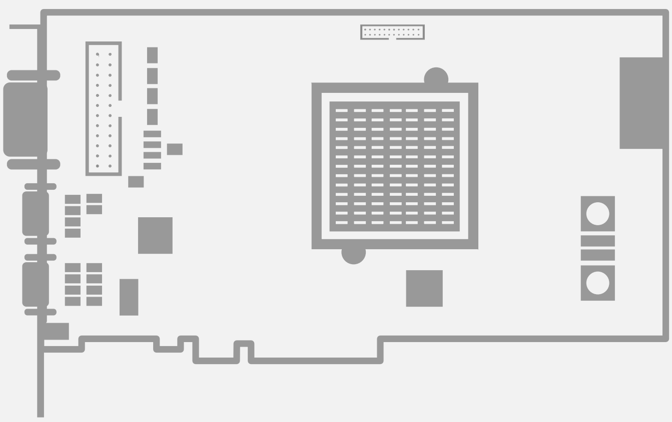
FUNCTIONAL GUIDE

Grablink

Grablink Functional Guide

1622 Grablink Full
1623 Grablink DualBase
1624 Grablink Base
1626 Grablink Full XR



This documentation is provided with **Grablink 6.19.0** (doc build **4054**).
www.euresys.com

Contents

1. About This Document

1.1. Document Scope

This document describes the **functions** of all the products of the Grablink series together with their related products.

Grablink main products

Product	S/N Prefix	Icon
1622 Grablink Full	FM1	Full
1623 Grablink DualBase	GDB	DualBase
1624 Grablink Base	GBA	Base
1626 Grablink Full XR	FXR	FullXR

Grablink accessories

Product	S/N Prefix	Icon
1625 DB25F I/O Adapter Cable	DBC	1625
3304 HD26F I/O Adapter Cable		3304
3305 C2C SyncBus Cable		3305
3306 C2C Quad SyncBus Cable		3306

NOTE
The S/N prefix is a 3-letter string at the beginning of the card serial number.

NOTE
Icons are used in this document for tagging titles of card-specific content.

2. Camera Link Interface

2.1. Camera Link Configurations

Camera Link 2.1 Configurations

Configuration	Channel Link count (names)	Connectors count	Bit count	Ports count(names)
Lite	1 (X)	1	10	2 (A, B)*
Base	1 (X)	1	24	3 (A, B, C)
Medium	2 (X, Y)	2	48	6 (A to F)
Full	3 (X, Y, Z)	2	64	8 (A to H)
72-bit	3 (X, Y, Z)	2	72	9 (A to I)
80-bit	3 (X, Y, Z)	2	80	10 (A to J)

NOTE
(*) Up to 10 bits only

Supported Camera Link Configurations vs. Grablink Product

Configuration	Base	DualBase	Full	FullXR
Lite	OK	OK	-	-
Base	OK	OK	OK	OK
Medium	-	-	OK	OK
Full	-	-	OK	OK
72-bit	-	-	OK	OK
80-bit	-	-	OK	OK

2.2. Enable Signals

The Camera Link standard defines 4 enable signals:

- FVAL (Frame Valid) is defined HIGH for valid lines.
- LVAL (Line Valid) is defined HIGH for valid pixels.
- DVAL (Data Valid) is defined HIGH when data is valid.
- Spare has been defined for future use.

The Camera Link standard requires that enable signals are provided on Channel Link chips as follows:

Camera Link Configuration	FVAL	LVAL	DVAL	Spare
Lite	X	X	-	-
Base	X	X	X	X
Medium	X and Y	X and Y	X and Y	X and Y
Full	X, Y and Z	X, Y and Z	X, Y and Z	X, Y and Z
72-bit	X, Y and Z	X, Y and Z	X, Y and Z	X, Y and Z
80-bit	X only	X, Y and Z	-	-

Grablink Usage

On Grablink boards, the enable signals are used differently according to the type of acquisition:

Area-scan Image Acquisition

- The rising edge of the FVAL signal is used as a "Start-of-Frame"
- The rising edge of the LVAL signal is used as a "Start-of-Line"
- The DVAL signal can optionally be used as a clock qualifier
- The Spare signal is unused

Line-scan Image Acquisition

- The FVAL signal is unused
- The rising edge of the LVAL signal is used as a "Start-of-Line"
- The DVAL signal can optionally be used as a clock qualifier
- The Spare signal is unused

Raw Data Acquisition

- The FVAL signal is used as a "Frame cover" signal surrounding the data to acquire
- The LVAL signal is unused

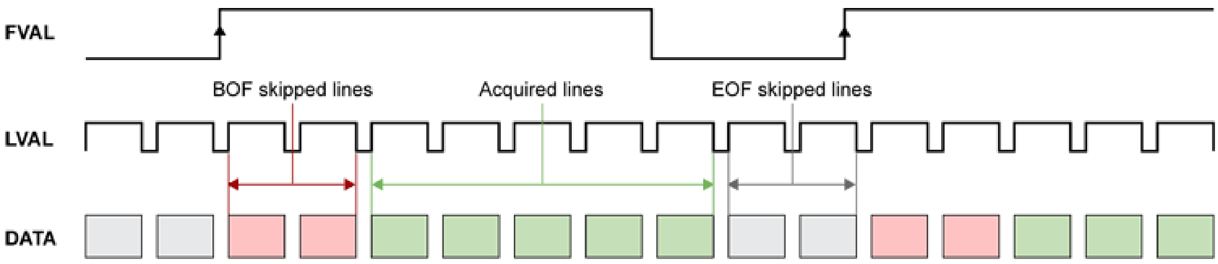
- The DVAL signal can optionally be used as a clock qualifier
- The Spare signal is unused

Enable Signals Timing Diagrams

FVAL Timing for Area-Scan Acquisition

When the Grablink board is configured for image acquisition from area-scan cameras:

- The rising edge of FVAL is used as a start of frame signal.
- The falling edge of FVAL is ignored.



FVAL timing diagram (area-scan acquisition)

If the acquisition trigger is armed when FVAL raises, the board:

1. Skips a pre-defined amount (VsyncAft_Ln) of video data lines at begin of frame (BOF),
2. Acquires a pre-defined amount (Vactive_Ln) of video data lines,
3. Terminates the image acquisition

The subsequent video data lines are all skipped until a new FVAL rising edge occurs.

Applicable limits on FVAL timing for Area-Scan Acquisition

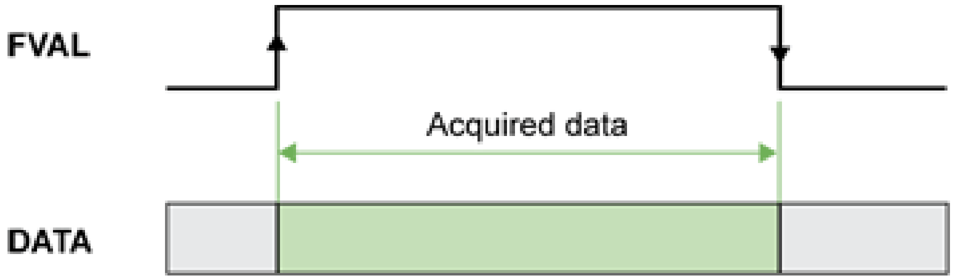
Parameter	Min	Typ	Max	Unit
FVAL high duration	64	Lines with active video	N/A	Clock cycle
FVAL low duration	64	Lines with blanked video	N/A	Clock cycle
FVAL rising edge to LVAL rising edge setup time	0	-	N/A	Clock cycle
Skipped lines at begin of frame (BOF)	0	0	255	LVAL cycle
Skipped lines at end of frame (EOF)	0	-	N/A	LVAL cycle

Refer to "Camera Active Area Properties" on page 40 for constraints on the value of Vactive_Ln.

FVAL Timing for Raw Data Acquisition

When the Grablink board is configured for raw data acquisition:

- The rising edge of FVAL starts the data acquisition.
- The falling edge of FVAL stops the data acquisition.



FVAL timing diagram (area-scan acquisition mode)

If the acquisition trigger is armed when FVAL rises, the board acquires all data until FVAL goes down.

You can configure the frame grabber to use the DVAL signal as a clock qualifier but this feature is rarely used. By default, the configuration ignores the DVAL signal. When DVAL is enabled, the data acquisition is inhibited for clock cycles where DVAL = 0.

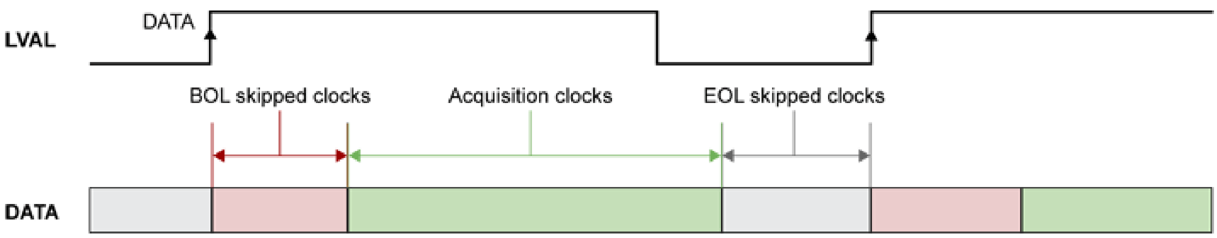
Applicable limits on FVAL timing for Raw Data Acquisition

Parameter	Min	Typ	Max	Unit
FVAL high duration	1	-	N/A	Clock cycle
FVAL low duration	1	-	N/A	Clock cycle

LVAL Timing Diagram

When the Grablink board is configured for image acquisition from an area-scan camera or from a line-scan camera:

- The rising edge of LVAL is actually the reference for the horizontal timing
- The falling edge of LVAL is ignored



LVAL timing diagram

If, at the rising edge of LVAL, the acquisition of the next line is enabled, the board

1. Skips a pre-defined amount (HsyncAft_Tk) of camera clock cycles at begin of line (BOL)

2. Acquires a pre-defined amount (Hactive_Px) pixel data
3. Terminates the line acquisition

The subsequent clock cycles are skipped until a new LVAL rising edge occurs.

You can configure the frame grabber to use the DVAL signal as a clock qualifier but this feature is rarely used. Therefore, the default configuration ignores the DVAL signal.

Applicable limits on LVAL timing for Area-Scan and Line-Scan Acquisitions

Parameter	Min	Typ	Max	Unit
LVAL high duration	1	# clocks with active video	N/A	Qualified clock cycle
LVAL low duration	1	# clocks with blanked video	N/A	Qualified clock cycle
Skipped clocks at begin of line (BOL)	0	0	255	Qualified clock cycle
Skipped clocks at end of line (EOL)	0	-	N/A	Qualified clock cycle
EOL skipped clocks	Others: 0	-	N/A	Qualified clock cycle

Refer to "Camera Active Area Properties" on page 40 for constraints on the value of Hactive_Px.

A qualified clock cycle is defined as:

- Any clock cycle when the frame grabber is configured to ignore DVAL.
- A clock cycle with DVAL = 1 when the frame grabber is configured to use DVAL.

When DVAL is enabled:

- The data acquisition is inhibited for clock cycles where DVAL = 0. Only the data corresponding to DVAL = 1 are effectively acquired.
- The BOL skipped clock counter is not incremented for clock cycles where DVAL = 0. In other words, HsyncAft_Tk specifies the amount number of "clock cycles with DVAL = 1" to skip at begin of line.

Enable Signals Configuration

The enumerated parameter FvalMode specifies the usage of the FVAL downstream signal; possible values are:

Value	Meaning
FA	The rising edge of the FVAL signal is used as a Start of Frame; the falling edge is irrelevant.
FN	The FVAL signal is ignored by the board.
FC	Raw grabbing; start/stop recording on FVAL rising/falling edges

The enumerated parameter LvalMode specifies the usage of the LVAL downstream signal; possible values are:

Value	Meaning
LA	The rising edge of the LVAL signal is used as a Start of Line; the falling edge is irrelevant.
LN	The LVAL signal is ignored by the board.

The enumerated parameter DvalMode specifies the usage of the DVAL downstream signal; possible values are:

Value	Meaning
DG	The DVAL signal is a clock qualifier,only the data transmitted during clock cycles with DVAL = 1 are captured by the board.
DN	The DVAL signal is ignored by the board.

The MultiCam channel must be configured for the appropriate camera operation modes by assigning the appropriate values to the FvalMode, LvalMode, and DvalMode parameters.

Configuring Enable Signals for Area-Scan Cameras

The following combinations of values of FvalMode, LvalMode, and DvalMode parameters are allowed for image acquisition from area-scan cameras (Imaging = AREA):

- FA-LA-DN and FA-LA-DG are the recommended configurations for capturing fixed size images. The leading (rising) edges of the FVAL and LVAL signals are used as vertical and horizontal synchronization events. Their trailing (falling) edges are ignored. The DVAL can optionally be used as a DATA qualifier.
- FC-LA-DN and FC-LA-DG are the recommended configurations for cameras delivering images having a variable amount of fixed size lines. The FVAL signal is used as a "Frame Cover" signal that surrounds the lines to be acquired. The leading (rising) edge of the LVAL signal is used as a horizontal synchronization event. Its trailing edge is ignored. The DVAL can optionally be used as a DATA qualifier.

Configuring Enable Signals for Line-Scan Cameras

The following combinations of values of FvalMode, LvalMode, and DvalMode parameters are recommended for image acquisition from line-scan (Imaging = LINE) and TDI line-scan cameras (Imaging = TDI):

- FN-LA-DN and FN-LA-DG are the recommended configurations for capturing fixed size lines. The FVAL signal is ignored. The leading (rising) edge of the LVAL signals is used as a start-of-line synchronization events. The trailing (falling) edge of LVAL is ignored. The DVAL can optionally be used as a DATA qualifier.

Configuring Enable Signals for Raw Data Acquisition

The following combinations of values of FvalMode, LvalMode, and DvalMode parameters are recommended for raw data acquisition from digital devices:

- FC-LN-DN and FC-LN-DG are the recommended configurations for digital devices delivering raw data or camera devices delivering irregularly structured images. The FVAL signal is used as a "Frame Cover" signal that surrounds the data to be acquired. The LVAL signal is ignored. The DVAL can optionally be used as a DATA qualifier.

2.3. Video Data Signals

Bit Assignments

Bit Assignments

Grablink products comply with the following bit assignment tables of section 4 of the Camera Link 2.1 Specification:

- Table 4-1: 8-Bit Modes, Base/Medium/Full
- Table 4-2: 8-Bit Modes, 80-bit
- Table 4-3: 10-Bit Modes, Base/Medium/Full
- Table 4-4: 10-Bit Modes, 80-bit
- Table 4-5: 12-Bit Modes, Base/Medium/Full
- Table 4-6: 14-Bit Modes, Base/Medium/Full/72-bit
- Table 4-7: 16-Bit Modes, Base/Medium/Full
- Table 4-8: 16-Bit Mode, 80-bit
- Table 4-9: Lite Modes

2.4. Upstream Control Lines

According to the Camera Link standard, four LVDS signals are reserved for general-purpose camera control.

They are defined as camera inputs and frame grabber outputs. Camera manufacturers can define these signals to meet their needs for a particular product. The signals are:

- Camera Control 1 (CC1)
- Camera Control 2 (CC2)
- Camera Control 3 (CC3)
- Camera Control 4 (CC4)

Each control line can be configured as:

Reset signal

A transition (either rising or falling edge) on this line resets the camera. This action initiates either a new exposure/readout, or a readout of a frame for an area-scan camera or a line for a line-scan camera.

Expose control signal

The leading edge (either rising or falling edge) on this line initiates a new exposure.

The trailing edge terminates the exposure and initiates the readout of a frame for an area-scan camera or a line for a line-scan camera.

The pulse width is actually the exposure time.

GPIO

Usually, CC1 is used for reset or expose signal for asynchronous reset cameras.

This board does not provide HDRIVE, VDRIVE signals. Usually, Camera Link cameras do not need genlocking.

2.5. Serial Communication

This board supports the asynchronous full-duplex serial communication between the camera and the frame grabber.

Serial Link for the Lite Camera Link Configuration

For cameras using the Lite configuration, the downstream serial communication link doesn't use a dedicated line pair but, instead, is embedded in the Channel Link.

Serial Link for the Base, Medium, Full, or 80-bit Camera Link Configurations

For cameras using the Base, Medium, Full, or 80-bit configurations, two differential line pairs of the first camera cable are dedicated to the serial communication, one for each direction:

- SerTFG— Downstream (camera to frame grabber) serial communication link
- SerTC— Upstream (frame grabber to camera) serial communication link

Serial Link Functionalities

The application software controls the serial communication channel through the standardized API defined by the Camera Link standard.

Alternatively, it can also be controlled using virtual COM ports. Therefore, the application must set the appropriate values to the parameters SerialControlA and SerialControlB respectively.

Supported baud rates

600, 1200, 1800, 2400, 3600, 4800, 7200, 9600 (Default), 14400, 19200, 28800, 38400, 57600, 115200 and 230400.

3. Cameras

3.1. Camera Classes

In MultiCam, cameras are classified according to four Channel parameters: Imaging, Spectrum, DataLink, and ColorMethod.

Imaging Parameter

The enumerated parameter Imaging specifies the geometry of the camera sensor; possible values are:

Value	Description
AREA	The camera is an area-scan model. An area-scan camera is based on a 2D imaging sensor; it delivers individual image frames composed of a fixed amount of lines, each containing a fixed amount of pixels.
LINE	The camera is a line-scan model. A line-scan camera is based on 1D imaging sensor; it delivers individual image lines composed of a fixed amount of pixels.
TDI	The camera is a TDI line-scan model. A particular type of line-scan camera using the Time Delayed Integration technology (TDI). It is based on a 2D imaging sensor having a small amount of lines; like any other line-scan camera, it delivers individual image lines composed of a fixed amount of pixels.

NOTE
The board's behavior is the same when Imaging is TDI instead of LINE; however TDI cameras exhibit less operational modes since they lack an electronic shutter.

Spectrum Parameter

The enumerated parameter Spectrum specifies the spectral sensitivity of the camera; possible values are:

Value	Description
BW	The camera delivers a monochrome image obtained from an image sensor operating in the human visible domain of the light spectrum.
IR	The camera delivers a monochrome image obtained from an image sensor operating in the infra-red domain of the light spectrum.
COLOR	The camera delivers a color image.

NOTE
The board's behavior is exactly the same when Spectrum is IR instead of BW.

DataLink Parameter

The enumerated parameter DataLink specifies the data transfer method used by the camera; the unique possible value is:

Value	Description
CAMERALINK	The camera delivers a digital video signal complying to the Camera Link standard.

ColorMethod Parameter

The enumerated parameter ColorMethod specifies the color analysis method used by the camera; possible values are:

Value	Description
NONE	The camera delivers a monochrome image.
BAYER	The camera uses a single imaging sensor coated with a Bayer Color Filter Array and delivers the raw Bayer CFA data as a single video data stream embedding the RGB information.
PRISM	The camera uses a wavelength-separating prism to feed three distinct imaging sensors. The color information is available as three R, G, B video data streams.
RGB	The camera uses a coated sensor and an internal processor to reconstruct the full color information. The color information is available as three R, G, B video data streams.
TRILINEAR	The camera uses three parallel sensing linear arrays of pixels exhibiting different wavelength sensitivities. The color information is available as three R, G, B video data streams.

Notes

- This board provides a limited support of TRILINEAR cameras since the scan-delay compensation function is not available.
- The board's behavior is the same when ColorMethod is TRILINEAR instead of RGB.
- The board's behavior is exactly the same when ColorMethod is PRISM instead of RGB.

Supported Camera Classes

Grablink products support the following combinations of values:

Imaging	Spectrum	ColorMethod	Camera Class
AREA	BW	NONE	Monochrome area-scan cameras – Visible spectrum
	IR	NONE	Monochrome area-scan cameras – Infra-red spectrum
	COLOR	BAYER	Color area-scan cameras –Raw BAYER data output
		RGB	Color area-scan cameras – RGB data output
		PRISM	3-CCD Color area-scan cameras – RGB data output
LINE	BW	NONE	Monochrome line-scan cameras – Visible spectrum
	IR	NONE	Monochrome line-scan cameras – Infra-red spectrum
	COLOR	BAYER	Color line-scan cameras –Raw BAYER data output
		RGB	Color line-scan cameras – RGB data output
		PRISM	3-CCD Color line-scan cameras – RGB data output
		TRILINEAR	Color line-scan cameras – 1 tri-linear sensor – RGB data output
TDI	BW	NONE	Monochrome Time-Delay-Integration line-scan cameras – Visible spectrum
	IR	NONE	Monochrome Time-Delay-Integration line-scan cameras – Infrared spectrum
	COLOR	PRISM	3-CCD Color Time-Delay-Integration line-scan cameras – 3 sensors with filters – RGB data output

3.2. Camera Operation Modes

The classification of the operation modes of the industrial cameras is based on the following MultiCam parameters: Expose and Readout.

Expose

The enumerated parameter Expose specifies the camera exposure principle used by the camera; possible values are:

Value	Description
INTCTL	The line or frame exposure condition is totally controlled by the camera. The exposure duration is set through camera configuration settings.
PLSTRG	The line or frame exposure condition starts upon receiving a pulse from the frame grabber.
WIDTH	The duration of a pulse issued by the frame grabber determines the line or frame exposure condition.
INTPRM	The exposure is permanent.

Readout

The enumerated parameter Readout specifies the camera readout principle used by the camera; possible values are

Value	Description
INTCTL	The frame read-out condition is totally controlled by the camera. The read-out duration is set through camera configuration settings.

Supported Area-Scan Camera Operation Modes

Grablink products support the following combinations of values for area-scan cameras (Imaging = AREA):

CamConfig	Expose	Readout	Description
PxxSC	INTCTL	INTCTL	Synchronous progressive scan, camera-controlled exposure
PxxRC	PLSTRG	INTCTL	Asynchronous progressive scan, camera-controlled exposure
PxxRG	WIDTH	INTCTL	Asynchronous progressive scan, grabber-controlled exposure

Supported Line-Scan Camera Operation Modes

Grablink products support the following combinations of values for (non-TDI) line-scan cameras (Imaging = LINE):

CamConfig	Expose	Readout	Description
LxxxxSP	INTPRM	INTCTL	Free-running or camera-controlled line rate Permanent exposure or disabled electronic shutter No control line
LxxxxSC	INTCTL	INTCTL	Free-running or camera-controlled line rate Camera-controlled exposure with electronic shutter Single control line
LxxxxRP	INTPRM	PLSTRG	Grabber-controlled camera line rate and exposure Permanent exposure or disabled electronic shutter Single control line
LxxxxRC	PLSTRG	INTCTL	Grabber-controlled camera line rate camera controlled exposure Single control line
LxxxxRG	WIDTH	INTCTL	Grabber-controlled camera rate and exposure Camera-controlled exposure with electronic shutter Single control line
LxxxxRG2	PLSTRG	PLSTRG	Grabber-controlled camera rate and exposure Camera-controlled exposure with electronic shutter Two control lines

Supported TDI Line-Scan Camera Operation Modes

Grablink products support the following combinations of values for TDI line-scan cameras (Imaging = TDI):

CamConfig	Expose	Readout	Description
LxxxxSP	INTPRM	INTCTL	Free-running, permanent exposure
LxxxxRP	INTPRM	PLSTRG	Grabber-controlled line-scanning, permanent exposure

3.3. Camera Configurations

MultiCam embeds predefined camera parameters settings for each available camera operation mode.

The user selects the by assigning a value to the Camera and CamConfig parameters. For all Grablink products:

- Camera must be set to MyCameraLink
- CamConfig must be set to any of the following value :

CamConfig	Camera Class	Camera Operation Mode	CamFile template
PxxSC	Area-scan	Synchronous progressive scan Camera-controlled exposure	MyCameraLink_ PxxSC.cam
PxxRC	Area-scan	Asynchronous progressive scan Camera-controlled exposure	MyCameraLink_ PxxRC.cam
PxxRG	Area-scan	Asynchronous progressive scan Grabber-controlled exposure	MyCameraLink_ PxxRG.cam
LxxxxSC	Line-scan	Free-running or camera-controlled line rate Camera-controlled exposure with electronic shutter No control line	N/A
LxxxxRC	Line-scan	Grabber-controlled camera line rate Camera controlled exposure Single control line	MyCameraLink_ LxxxxRC.cam
LxxxxRG	Line-scan	Grabber-controlled camera rate and exposure Camera-controlled exposure with electronic shutter Single control line	MyCameraLink_ LxxxxRG.cam
LxxxxSP	(TDI) Line-scan	Free-running or camera-controlled line rate Permanent exposure or disabled electronic shutter No control line	MyCameraLink_ LxxxxSP.cam
LxxxxRP	(TDI) Line-scan	Grabber-controlled camera line rate and exposure Permanent exposure or disabled electronic shutter Single control line	MyCameraLink_ LxxxxRP.cam

CamFile templates are delivered for most of the camera operation modes.

NOTE
A CamFile is a text file gathering all the relevant Channel parameters.

3.4. Camera Tap Properties

TapConfiguration Parameter

The enumerated parameter TapConfiguration declares the Camera Link tap configuration used by the camera.

Refer to "Supported Tap Configurations" on page 29 for an exhaustive list of configurations supported by Grablink products.

TapGeometry Parameter

The tap geometry is a Euresys proprietary taxonomy that describes, with a standardized name, the geometrical properties characterizing the different taps of a multi-tap camera.

The enumerated parameter TapGeometry declares the Camera Link tap geometry used by the camera.

Refer to "Supported Tap Geometries" on page 38 for an exhaustive list of valid combinations of TapConfiguration and TapGeometry values.

Image Reconstruction

For most TapConfiguration and TapGeometry values, the frame grabber is capable to re-arrange the data in the destination surface.

Refer to "Image Reconstruction" on page 47 for more information.

TapConfiguration Glossary

Naming Convention

A tap configuration is designated by:

<Config>_<TapCount>T<BitDepth>(B<TimeSlots>)

<Config>

Designates the Camera Link configuration as follows:

Camera Link Configuration name	<Config> value
Lite	LITE
Base	BASE
Medium	MEDIUM
Full	FULL
72-bit	DECA
80-bit	DECA

<TapCount>

Total number of pixel taps. Values range: 1 to 10.

<BitDepth>

Number of bits per tap. Values list: {8, 10, 12, 14, 16, 24, 30, 36, 42, 48}.

<TimeSlots>

Number of consecutive time slots required to transfer one pixel data. Values list: {2, 3}

The field and the letter B are omitted when a single time slot is sufficient to deliver all the pixel data.

Examples

BASE_1T8: Base Camera Link configuration, 1 tap, 8-bit pixel data

BASE_1T24: Base Camera Link configuration, 1 tap, 24-bit pixel data (likely RGB)

DECA_8T10: 80-bit Camera Link configuration, 8 taps, 10-bit pixel data

DECA_8T30B3: 80-bit Camera Link configuration, 8 taps, 30-bit pixel data (likely RGB), 3 time slots

Supported Tap Configurations

This topic lists all the Camera Link tap configurations (a.k.a. modes) defined in the section 4 of version 2.1 of the Camera Link standard.

The tap configurations are grouped by bit-depth then pixel type. Within a table, entries are sorted by increasing number of taps.

> NOTE
> Tap Configuration is a Euresys proprietary taxonomy that integrates, the channel link configuration, the number of taps and the pixel bit depth.

For each entry, it specifies:

1. **CL2.1 Name:** The name of the configuration as written in the section 4 of version 2.1 of the Camera Link standard
2. **Euresys Name:**The Euresys name of the configuration, i.e. the value of the TapConfiguration parameter.
3. **Compatible products:** The list of Grablink products supporting that configuration. An empty cell indicates that the configuration is not supported.

8-bit Tap Configurations

Monochrome 8-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Lite	LITE_1T8	Base DualBase
Base 1 tap	BASE_1T8	Express Base DualBase Full FullXR
Base 2 taps	BASE_2T8	Express Base DualBase Full FullXR
Base 3 taps	BASE_3T8	Base DualBase Full FullXR
Medium 4 taps	MEDIUM_4T8	Full FullXR
Medium 5 taps	-	-
Medium 6 taps	MEDIUM_6T8	Full FullXR
Full 7 taps	-	-
Full 8 taps	FULL_8T8	Full FullXR
Full 9 taps	DECA_9T8	Full FullXR
80-bit 10 taps	DECA_10T8	Full FullXR

RGB 8-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Base 1 tap	BASE_1T24	Express Base DualBase Full FullXR
Medium 2 taps	MEDIUM_2T24	Full FullXR
Full 3 taps	DECA_3T24	Full FullXR
80-bit 10 taps	-	-

RGBI 8-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	-	-
Full 2 taps	-	-

10-bit Tap Configurations

Monochrome 10-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Lite	LITE_1T10	Base DualBase
Base 1 tap	BASE_1T10	Express Base DualBase Full FullXR
Base 2 taps	BASE_2T10	Express Base DualBase Full FullXR
Medium 3 taps	MEDIUM_3T10	Full FullXR
Medium 4 taps	MEDIUM_4T10	Full FullXR
Full 5 taps	-	-
Full 6 taps	-	-
80-bit 7 taps	-	-
80-bit 8 taps	DECA_8T10	Full FullXR

RGB 10-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	MEDIUM_1T30	Full FullXR
Full 2 taps	-	-
80-bit 8 taps (3 slots)	DECA_8T30B3	Full FullXR

RGBI 10-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	-	-
Full 2 taps	DECA_2T40	Full FullXR

12-bit Tap Configurations

Monochrome 12-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Base 1 tap	BASE_1T12	Express Base DualBase Full FullXR
Base 2 taps	BASE_2T12	Express Base DualBase Full FullXR
Medium 3 taps	MEDIUM_3T12	Full FullXR
Medium 4 taps	MEDIUM_4T12	Full FullXR
Full 5 taps	-	-
Full 6 taps	-	-

RGB 12-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	MEDIUM_1T36	Full FullXR
Full 2 taps	-	-

RGBI 12-bit Tap Configuration

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	-	-

14-bit Tap Configurations

Monochrome 14-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Base 1 tap	BASE_1T14	Express Base DualBase Full FullXR
Medium 2 taps	MEDIUM_2T14	Full FullXR
Medium 3 taps	MEDIUM_3T14	Full FullXR
Full 4 taps	-	-
72-bit 5 taps	-	-

RGB 14-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	MEDIUM_1T42	Full FullXR

RGBI 14-bit Tap Configuration

CL2.1 Name	Euresys Name	Compatible products
Full 1 tap	-	-

16-bit Tap Configurations

Monochrome 16-bit Tap Configurations

CL2.1 Name	Euresys Name	Compatible products
Base 1 tap	BASE_1T16	Express Base DualBase Full FullXR
Medium 2 taps	MEDIUM_2T16	Full FullXR
Medium 3 taps	MEDIUM_3T16	Full FullXR
Full 4 taps	-	-
72-bit 5 taps	-	-

RGB 16-bit Tap Configuration

CL2.1 Name	Euresys Name	Compatible products
Medium 1 tap	MEDIUM_1T48	Full FullXR

RGBI 16-bit Tap Configuration

CL2.1 Name	Euresys Name	Compatible products
Full 1 tap	-	-

TapGeometry Glossary

Definitions

Adjacent taps

Two taps are adjacent when the extracted pixels are adjacent on the same row or on the same column.

Region

A rectangular area of adjacent pixels that are transferred in a raster-scan order through one or multiple adjacent taps.

Tap

One pixel stream output port of the camera that delivers one pixel every clock cycle.

Tap Geometrical Properties

A tap is characterized by the following properties:

XStart: X-position of the first extracted pixel of a camera readout cycle

XEnd: X-position of the last extracted pixel of a camera readout cycle

YStart: Y-position of the first extracted pixel of a camera readout cycle

YEnd: Y-position of the last extracted pixel of a camera readout cycle

YStep: the difference of Y-position between consecutive rows of pixels; it is positive when Y-position values are increasing (top to bottom); it is negative otherwise.

X-Position: the pixel column number in the (non-flipped) image; column 1 is the leftmost column; column W is the rightmost column of an image having a width of W pixels.

Y-Position: the pixel row number in the (non-flipped) image; row 1 is the topmost row; row H is the bottommost row of an image having a height of H pixels.

TapGeometry Values Syntax

There are two variants of the syntax:

1. For cameras delivering two or more rows of pixels every camera readout cycle:

   <TapGeometryX>_<TapGeometryY>

2. For cameras delivering only one row of pixels every camera, e.g. single line line-scan cameras:

   <TapGeometryX>

TapGeometryX Syntax

<TapGeometryX> describes the geometrical organization of the taps along one row of the image. It is built as follows:

<XRegions>X(<XTaps>)(<ExtX>)

- <XRegions>: an integer declaring the number of regions encountered across one image row (= the X-direction or the horizontal direction). Possible values are 1, 2, 3, 4, 6, 8, and 10.
- <XTaps>: an integer declaring the number of consecutive pixels along one region row that are extracted simultaneously.
  Possible values are 1, 2, 3, 4, 8, and 10.
  The field is omitted when <XTaps> is 1.
- <ExtX>: a letter declaring the relative location of the pixels extractors across one row of the image.
  - This field is omitted when all pixel extractors are at the left of each region.
  - Letter E indicates that pixel extractors are at both ends of the image row.
  - Letter M indicates that pixel extractors are at middle of the image row.
  - Letter R indicates that the pixel extractors are all at the right of each region

TapGeometryY Syntax

<TapGeometryY> describes the geometrical organization of the taps along one column of the image. It is built as follows:

<YRegions>Y(<YTaps>)(<ExtY>)

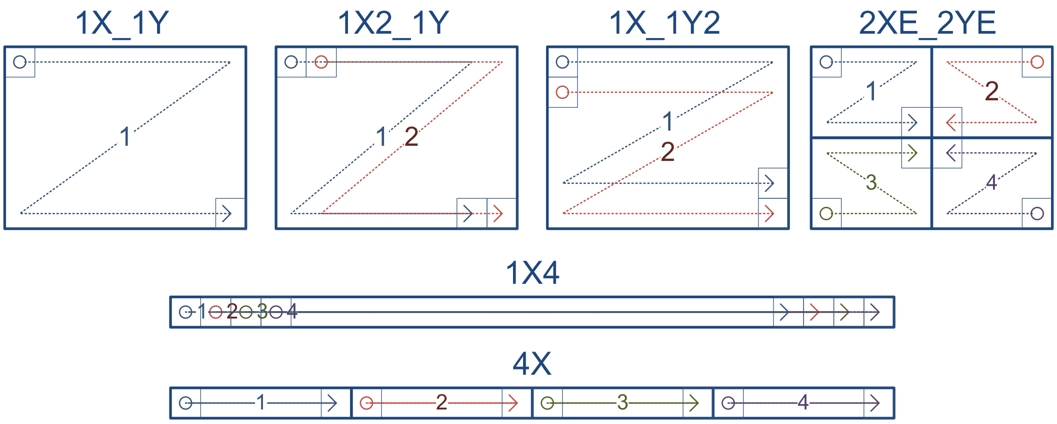
<YRegions>: an integer declaring the number of regions encountered across vertical direction. Possible values are 1 and 2.

<YTaps>: an integer declaring the number of consecutive pixels along one region column that are extracted simultaneously.
Possible values are 1 and 2. The field is omitted when YTaps is 1.

<ExtY>: a letter declaring the relative location of the pixels extractors across one column of the image.

- This field is omitted when all pixel extractors are at the top of each region.
- Letter E indicates that pixel extractors are at both ends of the image column.

TapGeometry Values Examples



1X_1Y designates the tap geometry of a single-tap camera having 1 region across the X-direction and 1 region across the Y direction.

The pixels are delivered one at a time on a single tap beginning with the leftmost pixel of the top row, scanning progressively all the rows of the image one by one, and ending with the rightmost pixel of the bottom row.

1X2_1Y designates the tap geometry of a two-tap camera having 1 region across the X-direction and 1 region across the Y direction.

The pixels are delivered two at a time on two taps beginning with the two leftmost pixels of the top row, scanning progressively all the rows of the image one by one, and ending with the two rightmost pixels of the bottom row.

1X_1Y2 designates the tap geometry of a two-tap camera having 1 region across the X-direction and 1 region across the Y direction.

The pixels are delivered two at a time on two taps beginning with the two uppermost pixels of the first column , scanning progressively all the rows of the image two by two, and ending with the two lowermost pixels of the rightmost column.

2XE_2YE designates the tap geometry of a four-tap camera having 2 regions across the X-direction and 2 regions across the Y direction.

The pixels are delivered four at a time on four taps. Each region delivers its pixels on a single-tap using a specific scanning scheme:

The pixels of the upper left quadrant are delivered on tap 1 starting with the upper left pixel and ending with the lower right pixel of the region.

The pixels of the upper right quadrant are delivered on tap 2 starting with the upper rightmost pixel and ending with the lower left pixel of the region.

The pixels of the lower left quadrant are delivered on tap 3 starting with the lower left pixel and ending with the upper right pixel of the region.

The pixels of the lower right quadrant are delivered on tap 4 starting with the lower rightmost pixel and ending with the upper left pixel of the region.

1X4 designates the tap geometry of a four-tap line-scan camera having 1 region across the X-direction.

The pixels are delivered four at a time on four taps beginning with the four leftmost pixels and ending with the four rightmost pixels.

4X designates the tap geometry of a four-tap line-scan camera having 4 regions across the X-direction.

The pixels are delivered four at a time on four taps. Each region delivers its pixels on a single-tap using a common scanning scheme beginning with the leftmost pixel and ending with the rightmost pixel.

Supported Tap Geometries

Tap Geometries for Line-scan Cameras

Number of taps	1 X-region	2 X-regions	3 X-regions	4 X-regions	8 X-regions	10 X-regions
1	1X	-	-	-	-	-
2	1X2	2X 2XE 2XM 2XR	-	-	-	-
3	1X3	-	3X	-	-	-
4	1X4	2X2 2X2E 2X2M	-	4X 4XE 4XR	-	-
8	1X8	2X4	-	4X2 4X2E	8X 8XR	-
10	1X10	-	-	-	-	10X

Tap Geometries for Area-scan Cameras having only one tap along the vertical direction

Number of taps	1 X-region	2 X-regions	3 X-regions	4 X-regions	8 X-regions	10 X-regions
1	1X_1Y	-	-	-	-	-
2	1X2_1Y	2X_1Y 2XE_1Y 2XM_1Y 2XR_1Y	-	-	-	-
3	1X3_1Y	-	3X_1Y	-	-	-
4	1X4_1Y	2X2_1Y 2X2E_1Y 2X2M_1Y	-	4X_1Y 4XE_1Y 4XR_1Y	-	-
8	1X8_1Y	2X4_1Y	-	4X2_1Y 4X2E_1Y	8X_1Y 8XR_1Y	-
10	1X10_1Y	-	-	-	-	10X_1Y

Tap Geometries for Area-scan Cameras having Two taps along the vertical direction

Number of taps	1 X-region	2 X-regions	3 X-regions	4 X-regions	8 X-regions	10 X-regions
2	1X_1Y2 1X_2YE	-	-	-	-	-
4	-	2XE_2YE	-	-	-	-

NOTE
Refer to TapGeometry in the Parameters Reference for a description of each geometry.

3.5. Camera Active Area Properties

The Camera Active Area is a rectangular array of pixels containing active video that are delivered by the camera to the frame grabber.

> NOTE
> For line-scan cameras, the height of the active area is 1 (or 2 for bilinear line-scan).

Hactive_Px Parameter

For all cameras, the MultiCam parameter Hactive_Px represents the number of pixels in each line of the Camera Active Area. The following rules apply:

Rule #1

The width of the Camera Active Area may contain at most 65535 pixels:

$$Hactive\_Px \leq 65535$$

Rule #2

Each tap delivers the same amount of pixels every line, Hactive_Px must be a multiple of XTaps:

$$\frac{Hactive\_Px}{XTaps} = N$$

N is an integer number since each tap delivers the same amount of pixels every line:

XTaps is the number of taps along the X direction. It can be obtained from the value of TapGeometry by multiplying together the two numbers surrounding the letter "X". For example, 1X2, 1X2_1Y, 1X2_1Y2, 2X, 2X_1Y have all 2 taps along the X direction.

Rule #3

Each XRegion must contain at least MinBytesPerRegionLine bytes:

$$\frac{Hactive\_Px \times BytesPerPixel}{XRegions} \geq MinBytesPerRegionLine$$

MinBytesPerRegionLine = 48

XRegions is the number of geometrical regions in the X direction. This is the number preceding the letter "X"in the TapGeometry value: For example: 2X, 2X_1Y, 2X2 have all 2 regions along the X direction.

BytesPerPixel is the amount of bytes required to store one pixel into the on-board memory:

1 byte for 8-bit monochrome and Bayer CFA cameras

2 bytes for 10-/12-/14- and 16-bit monochrome and Bayer CFA cameras
3 bytes for 24-bit RGB cameras
6 bytes for 30-/36-/42-bit and 48-bit RGB cameras

TapConfiguration	TapGeometry	Min. value	Multiple of	Max. value
BASE_1T8	1X	48	1	65535
BASE_1T10, BASE_1T12 BASE_1T14, BASE_1T16	1X	24	1	65535
BASE_1T24	1X	16	1	65535
MEDIUM_1T30, MEDIUM_1T36 MEDIUM_1T42, MEDIUM_1T48	1X	8	1	65535
BASE_2T8	1X2	48	2	65534
	2X	96	2	65534
BASE_2T10, BASE_2T12 MEDIUM_2T14, MEDIUM_2T16	1X2	24	2	65534
	2X	48	2	65534
MEDIUM_2T24	1X2	16	2	65534
	2X	32	2	65534
BASE_3T8	1X3	48	3	65535
	3X	144	3	65535
MEDIUM_3T10, MEDIUM_3T12 MEDIUM_3T14, MEDIUM_3T16	1X3	24	3	65535
	3X	72	3	65535
MEDIUM_4T8	1X4	48	4	65532
	4X	192	4	65532
MEDIUM_4T10, MEDIUM_4T12	1X4	24	4	65532
	4X	96	4	65532
FULL_8T8	1X8	48	8	65528
	8X	384	8	65528
DECA_10T8	1X10	50	10	65530
	10X	480	10	65530

Vactive_Ln Parameter

For area-scan cameras only, the MultiCam parameter Vactive_Ln represents the number of lines of the Camera Active Area.

The following rules apply:

Rule #1: The camera active window may contain at most 65535 lines.

$$Vactive\_Ln \leq 65535$$

Rule #2: Each tap delivers exactly the same amount of pixels, Vactive_Ln must be a multiple of YTaps.

$$\frac{Vactive\_Ln}{YTaps} = N$$

N is an integer number

YTaps is the number of taps along the Y direction. YTaps can be obtained from the value of TapGeometry by multiplying together the two numbers surrounding the letter "Y". For example: 1X_1Y2, 1X_2YE have all 2 taps along the Y direction.

3.6. Bayer CFA Color Registration

When ColorMethod = BAYER, the enumerated parameter ColorRegistration specifies the alignment of the color pattern filter over the sensor active area.

Possible values are: GB, BG, RG, GR. The two letters indicate respectively the color of the two first pixels of the first line.

Value	Description
GB	The first two pixels are green and blue
BG	The first two pixels are blue and green
RG	The first two pixels are red and green
GR	The first two pixels are green and blue

The information is used by MultiCam to automatically configure the Bayer CFA decoder.

4. Processing

4.1. Overview

Overview of the image data processing on Grablink cards

The acquisition channels of Grablink boards performs the following successive operations on the image data stream:

Image Reconstruction

This operation unscrambles the pixel streams of multi-tap cameras and reconstructs the image exactly like it was captured on the camera sensor

For more information, refer to "Image Reconstruction" on page 47.

Image Cropping

This operation extracts a rectangular area from the Camera Active Area.

For more information, refer to "Image Cropping" on page 50.

Image Flipping

This operation flips the image around an horizontal and/or a vertical axis.

For more information, refer to "Image Flipping" on page 52.

Lookup Table Transformation

Applies to: Base DualBase Full FullXR

This operation performs lookup table processing on individual pixel components.

For more information and configuration instructions, refer to "Look-up Table Transformation" on page 61.

Bayer CFA decoding

Applies to: Base DualBase Full FullXR

This operation transforms the raw Bayer CFA data stream issued by the camera into an RGB color data stream.

For more information and configuration instructions, refer to "Bayer CFA to RGB Conversion" on page 64.

White Balancing

Applies to: Base DualBase Full FullXR

This operation adjusts the gain and the offset of each color channel.

For more information, refer to "White Balance Operator" on page 69.

Pixel Formatting

This stage performs several operations:

- unpacking of 10-bit, 12-bit, and 14-bit pixel components to 8-bit or 16-bit.
- delivery of RGB data in packed or planar formats

For more information and configuration instructions, refer to"Pixel Formatting" on page 76 .

Image line build-up

This operation builds concatenates the components data of all pixels of an image line:

- 8-bit pixel components are aligned to byte boundaries
- 16-bit pixel components (possibly expanded by unpacking or lookup table processing) are aligned to word (2-byte) boundaries, the 2 bytes are stored according to the little-endian convention.

Image Transfer

The processed and formatted image data are transferred into a MultiCam Surface over the PCI Express bus using a DMA engine.

For more information, refer to "Image Transfer" on page 78.

Transfer Latencies

Image data are transferred ASAP to the MultiCam Surface, keeping the time latency as short as possible.

For more information, refer to"Transfer Latency" on page 80.

4.2. Image Reconstruction

Grablink boards unscramble the pixel streams of multi-tap cameras and reconstruct the image exactly like it was captured on the camera sensor for most of the tap configurations and geometries.

The following tables list, for each tap configuration, the tap geometries that allows the reconstruction of the image.

- Refer to TapGeometry in the Parameters Reference for a description of each geometry.

Tap Geometries for Lite Camera Link Configuration

Applies to: Base DualBase

Tap Configuration	Line-scan	Area-scan,1 YTap	Area-scan, 2 YTap
LITE_1T8 LITE_1T10	1X	1X_1Y	-

Tap Geometries for Base Camera Link Configuration

Applies to:

Tap Configuration	Line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
BASE_1T8 BASE_1T10 BASE_1T12 BASE_1T14 BASE_1T16 BASE_1T24	1X	1X_1Y	-
BASE_2T8 BASE_2T10 BASE_2T12	1X2 2X 2XE 2XM 2XR	1X2_1Y 2X_1Y 2XE_1Y 2XM_1Y 2XR_1Y	1X_1Y2 1X_2YE

Applies to: Base DualBase Full FullXR

Tap Configuration	Line-scan	Bilinear line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
BASE_1T8 BASE_1T10 BASE_1T12 BASE_1T14 BASE_1T16 BASE_1T24	1X	-	1X_1Y	-
BASE_2T8 BASE_2T10 BASE_2T12	1X2 2X 2XE 2XM 2XR	1X_1Y2	1X2_1Y 2X_1Y 2XE_1Y 2XM_1Y 2XR_1Y	1X_1Y2 1X_2YE
BASE_3T8	1X3 3X	-	1X3_1Y 3X_1Y	-

Tap Geometries for Medium Camera Link Configuration

Applies to: Full FullXR

Tap Configuration	Line-scan	Bilinear line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
MEDIUM_1T30 MEDIUM_1T36 MEDIUM_1T42 MEDIUM_1T48	1X	-	1X_1Y	-
MEDIUM_2T14 MEDIUM_2T16 MEDIUM_2T24	1X2 2X 2XE 2XM 2XR	1X_1Y2	1X2_1Y 2X_1Y 2XE_1Y 2XM_1Y 2XR_1Y	1X_1Y2 1X_2YE
MEDIUM_3T10 MEDIUM_3T12 MEDIUM_3T14 MEDIUM_3T16	1X3 3X	-	1X3_1Y 3X_1Y	-
MEDIUM_4T8 MEDIUM_4T10 MEDIUM_4T12	1X4 2X2 2X2E 2X2M 4X 4XE 4XR	1X2_1Y2 2X_1Y2 2XE_1Y2 2XM_1Y2 2XR_1Y2	1X4_1Y 2X2_1Y 2X2E_1Y 2X2M_1Y 4X_1Y 4XE_1Y 4XR_1Y	1X2_1Y2 2X_1Y2 2XE_1Y2 2XM_1Y2 2XR_1Y2 1X2_2YE 2X_2YE 2XE_2YE 2XM_2YE 2XR_2YE
MEDIUM_6T8	-	1X3_1Y2 3X_1Y2	-	1X3_1Y2 1X3_2YE 3X_1Y2 3X_2YE

Tap Geometries for Full Camera Link Configuration

Applies to: Full FullXR

Tap Configuration	Line-scan	Bilinear line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
FULL_8T8	1X8 2X4 4X2 4X2E 8X 8XR	1X4_1Y2 2X2_1Y2 2X2E_1Y2 2X2M_1Y2 4X_1Y2 4XE_1Y2 4XR_1Y2	1X8_1Y 2X4_1Y 4X2_1Y 4X2E_1Y 8X_1Y 8XR_1Y	1X4_1Y2 2X2_1Y2 2X2E_1Y2 2X2M_1Y2 4X_1Y2 4XE_1Y2 4XR_1Y2 1X4_2YE 2X2_2YE 2X2E_2YE 2X2M_2YE 4X_2YE 4XE_2YE 4XR_2YE

Tap Geometries for 72-bit Camera Link Configuration

Applies to: Full FullXR

Tap Configuration	Line-scan	Trilinear line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
DECA_3T24	1X3 3X	-	1X3_1Y 3X_1Y	-
DECA_9T8	-	3X_1Y3	-	3X_1Y3

Tap Geometries for 80-bit Camera Link Configuration

Applies to: Full FullXR

Tap Configuration	Line-scan	Area-scan, 1 YTap	Area-scan, 2 YTap
DECA_2T40	-	1X2_1Y	-
DECA_8T10	1X8	1X8_1Y	-
DECA_8T30B3	1X8	1X8_1Y	-
DECA_10T8	1X10 10X	1X10_1Y 10X_1Y	-

4.3. Image Cropping

Grablink boards implement an image cropping operator that selects a subset of the pixels delivered by the camera to build the image delivered to the Host PC.

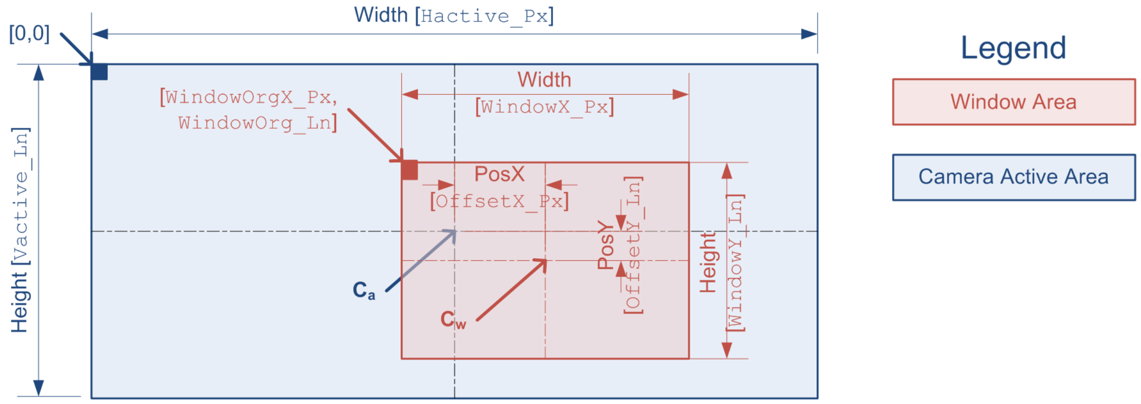
This subset, named *Window Area*, includes:

- For area-scan cameras: a single rectangular region of the 2D image sensor.
- For line-scan cameras: a single segment of the 1D image sensor.

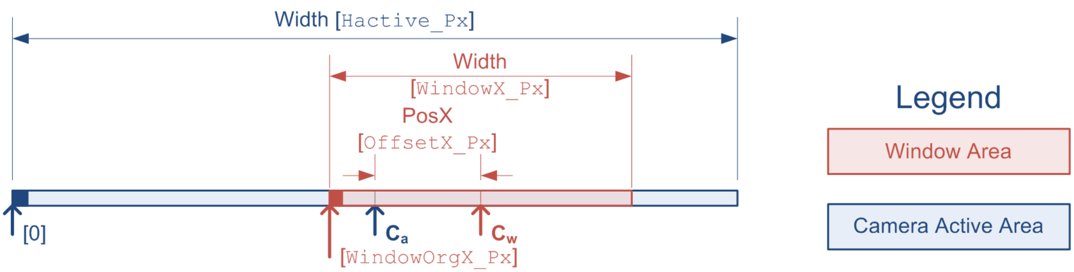
Image Cropping parameters

The operator is controlled through the following Channel Class parameters of the Grabber Timing category:

- GrabWindow: the main control parameter.
- WindowX_Px, WindowY_Ln: integer parameters defining the size of the *Window Area*.
- OffsetX_Px, and OffsetY_Ln: integer parameters defining the position of the *Window Area* within the Camera Active Area.



Window Area Parameters for Area-Scan cameras



Window Area Parameters for Line-Scan cameras

NOTE
The position of the Window Area within the Camera Active Window is expressed as the difference of coordinates between Cw, the center of the Window Area, and Cw, the center of the Camera Active Area.

NOTE
The range of allowed values of OffsetX_Px and OffsetY_Ln parameters is automatically adjusted to force the Window Area to stay within the boundaries of the Camera Active Area.

WindowOrgX_Px reports the X-coordinate in the Camera Active Area of the leftmost pixels of the Window Area:

$$WindowOrgX\_Px = (Hactive\_Px - WindowX\_Px)/2$$

For area-scan cameras only, WindowOrgY_Ln reports the Y-coordinate in the Camera Active Area of the topmost pixels of the Window Area:

$$WindowOrgY\_Ln = (Vactive\_Ln - WindowY\_Ln)/2$$

Configuring Image Cropping

By default, GrabWindow is set to NOBLACK disabling the ICO: the acquired image includes all active pixels delivered by the camera without any surrounding weak or blind pixels on the image edges.

To enable image cropping, proceed as follows:

- Enable cropping by setting GrabWindow to MAN.
- Adjust the width of the Window Area using WindowX_Px. Any integer value ranging from8 up to Hactive_Px is allowed.
- *For area-scan cameras only:* Adjust the height of the Window Area using WindowY_Ln. Any integer value ranging from 1 up to Vactive_Ln is allowed.
- Move horizontally the Window Area using OffsetX_Px. Increasing the value moves the Window Area towards the right of the Camera Active Area and vice-versa, decreasing the value moves the Window Area towards the left of the Camera Active Area.
- *For area-scan cameras only:*Move vertically the Window Area using OffsetY_Ln. Increasing the value moves the Window Area towards the top of the Camera Active Area and vice-versa, decreasing the value moves the Window Area towards the bottom of the Camera Active Area.

Conditions of applicability

Cropping is applicable to the following camera classes:

- Monochrome, RGB color, and Bayer CFA color area-scan cameras: any valid combination of TapConfiguration and TapGeometry is allowed except whenTapGeometry = *_2YE
- Monochrome, and RGB color line-scan cameras.

4.4. Image Flipping

Grablink boards implement an image flipping operator that performs the mirroring of the image delivered to the Host PC:

- For area-scan cameras, it performs the left/right and the top/bottom mirroring.
- For line-scan camera, it is capable to perform the left/right mirroring only.

The operator controlled through the following Channel Class parameters of the Cluster Category:

- ImageFlipX enables the left/right mirroring
- ImageFlipY enables the top/bottom mirroring.

By default, both operators are OFF disabling any mirroring.

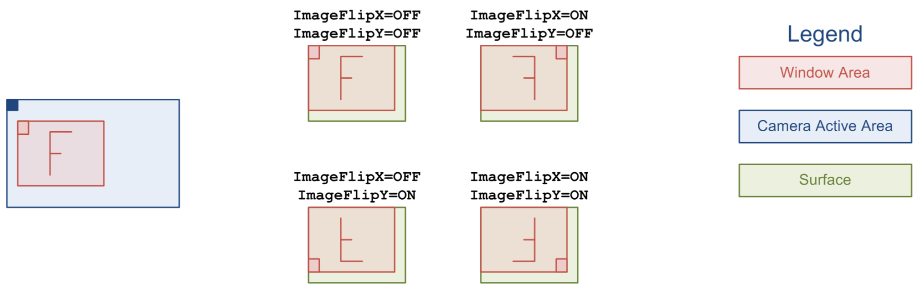


Image Flipping Operations

Conditions of applicability

IFO is applicable to the following camera classes:

- Monochrome, RGB color, and Bayer CFA color *area-scan cameras*
- Monochrome, and RGB color *line-scan cameras*

4.5. Pixel Data Processing Configurations

Configurations for Monochrome Pixels

Processing elements availability for monochrome pixels vs. products

Capability	Base	DualBase	Full	FullXR
LUT transformation	OK	OK	OK	OK
Pixel formatting	OK	OK	OK	OK

Valid configurations when LUT transformation is disabled

Applies to: Base DualBase Full FullXR

The pixel output format is defined by ColorFormat.

Camera PFNC Pixel Format	ColorFormat	Output PFNC Pixel Format
Mono8	Y8	Mono8
Mono10	Y8	Mono8
	Y10	Mono10
	Y16	Mono16
Mono12	Y8	Mono8
	Y12	Mono12
	Y16	Mono16
Mono14	Y8	Mono8
	Y14	Mono14
	Y16	Mono16
Mono16	Y8	Mono8
	Y16	Mono16

Valid configurations when LUT transformation is enabled

Applies to: Base DualBase Full FullXR

The LUT operator operates in the monochrome mode, its input bit depth is the camera pixel bit depth.

The LUT output bit depth and the pixel output format are defined by ColorFormat.

Camera PFNC Pixel Format	Lookup Table Configuration	ColorFormat	Output PFNC Pixel Format
Mono8	M_8x8	Y8	Mono8
Mono10	M_10x8	Y8	Mono8
	M_10x10	Y10	Mono10
	M_10x16	Y16	Mono16
Mono12	M_12x8	Y8	Mono8
	M_12x12	Y12	Mono12
	M_12x16	Y16	Mono16

Configurations for Bayer CFA Pixels

Processing elements availability for Bayer CFA pixels vs. products

Elements	Base	DualBase	Full	FullXR
Bayer CFA Decoding	OK	OK	OK	OK
White Balance	OK	OK	OK	OK
LUT Transformation	OK	OK	OK	OK
Pixel Formatting	OK	OK	OK	OK

Valid configurations when Bayer CFA decoding is disabled

Applies to: Base DualBase Full FullXR

The pixel output format is defined by ColorFormat.

Camera PFNC Pixel Format	ColorFormat	Output PFNC Pixel Format
Bayer**8	BAYER8	Bayer**8
Bayer**10	BAYER8	Bayer**8
	BAYER10	Bayer**10
	BAYER16	Bayer**16
Bayer**12	BAYER8	Bayer**8
	BAYER12	Bayer**12
	BAYER16	Bayer**16
Bayer**14	BAYER8	Bayer**8
	BAYER14	Bayer**14
	BAYER16	Bayer**16
Bayer**16	BAYER16	Bayer**16

NOTE
The white balance and the LUT transformation are not available when Bayer CFA decoding is disabled!

Valid configurations when Bayer CFA decoding is enabled

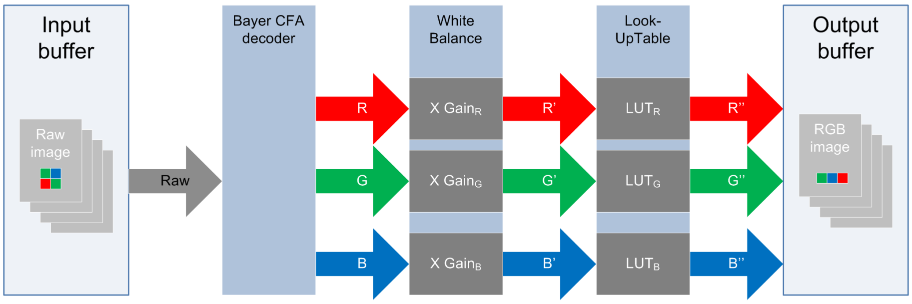
Applies to: Base DualBase Full FullXR

The pixel processing chain uses the following elements:

- Bayer CFA Decoder
- White Balance operator (Optional)
- Look-Up-table operator (Optional)

The Look-Up-table operator is configured for RGB color processing.

The processing chain outputs one RGB pixel for each RAW pixel of the input buffer.



Pixel Processing Chain - Bayer CFA => RGB Configuration

Valid configurations and peak processing rate [Megapixels/sec] for **1624 Grablink Base** and **1623 Grablink DualBase**

Applies to: Base DualBase

Camera PFNC Pixel Format	WBO	Lookup Table Configuration	ColorFormat	Output PFNC Pixel Format	Max. rate
Bayer**8	Optional	8-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	125
Bayer**10	Optional	10-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	125
Bayer**12	Optional	12-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	125
Bayer14	Optional	Not available	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	125
Bayer16	Optional	Not available	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	125

Valid configurations and peak processing rate [Megapixels/sec] for **1622 Grablink Full and 1626 Grablink Full XR**

Applies to: Full FullXR

Camera PFNC Pixel Format	WBO	Lookup Table Configuration	ColorFormat	Output PFNC Pixel Format	Max. rate
Bayer8	Optional	8-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	250
Bayer10	Optional	10-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	250
Bayer10	Optional	10-bit to 10-bit RGB	RGB30PL	-	125
Bayer10	Optional	10-bit to 16-bit RGB	RGB48PL	-	125
Bayer12	Optional	12-bit to 8-bit RGB	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	250
Bayer12	Optional	12-bit to 12-bit RGB	RGB36PL	-	125
Bayer12	Optional	12-bit to 16-bit RGB	RGB48PL	-	125
Bayer14	Optional	Not available	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	250
Bayer14	Optional	Not available	RGB42PL	-	125
Bayer14	Optional	Not available	RGB48PL	-	125
Bayer16	Optional	Not available	RGB24 RGB32 RGB24PL	BGR8 BGRa8 -	250
Bayer16	Optional	Not available	RGB48PL	-	125

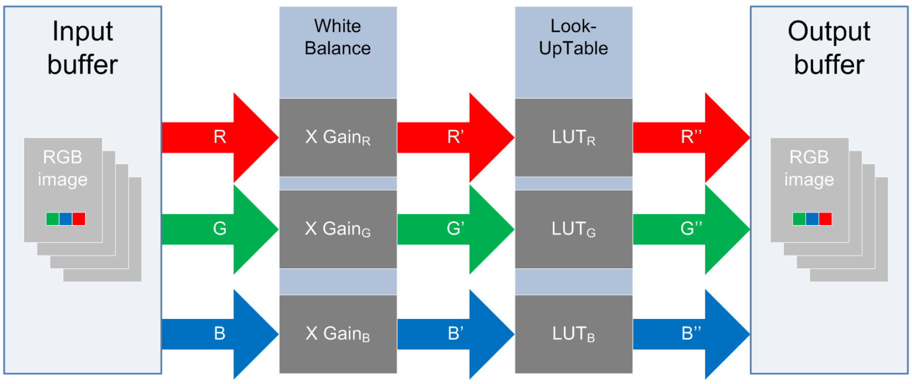
Configurations for RGB Pixels

Processing elements availability for RGB pixels vs. products

Elements	Base	DualBase	Full	FullXR
White Balance	OK	OK	OK	OK
LUT Transformation	OK	OK	OK	OK
Pixel Formatting	OK	OK	OK	OK

Valid configurations

The processing chain outputs one RGB pixel for each RGB pixel of the input buffer.



Pixel Processing Chain - RGB => RGB Configuration

Valid configurations for **1624 Grablink Base** and **1623 Grablink DualBase**

Applies to: Base DualBase

Camera PFNC Pixel Format	WBO	Lookup Table Configuration	ColorFormat	RedBlueSwap	Output PFNC Pixel Format
RGB8	Optional	8-bit to 8-bit RGB	RGB24	ENABLE	BGR8
				DISABLE	RGB8
			RGB32	ENABLE	BGRa8
				DISABLE	RGBa8
			RGB24PL	-	-

Valid configurations for 1622 Grablink Full and 1626 Grablink Full XR

Applies to: Full FullXR

Camera PFNC Pixel Format	WBO	LUT	ColorFormat	RedBlueSwap	Output PFNC Pixel Format
RGB8	Optional	8-bit to 8-bit RGB	RGB24	ENABLE	BGR8
				DISABLE	RGB8
			RGB32	ENABLE	BGRa8
				DISABLE	RGBa8
			RGB24PL	-	-
RGB10	Optional	10-bit to 8-bit RGB	RGB24	ENABLE	BGR8
				DISABLE	RGB8
			RGB32	ENABLE	BGRa8
				DISABLE	RGBa8
			RGB24PL	-	-
	Optional	10-bit to 10-bit RGB	RGB30PL	-	-
	Optional	10-bit to 16-bit RGB	RGB48PL	-	-
RGB12	Optional	12-bit to 8-bit RGB	RGB24	ENABLE	BGR8
				DISABLE	RGB8
			RGB32	ENABLE	BGRa8
				DISABLE	RGBa8
			RGB24PL	-	-
	Optional	12-bit to 10-bit RGB	RGB36PL	-	-
	Optional	12-bit to 16-bit RGB	RGB48PL	-	-

4.6. Look-up Table Transformation

Applies to: Base DualBase Full FullXR

The look-up table operator enables you to process monochrome or RGB color pixel data streams.

Storage for four LUT definitions is available in the main memory. They are indexed from 1 to 4.

Selecting the LUT of index 0 disables the LUT operator and establishes a bypass over the Look-up table operator in the pixel processing stream.

During MultiCam channel activation, the hardware initializes the LUT operator. Therefore it fills the tables of the LUT operator with the selected LUT definition.

Any further modification of the LUT operator configuration that occurs during the acquisition sequence is applied without any further delay. For example, this occurs when:

- Changing the LUT_UseIndex parameter.
- Modifying the LUT definition have the same index as the LUT_UseIndex value.

See also: Using Look-Up Tables in the MultiCam User Guide.

Monochrome Operation

When the acquisition channel is configured for acquisition from monochrome cameras, the LUT operator is modeled as a single very high speed RAM inserted into the pixel data stream.

Available configurations and performance of the LUT operator for monochrome cameras

Camera	LUT Input bit depth	LUT output bit depth	Peak pixel rate [Megapixels/s] Base DualBase	Peak pixel rate [Megapixels/s] Full FullXR
8	8	8	500	1000
10	10	8, 10, 16	250	500
12	12	8, 12, 16	250	500
14	12	8, 14, 16	250	500
16	12	8, 16	250	500

The input bit depth of the Look-Up-Table is:

- Equal to the camera bit depth for 8-, 10- and 12-bit cameras.
- 12-bit for 14-bit and 16-bit cameras.

NOTE
For 14-bit and 16-bit cameras, when the look-up table operator is enabled, only 12 most significant bits of the camera pixel data are effectively considered; the remaining bits are ignored.

The output bit depth of look-up table is equal to the bit depth of the selected output format. The possible bit depths depends on the pixel depth of the camera:

- For 8-bit cameras: 8-bit
- For cameras delivering more than 8-bit: 8-bit, 16-bit and the same bit depth as the camera.

The LUT operator is designed to sustain the highest pixel rate achievable by the board-compatible monochrome cameras.

RGB Color Acquisition

When the board is configured for acquisition from RGB color cameras, the LUT operator is modeled as a triplet of very high speed RAMs inserted into the red, green, and blue pixel components data streams.

The three color components have the same bit depth. Consequently, the three look-up tables have the same input bit depth and the same output bit depth.

Available configurations and performance of the LUT operator for RGB color cameras

Camera	LUT Input bit depth	LUT output bit depth	Peak pixel rate [Megapixels/s] Base DualBase	Peak pixel rate [Megapixels/s] Full FullXR
8	8	8	125	250
10	10	8, 10, 16	-	125
12	12	8, 10, 16	-	125

The input bit depth of each look-up table is equal to the camera bit depth of each color component.

The output bit depth of each look-up table is equal to the bit depth of each color component of the selected output format. The possible color components bit depths depends on the color component pixel bit depth of the camera:

- For 3 x 8-bit RGB cameras: 8-bit.
- Full FullXR For cameras delivering more than 8-bit per component: 8-bit,16-bit and the same bit depth as the component bit depth of the camera.

The LUT operator can sustain the highest pixel rate achievable by the board-compatible RGB color cameras.

Bayer Color Acquisition

When the board is configured for acquisition from Bayer color cameras, the LUT operator is modeled as a triplet of very high speed RAM inserted into the red, green, and blue pixel components data streams delivered by the CFA decoder.

Available configurations of the LUT operator for Bayer color cameras when the Bayer decoder is enabled

Camera	LUT Input bit depth	LUT output bit depth	Peak pixel rate [Megapixels/s] Base DualBase	Peak pixel rate [Megapixels/s] Full FullXR
8	8	8	125	250
10	10	8	-	250
		10, 16	-	125
12	12	8	-	250
		12, 16	-	125
14	12	8	-	250
		14, 16	-	125
16	12	8	-	250
		16	-	125

The input bit depth of the look-up table is:

- Equal to the camera bit depth for 8-, 10- and 12-bit cameras.
- 12-bit for 14-bit and 16-bit cameras.

> NOTE
> For 14-bit and 16-bit cameras, when the look-up table operator is enabled, only 12 most significant bits of each component delivered by the CFA decoder are effectively considered; the remaining bits are ignored.

The output bit depth of each of the 3 look-up tables is equal to the bit depth of each color component of the selected output format. The possible color components bit depths depends on the pixel bit depth of the camera and board type:

- For 8-bit Bayer cameras: 8-bit per component.
- Full FullXR For cameras delivering more than 8-bit per component; 8-bit, 16-bit and the same bit depth as the component bit depth of the camera.

The performance of the RGB LUT operator matches the performance of the Bayer CFA decoder.

4.7. Bayer CFA to RGB Conversion

Applies to: Base DualBase Full FullXR

The Bayer CFA decoder transforms the raw Bayer CFA data stream issued by the camera into an RGB color data stream.

The missing pixel components are reconstructed using one of the following interpolation methods:

- Legacy interpolation method computes the missing color components using exclusively Mean() functions of the nearest components.
- Advanced interpolation method computes the missing color components using Mean() and Median() functions of the nearest components. The advanced interpolation eliminates the "creneling" effect on the highly contrasted sharp transitions in the image.

The CFA decoder requires up to eight surrounding pixels to compute the missed components of RGB pixels. Surrounding pixels are identified by their geographic location relative to the pixel for computation.

NW	N	NE
W		E
SW	S	SE

Definitions

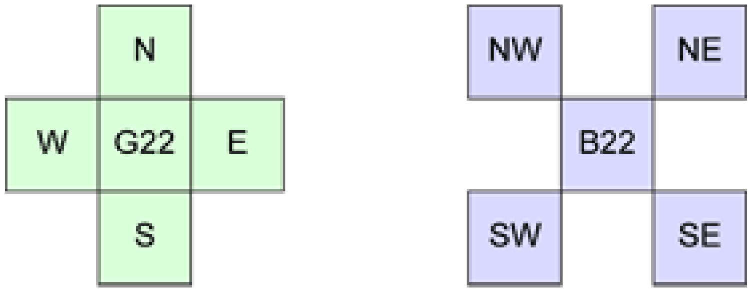
```
Mean2(a,b) = (a+b)/2
Mean4(a,b,c,d) = (a+b+c+d)/4
Median2Of4(a,b,c,d) = Mean2{ Min [ Max(a,b); Max(c,d) ] ; Max [ Min(a,b); Min(c,d) ] }
```

Computing Missing Components on 4 Positions of a Bayer CFA Array

B11	G21	B31	G41
G12	R22	G32	R42
B13	G23	B33	G43
G14	R24	G34	R44

For red pixel locations (case of R22)

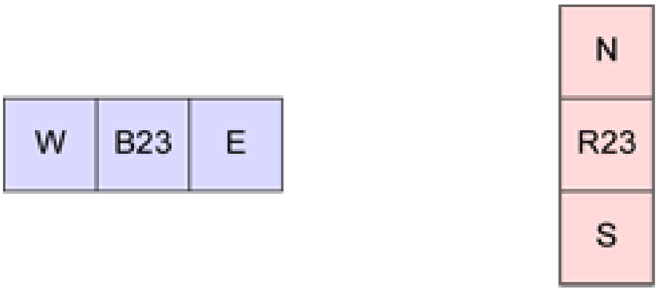
```
G <= Mean4(GN, GS, GE, GW)
B <= Mean4(BNE, BSE, BSW, BNW)
```



Case of R22

For green pixel locations in lines with blue (case of G23)

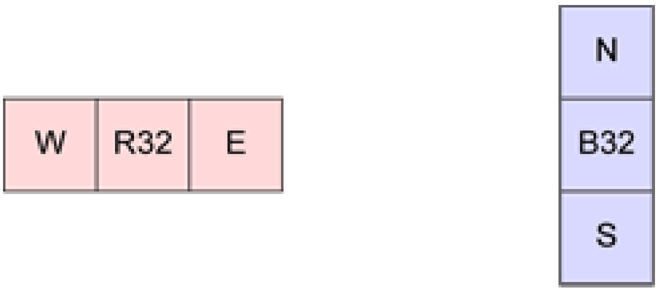
```
R <= Mean4(RN, RS)
B <= Mean4(BE, BW)
```



Case of G23

For green pixel locations in lines with red (case of G32)

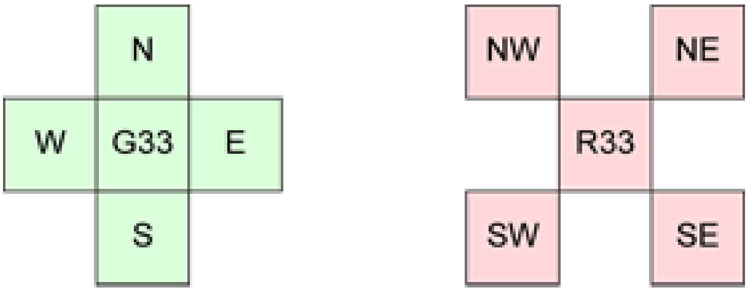
```
R <= Mean2(RE, RW)
B <= Mean2(BN, BS)
```



Case of G32

For blue pixel locations (case of B33)

```
G <= Mean4(GN, GS, GE, GW)
R <= Mean4(RNE, RSE, RSW, RNW)
```



Case of B33

Enabling the Bayer CFA Decoder

The Bayer CFA decoding function is automatically enabled if all the following conditions are satisfied:

1. The camera is an area-scan camera (Imaging = AREA)
2. The camera is a color camera (Spectrum = COLOR)
3. The camera delivers raw data from a Bayer Color Filter Array sensor (ColorMethod = BAYER)

Registering Bayer CFA

The registration of the BAYER CFA must be correctly set by assigning the appropriate value to the ColorRegistration parameter.

There are 4 values: GB, BG, RG, GR corresponding to the colors of the 2 first pixels of the first image line delivered by the camera.

Configuring the Bayer CFA Decoder

The CFA decoder has only one setting to select the interpolation method: the CFD_Mode parameter.

The default and recommended setting is ADVANCED. The alternate setting is LEGACY.

CFA Decoder Performance

The peak pixel processing rate of the CFA decoder of each acquisition channel is 250 megapixels/s.

The performance level of the Bayer CFA decoder is matching approximately the performance of the DMA transfer. However, the peak pixel processing rate is significantly lower than the highest pixel rate achievable by the board-compatible Bayer CFA cameras.

4.8. White Balance

Applies to: Base DualBase Full FullXR

Detailed description of the White Balance Operator

What Is White Balance?

Color image acquisition

A color image acquisition involves the use of three color filters on the camera sensor. Each color filter restricts the light source to a range of wavelengths of the light spectrum, either red (R), green (G), or blue (B).

An ideal capture system renders a white object as a white image. A white stimulation should yield the same signal for R, G and B filters. But practically, there are always unavoidable defects on the signals that introduce a *white imbalance*.

White imbalance factor

Several factors, due to the camera and to the capture conditions, are responsible for the white imbalance:

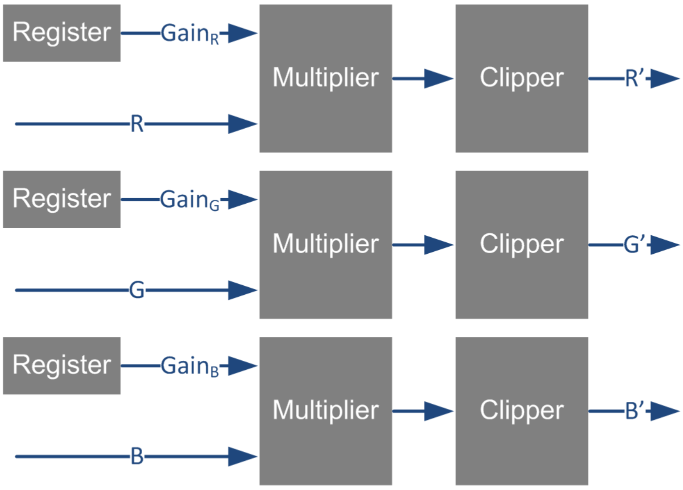
- Object illumination. The color of an object is a combination of its reflectivity and the spectral contents of the illuminating light.
- Camera optical filters response.
- Sensor sensitivity, which is not the same for the three ranges of wavelength.
- Different gain coefficients applied to each color signal before digitization.

White balance correction

MultiCam can correct the white imbalance of the capture system. The operation is called the *white balance*:

- The *white balance operator* applies correcting coefficients (R, G, and B gains) to each color signal, so, for a white object, the combination of the R, G, and B signals renders a white image.
- The *white balance calibration* is the computation of the three R, G, and B gains. It is performed on a representative image area, prior to the image capture. It can be automatic or manual.

White Balance Operator



White Balance Operator - Block Diagram

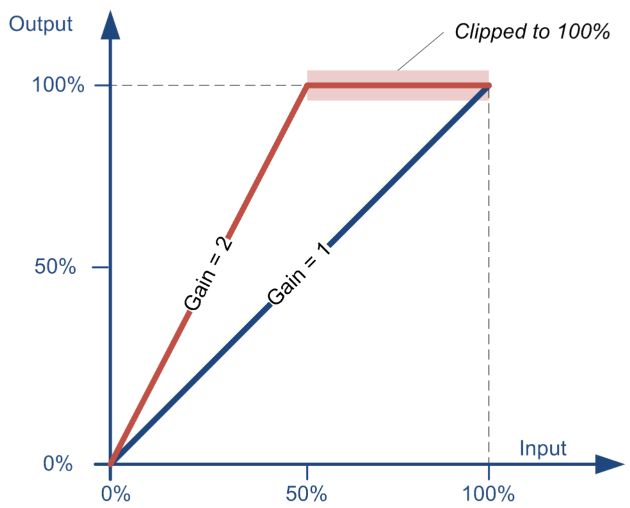
The White Balance Operator is an element of the pixel processing chain. It is composed with 3 identical processing blocks, one for each color component.Each processing block contains 3 elements:

- One register
- One multiplier
- One clipper

The register element holds the gain correction factor. The gain value is registered as a 16-bit unsigned binary value allowing gain correction factors to be accurately defined.

The multiplier computes the product of the gain correction factor and the color component value. It is capable to handle components having 8-bit, 10-bit, 12-bit, 14-bit and 16-bit bit depth.

The multiplier output is clipped to the maximum value of the digital output scale. The digital output scale is in all cases identical to the digital input scale; itself identical to the digital output scale of the camera. For instance, for a camera delivering 10-bit components, the digital scale is [0..1023].



White Balance Operator - Transfer Function

The above drawing shows 2 transfer functions of one component of the White Balance Operator:

- The blue line corresponds to a gain setting of 1.000; i.e., the minimal allowed gain value.
- The red line corresponds to a gain setting of 2.000. The output remains proportional to the input until the 100% full-scale output is reached; for greater input values, the output is clipped to 100% full-scale!

Automatic Calibration Description

The color calibration process takes place during the first acquisition phase of a MultiCam acquisition sequence when the WBO_Mode is set to ONCE.

The color calibrator analyzes a rectangular area (AWB_AREA) of one uncorrected image and computes a correcting gain factor for each RGB color component.

The correction factor for the color component having the strongest response is always 1; the correction factors for the weakest color components are greater than 1.

Providing that the requirements of the *color source equipment*, the *calibration target* and the *acquisition channel settings* are fulfilled, the calibrator estimates the gain factors with an accuracy better than 1/1000.

Applying the calculated gain correction factors to the White Balance Operator for subsequent image acquisitions allows on-the-fly color balancing of the acquired images.

The calibrator returns a NOT_OK status in the following cases:

- Excessive color imbalance.
- Not enough pixels satisfying the calibration target requirements in the AWB_AREA.

Automatic Calibration Requirements

This topic describes the requirements that must be fulfilled to obtain optimal calibration results.

Image Source Equipment Requirements

The image source equipment including: the camera, the lighting and the optical elements, must exhibit:

- A linear response: The digital value of each color component must be proportional to the light intensity of the corresponding color.
- A moderate color imbalance: The ratio between the response of the strongest color component and the weakest color component must be less than 5.

Calibration Target Requirements

The calibration target is a neutral color object located in the field of view of the camera during the calibration process.

The form of the target can be either:

- Clustered light gray pixels located in a specific area of the camera field of view.
- Non-clustered-light gray pixels located in a specific area of the camera field of view.
- Non-clustered-light gray pixels located anywhere in the camera field of view.

The calibration target can be:

- In the object to inspect.
- A specific object placed in the camera field of view during the calibration phase.

The appearance of the target must be:

- A neutral light gray color.
- The level of the brightest component within 75% to 90% of the full scale.
- The level of the darkest component above 15% of the full scale.

The target must contain at least 256 pixels satisfying the appearance requirements.

Acquisition Channel Settings

The parameter WBO_Mode must be set to ONCE.

The parameters defining the position and the size of the AWB_AREA must be configured such that:

- It includes at least 256 pixels satisfying the calibration target appearance requirements.
- It contains at least 1 line and 32 columns of pixels.
- It is located entirely within the Camera Active Area.

Specifically on**1624 Grablink Base**, **1623 Grablink DualBase**, **1622 Grablink Full** and **1626 Grablink Full XR**:

- The LUT Operator must be disabled.

- The position and the size of the cropping area must be configured such that it encompasses the AWB_AREA

Automatic Calibration Timing

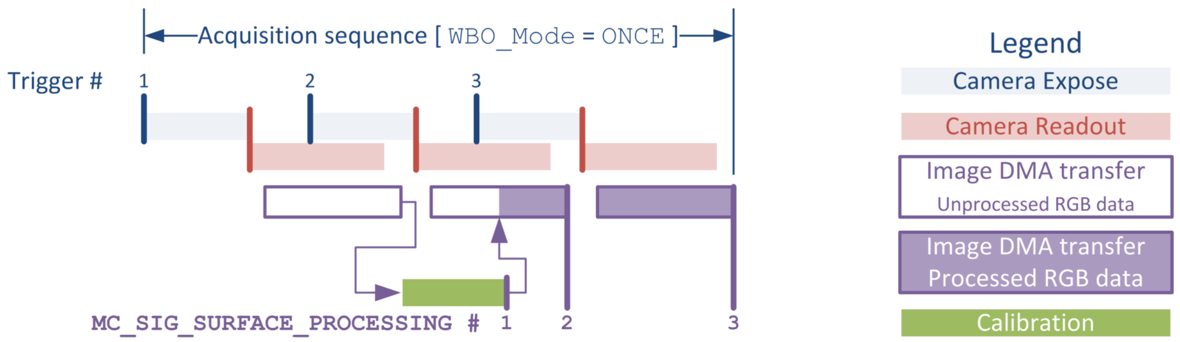
The color calibration process takes place during the first acquisition phase of a MultiCam acquisition sequence when the WBO_Mode is set to ONCE.

The White Balance Operator is disabled before the sequence starts.

The calibration process begins when the DMA transfer of the first acquisition phase is completed. The first MC_SIG_SURFACE_PROCESSING signal of the sequence is delayed until the completion of the calibration process.

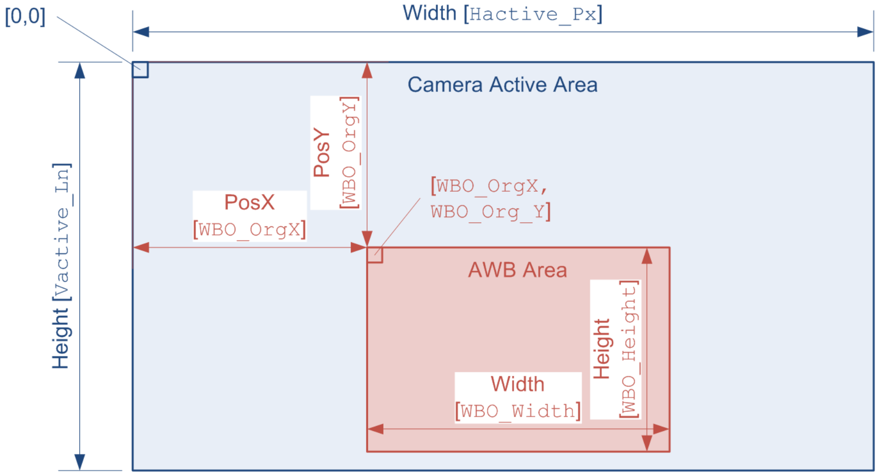
- At the completion of a successful calibration process:
  - The value of the parameter WBO_Status is set to OK.
  - The values of parameters WBO_GainR, WBO_GainG, and WBO_GainB are updated with the calibration results.
  - The White Balance Operator is reconfigured with the new settings.

  At the completion of an unsuccessful calibration process:
  - The value of the parameter WBO_Status is set to NOT_OK.
  - The original values of parameters WBO_GainR, WBO_GainG, and WBO_GainB are restored.
  - The White Balance Operator is reconfigured with the original settings.



Calibration Timing Diagram

AWB_AREA Settings Description



AWB_AREA layout

The AWB_AREA is a rectangular area within the Camera Active Window that is analyzed by the color balancing calibrator.

The size and the position of the AWB_AREA within the Camera Active Area is defined by the following parameters: WBO_Width, WBO_Height, WBO_OrgX, and WBO_OrgY.

The default size of the AWB_AREA is the whole Camera Active Area.

4.9. Pixel Formatting

Pixel Component Unpacking

Grablink boards unpack 10-bit, 12-bit, and 14-bit pixel component data to 16-bit pixel data.

Two unpacking options are available:

- Unpacking to lsb (Default setting)
- Unpacking to msb

Unpacking to lsb

The significant bits of the pixel component data are aligned to the **least significant bit** of the data container. Padding '0' bits are put as necessary in the **most significant bits** to reach the next 8-bit boundary.

- 10-bit pixels: 0000 00<pp pppp pppp>
- 12-bit pixels: 0000 <pppp pppp pppp>
- 14-bit pixels: 00<pp pppp pppp pppp>

> NOTE
> Unpacking to lsb doesn't modify the pixel component value.

Unpacking to msb

The significant bits of the pixel component data are aligned to the **most significant bit** of the data container. Padding '0' bits are put as necessary in the **least significant bits** to reach the next 8-bit boundary.

- 10-bit pixels: <pppp pppp pp>00 0000
- 12-bit pixels: <pppp pppp pppp> 0000
- 14-bit pixels: <pppp pppp pppp pp>00

> NOTE
> Unpacking 10-bit, 12-bit, and 14-bit pixel components to msb multiplies the pixel component value by 64, 16, and 4 respectively.

> NOTE
> Unpacking 8-bit and 16-bit pixel components is a neutral operation:
>
> - The size of the data container is unchanged: One byte for 8-bit pixel components; two bytes for 16-bit pixel components
> - The data bits are not modified

> NOTE
> Unpacking 10-bit, 12-bit, and 14-bit pixel components increases the amount of data by 160%, 133%, and 114% respectively.

No unpacking

The packed image data transmitted by the camera through the CoaXPress Link is delivered as is to the output buffer.

Pixel Bit Depth Reduction

Grablink boards are capable to reduce the bit depth of 10-/12-/14- and 16-bit pixel components to 8-bit by truncation of the least significant bits.

Pixel Format Control

Pixel Component Unpacking and Pixel Bit Depth reduction are controlled by the ColorFormat parameter.

For instance for monochrome 10-bit pixels:

- Set ColorFormat to Y8 to select the bit depth reduction
- Set ColorFormat to Y16 to select the unpacking to msb
- Keep the default value (or set) ColorFormat to Y10 to select unpacking to lsb

Refer to "Configurations for Monochrome Pixels" on page 54, "Configurations for Bayer CFA Pixels" on page 56 and "Configurations for RGB Pixels" on page 59 for an exhaustive list of valid pixel processing configurations.

Refer to *D406EN-MultiCam Storage Formats* PDF document for an exhaustive description of pixel formats.

4.10. Image Transfer

The processed and formatted image data are transferred into a surface over the PCI Express bus using a DMA engine.

> NOTE
> In the MultiCam driver, a surface is the physical memory space allocated into the host PC memory for the storage of one image.

The transferred image is stored in the destination surface in a progressive-scan order:

- The first pixel (top-left corner) of the transferred image is stored at the first memory location of the surface (at 0).
- The first pixels of the subsequent lines are stored at a byte address that is a multiple of the surface pitch.

Surface Pitch

The MultiCam driver establishes a default surface pitch that corresponds to the amount of bytes required to store one pixel row of the image data. You may increase this value if the application requires it.

Surface Size

The MultiCam driver establishes a default surface size that corresponds to the amount of bytes required to store all the rows of the image data. You may increase this value if its application requires it.

Extended Addressing Capabilities

Applies to: Base DualBase Full FullXR

These Grablink boards are capable of transferring image data anywhere into the physical memory of the system.

Automatic DMA Descriptors Loading

Applies to: Base DualBase Full FullXR

These Grablink boards implement an automatic mechanism for the loading of the DMA descriptors from the host PC memory to the DMA descriptor section of the on-board memory.

The DMA descriptors lists can then be prepared and stored into the host PC memory; the automatic loader pre-fetches the descriptors such that they are available for the DMA engine when it needs them.

Notes

- The transfer of the descriptors is performed with the second DMA engine, it doesn't require any CPU work.

- The transfer of the descriptors does not impact the available bandwidth on the PCI Express link for image transfer since it conveys data on the opposite direction.

Transfer Rate

Applies to: Base

This board sustains image data transfer over the PCI Express bus:

- Up to 200 megabytes/s for a PCI Express payload size of 256 bytes
- Up to 180 megabytes/s for a PCI Express payload size of 128 bytes.

> WARNING
> The effective data rate depends on the performance of the PCI Express link.

Transfer Rate

Applies to: DualBase Full FullXR

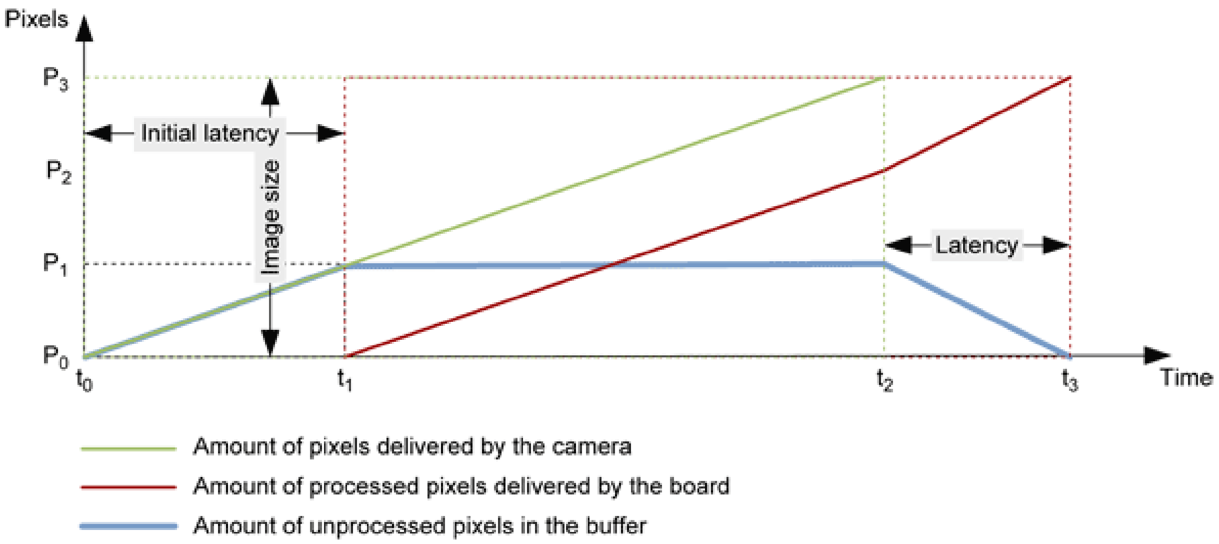
This board sustains image data transfer over the PCI Express bus:

- Up to 833 megabytes/s for a PCI Express payload size of 256 bytes and 64-bit addressing.
- Up to 844 megabytes/s for a PCI Express payload size of 256 bytes and 32-bit addressing.
- Up to 754 megabytes/s for a PCI Express payload size of 128 bytes and 64-bit addressing.
- Up to 780 megabytes/s for a PCI Express payload size of 128 bytes and 32-bit addressing.

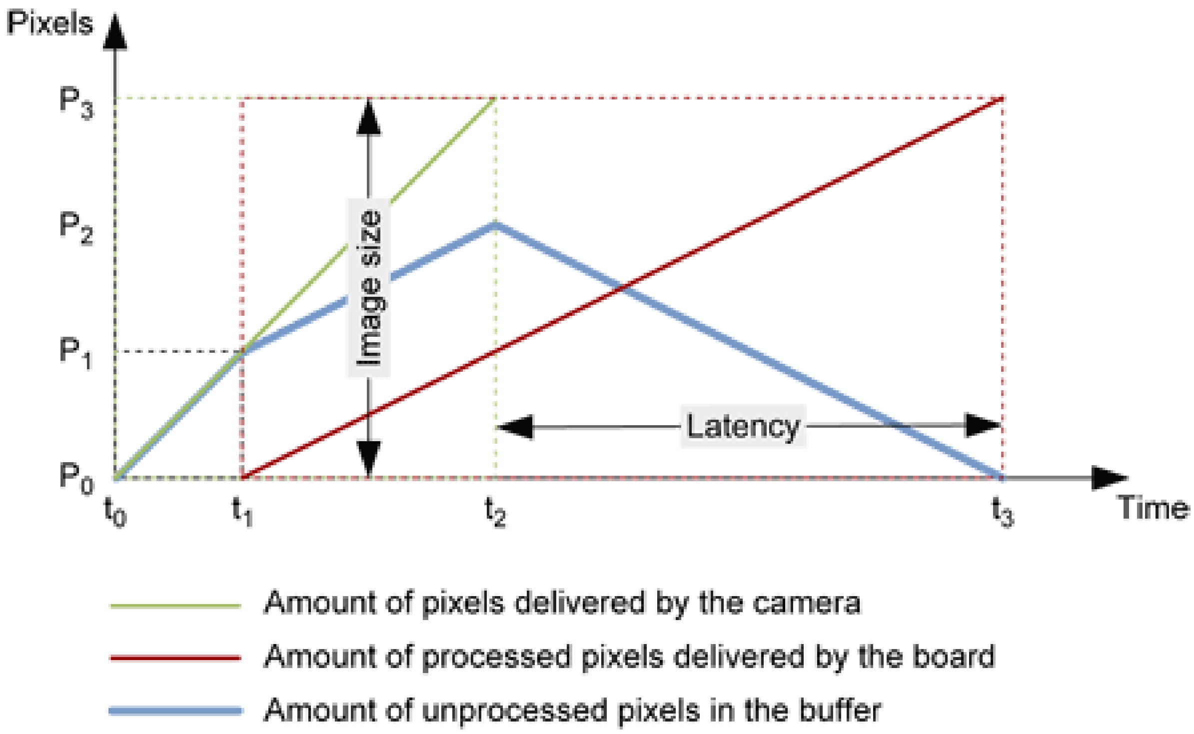
> WARNING
> The effective data rate depends on the performance of the PCI Express link.

4.11. Transfer Latency

The transfer latency is the time interval between the time when the last camera pixel of the image enters the frame grabber and the same processed pixel is stored in the host PC memory.



Case #1: Camera pixel rate < max pixel processing or pixel delivery rate



Case #2: Camera pixel rate > max pixel processing or pixel delivery rate

For both cases

- The camera delivers the image starting at time t_0 and ending at time t_2. For the simplicity, the line blanking intervals are not shown.
- The on-board pixel processing and DMA transfer to the host PC memory begins at time t_1 and ends at time t_3.
- The pixel processing requires that a minimum of pixel data (P_1 pixels) is available into the buffer. Consequently, the processing of the first pixel is retarded until the minimum amount of pixel is available. The time interval (t_1 - t_0) is the "initial latency"; it depends only on the camera pixel data rate and P_1.
- The time interval (t_3 - t_2) is the "latency".

For case #1

- After t_1, the effective pixel processing rate is equal to the camera pixel rate; the processing is eventually halted at line boundaries until enough data is available from the camera to resume it.
- When the camera has delivered the last pixel of the image, the processing continues at the max pixel processing (or the maximum delivery rate) until the last pixel of the image. The latency depends only on P_1 and the maximum processing/delivery rate.

For case #2

- After t_1, the effective pixel processing rate is the maximum pixel processing/delivery rate until the last pixel of the image. The time interval (t_3 - t_2) is the "latency"; it depends only on P_1 and on the maximum processing/delivery rate.

For the estimation of the latency

The following board characteristics are be considered:

- P_1 is the amount of pixel that must be received from the camera before initiating the pixel processing. This amount is equal to the number of pixels contain into:
  - Two lines of the image if the Bayer CFA decoder is used.
  - One line of the image if the Bayer CFA decoder is not used.
- The maximum processing/delivery pixel rate is the smallest value of :
  - The pixel processing rate.
  - The pixel delivery rate over the PCIe interface.
- For the pixel processing rate, the following processing functions may limit the processing rate if they are used:
  - For the Bayer CFA decoder performances, refer to Bayer CFA to RGB Conversion for more details
  - For LUT processor performances, refer to Look-up Table Transformation for more details.
- For the pixel delivery rate, refer to "Image Transfer" on page 78 for an estimation of the data transfer rate and divide by the number of bytes/pixel to obtain an evaluation in pixels/s.

5. Acquisition

5.1. Grablink Acquisition Modes

Grablink products support the following fundamental acquisition modes for area-scan and line-scan cameras:

Fundamental acquisition modes for area-scan cameras

Acquisition Mode	Short Description
SNAPSHOT	The SNAPSHOT acquisition mode is intended for the acquisition of *snapshot images*.
HFR	The HFR acquisition mode is intended for the acquisition of *snapshot images* from *high frame rate* cameras.

Fundamental acquisition modes for line-scan cameras

Acquisition Mode	Short Description
WEB	The WEB acquisition mode is intended for image acquisition of *single continuous objects of any size*.
PAGE	The PAGE acquisition mode is intended for image acquisition of *multiple discrete objects having a fixed size*. The page size is user-configurable up to 65,535 lines. The acquisition sequence can be configured to terminate automatically after a predefined number of objects.
LONGPAGE	The LONGPAGE acquisition mode is intended for image acquisition of *multiple discrete objects having, possibly, a variable and/or a larger size*. This mode supports objects up to 2,147,483,648 lines and has the unique capability to acquire variable size objects as defined by a "Page Cover" signal.

The user must select the fundamental acquisition mode by assigning the appropriate value to the AcquisitionMode parameter before any other acquisition control parameter.

5.2. SNAPSHOT Acquisition Mode

The SNAPSHOT acquisition mode is intended for the acquisition of *snapshot images*.

Description

In the SNAPSHOT acquisition mode, the unique sequence is capable of acquiring SeqLength_Fr frames within the channel activity period.

The SNAPSHOT acquisition mode is the default mode enforced automatically by MultiCam for all area-scan cameras; it can also be explicitly invoked by assigning value SNAPSHOT to AcquisitionMode.

Preparing the Channel for SNAPSHOT acquisition

The first action is to define all MultiCam Channel parameters before channel activation.

More specifically the following acquisition control parameters need to be configured:

Parameter	Value range
AcquisitionMode	SNAPSHOT
TrigMode	IMMEDIATE, HARD, SOFT and COMBINED
NextTrigMode	SAME, REPEAT, HARD, SOFT and COMBINED
SeqLength_Fr	MC_INDETERMINATE, 1 ~ 65534

When invoking the SNAPSHOT acquisition mode:

- ActivityLength is enforced to 1. The channel goes inactive at the completion of the sequence.
- PhaseLength_Fr is enforced to 1. A single frame is acquired during an acquisition phase.
- TrigMode establishes the starting condition of the sequence and consequently the starting condition of the first phase of the sequence. Possible values are IMMEDIATE, HARD, SOFT and COMBINED. The default MultiCam setting is IMMEDIATE.
- NextTrigMode establishes the starting condition of the subsequent phases within the sequence. Possible values are SAME, REPEAT, HARD, SOFT and COMBINED. The default value is SAME.
- The sequence length is specified by SeqLength_Fr. Assigning a value MC_INDETERMINATE enforces an indefinite acquisition sequence.

Activating the Channel

Setting ChannelState parameter to ACTIVE activates the channel and arms the trigger circuit.

The SNAPSHOT acquisition sequence will effectively start after the first trigger event occurring after channel activation when the first acquisition phase is triggered.

Starting the first SNAPSHOT acquisition phase

The trigger source is determined by the Start Trigger condition. Usually, the start trigger event is a hard trigger; however a soft trigger signal can also be selected. Usually, the trigger is derived from a position detector. The trigger condition is defined by parameter TrigMode.

A programmable time delay can optionally be specified with parameter TrigDelay_us. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

At first trigger event, the image capture starts effectively; a "Start of Sequence" signal is reported to the user.

Starting the subsequent SNAPSHOT acquisition phases

The trigger source for all subsequent acquisition phases is determined by the Next Start Trigger condition. Usually, the Next start trigger event is the same as the Start Trigger condition. The next trigger condition is defined by parameter NextTrigMode.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

A programmable time delay can optionally be specified with parameter TrigDelay_us. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

At subsequent trigger events, the image capture starts effectively; however no "Start of Sequence" signal is reported to the user.

SNAPSHOT acquisition phase

Once the SNAPSHOT acquisition phase is started, the frame grabber acquires one image frame and stores image data into one surface.

Stopping a SNAPSHOT acquisition sequence

The SNAPSHOT acquisition mode allows two methods to stop the sequence: *Manual stop* and *Automatic stop*.

If the number of frames to capture is known before starting the sequence and is not higher than 65,535, the automatic stop method can be used to automatically stop the sequence after a predefined number of frames. This variant of SNAPSHOT acquisition is named *Finite SNAPSHOT acquisition*. In this case, the number of frames to be acquired needs to be specified before Channel activation.

If the number of frames is unknown or higher than 65,535, the manual stop method is required. In this case, the parameter SeqLength_Fr should be set to MC_INDETERMINATE, in order to define an *infinite SNAPSHOT acquisition sequence*.

Manual sequence stop

The SNAPSHOT acquisition sequence stops by setting ChannelState=IDLE.

In case of a user break event, the BreakEffect parameter value is irrelevant. The acquisition terminates ALWAYS at a phase —frame— boundary ensuring the integrity of the frame.

Automatic sequence stop

The sequence terminates automatically after the acquisition of the specified number of frames. An indefinite acquisition sequence stops when the channel is forced to its inactive state.

Use parameter SeqLength_Fr to specify the total number of frames to be acquired. The sequence will automatically stop after the last acquired frame.

Monitoring a SNAPSHOT acquisition

- Elapsed_Fr reports the number of acquired frames in the sequence.
- When the sequence length is defined (SeqLength_Fr≠MC_INDETERMINATE), Remaining_Fr reports the number of remaining frames in the sequence.
- When the sequence contains more than 1 frame (SeqLength_Fr>1), PerSecond_Fr reports the measured average frame rate.

5.3. HFR Acquisition Mode

The HFR acquisition mode is intended for the acquisition of *snapshot images* from *high frame rate* cameras.

Description

In HFR acquisition mode, the unique sequence is divided into phases, each phase acquiring PhaseLength_Fr frames into a single destination surface.

The HFR acquisition mode is applicable to area-scan cameras with a frame rate not exceeding 1,275,000 frames per second.

The HFR acquisition mode is explicitly invoked by assigning value HFR to AcquisitionMode.

Preparing the Channel for SNAPSHOT acquisition

The first action is to define all MultiCam Channel parameters before channel activation.

More specifically the following acquisition control parameters need to be configured:

Parameter	Value range
AcquisitionMode	HFR
TrigMode	IMMEDIATE, HARD, SOFT and COMBINED
NextTrigMode	SAME, REPEAT, HARD, SOFT and COMBINED
SeqLength_Fr	MC_INDETERMINATE, 1 ~ *(PhaseLength_Fr × 65,534)*
PhaseLength_Fr	1 ~ 255

When invoking the HFR acquisition mode:

- The ActivityLength parameter is enforced to 1. The channel goes inactive at the completion of the sequence.
- The number of frames per acquisition phase is specified by PhaseLength_Fr. The minimal applicable value is the camera frame rate divided by 5000.
- The TrigMode parameter establishes the starting condition of the sequence and consequently the starting condition of the first slice of the first phase —the first frame— of the sequence. Possible values are IMMEDIATE, HARD, SOFT and COMBINED. The default MultiCam setting is IMMEDIATE.
- The NextTrigMode parameter establishes the starting condition of the subsequent slices —frames— within the sequence. Possible values are SAME, REPEAT, HARD, SOFT and COMBINED. The default value is SAME.
- The sequence length is specified by SeqLength_Fr. Assigning a value MC_INDETERMINATE enforces an indefinite acquisition sequence.

Starting the first slice —frame— of a HFR acquisition sequence

The trigger source is determined by the Start Trigger condition. Usually, the start trigger event is a hard trigger; however a soft trigger signal can also be selected. Usually, the trigger is derived from a position detector. The trigger condition is defined by parameter TrigMode.

A programmable time delay can optionally be specified with parameter TrigDelay_us. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

At first trigger event, the image capture starts effectively; a "Start of Sequence" signal is reported to the user.

Starting the subsequent slices —frames— of a HFR acquisition sequence

The trigger source for all subsequent acquisition slices is determined by the Next Start Trigger condition. Usually, the Next start trigger event is the same as the Start Trigger condition. The next trigger condition is defined by parameter NextTrigMode.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

A programmable time delay can optionally be specified with parameter TrigDelay_us. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

At subsequent trigger events, the image capture starts effectively; however no "Start of Sequence" signal is reported to the user.

Stopping a HFR acquisition sequence

The HFR acquisition mode allows two methods to stop the sequence: *Manual stop* and *Automatic stop*.

If the number of frames to capture is known before starting the sequence and is not higher than *(PhaseLength_Fr × 65,534)*, the automatic stop method can be used to automatically stop the sequence after a predefined number of frames. This variant of HFR acquisition is named *Finite HFR acquisition*. In this case, the number of frames to be acquired needs to be specified before Channel activation.

If the number of frames is unknown or higher than *(PhaseLength_Fr × 65,534)*, the manual stop method is required. In this case, the parameter SeqLength_Fr should be set to MC_INDETERMINATE, in order to define an *infinite HFR acquisition sequence*.

Manual sequence stop

The HFR acquisition sequence stops by setting ChannelState=IDLE.

In case of a user break event, the BreakEffect parameter value is irrelevant. The acquisition terminates ALWAYS at a phase —frame— boundary ensuring the integrity of the frame.

Automatic sequence stop

The sequence terminates automatically after the acquisition of the specified number of frames. An indefinite acquisition sequence stops when the channel is forced to its inactive state.

Use parameter SeqLength_Fr to specify the total number of frames to be acquired. The sequence will automatically stop after the last acquired frame.

Activating the Channel

Setting ChannelState parameter to ACTIVE activates the channel and arms the trigger circuit.

The HFR acquisition sequence will effectively start after the first trigger event occurring after channel activation when the first acquisition phase is triggered.

HFR acquisition phase

Once the HFR acquisition phase is started, the frame grabber acquires PhaseLength_Fr image frames and stores images data into one surface.

This means that each phase is divided in slices. The interruption rate of the operating system is then divided by the number of slice in a phase.

Stopping a PAGE acquisition sequence

The HFR acquisition mode allows two methods to stop the sequence: *Manual stop* and *Automatic stop*.

If the number of frames to capture is known before starting the sequence and is not higher than 65,535, the automatic stop method can be used to automatically stop the sequence after a predefined number of frames. This variant of HFR acquisition is named *Finite HFR acquisition*. In this case, the number of frames to be acquired needs to be specified before Channel activation.

If the number of frames is unknown or higher than 65,535, the manual stop method is required. In this case, the parameter SeqLength_Fr should be set to MC_INDETERMINATE, in order to define an *infinite SNAPSHOT acquisition sequence*.

Manual sequence stop

The HFR acquisition sequence stops by setting ChannelState=IDLE.

In case of a user break event, the BreakEffect parameter value is irrelevant. The acquisition terminates ALWAYS at a phase —frame— boundary ensuring the integrity of the frame.

Automatic sequence stop

The sequence terminates automatically after the acquisition of the specified number of frames. An indefinite acquisition sequence stops when the channel is forced to its inactive state.

Use parameter SeqLength_Fr to specify the total number of frames to be acquired. The sequence will automatically stop after the last acquired frame.

Monitoring a HFRacquisition

- The Elapsed_Fr parameter reports the number of acquired frames in the sequence.
- When the sequence length is defined (SeqLength_Fr≠MC_INDETERMINATE), Remaining_Fr reports the number of remaining frames in the sequence.
- When the sequence contains more than 1 frame (SeqLength_Fr>1), PerSecond_Fr reports the measured average frame rate.

5.4. WEB Acquisition Mode

The WEB acquisition mode is intended for image acquisition of *single continuous objects of any size*.

Description

In the WEB acquisition mode, a unique acquisition sequence can be executed within the Channel activity period.

A WEB acquisition sequence acquires SeqLength_Ln contiguous lines. It is divided in contiguous phases, each phase acquiring PageLength_Ln lines. When SeqLength_Ln is not a multiple of PageLength_Ln, the last phase fills partially the surface.

The sequence and the first acquisition phase are initiated according to TrigMode. Subsequent acquisition phases are automatically initiated without any line loss.

BreakEffect specifies the behavior in case of a user break.

The WEB acquisition mode is the default mode enforced automatically by MultiCam for line-scan cameras; it can also be explicitly invoked by assigning value WEB to AcquisitionMode.

Preparing the Channel for WEB acquisition

The first action is to define all MultiCam channel parameters before channel activation.

More specifically the following acquisition control parameters need to be configured:

Parameter	Value range
AcquisitionMode	WEB
TrigMode	IMMEDIATE, HARD, SOFTand COMBINED
BreakEffect	FINISH, ABORT
PageLength_Ln	1 ~ 65535
SeqLength_Ln	MC_INDETERMINATE and 1 ~ *(PageLength_Ln × 65,535)*

When invoking the WEB acquisition mode:

- ActivityLength is enforced to 1. The channel automatically goes inactive at the completion of the sequence.
- PhaseLength_Pg is enforced to 1. A single page is acquired during an acquisition phase.
- PageLength_Ln is automatically set to a working value. However, the page length can be enforced by setting PageLength_Ln. For more information see "Setting Optimal Page Length" on page 100.
- TrigMode establishes the starting condition of the sequence and consequently the starting condition of the first phase of the sequence. Possible values are IMMEDIATE, HARD, SOFT and COMBINED. The default MultiCam setting is IMMEDIATE.

- NextTrigMode is enforced to REPEAT. This ensures that no lines are missed between subsequent acquisition phases.
- The sequence length is specified by SeqLength_Ln. Assigning a value MC_INDETERMINATE enforces an *indefinite WEB acquisition sequence*. Assigning any value ≥ 1 enforces a *finite WEB acquisition sequence.*
- EndTrigMode is enforced to AUTO. The sequence terminates automatically after the acquisition of the specified number of pages. An indefinite acquisition sequence stops when the channel is forced to its inactive state.
- BreakEffect establishes the effect of a user break on the channel. When set to FINISH, it ensures the integrity of the last acquired phase —page— even when the user break event occurs during its execution; this is the default value. When set to ABORT, the effect of the user break is immediate (at line boundary); the current acquisition might be incomplete; the portion of image already acquired is available.
  When SeqLength_Ln is not a multiple of PageLength_Ln, the last acquired page is partially filled despite the FINISH setting.

Activating the Channel

Setting ChannelState parameter to ACTIVE activates the channel and arms the trigger circuit.

The WEB acquisition sequence will start after the first trigger event occurring after channel activation.

Starting a WEB acquisition sequence

The origin of the trigger event is determined by the trigger condition as specified by TrigMode parameter.

Usually, the trigger event is immediate (TrigMode=IMMEDIATE) in order to start the acquisition sequence immediately. Alternatively soft trigger (TrigMode=SOFT) or hard trigger signal (TrigMode=HARD) or both can be selected (TrigMode=COMBINED). When hard trigger is specified, additional parameters TrigCtl, TrigEdge, TrigFilter and TrigLine define the trigger input.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

WEB acquisition sequence

Once the WEB acquisition sequence is started, the frame grabber acquires data lines continuously until the acquisition sequence is stopped.

The acquisition sequence is composed of one or more acquisition phases. During an acquisition phase the frame grabber stores data lines into one destination surface.

Destination surfaces contain an arbitrary number of lines as defined by parameter PageLength_Ln.

When a surface is filled, the acquisition continues automatically into the next available surface without any missing lines. This process repeats until a stop condition occurs.

Every time a surface is filled, the "MC_SIG_SURFACE_FILLED" signal is reported to the user. Parameter LineIndex reflects the number of lines already written in a partially filled surface. If SeqLength_Ln is not a multiple of PageLength_Ln, the last surface will be partially filled. A new surface is selected at each begin of acquisition phase.

Lines are acquired at a rate defined by the line trigger condition. When object speed is variable, it is convenient to generate a line trigger derived from a motion encoder.

For more information, see "Line Trigger" on page 153 and "Line-Scan Synchronization" on page 146.

Stopping a WEB acquisition sequence

The WEB acquisition mode allows two methods to stop the sequence: *Manual stop* and *Automatic stop*.

If the scanned object has a finite length, the automatic stop method can be used to automatically stop the sequence after a predefined number of lines. This variant of WEB acquisition is named *WEB Finite*. In this case, the number of lines to be acquired needs to be specified before Channel activation.

More often the length of the object is unknown. Therefore, the manual stop method is required. In this case, the parameter SeqLength_Ln should be set to MC_INDETERMINATE, in order to define an infinite WEB acquisition sequence.

Manual stop

The WEB acquisition sequence stops by setting ChannelState to IDLE.

Two flavors of stop are selectable with parameter BreakEffect:

- When BreakEffect=FINISH, the WEB acquisition sequence stops after the completion of the surface filling.
- When BreakEffect=ABORT, the WEB acquisition sequence stops immediately, interrupting also the filling of the current surface. The last surface might be partially filled.

Automatic stop

Use parameter SeqLength_Ln to specify the total number of lines to be acquired. The sequence will automatically stop after the last acquired line. The last surface might be partially filled.

The maximum value of SeqLength_Ln is *(PageLength_Ln × 65,535)*.

Monitoring a WEB acquisition

- Elapsed_Ln reports the number of acquired lines in the sequence.
- When the sequence length is defined (SeqLength_Ln≠MC_INDETERMINATE), Remaining_Ln reports the number of remaining lines in the sequence.

5.5. PAGE Acquisition Mode

The PAGE acquisition mode is intended for image acquisition of *multiple discrete objects having a fixed size.*

The acquisition sequence can be configured to terminate automatically after a predefined number of objects.

Description

In the PAGE acquisition mode, a unique acquisition sequence can be executed within the Channel activity period.

The PAGE acquisition sequence is composed of a repetitive sequence of PAGE acquisition phases. Each PAGE acquisition phase is responsible for the image capture of one object.

Each page is constituted of contiguous lines; the page length, expressed in lines, is specified by PageLength_Ln.

A single sequence is capable to acquire SeqLength_Pg pages within the channel activity period.

The PAGE acquisition mode is explicitly invoked by assigning value PAGE to AcquisitionMode.

Preparing the Channel for PAGE acquisition

The first action is to define all MultiCam Channel parameters before channel activation.

More specifically the following acquisition control parameters need to be configured:

Parameter	Value range
AcquisitionMode	PAGE
TrigMode	IMMEDIATE, HARD, SOFT and COMBINED
NextTrigMode	SAME, REPEAT, HARD, SOFT and COMBINED
BreakEffect	FINISH, ABORT
PageLength_Ln	1 ~ 65535
SeqLength_Pg	MC_INDETERMINATE, 1 ~ 65535

When invoking the PAGE acquisition mode:

- The ActivityLength parameter is enforced to 1. The channel goes inactive at the completion of the sequence.
- The PhaseLength_Pg parameter is enforced to 1. A single page is acquired during an acquisition phase.
- The page length can be enforced by setting PageLength_Ln to any value up to 65,535. For more information see "Setting Optimal Page Length" on page 100.
- TrigMode establishes the starting condition of the sequence and consequently the starting condition of the first phase —the first PAGE— of the sequence. Possible values are IMMEDIATE, HARD, SOFT and COMBINED. The default MultiCam setting is COMBINED.

- NextTrigMode establishes the starting condition of the subsequent phases —pages— within the sequence. Possible values areSAME, REPEAT, HARD, SOFT and COMBINED. The default value is SAME.
- The sequence length is specified by SeqLength_Pg. Assigning a value MC_INDETERMINATE enforces an *indefinite PAGE acquisition sequence*. Assigning any value ≥ 1 enforces a *finite PAGE acquisition sequence.*
- EndTrigMode is enforced to AUTO. The sequence terminates automatically after the acquisition of the specified number of pages. An indefinite acquisition sequence stops when the channel is forced to its inactive state.
- BreakEffect establishes the effect of a user break on the channel. When set to FINISH, it ensures the integrity of the last acquired phase —page—– even when the user break event occurs during its execution; this is the default value. When set to ABORT, the effect of the user break is immediate (at line boundary); the current acquisition might be incomplete; the portion of image already acquired is available.

Activating the Channel

Setting ChannelState parameter to ACTIVE activates the channel and arms the trigger circuit.

The PAGE acquisition sequence will effectively start after the first trigger event occurring after channel activation when the first acquisition phase is triggered.

Starting the first PAGE acquisition phase

The trigger source is determined by the Start Trigger condition. Usually, the start trigger event is a hard trigger; however a soft trigger signal can also be selected. Usually, the trigger is derived from a position detector. The trigger condition is defined by parameter TrigMode.

A programmable page delay can optionally be specified with parameter PageDelay_Ln. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

At first trigger event, the object scanning starts effectively; a "Start of Sequence" signal is reported to the user.

Starting the subsequent PAGE acquisition phases

The trigger source for all subsequent acquisition phases is determined by the Next Start Trigger condition. Usually, the Next start trigger event is the same as the Start Trigger condition. The next trigger condition is defined by parameter NextTrigMode.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

A programmable page delay can optionally be specified with parameter PageDelay_Ln. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

At subsequent trigger events, the object scanning starts effectively; however no "Start of Sequence" signal is reported to the user.

PAGE acquisition phase

Once the PAGE acquisition phase is started, the frame grabber acquires data lines and stores them into one surface.

Destination surface receives an arbitrary number of lines as defined by parameter PageLength_Ln.

Parameter LineIndex reflects the number of lines already written in a partially filled surface. If SeqLength_Ln is not a multiple of PageLength_Ln, the surface will be partially filled. A new surface is selected at each begin of Page acquisition phase.

Lines are acquired at a rate defined by the line trigger condition. When object speed is variable, it is convenient to generate a line trigger derived from a motion encoder.

For more information, see "Line Trigger" on page 153 and "Line-Scan Synchronization" on page 146.

Stopping a PAGE acquisition phase

Within a PAGE acquisition sequence, the acquisition phase stops automatically when the surface is filled after the acquisition of PageLength_Ln lines.

The PAGE acquisition sequence supports objects up to highest possible value of PageLength_Ln, namely 65,535 lines. For large objects, consider using the LONGPAGE acquisition mode.

When acquisition phase is stopped, a "Surface filled" signal is reported immediately to the user. The "Surface filled" signal will be reported as soon as all the acquired data lines are transferred to the host memory.

Stopping a PAGE acquisition sequence

The PAGE acquisition mode allows two methods to stop the sequence: *Manual stop* and *Automatic stop*.

If the number of scanned objects is known before starting the sequence and is not higher than 65,535, the automatic stop method can be used to automatically stop the sequence after a predefined number of pages. This variant of PAGE acquisition is named *Finite PAGE acquisition*. In this case, the number of pages to be acquired needs to be specified before Channel activation.

If the number of scanned objects is unknown or higher than 65,535, the manual stop method is required. In this case, the parameter SeqLength_Pg should be set to MC_INDETERMINATE, in order to define an *infinite PAGE acquisition sequence*.

Manual sequence stop

The PAGE acquisition sequence stops by setting ChannelState=IDLE.

Two flavors are selectable with parameter BreakEffect:

- When BreakEffect=FINISH, the PAGE acquisition sequence stops after normal completion of the current PAGE acquisition phase if the object scanning is already started. Otherwise the PAGE acquisition sequence stops immediately.

- When BreakEffect=ABORT, the PAGE acquisition sequence stops immediately, interrupting also a PAGE acquisition phase in progress. The last object acquisition is not usable.

Automatic sequence stop

Use parameter SeqLength_Pg to specify the total number of pages to be acquired. The sequence will automatically stop after the last acquired page.

The maximum value of SeqLength_Pg is *65,535*.

Monitoring a PAGE acquisition

- Elapsed_Pg reports the number of acquired pages in the sequence.
- When the sequence length is defined (SeqLength_Pg≠MC_INDETERMINATE), Remaining_Pg reports the number of remaining pages in the sequence.

5.6. LONGPAGE Acquisition Mode

The LONGPAGE acquisition mode is intended for image acquisition of *multiple discrete objects having, possibly, a variable and/or a larger size.*

Description

In the LONGPAGE acquisition mode, multiple acquisition sequences can be executed within the Channel activity period.

The ActivityLength parameter specifies the number of sequences within the channel activity period. Each sequence is capable to acquire SeqLength_Ln contiguous lines.

A sequence is divided in phases, each phase acquiring PageLength_Ln lines.

The LONGPAGE acquisition mode is explicitly invoked by assigning value LONGPAGE to AcquisitionMode.

Preparing the Channel for LONGPAGE acquisition

The first action is to define all MultiCam channel parameters before channel activation.

More specifically the following acquisition control parameters need to be configured:

Parameter	Value range
AcquisitionMode	LONGPAGE
TrigMode	IMMEDIATE, HARD, SOFT and COMBINED
NextTrigMode	SAME, REPEAT, HARD, SOFT and COMBINED
EndTrigMode	AUTO, HARD
BreakEffect	FINISH, ABORT
PageLength_Ln	1 ~ 65535
SeqLength_Ln	MC_INDETERMINATE and 1 ~ *(PageLength_Ln × 65,535)*

When invoking the LONGPAGE acquisition mode:

- The ActivityLength parameter is enforced to INDETERMINATE. The channel remains active at the completion of the sequence.
- The PhaseLength_Pg parameter is enforced to 1. A single page is acquired during an acquisition phase.
- The PageLength_Ln parameter is automatically set to a working value. However, the page length can be enforced by setting PageLength_Ln. For more information see "Setting Optimal Page Length" on page 100.
- The TrigMode parameter establishes the starting condition of the sequence and consequently the starting condition of the first slice of the first phase of the sequence. Possible values are IMMEDIATE, HARD, SOFT and COMBINED. The default MultiCam setting is COMBINED.

- The NextTrigMode parameter is enforced to REPEAT. This ensures that no lines are missed between subsequent acquisition phases.
- The EndTrigMode parameter establishes the conditions of a sequence termination. When EndTrigMode = AUTO, the sequence terminates automatically after the acquisition of the specified number of frames. When EndTrigMode = HARD, the sequence terminates upon an external End Trigger event.
- The BreakEffect parameter establishes the effect of a user break on the channel. When set to FINISH, it ensures the integrity of the last acquired sequence —long page— even when the user break event occurs during its execution; this is the default value. When set to ABORT, the effect of the user break is immediate (at line boundary); the current acquisition might be incomplete; the portion of image already acquired is available.
  When SeqLength_Ln is not multiple of PageLength_Ln, the last acquired page is partially filled despite the FINISH setting.
- The sequence length is specified by SeqLength_Ln. Assigning a value MC_INDETERMINATE enforces an indefinite acquisition sequence.

Activating the Channel

Setting ChannelState parameter to ACTIVE activates the channel and arms the trigger circuit.

The first LONPAGE acquisition sequence will start after the first trigger event occurring after channel activation.

Starting a LONGPAGE Acquisition Sequence

The trigger source is determined by the Start Trigger condition. Usually, the start trigger event is a hard trigger; however a soft trigger signal can also be selected. Usually, the trigger is derived from a position detector. The trigger condition is defined by parameter TrigMode.

At trigger event, the acquisition sequence starts effectively.

A programmable page delay can optionally be specified with parameter PageDelay_Ln. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

To summarize the usage of trigger parameters, see "Hardware Trigger" on page 126.

LONGPAGE Acquisition Sequence

Once the LONGPAGE acquisition sequence is started, the frame grabber acquires data lines continuously until the acquisition sequence is stopped.

The acquisition sequence is composed of one or more acquisition phases. During an acquisition phase the frame grabber stores data lines into one destination surface.

Destination surfaces contain an arbitrary number of lines as defined by parameter PageLength_Ln.

When a surface is filled, the acquisition continues automatically into the next available surface without any missing lines. This process repeats until a stop condition occurs.

Every time a surface is filled, the "Surface Filled" signal is reported to the user. Parameter LineIndex reflects the number of lines already written in a partially filled surface. If SeqLength_Ln is not a multiple of PageLength_Ln, the last surface will be partially filled. A new surface is selected at each begin of acquisition phase.

Lines are acquired at a rate defined by the line trigger condition. When object speed is variable, it is convenient to generate a line trigger derived from a motion encoder.

For more information, see "Line Trigger" on page 153 and "Line-Scan Synchronization" on page 146.

Stopping a LONGPAGE Acquisition Sequence

MultiCam provides solutions for both fixed size and variable size objects.

When acquisition sequence is stopped, the "Surface Filled" signal will be reported as soon as all the acquired data lines are transferred to the host memory. The "MC_SIG_EAS" signal is also reported to the user.

Fixed size objects

When objects have fixed size, it is convenient to specify the number of lines to be acquired during a LONGPAGE acquisition sequence with parameter SeqLength_Ln.

The acquisition sequence will automatically stop after the last acquired line. The last surface might be partially filled. All following conditions must be satisfied:

- SeqLength_Ln > 0
- SeqLength_Ln < *(PageLength × 65 535)*
- SeqLength_Ln < 2^{31}

This method does not require any specific signal or user actions.

Variable size objects

When objects have variable size, it is convenient to use the signal delivered by a position detector to generate an end trigger condition.

Parameter EndTrigLine specify the input pin. Polarity and electrical style are specified by parameters EndTrigEdge and EndTrigCtl.

In case a single signal is used to indicate the start and the stop object positions, the EndTrigLine input pin is the same as the TrigLine input pin with opposite polarities.

A programmable page delay can optionally be specified with parameter EndPageDelay_Ln. It compensates a trigger advance delivered by a position detector placed away from the camera field of view.

To summarize the usage of end trigger parameters, see "Hardware End Trigger" on page 133.

Monitoring a LONGPAGE acquisition

- The Elapsed_Ln parameter reports the number of acquired lines in the sequence.
- When the sequence length is defined (SeqLength_Ln≠MC_INDETERMINATE), Remaining_Ln reports the number of remaining lines in the sequence.

Deactivation of the Channel

The Channel is deactivated by setting ChannelState to IDLE.

Two flavors are selectable with parameter BreakEffect:

- When BreakEffect=FINISH, the Channel deactivates after normal completion of the current LONGPAGE acquisition sequence. If the trigger event has not yet occurred, the Channel deactivates immediately.
- When BreakEffect=ABORT, the LONGPAGEacquisition sequence stops immediately.

NOTE
An automatic channel deactivation is not available for the LONGPAGEacquisition mode.

5.7. Setting Optimal Page Length

In line-scan acquisition modes, the PageLength_Ln parameter specifies the number of lines to acquire in a single surface.

Following rules and recommendation applies to determine the optimal value:

Rule 1

Current hardware implementations limit PageLength_Ln to a 16-bit value.

$$PageLength\_Ln \leq 65536$$

Rule 2

The maximum surface transition rate should not exceed 1 kHz. With *MaximumLineAcquisitionRate* being the highest line acquisition rate of the application expressed in Hertz:

$$PageLength\_Ln > \frac{MaxLineAcquisitionRate}{1000}$$

Rule 3

The maximum number of pages per sequence is 65565:

$$PageLength\_Ln \geq \frac{SeqLength\_Ln}{65535}$$

Recommendation

For optimal usage of the on-board buffer, the amount of data in a single surface should be in the range 1..4 Megabytes.

Therefore:

$$PageLength\_Ln \geq \frac{1048576}{LineSize\_Bytes}$$

$$PageLength\_Ln \geq \frac{4194304}{LineSize\_Bytes}$$

NOTE
This recommendation becomes significant only when the average data rate on the PCI interface is approaching the board limits.

6. Input/Output Ports

6.1. I/O Ports Overview

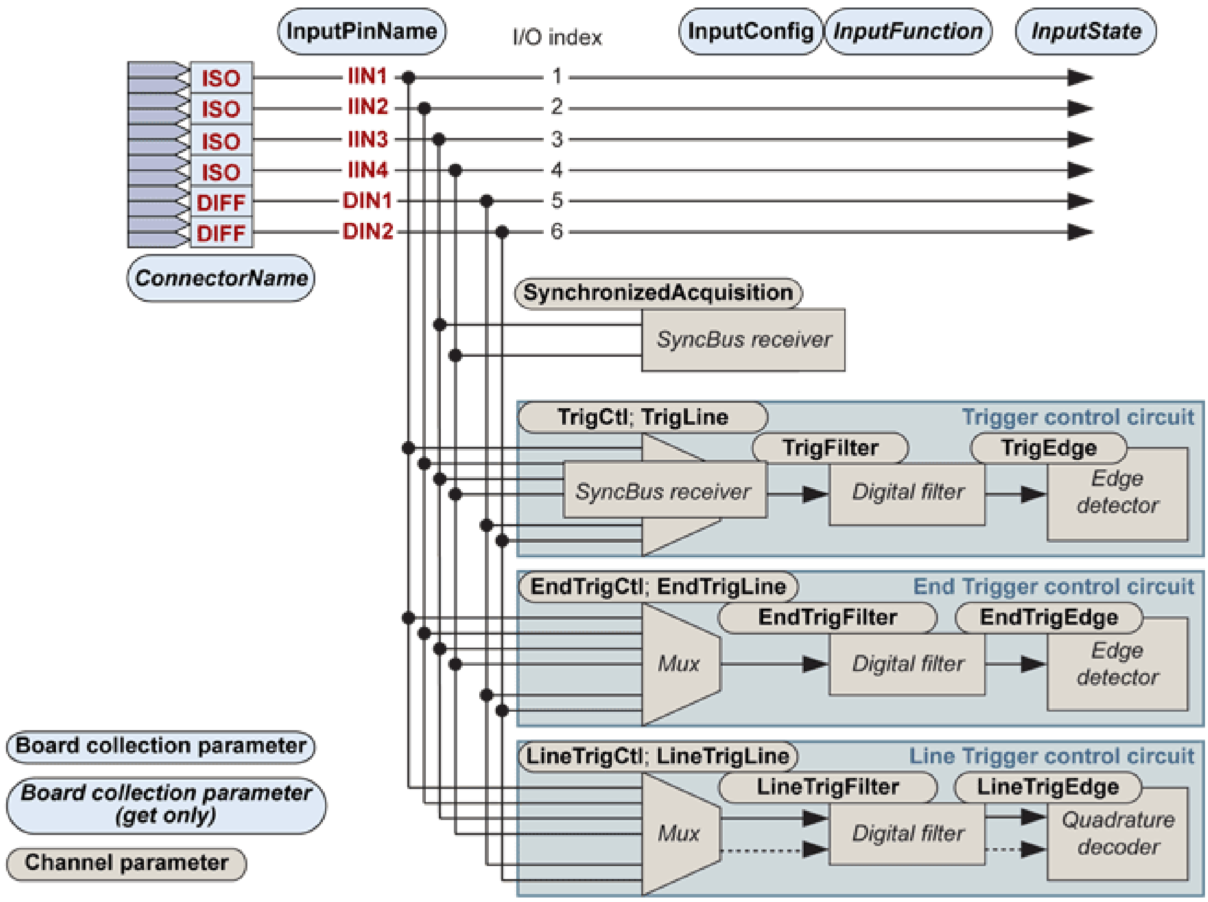
Applies to: Base DualBase Full FullXR

Every Channel owns a dedicated set of 10 system I/O ports including:

- 4 isolated input ports named IIN1, IIN2, IIN3, IIN4
- 2 high-speed differential input ports named DIN1, DIN2
- 4 isolated output ports named IOUT1, IOUT2, IOUT3, IOUT4

Input ports

Structure



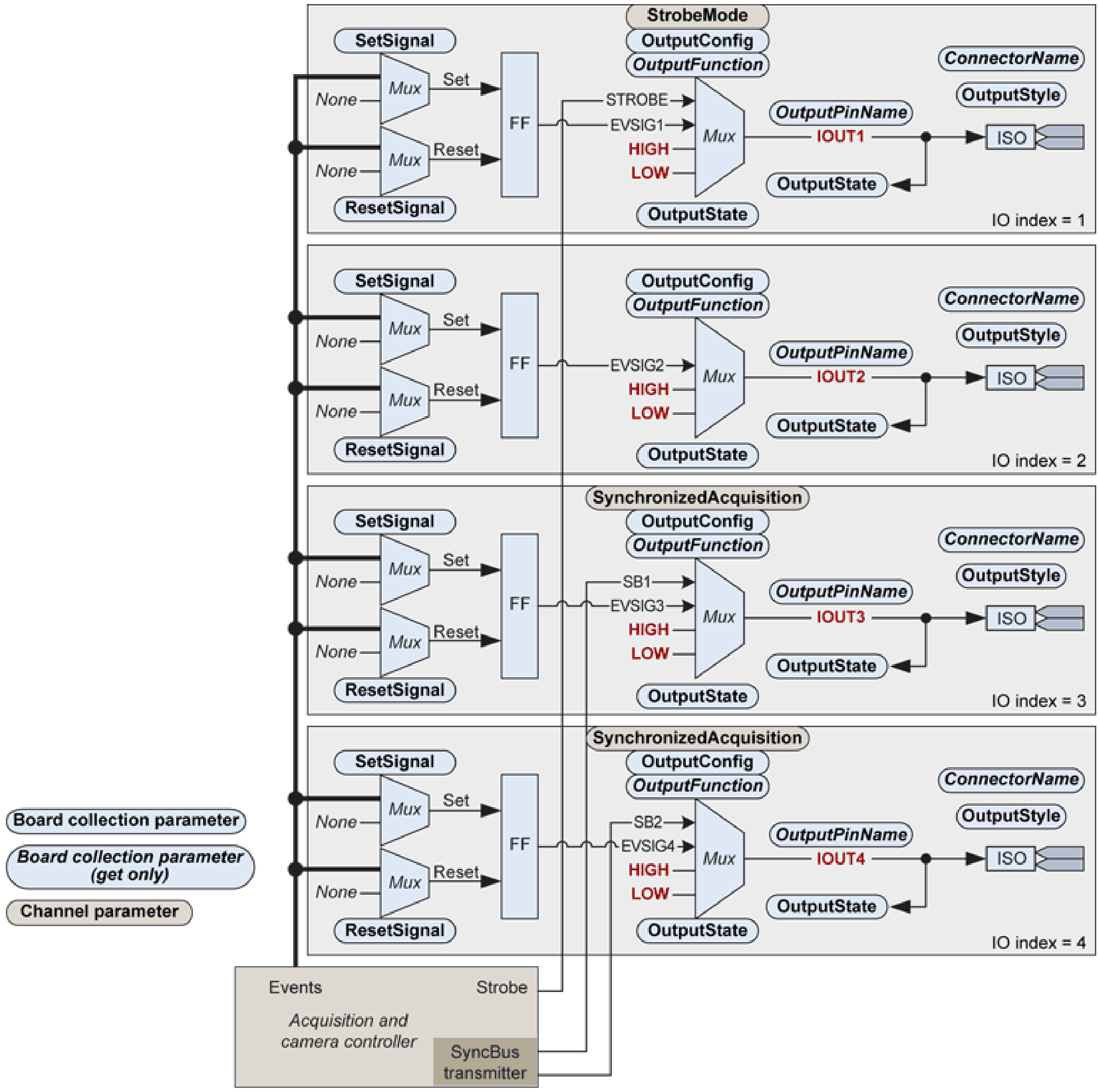
Functions

Input Function	DIN1	DIN2	IIN1	IIN2	IIN3	IIN4
"General-Purpose Inputs" on page 109	OK	OK	OK	OK	OK	OK
"Trigger Input" on page 111	OK	OK	OK	OK	OK	OK
"End Trigger Input" on page 112	OK	OK	OK	OK	OK	OK
"Line Trigger Input" on page 113	OK	OK	OK	OK	OK	OK
"Isolated I/O SyncBus Receiver" on page 116	-	-	-	-	OK	OK

NOTE
The input ports are individually designated by their I/O index. Refer to "I/O Indices Catalog" on page 119 for a list of I/O indices for each product.

Output Ports

Structure



Organic diagram of the output ports of a set of system I/O

The four output ports are based on a uniform structure that includes the following elements:

A programmable event signal generator composed with a set/reset flip-flop and a pair of configurable multiplexers that selects the set and the reset conditions from a panel of internal "events" issued by the acquisition and camera controller.

An output multiplexer that selects the signal to be issued on the output port. Possible selections are :

- "LOW" to connect any of the 4 output port to the logical level corresponding to the OFF state of the opto-coupler

- "HIGH" to connect any of the 4 output port logical level corresponding to the OFF state of the opto-coupler
- "EVSIGx" to connect any of the four output port to the signal issued by the respective event signal generator
- "STROBE" to connect the IOUT1 port to the signal produced by the acquisition and camera controller
- "SB1" to connect the IOUT3 port to the first of the two signals produced by the SyncBus transmitter of the acquisition and camera controller
- "SB2" to connect the IOUT4 port to the second of the two signals produced by the SyncBus transmitter of the acquisition and camera controller

- The ISO electrical interface built with an opto-coupler device.
- A readback circuit allowing getting at any time the actual logic state of the output multiplexer.

Functions

Output Function	IOUT1	IOUT2	IOUT3	IOUT4	LED	LED_A	LED_B
General-purpose output	OK	OK	OK	OK	-	-	-
Event signaling	OK	OK	OK	OK	-	-	-
Strobe output	OK	-	-	-	-	-	-
"Isolated I/O SyncBus Driver" on page 115	-	-	OK	OK	-	-	-
"Bracket LED Control" on page 118	-	-	-	-	OK	OK	OK

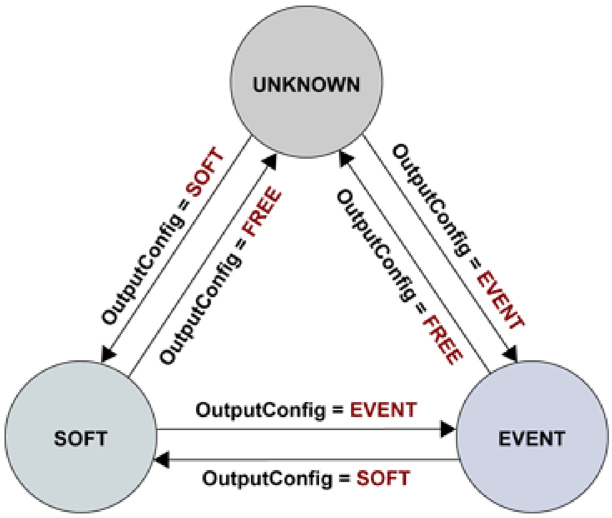
Selecting the output function

The output ports are primarily managed using Board class parameters belonging to the Input/Output Control Category:

OutputConfig is a set-only collection parameter that must be used by the application software to configure an output port for a particular usage.

OutputFunction is a get-only collection parameter that reports the actual function assigned to the output port designated.

The following state diagram shows the 3 states of OutputFunction and all the possible inter-state transition:



OutputFunction state diagram

The "UNKNOWN" state means that the function of the output port is not known by the MultiCam Board object. The output port is then free to be used by a MultiCam Channel for "Strobe Output" on page 114 or "Isolated I/O SyncBus Driver" on page 115 functions. Setting OutputConfig to FREE forces immediately OutputFunction to the value UNKNOWN. This is the default state after board startup.

The "SOFT" state means that the output port is directly under control of the application software for general-purpose usage. Setting OutputConfig to SOFT forces immediately OutputFunction to the value SOFT. The output port can be used by the MultiCam Board for "General-Purpose Output" on page 110 function.

The "EVENT" state means that the output port is driven by the respective event signal generator for the event signaling usage. Setting OutputConfig to EVENT forces immediately OutputFunction to the value EVENT. The output port can be used by the MultiCam Board for "Event Signaling" on page 117 function.

> NOTE
> The output ports are individually designated by their I/O index. Refer to "I/O Indices Catalog" on page 119 for a list of I/O indices for each product.

6.2. I/O Functions

General-Purpose Inputs

All the system I/O input port can be used as a general-purpose digital input port.

For that usage, use the MultiCam Board parameters belonging to the Input/Output Control Category.

Prior to the first attempt to get the state of an input port, it is mandatory to configure the port for that usage by assigning the value SOFT to the corresponding member of the collection parameter InputConfig.

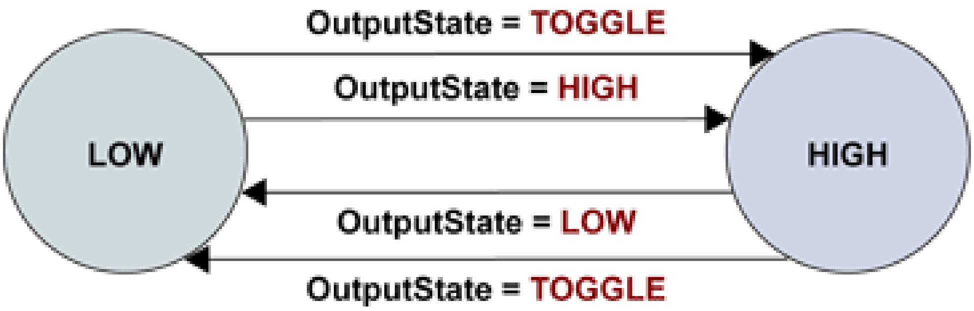
When configured for general-purpose input usage, the corresponding member of the get only InputFunction parameter reports the value SOFT.

The digital state of the input port can then be read at any time by getting the value of the corresponding member of the InputState parameter.

General-Purpose Output

When configured for general-purpose usage, the output multiplexer is restricted to two positions: LOW and HIGH .

The following state diagram shows the 2 states and all the possible inter-state transition:



Output multiplexer state diagram (OutputFunction = SOFT)

The position of the output multiplexer is controlled by means of OutputState, a Board class MultiCam parameter belonging to the Input/Output Control Category .

The "LOW" state means that the output multiplexer is in the "LOW" position. Setting OutputState to LOW forces immediately the output multiplexer to the "LOW state".

The "HIGH" state means that the output multiplexer is in the "HIGH" position. Setting OutputState to HIGH forces immediately the output multiplexer to the "HIGH state".

Setting OutputState to TOGGLE forces immediately the output multiplexer to change its position from LOW to HIGH, if it was at the LOW position or vice-versa.

Trigger Input

Applies to: Base DualBase Full FullXR

For applications using a hardware acquisition trigger, anyone of the system I/O input ports can be selected as the source for the trigger control circuit of the acquisition channel.

For that usage, use the parameters belonging to the Channel Trigger Control Category .

The trigger source signal can originate from the following type of devices:

- Through a single high-speed differential input port driven by an RS-422 compatible detector.
- Through a single isolated current-sense input port driven by a detector that is not RS-422 compliant.

The selection of the port is primarily based on the electrical style of the sensor device used as trigger source.

Possible ports assignments

Sourcing device type	Default port(s) assignment	Alternate port assignment(s)
RS-422 compatible detector	High-speed diff. input #2	High-speed diff. input #1
Other detectors	Isolated input #2	Isolated input #1 Isolated input #3 Isolated input #4

NOTE
The default port assignment for both electrical styles is different than the one of the line trigger (at least when a single signal is used).

See also: "Hardware Trigger" on page 126

End Trigger Input

Applies to: Base DualBase Full FullXR

For applications using a hardware acquisition end trigger, anyone of the system I/O input ports can be selected as the source for the end trigger control circuit of the acquisition channel.

For that usage, use the parameters belonging to the Trigger Control Category .

The end trigger source signal can originate from the following type of devices:

- Through a single high-speed differential input port driven by an RS-422 compatible detector.
- Through a single isolated current-sense input port driven by a detector that is not RS-422 compliant.

The selection of the port is primarily based on the electrical style of the sensor device used as End Trigger source.

Possible ports assignments

Sourcing device type	Default port(s) assignment	Alternate port assignment(s)
RS-422 compatible detector	High-speed diff. input #2	High-speed diff. input #1
Other detectors	Isolated input #2	Isolated input #1 Isolated input #3 Isolated input #4

NOTE
Any input port and hence any electrical style can be specified for that function.

NOTE
The default port assignment is the same as the one for the trigger. This corresponds to the case where a single signal is used for both functions, one edge being the trigger, the opposite edge being the end trigger.

See also: "Hardware End Trigger" on page 133

Line Trigger Input

Applies to: Base DualBase Full FullXR

For line-scan applications using a hardware acquisition line trigger, anyone or some pairs of the system I/O input ports can be selected as the source(s) for the line trigger control circuit of the acquisition channel.

For that usage, use the parameters belonging to the Encoder Control Category .

The line trigger signal can be elaborated from one or two external signals provided by one of the following type of devices:

- Through one pair of high-speed differential input ports driven by an RS-422 compatible dual output phase quadrature incremental motion encoder.
- Through one pair of isolated current-sense input ports driven by a dual output phase quadrature incremental motion encoder that is not RS-422 compliant.
- Through a single high-speed differential input port driven by an RS-422 compatible single output incremental motion encoder or a similar device. This can be a dual output type of incremental motion encoder for which only one output signal is connected.
- Through a single isolated current-sense input port driven by an incremental motion encoder or a similar device that is not RS-422 compliant.

Possible ports assignments for each case

Sourcing device type	Default port(s) assignment	Alternate port assignment(s)
RS-422 compatible dual output phase quadrature incremental motion encoder	High-speed diff. inputs #1 and #2	-
Other dual output phase quadrature incremental motion encoder	Isolated input #1 and #2	Isolated input #3 and #4
RS-422 compatible single output incremental motion encoder or similar device	High-speed diff. input #1	High-speed diff. input #2
Single output incremental motion encoder or similar device	Isolated input #1	Isolated input #2 Isolated input #3 Isolated input #4

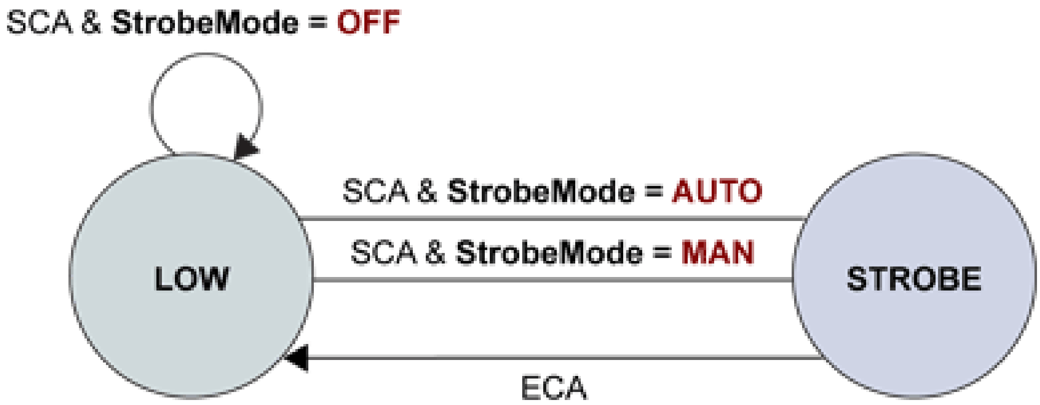
NOTE
Any input port and hence any electrical style can be specified for that function.

NOTE
The default port assignment for both single signal electrical styles is different of the one of the trigger.

See also: "Line Trigger" on page 153

Strobe Output

When the Board class OutputFunction parameter is UNKNOWN, the output multiplexer of IOUT1 is under control of the Channel class StrobeMode parameter.



Output multiplexer state diagram (OutputFunction = UNKNOWN)

The output multiplexer is reconfigured at channel activation (SCA event) and deactivation (ECA event) according to the value of StrobeMode:

- When StrobeMode = AUTO or MAN, the output multiplexer is configured as follows:
  - At channel activation, it is forced to the STROBE position, allowing the STROBE signal to drive the opto-coupler of the output port.
  - At channel deactivation, it is forced to the LOW position, turning off the opto-coupler and preventing any strobe pulses to occur while the channel is deactivated.
- When StrobeMode = OFF, the output multiplexer is configured at channel activation to the LOW position, turning off the opto-coupler and preventing any strobe pulses to occur during channel activity. The OFF state persists after channel deactivation.

When StrobeMode = NONE, the output multiplexer is left unchanged.

See also: "Strobe Control" on page 141

Isolated I/O SyncBus Driver

Applies to: Base DualBase Full FullXR

When the Board class OutputFunction parameter is UNKNOWN, the output multiplexer of IOUT3 and IOUT4 are under control of the Channel class SynchronizedAcquisition parameter.

The output multiplexer is reconfigured at channel activation (SCA event) according to the value of SynchronizedAcquisition :

- When SynchronizedAcquisition = MASTER or LOCAL_MASTER, it is forced to the SYNCBUS position, allowing the respective signal of the SyncBus transmitter to drive the output port.
- For other values of SynchronizedAcquisition, the output multiplexer is left unchanged.

At channel deactivation, the output multiplexer remains unchanged.

See also: "Synchronized Line-scan Acquisition" on page 164 and "Two-line Synchronized Line-scan Acquisition" on page 227

Isolated I/O SyncBus Receiver

Applies to: Base DualBase Full FullXR

For applications using the synchronized acquisition feature, IIN3 and IIN4 ports can be used for the SyncBus receiver. For that usage, use the SynchronizedAcquisition parameter.

See also: "Synchronized Line-scan Acquisition" on page 164 and "Two-line Synchronized Line-scan Acquisition" on page 227

Event Signaling

Applies to: Base DualBase Full FullXR

When the Board class OutputFunction parameter is set to EVENT, the output multiplexer selects the output of the event signal generator.

The event signal generator is configured by means of Board class SetSignal and ResetSignal parameters.

SetSignal is a collection parameter that configures the multiplexer on the set branch of the SR flip-flop.

ResetSignal is a collection parameter that configures the multiplexer on the reset branch of the SR flip-flop.

All the multiplexers of the event signal generator exhibit the same set of events sources.

- Start and end of : channel activity, acquisition phase, acquisition sequence
- Rising and falling edges of Camera Link downstream control signals: FVAL, LVAl, DVAL
- Rising and falling edges of Camera Link upstream control signals: CC1, CC2, CC3, CC4

In addition, the multiplexer can be set to the position NONE ensuring that no more event are considered.

NOTE
When the set and reset condition are identical, the SR flip/flop toggles at every event.

Bracket LED Control

Applies to: Base DualBase Full FullXR

The application can turn ON and OFF the bracket LED's to identify a card in a PC using the I/O control parameters OutputConfig and OutputState of the Board object with the following I/O indices:

Product	PinName	Index
Base	LED	25
DualBase	LED_A	27
	LED_B	28
Full	LED	25
FullXR	LED	25

6.3. I/O Indices Catalog

I/O indices for input lines Express

Index	ConnectorName	InputPinName	InputStyle
1	SYSTEM	Enhanced_I01	TTL
2	SYSTEM	Enhanced_I02	TTL
3	SYSTEM	Enhanced_I03	TTL
4	SYSTEM	Enhanced_I04	TTL
28	SYSTEM	ISOA1	ITTL, I12V
29	SYSTEM	ISOA2	TTL, I12V
17	SYSTEM	TRA1	LVDS
18	SYSTEM	TRA2	LVDS
21	CAMERA	LVAL	CHANNELLINK
22	CAMERA	FVAL	CHANNELLINK
23	CAMERA	DVAL	CHANNELLINK
24	CAMERA	SPARE	CHANNELLINK

I/O indices for output lines Express

Index	ConnectorName	OutputPinName	OutputStyle
1	SYSTEM	Enhanced_I01	TTL
2	SYSTEM	Enhanced_I02	TTL
3	SYSTEM	Enhanced_I03	TTL
4	SYSTEM	Enhanced_I04	TTL
28	SYSTEM	ISOA1	ITTL, IOC, IOE
29	SYSTEM	ISOA2	ITTL, IOC, IOE
17	SYSTEM	STA	OPTO
21	CAMERA	CC1	LVDS
22	CAMERA	CC2	LVDS
23	CAMERA	CC3	LVDS
24	CAMERA	CC4	LVDS
51	LED	RED	TTL
52	LED	GREEN	TTL

I/O indices for input lines Base

Index	ConnectorName	InputPinName	InputStyle
1	IO	IIN1	ISO
2	IO	IIN2	ISO
3	IO	IIN3	ISO
4	IO	IIN4	ISO
5	IO	DIN1	DIFF
6	IO	DIN2	DIFF
7	CAMERA	LVAL	CHANNELLINK
8	CAMERA	FVAL	CHANNELLINK
9	CAMERA	DVAL	CHANNELLINK
10	CAMERA	SPARE	CHANNELLINK
11	CAMERA	CK_PRESENT	CHANNELLINK
23	IO	POWER_5V	POWERSTATE5V
24	IO	POWER_12V	POWERSTATE12V

I/O indices for output lines Base

Index	ConnectorName	OutputPinName	OutputStyle
1	IO	IOUT1	ISO
2	IO	IOUT2	ISO
3	IO	IOUT3	ISO
4	IO	IOUT4	ISO
7	CAMERA	CC1	CHANNELLINK
8	CAMERA	CC2	CHANNELLINK
9	CAMERA	CC3	CHANNELLINK
10	CAMERA	CC4	CHANNELLINK
25	BRACKET	LED	NA

I/O indices for input lines DualBase

Index	ConnectorName	InputPinName	InputStyle
1	IO_A	IIN1	ISO
2	IO_A	IIN2	ISO
3	IO_A	IIN3	ISO
4	IO_A	IIN4	ISO
5	IO_A	DIN1	DIFF
6	IO_A	DIN2	DIFF
7	CAMERA_A	LVAL	CHANNELLINK
8	CAMERA_A	FVAL	CHANNELLINK
9	CAMERA_A	DVAL	CHANNELLINK
10	CAMERA_A	SPARE	CHANNELLINK
11	CAMERA_A	CK_PRESENT	CHANNELLINK
12	IO_B	IIN1	ISO
13	IO_B	IIN2	ISO
14	IO_B	IIN3	ISO
15	IO_B	IIN4	ISO
16	IO_B	DIN1	DIFF
17	IO_B	DIN2	DIFF
18	CAMERA_B	LVAL	CHANNELLINK
19	CAMERA_B	FVAL	CHANNELLINK
20	CAMERA_B	DVAL	CHANNELLINK
21	CAMERA_B	SPARE	CHANNELLINK
22	CAMERA_B	CK_PRESENT	CHANNELLINK
23	IO_A	POWER_5V	POWERSTATE5V
24	IO_A	POWER_12V	POWERSTATE12V
25	IO_B	POWER_5V	POWERSTATE5V
26	IO_B	POWER_12V	POWERSTATE12V

I/O indices for output lines DualBase

Index	ConnectorName	OutputPinName	OutputStyle
1	IO_A	IOUT1	ISO
2	IO_A	IOUT2	ISO
3	IO_A	IOUT3	ISO
4	IO_A	IOUT4	ISO
7	CAMERA_A	CC1	CHANNELLINK
8	CAMERA_A	CC2	CHANNELLINK
9	CAMERA_A	CC3	CHANNELLINK
10	CAMERA_A	CC4	CHANNELLINK
12	IO_B	IOUT1	ISO
13	IO_B	IOUT2	ISO
14	IO_B	IOUT3	ISO
15	IO_B	IOUT4	ISO
18	CAMERA_B	CC1	CHANNELLINK
19	CAMERA_B	CC2	CHANNELLINK
20	CAMERA_B	CC3	CHANNELLINK
21	CAMERA_B	CC4	CHANNELLINK
22	BRACKET	LED_A	NA
28	BRACKET	LED_B	NA

I/O indices for input lines Full FullXR

Index	ConnectorName	InputPinName	InputStyle
1	IO	IIN1	ISO
2	IO	IIN2	ISO
3	IO	IIN3	ISO
4	IO	IIN4	ISO
5	IO	DIN1	DIFF
6	IO	DIN2	DIFF
7	CAMERA	LVAL_X	CHANNELLINK
8	CAMERA	FVAL_X	CHANNELLINK
9	CAMERA	DVAL_X	CHANNELLINK
10	CAMERA	SPARE_X	CHANNELLINK
11	CAMERA	CK_PRESENT_X	CHANNELLINK
12	CAMERA	LVAL_Y	CHANNELLINK
13	CAMERA	FVAL_Y	CHANNELLINK
14	CAMERA	DVAL_Y	CHANNELLINK
15	CAMERA	SPARE_Y	CHANNELLINK
16	CAMERA	CK_PRESENT_Y	CHANNELLINK
17	CAMERA	LVAL_Z	CHANNELLINK
18	CAMERA	FVAL_Z	CHANNELLINK
19	CAMERA	DVAL_Z	CHANNELLINK
20	CAMERA	SPARE_Z	CHANNELLINK
21	CAMERA	CK_PRESENT_Z	CHANNELLINK
23	IO	POWER_5V	POWERSTATE5V
24	IO	POWER_12V	POWERSTATE12V

NOTE
The I/O indices 0 and 22 have no input-related function.

I/O indices for output lines Full FullXR

Index	ConnectorName	OutputPinName	OutputStyle
1	IO	IOUT1	ISO
2	IO	IOUT2	ISO
3	IO	IOUT3	ISO
4	IO	IOUT4	ISO
7	CAMERA	CC1	CHANNELLINK
8	CAMERA	CC2	CHANNELLINK
9	CAMERA	CC3	CHANNELLINK
10	CAMERA	CC4	CHANNELLINK
25	BRACKET	LED	NA

NOTE
The I/O indices 0, 5, 6, and {11 24} have no output-related function.

7. Triggers

7.1. Hardware Trigger

About hardware trigger event sources

When the frame grabber is configured for area-scan acquisition using the SNAPSHOT or the HFR acquisition modes, a (frame) trigger is an electrical signal sent by the external system to instruct the frame grabber to take control over the camera, including exposure control, and to perform a frame acquisition. This is usually used when an asynchronous capture of a moving object is involved. The trigger pulse is issued by a position sensor indicating when the observed object is adequately located in the field of view.

When the frame grabber is configured for line-scan acquisition using the WEB, PAGE or the LONGPAGE acquisition modes, a (page) trigger is an electrical signal sent by the external system to instruct the frame grabber to perform the acquisition of a set of several successive lines. This is usually used when a moving object is about to enter the field of view of the line-scan camera.

Each MultiCam channel elaborates a clean trigger event using a dedicated set of hardware resources including: source multiplexer, edge detector, noise filter, delay line and decimation filter.

The hardware trigger input function is available for a restricted set of AcquisitionMode, TrigMode and NextTrigMode acquisition control parameters. In the following table, a OK indicates that the hardware trigger input function is effectively used:

Initial Trigger Event	Subsequent Trigger Events				
TrigMode	NextTrigMode				
	HARD	SOFT	COMBINED	SAME	REPEAT
IMMEDIATE	OK	-	OK	-	-
HARD	OK	OK	OK	OK	OK
SOFT	OK	-	OK	-	-
COMBINED	OK	OK	OK	OK	OK

Preparing the Channel for hardware triggering

When hardware trigger is required, the following trigger control parameters need to be configured:

Parameter	Value range
TrigCtl	See "Source Selection and Electrical Style Control" on page 127
TrigEdge	GOHIGH, GOLOW See "Polarity Control" on page 129
TrigFilter	See "Filter Control" on page 130
TrigDelay_us	See "Delay Control" on page 131
PageDelay_Ln	
TrigLine	See "Source Selection and Electrical Style Control" on page 127

Parameter	Value range
TrigDelay_Pls	See "Decimation Control" on page 132
NextTrigDelay_Pls	

Source Selection and Electrical Style Control

Source Selection and Electrical Style Control

Applies to:

The trigger signal can originate from the following type of devices:

1. A TTL compatible detector attached to any of the four Enhanced I/O ports or any of the two Isolated I/O ports
2. A 12V CMOS compatible device attached to any of the two Isolated I/O ports
3. A LVDS or RS-422 compatible detector attached to any of the two differential input ports

Sourcing device type	TrigCtl	Input Port	TrigLine
TTL	TTL	Enhanced IO1	NOM or IO1
		Enhanced IO2	IO2
		Enhanced IO3	IO3
		Enhanced IO4	IO4
TTL and 12V CMOS	ITTL I12V	IsoA1	NOM or ISOA1
		IsoA2	ISOA2
LVDS or RS-422	LVDS	TRA1	NOM or TRA1
		TRA2	TRA2

To select a port:

1. Set the value of the TrigCtl parameter corresponding to the electrical style of the sensor device used as trigger source.
2. Optionally, set the value of the TrigLine parameter corresponding to the I/O port used to attach the trigger detector.

> NOTE
> The default value of TrigLine is NOM.

The hardware trigger input ports are available on the (External) System Connector and on the Internal System Connector

Source Selection and Electrical Style Control

Applies to: Base DualBase Full FullXR

The trigger signal can originate from the following type of devices:

1. An RS-422 compatible detector attached to any of the two high-speed differential input ports belonging to the channel or ...
2. ... another type of device attached to any of the 4 isolated current-sense input ports belonging to the channel.

Sourcing device type	TrigCtl	Input Port	TrigLine
RS-422	DIFF	Diff. Input #1	DIN1
		Diff. Input #2	NOM or DIN2
Other detectors	ISO	Isolated input #1	IIN1
		Isolated input #2	NOM or IIN2
		Isolated input #3	IIN3
		Isolated input #4	IIN4

To select a port:

1. Set the value of the TrigCtl parameter corresponding to the electrical style of the sensor device used as trigger source.
2. Optionally, set the value of the TrigLine parameter corresponding to the I/O port used to attach the trigger detector.

> NOTE
> The default value of TrigLine is NOM.

The hardware trigger input ports are available on Internal IO and External IO connectors:

Product	Camera	Connector(s)	Trigger Input Ports
Base	-	Internal I/O External I/O	DIN1, DIN2 IIN1, IIN2, IIN3, IIN4
DualBase	A	Channel A Internal I/O	DIN1A, DIN2A IIN1A, IIN2A, IIN3A, IIN4A
		External I/O	DIN1A, DIN2A IIN1A, IIN2A
DualBase	B	Channel B Internal I/O	DIN1B, DIN2B IIN1B, IIN2B, IIN3B, IIN4B

Product	Camera	Connector(s)	Trigger Input Ports
		External I/O	DIN1B, DIN2B IIN1B, IIN2B
Full FullXR	-	Internal I/O External I/O	DIN1, DIN2 IIN1, IIN2, IIN3, IIN4

Polarity Control

A trigger event is generated on a positive-going or a negative-going transition of the electrical signal.

To select the transition, set accordingly the value of the TrigEdge parameter:

TrigEdge	Description
GOHIGH	The trigger event is generated at each positive-going transition of the trigger line
GOLOW	The trigger event is generated at each negative-going transition of the trigger line

The default value for TrigEdge is GOHIGH.

Filter Control

The hardware signal flows through a digital filter that removes any pulse narrower than its time constant.

The filter strength is configurable in 3 steps by means of the TrigFilter parameter. Each step corresponds to a specific filter time constant.

TrigFilter	Time Constant
OFF	100 nanoseconds
ON or MEDIUM	500 nanoseconds
STRONG	2.5 microseconds (Default value)

TIP
To avoid unexpected loss of trigger events, check that the selected time constant is shorter than the trigger pulse width sent by the detector!

Product specific notes

Product	Description
Express	The value OFF is not allowed for isolated ports IsoA1 and IsoA2
Base DualBase Full FullXR	There is no digital filter for isolated inputs.

Delay Control

For area-scan cameras operated with the SNAPSHOT or the HFR acquisition modes, the hardware frame trigger signal can be delayed by a user-programmable time delay.

For (TDI) line-scan cameras operated with the PAGE or the LONGPAGE acquisition modes, the hardware page trigger signal can be delayed by a user-programmable number of captured lines.

The following table shows the respective control parameters, their value range and the default value:

AcquisitionMode	Parameter	Value Range	Default Value
SNAPSHOT or HFR	TrigDelay_us	0 to 2,000,000 (2 seconds)	0
PAGE or LONGPAGE	PageDelay_Ln	0 to 65,534 lines	0

NOTE
The "number of captured lines" is equal to the "number of camera cycles" when the frame grabber is configured to capture all lines. When the frame grabber performs "downweb resampling", the "number of captured lines" might be different than the "number of camera cycles".

NOTE
When the downweb line rate is linked to the web speed through an encoder, the delay expressed as a number of captured lines represents a fixed length on the web!

Decimation Control

Applies to: Base DualBase Full FullXR

The trigger decimation feature applies:

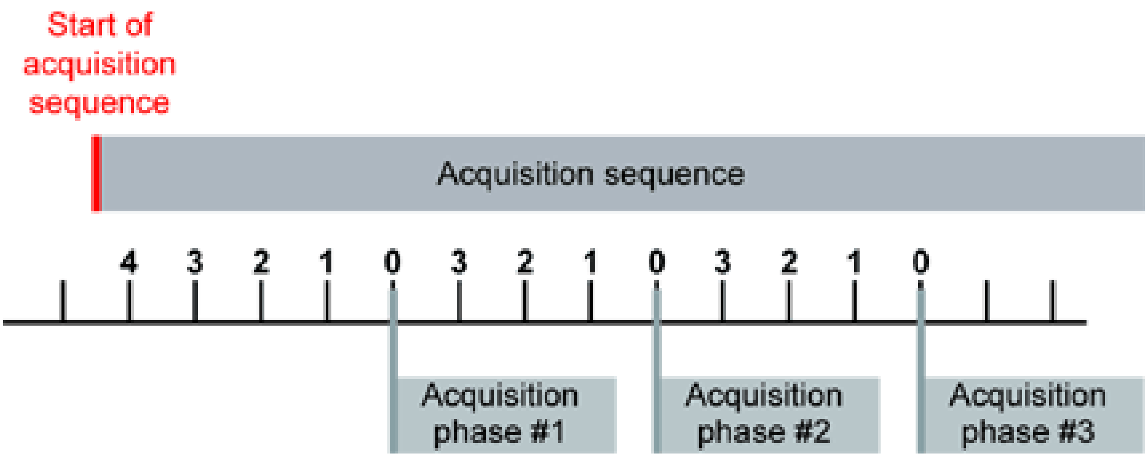
- when a hardware frame trigger source is selected for the area-scan SNAPSHOT or HFR acquisition modes.
- When a hardware page trigger source is selected for the (TDI) line-scan WEB, PAGE or LONGPAGE acquisition modes.

Trigger decimation discards a configurable number of trigger events after the start of acquisition sequence and after every start of acquisition phase.

TrigDelay_Pls specifies the number of detected pulses on the hardware trigger line to be skipped after the acquisition sequence begins.

NextTrigDelay_Pls specifies the number of detected pulses on the hardware trigger or page trigger line to be skipped between successive acquisition phases.

Parameter	Value Range	Default Value
TrigDelay_Pls	0 to 65,536 pulses	0
NextTrigDelay_Pls	0 to 65,536 pulses	0



Acquisition rate and trigger decimation, with TrigDelay_Pls = 4 and NextTrigDelay_Pls = 3

> WARNING
> NextTrigDelay_Pls is irrelevant for the LONGPAGE acquisition mode.

7.2. Hardware End Trigger

About End Trigger Input

When the frame grabber is configured for line-scan acquisition using the LONGPAGE acquisition mode, a end trigger is an electrical signal sent by the external system to instruct the frame grabber to stop the acquisition of a set of several successive lines.

Each MultiCam channel elaborates a clean end trigger event using a dedicated set of hardware resources including: source multiplexer, edge detector, noise filter and delay line.

The hardware end trigger input function is only available when EndTrigMode parameter is set to HARD.

Preparing the Channel for hardware triggering

When hardware trigger is required, the following trigger control parameters need to be configured:

Parameter	Value range
EndTrigCtl	See "Source Selection and Electrical Style Control " on page 134
EndTrigEdge	GOHIGH, GOLOW See "Polarity Control" on page 136
EndTrigFilter	See "Filter Control" on page 136
EndTrigEffect	FOLLOWINGLINE, PRECEDINGLINE See "Effect Control" on page 137
EndPageDelay_Ln	See "Delay Control" on page 138
EndTrigLine	See "Source Selection and Electrical Style Control " on page 134

Source Selection and Electrical Style Control

Source Selection and Electrical Style Control

Applies to:

The end trigger signal can originate from the following type of devices:

1. A TTL compatible detector attached to any of the four Enhanced I/O ports or any of the two Isolated I/O ports
2. A 12V CMOS compatible device attached to any of the two Isolated I/O ports
3. A LVDS or RS-422 compatible detector attached to any of the two differential input ports

Sourcing device type	EndTrigCtl	Input Port	EndTrigLine
TTL	TTL	Enhanced IO1	NOM or IO1
		Enhanced IO2	IO2
		Enhanced IO3	IO3
		Enhanced IO4	IO4
TTL and 12V CMOS	ITTL I12V	IsoA1	NOM or ISOA1
		IsoA2	ISOA2
LVDS or RS-422	LVDS	TRA1	NOM or TRA1
		TRA2	TRA2

To select a port:

1. Set the value of the EndTrigCtl parameter corresponding to the electrical style of the sensor device used as trigger source.
2. Optionally, set the value of the EndTrigLine parameter corresponding to the I/O port used to attach the trigger detector.

NOTE
The default value of EndTrigLine is NOM.

The hardware trigger input ports are available on the (External) System Connector and on the Internal System Connector

Source Selection and Electrical Style Control

Applies to: Base DualBase Full FullXR

The end trigger signal can originate from the following type of devices:

1. An RS-422 compatible detector attached to any of the two high-speed differential input ports belonging to the channel or ...
2. ... another type of device attached to any of the 4 isolated current-sense input ports belonging to the channel.

Sourcing device type	EndTrigCtl	Input Port	EndTrigLine
RS-422 compatible detector	DIFF	Diff. Input #2	NOM
		Diff. Input #1	DIN1
		Diff. Input #2	DIN2
Other detectors	ISO	Isolated input #2	NOM
		Isolated input #1	IIN1
		Isolated input #2	IIN2
		Isolated input #3	IIN3
		Isolated input #4	IIN4

To select a port:

1. Set the value of the EndTrigCtl parameter corresponding to the electrical style of the sensor device used as end trigger source.
2. Optionally, set the value of the EndTrigLine parameter corresponding to the I/O port used to attach the end trigger detector.

NOTE
The default value of EndTrigLine is NOM.

The hardware end trigger input ports are available on Internal IO and External IO connectors:

Product	Camera	Connector(s)	End Trigger Input Ports
Base	-	Internal I/O Connector External I/O Connector	DIN1, DIN2 IIN1, IIN2, IIN3, IIN4
DualBase	A	Channel A Internal I/O Connector	DIN1A, DIN2A IIN1A, IIN2A, IIN3A, IIN4A
		External I/O Connector	DIN1A, DIN2A IIN1A, IIN2A
DualBase	B	Channel B Internal I/O Connector	DIN1B, DIN2B IIN1B, IIN2B, IIN3B, IIN4B
		External I/O Connector	DIN1B, DIN2B

Product	Camera	Connector(s)	End Trigger Input Ports
			IIN1B, IIN2B
Full FullXR	-	Internal I/O Connector External I/O Connector	DIN1, DIN2 IIN1, IIN2, IIN3, IIN4

Polarity Control

A end trigger event is generated on a positive-going or a negative-going transition of the electrical signal.

To select the transition, set accordingly the value of the EndTrigEdge parameter:

EndTrigEdge	Description
GOHIGH	The end trigger event is generated at each positive-going transition of the trigger line
GOLOW	The end trigger event is generated at each negative-going transition of the trigger line

The default value for EndTrigEdge is GOLOW.

Filter Control

Applies to: Base DualBase Full FullXR

The hardware signal issued from differential inputs only flows through a digital filter that removes any pulse narrower than its time constant.

The filter strength is configurable in 3 steps by means of the EndTrigFilter parameter. Each step corresponds to a specific filter time constant.

EndTrigFilter	Time Constant
OFF	100 nanoseconds
ON or MEDIUM	500 nanoseconds
STRONG	2.5 microseconds (Default value)

TIP

To avoid unexpected loss of end trigger events, check that the selected time constant is shorter than the end trigger pulse width sent by the detector!

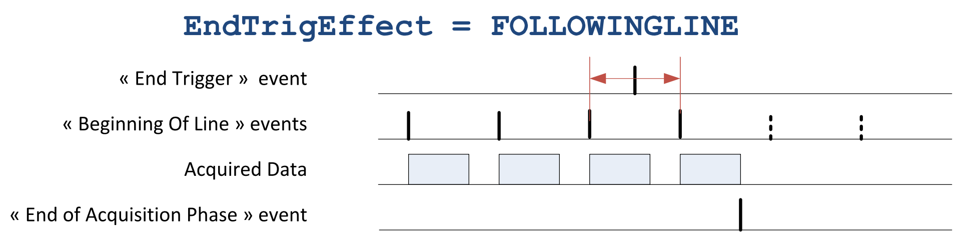
Product specific notes

Product	Description
Express	The value OFF is not allowed for isolated ports IsoA1 and IsoA2
Base DualBase Full FullXR	There is no digital filter for isolated inputs.

Effect Control

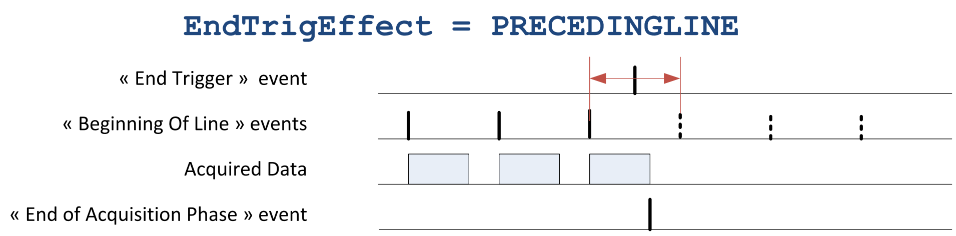
For (TDI) line-scan cameras operated with the LONGPAGE acquisition mode, two variants are selectable with the parameter EndTrigEffect:

- When EndTrigEffect=FOLLOWINGLINE, on reception of an "End Trigger" event, the MultiCam Acquisition Controller acquires the line following the "End Trigger" event then terminates the acquisition phase.



Terminates after the following line

- When EndTrigEffect=PRECEDINGLINE, on reception of an "End Trigger" event, the MultiCam Acquisition Controller acquires the line preceding the "End Trigger" event and terminates the acquisition phase immediately.



Terminates immediately

> NOTE
> The PRECEDINGLINE value is not allowed for Bayer bi-linear line-scan cameras.

Delay Control

For (TDI) line-scan cameras operated with the LONGPAGE acquisition mode, the hardware page end trigger signal can be delayed by a user-programmable number of captured lines.

The following table shows the control parameter, its value range and its default value:

AcquisitionMode	Parameter	Value Range	Default Value
LONGPAGE	EndPageDelay_Ln	0 to 65,534 lines	0

NOTE
The "number of captured lines" is equal to the "number of camera cycles" when the frame grabber is configured to capture all lines. When the frame grabber performs "downweb resampling", the "number of captured lines" might be different than the "number of camera cycles".

NOTE
When the downweb line rate is linked to the web speed through an encoder, the delay expressed as a number of captured lines represents a fixed length on the web.!

8. Exposure Control

Grabber-Controlled Exposure

This board supports the following grabber-controlled exposure class of cameras:

Imaging	CamConfig	Camera operation class
AREA	PxxRG	Asynchronous progressive scan, grabber-controlled exposure
LINE	LxxxxRG	Grabber-controlled line-scanning, grabber controlled exposure
LINE	LxxxxRG2	Grabber-controlled line-scanning, grabber controlled exposure, dual signal
LINE	LxxxxRP	Grabber-controlled line-scanning, permanent exposure
TDI	LxxxxRP	Grabber-controlled line-scanning, permanent exposure

If the camera belongs to the grabber-controlled exposure class, you can specify the desired exposure time through parameters Expose_us and optionally ExposeTrim. This board provides an exposure time range of 1 µs up to 5 s.

The lower limit of the exposure time range is defined by the camera parameter ExposeMin_us. The upper limit of usable exposure time range is defined by the camera parameter ExposeMax_us.

> NOTE
> Both parameters prevent using the camera outside the permitted range.

The grabber controls the exposure time through the reset line and optionally —in case of LxxxxRG2 operation mode— through the auxiliary reset line.

Any of the four Camera Link upstream control line can be used for these purposes with independent polarity control. MultiCam selects automatically the exposure control line(s) according to the value of camera parameters CC1Usage, CC2Usage, CC3Usage and CC4Usage; it configures automatically the polarity according to camera parameters ResetEdge and AuxResetEdge.

Uncontrolled Exposure

This board supports the following grabber-controlled exposure class of cameras:

Imaging	CamConfig	Camera operation class
AREA	PxxSC	Synchronous progressive scan, camera-controlled exposure
	PxxRC	Asynchronous progressive scan, camera-controlled exposure
LINE	LxxxxSP	Free-running, permanent exposure
	LxxxxSC	Free-running, camera-controlled exposure
	LxxxxRC	Grabber-controlled line scanning, camera controlled exposure

If the camera belongs to the camera-controlled exposure class, you can specify the actual exposure time through parameter TrueExp_us. This board provides an exposure time range of 1 microsecond up to 20 s.

9. Strobe Control

Each MultiCam acquisition channel embeds one strobe controller capable of delivering one strobe signal.

Function Availability

The strobe function is only available for these camera operation modes:

Area-scan cameras (Imaging = AREA)

Short name	Camera operation class
PxxRC	Asynchronous progressive scan, camera-controlled exposure
PxxRG	Asynchronous progressive scan, grabber-controlled exposure

Line-scan cameras (Imaging = LINE)

Short name	Camera operation class
LxxxxRC	Grabber-controlled line scanning, camera controlled exposure
LxxxxRG	Grabber-controlled line-scanning, grabber controlled exposure
LxxxxRG2	Grabber-controlled line-scanning, grabber controlled exposure, dual signal
LxxxxRP	Grabber-controlled line-scanning, permanent exposure

TDI line-scan cameras (Imaging = TDI)

Short name	Camera operation class
LxxxxRP	Grabber-controlled line-scanning, permanent exposure

NOTE
The strobe function is inoperative for PxxSC, LxxxxSC, and LxxxxSP camera operation modes; therefore, the StrobeMode parameter is filtered in MultiCam Studio for these classes of cameras.

Mode Control

The main control parameter is StrobeMode:

StrobeMode	Description
NONE	The strobe function is disabled. No strobe line is allocated to the channel.
MAN	The strobe function is enabled with a manual timing control feature.
AUTO	The strobe function is enabled with an automatic timing control feature.
OFF	The designated strobe line is set to the inactive level; no more strobe pulses are issued.

The default and allowable values of are depending on the camera camera operation mode:

Camera operation modes	StrobeMode			
	NONE	MAN	AUTO	OFF
*Grabber-controlled rate and exposure*PxxRG, LxxxxRG, LxxxxRG2	OK	-	Default	OK
Grabber-controlled rate, permanent exposure LxxxxRP	OK	-	Default	OK
Grabber-controlled rate, camera controlled exposure PxxRC, LxxxxRC	OK	Default	-	OK

Duration and Position Controls

Parameter	Value Range	Default Value
StrobeDur	1 to 100	50
StrobePos	0 to 100	50

The strobe duration is configured as a percentage of the exposure time using the StrobeDur parameter.

The effective strobe pulsation is:

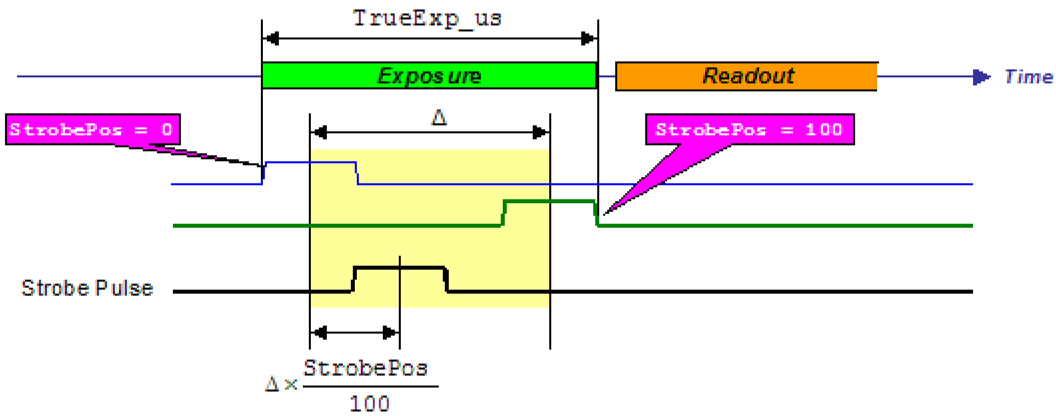
- Expose_us x StrobeDur when the exposure time is controlled by the frame grabber (RG and RP modes)
- TrueExp_us x StrobeDur when the exposure time is controlled by the camera (RC modes)

The strobe position is adjustable in 100 steps within the exposure time using the StrobePos parameter.

A value of 0 establishes the earliest position. The leading edge of the strobe pulse is simultaneous with the beginning of the exposure.

A value of 100 establishes the latest position. The trailing edge of the strobe pulse is simultaneous with the end of exposure.

A value of 50 % means that the strobe pulse is located in the middle of the exposure period.



Output Selection, Polarity and Electrical Style Controls

Applies to:

Output Line Type	StrobeCtl	StrobeLevel	Input Port	StrobeLine
Opto-isolated	OPTO	PLSLOW	STA	NOM or STA
TTL	TTL	PLSLOW or PLSHIGH	Enhanced IO1	IO1
			Enhanced IO2	NOM or IO2
			Enhanced IO3	IO3
			Enhanced IO4	IO4
Isolated TTL	ITTL		IsoA1	ISOA1
			IsoA2	NOM or ISOA2
Isolated open-collector	IOC		IsoA1	ISOA1
			IsoA2	NOM or ISOA2
Isolated open-emittor	IOE		IsoA1	ISOA1
			IsoA2	NOM or ISOA2

To select a strobe output port:

1. Set the value of the StrobeCtl parameter corresponding to the electrical style of the strobe light device.
2. Set the value of the StrobeLevelparameter corresponding to the desired signal polarity:
3. Optionally, set the value of the StrobeLine parameter corresponding to the I/O port used to attach the strobe light device.

> NOTE
> The default value of StrobeLine is NOM.

The strobe output ports are available on the System I/O Connector.

Output Selection and Electrical Style Control

Applies to: Base DualBase Full FullXR

These Grablink boards only have one dedicated strobe output line per camera.

The strobe output line is available on both the Internal IO and External IO connectors:

Product	Camera	Connector(s)	Pins name
Base	-	Internal I/O Connector External I/O Connector	IOUT1+/IOUT1-
DualBase	A	Channel A Internal I/O Connector External I/O Connector	IOUT1A+/IOUT1A-
DualBase	B	Channel B Internal I/O Connector External I/O Connector	IOUT1B+/IOUT1B-
Full FullXR	-	Internal I/O Connector External I/O Connector	IOUT1+/IOUT1-

The strobe line drives an optically-isolated pair of pins. The + pin is the collector and the - pin is the emitter of an uncommitted photo-transistor driven by LED-emitted light. The photo-transistor remains OFF during the board initialization.

There is no line selection control: the Strobeline parameter is not applicable.

There is no electrical style control. The StrobeCtl parameter is not applicable.

NOTE
The strobe being always enabled by default, the IOUT1 output port is configured by default as a strobe output and driven by the strobe controller. To disconnect the IOUT1 output port from the strobe generator, set StrobeMode to OFF.

10. Line-Scan Synchronization

10.1. Line Capture Modes

LineCaptureMode	Description
ALL	"Take-All-Line" line capture mode The board acquires all the lines delivered by the camera providing that the acquisition channel is active and the trigger conditions are satisfied. If the downweb motion speed is varying, the line-scanning process of the camera would be rate-controlled accordingly. This is the default line capture mode.
PICK	"Pick-A-Line" line capture mode Each pulse occurring at the downweb line rate determines the acquisition of the next line delivered by the camera providing that the acquisition channel is active and the trigger conditions are satisfied. This downweb resampling method allows the camera to be operated at a constant line rate while acquiring lines at a variable downweb line rate.
TAG	Tag-A-Line line capture mode The line-scanning process of the camera is running at a constant rate determined by Period_us. The down-web line rate is determined by the pulse rate of A/B signals delivered by an external encoder and processed by the quadrature decoder and the rate divider. The frame grabber captures all lines delivered by the camera after having replaced the first pixel data by a **tag** indicating that the line was preceded or not by an hardware event on the divider output.

When LineCaptureMode = ALL, the *Downweb Line Rate* and the *Camera Line Rate* are the same. The requested resolution and the effective motion speed uni-vocally dictate the *Downweb Line Rate*. Then the camera has to be chosen to operate at an exactly matching Camera Line Rate, even if the speed of motion is varying. This imposes a requirement for a rate-controllable camera.

Using *Downweb Resampling* offers a way to eliminate the requirement for this exact match. The *Camera Line Rate* may be chosen at a fixed value, and the acquisition will still acquire lines at the expected downweb resolution, even when the speed of motion is varying.

The *Tag-A-Line* line capture mode is used together with the two-line synchronized line-scan acquisition advanced feature. This feature enables a line-scan imaging application to acquire, in a single scanning operation, images from 2 (or more) Basler Sprint bi-linear Bayer CFA color line-scan cameras with 2 illumination devices turned on alternatively. The Tag-A-Line line capture mode eliminates the spatial aliasing artifacts in the downweb direction that occurs when using the *Take-All-Lines* method.

The relevant and the applicable values of LineCaptureMode depend on two prerequisites settings: Imaging, CamConfig.

See also: Refer to "Valid Line-Scan Synchronization Settings" on page 151 for a global view

10.2. Line Rate Modes

Line Rate Mode expresses how the *Downweb Line Rate* is determined in a line-scan acquisition system.

The user specifies the *Line Rate Mode* by means of MultiCam parameter LineRateMode. Five *Line Rate Modes* are identified in MultiCam:

LineRateMode	Description
CAMERA	**Camera** – The *Downweb Line Rate* is originated by the camera.
PULSE	**Trigger Pulse** – The *Downweb Line Rate* originates from a train of pulses applied on the line trigger input belonging to the grabber.
CONVERT	**Rate Converter** – The *Downweb Line Rate* originates from a train of pulses applied on the line trigger input and processed by a rate converter belonging to the grabber.
PERIOD	**Periodic** – The *Downweb Line Rate* originates from an internal periodic generator belonging to the grabber
EXPOSE	**Exposure Time** – The *Downweb Line Rate* is identical to the camera line rate and established by the exposure time settings

LineRateMode = CAMERA

This mode is applicable exclusively for free-run permanent exposure – LxxxxSP – class of line scan cameras when LineCaptureMode = ALL. The grabber does not perform any sampling in the downweb direction; the *Downweb Line Rate* is equal to the camera line rate. The camera line rate is entirely under control of the camera. Notice that most of the line scan cameras provide an internal line rate adjustment.

LineRateMode = PULSE

When the speed of motion is varying, the *Downweb Line Rate* should be slaved to this motion. To achieve this, a motion encoder is a good solution.
The motion encoder delivers an electrical pulse each time the moving web advances by a determined amount of length. The continuous motion results in a train of pulses the frequency of which is proportional to the web speed.
There exists another way to take knowledge of the web speed. In some applications, the motion is caused by a stepping motor controlled by pulses. The controlling train of pulses is also a measure of relative motion.
In both cases, the pulses are called line trigger pulses, and their repetition rate is the Line Trigger Rate. The line trigger pulses are applied to the frame grabber to determine the *Downweb Line Rate* .
Each line trigger pulse may result into the generation of one line in the acquired image. This means that the *Downweb Line Rate* is equal to the Trigger Rate.

LineRateMode = CONVERT

Alternatively to the "PULSE" mode, for more flexibility, the Line Trigger Rate may be scaled up or down to match the required *Downweb Line Rate*. The proportion between the two rates is freely programmable to any value lower or greater than unity, with high accuracy. This makes possible to accommodate a variety of mechanical setups, and still maintain a full control over the downweb resolution. The hardware device responsible for this rate conversion is called the rate converter. This device is a unique characteristic of Euresys line-scan frame grabbers.

LineRateMode = PERIOD

Other circumstances necessitate the *Downweb Line Rate* to be hardware-generated by a programmable timer, called the "periodic generator".

LineRateMode = EXPOSE

Applies to: Base DualBase Full FullXR

This mode is applicable exclusively for line rate controlled permanent exposure – LxxxxRP – class of line scan cameras when LineCaptureMode = ALL. The grabber does not perform any sampling in the downweb direction; the *Downweb Line Rate* is equal to the camera line rate. The camera line rate is entirely under control of the grabber through the exposure time settings.

This mode is the default and recommended mode for LxxxxRP class of cameras on **1621 Grablink Express**.

10.3. Valid Line-Scan Synchronization Settings

The following table shows the valid combinations of parameters values to setup a line-scan acquisition system:

Imaging	CamConfig	LineCaptureMode								
		ALL					PICK			TAG
		LineRateMode								
		CAMERA	PERIOD	PULSE	CONVERT	EXPOSE	PERIOD	PULSE	CONVERT	PERIOD
LINE	LxxxxSP	✓					✓	✓	✓	
	LxxxxRP			✓ (*)	✓ (*)	✓	✓	✓	✓	✓
	LxxxxSC	✓					✓	✓	✓	
	LxxxxRC		✓	✓	✓					
	LxxxxRG		✓	✓	✓					✓
	LxxxxRG2		✓	✓	✓					
TDI	LxxxxSP	✓					✓	✓	✓	
	LxxxxRP			✓ (*)	✓ (*)	✓	✓	✓	✓	

NOTE

(*) These settings are not recommended since the camera sensitivity is varying with the line rate.

10.4. Operating Limits

When LineCaptureMode is set to PICK or ALL, the downweb line rate may not exceed the maximum camera line rate.

$$\text{Maximum downweb line rate} = \text{Maximum effective camera line rate}$$

The maximum effective camera line rate is the highest line rate that the line-scan camera can achieve in the operating conditions. It can be evaluated using following formula:

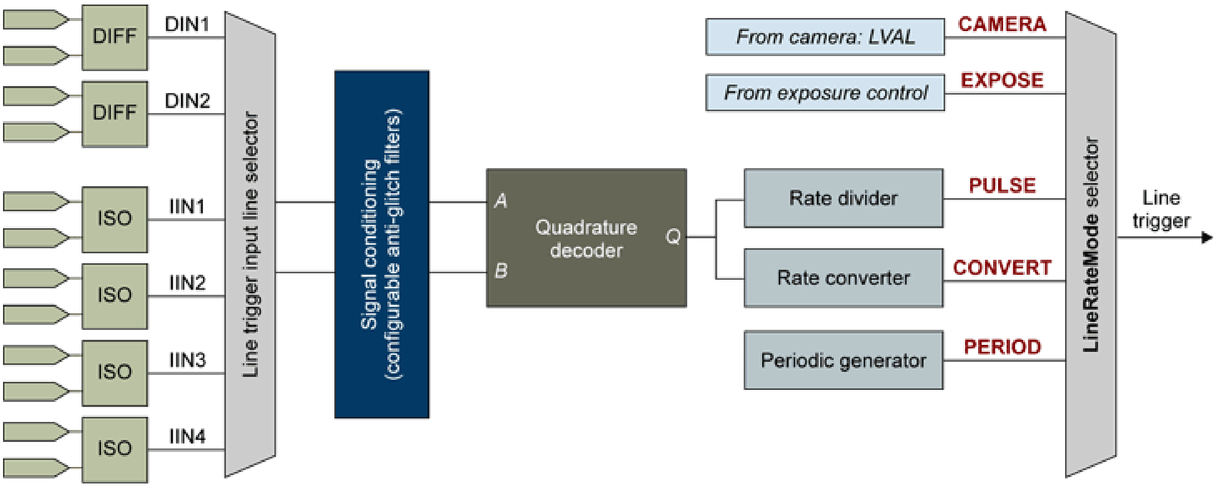
$$\text{Maximum effective camera line rate} = \text{Minimum}\left(\frac{1}{\text{Exposure time}} ; \frac{1}{\text{Readout time}}\right)$$

- For free-running operation modes: LxxxxSP and LxxxxSC, it is mandatory to set the LineRate_Hz parameter to a value equal to (or smaller than) the actual camera line rate.
- For grabber-controlled rate operation modes: LxxxxRP, LxxxxRC, LxxxxRG, and LxxxxRG2, it is mandatory to set the LineRate_Hz parameter to a value equal to (or smaller than) the maximum rate allowed by the camera.
- For grabber-controlled exposure operation modes: LxxxxRP, LxxxxRG, and LxxxxRG2, the exposure time is defined by means of exposure control parameters.
- For grabber-controlled rate and camera-controlled exposure operation mode: LxxxxRC, it is mandatory to set TrueExp_us to a value equal to (or higher than) the actual exposure time.

11. Line Trigger

11.1. Line Trigger Overview

The "line trigger" signal triggers the acquisition of one line of the image.



Block diagram

> NOTE
> The line trigger is available only for the line-scan acquisition modes of MultiCam, namely WEB, PAGE, and LONGPAGE. It is inoperative for the area-scan acquisition mode.

> NOTE
> The line trigger is effective within a MultiCam acquisition sequence. Any line trigger applied outside a MultiCam acquisition sequence is lost.

11.2. Source Path Selector

The line trigger has five possible source paths. The path is selectable by means of the MultiCam parameter LineRateMode:

- When LineRateMode is set to PULSE, the line trigger signal is generated by the quadrature decoder circuit through a 1/N rate divider.
- When LineRateMode is set to CONVERT, the line trigger signal is generated by the quadrature decoder circuit through a P/Q rate converter.
- When LineRateMode is set to PERIOD, the line trigger signal is generated by a periodic pulse generator.
- When LineRateMode is set to CAMERA, the line trigger is generated by the camera through the LVAL signal. The time interval between line triggers is actually driven by the camera.
- When LineRateMode is set to EXPOSE, the line trigger is generated by the exposure control circuit. The time interval between line triggers is actually driven by the exposure time.

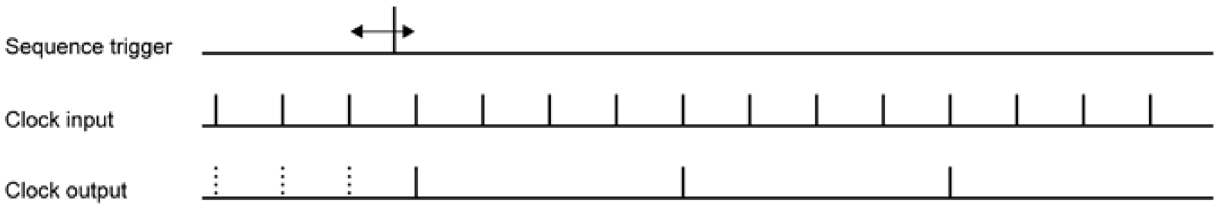
11.3. Rate Divider

The rate divider circuit generates a line trigger signal at a frequency that is an integer fraction 1/N of the frequency of the pulses delivered by the quadrature decoder circuit.

For N consecutive incoming pulses issued by the quadrature decoder circuit, the 1/N rate divider:

- generates one output pulse (one line trigger)
- skips N-1 input pulse

The rate divider is initialized at the beginning of every MultiCam acquisition sequence. The first output pulse is produced from the first clock input pulse occurring after the sequence trigger event.



Beginning of an acquisition sequence for a value N of 4

The division factor N is user-programmable. Possible values of N include all integer numbers ranging from 1 up to 512, the default value is 1.

N is configured by the MultiCam parameter RateDivisionFactor.

Notes

- The output frequency is lower than (N > 1) or equal to (N = 1) the input frequency. It cannot be higher.
- The output pulse is generated immediately after a non-skipped input pulse. The line trigger pulses are phase-locked to the quadrature decoder output.
- The rate divider settings may not be modified while acquisition is in progress.

11.4. Rate Converter

The rate converter circuit generates a line trigger signal at a frequency that is proportional to the frequency of the pulses delivered by the quadrature decoder circuit.

Rate conversion ratio

The rate converter is capable to multiply or divide the input rate of encoder ticks by any rational number ranging from 1/1000 up to 1000/1

The rate conversion ratio RCR is defined as the ratio between the output rate and the input rate:

RCR = EncoderPitch/LinePitch

The possible values of RCR range from 0.001 up to 1000.0. The recommended values range from 0.01 up to 1.

Operating range

The rate converter operates within in a limited range of frequencies:

- The upper limit of the output frequency range is user configurable with parameter MaxSpeed. By default, it is set to the maximum line rate sustainable by the camera defined by LineRate_Hz.
- The lower limit of the output frequency is automatically set by the driver and reported to the application via the MinSpeed parameter. The MaxSpeed/MinSpeed ratio is typically greater than 100.

When the input rate drops below MinSpeed, the rate converter behaves according to the OnMinSpeed setting:

- When set to MUTING, it stops delivering line trigger ticks.
- When set to IDLING, it continues delivering line trigger ticks at a constant frequency.

> **WARNING**
> To enlarge the usable speed range, it is mandatory to set MaxSpeed at a value slightly above the actual max camera line rate.

Notices

- The line trigger pulses are NOT phase-locked to the quadrature decoder output.
- The rate converter settings may not be modified while acquisition is in progress.

11.5. Periodic Generator

The periodic generator circuit generates a line trigger signal at a constant frequency.

The time interval T between two consecutive pulses is user programmable. Values of T range from 1 µs up to 5 seconds.

The period T is configured by Period_us and PeriodTrim.

11.6. Line Trigger Line Selection

When LineRateMode is PULSE or CONVERT, the line trigger signal originates from an external motion encoder device. In that case line trigger input port(s) must be selected.

The selection is performed in two steps:

- Determine the electrical style of the input port(s) and set LineTrigCtl accordingly. MultiCam selects the default input port(s) for the selected style.
- Optionally select one alternate choice for the input ports by setting the LineTrigLine parameter.

LineTrigCtl	Description	Targeted type of motion encoder device
DIFF	Single differential high-speed input port compatible with EIA/TIA-422 signaling	Single output RS-422 compatible incremental motion encoder
DIFF_PAIRED	Pair of differential high-speed input ports compatible with EIA/TIA-422 signaling. Default value.	Dual-output RS-422 compatible phase quadrature incremental motion encoder
ISO	Single isolated current loop input port compatible with TTL, +12V, + 24V signaling	Single output incremental motion encoder
ISO_PAIRED	Pair of isolated current loop input ports compatible with TTL, +12V, + 24V signaling	Dual-output phase quadrature incremental motion encoder

LineTrigCtl	Default port(s) assignment	Alternate port assignment(s)
DIFF	DIN1	DIN2
DIFF_PAIRED	DIN1 (A) + DIN2 (B)	-
ISO	IIN1	IIN2 IIN3 IIN4
ISO_PAIRED	IIN1 (A) + IIN2 (B)	IIN3 (A) + IIN4 (B)

Notes

- Dual output devices where only one output is connected are assimilated to single output devices.
- Any input port and hence any electrical style can be specified for that function.
- The default port assignment for both single signal electrical styles is different of the one of the trigger.

11.7. Signal Conditioning

Applies to: Base DualBase Full FullXR

The hardware Trigger and End Trigger signals issued from differential inputs are conditioned before being applied to the acquisition controller.

Each signal is sampled at a constant frequency of 50 MHz and flows through a digital filter.

With such a filter:

- All the pulses having a duration larger than T_{HIGH}[ns] are transmitted to the output.
- All the pulses having a duration smaller than T_{LOW}[ns] are blocked.
- Pulses having duration in between the above mentioned limits can be transmitted or blocked.

The following table shows for each possible value of the respective TrigFilter and EndTrigFilter parameters:

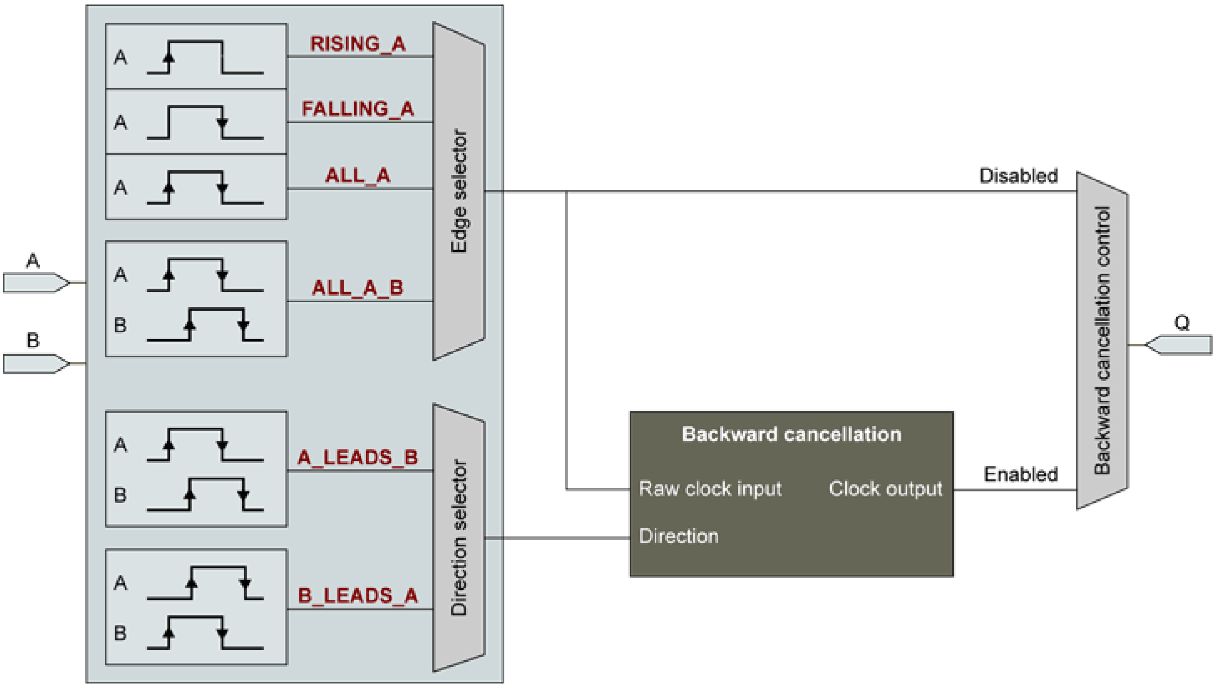
- T_{LOW}[ns]: the lower limit of the time constant
- T_{HIGH}[ns]: the upper limit of the time constant

TrigFilter EndTrigFilter	T_{LOW}[ns]	T_{HIGH}[ns]	Note
OFF	96	112	
ON	496	512	
MEDIUM	496	512	
STRONG	2496	2512	Default value

NOTE
TrigFilter and EndTrigFilter are not relevant for isolated inputs.

11.8. Quadrature Decoder

The quadrature decoder circuit interfaces directly with dual output phase quadrature incremental motion encoders. It decodes the encoder A and B signals and generates pulses on the Q output.



Quadrature decoder block diagram

Edge Selection

The rate of the output pulse can be 1, 2, or 4 times the frequency of the A signal according to the position of the edge selector.

- When the edge selector is in the rising A position, an output pulse is generated for every rising edge of the A signal. The falling edge on the A signal and both edges on the B-signal are ignored.
- When the edge selector is in the falling A position, an output pulse is generated for every falling edge of the A signal. The rising edge on the A signal and both edges on the B-signal are ignored.
- When the selector is in the All A position, an output pulse is generated for every rising and falling edges of the A signal. The B-signal is ignored.
- When the selector is in the All A B position, an output pulse is generated for every rising and falling edges of the A and B signals.

The edge selector is controlled by the enumerated MultiCam parameter LineTrigEdge.

Direction Selector

The motion direction is determined by the phase relationship of the A and B signals.

By construction, the dual-output phase quadrature incremental motion encoder maintains a phase relationship of about 90 degrees between the two signals. For motion in one direction, the A signal leads the B signal by about 90 degrees. For a motion in the other direction, the B signal leads the A signal by about 90 degrees.

The direction selector provides the capability to define which one of the phase relationships is considered as the forward direction for the application.

The default assignment identifies the case "A Leads B" as the forward direction.

Backward Motion Cancellation

The backward cancellation circuit stops sending line trigger pulses as soon as a backward motion is detected. If such an event occurs, the acquisition is stopped.

When the backward cancellation control is configured in the filter mode (F-Mode), the line acquisition resumes when the motion changes to the forward direction. Therefore, the cancellation circuit filters out all the pulses corresponding to the backward direction.

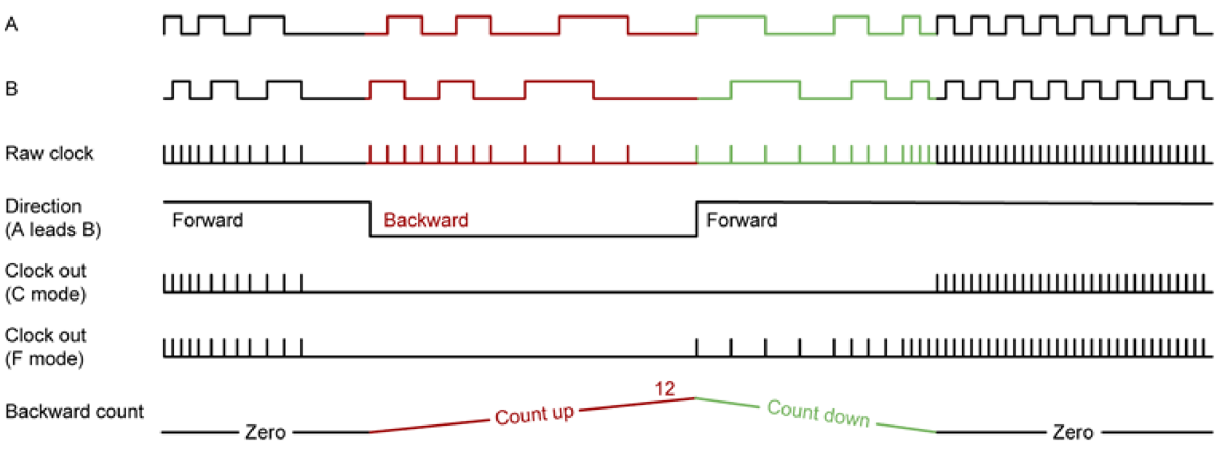
When the backward cancellation control is configured in the compensation mode (C-Mode), the line acquisition resumes when the motion changes to the the forward direction at the place it was interrupted. Therefore, the cancellation circuit filters out not only the pulses corresponding to the backward direction, but a number of forward pulses equal to the number of skipped backward pulses.

In C-Mode, the cancellation circuit uses a "backward pulse counter" that:

- Increments by 1 every clock in the backward direction
- Decrements by 1 every clock in the forward direction until it reaches 0
- Resets at the beginning of each MultiCam acquisition sequence. More precisely, at the first trigger event of the sequence. This trigger is considered as the reference for the position along the web for the whole acquisition sequence.

In C-Mode, all pulses occurring when the counter value is different of zero are blocked.

The counter has a 16-bit span, backward displacement up to 65535 pulses can be compensated.



The backward cancellation circuit operates exclusively with quadrature motion encoders when LineRateMode = PULSE.

The backward cancellation mode is configured by BackwardMotionCancellationMode.

12. Advanced Features

12.1. Synchronized Line-scan Acquisition

Applies to: Base DualBase Full FullXR

Introduction

The "Synchronized Line-scan Acquisition" feature synchronizes accurately two or more line-scan cameras using a **SyncBus**.

The SyncBus interconnects one **Master** MultiCam channel to one or more **Slave** MultiCam channel(s).

The SyncBus conveys two synchronization signals:

- a line trigger signal, that, typically, originates from the motion encoder attached to the **Master** MultiCam channel
- a start (and optionally end) of acquisition signal, that originates from the acquisition controller of the **Master** MultiCam channel.

The synchronization signals are propagated to all the camera and acquisition controllers of all the participating channels, including the master one.

The SyncBus interconnection is made using one of the following wiring schemes:

- "Internal SyncBus wiring" on page 164
- "C2C SyncBus wiring" on page 164
- "Isolated I/O SyncBus wiring" on page 165

Internal SyncBus wiring

Applies to: DualBase

In the specific case of a SyncBus linking only the 2 channels of a **1623 Grablink DualBase**, the SyncBus doesn't require any physical interconnect wiring; instead, it is routed locally inside the FPGA.

C2C SyncBus wiring

Applies to: Full FullXR

The SyncBus wiring interconnects the C2C SyncBus Connector of the **Master** channel to the C2C SyncBus Connector of one Slave channel using the 3305 C2C SyncBus cable or up to 3 Slave channels using the 3306 C2C Quad SyncBus Cable.

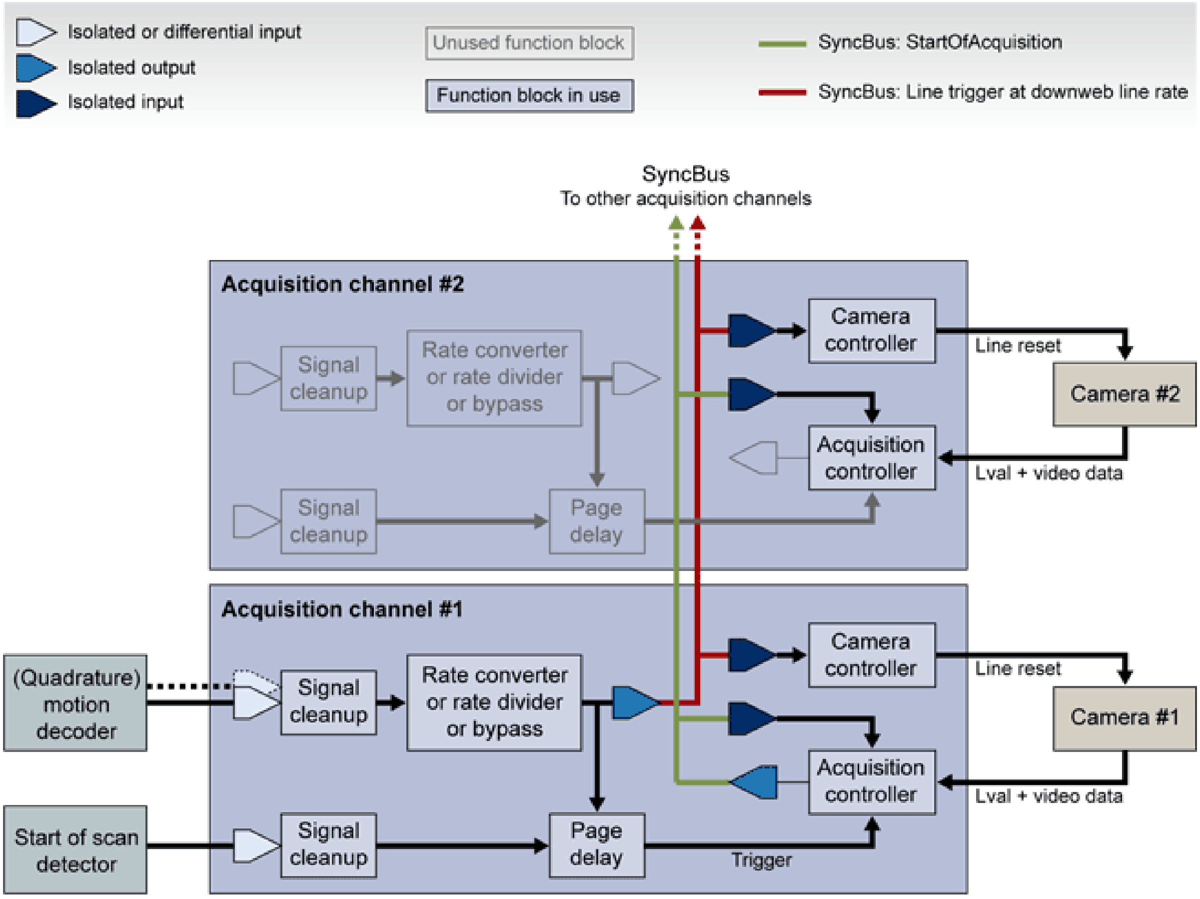
> NOTE
> This wiring scheme directly interconnects FPGA I/O’s allowing very accurate synchronization with the fastest line-scan cameras.
>
> This wiring scheme applies only to one pair of cards.

Isolated I/O SyncBus wiring

Applies to: Base DualBase Full FullXR

The SyncBus wiring interconnects the IOUT3/IOUT4 output ports of the **Master** channel to the IIN3/IIN4 input ports of all the participating channels.

> NOTE
> This wiring scheme restricts the camera line rate range to 40 kHz.



Synchronized acquisition using Isolated I/O SyncBus wiring

Requirements

For adequate synchronization, the line rate of the cameras must be controlled by the frame grabber. Synchronization acquisition is allowed exclusively for the following values of CamConfig: LxxxxRC, LxxxxRG, LxxxxRG2, and LxxxxRP.

The exposure settings of all cameras must be identical:

- For cameras having the exposure time controlled by the frame grabber, the value of Expose_us and ExposeTrim must be identical on all channels.
- When the exposure time is controlled by the camera, all cameras must be configured identically, and the value of TrueExp_us must be identical on all channels.

The line capture controller must be configured to take all lines: LineCaptureMode = ALL.

> NOTE
> The Pick-A-Line mode LineCaptureMode = PICK is not allowed.

Control Parameters

The SynchronizedAcquisition Channel parameter is the main control:

- when set to OFF (default value), the synchronized acquisition feature is disabled.
- when set to MASTER, LOCAL_MASTER, SLAVE or LOCAL_SLAVE, the synchronized acquisition feature is enabled.

To configure the synchronized acquisition and the participating channels, proceed as follows:

The SynchronizedAcquisitionBus Channel parameter provides an additional option to select the SyncBus wring:

- when set to ISO (default value), the SyncBus uses the Isolated I/O SyncBus wiring (or the internal SyncBus wiring of **1623 Grablink DualBase**).
- when set to C2C, the SyncBus uses the C2C SyncBus wiring avaialble only on On **1622 Grablink Full** and **1626 Grablink Full XR**.

Master channel setup procedure

1. Select a line-scan acquisition mode by setting the value WEB, PAGE or LONGPAGE to AcquisitionMode.
2. Set the value MASTER (or LOCAL_MASTER if local wiring can be used) to SynchronizedAcquisition.
3. Set the value C2C to SynchronizedAcquisitionBus if C2C SyncBus wiring is required or leave the ISO value
4. Configure remaining acquisition control parameters as for a stand-alone channel.
5. Configure the trigger control, and the encoder control parameters as for a stand-alone channel.
6. Configure the exposure control parameters.

Slave channel(s) setup procedure

1. Assign to AcquisitionMode the same value as on the master channel.
2. Set the value SLAVE (or LOCAL_SLAVE if internal SyncBus wiring can be used) to SynchronizedAcquisition.
3. Set the value C2C to SynchronizedAcquisitionBus if C2C SyncBus wiring is required or leave the ISO value
4. Configure the remaining acquisition control parameters as follows:
   a. TrigMode and NextTrigMode are automatically set by MultiCam to the appropriate values, they may not be modified.
   b. EndTrigMode must be set to SLAVE if it is configured to HARD on the master channel. Otherwise, it remains at its default value AUTO.
   c. BreakEffect, PageLength_Ln, SeqLength_Pg and SeqLength_Ln, when applicable, must be configured to the same values as on the master channel.
5. All the trigger control parameters are irrelevant and don't need to be configured.
6. The LineRateMode parameter is automatically set to SLAVE; the other parameters of the encoder control category are irrelevant.
7. Apply to exposure control parameters the same settings as the master channel.

12.2. Metadata Insertion

Applies to: Base DualBase Full FullXR

Introduction to Metadata Insertion

The metadata insertion feature inserts metadata in the Camera Link pixel data stream.

Requirements

Metadata insertion is available only with **1624 Grablink Base**, **1623 Grablink DualBase**, **1622 Grablink Full** and **1626 Grablink Full XR** for a subset of cameras.

The metadata insertion feature is NOT compatible with the following frame grabber pixel processing options:

- Look-up table transformation
- On-board Bayer CFA to RGB color conversion
- Pixel bit depth reduction

Capabilities

One, two or three fields of metadata are inserted in the Camera Link data stream according to the camera configuration. Refer to "Metadata Content" on page 172 for an detailed description.

Refer to "Metadata Fields" on page 174 for an extensive description of each field.

Refer to "Memory Layouts" on page 177 for an extensive description of the metadata layout in the captured images.

Refer to "Metadata Controls" on page 170 for an exhaustive list of control parameters.

Metadata Controls

Main control

The activation of the Metadata Insertion feature is controlled through the MultiCam Channel parameter MetadataInsertion.

By default, MetadataInsertion is set to DISABLE.

To activate the feature, set the parameter to ENABLE at channel creation. The setting takes effect at the next channel activation.

> NOTE
> An error is reported when setting to ENABLE if the camera interface configuration is not compatible.

Metadata location control

There are three distinct methods to insert metadata in the Camera Link pixel data stream according to the value of the MetadataLocation parameter: LVALRISE, TAP1 or TAP10.

- When set to LVALRISE, the image data conveyed during the first Camera Link time slot after an LVAL are replaced by metadata.
- When set to TAP1, the image data conveyed on the Camera Link port A (Tap 1) is replaced by metadata during the first 10 Camera Link Clock cycles of every line after the LVAL rising edge.
- When set to TAP10, the image data conveyed on the Camera Link port J (Tap 10) is replaced by metadata during the first 10 Camera Link Clock cycles of every line after the LVAL rising edge. For the other clock cycles, the frame grabber inserts bytes of '0'.

By default, MetadataLocation is set to LVALRISE. This value is always available.

The TAP1 option is applicable only to Medium 4-tap 8-bit line-scan and TDI line-scan cameras characterized by TapConfiguration = MEDIUM_4T8 and TapGeometry = 4X.

The TAP10 option is applicable only to 80-bit (10-tap 8-bit) line-scan and TDI line-scan cameras characterized by TapConfiguration = DECA_10T8 and TapGeometry = 1X10.

General Purpose Pulse Counter (GPPC) controls

Applies to: Full FullXR

The GPPC, a 32-bit binary counter, is available only on **1622 Grablink Full** and **1626 Grablink Full XR** when MetadataContent = THREE_FIELD.

The GPPC value is sampled at each rising edge of LVAL is reported in the GPPC metadata field.

Main control

The MetadataGPPCInputLine channel parameter is the main control of the GPPC:

- when set to NONE (default value), the GPPC is disabled,
- when set to IIN1, the GPPC counts the rising edge events of the electrical signal applied to the IIN1 isolated input line.

GPPC field location control

The MetadataGPPCLocation parameter controls the location of the GPPC field in the metadata:

- when set to NONE (default value), the GPPC metadata is not inserted into the Camera Link data stream.
- when set to INSTEAD_LVALCNT, the GPPC metadata replaces the LVAL Count metadata in the Camera Link data stream,
- when set to INSTEAD_QCNT, the GPPC metadata replaces the Q Count metadata in the Camera Link data stream,

GPPC reset control

The MetadataGPPCResetLine parameter controls the reset feature of the GPPC:

- when set to NONE (default value), the GPPC has no reset input line; the IIN4 input remains available for another purpose.
- when set to IIN4, the GPPC resets when a high-level is applied to the IIN4 isolated input line.

Metadata Content

The get-only MultiCam Channel parameter MetadataContent reports the number of distinct metadata fields in the metadata content.

MetadataContent	Description
NONE	There is no metadata content.
ONE_FIELD	The metadata content includes one single field: I/O State.
TWO_FIELD	The metadata content includes two fields: I/O State + LVAL Count
THREE_FIELD	The metadata content includes three fields.

When MetadataContent = THREE_FIELD, the composition of the metadata depends on the MetadataGPPCLocation control value:

MetadataGPPCLocation	Field 1	Field 2	Field 3
NONE	I/O State	LVAL Count	Q Count
INSTEAD_LVALCNT	I/O State	GPPC Count	Q Count
INSTEAD_QCNT	I/O State	LVAL Count	GPPC Count

NOTE
Refer to "Memory Layouts" on page 177 for the bit assignment and memory layout applicable to each configuration

Camera configurations providing 3 fields

Imaging	Tap Configuration	Tap Geometry	Metadata Location	Memory Layout
LINE or TDI	MEDIUM_4T8	4X	TAP1	"3-field 8-bit (TAP1)" on page 193
	DECA_10T8	1X10	TAP10	"3-field 8-bit (TAP10)" on page 195
			LVALRISE	"3-field 8-bit (LVALRISE)" on page 197
	DECA_8T10	1X8		"3-field 10-bit Packed" on page 199
	DECA_8T30B3	1X8		"3-field 30-bit Packed" on page 201
	DECA_2T40	1X2		"3-field 40-bit Packed" on page 203

Camera configurations providing 2 fields

Imaging	TapConfiguration	TapGeometry	Memory Layout
LINE or TDI	MEDIUM_6T8	1X3_1Y2	"2-field 8-bit " on page 190
	FULL_8T8	1X8	
	MEDIUM_2T24	1X2	"2-field 24-bit " on page 191

Camera configurations providing 1 field

Imaging	TapConfiguration	TapGeometry	Memory Layout
AREA, LINE or TDI	*T8	All but[1] 2XM*, 2XR*, 2X2M*, 4XR*, 8XR*	"1-field 8-bit " on page 178
	*T10		"1-field 10-bit " on page 179
	*T12		"1-field 12-bit " on page 180
	*T14		"1-field 14-bit " on page 181
	*T16		"1-field 16-bit " on page 182
AREA, LINE or TDI	*T24		"1-field 24-bit " on page 183
	*T30		"1-field 30-bit " on page 184
	*T36		"1-field 36-bit " on page 185
	*T42		"1-field 42-bit " on page 187
	*T48		"1-field 48-bit " on page 189

[1] Any tap geometry where the pixel order of the first region is not modified!

Metadata Fields

I/O State Field

The I/O State field is a 6-bit field reporting the logical state of all System I/O input lines belonging to the Channel.

The reported state is the logical state measured right at the input stage of the Grablink card.

> WARNING
> As the measurement takes place before any glitch removal filters, spurious state transitions may occur!

The state of System I/O input lines and the values of the counters are sampled at each rising edge of the Camera Link LVAL signal. The sampling time is not adjustable.

LVAL Count Field

The LVAL Count field is a 32-bit field reporting the current value of the LVAL pulse counter

LVAL pulse counter

The LVAL pulse counter is a 32-bit binary counter that counts the Camera Link LVAL pulses.

The counter is not resettable, it is set to 0 at driver initialization. As soon as the Camera Link de-serializers are initialized, it is incremented by 1 at every LVAL cycle whatever the acquisition conditions, i.e. whether the corresponding line data is acquired or not. It wraps around to 0 when it reaches the maximum count 4,294,967,295 (=2^{32} -1).

> NOTE
> The counter is incremented before its value is inserted as metadata: the first line cycle is marked 1.

GPPC Count Field

The GPPC Count field is a 32-bit field reporting the current value of the General Purpose Pulse Counter - GPPC.

General purpose pulse counter

The GGPC is a 32-bit binary counter.

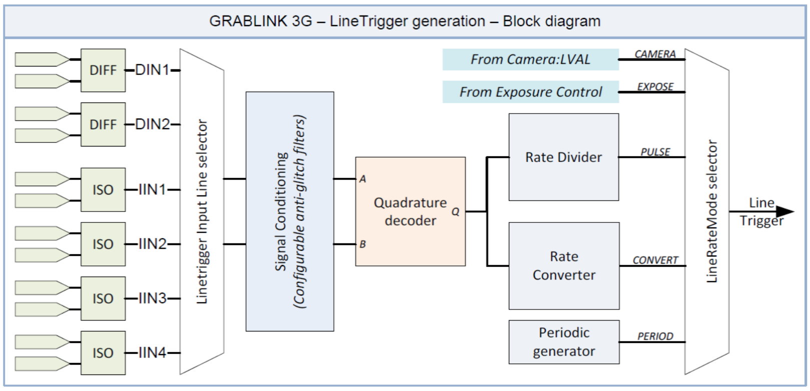
The counter is set to 0 at driver initialization and is incremented by 1 at every rising edge event detected on its input (IIN1). It wraps around to 0 when it reaches the maximum count 4,294,967,295 (=2^{32} -1).

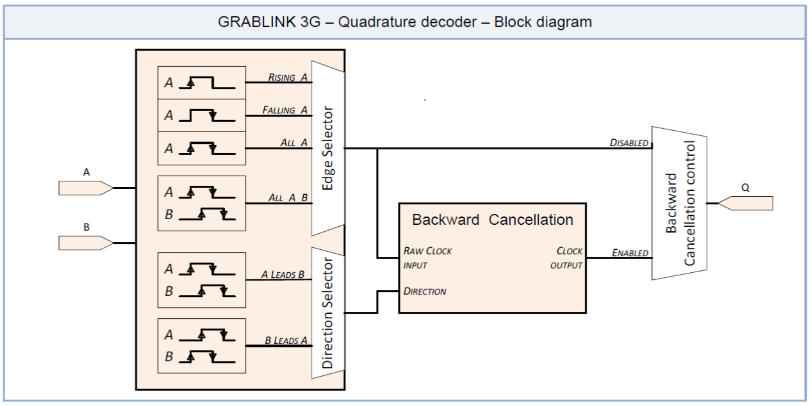
The counter has an optional reset input (IIN4). Applying a high level to the reset input, resets the count value to 0.

NOTE
The counter is incremented before its value is inserted as metadata: the first line cycle is marked 1.

Q Count Field

The Q Count Field is a 32-bit field reporting the current value of the Motion Encoder Q counter. This 32-bit binary counter counts the pulses at the Q output of the Quadrature Decoder:





> **NOTE**
> Depending on the Quadrature Decoder settings, the counter increments by 0, 1, 2, or 4 units every encoder cycle.

The counter is not resettable:

- It is set to 0 at driver initialization.
- It is incremented by 1 at every Q cycle.
- It wraps around to 0 when it reaches the maximum count 4,294,967,295 (=2^{32} -1).

Memory Layouts

Memory layouts of the metadata as delivered in the MultiCam surface

Introduction

This section provides one topic for each combination of number of metadata fields and pixel bit count.

Each topic provides memory layouts of metadata for applicable combinations of ColorFormat, MetadataLocation and ImageFlipX.

All image lines contain metadata. However, there are exceptions:

1. When TapGeometry is set to any *_1Y2 value, only one line out of two contains metadata.
2. When TapGeometry is set to any *_2YE value, only the lines belonging to the upper (when ImageFlipY = OFF) or the lower (when ImageFlipY = ON) half region contain metadata.

1-field 8-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 10-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y10 or BAYER10; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	IIN2	IIN1	0	0	0	0	0	0
1	0	0	0	0	DIN2	DIN1	IIN4	IIN3

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y10 or BAYER10; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	IIN2	IIN1	0	0	0	0	0	0
last	0	0	0	0	DIN2	DIN1	IIN4	IIN3

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 12-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y12 or BAYER12; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	IIN4	IIN3	IIN2	IIN1	0	0	0	0
1	0	0	0	0	0	0	DIN2	DIN1

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y12 or BAYER12; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	IIN4	IIN3	IIN2	IIN1	0	0	0	0
last	0	0	0	0	0	0	DIN2	DIN1

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 14-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y14 or BAYER14; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1	0	0
1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y14 or BAYER14; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1	0	0
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 16-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = Y16 or BAYER16; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 24-bit

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
G 0	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 2	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last - 1	0	0	0	0	0	0	0	0
last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
G last	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 30-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB30PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B 1	0	0	0	0	0	0	0	0
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	IIN2	IIN1	0	0	0	0	0	0
B 1	0	0	0	0	DIN2	DIN1	IIN4	IIN3
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

1-field 36-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB36PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B 1	0	0	0	0	0	0	0	0
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	IIN4	IIN3	IIN2	IIN1	0	0	0	0
B 1	0	0	0	0	0	0	DIN2	DIN1
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB36PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B last	0	0	0	0	0	0	0	0
G last - 1	0	0	0	0	0	0	0	0
G last	0	0	0	0	0	0	0	0
R last - 1	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last - 1	IIN4	IIN3	IIN2	IIN1	0	0	0	0
B last	0	0	0	0	0	0	DIN2	DIN1
G last - 1	0	0	0	0	0	0	0	0
G last	0	0	0	0	0	0	0	0
R last - 1	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 42-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB42PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B 1	0	0	0	0	0	0	0	0
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1	0	0
B 1	0	0	0	0	0	0	0	0
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB42PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B last	0	0	0	0	0	0	0	0
G last - 1	0	0	0	0	0	0	0	0
G last	0	0	0	0	0	0	0	0
R last - 1	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last - 1	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1	0	0
B last	0	0	0	0	0	0	0	0
G last - 1	0	0	0	0	0	0	0	0
G last	0	0	0	0	0	0	0	0
R last - 1	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

1-field 48-bit

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B 1	0	0	0	0	0	0	0	0
G 0	0	0	0	0	0	0	0	0
G 1	0	0	0	0	0	0	0	0
R 0	0	0	0	0	0	0	0	0
R 1	0	0	0	0	0	0	0	0

MetadataLocation = LVALRISE; MetadataContent = ONE_FIELD

ColorFormat = RGB48PL; ImageFlipX = ON

Plane Byte #	7	6	5	4	3	2	1	0
B last - 1	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
B last	0	0	0	0	0	0	0	0
G last - 1	0	0	0	0	0	0	0	0
G last	0	0	0	0	0	0	0	0
R last - 1	0	0	0	0	0	0	0	0
R last	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

2-field 8-bit

TapConfiguration = MEDIUM_6T8; TapGeometry = 1X3_1Y2

TapConfiguration = FULL_8T8; TapGeometry = 1X8

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0
2	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
3	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
4	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
5	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

TapConfiguration = MEDIUM_6T8; TapGeometry = 1X3_1Y2

TapConfiguration = FULL_8T8; TapGeometry = 1X8

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 5	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
last - 4	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
last - 3	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
last - 2	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
last - 1	0	0	0	0	0	0	0	0
last	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

2-field 24-bit

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0
2	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
3	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
4	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
5	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24PL; ImageFlipX = OFF

Plane Byte #	7	6	5	4	3	2	1	0
B 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
G 0	0	0	0	0	0	0	0	0
R 0	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
B 1	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
G 1	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
R 1	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 5	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
last - 4	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
last - 3	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
last - 2	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last - 1	0	0	0	0	0	0	0	0
last	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

TapConfiguration = MEDIUM_2T24; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataContent = TWO_FIELD

ColorFormat = RGB24PL; ImageFlipX = ON

	Plane Byte #	7	6	5	4	3	2	1	0
3	B last - 1	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
4	G last - 1	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
5	R last - 1	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
6	B last	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
7	G last	0	0	0	0	0	0	0	0
8	R last	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

3-field 8-bit (TAP1)

TapConfiguration = MEDIUM4_T8; TapGeometry = 4X

MetadataLocation = TAP1; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0
2	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
3	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
4	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
5	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE

- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

TapConfiguration = MEDIUM4_T8; TapGeometry = 4X

MetadataLocation = TAP1; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
last - 8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
last - 7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
last - 6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
last - 5	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
last - 4	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
last - 3	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
last - 2	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
last - 1	0	0	0	0	0	0	0	0
last - 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

NOTE

- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

3-field 8-bit (TAP10)

TapConfiguration = DECA_10T8; TapGeometry = 1X10

MetadataLocation = TAP10; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
9	0	0	0	0	0	0	0	0
19	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
29	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
39	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
49	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
59	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
69	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
79	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
89	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
99	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE

- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

TapConfiguration = DECA_10T8; TapGeometry = 1X10

MetadataLocation = TAP10; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 99	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
last - 89	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
last - 79	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
last - 69	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
last - 59	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
last - 49	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
last - 39	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
last - 29	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
last - 19	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
last - 9	0	0	0	0	0	0	0	0

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

NOTE
- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

3-field 8-bit (LVALRISE)

TapConfiguration = DECA_10T8; TapGeometry = 1X10

MetadataLocation = LVALRISE; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	0	0	0	0	0	0	0	0
2	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
3	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
4	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
5	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE

- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

TapConfiguration = DECA_10T8; TapGeometry = 1X10

MetadataLocation = LVALRISE; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y8 or BAYER8; ImageFlipX = ON

Byte #	7	6	5	4	3	2	1	0
last - 9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24
last - 8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
last - 7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
last - 6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
last - 5	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
last - 4	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
last - 3	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
last - 2	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
last - 1	0	0	0	0	0	0	0	0
last - 0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1

NOTE
last = address offset of the last byte of the rightmost active pixel of the line

NOTE
- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

3-field 10-bit Packed

TapConfiguration = DECA_8T10; TapGeometry = 1X8

MetadataLocation = LVALRISE; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = Y10P; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
2	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
3	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
4	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
5	0	0	0	0	0	0	0	0
6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE
ImageFlipX = ON is not available when ColorFormat = Y10P

NOTE
- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

After unpacking to 16-bit with justification to lsb

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1							QC1	QC0
2	QC9	QC8	QC7	QC6	QC5	QC4	QC3	QC2
3							QC11	QC10
4	QC19	QC18	QC17	QC16	QC15	QC14	QC13	QC12
5							QC21	QC20
6	QC29	QC28	QC27	QC26	QC25	QC24	QC23	QC22
7							QC31	QC30
8	0	0	0	0	0	0	0	0
9							LV1	LV0
10	LV9	LV8	LV7	LV6	LV5	LV4	LV3	LV2
11							LV11	LV10
12	LV19	LV18	LV17	LV16	LV15	LV14	LV13	LV12
13							LV21	LV20
14	LV29	LV28	LV27	LV26	LV25	LV24	LV23	LV22
15							LV31	LV30

3-field 30-bit Packed

TapConfiguration = DECA_8T30B3; TapGeometry = 1X8

MetadataLocation = LVALRISE; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = RGB30P; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
2	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
3	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
4	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
5	0	0	0	0	0	0	0	0
6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE
ImageFlipX = ON is not available when ColorFormat = RGB30P

NOTE

- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

After unpacking to 16-bit with justification to lsb

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1							QC1	QC0
2	QC9	QC8	QC7	QC6	QC5	QC4	QC3	QC2
3							QC11	QC10
4	QC19	QC18	QC17	QC16	QC15	QC14	QC13	QC12
5							QC21	QC20
6	QC29	QC28	QC27	QC26	QC25	QC24	QC23	QC22
7							QC31	QC30
8	0	0	0	0	0	0	0	0
9							LV1	LV0
10	LV9	LV8	LV7	LV6	LV5	LV4	LV3	LV2
11							LV11	LV10
12	LV19	LV18	LV17	LV16	LV15	LV14	LV13	LV12
13							LV21	LV20
14	LV29	LV28	LV27	LV26	LV25	LV24	LV23	LV22
15							LV31	LV30

3-field 40-bit Packed

TapConfiguration = DECA_2T40; TapGeometry = 1X2

MetadataLocation = LVALRISE; MetadataGPPCLocation = NONE

MetadataContent = THREE_FIELD

ColorFormat = RGBI40P; ImageFlipX = OFF

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1	QC7	QC6	QC5	QC4	QC3	QC2	QC1	QC0
2	QC15	QC14	QC13	QC12	QC11	QC10	QC9	QC8
3	QC23	QC22	QC21	QC20	QC19	QC18	QC17	QC16
4	QC31	QC30	QC29	QC28	QC27	QC26	QC25	QC24
5	0	0	0	0	0	0	0	0
6	LV7	LV6	LV5	LV4	LV3	LV2	LV1	LV0
7	LV15	LV14	LV13	LV12	LV11	LV10	LV9	LV8
8	LV23	LV22	LV21	LV20	LV19	LV18	LV17	LV16
9	LV31	LV30	LV29	LV28	LV27	LV26	LV25	LV24

NOTE
ImageFlipX = ON is not available when ColorFormat = RGBI40P

NOTE
- When MetadataGPPCLocation = INSTEAD_LVALCNT replace LV* by GPPC*
- When MetadataGPPCLocation = INSTEAD_QCNT replace QC* by GPPC*

After unpacking to 16-bit with justification to lsb

Byte #	7	6	5	4	3	2	1	0
0	0	0	DIN2	DIN1	IIN4	IIN3	IIN2	IIN1
1							QC1	QC0
2	QC9	QC8	QC7	QC6	QC5	QC4	QC3	QC2
3							QC11	QC10
4	QC19	QC18	QC17	QC16	QC15	QC14	QC13	QC12
5							QC21	QC20
6	QC29	QC28	QC27	QC26	QC25	QC24	QC23	QC22
7							QC31	QC30
8	0	0	0	0	0	0	0	0
9							LV1	LV0
10	LV9	LV8	LV7	LV6	LV5	LV4	LV3	LV2
11							LV11	LV10
12	LV19	LV18	LV17	LV16	LV15	LV14	LV13	LV12
13							LV21	LV20
14	LV29	LV28	LV27	LV26	LV25	LV24	LV23	LV22
15							LV31	LV30

12.3. Interleaved Acquisition

Applies to: Base DualBase Full FullXR

Image acquisition from grabber-controlled exposure asynchronous reset cameras driven alternatively by two different camera cycle programs

Introduction

When Interleaved Acquisition is enabled, the Camera and Illumination Controller is configured with two different programs named P1 and P2.

Each program defines entirely a *camera and illumination cycle* including:

- One Reset pulse controlling the start-of-exposure and the end-of-exposure of the camera.
- One Strobe pulse on any of the 2 strobe outputs.

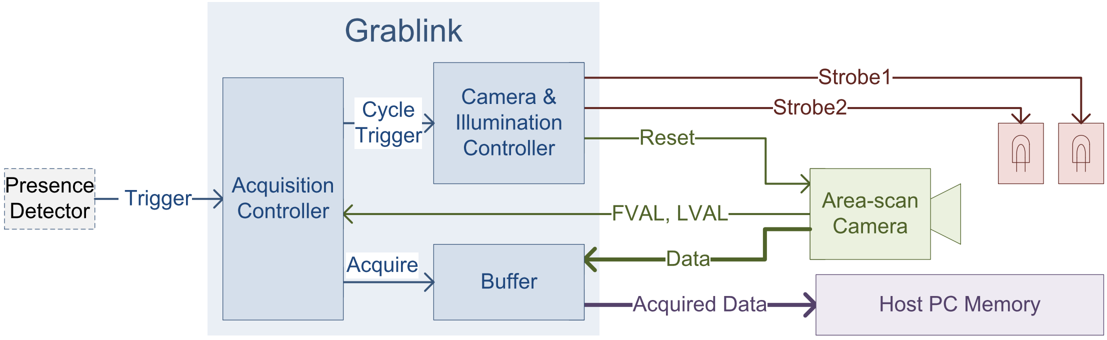
The programs are executed alternatively, starting with P1.

This feature is available for *line-scan cameras* since MultiCam 6.9.7. For more information, refer to "Interleaved Line-scan Acquisition Principles" on page 208.

This feature is available for *area-scan cameras* since MultiCam 6.13. For more information, refer to "Interleaved Area-scan Acquisition Principles" on page 206.

Interleaved Area-scan Acquisition Principles

System Description



Main elements of an area-scan acquisition system configured for Interleaved Area-scan Acquisition

The system is composed of:

- One asynchronous reset grabber-controlled exposure area-scan camera.
- One acquisition channel of a compatible Grablink frame grabber configured for Interleaved Area-scan acquisition.
- Two illumination devices, each being controlled by a specific strobe output of the frame grabber.

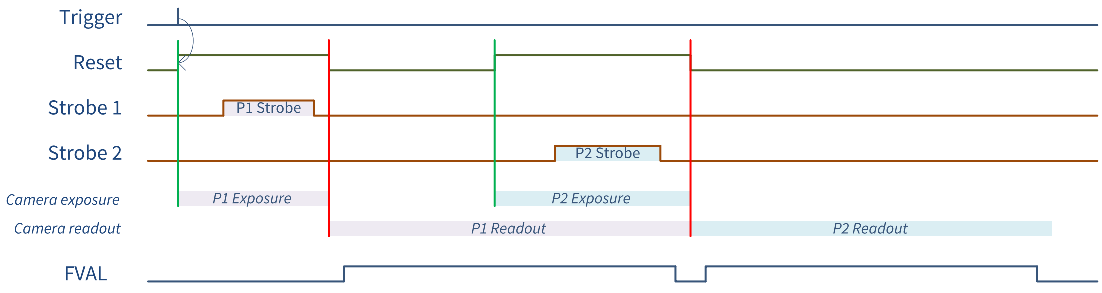
Usually, the Trigger event is delivered by a presence detector.

SNAPSHOT and HFR area-scan acquisition modes are compatible with Interleaved Area-scan Acquisition.

Operation

The Interleaved Acquisition feature allows to capture, with a time-optimized sequence of two camera cycles, two images with different exposure time, strobe duration, strobe delay and strobe output settings.

The first cycle of the sequence uses the settings defined by P1, the second cycle uses the settings defined by P2.



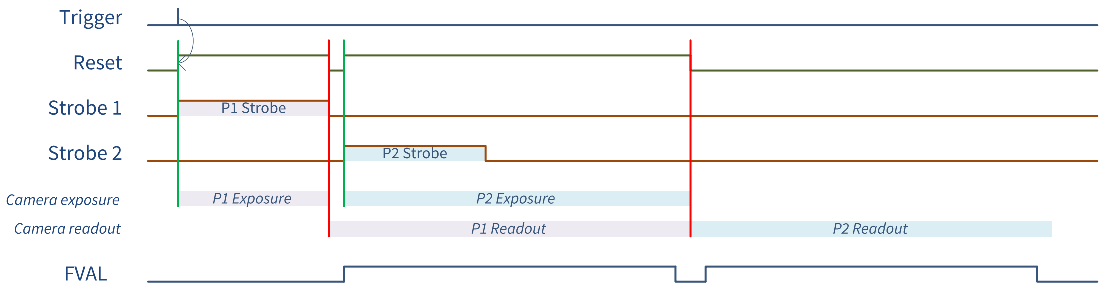
Acquisition sequence of two overlapping cycles (Exposure < Readout for P1 & P2)

The above sequence is time-optimized. Assuming that the exposure time is smaller than the readout time for both cycles:

- The exposure of the second cycle overlaps the readout of the first cycle.
- The exposure of the second cycle terminates exactly when the readout of the first cycle terminates.

Double Exposure Mode Emulation

The following drawing shows a particular Interleaved Area-scan Acquisition sequence of two overlapping cycles where the second exposure time matches the readout time:



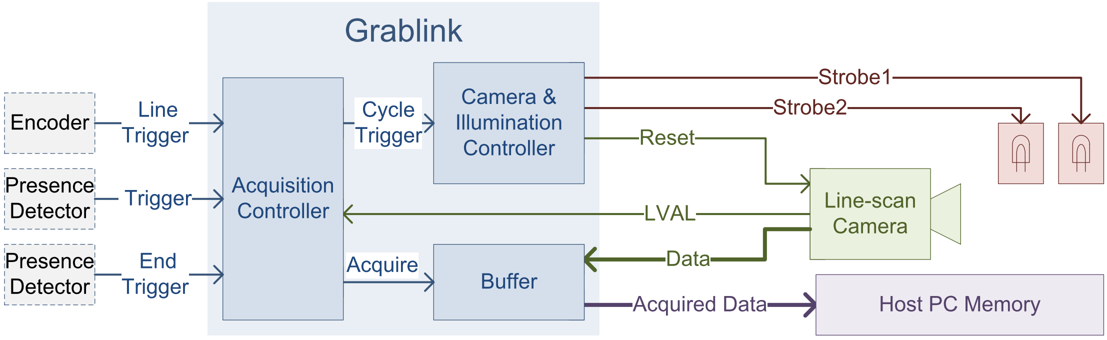
Acquisition sequence of two overlapping cycles (Exposure < Readout for P1; Exposure = Readout for P2)

The exposure time of the second cycle is increased to become equal to the readout time. This allows the second strobe to be issued immediately after the first strobe.

This emulates the *double exposure mode*.

Interleaved Line-scan Acquisition Principles

System Description



Main elements of an line-scan acquisition system configured for Interleaved Area-scan Acquisition

The system is composed of:

- One asynchronous reset grabber-controlled exposure line-scan camera.
- One acquisition channel of a compatible frame grabber configured for Interleaved Line-scan acquisition.
- Two illumination devices, each being controlled by a specific strobe output of the frame grabber.

Usually, the Line Trigger event is obtained by processing signals delivered by a motion encoder. As for any line-scan imaging systems, it can be processed by the rate converter or the rate divider.

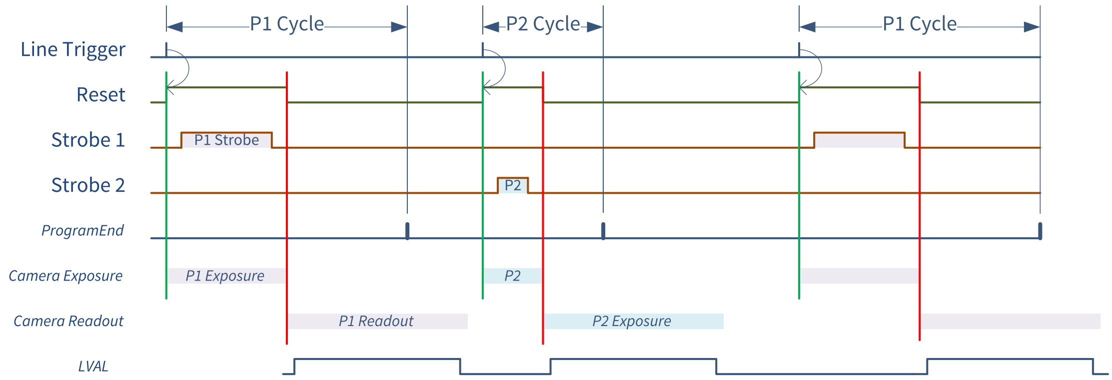
Usually, the Trigger and the End Trigger events are delivered by a presence detector.

WEB, PAGE and LONGPAGE line-scan acquisition modes are compatible with Interleaved Line Acquisition.

Operation

The Interleaved Acquisition feature allows to capture, in a single scanning operation, a composite image where the odd and even lines are captured with different exposure time, strobe duration, strobe delay and strobe output settings.

As shown on the following diagram, the Camera and Illumination Controller executes both programs alternatively: P1 then P2 then P1 ··· :



Acquisition sequence showing the alternating P1 and P2 cycles

> NOTE
> In this example, the line trigger interval is larger than the minimum allowed.

The toggling program sequence is reset at every start-of-scan to ensure that the first captured image line of a scanned object is always built using P1.

In WEB acquisition mode, a reset occurs only once at the beginning of the acquisition sequence.

In PAGE acquisition mode, a reset occurs at the beginning of every acquisition phase.

In LONGPAGE acquisition mode, a reset occurs at the beginning of the first acquisition phase of every acquisition sequence. No reset occurs at the beginning of the subsequent phases of the same sequence.

Reset and Strobe Signals Routing

The reset pulses of both programs are merged into a common Reset signal; the Reset signal can be sent to one or more of the 4 Camera Link Control lines CC1 ··· CC4.

The strobe pulse of each program can be routed individually to IOUT1, to IOUT2 or left unused.

When routed to the same output line, the two pulses are merged!

Interleaved Camera and Illumination Control

This section describes the operation of the Camera and Illumination Controller – CIC – when Interleaved Acquisition is enabled.

NOTE
This section applies to line-scan and area-scan interleaved acquisition.

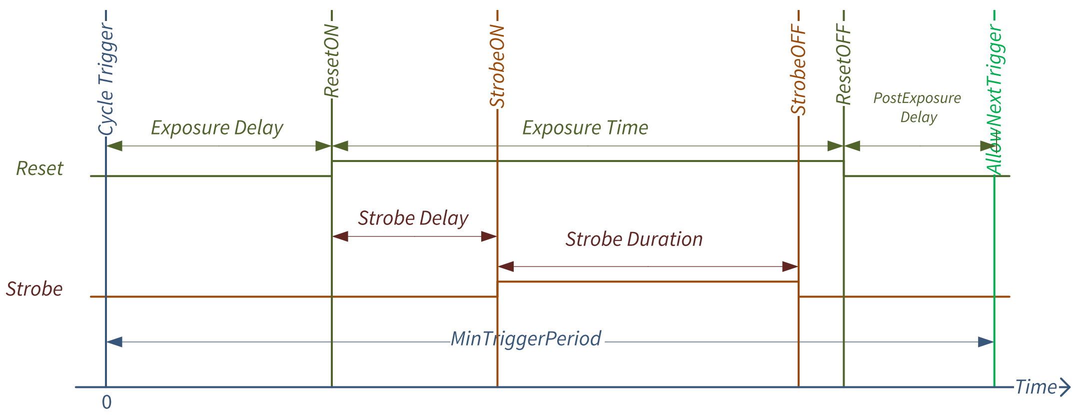
Cycle Trigger designates the event that initiates a CIC cycle: a Line Trigger event in case of line-scan cameras or a Trigger event in case of area-scan cameras.

CIC Cycle Programs

When Interleaved Acquisition is enabled, the Camera and Illumination Controller is configured with two, usually different, camera and illumination cycle programs. These programs are named P1 and P2 respectively.

Each camera and illumination cycle program defines five events on a timeline beginning with a Cycle Trigger event.

1. **ResetON:** turn ON time of the Reset pulse and Start of Exposure
2. **ResetOFF:** turn OFF time of the Reset pulse and End of Exposure
3. **StrobeON:** turn ON time of the Strobe pulse and Start Of Illumination
4. **StrobeOFF**: turn OFF time of the Strobe pulse and End Of Illumination
5. **AllowNextTrigger** : the last event of a program indicating that a new cycle may be initiated.



CIC Program Cycle events and timing definitions

Each program defines two pulses: one Reset pulse and one Strobe pulse. Their timing is user configurable:

- Exposure Time is the time interval between the ResetON and the ResetOFF events.
- Strobe Duration is the time interval between the StrobeON and the StrobeOFF events.
- Exposure Delay is the time interval between the Cycle Trigger and ResetON events.

- Strobe Delay is the time interval between the ResetON and StrobeON events. This value can be positive, null, or negative allowing the Strobe pulse to be positioned anywhere relatively to the start of exposure.

The following restrictions apply on the position order of the events on the timeline:

$$0 \leq ResetON < ResetOFF \leq AllowNextTrigger$$

$$0 \leq StrobeON < StrobeOFF \leq AllowNextTrigger$$

MultiCam Camera Trigger Overrun Protection Principle

At acquisition channel configuration time:

- MultiCam checks if the exposure time user setting can be achieved by the camera. If the user setting of the exposure time is out of bounds, MultiCam corrects its value. The effective exposure time will be set to the nearest boundary.
- MultiCam calculates the position on the timeline of the AllowNextTrigger event of P1 and P2 programs. This calculation takes into account the camera operating limits and the user-defined exposure and strobe timing settings for P1 and P2 programs.

At acquisition channel run time, MultiCam reports a "trigger violation" error if a Cycle Trigger event is issued before the AllowNextTrigger event during the execution of a program.

Camera Operating Limits

The following camera operating limits are considered:

- Exposure time range
- Minimum time interval between two consecutive Exposure
- Maximum line rate

In MultiCam, the following parameters describe the operating limits of a camera:

- ExposeMin_us: declares the minimum exposure time, expressed in microseconds (i.e. the minimum duration of a Reset pulse).
- ExposeMax_us: declares the maximum exposure time, expressed in microseconds (i.e. the maximum duration of a Reset pulse).
- ResetDur: for line-scan cameras only, declares the minimum time interval between two consecutives Reset pulses.
- ExposeRecovery_us: for area-scan cameras only, declares the minimum time interval between two consecutive Reset pulses.
- LineRate_Hz: for line-scan cameras only, declares the highest line rate supported by the camera (i.e. the reciprocal of the readout time)
- FrameRate_mHz: for area-scan cameras only, declares the highest frame rate supported by the camera (i.e. the reciprocal of the readout time)
- ExposeOverlap: declares that the camera allows or forbids the next exposure to begin before the completion of the current readout.

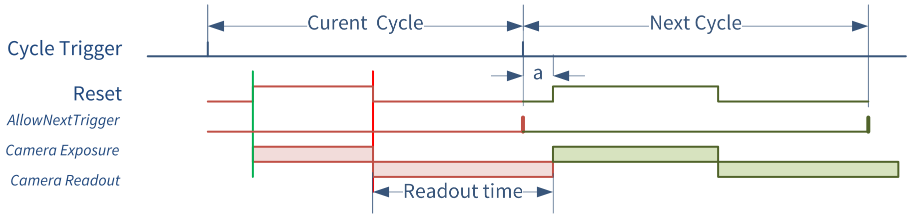
Allow Next Trigger Rules

MultiCam applies the following rules when it calculates the position of the *AllowNextTrigger* event.

RULE 1a – Readout time limitation (Expose Overlapping forbidden)

This rule applies only when ExposeOverlap = FORBID.

The start of exposure of the next cycle may not occur before the end of the current camera readout.

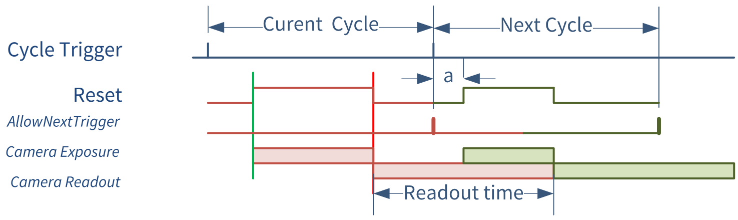


> **NOTE**
> If there is any exposure delay (a) in the next cycle, the AllowNextTrigger event may be generated earlier.

RULE 1b - Readout time limitation (Expose Overlapping allowed)

This rule applies only when ExposeOverlap = ALLOW.

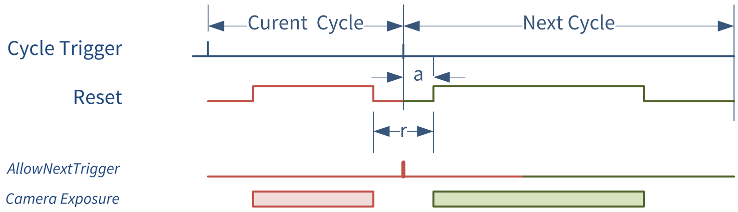
The end of exposure of the next cycle must not occur before the end of the current camera readout.



> **NOTE**
> If there is any exposure delay (a) in the next cycle, the AllowNextTrigger event may be generated earlier.

RULE 2 – Reset interval limitation

The time interval (r) between consecutive Reset pulses may not be shorter than the value specified by ResetDur.



NOTE
If there is any exposure delay (a) in the next cycle, the **AllowNextTrigger** event may be generated earlier.

RULE 3 – Next Cycle

NOTE
This rule applies only to line-scan interleaved acquisition!

The next cycle after P1 is undetermined, it can be either P2 or P1. The next cycle after P2 is always P1.

For the calculation of the position of the **AllowNextTrigger** event of P1, MultiCam evaluates both hypothesis (P1 and P2) and keeps the worst case.

For the calculation of the position of the **AllowNextTrigger** event of P2, MultiCam assumes that the next cycle is P1.

Exposure Delay

By default, MultiCam configures P1 and P2 with the smallest possible value:

- 0 when StrobeDelay_P<1,2>_us ≥ 0
- (-StrobeDelay_P<1,2>_us) when StrobeDelay_P<1,2>_us < 0

If required, the exposure delay can be configured using any of the following methods:

Exposure Delay - Manual Method

This method is invoked when ExposureDelayControl is set to MANUAL. This is the default method.

With this method, the user may specify the exposure delay for P1 and P2 with:

ExposureDelay_MAN_P1_us and ExposureDelay_MAN_P2_us.

By default, these parameters are set to 0.

MultiCam calculates the smallest possible value for each program separately as follows:

- ExposureDelay_MAN_P<1,2>_us whenStrobeDelay_P<1,2>_us ≥ (- ExposureDelay_MAN_P<1,2>_us)
- (-StrobeDelay_P<1,2>_us) when StrobeDelay_P<1,2>_us < (- ExposureDelay_MAN_P<1,2>_us)

Exposure Delay - Automatic method 1 (Same Start of Exposure)

Select this method by setting ExposureDelayControl to SAME_START_EXPOSURE. MultiCam calculates, the smallest value ensuring that the start of exposure occurs at the same position on the program timeline.

Exposure Delay - Automatic method 2 (Same Endof Exposure)

Select this method by setting ExposureDelayControl to SAME_END_EXPOSURE.

MultiCam calculates the smallest values ensuring that the end of exposure occurs at the same position on the program timeline.

Effective Exposure Time

The effective exposure time values are reported by ExposureTime_P1_Effective_us and ExposureTime_P2_Effective_us.

> NOTE
> In general, the effective values are very close to the user settings, the slight differences can be explained by rounding issues to the nearest timer tick period.

> NOTE
> Large differences can be observed in the case of an out-of-bound user setting.

Effective Strobe Duration and Strobe Delay

The effective strobe duration and strobe delay values are reported by StrobeDuration_P1_Effective_us, StrobeDuration_P2_Effective_us, StrobeDelay_P1_Effective_us and, StrobeDelay_P2_Effective_us.

NOTE
The effective values are, in any case, very close to the user settings, the slight differences can be explained by rounding issues to the nearest timer tick period.

Effective Exposure Delay

The effective exposure delay values are reported by ExposureDelay_P1_Effective_us and ExposureDelay_P2_Effective_us.

NOTE
When ExposureDelayControl = MANUAL, the effective values are very close to the user settings, the slight differences can be explained by rounding issues to the nearest timer tick period.

NOTE
Large differences can be observed in the case of negative strobe delay values.

Effective Minimum Trigger Period

The run time of each program is reported by MinTriggerPeriod_P1_us and MinTriggerPeriod_P2_us.

NOTE
The values can be different. Considering that programs are executed alternatively, the user should only consider the larger value as the minimum time interval between line triggers.

Interleaved Area-scan Acquisition Channel Setup

PxxRG_IA CAM File Template

```
;*******************************************************************************************
**
; Camera Manufacturer: Templates
; Camera Model: MyCameraLink
; Camera Configuration: Interleaved Area-Scan Acquisition, Asynchronous Reset, Grabber-
Controlled Exposure
; Board: Grablink

;*******************************************************************************************
**
; This CAM file template is suitable for the following camera configuration:
;   - Progressive area-scan camera
;   - Asynchronous Reset
;   - Pulse-Width grabber-controlled exposure
; This CAM file template is suitable for the following system configuration:
;   - SNAPSHOT and HFR Acquisition Modes
;   - Interleaved Acquisition
;
; ********************************************************************************
; ** CAUTION:                                                                   **
; ** This file is a template, it can be further customized!                     **
; ** The lines that can be edited are marked with an arrow followed by the most **
; ** popular alternate values for that parameter.                               **
; ** For a complete list of possible values; refer to MultiCam Studio and/or to **
; ** the MultiCam Reference documentation.                                      **
; ********************************************************************************
;

;*******************************************************************************************
**
; ==Begin of "Camera properties Section"==
;
; -Camera Specification category-
    Camera =            MyCameraLink;
    CamConfig =         PxxRG;
    Imaging =           AREA;
    Spectrum =          BW;                 <== BW COLOR ...
;
; -Camera Features category-
    TapConfiguration =  BASE_1T8;           <== BASE_1T8 BASE_1T10 BASE_1T24 ...
    TapGeometry =       1X_1Y;              <== 1X_1Y 1X2_1Y 2X_1Y ...
    Expose =            WIDTH;
    Readout =           INTCTL;
    ColorMethod =       NONE;               <== NONE PRISM BAYER RGB
    ColorRegistration = BG;                 <== GB BG RG GR (when ColorMethod=BAYER)
    ExposeOverlap =     FORBID;             <== FORBID ALLOW
;
; --Downstream signals--
    FvalMode =          FA;
    LvalMode =          LA;
    DvalMode =          DN;                 <== DN DG
;
; --Upstream signals--
    ResetCtl =          DIFF;
    ResetEdge =         GOHIGH;             <== GOHIGH GOLOW
    CC1Usage =          RESET;              <== LOW HIGH RESET SOFT DIN1 IIN1
    CC2Usage =          LOW;                <== LOW HIGH RESET SOFT DIN2
```

```
    CC3Usage =          LOW;                <== LOW HIGH RESET SOFT IIN1
    CC4Usage =          LOW;                <== LOW HIGH RESET SOFT
;
; -Camera Timing category-
    Hactive_Px =        640;                <==
    Vactive_Ln =        480;                <==
    HSyncAft_Tk =       0;                  <==
    VSyncAft_Ln =       0;                  <==
    FrameRate_mHz =     30000;              <==
    ExposeRecovery_us = 10;                 <==
    ReadoutRecovery_us = 10;                <==
    ExposeMin_us =      10;                 <==
    ExposeMax_us =      1000000;            <==
;
; ==End of "Camera properties Section"==

;****************************************************************************************************
**
; ==Begin of "System properties Section"==
;
; -Acquisition Control category-
    AcquisitionMode =   SNAPSHOT;           <== SNAPSHOT HFR
    TrigMode =          IMMEDIATE;          <== IMMEDIATE HARD SOFT COMBINED
    NextTrigMode =      SAME;               <== SAME HARD SOFT COMBINED REPEAT
    ActivityLength =    1;                  <== 1
    SeqLength_Fr =      2;                  <== -1 1..65534
    PhaseLength_Fr =    1;                  <== 1 (when AcquisitionMode = SNAPSHOT)
;                                           <== 1..255 (when AcquisitionMode = HFR)
;
; -Trigger Control category-
    TrigCtl =           ISO;                <== ISO DIFF ...
    TrigEdge =          GOHIGH;             <== GOHIGH GOLOW
    TrigFilter =        MEDIUM;             <== OFF ON MEDIUM STRONG
    TrigDelay_us =      0;                  <==
    TrigLine =          NOM;                <== NOM ...
;       The following 2 parameters are controlling the Trigger Decimation circuit:
    TrigDelay_Pls =     0;                  <== 0..65536
    NextTrigDelay_Pls = 0;                  <== 0..65536
;
; -Interleaved Acquisition category-
    InterleavedAcquisition =    ON;         <== Enable interleaved acquisition
;       Define the exposure time for P1 and P2 (= RESET signal pulse width)
    ExposureTime_P1_us =        7000.0;     <== Float (0.16 up to 5000000)
    ExposureTime_P2_us =        35000.0;    <== Float (0.16 up to 5000000)
;       Define the strobe duration for P1 and P2 (= STROBE1 and STROBE2 signals pulse width)
    StrobeDuration_P1_us =      7000.0;     <== Float (0.16 up to 5000000)
    StrobeDuration_P2_us =      10000.0;    <== Float (0.16 up to 5000000)
;       Define the strobe delay for P1 and P2 (relative time offset from RESET going ON to
STROBEx going ON)
;       The time offset can be positive, null or negative
    StrobeDelay_P1_us =         0.0;        <== Float (-10000 up to 5000000)
    StrobeDelay_P2_us =         0.0;        <== Float (-10000 up to 5000000)
;       Select the Exposure delay control method
    ExposureDelayControl =      MANUAL;     <== MANUAL SAME_END_EXPOSURE SAME_START_EXPOSURE
;       When ExposureDelayControl is MANUAL, select the minimum delay from the trigger
;       to the start of exposure (RESET signal going on)
    ExposureDelay_MAN_P1_us =   0;          <== Float (0 up to 5000000)
    ExposureDelay_MAN_P2_us =   0;          <== Float (0 up to 5000000)
    StrobeLine_P1 =             IOUT1;      <== IOUT1 IOUT2 NONE
    StrobeLine_P2 =             IOUT2;      <== IOUT1 IOUT2 NONE
    StrobeOutput_P1 =           ENABLE;     <== ENABLE DISABLE
    StrobeOutput_P2 =           ENABLE;     <== ENABLE DISABLE
;
; ==End of "System properties Section"==
```

```
;*****************************************************************************************
**
; ==Begin of "Grabber properties Section"==
;
; -Grabber Configuration, Timing & Conditioning categories-
    GrabWindow =         NOBLACK;            <== NOBLACK MAN
;       The following 4 parameters are relevant only when GrabWindow = MAN:
    WindowX_Px =         640;                <==
    WindowY_Ln =         480;                <==
    OffsetX_Px =         0;                  <==
    OffsetY_Ln =         0;                  <==
;       The following parameter configures the Bayer CFA Decoder:
    CFD_Mode =           ADVANCED;           <== ADVANCED, LEGACY
;
; -Look-Up Tables category-
;   LUT configuration parameters can be inserted here if required by the application
;
; -Cluster category-
    ColorFormat =        Y8;                 <== Y8 Y10 RGB24 RGB24PL ...
    ImageFlipX =         OFF;                <== OFF ON
    ImageFlipY =         OFF;                <== OFF ON
;
; End of "Grabber properties Section"

;*****************************************************************************************
**
; End of File
;=============
```

Customizing Camera Parameters

The following camera parameters must be set according to the selected camera model:

Spectrum, TapConfiguration, TapGeometry, ColorMethod, DvalMode, ResetEdge, CC1Usage, CC2Usage, CC3Usage, CC4Usage, Hactive_Px, Vactive_Ln , HSyncAft_Tk and, VSyncAft_Ln.

For correct operation of the camera trigger overrun protection mechanism it is mandatory to carefully set the following parameters: FrameRate_mHz, ExposeMin_us, ExposeMax_us and, ExposeRecovery_us.

Customizing Acquisition Control Parameters

AcquisitionMode can optionally be set to HFR.

In that case PhaseLength_Fr can be set to any value in 1 ··· 255 range.

The other parameters are not customizable.

Customizing Trigger Control Parameters

The following trigger parameters must be set according to the application needs: TrigCtl, TrigEdge, TrigFilter, TrigLine.

The trigger decimation circuit can optionally be activated using TrigDelay_Pls and NextTrigDelay_Pls.

Customizing Interleaved Acquisition parameters

Enable Interleaved Acquisition by assigning the value ON to InterleavedAcquisition.

Customizing Interleaved Acquisition – Exposure and Strobe Timing Parameters

When Interleaved Acquisition is enabled, the following exposure and strobe parameters are irrelevant:

Expose_us, ExposeTrim, StrobeMode, StrobeDur and, PreStrobe_us.

Instead, the exposure and strobe timings must be defined for P1 and P2 using the following parameter set:

ExposureTime_P1_us, ExposureTime_P2_us, StrobeDuration_P1_us, StrobeDuration_P2_us, StrobeDelay_P1_us and, StrobeDelay_P2_us.

Customizing Interleaved Acquisition – Exposure Delay Parameters

By default, MultiCam configures P1 and P2 with the smallest possible Exposure Delay value. This setting is satisfactory for the use cases where the exposure time is shorter than the readout time.

Optionally, keeping ExposureDelayControl set to MANUAL, you may manually change the minimum exposure delay value of P1 and/or P2 using the ExposureDelay_MAN_P1_us and ExposureDelay_MAN_P2_us parameters.

Alternatively, you may also change ExposureDelayControl to one of the automatic control methods: SAME_START_EXPOSURE or SAME_END_EXPOSURE.

With SAME_START_EXPOSURE, the start of exposure is delayed by the same amount of time for both programs: both exposure delay values are equal.

With SAME_END_EXPOSURE the end of exposure is delayed by the same amount of time for both programs.

In case of asymmetric exposure times, when at least one exposure time is greater than the readout time, the minimal line trigger period can be achieved when:

- Assigning the longest exposure time to P2
- Inserting an exposure delay prior to the lowest one

Customizing Interleaved Acquisition – Strobe Control Parameters

The StrobeLine_P1 and StrobeLine_P2 parameters designate the I/O lines used as strobe outputs for P1 and P2 respectively. The default values are IOUT1 for P1 and IOUT2 for P2.

Setting StrobeLine_P2 to IOUT1 or NONE disconnects the IOUT2 output from the P2 Strobe and makes it available for another usage (Software controlled I/O).

Setting StrobeLine_P1 and StrobeLine_P2to the same output IOUT1 merges the two strobe pulses .

The StrobeOutput_P1 and StrobeOutput_P2 parameters control the delivery of the strobe pulse for P1 and P2 respectively. The delivery is enabled by default. Assigning the DISABLE value, inhibits the delivery of the strobe pulse.

Customizing Grabber Timing Parameters

As for any are-scan application, the following grabber configuration, timing and conditioning parameters must be set according to the application needs: GrabWindow, WindowX_Px, WindowY_Ln, OffsetX_Px and OffsetY_Ln.

Customizing Cluster Parameters

As for any area-scan application, the following cluster parameters must be set according to the application needs: ColorFormat, ImageFlipX and, ImageFlipY.

Interleaved Line-scan Acquisition Channel Setup

LxxxxRG_IA CAM File Template

```
;***********************************************************************************************
**
; Camera Manufacturer: Templates
; Camera Model: MyCameraLink
; Camera Configuration: Interleaved Line-Scan Acquisition, Grabber-Controlled Rate and
Exposure
; Board: Grablink

;***********************************************************************************************
**
; This CAM file template is suitable for the following camera configuration:
;    - Line-scan camera
;    - Grabber-controlled rate
;    - Pulse-Width grabber-controlled exposure
; This CAM file template is suitable for the following system configuration:
;    - WEB, PAGE, or LONGPAGE Acquisition Modes
;    - Take all lines
;    - Interleaved Acquisition
;
; ***************************************************************************************
; ** CAUTION:                                                                          **
; ** This file is a template, it can be further customized!                            **
; ** The lines that can be edited are marked with an arrow followed by the most        **
; ** popular alternate values for that parameter.                                      **
; ** For a complete list of possible values; refer to MultiCam Studio and/or to        **
; ** the MultiCam Reference documentation.                                             **
; ***************************************************************************************
;

;***********************************************************************************************
**
; ==Begin of "Camera properties Section"==
;
; -Camera Specification category-
    Camera =            MyCameraLink;
    CamConfig =         LxxxxRG;
    Imaging =           LINE;
    Spectrum =          BW;                 <== BW COLOR ...
;
; -Camera Features category-
    TapConfiguration =  BASE_1T8;           <== BASE_1T8 BASE_1T10 BASE_1T24 ...
    TapGeometry =       1X;                 <== 1X 1X2 2X ...
    Expose =            WIDTH;
    Readout =           INTCTL;
    ColorMethod =       NONE;               <== NONE PRISM TRILINEAR RGB
;
; --Downstream signals--
    FvalMode =          FN;
    LvalMode =          LA;
    DvalMode =          DN;                 <== DN DG
;
; --Upstream signals--
    ResetCtl =          DIFF;
    ResetEdge =         GOHIGH;             <== GOHIGH GOLOW
    CC1Usage =          RESET;              <== LOW HIGH RESET SOFT DIN1 IIN1
    CC2Usage =          LOW;                <== LOW HIGH RESET SOFT DIN2
    CC3Usage =          LOW;                <== LOW HIGH RESET SOFT IIN1
```

```
    CC4Usage =          LOW;                <== LOW HIGH RESET SOFT
;
; -Camera Timing category-
    Hactive_Px  =       4096;               <==
    HSyncAft_Tk =       0;                  <==
    LineRate_Hz =       5000;               <== Max. line rate (= reciprocal of readout
duration)
    ExposeMin_us =      1;                  <== Min. exposure time (= RESET signal pulse
width)
    ExposeMax_us =      10000;              <== Max. exposure time (= RESET signal pulse
width)
    ResetDur =          3000;               <== Min. time interval, in ns, between
consecutive RESET pulses
;
; ==End of "Camera properties Section"==

;*******************************************************************************************
**
; ==Begin of "System properties Section"==
;
; -Acquisition Control category-
    AcquisitionMode =   WEB;                <== WEB PAGE LONGPAGE
    TrigMode =          IMMEDIATE;          <== IMMEDIATE HARD SOFT COMBINED
    NextTrigMode =      REPEAT;             <== REPEAT (when AcquisitionMode = WEB or
LONGPAGE)
;                                           <== SAME REPEAT HARD SOFT COMBINED (when
AcquisitionMode = PAGE)
    EndTrigMode =       AUTO;               <== AUTO HARD (when AcquisitionMode = LONGPAGE)
;                                           <== AUTO (when AcquisitionMode = WEB or PAGE)
    BreakEffect =       FINISH;             <== FINISH ABORT
    SeqLength_Pg =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = PAGE)
    SeqLength_Ln =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = WEB or
LONGPAGE)
    PageLength_Ln =     500;                <== 1 .. 65535
;
; -Trigger Control category-
    TrigCtl =           ISO;                <== ISO DIFF ...
    TrigEdge =          GOHIGH;             <== GOHIGH GOLOW
    TrigFilter =        MEDIUM;             <== OFF ON MEDIUM STRONG
    TrigLine =          NOM;                <== NOM ...
;       The following 4 parameters are relevant only when EndTrigMode = HARD!
    EndTrigCtl =        ISO;                <== ISO DIFF ...
    EndTrigEdge =       GOLOW;              <== GOHIGH GOLOW
    EndTrigFilter =     MEDIUM;             <== OFF ON MEDIUM STRONG
    EndTrigLine =       NOM;                <== NOM ...
;
; -Interleaved Acquisition category-
    InterleavedAcquisition =    ON;         <== Enable interleaved acquisition
;       Define the exposure time for P1 and P2 (= RESET signal pulse width)
    ExposureTime_P1_us =        64.0;       <== Float (0.16 up to 5000000)
    ExposureTime_P2_us =        64.0;       <== Float (0.16 up to 5000000)
;       Define the strobe duration for P1 and P2 (= STROBE1 and STROBE2 signals pulse width)
    StrobeDuration_P1_us =      32.0;       <== Float (0.16 up to 5000000)
    StrobeDuration_P2_us =      32.0;       <== Float (0.16 up to 5000000)
;       Define the strobe delay for P1 and P2 (relative time offset from RESET going ON to
STROBEx going ON)
;       The time offset can be positive, null or negative
    StrobeDelay_P1_us =         16.0;       <== Float (-10000 up to 5000000)
    StrobeDelay_P2_us =         16.0;       <== Float (-10000 up to 5000000)
;       Select the Exposure delay control method
    ExposureDelayControl =        MANUAL;   <== MANUAL SAME_END_EXPOSURE SAME_START_EXPOSURE
;       When ExposureDelayControl is MANUAL, select the minimum delay from the trigger
;       to the start of exposure (RESET signal going on)
    ExposureDelay_MAN_P1_us =   0;          <== Float (0 up to 5000000)
```

```
    ExposureDelay_MAN_P2_us =   0;          <== Float (0 up to 5000000)
    StrobeLine_P1 =             IOUT1;      <== IOUT1
    StrobeLine_P2 =             IOUT2;      <== IOUT2 NONE
    StrobeOutput_P1 =           ENABLE;     <== ENABLE DISABLE
    StrobeOutput_P2 =           ENABLE;     <== ENABLE DISABLE
;
; -Encoder Control category-
    LineCaptureMode =   ALL;
    LineRateMode =      PERIOD;             <== PERIOD PULSE CONVERT
;       The following 2 parameters are relevant only when LineRateMode = PERIOD:
    Period_us =         1000;               <==
    PeriodTrim =        0;                  <==
;       The following 4 parameters are relevant only when LineRateMode = CONVERT:
    LinePitch =         100;                <==
    EncoderPitch =      100;                <==
    ConverterTrim =     0;                  <==
    OnMinSpeed =        IDLING;             <== IDLING MUTING
;       The following 4 parameters are relevant only when LineRateMode = PULSE or CONVERT:
    LineTrigCtl =       DIFF_PAIRED;        <== ISO DIFF ISO_PAIRED DIFF_PAIRED
    LineTrigEdge =      ALL_A_B;            <== RISING_A FALLING_A ALL_A (when LineTrigCtl =
ISO or DIFF)
;                                           <== ALL_A_B (when LineTrigCtl = ISO_PAIRED or
DIFF_PAIRED)
    LineTrigFilter =    MEDIUM;             <== OFF MEDIUM STRONG ...
    LineTrigLine =      NOM;                <== NOM ...
;       The following parameter controls the Rate divider circuit that is available when
LineRateMode = PULSE:
    RateDivisionFactor = 1;                 <== 1..512
;       The following 2 parameters are controlling the Backward Motion Cancellation circuit
that is available
;       when LineTrigCtl = ISO_PAIRED or DIFF_PAIRED:
    ForwardDirection =  A_LEADS_B;          <== A_LEADS_B B_LEADS_A
    BackwardMotionCancellationMode = OFF;   <== OFF FILTERED COMPENSATE
;
; ==End of "System properties Section"==

;*******************************************************************************************
**
; ==Begin of "Grabber properties Section"==
;
; -Grabber Configuration, Timing & Conditioning categories-
    GrabWindow =        NOBLACK;            <== NOBLACK MAN
;       The following 2 parameters are relevant only when GrabWindow = MAN:
    WindowX_Px =        2048;               <==
    OffsetX_Px =        0;                  <==
;
; -Look-Up Tables category-
;   LUT configuration parameters can be inserted here if required by the application
;
; -Cluster category-
    ColorFormat =       Y8;                 <== Y8 Y10 RGB24 RGB24PL ...
    ImageFlipX =        OFF;                <== OFF ON
;
; End of "Grabber properties Section"

;*******************************************************************************************
**
; End of File
;=============
```

Customizing Camera Parameters

As for any line-scan camera, the following camera parameters must be set according to the selected camera model:

Spectrum, TapConfiguration, TapGeometry, ColorMethod, DvalMode, ResetEdge, CC1Usage, CC2Usage, CC3Usage, CC4Usage, Hactive_Px and, HSyncAft_Tk.

For correct operation of the camera trigger overrun protection mechanism it is essential to carefully set the following parameters:

LineRate_Hz, ExposeMin_us, ExposeMax_us and, ResetDur.

Customizing Acquisition Control Parameters

As for any line-scan application, the following acquisition control parameters must be set according to the application needs: AcquisitionMode, TrigMode, NextTrigMode, EndTrigMode, BreakEffect, SeqLength_Pg, SeqLength_Ln and, PageLength_Ln.

Customizing Trigger Control Parameters

As for any line-scan application, the following trigger and end trigger control parameters must be set according to the application needs: TrigCtl, TrigEdge, TrigFilter, TrigLine, EndTrigCtl, EndTrigEdge, EndTrigFilter and, EndTrigLine.

Customizing Interleaved Acquisition parameters

Enable Interleaved Line-scan Acquisition by assigning the value ON to InterleavedAcquisition.

Customizing Interleaved Acquisition – Exposure and Strobe Timing Parameters

When Interleaved Line-scan Acquisition is enabled, the following exposure and strobe parameters are irrelevant:

Expose_us, ExposeTrim, StrobeMode, StrobeDur and, PreStrobe_us.

Instead, the exposure and strobe timings must be defined for P1 and P2 using the following parameter set:

ExposureTime_P1_us, ExposureTime_P2_us, StrobeDuration_P1_us, StrobeDuration_P2_us, StrobeDelay_P1_us and, StrobeDelay_P2_us.

Customizing Interleaved Acquisition – Exposure Delay Parameters

By default, MultiCam configures P1 and P2 with the smallest possible Exposure Delay value. This setting is satisfactory for the use cases where the exposure time is shorter than the readout time.

Optionally, keeping ExposureDelayControl set to MANUAL, you may manually change the minimum exposure delay value of P1 and/or P2 using the ExposureDelay_MAN_P1_us and ExposureDelay_MAN_P2_us parameters.

Alternatively, you may also change ExposureDelayControl to one of the automatic control methods: SAME_START_EXPOSURE or SAME_END_EXPOSURE.

With SAME_START_EXPOSURE, the start of exposure is delayed by the same amount of time for both programs: both exposure delay values are equal.

With SAME_END_EXPOSURE the end of exposure is delayed by the same amount of time for both programs.

In case of asymmetric exposure times, when at least one exposure time is greater than the readout time, the minimal line trigger period can be achieved when:

- Assigning the longest exposure time to P2
- Inserting an exposure delay prior to the lowest one

Customizing Encoder Control Parameters

As for any line-scan application, the following encoder control parameters must be set according to the application needs: LineCaptureMode, LineRateMode, Period_us, PeriodTrim, LinePitch, EncoderPitch, ConverterTrim, OnMinSpeed, LineTrigCtl, LineTrigEdge, LineTrigFilter, LineTrigLine, RateDivisionFactor, ForwardDirection and, BackwardMotionCancellationMode.

Customizing Interleaved Acquisition – Strobe Control Parameters

The StrobeLine_P1 and StrobeLine_P2 parameters designate the I/O lines used as strobe outputs for P1 and P2 respectively. The default values are IOUT1 for P1 and IOUT2 for P2.

Setting StrobeLine_P2 to NONE disconnects the IOUT2 output from the P2 Strobe and makes it available for another usage (Software controlled I/O).

The StrobeOutput_P1 and StrobeOutput_P2 parameters control the delivery of the strobe pulse for P1 and P2 respectively. The delivery is enabled by default. Assigning the DISABLE value, inhibits the delivery of the strobe pulse.

Customizing Grabber Timing Parameters

As for any line-scan application, the following grabber configuration, timing and conditioning parameters must be set according to the application needs: GrabWindow, WindowX_Px and, OffsetX_Px.

Customizing Cluster Parameters

As for any line-scan application, the following cluster parameters must be set according to the application needs: ColorFormat and, ImageFlipX.

12.4. Two-line Synchronized Line-scan Acquisition

Applies to: Base DualBase Full FullXR

Introduction

The *Two-line Synchronized Line-scan Acquisition* feature takes advantage of a specificity of the BASLER Sprint bilinear CMOS camera that, when operating in the so-called "Exsync controlled operation – Level controlled Mode – Enhanced Raw Line A" exposes light once every two *Exsync cycles*. For a full description of such camera cycle, refer to "Two-line Camera Cycles" on page 228.

This feature extends the capability of Grablink cards to synchronize multiple line-scan acquisition channels using the 2-signal SyncBus. For an architectural description, refer to "System Architecture" on page 230. For a description of the hardware layer and the SyncBus wiring, refer to "SyncBus Wiring" on page 236.

This feature supports two line capture modes:

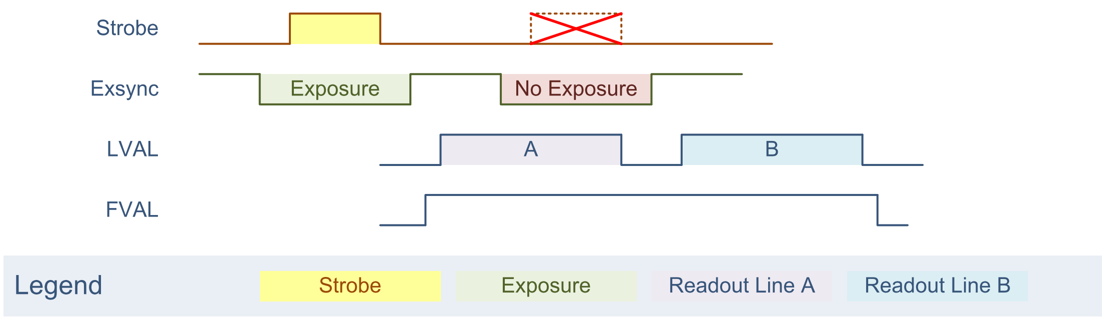
- LineCaptureMode = ALL: Take-All-Lines
- LineCaptureMode = TAG: Tag-A-Line

The "two-line synchronized acquisition" feature is available since MultiCam 6.9.8. The Tag-A-Line mode is available since MultiCam 6.12.

Two-line Camera Cycles

Basler Sprint Camera Cycle

A single camera cycle of a Basler Sprint CMOS bilinear line-scan camera operating in the "Exsync controlled operation – Level controlled Mode – Raw Line A" requires two consecutive Exsync pulses to be completed:



Basler Sprint camera cycle

The leading (=falling) edge of the first Exsync pulse initiates a new exposure.

The trailing (=rising) edge of the first Exsync terminates the exposure and initiates the readout of the first line (line A) of the sensor.

The leading (=falling) edge of the second Exsync pulse has no function.

The trailing (=rising) edge of the second Exsync pulse initiates the readout of the second line (line B) of the sensor.

The sensor integrates light for all pixels simultaneously during the time interval between the leading and the trailing edge of the first Exsync pulse. The strobe light must be fired during that time interval.

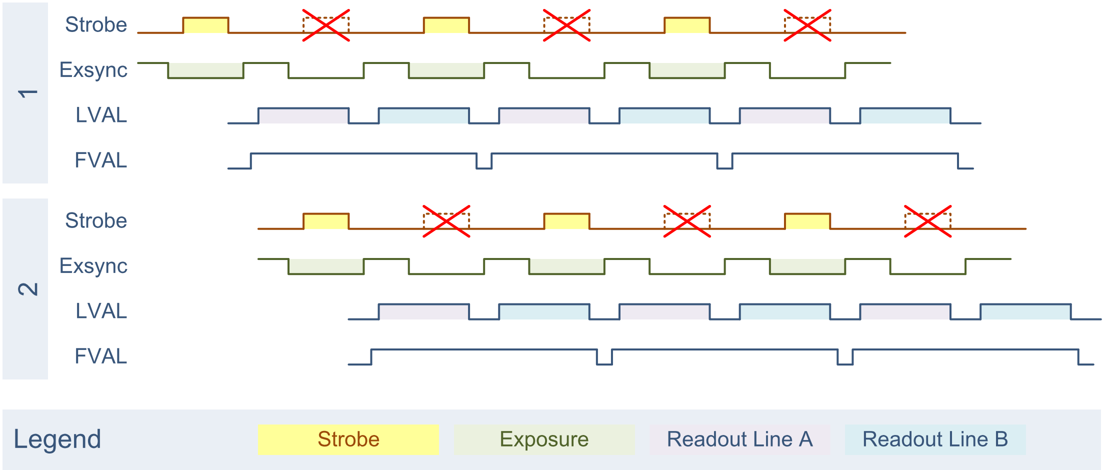
The sensor doesn't integrate light during the low period of the second Exsync pulse. Firing the strobe during that interval has no effect on the acquired data.

The camera qualifies each line of image data by the LVAL signal.

The camera delivers also an FVAL pulse surrounding the two LVAL pulses belonging to the same camera cycle. This allows the frame grabber to unambiguously identify the "line parity"(A or B).

> NOTE
> The FVAL Length CSR parameter of the Basler Sprint camera must be set to 2.

Phase-shifted Camera Cycles



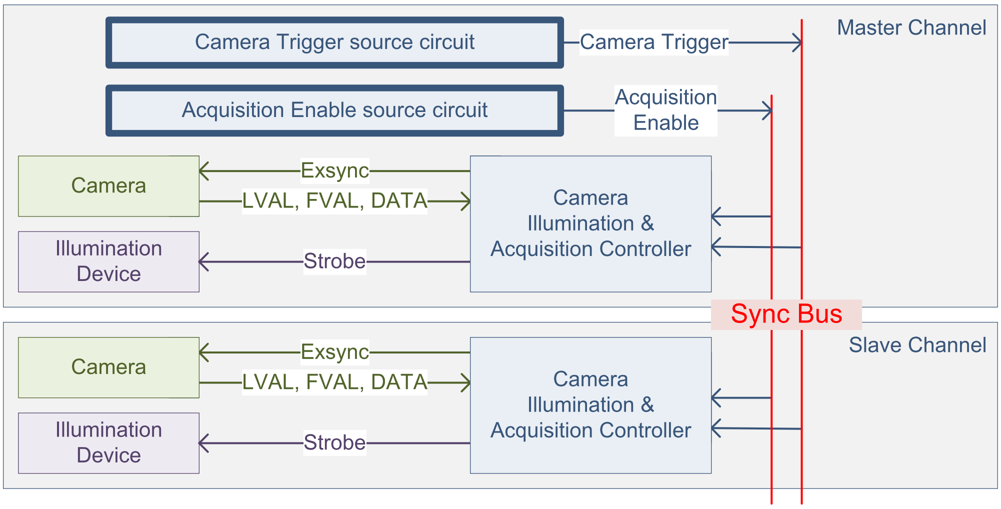
Phase-shifted camera cycles of two Basler Sprint cameras.

The drawing shows the camera cycles of two Basler Sprint cameras where the Exsync periods are synchronized with a phase shift of one period of the Exsync signal.

Notice that:

- The 2 cameras are never exposing simultaneously!
- Firing the illumination during the exposure time interval of a camera will not affect the other camera.

System Architecture



Two-line synchronized line-scan acquisition system

A two-line synchronized line-scan acquisition system is composed of at least 2 MultiCam acquisition channels:

- One "Master Channel"
- One or more "Slave Channels"

Each MultiCam acquisition channel includes:

- 1 Basler Sprint bilinear color line-scan camera
- 1 Strobed illumination device
- 1 Camera, Illumination and Acquisition controller (CIAC).

The Master channel includes:

- 1 Camera Trigger Source circuit that generates the SyncBus: Camera Trigger signal.
- 1 Acquisition Enable source circuit that generates the SyncBus: Acquisition Enable signal.

The SyncBus distributes the two signals to the Camera, Illumination and Acquisition Controller of all participating channels.

The leading edge of the SyncBus: Camera Trigger signal triggers simultaneously all camera and illumination controllers. Each controller sends an Exsync pulse (MultiCam reset signal) having a specified width to the camera. It generates also a strobe pulse once every two Exsync.

The leading edge of the SyncBus: Acquisition Enable signal initiates the image data capture on all channels. The image data capture effectively begins on the next occurrence of a line A ensuring that the image data capture begins always on a boundary of the 2 x 2 Bayer CFA pattern.

The falling edge of the SyncBus: Acquisition Enable signal terminates the image data capture on all channels. The image data capture effectively terminates after the next occurrence of a line B ensuring that the image data capture terminates always on a boundary of the 2 x 2 Bayer CFA pattern.

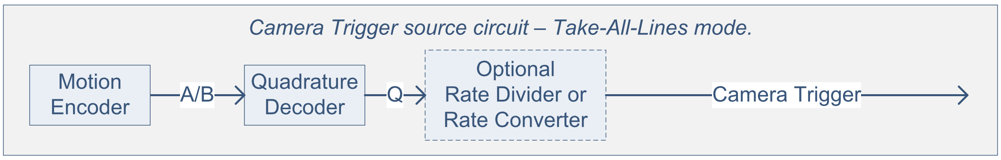
Line Capture Modes

Two line capture modes are available: Take-All-Lines and Tag-A-Line.

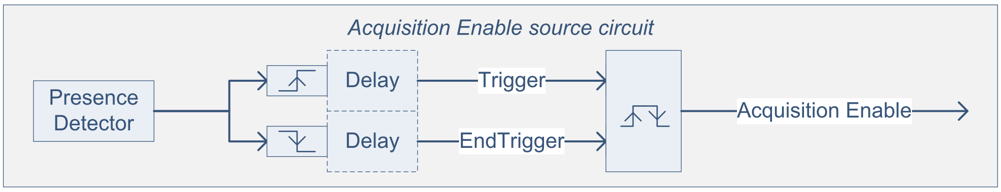
The following table summarizes the characteristics:

Characteristics	Take-All-Lines	Tag-A-Line
Camera line rate	Variable, linked to web speed	Fixed, defined by the frame grabber
Captured image data	All lines	All lines
Line tagging	No	Yes, linked to web speed
Image re-sampling	Not required	Required to be done by the application using tag metadata

Take-All-Lines Line Capture Mode

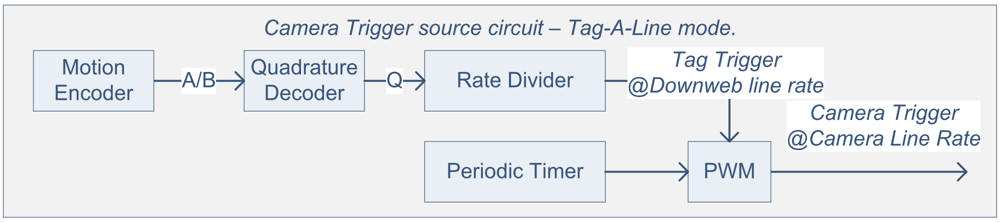


The camera line rate is proportional to the web speed to maintain a fixed pitch along the down-web web direction. Therefore, the Master Channel elaborates a Camera Trigger signal from the A/B signals using the Quadrature Decoder and, when necessary, the Rate Divider or the Rate Converter.



All lines are captured by the frame grabber when the acquisition is enabled. Therefore, the Master channel elaborates the Acquisition Enable signal from both edges of the position detector signal.

Tag-A-Line Line Capture Mode



The camera line rate is fixed. Therefore, the Master Channel elaborates a Camera Trigger signal using the Periodic Timer.

The down-web line rate is proportional to the web speed to obtain, after re-sampling by the application , a fixed pitch along the down-web web direction. The Master channel elaborates also a Tag Trigger signal from the A/B signals using the Quadrature Decoder and the Rate Divider. This signal will be used by all acquisition controllers to tag the lines of image data lines to be kept during the down-web re-sampling process.

The Master channel combines both Tag Trigger and Camera Trigger signals for transmission on the SyncBus.

All lines are tagged and captured by the frame grabber when the acquisition is enabled. Therefore, the Master channel elaborates the Acquisition Enable signal from both edges of the position detector signal in the same way as for the Take-All-Lines mode.

The RGB components data of the first pixel of each image line are replaced by a tag indicating if the line was preceded by a Tag Trigger or not.

All data bits of R,G and B components are set to 1 when a Tag Trigger occurred during the preceding line interval.

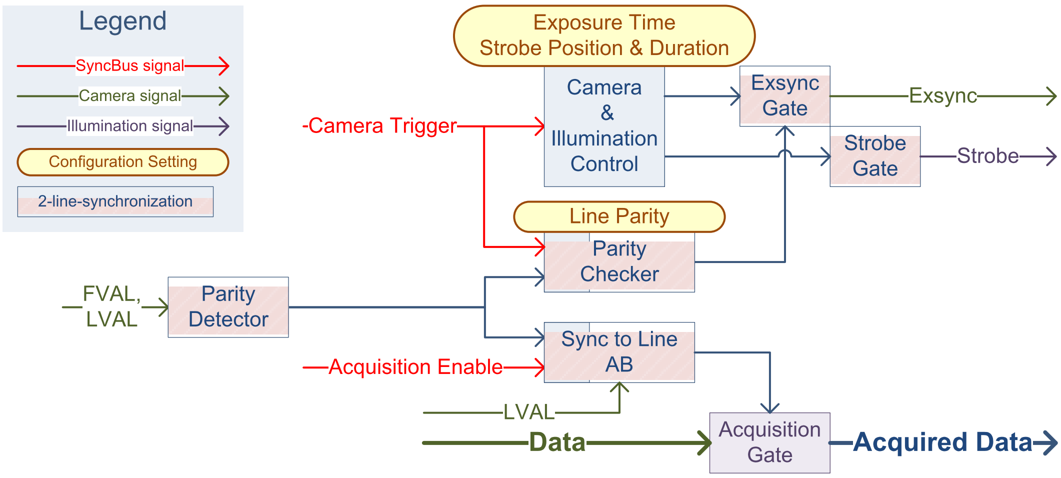
All data bits of R,G and B components are set to 0 when no Tag Trigger occurred during the preceding line interval.

> NOTE
> When ColorFormat is set to RGB32, the alpha component is not tagged!

All image data lines are delivered to the application. The application has to perform down-web re-sampling using tags to obtain an undistorted image with a constant down-web line pitch.

Camera, Illumination and Acquisition controller

Camera and Illumination Controller



Camera and Illumination Controller block diagram

On every Camera Trigger event, the Camera and Illumination Controller generates:

- One single Exsync pulse, having a duration set by the MultiCam parameter Expose_us
- One single Strobe pulse, having a duration and a position set by the MultiCam parameters StrobeDur and StrobePos.

The width of the Exsync pulse determines the exposure time of the camera. The strobe pulse duration is entirely located within the exposure time interval. Its position, and its duration are defined as a percentage of the exposure time.

Two-line Synchronization Mode

The two-line synchronization mode of the CIAC must be enabled by setting the value ENABLE to the MultiCam Parameter TwoLineSynchronization.

This mode of synchronization ensures that the acquisition gate opens and closes at a line-pair boundary. It provides also the capability to control the "Line Parity" of the camera by means of the TwoLineSynchronizationParity parameter:

When set to EVEN, the camera line parity of the local camera is such that the camera cycle begins at an even line trigger count boundary.

When set to ODD, the camera line parity of the local camera is such that the camera cycle begins at an odd line trigger count boundary.

Line Parity Control

The line parity control is composed of three function blocks:

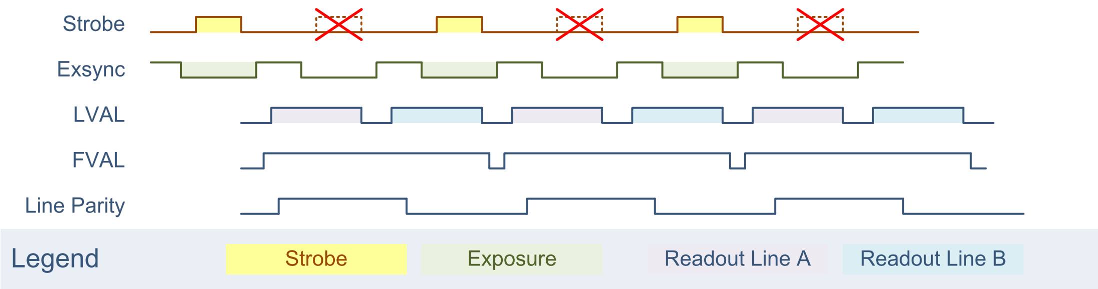
- Parity Detector
- Parity Checker
- Exsync Gate

The Parity Detector function block analyzes the FVAL and the LVAL signal of the camera and generates the Camera Line Parity signal. This signal identifies unambiguously the row A and the row B of the image sensor.

The Parity Checker function block checks whether the Camera Line Parity signal is as expected according to the TwoLineSynchronizationParity settings.

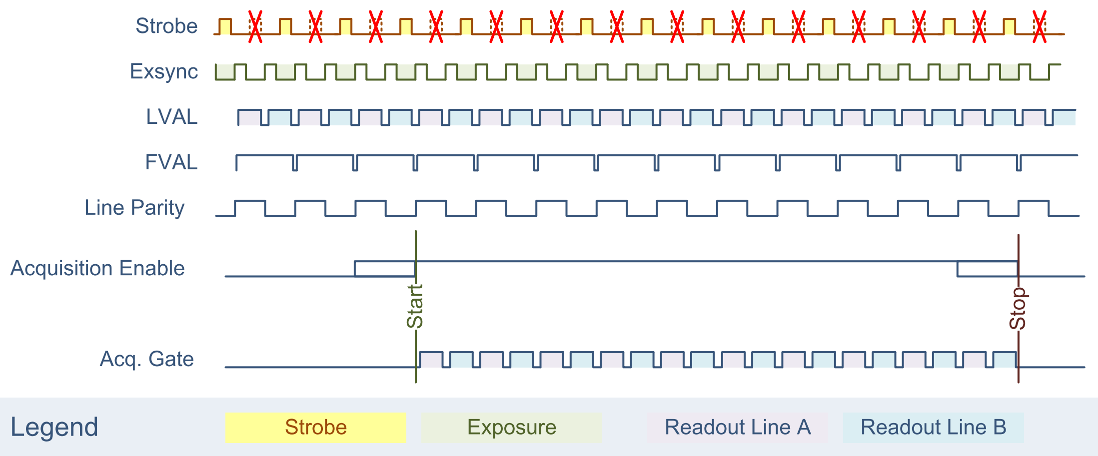
If the Camera Line Parity is incorrect, the Exsync Gate removes the next Exsync pulse. This action restores the appropriate line parity.

Strobe Gating



The Strobe Gate removes one strobe pulse every two. It keeps only, the strobe corresponding to the Exsync cycle where the local camera exposes.

Acquisition Gating



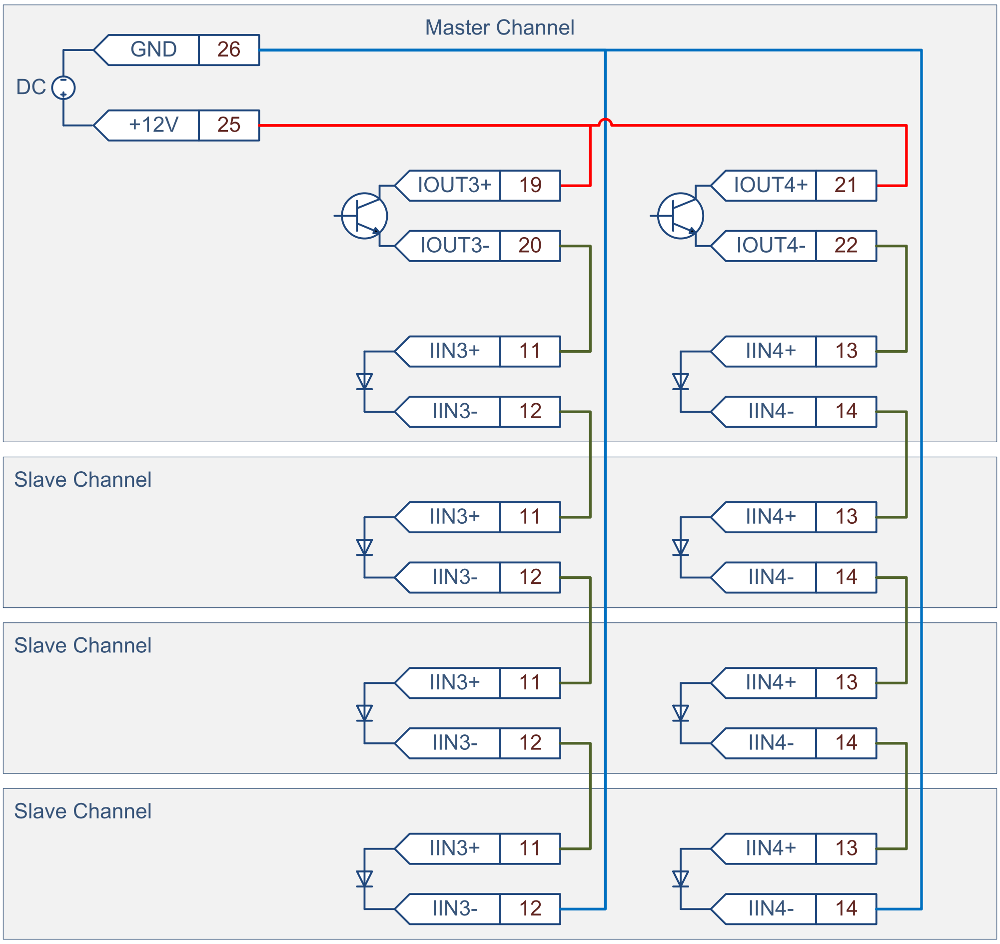
The acquisition gate opens and closes at line-pair boundaries to ensure that buffers always start with a line A and ends with a line B.

SyncBus Wiring

Isolated I/O SyncBus Wiring Scheme

The Isolated I/O SyncBus is implemented with a custom made wiring interconnecting a selected set of I/O pins of the internal I/O connector of each MultiCam Channel.

The following diagram shows the interconnections for a 4-channel SyncBus:



Isolated I/O SyncBus wiring diagram

Camfile Template –Take-All-Lines mode

The following section highlights the additions to the generic MyCameraLink_LxxxxRG.cam camfile for configuring the Master MultiCam Channel of a two-line synchronized line-scan acquisition system using the Take-All-Lines line capture mode.

```
;***********************************************************************************************
**
; Camera Manufacturer: Templates
; Camera Model: MyCameraLink
; Camera Configuration: Line-Scan, Grabber-Controlled Rate and Exposure
; Board: Grablink

;***********************************************************************************************
**
; This CAM file template is suitable for the following camera configuration:
;   - Line-scan camera
;   - Grabber-controlled rate
;   - Pulse-Width grabber-controlled exposure
; This CAM file template is suitable for the following system configuration:
;   - WEB, PAGE, or LONGPAGE Acquisition Modes
;   - Take all lines
;
; *********************************************************************************
; ** CAUTION:                                                                    **
; ** This file is a template, it can be further customized!                      **
; ** The lines that can be edited are marked with an arrow followed by the most **
; ** popular alternate values for that parameter.                                **
; ** For a complete list of possible values; refer to MultiCam Studio and/or to **
; ** the MultiCam Reference documentation.                                       **
; *********************************************************************************
;

;***********************************************************************************************
**
; ==Begin of "Camera properties Section"==
;
; -Camera Specification category-
    Camera =            MyCameraLink;
    CamConfig =         LxxxxRG;
    Imaging =           LINE;
    Spectrum =          BW;                   <== BW COLOR ...
;
; -Camera Features category-
    TapConfiguration =  BASE_1T8;             <== BASE_1T8 BASE_1T10 BASE_1T24 ...
    TapGeometry =       1X;                   <== 1X 1X2 2X ...
    Expose =            WIDTH;
    Readout =           INTCTL;
    ColorMethod =       NONE;                 <== NONE PRISM TRILINEAR RGB
    TwoLineSynchronization = ENABLE;
    TwoLineSynchronizationParity = EVEN;      <== EVEN ODD
;
; --Downstream signals--
    FvalMode =          FN;
    LvalMode =          LA;
    DvalMode =          DN;                   <== DN DG
;
; --Upstream signals--
    ResetCtl =          DIFF;
    ResetEdge =         GOHIGH;               <== GOHIGH GOLOW
    CC1Usage =          RESET;                <== LOW HIGH RESET SOFT DIN1 IIN1
```

```
    CC2Usage =          LOW;                <== LOW HIGH RESET SOFT DIN2
    CC3Usage =          LOW;                <== LOW HIGH RESET SOFT IIN1
    CC4Usage =          LOW;                <== LOW HIGH RESET SOFT
;
; -Camera Timing category-
    Hactive_Px  =       4096;               <==
    HSyncAft_Tk =       0;                  <==
    LineRate_Hz =       5000;               <== Max. line rate (= reciprocal of readout
duration)
    ExposeMin_us =      1;                  <== Min. exposure time (= RESET signal pulse
width)
    ExposeMax_us =      10000;              <== Max. exposure time (= RESET signal pulse
width)
    ResetDur =          3000;               <== Min. time interval, in ns, between
consecutive RESET pulses
;
; ==End of "Camera properties Section"==

;*******************************************************************************************
**
; ==Begin of "System properties Section"==
;
; -Acquisition Control category-
    SynchronizedAcquisition = MASTER;       <== MASTER, SLAVE, LOCAL_MASTER, LOCAL_SLAVE
    AcquisitionMode =   WEB;                <== WEB PAGE LONGPAGE
    TrigMode =          IMMEDIATE;          <== IMMEDIATE HARD SOFT COMBINED
    NextTrigMode =      REPEAT;             <== REPEAT (when AcquisitionMode = WEB or
LONGPAGE)
;                                           <== SAME REPEAT HARD SOFT COMBINED (when
AcquisitionMode = PAGE)
    EndTrigMode =       AUTO;               <== AUTO HARD (when AcquisitionMode = LONGPAGE)
;                                           <== AUTO (when AcquisitionMode = WEB or PAGE)
    BreakEffect =       FINISH;             <== FINISH ABORT
    SeqLength_Pg =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = PAGE)
    SeqLength_Ln =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = WEB or
LONGPAGE)
    PageLength_Ln =     500;                <== 1 .. 65535
;
; -Trigger Control category-
    TrigCtl =           ISO;                <== ISO DIFF ...
    TrigEdge =          GOHIGH;             <== GOHIGH GOLOW
    TrigFilter =        MEDIUM;             <== OFF ON MEDIUM STRONG
    TrigLine =          NOM;                <== NOM ...
;       The following 4 parameters are relevant only when EndTrigMode = HARD!
    EndTrigCtl =        ISO;                <== ISO DIFF ...
    EndTrigEdge =       GOLOW;              <== GOHIGH GOLOW
    EndTrigFilter =     MEDIUM;             <== OFF ON MEDIUM STRONG
    EndTrigLine =       NOM;                <== NOM ...
;
; -Exposure & Strobe Control categories-
    Expose_us =         90;                 <==
    ExposeTrim =        0;                  <==
    StrobeMode =        NONE;               <== To free the Strobe Output IO port
;
; -Encoder Control category-
    LineCaptureMode =   ALL;
    LineRateMode =      PERIOD;             <== PERIOD PULSE CONVERT
;       The following 2 parameters are relevant only when LineRateMode = PERIOD:
    Period_us =         1000;               <==
    PeriodTrim =        0;                  <==
;       The following 4 parameters are relevant only when LineRateMode = CONVERT:
    LinePitch =         100;                <==
    EncoderPitch =      100;                <==
    ConverterTrim =     0;                  <==
```

```
    OnMinSpeed =        IDLING;             <== IDLING MUTING
;       The following 4 parameters are relevant only when LineRateMode = PULSE or CONVERT:
    LineTrigCtl =       DIFF_PAIRED;        <== ISO DIFF ISO_PAIRED DIFF_PAIRED
    LineTrigEdge =      ALL_A_B;            <== RISING_A FALLING_A ALL_A (when LineTrigCtl =
ISO or DIFF)
;                                           <== ALL_A_B (when LineTrigCtl = ISO_PAIRED or
DIFF_PAIRED)
    LineTrigFilter =    MEDIUM;             <== OFF MEDIUM STRONG ...
    LineTrigLine =      NOM;                <== NOM ...
;       The following parameter controls the Rate divider circuit that is available when
LineRateMode = PULSE:
    RateDivisionFactor = 1;                 <== 1..512
;       The following 2 parameters are controlling the Backward Motion Cancellation circuit
that is available
;       when LineTrigCtl = ISO_PAIRED or DIFF_PAIRED:
    ForwardDirection =  A_LEADS_B;          <== A_LEADS_B B_LEADS_A
    BackwardMotionCancellationMode = OFF;   <== OFF FILTERED COMPENSATE
;
; ==End of "System properties Section"==

;*********************************************************************************************
**
; ==Begin of "Grabber properties Section"==
;
; -Grabber Configuration, Timing & Conditioning categories-
    GrabWindow =        NOBLACK;            <== NOBLACK MAN
;       The following 2 parameters are relevant only when GrabWindow = MAN:
    WindowX_Px =        2048;               <==
    OffsetX_Px =        0;                  <==
;
; -Look-Up Tables category-
;   LUT configuration parameters can be inserted here if required by the application
;
; -Cluster category-
    ColorFormat =       Y8;                 <== Y8 Y10 RGB24 RGB24PL ...
    ImageFlipX =        OFF;                <== OFF ON
    ImageFlipY =        OFF;                <== OFF ON
;
; End of "Grabber properties Section"

;*********************************************************************************************
**
; End of File
;=============
```

Camfile Template –Tag-A-Line mode

The following section highlights the additions to the generic MyCameraLink_LxxxxRG.cam camfile for configuring the Master MultiCam Channel of a two-line synchronized line-scan acquisition using the Tag-A-Line line capture mode.

```
;*******************************************************************************************
**
; Camera Manufacturer: Templates
; Camera Model: MyCameraLink
; Camera Configuration: Line-Scan, Grabber-Controlled Rate and Exposure
; Board: Grablink

;*******************************************************************************************
**
; This CAM file template is suitable for the following camera configuration:
;   - Line-scan camera
;   - Grabber-controlled rate
;   - Pulse-Width grabber-controlled exposure
; This CAM file template is suitable for the following system configuration:
;   - WEB, PAGE, or LONGPAGE Acquisition Modes
;   - Take all lines
;
; *******************************************************************************
; ** CAUTION:                                                                  **
; ** This file is a template, it can be further customized!                    **
; ** The lines that can be edited are marked with an arrow followed by the most **
; ** popular alternate values for that parameter.                              **
; ** For a complete list of possible values; refer to MultiCam Studio and/or to **
; ** the MultiCam Reference documentation.                                     **
; *******************************************************************************
;

;*******************************************************************************************
**
; ==Begin of "Camera properties Section"==
;
; -Camera Specification category-
    Camera =            MyCameraLink;
    CamConfig =         LxxxxRG;
    Imaging =           LINE;
    Spectrum =          BW;                 <== BW COLOR ...
;
; -Camera Features category-
    TapConfiguration =  BASE_1T8;           <== BASE_1T8 BASE_1T10 BASE_1T24 ...
    TapGeometry =       1X;                 <== 1X 1X2 2X ...
    Expose =            WIDTH;
    Readout =           INTCTL;
    ColorMethod =       NONE;               <== NONE PRISM TRILINEAR RGB
    TwoLineSynchronization = ENABLE;
    TwoLineSynchronizationParity = EVEN;    <== EVEN ODD
;
; --Downstream signals--
    FvalMode =          FN;
    LvalMode =          LA;
    DvalMode =          DN;                 <== DN DG
;
; --Upstream signals--
    ResetCtl =          DIFF;
    ResetEdge =         GOHIGH;             <== GOHIGH GOLOW
    CC1Usage =          RESET;              <== LOW HIGH RESET SOFT DIN1 IIN1
```

```
    CC2Usage =          LOW;                <== LOW HIGH RESET SOFT DIN2
    CC3Usage =          LOW;                <== LOW HIGH RESET SOFT IIN1
    CC4Usage =          LOW;                <== LOW HIGH RESET SOFT
;
; -Camera Timing category-
    Hactive_Px  =       4096;               <==
    HSyncAft_Tk =       0;                  <==
    LineRate_Hz =       5000;               <== Max. line rate (= reciprocal of readout
duration)
    ExposeMin_us =      1;                  <== Min. exposure time (= RESET signal pulse
width)
    ExposeMax_us =      10000;              <== Max. exposure time (= RESET signal pulse
width)
    ResetDur =          3000;               <== Min. time interval, in ns, between
consecutive RESET pulses
;
; ==End of "Camera properties Section"==

;*******************************************************************************************
**
; ==Begin of "System properties Section"==
;
; -Acquisition Control category-
    SynchronizedAcquisition = MASTER;       <== MASTER, SLAVE, LOCAL_MASTER, LOCAL_SLAVE
    AcquisitionMode =   WEB;                <== WEB PAGE LONGPAGE
    TrigMode =          IMMEDIATE;          <== IMMEDIATE HARD SOFT COMBINED
    NextTrigMode =      REPEAT;             <== REPEAT (when AcquisitionMode = WEB or
LONGPAGE)
;                                           <== SAME REPEAT HARD SOFT COMBINED (when
AcquisitionMode = PAGE)
    EndTrigMode =       AUTO;               <== AUTO HARD (when AcquisitionMode = LONGPAGE)
;                                           <== AUTO (when AcquisitionMode = WEB or PAGE)
    BreakEffect =       FINISH;             <== FINISH ABORT
    SeqLength_Pg =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = PAGE)
    SeqLength_Ln =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = WEB or
LONGPAGE)
    PageLength_Ln =     500;                <== 1 .. 65535
;
; -Trigger Control category-
    TrigCtl =           ISO;                <== ISO DIFF ...
    TrigEdge =          GOHIGH;             <== GOHIGH GOLOW
    TrigFilter =        MEDIUM;             <== OFF ON MEDIUM STRONG
    TrigLine =          NOM;                <== NOM ...
;       The following 4 parameters are relevant only when EndTrigMode = HARD!
    EndTrigCtl =        ISO;                <== ISO DIFF ...
    EndTrigEdge =       GOLOW;              <== GOHIGH GOLOW
    EndTrigFilter =     MEDIUM;             <== OFF ON MEDIUM STRONG
    EndTrigLine =       NOM;                <== NOM ...
;
; -Exposure & Strobe Control categories-
    Expose_us =         90;                 <==
    ExposeTrim =        0;                  <==
    StrobeMode =        NONE;               <== To free the Strobe Output IO port
;
; -Encoder Control category-
    LineCaptureMode =   TAG;
    LineRateMode =      PERIOD;             <= PERIOD
;       The following 2 parameters are relevant when LineCaptureMode = TAG:
    Period_us =         1000;               <==
    PeriodTrim =        0;                  <==
;       The following 4 parameters are relevant only when LineCaptureMode = TAG:
    LinePitch =         100;                <==
    EncoderPitch =      100;                <==
    ConverterTrim =     0;                  <==
```

```
    OnMinSpeed =        IDLING;             <== IDLING MUTING
;       The following 4 parameters are relevant only when LineCaptureMode = TAG:
    LineTrigCtl =       DIFF_PAIRED;        <== ISO DIFF ISO_PAIRED DIFF_PAIRED
    LineTrigEdge =      ALL_A_B;            <== RISING_A FALLING_A ALL_A (when LineTrigCtl =
ISO or DIFF)
;                                           <== ALL_A_B (when LineTrigCtl = ISO_PAIRED or
DIFF_PAIRED)
    LineTrigFilter =    MEDIUM;             <== OFF MEDIUM STRONG ...
    LineTrigLine =      NOM;                <== NOM ...
;       The following parameter controls the Rate divider circuit that is available when
LineCaptureMode = TAG:
    RateDivisionFactor = 1;                 <== 1..512
;       The following 2 parameters are controlling the Backward Motion Cancellation circuit
that is available
;       when LineTrigCtl = ISO_PAIRED or DIFF_PAIRED:
    ForwardDirection =  A_LEADS_B;          <== A_LEADS_B B_LEADS_A
    BackwardMotionCancellationMode = OFF;   <== OFF FILTERED COMPENSATE
;
; ==End of "System properties Section"==

;*******************************************************************************************
**
; ==Begin of "Grabber properties Section"==
;
; -Grabber Configuration, Timing & Conditioning categories-
    GrabWindow =        NOBLACK;            <== NOBLACK MAN
;       The following 2 parameters are relevant only when GrabWindow = MAN:
    WindowX_Px =        2048;               <==
    OffsetX_Px =        0;                  <==
;
; -Look-Up Tables category-
;   LUT configuration parameters can be inserted here if required by the application
;
; -Cluster category-
    ColorFormat =       Y8;                 <== Y8 Y10 RGB24 RGB24PL ...
    ImageFlipX =        OFF;                <== OFF ON
    ImageFlipY =        OFF;                <== OFF ON
;
; End of "Grabber properties Section"

;*******************************************************************************************
**
; End of File
;=============
```

Camfile Customization

Camera Parameters

As for any line-scan camera, the following camera parameters must be set according to the selected camera model:

Spectrum, TapConfiguration, TapGeometry, ColorMethod, DvalMode, ResetEdge, CC1Usage, CC2Usage, CC3Usage, CC4Usage, Hactive_Px and, HSyncAft_Tk.

For correct operation of the camera trigger overrun protection mechanism it is essential to carefully set the following parameters:

LineRate_Hz, ExposeMin_us, ExposeMax_us and, ResetDur.

To operate with bilinear line-scan cameras:

- The 2-line synchronization mode must be enabled by setting TwoLineSynchronization to ENABLE.
- The 2-line synchronization parity must be selected by setting TwoLineSynchronizationParity to ODD or EVEN.

There is a phase-shift of 1 Exsync cycle between cameras set to ODD and cameras set EVEN.

Acquisition Control Parameters

As for any line-scan application, the following acquisition control parameters must be set according to the application needs: AcquisitionMode, TrigMode, NextTrigMode, EndTrigMode, BreakEffect, SeqLength_Pg, SeqLength_Ln and, PageLength_Ln.

The synchronized acquisition feature must be enabled on all synchronized channels. Refer to "Synchronized Line-scan Acquisition" on page 164.

Trigger Control Parameters

As for any line-scan application, the following trigger and end trigger control parameters must be set according to the application needs: TrigCtl, TrigEdge, TrigFilter, TrigLine, EndTrigCtl, EndTrigEdge, EndTrigFilter and, EndTrigLine.

Exposure and Strobe Timing Parameters

As for any line-scan application, the following exposure and strobe control parameters must be set according to the application needs:

Expose_us, ExposeTrim, StrobeMode, StrobeDur and, PreStrobe_us.

Encoder Control Parameters

As for any line-scan application, the following encoder control parameters must be set according to the application needs: LineCaptureMode, LineRateMode, Period_us, PeriodTrim, LinePitch, EncoderPitch, ConverterTrim, OnMinSpeed, LineTrigCtl, LineTrigEdge, LineTrigFilter, LineTrigLine, RateDivisionFactor, ForwardDirection and, BackwardMotionCancellationMode.

Grabber Timing Parameters

As for any line-scan application, the following grabber configuration, timing and conditioning parameters must be set according to the application needs: GrabWindow, WindowX_Px and, OffsetX_Px.

Cluster Parameters

As for any line-scan application, the following cluster parameters must be set according to the application needs: ColorFormat and, ImageFlipX.

Basler spL4096-70kc Camfile for Tag-A-Line mode

This topic a customization of the generic MyCameraLink_LxxxxRG.cam camfile for a bilinear color *Basler spL4096-70kc* camera attached to the Master MultiCam Channel of a two-line synchronized line-scan acquisition using the Tag-A-Line line capture mode.

```
;***********************************************************************************************
**
; Camera Manufacturer: BASLER
; Camera Model: spL4096-70kc
; Camera Configuration: RAW Dual Line, 2048 pixels, Grabber-Controlled rate and exposure
; Board: Grablink
; Minimum MultiCam Version: 6.5
; Last update: 25 Sept 2017

;***********************************************************************************************
**
;Disclaimer:
;
;These CAM-files are provided to you free of charge and "as is".
;You should not assume that these CAM-files are error-free or
;suitable for any purpose whatsoever.
;Nor should you assume that all functional modes of the camera are
;covered by these CAM files or that the associated documentation is complete.
;EURESYS does not give any representation or warranty that these CAM-files are
;free of any defect or error or suitable for any purpose.
;EURESYS shall not be liable, in contract, in torts or otherwise,
;for any damages, loss, costs, expenses or other claims for compensation,
;including those asserted by third parties, arising out of or in connection
;with the use of these CAM-files.

;***********************************************************************************************
**
;
; ==Begin of "Camera properties Section"==
;
; -Camera Specification category-
    Camera =            MyCameraLink;
    CamConfig =         LxxxxRG;
    Imaging =           LINE;
    Spectrum =          COLOR;          <== BW COLOR ...
;
; -Camera Features category-
    TapConfiguration =  BASE_2T8;       <== BASE_1T8 BASE_1T10 BASE_1T24 ...
    TapGeometry =       1X2;            <== 1X 1X2 2X ...
    Expose =            WIDTH;
    Readout =           INTCTL;
    ColorMethod =       BAYER;          <== NONE PRISM TRILINEAR RGB
    ColorRegistration=  RG;
    ColorRegistrationControl= FVAL;
;
; --Downstream signals--
    FvalMode =          FN;
    LvalMode =          LA;
    DvalMode =          DN;                 <== DN DG
;
; --Upstream signals--
    ResetCtl =          DIFF;
    ResetEdge =         GOLOW;              <== GOHIGH GOLOW
    CC1Usage =          RESET;              <== LOW HIGH RESET SOFT DIN1 IIN1
    CC2Usage =          LOW;                <== LOW HIGH RESET SOFT DIN2
```

```
    CC3Usage =          LOW;                <== LOW HIGH RESET SOFT IIN1
    CC4Usage =          LOW;                <== LOW HIGH RESET SOFT
;
; -Camera Timing category-
    Hactive_Px =        2048;               <==
    HSyncAft_Tk =       0;                  <==
    LineRate_Hz =       50000;              <== Max. line rate (= reciprocal of readout
duration)
    ExposeMin_us =      2;                  <== Min. exposure time (= RESET signal pulse
width)
    ExposeMax_us =      10000;              <== Max. exposure time (= RESET signal pulse
width)
    ResetDur =          3000;               <== Min. time interval, in ns, between
consecutive RESET pulses

    TwoLineSynchronization= ENABLE;
    TwoLineSynchronizationParity= EVEN;
;
; ==End of "Camera properties Section"==

;******************************************************************************************
**
; ==Begin of "System properties Section"==
;
; -Acquisition Control category-
    AcquisitionMode =   LONGPAGE;           <== WEB PAGE LONGPAGE

    SynchronizedAcquisition= MASTER;        <== MASTER, SLAVE, LOCAL_MASTER, LOCAL_SLAVE

    TrigMode =          HARD;               <== IMMEDIATE HARD SOFT COMBINED
    NextTrigMode =      REPEAT;             <== REPEAT (when AcquisitionMode = WEB or
LONGPAGE)
;                                           <== SAME REPEAT HARD SOFT COMBINED (when
AcquisitionMode = PAGE)
    EndTrigMode =       HARD;               <== AUTO HARD (when AcquisitionMode = LONGPAGE)
;                                           <== AUTO (when AcquisitionMode = WEB or PAGE)
    BreakEffect =       ABORT;              <== FINISH ABORT
    SeqLength_Pg =      -1:                 <== -1 1 .. 65534 (when AcquisitionMode = PAGE)
    SeqLength_Ln =      -1;                 <== -1 1 .. 65534 (when AcquisitionMode = WEB or
LONGPAGE)
    PageLength_Ln =     128;                <== 1 .. 65535
;
; -Trigger Control category-
    TrigCtl =           ISO;                <== ISO DIFF ...
    TrigEdge =          GOHIGH;             <== GOHIGH GOLOW
    TrigFilter =        MEDIUM;             <== OFF ON MEDIUM STRONG
    TrigLine =          IIN1;               <== NOM ...
;       The following 4 parameters are relevant only when EndTrigMode = HARD!
    EndTrigCtl =        ISO;                <== ISO DIFF
    EndTrigEdge =       GOLOW;              <== GOHIGH GOLOW
    EndTrigFilter =     MEDIUM;             <== OFF ON MEDIUM STRONG
    EndTrigLine =       IIN1;               <== NOM ...
;
; -Exposure & Strobe Control categories-
    Expose_us =         245;                <==
    ExposeTrim =        0;                  <==
    StrobeMode =        AUTO;               <== To free the Strobe Output IO port
;
; -Encoder Control category-
    LineCaptureMode =   TAG;
    LineRateMode =      PERIOD;             <== PERIOD PULSE CONVERT
;       The following 2 parameters are relevant only when LineRateMode = PERIOD:
    Period_us =         250;                <==
    PeriodTrim =        0;                  <==
```

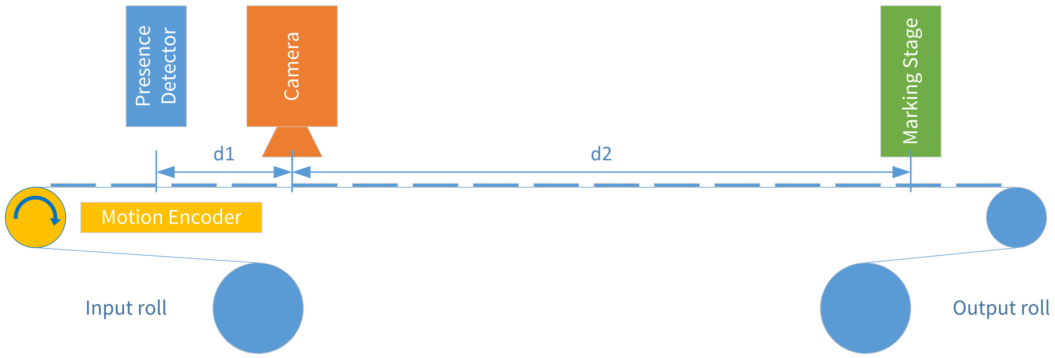
```
;       The following 4 parameters are relevant only when LineRateMode = CONVERT:
    LinePitch =          100;                 <==
    EncoderPitch =       100;                 <==
    ConverterTrim =      0;                   <==
    OnMinSpeed =         IDLING;              <== IDLING MUTING
;       The following 4 parameters are relevant only when LineRateMode = PULSE or CONVERT:
    LineTrigCtl =        ISO;                 <== ISO DIFF ISO_PAIRED DIFF_PAIRED
    LineTrigEdge =       RISING_A;            <== RISING_A FALLING_A ALL_A (when LineTrigCtl =
ISO or DIFF)
;                                             <== ALL_A_B (when LineTrigCtl = ISO_PAIRED or
DIFF_PAIRED)
    LineTrigFilter =     MEDIUM;              <== OFF MEDIUM STRONG ...
    LineTrigLine =       IIN2;                <== NOM ...
;       The following parameter controls the Rate divider circuit that is available when
LineRateMode = PULSE:
    RateDivisionFactor = 4;                   <== 1..512
;       The following 2 parameters are controlling the Backward Motion Cancellation circuit
that is available
;       when LineTrigCtl = ISO_PAIRED or DIFF_PAIRED:
    ForwardDirection =  A_LEADS_B;            <== A_LEADS_B B_LEADS_A
    BackwardMotionCancellationMode = OFF;     <== OFF FILTERED COMPENSATE
;
; ==End of "System properties Section"==

;*******************************************************************************************
**
; ==Begin of "Grabber properties Section"==
;
; -Grabber Configuration, Timing & Conditioning categories-
    GrabWindow =         NOBLACK;             <== NOBLACK MAN
;       The following 2 parameters are relevant only when GrabWindow = MAN:
    WindowX_Px =         4096;                <==
    OffsetX_Px =         0;                   <==
;
; -Look-Up Tables category-
;   LUT configuration parameters can be inserted here if required by the application
;
; -Cluster category-
    ColorFormat =        RGB24PL;             <== Y8 Y10 RGB24 RGB24PL ...
    ImageFlipX =         OFF;                 <== OFF ON
    ImageFlipY =         OFF;                 <== OFF ON
;
; End of "Grabber properties Section"

;*******************************************************************************************
**
; End of File
;=============
```

12.5. Machine Pipeline Control

Applies to: Base DualBase Full FullXR

Pipe-lined Machine Description

Mechanical setup



The objects to inspect, for instance labels, are mounted on a tape. The tape is moving continuously from the input roll to the output roll at a variable speed. A motion encoder, typically a rotary quadrature motion encoder, is installed on a machine axis.

Every object successively passes under a presence detector, then under the camera and finally under a marking stage before exiting the machine.

The presence detector is installed upstream from the camera (distance d1).

The camera is a line-scan camera controlled by the frame grabber. It captures lines of image data at a rate proportional to the motion speed to avoid geometric distortions.

The marking stage is installed downstream from the camera (distance d2). It applies a "not good" mark on invalid objects. During the d2 travel time, the application analyzes the object image and determines the action to be performed when it reaches the marking stage.

Normal operation mode

In normal operation mode, the machine executes the following operations for each object:

An object to inspect comes in from the input roll.

The presence detector delivers *trigger pulse* for each object

The Grablink frame grabber starts acquiring the first image line when the label reaches the camera field-of-view, i.e. after a position offset equal to d1.

Grablink stops acquiring after having captured a specified number of lines and wakes-up the application using the call-back mechanism when the image buffer are filled with the object image.

The application software analyzes the captured image and asserts a "set action" command specifying the action to execute when the object reaches the marking stage.

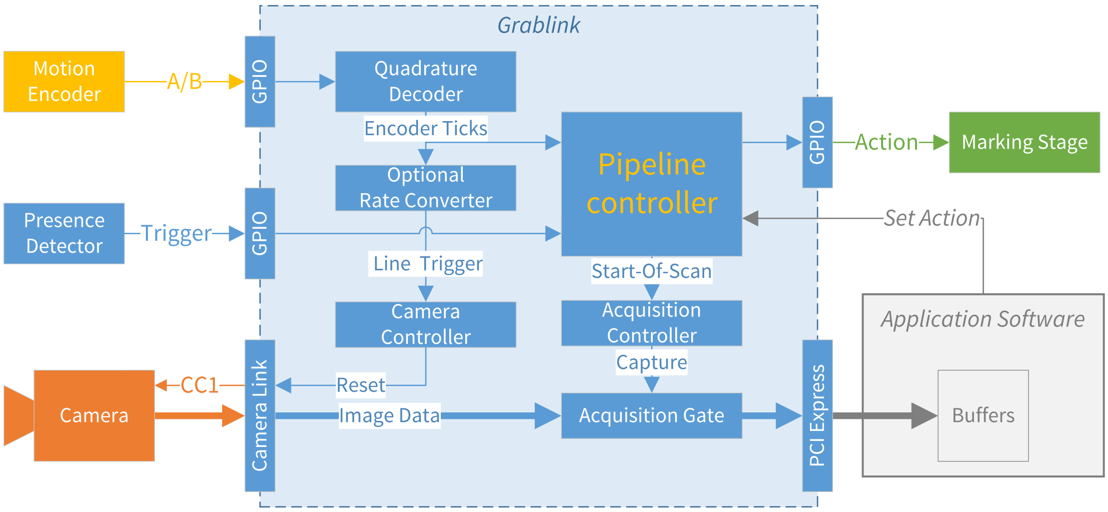
Grablink activates the marking stage, when an invalid object reaches the action stage, i.e. after a position offset equal to d1 + d2 .

The above operations are pipe-lined to optimize the machine throughput.

Pipeline Controller Description

Description of the Grablink implementation of the pipelined machine controller

Functional block diagram



System diagram for machine pipeline control

Camera controller

The camera controller is configured for line-scan grabber-controlled exposure mode: parameter CamConfig = LxxxxRG.

For every line trigger tick, the controller delivers a **RESET** pulse having a width equal to the exposure time set by parameter Expose_us. The **RESET** pulse is sent to the camera though the **Camera Link CC1** line.

Two options are applicable to select the line trigger source with the parameter LineRateMode:

- When set to PULSE, the encoder ticks are used directly as line triggers.
- When set to CONVERT, the rate converter output ticks are used as line triggers.

Rate converter

The rate converter is capable to multiply or divide the input rate of encoder ticks by a ratio of 2 integers defined by parameters LinePitch and EncoderPitch.

It operates within in a limited range of frequencies:

- The upper limit of the output frequency range is user configurable with parameter MaxSpeed. By default, it is set to the maximum line rate sustainable by the camera defined by LineRate_Hz.
- The lower limit of the output frequency takes is automatically set by the driver and reported to the application via the MinSpeed parameter. The MaxSpeed/MinSpeed ratio is typically greater than 100.

When the input rate drops below MinSpeed, the rate converter behaves according to the OnMinSpeed settings:

- When set to MUTING, it stops delivering line trigger ticks
- When set to IDLING, it continues delivering line trigger ticks at a constant frequency

To enlarge the usable speed range, it is mandatory to set MaxSpeed at a value slightly above the actual max camera line rate.

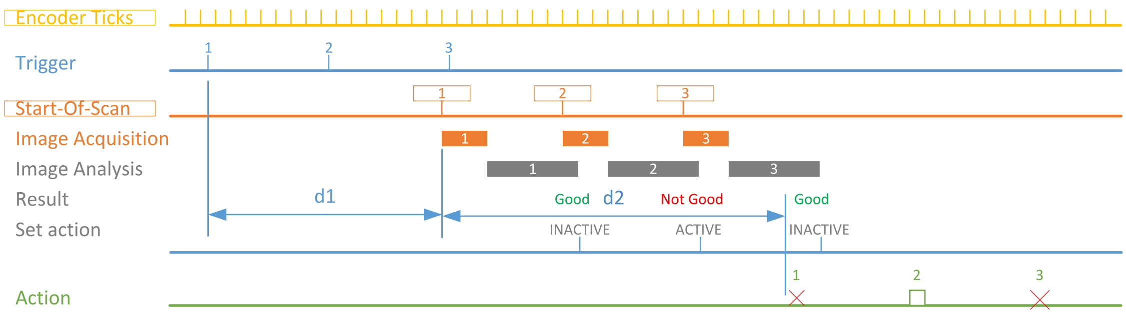
Pipeline controller

The pipeline controller is a piece of hardware responsible for the generation of two time-critical events:

- A Start-of-Scan trigger that initiates the image acquisition of one object when it reaches the camera.
- An Action pulse on a GPIO output port that triggers the marking stage.

The pipeline controller monitors the machine with two external sensors:

- A motion encoder that delivers encoder ticks at a rate proportional to the motion speed.
- A presence detector that delivers a trigger pulse for each object.



To generate the Start-of-Scan trigger, the pipeline controller delays the incoming Trigger by a configurable count of encoder ticks corresponding to the position offset between the detector and the camera field-of-view (d1).

Similarly, to generate the Action pulse, the pipeline controller delays the incoming Trigger by a configurable count of encoder ticks corresponding to the position offset between the detector and the marking stage (d1 + d2). The generation of the Action pulse is conditioned to the Set action command issued by the application software after image analysis.

The pipeline controller is capable of managing up to 32 objects in the pipeline between the detector and the marking stage.

Acquisition controller & acquisition gate

The acquisition controller is configured for PAGE or LONGPAGE acquisition modes using the AcquisitionMode parameter :

- When set to PAGE, one MultiCam surface is filled after each start-of-scan trigger.
- When set to LONGPAGE, several MultiCam surfaces are filled after each start-of-scan trigger.

In both cases, the acquisition controller is configured to start acquisition when the hardware trigger line senses a valid transition or on software command. Parameter TrigModeis set to COMBINED and parameter NextTrigModeis set to COMBINED).

Parameters TrigCtl, TrigEdge and TrigFilter specify the configuration of the hardware trigger input line. Parameter TrigLine specifies the location of a hardware trigger input line.

In PAGE acquisition mode, the acquisition controller stops after having acquired a number of lines specified by PageLength_Ln

In LONGPAGE acquisition mode, the acquisition controller is configured to stop acquisition automatically by setting parameter EndTrigMode to AUTO. Acquisition stops after having acquired a fixed number of lines specified by parameter SeqLength_Ln. The parameter PageLength_Ln specifies the maximum number of lines that can be stored in a buffer. The last buffer might be incompletely filled. The image data acquisition of an object starts always with a new buffer.

The **acquisition gate** opens and close at line boundaries according to the settings of the acquisition controller.

Packed RGB data acquired from the Camera Link interface are internally buffered and transmitted as soon as possible, by a DMA engine, to the application buffers in the Host PC memory via the PCI Express interface.

To minimize latencies, ensure that the PCI Express is capable of sustaining the image data rate with a comfortable margin.

12.6. 8-tap/10-bit Acquisition

Applies to: Full FullXR

Introduction to 8-tap/10-bit Acquisition

1622 Grablink Full and **1626 Grablink Full XR** acquire images from cameras using the 8-tap/10-bit variant of the Camera Link 80-bit Configuration.

Three classes of cameras are supported:

- Monochrome cameras delivering 8 consecutive 10-bit pixels for every Camera Link clock cycle.
- 3-component RGB color cameras delivering 10-bit color components for 8 consecutive pixels along 3 successive Camera Link clock cycles.
- 4-component RGBI color cameras delivering 10-bit color components for 2 consecutive pixels for every Camera Link clock cycle.

These classes are identified by new values of the TapConfiguration Channel parameter: DECA_8T10, DECA_8T30B3 and DECA_2T40.

For such cameras, the frame grabber doesn't unpack 10-bit components to 16-bit. Instead, it stores the 10-bit pixel components one after the other without inserting any padding bits for alignment to 16-bit word boundaries. Pixel components are stored using the little-endian convention: the lsb is stored first.

The following table shows how the first two pixel components are stored in a MultiCam surface:

Byte address	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
+0	PC1 bit7	PC1 bit6	PC1 bit5	PC1 bit4	PC1 bit3	PC1 bit2	PC1 bit1	PC1 bit0
+1	PC2 bit5	PC2 bit4	PC2 bit3	PC2 bit2	PC2 bit1	PC2 bit0	PC1 bit9	PC1 bit8
+2	...	...	...	...	PC2 bit9	PC2 bit8	PC2 bit7	PC2 bit6

The storage formats are identified by three new values of the ColorFormat Channel parameter:

- Y10P for 10-bit packed monochrome pixels.
- RGB30P for 30-bit packed 3-component (RGB) color pixels.
- RGBI40P for 40-bit packed 4-component (RGBI) color pixels.

Packing the pixel components reduces the image data size:

- 8 monochrome pixels are stored in 10 bytes.
- 8 RGB color pixels (= 24 components) are stored in 30 bytes.
- 8 RGBI color pixels (= 32 components) are stored in 40 bytes.

> NOTE
> Reducing the data size allows the frame grabber to deliver the image data without significant latencies caused by limitations of the available PCI Express bandwith.

The order of components defined by the camera is preserved in the MultiCam surface:

- R (first), G, B (last) for RGB cameras.
- R (first), G, B, I(last) for RGBI cameras.

Insertion of metadata is possible with such cameras:

- One-field metadata insertion is available for area-scan cameras.
- Three-field metadata insertion is available for line-scan cameras.

8-tap/10-bit MultiCam Tap Configurations

The following values of the TapConfiguration Channel parameter apply to Camera Link 8-tap/10-bit cameras:

- DECA_8T10 for monochrome cameras delivering 8-consecutive pixels of 10 bits every Camera Link clock cycle.
- DECA_8T30B3 for 3-component (RGB) color cameras delivering 10-bit pixel components for 8 consecutive pixels along 3 successive Camera Link clock cycles.
- DECA_2T40 for 4-component (RGBI) color cameras delivering 10-bit pixel components for 2 consecutive pixels every Camera Link clock cycle.

The above values are available only when BoardTopology is set to MONO_DECA or MONO_DECA_OPT1.

> WARNING
> The DECA_8T10, DECA_8T30B3 TapConfiguration values authorize only the 1X8 and the 1X8_1Y TapGeometry values.

> WARNING
> The DECA_2T40 TapConfiguration value authorizes only the 1X2 and the 1X2_1Y TapGeometry values.

> WARNING
> On-board pixel processing (e.g. look up tables, white balance, image flipping, image cropping) is unavailable.

10-bit, 30-bit and 40-bit MultiCam Packed Pixel Formats

The following values of the ColorFormat Channel parameter apply to Camera Link 8-tap/10-bit cameras:

- Y10P for 10-bit packed monochrome pixels.
- RGB30P for 30-bit packed 3-component (RGB) color pixels.
- RGBI40P for 40-bit packed 4-component (RGBI) color pixels.

> WARNING
> The pixel unpacking is not performed by the Grablink card! It must be done by the application.

12.7. Video Lines Reordering

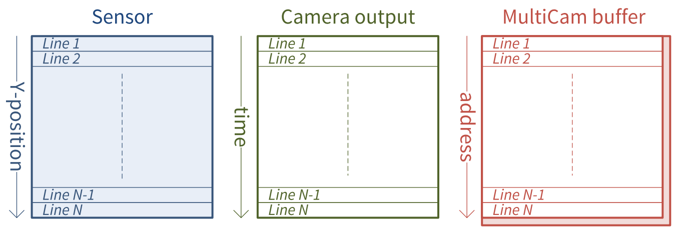
Applies to: Base DualBase Full FullXR

Grablink frame grabbers are capable to reorder video lines during the transfer from internal FIFO buffer to the MultiCam buffer.

The reordeing is controlled by two Channel parameters of the Cluster category: FifoOrdering and FifoOrderingYTapCount.

The following reordering schemes are supported:

PROGRESSIVE

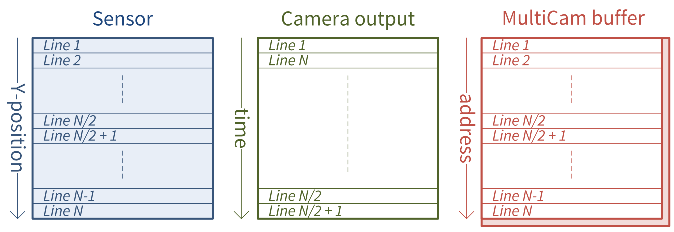


When FifoOrdering is set to PROGRESSIVE, the video data lines delivered by the camera are not reordered: the line order in the MultiCam buffer corresponds to the line order at the Camera output and to the line order on the sensor.

This is the default setting automatically invoked by MultiCam.

FifoOrderingYTapCount is irrelevant.

DUALYEND

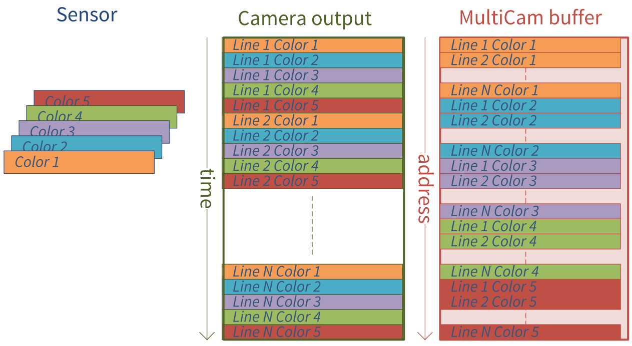


When FifoOrdering is set to DUALYEND, the video data lines delivered by the camera using the *_2YE tap geometry are reordered in the progressive order. After re-ordering, the line order in the MultiCam buffer corresponds to the line order on the sensor.

This setting is enforced by MultiCam for area-scan cameras having a TapGeometry value terminated by _2YE. Refer to "Image Reconstruction" on page 47.

FifoOrderingYTapCount is forced to 2 and cannot be changed.

NYTAP



When FifoOrdering is set to NYTAP and FifoOrderingYTapCount is set to any integer value N, the video data lines delivered by the camera in block of N lines are stored into N separate color planes in the MultiCam surface.

The above drawing shows an example with FifoOrderingYTapCount = 5.

> NOTE
> The PENTAYTAP value is kept for backward compatibility.

13. Annex

13.1. Interfacing Camera Link Cameras

CamFile Templates

CamFile templates for Camera Link area-scan cameras

Camera description	CamFile name
Progressive-scan, asynchronous reset operation, camera-controlled exposure, area-scan camera	MyCameraLink_PxxRG.cam
Progressive-scan, asynchronous reset operation, grabber-controlled exposure, area-scan camera	MyCameraLink_PxxRC.cam
Progressive-scan, synchronous operation, camera-controlled exposure, area-scan camera	MyCameraLink_PxxSC.cam

Selecting a template for Camera Link area-scan cameras

The majority of cameras used for industrial applications are progressive-scan cameras operating in the asynchronous reset mode. There are 2 templates for such cameras.

- When the exposure time of the camera can be controlled by the frame grabber using the pulse width of the "Reset" signal; it is recommended to select the PxxRG template. With that template, the exposure time is fully controlled by the Channel parameters of the Exposure Control category.
- If using the PxxRG template is not possible, select the PxxRC template. In that case, the exposure time needs to be defined by a camera setting. Furthermore, if a strobe output is also needed, it is necessary to copy the value of the exposure setting of the camera into the Channel parameter TrueExp_us in order to have the appropriate timing for the Strobe pulse produced by the Grablink board.
- For free-running cameras, select the PxxSC template

> NOTE
> All the templates select a monochrome camera by default. However, they can be customized in order to support RGB color or Bayer color cameras.

CamFile templates for Camera Link line-scan cameras

Camera description	CamFile name
Free-running, permanent exposure, line-scan camera	MyCameraLink_LxxxxSP.cam
Free-running, permanent exposure, line-scan camera	MyCameraLink_LxxxxSP_DR.cam

Camera description	CamFile name
Grabber-controlled rate, permanent exposure, line-scan camera	MyCameraLink_LxxxxRP.cam
Grabber-controlled rate, permanent exposure, line-scan camera	MyCameraLink_LxxxxRP_DR.cam
Progressive, asynchronous reset operation, camera-controlled exposure, area-scan camera	MyCameraLink_LxxxxRC.cam
Progressive, asynchronous reset operation, grabber-controlled exposure, area-scan camera	MyCameraLink_LxxxxRG.cam

Selecting a template for Camera Link line-scan cameras

For cameras having *no electronic shutter*, it is mandatory to use one of the following templates: LxxxxSP, LxxxxSP_DR, LxxxxRP and LxxxRP_DR . If the camera allows grabber controlled line rate, LxxxxRP and LxxxRP_DR offer the capability to control the exposure time using Channel parameters of the Exposure Control category. LxxxxSP_DR and LxxxxRP_DR templates enable the *DownWeb Resampling* to control also the vertical resolution.

For camera having an electronic shutter, it is required to use LxxxxRC and LxxxxRG templates. The LxxxRG offers the advantage to control the exposure time using Channel parameters of the Exposure Control category. Both templates allow a separate control of the camera line rate providing that the line period remains greater than the exposure time.

Camera Interfaces

> TIP
> Camera interfaces are available for download from the Supported Cameras page of the Euresys Web Site.