Remote Head Progressive Scan
Monochrome Camera

CV-A436

Operation Manual

Camera: Revision A
Manual: Version 1.0

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1. General

The CV-A436 is a remote head monochrome progressive scan 1/3" CCD camera. The CV-A436 camera is based on the CV-A11 functions, and the camera head has same dimension as CV-M536. 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 vertical binning.
All modes and functions can be set via an RS-232C interface, greatly reducing the need for mechanical switches or jumpers.
CV-A436 Camera Control Tool for Windows NT/2000/XP contents a camera control program and tools for making your own program.

The latest version of this manual can be downloaded from: www.jai.com
The latest version of Camera Control Tool for CV-A436 can be downloaded from: www.jai.com

2. Standard Composition

The standard camera composition consists of the camera main body.

3. Main Features

- Remote head 1/3" progressive scan monochrome camera
- Based on CV-A11 specifications and head like CV-M536
- 17ø x 46mm head with 2m cable
- 659 (h) x 494 (v) square pixels (VGA format)
- 60 full frames per second in single channel video output
- High S/N ratio >53 dB
- Shutter speeds from 1/60 to 1/200,000 second in 15 steps in continuous mode
- Shutter speeds from 1/60 to 1/20,000 second in 10 steps in EPS trigger mode
- Programmable exposure with 1H steps. (31.8µs)
- Partial scanning 1/2, 1/3 and 1/6 for higher frame rates
- Internal, external HD/VD or random trigger synchronization
- Edge pre-select, pulse width control, start/stop trigger modes
- Long time exposure with external VD pulse interval
- Frame-delay readout in connection with pulse width controlled shutter
- Exposure enable EEN, write enable WEN and pixel clock output
- Short ASCII commands for fast mode setup via serial port
- Setup by Windows NT/2000/XP software via RS 232C

4. Locations and Functions
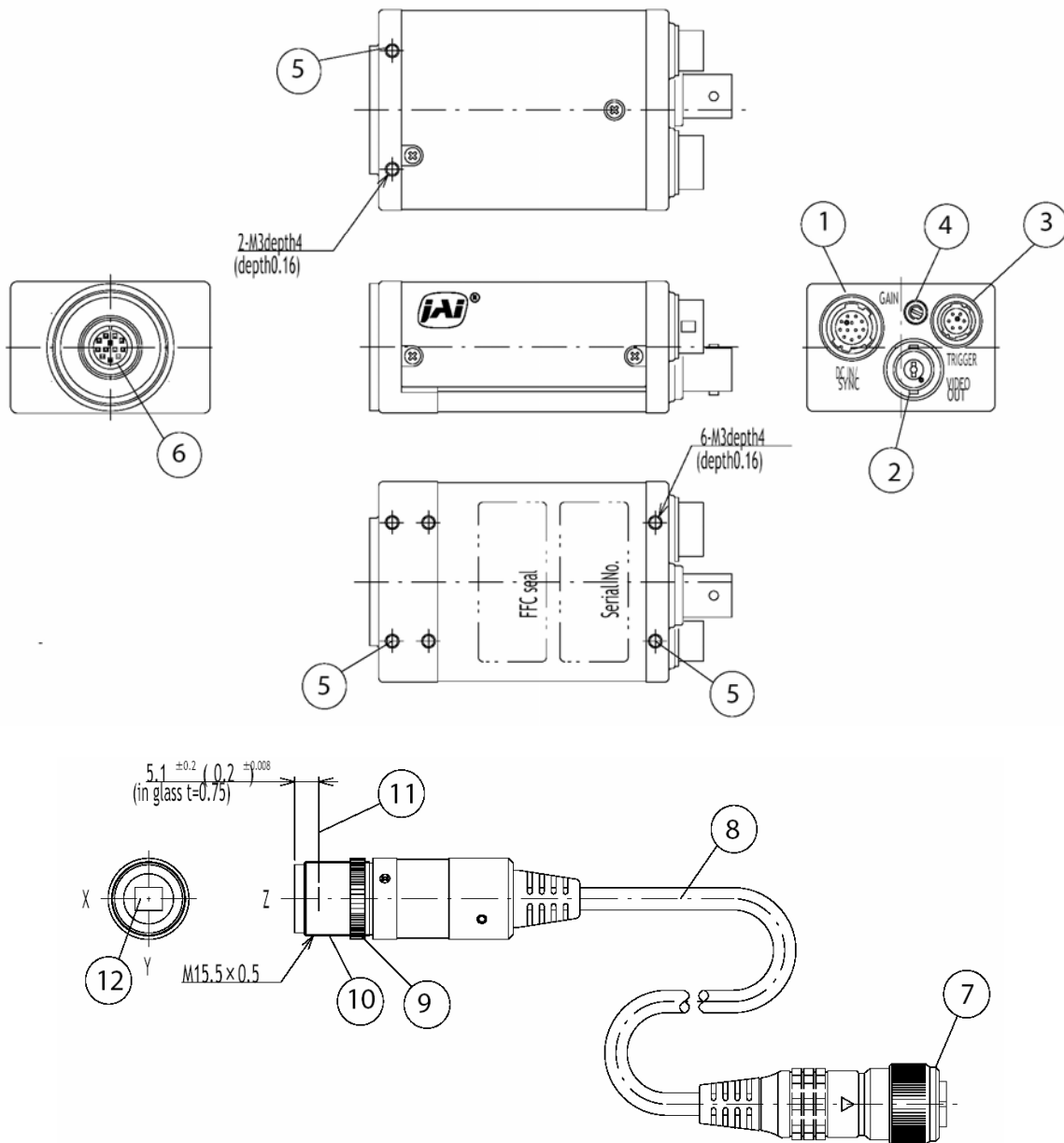
Fig. 1. Locations.

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. Depth 4.
6. Connector for camera head.
7. Camera head connector.
8. Camera head cable. 2 m.
9. Lock ring for focus.
10. Lens mount M15.5 x 0.5.
11. Focal plane. (Shown distance with CCD cover glass 0.75 mm, refractive index 1.5.)
12. 1/3" interline-transfer type CCD sensor.

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

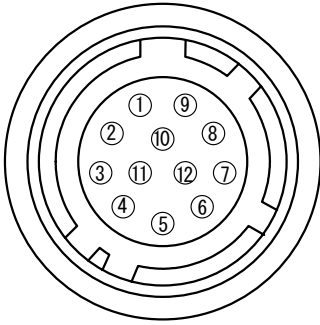| Pin no.	Signal	Remarks
1	GND	GND for pin #2
2	+12 V DC input	
3	GND	
4	*Video output*	Parallel with the BNC connector
5	GND	
6	*HD input*/HD output	*) SW1.1 on for HD out. SW2.1 on for 75Ω.
7	*VD input*/VD output	*) SW1.2 on for VD out. SW2.2 on for 75Ω.
8	GND	
9	*WEN*/Pixel clk outp	CW=1 for pixel clk output
10	*WEN output*	
11	*Trigger input*	Parallel with pin 5 on 6 pin connector
12	GND	GND for pin #2

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.
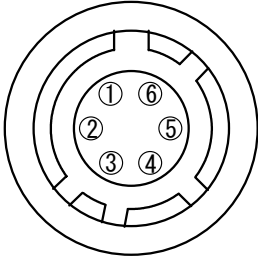
Pin no.	Signal	Remarks
1	TXD out	
2	RXD in	
3	GND	
4	GND	
5	*Trigger input*	Parallel with pin 11 on 12 pin connector
6	*EEN output*	

Fig. 3. 6-pin connector.

Plugs for cable: HR10A-7P-6S

*) Notes.   Alternative signals can be placed on these pins by switch settings.
Configurations shown in *Bold + italic* is factory setting.

5.3. Input and Output Circuits

In the following the principle for the input and output circuits for video and timing signals are shown. Jumper settings are shown as for factory default.

5.3.1. Video output

The video output on the BNC connector is a 75 Ω DC coupled circuit. The video black DC level is 0.0 volt. The composite sync signal can be disabled. (SO=0). Pin #4 on the 12-pin connector is in parallel with the BNC connector. Avoid double termination.
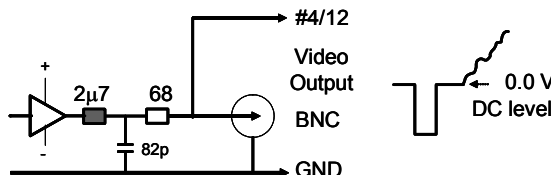
Fig. 4. Video output.

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.
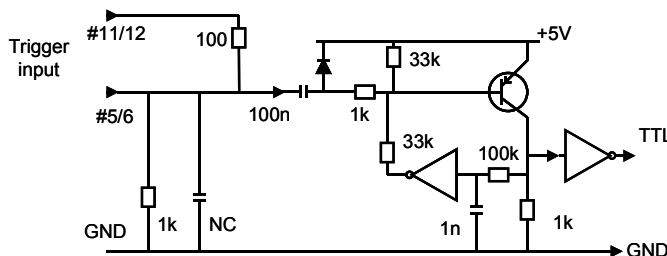
Fig. 5. Trigger input.

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.
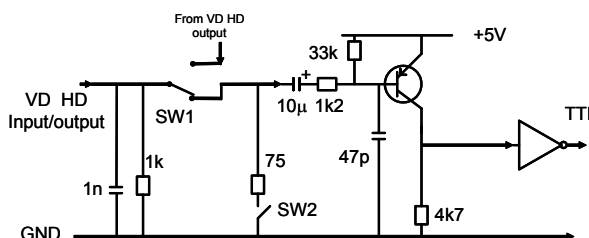
Fig. 6. HD and VD input.

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. Output level ≥4 V from 75Ω. (No termination).
The WEN polarity can be changed.
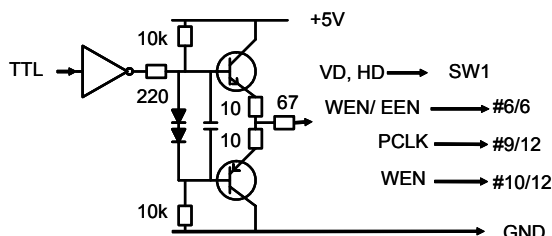
Fig. 7. HD, VD, PCLK, WEN and EEN output.

5.4. CV-A436 Block Diagram
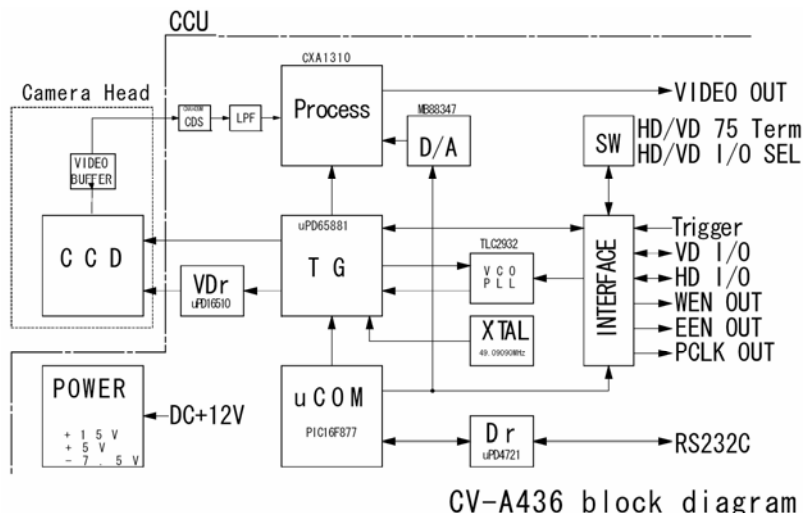
Fig. 8. Block diagram.

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 1/200,000 second
PE	Programmable Exposure	0.5H to 523.5 H.
SC	Scanning Format	Full frame, 1/2 partial, 1/3, 1/6 partial
TR	Trigger Mode	Continuous, EPS, PWC, frame delay read out PWC,
		Long time exposure, start-stop, smearless EPS

The shutter *SM* can be set to normal (SM=0), where the exposure time is selected from 15 fixed steps with the command *SH*, or programmable exposure (SM=1). The command *PE* allows 523 steps with 1 line period resolution. (31.8 μs).

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.

The accumulation mode *HC* is H synchronous (HC=0). For PWC mode (TR =2) and Frame Delay readout (TR=3) it can also be set to asynchronous accumulation (HC=1).
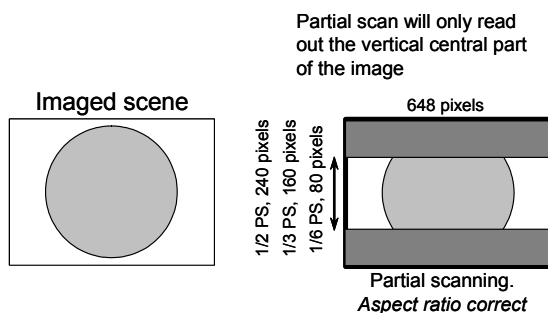In H synchronous mode, the exposure will start at the first HD pulse after the trigger falling edge. In H asynchronous mode the exposure will start immediately at the leading edge of the trigger pulse without waiting for the HD. Fig. 9 and fig. 10 shows the details.
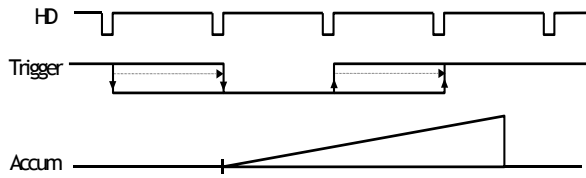
Fig. 9. PWC H synchronous accumulation.   Fig 10. PWC asynchronous accumulation.
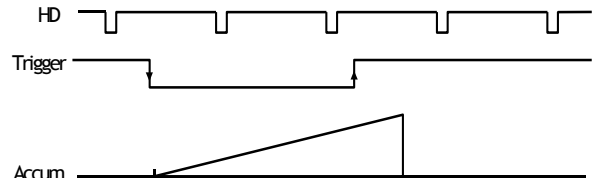
The accumulation mode is normal H synchronous. In this mode it is possible to start a new exposure during the previous frame readout. The exposure should not be finished before the frame is read out.

In normal trigger mode (TR=0) shutter speed up to 1/200,000 sec. can be used. In all triggered shutter modes, the shortest shutter time is limited to $\geq$1.44 H. (1/20,000). In triggered shutter modes with partial scan, the longest shutter speed is not limited by the frame readout time. It can be longer. In EPS mode, 1/60 is the longest exposure.

Trigger modes with possible partial scanning

TR=	Scanning	Full scan	Partial scan	Remarks
0	Normal	√	√	SM=0, SM=1 active. AS=1 active. (Progr. Exposure and AGC active).
1	Edge Pre-sel.	√	√	SM=0, SM=1 active. (Progr. Exposure active).
2	Pulse Width	√	√	HC=0, HC=1 active. (sync and a-sync accumulation active).
3	Fr. Delay r.o.	√	-	HC=0, HC=1 active. (sync and a-sync accumulation active).
4	Long Time int	√	-	
5	Start/Stop	√	-	
6	Smearless	√	√	SM=0, SM=1 active. (Progr. Exposure active).

√   Described mode

Note for mode setting.
With RS232C short ASCII commands it is possible to set up all combinations of mode and functions. Avoid function and mode combinations not described.

6.1.1. CCD sensor layout and full Image format
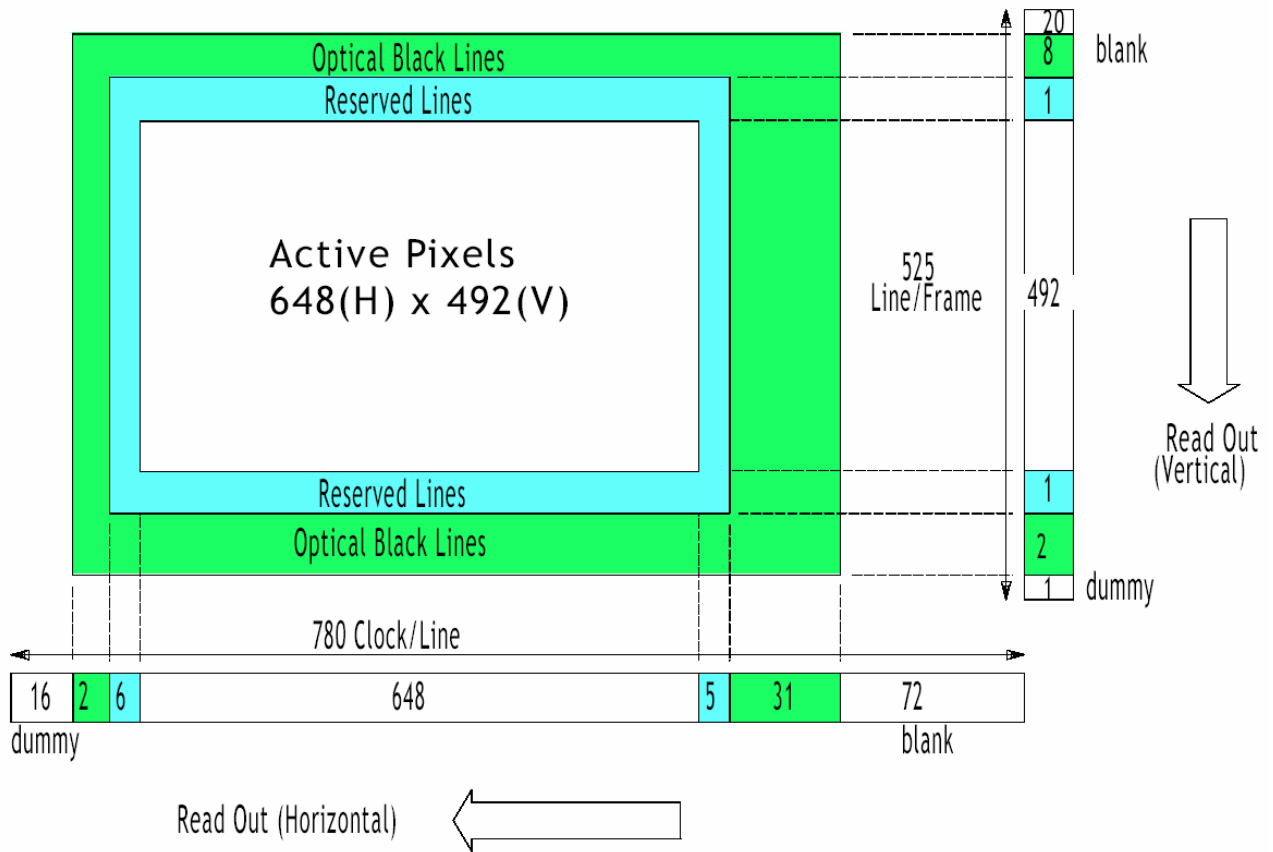
Fig. 11. CCD sensor layout

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 input is TTL level as factory setting. It can be 75 Ohm terminated by the internal switch on the PK8600A 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 PK8600A board should be set ON. The output is TTL level from a 75-Ohm source.

To use this mode:
Set function: SW 1-1 and 1-2 on PK8342 to *IN for ext. VD/HD input. (Factory default.)*
                       SW 2-1 and 2-2 on PK8342 to 75 Ω for termination of VD/HD.
                       SW 2-1 and 2-2 on PK8342 to *TTL for TTL level VD/HD. (Fact. default.)*
                       SW 1-1 and 1-2 on PK8342 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.*
- *External H frequency 31.46 kHz ±1%*
- *In trigger modes there are no continuous VD out, only after each trigger input.*
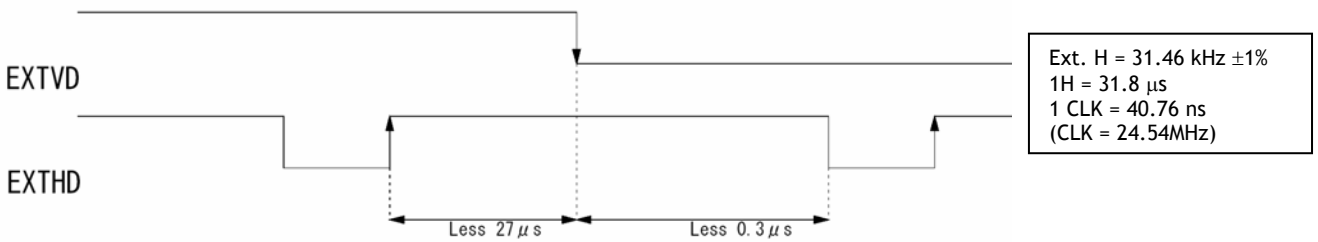
Fig. 12. Ext. HD and ext. VD phase conditions.
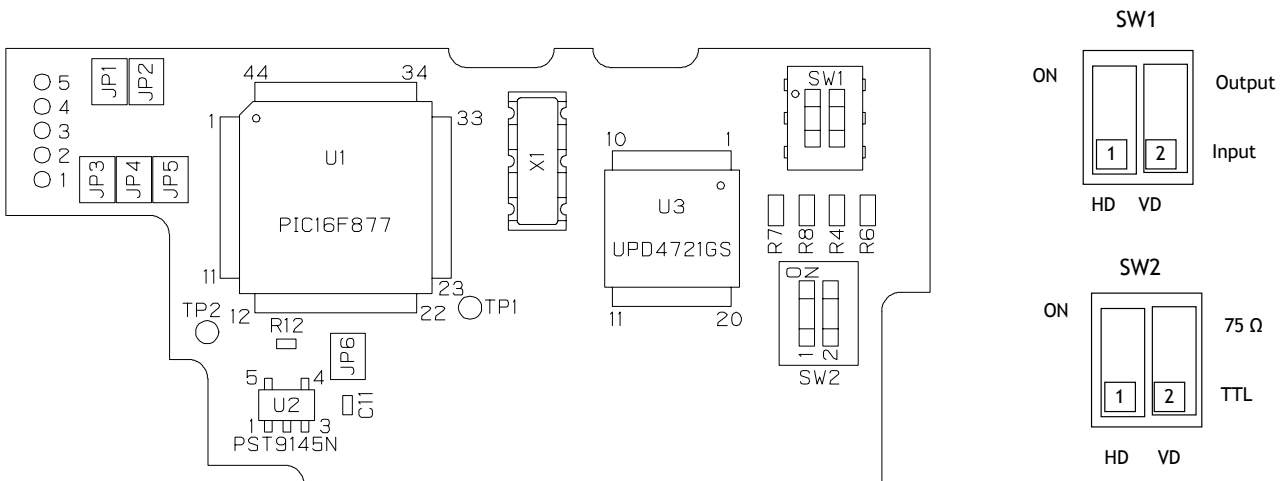
Fig. 14. Switches on PK8600A for int./ext. sync and termination.

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, programmable. (SM=0, SM=1,). The shutter will work in all 15 steps up to 1/200,000 second or with the programmable exposure in 524 steps. In partial scanning modes, a selection of shutter times longer than the actual frame time will result in an exposure equal to the frame time.

To use this mode:
Set function: Trigger mode "Normal"   TR=0
                   Shutter mode "Normal", "Programmable"   SM=0, SM=1,
                   "Shutter Speed"   SH=0 through 14
                   "Programmable exposure"   PE=0 through 523
                   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 system.
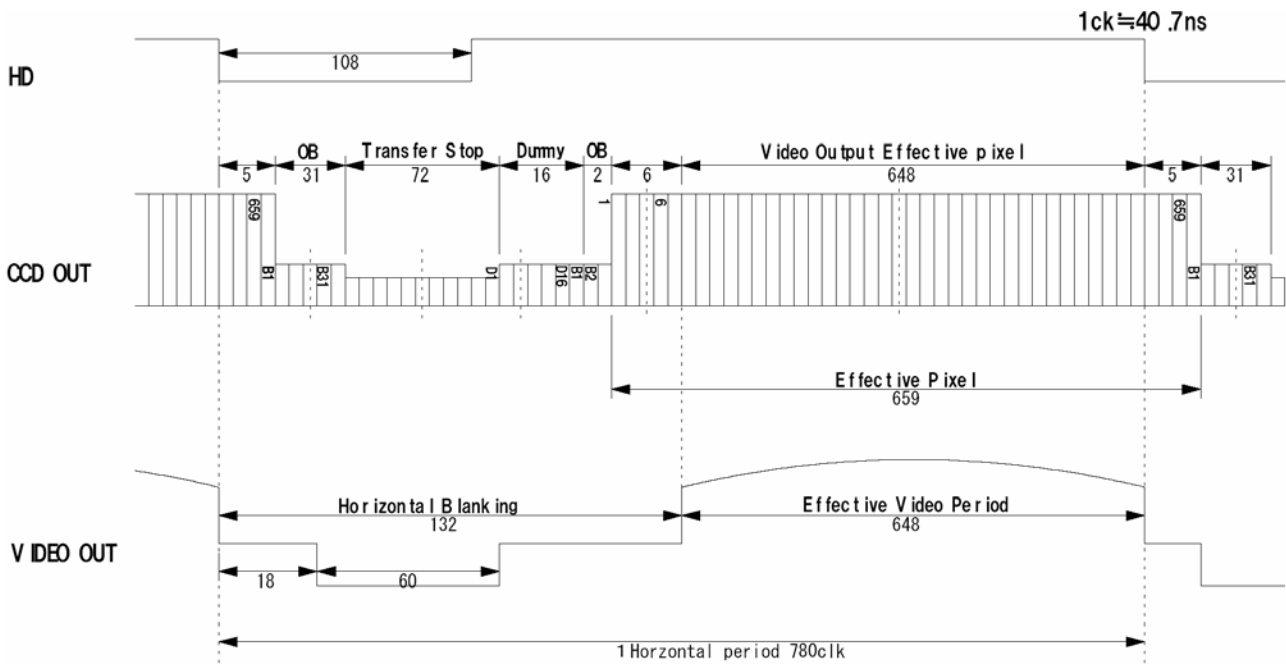
Fig. 15. Horizontal timing details and pixel numbering for the CCD array.
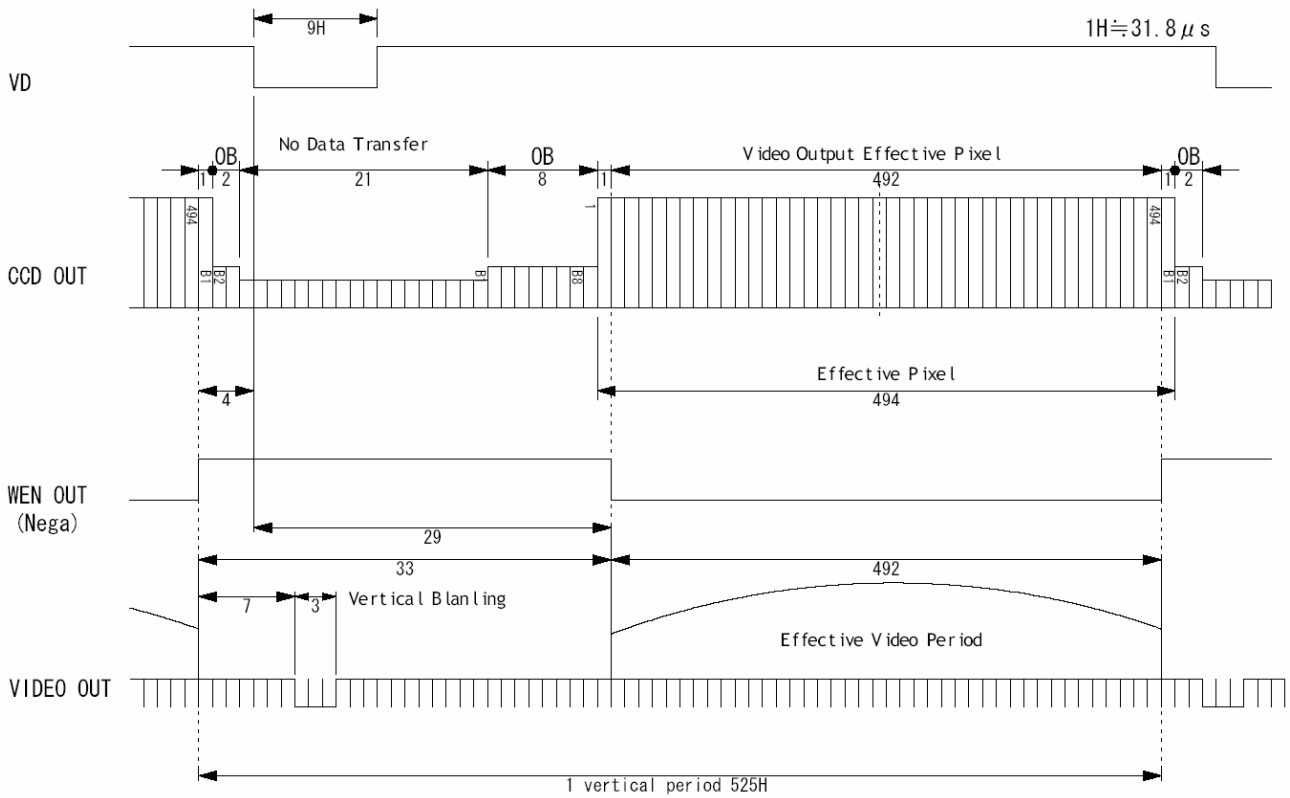
Fig. 16. Vertical timing details. Full

Table showing the figures for scanning in continuous mode

Scanning	Lines per frame [H]	Effective lines [H]	Frame rate [fps]	Remarks
Full	525	492	60	Shutter 1/60 – 1/200,000
1/2 partial	277	240	112	Shutter 1/120 – 1/200,000
1/3 partial	197	160	158	Shutter 1/250 – 1/200,000
1/6 partial	117	80	268	Shutter 1/500 – 1/200,000

Fig. 17. Vertical timing details for partial scan.

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.
3.   *Frame Delay read out mode. TR=3* PWC exposure read out by ext. VD.
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 accumulation is HD synchronously accumulation. The accumulation starts at the first HD after the trigger leading edge. To avoid the <1H jitter caused by this delay, synchronize the external trigger falling and rising edge to HD as shown in fig. 18. below. The trigger level translations should be placed inside A. 2 x 8 μseconds.
To obtain the highest triggered frame rate in EPS mode and PWC 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.
For pulse width control TR=2, and frame delay TR=3, the accumulation can be HD synchronous HC=0 or HD asynchronous HC=1.
In Edge pre-select TR=1 and smearless TR=6, the shutter mode can be SM=0 or SM=1.

Fig. 18. Extern Trigger/HD Timing requirements.

6.5. Edge Pre-select Mode

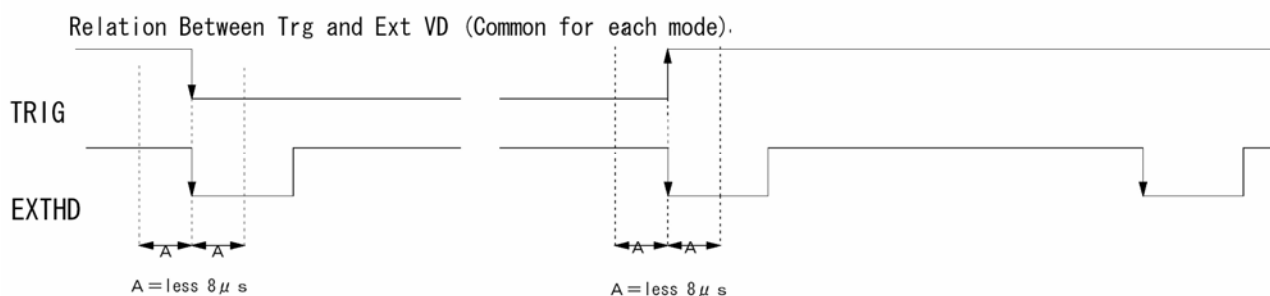The exposure starts at the first HD pulse after the trigger leading edge. It stops and is read out after the duration of the shutter time selected. It can be the first 9 steps in normal or 524 steps in programmable shutter. SM=0 or SM=1. Shutter selections SH ≥10 will result in 1/20,000 sec. This mode will operate with full and partial scanning modes. 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=0 through 523
                     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 on 12 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. 18.
- The duration of the trigger should be >1H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there is no continuous VD out, only after each trigger input.*

1H = 31.8μS

Table showing the figures for the different scanning modes.

Scan mode	A	B CCD array line #	C Effective video	D	Max frame rate fps	Remarks
Full	14H	2 to 493	492H	18H	58	Shutter 1/60-1/20,000
1/2 Partial	22H	134 to 373	240H	14H	107	Shutter 1/60-1/20,000
1/3 Partial	22H	174 to 333	160H	14H	149	Shutter 1/60-1/20,000
1/6 Partial	22H	214 to 293	80H	14H	240	Shutter 1/60-1/20,000

Fig. 19. Timing for Edge Pre-select with partial scanning.

6.6. Pulse Width Control Mode

In this mode the accumulation can be H synchronous, or H asynchronous. For H synchronous, the accumulation starts at the first HD pulse after the leading edge of the trigger and it stops after the fist HD after the trailing edge of the trigger. It can result in <1H jitter if the trigger is not synchronized to H. For H asynchronous accumulation 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.
This mode will operate with full and partial scanning. 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
                                Accumulation "H sync or H async"   HC=0, 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 on 12-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. 18. With HC=1 the exposure will start immediately.
- The duration of the trigger can be >1H to <2seconds.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there is no continuous VD out, only after each trigger input.*

1H = 31.8μS
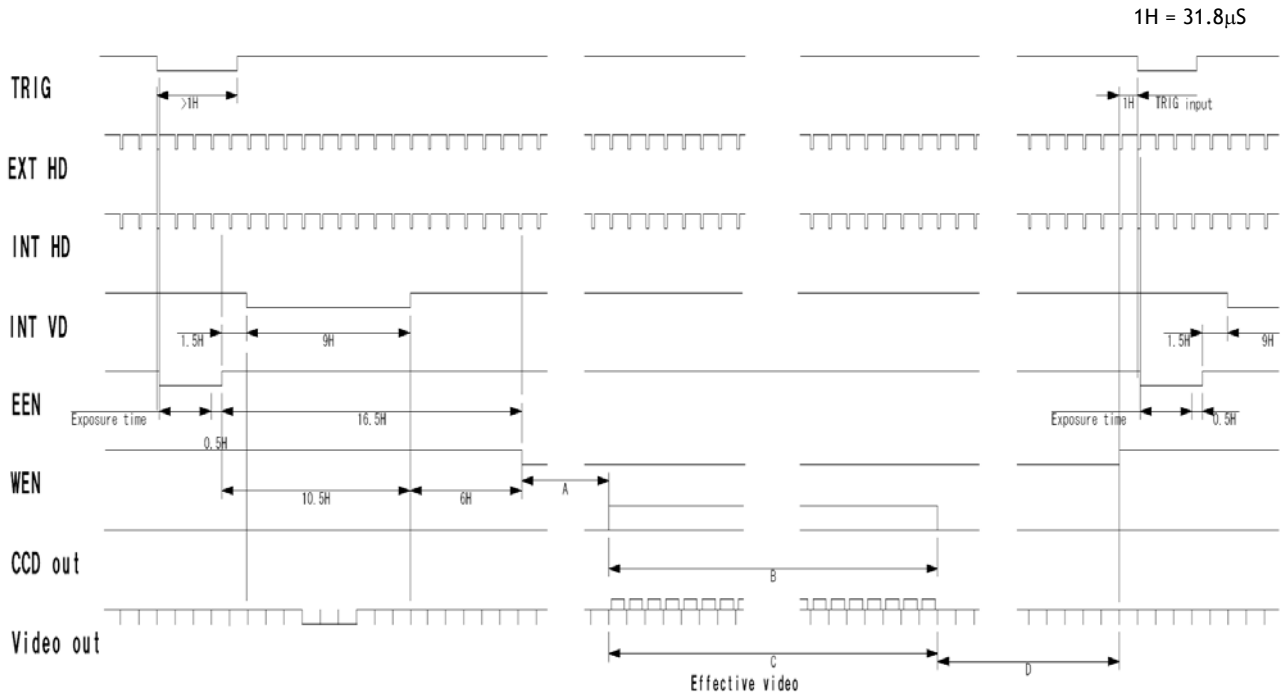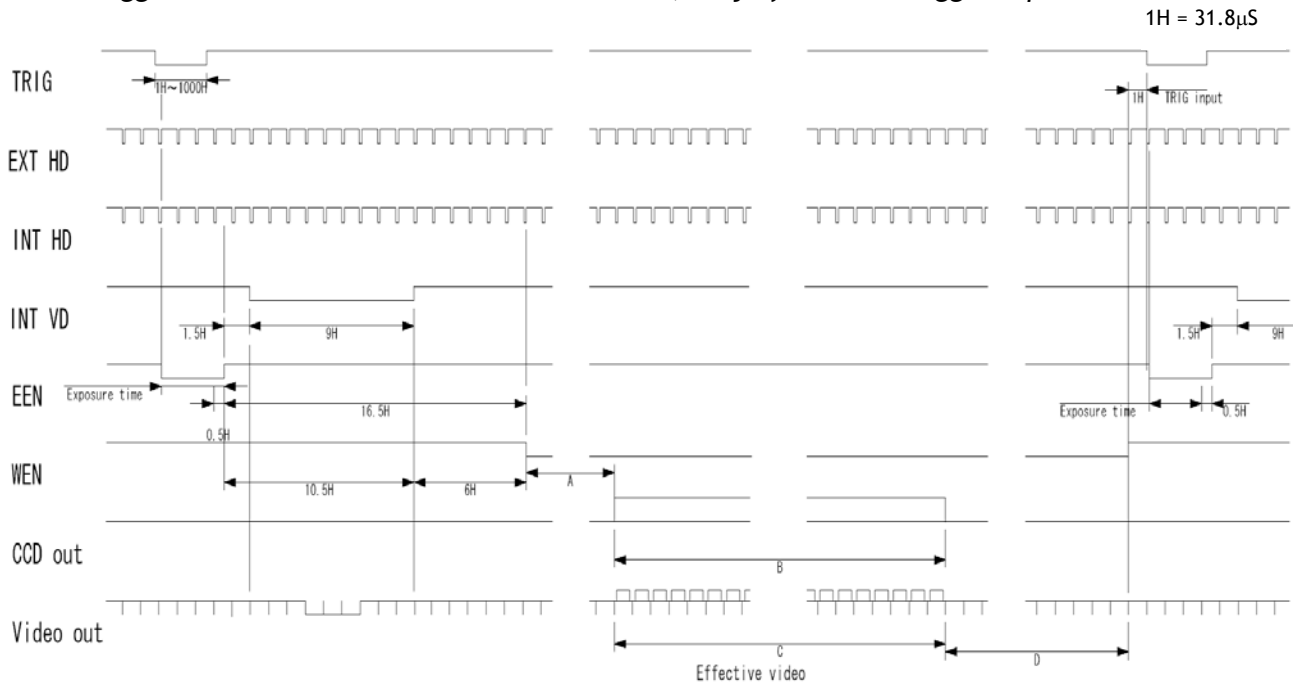

Table showing the figures for the different modes.

Scan mode	A	B CCD array line #	C Effective video	D	Max frame rate fps	Remarks
Full	14H	2 to 493	492H	18H	58	Shutter 2s - 1/20,000
1/2 Partial	22H	134 to 373	240H	14H	107	Shutter 2s - 1/20,000
1/3 Partial	22H	174 to 333	160H	14H	149	Shutter 2s - 1/20,000
1/6 Partial	22H	214 to 293	80H	14H	240	Shutter 2s - 1/20,000

Fig. 20. 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. (Like PWC mode.) The accumulation can be H synchronous or H asynchronous. The accumulation starts at the first HD pulse after the leading edge of the trigger, and it stops after the first HD after the trailing edge of the trigger. It can result in <1H jitter if the trigger is not synchronized to H.
The resulting video is read out after an external VD pulse is applied. (Delay < 2sec.)
This mode will operate with full scanning only.
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
                           Accumulation "H sync or H async"   HC=0, 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 on 12-pin connector. (If used).

Important notes on using this mode.
- The 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. 18.
- The duration of the trigger can be>1H to<1000H.
- A new trigger must not be applied before WEN is high.
- *In trigger modes there is no continuous VD out, only after each trigger input.*
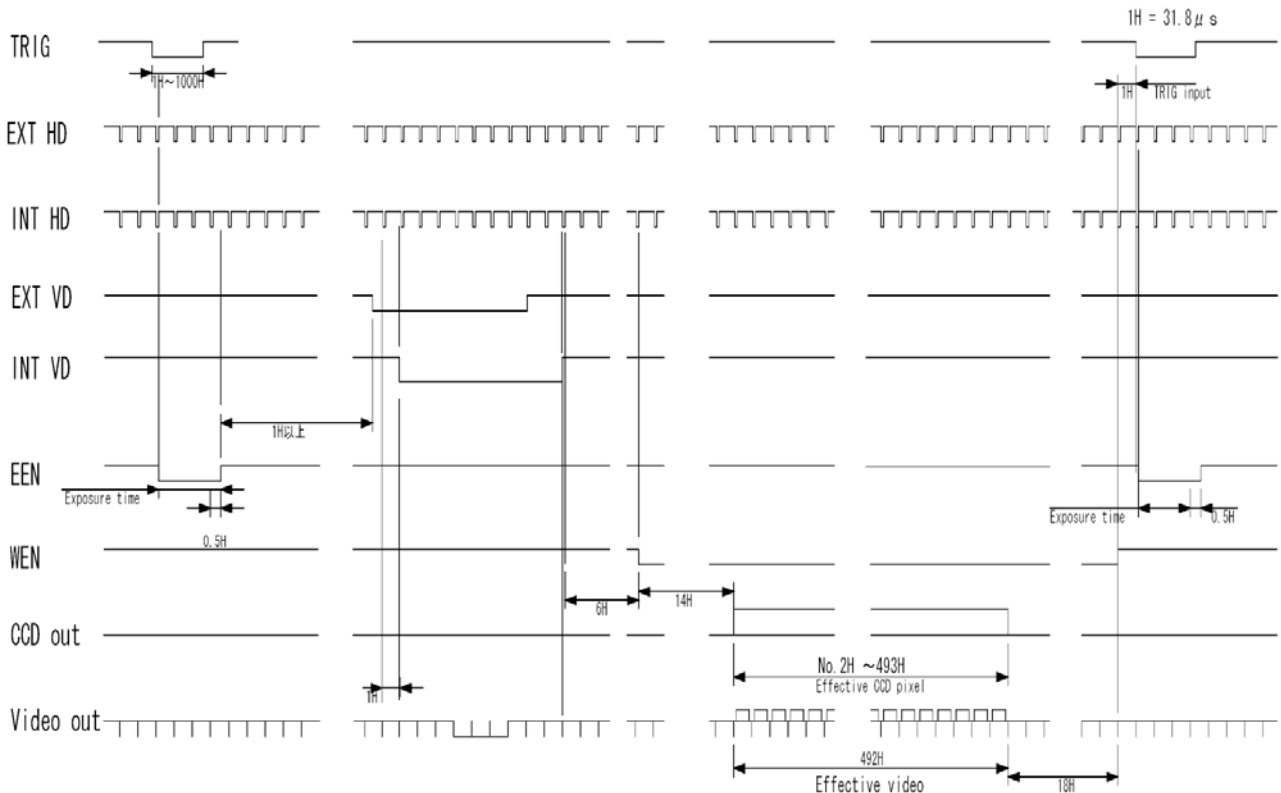
Fig. 21. Frame Delay read out mode

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 2V to ∞. Thermal and dark current noise will increase by accumulation time, therefore the exposure time is not recommended to exceed 2 seconds. 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 on 12-pin connector. (If used).

Important notes on using this mode.
- Depending of the temperature, it is not recommended to use integration time >2 sec.
- External sync system should follow the camera sync system.
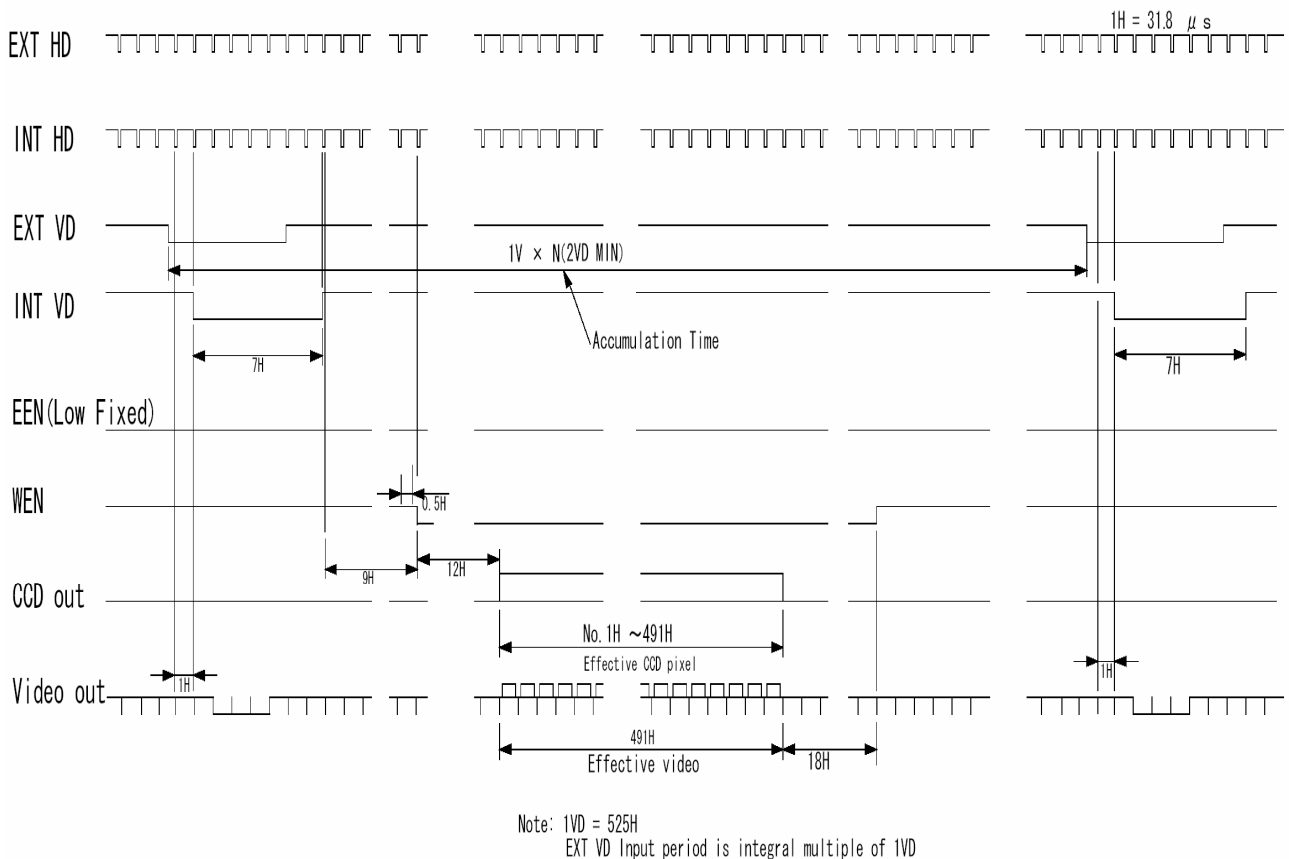
Fig. 22. Long time exposure

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.
This mode works for full scan only.
The shortest exposure time in this mode is >1.5H. (See important note below).

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 on 12-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. 18.
- The duration of the trigger should be >1H.
- External sync system should follow the camera sync system.
- *For the shortest exposure, the trigger should be applied after the ext. VD pulse falling edge.*
- A new trigger must not be applied before WEN is high.
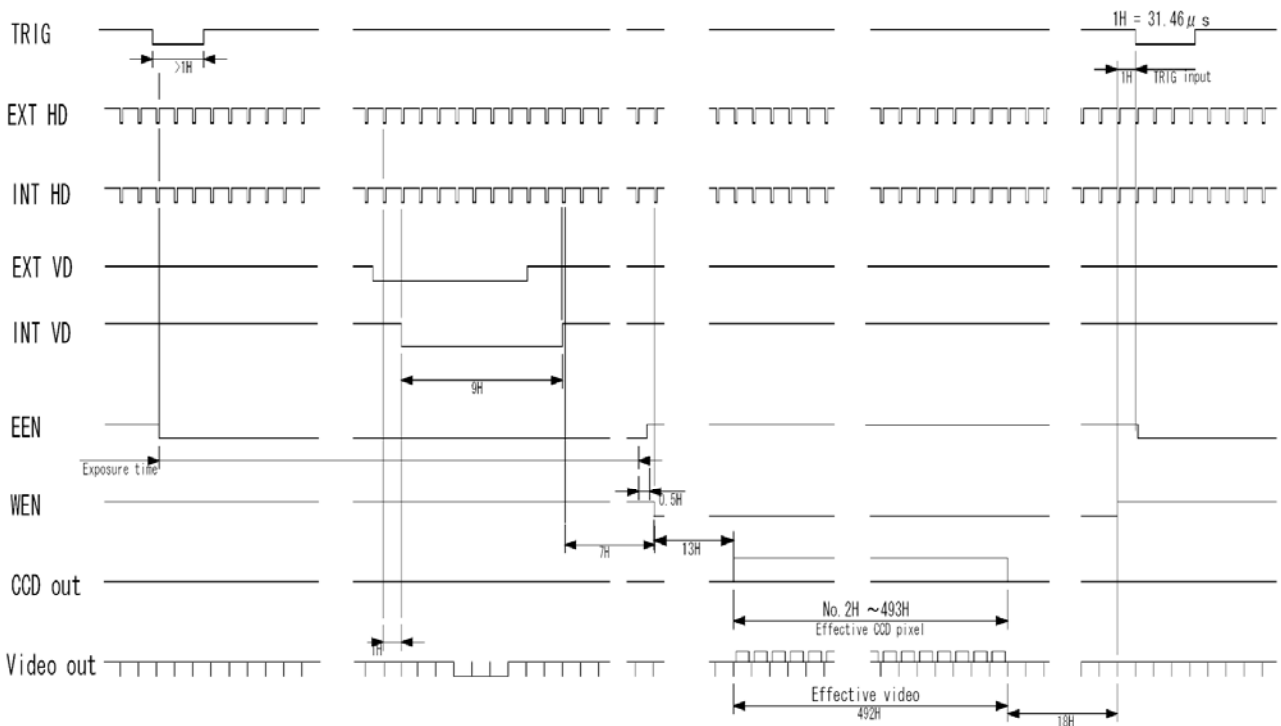- *In trigger modes there is no continuous VD out, only after each trigger input.*

Fig. 23. Timing for Start/Stop mode

6.10. Smearless Mode (EPS)

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 28 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 10 step normal or 523 step programmable. SM=0 or SM=1.
This mode will operate with full and partial scanning.
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=0 through 523
                            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 on 12-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. 18.
- The duration of the trigger should be >1H
- A new trigger must not be applied before WEN is high.
- *In trigger modes there is no continuous VD out, only after each trigger input.*

Table showing the figures for the different modes.

Scan mode	A	B CCD array line #	C Effective video	D	Max frame rate fps	Remarks
Full	14H	2 to 493	492H	18H	58	Shutter 1/60-1/20,000
1/2 Partial	22H	134 to 373	240H	14H	107	Shutter 1/60-1/20,000
1/3 Partial	22H	174 to 333	160H	14H	149	Shutter 1/60-1/20,000
1/6 Partial	22H	214 to 293	80H	14H	240	Shutter 1/60-1/20,000

Fig. 24. Smearless Mode

6.13. Other Functions.

Here a short description of functions not covered in the previous chapters.

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. This central 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.
Partial scan will work in continuous, EPS, PWC and smearless EPS mode. With partial scan in continuous mode, the shutter speed is limited to be shorter than the frame read out time. There is no limitation in trigger modes.

Trigger mode. TR=0 through TR=6.

Smearless readout. TR=6.
This function will reduce the unwanted smear signal from a highlighted scene when a short exposure time is used. It works like EPS 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 28 lines before the exposure starts. The exposure stops and the resulting video signal are read out.

Shutter mode. SM=0, SM=1. SH=0 through SH=14 and PE=0through PE=523.
With SM=0 the shutter (SH) selects from the 14 steps in normal mode. 9 steps in trigger mode. With SM=1 from programmable in 524 steps (PE).

Sync signal. SO=0, SO=1.
Off will remove the composite sync signal from the video signal. (BNC and pin #4/12)

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).

WEN polarity. WP=0, WP=1.
Will invert the WEN output signal. Normal WEN active is low.

WEN/Clk output. CW=0, CW=1.
Will select if WEN or pixel clock is output on pin #9 12 pin con. Default CW=0 is WEN out.
Do not have pixel clock output if not used.

Gamma Select. GS=0, GS=1.
Gamma can be selected to be 1 (linear) GS=0, or to be 0.45.

Gain and analogue settings.
!! Do not adjust these settings unless you have knowledge to video adjustments!

Gain settings. AS=0, AS=1.
The video gain can be selected between manual gain (AS=0), or AGC (AS=1). Manual gain is set either by the gain level command (GA=0 through GA=255) if RP=0, or the rear potentiometer if RP=1. The reference level for the AGC is set by the AGC reference level AG=0 through AG=255. In AGC mode the video level is kept constant (normal 700 mVpp ±30 mV) by the automatic gain control circuit within a 12 dB range. For continuous mode only.

Black level. BL=0 through BL=255.
Black level (or set-up level) will set the video level for black. Normal 20 mVpp ±2 mv.

White clip level. *WC=0 through WC=255.*
For adjusting the wanted white clip level. Normal 800 mVpp ±30 mv.

Mode and function matrix.

The following table shows which functions will work in the different modes for CV-A436.

	Func.	Shutter SM=		Part. s SC=	Gain AS=		Ext sync		Trig	Accumulation		Remarks
Mode	TR=	0	1		0	1	VD	HD		H sync	H a-sync	
Cont.	0	√	√	√	√	√	√	√	x	-	-	
EPS	1	√	√	√	√	x	x	√	√	√	-	
PWC	2	-	-	√	√	x	x	√	√	√	√	
FDRO	3	-	-	x	√	x	√	√	√	√	√	
LONG	4	-	-	x	√	x	√	√	x	-	-	
St/St	5	-	-	x	√	x	√	√	√	√	-	
SmLe	6	√	√	√	√	x	x	√	√	√	-	

√ = ok,   - = no function,   x = not allowed

6.14. Request Functions.
The following commands are for identification and help.
Fig. 26. 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 7.1. RS-232C control and chapter 7.2. CV-A436 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. 26.

Help. *HP.*
If received, the camera will send back a help list for all functions. Refer to fig. 26.

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

6.15. 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 the 3 user area in the camera EEPROM.

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

```
eb=1
COMPLETE

vn?
VN=2
id?
ID=ES00001
md?
MD=CV-A436
ud?
UD=jptES00001


st?
SM=0
SH=0
PE=523
SC=0
TR=0
HC=0
SO=1
TP=0
WP=0
CW=0
AS=0
AG=86
GA=72
RP=1
BL=74
WC=122
GS=0
```

```
hp?
*** CV-A436 Camera Control Help List ****************************
EB(Echo Back): 0=off, 1=on
ST(Status Request): return the all settings
VN(Firmware Version): return the version no. of firmware
ID(Camera ID): return the camera ID (10 characters)
MD(Model Name): return the model name (max 10 characters)
UD(User ID): free text for user (max 16 characters)
SM(Shutter Mode): 0=normal shutter, 1=programmable exposure
SH(Shutter Speed): 0=off,   1=1/60,   2=1/100,  3=1/120,  4=1/250
                5=1/500,  6=1/1k,   7=1/2k,   8=1/4k,   9=1/8k,
                10=1/20k, 11=1/40k, 12=1/80k, 13=1/120k, 14=1/160k
                15=1/200k
PE(Programmable Exposure): 0 - 523
SC(Scanning Format): 0=full frame, 1=1/2 partial, 2=1/3, 3=1/6
TR(Trigger Mode): 0=normal, 1=EPS, 2=PWC, 3=frame delay readout
            4=long time exposure, 5=start-stop 6=smearless(EPS)
HC(HD Accumulation): 0=sync., 1=async.
SO(Sync Signal): 0=off, 1=on
TP(Trigger Polarity): 0=active low, 1=active high
WP(WEN Polarity): 0=active low, 1=active high
CW(Clock Wen select) : 00WEN; 1=clock
AS(AGC Select): 0=AGC off(manual), 1=AGC on
AG(AGC Level): 0 - 255
GA(Manual Gain Level): 0 - 255
RP(Rear Potentiometer): 0=off(remote), 1=on
BL(Black Level): 0 - 255
WC(White Clip Level): 0 - 255
GS(Gamma Select): 0=1, 1=0.45
LD(Load settings from EEPROM): 0=factory area, 1=user1, 2=user2, 3=user3
SA(Save settings into EEPROM): 1=user1 area, 2=user2, 3=user3
*** Firmware Version 0.02 ***** Copyright(c) 2004 JAI Corporation *****
```

Fig. 26. Terminal printout of ID, status and Help for CV-A436.

7. Configuring the Camera

7.1. RS-232C control.

All configuration of the A436 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

CAMERA
TXD ——— 2 RXD
RXD ——— 3 TXD
GND ——— 5 GND

1 CD
4 DTR
6 DSR
7 RTS
8 CTS
9 CI

9 pin D-con PC COM PORT

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.

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>**

7.2. CV-A436 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 digit version
ID	Camera ID request	ID?<CR><LF>			10 characters
MD	Model name request	MD?<CR><LF>			≤10 characters
UD	User ID	UD=[Param.]<CR><LF>	Save and load user text		≤16 characters
	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	SC=1-3 only with TR=0-2 and TR=6
TR	Trigger mode	TR=[Param.]<CR><LF>	0=normal 2=Pulse width 4=Long time 6=Smearless EPS	1=Edge 3=Frame delay 5=Start/stop	
SM	Shutter mode	SM=[Param.]<CR><LF>	0=Normal	1=Programmabl	SM=0-1 only for TR=0, 1, 6
SH	Shutter speed	SH=[Param.]<CR><LF>	0=Off 2=1/120 4=1/500 6=1/2000 8=1/8000 10=1/40,000 12=1/120,000 14=1/200,000	1=1/100 3=1/250 5=1/1000 7=1/4000 9=1/20,000 11=1/80,000 13=1/160,000	All15 step is valid when TR=0. When TR=1 and 6, shutter speeds higher than 9 will result in 1/20,000
PE	Programmable expos.	PE=[Param.]<CR><LF>	0=0.5 H	523=523.5 H	H= 31.8μsec
	C – Signals and polarity				
HC	HD Accumulation	HC=[Param.]<CR><LF>	0=HD sync accu	1=HD a-sync acc	1 only for TR=2 TR=3
SO	Sync signal output	SO=[Param.]<CR><LF>	0=OFF	1=ON	
TP	Trigger polarity	TP=[Param.]<CR><LF>	0= active low	1= active high	*1)
CW	Pixel clk/WEN out		0=WEN out	1=pixel clk out	On pin #9 12 pin connector
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. RP=0 or RP=1
AG	AGC Level	AG=[Param.]<CR><LF>	0=low	255=high	Reference for AGC
GA	Manual gain Level	GA=[Param.]<CR><LF>	0=low	255=high	
RP	Rear Potentiometer	RP=[Param.]<CR><LF>	0=manual gain	1=rear pot. on	
BL	Black Level	BL=[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)   If positive logic is used (TP=1), the first trigger pulse after power up will be ignored.

Note for mode setting.
- With RS232C commands it is possible to set up combinations of mode and functions, which has no meaning, or which can disturb the normal mode function.
- Refer to mode and function matrix.
- Do not try to use commands or parameters not shown in this list!

7.3. Camera Control Tool for CV-A436

From www.jai.com Camera Control Tool for Windows 98/NT/2000/XP 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/NT/2000 and XP. The OCX interface has the ability to connect to the camera using the serial interface of the PC by reading and writing properties for the camera. This integration requires simple programming skills within Visual Basic, Visual C++ or similar languages in a Microsoft Windows environment.

7.3.1. Control Tool Windows
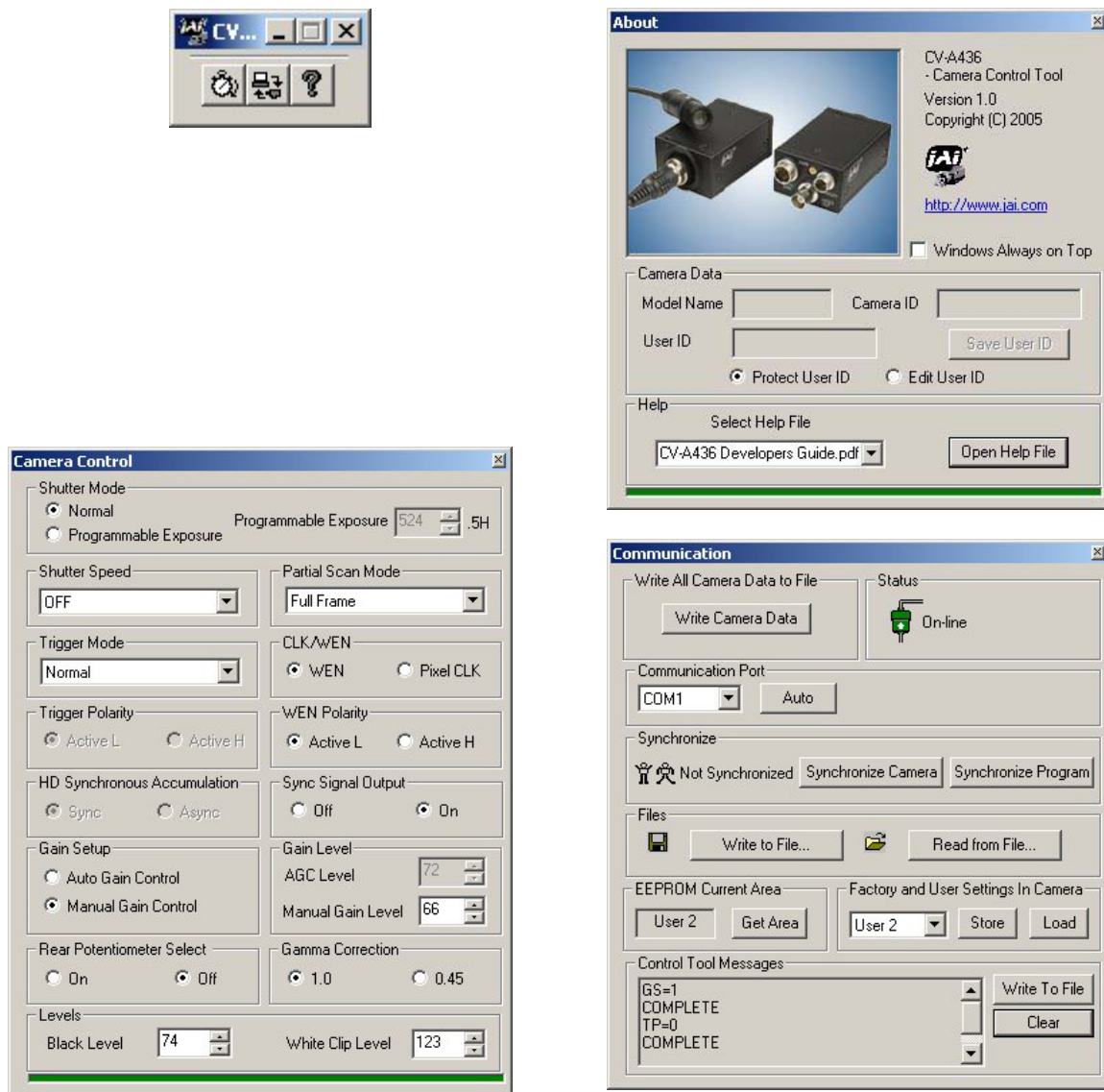
Fig. 27. Windows from Camera Tools.

7.3.2. Camera Control Tool Interface

The following description use A10CL as an example. Actual windows can differ, but it canbe used for the following explaination.

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.
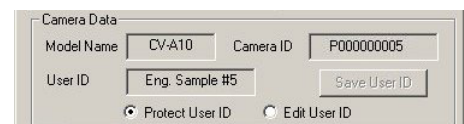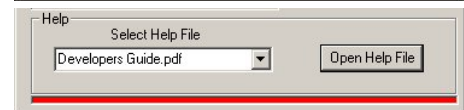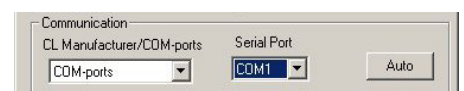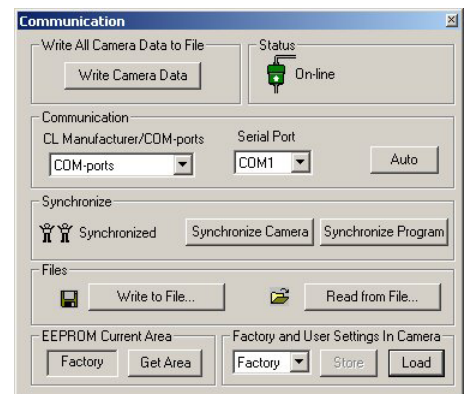
The Communication Window

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.
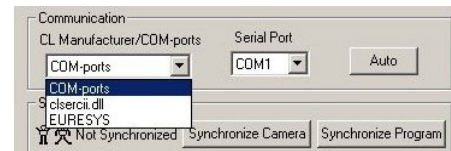
RS-232 communication:
1. Select 'COM-ports' from the 'CL Manufacturer/COM-ports' list Box.
2. Select the communication port, where the serial cable is connected to the camera from the 'Serial Port' list box or click the 'Auto' button to search for a camera on communication port 1 to 16.

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.
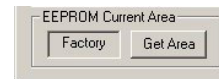The file is formatted as shown in the picture below:
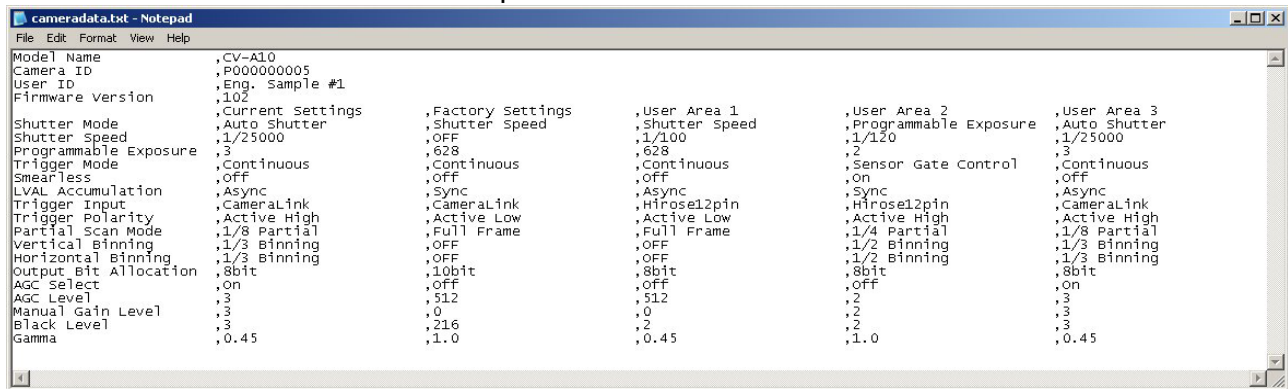
Note: The shown table is not for the actual camera.

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".
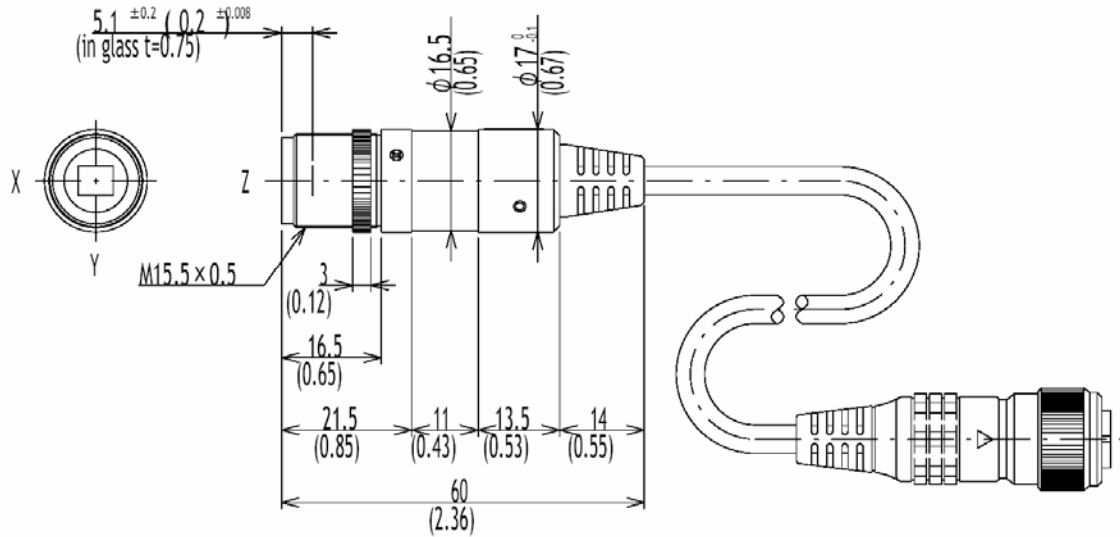
8. External Appearance and Dimensions
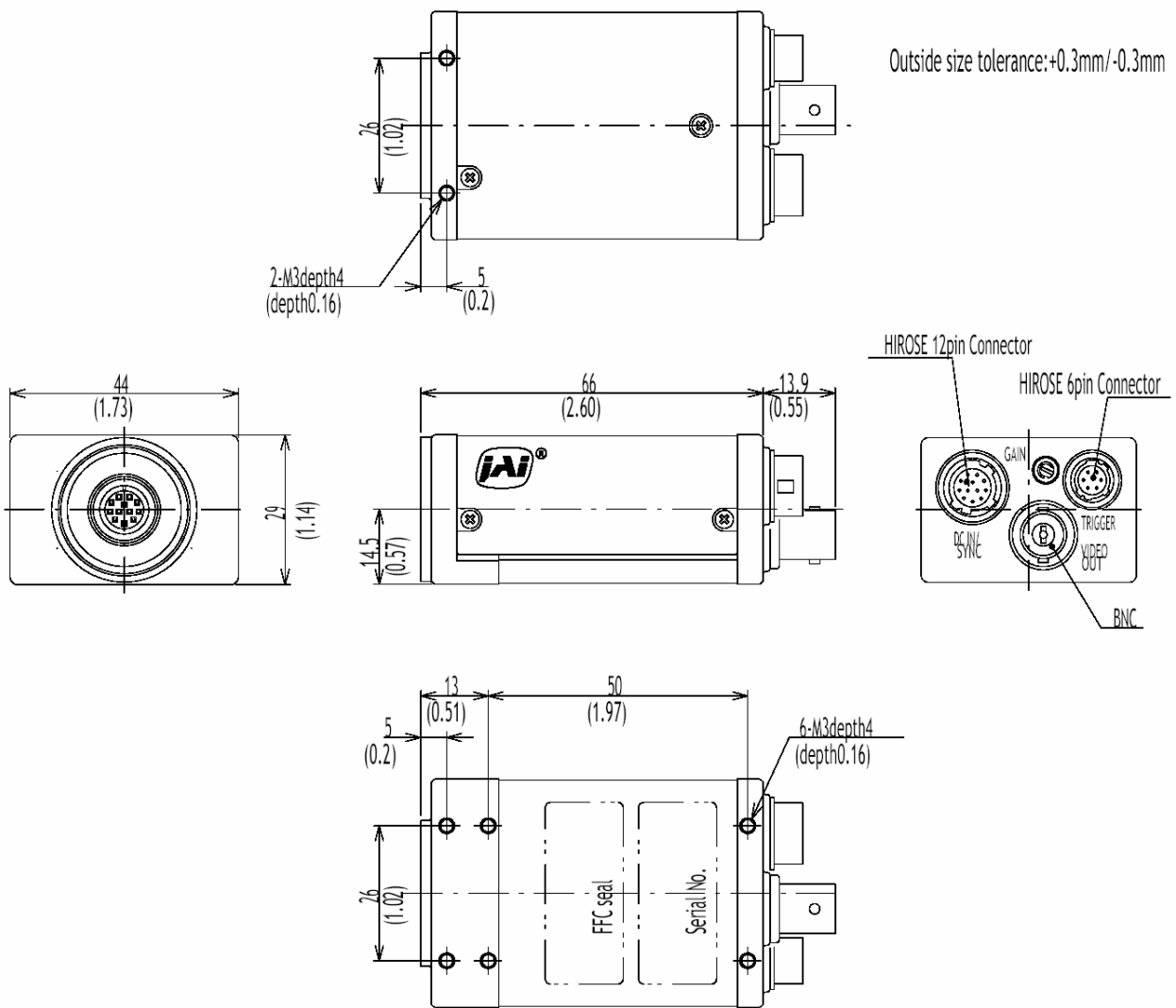

Fig. 29. Camera head dimensions

Fig. 30. Camera dimensions

9. Specifications

9.1. Specification table

| Specifications	CV-A436
Scanning system	Progressive 525 lines 60 frames/sec.
Pixel clock	25.54 MHz
Line frequency	31.46 kHz. (780 pixel clock/line)
CCD sensor	Monochrome 1/3" IT CCD. Sony ICX424AL
Sensing area	4.9 (h) x 3.7(v) mm
Cell size	7.4 (h) x 7.4 (v) μm
Effective pixels	659 (h) x 494 (v)
Pixels in video output. Full: 1/2 partial 1/3 partial 1/6 partial	648(h) x 492 (v) 60 frames/sec. 648(h) x 240 (v) 112 frames/sec. 648(h) x 160 (v) 158 frames/sec. 648(h) x 80 (v) 268 frames/sec.
Sensitivity on sensor	0.1 Lux (Max gain, 50% video)
S/N ratio	>53 dB
Video output (with/without sync)	Composite VS signal, 1.0 Vpp, 75 Ω Video signal 0.7 Vpp
Gamma	1.0 or 0.45
Gain Gain range	Manual – Automatic Man.: -3 to +12 dB – Auto.: 0 to +12 dB
Synchronization	Int. X-tal. Ext HD/VD or random trigger
HD/VD input/output	4 Vpp $\pm$2 V, 75 Ω (or TTL inut)
External H frequency input	31.46 kHz ±1%
Trigger input	4 Vpp $\pm$2 V, TTL
WEN output (write enable)	4 V, 75 Ω
EEN output (exposure enable)	4 V, 75 Ω
Pixel clock output	4 V, 75 Ω
Trigger modes	Continuous, EPS, PWC, Long time, Start/Stop and Smearless
Trigger accumulation	HD synchronous, HD a-synchronous
Readout modes	Frame delay, Smearless, Partial
Shutter speed Continous EPS	1/60 to 1/200,000 second 1/60 to 1/20,000 second
Programmable exposure	0.5 H to 523.5 H
Pulse width control	1 H to 1000 H
Start/stop	1/60 to 1/20,000 second
Long time exposure	2 frames to ∞
Frame-delay readout	Time from PWC trigger input to ext. VD input
Smearless readout	Reduced smear at high shutter speeds
Functions controlled by RS 232C	Trigger mode, shutter speed, shutter mode, scanning, gain, timing signal polarity
Functions controlled by internal DIP switches	VD input/output, HD input/output HD, VD 75 Ω termination on/off
Operating temperature	-5°C to +45°C.
Humidity	20 - 80% non-condensing
Storage temp./humidity	-25°C to 60°C./20% - 80 % non condensing
Vibration	10G (20Hz to 200Hz XYZ)
Shock	70G
Regulations	CE (EN50081-1, EN50082-2), FCC part 15
Power	12V DC $\pm$ 10%. 2 W
Lens mount	M15.5 x 0.5
Dimension/weight cam. head	ø17 x 46 mm. 25 g exclding cable
Cable length	2m. detachable at control unit
Dimensions control unit	29 x 44 x 66 mm (HxWxD)
Weight control unit	150 g

9.2. Spectral Sensitivity
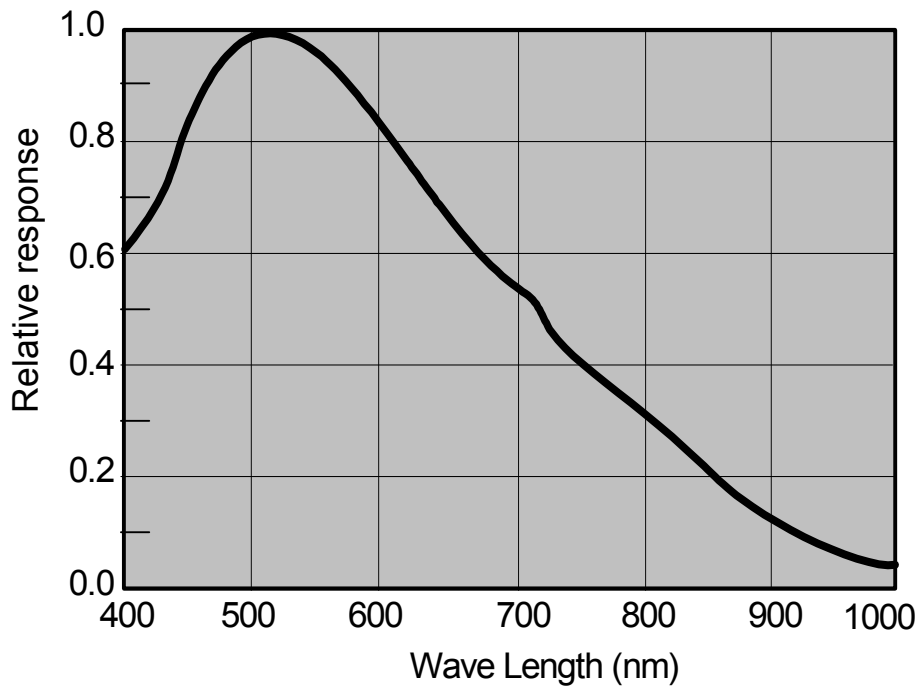
Fig. 30. Spectral sensitivity

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
All cameras produced are shipped in the condition that no blemished of CCD sensor are visible. In general, the CCD sensor can be affected by radiation, which makes photo diode defective and as the result, the CCD sensor will have blemishes. Be careful not to expose the camera by radiation during transportation and storage.
Since we learned that air shipment can cause blemishes by radiation, we recommend to use sea shipment instead.
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-A436**

       Revision: **(Revision A)**

       Serial No.   ……………..

Users Mode Settings

Users Modifications

CE

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-50082-2

JAi ®

THE MECHADEMIC COMPANY

Supplement

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

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

重要注意事项

有毒，有害物质或元素名称及含量表

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

部件名称	有毒有害物质或元素					
	铅 （Pb）	汞 （Hg）	镉 （Cd）	六价铬 （Cr(VI)）	多溴联苯 （PPB）	多溴二苯醚 （PBDE）
摄像头外壳	×	○	○	○	○	○
电缆线夹	×	○	○	○	○	○
………	………	………	………	………	………	………

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

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