Scope of this document

This document describes triggering basics for Allied Vision USB3 Vision cameras, from best-practice rules to general examples.

Features use in programming
For information on programming with features, see the Vimba Viewer Guide, included in Vimba. See:
https://www.alliedvision.com/software.

Trigger signal flow

The following diagram shows the exposure of a frame started by an external signal. High levels show the active state of a signal. Proportions and dependencies are simplified to show the basic signal flow. Signal 1 starts Cycle 1.

Figure 1: Trigger signal flow

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>External signal</td>
<td>Electrical trigger signal starting the signal flow</td>
</tr>
<tr>
<td>ExposureActive</td>
<td>Exposing a frame</td>
</tr>
<tr>
<td>ReadoutActive</td>
<td>Reading out a frame, high when the image sensor is reading out data</td>
</tr>
<tr>
<td>FrameTriggerWait</td>
<td>Waiting for a trigger</td>
</tr>
<tr>
<td>AcquisitionActive</td>
<td>• Acquiring of frames, needs to be high to start triggering</td>
</tr>
<tr>
<td></td>
<td>• High when the camera image sensor is either exposing, reading out data,</td>
</tr>
<tr>
<td></td>
<td>or waiting for a trigger</td>
</tr>
</tbody>
</table>

Table 1: Trigger signal flow, legend
Trigger latency

Trigger latency is the time delay between the FrameStart trigger and the start of exposure. Trigger latency consists of:

- Jitter and delay of ExposureStart
- TriggerDelay

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ExposureStart jitter</td>
<td>• Deviation from the average periodical signal time</td>
</tr>
<tr>
<td></td>
<td>• Time range mainly caused by sensor line synchronization</td>
</tr>
<tr>
<td>ExposureStart delay</td>
<td>• Deviation from the average periodical signal time</td>
</tr>
<tr>
<td></td>
<td>• Time range caused by camera internal timing</td>
</tr>
<tr>
<td>TriggerDelay</td>
<td>Value set by the user to extend the trigger latency</td>
</tr>
</tbody>
</table>

*Table 2: Trigger latency -> Components*

Best practice rules for triggering

- Set the trigger to RisingEdge for fastest possible reaction time.
- Set the trigger pulse width in the supported range.
- Consider that the end of exposure triggers the next readout.
- Make sure the exposure of a frame ends after the readout of the previous frame.
- Start exposure only between the readouts of two lines.
- Consider that ExposureStart delay = readout time – ExposureTime.

Triggering when ReadoutActive is low

Apply FrameStart trigger when ReadoutActive is low. This way, you keep trigger latency (including ExposureStart jitter) short.

Triggering when ReadoutActive is high

For fastest triggering cycle time with simultaneous exposure and readout, apply FrameStart trigger immediately when FrameTriggerWait is high.

Because exposure must always begin at sensor line synchronization, the ExposureStart jitter can be up to 1 line cycle.

Additional information

- For detailed camera control definitions, see your camera’s technical manual: https://www.alliedvision.com/en/support/technical-documentation.html
- For detailed camera control definitions, see USB3 Vision Features Reference at Additional Documents for your USB camera: https://www.alliedvision.com/en/support/technical-documentation.html
Examples

AcquisitionStart trigger and FrameStart trigger

AcquisitionStart description

To acquire images, \textit{AcquisitionActive} must be high. Even to trigger the start of an acquisition by a pulse through an I/O, you have to issue an \textit{AcquisitionStart} command.

\textbf{AcquisitionStop}

\textit{AcquisitionStop} is mandatory to end acquisition.

With \textit{AcquisitionMode} = \textit{SingleFrame} or \textit{MultiFrame}:

If no \textit{AcquisitionStop} is signaled, after the selected number of frames has been acquired, the camera internally creates an \textit{AcquisitionStop} command; this turns \textit{AcquisitionActive} to low.
AcquisitionStart trigger and FrameStart trigger dependencies

Figure 4 shows the dependencies between AcquisitionStart and FrameStart trigger.

Figure 4: Dependencies of AcquisitionStart and FrameStart
Modes for triggering

The following sections describe in general the main modes for triggering:

- TriggerMode
- AcquisitionMode
- ExposureMode

TriggerSelector

The TriggerSelector examples in this section show triggering with AcquisitionMode = Continuous.

<table>
<thead>
<tr>
<th>AcquisitionMode</th>
<th>TriggerSelector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AcquisitionStart</td>
</tr>
<tr>
<td>Continuous</td>
<td>Off</td>
</tr>
<tr>
<td>Continuous</td>
<td>Off</td>
</tr>
<tr>
<td>Continuous</td>
<td>Off</td>
</tr>
<tr>
<td>Continuous</td>
<td>Off</td>
</tr>
</tbody>
</table>

*Table 3: TriggerSelector examples overview*

An AcquisitionStart command sets ExposureActive to high. After this, the camera continues exposing with the maximum frame rate allowed. Maximum frame rate depends on factors, such as camera specifications and available bandwidth.
Acquisition without triggering

If no trigger is selected, the `AcquisitionStart` command starts exposure.

```
AcquisitionMode = Continuous;
TriggerSelector = AcquisitionStart;
    TriggerMode = Off;
TriggerSelector = FrameStart;
    TriggerMode = Off;
```

**Figure 5: Acquisition without triggering**
??§ûò $\text{TriggerSelector} = \text{FrameStart}$

$\text{FrameStart}$ triggers the exposure.

```
AcquisitionMode = Continuous;
TriggerSelector = AcquisitionStart;
    TriggerMode = Off;
TriggerSelector = FrameStart;
    TriggerMode = On;
AcquisitionStart();
FrameStart trigger
ExposureActive
ReadoutActive
AcquisitionActive
```

*Figure 6: TriggerSelector = FrameStart trigger*
AcquisitionMode

AcquisitionMode = SingleFrame

The **AcquisitionStart** command triggers the exposure of a single frame. Every frame needs a separate **AcquisitionStart** command.

```c
AcquisitionMode = SingleFrame;
TriggerSelector = AcquisitionStart;
    TriggerMode = Off;
TriggerSelector = FrameStart;
    TriggerMode = Off;
ExposureMode = Timed;
AcquisitionStart ();
```

*Figure 7: AcquisitionMode = SingleFrame*
**AcquisitionMode = MultiFrame**

*AcquisitionStart* triggers exposure. *FrameCount* sets the number of images.

```c
AcquisitionMode = MultiFrame;
FrameCount = 6;

TriggerSelector = AcquisitionStart;
TriggerMode = Off;

TriggerSelector = FrameStart;
TriggerMode = Off;

ExposureMode = Timed;

AcquisitionStart();
```

![Diagram](image)

*Figure 8: AcquisitionMode = MultiFrame*
**ExposureMode**

**ExposureMode = Timed**

FrameStart triggers exposure.
ExposureTime sets exposure time.

AcquisitionMode = Continuous;
TriggerSelector = AcquisitionStart;
TriggerMode = Off;

TriggerSelector = FrameStart
TriggerMode = On;

ExposureMode = Timed;
ExposureTime = 500;

AcquisitionStart();
AcquisitionStop();

FrameStart trigger
ExposureActive
ReadoutActive
AcquisitionActive

*Figure 9: ExposureMode = Timed*
ExposureMode = TriggerWidth

*FrameStart* triggers exposure.

The duration of the *FrameStart* trigger sets the exposure time.

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**Figure 10: ExposureMode = TriggerWidth**

**ExposureModes Mako U-503B**

Mako U-503B provides only *Timed* value for ExposureMode.

**TriggerWidth and TriggerActivation**

If the frame or line TriggerActivation[TriggerSelector] is *RisingEdge* or *LevelHigh*, the camera exposes as long as the trigger is high.

If TriggerActivation[TriggerSelector] is *FallingEdge* or *LevelLow*, the camera exposes as long as the trigger is low.
Contact
For technical support, please contact support@alliedvision.com.
For comments or suggestions regarding this document, please contact info@alliedvision.com.

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