SONY

A-C7X-100-**11** (1)

Digital Video Camera Module

Technical Manual

XCD-V50CR (Color model)
XCD-V50 (Black and white model)

Table of Contents

Overview

The XCD-V50CR/V50 with its 1/3-type PS IT CCD is industrial-use digital video camera module. Utilizing an IEEE 1394b-2002 digital interface, transfer rates as high as 800 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 ratio 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.

What is IEEE 1394b?

IEEE 1394b-2002 is an interface extension based on the IEEE 1394a-2000 specifications.
The outstanding feature of this interface is that it enables transfer speeds of up to 3.2 Gbps, and long distance transfer.
Five types of cables (STP, UTP, POF, HPCF and, GOF) can be used. Maximum transfer speed and cable lengh are defined for each type of cable.
This interface has two modes, one is a mode only for use with 1394b and the other is a legacy mode which is compatible with the 1394a interface. This allows you to make compatible connections with a network based on the 1394a interface.

* The Institute of Electrical and Electronics Engineers, Inc.

Main Features

The XCD-V50 video camera module utilizes a 1/3-type PS IT CCD

RAW mode output using the RGB Bayer pattern (XCD-V50CR only)

High-speed digital interface IEEE1394b-2002

High frame rate

The XCD-V50CR/V50 adopts an VGA-compatible 330000 pixels CCD to operate at a high speed of 60 fps.

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.

C-mount

High vibration-resistance structure

Black & white (Monochrome) 16-bit mode

A Black & white (Monochrome) 16-bit mode is available. The bits used are the least significant (lowest) 14 bits.

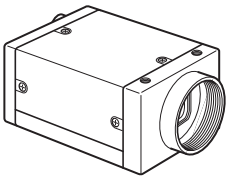
Daisy chained connection

The XCD-V50CR/V50 is equipped with two IEEE1394b connectors. This allows you to make up daisy chained connections.

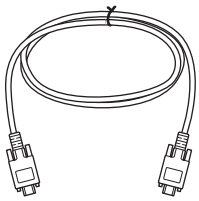
Low Power Consumption

System Components

The XCD-V50CR/V50 Video Camera Module system comprises the following components.

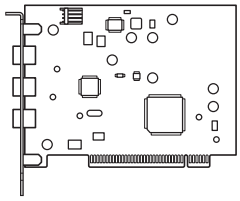


Video Camera Module XCD-V50CR/V50

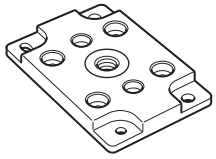


IEEE1394b Cable
(9 pin-9 pin 4.5 m)

C-mount Lens

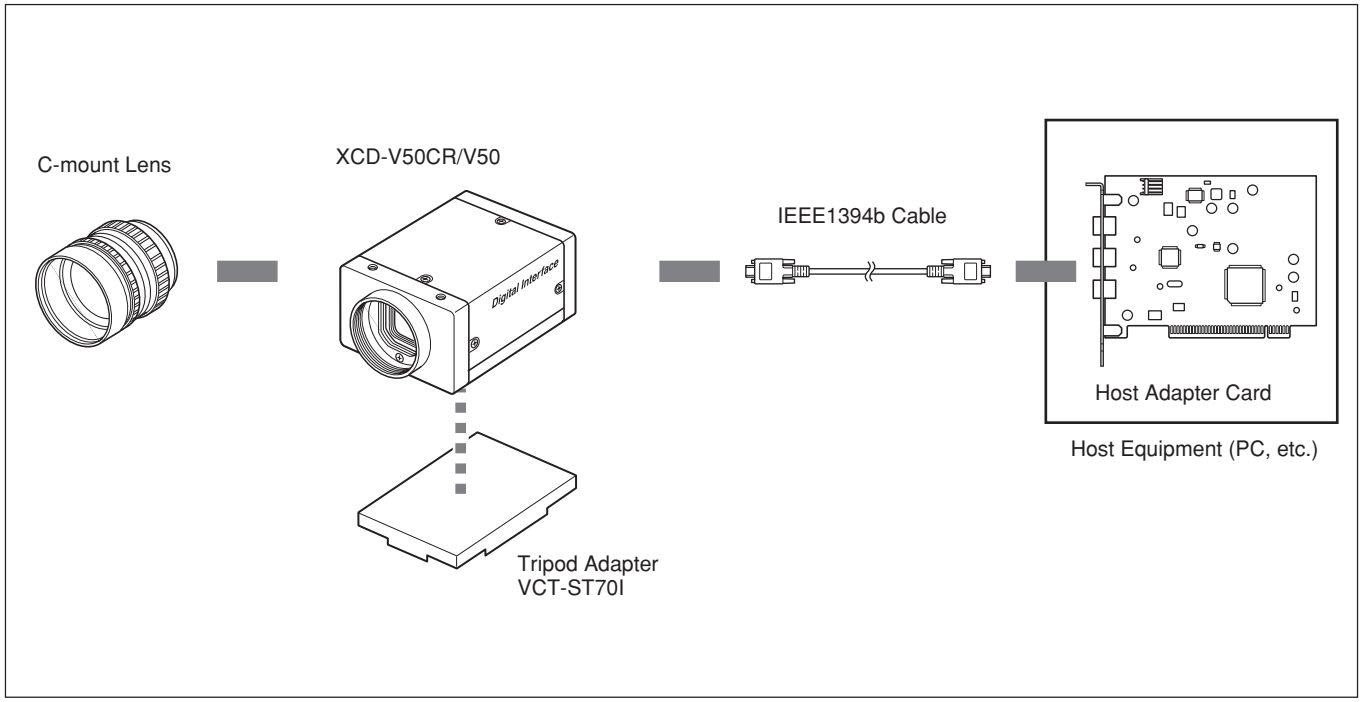


Host Adapter Card
(Commercially available)



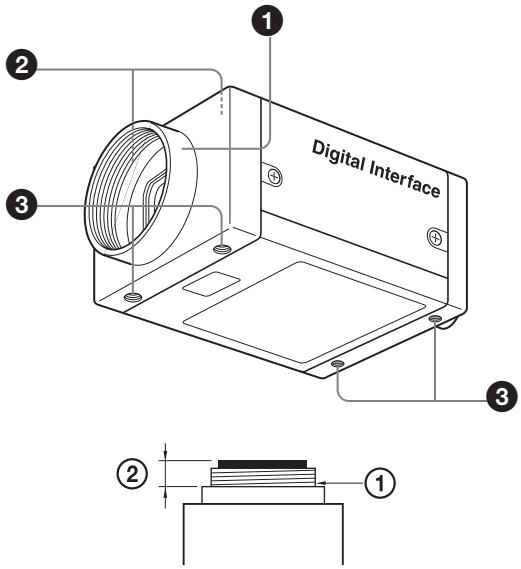
Tripod Adapter
VCT-ST70I (Isolated type)

Connection Diagram

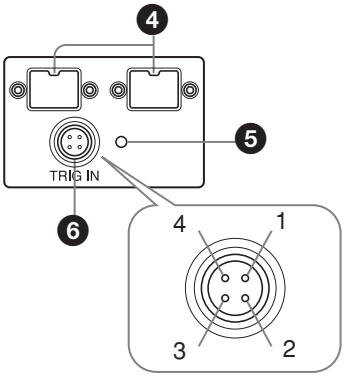


Location of Parts and Operation

Front/Top/Bottom



Rear Panel



❶ 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

❷ Auxiliary holes (Top)

❸ 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.

Four screw reference holes of ❸ can be used as the tripod adapor screw holes, too. Screw the tripod adaptor VCT-ST70I into the four screw holes when you use a tripod.

❹ IEEE1394b connectors
Connect the IEEE1394b cable (supplied) to this connector.

❺ 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

❻ TRIG IN (Trigger)/Exposure OUT connector
Connect the trigger signal generator (trigger output connector) to this connector.
When the external trigger function is set to OFF, a signal indicating the exposure time is output.

Pin No.	Signal
1	EXPO-OUT
2	TRG-GND
3	TRG-IN
4	NC

Functions

Gain

Manual Gain setting is available with this camera.
The variable range extends from 0 to 18 dB, and the unit is designed so that the gain can be subdivided and set to any of 512 steps.
At the factory default setting, the gain is set to 0 dB.

Shutter

This camera allows Manual Shutter setting.

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

P = Parameter (001h ~ C7ch)
E = Exposure time (μs)

$$E = (\mathrm{Int}(P \times 0.64) \times 32.55) + 10\ [\mu s]$$

Setting examples

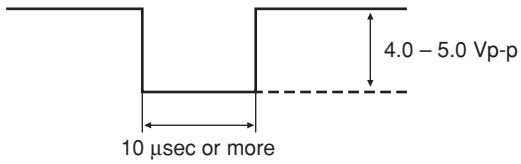
1 (001h) : 10 μs
48 (030h) : 0.99 ms
480 (1E0h) : 10 ms

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 4 pin 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. When trigger mode 0 is used, 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

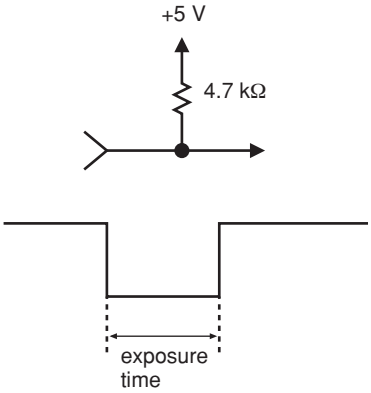
16-bit Mode

The camera supports 16-bit Black & white (Monochrome) mode, but because the output of the AD converter is 14-bit, only the least significant 14 bits of the 16 bits will handle data. The upper 2 bits will be filled with zeros.

00dddd	dddddddd

ExposureOut

When trigger is OFF, or software trigger is ON, a signal that indicates the exposure time is output from the TRIG IN/Exposure OUT connector of the camera.



The LOW period that is given by an output wave form is an approximate guideline. It does not correspond exactly to the actual exposure time.

White Balance
(XCD-V50CR 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-V50CR only)

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

The following Bayer patterns are available.

G	B
R	G

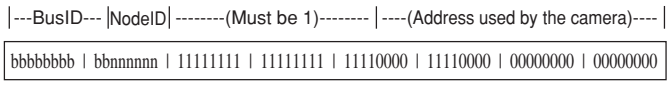
Control

Camera Command Status Register

This camera complies with IIDC 1394-based Digital Camera Specification, Version 1.31 (hereinafter referred to as IIDC v1.31).
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 v1.31.

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.



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
F0F00400	Basic Func Inq
F0F00500	Feature Element Inq
F0F00600	Isochronous Control register
F0F00800	FeatureControl

ConfigROM

	Offset	0-7	8-15	16-23	24-31	
Bus	400h	04	21	ROM CRC		
Info	404h	31	33	39	34	
Block	408h	20	FF	60	00	
	40ch	08	00	46	02	NodeVendorID/ChipID-Hi
	410h	00	10	00	01	ChipID-Lo
Root	414h	0003		CRC		
Directory	418h	03	08	00	46	ModuleVendorID
	41ch	0C	00	83	C0	
	420h	D1	00	00	01	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 21h Quadlets. So the ConfigROM from 400h to 487h is 136 bytes.

The UnitDirectory offset address is required to be

420h +000004h * 1 = 424h

	Offset	0-7	8-15	16-23	24-31	
Unit	424h	0003		CRC		
Directory	428h	12	00	A0	2D	UnitSpecID
	42Ch	13	00	01	02	UnitSoftwareVersion
	430h	D4	00	00	01	UnitDependentDirectory Offset

For offset address 424h, the length of the UnitDirectory is 3 Quadlets. UnitSpecID (00A02Dh) conforms to 1394TA standards. UnitSoftwareVersion (000102h) conforms to IIDC Standards, Version 1.3X.

The offset address of UnitDependentInfo is required to be

430h + 000001h * 4 = 434h

	Offset	0-7	8-15	16-23	24-31	
Unit	434h	000B		CRC		
Dependent	438h	40	3C	00	00	CommandRegsBase
Info	43Ch	81	00	00	0A	VendorNameLeaf
	440h	82	00	00	0D	ModelNameLeaf
	444h	38	00	00	10	Unit sub sw version
	448h	39	00	00	00	Reserved
	44Ch	3A	00	00	00	Reserved
	450h	3B	00	00	00	Reserved
	454h	3C	00	00	01	Vendor unique info 0
	458h	3D	00	00	00	Vendor unique info 1
	45Ch	3E	00	00	00	Vendor unique info 2
	460h	3F	00	00	00	Vendor unique info 3

For offset address 434h, the length of the UnitDependentInfo is 11 Quadlets.

CommandRegsBase is the base address of the camera control register.

F0000000h + 3c0000h * 4 = F0F00000h

The offset address of VendorNameLeaf is required to be

43Ch + 000002Ah * 4 = 464h

The offset address of ModelNameLeaf is required to be

440h + 000005Dh * 4 = 474h

Unit sub sw version indicates that this camera conforms to IIDC Version 1.31.

VendorNameLeaf

	Offset	0-7	8-15	16-23	24-31	
Vendor	464h	0003		CRC		
Name	468h	00	00	00	00	
Leaf	46ch	00	00	00	00	
	470h	53	4F	4E	59	“SONY”

For offset address 464h, 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	474h	0004		CRC		
Name	478h	00	00	00	00	
Leaf	47ch	00	00	00	00	
	480h	58	43	44	2D	“XCD-”
	484h	56	35	30	00	“V50”

For offset address 474h, the length of the ModelNameLeaf is 4 Quadlets. The subsequent 8 bytes are fixed at 00.
For the XCD-V50, the 7 characters “XCD-V50” come next. For the XCD-V50CR, the 9 characters “XCD-V50CR” come next.

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
F0F00100h	80000000h

We find that Format0 is supported.

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

Format0

Address	Data
F0F00180h	06000000h

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

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

Address	Data
F0F00214h (Format0Mode5)	1C000000h
F0F00218h (Format0Mode6)	18000000h

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

Video modes supported

				FrameRate PacketSize (bytes)				
Format	Mode	ImageSize	ColorCoding	60	30	15	7.5	3.75
0	5	640 × 480	Mono8	○ 2560	○ 1280	○ 640	×	×
	6	640 × 480	Mono16	×	○ 2560	○ 1280	×	×

Video Mode Settings

Select the video mode you want to use from the tables, and make the required settings. As example, the register setting for Format0, Mode5, and a frame rate of 60 fps is shown.
In addition, an isochronous transfer speed of 800 Mbps, and isochronous channel 0 are used in this example. When you use the camera via the 1394a interface, set the isochronous transfer speed to 400 Mbps.
When multiple cameras are used simultaneously, set different isochronous channels for each one.

Address	Data	
F0F00600h (FrameRate)	A0000000h	60fps
F0F00604h (VideoMode)	A0000000h	Mode5
F0F00608h (VideoFormat)	00000000h	Format0
F0F0060Ch (IsoChannel/ IsoSpeed)	00008003h	Ch=0/800Mbps

When the transfer speed is set to 400 Mbps, also make the following settings.

Address	Data	
F0F0060Ch (IsoChannel/ IsoSpeed)	02000000h	Ch=0/400Mbps

Inquiring the Effective Bit Length

You can verify the effective bit length in each mode after you set the video modes.

Address	Data	
F0F00630h (FrameRate)	08000000h	Mono8 at setting
F0F00630h (VideoMode)	0E000000h	Mono16 at setting

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

Feature Controls

This camera supports the following features.

Shutter	Controls the exposure time. Can be controlled by both relative control values from 1/100000 of a second to 1/15s, allocated from 1 to 3196.
Gain	Can be changed to 0 to 18 dB, subdivided in 512 steps.
Trigger	Sets external trigger mode. Trigger Mode 0 and 1 are available. Software Trigger Mode in which triggers can be output by software.

The XCD-V50CR 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.

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

Address	Data	Bit*	
F0F0050Ch (White Balance) (XCD-V50CR only)	8900003Fh	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
F0F00510h (Hue) (XCD-V50CR only)	8900003Fh	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)	89001C7Ch	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 1
		20-31	Max. 3196
F0F00520h (Gain)	89000200h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0 (XCD-V50) or 256 (XCD-V50CR)
		20-31	Max. 256 (XCD-V50) or 768 (XCD-V50CR)
F0F00530h (Trigger)	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.
		15	Software Trigger Mode exists.
		16	Trigger Mode0 exists.
		17	Trigger Mode1 exists.

* According to the IEEE1394 specifications, the most significant bit is shown as 0.

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.

Shutter (exposure time) control

Address	Data	
F0F0081C	82000ddd	Sets Shutter manually.

Gain control

Address	Data	
F0F00820	82000ddd	Sets Gain 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.

White Balance control (XCD-V50CR only)

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

Hue (G Gain) control (XCD-V50CR only)

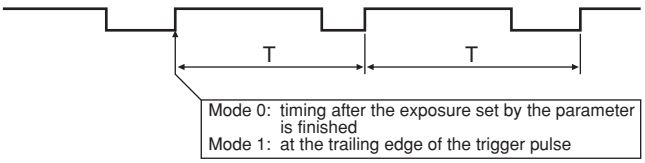
Address	Data	
F0F00810	82000ddd	Sets G Gain.

Appendix

Notes on the Camera Operations

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.



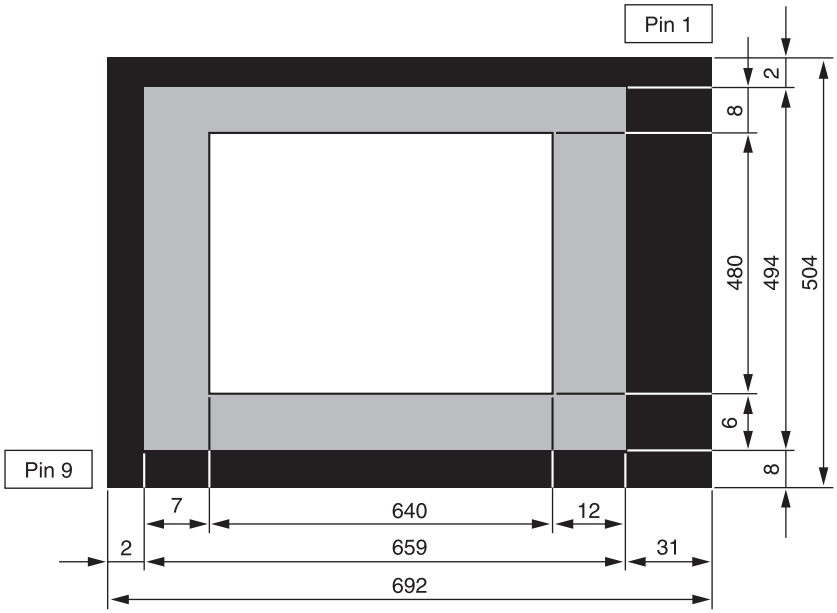
T≥1/30 sec

Specifications

Image sensor	1/3-type progressive scan IT transfer CCD
Number of effective pixels	Approx. 330,000 659 (H) × 494 (V)
Unit cell size	7.4 μm (H) × 7.4 μm (V)
Interface format	IEEE1394b-2002
Transfer speed	800, 400 Mbps
Protocol	IIDC 1394-based Digital Camera Specification Version 1.31 Compliant
Image format	640 × 480 Mono8/16
Frame rate	15/30/60 fps (mono8) 15/30 fps (mono16)
Lens mount	C-mount
Flange back	17.526 mm
Minimum illumination	XCD-V50CR: 20 lx (F0.95, Gain: +18 dB) XCD-V50: 4 lx (F0.95, Gain: +18 dB)
Gamma	$\gamma = 1$ (Fixed)
Shutter	1/10000 to 1/15 s (at 15 fps) 1/10000 to 1/30 s (at 30 fps) 1/10000 to 1/60 s (at 60 fps)
Gain	0 to 18 dB
External trigger shutter	Available (Trigger Mode0/1)
Power supply/Power consumption	+8 to +30 V (from IEEE1394b cable)
Power consumption	2 W (12 V)
Operating temperature	–5 to +45˚C
Storage temperature	–20 to +60˚C
Operating relative humidity	20 to 80% (No condensation)
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	53982 Hrs (Approx. 6.2 years)
Shock resistance	70 G
Dimensions	44 (W) × 29 (H) × 57.5 (D) mm
Mass	120 g
Accessories	IEEE1394b cable (1) Lens mount cap (1) 4-pin connector for the trigger input (1) Operating Instructions (1)

CCD Pixel Location (Top View)

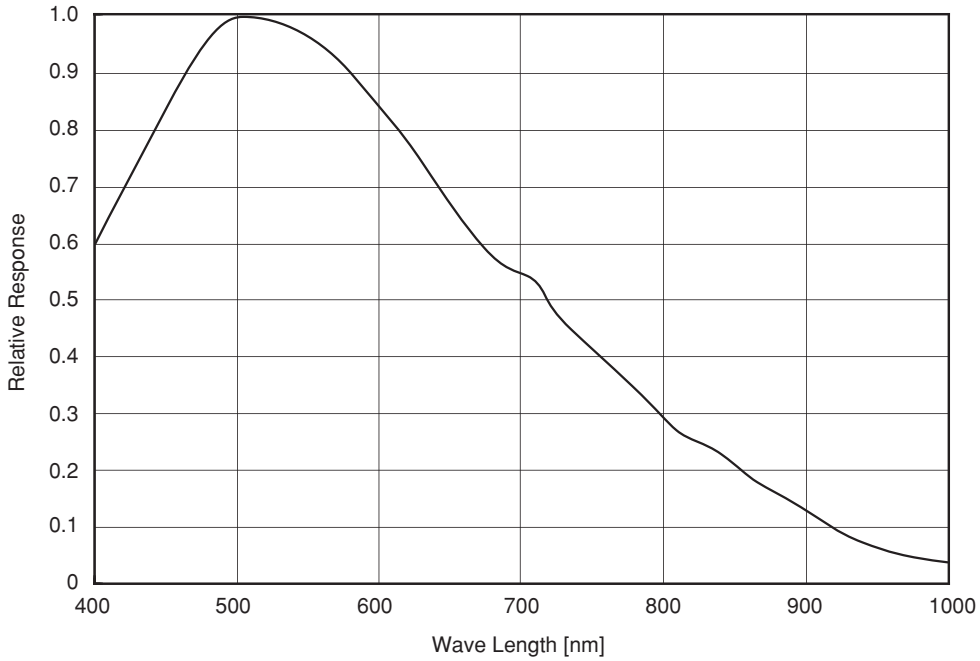
Total number of pixels: 692 (H) × 504 (V)
Number of effective pixels: 659 (H) × 494 (V)
Number of output pixels: 640 (H) × 480 (V)



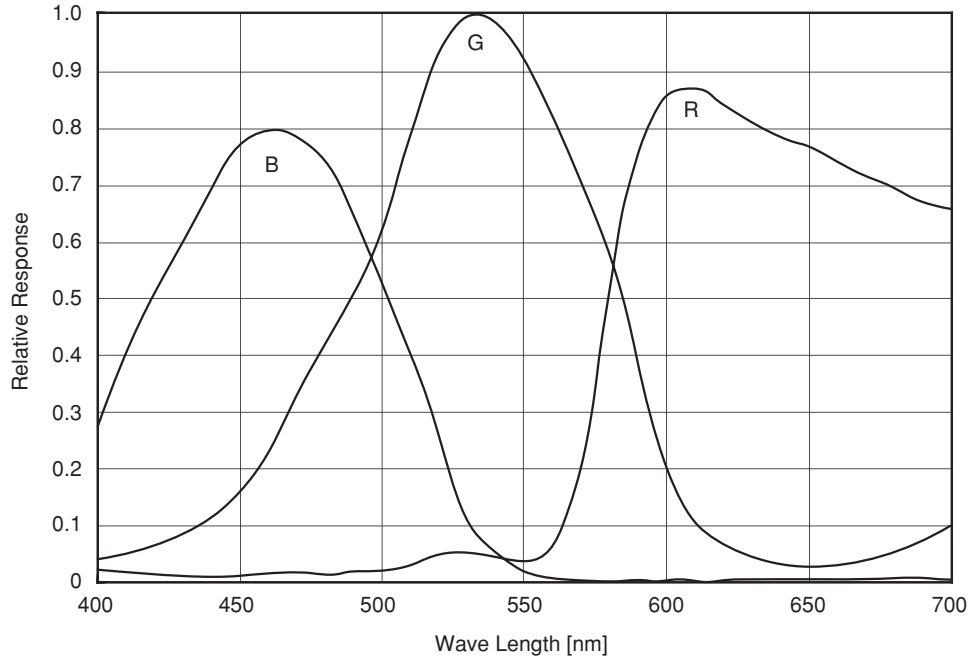
Spectral Sensitivity (Relative Response) Parameters

(Without lens and light source parameters.)

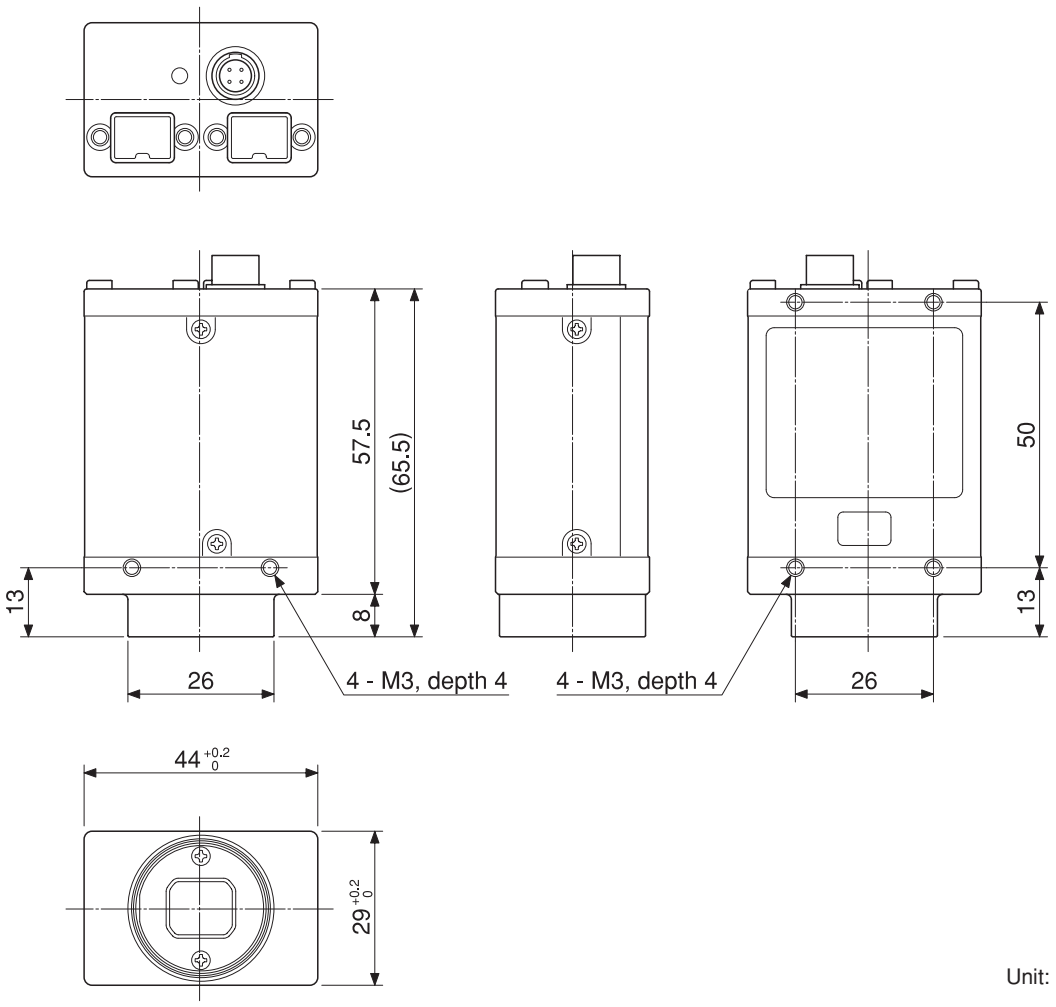
XCD-V50



XCD-V50CR



Dimensions



Unit: mm