*Digital 3CCD Progressive Scan*
*RGB Color Camera*

# *CV-M 9CL*

# *Operation Manual*

*Camera: Revision A*
*Manual: Version 1.3*

## Table of Contents

## 1. General

The CV-M9CL is a digital 3 CCD progressive scanned RGB color camera. It provides an upgraded path from the CV-M90, adding higher resolution and Camera Link output.
It is based on a 1/3" image format, making it optically compatible with CV-M90 and CV-M91.
The compact 3 CCD C-mount prism unit is designed for high color quality, and combined with a color shading correction, it allows use of a wide range of C-mount lenses.
30 full RGB frames can be read out as 3 x 8 bit via a base Camera Link connection, or 3 X 10 bit in a medium Camera Link configuration. Functions like partial scanning and vertical binning allows higher frame rates.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of Camera Control Tool for CV-M9CL can be downloaded from: www.jai.com

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

## 2. Standard Composition

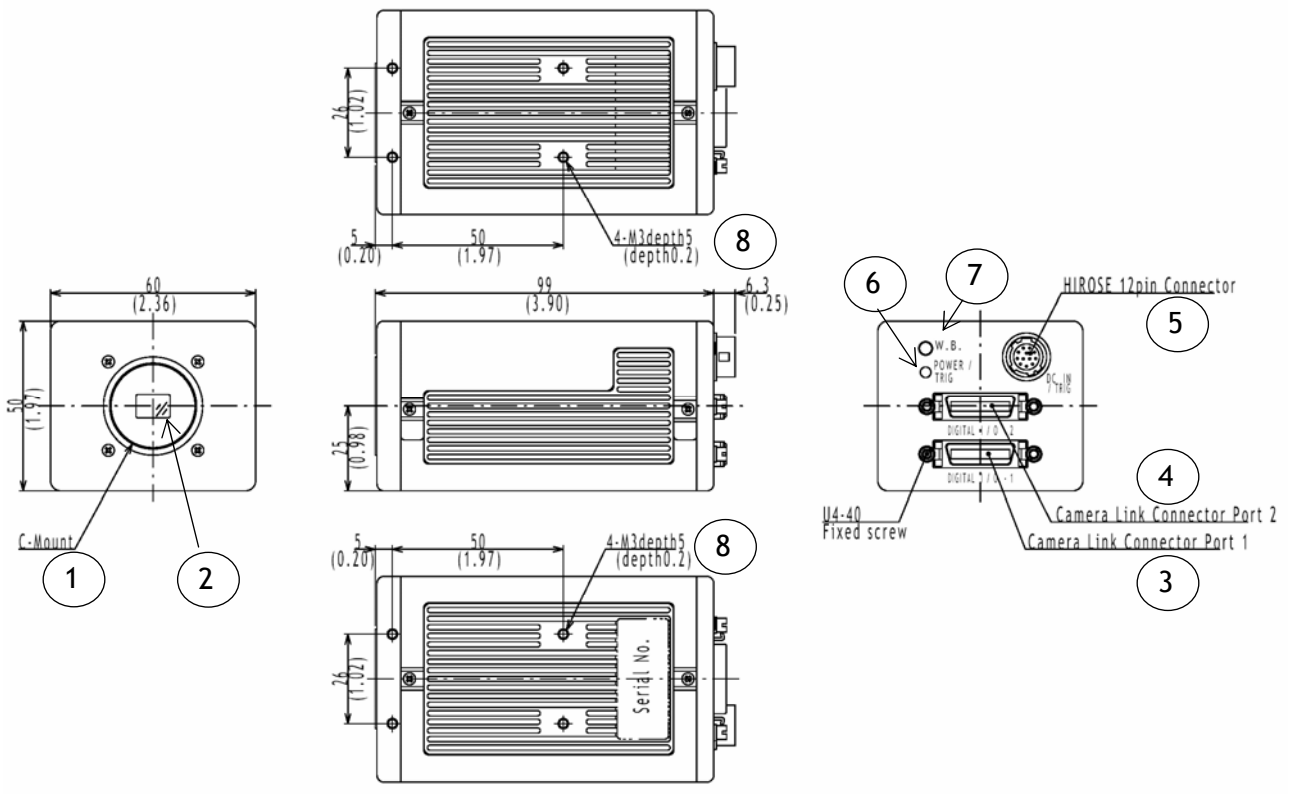
The standard camera composition consists of the camera main body and tripod mount plate.

The camera is available in the following version:
CV-M9CL. 3 CCD progressive scan color camera.

## 3. Main Features

- 3 x 1/3" CCD Progressive Scan RGB Color Camera for vision applications
- 3 x 1034(h) x 779 (v) 4.65 μm effective square pixels
- Compact RGB prism for C-mount lenses
- Chromatic shading reduction makes lens choice wider
- 30 frames per second with 1024 (h) x 768 (v) pixels
- 87 fps with 1024 (h) x 96 (v) pixels In 1/8 partial scan
- Vertical binning for higher sensitivity and frame rate
- 8 bit RGB output via single port Camera Link. 10 bit via dual port
- Edge pre-select, pulse width and sensor gate trigger modes
- Reset Continuous Trigger mode and smearless mode
- Programmable exposure individual for RGB
- Manual, Continuous or One Push white balance
- Color bar test image for set-up
- Customized shading correction
- Knee point and slope settings for higher dynamic range
- Analogue iris video output for lens iris control
- Setup by Windows 98/NT/2000/XP software via RS 232C

## 4. Locations and Functions




1 Lens mount of C-mount type. *1)
2 RGB Prism with 3 x 1/3” CCD sensors
3 Camera Link base connector 1
4 Camera Link medium connector 2
5 12 pin connector for DC +12V power external sync signals
6 LED for power and trigger indication
7 Switch for 1 push white balance
8 Mounting holes 8 x M3deept5.

**1) **Note**: Rear protrusion on C-mount lens must be less than 4.0mm*

Fig. 1. Locations

# 5. Pin Assignment

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

Type: HR10A-10R-12PB-01
(Hirose) male.
(Seen from rear of camera.)

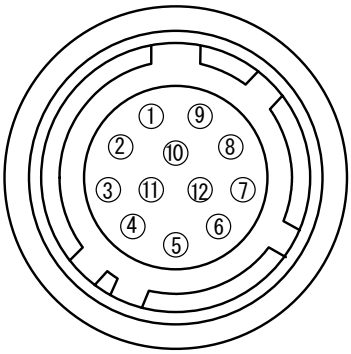
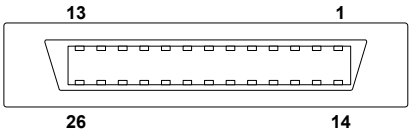



Fig. 2. 12-pin connector.

| Pin no. | Signal | Remarks |
|---|---|---|
| **1** | GND | |
| **2** | +12 V DC input | |
| **3** | GND | |
| **4** | Iris video | Only Contin. and RCT mode. TR=0, TR=4 |
| **5** | GND | |
| **6** | RXD in | RXD in HR, or ***CL***. SW301.1 ***off for CL*** *1) |
| **7** | TXD out | TXD in HR, or ***CL***. SW301.1 ***off for CL*** *1) |
| **8** | GND | |
| **9** | XEEN out | Low during exposure |
| **10** | Trigger in | TI=1 or ***in CL*** (TI=0). SW301.2 on for 75Ω |
| **11** | +12 V DC | |
| **12** | GND | |

***Notes:*** **1) See "7. Configuring the Camera" for more information. SW301.1 Off for CL. ON for 12 p HR. (SW301.2 is for trig 75Ω).*
Factory settings are shown in ***Bold Italic***

## 5.2. Digital Output Connector for Camera Link




Type: 26 pin MRD connector
3M 10226-1A10JL

Fig. 3. Camera Link connector

The digital output signals follow the Camera Link standardized multiplexed signal output interface. Camera Link base configuration is used for 3 x 8 bit RGB signal. The interface circuit is build around the NS type DS90CR285MTD.

The following signals are found on the Digital Output Connector:

| | | |
|---|---|---|
| SerTC | ***RXD serial data to camera*** | (***SW301.1. Off for CL***. On for HR) |
| SerTFG | ***TXD serial data to frame grabber*** | (***SW301.1. Off for CL***. On for HR) |
| CC1 | ***Trigger input*** | (***TI=0 for CL***. TI=1 for 12 pin HR) |
| CC2 | Factory use | |
| X0 to X3 | Camera Link multiplexed data out | |
| Xclk | Camera Link clock. Used as pixel clock. | |

In the Channel Link X0 to X3 multiplexed signals the following signals are encoded.

| | |
|---|---|
| D0 – D9 | 3 x 8 bit RGB video data out. |
| LVAL | Line VALid. Video line data is valid. High for valid line. |
| FVAL | Frame VALid. Video frame data is valid. High for valid frame. |
| DVAL | Data VALid. Effective video pixel data is valid. High for valid data. |
| EEN | Exposure ENable. High during exposure. |

The polarity is positive and TRIG in negative as factory setting.
For Camera Link interface principle diagram please check Fig. 7.

## 5.3. Input and output circuits

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

### 5.3.1. Iris video output

This signal can be used for lens iris control
In Continuous and Reset Continuous Trigger Mode. The signal is taken from the CCD sensor output before the gain circuit.
The iris video output is 0.7 Vpp from 75 Ω.
The signal is without sync.

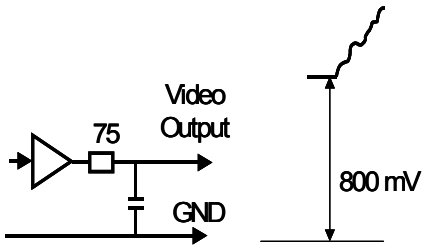



Fig. 4. Iris video output.

### 5.3.2. Trigger input

With TI=1, the trigger input is on pin #10 on 12 pin connector. The 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 by TP=1.
Trigger input level 4 V ±2 V. It can be terminated by SW301.2: ON for 75Ω. OFF for TTL.
The trigger inputs can be changed to Camera Link. (TI=0 for CL)

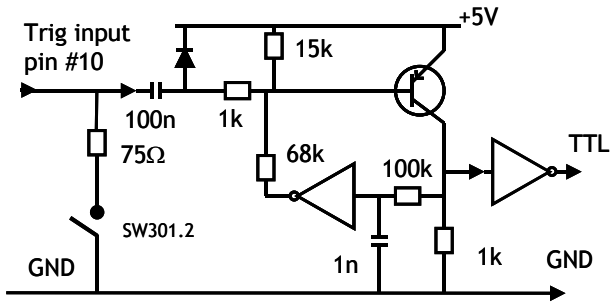



Fig. 5. Trigger input.

### 5.3.3. EEN output

XEEN is found on pin #9 on 12 pin HR connector.
The output circuit is 75 Ω complementary emitter followers. It will deliver a full 5 volt signal.
Output level ≥4 V from 75Ω. (No termination).
XEEN is low during exposure.
EEN is found in Camera Link. It is high during exposure.

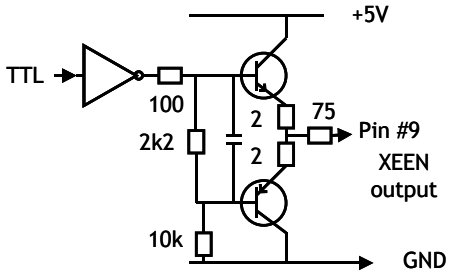
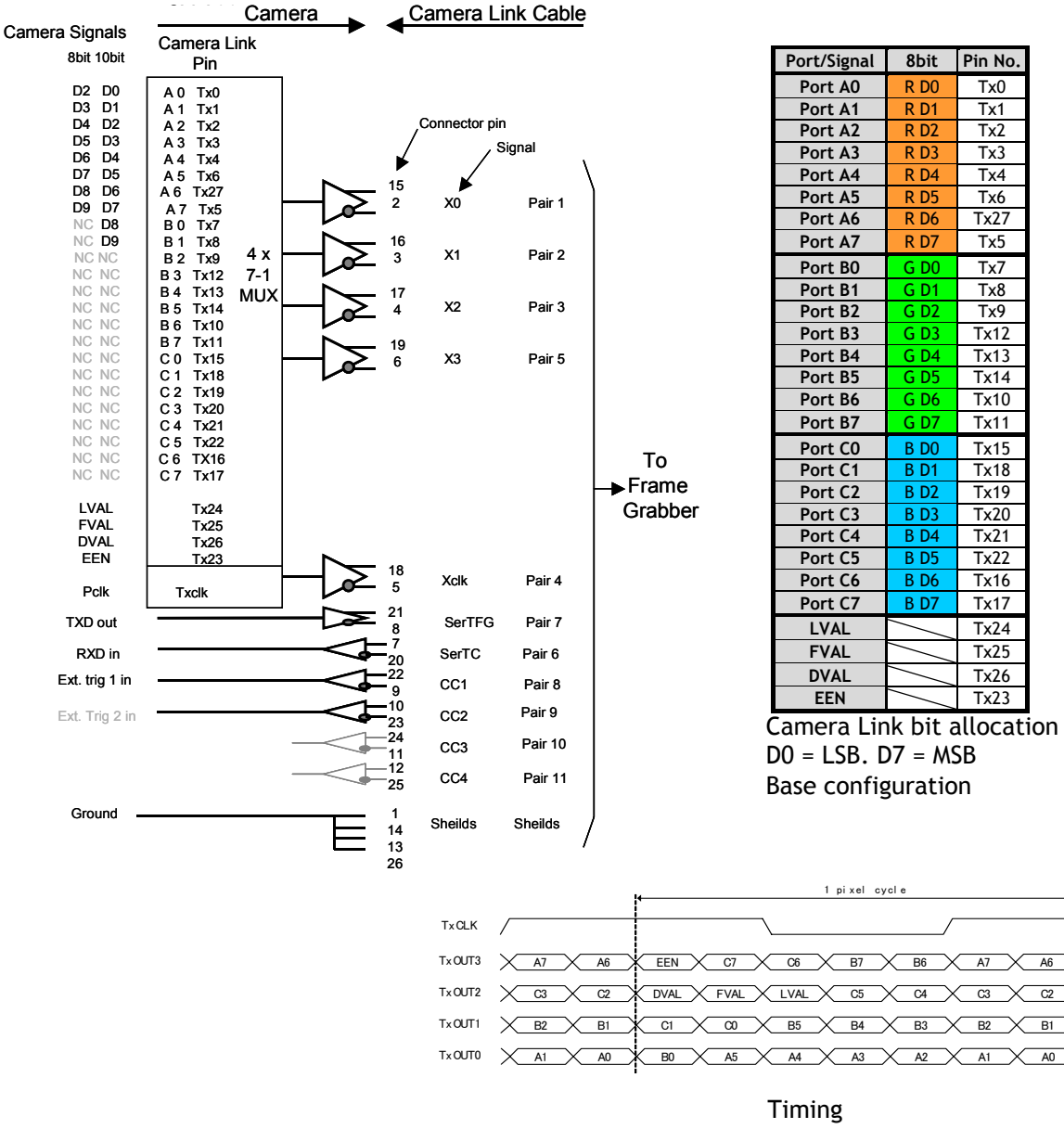



Fig. 6. EEN output

### 5.3.3. Camera Link interface

The video output is Camera Link with either 3 x 8 bit RGB video placed in a base configuration, or 3 x 10 bit RGB placed in a Camera Link medium configuration. The digital output signals follow the Camera Link standardized multiplexed signal output interface. The Camera Link output driver is NS type DS90CR285MTD.
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 trigger input can also be TTL on the 12 pin connector. (***TI=0 for CL***. TI=1 for 12 pin HR). Factory setting is ***CL***.
The serial camera control can be switches between the 12 pin connector or CL by the internal switch SW301.1. Factory setting is ***CL***.
The 26 pin MDR connector pin assignment follows the Camera Link base configuration.

For a detailed description of Camera Link specifications, please refer to the Camera Link standard specifications found on www.jai.com




| Port/Signal | 8bit | Pin No. |
|---|---|---|
| Port A0 | R D0 | Tx0 |
| Port A1 | R D1 | Tx1 |
| Port A2 | R D2 | Tx2 |
| Port A3 | R D3 | Tx3 |
| Port A4 | R D4 | Tx4 |
| Port A5 | R D5 | Tx6 |
| Port A6 | R D6 | Tx27 |
| Port A7 | R D7 | Tx5 |
| Port B0 | G D0 | Tx7 |
| Port B1 | G D1 | Tx8 |
| Port B2 | G D2 | Tx9 |
| Port B3 | G D3 | Tx12 |
| Port B4 | G D4 | Tx13 |
| Port B5 | G D5 | Tx14 |
| Port B6 | G D6 | Tx10 |
| Port B7 | G D7 | Tx11 |
| Port C0 | B D0 | Tx15 |
| Port C1 | B D1 | Tx18 |
| Port C2 | B D2 | Tx19 |
| Port C3 | B D3 | Tx20 |
| Port C4 | B D4 | Tx21 |
| Port C5 | B D5 | Tx22 |
| Port C6 | B D6 | Tx16 |
| Port C7 | B D7 | Tx17 |
| LVAL | | Tx24 |
| FVAL | | Tx25 |
| DVAL | | Tx26 |
| EEN | | Tx23 |

Camera Link bit allocation
D0 = LSB. D7 = MSB
Base configuration




Timing

Fig. 7. Principle diagram for 3 x 8 bit RGB in Camera Link base configuration

### 5.3.5. Bit allocation in Camera Link connectors

The CV-M9CL camera has outputs for the RGB signals in Camera Link. The RBG output can be allocated as 3 x 8 bit in Camera Link base configuration. Connector 1 is then used.
For 3 x 10 bit RGB output in Camera Link, 2 connectors are used in medium configuration.

The below 2 tables shows the bit allocations in the Camera Link connectors.

| CL base configuration Connector 1 | | |
|---|---|---|
| Camera signals 8 bit | Camera Link Port | CL Pin No. |
| R D0 | Port A0 | Tx0 |
| R D1 | Port A1 | Tx1 |
| R D2 | Port A2 | Tx2 |
| R D3 | Port A3 | Tx3 |
| R D4 | Port A4 | Tx4 |
| R D5 | Port A5 | Tx6 |
| R D6 | Port A6 | Tx27 |
| R D7 | Port A7 | Tx5 |
| G D0 | Port B0 | Tx7 |
| G D1 | Port B1 | Tx8 |
| G D2 | Port B2 | Tx9 |
| G D3 | Port B3 | Tx12 |
| G D4 | Port B4 | Tx13 |
| G D5 | Port B5 | Tx14 |
| G D6 | Port B6 | Tx10 |
| G D7 | Port B7 | Tx11 |
| B D0 | Port C0 | Tx15 |
| B D1 | Port C1 | Tx18 |
| B D2 | Port C2 | Tx19 |
| B D3 | Port C3 | Tx20 |
| B D4 | Port C4 | Tx21 |
| B D5 | Port C5 | Tx22 |
| B D6 | Port C6 | Tx16 |
| B D7 | Port C7 | Tx17 |
| LVAL | | Tx24 |
| FVAL | | Tx25 |
| DVAL | | Tx26 |
| EEN | | Tx23 |

| | |
|---|---|
| TXD out | Ser TFG |
| RXD in | Ser TC |
| Trig in | CC1 |
| NC | CC2 |
| NC | CC3 |
| NC | CC4 |

| CL medium configuration Connector 1 | | | Connector 2 | | |
|---|---|---|---|---|---|
| Camera signals 10 bit | Camera Link Port | CL Pin No. | Camera signals 10 bit | Camera Link Port | CL Pin No. |
| R D0 | Port A0 | Tx0 | NC | Port D0 | Tx0 |
| R D1 | Port A1 | Tx1 | NC | Port D1 | Tx1 |
| R D2 | Port A2 | Tx2 | NC | Port D2 | Tx2 |
| R D3 | Port A3 | Tx3 | NC | Port D3 | Tx3 |
| R D4 | Port A4 | Tx4 | NC | Port D4 | Tx4 |
| R D5 | Port A5 | Tx6 | NC | Port D5 | Tx6 |
| R D6 | Port A6 | Tx27 | NC | Port D6 | Tx27 |
| R D7 | Port A7 | Tx5 | NC | Port D7 | Tx5 |
| R D8 | Port B0 | Tx7 | G D0 | Port E0 | Tx7 |
| R D9 | Port B1 | Tx8 | G D1 | Port E1 | Tx8 |
| NC | Port B2 | Tx9 | G D2 | Port E2 | Tx9 |
| NC | Port B3 | Tx12 | G D3 | Port E3 | Tx12 |
| B D8 | Port B4 | Tx13 | G D4 | Port E4 | Tx13 |
| B D9 | Port B5 | Tx14 | G D5 | Port E5 | Tx14 |
| NC | Port B6 | Tx10 | G D6 | Port E6 | Tx10 |
| NC | Port B7 | Tx11 | G D7 | Port E7 | Tx11 |
| B D0 | Port C0 | Tx15 | G D8 | Port F0 | Tx15 |
| B D1 | Port C1 | Tx18 | G D9 | Port F1 | Tx18 |
| B D2 | Port C2 | Tx19 | NC | Port F2 | Tx19 |
| B D3 | Port C3 | Tx20 | NC | Port F3 | Tx20 |
| B D4 | Port C4 | Tx21 | NC | Port F4 | Tx21 |
| B D5 | Port C5 | Tx22 | NC | Port F5 | Tx22 |
| B D6 | Port C6 | Tx16 | NC | Port F6 | Tx16 |
| B D7 | Port C7 | Tx17 | NC | Port F7 | Tx17 |
| LVAL | | Tx24 | LVAL | | Tx24 |
| FVAL | | Tx25 | FVAL | | Tx25 |
| DVAL | | Tx26 | DVAL | | Tx26 |
| EEN | | Tx23 | NC | | Tx23 |

| | |
|---|---|
| TXD out | Ser TFG |
| RXD in | Ser TC |
| Trig in | CC1 |
| NC | CC2 |
| NC | CC3 |
| NC | CC4 |

Fig. 8. Connector 1 base configuration and connector 1 and 2 medium configuration

# 6. Functions and Operations

## 6.1. Basic functions

A 16-bit processor controls all functions in the CV-M9CL camera. The CCD sensor output is normalized in preamplifiers. The signals are then digitized to 12 bits. Digital gain control and look-up tables can do signal processing in 12 bits before it is truncated to a 10 or 8 bit camera link signal.

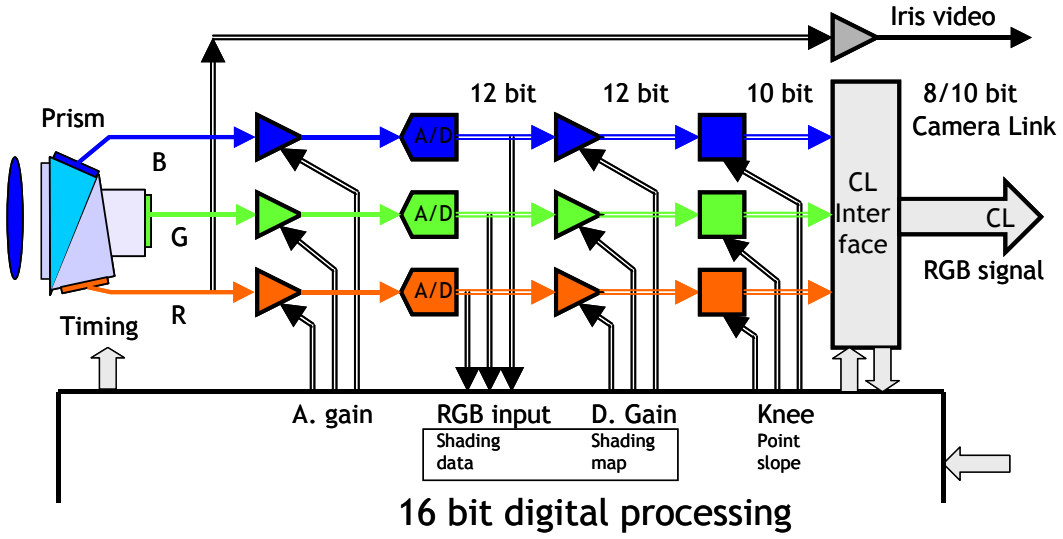



Fig. 9. Principle diagram for signal processing

### 6.1.1. Dynamic shading correction

The CV-M9CL camera has a digital shading correction circuit, which can compensate for prism chromatic shading, for lens vignetting and for CCD shading. It makes the choice of lenses wider. The camera with a given lens and a given f-number is looking on a homogeneous white scene. A horizontal profile of the shading in 128 points is made for the 3 colors. A vertical profile of the shading in 96 points is made for the 3 colors. The result is stored as gain difference from the image centre. Data from this h and v profile is used to adjust the R, B and G gain depending of the H and V position. The resulting image is then compensated for shading caused by the lens, prism and CCD. The lens used is a Fujinon 15mm F2.2. The iris is set to F5.6. With the camera control tool it is possible to customize the correction for a given set-up, and store the corrections in a file. Refer to chapter 6.5.1.

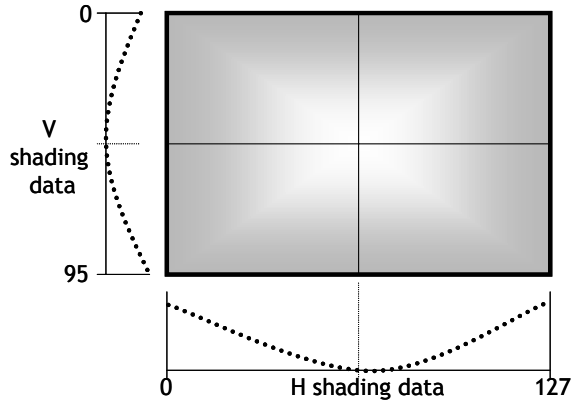



Fig. 10. Shading correction.

***Note: Lens requirements.***
To obtain the best possible image, it is recommended to use lenses designed for 1/3" 3 CCD cameras. The shading depends of the focal length and the iris setting. Avoid wide-angle lenses, and do not use an iris setting fully open.

### 6.1.2. Knee function

The internal video signal is 12 bit, and only 8 or 10 bit is output. By help of the look-up table function it is possible to compress or expand the video signal to change the dynamic range. It can be done individually for R, G and B with the knee function.
The Knee function is given by 2 sets of parameters. Knee point and slope. These 2 sets of data determine how the output would be with reference to the input data. This conversion is done by the hardware (FPGA) doing calculations using the knee data.
The normal transfer function is with a slope 1:1. From a given point and up, the slope can be changed. This point is the knee point parameter, and its range is from 0 to 1023 referring to the video output. Factory setting is 890.
The new slope can be set from 1:0 to 1:2. A slope 1:0 is a clipper function, which will limit the output signal. A slope 1:2 will function as a 2 times contrast expanding function.
The slope parameter range is from 0 to 4095.
0 is slope 1:0.
2048 is slope 1:1.
4095 is slope 1:2.
Factory setting is 800. The slope is then 800/2048 =1: 0.39.

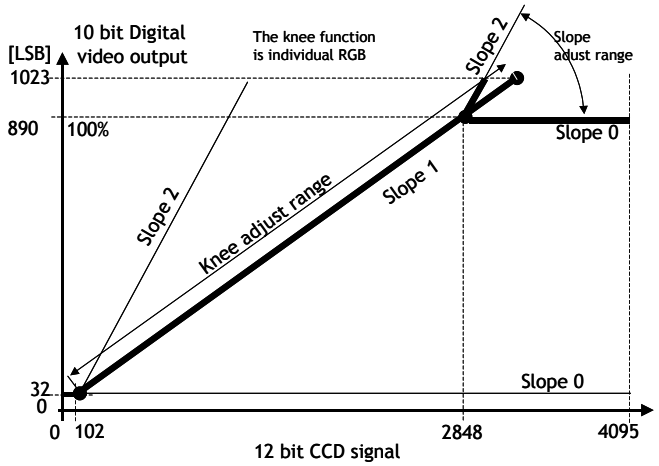
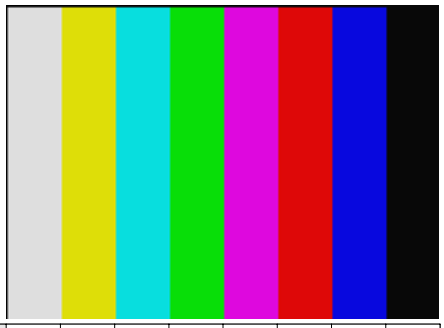



Fig. 11. Knee function.

### 6.1.3. Color bar for test

The CV-M9CL camera has a build in color bar generator. When it is activated, the output image will be as shown below. The RGB values are shown for both 8 and 10 bit output.



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Values in 8 bit | Red | 222 | 222 | 8 | 8 | 222 | 222 | 8 | 8 |
| | Green | 222 | 222 | 222 | 222 | 8 | 8 | 8 | 8 |
| | Blue | 222 | 8 | 222 | 8 | 222 | 8 | 222 | 8 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Values in 10 bit | Red | 890 | 890 | 32 | 32 | 890 | 890 | 32 | 32 |
| | Green | 890 | 890 | 890 | 888 | 32 | 32 | 32 | 32 |
| | Blue | 890 | 32 | 890 | 32 | 890 | 32 | 890 | 32 |

Fig. 12. Color bar RGB values

## 6.2. Sensor Layout and timing

### 6.2.1. CCD Sensor Layout

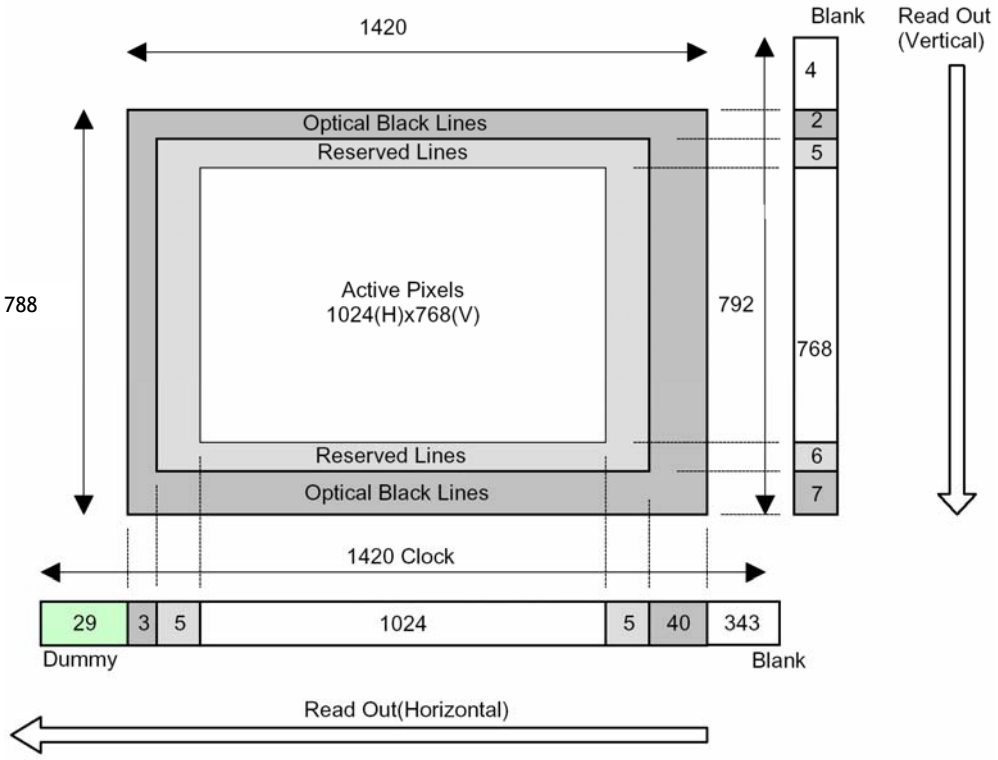



Fig. 13. CCD sensor layout

Table for scanning.
The below table shows the start line, the stop line and the number of active lines in the vertical centred scanned area on the CCD sensor. The front and back lines are the lines used for the fast dump readout used in partial scanning.

| Scanning | | Start line # | End line # | Active lines | Front lines | Back lines | Blank lines | Remarks |
|---|---|---|---|---|---|---|---|---|
| SC=0 | Full | 1 | 768 | 768 | 12 | 8 | 4 | *Refer to fig. 15.* |
| SC=1 | 1/2 | 192 | 576 | 384 | 54 | 50 | 4 | *Refer to fig. 16.* |
| SC=2 | 1/4 | 288 | 480 | 192 | 78 | 74 | 4 | *Refer to fig. 17.* |
| SC=3 | 1/8 | 336 | 432 | 96 | 90 | 86 | 4 | *Refer to fig. 18.* |

### 6.2.2. Horizontal timing

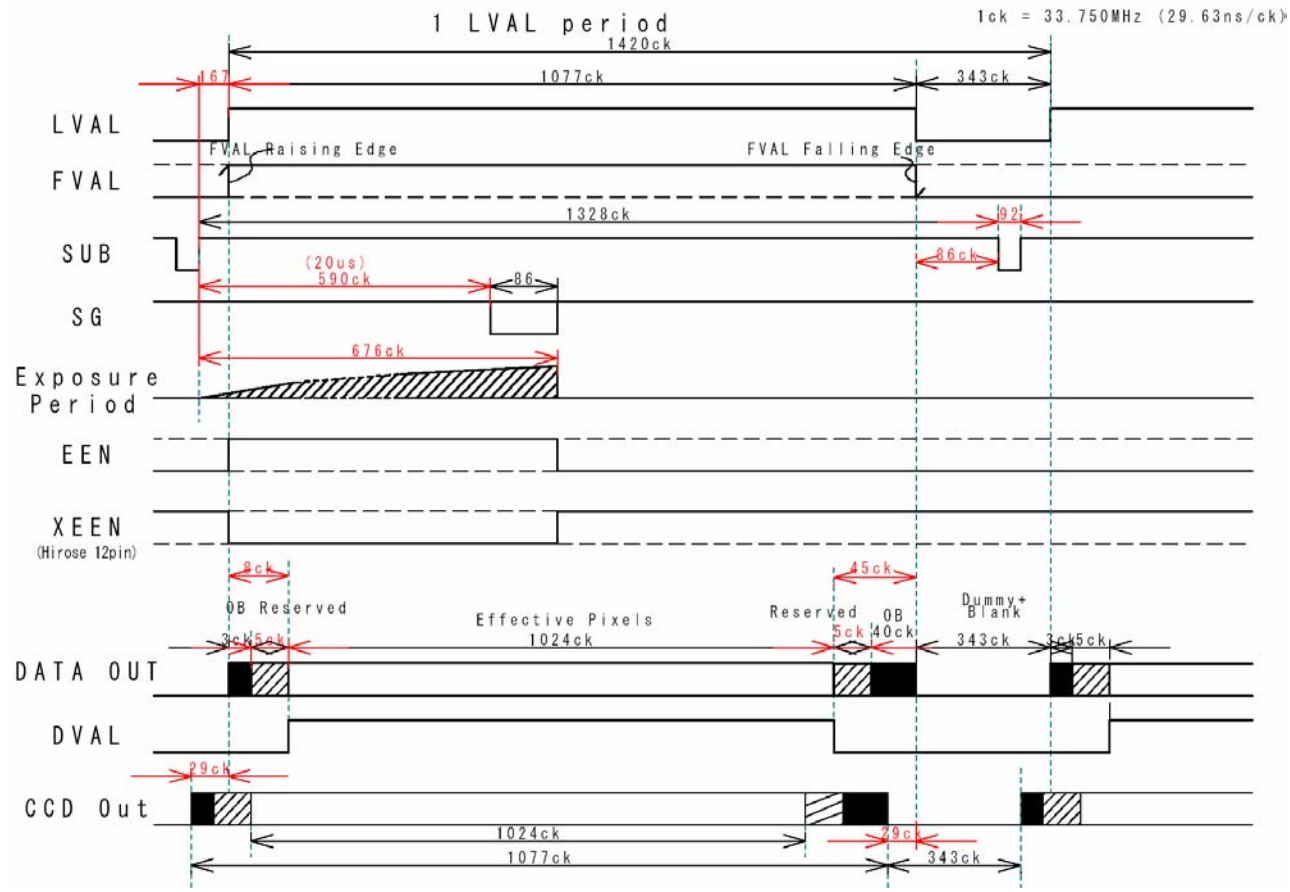



Fig. 14. Horizontal timing

### 6.2.3. Vertical timing

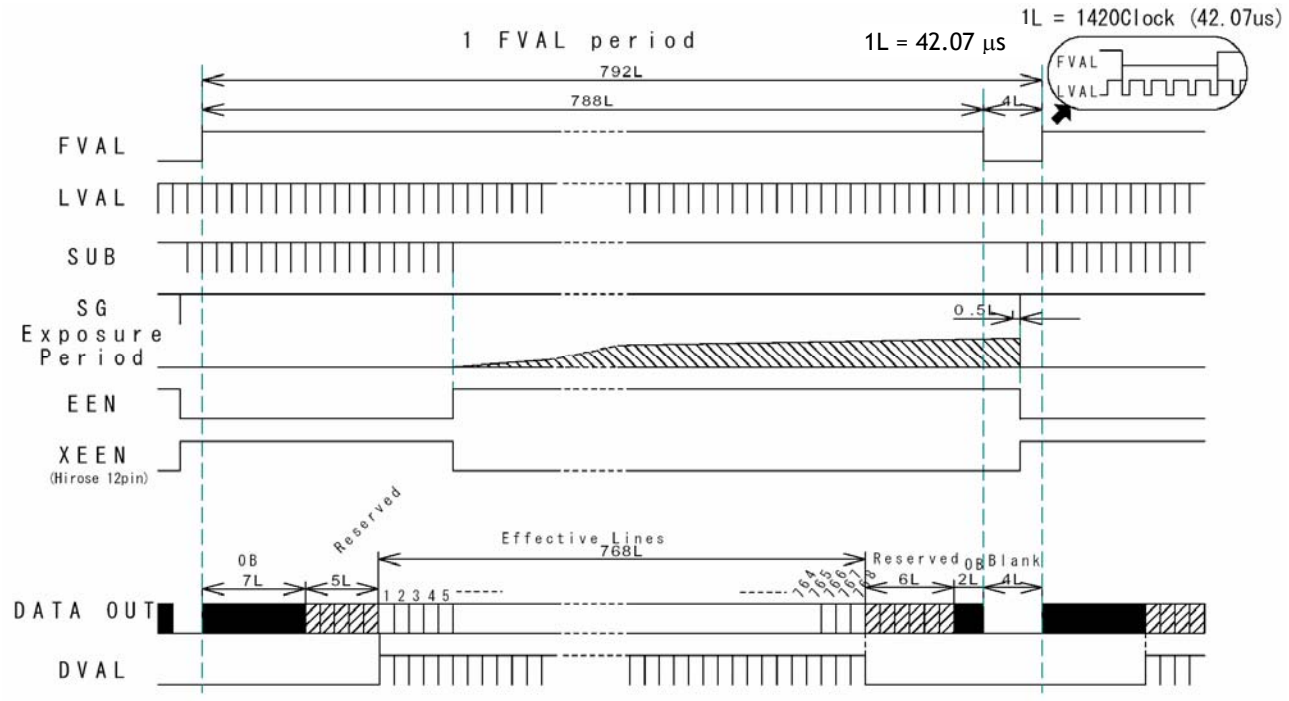



Fig. 15. Vertical timing for full scan

### 6.2.4. Partial Scanning

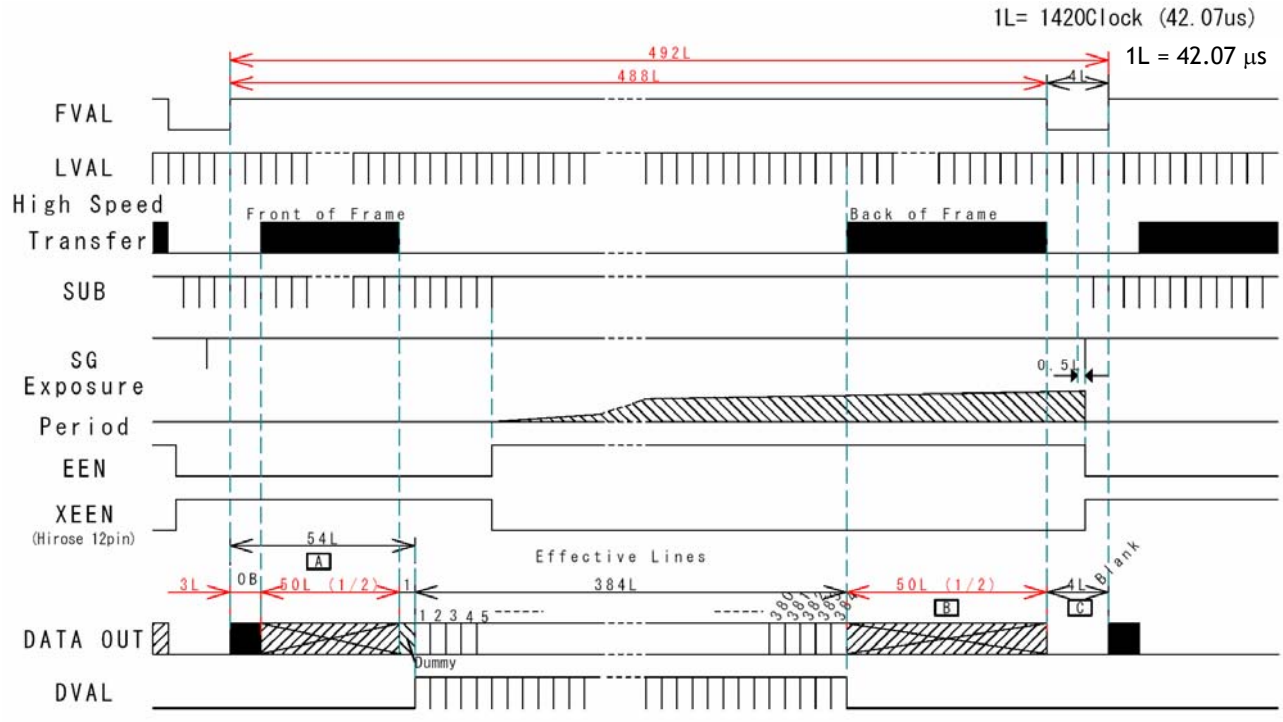



Fig. 16 Vertical timing for 1/2 partial scan

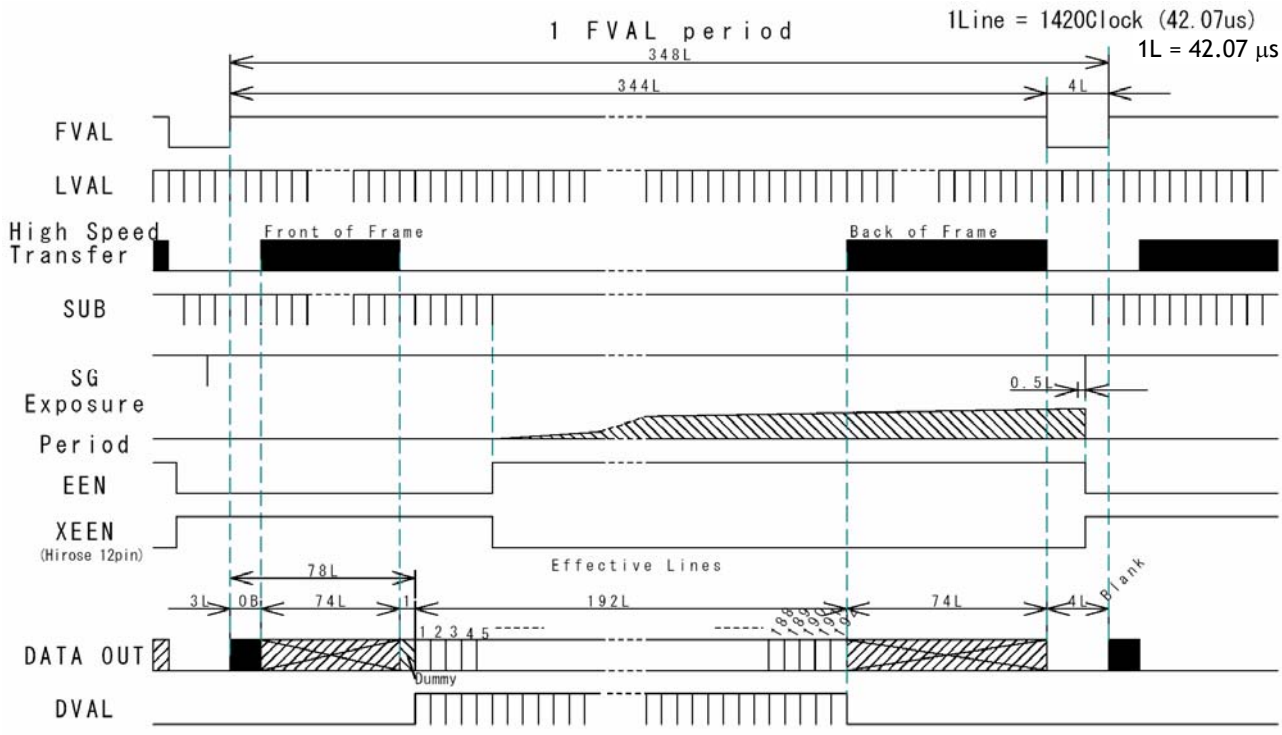



Fig. 17 Vertical timing for 1/4 partial scan

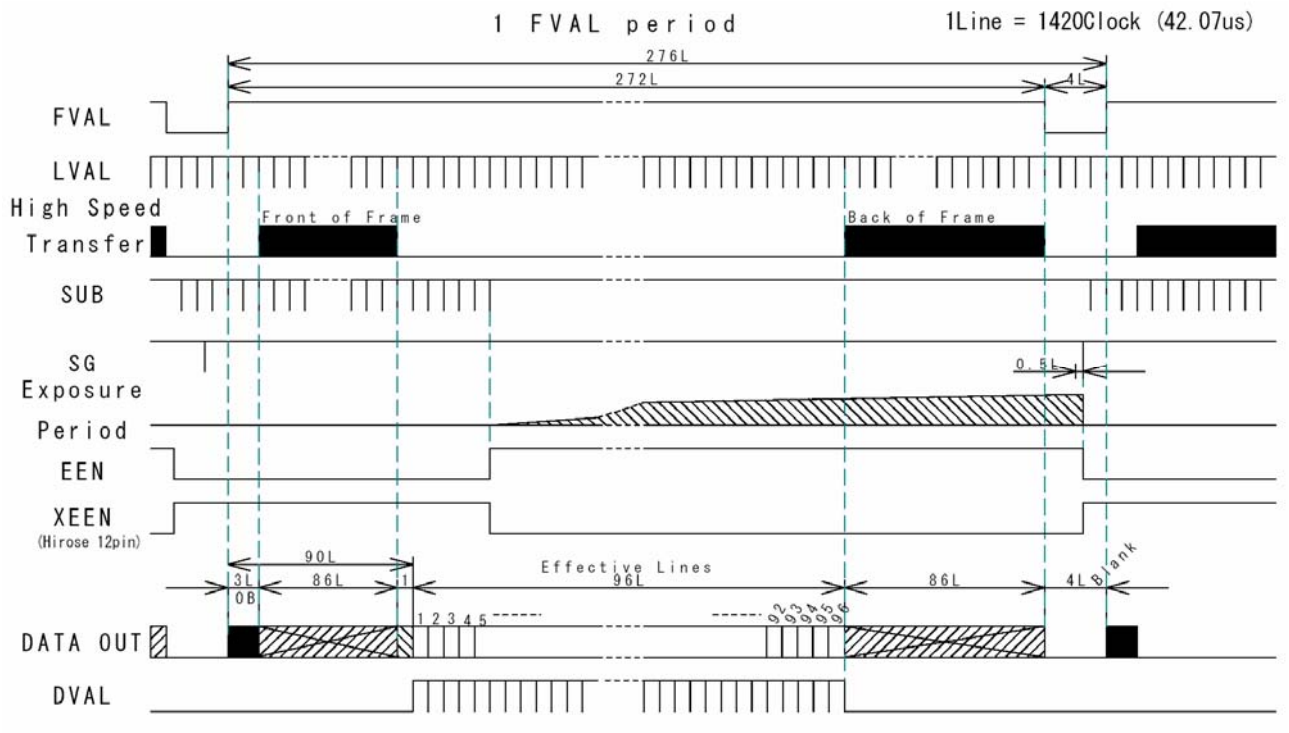



Fig. 18 Vertical timing for 1/8 partial scan

### 6.2.5. Vertical binning

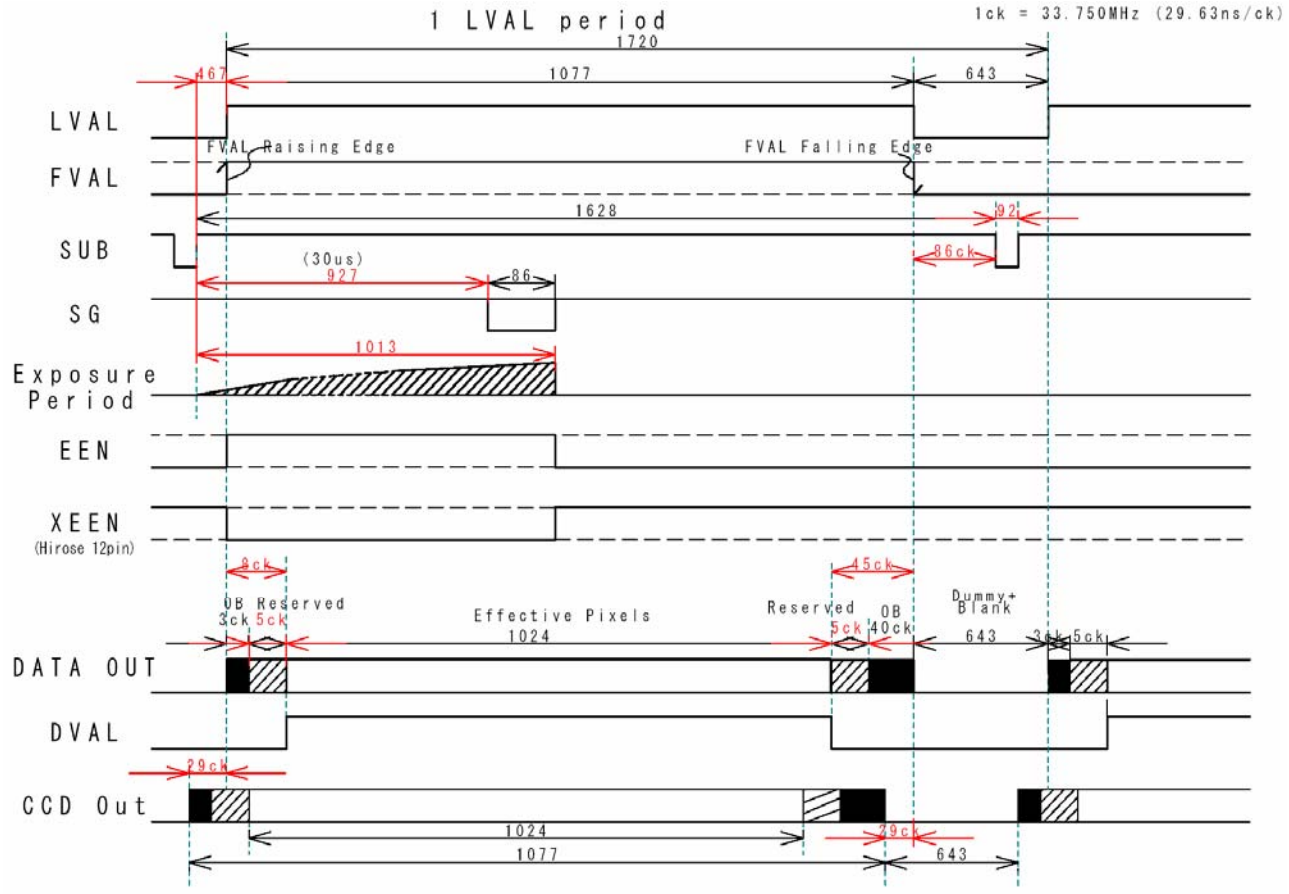



Fig. 19. Horizontal timing for V binning.

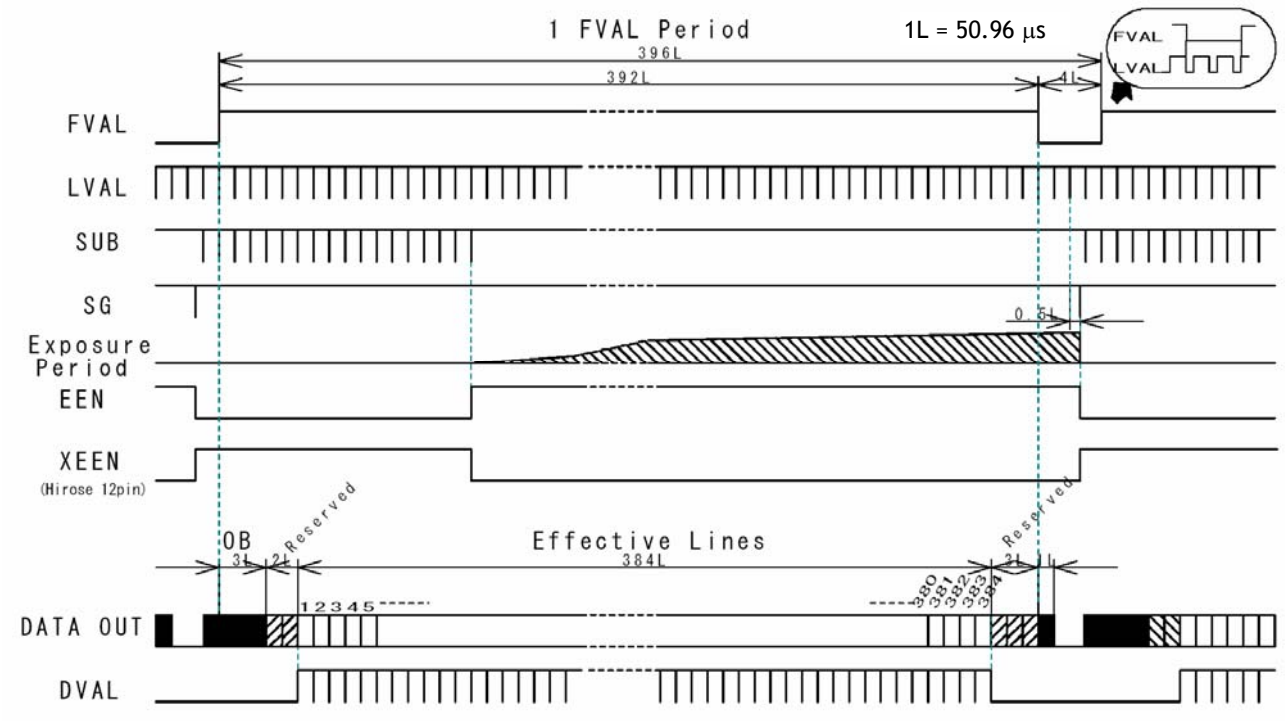



Fig. 20. Vertical timing for V binning.

## 6.3. Input/Output of Timing Signals

*For settings, please refer to chapter "7. Configuring the Camera"*

### 6.3.1. Input of external trigger

Input of external trigger signal can be via Camera Link (***TI=0***). Factory setting. Or as TTL on the 12 pin connector pin 10. (TI=1). Here it should be 4.0 Vp-p ±2.0 V from a 75 Ω source. The trigger input signal can be 75 Ω terminated. Factory setting is TTL. For 75 Ω termination SW301.2 should be ON.

### 6.3.2. Output of EEN (XEEN)

The Exposure Enable signal EEN indicate that the accumulation is ongoing. It can be used for controlling a strobe flash. The XEEN signal is found on the 12 pin connector pin 9. It is 4.0 Vp-p from a 75 Ω source. The EEN signal is also found in Camera Link.

## 6.4. Operation Modes

This camera can operate in 5 primary modes.

| | | | | |
|---|---|---|---|---|
| *1.* | *TR=0* | *Con* | ***Normal continuous Mode*** | Pre-selected exposure. |
| *2.* | *TR=1* | *EPS* | ***Edge Pre-select Mode*** | Pre-selected exposure. |
| *3.* | *TR=2* | *PWC* | ***Pulse Width Control Mode*** | Pulse width controlled exposure. |
| *4.* | *TR=3* | *SG* | ***Sensor Gate Control*** | Strobe illum. exp. with delayed read out |
| *5.* | *TR=4* | *RCT* | ***Reset Continuous Trigger*** | Pre-selected exposure. |

The triggered accumulation in EPS, PWC and RTC mode can be LVAL synchronous or LVAL a-synchronous.

In **LVAL synchronous accumulation**, a new exposure can be started while the previous frame is read out. The new exposure should not be finished before the frame is read out. FVAL shall be low for >2 LVAL. The maximum frame rate in trigger modes can then be close to the frame rate in continuous mode.
The minimum trigger interval should be longer than (1 FVAL+2 LVAL).
To avoid <1L time jitter in LVAL synchronous mode, it is recommended to synchronize the trigger to LVAL.

In **LVAL a-synchronous accumulation**, a new trigger must not be applied before the previous frame is read out. (FVAL is low).
The minimum trigger interval should be longer than (exposure time + 1 FVAL+3 LVAL).

*Refer to chapter 6.4.1. and 6.4.2. for accumulation details.*

*Refer to chapter "7. Configuring the Camera" for details in mode settings.*

***Mode and function matrix.***
The following table shows which functions will work in the different modes.

| Func. / Mode | TR= | Shutter SM= 0 | Shutter SM= 1 | Part. sc SC= 0 to 3 | Binning BI=1 | Smearl SL=1 | Accum LS= 0 | Accum LS= 1 | Iris video out | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cont.** | **0** | √ | √ | √ | √ | - | - | - | √ | |
| **EPS** | **1** | √ | √ | √ | √ | √ | √ | √ | - | |
| **PWC** | **2** | - | - | √ | √ | √ | √ | √ | - | |
| **SG** | **3** | - | - | - | - | - | - | - | - | |
| **RCT** | **4** | √ | √ | √ | √ | √ | √ | √ | √ | |

√ = ok, - = no function
Partial scanning has priority over Binning.

### 6.4.1. LVAL synchronous accumulation

With LS=0, the accumulation will start synchronously with LVAL. The trigger pulse should be longer than 2 LVAL intervals, and the accumulation will then start at the first LVAL after the trigger leading edge. The exposure start delay will be up to 1 line. (42.07 μsec.).
In EPS mode the exposure stops 0.5 L after the selected shutter time, (in number of LVAL).
In PWC mode the exposure stops 0.5 L after the first LVAL after the trigger trailing edge. It results in up to 1 LVAL jitter.
*In trigger modes with LVAL synchronous accumulation, a new exposure can be started while the previous frame is read out. The new exposure should not finish before the frame is read out. FVAL shall be low for >2 LVAL. The maximum frame rate in trigger modes can then be close to the frame rate in continuous mode.*

***Minimum trigger interval ≥ (1 FVAL + 2 LVAL).***

Important notes on using this mode.
In LVAL synchronous PWC mode exposure jitter up to 1 LVAL can be the result, if the trigger trailing edge is not synchronized to LVAL.

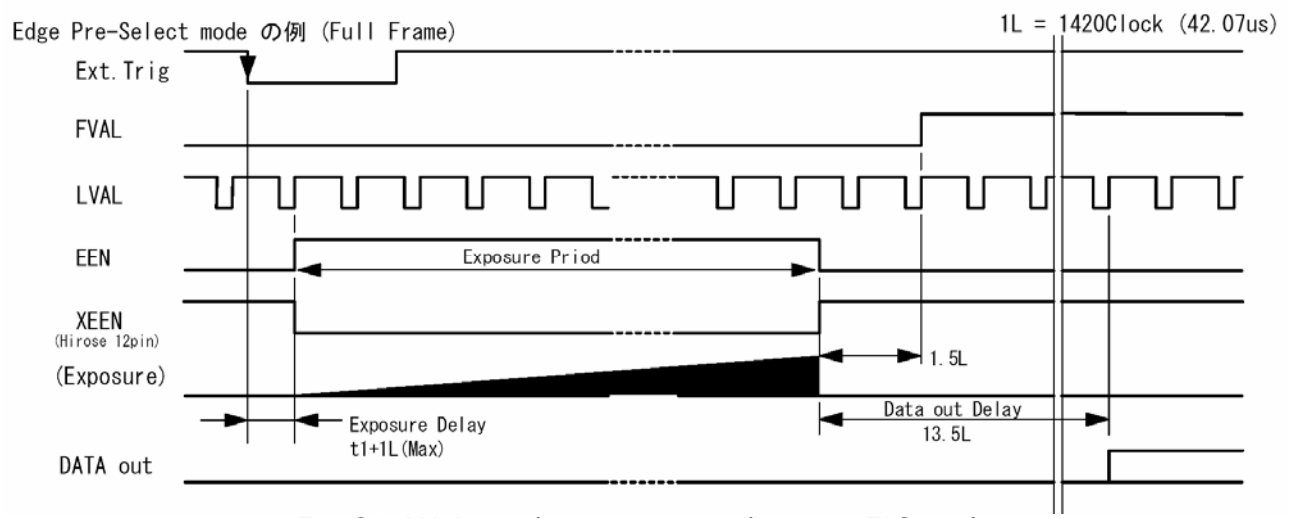



Fig. 21. LVAL synchronous accumulation in EPS mode

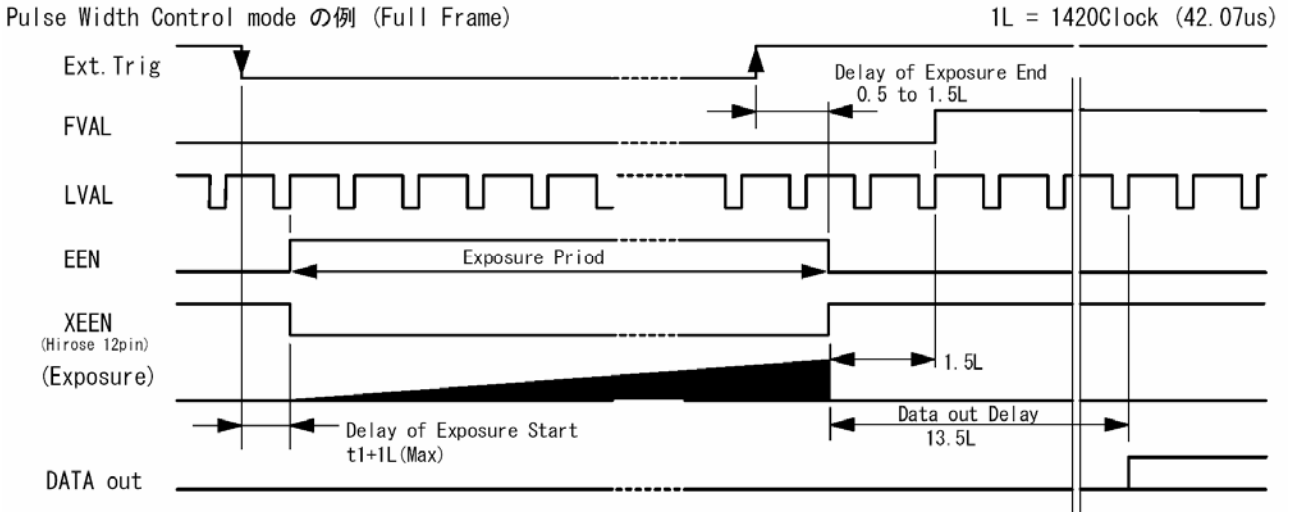



Fig. 22. LVAL synchronous accumulation in PWC mode

### 6.4.2. LVAL a-synchronous accumulation

With LS=1, the accumulation will start immediately after the trigger leading edge.
The exposure start delay is 9.7 μsec.
In EPS mode the exposure stops 0.5 L after the selected shutter time, (in number of LVAL).
In PWC mode the exposure stops 0.5 L after the trigger trailing edge.
*A new trigger must not be applied before the previous frame is read out. (FVAL is low).*

***Minimum trigger interval ≥ ( exposure time + 1 FVAL + 3 LVAL).***

Important notes on using this mode.
In LVAL a-synchronous PWC mode there is no exposure jitter.

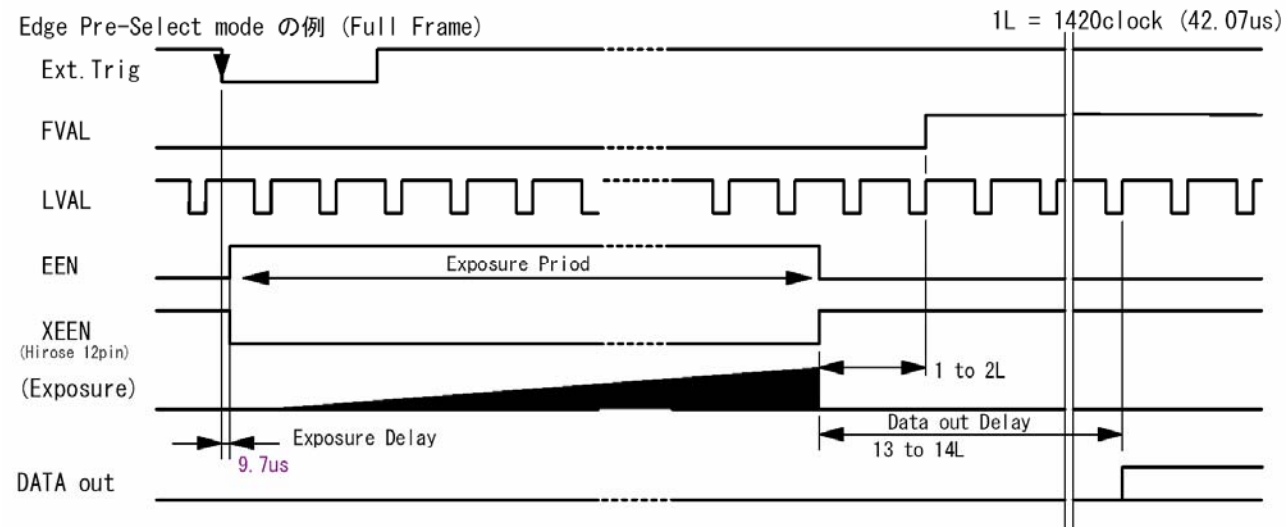



Fig. 23. LVAL a-synchronous accumulation in EPS mode

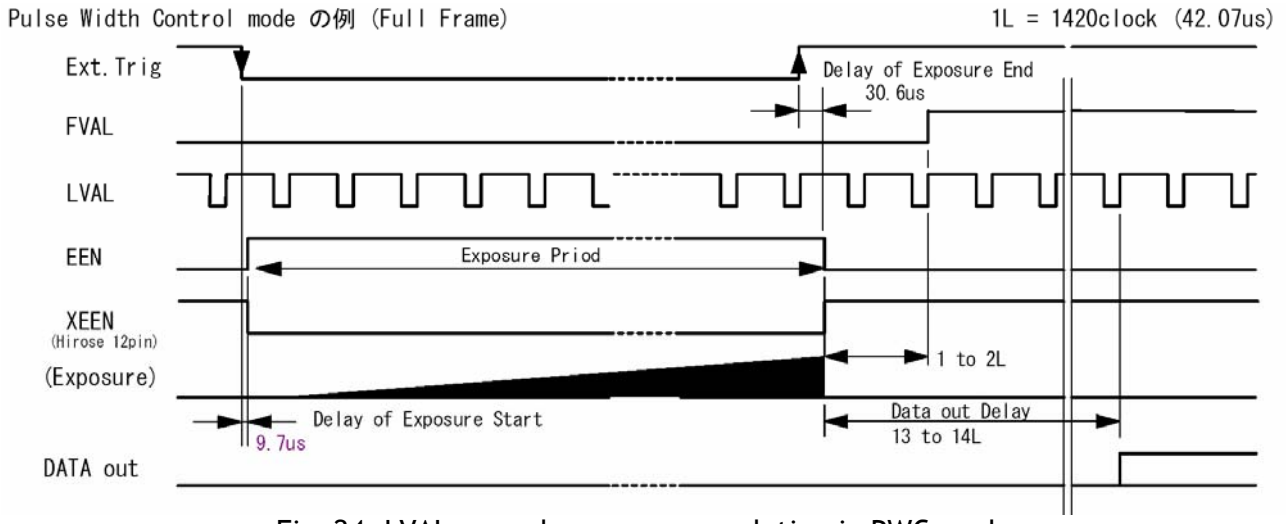



Fig. 24. LVAL a-synchronous accumulation in PWC mode

### 6.4.3. Continuous operation

For applications not requiring asynchronous external trigger, but should run in continuous operation, this mode is used.
In this mode it possible to use a lens with video controlled iris.
*For timing details, refer to fig. 13. through fig. 20.*

To use this mode:

| | | |
|---|---|---|
| Set function: | Trigger mode to "Continuous" | TR=0 |
| | Scanning | SC=0 through 3 |
| | Vertical binning | BI=0, BI=1 |
| | Shutter mode normal, programmable | SM=0 through 2 |
| | Shutter speed | SH=0 through 11 |
| | Programmable exp. | PE=0 through 791 |
| | Other functions and settings | |

Input:

Important notes on using this mode

*For timing details, refer to fig. 13. through fig. 20.*

### 6.4.4. Edge Pre-select Trigger Mode

An external trigger pulse initiates the capture, and the exposure time (accumulation time) is the fixed shutter speed set by SH or PE. The accumulation can be LVAL synchronous or LVAL a-synchronous.
The resulting video signal will start to be read out after the selected shutter time.

*For timing details, refer to fig. 13. through fig. 20. and fig. 25.*

To use this mode:

| | | |
|---|---|---|
| Set function: | Trigger mode to "Edge pre-select" | TR=1 |
| | Scanning | SC=0 through 3 |
| | Vertical binning | BI=0, BI=1 |
| | Shutter mode to normal or programmable | SM=0 through 2 |
| | Shutter speed | SH=0 through 11 |
| | Programmable exp. | PE=0 through 791 |
| | Accumulation LVAL synch. or a-synch. | LS=0, LS=1 |
| | Other functions and settings | |
| Input: | Ext. trigger. Camera Link or 12 HiRose | TI=0, TI=1 |

Important notes on using this mode

Trigger pulse >2 LVAL to <1 FVAL
To avoid ≤ 1 LVAL jitter in synch. accum, synchronize the trigger to LVAL.
Minimum trigger interval in synch. accum. ≥ (1 FVAL + 2 LVAL).
Minimum trigger interval in a-synch. accum. ≥ ( exposure time + 1 FVAL + 3 LVAL).

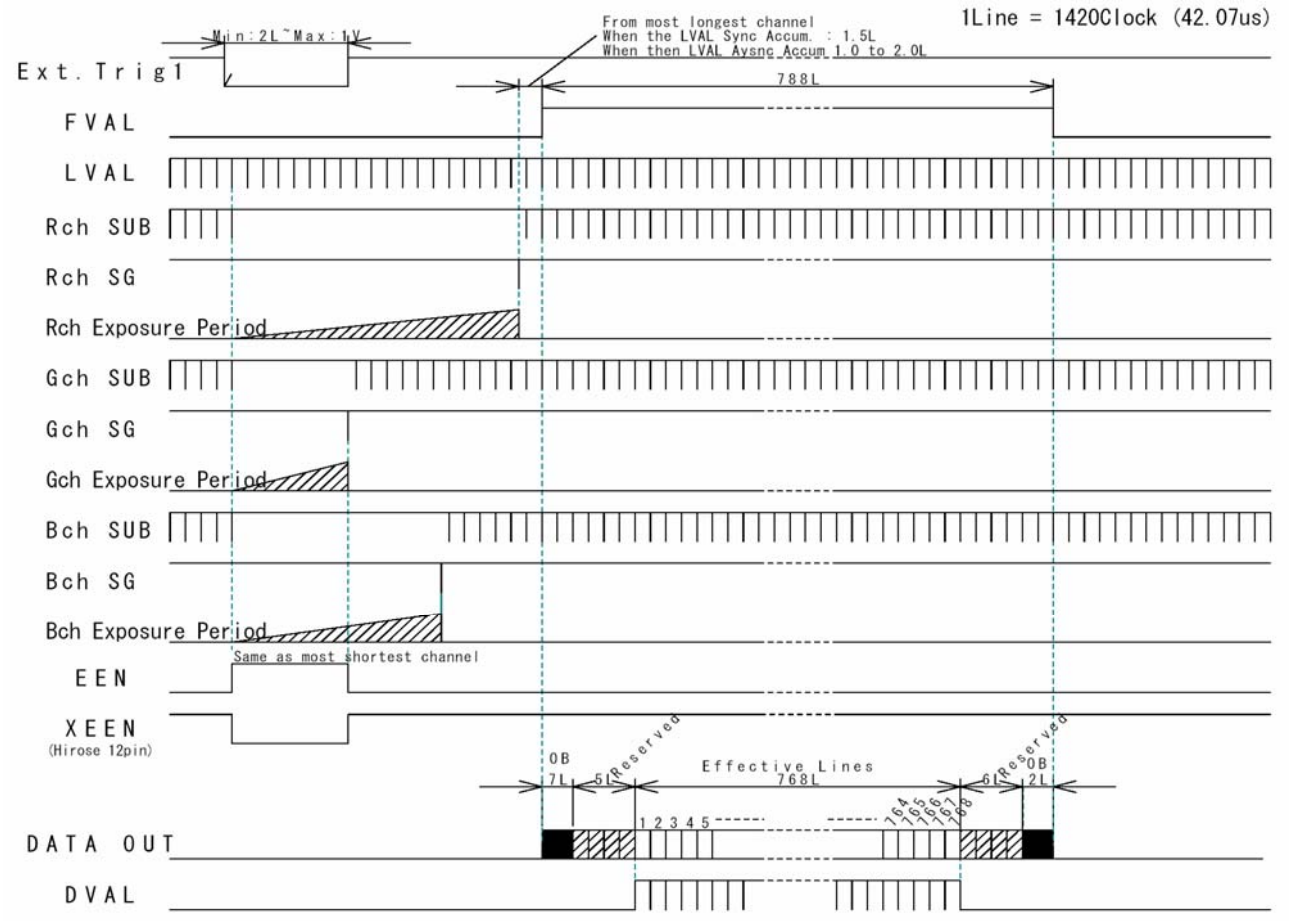



Fig. 25. Edge pre-select. LVAL synchronized.

### 6.4.5. Pulse Width Control Trigger Mode

In this mode the accumulation time is equal the trigger pulse width. Here it is possible to have long time exposure. The maximum recommended time is <2 seconds.
The accumulation can be LVAL synchronous or LVAL a-synchronous.
The resulting video signal will start to be read out after the trigger rising edge.
*For timing details, refer to fig. 13. through fig. 20. and fig. 26.*

To use this mode:

| | | |
|---|---|---|
| Set function: | Trigger mode to "Pulse width control". | TR=2 |
| | Scanning | SC=0 through 3 |
| | Vertical binning | BI=0, BI=1 |
| | Accumulation LVAL synch. or a-synch. | LS=0, LS=1 |
| | Other functions and settings | |
| Input: | Ext. trigger. Camera Link or 12 HiRose | TI=0, TI=1 |

Important notes on using this mode

Trigger pulse width >2 LVAL to <1 seconds.
To avoid ≤ 1 LVAL jitter in synch. accum, synchronize the trigger to LVAL.
Minimum trigger interval in synch. accum. ≥ (1 FVAL + 2 LVAL).
Minimum trigger interval in a-synch. accum. ≥ ( exposure time + 1 FVAL + 3 LVAL).

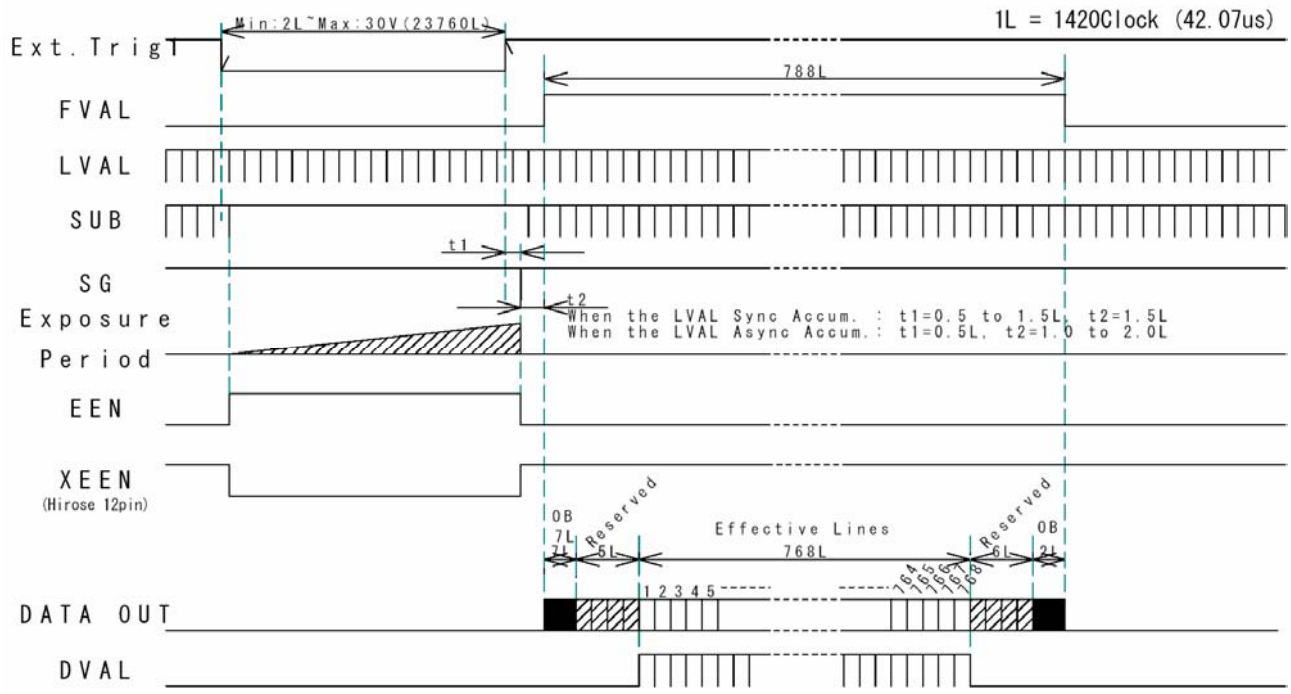



Fig. 26. Pulse width control. LVAL synchronized.

### 6.4.6. Reset Continuous Trigger mode

The RCT mode is in principle the same as normal continuous mode. The difference is that an external trigger pulse will immediately stop the video read out and reset and restart the vertical timing. After a fast dump read out (198 L = 8.33ms), a new triggered exposure is started and read out as normal. The fast dump read out is performed with a speed 4 times faster as normal. If no further trigger pulses are applied, the camera will continue in normal mode. This fast dump read out has the same effect as "smearless read out". Smear over highlighted areas are reduced for the triggered frame.
The reset continuous trigger mode makes it possible to use a lens with video controlled iris together with a triggered exposure.
*For timing details, refer to fig. 13. through fig. 20. and fig. 27.*

To use this mode:

| | | |
|---|---|---|
| Set function: | Trigger mode to "Reset continuous trigger". | TR=4 |
| | Scanning | SC=0 through 3 |
| | Vertical binning | BI=0, BI=1 |
| | Shutter mode normal, programmable or auto | SM=0 through 2 |
| | Shutter speed | SH=0 through 11 |
| | Programmable exp. | PE=0 through 791 |
| | Accumulation LVAL synch. or a-synch. | LS=0, LS=1 |
| | Other functions and settings | |
| Input: | Ext. trigger. Camera Link or 12 HiRose | TI=0, TI=1 |

Important notes on using this mode

Trigger pulse >2 LVAL to <1 FVAL
To avoid ≤ 1 LVAL jitter in synch. accum, synchronize the trigger to LVAL.
Minimum trigger interval ≥ (exposure time + 1 FVAL + 2 LVAL + 198 LVAL).
A new trigger must not be applied before the previous triggered frame is read out.

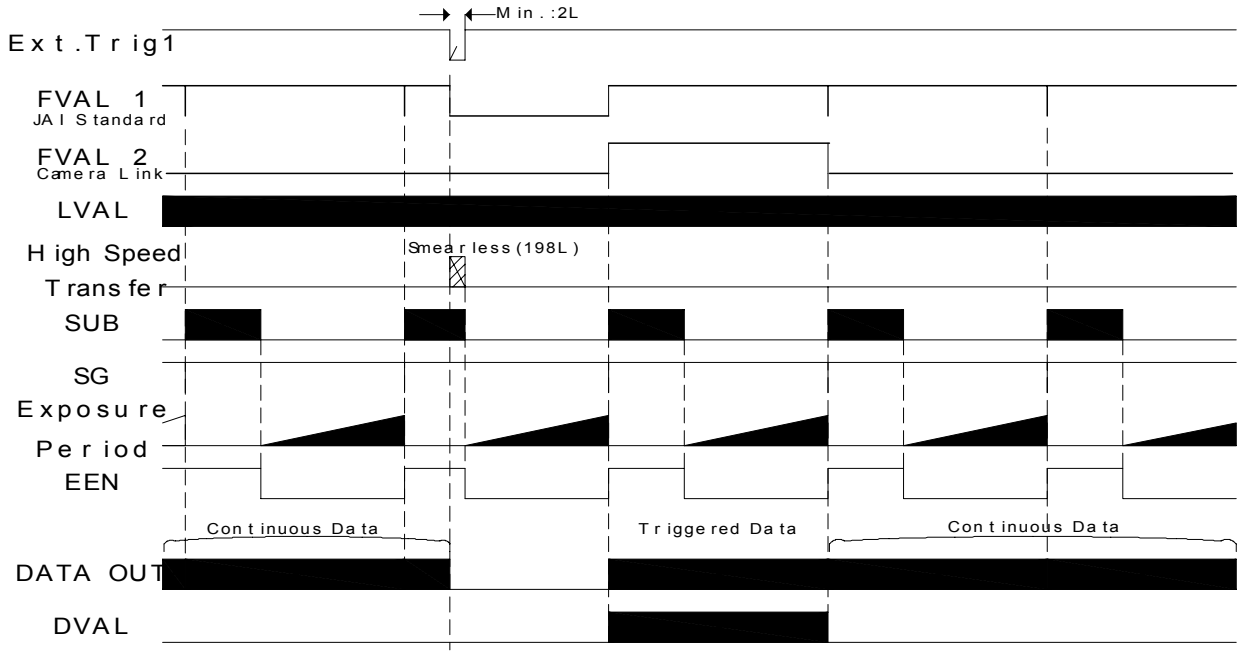



Fig. 27. Reset Continuous Trigger

### 6.4.7. Sensor Gate Control

This function is for applications with strobe flash illuminations or long time accumulations up to several frames. The external Sensor Gate control signal will disable the internal SG pulse so the accumulation will continue during the next frame. As long as the sensor gate control signal is low, the accumulation will continue. The resulting video is read out after the first FVAL (or SG), following the trailing edge of the Sensor Gate Control signal. Fig. 28.
To disable the internal SG pulse, the sensor gate control signal should be low 2 μs before.
Fig. 29. shows the sensor gate signal setup time and hold time. It is inside the first line after FVAL goes low.
*For timing details, refer to fig. 13. through fig. 20. and fig. 28. - 29.*

To use this mode:

| | | |
|---|---|---|
| Set function: | Trigger mode to "Sensor gate control". | TR=3 |
| | Scanning | SC=0 |
| | Vertical binning | BI=0 |
| | Other functions and settings | |
| Input: | Ext. SG control to trigger input, CL or 12 pin HR | |

Important notes on using this mode

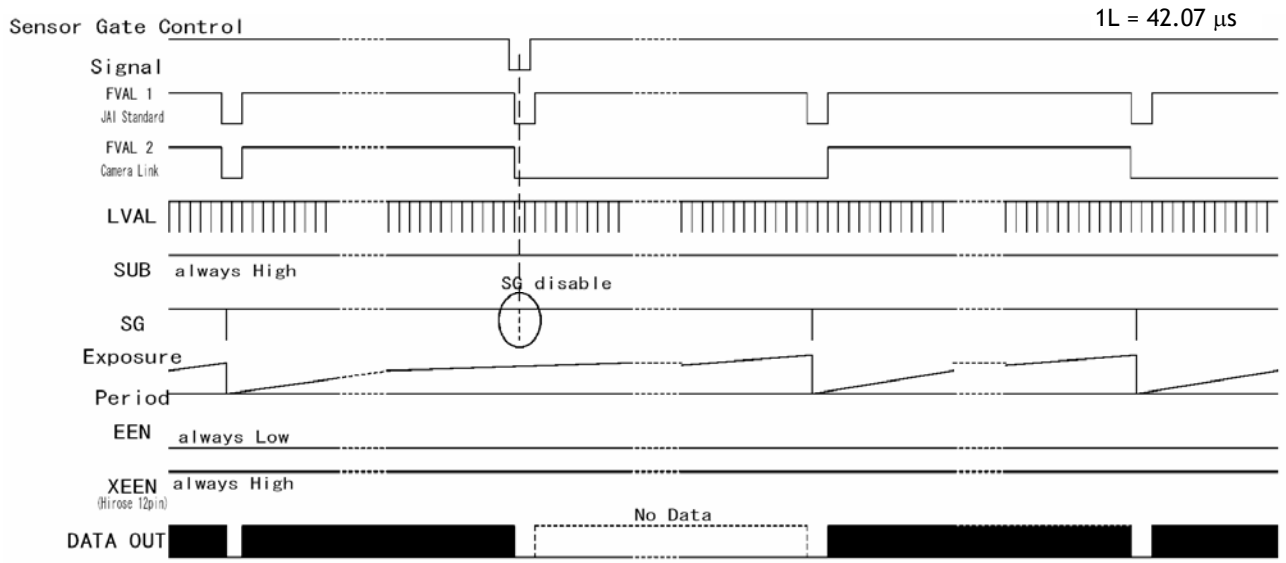
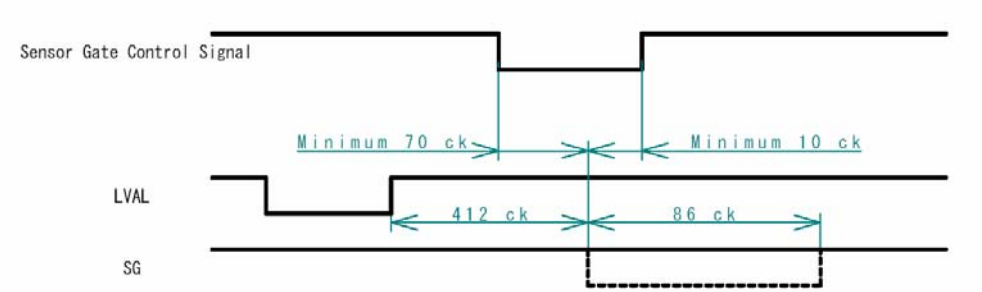



Fig. 28. Sensor Gate Control




Minimum setup and hold time for external sensor gate control signal is shown in relation to the first LVAL after FVAL falling edge.

Fig. 29. Sensor Gate control signal minimum specifications

## 6.5. Other Functions.

***Scanning**. SC=0 through 3.*
The CCD scanning format 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 is read out and dumped with a high speed. With partial scan the shutter speed is limited to be shorter than the frame read out time. There is no limitation in PWC mode.

***Bit allocation**. BA=0, BA=1.*
The video output in Camera Link can be selected to be 10 or 8 bits (BA=0, BA=1). For 8 bits only the 8 most significant bits are output.
The relations between CCD signal output, normal analog video signal and the digital video signal are shown.

| CCD out | Analog Signal | Digital Out(10bit) | Out(8bit) |
|---|---|---|---|
| Black | Setup 3.6% 25mV | 32LSB | 8LSB |
| 200mV | 700mV | 890LSB | 222LSB |
| >230mV | 800mV | 1023LSB | 255LSB |

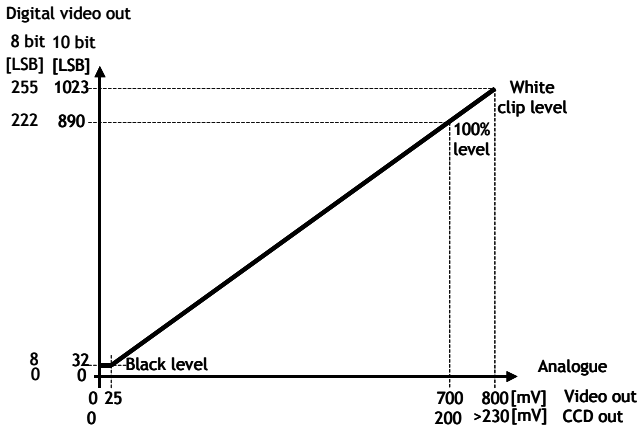



Fig. 30. Bit allocation.

***Binning**. BI=0 through BI=1.*
Binning mode 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 spatial resolution can be read out with a higher rate, and higher sensitivity. The CV-M9CL has vertical binning 2:1. Vertical binning is done by adding the pixel charge from adjacent lines together in the horizontal ccd register. It is done by multiple shift pulses to the vertical ccd register.
Lowest shutter speed is reduced to be shorter than the frame read out time. There are no limitations in PWC mode.

***Smearless readout**. SL=1.*
This function will reduce the unwanted smear signal from a highlighted scene when a short exposure time is used. It works in all trigger modes, 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 198 LVAL (8.33ms) before the exposure starts. The exposure stops and the resulting video signal is read out. This mode will operate with full and partial scanning and with all binning modes.

***Color bar**. CBAR=0, CBAR=1.*
The command CBAR=1 insert a standard color test bar on the output image, so it can be used for calibration. For color bar specifications refer to chapter 6.1.3.

***Shutter mode**. SM=0, SM=1 and SM=2. SH=0 through SH=11 and PE=2 through PE=791.*
With SM=0 this function selects the shutter from the 12 fixed steps (SH). With SM=1 from programmable in 789 steps (PE). SM=2 is for individual programmable exposure of red, green and blue. PER, PEG and PEB =2 through =791. It allows a wide range of manual color balance adjusting.

***RCT FVAL type**. RF=0, RF=1.*
This command selects the FVAL type in RCT mode. Refer to chapter 6.4.6. Reset Continuous Trigger mode.

***Trigger input select**. TI=0, TI=1.*
This function selects the trigger input to be through Camera Link (TI=0), or as TTL through the 12 pin Hirose connector (TI=1).

***Trigger polarity**. TP=0, TP=1.*
The active trigger polarity is normal low (TP=0). It can be invert it to active high (TP=1).
*Note: With TP=1 and TI=1, the first trigger pulse after power up will be ignored.*

***White balance**. WB=0 through, WB=4.*
By adjusting the R, G and B gain depending of the scene illumination color temperature it is possible to have correct color balance in the video output. A white scene will be shown as a white image. This white balance can be done in different ways.
WB=0 is for manual/one push white balance. In manual, the white balance can be changed by the gain settings. The one push white balance function is also active here. WB=1 is continuous white balance. WB=2, WB=3 and WB=4 are fixed values 3200K, 4600K and 5600K. Factory adjusted to 3200K.

***One push white balance**. AW=0*
If the command WB=0 is received, an automatic white balance is performed once. The result of this function can be requested by the command AWRS?

**S*et Auto White Balance area**. WA=*
This function makes it possible to set the one push white balance sensing area to the area of interest. WA=0 is the whole image, WA=1 through 9 are one of the 9 areas shown.

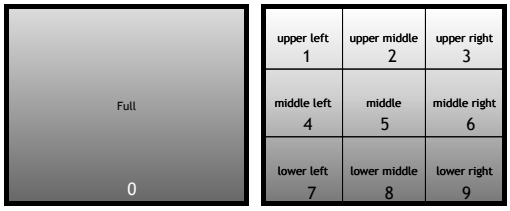



Fig. 31. Auto white balance areas.

***Request result of one push white balance**. AWRS?*
If the request AWRS? is received, the camera will answer with the result of the one push white balance operation. "0" = complete, "1" scene is too bright, "2" scene too dark, "3" is timeout error, "4" is busy, "5" limit and "6" balance can't be done because camera is in trigger mode.

***Master gain level**. GA=-132 through, GA=+429*
Sets the gain level for RGB. The range is –4dB to +13dB. GA=0 is 0dB.

***Gain level red**. GAR=-231 through GAR=+231.*
The gain range for red is –7dB to +7 dB. GAR=0 is 0dB.

***Gain level blue**. GAB=-231 through GAB=+231.*
The gain range for blue is –7dB to +7 dB. GAB=0 is 0 dB.

***Black level green**. BLG=0 through BLG=1023.*
Set up level for green. Factory setting is 460.

***Black level red**. BLR=0 through BLR=1023*
Set up level for red. Factory setting is 460.

***Black level blue**. BLB=0 through BLB=1023.*
Set up level for blue. Factory setting is 460.

***Knee function**. KN=0, KN=1.*
If KN=1 is received the knee function is enabled.
With the knee functions is possible to change the relation between CCD signal and the resulting output video signal. With the function disabled, the transfer slope is 1:1.
The level where the slope should be changed is set with the knee point settings. Its range is from 0 to 1023 related to the video output. Factory setting is 890. (100%).
From the knee point and up, the slope can be changed from the normal 1:1. The slope parameter range is from 0 to 4095, where 0 is slope 1:0, 2048 is slope 1:1, and 4095 is slope 1:2. The slope range is from 0 to 2, where 0 is completely limitation (or clipping) and 2 is contrast expanding. Factory setting is 800. The slope is then 800/2048 or 0.39
*For details refer to 6.1.2. Knee function.*

***Knee point red**. KPR=0 through KPR=1023*

***Knee point green**. KPG=0 through KPG=1023*

***Knee point blue**. KPB=0 through KPB=1023*

***Knee slope red**. KSR=0 through KSR=4095*

***Knee slope green**. KSG=0 through KSG=4095*

***Knee slope blue**. KSB=0 through KSB=4095*

***Shading Mode**. SDM=0, SDM=1.*
If the command SDM=1 is received, the shading corrector is enabled. This corrector will compensate for the color shading caused by the prism, for the circular shading caused by the lens vignetting and for CCD sensor shading.
The parameters for shading corrections are factory loaded with a given lens and f-number.
*For details refer to 6.1.1. Dynamic shading correction.*

*For customoized shading correction, please refer to chapter 6.5.1. Customized shading correction.*

***LED for power and trigger**.*
On the camera rear a Light Emitter Diode is found. The light will be green when power is connected. For trigger pulse input an amber flash will be seen.

***Iris video output**.*
On pin 4 on the 12 pin Hirose connector an analog video signal is found. It can be used for iris regulation if the camera is in continuous or RCT mode.
The curve shows the relation between the CCD signal output and the iris video output.
100% video is 700 mV. The iris video output is without sync.

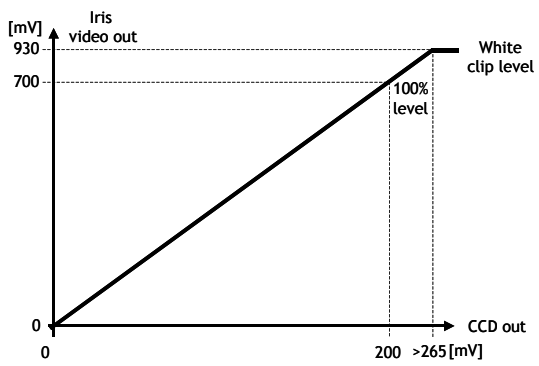



Fig. 32. Iris video output.

### 6.5.1. Customized shading correction.

From factory, the CV-M9CL camera is delivered with a shading correction adjusted to work with homogeny lightening coming from a DC regulated halogen lamp at 3200K and a certain Fujinon lens. This shading data stored in the factory area is also used for the 3 user areas. For other fixed illumination and for another fixed lens in a specific setup, it makes sense to make a temporary customized shading calibration.
*When such calibration is done, it will be used in the camera until next power up. Here the old factory shading data will be called and used.*
With the *Camera Control Tool* it is possible to store the customized shading corrections in a file. This file can then be loaded into the camera after next power up.

To make a customized shading calibration it is most important to avoid flickering of the lightening like AC powered light and also reflections should be avoided – such effects will interfere with the calibration. Apart from that the light temperature and the light density over the area of interest should be exactly as for the real setup.

The camera setting has to be as follows:

- Master gain 0dB
- Individual gain 0dB
- Shutter off
- Trigger modes off - use Normal mode
- Binning and Partial scan off
- Use 10 bit output mode
- Shading corrector off

Continue with the following:

- Set up the illumination, as it should be in the real application.
- Place a perfectly flat white object (piece of paper) at the actual scene. No reflections must be visible.
- Adjust the lens iris and focus to the level, which should be used in the real application.
- Make sure that the signal level at scene centre equals around 800LSB.
- When the above is okay then perform an Auto White Balance [command: ***WB=1***].
- Be sure that no part of the image is saturated.
- Now the camera is ready to perform an Auto Shading Correction: [Command: ***ATSH=0***].
- If the shading correction is successful, the camera will respond COMPLETE.
- Turn the shading on and off some times to verify the effect of the shading correction. [Command: ***SDM=1*** and ***SDM=0***].
- *The new customized shading corrections data will be used for all user areas until factory area is called, or until next power up, where the factory shading corrections are called.*
- *With the camera control tool (version 1.2 or later), the customized shading data can be stored in a file. For later use, this file can then be loaded into the camera.*

## 6.6. Request Functions.

The following commands are for identification and help.
Fig. 33. shows some printout examples from a PC running terminal emulator software. (Hyper terminal). Status, version, camera ID, model name, user ID and the help list are shown.

*Please refer to chapter 7.2. RS-232C control, and chapter 7.3. CV-M9CL Command List.*

***Echo Back**. EB=1.*
If on, the camera will echo back the RS-232C transmission.

***Status**. ST.*
If received, the camera will send back its current setting for all functions. Refer to fig. 33. left.

***Help**. HP.*
If received, the camera will send back a help list for all functions. Refer to fig. 33. right.

***Version Number**. VN.*
If received, the camera will send back its firmware version number as a 3 digits number.

***PLD version**. PLD.*
If received, the camera will send back the PLD version number as a 4 digits number.

***Camera ID**. ID.*
If received, the camera will send back its ID, which is a manufacturing code.

***Model Name**. MD.*
If received, the camera will send back its model name.

***User ID**. UD.*
With this command, the user can program and store up to 16 characters for identification.

***Change RS232C Baud Rate**. BDRT=0* .
It is possible to change the communication speed from the normal 9600 Baud to a higher value. BDRT=0 is 9600, BDRT=1 is 19200 and BDRT=2 is 38400 bps. The new speed will be effective after next power up. It is *not* possible to request for the baud rate. *(BDRT?)*

## 6.7. Save and Load Functions.

The following commands are for store and load camera settings in the camera EEPROM.

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

***Save Settings**. SA.*
This command will store the actual camera settings to 1 of 3 user areas in the camera EEPROM. Factory settings can not be changed.

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

## Printout of status and help list from the camera.

The below lists shows printout from a hyperterminal.

```
Fpga Init. NG
COMPLETE


ST?
SM=2
SH=2
PE=791
PER=250
PEG=250
PEB=250
TR=0
SL=0
LS=1
RF=1
TI=0
TP=0
SC=0
BI=0
BA=1
CBAR=0
WB=0
GA=0
GAR=0
GAB=0
BLG=0
BLR=0
BLB=0
KN=1
KSR=2048
KSG=2048
KSB=2048
KPR=890
KPG=890
KPB=890
WA=0
SDM=1

VN?
VN=100
PV?
PV=37
ID?
ID=A100016683
MD?
MD=
UD?
UD=
```

```
hp?
*** CV-M9 Camera Control Help List ******************************
EB(echo back): 0=off, 1=on
ST(status request): return the all settings
VN(firmware version request): return the version no. of firmware
UD(user ID request): return 16 letters of user ID
SM(Shutter Mode): 0=preset shutter (RGB common set), 1=programmable exposure
          (RGB common set), 2=programmable exposure(RGB individual set)
SH(Shutter Speed): 0=off, 1=1/60, 2=1/100, 3=1/120, 4=1/250, 5=1/500
          6=1/1000, 7=1/2000, 8=1/4000, 9=1/10000, 10=1/16000, 11=1/50000
PE(programmable exposure)(RGB common set): 0-791
PE(programmable exposure)(RGB common set): 0-791
PER(programmable exposure for Red): 0-791
PEG(programmable exposure for Green): 0-791
PEB(programmable exposure for Blue): 0-791
TR(trigger mode): 0=normal, 1=edge pre-select, 2=pulse width control
          3=sensor gate control, 4=reset continuous
SL(smearless mode): 0=off, 1=on
LS(lval synchronous accumulation): 0=sync., 1=async.
RF(rct fval type): 0=cameralink, 1=JAI standard
TI(trigger input): 0=camera-link, 1=hirose 12pin
TP(trigger polarity): 0=active low, 1=active high
SC(scanning format): 0=full frame, 1=1/2 partial, 1=1/4 partial, 1=1/8 partial
BI(binning): 0=binning off, 1=v binning
BA(output bit allocation): 0=10bit, 1=8bit
CBAR(color bar): 0=off, 1=on
WB(white balance): 0=manual/one push, 1=continuous, 2=3200K, 3=4600K, 4=5600K
GA(master gain level): -132-429
GAR(red gain level): -231-231
GAB(blue gain level): -231-231
AW(one push white balance): 0=one push
BLG(green black level): 0-1023
BLR(red black level): 0-1023
BLB(blue black level): 0-1023
KN(knee on/off): 0=on, 1=off
KSR(knee slope for red): 1-4095
KSG(knee slope for green): 1-4095
KSB(knee slope for black): 1-4095
KSR(knee point for red): 0-1023
KSG(knee point for green): 0-1023
KSB(knee point for black): 0-1023
SDM(shading mode): 0=on, 1=off
LD(Load settings from Flash memory): 0=factory, 1=user1, 2=user2, 3=user3
SA(Save settings in Flash memory): 1=user1, 2=user2, 3=user3
WA(Set auto white sampling Area): 0=full, 1=upper left, 2=upper middle,
          3=upper right, 4=middle left, 5=middle, 6=middle right,
          7=lower left, 8=lower middle, 9=lower right,
AWRS(Request one push W.Bal. result): 0=complete, 1=too bright, 2=too dark,
          3=timeout, 4=busy, 5=limit,
*** Firmware Version 1.00 ***** Copyright(c) 2003-2004 JAI Corporation *****
```

Fig. 33. Terminal printout of status, ID and Help.

# 7. Configuring the Camera

## 7.1. Setting by internal Switch SW301

SW 301 is used for communication port select and trigger termination. The switch is placed on the rear board behind the LED and WB button.

To access the switch:

Remove the top cover frame. 6 screws.
Remove the bottom cover frame. 6 screws.
Remove left side cover. (Seen from rear). 5 screws.
SW 301 is seen on the rear board behind the LED and WB button.

| No | Functions | | |
|---|---|---|---|
| | | OFF | ON |
| 1 | Communication port switch | ***LVDS (Camera Link)*** | RS232C (HIROSE 12pin) |
| 2 | Trigger In Termination switch | ***TTL*** | 75Ω |

Factory settings are shown in ***Bold Italic***.

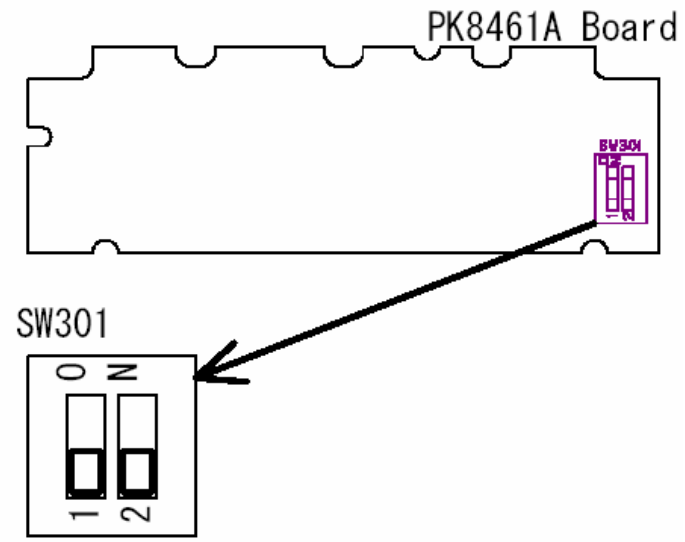



Fig. 34. Switch position

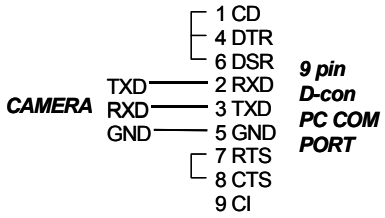
## 7.2. RS-232C control

All configuration of the CV-M9CL camera is done via the RS-232C port on the 12 pin HR connector or via Camera Link. (Internal switch SW301.1 off for HR). 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




*) Baud rates can be changed by RS232C commands. (9600bps to 38400 bps.)

**Protocol.**

Transmit setting to camera:
**NN=[Parameter]<CR><LF>** (NN is any kind of command. Capital or small letters.)
The camera answers:
**COMPLETE<CR><LF>**
Note: Some commands can only be requested.

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

Transmit request command to camera:
**NN?<CR><LF>** (NN is any kind of command.)
The camera answers:
**NN=[Parameter]<CR><LF>**

Transmit the following to have the camera actual setting:
**ST?<CR><LF>**
The camera answers:
A complete list of the current settings

Transmit the following to have a command list:
**HP?<CR><LF>**
The camera answers:
A list with all commands and possible settings

Invalid parameters send to camera: (99 is an invalid parameter)
**SH=99<CR><LF>**
The camera answers:
**02 Bad Parameters!!<CR><LF>**

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

## 7.3. CV-M9CL 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 digits version |
| **PV** | PLD version request | PV?<CR><LF> | | 4 digits version |
| **ID** | Camera ID request | ID?<CR><LF> | | 10 characters |
| **MD** | Model Name request | MD?<CR><LF> | | ≤ 10 characters |
| **UD** | User ID (Free text) | TR=[Param.]<CR><LF> | User can save and load free text | ≤ 16 characters |
| **BDRT** | Baud rate | BDRT=[Param.]<CR><LF> | 0=9600 bps 1=19200 bps 2=38400 bps | At next power up |
| **B - Video Output** | | | | |
| **SC** | Scanning format | SC=[Param.]<CR><LF> | 0=full 1=1/2 partial<br>2=1/4 partial 3=1/8 partial | |
| **BA** | Output bit allocation | BA=[Param.]<CR><LF> | 0=10 bit 1=8 bit | In Camera Link |
| **BI** | Vertical binning | BI=[Param.]<CR><LF> | 0=off 1=V binning | Only when SC=0 |
| **SL** | Smearless readout | SL=[Param.]<CR><LF> | 0=off 1=on | |
| **CBAR** | Color Bar | CBAR=[Param.]<CR><LF> | 0=off 1=on | Test image output |
| **C - Trigger and shutter related commands** | | | | |
| **TR** | Trigger mode | TR=[Param.]<CR><LF> | 0=Contin 1=EPS 2=PWC 4=RCT | |
| **LS** | LVAL accumulation | LS=[Param.]<CR><LF> | 0= LVAL sync. 1= LVAL a-sync. | |
| **SM** | Shutter mode | SM=[Param.]<CR><LF> | 0=RGB common EPS 1=RGB common PE<br>2=RGB individual PER, PEG and PEB | Only for TR=0 ,<br>TR=1 and TR=4 |
| **SH** | Shutter speed | SH=[Param.]<CR><LF> | 0=Off (1/30) 1=1/60 2=1/100<br>3=1/120 4=1/250 5=1/500<br>6=1/1000 7=1/2000 8=1/4000<br>9=1/10,000 10=1/16,000 11=1/50,00 | When SM=0 |
| **PE** | Programmable exp. RGB | PE=[Param.]<CR><LF> | 0 to 791 | RGB com. SM=1 |
| **PER** | Programmable exp. Red | PER=[Param.]<CR><LF> | 0 to 791 | Red exp. SM=2 |
| **PEG** | Programmable exp. Green | PEG=[Param.]<CR><LF> | 0 to 791 | Green exp. SM=2 |
| **PEB** | Programmable exp. Blue | PEB=[Param.]<CR><LF> | 0 to 791 | Blue exp. SM=2 |
| **D- Signals and polarity** | | | | |
| **RF** | RCT FVAL type | RF=[Param.]<CR><LF> | 0=CameraLink 1=JAI standard | |
| **TI** | Trigger Input | TI=[Param.]<CR><LF> | 0= CamerLink 1= 12 pin Hirorose | |
| **TP** | Trigger polarity | TP=[Param.]<CR><LF> | 0= active low 1= active high | |
| **E - Gain and analogue signals setting** | | | | |
| **WB** | White Balance | WB=[Param.]<CR><LF> | 0=Manual/One Push 1=Continuous AWB<br>2=3200K 3=4600K 4=5600K | |
| **AW** | One Push White balance | AW=[Param.]<CR><LF> | 0=one push auto white balance | When WB=0 |
| **WA** | Set Auto White Area | WA=[Param.]<CR><LF> | 0=Full, 1=UL, 2=UM, 3=UR, 4=ML, 5=MM,<br>6=MR, 7=LL, 8=LM. 9=LR | Full or 1 of 9 areas |
| **AWRS** | Request Auto White result | AWRS?<CR><LF> | 0=complete, 1=too bright, 2=too dark,<br>3=timeout, 4=busy, 5=limit, 6=trig not norm. | |
| **GA** | Master Gain level | GA=[Param.]<CR><LF> | -132 to +429 | -4 to +13 dB, |
| **GAR** | Gain level Red | GA=[Param.]<CR><LF> | -231 to +231 | -7 to +7 dB |
| **GAB** | Gain level Blue | GA=[Param.]<CR><LF> | -231 to +231 | -7 to +7 dB |
| **BLG** | Black level Green | BLG=[Param.]<CR><LF> | 0-1023 (0=low 1023=high) | Default=460 |
| **BLR** | Black level Red | BLR=[Param.]<CR><LF> | 0-1023 (0=low 1023=high) | Default=460 |
| **BLB** | Black level Blue | BLB=[Param.]<CR><LF> | 0-1023 (0=low 1023=high) | Default=460 |
| **KN** | Knee On/Off | KN=[Param.]<CR><LF> | 0=on 1=off | |
| **KSR** | Knee Slope for Red | KSR=[Param.]<CR><LF> | 0 to 4095 | Default=800 |
| **KSG** | Knee Slope for Green | KSR=[Param.]<CR><LF> | 0 to 4095 | Default=800 |
| **KSB** | Knee Slope for Blue | KSR=[Param.]<CR><LF> | 0 to 4095 | Default=800 |
| **KPR** | Knee Point for Red | KPR=[Param.]<CR><LF> | 0 to 1023 | Default=890 |
| **KPG** | Knee Point for Green | KPR=[Param.]<CR><LF> | 0 to 1023 | Default=890 |
| **KPB** | Knee Point for Blue | KPB=[Param.]<CR><LF> | 0 to 1023 | Default=890 |
| **SDM** | Shading Mode | SDM=[Param.]<CR><LF> | 0=on 1=off | |
| **ATSH** | Shading Correction mask | ATSH=[Param.]<CR><LF> | 0=Auto | Only 0 is allowed |
| **F - Saving and loading data in EEPROM** | | | | |
| **LD** | Load settings from camera EEPROM | LD=[Param.]<CR><LF> | 0=Factory data 1=User 1 area<br>2=User 2 area 3=User 3 area | Latest used data defa. at power up |
| **SA** | Save settings to camera EEPROM | SA=[Param.]<CR><LF> | 1=User 1 area<br>2=User 2 area 3=User 3 area | Parameter = 0 is not allowed |
| **EA** | EEPROM area request | EA?<CR><LF> | 0=Factory data 1=User 1 area<br>2=User 2 area 3=User 3 area | Return latest used area |

!! Do not try to use commands not shown in this list.

# 8. Camera Control Tool for CV-M9CL

From www.jai.com Camera Control Tool for Windows 98/NT/2000 can be downloaded.
The control tool contains a camera control program and tools for making your own program.
For the integrator and experienced user, the Camera Control Tool 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.

## 8.1. Control Tool Windows

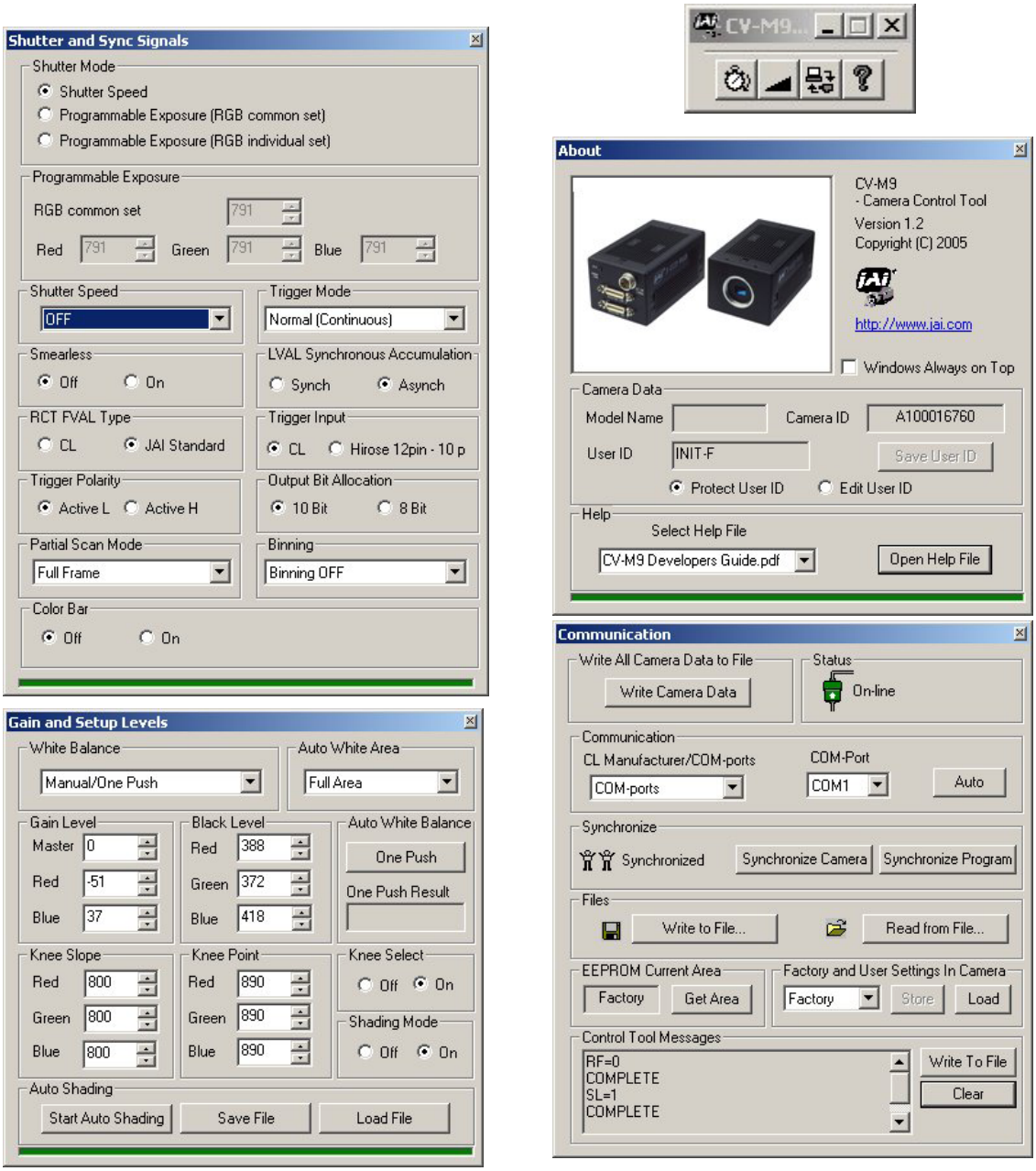
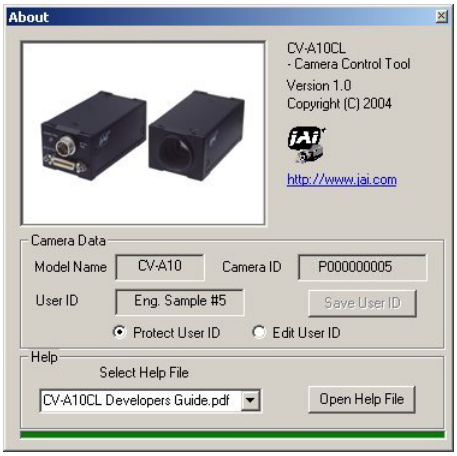



Fig. 35. Camera control tool windows.

## 8.2. 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



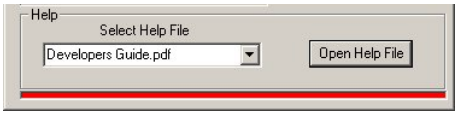

The about window contains a picture of the camera and information about the version of the program, Internet connection to JAI A/S and access to the help documents.
The List box that contains the help documents will list all files, which have the extension .pdf and that are found in the program (default)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

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

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

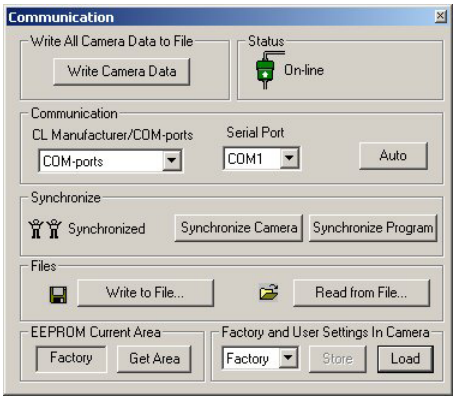
http://www.jai.com/camera/manuals.asp/sprog=uk

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.

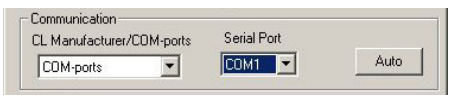




### The Communication Window




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.

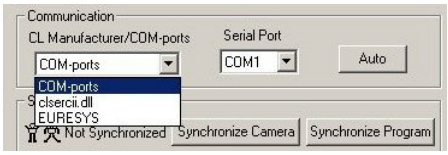


RS-232 communication:

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:


cameradata.txt - Notepad

File Edit Format View Help

| | | | | | |
|---|---|---|---|---|---|
| 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 |

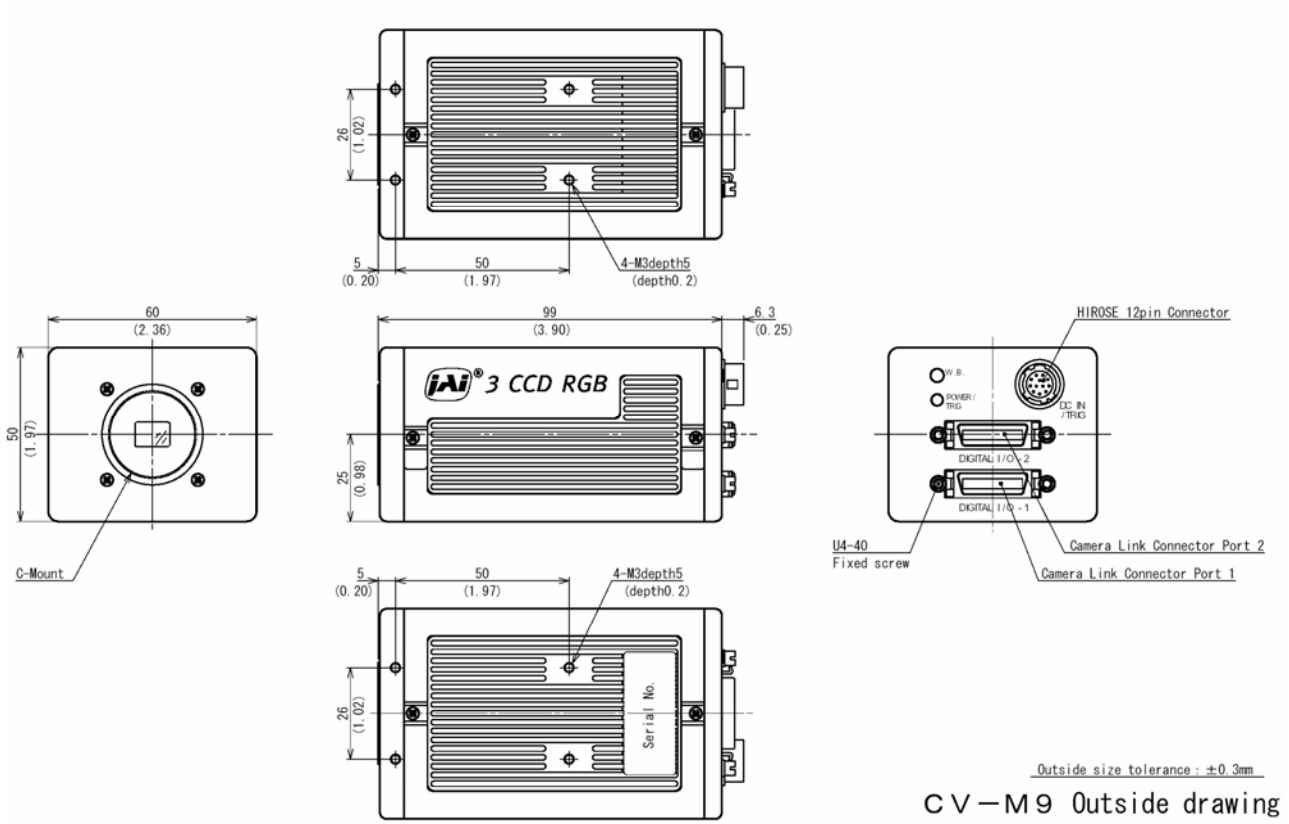
EEPROM Current Area.
Click the 'Get Area' button to read the power up settings area number.


## 8.3. 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".

# 9. External Appearance and Dimensions




***Note**: Rear protrusion on C-mount lens must be less than 4.0mm*

Fig. 37. Outline.

# 10. Specifications

## 10.1. Spectral sensitivity

The shown responses are for prism and CCD sensors combined.

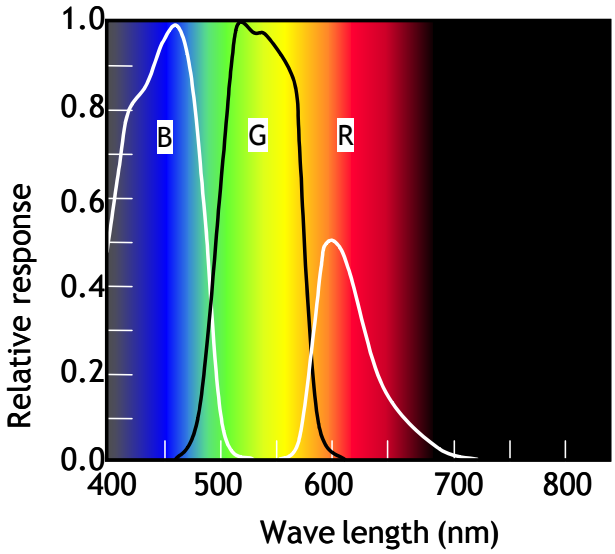



Fig. 38. Spectral sensitivity for CV-M9CL

## 10.2. Specification table

| Specifications | CV-M9CL |
|---|---|
| Scanning system | Progressive |
| Frame rate | 30 fps (792 lines per frame) |
| Line frequency<br>V binning | 23.768 kHz (1420 clk per line)<br>19.622 kHz (1720 clk per line) |
| Pixel frequency | 33.75 MHz |
| CCD sensors | 3 x 1/3" IT CCD on prism. Sony ICX204AL |
| Sensing area | 4.8 (h) x 3.6 (v) mm |
| Effective pixels | 1034 (h) x 779 (v) |
| Cell size | 4.65 (h) x 4.65 (v) μm |
| Pixels in video output full<br>1/2 partial<br>1/4 partial<br>1/8 partial<br>V binning | 1024 (h) x 768 (v) 30fps. (792 lines per frame)<br>1024 (h) x 384 (v) 48fps. (492 lines per frame)<br>1024 (h) x 192 (v) 68fps. (384 lines per frame)<br>1024 (h) x 96 (v) 86fps. (276 lines per frame)<br>1024 (h) x 384 (v) 50fps. (396 lines per frame) |
| Sensitivity (on sensor) | 6 Lux, 0dB gain, 100% video<br>2 Lux, max gain, 50% video |
| S/N ratio | >50 dB. (On Green) |
| Video outputs. | 3 x 8 bit RGB via single port Camera Link base configuration<br>3 x 10 bit RGB via dual port Camera Link medium configuration |
| Iris video output | 0.7 Vpp, 75 Ω |
| Gamma | 1.0 |
| Gain<br>Gain range | Manual for all 3 colors<br>Master -3 to +12 dB. R and B –6 to +6 dB |
| White balance<br>Tracking range | Manual/one push, continuous, Fixed 3200K, 4600K, 5600K<br>-6 to +6 dB. (2800K to 6500K) |
| Dynamic shading correction | On/Off |
| Knee correction | Knee point and slope individually for RGB |
| Synchronization | Int. X-tal. or random trigger |
| Inputs TTL<br>Camera Link | Ext. trigger 4 Vpp ±2 V. (TTL or 75 Ω)<br>Ext,. trigger |
| Outputs TTL<br>Camera Link | EEN output 4 Vpp from 75 Ω source<br>RGB 8/10 bit video output. D0 – D9<br>Pixel clock, DVAL, LVAL, FVAL and EEN |
| Control interface | TXD and RXD via RS232C<br>serTC and serTFG via Camera Link |
| Trigger modes | Continuous, Edge Pre-Select, Pulse Width Control,<br>Reset Continuous Trigger and Sensor Gate control |
| Trigger function | LVAL synchronous or LVAL a-synchronous |
| Shutter speed (fixed). | 1/30, 1/60, 1/100, 1/120, 1/120, 1/250, 1/500, 1/1000, 1/2000, 1/4000, 1/10,000<br>1/16,000 and 1/50,000 sec. |
| Programmable exposure | 0L – 791L. RGB common or individual. (L=50.96μs.) |
| Pulse Width Control | >2L to <23760L (>84 μs to <1s) |
| Sensor gate control | >1Frame to <30 frames. (>1/30s to <1s) |
| Functions controlled by<br>RS 232C or Camera Link | Trigger, Shutter, scanning, readout, polarity, gain, Set-up, white balance, knee point and slope |
| Operating temperature | -5°C to +45°C. |
| Humidity | 20 - 80% non-condensing |
| Storage temp./humidity | -25°C to 60°C./20% - 90 % non-condensing |
| Vibration | 10 G (15 Hz – 200 Hz in XYZ) |
| Shock | 70 G |
| Regulations | CE (EN 50081-1, EN 50082-1) FCC part 15 class B |
| Power | 12V DC ± 10%. 0.62A |
| Lens mount | C-mount. (Max 4.0 mm thread) |
| Flange back | 17.526mm +0 –0.05mm |
| Optical axis | Centre ±0.1mm |
| Dimensions | 50 x 60 x 99 mm (HxWxD) |
| Weight | 400 g |

Note: Above specifications are subject to change without notice
Specifications are valid after a 30 min. warm up period.

# 11. Appendix

## 11.1. 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.

## 11.2. Typical Sensor Characteristics

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

**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 sensor captures a dark object at high temperature or is used for long time integration, fixed pattern noise may appear on the video monitor screen.

## 11.3. References

1. This manual can and datasheet for CV-M9CL can be downloaded from www.jai.com
2. Camera control software can be downloaded from www.jai.com
3. Specifications for the CCD sensor Sony ICX-204AL can be found on www.jai.com

## 12. Users Record

**Camera type:** **CV-M9CL**

**Revision:** **(Revision A)**

**Serial No.** **……..**

**Firmware version.** **……..**

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

**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



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