



# Aurora Expansion Box User Guide

Version 12.0



# **Aurora Expansion Box User Guide**

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## 1 About The Aurora Expansion Box



Figure 1: The Aurora Expansion Box.

The Aurora Expansion Box is used to precisely synchronize the output from your Smart Eye application with other systems by time stamping external events with the clock on the Aurora. You can also use it to log smaller amount of data in the Aurora log.

## 2 How To Use The Aurora Expansion Box

The Aurora Expansion Box is connected to the Aurora via the port on the side of the Aurora labeled with "EXP. PORT". The box is supplied with power via the Aurora. To supply enough power to the Aurora and the Expansion Box, the Aurora needs to be connected to the PC using a USB-C to USB-C cable.

## 3 Output Data Structure And Use

The data structure containing the data sent to the Aurora expansion box is called UserMarker (see `SEType_UserMarker` in Programmer's Guide). A User Marker consists of:

- An error code (`error`), if the marker contains any other error code than success something has gone wrong and the marker is to be viewed as "best effort", i.e. the other fields in the marker may not contain correct information.
- A timestamp (`cameraClock`) corresponding to the CameraClocks output. This is the timestamp that should be used for synchronization between markers and other output from the Aurora. Unit is 100 ns.
- A camera index (`cameraIdx`). For the Aurora this fields is not applicable and can be disregarded since both cameras in the Auroras use the same time.
- A data field (`data`) which contains a user defined integer in range [0-255]. The data is sent from the external system connected to the expansion box.

## 4 Time Stamping and Synchronization

It is advised to send markers from the external system with a regular interval to the Aurora, which can then be used to synch the two systems together. The markers will be provided with approximately the right frame, but for applications requiring high accuracy the *UserMarker.cameraClock* timestamp should be compared to the *CameraClocks* output. The *CameraClocks* will contain the start time of the exposure for the two sensors. The difference between the exposure time for the two cameras is approximately 100-600  $\mu\text{s}$  depending on the system.

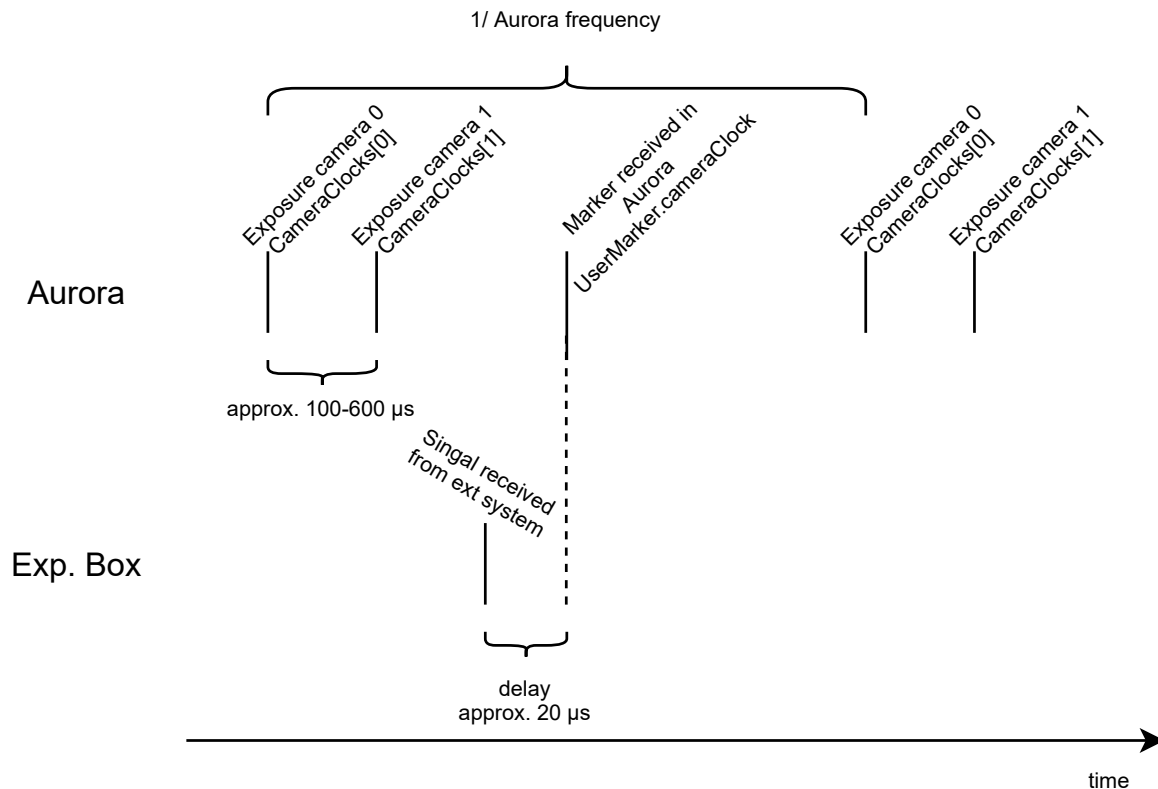


Figure 2: A time diagram showing the time stamping in the Aurora.

For a time diagram of the system receiving a marker see Figure 2. The diagram shows how the two different sensor in the Aurora are exposed after each other. The times for their respective exposure are provided in the *CameraClocks* output. It is recommended to see the eye tracking data time as the midpoint of the two exposure times. As seen in the figure the marker sent from the external system is time stamped when arriving at the Aurora. The *cameraClock* field of the *UserMarker* is time stamped using the same clock as the *CameraClocks* field of the output data.

The frequency drift of the Aurora clock is  $\pm 25$  ppm. By sending a marker each second the drift of the Aurora clock will be approx. 25  $\mu\text{s}$  at most between two consecutive markers. Using that, and the knowledge of the drifting of the clocks in the external system, a suitable frequency of sending markers can be decided. Please note that it is not recommended to calculate a constant drift for a whole experiment, rather the systems should be synchronized at a regular interval using the markers.

## 5 Hardware Interface



Figure 3: The Aurora Expansion Box Hardware Interface.

The expansion box is connected to the additional equipment using the female DSUB-9 port on the expansion box, see Figure 3 for an image of that side of the box. The eight pins in the DSUB adapter each correspond to one bit, and the ground pin has to be connected to ground. The pins support an input voltage between 3 and 30 V, and will draw 5 mA from the connected equipment.

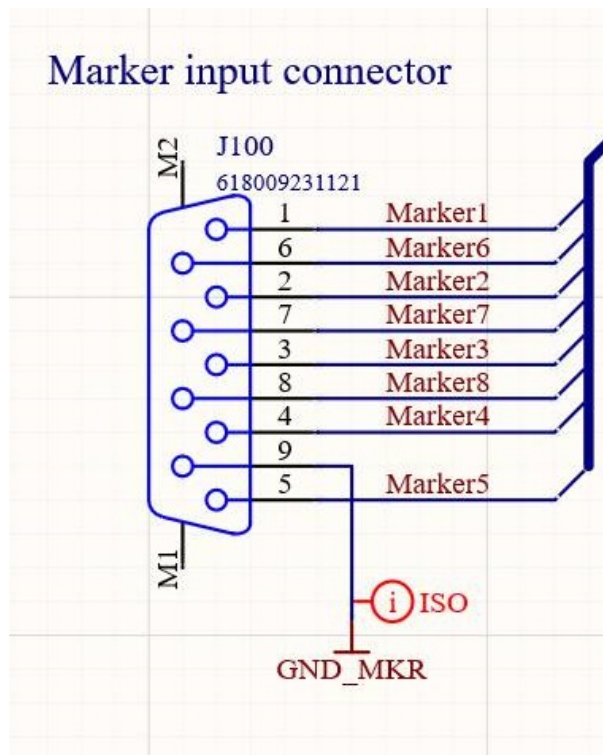


Figure 4: Expansion box DSUB interface.

In order to send a marker from the additional system to the expansion box the pins on the DSUB connector has to be set for at least 22  $\mu$ s. Each state for these pins correspond to a marker, where marker with data 0 corresponds to all pins set low. See Figure 4 for a schematic

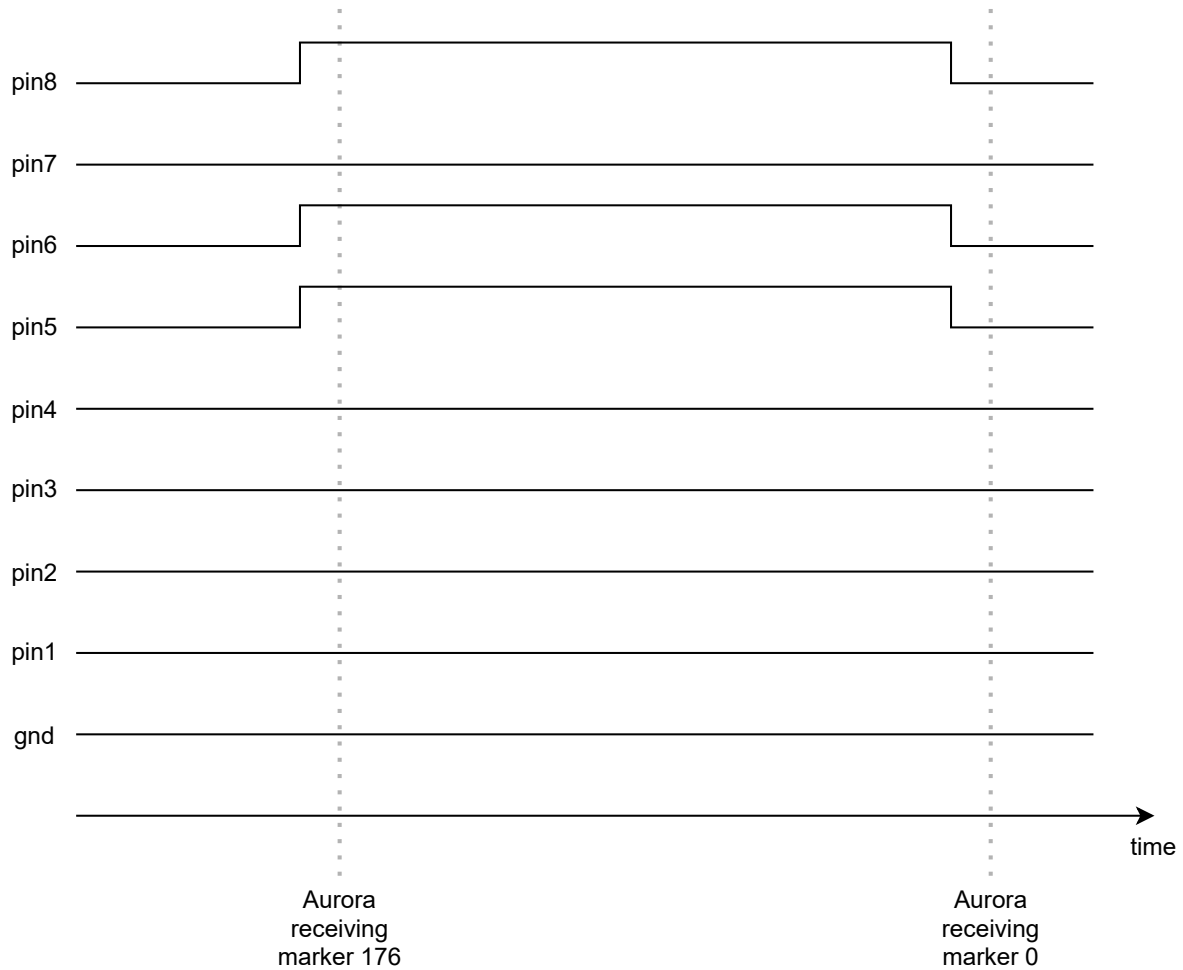


Figure 5: A diagram showing how the pins are set over time when sending a marker to the Aurora. When sending a marker the pins are set high (to for example 5 V) for some time. After approx 22  $\mu$ s the Aurora will receive, time stamp and decode the marker to it's decimal format. When all the pins are set to 0 V the Aurora will receive and time stamp marker 0 after the same approximate delay.

of DSUB-9 connector. See Figure 5 for an example of how the pins are set when a marker is sent to the Aurora.

The sync in and sync out ports are not yet supported.

## 6 Known Limitations

- To supply the Aurora and the expansion box with enough power, the Aurora needs to be connected to the PC using a USB-C to USB-C cable.
- The Aurora Expansion box is only available for Auroras with "smart eye" written on the front glass.



- The Aurora firmware version has to be higher or equal to 5.6 to use the Expansion Box.
- The version of the Smart Eye application has to be higher than 9.1.
- The frequency over time of which markers are sent must be lower than the camera frame rate. So, for a 120 Hz Aurora you can send a marker approximately each 9th millisecond. Occasionally, two markers can be sent close together after each other, but a maximum of two marker for a frame. E.g. for a 120 Hz Aurora you can send two but not more markers over an interval of 8.4 milliseconds.
- A delay of approximately 22  $\mu\text{s}$  is to be expected from sending the marker to the Aurora to time stamping the marker.