See the possibilities

User's Manual

AM-1600CL
AB-1600CL

Digital Monochrome/Color 16 megapixel Camera with Camera Link interface

Document Version: ver.1.0

Notice

The material contained in this manual consists of information that is proprietary to JAI Ltd., Japan and may only be used by the purchasers of the product. JAI Ltd., Japan makes no warranty for the use of its product and assumes no responsibility for any errors which may appear or for damages resulting from the use of the information contained herein. JAI Ltd., Japan reserves the right to make changes without notice.

Company and product names mentioned in this manual are trademarks or registered trademarks of their respective owners.

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 AM-1600CL-P, AM-1600CL-F, AB-1600CL-P and AB-1600CL-F comply with the following provisions applying to its standards.
EN 61000-6-3 (Generic emission standard part 1)
EN 61000-6-2 (immunity)

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 an 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.

- Contents -

1. General

The AM-1600CL and AB-1600CL are 16-megapixel high resolution cameras for applications such as high density board inspection, flat panel display inspection, and so on. The AM-1600CL is a monochrome progressive scan CCD camera and the AB-1600CL is the equivalent Bayer mosaic progressive scan CCD camera. Both cameras have 16 million pixels resolution and a continuous frame rate of 3.0 frames per second. The AM-1600CL and AB-1600CL support the partial scan read out modes for faster frame rates. The AM-1600CL also has a horizontal and/or vertical binning modes for a faster frame rate, as well as higher sensitivity.
The AM-1600CL has internal pre-processing circuits for blemish compensation, flat field compensation and a LUT (Look Up Table). Both cameras accept external trigger pulses with EPS and PWC modes available.
The Camera Link digital output is selectable at8 bits, 10 bits or 12 bits. Lens mount options include F mount or Universal P mount, which is the factory option.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of Camera Control Tool for AM-1600CL/AB-1600CL can be downloaded from: www.jai.com

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

2. Camera nomenclature

The standard camera composition consists of the camera main body and C-mount protection cap.
Standard Configuration

Camera body	1
Sensor Protection cap	1

The camera is available in the following versions.

AM-16000CL-P/F	A	: "Advanced" Family
	M	: Monochrome
	1600	: Resolution 16 million pixels
	CL	: Camera Link
	P	: Universal P Mount
	F	: Nikon F Mount
AB-16000CL-P/F	A	: "Advanced" Family
	B	: Bayer mosaic color
	1600	: Resolution 16 million pixels
	CL	: Camera Link
	P	: Universal P Mount
	F	: Nikon F Mount

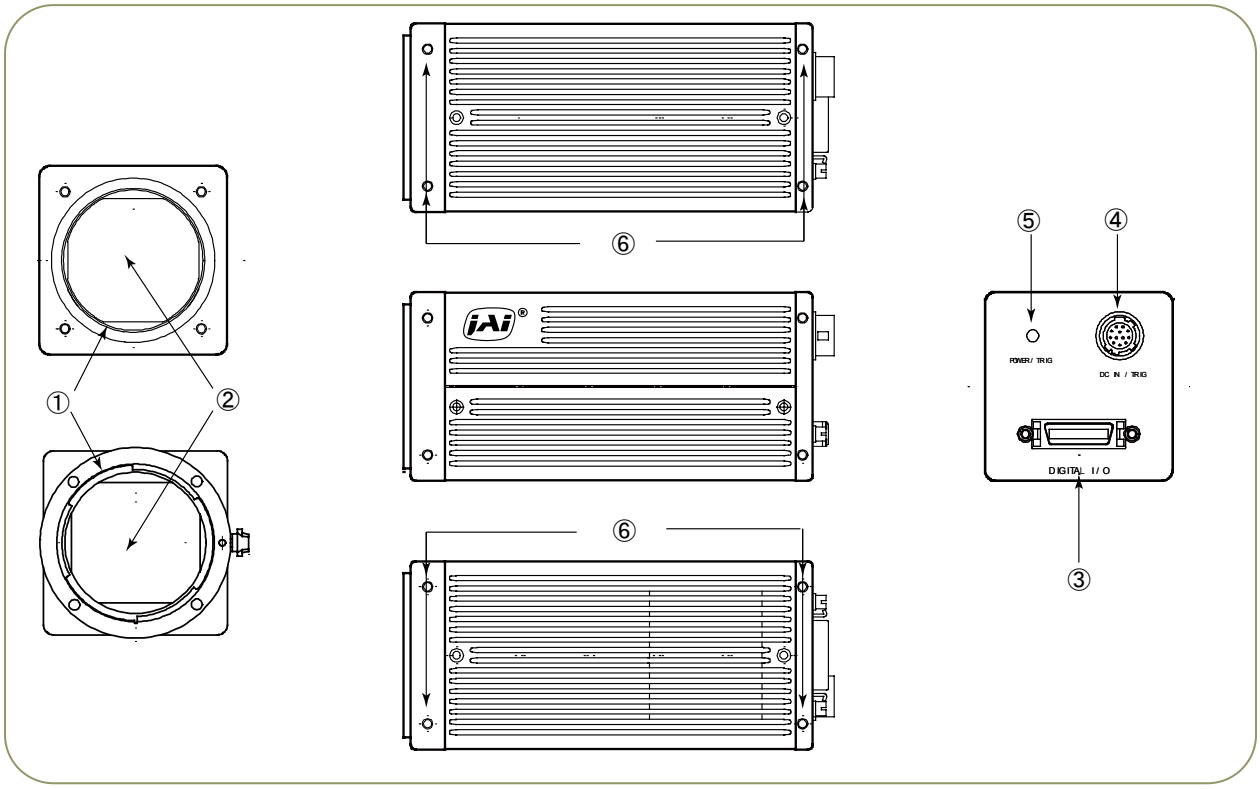
Options

AC Power Adaptor	PD-12U series
Power Cable	12P-02S
Tripod plate	MP-41

3. Main Features

- C3 Advanced series progressive scan camera
- Monochrome and Bayer mosaic color versions
- KAI-16000 IT CCD, 43.3 mm diagonal (35mm film size)
- 4872 (h) x 3248 (v) active pixels
- 7.4 µm square pixels
- 12- or 10- or 8-bit output
- 3 frames/second with full resolution in continuous operation
- Variable partial scan is available with user-definable height and starting point
- 2X binning in horizontal, vertical, or H & V directions (AM-1600CL only)
- Programmable shutter from 3 lines (295.98µs) to 3248 lines (320.45ms)
- Pre-select and Pulse width trigger modes
- Built in LUT (Look Up Table) (AM-1600CL only)
- Blemish compensation circuit built in (AM-1600CL only)
- Flat field compensation (pixel non-uniformity compensation) (AM-1600CL only)
- Built in test pattern generator
- LVAL-synchronous/-asynchronous operation (auto-detect)
- Two types of lens mounts is available as factory option, Universal P mount or Nikon F mount
- Setup by Windows 2000/XP via serial communication

4. Locations and Functions



①	Lens mount	Universal P-mount (Note *1)
①	Lens mount	Nikon F mount (Note*2)
②	CCD sensor	35mm size CCD sensor
③	26-pin connector	Camera Link Interface (Note *3)
④	12-pin connector	DC+12V and trigger input
⑤	LED	Indication for power and trigger input
⑥	Mounting holes	M3 depth 5mm for tripod mount plate (Note *4)

*1) Note: Rear protrusion on Universal P-mount lens must be less than 11.0mm.
*2) Note: Rear protrusion on Nikon F-mount lens must be less than 12.0mm.
*3) Note: When a CameraLink cable is connected to the camera, please do not excessively tighten screws by using a driver. The CameraLink receptacle on the camera might be damaged. For security, the strength to tighten screws is less than 0.291 Newton meter (Nm). Tightening by hand is sufficient in order to achieve this.
*4) Note: The part number for the tripod adapter plate (with 1/4"-20 thread) is MP-41 (option).

Fig. 1. Locations

5. Pin Assignment

5.1. 12-pin Multi-connector (DC-IN/Trigger)

Type: HR10A-10R-12PB-01 (Hirose) male.
Use the part number HR10A-10P-12S for the cable side

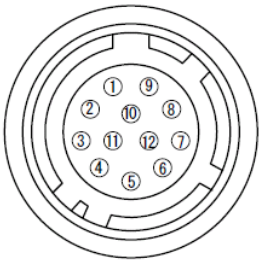


Fig. 2 Hirose 12-pin connector

Pin no.	Signal	Remarks
1	GND	
2	+12 V DC input	
3	GND	
4	NC	
5	GND	
6	NC	
7	NC	
8	GND	
9	XEEN out	
10	Trigger in	*1)
11	DC+12V	
12	GND	

*1) Factory default is trigger via Camera Link. 12 pin input can be selected by using serial control.

5.2. Digital Output Connector for Camera Link

Type: 26-pin MDR connector (3M 10226-1A10PL)

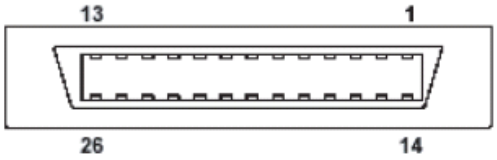


Fig.3 26-Pin Camera Link Connector

Pin No	In/Out	Name	Note
1,14		Shield	GND
2(-),15(+)	O	TxOUT0	Data out
3(-),16(+)	O	TxOUT1	
4(-),17(+)	O	TxOUT2	
5(-),18(+)	O	TxClk	Clock for CL
6(-),19(+)	O	TxOUT3	Data out
7(+),20(-)	I	SerTC (RxD)	LVDS Serial Control
8(-),21(+)	O	SerTFG (TxD)	
9(-),22(+)	I	CC1 (Trigger)	Trigger IN
10(+),23(-)	I	CC2(Reserved)	
11,24		N.C	
12,25		N.C	
13,26		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. Trigger input

An external trigger input can be applied to pin 10 of 12-pin Hirose connector .
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 command.
Trigger input level is 4 V ±2 V.
Internal DIP SW700 can terminate the trigger input by 75 ohm.

Trigger is applied through the Camera Link connector as the default setting.

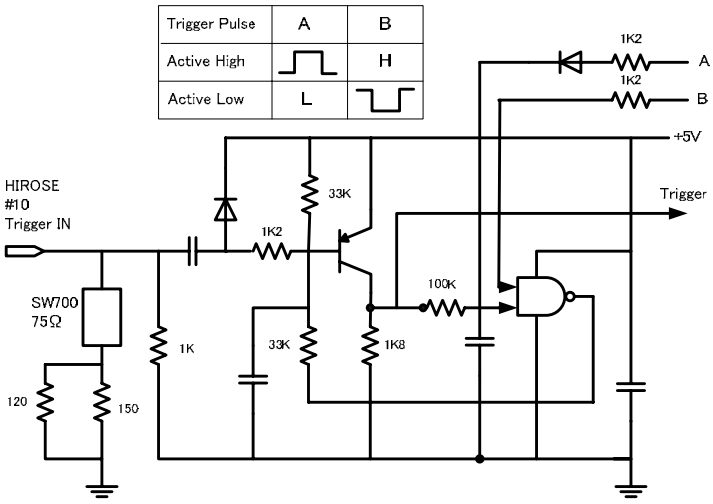


Fig.4. Trigger input

5.3.2. XEEN output

XEEN output is on pin 9 on 12-pin Hirose connector.
The output circuit uses a 75 ohm complementary emitter follower circuit.
The line voltage is 5V and the output level is 4V without termination.
XEEN output is always negative polarity.
Through Camera Link connector, EEN output is available. This output is always positive polarity.
The polarity for XEEN and EEN cannot be changed.

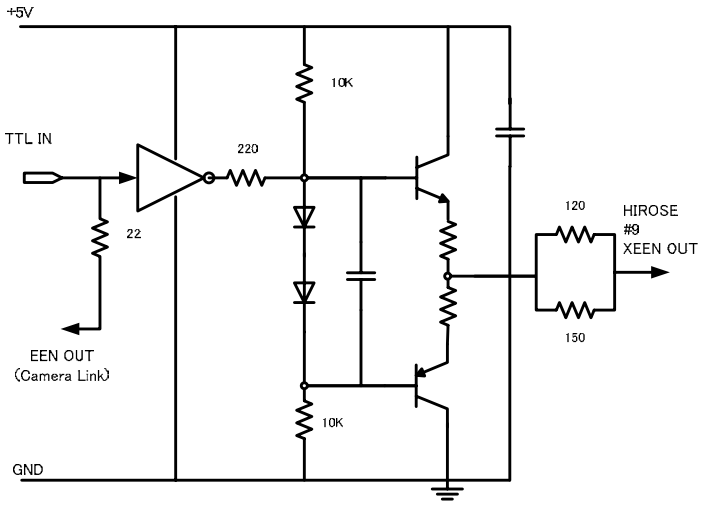


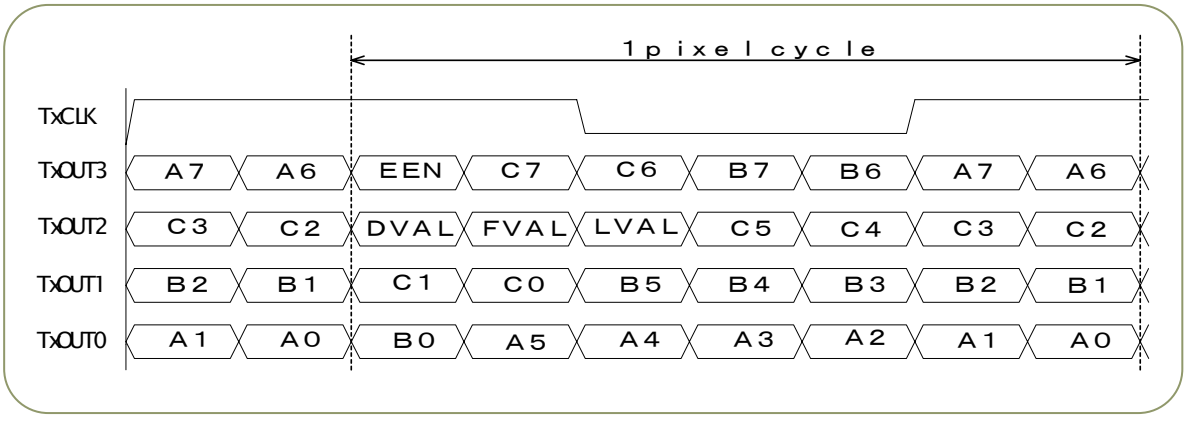
Fig.5. XEEN output

5.3.3. Camera Link interface

The digital video is available via Camera Link, with 8-, 10- or 12-bit pixel depth, using the CL Base configuration. The digital output signals follow the Camera Link standard using Channel Link chip sets.
The data bits from the digital video, FVAL, LVAL, DVAL and EEN are multiplexed into the twisted pairs, which are a part of the Camera Link. Trigger signals and the serial camera control are feed directly through its own pairs.
The 26-pin MDR Camera Link connector pin assignment follows the Camera Link base configuration.
For a detailed description of the Camera Link standard, please refer to the Camera Link standard specifications found at the AIA web site, www.machinevisiononline.org.

Port/Signal	8bitOutput	10bitOutput	12bitOutput	Pin No.
Port A0	A2	A0	A0	Tx0
Port A1	A3	A1	A1	Tx1
Port A2	A4	A2	A2	Tx2
Port A3	A5	A3	A3	Tx3
Port A4	A6	A4	A4	Tx4
Port A5	A7	A5	A5	Tx6
Port A6	A8	A6	A6	Tx27
Port A7	A9	A7	A7	Tx5
Port B0	B2	A8	A8	Tx7
Port B1	B3	A9	A9	Tx8
Port B2	B4	NC	A10	Tx9
Port B3	B5	NC	A11	Tx12
Port B4	B6	B8	B8	Tx13
Port B5	B7	B9	B9	Tx14
Port B6	B8	NC	B10	Tx10
Port B7	B9	NC	B11	Tx11
Port C0	NC	B0	B0	Tx15
Port C1	NC	B1	B1	Tx18
Port C2	NC	B2	B2	Tx19
Port C3	NC	B3	B3	Tx20
Port C4	NC	B4	B4	Tx21
Port C5	NC	B5	B5	Tx22
Port C6	NC	B6	B6	Tx16
Port C7	NC	B7	B7	Tx17
LVAL				Tx24
FVAL				Tx25
DVAL				Tx26
EEN				Tx23

Output Timing



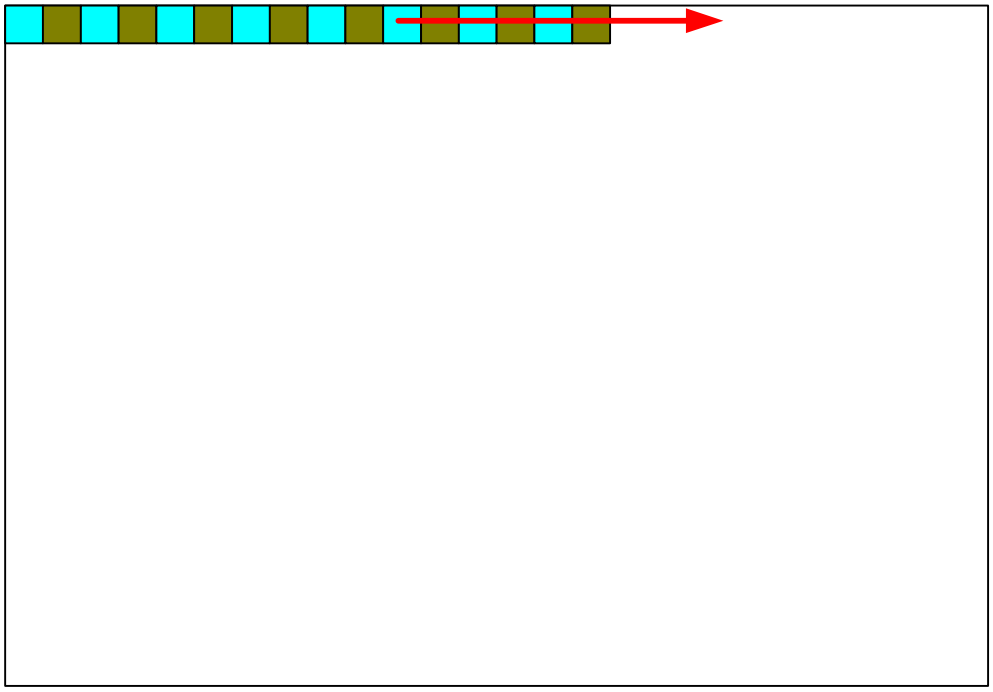
5.4. Video output through Camera Link connector

AM-1600CL and AB-1600CL use a dual tap CCD sensor. The L channel video and R channel video are recomposed in the camera as one frame of the video. The odd pixel and even pixel on the raster frame is alternatively output through the camera link connector.

2 channel Pixel Interleaved output.

A-channel of one frame

B-channel of one frame



6. Functions and Operations

6.1. Before starting

Important Note for operation of AM-1600CL and AB-1600CL

AM-1600CL and AB-1600CLcameras use OS (Operating System) inside. Due to this, it is important to pay special attention when using the camera control tool.

1. **The camera cannot communicate with the camera control tool until the LED turns to GREEN which is approx. 30 seconds.**
2. **After the camera control tool is initiated, push "Refresh" and then "Connect" for establishing the communication. Then click the "Refresh Tab" to view the status of the camera on each window: Gain & Offset, General, Image Processing and Utilities. It is also necessary to do this for restart.**

6.2. Basic functions

The AM-1600CL / AB-1600CL camera is a progressive scan camera with a16-mega pixel monochrome or Bayer mosaic color CCD. The interface to the host PC is via digital Camera Link. Both models output digital video as 8-, 10- or 12-bits. The output through Camera Link connector is 2 channels, pixel interleaved output. The color version, AB-1600CL, outputs raw Bayer video, requiring host-based color interpolation. The camera also features several pre-processing functions (see chapter 6.3)
The camera has a partial scan function selectable as user programmable. It also features horizontal, vertical and horizontal plus vertical binning modes (AM-1600CL only) for faster frame rates and increased sensitivity.

There are 2 trigger modes in addition to continuous operation. The Pre-Select and Pulse Width trigger modes are available with a unique automatic LVAL sync or a-sync selection function.

The functions are described in detail below.

6.2.1. Digital Video Output (Bit Allocation)

The 10-bit digital output is set 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.

CCD out	Digital Out		
	8 bits	10 bits	12 bits
Black	8 LSB	32 LSB	128 LSB
400mV	222 LSB	890 LSB	3560 LSB
460mV	255 LSB	1023 LSB	4095 LSB

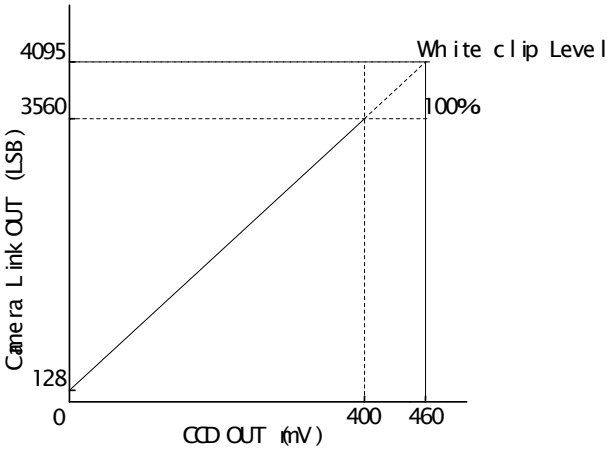


Fig.6. Digital Output Bit Allocation (In case of 12 bits)

6.2.2. Electronic Shutter

The AM/AB-1600CL allows the shutter speed to be selected in two ways; preset shutter (10 fixed steps) and programmable shutter (up to 3248 line periods, 1 LVAL increments).

Preset shutter

0	1	2	3	4	5	6	7	8	9	A
OFF(1/3)	1/6	1/12	1/24	1/48	1/100	1/200	1/400	1/800	1/1600	1/3200

Programmable Shutter

The exposure time can be programmed in 98.66µs (LVAL period) increments. The range is from 3 LVAL to 3248 LVAL. OFF is 3327L. L=LVAL.

Minimum exposure time 3 L	Maximum exposure time 3327 L
98.66 µs x 3(L) = 295.98 µs	98.66 µs x 3327 (L) ≈ 328.24 ms

In Binning Mode (Vertical Binning)

Minimum Exposure time	Maximum exposure time 1665 L
106.66 µs x 3(L) = 319.98 µs	106.66 µs x 1665(L) = 175.89 ms

6.2.3. Continuous operation or triggered operation

The camera can be operated in continuous mode for applications not requiring asynchronous external triggering. The camera will operate at its maximum frame rate, 3.0 frames/seconds, in this mode.

For applications that require an external trigger, the camera can accept external trigger input on pin 10 of the 12-pin Hirose connector or via the Camera Link interface. This can be selected via serial interface.

6.2.4. Rear panel indicator.

The rear panel mounted LED provides the following information:

- Amber and Red: Power connected – initiating OS (approx. 20 sec.)
- Red: Initiating the application (approx. 10sec.)
- Steady green: Camera is operating in Continuous mode
- Flashing green: The camera is receiving external trigger

Note: When the camera is receiving the external trigger in Continuous mode, the LED does not flash. The LED flashing indicates incoming trigger but not the trigger duration.

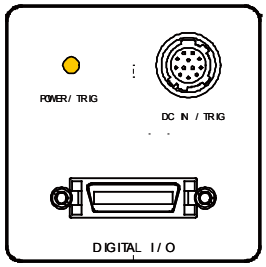
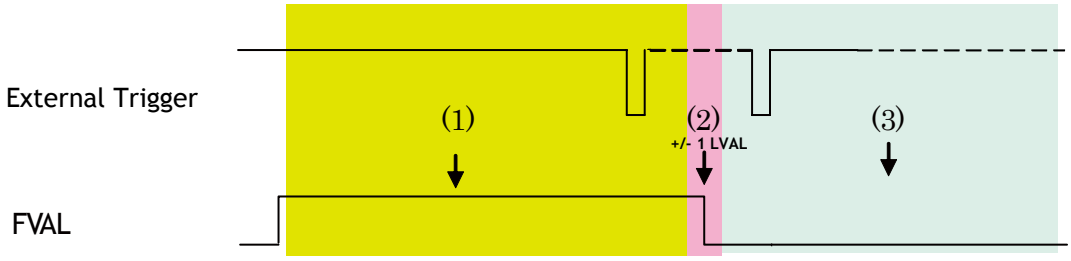


Fig.7. Rear Panel indicator

6.2.5. 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 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 the start of a trigger to the start of accumulation.
When the trigger is received and FVAL is Low, the camera operates 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 (+/- LVAL period), as the function may randomly switch between " next LVAL " and " immediate ".

(3) In this period, camera executes trigger immediately (no delay).

Fig.8. Auto-detect LVAL sync/a-sync accumulation

6.2.6. Starting pixel - Bayer color mosaic

The AB-1600CL is a color camera based on a CCD sensor with a Bayer color mosaic.
The color image reconstruction is done in the host PC.
The color sequence in the video signal is dependent on the scan modes.

AB-1600CL starts with GR sequence for Full scan mode. In partial scan mode, the starting line is user programmable (see next section). When an odd line is selected for the start, it starts with the GRG sequence. When an even line is selected, it starts with BGB sequence.

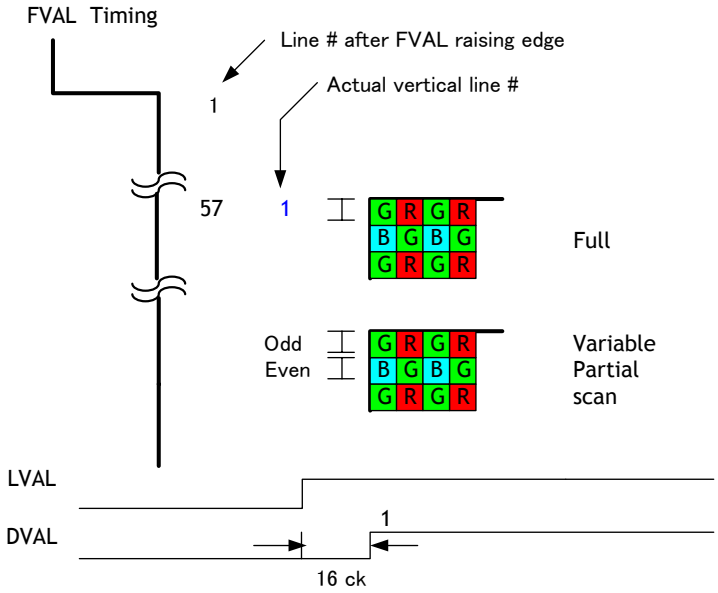


Fig.9. Bayer layout

6.2.7. Partial Scanning

The partial scanning function employed in AM/AB-1600CL is programmable.
The height of the image can be set from 800 lines as the minimum height and expanded to 3248 lines which is the full scan image. The starting point of the scan can be set from the first line to 2448th line, when the height is set to 800 lines.
The camera has 4 memory settings for use with partial scan mode.
The following describes the programmable partial scan image.

Variable Partial Scan

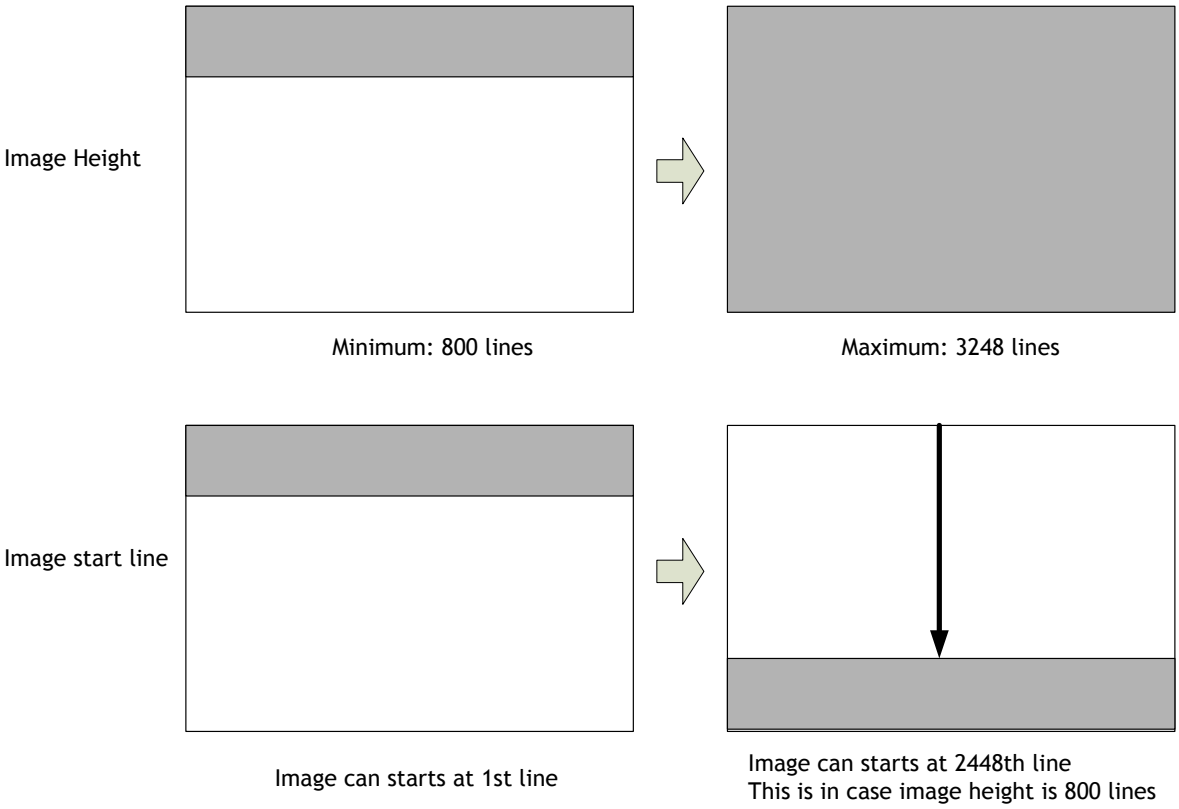


Fig.10. Variable Partial scan

6.2.8. Binning Functions (AM-1600CL only)

This function is only available on the AM-1600CL camera.
The AM-1600CL incorporates 3 binning modes described below.
Binning mode is a function where the signal charges from 2 adjacent (horizontal or/and vertical) pixels are added together and read out as one pixel. Binning results in half of horizontal and/or vertical resolution but higher frame rate and higher sensitivity.

For horizontal binning, a Low Pass Filter (LPF)) is used to realize a smooth edge transition.
The LPF adds the data from the processed pixel and the data from the left and the right pixels of the processed pixel, using a specified ratio, and replaces the data of the processed pixel with the added data.

The ratio is fixed and can be selected from the following:
1/4, 1/2, 1/4 : Adding data Ratio Left and right 25%、center 50%
1/8, 3/4, 1/8 : Adding data Ratio Left and right 12.5%、center 75%

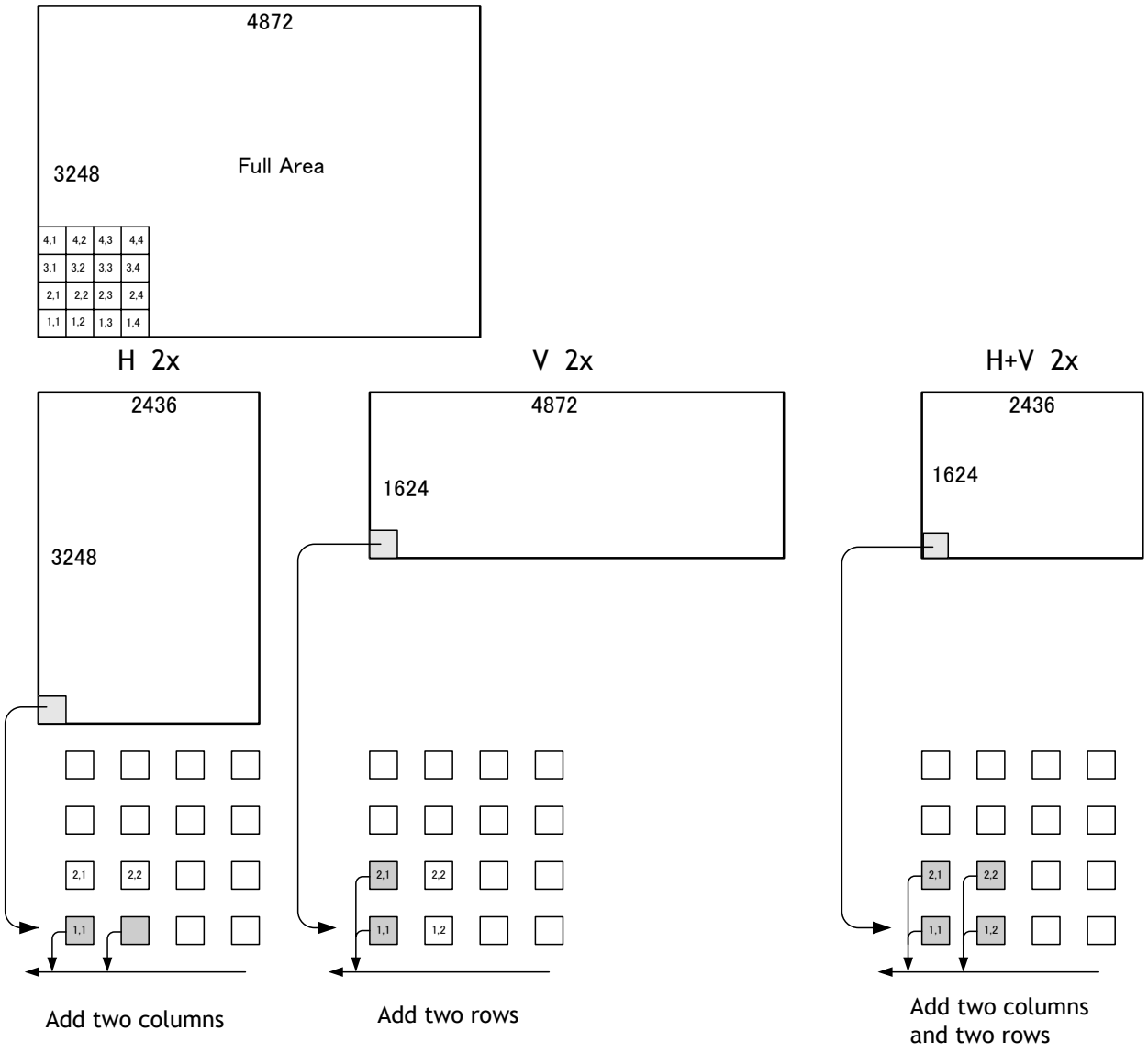


Fig. 11. Binning

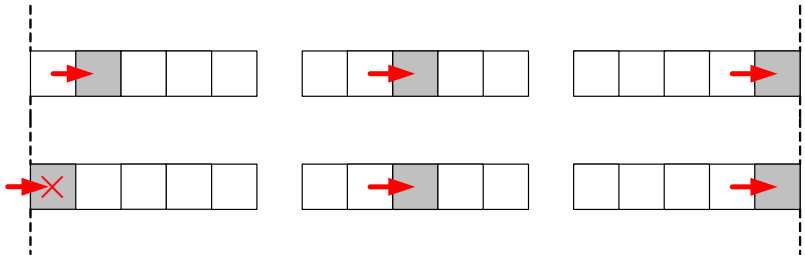
6.3. Pre-processing Functions (overview)

AM-1600CL and AB-1600CL have several pre-processing functions.
The pre-processing functions include Blemish Compensation, Flat Field Compensation (pixel non-uniformity) and LUT (Look Up Table). A brief description of each function is included on the following pages. See Section 8 for instructions regarding how to set up these functions using the camera's GUI Control Tool, or see Section 7 for register-level command information.

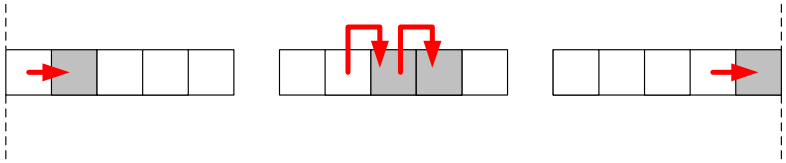
6.3.1. Blemish Compensation (AM-1600CL only)

AM-1600CL has a blemish compensation circuit. This function compensates for blemishes on the CCD sensor (typically pixels with extremely high response or extremely low response). This applies to Monochrome version only. Pixels that fulfill the blemish criteria can be compensated by using the adjacent pixel on the left side column as shown below.

There is no limit to the number of pixels that can be compensated. As L channel and R channel images are composed as one image inside the camera, there is also no limitation on L channel and R channel compensation.
When the leftmost pixel has blemish, it cannot be compensated because there is no data for compensation.



When two or more consecutive pixels have blemishes, the leftmost pixel with a blemish is compensated by the left normal pixel data and the second pixel is then compensated by the left pixel which is already compensated.



The default setting is Disable.

6.3.2. Gain and Channel Balance

The AM-1600CL/AB-1600CL has a dual-tap readout architecture, with Left (L) and Right (R) channels. In order to achieve the same gain and black level for both channels, the AM-1600CL/AB-1600CL has independent control for L channel and R channel gain and offset.
In order to balance both channels, the balancing uses L channel as the reference and R channel is adjusted so as to have the same level as that of L channel for both gain and offset.

6.3.3. Flat Field Correction (Pixel non-uniformity) (AM-1600CL only)

The flat field correction function can compensate different gain and offset on each pixel. It is possible to use offset only (black-level correction) or offset and gain corrections in sequence.

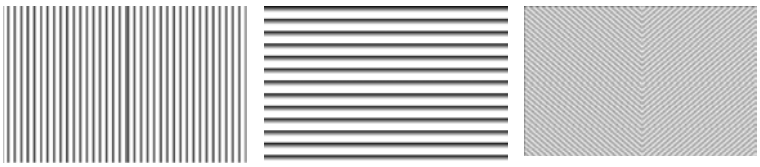
6.3.4. Programmable Look-Up Table (LUT) (AM-1600CL only)

AM-1600CL has a programmable look-up table (LUT) that lets the user adjust the gamma characteristics of the video output by adding “knees” or otherwise adjusting points along the video response graph.

6.3.5. Test pattern generator

The AM-1600CL and AB-1600CL cameras have the following test pattern generators. While the test pattern is selected, the video output is disabled. This function does not depend on the setting of gain and offset. This function can be set by command but the setting is not stored in the memory.

1. Horizontal Ramp
2. Vertical Ramp
3. Horizontal and Vertical Ramp



6.4. Sensor Layout and Timing

6.4.1. CCD 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.

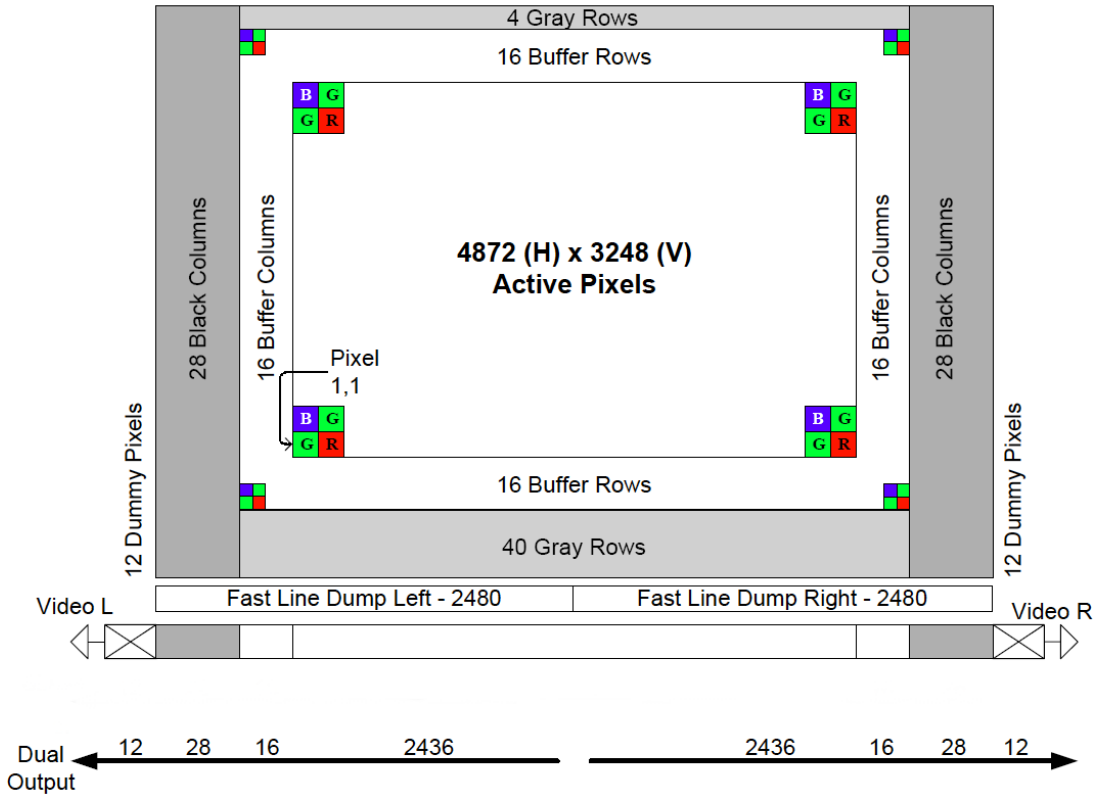


Fig. 12. CCD sensor layout

6.4.2. Horizontal Timing

The LVAL period is shown for continuous mode.

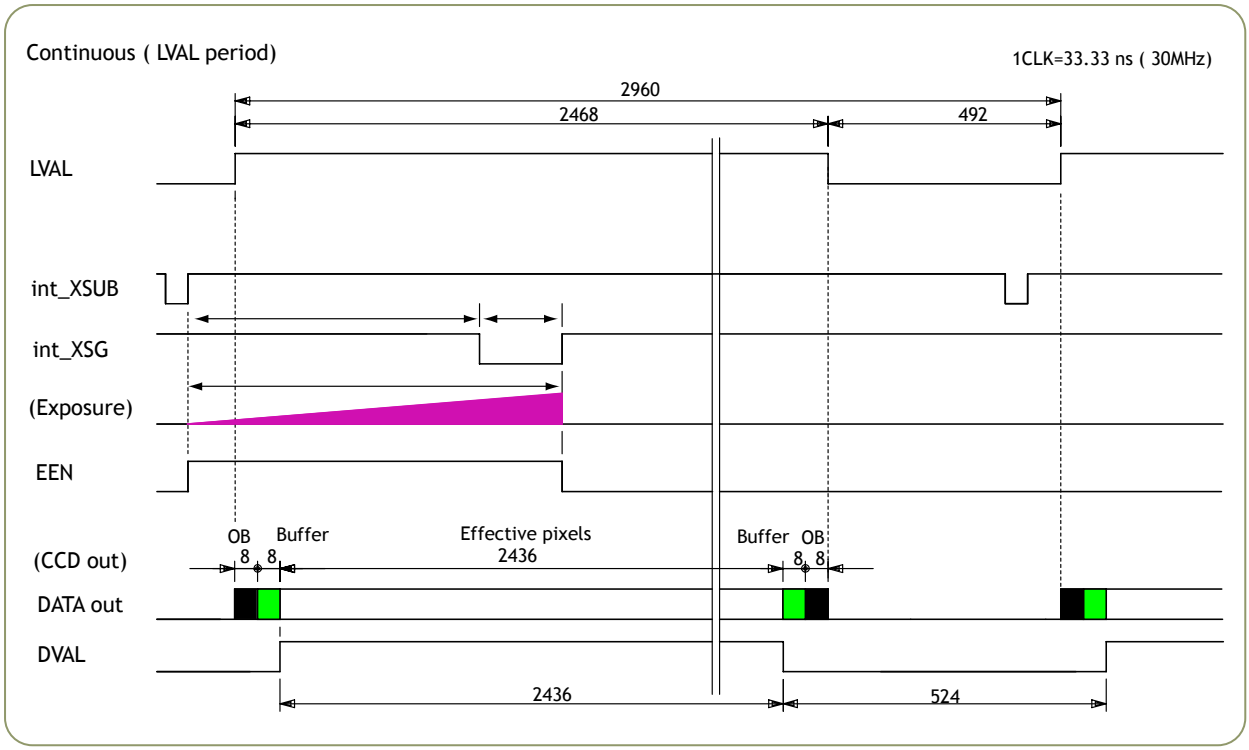


Fig. 13. Horizontal Timing

6.4.3. Vertical Timing

The FVAL period for continuous mode full scan is shown.

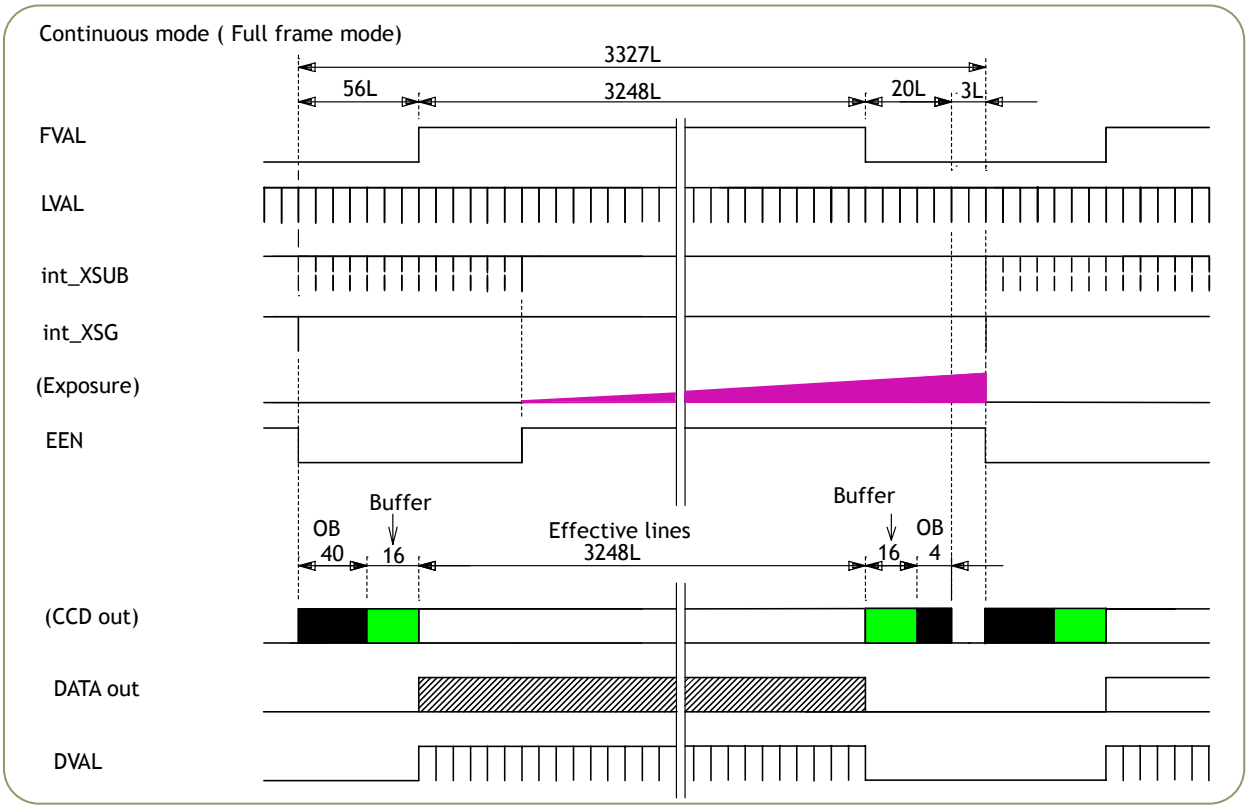


Fig. 14. Vertical Timing for full scan

6.4.4. Partial Scan

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

Vertical timing

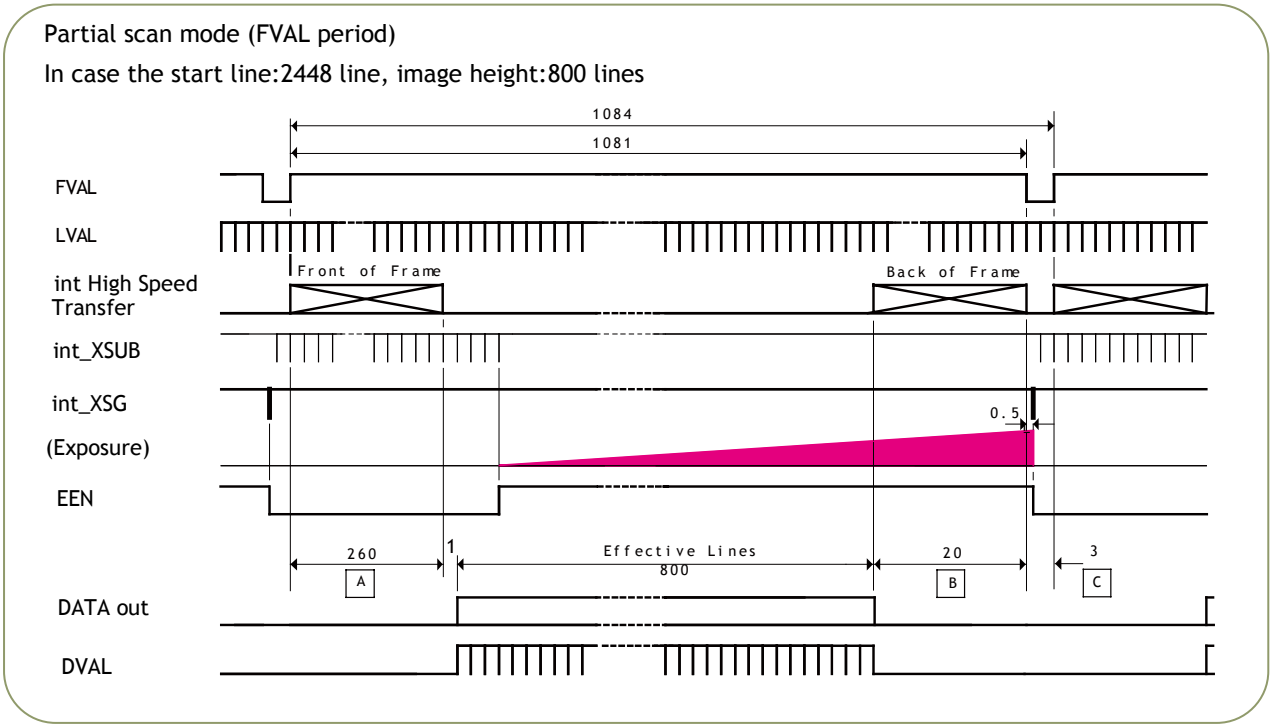


Fig.15. Partial scan Vertical Timing

Horizontal Timing (Same as normal scan)

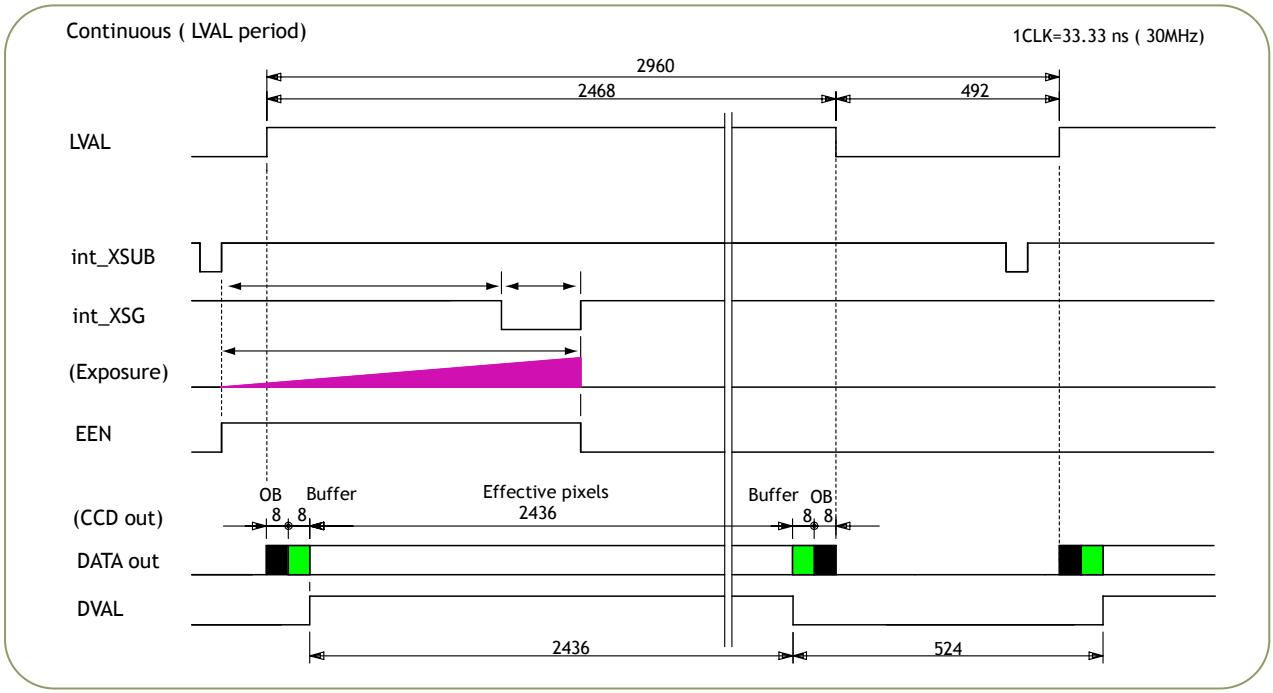


Fig.16. Partial scan Horizontal Timing

The frame rate can be calculated in the following formula.
In this formula, “Ceil” is round up. And(Top_Dump_line + Partial lines + Bottom_Dump_line)=3248

Total lines = 59 + A_line + Partial lines + B_line + 20
Frame Rate (fps) = 1 / (2960 * Total lines * 33.333333 / 1000000000)

A _line Ceil{(Top_Dump_line + 3)/12}, If Top_Dump_Line is 0, A_line is 0.

B_line Ceil{(Bottom_Dump_line + 3)/12}, If Bottom_Dump_line is 0, B_line is 0.

Example:

Case	Partial lines	Start line	H period (clock)	V period (Lines)	Frame rate (fps)	Calculation
1	1/2 (1624)	0	2960	1839	5.51	59+0+1624+136+20
2	1/2 (1624)	812	2960	1839	5.51	59+68+1624+68+20
3	1/2 (1624)	1624	2960	1839	5.51	59+136+1624+0+20
4	1/4(812)	0	2960	1095	9.25	59+0+812+204+20
5	1/4(812)	812	2960	1095	9.25	59+68+812+136+20
6	1/4(812)	2436	2960	1095	9.25	59+204+812+0+20

6.4.5. Horizontal and Vertical binning

Vertical binning combines charge from two adjacent rows, while horizontal binning combines charges from two adjacent columns, reducing the vertical or horizontal resolution to half and at the same time increasing frame rate. This function is available only for AM-1600CL.

Important Note
Vertical Binning cannot be used together with Partial Scanning.

Vertical Binning (Horizontal Timing)

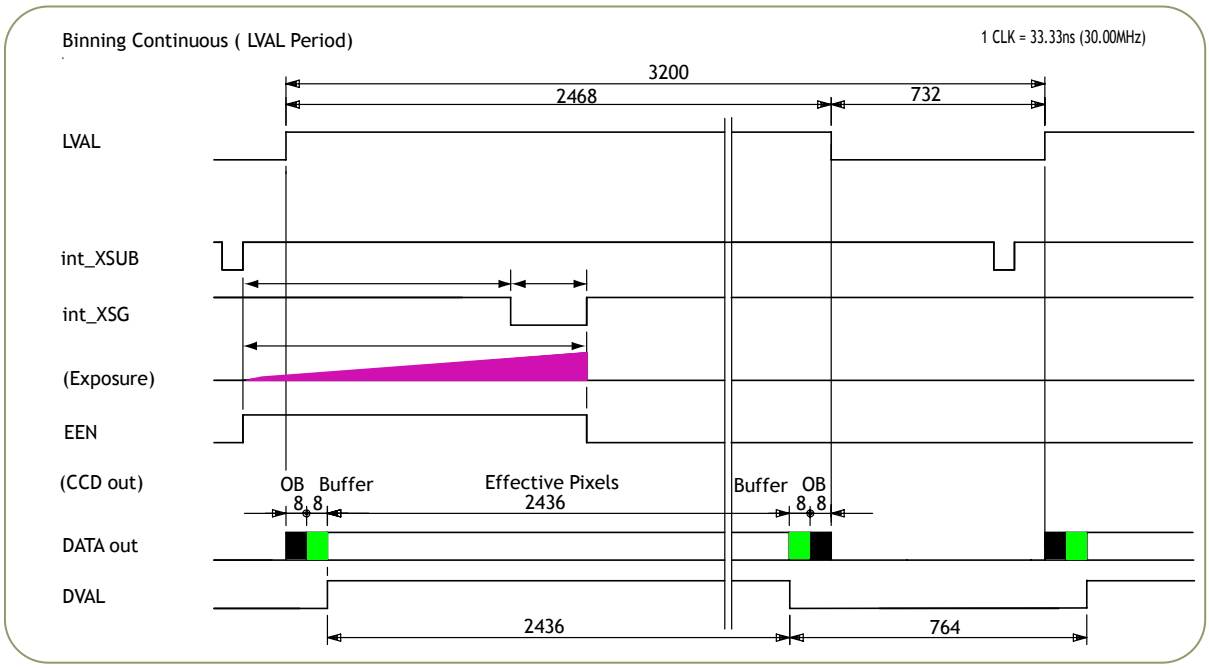


Fig.17. Horizontal Timing for Vertical Binning

Vertical Binning (Vertical Timing)

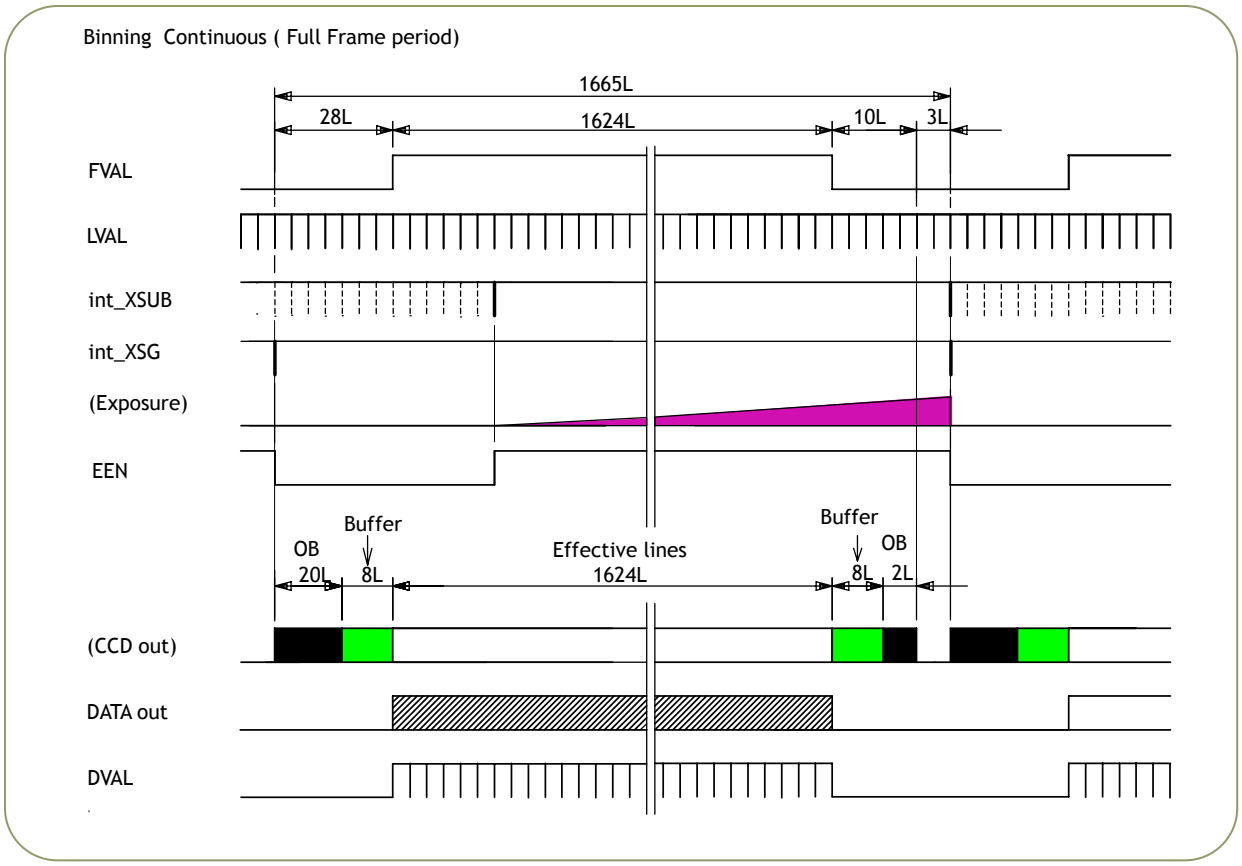


Fig.18. Vertical Timing for vertical binning

The frame rate can only be increased in 2x vertical binning mode. It can be calculated as the followings.
1 line in 2x binning mode = 106.66μs
Total lines = 1665 lines
Frame rate = 1/(3200*1665*33.333333/1000000000)=5.63 fps

6.5. Operation Modes

This camera can operate in 3 primary modes.

1. *Continuous Mode.* Pre-selected exposure.
2. *Edge Pre-select Mode.* Pre-selected exposure.
3. *Pulse Width Control Mode.* Pulse width controlled exposure.

6.5.1. Continuous operation

Applications not requiring asynchronous external triggering should be run in continuous mode. For timing details, refer to fig. 13 through fig. 18.

6.5.2. Edge Pre-select Trigger Mode (EPS)

In this mode, an external trigger pulse initiates the capture, and the exposure time (accumulation time) is defined by the selected shutter time .
The resulting video signal will start to be read out after the shutter time.

For timing details, refer to fig. 13 through fig. 18 and fig. 19.

To use this mode:

Set function:	Trigger mode	EPS
	Scanning	Normal, Programmable Partial H, V or H+V Binning
	Shutter mode	pre-set or programmable
	Shutter speed or Programmable exposure	
	Other functions and settings	
Input:	Ext. trigger	Camera Link or 12-pin Hirose

Important notes on using this mode

1. The minimum trigger duration > 1LVAL.
2. Depending on the timing of the leading edge of the trigger pulse in relationship to FVAL, accumulation will be synchronous or asynchronous in relation to LVAL. See chapter 6.2.5 for details.
3. The minimum interval of the trigger is 3327 LVAL.

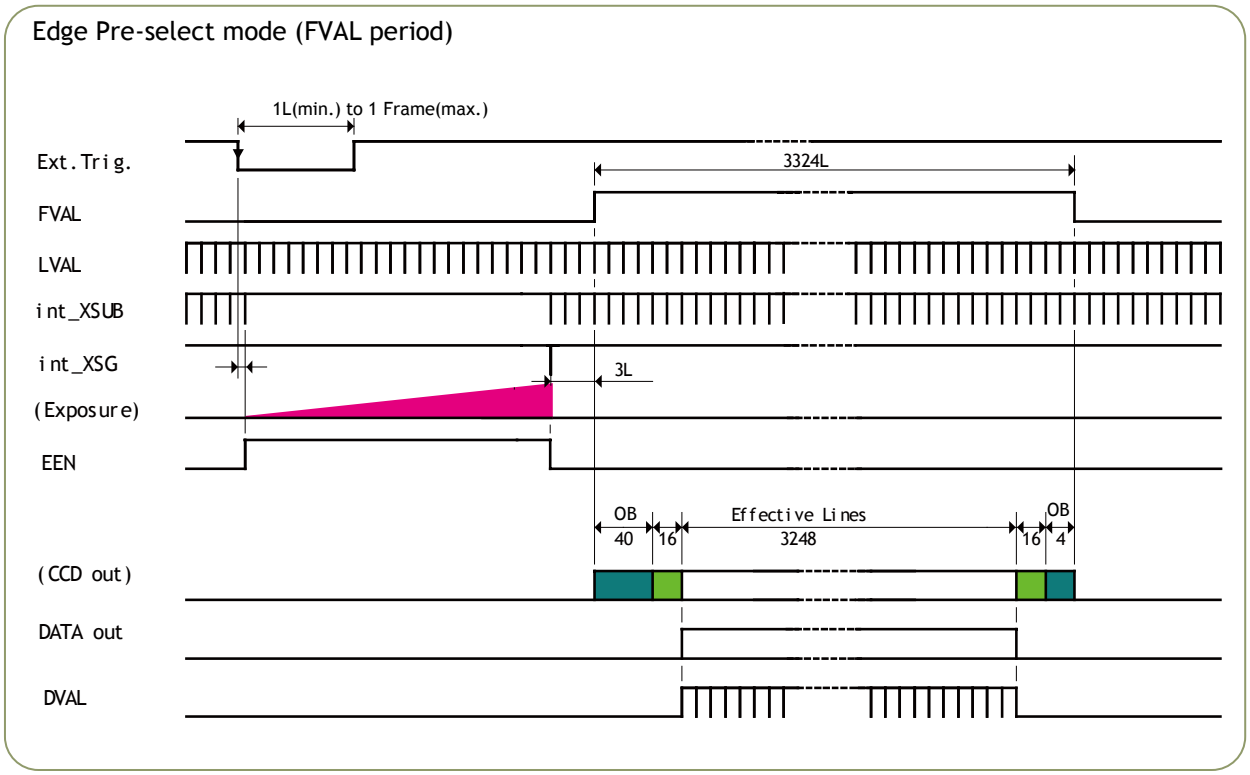


Fig. 19. Pre-select trigger mode.

6.5.3. Pulse Width Control Trigger Mode (PWC)

In this mode the accumulation time is equal to the trigger pulse width. Here it is possible to have a long time exposure. For best image quality, the maximum recommended time is <6 frames (2 seconds), however, depending on your application, significantly longer exposure may still produce an acceptable signal-to-noise ratio, even without applying any external cooling.

For timing details, refer to fig. 13 through fig. 18 and fig. 20.

To use this mode:

Set function:	Trigger mode	PWC
	Scanning	Normal
		Programmable Partial scan
		H, V or H+V binning
	Other functions and settings	
Input:	Ext. trigger	Camera Link or 12-pin Hirose

Important notes on using this mode

1. The minimum trigger duration > 2 LVAL and the maximum duration 2 seconds (6 frames)
2. Depending on the timing of the leading edge of the trigger pulse in relationship to FVAL, accumulation will be synchronous or asynchronous in relationship to LVAL. See chapter 6.2.5 for details.
3. The minimum interval of the trigger is 3331L.

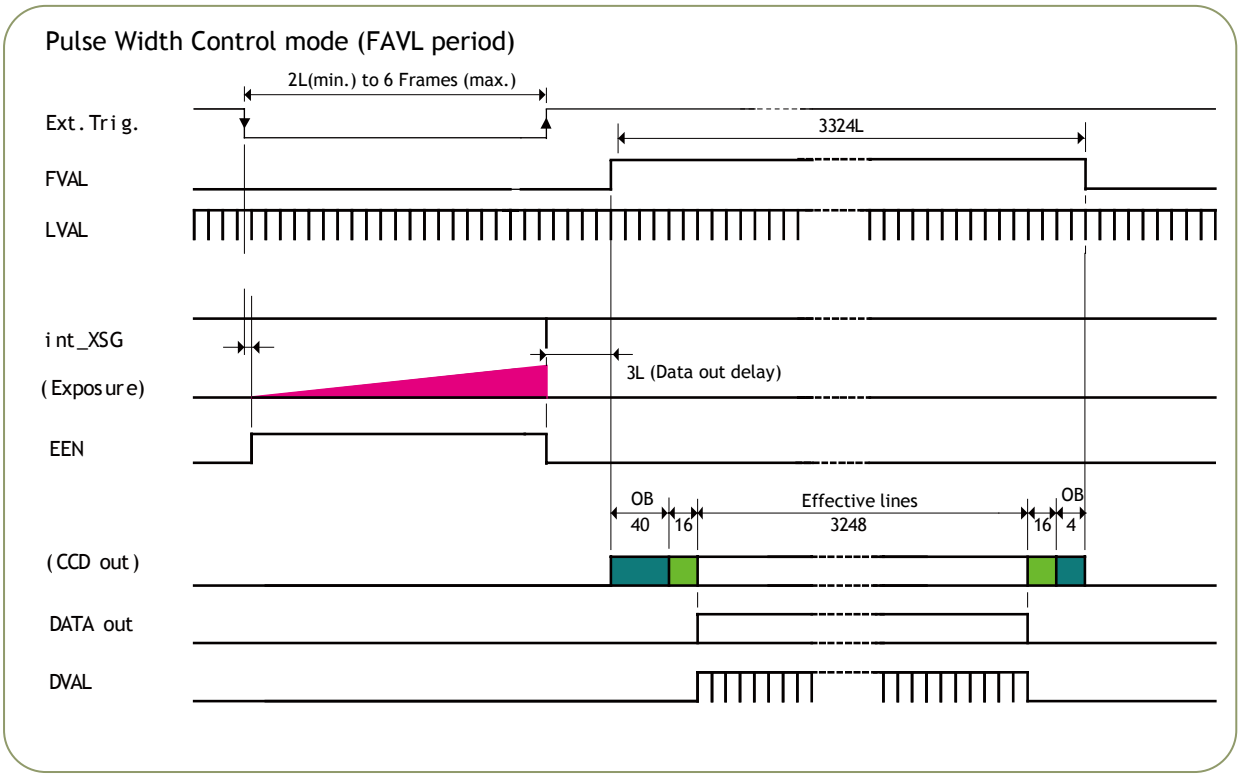


Fig. 20. Pulse width trigger mode

6.6. Mode and function matrix

The following table shows which functions will work in the different modes for AM-1600CL / AB-1600CL.

Function	Shutter		Partial	Binning (Note*1)			Accumulation
Trigger mode	Pre-set	Programmable		H	V	H+V	LVAL sync / async
Cont.	○	○	○	○	○	○	-
EPS	○	○	○	○	○	○	Auto
PWC	—	—	○	○	○	○	Auto

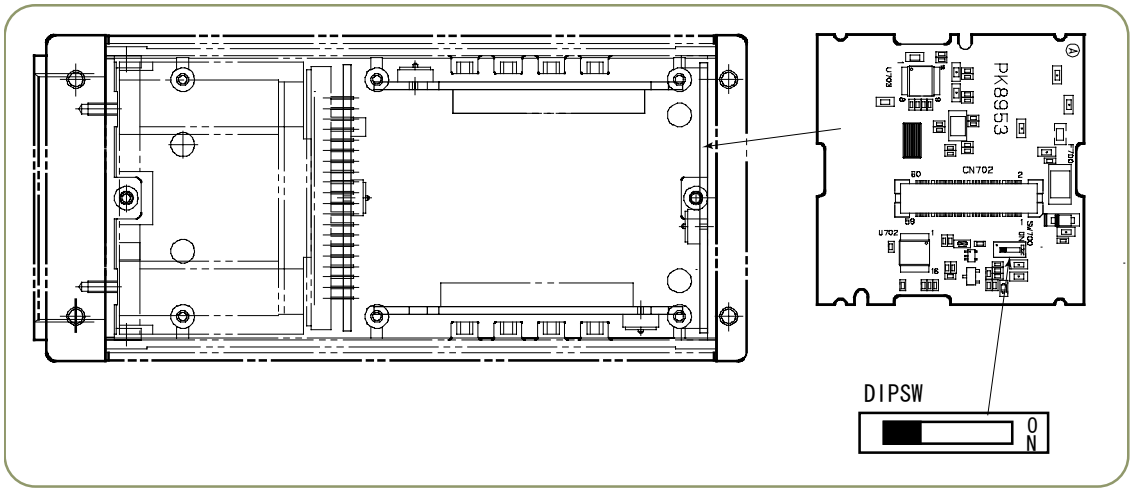
Note *1) The binning function is available for AM-1600CL only.
Note *2) The partial scan and the Binning functions cannot be used at the same time.

Fig.21. Mode and function matrix.

7. Configuring the Camera

7.1. DIP switch SW700

SW1 provides Enable/Disable 75 ohm termination for the trigger input, which is pin 10 on the HIROSE connecter.
This switch is located on the inside of the rear panel.



Function	ON	OFF
External trigger termination	75 Ω	TTL

The factory default is OFF (TTL).

Fig. 22. DIP switch location

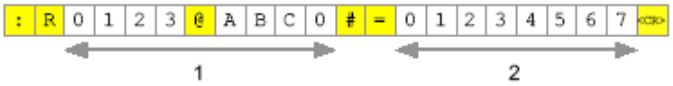
7.2. Register based command control

All configuration of the AM-1600CL / AB-1600CL camera is done via serial communication in the Camera Link connector. The camera can be set up from a PC running terminal emulator software, or using JAI's camera control software.

The following pages contain a description of the register-based command protocol used in the AM-1600CL and AB-1600CL.

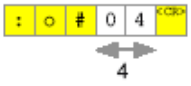
"R" Write Command Packet Format without CRC-8

A. Numeral Data Write Command Packet

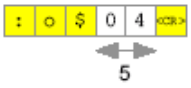


B. String Data Write Command Packet

Response Packet



Response Packet



1. Address

(1) 32 bits for addressing 4 G byte size space.
(2) The last byte must be either "0", "4", "8" or "C" for DWORD aligned address.

2. Numeral Data Field

(1) 8 Hex ASCII letters for DWORD.

3. String Data Field

(1) String containing only printable ASCII letters from 20H (space) to 7EH ("~").
(2) The string must be from 1 letter to 4 letters long.

4. Number of Numeral Data Received

(1) The number of byte data found in Command Packet.
(2) Always "04".

5. Number of Character Data Received

(1) The number of ASCII code found in Command Packet.
(2) The number must be from 1 to 4.

Example:

1) Write a 32 bit data, 0x1234ABCD, to address 0x23456780

Command Packet: ":R2345@6780#=1234ABCD"<CR>

Response Packet: ":o#04"<CR>

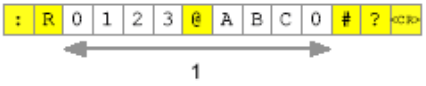
2) Write a string, "JAI", to address 0x12345678

Command Packet: ":R1234@5678$=JAI"<CR>

Response Packet: ":o$03"<CR>

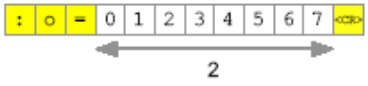
"R" Read Command Packet Format without CRC-8

A. Numeral Data Read Command Packet

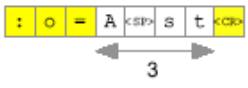


B. String Data Read Command Packet

Response Packet



Response Packet



1. Address

(1) 32 bits for addressing 4 G byte size space.
(2) The last byte must be either "0", "4", "8" or "C" for DWORD aligned address.

2. Numeral Data

(1) 8 Hex ASCII letters for DWORD.

3. String Data

(1) String containing only printable ASCII letters from 20H (space) to 7EH ("~").
(2) When the string has less than 4 letters, the string field returns less than 4 letters.
(3) If the data is less than 0x20 (space), the rest of the bytes are not returned.

Example:

1) Read a 32 bit data, 0x1234ABCD, from address 0x23456780

Command Packet: ":R2345@6780#?"<CR>

Response Packet: ":o=1234ABCD"<CR>

2) Read a string, "JAI", from address 0x12345678

Command Packet: ":R1234@5678$?"<CR>

Response Packet: ":o=JAI"<CR>

Gain & Offset

Functions			Min. Value	Max. Value	RW	Command	Note
Gain	Relative Gain with Offset Adjustment	CH-A	0	0x5FF	RW	:R0020@04A0#=00000XXX	Relative Gain adjustment together with OFF-SET adjustment for L ch.
		CH-B	0	0x5FF	RW	:R0020@04A4#=00000XXX	Relative Gain adjustment together with OFF-SET adjustment for R ch
	Channel Balance	Start Balancing	-	-	WO	:R0020@00E0#=00000001	Adjust R ch Gain to be equal with that of L ch
		Stop Balancing	-	-	WO	:R0020@00E0#=00000000	Stop balancing operation
		Done Status	-	-	RW	:R0020@00E4?	After the balancing is completed, change from "00000000" to "00000001".
		Stop Status	-	-	RW	:R0020@00E8?	When the stop is accepted, change from "00000000" to "00000001".
	Load from RAM Table	Factory/User Selection	-	-	RW	:R0010@02E4#=00000XXX	0: Factory , 1: User
		Factory Gain Index	0	255	RW	:R0010@02E8#=00000XXX	Default is 0
		User Gain Index	0	255	RW	:R0010@02EC#=00000XXX	Default is 0
	Save to RAM Table	Execute	-	-	WO	:R0020@0460#=00000001	Write "00000001" , then the save is executed.
		Factory/User Selection	-	-	RW	:R0020@0464#=0000000X	0: Factory , 1: User
		Index Number	0	255	RW	:R0020@0468#=000000XX	Default is 0
		dB Value	-3,000,000	+1,300,000	RW	:R0020@046C#=00000004	1,000,000 times by DB value. Example: 3dB is 3,000,000.
Offset	0dB Gain Offset Balance	Start Balancing	-	-	WO	:R0020@03C0#=00000001	At first, set the L channel OFF-SET at the expected value. Then set the R channel OFF-SET at the average value of L channel.
		Stop Balancing	-	-	WO	:R0020@03C0#=00000000	Stop balancing operation
		Done Status	-	-	RO	:R0020@03C4?	After the balancing is completed, change from "00000000" to "00000001".
		Stop Status	-	-	RO	:R0020@03C8?	When the stop is accepted, change from "00000000" to "00000001".
	Load from RAM Table	Factory/User Selection	-	-	RW	:R0010@0314#=0000000X	0: Factory, 1: User
		Factory Gain Index	0	255	RW	:R0010@0318#=000000XX	Default is 0
		User Gain Index	0	255	RW	:R0010@031C#=000000XX	Default is 0
	Save to RAM Table	Execute	-	-	RW	:R0020@0490#=00000001	Write "00000001" , then the save is executed.
		Factory/User Selection	-	-	RW	:R0020@0494#=0000000X	0: Factory, 1: User
		Index Number	0	255	RW	:R0020@0498#=000000XX	Default is 0
		Black Offset Level	-100	+300	RW	:R0020@049C#=XXXXXXXX	Minimum and maximum values depend on the difference occurred in the circuits through AFE circuit. Register value is the tow's complement.

Exposure

Functions			Min. Value	Max. Value	RW	Command	Note
Exposure	Common	Control Mode Selection	–	–	RW	:R0010@0080#=0000000X	Select Exposure control mode. 0: Preset mode control、1: Line step mode
	Preset Mode	Preset Mode Table Type	–	–	RW	:R0010@0084#=0000000X	Select Factory or User table on Preset mode
		Max Selection for Preset Factory	0	0xF	RW	:R0010@0088#=0000000X	Maximum index(size) of Factory table on Preset mode
		Current Selection for Preset Factory	0	0xF	RW	:R0010@008C#=0000000X	The current using index of Factory table on Preset mode
		Max Selection for Preset User	0	0xF	RW	:R0010@0090#=0000000X	Maximum index(size) of User table on Preset mode
		Current Selection for Preset User	0	0xF	RW	:R0010@0094#=0000000X	The current using index of User table on Preset mode
	Line Step Mode	Direct Mode Table Type	–	–	RW	:R0010@0098#=0000000X	Select Factory or User table on Line Step mode
		Min Direct Exposure Time Factory	3	3248	RW	:R0010@009C#=00000XXX	Minimum step number of Factory set on Line Step control
		Max Direct Exposure Time Factory	3	3248	RW	:R0010@00A0#=00000XXX	Maximum step number of Factory set on Line Step control
		Current Direct Exposure Time Factory	3	3248	RW	:R0010@00A4#=00000XXX	Current step number of Factory set on Line Step control
		Min Direct Exposure Time User	3	3248	RW	:R0010@00A8#=00000XXX	Minimum step number of User set on Line Step control
		Max Direct Exposure Time User	3	3248	RW	:R0010@00AC#=00000XXX	Maximum step number of User set on Line Step control
		Direct Exposure Time User	3	3248	RW	:R0010@00B0#=00000XXX	Current step number of User set on Line Step control

LUT

Functions			Min. Value	Max. Value	RW	Command	Note
Table Selection	Linear		–	–	RW	:R0010@00C0#=00000000	The curve data can only be changed on Factory
	Gamma		–	–	RW	:R0010@00C0#=00000001	
	User 1		–	–	RW	:R0010@00C0#=00000002	The curve data can be changed on User and the tool is supplied.
	User 2		–	–	RW	:R0010@00C0#=00000003	
	User 3		–	–	RW	:R0010@00C0#=00000004	
	User 4		–	–	RW	:R0010@00C0#=00000005	
	User 5		–	–	RW	:R0010@00C0#=00000006	
	User 6		–	–	RW	:R0010@00C0#=00000007	
User Table Generation	Select Table		–	–	RW	:R0020@0130#=0000000X	0: Linear , 1: 0.45, 2 to 7 : User 1 to User 6
	Request Job	Load	–	–	WO	:R0020@0134#=00000001	Write "00000001" to execute " Load ".
		Save	–	–	WO	:R0020@0138#=00000001	Write "00000001" to execute " SAVE ".
	Pivot	Point 0	0	0	RW	:R0020@0140#=00000000	X coordinate position of LUT first point. MUST be 0.
		Point 1	0	65535	RW	:R0020@0144#=0000XXXX	X coordinate position of LUT 2nd point.
		Point 2	0	65535	RW	:R0020@0148#=0000XXXX	X coordinate position of LUT 3rd point.
		Point 3	0	65535	RW	:R0020@014C#=0000XXXX	X coordinate position of LUT 4ht point.
		Point 4	0	65535	RW	:R0020@0150#=0000XXXX	X coordinate position of LUT 5th point.
		Point 5	0	65535	RW	:R0020@0154#=0000XXXX	X coordinate position of LUT 6th point.
		Point 6	0	65535	RW	:R0020@0158#=0000XXXX	X coordinate position of LUT 7th point.
		Point 7	0	65535	RW	:R0020@015C#=0000XXXX	X coordinate position of LUT 8th point.
		Point 8	0	65535	RW	:R0020@0160#=0000XXXX	X coordinate position of LUT 9th point.
		Point 9	0	65535	RW	:R0020@0164#=0000XXXX	X coordinate position of LUT 10th point.
		Point 10	0	65535	RW	:R0020@0168#=0000XXXX	X coordinate position of LUT 11th point.
		Point 11	0	65535	RW	:R0020@016C#=0000XXXX	X coordinate position of LUT 12th point.
		Point 12	0	65535	RW	:R0020@0170#=0000XXXX	X coordinate position of LUT 13th point.
		Point 13	0	65535	RW	:R0020@0174#=0000XXXX	X coordinate position of LUT 14th point.
		Point 14	0	65535	RW	:R0020@0178#=0000XXXX	X coordinate position of LUT 15th point.
		Point 15	0	65535	RW	:R0020@017C#=0000XXXX	X coordinate position of LUT 16th point.
		Point 16	0	65535	RW	:R0020@0180#=0000XXXX	X coordinate of 17th point. This is the virtual point to get the last slope.

LUT(continued)

User Table Generation	Offset	Point 0	0	131071	RW	:R0020@0190#=000XXXXX	Y coordinate position of LUT first point. MUST be 0.
		Point 1	0	131071	RW	:R0020@0194#=000XXXXX	Y coordinate position of LUT 2nd point.
		Point 2	0	131071	RW	:R0020@0198#=000XXXXX	Y coordinate position of LUT 3rd point.
		Point 3	0	131071	RW	:R0020@019C#=000XXXXX	Y coordinate position of LUT 4th point.
		Point 4	0	131071	RW	:R0020@01A0#=000XXXXX	Y coordinate position of LUT 5th point.
		Point 5	0	131071	RW	:R0020@01A4#=000XXXXX	Y coordinate position of LUT 6th point.
		Point 6	0	131071	RW	:R0020@01A8#=000XXXXX	Y coordinate position of LUT 7th point.
		Point 7	0	131071	RW	:R0020@01AC#=000XXXXX	Y coordinate position of LUT 8th point.
		Point 8	0	131071	RW	:R0020@01B0#=000XXXXX	Y coordinate position of LUT 9th point.
		Point 9	0	131071	RW	:R0020@01B4#=000XXXXX	Y coordinate position of LUT 10th point.
		Point 10	0	131071	RW	:R0020@01B8#=000XXXXX	Y coordinate position of LUT 11th point.
		Point 11	0	131071	RW	:R0020@01BC#=000XXXXX	Y coordinate position of LUT 12th point.
		Point 12	0	131071	RW	:R0020@01C0#=000XXXXX	Y coordinate position of LUT 13th point.
		Point 13	0	131071	RW	:R0020@01C4#=000XXXXX	Y coordinate position of LUT 14th point.
		Point 14	0	131071	RW	:R0020@01C8#=000XXXXX	Y coordinate position of LUT 15th point.
		Point 15	0	131071	RW	:R0020@01CC#=000XXXXX	Y coordinate position of LUT 16th point.
		Point 16	0	131071	RW	:R0020@01D0#=000XXXXX	Y coordinate of 17th point. This is the virtual point to get the last slope.
	Slope	Point 0	0x80	0x7F	RO	:R0020@01E0#?	The slope of LUT first point. Calculated by 1st and 2nd points.
		Point 1	0x80	0x7F	RO	:R0020@01E4#?	The slope of LUT 2nd point. Calculated by 2nd and 3rd points.
		Point 2	0x80	0x7F	RO	:R0020@01E8#?	The slope of LUT 3rd point. Calculated by 3rd and 4th points.
		Point 3	0x80	0x7F	RO	:R0020@01EC#?	The slope of LUT 4th point. Calculated by 4th and 5th points.
		Point 4	0x80	0x7F	RO	:R0020@01F0#?	The slope of LUT 5th point. Calculated by 5th and 6th points.
		Point 5	0x80	0x7F	RO	:R0020@01F4#?	The slope of LUT 6th point. Calculated by 6th and 7th points.
		Point 6	0x80	0x7F	RO	:R0020@01F8#?	The slope of LUT 7th point. Calculated by 7th and 8th points.
		Point 7	0x80	0x7F	RO	:R0020@01FC#?	The slope of LUT 8th point. Calculated by 8th and 9th points.
		Point 8	0x80	0x7F	RO	:R0020@0200#?	The slope of LUT 9th point. Calculated by 9th and 10th points.
		Point 9	0x80	0x7F	RO	:R0020@0204#?	The slope of LUT 10th point. Calculated by 10th and 11th points.
		Point 10	0x80	0x7F	RO	:R0020@0208#?	The slope of LUT 11th point. Calculated by 11th and 12th points.
		Point 11	0x80	0x7F	RO	:R0020@020C#?	The slope of LUT 12th point. Calculated by 12th and 13th points.
		Point 12	0x80	0x7F	RO	:R0020@0210#?	The slope of LUT 13th point. Calculated by 13th and 14th points.
		Point 13	0x80	0x7F	RO	:R0020@0214#?	The slope of LUT 14th point. Calculated by 14th and 15th points.
		Point 14	0x80	0x7F	RO	:R0020@0218#?	The slope of LUT 15th point. Calculated by 15th and 16th points.
		Point 15	0x80	0x7F	RO	:R0020@021C#?	The slope of LUT 16th point. Calculated by 16th and 17th points.
	Slope Value	Table Selection	–	–	WO	:R0020@0030#=0000000X	0: Linear , 1: 0.45, 2 to 7 : User 1 to User 6
		Read Status	–	–	RO	:R0020@0034#?	BitX corresponds PointX. In case BitX is 1, error (wrong)

Miscellaneous

Functions			Min. Value	Max. Value	RW	Command	Note
V-Reset	Control Mode	Free-run	-	-	RW	:R0010@0014#=00000000	Synchronize with the Internal Pulse Rest (Free Run Mode)
		Trigger-Run	-	-	RW	:R0010@0014#=00000001	Synchronized with the External Trigger Pulse (Trigger Mode)
	Trigger Mode	EPS	-	-	RW	:R0010@0024#=00000000	Trigger mode. The pre-set exposure
		PWC	-	-	RW	:R0010@0024#=00000001	Trigger mode. The pulse width exposure
	Camera Link trigger polarity	LOW	-	-	RW	:R0010@0344#=00000000	Negative polarity
		HIGH	-	-	RW	:R0010@0344#=00000001	positive polarity
	HIROSE 12-pin trigger polarity	LOW	-	-	RW	:R0010@0340#=00000000	Negative polarity
		HIGH	-	-	RW	:R0010@0340#=00000001	positive polarity
	Trigger Select	HIROSE 12 pin	-	-	RW	:R0010@0380#=00000001	Trigger input select for 12 pin
		Camera link	-	-		:R0010@0380#=00000000	Trigger input select for Camera Link,
	Auto Sync /Async Detect	Enable/Disable	-	-	RW	:R0010@0028#=0000000X	0: Disable, 1: Enable、Default is 1: Enable
Partial Scan	Enable/Disable	Enable	-	-	RW	:R0010@0118#=00000001	Partial scan is enabled
		Disable	-	-	RW	:R0010@0118#=00000000	Partial scan disabled
	Area Selection		0	7	RW	:R0010@0114#=0000000X	Select one area out of 8 areas
	Area A	Start	0	3247	RW	:R0010@0120#=00000XXX	Start line of Partial scan
		Height	800	3247	RW	:R0010@0124#=00000XXX	Line numbers for Partial scan (Height of the picture)
	Area B	Start	0	3247	RW	:R0010@0128#=00000XXX	Start line of Partial scan
		Height	800	3247	RW	:R0010@012C#=00000XXX	Line numbers for Partial scan (Height of the picture)
	Area C	Start	0	3247	RW	:R0010@0130#=00000XXX	Start line of Partial scan
		Height	800	3247	RW	:R0010@0134#=00000XXX	Line numbers for Partial scan (Height of the picture)
	Area D	Start	0	3247	RW	:R0010@0138#=00000XXX	Start line of Partial scan
		Height	800	3247	RW	:R0010@013C#=00000XXX	Line numbers for Partial scan (Height of the picture)
V-Binning		None	-	-	RW	:R0010@0104#=00000000	Vertical Binning function is OFF
		2X	-	-	RW	:R0010@0104#=00000001	Two Rows binning for vertical direction
Horizontal Effects	H-Binning/LPF Selection		-	-	RW	:R0010@0170#=0000000X	0: Both Horizontal Binning and LPF are disable 1: Horizontal Binning is enable 2: LPF is enable
		2X	-	-	RW	:R0010@0174#=00000000	Two columns Binning for Horizontal direction
	LPF	1/4 1/2 1/4	-	-	RW	:R0010@0178#=00000000	Among three pixels for horizontal direction, add each 25% of the first and the last pixel data and 50% of the center pixel data to make the center pixel data
		1/8 3/4 1/8	-	-	RW	:R0010@0178#=00000001	Among three pixels for horizontal direction, add each 12.5% of the first and the last pixel data and 75% of the center pixel data to make the center pixel data
Pixel Depth		8bit	-	-	RW	:R0010@00E0#=00000000	8 bit depth (256)
		10bit	-	-	RW	:R0010@00E0#=00000001	10 bit depth (1024)
		12bit	-	-	RW	:R0010@00E0#=00000002	12 bit depth (4096)
External I/O	TTLIN1	Polarity	-	-	RW	:R0010@0340#=0000000X	0 : Active Low, 1 : Active High
	TTLIN1	Software Control	-	-	RW	:R0010@0360#=0000000X	0 : Hardware Control IO 1 : Software Control IO

Parameter

Functions			Min. Value	Max. Value	RW	Command	Note
Parameter Storage (Page Memory)	Initial Loaded Page		–	–	RW	:R0010@0000#=0000000X	0 : Page 0, 1 : Page 1
	Save	Execute	–	–	RW	:R0020@0040#=00000001	Write "00000001" to execute " SAVE "
		Page Select	–	–	RW	:R0020@0044#=0000000X	0 : Page 0, 1 : Page 1
	Load	Execute	–	–	RW	:R0020@0048#=00000001	Write "00000001" to execute " LOAD "
		Page Select	–	–	RW	:R0020@004C#=0000000X	0 : Page 0, 1 : Page 1
	Verification	Execute	–	–	RW	:R0020@0050#=00000001	Write "00000001" to execute verification
		Page Select	–	–	RW	:R0020@0054#=0000000X	0 : Page 0, 1 : Page 1
		Read Result	–	–	RO	:R0020@0058#?	Number of error detection (Data Mismatching of Flash memory and RAM)

Trouble Shooting

Functions		Min. Value	Max. Value	RW	Command	Note
Reset	Execute	–	–	WO	:R0020@0000#=00000001	The same initialization as Cold Start except FPGA reset
	Hardware Status	–	–	RO	:R0020@0010#?	Bit 0 : :GPIO, Bit 1 : AFE, Bit 2 : TSG, Bit 3 : DAC, Bit 4 : Flash Memory、 Bit 5 : WDT
CCD Temperature		0x800	0x7FF	RO	:R0020@0060#?	Inside temperature around CCD (−128°C to + 128°C)
Test Pattern		–	–	RW	:R0020@0230#=0000000X	Test pattern output 0 : No output, 1 : Horizontal Ramp、 2 : Vertical Ramp、3 : H/V Mix Ramp

Revision and Camera Information

Functions		Min. Value	Max. Value	RW	Command	Note
Revision	Firmware 0	–	–	RO	:R0000@A6D4#?	Revision number of Camera Control Firmware
	Firmware 1	–	–	RO	:R0000@A6D8#?	Revision number of OS
	FPGA 0	–	–	RO	:R0000@A6F4#?	Revision number of FPGA
	BASESET	–	–	RO	:R0020@0110#?	Date and revision of Factory setting script (BASESET)
Camera Information	Model	–	–	RO	:R0000@0068$?	Model name
	Device Version	–	–	RO	:R0000@0088$?	Revision number of camera
	Manufacturer Name	–	–	RO	:R0000@0048$?	Manufacture's name
	Manufacturer Specific Info	–	–	RO	:R0000@00A8$?	Manufacture's specific information
	Serial Number	–	–	RO	:R0000@00D8$?	Camera serial number
	Camera ID	–	–	RO	:R0000@00E8$?	Load camera ID

Image Processing

Functions			Min. Value	Max. Value	RW	Command	Note
Flat Field Compensation	Function Used	None	–	–	RW	:R0010@02AC#=00000000	No use of any functions
		Offset Correction	–	–	RW	:R0010@02AC#=00000001	Use only OFFSET correction
		Gain and Offset Correction	–	–	RW	:R0010@02AC#=00000002	Use Gain and OFFSET correction
		Image Subtraction	–	–	RW	:R0010@02AC#=00000003	Sunstract image
Flat Field Compensation Calibration	Dark Calibration	Run/Stop	–	–	WO	:R0020@02A0#=0000000X	1 : Start 0 : Stop
		Status	–	–	RO	:R0020@02A4#?	Bit 0 : Complete Bit 1 : Stop
		Progress	0	100	RO	:R0020@02B0#?	Completion ratio until now (%)
	Bright Calibration	Run/Stop	–	–	WO	:R0020@02A8#=0000000X	1 : Start 0 : Stop
		Status	–	–	RO	:R0020@02AC#?	Bit 0 : Complete Bit 1 : Stop
		Progress	0	100	RO	:R0020@02B4#?	Completion ratio until now (%)
	Coef Bit	11bit	–	–	RW	:R0010@02A4#=00000000	Gain compensation data in 11 bits
		12bit	–	–	RW	:R0010@02A4#=00000001	Gain compensation data in 12 bits
	K.Value		0	4095			
	Loop		2	16			
	Black Average		0	511			
	Bright Coef		0	4095			
Blemish Compensation	Enable/Disable	Enable	–	–	RW	:R0010@02B8#=00000000	Compensation is effective
		Disable	–	–	RW	:R0010@02B8#=00000001	Compensation is not effective
	Count	Dark			RO	:R0020@02D8#?	Detected black defective pixel numbers
		Bright			RO	:R0020@02DC#?	Detected white defective pixel numbers
Blemish Compensation Calibration	Dark	Run/Stop	–	–	WO	:R0020@02C0#=0000000X	1 : Start 0 : Stop
		Status	–	–	RO	:R0020@02C4#?	Bit 0 : Complete Bit 1 : Stop
		Dark Ratio	0	100	RW	:R0010@02B0#?	0% (0) to 100% (100)
		Progress	0	100	RO	:R0020@02D0#?	Completion ratio until now (%)
	Bright	Run/Stop	–	–	WO	:R0020@02C8#=0000000X	1 : Start 0 : Stop
		Status	–	–	RO	:R0020@02CC#?	Bit 0 : Complete Bit 1 : Stop
		Data Level	0	65535	RW	:R0010@02B4#?	16 bit LSB
		Progress	0	100	RO	:R0020@02D4#?	Completion ratio until now (%)
Compensation Common	Coef Save	Control	–	–	WO	:R0020@0270#=0000000X	1 : Execute " SAVE " 0 : Interrupt " SAVE "
		Done	–	–	RO	:R0020@0274#?	Complete by "00000001"
	Coef Load	Control	–	–	WO	:R0020@027C#=0000000X	1 : Execute " LOAD " 0 : Interrupt " LOAD "
		Done	–	–	RO	:R0020@0280#?	Complete by "00000001"
	Coef Verification	Control	–	–	RW	:R0020@0288#=0000000X	1 : Execute " VERIFICATION " 0 : Interrupt " VERIFICATION "
		Done	–	–	RW	:R0020@028C#?	Complete by "00000001"
		Error Count	0	?	RO	:R0020@0298#?	Number of error detection (Data Mismatching of Flash memory and RAM)
	Progress		0	100	RO	:R0020@029C#?	Completion ratio until now (%)

NOTE: Do not try to use commands not shown in this list.

8. Camera Control Tool for AM-1600CL / AB-1600CL

8.1. General

The Camera Control Tool for Windows 2000/XP/Vista can be downloaded from www.jai.com.
The AM-1600CL/AB-1600CL Camera Control Tool has the following windows:
Configuration, Camera Settings, About, Gain & Offset, General, Image Processing and Utilities.
The Gain & Offset, General, Image Processing, and Utilities windows also contain a Communication window.

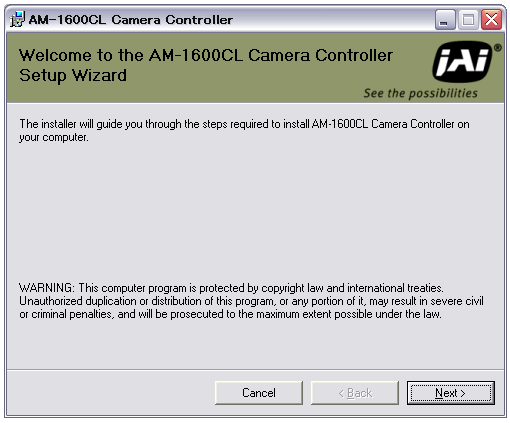
The camera control software is for configuring and setting parameters of the AM-1600CL and AB-1600CL. The interface is asynchronous serial communication through Camera Link, SerTFG and SerTC. The data can be stored in the EEPROM of the cameras.

8.2. How to install

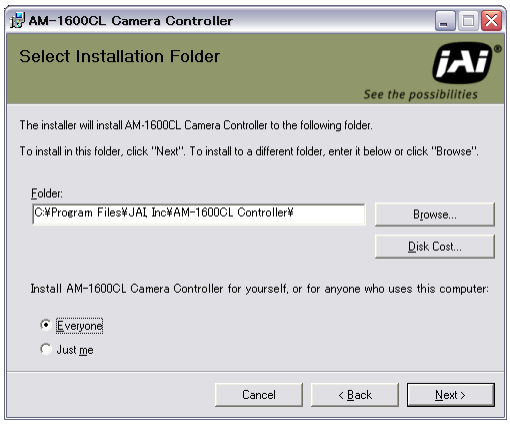
The software is in a compressed file and in order to install it, you must first extract the file.
After extraction, SETUP.exe is created.
The following is the setup procedure.

1. Click SETUP.exe

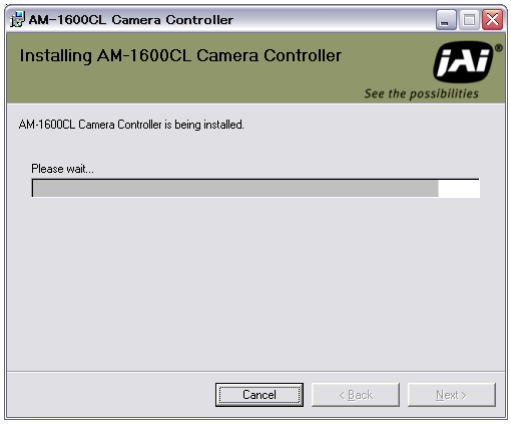
2. Follow the SETUP screen, Click[NEXT]



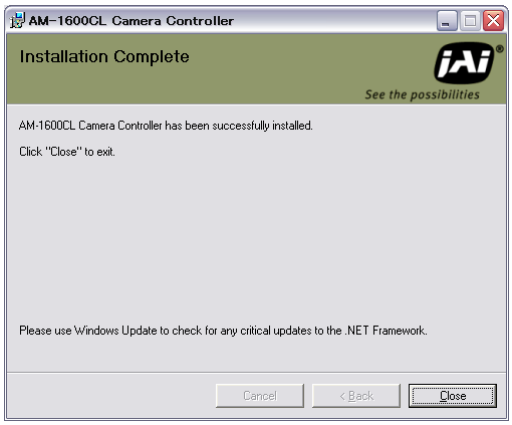
3. Select a default location or input your own path. Then, click [NEXT].



4. **Start to install the software**



5. When the installation is completed. Click [CLOSE].

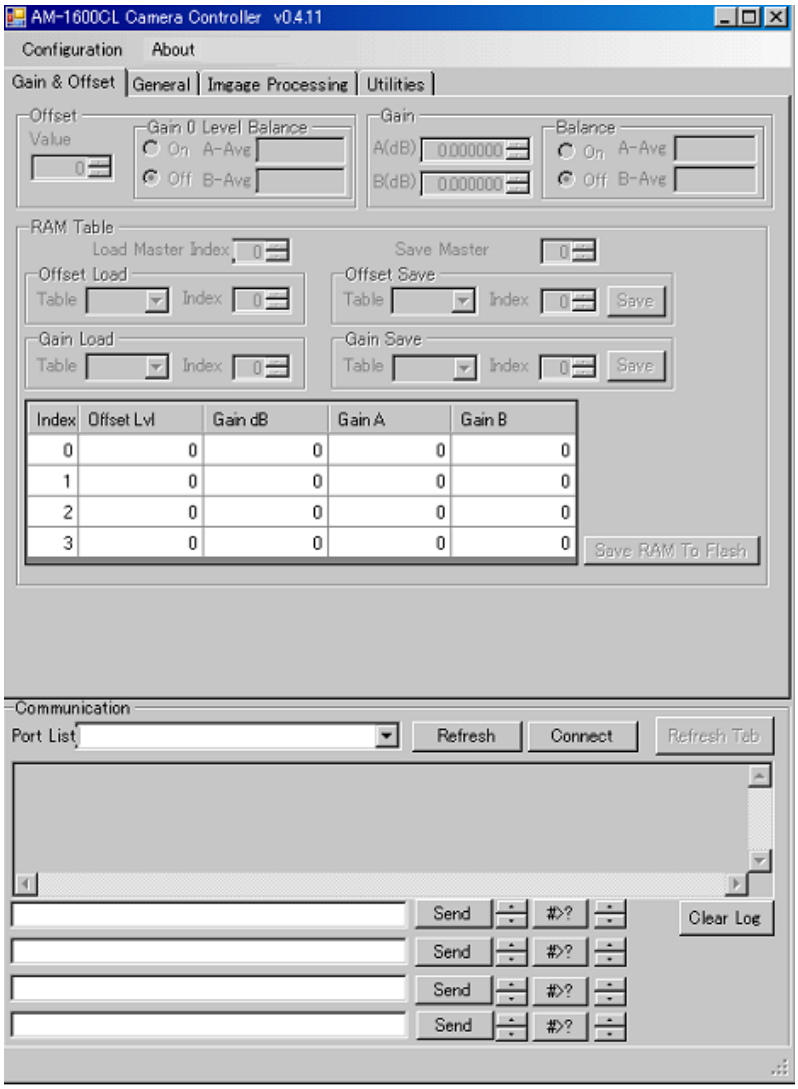


8.3. Start up the software

In order to communicate with the camera , it is necessary to select the appropriate port after starting up the software.

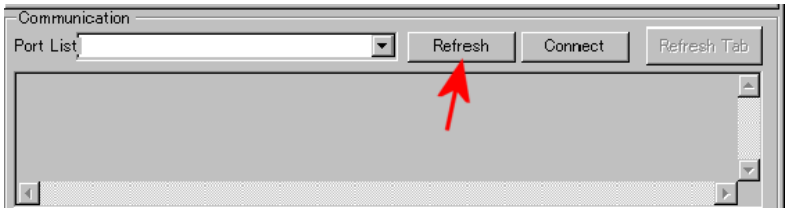
1. Click the Camera control tool icon to start up the software.

2. The following start-up screen appears.
Note: At this moment, communication is not initiated.

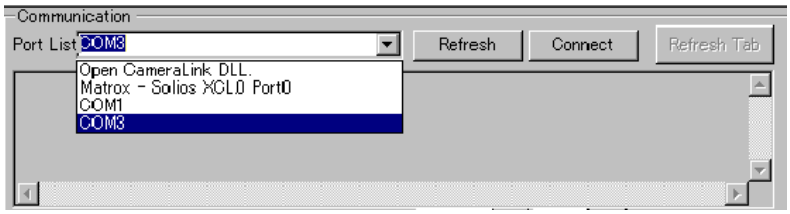


8.4. How to connect the camera

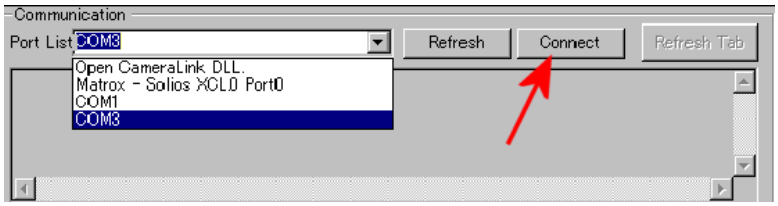
1. Click [Refresh] to read available ports.



2. Select the appropriate port (in this case , COM3)
   Note: The available ports will differ depending on the setting of the Frame Graber board.
   Check the COM setting of Frame Graber board.



3. Click [Connect] in order to connect the camera.



4. After the connection is activated, the indication is changed to [Disconnect].

8.5. How to disconnect the camera

Click [Disconnect] and when the indication is changed to [Connect] , the camera is disconnected.

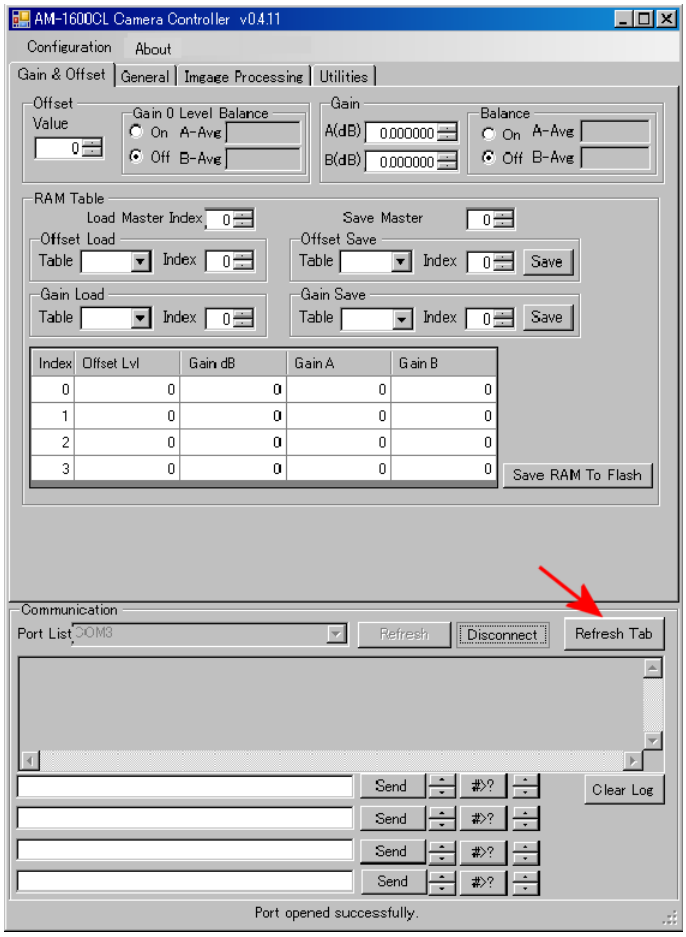
8.6. How to reconnect the camera

While the camera is connecting to the control tool software, if the camera power is OFF, click [Disconnect] and follow the procedure described in “8.4 How to connect the camera”.

8.7. Description of screens and functions

8.7.1 Initial screen and inclusion of camera setting status

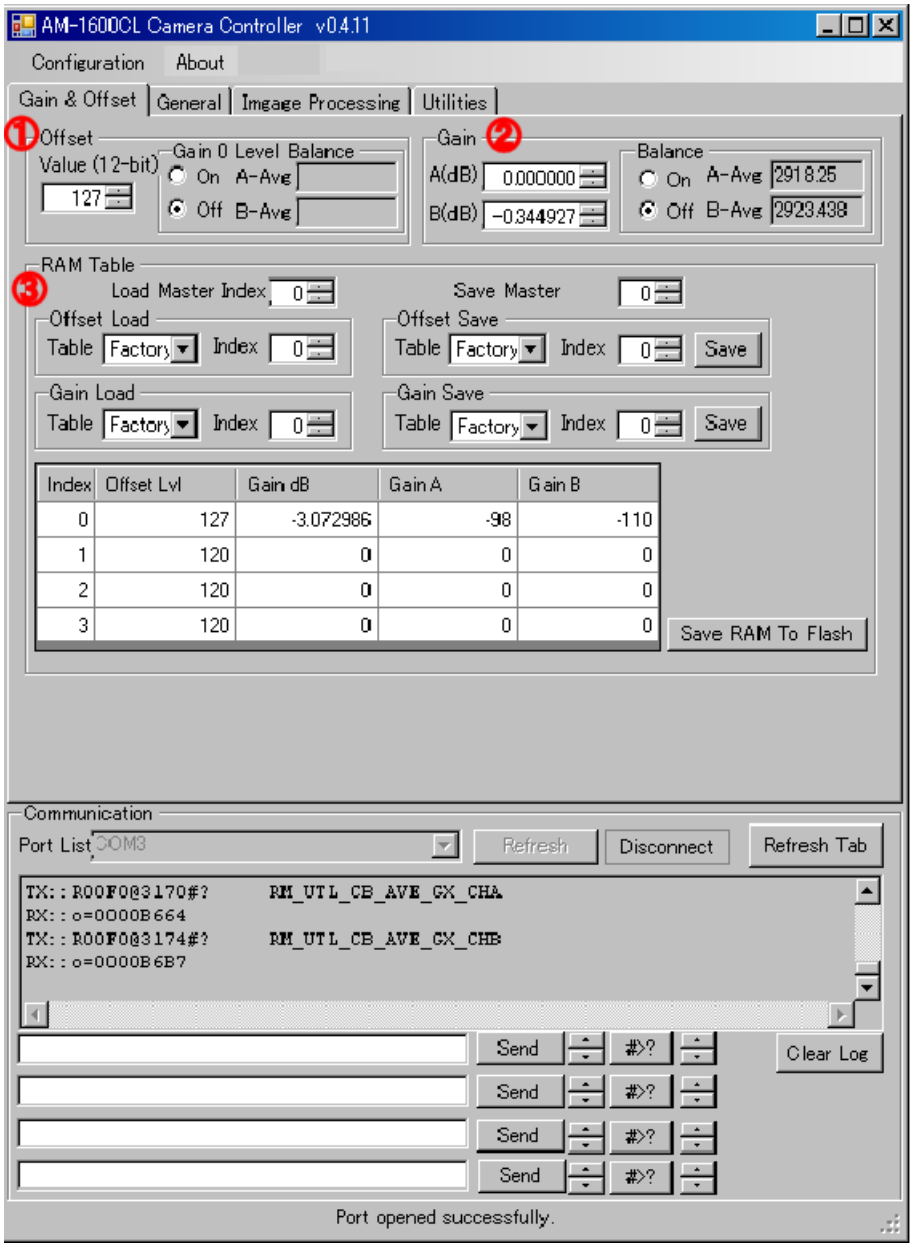
After connecting the camera, the control tool indicates the following status.
In order to read the camera setting status, click [Refresh tab].



Note: [Refresh Tab] is independent on each control page. Accordingly, clicking on [Refresh tab] should be executed on each screen such as “General”, “Image Processing” and “Utilities”.
Once it is executed, the communication between the control tool and camera is activated, and the indication of the control tool and the camera settings are synchronized.

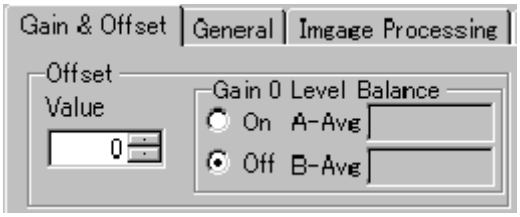
8.7.2 Functions

8.7.2(a) Gain & Offset



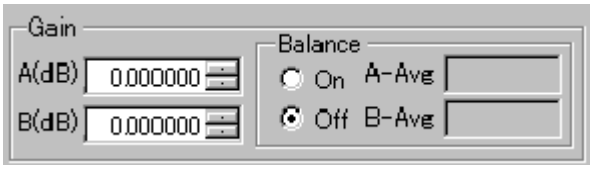
Use these control to balance the left and right channels of the dual-tap output. Options are provided for manual or automatic balancing.

❶ **Offset :** This is used to adjust the video black level of the right channel to match the left channel. It should be performed by covering the lens, then adding or subtracting an offset value by clicking on the up or down buttons, or by entering the value directly in the text box.



- Offset value can be changed from -512 to +511 for 12 bit output.
- When Gain 0 Level Balance is set to ON, automatic R/L black balance is initiated.

❷ **Gain :** Use these control to adjust video gain and R/L gain balance. This is best achieved by first exposing the camera to a uniform light source under 80% saturation.



◆ **Manual adjustment for Gain and Gain channel balance**
Input the appropriate value between -3dB and +12dB in A(dB) and B(dB) to adjust the gain and gain channel balance for L and R channels. Use the up and down arrows, or type the values directly into the text boxes.

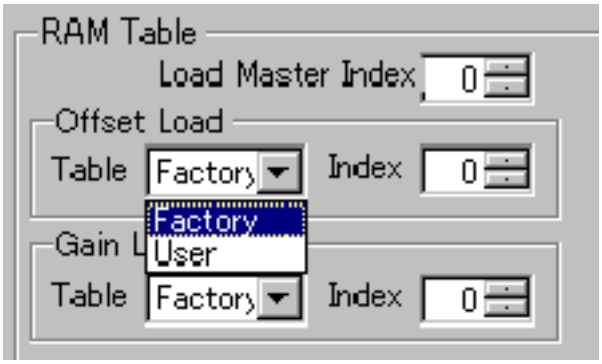
◆ **Automatic gain and gain channel balance**
1. Click [ON] in the Balance pane.
2. Input the required gain value in [A(dB)] , for instance 3.
3. Click the balance [ON]. After completion, ON turns OFF automatically.

Note: The Automatic balance adjustment for AM-1600CL and AB-1600CL uses L channel (A) as the reference level and adjusts R channel (B) so that it matches to the L channel level.

❸ **RAM table:** Use this control to store the settings for Gain and Offset in Flash memory. There are four user memories available for storing Offset and Gain settings.

Note: There are Factory memories but these are only for loading factory data to camera.

◆**How to select the table**

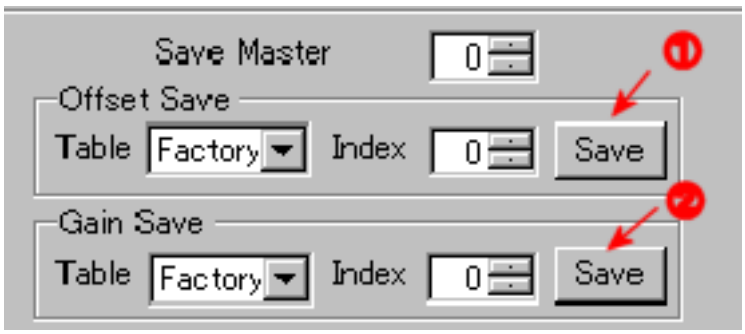


[Offset Load] and [Gain Load] can load the Factory data or the user data independently.
Four user indexes (0 to 3) are available for each Offset and Gain.
Use [Load Master Index] to select the same index for both Gain and Offset.

◆How to store Offset and Gain data

1. Select the location by Index (0 to 3)
2. Click [Save] for saving data for Offset and Gain
3. Click [Save RAM to Flash]

Note: Data cannot be stored if the power of the camera is OFF before the execution of [Save RAM to Flash].

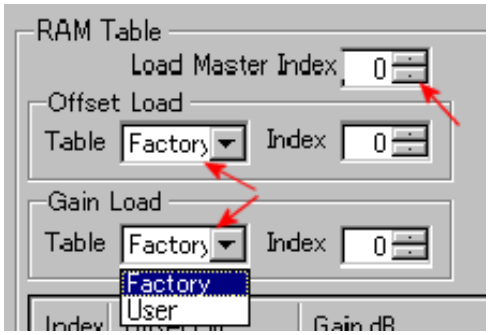


Special Caution: For saving data, Factory settings should not be used. Doing so will cause Factory default-data to be over-written.

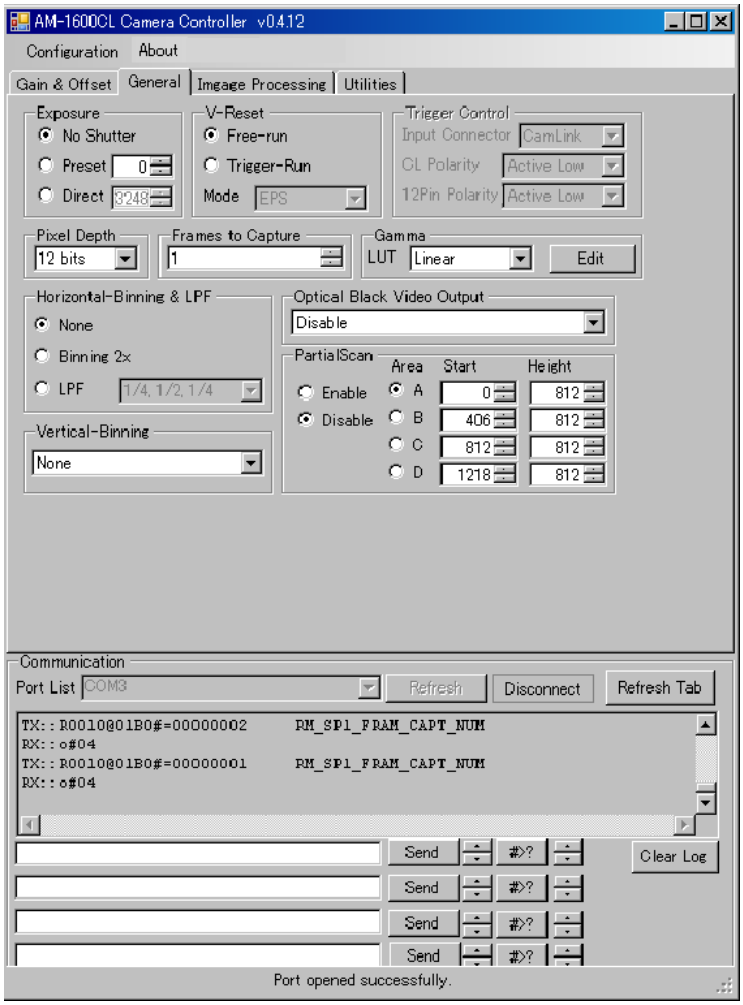
After the settings data is stored in the flash memory, when the camera is restarted, the saved data can be loaded to the camera as the initial settings.

◆How to read Table

Select the table (Factory or User) and Index (0 to 3) and read the required Offset and Gain setting data.



8.7.2(b) General



Note: In order to store the setting data on this page, click [Save RAM to Flash] on Gain & Offset page. The characteristics for LUT data can be stored on LUT setting page.

❶ Exposure: Set exposure time.

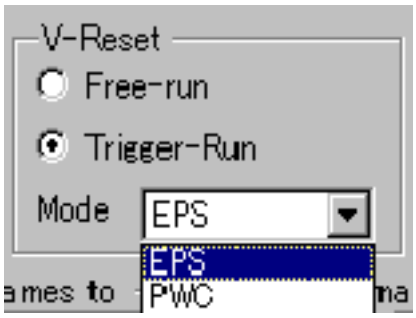
Use this to control the camera's electronic shutter settings.

- **No Shutter**: No shutter operation
- **Preset** : Select Preset shutter speed. 0 to A(see the table below)
- **Direct** : Set the exposure from 3L to 3248L by 1 LVAL increments. Use the buttons or type the value directly into the text box.

Setting	Shutter Speed	Setting	Shutter Speed
0	1/3(OFF)	6	1/200
1	1/6	7	1/400
2	1/12	8	1/800
3	1/24	9	1/1600
4	1/48	A	1/3200
5	1/100		

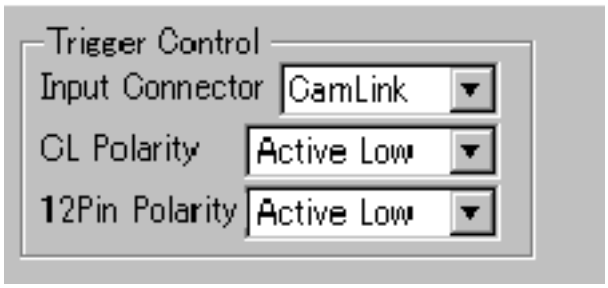
❷ V-Reset
Use this area to indicate whether or not the camera will be controlled by triggering.

Free-run : Continuous operation by internal trigger
Trigger-Run : Indicates that an external trigger will be used.
Select EPS or PWC for Trigger-Run mode

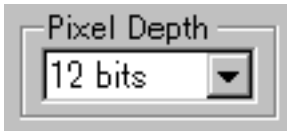


❸ Trigger Control

Select whether the trigger input will come via the HIROSE 12-pin or the Camera Link connector. Also select the trigger polarity for Camera Link and 12-pin respectively.



❹ Pixel Depth
Select the depth of the video output through Camera Link. Choose from 12 bits, 10 bits or 8 bits.



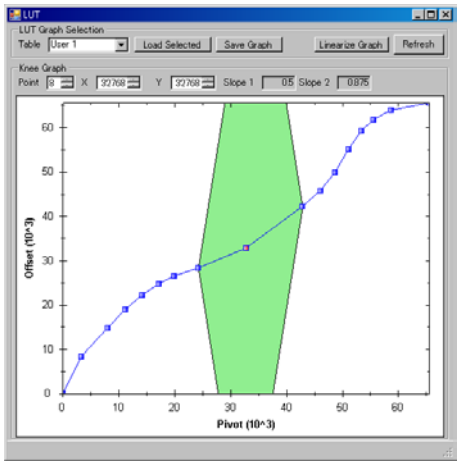
❺ Frames to Capture
Select the number of frame to capture per trigger: from 1 to 4 frames

❻ Gamma (AM-1600CL only)
Select the type of video output response from the following choices (this function is only for AM-1600CL).

- Linear (γ=1.0)
- Gamma (γ=0.45)
- USER 1 to 6: User programmable LUT (refer to LUT instructions below)

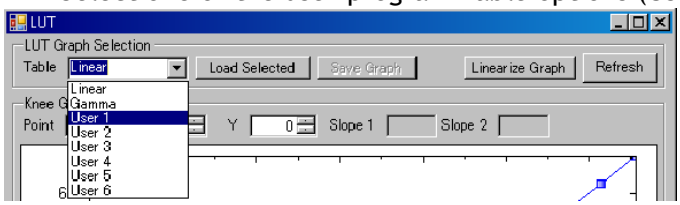
❼ LUT (AM-1600CL only)

When a Gamma type of USER 1 to USER 6 is selected, a user-programmable Look-Up Table (LUT) appears. By using the LUT, the desired video output characteristics for the system can be created and stored.



◆How to use the LUT

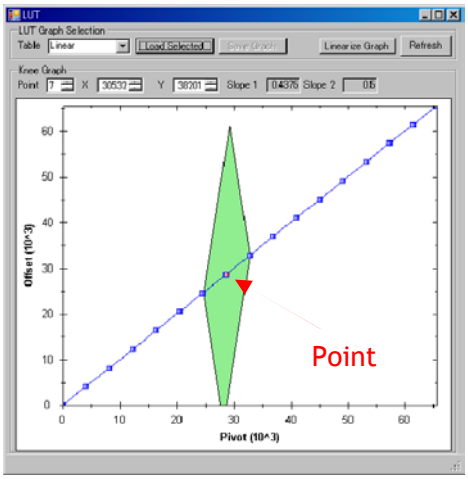
① Select one of the user-programmable options (User 1 to 6 in the Table drop-down)



Click [Load Selected] to load any previously saved values for this setting.
Note: As for [Linear] and [Gamma], the characteristics can not be changed.

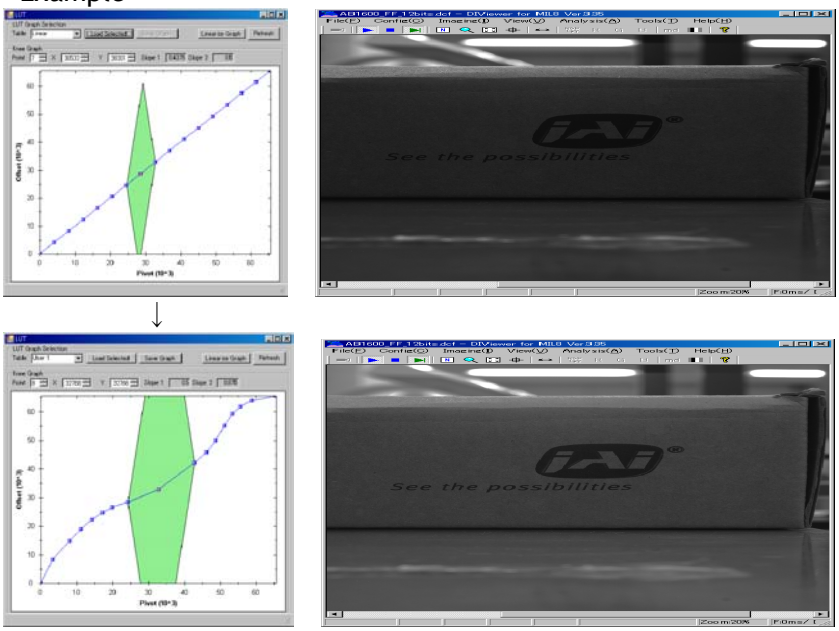
② Click linearize graph to produce a line with adjustable points representing the video response to specific light levels.

③ Select a point from the graph. The range within which the response can be adjusted is shown in green.



④ Drag the point to a new location within the range or enter new coordinates in the X and Y boxes. Repeat with additional points until the desired response is defined.

Example



⑤ Click [Save Graph] to save this setting for future recall.

❽ Horizontal-Binning & LPF (AM-1600CL only)

Use this area to activate the horizontal binning function and LPF(Low Pass Filter).

- **None** : No horizontal binning
- **Binning** : Add two pixels in horizontal direction and read as one pixel
- **LPF** : Add the data from the processed pixel and the data from the left and the right pixels of the processed pixel by a certain ratio and replace the data of the processed pixel with added data.
  The ratio is fixed and can be selected from the followings.
  1/4, 1/2, 1/4 : Adding data ratio left and right 25%、center 50%
  1/8, 3/4, 1/8 : Adding data ratio left and right 12.5%、center 75%

❾ Vertical-Binning (AM-1600CL only)

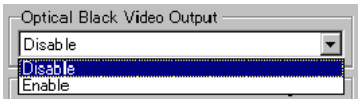
Use this area to activate the vertical binning function

- **None** : No vertical binning (Normal)
- **2x** : Add pixels in two rows (vertical direction)

Note: It is possible to activate both horizontal binning and vertical binning simultaneously.

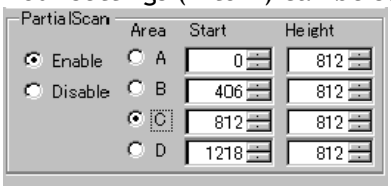
❿ Optical Black Video out

Disable : No optical black is output
Enable : Optical black is output

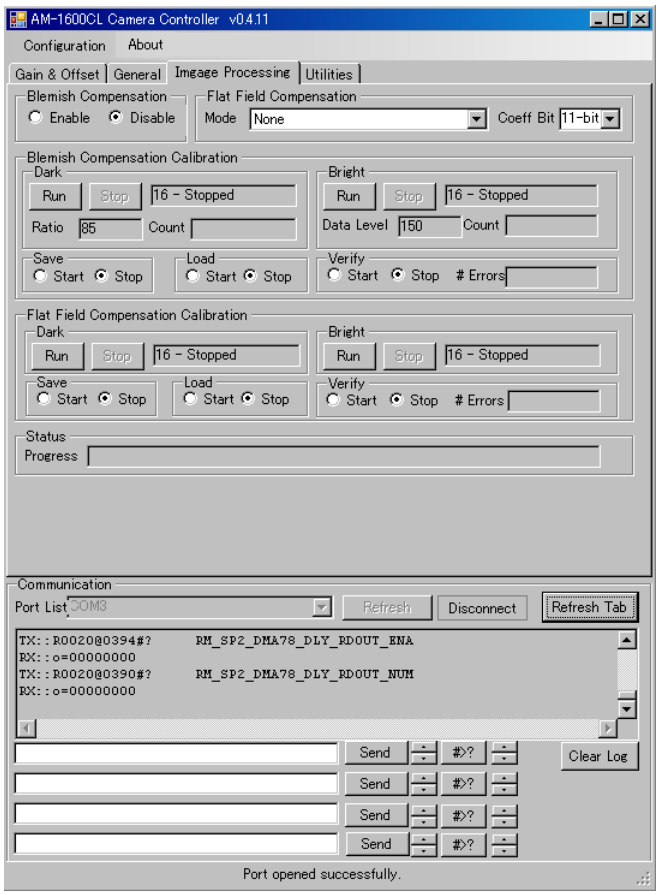


⓫ Partial Scan

Select [Enable] to initiate partial scanning, then enter the start line and the image height. Four settings (A to D) can be stored for future use.



8.7.2(C) Image Processing



Note: In order to save the status of settings on this page, click [Save RAM to Flash] on the Gain & Offset page.

⓫ Blemish (AM-1600CL only)

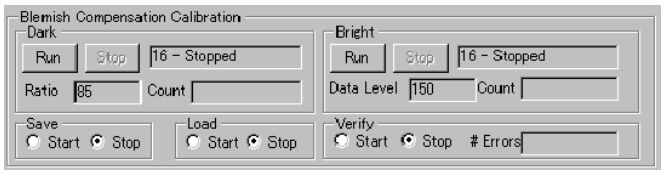
You can choose to activate blemish compensation or you can leave it off, which is the factory default setting. Blemish compensation will compensate both dark and bright pixels.

▪ Blemish : Use this area to activate the blemish compensation function (Enable / Disable)

Important note: At the first start up, the camera load data from the initial calibration which has been performed at the factory.

❷ Blemish Compensation Calibration (AM-1600CL only)

Initial blemish compensation calibration is performed at the factory and is not typically required. Factory data is loaded at startup and is then applied if the user has enabled Blemish Compensation. If subsequent calbration is performaed. it must be done in the sequence of [Dark] first, then [Bright].



To perform calibration, first click [Run] in the [Dark] section. You will be instructed to set a particular saturation level for compensation. The process will then proceed automatically until the compensation data for dark pixels has been created. Use the [STOP] button if you want to halt the process before it is completed.

Repeat the process in the [Bright] section to read in compensation data for the bright pixels.

This [Dark] to [Bright] process must be done as a set of calibration. [Dark] only or [Bright] only cannot be initiated.

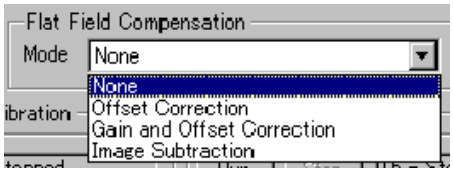
Use the remaining controls as follows:

Save : Save the compensation data stored in RAM to Flash memory
Load: Load the [Dark] and [Bright] compensation data
Verify : **Verify** the data in RAM and in Flash memory to be the same

Special Caution: When saving calibration data, Factory default settings are over-written. Special attention is needed.

❸ Flat Field Compensation (AM-1600CL only)

Flat field compensation uses per-pixel gain and/or offset correction to adjust the image for non-uniform sensor response. Use the **Mode** drop-down list to enable flat field compensation by choosing the type of correction you wish to perform. Choices are:



- **None** : No flat field compensation
- **Offset Correction** : Correct the black level shading only
- **Gain and Offset Correction** : Correct both black level and gain level
- **Image Subtraction** : Identify the adjustment by comparing to the previous frame (adjust-areas which are different in video level from the previous frame)

After selecting a flat field compensation mode -Offset, Offset & Gain or Image Subtraction- you must execute [Flat Field Compensation Calibration] before the compensation can be performed.

Calibration must be performed in the sequence of [Dark] first, then [Bright]. Begin by clicking the [**RUN**] button in the [Dark] section. A pop-up window will instruct you to close the lens before continuing. Calibration will then proceed automatically untill completed. The status window next to the [**STOP**] button shows the percentage of completion. It can take up to 20 minutes for a calibration to be perfromed. Click the [**Stop**] button to halt the calibration at any time.
When [**Dark**] calibration is completed, click the [**RUN**] button in the [**Bright**] section. You will be prompted to open the lens to a saturation level of approximately 50% before continuing. Calibration will then proceed automaticvaally unles halted by clicking the [**STOP**] button.

This [Dark] to [Bright] process must be done as a set of calibration. [Dark] only or [Bright] only cannot be initiated.

After running both [**Dark**] and [**Bright**] calibration, the data should be saved to Flash memory to avoid having to return calibration. Click [**Start**] button in the [**Save**] section to save the data. The process can take up to 40 minuates.

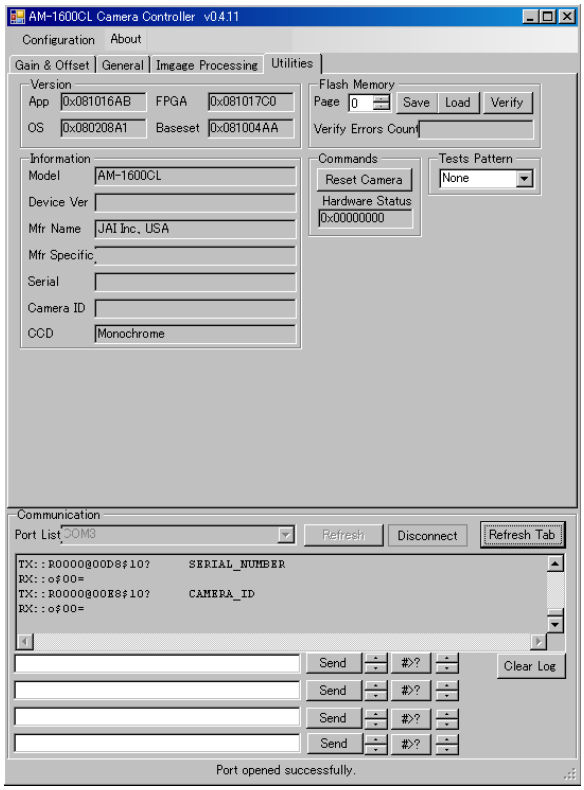
If a flat field compensation mode has been selcted and saved via the [**Save RAM to Flash**] command on the Gain & Offset page, the calibration settings will be automatically loaded to the Camera at start-up (the rear panel indicator light will turn red during the loading process, which may last a few minutes).

Use the [**Load**] section to load pre-saved calibration data from Flash to RAM.

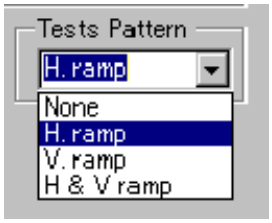
Use the [**verify**] section to compare new calibration data in RAM to saved data in Flash memory.

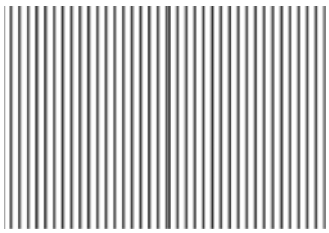
8.7.2(d) Utilities

On this screen, model name, firmware versions and test patterns are indicated.

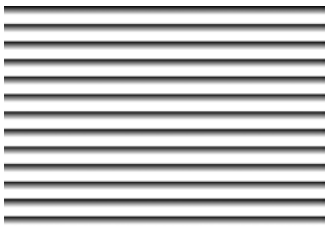


■ **Test Pattern** : The following three patterns are available.

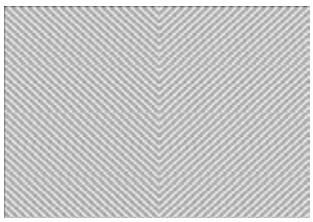




H.ramp



V.ramp

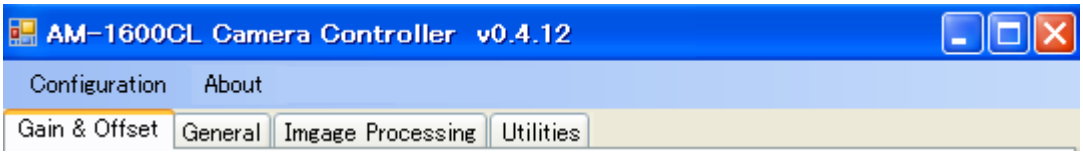


H & V ramp

■ **Flash memory**: There is a flash memory of two pages for saving data. The saving dat can be loaded to the camera or verified.

8.8. Other menu selection

The camera controller software has three additional drop-down menus located in the top bar of the software.



Configuration Menu

Reply Wait time(ms): This is used to set the maximum length (in milliseconds) that the software will wait for a replay after a serial command has been sent to the camera. If no reply is received in the allocated time, the software will "time out." Note that some commands may take up to five seconds (5000ms) for a response to be received.

Use sound: This enables the user to toggle whether or not the software will provide an audible "alert" sound when blemish compensation calibration or flat field calibration operation is completed.

About

This menu opens a separate window which provides information such as software version about the AM/AB- 1600CL camera controller

9. External Appearance and Dimensions

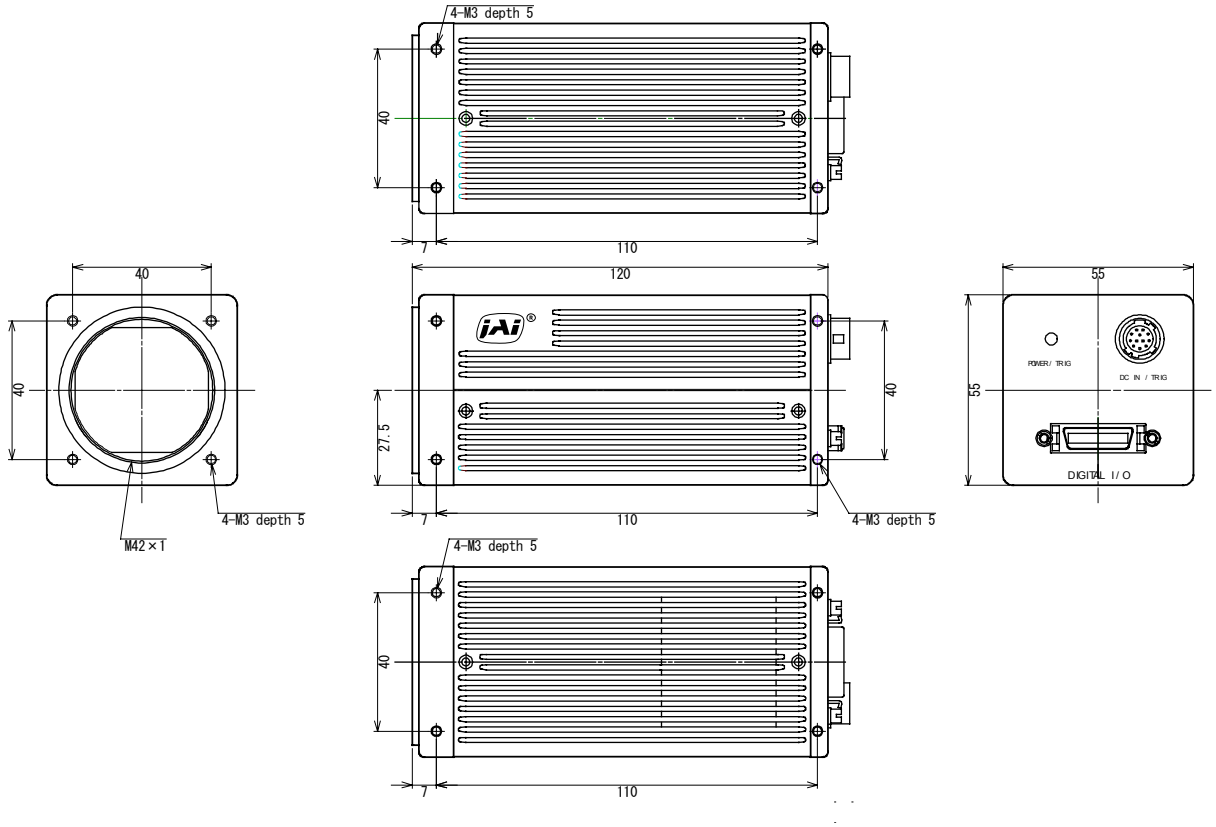


Fig. 23. Outline. (AM-1600CL-P/AB-1600CL-P)

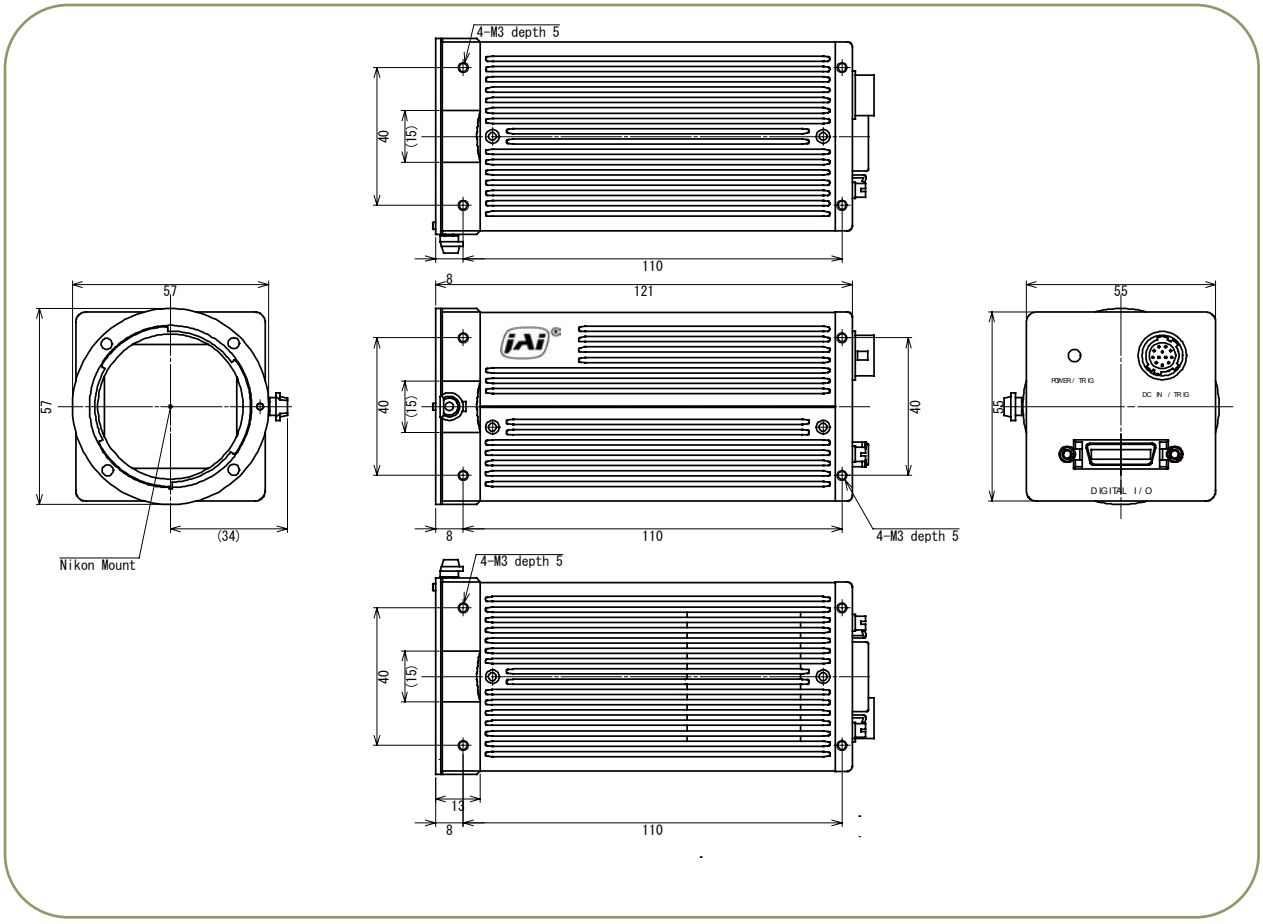


Fig. 24. Outline (AM-1600CL-F/AB-1600CL-F)

10. Specifications

10.1. Spectral response

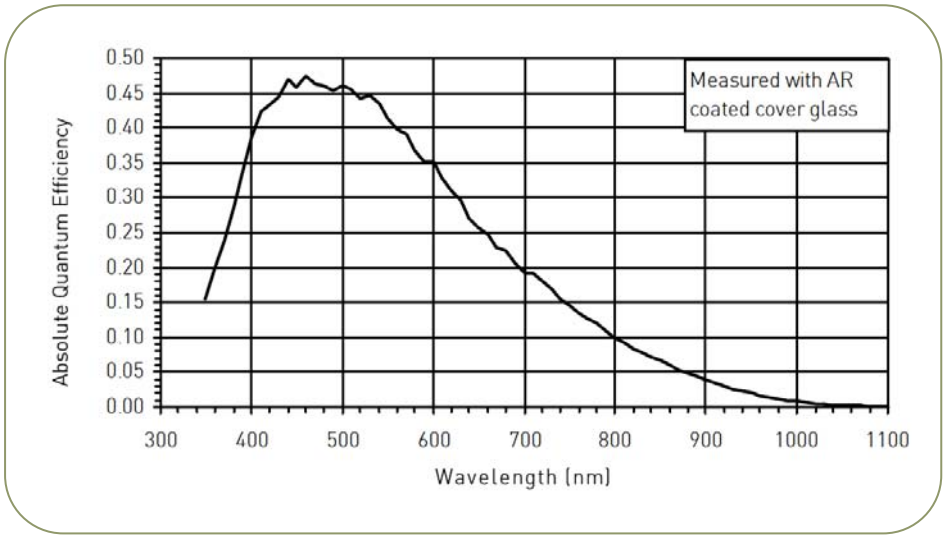


Fig. 25. Spectral response for AM-1600CL

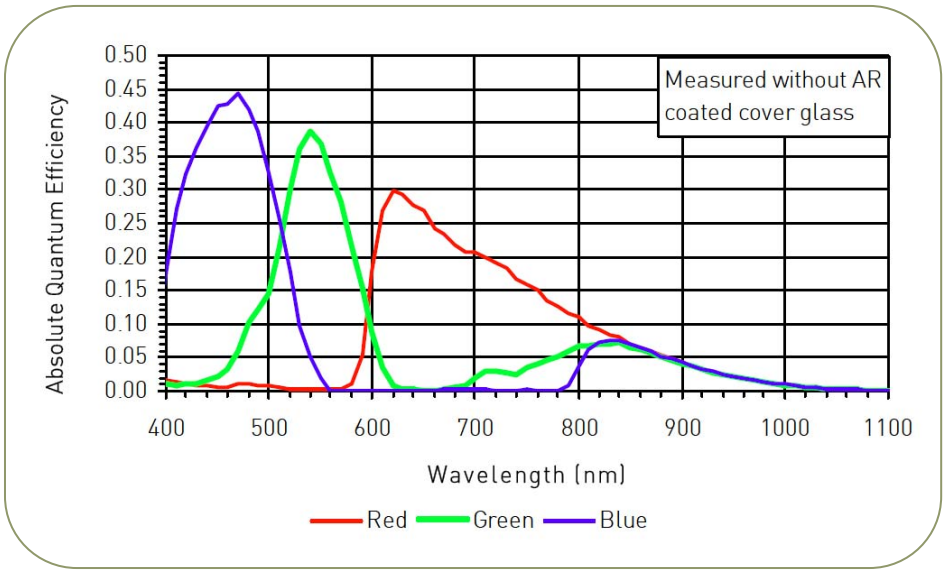


Fig.26. Spectral response for AB-1600CL

10.2. Specification table

Item	AM-1600CL	AB-1600CL
Scanning System	Progressive scan	
Frame Rate	Full 4872 (H) x 3248 (V) 3.05 fps (dual tap) 1/2 4872 (H) x 1624 (V) 5.51 fps (Note) 1/4 4872 (H) x 814 (V) 9.26 fps (Note) Note: When the partial scan is set at these lines	
Pixel Clock	30.00 MHz	
Line Frequency	10.136 KHz (1H = 98.66 μs)	
CCD sensor	Monochrome IT CCD KAI-16000-AXA	Bayer Color IT CCD KAI-16000-CXA
Sensing area	36.05 (H) x 24.035 (V) mm, 43.3mm diagonal	
Cell size (μm)	7.4 (H) x 7.4 (V) μm	
Active Pixels （H x V）	4872(H) x 3248 (V)	
Sensitivity of sensor	Output sensitivity 30μV/e Saturation signal 30,000 e	
Sensitivity on sensor	0.02 lux (Gain :max, IR cur filter)	0.35 lux (Gain :max, IR cut filter)
S/N (dB)	More than 56dB （0dB）	More than 56dB (0dB Green)
Synchronization	Internal	
Partial scan	Effective line from 800 to 3248 lines Adjustable unit 1 line Adjustable reading start from 1st line to 2448th line	
Binning	Horizontal x 2 Vertical x 2 H/V x 2	None
Digital Video output	Camera Link, Base Configuration, 8 bit, 10 bit and 12 bit selectable 2-channel Pixel Interleaved output	
Input signal	Trigger signal (TTL/75Ω) Polarity : Positive or Negative Hirose 12pin : 4.0V ± 2.0V p-p TTL/75 ohm selectable (DIP switch) or Camera Link : LVDS (CC1)	
Output signal	Hirose 12P XEEN （No termination） Camera Link EEN、LVAL, DVAL, （LVDS）	
Gain	Master Gain : -3dB ～ +12dB	
Black Level	32 LSB (10 bit output) Adjustable range : 0 to 128 LSB (10 bit output)	
Knee Gamma	LUT & Gamma 1.0 / 0.45	None
Pixel gain	Flat field non-uniformity	None
Blemish compensation	Built in	None
Trigger mode	Edge pre-select, Pulse width	
Pulse width (second)	1/3200 to 2 seconds (recommended maximum)	
Electronic Shutter	Preset : OFF(1/3) to 1/3200 11 steps	
	Programmable :3 L to 3248 L (1 LVAL unit)	
Accumulation	LVAL sync / async auto detection	
Test Pattern generator	Built in	
Communication Interface	Camera Link CC1 (EIA-644 LVDS)	
Operating Temperature	-5°C ～ +45°C	
Operating Humidity	20 to 80% (non-condensing)）	
Storage Temp/Humidity	-25°C to +60°C/20% to 80% (non-condensing)	
Vibration	10 G (20 Hz to 200 Hz XYZ directions)	

Item	AM-1600CL	AB-1600CL
Shock	70 G	
Regulatory	CE (EN61000-6-3,EN61000-6-3), FCC Part15 Class B、RoHS Noise Immunity (EN61000-6-2)	
Power	DC +12V ± 10%	
Power consumption (W)	5.8 W (typical , Continuous , Lens Cap on) 7.8W (Max. , 800 partial, Light in)	
Lens Mount	Universal P Mount (M42 x 1.0) or Nikon F mount (Factory option) Rear protrusion on Universal P Mount must be less than 11mm and 12 mm for Nikon F mount	
Flange back	Universal P Mount 45.5 mm Tolerance 0 to – 0.05 mm Nikon F Mount 46.5 mm Tolerance 0 to -0.05 mm	
Dimensions (W x H x D) (mm)	55 (H) x 55 (W) x 120 (D) without surface projection	
Weight	410 g	

Note: Above specifications are subject to change without notice
Note: It is required approx. 30 minutes pre-heating in order to perform as specified.

11. Appendix

10.3. 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.

10.4. Typical Sensor Characteristics

The following effects may be observed on the video monitor screen. They do not indicate any fault of the camera, but do associate with typical sensor characteristics.

V. Aliasing
When the camera captures stripes, straight lines or similar sharp patterns, a 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.

Caution when mounting a lens on the camera
When mounting a lens on the camera dust 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.

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

10.5. References

1. This manual for AM-1600CL / AB-1600CL can be downloaded from www.jai.com
2. Datasheet for AM-1600CL / AB-1600CL can be downloaded from www.jai.com
3. Camera control software can be downloaded from www.jai.com
4. Specifications for the CCD sensor Kodak KAI-16000-AXA and KAI-16000-CXA can be found on www.jai.com

Index

11. User's Record

Camera type: **AM-1600CL / AB-1600CL**

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

AM-1600CL-F / AM-1600CL-P

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。

AB-1600CL-F / AB-1600CL-P

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	×	○	○	○	○	○
光学滤色镜	×	○	×	○	○	○
.....	.....	.....	.....	.....	.....	.....

○：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。