Compact Monochrome Megapixel
Progressive Scan Camera

CV-A1-20

Operation Manual

Camera: Revision C
Manual: Version 1.2

Table of Contents

1. General

The CV-A1-20 is a monochrome progressive scan 1/2" CCD camera with 1.4 Megapixel resolution. CV-A1-20 is identical to CV-A1, but the pixel frequency is 20 MHz instead of 28.636 MHz. It is designed for automated inspection, featuring a small housing and a wide range of unique functions. The asynchronous trigger can be set to work in several modes, to allow such functions as pulse width controlled shutter, programmable shutter speed and long time integration. To obtain higher frame rates, the camera has partial scanning and both horizontal and vertical binning.
All modes and functions can be set via an RS-232C interface, greatly reducing the need for mechanical switches or jumpers.
CV-A1-20 Camera Control Tool for Windows 98/NT/2000 contents a camera control program and tools for making your own program.
Camera ID, model name and user ID is present in the camera from revision B. S/N E121231.
Revision C has updated boards for higher solder quality.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of Camera Control Tool for CV-A1-20 can be downloaded from: www.jai.com

2. Standard Composition

The standard camera composition consists of the camera main body and operation manual.

3. Main Features

- New compact size 1/2" progressive scan monochrome CCD camera
- 11 full frames 1392 (h) x 1040 (v) 4.65 μm square pixels per second
- Up to 52 fps with 1/6 partial scan.
- Double speed and double sensitivity with V binning
- 4 times normal sensitivity with H and V binning
- Internal, external HD/VD or random trigger synchronization
- Edge pre-select, programmable shutter and pulse width control trigger modes
- Start/stop mode (trigger/ext. VD) and long time exposure (ext. VD interval)
- Shutter speeds from 1/11 to 1/140,000 second in continuous mode
- Triggered shutter speed up to 1/8381 second
- Programmable shutter speed from 1.3 H to 1023.3 H
- Pulse width controlled shutter 1.3 H to 2000 H
- H synchronized or H non-synchronized accumulation in PWC mode
- Frame delay readout 1.3 H to 2000 H for pulse width controlled shutter
- Smear-less readout mode for edge pre-select and programmable shutter
- Exposure enable EEN, write enable WEN and pixel clock output
- Short ASCII commands for fast mode set-up via serial port
- Set-up by Windows 98/NT/Win2000 software via RS 232C
- Compact housing with C-mount

4. Locations and Functions

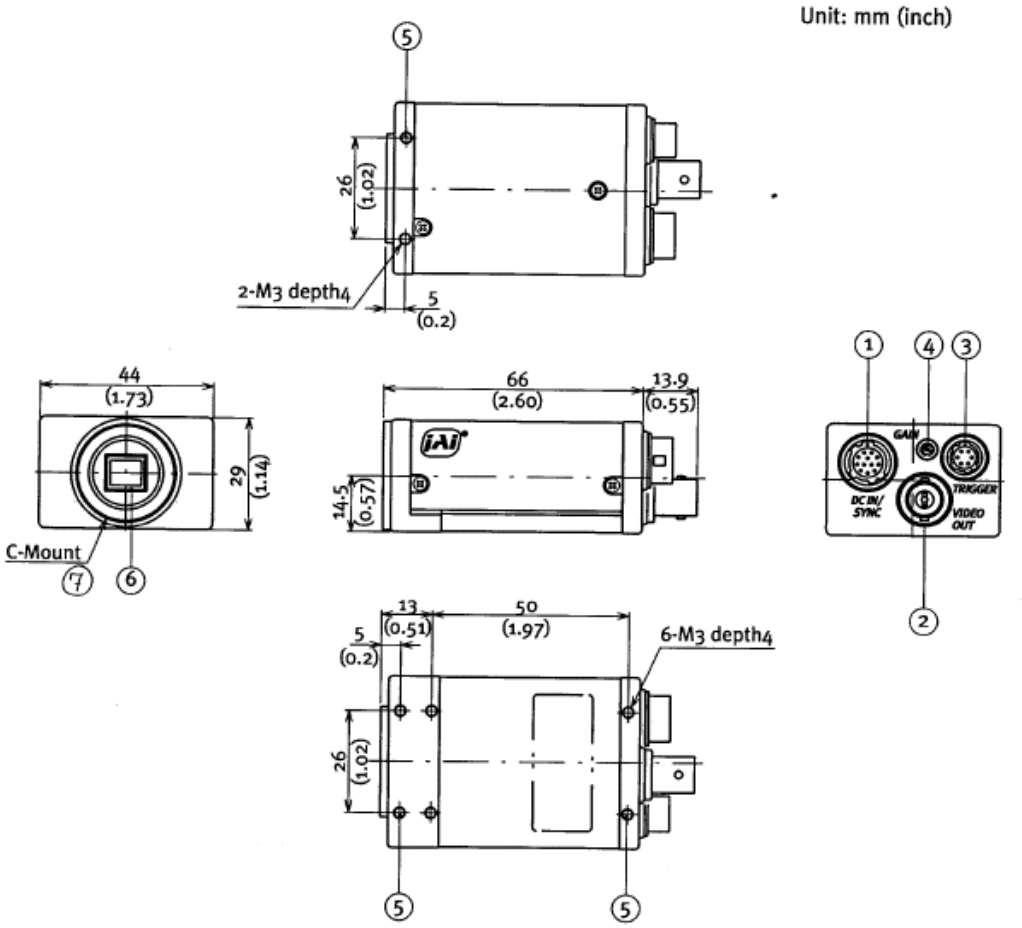


Fig. 1. Locations.

1. 12 pin Hirose connector for frame grabber interfacing and power (12V DC).
2. BNC connector for video output. VS 1.0 Vpp 75 Ohm.
3. 6 pin Hirose connector for trigger input and RS-232C control interface.
4. Gain potentiometer for manual gain setting.
5. Mounting holes, 8 x M3. For precision mounting use only the 4 holes located at the forward part of the bottom plate.
6. 1/2" interline-transfer type CCD sensor.
7. Lens mount for C-mount lenses. *1)

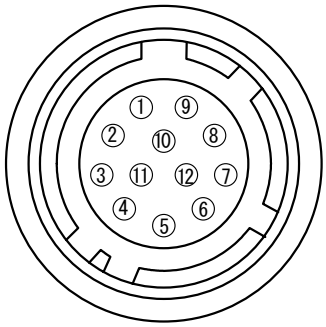
Note: *1) Rear protrusion on the C-mount lens must be less than 10mm (0.4 inches approx.). When IR-cut filter is used, it must be less than 7.0 mm (0.28 inches approx.).

The IR-cut filter is placed in the C-mount thread.
The C-mount IR-cut filter must be ordered separately.

5. Pin Assignment

5.1. 12-pin Multi-connector (DC-IN/VIDEO OUT, EXT.HD/VD IN)

Type: HR10A-10R-12PB-01 (Hirose) male
Seen from rear. *Pin configuration is compatible with EIAJ standard*



Pin no.	Signal	Remarks
1	GND	
2	+12 V DC input	
3	GND	
4	Video output	Parallel with the BNC connector.
5	GND	
6	***HD input***/HD output	*) SW2.1 on for 75Ω. SW1.1 on for HD out.
7	***VD input***/VD output	*) SW2.2 on for75Ω. SW1.2 on for VD out.
8	GND	
9	Pixel clock output	*) JP2 short and PC=1 for pclk out.
10	***WEN output***	*) GND if JP5 open and JP3 short
11	***Trigger input***	*) +12V DC if JP1 short and JP4 open
12	GND	

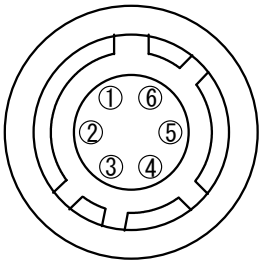
Fig. 2. 12-pin connector.

Plugs for cable: HR10A-10P-12S

5.2. 6-pin Multi-connector (TRIGGER)

Type: HR10A-7R-6PB (Hirose) male

Seen from rear.



Pin no.	Signal	Remarks
1	TXD out	
2	RXD in	
3	GND	
4	GND	
5	***Trigger input***	*) Parallel with pin 11 on 12 pin con
6	***EEN output***	*) *2). WEN output if EW=1

Fig. 3. 6-pin connector.

Plugs for cable: HR10A-7P-6S

Notes.

*) Alternative signals can be placed on these pins by switch or jumper settings or RS-232C commands.
Configurations shown in ***Bold + italic*** is factory setting.

*2) EEN will be low all the time in normal continous mode (TR=0), if the selected exposure time is longer than the frame readout time.

5.3. Input and Output Circuits

In the following schematic diagrams the input and output circuits for video and timing signals are shown. For alternative connections refer to "7.4. Internal Switch and Jumper Settings." Jumper settings are shown as for factory default.

5.3.1. Video output

The video output is a 75 Ω DC coupled circuit. The BNC connector and pin #4 on the 12-pin connector is in parallel. Avoid double termination. The video DC level is shown with 75 Ω termination.
In the composite signal, there are no equalize and serration pulses in the vertical sync.

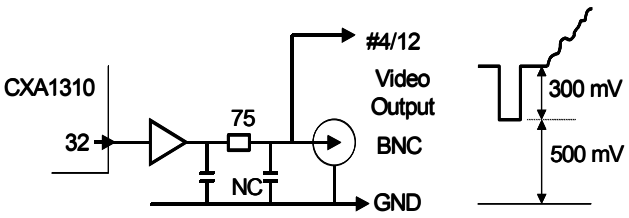


Fig. 4. Video output.

5.3.2. Trigger input

The trigger input is AC coupled. To allow a long pulse width, the input circuit is a flip flop, which is toggled by the negative or positive differentiated spikes caused by the falling or rising trigger edges.
The trigger polarity can be changed.
Trigger input level 4 V ±2 V.
The trigger-input impedance is 1 kΩ.
JP1 and JP4 are for alternative configuration for pin #10.

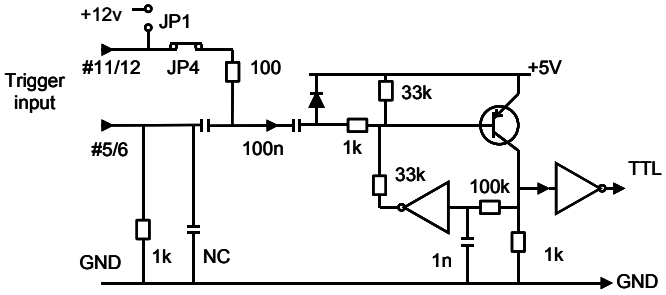


Fig. 5. Trigger input.

5.3.3. HD and VD input

The input circuit for external HD and VD signals are shown. It can be 75 Ω terminated by closing SW2. SW1 will switch to output the internal HD and VD signal.
HD and VD input level is 4 V ±2 V.

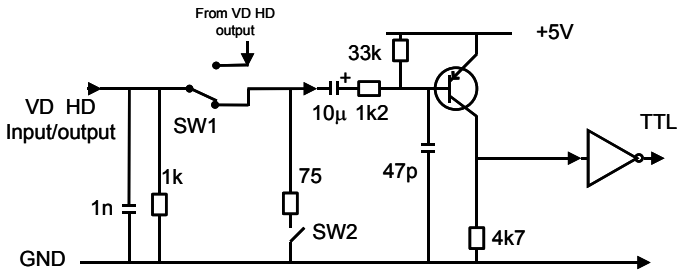


Fig. 6. HD and VD input.

5.3.4. HD, VD, PCLK, WEN and EEN output

Output circuit for these signals are 75 Ω complementary emitter followers. It will deliver a full TTL signal. JP5 and JP3 are for alternative configuration for pin #10.
Output level ≥4 V from 75Ω. (No termination).
The WEN polarity can be changed.
Signal on pin #6/6 can be changed.

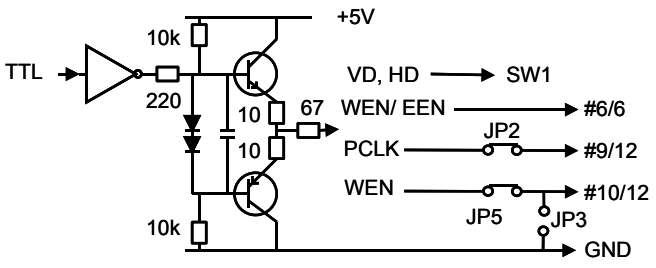


Fig. 7. HD, VD, PCLK, WEN and EEN output.

5.4. CV-A1 Block Diagram

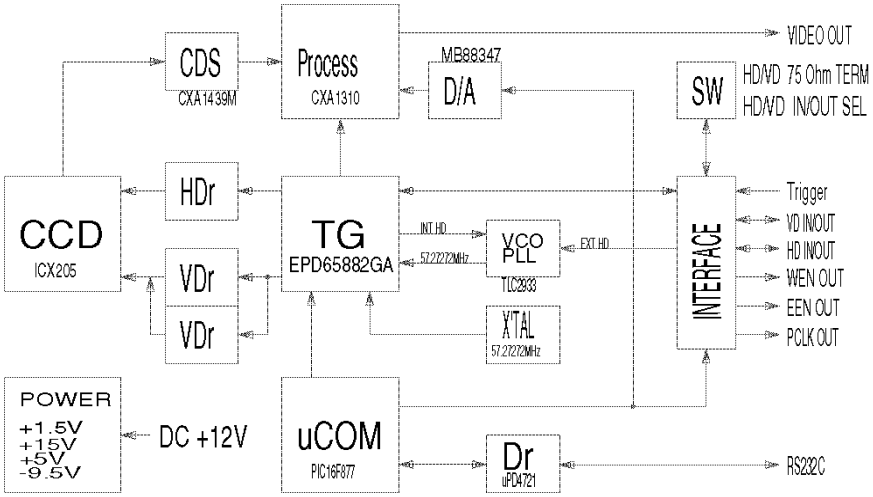


Fig. 8. Block diagram.

6. Functions and Operations

6.1. Basic functions

Some of the primary camera functions need a general introduction before the operation modes are described. The list below shows the primary functions from the command list.

SM	Shutter Mode	Normal shutter, Programmable Exposure
SH	Shutter Speed	Off to 1/140,000 second
PE	Programmable Exposure	1.3 H to 1023.3 H
SC	Scanning Format	Full frame, 1/2 partial, 1/3, 1/6 partial
BI	Binning	Off, vertical, horizontal, vertical + horizontal
TR	Trigger Mode	Normal, Edge, PWC, frame delay readout
		Long time exposure, start-stop, smearless (Edge)
HC	HD Accumulation	Sync., async.

The shutter ***SM*** can be set to normal (SM=0), where the exposure time is selected from 16 fixed step with the command ***SH***, or programmable exposure (SM=1). The command ***PE*** allows 1023 step with 1 line period resolution. (83.6 μs). Note that PE=0 and PE=1 results in 1.3H.
The CCD scanning format ***SC*** can be selected between full or partial scanning. With partial scanning, only the vertical central part of the CCD sensor is read out with a higher frame rate. The partial scan is done by a fast dump read out of the lines in the vertical ccd register down to the top of the partial image. The partial part of the image is read out with normal speed. The lines below the partial image are read out and dumped with a high speed.
Some signal distortion can be expected below highlighted areas, (saturated areas). It is caused by limitation in the vertical ccd register transfer efficiency at high speed.

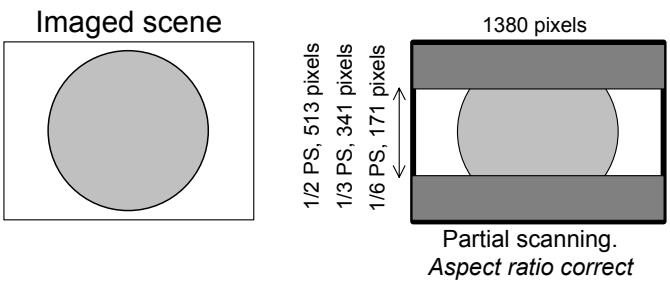


Fig. 9. Partial scanning.

Binning mode ***BI*** is a function where the signal charge from 2 or more adjacent pixels are added together and read out as one pixel. A resulting full frame with lower resolution can be read out with a higher rate. By adding 2 pixels together, the sensitivity is doubled. The CV-A1-20 has both vertical and horizontal binning. With V binning the pixel charge from 2 adjacent lines are added together in the horizontal ccd register. It is done by double pulses to the vertical ccd register. With H binning the pixel charge from 2 horizontal adjacent pixels are added together in the sample/hold circuit after the horizontal ccd register. It is done by shifting the charge from 2 horizontal ccd cells into the sample/hold capacitor for each reset pulse.
Both vertical and horizontal binning can work together. The sensitivity is then 4 times normal. The aspect ratio will be correct, if the sampling frequency is divided with 2. See fig. 10.

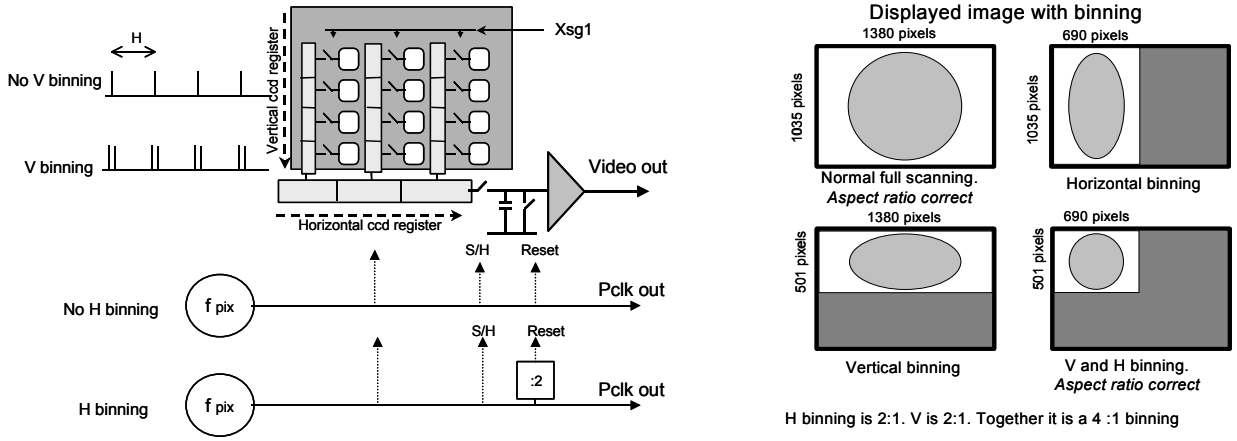


Fig. 10. Binning.

The following table shows the frame rates in normal continuous mode.

Scanning	Lines per frame [H]	Effective lines [H]	Frame rate [fps]	Remarks
Full	1068	1035	16	
1/2 partial	572	513	30	
1/3 partial	400	341	43	
1/6 partial	230	171	75	
H binning	1068	1035	16	
V binning	534	501	32	
H+V binning	534	501	32	

The accumulation mode ***HC*** can be set to asynchronous accumulation (HC=1). The exposure in PWC mode (TR =2) and Frame Delay readout (TR=3) will start immediately at the leading edge of the trigger pulse without waiting for the HD. Fig. 11 and fig. 12 shows the details.

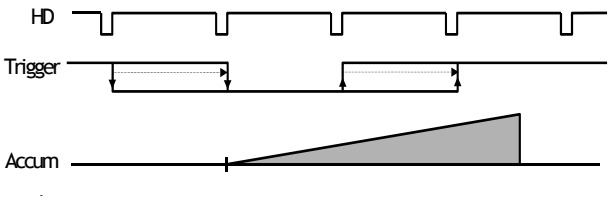


Fig. 11. PWC H synchronous accumulation

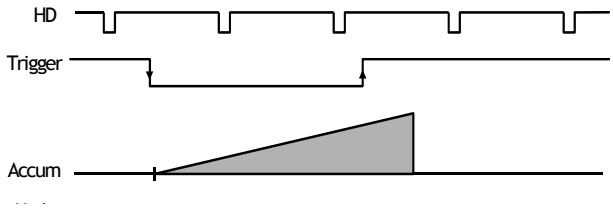


Fig 12. PWC asynchronous accumulation

In normal trigger mode (TR=0) shutter speed up to 1/140,000 sec. can be used. In all triggered shutter modes, the shortest shutter time is limited to ≥1,3 H. (1/8381). In triggered shutter modes with partial scan or binning, the longest shutter speed is not limited by the frame read out time. It can be longer.

Trigger modes with possible scanning and binning combinations

TR=	Scanning / Binning	Full scanning norm.	Full scanning V	Full scanning H	Full scanning V+H	Partial scanning Norm	Partial scanning V	Partial scanning H	Partial scanning V+H	Remarks
0	Normal	√	√	√	√	√	n	n	n	SM=0, SM=1 active
1	Edge Pre-sel.	√	√	√	√	√	n	n	n	SM=0, SM=1 active
2	Pulse Width	√	√	√	√	√	n	n	n	HC=0, HC=1 active
3	Fr. Delay r.o.	√	√	√	√	√	n	n	n	HC=0, HC=1 active
4	Long Time int	√	n	n	n	n				
5	Start/Stop	√								
6	Smearless	√	√	√	√	√	n	n	n	SM=0, SM=1 active

√ Described mode
n Non-described mode combination, which will work

6.2. Input-output of HD/VD Signals

In the default setting the camera will accept external HD/VD signals on pin 6 and 7 of the 12 pin Hirose connector. If external HD/VD is applied, the camera will synchronize to it. If no external sync signals are applied, the camera will operate with its internal x-tal controlled sync. The camera scanning system should be set to the same as the external connected sync. In fig. 13 below, the time requirements to relation between VD and HD are shown. The high to low transition for the external VD pulse should be placed within the 68 μsec. time interval to HD. The input is TTL level as factory setting. It can be 75 Ohm terminated by the internal switch on the PK8342A board. SW2-1 for HD and SW2-2 for VD. On for 75 Ohm termination.
To output the internal HD/VD signals on pin 6 and 7 the internal switch SW1-1 and 1-2 on the PK8342A board should be set ON. The output is TTL level from a 75-Ohm source.

To use this mode:

Set function:	SW 1 on PK8342A to IN for external VD/HD input. *Factory default.*
	SW 2 on PK8342A to 75 Ω for termination of VD/HD.
	SW 2 on PK8342A to TTL for TTL level for VD/HD. *Factory defaults.*
	SW 1 on PK8342A to OUT for internal VD/HD output.
Input:	Ext. VD in or int. VD out on pin 7 on 12-pin connector.
	Ext. HD in or int. HD out on pin 6 on 12-pin connector.

Important notes on using this mode

- *External sync system should follow the camera scanning and binning system.*
- *In trigger modes there are no continuous VD out, only after each trigger input.*
- *With external HD/VD synchronizing I continuous partial scanning modes, a few pixel jitter can be expected in the first few lines. It can be avoided if a trigger mode is used.*

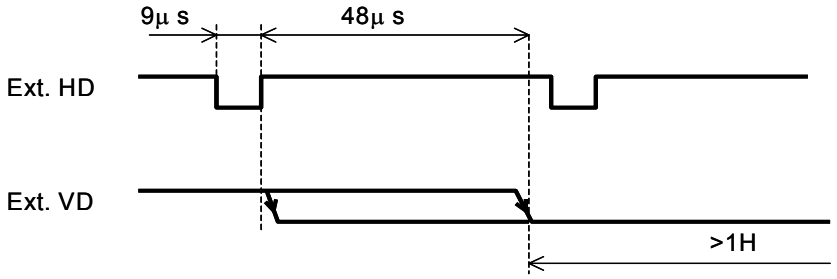


Fig. 13. Ext. HD and ext. VD phase conditions.

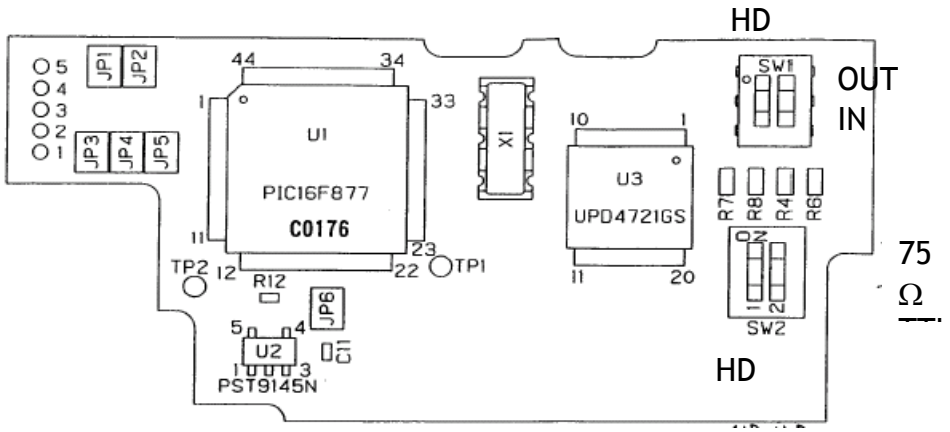


Fig. 14. Switch positions for int./ext. sync and termination.

6.3. Continuous Operation (Non triggered)

Trigger Mode Normal. TR=0. It is for applications where the camera is continuous running without external trigger. In normal mode the shutter mode can be normal or programmable exposure. (SM=0 SM=1). The shutter will work in all 16 steps up to 1/140,000 second or with the programmable exposure in 1023 steps. In partial scanning and binning modes, shutter times longer than the actual frame time has no meaning. The exposure will be equal the frame time. If external synchronizing is used input external HD and VD signals.

To use this mode:

Set function:	Trigger mode	TR=0
	Shutter mode "Normal" or "Programmable"	SM=0, SM=1
	"Shutter Speed"	SH=0 through 15
	"Programmable exposure"	PE=1 through 1023
	Other functions	
Input:	Ext. VD on pin 7 on 12-pin connector. If used.	
	Ext. HD on pin 6 on 12-pin connector. If used.	

Important notes on using this mode

External sync system should follow the camera scanning and binning system.

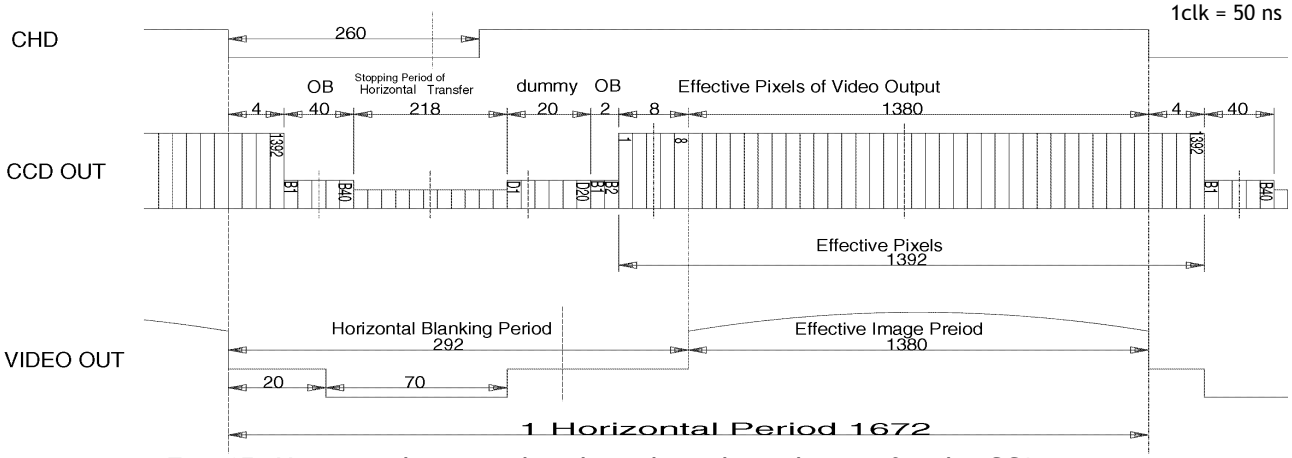


Fig. 15. Horizontal timing details and pixel numbering for the CCD array.

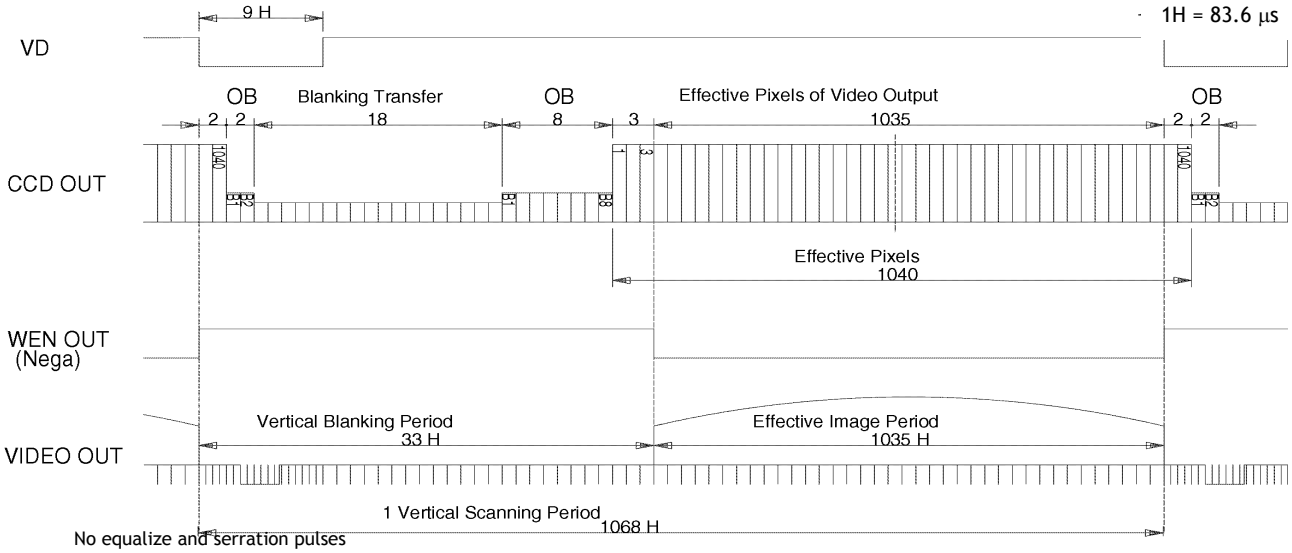


Fig. 16. Vertical timing details and lines numbering for the CCD array.

6.4. External Trigger Modes

This camera has 6 external asynchronous trigger modes, which can be set by RS-232C commands.

1.	*Edge Pre-select Mode.TR=1*	Pre-selected exposure. (SM=0, SM=1)
2.	*Pulse Width Control Mode. TR=2*	Pulse width controlled exposure. (HC=0, HC=1)
3.	*Frame Delay read out mode. TR=3*	PWC exposure read out by ext. VD. (HC=0, HC=1)
4.	*Long Time Exposure Mode. TR=4*	Exposure is interval between ext. VD.
5.	*Start/stop Mode. TR=5*	Exposure start by trigger and stop by ext. VD
6.	*Smearless Read out mode. TR=6*	Pre-sel. exp. after dummy readout. (SM=0, SM=1)

The default accumulation is HD synchronously accumulation (HC=0). The accumulation starts at the first HD after the trigger leading edge. Fig. 18. To avoid the <1H jitter caused by this delay, synchronize the external trigger to HD as shown in fig. 17 below. The trigger level translations should be placed inside the 8 + 4 μseconds.
In PWC mode (TR =2) and Frame Delay readout (TR=3), the accumulation mode ***HC*** can be set to asynchronous accumulation (HC=1). The exposure will start immediately at the leading edge of the trigger pulse without waiting for the HD. Fig. 19.
In this mode it is possible to start a new exposure while the previous triggered exposure is read out. The exposure should not be finished before the previous frame is read out.

In Edge pre-select TR=1 and smearless TR=6, the shutter mode can be SM=0 or SM=1.

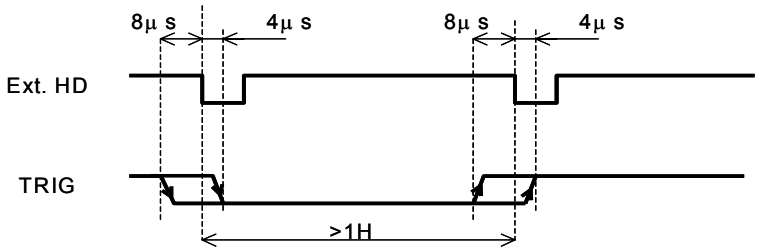


Fig. 17. Trigger/HD Timing.

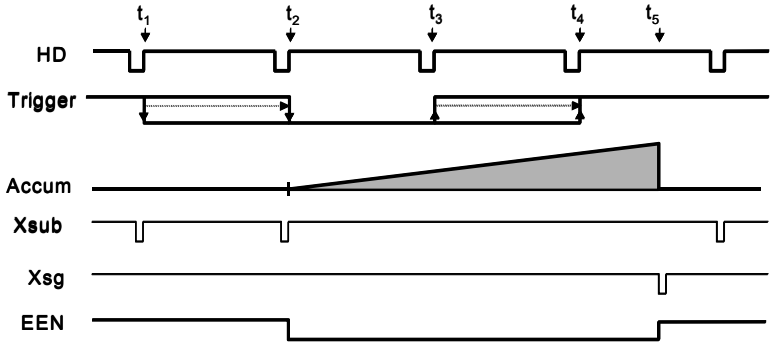


Fig.18. Pulse Width H Synchronous Accumulation

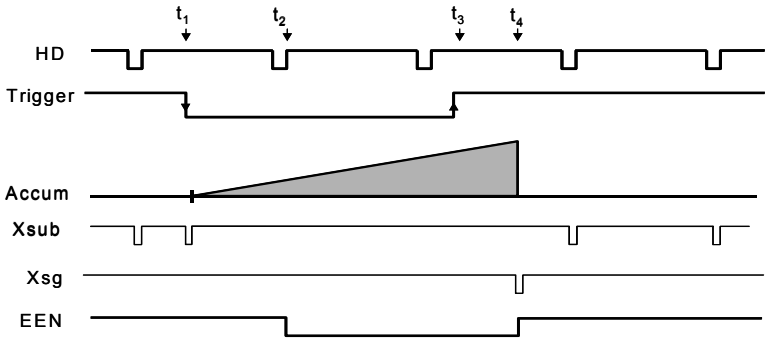


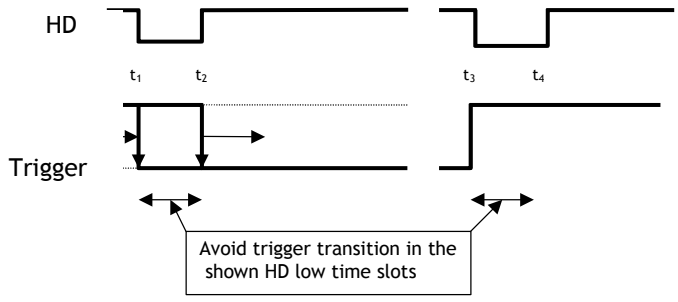
Fig. 19. Pulse Width H Asynchronous Accumulation.

Note: Xsg and Xsub are internal signals in the camera. They are shown in the timing diagram for better understanding.

Note for HD asynchronous trigger mode.

If the trigger leading edge falls inside the HD low period, or the trigger trailing edge rises inside the HD low period, an accumulation time jitter <0.1H can be expected. With the shortest PWC trigger pulse width just >1H, the accumulation time is about >1.7H.
With shortest possible trigger pulse width just >1H, the time jitter at accumulation start or accumulation stop can result in up to 5% amplitude jitter.

The jitter can only be avoided if the PWC trigger is synchronized to change state outside the HD low period.



6.5. Edge Pre-select Mode

The exposure starts at the first HD pulse after the trigger leading edge. It stops and is read out after the duration of the shutter time selected. It can be the first 9 step in normal or 1023 steps in programmable shutter. SM=0 or SM=1. Shutter selections SH ≥10 will result in 1/8381 sec. This mode will operate with full and partial scanning and with all binning modes. Partial scanning together with binning will work, but it is not described, and no timing diagrams are documented. An EEN pulse will indicate the active accumulation time, and a WEN pulse indicates that the resulting video is being read out.

To use this mode:

Set function:	Trigger mode "Edge Pre-select"	TR = 1
	Shutter mode "Normal" or "Programmable"	SM=0, SM=1
	"Shutter Speed"	SH=0 through 9
	"Programmable exposure"	PE=1 through 1023
	Polarity and other functions	
Input:	Ext. trigger to pin 5 on 6 pin connector (or pin 11 on 12-pin connector).	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- The start of exposure will start synchronized to the internal H signal. The start may be shifted max 1H. To avoid this shift (1 H jitter), synchronize the camera to an external HD and make sure that the trigger pulse aligns to the HD as shown in fig. 17.
- The duration of the trigger should be >1H to <2000H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there are no continuous VD out, only after each trigger input.*

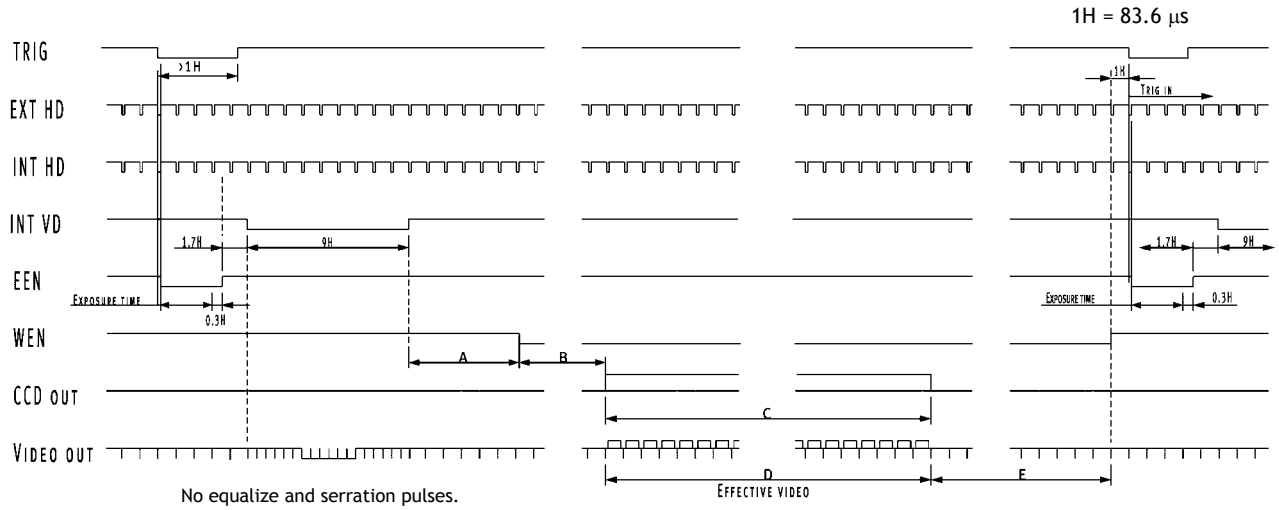


Table showing the figures for the different modes.

Scan mode	A	B	C CCD array line #	D Effective video	E	Max frame rate fps	Remarks
Full	10H	14H	4 to 1038	1035H	18H	11	
1/2 Partial	17H	33H	271 to 783	513H	25H	20	
1/3 Partial	17H	33H	357 to 697	341H	25H	28	
1/6 Partial	17H	33H	442 to 612	171H	25H	46	
H binning	10H	14H	4 to 1038	1035H	18H	11	
V binning	10H	14H	18 to 1019	501H	18H	22	
V+H binning	10H	14H	18 to 1019	501H	18H	22	

Fig. 20. Timing for Edge Pre-select with partial scanning and binning.

6.6. Pulse Width Control Mode

In this mode the exposure starts from the leading edge of the trigger pulse. It stops at the trailing edge of the trigger pulse, and the resulting video is read out. The accumulation can be either H synchronous or H asynchronous. HC=0 or HC=1. In H synchronous mode the accumulation starts at the first HD pulse after the leading edge of the trigger. It can result in <1H jitter if the trigger is not synchronized to H. In H asynchronous mode the accumulation starts immediately after the leading edge of the trigger. (The internal H is not reset.)
This mode will operate with full and partial scanning and with all binning modes. Partial scanning together with binning will work, but it is not described, and no timing diagrams are documented. An EEN pulse will indicate the active accumulation time, and a WEN pulse indicates that the resulting video is being read out.

To use this mode:

Set function:	Trigger mode "Pulse Width Controlled"	TR = 2
	"H accumulation"	HC=0 or HC=1
	Polarity and other functions	
Input:	Ext. trigger to pin 5 on 6 pin connector (or pin 11 on 12-pin connector).	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- With HC=0 the start of exposure will start synchronized to the internal H signal. The start may be shifted max 1H. To avoid this shift (1 H jitter), synchronize the camera to an external HD and make sure that the trigger pulse aligns to the HD as shown in fig. 17. With HC=1 the exposure will start immediately. Refer to fig. 18 and fig. 19.
- The duration of the trigger can be >1H to <2000H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there are no continuous VD out, only after each trigger input.*

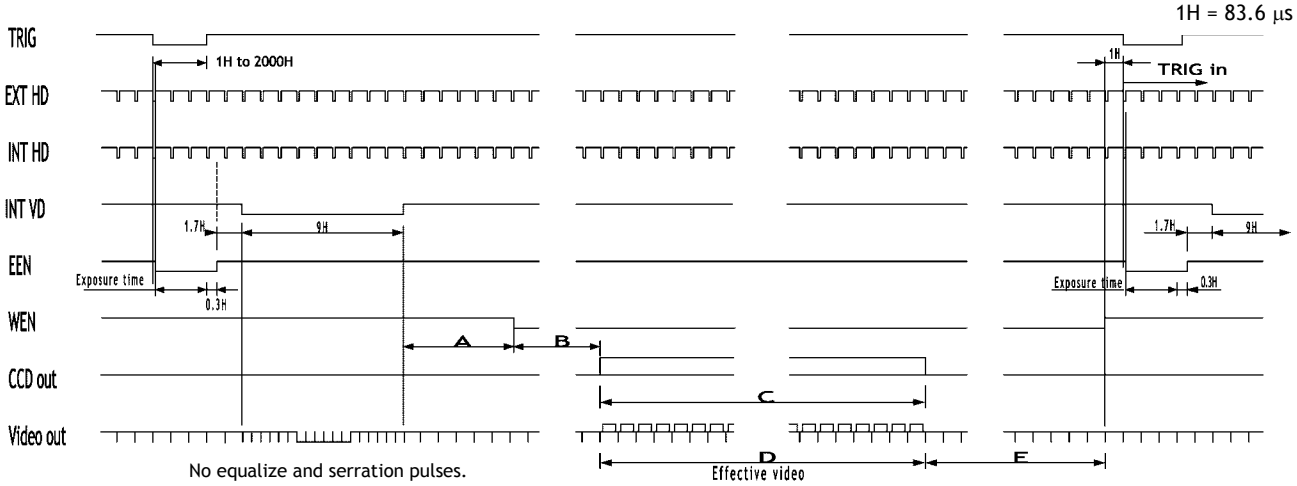


Table showing the figures for the different modes.

Scan mode	A	B	C CCD array line #	D Effective video	E	Max frame rate fps	Remarks
Full	10H	14H	4 to 1038	1035H	18H	11	
1/2 Partial	17H	33H	271 to 783	513H	25H	20	
1/3 Partial	17H	33H	357 to 697	341H	25H	28	
1/6 Partial	17H	33H	442 to 612	171H	25H	46	
H binning	10H	14H	4 to 1038	1035H	18H	11	
V binning	10H	14H	18 to 1019	501H	18H	22	
V+H binning	10H	14H	18 to 1019	501H	18H	22	

Fig. 21. Pulse Width Control trigger mode

6.7. Frame-delay read out Mode

In this mode the exposure starts from the leading edge of the trigger pulse. It stops at the trailing edge of the trigger pulse. The accumulation can be either H synchronous or H asynchronous. HC=0 or HC=1. In H synchronous mode the accumulation starts at the first HD pulse after the leading edge of the trigger. In H asynchronous mode the accumulation starts immediately after the leading edge of the trigger. (The internal H is not reset.) The resulting video is read out after an external VD pulse is applied. This mode will operate with full and partial scanning and with all binning modes. Partial scanning together with binning will work, but it is not described, and no timing diagrams are documented.
An EEN pulse will indicate the active accumulation time, and a WEN pulse indicates that the resulting video is being read out.

To use this mode:

Set function:	Trigger mode "Frame-delay read out"	TR = 3
	"H accumulation"	HC=0 or HC=1
	Polarity and other functions	
Input:	Ext. trigger to pin 5 on 6 pin connector (or pin 11 on 12-pin connector).	
	Ext. VD to pin 7 on 12-pin connector.	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- With HC=0 the start of exposure will start synchronized to the internal H signal, the start of exposure may be shifted max 1H. To avoid this shift (jitter), synchronize the camera to an external HD and make sure that the trigger pulse aligns to the HD as shown in fig. 17.
- With HC=1 the exposure will start immediately. Refer to fig. 18 and fig. 19.
- The duration of the trigger can be>1H to<2000H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there are no continuous VD out, only after each trigger input.*

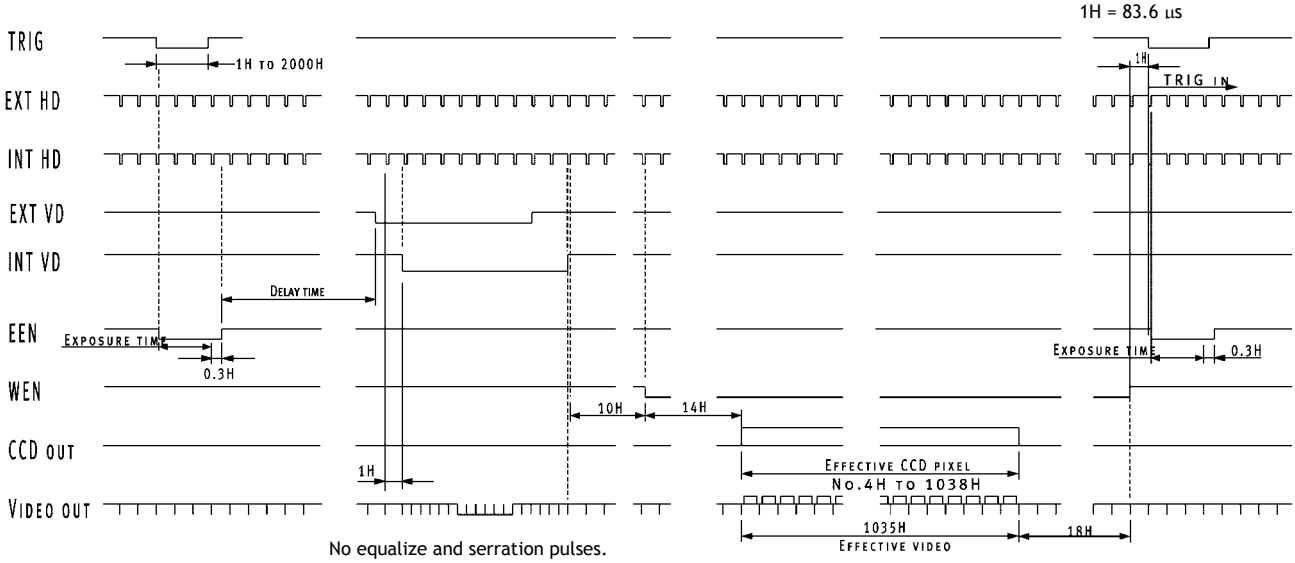


Table showing the figures for the different modes.

Binning	A (CCD array line #)	B
Normal	4 to 1038	1035H
H	4 to 1038	1035H
V	18 to 1019	501H
V+H	18 to 1019	501H

Fig. 22. Frame Delay read out mode

6.8. Long Time Exposure Mode

The exposure time is the interval between 2 external VD pulses sent to the VD input. The exposure starts after the input of a VD, and it ends after the next VD input, which again starts a new exposure. The interval between the external VD pulses (exposure time) can be from V to ∞. Thermal and dark current noise will increase by accumulation time, therefore the exposure time is not recommended to exceed 2 seconds (or 30 V periods). The external applied sync system should follow the camera scan system.
The long time exposure is a continuous process where each external VD pulse will synchronize the camera, stop an exposure, start a new exposure and read out the previous accumulated video signal.
A WEN pulse indicates that the resulting video is being read out.

To use this mode:

Set function:	Trigger mode "Long Time Exposure"	TR = 4
	Polarity and other functions	
Input:	Ext. VD to pin 7 on 12-pin connector.	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- Depending of the temperature, it is not recommended to use integration time >2 sec.

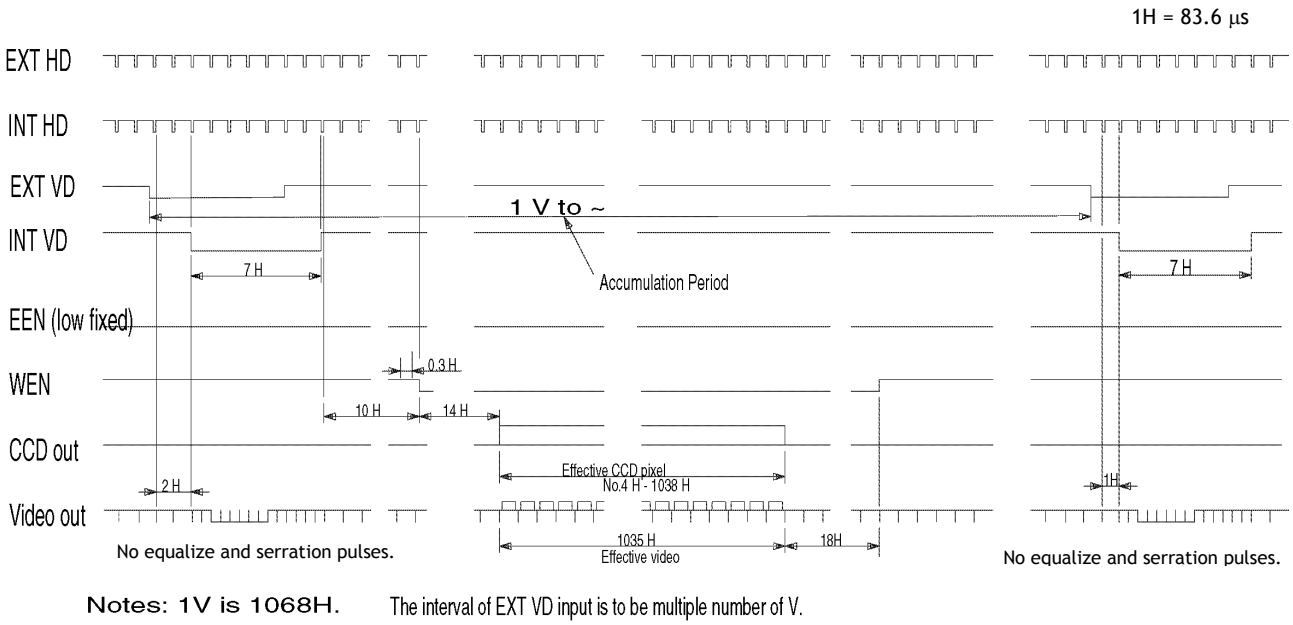


Fig. 23. Long time exposure

6.9. Start/Stop Mode

The exposure is controlled by the interval between the external trigger pulse and an external VD pulse. The exposure start at the first HD pulse after the trigger leading edge, and it stops after the rising edge of the VD. An EEN pulse will indicate the active accumulation time, and a WEN pulse indicates that the resulting video is being read out.
The shortest exposure time in this mode is >1.3H.
The longest exposure time is <2000 H.

To use this mode:

Set function:	Trigger mode "Start/Stop Mode"	TR = 5
	Polarity and other functions	
Input:	Ext. trigger to pin 5 on 6-pin connector (or pin 11 on 12-pin con.).	
	Ext. VD to pin 7 on 12-pin connector.	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- The start of exposure will start synchronized to the internal H signal. The start may be shifted max 1H. To avoid this shift (1 H jitter), synchronize the camera to an external HD and make sure that the trigger pulse aligns to the HD as shown in fig. 17.
- The duration of the trigger should be >1H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there are no continuous VD out, only after each trigger input.*

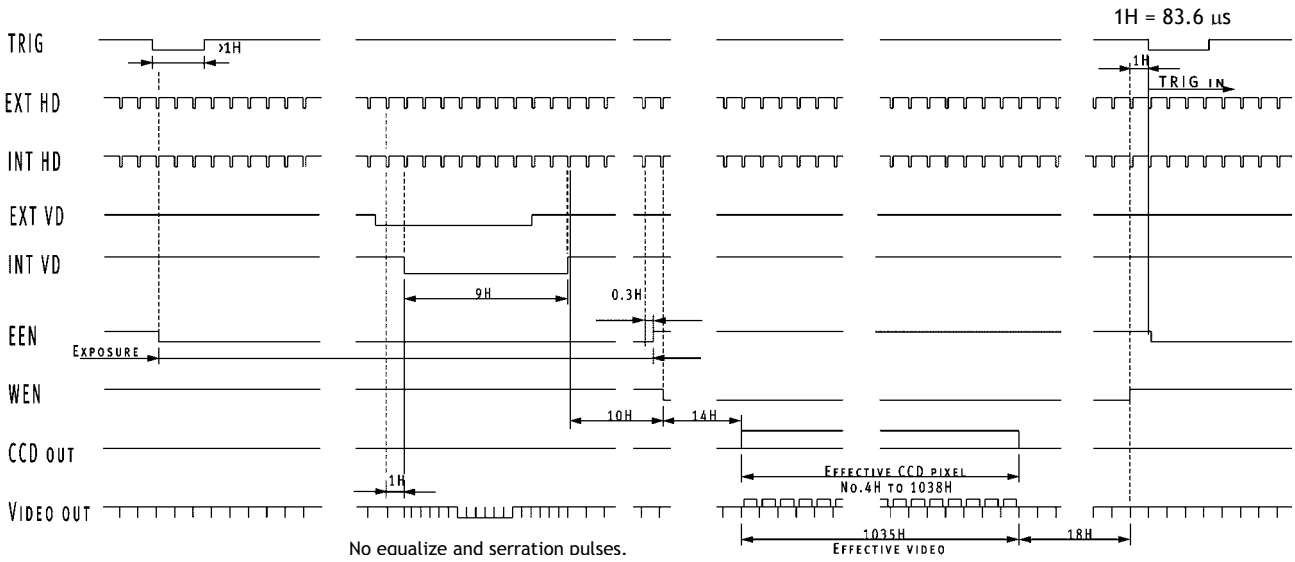


Fig. 24. Start/Stop mode

6.10. Smearless Mode

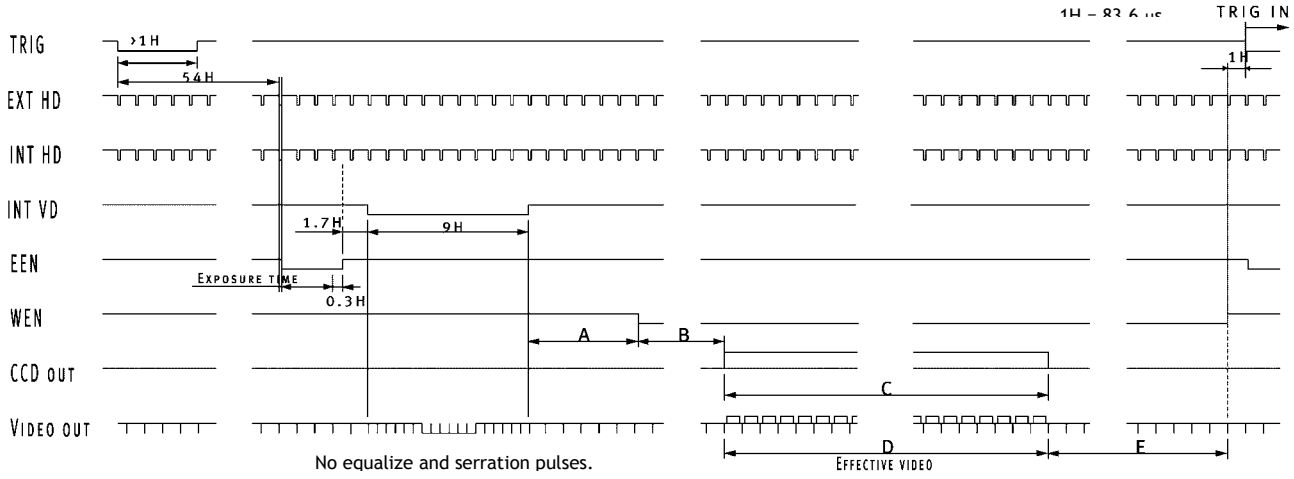
This mode will reduce the unwanted smear signal from a highlighted scene when a short exposure time is used. The trigger mode is like edge pre-select, but a dummy readout is performed before the active accumulation is started. It will remove the smear above the highlighted parts in the image, but there is still smear left below highlighted areas.
The trigger leading edge will start the dummy readout. It takes 54 H before the exposure starts. The exposure stops and the resulting video signal is read out after the selected shutter time. It can be the 16 step normal or 1023 step programmable. SM=0 or SM=1.
This mode will operate with full and partial scanning and with all binning modes. Partial scanning together with binning will work, but it is not described, and no timing diagrams will be documented. An EEN pulse will indicate the active accumulation time, and a WEN pulse indicates that the resulting video is being read out.

To use this mode:

Set function:	Trigger mode "Smearless read out"	TR = 6
	Shutter mode "Normal" or "Programmable"	SM=0, SM=1
	"Shutter Speed"	SH=0 through 9
	"Programmable exposure"	PE=1 through 1023
	Polarity and other functions	
Input:	Ext. trigger to pin 5 on 6 pin connector (or pin 11 on 12-pin connector).	
	Ext. HD to pin 6 on12-pin connector. (If used).	

Important notes on using this mode.

- The start of exposure will start synchronized to the internal H signal. The start may be shifted max 1H. To avoid this shift (1 H jitter), synchronize the camera to an external HD and make sure that the trigger pulse aligns to the HD as shown in fig. 17.
- The duration of the trigger should be >1H to <2000H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there are no continuous VD out, only after each trigger input.*



Scan mode	A	B	C CCD array line #	D Effective video	E	Max frame rate fps	Remarks
Full	10H	14H	4 to 1038	1035H	18H	11	
1/2 Partial	17H	33H	271 to 783	513H	25H	18	
1/3 Partial	17H	33H	357 to 697	341H	25H	25	
1/6 Partial	17H	33H	442 to 612	171H	25H	38	
H binning	10H	14H	4 to 1038	1035H	18H	11	
V binning	10H	14H	18 to 1019	501H	18H	20	
V+H binning	10H	14H	18 to 1019	501H	18H	20	

Fig. 25. Smearless Mode

6.11. Other Functions.

Gain and analogue settings.
!! Do not adjust these settings unless you have knowledge to video adjustments !!
The video gain can be set to **AGC** or **manual**. In AGC mode the video level is kept constant by the automatic gain control circuit within a 12 dB range. Normal 700 mVpp ±30 mV. The level can be adjusted with **AGC level**.
In manual gain mode, either the gain level or the rear potentiometer can adjust the level.
Setup level. This setting can adjust the setup level (or black level). Normal 20 mVpp ±2 mv.
White clip level. For adjusting the wanted white clip level. Normal 800 mVpp ±30 mv.
Gamma select. Gamma can be 1 (linear) or 0.45.

Sync signal on/off. Off will remove the composite sync signal from the video signal.
Pixel clock on/off. Set to on if the pixel clock is used. To avoid interference the pixel clock out should be off when not used.
EEN/WEN output. Will select EEN or WEN signal output on pin #6 on 6-pin connector.
Trigger polarity. Will invert the trigger-input signal.
WEN polarity. Will invert the WEN output signal.

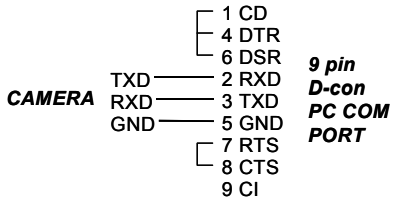
7. Configuring the Camera

7.1. RS-232C control.

All configuration of the CV-A1-20 camera is done via the RS-232C port. The camera can be set up from a PC running terminal emulator software, or using JAI´s camera control software.
Below is the description of the ASCII based short command protocol.
Communication setting.

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



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

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

Transmit the following to have the actual parameter for a command:
NN?<CR><LF> (NN is any commands with parameters.)
The camera answers: **NN=[Parameter]**

Transmit the following to have the camera actual setting:
ST?<CR><LF>
The camera returns the actual parameter settings.

Transmit the following to have a command list:
HP?<CR><LF>
The camera returns a complete command list.

7.2. CV-A1-20 RS-232C command list.

	Command Name	Format	Parameter		Remarks
A – General settings and useful commands					
EB	Echo Back	EB=[Param.]<CR><LF>	0=Echo off	1=Echo on	Off at power up
ST	Camera Status request	ST?<CR><LF>			Actual setting
HP	Online Help request	HP?<CR><LF>			Command list
VN	Firmware version	VN?<CR><LF>			3 letter version
ID	Camera ID request	ID?<CR><LF>			10 characters *3)
MD	Model name request	MD?<CR><LF>			≤10 characters *3)
UD	User ID	UD=[Param.]<CR><LF>	Save and load user text		≤16 characters *3)
B – Timing and shutter related commands					
SC	Scanning format	SC=[Param.]<CR><LF>	0=full frame 2=1/3 partial	1=1/2 partial 3=1/6 partial	
TR	Trigger mode	TR=[Param.]<CR><LF>	0=normal 2=Pulse width 4=Long time 6=Smearless	1=Edge 3=Frame delay 5=Start/stop	
SM	Shutter mode	SM=[Param.]<CR><LF>	0=Normal	1=Programmab.	
SH	Shutter speed	SH=[Param.]<CR><LF>	0=Off 2=1/42 4=1/175 6=1/698 8=1/2794 10=1/14,000 12=1/56,000 14=1/112,000	1=1/21 3=1/70 5=1/349 7=1/1397 9=1/5587 11=1/28,000 13=1/84,000 15=1/140,000	All16 step is valid in normal trigger mode. In all trigger modes shutter speeds higher than 9 will result in 1/8381
PE	Programmable expos.	PE=[Param.]<CR><LF>	0=1.3 H, 1=1.3H	1023=1023.3 H	H= 83.6 μsec
BI	Binning	BI=[Param.]<CR><LF>	0=off 2=horizontal	1=vertical 3=hor. + ver.	*1)
HC	HD accumulation	HC=[Param.]<CR><LF>	0=H synchron accumulation	1=a-synchron accumulation	a-sync. only for TR=2 and TR=3
C – Signals and polarity					
SO	Sync signal	SO=[Param.]<CR><LF>	0=no sync	1=sync on video	
PC	Pixel clock	PC=[Param.]<CR><LF>	0=no clock out	1=clock out	Should be off when not used
EW	EEN/WEN	EW=[Param.]<CR><LF>	0= EEN out	1=WEN out	Pin#6 on 6 pin
TP	Trigger polarity	TP=[Param.]<CR><LF>	0= active low	1= active high	*2)
WP	WEN polarity	WP=[Param.]<CR><LF>	0= active low	1= active high	
D – Gain and analogue signals setting					
AS	AGC Switch	AS=[Param.]<CR><LF>	0=AGC off	1=AGC on	0= manual gain
AG	AGC Level	AG=[Param.]<CR><LF>	0=low	255=high	Range 0 to 255
GA	Manual gain Level	GA=[Param.]<CR><LF>	0=low	255=high	Range 0 to 255
RP	Rear Potentiometer	RP=[Param.]<CR><LF>	0=manual gain	1=rear potm.	
SU	Setup Level	SU=[Param.]<CR><LF>	0=low	255=high	Range 0 to 255
WC	White clip Level	WC=[Param.]<CR><LF>	0=low	255=high	Range 0 to 255
GS	Gamma Select	GS=[Param.]<CR><LF>	0=gamma 1	1=gamma 0.45	
E – Saving and loading data in EEPROM					
LD	Load settings from camera EEPROM	LD=[Param.]<CR><LF>	0=Factory data 2=User 2 area	1=User 1 area 3=User 3 area	Latest used data area becomes default at next power up
SA	Save settings to camera EEPROM	SA=[Param.]<CR><LF>	1=User 1 area 3=User 3 area	2=User 2 area	
EA	EEPROM area request	EA?<CR><LF>			Return latest used area

*1) The internal pixel clock is not changed in H binning (BI=2 and BI=3). To keep the aspect ratio correct, divided the clock by 2 in the frame grabber.
*2) If positive logic is used (TP=1), the first trigger pulse after power up will be ignored.
*3) Functions implemented from s/no E121231.

7.3. Camera Control Tool for CV-A1-20

From www.jai.com Camera Control Tool for Windows 98/NT/2000 can be downloaded.
The control tool contents a camera control program and tools for making your own program.
For the integrator and experienced user, the Camera Control Toll is much more than a program with a window interface. It also provides an easy and efficient ActiveX interface built for MS Windows 98, ME, NT and 2000. 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.

7.3.1. Control Tool Windows

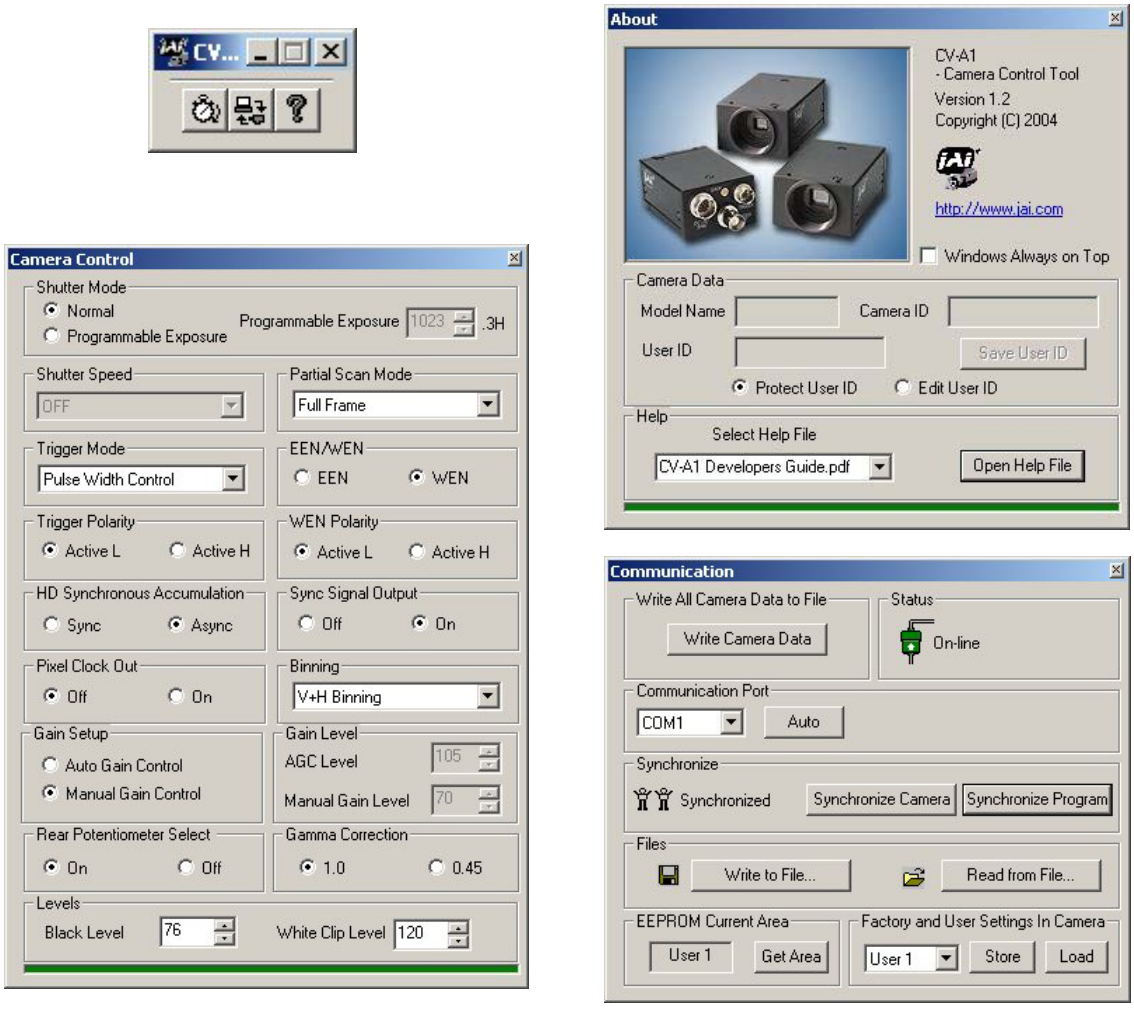
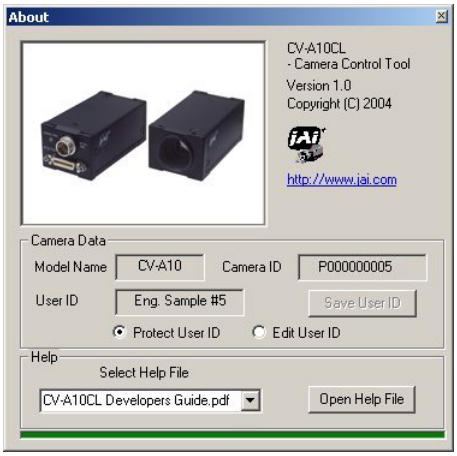


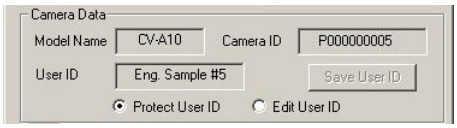
Fig. 26. Windows from Camera Tools.

7.3.2. 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.

The About window





The about window contains a picture of the camera and information about the version of the program, Internet connection to JAI A/S and access to the help documents.
The List box that contains the help documents will list all files, which have the extension .pdf and that are found in the program (default) folder

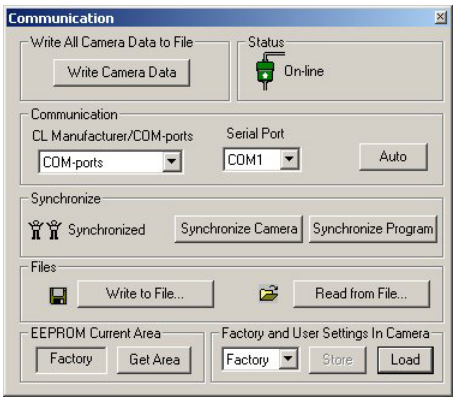
C:\Program Files\JAI A-S\'Control Tool Name'

It is possible to download updated operation manuals from the jai website:

http://www.jai.com/camera/manuals.asp/sprog=uk

An updated manual can be saved in the folder address mentioned above and it will automatically be included in the list of help files.
For newer camera models the About Window also shows Model Name, camera ID and User ID. It is possible to edit and save free text in User ID.
At the bottom of the windows (all windows but the Communication Window is a coloured 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.

The Communication Window



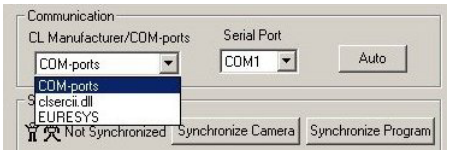
The Communication Window is used to connect the Camera Control Tool with the JAI camera. Depending of camera there are 2 possible ways to communicate with a JAI camera.
RS-232:
Select the communication port, where the serial cable is connected from the list box in the 'Communication Port' field, or click 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.
RS-232 and Camera Link:
The Communication Window looks a bit different when it is possible to communicate with the camera using Camera Link and RS-232 com port. The Communication area contains 2 list boxes now.

RS-232 communication:

1. Select 'COM-ports' from the 'CL Manufacturer/COM-ports' list Box.
2. Select the communication port, where the serial cable is connected to the camera from the 'Serial Port' list box or click the 'Auto' button to search for a camera on communication port 1 to 16.

The Serial Port list box and the Auto search button are only active when COM-ports is selected.

Camera Link communication:
The 'CL Manufacturer/COM-ports' list box also contains 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 in 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 camera request on every communication port. The user is prompted to use a communication port if a camera answers the request.
This button is only used for RS-232 communication.

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.

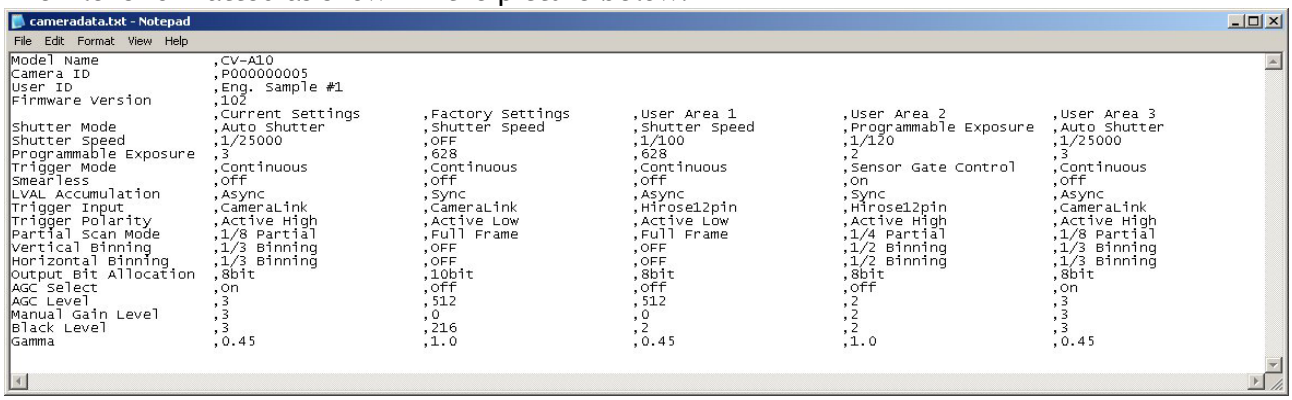
Synchronize program and camera
The Camera Control software has the ability to synchronize either the camera or the program. Click Synchronize camera to write all settings from the program to the camera or click the Synchronize program to load all settings from the camera to the program.

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 on 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.
The file is formatted as shown in the picture below:



Model Name	,CV-A10				
Camera ID	,P000000005				
User ID	,Eng. Sample #1				
Firmware Version	,102				
	,Current Settings	,Factory Settings	,User Area 1	,User Area 2	,User Area 3
Shutter Mode	,Auto Shutter	,Shutter Speed	,Shutter Speed	,Programmable Exposure	,Auto Shutter
Shutter Speed	,1/25000	,OFF	,1/100	,1/120	,1/25000
Programmable Exposure	,3	,628	,628	,2	,3
Trigger Mode	,Continuous	,Continuous	,Continuous	,Sensor Gate Control	,Continuous
Smearless	,Off	,Off	,Off	,On	,Off
LVAL Accumulation	,Async	,Sync	,Async	,Sync	,Async
Trigger Input	,CameraLink	,CameraLink	,Hirose12pin	,Hirose12pin	,CameraLink
Trigger Polarity	,Active High	,Active Low	,Active Low	,Active High	,Active High
Partial Scan Mode	,1/8 Partial	,Full Frame	,Full Frame	,1/4 Partial	,1/8 Partial
Vertical Binning	,1/3 Binning	,OFF	,OFF	,1/2 Binning	,1/3 Binning
Horizontal Binning	,1/3 Binning	,OFF	,OFF	,1/2 Binning	,1/3 Binning
Output Bit Allocation	,8bit	,10bit	,8bit	,8bit	,8bit
AGC Select	,On	,Off	,Off	,Off	,On
AGC Level	,3	,512	,512	,2	,3
Manual Gain Level	,3	,0	,0	,2	,3
Black Level	,3	,216	,2	,2	,3
Gamma	,0.45	,1.0	,0.45	,1.0	,0.45

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

7.3.3. 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 and 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".

7.4. Internal Switch and Jumper Settings

For VD and HD input/output and termination refer to "6.2. Input-output of HD/VD Signals."
For alternative connections of pin #10 and #11 on 12-pin connector, jumper JP1, JP2, JP3, JP4 and JP5 can be used. Refer "5.3. Input and Output Circuits."
Jumper setting for alternative pin configuration for M-series camera emulating is shown below.

Pin #	Function	JP2	JP3	JP5	JP1	JP4	Remarks
9	PCLK out	***Short***					***Factory default setting*** (EIA-J standard)
9	No connection	Open					
10	WEN out		***Open***	***Short***			***Factory default setting*** (EIA-J standard)
10	Ground		Short	Open			
11	Ext. trigger in				***Open***	***Short***	***Factory default setting*** (EIA-J standard)
11	+12 Volt in/out				Short	Open	Warning! +12 volt power out here.

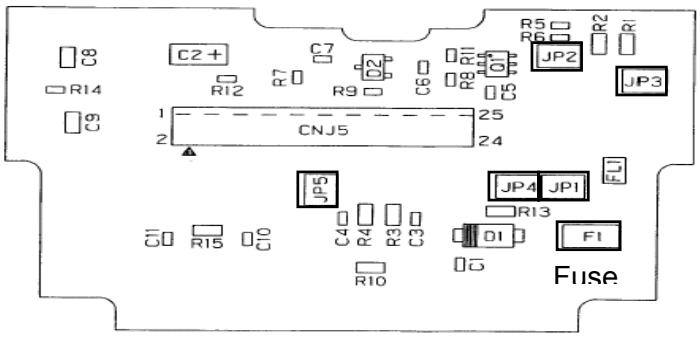


Fig. 27. Jumper positions.

8. External Appearance and Dimensions

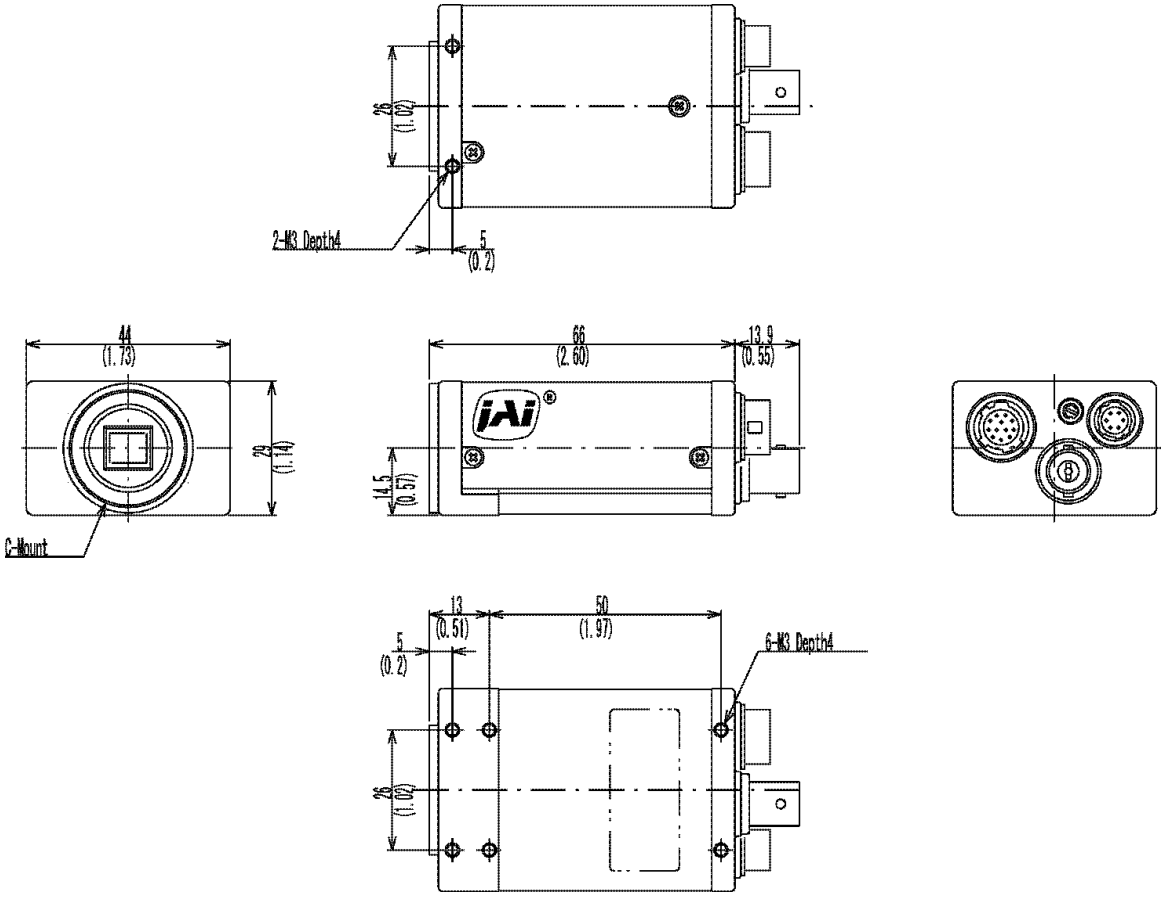
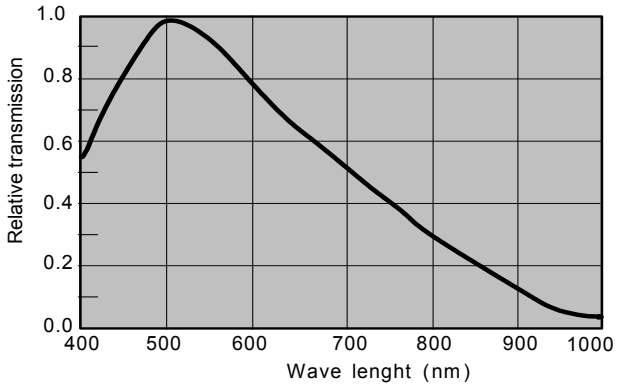


Fig. 28. Dimensions

9. Specifications

Specifications	CV-A1-20
Scanning system	Progressive 1068 lines 11.2 frames/sec.
Pixel clock	20.00 MHz
Line frequency	11.962 kHz (1672 pixel clock/line)
Frame rate for full frame	11.2 frames/sec. (1068 lines/frame)
CCD sensor	1/2" progressive monochrome IT CCD
Sensing area for video out	6.42 (h) x 4.81 (v) mm
Effective pixels	1392 (h) x 1040 (v)
Pixels in video output	1380 (h) x 1035 (v)
Cell size	4.65 (h) x 4.65 (v) μm
Resolution horizontal	1000 TV lines
Sensitivity on sensor	0.2 Lux, Max gain, 50% video
S/N ratio	>50 dB
Video output	Composite VS signal, 1 Vpp, 75 Ω Video signal 0.7 Vpp (selectable)
Gamma	1.0 - 0.45
Gain Gain range	Manual - Automatic Man. -3 to +12 dB. Aut. 0 to +12 dB
Synchronization	Int. X-tal. Ext. HD/VD or random trigger
HD sync. input/output	4 V ±2 V, 75 Ω
Trigger input	4 V ±2 V, 1kΩ input impedance
WEN output (write enable)	4 V ±2 V, 75 Ω
EEN output (exposure enable)	4 V ±2 V, 75 Ω
Pixel clock output	4 V ±2 V, 75 Ω
Read out modes for full frame	Full, 2:1 H binning, 2:1 V binning, H+V binning
Read out partial scan vertical	Full, 1/2, 1/3, 1/6
Trigger	Continuous, Edge pre-select, Pulse width control, frame delay
Accumulation by trigger	H synchronized/ (H non synchronized. In PWC and frame delay only)
Shutter speed. Fixed (Full frame only)	1/11, 1/21, 1/42, 1/70, 1/175, 1/349, 1/698, 1/1400, 1/2800, 1/5587, 1/14,000, 1/28,000, 1/56,000, 1/84,000, 1/112,000, 1/140,000 second
Shutter speed in trigger modes	Max. 1/5587 second. (1/8381 for settings >1/5587)
Programmable exposure	1.3 H to 1023.3 H in 1 H step
Pulse width control	1.3 H to 2000 H
Long time exposure	<2 sec. (Interval between ext. VD)
Start/stop exposure	1.3 H to - 2000 H (Time from trigger to ext. VD)
Frame delay readout PWC	1.3 H to 2000 H
Delay in frame delay readout mode	< 2 seconds (Time from PWC trigger input to ext. VD input.)
Smearless readout	For edge pre-select mode only
Functions controlled by internal DIP switches	VD input/output, HD input/output HD, VD 75 Ω termination on/off
Functions controlled by RS 232C short commands	Shutter speed, shutter mode, Trigger mode, Readout mode, polarity, Sync. on/off, Programmable exposure, Gain levels, Gamma and RS 232C Commands
Communication Baud rate	9600 bps
Operating temperature	-5°C to +45°C
Humidity	20 - 80% non-condensing
Storage temp./humidity	-30°C to +60°C/20% - 90 % non-condensing
Power	12V DC ± 10%. 1.8 W
Lens mount	C-mount
Dimensions	29 x 44 x 66 mm (HxWxD)
Weight	150g

Spectral Sensitivity



10. Appendix

10.1. 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.
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.

Power off the camera during any modification such as changes of jumper and switch setting.

10.2. Typical CCD Characteristics

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

V. Smear
Due to an excessive bright object such as electric lighting, sun or strong reflection, vertical smear may be visible on the video monitor screen. This phenomenon is related to the characteristics of the Interline Transfer System employed in the CCD.

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

Blemishes
Some pixel defects can occur, but this does not have en effect on the practical operation.

Patterned Noise
When the CCD camera captures a dark object at high temperature or is used for long time integration, fixed pattern noise (shown as white dots) may appear on the video monitor screen.

11. Users Record

Camera type: **CV-A1-20**

Revision: **(Revision C)**

Serial No. **……..**

Users Mode Settings

Users Modifications

DECLARATION OF CONFORMITY

AS DEFINED BY THE COUNCIL DIRECTIVE
89/336/EEC
EMC (ELECTROMAGNETIC COMPABILITY)
WE HEREWITH DECLARE THAT THIS PRODUCT
COMPLIES WITH THE FOLOWING PROVISIONS APPLYING TO IT.
EN-50081-1
EN-50082-1

JAI A-S, Denmark
Phone +45 4457 8888
Fax +45 4491 8880
www.jai.com

JAI Corporation, Japan
Phone +81 45 440 0154
Fax +81 45 440 0166
www.jai-corp.co.jp

JAI UK Ltd., England
Phone +44 1895 821 481
Fax +44 1895 824 433
www.jai.com

JAI PULNiX Inc., USA
Phone (Toll-Free) +1 877 445 5444
Phone +1 408 747 0300
Fax +1 408 747 0880
www.jaipulnix.com

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