CCD Video Camera Instruction Manual

2 Megapixel Progressive Scan Monochrome Camera

FC2600CL

- 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.: K12703
FC2600CL Instruction Manual (3rd version)

[History of revision]

	Version	Content of change	Description	Date	Document No.	Remark
	Preliminary Version			2010-07-07	K10707	FC2600CL
	1st version			2010-09-24	K10924c	
	2nd version	Error correction	Dimensional outline drawing	2012-05-29	K12529	
	3rd version	Error correction	Amendment of description of the pixel defect	2012-07-03	K12703	

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

- FC2600CL is a progressive scan monochrome camera incorporated with 2.07 megapixel, 2/3“-size CCD image sensor .
- A full frame shutter image can be obtained at a rate of 60 frames per second.
- 10 or 8 bit digital image signal output complying with Camera Link (Medium/Base Configuration).
- The internal set values of the camera can be externally controlled with serial communication via Camera Link.
- 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.
- The ID information set by the user for each camera can be saved and read out whenever necessary (via serial communication link).

2. Outline

Image sensor Imaging area size Number of pixels Pixel size		CCD Image sensor: Monochrome/Color 10.56mm × 5.94mm (Diagonal 12.1mm) 1920(H) × 1080(V) 5.5μm(H) × 5.5μm(V)		
Effective pixels		2.07 megapixels		
CCD output system		QUAD	DUAL	SINGLE
Read out scanning	Horizontal	36.0 kHz	36.0 kHz	18.8 kHz
	Vertical	62.7 Hz	31.4 Hz	16.4 Hz
	Clock	40.0 MHz		
Electronic shutter		1/25000 to 1/62 sec.	1/25000 to 1/31 sec.	1/15000 to 1/16 sec.
		(Continuous shutter / asynchronous shutter)		
Video output signal		Camera Link compliant		
		Medium 4Tap	Base 2Tap	Base 1Tap
		10 or 8 bit		
Scanning mode		All pixels readout		

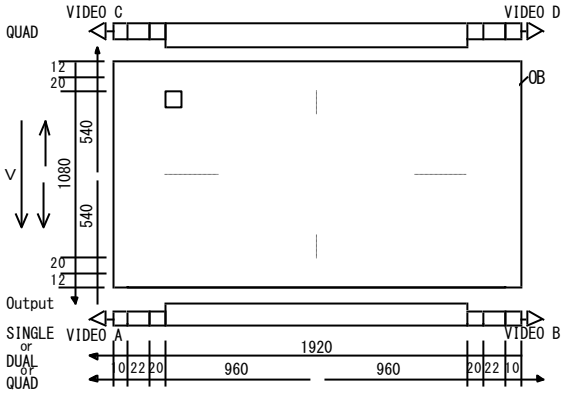


Fig.2-1 CCD architecture

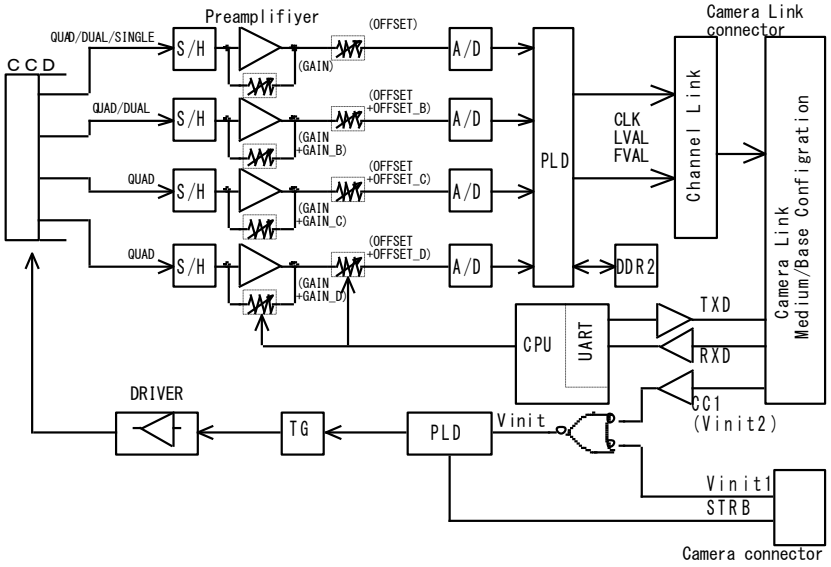
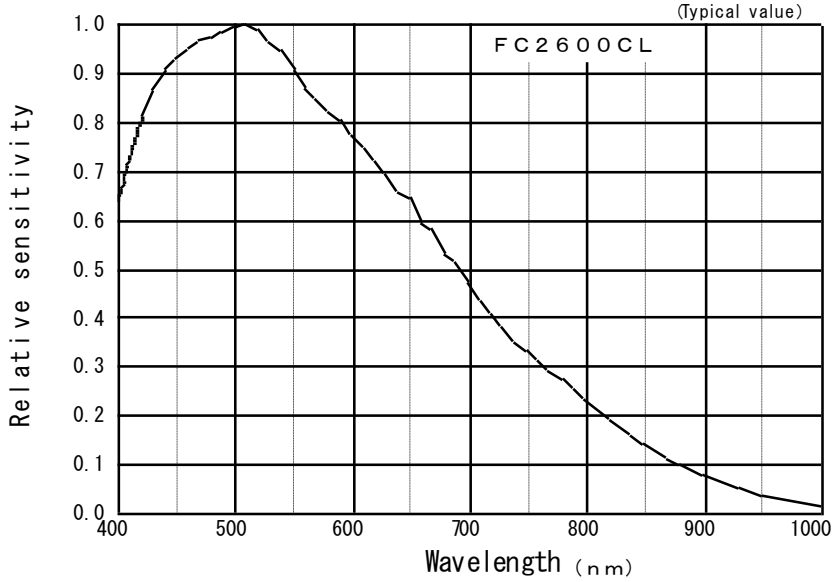


Fig.2-2 Block diagram



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

Fig.2-3 Spectral sensitivity characteristic

3. Description of Each Component

(3-1) Description of rear panel of camera

Layout of each connector

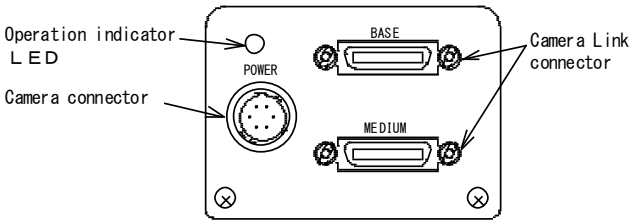
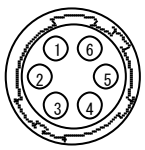


Fig.3-1 Rear panel layout

(3-2) Camera connector (POWER) (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 No.	Signal name	Description	I/O
1	GND (0V)	Power ground	
2	IC		
3	GND	Signal ground	
4	Vinit1	Input for external trigger	In
5	STRB	Strobe signal output	Out
6	+12VDC	DC power input	

* Do not assign any signals to the IC pins because they are occupied internally.

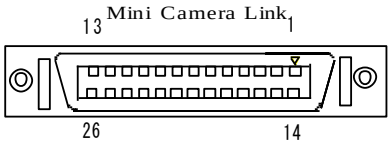
(3-3) Camera Link connector (3M/SDR-26 FEMALE)

The pin arrangement of the Camera Link connector and the signals assigned to those pins are shown in the following table:

Pin No.	Signal name	Twin-ax cable assignment	Pin No.	Signal name	Twin-ax cable assignment
1	inner shield	shield	14	inner shield	shield
2	X0-	PAIR1-	15	X0+	PAIR1+
3	X1-	PAIR2-	16	X1+	PAIR2+
4	X2-	PAIR3-	17	X2+	PAIR3+
5	Xclk-	PAIR4-	18	Xclk+	PAIR4+
6	X3-	PAIR5-	19	X3+	PAIR5+
7	SerTC+	PAIR6+	20	SerTC-	PAIR6-
8	SerTFG-	PAIR7-	21	SerTFG+	PAIR7+
9	CC1-	PAIR8-	22	CC1+	PAIR8+
10	CC2+	PAIR9+	23	CC2-	PAIR9-
11	CC3-	PAIR10-	24	CC3+	PAIR10+
12	CC4+	PAIR11+	25	CC4-	PAIR11-
13	inner shield	shield	26	inner shield	shield

Pin No.	Signal name	Twin-ax cable assignment	Pin No.	Signal name	Twin-ax cable assignment
1	inner shield	shield	14	inner shield	shield
2	Y0-	PAIR1-	15	Y 0+	PAIR1+
3	Y 1-	PAIR2-	16	Y 1+	PAIR2+
4	Y 2-	PAIR3-	17	Y 2+	PAIR3+
5	Y clk-	PAIR4-	18	Y clk+	PAIR4+
6	Y 3-	PAIR5-	19	Y 3+	PAIR5+
7	terminated	PAIR6+	20	100Ω	PAIR6-
8	(Z0-)	PAIR7-	21	(Z0+)	PAIR7+
9	(Z1-)	PAIR8-	22	(Z1+)	PAIR8+
10	(Z2-)	PAIR9+	23	(Z2+)	PAIR9-
11	(Zclk-)	PAIR10-	24	(Zclk+)	PAIR10+
12	(Z3-)	PAIR11+	25	(Z3+)	PAIR11-
13	inner shield	shield	26	inner shield	shield

(Note) The pins of Camera Link are differently laid out for the camera (upper table) and for the capture board. Note that the connection numbers of the cable for the capture board are opposite to those for the camera as described below:



Exterior appearance of Camera Link connector
(Viewed from the outside of camera)

1 = inner shield, 14 = inner shield
2 = CC4-, 15 = CC4+
3 = CC3+, 16 = CC3-
....
12 = X0+, 25 = X0-
13 = inner shield, 26 = inner shield
(Pin layout on frame grabber side)

[Table of Camera Link bit assignment] (Showing correspondence relation between before and after encoding)

Camera Link port	Camera signal name	I/O	Remark
Strobe	CLK	O	Pixel clock
LVAL	LDV	O	Horizontal synchronous timing
FVAL	FDV	O	Vertical synchronous timing
DVAL	-	O	(Fixed to H level)
Spare	-	O	(Fixed to H level)
CC1	Vinit2	I	Asynchronous shutter trigger
CC2	(reserved)	I	(Reserved for future products)
CC3	(reserved)	I	(Reserved for future products)
CC4	(reserved)	I	(Reserved for future products)
SerTFG	TXD	O	URAT transmission data (Same timing as conventional RS-232C)
SerTC	RXD	I	URAT reception data (Same timing as conventional RS-232C)

[Table of Camera Link data assignment]

8 bit						
TAP1	TAP2	TAP3	TAP4	Camera signal name		
A0	B0	C0	D0	D00	0	Lowermost data
A1	B1	C1	D1	D01	0	
A2	B2	C2	D2	D02	0	
A3	B3	C3	D3	D03	0	
A4	B4	C4	D4	D04	0	
A5	B5	C5	D5	D05	0	
A6	B6	C6	D6	D06	0	
A7	B7	C7	D7	D07	0	Uppermost data at the time of 8-bit scale capturing
Unused output				-		(Fixed to L level)
10bit						
TAP1	TAP2	TAP3	TAP4	Camera signal name		
A0	C0	E0	D0	D00	0	Lowermost data
A1	C1	E1	D1	D01	0	
A2	C2	E2	D2	D02	0	
A3	C3	E3	D3	D03	0	
A4	C4	E4	D4	D04	0	
A5	C5	E5	D5	D05	0	
A6	C6	E6	D6	D06	0	
A7	C7	E7	D7	D07	0	
B0	B4	F0	F4	D08	0	
B1	B5	F1	F5	D09	0	Uppermost data at the time of 10-bit scale capturing
Unused output				-	0	(Fixed to L level)

* The port assignment is in conformity to "**Medium/Base Configuration",** the standard of Camera Link.

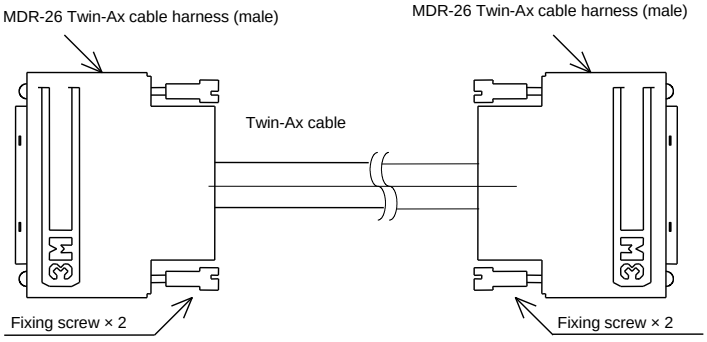


Fig.3-2 External view of Camera Link cable assembly

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 TAKENAKA SYSTEM standard camera cable(6P12G-series) is 20 m.

(3) 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.

(4) Connect the digital output connectors on the rear of the camera to the input terminals of the image processing units (frame grabber board, computer, etc.) with digital cables (option) conforming to Camera Link . The maximum allowable length between the digital output connector of the camera and the input terminal of said image processing unit is 10 m.

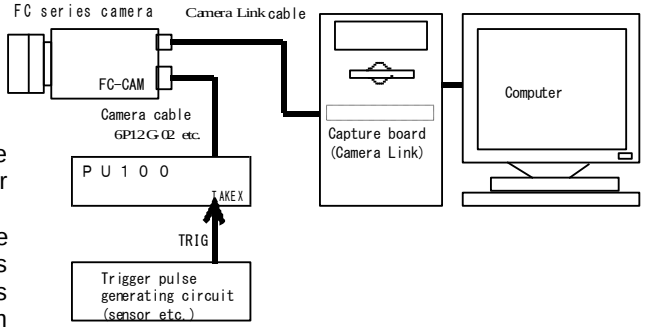


Fig. 4-1 Connection example between camera and peripheral devices

(5) Confirm the connecting condition before turning on the power switch of the camera. In 1 or 2 seconds after the power is turned on, the LED operation indicator on the rear panel of the camera changes from orange to green to show that the camera is in operation.

(Note) The maximum allowable lengths of the camera cable and the digital 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.

- Application of test pattern

This equipment has the function of generating test patterns. This test pattern allows the user to confirm the appropriateness of the connection between the camera and PC as well as the setting of the board to some extent when used during the initial setup process for the connection with the capture board and others.

[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:	900mA or over (recommended value)
	Take into consideration the fact that transient current of about 1.5A 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) 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 "POWER" connector (6 pin connector) on the rear of the camera, or is input as the CC1 signal of the "Camera Link" connector.

If the camera is connected to the power supply unit PU100 with a Takenaka's 6P12G series cable, connect the Vinit signal (asynchronous trigger signal) to the trigger input terminal of the power supply unit (PU100).

(Note) OR operation (negative OR) is implemented inside the camera between the Vinit1 input signal of "POWER" connector and Vinit2 input signal as CC1 signal of "Camera Link" connector.
If either one of those are fixed to the active level, the Vinit signal (logical sum) is also fixed to the H level and the trailing edge signal cannot be obtained. This would result in failure in starting up the asynchronous shutter operation. Make sure to fix the input signal on the unused side to the non active level, keep it at high impedance level or open state (no connection).

- LED indicator for Vinit signal monitoring
  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 LED lights up in red for a certain period of time (for about 100 ms) each time upon detection of a trailing edge of the trigger signal. 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.

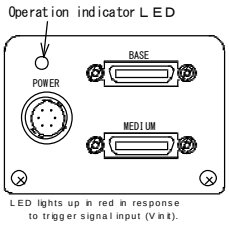


Fig. 4-2. LED indicator

- Setting of various asynchronous shutter modes
  Set the parameters and others in accordance with the following table:

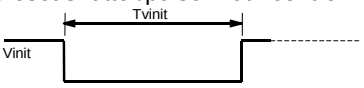
Table 4-1 Setting of various asynchronous shutter modes

Asynchronous shutter mode	PWC	Shutter switch	Remark
Preset shutter (PWC=DISABLED)	DISABLED	1 to 9	
Preset shutter (PWC=ENABLED)	ENABLED	1 to 8	
Pulse width control		9	Shutter switch = 1 to 8: same as preset shutter

(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 others → See “ How to set operation mode”.

- 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 40H as described below.
For this case, the exposure operation starts in synchronization with the trailing edge 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, and the integer multiple number of H (1 horizontal synchronous interval) that is closest to the retrieved Vinit pulse duration is transmitted as nH 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 ≤ 40H
(The exposure time is independent of the Vinit width.)
1H=1 horizontal scan time
[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)

Fig.4-3 Vinit signal timing

(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).
→ 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

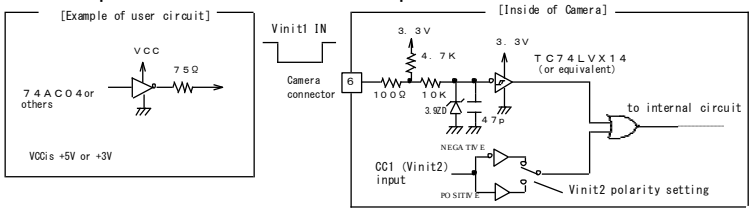


Fig. 4-4. Vint circuit

* The Vinit signal should not include unnecessary noise components such as chattering.
[Input voltage range]

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

- Polarity reversal of Vinit2 input
  The input polarity of the trigger signal (Vinit2) to be applied via CC1 of Camera Link can be inverted.
  Some capture boards may have the polarity of the trigger signal input from CC1 that is fixed to positive logic (L level at normal/H level at active), which is not compatible with the trigger signal of negative logic input (factory preset polarity of this equipment). In this case, the input polarity of the trigger signal (Vinit2) via CC1 can be inverted to change from negative to positive logic by the setting of the camera.

→ Refer to “(6-3) How to set operation mode” for the specific setting method.

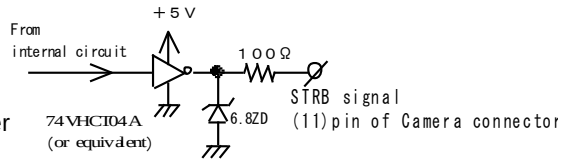
(Note) The setting of the polarity reversal is valid only for Vinit2. The input polarity of Vinit1 is always negative logic regardless of this setting.

(4-3) Strobe signal output circuit

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 the setting of STRBC0 and STRBC1 in (6-5) Internal flag register and configuration register



[output voltage range]

H level	5.0V (at 0mA) to 4.0 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

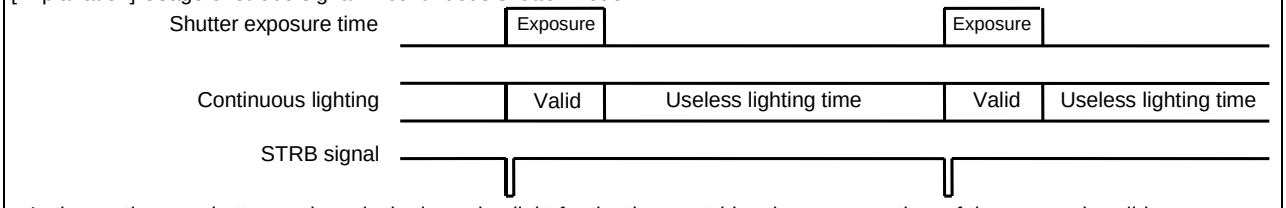
The signal from this terminal is set to OFF as a factory default value.
This can be changed to STRB (Strobe timing signal) or BUSY state by way of rewriting the configuration register(CR) with serial communication commands.
(CR5) and (CR6) correspond to STRBC0 and STRBC1, respectively

(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.

(4-4) Test pattern display function

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 1 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 1023.

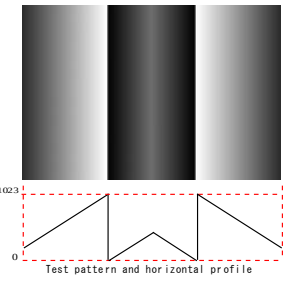


Fig. 4-6. Test pattern

(Note) In the data, a numerical value of 1 is incrementally added for every horizontal pixel in the range of 0 to 1023 for the case of 10 bit output, and in the range of 0 to 255 for the case of 8 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 on the configuration menu (Operation Mode Setting Group 4) or by way of rewriting the configuration register with serial communication command.

[Procedure for switching test pattern output ON/OFF]

(1) Start up in the Setting group 4.(Set the mode switch to the position “D”, keeping the power to the camera off. Then turn on the power of the camera while turning and keeping the UP/DOWN switch lever to the either of upper or lower position).
(2) Return the UP/DOWN switch lever to the neutral position when the response sound of “pip-pip” is heard
(3) Change the position of the mode switch to “2” after confirming that LED indicator flashes in orange.
(4) The test pattern display gets ON by stroking UP/DOWN switch upward and gets OFF by stroking that downward.
(5) Switch to OFF when Test pattern is not necessary anymore. Since the setting of the test pattern output is automatically saved, the test pattern will be output with last setting when the power is reapplied from next time.

(4-5) 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°C (-40°C to +85°C), +3 to -2°C (55°C to 125°C)
Effective data range :	-55°C to 125°C (as long as the 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°C) to +250 (125°C)

(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°C
(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°C=+25°C

(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
Then, Tc is calculated from the following formula: Tc=Dt×0.5°C=-6×0.5°C=-3°C

(4-6) Operation confirmation buzzer

This equipment is designed to sound the confirmation buzzer of “pip” when a stroke is applied to the UP/DOWN switch on the rear panel, or at the time of other manipulation including the start-up after power application.
The factory default setting is ON. This setting can be changed to cancel the buzzer.

[Procedure for switching buzzer between ON/OFF]

(1) Start up in the Setting group 3.(Set the mode switch to the position “C”, keeping the power to the camera off. Then turn on the power of the camera while turning and keeping the UP/DOWN switch lever to the either of upper or lower position).
(2) Return the UP/DOWN switch lever to the neutral position when the response sound of “pip-pip” is heard
(3) Change the position of the mode switch to “2” after confirming that LED indicator flashes in orange.
(4) The buzzer sound gets ON by stroking UP/DOWN switch upward and gets OFF by stroking that downward.
(5) Turn off the power following the completion of setting . Since the setting is automatically saved, the camera starts up with the last setting when the power is reapplied from next time.

(4-7) 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.)

(4-8) Auto Level Control function (ALC)

The CCD in this equipment has 4ch output ports (for right, left, upper and lower images), and the image signal can be read out in high speed from four ports.(QUAD mode) At that time, the right,left,upper and lower quarters of image data are synthesized to make a full area picture image bringing together at a center boundary of the screen. Then the right, left, upper and lower output may differ in level, as the four output characteristics are not exactly the same. This equipment has the automatic correction function to reduce and obscure the level difference at the boundary. The factory default of this function is OFF. It can also correct the level difference manually deactivating the automatic correction function. Depending status of camera usage, difference in level or border line may appear on the center boundary. However, it does not arise from camera failure.

※ ALC may not function well depending on image signal state. In that case, adjust GAIN and OFFSET manually deactivating ALC.
※ When ALC(CONTINUOUS) is operating, GAIN correction value obtained by ALC(1 shot) gets disabled.

The target video level is that of reference image obtained in advance (Right and left)
The initial value of reference image video level (right and left levels) is 160 (8bit scale).
(Refer to “Serial communication control” for more detailes.)

1. ALC (CONTINUOUS:always-on)
GAIN correction value is controlled to bring the video level closer to the target level detecting the right and left video levels. GAIN correction value is controlled every time the image is renewed. GAIN correction value always varies. OFFSET correction value is not controlled and when ALC (1 shot) is in effect the correction value of that is applied. This function becomes effective when bit 12 of configuration register is “1”.
2. ALC (1 shot)
GAIN correction value and OFFSET correction value are determined from image signal when correction value acquisition command (serial communication) is received. These correction values becomes effective when bit 11 of configuration register is “1”.

・OFFSET correction value acquisition ALC (1 SHOT_O)
CCD is closed using the electronic shutter function when the command is received. After that, the right and left OFFSET correction values are computed to adjust the image level when CCD is closed to the defined value using predetermined number of frames of image signal. It is automatically terminated when predetermined number of image frames are renewed and the value upon termination becomes OFFSET correction value of ALC(1 shot).

・GAIN correction value acquisition ALC (1 SHOT_G)
When the command is received, the right GAIN correction value is computed using predetermined frames of image signal to minimize the level difference between right and left images. It is automatically terminated when predetermined number of image frames are renewed and the value upon termination becomes GAIN correction value of ALC(1 shot).

・ALC (1 SHOT_G) correction value clear
It is to clear GAIN and OFFSET correction values set at ALC(1 SHOT_O,G).

5. Various Settings

(5-1) Operation mode

- CCD output mode ····· QUAD/DUAL / SINGLE
- 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)
- Scanning system ····· Normal scan

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

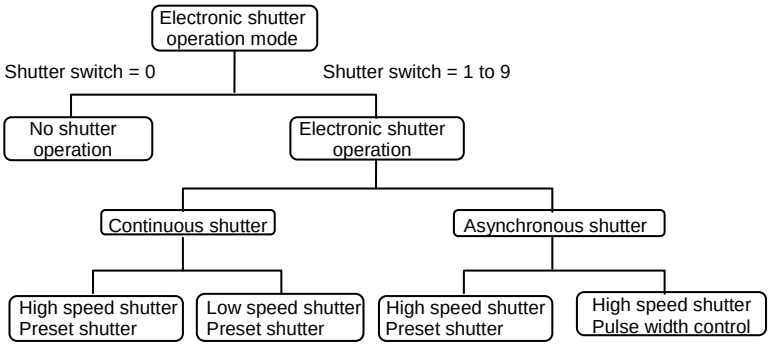


Fig. 5-1. Electric shutter mode

Table 5-1. CCD output modes

CCD output mode	QUAD	Image signal is output from right,left,upper and lower output ports simultaneously. High speed readout is realized by using four output ports.(High frame rate)
	DUAL	Image signal is output from right and left output ports simultaneously. High speed readout is realized by using two output ports.(High frame rate)
	SINGLE	Image signal is output from single output port. Stable image can be obtained by using single output port sacrificing the frame rate to some extent.

Table 5-2. Electronic shutter operation modes

Shutter system	No shutter	Electronic shutter is not used. Exposure time of image sensor is equivalent to one frame duration. Exposure is continuously performed for each frame.
	Continuous shutter	Repeats exposure regardless of external trigger input (Vinit). Repetition pitch is per frame.
	Asynchronous shutter	Electronic shutter is released each time the external trigger is input (Vinit). The shortest repetition pitch is [exposure time + 1 frame duration].

Table 5-3. Type of shutter speed

Type of shutter speed	Normal shutter (High speed shutter)	Shutter ,of which the exposure time is less than one frame, is used. The exposure time 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. (Only for continuous shutter mode) The exposure time can be set as a preset shutter speed at 9 different levels. (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 the exposure time corresponds to the pulse width (during L level) of the external trigger input (Vinit), is released. Exposure time can be set as nH (n = 1 or larger integer number) in H (horizontal synchronous time) unit.

Table 5-4. Other operation mode

Scanning system	Normal scan	The readout for each frame is conducted by the all pixel readout scanning.

[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 6-1.

[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.

(!) In conventional camera, the shutter speed type was always pulse width control mode when in asynchronous shutter mode and when the shutter switch position is "9". however, the shutter speed of this camera becomes preset fixed shutter when it is set "PWC=DISABLED", even if the shutter switch position is "9" in the asynchronous shutter operation.

[Terminology] High speed shutter ····· This means the shutter of which shutter speed is shorter than 1 frame duration (=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 duration. 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).

(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 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.

Table 5-5 Set value of shutter speed

Shutter SW position	High speed shutter (continuous/asynchronous)			Low speed shutter (continuous)		
	QUAD	DUAL	SINGLE	QUAD	DUAL	SINGLE
0	No shutter (continuous)					
	1/ 60 sec	1/ 30 sec	1/ 15 sec	1/60 sec	1/30 sec	1/15 sec
1	1/25000 sec(1H)	1/25000 sec	1/15000 sec	1/30 sec (2V)	1/15 sec	1/ 7.5 sec
2	1/15000 sec(2H)	1/15000 sec	1/ 8500 sec	1/15 sec (3V)	1/ 7.5 sec	1/ 3.75 sec
3	1/ 8000 sec (4H)	1/ 8000 sec	1/ 4400 sec	1/ 7.5 sec (4V)	1/ 3.75 sec	1/ 1.88 sec
4	1/ 4000 sec (8H)	1/ 4000 sec	1/ 2200 sec	1/ 3.75 sec(5V)	1/ 1.88 sec	1/ 0.94 sec
5	1/ 2000 sec (17H)	1/ 2000 sec	1/ 1100 sec	1/ 1.88 sec(6V)	1/ 0.94 sec	1/ 0.47 sec
6	1/ 1000 sec (35H)	1/ 1000 sec	1/ 500 sec	1/ 0.94 sec(7V)	1/ 0.47 sec	1/ 0.23 sec
7	1/ 500 sec (72H)	1/ 500 sec	1/ 250 sec	1/ 0.47 sec(8V)	1/ 0.23 sec	1/ 0.12 sec
8	1/ 250 sec (144H)	1/ 250 sec	1/ 125 sec	1/ 0.23 sec(9V)	1/ 0.12 sec	1/ 0.06 sec
9	1/ 120 sec (298H)	1/ 120 sec	1/ 60 sec	1/ 0.12 sec(10V)	1/ 0.06 sec	1/ 0.03 sec
	Pulse width control / asynchronous (!)					

(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 duration.
(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 ratio) of the preamplifier between the CCD imaging device inside the camera and A/D converter.

- Offset setting
  This is to set the offset of the preamplifier between the CCD imaging device 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 setting except for a special case.
(Note) Follow the procedure (gain setting → offset setting) if fine tuning of the offset value is required.

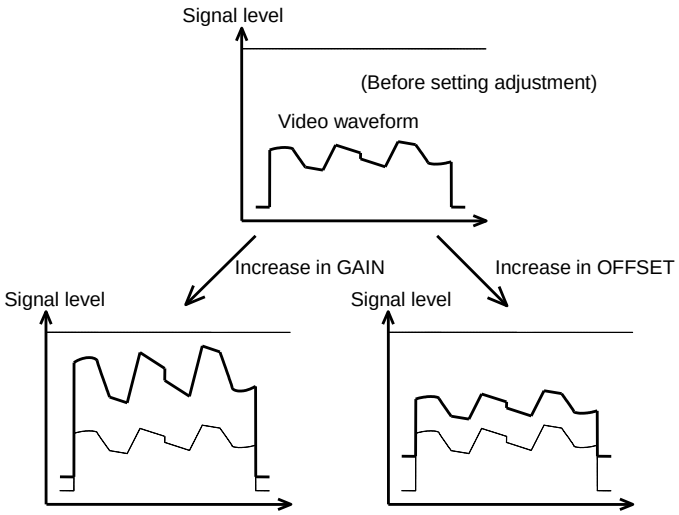


Fig. 5-2 Conceptual diagram of gain and offset levels

(5-4) Gain setting of preamplifier

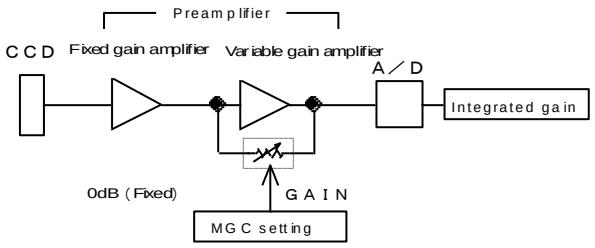


Fig. 5-3 Gain setting

- 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
  This equipment is controlled by giving the MGC setting value. 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.

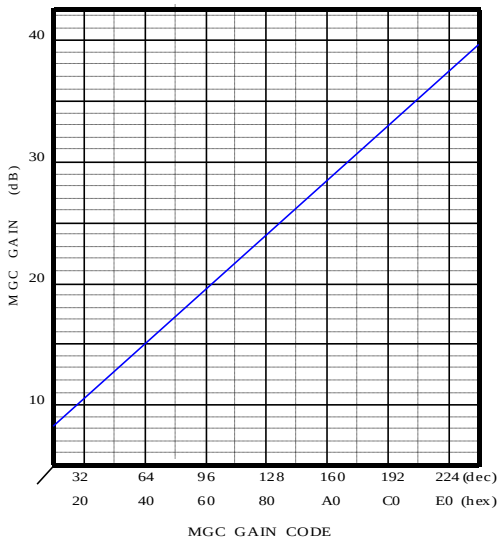


Fig. 5-4 Gain characteristics

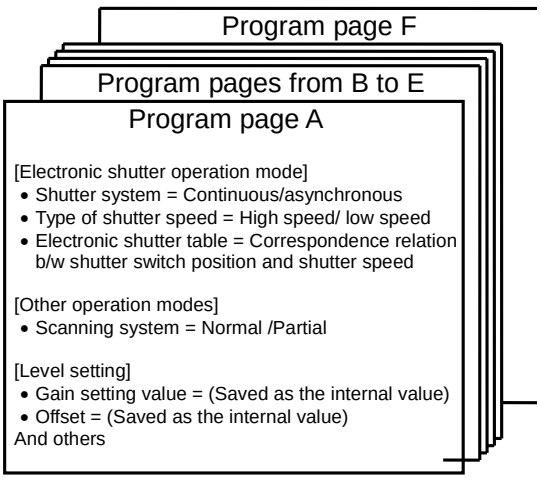
(Note) When the CCD element receives excessive light with a low gain value of the amplifier due to the restriction of the dynamic range of the CCD light receiving element, the signals of the nonlinear area of the CCD element and the preamplifier are output at the high brightness area.
In this state,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

The FC series cameras are internally equipped with nonvolatile memories then 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.

6. Various setting via serial communication

This camera is not equipped with the substantial switches. Setting parameters for shutter speed, gain, offset or operational mode can be manipulated in a manner to directly provide serial communication command to the camera using serial communication software (such as “FCTool”).

(6-1) 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) ※Applied to page A to F	Flag register (FR)	Various operation mode setting	16 bit
	Gain set value	MGC set value	
	Gain correction value	MGC(B,C,D) set value	
	Offset set value	Offset set value	
	Offset correction value	Offset(B,C,D) correction value	
	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	32 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(FC2600CL), EXP_ MAX(Maximum value) is “H’023C”(=D’0572) for the high speed shutter(QUAD/DUAL) , “H’0478”(=D’1144) for the high speed shutter(SINGLE), and “H’0032” for the low speed shutter.

[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.

(6-2) 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 5-5 “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 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]

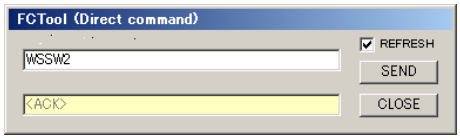
It can be changed to the shutter speed prescribed in Table 5-5 “Setting value of shutter speed” by designating the shutter switch set value .
(!) This corresponds to the method of changing the shutter switch on the rear panel of the conventional camera.

- 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.

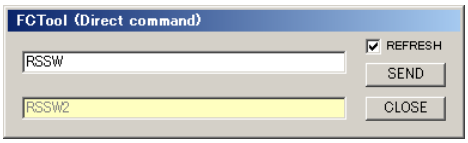
- Command “RSSW”
  Function: Command for reading out the shutter switch set value (Read Shutter Switch)

  Transmission from host: STX : “RSSW” : ETX
  Return by camera: STX : ACK : 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.

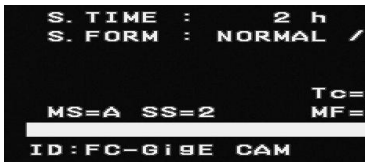


- Command “SSSW”
  Function: Command for saving the shutter switch set value (Save Shutter Switch)

  Transmission from host: STX : “SSSW” : ETX
  Return by camera: STX : ACK : 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)

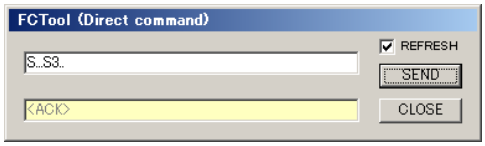
  Transmission from host: STX : “S” : ※1 : ※2 : ※3 : exposure time : ETX
  Return by camera: STX : ACK : set value : ETX (transaction completion), or STX : NAK : ETX (transaction rejection)

  ※ 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), EXP_MAX (maximum value) is “H’023C” (=D’0572) in high speed shutter mode(QUAD/DUAL), “H’0478” (=D’1144) in high speed shutter mode(SINGLE) and “H’0032” 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

(6-3) 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 of the conventional camera.

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

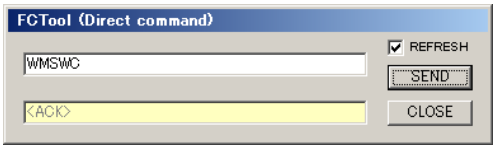
  Transmission from host: STX : “WMSW” : set value : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK: ETX (transaction rejection)

  ※ 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”.



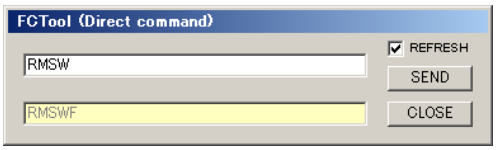
- Command “RMSW”
  Function: Command for reading out the mode switch set value (Read Mode Switch)

  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.

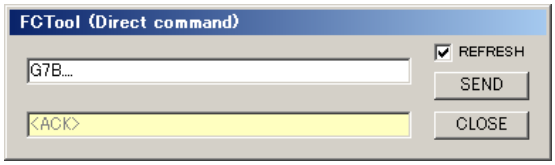
[Explanation]
The set contents of the program page can not be read out by merely changing the program page settings.
The set contents designated in this page are automatically loaded when the set values are saved in nonvolatile ROM and restarted (application of power or “ARESET”) next time.
The mode 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.

(6-4) How to set Gain and Offset

"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.
- OFFSET setting … Setting the fixed offset.



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

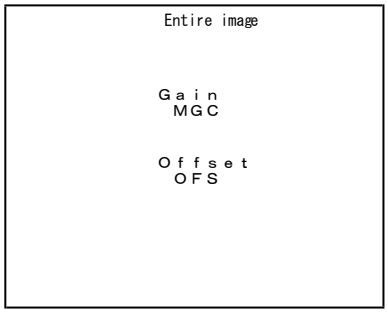
(Note) "…." (four periods)

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

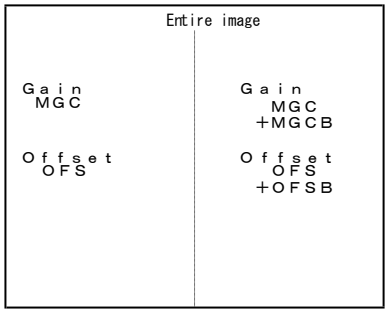
● Adjustment of Gain and Offset

The camera has three types of CCD output system; SINGLE(one output port), DUAL(two output ports) and QUAD(four output ports). Gain and Offset must be set for each output system and they are controlled by four kinds of set values; MGC set value, MGC(B,C,D) correction value, OFFSET set value and OFFSET(B,C,D) correction value.

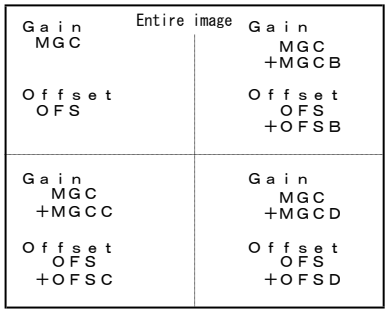
・Gain and Offset setting in SINGLE



・Gain and Offset setting in DUAL



・Gain and Offset setting in QUAD

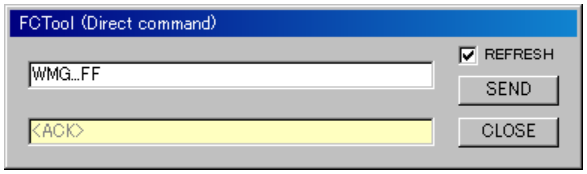


MGC set value and OFFSET set value of the above G command control Gain and Offset of the entire image in SINGLE, of the left half image in DUAL and of the upper left image in QUAD, and are also the base value for the another part.
For example. The Gain of lower right image in QUAD is controlled by MGC set value + MGCD correction value, and the Offset is controlled by OFFSET set value + OFFSETD correction value. Therefore, the entire GAIN and OFFSET can be changed by changing MGC set value and OFFSET set value using G command.

However, when GAIN and OFFSET is changed widely, it may needs to change each correction value.

"WMG" command is used for Gain setting.
Transmission from host: STX : "WMG" : MGC set value: MGCB correction value: MGCC correction value: MGCD correction value: ETX
Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

- MGC correction value … It is given in two's complement.



[Example] To set the lower left Gain in QUAD to the value that is one less than MGC set value.(To set MGCD correction value to "-1"(=H'FF))
Transmit as follows
Transmission from host: STX: "WMG": "…": "FF": ETX

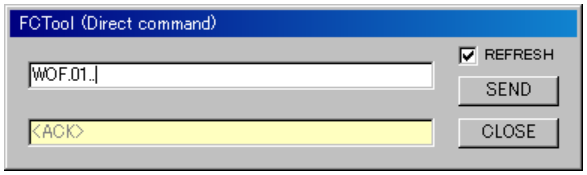
(Note) "…" (three periods)

"WOF" command is used for Offset setting.

Transmission from host: STX : "WOF" : OFFSET set value: OFFSETB correction value: OFFSETC correction value: OFFSETD correction value : ETX
Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

- MGC correction value … It is given in two's complement.

[Example] To set the left half Offset in DUAL to the value that is one greater than OFFSET set value.(To set OFFSETB correction value to "+1"(=H'01))
Transmit as follows
Transmission from host: STX: "WOF": ".": "01": "..": ETX



(6-5) Internal flag register and configuration register

There are RAM areas inside the camera consisting of flag register (FR) (2 bytes) and configuration register (CR) (4 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 (two bytes, 16bit) and CR (four bytes, 32bit) which are the 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 twelve digits like "MF=0000.0000.0000" representing the current status of the registers.
Each numerical value is displayed in hexadecimal system. And each part represents the set contents of configuration register(CR(H)), configuration register(CR(L))and flag register(FR), from left.

Table 6-1 [Contents of CR(L)]

Bit	Abbrev.	Contents	Logic	Remarks
0	MNI	Disabled display of menu screen	1: Disabled (OFF)	
1	BZI	Disabled buzzer output	1: Disabled (OFF)	
2	TPEN	ON/OFF selection of Test pattern	1: Test pattern ON	
3	DFRM0	Selection of output data format	00: 10 bit 01: 8 bit	
4	DFRM1			
5	STRB0	Selection of output mode on STRB output terminal	00: OFF, 01: STRB 10: BUSY, 11: (-)	(STRB1,STRB0) 11: Inhibited 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	Serial communication baud rate 9600bps fixed	0=9600bps	*1
10	-	(not used)		
11	ALC1	AutoLevel Control (1Shot)	1: Correction value valid	
12	ALCC	AutoLevel Control (Continuous)	1: to perform the correction	
13	CCD01	CCD output mode	01:QUAD, 00:DUAL 10:SINGLE, 11=(-)	(CCD01,CCD00) 11: Inhibited
14	CCD00			
15	DFER	Request for reading out default value at next start-up	1: Request	*1

*1 Unable to change by communication command.

Table 6-2 [Contents of CR(H)]

Bit	Abbrev.	Contents	Logic	Remarks
0	SORT	Sorting permitted	1: with Sorting	
1	REPT	Repetitive output permitted	1: Repetitive output	
2	-	(not used)		
3	-	(not used)		
4	-	(not used)		
5	-	(not used)		
6	-	(not used)		
7	-	(not used)		
8	-	(not used)		
9	-	(not used)		
10	-	(not used)		
11	-	(not used)		
12	-	(not used)		
13	-	(not used)		
14	-	(not used)		
15	-	(not used)		

Table 6-3 [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: Enabled	
2	LEXE	Selection of high speed/low speed shutter	1: Low speed shutter	
3	-	(not used)		
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	-	(not used)		
15	AGCE	(not used)		

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

(Example) If "MF=0001.0008.0003" is displayed on the menu screen, the camera is in the following state (converting the numbers to ones in binary system):
CR_H=B'0000000000000001, CR_L=B'0000000000001000 and FR=B'0000000000000011

…… CR_H(0)=CR_L(3)=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 1/0 state of these bits and the information in the above table, the user can know that the camera is in the state of "with Sorting","8 bit output","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 "WMCH", "WMCL"
Function: Command for writing on the configuration register (Write Mode Configuration)

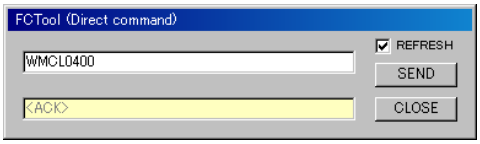
Transmission from host: STX : "WMC" : "H" or "L": set value : ETX
Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

※ "H" or "L" represents CR_H or CR_L respectively.
※ " 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_L.
Transmit as follows
Transmission from host: STX: "WMCL": "0400" : ETX

Right figure shows the example of transmitting the command using FCTool. The CR_L is set to "0400".

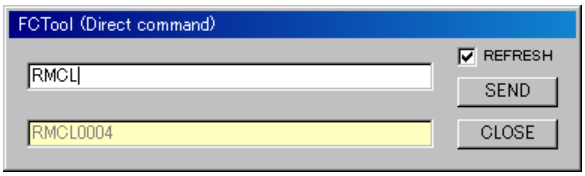


- Command “RMCH”, “RMCL”
  Function: Command for reading the configuration register (Read Mode Configuration)

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

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

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



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

  Transmission from host: STX : “SMC”: “H” or “L”: 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_H and CR_L 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.

→ 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)

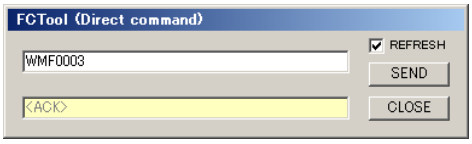
  Transmission from host: STX : “WMF” : set value : ETX
  Return by camera: STX : ACK : ETX (transaction completion) or STX : NAK : ETX (transaction rejection)

  ※ “ 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”.

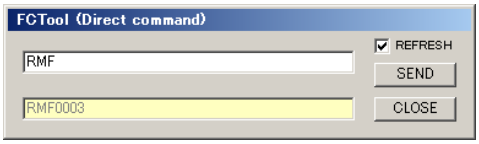


- Command “RMF”
  Function: Command for reading the flag register (Read Mode Flag)

  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.

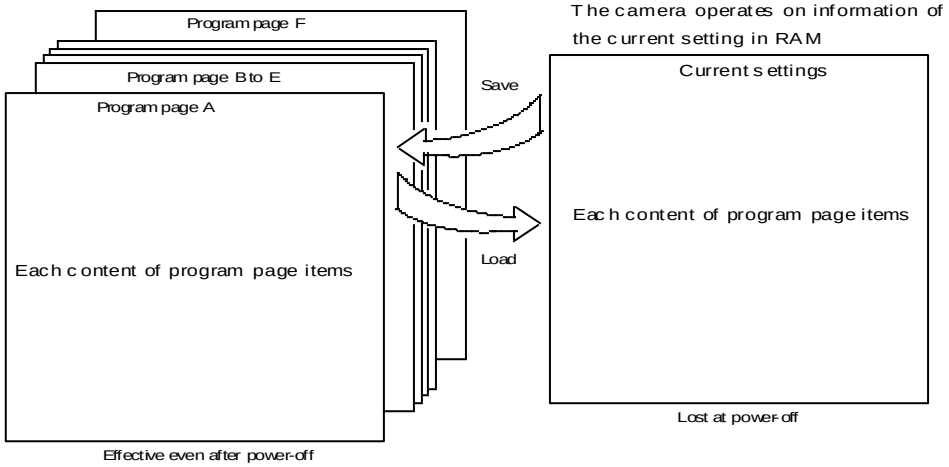


  (Note) The settings of FR are saved using “WA” to ”WF” command.

  ● Changing of QUAD/DUAL/SINGLE mode (When other settings of CR_L are all “0”.)
  - Change to SINGLE MODE (Set CR_L to “4000” (=H’4000))
    Transmission from host: STX: “WMCL”: “4000” : ETX
  - Change to DUAL MODE (Set CR_L to “0000” (=H’0000))
    Transmission from host: STX: “WMCL”: “0000” : ETX
  - Change to QUAD MODE (Set CR_L to “2000” (=H’2000))
    Transmission from host: STX: “WMCL”: “2000” : ETX

(6-6) 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.

(Note) Note that the program page “A” is automatically loaded at the position of other than “B” to “F”.

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

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

- 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). .

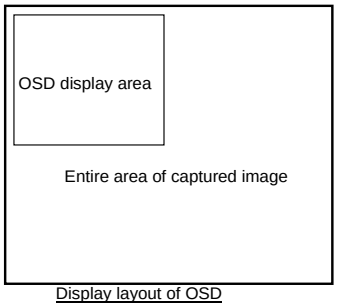
- Command “LA” to “LF”

  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.

(6-7) 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

(Note) Basically, this camera is designed to perform all the settings without menu display like a conventional FC series camera. However 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 FDV/LDV to be output from the camera, on the user's capture board.

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.

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.

- 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.

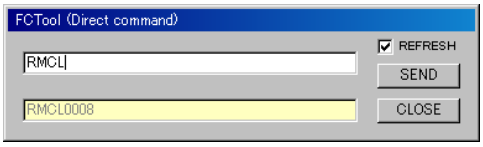
[ON/OFF switching procedure]

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

① Read out the current CR_L data.

Transmit the command "RMCL" and acquire the return data.

→ Refer to (6-5).



[Example]

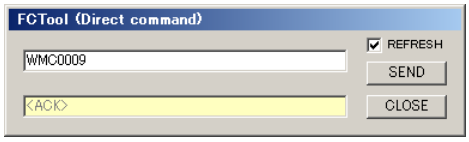
Right figure shows the example of transmitting the command using the direct command input of TAKENAKA's communication software for evaluation (FCTool)

It turns out that CR_L=0008

Based on this return data, CR_L(0)=0 and OSD menu display is set to ON now.

② Change the least significant bit of CR_L 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 "WMCL" command.



[Example]

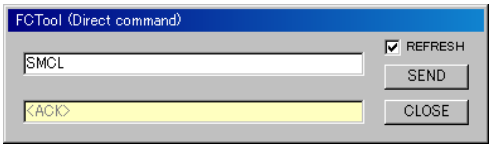
In the "CR_L=H'0008"case above, menu setting is changed from ON to OFF by rewriting the camera setting with CR_L(0)=1. Write the new data "CR_L=H'0009" setting CR_L(0) to 1.

"WMCL" 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 "SMCL" command and to save the set values into the internal nonvolatile ROM(EEPROM) to enable CR data even after next start-up.



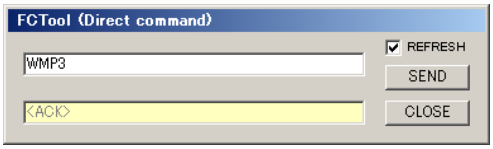
[Example]

Right figure shows the example of transmitting the command "SMCL" using the direct command of FCTool.

- 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.



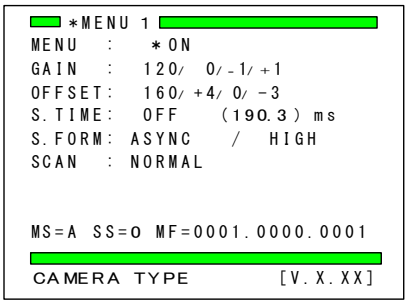
[Example]

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> Displayed contents



Menu 1 display

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.

GAIN: The left number is the gain setting value expressed in the decimal system. The Gain correction value is displayed in order of B,C,D.

OFFSET: The set value of the digital signal offset is displayed in the decimal system.
The Offset correction value is displayed in order of B,C,D.

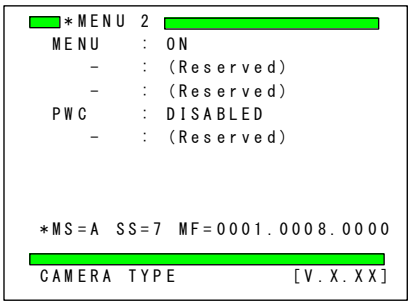
S.TIME: The current shutter exposure time is displayed. The left number is H number (Horizontal synchronous time unit/ decimal number in the 1 to horizontal line number range in the case of high speed shutter) or V number (vertical synchronous time unit/ decimal number in the 1 to 50 range in the case 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 scan mode (All pixel readout/Partial scan) and 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 system is displayed. It is either all pixel readout scan (NORMAL) or partial readout scan (PARTIAL).

<MENU2> Displayed contents



Menu 2 display

PWC: Whether the position “9” of the shutter switch for the asynchronous shutter operation is used (ENABLED) or not used (DISABLED) is selected.

DUMP Whether the Fast-dump operation for the asynchronous shutter operation is used (ENABLED) or not used (DISABLED) is selected.

<MENU3> Displayed contents

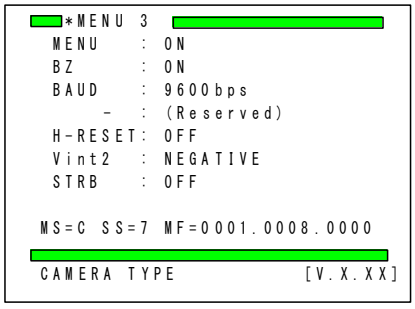
BZ: Whether the confirmation sound for manipulating a switch is enabled (ON) or disabled (OFF) is displayed.

BAUD: The baud rate used for serial communication is displayed.

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.

Vint2: The polarity of trigger signal via CC1 of Camera Link is displayed. It is in negative logic (NEGATIVE) as a factory default, however it can be reversed.

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



Menu3 display

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

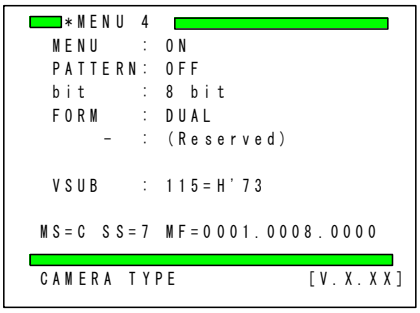
<MENU4> Displayed contents

PATTERN: ON /OFF state of the test pattern output is displayed.

bit: Bit format (8/10 bit) for image output is displayed.

FORM: CCD output system (QUAD/DUAL/SINGLE) is displayed.

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.

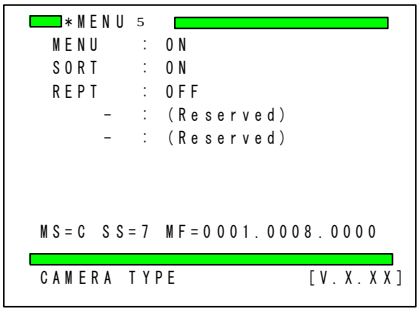


Menu4 display

<MENU5> Displayed contents

SORT: Whether the vertical line sorting in QUAD is enabled (ON) or disabled (OFF) is displayed.

REPT: Whether the continuous output of image signal in the asynchronous shutter mode is enabled (ON) or disabled (OFF) is displayed.



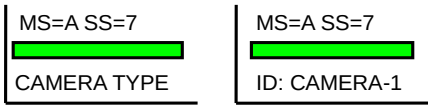
Menu5 display

* 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 switch.

MS= The current position of the mode switch is displayed.
SS= The current position of the shutter setting switch (EXP.) is displayed.
MF= The information(32/16 bit) 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.

[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.

(6-8) Description of operation mode and functional limitation

[Scanning mode]

- Description of scan mode

This camera has the normal scan mode only:

Scan mode	Operation	Frame rate
Normal scan mode (NORMAL)	Readout of all 2.07 megapixels	60 fps(QUAD)

- Normal scan mode ···· The image of all effective pixels is read out at a frame rate of 60 Hz (QUAD).

- Functional limitation by scan mode

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

Current scan mode	No shutter	Continuous shutter	Asynchronous shutter	Low speed shutter
Normal scan mode (NORMAL)	O	O	O	O

(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 (Stored in each program page) ※Applied to page A to F	Flag register (FR)	FR = H'0000
	MGC gain set value	(Factory default)
	MGC gain correction value	(Factory default)
	Offset set value	(Factory default)
	Offset correction value	(Factory default)
	Direct designated value of shutter speed	H'0000 (none specified)
	Electric shutter table	Contents of table 5-5
Configuration item (Stored in common area)	Configuration register (CR(H))	CR(H)=H'0001
	Configuration register (CR(L))	CR(L)=H'2008
	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 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.

7. Serial Communication Command

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

(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. FC2000CL).

- The setting of the serial communication is as follows:
  Baud rate : 9600bps
  Data : 8bit / character
  Stop bit : 1stop bit
  Parity : Non
  XON/XOFF : no control

- 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 code.
  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).

- Description of each command

  (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 request of initialization 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 cancellation of request to initialize the page memory when the power is turned on next time.

  (3) Command “R”
  Function: Command for reporting camera operating state 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
  V: Camera version report
  T: Shutter SW set report
  S: Shutter report

  (4) 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

  (!) FC2600CL does not use the values in parentheses. This camera returns the fixed values instead.

  (5) Camera version report
  Transmission from host: STX: “R”: “V”: ETX
  Return by camera: STX: ACK: “R”:“Takenaka SYS.FC2600CL V1.00”: 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.

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

(7) Shutter mode report

Transmission from host: STX: “R”: “S”: ETX

Return by camera: STX: ACK: “R”: “□”: “□”: “□”: Exposure time: ETX

*1 *2 *3 *4

*1 to 3 Refer to (9) command “S”

*4 : 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 16Hs “0010”
- In the case where the exposure time is set by the shutter switch number on the connector panel:
  Example) If the shutter switch is set to “4”: “I4..”
- In the case where the exposure time is set by the shutter switch number via a serial communication command:
  Example) If “3” is specified for the shutter switch, : “S3..”

(8) 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 code in hexadecimal “20” ~ ”E0”(32 to 224; decimal) are used for the data setting values of MGC and OFFSET.

Example) If level 128 (decimal) is set: “80”
If level 200 (decimal) is set: “C8”

The setting value that does not need 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

(9) Command “S”

Function: Command for setting shutter mode and shutter exposure time

Transmission from host: STX: “S”: “A” or “M”: “H” or “L”: “N”: 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”: 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

*4: Exposure time
The format of “Exposure time” complies with one of the followings:

a. 4 characters corresponding to the hexadecimal which represents 2-byte number
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 16Hs:
  STX: “S”: “.”: “.”: “.”: “0010”: ETX
- In the case where the exposure time is set by the shutter SW number on the connector panel:
  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 shutter switch on the rear panel.:
  STX: “S”: “.”: “.”: “.”: “0000”: ETX

(Note) In the case where the exposure time is externally set using S command, the exposure time is locked finally to the position designated by S command or directly designated value. The locked state is released by setting the exposure time to “0000” using RS-232C as described above. To release the locked state without the use of RS-232C after setting the exposure time by RS232C, execute “Read-out of Factory Default” operation

(Note) The allowable range of number is as follows when in directly setting the exposure time. The operation out of the range is not guaranteed.
In QUAD or DUAL : H’0000 to H’023C (D’ 0 to 0572)
In SINGLE : H’0000 to H’0478 (D’ 0 to 1144)
(where “0” is used only when cancelling the external time setting)

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

Transmission from host: STX: “E”: “H” : 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 exposure time (H) to be allocated to the shutter SW number is expressed in 4 digits in the hexadecimal system for SW0 to SW9.
※ The exposure time for SW0 can not be changed.
Example) If only the exposure time of SW5 for the high speed shutter operation is changed to 88 (decimal):
STX: “E”: “H”: “.”: “.”: “.”: “.”: “.”: “.”
: “0058”: “.”: “.”: “.”: “.”: ETX

(11) 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 setting is written and saved in the EEPROM of the specified page number.

(12) 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.

(13) Command “WMCH”,”WMCL”
Function: Command for writing in configuration flag register (CR) (Write Mode Configuration)

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

The content of “flag set value” (2 bytes/4 characters) is written in the configuration register(H or L).
(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”.

(14) 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 content of “flag set value” (2 bytes/4 characters) is 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.

(15) Command “RMCH”,”RMCL”
Function: Command for reading configuration flag register (CR) (Read Mode Configuration)

Transmission from host: STX: “RMC”: “H”or”L”: ETX
Return by camera: STX: ACK: “RMC”: “H”or”L”: flag set value: ETX

The current content of the configuration flag register (H or L) (2 bytes/4 characters) is returned in the hexadecimal system.

(16) 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

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

(17) 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 content of the common mode flag register is saved in EEPROM.

(18) 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

The current content of the internal temperature data of the camera is returned in the hexadecimal system.
The effective data is the low 10 bits out of the returned 16 bits. This 10 bit value represents 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 “(4-6) Monitoring function for internal temperature of camera” for the conversion method from the returned data to temperature value.

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

Transmission from host: STX: “RMSW”: ETX
Return by camera: STX: ACK: Position No.n (1 character): ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(20) Command “WMSW”
Function: Command for changing hypothetical mode switch position to n (Write Mode SW)

Transmission from host: STX: “WMSW”: Position No.n (1 character): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(21) Command “SMSW”
Function: Command for saving 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)

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

Transmission from host: STX: “RSSW”: ETX
Return by camera: STX: ACK: Position No.n (1 character): ETX (transaction completion),
or STX: NAK: ETX (transaction rejection)

(23) Command “WSSW”
Function: Command for changing hypothetical shutter switch position to n (Write Shutter SW)

Transmission from host: STX: “WSSW”: Position No.n (1 character): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(24) Command “SSSW”
Function: Command for saving 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)

(25) 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 100ms±5%. The minimum value of repetitive pitch in asynchronous shutter operation using this command is 300ms. Only in the case of trigger signal by this command, the buzzer inside the camera sounds for one shot (aprrox. 50ms) in response to trigger signal input. If the buzzer is not required to sound , make “Operation confirmation buzzer = OFF” changing the configuration flag by the configuration menu setting or serial communication command.

(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 normal trigger signal. 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.

(26) 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. As power–on processing is executed, Camera Link output (synchronous signal, image signal etc.) gets temporarily indeterminate

(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.

(27) 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”.

(28) 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 is 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.

(29) 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) is read out. When an ID code is not set, the number of the characters to be returned is 0.

(30) Command “RMG”
Function: Command for reading MGC gain (Read MGC GAIN)

Transmission from host: STX: “RMG”: ETX
Return by camera: STX: ACK: “RMG”: MGC set value: MGCB correction value(Upper right screen): MGCC correction value(Lower left screen): MGCD correction value(Lower right screen): ETX

(31) Command “WMG”
Function: Command for writing MGC gain (Write MGC GAIN)

Transmission from host: STX: “WMG”: MGC set value: MGCB correction value(Upper right screen): MGCC correction value(Lower left screen): MGCD correction value(Lower right screen):ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

A 2 digit ASCII code from “20” to “E0” in the hexadecimal system (32 to 224;decimal) is used for the MGC setting value.
A 2 digit ASCII code from “80” to “7F” in the hexadecimal system (-128 to +127;decimal) is used for the MGC correction value.

Example) When -2 (decimal) is set as a MGC correction value
STX: “WMG”: “.”: ”FE”: ”.”: ”.”: ETX

(32) Command “ROF”
Function: Command for reading offset (Read OFFSET)

Transmission from host: STX: “ROF”: ETX
Return by camera: STX: ACK: “RMG”: OFFSET set value: OFFSETB correction value(Upper right screen): OFFSETC correction value(Lower left screen): OFFSETD correction value(Lower right screen):ETX

(33) Command “WOF”
Function: Command for writing offset (Write OFFSET)

Transmission from host: STX: “WMG”: OFFSET set value: OFFSETB correction value(Right screen): OFFSETC correction value(Lower left screen): OFFSETD correction value(Lower right screen):ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

A 2 digit ASCII code from “20” to “E0” (32 to 224; decimal) in the hexadecimal system is used for the OFFSET setting value.
Example) If level 100 (decimal) is set: ”64”
Example) If level 90 (decimal) is set as an OFFSET setting value:
STX: “WOF”: “64”: ”.”: ”.”: ”.”: ETX

(34) 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)

(35) Command “ALC”
Function: ALC Command

Transmission from host: STX: “ALC”: “Command character string”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)
Command No.=”0” : ALC(1 SHOT_C) to Clear the correction value
=”1” : ALC(1 SHOT_O) to Determine the Offset correction value (Automatic termination)
=”2” : ALC(1 SHOT_G) to Determine the Gain correction value (Automatic termination)
=”3” : to Determine the ALC target level

(36) Command “RALC”
Function: Command for reading ALC (Read ALC)

Transmission from host: STX: “RALC”: ETX
Return by camera: STX: ACK: “RALC”:ALC flag:
Target level (Upper left):Target level (Upper right): Target level (Lower left): Target level (Lower right):
Target shift (Upper left): Target shift (Upper right): Target shift (Lower left): Target shift (Lower right):
Gain correction value (CNT) (Upper left): Gain correction value (CNT) (Upper right):
Gain correction value (CNT) (Lower left): Gain correction value (CNT) (Lower right):
Gain correction value (1 SHOT) (Upper left): Gain correction value (1 SHOT) (Upper right):
Gain correction value (1 SHOT) (Lower left): Gain correction value (1 SHOT) (Lower right):
Offset correction value (1 SHOT) (Upper left): Offset correction value (1 SHOT) (Upper right):
Offset correction value (1 SHOT) (Lower left): Offset correction value (1 SHOT) (Lower right): ETX
ALC flag: Operation flag of ALC. 4-digit ASCII code in hexadecimal
Target level: Target image level of ALC.(0 to 255) 2-digit ASCII code in hexadecimal
Target shift: Shift value to manually fine-tune the target image level. 2-digit ASCII code in hexadecimal
Gain correction value: Gain correction value for each image area. 2-digit ASCII code in hexadecimal.
Offset correction value: Offset correction value for each image area. 2-digit ASCII code in hexadecimal.

(37) Command “WALC”

Function: Command for writing ALC (Write ALC)

Transmission from host: STX: “WALC”: ALC flag:
Return by camera: STX: ACK: “RALC”:ALC flag:
Target level (Upper left):Target level (Upper right): Target level (Lower left): Target level (Lower right):
Target shift (Upper left): Target shift (Upper right): Target shift (Lower left): Target shift (Lower right):
Gain correction value (CNT) (Upper left): Gain correction value (CNT) (Upper right):
Gain correction value (CNT) (Lower left): Gain correction value (CNT) (Lower right):
Gain correction value (1 SHOT) (Upper left): Gain correction value (1 SHOT) (Upper right):
Gain correction value (1 SHOT) (Lower left): Gain correction value (1 SHOT) (Lower right):
Offset correction value (1 SHOT) (Upper left): Offset correction value (1 SHOT) (Upper right):
Offset correction value (1 SHOT) (Lower left): Offset correction value (1 SHOT) (Lower right): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

ALC flag is set in 4-digit ASCII code in hexadecimal. Only the low two bits are alterable.
“000F”: to request the correction value with a goal of the reference image. Do not set other than that.
Target level is set in 2-digit ASCII code in hexadecimal “0” to “FF” (0 to +255,decimal)
Usually, it is automatically set by ALC command “3”, then transmit “.”.
Target shift is set in 2-digit ASCII code in hexadecimal “C0” to ”3F” (-64 to +63, decimal).
It can shift the target value of right and left images. Set it to + side when it is required to brighten the image during automatic correction and to - side when it is required to darken the image. Transmit “.”,unless it is needed to change.
Gain & Offset correction value is set in 2-digit ASCII code in hexadecimal “B0” to ”4F” (-79 to +79, decimal).
Usually, it is automatically set by ALC operation, then transmit “.”.

(38) Command “SALC”

Function: Command for saving ALC setting. (Save ALC)

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

The current ALC settings are saved in EEPROM.
(Note) ALC setting is saved in an area independent from the program pages, and this common value is applied when the camera is turned on with any one of the program pages.

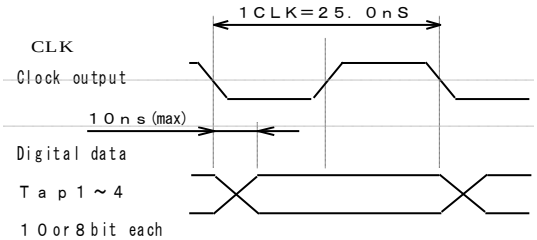
● Note in use of commands

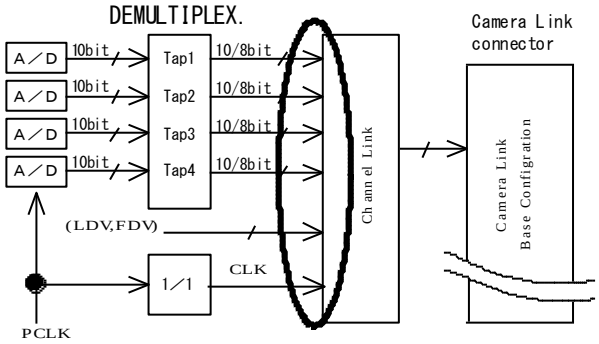
- The internal nonvolatile ROM (EEPROM) guarantees the rewritable times up to 1 million based on the specifications of the device. Accordingly, it is highly recommended to avoid such usage as the commands accompanied by writing in EEPROM including “WA to WF”, “SMC” and “e” are repeated endlessly (or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

8. Timing Chart

- Pixel clock timing (common in various operation modes)

[Phase relationship between clock output and data]



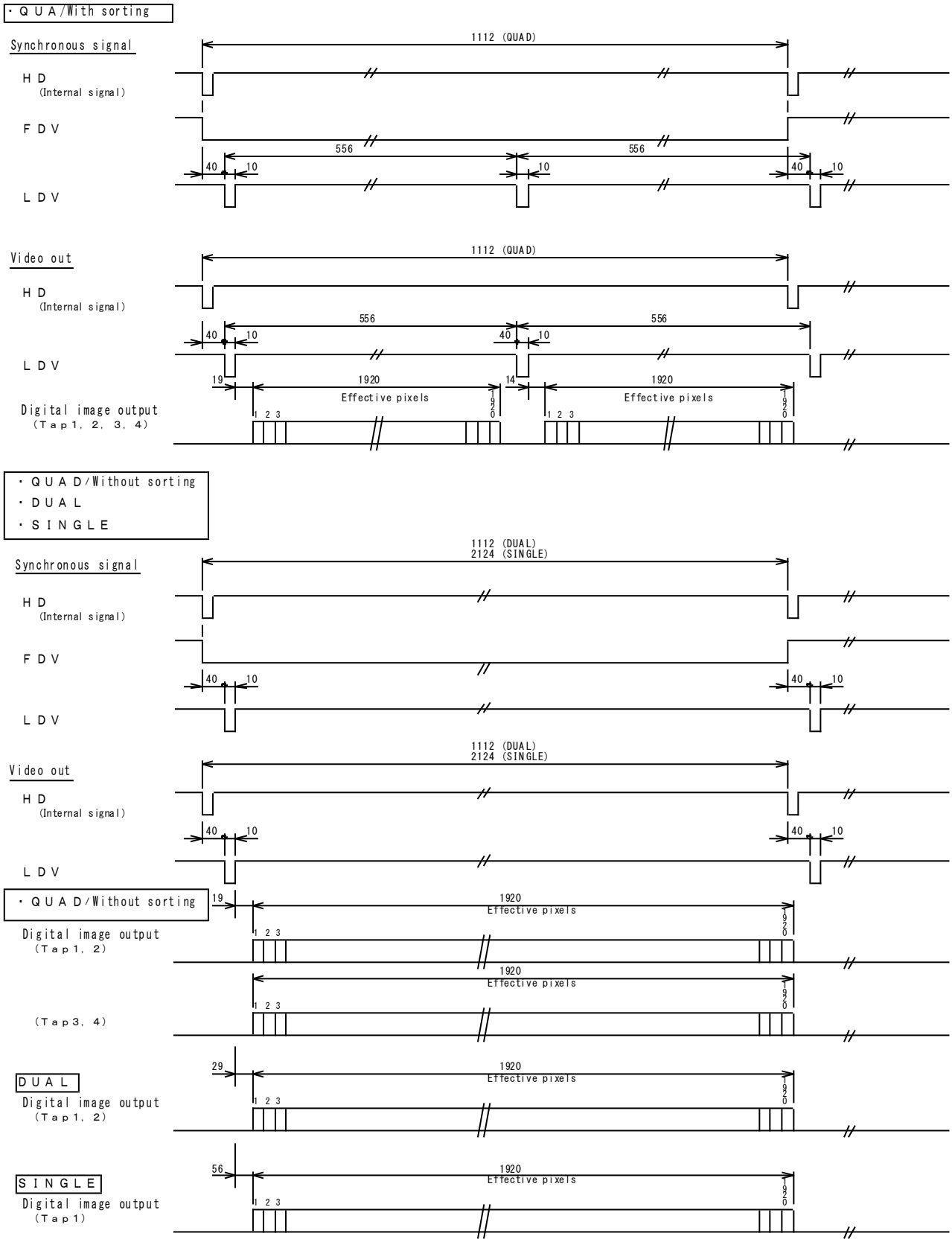


(Note) The above timing represents the signal timing before being encoded to serial data by the channeling device on the side of the sending end (the part circled in the above right figure). If signal conversion from serial to parallel is made by a channel link device in accordance with the standard of Camera Link on the side of the receiving end, the phase relationship between the clock and the data after decoding will be different from that of the above timing due to the structural nature of a channel link device. (In the case of the output from a channel link device, the data are aligned with the falling of the clock signal.) As a general rule, this variation in timing is correctly adjusted at the capture timing of a capture board, the equal definition file to that of the conventional parallel output type can be used for capturing.

(Note) When a channel link device is mounted directly to the capture interface on the user side, instead of using a commercially available capture board that supports Camera Link, it is necessary to pay close attention to the descriptions of the data sheet of the channel link device including the phase relationship between data and clock prior to the use.

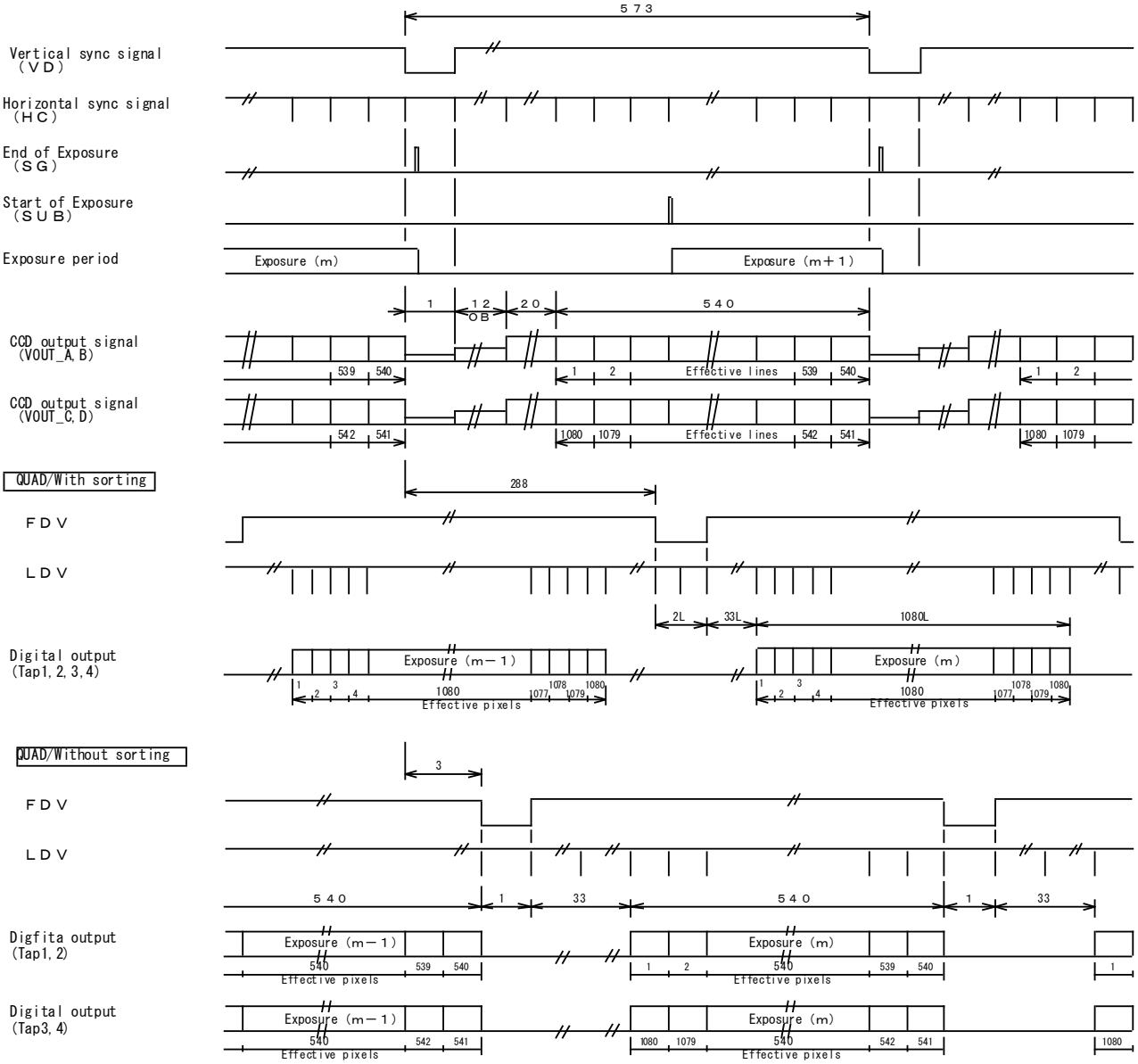
(!) 10 or 8 bit x 4 tap output is adopted for FC2600CL.
(!) In the case of FC2600CL, the image signals are output in order from the upper left even in QUAD output mode (60fps) as they are sorted using internal buffer.

- Horizontal timing

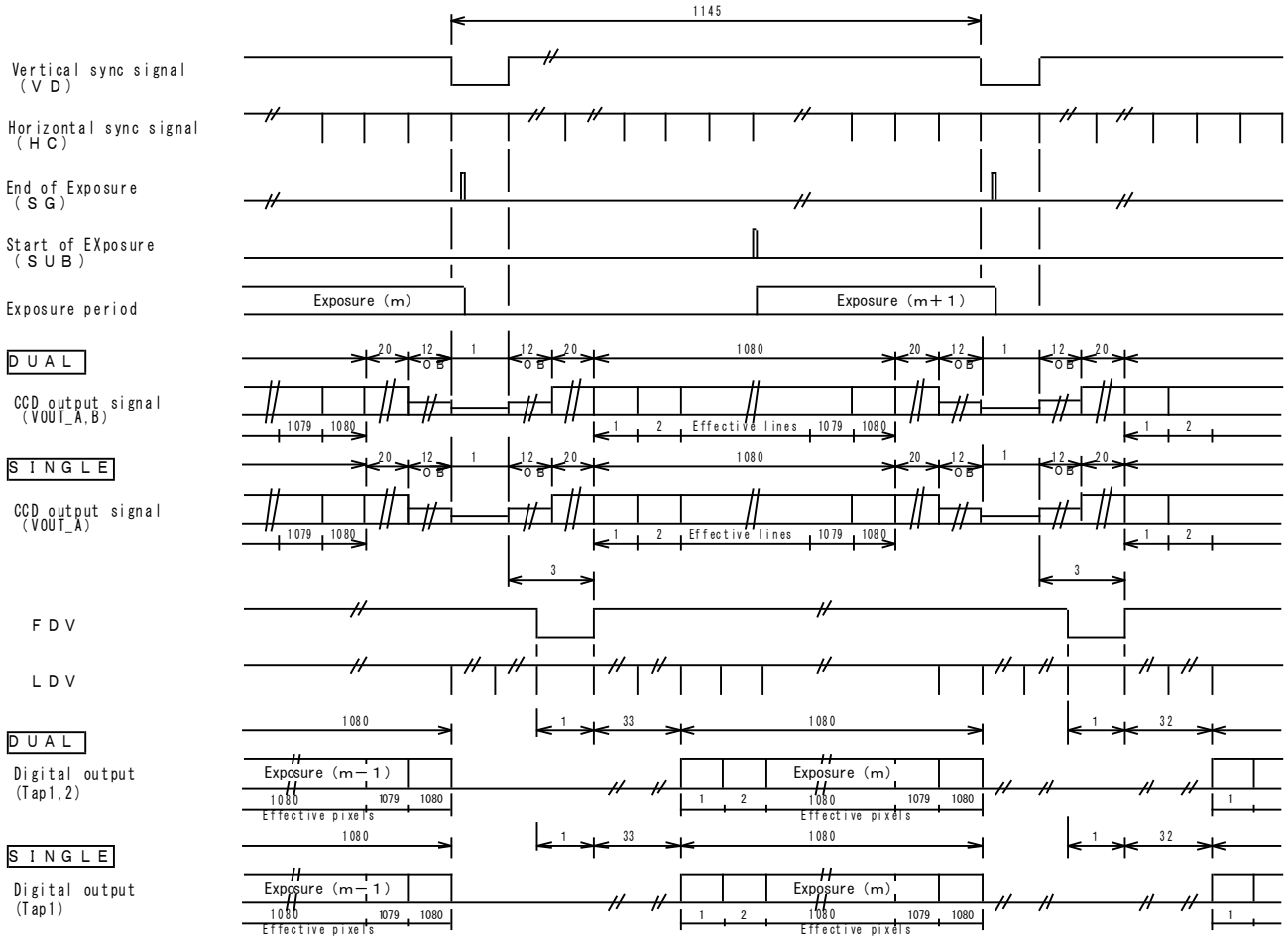


※Unless otherwise specified, the time unit of the values in the horizontal timing chart is CLK (1/40.00MHz = 25.0nS).
※Numerical values here are design values.

- Vertical timing: QUAD/Continuous shutter

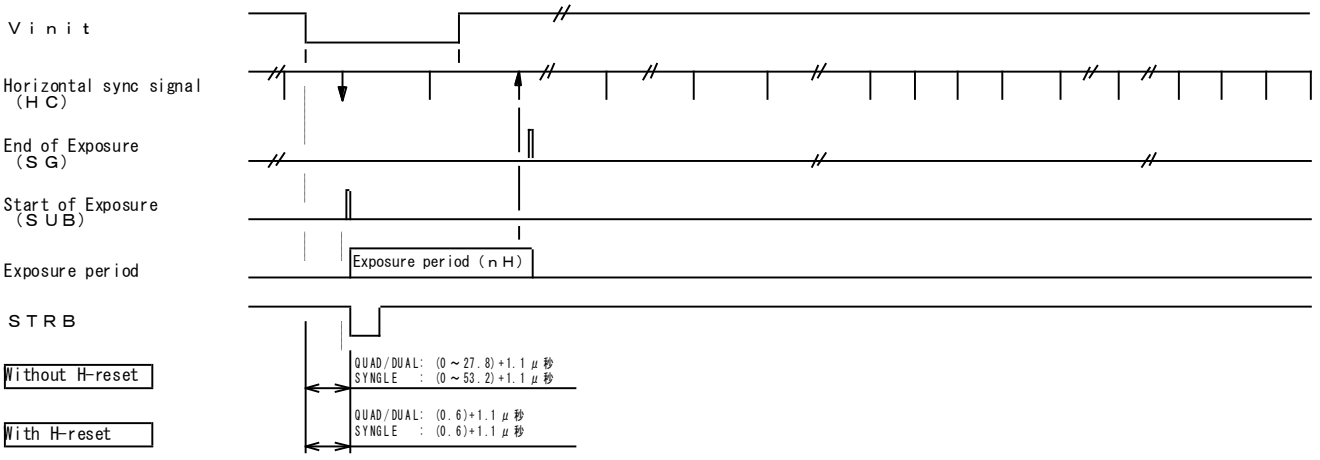


- Vertical timing: DUAL/SINGLE/Continuous shutter



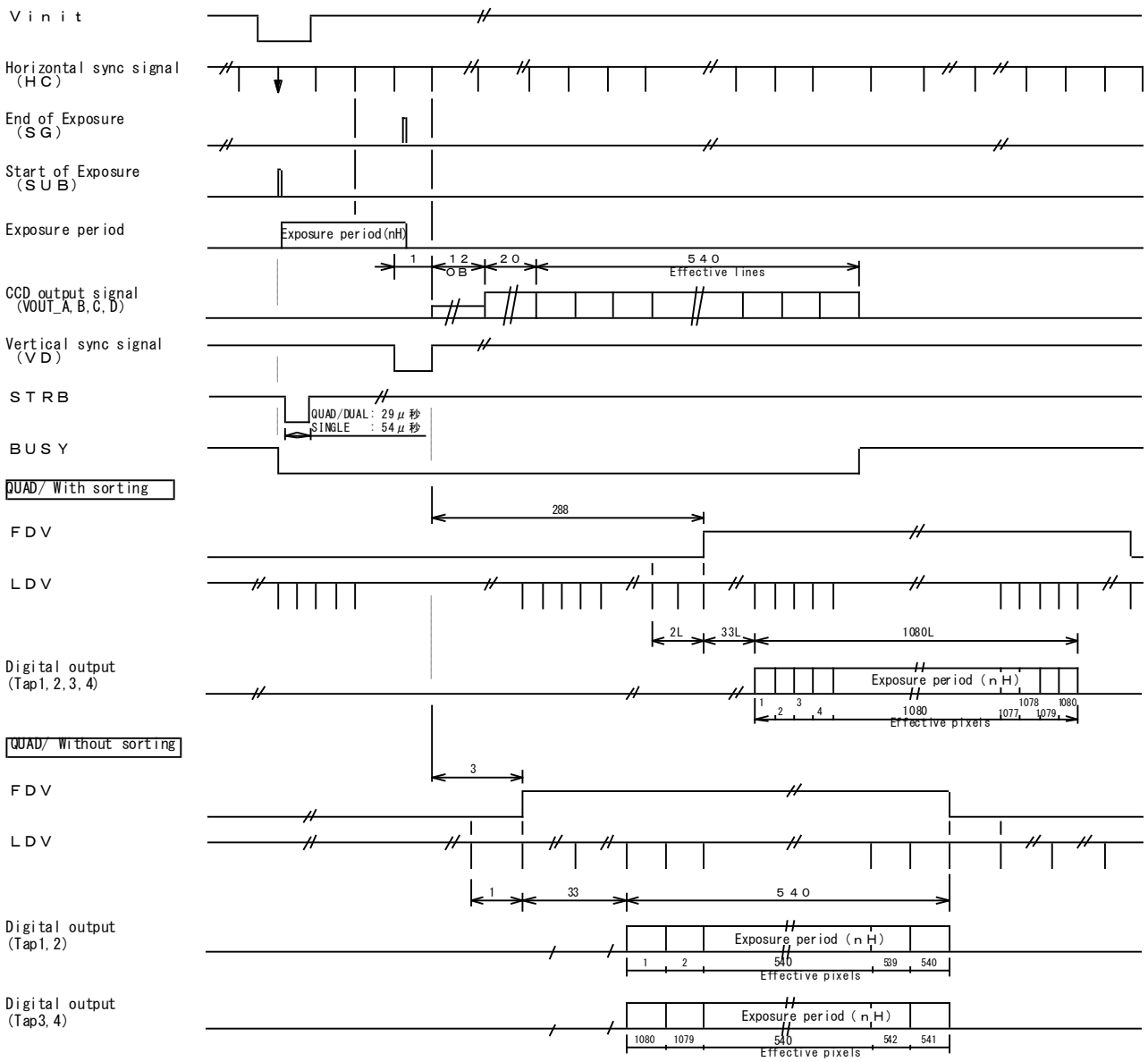
※The period of LDV is indefinite. It varies depending on shutter operation mode.
Refer to the Horizontal timing chart for details.

- H-reset in asynchronous shutter mode



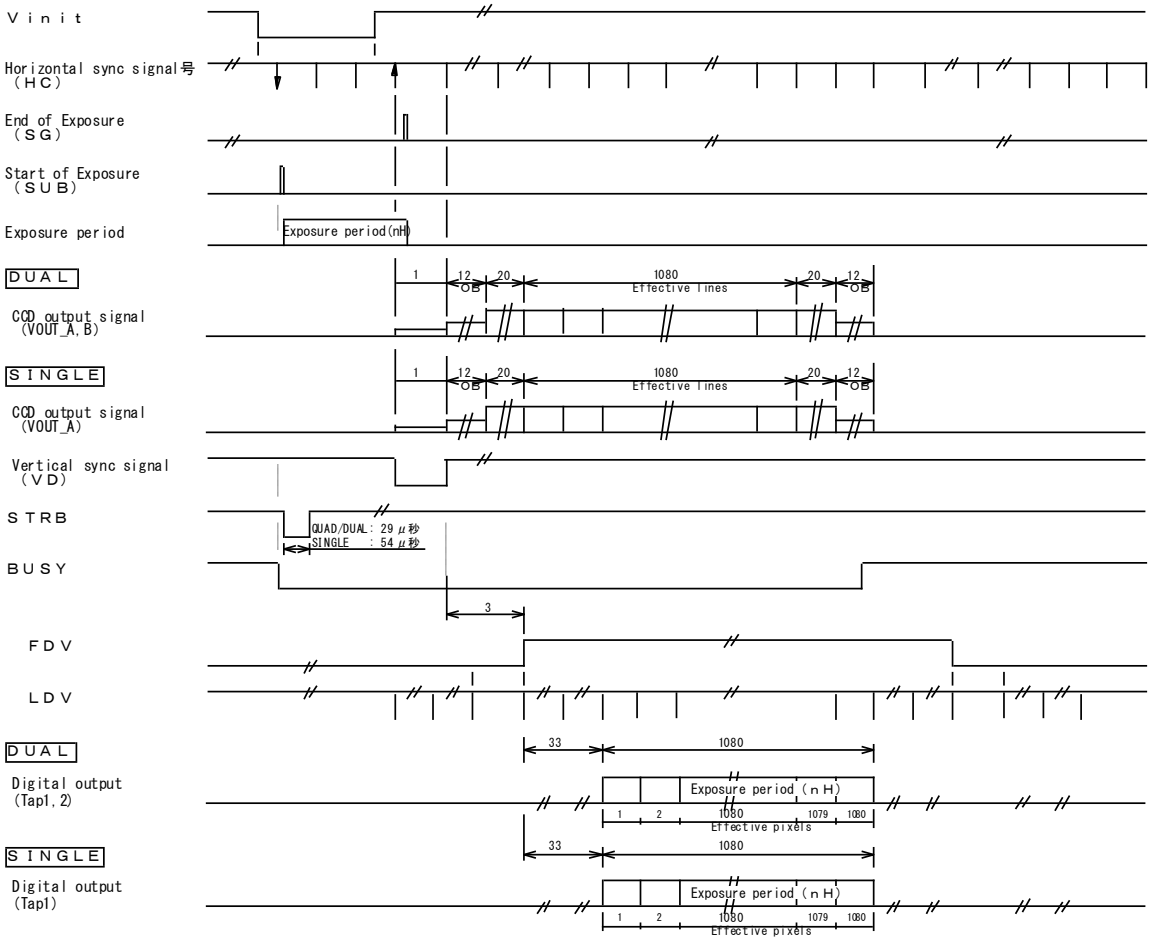
※Horizontal scan is reset on the trailing edge of Vint signal in the case of with H-reset. It can provide a regular period between Vint signal input and exposure start.
※Unless otherwise specified, the time unit of the values in the horizontal timing chart is CLK (1/40.00MHz = 25.0nS).
※Numerical values here are design values.

- Vertical timing: High speed/ Preset shutter/ Asynchronous shutter



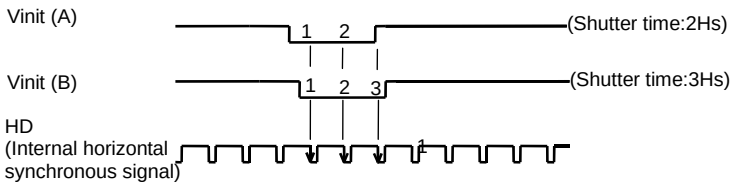
※After VD (Internal vertical sync signal) reached at L level, the image is output at the same timing as that of Continuous shutter.
Refer to the timing of Continuous shutter mode for the image output timing in DUAL/SINGLE mode.

- Vertical timing: High speed/pulse width control/asynchronous shutter



(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 exposure time 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) Maintain the phase relationship of Vinit with the external trigger signal being synchronized with LDV signal of the camera.
••• The exposure time can be controlled without generation of indefinite time of 1H by keeping Vint generating phase against internal HD signal constant.

(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.

9. Accessories

<Camera cable> The cable to supply power to the camera or to connect the I/O signal.

Product name	Cable length	Type	Remarks
Camera cable	2 m	6P12G-02	Possible to make by the meter in the 1m to 25m range.
	5 m	6P12G-05	
	10 m	6P12G-10	

<Tripod attachment> The mounting bracket for tripod screw.

Product name	Type	Remarks
Tripod attachment	AT400	Refer to the figure below for the external dimensions.

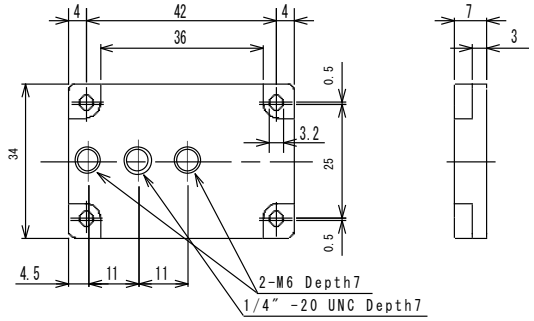


Fig.9-1 External dimensions of Tripod attachment

10. Notes

- This equipment achieves 60fps high frame rate for 2 megapixels by employing quad output CCD. It may have some level difference in brightness between right, left, upper and lower image signals, as each of those signals goes through the different analog circuit. As the level difference in brightness may increase over time, it is recommended to use the camera readjusting regularly. Note that the level difference in brightness may be likely to develop especially when the camera is used in high sensitivity mode (high-gain mode).
- As two or four kinds of image signal are simultaneously output in the multiple output mode(DUAL,QUAD),the projected pseudo image may happen to occur on the axially opposite image.
- More stable images can be obtained by leaving the equipment for 20 to 30 minutes after power-on.
- A longer exposure time in the pulse width control mode is accompanied by the degradation of S/N ratio due to a decrease in the dynamic range of CCD, accumulation of thermal noise components of the CCD imaging device in proportion to the shutter speed. Therefore, it is recommended that the optimum exposure time to be employed is determined after implementing experiments based on the conditions of the actual operation.
- Refrain from connecting or disconnecting cables and connectors when applying current, otherwise troubles may be caused.
- Fix a lens or implement other measures when using with a large or heavy lens, so that no extraordinarily large force is applied to the camera.
- 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.
- 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.
- 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 prolonged 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.
- 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.
- 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.).

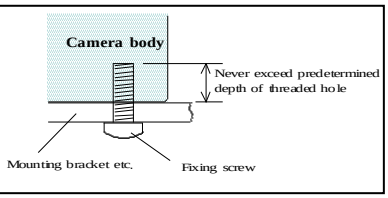
- Do not use this equipment in an environment subject to high temperatures and high humidity.
  Especially in a high-temperature environment, degradation of CCD image sensor is accelerated, and pixel defects such as sunspot may be caused. It is recommended that the equipment is used in an ambient temperature 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 already been confirmed before shipment that the amount of pixel defects is below a specified level.
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.

[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 in "External dimensions" on the end of this document.
If it exceeds the value, there is a possibility that the contents of the camera are broken.



11. Specifications

Image sensor	Progressive scanning, interline transfer CCD 2/3 inch size Unit cell size: 5.5um(H) × 5.5um(V) square grid pattern
Number of effective pixels	1920 (H)×1080(V)
Read out scanning	Horizontal scanning frequency: f_H=36.0 kHz(QUAD):36.0 kHz(DUAL):36.0 kHz(SINGLE) Vertical scanning frequency: f_V= 62.7 Hz(QUAD): 31.4 Hz(DUAL): 16.4 Hz(SINGLE) Pixel clock frequency: f_{CLK}=40.00 MHz * Horizontal / vertical scanning frequency is a typical value.
Standard sensitivity	800Lx F16 * (* Digital output with exposure time of 1/30 sec and 512/1024 gray scale)
Minimum subject illuminance	2 Lx at F1.4
S/N	Approx. 50dB
Video output signal	Progressive scanning: 62 fps(QUAD), 31fps(DUAL), 16fps(SINGLE) Output signal: Digital output / Complied with Camera Link (Medium/Base Configuration), 62fps(QUAD) : 40.0MHz × 4tap × 10or8bit output(Medium) 31fps(DUAL) : 40.0MHz × 2tap × 10or8bit output(Base) 16fps(SINGLE): 40.0MHz × 1tap × 10or8bit output(Base)
External sync input	Internal synchronization only
Electronic shutter	1/25000sec. to 1/62 sec. (no shutter) 62fps (QUAD) 1/25000sec. to 1/31 sec. (no shutter) 31fps (DUAL) 1/15000sec. to 1/16 sec. (no shutter) 16fps (SINGLE)
Asynchronous shutter	Preset fixed shutter / pulse width control
Scanning mode	Normal scan (all pixels)
Lens mount	C mount (flange back fixed)
External control	Serial interface via Camera Link
Special functions	Function of imposing setting information on image screen Function of monitoring internal temperature of camera Function of storing camera ID information
Strobe signal output	Exposure start timing signal (+5V logic level)
Power supply	DC12V±10%, 400mA (typical value)
Operation ambient temperature	0°C to 40°C (Shall be free from dew condensation and frost.)
Storage temperature range	-30°C to 60°C (Shall be free from dew condensation and frost.)
Anti-shock	70G
Anti-vibration	7G
External dimension	46(W) × 33(H) × 94(L) mm
Weight	Approx. 200 g

(Note) The specifications are subject to change without notice for improvement.

12. External dimensions

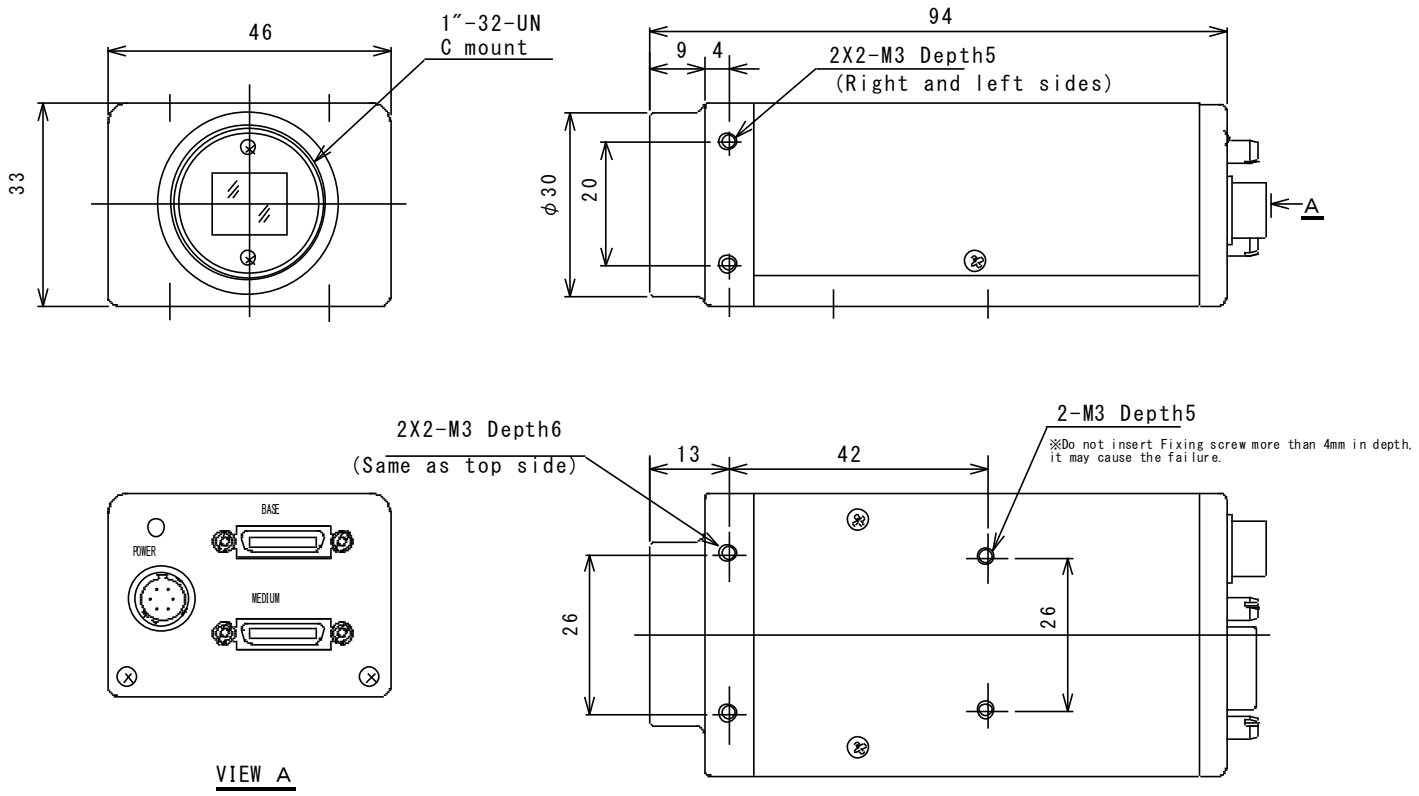


Fig.12-1 FC2600CL External views