JAI ®

See the possibilities

User's Manual

AD-081CL

*Digital 2CCD Progressive Scan
HDR / High Frame Rate Camera*

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Notice

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Warranty

For information about the warranty, please contact your factory representative.

Certifications

CE compliance

As defined by the Directive 2004/108/EC of the European Parliament and of the Council, EMC (Electromagnetic compatibility), JAI Ltd., Japan declares that AD-081CL complies with the following provisions applying to its standards.
EN 61000-6-3   (Generic emission standard part 1)
EN 61000-6-2   (Generic immunity standard part 1)

FCC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into a outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning
Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

AD-081CL

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1.   General

The AD-081CL is a unique prism-based 2CCD camera, incorporating two monochrome CCD sensors with sensitivity in the visible spectrum. The prism-based design enables a single optical path to be split across both CCDs simultaneously while maintaining alignment to within one-quarter pixel. By altering the shutter and/or gain of the two CCDs and fusing the two synchronized video streams during post-processing, the AD-081CL can provide more than double the dynamic range of standard CCD cameras while maintaining high image quality.

Alternatively, the timing of each CCD's readout can be offset by one-half frame and interleaved together to produce double the normal frame rate without any image degradation from over-clocking the CCDs.

The AD-081CL is equipped with continuous mode, pre-select trigger mode, pulse width trigger mode and PIV (Particle Image Velocimetry) mode.

The AD-081CL uses a standard Camera Link interface, whereby each channel can output images with 8- or 10-bit depth.

2.   Camera nomenclature

The standard camera composition consists of the camera main body and Sensor protection cap.

The camera is available in the following version.

AD-081CL
Where **A** stands for "Advanced family" , **D** stands for "Dual CCD", **080** represents the resolution "800K pixels" , **081** stands for the extension of product range and **CL** stands for Camera Link^{TM} Interface.

3. Main Features

- 2-monochrome progressive scan CCDs (1/3") mounted on an optical prism
- Member of the C3 Advanced series
- 1024 (h) x 768 (v) active pixels per channel
- 4.65 µm square pixels
- Two Camera Link connectors provided for separate or combined output
- 30 frames/second with full resolution when used for high dynamic range image fusion
- 60 frames / second with full resolution for interleaved high frame rate operation
- Increased frame rates with partial scan - 1/2, 1/4 and 1/8 screen
- Vertical binning function provided
- Programmable exposure from 20µs to 33ms
- 11-step preset shutter from 1/60s to 1/50000s
- Pre-select and pulse width trigger modes
- PIV (Particle Image Velocimetry) mode available
- LVAL synchronous/asynchronous operation (auto-detect)
- Analog video output for auto-iris lens control
- 10- or 8-bit Camera Link output
- Built-in AGC to balance interleaved frames
- Setup by Windows NT/2000/XP via serial communication

4.   Locations and functions
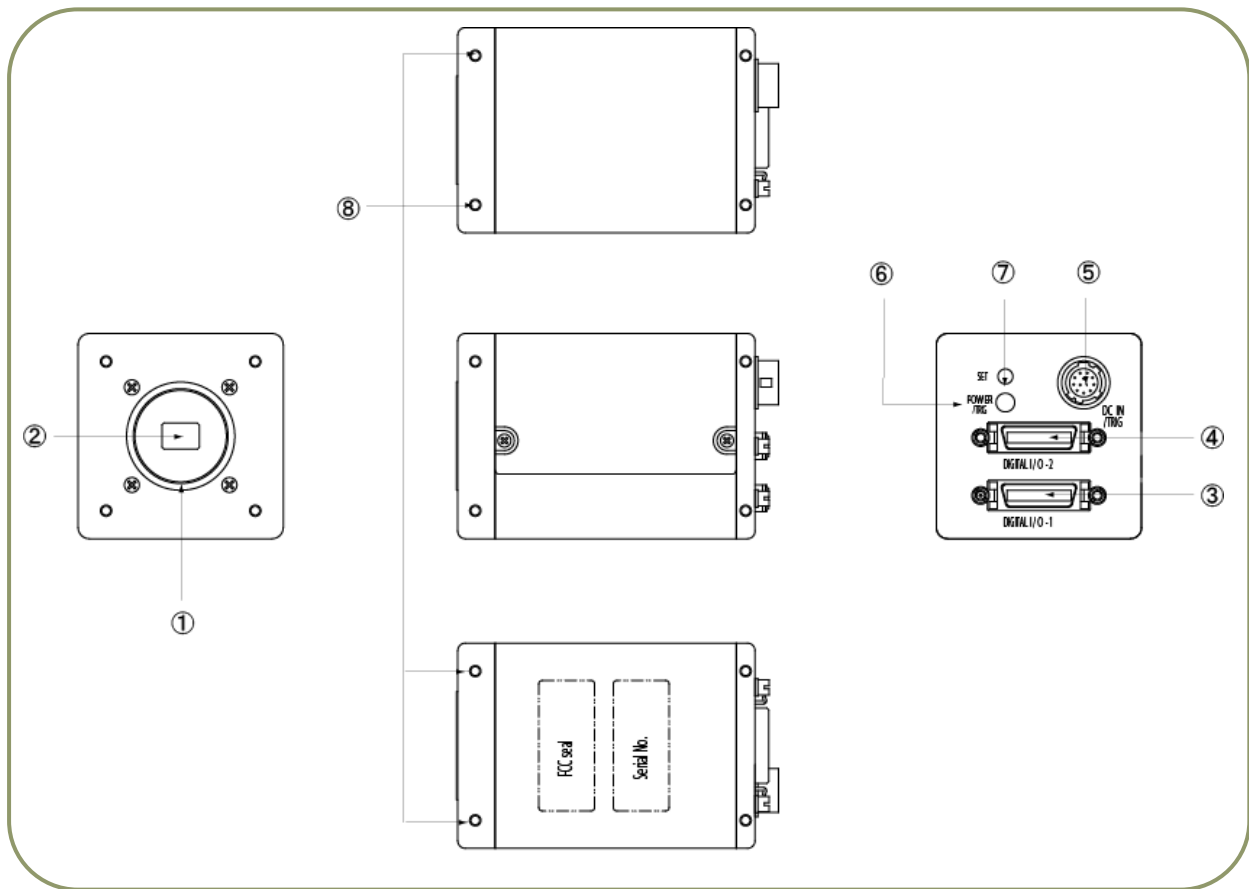
1	Lens Mount	: C-mount (Note 1)
2	CCD Sensor	: 1/3 inch CCD sensor
3	26P Multi Connector	: Camera Link connector Output 1 (Note 2)
4	26P Multi Connector	: Camera Link connector Output 2 (Note 2)
5	12P Multi Connector	: DC+12V and Trigger Input
6	LED	: Power and Trigger indications
7	Push Button	: For Auto Luminance balance
8	Mounting holes	: M3, max length 5mm

(Note 1)
AD-081CL uses Prism Optics. C-mount lens should be designed for interfacing to a 3-CCD camera. Rear protrusion of the C-mount lens must be less than 4mm to avoid damage to the prism.

(Note 2)
When a Camera Link cable is connected to the camera, please do not excessively tighten screws by using a driver, as the Camera Link receptacle on the camera could get damaged. For security, the strength to tighten screws should be less than 0.291 Newton meter (Nm), (Manufacturer's recommendation). It is sufficient to tighten the screws by fingers.

Fig.1. Locations

See the possibilities

5. Pin configuration

5.1 12-pin multi connector (DC in / Trigger in)

Type: HR-10A-10R-12PB
(Hirose) male
(Seen from rear of the camera)

Fig.2. 12-pin connector
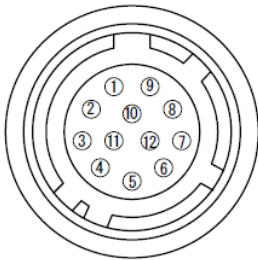
No	In/Out	Name	Remarks
1		GND	
2		DC (+12V) in	
3		GND	
4	O	Iris Video	For Auto iris lens
5		GND	
6	O	XEEN1	Negative Logic
7	O	XEEN2	
8		GND	
9			
10	I	Trigger1	External trigger
11	I	Trigger2	External trigger
12		GND	

5.2 Digital Output Connector (Camera Link^{TM})

Type: 3M 10226-1A10JL
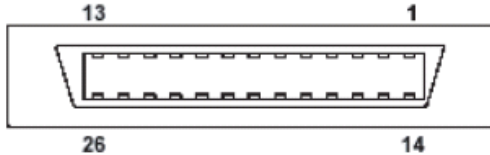
Fig.3. 26-pin Camera Link connector

Pin No	CameraLink Connector 1		CameraLink Connector 2		Remarks
	In/Out	Name	In/Out	Name	
1,14		Shield		Shield	GND
2(-),15(+)	O	TxOUT0	O	TxOUT0	Data output
3(-),16(+)	O	TxOUT1	O	TxOUT1	
4(-),17(+)	O	TxOUT2	O	TxOUT2	
5(-),18(+)	O	TxClk	O	TxClk	Clock for CL
6(-),19(+)	O	TxOUT3	O	TxOUT3	Data output
7(+),20(-)	I	SerTC (RxD)	I	SerTC (RxD)	LVDS serial control
8(-),21(+)	O	SerTFG (TxD)	O	SerTFG (TxD)	
9(-),22(+)	I	CC1 (Trigger)	I	CC1 (Trigger)	External trigger IN
10(+),23(-)		N.C		N.C	
11,24		N.C		N.C	
12,25		N.C		N.C	
13,26		Shield		Shield	GND

5.3 Input and output circuits

In the following schematic diagrams the input and output circuits for video and timing signals are shown.

5.3.1 Iris Video output

This signal can be used for lens iris control in Continuous mode. The signal is taken from the CCD sensor output before the gain circuit. The video output is without sync. The signal is 0.7 V p-p from 75 Ω without termination. The signal from Imager 1 is used for this purpose.
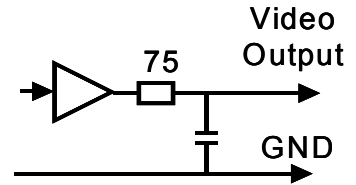
Fig.4. Iris video circuit

5.3.2 Trigger input

An external trigger input can be applied to pin 10 and 11 of 12-pin Hirose connector (when the command TI1/TI2=1 have been set).
The input is AC coupled. To allow long pulses the input circuit is designed as a flip-flop circuit. The leading and trailing edges of the trigger pulse activate the circuit.
The trigger polarity can be changed by TP1/TP2=1.
Trigger input level 4 V ±2 V.
Trigger can also be applied through the Camera Link connector, when the commands TI1/TI2=0 have been sent.
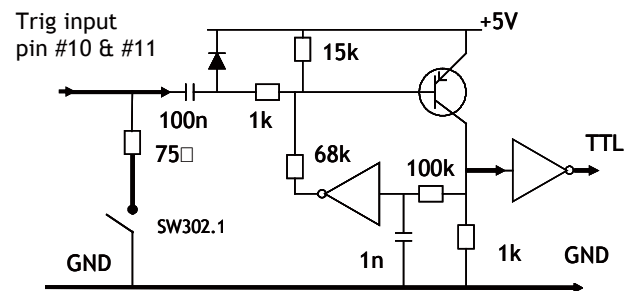
Fig.5. Trigger circuit

5.3.3 XEEN (Exposure Enable) output

XEEN is available on pin 6 and 7 of the 12-pin HR connector. The output circuit is 75 Ω complementary emitter followers. It will deliver a full 5 volt signal.
Output level ≥4 V from 75Ω. (No termination).
EEN is also found in Camera Link.
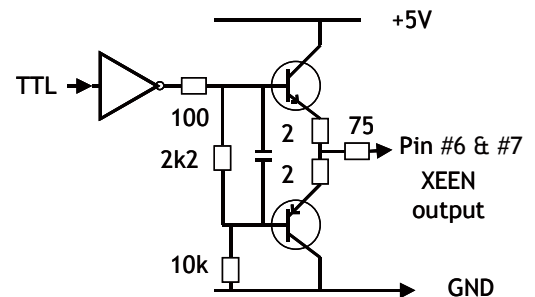
Fig.6. XEEN output circuit

5.3.4 Camera Link Interface

The video output is possible as 10/8-bit monochrome signals via standard Camera Link interface.

The pin configuration of 26-pin connector conforms to Camera Link BASE configuration. However, since AD-081CL camera has various outputs, pin assignment depends on the specific output mode selected.

For details, please refer the table shown on the next page.

Port/ Signal	Camera Link Connector - 1				Camera Link connector - 2				Pin No.
	BW1 10bit output	BW1 8bit output	BW1 10bit BW2 10bit output * note)	BW1 8bit BW2 8bit output * Note)	BW2 10bit output	BW2 8bitoutput	BW2 10bit BW1 10bit output * Note)	BW2 8bit BW1 8bit output * Note)	
Port A0	BW1_D0	BW1_D0	BW1_D0	BW1_D0	BW2_D0	BW2_D0	BW2_D0	BW2_D0	Tx0
Port A1	BW1_D1	BW1_D1	BW1_D1	BW1_D1	BW2_D1	BW2_D1	BW2_D1	BW2_D1	Tx1
Port A2	BW1_D2	BW1_D2	BW1_D2	BW1_D2	BW2_D2	BW2_D2	BW2_D2	BW2_D2	Tx2
Port A3	BW1_D3	BW1_D3	BW1_D3	BW1_D3	BW2_D3	BW2_D3	BW2_D3	BW2_D3	Tx3
Port A4	BW1_D4	BW1_D4	BW1_D4	BW1_D4	BW2_D4	BW2_D4	BW2_D4	BW2_D4	Tx4
Port A5	BW1_D5	BW1_D5	BW1_D5	BW1_D5	BW2_D5	BW2_D5	BW2_D5	BW2_D5	Tx6
Port A6	BW1_D6	BW1_D6	BW1_D6	BW1_D6	BW2_D6	BW2_D6	BW2_D6	BW2_D6	Tx27
Port A7	BW1_D7	BW1_D7	BW1_D7	BW1_D7	BW2_D7	BW2_D7	BW2_D7	BW2_D7	Tx5
Port B0	BW1_D8	×	BW1_D8	BW2_D0	BW2_D8	×	BW2_D8	BW1_D0	Tx7
Port B1	BW1_D9	×	BW1_D9	BW2_D1	BW2_D9	×	BW2_D9	BW1_D1	Tx8
Port B2	×	×	×	BW2_D2	×	×	×	BW1_D2	Tx9
Port B3	×	×	×	BW2_D3	×	×	×	BW1_D3	Tx12
Port B4	×	×	BW2_D8	BW2_D4	×	×	BW1_D8	BW1_D4	Tx13
Port B5	×	×	BW2_D9	BW2_D5	×	×	BW1_D9	BW1_D5	Tx14
Port B6	×	×	×	BW2_D6	×	×	×	BW1_D6	Tx10
Port B7	×	×	×	BW2_D7	×	×	×	BW1_D7	Tx11
Port C0	×	×	BW2_D0	×	×	×	BW1_D0		Tx15
Port C1	×	×	BW2_D1	×	×	×	BW1_D1		Tx18
Port C2	×	×	BW2_D2	×	×	×	BW1_D2		Tx19
Port C3	×	×	BW2_D3	×	×	×	BW1_D3		Tx20
Port C4	×	×	BW2_D4	×	×	×	BW1_D4		Tx21
Port C5	×	×	BW2_D5	×	×	×	BW1_D5		Tx22
Port C6	×	×	BW2_D6	×	×	×	BW1_D6		Tx16
Port C7	×	×	BW2_D7	×	×	×	BW1_D7		Tx17
L V A L									Tx24
F V A L									Tx25
D V A L									Tx26
E E N									Tx23

*Note: When the output mode is set at "Separate ", only one channel signal is output.
For instance, if "BW1 10 bit/ BW2 10 bit" is selected on channel 1, only "BW1 10 bit" is output when the output mode is set at "Separate".
Command "IS" is related to this. IS=0 Synchronous and IS=1 Separate

6. Advise on camera settings

6.1 Lens considerations

AD-081CL utilizes prism optics for separating the incident light onto the two CCDs. The camera employs a C-mount for the lens but for high image quality it is strongly recommended to use lenses specifically designed for 3-CCD cameras.

6.2 About capture boards

AD-081CL has two Camera Link connectors. In order to capture the signals from both connectors, two frame grabber boards or a frame grabber board with two inputs are required. As described in the chapter 7.1.2, the configuration for the outputs can be selected to utilize only one connector. Therefore, it is still possible to capture images via a frame grabber board that has only one input.

7. Functions and operations

7.1 Basic functions

The AD-081CL utilizes prism optics to split the incident light onto two monochrome CCDs. These two images, if captured with different exposure settings, can be combined in the PC to create high dynamic range output. Alternatively, these two images can be read out in different timing to achieve a faster frame rate.

The interface to the frame grabber board is Camera Link™ BASE configuration and two connectors are used. Each connector provides 8/10 bit Monochrome signals. These signals can be output in synchronous mode or separately.

The AD-081CL has continuous mode, pre-select trigger mode, pulse width trigger mode and PIV (Particle Image Velocimetry) mode. In addition to full frame readout, 1/2, 1/4 and 1/8 partial scan readouts and vertical binning are available.

The AD-081CL is equipped with automatic detection for LVAL sync or LVAL async mode.

7.1.1 2CCD optical assembly

The AD-081CL incorporates prism optics designed for light in the visible spectrum ranging from 400nm to 650nm wavelengths. 1/2 of the incident light is reflected by the Dichroic Mirror and provides the input to Imager 2. The other half is transmitted through the prism and provides the input to Imager 1.

The following conceptual diagram illustrates this process.
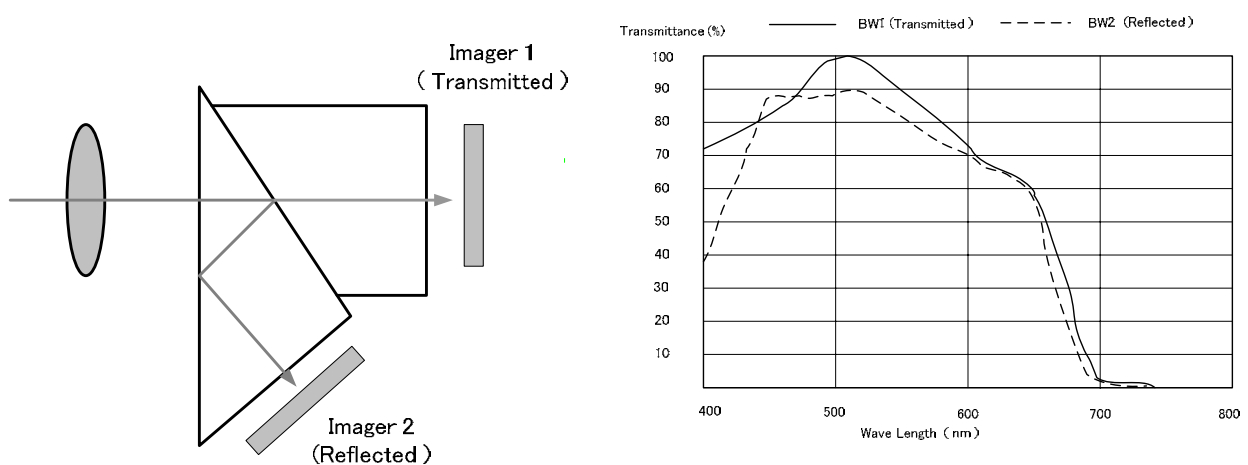
Fig 7. The conceptual diagram for 2CCD prism optics

7.1.2 Configuring Camera Link outputs (Command: OS1, OS2)

The AD-081CL has two Camera Link connectors. These two outputs can be synchronized or separated by the software command IS. Each connector can output an individual signal or two signals added as shown below. In order to output two signals through one Camera Link connector, the output mode must be set at "synchronous", IS=0.

If it is set at "Separate", IS=1, the output is automatically limited to one output.

Setting command: IS   IS=0 Synchronous   IS=1 Separated

Output IS=0,1	Camera Link 1			Camera Link 2		
	Comm.˚	Output format	Default	Comm.	Output format	Default
Sync/async	OS1=0	BW1 10 bit	◎	OS2=0	BW2 10bit	◎
Sync/async	OS1=1	BW1 8 bit		OS2=1	BW2 8bit	
Sync	OS1=2	BW1+BW2 10bit		OS2=2	BW2+BW1 10bit	
Sync	OS1=3	BW1+BW2 8bit		OS2=3	BW2+BW1 8bit	

If OS is set to 0 or 1, the camera can be operated in either Synchronous mode or Separate Mode.

In Synchronous mode, trigger 1 input is effective as a trigger for both BW1 and BW2. In case of Separate mode, trigger 1 and trigger 2 are both in effect so that different trigger timing can be applied to each camera.

7.1.3 Continuous operation or triggered operation

The AD-081CL can operate in continuous mode to support applications not requiring an external trigger.

This mode permits the use of a lens with video controlled iris. The AD-081CL uses the signal from imager 1 (BW1) for this purpose.

The external trigger signal can be input through pins number 10 and 11 of the 12-pin HIROSE connector.

These inputs can be changed to Camera Link by the command "TI". When the camera output is in "Synchronous" mode, trigger 1 input has a priority and controls two imagers. In the case of "Separate" mode, each imager operates by Trigger 1 and Trigger 2 respectively.

Trigger signal is TTL as the default setting but it can be changed to 75 ohm input by the internal DIP switch as described in Fig.8.
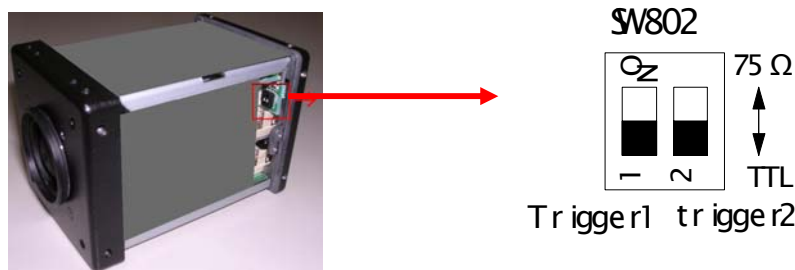
Fig.8. DIP switch

7.1.4 Digital Video output (Bit allocation)
The 10-bit digital output is set at 890 LSB as 100% video level when CCD output is 200mV.
The white clip level is set at 1023 LSB when CCD output is 230mV.

In case of the 8 bit output, it is set at 222LSB, 255LSB respectively.
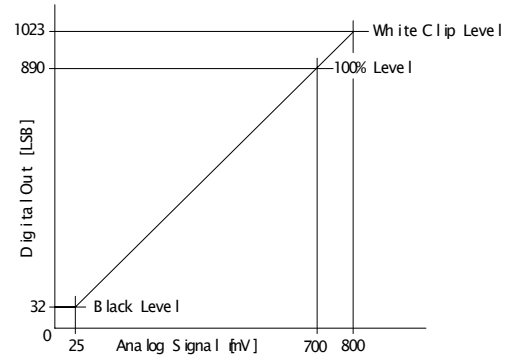
Fig.9. Digital Video Output

7.1.5 Iris Video output
The lens-iris video output on pin 4 of the 12-pin HIROSE is 700 mV for 100% video out in Camera Link. The iris video signal is taken before the gain circuit. It is without sync. The iris video signal can be used for auto iris lens drive in continuous mode only.
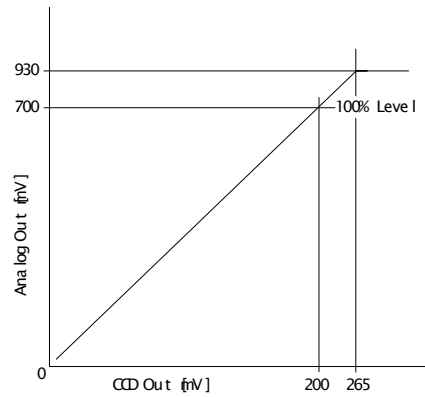
Fig.10. Iris Video output

7.1.6 Auto-detect LVAL-sync / async accumulation

This function replaces the manual setting found in older JAI cameras. Whether accumulation is synchronous or asynchronous in relationship to LVAL depends on the timing of the trigger input. When a trigger is received while FVAL is high (during readout), the camera works in LVAL-synchronous mode, preventing reset feed-through in the video signal. There is a maximum jitter of one LVAL period from issuing a trigger and accumulation start.
If a trigger is received when FVAL is low, the camera works in LVAL-asynchronous mode (no delay) mode.
This applies to both pre-select (PS) trigger mode and pulse width trigger (PW) mode.
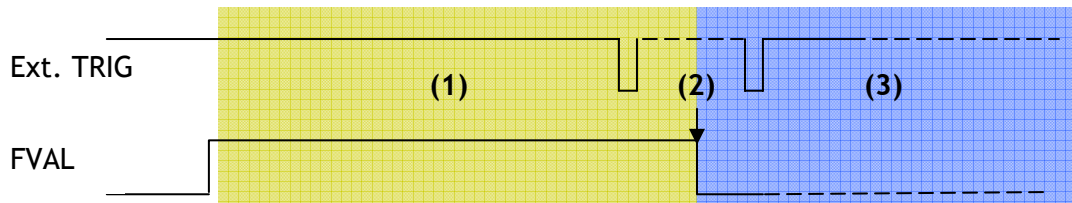
(1) In this period camera executes trigger at next LVAL (prevents feed-through noise)
(2) Avoid trigger at FVAL transition (+/- 1 LVAL period), as the function may randomly switch between "next LVAL" and "immediate".
(3) In this period camera executes trigger immediately (no delay)

Fig.11.   LVAL sync/async Automatic Detection

7.1.7 Partial scan and Color Pixels layout

Partial scan allows higher frame rates by reading out a smaller center portion of the image. This is particularly useful when inspecting objects that do not fill the whole height of the image.

Full scan   Partial Scan
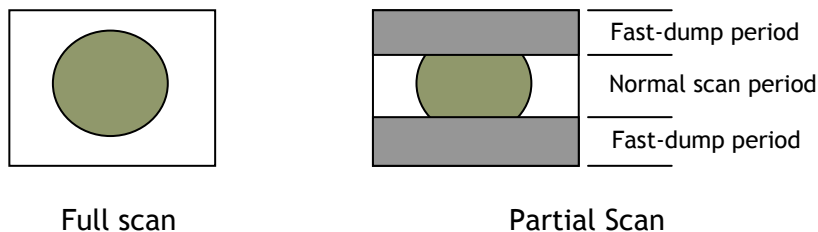
Fig.12.   Partial scan

7.1.8 Vertical Binning

The binning functions can be used to achieve higher frame rate and higher sensitivity. The drawback is lower resolution.
Vertical binning is done by adding the charge from pixels in adjacent lines in the horizontal CCD register.
The AD-081CL uses vertical binning to increase the frame rate.
Fig. 13 shows the vertical binning principle.
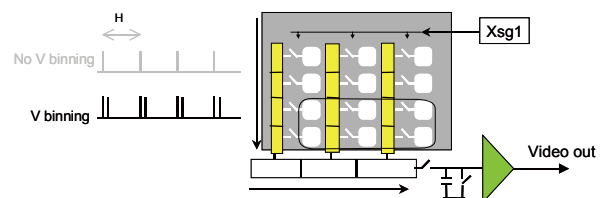
Fig.13. Vertical binning

7.1.9 Electronic shutter (Commands SM1,SM2,SH1,SH2,PE1,PE2)

The AD-081CL has two shutter modes. One is an 11-step pre-set shutter and the other is a programmable exposure mode which can be controlled from 0.5L to 792L in one-line increments.

Pre-set Shutter (SH1 / SH2)

The setting command is from SH1/SH2=0(OFF) to SH1/SH2=11（1/50,000）
OFF(1/30),1/60,1/100,1/120,1/250,1/500,1/1000,1/2,000,1/4,000,1/10,000,1/16,000,1/50,000

Programmable Exposure (PE1 / PE2)

The setting command is PE1/PE2 and the exposure time can be controlled in 1 LVAL unit (42.07μs).
The range is from 0.5LVAL to 792LVAL. (In case of vertical binning, 1 LVAL equals 50.96μs.)
The shutter speed for each operation mode is shown below.

Mode	Read Out	Minimum shutter speed	Maximum shutter speed
Continuous	Full, Partial	20μs at PE=0(1/50,000)	1 Frame
	V Binning	30μs at PE=0(1/50,000)	
Pre-Select	Full, Partial	20μs at PE=0(1/50,000)	792 L
	V Binning	30μs at PE=0(1/50,000)	
Pulse Width	Full, Partial	42.07μsx2L+ 20μs= 104.14μs （≒1/10,000s）(Note)	60 Frames (2 seconds)
	V Binning	50.96μsx2L+ 20μs= 131.92μs （≒1/8,000s）(Note)	

Note: In Pulse Width mode, the minimum trigger pulse width requires more than 2LVAL.

Exposure time calculation

Mode	Equality
Full scan	= PE (line) x 1L (42.07μs) + 20 μs (PE= 0 to 791)
1/2 Partial scan	= PE (line) x 1L (42.07μs) + 20 μs (PE= 0 to 491)
1/4 Partial scan	= PE (line) x 1L (42.07μs) + 20 μs (PE= 0 to 347)
1/8 Partial scan	= PE (line) x 1L (42.07μs) + 20 μs (PE= 0 to 275)
Vertical binning	= PE (line) x 1L (50.96μs) + 30 μs (PE= 0 to 395)

7.1.10 PIV (Particle Image Velocimetry) mode

The AD-081CL is equipped with PIV (Particle Image Velocimetry) mode. This mode provides three (3) consecutive images by one trigger pulse. When the trigger is input, the first exposure on BW1 can be captured, followed quickly by an exposure on BW2. After the exposure on BW2 is completed, a second exposure on BW1 is made. Each exposure is executed by a strobe flash in a very short interval period. The exposure time is preset at 4 µs, 6µs or 8µs by the Trigger mode command, TR1=4(PIV1), 5(PIV2) or 6(PIV3) respectively.
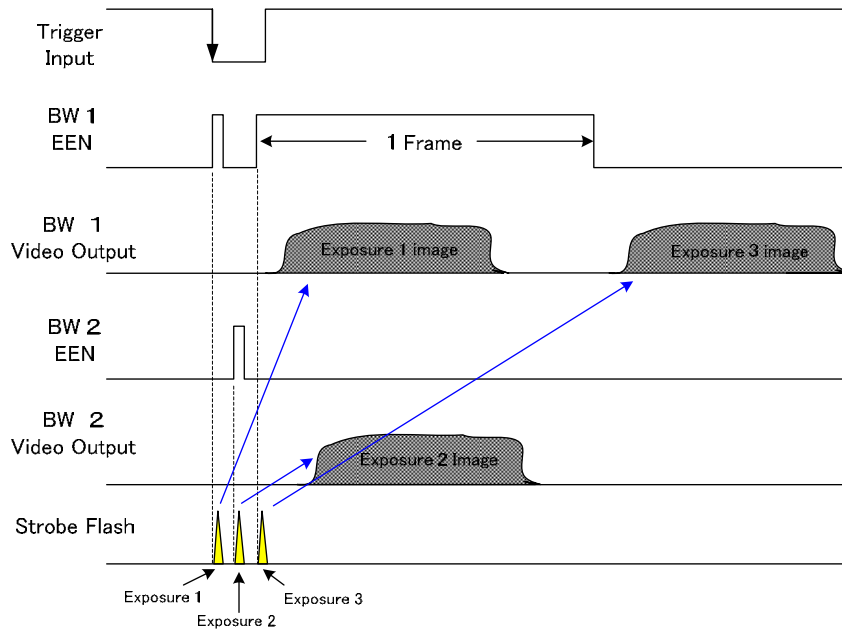
Fig.14 PIV conceptual drawing

7.1.11 High Frame Rate function (double speed readout)

A high frame rate (double speed) can be achieved by shifting the exposure timing of BW1 and BW2 by 1/2 frame duration. As the AD-081CL operates at the rate of 30 fps in continuous mode, this will produce a rate of 60 fps in high frame rate mode (double speed mode). The shutter speed must be less than 1/60s (396L). This mode can be set by process mode command HF=1 in the case of normal mode.

In the case of trigger mode, after setting Output Mode IS=1 (Separate), high frame rate is achieved by providing a trigger pulse to each camera at 1/2 frame duration.
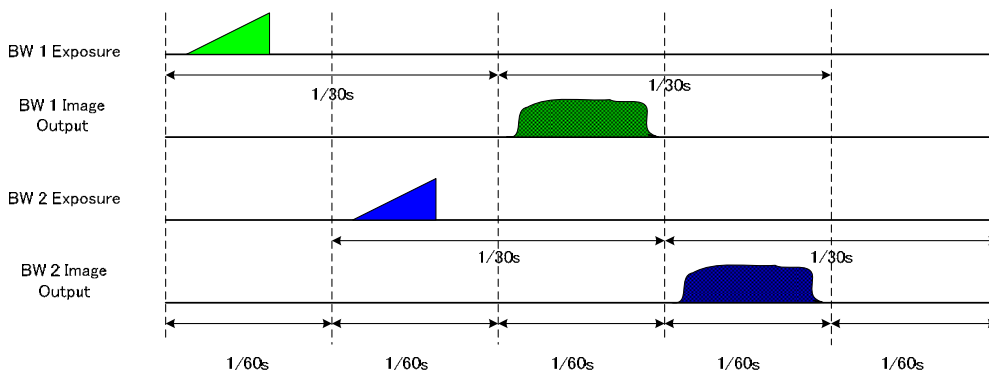
Fig.15 High Frame rate conceptual drawing

7.1.12   High Dynamic Range function

A CCD camera has ability to capture high speed moving objects or high luminance objects by using the electronic shutter function. The AD-081CL camera uses this shutter function to simultaneously capture two images with different shutter speeds. As a result, the AD-081CL can output two identical images with different video levels, one for capturing the details in the dark portion and the other for maintaining details in the brightest portions of the image.
In the PC, these images can be composited into a single image providing proper exposure and details across a wider dynamic range than is normally possible with CCD sensors. In this way the camera can provide dynamic range equal to specialized CMOS sensors, without the noise tradeoffs commonly associated with that technology.

The following illustrates the high dynamic range concept.
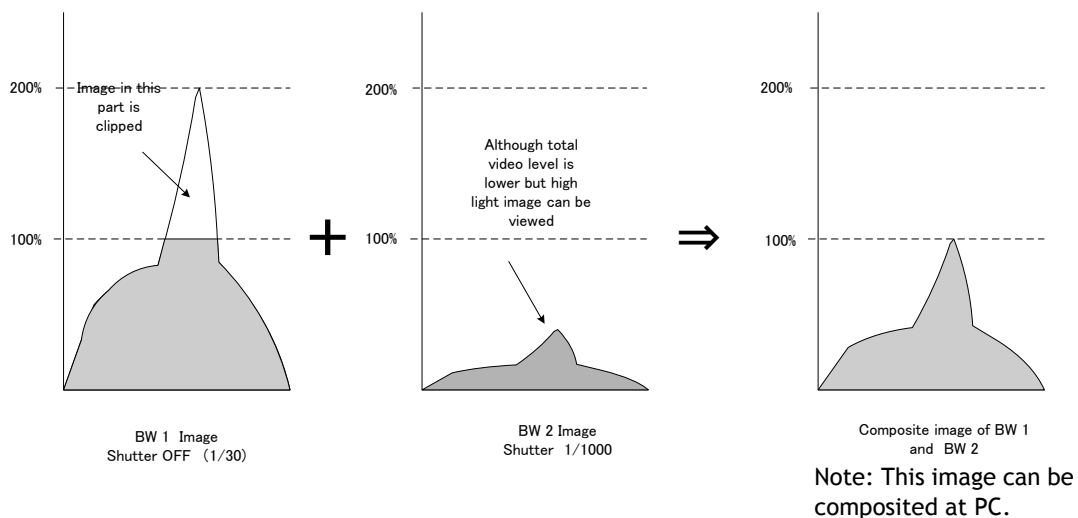
Fig.16 High Dynamic Range Conceptual Drawing

7.1.13   Shading compensation (Commands SDM1,SDM2,RSem Rate mode.1,RS2)

AD-081CL implements a compensation circuit for the white shading which could be caused in the prism or the optics. This circuit divides the whole image into 128 regions horizontally and 96 regions vertically and compensates the divided video level using the level of the center as the reference.
There are three memories inside the camera for shading compensation. One is for the factory setting data and other two memories are for user settings. Commands SDM1 and SMD2 activate the shading compensation using setting 1, 2 or 3. Setting 1 is for the factory setting, while settings 2 and 3 are for user settings. When SDM1/SDM2 is set at 2 or 3, the shading compensation can be executed under operating conditions by commands RS1 and RS2 and stored in memories.

7.1.14   Knee compensation (Commands KN1,KN2,KSY1/KSY2,KPY1/KPY2)

The camera operates at 12 bits internally and has 1279 LSB dynamic range.
However, the output of AD-081CL is 8-bit or 10-bit and the data over 1023 LSB (in case of 10-bit) is clipped if the relationship between IN and OUT is set at linear.
A knee compensation circuit including Knee point and Knee slope compensates the data up to 1279 LSB for 8-bit or 10-bit output.
The drawing to the right shows the characteristics for factory default.

Knee point = 890
Knee Slope = 1/16
In this case : Maximum value is 918 LSB
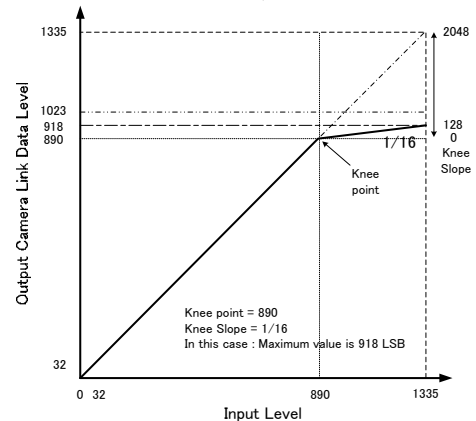
Fig.17. Knee characteristics (Default setting)

7.1.15 Automatic luminance balance (Commands AYB,YA)

This function adjusts automatically the video levels for the two monochrome sensors, BW1 and BW2. The BW2 video level is automatically compensated using BW1 video level as the reference level.
In order to activate this function, the button on the rear panel can be used. It is also possible to set by software command AYB via the RS232C communication interface. It may take up to 3 seconds in order to complete Automatic Luminance balance.

Items	Continuous AWB
Adjusting range	-3dB ～ +6dB
Operation on the camera	No
Store the data	No

Measuring area

The area to be used for auto luminance balance adjustment can be selected as the full image or from one of 9 other areas as shown below.

0: Full area
1: Upper Left
2: Upper Middle
3: Upper Right
4: Middle Left
5: Middle
6: Middle Right
7: Lower Left
8: Lower Middle
9: Lower Right
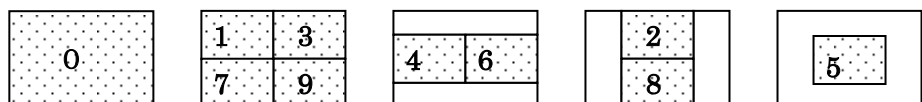
7.1.16 Rear Panel Indication

The rear panel mounted LED provides the following information:

● Amber   : Power connected - initiating
● Steady green : Camera is operating in Continuous mode
✳ Flashing green: The camera is receiving external trigger
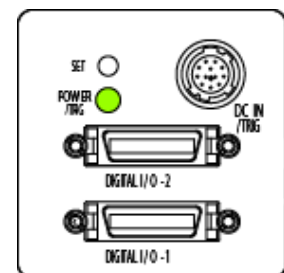
7.1.17 Test Signal Generator (Commands: PBY1,PBY2)

AD-081CL is equipped with a test signal generator. The following test signals are selected by commands, PBY1 and PBY2.

PBY1 / PBY2   : 0= Video, 1=Bypass, 2= Test pattern1 (Gradation),
                  3= Test Pattern 2 (White 100%)

7.1.18 Center marker generator (Commands: CM1,CM2)

The AD-081CL has a center marker generator. Three markers are available, one for Vertical, one for Horizontal and one for both.

Commands CM1 and CM2 can select one of those markers.

1 = Vertical   2 = Horizontal   3 = Both
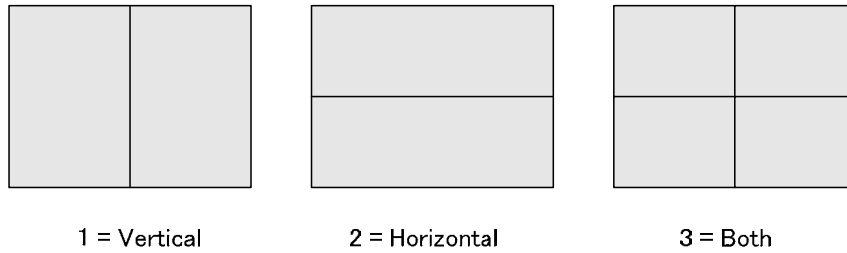
7.2 Sensor Layout and Timing

7.2.1 Sensor Layout

The CCD sensor layout, with respect to pixels and lines used in the timing and video full frame read out, is shown below. For Bayer color sequence, refer to chapter 7.1.7.
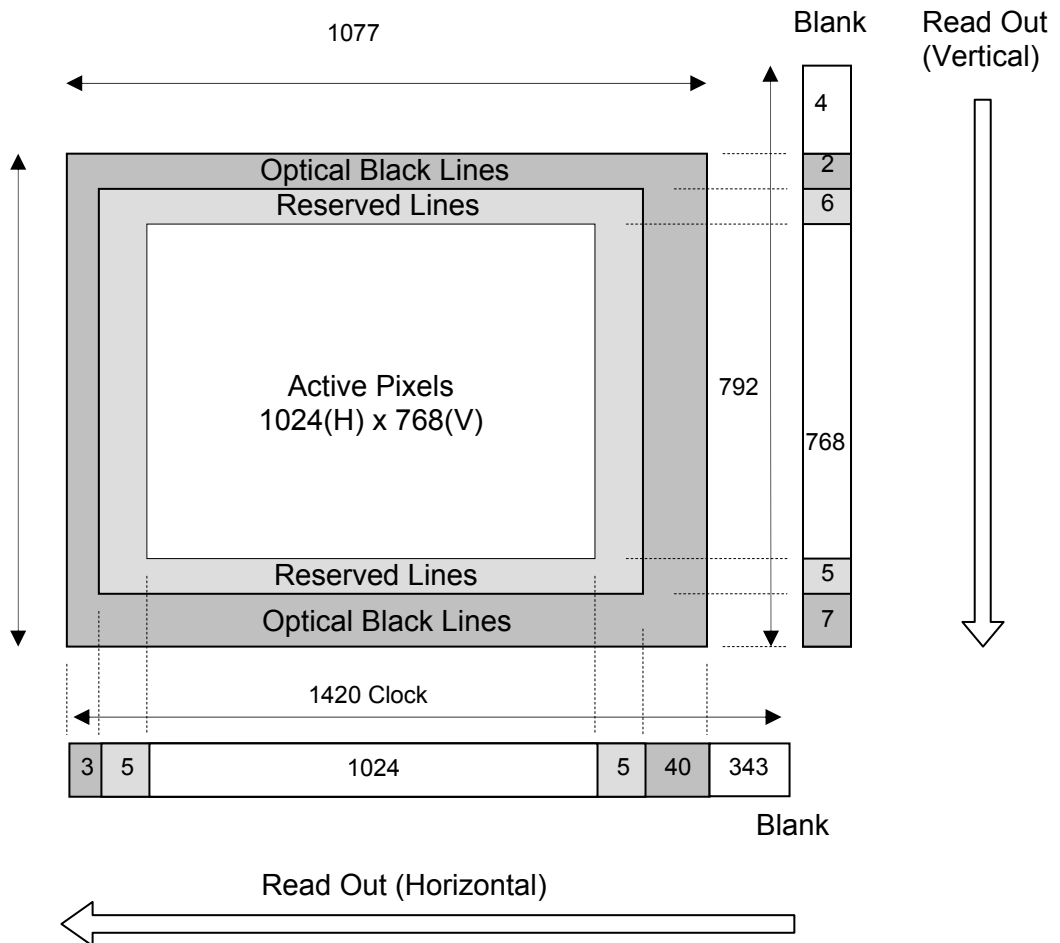
Fig.18. Sensor layout and video output image

7.2.2 Horizontal Timing

The horizontal timing for continuous mode, full frame and partial scan are shown below.
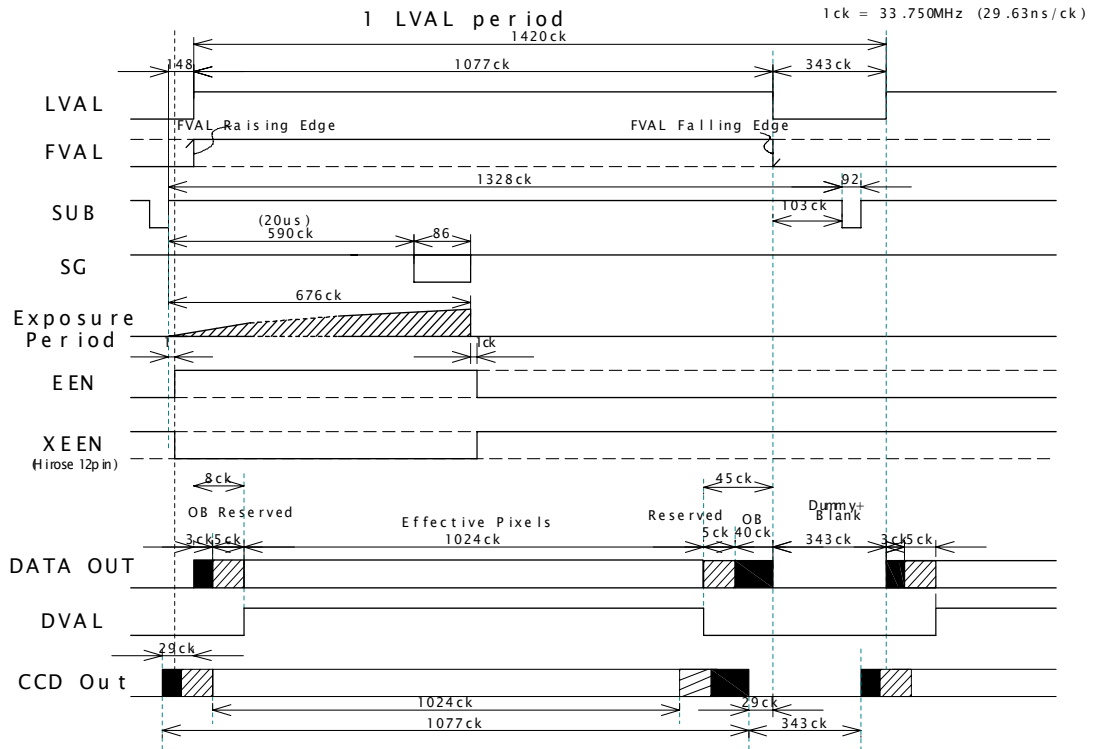
1CLK : 1 Pixel clock period   OB : Optical black
LVAL is HIGH in the period of optical black and effective video periods
DVAL is HIGH in the effective video period

Fig.19. Horizontal Timing

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7.2.3 Vertical Timing

The vertical timing for continuous mode and full frame scan are shown below.
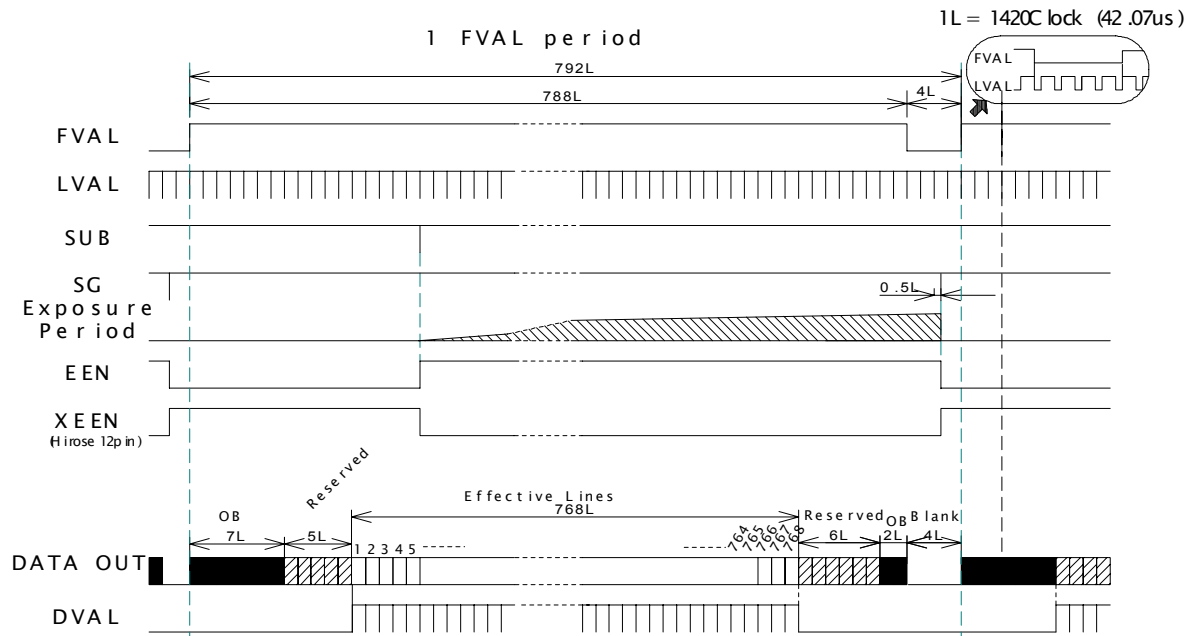
1L : 1 LVAL period   OB: optical black
FVAL is HIGH in the optical black and effective video periods
LVAL is always output
DVAL is output during the effective lines

Fig.20. Vertical Timing

7.2.4 Partial Scan

The vertical timing for continuous mode and partial scan is shown below. The horizontal timing for partial scan is the same as full scan.

SC	Option	Start (Line)	End (Line)	Line No. (Lines)	Output Image	Front of Frame -A-	Back of Frame -B-	Blank of Frame -C-
0	Full Screen	1	768	768	Full Frame	12	8	4
1	1/2 Screen	192	576	384	Partial Scan	54	50	4
2	1/4 Screen	288	480	192		78	74	4
3	1/8 Screen	336	432	96		90	86	4

Vertical Timing for 1/2 Partial scan

1L = 1420Clock (42.07us)

1L : 1LVAL period   OB: Optical Black
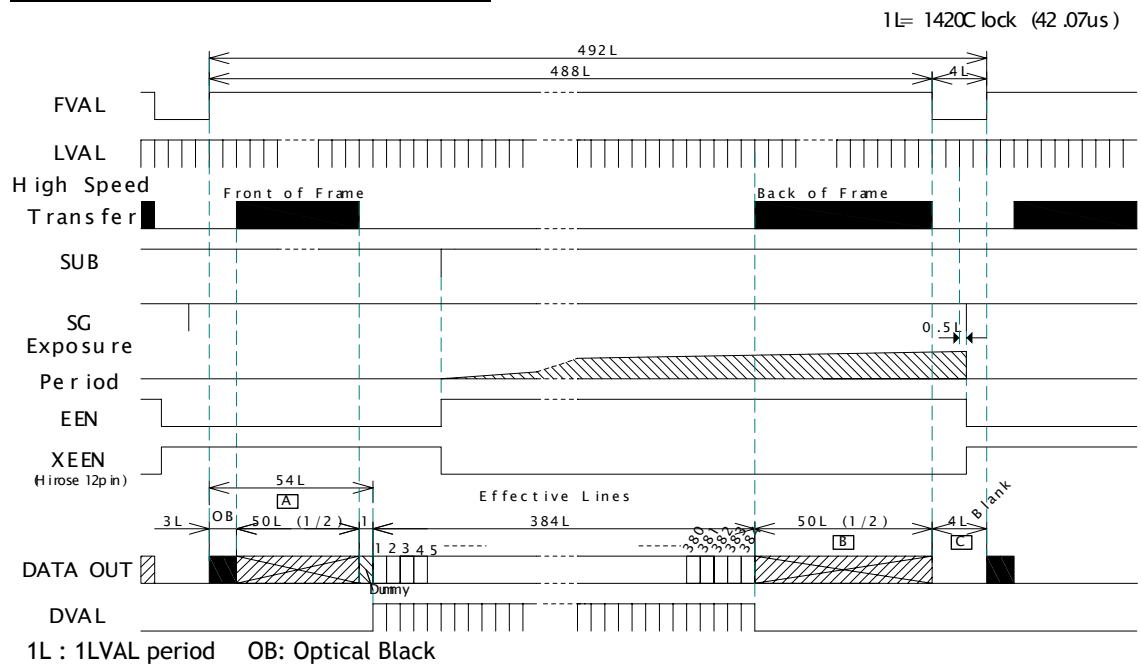
Fig.21. Vertical Timing for 1/2 Partial scan

Vertical Timing for 1/4 Partial scan
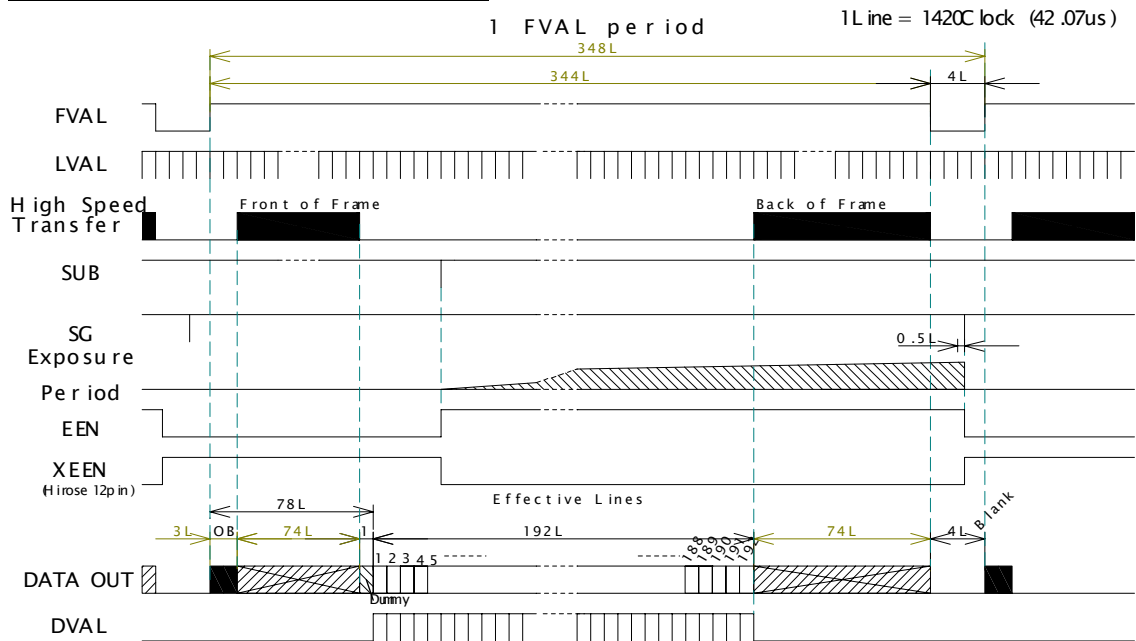
Fig.22. Vertical Timing for 1/4 partial scan

Vertical Timing for 1/8 Partial scan
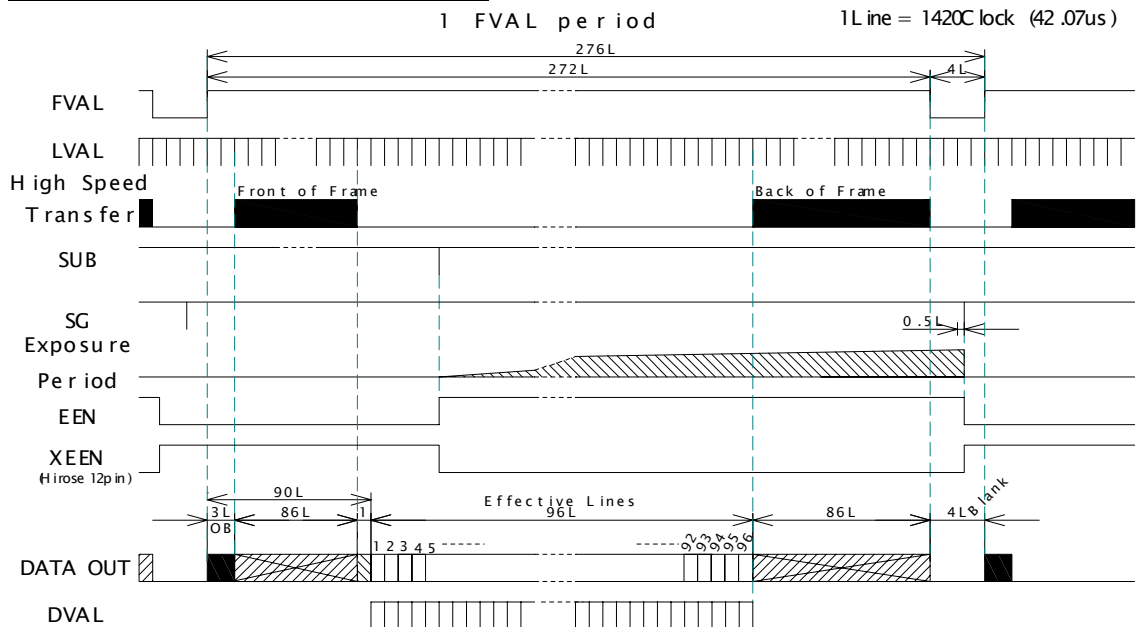
Fig.23. Vertical Timing for 1/8 Partial scan

See the possibilities

Horizontal Timing (Common for Full and Partial Scans)
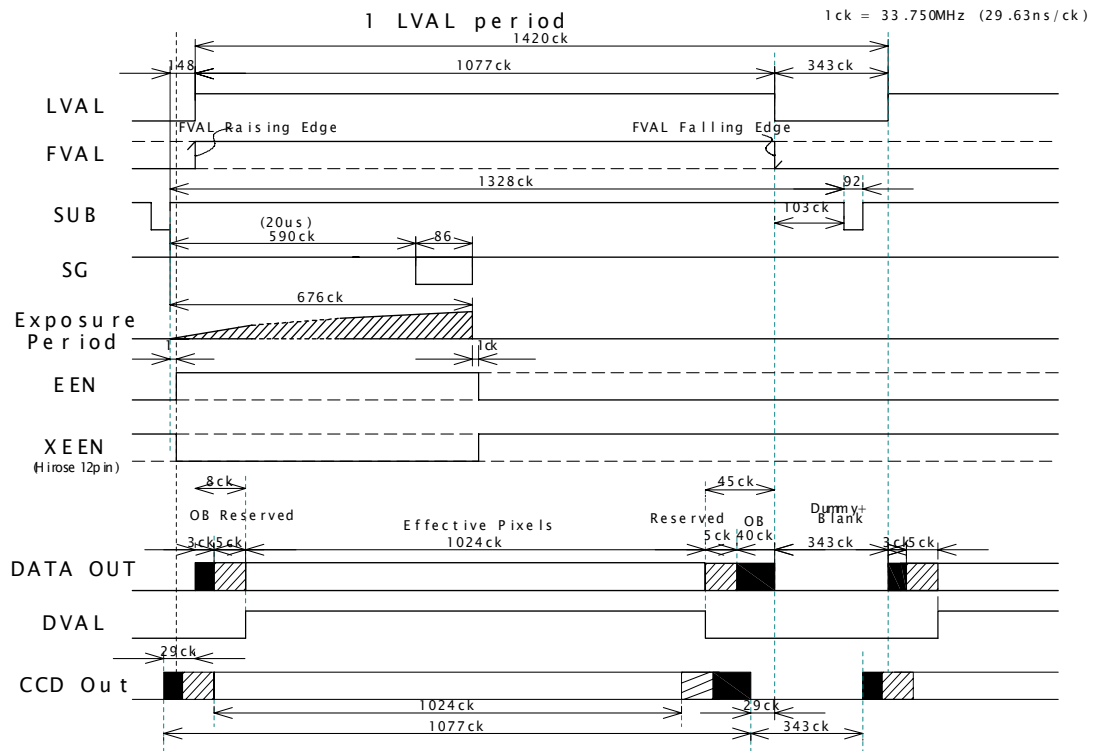
Fig.24. Horizontal Timing

7.2.5 Vertical binning
The vertical timing chart and horizontal timing for the vertical binning mode is as follows.

Horizontal timing
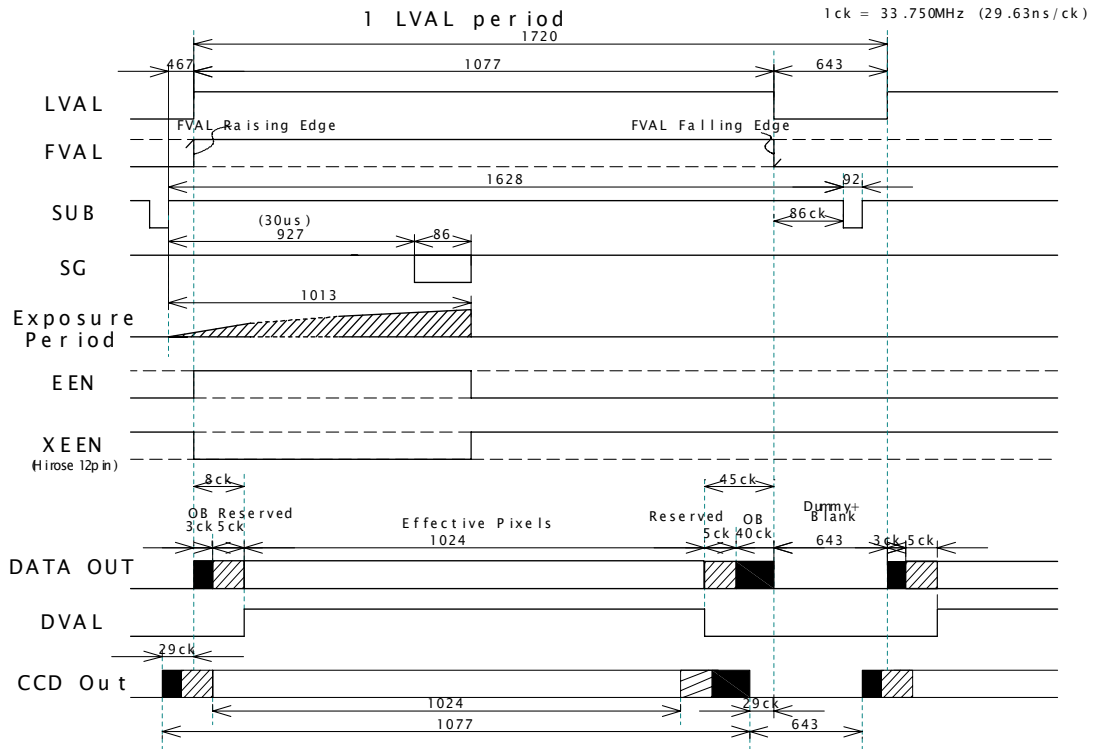
Fig 25. Horizontal timing for vertical binning mode
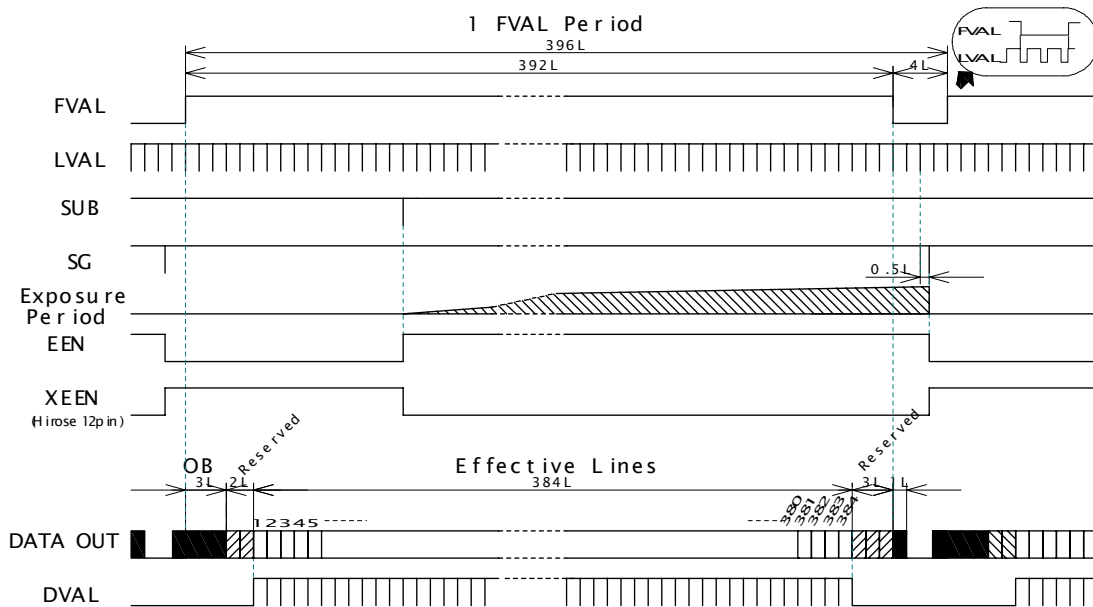
1L = 1 LVAL (50.96 µ) ,   OB = Optical Black

Fig 26. Vertical timing for vertical binning mode

See the possibilities

7.3 Operating modes

The AD-081CL can function as a high frame rate (double speed readout) camera or a high dynamic range camera. Most of the camera's main operating modes can be configured to work with either camera setup. Only PIV mode is an independent function.

Mode/ Function		High Frame rate (Note 1)		High Dynamic range (Note3)	
Output mode (IS =)		Sync	Separate	Sync	Separate
Operating Mode	Continuous	–	–	O	×
	PS mode	×	O (Note 2)	O	×
	PW mode	×	O (Note 2)	O	×
	Smearless	×	O (Note 2)	O	×
	PIV	×	×	×	×
Read out	Full frame	O	O	O	×
	Partial Scan	O	O	O	×
	Vertical Binning	O	O	O	×

Note1) In order to use High Frame Rate mode, Process mode command, HF should be set at HF=1. At HF=1, the output from BW1 and BW2 is offset by 1/2 frame in continuous operation.

Note2) When High Frame Rate mode is used with a trigger pulse, the output mode is set at IS=1 and HF should be set at HF=0. Trigger 1 and trigger 2 should be input with 1/2 frame duration.

Note3) High Dynamic Range is available only in synchronized mode.

AD-081CL has 6 operating modes.

1	*TR=0*	*Continuous*	Pre-selected exposure
2	*TR=1*	*Pre-select Trigger (PS)*	Pre-selected exposure
3	*TR=2*	*Pulse Width Trigger (PW)*	Pulse width controlled exposure
4	*TR=4*	*PIV Mode 1*	4µs exposure, 1.5µ Pulse duration
5	*TR=5*	*PIV Mode 2*	6µs exposure, 1.5µ Pulse duration
6	*TR=6*	*PIV Mode 3*	8µs exposure, 1.5µ Pulse duration

7.3.1 High Frame Rate function

This function can achieve 60 frames per second (double frame rate) by combining two 30 fps video streams which are output in and interleaved manner with 1/2 frame duration. Refer to the details in section 7.1.11.

The following table shows frame rates at trigger OFF, Continuous mode.
Since the frame rate is 60 fps, the shutter speed must be less than 1/60 (= 396L). In vertical binning mode, it must be less than 326L.

Read out	Frame rate
Full frame	60 fps
1/2 Partial	96 fps
1/4 Partial	136 fps
1/8 Partial	172 fps
Vertical Binning	99 fps

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Basic configuration to use this function

Mode	Setting	Command
Process mode	High frame rate	HF=1

In case of trigger mode

Trigger	PS, PW	TR1/TR2= 1,2
Output mode	Separate	IS=1 (Separate)

Common setting

Output Select	8 bit, 10 bit	OS1/OS2 = 0 to 3
Scan Format	Full scan, Partial scan	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1
Shutter	Preset , Programmable	SW1/SW2 = 0,1
Preset shutter	Shutter speed	SH1/SH2 = 1 to 11
Programmable shutter	Shutter speed (1l unit)	PE1/PE2=0 to 396 (326 binning)

PS HIgh Frame Rate (Example)
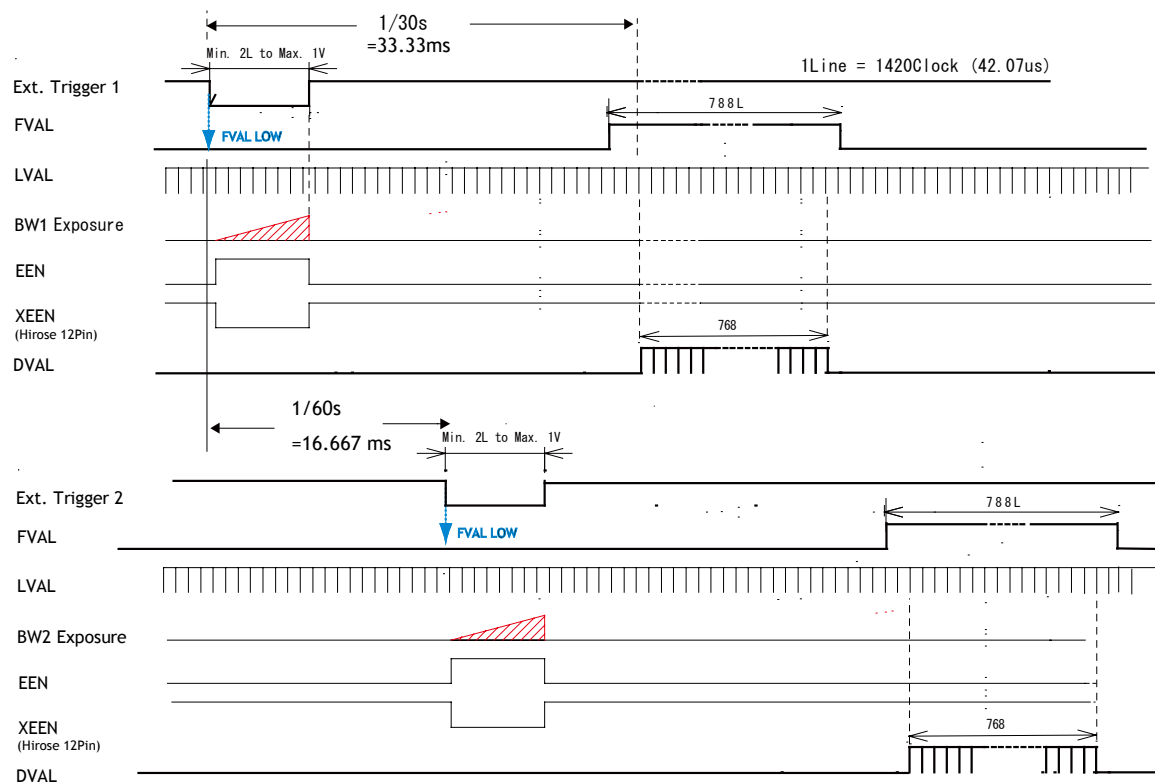
Fig. 27 High Frame Rate Timing (PS trigger, Example)

See the possibilities

7.3.2 High Dynamic Range function

A high dynamic range image or video stream can be obtained by compositing during post processing two images or video streams which have different exposure times.

The maximum dynamic range is achieved when:
One camera is set at 1/30s shutter speed
The other is set at 1/50,000s shutter speed
The dynamic range is 118 dB (s/n = 54dB + exposure time difference of 64 dB)

To use this mode :

Mode	Setting	Command
Trigger	Continuous, PS, PW	TR1/TR2= 1,2
Output mode	Sync	IS=0 (Sync)
Output Select	8 bit, 10 bit	OS1/OS2 = 0 to 3
Scanning	Full scan, Partial scan	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1

Individual setting for BW1 and BW2

Shutter	Preset , Programmable	SW1/SW2 = 0,1
Preset shutter	Shutter speed	SH1/SH2 = 1 to 11
Programmable shutter	Shutter speed (1l unit)	PE1/PE2=0 to 396 (326 binning)

7.3.3 Continuous mode
This mode is used for applications not requiring an asynchronous external trigger.
For timing details, refer to fig. 19 through fig. 26.

To use this mode:

Mode	Setting	Command
Trigger	Continuous	TR1/TR2=0
Output mode	Sync/Separate	IS=0(Sync),IS=1(Separate)
Output Select	8bit, 10bit	OS1/OS2=0 to 3
Scanning	Full/Partial	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1
Shutter	Preset / Programmable	SM1/SM2=0、1
Preset Shutter	Shutter speed	SH1/SH2=0 to 10
Programmable Shutter	Shutter speed (1L unit)	PE1/PE2=0 to 792
Other functions		

7.3.4 Pre-Select trigger mode

An external trigger pulse initiates the capture, and the exposure time (accumulation time) is defined by the SH or PE commands.

The resulting video signal will start to be read out after the selected shutter time.

For timing details, refer to fig. 19 through fig. 26 and fig. 28.

To use this mode:

Mode	Setting	Command
Trigger	Edge Pre-select(EPS)	TR1/TR2=1
Output mode	Sync/Separate	IS=0(Sync),IS=1(Separate)
Output Select	8bit, 10bit	OS1/OS2=0 to 3
Scanning	Full/Partial	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1
Shutter	Preset / Programmable	SM1/SM2=0、1
Preset Shutter	Shutter speed	SH1/SH2=0 to 10
Programmable Shutter	Shutter speed (1L unit)	PE1/PE2=0 to 792
Other functions		
Trigger Input	Camera Link / HIROSE 12pin	TI1/TI2=0, 1

Important Note:

1   The minimum width of the trigger is 2L. The minimum interval of trigger input is as follows.

Output mode IS=0 Sync	Smearless OFF	FVAL(792L) + 3L+(Exposure time difference of BW1 and BW2)
	Smearless ON	Smearless Time(198L) +1+ (longer exposure time between BW1 and BW2) + FVAL(792L) + 3L
Output mode IS=1 Separate	Smearless OFF	FVAL(792L) + 3L
	Smearless ON	Smearless Time(198L) +1＋FVAL(792L)+3L
FVAL(792L) is the FVAL period of continuous operation.		

2   In the case that "Output mode" is set at "SYNC", the trigger input for BW1 has priority. The exposure time can be set individually, but the output timing is synchronized with the rising edge of the longer exposure time.

AUTO (LVAL ASYNC)
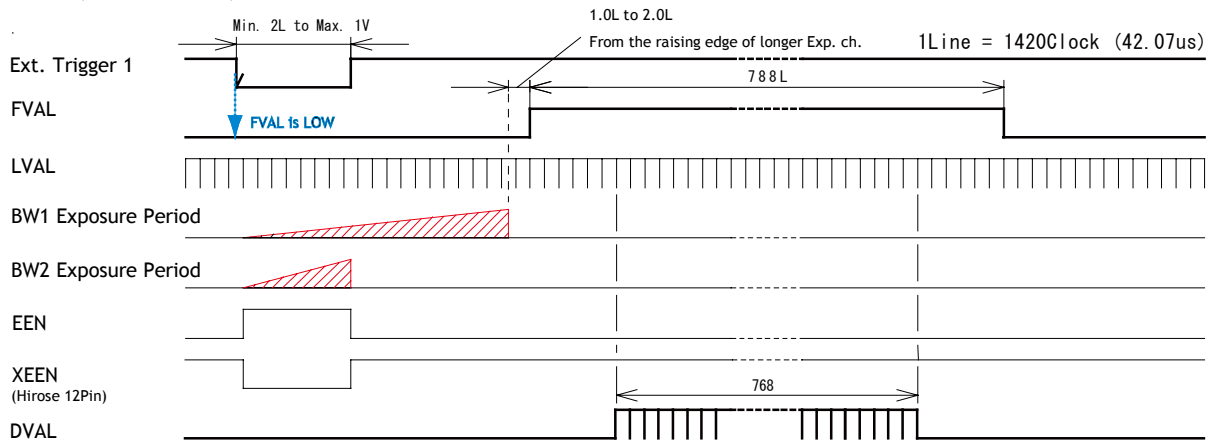
Fig.28. PS trigger mode (LVAL async) timing chart
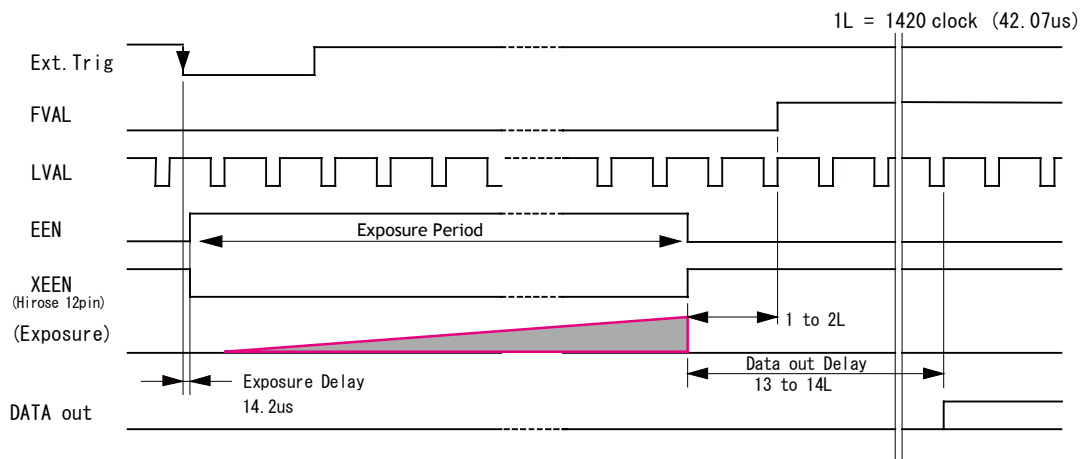
Fig. 29.   PS trigger mode (LVAL async details)

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AUTO (LVAL SYNC)

Min. 2L to Max. 1V

1.5L
From the raising edge of longer Exp. ch.   1Line = 1420Clock (42.07us)

Ext. Trigger 1

788L

FVAL

FVAL is HIGH

LVAL

BW1 Exposure Period

BW2 Exposure Period

EEN

XEEN
(Hirose 12Pin)

768

DVAL
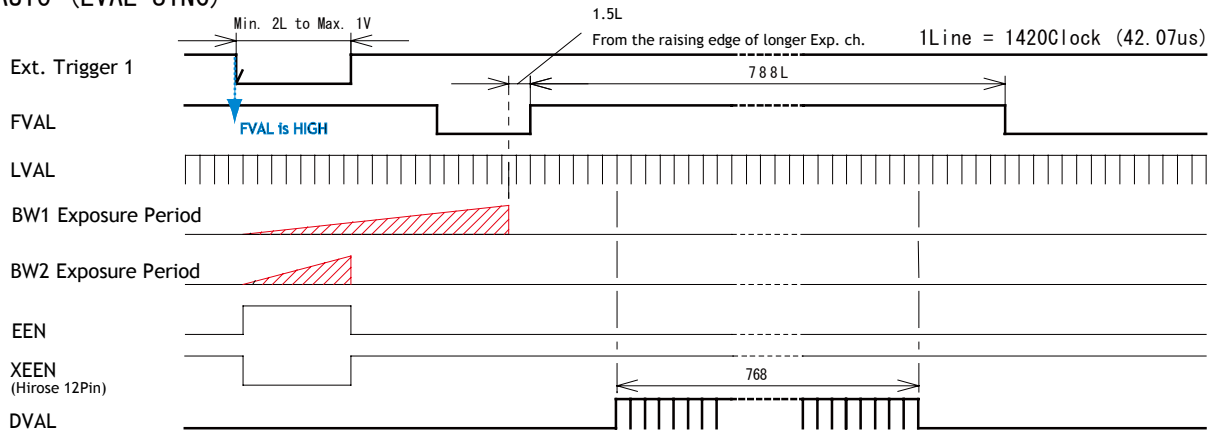
Fig.30. PS trigger mode (LVAL sync) timing chart

Edge Pre-Select mode (Full Frame)   (LVAL sync)

1L = 1420 Clock (42.07us)

Ext.Trig

FVAL

LVAL

EEN

Exposure Period

XEEN
(Hirose 12pin)

(Exposure)

1.5L

Exposure Delay   Data out Delay
t1+1L(Max)   When the LVAL Sync Accum : t1=0.5 to 1.5L   13.5L

DATA out
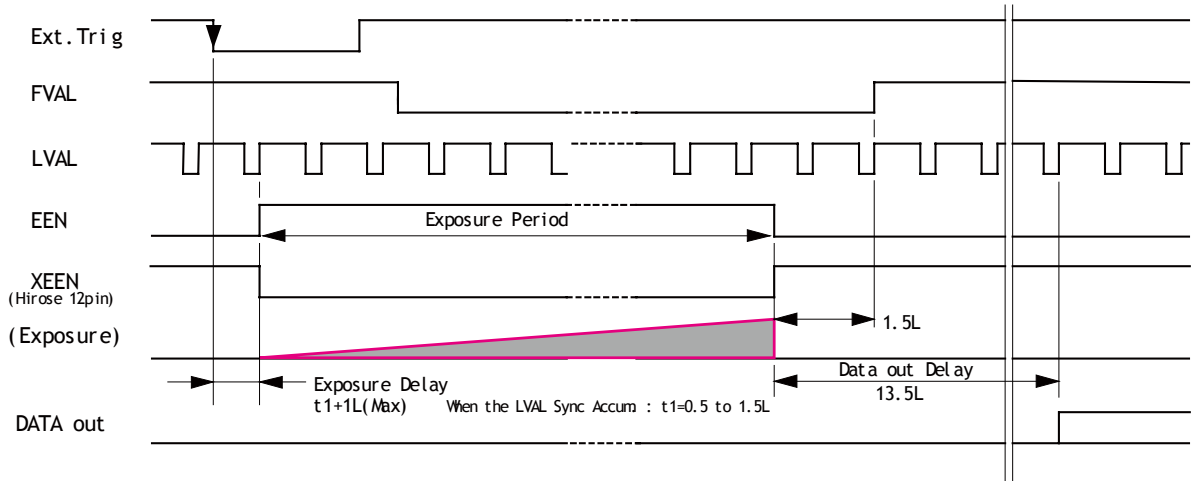
1L: 1LVALPeriod   OB : Optical Black

Fig.31. PS trigger mode (LVAL sync details)

7.3.5 Pulse Width trigger mode

In this mode, the accumulation time is equal to the trigger pulse width. Here it is possible to have long exposure times. For the best image quality, the maximum recommended time is <60 frames (2 seconds), however longer exposures may produce acceptable results depending on the application.

For timing details, refer to fig. 19 through fig. 26 and fig. 29.

To use this mode:

Mode	Setting	Command
Trigger	Pulse Width (PW)	TR1/TR2=2
Output mode	Sync/Separate	IS=0(Sync),IS=1(Separate)
Output Select	8bit, 10bit	OS1/OS2=0 to 4
Scanning	Full/Partial	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1
Other functions		
Trigger Input	Camera Link / HIROSE 12-pin	TI1/TI2=0, 1

Important Note:

1   The minimum width of the trigger is 2L. The minimum interval of trigger input is as follows.

Output mode: IS=0 Sync IS=1 Separate	Smearless OFF	In case of Pulse width＞FVAL(792L) Exposure time – 792L + 3L In case of Pulse width(Min:2L) ≦ 792L 792L + 2L
	Smearless ON	In case of Pulse width＞FVAL(792L) Exposure time – 792L + 3L Incase of Pulse width(Min:199L+2L) ≦ 792L 792L + 2L

FVAL(792L) is the FVAL period of continuous operation.

Fig. 32. PW trigger mode (LVAL async) Timing chart

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Pulse Width mode(Full Frame) (LVAL aSYNC)   1L = 1420 clock (42.07us)

Ext.Trig

FVAL   Delay of Exposure End
                                            32.1us
LVAL

EEN   Exposure Period

XEEN
(Hirose 12pin)

(Exposure)   1 to 2L

                    Delay of Exposure Start   Data out Delay
                    14.2us   13 to 14L
DATA out

Fig. 33. PW trigger mode (LVAL sync   Details)

AUTO (LVAL SYNC)

                    Min:2L to Max:60V(47520L)   1L = 1420Clock (42.07us)

EXT.Trigger 1   788L

FVAL   FVAL is HIGH

LVAL

                    t1   t1=0.5L to 1.5L
                         t2   t2=1.5L
Exposure Period

EEN

XEEN   768
(HIROSE 12 pin)

DVAL

Fig. 34. PW trigger mode (LVAL sync) Timing chart

Pulse Width mode(Full Frame) (LVAL SYNC)   1L = 1420Clock (42.07us)

Ext.Trig

FVAL   Delay of Exposure End
                                            0.5 to 1.5L
LVAL

EEN   Exposure Period

XEEN
(Hirose 12pin)

(Exposure)   1.5L
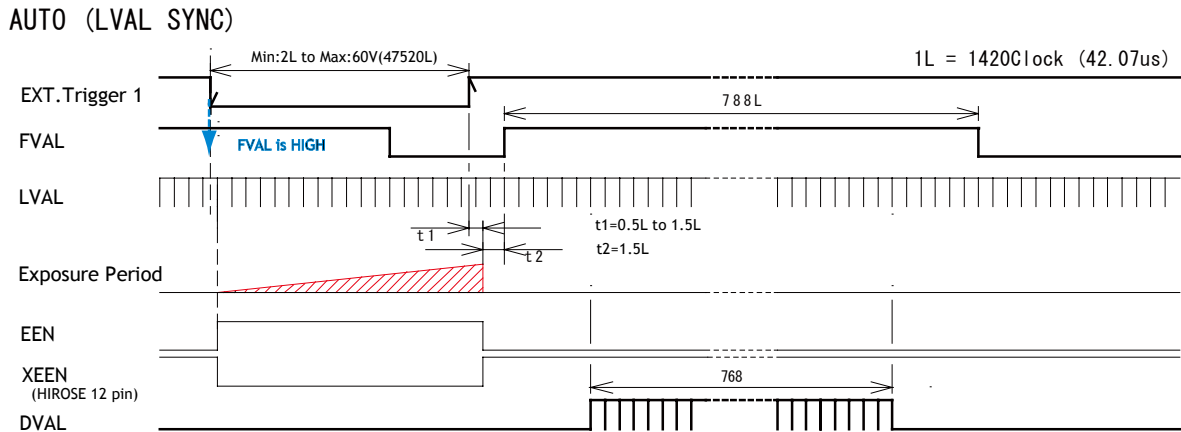
                    Delay of Exposure Start   Data out Delay
                    t=0.5 to 1.5L   13.5L
DATA out
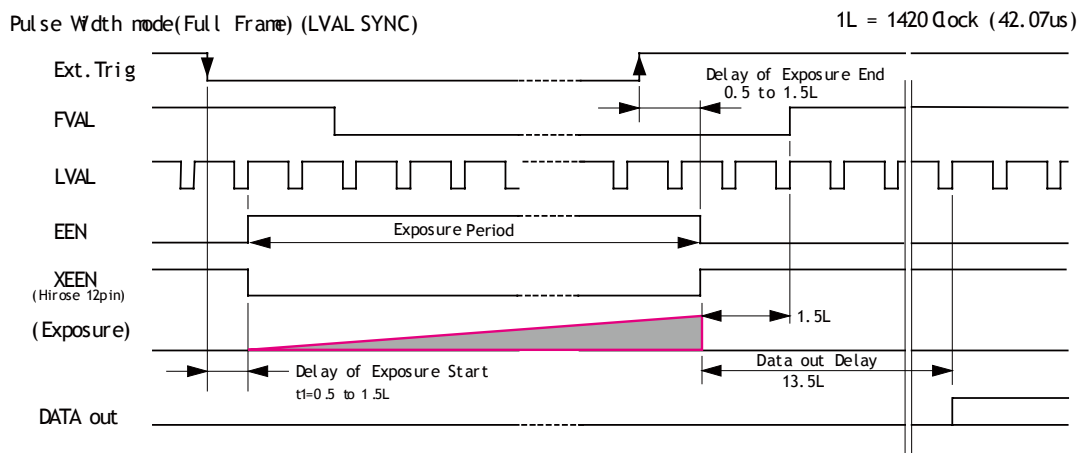
Fig.35. PW trigger mode (LVAL sync details)

In PW mode, when "Smearless ON" is selected, the actual accumulation time is (the trigger pulse width minus Smearless active period (199L)). If the trigger pulse width is shorter than 199L, the exposure is not active.

7.3.6 PIV mode (Particle Image Velocimetry)

PIV mode is an independent function and is not to be combined with the High Frame Rate function, the High Dynamic Range function, or the normal output mode (Sync or Separate). In this mode, one trigger input provides three consecutive outputs. A strobe light is used for illumination. PIV has three preset modes.

PIV mode	Exposure time	Trigger Interval
PIV 1	4 µ	1.5 µ
PIV 2	6 µ	1.5 µ
PIV 3	8 µ	1.5 µ

Trigger width	2L(min.) to 1V (max.)

To use this mode :		
Mode	Setting	Command
Trigger	PIV	TR1=4,5,6
Output Select	8bit, 10bit	OS1/OS2=0 to 3
Scanning	Full/Partial	SC1/SC2 = 0 to 3
Vertical Binning	ON/OFF	BI1/BI2= 0,1
Other functions		
Trigger Input	Camera Link / HIROSE 12-pin	TI1/TI2=0, 1
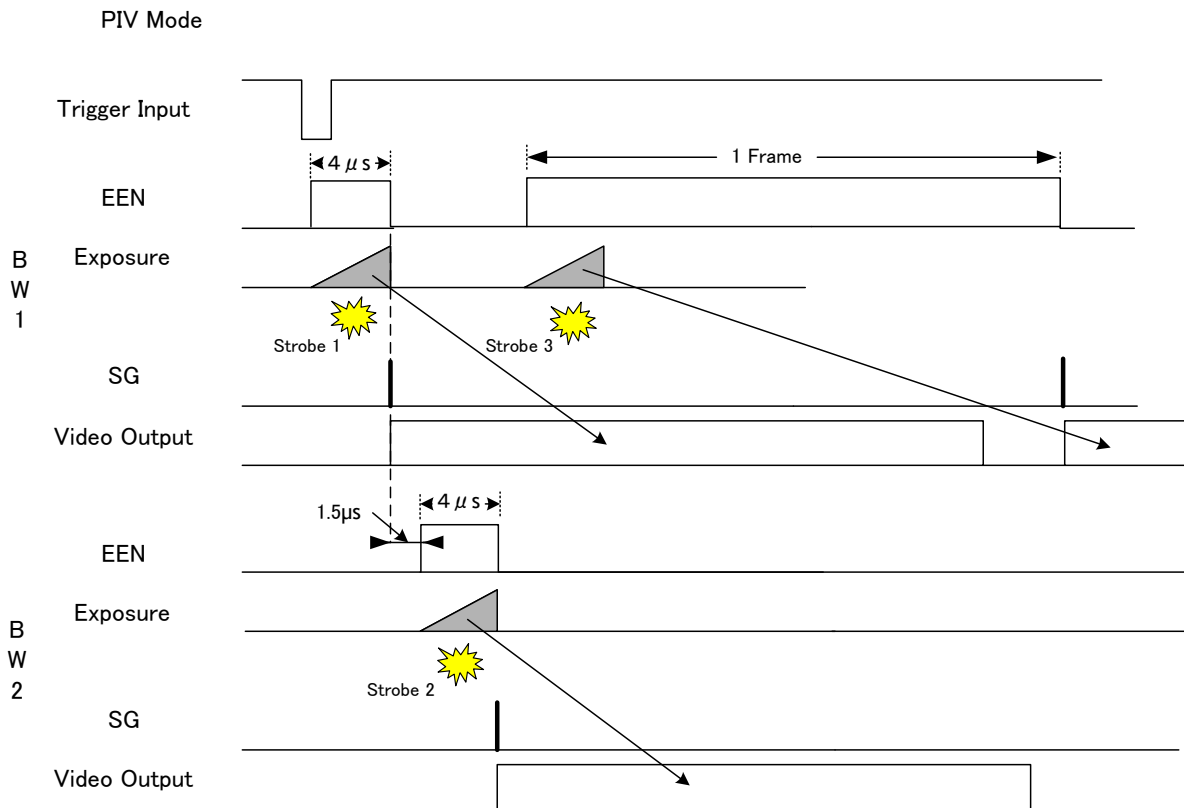
Fig. 36.   PIV mode timing chart

7.3.7 Smearless mode

This function can reduce the smear on highlights within the image. This is effective for both PS and PW trigger modes. Before the accumulation starts, stored charges are read out at high speed. This can reduce the smear in the upper areas of the object without affecting the lower areas. At the trailing edge of the trigger pulse, the high speed readout starts. This period is 198L. The residual charges in the horizontal transfer gate are read out in 1L and the exposure starts. This function is available for both full scan and partial scan.
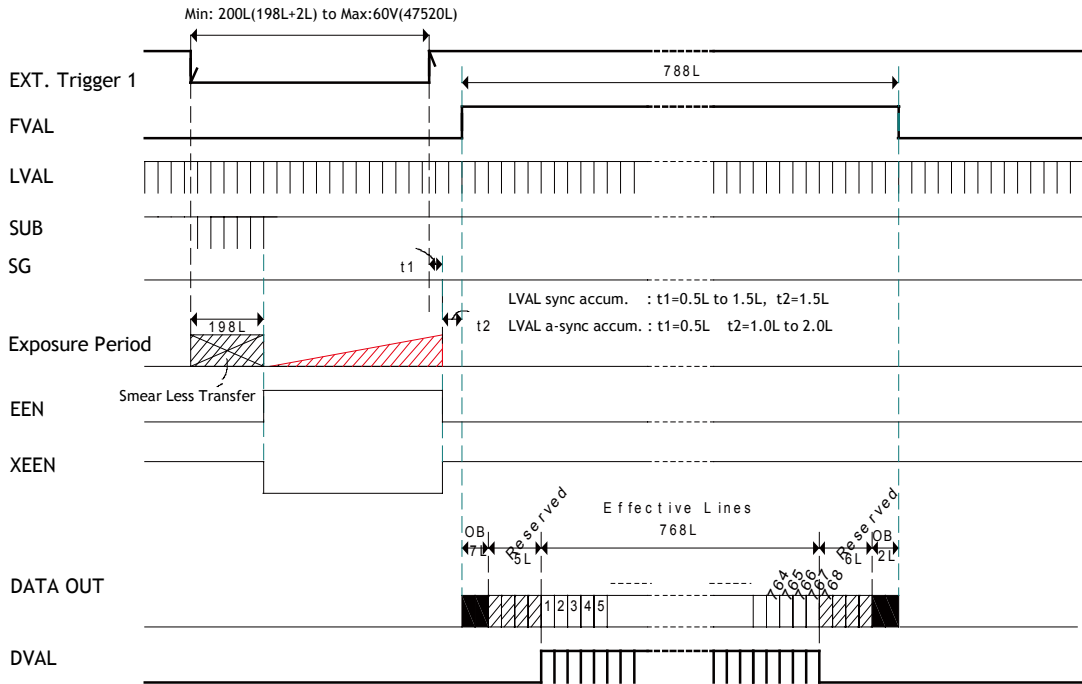
Fig 37. PW timing chart with Smearless OFF
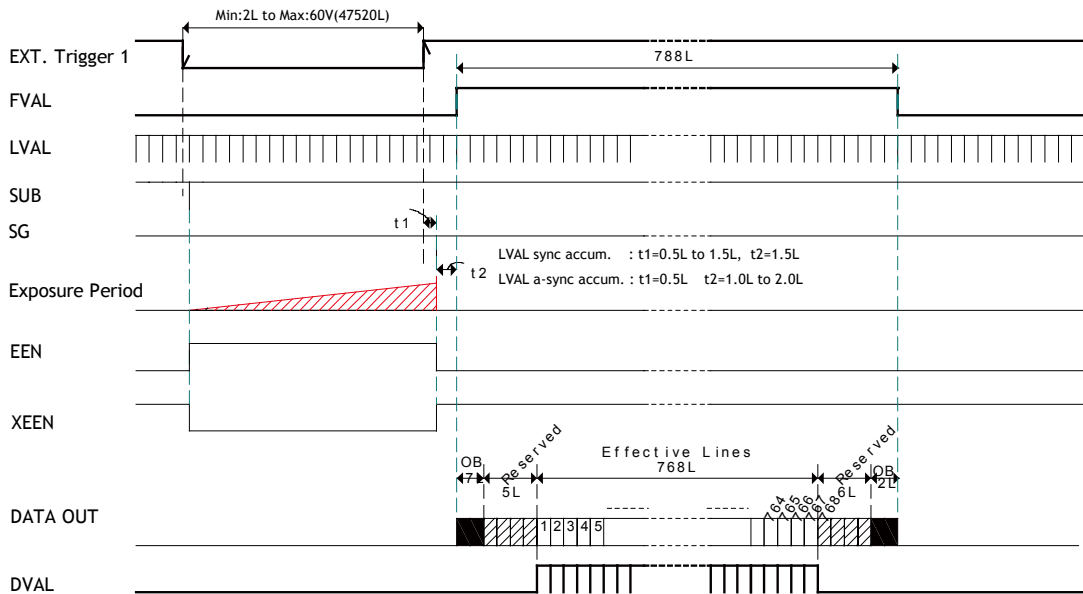
Fig 38. PW timing chart with Smear less ON

7.4 Modes and functions matrix

AD-081CL has two output modes when the external trigger pulse is used. One is "Synchronous" mode and the other is "Separate" mode. In Synchronous mode, two Camera Link outputs are synchronized with each other, whereas in Separate mode, two Camera Link outputs are not synchronized.
The following table shows modes and functions matrix.

Output mode IS=	Operation		BW1　Imager (1)				BW2　imager (2)				Auto Iris
	TR	Mode °	Trig. IN 1	Shutter	Partial	Smear Less	TRIG. IN 2	Shutter	Partial	Smear Less	
IS=0 Sync	0	Cont.	–	Yes	Yes	No	–	Yes	←	No	Yes Note
	1	PS	Yes	Yes	Yes	Yes	No	Yes	←	←	
	2	PW	Yes	No	Yes	Yes	No	No	←	←	
IS=1 Separate	0	Cont.	–	Yes	Yes	No	–	Yes	Yes	No	Yes Note
	1	PS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
	2	PW	Yes	No	Yes	Yes	Yes	No	Yes	Yes	
–	4	PIV1	Yes	No	Yes	No	–	–	–	–	
	5	PIV2	Yes	No	Yes	No	–	–	–	–	
	6	PIV3	Yes	No	Yes	No	–	–	–	–	

– : not related to , ← : Use BW1 imager (1) setting
Note: The analog output for auto iris uses the signal from BW1 imager (1).

8.   Configuring Camera
8.1   Serial communications
All configuration of the AD-081CL camera is done by LVDS via Camera Link. Baud rate is 9600 bps. The camera can be set up from a PC running terminal emulator software, or through a graphical user interface (GUI) using JAI's camera control software.
Below is the description of the ASCII-based short command protocol.

Communication Settings

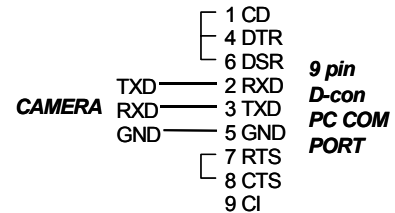| Baud Rate	9600 bps
Data Length	8 bit
Start Bit	1 bit
Stop Bit	1 bit
Parity	None
Xon/Xoff Control	None

RS 232C cable

```
                                    1 CD
                                    4 DTR
                                    6 DSR     9 pin
                        TXD ──────  2 RXD     D-con
              CAMERA    RXD ──────  3 TXD     PC COM
                        GND ──────  5 GND     PORT
                                    7 RTS
                                    8 CTS
                                    9 CI
```

Protocol.

Transmit setting to camera:
>   **NN=[Parameter]<CR><LF>**
>   (NN is any kind of command. Capital or small letters.)

The camera answers:
>   **COMPLETE<CR><LF>**

To have all communication visible on the emulator screen, start with:
>   **EB=1<CR><LF>**

The camera answers:
>   **COMPLETE<CR><LF>**

Transmit request command to camera:
>   **NN?<CR><LF>**   (NN is any kind of command.)

The camera answers:
>   **NN=[Parameter]<CR><LF>**

Transmit the following to have the camera actual setting:
>   **ST?<CR><LF>**

The camera answers:
>   A complete list of the current settings

Transmit the following to have a command list:
>   **HP?<CR><LF>**

The camera answers:
>   A list with all commands and possible settings

Invalid parameters send to camera: (99 is an invalid parameter)
>   **SH=99<CR><LF>**

The camera answers:
>   **02 Bad Parameters!!<CR><LF>**

To see firmware number.
>   **VN?<CR><LF>**

To see camera ID. It shows the manufacturing lot number.
>   **ID?<CR><LF>**

8.2 Setting functions
8.2.1 Output mode (Command IS)
AD-081CL has two imagers and this function selects synchronized output for both imagers or individual output for each imager. This function should be set at first.
IS=0 is synchronous output and IS=1 is separate output.

8.2.2 Trigger input select (Command TI1 and TI2)
This function selects the trigger input to be through Camera Link (TI1/TI2 =0), or as TTL through the 12-pin Hirose connector (TI1/TI2 =1).

8.2.3 Trigger mode (Command TR1 and TR2)
This can select continuous mode (0), PS (1) or PW (2).

8.2.4 Trigger polarity (Command TP1 and TP2)
The active trigger polarity is normally low (TP1/TP2 =0). It can be inverted to active high (TP1/TP2 =1).

8.2.5 Smearless (Command SL1 and SL2)
This command selects Smear ON (1) or OFF (0).

8.2.6 Scan Format (Command SC1 and SC2)
4 scan formats, full scan, 1/2 partial, 1/4 partial or 1/8 partial scan can be selected by this command.

8.2.7 Gain Master level (Command GA1 and GA2)
GA1/GA2 =0 is 0dB gain, which is the normal working point. The range is from -3 dB to +12 dB.

8.2.8 AGC select (Command AGC1 and AGC2)
Select AGC ON (1) or OFF (0).

8.2.9 Setup-Y (Command BLY1 and BLY 2)
Valid range for settings is -128 to 256
The black level for 10-bit output is set at 32 LSB and that for 8-bit output is set at 8 LSB.

8.3 Load and Save functions
The following commands are for storing and loading camera settings in the camera EEPROM.

Load settings. LD.
This command will load previously stored settings to the camera. 3 user settings can be stored in the camera EEPROM. 1 factory setting is also stored in the camera. The settings stored in the last used user area are used as default settings at power up.

Save Settings. SA.
This command will store the actual camera settings to 1 of the 3 user areas in the camera EEPROM.

EEPROM Area. EA.
If received, the camera will return the last used user area number.

8.4 AD-081CL   Command list

	Command	Format	Parameter	Remarks
A – General settings and utility commands ˙				
1	Echo Back	**EB**=[Param.]<CR><LF> EB?<CR><LF>	0=Echo off 1=Echo on	Off at power up
2	Camera Status Request	**ST**?<CR><LF>		Actual setting
3	Online Help Request	**HP**?<CR><LF>		Command list
4	Firmware Version	**VN**?<CR><LF>		3 digits, (e.g.) 100 = Ver. 1.00
5	Camera ID Request	**ID**?<CR><LF>		Max 10 characters
6	Model Name Request	**MD**?<CR><LF>		Max 10 characters
7	User ID	**UD**=[Param.]<CR><LF> UD?<CR><LF>		User can save and load free text. (16 or less characters)
B – BW1, BW2 Common settings				
1	Output Mode	**IS**=[Param.]<CR><LF> IS?<CR><LF>	0 = SYNC 1 = Separate	
2	V Binning	**BI1**=[Param.]<CR><LF> BI1?<CR><LF>	0 = OFF 1 = ON	
3	One-push AYB	**AYB**=[Param.]<CR><LF>	O = One push AYB activated	
4	Inquire the status after one-push AYB	AYB?<CR><LF>		
5	AYB area	**YA**=[Param.]<CR><LF> YA?<CR><LF>	0=Full area 1=Upper left 2=Upper mid 3=Upper right 4=Middle left 5=Middle 6=Mid. Right 7=Lower left 8=Lower mid. 8=Lower right	
C – Shutter				
1	Shutter Mode	**SM1**=[Param.]<CR><LF> SM1?<CR><LF>	0=Preset Shutter 1=Programmable exposure	For Imager BW1
		SM2=[Param.]<CR><LF> SM1?<CR><LF>		For Imager BW2
2	Preset Shutter	**SH1**=[Param.]<CR><LF> SH1?<CR><LF>	0=Off, 1=1/60, 2=1/100, 3=1/120, 4=1/250, 5=1/500, 6=1/1000, 7=1/2000, 8=1/4000, 9=1/8000 10=1/16000, 11=1/50000	Available when SM1=0
3	Preset Shutter	**SH2**=[Param.]<CR><LF> SH2?<CR><LF>	0=Off, 1=1/60, 2=1/100, 3=1/120, 4=1/250, 5=1/500, 6=1/1000, 7=1/2000, 8=1/4000, 9=1/8000 10=1/16000, 11=1/50000	Available when SM2=0

	Command	Format	Parameter	Remarks
3	Programmable Exposure	**PE1**=[Param.]<CR><LF> PE1?<CR><LF>	**0** to **792**	Available when SM1=1
		PE2=[Param.]<CR><LF> PE2?<CR><LF>		Available when SM2=1
D – Trigger mode				
1	Trigger Mode	**TR1**=[Param.]<CR><LF> TR1?<CR><LF>	0=Normal (Continuous) 1=PS(Pre select) 2=PW (Pulse width) 4=PV1 5=PV2 6=PV3	For Imager BW1
		TR2=[Param.]<CR><LF> TR2?<CR><LF>		For Imager BW2
2	Trigger Polarity	**TP1**=[Param.]<CR><LF> TP1?<CR><LF>	0=Active Low 1=Active High	For Imager BW1
		TP2=[Param.]<CR><LF> TP2?<CR><LF>		For Imager BW2
3	Trigger Input	**TI1**=[Param.]<CR><LF> TI1? <CR><LF>	0=Camera Link 1=Hirose 12-pin	For Imager BW1
		TI2=[Param.]<CR><LF> TI2? <CR><LF>		For Imager BW2
4	Smearless	**SL1**=[Param.]<CR><LF> SL1? <CR><LF>	0=OFF 1=ON	For Imager BW1 Available when TR1=1 or 2
		SL2=[Param.]<CR><LF> SL2? <CR><LF>		For Imager BW2 Available when TR2=1 or 2
E – Image Format				
1	Scan Format	**SC1**=[Param.]<CR><LF> SC1? <CR><LF>	0=Full Frame 1=1/2 Partial 2=1/4 Partial 3=1/8 Partial	For Imager BW1
		SC2=[Param.]<CR><LF> SC2? <CR><LF>		For Imager BW2
2	Output Select	**OS1**=[Param.]<CR><LF> SC1? <CR><LF>	0=Imager 1 10 bit 1=Imager 1 8bit 2=Imager 1 +Imager 2 10bit 3=Imager 1+Imager 2 8bit	For Imager BW1
		OS2=[Param.]<CR><LF> SC2? <CR><LF>	0=Imager 2 10bit 1=Imager 2 8bit 2=Imager 2+Imager 1 10bit 3=Imager 2+Imager 1 8bit	For Imager BW2
F – Gain, White Balance, Black				
1	Gain-master	**GA1**=[Param.]<CR><LF> GA1?<CR><LF>	**-84** to **336**	For Imager 1
		GA2=[Param.]<CR><LF> GA2?<CR><LF>	**-84** to **336**	For Imager 2

		Command	Format	Parameter	Remarks
2		Setup Level Y	**BLY1**=[Param.]<CR><LF> BLy2?<CR><LF>	-128 to 256	For Imager 1
			BLY2=[Param.]<CR><LF> BLy2?<CR><LF>		For Imager 2
3		AGC Select	**AGC1**=[Param.]<CR><LF> AGC1?<CR><LF>	0=AGC OFF 1=AGC ON	For Imager 1
			AGC2=[Param.]<CR><LF> AGC2?<CR><LF>		For Imager 2
4		AGC Reference	**AGR1**=[Param.]<CR><LF> AGR1?<CR><LF>	0 to 1023	For Imager 1
			AGR2=[Param.]<CR><LF> AGR2?<CR><LF>		For Imager 2
G – Knee function					
1		Knee ON/OFF	**KN1**=[Param.]<CR><LF> KN1?<CR><LF>	0=OFF 1=ON	For Imager BW1
			KN2=[Param.]<CR><LF> KN2?<CR><LF>		For Imager BW2
2		Knee Slope Y	**KSY1**=[Param.]<CR><LF> KSY1?<CR><LF>	0 to 4095	For Imager BW1
			KSY2=[Param.]<CR><LF> KSY2?<CR><LF>		For Imager BW2
3		Knee Point Y	**KPY1**=[Param.]<CR><LF> KPY1?<CR><LF>	0 to 1023	For Imager BW1
			KPY2=[Param.]<CR><LF> KPY2?<CR><LF>		For Imager BW2
H – Shading Compensation					
1		Shading correction mode	**SDM1**=[Param.]<CR><LF> SDM1?<CR><LF>	0=OFF 1=Factory setting 2=User 1 3=User2	For Imager BW1
			SDM2=[Param.]<CR><LF> SDM2?<CR><LF>		For Imager BW2
2		Recalibrate Shading Corr.	**RS1**=[Param.]<CR><LF>	O=User 1 1=User 2	For Imager BW1
			RS2=[Param.]<CR><LF>		For Imager BW2
3		Inquire the status after shading correction	RSS1?<CR><LF>	0=Shading correction in process 1=Succeeded 2=Error 1- Image too bright 3=Error 2- Image too dark 4=Error 3- Time out	For Imager BW1
			RSS2?<CR><LF>		For Imager BW2

	Command	Format	Parameter	Remarks
I – Other functions				
1	Process Bypass	**PBY1**=[Param.]<CR><LF> PBY1?<CR><LF>	**0=Video** **1=Bypass** **2=Test Pattern 1** **3=Test Pattern 2**	For Imager BW1
		PBY2=[Param.]<CR><LF> PBY2?<CR><LF>	**0=Video** **1=Bypass** **2=Test Pattern 1** **3=Test Pattern 2**	For Imager BW2
2	Center Marker	**CM1**=[Param.]<CR><LF> CM1?<CR><LF>	**0=OFF 1=Vertical** **2=Horizontal 3=BOth**	For Imager BW1
		CM2=[Param.]<CR><LF> CM2?<CR><LF>		For Imager BW2
F – Saving and loading setting for EEPROM				
1	Load Settings (from Camera EEPROM)	**LD**=[Param.]<CR><LF>	0=Factory area 1=User 1 area 2=User 2 area	Latest used DATA AREA will become default at next power up
2	Save Settings (to Camera EEPROM)	**SA**=[Param.]<CR><LF>	1=User 1 area 2=User 2 area "0" is prohibited.	
3	EEPROM Current Area No Request.	**EA**?<CR><LF>	0=Factory area 1=User 1 area 2=User 2 area	The camera returns latest used DATA AREA

9. AD-081CL Camera Control Tool

The Camera Control Tool for Windows 2000/XP can be downloaded from www.jai.com.

The control tool contains a camera control program and a developer's kit for integrating the control tool in your own software. For the integrator and experienced user, the Camera Control Tool is much more than a program with a Windows interface. It also provides an easy and efficient ActiveX interface built for MS Windows 2000/XP. The OCX interface has the ability to connect to the camera using the serial interface of the PC by reading and writing properties for the camera. This integration requires simple programming skills within Visual Basic, Visual C++ or similar languages in a Microsoft Windows environment.

9.1 Camera Control Tool Interface

The Camera Control Tool Software is based on a main Tool Bar and a number of associated Tool Windows. Each button in the Tool Bar pops up a separate Tool Window when pressed. The layout of the program can be adjusted by arranging the windows the way it is preferred. The program will store this information and recreate this layout, when the program is restarted. All Camera Control Tools have a Communication Window and an About Window. The other window(s) contains camera control commands.

9.1.1 Camera Control Tool Bar

This is a Camera Control Tool Bar and when the button of each window is selected, each control GUI can be initiated.
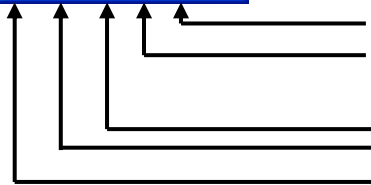
About Window
Communication Window

Camera Control Window
❶ for Imager 1 (BW1) and ❷ for Imager 2
Common Control Window

9.1.2 The About Window

The about window contains information about the version of the program, Internet connection to JAI A/S and access to the help documents.

The drop-down box labeled "Help File" will list all files which have the extension .pdf and that are found in the program (default) folder.

C:\Program Files\JAI A-S\"control tool name"

It is possible to download updated operation manuals from the jai website: http://www.jai.com

At the bottom of the windows (all windows but the Communication Window) is a colored bar. The bar is green when the Camera Control Tool is connected to a camera and the camera is turned on. The bar is red when the Camera Control Tool is not connected to a camera or when the camera is turned off.
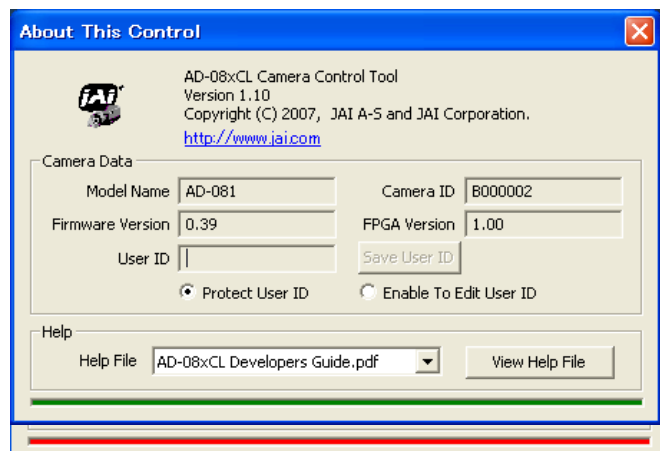
9.1.3 Communication Window

The Communication Window is used to connect the Camera Control Tool with the JAI camera.

Camera Link communication:

Select "Camera Link" in the "Category" box. "Port Name" indicates DLL file names (or frame grabber names) for all Camera Link frame grabbers that are installed in the pc. This is done by using a DLL file called "clserial.dll" to upload all frame grabber DLLs that are found on the pc.

Just select the option for the frame grabber that is installed in the pc.

Auto search

Click the auto button to search for a camera on communication port 1 to 16. The camera control program automatically sends a camera request on every communication port. The user is prompted to use a communication port if a camera answers the request.
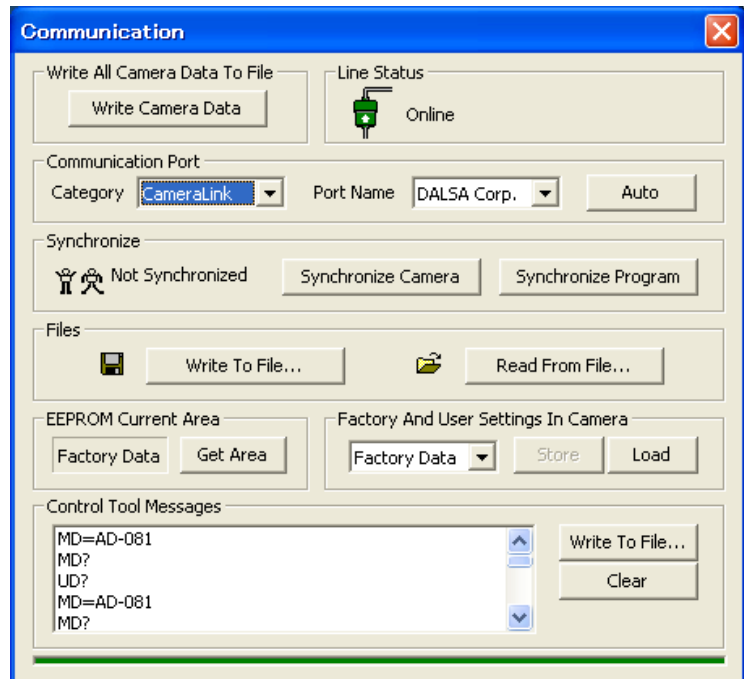
Off/On-line mode

The Camera Control Tool Application can run Offline (without a camera attached) and all functions are fully functional in offline mode.

Off line mode is indicated in The Communication Window, where a status field with graphic and text indicates the on/off-line status.

Changing the selected communication port (from the communication window) changes the online/off-line status. If a camera is found on the selected communication port the application runs online otherwise offline.

Changing the settings in the application will automatically update the camera settings when the application is online.

If the application looses connection with the camera it will automatically go to offline mode and it is indicated in the communication window.

Synchronize program and camera

The Camera Control software has the ability to synchronize either the camera or the program. Click Synchronize camera to write all settings from the program to the camera or click the Synchronize program to load all settings from the camera to the program.

Files

When clicking the Write to File or Read from File button, the user is prompted for a file using a standard file dialog. New files are created if they do not already exist.

Files for camera settings have the extension cam. Information about the communication port is not stored in the files. All settings are automatically sent to the camera when a file has been loaded (if the camera is online).

Factory and User Settings
Use the Store button to store the current camera settings into the user settings area in EEPROM.
Current camera settings are not saved when the camera is turned off. To save current camera
settings you have to save them in one of the available user areas.
Use the Load button to restore previously saved camera settings from either the Factory or the
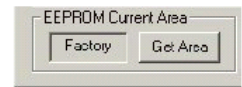User EEPROM area.

Write All Camera Data to File.
Click the "Write Camera Data" button to save all camera settings into a
text file. The information that can be saved is:
Model Name, Camera ID, User ID, Firmware Version, Current Settings,
Factory Settings and the available User Areas.

EEPROM Current Area.
Click the 'Get Area' button to read the power up settings area number.

9.1.4   Common Control window
In this window, the output mode can be selected, synchronous
or separate. The output from Camera Link connector 1 and 2 is
also selected in this window.
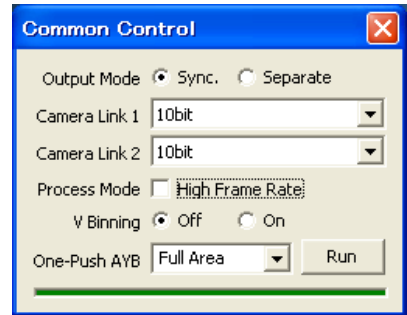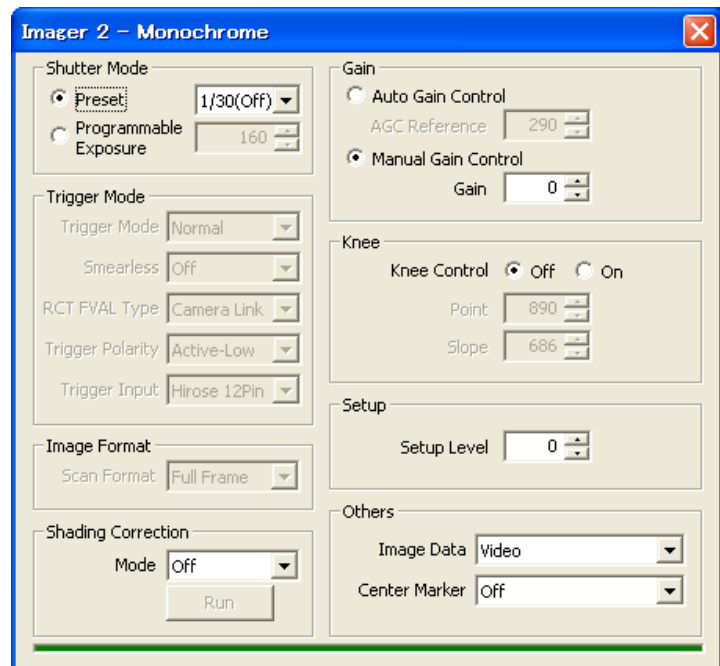
9.1.5   Camera Control Window
The Camera Control Window contains
the fundamental camera setting
functions.
It is possible to set the shutter mode,
trigger mode, image format, scan
format, gain control and black setting.

AD-081CL has two camera control
windows, one for Imager 1 and the
other for Imager 2. The right hand side
picture is for Imager 1, BW1.
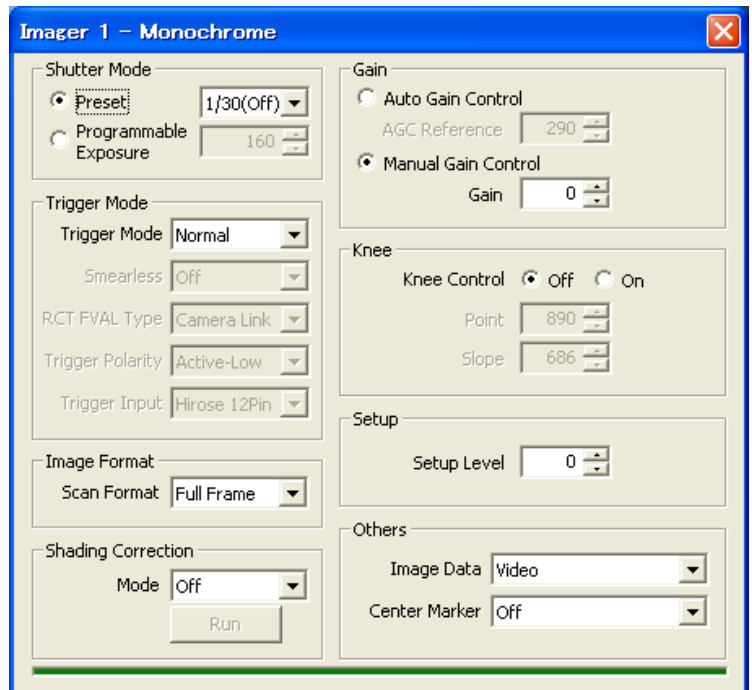
This picture is for Imager 2, BW2.

9.2 Using the Camera Control Tool
Here is some practical information about the Camera Control Tool:
1. The Camera Control Tool bar is always on top of other windows.
2. When you minimize the Camera Control Tool bar all open windows will close.
3. It is possible to work with the Camera Control Tool when the camera is online or when the camera is offline.
4. The newer JAI cameras always start up with the last used user area (but for some old models it will start up with the last saved user area.)
5. The Camera Control Tool saves the last used settings (not the user area), which don't have to be the same as for the last saved user area.
6. The setup file 'CameraName.ini' stores all information about camera settings. When the program is started the last settings for the program are loaded from the file 'CameraName.ini'
7. When you turn on the camera and the Camera Control Tool, it is possible that the Camera Control Tool does not show the actual camera settings (see 4. and 5.).
   a. To obtain the camera settings click "Synchronize Program".
   b. To send the settings that are saved in the Camera Control Tool (last used settings) to the camera click "Synchronize Camera".
   c. To see which area the camera has started up in click "Get Area".

10. External Appearance and Dimensions

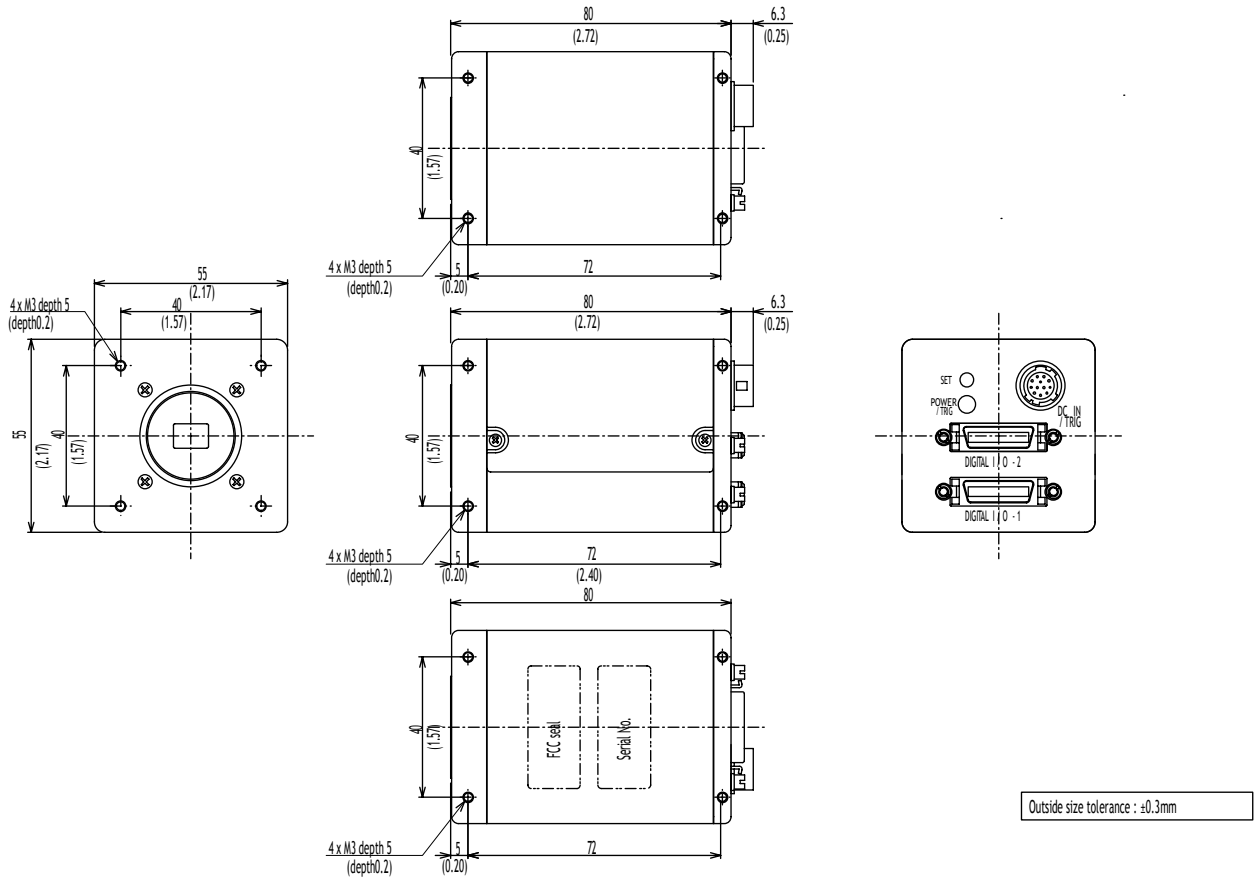

Fig. 39. Dimensions

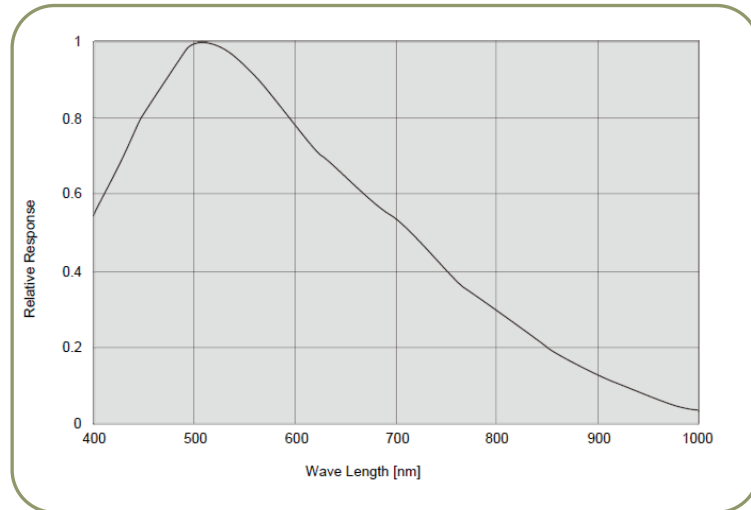# 11. Specifications
11.1 Spectrum response
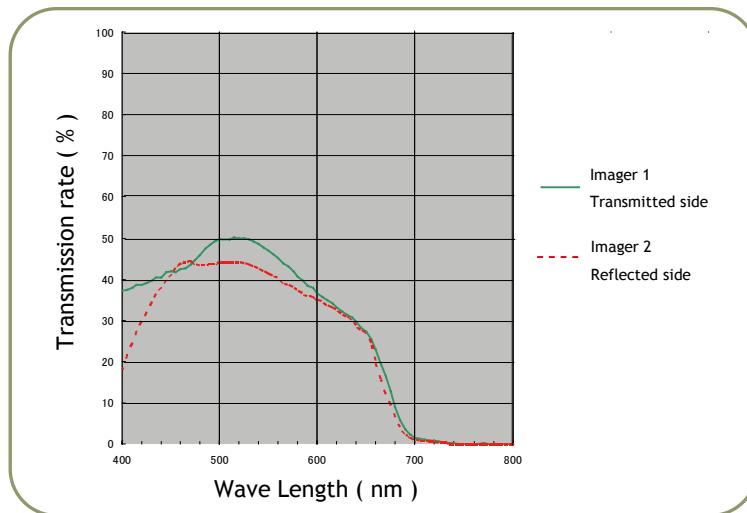

Fig. 40. Spectrum response

Fig.41. Total Spectrum response including prism and sensor

AD-081CL

11.2 Specifications Table

Specifications	AD-081CL
Scanning system	Progressive scan
Frame Rate Full scan	30 frames/sec. Progressive (768 lines/frame) High Frame Rate mode : 60 frames / sec. (768 lines/frame)
Pixel clock	33.75MHz
Line frequency	23.768 KHz (1420 pixel clocks/line)
Image sensor	1/3 inch Monochrome IT CCD (ICX204AL)
Sensing area	4.76 (H) x 3.57 (V) mm (1/3 inch diagonally)
Cell size	4.65 (H) x 4.65 (V) μm
Active pixels	1024(H) x 768 (V)
Pixels in Video output Full 1/2 Partial 1/4 Partial 1/8 Partial V Binning	1024 (h) x 768 (v) 30fps/60fps H = 23.768 kHz 1024 (h) x 384(v) 48fps/96fps H = 23.768 kHz 1024 (h) x 192 (v) 68 fps/136fps H = 23.768 kHz 1024 (h) x 96 (v) 86fps/172fps H = 23.768Hz 1024 (h) x 384 (v) 49.5 fps/99fps H= 19.622 KHz
Minimum Sensitivity on sensor	1.1 Lux
	Max. Gain, Shutter OFF, 50% Video Level
S/N (dB)	More than 54dB (0dB gain)
Iris video output, Analogue	0.7 V p-p (without Sync)

Digital Video Output	Via Camera Link connector 1
	      BM1_10bit, BW1_10bit+BW2_10bit, BW1_8bit, BW1_8bit+BW2_8bit
	Via Camera Link connector 2
	      BM2_10bit, BW2_10bit+BW1_10bit, BW2_8bit, BW2_8bit+BW1_8bit
	Note: Synchronized or separate output is selectable.

Input signal	Trigger（TTL/75Ω）x 2 via Camera Link or HIROSE 12P
Output signal	Hirose 12P XEEN（TTL/75Ω）x 2 Camera Link 1,2: EEN、FVAL、LVAL、DVAL、PCLK (LVDS)
Gain	Master Gain: -3dB ～ +12dB
Knee compensation	Knee point, Knee slope (10bit/8bit)
Gamma	1.0 fixed
Shading compensation	ON/OFF
Auto luminance balance	Gain setting range: -3dB to +6dB (High Frame Rate mode) Detection area is selectable from 9 divisions.
Synchronization	Int. X-tal
Trigger mode	Pre-select, Pulse width and PIV mode
Accumulation	LVAL synchronous or LVAL a-synchronous automatic selection
Preset shutter speed	11steps: OFF(1/30),1/60,1/100,1/120,1/250,1/500,1/1000,1/2000, 1/4000,1/10,000,1/16,000,1/50,000 sec.
Programmable exposure	0.5 L to 792L (1 LVAL unit)
Pulse width control	1/10,000 sec. to 2 seconds
Control interface	Camera Link x 2（EIA-644 LVDS） Effective for the first established communication port
Lens Mount	C Mount （Rear protrusion on C mount lens must be less than 4mm） The lens should be designed for 3CCD cameras
Operating temperature	-5°C to +45°C
Operating humidity	20 to 80% (non-condensing)
Storage temperature/humidity	-25°C to +60°C/20% ～ 80% (non-condensing)
Vibration	3G (15Hz to 200Hz XYZ)
Shock	50G

Specifications	AD-081CL
Regulatory	CE （EN61000-6-2,EN61000-6-3），FCC Part15 Class B、RoHS
Power	DC +12V ± 10%, 0.32A （Typical, normal operation）
Dimensions	55（H）x55（W）x80（D） mm
Weight	400g

Note: Above specifications are subject to change without notice.
Note: Approximately 30 minute pre-heating required to meet specifications.

12. Appendix

12.1 Precautions
Personnel not trained in dealing with similar electronic devices should not service this camera. The camera contains components sensitive to electrostatic discharge. The handling of these devices should follow the requirements of electrostatic sensitive components.
Do not attempt to disassemble this camera.
Do not expose this camera to rain or moisture.
Do not face this camera towards the sun, extreme bright light or light reflecting objects, including laser sources.
When this camera is not in use, put the supplied lens cap on the lens mount.
Handle this camera with the maximum care.
Operate this camera only from the type of power source indicated on the camera.
Remove power from the camera during any modification work, such as changes of jumper and switch settings.

12.2 Typical Sensor Characteristics
The following effects may be observed on the video monitor screen. They do not indicate any fault of the camera, but are associated with typical sensor characteristics.

V. Aliasing
When the camera captures stripes, straight lines or similar sharp patterns, jagged image on the monitor may appear.

Blemishes
All cameras are shipped without visible image sensor blemishes.
Over time some pixel defects can occur. This does not have a practical effect on the operation of the camera. These will show up as white spots (blemishes).
Exposure to cosmic rays can cause blemishes to appear on the image sensor. Please take care to avoid exposure to cosmic rays during transportation and storage. It is recommended using sea shipment instead of air flight in order to limit the influence of cosmic rays to camera.
Pixel defects/blemishes also may emerge due to prolonged operation at elevated ambient temperature, due to high gain setting or during long time exposure. It is therefore recommended to operate the camera within its specifications.

Patterned Noise
When the sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear in the image.

12.3 Caution when mounting a lens on the camera
When mounting a lens on the camera dusts particles in the air may settle on the surface of the lens or the image sensor of the camera. It is therefore important to keep the protective caps on the lens and on the camera until the lens is mounted. Point the lens mount of the camera downward to prevent dust particles from landing on the optical surfaces of the camera. This work should be done in a dust free environment. Do not touch any of the optical surfaces of the camera or the lens.

12.4 Exportation
When exporting this product, please follow the export regulation of your own country.

12.5 References
1. This manual for AD-081CL can be downloaded from www.jai.com
2. Datasheet for AD-081CL can be downloaded from www.jai.com
3. Camera control software can be downloaded from www.jai.com
4. Specifications for the CCD sensor Sony ICX-204AL can be found on www.jai.com

Change tracking

Date	Revision	Changes
Feb.2009	1.0	New issue

See the possibilities

User's Record

Camera type: AD-081CL

Revision: ……………..

Serial No.   ……………..

Firmware version.   ……………..

For camera revision history, please contact your local JAI distributor.

User's Mode Settings.

User's Modifications.

Europe, Middle East & Africa	*Asia Pacific*	*Americas*
Phone +45 4457 8888 *Fax +45 4491 8880*	*Phone +81 45 440 0154* *Fax +81 45 440 0166*	*Phone (toll-free) +1 800 445 5444* *Phone +1 408 383 0300*

Visit our web site at www.jai.com

See the possibilities

Supplement

The following statement is related to the regulation on " Measures for the Administration of the control of Pollution by Electronic Information Products " , known as " China RoHS ".
The table shows contained Hazardous Substances in this camera.

⑮ mark shows that the environment-friendly use period of contained Hazardous Substances is 15 years.

重要注意事项

有毒，有害物质或元素名称及含量表

根据中华人民共和国信息产业部『电子信息产品污染控制管理办法』，本产品《 有毒，有害物质或元素名称及含量表 》如下．

部件名称	有毒有害物质或元素					
	铅 （Pb）	汞 （Hg）	镉 （Cd）	六价铬 （Cr(Ⅵ)）	多溴联苯 （PPB）	多溴二苯醚 （PBDE）
螺丝固定座	×	○	○	○	○	○
………	………	………	………	………	………	………

○：表示该有毒有害物质在该部件所有均质材料中的含量均在SJ／T11363-2006规定的限量要求以下．
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ／T11363-2006规定的限量要求．
（企业可在此处、根据实际情况对上表中打 "×" 的技术原因进行进一步说明．）

环保使用期限
电子信息产品中含有的有毒有害物质或元素在正常使用的条件下不会发生外泄或突变、电子信息产品用户使用该电子信息产品不会对环境造成严重污染或对基人身、财产造成严重损害的期限。
数字「15」为期限15年。