CCD Video Camera Instruction Manual

1.45Mega pixel Progressive Scan Monochrome Camera

FC1600FPL

- 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.

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TAKENAKA SYSTEM CO., LTD.
Document No. N11823
FC1600FPL Instruction Manual (7th Version)

[Revision history]

	Version	Revised contents	Articles	Date	Document No.	Remarks
	1st version	First edition-		2008-02-08	N08208	FC1600FPL
	2nd version	Added descriptive sentence		2008-04-04	N08208	
	3rd version	Error correction		2008-04-10	N08208	
	4th version	Error correction	Outline dimensional drawing	2009-10-29	N08A29	
	5th version	Error correction	Default 8bit → 10bit	2009-01-23	N09123	
	6th version	Function added Error correction	H-Reset function added	2011-05-19	K11519	Adapted since Firmware Ver.1.13
	7th version	Error correction		2011-08-23	K11823	

Description of special remarks used in this manual

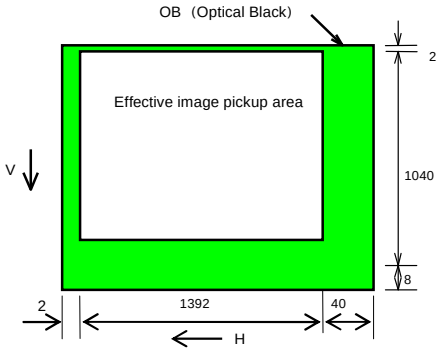
(Note)····· Particulars which require the user's attention are explained.
(!)····· Particulars which require the user's close attention in terms of comparison with the conventional products are explained.
[Terminology]····· Terms specifically defined for the purpose of describing the operation of this 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

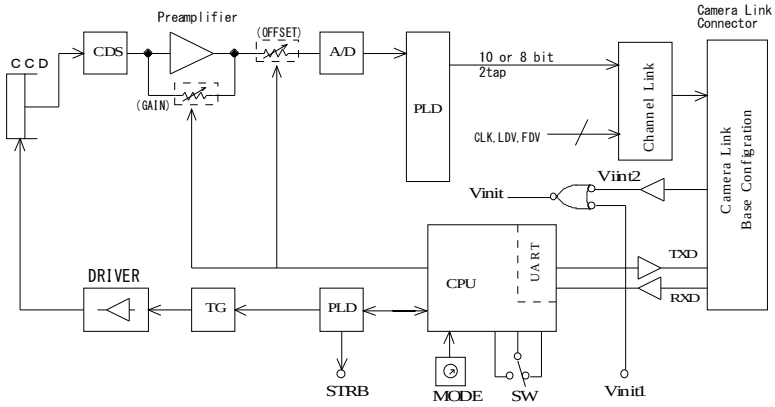
- FC1600FPL is a full frame shutter camera incorporated with 1.45 megapixel, 2/3”-size, CCD image sensor
- A full frame shutter image can be obtained at 30 fps frame rate.
- Power delivery, image data transmission and camera control are performed using single cable by adopting Power over Camera Link (PoCL).
- 10 (or 8) bit format digital image signal output complying with Camera Link (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

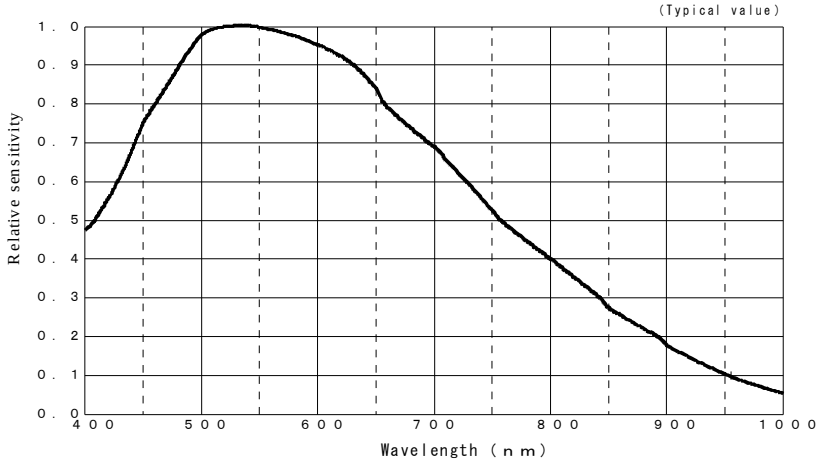
Image sensor Size of image pickup area Number of pixels Pixel size		Progressive scanning, interline 2/3 inch(8.98mm×6.71mm) 1392(H) ×1040(V) 6.45μm(H)×.6.45μm(V)
Number of effective pixels		1.45 megapixels
Read out scanning	Horizontal	32.0 KHz
	Vertical	30 Hz
	Clock	60.00 MHz
Electronic shutter		1/23000 to 1/30 second (Continuous shutter / Asynchronous shutter)
Video output signal		Digital out 10bit / 8bit (2 Tap) Complied with Camera Link (Base Configuration)
Scanning mode		Normal scanning for all pixels (30 fps)
		Partial scanning for central part (60 fps)



Block chart of this equipment

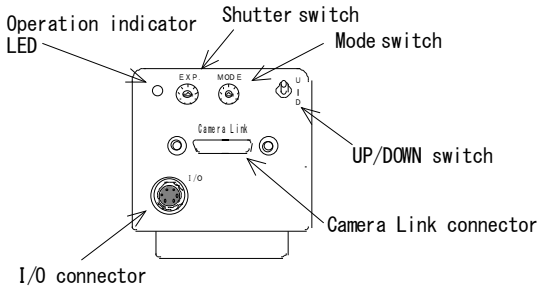


Spectral sensitivity

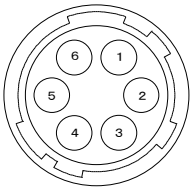


3. Description of Each Component

(3-1) Description of rear panel of camera
Panel to set up operation mode, electronic shutter speed and other parameters and to connect each output connector



(3-2) I/O connector (HRS HR10G-7R-6SB)
The pin arrangement of the camera cable connector (6 pins) and the signals assigned to those pins are shown in the following table:



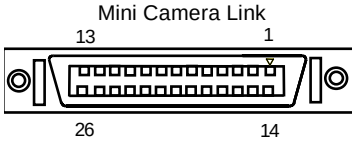
Pin No.	Signal name	Description	I/O
1	GND	Signal ground	
2	IC	※	
3	GND	Signal ground	
4	Vinit1	Input for external trigger	In
5	STRB	Strobe signal output	Out
6	IC	※	

※ Do not assign any signals to the IC pins ,as it is internally used.

(3-3) Camera Link connector (3M / SDR-26 FEMALE)
The pin arrangement and the signals assigned to those pins are shown in the following table:

[Pin arrangement of Camera Link connector (SDR-26 Connector)]

Pin No.	Signal name	Twin-ax cable assignment	Pin No.	Signal name	Twin-ax cable assignment
1	Insulated wire	power	14	Bare wire	GND
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	Bare wire	GND	26	Insulated wire	power



External view of Camera Link connector
(Viewed from the outside of the camera)

(Note) The pins of Camera Link connector 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:

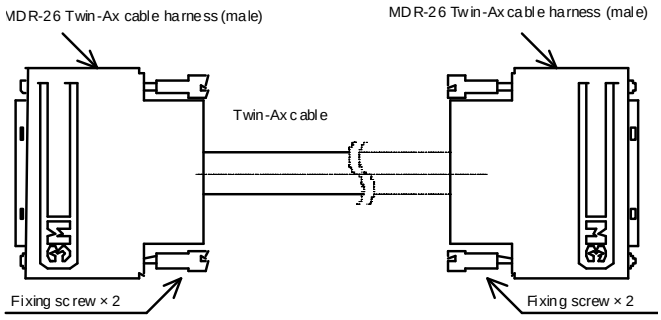
1 = Power, 14 = Gnd
2 = CC4-, 15 = CC4+
3 = CC3+, 16 = CC3-
....
12 = X0+, 25 = X0-
13 = Gnd, 26 = Power

(Pin layout on frame grabber board side)

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

Camera Link port (Node name)		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)
8 BIT OUTPUT	PORTA0 / PORTB0	D00	O	Lowermost data
	PORTA1 / PORTB1	D01	O	
	PORTA2 / PORTB2	D02	O	
	PORTA3 / PORTB3	D03	O	
	PORTA4 / PORTB4	D04	O	
	PORTA5 / PORTB5	D05	O	
	PORTA6 / PORTB6	D06	O	
	PORTA7 / PORTB7	D07	O	Uppermost data
	PORTC0,1,2,3,4,5,6,7		O	(Fixed to L level)
10 BIT OUTPUT	PORTA0 / PORTC0	D00	O	Lowermost data
	PORTA1 / PORTC1	D01	O	
	PORTA2 / PORTC2	D02	O	(Lowermost data at 8 bit scale)
	PORTA3 / PORTC3	D03	O	
	PORTA4 / PORTC4	D04	O	
	PORTA5 / PORTC5	D05	O	
	PORTA6 / PORTC6	D06	O	
	PORTA7 / PORTC7	D07	O	
	PORTB0 / PORTB4	D08	O	
	PORTB1 / PORTB5	D09	O	Uppermost data
	PORTB2,3,6,7		O	(Fixed to L 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)

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



External view of Camera Link cable assembly

(Note) The pin assignment is different between the PoCL Camera Link cable and the normal Camera Link cable. Be sure to connect the cable after confirming that the cable is in conformity to PoCL. Note that the failure associated with power activation of out-of-specification pins shall be exempt from charge-free repair.

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) The maximum allowable length of a I/O cable is 25 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 panel of the camera to the input terminals of the image processing units (PoCL- compliant frame grabber board, computer, etc.) with digital cables (option) conforming to PoCL. The maximum allowable length between the digital output connector of the camera and the input terminal of said image processing unit is 10m.
(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.

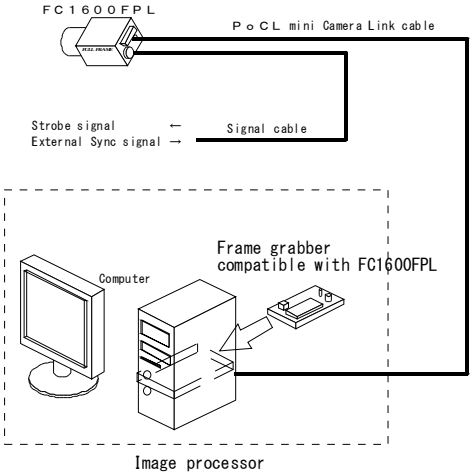


Fig. 4-1 Connection example between camera and peripheral devices

(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.

<Procedure for switching to test pattern output>
(1) Set the mode switch on the rear of the camera to the position “D” , keeping the power to the camera off.
(2) Turn on the power of the camera while turning and keeping the UP/DOWN switch lever to the upper position (or lower position).
(3) Return the UP/DOWN switch lever to the neutral position after having heard a buzzer sounding “pip-pip”.
(4) Set the mode switch to the position “2” after confirming that the LED indicator on the rear of the camera is flashing in orange.
(5) Apply an upward stroke to the UP/DOWN switch lever after confirming that the mode switch is at the position “2”.
(6) Confirm that the buzzer sounds “pip”. → Then, the camera start outputting test pattern images.
(7) Turn off the power to the camera.

Since the setting of the test pattern output in the above process is automatically saved, the test pattern will be output when the power is reapplied from next time.
To shift from the test pattern output mode to the regular camera image output mode, repeat the above steps up until (4) of <Procedure for switching to test pattern output>, and then apply a downward stroke to the UP/DOWN switch lever at the step (5). → From then on, the camera will output regular image.
Since this setting is saved, it continues to be effective after the power is turned off.

→ Refer to “(4-5) Test pattern display function” for the details of the test pattern.

[Important]
(Note) Make sure to stop supply power from the frame grabber 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) Make sure to use the frame grabber that confirms to PoCL standard.
This camera is in conformity with PoCL standard Ver.1.2 SafePower.
(Note) When a power supply unit other than Takenaka’s product that are separately sold is used, make sure that it complies with the following rated specifications:
Power supply voltage: DC12V±10%
Current capacity: 350mA or over
Take into consideration the fact that inrush current of about 1A flows in when power is applied.
Ripple voltage: 50mVp-p or less (recommended value)
Connector: 3M/SDR-26 FEMALE
(Note) The connector pin assignment is different between PoCL-compliant Camera Link cable and normal Camera Link cable. Make sure to connect the cable after checking the compatibility of the Camera Link cable 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 side unit.
  The Vinit signal is input from Pin (4) of the “I/O” connector (6 pin connector) on the rear of the camera, or is input as the CC1 signal from the “Camera Link” connector.

(Note) OR operation (negative OR) is implemented inside the camera between Vinit1 input signal of “I/O” and Vinit2 input signal CC1 of “Camera Link” (see the figure below).

(Note) If either one of those are fixed to the L level (active state), the Vinit signal (logical sum) is also fixed to the L 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 H level, to keep it at high impedance level or open state (no connection).

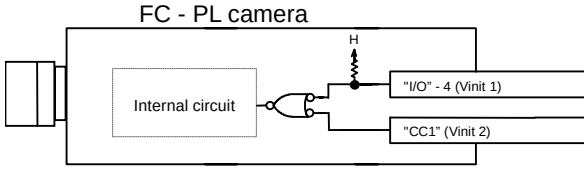
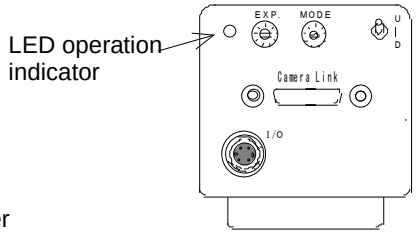


Fig. 4-2 Internal connection of Vinit signals

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



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

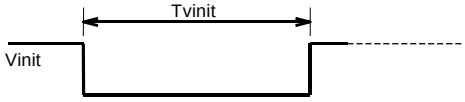
- Setting of various asynchronous shutter modes
  Set the parameters and others in accordance with the following table:

Table 4-1 Setting of various asynchronous shutter modes

Asynchronous shutter mode	Double pulse (2 TRIG)	PWC	Shutter switch	Remark
Preset shutter (PWC=DISABLED)	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 (without shutter)” is applied for the all.
(Note) For setting methods for the respective parameters of “PWC” and others → See “(6-3) 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 1H (1 horizontal synchronous interval) to 40 H as described below.
  For this case, the exposure operation starts in synchronization with the trailing edge timing of the applied pulse.
  For the case of the pulse width control exposure mode, numeric value of the L level interval of the input Vinit pulse (shown as Tvinit in the figure) is retrieved in synchronization with the HD trailing edge inside the camera, 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 shutter speed is independent of the Vinit width.)
1H=31.23μsec

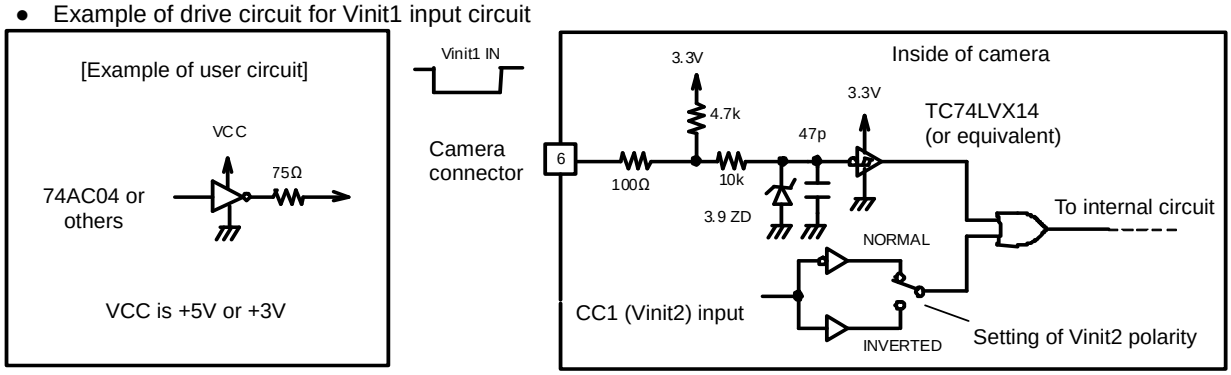
[For the case of pulse width control mode]
(Where PWC=ENABLED, shutter switch = 9)
nH ≤ Tvinit <(n+1)H (n is 1 or larger integer.)
(This is the pulse width where shutter exposure time =nH)

Fig. 4-3 Recommended Vinit signal timing waveform

(Note) In the pulse width control, the shutter exposure time is almost equal to the integral multiple number of the horizontal synchronous time (H) that is closest to the Vinit pulse duration. More specifically, however, the shutter exposure time is indefinite for the time period corresponding to 1H width in the case of normal external trigger input (or the case where the Vinit signal is not in synchronization with the horizontal synchronous timing of the camera) → 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 imaging device 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 Vinit1 input circuit



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

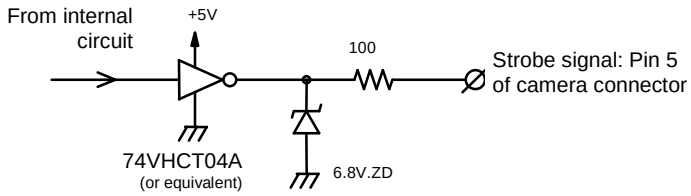
- Polarity reversal of Vinit2 input
  The input polarity of the trigger signal (Vinit2) to be applied via CC1 of Camera Link can be inverted.
  Some capture boards may have the polarity of the trigger signal input from CC1 that is fixed to positive logic (L level at normal/H level at active), which is 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) Other input/output circuit

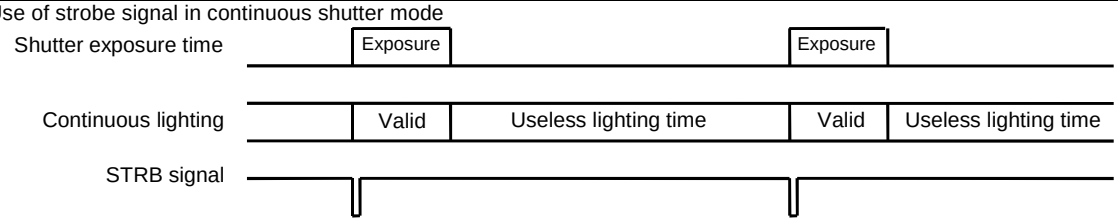
- Strobe signal output circuit
  The internal output circuit is shown in the right figure.



(4-4) Strobe signal in continuous shutter mode

Although conventional cameras output the strobe signal (STRB) only in the asynchronous shutter mode, this equipment is capable of outputting the strobe signal even in the continuous shutter mode by changing the settings.
The default setting is OFF (no strobe signal in continuous shutter mode). This setting can be changed on the configuration menu (Operation Mode Setting Group C) or by way of rewriting the configuration register with serial communication commands.

[Explanation] Use of strobe signal in continuous shutter mode



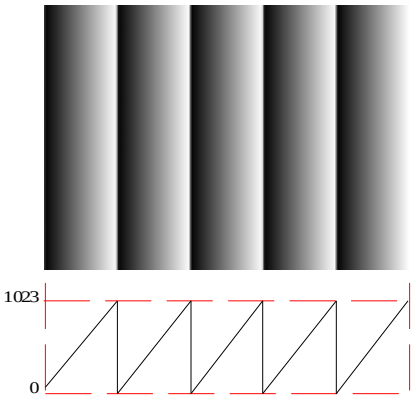
In the continuous shutter mode, only the incoming light for the time matching the exposure time of the camera is valid.
Accordingly, when a lighting unit is used in the continuous lighting mode, the lighting in any time other than this exposure time period would be wasted.
Since this equipment is capable of outputting strobe signal (STRB) even in the continuous shutter mode, this output is used as a trigger to control a LED light or other lighting units that can be turned on or off, 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.

(4-5) 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 imaging device outputs not pictures but the test pattern as shown on the right.
As for this pattern, a numerical value of 4 is simply added in an incremental manner for every horizontal pixel, and a saw-tooth profile is shown in the range from the numerical value of 0 to 1023.
(Lower part of the right figure)



(Note) A numerical value of 1 is incrementally added for every horizontal pixel in the range of 0 to 1023 for the case of 10bits output and 0 to 255 for the case of 8 bits 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 commands.

(4-6) 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 it by the OSD over the image. (Temperature to be displayed in Celsius)
- Confirm it by temperature data to be returned in response to the RS-232C 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 performance for temperature data

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

- Temperature data by RS-232C communication

The temperature data to be returned in response to the “RTMP” command of RS-232C is generated in the following format:

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

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

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

Internal temperature of camera: Tc=Dt×0.5℃

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

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

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

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

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

(4-7) 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]
- Start up in the Setting Group C. (Set the mode switch to the position “C” while the power is turned off. Then apply the power while the UP/DOWN switch is positioned to either side.)
- Change the mode switch to the position 2” after confirming that the orange LED is flashing.
- When an upward stroke is applied to the UP/DOWN switch, the buzzer is set to be ON. When a downward stroke is applied, it is set to be OFF.
- Simply turn off the power after the setting is complete. (The setting is saved.)

(4-8) Camera ID saving function
The ID code and other information set by the user for each camera can be stored in the camera and read out wherever necessary.
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 alphanumeric characters (both uppercase and lowercase characters) and some special symbols such as ”+” and “-” excluding the control codes can be used.
(→ Refer to the section of “Serial Communication Control” for the details.)

5. Various Settings

(5-1) Operation mode

- CCD output ·····Single output
  (Single line output)
- Electronic shutter operation mode
  Shutter mode
  No shutter/continuous/asynchronous
  Shutter speed category
  High speed/low speed/pulse width control
  (See the right schematic diagram)
- Scanning system ····· Normal scan/partial scan
  → Refer to the following page (Section 6) for the specific setting method.

(!) This camera does not support the asynchronous shutter mode for the low speed shutter operation.

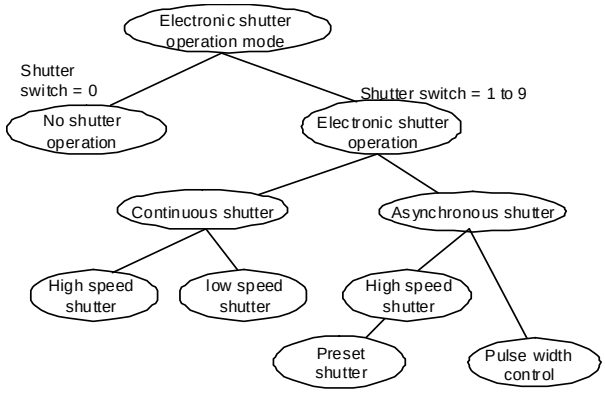


Fig. 5-1 Electronic shutter operation modes

Table 5-1. Description of electronic shutter operation modes

Shutter mode	No shutter	Electronic shutter is not used. Exposure time of imaging device is equivalent to one frame period. 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 permissible shortest repetition pitch is [exposure time + 1 frame period].
Type of shutter speed	Normal shutter (High speed shutter)	Shutter, the exposure time of which is less than one frame period, is used. The shutter speed can be set as a preset shutter speed at 9 different levels both for the continuous shutter/asynchronous shutter mode. (!) As for the shutter speed of the conventional FC series cameras, 8 different levels for the asynchronous shutter mode.
	Low speed shutter	The shutter, the exposure time of which is two frame periods or over, is used. (Only for continuous shutter mode) The shutter speed 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	In case of the asynchronous shutter setting only, the shutter of which the exposure time corresponds to the pulse width (L level period) of the external trigger input (Vinit) , is released. Shutter speed can be set as nH (n = 1 or larger integer number) in H (horizontal synchronous time) unit.

Table 5-2 Description of other operation modes

Scanning system	Normal scan	The read out for each frame is conducted by the all pixel readout scanning
	Partial scan	The read out for each frame is conducted by the partial readout scanning The vertical width of the longitudinal picture area corresponds to 398 lines of the central portion of the image pickup area.

[Terminology] Preset shutter····· This refers to the shutter speed setting other than those specified by the pulse width control. More specifically, the shutter speed is preliminarily 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 (where pulse width operation mode setting)=DISABLED) or from “1” to “8” (PWC (where pulse width operation mode setting)=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 or controlling 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 as “PWC=ENABLED” in the asynchronous shutter mode together with the shutter switch position of “9”.

(!) With the conventional products, the pulse width operation mode is always enabled when “9” is selected for the shutter switch in the asynchrony shutter mode. Carefully note that this camera, however, will be in the preset shutter mode when “PWC=DISABLED (prohibited)” is set, even if the shutter switch is positioned at “9”.

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

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

(5-2) Setting of shutter speed

The shutter speed is determined mainly by the shutter switch position from “0” to “9”.
When a shutter speed is specified using a communication command, the communication command is prioritized.

The shutter speed to be displayed is the one that is corresponding to the currently selected shutter switch position. When “7” is selected for the mode switch, the current shutter speed can be changed.

(Note) The change of the shutter speed is enabled only when the shutter switch is set to any positions other than “0”. As long as the shutter switch is positioned at “0”, shutter speed cannot be changed even if “7” is selected for the mode switch and the UP/DOWN switch is manipulated. (The shutter is always OFF where the shutter switch = “0”)

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

(!) Since FC1600FPL is equipped with the independent shutter setting switch and mode setting switch, it does not require the setting manipulation for the current shutter speed unlike the FC20 series products.

(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 to A/D converter.

- Offset setting
  This is to set the offset of the preamplifier between the CCD imaging device inside the camera to 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.

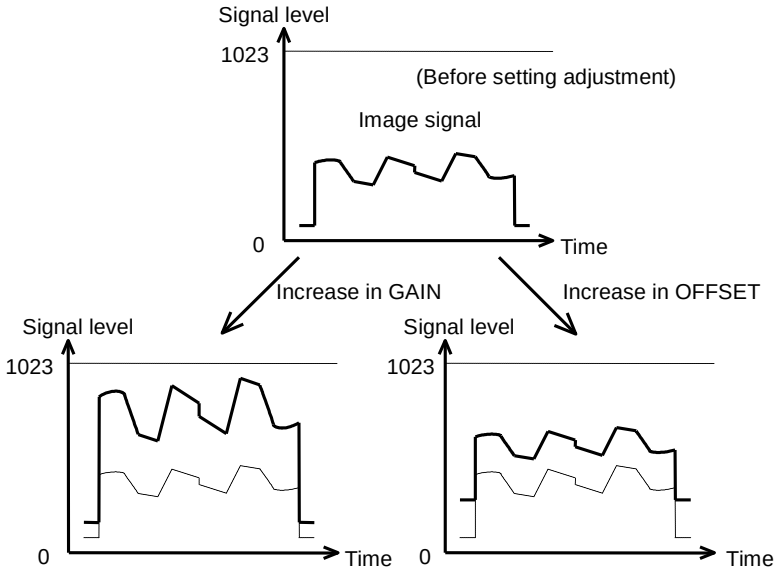
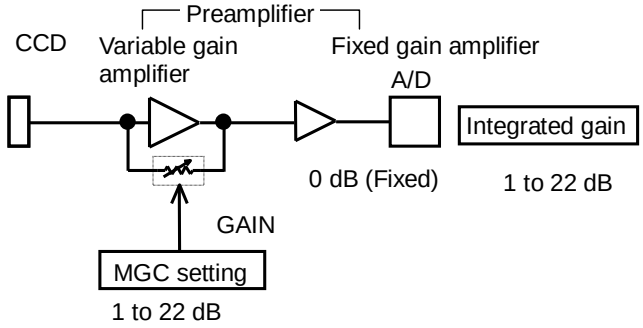


Fig. 5-2 Conceptual diagram of gain and offset levels

(5-4) MGC gain setting value

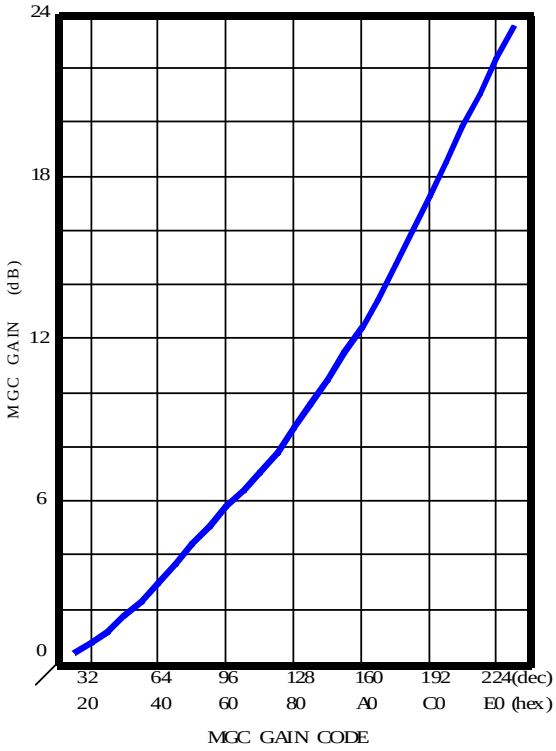


- Gain variable amplifier and integrated gain
  The image signal output from CCD is amplified inside the camera through the following variable gain amplifier and then through the fixed gain amplifier before being input into the A/D converter.
  The left block chart shows this flow.

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

- Correlation between MGC gain setting value and MGC gain

The MGC setting value of this equipment is controlled by giving 24 to 224.
The correlation between this setting value and the MGC gain (integrated gain including the gain of the variable gain amplifier and that of the fixed gain amplifier) is shown in the right graph.



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

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 value of the saturating area does not reach 1023.

(5-5) Program page setting

The FC series cameras incorporate nonvolatile memories and various operation mode settings and level settings can be stored in them.
The setting items are stored in the virtual pages (hereinafter referred to as “program pages”) inside the camera.
This camera has 6 program pages of “A”, “B”, “C”, “D”, “E” and “F” (right figure).

The camera starts operating according to the various settings stored in the relevant page when the mode switch is at any one of the positions from “A” to “F” at the time of power-on.

The camera starts operating according to the settings stored in the page “A” when the mode switch is at any position other than those from “A” to “F” at the time of power-on.

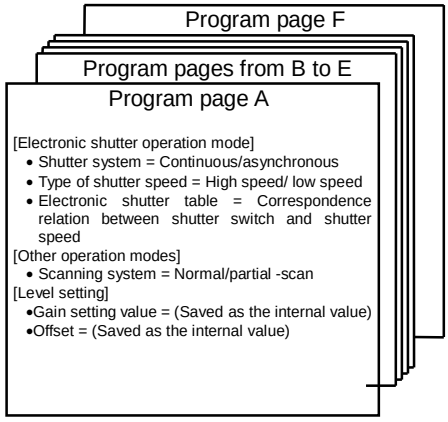


Fig. 5-3 Conceptual diagram of program page

6. How to Change Setting

(6-1) How to set shutter speed
The shutter speed is determined mainly by the setting positions of the shutter switch from “0” to “9”.

Table 6-1 Setting value of shutter speed

Position of shutter switch	High speed shutter (continuous/asynchronous)		Low speed shutter (continuous)	
0	No shutter (continuous)	(1/30 sec)		
1	1/23000 second	(1H)	1/15 second	(2V)
2	1/10000 second	(3H)	1/10 second	(3V)
3	1/ 4000 second	(8H)	1/7.5 second	(4V)
4	1/ 2000 second	(16H)	1/6.0 second	(5V)
5	1/ 1000 second	(32H)	1/5.0 second	(6V)
6	1/ 500 second	(64H)	1/4.3 second	(7V)
7	1/ 250second	(128H)	1/3.8 second	(8V)
8	1/ 125 second	(266H)	1/3.3 second	(9V)
9	1/ 60 second (532H)	Pulse width control / asynchronous (!)	1/3.0 second	(10V)

(Note) (H) and (V) in the table represent the horizontal time unit and the vertical time (frame period) unit respectively.
(Note) ”No shutter” in the table means the continuous shutter mode with exposure time = 1 frame period.
(Note) The value of 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 in the operation mode [Group 1].

(!) As for this camera, it must be set to be “Pulse width control (PWC) = ENABLED” for implementing “Pulse width control /asynchronous” shutter operation .
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.

(6-2) How to set operation mode
The setting items of the operation modes are divided into 4 groups of Group 1, Group 2, Group C and Group D as follows:

Group 1 ····· These are mainly used for setting the basic functions (shutter speed change, gain change etc.). Set the mode switch to the position corresponding to the item to be changed and then manipulate UP/DOWN switch to change the setting.

Group 2 ····· These are mainly used for setting the auxiliary function (gain correction setting). Set the mode switch to the position corresponding to the item to be changed and then manipulate UP/DOWN switch to change the setting.

Group 3 and 4 ····· These are mainly used for setting the configuration items (Terminology below).
Set the mode switch to the position corresponding to the item to be changed and then manipulate UP/DOWN switch to change the setting.

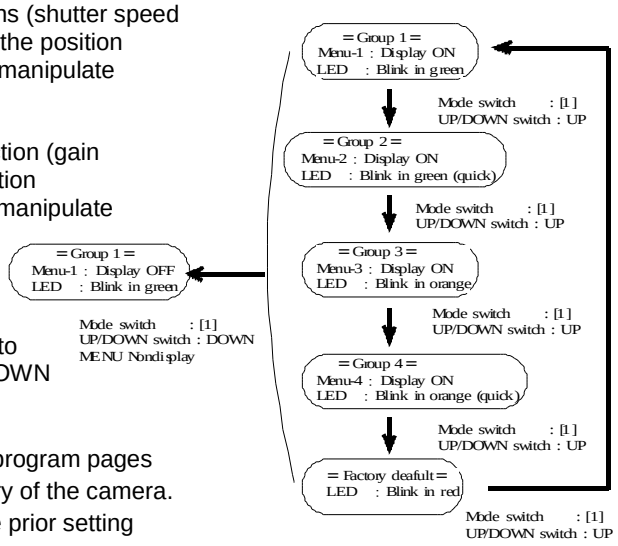


Fig. 6-1 Flowchart of operation mode

(Note) When any setting item is changed, it must be saved in one of the program pages from “A” to “F” before turning off the power to store the data in the memory of the camera. Carefully note that the new setting is not automatically saved and that the prior setting will be effective at the next time of power-on if the power is turned off before storing it. The configuration items, however, are automatically saved whenever they are changed.

[Terminology] Configuration items ····· They are the common setting items that are independent of the program pages. These items are automatically saved in the internal EEPROM at the same time as they are changed by manipulating the switches on the rear panel.

Table 6-2 Start-up condition for each setting Group

Start-up condition (at time of power-on)		The groups of Operation Mode Setting	Operation state of camera at start-up
Position of mode switch	UP/DOWN switch		
Arbitrary position from 0 to F	Neutral position (no switch manipulation)	Group 1	By normal automatic loading (→ Table 6-8)

Table 6-3 Set contents for Operation Mode Setting [Group 1]

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
0	Change of gain	Increase in gain	Decrease in gain
1	Menu display (MENU) <* C>	Group 2	Menu OFF
2	Preset select 1 or 2	Preset2 (±0dB)	Preset1 (-3dB)
3	Preset select 3 or 4	Preset4 (+12dB)	Preset3 (+6dB)
4	(Not used)		
5	Shutter – continuous/asynchronous (S.FORM)	Continuous (NORMAL)	Asynchronous (ASYNC)
6	Shutter – high speed/low speed (S.TIME)	High speed (HIGH)	Low speed (LOW)
7	Change of shutter speed (S.TIME)	Shorter	Longer
8	Digital offset (OFFSET)	Increase in offset	Decrease in offset
9	Switch between normal scan/partial scan (SCAN)	All pixels (NORMAL)	Partial (PARTIAL)
A to F	Program pages from A to F	Write	Read

(Note)The decibel value of Preset select is a relative value(reference value) based on Preset 2.
(Note) The shutter speed can be changed only when the shutter switch is currently set at any other positions than “0”. When the shutter switch is positioned at “0”, the shutter speed cannot be changed even if the mode switch is set to the position “7” and the UP/DOWN switch is manipulated. (The shutter is always OFF where shutter switch = “0”.)

Table 6-4 Set contents for Operation Mode Setting [Group 2]

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
1	Menu display (MENU) <* C>	Group C	Menu OFF
2 to3	(Not used)	-	-
4	Enabled/disabled for pulse width control (PWC) (!)	ENABLED	DISABLED
A to F	Program pages from A to F	Write	Read

(!) When the setting of “ Enabled/disabled for pulse width control” is not set to be “ENABLED”, the pulse width control is not effective even if the shutter switch is set to the position “9” for the asynchronous shutter operation. In this case, the preset shutter in asynchronous shutter mode is effective.

Table 6-5 Set contents for Operation Mode Setting [Group C]

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
1	Menu display (MENU) <* C>	Group D	Menu OFF
2	Operation confirmation buzzer (BZ) <* C>	ON	OFF
3	Serial communication baud rate (BAUDP) <* C>	19200 bps	9600 bps
4	(Not used) (-)	-	-
5	H-RESET in asynchronous shutter mode (H-RESET) <* C>	DISABLED	ENABLED
6	Polarity setting for Vinit2 (Vinit2) <* C>	Positive logic (INVERTED)	Negative logic (NORMAL)
7	Continuous shutter strobe signal (STRB-C) <* C>	ON	OFF

(Note) Although this version of the firmware is designed to display the setting items of (CLOCK), any change made for these items is disabled and not affect the internal operation. As a general rule, use with the default setting.

Table 6-6 Set contents for Operation Mode Setting [Group D]

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
1	Menu display (MENU) <* C>	Factory default	Menu OFF
2	Test pattern (PATTERN) <* C>	ON	OFF
3	Output bit (BIT) <* C>	10bit	8bit
4 to 7	(Not used) (-)	-	-

Table 6-7 Set contents for Operation Mode Setting [Factory default]

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
0	Initialization	Initialization	Initialization
1	Menu display (MENU) <* C>	Group 1	Menu OFF
2	Read out default value	Read	Read

* Notes in common with all setting groups
(Note) The standard factory mode (default) is underlined.
(Note) The items marked with <* C> in the table (configuration items) are automatically stored in EEPROM whenever they are changed.
(Note) The new settings of the other items than the configuration items are lost at the time of power-off unless they are manually saved in the program pages after changing them.

(6-3) 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 one of the program pages as the current setting.

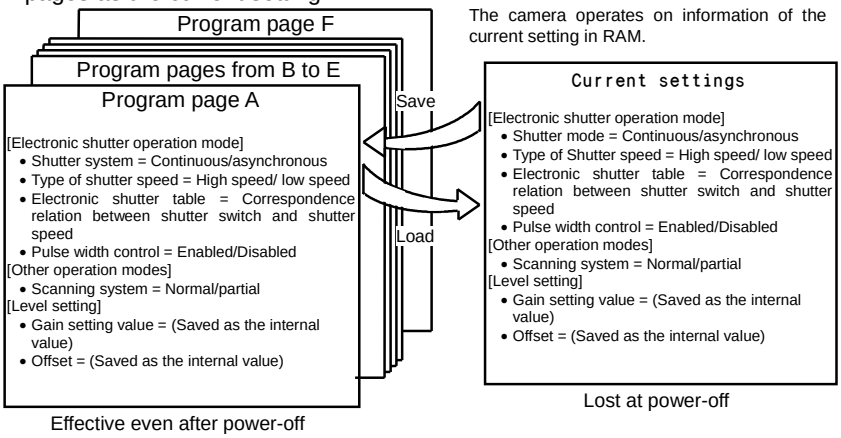


Fig. 6-2 Conceptual diagram of saving and loading operations

[Explanation] Correlation between current setting and program page

The setting information saved in the program page is automatically read out to RAM (volatile memory) 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, 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 load 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 (virtual) mode switch at the time of power-on.

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

Table 6-8 Automatically loaded program page

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

- Manual load/save

  Manual load/save of the setting from/to the program page can be enabled when setting the mode switch to one of the positions from “A” to “F” and manipulate the UP/DOWN switch after the power is turned on.

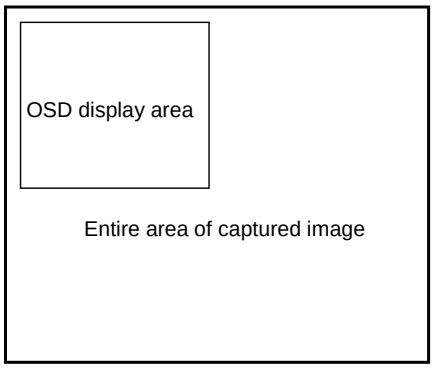
(Note) This saving operation must be performed to keep the new setting effective for later use after changing it.

Table 6-9 Setting operation for program page (manual operation)

Position of mode switch	Item to be changed	UP/DOWN switch	
		UP position	DOWN position
A	Program page A	Save	Load
B	Program page B		
C	Program page C		
D	Program page D		
E	Program page E		
F	Program page F		

(6-4) 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 position by OSD

(Note) This camera is basically designed so that all settings can be done without this menu display by OSD just like the conventional cameras of FC series. However the menu display allows the user to quickly understand 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 side of 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]

If the OSD menu display does not appear on the capture image, perform the following procedure to display it:

Turn on the power in the normal manner → Set the mode switch to "1" → Apply an upward stroke to the UP/DOWN switch

To disable the output of the menu display, perform the same procedure except for applying a downward stroke to the switch.

(Note) Since the ON/OFF setting of the menu display is a configuration item, it is automatically saved in the internal EEPROM.

(Note) If the menu display is set to be ON in the asynchronous shutter mode, the repetitive trigger (cyclic trigger) that is generated inside the camera is automatically input. Make sure to set the menu display OFF when the camera is used in the normal state (online state).

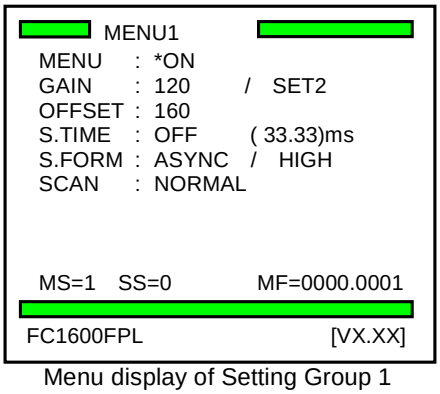
(Note) Note that the difference between the pulse width generated by the camera with the menu display turned on and that provided by the user unit results in the difference in the brightness of image between those when the asynchronous shutter operation in the pulse width control mode is set (S.FORM=ASYNC/HIGH,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

[Description of display content]

MENU 1, 2, 3 or 4: Current setting is displayed.

The following is displayed:

"1": Set content of Setting Group 1
"2": Set content of Setting Group 2
"3": Set content of Setting Group C
"4": Set content of Setting Group D



Menu display of Setting Group 1

MENU: Current menu status is displayed.
When the menu is being displayed, "ON" is kept displayed.
When "(CYCLIC)" is displayed on the right, 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. (Range: 16 to 240).
When gain and offset set value coincides with preset value (four levels of preset value), "SET" followed by corresponding preset No. is displayed on the right side.

OFFSET: The set value of the digital signal offset is displayed in the decimal system. (Range: 32 to 224)

S.TIME: The current shutter speed is displayed. The left number is H number (horizontal synchronous time unit, in the case of high speed shutter – range: 1 to 1068 <normal scan> or range: 1 to 533 <partial scan> in decimal system) or V number (vertical synchronous time unit, in the case of low speed shutter – range: 1 to 255 in decimal system). 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 pixels/partial) and 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 in the partial scan mode, 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).
(→See "Priority relationship among scan mode setting items" described in another section

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

BZ: This is to switch between (ON) and (OFF) for the confirmation sound to be activated when switch manipulation is made.

BAUD: The baud rate used for RS-232C communication is displayed.

H-RESET: Whether the horizontal timing resetting(initialization) is enabled or not enabled is selected. If it is enabled, H(horizontal synchronization) timing is reset when the trigger signal is input in the asynchronous shutter operation mode.

Vinit2: The polarity of the trigger signal via CC1 of Camera Link is set. The factory default is negative logic (NORMAL). When (INVERTED) is selected, positive logic input is used.

STRB-C: ON/OFF is set for the strobe signal (STRB) output for the continuous shutter operation. When (ON) is selected, the strobe signal is output even in the continuous shutter mode.

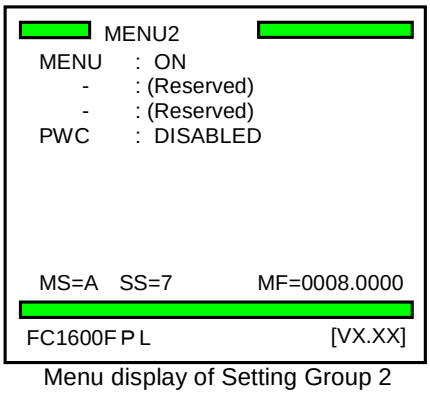
(Note) The strobe signal is always output in the asynchronous shutter mode regardless of this setting.

PATTERN: This is to switch between (ON) and (OFF) for the test pattern output.

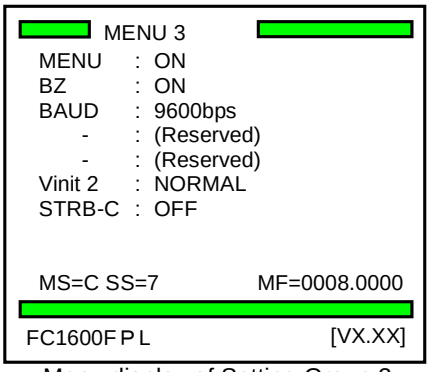
bit This is to switch between (8 bit) and (10 bit) for the bit rate of image output.

* 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 using the switches:

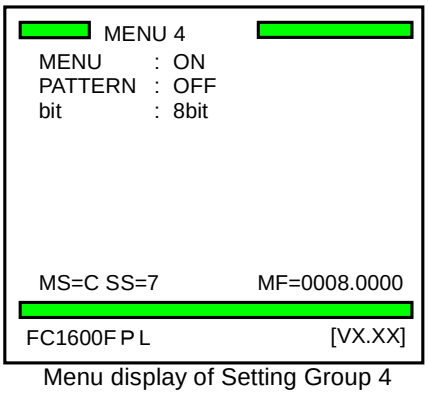
MS= The current position of the mode switch is displayed.
SS= The current position of the shutter setting switch (EXP.) is displayed.
MF= The information (16 bits x 2 sets) of the internal mode flags of the camera (internal flags to determine operation) is displayed in the hexadecimal system. The details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



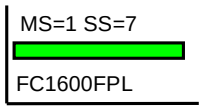
Menu display of Setting Group 2



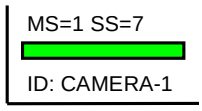
Menu display of Setting Group 3



Menu display of Setting Group 4



ID not specified



ID specified

[ID information display]
The ID code and other information set by the user for each camera can be saved in the camera (with the use of the serial communication). The settable maximum number of characters are 15, and alphanumeric characters (both upper and lower cases) and some special symbols such as"+" and "-" excluding the control codes are used.
(→ Refer to the section of "Serial Communication Control" for the details.)

The ID code set by the user is displayed on the lower left of the "Menu Display of Setting Group 1" by the OSD function; this allows the user to confirm the setting content (ID: onward).
(If the ID code is not set, the camera model name is displayed instead.)
The bottommost and right figure shows an example where "CAMERA-1" is set as the ID information.

[Change of setting]
Perform the procedure described in another section: "(6-2) How to set operation mode" when changing the current setting while referring to the information displayed by the OSD function.
When the position of the mode switch is changed, a flashing " * " mark appears on the left of the numeric value or the parameter of the item corresponding to the switch position to indicate that the setting can be changed using the UP/DOWN switch.

When a stroke is applied to the UP/DOWN switch, the value of gain or others increases or decreases by 1. When a stroke is applied and kept for about 2 seconds, the number continuously increases or decreases at fast speed after the response sound of “pip-pip”.

[Save of setting after change]
The settings changed on the menu are divided into 2 groups; one is for those that are automatically saved in the nonvolatile ROM area whenever a change is made (configuration items) and the other is for those that are saved in the program pages only when manually stored (See the following table).

Automatic save and manual save	Item	Remark
Items automatically saved when changed on menu	“MENU”	Reflected in (CR)
	“BZ”	Reflected in (CR)
	“BAUD”	Reflected in (CR)
	“Vinit2”	Reflected in (CR)
	“STRB-C”	Reflected in (CR)
	“PATTERN”	Reflected in (CR)
	“VSUB”	Saved as numerical value
Items requiring manual save into program pages after changed on menu	“GAIN”	Saved as numerical value
	“OFFSET”	Saved as numerical value
	“S.TIME”	Saved as numerical value
	“S.FORM”	Reflected in (FR)
	“SCAN”	Reflected in (FR)
	“PWC”	Reflected in (FR)

(Note) The Vsub value is saved in an area independent from the program pages .

(6-5) Internal flag register (FR) and configuration register (CR)

The camera internally has RAM areas for the flag register (FR) (2 bytes) and the configuration register (CR) (2 bytes).
If the user checks the contents of these registers, he or she can get the information on the current operational status. In addition, it is possible to change more than one operation mode at a time by way of rewriting the contents of the registers. In this section, the functions of the flag register and the configuration resister are described.

- Flag register (FR) and configuration register (CF)
  Both FR and CR are 2 bite (16 bit) memory areas in RAM. When the camera is turned on, the data stored in the internal EEPROM (nonvolatile storage) are read out and copied into these areas. The current operation mode of the camera is determined by the data in FR and CR.
  Each set of FR data is saved in each of the program pages (A to F), and the data are copied to the flag register by the automatic loading at the time of power-on or manual loading onto one of the program pages to determine the operation of the camera. On the contrary, the memory area for CR in EEPROM is only one and the data are read out separate from the program pages to determine the operation mode.

- The data of those registers can be changed by manipulating the switches on the rear panel of the camera (regardless of ON/OFF state on the menu display) or using serial communication commands.

- When the menu display is set to “ON”, the contents of (FR) and (CR) are displayed as 8 numbers like “MF=0000.0000” to show the current states of the registers. The numbers are expressed in the hexadecimal system. The first (upper) 2 bytes show the setting data of the configuration register (CR) and the bottom (lower) 2 bytes show the setting data of the flag register (FR).

[Description of CR data]

Bit	Abbrev.	Content	Logic	Remark
0	MNI	Disabled display of menu screen	1: Disabled (OFF)	
1	BZI	Disabled buzzer output	1: Disabled (OFF)	
2	TPEN	ON/OFF selection for test pattern	1: Test pattern ON	
3	DFRM	Selection of output data format	1: 8bit format	0: 10bit format
4	CLKP	(Not used)		
5	TWEN	(Not used)		
6	STRBC	Enabled STRB signal output for continuous shutter	1: Enabled	
7	CC1P	Selection of trigger signal (Vinit2) polarity via CC1	1: Positive polarity	
8	H-RESET	H-RESET Enabled in asynchronous shutter mode	1:H-RESET Enabled	
9	BAUD	9600bps/19200bps selection for serial communication baud rate	1=19200bps	* 1
10	-	(Not used)		
11	-	(Not used)		
12	-	(Not used)		
13	-	(Not used)		
14	CCD0	(Not used)		
15	DEFR	Request for reading out default value at next start-up	1: Request	* 1

(Note) All the items of the CR data are “0” as factory default.

The items marked with <* 1> can not be changed by the communication command.

[Description of FR data]

Bit	Abbrev	Content	Logic	Remark
0	ASYE	Selection of continuous/asynchronous shutter	1: Asynchronous (ASYNC)	
1	PWCE	Selection of enabled/disabled for pulse width control	1: Enabled pulse width control	
2	LEXE	Selection of high speed/low speed shutter	1: Low speed shutter	
3	PSCE	Selection of normal scan/partial scan	1: Partial scan	
4	DSCE	(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) All the items of the FR data are “0” as factory default.

(Example) If “MF=H’0008.0003” is displayed on the menu screen, the camera is in the following state (converting the numbers to ones in binary system):
H’00=B’00000000, H’08=B’00001000 and H’03=00000011 are substituted to the above numbers.
CR=B’0000000000001000, FR=B’0000000000000011
……. CR(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 or 0 of these bits and the information in the above table, the user can know that the camera is in the state of “8bit format”, “ASYNC” and “Enabled pulse width control”.

[Explanation]
The setting values (1 or 0 of respective bits) of (CR) and (FR) vary according to the change to be made using the switches on the rear panel of the camera. The operation modes that cannot be changed by the RS-232C commands can be changed by altering the bits of (CR) and (FR).

(Example 1) When a change is made from the continuous shutter mode → asynchronous shutter mode, “MF=0000.0000” is replaced by “MF=0000.0001” (ASYE bit = 1).
(Example 2) When CR (0) is changed from 0 → 1 using a serial communication command, “ON” on the menu display is replaced by “OFF” (MIND=1).

(6-6) Description of scan mode and functional limitation

- Description of scan mode
  This camera has the following 2 scan modes which are selectable by setting:

Scan mode	Operation	Frame rate
Normal scan mode (NORMAL)	Readout of all 1.45 megapixels	30fps
Partial scan mode (PARTIAL)	Read out of approx. 0.55megapixels (398 lines) at the central area	60fps

  - Normal scan mode ···· The image of all effectivepixels is read out at a frame rate of 30 Hz.
  - Partial scan mode····· The image of the centralarea of 398 lines in vertical width is read out at a frame rate of 60Hz. This mode is suitable for capturing the image only of the central area at a high speed.

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

Current scan mode	No shutter	Continuous shutter	Asynchronous shutter	Long exposure
Normal scan mode (NORMAL)	O	O	O	O
Partial scan mode (PARTIAL)	O	O	O	X

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

(6-7) Typical setting procedure

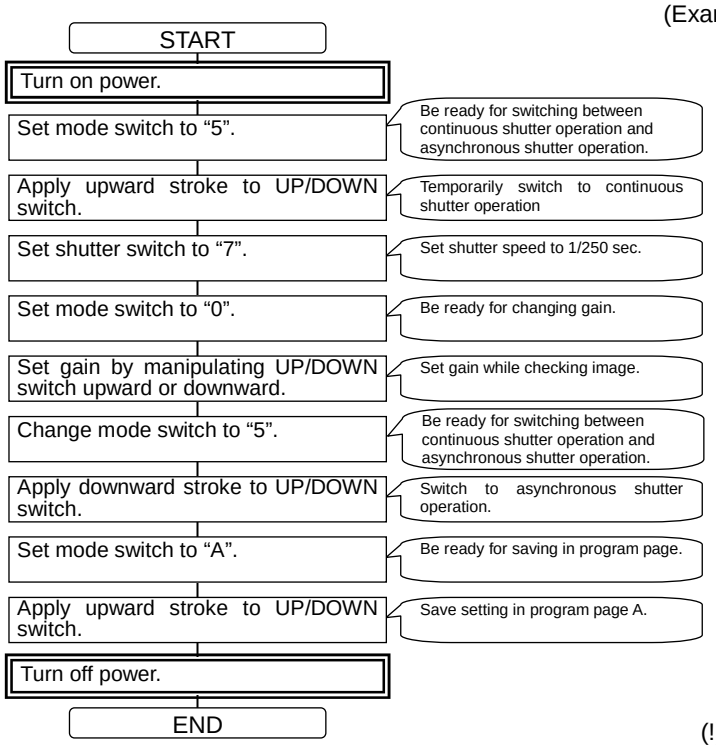


Fig. 6-3 Example of procedure for gain setting for random shutter

(Example 1) This is the procedure for setting the gain for the asynchronous shutter operation (1/250 sec.).

[Explanation]
The left example of the setting procedure is for using the camera in the asynchronous shutter operation. In the left example, the operation mode is temporarily set to be the continuous shutter operation because this makes it easier to set the gain and others. In the case where the image output state can be easily checked by way of repeatedly inputting external trigger signal (Vinit) from a user device, the operation mode should be set to be “Asynchronous Shutter” from the beginning before setting the gain and others.

(Note) When the pulse width control mode is set for the asynchronous shutter operation, the above described method in which the continuous shutter mode is temporarily set cannot be used (because the shutter speed at the position “9” for the asynchronous shutter mode is different from that for the continuous shutter mode). If the camera is used in the pulse width control mode, it is necessary to set the asynchronous shutter operation and then set the gain and others while actually inputting the trigger signal (Vinit) from a user device.

(!) This equipment is designed so that the pulse width control mode can be set to OFF even when it is in the asynchronous shutter mode and the mode switch is at the position “9”. (Default condition)

(Note) This equipment is put into the condition where the cyclic asynchronous shutter trigger is internally generated (in the cyclic trigger state) when the menu is displayed, therefore it is not necessary to temporarily switch to the continuous shutter operation as shown above when the menu is displayed,.

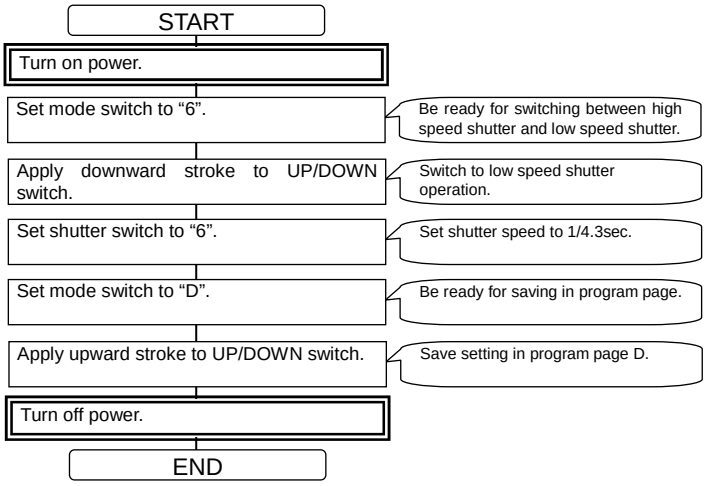


Fig. 6-4 Procedure 1 for use in continuous/low speed shutter operation (1/4.3 sec.)

(Example 2) This is the procedure for use in continuous/ low speed shutter operation (1/4.3 sec.)

[Explanation]
The above example is for saving the setting in the program page D.

(6-8) Read out of factory default

Setting items to be read out to RAM

[Electronic shutter operation mode]
- Shutter mode = Continuous
- Type of shutter speed = High speed
- Electronic shutter table = Content of (Table 6-1)
- Pulse width control = DISABLED

[Other operation modes]
- Scanning system = Normal scan

[Level setting]
- Gain setting value = (Factory default)
- Offset setting value = (Factory default)

[Configuration]
- Manu display = ON
- BZ = ON
- Baud rate = 9600bps
- Vinit2 polarity = NORMAL (negative logic)
- Test pattern = OFF
- Continuous strobe signal =OFF

Fig. 6-5 Setting contents immediately after reading out 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.
With this equipment, the following 2 different procedures are selectable for the readout:
a. The factory default is loaded into the internal RAM of the camera.
b. The factory default is loaded into the internal RAM of the camera and written on the all program pages.

(Note) When the procedure a. is selected, the “storage page for factory default” that is located separately from the memory for automatic loading at the time of power-on (program pages from “A” to “F”) is loaded and the camera is started up. In this case, the data is temporarily read out to the internal RAM of the camera. If it is necessary to use the camera with the factory default values after the power is turned off, those must be saved in the program pages from “A” to “F”.
When the procedure b. is selected, the parameters that were read out are automatically saved in the program pages from “A” to “F”. Carefully note that the earlier setting data that were saved by the user are all overwritten and lost.

[Procedure a. (to load the default into RAM)]

<Step 1> Set the mode switch to the position “9”, and manipulate the UP/DOWN switch either upward or downward. Then, turn on the power and keep the position of the UP/DOWN switch for several seconds.
<Step 2> Return the UP/DOWN switch to the neutral position when the response sound of “pip-pip” is heard and LED flashes in orange.
<Step 3> For execution, apply an upward or downward stroke to the UP/DOWN switch again. For cancellation, turn off the power to the camera.
<Step 4> The camera automatically restarts and the operation mode is set to be Group 1.

(Note) To save the read data, set the mode switch to “A” (or other page corresponding to the data to be saved) and apply an upward stroke to the UP/DOWN switch (save to the program page).

[Procedure b. (to load the default into RAM and to save them on all program pages)]

<Step 1> Set the mode switch to the position “9”, and manipulate the UP/DOWN switch either upward or downward. Then, turn on the power and keep the position of the UP/DOWN switch for several seconds.
<Step 2> Return the UP/DOWN switch to the neutral position when the response sound of “pip-pip” is heard and LED flashes in orange.
<Step 3> Then, change the position of the mode switch to “0”. LED will flash in red.
<Step 4> For execution, apply an upward or downward stroke to the UP/DOWN switch again. For cancellation, turn off the power to the camera.
<Step 5> The camera restarts and the operation mode is set to be Group 1.

7. Serial Communication Control

FC1600FPL can be externally controlled by serial communication 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 each one frame 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.

- The setting of the serial communication is as follows:
  Baud rate : 9600bps or 19200bps (Specified by Setting Group 2, default: 9600bps)
  Data : 8bit/character
  Stop bit : 1stop bit
  Parity : none
  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 codes.
  When the camera receives 1 packet (by detecting ETX:03h) and judges it is a normal packet, it returns a transaction completion signal (ACK: 06h) or others corresponding to the commands received. When the camera judges it is an abnormal packet, it returns the abnormal signal (NAK: 15h).

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

- Description of commands

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

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

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

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

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

  (!) FC1600FPL does not use the values in parentheses. This camera returns the fixed values instead.

  2) Camera version report
  Transmission from host: STX: “R”: “V”: ETX
  Return by camera: STX: ACK: “R”: “Takenaka SYS.FC1600FPL 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 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.

  3) 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

4) Shutter mode report
Transmission from host: STX: “R”: “S”: ETX

Return by camera: STX: ACK: “R”: “□” *1: “□” *2: “□” *3: Exposure time *4: ETX

*1 to 3 : Refer to (4) command “S”

*4 : Exposure time

4 characters are returned as the electronic shutter exposure time.

- In the case where the electronic shutter exposure time is externally set:
  When the exposure time is set in the unit of H (horizontal scan time), the exposure setting count value of the time in H is returned.
  Example) If the shutter exposure time is 16Hs: “0010”
- In the case where the electronic shutter exposure time is set using the shutter switch number on the connector panel:
  Example) If the shutter switch is set to “4”: “I4..”
- In the case where the electronic shutter exposure time is set by the shutter switch number via a RS-232C command:
  Example) If “3” is specified for the shutter switch, : “S3..”

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

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

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

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

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

Transmission from host: STX: “S”: “A” or “M”: “H” or “L”: “N” or “P”: exposure time: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)
The transmitting command has the following meanings:
STX: “S”: “A” or “M”: “H” or “L”: “N” or “P”: Exposure time: ETX
*1 *2 *3 *4

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

- In the case where the electronic shutter exposure time is externally set:
  When the exposure time is set in the unit of H (horizontal scan time), the exposure setting count value of the time in H is set.
  Example) If the shutter exposure time is 16Hs:
  STX: “S”: “.”: “.”: “.”: “0010”: ETX
- In the case where the exposure time is set using 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 one using the rear panel of the camera:
  STX: “S”: “.”: “.”: “.”: “0000”: ETX

(Note) When the exposure time is externally set with the command “S”, the exposure time of the camera will finally be locked to the position specified by the command or to the value directly specified. This locked state is released when the exposure time is set to “0000” by RS-232C again as described above.
To release this locked state without using RS-232C after specifying the exposure time using RS-232C, perform the procedure of “Read out of factory default” as described in the Section (6-9).

(Note) When directly specifying the exposure time, only the following range of values is acceptable. The operation with other values than these is not guaranteed.
Normal scan: H'0000 to H'01EC (D'0 to 492) ("0" is used only when the external specification is cancelled.)
Partial scan: H'0000 to H'00A9 (D'0 to 169) ("0" is used only when the external specification is cancelled.)

(5) Command "A"
Function: Command for setting analog image signal

Transmission from host: STX: "A": (SETUP setting value): (WC setting value): ".": ETX
Return by camera: STX: NAK: ETX (transaction rejection)

(Note) FC1600FPL does not support this command.

(6) 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 of SW0 cannot 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

(7) 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.

(8) 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 resetting to the default setting.

<The following commands are exclusively for FC1600FPL, and not common with other FC cameras.>

(9) Command "WMC"
Function: Command for writing in configuration flag register (CR) (Write Mode Configuration)

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

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

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

The content of "flag setting 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 setting value in EEPROM, use other commands, "WA to WF", to save in the specified pages.

(11) Command "RMC"
Function: Command for reading configuration flag register (CR) (Read Mode Configuration)

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

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

(12) 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 setting value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

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

(13) 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.

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

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

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

→ Refer to “(4-6) Monitoring function for internal temperature of camera” for the conversion method from the returned data to temperature value.

(15) Command “X”
Function: Command for 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 (excluding 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 at 100ms±5%. The minimum repetition pitch is approx. 300ms.
Only when the trigger signal is input by this command, the internal buzzer of the camera sounds for one shot time (approx. 50 ms) in response to the input. If this buzzer should not be activated, set “operation confirmation buzzer = OFF” either by changing the setting of the configuration menu or the configuration flag by the 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 a 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.

(16) 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 reset the camera to the initial power-on state. The processing upon power-on procedure is executed, therefore camera link output (synchronous signal, image signal) temporarily get into indefinite state

(Note) This command responds to the operation when the camera is restarted after the power is turned off. The data stored in EEPROM are not lost.
(Note) Only this command is received in the operation modes of “Group 2”, “Group C” and “Group D”.

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

Transmission from host: STX: “WID”: character string with 0 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”.

(18) 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 a separate area 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.

(19) 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 with 0 up to 15 characters: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The data (0 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.

(20) Command “WVSUB”

Function: Command for writing Vsub value (CCD substrate voltage) (Write VSUB)

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

(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, “SVSUB”.
(Note) FC1600FPL does not support this command.

(21) Command “SVSUB”

Function: Command for saving Vsub value (CCD substrate voltage) (Save VSUB)

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

The data of the current Vsub setting value is saved in EEPROM.

(Note) The Vsub value is saved in a separate area 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) FC1600FPL does not support this command.

(22) 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 setting value: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

The contents of “Vsub setting value” (1 byte/2 characters) is read out.
(Note) FC1600FCL does not support this command.

(23) Command “RMG”

Function: Command for reading MGC gain (Read MGC GAIN)

Transmission from host: STX: “RMG”: ETX
Return by camera: STX: ACK: “RMG”: MGC setting value: (MGCB setting (right screen)): ETX

(!) FC1600FPL does not use the values in parentheses.

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

Transmission from host: STX: “WMG”: MGC setting value: (MGCB setting (right screen)): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

(!) FC1600FPL does not use the values in parentheses. Transmit “00” to this camera.
A 2 digit ASCII code from “00” to “FF” in the hexadecimal system is used for the MGC setting value.
Example) If level 90 (decimal) is set: “5A”
Example) If level 90 (decimal) is set as a MGC setting value.
STX: “WMG”: “5A”: “00”: ETX

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

Transmission from host: STX: “ROF”: ETX
Return by camera: STX: ACK: “ROF”: OFFSET setting value: (OFFSETB setting (right screen)): ETX

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

Transmission from host: STX: “WOF”: OFFSET setting value: (OFFSETB setting (right screen)): ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

A 2 digit ASCII code from “00” to “FF” 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”: “00”: ETX

(27) Command “RPS”
Function: Command for reading preset (Read PRESET)

Transmission from host: STX: “RPS”: ETX
Return by camera: STX: ACK: “RPS”: PRESET No.: ETX

When gain and offset set value coincides with preset value (four levels of preset value), corresponding preset No. is read. When it does not coincide with preset value, ”0” is returned.

(28) Command “WPS”
Function: Command for writing0 preset (Write PRESET)

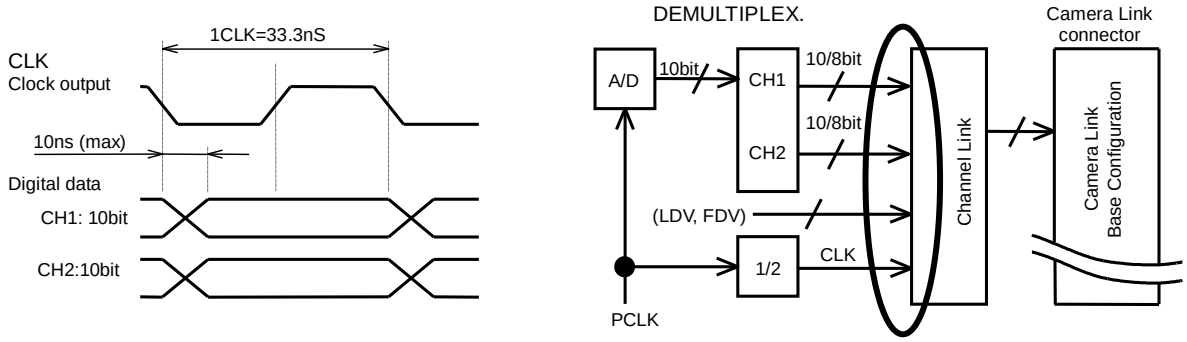
Transmission from host: STX: “WPS”: “PRESET No.”: ETX
Return by camera: STX: ACK: ETX (transaction completion), or STX: NAK: ETX (transaction rejection)

It can read out and employ PRESET (four levels of gain preset value) set before shipment.

- 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]

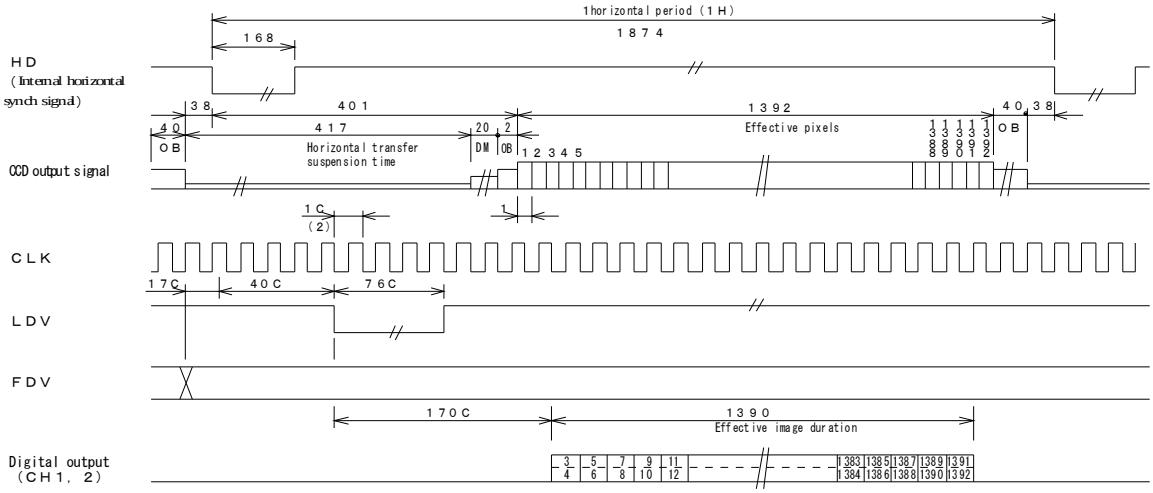


(Note) The above timing represents the signal timing before being encoded to serial data by the channel link device on the side of the sending end (the part circled in the above right figure). If signal conversion from serial to parallel is made by a channel link device in accordance with the Camera Link standard 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 trailing edge 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.

(!) 8 or 10 bit x 2 tap output is employed for FC1600FCL. Therefore, there is no compatibility with the conventional parallel type camera FC2000CL etc. and so dedicated setting files are required.

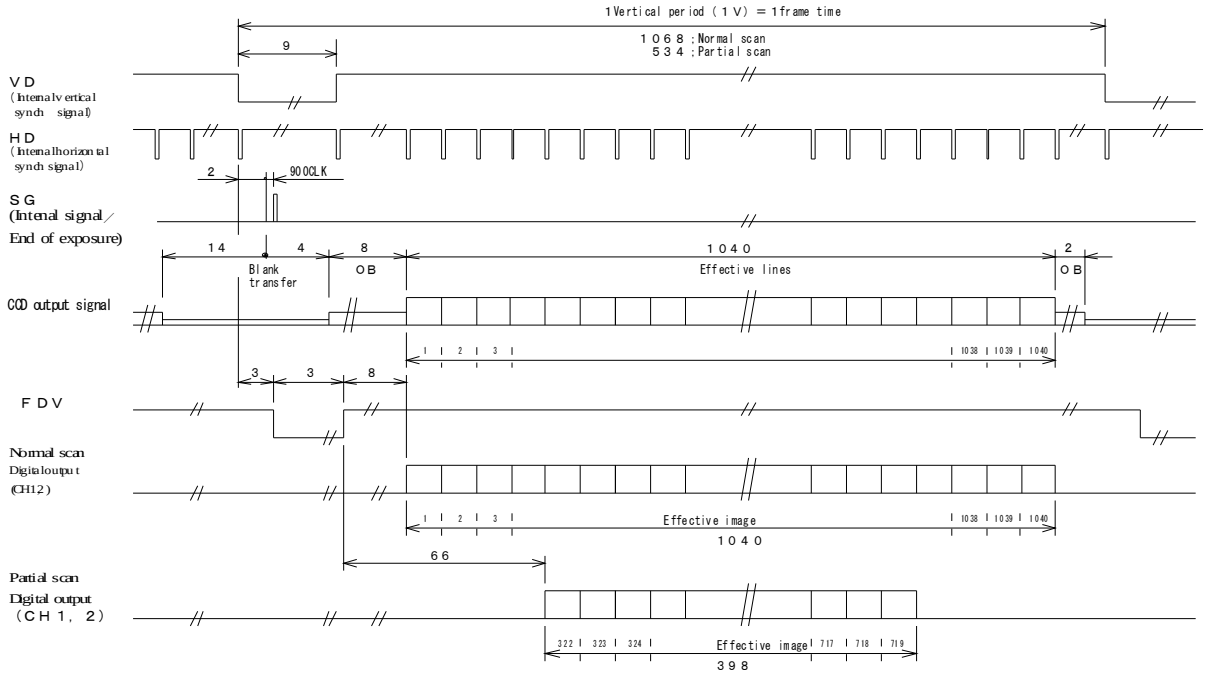
(Note) When a channel link device is mounted directly to the capture interface on the user side, instead of using a commercially available capture board that supports Camera Link, it is necessary to pay close attention to the descriptions of the data sheet of the channel link device including the phase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

- Horizontal timing



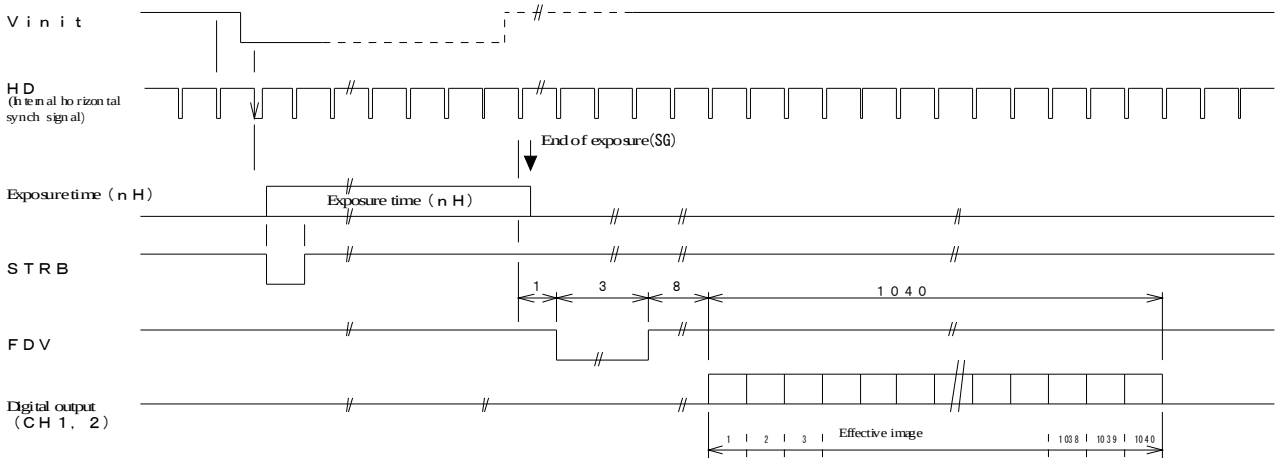
* Unless otherwise specified, the time unit of the numbers in the horizontal timing chart is pixel CLK (= 1/60.0MHz = 16.7nS), and 1C=1/30.00MHz=33.3ns (CLK output).
* The numbers shown here are design values, and the actual equipment should be checked for the details.

- Vertical timing: Continuous shutter



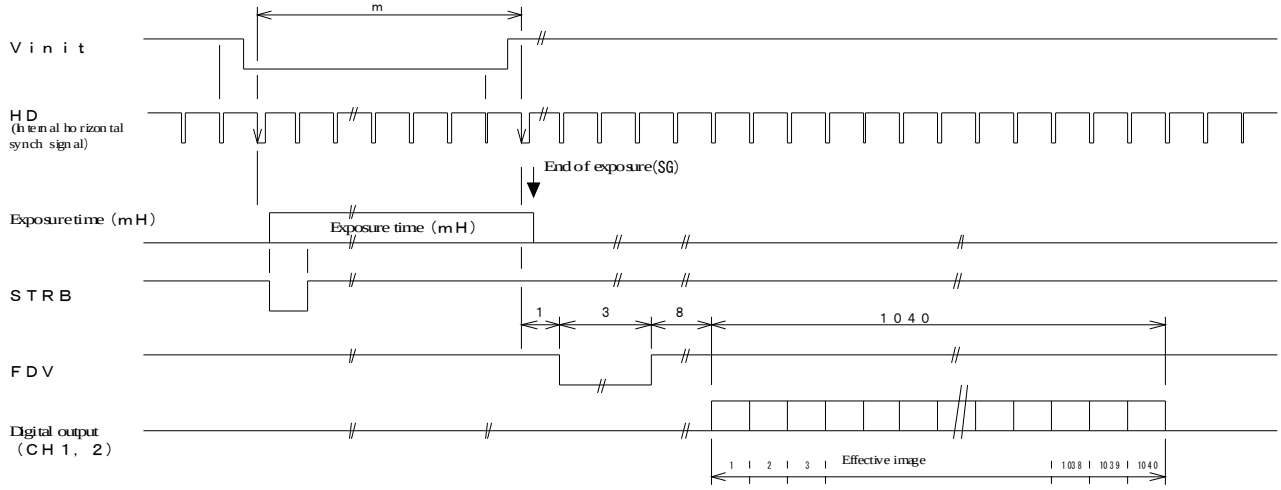
* Unless otherwise specified, the time unit of the numbers in the vertical timing chart is H(= 1874 PCLK =1874 x 1/60.0MHz = 31.23μS).

- Vertical timing: High speed/preset shutter/asynchronous shutter/normal scan



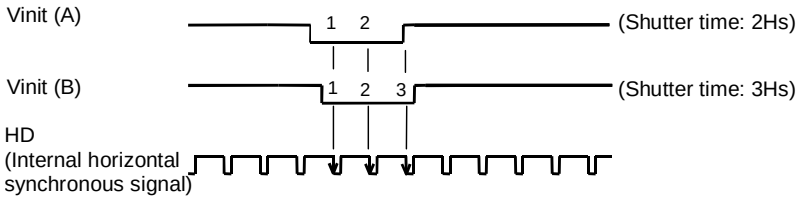
* n is an integer value defined by the shutter switch position.

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



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

Example of 1H difference with same Vinit signal



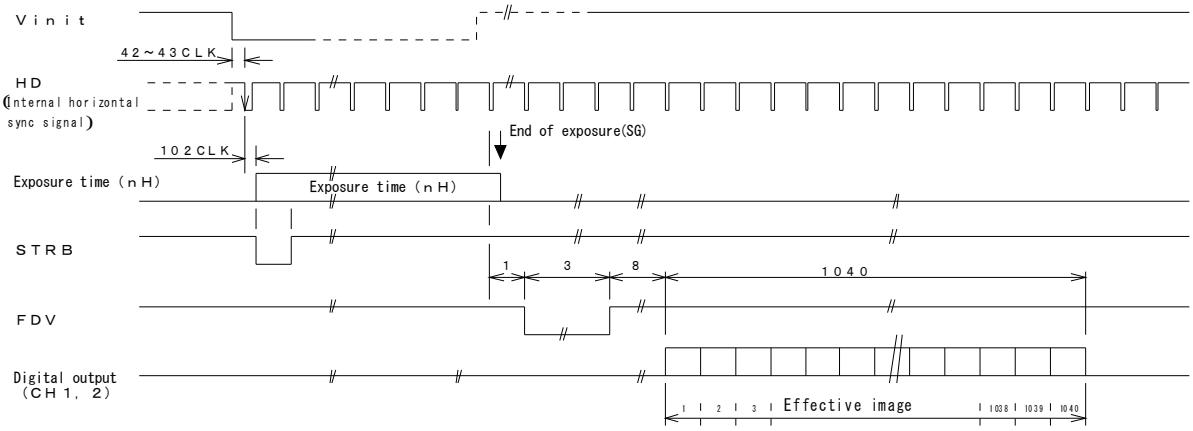
Because of the above reason, consideration must be given to the fact that the exposure time becomes indefinite for the period of 1H shutter speed when a Vinit signal that is not in synchronization with the internal horizontal synchronous signal (HD) is input from the user side. Some of the countermeasures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

(1) Use only with the shutter speed 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) Synchronize the external trigger signal with the use of the LDV signal of the camera to keep the Vinit phase relationship constant.
••• Control can be made in the absence of the infinite time of 1H by stabilizing the generation phase of Vinit against the internal HD.

(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.

- Vertical timing: High speed /preset shutter/ asynchronous shutter /normal scan/ with H-Reset

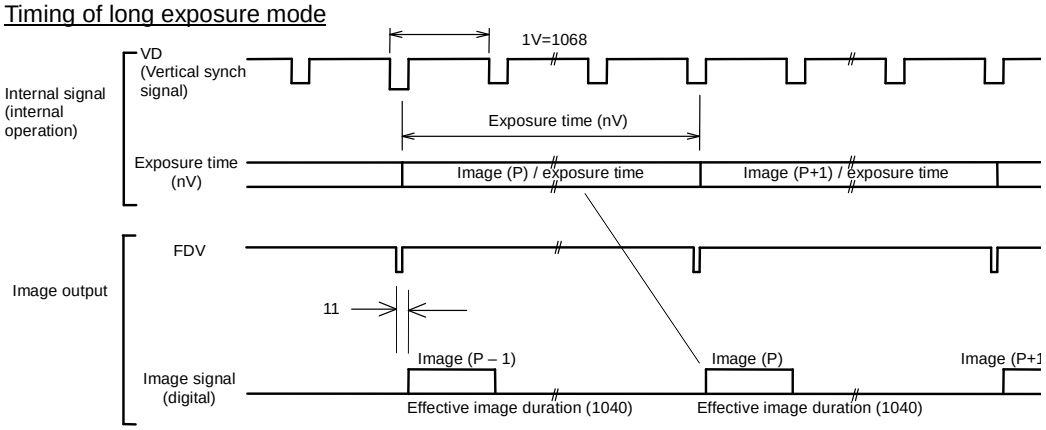


* n is an integer value defined by the shutter switch position.

* Unless otherwise specified, the time unit of the numbers in the vertical timing chart is H(= 1874 PCLK =1874 x 1/60.0MHz = 31.23μS).
* The operation timing when Vint is detected is the same both for preset shutter and pulse width control.
* The numbers shown here are design values, and the actual equipment should be checked for the details.

- Vertical timing: Low speed (long exposure)/preset shutter/continuous/normal scan

Timing of long exposure mode



* The detailed vertical timings of the respective effective image duration are the same as those of “Vertical timing for continuous shutter and without shutter”.

(Note) The long exposure operation is not compatible with the partial scanning.
(Note)The asynchronous shutter operation is not supported for the long exposure operation.

9. Notes

- More stable image (suitable for highly accurate measurement) can be obtained by leaving the equipment for 20 or 30 minutes after the power is turned 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 exposure time. 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 while power is being supplied, 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 disassemble 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 a place subject to considerable dust or constant vibration/impact.
- When this equipment is not used for a long time, isolate the power from the equipment and remove the power cable and external connection cables.
- When an abnormal or failure condition is detected, immediately stop using this equipment, cut off the power supply, remove the external connection cables and contact the dealer for inspection/repair.
- The specifications and operational details described in the catalogues, manuals and others are subject to change for performance improvement or other reasons without notice.

10.Specifications

[Specifications]

Imaging device	Progressive scanning, interline transfer CCD 2/3 inch in size Unit cell size: 6.45μm(H) × 6.45μm(V)
Number of effective pixels	1390 (H)×1040(V)　square grid pattern
Read out scanning	Horizontal scanning frequency: f_H = 32.0kHz Vertical scanning frequency: f_V = 30 Hz Pixel clock frequency: f_{CLK}= 60.00 MHz
Standard sensitivity	400Lx　at F22 * (* Digital output with exposure time of 1/30 seconds and 512/1024 gray scale)
Minimum illuminance	1 Lx　at F1.4
S/N	50dB and above
Video output signal	Progressive scanning: 30 frames / sec Output signal: Digital output: Complied with Camera Link (Base Configuration) 10 bit scale (30MHz × 2tap × 10 or 8 bit output)
Synchronization	Internal synchronization only
Electronic shutter	1/23000 sec. to 1/ 30 sec. (no shutter) to 1/3 sec.
Asynchronous shutter	Preset shutter/pulse width control
Scan mode	Normal scan (all pixels)/Partial scan (central area)
Lens mount	C mount (flange back fixed)　* movable type: option
External control	Serial interface via Camera Link
Special functions	Function of superimposing setting information on screen Function of monitoring internal temperature of camera Function of storing camera ID information
Strobe output	Exposure start timing signal (+5V logic level)
Power supply	DC12V±10%, 350mA (max)
Operation ambient temperature	0℃ to 40℃ (Shall be free from dew condensation an d frost.)
Storage temperature range	-30℃ to 60℃ (Shall be free from dew condensation a nd frost.)
Anti-shock	70G
Anti-vibration	7G
External dimension	46(W) × 42(H) × 60(L) mm　(excluding tripod attachment)
Weight	Approx. 150g

11. External Dimensions

[External dimensions]

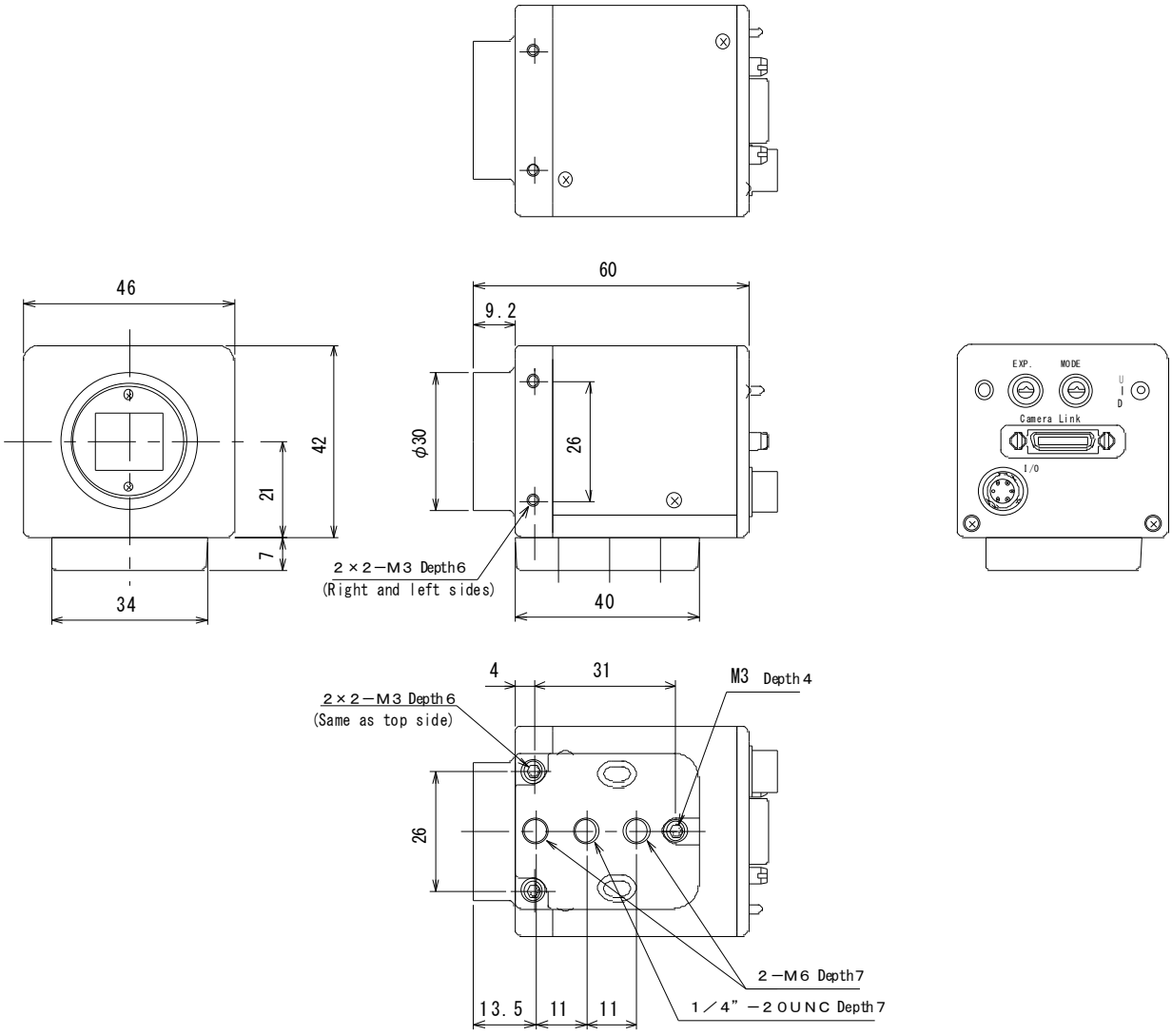


Fig.11-1 FC1600FPL external views