SONY

C-629-100-**11** (1)

# *Digital Video Camera Module*

## Technical Manual

# XCL-CG510/CG510C

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## *Overview*

This unit is a digital video camera module that achieves image output with LVDS signal via DIGITAL Interface connector.

This operating instructions of digital video camera module covered:
- XCL-CG510 (monochrome models)
- XCL-CG510C (color models)

In this document, we refer to “Digital Video Camera Module” as “the unit”, “XCL-CG510” as “Monochrome camera”, and “XCL-CG510C” as “Color camera”.

# Features

### DIGITAL Interface connector

Equipped with a Camera Link standard mini connector. The unit can output a detailed and high speed digital image.

### High image quality

2/3 type 5.07 Megapixel CMOS image sensors with a global shutter function (Monochrome/Color)

### Various settings

Sending a command from the host device allows various settings, including the following.
- Gain
- Shutter
- Partial scan
- Trigger control
- LUT (Look Up Table)
- Output: 8/10/12-bit
- Defect correction
- Shading correction

### Electronic shutter function

Set anywhere from 1/100,000 sec to 60 sec in 1 µs increments.

### External trigger shutter function

By synchronizing with an external trigger signal, any shutter timing can be used.

### Partial scan

The camera module can limit the number of video output lines to achieve high frame rates, enabling high-speed image processing.

### Body fixing

The screw holes to install the camera module are located under the front panel (the image sensor reference plane). Installing the camera module on the front panel minimizes deviation of the optical axis.

### LUT (Look Up Table)

You can switch to OFF or ON. When set to ON, you can select from five preset values, such as inversion, binarization, any of five-point approximation, etc.

### Switching an Output Bit Length

You can select 8-bit output, 10-bit output or 12-bit output.

### Binning (XCL-CG510 only)

Sensitivity can be doubled approximately by combining two pixels aligned vertically or horizontally. You can set horizontal and vertical binning at the same time.

### Defect correction

The unit includes a function to reduce sensor defects, and can be set to ON or OFF.

### Shading correction

The unit includes a function to correct shading, resulting from a light source or a particular lens, and can be set to ON or OFF.

### Area gain function

You can set the individual digital gain to 16 optional rectangular areas. In the case that multiple rectangular areas overlap, the gain value with the smaller area number will have priority.

# Phenomena Specific to Image Sensors

**Note**

The following phenomena that may occur in images are specific to image sensors.
They do not indicate a malfunction.

## White flecks

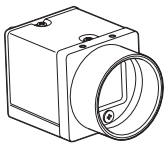
Although the image sensors are produced with high-precision technologies, fine white flecks may be generated on the screen in rare cases, caused by cosmic rays, etc.
This is related to the principle of image sensors and is not a malfunction.
The white flecks especially tend to be seen in the following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

- when operating at a high environmental temperature
- when you have raised the gain (sensitivity)
- when using the slow shutter

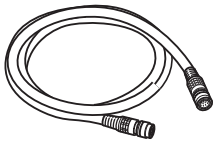
## Aliasing

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

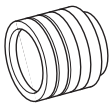
# System Components



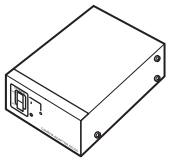
Video Camera Module



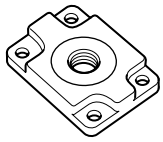
Camera cable
CCXC-12P02N (2 m, 6.6 ft)
CCXC-12P05N (5 m, 16.4 ft)
CCXC-12P10N (10 m, 32.8 ft)
CCXC-12P25N (25 m, 82 ft)



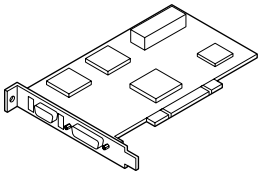
C-mount lens
Use a lens appropriate for the pixel count of the camera.



Camera adaptor
DC-700/700CE

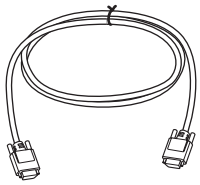


Tripod adaptor
VCT-333I (Insulated type)



Camera module interface board

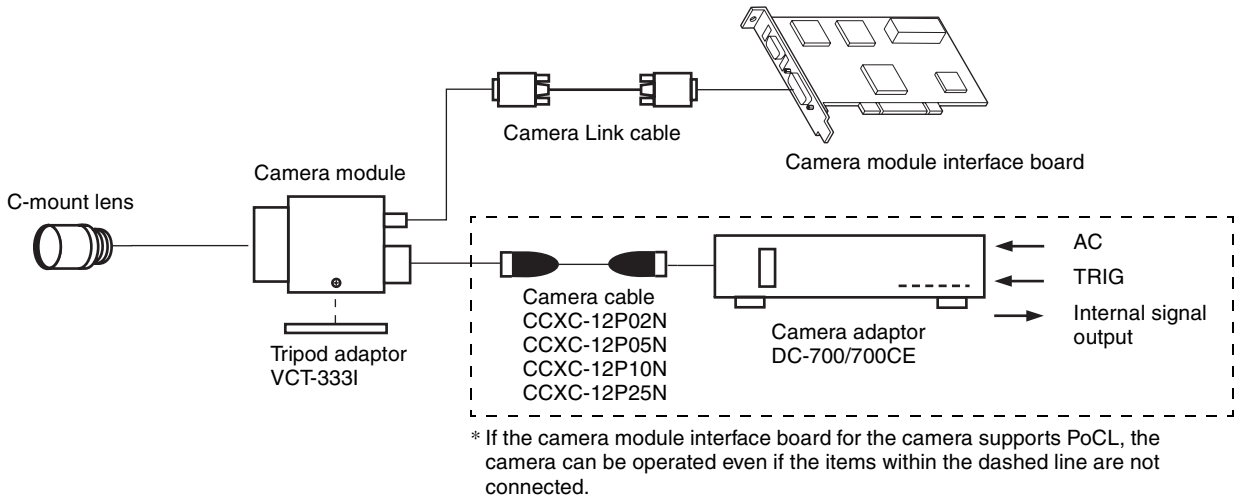
Install the board in a PCI/PCI-Express slot in devices such as a computer. Select a commercially available interface board compatible with the Camera Link feature. You can use either a board that supports PoCL, or one that does not.
Due to the performance of the board, the frame rate may become low according to lack of processing capacity. To have this product output frames at the highest speed, use a board corresponding to PCI-Express.
Performance may also be dependent on the host device (e.g., Computer), so consult the dealer if images are not displayed properly.



Camera Link cable
(Sony Camera-compatible)

This cable connects to the DIGITAL Interface connector on the rear panel of the camera module. Image/control signals are transmitted via this cable.
If there is support for PoCL, power is also supplied at the same time.
If you use a camera module interface board with support for PoCL, be sure to use a camera link cable with support for PoCL.
Spotted noise may appear in a specific brightness in the window according to the attribute of the cable. If this noise is an obstacle, use a shorter cable.

# Connection




* If the camera module interface board for the camera supports PoCL, the camera can be operated even if the items within the dashed line are not connected.

**Power supply**
You can supply power to the camera module using the following methods.

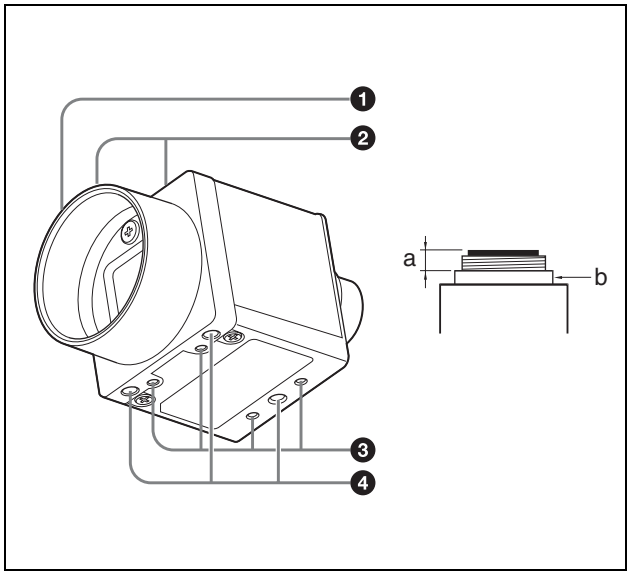
**Using the DIGITAL Interface connector**
This unit supports the PoCL (Power over Camera Link) standard. By connecting a PoCL-compatible camera link cable to a PoCL-compatible camera module interface board, you can power, control, and output images from the camera using a single cable. Heat dissipation is required depending on the usage environment.

**Using the DC power input connector**
You can supply power via the DC power input connector using the power adapter.
Use DC-700/700CE which is the stable power source free from ripple or noise.

**Heat dissipation**
For heat dissipation, refer to When mounting the camera (see page 10).

# 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**

Use a C-mount lens with a protrusion (a) extending from the lens mount face (b) of 10 mm or less.
When you use the camera with the lens attached, the resolution of the image output from the camera may differ according to the performance of the lens. Note it when you select a lens.
The performance of a lens may change according to the aperture level.
If the resolution is not enough, adjust the aperture level.

**❷ Guide screw holes (Top)**

**❸ Guide screw holes / Tripod screw holes (Bottom)**
When using a tripod, use these four screw holes to attach a VCT-333I tripod adaptor.

**❹ Reference screw holes (Bottom)**
These precision screw holes are for locking the camera module. Locking the camera module into these holes secures the optical axis alignment.

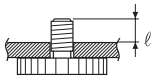
**Note**

Refer to the outer dimensions on page 47 about the guide hole and the position and size of standard hole.

## Using a tripod

To use the tripod, install the tripod adaptor VCT-333I (not supplied) on the camera module.
Use a tripod screw with a protrusion (ℓ) extending from the installation surface, as follows, and tighten it, using a screwdriver. Be sure that the protrusion (ℓ) does not exceed 5.5 mm in length.

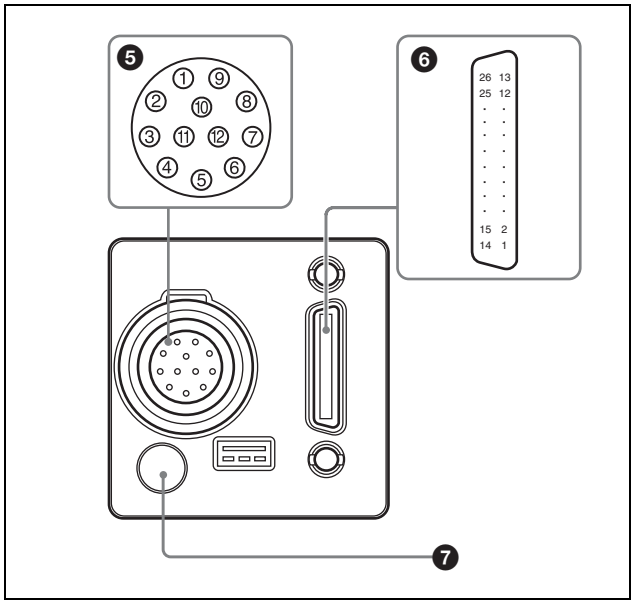
Length 4.5 to 5.5 mm




**Note**

If you install a tripod adapter (not supplied), use the screws provided.

## Rear




**❺ ⎓ (DC power input) connector (12-pin)**
You can connect a camera cable CCXC-12P05N etc. to input the 12 V DC power supply. The pin configuration of this connector is as follows. You can operate the camera without using this connector when using a PoCL-compatible camera module interface board.
For details on the pin arrangement, see the following table.

| Pin No. | Signal | Pin No. | Signal |
|---|---|---|---|
| 1 | Ground | 7 | GPI3*2 |
| 2 | DC 12 V | 8 | Ground |
| 3 | Ground | 9 | GPI3*1 |
| 4 | GPO1*1 | 10 | GPI2*2 |
| 5 | Ground | 11 | GPI1*2 |
| 6 | GPO2*1 | 12 | Ground |

***1 Signal output from pin 4, 6, 9 (GPO1/2/3) of DC power input connector**
This setting allows you to select from exposure signal, strobe control signal, Hi/Low fixed value, etc. The initial values of GPO1/2/3 are all Hi fixed.

***2 Signal output from pin 7, 10, 11 (GPI3/2/1) of DC power input connector**
Function as GPI input or trigger input. The initial setting is GPI1 for trigger input and GPI2/3 for GPI input.

**❻ DIGITAL Interface connector (26-pin mini conector)**

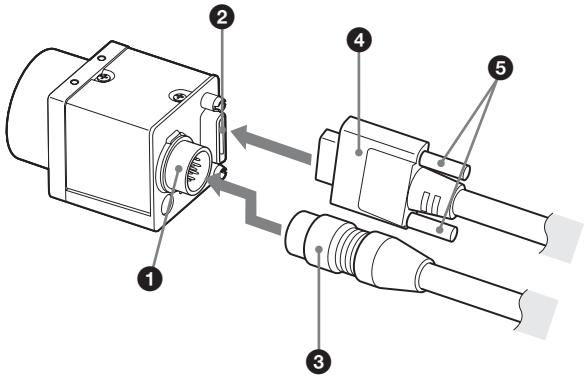
**Camera Link Base Configuration:**
You can connect a Camera Link cable to this connector to control a camera module from a host device utilizing the serial communication protocol while outputting a video signal from the camera module. If you use a camera module interface board with support for PoCL, you can also supply power from this connecter. You can input the external trigger signal via the DIGITAL Interface connector and operate a camera module in the external trigger mode.
The following table shows the relation between the pin numbers of the DIGITAL Interface connector and the input/output signals and the like.

| Pin No. | Signal | Pin No. | Signal |
|---|---|---|---|
| 1 | Power supply or Ground* | 14 | Ground |
| 2 | X0– | 15 | X0+ |
| 3 | X1– | 16 | X1+ |
| 4 | X2– | 17 | X2+ |
| 5 | XCLK– | 18 | XCLK+ |
| 6 | X3– | 19 | X3+ |
| 7 | SerTC+ | 20 | SerTC– |
| 8 | SerTFG– | 21 | SerTFG+ |
| 9 | CC1– | 22 | CC1+ |
| 10 | CC2+ | 23 | CC2– |
| 11 | CC3– | 24 | CC3+ |
| 12 | CC4+ | 25 | CC4– |
| 13 | Ground | 26 | Power supply or Ground* |

*** About the 1st pin and 26th pin of the DIGITAL Interface connector**
The connection differs depending on the type of camera module interface board you use.
In the case of PoCL support: Both the 1st pin and 26th pin are Power supply
In the case of non-PoCL support: Both the 1st pin and 26th pin are Ground

**❼ Status LED (Green)**
Indicates the status of the Camera.
For details, refer to “Status LED” (page 31).

## Connecting the cables




Connect the camera cable (❸) to the DC power input connector (❶) and the Camera Link cable (❹) to the DIGITAL Interface connector (❷) respectively. If you use a camera module interface board with support for PoCL, you can operate the camera even if you do not connect the camera cable to the DC power input connector. When you connect the Camera Link cable, turn the two fastening screws (❺) on the connector to secure the cable tightly.
Connect the other end of the camera cable to the DC-700/700CE and the other end of the Camera Link cable to the camera module interface board.

**Note**

Please be careful with the points below, as they may be the cause of camera or camera image input board failure.
– Connect or disconnect camera cables or camera link cables while the power is not supplied.
– Supply power after confirming each cable is firmly connected.
– Do not supply power from both camera cable and camera link cable simultaneously.
– If you use the camera with PoCL connection, make sure to connect a cable that supports PoCL.

## Controlling the camera from the host device

You can control the camera from host device such as a computer.
You can send a command corresponding to the control items, with parameters for the desired settings, if necessary, from the host device to control the camera. Refer to “Camera Control Commands” on page 37 for details on how to send a command and its parameter.

**Note**

Make sure to supply power to the camera module and confirm that the camera module is operating before inputting a trigger signal. If you input trigger signal to a camera module without the power supplied, this may cause a malfunction of the camera module.

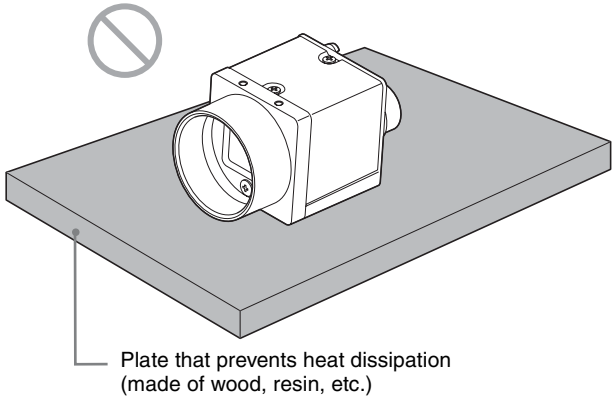
## When mounting the camera

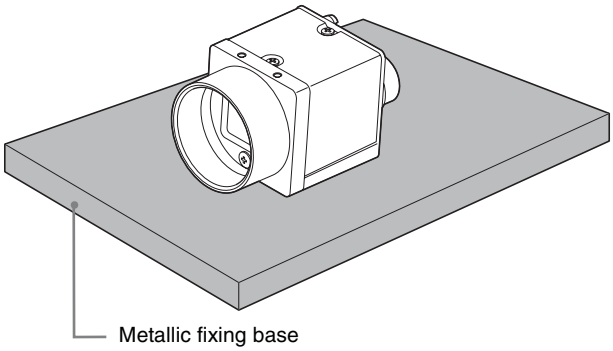
When the value read from the temperature sensor is above 75 °C (167 °F), heat dissipation is required. For more information about reading from the temperature sensor, see “Temperature Readout Function” (page 32).

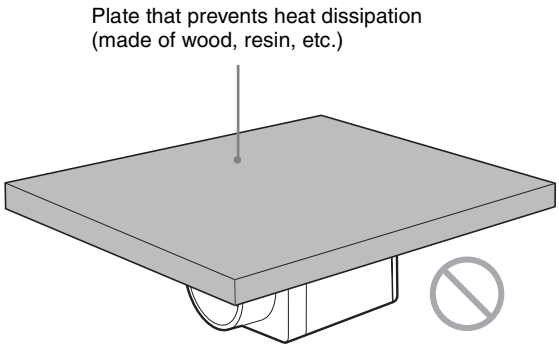
To promote heat dissipation from the unit and maintain the performance, mount the camera to a metallic base to fix.

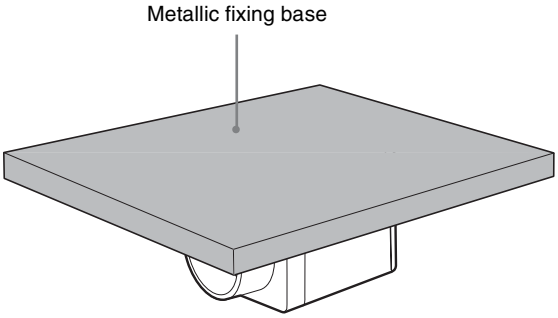
**Notes**

- When mounting the camera to the fixing base, secure the camera tightly by using the reference screw holes (see page 7) and screws.
- Do not mount the camera to a plate made of a material such as wood or resin that prevents heat dissipation.



# Communication Setting

Use the serial port assigned to the image input board for the camera. Communication settings are shown in the table below. Echo back is performed for input commands.
Echo back can be set OFF to accelerate command responses. Commands are not case sensitive.

| | |
|---|---|
| Baud rate | 921600/460800/230400/115200/57600/38400/19200/14400/9600 |
| Data bit | 8 |
| Parity | None |
| Stop bit | 1 |
| Flow control | None |

Default values are underlined. (same applies hereinafter)

| Command | Parameter | |
|---|---|---|
| BAUDRATE | 115200/57600/38400/19200/14400/9600 | Settings are saved in the camera and will be enabled after restart. |
| BAUDRATE-TMP | 921600/460800/230400/115200/57600/38400/ 19200/14400/9600 | Settings will be implemented immediately, but not saved in the camera. |
| BAUDRATE-SAVE | 921600/460800/230400/115200/57600/38400/ 19200/14400/9600 | Settings are saved in the camera and will be enabled after restart. |

When you increase the baud rate, save them using the BAUDRATE-SAVE command after changing the settings temporarily using the BAUDRATE-TMP command and confirming the communication between PC is enabled.

# Camera link output settings

Camera link tap can be selected from 1, 2 or 3.
Camera link clock frequency can be selected from 45 MHz or 75 MHz.
By turning down the clock frequency, the length of the camera link cable can be extended because of durability improvement against the attenuation of image signals.
Camera link tap and Camera link clock settings will be saved on the flash memory automatically and enabled after restart.
You don't have to set each time when launching the application.

| Command | Parameter | |
|---|---|---|
| CAMERALINK-TAP | 1/2/3 | Sets the Camera link tap. |
| BASE-CLOCK | 45/75 | Specifies the Camera link clock frequency [MHz].<br>Setting other than provided in left will not work. |

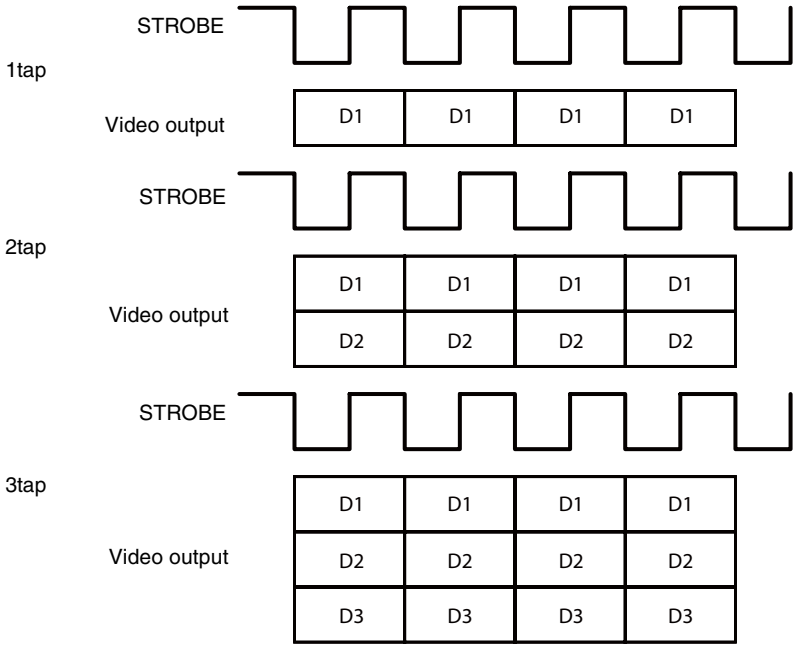
Combinations of camera link taps and output bit lengths.

| | | CAMERALINK-TAP | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| Output Bit Length | 8 | ● | ● | ● |
| | 10 | ● | ● | – |
| | 12 | ● | ● | – |
| | 24* | ● | – | – |
| Defect detection function | | ● | – | – |
| Defect offset function | | ● | ● | ● |
| Shading detection function | | ● | – | – |
| Shading offset function | | ● | ● | ● |

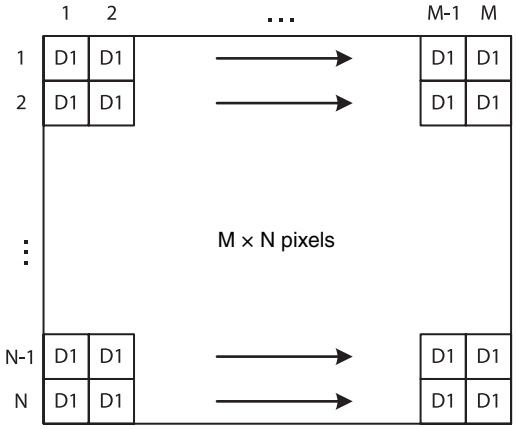
● Usable function – Not usable function
* XCL-CG510C only

# Data Order

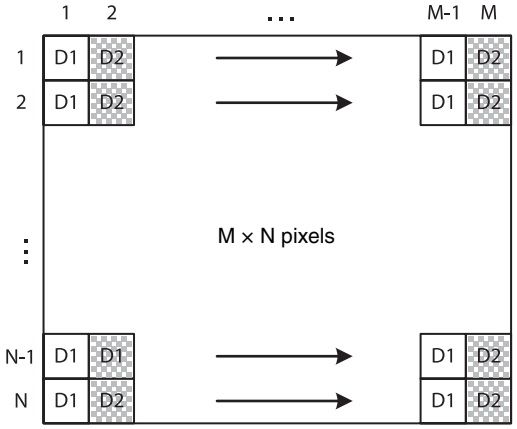
Figures below show the data order when an image of M × N pixels is transmitted in 1tap/2tap/3tap.



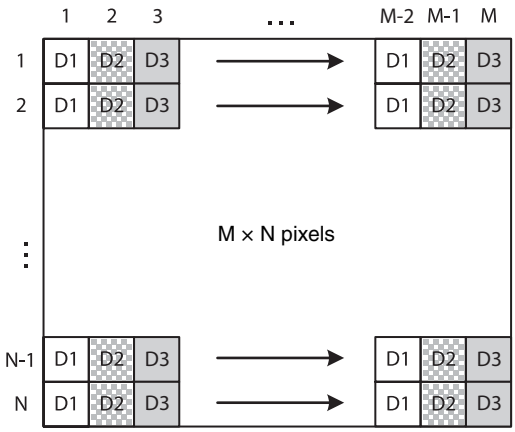

## 1tap




## 2tap



## 3tap

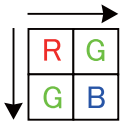
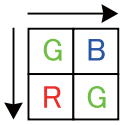
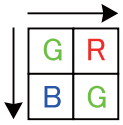
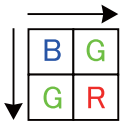



## Port assignment

Camera link port allocation to image signal output data of this unit complies with Camera Link V2.0 specifications.

## Color pixel array

Signals of all pixels are output sequentially according to the Bayer Array corresponding to the settings of image grip.

| Reverse X | Reverse Y | Location |
|---|---|---|
| 0 | 0 |  |
| 0 | 1 |  |
| 1 | 0 |  |
| 1 | 1 |  |

# Trigger Signal Input

Trigger signals can be input via the 7th, 10th, 11th pins of the DC power input connector, the CC1, CC2, CC3, CC4 pins of the DIGITAL Interface connector, or the software command. Switchover of the trigger signal can be changed via the TRG-SRC command.

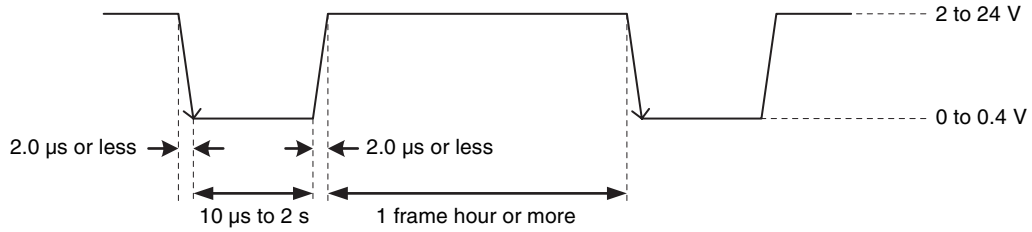
| Command | Parameter | Trigger signal assigned pin |
|---|---|---|
| TRG-SRC | 7 | DC power input connector 7th pin (GPI3) |
| | 10 | DC power input connector 10th pin (GPI2) |
| | 11 | DC power input connector 11th pin (GPI1) |
| | 101 | DIGITAL Interface connector 22nd [+]/9th [-] (CC1) |
| | 102 | DIGITAL Interface connector 10th [+]/23rd [-] (CC2) |
| | 103 | DIGITAL Interface connector 24th [+]/11th [-] (CC3) |
| | 104 | DIGITAL Interface connector 12th [+]/25th [-] (CC4) |
| | 0 | Software command (TRG-SOFT) |
| | 20 | OR of GPI1/GPI2/GPI3 |

## Trigger signal polarity

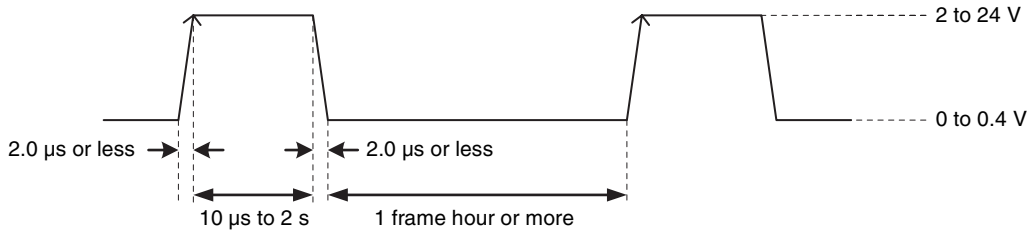
Positive refers to a trigger signal polarity activated while rising from Low to Hi, or during the Hi interval. Negative refers to a trigger signal polarity activated while falling from Hi to Low, or during the Low interval. The default value of a camera is Negative. The GPI connectors 1, 2, and 3 are pulled up on the camera side. When a connector is open, the trigger signal is at the high level and is logically inactive. Note that when Positive of GPI1, 2 or 3 is selected as a trigger input, when the terminal is open, the trigger will be activated.

| Command | Parameter | Trigger signal polarity |
|---|---|---|
| TRG-POL | 0 | Negative |
| | 1 | Positive |

### DC power input connector specifications




Trigger input polarity = Negative

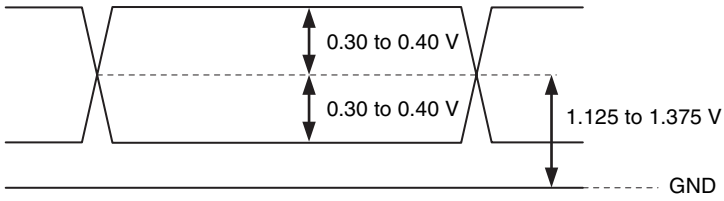



Trigger input polarity = Positive

**Note**

When inputting a trigger signal to the camera using the DC-700/700CE, use DC 5 V or less at the logical high level.

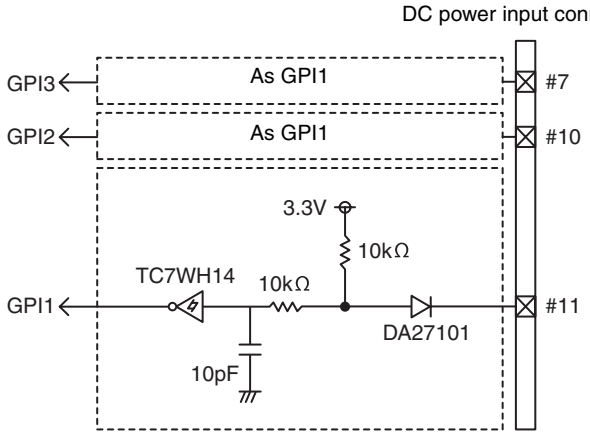
### DIGITAL Interface connector specifications



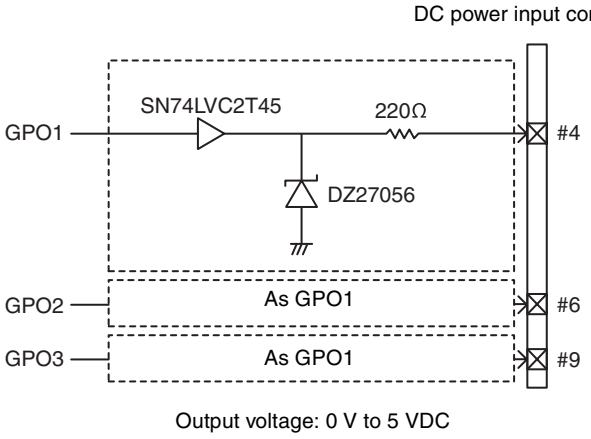

# GPIO Connector

The DC power input connector 7th, 10th, 11th are the GPI connector and the 4th, 6th, 9th are the GPO connector. The trigger reset pin is the DC power input connector 11th pin (GPI1). If you are connecting an external device to the GPI or GPO connector, refer to the circuit specifications below.

### GPI circuit specifications



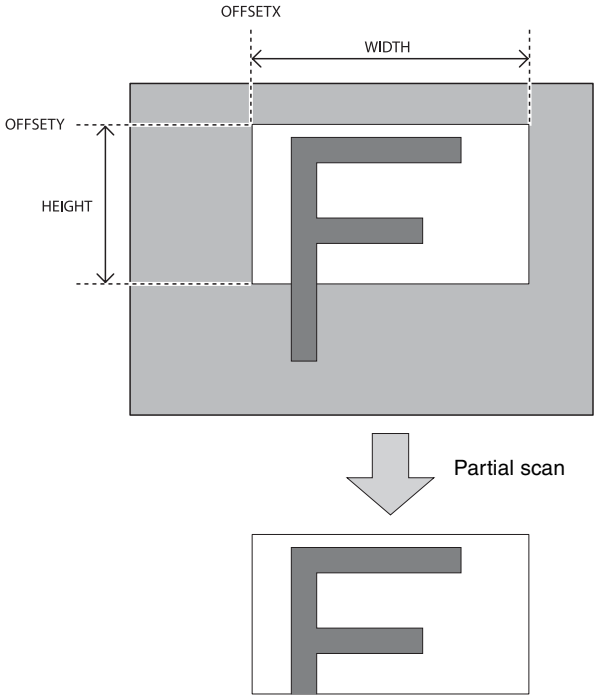

### GPO circuit specifications




Output voltage: 0 V to 5 VDC

# Partial Scan

Only the area selected from the effective pixel area can be read out. Clearing unnecessary parts at high-speed allows high-speed reading. The area size is selected by the HEIGHT and WIDTH commands, and the read beginning point is selected by the OFFSETX and OFFSETY commands. Using the ROI command, you can set HEIGHT, WIDTH, OFFSETX and OFFSETY at the same time. Reducing HEIGHT increases the frame rate, but changing WIDTH does not change the frame rate. Partial scan can be set with or without a trigger. Binning can be used at the same time.
OFFSETX and OFFSETY relate to WIDTH and HEIGHT as follows:
OFFSETX + WIDTH ≤ WIDTH (maximum value)
OFFSETY + HEIGHT ≤ HEIGHT (maximum value)




### Configurable range

| WIDTH | HEIGHT |
|---|---|
| 16 to 2464 | 4 to 2056 |

### Configurable values

OFFSETX, WIDTH: in 16 step
OFFSETY, HEIGHT: in 4 step

| Command | Parameter 1 | Parameter 2 | Parameter 3 | Parameter 4 |
|---|---|---|---|---|
| ROI | Width | Height | OffsetX | OffsetY |

**Notes**

- Since the shutter setting has priority, use a shutter speed high enough to enable partial scan at a higher frame rate.
- When using the binning function, the configurable range will be 1/2.

# Binning

By adding 2 vertical pixels or 2 horizontal pixels, the frame rate is increased the sensitivity. The color camera cannot set this. This can be set with or without a trigger. Partial scan can be used concurrently and horizontal and vertical can be set at the same time.

| Command | Parameter | Setting |
|---|---|---|
| VBIN | 1 | No binning |
| | 2 | Vertical binning |
| HBIN | 1 | No binning |
| | 2 | Horizontal binning |

# Output Bit Length

Toggling between 8 bit/10 bit/12 bit for monochrome camera, and toggling between Raw output 8 bit/10 bit/ 12 bit and RGB output 24 bit for color camera are available.

| Command | Parameter |
|---|---|
| PIXEL-DEPTH | 8/10/12/24* |

* XCL-CG510C only

# Image flip

Flips an image vertically and horizontally.
Reboot the unit to reflect the changes of the setting.

| Register | Parameter | Function |
|---|---|---|
| REVERSEX | 0/1 | 0: Normal<br>1: Inversion |
| REVERSEY | 0/1 | 0: Normal<br>1: Inversion |

# Gain

## Manual gain

Manual gain can be set finely in 0.1dB increments. Although the settable lower/upper limit values of the gain are slightly different in each camera, the GAIN parameter value can be set from –1 dB or less to 27 dB or more. Same as the gain, the parameter value of the GAIN-FINE can be set from –10 or less to 270 or more. The setting range of the gain that guarantees image quality is from 0 dB to 18 dB.

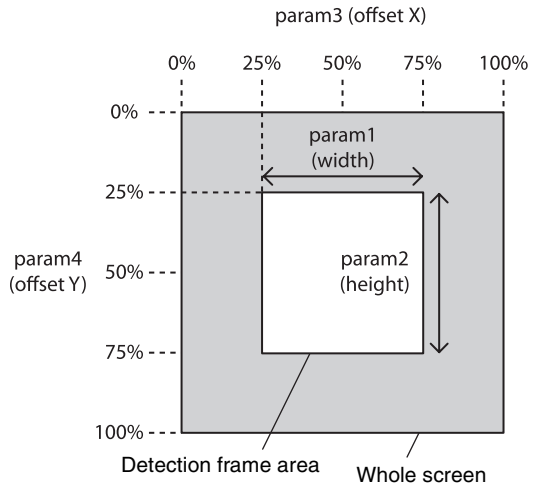
| Command | Command parameter | Setting |
|---|---|---|
| GAIN | –1 or less ~ 0 ~ 27 or more | Gain dB unit |
| GAIN-FINE | –10 or less ~ 0 ~ 270 or more | Gain advanced setting |

## Auto gain (AGC)

By executing the GAIN-AUTO command, the gain is automatically adjusted according to the image pickup environment. AGC works so that the average level in a detection frame may reach AGC-LEVEL. The AGC detection frame is set to the central region by default. The detection frame can be displayed or the detection area changed.

| Command | Parameter | Setting |
|---|---|---|
| GAIN-AUTO (AGC) | 0 | Manual gain |
| | 1 | One-push AGC |
| | 2 | Continuous AGC |
| AGC-LEVEL | 0 to 11264 to 16383 | AGC target level (14 bit) |
| AGC-SPEED | 1 to 256 | AGC convergence speed |
| AGC-UPPER | 0 to 18 | AGC upper limit (dB) |
| AGC-LOWER | 0 to 18 | AGC lower limit (dB) |
| AGC-FRAME-HIGHLIGHT | 0 | AGC detection frame is hidden |
| | 1 | AGC detection frame is displayed |

| Command | Parameter 1 | Parameter 2 | Parameter 3 | Parameter 4 |
|---|---|---|---|---|
| AGC-FRAME | 1 to 100 | 1 to 100 | 0 to 99 | 0 to 99 |




## Area gain

A separate digital gain can be set for a rectangular area of preference 16 positions.
If multiple rectangular areas are duplicated, the gain value of the low-numbered area takes priority.

| Command | Parameter |
|---|---|
| AREA-GAIN-ENABLE | 0/1 |

| Command | Para-meter1 | Para-meter2 | Para-meter3 | Para-meter4 | Para-meter5 | Para-meter6 | Para-meter7 |
|---|---|---|---|---|---|---|---|
| AREA-GAIN *1 | Index 0 to 15 | Enable 0/1 | Width | Height | Offset X | Offset Y | Gain 0 to 8191 |
| AREA-GAIN *2 | Index 0 to 15 | Enable 0/1 | – | – | – | – | – |
| AREA-GAIN *3 | Index 0 to 15 | – | – | – | – | – | – |
| AREA-GAIN *4 | – | – | – | – | – | – | – |

Set area for Width/Height/OffsetX/OffsetY is same as "partial read-out".
Gain means 256=1 time. i.e. 8191=approx. 32 times. When this is set to 0, selected area will be completely black.

* Area size and position settings are performed based on the absolute coordinate value against the valid pixel. Therefore, the area size and position range should be set within the partial read-out range.

*1 This is used to set the area and gain.
*2 The area can be switched between valid/invalid without changing the area.
*3 Reads out the current settings.
*4 List the 16 areas.

# Shutter (Exposure)

## Configuring the setting

The setting is configured in µs unit. If you do not prioritize the image quality, you can set it up to 60 sec during operation. If the exposure time is long, it will be easier to see the pixel defects.

| Command | Parameter |
|---|---|
| EXP | 1 to 60000000 |

**Note**

Exposure time to be set varies depending on modes. Check the actual value with read out after completing settings.

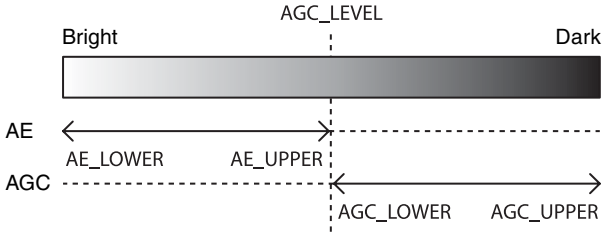
## Auto exposure (AE)

The shutter is set automatically by detecting the output level. The target level is the same as the value of AGC-LEVEL. This can be performed along with auto gain.

| Command | Parameter | Setting |
|---|---|---|
| EXPOSURE-AUTO (AE) | 0 | Manual shutter |
| | 1 | One-push AE |
| | 2 | Continuous AE |
| AE-SPEED | 1 to 192 to 256 | AE convergence speed |
| AE-UPPER | 1 to 60000000 | AE upper limit |
| AE-LOWER | 1 to 60000000 | AE lower limit |

# Combination of Continuous AGC and Continuous AE

AGC and AE coordinate with each other to adjust the level automatically with AGC-LEVEL as the target level. When the environment starts getting dark and the shutter is released, AGC starts to work.



# Trigger Control

## Free run/trigger mode

### Free run

The camera operates without a trigger signal and performs the video output operation continuously after the shutter (exposure) is finished. The horizontal and vertical timing signals are generated within the camera. During the free-run operation, image pickup timing cannot be controlled. In the free-run operation, the adjustment is made automatically to achieve the maximum frame rate according to the shutter setting.

### Trigger mode

Exposure is started by detecting the externally input trigger signal. When EXP-MODE is 0, exposure is started by detecting the rising or falling edge of the trigger signal and the trigger edge detection (exposure is performed based on the set shutter value) is performed. When EXP-MODE is 1, the trigger width detection (exposed for the period of the trigger signal width) is performed.

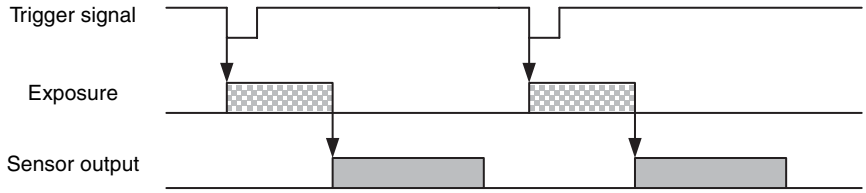
| Command | Parameter | Setting |
|---|---|---|
| TRG-MODE | 0 | Free run |
| | 1 | Trigger mode |
| | 2 | Burst trigger mode |

#### For trigger mode (TRG-MODE=1)

| Command | Parameter | Setting |
|---|---|---|
| EXP-MODE | 0 | Trigger edge detection |
| | 1 | Trigger width detection |

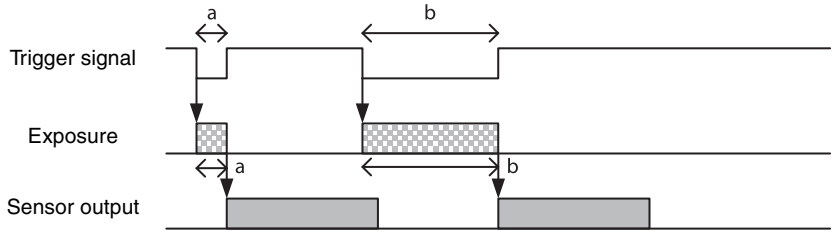
#### Trigger edge detection

The figure shows the trigger signal negative polarity (detecting the drop edge).




#### Trigger width detection

The figure shows the trigger signal negative polarity (detecting Low level width).



## Special trigger

When operating in trigger mode and performing image pickup in different conditions (such as the shutter, gain, and image pickup area), the setting has to be changed in advance for each trigger input. However, if the special trigger operation is enabled, the setting does not have to be changed and continuous image pick up in different conditions is facilitated. Up to 16 settings can be configured. There are the bulk operations in which images are taken consecutively by inputting the trigger signal once and the sequential operation in which images are taken each time the trigger signal is detected. The next exposure is started after the end of video output. In the sequential operation, the second and subsequent trigger signals should be input 5 ms or more after the end of video output. During the special trigger operation, the device cannot be entered to the trigger mode. The source and polarity of the special trigger signal should be defined separately from the trigger mode. Each setting should be saved in the user set. For the items reflected, refer to “Command List” (page 38).

**Note**

During special trigger operation, defect correction cannot be used.

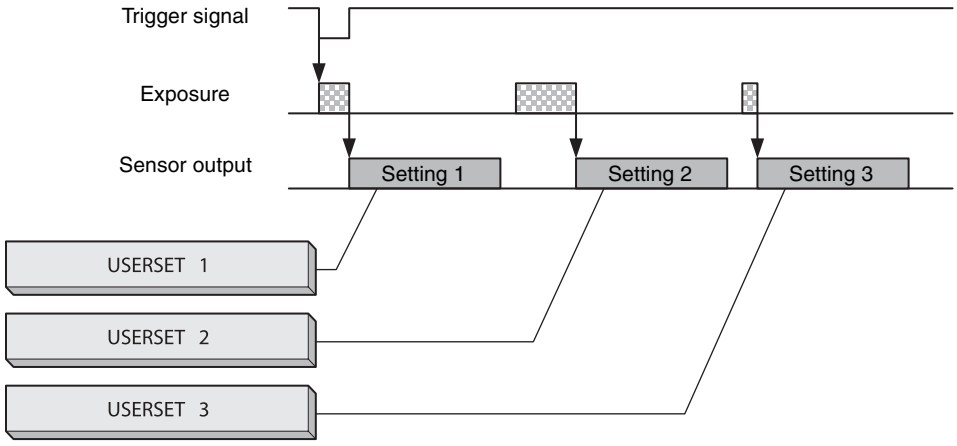
| Command | Parameter | Setting |
|---|---|---|
| SP-TRG-MODE | 0 | Special trigger off |
| | 1 | Bulk |
| | 2 | Sequential |

| Command | Parameter | Setting |
|---|---|---|
| SP-TRG-SRC | 4 | DC power input connector 4th pin (GPI1) |
| | 7 | DC power input connector 7th pin (GPI3) |
| | 10 | DC power input connector 10th pin (GPI4) |
| | 11 | DC power input connector 11th pin (GPI2) |
| | 101 | DIGITAL Interface connector 22nd [+]/9th [-] (CC1) |
| | 102 | DIGITAL Interface connector 10th [+]/23rd [-] (CC2) |
| | 103 | DIGITAL Interface connector 24th [+]/11th [-] (CC3) |
| | 104 | DIGITAL Interface connector 12th [+]/25th [-] (CC4) |
| | 0 | Software command (TRG-SOFT) |
| | 20 | OR of GPI1/GPI2/GPI3/GPI4 |

| Command | Parameter | Setting |
|---|---|---|
| SP-TRG-POL | 0 | Negative |
| | 1 | Positive |

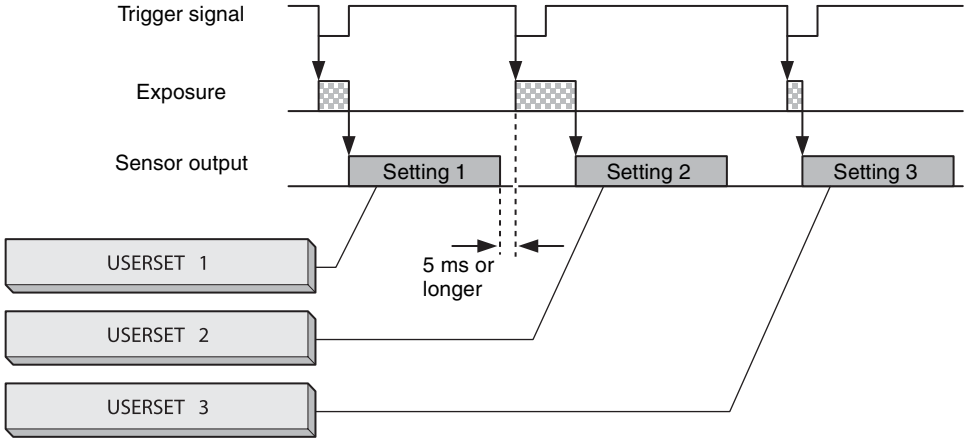
### Bulk

SP-TRG-MODE=1, SP-TRG-POL=0, SP-TRG-F-CNT=3 in the figure.




### Sequential

SP-TRG-MODE=2, SP-TRG-POL=0, SP-TRG-F-CNT=3 in the figure.



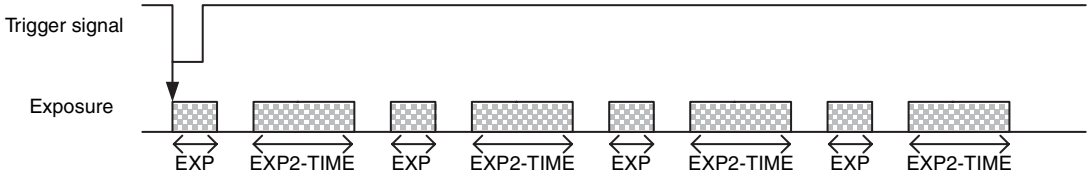

## Burst trigger

Exposure can be repeated continuously with one trigger signal. Modes with repeating single exposure time and with repeating two exposure times alternately are available. The number of times of exposer can be specified.

| Register | Parameter | Setting | |
|---|---|---|---|
| TRG-BST-MODE | 0 | Single Exposure Time mode | |
| | | Upon trigger edge detection | Exposer for the time set on EXP. |
| | | Upon trigger width detection | Exposer for only the width of trigger. |
| | 1 | Dual Exposure Time mode | |
| | | Upon trigger edge detection | Exposer for the time set on EXP and EXP2-TIME alternately. |
| | | Upon trigger width detection | Exposure for trigger width, trigger width × time set on EXP2-RAT alternately. |
| TRG-BST-F-CNT | 0-65533 | 0: repeat infinitely | |
| | | 1 and above: exposure for specified times | |
| TRG-BST-STOP | 1 | Force terminate repeating exposure | |
| EXP2-TIME | 1-60000000 | The secondary exposure time upon trigger edge detection | |
| EXP2-RAT | 1, 2, 4, 8, 16 | The value to determine the secondary exposure time upon trigger edge detection. The primary exposure time (trigger width) multiplied by this value will be the secondary exposure time. | |

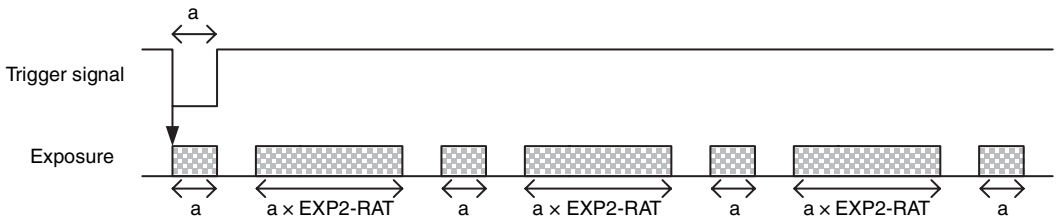
### Trigger edge detection (EXP-MODE=0)

TRG-BST-F-CNT=8
TRG-BST-MODE=1 (DualExposureTime)

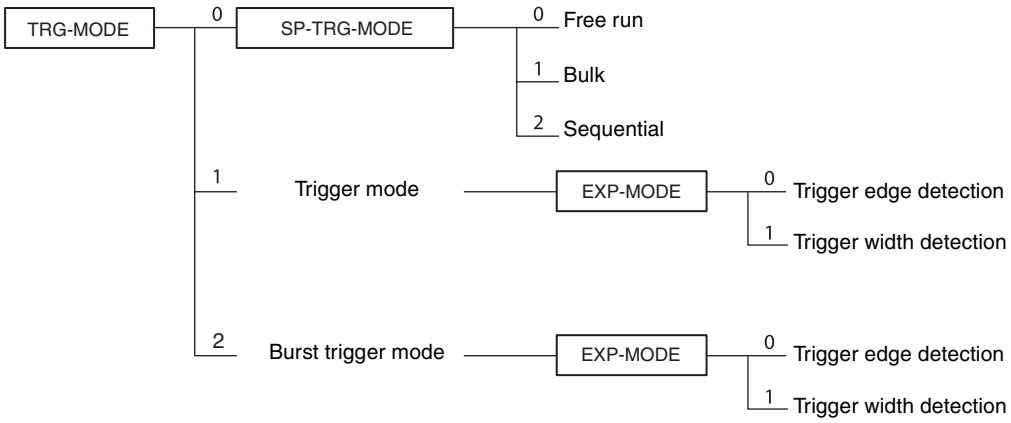



### Trigger width detection (EXP-MODE=1)

TRG-BST-F-CNT=7
TRG-BST-MODE=1 (DualExposureTime)




### Trigger states

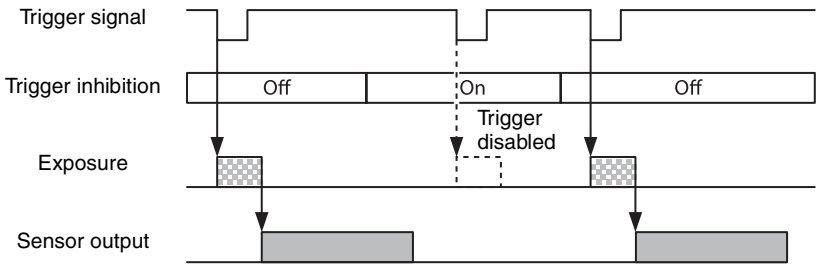



## Trigger source

This can be input via the DC power input connector, DIGITAL Interface connector, or software command (TRG-SOFT). Refer to “Trigger Signal Input” (page 15) for details. Note that the trigger sources for the special trigger operation and the trigger mode operation are defined separately.

## Trigger inhibition

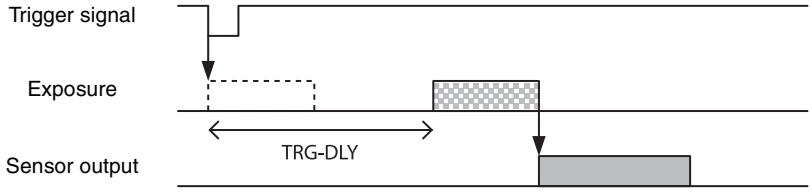
Trigger input can be disabled. This function is effective when disabling the trigger signal to a specific camera in the environment where multiple cameras are connected by the same trigger signal and when preventing false operations caused by noise contamination to the trigger signal line (due to the installed environment).




| Command | Parameter | Setting |
|---|---|---|
| TRG-INH | 0 | Trigger is accepted |
| | 1 | Trigger is not accepted |

## Trigger delay

The camera can delay the trigger signal.




| Command | Parameter | Setting |
|---|---|---|
| TRG-DLY | 0 to 4000000 | Trigger delay [µs] |

## Trigger counter

Accepted triggers by which video output is performed are counted. Triggers are counted up by the internal counter even in the free-run operation. Setting 0 resets the counter. Triggers that have been removed by trigger range limit are not counted. The trigger counter returns to 0 when the upper limit (2147483647) is reached.

| Command |
|---|
| TRG-CNT |

## Frame counter

The frame counter increases when an image is output. Setting 0 resets the counter. The trigger counter returns to 0 when the upper limit (2147483647) is reached.

| Command |
|---|
| FRAME-COUNTER |

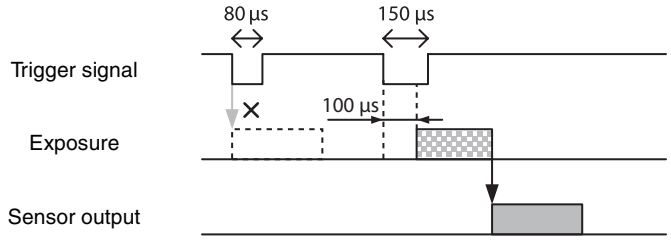
## Trigger range limit

Only signals in the set trigger width can be accepted as the trigger signal. This functions as a noise filter, which removes chattering or disturbance noise in the trigger signal line. This also functions as a trigger selector, whereby only a specific camera can be operated by the trigger when multiple cameras share one trigger signal line. When the trigger signal is input, exposure is started after the latency as per trigger range settings. If the trigger width is out of the range, video is not output. If the trigger source is a soft trigger, trigger range limitation is not enabled.

| Command | Parameter | Setting |
|---|---|---|
| TRG-RANGE | 0 | Trigger range off |
| | 1 | Trigger range on |
| TRG-RANGE-LOWER | 1 to 2000000 | Trigger range lower limit [µs] |

### Trigger range operation example

EXP=300, TRG-RANGE-LOWER=100 in the figure.




## Image sensor Fast trigger mode

If the mode is set to OFF, the next exposure can be started even while reading images from the sensor. The exposure will be started after approximately 2 line hours later from trigger signal detection.
If the mode is set to ON, the exposure will start immediately upon the trigger detection. The next exposure cannot be started while reading images.

| Command | Parameter | Setting |
|---|---|---|
| TRG-FAST | 0 | Off |
| | 1 | On |

# Frame Rate

## Auto frame rate

The reading cycle is set to allow the frame rate to be the maximum value automatically according to the current shutter setting and the partial scan setting in the free-run operation (Shutter has priority). The next exposure is performed while outputting a video and the next video output is started immediately after finishing all video outputs. The frame rate is lowered when setting the shutter time longer than the video output time.

| Command | Parameter | Setting |
|---|---|---|
| FRAMERATE-AUTO | 0 | Off |
| | 1 | On |

## Specifying frame rate

The frame rate of the video output can be specified in the free-run operation. The value of the frame rate [fps] × 1,000,000 should be entered. The frame rate faster than the fastest frame rate cannot be set.

| Command | Parameter |
|---|---|
| FRAMERATE | 62500 to 30000000 to * |

* The upper limit varies depending on the partial scan setting.
  Example for setting 15 [fps]: FRAMERATE 15000000

## Displaying frame rate

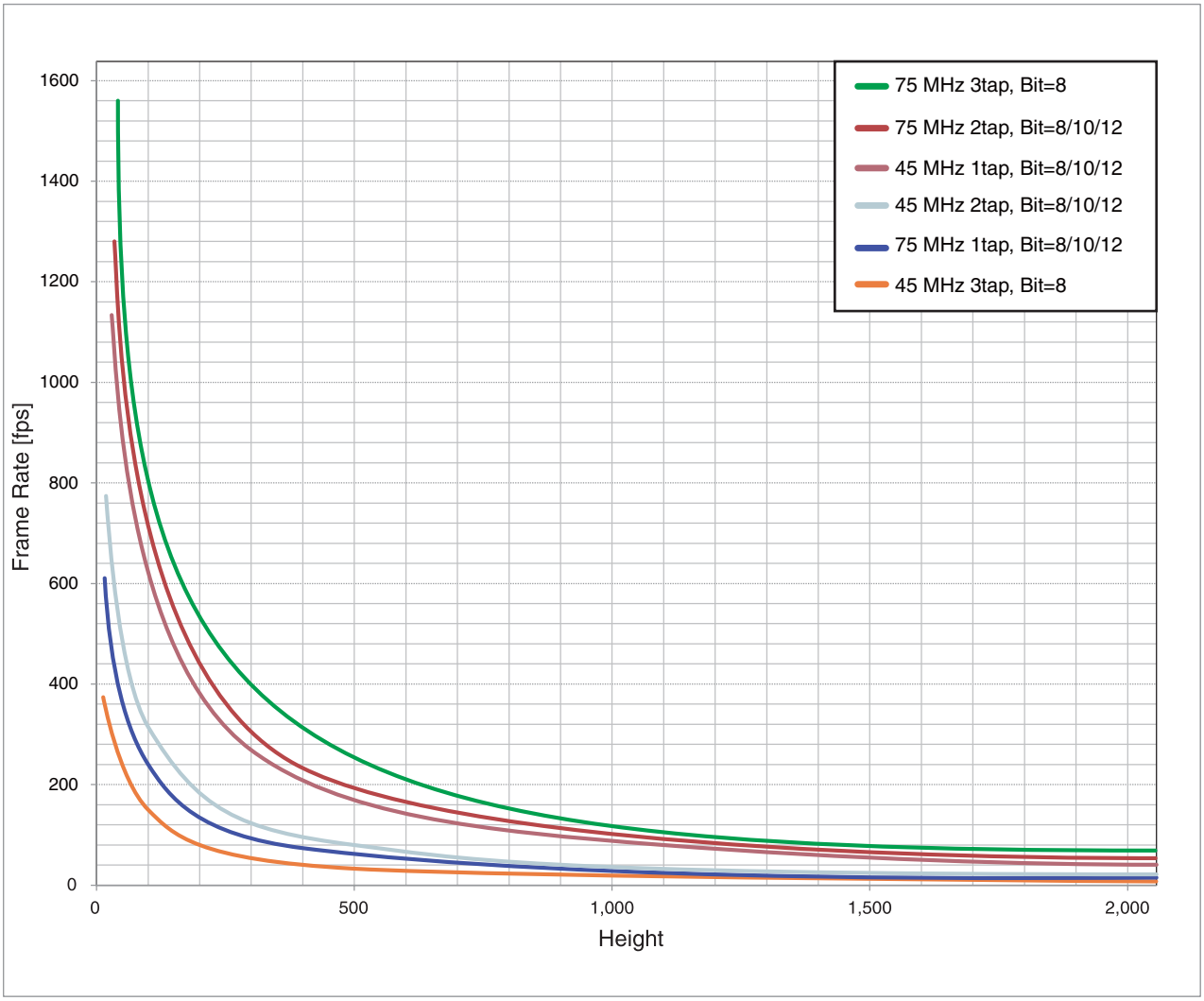
The current frame rate during the auto frame rate operation is displayed.

| Command |
|---|
| FRAMERATE-ACTUAL |

## Fastest frame rate for partial scanning

The fastest frame rate varies depending on HEIGHT for partial scanning.

### BASE-CLOCK:75MHz/45MHz



# White Balance

The white balance can be automatically adjusted once when the WHITEBALANCE-AUTO command is executed. The detection area is set to the screen center by default. The detection area can also be displayed on the screen. The detection frame can be changed arbitrarily (AWB-FRAME). For manual correction, the FINE command should be executed. The white balance can be set finely per sensor tap. Therefore, a fine adjustment should be made if the color difference between sensor taps cannot be adjusted completely by AWB.

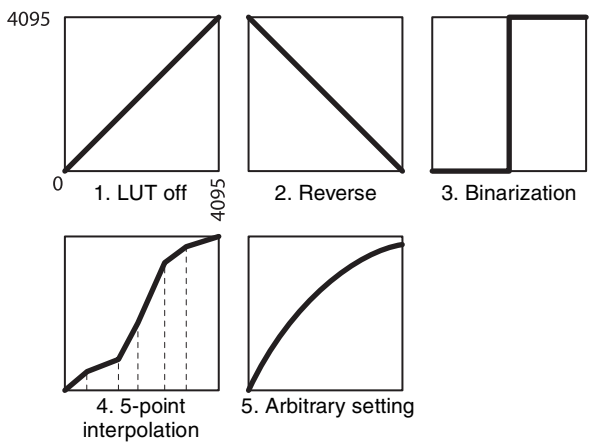
| Command | Parameter | Setting |
|---|---|---|
| WHITEBALANCE-AUTO (AWB) | 0 | Manual correction |
| | 1 | One-push AWB |
| AWB-FRAME-HIGHLIGHT | 0 | Detection frame is hidden |
| | 1 | Detection frame is displayed |

| Command | Parameter | Setting |
|---|---|---|
| RGAIN-FINE | 256 (×1) to 4095 | Red gain |
| GGAIN-FINE | 256 (×1) to 4095 | Green gain |
| BGAIN-FINE | 256 (×1) to 4095 | Blue gain |

# LUT

Five types of presets are provided. Specify using a 12 bit value. Binarization, 5-point interpolation, and arbitrary setting can be changed.

| Command | Parameter | Setting |
|---|---|---|
| LUT-FORMAT | 0 | LUT off (γ=1) |
| | 1 | Reverse |
| | 2 | Binarization |
| | 3 | 5-point interpolation |
| | 4 | Arbitrary setting |




## Binarization

The binarization threshold can be changed.

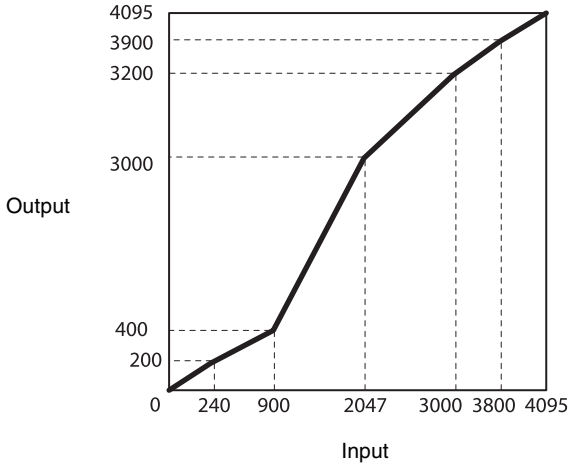
| Command | Parameter |
|---|---|
| BINARIZATION | 0 to 2047 to 4095 |

## 5-point interpolation

The values of output points 1 through 5 that correspond to input points 1 through 5 can be changed. Linear interpolation is performed between interpolation points.

| Command | Parameter1 | Parameter2 | Parameter3 |
|---|---|---|---|
| LINEAR-INTERPOLATION | 1 to 5 | 0 to 4095 | 0 to 4095 |

**Setting example:**




```
>LINEAR-INTERPOLATION 1 240 200
>LINEAR-INTERPOLATION 2 900 400
>LINEAR-INTERPOLATION 3 2047 3000
>LINEAR-INTERPOLATION 4 3000 3200
>LINEAR-INTERPOLATION 5 3800 3900
>LINEAR-INTERPOLATION-BUILD
>LUT-FORMAT 3
```

## Arbitrary setting

The output values 0 through 4095 that correspond to input values 0 through 4095 can be changed.

| Command | Parameter1 | Parameter2 |
|---|---|---|
| LUT | 0 to 4095 | 0 to 4095 |

**Setting example:**

```
>LUT 0 3
>LUT 1 10
>LUT 2 20
…
>LUT 4094 4000
>LUT 4095 4010
>LUT-FORMAT 4
```

### Save LUT

When you change the settings, save them using the LUT-SAVE command.

| Command |
|---|
| LUT-SAVE |

# 3 × 3 filter

A 3×3 area filter processing can be applied. The filter processing with brightness of the central pixel and the surrounding area, and the parameter of each pixel are multiplied and added together. The result is the brightness of the central pixel. Specify the coefficient in the range of –8191 to 8191. 256 is regarded as ×1. Depending on the parameter patterns, it can reduce noise, adjust edge, and extract the outline.

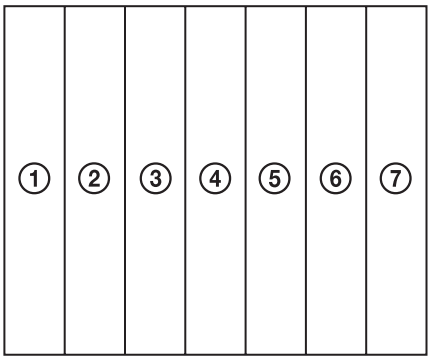
| Command | Parameter | Setting |
|---|---|---|
| SP-FL | 0 | filter off |
| | 1 | filter on |

| Command | Parameter1 | Parameter2 | Setting |
|---|---|---|---|
| SP-FL-VAL | 00 | –8191 to 8191 | Parameter for the upper left pixel |
| | 01 | –8191 to 8191 | Parameter for the upper pixel |
| | 02 | –8191 to 8191 | Parameter for the upper right pixel |
| | 10 | –8191 to 8191 | Parameter for the left pixel |
| | 11 | –8191 to 8191 | Parameter for the central pixel |
| | 12 | –8191 to 8191 | Parameter for the right pixel |
| | 20 | –8191 to 8191 | Parameter for the lower left pixel |
| | 21 | –8191 to 8191 | Parameter for the lower pixel |
| | 22 | –8191 to 8191 | Parameter for the lower right pixel |

# Test Chart Output

For monochrome camera, monochrome chart can be set. For color camera, monochrome chart or color chart can be set.

| Command | Parameter | Setting |
|---|---|---|
| TESTCHART | 0 | Off |
| | 1 | Monochrome chart |
| | 2 | Color chart |




| | Monochrome | Color | | |
|---|---|---|---|---|
| | Raw/Mono | R | G | B |
| ① | 0xF30 | 0xFFF | 0xFFF | 0xFFF |
| ② | 0xDC0 | 0xFFF | 0xFFF | 0 |
| ③ | 0xC80 | 0 | 0xFFF | 0xFFF |
| ④ | 0xA00 | 0 | 0xFFF | 0 |
| ⑤ | 0x7A0 | 0xFFF | 0 | 0xFFF |
| ⑥ | 0x550 | 0xFFF | 0 | 0 |
| ⑦ | 0x340 | 0 | 0 | 0xFFF |

* 12 bit notation

# GPIO

## GPI

The value can be checked by detecting the signals input to the DC power input connector 7th, 10th, and 11th using the GPI command. Since all pins are pulled up, 1 (Hi level) is returned if they are opened.

| Command | Parameter |
|---|---|
| GPI | 7/10/11 |

## GPO

GPO1, GPO2, and GPO3 outputs can be transmitted from the DC power input connector 4th, 6th, and 9th pins, respectively. After selecting a signal, the output polarity should be determined by GPO-INVERTER. The strobe control signal can be set separately for GPO1, GPO2, and GPO3.

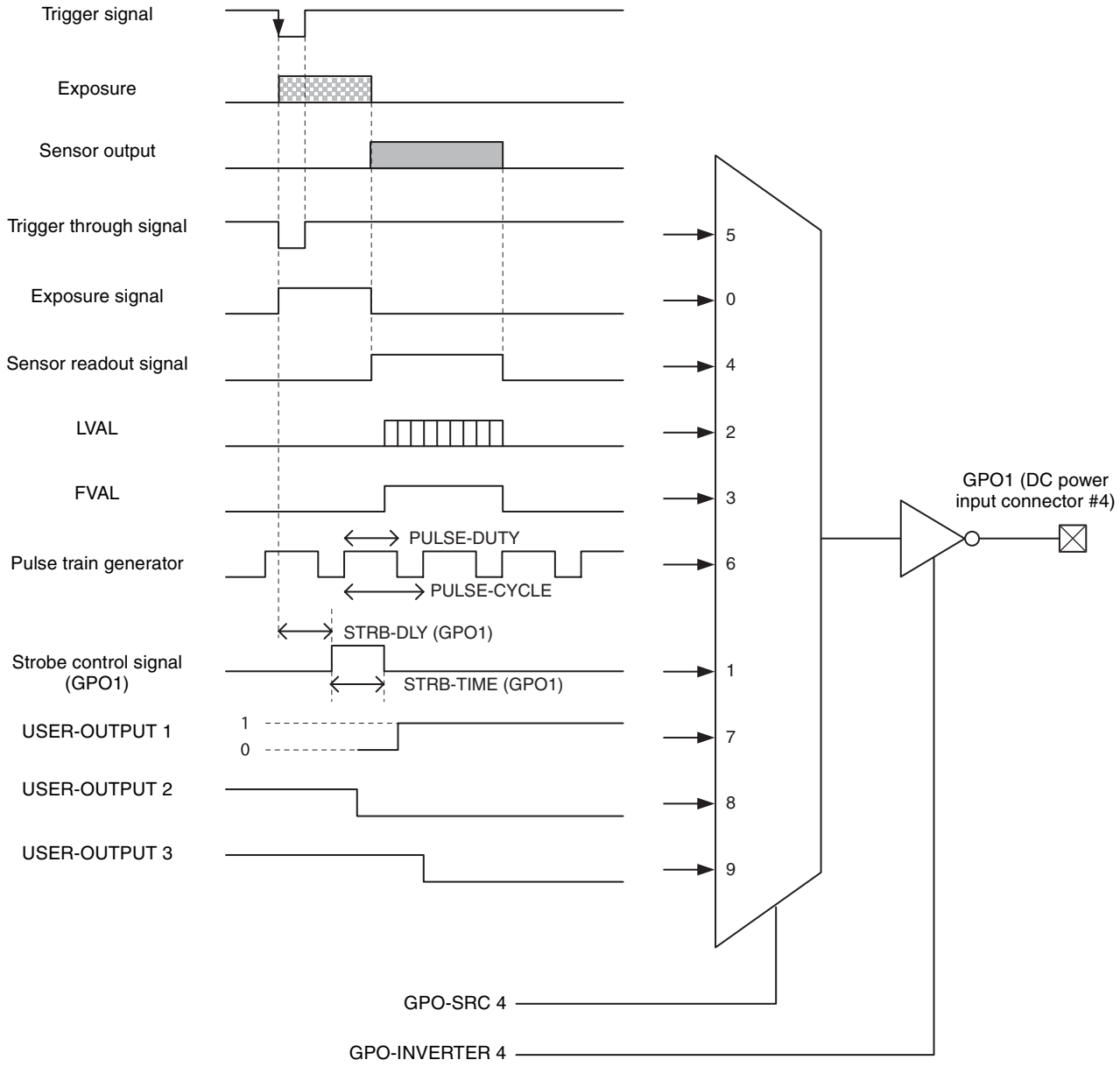
| Command | Parameter1 | Parameter2 | Setting |
|---|---|---|---|
| GPO-SRC | 4/6/9 | 0 | Exposure signal |
| | | 1 | Strobe control signal |
| | | 2 | LVAL signal |
| | | 3 | FVAL signal |
| | | 4 | Sensor readout signal |
| | | 5 | Trigger through signal |
| | | 6 | Pulse generation signal |
| | | 7 | User definition 1 |
| | | 8 | User definition 2 |
| | | 9 | User definition 3 |

| Command | Parameter | Setting |
|---|---|---|
| GPO-INVERTER | 0 | Without signal inversion |
| | 1 | With signal inversion |

**Setting example:**

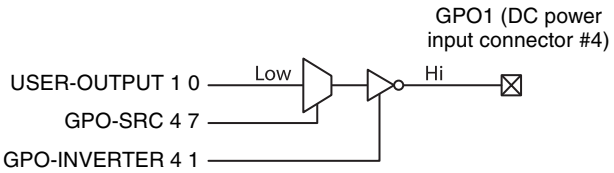
LVAL signal is output to GPO2 (DC power input connector 6th pin), Hi active setting (Hi is enabled)
>GPO-SRC 6 2
>GPO-INVERTER 6 0

### GPO output system diagram (example of GPO1)



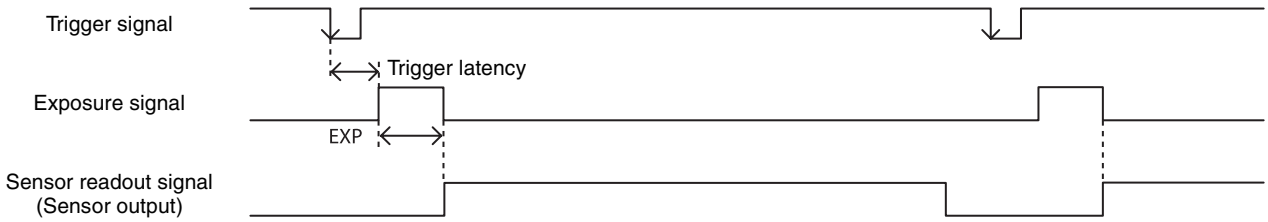

### Factory Setting

The following chart shows the factory setting for GPO1 (DC power input connector No.4). User-defined 1 is also set to GPO2 and GPO3 (Hi output).



## Sensor Readout (Sensor Output)

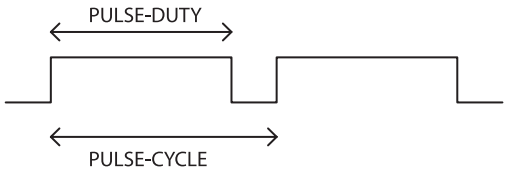
This signal indicates that exposure has completed and the image sensor has entered the video output sequence (enabled only when operating the trigger mode). Output is available from the GPO2 or 3 terminals. The sensor readout signal is asserted before optical black (OB) and the effective pixel area is output. Image might not be output properly, if trigger signal is input while this signal is asserted.




# Pulse Train Generator

Pulse waveforms can be output from the GPO connector. Available range is 0.5Hz to 100kHz.

| Command | Parameter |
|---|---|
| PULSE-DUTY | 1 to 2000000 [µs] |
| PULSE-CYCLE | 10 to 2000000 [µs] |




# Status LED

LED on the rear panel lights up according to the output specification set for GPO1 connector. Various settings are possible such as assigning the trigger signal and pulse train generator. The setting is saved immediately and reflected at the next startup.

| Command | Parameter | Setting |
|---|---|---|
| LED-MODE | 0 | Off |
| | 1 | On |
| | 2 | GPO1 setting |
| | 3 | GPO2 setting |
| | 4 | GPO3 setting |
| | 5 | GPO4 setting |

# Temperature Readout Function

The camera's internal temperature can be read from the temperature sensor installed in the circuit board. Its accuracy is ±2°C. Use this value as a general guide.

| Command |
|---|
| TEMPERATURE |

# Defect Correction

It corrects clear defect points and opaque defect points of the image sensor. From the peripheral pixels, correction is performed on coordinate pixels in which defects are detected. Factory setting and user setting can be selected.

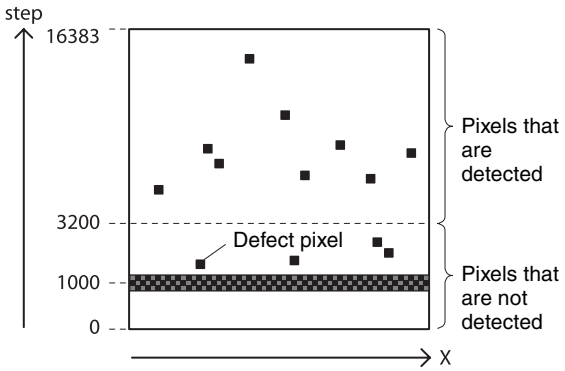
| Command | Parameter | Setting |
|---|---|---|
| DEFECT-CORRECTION | 0 | Correction off |
| | 1 | Correction on |

## Defect correction setup procedure

**1** Set conditions in which clear defect points are prone to occur.
Below is an example in which gain is 18 dB and the shutter is 1 second. Prevent as much light as possible from entering such as by blocking light.
>GAIN 18
>EXP 1000000

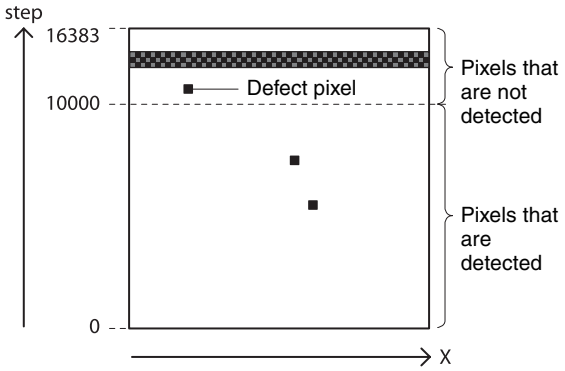
**2** Set the threshold in units of 14 bits.
Points are detected as clear defect points when this level is exceeded. Below is an example for 3200 step/14bit. Pixels that indicate 3200 to 16383 are detected.
>DEFECT-THRESHOLD 3200

**3** Execute clear defect point detection.
Detection takes four times the EXP time setting. The output levels on the same x coordinate axis are shown below. The levels uniformly indicate around 1000 steps when an all-black image is taken, but defect pixels (at high levels) are present in some locations. All pixels whose levels exceed 3200 steps, which was set in step 2, are detected.
>DEFECT-DETECTION 1




**4** Send a DEFECT-DETECTION command to confirm that the detection is completed.
End if 0 is returned.

**5** Execute opaque defect point detection.
Like the clear defect point detection, set the image pickup conditions and the threshold in units of 14 bits. Below is an example for 10000 step/14bit. Pixels that indicate 0 to 10000 steps are detected. If are not setting opaque defect points, you can skip this step.
>DEFECT-THRESHOLD 10000
>DEFECT-DETECTION 2

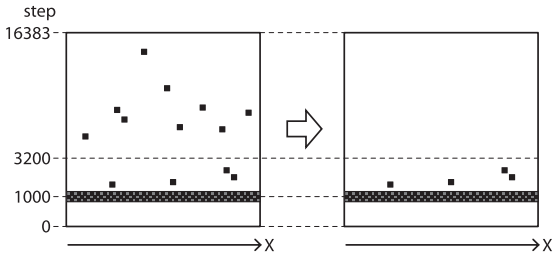



**6** Send DEFECT-DETECTION command to confirm that the detection is completed.
End if 0 is returned.

**7** Select the data for applying defect correction.
To apply the pixels detected in steps 3 and 4, select 2. To apply factory settings, select 0. To apply values that have been saved, select 1.
>DEFECT-PATTERN-LOAD 2

| Command | Parameter | Setting |
|---|---|---|
| DEFECT-PATTERN-LOAD | 0 | Factory setting |
| | 1 | User setting |
| | 2 | Data detected using DEFECT-DETECTION |

**8** Turn on defect detection correction.
>DEFECT-CORRECTION 1




**9** Save the settings.
To repeat defect detection without saving, repeat steps 1 to 6.
>DEFECT-PATTERN-SAVE

**Note**

The upper limit of defect detection points is 2047 for clear and opaque defect points combined. Correction cannot be performed over the upper limit. The detected defect points can be confirmed using DEFECT-DETECTION-RESULT. If the upper limit is exceeded, defect detection will fail or abnormal defect detection will occur and RESULT will be -1.

# Shading Correction

Depending on the characteristics of the lens, shadings caused by a drop in the amount of light around the lens, or light source variation, are corrected. The nine patterns can be saved as the user settings.
Shading Correction has two modes. In peak detection mode, you can adjust the screen to brightest level. In average detection mode, you can adjust the whole screen to its average brightness.

| Command | Parameter | Function |
|---|---|---|
| SHADING-DETECTION | 1 | Start detection (peak detection) |
| | 2 | Start detection (average detection) |

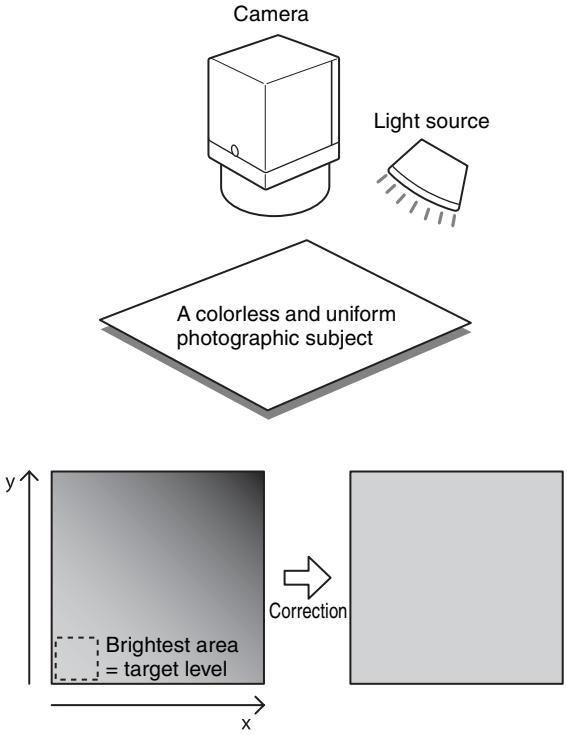
| Command | Parameter | Function |
|---|---|---|
| SHADING-CORRECTION | 0 | Correction off |
| | 1 | Correction on |

| Command | Parameter | Function |
|---|---|---|
| SHADING-PATTERN-SAVE | 0 to 8 | Save shading pattern |

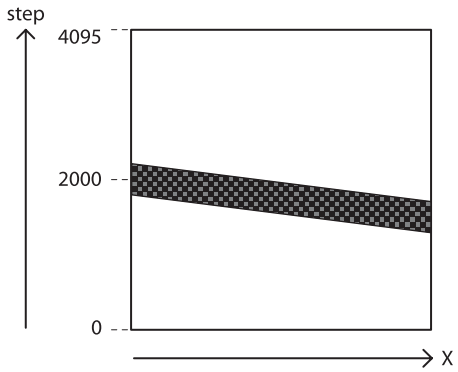
| Command | Parameter | Function |
|---|---|---|
| SHADING-PATTERN-LOAD | 0 to 8 | Read shading pattern |

## Shading detection setup procedure

**1** Fix the lens and lighting conditions.
Make an adjustment by assuming the brightest level as the target level in the peak detection mode, where the condition of the brightness is not uniform due to an uneven light source, as shown in the figure below.




**2** Adjust the exposure time and other parameters so that the target level is about 50%.
On color cameras, adjust the white balance.




**3** Execute shading detection.
>SHADING-DETECTION 1
Read the Status to determine whether the calculation is finished.
>SHADING-DETECTION
1 (running)
0 (finished)
Return to 0 when finished.

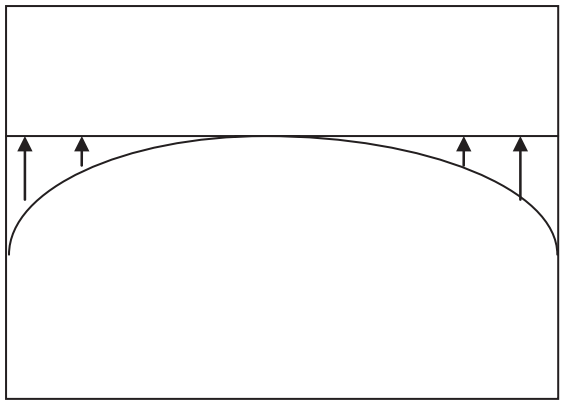
**4** Determine the effect of shading correction.
> SHADING-PATTERN-CHECK

**5** Save shading pattern.
>SHADING-PATTERN-SAVE 0

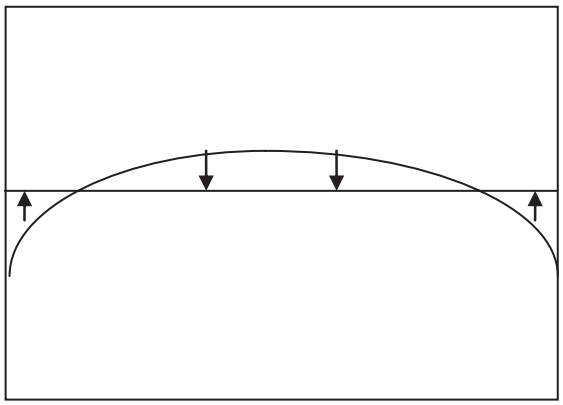
**6** Readout the saved pattern.
>SHADING-PATTERN-LOAD 0

**Note**

Keep the trigger mode off when doing the shading detection. Reset the camera once if the shading correction cannot be finished.



Peak detection mode:
The whole object tends to become brighter.



Average detection mode:
The bright parts of the object may darken.

## Specify the color to detect shading (XCL-CG510C only)

You can select the color of pixel to detect shading.

| Command | Parameter | Setting |
|---|---|---|
| SHADING-DETECT-COLOR | R | RED |
| | G | GREEN |
| | B | BLUE |
| | Y | BRIGHTNESS |

# User Set

Main set values can be saved to the channels 1 to 16 of USERSET. Refer to “Command List” (page 38) for items to be saved. The factory setting is saved to channel 0, which cannot be overwritten.

**Setting example ①:**

Shutter 3 ms, Gain 3 dB, FVAL signal is output to GPO3 connector (This setting is saved to the channel 1.)

```
>EXPOSURE 3000
>GAIN  3
>GPO  9  3
>USERSET-SAVE 1
```

**Setting example ②:**

The user set saved in the channel 2 is loaded.

```
>USERSET-LOAD  2
```

## User set name

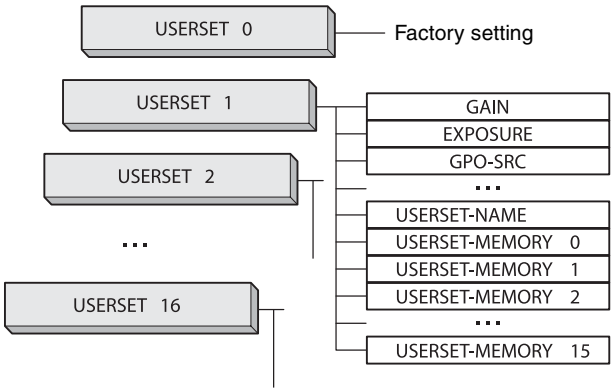
Strings that are 31 characters long can be assigned to channels 0 to 16. For example, you can assign names such as “setting1” and “setting2” in accordance with the settings.

| Command | Parameter |
|---|---|
| USERSET-NAME | 31 characters of your choice |

## User set memory

This is one of the items to be saved in the user set channel. Signed 32-bit numbers are assigned to slots 0 to 15.

### Configuration diagram of user set




# Free Memory

Signed 32-bit numbers can be saved and loaded to 8192 areas.

| Command | Parameter1 | Parameter2 |
|---|---|---|
| FREE-MEMORY | 0 to 8191 | $-2^{31}$ to $2^{31} - 1$ |

# User ID

User IDs are unique names that can be assigned to cameras. A string that is 15 characters long can be assigned.

| Command | Parameter |
|---|---|
| USER-ID | 15 characters of your choice |

# Saving and Startup

The startup setting can be determined by USERSET-DEFAULT. This is also used to check which user set settings are currently being used.

**Usage example:**

Startup with the setting saved in the user set channel 3.

```
>USERSET-DEFAULT  3
(Restart or RESET command)
```

Check which user set settings are the current settings.

```
>USERSET-DEFAULT
0
OK
```

# Initializing

Perform “USERSET-LOAD 0” if you want to format only the camera settings.
Perform the commands below only when you want to restore all settings (ex. Boa rate not stored in user set and the camera link tap) to the factory settings.

**Notes**

- Defect data, shading data will be eliminated as well.
- Do not turn off the power for 1 minute, as the unit is initializing after operation.

| Command |
|---|
| FACTORY-DEFAULT |

# Camera Information

The model name of a camera or its firmware information can be read out.

| Command | Read out items |
|---|---|
| VENDOR | Manufacture name (SONY) |
| MODEL | Model name |
| VERSION | Firmware version |
| ID | Serial number |
| MANUFACTURER | Data for service |

# Help Command

To display the command list, execute HELP. To display the details of a command, add HELP in front of the command and execute.

**Setting example:**

Check about GAIN.
>HELP  GAIN
GAIN:
Controls the analog gain (in dB).
This can take the value in following range:
min:0, max:18, step:1
OK

# Echo off

Echo back of the command is not available.
Set to echo off when you want to speed up the communication response.

| Command | Parameter | Function |
|---|---|---|
| ECHO | 0 | Excluding echo back |
| | 1 | Including echo back |

# Restart

The camera is rebooted.

| Command |
|---|
| RESET |

# Error information acquisition

When an Access Denied error occurs, you can check the details of the error from the excluded controls.

| Command | Message |
|---|---|
| GET-LAST-ERROR | Auto Exposure feature is enabled.<br>Wide Dynamic Range feature is enabled.<br>Shading detection is in process.<br>etc. |

# Command Form

When inputting commands, separate a command and a parameter by a space, and press <Carriage Return> to confirm. Commands are not case sensitive. Lower case can be used for input strings on USER-ID. Input format and an input example are shown below.

**Input format:**
Command Param1 Param2 Param3 Param4 Param5 Param6 Param7 <CR>

**Input example:**
ROI 640 480 8 6 <CR>

# Command Input and Response

Camera echoes back against characters (alphabetic, numeric), space, backspace and Enter; otherwise, other invalid characters are ignored. When a command is successfully completed, the status will be echoed.

**Input:** Gain 6<CR>
**Output:** OK<CR>

| Status | Explanation (Example) |
|---|---|
| OK | Successfully completed |
| ERROR: Invalid argument number. | The argument number of the parameter is invalid.<br>(Width 100 100) |
| ERROR: Invalid parameter. | The parameter is invalid.<br>(Width abc) |
| ERROR: Not implemented. | The command is not supported.<br>(Vbin of a color camera) |
| ERROR: Access denied. | Commands are limited.<br>(A trigger mode related command is controlled by SP-TRG-MODE=1.) |
| ERROR: Busy | The command cannot be received. |
| SYNTAX ERROR! | The command is not correct.<br>(Widtt 100) |

# Command List

| | | |
|---|---|---|
| **Save** | **Device** | This item is saved in a different area to the user set. |
| | **UserSet** | This item is saved in the user set from 1-16. |
| **Load** | **SpecialTrigger** | This item is set in the special trigger mode. |
| | **UserSet** | This item is set with the Userset-load command. |
| **Reset** | **Device Reset** | This item is initialized if a reset or reboot command is executed. |
| | **FactoryDefault** | This item is initialized if a Factory-Default command is executed. |

| | | | | | **Device** | **User Set** | **Special Trigger** | **User Set** | **Device Reset** | **Factory Default** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | **Access** | **Parameter** | **XCL-CG510** | **XCL-CG510C** | **Save** | | **Load** | | **Reset** | |
| VENDOR | RO | – | SONY | | – | – | – | – | – | – |
| MODEL | RO | – | XCL-CG510 | XCL-CG510C | – | – | – | – | – | – |
| MANUFACTURER | RO | – | | | – | – | – | – | – | – |
| VERSION | RO | – | | | – | – | – | – | – | – |
| ID | RO | – | 7-digit numeric (unique value) | | – | – | – | – | – | – |
| USER-ID | RW | String | Initial value is blank | | ● | – | – | – | – | ● |
| USER-ID-DELETE | WO | – | – | | – | – | – | – | – | – |
| RESET | WO | – | – | | – | – | – | – | – | – |
| TEMPERATURE | RO | – | | | – | – | – | – | – | – |
| BAUDRATE | RW | Rate | 9600/14400/19200/ (38400)/57600/115200 | | ● | – | – | – | – | ● |
| BAUDRATE-TMP | RW | Rate | 9600/14400/19200/ (38400)/57600/115200/ 230400/460800/921600 | | – | – | – | – | – | ● |
| BAUDRATE-SAVE | RW | Rate | 9600/14400/19200/ (38400)/57600/115200/ 230400/460800/921600 | | ● | – | – | – | – | ● |
| LED-MODE | RW | – | 0 to (1) to 5 | | ● | – | – | – | – | ● |
| SENSOR-WIDTH | RO | – | 2464 | | – | – | – | – | – | – |
| SENSOR-HEIGHT | RO | – | 2056 | | – | – | – | – | – | – |
| SENSOR-TAP | RO | – | 1 | | – | – | – | – | – | ● |
| ROI | RW | Width<br>Height<br>OffsetX<br><br>OffsetY | 16 to (2448) to 2464<br>4 to (2048) to 2056<br>0 to (8) to [2464 to MinWidth]<br>0 to (8) to [2056 to MinHeight] | | – | ● | ○ | ● | – | ● |
| WIDTH | RW | Pixel | 16 to (2448) to 2464 | | – | ● | – | ● | – | ● |
| HEIGHT | RW | Line | 4 to (2048) to 2056 | | – | ● | – | ● | – | ● |
| OFFSETX | RW | Pixel | (0) to [2464 to MinWidth] | | – | ● | ● | ● | – | ● |
| OFFSETY | RW | Line | (0) to [2056 to MinHeight] | | – | ● | ● | ● | – | ● |
| HBINNING / HBIN | RW | Pixel | (1) / 2 | – | – | ● | ○ | ● | – | ● |
| VBINNING / VBIN | RW | Line | (1) / 2 | – | – | ● | ○ | ● | – | ● |
| REVERSEX / REVX | RW | Mode | (0) / 1 | | ● | – | – | – | – | ● |
| REVERSEY / REVY | R/W | Mode | (0) / 1 | | ● | – | – | – | – | ● |
| PIXEL-DEPTH | RW | Depth | (8) / 10 / 12 | (8) / 10 / 12 / 24 | – | ● | – | ● | – | ● |

● Available function, – unavailable function, ○ The contents in UserSet1 will be reflected. If you use Special Trigger, use UserSet1.

Initial set value for each item is indicated within ( ).

| | | | | | Device | User Set | Special Trigger | User Set | Device Reset | Factory Default |
|---|---|---|---|---|---|---|---|---|---|---|
| Command | Access | Parameter | XCL-CG510 | XCL-CG510C | Save | | Load | | Reset | |
| CAMERALINK-TAP / CL-TAP | RW | Tap | 1 / (2) / 3 | | ● | – | – | ● | – | ● |
| BASE-CLOCK | RW | Freq | (75) / 45 | | ● | – | – | – | – | ● |
| TESTCHART | RW | Mode | (0) / 1 | (0) / 1 / 2 | | | | | | |
| FRAMERATE | RW | Rate | 62500 to (30000000) to *1 | | – | ● | – | ● | – | ● |
| FRAMERATE-AUTO | RW | Mode | 0 / (1) | | – | ● | – | ● | – | ● |
| FRAMERATE-ACTUAL | RO | Rate | | | – | – | – | – | – | – |
| SPECIAL-TRIGGER-MODE / SP-TRG-MODE | RW | Mode | (0) / 1 / 2 | | – | – | – | – | ● | ● |
| SPECIAL-TRIGGER-FRAMECOUNT / SP-TRG-F-CNT | RW | Frame | 1 to (2) to 16 | | ● | – | – | – | – | ● |
| SPECIAL-TRIGGER-SOURCE / SP-TRG-SRC | RW | Source | 0 / 4 / 7 / 10 / (11) /20 / 101 / 102 / 103 / 104 | | ● | – | – | – | – | ● |
| SPECIAL-TRIGGER-POLARITY / SP-TRG-POL | RW | Polarity | (0) / 1 | | ● | – | – | – | – | ● |
| TRIGGER-MODE / TRG-MODE | RW | Mode | (0) / 1 / 2 | | – | ● | – | ● | – | ● |
| TRIGGER-SOURCE / TRG-SRC | RW | Source | 0 / 4 / 7 / 10 / (11) / 20 / 101 / 102 / 103 / 104 | | – | ● | – | ● | – | ● |
| TRIGGER-INHIBIT / TRG-INH | RW | Mode | (0) / 1 | | – | ● | – | ● | – | ● |
| TRIGGER-POLARITY / TRG-POL | RW | Polarity | (0) / 1 | | – | ● | – | ● | – | ● |
| TRIGGER-DELAY / TRG-DLY | RW | Time | (0) to 4000000 | | – | ● | – | ● | – | ● |
| TRIGGER-SOFTWARE / TRG-SOFT | RW | Status | (0) / 1 | | – | – | – | – | – | – |
| TRIGGER-RANGE / TRG-RANGE | RW | Mode | (0) / 1 | | – | ● | – | ● | – | ● |
| TRIGGER-RANGE-LOWERLIMIT / TRG-RANGE-LOWER | RW | Time | 1 to (10) to 2000000 | | – | ● | – | ● | – | ● |
| TRIGGER-FAST-MODE / TRG-FAST | RW | Mode | 0 / (1) | | – | ● | – | ● | – | ● |
| TRIGGER-BURST-MODE / TRG-BST-MODE | RW | Mode | 0 / (1) | | – | ● | – | ● | – | ● |
| TRIGGER-BURST-FRAMECOUNT / TRG-BST-F-CNT | RW | Frame | 0 to (1) to 65533 | | – | ● | – | ● | – | ● |
| TRIGGER-BURST-STOP / TRG-BST-STOP | WO | Mode | – | | – | – | – | – | – | – |
| EXPOSURE2-TIME / EXP2-TIME | RW | Time | 1 to (65500) to 60000000 | | – | ● | – | ● | – | ● |
| EXPOSURE2-RATIO / EXP2-RAT | RW | Ratio | 1 / (2) / 4 / 8 / 16 | | – | ● | – | ● | – | ● |
| EXPOSURE-MODE / EXP-MODE | RW | Mode | (0) / 1 | | – | ● | – | ● | – | ● |
| EXPOSURE / EXP | RW | Time | 10 to (32750) | | – | ● | ● | ● | – | ● |

*1: The upper limit will be changed depending on the settings.

| | | | | Device | User Set | Special Trigger | User Set | Device Reset | Factory Default |
|---|---|---|---|---|---|---|---|---|---|
| Command | Access | Parameter | XCL-CG510 XCL-CG510C | Save | | Load | | Reset | |
| EXPOSURE-AUTO / AE | RW | Mode | (0) / 1 / 2 | – | ● | – | ● | – | ● |
| EXPOSURE-AUTO-SPEED / AE-SPEED | RW | | 1 to (192) to 256 | – | ● | – | ● | – | ● |
| EXPOSURE-AUTO-UPPERLIMIT / AE-UPPER | RW | Time | 10 to (42000) to 60000000 | – | ● | – | ● | – | ● |
| EXPOSURE-AUTO-LOWERLIMIT / AE-LOWER | RW | Time | (10) to 60000000 | – | ● | – | ● | – | ● |
| GPO-INVERTER / GPO-INV | RW | Pin<br>Mode | 4 / 6 / 9<br>0 / (1) | – | ● | ● | ● | – | ● |
| GPI | RO | Pin | 7 / 10 / 11 | – | – | – | – | – | – |
| | | – | | | | | | | |
| GPO-SOURCE / GPO-SRC | RW | Pin<br>Source | 4 / 6 / 9<br>(0) to 9 | – | ● | ● | ● | – | ● |
| STROBE-TIME / STRB-TIME | RW | Pin<br>Time | 4 / 6 / 9<br>1 to (256) to 4000000 | – | ● | ● | ● | – | ● |
| STROBE-DELAY / STRB-DLY | RW | Pin<br>Time | 4 / 6 / 9<br>(0) to 4000000 | – | ● | ● | ● | – | ● |
| USER-OUTPUT | RW | Register<br>Value | 1 / 2 / 3 / 4<br>(0) / 1 | – | ● | ● | ● | – | ● |
| PULSE-CYCLE | RW | Time | 10 to (1000000) to 2000000 | – | ● | ● | ● | – | ● |
| PULSE-DUTY | RW | Time | 1 to (500000) to 2000000 | – | ● | ● | ● | – | ● |
| TRIGGER-COUNTER / TRG-CNT | RW | Reset | | – | – | – | – | ● | ● |
| FRAME-COUNTER | RW | Frame<br>Reset | | – | – | – | – | ● | ● |
| GAIN | RW | Step | Individual to (0) to Individual | – | ● | ● | ● | – | ● |
| GAIN-FINE | RW | Step | Individual to (0) to Individual | – | ● | ● | ● | – | ● |
| GAIN-AUTO / AGC | RW | Mode | (0) / 1 / 2 | – | ● | – | ● | – | ● |
| GAIN-AUTO-LEVEL / AGC-LEVEL | RW | Level | 0 to (11264) to 16383 | – | ● | – | ● | – | ● |
| GAIN-AUTO-SPEED / AGC-SPEED | RW | Coefficient | 1 to (192) to 256 | – | ● | – | ● | – | ● |
| GAIN-AUTO-UPPERLIMIT / AGC-UPPER | RW | Step | Individual to (18) to Individual | – | ● | – | ● | – | ● |
| GAIN-AUTO-LOWERLIMIT / AGC-LOWER | RW | Step | Individual to (0) to Individual | – | ● | – | ● | – | ● |
| GAIN-AUTO-FRAME-HIGHLIGHT / AGC-FRAME-HIGHLIGHT | RW | Mode | (0) / 1 | – | – | – | – | ● | ● |
| GAIN-AUTO-FRAME / AGC-FRAME | RW | Width<br>Height<br>OffsetX<br>OffsetY | 1 to (50) to 100<br>1 to (50) to 100<br>0 to (25) to 99<br>0 to (25) to 99 | – | ● | – | ● | – | ● |
| GAIN-AUTO-WIDTH / AGC-WIDTH | RW | Width | 1 to (50) to 100 | – | ● | – | ● | – | ● |
| GAIN-AUTO-HEIGHT / AGC-HEIGHT | RW | Height | 1 to (50) to 100 | – | ● | – | ● | – | ● |
| GAIN-AUTO-OFFSETX / AGC-OFFSETX | RW | OffsetX | 0 to (25) to 99 | – | ● | – | ● | – | ● |

| | | | | | Device | User Set | Special Trigger | User Set | Device Reset | Factory Default |
|---|---|---|---|---|---|---|---|---|---|---|
| Command | Access | Parameter | XCL-CG510 | XCL-CG510C | Save | | Load | | Reset | |
| GAIN-AUTO-OFFSETY / AGC-OFFSETY | RW | OffsetY | 0 to (25) to 99 | | – | ● | – | ● | – | ● |
| GAIN-RED-FINE / RGAIN-FINE | RW | Step | – | 256 to *2 to 4095 | – | ● | ● | ● | – | ● |
| GAIN-GREEN-FINE / GGAIN-FINE | RW | Step | – | (256) to 4095 | – | ● | ● | ● | – | ● |
| GAIN-BLUE-FINE / BGAIN-FINE | RW | Step | – | 256 to *2 to 4095 | – | ● | ● | ● | – | ● |
| WHITEBALANCE-AUTO / AWB | RW | Mode | – | (0) / 1 / 2 | – | – | – | – | ● | ● |
| WHITEBALANCE-FRAME-HEIGHLIGHT / AWB-FRAME-HIGHLIGHT | RW | Mode | – | (0) / 1 | – | – | – | – | ● | ● |
| WHITEBALANCE-FRAME / AWB-FRAME | RW | Width<br>Height<br>OffsetX<br>OffsetY | | 1 to (50) to 100<br>1 to (50) to 100<br>0 to (25) to 99<br>0 to (25) to 99 | – | ● | – | ● | – | ● |
| WHITEBALANCE-WIDTH / AWB-WIDTH | RW | Width | | 1 to (50) to 100 | – | ● | – | ● | – | ● |
| WHITEBALANCE-HEIGHT / AWB-HEIGHT | RW | Height | | 1 to (50) to 100 | – | ● | – | ● | – | ● |
| WHITEBALANCE-OFFSETX / AWB-OFFSETX | RW | OffsetX | | 0 to (25) to 99 | – | ● | – | ● | – | ● |
| WHITEBALANCE-OFFSETY / AWB-OFFSETY | RW | OffsetY | | 0 to (25) to 99 | – | ● | – | ● | – | ● |
| BLACKLEVEL / BL | RW | Level | 0 to (960) to 2047 | | – | ● | ● | ● | – | ● |
| LUT-FORMAT | RW | Format | (0) / 1 / 2 / 3 / 4 | | – | ● | ● | ● | – | ● |
| LINEAR-INTERPOLATION | RW | Point<br>InValue<br>OutValue | 1 to 5<br>0 to 4095<br>0 to 4095 | | ● | – | – | – | – | ● |
| LINEAR-INTERPOLATION-BUILD | WO | – | – | | – | – | – | – | – | – |
| LUT | RW | Index<br>Value | 0 to 4095<br>0 to 4095 | | ● | – | – | – | – | ● |
| LUT-SAVE | WO | – | – | | – | – | – | – | – | – |
| BINARIZATION | RW | Threshold | 0 to (2047) to 4095 | | – | ● | ● | ● | – | ● |
| USERSET-LOAD | RW | Index | (0) to 16 | | – | – | – | – | – | – |
| USERSET-SAVE | RO | Index | 1 to 16 | | – | – | – | – | – | – |
| FACTORY-DEFAULT | WO | – | – | | – | – | – | – | – | – |
| USERSET-DEFAULT | RW | Index | (0) to 16 | | – | – | – | – | – | – |
| USERSET-NAME | RW | String | | | – | ● | ● | ● | – | ● |
| USERSET-NAME-DELETE | WO | – | | | – | – | – | – | – | – |
| USERSET-MEMORY | RW | Index<br>Value | 0 to 15<br>0 to 0xFFFFFFFF | | – | ● | ● | ● | – | ● |
| SPATIAL-FILTER / SP-FL | RW | Mode | (0) / 1 | | – | ● | ● | ● | – | ● |

*2: The factory settings vary by camera.

| | | | | | Device | User Set | Special Trigger | User Set | Device Reset | Factory Default |
|---|---|---|---|---|---|---|---|---|---|---|
| **Command** | **Access** | **Parameter** | **XCL-CG510** | **XCL-CG510C** | **Save** | | **Load** | | **Reset** | |
| SPATIAL-FILTER-VALUE / SP-FL-VAL | RW | Element<br><br>Coefficient | 00 / 01 / 02 / 10 / 11 / 12 / 20 / 21 / 22 / -8191 to 8191 | | – | ● | ● | ● | – | ● |
| SHADING-CORRECTION | RW | Mode | (0) / 1 | | – | ● | ● | ● | – | ● |
| SHADING-DETECTION | RW | Mode | (0) / 1 / 2 | | – | – | – | – | – | – |
| SHADING-PATTERN-LOAD | RW | Index | (0) to 8 | | – | ● | ● | ● | – | ● |
| SHADING-PATTERN-SAVE | RW | Index | (0) to 8 | | – | – | – | – | – | – |
| SHADING-DETECT-COLOR | RW | Color | – | R / (G) / B / Y | – | – | – | – | – | ● |
| DEFECT-CORRECTION | RW | Mode | 0 / (1) | | – | ● | ● | ● | – | ● |
| DEFECT-DETECTION | RW | Mode | (0) / 1 / 2 | | – | – | – | – | – | – |
| DEFECT-PATTERN-LOAD | RW | Pattern | 0 / 1 / 2 | | – | ● | ● | ● | – | ● |
| DEFECT-PATTERN-SAVE | RW | – | – | | – | – | – | – | – | – |
| DEFECT-THRESHOLD | RW | Threshold | 0 to (8192) to 16383 | | ● | – | – | – | ● | ● |
| DEFECT-DETECTION-RESULT | RO | | | | – | – | – | – | – | – |
| FREE-MEMORY | RW | Index<br>Value | 0 to 8191<br>0 to 0xFFFFFFFF | | ● | – | – | – | – | ● |
| FREE-MEMORY-READ | RO | Index<br>Size | 0 to 8191<br>1 to 8192 | | – | – | – | – | – | – |
| FREE-MEMORY-SAVE | WO | – | | | – | – | – | – | – | – |
| FREE-MEMORY-PROTECT | WO | Mode<br>ID | (0) / 1<br>(0) to 0xFFFFFFFF | | ● | – | – | – | – | – |
| AREA-GAIN-ENABLE | R/W | Enable | (0) / 1 | | – | ● | ● | ● | ● | ● |
| AREA-GAIN | R/W | Index<br>Enable<br>Width<br>Height<br>OffsetX<br>OffsetY<br>Gain | 0 to 15<br>(0) / 1<br>16 to 2464<br>4 to 2056<br>0 to 2448<br>0 to 2052<br>0 to 8191 | | – | ● | ● | ● | ● | ● |
| HELP / ? | RO | – | | | – | – | – | – | – | – |
| | | Command | | | | | | | | |
| VISIBILITY | RW | Mode | | | – | – | – | – | ● | ● |
| ECHO | RW | Mode | (0) / 1 | | – | – | – | – | ● | ● |
| GET-LAST-ERROR | RO | – | – | | – | – | – | – | – | – |

# Specifications

Pickup device CMOS image sensors with a global shutter function
2/3 type
Standard video output size (horizontal/vertical)
2,448 × 2,048
Frame rate 28 fps (2tap)
35 fps (3tap)
Lens mount C-mount
Flange focal length
17.526 mm
Video output signal
XCL-CG510:
Mono 8 bits (default setting)/10 bits/12 bits
XCL-CG510C:
Raw 8 bits (default setting)/10 bits/12 bits, RGB
Reference video output level
235 steps (8 bits)/3,760 steps (12 bits)
Reference pedestal level
15 steps (8 bits)/240 steps (12 bits)
Minimum illumination
XCL-CG510:
0.5 lx (gain control at +18 dB, F1.4, shutter speed at 1/30 sec)
XCL-CG510C:
12 lx (gain control at +18 dB, F1.4, shutter speed at 1/30 sec)
Sensitivity XCL-CG510:
F5.6 (gain control at 0 dB, 400 lx, shutter speed at 1/30 sec)
XCL-CG510C:
F5.6 (gain control at 0 dB, 2,000 lx, shutter speed at 1/30 sec)
Gain 0 dB to 18 dB, Auto gain
Shutter speed 1/100,000 sec to 60 sec, automatic shutter
Gamma γ=1 (Changeable by LUT)
Binning XCL-CG510:
2×1, 1×2, 2×2
XCL-CG510C:
Not included
External trigger pulse condition
pulse width: Between 10 µs and 2 s
amplitude: DC 2 V to 24 V (DC power input connector)
External power DC 12 V (10.5 V to 15 V: DC power input connector/10 V to 13 V: DIGITAL Interface connector)
Power consumption (DC 12 V input)
2.7 W
Usable cable length (DIGITAL Interface cable)
10 m (at BASE-CLOCK 45 MHz),
7 m (at BASE-CLOCK 75 MHz)
(Cable length may vary depending on the used camera link cable or image input board for the camera.)

Performance guarantee 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)
MTBF About 9.3 years
Vibration resistance
10 G (20 Hz to 200 Hz)
Shock resistance
70 G
External dimension (w/h/d)
29 × 29 × 30 mm ($1\ ^3/_{16} \times 1\ ^3/_{16} \times 1\ ^3/_{16}$ inches) (excluding protrusions)
Mass About 53 g (1.9 oz)
Accessories Lens mount cap (1)
Operating Instructions (1)

Design and specifications are subject to change without notice.

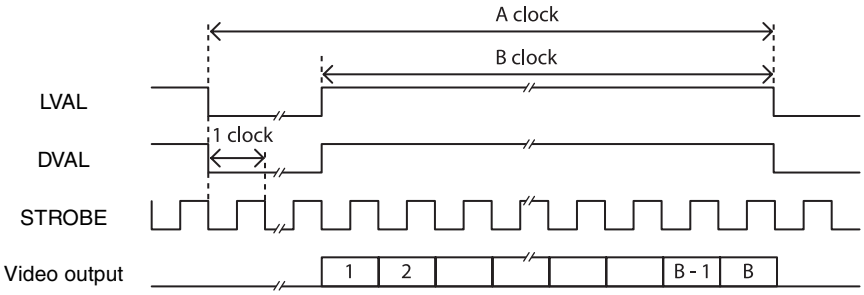
**IMPORTANT**

The nameplate is located on the bottom.

# Timing Chart

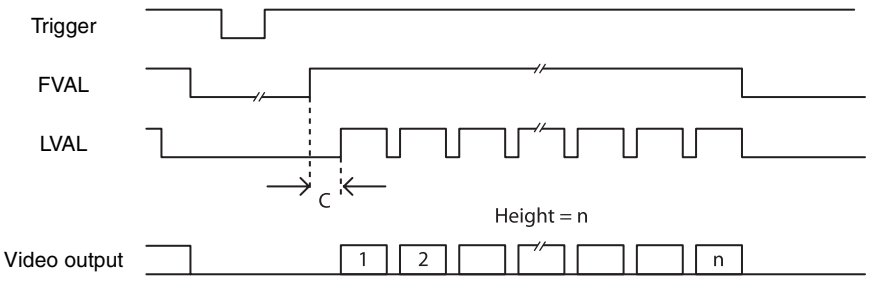
## Horizontal timing

Constant regardless of the trigger mode, binning, and partial scanning. DVAL and LVAL are the same signal.




| BASE-CLOCK | CAMERALINK-TAP | A | B |
|---|---|---|---|
| 45 | 1 | 2480 to 2484 | WIDTH / CAMERALINK-TAP |
| | 2 | 1248 to 1252 | |
| | 3 | 840 to 844 | |
| 75 | 1 | 2480 to 2484 | |
| | 2 | 1248 to 1252 | |
| | 3 | 840 to 844 | |

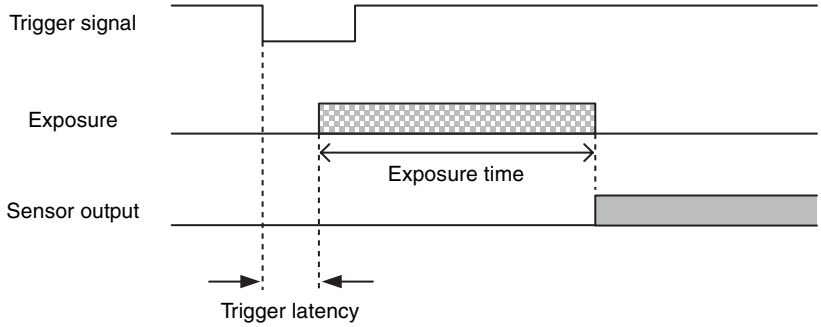
## Vertical timing




| CAMERALINK-TAP | C |
|---|---|
| 1 | 49 |
| 2 | 49 |
| 3 | 49 |

## Trigger latency/Exporure time

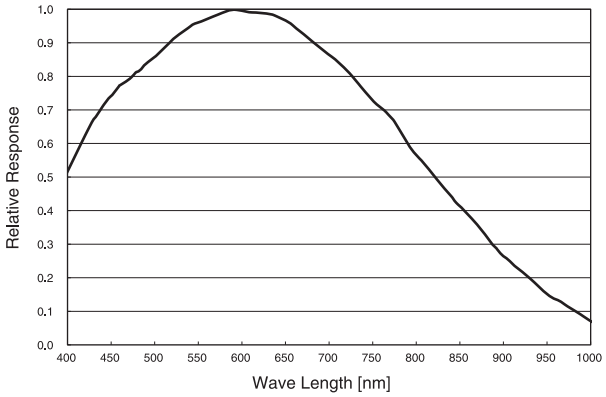
The time value from the trigger acceptance to exposure start (trigger latency) is listed below.



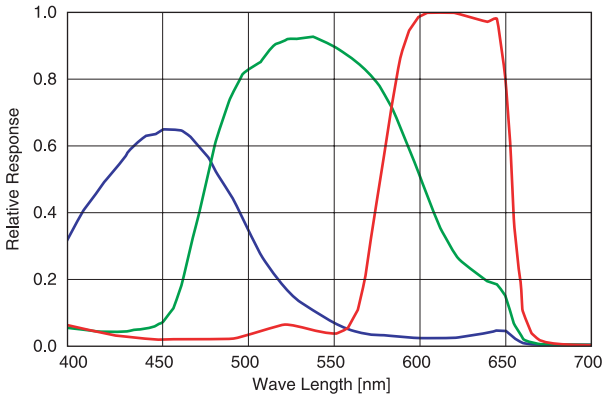

| Trigger latency | Exposure time |
|---|---|
| approx. 0.2 µs | ExposureTime ± (approx. 0 µs to approx. 13 µs) |

# Spectral Sensitivity Characteristics (Typical Values)

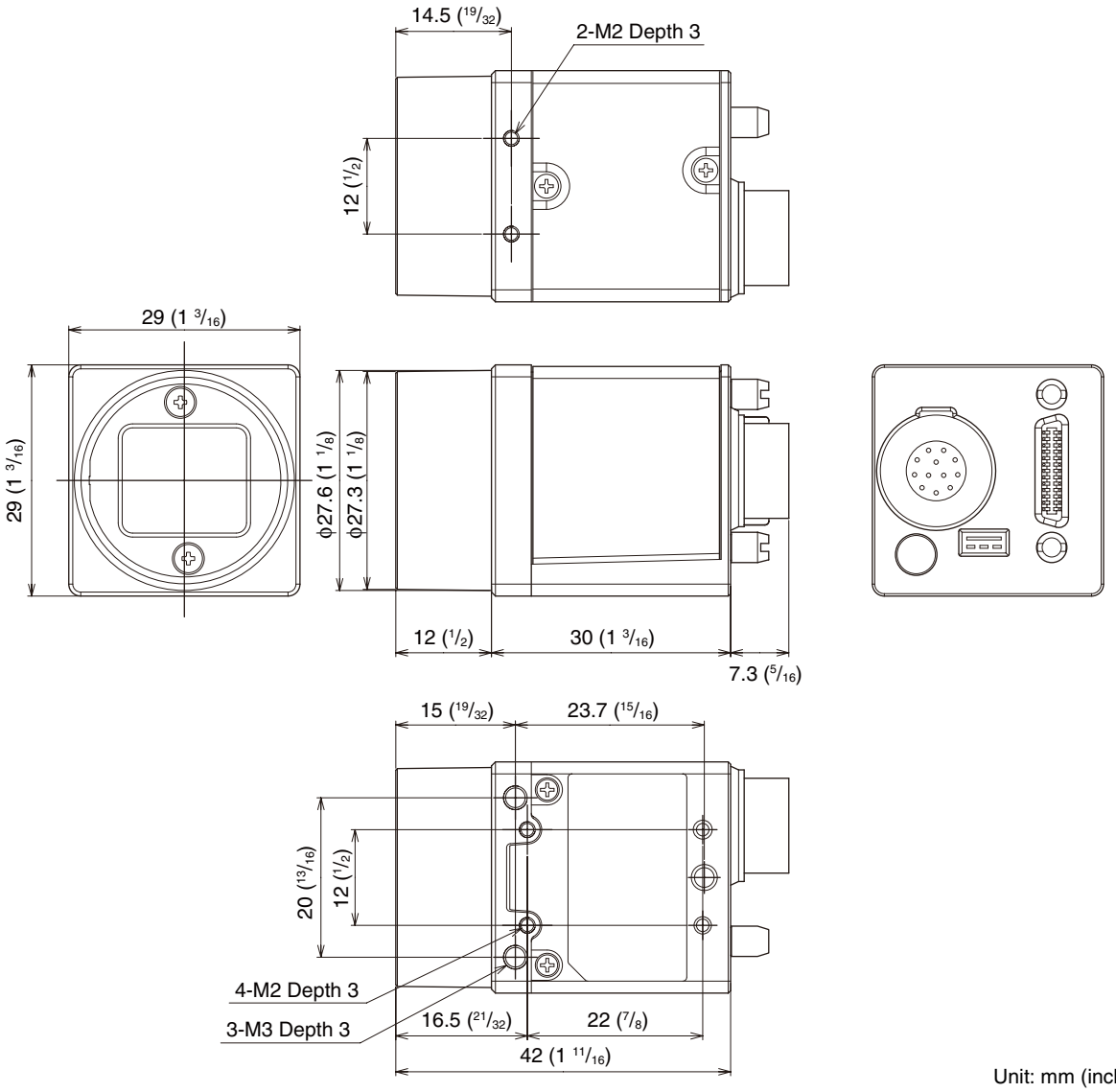
## XCL-CG510




## XCL-CG510C



# Dimensions




Unit: mm (inches)

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