

Matrox Helios eCL/XCL

Camera Interface Application Note

NED XCM8040SA

April 2, 2008

Basics about the
camera

Camera Descriptions

- Effective resolution: Up to 8192 pixels/line @ up to 18.65k line per second.
- Camera Link FULL interface (4 taps, 10-bit).
- External and internal sync.
- External or internal exposure control.
- 40 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

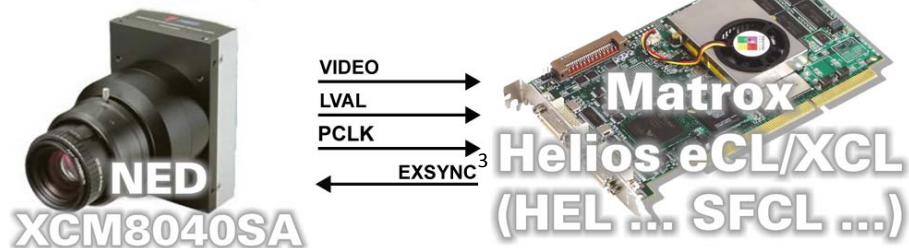
Mode of operations as
per Matrox Imaging (in
parentheses as per
camera manufacturer)

Basics about the
interface modes

Camera Interface Briefs

Mode 1: Fixed line scan rate

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC)³ signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsFLS.DCF](#)



¹ EXSYNC, Ext Level controlled or Free Run programmable

² EXSYNC, level-controlled

³ EXPOSURE1 (EXSYNC) signal not required with Free Run mode.

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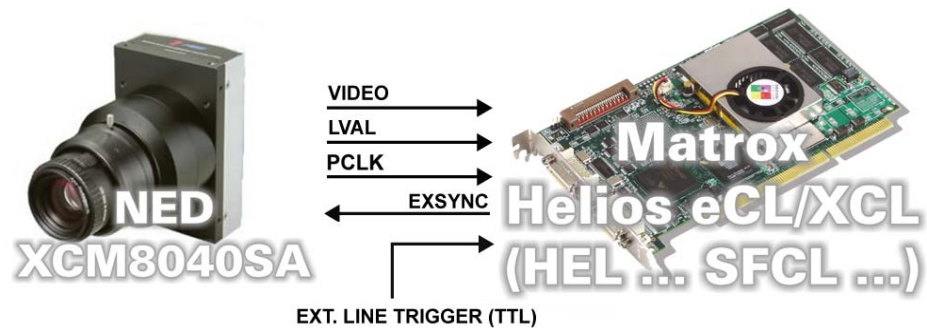
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Basics about the
interface modes

Camera Interface Briefs

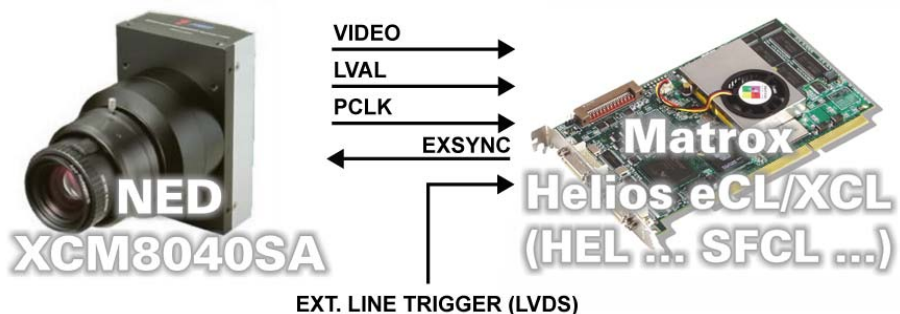
Mode 2: Variable line scan rate

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-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 (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLS.DCF](#)



Mode 3: Variable line scan rate with rotary encoder

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external LVDS line trigger signal.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLSRE.DCF](#)



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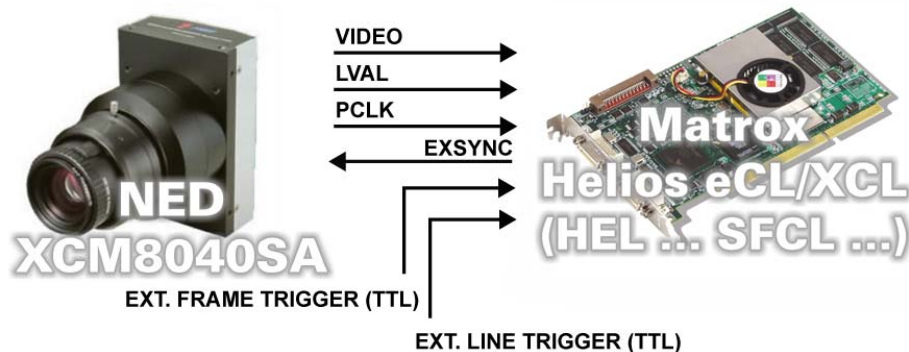
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Basics about the
interface modes

Camera Interface Briefs (cont.)

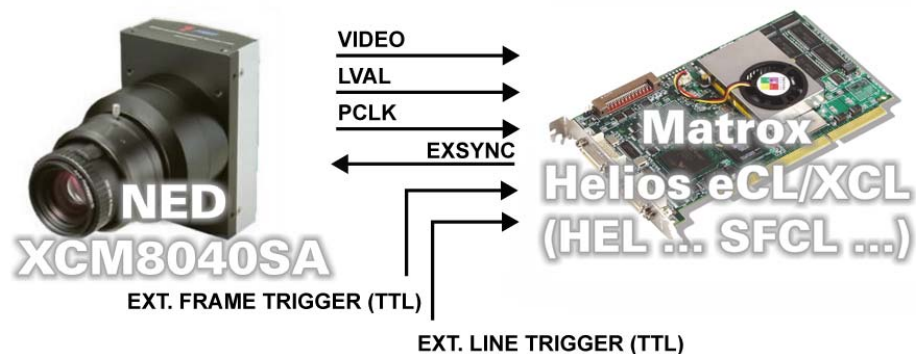
Mode 4: Fixed line scan rate with frame trigger

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame and line trigger signals.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsFLSFT.DCF](#)



Mode 5: Variable line scan rate with frame trigger

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame and line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLSFT.DCF](#)



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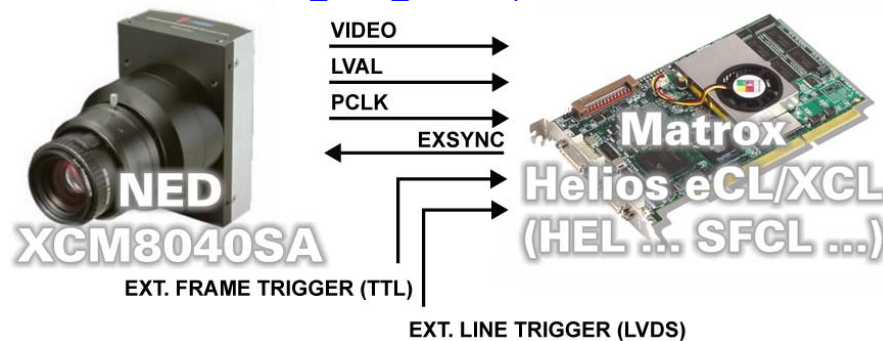
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Basics about the
interface modes

Camera Interface Briefs (cont.)

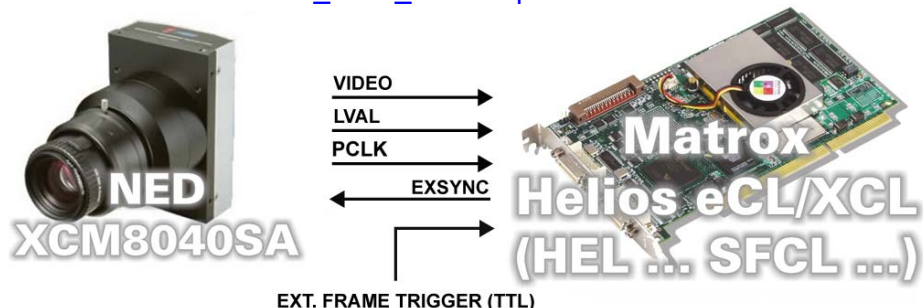
Mode 6: Variable line scan rate with rotary encoder and frame trigger

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame and LVDS line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLSFTRE.DCF](#)



Mode 7: Fixed line scan rate with variable frame size

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame trigger signal.
- Matrox Helios eCL/XCL sending periodic EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsFLSVF.DCF](#)



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Camera Interface Application Note

NED XCM8040SA

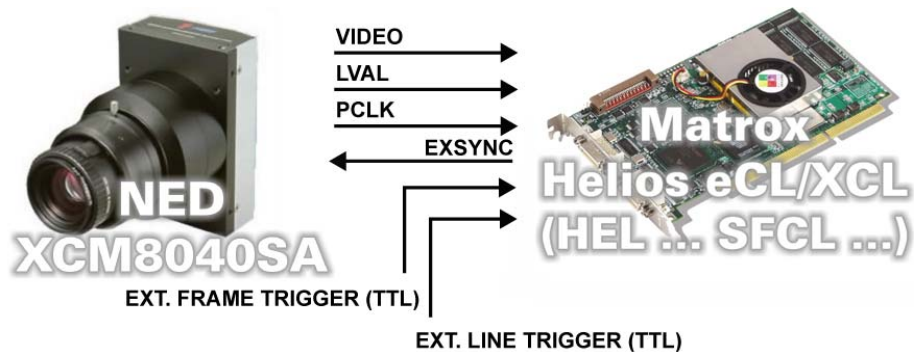
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Basics about the
interface modes

Camera Interface Briefs (cont.)

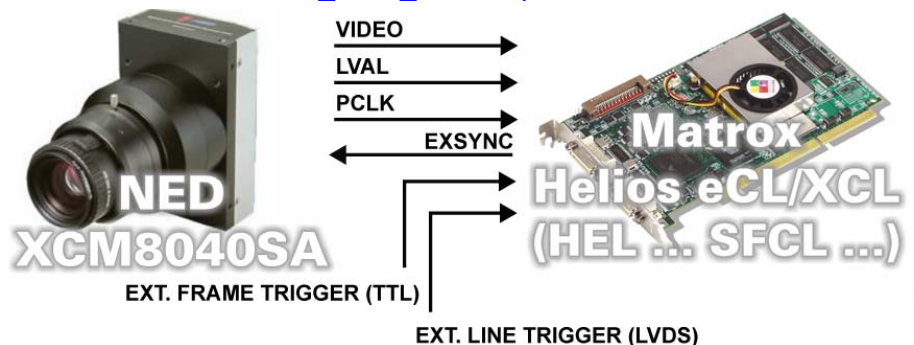
Mode 8: Variable line scan rate with variable frame size

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame and line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLSVF.DCF](#)



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

- 8192 pixels/line.
- Camera Link FULL interface (Four 10-bit taps).
- DCF configured for 1000 lines per virtual frame.
- Matrox Helios eCL/XCL receiving external TTL frame and LVDS line trigger signals.
- Matrox Helios eCL/XCL sending EXPOSURE1 (EXSYNC) signal to camera.
- Matrox Helios eCL/XCL receiving LVAL, PIXEL CLOCK (@ 40 MHz) and video data from camera.
- DCF used: [XCM8040SA_8192_10bit4tapsVLSVFRE.DCF](#)



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Camera Interface Application Note

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Specifics about the
interface modes

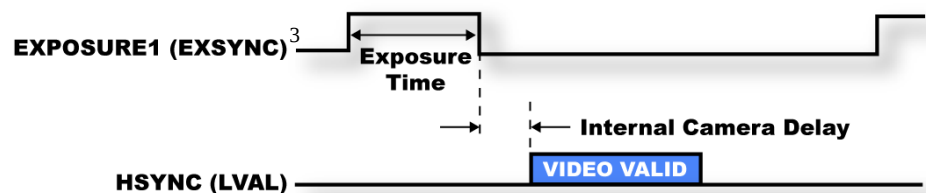
Camera Interface Details

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 **18.65 kHz**.
- **Exposure time:** For **Ext Level controlled** mode the exposure time is the high level period between the rising and falling edges of the EXPOSURE1 (EXSYNC) signal. The default exposure time for this DCF is **54 μ s**. Minimum exposure time per line for this DCF is **53.6 ms**. 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 **Ext Level controlled** modes however **Ext Level controlled** is the recommended mode for use with this DCF. Set the mode using the NED CLISBeeCtrl camera configuration utility. Refer to the camera manual for additional information.

Parameter	Setting
Video Data Output Mode	voa 1,0 = 4 taps, 10-bit
Exposure Time Control Mode	inm 2 Ext 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 (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu$ s) or slower than the maximum line rate of the camera.
- **Exposure time:** Refer to Mode 1: Fixed line scan rate.
- **Camera communication:** **Ext Level controlled** is the recommended mode for use with this DCF. Set the mode using the NED CLISBeeCtrl camera configuration utility. Refer to the camera manual for additional information.

Parameter	Setting
Video Data Output Mode	voa 1,0 = 4 taps, 10-bit
Exposure Time Control Mode	inm 2 Ext Level controlled

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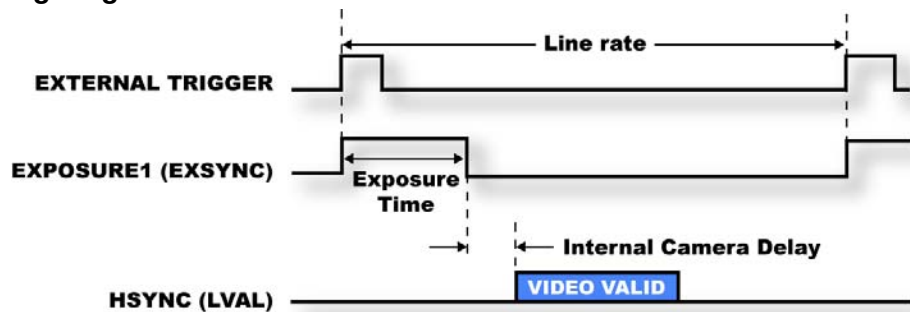
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Specifics about the
interface modes

Camera Interface Details (cont.)

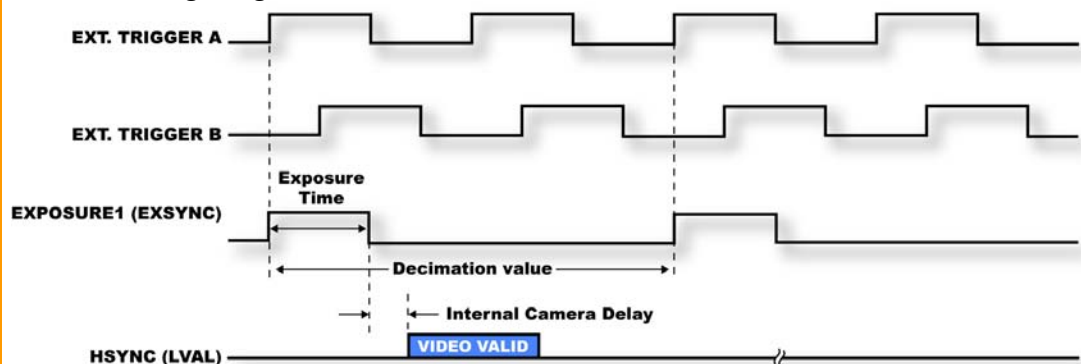
Mode 2: Variable line scan rate

▪ 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 (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu\text{s}$) 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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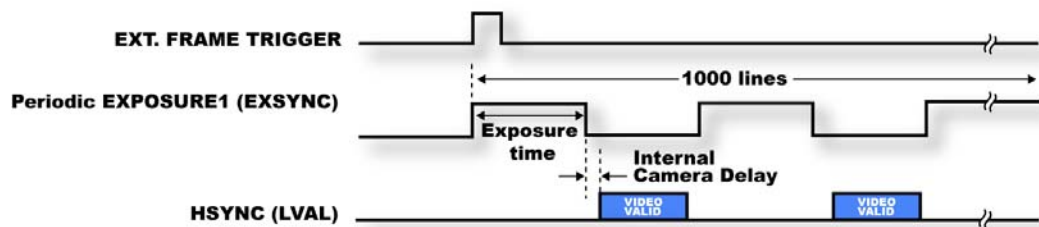
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Specifics about the
interface modes

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 **54 μ s**. The virtual frame rate is variable and controlled by the period of the external frame trigger signal, however the external TTL 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 (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu$ s) or slower than the maximum line rate of the camera. The default exposure time for this DCF is **54 μ s**. The virtual frame rate is variable and controlled by the period of the external TTL 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.

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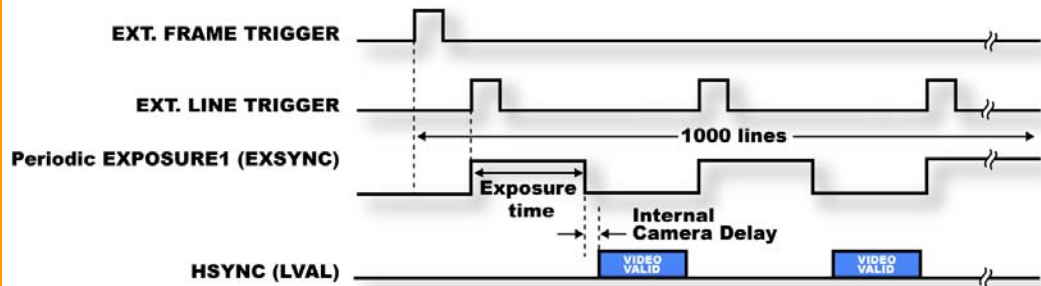
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Specifics about the
interface modes

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 (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu\text{s}$) 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 TTL 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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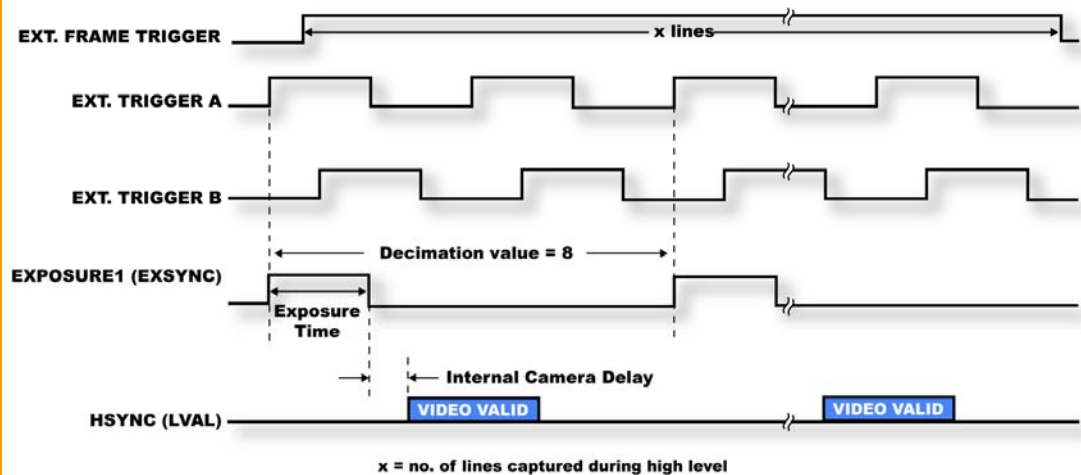
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Specifics about the
interface modes

Camera Interface Details (cont.)

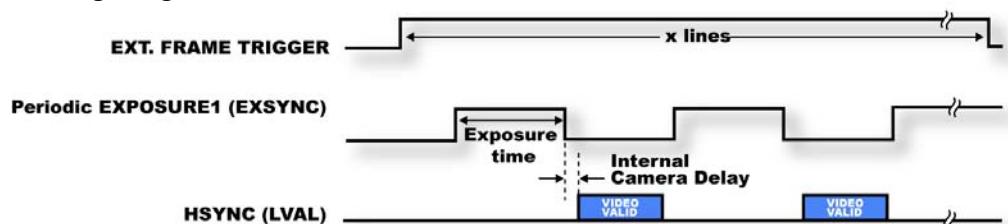
Mode 6: Variable line scan rate with rotary encoder and frame trigger

▪ Timing diagram:



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 54 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 external TTL 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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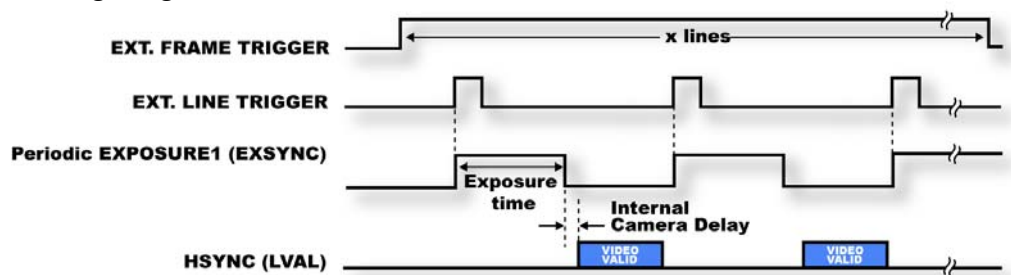
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Specifics about the
interface modes

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 TTL line trigger frequency. The line trigger signal period must be larger than the total duration of the exposure time (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu\text{s}$) or slower than the maximum line rate of the camera. The default exposure time for this DCF is **54 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 external TTL 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 (high level duration of the timer), plus the internal delay of the camera ($\approx 3.2 \mu\text{s}$) 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 external TTL 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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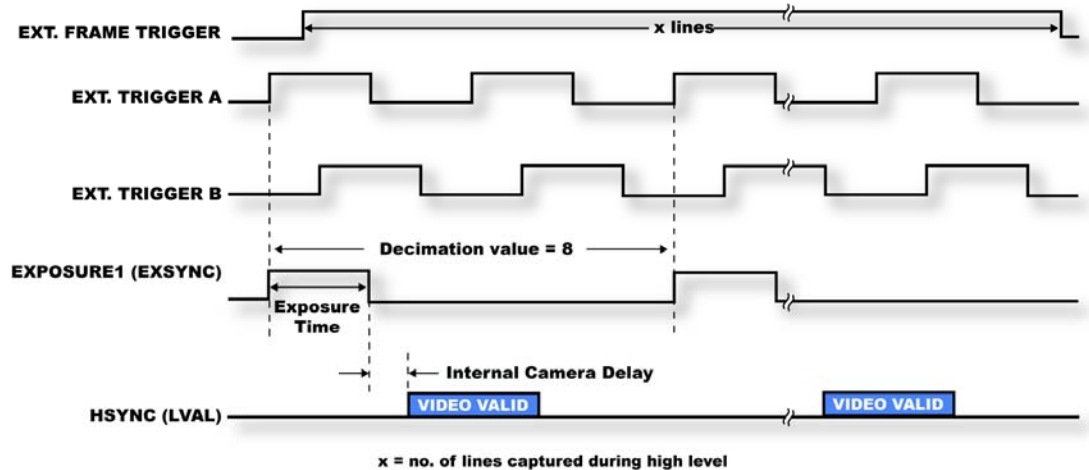
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Specifics about the
interface modes

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:**



Cabling details for the
interface modes

Cabling Requirements

Mode 1: Fixed line scan rate

- **Cable and Connection:** Two standard Camera Link cables.

Mode 2: Variable line scan rate

- **Cable and Connection:** Two standard Camera Link cables.
- **External trigger:** External line trigger should be connected to the OPTO TRIG input of the 9-pin connector (pins 7 and 2) 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_IN0 +	07	←	LINE TRIGGER (TTL FORMAT)
OPTO_AUX_IN0 -	02	←	LINE TRIGGER (GROUND)

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Camera Interface Application Note

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Cabling details for the
interface modes

Cabling Requirements (cont.)

Mode 3: Variable line scan rate with rotary encoder

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame and line triggers should be connected to the Frame Trigger (pins 4 and 5 of DB-9 connector), LVDS Auxiliary Input 0 (pins 8 and 3 of the DB-9 connector), and LVDS Auxiliary Input 1 (pins 37 and 23 of the HD-44 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_IN0 +	07	←	LINE TRIGGER (TTL FORMAT)
OPTO_AUX_IN0 -	02	←	LINE TRIGGER (GROUND)
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

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame trigger should be connected to the OPTO TRIG input of the 9-pin connector (pins 4 and 5) 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

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame and line triggers should be connected to the OPTO TRIG inputs of the 9-pin connector (pins 4 & 5 and pins 7 & 2) 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 (cont.)

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

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame and line triggers should be connected to the Frame Trigger (pins 4 and 5 of DB-9 connector), LVDS Auxiliary Input 0 (pins 8 and 3 of the DB-9 connector), and LVDS Auxiliary Input 1 (pins 37 and 23 of the HD-44 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)
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)

Mode 7: Fixed line scan rate with variable frame size

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External trigger should be connected to the OPTO TRIG input (pins 4 and 5) of 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)

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Cabling details
for the interface modes

Cabling Requirements (cont.)

Mode 8: Variable line scan rate with variable frame size

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame and line triggers should be connected to the OPTO TRIG inputs (pins 4 & 5 and pins 7 & 2) of 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)

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

- **Cables and Connection:** Two standard Camera Link cables.
- **External trigger:** External frame and line triggers should be connected to the Frame Trigger (pins 4 and 5 of DB-9 connector), LVDS Auxiliary Input 0 (pins 8 and 3 of the DB-9 connector), and LVDS Auxiliary Input 1 (pins 37 and 23 of the HD-44 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)
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)

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, 2008-2011.

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