SONY®

Digital Video Camera Module

Technical Manual

XCD-MV6

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Overview

The XCD-MV6 digital video camera module employs the IEEE1394b-2002 standard and is equipped with quality digital camera features. Despite its compact size, this camera is equipped with a host of features such as digital signal processing in the camera which reduces the load of image processing in a PC, bus synchronization, and broadcast delivery of commands. This digital output camera conforms to the IIDC 1.32 protocol, taking full advantage of IEEE1394 capabilities.

Main Features

High-speed transmission at 1.6 Gbps

Transmission speed supports the following two types: S1600 (1.6 Gbps (1600Mbps)) and S800 (800 Mbps).

Equipped with a CMOS sensor

With a 1/3" CMOS Sensor, the camera can output video at a frame rate of 60 fps with a image size of WVGA (H:752 × V:480) and VGA (H:640 × V:480).

Digital signal processing

The camera is equipped with Sony's own correction function which corrects pixel blemishes and vertical stripes characteristic of CMOS Sensors.
In addition, it is also equipped with a function to correct shading produced by lenses and light sources, achieving high image quality required for machine vision use.

Broadcast delivery of commands

The camera settings for all the cameras connected to the same bus can be changed at the same time. For example, the gain or shutter speed is set to the same value on all the cameras, or exposure starts on all the cameras simultaneously using a software trigger.

Memory Channel

The memory channel allows storage of up to 15 sets of camera settings such as gain and shutter.

Image Buffer (Memory Shot)

The image exposed from the sensor is stored in the camera's built-in memory. The stored image can be read out using a command from the host PC when required.

		XCD-MV6
Standard image size (H × V)		640 × 480 (VGA)
Bit length	Mono8	100 frames maximum
	Mono16	100 frames maximum

The number of frames is not dependent on bit length. The maximum number of frames is 100, regardless of image size.

Partial scan

Partial scan clips a required angle of view (area) from the entire screen to be read out. As a part of the image is read out, the unit takes advantage of reduced image data and high-speed transfer. The minimum clipping unit is 64 pixels × 24 lines.

Connector with fixing screws

The camera employs a fixing screw connector resistant to vibration and shock in both the IEEE1394b and 8-pin connectors.

Low power consumption, vibration and shock-resistant structure, and compact size

IIDC Ver.1.32 protocol compliant

System Components

The camera module imaging system comprises the following products.
Products ❶ to ❹ are used for the basic configuration, and ❶ to ❻ for the optional configuration. (All the products except the camera module are available separately.)
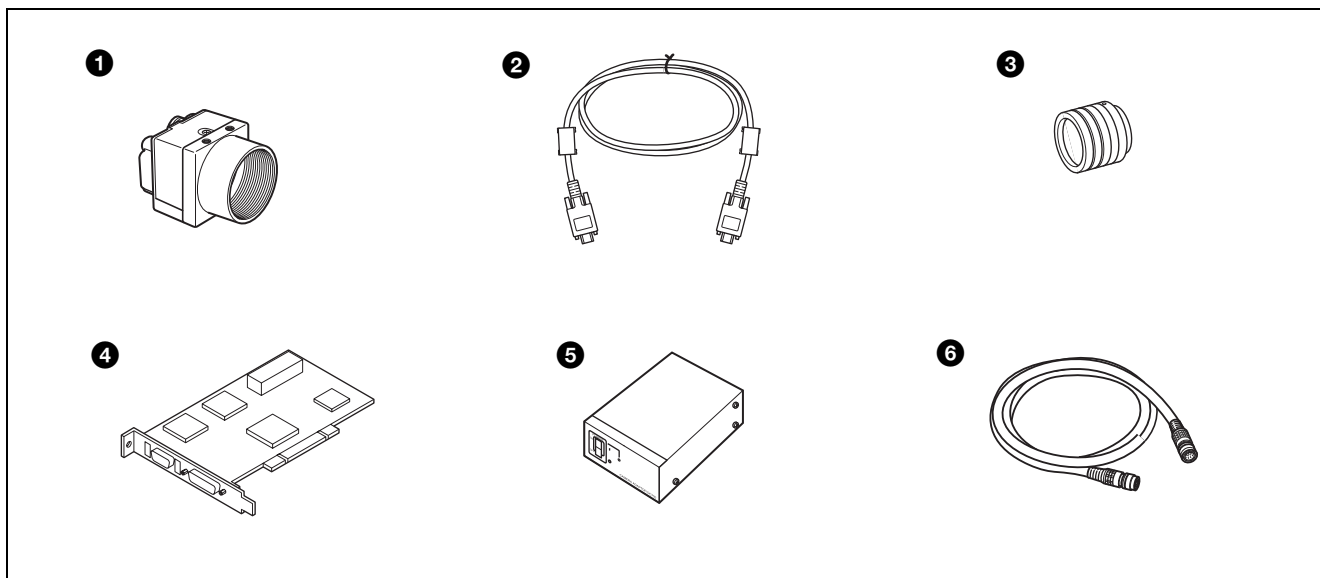
❶ **Camera module**
This is a small-size, high-resolution, camera module using a CMOS sensor.

❷ **IEEE1394b camera cable (commercially available)**
Connect this cable to the IEEE1394b connector on the rear panel of the camera module. The power and image/control signals are transmitted through this cable. To prevent a poor connection or damage to the camera or cable, use the cable equipped with fixing screws.

❸ **C-mount lens (commercially available)**
Use an appropriate lens for the camera module and usage.

❹ **Camera module interface board (commercially available)**
This is inserted in slots such as the PCI Express bus or PCI bus of the host equipment (PC etc.)
Select an IEEE1394b interface board to match your system.

❺ **DC-700/700CE camera adaptor (Sony)**
Connect this adaptor to the camera module to enable power supply from an ordinary AC power source.

❻ **Camera cable (commercially available)**
Connect this cable to the 8-pin I/O connector on the rear panel of the camera module. The cable is used for power supply and exchange of trigger signals. For details about the suitable cable, please contact your Sony Dealer.

Connection Diagram

C-mount lens — **XCD-MV6** — **IEEE1394b cable** — **Host adaptor card**

Host equipment (PC, etc.)
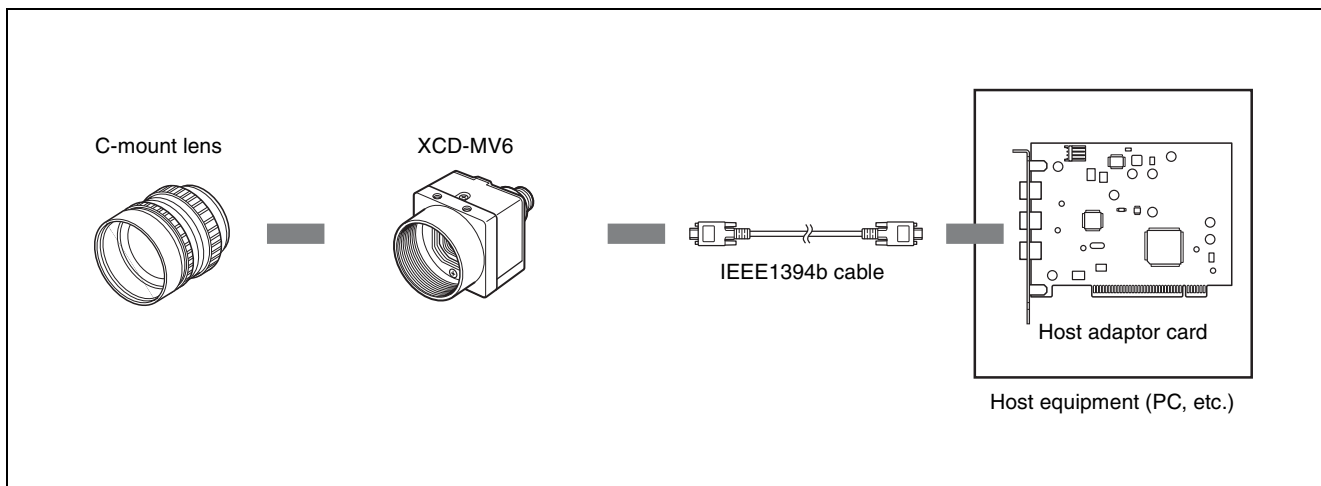
Note

To enable S1600 (1.6 Gbps (1600 Mbps) high-speed transmission, you will require a S1600-compatible host adapter card and IEEE1394b cable. For details, contact your Sony dealer.
In addition, this equipment is exclusively for beta mode use, so it is not possible to connect it to the IEEE1394a host adapter card with the IEEE1394-9P/6P cable.

Location and Function of Parts and Operation

Front/Top/Bottom
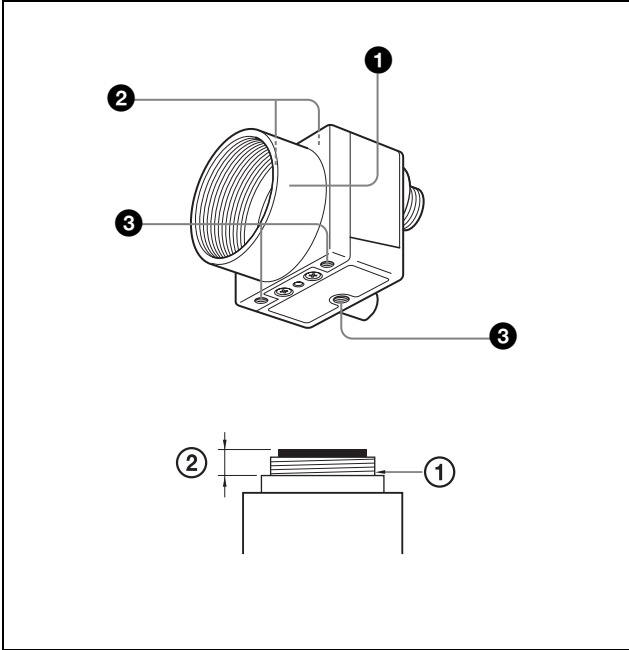
❶ **Lens mount (C-mount)**
Attach any C-mount lens or other optical equipment.

Note

The lens must not project more than 10 mm (13/32 inch) from the lens mount.
① Lens mount face ② 10 mm (13/32 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.
For details, see "Dimensions" on page 33.

Rear
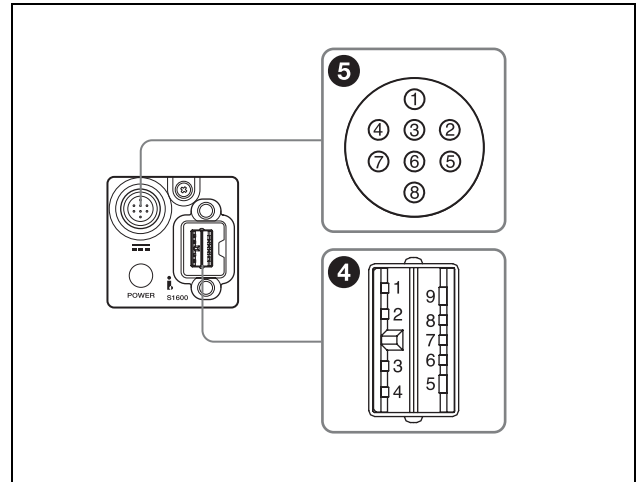
❹ **IEEE1394b connectors**
Connect an IEEE1394b camera cable (not supplied) to this connector.

Pin No.	Signal	Pin No.	Signal
1	TPB–	6	VG
2	TPB+	7	NC
3	TPA–	8	VP
4	TPA+	9	TPBG
5	TPAG		

❺ **8-pin I/O connector**
When power from the IEEE1394b connector is insufficient, power is supplied through this connector.

Pin No.	Signal	Pin No.	Signal
1	Trigger IN	5	GPI1 IN
2	Strobe OUT	6	Power GND
3	GPO1 OUT	7	Power IN
4	GPI2 IN	8	GPO2 OUT

Installation

Fitting the lens
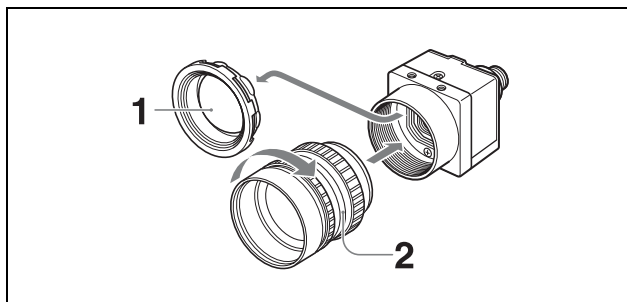
1 Remove the lens mount cap.

2 Screw in the lens (not supplied), and turn it until it is secured.

Note

Clean the optical filter with a commercially available blower brush to remove dust.

Connecting the camera cable

Connect a commercially available IEEE1394b camera cable to the IEEE1394b connector and the 1394b interface connector of your PC. When you connect the cable, insert the cable connector into the IEEE1394b connector until it snaps into place, holding it. Then, tighten the fixing screws placed on both sides of the cable connector.
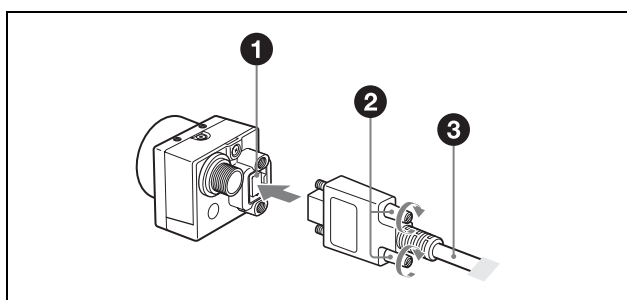
❶ **IEEE1394b connector**
❷ **Fixing screws**
❸ **IEEE1394b camera cable (not supplied)**

Note

Loose fixing screws may cause a poor connection or damage to the camera or cable. Be sure to tighten the fixing screws.

When power supply from the IEEE1394b connector is insufficient

Power can be supplied to the camera module via the DC-700/700CE camera adaptor (optional) and a camera cable (optional) if power supply from the IEEE1394b connector is insufficient.
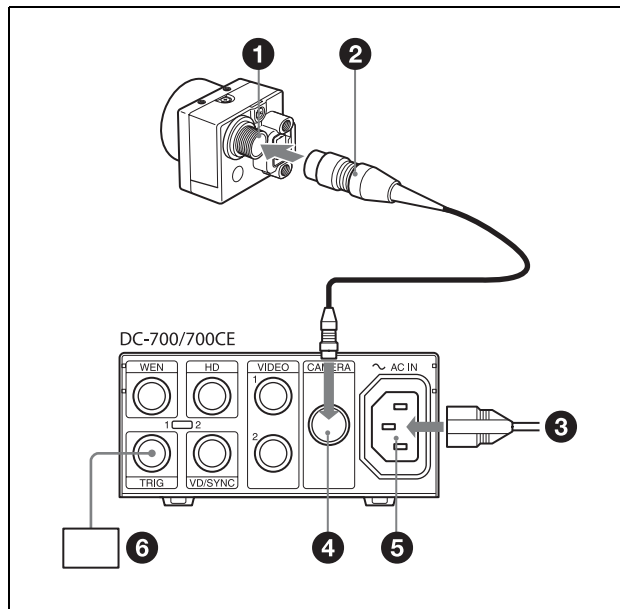
❶ **8-pin I/O connector**
❷ **Camera cable**
❸ **to AC power source**
❹ **CAMERA connector**
❺ **∼AC IN connector**
❻ **Trigger generator**

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Notes on Operation

Power supply

Power is supplied to the camera module via the IEEE1394b cable connected to a PC. If the power supply is insufficient, use the DC-700/700CE that supplies stable power with less ripple or noise.

Foreign bodies

Be careful not to spill liquids, or drop any flammable or metal objects in the camera body.

Locations for operation and storage

Avoid operation or storage in the following places.
• Extremely hot or cold locations. Recommended temperature range is 0°C to 40°C (32°F to 104°F)
• Locations subject to strong vibration or shock
• Near generators of strong electromagnetic radiation such as TV or radio transmitters

Care

Use a blower to remove dust from the surface of the lens or optical filter. Clean the exterior with a soft, dry cloth. If the camera is very grimy, apply a cloth soaked in a mild detergent then wipe with a dry cloth. Do not apply organic solvents such as alcohol which may damage the finish.

Note on laser beams

Laser beams may damage a CMOS sensor. You are cautioned that the surface of a CMOS sensor should not be exposed to laser beam radiation in an environment where a laser beam device is used.

Phenomena Specific to CMOS Sensors

The following phenomena that may appear in images are specific to CMOS sensors. They do not indicate malfunctions.

White flecks

Although the CMOS sensors are produced with high-precision technologies, fine white flecks may be generated on the screen in rare cases, caused by cosmic rays, etc.
This is related to the principle of CMOS sensors and is not a malfunction.

The white flecks especially tend to be seen in the following cases:
• when operating at a high environmental temperature
• when you have raised the gain (sensitivity)
• when using a slow shutter or the trigger cycle is long

Aliasing

When fine patterns, stripes, or lines are shot, they may appear jagged or flicker.

Strobe/GPIO Circuit

Strobe Output / GPIO Circuit

The Strobe output and GPIO circuit is configured as follows. Be sure to take note of this before use.

Strobe output circuit

This is a strobe output circuit diagram.
This is a standard CMOS level output (5 V).
The camera is equipped with a protective resistor of 220 Ω. Be sure to confirm the output waveform before use.

220 Ω

Strobe output terminal
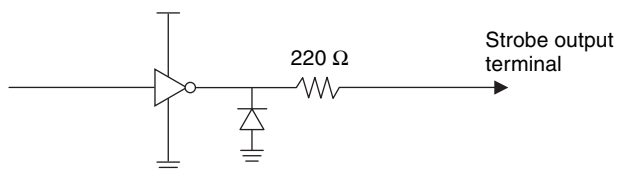
GPO1/2 output circuit

This is a GPO1/2 output circuit diagram.
This is a standard CMOS level output (5 V).
Equipped with a protective resistor of 2.2 kΩ. Be sure to confirm the output waveform before use.

2.2 kΩ

GPO1/2 output circuit
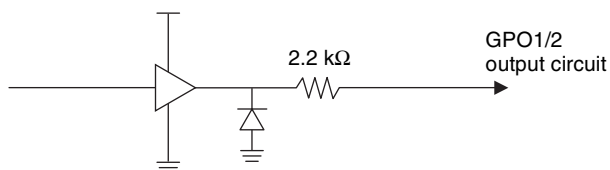
GPI1/2 input circuit

This is a GPI1/2 input circuit diagram.
Compatible with standard TTL level input.
Equipped with a protective resistor of 10 kΩ. Be sure to confirm the input waveform before use.

10 kΩ

GPI1/2 input circuit

10 pF
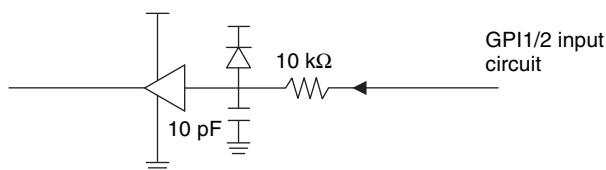
Shutter

This camera allows users to set manual shutter speeds. The variable range extends from 20 microseconds to 1 seconds; relative values are indicated by a 12-bit integer, and absolute values are indicated using a 32-bit floating point value.
When setting an exposure time longer than the cycle of the set frame rate, it sets to long exposure time mode and the actual frame rate is reduced in accordance with the exposure time.

The relationship between the parameter and the exposure time is given by the following formulas, where:

  P = Parameter (004h to 3E8h)
  E = Exposure time (s)

If P= 4
  E = 0.00002

If $5 <= P <= 1000$

$$E = \frac{P^2}{1000000}$$

Setting examples

      4 (003h) : 20 μs (1/50000)
     32 (020h) : 1 ms (1/1000)
    100 (064h) : 10 ms (1/100)
   1000 (3E8h) : 1 s
    128 (080h) : 16.384 ms (1/60: default setting)
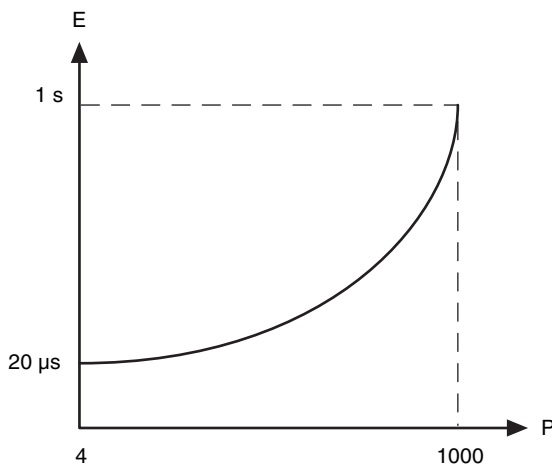
Note

This camera outputs images for 4 frames from the frame changed by the shutter. Images effective from the fifth frame are output. Be sure to take note of this before use.

Trigger

Trigger shutter is useful for capturing images in response to a trigger signal 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. This camera supports a hardware trigger input from 8-pin connectors, and 2 types of software trigger set by 1394 bus command.

Note

Switching trigger signals may cause image disturbance. Be sure to take note of this before use.

Trigger Polarity

This feature selects the active polarity of the hardware trigger. There are positive and negative polarities so, first, fix the trigger polarity and then use the other trigger function.
Active polarity: Negative polarity (default setting)

Trigger Delay

This feature adds an internal delay to the trigger. It is used to align the timing by adjusting the delay when the trigger timing and object position are out of alignment, or when fine-tuning the trigger signal timing in multiple machines.
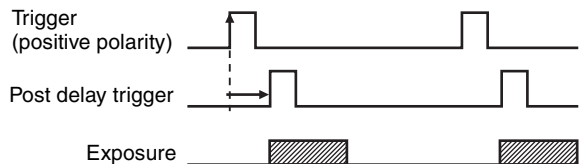
Note

Use the trigger delay when the input trigger cycle is long enough for the trigger delay. The image will not be output properly if the trigger delay value is longer than the input trigger cycle.

Trigger Mode

This camera support 2 trigger modes: 0 and 1.

Trigger mode 0
Trigger mode 0 starts exposure by detecting the edge of a trigger signal. The exposure time is determined by the shutter parameter.

Trigger mode 0 (negative polarity)
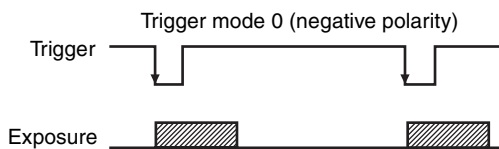
Trigger mode 1
Trigger mode 1 controls the exposure time by the width of the trigger signal pulse. Input a trigger with a trigger width (Tw) expressed as exposure time = Tw+4.45 µs.

Trigger mode 1 (negative polarity)

Tw+4.45 µs
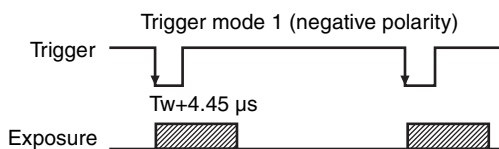
Hardware trigger latency (Tl) from inputting the hardware trigger from an 8-pin connector to the actual exposure starting becomes fixed at 7.52 µs, as shown in the below diagram which expands the exposure time start part.

Trigger mode 0 (negative polarity)

T1=7.52 µs
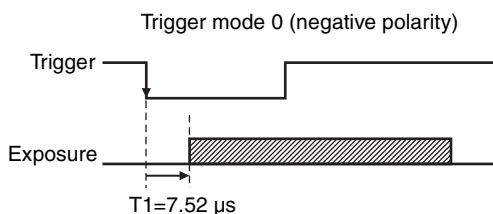
Trigger signal input conditions
Input a signal that satisfies the below levels.

When set to negative (default setting)   When set to positive

High-level DC 5 to 24 V
Low-level DC 0 to 0.5 V   DC 0 V   DC 0 V
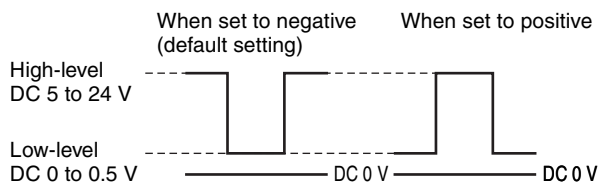
> **Note**
>
> Trigger operations such as changing the shutter for each trigger are not possible with this camera's trigger mode. A normal image is output for the first time by trigger operations with a shutter setting equal to 5 frames or more. Images for 4 frames cannot be output by the camera itself. Be sure to take note of this before use.

In addition, with trigger mode 1, images are not output normally when the jitter component of the trigger signal itself is large. Keep the jitter component of the trigger signal itself within 296 ns. Use trigger mode 0 if this condition cannot be met.

Strobe Control

A strobe control output signal is assigned to the 8-pin connector. This feature allows strobe equipment connected to the camera to directly emit light. Output delay and width can be set for the exposure time. Camera exposure time can be output without change.

Trigger (positive polarity)
Exposure
Strobe output signal
Delay
High-level DC 4 to 5 V
Low-level DC 0 to 0.5 V
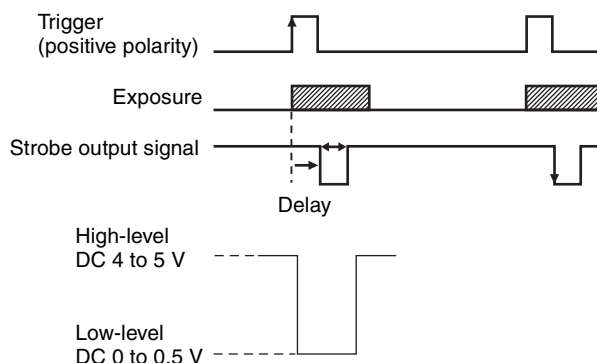
GPIO

A general-purpose I/O port with a 2-bit output and 2-bit input is assigned in the 8-pin connector.
This port is used for reading information of external switches and sensors from the camera and controlling external devices.

Memory Channel

Since this camera is equipped with 15 memory channels to hold camera settings, it can presave parameter settings to match scenes.
The applicable parameters include: brightness, gamma, shutter, gain, pan, trigger mode, trigger delay, strobe ON/OFF, strobe delay, width, and GPO.

User Free Memory

This camera is equipped with a 256-byte memory space so the user can write and read data freely.
The written data is retained after the power is turned off. For example, the user can name the camera and note the installation conditions using this memory space.
The memory content is retained even if the camera initialization is performed.

Broadcast Command

The normal 1394 communication method specifies the node number at the host side so that only a specified camera responds to the command.
If the node number is set to 63, all the cameras connected to the same bus can receive the command simultaneously, i.e., only one command issued from the host can control multiple cameras at the same time.

Example: To broadcast a software trigger

1. Connect multiple cameras to the same bus.

2. Set the video mode and frame rate appropriately on each camera and prepare the cameras for sending images at the same time.

3. Set each camera to the software trigger mode.

4. Issue a software command for node number 63.

Now all the cameras start exposure and output images simultaneously.

All the commands including the video mode setting and the feature control are capable of broadcasting except the block writing command.
When setting different types of cameras using a broadcast command, be careful not to issue a command that the cameras do not support.

1394 Bus Synchronization

This camera is equipped with a function that synchronizes with the cycle time resistor of the 1394 bus to define exposure timing. This synchronization occurs at the start of exposure.
When the bus synchronization function is enabled, multiple cameras connected to the same bus will automatically synchronize with the 1394 bus and operate. As band restrictions will be applied depending on the transmission rate configured, you must configure a video mode that will allow simultaneous video transmission.
When long exposure mode (i.e., when the exposure time configured is longer than the image transmission frequency), pseudo-binning mode, or partial scan mode is configured, the synchronization function will be disabled.
The 1394 bus synchronization function includes jitter between the bus clock and camera clock. To obtain more accurate synchronization, perform external synchronization via hardware triggering.

Gain

This camera allows manual gain settings of up to 1 to 8 times in 0.125 increments. The analog gain is 1 to 4 times, while the digital gain is 4.125 to 8 times.

Note

The timing reflected by the gain is from the 2nd frame. Be sure to take note of this before use.

Brightness

This feature controls the black level of a video image.

Gamma

This feature sets the gamma coefficient. Gamma coefficient values can be set at the following settings between a variable range of 0 to 15.
0: Linear
1 to 15: 0.1 to 1.5 curve coefficient (increments of 0.1)
Gamma offset allows you to set the black standard value at a variable range between 0 to 255 (1/4 the low-level side of the 0 to 1023 output range during 10-bit output).
Levels equal to or below the black standard value set with gamma offset can prevent too much white in the black level because the gamma level is fixed at 1.
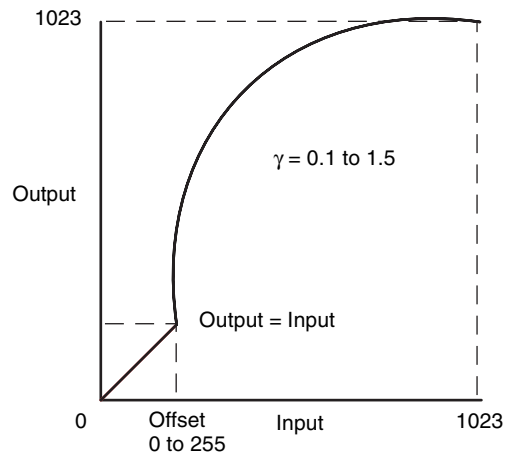
Pan

Pan is a function used to move a camera left and right. However this camera supports a video mode much smaller than the image sensor's effective pixels by cutting out images from the whole screen. You can specify the portion to be cut out using Pan commands. The variable range differs according to the selected video mode.

When a video mode is changed, the pan values are set to the default setting.

Image Buffer (Memory Shot)

The camera has image buffer (Memory Shot) that temporarily stores an image in the frame memory inside the camera and transfers it later.

When multiple cameras are connected in the same bus, all the cameras may not output images at the same time due to the restriction of the set transmission rate. ImageBuffer (Memory Shot) may resolve this inconvenience.

When exposure starts, each camera stores an image in the frame memory without allocating the isochronous resource.
When outputting, each PC outputs the image from the camera allocating the isochronous resource.
The number of images to be stored is 100 at maximum.

Partial Scan

The partial scan is a function for outputting part of a whole image as 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.

Vertical (Vertical Direction)

Cutting by Partial scan mode

Horizontal (Horizontal Direction)
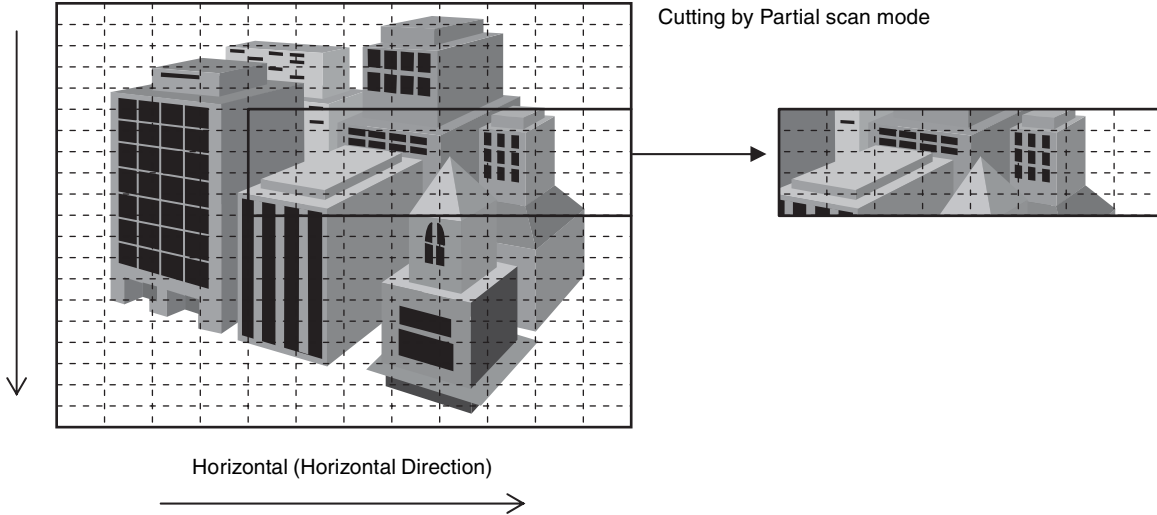
The minimum unit size for partial scan is 64 pixels × 24 lines. The cut-out position can be set in unit of 4 pixels × 4 lines. For high-speed scanning, set the maximum packet size.
When using multiple cameras at the same time, set a small packet size that falls within the set transmission rate band.

When using Partial scan mode, set Format7, Mode0.

Note

By selecting Partial scan mode, it is possible to set the maximum value of 752 pixels for the horizontal size of the image. However, because the horizontal direction increases by a factor of 64, the image data is set to 768 pixels causing 16 pixel-wide completely black data to be output in the right edge of the image.
Although this completely black data will definitely appear in the right edge of the image when the horizontal size is set to 752 pixels, this is not a malfunction because it is caused by a difference between the sensor's effective resolution and the values set for the image size.

Pseudo-Binning Mode

This feature compresses images in units of 2 pixels and multiplies the frame rate speed in the vertical direction only.

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 both the vertical and horizontal directions.

When Binning mode is used, set either Format7 Mode1 (2×2 binning), or Format7 Mode2 (1×2 binning).

Note

If 1×2 binning mode is used when the image level difference of the 2 value is above 50 steps for 8-bit mode, a line including darker pixels will be selected and output. If it is 50 STEP or below, the average value of the 2 pixels will be output.

The fixed and average value of the 2 pixels is output for horizontal direction binning in 2×2 binning mode. The frame rate does not increase for horizontal direction binning.

In addition, the image correction function does not work in pseudo-binning mode.

16-bit Mode

This camera supports 16-bit Black & white (Monochrome) mode. Only the least significant 10 bits of the 16 bits will handle data. The upper 6 bits will be filled with zeros.

000000dd	dddddddd
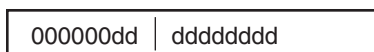
Image Correction

This camera is equipped with the following image correction functions.

Vertical stripe correction (default setting: ON)
This feature corrects vertical stripes generated from the image sensor. Only ON/OFF can be selected for this feature.

Blemish correction (default setting: ON)
This feature corrects bugs in the image sensor. Default and user settings can be selected.

Shading correction (default setting: OFF)
This features corrects shading caused by light falloff at lens edges, uneven brightness, and sensors. This can only be selected with user settings, and either the average value or the pixel-level maximum value within 1 frame can be selected as the target value. It would be useful to make the following distinction when generating shading correction values: little noise - maximum value; lots of noise - average value.

When calibrating blemish and shading correction user settings, be sure to capture subjects that fulfill the following conditions.
Blemish correction: Completely black images
Shading correction: full-frame medium visual level (50% grey level) images for which you have used a uniform subject such as white paper in your lighting environment
Be sure to decide the shutter, gain and temperature environment in advance when calibrating settings. Refer to the explanation in the control register for more details about setup steps.

Notes

- The dynamic range of the visual level may reduce slightly when correcting vertical stripes. Be sure to take note of this before use.
- The resolution may reduce when correcting blemishes. Be sure to take note of this before use.
- When correcting the shading correction average value, the dynamic range of the visual level may drop by a large degree depending on the original shading amount. Be sure to take note of this before use. In addition, the maximum shading correction value may be falsely recognized in environments where there is a lot of noise. Be sure to take note of this before use.

Flipping images horizontally and vertically

This camera can flip images horizontally and vertically. This is useful in situations when the camera itself cannot be flipped horizontally and vertically.

Camera Command Status Register

This camera complies with IIDC 1394-based Digital Camera Specification, Version 1.32 (hereinafter referred to as IIDC v1.32).
The standards document can be purchased from 1394TA (the 1394 Trade Association). As it is very helpful in understanding the explanations in this Technical Manual, we recommend that you purchase a copy of IIDC v1.32.

Memory Map

├── BusID ──┤	NodeID	├─────── Must be 1 ───────┤	├────── Address used by the camera ──────┤			
bbbbbbbb	bbnnnnnn	11111111	11111111	11110000	11110000	00000000	00000000
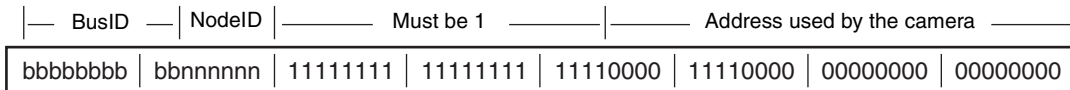
1394 devices have a 64-bit address space. The upper 10 bits show the bus ID (0-1023), and the next six bits show the node ID (0-63). The IIDC standards require the next 20 bits to be 1.
The remaining 28 bits can be allocated to the camera as addresses.
The bus and node IDs may be changed if the topology is restructured because of bus reset, so only the least significant 32 address bits are shown in this Guide.

Address	Resister
F0000000	Base address
F0000400	ConfigROM area
F0F00000	Base address 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	Format7Mode1 CSR
F0F12000	Format7Mode2 CSR
F0F30000	AccessControlRegister
F0F40000	MemoryShotControl
F0F50000	UserFreeMemory

ConfigurationROM

The ConfigurationROM is normally used for the OS to identify the device.
The serial number and firmware version of the camera are stored in ConfigurationROM to be used when required. Note that the setting method for the serial number and firmware version information is of Sony's unique specification and is not compatible with cameras of other manufacturers.

	Offset	0-7	8-15	16-23	24-31	
Bus Info Block	400h	04	21	ROM CRC		
	404h	31	33	39	34	
	408h	20	FF	92	14	
	40ch	08	00	46	10	NodeVendorID/ChipID-Hi
	410h	00	37	1A	96	Chip ID-Lo
Root Directory	414h	0003		CRC		
	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. Therefore, the ConfigROM from 400h to 487h is 136 bytes.

The UnitDirectory offset address is required to be
$420h + 000001h \times 4 = 424h$

	Offset	0-7	8-15	16-23	24-31	
Unit Directory	424h	0003		CRC		
	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 1.3.

The offset address of UnitDependentInfo is required to be
$430h + 000001h \times 4 = 434h$

	Offset	0-7	8-15	16-23	24-31	
Unit Dependent Info	434h	000B		CRC		
	438h	40	3C	00	00	CommandRegsBase
	43ch	81	00	00	0A	VendorNameLeaf
	440h	82	00	00	0D	ModelNameLeaf
	444h	38	00	00	20	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	01	00	Vendor_unique_info_0
	458h	3D	01	00	00	Vendor_unique_info_1
	45Ch	3E	00	00	30	Vendor_unique_info_2
	460h	3F	01	86	A1	Vendor_unique_info_3

For offset address 434h, the length of the UnitDependentInfo is 0Bh 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 + 00000Ah × 4 = 464h

The offset address of ModelNameLeaf is required to be
    440h + 00000Dh × 4 = 474h

Unit_sub_sw_version conforms to IIDC Standards, Version 1.32.

Vendor_unique_info 0 to Vendor_unique_info 3 are terms of information that the vendor of the camera can define.
The meanings in this camera are as follows:

Vendor_unique_info_0 is the firmware version.
Vendor_unique_info_1 is the hardware version.
Vendor_unique_info_2 is the link version.
Vendor_unique_info_3 is the serial number of the camera.

VendorNameLeaf

	Offset	**0-7**	**8-15**	**16-23**	**24-31**	
Vender Name Leaf	464h	0003		CRC		
	468h	00	00	00	00	
	46h	00	00	00	00	
	470ch	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 Name Leaf	474h	0004		CRC		
	478h	00	00	00	00	
	47ch	00	00	00	00	
	480h	58	43	44	2D	" XCD- "
	484h	4D	56	36	00	" MV6 "

For offset address 474h, the length of the ModelNameLeaf is 4 Quadlets.
The subsequent 8 bytes are fixed at 00.
After that, the model name is entered.

Control Base Address

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

Inquiring about Supported Video Modes

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

	Data
Address	XCD-MV6
F0F00100h	81000000h

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

Format0

	Data
Address	XCD-MV6
F0F00180h	06000000h

Format7

	Data
Address	XCD-MV6
F0F0019Ch	E0000000h

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

	Data
Address	XCD-MV6
F0F00214h (Format0Mode5)	FC000000h
F0F00218h (Format0Mode6)	FC000000h

Video Mode Settings (S800/S1600)

Select the video mode you want to use from the tables, and make the required settings.
As examples, the register settings for Format0, Mode5, and a frame rate of 60 fps are shown.
In addition, an isochronous transfer speed of 800 Mbps, and isochronous channel 0 are used in these examples.
Normally, set the isochronous transfer speed to 800 Mbps or 1600 Mbps.
When multiple cameras are used simultaneously, set different isochronous channels for each.

	Data
Address	XCD-MV6
F0F00600h (FrameRate)	A0000000h
F0F00604h (VideoMode)	A0000000h
F0F00608h (VideoFormat)	00000000h
F0F0060Ch (IsoChannel / IsoSpeed)	00008003h

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, MultiShot and ImageBuffer

This camera supports both OneShot, MultiShot and ImageBuffer commands. With a OneShot command, after outputting just one single-frame live image is output. With a MultiShot command, the specified number of images are output. ImageBuffer outputs a specified number of images stored in the camera. Issue the following commands when using OneShot and MultiShot.

ImageBufferCtr OFF / TransferDataSelect LiveData

Address	Data
F0F00634h	00000000h

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 and FFFFh (1 and 65535). If 0000h is specified, you can think of it as being 1.

Issue the following commands to start saving ImageBuffer images.

ImageBufferCtr ON

Address	Data
F0F00634h	80000000h

Issue the following commands to stop saving ImageBuffer images.

ImageBufferCtr OFF

Address	Data
F0F00634h	00000000h

When the following command is read, the maximum number of saved frames and the number of currently saved frames is understood.

MaxNumImages / NumberOfImages

Address	Data
F0F00634h	x0640nnh

64h (100) is the maximum number of saved frames. nn is the number of currently saved frames. It will be 00h to 64h (0 to 100).

Issue the following commands to output ImageBuffer images.

TransferDataSelect BufferedImageData

Address	Data
F0F00634h	40000000h

ImageBufferRead

Address	Data
F0F0061Ch	400000nnh

nn specifies the number of output frames. It is possible to specify between 01h to 64h (1 to 100). When 00h is specified it is construed that 1 was set.

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

ContinuousShot > OneShot > MultiShot/ImageBuffer

Control of IIDC Standard Features

Before transmitting the control command, check the variable ranges of settings and if there is an automatic mode for each feature.
As the variable ranges of the settings vary with video modes for the Pan and Tilt features, be sure to check them if the video mode is changed.

Address	Data	Bit	
F0F00500h (Brightness)	890023FFh	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 2
		20-31	Max. 1023
F0F00518h (Gamma)	89000FFFh	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 4095
F0F0051Ch (Shutter)	90033E8h	0	This feature exists.
		1	Absolute value control possible.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 3
		20-31	Max. 1000
F0F00520h (Gain)	9000039h	0	This feature exists.
		4	The value can be read out.
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 57
F0F00530h (Trigger)	8E81C000h	0	This feature exists.
		4	The value can be read out.
		5	Feature can be switched between ON and OFF.
		6	Polarity can be changed
		8	Trigger Source 0 exists.
		15	Software Trigger Mode exists.
		16	Trigger Mode0 exists.
		17	Trigger Mode1 exists.
F0F00534h (TriggerDelay)	8D000FFFh	0	This feature exists.
		4	The value can be read out.
		5	Feature can be switched ON/OFF
		7	Manual setting can be selected.
		8-19	Min. 0
		20-31	Max. 4095
F0F00584h (Pan)	89******h	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.)

* According to the IEEE 1394 specifications, the most significant bit is shown as 0, and the least significant bit as 31.

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.

Gamma control

Address	Data	
F0F00818	82000000	Sets Gamma to OFF.
	82000mmn	n: 1h to Fh (1 to 16) gamma curve n×0.1 equivalent mm: 00h to FFh (0 to 255) gamma curve starting position

Shutter (exposure time) control

Address	Data	
F0F0081C	82000ddd	Controls shutter using the manually set relative value.
	C2000xxx	Controls shutter using the manually set absolute value.
F0F00978h (To obtain this address, see "The formula for absolute value shutter control register address" on page 22.)	Determines the optional value using the 32-bit floating-point format.	After F0F0081C has been set to the absolute value control, set the exposure time using this register.

Gain control

Address	Data	
F0F00820	82000ddd	Set 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.
F0F0062C	80000000	Outputs a software trigger. Automatically resets to 0 when exposure ends.

Trigger Delay control

Address	Data	
F0F00834	82000ddd	Sets Trigger Delay.

Pan control

Address	Data	
F0F00884	82000ddd	Sets Pan manually.

GPIO control

Address	Data	
F0F20400	0000000d	Outputs a signal to the output port. bit31: GPO1 bit30: GPO2
F0F20404		Reads out the status of the input port. bit31: GPI1 bit30: GPI2

Strobe control

Address	Data	
F0F20200	80000000	A strobe signal is not output.
	82000000	Outputs an exposure signal.
	82dddwww	ddd = delay, www = signal width, unit = μs.

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.

$$F0000000h + 003C025Ch \times 4 = F0F00970h$$

Address	Data	
F0F00970	3727C5AC	Absolute value shutter control minimum value. (ReadOnly)
F0F00974	41800000	Absolute value shutter control maximum value. (ReadOnly)
F0F00978		Absolute value shutter control setting value.

The data is indicated by 32-bit floating-point format. 3727C5AC is 0.00001, and 41800000 is 1.

Control of IIDC Optional Features

Check if the camera is equipped with optional features by reading bit 3 of BASIC_FUNC_INQ.

Address	Data	Bit	
F0F00400 (BASIC_FUNC_INQ)	90801A0Fh	0	Vendar unique feature exists.
		1	Does not support the error status in video mode.
		2	Does not support the feature control error.
		3	The optional feature exists.
		8	1394b mode is available.
		16	The power control is not available.
		19	OneShot is available.
		20	MultiShot is available.
		22	ImageBuffer is available.
		28-31	15 memory channels

Check the supported feature by reading Opt_Function_Inq.

Address	Data	Bit	
F0F0040Ch Opt_Function _Inq	50000000h	0	
		1	Does not support PIO.
		2	Does not support SIO.
		3	Supports Strobe output.

PIO control

Check the offset address of PIO.

Address	Data	Control register address
F0F00484h PIO_Control_ CSR_Inq	003C8100h	F0F20400h

F0F20400h indicates the address of the PIO output port.
F0F20404h indicates the address of the PIO input port.

Address	Data	
F0F20400h	0000000dh	Outputs a signal to the output port. bit31: GPO1 bit30: GPO2
F0F20404h	0000000dh	Reads the status of the input port. bit31: GPI1 bit30: GPI2

Strobe control

Check the offset address of Strobe control.

Address	Data	Control register address
F0F0048Ch Strobe_output _CSR_Inq	003C8000h	F0F20000h

F0F20200h indicates the control address of the strobe signal.

Address	Data	Output signal
F0F20200h	80000000h	A strobe signal is not output.
	82000000h	Outputs the signal indicating the exposure time. (ExposureOut)
	82dddwwwh	Outputs a signal having a width "www" after a delay "ddd" from the start of exposure. The unit is μs.

Control of Sony's Unique Features

Displaying the Test Chart

Displaying the gray scale
Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0037FFFF	
F0F30008	80000002	

Turning off the test chart
Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0037FFFF	
F0F30008	00000000	

User Free Memory

Enabling User free memory
Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0032FFFF	
F0F30008	80000001	

Disabling User free memory
Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0032FFFF	
F0F30008	00000000	

When User free memory is enabled, the addresses 0xF0F50000 to 0xF0F500FC become open.
These addresses are available for writing data freely.
The written data are retained even if the power is turned off.

Address	Data	
F0F50000	Any data	
F0F50004		
:		
F0F500FC		

Vertical Stripe Correction

Enabling vertical stripe correction
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0040FFFF	
F0F30008	80000000	

Disabling vertical stripe correction
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0040FFFF	
F0F30008	00000000	

Blemish Correction

Generating blemish correction data for user settings

1 Set all corrections to OFF.

2 Set image format mode.
Specify the following - Format7 Mode0 Mono8 768 × 480 Packet Size 3072.

3 Set the shooting conditions.
Close the lens.
Adjust gain and shutter etc. to match the use conditions.

4 Set the threshold value.
Set it according to the use environment.
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0044FFFF	
F0F30008	00000ddd	ddd = 000h to 3FFh

5 Generate the data
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0043FFFF	
F0F30008	80000011	

6 Regenerate the moving image.
Specify the following - Format7 Mode0 Mono8 768 × 480 Packet Size 3072.

7 Save the data
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0043FFFF	
F0F30008	80000020	

Enabling blemish correction (default data)

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0042FFFF	
F0F30008	80000000	

Enabling blemish correction (user data)

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0042FFFF	
F0F30008	80000001	

Disabling blemish correction

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0042FFFF	
F0F30008	00000000	

Shading correction

Generating shading correction data

1 Set the correction conditions.
Set all corrections to OFF.

2 Set image format mode.
Specify the following - Format7 Mode0 Mono8 768 × 480 Packet Size 3072.

3 Set the shooting conditions.
Adjust lens, lighting, gain, and shutter etc. in line with the use conditions.

4 Generate data.
When using the maximum value as the base
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0046FFFF	
F0F30008	80000010	

When using the average value as the base
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0046FFFF	
F0F30008	80000011	

5 Regenerate the moving image.
Specify the following - Format7 Mode0 Mono8 768 × 480 Packet Size 3072.

6 Save the data
Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0046FFFF	
F0F30008	80000020	

Enabling shading correction

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0045FFFF	
F0F30008	80000000	

Disabling shading correction

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0045FFFF	
F0F30008	00000000	

Flipping Images Horizontally and Vertically

Enabling images to be flipped vertically

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0048FFFF	
F0F30008	80000000	

Disabling vertical flipping of images

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0048FFFF	
F0F30008	00000000	

Enabling images to be flipped horizontally

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0049FFFF	
F0F30008	80000000	

Disabling horizontal flipping of images

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0049FFFF	
F0F30008	00000000	

Bus Synchronization

Enabling bus synchronization

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0036FFFF	
F0F30008	80000000	

Disabling bus synchronization

Write the following 3 commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0036FFFF	
F0F30008	00000000	

Memory Shot

Switching to Memory shot mode

Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0010FFFF	
F0F30008	80000000	

Switching to normal mode

Write the following three commands in sequence.

Address	Data	
F0F30000	08004600	
F0F30004	0010FFFF	
F0F30008	00000000	

When the Memory shot mode is set, the following control registers become effective.

Address	Data	
F0F40000	010000nn	Starts recording and obtains the status information.
F0F40004		Obtains the number of frames that can be recorded.

Operation when the trigger mode is set

1 Before starting, stop video and open the isochronous resource.

2 Set trigger mode to ON.

3 Switch to Memory shot mode.

4 Read F0F40004 to obtain the maximum number of frames.

5 Write 010000nn for F0F40000 to start recording. (nn represents the number of frames to be used for recording.)

6 Input triggers required number of times.

7 Read F0F40000 to check the recording status. 01000000 indicates during recording, and 010100nn indicates recording has stopped.

8 Set trigger mode to OFF.

9 Secure the isochronous resource and start video. The recorded images are output continuously. If trigger mode remains ON, one image is output each time a trigger is input.

10 Read F0F40000 to check the playback status. 02000000 indicates during playback, and 02010000 indicates playback has stopped. When playback stop is confirmed, stop video and open the isochronous resource. To continue recording/playback, go back to step 5.

11 To stop Memory shot, switch to normal mode.

Notes on the Camera Operations

If Frame Rate Decrease Occurs

With this camera, the frame rate may reduce depending on shutter settings and changes.

1) 4-frame images will not be output when the shutter is changed.

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

When Using Trigger Mode

This camera is set to accept a trigger at the fastest possible timing and it can accept overlap of the next trigger signal during video transmission. For this reason, a trigger inhibition period is not available. Thus, if a trigger signal is input before the image sensor can accept exposures, multiple exposures can occur, and it cannot capture the correct image. Design the trigger generation circuit so that the trigger cycle is not faster than necessary. For the same reason, a malfunction may occur when noise overlaps a trigger signal. In this case, suppress noise in the trigger generation circuit. Further, operations such as changing the shutter for each trigger are not possible with this camera's trigger mode. A normal image is output for the first time by trigger operations with a shutter setting equal to 5 frames or more. Images for 4 frames cannot be output by the camera itself. Be sure to take note of this before use. Also, with trigger mode 1, images are not output normally when the jitter component of the trigger signal itself is large. Keep the jitter component of the trigger signal itself within 296 ns. Use trigger mode 0 if this condition cannot be met. Changing the trigger mode or trigger polarity may cause image disturbance. Be sure to take note of this before use.

Increase in White Flecks and Noise

White flecks and noise, which are phenomena specific to image sensors in this camera, may increase. Noise tends to increase in the following cases:

1) When used in a high-temperature environment

2) When the gain is increased

3) When using a slow shutter or the trigger cycle is long

4) When the image sensor itself is depleted

This is attributable to the basics of the image sensor and is not a malfunction.

Pseudo-binning mode sensitivity

Binning mode included in XCD-V60/SX90/U100 can increase sensitivity because it adds a vertical direction signal. In contrast, the pseudo-binning mode included in this camera outputs dark pixels or the average value of the vertical direction 2 pixels, so sensitivity never increases. The operating principle differs to standard binning modes, so be sure to take note of this before use.

Shutter Speed and Image Quality Assurance

With this camera, the shutter speed can be set at 1/50,000 to 1 s, but image quality problems can arise with shutter speeds close to the setting threshold, such as noise and tiny white flecks. Therefore, the shutter speed ranges shown below are recommended to prevent image quality interference.

Guaranteed operating range: 1/50,000 to 1 s
Guaranteed image quality range: 1/30,000 to 1/10 s

As to the shutter speed range for guaranteed image quality, because noise and tiny white flecks may arise when used in a high-temperature environment or with an increased gain, set the blemish correction to ON after you have retrieved the blemish correction data set according to your user conditions.

However, when there is a large number of blemishes to be corrected, be sure to note that this will cause the resolution to reduce.

Performance Assured Visual Output

When the image correction function of the camera is set to ON, a portion of the level range of the dynamic range will be used for correction processing. As a result, the upper limit of the visual output level may not reach the white clip level.

The performance assured range for visual output level is 16 to 243 steps.

Power Consumption

Be sure to take note of power consumption before use. The power consumption of this camera will increase at high ambient temperatures if you use a power supply that is close to the upper limit (+30 V) or lower limit (+8 V) of the camera's operating voltage range, or use the S1600 (1600 Mbps) transmission speed. In such cases, lower the ambient temperature by applying cooling measures, or use a power supply that is approximately +12 V.

Specifications

	XCD-MV6
Image sensor	1/3-type CMOS sensor
Number of effective pixels	Approx. 360,000 752 (H) × 480 (V)
Cell size	6.0 (H) × 6.0 (V) μm
Chip size	4.51 (H) × 2.88 (V) mm
Interface format	IEEE1394b-2002
Transfer speed	1600, 800 Mbps
Protocol	IIDC 1394-based Digital Camera Specification Version 1.32 Compliant
Image format (fixed size)	640 × 480 Mono8/16
Frame rate (depends on the image format)	60 to 1.875 fps
Image format (Format7) (* for Partial scan)	680 × 480 Mono8/16* 320 × 240 (Binning) 640 × 240 (Binning) 752 × 480 (60 fps)
Partial scan function	Minimum unit: 64 × 24 Trimming position selectable by the unit of 4 × 4
Lens mount	C-mount
Flange back	17.526 mm
Minimum illumination	0.5 lx(Iris: F1.4, Gain:18 dB, Shutter: $^1/_{60}$s)
Brightness	Adjustable
Gamma	15 gamma curve coefficient types
Shutter speed	1/50,000 to 1 s (Absolute value control possible)
Gain	0 to 18 dB (Analog gain: 0 to 12 dB / Digital gain: 12 to 18 dB)
External trigger shutter	Edge detection (Mode0), Exposure time setting by trigger width (Mode1), Software trigger (IEEE1394 bus), Trigger/strobe delay setting
Power supply	+8 to +30 V (IEEE1394b cable or 8-pin connector)
Power consumption	2.2 W (12 V)
Performance guaranty temperature	0 °C to 40 °C (32 °F to 104 °F)
Operating temperature	–5 °C to +45 °C (23 °F to 113 °F)
Storage temperature	–30 °C to +60 °C (–22 °F to +140 °F)
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	73800 Hrs (Approx. 8.4 years)
Shock resistance	70 G
Dimensions	29 (W) × 29 (H) × 19 (D) mm, not including projecting parts (1 3/16 (W) × 1 3/16 (H) × 3/4 (D) inches)
Mass	37 g (1.3 oz)

Video Modes Supported

Fixed format

Format	Mode	Image Size	Color Coding	Frame Rate	XCD-MV6
0	5	640 × 480	Mono8	1.875	○
				3.75	○
				7.5	○
				15	○
				30	○
				60	○
	6	640 × 480	Mono16	1.875	○
				3.75	○
				7.5	○
				15	○
				30	○
				60	◎
1	2	800 × 600	Mono8	7.5	
				15	
				30	
	5	1024 × 768	Mono8	1.875	
				3.75	
				7.5	
				15	
				30	
	6	800 × 600	Mono16	3.75	
				7.5	
				15	
				30	
	7	1024 × 768	Mono16	1.875	
				3.75	
				7.5	
				15	
				30	

Format	Mode	Image Size	Color Coding	Frame Rate	XCD-MV6
2	2	1280 × 960	Mono8	1.875	
				3.75	
				7.5	
				15	
				30	
	5	1600 × 1200	Mono8	1.875	
				3.75	
				7.5	
				15	
	6	1280 × 960	Mono16	1.875	
				3.75	
				7.5	
				15	
	7	1600 × 1200	Mono16	1.875	
				3.75	
				7.5	
				15	

◎ S800 band is required.

Free format

Format	Mode		XCD-MV6
7	0	Partial scan	○
		Frame rate	Depends on the area.
	1	2 × 2 binning	○
		Frame rate	120 fps
	2	1 × 2 binning	○
		Frame rate	120 fps

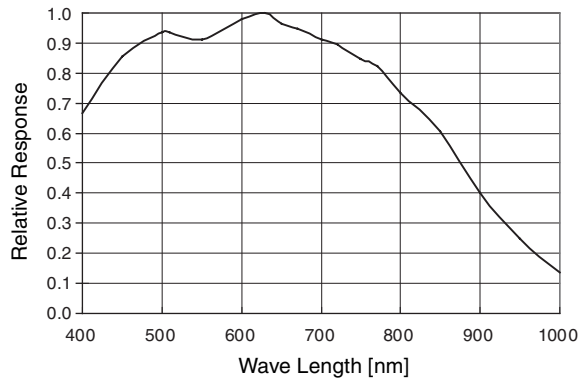The frame rates indicate the values in 8-bit mode and under S800 conditions.

To operate with a frame rate of 120 fps, the shutter speed should be faster than 1/120 s.
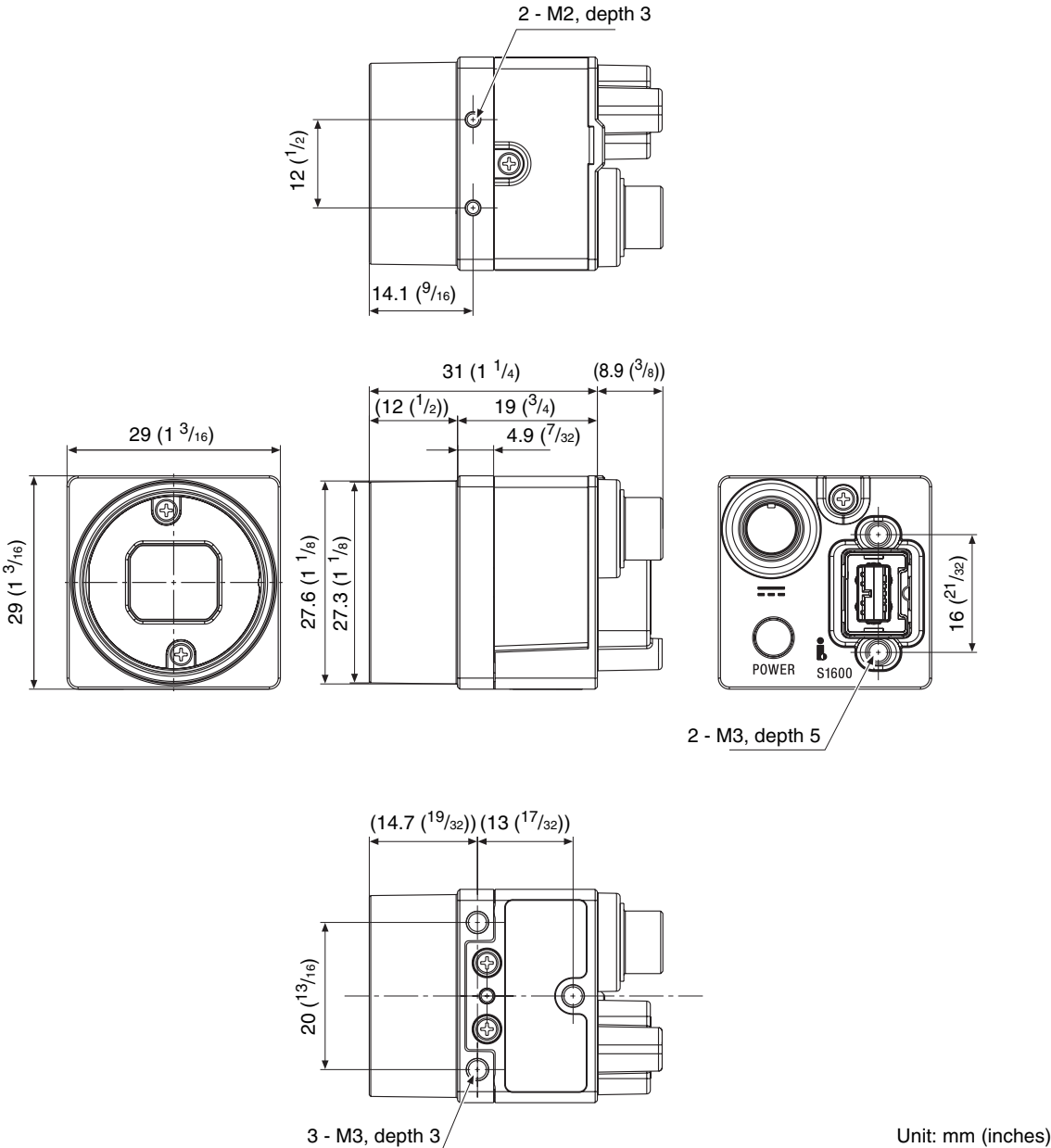To operate with a frame rate of 60 fps, the shutter speed should be faster than 1/60 s.

Spectral Sensitivity (Relative Response) Parameters

XCD-MV6

Spectral sensitivity (relative response) parameters (without lens and light source parameters)

Dimensions

2 - M2, depth 3

12 ($^1/_2$)

14.1 ($^9/_{16}$)

29 (1 $^3/_{16}$)

29 (1 $^3/_{16}$)

31 (1 $^1/_4$)

(8.9 ($^3/_8$))

(12 ($^1/_2$))

19 ($^3/_4$)

4.9 ($^7/_{32}$)

27.6 (1 $^1/_8$)

27.3 (1 $^1/_8$)

POWER S1600

16 ($^{21}/_{32}$)

2 - M3, depth 5

(14.7 ($^{19}/_{32}$)) (13 ($^{17}/_{32}$))

20 ($^{13}/_{16}$)

3 - M3, depth 3

Unit: mm (inches)

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