

Matrox Helios eCL/XCL

Camera Interface Application Note

BASLER spL4096-70k

August 26, 2009

Basics about the
camera

Camera Descriptions

- Effective resolution: Up to 4096 pixels/line @ up to 70k line per second.
- Camera Link FULL interface (2 to 8 taps, and 8, 10 or 12-bit).
- External and internal sync.
- External or internal exposure control.
- 60.75 MHz pixel clock rate.

Interface Mode

- Fixed line scan rate¹
- Variable line scan rate²
- Variable line scan rate using the Rotary Encoder²
- Fixed line scan rate with frame trigger¹
- Variable line scan rate with frame trigger²
- Variable line scan rate using the Rotary Encoder with frame trigger²
- Fixed line scan rate with variable frame size¹
- Variable line scan rate with variable frame size²
- Variable line scan rate using the Rotary Encoder with frame trigger²

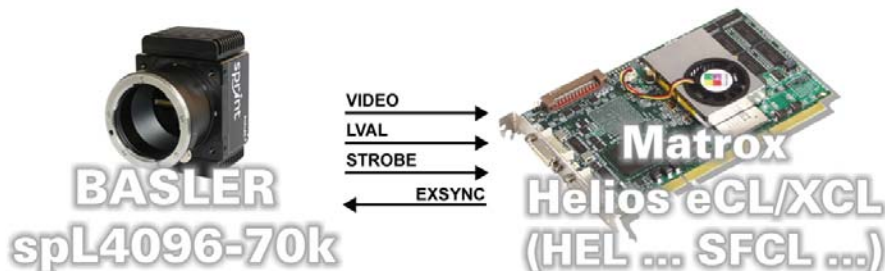
Mode of operations as
per Matrox Imaging (in
parentheses as per
camera manufacturer)

Basics about the
interface modes

Camera Interface Briefs

Mode 1: Fixed line scan rate

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsFLS.DCF](#)



¹ EXSYNC, level-controlled or Free Run programmable

² EXSYNC, level-controlled

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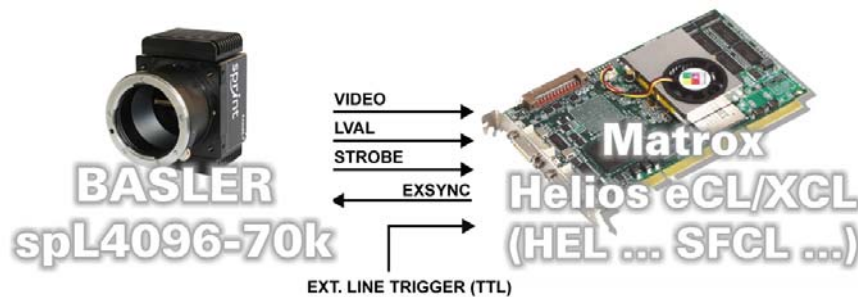
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Basics about the
interface modes

Camera Interface Briefs

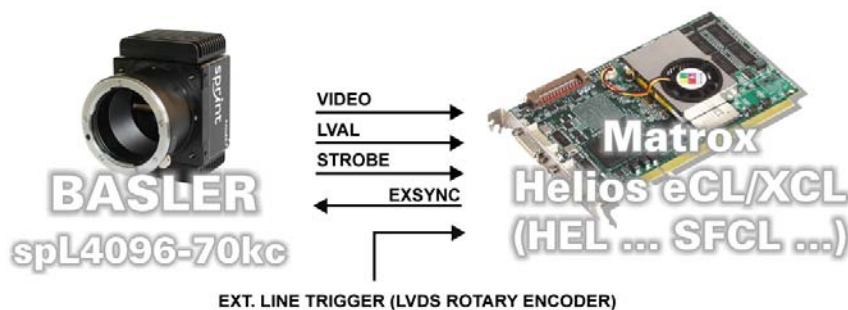
Mode 2: Variable line scan rate

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL line trigger signal.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLS.DCF](#)



Mode 3: Variable line scan rate with rotary encoder

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external LVDS line trigger (ROTARY ENCODER) signal.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLSRE.DCF](#)



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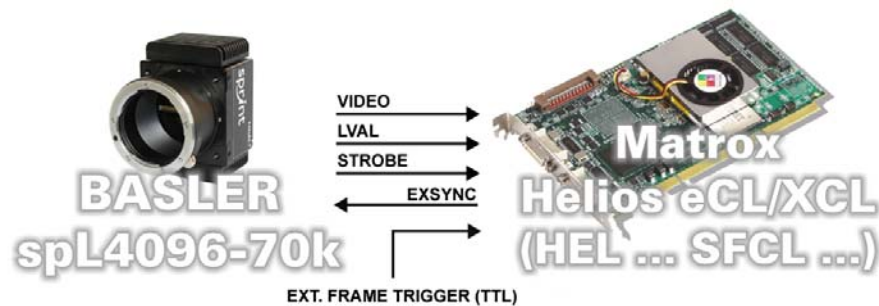
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Basics about the
interface modes

Camera Interface Briefs (cont.)

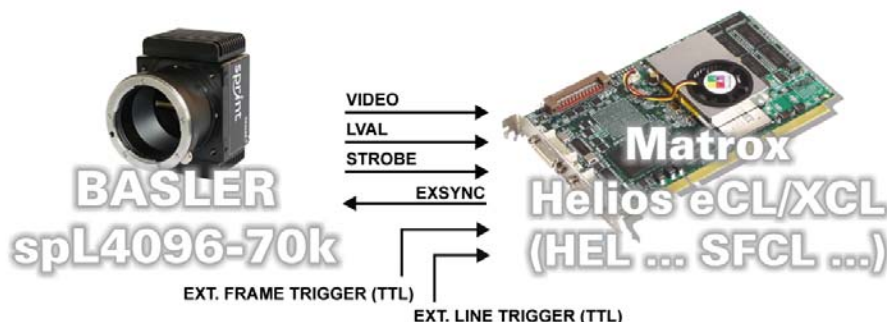
Mode 4: Fixed line scan rate with frame trigger

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame (virtual) trigger signal.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsFLSFT.DCF](#)



Mode 5: Variable line scan rate with frame trigger

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame (virtual) and line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLSFT.DCF](#)



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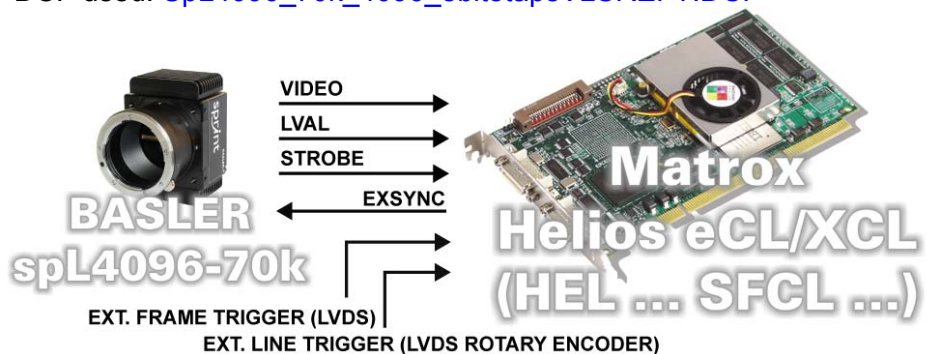
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Basics about the
interface modes

Camera Interface Briefs (cont.)

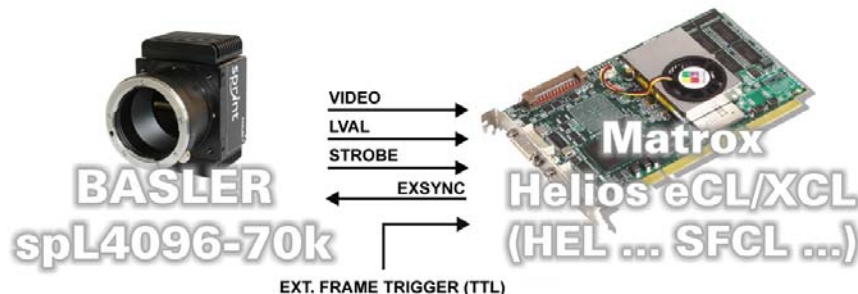
Mode 6: Variable line scan rate with rotary encoder and frame trigger

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external LVDS frame (virtual) and external LVDS line trigger (ROTARY ENCODER) signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLSREFT.DCF](#)



Mode 7: Fixed line scan rate with variable frame size

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame (virtual) trigger signal.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsFLSVF.DCF](#)



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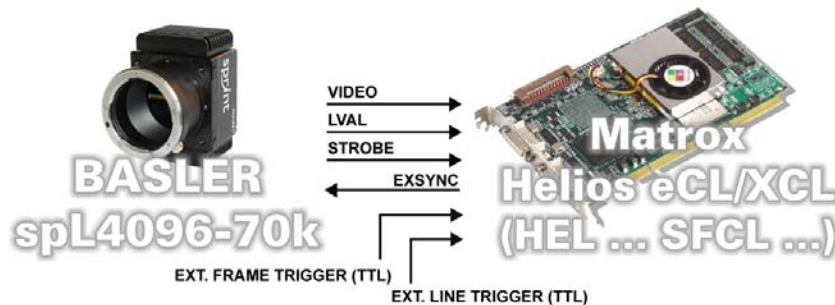
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Basics about the
interface modes

Camera Interface Briefs (cont.)

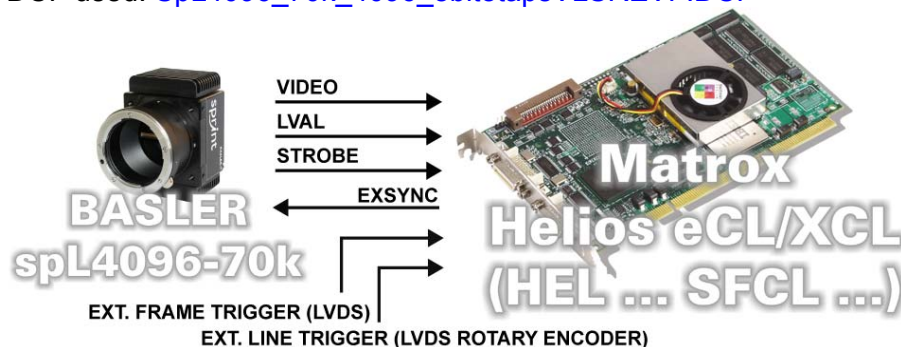
Mode 8: Variable line scan rate with variable frame size

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame (virtual) and line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLSVF.DCF](#)



Mode 9: Variable line scan rate with rotary encoder and variable frame size

- 4096 pixels/line.
- Camera Link FULL interface (eight 8-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external LVDS frame (virtual) and external LVDS line trigger (ROTARY ENCODER) signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 60.75 MHz) and video data from camera.
- DCF used: [SpL4096_70k_4096_8bit8tapsVLSREVF.DCF](#)



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Specifics about the
interface modes

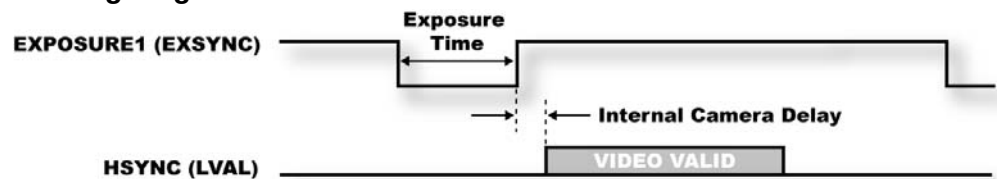
Camera Interface Details

Mode 1: Fixed line scan rate

- **Line rate:** The frequency of the periodic EXPOSURE1 (EXSYNC) signal determines the camera's line rate. The maximum line rate for this camera equals **140 kHz**.
- **Exposure time:** For **EXSYNC, level-controlled** mode the exposure time is the inactive (low level) period between the falling and rising edges of the EXPOSURE1 (EXSYNC) signal. The default exposure time for this DCF is **33 μ s**. Maximum/minimum exposure time per line for this DCF is **276 ms** and **16.46 ns** respectively. The exposure time can be modified in the DCF using Matrox Intellicam or with the MIL MdigControl() function. Consult the respective manual for more information.
- **Camera communication:** This DCF will work with all **Free Run** and **EXSYNC** modes however **EXSYNC, Level controlled** is the recommended mode for use with this DCF. Set the mode using the Basler Camera Configuration Tool Plus (CCT+). Refer to the camera manual for additional information.

Parameter	Setting
Video Data Output Mode	8 taps, 8-bits
Exposure Time Control Mode	EXSYNC, Level-controlled

▪ Timing diagram:



Mode 2: Variable line scan rate

- **Line rate:** The line rate is controlled by the frequency of the external TTL line trigger signal. The line trigger signal period must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.5 \mu$ s) or slower than the maximum line rate of the camera.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** This DCF works with all **EXSYNC** modes however **EXSYNC, Level-controlled** is the recommended mode for use with this DCF. Set the mode using the Basler Camera Configuration Tool Plus (CCT+). Refer to the camera manual for additional information.

Parameter	Setting
Video Data Output Mode	8 taps, 8-bits
Exposure Time Control Mode	EXSYNC, Level-controlled

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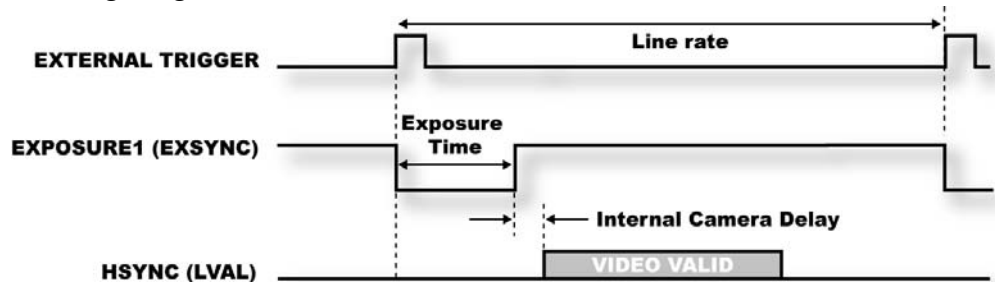
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Specifics about the
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Camera Interface Details (cont.)

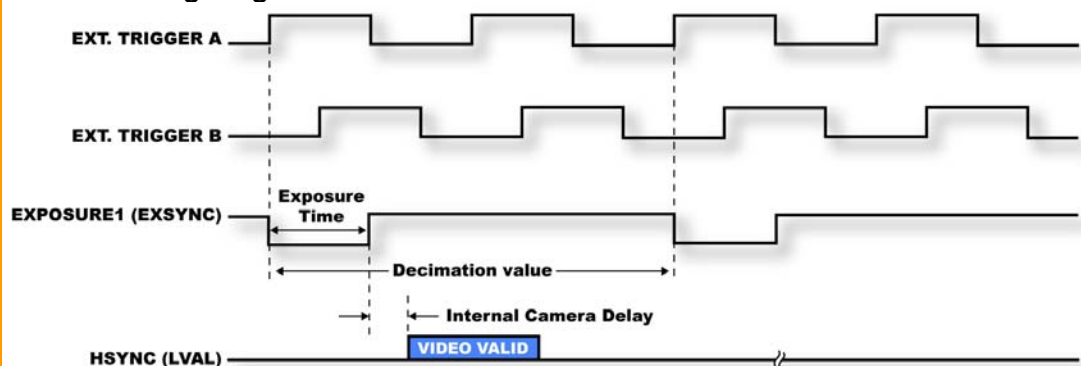
Mode 2: Variable line scan rate

▪ Timing diagram:



Mode 3: Variable line scan rate with rotary encoder

- **Line/frame rate:** The line rate is controlled by the frequency of the external LVDS line trigger signal with a Rotary Encoder format. With the Rotary Encoder approach, it is possible to force a certain decimation value to grab a line every x number of pulses from the line trigger (combination of the A and B signals). The line trigger signal controlled by the decimation value must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.50 \mu\text{s}$) or slower than the maximum line rate of the camera. The DCF is done for a forward direction from the Rotary Encoder.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 2: Variable line scan rate.
- **Timing diagram:**



* The decimation value showed in this timing diagram is eight (8).

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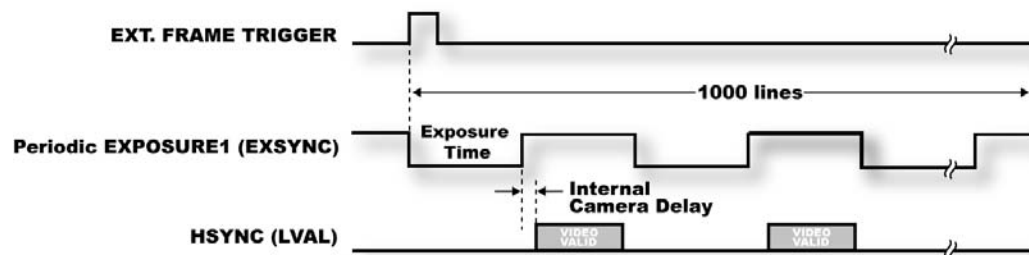
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Specifics about the
interface modes

Camera Interface Details (cont.)

Mode 4: Fixed line scan rate with frame trigger

- **Line/frame rate:** The line rate is fixed and controlled by the frequency of EXPOSURE1 (EXSYNC) signal. The default exposure time for this DCF is **33 μ s**. The virtual frame rate is variable and controlled by the period of the external frame trigger signal, however the external frame trigger period must always be greater than the total time of the number of lines captured. The number of lines per virtual frame (maximum of 1000 for this DCF) is fixed and controlled by the vertical timing of the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 1: Fixed line scan rate.
- **Timing diagram:**



Mode 5: Variable line scan rate with frame trigger

- **Line/frame rate:** The line rate is controlled by the frequency of the external TTL line trigger signal. The line trigger signal period must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.50 \mu$ s) or slower than the maximum line rate of the camera. The default exposure time for this DCF is **33 μ s**. The virtual frame rate is variable and controlled by the period of the external frame trigger signal, however the external trigger period must always be greater than the total time of the number of lines captured. The number of lines per virtual frame (1000 for this DCF) is fixed and controlled by the vertical timing of the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 2: Variable line scan rate.

Continued....

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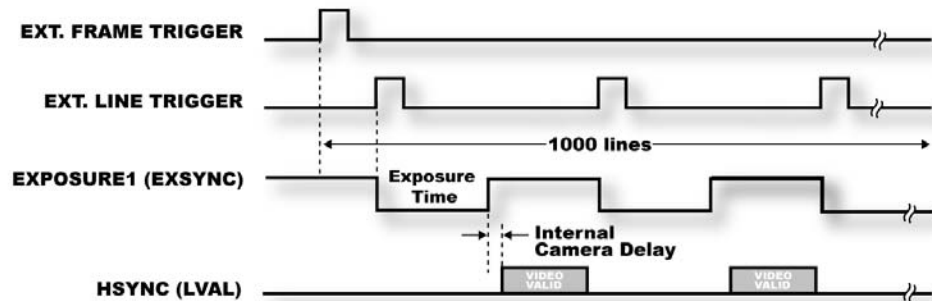
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Specifics about the
interface modes

Camera Interface Details (cont.)

Mode 5: Variable line scan rate with frame trigger

▪ Timing diagram:



Mode 6: Variable line scan rate with rotary encoder and frame trigger

- **Line/frame rate:** The line rate is controlled by the frequency of the external LVDS line trigger signal with a Rotary Encoder format. With the Rotary Encoder approach, it is possible to force a certain decimation value to grab a line every x number of pulses from the line trigger (combination of the A and B signals). The line trigger signal controlled by the decimation value must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.50 \mu\text{s}$) or slower than the maximum line rate of the camera. The DCF is done for a forward direction from the Rotary Encoder. The number of lines per virtual frame (maximum of 1000 for this DCF) is variable and controlled by the frame trigger signal. Matrox Helios eCL/XCL captures lines during the high level of the frame trigger signal. To modify the maximum amount of lines captured, change the active vertical timing period in the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 1: Fixed line scan rate.

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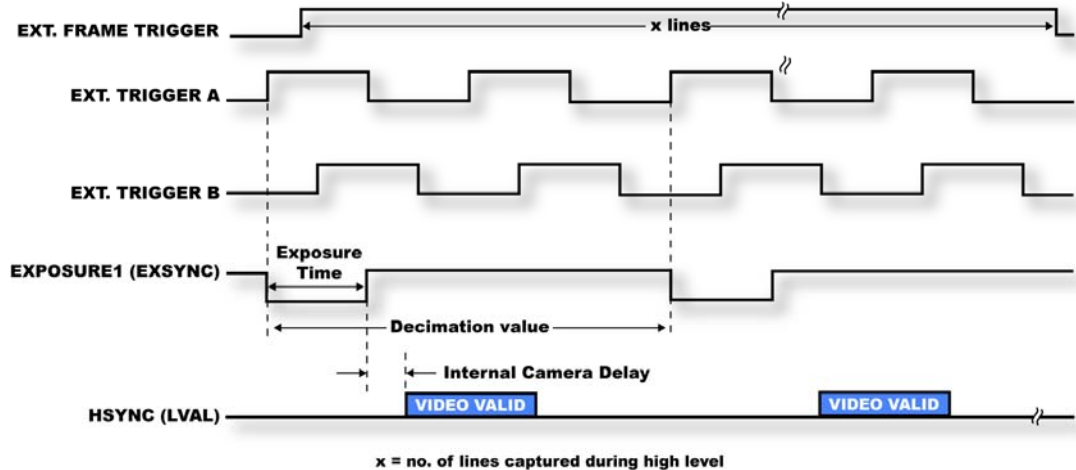
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Specifics about the
interface modes

Camera Interface Details (cont.)

Mode 6: Variable line scan rate with rotary encoder and frame trigger

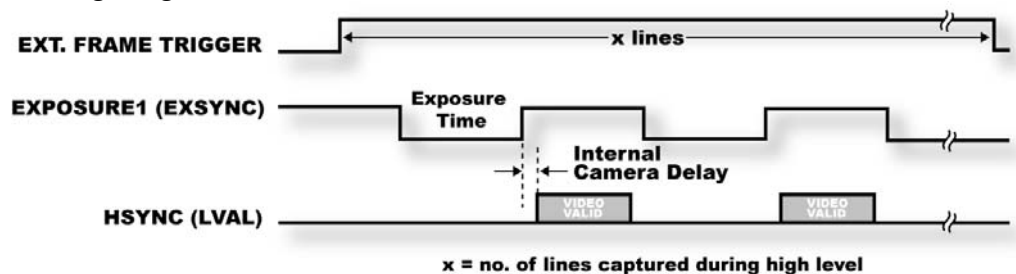
▪ Timing diagram:



* The decimation value shown in this timing diagram is eight (8).

Mode 7: Fixed line scan rate with variable frame size

- **Line/frame rate:** The line rate is fixed and controlled by the frequency of EXPOSURE1 (EXSYNC) signal. The default exposure time for this DCF is 33 μ s. The number of lines per virtual frame (maximum of 1000 for this DCF) is variable and controlled by the frame trigger signal. Matrox Helios eCL/XCL captures lines during the high level of the frame trigger signal. To modify the maximum amount of lines captured, change the active vertical timing period in the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 1: Fixed line scan rate.
- **Timing diagram:**



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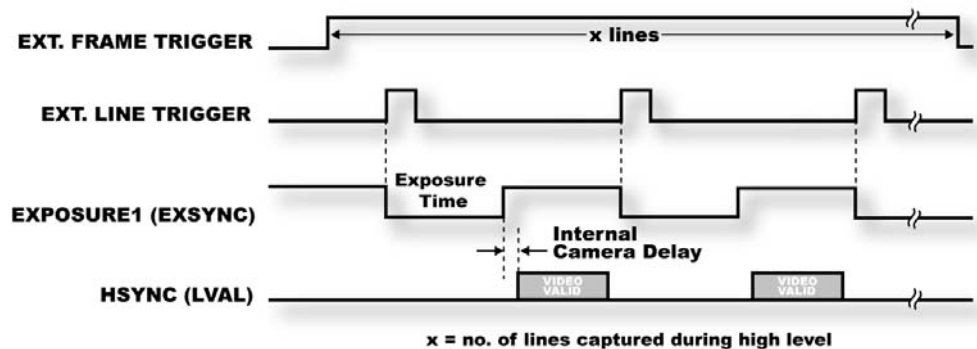
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Specifics about the
interface modes

Camera Interface Details (cont.)

Mode 8: Variable line scan rate with variable frame size

- **Line/frame rate:** The line rate is variable and controlled by the external line trigger frequency. The line trigger signal period must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.50 \mu\text{s}$) or slower than the maximum line rate of the camera. The default exposure time for this DCF is **33 μs** . The number of lines per virtual frame (maximum of 1000 for this DCF) is variable and controlled by the frame trigger signal. Matrox Helios eCL/XCL captures lines during the high level of the frame trigger signal. To modify the maximum amount of lines captured, change the active vertical timing period in the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 2: Variable line scan rate.
- **Timing diagram:**



Mode 9: Variable line scan rate with rotary encoder and variable frame size

- **Line/frame rate:** The line rate is controlled by the frequency of the external LVDS line trigger signal with a Rotary Encoder format. With the Rotary Encoder approach, it is possible to force a certain decimation value to grab a line every x number of pulses from the line trigger (combination of the A and B signals). The line trigger signal controlled by the decimation value must be larger than the total duration of the exposure time (low level duration of the timer), the internal delay of the camera ($\approx 2.50 \mu\text{s}$) or slower than the maximum line rate of the camera. The DCF is done for a forward direction from the Rotary Encoder. The number of lines per virtual frame (maximum of 1000 for this DCF) is variable and controlled by the frame trigger signal. Matrox Helios eCL/XCL captures lines during the high level of the frame trigger signal. To modify the maximum amount of lines captured, change the active vertical timing period in the DCF. Capture of the lines will start with the rising edge of the frame trigger signal.

Continued...

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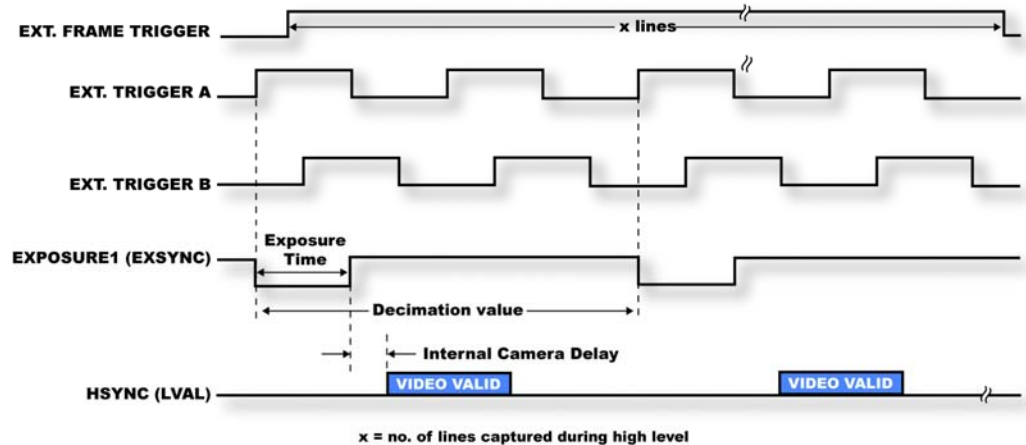
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Specifics about the
interface modes

Camera Interface Details (cont.)

Mode 9: Variable line scan rate with rotary encoder and variable frame size

- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** Refer to Mode 2: Variable line scan rate.
- **Timing diagram:**



* The decimation value showed in this timing diagram is eight (8).

Cabling details for the
interface modes

Cabling Requirements

Mode 1: Fixed line scan rate

- **Cable and Connection:** Standard Camera Link cable.

Mode 2: Variable line scan rate

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External line trigger should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin Name	Pin no.	External Trigger Source
OPTO_AUX_IN0 +	07	← LINE TRIGGER (TTL FORMAT)
OPTO_AUX_IN0 -	02	← LINE TRIGGER (GROUND)

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Cabling details for the
interface modes

Cabling Requirements

Mode 3: Variable line scan rate with rotary encoder

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External line trigger should be connected to the 9-pin and 44-pin connectors on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin Name	Pin no.		External Trigger Source Pin Name
P0_LVDS_AUX_IN0 +	08	←	Line TRIGGER A + (LVDS FORMAT)
P0_LVDS_AUX_IN0 -	03	←	Line TRIGGER A - (LVDS FORMAT)

(44-pin connector)

Pin Name	Pin no.		External Trigger Source Pin Name
P0_LVDS_AUX_IN1 +	37	←	Line TRIGGER B + (LVDS FORMAT)
P0_LVDS_AUX_IN1 -	23	←	Line TRIGGER B - (LVDS FORMAT)

Mode 4: Fixed line scan rate with frame trigger

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame trigger should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin Name	Pin no.		External Trigger Source Pin Name
OPTO_AUX_IN1 +	04	←	FRAME TRIGGER (TTL FORMAT)
OPTO_AUX_IN1 -	05	←	FRAME TRIGGER (GROUND)

Mode 5: Variable line scan rate with frame trigger

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame/line triggers should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
OPTO_AUX_IN1 +	04	←	FRAME TRIGGER (TTL FORMAT)
OPTO_AUX_IN1 -	05	←	FRAME TRIGGER (GROUND)
OPTO_AUX_IN0 +	07	←	LINE TRIGGER (TTL FORMAT)
OPTO_AUX_IN0 -	02	←	LINE TRIGGER (GROUND)

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Cabling details for the
interface modes

Cabling Requirements

Mode 6: Variable line scan rate with rotary encoder and frame trigger

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame/line triggers should be connected to the 9-pin and 44-pin connectors on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
P0_LVDS_AUX_IN0 +	08	←	Line TRIGGER A + (LVDS FORMAT)
P0_LVDS_AUX_IN0 -	03	←	Line TRIGGER A - (LVDS FORMAT)

(44-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
P0_LVDS_AUX_IN1 +	37	←	Line TRIGGER B + (LVDS FORMAT)
P0_LVDS_AUX_IN1 -	23	←	Line TRIGGER B - (LVDS FORMAT)
LVDS_AUX_IN1 +	12	←	FRAME TRIGGER (LVDS FORMAT)
LVDS_AUX_IN1 -	28	←	FRAME TRIGGER (LVDS FORMAT)

Mode 7: Fixed line scan rate with variable frame size

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame trigger should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
OPTO_AUX_IN1 +	04	←	FRAME TRIGGER (TTL FORMAT)
OPTO_AUX_IN1 -	05	←	FRAME TRIGGER (GROUND)

Mode 8: Variable line scan rate with variable frame size

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame/line triggers should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
OPTO_AUX_IN1 +	04	←	FRAME TRIGGER (TTL FORMAT)
OPTO_AUX_IN1 -	05	←	FRAME TRIGGER (GROUND)
OPTO_AUX_IN0 +	07	←	LINE TRIGGER (TTL FORMAT)
OPTO_AUX_IN0 -	02	←	LINE TRIGGER (GROUND)

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Cabling details for the
interface modes

Cabling Requirements

Mode 9: Variable line scan rate with rotary encoder and variable frame size

- **Cable and Connection:** Standard Camera Link.
- **External trigger:** External frame/line triggers should be connected to the 9-pin connector on the External I/O adapter bracket:

EXTERNAL I/O BRACKET

(9-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
P0_LVDS_AUX_IN0 +	08	←	Line TRIGGER A + (LVDS FORMAT)
P0_LVDS_AUX_IN0 -	03	←	Line TRIGGER A - (LVDS FORMAT)

(44-pin connector)

Pin name	Pin no.		External Trigger Sources Pin name
P0_LVDS_AUX_IN1 +	37	←	Line TRIGGER B + (LVDS FORMAT)
P0_LVDS_AUX_IN1 -	23	←	Line TRIGGER B - (LVDS FORMAT)
LVDS_AUX_IN1 +	12	←	FRAME TRIGGER (LVDS FORMAT)
LVDS_AUX_IN1 -	28	←	FRAME TRIGGER (LVDS FORMAT)

The DCFs mentioned in this application note are also attached (embedded) to this PDF file – use the Adobe Reader's View File Attachment to access the DCF files. The information furnished by Matrox Electronics System, Ltd. is believed to be accurate and reliable. Please verify all interface connections with camera documentation or manual. Contact your local sales representative or Matrox Sales office or Matrox Imaging Applications at 514-822-6061 for assistance. © Matrox Electronic Systems Ltd, 2009-2011.

Matrox Electronic Systems Ltd.

1055 St. Regis Blvd.
Dorval, Quebec H9P 2T4
Canada
Tel: (514) 685-2630
Fax: (514) 822-6273

HEL-CID-103

