

TN013: Using an External Trigger Input with a FireBird CoaXPress Board

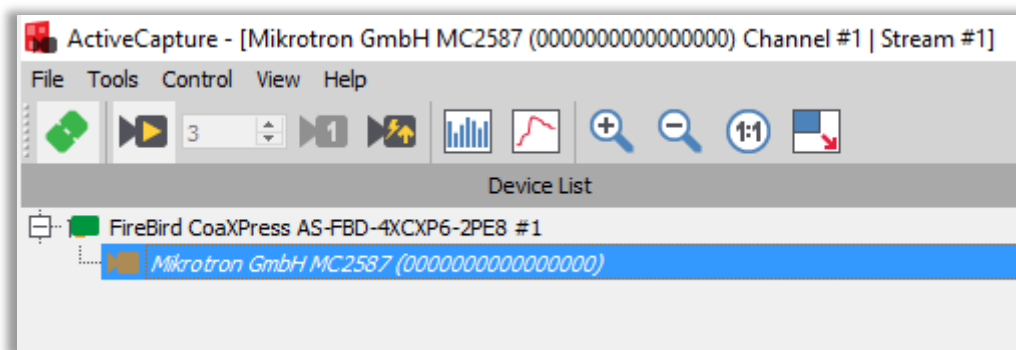
Summary

This is a step-by-step guide to trigger area scan CoaXPress (CXP) compatible cameras from ActiveCapture using an external signal input via the FireBird 50-way I/O connector or the FireBird 15-way D-Type end bracket I/O connector on supported boards.

Compatibility:	All FireBird CoaXPress boards
Software required:	ActiveCapture v1.5.7 onwards
Windows installer required:	All CoaXPress installers from v1.5.1 onwards

GenICam support for CXP cameras

All CXP cameras support GenICam, therefore ActiveCapture can be used to control the camera and it is displayed in ActiveCapture's 'Device List', as shown below:



ActiveCapture connected to a Mikrotron MC2587 CXP camera



Get a live image

Connect to the camera in ActiveCapture as described in the FireBird QuickStart guide included with the Windows installer and available on our [website](#). Once connected, live images should be obtained to check that the camera image is undistorted and correctly proportioned.

Also, make a note of the frame rate displayed at the bottom of the image window in frames per second (FPS), which is the acquired frame rate from the camera, whilst free running using the camera's own internal timing. If the camera does not produce live images, it is possible that it is expecting an external trigger signal to operate and should be reconfigured, such that the 'Trigger mode' is set to 'off', as shown in the figure below.

The value shown below is 80.4 FPS for this 25MP camera using its internal triggering. This value will be used later when comparing to the externally triggered frame rate that we can control using the external trigger input.

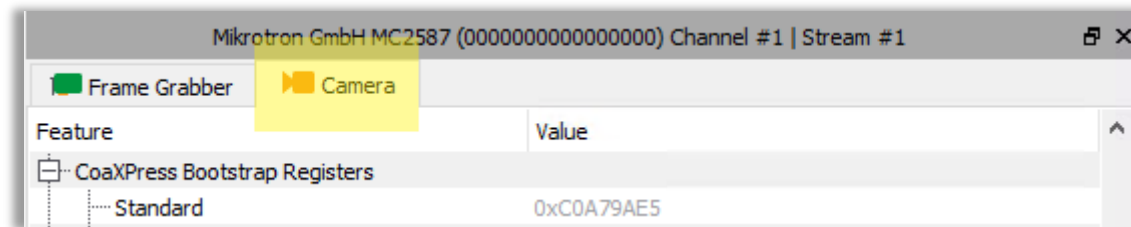
The screenshot shows the ActiveCapture software interface. On the left, the 'Feature' pane lists various camera settings. The 'TriggerMode' is set to 'Off', which is highlighted with a red arrow. The 'Trigger Source' is set to 'Software Trigger'. The 'Acquisition Control' pane on the right shows 'Acquisition Mode' set to 'Continuous', 'Acquisition Start' and 'Acquisition Stop' buttons, 'Trigger Selector' set to 'FrameStart', 'TriggerMode' set to 'Off' (highlighted with a red arrow), and 'Trigger Source' set to 'Software Trigger'. The main image window displays a live image of several glass vials on a rotating platform. At the bottom of the image window, the frame rate is displayed as '80.4 FPS' in a yellow box. The bottom status bar shows '50%' zoom, '69263' frame count, '80.4 FPS' frame rate, 'BayerRG8' color format, '5120x5120' resolution, 'x:3552, y:2684' coordinates, and 'Raw Luminance (R): 0x0'. The console at the bottom shows a log of events, including 'Connected to Mikrotron GmbH MC2587 (0000000000000000) Channel #1' and 'Application started'.

Camera trigger mode Off for internal triggering

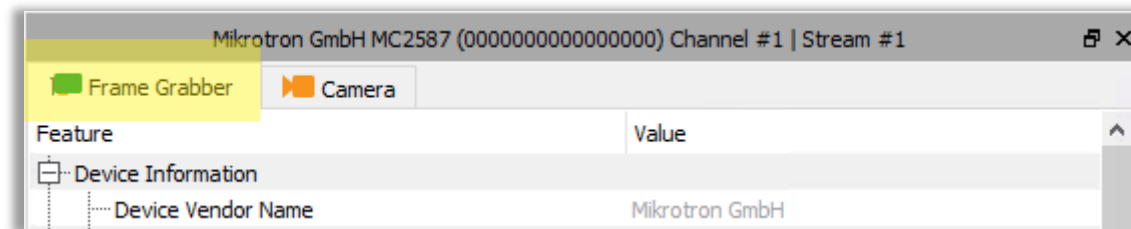
Frame rate display (capture rate) and bit depth/resolution information



The configuration of both the FireBird frame grabber and the camera are set up by using the feature browser menus in the ActiveCapture GUI. The controls for the camera and FireBird board are shown in separate tabs in ActiveCapture, as indicated below.



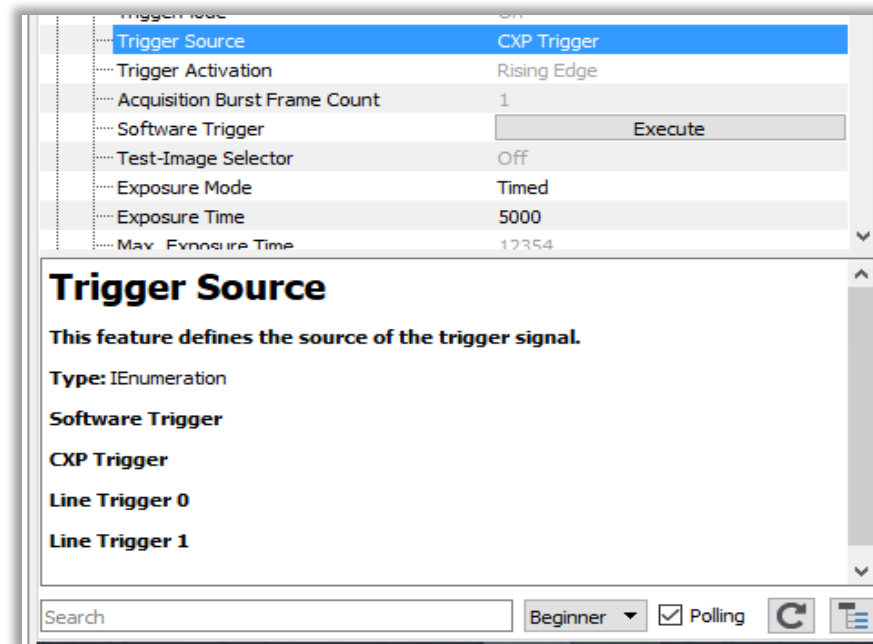
Feature browser 'Camera' tab when connected to a Mikrotron MC2587 CXP camera



Feature browser 'Frame Grabber' tab when connected to a FireBird CXP board

Configuring the camera for external trigger input

Referring to the documentation supplied by the manufacturer of your camera, including the built-in help of the ActiveCapture feature browser (see the screenshot on the next page), find the available options for external trigger input via the CoaXPRESS interface. Options available could be to trigger on a rising edge signal, a falling edge or on both edge types at the same time, i.e. any edge will initiate a trigger event in the camera.



Feature browser built-in help for the 'Trigger Source' menu item.

Make a note of these settings, as they will be used next to configure the FireBird board's output to match the camera trigger input and enable triggering via the FireBird board using the CoaXPress cable uplink.

Configuring the FireBird board in the Frame Grabber tab

The next step is to set up the FireBird board to output a trigger signal to the camera via the CoaXPress cable. The trigger signal is looped through the FireBird's timer M1, such that either the pulse width is fixed and defined by the value of M1, e.g. 10,000ns (0.01ms) or the input pulse width is used unmodified, just looping through. This latter method is often used when the pulse width from the external trigger is used to control the exposure duration in cameras that support this mode. The external trigger's edge timing is always used to trigger the camera's exposure start, but when setting $M1 > 0$, the pulse width of M1 is used instead of the pulse width from the external pulse and it is this that is sent to the camera. See the screenshot on the next page.



Mikrotron GmbH MC2587 (0000000000000000) Channel #1 | Stream #1

Feature	Value
PHX_CAMTRIG_SRC	PHX_CAMTRIG_SRC_TTLIN_CH1_0_RISE
PHX_EXPOSE	Execute
PHX_CAMTRIG_FILTER_NS	200
PHX_CAMTRIG_ENCODER_MODE	PHX_CAMTRIG_ENCODER_MODE1
PHX_CAMTRIG_ENCODER_SRC	PHX_CAMTRIG_SRC_422IN_CHX_0
PHX_CAMTRIG_ENCODER_FILTER_NS	0
PHX_CAMTRIG_MULTIPLIER	1
PHX_CAMTRIG_DIVIDER	1
PHX_CAMTRIG_DELAY_MODE_D1CAM	PHX_CAMTRIG_DELAY_NONE
PHX_CAMTRIG_DELAY_MODE_D2CAM	PHX_CAMTRIG_DELAY_NONE
PHX_CAMTRIG_CXPTRIG_SRC	PHX_CAMTRIG_CXPTRIG_TIMERM1_CH1
PHX_CAMTRIG_CXPTRIG_MODE	PHX_CAMTRIG_CXPTRIG_RISEFALL
PHX_FrameGrabberTriggerControl	
PHX_FGTRIG_SRC	PHX_FGTRIG_SRC_TIMERM1_CHX
PHX_FGTRIG_MODE	PHX_FGTRIG_FREERUN
PHX_FGTRIG_DELAY_MODE	PHX_FGTRIG_DELAY_NONE
PHX_FGTRIG_FILTER_NS	200
PHX_CounterTimer	
PHX_TIMERM1_PERIOD_NS	100000000
PHX_TIMERM1_MODE	PHX_TIMERM1_MODE_RUN
PHX_TIMERM1_PULSE_COUNT	1
PHX_TIMERD1FG_VALUE_NS	0
PHX_TIMERD1FG_COUNT	0
PHX_TIMERD1CAM_VALUE_NS	1000
PHX_TIMERD2CAM_VALUE_NS	1000
PHX_TIMERM1_WIDTH_NS	1000000
PHX_TIMERM2_WIDTH_NS	0

This feature sets the camera trigger source to be the TTL CH1 input on the 50-way I/O FireBird connector. Other input signal types are available on this connector as well, please refer to the 'FireBird Hardware Manual' for details.

The CXP trigger source feature also needs to be defined, so that a pulse is sent to the camera via the CXP uplink from FireBird. In the example shown, it is set for a positive pulse with a rising edge followed by a falling edge after the width defined by the value of M1 in nanoseconds.

This feature ensures that frame grabber triggers are not used. By configuring this to "Free Run" mode, its settings will have no effect on the acquisition and only the camera's trigger is used with the frame grabber slaved to the camera's output timing.

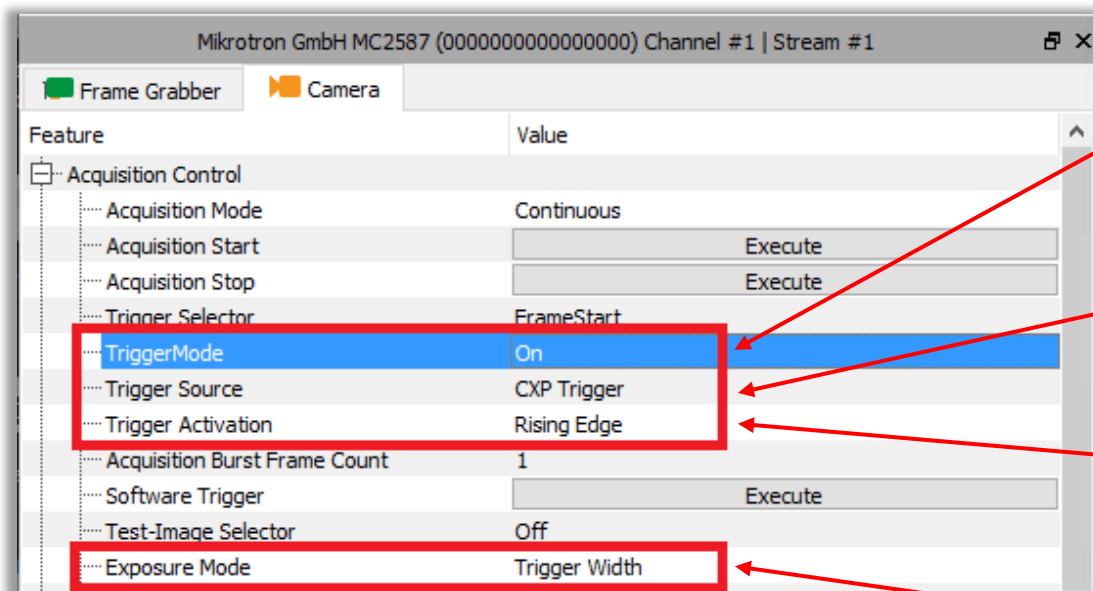
This feature sets the pulse width (in nanoseconds) sent to the camera, with a pulse repetition frequency dependant on the external trigger's input frequency. In this case the pulse width is fixed to a value of 1,000,000ns (1ms) using the timer M1. This value should be equal to or greater than the minimum required to trigger the camera, but not so large as to overlap the frame period of the pulse repetition frequency used.

Note: If the pulse width sent to the camera is to be varied for exposure control by controlling the incoming external pulse width, then a value M1=0 should be used. In this case the value of M1 is ignored and the incoming pulse is mapped to the CXP uplink pulse width sent to the camera.



Camera setup via the Camera tab

The camera must be configured to be externally triggered via the CXP trigger input, which is controlled via the settings in the Camera tab of the feature browser, as shown below. The setup options will vary slightly between different camera models and camera manufacturers, but it will follow a similar layout. Refer back to the documentation supplied by the manufacturer of your camera, including that shown in the help built into the ActiveCapture feature browser.



The TriggerMode feature sets the camera's trigger to accept or reject external input. It should be noted that if no valid external trigger signal is received, either via the CXP cable or directly into the camera head (for models that support this), the camera will not output any video at all, and no live image can be obtained.

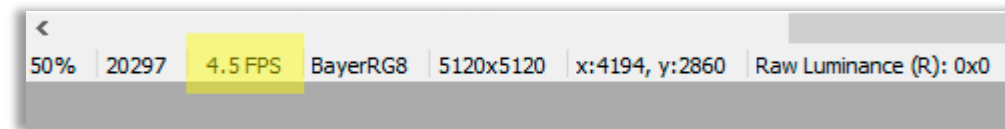
In the Trigger Source line, we define the source of the external trigger input to the camera to be the CXP uplink from our FireBird frame grabber using the CXP cable.

The trigger can occur on either a rising or falling edge on the CXP uplink or both (either edge). In our example it is set to use a rising edge. Note: if both edges are selected, then any edge will be used, and this will lead to a doubling of the trigger rate obtained.

The Exposure Mode setting "Trigger Width" is used to configure the camera into an exposure control mode where the exposure time is controlled via the width of the trigger pulse, in this case via CXP.

The camera will now trigger from the CXP trigger input using the frequency from the external input supplied to FireBird's TTL CH1 and using the M1 value for its pulse width. The M1 value also sets the camera exposure duration using the camera's 'Trigger Width' mode.

Selecting 'Live Acquisition' from ActiveCapture's ribbon will now show the camera operating at the frequency set by the external trigger source, and in this example that value is 4.5Hz, as shown below.



ActiveCapture running with the camera acquiring images at 4.5Hz (FPS) triggered via FireBird's external input TTL signal.

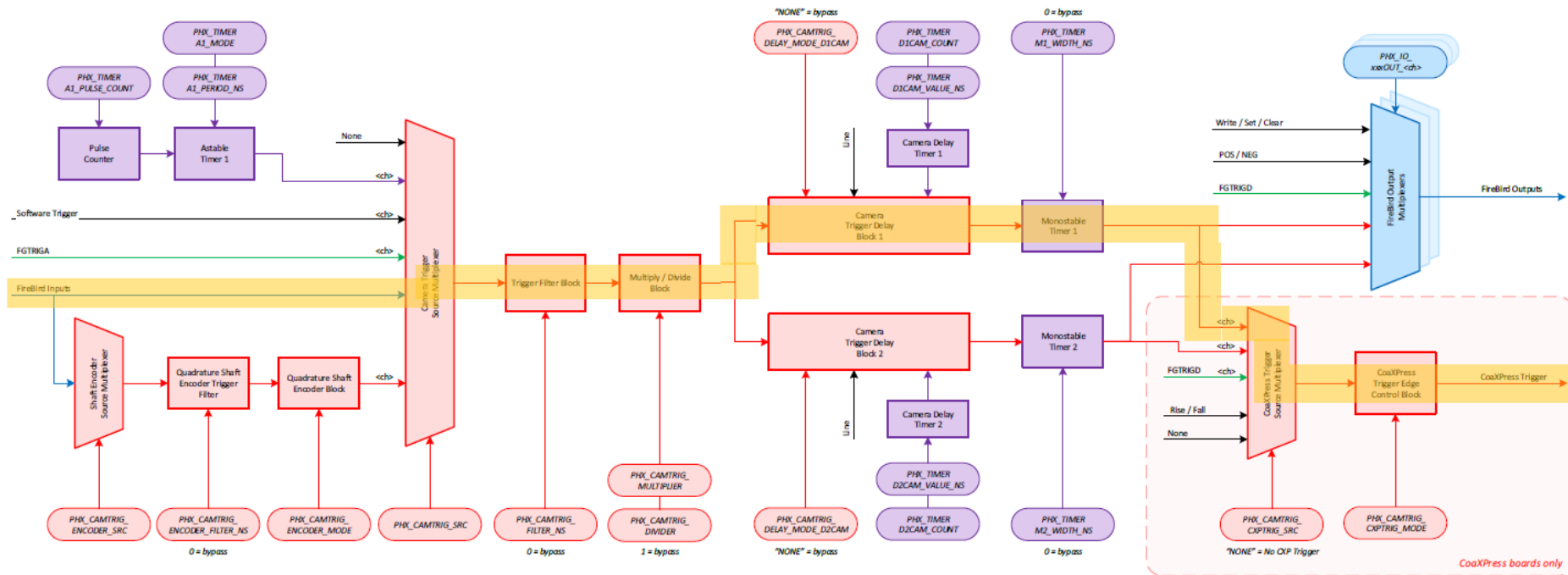
Notes

1. This example uses a 4.5Hz signal connected to FireBird, which is the target frame rate we wanted to achieve. The camera in internally triggered mode produces live images at ~80Hz and so the 4.5Hz external trigger frequency is well within that maximum limit.
2. The trigger pulse width should be above the minimum required for reliable triggering, as specified by the camera manufacturer for that model, when using external input. In this example, the pulse is fixed at 1ms (using M1) and the minimum trigger width for this camera is around 0.001ms, so reliable trigger should easily be achieved. The camera's exposure time is set to this same value using its Trigger Width exposure mode.
3. If, however, the pulse width sent to the camera is made too large it will also cause unreliable triggering, as the pulse width approaches the limit defined by the period of the trigger frequency. In our example the 4.5Hz external trigger frequency gives a maximum possible frame period of $1/4.5$ i.e. 222ms, therefore it can be seen that the pulse width to be sent to the camera must be less than this value or a trigger overlap condition can occur. In the event of overlap, some triggers will likely be lost and a lower frame rate than expected can occur.
4. The trigger signal in this example is TTL for ease of setup. However, in a deployed system we recommend that RS-422 is used for connections to external equipment outside the PC's case, due to its noise immunity in industrial environments. For more information on the supported external input signal types and pin connections on our 50-way I/O connector, please refer to the 'FireBird Hardware Manual', 'FireBird 50 Way I/O (55mm) Connector' section.

For more information on trigger scenarios, please refer to the 'FireBird System Manual' included with the installed documentation.



Trigger configuration path indicated in yellow:



Key: Red = Camera Trigger Block Green = Frame Grabber Trigger Block Purple = Timer Block Blue = I/O Block Black = General Control <cho> = The API allows this signal to be selected from other channels

PHX_xxxx = eParam value for PHX_Parameter_Set()

Camera Trigger Block Diagram per Channel



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