

TN012: Using an External Trigger Input with a FireBird Camera Link Board

Summary

This is a step-by-step guide to trigger area scan GenCP compatible cameras from ActiveCapture using an external signal input via the FireBird 50-way I/O connector.

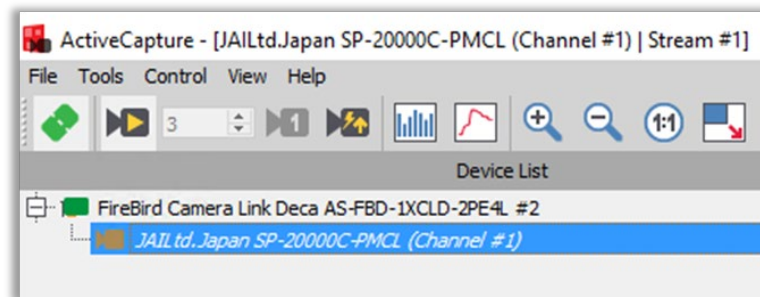
Compatibility:	All FireBird Camera Link boards
Software required:	ActiveCapture v1.5.7 onwards
Windows installer required:	All Camera Link installers from v1.5.0 onwards

Variation for non-GenCP cameras

This example uses a GenCP compatible camera and therefore the camera's name is displayed in the 'Device List', as shown below. The same procedure applies if a proprietary GenICam Camera Link protocol DLL is installed. This DLL must be supplied by the camera manufacturer and configured via our GenTL setup utility, as described in the FireBird QuickStart guide.

If a non-GenICam camera is used instead, the same trigger settings for the 'Frame Grabber' tab can be used. The camera settings, however, will need to be controlled via the manufacturer's own application software, as shown in the video 'Setting up a pcf configuration file':

<https://www.youtube.com/watch?v=6dchyXogsQE>



ActiveCapture connected to a GenCP compatible JAI SP-20000C-PMCL camera.

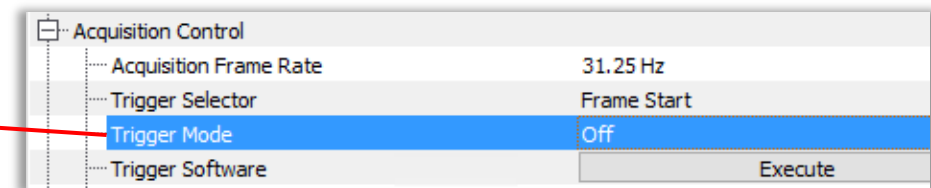
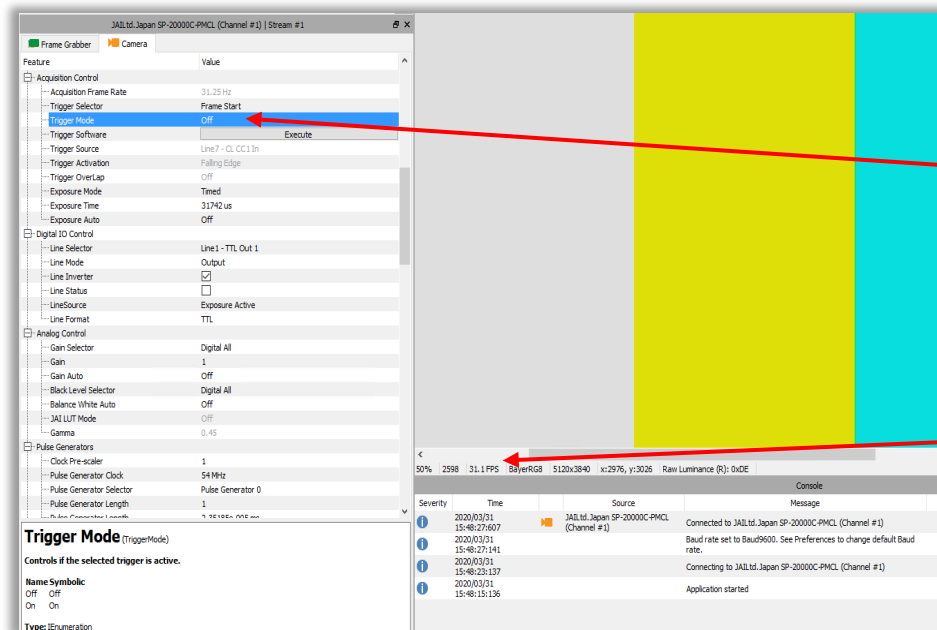
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Get a live image

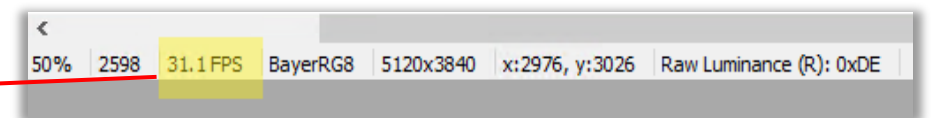
Connect to the camera in ActiveCapture after first setting up the GenTL connection, as described in the FireBird QuickStart guide included with the Windows installer. Once connected, live images should be obtained to check that the camera tap mode settings are correct and the image is undistorted and 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, usually 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 highlighted in blue.

The frame rate shown below is 31.1 FPS for this 20MP camera using its internal trigger timing. This value will be used later, when comparing to the externally triggered frame rate that we can control using the externally input trigger signal.



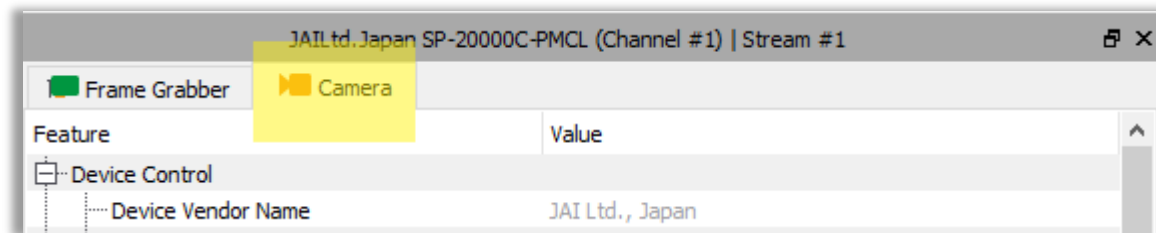
Camera trigger mode Off for internal triggering



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

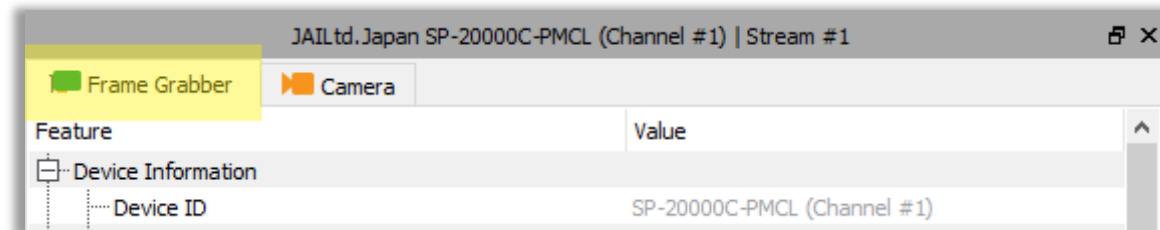
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The configuration of both the FireBird frame grabber and the camera are set up by using drop down menus in the ActiveCapture GUI. The controls for the camera and FireBird board are shown in separate tabs in ActiveCapture, as indicated below.



Feature browser 'Camera Tab' when connected to a JAI SP-20000C-PMCL camera

Note: The 'Camera Tab' feature browser will only appear when a GenCP compatible camera is used or a proprietary Camera Link DLL is installed.

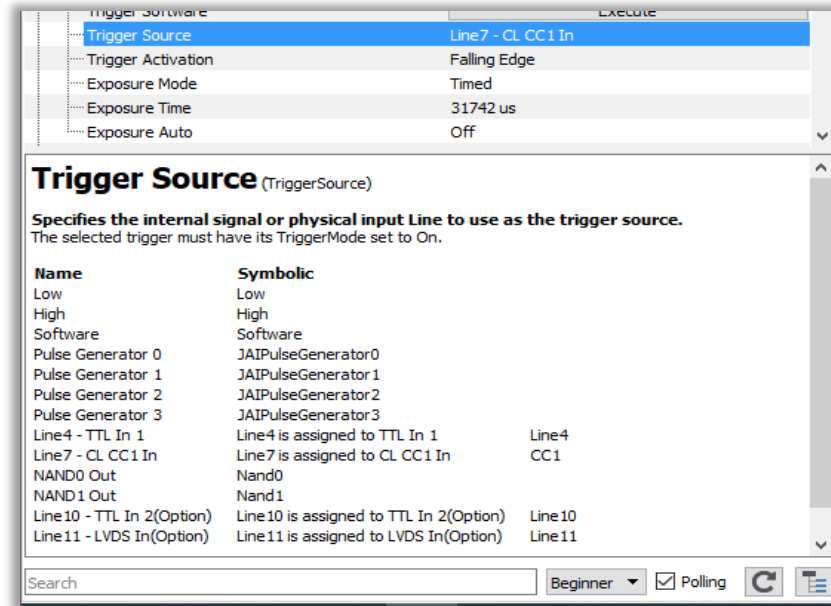


Feature browser 'Frame Grabber Tab' when connected to a FireBird Camera Link board

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 Camera Link interface. Typical settings on offer could be configuring the trigger source to be one of the four dedicated Camera Link CCout1-4 trigger lines. Other options could be to trigger on a rising edge signal, falling edge or on both edge types at the same time, i.e. any edge will initiate a trigger event in the camera.

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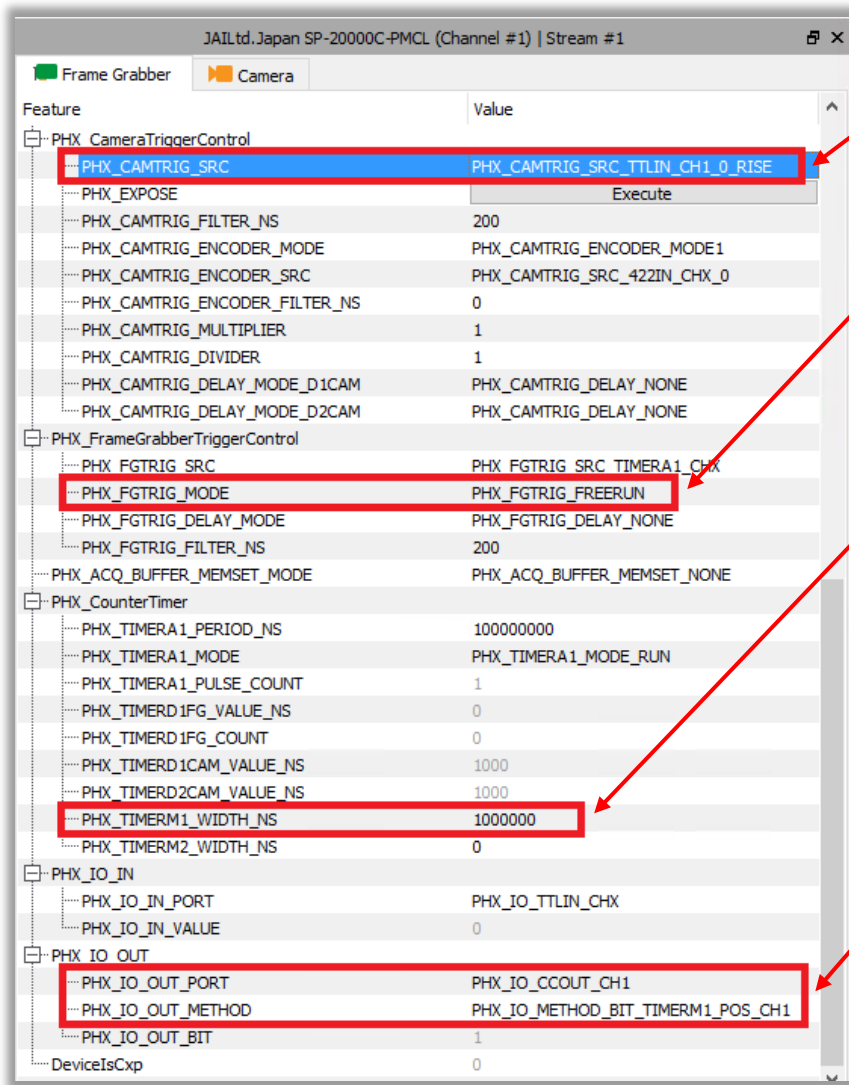
Feature browser built-in help shown for the 'Trigger Source' camera menu item

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

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 one of the Camera Link cable dedicated trigger lines. The trigger signal is looped through the FireBird timer M1, such that either the pulse width is fixed and defined by the M1 set value, 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 explicit pulse width of M1 is also used instead of the incoming pulse width from the external pulse and it is this that is sent to the camera. See the screenshot on the next page.

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Feature	Value
PHX_CameraTriggerControl	
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_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_ACQ_BUFFER_MEMSET_MODE	PHX_ACQ_BUFFER_MEMSET_NONE
PHX_CounterTimer	
PHX_TIMERM1_PERIOD_NS	10000000
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
PHX_IO_IN	
PHX_IO_IN_PORT	PHX_IO_TTLIN_CHX
PHX_IO_IN_VALUE	0
PHX_IO_OUT	
PHX_IO_OUT_PORT	PHX_IO_CCOUT_CH1
PHX_IO_OUT_METHOD	PHX_IO_METHOD_BIT_TIMERM1_POS_CH1
PHX_IO_OUT_BIT	1
DeviceIsCxp	0

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

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

This feature sets the pulse width (in nanoseconds) sent to the camera, with a pulse repetition frequency defined by the external trigger source frequency. In this case the pulse width is fixed to 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.

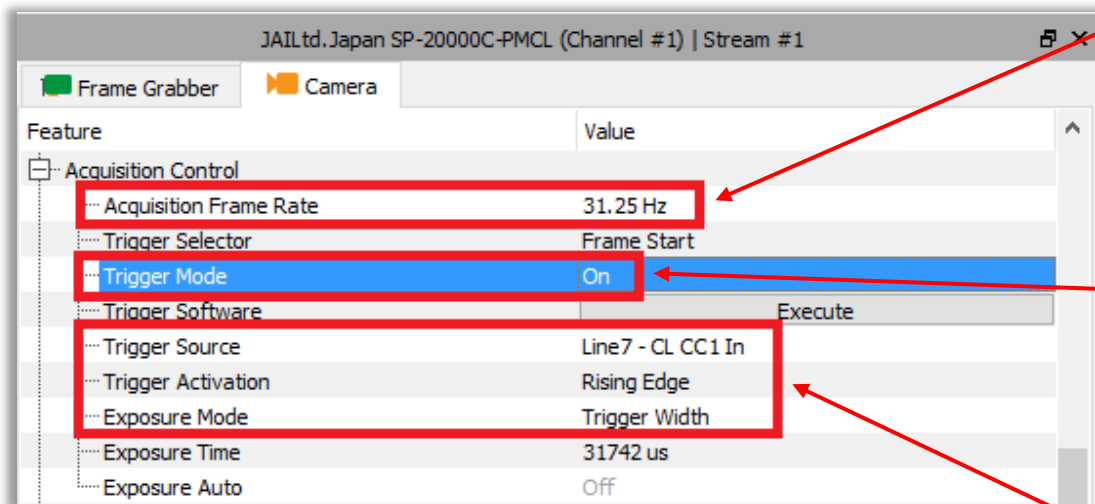
Note: If the pulse width sent to the camera is to be varied for exposure control by controlling the incoming external pulse width, then a value M1=0 should be used. In this case the value of M1 is now ignored and the incoming pulse width is mapped to the pulse width sent to the camera.

Next, the M1 timer output pulses must be routed up the Camera Link (CL) cable and into the camera head, where the camera can use this for its triggered timing. This is achieved by setting one of the four CL trigger lines (CCOUT1-CCOUT4) to be the output of our FireBird Timer M1. Most CL cameras will use CCOUT1 as their primary trigger input via the Camera Link interface, so it is used in this example, but CC2 is also often used for other functionality. In the next line we define the polarity of the pulse and this is set to use a positive edge in this example. A negative edge could also be used if required by the camera.

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Camera setup via the Camera tab

The camera must be configured to be externally triggered via the CC1 CL trigger input, which is controlled via the settings in the Camera tab of the feature browser, as shown below. The GUI setup will vary slightly between camera models and different manufacturers, but it will follow a similar layout. Refer back to the documentation supplied by the manufacturer of your camera, including that listed in the help built into the ActiveCapture feature browser.



This feature shows the camera acquisition frame rate with the camera free running, internally triggered using its own timing. In this case it is also the maximum frame rate possible for this camera in this tap mode and for this Camera Link clock frequency setting. The external trigger rate must not exceed this rate, or triggers will typically be ignored, and the target frame rate not achieved.

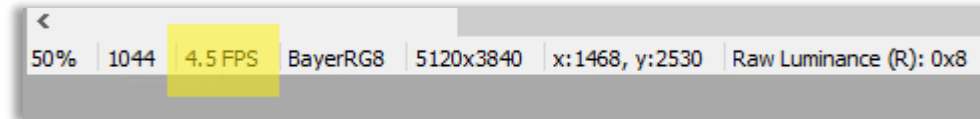
The Trigger Mode feature sets the camera's external trigger mode and is set to ON. It should be noted that if no valid external trigger signal is received, either via the Camera Link cable or directly into the camera head (for some models that support this), the camera will not output any video and no live image can be obtained.

With a valid trigger input applied, 'live video' can only be obtained when the trigger signal is present. In the "Trigger source", we define the source of the external trigger input to the camera to be 'CC1 In', i.e. one of the dedicated Camera Link lines from the frame grabber to the camera via the Camera Link cable. The trigger can occur on either a rising or falling edge on CC1 and here it is set to use a rising edge.

The camera will now trigger from the CC1 trigger input using the timing from the external input supplied to TTL CH1 and using the value of M1 for its pulse width. The M1 value also sets the camera exposure duration using the camera's 'Trigger Width' mode.

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Selecting 'Live Acquisition' from ActiveCapture's ribbon will 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 external TTL input.

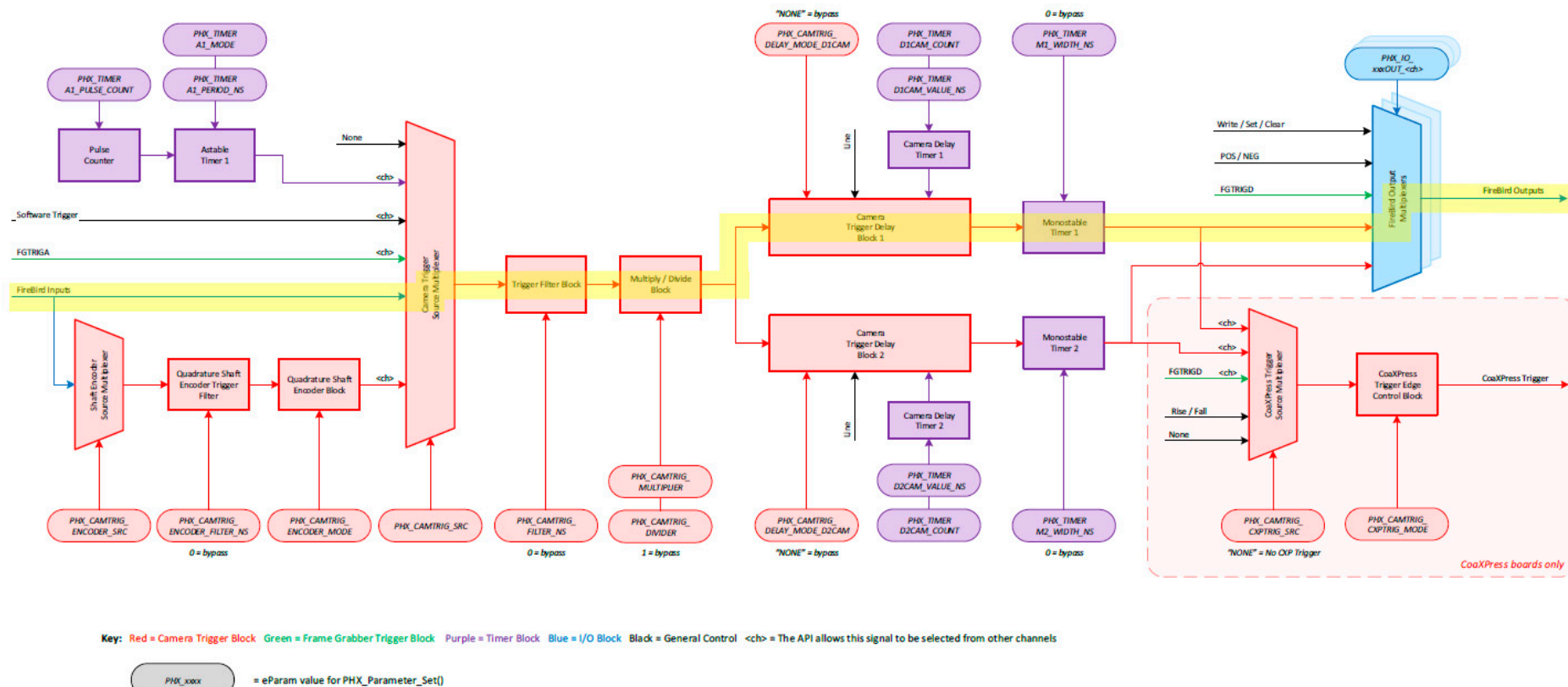
Notes

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 ~31Hz and so the 4.5Hz external trigger frequency is well within that maximum limit.
2. The camera's maximum frame rate can only be obtained however, if the camera's configuration is capable of at least this frame rate in the current Camera Link tap mode and clock frequency settings.
3. 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 0.01ms, so reliable trigger should easily be achieved. The camera's exposure time is set to this same value using its Trigger Width exposure mode.
4. 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.
5. 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', page 35 onwards.

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

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Trigger configuration path indicated in yellow:



Camera Trigger Block Diagram per Channel

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