# CCD Video Camera Instruction Manual

## GigE Vision compliant
## 1.45 Megapixel Progressive Scan Monochrome Camera

# FC1650GE

- We greatly appreciate your confidence choosing our TAKEX CCD Video Camera.
- Please read this manual and the attached guarantee certificate carefully and manage the camera properly. Keep this manual at hand and reread it whenever you are uncertain about the operation.

Table of Contents




**TAKENAKA SYSTEM CO., LTD**
Document No.: M11517
FX1650GE Instruction Manual (1st version)

[History of revision]

| | Version | Content of change | Description | Date | Document No. | Remark |
|---|---|---|---|---|---|---|
| | 1st version | - | Initial version | 2011-05-17 | M11517 | Ver.1.0 |

Description of special remarks used in this manual

(Note)····· Particulars which require the user's attention are explained.

(!)····· Particulars which require the user's close attention in terms of comparison with the conventional products are explained.

[Terminology]····· Terms specifically defined for the purpose of describing the operation of this camera are explained.

[Explanation]····· Particulars for which details may be needed for user's understanding of the operation of this camera are explained.

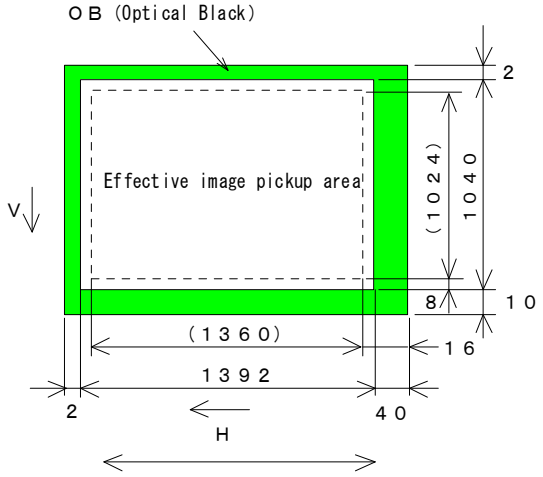
## 1. Features

- Progressive scan monochrome camera incorporated with 1.45 megapixel, 2/3”-size CCD image sensor
- A full frame shutter image can be obtained at a rate of 31 frames per second.
- Gigabit Ethernet is adopted as the output interface of image signal.
- Image signal can be output at resolution of 12/10/8-bits.
- The internally set values of the camera can be externally controlled with serial communication via Ethernet.
- Auto iris lenses can be used, as it is provided with a false image signal output to drive an auto iris lens.
- The character information of the current setting status of the camera can be superimposed over the captured image on the screen. (On Screen Display function)
- The monitoring function for measuring the internal temperature of the camera.
- The asynchronous shutter is applicable both in the preset shutter mode and the pulse width control mode.
- The camera is designed so that the strobe signal can be output even in the continuous shutter mode, and this contributes to the power saving for LED lighting and others as well as the reduction of smear.

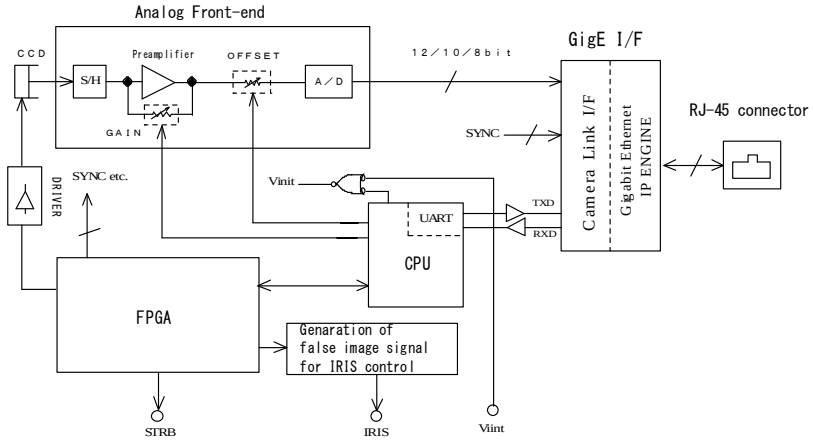
(Note) “Ethernet” is a registered trademark of XEROX

## 2. Outline

| | | FC1650GE |
|---|---|---|
| Image sensor | | Progressive scanning, interline transfer CCD |
| | | 2/3inch |
| Effective pixels | | 1.45megapixels 1392 (H) × 1040 (V) |
| Read out scanning | Horizontal | 33.5 kHz |
| | Vertical | 31.4 Hz |
| | Clock | 60.00 MHz |
| Electronic shutter | | 1/23,000～1/31 second～Long exposure<br>(Continuous shutter and asynchronous shutter) |
| Video output signal | | Digital 12/10/8 bit<br>Gigabit Ethernet interface (GigE Vision compliant) |
| Scanning mode | | Normal scan for all pixels (31 fps)<br>Partial scan for central part (62 fps) |




CCD architecture




Block diagram

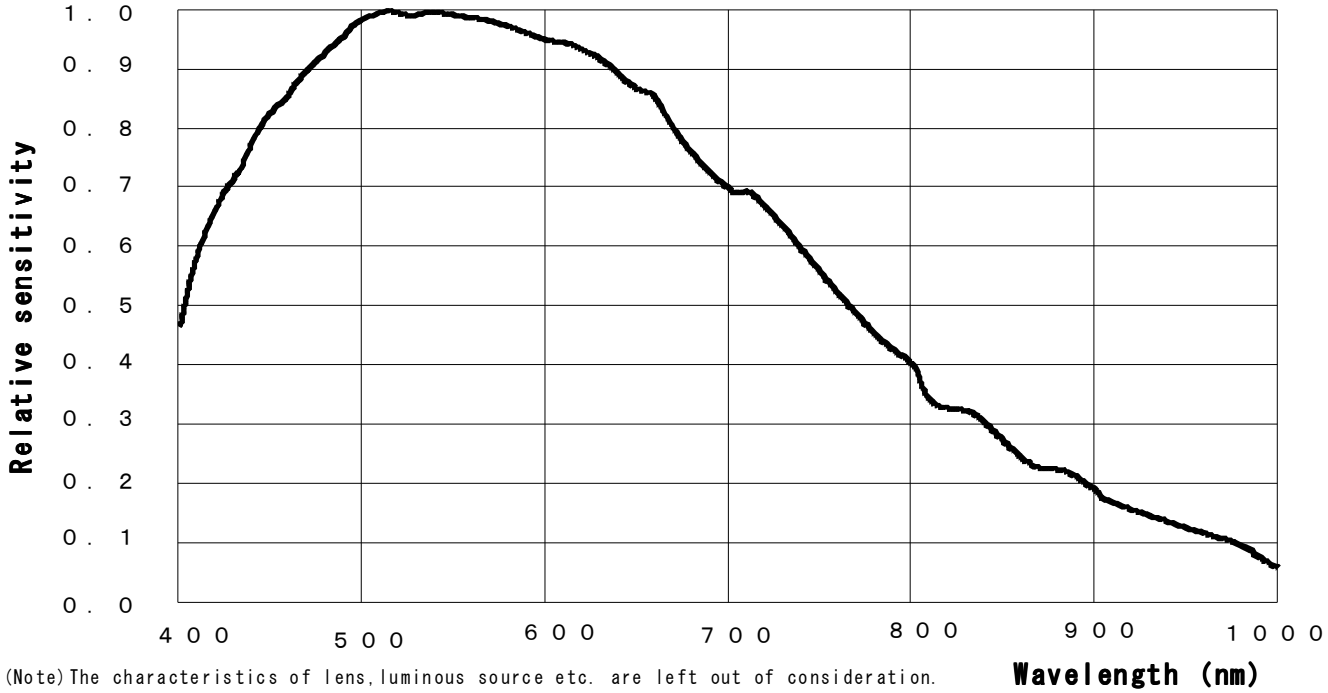
[Explanation] Number of pixels

In this equipment,
Number of Total pixels: 1434(H) × 1050(V) approx.1.50 megapixels
Number of Effective pixels: 1392(H) × 1040(V) approx.1.45 megapixels
Number of Certified pixels: 1360(H) × 1024(V) approx.1.40 megapixels

Where
Number of Total pixels: Number of pixels of whole area consisting of pixel elements on image sensor.
Number of Effective pixels: Number of pixels which is possible to be output as image signal.
Number of Certified pixels: Number of pixels of which output characteristics are assured.
respectively.

It is recommended to use the image signal output within the area of certified pixels in the case of application where image quality of peripheral part is emphasized.

(Typical value)




(Note)The characteristics of lens,luminous source etc. are left out of consideration.

Typical sensitivity characteristic

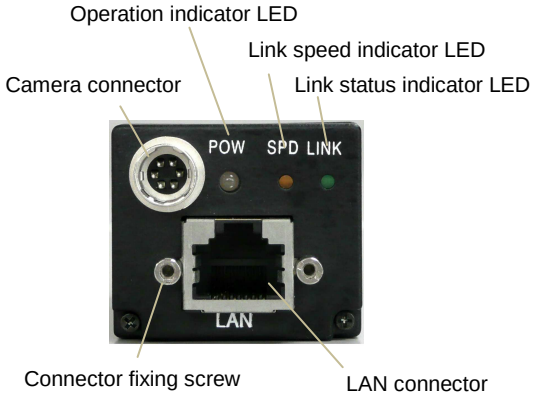
## 3. Description of Each Component

### (3-1) Description of rear panel of camera

The following parts are laid on the rear panel as shown on the right diagram..

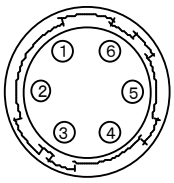
- Camera connector
- LAN connector
- Connector fixing screw
- Operation indicator LED
- Link speed indicator LED
- Link status indicator LED

(!) Rotary switch and toggle switch which are equipped on the conventional FC series camera are not equipped.
The camera operation setting (parameter setup) is performed using serial communication function of application software via LAN connection.




### (3-2) Camera connector (HRS HR10A-7R-6PB)

The pin arrangement of the camera connector (6 pins) and the signals assigned to those pins are shown in the following table:




(Pin arrangement viewed from the outside of the camera)

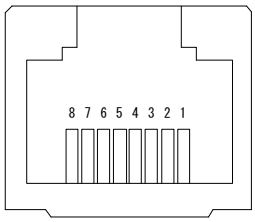
| Pin No. | Signal name | Description | I/O |
|---|---|---|---|
| 1 | GND (0V) | Power ground | |
| 2 | IRIS *1 | Image signal for Auto iris lens | Out |
| 3 | GND | Signal ground | |
| 4 | Vint | Input for external trigger signal | In |
| 5 | STRB *2 | Strobe timing signal | Out |
| 6 | +12VDC | DC power Input | (In) |

*1 ・・・"IRIS" is the false image signal output exclusively used for controlling the image signal input type-Auto iris lens
It is not possible to take out the normal image signal from this pin terminal.

*2 ・・・ Strobe signal(STRB) and Busy signal(BUSY) can be output from this terminal. Default setting for those are OFF and H level signal is normally output. When it is required to output any of those signals, it is necessary to set the configuration register via serial communication or to change setting of Digital IO-LineSource d of GenICam API to any of (Strobe,Busy).

### (3-3) LAN connector (Standard type RJ-45 connector)

This is the LAN connector (RJ-45 type) conforming to Gigabit Ethernet interface (1000BASE-T/IEEE802.3ab).
It is connected with the LAN connector of PC using standard LAN cable conforming to Gigabit Ethernet.




Pin arrangement of RJ-45 connector

[Pin arrangement of LAN connector (RJ-45)]

| Pin No. | Signal name | Description | I/O |
|---|---|---|---|
| 1 | TP0+ | Twisted pair 0 (+) | In/Out |
| 2 | TP0- | Twisted pair 0 (-) | In/Out |
| 3 | TP1+ | Twisted pair 1 (+) | In/Out |
| 4 | TP2+ | Twisted pair 2 (+) | In/Out |
| 5 | TP2- | Twisted pair 2 (-) | In/Out |
| 6 | TP1- | Twisted pair 1 (-) | In/Out |
| 7 | TP3+ | Twisted pair 3 (+) | In/Out |
| 8 | TP3- | Twisted pair 3 (-) | In/Out |

When using this equipment on a place subject to constant vibration or impact, it is recommended to employ a screw lock type LAN cable.
Firmly screw a locking screw into a connector fixing screw hole when using a screw lock type cable.
Insert the LAN connector with the retaining latch facing upward until it clicks both for Screw lock type and Universal type..


## (3-4) Display LED

Three indicator LEDs are laid on the rear panel

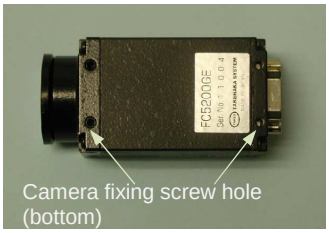
・Operation indicator LED (POW: Three colors: green/red/orange)
It lights up (or brinks ) to indicate that the camera is powered.
When the camera is set in the asynchronous shutter mode, It lights up in red for one shot in response to the input of the external trigger signal.

・Link speed indicator LED (SPD: orange)
It lights up in orange to indicate that the camera is connected to LAN port (LAN card) or HUB of Gigabit Ethernet Interface (1000BASE-T).
It turns off when the camera is connected to LAN port (LANBASE-T, 10BASE-T) of which communication speed is lower than 1000BASE-T or when the camera is connected to nothing.

・Link status indicator LED (LINK: green)
It lights up when the camera is connected to the other LAN port via Ethernet and the data-access is running as well.

| Name | Color | OFF | ON | Blinking |
|---|---|---|---|---|
| SPD | Orange | Disconnected from LAN<br>or Connecting at 10Mbps/100Mbps | Connecting at 1000Mbps | - |
| LINK | Green | Disconnected from LAN | Connected to LAN | Data accessing |

## (3-5) How to fix the Camera




The camera is fixed using four screw holes on the bottom or each two screw holes on the top and side.
Use an available tripod attachment (AT500) to fix the camera with a screw for a tripod (1/4-20UNC).

(!) This equipment is not shipped with a tripod attachment .

(Note) The tripod attachment (AT500) can be attached only on the bottom surface.
(Note) Pay attention to thread length of the fixing screw.(See 15. External dimensions)
There is a possibility that excessively long screw may cause damage to internal structure.

## (3-6) Connection when using a power cable for pin number conversion

The pin arrangement of the power connector when using 6pin -12 pin conversion cable (6P12G-XX) is shown in the following table.
[Pin arrangement of the power cable for pin number conversion cable (6P12G-XX)]

| 6 pin (Camera side) – pin number | 12 pin (Power supply side) – pin number | Signal name | Contents |
|---|---|---|---|
| 1 | 1 | GND (0V) | Power ground |
| 2 | - | NC | No connection |
| 3 | 5,12 | GND | Signal ground |
| 4 | 6 | Vint | Input for external trigger |
| 5 | 11 | STRB | Strobe timing signal |
| 6 | 2 | +12VDC | DC power Input |
| - | 3,4,7,8,9,10 | NC | No connection |

* It is possible to directly connect to TAKENAKA's camera power unit (PU100) by using this cable.
→See (4-1) Connection method
(Note) The optional cable is separately needed when auto iris lens is connected.

## 4. How to Operate

### (4-1) Connection method

- Connection

Refer to the connection example between the camera and peripheral devices (Fig. 4-1).

(1) Remove the cover of the lens attachment section and attach a lens (option).
(2) Connect the camera head to a power supply unit (option) with a camera cable (option).
The maximum allowable length for a TAKENAKA's standard camera cable (6P12G-series) is 20 m.
(3) Connect the LAN connector on the rear of the camera to the LAN connector of PC through LAN cable(Cat-5e or greater). The maximum allowable length for a standard LAN cable is 100m.
Also, the maximum allowable length for a hi-flex LAN cable is 30m.
(4) Turn on the power switch of the camera after confirming the connecting condition.
In 1 or 2 seconds after the power is turned on, the operation indicator LED on the rear panel of the camera changes from orange to green to show that the camera is in operation.
(5) Set the camera operation modes in accordance with the setting instructions for the operation modes and the shutter speed that are described in another section.

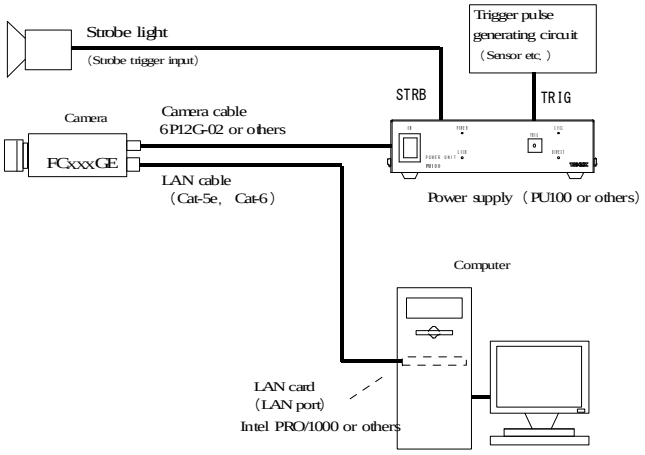



Fig. 4-1. Connection example between camera and peripheral devices

(Note) The maximum allowable lengths of the camera cable and the LAN cable aforementioned are not for the purpose of guaranteeing the operation of the camera. Proper image signals may not be obtained even when the cables are within the allowable ranges, depending on the installation conditions of the camera, cables in use and others. Especially for a camera cable (Power cable), the voltage of the terminal end on camera side is required to be within a voltage range of the specification (12V±10%) with the camera being connected.

(Note) As the LAN card, use a separately recommended product or a LAN port equipped with recommended Ethernet controller(PHY).

[Important]
(Note) Make sure to turn off the power switch of the camera before connecting or disconnecting the camera cable.
If the cable is connected or disconnected while the power is supplied, troubles may be caused.
(Note) Make sure to turn off the camera and connected devices in advance when the camera is connected.
(Note) When a power supply unit other than Takenaka's camera power supply units that are separately sold is used, make sure that it complies with the following rated specifications:
Power supply voltage: DC12V±10%
Current capacity: 800mA or over (recommended value)
Take into consideration the fact that transient current of about 1A flows when power is applied.
Ripple voltage: 50mVp-p or less (recommended value)
Connector: 6 pin connector 1 pin (GND), 6 pin (+12VDC)
(Note) Some power supply units other than TAKENAKA's products have different layout of power connection pins. Make sure to check the compatibility of the power supply unit and the camera connection pins in advance.
Carefully note that any failure associated with power application to out-of-specification pins and others is subject to charged repair.

## (4-2) Setting of various asynchronous shutter modes

- Preset shutter mode and pulse width control mode
  Set the parameters and others in accordance with the following table.
  Each parameter is set by serial communication commands via Ethernet in this camera.
  Four kinds of modes are selectable as follows.

| | | |
|---|---|---|
| With H-reset | Preset shutter | ⋯PWC=DISABLED,HREN=DISABLED |
| | Pulse width control | ⋯PWC=ENABLED,HREN=DISABLED (shutter SW=9) |
| Without H-reset | Preset shutter | ⋯PWC=DISABLED,HREN=ENABLED |
| | Pulse width control | ⋯PWC=ENABLED,HREN=ENABLED (shutter SW=9) |

(Note) When shutter switch is 0, “Continuous image output” (No shutter) is applied for the all.
(Note) For setting methods for the respective parameters of “PWC” and “HREN” → See “(6-3) How to set operation mode”.
(Note) This camera is not equipped with the substantial shutter setting switch on the rear panel. “Shutter switch” described in this manual means setting values of hypothetical shutter switch set on the memory inside the camera via serial communication command.

- Asynchronous shutter in H-reset mode
  It is possible to select whether or not to reset (initialize) H timing (horizontal synchronization timing ) made by the external trigger signal (Vint). (Default setting is without H-reset)
  It is possible to control the timing of the exposure time with a pixel clock accuracy by setting “H-reset”, when it needs to expose at fully simultaneous time among plural cameras or to accurately control the exposure time of the camera in pulse width control mode.
  → Refer to “10.Timing chart” for more information about detailed timing.

## (4-3) Functional limitation by shutter mode

Usable functions vary by the shutter mode that is currently selected.
The functions marked with ○ in the following table are usable and those marked with × are not usable.

| Current shutter mode | AGC function | AEC function | Long exposure | Auto iris |
|---|---|---|---|---|
| No shutter | O | - | O | O |
| Continuous shutter | O | O | O | O |
| Asynchronous shutter | X | X | X | X |

(Note) When “AEC” (Auto Exposure Control) is turned ON in no shutter mode , the shutter mode is automatically changed to continuous shutter mode and shutter time is automatically controlled in response to luminance.

## (4-4) Input of Vinit signal (asynchronous trigger signal)

- How to input Vinit signal
  If the camera is used in the asynchronous shutter mode, the Vinit signal (asynchronous trigger signal) must be input from the user unit.
  The Vinit signal is input from Pin (4) of the “CAMERA” connector (6 pin connector) on the rear of the camera.

(Note) Though the asynchronous trigger signal can be given by serial communication command via GigE interface, it is not suitable for real-time image capturing as it gets delayed following packet forwarding.
(Note) When the camera is in OSD menu displaying status (when the operation indicator LED blinks in green), periodic trigger signal continues to be supplied from internal CPU so that OSD display is updated on regular basis.In this state, the external trigger signal (Vint) can not be accepted. Turn the OSD menu to hidden status to make Vint signal input effective.

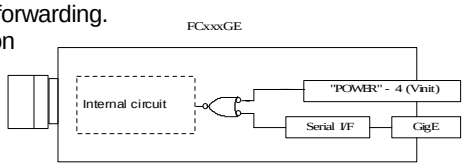


Fig. 4-2 Internal connection of Vinit signals

- LED Vinit signal monitor indicator
  When this camera is set in the asynchronous shutter mode, the LED indicator on the rear panel of the camera lights up in red for one shot in response to the input of the external trigger signal (Vinit signal).
  This allows the user to confirm the state of signal input.
  The red LED lights up for a certain period of time (for about 100 ms) each time for a trailing edge of the trigger input. If a following trigger signal is input within this period, the lighting time of the LED will be retriggered and extended.
  Since the lighting of the LED responses only to the trailing edge of the trigger input, it lights up only once for 100 ms even if the trigger input pulse duration is longer than the one shot time of period.

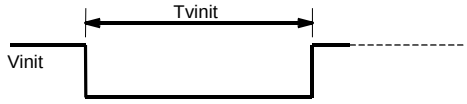
Red LED lights up in red in response to trigger signal input (Vinit).

(Note) The external trigger signal (Vint) is not accepted when the camera is OSD menu displaying status (when the operation indicator LED blinks in green).
(Note) Check again the connection status of Vint signal, input status of trigger signal and the operation setting of the camera for any mistakes, if this monitor LED is not properly displayed.

● Recommended timing of asynchronous shutter trigger signal (Vinit signal) for preset shutter/pulse width control

For the case of preset shutter mode, the negative logic pulse is applied within the width range from 1 H (1 horizontal synchronous interval) to 1ms as described below.For this case, the exposure operation starts in synchronization with the trailing edge of the internal HD pulse (the leading edge of pixel clock in the case of H-reset mode) after and closest to the trailing edge timing of the applied pulse.

For the case of the pulse width control exposure mode, numeric value of the L level interval of the input Vinit pulse (shown as Tvinit in the figure) is retrieved in synchronization with the trailing edge of the internal HD pulse (the leading edge of pixel clock in the case of H-reset mode), and the integer multiple number of H (1 horizontal synchronous interval) that is closest to the retrieved Vinit pulse duration is transmitted as nH (the integer multiple number of pixel clock in the case of H-reset mode) to the inside of the camera. Then the shutter speed is determined in response to the time nH.



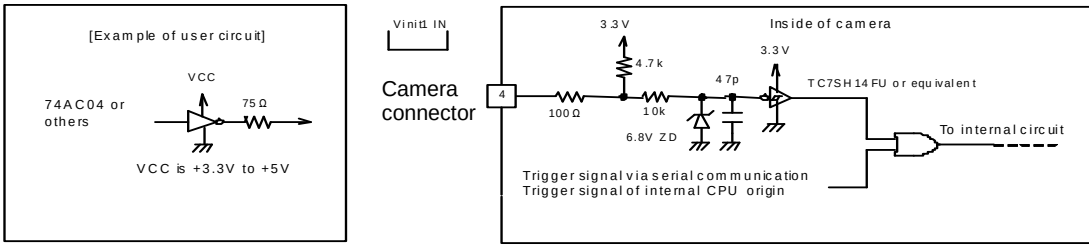

[For the case of preset shutter mode]
1H ≤ Tvinit ≤ 1ms
(The exposure time is independent of the Vinit width.)
[For the case of pulse width control mode]
(Where PWC=ENABLED, shutter switch = 9)
nH ≤ Tvinit <(n+1)H (n is 1 or larger integer.)
(This is the pulse width where shutter exposure time =nH)

Recommended Vinit signal timing waveform

(Note) In the pulse width control, the shutter exposure time is almost equal to the integral multiple number of the horizontal synchronous time (H) that is closest to the Vinit pulse duration. More specifically, however, the shutter exposure time is indefinite for the time period corresponding to 1H width in the case of normal external trigger input (or the case where the Vinit signal is not in synchronization with the horizontal synchronous timing of the camera). It is improved by being employed in “with H-reset” mode
→ Refer to the timing chart described in another section for the details.

(Note) When the shutter exposure time is too long in the pulse width control mode, the S/N ratio of the image will be degraded due to the reduction of dynamic range of CCD, accumulation of thermal noise components of CCD image sensor in proportion to the shutter speed and other factors. Therefore, if a long exposure time is employed, it is recommended to conduct experiments using realistic exposure times in actual conditions to check for the appropriateness.

● Example of drive circuit for Vinit input circuit




* The Vinit signal should not include unnecessary noise components such as chattering.

[Input voltage range]

| | |
|---|---|
| H level | 2.5 to 5.5 V |
| L level | -0.5 to 0.5 V |

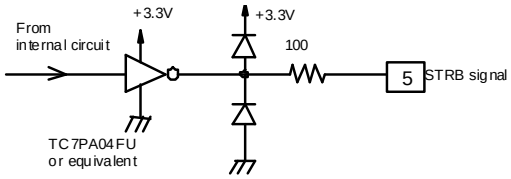
* The voltage of the terminal end on camera side is required to be within the above voltage range with the camera being connected.

## (4-5) Strobe signal (STRB)

It is able to adjust the light emitting timing of external strobe light to the exposure time of the camera.
This signal can be output in the continuous shutter mode as well as in the asynchronous shutter mode.

● Strobe signal output circuit

The signal output terminal is used both for strobe signal (STRB) and busy (BUSY) signal.
Select any of OFF (Default: H level fixed), STRB and BUSY in configuration setting.
→ Refer to (7-5) Internal flag register and configuration register
The internal output circuit is shown in the right figure.




[output voltage range]

| | | | |
|---|---|---|---|
| H level | 3.0V (at 0mA) | to | 2.0 V (at 10mA) |
| L level | 0.2V (at 0mA) | to | 0.5 V (at 10mA) |

(!) The factory default is set to OFF for this camera.
It is required to set STRBC0 flag and STRBC1 flag when outputting STRB or BUSY signal,

● Output signal switching at strobe signal terminal

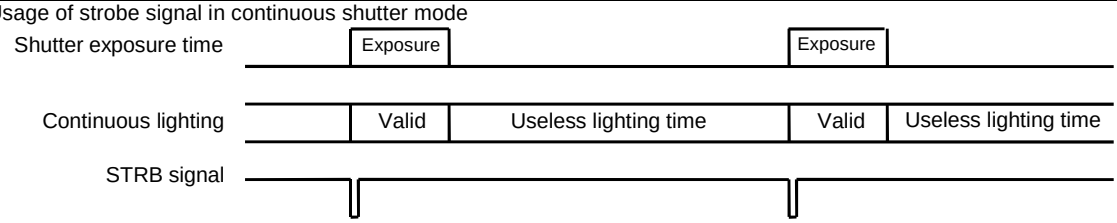
The signal from this terminal is set to OFF as a factory default value.
This can be changed to STRB (Strobe timing signal) or BUSY state by way of rewriting the configuration register(CR) with serial communication commands.
(CR5) and (CR6) correspond to STRBC0 and STRBC1, respectively.

| (STRBC1,STRBC0) | Signal name | Remarks |
|---|---|---|
| (0,0) | OFF | Always H level(Default) |
| (0,1) | STRB | Strobe timing |
| (1,0) | BUSY | Asynchronous shutter busy |

- Strobe signal in continuous shutter mode

This equipment is capable of outputting the strobe signal even in the continuous shutter mode as well as in the asynchronous shutter mode when the setting is changed to output the strobe timing signal(STRB).

[Explanation] Usage of strobe signal in continuous shutter mode




In the continuous shutter mode, only the incoming light for the time matching the exposure time of the camera is valid.
Accordingly, when a lighting unit is used in the continuous lighting mode, the lighting during the time other than this exposure time period would be wasted.
Since this equipment is capable of outputting strobe signal (STRB) even in the continuous shutter mode, this output is used as a trigger signal to control a LED light or other lighting units that can be turned on and off at high frequencies, which helps eliminating the lighting during the useless lighting time.
The following benefits are derived from this type of lighting control:

- The consumption of the power to a light can be saved by way of lighting only during the valid time for exposure.
- The occurrence of smear is reduced because no light enters any time other than the exposure time periods.

(Note) When the strobe signal is used in the continuous shutter mode to make ON/OFF control on a lighting source unit, the following must be taken into consideration:
Wherever possible, use a strobe lighting unit or others that are equipped with a power source separated from that of the camera (electrically isolated power source) and a trigger input terminal (photo coupler input, etc.). If a lighting unit that shares a power source or a ground circuit with the camera is turned on or off by the strobe signal, the image output from the camera may have noise due to the influence of the fluctuation of the power supply voltage or change in the electric potential that occurs at the ON/OFF timing.
Even when the insulation aforementioned is applied, the electromagnetic induction may lead to the occurrence of noise on the image signal if the electric current of the lighting unit to be control is large. In this case, a measure must be introduced to reduce electromagnetic induction noise arising from the lighting unit.

## (4-6) Auto iris signal (IRIS)

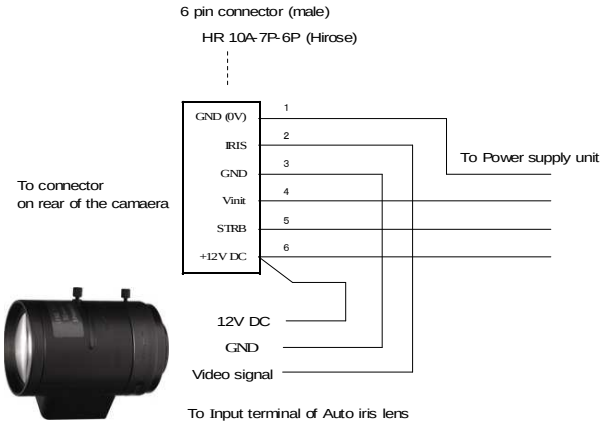
- Connection method for Auto iris signal

This equipment has the function to output the signal for controlling the auto iris lens.
It can be used with the image signal input type-Auto iris lens being connected.
The specifications of the suitable auto iris lens are as follows.

| | |
|---|---|
| Video signal | 1.0Vp-p / High impedance input |
| Power input | DC 12V / 60mA or less |

(Note) "IRIS" is the false image signal output exclusively used for controlling the image signal input type-Auto iris lens. It is not possible to take out the normal image signal from this pin terminal.

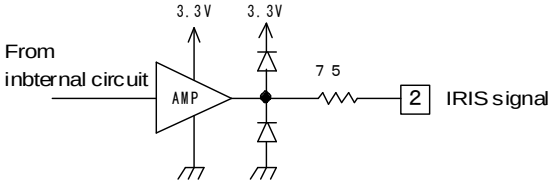
(Note) Combined use of the Auto iris lens and AGC/AEC function of this equipment is not permissible.
Turn the AGC/AEC setting OFF when connecting Auto iris lens.




- Output circuit for Auto iris signal (IRIS)

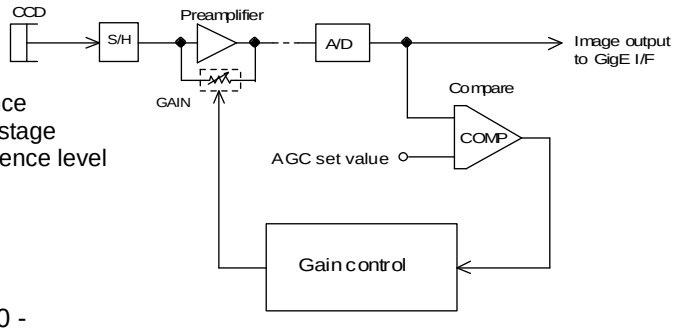
This signal is effective as the Auto iris controlling signal only in the case of no shutter mode or continuous shutter mode

| | |
|---|---|
| Signal output level | 0 to 0.7 V (DC) |
| Output impedance | 75Ω |
| Synchronizing signal | None |




## (4-7) Auto gain control function (AGC)

When AGC (Auto Gain Control) function is set to ON, the average value of the output signal is compared to the set reference level (AGC set value), then the gain value of preamplifier on the stage prior to A/D converter is automatically controlled so that the reference level and the average output value get equal .
The operating range of AGC is about 20dB.




**Block diagram of AGC control circuit**

Five functions below are limited to use in combination with AGC function.
Note that the combined use of them does not function well.

| | AEC function | Asynchronous shutter | Partial scanning | Long exposure | Auto iris lens |
|---|---|---|---|---|---|
| AGC function | × | × | × | × | × |

[Setup procedure]

● Set FR(15) and FR(14) as follows rewriting FR (Flag register) with serial communication software.

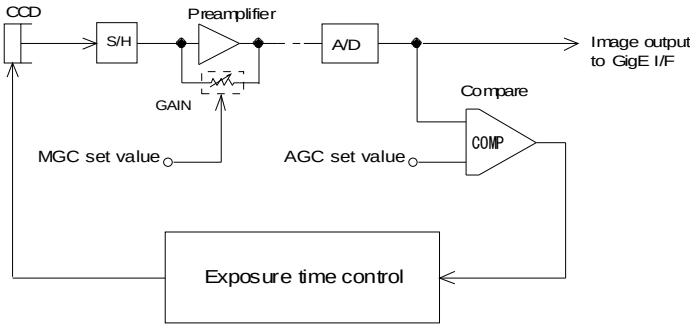
| | AGCE=FR(15) | AECE=FR(14) |
|---|---|---|
| AGC function | 1 | 0 |

(Note) “AECE” (Auto Exposure Control Enable) needs to be set to “0”

● Adjust the AGC set value (Reference level) to get necessary luminance level.
(Note) S/N ratio of output signal degrades by using AGC function, in case that the amount of light is insufficient.

## (4-8) Auto exposure control (AEC) function

Normal lens ( lens without auto iris function) can have an equal feature with an auto iris lens by using AEC function.
The average value of the output signal is compared to the set reference level (AGC set value), then the exposure time (electronic shutter time) is automatically controlled so that the reference level and the average output value get equal .




**Block diagram of AEC control circuit**

When AEC function is set to ON, the camera enters Continuous shutter mode and the exposure time changes linearly by 1H (Horizontal synchronous time) within the range of 1/1000 sec to No shutter.

Five functions below are limited to use in combination with AEC function.
Note that the combined use of them does not function well.

| | AGC function | Asynchronous shutter | Partial scanning | Long exposure | Auto iris lens |
|---|---|---|---|---|---|
| AEC function | × | × | × | × | × |

(Note) When AEC(Auto exposure control) is set to ON in No shutter mode, the camera automatically enters Continuous shutter mode and the shutter time (exposure time) is automatically controlled in response to luminance.
(Note) When using AEC function, the picture level is subject to hunting phenomenon (phenomenon in which light-dark change periodically occurs) for the image with the light source of which a brightness fluctuates.

[Setup procedure]

● Set FR(15) and FR(14) as follows rewriting FR (Flag register) with serial communication software.

| | AGCE=FR(15) | AECE=FR(14) |
|---|---|---|
| AEC function | 0 | 1 |

(Note) “AGCE” (Auto Gain Control Enable) needs to be set to “0”

● Adjust the AGC set value (Reference level) to get necessary luminance level.
When the gain is insufficient, adjust the MGC set value a bit higher.

(Note) MGC set value is applied as the gain value of preamplifier on the stage prior to A/D converter.
S/N ratio of output signal degrades by setting MGC set value higher.

[Explanation] FR (15,14) setting and its operational mode
Correspondence relation of the content of each flag register FR(15),FR(14) and its operational mode is as follows.

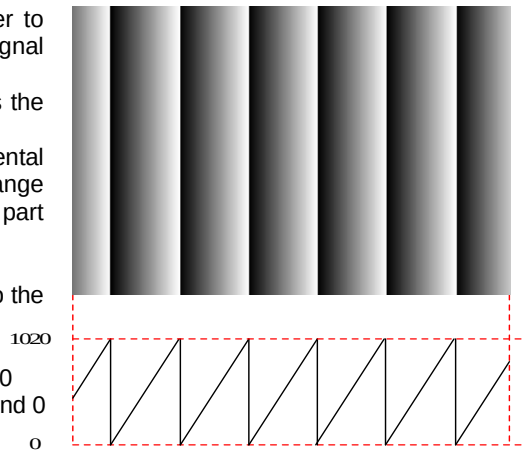
| AGCE=FR(15) | AECE=FR(14) | Operational mode | Remarks |
|---|---|---|---|
| 0 | 0 | AGC=OFF, AEC=OFF | Factory Default |
| 0 | 1 | AEC=ON | Auto Exposure Control valid |
| 1 | 0 | AGC=ON | Auto Gain Control valid |
| 1 | 1 | Set inhibit | Not use in this setting |

※ Set contents of FR can be saved with respect to each program page by executing commands “WA” to “WF” .

(Note) Refer to (7-5)” Internal flag register and configuration register”

## (4-9) Test pattern display function (Black and white data output)

When initially connecting this camera to an image capture board, the use of the test pattern display function of the equipment makes it easier to confirm that the output timing of the camera and the details of the signal connection match the particulars of the capture board.
When the test pattern function is set to be ON, the image sensor outputs the test pattern in place of pictures as shown on the right.
As for this pattern, a numerical value of 4 is simply added in an incremental manner for every horizontal pixel, and a saw-tooth profile is shown in the range from the numerical value of 0 to 1020.(When set at 10 bit output) (Lower part of the right figure)



Test pattern and horizontal profile

(Note) In terms of upper 8 bits in 10 bit data, this 8 bits data corresponds to the data in which a numerical value of 1 is incrementally added for every horizontal pixel in the range of 0 to 255.
The lower 2 bits in 10 bit data are fixed to 0. Therefore, it is 0 to 1020 (only the lowermost bit and next bit are 0 ) in the 10 bit data range, and 0 to 4080 for the case of 12 bit output.

(Note) The value does not start with 0 at the edge of the effective image area.
(Note) The output values of the test pattern are not affected by the values of the gain setting or offset setting of the camera.

The default setting is OFF. This setting can be changed by way of rewriting the configuration register with serial communication commands.

## (4-10) Monitoring function for internal temperature of camera

This camera is equipped with an internal temperature sensor to monitor the temperature inside the body. This function makes it possible to use the camera in a safer way even in a harsh environment in terms of temperature, for example use in the open air. With the use of serial communication commands, this function also works to control the forced air-cooling fan of the camera and peripheral devices and others.

- How to monitor internal temperature of camera

The following two methods are available for monitoring the internal temperature of the camera:

- Turn on the MENU display and confirm on the OSD over the image. (Temperature to be displayed in Celsius)
- Confirm with temperature data to be returned in response to the serial communication command (”RTMP” command). (Numerical conversion required separately)

(Note) Carefully note that the temperature data obtained by this monitoring function is not for the ambient temperature but the internal temperature of the camera. As a general rule, the internal temperature of the camera is higher than the ambient temperature because of the heat generation associated with the consumed electric power inside the camera. Even when the temperature monitored by this function exceeds the value of the “Operation ambient temperature” shown in the specifications of the camera, no operational trouble will be caused as long as the ambient temperature is equal to the one of the specifications or lower, and sufficient countermeasures against temperature are taken.

- Detection capability for temperature data

| | |
|---|---|
| Minimum unit for temperature data : | 0.5° |
| Data refreshing cycle : | 0.4 sec. |
| Temperature detection accuracy: | ±2℃ (-40℃ to +85° C), +3 to -2℃ (55℃ to 125℃) |
| Effective data range : | -55℃ to 125℃ (as long as t he operation ambient temperature of the camera is within the range defined by the specifications.) |

- Temperature data by serial communication
  The temperature data to be returned in response to the “RTMP” command of serial communication is generated in the following format:

[Data format]
The lower 10 bits out of the 16 bits of the returned data are valid.
XXXXXD9D8…D0 (invalid upper 6 bits/valid lower 10 bits as the data)
Db=B’D9D8…D0 in the binary system shows a signed integer value in two’s complement form.
However, the effective range of the temperature data is limited to the following due to the operational restriction of the temperature sensor:
Effective range of temperature data: -110 (-55℃) to +250 (125℃)

(Note) The accuracy of the values of the temperature data is not guaranteed when the operation ambient temperature is not within the range defined by the specifications.

[Conversion method from returned data to temperature in Celsius]
The temperature in Celsius is computed as Tc from the following formula where Dt is the signed integer number converted from the above described 10 bit binary value of “Db=B’D9D8…D0”:

Internal temperature of camera: Tc=Dt×0.5℃

(Example 1) Where Td, the returned value of the temperature data, is “H’0032” in the hexadecimal system, it is expressed in the binary system as follows:
Td=H’0032=B’0000.0000.0011.0010
∴ Db=B’00.0011.0010 =+50 (Only upper 10 digits of Td are valid.)
Then, Tc is calculated from the following formula: Tc=+50×0.5℃=+25℃

(Example 2) Where Td, the returned value of the temperature data, is “H’03FA” in the hexadecimal system, it is expressed in the binary system as follows:
Td=H’03F1=B’0000.0011.1111.1010
∴ Db=B’11.1111.1010 (Only upper 10 digits of Td are valid.) → Dt=-6 (↓ Refer to [Explanation])
Then, Tc is calculated from the following formula: Tc=Dt×0.5℃=-6×0.5℃=-3℃

[Explanation] Example of conversion algorithm from data in the complement number system to signed data
The following example shows how to convert 10 digit data in the complement number system into ordinary signed data:

(1) Whether the value is positive or negative is determined by checking the uppermost bit (MSB) out of the 10 digit number. When the MSB is 0, “+” is added, and when it is “1”, “-“ is added to the number (absolute value) to be obtained in accordance with the below described (2).
(2) The absolute value is obtained from a binary number expressed in the remaining 9 digits including the lowermost bit (LSB) as follows:
Simply convert into an integer number if the MSB is 0 (”+” sign) in accordance with (1).
Reverse each of all the 9 digits and add 1 to the result if the MSB is 1 (“-“ sign) in accordance with (1).
(3) The signed number is obtained from (1) for the sign and (2) for the absolute value.

* In the case of the (Example 2) as above, its sign is “-“ because the MSB is 1 in accordance with (1). The absolute value is “6” because of (invert(B'11111010)+ 1 = B'00000101 +1 = 5+1 =6) in accordance with (2). Therefore, this value (Dt) is expressed as “-6” in the ordinary signed number system.

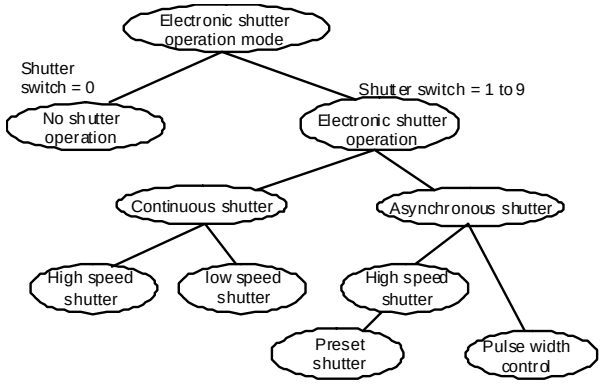
## (4-11) Camera ID saving function

The ID code and other information set by the user for each camera can be stored in the camera and be read out when needed. The saved identification data for each camera including installation location in the case of using more than one camera (e.g., “CAMERA-RIGHT” and “CAMERA-LEFT”) allows the user to easily control and identify the camera (s).
The setting is executed through the serial communication. The settable maximum number of characters are 15, and alphabets (both upper and lower cases), numbers and some special symbols such as”+” and “-” excluding the control codes can be used.
(→ Refer to the section of “Serial Communication Control” for the details.)

## 5. Various Settings

(!) This camera is not equipped with the substantial shutter setting switch on the rear panel. “Shutter switch” or “Mode switch” described below means setting values of hypothetical shutter switch set on the memory inside the camera via serial communication command.
→ Refer to (5-8) for the specific setting method.

### (5-1) Operation mode




- Electronic shutter operation mode
  Shutter system
  No shutter / continuous/asynchronous
  Type of shutter speed
  High speed / low speed/pulse width control
  (See the right schematic diagram)

- Reset mode
  It is able to select whether or not to reset the internal horizontal synchronous timing (H) when in asynchronous shutter mode.
  Shutter system ….Without H-reset / With H-reset

- Scanning system…Normal scan / Partial scan

Table 5-1. Description of electronic shutter operation modes

| | | |
|---|---|---|
| Shutter system | No shutter | Electronic shutter is not used.<br>Exposure time of image sensor is equivalent to one frame time.<br>Exposure is continuously performed for each frame. |
| | Continuous shutter | Repeats exposure regardless of external trigger input (Vinit).<br>Repetition pitch is per frame. |
| | Asynchronous shutter | Electronic shutter is released each time the external trigger is input (Vinit).<br>The shortest repetition pitch is [exposure time + 1 frame time]. |
| Type of shutter speed | Normal shutter (High speed shutter) | Shutter ,of which the exposure time is less than one frame time, is used.<br>The shutter speed can be set as a preset shutter speed at 9 different levels both for the continuous shutter/asynchronous shutter operations. |
| | Low speed shutter | The shutter, of which the exposure time is two frames or over, is used.<br>(Only for continuous shutter mode) The shutter speed can be set as a preset shutter speed at 9 different levels.<br>(Note) This camera allows this setting only for the continuous shutter mode. |
| | Pulse width control | Only in the case of asynchronous shutter setting, the shutter, of which shutter speed corresponds to the pulse width (during L level) of the external trigger input (Vinit), is released.<br>Shutter speed can be set as nH (n = 1 or larger integer number) in H (horizontal synchronous time) unit. |

Table 5-2 Description of other operation modes

| | | |
|---|---|---|
| Scanning system | Normal scan | The read out for each frame is conducted by the all pixel readout scanning. (31Hz) |
| | Partial scan | The read out for each frame is conducted by the partial readout scanning.<br>The vertical width of the longitudinal picture area corresponds to 440 lines at the central portion of the image pickup area. |

[Terminology] Preset shutter…….This refers to the shutter speed setting other than those specified by the pulse width control. More specifically, the shutter speed is set by the shutter switch positions from “1” to “9” for the continuous shutter operation, or the shutter switch positions from “1” to “9” (PWC (Pulse width control mode)=DISABLED) or from “1” to “8” (PWC (Pulse width control mode)=ENABLE) for the asynchronous shutter operation. The shutter speed is defined in the Table 5-3.

[Terminology] Pulse width control….This is the way of setting and controlling of the shutter speed by the width of the Vinit signal that is externally input in the asynchronous shutter mode. With this camera, this is selected by setting PWC to “ENABLED” and the shutter switch position to “9” in the asynchronous shutter mode.

[Terminology] High speed shutter…. This means the shutter of which shutter speed is shorter than 1 frame time (=1 vertical synchronous time). The shutter speed is set as a preset fixed length of the 9 different levels that are determined by the position of the shutter switch (continuous shutter and asynchronous shutter).

[Terminology] Low speed shutter….This means the shutter of which shutter speed is longer than 1 frame time. The shutter speed is set as a preset fixed length of the 9 different levels that are determined by the position of the shutter switch (continuous shutter).

(!) This camera does not support the functions of “low speed/asynchronous shutter”.

## (5-2) Setting of shutter speed

The shutter speed is determined by assigning “0 - 9” to the shutter switch position or specifying the shutter speed in H (Horizontal scan time) unit.
As this camera is not equipped with the substantive shutter setting switch, the shutter speed is specified by changing the Feature settings regarding the exposure time of GenICam API or using the serial communication command via serial communication software.

The shutter speed setting is mainly decided by setting position “0” to ”9” of (Hypothetical) shutter switch.

- Correspondence relation between Shutter speed and shutter switch setting

Table 5-3 Setting value of shutter speed

| | Shutter speed | | |
|---|---|---|---|
| Position of shutter switch | High speed shutter (continuous/asynchronous) | | Low speed shutter (continuous) |
| 0 | No shutter (continuous) 1/31sec. (31.4 ms) (1068H=1V) | | |
| 1 | 1/23000 sec. (0.04 ms) ( 1H) | | 1/15.7 sec. (0.06sec) (2V) |
| 2 | 1/10000 sec. (0.10 ms) ( 3H) | | 1/10.0 sec. (0.10sec) (3V) |
| 3 | 1/4000 sec. (0.25 ms) ( 8H) | | 1/7.9 sec. (0.13sec) (4V) |
| 4 | 1/2000 sec. (0.49 ms) (16H) | | 1/6.3 sec. (0.16sec) (5V) |
| 5 | 1/1000 sec. (1.00 ms) (33H) | | 1/5.2 sec. (0.19sec) (6V) |
| 6 | 1/500 sec. (2.02 ms) (67H) | | 1/4.5 sec. (0.22sec) (7V) |
| 7 | 1/250 sec. (4.01 ms) (134H) | | 1/3.9 sec. (0.26sec) (8V) |
| 8 | 1/120 sec. (8.33 ms) (279H) | | 1/3.5 sec. (0.29sec) (9V) |
| 9 | 1/63 sec. (15.91ms) (533H) | Pulse width control /asynchronous (!) | 1/3.1sec. (0.32sec) (10V) |

(Note) (H) and (V) in the table represent the horizontal time unit and the vertical time (frame duration) unit respectively.
(Note) ”No shutter” in the table means the continuous shutter mode with exposure time = 1 frame time.
(Note) The value of the each shutter speed is the factory default value. The shutter speed of each position (excluding shutter position = 0) is possible to change by the user with serial communication command.

(!) As for this camera, “Pulse width control time/asynchronous” must be set to be “Pulse width control (PWC) = ENABLED”. When it is set to be “Pulse width control (PWC) = DISABLED” (default), the selection can be made out of the 9 levels not only for the continuous shutter operation but also for the asynchronous shutter operation.
(!) “Shutter switch” means the hypothetical shutter switch set on the memory inside the camera via serial communication command.

[Explanation]
The shutter speed is specified by reading out the value on the electronic shutter table (separately exist on page A to F ) corresponding to the set position of shutter switch.(excluding directly designated value )
The electronic shutter table can all be rewritten with the serial command “E” (shutter table Edit command) except shutter switch ”0”..

## (5-3) Level setting

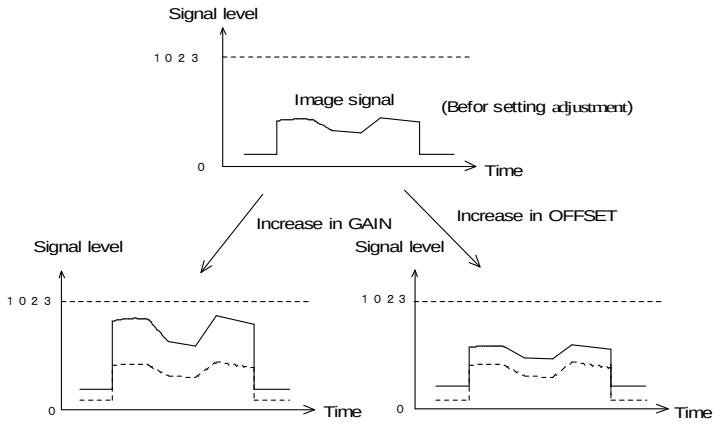
The level setting is mostly divided into the following two groups:

- Gain setting
  This is to set the gain (amplification factor) of the preamplifier between the CCD image sensor inside the camera and A/D converter.

- Offset setting
  This is to set the offset value of the preamplifier between the CCD image sensor inside the camera and A/D converter.

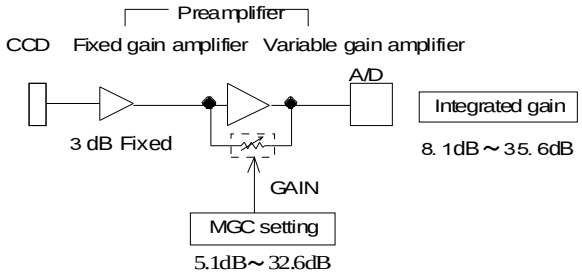
→ Refer to the next section (Section 6) for the specific setting method.

(Note) As for the offset setting, it is recommended to use the factory default value except for a special case.
(Note) Follow the procedure (gain setting followed by offset setting) if fine tuning of the offset value is needed.




Conceptual diagram of gain and offset levels

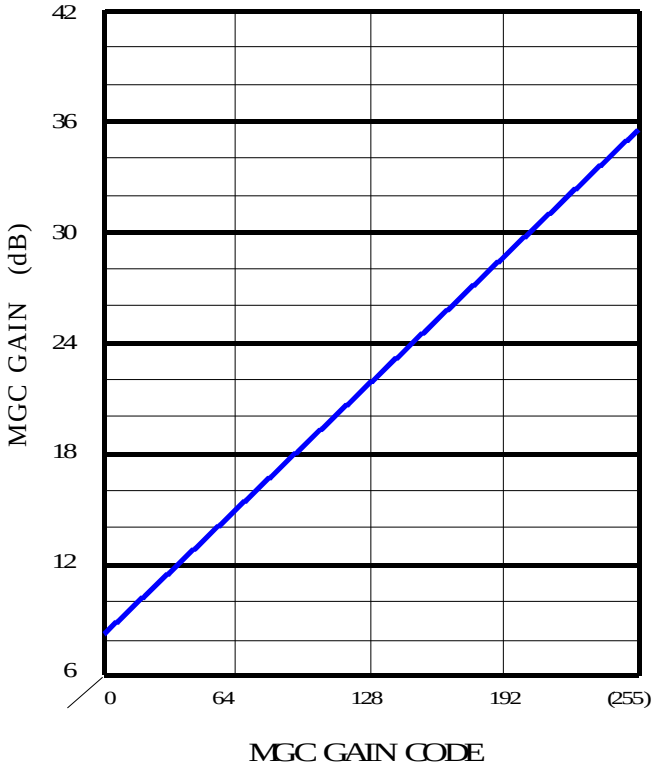
## (5-4) Gain setting of preamplifier




- Gain variable amplifier and integrated gain
  The image signal output from CCD is amplified inside the camera through the fixed gain amplifier on the anterior stage and then through the following variable gain amplifier before being input into the A/D converter.
  The left block chart shows this flow.

(Note) The gain value (dB) described here is the one based on the CCD output (0 dB) as the baseline.

- Correlation between MGC gain setting value and MGC gain
  The MGC setting value of this equipment is controlled by giving 0 to 255.
  The correlation between this setting value and the MGC gain (integrated gain including the gain of the variable gain amplifier and that of the fixed gain amplifier) is shown in the right graph.




(Note) When the CCD element receives excessive light with a low gain value of the amplifier due to the restriction of the dynamic range of the CCD light receiving element, the signals of the nonlinear area of the CCD element and the preamplifier are output at the high brightness area.

In this state, unnatural image (Note below) may appear in the neighborhood of the saturating signal area of the image due to the characteristic of the nonlinear area. This phenomenon, which is associated with the saturation characteristic of the CCD element, is not a failure arising from the camera.

To eliminate this phenomenon, reduce the amount of light by stopping down the lens and newly set a higher gain value. Then, the output signal from the CCD element at the saturating area will be appropriately saturated into a white level for the output.

(Note) The above described unnatural image represents the following states:
- Black and white look inverted at the saturating area.
- The outline of the saturating area is blurred.
- The saturating area slightly shifts upward or downward.
- The brightness of the saturating area does not reach 1023.

## (5-5) AGC gain setting

AGC function turns on by setting AGCE(AGC Enable) bit in flag register(FR) to 1.
The operating range of AGC is approximately 20dB.

(Note) AGC setting and MGC setting are incompatible with each other.

## (5-6) Output data bit format setting

Three formats below are selectable as the output data format conforming to Camera Link.

8 bit gray scale (Default)
10 bit gray scale
12 bit gray scale

This camera is equipped with 14-bit scale A/D converter.
8 bit to 12 bit data of the upper bits of A/D converter is output in accordance with output format setting as the right table.
The setting is changed by rewriting (CR)(Configuration register) with serial communication command.

| Image data (A/D output) | Assignment of Output data | | |
|---|---|---|---|
| | 12 bit | 10 bit | 8 bit |
| AD13 | D11 | D9 | D7 |
| AD12 | D10 | D8 | D6 |
| AD11 | D9 | D7 | D5 |
| AD10 | D8 | D6 | D4 |
| AD9 | D7 | D5 | D3 |
| AD8 | D6 | D4 | D2 |
| AD7 | D5 | D3 | D1 |
| AD6 | D4 | D2 | D0 |
| AD5 | D3 | D1 | - |
| AD4 | D2 | D0 | - |
| AD3 | D1 | - | - |
| AD2 | D0 | - | - |
| AD1 | - | - | - |
| AD0 | - | - | - |

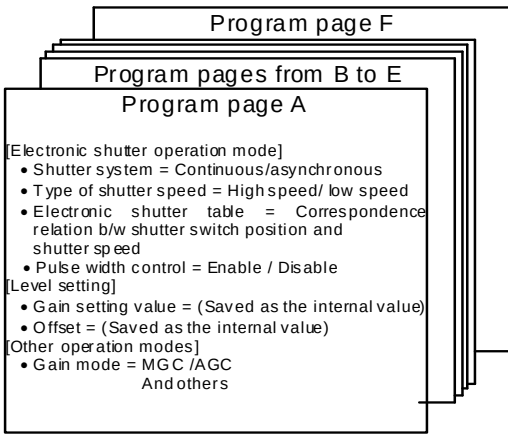
(Default)

## (5-7) Program page setting

The FC series cameras are internally equipped with nonvolatile memories and various operation mode settings and level settings can be stored in them.
The setting items are stored in the virtual pages (hereinafter referred to as “program pages”) inside the camera.
This camera has 6 program pages of “A”, “B”, “C”, “D”, “E” and “F” (right figure).
The camera starts operating according to the various settings stored in the relevant page when the mode switch is at any one of the positions from “A” to “F” at the time of power-on.

(!) As this camera is not equipped with the substantial shutter setting switch on the rear panel, “Mode switch” described here means setting values of hypothetical mode switch set on the memory inside the camera.
The position of this (hypothetical) mode switch can be set, read and saved with serial communication command.

(Note) The memory has the configuration area aside from the saving area of the program pages that is independent from the program pages.
The common setting items (Configuration items) are saved on this area.



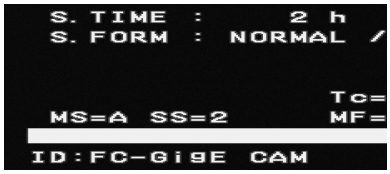

Conceptual diagram of program page

## (5-8) Setting of Shutter switch and Mode switch

This camera is not equipped with the substantial shutter switch and mode switch. The hypothetical switches set on the memory inside the camera are used as a substitute for these switches.
The set values of these switches are stored in nonvolatile ROM and these values are read out onto RAM at the time of power-on.

### (5-8-1) Confirmation of set position of Shutter switch and Mode switch

It can be confirmed by any of the following methods.




- Confirmation on the OSD menu screen
  Current setting status of Mode switch (MS) and Shutter switch (SW) can be confirmed by displaying the OSD menu on the captured image.
  MS・・・・Set value of Mode switch
  SS・・・・Set value of Shutter switch
  → Mode switch is set to A and Shutter switch is set to 2 on the right example.

- Confirmation by GenICam feature
  It can be confirmed by GenICam feature as below when using the application software like GEVPlayer (that comes with attached SDK) which can set up and read out the GenICam feature.

  TakexCameraControls > FcModeSW ・・・Feature of Mode switch setting
  TakexCameraControls > FcShutterSW ・・・Feature of Shutter switch setting

- Confirmation by Serial communication command
  The current setting values of Shutter switch and Mode switch can be confirmed by using the following commands when the communication with serial communication commands is possible using Coyote and FCTool (that comes with attached SDK) or others.

  Command ”RMSW” ・・・To read out the current set values of Mode switch
  Command ”RSSW” ・・・To read out the current set values of Shutter switch

(5-8-2) Mode switch and Shutter switch settings change
It can change settings by any of the following methods.

- Setting by GenICam feature

It can be changed by changing GenICam feature settings as below when using the application software like GEVPlayer (that comes with attached SDK) which can set up and read out the GenICam feature.

TakexCameraControls > FcModeSW ・・・Feature of Mode switch setting
TakexCameraControls > FcShutterSW ・・・Feature of Shutter switch setting

- Setting by Serial communication command

The current setting values of Shutter switch and Mode switch can be changed by using the following commands when the communication with serial communication commands is possible using Coyote and FCTool (that comes with attached SDK) or others.

Command ”WMSW” ・・・To write the set values of Mode switch
Command ”WSSW” ・・・To write the set values of Shutter switch

(Note) Refer to section 6-3 for the details about setting and reading of the GenICam feature.
(Note) Refer to section 7-2 and 7-3 for the details about confirmation and setting by serial communication command.

## 6. Operation using Image display software

Operation examples for changing camera settings using Image display demonstration software in attached SDK (Software development kit) are described in this section

→ Refer to “FC-GE series camera Instruction manual (Connection edition)” of separate volume for the details about the installing method of SDK or the specific procedure for executing image display with the camera being connected to PC.

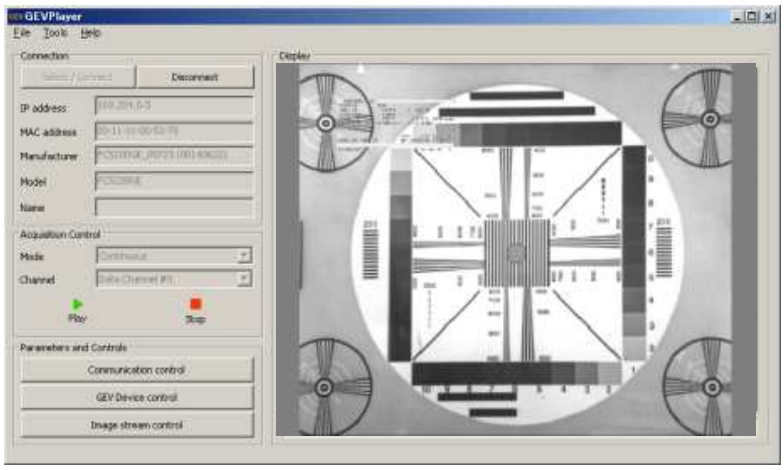
### (6-1) Image display software in attached SDK

Image display demonstration software “GEVPlayer”(eBUS-PureGEV Packge) and ”Coyote”(eBUS-Vision Package) become available by connecting the camera to PC via Ethernet and by installing attached SDK (“eBUS-PureGEV Packge” and ” eBUS-Vision Package”).

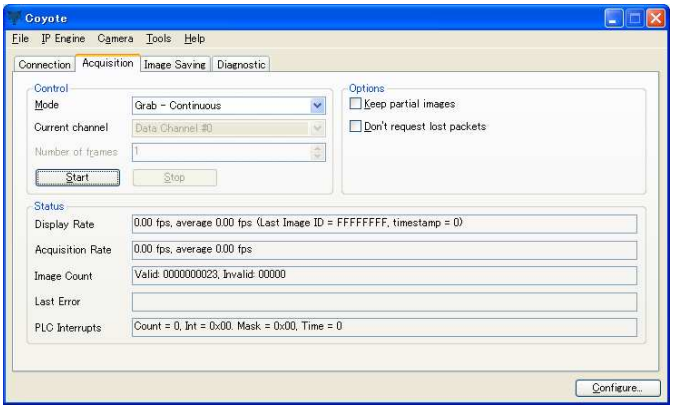
It can display the image on PC monitor and can save the image data using these Image display demonstration software.

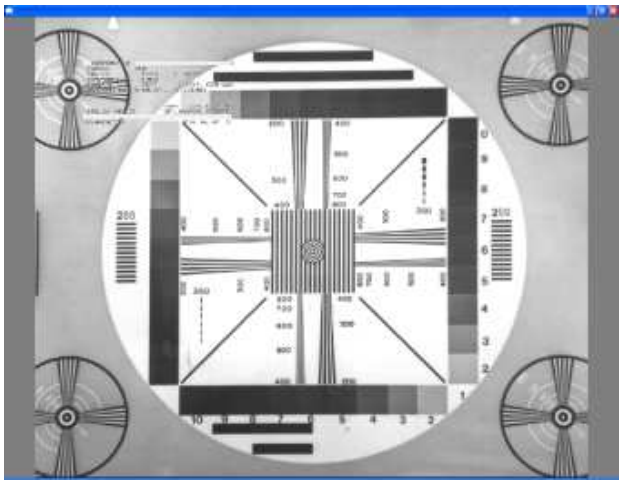
→ Refer to “FC-GE series camera Instruction manual (Connection edition)” of separate volume for the details about the installing procedure and the usage of these display software (“GEVPlayer” and ”Coyote”).

<GEVPlayer Display screen>




<Coyote Display screen>



[Important] Regarding SDK selection at the time of development of application software

This equipment adopts the Pleora (Canada)’s iPORT as IP engine.
“eBUS-PureGEV Packge“(GenCam API-compliant development environment) and “eBUS-Vision Package”(non-GenCam API-compliant) are available as SDK in iPORT.
Although “eBUS-Vision Package” including demonstration display software “Coyote” has been used for many years, Pleora strongly recommends to use “eBUS-PureGEV Packge“(GenICam API-compliant development environment), as a trend shifting to GenICam API-compliant cameras becomes more common among third-party image processing software makers and many GigE camera makers.

Except for particular reasons that iPORT interface or application software has been developed for years on the platform of Pleora’s “eBUS-Vision Package”, we recommend to develop the new application software using “eBUS-PureGEV Packge“ that is the GenICam API-compliant development environment.

## (6-2) Setting procedure of the camera using demonstration display software

<Setting procedure using “GEVPlayer”>
This camera supports GenICam API established by EMVA(European Machine Vision association).
Display software “GEVPlayer” included in the attached SDK ”eBUS-PureGEV Package” is GenICam API-compatible.
And it can change most of set contents (e.g. Gain setting, Shutter speed etc.) by directly specifying parameter value for each prescribed feature from this software.

→ In this case, there is no need to use serial communication software such as “FCTool”.

<Setting procedure using serial communication command>
It can execute camera setting with “GenICam API” by using demonstration display software “Coyote” in the attached SDK ”eBUS-Vision Package” and the serial communication software (such as “FCTool”) .

→ Refer to “7.Serial communication command” for the detail about setting procedure using serial communication command.

## (6-3) Example of camera setting with “GEVPlayer”

It can directly confirm and change the setting parameters of the camera without the serial communication software (such as “FCTool”) from the application software by using GenICam API.

Following examples show the parameter setting procedure of the camera using the Image display software “GEVPlayer” included in the attached SDK ”eBUS-PureGEV Package”.

Various examples of the way to change settings using the Control dialogue ”GEV Device Control” are provided.

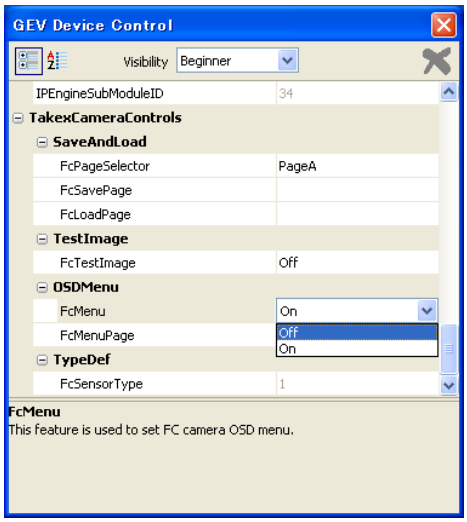
(Example1) ON/OFF switching of OSD menu display
OSD menu display is set to ON as factory default with FC series camera.
The example of the way to turn off OSD menu is shown below.

- Select the item ” TakexCameraControls > OSDMenu > FCMenu ”

→ Select “off ” and press the return key.

(Note) It is essentially possible to change parameters and reflect it to the camera while displaying images, in the case that the selected item is indicated in deep color during streaming images (displaying images), however streaming may be interrupted sometimes and display status may get unstable.

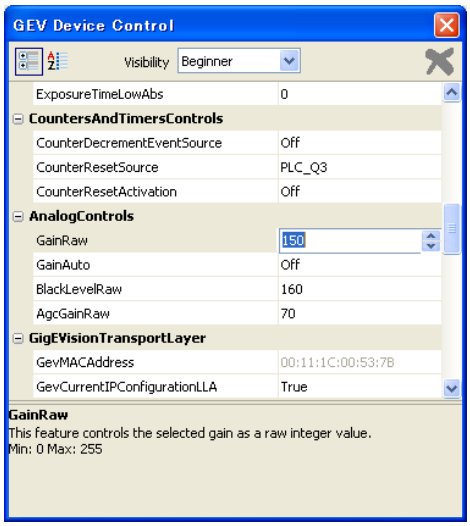
In that case, change settings after clicking “STOP” (red colored button) and stopping display.




(Example2) MGC gain setting
The example of the way to change MGC gain setting is shown below.

- Select the item “ AnalogControl > GainRaw ” and enter the numerical number. The range of numerical number is 0 to 255 for FC-GE series camera. It is possible to either increase or decrease the number in increments of one by directly entering the numerical number or by clicking the up-down arrows to the right of the entry field.

→ Set value is reflected to the camera by pressing the return key after having changed the numerical number or by selecting the other item.




(Example3) Exposure time setting – Continuous shutter – Direct designation of shutter speed
The example of the way to directly designate the shutter exposure time (e.g. 1000) in continuous shutter mode is shown below.
Set the following set of parameters.

① Set to “Timed” on the item “AcquisitionAndTriggerCntrols > ExposureMode “.
② Set to “ExposuTime” on the item “AcquisitionAndTriggerCntrols > PresetShutter“.
③ Enter “1000” on the item “AcquisitionAndTriggerCntrols > ExposureTimeRaw”. And press the return key.

(Example4) Exposure time setting – Asynchronous shutter – Designation of Preset value

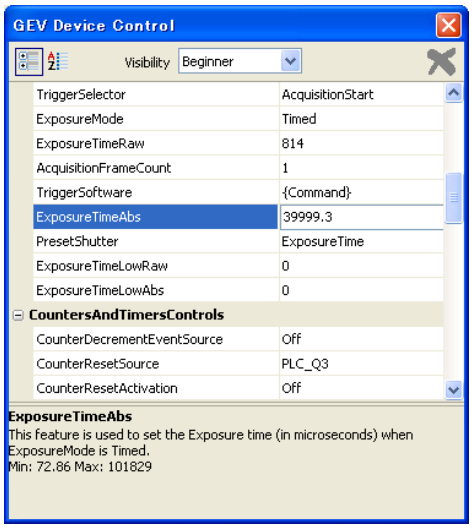
The example of the way to set the shutter exposure time to Preset 5 is shown below.
Set the following set of parameters.

① Set to “TriggerCntrolled” on the item “AcquisitionAndTriggerCntrols > ExposureMode “.

② Select “Preset5” on the item “AcquisitionAndTriggerCntrols > PresetShutter “ and press the return key.

(Example5) Exposure time setting – Continuous shutter – Designation of Absolute time (in ms unit)

The example of the way to designate the shutter exposure time in μs unit in continuous shutter mode is shown below. (e.g. 40000μs=40ms)
Set the following set of parameters.




① Set to “Timed” on the item “AcquisitionAndTriggerCntrols > ExposureMode “.

② Set to “ExposureTime” on the item “AcquisitionAndTriggerCntrols > PresetShutter “.

③ Enter “40000” on the item “AcquisitionAndTriggerCntrols > ExposureTimeAbs”.
And press the return key.

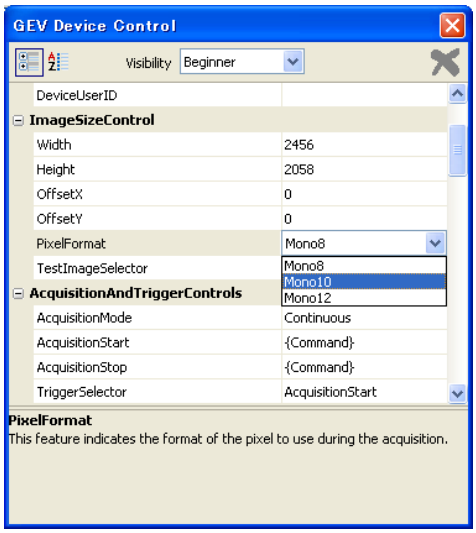
(Note) The example of setting and entering numerical number “40000” with FC5200GE (*) is shown in the right figure.
“3999.3”μs corresponding to the numerical number “40000”μs is reflected as an actually assignable number.
This is because the shutter speed is set in H(horizontal synchronous time) unit on the camera side.

→ It turns out that the value of “ExposureTimeRaw” gets “814” In response to the value “40000”μs. That means H number “814” which is closest to the set value “40000”μs is set into the camera.

* Further details of each numerical number vary with the type of camera.
The above example shows the case of FC5200GE(5 megapixels/GigE)

(Example6) Image output format setting

The example of the way to switch the image output format from 8 bit (default) to 10 bit is shown below.




• Select “mono10” (“Bayer RG10” in the case of color camera) on the item ” ImageSizeControl > PixelFormat ” and press the return key.

(Example7) Saving the settings

The example of the way to save the set contents of parameters making it reflected at next power-on is shown below.

① Select “UserSet1” on the item “UserSets > UserSetSelector “.

② Click the command button on the item “UserSets > UserSetSave “.

③ Select “UserSet1” on the item “UserSets > UserSetDefaultSelector “.
And press the return key.

* Set values are saved in the XML file inside the camera herewith and is applied at next power-on.

(Example8) Default setting restoring (Reloading of Default setting)

The example of the way to restore the settings of various parameters to default is shown below.

① Select “UserSet1” on the item “UserSets > UserSetDefaultSelector “.

② Click “Disconnect” button to disconnect the connection.

*In this way, the camera gets started by default setting at next power-on.

→ After restarting, return the item “UserSetDefaultSelector “ to “UserSet1 “ after having saved set values in “UserSet1“.
(Note) It is always set to default at startup if “UserSetDefaultSelector “ is set to “Default”.

※ Other setting parameters

Refer to chapter 9 for more details about other setting parameters(Features).

## 7. How to change and confirm the settings

This camera is not equipped with the substantial switches. Camera setting such as shutter speed, gain, offset or operational mode setting can be done by changing parameter setting for each Feature (item: gain setting, shutter speed etc.) using the attached display demonstration software “GEVPlayer” which is GenICam API-compatible or the software made by user with the attached SDK “eBUS-PureGEV Packge” or the software made by third party.

Aside from this, the method for manipulating setting parameters by directly providing serial communication command to the camera with serial communication software (such as “FCTool”) is described in this section.

### (7-1) Operation setting register

Setting of camera operation is performed by writing numerical values or status of flag onto the register on the memory inside the camera. It can confirm or change the setting by using serial communication command.
These registers are divided into two main groups, the registers which is in the saving area of each of A to F six program pages (Program page items) and the registers which is in an common area independent from the program pages (Configuration items).

[Operational mode setting-related registers ]

| | Storage area (Register) | Remarks | Range of setting values |
|---|---|---|---|
| Program page items (Saved in each of program pages)<br><br>※Applied to page A to F | Flag register (FR) | Various operation mode setting | 16 bit |
| | MGC gain set value | MGC set value | 0 to 255 |
| | AGC gain set value | AGC set value | 0 to 255 |
| | Offset set value | Offset set value | 0 to 255 |
| | Direct designated value of shutter speed | Externally designated value of shutter speed | 0 to ※EXP_ MAX |
| | Electronic shutter table | Shutter value corresponding to 0 to 9 | 0 to ※EXP_ MAX ×10sets |
| Configuration items (Saved in common area) | Configuration register (CR) | Various operation mode setting | 16 bit |
| | Hypothetical shutter switch | Set value of shutter switch | 0 to 9 |
| | Hypothetical mode switch | Set value of mode switch | A to F |
| | Set value of VSUB voltage | Saved in numerical number | 0 to 255 |

※EXP_ MAX: The maximum value which is possible to directly designate as a shutter speed. In this camera, EXP_ MAX is “H’042A”(=D’1066) for the high speed shutter, “H’00FF” (=D’255) for the low speed shutter and “H’0215”(=D’533) in the case of partial scanning (central part).

[Explanation] Vsub voltage
Vsub voltage is the bias voltage (substrate voltage) that serves to control the blooming effect (resulting in blur or running image at a saturating area) that arises from excessive light getting into CCD.
If a high Vsub voltage is set, the blooming effect can be reduced, although an excessively high voltage leads to a narrower operation range of CCD because it is associated with a decrease in the saturating voltage of the CCD output.
It is appropriately set before shipment because the optimum Vsub voltage varies by CCD.

### (7-2) How to set Shutter speed

The shutter speed is determined mainly by the set position “0” to ”9” of the (hypothetical) shutter switch.
Refer to Table 5-3 “Setting value of shutter speed” for the shutter speed corresponding to each set position.

● The shutter speed setting by the serial communication command
The shutter speed setting is done by inputting the serial communication commands via Ethernet as this camera is not equipped with the substantial shutter switch.
The shutter speed setting is divided into the following three categories.

| | Setting method of shutter speed | Command used | Remarks |
|---|---|---|---|
| Shutter speed setting | Direct designation of shutter switch position | Command “WSSW” | Common to page A to F |
| | External designation of shutter switch setting | Command “S” | Separately set in page A to F |
| | External value setting of shutter speed | Command “S” | Separately set in page A to F |

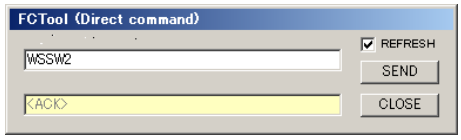
[Designation of shutter switch position]
It can be changed to the shutter speed prescribed in Table 5-3 “Setting value of shutter speed” by designating the shutter switch set value .
(!) This corresponds to the method of changing the shutter switch on the rear panel of the conventional camera.

- Command “WSSW”
Function: Command for writing the shutter switch set value (Write Shutter Switch)

Transmission from host: STX : “WSSW” : set value : ETX
Return by camera: STX : ACK : ETX (transaction completion), or STX : NAK: ETX (transaction rejection)
※ The “set value” (one character: “0” to “9”) is written into shutter switch.

(Note) Set contents by this command are all lost when the power is turned off as they are not written into EEPROM (nonvolatile memory) by this command. Execute another command “SSSW”(Save Shutter Switch) if it is needed to save the set contents into EEPROM.

[Example] To set shutter switch to “2”
Transmit as follows
Transmission from host: STX: “WSSW”: “2”: ETX
Right figure shows the example of transmitting the command using the TAKENAKA’s communication software for evaluation (FCTool)




(Note) STX(=H’02) and ETX(=H’03) are automatically inserted before and after the input character string in the case of using FCTool.

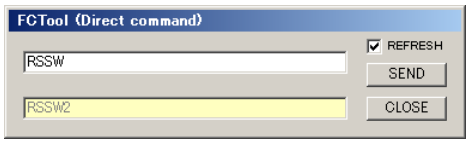
- Command “RSSW”
  Function: Command for reading out the shutter switch set value (Read Shutter Switch)

  Transmission from host: STX : “RSSW” : ETX
  Return by camera: STX : ACK : set value : ETX (transaction completion), or STX: NAK : ETX (transaction rejection)

  ※ The current “set value” (one character: “0” to “9”) of the shutter switch is read out.

[Example] To read out the current set value of shutter switch
Transmit as follows
Transmission from host: STX: “RSSW”: ETX

Right figure shows the example of transmitting the command using FCTool. Set value of shutter switch “2” is read out.

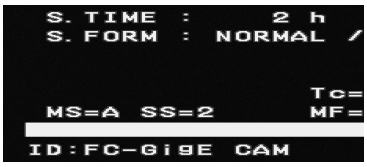



- Command “SSSW”
  Function: Command for saving the shutter switch set value (Save Shutter Switch)

  Transmission from host: STX : “SSSW” : ETX
  Return by camera: STX : ACK : set value : ETX (transaction completion), or STX : NAK : ETX (transaction rejection)

  ※ The current “set value” (one character: “0” to “9”) of the shutter switch is saved into nonvolatile ROM.

(Note) The current set value of the shutter switch can be confirmed on OSD menu screen. In the right example, it shows that the current shutter switch position is “2”.




## [External designation of shutter switch position]

It can set the shutter speed by the external designation command for the shutter switch setting to the one that corresponds to the set value (0 to 9) of the shutter speed regardless of the current shutter switch position (displayed as “SS= ” in OSD menu). This set value can be saved separately into the program page (A to F).

- Command “S”
  Function: Command for setting the shutter mode and the shutter exposure time (Shutter)

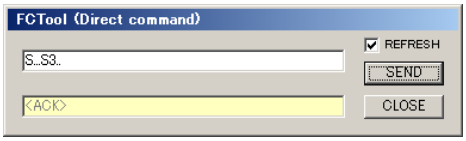
  Transmission from host: STX : “S” : ※1 : ※2 : ※3 : exposure time : ETX
  Return by camera: STX : ACK : set value : ETX (transaction completion), or STX : NAK : ETX (transaction rejection)

  ※ The current shutter mode and shutter exposure time are set.
  ※ Specified parameter or “ . ”(period=no change) is entered into ※1 to ※3 part.

(Note) Refer to “8.Serial communication command” for the detail about command provisions.

[Example] To change the current shutter switch setting to “3” by external designation.
Transmit as follows
Transmission from host: STX : “S…S3..” : ETX

Right figure shows the example of transmitting the command using FCTool. The shutter switch set value is changed to “3” as designated exposure time.




## [External designation of shutter exposure time]

It can externally designate the shutter exposure time (horizontal scan time: in H unit) by “ S ” command in the same fashion. It is done by assigning 4-digit values (in hexadecimal system) to “exposure time ” in the above transmission data.

[Example] To set the current shutter exposure time to hundredfold of the horizontal scan time (“0064” in hexadecimal system)
Transmit as follows
Transmission from host: STX : “S…0064” : ETX
(Note) Settable minimum value of the shutter exposure time is “0001” (=D’1), the maximum value is “0819” (=D’2073) in high speed shutter mode and “H’00FF” (=D’255) in low speed shutter mode.
The normal image cannot be output if the value beyond the above range is set.
Also, the external shutter setting is cancelled when “0000” (=D’0) is designated. (next section)

[Cancellation of external designation in shutter setting]

The shutter switch position set by “S command” or the external designation of the shutter exposure time (above two methods) is applied ahead of (hypothetical) shutter switch position.
These shutter setting (the external designation of the shutter switch position and the shutter exposure time) is cancelled by transmitting “0000” with “S” command as the exposure time parameter.

[Example] To restore the current shutter switch setting to the value designated by the (hypothetical) shutter switch.
Transmit as follows
Transmission from host: STX : “S…0000” : ETX

## (7-3) How to set Mode switch

The mode switch is also hypothetical switch.
It can designate the program page on camera start-up by setting the mode switch position to any of A to F.
(!) It corresponds to the method setting the mode switch on the rear panel.

- Command “WMSW”
  Function: Command for writing the mode switch set value (Write Mode Switch)

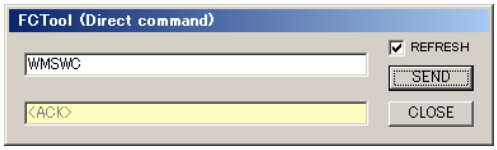
  Transmission from host: STX : “WMSW” : set value : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK: ETX (transaction rejection)

  ※ The “set value” (one character: “A” to “F”) is written into mode switch.

(Note) Set contents by this command are all lost when the power is turned off as they are not written into EEPROM (nonvolatile memory) by this command. Execute another command “SMSW”(Save Mode Switch) if it is needed to save the set contents into EEPROM.

[Example] To set the mode switch to “C”
Transmit as follows
Transmission from host: STX : “WMSW” : “C” :ETX

Right figure shows the example of transmitting the command using FCTool. The mode switch is set to “C”.



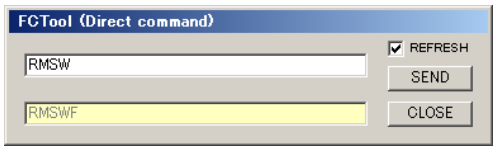

- Command “RMSW”
  Function: Command for reading out the mode switch set value (Read Mode Switch)

  Transmission from host: STX : “RMSW” : ETX
  Return by camera: STX : ACK : “RMSW” : set value : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ The current “set value” (one character: “A” to “F”) of the mode switch is read out.

[Example] To read out the current set value of mode switch
Transmit as follows
Transmission from host: STX: “RMSW”: ETX

Right figure shows the example of transmitting the command using FCTool. Set value of mode switch “F” is read out.




- Command “SMSW”
  Function: Command for saving the mode switch set value (Save Mode Switch)

  Transmission from host: STX : “SMSW” : ETX
  Return by camera: STX : ACK : set value : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

※ The current “set value” (one character: “A” to “F”) of the mode switch is saved into nonvolatile ROM.

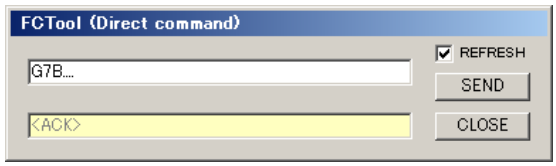
[Explanation]
The set contents of the program page can not be read out by merely changing the program page settings.
The set contents designated in this page are automatically loaded when the set values are saved in nonvolatile ROM and restarted (application of power or “ARESET”) next time.
The mode switch position is set to “A” as default .The set contents stored in program page A is automatically loaded at start-up and the operational mode is determined.

## (7-4) How to set Gain

"G" command is used for gain setting.

Transmission from host: STX : "G" : MGC set value : AGC set value : (VRT set value) : (VRB set value) : OFFSET set value : ETX
Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

- MGC gain setting … Setting the fixed gain.




[Example] To set the MGC gain to "123"(=H'7B)
Transmit as follows
Transmission from host: STX: "G": "7B" : "…." ETX

(Note) "…." (four periods)

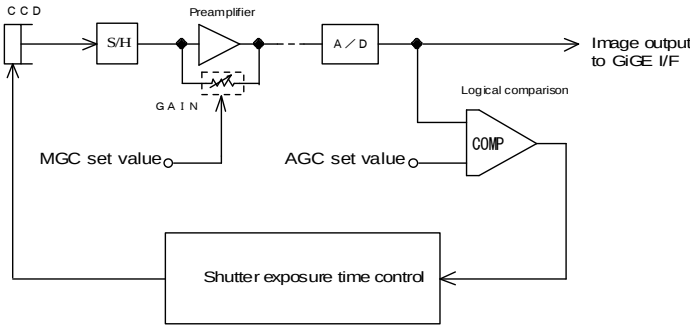
Right figure shows the example of transmitting the command using FCTool. The MGC set value is set to "7B".

- AGC gain setting … Setting the AGC gain (reference value).

[Example] To set the AGC gain to "82"(=H'52)
Transmit as follows
Transmission from host: STX: "G" : " ." : "52" : " … " ETX

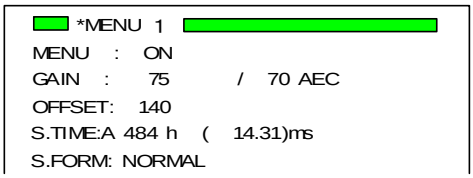
[Explanation] The replacement of set value by " . "
It can use " . " as replacement of the parameter value which should not be changed, if it is needed to change only the specific parameters by the communication command accompanying plural parameters such as "G" command.
For example, in the case of AGC gain setting four " . " are used as replacement of each of "MGC","VRB","VRT" and "OFFSET".

- Gain setting in AEC…. In AEC (Auto Exposure Control), AGC gain set value is applied as the reference value and MGC set value as the fixed preamplifier gain value.




Block diagram of AEC control

When AEC function is ON, the value displayed at the left side of GAIN column on OSD menu is MGC set value, and the value displayed at the right side is AGC set value.
(→ MGC set value=75, AGC set value=70 in the right example)
In the AEC function, the shutter exposure time is automatically controlled with reference to AGC set value( comparative level).
The average of image output level is increased or decreased in proportion to AGC set value.
Increase the AGC set value when it is needed to increase the output image luminance.




AEC ON / Menu1 display

Preamplifier gain of A/D converter is defined in terms of MGC gain value.
MGC gain value can be set independently of AGC set value.
If MGC set value is increased, the sensitivity is improved but the S/N ratio degrades.

[Example] To set AGC set value (reference value) to "75" (=H'4B) and MGC set value(preamplifier gain) to "100" (=H'64) .
Transmit as follows
Transmission from host: STX: "G": "64" : "4B" : "…" ETX

## (7-5) Internal flag register and configuration register

There is RAM area inside the camera consisting of flag register (FR) (2 bytes) and configuration register (CR) (2 bytes) which defines the operational mode of the camera.
It is possible to recognize the current operational status with these register contents and to change multiple operational modes at a time by rewriting the register contents using serial communication command.
The functions of each flag register and configuration register are described below.

● Flag register (FR) and configuration register (CR)

The contents of the internal EEPROM (nonvolatile ROM) are retrieved at the time of startup and copied onto FR and CR which are the double-byte (16-bit) storage area on RAM. The camera decides the current operational mode in accordance with the contents of FR and CR.
The one each of the contents of FR is saved on each program page (A to F) and that contents is copied onto the flag register to decide the operational status by auto-loading on start-up or manual loading of program page. In contrast, the contents of CR is saved on a single storage area on EEPROM and they are read out independently of program page to decide the operational mode.

● Contents of (FR) and (CR )

When the OSD menu is turned on, the contents of each register are displayed on the menu in eight figures like "MF=0000.0000" representing the current status of the registers.
Each numerical value is displayed in hexadecimal system. The first half (upper 2 bytes) represents the set contents of the configuration register (CR) and the last half (lower 2 bytes) represents the set contents of the flag register (FR).

[Contents of CR]

| Bit | Abbrev. | Contents | Logic | Remarks |
|---|---|---|---|---|
| 0 | MNI | Disabled display of menu screen | 1: Disabled (OFF) | |
| 1 | - | (not used) | | |
| 2 | TPEN | ON/OFF selection of test pattern | 1: Test pattern ON | |
| 3 | DFRM0 | Selection of output data format | (DFRM1,DFRM0) : 00: 10BIT<br>01: 8BIT,10: 12BIT, 11: ( - ) | (DFRM1,DFRM0) 11: Inhibited |
| 4 | DFRM1 | | | |
| 5 | STRB0 | Selection of output mode on STRB output terminal | (STRB1,STRB0) : 00: OFF<br>01: STRB,10: BUSY, 11: ( - ) | (STRB 1, STRB 0) 11: Inhibited<br>OFF: Normally H level output |
| 6 | STRB1 | | | |
| 7 | CC1P | Selection of polarity of trigger signal (Vinit2) via CC1 | 1: Positive polarity | |
| 8 | HREN | Permission of H-reset in asynchronous shutter operation | 1: H-reset permitted | |
| 9 | (BAUD) | Selection of serial communication baud rate | (Fixed to 0=9600bps) | Unable to change via serial communication<br>(possible to read out) |
| 10 | - | (not used) | | |
| 11 | - | (not used) | | |
| 12 | - | (not used) | | |
| 13 | - | (not used) | | |
| 14 | - | (not used) | | |
| 15 | DFER | Request for reading out default value at next start-up | 1: Request | |

(Note) The contents of CR are " CR(3)=1, All other bits=0 " by default (Factory default).

[Contents of FR]

| Bit | Abbrev. | Contents | Logic | Remarks |
|---|---|---|---|---|
| 0 | ASYE | Selection of continuous/asynchronous shutter | 1: Asynchronous(ASYNC) | |
| 1 | PWCE | Selection of enabled/disabled for pulse width control | 1: Pulse width control | |
| 2 | LEXE | Selection of high speed/low speed shutter | 1: Low speed shutter | |
| 3 | PSCE | Selection of normal scan/partial scan | 1: Partial scan | |
| 4 | - | (not used) | | |
| 5 | - | (not used) | | |
| 6 | - | (not used) | | |
| 7 | - | (not used) | | |
| 8 | ESP(0) | Externally designated shutter speed position | H'0 to H'9 or H'F | Where ESPE=1, externally designated number from 0 to 9 (designated position) is reflected. In case of H'F, external shutter speed in H unit is selected. |
| 9 | ESP(1) | | | |
| 10 | ESP(2) | | | |
| 11 | ESP(3) | | | |
| 12 | ESPE | Validity of externally designated shutter speed | 1: Valid | |
| 13 | - | (not used) | | |
| 14 | AECE | Validity of auto Exposure Control | (AGCE,AECE) : 00: OFF<br>01: AEC,10: AGC, 11: ( - ) | When in OFF, MGC=OFF and AEC=OFF (AGC,AECE):<br>11:inhibited |
| 15 | AGCE | Validity of auto Gain Control | | |

(Note) The contents of FR are all "0" by default (Factory default).

(Example) If "MF=H'0040.0003" is displayed on the menu screen, the camera is in the following state (converting the numbers to ones in binary system):
H'00=B'00000000, H'40=B'01000000 and H'03=00000011 are substituted to the above numbers.
CR=B'0000000001000000, FR=B'0000000000000011
…… CR(6)=FR(1)=FR(0)=1, All other bits = 0
(Where CR(n) and FR(m) represent the nth bit of CR and mth bit of FR respectively)
Based on 1 or 0 of these bits and the information in the above table, the user can know that the camera is in the state of "Enabled STRB signal output in the continuous shutter", "ASYNC" and "Enabled pulse width control".

(Note) Any of set items of FR are only stored on the nonvolatile memory by saving those to any of program page “A” to “F” using “WA” to “WF” command (Write into page memory A to F) before turning the power off.
Also set items of CR are stored on the nonvolatile memory inside the camera by executing “SMC” command (Save Mode Configuration) after changing.
Note that the changes in either setting are not saved when turning the power off without saving (onto nonvolatile memory) and the set contents return to those before setting change at the next power-on.

(Note) CR is applied independently of the current program page, as it is one of the configuration items.

[Terminology] Configuration item ... The common configuration item that is independent of the program page.
The configuration items contain hypothetical mode switch, hypothetical shutter switch and VSUB voltage set value in addition to CR.

● Setting of configuration register (CR ) by serial communication command
Setting ,reading and saving of CR in this camera are all executed using serial communication command.

- Command “WMC”
  Function: Command for writing on the configuration register (Write Mode Configuration)

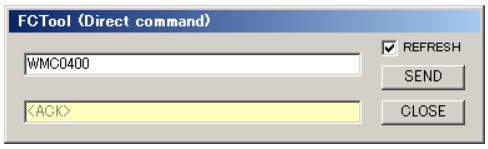
  Transmission from host: STX : “WMC” : set value : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ “ set value”(four characters in hexadecimal) is written on CR .

  (Note) This command does not execute the writing in EEPROM, and the setting by this command is lost when the power is turned off. To save the setting value in EEPROM, use another command, “SMC”(Save Mode Configuration).

[Example] To set “0400” (=H’0400) to CR.
Transmit as follows
Transmission from host: STX: “WMC”: “0400” : ETX

Right figure shows the example of transmitting the command using FCTool. The CR is set to “0400”.

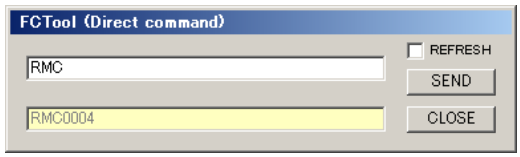



- Command “RMC”
  Function: Command for reading the configuration register (Read Mode Configuration)

  Transmission from host: STX : “RMC” : ETX
  Return by camera: STX : ACK : “RMC” : set value :ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ The current “set value”(four characters from “0000” to “FFFF”) of CR is read out.

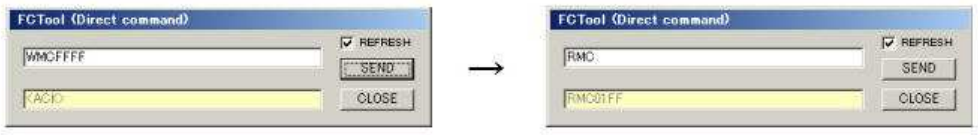
Right figure shows the example of transmitting the command using FCTool. The data of CR “0004” is read out.




- Command “SMC”
  Function: Command for saving the shutter switch value (Save Mode Configuration)

  Transmission from host: STX : “SMC” : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

※ The current “set value”(four characters from “0000” to “FFFF”) of CR is saved into nonvolatile ROM.
(Note) The several bits in CR are inhibited from writing via serial communication.
Note that it is not regarded as error even when the writing to these bits is executed via serial communication.
The figure below shows the example of writing the set value “FFFF”. In this case, the confirmatory result by readout command is “01FF”.




Writing “FFFF”

Confirmatory result

→ Refer to the table [Contents of CR] in this section for the details about inhibit bit .

● Setting of flag register (FR ) by serial communication command
Setting ,reading and saving of FR in this camera are all executed using serial communication command.

- Command “WMF”
  Function: Command for writing on the flag register (Write Mode Flag)

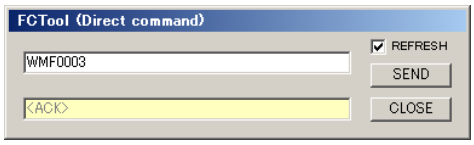
  Transmission from host: STX : “WMF” : set value : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ “ set value”(four characters in hexadecimal) is written on FR .

  (Note) This command does not execute the writing in EEPROM, and the setting by this command is lost when the power is turned off. To save the setting value in EEPROM, use another command “WA” to “WF”(Write into page A to F).

  [Example] To set “0003” (=H’0003) to FR.
  Transmit as follows
  Transmission from host: STX: “WMF”: “0003” : ETX

  Right figure shows the example of transmitting the command using FCTool. The FR is set to “0003”.

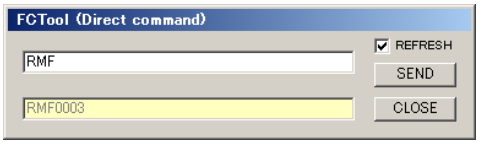



- Command “RMF”
  Function: Command for reading the flag register (Read Mode Flag)

  Transmission from host: STX : “RMF” : ETX
  Return by camera: STX : ACK : “RMF” : set value :ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ The current “set value”( “0000” to “FFFF”) of FR is read out.

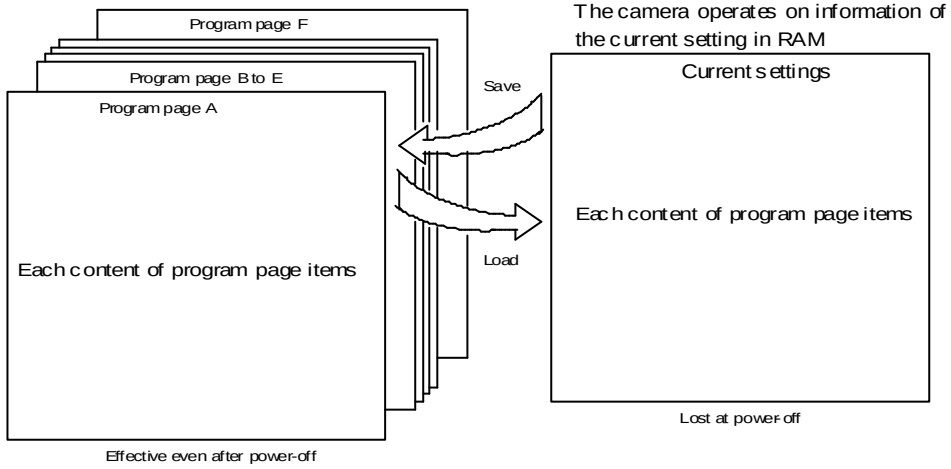
  Right figure shows the example of transmitting the command using FCTool. The data of FR “0003” is read out.




  (Note) The settings of FR are saved using “WA” to ”WF” command.

(7-6) Setting of program page

The setting operations for the program pages are roughly divided into 2 groups: save (writing the current setting into the program page) and load (reading out the setting that was previously saved in the program page as the current setting). More specifically, “save” means overwriting the new setting that was changed from the current one onto one of the program pages after turning on the power while “load” means the opposite operation that is reading out the setting saved in one of the program pages as the current setting.




Conceptual diagram of saving and loading operations

[Terminology] Program page item … Set items which are saved for each program page (A to F). Program page items contain Flag register(FR), MGC gain set value, AGC gain set value, Offset set value, Directly designated value of shutter speed and Electronic shutter table etc..

[Explanation] Correlation between current setting and program page

The setting information saved in the program page is automatically read out from nonvolatile ROM and written into internal RAM (volatile memory) in accordance with the (hypothetical) mode switch data (A to F) when the camera is turned on, and that determines the operation of the camera as the current setting.

When the setting of a mode is changed by serial command , the older one is overwritten, and the new setting is temporarily effective as the operation setting for the camera until the power is turned off. The new setting in the program page on RAM, however, is lost when the power is turned off, and the old setting before power-on will be effective for the operation of the camera.

Accordingly, it is absolutely necessary to write the new setting in one of the program pages from “A” to “F” to save it.

The setting saved in the program page can be read out for use by the loading operation (including automatic load at power-on) as described later.

- Automatic loading at power-on

  When the power is turned on, the camera automatically loads the setting stored in one of the program page from “A” to “F”, which determines the operation of the camera.

  The program page of which setting is automatically loaded is determined by the position of the (hypothetical) mode switch at the time of power-on.

| Position of mode switch | Automatically loaded program page |
|---|---|
| A | Program page A |
| B | Program page B |
| C | Program page C |
| D | Program page D |
| E | Program page E |
| F | Program page F |

- Saving/loading after power-on

  It is possible to read out the settings of program page “A” to “F” using serial command to reflect in the operation of the camera as the current settings. (loading)

  It is also possible to save the changed settings of program page to page “A” to “F”.(saving)

(Note) This saving operation must be performed to keep the new setting effective for later use after changing it.

- Command “WA” to “WF”

  Function: Command for saving in program page (Write into page memory A to F)

  Transmission from host: STX : “W” : “A to F” : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)
  ※ The current set values of program page items are saved into nonvolatile ROM area in specified page(A to F). .

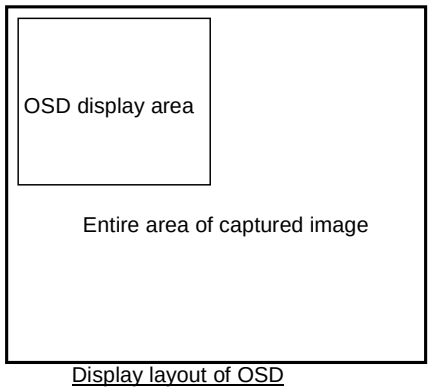
- Command “LA” to “LF”

  Function: Command for loading(reading out) program page (Load from page memory A to F)

  Transmission from host: STX : “L” : “A to F” : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)
  ※ The set values of program page(A to F) which are saved in nonvolatile ROM area are loaded and reflected in the current operation.

## (7-7) Description of menu display by OSD (On Screen Display)

This camera is equipped with the OSD function of superimposing a character information on the output digital image signal. Using this function, the current setting status of the camera can be displayed over the image of the capture board in menu-driven form.



Display layout of OSD

The menu display allows the user to quickly gain an understanding of the current settings at a glance. Furthermore, if the contents of the menu display are captured and saved before collecting data using the camera, they serve as useful information to be referred when comparing data or setting additionally introduced cameras.

- Requirement for menu display

The menu display requires a system that is capable of updating the captured image constantly responding to the timing of the image signal to be output from the camera on the demonstration software for image display or on the user's application software.
The display area of OSD is located on the upper left on the entire area of the captured image, and therefore this system must be additionally capable of displaying this menu on the screen.

- Display in the asynchronous shutter operation

When the asynchronous shutter mode is set for the camera, the repetitive asynchronous shutter operations are automatically made at certain intervals to automatically refresh the image so that the menu display is updated. During this process, the externally input trigger signals are ignored.

(Note) If the menu display is set to be on in the asynchronous shutter mode, the repetitive trigger (cyclic trigger) that is generated inside the camera is automatically input. Make sure to set the menu display off when the camera is used in the normal conditions (enabling external trigger input in online state). The external trigger signal (Vint) is ignored if the menu display is set to be on.

(Note) Note that the difference between the pulse width generated by the camera with the menu display turned on and that provided by the user unit results in the difference in the brightness of image (shutter speed) between those when the asynchronous shutter operation in the pulse width control mode is set (S.FORM=ASYNC/HIGH, PWC=ENABLED).

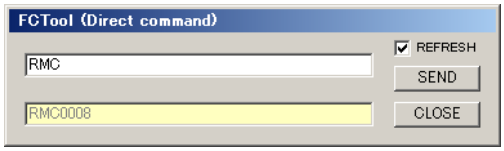
- ON/OFF operation of menu display

OSD menu is set to be on as a factory default.
ON/OFF operation of the menu display is done using the serial communication command.

[ON/OFF switching procedure]

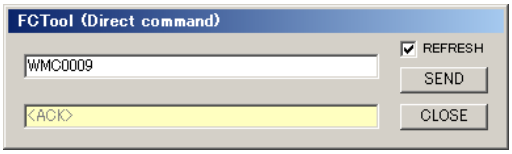
Set CR(0) (bit 0 of configuration flag) to 1 (OFF) or 0 (ON) following the procedure below.

① Read out the current CR data.
Transmit the command "RMC" and acquire the return data.
→ Refer to (7-5)




[Example]
Right figure shows the example of transmitting the command using the direct command input of TAKENAKA's communication software for evaluation (FCTool)
It turns out that
CR=H'0008
From this return data
CR(0)=0 and OSD menu display is set to ON now.

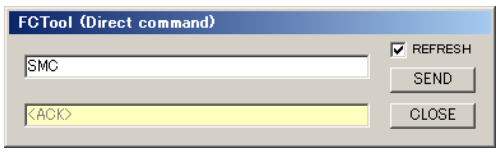
② Change the least significant bit of CR data to 0(OFF) or 1(ON) and rewrite the camera setting.
After having changed CR(0) which was read in procedure ① to 1 or 0, transmit it to the camera by "WMC" command.



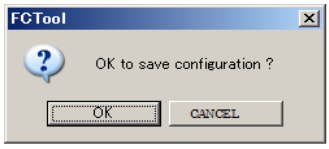

[Example]
In the "CR=H'0008"case above, menu setting is changed from ON to OFF by rewriting the camera setting with CR(0)=1.
Write the new data "CR=H'0009" setting CR(0) to 1.
"WMC" command is transmitted by the direct command input of FCTool In the right figure.

(Note) The above procedures ① to ③ can be performed by clicking "MENU OFF" or "MENU ON" button on the main window , when using FCTool.

③ Save CR data to enable the settings at next start-up.
As the CR data set on② are stored only on RAM, it will be lost at the time of power-off.
It is needed to send the “SMC” command and to save the set values into the internal nonvolatile ROM(EEPROM) to enable CR data even after next start-up.

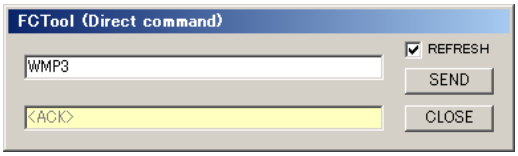



[Example]
Right figure shows the example of transmitting the command “SMC” using the direct command of FCTool.




(Note) When using FCTool, “SMC” command can be performed following next procedure as well.
Select Tools → Save → Configuration Flags in series on the menu bar.
Click the “OK” button on “OK to save confirmation?” screen.

- Switching of the menu page
Set contents are displayed item by item on the plural menu pages.
“WMP” command is used to change the menu page.



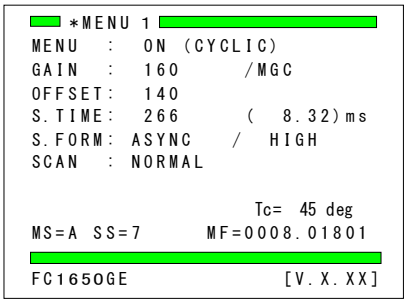

[Example]
Right figure shows the example of transmitting the command “WMP3” using the direct command input of TAKENAKA's communication software for evaluation (FCTool) to switch the menu page to “MENU3”.

- Description of display content

Current settings of MENU 1,2,3,4 are displayed.

<MENU1> Display content

MENU: Current menu status is displayed.
While the menu is being displayed, “ON” is kept displayed.
When “(CYCLIC)” is displayed on the right side, the camera is cyclically outputting the asynchronous shutter image using the internal trigger to refresh the image.
When the asynchronous shutter mode is set and the menu is set to ON, the cyclic trigger input is automatically selected. When the menu is set to OFF, the cyclic trigger input is automatically cancelled and external trigger is ready to be received.




Menu 1 display

GAIN: The left number is the gain setting value expressed in the decimal system. (Range: 0 to 255). The item which is currently valid among MGC/AGC/AEC is displayed on the right side.

OFFSET: The set value of the digital signal offset is displayed in the decimal system. (Range: 0 to 255)

S.TIME: The current shutter exposure time is displayed. The left number is H number (horizontal synchronous time unit, in the case of high speed shutter) or V number (vertical synchronous time unit, in the case of low speed shutter). The right number in parentheses shows the actual time.
The actual time is displayed after being converted in accordance with the settings of the shutter mode (HIGH/LOW).

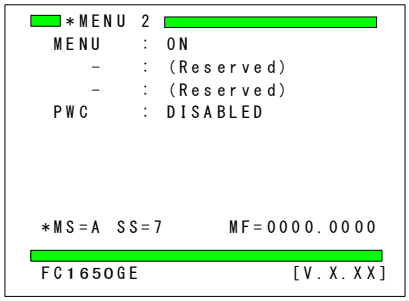
(Note) When the pulse width control mode is set for the asynchronous shutter operation or when a shutter setting value is out of the predetermined range, the actual time is displayed as “--.-”.

S.FORM: The current shutter operation mode is displayed. The left is either continuous (NORMAL) or asynchronous (ASYNC), and the right is either high speed (HIGH) or low speed (LOW).

SCAN: The current scanning mode is displayed. (NORMAL/PARTIAL)

<MENU2> Display content

PWC: Whether the pulse width operation mode is ENABLED or DISABLED in the asynchronous shutter mode when the shutter switch is positioned at “9” , is selected.




Menu 2 display

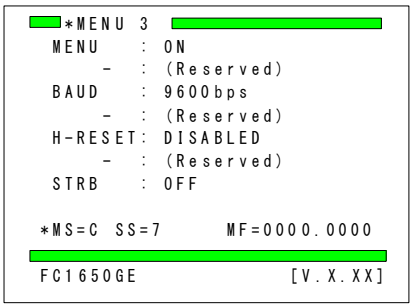
<MENU3> Display content

BAUD: The baud rate used for serial communication is displayed. The baud rate is fixed to 9600bps for this camera. The setting can not be changed.

H-RESET: It is selected whether or not to permit to reset (initialize) H timing. If it is permitted (ENABLED), H timing (horizontal synchronization timing ) is reset by the trigger signal input in asynchronous shutter operation.

STRB: The output signal on STRB output terminal of camera connector is selected.
OFF … Always output H level (Default setting)
STRB …Output STRB(strobe timing signal)
BUSY …Output BUSY(Asynchronous shutter busy signal)

(Note) The strobe signal can be output in any setting of Asynchronous shutter / Continuous shutter / No shutter.



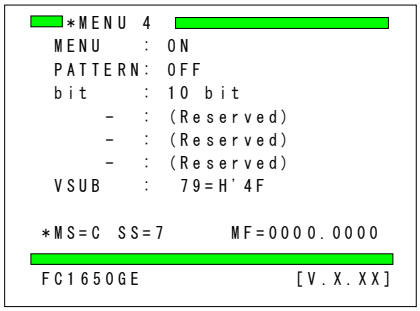

Menu3 display

<MENU4> Display content

PATTERN: This is to switch between ON /OFF for the test pattern output.

bit: This is to select the output bit format (gray scale) of the output data in Camera Link Std. 10bit, 8bit or 12bit format are settable for this camera. Default setting is 10bit gray scale.

VSUB: The setting value of Vsub voltage (substrate voltage of CCD element) is displayed.
Since the value is optimally set before shipment, the user is not required to change it as a general rule.



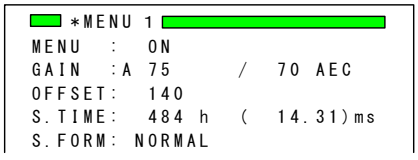

Menu4 display

* The following items are for display only; they cannot be directly changed on the menu. These are automatically updated when a corresponding change is made by the serial communication command.

MS= The current position of the (hypothetical) mode switch is displayed.
SS= The current position of the (hypothetical) shutter setting switch (EXP.) is displayed.
MF= The information (16 bits x 2 sets) of the internal mode flags of the camera (internal flags to determine operation) is displayed in the hexadecimal system. The details of the internal flags are described later.
Tc= The current internal temperature of the camera is displayed in Celsius. The temperature data are refreshed every 0.4 seconds.

● Menu (MENU1) display when setting AGC(Auto Gain Control)
When AGC is set ON, the value which is displayed on the left side column of “GAIN” on MENU1 is the current Preamplifier gain, the value on the right side is set value of “AGC”(reference value).

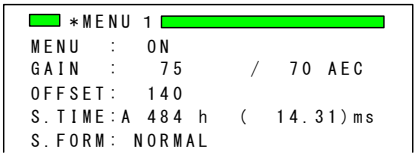
In “GAIN” column, the current Preamplifier gain is displayed. e.g. “A 120”
“A” represents dynamically changing value of Preamplifier gain




AGC operating／Menu1display

When it reaches to upper limit or lower limit of variable range of Preamplifier, “↑”(upper limit) or ”↓”(lower limit) marks are displayed. e.g. “↑A255” (Limit value varies among camera models)

● Menu (MENU1) display when setting AEC(Auto Exposure Control)
When AEC is set ON, the value which is displayed on the left side column of “GAIN” on MENU1 is ”MGC” (Preamplifier gain), the value on the right side is “AGC” (reference value).
In AEC operation, the exposure time is automatically controlled applying “AGC” set value as the reference value.




AEC operating／Menu1display

In addition, though AGC set value is applied as the reference value of AEC, combined use of AGC and AEC is not allowed.

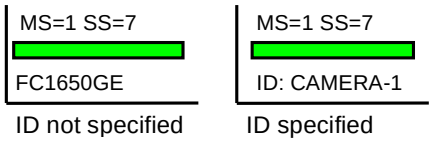
Also, “MGC” set value is applied as the Preamplifier set value of A/D converter in AEC operation.

The current shutter exposure time is displayed in “S.TIME”column.
e.g. “A 484 h ( 14.31) ms
“A” suggests that the shutter exposure time which dynamically changes in AEC mode is now displayed.

When it reaches to upper limit or lower limit of variable range of Shutter exposure time, “↑”(upper limit) or ”↓”(lower limit) marks are displayed. e.g. “↑A1250” (Limit value varies among camera models)

- Display of ID information

The ID code and other information set by the user for each camera can be stored in the camera (The setting is executed through the serial communication.). The settable maximum number of characters are 15, and alphabets (both upper and lower cases), numbers and some special symbols such as”+” and “-” excluding the control codes can be used.



ID not specified　　ID specified

Set ID code can be confirmed as it is displayed on the lower left of “MENU display of set group 1” (On screen display)
(When ID code is not set, the camera type is displayed.)
The right figures shows the display example setting “CAMERA-1” as ID information.

- Confirmation of changed settings by menu

They can also be changed by serial communication command confirming the currently displaying menu contents.
Each time the settings of each menu item are changed, display contents is updated.

## (7-8) Description of scan mode and functional limitation

- Description of scan mode

This camera has the following two scan modes which are selectable by setting:

| Scan mode | Operation | Horizontal period/Vertical period | Frame rate |
|---|---|---|---|
| Normal scan mode (NORMAL) | Readout of all 1.45 megapixels | 31.25μs/33.38ms | 31Hz |
| Partial scan mode (PARTIAL) | Read out of 0.6megapixels (440 lines) at the central area | 31.25μs/16.69ms | 62Hz |

- Normal scan mode……..The image of all effective pixels is read out at 31 Hz frame rate of.
- Partial scan mode……The image of the central area of 440 lines in vertical width is read out at 62Hz frame rate.
  .This mode is suitable for capturing the image only of the central area at a high speed.

- Functional limitation by scan mode

Usable functions vary by the scan mode that is currently selected.
The functions marked with O in the following table are usable and those marked with ✕ are not usable.

| Current scan mode | No shutter | Continuous shutter | Asynchronous shutter | Long exposure | AGC or AEC |
|---|---|---|---|---|---|
| Normal scan mode (NORMAL) | O | O | O | O | O |
| Partial scan mode (PARTIAL) | O | O | O | X | X |

(Note) Carefully note that the operation is not guaranteed if an unusable function is selected.
(Note) Caution is required especially when control is executed using the write commands for the flag register among the serial communication commands because the incompatibility between the selected scan mode and the selected function is not warned. Setting of an inappropriate parameter results in operation failure.

(7-9) Read out of factory default

This procedure is for reading out the factory default (initial setting before shipment) in order to initialize the setting that was changed by the user after purchase.
The factory default is shown by the table below.

[Factory default of each register]

| | Storage area (Register) | Factory default |
|---|---|---|
| Program page item<br>(Stored in each program page)<br><br>※Applied to page A to F | Flag register (FR) | FR = H'0000 |
| | MGC gain set value | (Factory default) |
| | AGC gain set value | (Factory default) |
| | Offset set value | (Factory default) |
| | Direct designated value of shutter speed | H'0000 (none specified) |
| | Electric shutter table | Contents of table 5-3 |
| Configuration item<br>(Stored in common area) | Configuration register (CR) | CR=H'0008 |
| | Hypothetical shutter switch | 0 |
| | Hypothetical mode switch | A |
| | ID data | Blank |
| | Vsub voltage set value | (Factory default) |

(Note) (Factory default) is the adjusted value for each camera.
(!) The factory setting of configuration register for this camera is CR=H'0008 and the image output format is 8bit.

[The procedure for restoring the setting to factory default]

① Transmit " e " command by serial communication.
② Turn off the power to the camera. Several seconds after that , restore the power.

→The settings inside the camera (contents of nonvolatile EEPROM) are restored to the factory default of the upper table by this operation.
(Note) Note that the contents having being set by the user are all lost by executing upper procedures.

## 8. Serial communication command

This camera can be externally controlled by the serial interface via Ethernet.

(Note) When the operation modes of the camera are changed by the communication functions, it takes some time to switch the modes. Carefully note that normal image may not be obtained from the signal for one frame each before and after transmitting a command.
(Note) The settings and timings of the serial communication commands are the same as those of the products that have the conventional RS-232C communication functions (e.g. FC2000).

- The setting of the serial communication is as follows:
  Baud rate : 9600bps
  Data : 8bit / character
  Start bit : 1start bit
  Stop bit : 1stop bit
  XON/XOFF : no control
  (!) The baud rate is fixed to 9600bps for this camera. The setting can not be changed.

- Serial communication commands
  The command packet starts with STX(02h), followed by command code(s) and command option parameter(s) and ends with ETX(03h). All those are of 8 bit ASCII codes.
  When the camera receives 1 packet (by detecting ETX:03h) and judges it is a normal packet, it returns a transaction completion signal (ACK: 06h) or others corresponding to the commands received. When the camera judges it is an abnormal packet, it returns the abnormal signal (NAK: 15h).

- Operation mode “Group 1/2” and reception of serial communication commands
  Serial communication commands are received only for the period when the camera is in the operation mode of “Group 1” (= “normal power-on state”).
  However, only the command “ARESET” (restoring to power-on state) is received even during the periods when the camera is in the operation modes of Group 2 to D.

- Description of commands

  (1) Command “e”
  Function: Initialization of page memory

  Transmission from host: STX: “e”: ETX
  Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

  * CPU initializes each of the page memories when the power is turned on next time. “Initialization” here means restoring the parameter values stored in the internal EEPROM of the camera to the factory default values.

  (2) Command “eCLR”
  Function: Cancellation of initialization request of page memory

  Transmission from host: STX: “eCLR”: ETX
  Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

  * The command for cancelling the request for initialization of page memory at next start-up by “e” command.

  (3) Command “R”
  Function: Command for reporting camera operation and setting status
  The contents of the report can be selected by adding the following option code after the command code “R”.
  G: Gain report
  S: Shutter report
  T: Shutter SW set report
  V: Camera version report

  1) Analog report
  Transmission from host: STX: “R”: “A”: ETX
  Return by camera: STX: ACK: “R”: (SETUP set value) : (WC set value): “1” : ETX

  (!) FC/FS1650GE does not use the values in parentheses. This camera returns the fixed values instead. However it is not regarded as error even when the value in parentheses is input.

  2) Gain report
  Transmission from host: STX: “R”: “G”: ETX
  Return by camera: STX: ACK: “R”: MGC set value: AGC set value: (VRT set value): (VRB set value): OFFSET set value: ETX

  (!) FC/FS1650GE does not use the values in parentheses. This camera returns the fixed values instead.

3) Camera version report
Transmission from host: STX: “R”: “V”: ETX
Return by camera: STX: ACK: “R”:
“Takenaka SYS.FC1650GE VX.XX TXXXXX”: ETX

* The underlined values show the control program version number of the camera and a file name. These values and the number of characters vary by program version. Use it when confirming the communication mode of the camera and obtaining internal information of the camera.
The maximum number of the characters to be inserted between ACK and ETX is 48.

4) Shutter SW report
Transmission from host: STX: “R”: “T”: “H” or “L”: ETX
Return by camera: STX: ACK: “R”: “H” or “L”:
SW0: SW1: SW2: SW3: SW4: SW5: SW6: SW7: SW8: SW9: ETX

5) Shutter mode report
Transmission from host: STX: “R”: “S”: ETX
Return by camera: STX: ACK: “R”: “A” or “M”: “H” or “L”: “N” or “F”: Exposure time: ETX
Character strings has the following meanings.
STX: ACK: “R”: “A” or “M”: “H” or “L”: “N” or “F”: Exposure time: ETX
*1 *2 *3 *4

*1 A: Asynchronous shutter
M: Continuous shutter
*2 H: High speed shutter
L: Low speed shutter
*3 N: Normal scan
F: Partial scan
*4 : Exposure time

- Four characters are returned as the electronic shutter exposure time.
- In the case where the electronic shutter exposure time is externally set:
When the exposure time is set in the unit of H (horizontal scan time), the exposure setting count value of the time in H is returned.
Example) If the shutter exposure time is 8Hs (Horizontal scan time× 8): 0008”
If the shutter exposure time is 120Hs (Horizontal scan time× 120): “0078”
- In the case where the electronic shutter exposure time is set by the hypothetical shutter switch number l:
Example) If the shutter switch is set to “4”: “I4..”
- In the case where the electronic shutter exposure time is set by the shutter switch number via a serial communication command:
Example) If “3” is specified for the shutter switch, : “S3..”

(Note) The allowable range is as follows when in directly specifying the exposure time. The operation out of the range is not guaranteed.
In High speed shutter: H’0000 to H’04E2 (D’0 to 1066) (Where, “0” is used only when cancelling the external shutter setting. )
In Low speed shutter: H’0000 to H’00FF (D’0 to 255) (Where, “0” is used only when cancelling the external shutter setting. )
In Partial sanning: H’0000 to H’026C (D’0 to 533) (Where, “0” is used only when cancelling the external shutter setting. )

(4) Command “G”
Function: Command for setting gain

Transmission from host: STX: “G”: MGC set value: AGC set value: (VRT set value): (VRB set value): OFFSET set value: ETX
Return by camera: STX: ACK: ETX (transaction completion) or STX: NAK: ETX (transaction rejection)

(!) This camera does not use the values in parentheses “ . ” must be transmitted to the camera.

2 digit ASCII codes in the hexadecimal system are used for the data setting values of MGC,AGC and OFFSET.
Example) If level 128 (decimal) is set: “80”
If level 200 (decimal) is set: “C8”
The setting value that does not require a change should be represented by “.” (a full stop) so that the setting value before the command transmission is retained.
Example) if only MGC is changed to Level 90 (decimal):
STX: “G”: “5A”: “.”: “.”: “.”: “.”: ETX

(5) Command “S”
Function: Command for setting shutter mode and shutter exposure time

Transmission from host: STX: “S”: “A” or “M”: “H” or “L”: “N” or “F”: exposure time: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The transmitting command has the following meanings:
STX: “S”: “A” or “M”: “H” or “L”: “N” or “F”: Exposure time: ETX
*1 *2 *3 *4

*1 A: Asynchronous shutter
M: Continuous shutter

*2 H: High speed shutter
L: Low speed shutter
*3 N: Normal scan
F: Partial scan
*4: Exposure time
The format of “Exposure time” complies with one of the followings:
a. 4 characters representing 2-byte number and corresponding to the hexadecimal system
b. 4 characters of “S” “0 to 9” “..” for externally specifying a shutter position (2 full stops of “.” in the last are mandatory.)

● In the case where the electronic shutter exposure time is externally set:
When the exposure time is set in the unit of H (horizontal scan time), the exposure setting count value of the time in H is set.
Example) If the shutter exposure time is 17Hs (Horizontal scan time × 17):
STX: “S”: “.”: “.”: “.”: “0011”: ETX
● In the case where the exposure time is set by the hypothetical shutter SW number:
Example) If the shutter SW is set to “4”:
STX: “S”: “.”: “.”: “.”: “S4..”: ETX
● In the case where the exposure time is set to 3Hs in the asynchronous/high speed shutter mode:
STX: “S”: “A”: “H”: “.”: “0003”: ETX
● In the case where the control is returned to the setting by the (hypothetical) shutter switch:
STX: “S”: “.”: “.”: “.”: “0000”: ETX

(Note) The exposure time setting using “S” command is given priority over the set position of the shutter switch.
It is needed to specify the exposure time to “0000” and transmit the S command via serial communication to restore the exposure time setting to the value specified by the set position of the (hypothetical) shutter switch.
(Note) The set contents are stored by saving them to the program page by “W” command (“WA” to “WF”).

(6) Command “A”
Function: Command for setting analog image signal

Transmission from host: STX: “A”: (SETUP set value): (WC set value): “.”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(!) Nevertheless FC1650GE does not use the values in parentheses, it is not regarded as error even when the value in parentheses is input. The received set value is neglected.

(7) Command “E”
Function: Command for editing shutter menu

Transmission from host: STX: “E”: “H” or “L” : SW0: SW1: SW2: SW3: SW4: SW5: SW6: SW7: SW8: SW9: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The transmitting command has the following meaning.
STX: “E”: “H” or “L” : SW0: … : SW9: ETX
*1 *2 … *2
*1 H: High speed shutter
L: Low speed shutter
*2 The exposure time (H) to be allocated to the shutter SW number is expressed in 4 digits in the hexadecimal system for SW0 to SW9.

Example) If only the exposure time of SW5 for the high speed shutter operation is changed to 88 (decimal):
STX: “E”: “H”: “.”: “.”: “.”: “.”: “.”
: “0058”: “.”: “.”: “.”: “.”: ETX
(Note) For the SW0, regardless of the specified exposure time ,it always goes into no shutter operation mode by setting the shutter switch position to 0.
(Note) The allowable range is as follows when in setting the exposure time by this command. The operation out of the range is not guaranteed.
In High speed shutter: H’0000 to H’042A (D’0 to 1066) (Where, “0” is used only when cancelling the external shutter setting. )
In Low speed shutter: H’0000 to H’00FF (D’0 to 255) (Where, “0” is used only when cancelling the external shutter setting. )
In Partial scan mode: H’0000 to H’0215 (D’0 to 533) (Where, “0” is used only when cancelling the external shutter settin

(8) Command “W”
Function: Command for saving operation mode (Write into page memory)

Transmission from host: STX: “W”: memory page (“A” to “F”): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current settings are written and saved in the EEPROM of the specified page number.

(9) Command “L”
Function: Command for reading out operation mode (Load)

Transmission from host: STX: “L”: reading page (“A” to “H”): ETX
Return by camera : STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

* The factory default is stored in the Page H, which will be used when restoring to the default setting.

(10) Command “WMC”
Function: Command for writing in configuration flag register (CR) (Write Mode Configuration)

Transmission from host: STX: “WMC”: flag set value: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The contents of “flag set value” (2 bytes/4 characters) are written in the configuration register.
(Note) This command does not execute the writing in EEPROM, and the setting by this command is lost when the power is turned off. To save the setting value in EEPROM, use another command, “SMC”.

(11) Command “WMF”
Function: Command for writing in mode flag register (FR) (Write Mode Flag)
Transmission from host: STX: “WMF”: flag set value: ETX
Return by camera : STX: ACK: ETX (transaction completion) or STX: NAK: ETX (transaction rejection)

The contents of “flag set value” (2 bytes/4 characters) are written in the flag register.
(Note) This command does not execute the writing in EEPROM, and the setting by this command is lost when the power is turned off. To save the set value in EEPROM, use other commands, “WA to WF”, to save in the specified pages.

(12) Command “RMC”
Function: Command for reading configuration flag register (CR) (Read Mode Configuration)

Transmission from host: STX: “RMC”: ETX
Return by camera: STX: ACK: “RMC”: flag set value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the configuration register (2 bytes/4 characters) are returned in the hexadecimal system.

(13) Command “RMCA”
Function: Command for reading specified bit of configuration flag register (CR) (Read Mode Configuration And)

Transmission from host: STX: “RMCA”: “Specified bit(4 characters) : ETX
Return by camera: STX: ACK: “RMC”: flag set value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the specified bit of the configuration register (2 bytes/4 characters) are returned in the hexadecimal system. “Specified bit” is defined by 2 bytes data (4 characters) in binary coded hexadecimal system assigning “1” to the specified bit and “0” to the other bit.
(Example) Transmit as (STX) RMCA1005(ETX) to read specified bit12,2 and 0.

(14) Command “RMF”
Function: Command for reading mode flag register (FR) (Read Mode Flag)

Transmission from host: STX: “RMF”: ETX
Return by camera: STX: ACK: “RMF”: flag set value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the mode flag register (2 bytes/4 characters) are returned in the hexadecimal system.

(15) Command “RMFA”
Function: Command for reading specified bit of mode flag register (FR) (Read Mode Flag And)

Transmission from host: STX: “RMFA”: specified bit(4 characters) : ETX
Return by camera: STX: ACK: “RMF”: flag set value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the specified bit of the mode flag register (2 bytes/4 characters) are returned in the hexadecimal system. “Specified bit” is defined by 2 bytes data (4 characters) in binary coded hexadecimal system assigning “1” to the specified bit and “0” to the other bit.
(Example) Transmit as (STX) RMFA1005(ETX) to read specified bit12, 2 and 0 in the register.

(16) Command “BCMC”
Function: Command for clearing the specified bit of configuration flag register (CR) (Bit Clear Mode Configuration)

Transmission from host: STX: “BCMC”: specified bit(4 characters) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The specified bit of the mode flag register is cleared (reset).
The specified bit is defined by the data assigning “1” to the corresponding bit.
(Example) Transmit as (STX) BCMC1005(ETX) to clear the specified bit12,2 and 0 in the register.

(17) Command “BCMF”
Function: Command for clearing the specified bit of mode flag register (FR) (Bit Clear Mode Flag)

Transmission from host: STX: “BCMF”: specified bit(4 characters) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The specified bit of the mode flag register is cleared (reset).
“Specified bit” is defined by 2 bytes data (4 characters) in binary coded hexadecimal system assigning “1” to the specified bit and “0” to the other bit.
(Example) Transmit as (STX) BCMF1005(ETX) to clear the specified bit12,2 and 0 in the register.

(18) Command “BSMC”
Function: Command for setting the specified bit of configuration flag register (CR) (Bit Set Mode Configuration)

Transmission from host: STX: “BSMC”: specified bit(4 characters) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The specified bit of the configuration register is set.
“Specified bit” is defined by 2 bytes data (4 characters) in binary coded hexadecimal system assigning “1” to the specified bit and “0” to the other bit.
(Example) Transmit as (STX) BSMC1005(ETX) to set the specified bit12,2 and 0 in the register.

(19) Command “BSMF”
Function: Command for setting the specified bit of mode flag register (FR) (Bit Set Mode Flag)

Transmission from host: STX: “BSMF”: specified bit(4 characters) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The specified bit of the mode flag register is set.
“Specified bit” is defined by 2 bytes data (4 characters) in binary coded hexadecimal system assigning “1” to the specified bit and “0” to the other bit.
(Example) Transmit as (STX) BSMF1005(ETX) to set the specified bit12,2 and 0 in the register.

(20) Command “SMC”
Function: Command for saving configuration flag register (CR) (Save Mode Configuration)

Transmission from host: STX: “SMC”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the common mode flag register are saved in EEPROM.

(21) Command “RMP”
Function: Command for reading the current OSD menu page (Read Menu page)

Transmission from host: STX: “RMP”: ETX
Return by camera: STX: ACK: “RMP”: Page number(1 character) : ETX (transaction completion),
or STX: NAK: ETX (transaction rejection)

(22) Command “WMP”
Function: Command for switching the current OSD menu page to page n (Write Menu page)

Transmission from host: STX: “WMP”: n (1 character): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(23) Command “RTMP”
Function: Command for reading data of internal temperature of camera (Read TeMPerature)

Transmission from host: STX: “RTMP”: ETX
Return by camera: STX: ACK: “RTMP”: internal temperature data: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The current contents of the internal temperature data of the camera are returned in the hexadecimal system.
The effective data is the low 10 bits out of the returned 16 bits. This 10 bit value presents a signed integer value in two’s complement form -511 to 511. Actual temperature in Celsius is calculated by multiplying the value by a certain factor.

→ Refer to “(4-10) Monitoring function for internal temperature of camera” for the conversion method from the returned data to temperature value.

(24) Command “RMSW”
Function: Command for reading the hypothetical mode switch position (Read Mode SW)

Transmission from host: STX: “RMSW”: ETX
Return by camera: STX: ACK: n (1 character) : ETX (transaction completion),
or STX: NAK: ETX (transaction rejection)

(25) Command “WMSW”
Function: Command for switching the hypothetical mode switch position to n (Write Mode SW)

Transmission from host: STX: “WMSW”: n (1 character) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(26) Command “SMSW”
Function: Command for saving the hypothetical mode switch position (Save Mode SW)

Transmission from host: STX: “SMSW”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(27) Command “RSSW”
Function: Command for reading the hypothetical shutter switch position (Read Shutter SW)

Transmission from host: STX: “RSSW”: ETX
Return by camera: STX: ACK: n (1 character) : ETX (transaction completion),
or STX: NAK: ETX (transaction rejection)

(28) Command “WSSW”
Function: Command for switching the hypothetical shutter switch position to n (Write Shutter SW)

Transmission from host: STX: “WSSW”: n (1 character) : ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(29) Command “SSSW”
Function: Command for saving the hypothetical shutter switch position (Save Shutter SW)

Transmission from host: STX: “SSSW”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(30) Command “X”
Function: Command for generating asynchronous shutter trigger (eXecute Trigger)

Transmission from host: STX: “X”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

When the camera is set to be in the asynchronous shutter mode (except in the time when the menu is being displayed), this command enables the camera to update the image by internally generating the asynchronous trigger signal.
The internally generated trigger signal is of negative logic in 1ms±5%.

(Note) When the command “X” is received, “ACK”(transaction completion) is returned even if the asynchronous shutter mode is not selected or the menu is displayed (in the setting condition where the asynchronous shutter operation is disabled by the command “X”).
(Note) Since the command is executed through the serial communication, it does not quickly act unlike the trigger signal (Vint signal) which is input from the camera connector. Therefore, it is recommended to use the commands only when no immediacy is required, for example, in the case where the operation of the camera is checked for setting, or the moving velocity of an object to be shot is extraordinary slow.

(31) Command “ARESET”
Function: Command for operation reset (All Reset)

Transmission from host: STX: “ARESET”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

This command is used to restore the camera to the initial power-on state.

(Note) This command corresponds to the operation when the camera is restarted after the power is turned off. The data stored in EEPROM are not lost.

(32) Command “WID”
Function: Command for writing camera ID (set by user) (Write ID)

Transmission from host: STX: “WID”: character string of up to 15 characters: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The acceptable characters are English 1 byte characters (both upper and lower cases) and some special symbols as shown below:
Usable special symbols····· SP(H'20), !(H'21), ’(H'27), +(H'2B), comma (H'2C), -(H'2D), .(a full stop mark)(H'2E), /(H'2F), : (H'3A), ;(H'3B), <(H'3C), =(H'3D), >(H'3E), ?(H'3F), [(H'5B)], (H'5D), _ (H'5F)

(Note) When the number of the characters exceeds 15, (transaction rejection) is returned.
(Note) When the number of the characters is 0, the ID code is deleted.
(Note) Carefully note that ID is not correctly written when the character string to be sent includes an unusable character(s). This case, however, is not regarded as error ((transaction rejection) is not returned).
(Note) This command does not execute the writing into EEPROM and therefore, the setting by this command is lost when the power is turned off. If it is necessary to store the setting in EEPROM, transmit another command of “SID”.

(33) Command “SID”
Function: Command for saving camera ID (set by user) (Save ID)

Transmission from host: STX: “SID”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The data of the current ID code are saved in EEPROM.

(Note) The ID code (character string) is saved in an area independent from the program pages, and this common value (one numerical number) is applied when the camera is turned on with any one of the program pages.
(Note) No ID code is stored before shipment.

(34) Command “RID”
Function: Command for reading out camera ID (set by user) (Read ID)

Transmission from host: STX: “RID”: ETX
Return by camera: STX: ACK: “RID”: character string of up to 15 characters: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)
The data (up to 15 characters) of the ID code (character string) are read out. When an ID code is not set, the number of the characters to be returned is 0.

(35) Command “WVSUB”
Function: Command for writing Vsub value (CCD substrate voltage) (Write VSUB)

Transmission from host: STX: “WVSUB”: Vsub set value: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The set value (1 byte/2 characters) is written in the internal register as “Vsub set value”.

(Note) This command does not execute the writing into EEPROM and therefore, the setting by this command is lost when the power is turned off. If it is necessary to store the setting in EEPROM, transmit another command of “SVSUB”

(36) Command “SVSUB”
Function: Command for saving Vsub value (CCD substrate voltage) (Save VSUB)

Transmission from host: STX: “SVSUB”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The data of the current Vsub set value are saved in EEPROM.

(Note) The Vsub value (configuration item) is saved in an area independent from the program pages, and this common value (one numerical number) is applied when the camera is turned on with any one of the program pages.

(37) Command “RVSUB”

Function: Command for reading out Vsub value (CCD substrate voltage) (Read VSUB)

Transmission from host: STX: “RVSUB”: ETX
Return by camera: STX: ACK: “RVSUB”: Vsub set value: ETX (transaction completion),
or STX: NAK: ETX (transaction rejection)

The data of “Vsub set value” (1 byte/2 characters) are read out.

● Note in use of commands

- The internal nonvolatile ROM (EEPROM) guarantees the rewritable times up to 1 million based on the specifications of the device. Accordingly, it is highly recommended to avoid such usage as the commands accompanied by writing in EEPROM including “WA to WF”, “SMC” and “e” are repeated endlessly (or almost endlessly) in the program loop on the user side.

## 9. GenICam API features

This equipment meets GenICam API established by EMVA (European Machine Vision Association).
The Feature(Item) and that content of GenICam API are described below.

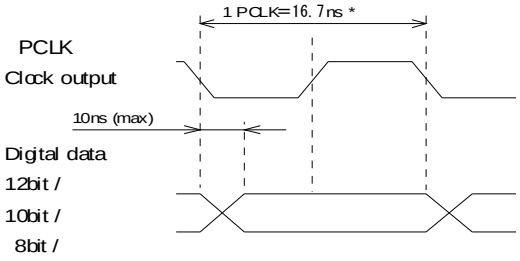
| Feature (Item) | Content (Set value) | Read/ Write |
|---|---|---|
| <AcquisitionAndTriggerControls> | | |
| AcquisitionMode | Sets the acquisition mode of the device.<br>Continuous :Frames are captured continuously.<br>Single Frame :One frame is captured.<br>Multi Frame :The number of frames specified by AcquisitionFrameCount is captured. | R/W |
| AcquisitionStart | Starts the Acquisition of the device. | C |
| AcquisitionStop | Stops the Acquisition of the device. | C |
| AcquisitionFrameCount | Sets the number of frames to acquire in MultiFrame Acquisition mode.(1 to 255) | R/W |
| ExposureAuto | Sets the automatic exposure mode (AEC).<br>Off : AEC off<br>Continuous :AEC on. | R/W |
| ExposureMode | Sets the operation mode of the Exposure (or shutter).<br>Off : No shutter operation (The exposure time is one frame time).<br>Timed : Continuous shutter operation with the specified exposure time(※1).<br>TriggerWidth : Asynchronous shutter operation in pulse width control mode.<br>TriggerControlled : Preset asynchronous shutter operation with the specified exposure time(※1).<br>**TimedLow :** Continuous Low speed shutter operation with the specified exposure time(※2).<br>※1…The exposure time is set by the ExposureTimeAbs or by Preset0 to 9.<br>※2…The exposure time is set by the ExposureTimeLowAbs or by Preset0 to 9. | R/W |
| ExposureTimeRaw | Sets the Exposure time in H unit (Horizontal synchronization time). (1 to 1250) | R/W |
| ExposureTimeAbs | Sets the Exposure time in microseconds. (72.86 to 61411.3) | R/W |
| **ExposureTimeLowRaw** | Sets the Exposure time in V unit (Vertical synchronization time). (1 to 255) | R/W |
| **ExposureTimeLowAbs** | Sets the Exposure time in milliseconds. (101.85 to 25971.8) | R/W |
| TriggerSelector | Selects the type of Asynchronous shutter operation.<br>AcquisitionStart : Normal Asynchronous shutter (H none-reset)<br>**HReset :** Permission of H reset in Asynchronous shutter mode. ※<br>※ Valid only in Asynchronous shutter mode | R/W |
| TriggerSoftware | Trigger signal is generated by software .(Internal trigger is generated when “1” is given.) | C |
| **PresetShutter** | Sets the Exposure time with Preset value.<br>**ShutterSW**: Exposure time is set by hypothetical shutter SW.<br>**Preset0** : Specifies Preset value 0<br>**Preset1**: Specifies Preset value 1<br>….<br>**Preset9**: Specifies Preset value 9<br>**ExposureTime**: Exposure time is specified by ExposureTimeRaw or ExpposureTimeAbs | R/W |
| <DigitalIO> | | |
| LineSource (EX) | Selects Digital signal output from STRB terminal of the camera connector. | R/W |
| | Off: Output from STRB terminal is fixed to H level. | |
| | Strobe: Strobe timing signal (STRB signal) is output from STRB terminal. | |
| | Busy: BUSY signal is output from STRB terminal.(in Asynchronous shutter mode) | |
| <ImageSizeControl> | | |
| SensorWidth | Effective width of the sensor in pixels. (1628) | R |
| SensorHight | Effective height of the sensor in pixels.(1236) | R |
| Width | Width of the Image provided by the device (in pixels).(2 to WidthMax) | R/W |
| Height | Height of the image provided by the device (in pixels).(1 to HeightMax) | R/W |
| WidthMax | Maximum width (in pixels) of the image. (1628) | R |
| HeightMax | Maximum height (in pixels) of the image. (1236) | R |
| OffsetX | Horizontal offset from the origin to the AOI (in pixels). (0 to (WidthMax-Width)) inc=2 | R/W |
| OffsetY | Vertical offset from the origin to the AOI (in pixels). (0 to (HeightMax-Height)) inc=2 | R/W |
| SensorDigitizationTaps(EX) | Number of taps for image output. (One) | R |
| PixelFormat | Sets the output format (gray level) of the image.<br>Mono8 : Output in 8bit format<br>Mono10 : Output in 10bit format<br>Mono12 : Output in 12bit format | R/W |
| PartialScan (EX) | Sets the partial scan<br>Off : Normal scan<br>On : Partial scan for the central area | R/W |

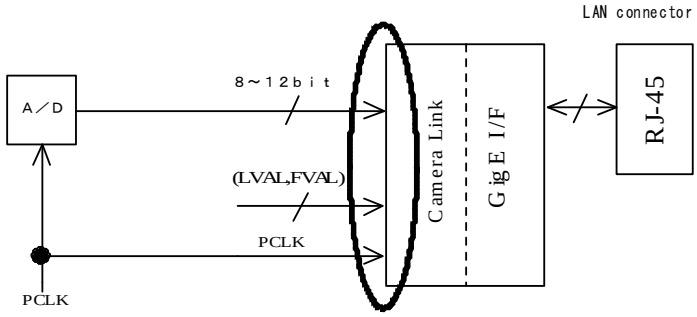
| Feature (Item) | Content (Set value) | Read/ Write |
|---|---|---|
| <AnalogControls> | | |
| GainRaw | Sets the gain set value in MGC mode. (0 to 255) | R/W |
| GainAuto | Sets the AGC operation<br>Off : AGC = OFF<br>Continuous : AGC = ON | R/W |
| **AgcGainRaw** | Sets the gain set value in AGC mode. (0 to 255) | R/W |
| BlackLevelRaw | Sets the black level (Image offset level) (0 to 255) | R/W |
| <UserSets> | | |
| UserSetSelector | Selects the destination to do UserSetSave.<br>Default**:** Selects the factory default.<br>UserSet1: Selects the first user set. | R/W |
| UserSetSaves | Saves the set contents to the destination specified by **UserSetSelector.**<br>(Note) Can not be saved to Default. | C |
| UserSetDefaultSelector | Selects the destination to load at start-up.<br>the feature User Set to load and make active when the device is reset.<br>Default**:** Selects the factory default.<br>UserSet1: Selects the first user set. | R/W |
| <TakexCameraControls> | | |
| **FcTestImage** | Displays the test pattern output from camera block.(BW gray scale)<br>Off: Display OFF<br>FcTestPattern: Display ON | R/W |
| **FcMenu** | ON/OFF of OSD menu display<br>Off: Display OFF<br>On: Display ON | R/W |
| ***FcCallDefault*** (EX) | Request to restore the camera to the factory default setting at next power-on.<br>Off: Request<br>On: No request | R/W |
| **FcPageSelector** | Selects the page of FcSavePage and FcLoADPage | R/W |
| ***FcSaveCfg*** | Saves the current configuration flag set value of the camera. | C |
| ***FcSavePage*** | Saves the set contents of the camera.(Specified by FcPageSelector)<br>(Note) it boots up at next start-up in accordance with the contents of FR and CR (common for each page) saved in the page (Page A as default)specified by hypothetical mode SW. | C |
| **FcLoadPage** | Loads the set contents of the program page of the camera.<br>(Page is specified by FcPageSelector) | C |
| ***FcModeSW*** (EX) | Changes the set value of hypothetical mode SW<br>***PositionA*** : Sets the hypothetical mode SW to A<br>***PositionB*** : Sets the hypothetical mode SW to B<br>…<br>***PositionF***: Sets the hypothetical mode SW to F<br>(Note) Changed contents are saved and remains effective at next power-on. | R/W |
| ***FcShutterSW*** | Changes the set value of hypothetical shutter SW<br>***PositionA*** : Sets the hypothetical shutter SW to 0<br>***PositionB*** : Sets the hypothetical shutter SW to 1<br>…<br>***PositionF***: Sets the hypothetical shutter SW to 9<br>(Note) Changed contents are saved and remains effective at next power-on. | R/W |

[Explanatory note]
Items indicated by **bold face** : The custom feature or custom value of TAKENAKA's product.
Items indicated by *italic face* : Accompanied by writing/rewriting to the nonvolatile ROM inside the camera.
Items indicated by (Ex) : Visibility is defined in Expert.
Read/Write : R/W (Read/Write), R (Read only). C (Command)

## 10. Timing Chart

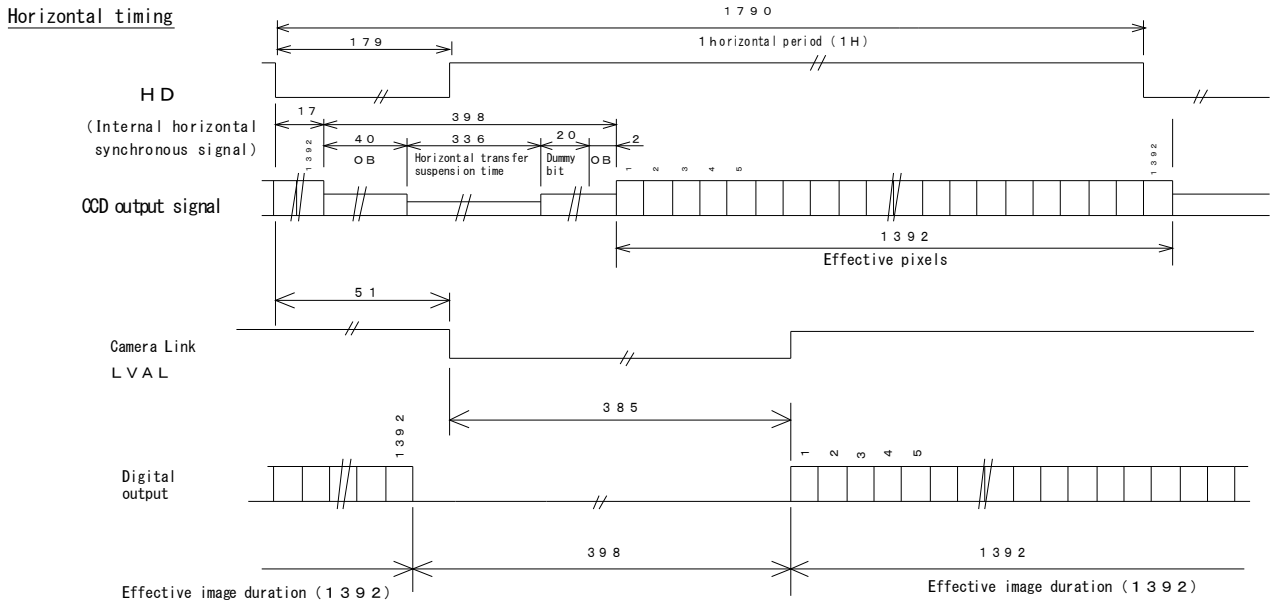
- Pixel clock timing (common in various operation modes)
  [Phase relationship between clock output and data]



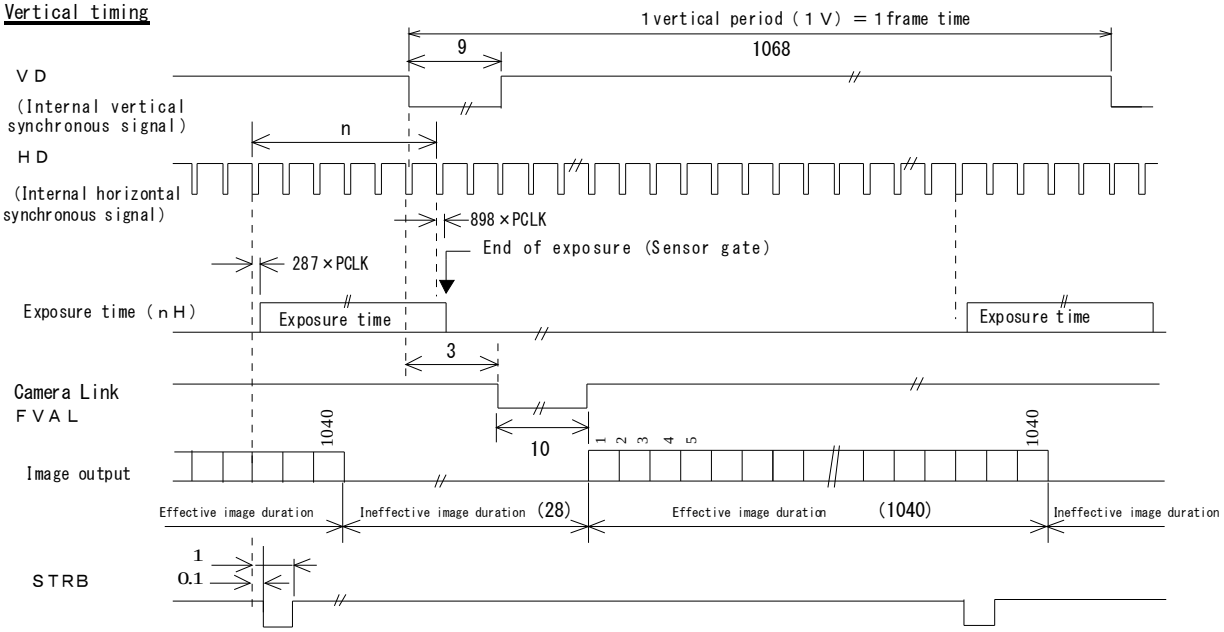

(Note) The above timing represents the signal timing before being input to the input part of the interface unit (Camera Link interface).
All the synchronization signals described in this chapter are internal signals as the synchronization signal (FVAL,LVAL,CLK etc.) is not output to the outside in the case of GigE camera.

- Horizontal timing (Common in each operation mode)




※ Unless otherwise specified, the time unit of the values in the horizontal timing chart is PCLK (1/60.0MHz = 16.7nS).
(Note) Excluding the case that the trigger signal (Vint) is input permitting H-reset in the asynchronous shutter mode.

- Vertical timing: Continuous shutter, No shutter

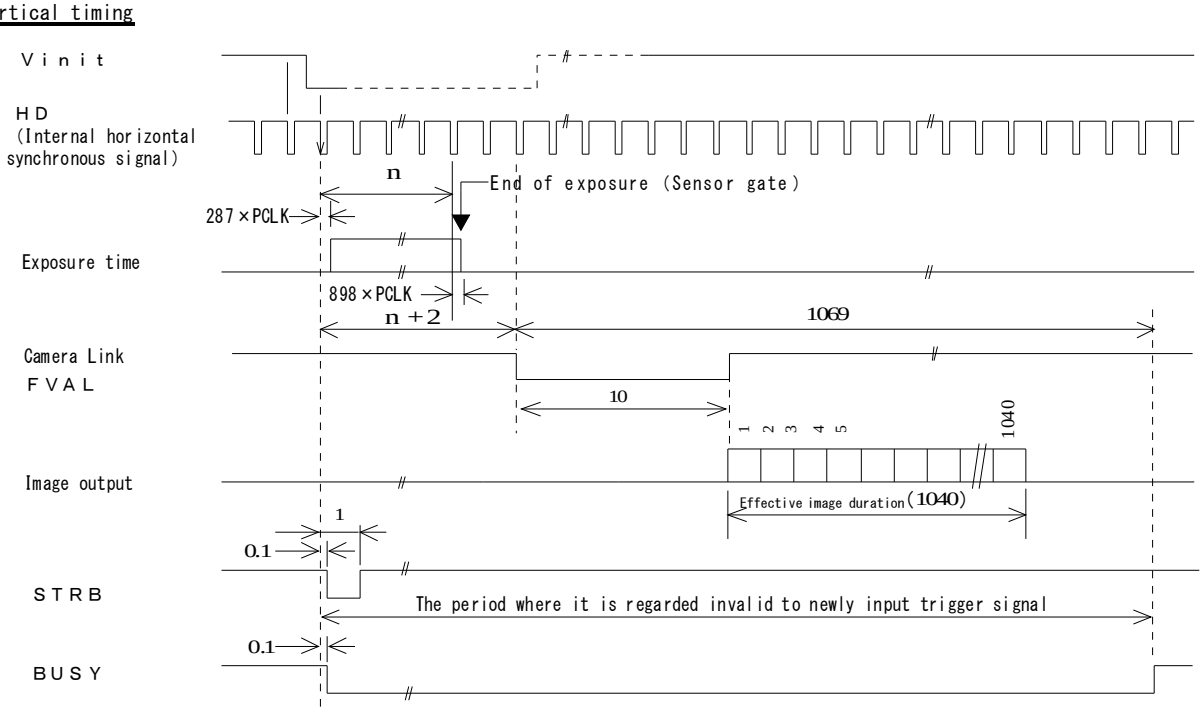



※In this chart,PCLK(*1)represents pixel clock and the unit of value is Horizontal synchronous time H(*2) except as otherwise noted.

*1 PCLK = 1/60.00MHz = 16.7nS

*2 H = 1790 ×1/60.00 MHz = 29.8 uS

- Vertical timing: High speed/Preset shutter/Asynchronous shutter/Without H-reset

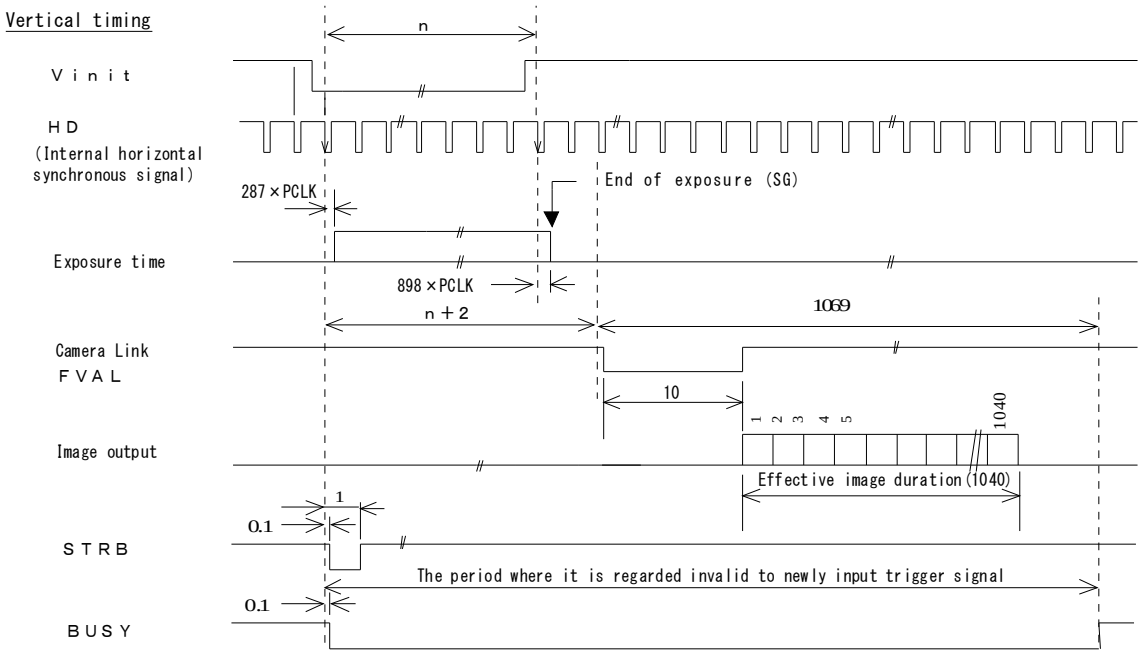



※In this chart,PCLK(*1)represents pixel clock and the unit of value is Horizontal synchronous time H(*2) except as otherwise noted.

*1 PCLK = 1/60.00MHz = 16.7nS

*2 H = 1790 ×1/60.00 MHz = 29.8 uS

- Vertical timing: High speed/Pulse width control/Asynchronous shutter/Without H-reset

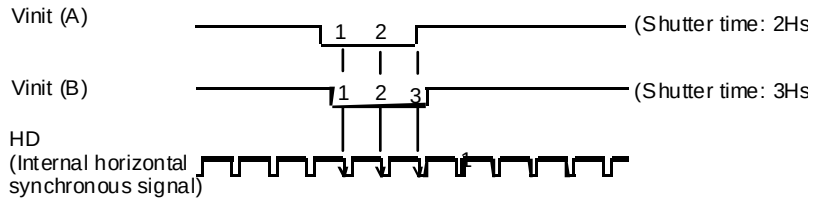



※In this chart, PCLK(*1) represents pixel clock and the unit of value is Horizontal synchronous time H(*2) except as otherwise noted.
*1 PCLK = 1/60.00MHz = 16.7nS
*2 H = 1790 ×1/68.00MHz = 29.8uS

(Note) The width of Vint must be larger than 1H (Horizontal synchronous time). However, for the following reason, the output level becomes unstable due to uncertainty of exposure time corresponding to 1H in the case of short exposure time, if the trigger pulse which is out of synchronization with the horizontal timing of the camera is given.

(Note) Strictly speaking, even if the same pulse width of Vinit is applied, the shutter speed differs for the period corresponding to 1H width when the asynchronous shutter operation is executed in the pulse width control mode (indefinite for 1H width).
Although an equal pulse width (value between 2Hs and 3Hs) is applied both for (A) and (B) in the figure below, the phase relationship with the internal horizontal synchronous timing makes their shutter speeds different from each other: (A) shutter speed = 2Hs and (B) shutter speed = 3Hs.

Example of 1H difference with same Vinit signal




Because of the above reason, consideration must be given to the fact that the exposure time becomes indefinite for the period of 1H shutter speed when a Vinit signal that is not in synchronization with the internal horizontal synchronous signal (HD) is input from the user side. Some of the countermeasures to be taken are as follows:

(1) Use only with the shutter speeds that do not have serious impact even if the shutter speed is indefinite for a period of 1H.
••• No practical problem may be caused when the shutter speed is fairly long, say 100H width or longer because the impact of 1H difference in exposure time over the signal level is relatively small.

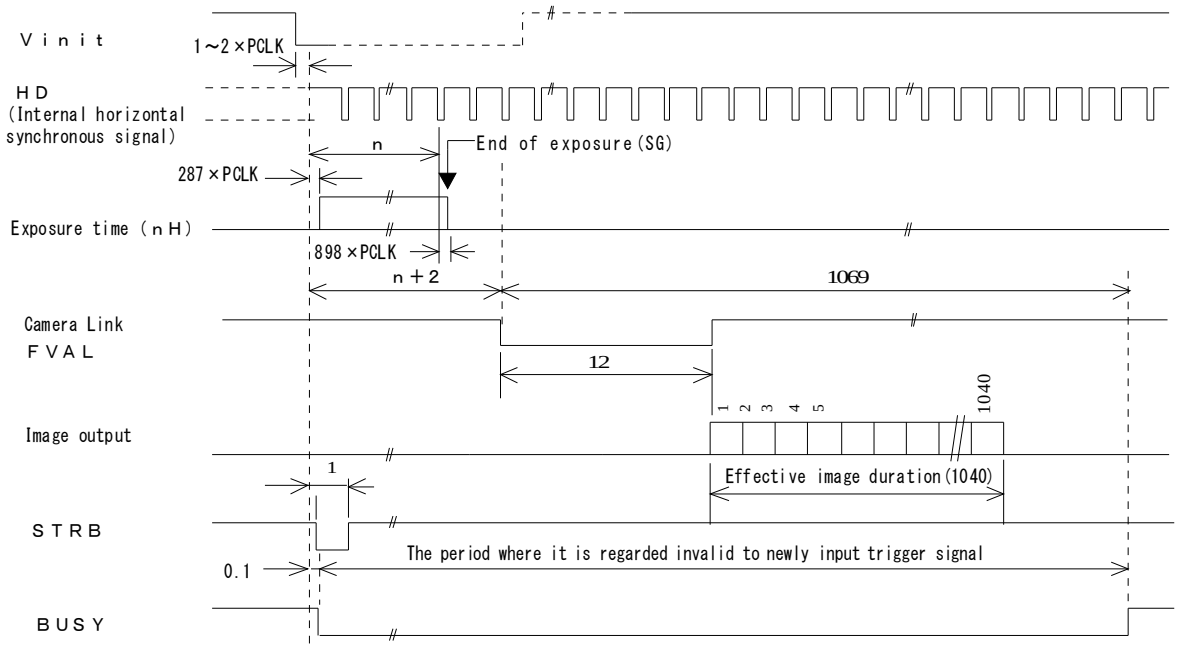
(2) Use with H-reset
••• The duration time where the exposure time is indefinite falls within up to 1 clock because the internal HD timing is reset (initialized) by inputting the trigger signal.

(Note) Since n does not have an upper limit, the exposure time can be prolonged to be more than one frame time. The maximum exposure time to be employed, however, should be determined after implementing experiments based on the conditions of the actual operation because a longer exposure time is accompanied by the degradation of S/N ratio due to the accumulation of CCD thermal noises.

(Note) It is necessary to set “PWEN=ENABLED” in flag register(FR) and to set (hypothetical) shutter switch (or externally specified shutter SW position) to “9” for enabling the settings of pulse width control mode.

- Vertical timing: High speed /Preset shutter/Asynchronous shutter/With H-reset

Vertical timing

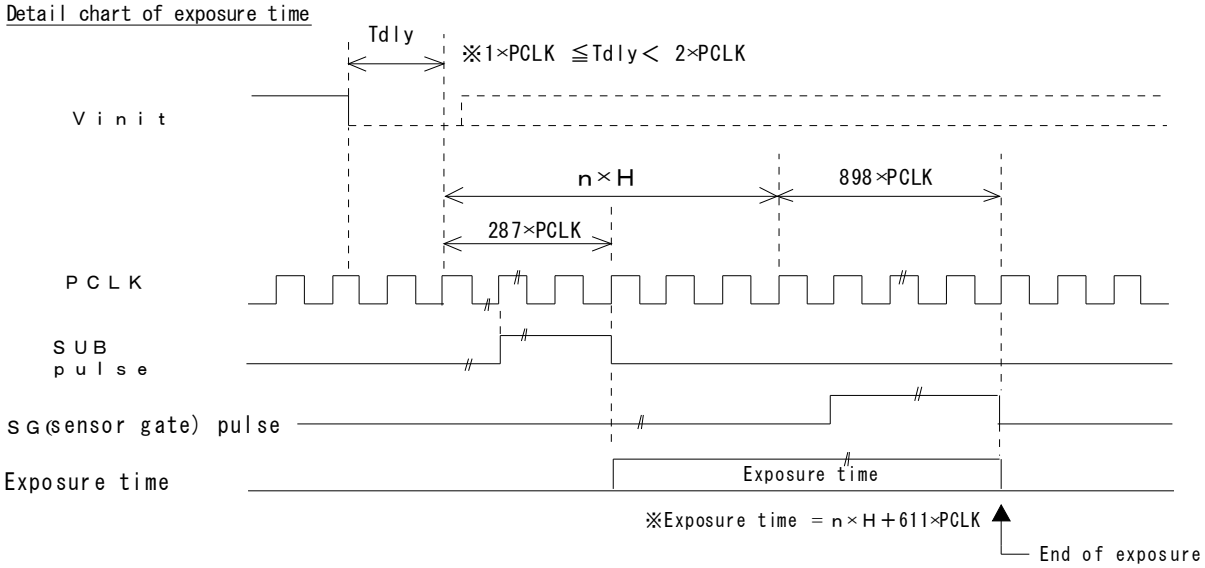



※In this chart, PCLK(＊1)represents pixel clock and the unit of value is Horizontal synchronous time H(＊2) except as otherwise noted.

＊1 PCLK = 1/60.00MHz = 16.7nS
＊2 H = 1790 ×1/60.00MHz = 29.8 uS

(Note) n (Integer) represents the set value of shutter exposure time. The set value of shutter exposure time is the shutter set value defined in “Table 5-3” or the directly specified value by external specification.

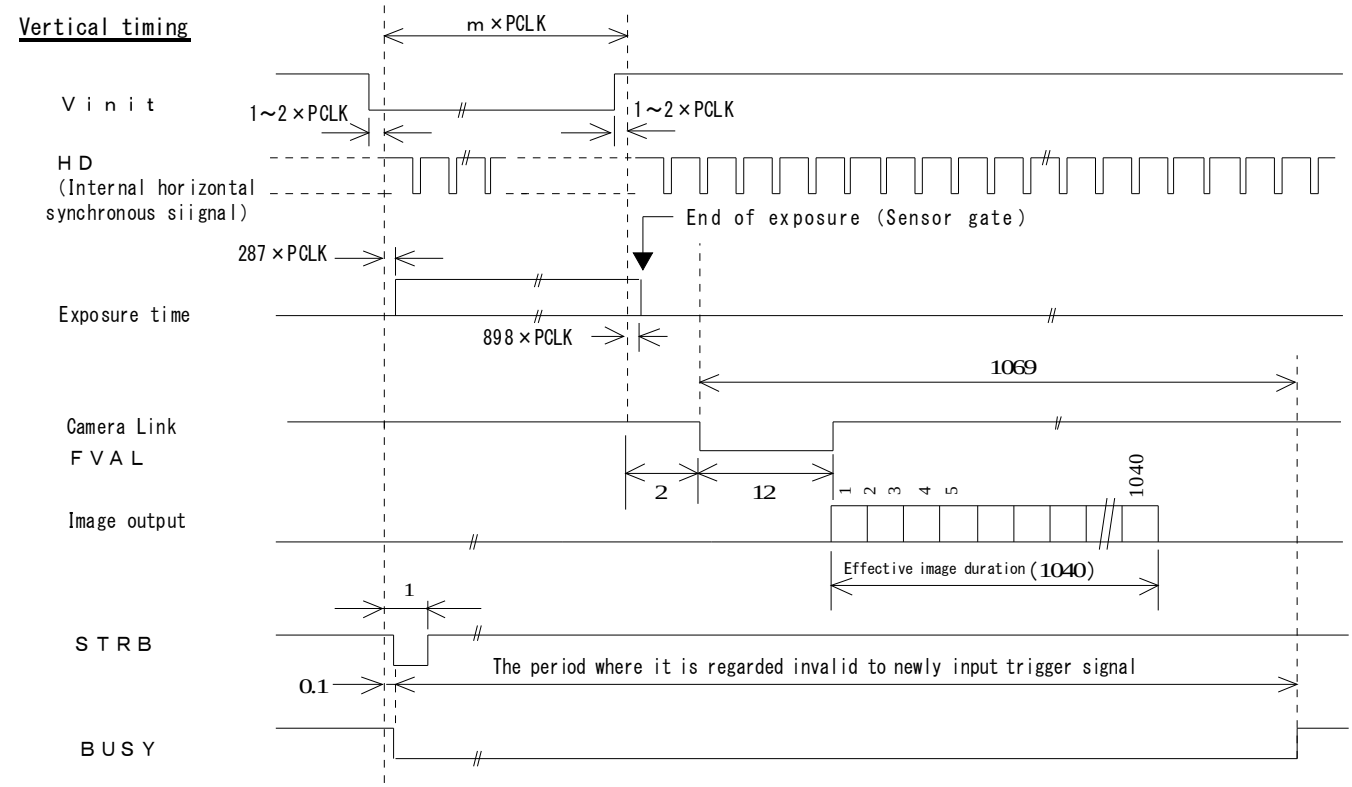
Detail chart of exposure time




※In this chart, PCLK(＊1)represents pixel clock and the unit of value is Horizontal synchronous time H(＊2) except as otherwise noted.

＊1 PCLK = 1/60.00 MHz = 16.7nS
＊2 H = 1600 ×1/60.00 MHz = 29.8 uS

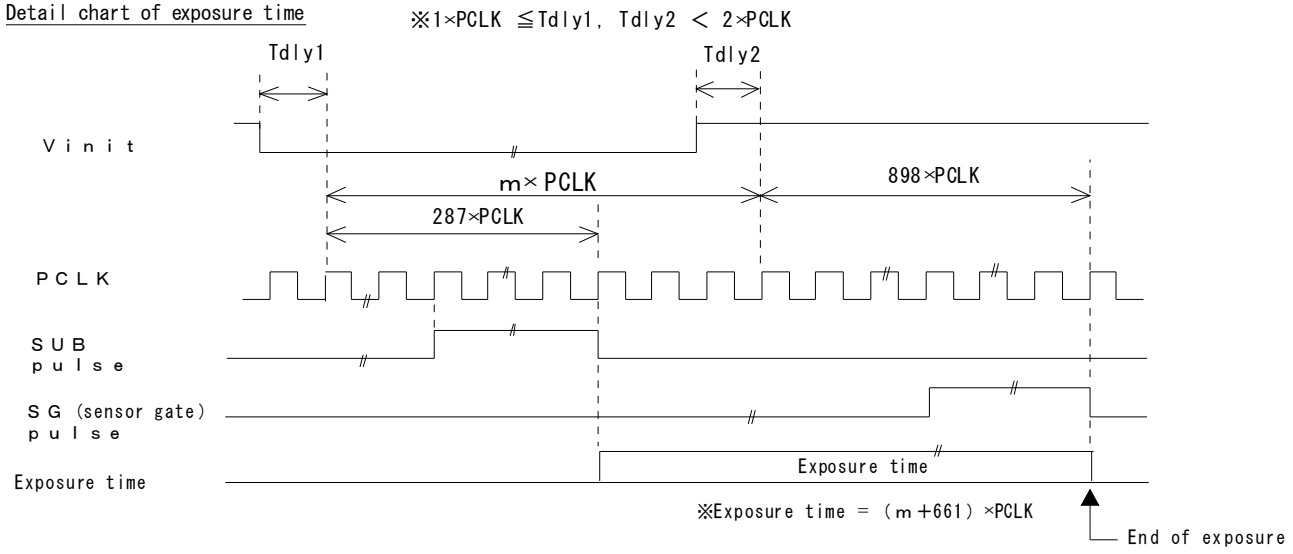
- Vertical timing: High speed /Pulse width control/Asynchronous shutter/With H-reset




※In this chart, PCLK(＊1)represents pixel clock and the unit of value is Horizontal synchronous time H(＊2) except as otherwise noted.

＊1 PCLK = 1/60.00MHz = 16.7nS

＊2 H = 1790 ×1/60.00 MHz = 29.8 uS




※In this chart, PCLK(＊1)represents pixel clock and the unit of value is Horizontal synchronous time H(＊2) except as otherwise noted.

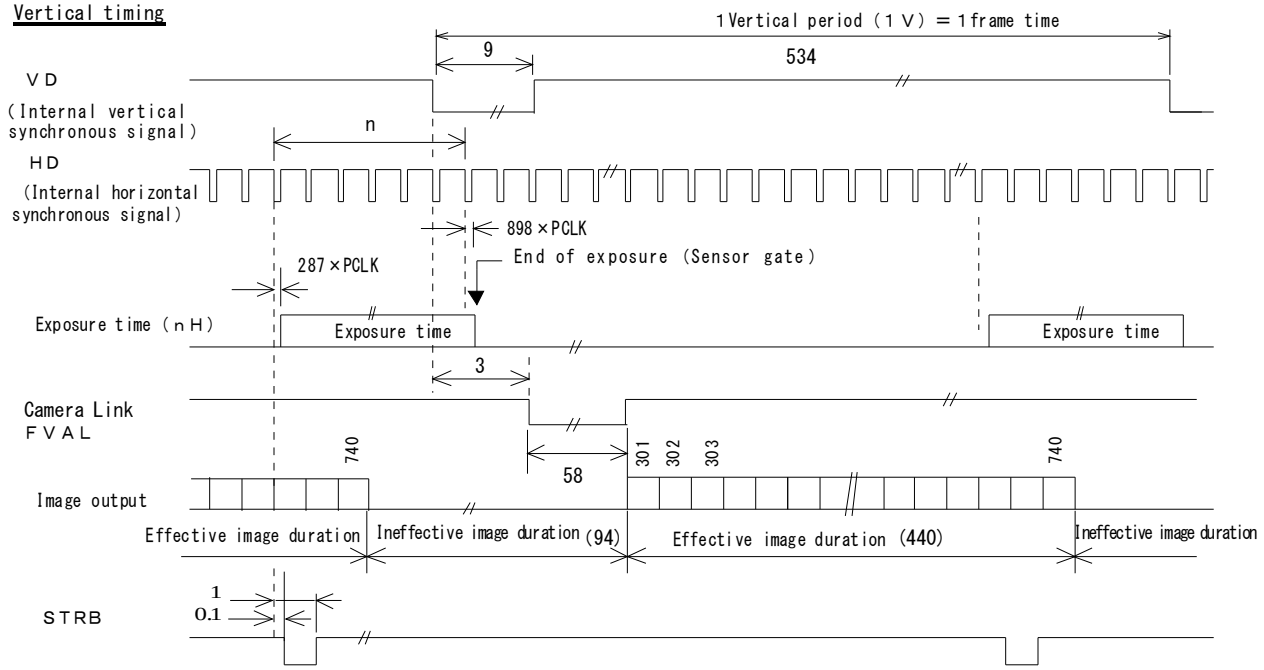
＊1 PCLK = 1/60.00MHz = 16.7nS

＊2 H =1790 ×1/60.00MHz =29.8uS

(Note) The width of Vint must be larger than 1H (Horizontal synchronous time).

(Note) It is necessary to set “PWEN=ENABLED” in flag register(FR) and to set (hypothetical) shutter switch (or externally specified shutter SW position) to “9” for enabling the settings of pulse width control mode.
In addition, it is needed to set “HREN=ENABLED” in configuration register for enabling “with H-reset”.

- Vertical timing: Continuous shutter,No shutter/Partial scan

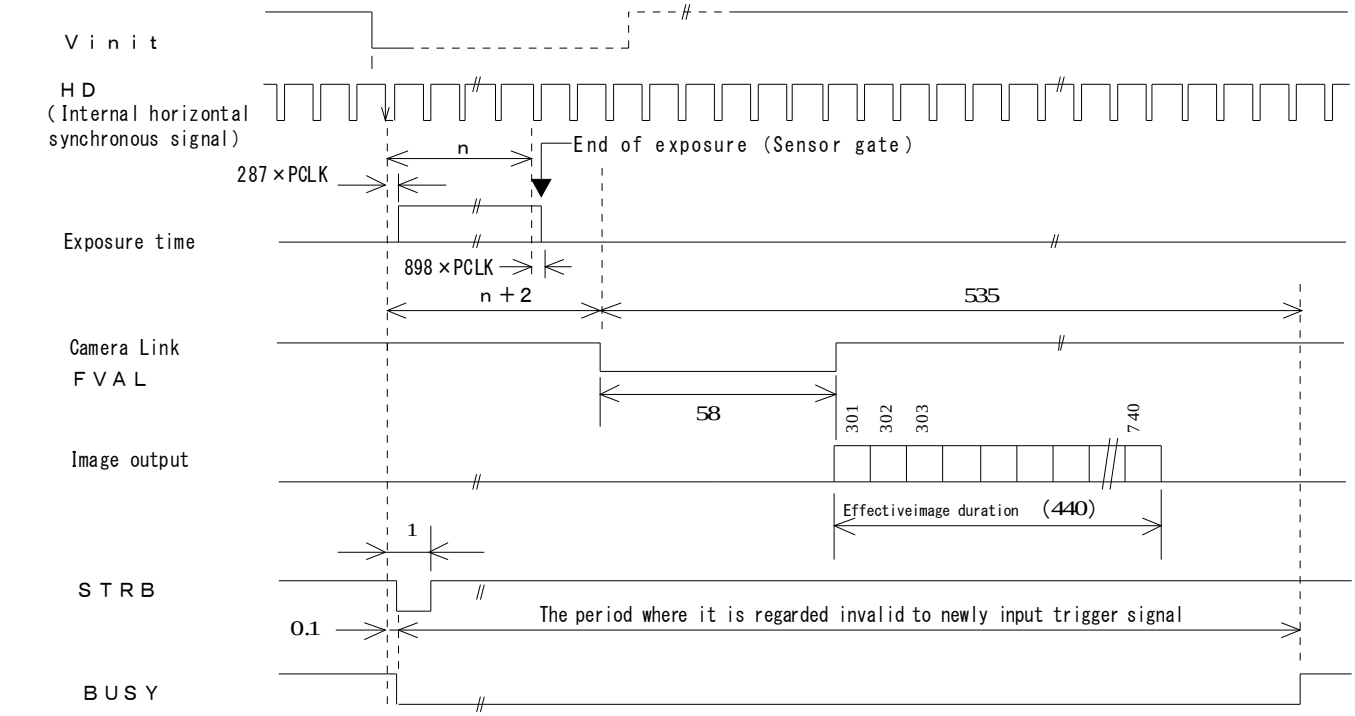



※In this chart, PCLK(*1)represents pixel clock and the unit of value is Horizontal synchronous time H(*2) except as otherwise noted.

*1 PCLK = 1/60.00MHz = 16.7nS

*2 H =1790 ×1/60.00MHz =29.8uS

- Vertical timing: High speed/Preset shutter/Asynchronous shutter/Partial scan/Without H-reset



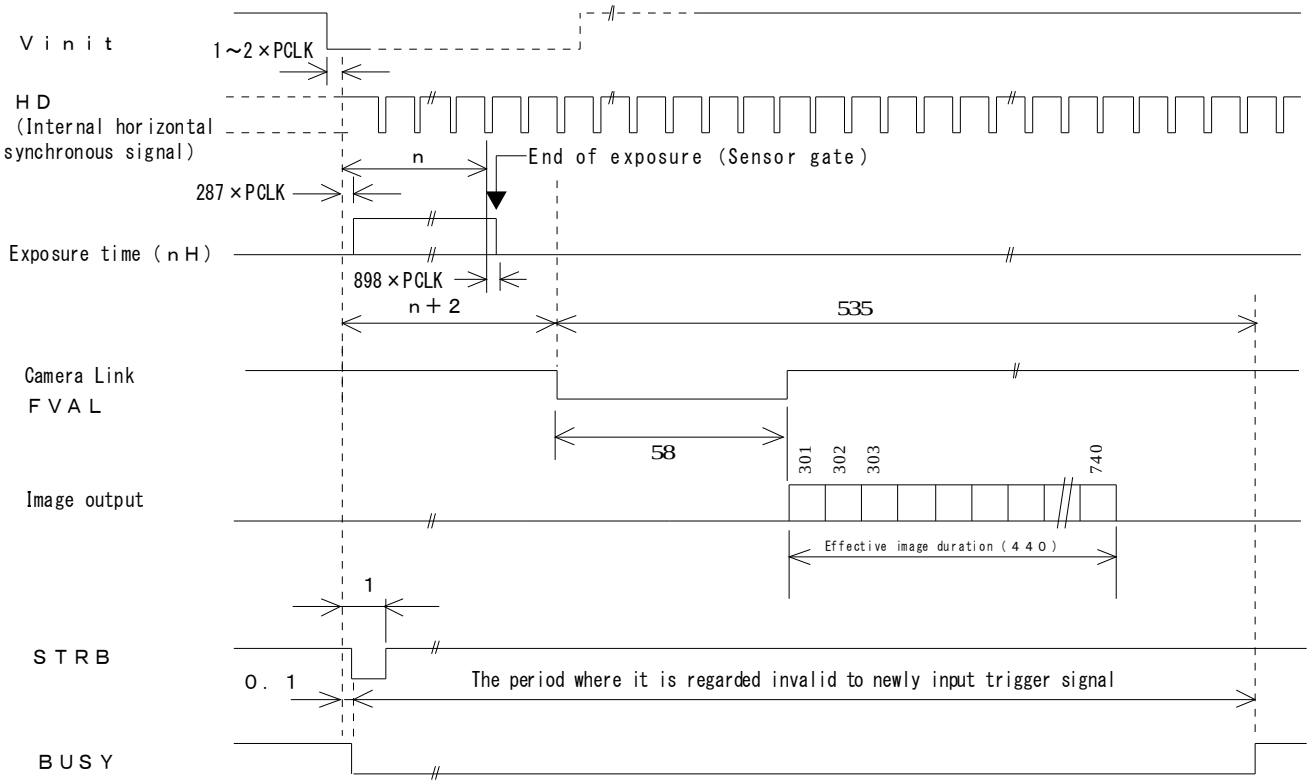

※In this chart, PCLK(*1)represents pixel clock and the unit of value is Horizontal synchronous time H(*2) except as otherwise noted.

*1 PCLK = 1/60.00MHz = 16.7nS

*2 H = 1790 ×1/60.00 MHz = 29.8 uS

- Vertical timing: High speed/Preset shutter/Asynchronous shutter/Partial scan/With H-reset

Vertical timing



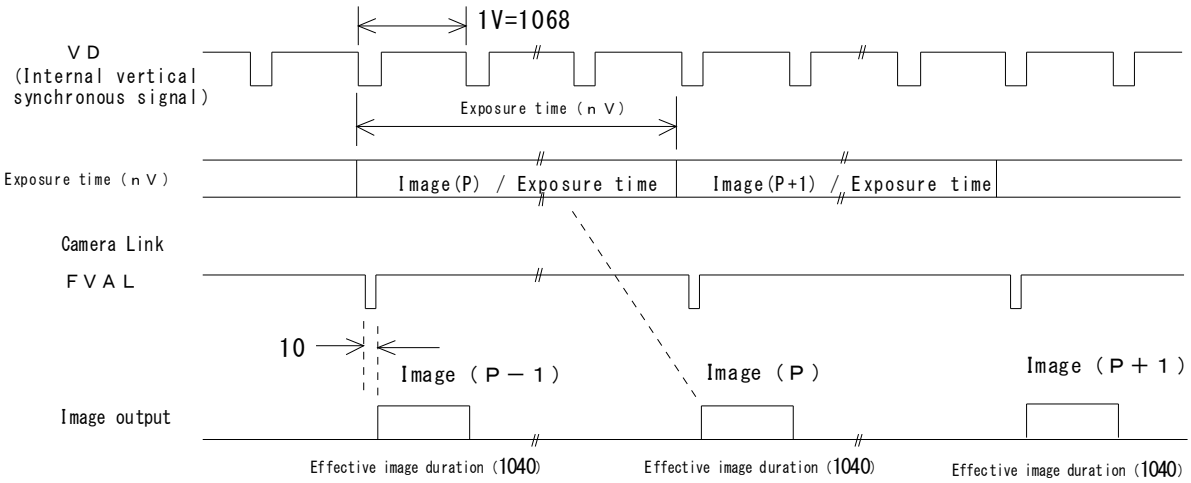

※In this chart, PCLK(＊1)represents pixel clock and the unit of value is Horizontal synchronous time H(＊2) except as otherwise noted.

＊1 PCLK = 1/60.00MHz = 16.7nS

＊2 H = 1790 ×1/60.00 MHz = 29.8 uS

- Vertical timing: Low speed (long exposure)/Preset shutter/Continuous

Long exposure timing




※The time unit of value is H(＊) except as otherwise noted.

※The detailed vertical timing for each image duration is the same as in the case of "vertical timing/continuous shutter,no shutter"

＊ H = 1790 ×1/60.00MHz = 29.8 uS

(Note) This camera does not support the asynchronous shutter operation in the long exposure mode.

(Note) Pixel defect on the white spot which were invisible in the case of no shutter operation or high speed operation may appear on the picture image when taking images under long exposure operation.
Please note that pixel defect which comes into existence in long exposure operation (exposure operation of more than one vertical scan period ) is not covered under warranty.

## 11. Accessories

Available accessories are listed below.

<Camera cable> Cable for supplying power to camera and for connecting I/O signal

| Product name | Cable length | Type | Remarks |
|---|---|---|---|
| Camera cable | 2m | 6P12G-02 | 1 to 25m<br>Possible to make in one meter unit. |
| | 5m | 6P12G-05 | |
| | 10m | 6P12G-10 | |

<LAN card> LAN connecting adapter for PCI slot

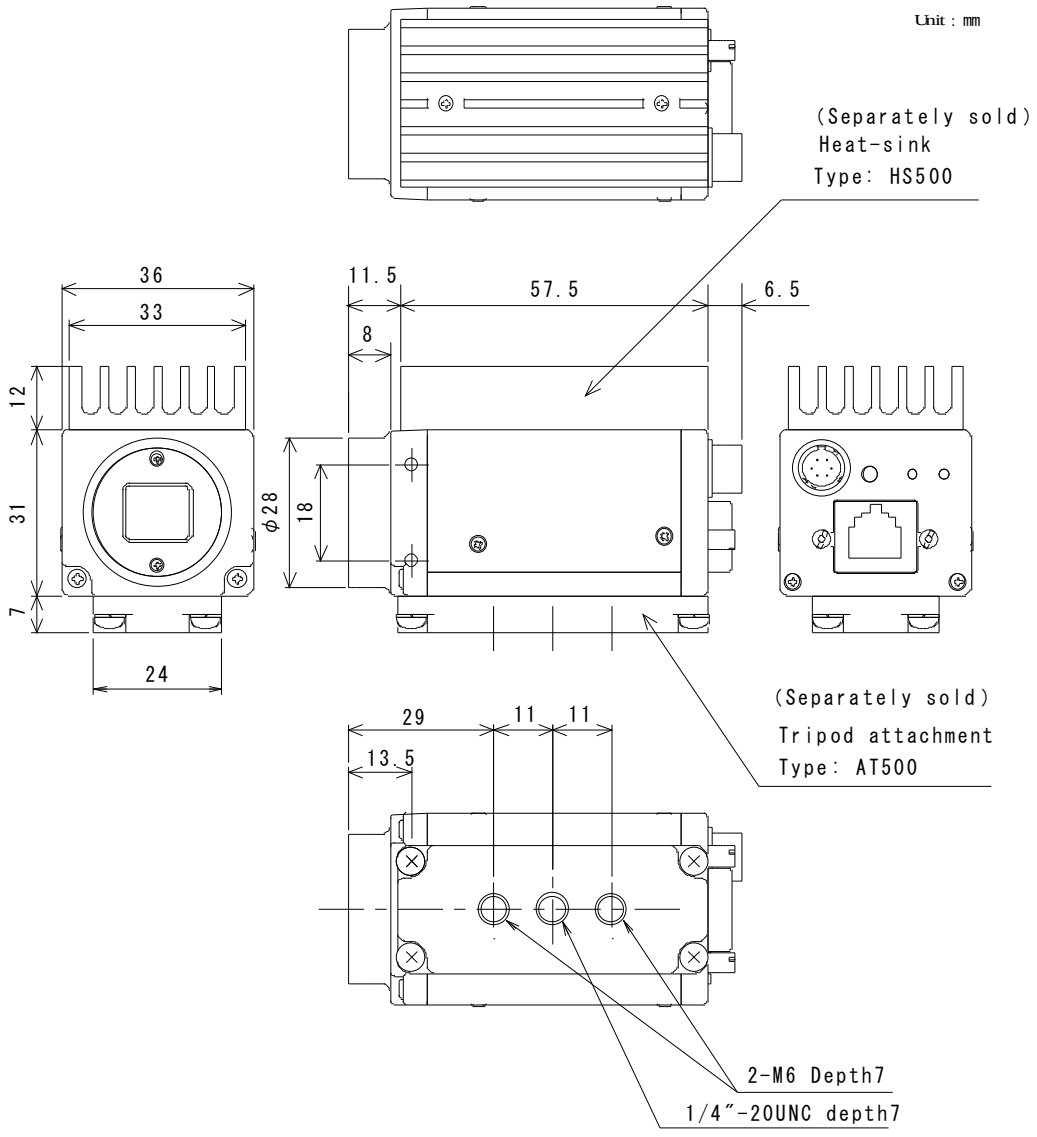
| Product name | Type | Remarks |
|---|---|---|
| LAN card | PWA8391GT | Recommended LAN card<br>(Intel Pro/1000) |

<Tripod attachment> Mounting hardware for tripod fixing screw

| Product name | Type | Remarks |
|---|---|---|
| Tripod attachment | AT500 | (External dimensions → the diagram below) |

<Heat-sink> Optional heat-sink for heat generation

| Product name | Type | Remarks |
|---|---|---|
| Heat-sink for GigE camera | HS500 | Recommended to use when heat dissipation from camera mount is insufficient.<br>(External dimensions → the diagram below) |




External dimensions equipping optional Accesories

## 12. Notes

[General notes]

- This equipment is not allowed to be used for medical purposes, detection of hazardous materials or any other operations of which performance may exert influence on human lives or safety.
- We assume no responsibility whatsoever for any incidental damages (loss of business interests, business interruption, change in data, loss of data etc.) resulting from the user's use of this equipment or performance failure.
- Do not disassembly this equipment or alter the internal circuits. Accidents such as a fire may be caused by the heat generation associated with failure in operation.
- Refrain from connecting or disconnecting cables and connectors while power is being supplied, otherwise troubles may be caused.
- Connect this equipment to a high quality power source unit that does not contain noise components.
- Take appropriate measures to control the generation of noise if a power machine or other installations in the close neighborhood of this equipment radiates noise, which might adversely affect this equipment.
- Do not use this equipment in an environment subject to any temperatures other than that of the specifications or condensation, or on a place subject to considerable dust or constant vibration/impact.
- When this equipment is not used over a long period of time, isolate the power from the equipment and remove the power cable and external connection cables.
- When an abnormal or failure condition is detected, immediately stop using this equipment, cut off the power supply, remove the external connection cables and contact the dealer for inspection/repair.
- The specifications and operational details described in the catalogues, manuals and others are subject to change for performance improvement or other reasons without notice.

[Countermeasure for time degradation of image sensor ]

[Important]
On the usage of this equipment, please note the following to prevent the problem of time degradation of CCD image sensor(Increase of pixel defects etc.).

- Do not use this equipment in an environment subject to high temperatures and high humidity.
  Especially in a high-temperature environment, degradation of CCD image sensor is accelerated, and pixel defects such as sunspot may be caused. It is recommended that the equipment is used in an ambient temperature around normal room temperature (below 30℃ degrees) as far as possible. If there is any concern that ambient temperature of the camera may be heated up when embedded in the apparatus, please consider to use a cooling equipment such as a cooling fan.
- Be careful not to get the light receiving surface be exposed to high intensity light over a long periods of time.
  If a right receiving surface is exposed to high intensity light over a long time (regardless of the on/off state of the camera), the color filter on a surface of CCD image sensor may get discolored or get burnt in and normal image could not be output. Please reduce the amount of incoming light by using dark filter or by stopping down the aperture of the lens if the high intensity light like sunlight enters over a long periods of time.
  The amount of light falling on the light receiving surface does not decrease with an adjustment of output level by getting electronic shutter speed higher, therefore note that discoloration or burn-in of image sensor can not be prevented that way. When this equipment is not used for a long time, it is recommended to store the equipment disconnecting the cable and fixing a lens cap.

[Pixel defect on image sensor ]

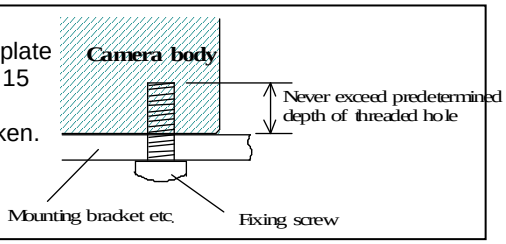
[Important]
It has been confirmed by inspections before shipment that all of our products has no distinct pixel defect.
However, new pixel defect may be generated or the defect level of some pixels may increase over time after shipment according to inherent nature of image sensor.
Number or level of pixel defect of image sensor may inevitably increase after purchase under natural conditions. However, it does not arise from structural failure or design failing of the camera.
Therefore, please be aware that such increase of number or level of pixel defect is not covered by warranty.
And the same goes for pixel defect which is generated by long exposure.

[Countermeasures against heat]

[Important]
The equipment is subject to temperature increase caused by internal power consumption as its overall size is notably small.
Place the equipment on the high thermal conductive mount to fix it.
Consider to use a cooling system such as separately sold heat sink (HS500) or air-cooled fan, if the increase of temperature is a concern. Also, avoid using the plural equipments placing in mutual proximity.

[Fixing screw for the camera]

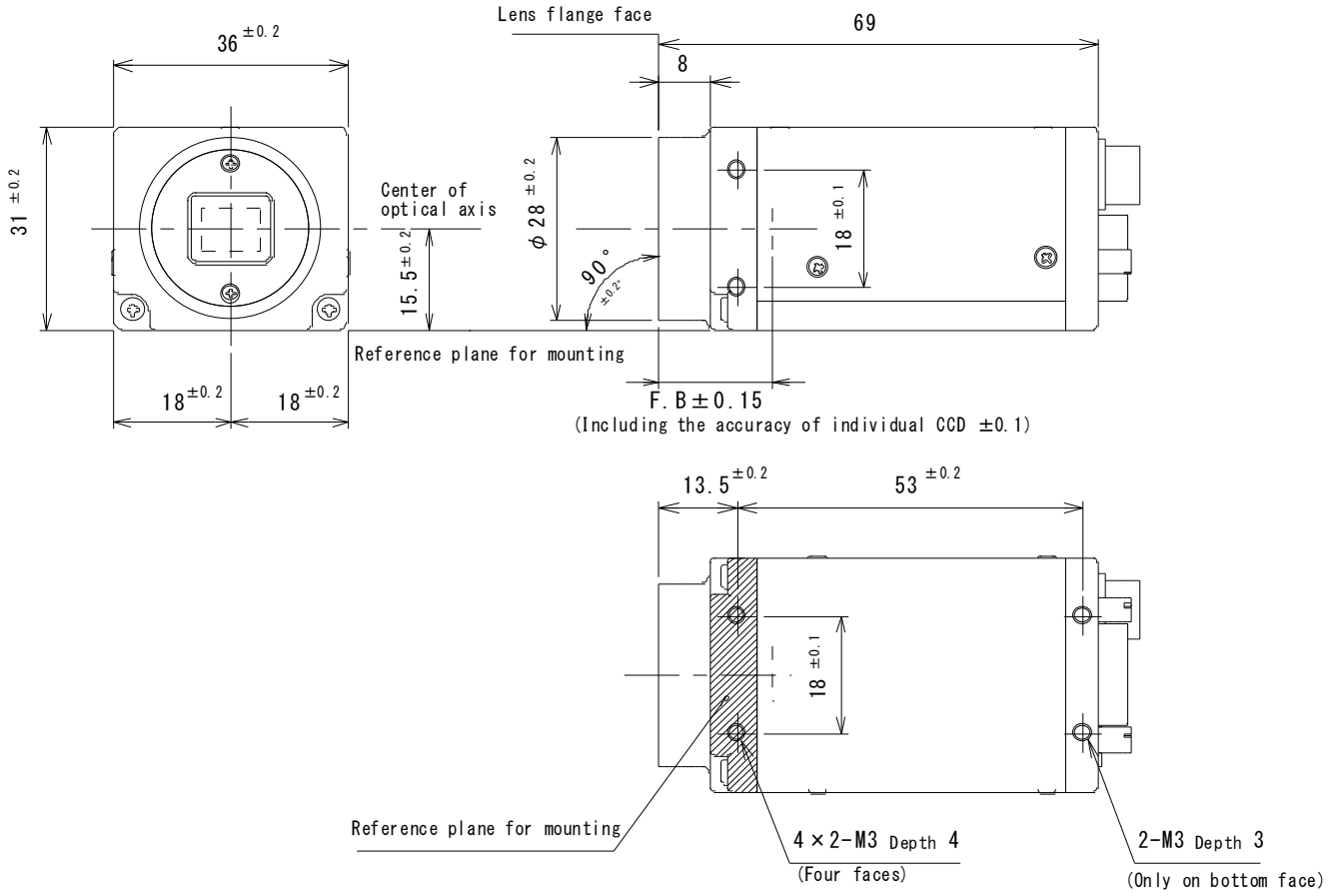
[Important]
Beware of a screw length when fixing the camera to a mounting bracket or a metal plate at user's site. The screw length should not exceed the value designated on section 15 "External dimensions".
If it exceeds the value, there is a possibility that the contents of the camera are broken.



## 13. Specifications

| | FC1650GE (Monochrome) |
|---|---|
| Image sensor | Progressive scanning, interline transfer CCD<br>2/3 inch in size<br>Unit cell size: 6.45um(H) × 6.45um(V)<br>square grid pattern |
| Number of effective pixels | 1392 (H)×1040(V) |
| Read out scanning | Horizontal scanning frequency: $f_H$ = 33.5 KHz<br>Vertical scanning frequency: $f_V$ = 31.4 Hz<br>Pixel clock frequency: $f_{CLK}$=60.00 MHz |
| Standard sensitivity | 400Lx / F11 *<br>(* Digital output with exposure time of 1/30 seconds and 512/1024 gray scale) |
| Minimum subject illuminance | 1 Lx at F1.4 |
| S/N | 50dB or more |
| Video output signal | Progressive scanning: 31 fps<br>Digital output: 10 or 8 or 12 bit<br>GigE Vision compliant (Gigabit Ethernet)<br>10bit/8bit/12bit Switchable |
| External sync input | None |
| Electronic shutter | 1/23000sec. ~ 1/31 sec. (no shutter) ~ Long exposure. |
| Asynchronous shutter | Preset fixed shutter / Pulse width control<br>(H-reset ON/OFF settable for each) |
| Scan mode | Normal scan(all pixels) / Partial scan(central area) |
| Lens mount | C mount (flange back fixed) |
| Optical filter | None |
| External control | Serial interface via Ethernet |
| Special functions | Image signal for Auto iris lens(without Sync. 0 to 0.7V)<br>Function of imposing setting information over output image<br>Function of monitoring internal temperature of camera<br>Function of storing camera ID information |
| Power supply | DC12V±10%, 500mA (max) |
| Operation ambient temperature | 0℃ to 40℃ (Shall be free from dew condensation and frost.) |
| Storage temperature range | -30℃ to 60℃ (Shall be free from dew condensation and frost.) |
| Anti-shock | 70G |
| Anti-vibration | 7G |
| External dimension | 36(W) × 31(H) × 69(L) mm<br>(excluding projection like connector) |
| Weight | Approx. 120g |

## 14. Illustration of positional accuracy of image sensor




(Note)

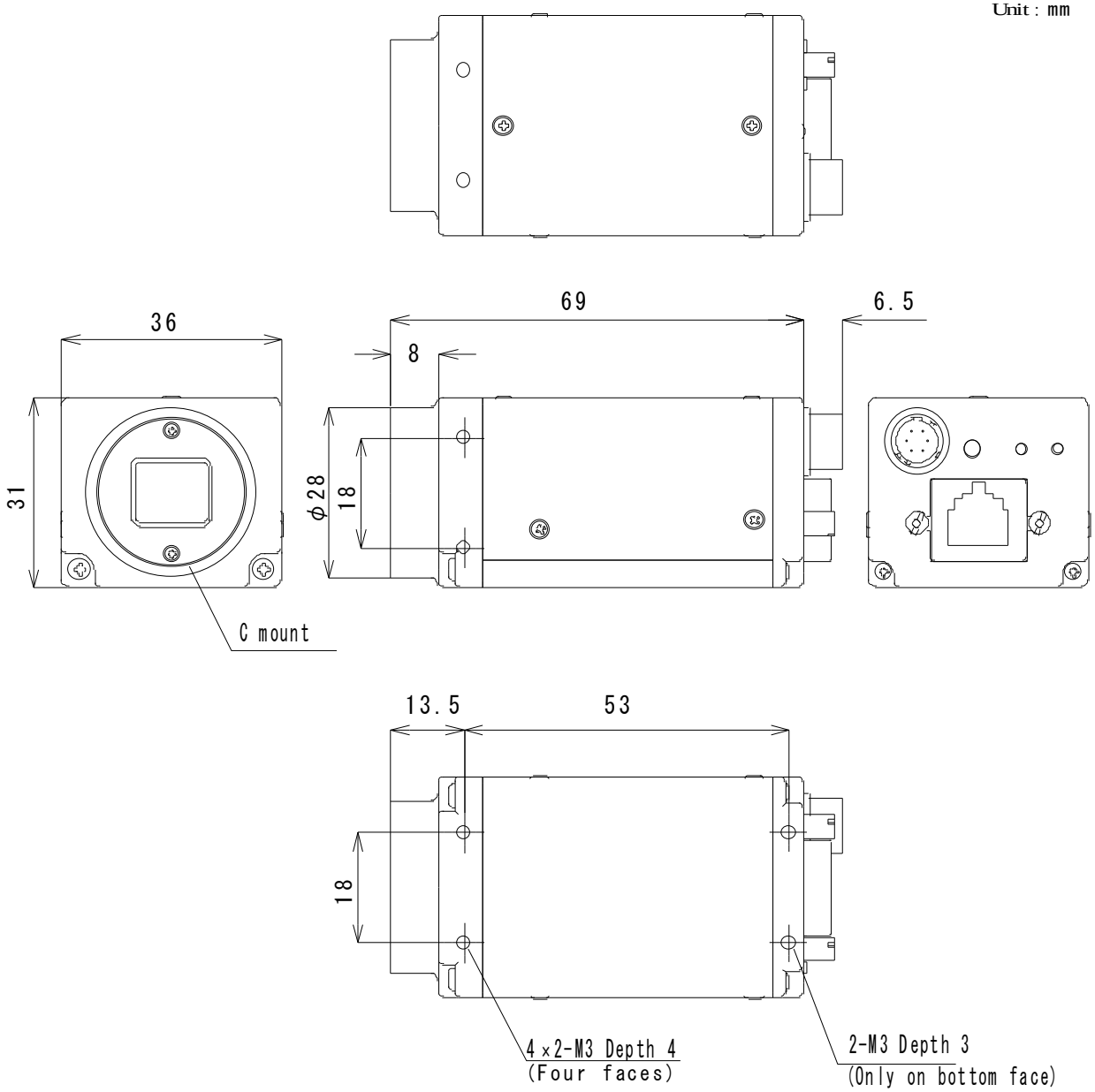
*The accuracy of the center of CCD image pickup area is ±0.275mm against the center of optical axis both for vertical and horizontal directions.
(Including the accuracy of individual CCD ±0.075)

*The rotation accuracy of the image pickup area for H,V direction is ±1.5° against the reference plane for mounting.
(Including the accuracy of individual CCD ±1° )

FC1650GE Illustration of positional accuracy of image sensor

## 15. External Dimensions

Unit : mm




(Note) Do no use the fixing screw the length of which exceeds the value designated in this diagram, It may cause the failure.

FC1650GE External Dimensions