SONY

CCD B/W DIGITAL CAMERA MODULE

XCD-SX900
XCD-X700

User's Guide

(Ver. 1.0) —English—

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OUTLINE

The XCD-SX900/X700 is a high-resolution industrial monochrome digital video camera utilizing a 1/2-type PS IT CCD. The IEEE1394-1995 digital interface realizes a transfer speed of 400M bps. Furthermore, use of digital signals ensures against “image deterioration” considered a serious problem in the industrial image processing field. The square pixels eliminate the need for aspect ratio conversion in the image processor.
The vibration-resistance feature also allows use of the XCD-SX900/X700 in various industrial inspection devices.

◇ What is the IEEE1394?

The IEEE1394 is the standard serial bus for sending and receiving digital data. It is prescribed as “IEEE* Std. 1394-1995”. The most outstanding feature of this interface is that it realizes transfer speeds of up to 400M bps and can handle large image data size. The interface is also capable of “Isochronous transmission” which transmits data real-time, up to 64 supports independent. Connectors can be inserted and disconnected with the power supplied, and no terminators and no ID settings such as the SCSI are required.

* The Institute of Electrical and Electronics Engineers, Inc.

MAIN FEATURES

◇ 1/2-type progressive scan IT CCD with square pixels

◇ High-speed digital interface IEEE1394

◇ High-resolution

The XCD-SX900 adopts an SXGA-compatible 1.45M-pixel CCD while the XCD-X700 adopts an XGA-compatible 800K-pixel CCD to produce high-picture quality images.

◇ External trigger function

The external trigger shutter function allows the image exposure to be coordinated with external equipment and moving objects. The exposure time can be controlled via software over the 1394 bus.

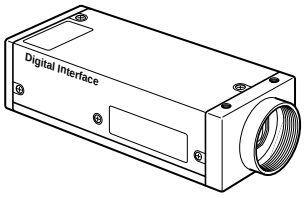
◇ Partial scan output image format

The XCD-SX900/X700 supports partial scan output image format. Use of this function enables frame rates faster than normal speeds, thus enabling efficient image capture.

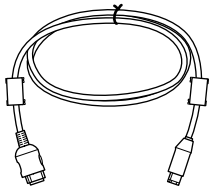
◇ C-mount

◇ High vibration-resistance structure

SYSTEM COMPONENTS

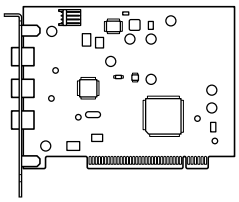


Video Camera Module
XCD-SX900/X700

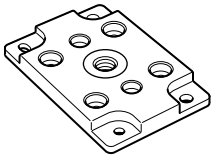


IEEE1394 Cable
(6-pin, 4.5 m)

C-mount Lens
VF2509 (Canon) (Option)



Host Adapter Card
DFWA-400 (Option)

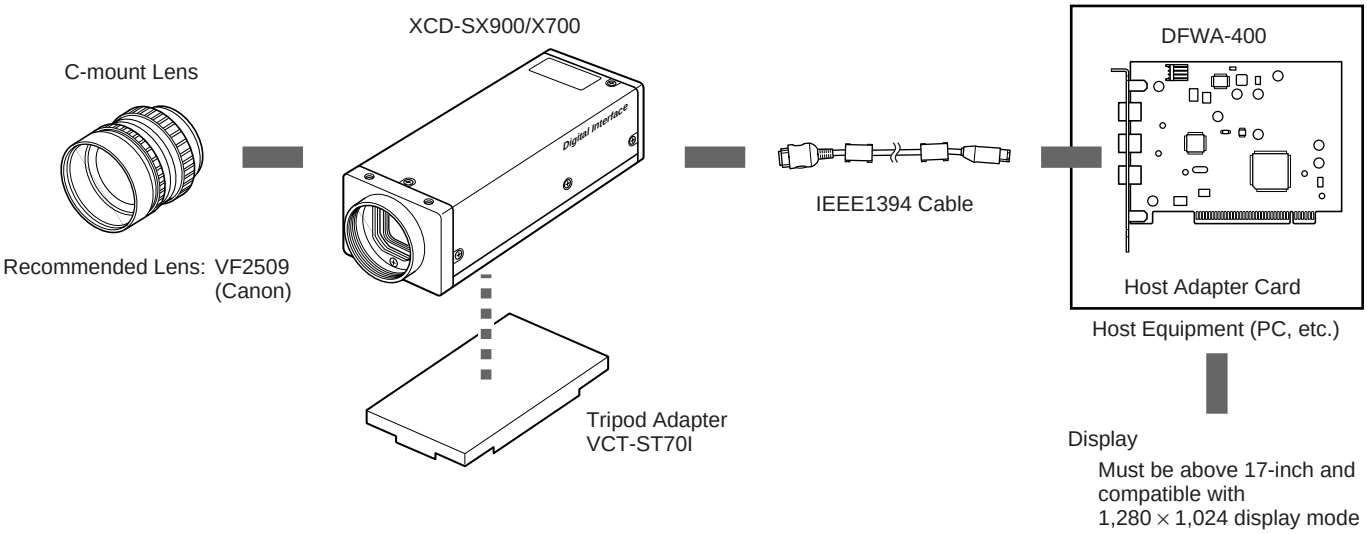


Tripod Adapter
VCT-ST70I (Insulated type)
(Option)

SPECIFICATIONS

Image sensor	:	1/2-type progressive scan IT transfer CCD
Number of effective pixels		
XCD-SX900	:	1,392 (H) × 1,040 (V)
XCD-X700	:	1,034 (H) × 779 (V)
Output image size (Max.)		
XCD-SX900	:	SXGA : 1,280 (H) × 960 (V)
XCD-X700	:	XGA : 1,024 (H) × 768 (V)
Cell size		
XCD-SX900	:	4.65 µm (H) × 4.65 µm (V)
XCD-X700	:	6.25 µm (H) × 6.25 µm (V)
Interface format	:	IEEE1394-1995
Video mode		
XCD-SX900	:	Format-2, Mode-2 1,280 × 960 Y/Format-7
XCD-X700	:	Format-1, Mode-5 1,024 × 768 Y/Format-7
Frame rate		
XCD-SX900	:	7.5/3.75 fps
XCD-X700	:	15/7.5 fps
Transfer speed	:	400M/200M bps
Lens mount	:	C-mount
Flange back	:	17.526 mm
Minimum illumination	:	4 lx (Gain +18 dB, F0.95)
Gamma	:	γ = 1 (Fixed)
Gain	:	Manual (0 to 18 dB)
Shutter speed		
XCD-SX900	:	1/100,000s to 1/10,000s (High speed)
		1/5,880s to 1/7.5s (Standard) *Variable by 125 µs
		1/7.5s to 2s (Low speed) *Variable by 1/7.5s
XCD-X700	:	1/100,000s to 1/20,000s (High speed)
		1/8,330s to 1/15s (Standard) *Variable by 83.6 µs
		1/15s to 2s (Low speed) *Variable by 1/15s
External trigger shutter	:	Available
Partial scan function	:	Available (4 × 4 16 areas)
Trigger in	:	TTL level (via BNC connector)
Protocol	:	1394-based Digital Camera Specification version 1.20
Power supply	:	DC +8 to +30 V (from IEEE1394 cable)
Power consumption	:	3.0 W
Operating temperature	:	–5 to +45°C
Storage temperature	:	–30 to +60°C
Guaranteed temperature of performance	:	0 to +40°C
Operating relative humidity	:	20 to 80% (No condensation)
Storage relative humidity	:	20 to 95% (No condensation)
Vibration resistance	:	10G (20 to 200 Hz, 20 minutes for each direction-X, Y, Z)
Shock resistance	:	70G
MTBF	:	59,549 Hrs. (Approx. 6.8 years)
Dimensions	:	44 (W) × 33 (H) × 116 (D) mm
Mass	:	250 g
Accessories	:	IEEE1394 cable (Adopts 6-pin connector with latch) (1)
		Lens mount cap (1)
		Clamp filter (2)
		Operating Instructions (1)

CONNECTION



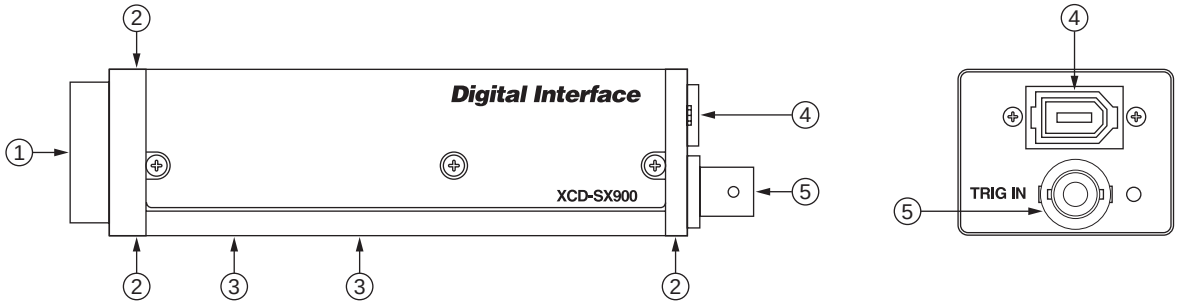
◇ Recommended specifications for personal computer (PC)

The following specifications are recommended when using the personal computer (PC) as the host equipment.

Processor	: Pentium 500 MHz or more
Empty main memory	: 40 MB or more
Video memory	: 8 MB or more
Display mode	: Can display 1,280 × 1,024
Expansion slot	: With empty slot of PCI bus
OS	: Windows* 98 or Windows* NT4.0 (When not using DFWA-400 as a host adapter card, OS is not limited to Windows 98 or Windows NT4.0.)

* “Windows” is a trademark of Microsoft Corporation, registered in the U.S.A. and other countries.

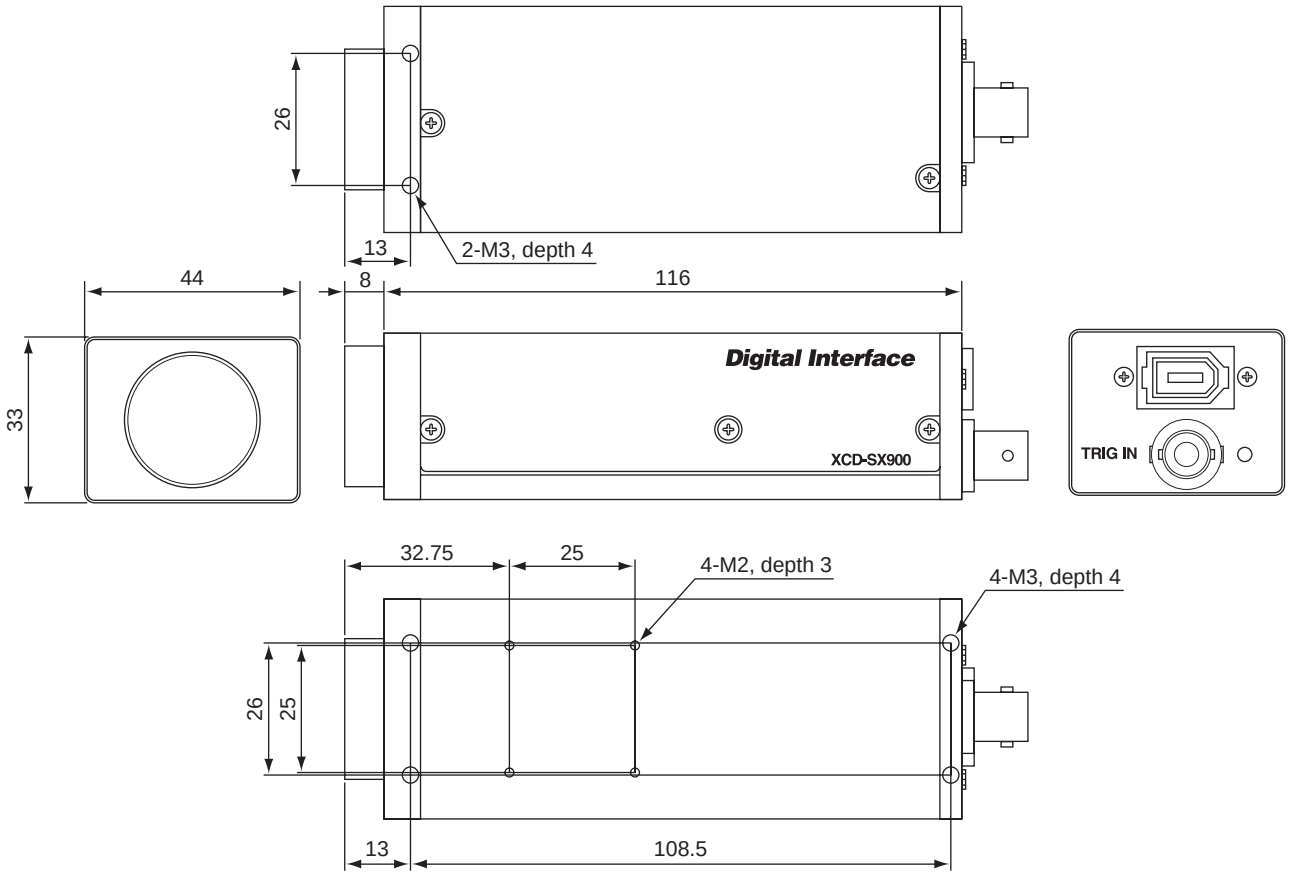
NAMES AND FUNCTIONS OF PARTS



① Lens mount section (C-mount)
② Holes for affixing camera
Screw holes processed at high precision for lens mounted surface.
③ Screw holes for attaching tripod adapter (VCT-ST70I)
④ IEEE1394 connector : Video out/Control signal IN/OUT
⑤ BNC connector : Trigger IN terminal

DIMENSIONS

XCD-SX900
XCD-X700



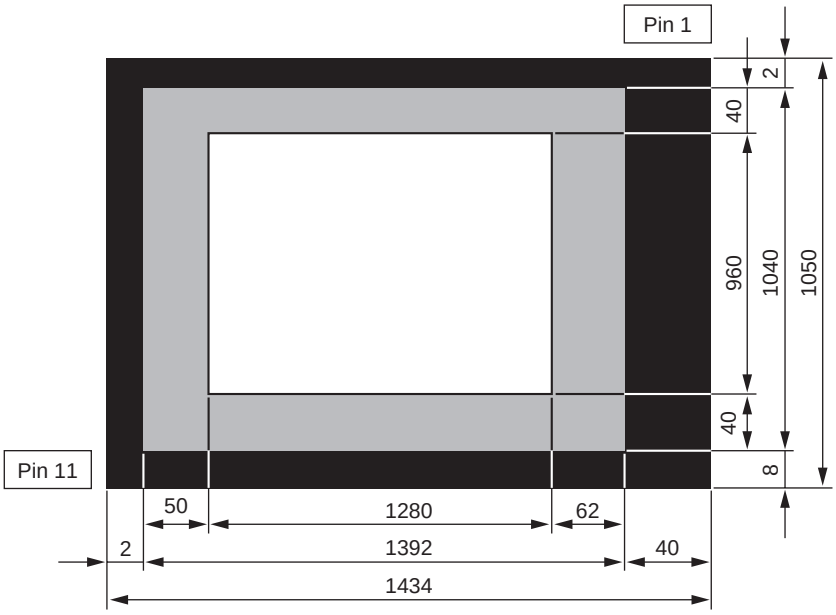
Unit: mm

CCD PIXEL LOCATION

Top View

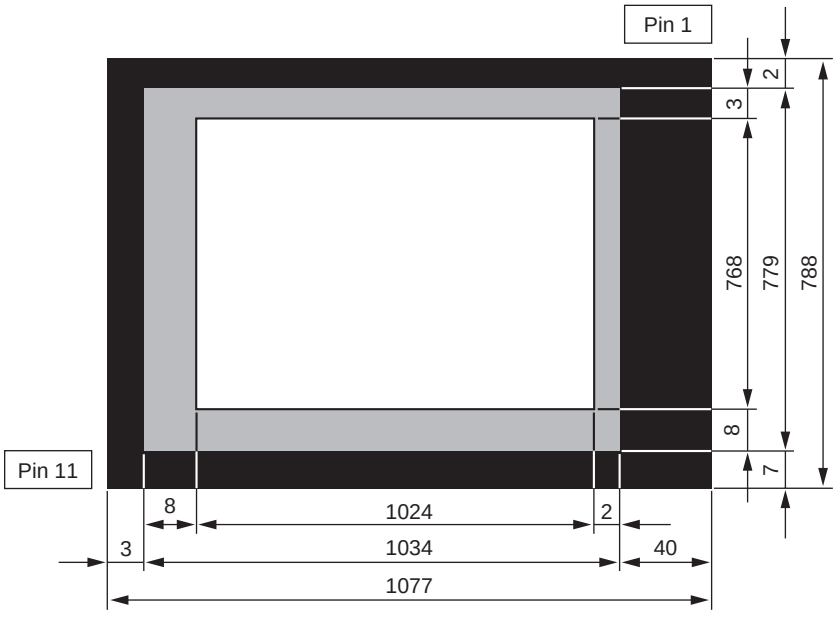
XCD-SX900

Total number of pixels : 1,434 (H) × 1,050 (V)
Number of effective pixels: 1,392 (H) × 1,040 (V)
Number of output pixels : 1,280 (H) × 960 (V)



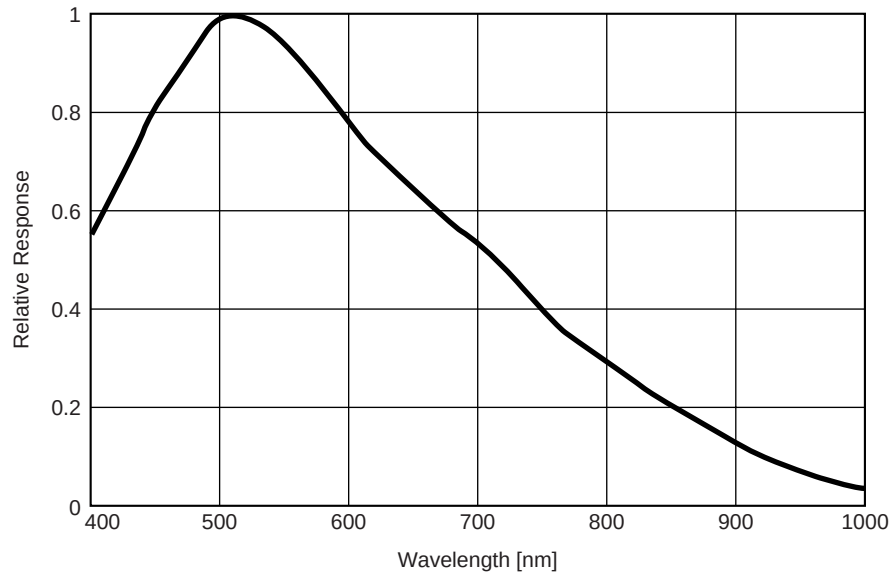
XCD-X700

Total number of pixels : 1,077 (H) × 788 (V)
Number of effective pixels: 1,034 (H) × 779 (V)
Number of output pixels : 1,024 (H) × 768 (V)

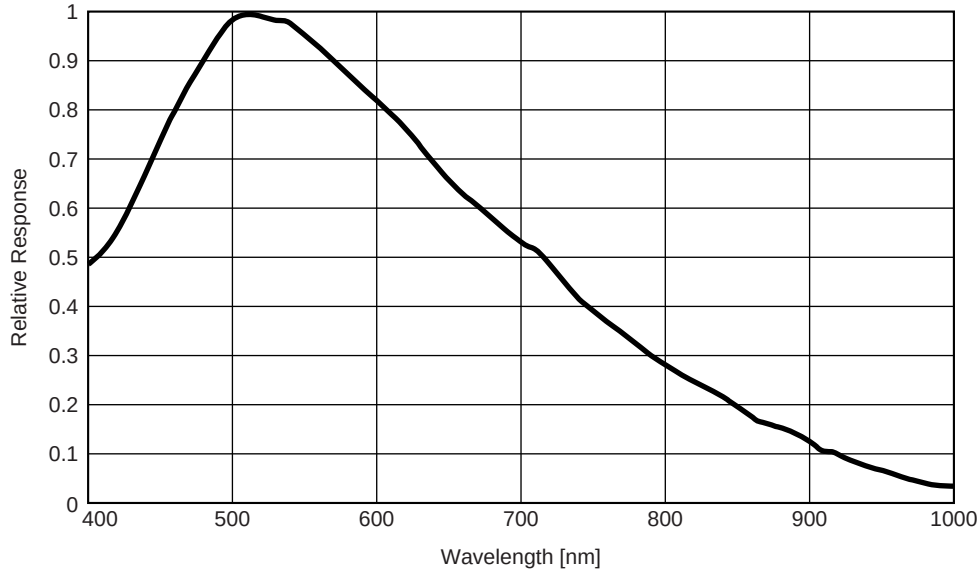


SPECTRAL CHARACTERISTICS (STANDARD VALUES)

XCD-SX900



XCD-X700



GAIN

This camera provides a manual variable gain function. The variable range is 0 to +18 dB. This range is designed so that it can be divided into 181-step.
However, since the variable characteristics of the gain control amplifier are not linear, the changes in gain per step set are not even, resulting in a difference between the changes at the low gain side and high gain side.
At factory default setting, the gain is set to 0 dB.

To control the gain, set the Command Status Register value in the camera.
By using the demonstration software provided with the optional host adapter card DFWA-400, the gain can be easily controlled from the control panel displayed on the window and by operating the slide bar in the panel.
To set the Command Status Register using commands, refer to page 20 of this User's Guide.

EXPOSURE TIME SETTINGS

This camera provides a manual variable shutter function. The variable range is 1/100,000s to 2s. This range is divided into high speed, standard, and low speed. The changes in the exposure time per one step set differ according to the area.

◇ High-speed area

Can be set to the following values.
1/100,000, 1/50,000, 1/20,000, 1/10,000 (XCD-SX900 only)

◇ Standard area

Can be set for one horizontal scanning period (1H) of the respective cameras.
XCD-SX900 : 1/5,880s to 1/7.5s range can be set per 125 μs
XCD-X700 : 1/8,330s to 1/15s range can be set per 83.6 μs

◇ Low-speed area

Can be set for one vertical scanning period (1V) of the respective cameras.
XCD-SX900 : 1/7.5s to 2s range can be set per 1/7.5s
XCD-X700 : 1/15s to 2s range can be set per 1/15s

At factory default setting, the exposure time is set as follows:

XCD-SX900 : 1/70s
XCD-X700 : 1/90s

To control the exposure time, set the Command Status Register value in the camera.
By using the demonstration software provided with the optional host adapter card DFWA-400, the exposure time can be easily controlled from the control panel displayed on the window and by operating the slide bar in the panel.
To set the Command Status Register using commands, refer to page 20 of this User's Guide.

SHUTTER

Normal Shutter Mode

Shutter mode which repeats exposure and readout according to the continuous VDs and is useful for capturing continuous images. Internal camera operations during normal shutter mode can be broadly divided into the following three options:

a) When exposure time is below 1 frame

b) When exposure time is over 1 frame

c) When frame rate is reduced

The frame rate of the camera is as follows:

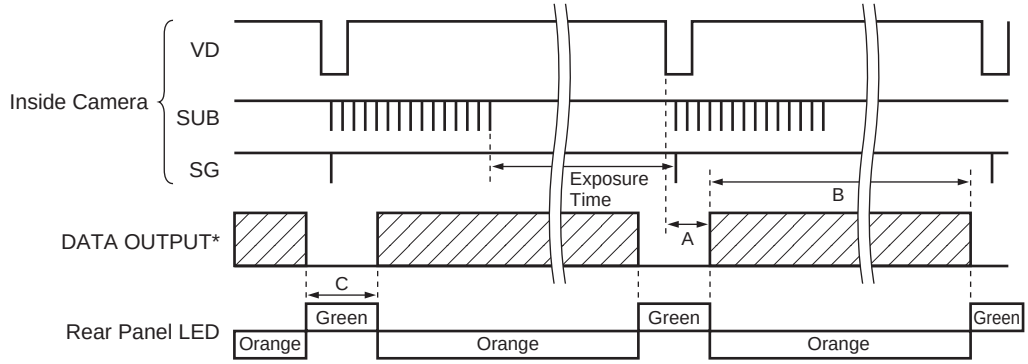
Camera	When power on	When frame rate is reduced
XCD-SX900	7.5 fps = approx. 133 ms	3.75 fps = approx. 267 ms
XCD-X700	15 fps = approx. 67 ms	7.5 fps = approx. 133 ms

Frame Rate of Camera

SHUTTER

a) When exposure time is below 1 frame

VDs are generated continuously inside the camera and images are sent accordingly. The images are output at the cycle of the frame rate set in the camera specifications.



* Image data output from camera

Operations of Normal Shutter

For the image output timing based on the falling edge of VDs generated inside the camera, image data output starts at the point the A period is passed, and the image data is output during the B period.

Camera	A [ms]	B [ms]	C [ms]
XCD-SX900	Approx. 8.0	Approx. 120	Approx. 13
XCD-X700	Approx. 2.4	Approx. 64	Approx. 2.6

Time until Data is Read Out and Output Period of Data

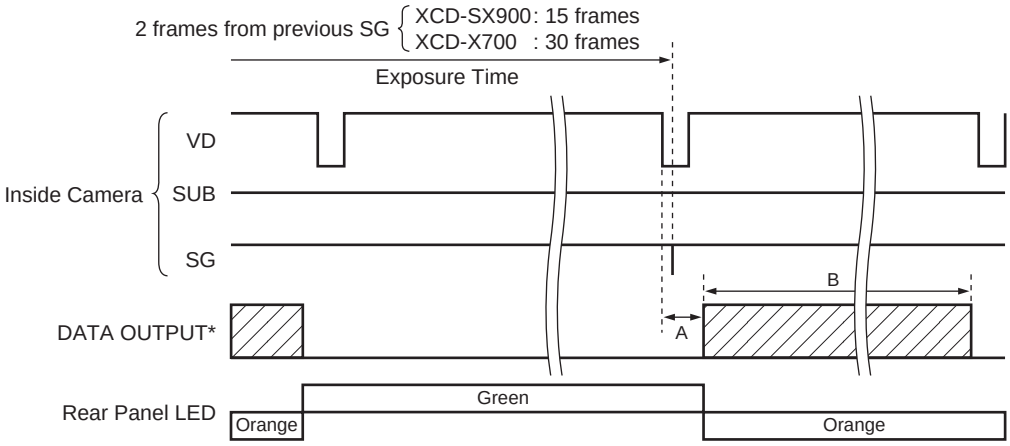
The operations during the A period cannot be observed from outside the camera. However unlike current cameras, no special settings such as inputting VDs at this timing are required with the XCD-SX900 or XCD-X700. By simply setting data input according to the camera specifications*, the image data output will be input to the computer. When the frame rate is not to be reduced for shutter speeds below 1 frame, C is set while no images are output.

* 1394-based digital camera protocol (Ver. 1.20)

SHUTTER

b) When exposure time is over 1 frame

When exposure time over 1 frame are specified, the A period until images are output from the VDs and B period outputting images are the same as the above case. However, no images will be output during the exposure time. Only when images are output from the camera data will be output to the IEEE1394 bus in the same way as the frame rate set in the camera specifications. In addition, as the time in which no data is transmitted is long, the actual frame rate will drop. For instance, even if a 15 fps frame rate is set for the XCD-X700, actually less than 7.5 fps frame rate will be set when the shutter speed is set to 1/7.5s.



* Image data output from camera

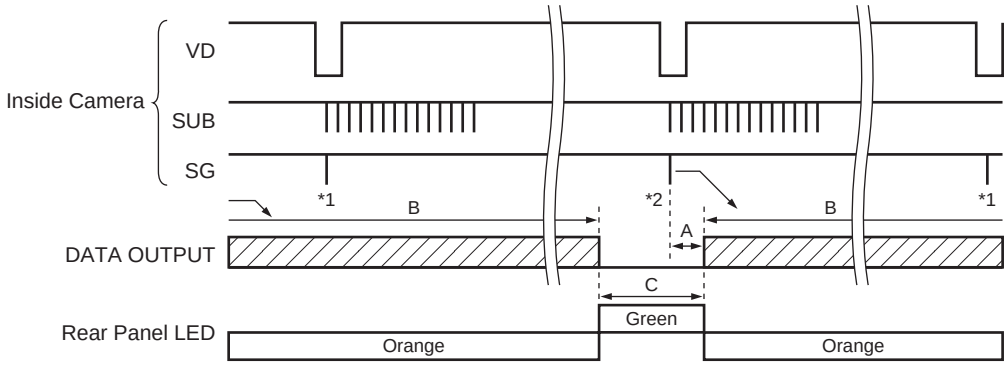
Normal Shutter of Exposure Time over 1 Frame

SHUTTER

c) When frame rate is reduced

When the output frame rate is reduced (3.75 fps of XCD-SX900, 7.5 fps of XCD-X700), images will be read out from the CCD for every VD. However, as every other image is used, the images read out by the SG* at *1 in the figure below will not be used. The images read out at *2 are output during the B period.

* SG: Sensor Gate pulse



Normal Shutter When Frame Rate is Reduced

Camera	A [ms]	B [ms]	C [ms]
XCD-SX900	Approx. 8	Approx. 240	Approx. 26
XCD-X700	Approx. 2.4	Approx. 128	Approx. 5

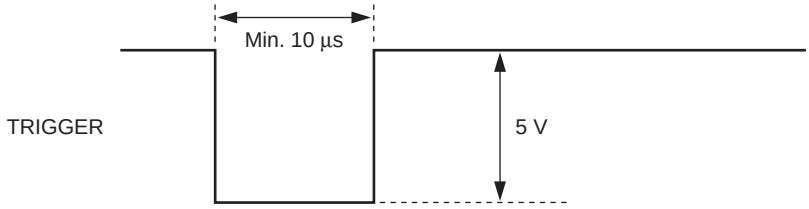
Time until Data is Read Out and Output Period of Data

NOTE **: When the frame rate is reduced and the exposure time of the shutter speed is set to 2 frames, the frame rate will be divided in half and the exposure time will be set to 2 frames.**

SHUTTER

Trigger Shutter

Trigger shutter is useful for capturing the images according to the external trigger. It can also be used for capturing images at same time with several cameras. The external trigger is input to the BNC connector of the rear panel. As the input signal 5 V pulse is required. As the falling edge of the signal is detected as the start of trigger, width of the trigger is unrelated to camera operations. The width of the trigger pulse must be set 10 µs or more.

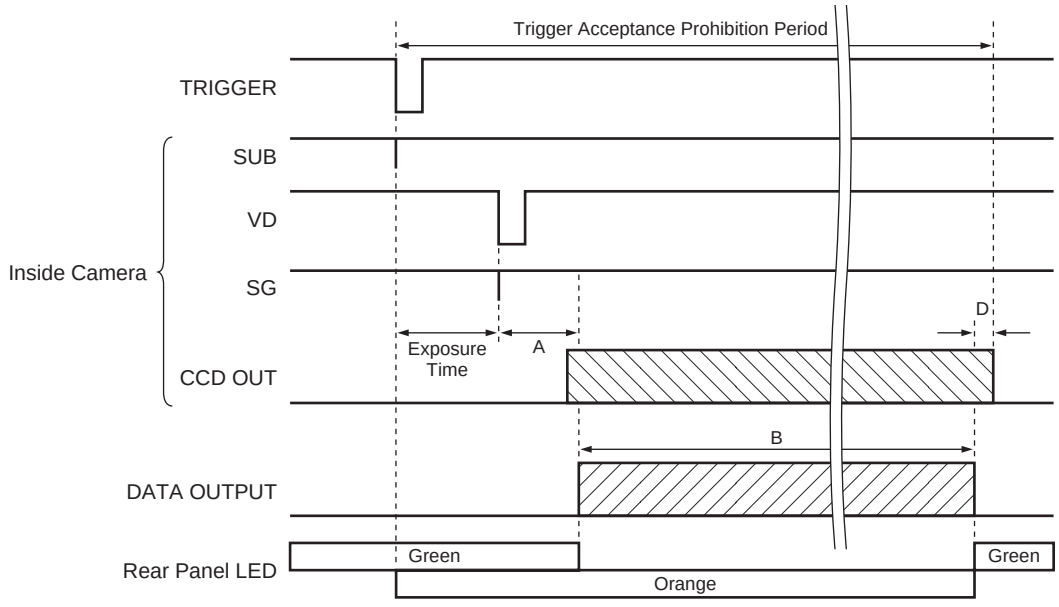


Trigger Pulse

◇ Internal operations of camera in trigger shutter operation mode

Immediately after trigger is input, an approximate 3 µs width SUB pulse is generated and exposure commerces. After the exposure time set in the camera specifications passes, VDs will be generated inside the camera. VDs are generated about 10 µs before the end of the exposure time.

After the A period passes from the falling edge of the VD, images are output during the B period.



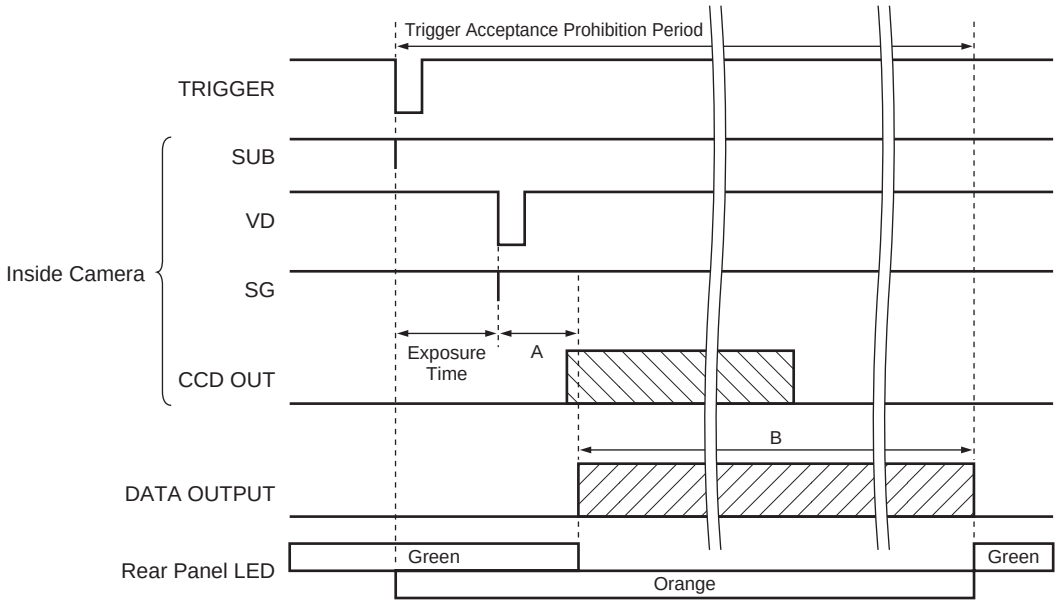
Trigger Shutter Operations

SHUTTER

Camera	A [ms]	B [ms]	D [ms]
XCD-SX900 (7.5 fps)	Approx. 8	Approx. 120	Approx. 4.2
XCD-X700 (15 fps)	Approx. 2.4	Approx. 64	Approx. 0

Time until Data is Read Out and Output Period of Data

The trigger acceptance prohibition period continues until all of CCD image has been transferred out of the camera. When the transfer frame rate is reduced (3.75 fps of XCD-SX900, 7.5 fps of XCD-X700), data will continue to be transferred even after readout of image has been completed as shown in the figure below. The trigger prohibition period continues until data transfer ends. All trigger inputs to the camera during the “Trigger Acceptance Prohibition Period” will be ignored.



Trigger Shutter Operations When Frame Rate is Reduced

SHUTTER

When the exposure time is 1/100,000s, the shortest trigger interval is approximately 133 ms for XCD-SX900 and approximately 67 ms for XCD-X700. In most cases, the exposure time is longer, so the acceptable trigger interval will consequently be longer for the exposure time increased. Likewise when the frame rate is reduced, it takes time to output images from the camera, thus the trigger interval becomes longer. If the frame rate is not be reduced, the trigger interval will be as follows for example.

Camera	Exposure Time		
	1/100,000s	1/1,000s	1/100s
XCD-SX900 (When set to 7.5 fps)	Approx. 133 ms	Approx. 134 ms	Approx. 143 ms
XCD-X700 (When set to 15 fps)	Approx. 67 ms	Approx. 68 ms	Approx. 77 ms

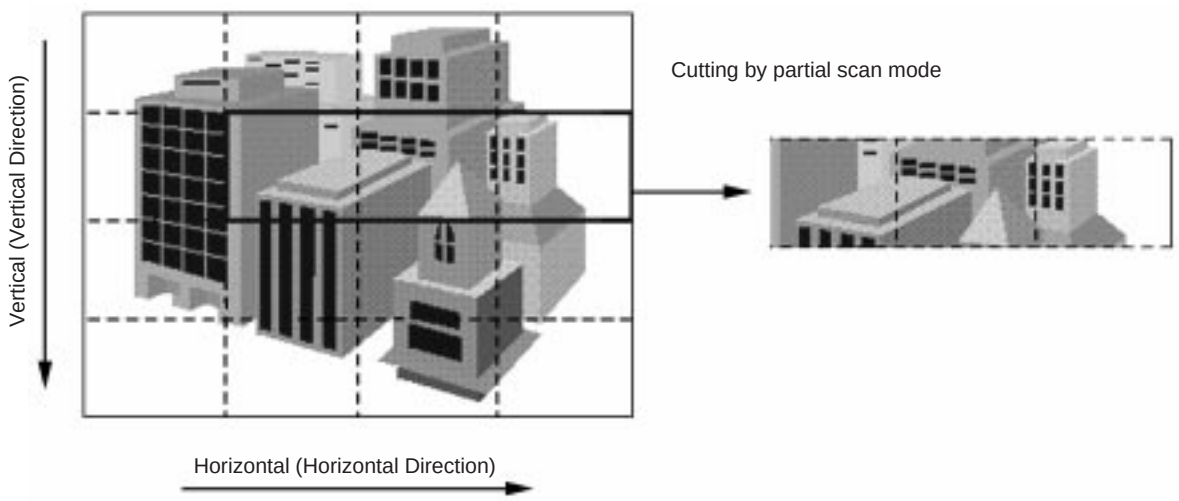
Example of Acceptable Trigger Interval

The following equation is one method of roughly calculating the acceptable trigger interval.

Trigger interval = Exposure time + Frame rate

PARTIAL SCAN MODE

The partial scan mode is a function for outputting part of the full images a region of interest on the whole image. Based on the unit cell as the unit, continuous parts can be selected. Only rectangles can be selected. The screen cannot be cut in convex and L shapes. The output image can be any rectangle drawn on an imaginary grid on the full image (shown here a 4 × 4 grid on the full CCD).

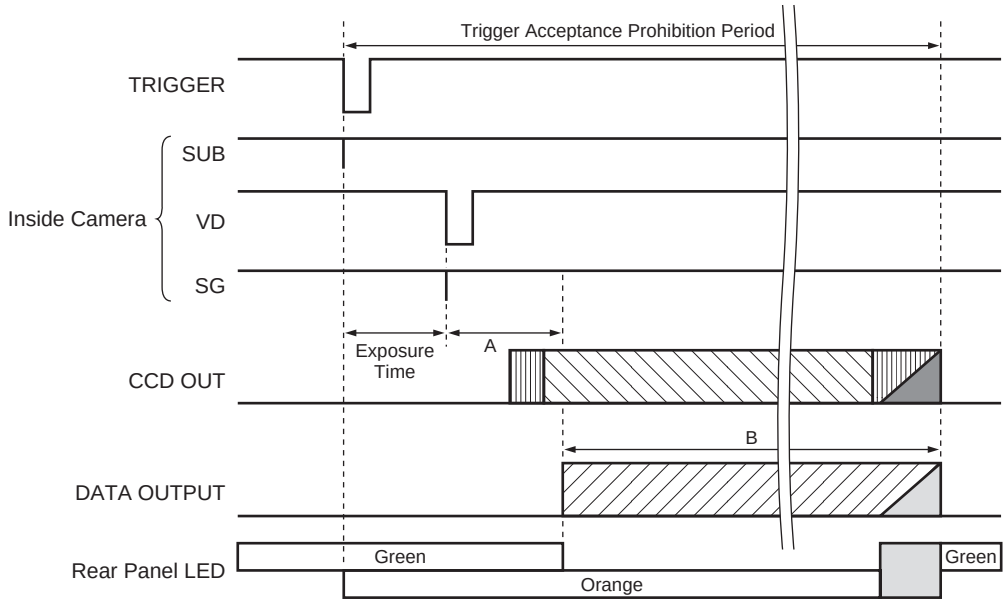


The XCD-SX900 and XCD-X700 partial scan mode can only be used with external trigger. The partial scan mode does not function in normal continuous mode. The unit size of the XCD-SX900 and XCD-X700 is 1/16 of the whole screen (screen divided into four parts vertically and horizontally).

The XCD-SX900 and XCD-X700 partial scan mode is designed to increase the frame rate when the number of vertical lines in the output image is reduced. The trigger interval is shortened when the height cut in the vertical direction is small, in addition to the partial readout function. No matter how small the width cut in the horizontal direction, the trigger interval cannot be shortened. (Users of the Sony camera adapter CMA-87 should take it as the same mechanism as the high-rate function when combining the XC-7500/XC-8500CE and CMA-87. However, cutting in the horizontal direction is not possible for the CMA-87.)

PARTIAL SCAN MODE

Although the internal operations of the camera are the same as the sequence of the trigger shutter, the timing at which images are output from the CCD will vary according to the location of the select output image. Therefore the A period will differ accordingly and the B period will also change according to the number of lines in the output image.



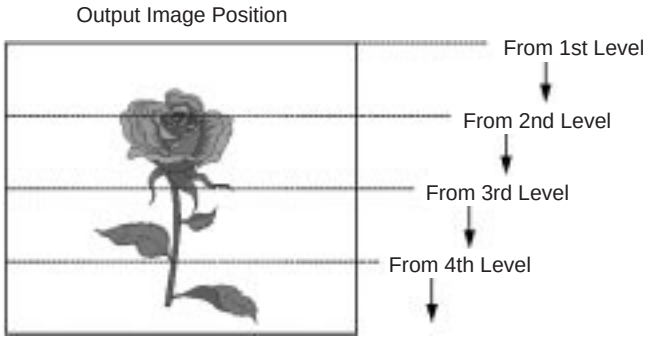
means that the CCD OUT or DATA OUTPUT is longer in some cases. In other words, the slower one will determine the trigger prohibition period. However the trigger interval will not be affected considerably as the difference is under several ms.

Outline of Internal Operations of Camera During Partial Scan Operation Mode

The A period until images are output after exposure ends is according to the readout position below.
This does not depend on the width of the output image.

Camera	1st Level	2nd Level	3rd Level	4th Level
XCD-SX900	Approx. 4.5 ms	Approx. 6 ms	Approx. 7.5 ms	Approx. 9 ms
XCD-X700	Approx. 2.5 ms	Approx. 3.5 ms	Approx. 4 ms	Approx. 4.5 ms

Time to Image Output

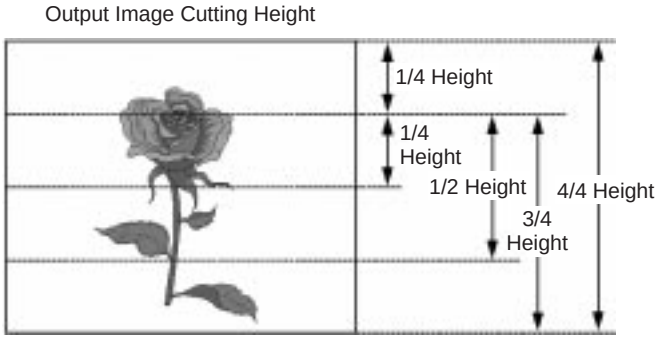


PARTIAL SCAN MODE

The B period in which data is output to the IEEE1394 bus is as follows according to the height of the output image. This does not depend on the width of the output image.

Camera	1/4 Height	1/2 Height	3/4 Height	4/4 Height
XCD-SX900	Approx. 30 ms	Approx. 60 ms	Approx. 90 ms	Approx. 120 ms
XCD-X700	Approx. 16 ms	Approx. 32 ms	Approx. 48 ms	Approx. 64 ms

Output Period of Image



The acceptable trigger interval in the partial scan mode can be made shorter than the normal trigger shutter by making the height of the output image small. The acceptable trigger interval does not depend on the output image position on the full CCD. If the cutting height is consistent, it will become more or less consistent. The output image width has no influence on the acceptable trigger interval.

Camera	1/4 Height	1/2 Height	3/4 Height	4/4 Height
XCD-SX900	Approx. 39 ms	Approx. 68 ms	Approx. 96 ms	Approx. 125 ms
XCD-X700	Approx. 21 ms	Approx. 36 ms	Approx. 52 ms	Approx. 67 ms

Acceptable Trigger Interval at Shutter Speed of 1/100,000s

However, this applies when the shortest exposure time is 1/100,000s. The acceptable trigger interval is the exposure time added to the above. For example, the acceptable trigger interval when the exposure time is 1 ms (1/1,000s) is as follows:

Camera	1/4 Height	1/2 Height	3/4 Height	4/4 Height
XCD-SX900	40 ms	69 ms	97 ms	126 ms
XCD-X700	22 ms	37 ms	53 ms	68 ms

Acceptable Trigger Interval at Shutter Speed of 1/1,000s

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

● In the following example, the CSR address is described by the lower 32 bits of 64 bits.

Example : CSR F0F00614h means:
Bus_ID, Node_ID, FFFF F0F0 0614h

● When describing the 32-bit command set for CSR in Hex, bit 0 is described as MSB (Most Significant Bit).

Example : 82012345h = 10000010 00000001 00100011 01000101b
: :
bit 0 bit 31

NOTE **: Leave more than 2 ms after performing each CSR reading or writing before executing the next reading or writing.**

==========

CSR F0F00000h Camera Initialize Register

Suspends image data transmission by Isochronous and returns each CSR setting to the setting at shipment. Returns to CSR F0F00000h = 00000000h when camera initialization is completed.
Before resuming image data transmission by Isochronous, perform the designated settings for each CSR.

Camera Initialize Start Command: 80000000h

==========

By writing the command from the CSR F0F00600h to CSR F0F00614h, image transmission by Isochronous is controlled.

CSR F0F00600h Current Frame Rate

Specify the Frame Rate.

XCD-SX900 :

Frame Rate	Command
1 (3.75 fps)	20000000h
2 (7.5 fps)	40000000h

XCD-X700 :

Frame Rate	Command
2 (7.5 fps)	40000000h
3 (15 fps)	60000000h

NOTE **:**
● Set when CSR F0F00614h Iso_EN is OFF.
● For the CSR F0F0081Ch Shutter setting of 82000nnnh, when nnn < 7FFh, as the extended exposing mode is set, Isochronous transmission at a lower frame rate than that set here may be performed.
In the Ext.Trigger and partial scan modes, the frame rate set here will not be effective. (As it depends on the cycle of the external trigger signal.)

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

CSR F0F00604h Current Video Mode

Specify the Video Mode.

XCD-SX900 :

Video Mode	Command	
2 (1,280 × 960 Y)	40000000h	(Only when set to Format2)
0 (partial scan)	00000000h	(Only when set to Format7)

XCD-X700 :

Video Mode	Command	
5 (1,024 × 768 Y)	A0000000h	(Only when set to Format1)
0 (partial scan)	00000000h	(Only when set to Format7)

NOTE : Set when CSR F0F00614h Iso_EN is OFF.

CSR F0F00608h Current Video Format

Specify the Video Format.

XCD-SX900 :

Video Format	Command
2 (1,280 × 960 Y)	40000000h
7 (partial scan)	E0000000h

XCD-X700 :

Video Format	Command
1 (1,024 × 768 Y)	20000000h
7 (partial scan)	E0000000h

NOTE : ● Set when CSR F0F00614h Iso_EN is OFF.
● When set to Format7, the Ext.Trigger mode is set automatically. Isochronous transmission will be performed for one screen at the falling edge of the external trigger signal.

CSR F0F0060Ch Isochronous Channel, Transmit Speed

Specify Isochronous Channel (0 – 0Fh), Transmit Speed (200M, 400M bps).

Speed	Command
1 (200M bps)	n1000000h
2 (400M bps)	n2000000h

n: Isochronous Channel 0 – Fh

NOTE : Set when CSR F0F00614h Iso_EN is OFF.

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

CSR F0F00614h Isochronous Transmission Start/Stop

Set the Start/Stop of image transmission by Isochronous.

Start : Command = 80000000h
Stop : Command = 00000000h

NOTE : ●Before setting Start, set the CSR F0F00600h – F0F0060Ch.
●If CSR settings related to Isochronous are inappropriate, the camera returns the CSR F0F00614h value to 00000000h, and no isochronous transmission will be performed. In this case, set the correct value for the inappropriate CSR, and then set the Start Command: 80000000h for CSR F0F00614h again.
●When set to Format7, after setting Start Command: 80000000h for CSR F0F00614h, perform isochronous transmission by inputting the external trigger signal.

CSR F0F00618h Memory Save

Memorize the current camera settings (Shutter, Gain, Trigger_Mode) in the Memory Channel specified by CSR F0F00620h. The settings will be preserved in the memory even when the camera power is turned off.

Execute: Command = 80000000h

NOTE : ●Before setting Execute, set the CSR F0F00620h Memory Save ch. If this setting is not performed correctly, Memory Save will not be executed.
●When the execution of Memory Save is completed, the CSR F0F00618h value will be returned to 00000000h. Do not write other commands before completing the execution of Memory Save.

CSR F0F00620h Memory Save Channel

Specify the Memory Channel (ch1, ch2) for memorizing the current camera settings.

ch1: Command = 10000000h
ch2: Command = 20000000h

CSR F0F00624h Current Memory Channel

Read out the camera settings (ch1, ch2) memorized in the CSR F0F00618h Memory Save or the factory settings from the memory, and set in the camera.

Channel	Command
Factory	00000000h
ch1	10000000h
ch2	20000000h

NOTE : The CSR F0F00624h settings are memorized in the nonvolatile memory in the camera. They are effective even when the camera power is turned on the next time.

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

By writing a command in the CSR F0F00830h from the CSR F0F0081Ch, the Shutter, Gain, and Trigger Mode of the camera are controlled.

CSR F0F0081Ch Shutter

Set the exposure time of the electronic shutter.

a) Manual adjustment

Command = 82000nnnh

<When XCD-SX900> nnn: Adjust in the range of 7F1h (long) – C2Fh (short).

T: exposure time

[Normal mode]

- 7F1h ≤ nnnh < 800h
  T (sec) = (800h – nnnh)/7.4897
- 800h < nnnh ≤ C2Bh
  T (sec) = (684d + 1790d × (C2Ch – nnnh))/14318182
- nnn = C2Ch
  T = 1/10,000 sec
- nnn = C2Dh
  T = 1/20,000 sec
- nnn = C2Eh
  T = 1/50,000 sec
- nnn = C2Fh
  T = 1/100,000 sec

[External trigger mode]

- 7F1h ≤ nnnh < 800h
  T (sec) = (1911720d + 98d) × (800h – nnnh)/14318182
- 800h ≤ nnnh ≤ C2Bh
  T (sec) = (5578244d – 1790d × nnnh)/14318182

h : hexadecimal numeral
d : decimal numeral

NOTE : When nnn < 800h is set as the extended exposing mode is set, the frame rate set by CSR F0F00600h cannot be preserved.

<When XCD-X700> nnn: Adjust in the range of 7E2h (long) – B22h (short).

T: exposure time

[Normal mode]

- 7E2h ≤ nnnh < 800h
  T (sec) = (800h – nnnh)/14.952
- 800h < nnnh ≤ B1Fh
  T (sec) = (489d + 1197d × (B20h – nnnh))/14318182
- nnn = B20h
  T = 1/20,000 sec
- nnn = B21h
  T = 1/50,000 sec
- nnn = B22h
  T = 1/100,000 sec

[External trigger mode]

- 7E2h ≤ nnnh < 800h
  T (sec) = (957600d + 99d) × (800h – nnnh)/14318182
- 800h ≤ nnnh ≤ B1Fh
  T (sec) = (3409527d – 1197d × nnnh)/14318182

NOTE : When nnn < 800h is set as the extended exposing mode is set, the frame rate set by CSR F0F00600h cannot be preserved.

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

b) Factory settings

Set the electronic shutter of the XCD-SX900 to the 1/70 sec factory setting and set it of the XCD-X700 to the 1/90 sec factory setting.

Command = 80000 ∗∗∗ h ∗∗∗ : Desired value

CSR F0F00820h Gain

Adjust the gain of the video signal amplifier.

Command = 82000nnnh

nnn: Adjust in the range of 800h (min) – 8B4h (max).
Approximate: nnn = 800h : 0 dB (Standard)
nnn = 83Ch: 6 dB
nnn = 878h : 12 dB
nnn = 8B4h: 18 dB

CSR F0F00830h Trigger Mode

When inputting a negative polarity signal to the TRIG IN connector at the back of the camera, isochronous transmission of images for only one frame will be performed.

ON : Command = 82000000h
OFF: Command = 80000000h

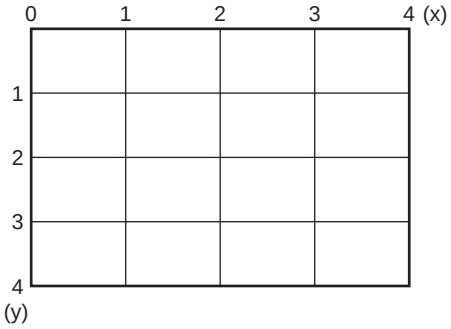
NOTE **:**
- **Isochronous transmission will not be performed if the CSR F0F00600h – F0F00614h settings are not appropriate.**
- **When the CSR F0F00608h Video Format is set to Format7, Trigger ON will automatically be set. Trigger OFF cannot be set while Format7 is in effective.**
- **During the period from the reception of the trigger signal by the camera to the completion of the corresponding isochronous transmission, new trigger signals are ignored.**

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

By writing a command in the CSR F1000044h from the CSR F1000008h, the Format7 partial scan function is controlled.
Only the image data of the rectangular area set is isochronously transmitted by the Ext.Trigger signal.

CSR F1000008h Image Position

Specify the coordinates at the top left of the screen when cutting one part of the screen by the partial scan function.



Set the coordinates corresponding to the lattice point when the whole screen is divided into four parts in the horizontal (x) and vertical (y) axes as shown in the figure.
(Set the multiplied value of the coordinates (x = 0, 1, 2, 3, y = 0, 1, 2, 3) of the lattice point for Hunit and Vunit written in the CSR F1000004 Unit Size Inq.)

<When XCD-SX900>

Command = 0mmm0nnnh mmm: X coordinates nnn: Y coordinates

Lattice point in above figure (x)	mmm	Lattice point in above figure (y)	nnn
0	000h	0	000h
1	140h	1	0F0h
2	280h	2	1E0h
3	3C0h	3	2D0h

<When XCD-X700>

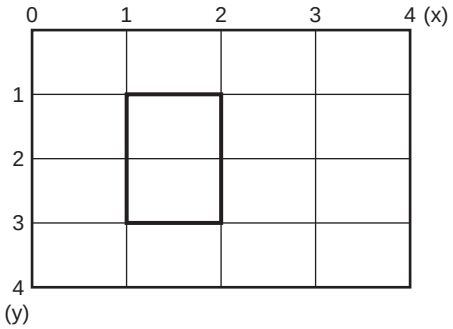
Command = 0mmm0nnnh mmm: X coordinates nnn: Y coordinates

Lattice point in above figure (x)	mmm	Lattice point in above figure (y)	nnn
0	000h	0	000h
1	100h	1	0C0h
2	200h	2	180h
3	300h	3	240h

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

CSR F100000Ch Image Size

Set the size of the area when cutting one part of the screen by the partial scan function.



Set the size (width and height) of the rectangular area on the lattice point obtained by equally dividing the whole screen in the horizontal (x) and vertical (y) directions.
(Set the multiplied value of the width (x) and height (y) (x = 1, 2, 3, 4, y = 1, 2, 3, 4) for the Hunit and Vunit written in the CSR F1000004 Unit Size Inq.)

<When XCD-SX900>

Command = 0iii0jjjh iii: Width of area jjj: Height of area

Width on lattice point (x)	i i i	Height on lattice point (y)	j j j
1	140h	1	0F0h
2	280h	2	1E0h
3	3C0h	3	2D0h
4	500h	4	3C0h

Limitations : Set the area so that the bottom right of the rectangular area does not exceed the lattice point (4, 4). When the CSR F1000008h Image Position is set to 0mmm0nnnh (mmm: X coordinates, nnn: Y coordinates), set the rectangular area so as to satisfy following two equations.

mmm + iii ≤ 500h (Max Image Size: Hmax)
nnn + jjj ≤ 3C0h (Max Image Size: Vmax)

NOTE **: Set when CSR F0F00614h Iso_EN is OFF.**

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

<When XCD-X700>

Command = 0iii0jjjh iii: Width of area jjj: Height of area

Width on lattice point (x)	i i i	Height on lattice point (y)	j j j
1	100h	1	0C0h
2	200h	2	180h
3	300h	3	240h
4	400h	4	300h

Limitations : Set the area so that the bottom right of the rectangular area does not exceed the lattice point (4, 4). When the CSR F1000008h Image Position is set to 0mmm0nnnh (mmm: X coordinates, nnn: Y coordinates), set the rectangular area so as to satisfy following two equations.

mmm + iii ≤ 400h (Max Image Size: Hmax)
nnn + jjj ≤ 300h (Max Image Size: Vmax)

NOTE **: Set when CSR F0F00614h Iso_EN is OFF.**

CSR F1000010h Color Coding ID

Set the Color Coding ID when cutting one part of the screen by the partial scan function.
As both the XCD-SX900 and XCD-X700 support only Color Coding ID 0 (Y 8 bits), always set ID 0.

Command = 00000000h

CSR F1000044h Byte per Packet

Set the Byte per Packet according to the value specified by CSR F1000040h Packet Para Inq.

When CSR F1000008h (Image Position) and CSR F100000Ch (Image Size) are set, the camera calculates the CSR F1000040h Packet Para Inq. Packet Para Inq specifies the maximum and minimum values of Byte per Packet. However in the case of XCD-SX900 and XCD-X700, as the maximum value is always the minimum value, set the value specified in the Byte per Packet.

When CSR F1000040h value is 0nnn0nnnh, set the command = 0nnn0000h to CSR F1000044h.

SETTINGS OF XCD-SX900/X700 CAMERA COMMAND STATUS REGISTER

◇ General precautions for partial scan function

- During the period from the reception of the trigger signal by the camera to the completion of the corresponding isochronous transmission, new trigger signals will be ignored.
  When camera settings are changed, trigger signals will be ignored until the change in the internal state of the camera is complete.

- When settings of CSR related to partial scan mode (F0F0060Ch, F1000008h, F100000Ch, F1000010h) are changed, the camera will recalculate the specified value of CSR F1000040h Packet Para Inq each time. After the settings are changed, it will take 5 ms for the specified value of CSR F1000040 to be finalized. During this time, do not perform reading of the CSR F1000040.

- When the trigger signal is input immediately after the partial scan mode settings are changed, images may be output based on the former settings. Therefore do not input trigger signals for 5 ms after changing settings.

- If incorrect settings are performed for CSR related to partial scan mode with the CSR F0F00614 Iso_EN in the ON state, Iso_EN will go OFF automatically. And isochronous transmission will be prohibited. In this case, set the correct settings for the CSR related to partial scan mode, and set Iso_EN to ON. The Iso_EN cannot be set to ON with the incorrect settings.

XCD-SX900/X700 COMMAND SENDING PROCEDURE UNTIL IMAGES ARE DISPLAYED

(1) Acquiring the camera control register base address

Read out the Configuration ROM and acquire the base address of the camera control register. The base address of the Configuration ROM is FFFF F0000000H.

	Offset	0 – 7	8 – 15	16 – 23	24 – 31
Bus Info Block	400H	04	1F	C0	01
	404H	31	33	39	34
	408H	20	FF	60	00
	40CH	08	00	46	02
	410H	00	05	00	0B
Root Directory	414H	00	04	C8	0A
	418H	03	08	00	46
	41CH	0C	00	83	C0
	420H	8D	00	00	02
	424H	D1	00	00	04

Obtain the offset address for Node Uniq ID Leaf

420H + 000002H ∗ 4 = 428H

Obtain the offset address for Unit Directory

424H + 000004H ∗ 4 = 434H

Node Uniq ID Leaf	428H	00	02	E7	33
	42CH	08	00	46	02
	430H	00	05	00	0B
Unit Directory	434H	00	03	7D	AF
	438H	12	00	A0	2D
	43CH	13	00	01	01
	440H	D4	00	00	01

Obtain the offset address for Unit Dependent Info

440H + 000001H ∗ 4 = 444H

Unit Dependent Info	444H	00	03	4F	EA
	448H	40	3C	00	00
	44CH	81	00	00	02
	450H	82	00	00	05

Obtain the offset address for Camera Control register

FFFFF0000000H + 3C0000H ∗ 4 = FFFFF0F00000H

The base address of the control register of this camera is FFFF F0F00000H.

(2) Acquiring the format/mode/frame rate (For XCD-SX900 Format2)

a) Check available formats

Refer to the Inquiry register for video format and check the available formats.

Address	Action	Data
F0F00100H	Read	21000000H

As bits 2 and 7 are set, it means that Format2 and Format7 are available.

b) Check available video modes

Refer to Inquiry register for video mode, and check which video mode in Format2 is available.

Address	Action	Data
F0F00188H	Read	20000000H

As bit 2 is set, it means that Mode2 is available.

c) Check available frame rates

Address	Action	Data
F0F00248H	Read	60000000H

As bits 1 and 2 are set, it means that 3.75 fps and 7.5 fps are available.

(3) Video transmission start command (Format2)

When the following values are set for Status and Control registers for camera, the camera starts video transmission.

(Video Format = 2, Video Mode = 2, Frame Rate = 7.5 fps, ISO Speed = 400M bps)

Address	Action	Data	
F0F00600H	Write	40000000H	Frame Rate = 7.5 fps
F0F00604H	Write	40000000H	Video Mode = 2
F0F00608H	Write	40000000H	Video Format = 2
F0F0060CH	Write	20000000H	ISO ch = 0, Speed = 400M bps
F0F00614H	Write	80000000H	ISO Enable ON

To stop the video, set the ISO Enable bit to 0.

Address	Action	Data	
F0F00614H	Write	00000000H	ISO Enable OFF

(4) To set the trigger mode

Set Status and Control register for feature and set the trigger mode to ON.

Address	Action	Data	
F0F00830H	Write	82000000H	Trigger ON, mode 0

As bit 0 is the Presence Inq bit, it cannot be written. Consequently, even if 02000000H is written for Data, the same operations are performed.

(5) Procedure for Format7

a) Check which mode is available for Format7.

Address	Action	Data
F0F0019CH	Read	80000000H

As bit 0 is set, it means that mode 0 is available.

b) Acquire the CSR offset address of Mode0.

Address	Action	Data
F0F002E0H	Read	00400000H

F0000000H + 00400000H ∗ 4 = F1000000H

It means that the address of Video Mode CSR for Format_7 is F1000000H.

c) Acquire the MaxSize/UnitSize/ColorCodingID.

Address	Action	Data	
F1000000H	Read	050003C0H	MaxSize
F1000004H	Read	014000F0H	UnitSize
F1000014H	Read	80000000H	ColorCodingID

It means that MaxSize is 1,280 ∗ 960, UnitSize is 320 ∗ 240, ColorCodingID is Mono8. Therefore, the screen can be divided into 16 parts (vertically 4 parts and horizontally 4 parts).

d) Set the ImagePosition/ImageSize/ColorCodingID.

Address	Action	Data	
F1000008H	Write	03C000F0H	Specify top left (320, 240)
F100000CH	Write	028001E0H	Specify size (640, 480)
F1000010H	Write	00000000H	Specify Mono8

The position and size must be the multiple of the unit size integer.
Write 0 for ColorCodingID for Mono8. (Note that it is not 80000000H)

XCD-SX900/X700 COMMAND SENDING PROCEDURE UNTIL IMAGES ARE DISPLAYED

e) Specify the packet size.

Address	Action	Data	
F1000040H	Read	02800280H	Unit = 640, Max = 640

As the Unit and Max of packet size in this model are the same, specify the same packet size.

Address	Action	Data	
F1000044H	Write	00000280H	Packet size = 640

The range of isochronous transmission is determined by the packet size.

NOTE **: When ImagePosition/ImageSize/ColorCodingID are set at step d), the camera recalculates and reflects the contents of PacketParaInq register. If the next readout is performed before the calculation is complete, errors may occur. Therefore be sure to wait for more than 5 ms before executing the PacketParaInq register readout command.**

f) Acquire the TotalBytes.

Address	Action	Data	
F1000038H	Read	0004B000H	Lower 32 bits
F100003CH	Read	00000000H	Upper 32 bits

Total number of bytes sent by the camera. For this camera, the number of pixels and bytes match.
For application softwares, secure a buffer of this size and prepare to receive data transmitted isochronously.

(6) Video transmission start command (Format7)

When the following values are set for Status and Control registers for camera, the camera starts video transmission.

(Video Format = 7, Video Mode = 0, ISO Speed = 400M bps)

Address	Action	Data	
F0F00604H	Write	00000000H	Video Mode = 0
F0F00608H	Write	E0000000H	Video Format = 7
F0F0060CH	Write	20000000H	ISO ch = 0, Speed = 400M bps
F0F00614H	Write	80000000H	ISO Enable ON

As there is no concept for the frame rate for Format7, the specification of F0F00600H (FrameRate) will be ignored.
The XCD-SX900/XCD-X700 Format7 operates only when trigger is set to ON. When the ISO EnableON command is received, the ON/OFF bit of the trigger register (F0F00800H) of Status and Control register for feature will automatically be set to 1.

After setting the above, input the trigger signal to the external trigger connector to start video transmission.

HOST ADAPTER CARD DFWA-400

The DFWA-400 host adapter card is an IEEE1394 serial bus interface card. You can install this card in the PCI bus slot in IBM PC/AT compatible computer.

Features

PCI interface

- Complies with PCI Short Card (5 V, 32-bit) standard
- Complies with PCI Local Bus Rev 2.1 standard
- Supports the PCI Bus Master function
- Supports the PCI Bus DMA transfer function

IEEE1394 interface

- High-speed data transfer rate: 100M/200M/400M bits/second
- Supports both asynchronous transfer and isochronous transfer
- Supports the isochronous cycle master function
- Provides three 6-pin connectors to connect the camera module

Recommended Specifications for Personal Computer (PC)

Processor	: Pentium 500 MHz or more
Empty main memory	: 40 MB or more
Video memory	: 8 MB or more
Display mode	: Can display 1,280 × 1,024
Expansion slot	: With empty slot of PCI bus
OS	: Windows* 98 or Windows* NT4.0

NOTE : For details on the peripherals and the computer to which you are connecting the DFWA-400 card, see the respective manuals.

* “Windows” is a trademark of Microsoft Corporation, registered in the U.S.A. and other countries.

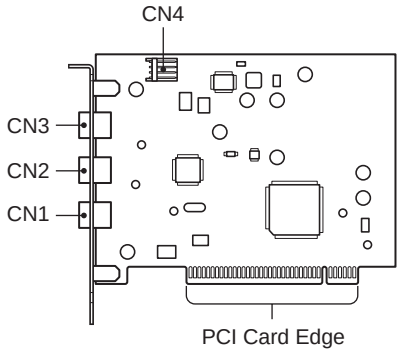
Note) Zenkuman (indicated on the card) is a registered trademark of Technoscope, Co., Ltd.

HOST ADAPTER CARD DFWA-400

Specifications

I/F standard : IEEE1394-1995 standard
Number of ports : 3
Supply voltage : +5 V, +12 V
Operating temperature : 10 to 35°C (no condensation)
Dimensions : 107 × 138 mm
Connectors
IEEE1394 : IEEE1394 6-pin connector
External power supply : 176153-4 (AMP) or equivalent
Accessories : Setup disk (1), Operating Instructions (1)

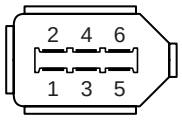
Board configuration



CN1, 2, 3 : IEEE1394 6-pin connector
CN4 : External power supply connector
PCI card edge : 124-pin PCI local bus connector

Pin assignment

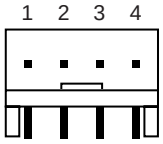
IEEE1394 6-pin connector



Pin No.	Signal
1	VP
2	VG
3	TPB*
4	TPB
5	TPA*
6	TPA

Common to CN1, CN2, and CN3.

External power supply connector



Pin No.	Signal
1	+12 V
2	GND
3	GND
4	+5 V (Not used)

External power supply connector

The IEEE1394 bus power supplied from PCI bus is about 0.5 A. If you need more power, use a separate power branch cable and connect the FDD power socket to this connector. You can get up to 1.5 A power through this connector.
(Example: Mounted connector 176153-4 (AMP))

HOST ADAPTER CARD DFWA-400

Installing the Host Adapter Card

NOTE : Before installing the host adapter card in the computer, be sure to install the setup disk software provided. Otherwise the computer may freeze when started.

(1) After starting the computer, insert the floppy disk provided into the floppy disk drive.

(2) Open “My Computer” and select the floppy disk drive.

(3) Open Readme.txt.

(4) While reading Readme.txt, install the software.

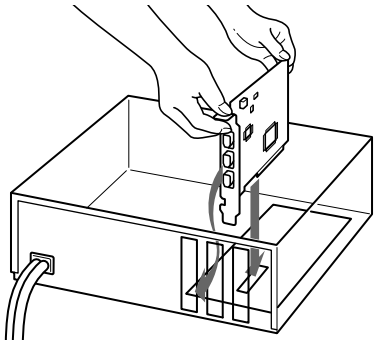
(5) After installing, eject the floppy disk, shut down Windows, and turn off the power of the computer.

(6) Unplug the computer power cable from the wall outlet.

NOTE : Make sure you unplug the computer power cable from the wall outlet. Installing the host adapter card without unplugging the power cable may damage both the computer and the card.

(7) Open the computer case and remove the PCI bus slot cover.

(8) Securely insert the host adapter card into the PCI bus slot and affix in place it with the screw.



NOTE :
- **When you install the card, hold the top part of the card. Make sure that the PCI card edge is parallel to the slot. Insert the card into the slot as straight in as possible.**
- **You may need to apply some force when installing the card into the slot. Insert the card until the card snaps into the slot.**
- **If you are having difficulty inserting the card properly, remove it from the slot and try again.**
- **Some computers are not required a screw to affix the card in place.**

(9) Install the computer case.

Setup of the Driver

◇ Precautions

(1) Precautions on installing the DFWA-400 in the PC using Windows 98

The DFWA-400 does not run with the standard Windows 98 1394 driver.
If the DFWA-400 is run with the standard driver, the PC may crash. To prevent this, before installing the DFWA-400 in the PC, make sure that to install the DFWA-400 driver.
To ensure this, be sure to perform the following procedure in Setting Up the Driver (for Windows 98).
Operations may not be performed normally if the board is installed without following the procedure.

(2) Precautions on software provided

- The driver and demonstration software included in the floppy disk (hereafter referred to as FD) provided are compatible only for Windows 98 and Windows NT4.0. In other operating system, these will not operate.
  Use of the driver and demonstration software may cause malfunction or damage to user's hardware and software. Sony Corporation is not liable for any of such damages.

- The demonstration software can be used for both Windows 98 and Windows NT4.0.

- The demonstration software can operate only with the Sony IEEE1394 digital camera DFW and XCD series*. It will not operate with other Sony products such as the Digital Handycam.

- During use with the DFW-V300, the demonstration software may not operate normally in some video modes.

- If the demonstration software does not operate normally during use, shut down the demonstration software, disconnect and reconnect the camera cable, and start the demonstration software again.

- Color modes which can be displayed for the demonstration software are 24 bits and 32 bits. Other color modes are not supported.

- If the PC performance (CPU clock, memory installed, etc.) is insufficient, the demonstration software may not operate normally.

* The Sony IEEE1394 digital camera DFW and XCD series include the DFW-V300, DFW-V500, DFW-VL500, XCD-SX900, and XCD-X700. (The CCM-DS250 does not operate with this software.)

HOST ADAPTER CARD DFWA-400

◇ Setting up the driver

<For Windows 98>

(1) Turn on the PC power without installing the DFWA-400 in the PC, and start Windows.

(2) Start \Setup98\Setup recorded in the FD.

(3) After ejecting the FD, quit Windows, and turn off the PC power.

(4) Unplug from wall outlet.

(5) Install the DFWA-400 in an empty PCI slot.

(6) Turn on the PC power, and start Windows.

(7) The DFWA-400 will be identified by the Windows Plug and Play function. For the driver used, select \Setup98\Driver\SonyPFW.inf in the FD.

(8) When the driver (SonyPFW) is installed normally, restart of the PC will be prompted. Eject the FD and restart the PC.

<For Windows NT4.0>

(1) Turn on the PC power, and start Windows.

(2) Execute \SetupNT\Setup.exe in the FD. (The installer starts automatically.)

(3) When installation completes, restart of the PC will be prompted. Select “No, I will restart my computer later”.

(4) After ejecting the FD, quit Windows, and turn off the PC power.

(5) Unplug from wall outlet.

(6) Install the DFWA-400 in an empty PCI slot.

(7) Turn on the PC power, and start Windows.

This completes the setup of the driver.

◇ Setting up the demonstration software

Copy \Demo\Dfwnt.exe in the FD to the desired directory for both Windows 98 and Windows NT4.0.

CCD B/W DIGITAL CAMERA MODULE

XCD-SX900
XCD-X700

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