

Digital Video Camera Module

Technical Manual



XCD-SX910CR/X710CR (Color model)
XCD-SX910/X710 (Black and white model)

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Overview

The XCD-SX910CR/SX910 with its 1/2-type PS IT CCD, and the XCD-X710CR/X710 with its 1/3-type PS IT CCD are high-resolution industrial-use digital video camera modules. Utilizing an IEEE 1394-1995 digital interface, transfer rates as high as 400 Mbps are realized. In addition, the use of digital signals enables industrial-use image processing without “image deterioration,” an important plus in the industrial world. Moreover, the use of a square pixel CCD eliminates the need for aspect ration conversion during image processing.

Finally, a vibration resistance feature permits use of these units in all types of inspection and imaging 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 400 Mbps and can handle large image data size. The interface is also capable of “Isochronous transmission” which transmits data real-time, for up to 64 channels. Connectors can be inserted and disconnected while the unit is turned on, and no terminators and no ID settings such as those necessary for the SCSI interface are required.

* The Institute of Electrical and Electronics Engineers, Inc.

Main Features

The XCD-SX910CR/SX910 video camera module utilizes a 1/2-type PS IT CCD, and the XCD-X710CR/X710 utilizes a 1/3-type PS IT CCD

RAW mode output using the RGB Bayer pattern (XCD-SX910CR/X710CR only)

High-speed digital interface IEEE1394

High-resolution

The XCD-SX910CR/SX910 adopts an SXGA-compatible 1.45 M-pixel CCD while the XCD-X710CR/X710 adopts an XGA-compatible 800 Kpixel 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.

For exposure time, the unit is equipped with Trigger Mode 0, which indicates the length of the exposure using the shutter parameter, and Trigger Mode 1, which controls exposure time by the width of the trigger signal.

It is also able to utilize a software trigger initiated by a command from a program running on a host computer.

Partial scan output image format

It is equipped with a partial scan feature that divides an entire screen image into 16×16 sections, allowing it to be output as an optionally designated rectangle within the required limits.

Use of this function enables frame rates faster than normal speeds, thus enabling efficient image capture. In addition, partial scan operations can be carried out even without the input of an external trigger.

C-mount

High vibration-resistance structure

Binning

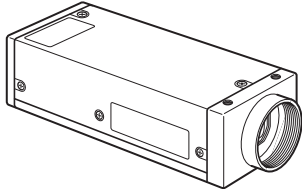
The unit is equipped with a Binning mode, which increases the frame rate and increases the sensitivity based on mixing the pixel data on the CCD imager. The XCD-SX910 provides a screen size of 640×480 , and on-screen movement at 30 fps is available; the XCD-X710 provides a screen size of 512×384 , and on-screen movement of 50 fps.

Black & white (Monochrome) 16-bit mode

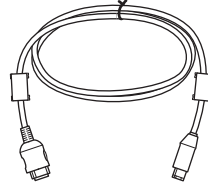
A Black & white (Monochrome) 16-bit mode is available. The bits used are the least significant (lowest) 10 bits.

System Components

The XCD-SX910CR/SX910 Video Camera Module system comprises the following components.



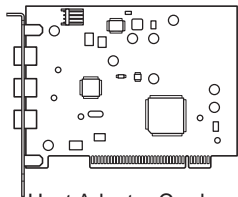
Video Camera Module
XCD-SX910CR/SX910



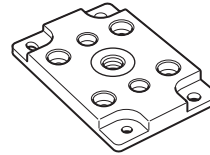
IEEE1394 Cable
(6-pin, 4.5 m)



C-mount Lens
VF2509 (Canon)

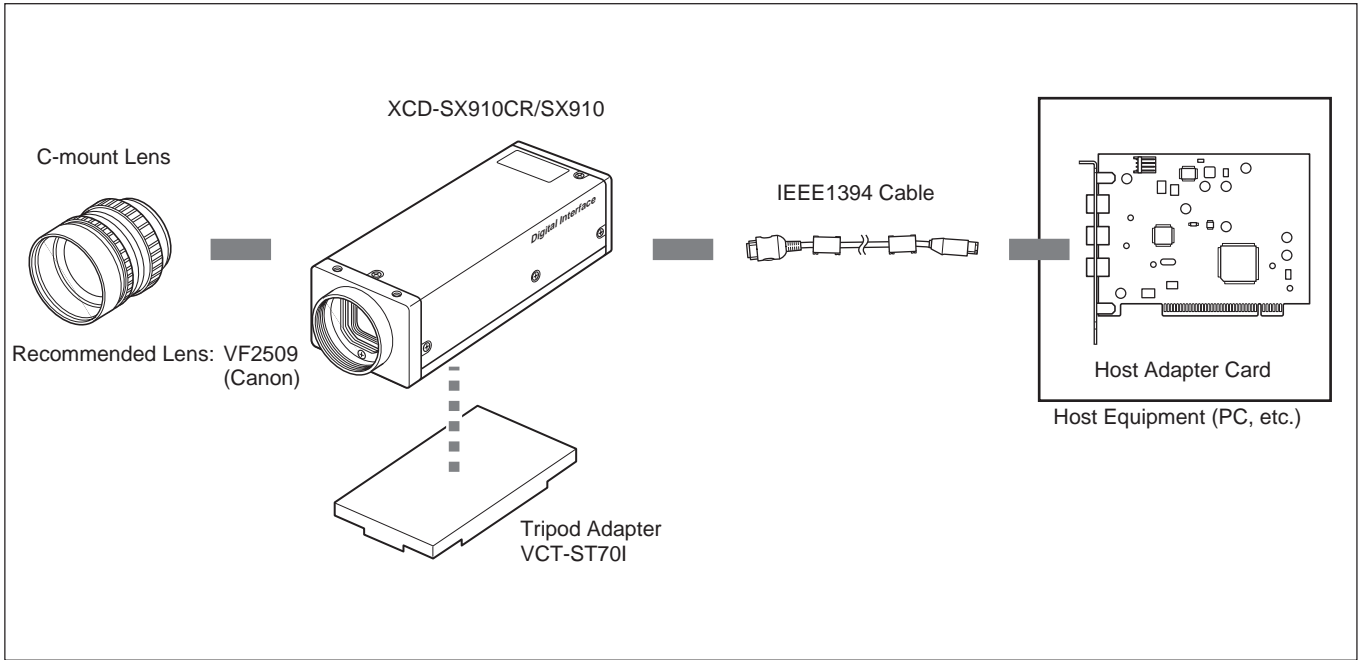


Host Adapter Card
(Commercially available)

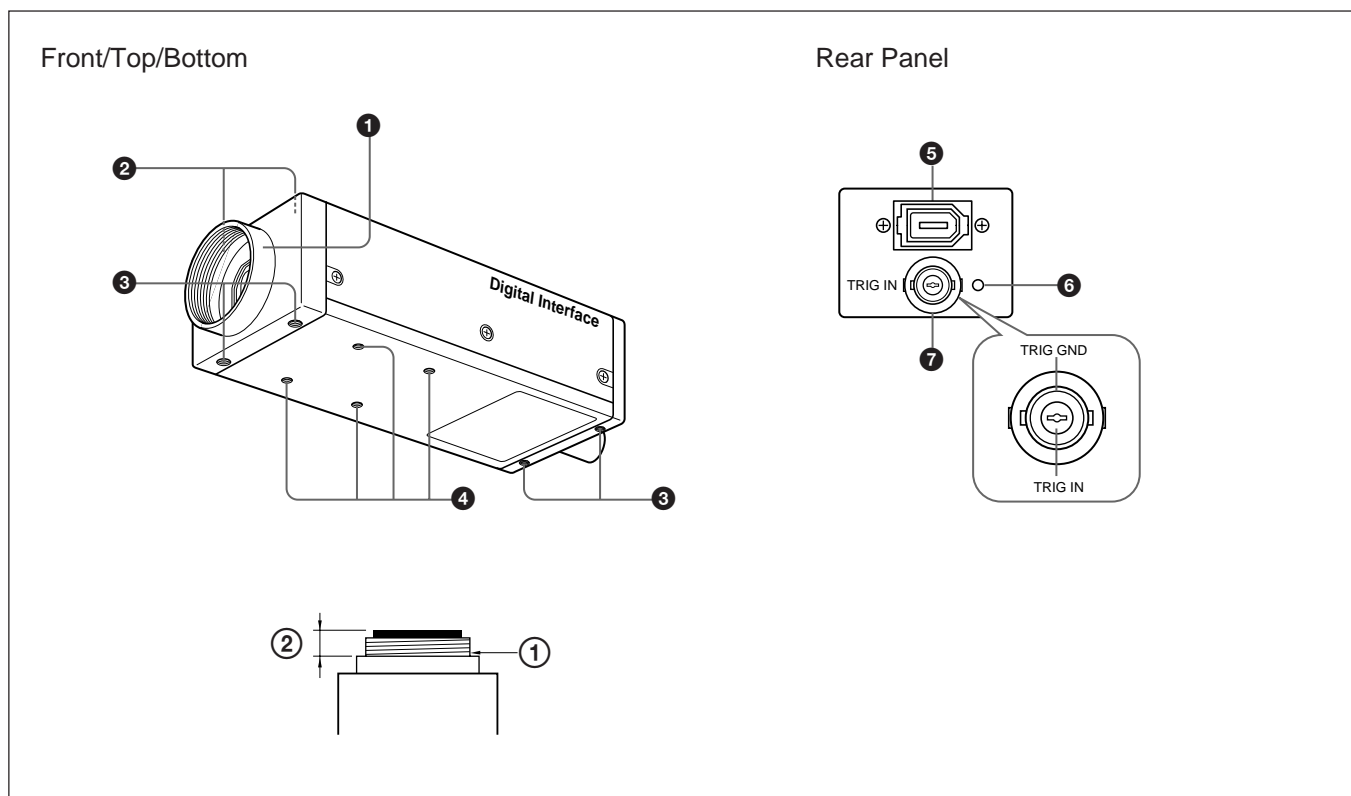


Tripod Adapter
VCT-ST70I (Isolated type)

Connection Diagram



Location of Parts and Operation



1 Lens mount (C-mount)

Attach any C-mount lens or other optical equipment.

Note

The lens must not project more than 7 mm (9/32 inch) from the lens mount.

① Lens mount face ② 7 mm (9/32 inch) or less

2 Reference holes (Top)

3 Reference holes (Bottom)

These precision screw holes are for locking the camera module. Locking the camera module into these holes secures the optical axis alignment.

4 Tripod adaptor screw holes

Screw the tripod adaptor VCT-ST70I into the four screw holes when you use a tripod.

5 CAMERA connector

Connect the IEEE1394 camera cable (supplied) to this connector.

6 Pilot lamp

This lamp indicates the camera module operation states:

OFF: Camera power OFF

Green: Camera power ON/Video signal output OFF

Orange: Camera power ON/Video signal output ON

7 TRIG IN/Exposure OUT connector

Connect the trigger signal generator (trigger output connector) to this connector.

When trigger is OFF, or software trigger is ON, a signal that indicates the exposure time is output from the BNC connector of the camera.

Functions

Brightness

This camera supports brightness control. This makes fine adjustment of the black level possible. (The former model, XCD-SX910/X710 (firmware version 1.07) does not support brightness control.)

Gain

Both Manual and Auto Gain setting are available with this camera.

The variable range extends from 0 to 18 dB (XCD-SX910CR/X710CR)/0 to 24 dB (XCD-SX910/X710), and the unit is designed so that the gain can be subdivided and set to any of 640 steps.

At factory default setting, the gain is set to 0 dB.

When Auto gain is selected, the gain is adjusted automatically, based on the brightness of the subject. At this time, the reference level (target point) is set in the AutoExposure register.

For details on Auto Exposure, see page 9.

The XCD-SX910CR/SX910 and XCD-X710CR/X710 are not compatible with the XCD-SX900 and XCD-X700 in Gain settings.

Shutter

This camera allows both Manual and Auto Shutter setting.

The variable range extends from 10 microseconds to 17.5 seconds; relative control values are indicated by a 12-bit integer, and absolute control values are indicated using a 32-bit floating point value.

The shutter settings for the XCD-SX910CR/SX910 and XCD-X710CR/X710 are the same, but these settings differ from some of those for the XCD-SX900 or XCD-X700.

The relationship between the parameter and the exposure time is given by the following formulas.

Where

P = Parameter (003h~424h)

E = Exposure time (s)

P>=3 ~ P<=1000

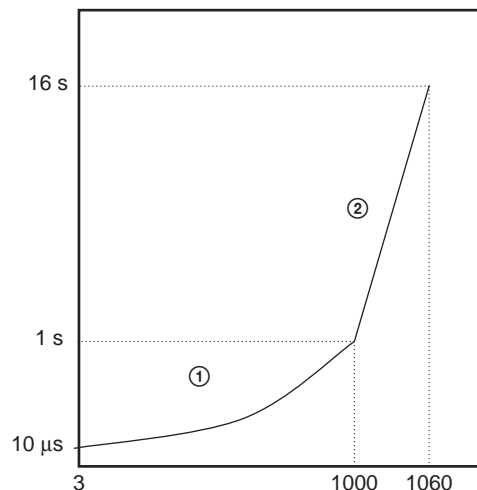
$$E = \frac{P^2}{1000000} \quad \text{①}$$

P>1000 ~ P<1060

$$E = (P-1000)*0.25 + 1 \quad \text{②}$$

Setting examples

3 (003h) :	9 μ s (1/100000)
32 (020h) :	1 ms (1/1000)
100 (064h) :	10 ms (1/100)
1000 (3E8h) :	1 s
1004 (3ECh) :	2 s
1060 (424h) :	16 s



When Auto Shutter is selected, the exposure time is adjusted automatically, based on the brightness of the subject. At this time, the reference level (target point) is set in the AutoExposure register.

For details on Auto Exposure, see page 9.

For long exposure times

When exposure times longer than the currently set frame rate cycle are set, the camera enters the long exposure time mode, and the actual frame rate is slowed in accordance with the exposure time.

Absolute Control Value for the Shutter

Control of exposure time using absolute values is possible. The values are indicated using a 32-bit floating point value. (Unit: sec.)

The control steps are synchronized with the pixel clock, and as the pixel clock is 30.5 MHz, one step is approximately 32.8 ns.

The range for these values extends from 10 microseconds to 17.5 seconds.

Programming example;

```
union {
    DWORD   dwValue;    // 1394 is expressed in quadlets,
    float   fValue;    // exposure time is indicated in seconds.
} AbsoluteShutterValue;

AbsoluteShutterValue.fValue = Exposure time;
WriteQuad(AbsoluteShutterOffsetAddress,
          AbsoluteShutterValue.dwValue);
```

WriteQuad is a virtual function used to write in the register.

AbsoluteShutterOffsetAddress is an offset address for the absolute value control. See page 25 for the formula for the offset address.

Auto Exposure

AutoExposure is a function that automatically adjusts the gain and shutter settings, based on the brightness of the subject. When this function is used, make sure the video mode is set to one of the following modes. This function is not effective in any other modes.

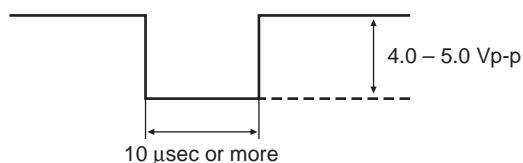
XCD-SX910CR/SX910	Format2Mode2 (1280 × 960)	15 fps	TriggerOFF
XCD-X710CR/X710	Format1Mode5 (1024 × 768)	30 fps	TriggerOFF

Trigger Shutter

Trigger shutter is useful for capturing images in response to a trigger that starts the exposure to match a preset timing. It can also be used to capture an image using multiple cameras with the same timing. When a trigger shutter is used, the required trigger is input via the BNC connector on the rear panel. The input signal is a 5-volt negative pulse. The falling edge of the signal is detected as the trigger, and the unit is equipped with an exposure time consisting of the shutter parameter set as trigger mode 0, and trigger mode 1 that controls the exposure timing using the width of the trigger signal pulse. The minimum width of the trigger is 10 microseconds. When trigger mode 1 is used, there is no limit to the exposure time.

This unit can also be used with a software trigger that issues the trigger signal via a software command. Both trigger mode 0 and trigger mode 1 can be used with software triggers.

Trigger shutter



- Input impedance: 10 kΩ

Pan/Tilt

Pan/Tilt is a function used to move a camera up and down or left and right, however this camera supports a video mode much smaller than the CCD's effective pixels by cutting out images from the whole screen. You can specify the portion to be cut out using Pan/Tilt commands. One unit of movement is two pixels. Refer to the table for the video modes in which Pan/Tilt commands can be used and the variable ranges for the mode. The values in parentheses are the initial settings.

	XCD-SX910CR/SX910		XCD-X710CR/X710	
	Pan	Tilt	Pan	Tilt
Format0Mode5 640 × 480	0 - 752 (376)	0 - 560 (280)	0 - 384 (192)	0 - 288 (144)
Format0Mode6 640 × 480	0 - 752 (376)	0 - 560 (280)	0 - 384 (192)	0 - 288 (144)
Format1Mode2 800 × 600	0 - 592 (296)	0 - 440 (220)	0 - 224 (112)	0 - 168 (84)
Format1Mode5 1024 × 768	0 - 368 (184)	0 - 272 (136)	Not available	Not available
Format1Mode6 800 × 600	0 - 592 (296)	0 - 440 (220)	0 - 224 (112)	0 - 168 (84)
Format1Mode7 1024 × 768	0 - 368 (184)	0 - 272 (136)	Not available	Not available
Format2Mode2 1280 × 960	0 - 112 (56)	0 - 80 (40)		
Format2Mode6 1280 × 960	0 - 112 (56)	0 - 80 (40)		
Format7Mode3 1376 × 1024	0 - 16 (8)	0 - 16 (8)		
Format7Mode4 1024 × 1024	0 - 368 (184)	0 - 16 (8)		

When a video mode is changed, the initial Pan/Tilt values for the mode are set.

On the XCD-SX910CR/X710CR, if you set the value of Pan/Tilt to maximum, the pixels on the edge of the picture may not be output correctly.

Memory Channels

This camera is equipped with two channels non-volatile memory to hold camera settings.

The settings of all camera features and the video mode can be stored.

The camera memorizes the channel most recently used to read out the setting information, and retains it, even if the power is turned off. Therefore, the camera loads the information from that channel when the power is turned on.

The video mode settings are loaded only when the power is turned on.

To start up the camera with the desired setting, perform the following procedure.

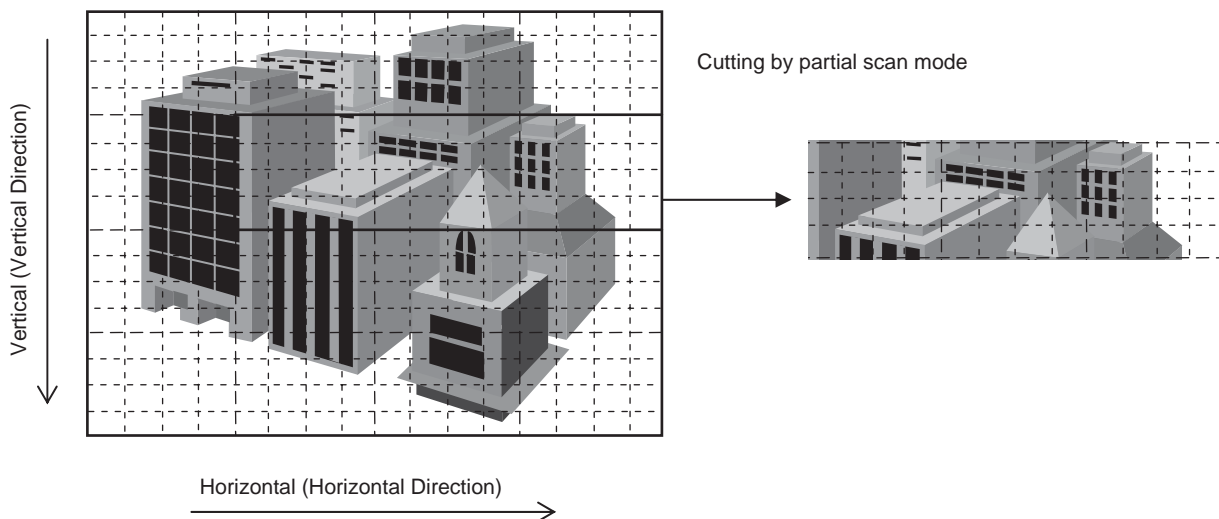
- 1 Make changes to the camera features or the video mode settings.
- 2 Store the current setting in Memory Channel 1 or Memory Channel 2.
- 3 Load the information that was stored in step 2.

Thus, when you start up the camera the next time, the settings that you have made will be loaded automatically.

Using the CameraInitialize command, the setting information stored in the channels is cleared and the camera features and the video mode are initialized. To preserve the information in the channels, be sure not to send the CameraInitialize command while driver software or application software is starting up. The value of Pan/Tilt is initialized when the video mode is changed. To preserve the value, be sure not to change the video mode while driver software or application software is starting up, or before sending the video start command.

Partial Scan

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 unit size of both the XCD-SX910CR/SX910 and the XCD-X710CR/X710 is 1/256th of the whole screen, divided into 16 sections, horizontally and vertically.

The partial scan mode for the XCD-SX910CR/SX910 and the XCD-X710CR/X710 has had a partial read out function added, and there is a frame rate speed-up feature for use when the vertical width of the cut-out is small. But because of the structure of the CCD, no matter how small the cut-out width is horizontally, the frame rate cannot be increased.

When Partial scan mode is used, set Format7, Mode 0.

Binning Mode

The mode used when the sensitivity is increased and the frame rate is multiplied based on mixing the CCD pixel data, is called the Binning mode.

There are two types of binning: 1×2 binning when the output image is compressed in the vertical direction only, and 2×2 binning when the image is compressed in the horizontal direction also.

When binning mode is used, set either Format7 Mode 1 (2×2 binning), or Format7 Mode 2 (1×2 binning).

The specifications for each model are given below.

	XCD-SX910	XCD-X710
Format7Mode1 (2×2 binning)	640 × 480	512 × 384
	Mono8 30/15 fps	Mono8 50/25 fps
	Mono16 15/7.5 fps	Mono16 25/12.5 fps
Format7Mode2 (1×2 binning)	1280 × 480	1024 × 384
	Mono8 30/15 fps	Mono8 50/25 fps
	Mono16 15/7.5 fps	Mono16 25/12.5 fps

Partial scan is not available in Binning Mode.

Be careful. If the exposure time is set slower than the frame rate in the shutter setting, the frame rate may also drop with respect to the exposure time.

Format7 Mode3/4 for XCD-SX910CR/SX910

Only the XCD-SX910CR/SX910 supports Format7, Mode3 and Mode4.

	XCD-SX910CR/SX910
Format7Mode3	1376 × 1024
	Mono8 15/7.5 fps
	Mono16 7.5/3.75 fps
Format7Mode4	1024 × 1024
	Mono8 15/7.5 fps
	Mono16 7.5/3.75 fps

Partial scan is not available in these modes.

Frame Rate Settings for Format 7

For Format 7, the offset address 600h frame rate settings are disabled, but with this camera, the frame rates for Modes 1 to 4 are determined by the packet size.

Format7		XCD-SX910CR/SX910		XCD-X710CR/X710	
		Frame rate	Packet size	Frame rate	Packet size
Mode1	Mono8	30	1280	50	1536
		15	640	25	768
	Mono16	15	1280	25	1536
		7.5	640	12.5	768
Mode2	Mono8	30	2560	50	3072
		15	1280	25	1536
	Mono16	15	2560	25	3072
		7.5	1280	12.5	1536
Mode3	Mono8	15	2752	-	-
		7.5	1376	-	-
	Mono16	7.5	2752	-	-
		3.75	1376	-	-
Mode4	Mono8	15	2048	-	-
		7.5	1024	-	-
	Mono16	7.5	2048	-	-
		3.75	1024	-	-

16-bit Mode

The camera supports 16-bit Black & white (Monochrome) mode, but because the output of the AD converter is 10-bit, only the least significant 10 bits of the 16 bits will handle data. The upper 6 bits will be filled with zeros.

000000dd | dddddddd

1394 Bus Synchronization

Timing used to start exposure is synchronized with the 1394 bus time cycle register.

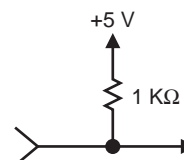
If cameras are connected in a bus connection, they are automatically synchronized in a 1394 bus operation. As 400 Mbps frequency area restriction can affect the synchronization, you must set the video mode in which the cameras can transmit video signal at the same time. 1394 synchronization does not work in long exposure mode. In a long exposure, the exposure time is set longer than the image transmission cycle.

CPU operation timing can cause jitter in 1394 bus synchronization. (Approx. 4 μ sec)

Hardware external synchronization will ensure further accuracy.

ExposureOut

When trigger is OFF, or software trigger is ON, a signal that indicates the exposure time is output from the BNC connector of the camera.



White Balance

(XCD-SX910CR/X710CR only)

You can adjust the R and B gain with respect to G. Shoot a white object and adjust the two gains to standardize the signal levels of R, G, and B.

Hue

(XCD-SX910CR/X710CR only)

You can adjust the G gain. Use this feature when you cannot obtain the correct white balance using the R and B gain.

Optical Filter

(XCD-SX910CR/X710CR only)

You can change the Bayer patterns by moving the starting position from which to output pixel data by one position up, down, right, or left.

XCD-SX910CR/SX910/ X710CR/X710 Camera Command Status Register

This camera complies with IIDC 1394-based Digital Camera Specification, Version 1.30 (hereinafter referred to as IIDC v1.30).

The standards document can be purchased from 1394TA (the 1394 Trade Association). Because it is very helpful in understanding the explanations in this Technical Manual, we recommend that you purchase a copy of IIDC v1.30.

Memory Map

1394 devices have a 64-bit address space. The upper 10 bits show the bus ID (0~1023), and the next six bits show the node ID (0~63). The IIDC standards require the next 20 bits to be 1.

|---BusID---|NodeID|------(Must be 1)-----|-----(Address used by the camera)----|
 bbbbbbb | bbnnnnn | 11111111 | 11111111 | 11110000 | 11110000 | 00000000 | 00000000

The remaining 28 bits can be allocated to the camera as addresses, but in reality, the first 2 bits are fixed at 0, so the largest number of bits that can be allocated to the camera as address space is 24 bits. The bus and node IDs may be changed if the topology is re-structured because of bus reset, so only the least significant 32 address bits are shown in this User's Guide.

Address	Register
F0000000	Base address
F0000400	ConfigROM area
F0F00000	Base addresses for camera commands
F0F00000	CameraInitialize
F0F00100	Video Format Inq
F0F00180	Video Mode Inq
F0F00200	Frame Rate Inq
F0F002E0	Format7 CSR Inq
F0F00400	Basic Func Inq
F0F00500	Feature Element Inq
F0F00600	Isochronous Control register
F0F0071C	AbsoluteControlCSR Inq for Shutter
F0F00800	FeatureControl
F0F00970	AbsoluteControlCSR for Shutter
F0F10000	Format7Mode0 CSR
F0F11000	Format7Mode0 CSR
F0F12000	Format7Mode0 CSR
F0F13000	Format7Mode0 CSR (SX910CR/SX910 only)
F0F14000	Format7Mode0 CSR (SX910CR/SX910 only)

ConfigROM

	Offset	0-7	8-15	16-23	24-31	
Bus	400h	04	1F	ROM CRC		
Info	404h	31	33	39	34	
Block	408h	20	FF	60	00	
	40ch	08	00	46	02	NodeVendorID/ChipID-Hi
	410h	00	0B	00	37	ChipID-Lo
Root	414h	0004		CRC		
Directory	418h	03	08	00	46	ModuleVendorID
	41ch	0C	00	83	C0	
	420h	8D	00	00	02	IndirectOffset
	424h	D1	00	00	04	UnitDirectoryOffset

With the exception of bits 8 to 15 of the 400h offset address field, the length of the entire ConfigROM is made up of 1Fh Quadlets. So the ConfigROM from 400h to 47Fh is 128 bytes.

Offset address 420h and key code 8Dh indicate a NodeUniqueID Leaf offset, but in 1394a-2000, this field has been eliminated. To ensure compatibility with

previous models, this field has been retained in this model, but in writing drivers and software applications, be sure to ignore this field. For a NodeUniqueID, use NodeVendorID/ChipID-Hi + ChipID-Lo.

The UnitDirectory offset address is required to be $424h + 000004h * 4 = 434h$

	Offset	0-7	8-15	16-23	24-31	
Unit	434h	0003		CRC		
Directory	438h	12	00	A0	2D	UnitSpecID
	43Ch	13	00	01	02	UnitSoftwareVersion
	440h	D4	00	00	01	UnitDependentDirectory Offset

For offset address 434h, the length of the UnitDirectory is 3 Quadlets. UnitSpecID (00A02Dh) conforms to 1394TA standards. UnitSoftwareVersion (000102h) conforms to IIDC Standards, Version 1.30.

The offset address of UnitDependentInfo is required to be

$$440h + 000001h * 4 = 444h$$

	Offset	0-7	8-15	16-23	24-31	
Unit	444h	0003		CRC		
Dependent	448h	40	3C	00	00	CommandRegsBase
Info	44ch	81	00	00	02	VendorNameLeaf
	450h	82	00	00	05	ModelNameLeaf

For offset address 444h, the length of the UnitDependentInfo is 3 Quadlets.

The offset address of VendorNameLeaf is required to be

$$44Ch + 000002h * 4 = 454h$$

CommandRegsBase is the base address of the camera control register.

$$F0000000h + 3c0000h * 4 = F0F00000h$$

The offset address of ModelNameLeaf is required to be

$$450h + 000005h * 4 = 464h$$

VendorNameLeaf

	Offset	0-7	8-15	16-23	24-31	
Vendor	454h	0003		CRC		
Name	448h	00	00	00	00	
Leaf	44ch	00	00	00	00	
	450h	53	4F	4E	59	“SONY”

For offset address 454h, the length of the VendorNameLeaf is 3 Quadlets. The subsequent 8 bytes are fixed at 00. After that, the four characters for “SONY” are entered.

ModelNameLeaf

	Offset	0-7	8-15	16-23	24-31	
Model	464h	0006		CRC		
Name	468h	00	00	00	00	
Leaf	46ch	00	00	00	00	
	470h	58	43	44	2D	“XCD-”
	474h	53	58	39	31	“SX91”
	478h	30	20	76	31	“0 v1”
	47Ch	2E	30	30	41	“.00A”

For offset address 464h, the length of the ModelNameLeaf is 6 Quadlets. The subsequent 8 bytes are fixed at 00.

For the XCD-SX910CR/SX910, the 16 characters “XCD-SX910 v1.00A” come next. For the XCD-X710CR/X710, the 15 characters are “XCD-X710 v1.00A”.

Model names are subject to change with the upgrade of firmwares.

Control Base Address

Every register address is decided based on the base address found in the CommandRegsBase field of ConfigROM. F0F00000h is the control base address on this camera.

Inquiring Supported Video Modes

First, we will find out what video formats are supported.

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00100h	E1000000h	C1000000h

We find that the XCD-SX910CR/SX910 supports Format0/1/2/7, and the XCD-X710CR/X710 supports Format0/1/7.

Next, for each format, we will find out which video modes are supported.

Format0

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00180h	06000000h	06000000h

We find video modes 5 and 6 of Format0 are supported.

Format1

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00184h	27000000h	27000000h

We find video modes 2, 5, 6 and 7 of Format1 are supported.

Format2 (XCD-SX910CR/SX910 only)

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00188h	22000000h	–

We find video modes 2 and 6 of Format2 are supported.

Format7

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F0019Ch	F8000000h	E0000000

We find that the XCD-SX910CR/SX910 supports video modes 0, 1, 2, 3 and 4 of Format7, and the XCD-X710CR/X710 supports video modes 0, 1 and 2 of Format7.

Next, for each video mode, we will find out which frame rates are supported.

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00214h (Format0Mode5)	70000000h	78000000h
F0F00218h (Format0Mode6)	60000000h	70000000h
F0F00228h (Format1Mode2)	30000000h	38000000h
F0F00234h (Format1Mode5)	F0000000h	F8000000h
F0F00238h (Format1Mode6)	60000000h	70000000h
F0F0023Ch (Format1Mode7)	E0000000h	F0000000h
F0F00248h (Format2Mode2)	F0000000h	–
F0F00258h (Format2Mode6)	E0000000h	–

Based on the data above, the formats, modes, and frame rates supported are shown in the tables below.

Video modes supported

XCD-SX910CR/SX910

Format	Mode	ImageSize	ColorCoding	FrameRate				
				30	15	7.5	3.75	1.875
0	5	640 × 480	Mono8		○	○	○	–
	6	640 × 480	Mono16			○	○	–
1	2	800 × 600	Mono8		○	○	–	–
	5	1024 × 768	Mono8		○	○	○	○
	6	800 × 600	Mono16			○	○	–
	7	1024 × 768	Mono16	–		○	○	○
2	2	1280 × 960	Mono8	–	○	○	○	○
	6	1280 × 960	Mono16	–	–	○	○	○

XCD-X710CR/X710

Format	Mode	ImageSize	ColorCoding	FrameRate				
				30	15	7.5	3.75	1.875
0	5	640 × 480	Mono8	○	○	○	○	–
	6	640 × 480	Mono16		○	○	○	–
1	2	800 × 600	Mono8	○	○	○	–	–
	5	1024 × 768	Mono8	○	○	○	○	○
	6	800 × 600	Mono16		○	○	○	–
	7	1024 × 768	Mono16	–	○	○	○	○

Video Mode Settings

Select the video mode you want to use from the tables, and make the required settings. As examples, the register settings for Format2, Mode2, and a frame rate of 15 fps for the XCD-SX910CR/SX910, and Format1, Mode5, and a frame rate of 30 fps, for the XCD-X710CR/X710, are shown.

In addition, an isochronous transfer speed of 400 Mbps, and isochronous channel 0 are used in these examples. Normally, set the isochronous transfer speed to 400 Mbps.

When multiple cameras are used simultaneously, set different isochronous channels for each one.

Address	Data	
	XCD-SX910CR/SX910	XCD-X710CR/X710
F0F00600h (FrameRate)	60000000h	80000000h
F0F00604h (VideoMode)	40000000h	A0000000h
F0F00608h (VideoFormat)	40000000h	20000000h
F0F0060ch (IsoChannel/IsoSpeed)	02000000h	02000000h

Starting/Stopping Video Transfer (ContinuousShot)

In the device driver, after the preparations for receiving isochronous data are made, video transfer starts when the following commands are issued.

Address	Data
F0F00614h	80000000h

When the following command is issued, video transfer stops.

Address	Data
F0F00614h	00000000h

OneShot and MultiShot

This camera supports both OneShot and MultiShot commands. With a OneShot command, after outputting a just one single-frame image, the camera enters an “idling” state. With a MultiShot command, the camera enters the “idling” state after outputting exactly the specified number of images.

OneShot

Address	Data
F0F0061Ch	80000000h

MultiShot

Address	Data
F0F0061Ch	4000nnnnh

Nnnn indicates the number of frames to be output. You can specify any number between 0001h ~ FFFFh (1~65,535). If 0000h is specified, you can think of it as 1 being set instead.

Execution of ContinuousShot, OneShot, and MultiShot are prioritized as follows. When a command with higher priority is being executed, the one with the lower priority is ignored.

ContinuousShot > OneShot > MultiShot

Memory Channel Operation

Save

Selecting the Memory Channel used to save the data

Address	Data	Operation
F0F00620h	10000000h	Selects Ch 1.
	20000000h	Selects Ch 2.

Saving data

Address	Data	Operation
F0F00618h	80000000h	Saves the current setting.

Load

Address	Data	Operation
F0F00624h	00000000h	Loads the default settings.
	10000000h	Loads the setting information in Ch 1.
	20000000h	Loads the setting information in Ch 2.

The settings of the camera features and the video mode can be stored.

The camera memorizes the channel most recently used to read out the setting information using non-volatile memory. Then, the information in that channel will be loaded when the power is turned on the next time.

The video mode settings are loaded only when the power is turned on. If you read out Memory Channels during operation, only the settings of the camera features are loaded.

The value of Pan/Tilt depends on the video mode settings. If you change the video mode after carrying out the Save command, the value of Pan/Tilt may not be loaded correctly.

Feature Controls

This camera supports the following features.

AutoExposure	Controls the target video level value when Shutter/gain is set to Auto.
Shutter	Controls the exposure time. Can be controlled by both relative control values from 1/100,000 of a second to 16 seconds, allocated from 3 to 1060, and absolute value control, from values 1/100,000 of a second to 17.5 seconds, set continuously.
Gain	Can be changed to 0 to 18 dB (XCD-SX910CR/X710CR)/0 to 24 dB (XCD-SX910/X710), subdivided in 640 steps, with approximately 0.035 dB per step.
Trigger	Sets external trigger mode. Trigger Mode 0 and 1 are available. Software Trigger Mode in which triggers can be output by software.
Pan/Tilt	Sets CCD output range (both horizontal (Pan) and vertical (Tilt)). The video mode predetermines the variable range. Not available in Partial Scan Mode (Format7/Mode0).
Brightness	Adjusts the black level precisely.

The XCD-SX910CR/X710CR supports the following additional features.

White Balance	Adjusts the White Balance by adjusting the R and B gain with respect to G.
Hue	Adjusts G gain. Use this feature when you cannot obtain the correct White Balance using the R and B gain.
Optical Filter	Selects the pixels to output from among the R, G, and B data on the Bayer pattern. Four kinds of Bayer pattern are available.

Before sending a command, check the predetermined variable range and check whether the feature supports AUTO mode.

Note that variable ranges for Pan/Tilt differ

considerably depending on the video mode. After switching video mode, check the variable range of the new video mode.

Address	Data	Bit* ¹⁾	
F0F00500h (Brightness)	8905A073h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 63
F0F00504h (AutoExposure)	8905A073h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 90
		20-31	Max. 115
F0F0050Ch (White Balance) (XCD-SX910CR/X710CR only)	CB003424h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 127
F0F00510h (Hue) (XCD-SX910CR/X710CR only)	8B1803FFh	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 63
F0F0051Ch (Shutter)	CB003424h	0	This feature exists.
		1	Absolute value control possible
		4	The value can be read out.
		6	Auto setting can be selected.
		7	Manual setting can be selected.
		8-19	Min. 3
		20-31	Max. 1060
F0F00520h (Gain)	8B1803FFh	0	This feature exists.
		4	The value can be read out.
		6	Auto setting can be selected.
		7	Manual setting can be selected.
		8-19	Min. 384
		20-31	Max. 1023
F0F00530h	8C81C000h	0	This feature exists.
		4	The value can be read out.
		5	Feature can be switched between ON and OFF.
		8	Trigger Source0 exists.* ²⁾
		15	Software Trigger Mode exists.* ²⁾
		16	Trigger Mode0 exists.
		17	Trigger Mode1 exists.
F0F00584h (Pan) F0F00584h (Tilt)	89*****	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. (Depends on the video mode.)
		20-31	Max. (Depends on the video mode.)
F0F0058Ch (Optical Filter) (XCD-SX910CR/X710CR only)	8C81C000h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 3

*¹⁾ According to the IEEE 1394 specifications, the most significant bit is shown as 0.

*²⁾ These feature are to be applied to IIDC v.1.31. Therefore, they may be changed after IIDC v.1.31 is formally approved.

Actual control can be carried out by setting registers from F0F00800 onward.

ddd indicates the control value expressed as a 12 bit hexadecimal number.

xxx indicates that any setting made will be ignored.

Brightness control

Address	Data	
F0F00800	82000ddd	Adjusts the black level.

AE reference control

Address	Data	
F0F00804	82000ddd	Sets the AE reference value.

Shutter (exposure time) control

Address	Data	
F0F0081C	82000ddd	Controls shutter using the manually set relative value.
	83000xxx	Sets to AUTO.
	C2000xxx	Controls shutter using the absolute control value.
F0F00970 (See page 25.)	Indicates an arbitrary value using a 32-bit floating point value.	After F0F0081C has been set to Absolute value control, set exposure time using this register.

Gain control

Address	Data	
F0F00820	82000ddd	Sets Gain manually.
	83000xxx	Sets Gain to AUTO.

Pan/Tilt control

Address	Data	
F0F00884	82000ddd	Sets Pan manually.
F0F00888	82000xxx	Sets Tilt manually.

Trigger control

Address	Data	
F0F00830	82000000	Sets to Hardware Trigger Mode0.
	82010000	Sets to Hardware Trigger Mode1.
	82E00000	Sets to Software Trigger Mode0. *
	82E10000	Sets to Software Trigger Mode1. *
F0F0062C*	80000000	Outputs a software trigger. In Trigger Mode0, automatically reset to 0 when exposure ends.
	00000000	In Trigger Mode1, ends exposure if "0" is set.

* These feature are to be applied to IIDC v.1.31. Therefore, they may be changed after IIDC v.1.31 is formally approved.

White Balance control (XCD-SX910CR/X710CR only)

Address	Data	
F0F0080C	82bbbrrr	Sets R and B Gain. "bbb" sets B Gain, "rrr" sets R Gain.

Hue (G Gain) control (XCD-SX910CR/X710CR only)

Address	Data	
F0F00810	82000ddd	Sets G Gain.

Optical Filter control (Bayer pattern selection) (XCD-SX910CR/X710CR only)

Address	Data	
F0F0088C	82000ddd	Selects the Bayer pattern.

The following Bayer patterns are available.

Pattern 0

G	B
R	G

Pattern 1

B	G
G	R

Pattern 2

R	G
G	B

Pattern 3

G	R
B	G

The formula for absolute value shutter control register address**Absolute value shutter control CSR offset address**

Address	Data	
F0F0071C	003C025C	Absolute value shutter control CSR offset

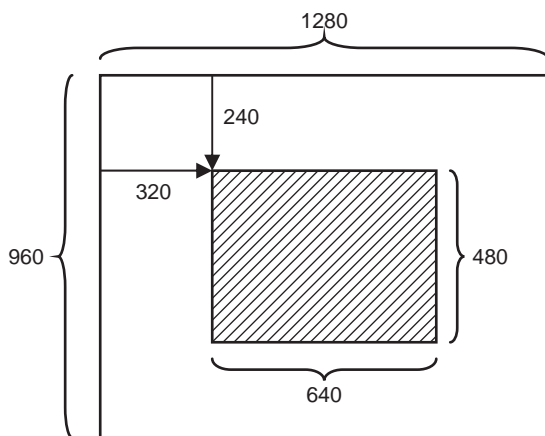
The register address for absolute value shutter control is given by the following formula.

$$F0000000h + 003C025Ch * 4 = F0F00970h$$

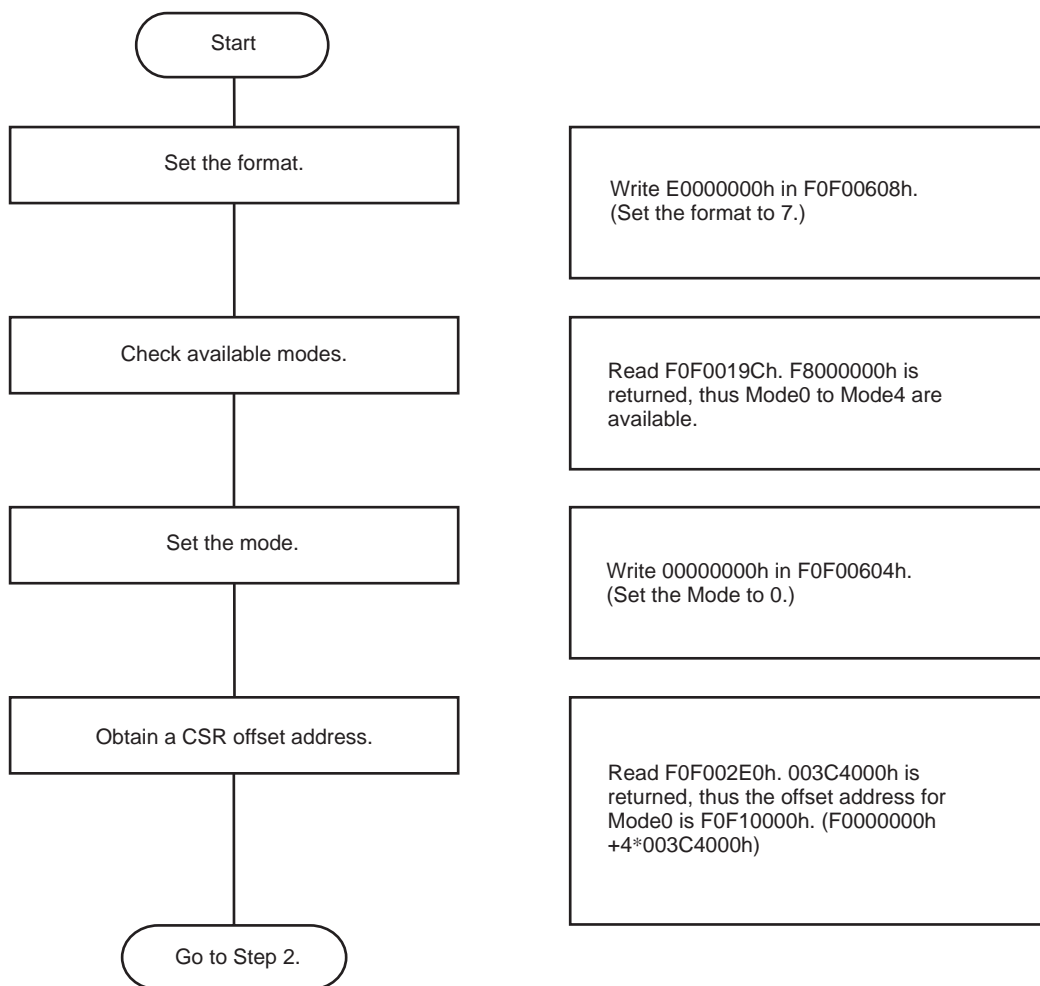
Partial Scan Operation

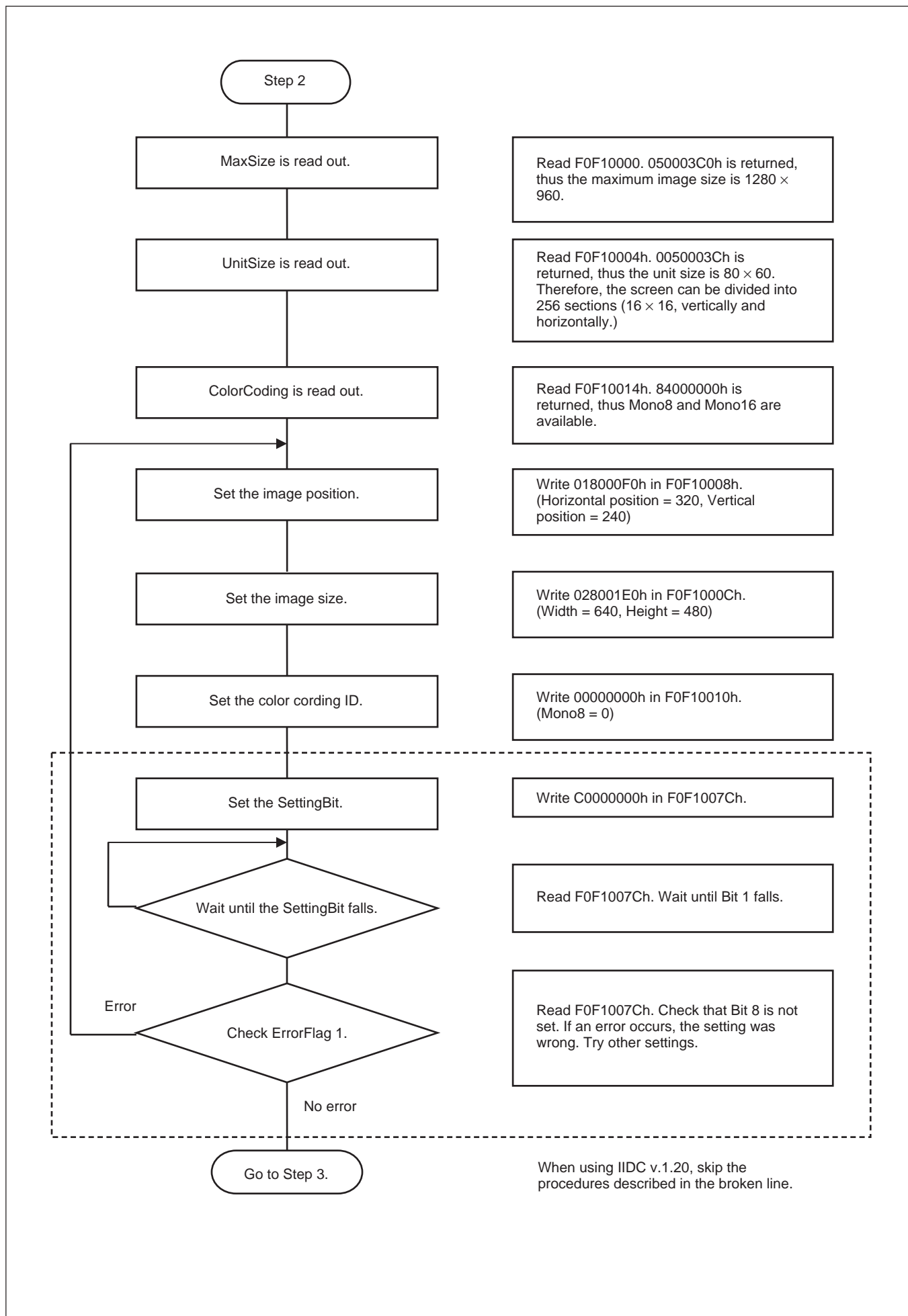
Partial scan can be set using either the SettingBit or IIDC v.1.20 interchange.

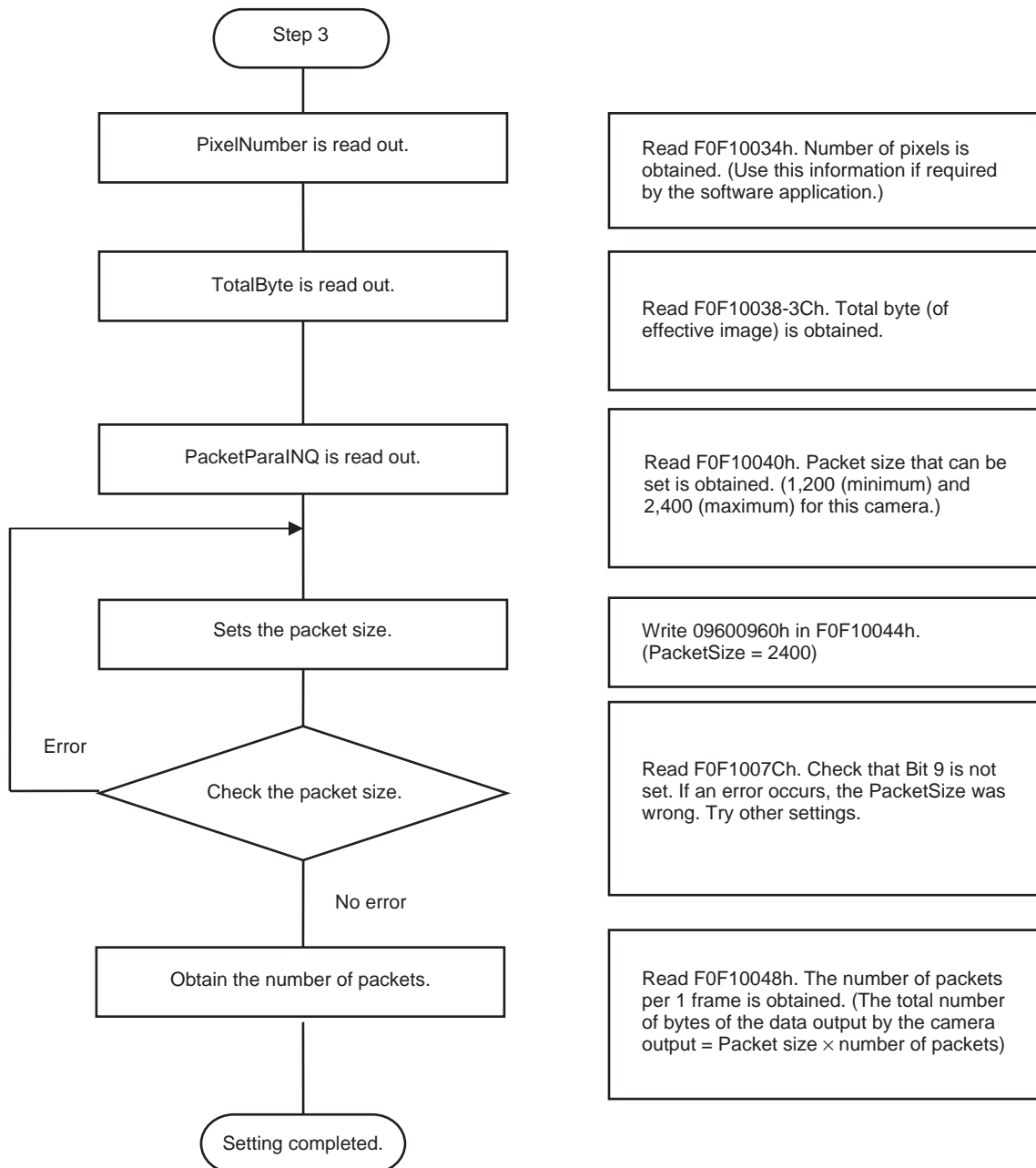
An example of the setting procedure (In the case of an XCD-SX910CR/SX910)



When shooting the center of the whole screen with the screen size of 640×480 , and color coding set to 8 bit Black & White Mode, the packet size is set to maximum in order to capture the image at the highest speed.







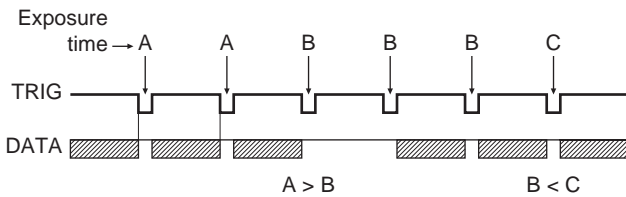
Now image transmission is ready. Send a video start command to output images.

Notes on the Camera Operations

1. If a Frame rate decrease.

Frame rate may decrease depending on your shutter settings.

- a. When a series of images is output, the instant when the exposure time is shorter than one frame, and the exposure time setting is shortened using the shutter.



- b. When the shutter is set to Auto, the instant when the exposure time decreases to match the light coming in. (Dark → Light)

In either cases, the camera tends to skip 1 frame image, resulting in a decrease in the frame rate. Keep this in mind when using an application that switches exposure time frequently.

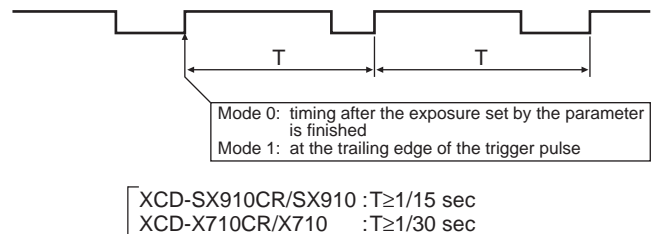
- c. With a long exposure

In long exposure mode, the exposure time is set longer than the image transmission cycle. In this case, frame rate decreases according to the exposure time.

2. When using Trigger mode

When this camera is set to accept a trigger at the fastest possible timing, it can accept overlap of the next trigger signal in the midst of video transmission. For this reason, a trigger inhibition period is not available. Thus, if a trigger signal is input before the CCD can change to the state where it can accept exposures, multiple exposures can occur, and it cannot capture the correct image. Make sure that the following conditions are met when the trigger is activated.

(However, partial activation can be used if the following conditions are exceeded. Refer to the table on pages 33 and 34.)



3. When AE is not available.

The camera loads the AE function that controls Gain and Shutter automatically. However, the function works properly in the Normal mode only.

XCD-SX910CR/SX910	Format2Mode2 15 fps
	TriggerOFF
XCD-X710CR/X710	Format1Mode5 30 fps
	TriggerOFF

When other modes are set, activating the AE function is possible, however, normal operation of the function is not guaranteed.

In Trigger mode—AE works properly when the video format is set to the normal setting and the trigger cycle is set to the same as that of the video format.

4. On the sensitivity in Binning mode

In the Binning mode, the vertical signal is factored in, so the sensitivity is doubled. The frame rate is also doubled (the frame cycle is halved), but if the shutter is set to off, the exposure time is halved, and so this effect is canceled out. On the other hand, when the shutter is on, the effect of this inclusion appears, and the sensitivity increases. So when setting the exposure time in the Binning mode, take this into consideration.

5. Auto shutter control and absolute value shutter control

The auto shutter control function cannot be used in the Absolute value control mode. When Shutter is set to AUTO, the Absolute value control mode is automatically canceled.

6. Issues to be considered with partial activation, and binning

With partial activation and binning, high-speed operation of the CCD occurs.

If strong light comes into the image at the same time, there may be some influence at the edges of the image. In such a case then, adjust the lens so that only the appropriate amount of light is allowed.

7. About the address range available for BlockWrite operations

The camera performs BlockWrite operations against consecutive registers. However, the range of the addresses stored in these registers are limited.

Available address ranges for BlockWrite operations	Functions
F0F00600h - F0F00614h	Frame rate/Video mode/Video format/Isochronous channel/Isochronous speed/Isochronous_Enable
F0F00800h - F0F008fCh	Feature control

If BlockWrite operations are performed outside the ranges listed above, an address error will occur.

Meanwhile, the camera can perform BlockRead operations for any sequence of consecutive registers even though the registers are not available for BlockWrite operations.

In Format 7 CSR, for example, BlockWrite operations are prohibited because Format 7 CSR requires a process for setting the register. However, BlockRead is possible in Format 7 CSR.

8. Note on the isochronous control register

The BlockWrite operations are available in the range F0F00600h to F0F00614h. However, setting the video mode in this range is not recommended because it may influence the variable range available for the features. Following the process listed below is recommended for setting the isochronous control register.

Set the isochronous channel/isochronous speed	(F0F0060Ch)
Set the video format	(F0F00608h)
Set the video mode	(F0F00604h)
Set the frame rate	(F0F00600h)
Confirm the variable range for the various features	(F0F00500-F0F005FCh)
Set the features (as needed)	(F0F00800-F0F008FCh)
Prepare for video data capture	
Video start	(F0F00614h)

9. About the Binning mode on the XCD-SX910CR/X710CR

On a camera using a color CCD, the color information is lost during the process of mixing pixels. Because of this, a color CCD camera cannot output a correct image in the Binning mode. Use the Binning mode only when you intend to perform something needing a high frame rate, such as focus adjustment.

Specifications

Image sensor	XCD-SX910CR/SX910	1/2-type progressive scan IT transfer CCD	Minimum illumination	XCD-SX910CR/X710CR	20 lx (F0.95, Gain: +18 dB, G ch)
	XCD-X710CR/X710	1/3-type progressive scan IT transfer CCD		XCD-SX910/X710	4 lx (F0.95, Gain: +24 dB)
Number of effective pixels	XCD-SX910CR/SX910	Approx. 1,450,000 1392 (H) × 1040 (V)	Brightness		Adjustable
	XCD-X710CR/X710	Approx. 800,000 1034 (H) × 779 (V)	Gamma		γ = 1 (Fixed)
Unit cell size		4.65 μm (H) × 4.65 μm (V)	CCD Iris		ON/OFF
Interface format		IEEE1394-1995	Shutter		1/100,000 to 17.5 s (Absolute value control possible)
Transfer speed		400, 200, 100 Mbps	Gain	XCD-SX910CR/X710CR	Auto/Manual (0 to 18 dB)
Protocol		IIDC 1394-based Digital Camera Specification Version 1.30 Compliant		XCD-SX910/X710	Auto/Manual (0 to 24 dB)
Image format (fixed size)	XCD-SX910CR/SX910	1280 × 960 Mono8/16 1024 × 768 Mono8/16 800 × 600 Mono8/16 640 × 480 Mono8/16	External trigger shutter		Available (Trigger Mode0/1)
	XCD-X710CR/X710	1024 × 768 Mono8/16 800 × 600 Mono8/16 640 × 480 Mono8/16	Partial scan function (Smallest unit)	XCD-SX910CR/SX910	80 (H) × 60 (V)
Frame rate (depends on the image format)	XCD-SX910CR/SX910	15 to 1.875 fps		XCD-X710CR/X710	64 (H) × 48 (V)
	XCD-X710CR/X710	30 to 1.875 fps	Power supply/Power consumption		+8 to +30 V (from IEEE1394 cable)
Image format (Format7) (*for Partial scan)	XCD-SX910CR/SX910	*1280 × 960 Mono8/16 640 × 480 Mono8/16 1280 × 480 Mono8/16 1376 × 1024 Mono8/16 1024 × 1024 Mono8/16	Power consumption		3.5 W (12 V)
	XCD-X710CR/X710	*1024 × 768 Mono8/16 512 × 384 Mono8/16 1024 × 384 Mono8/16	Operating temperature		-5 to +45°C
Partial scan function		16 × 16 (256 sections)	Storage temperature		-20 to +60°C
Lens mount		C-mount	Operating relative humidity		20 to 80% (No condensation)
Flange back		17.526 mm	Storage relative humidity		20 to 95% (No condensation)
			Vibration resistance		10 G (20 to 200 Hz, 20 minutes for each direction-X, Y, Z)
			MTBF		59549 Hrs (Approx. 6.8 years)
			Shock resistance		70 G
			Dimensions		44 (W) × 33 (H) × 116 (D) mm
			Mass		250 g
			Accessories		IEEE1394 cable (1) Lens mount cap (1) Operating Instructions (1)

Video modes supported

XCD-SX910CR/SX910

Fixed format

Format	Mode	ImageSize	ColorCoding	FrameRate				
				30	15	7.5	3.75	1.875
0	5	640 × 480	Mono8		○	○	○	–
	6	640 × 480	Mono16			○	○	–
1	2	800 × 600	Mono8		○	○	–	–
	5	1024 × 768	Mono8		○	○	○	○
	6	800 × 600	Mono16			○	○	–
	7	1024 × 768	Mono16	–		○	○	○
2	2	1280 × 960	Mono8	–	○	○	○	○
	6	1280 × 960	Mono16	–	–	○	○	○

Free format

Format	Mode	ImageSize	ColorCoding	PartialScan	FrameRate
7	0	1280 × 960	Mono8	○ (16 × 16)	Not specified
	0	1280 × 960	Mono16	○ (16 × 16)	Not specified
	1	640 × 480	Mono8	×	30/15 fps
	1	640 × 480	Mono16	×	15/7.5 fps
	2	1280 × 480	Mono8	×	30/15 fps
	2	1280 × 480	Mono16	×	15/7.5 fps
	3	1376 × 1024	Mono8	×	15/7.5 fps
	3	1376 × 1024	Mono16	×	7.5/3.75 fps
	4	1024 × 1024	Mono8	×	15/7.5 fps
	4	1024 × 1024	Mono16	×	7.5/3.75 fps

XCD-X710CR/X710

Fixed format

Format	Mode	ImageSize	ColorCoding	FrameRate				
				30	15	7.5	3.75	1.875
0	5	640 × 480	Mono8	○	○	○	○	–
	6	640 × 480	Mono16		○	○	○	–
1	2	800 × 600	Mono8	○	○	○	–	–
	5	1024 × 768	Mono8	○	○	○	○	○
	6	800 × 600	Mono16		○	○	○	–
	7	1024 × 768	Mono16	–	○	○	○	○

Free format

Format	Mode	ImageSize	ColorCoding	PartialScan	FrameRate
7	0	1024 × 768	Mono8	○ (16 × 16)	Not specified
	0	1024 × 768	Mono16	○ (16 × 16)	Not specified
	1	512 × 384	Mono8	×	50/25 fps
	1	512 × 384	Mono16	×	25/12.5 fps
	2	1024 × 384	Mono8	×	50/25 fps
	2	1024 × 384	Mono16	×	25/12.5 fps

Notes on the frame rates in Partial Scan Mode

The following table shows examples of frame rates in Partial Scan Mode. Note that the values in the table are given as examples, as the frame rate varies depending on exposure times or areas you have specified.

XCD-X710CR/X710

With Trigger OFF, and PacketSize = 3072

ImageWidth	ImageHeight	Shutter=129(16.641 ms)		Shutter=3(9 μ s)	
		Frame time(ms)	Frame rate(fps)	Frame time(ms)	Frame rate(fps)
64	48	24.7	40.5	8.1	123.8
64	96	26.4	38.0	9.7	102.6
64	144	28.0	35.7	11.4	87.7
64	192	29.7	33.7	13.1	76.5
64	240	31.3	31.9	14.7	67.8
64	288	33.0	30.3	16.4	61.0
64	336	34.6	28.8	18.1	55.3
64	384	36.4	27.5	19.7	50.7
64	432	38.0	26.3	21.4	46.7
64	480	39.7	25.2	23.1	43.3
64	528	41.3	24.2	24.7	40.4
64	576	43.0	23.2	26.4	37.9
64	624	44.6	22.4	28.0	35.6
64	672	46.3	21.6	29.7	33.6
64	720	48.0	20.8	31.4	31.9
64	768	49.7	20.1	33.0	30.2

With Trigger ON, PacketSize = 3072, and Shutter = 129 (16.6 ms)

ImageWidth	ImageHeight	Frequency of trigger (Hz)	Maximum frequency of an external trigger shutter that can be input
1024	48	59.9	<p>Frame rates are affected by exposure time.</p>
1024	96	59.9	
1024	144	59.9	
1024	192	59.9	
1024	240	59.9	
1024	288	59.9	
1024	336	56.1	
1024	384	51.3	
1024	432	47.2	
1024	480	43.7	
1024	528	40.8	
1024	576	38.2	
1024	624	35.9	
1024	672	33.8	
1024	720	32	
1024	768	30.2	

XCD-SX910CR/SX910

With Trigger OFF, and PacketSize = 2400

ImageWidth	ImageHeight	Shutter=129(16.641 ms)		Shutter=3(9 μ s)	
		Frame time(ms)	Frame rate(fps)	Frame time(ms)	Frame rate(fps)
80	60	39.9	25.1	23.2	42.9
80	120	42.7	23.4	26.1	38.3
80	180	45.5	22.0	28.9	34.6
80	240	48.3	20.7	31.8	31.5
80	300	50.7	19.7	34.6	28.9
80	360	54.0	18.5	37.4	26.7
80	420	56.8	17.6	40.2	24.9
80	480	59.6	16.7	43.0	23.2
80	540	62.4	16.0	45.8	21.8
80	600	65.3	15.3	48.7	20.6
80	660	68.1	14.7	51.5	19.4
80	720	70.9	14.1	54.3	18.4
80	780	73.7	13.6	57.1	17.5
80	840	76.5	13.1	59.9	16.7
80	900	79.3	12.6	62.7	15.9
80	960	82.2	12.2	65.6	15.3

With Trigger ON, PacketSize = 2400, and Shutter = 129 (16.6 ms)

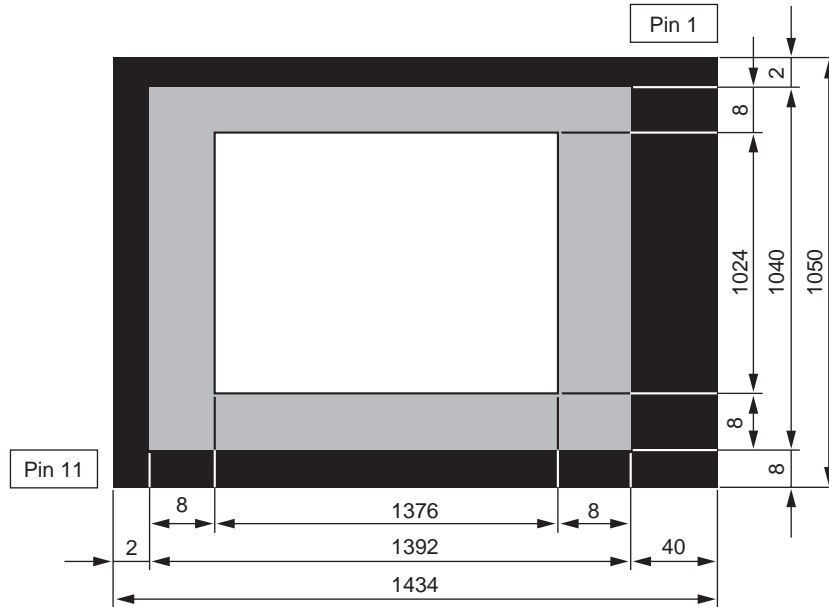
ImageWidth	ImageHeight	Frequency of trigger (Hz)
1280	60	59.8
1280	120	52.0
1280	180	44.8
1280	240	39.7
1280	300	35.7
1280	360	32.5
1280	420	30.1
1280	480	27.6
1280	540	25.6
1280	600	23.6
1280	660	22.2
1280	720	20.4
1280	780	18.8
1280	840	17.5
1280	900	16.4
1280	960	15.3

Maximum frequency of an external trigger shutter that can be input

CCD Pixel Location (Top View)

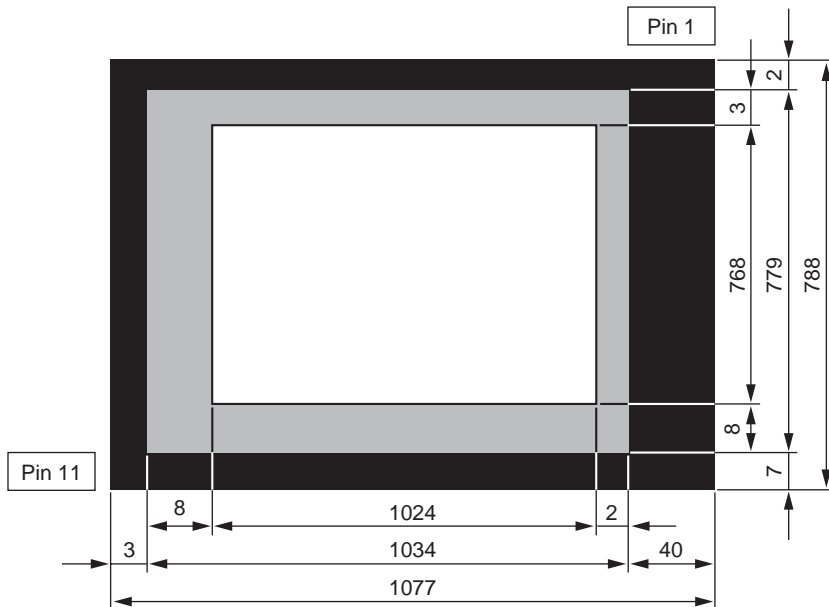
XCD-SX910CR/SX910

Total number of pixels: 1,434 (H) × 1,050 (V)
 Number of effective pixels: 1,392 (H) × 1,040 (V)
 Number of output pixels: 1,376 (H) × 1,024 (V) (Max.)



XCD-X710CR/X710

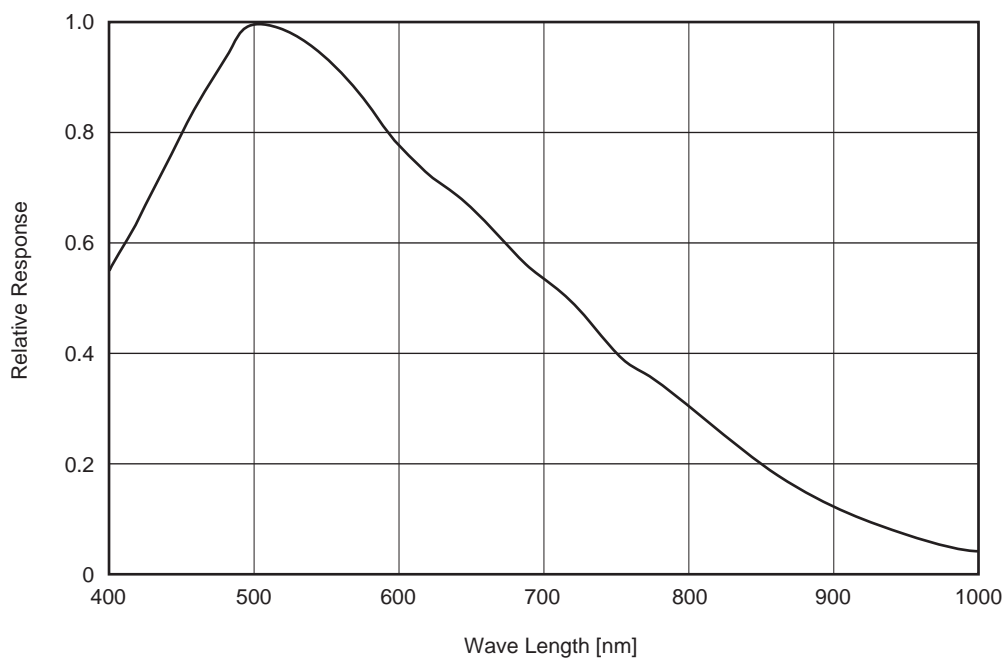
Total number of pixels: 1,077 (H) × 788 (V)
 Number of effective pixels: 1,034 (H) × 779 (V)
 Number of output pixels: 1,024 (H) × 768 (V)



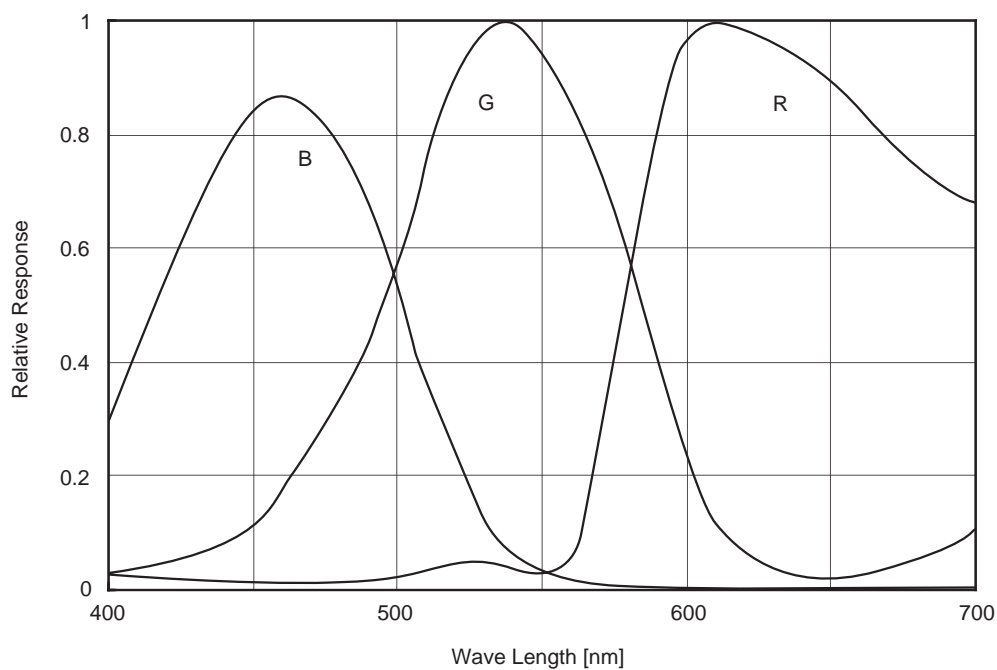
Spectral Sensitivity (Relative Response) Parameters

(Without lens and light source parameters.)

XCD-SX910/X710



XCD-SX910CR/X710CR



Dimensions

