only need to determine the difference in offset at the start of the observation.

  You should always send at least two trigger pulses because The Observer XT sends the first trigger pulse at the start of the observation when the external application might not be ready yet to record the SyncBox signal.

Using a series of trigger pulses

Send a *series* of pulses in the following case:

- You carry out a long observation (> 60 minutes) and you are not sure that the clocks on all systems are accurate — In this case you should send out a series of pulses during the observation. The pulse interval depends you use on a) the total duration of the observation and b) the inaccuracy of the clocks. By determining the difference in offset at the start and the end of the observation you know how much you should stretch the external data.

  Example 1 — You carry out an observation of 8 hours while simultaneously acquiring physiological data. You know that the

clock of one of the systems is not completely accurate but not dramatically so; you send a trigger pulse every 30 minutes. After you have imported the external data you determine the difference in offset at the start and end of the observation. The start is synchronous but at the end of the observation the external data lags behind 30 seconds; you should then re-import the data and shift the end time of the external data 30 seconds ahead.

Example 2 — You carry out an observation of 1 hour while simultaneously acquiring physiological data. You know that the clock of one the systems is very inaccurate; you send a trigger pulse every 5 minutes. After you have imported the external data you determine the difference in offset at the start and end of the observation. The start is synchronous but at the end of the observation the external data lags behind 15 seconds; you should then re-import the data and shift the end time of the external data 15 seconds ahead.

TROUBLESHOOTING

No time stamped trigger comments appear in my test observation.

- You did not select **Enable SyncBox pulse** in the **SyncBox settings** window — see step 6 on page 16.

No signals are sent out by the SyncBox

- You made incorrect connections — redo the connections and test the signals by pressing the blue Trigger button on the SyncBox.
- You did not connect the The Observer XT computer to the SyncBox — use the COM cable to make the connection.
- You selected the wrong COM port in the **SyncBox settings** window — see step 6 on page 16.

- One of the jumpers inside the SyncBox is in the wrong position — Open the SyncBox by unscrewing the two Philips screws sunk into the bottom of the SyncBox. Carefully remove the top part of the SyncBox. The two red jumpers are located between the COM port and the X-keys USB outputs (see Figure 7 below). The RTS/DTR jumper should be set to 'DTR', the 1/2 jumper should be set to '2'.

  To change the position of a jumper, lift the jumper (there is a small crevice just below the top that you can use for grip) and slide it back over two pins, moving one position.

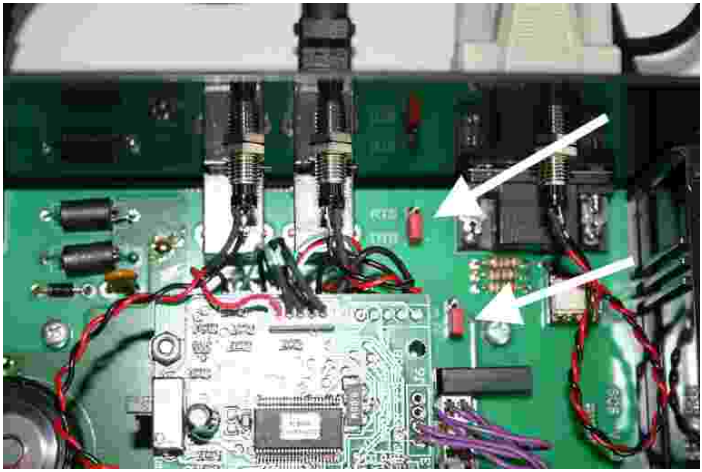


Figure 7 *The SyncBox after removing the top. The top white arrow indicates the location of the RTS/DTR jumper, the bottom white arrow indicates the location of the 1/2 jumper.*

When I start up my computer with the SyncBox connected, it almost continuously sends out (sound) signals

- This happens when the default voltage of the RTS/DTR pin of your computer is +11 Volt. Only when you open an observation in The Observer XT and select the SyncBox, the base voltage on the RTS/DTR pin is set to -11 Volt. During an observation, the SyncBox is triggered by + 11 Volt pulses. The only solution is to turn off the internal speaker and to disconnect the external speakers until you open the SyncBox settings in an observation.

What do I use the Auto on/off switch for?

- When the Auto on/off switch is set to on, the SyncBox sends out a signal every ± 30 seconds. You should preferably NOT use the Auto on/off switch for triggering the SyncBox but use The Observer XT instead because its time base is more accurate.

3 Determining the difference in offset

After you have imported all data (such as physiological data or a video file) into the corresponding observation in The Observer XT, you can determine the difference in offset by carrying out manual synchronization.

For more information on how to import data into The Observer XT, see **External Data** in The Observer XT Help.

When you used one trigger pulse

Through manual synchronization you make sure that the time stamped trigger comment logged in the event log file in The Observer XT coincides with the corresponding signal recorded in a video file, an audio file or a physiological data file. After you have carried out manual synchronization, you can see the difference in offset in the File Synchronization window in The Observer XT. Next time you carry out an observation, you need to enter this difference in offset as the delay for starting up an observation for this specific application in the Add External Programs window in The Observer XT. As a result, the start of the observation and the start of the external application are now synchronous.

When you used a series of trigger pulses

When you used a series of trigger pulses in case of a long observation, you first determine the delay in starting up the external application by using a pulse at the start of the observation. Next, you use the pulse at the end of the observation to determine how far the observational and external data have started running out of sync. Upon re-import of the external data you can stretch the external data to match the duration of the observation by changing the end time of the external data file.

DETERMINING THE DIFFERENCE IN OFFSET BETWEEN AN EVENT LOG FILE AND A VIDEO FILE

The procedure described below assumes that the video file already has been imported into the corresponding observation.

If you have The Observer XT 11.5 or higher and MediaRecorder 2.5,or higher and you start video recording with commands from The Observer XT, you do not have to determine the offset between the observation and the video. The Observer XT does that for you, and synchronizes event log data and video automatically. For more information, see the MediaRecorder Help.

In all other cases, see the instructions below.

To carry out manual synchronization of event log data and a video file created with an external program started from The Observer XT, do the following:

1. Open the observation.
2. In the Event log, click on the row with a trigger comment.
3. Click the **Offset** button on the toolbar.

4. Select **Manual offset**, read the instructions in the **Synchronize** window and click the **Start Synchronization** button.
5. Click in the **Video** window. The video window turns red.
6. Use the Playback Control to go forward or backward to find the onset of the corresponding visual/auditory signal in the video or the keycode signal recorded in, for example, the Notepad. (this should be visible in the screen capture).

7. Click the **Offset** button again to confirm the offset.

8. To view the offset, click the **Offset** button again and select **Numerical Offset**.

   The **File synchronization** window displays the offset for the video file relative to the event log file (0.24 s in the example in Figure 8).

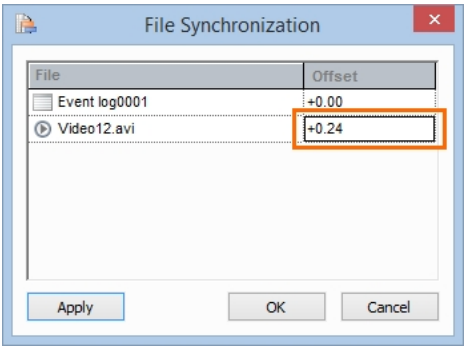
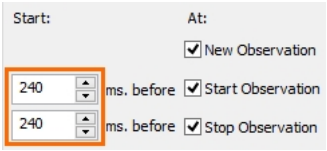


Figure 8 *The **File Synchronization** window. In this example the delay of the video files **Video12.avi** is 0.24 seconds relative to the event log file.*

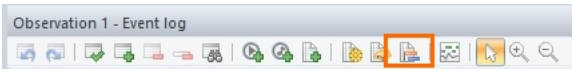
9. In the Project Setup, click Devices, then locate the video recording program item. Enter the offset value (converted to ms) in the fields **ms before Start Observation** and **ms before Stop Observation** in the **Add External Program** window.



DETERMINING THE DIFFERENCE IN OFFSET BETWEEN AN EVENT LOG FILE AND A PHYSIOLOGICAL DATA FILE

To carry out manual synchronization of event log data and physiological data acquired on a data acquisition system, do the following:

1. Open the observation containing the physiological data.
2. In the Event log, click on the row with the trigger comment.
3. Click the **Offset** button on the tool bar.



4. Select **Manual offset**, read the instructions in the **Synchronize** window and click the **Start Synchronization** button.
5. Click in the **External Data and Audio** window that displays the physiological data.

   Result — The border of the **External Data and Audio** window turns red.
6. In the **External Data and Audio** window, click on the graph and drag the graph so the peak created by the TTL pulse coincides with the vertical hairline (which indicates the corresponding position of the trigger comment in the Event Log file).
7. Click the **Offset** button again to confirm the offset.

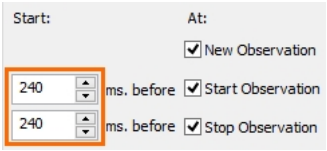
Result — The Event log and the external data file are now synchronized.

8. To view the offset, click the **Offset** button again and select **Numerical Offset**.

   The **File synchronization** window displays the (difference in) offset for the video file (see Figure 8).

9. Do one of the following:

- When you used one trigger pulse — This is the value you need to enter in the fields **ms before Start Observation** and **ms before Stop Observation** in the **Add External Program** window next time you carry out an observation.



- When you used a series of trigger pulses — After you have determined the offset difference at the start and end of the observation, you need to re-import the physiological data file and, upon import, change the Start and Stop time of the physiological data set.

See the section **Import external data** in the The Observer XT Help for how to *import a specific data set*; in the **Import External Data** window you can change the Start and Stop time by double-clicking the corresponding cell.