



User's Manual

Line Scan Camera

Type : SU2025GIG



NIPPON ELECTRO-SENSORY DEVICES CORPORATION

GigE Vision is a registered trademark of AIA

For Customers in the U.S.A.

This equipment has been tested and found to comply with the limits for a Class A digital device, in accordance with Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his or her own expense.

For Customers in the EU

This equipment has been tested and found to comply with the essential requirements of the EMC Directive 2004/108/EC, based on the following specifications applied:

EU Harmonised Standards

EN55022:2010 Class A

EN61000-6-2:2005

Warning

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Directive on Waste Electrical and Electronic Equipment (WEEE)



Please return all End of Life NED products to the distributor from whom the product was purchased for adequate recycling and / or disposal. All costs of returning the Product to NED are borne by the shipper.

Introduction

Thank you for purchasing NED's Line Scan Camera. We look forward to your continued custom in the future.

For safety use

- ◆ For your protection, please read these safety instructions completely before operating the product and keep this manual for future reference.
- ◆ The following symbols appear next to important information regarding safe product handling.

 Warning	If the product is not handled properly, this may result in serious injury or possible death.
 Caution	If the product is not handled properly, this may result in physical injury or cause property damage.

Safety precaution



Warning

- ◆ Never disassemble or modify this product, unless otherwise specified to do so in this manual.
- ◆ When hands are wet, avoid handling this product and do not touch any of the connection cable pins or other metallic components.
- ◆ Do not operate this product in an environment that is exposed to rain or other severe external elements, hazardous gases or chemicals.
- ◆ If the product is not to be used for an extended period of time, as a safety precaution, always unplug the connection cable from the camera unit.
- ◆ If the product installation or inspection must be executed in an overhead location, please take the necessary measures to prevent the camera unit and its components from accidentally falling to the ground.
- ◆ If smoke, an abnormal odor or strange noise is emitted from the camera unit, first turn OFF power, then unplug the cable from the camera unit.
- ◆ This product is not intended for use in a system configuration built for critical applications.

Instructions before use

- ◆ Only operate this product within the recommended environmental temperature range.
- ◆ Use only the specified power source and voltage rating.
- ◆ Do not drop this product. Avoid exposure to strong impact and vibrations.
- ◆ Install the camera unit in a well-ventilated environment, in order to prevent the camera from overheating.
- ◆ If the camera must be installed in an environment containing dust or other particles, take required measures to protect the camera unit from dust adhesion.
- ◆ Do not unplug the cable while power is being supplied to the camera unit. To prevent product damage, always shut down the power supply before unplugging the power cable.
- ◆ When the surface of the camera window becomes dirty due to dust or grime, black smudges appear in the displayed image. Use an air blower to remove the dust particles. Dip a cotton swab into ethanol alcohol and clean the camera window. Be careful not to scratch the glass.
- ◆ Use of non-infrared lighting such as a daylight fluorescent lamp is recommended. If halogen lighting is employed, always install an infrared filter into your system configuration.
- ◆ Please note that exposure to long wavelength light outside of the sensors visible optical range can affect the image.
- ◆ For stabilized image capturing, turn ON the power supply and execute aging for ten to twenty minutes before actually using the camera unit.
- ◆ Do not share the power supply with motor units or other devices that generate noise interference.
- ◆ Do not disconnect the camera while rewriting the embedded memory.
- ◆ When you change the exposure mode that is set at the NED factory, input control signal (CC1) from the capture board.
- ◆ SG (Signal Ground) and FG (Frame Ground) are connected inside the camera. Please install your system such that a loop is not created by the GND potential difference.

Product Warranty

Warranty Period

- ◆ The product warranty period, as a general rule, is two years from purchase; however for detailed conditions please contact the sales representative for your region/country.
- ◆ However, in some cases due to the usage environment, usage conditions and/or frequency of use, this warranty period may not be applicable.

Warranty Scope

- ◆ Product repair will be performed on a Return To Manufacturer basis. On-site maintenance will incur additional charges.
- ◆ If defects in material or workmanship occur during the warranty period, the faulty part will be replaced or repaired by us free of charge. Return shipping charges must be paid by the sender. However, the following cases fall outside of the scope of this warranty:

Exclusions from Warranty Coverage

- ◆ We will under no circumstances assume responsibility for the following cases: damage caused by fire, earthquake, other acts of a third party, other accidents, negligent or intentional misuse by the user, or other usage under extraordinary circumstances.
- ◆ Damages (e.g. loss of business profits, business interruption, etc.) resulting from use or non-use.
- ◆ Damages caused by use other than as described in this document.
- ◆ Damages resulting from malfunction due to a connected device.
- ◆ Damages resulting from repairs or modifications performed by the customer.

Fault Diagnosis

- ◆ As a general rule, in the first instance fault diagnosis should take the form of a telephone call or an email to enable us to assess the circumstances of the malfunction.
- ◆ However, depending on the customer's requests, we, or our agent, may require an additional fee for this service.

Exclusion of Liability for Compensation for Missed Opportunities

- ◆ Regardless of whether within the warranty period or not, our warranty does not cover compensation for missed opportunities for our customers, or our customers' customers, caused by a fault of our products, nor for damage to products other than our own, or related business.

Note about Product Usage

- ◆ This product has been designed and manufactured as a general-purpose product for general industry. In applications expected to be life-critical or safety-critical, the installer or user is requested to install double or triple failsafe systems.

Repair Service Outline

- ◆ The cost of dispatching engineers etc. for repair service is not included in the price of purchased and supplied goods. On request, arrangements can be made separately.

Scope of Repair Service

- ◆ The above assumes business dealings and usage to take place in the customer's region / country. In cases of business dealings and/or usage outside the customer's region/country, separate consultation is required.

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1 Product Outline

1.1 Features

- The camera uses the GigE Vision®¹ external interface for easy connection to a PC
- Can be operated without a frame grabber board, using only a low-cost cable
- Supports a cable length of up to 100m (or even more using repeaters)
- Offset and gain can be changed with a simple application
- With high sensitivity and low noise, the camera will capture reliable images
- The camera can be triggered by a software trigger, or a hardware trigger via the 12-pin connector.

1.2 Applications

- Inspection of Transparent panels and PCBs
- Inspection of high speed moving objects
- Flat panel display inspection
- Inspection of glass and sheet-like objects
- Printed circuit board inspection
- Outdoor surveillance

An example of Visual Inspection of Metallic part is shown below.

■ Example of using of one camera.
(Inspection of only surface)

■ Example of using of three cameras.
(Inspection of surface and roller end face)

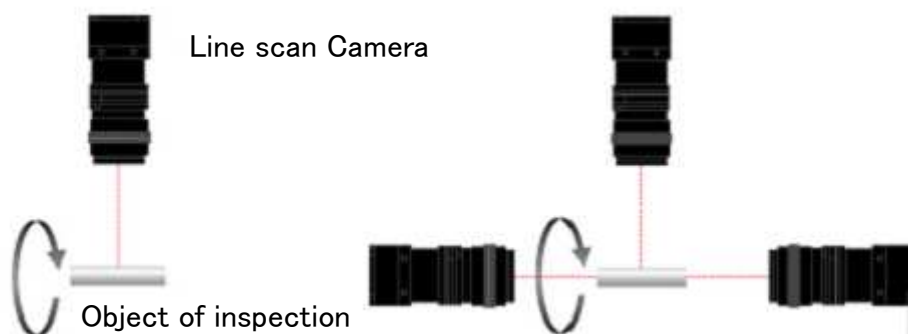


Figure 1-2-1 Visual Inspection of Metallic part

¹ GigE Vision is a registered trademark of AIA

Object of inspection (example)

Metallic part of cylinder and conical geometry (surface and roller end face)

- Automobile component
- Architectural reinforcement parts
- Various pin parts

Typical detection item

- chip
- dent
- scratch
- chip of roller end face
- external dimensions

Device specification

1. Camera: Line scan camera of number of 2048 pixels
2. Controller: Dedicated software for PC system

1.3 Image Sensor

The camera uses a maximum data rate of 25MHz to acquire high responsivity and superior quality images.

The pixel size is 14 μ m x 14 μ m. The camera output its 2048 pixels data through the GigE Vision external interface.

1.4 Performance Specifications

The Performance Specifications are shown below. Unless otherwise specified, the data shown is when the camera is operating at the maximum scan rate.

Table 1-4-1 Performance Specifications

Items	Specifications
Number of Pixels	2048
Pixel Size H x V (μ m)	14 x 14
Sensor Length (mm)	28.6
Spectral Responsivity (nm)	400~800 *Peak 567
DataRate (MHz)	25 [Fixed]
Scan Rate (μ s) / [kHz]	88 / [11.4]

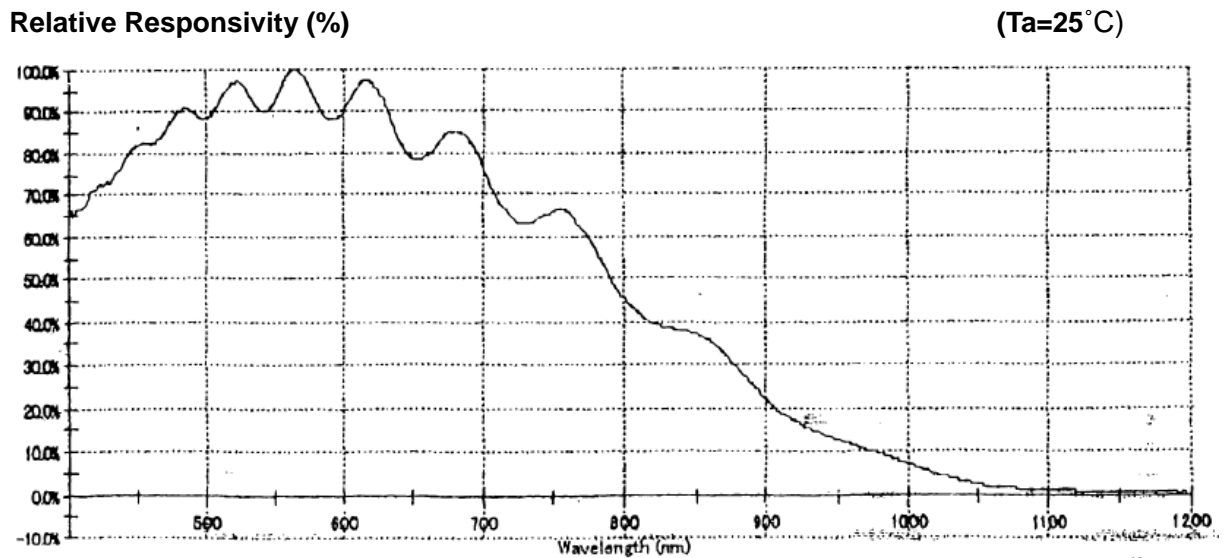
Saturation Exposure (lx·s) (typically)		0.0555 *PGA Gain 0dB, Ta=25°C, Daylight Fluorescent Light
Responsivity (V/ [lx·s]) (typically) * Analog 5V Conversion Sensitivity		90 *PGA Gain 0dB, Ta=25°C, Daylight Fluorescent Light
Gain Adjustable Range	Digital	0~21.5dB (0~688 STEP) 0.03125dB/STEP
	Analog	0dB/3 dB /6 dB /9 dB /-3 dB
Offset Adjustable Range (DN)	Video Output 8bit/tap	0~19 (1 LSB/Step)
	Video Output 10bit/tap	0~76 (4 LSB/Step)
	Video Output 12bit/tap	0~304 (16 LSB/Step)
Video output	Format	GigE Vision 8 / 10 / 12 bit monochrome
PRNU (Photo Response Non Uniformity)		3%
Random Noise (DN)		20 (Minimum gain 10bit)
Connectors	Data/Controller	RJ45
	Power Supply	Hirose: HR10G-7R-6PB (6Pin)
	External Trigger	Hirose: HR10G-10R-12PB (12Pin)
Cable Length (Maximum)		100m (CAT 6 and over)
Lens Mount		Nikon F Mount
Operating Temperature (°C) No Condensation		0 ~ 50
Power Supply Voltage (V)		DC 12 ~ 15 [±5%]
Consumption Current (mA) (typically)		DC 12V 500mA ※typ
Size W x H x D (mm)		64x70x118.09 (*see section Figure 2-3-1)
Mass (g) (Camera only)		450
Compatible Standards		RoHS, GigE Vision®, Gen<i>Cam, CE, FCC (all TBC)

N.B. Measurements were taken at room temperature with a daylight fluorescent light.

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1.5 CCD Spectral Responsivity Characteristics

The spectral Responsivity is shown below.



2 Camera Setting and Optical Interface

2.1 Setting Camera

Use the M4 screw holes or the screw hole for a tripod to set the camera.

2.2 Fixing Camera

- Use the M4 screw holes (4 places at the front, 8 places at the side) to fix the camera.
- Or use the 1/4"-20UNC screw hole (the screw hole for a tripod, 1 place at the side) to fix the camera.
- ◆ If using the front panel M4 mounting holes, the screw length for fixing the camera should be less than 6mm.
- ◆ No X-, Y-axis orientation and tilt adjustment mechanism is available. Please provide an adjustment mechanism yourself as necessary.

2.3 Camera dimension

The dimensions for camera are shown below.

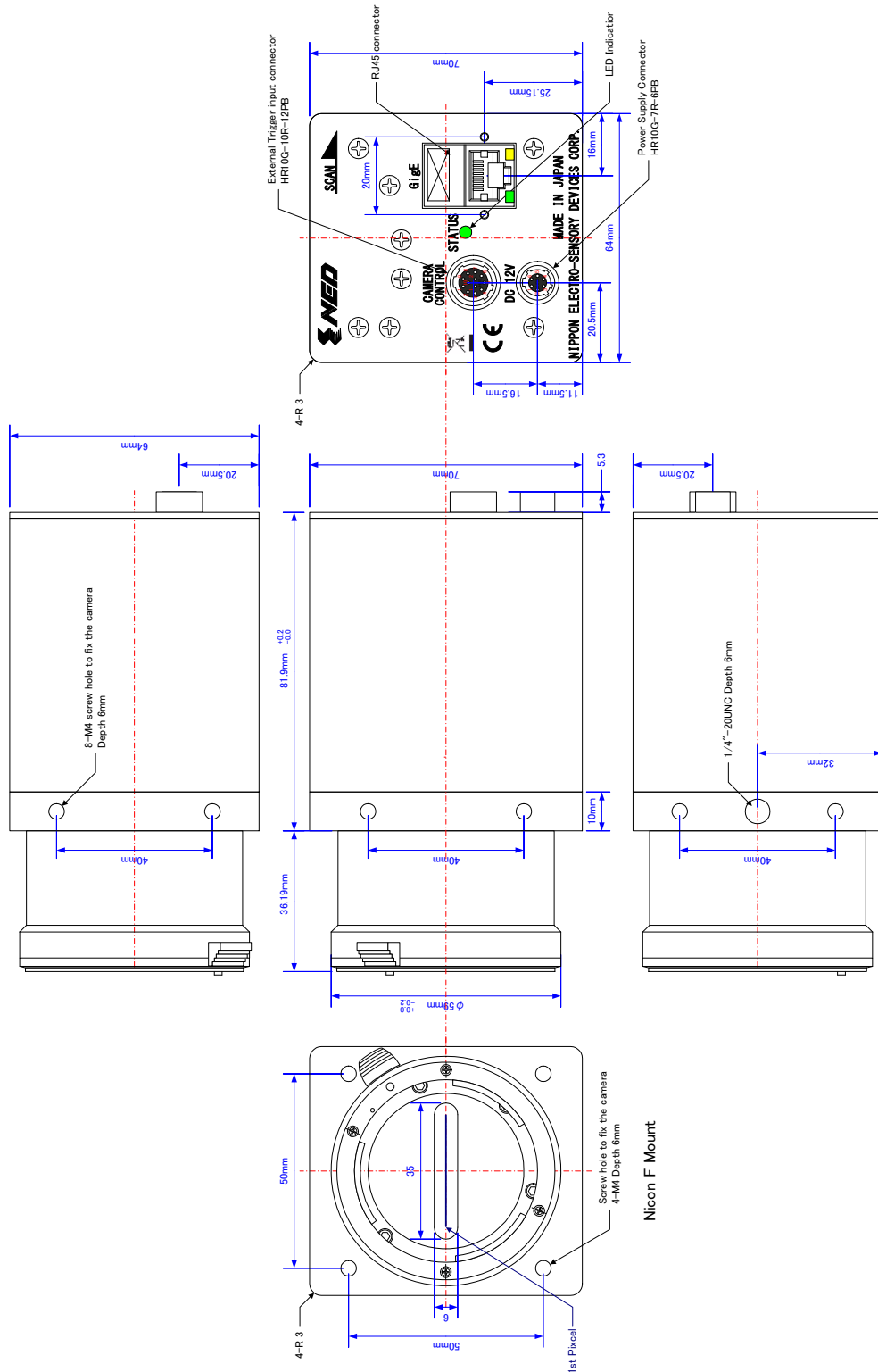


Figure 2-3-1 Dimensions

- ◆ The protuberance of screws and connectors, as well as cable space, is not measured.
- ◆ Leave 100mm space for wiring cables

2.4 Optical Interface

The amount and wavelengths of light required to capture useful images depend on the intended use. Factors include the property, speed, the object's spectral characteristics, exposure time, the light source characteristics, the specifications of the acquisition system and so on.

The exposure amount (exposure time x light amount) is the most important factor in getting desirable images. Please determine the exposure amount after studying what is most important to your system.

Keep these guidelines in mind when setting up your light source:

- LED light sources are relatively inexpensive, provide a uniform field and longer life span compared to other light sources. However, they also require a camera with excellent sensitivity.
- Halogen light sources generally provide very little blue relative to infrared light (IR).
- Fiber-optic light distribution systems generally transmit very little blue light relative to IR.
- Metal halide light sources are very bright but have a shorter life span compared to other light sources.

Generally speaking, the brighter light sources, the shorter life span.

CCD image sensors are sensitive to infrared (IR). We recommend using daylight color fluorescent lamps that have low IR emissions. If you use a halogen light source, to prevent infrared from distorting the images use an IR cutoff filter that does not transmit IR wavelengths.

3 Hardware

3.1 Camera Connection

The camera connects to a PC using a general-purpose or industrial-use LAN cable. To conform to EMC standards, all cables must be shielded.

The camera connects to the camera power supply with a digital power cable. Connect the plug end to the camera, and the open end to the camera power supply.

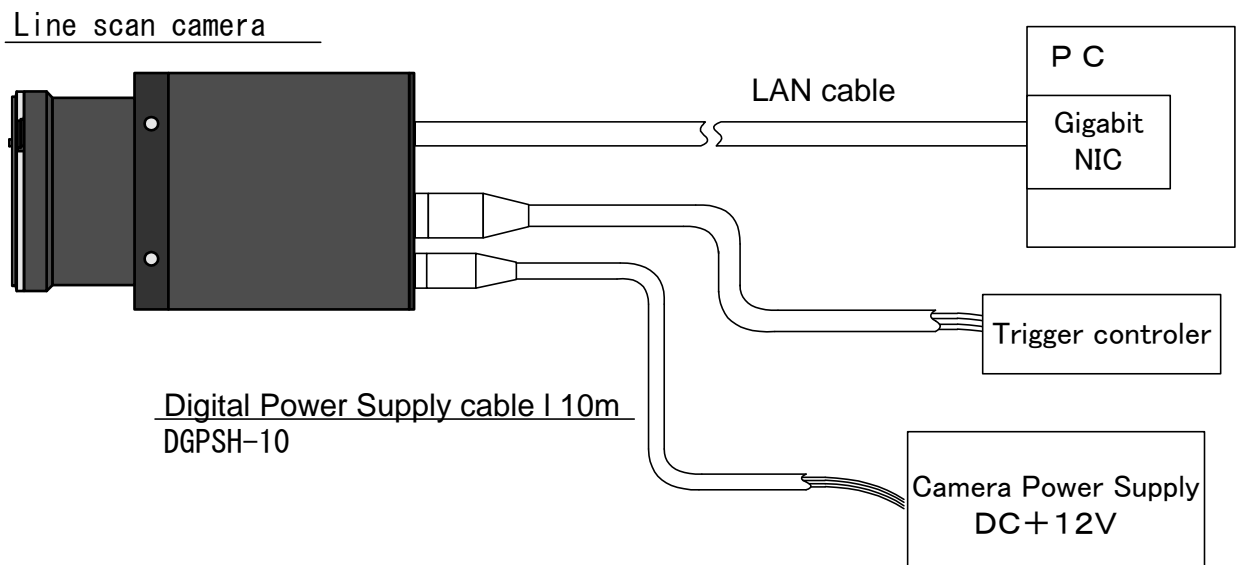
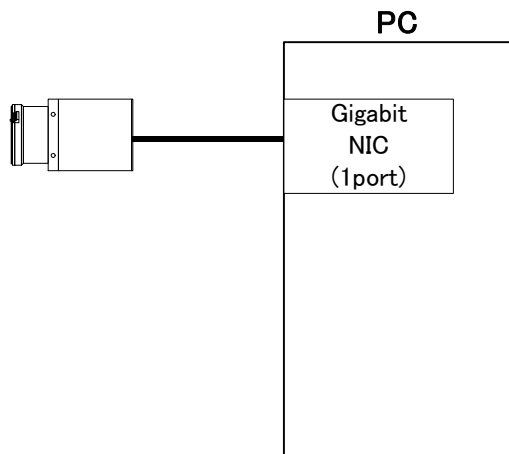


Figure 3-1-1 Connections between Camera and cable etc

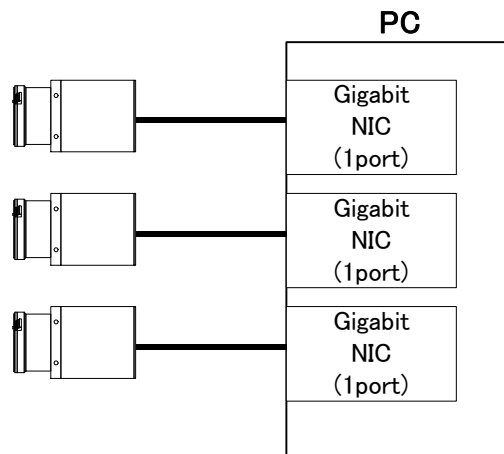
- ◆ The lancable should be CAT5E, CAT6 or above.
- ◆ In countries where the CE marking is enforced, please use a shielded cable.
- ◆ To conform to EMC standards, all cables must be shielded.

3.1.1 The example of connection of PC and a camera

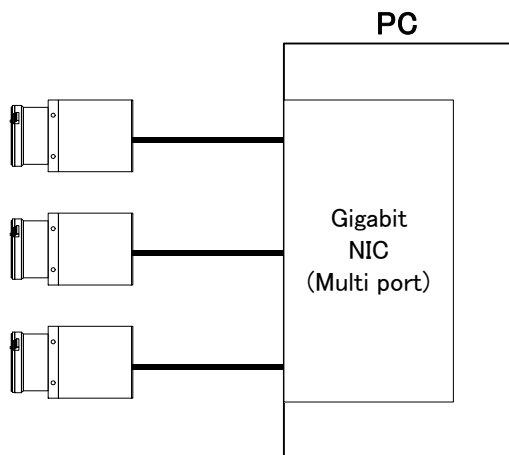
The example of connection of 1PC and 1camera



The example of connection of 1PC and 3 cameras



The example of connection of 1PC and 3 cameras



The example of connection of 1PC and 3 cameras

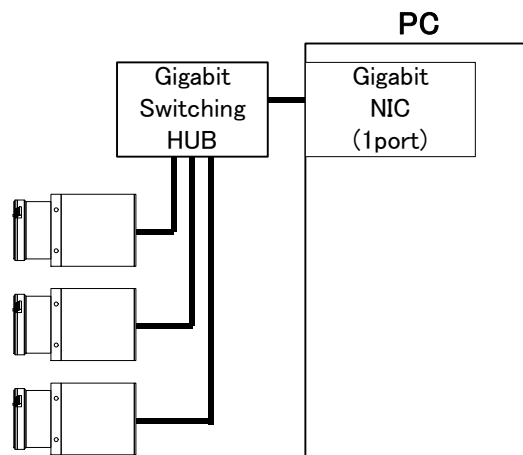


Figure 3-1-1-1 The example of connection of 1 PC

3.2 Input / Output Connectors and Indicator

The layout of input /output connectors and the indicator lamp are as follows.

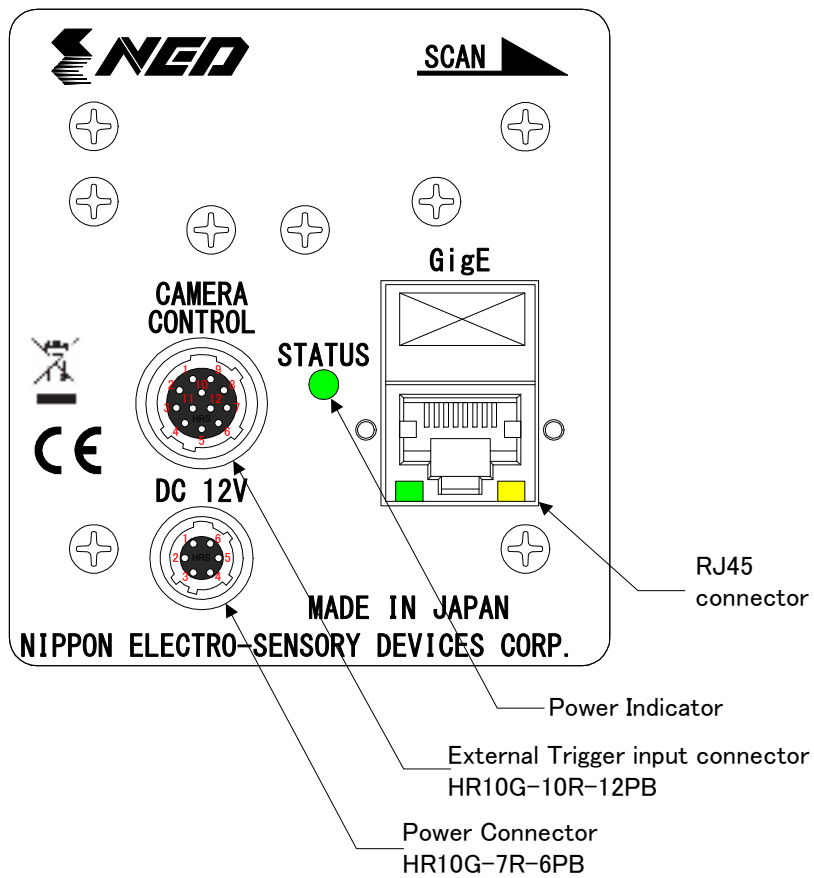


Figure 3-2-1 Input/Output Connectors and Indicator

3.3 External Trigger Connector (HR10G-10R-12PB)

- ◆ Round shape push-pull lock type.

The pin assignment of the External Trigger connector is shown below.

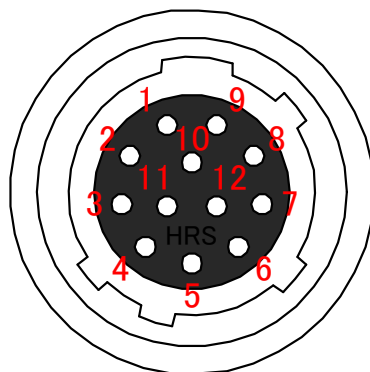


Figure 3-3-1 External Trigger Connector (HR10G-10R-12PB)

- ◆ This is used in External Trigger mode, or External Frame Trigger mode.

Table 3-3-1 External Trigger Connector pin assignments

No	NAME	I/O	No	NAME	I/O
1	LVDS_IN1+	IN	7	Unused	-
2	LVDS_IN1-	IN	8	Ext_Frame	IN
3	LVDS_IN2+	IN	9	Ext_Trigger	IN
4	LVDS_IN2-	IN	10	Unused	-
5	GND	GND	11	Unused	-
6	Unused		12	Unused	-

- ◆ Description of Signals

GND : Connect to the GND of the external trigger generator

LVDS_IN1+ : External Trigger input (LVDS_33+)

LVDS_IN1- : External Trigger input (LVDS_33-)

LVDS_IN2+ : External Frame input (LVDS_33+)

LVDS_IN2- : External Frame input (LVDS_33-)

Ext_Frame : External Frame input (LVCMOS)

Ext_Trigger : External Trigger input (LVCMOS)

Electrical Specification

LVDS_33 VID:minimum 100mV/maximum 600mV

LVCMOS (0V~3.3V) VIH:2.0V VIL:0.8V

Compatible Cable (Compatible plug)

HRS:HR10A-10P-12S

- ◆ Be sure to firmly insert the connector so that the cable does not become disconnected while the power is on.
- ◆ Since the LVDS input and LVCMOS input are the same function, an OR is performed on the internal circuit. Take care not to input both at the same time.
- ◆ If noise interferes with the input signal, it may cause a malfunction.
(When not in use, keep the camera in a suitable environment and take steps to prevent dust and static electricity, such as applying a lens cap etc.)

3.4 Power Supply Connection

- ◆ Round shape push-pull lock type

The pin assignment of the power supply connector is shown below.

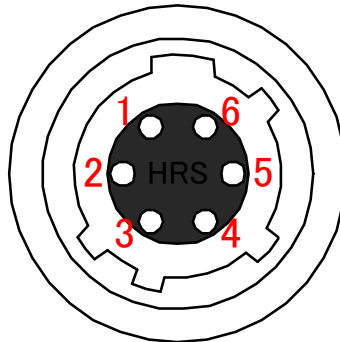


Figure 3-4-1 Power Supply Connector (HR10G -7R- 6PB)

The pin assignment of the power supply connector is shown below.

Table 3-4-1 Pin Assignment of Power Supply Connector

No	NAME	No	NAME
1	+12V	4	GND
2	+12V	5	GND
3	+12V	6	GND

- ◆ When selecting a power source, choose one with the capacity to allow for inrush current. (15W or more recommended)
- ◆ Insert the cable plug securely until it locks into position. This is to prevent the connector from coming loose during power transmission.
- ◆ Do not remove the cable while image data is being transmitted.

Compatible Cable (Compatible plug) : DGPSA-10 (HIROSE:HR10A-7P-6S)

Power supply voltage: +12V~+15V:DC+12V~+15V (±5%)

Consumption Current (rated): +12V :500mA

3.5 LED status (Power Indicator)

- ◆ LED = Green
Lights when +12V power is supplied and startup settings have been completed
- ◆ LED = Red
Lights when an error occurs, or during startup settings
- ◆ LED = Orange
Lights when an error occurs, or when connects with 10base/100Mbase

4 Camera startup

4.1 Flow of Camera Control

Immediately after turning on the power, the camera does not output image data (packets). In order to output image data, it is necessary to first perform Device Discovery.

Please see the manual for your viewer software on how to perform device discovery. If you are using the GigEGrab software shipped with this camera, please see the GigE カメラ__NED ビュアーソフト説明書.pdf on the same CD-ROM.

4.2 Startup

After turning on, the camera runs a startup procedure before it starts getting images and outputting data.

The startup procedure is as follows.

- (1) The camera initializes the hardware.
- (2) Reads out the latest camera settings from the flash memory. (User settings if any or factory default settings)
- (3) Sets up the camera with the setting values from the flash memory.

After this sequence, the camera is ready to get images and output data.

In order to output image data, it is necessary to perform Device Discovery from the PC side.

5 Camera Control

The camera control registers are listed below. Please see the manual for your viewer software on how to set registers. If you are using the GigEGrab software shipped with this camera, please see the GigE カメラ_NED ビュアーソフト説明書.pdf on the same CD-ROM.

5.1 List of Camera Control Registers

Table 5-1-1 List of Camera Control Registers

Control Item	Address	Value	Description
Acquisition Start	0x0000A000	1	Start packet transfer
Acquisition Stop	0x0000A000	0	Stop packet transfer
OffsetX	0x0000A00C	0 ~ 2044	X Offset Pixel No.
Width	0x0000A004	4 ~ 2048	1 Line Pixel Width
Height	0x0000A008	16 ~ 4096	1 Frame Line Count
PixelFormat	0x0000A018	0x1080001	8bit Output
		0x1100003	10bit Output
		0x1100005	12bit Output
DigitalGain	0x0000A084	0 ~ 688	Digital Gain Setting
AnalogGain	0x0000A080	0	Analog Gain Setting 0dB
		1	3dB
		2	6dB
		3	9dB
		4	-3dB
DigitalOffset	0x0000A088	0 ~ 19	Offset Setting
TriggerMode	0x0000A08C	0	Freerun
		1	Ext.Trigger
TriggerInternalCounter	0x0000A094	88 ~ 32767	Free Run Exposure Time unit(μs)
TestImageSelector	0x0000A03C	0	Test Pattern Output Disable
		1	Test Pattern Output 1 Enable
		2	Test Pattern Output 2 Enable
FrameTriggerEnable	0x0000A220	0	External Frame Trigger Disable
		1	External Frame Trigger Enable
FrameTriggerConfig	0x0000A224	0	External Frame Trigger Invert Disable
		1	External Frame Trigger Invert Enable

LineTriggerConfig	0x0000A228	0	External Trigger Invert Disable
		1	External Trigger Invert Enable
LineTriggerMaskTimeR	0x0000A22C	0 ~ 1000000	External Trigger Signal(Rising) Chatter prevention function
LineTriggerMaskTimeF	0x0000A230	0 ~ 1000000	External Trigger Signal (Falling) Chatter prevention function
FrameTriggerMaskTimeR	0x0000A234	0 ~ 1000000	Frame Trigger Signal (Rising) Chatter prevention function
FrameTriggerMaskTimeF	0x0000A238	0 ~ 1000000	Frame Trigger Signal (Falling) Chatter prevention function
UserSet_ResetToFactory Default	0x0000A0B8		Reset to Factory Settings (See 5.14.1)
UserSet_Load	0x0000A0BC		Load from Memory
UserSet_Save	0x0000A0C0		Save to Memory

NB) Make sure to only adjust the below registers while image acquisition is stopped. If the frame size is changed while acquiring images, a malfunction will occur on the acquisition side.

- OffsetX
- Width
- Height
- PixelFormat
- UserSet_ResetToFactoryDefault
- UserSet_Load

5.2 Factory (Default) Settings

The memory setup values (factory settings) are shown below.

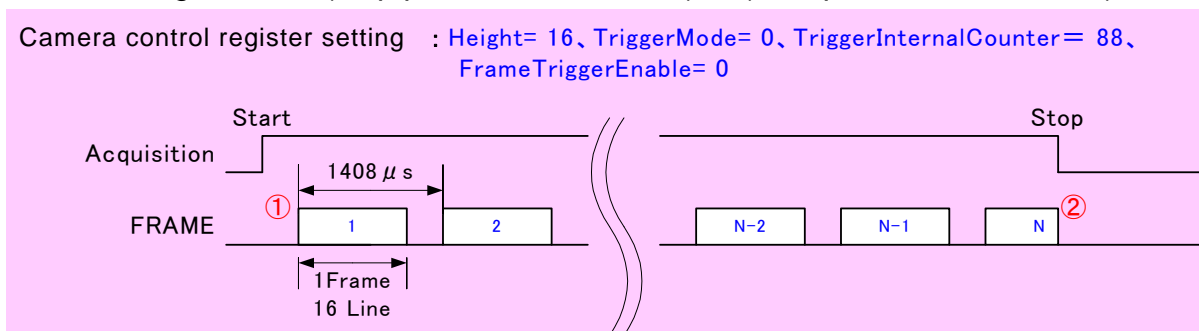
Control Item	Address	Value	Description
OffsetX	0x0000A00C	0	0
Width	0x0000A004	2048	2048
Height	0x0000A008	2048	2048
PixelFormat	0x0000A018	0x1080001	8bit Output
DigitalGain	0x0000A084	0	Digital Gain 0
AnalogGain	0x0000A080	4	Analog Gain 3dB
DigitalOffset	0x0000A088	4	Digital Offset 4
TriggerMode	0x0000A08C	0	Free Run Trigger Mode
TriggerInternalCounter	0x0000A094	88	Exposure Time 88 μ s
TestImageSelector	0x0000A03C	0	Test Pattern Output Off
FrameTriggerEnable	0x0000A220	0	External Frame Trigger Disable
FrameTriggerConfig	0x0000A224	0	External Frame Trigger Invert Disable
LineTriggerConfig	0x0000A228	0	External Trigger Invert Disable
LineTriggerMaskTimeR	0x0000A22C	0	External Trigger Signal (Rising) Chatter prevention function disable
LineTriggerMaskTimeF	0x0000A230	0	External Trigger Signal (Falling) Chatter prevention function disable
FrameTriggerMaskTimeR	0x0000A234	0	Frame Trigger Signal (Rising) Chatter prevention function disable
FrameTriggerMaskTimeF	0x0000A238	0	Frame Trigger Signal (Falling) Chatter prevention function disable

5.3 Acquisition Control Example

Image acquisition is started and stopped through the camera's acquisition registers. After AcquisitionStart is set, image acquisition continues until AcquisitionStop is set.

5.3.1 Acquisition Control Example

- Register Name: Acquisition Start / Stop
- Setting Value: 0 (stop packet transmission), 1 (start packet transmission)



1. After setting AcquisitionStart, a frame is generated automatically in the camera. The frame period is dependent on the value of the TriggerInternalCounter register and the Height register.
e.g. $88\mu\text{s} \times 16\text{Line} = 1408\mu\text{s}$
2. After setting AcquisitionStop, packet transmission is stopped. The frame being acquired at the time is stopped mid-frame. *The line being acquired at the time is transmitted up to the final pixel

5.4 Video Output Format

This camera's output format can be changed through the control registers. Settings are made via the PixelFormat register (see 5.1)

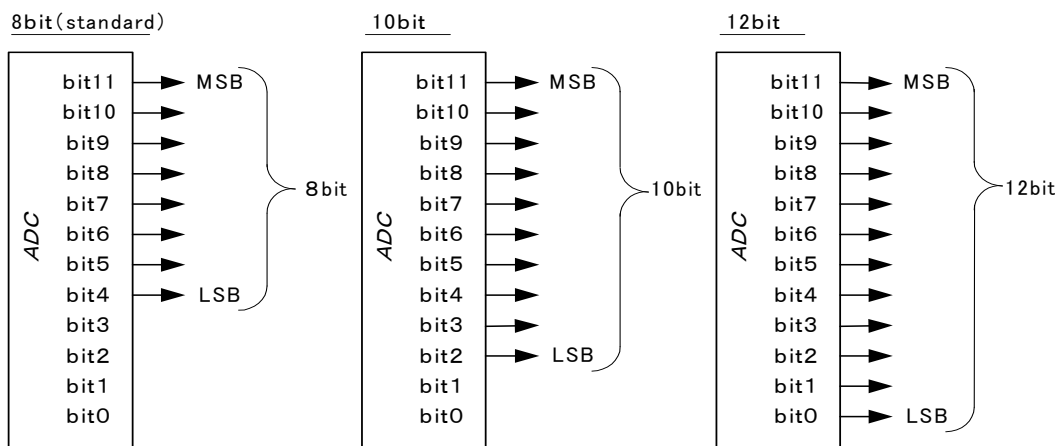


Figure 5-4-1 Pin Assignments of Digital Data

- ◆ The A/D converter of the camera has a 12-bit resolution. For 10-bit output, the upper 10-bit signal, for 8-bit output, the upper 8-bit signal, can be output as a video data.

5.4.1 Example of Video Output Format configuration

- register name : PixelFormat
- setting value : 0x1080001 (Mono 8)
0x1100003 (Mono 10)
0x1100005 (Mono 12)

(Example) Mono 12

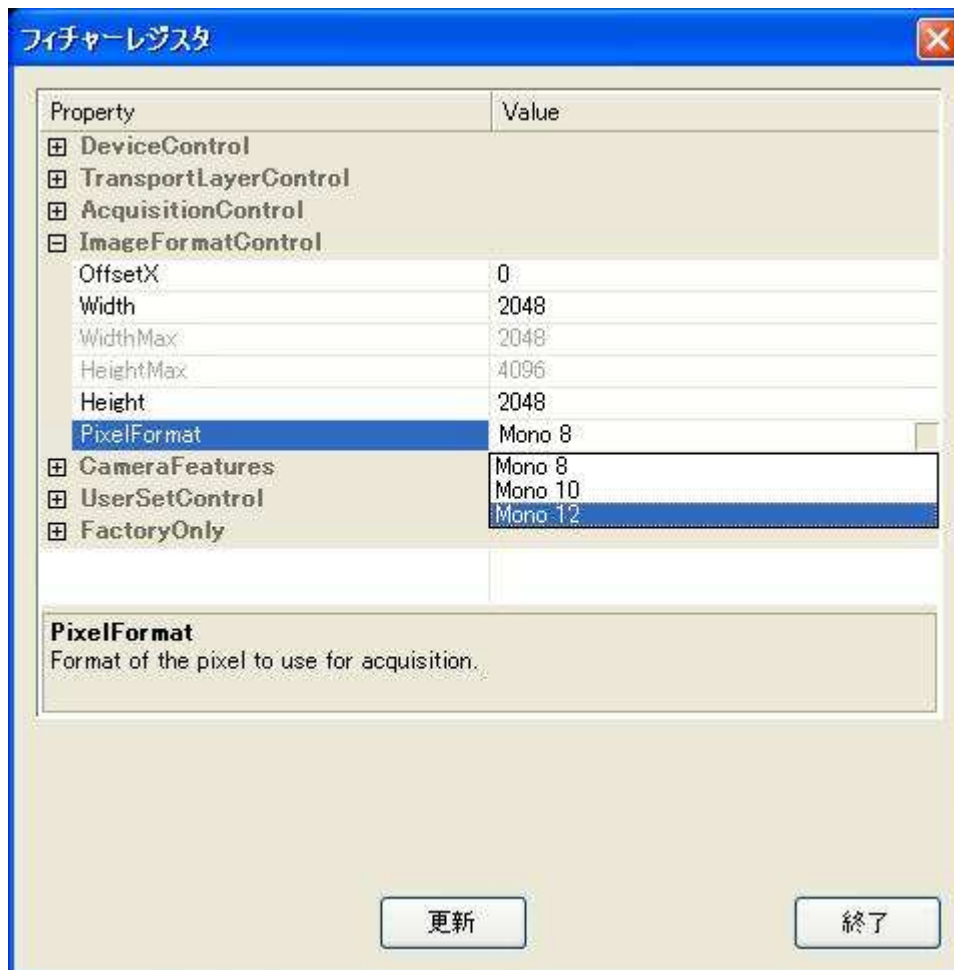


Figure 5-4-1 PixelFormat register (the GigEGrab picture)

5.5 Exposure Mode

This camera provides 2 types of exposure mode. The exposure mode can be set via the camera control registers. Settings are made via the TriggerMode register(see 5.1).

5.5.1 Example of free run mode configuration

- register name : TriggerMode
 - setting value : 0 (Free run) , 1 (Ext. Trigger)
- (Example) Free run

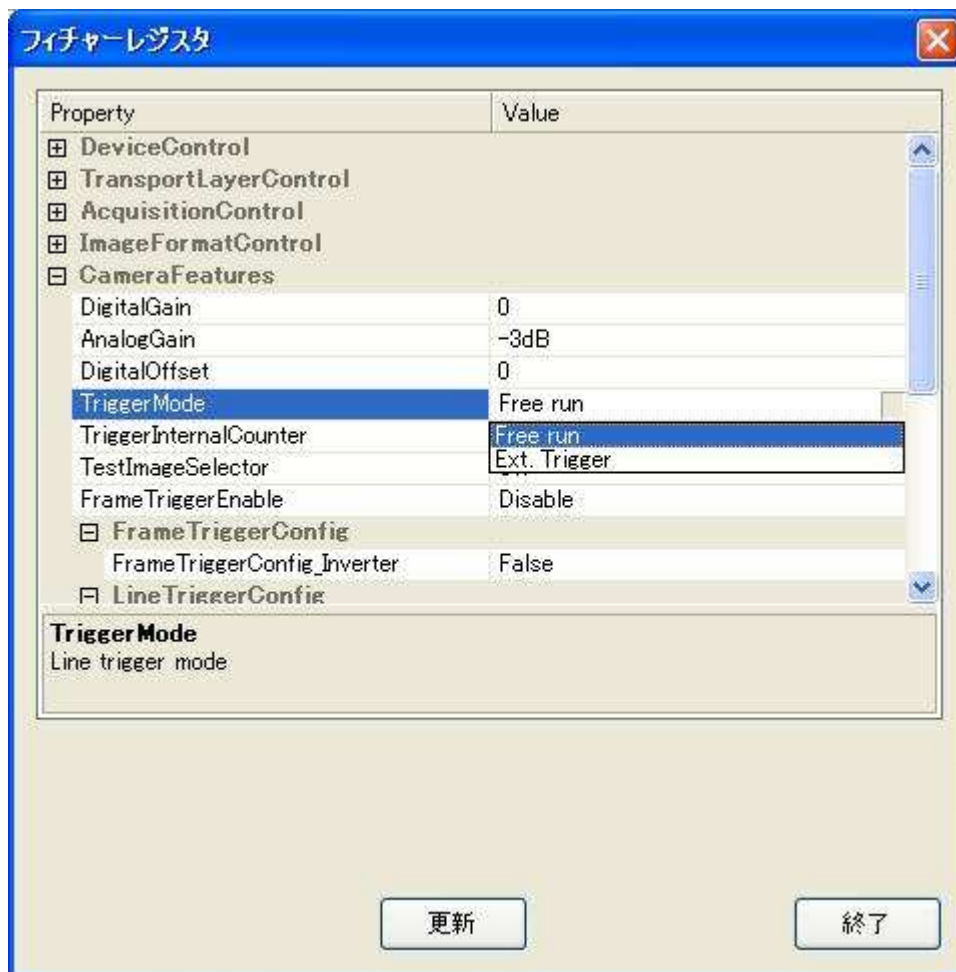


Figure 5-5-1 TriggerMode register (Free run) (the GigEGrab picture)

5.6 Scan Rate of free run mode

The scan rate in free run mode is set via the TriggerInternalCounter register.
(see 5.1)

The scan period can be set in the range from 88 μ s to 32.767ms. The setting increment is 1 μ s.

Note that in order for the scan period setting to be valid, the TriggerMode register must be set to Free Run Mode.

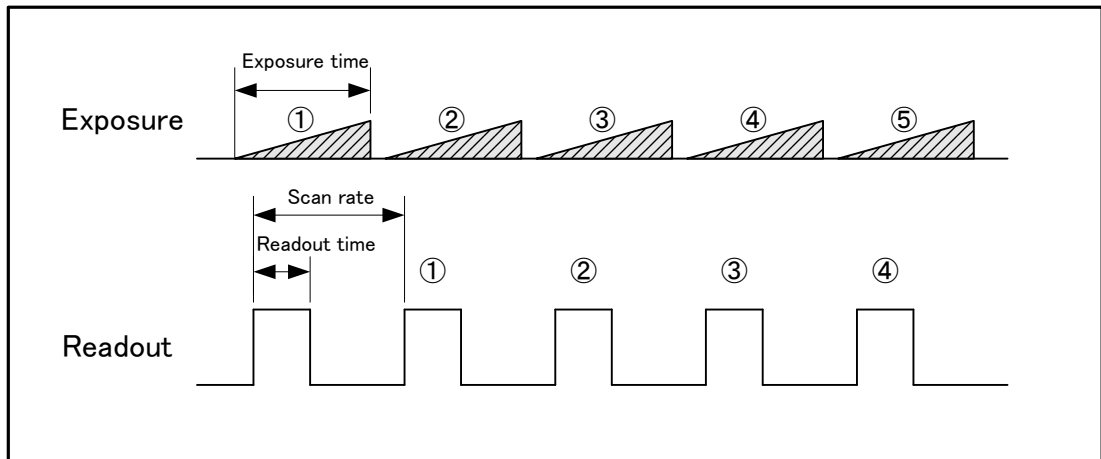


Figure 5-6-1 Free Run Exposure Mode

- ◆ The readout of Exposure (1) is read out at Readout (1). Depending on the Height setting and the scan period setting, your environment may result in a TimeOut. Set the TimeOut period in your application to an appropriate length.

5.6.1 Example of free run mode Scan Rate configuration

- register name : TriggerInternalCounter
- setting value : 88 ~ 32767

(Example) 100 μ s

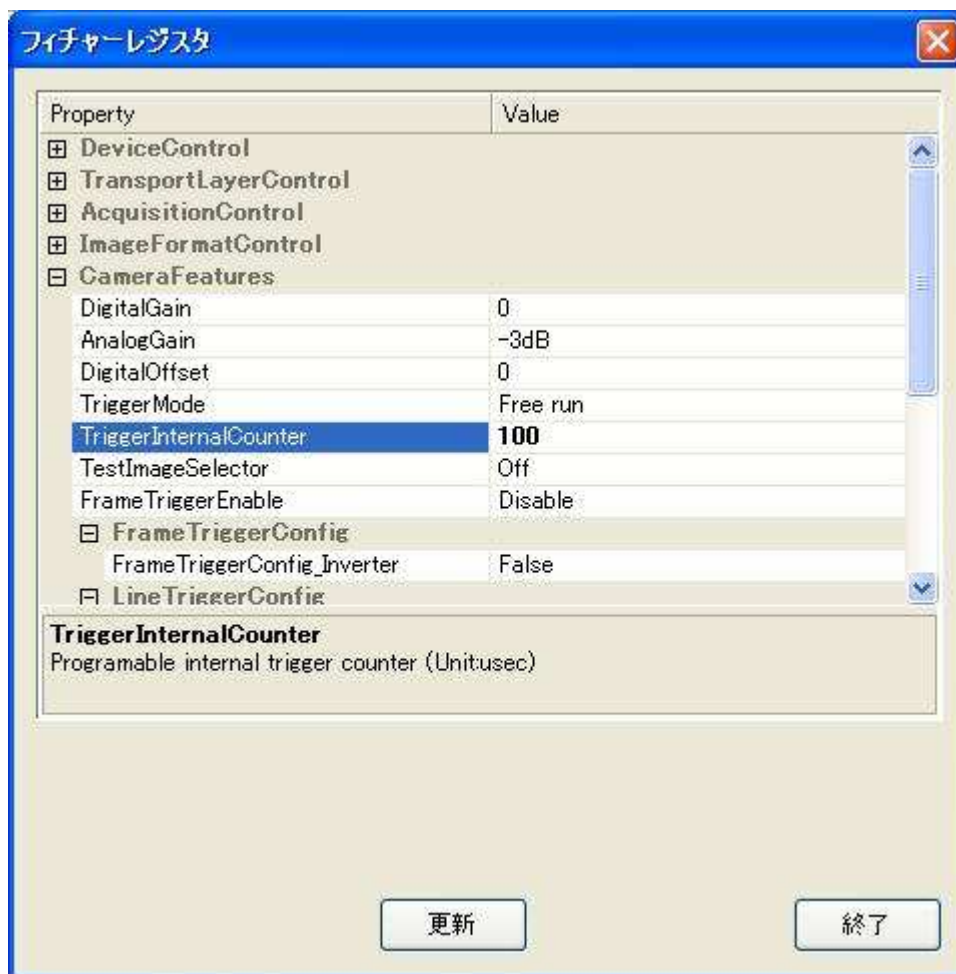


Figure 5-6-1 TriggerInternalCounter register (Free run) (the GigEGrab picture)

5.7 External Trigger Exposure Mode (Trigger Edge)

External Trigger Exposure Mode can be set via the TriggerMode register.
(see 5.1)

Timing limitations are explained below:

- a: External trigger pulse H period $> 80\text{ns}$ (2CK)
- b: External trigger pulse L period $> 80\text{ns}$ (2CK)
- a+b: Scan period $> 88\mu\text{s}$ $< 32.767\text{ms}$ ($2200 - 819,175\text{CK}$)

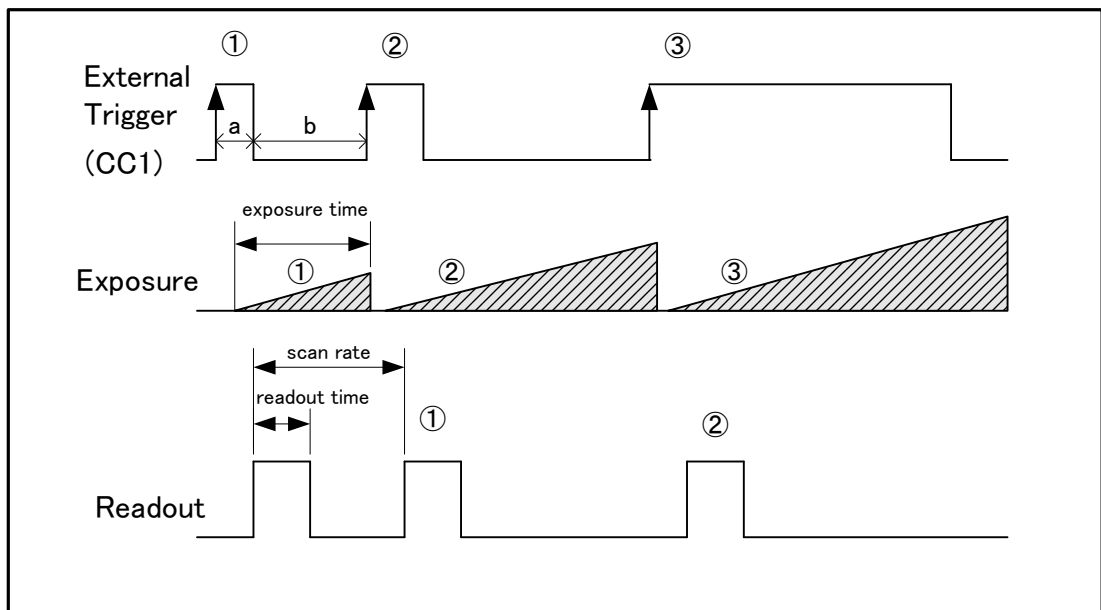


Figure 5-7-1 External Trigger Exposure Mode

- ◆ Depending on the Height setting and the scan period setting, your environment may result in a TimeOut. Set the TimeOut period in your application to an appropriate length.

5.7.1 Example of External Trigger Exposure Mode configuration (Ext. Trigger)

- register name : TriggerMode
- Setting value : 0 (Free run) , 1 (Ext. Trigger)
(Example) Ext. Trigger

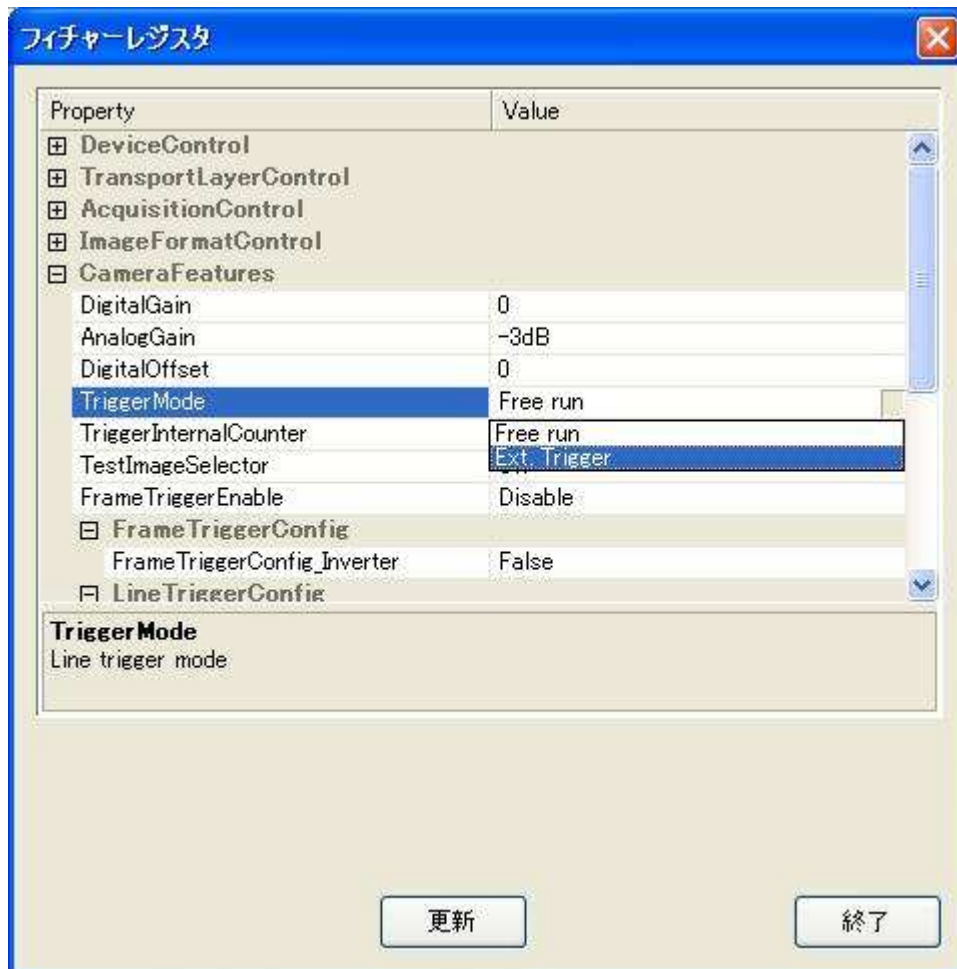


Figure 5-7-1 TriggerMode register (Ext. Trigger) (the GigEGrab picture)

5.7.2 External Trigger Invert Function Example

The external trigger signal can be inverted inside the camera.
Use this function when appropriate to your application.

- register name : LineTriggerConfig
- setting value : LineTriggerConfig_Inverter : 0 (False)、
LineTriggerConfig_Inverter:1(True)

(Example) True

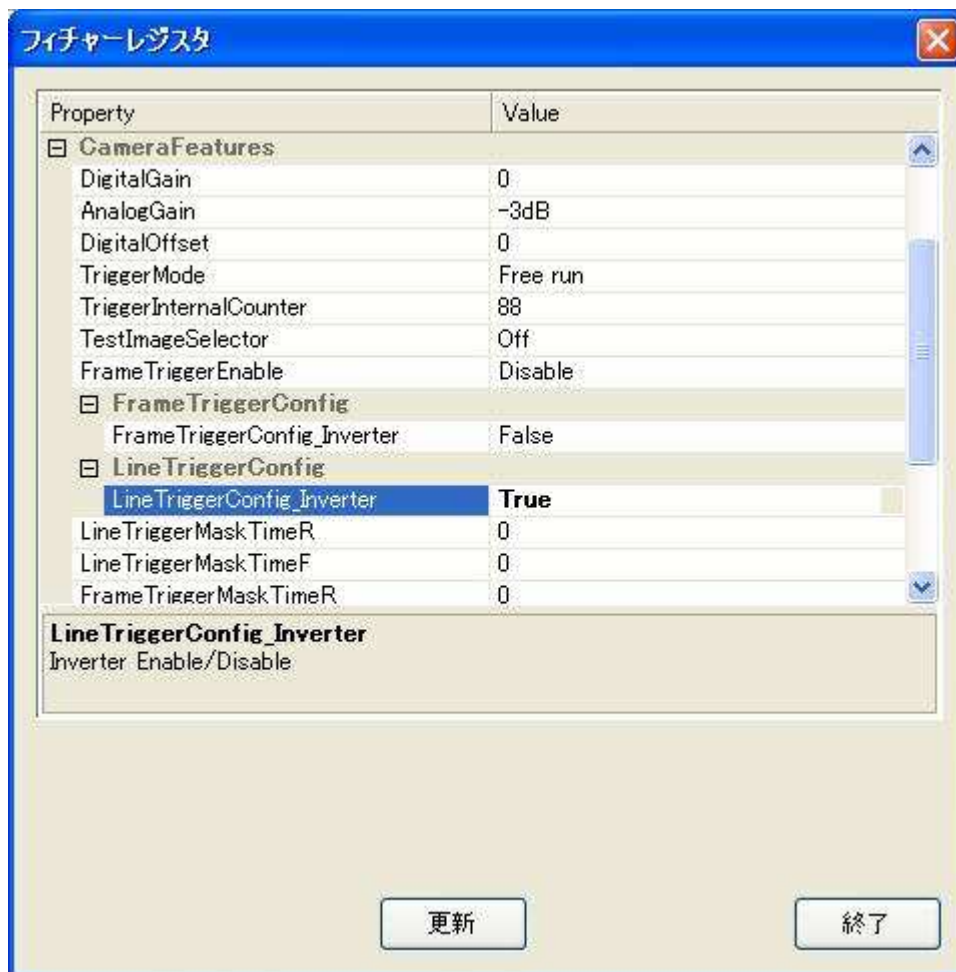
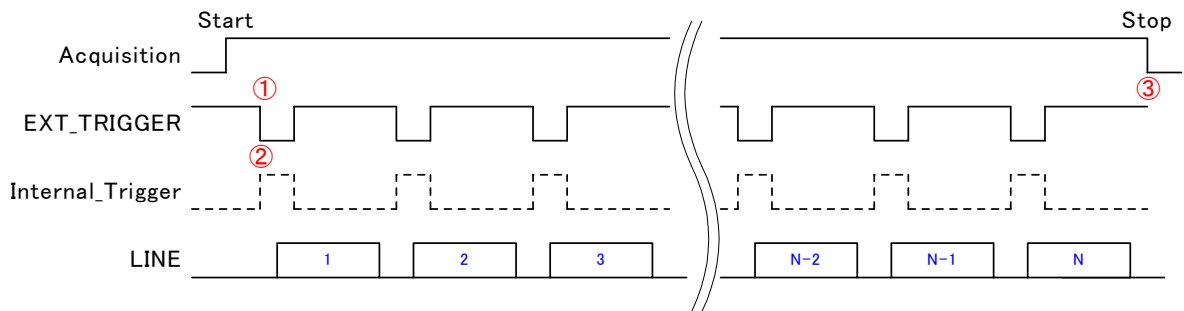


Figure 5-7-2 LineTriggerConfig register (the GigEGrab picture)

Camera control register setting : TriggerMode= 1、 LineTriggerConfig= 1



1. After setting AcquisitionStart, the external trigger's "Low" electrical pulse is input.
2. The camera detects the pulse and internally inverts it.
3. When AcquisitionStop is sent, packet transmission is stopped.

5.7.3 External Trigger Chatter Prevention Function Example (Rising)

Masks the chatter of the rising external trigger signal inside the camera.

Use this function as appropriate to your application.

- register name : LineTriggerMaskTimeR
- setting value : 0 ~ 1000000 (unit: μ s)

(Example) 10

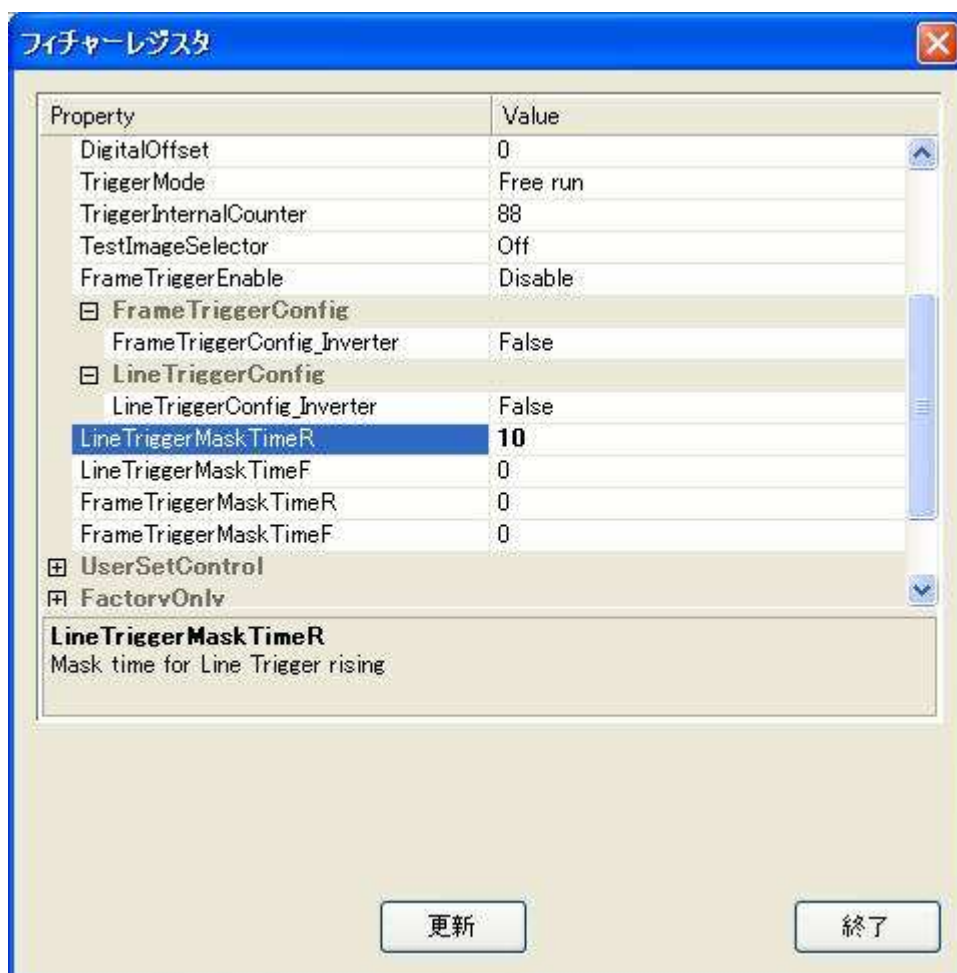
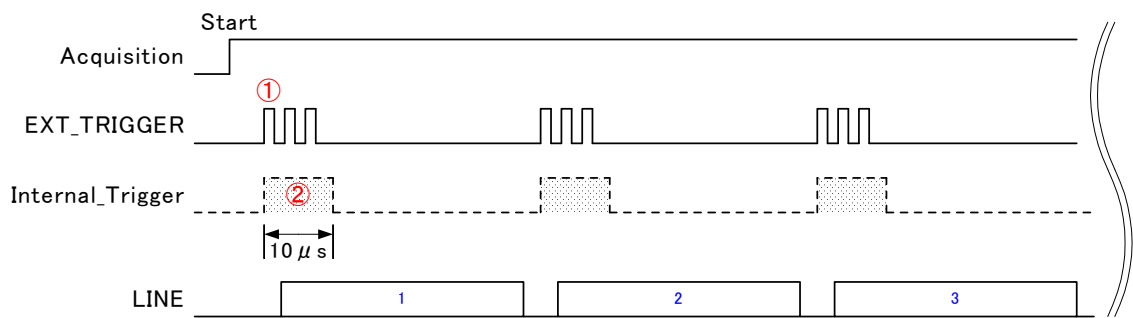


Figure 5-7-3 LineTriggerMaskTimeR register (the GigEGrab picture)

Camera control register setting : TriggerMode= 1、 LineTriggerMaskTimeR= 10



1. On the rising edge of the external trigger signal, a trigger signal is generated internally in the camera.
2. During the $10\ \mu\text{s}$ set in the register, signal transitions are ignored (masked).

5.7.4 External Trigger Chatter Prevention Function Example (Falling)

Masks the chatter of the falling external trigger signal inside the camera.
Use this function as appropriate to your application.

- register name : LineTriggerMaskTimeF
- setting value : 0~1000000 (unit: μ s)
(Example) 100

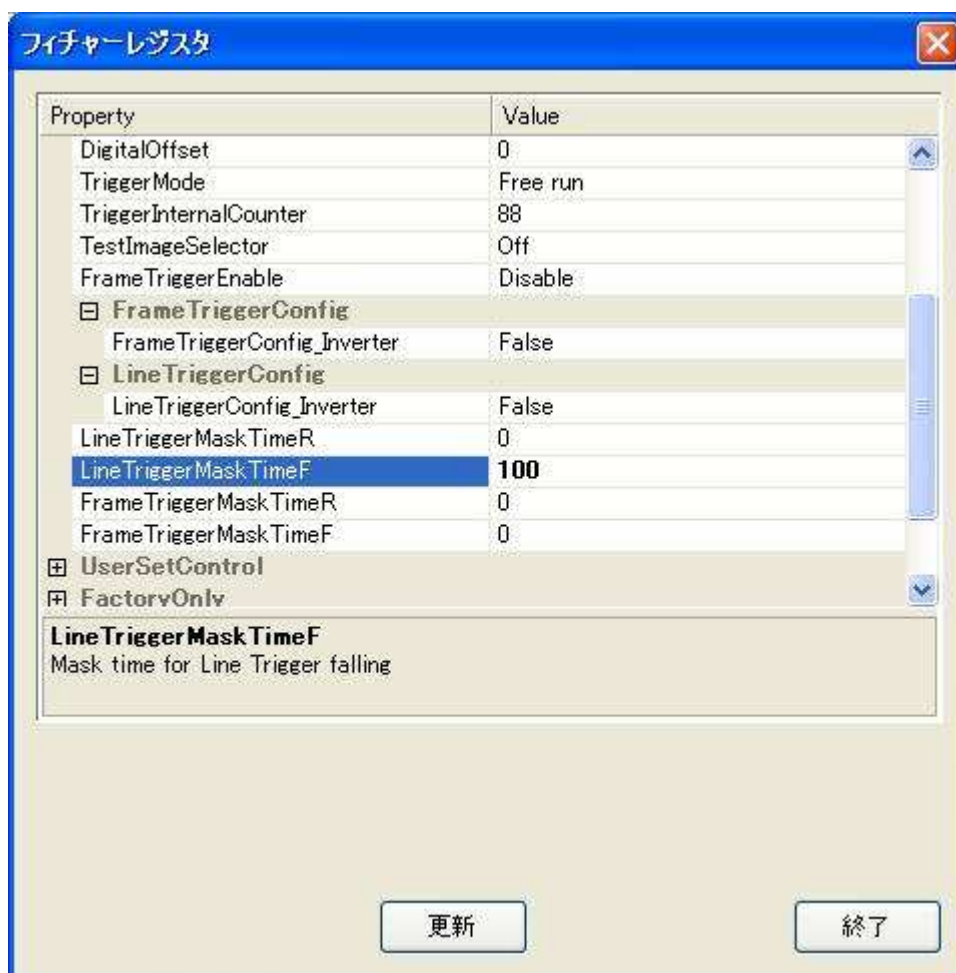
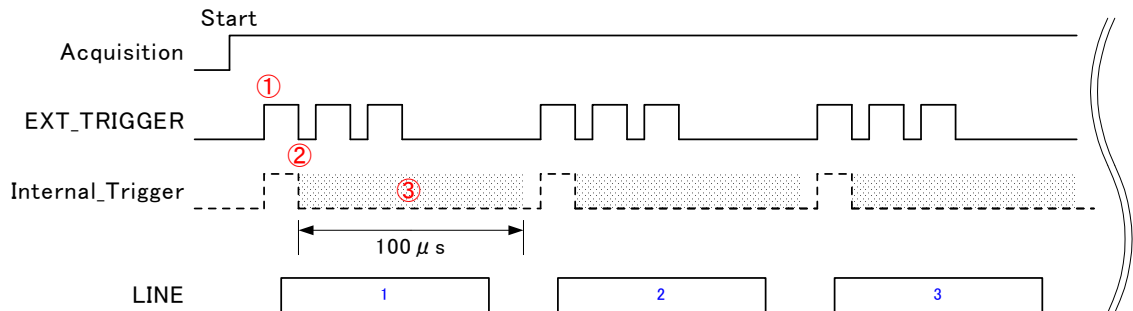


Figure 5-7-4 LineTriggerMaskTimeF register (the GigEGrab picture)

Camera control register setting : `TriggerMode= 1`、`LineTriggerMaskTimeF= 100`



1. On the rising edge of the external trigger signal, a trigger signal is generated internally in the camera.
2. On the falling edge of the external trigger signal, a mask period is generated internally in the camera.
3. During the 100μs set in the register, signal transitions are ignored (masked).

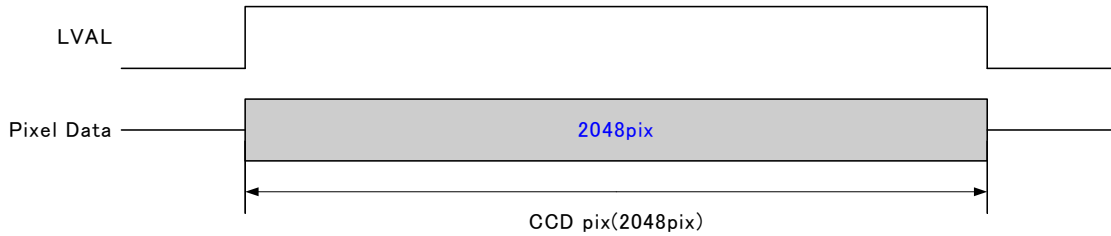
5.8 Changing the Number of Valid Pixels per Line

The number of pixels output per line can be set via the Width and OffsetX registers. (see 5.1)

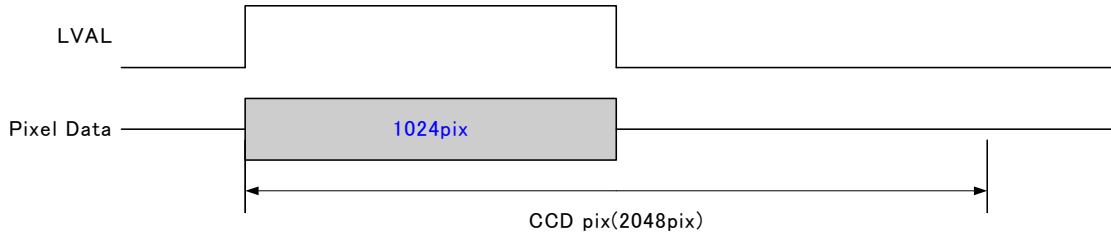
Width: This value should be set between 4~2048

OffsetX: This value should be set between 0~2044

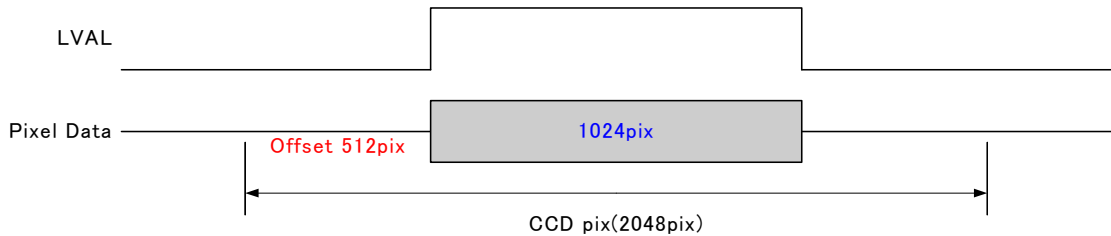
Camera Features Setting : **Width = 2048** , **OffsetX = 0**



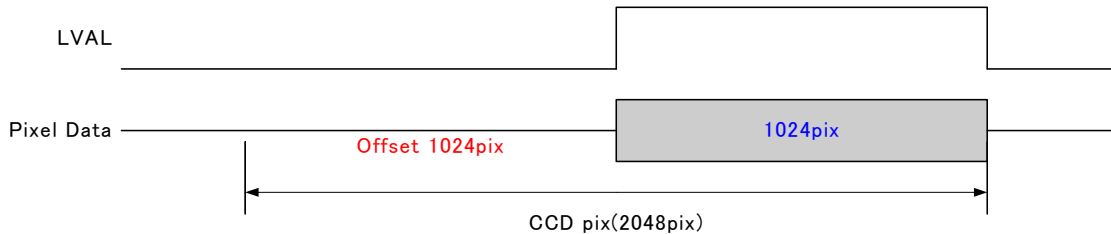
Camera Features Setting : **Width = 1024** , **OffsetX = 0**



Camera Features Setting : **Width = 1024** , **OffsetX = 512**



Camera Features Setting : **Width = 1024** , **OffsetX = 1024**



- ◆ When OffsetX=0 and Width=2048, Width must first be decreased before it is possible to increase OffsetX. Similarly, when returning Width to 2048, OffsetX must first be set to 0. The total number of pixels cannot be set to a value higher than 2048.

5.8.1 Setting Number of Valid Pixels Example (Width)

Sets the number of pixels in 1 line

- register name : Width
- setting value : 4 ~ 2048

(Example) 1024

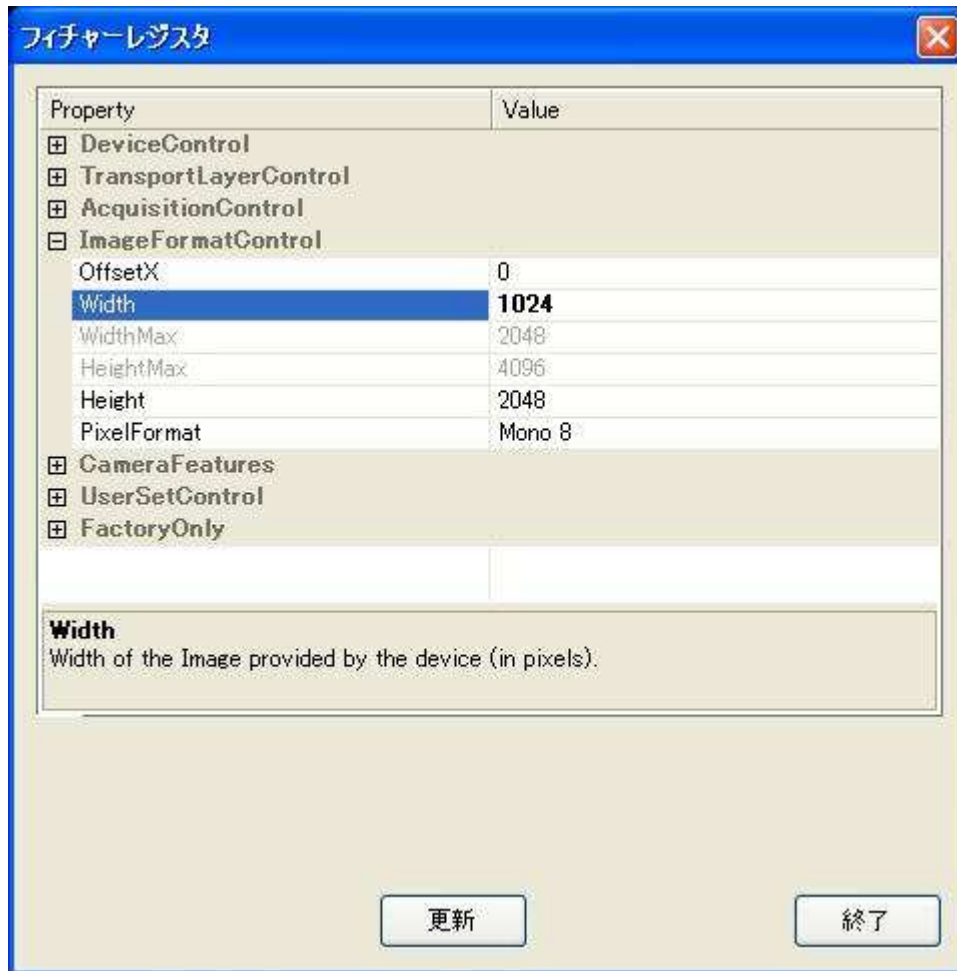


Figure 5-8-1 Width register (the GigEGrab picture)

5.8.2 Setting Number of Valid Pixels Example (Offset)

Sets the number of pixels to offset the line by

- register name : OffsetX
- setting value : 0 ~ 2044

(Example) 512

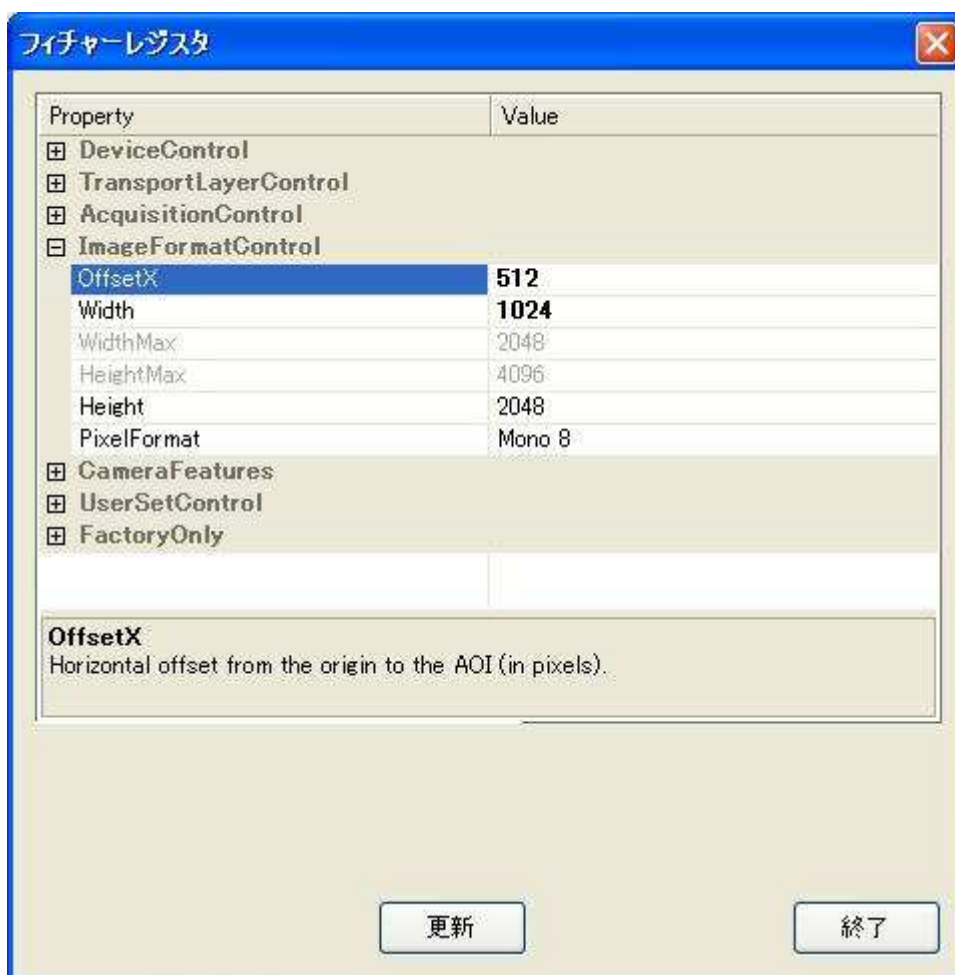
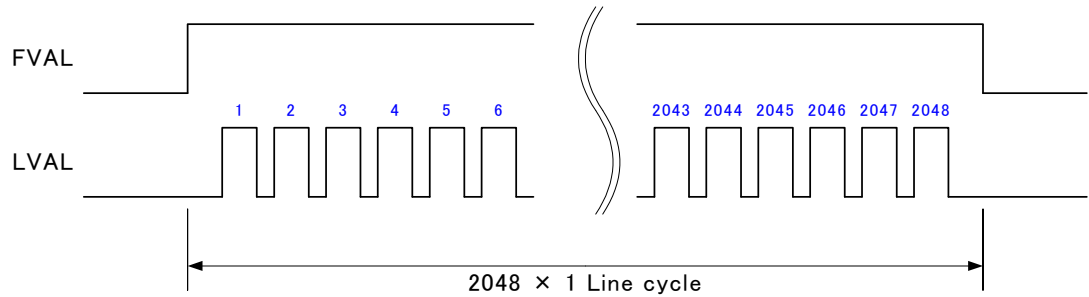


Figure 5-8-2 OffsetX register (the GigEGrab picture)

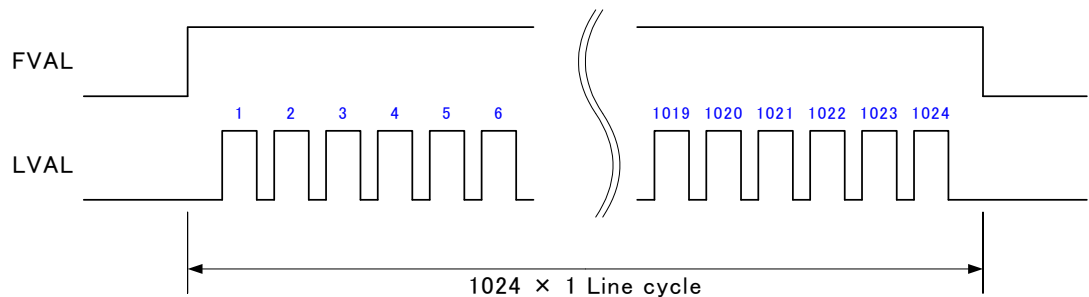
5.9 Valid Number of Lines Function

The number of lines output in 1 Frame can be set via the Height register (See 5.1). Height can be set from 16 to 4096.

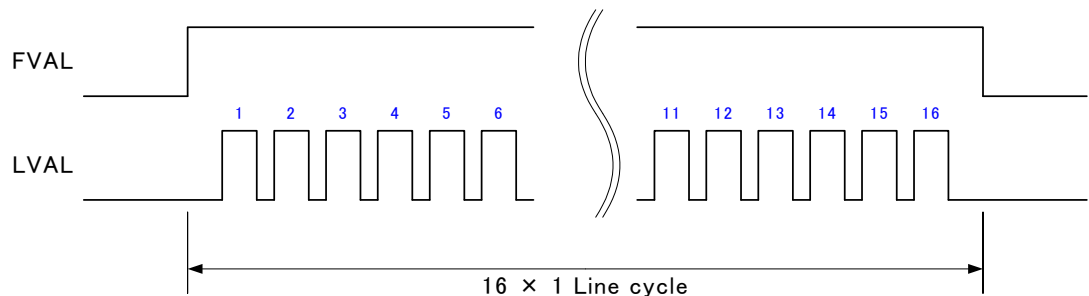
Camera Features Setting : **Height= 2048**



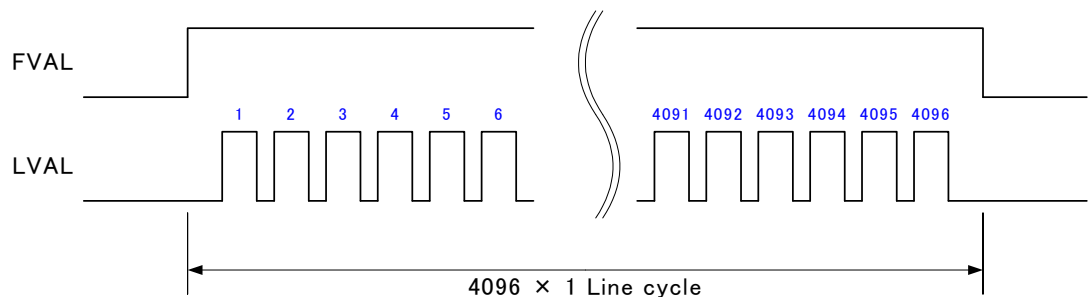
Camera Features Setting : **Height= 1024**



Camera Features Setting : **Height= 16**



Camera Features Setting : **Height= 4096**



- ◆ Depending on the Height setting and the scan period setting, your environment may result in a TimeOut. Set the TimeOut period in your application to an appropriate length.

5.9.1 Valid Number of Lines Setting Example

Sets the number of lines in a Frame.

- register name : Height
- setting value : 16 ~ 4096

(Example) 1024

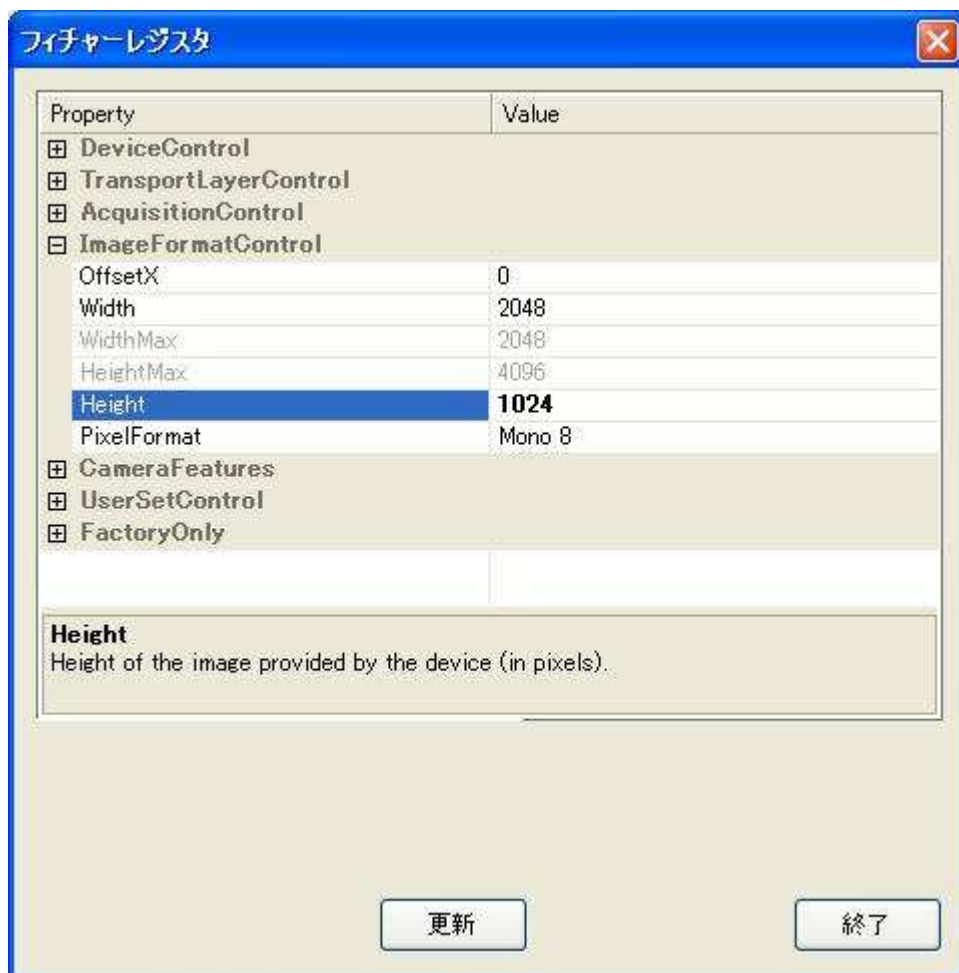


Figure 5-9-1 Height register (the GigEGrab picture)

5.10 Setting Digital Offset

In the figure below, the horizontal axis indicates the amount of incident light and the vertical axis indicates the output. F_s shows the output at saturation. D_d shows the output at darkness. (Both F_s and D_d are digital.) S_e shows the saturation current, or the amount of exposure when the output saturates.

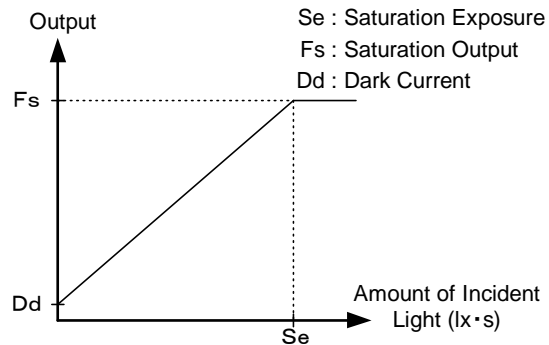


Figure 5-10-1 Saturation Exposure and Dark Current Output

By setting the offset, you can set the Y-intercept arbitrarily. D_f shows the digital offset value. The gradient of the line does not change.

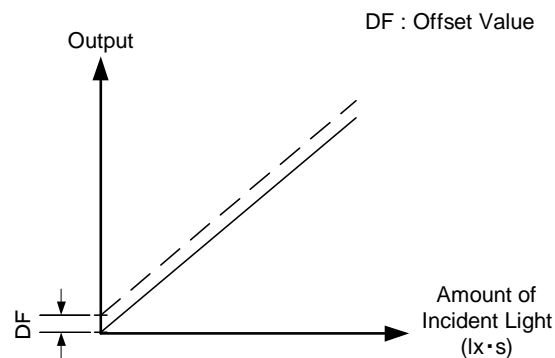


Figure 5-10-2 Offset Adjustment

- ◆ Adjust amount of offset in accordance with the requirements of your camera system.

5.10.1 Digital Offset Setting Example

Set the camera's Digital Offset

- register name : DigitalOffset
- setting value : 0 ~ 19

(Example) 10

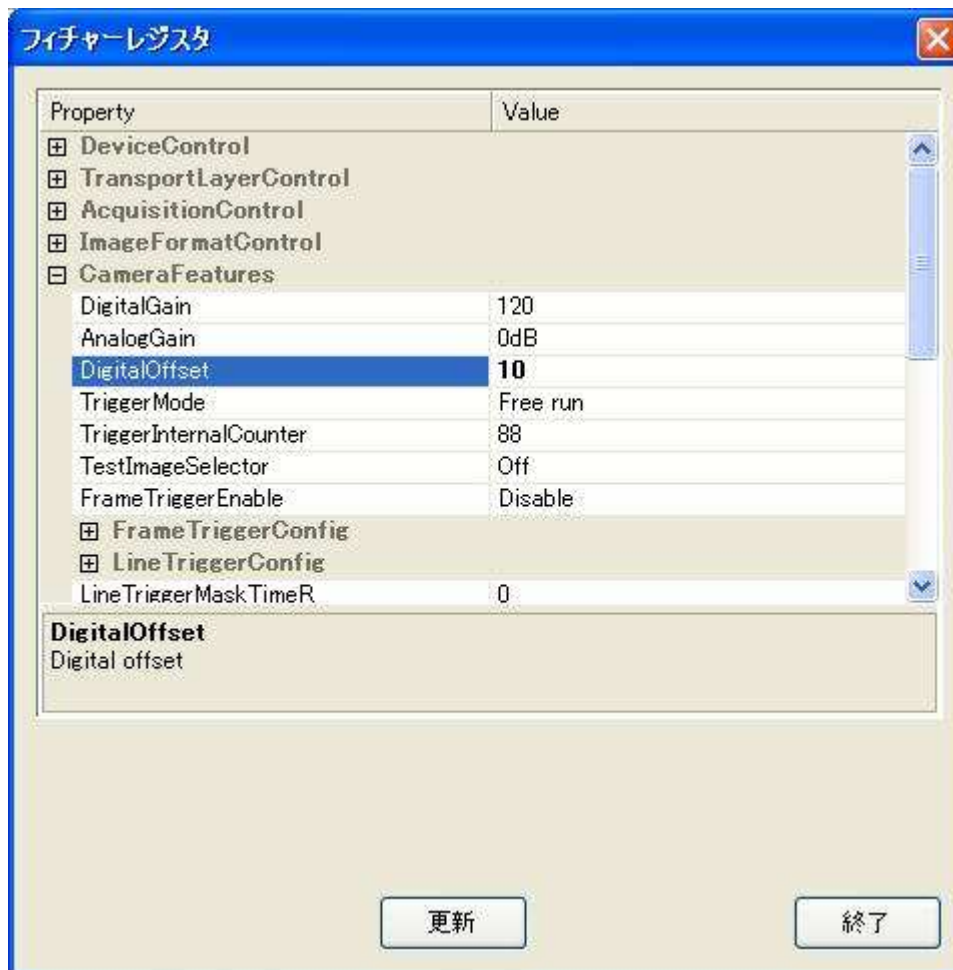


Figure 5-10-1 DigitalOffset register (the GigEGrab picture)

5.11 Setting Gain

- ◆ Gain can be adjusted via the camera control registers.
- ◆ Setting is done through the DigitalGain and AnalogGain registers (See 5.1)
- ◆ The digital gain setting value (0 to 688) follows the below formula:

$$\text{GAIN(dB)} = (\text{VAL} \times 0.03125)$$
- ◆ The camera gain can also be adjusted using the 5 steps of Analog Gain (0dB, 3dB, 6dB, 9dB, -3dB)
- ◆ If the camera gain level is set too low, the camera's output data may not attain its full range.
- ◆ If the camera gain level is set too high, the ratio of random noise increases. Set the gain as low as your application allows in order to attain the highest quality signal possible.
- ◆ In some cases, it may be necessary to use an IR cut filter.

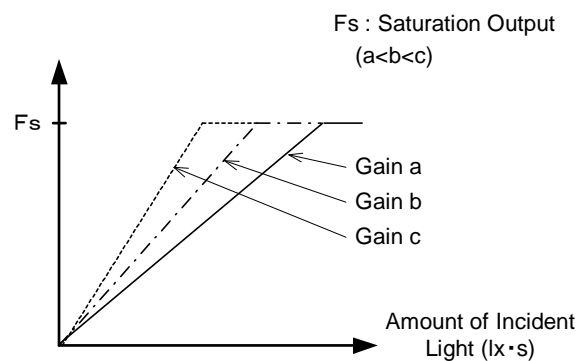


Figure 5-11-1 PGA Gain Adjustment

- ◆ Gain and noise values are proportionally related.
- ◆ Adjust the amount of gain in accordance with the requirements of your camera system.

5.11.1 Digital Gain Setting Example

Set the camera's digital gain.

- register name : DigitalGain
- setting value : 0 ~ 688

(Example) 120 ($120 \times 0.03125 = 3.75\text{dB}$)

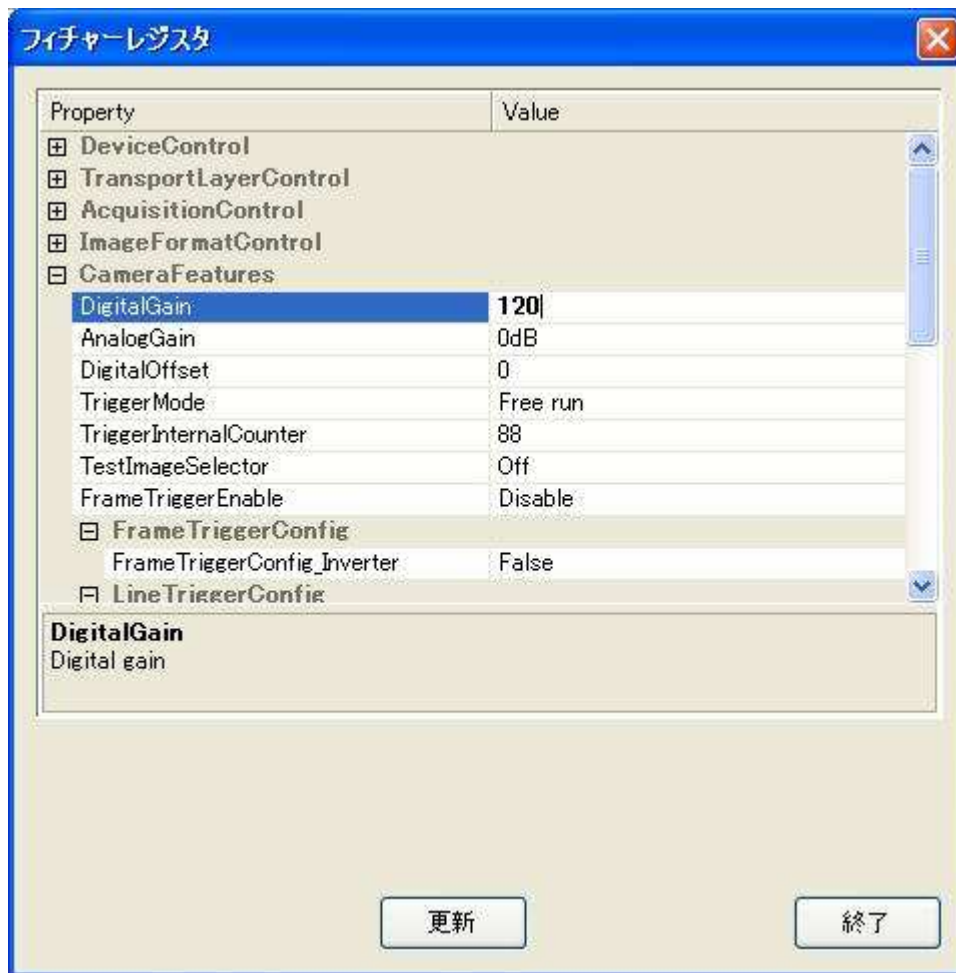


Figure 5-11-1 DigitalGain register (the GigEGrab picture)

5.11.2 Analog Gain Setting Example

Set the camera's analog gain

- register name : AnalogGain
- setting value : 0 (0dB)、1 (3dB)、2 (6dB)、3 (9dB)、4 (-3dB)

(Example) 0dB

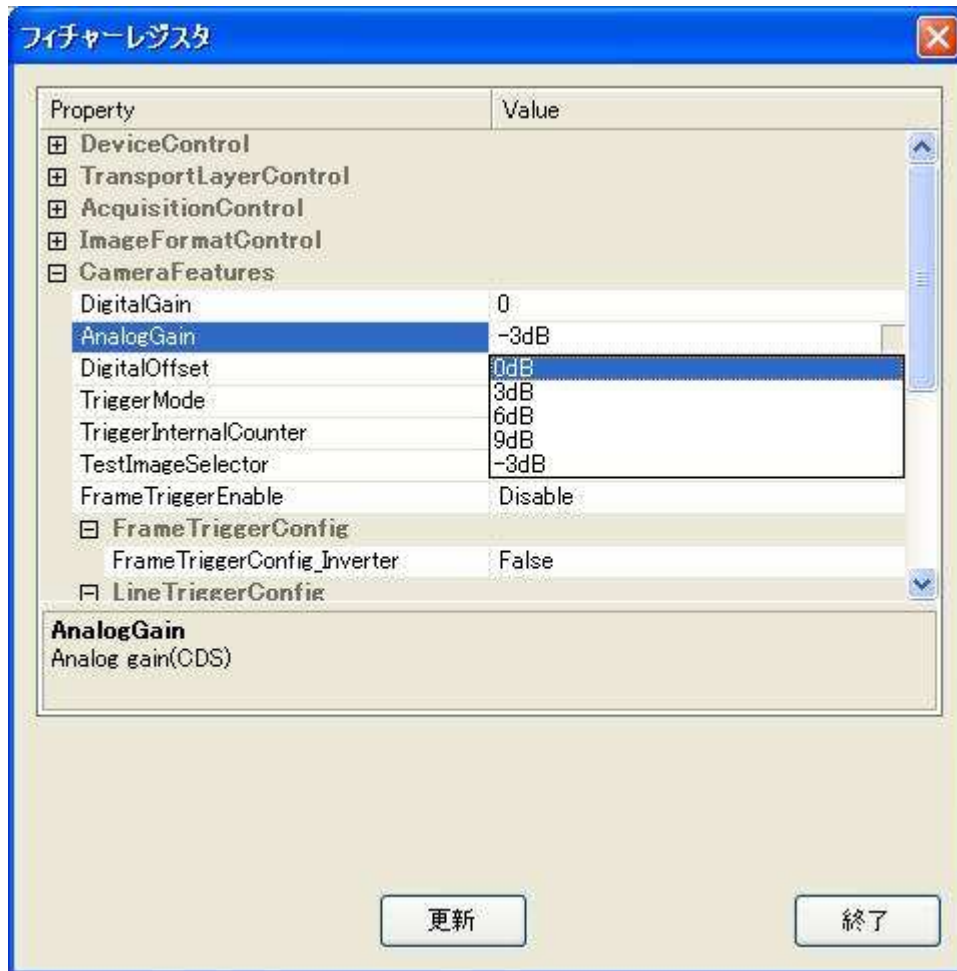


Figure 5-11-2 AnalogGain register (the GigEGrab picture)

5.12 External Frame Trigger Exposure Mode

Frame control through an external Frame Trigger can be achieved by setting the FrameTriggerEnable camera control register (see 5.1)

5.12.1 Example of Frame Trigger configuration

Set the Frame Trigger.

- register name : FrameTriggerEnable
- setting value : 0 (Disable)、1 (Enable)

(Example) Enable

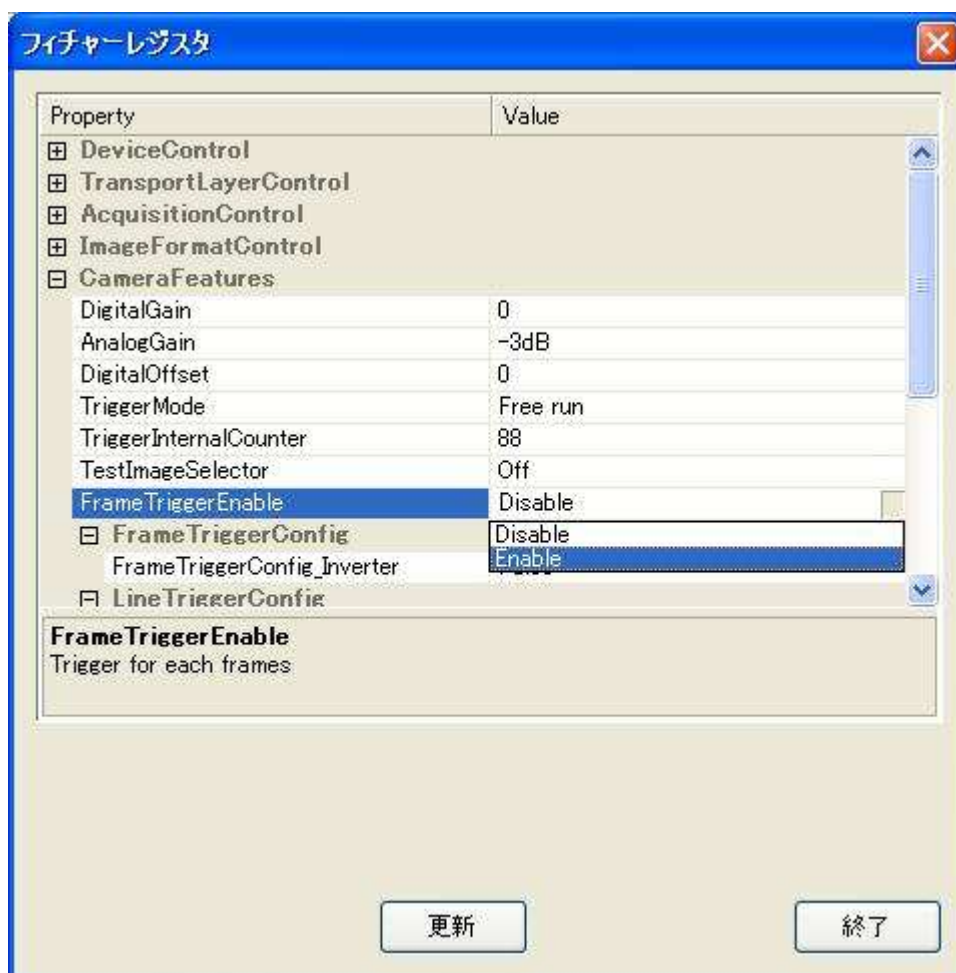
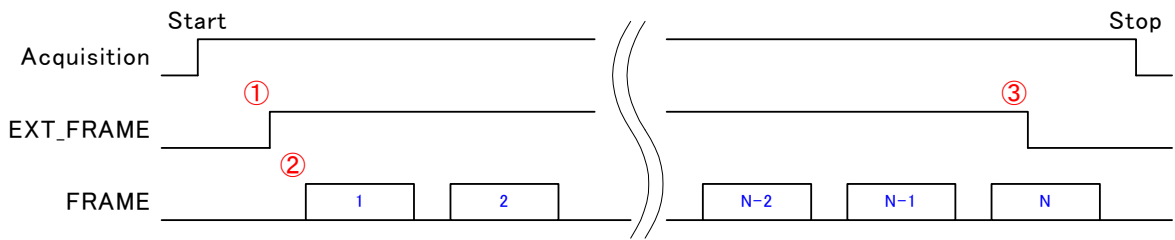


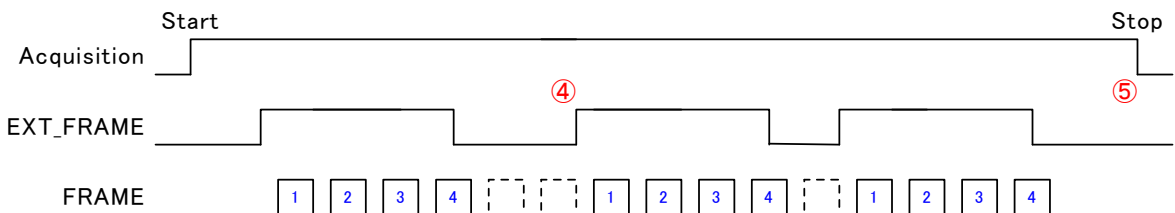
Figure 5-12-1 FrameTriggerEnable register (the GigEGrab picture)

Camera control register setting : `FrameTriggerEnable= 1`、`FrameTriggerConfig= 0`



1. After setting AcquisitionStart, a Frame signal is generate according to the external Frame Trigger signal. Frames continue to be sent while the electrical level of the external frame trigger is “High”.
2. The frame start timing is determined by the position of the first pixel of the line internally to the camera. This is controlled automatically in the case of Free Run exposure mode, or by the user in the case of External Trigger exposure mode.
3. When the external frame trigger signal becomes “Low”, frame transmission stops, after the currently transmitting frame has been completed.

Camera control register setting : `FrameTriggerEnable= 1`、`FrameTriggerConfig= 0`



4. While AcquisitionStart is valid, the external frame trigger can be used for control. At this time, set the timeout function of your application appropriately.
5. On AcquisitionStop, packet transmission is stopped.

5.12.2 External Frame Trigger Invert Function Example

Inverts the external frame trigger inside the camera.

Use this function as appropriate to your application.

- register name : FrameTriggerConfig
- setting value : FrameTriggerConfig_Inverter : 0 (False)、
FrameTriggerConfig_Inverter : 1 (True)

(Example) True

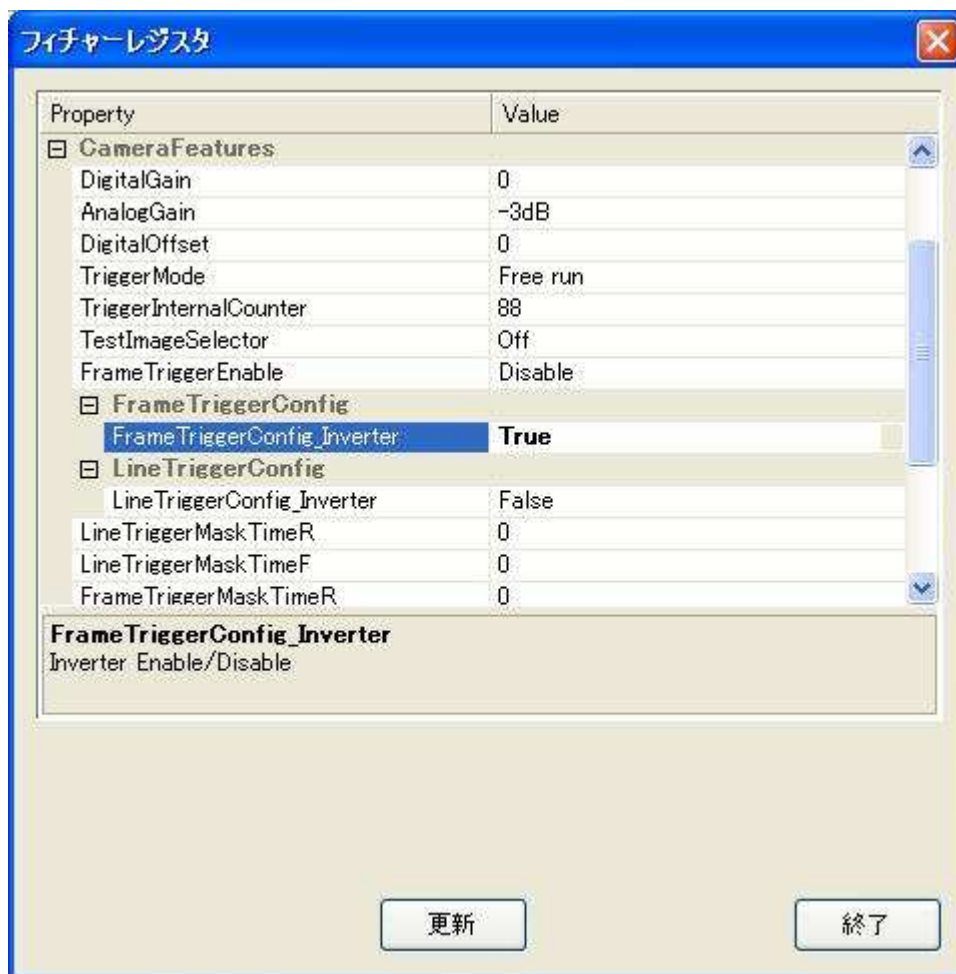
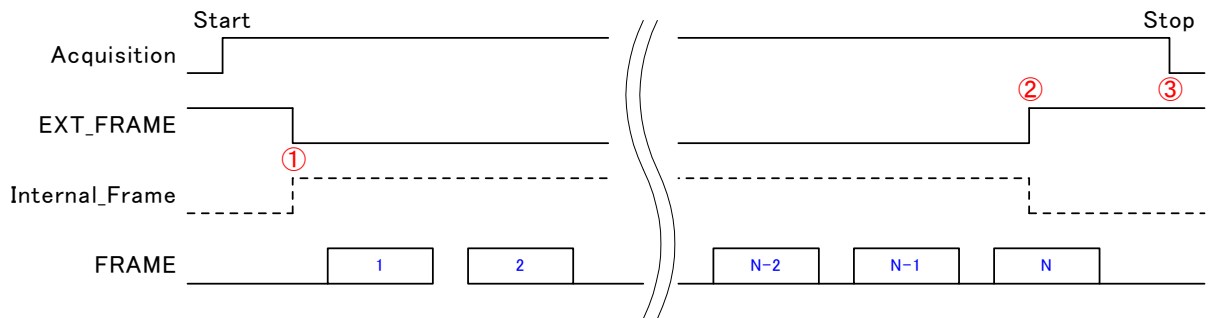


Figure 5-12-1 FrameTriggerEnable register (the GigEGrab picture)

Camera control register setting : `FrameTriggerEnable= 1`、 `FrameTriggerConfig= 1`



1. On AcquisitionStart, the external frame trigger input is inverted inside the camera. Frames continue to be sent while the electrical level of the external frame trigger is “Low”.
2. When the external frame trigger signal becomes “High”, frame transmission stops, after the currently transmitting frame has been completed.
3. On AcquisitionStop, packet data transmission is stopped.

5.12.3 External Frame Trigger Chatter Prevention Function (Rising) Example

Masks the chatter of the rising external frame trigger signal inside the camera.

Use this function as appropriate to your application.

- register name: FrameTriggerMaskTimeR
- setting value : 0 ~ 1000000 (unit: μ s)

(Example)20

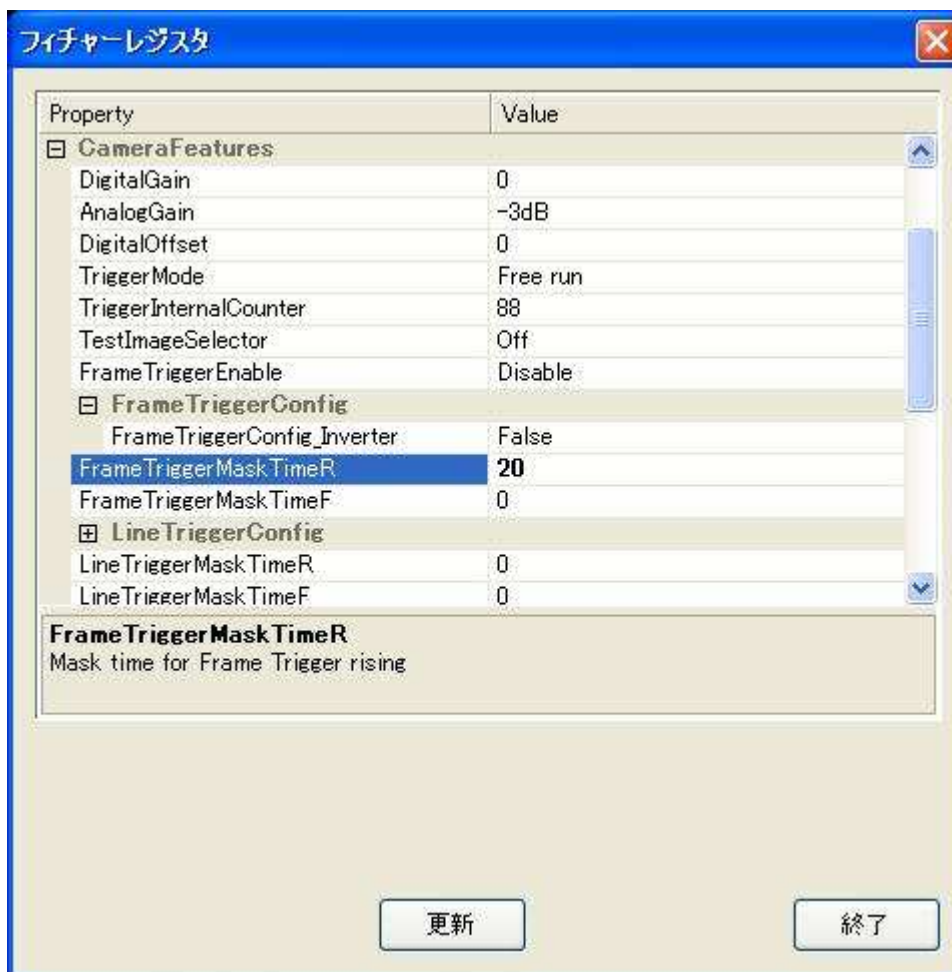
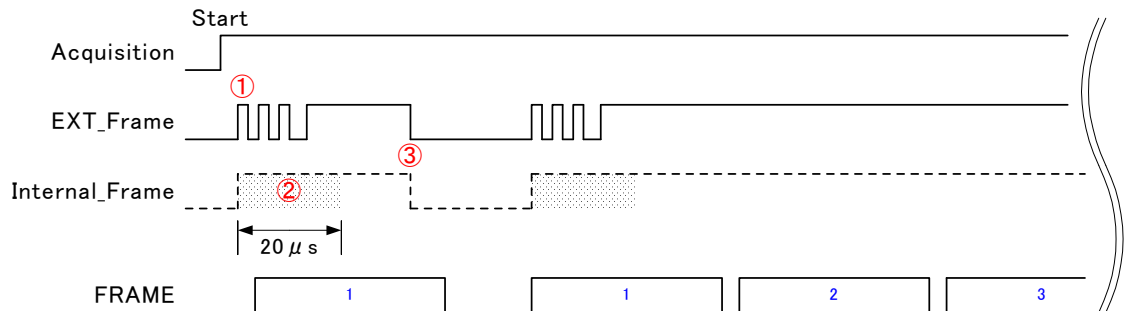


Figure 5-12-3 FrameTriggerMaskTimeR register (the GigEGrab picture)

Camera control register setting : `FrameTriggerEnable= 1`、`FrameTriggerMaskTimeR= 20`



1. The external frame trigger's rising edge is detected and a frame trigger signal is generated inside the camera.
2. During the $20\mu s$ set in the register, signal transitions are ignored (masked)
3. After the set time has elapsed from the rising edge, signal transitions become possible again.

5.12.4 External Frame Trigger Chatter Prevention Function (Falling) Example

Masks the chatter of the falling external frame trigger signal inside the camera.

Use this function as appropriate to your application.

- Register name : FrameTriggerMaskTimeF
- setting value : 0 ~ 1000000 (unit: μ s)

(Example)100

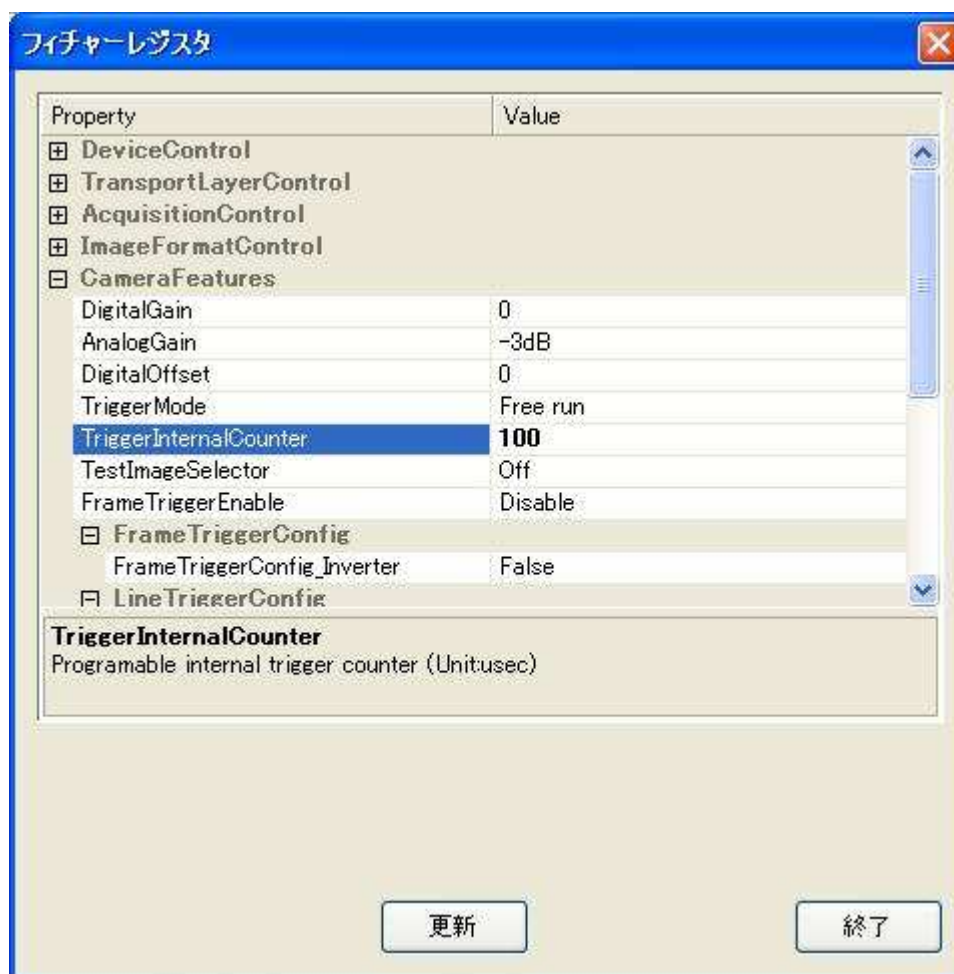
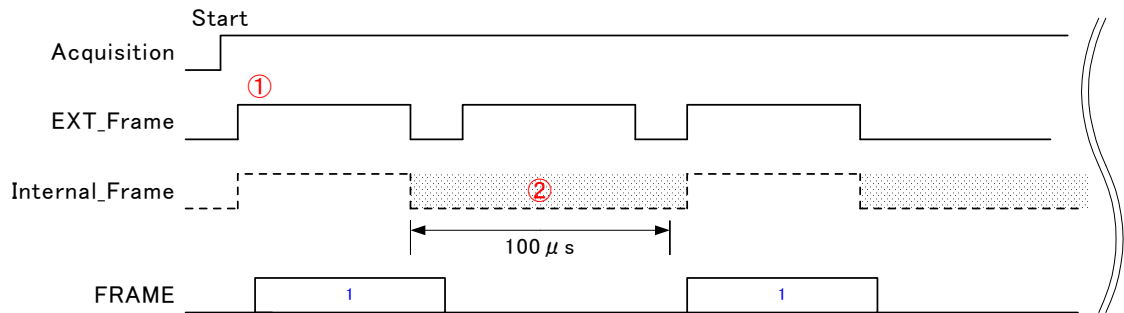


Figure 5-12-4 FrameTriggerMaskTimeF register (the GigEGrab picture)

Camera control register setting : `FrameTriggerEnable= 1`、`FrameTriggerMaskTimeF= 100`



1. The rising edge of the external frame trigger signal is detected, and a frame trigger signal is generated inside the camera.
2. On the falling edge of the external trigger signal, a mask period is generated internally in the camera.
3. During the 100μs set in the register, signal transitions are ignored (masked).

5.13 Test Pattern

The test pattern function allows you to check that data is being transferred correctly from the camera. The test pattern is generated in the FPGA.

The Test Pattern can be output by using the camera control registers.

Setting should be done through the TestImageSelector register (see 5 .1)

Pixels 1 through Pixel 2048 output values incrementing from 0.

5.13.1 Test Pattern Setting Example (Pattern 1)

Switches between Test Pattern and image data output

- register name: TestImageSelector
- setting value : 0(Off),
1(GreyHorizontalRamp),
2(GreyHorizontalRampMovingEachLine)

(Example)GreyHorizontalRamp

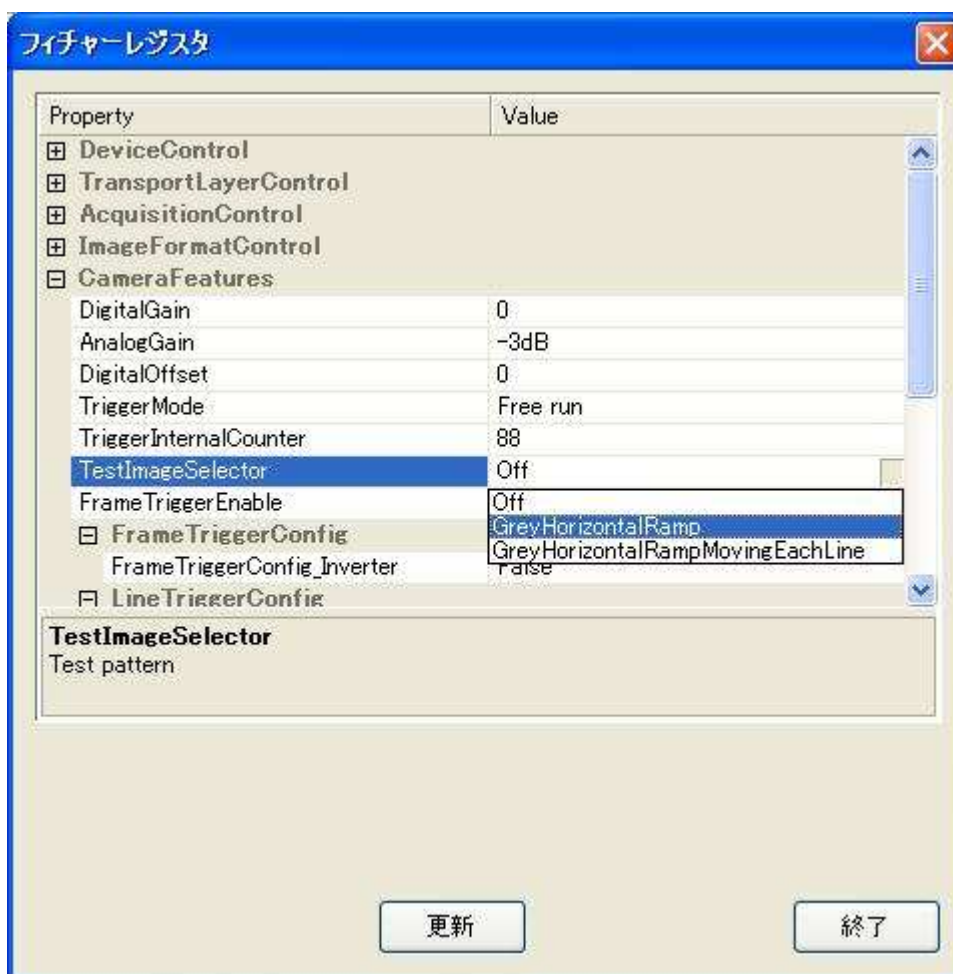
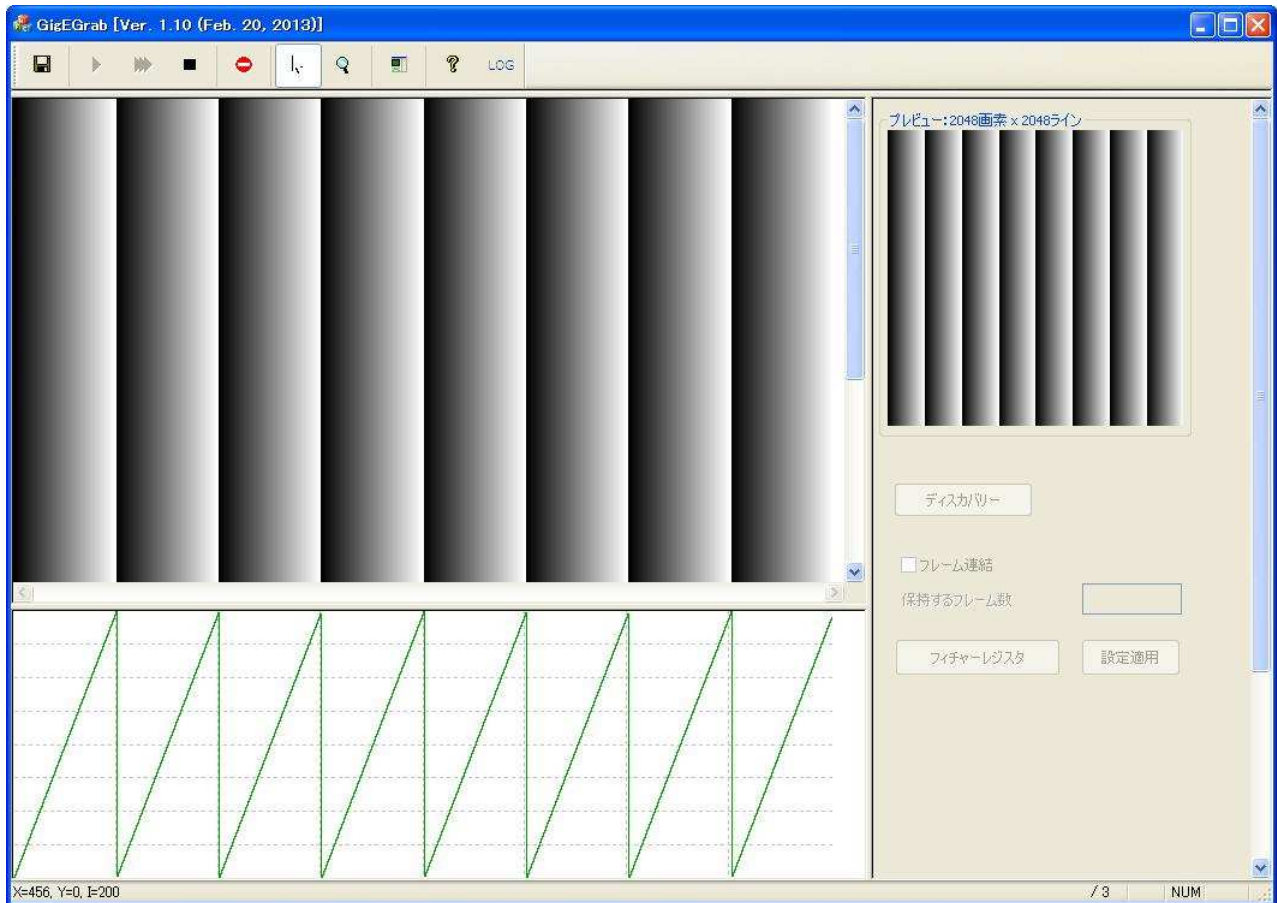


Figure 5-13-1 FrameTriggerMaskTimeF register (the GigEGrab picture)

In 8 bit mode, values from 0 to 255 are output; in 10-bit mode values from 0 to 1023, and in 12-bit mode values from 0 to 2047. The test pattern loop repeats until the last pixel.



- ◆ The Width, Height and OffsetX registers affect the Test Pattern output.
- ◆ The test pattern constantly outputs the same fixed image (pattern).

5.13.2 Test Pattern Setting Example (Pattern 2)

Switches between test pattern and image data output

- register name : TestImageSelector
- setting value : 0(Off),
1(GreyHorizontalRamp),
2(GreyHorizontalRampMovingEachLine)

(Example)GreyHorizontalRampMovingEachLine

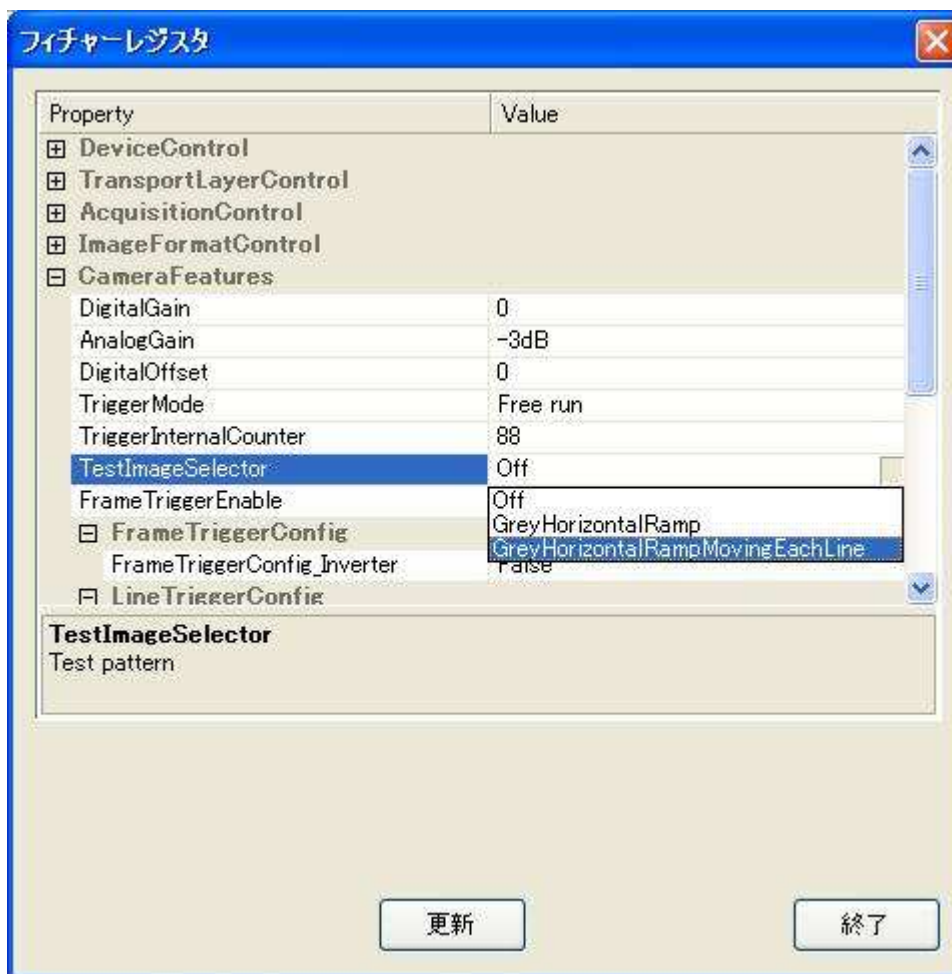
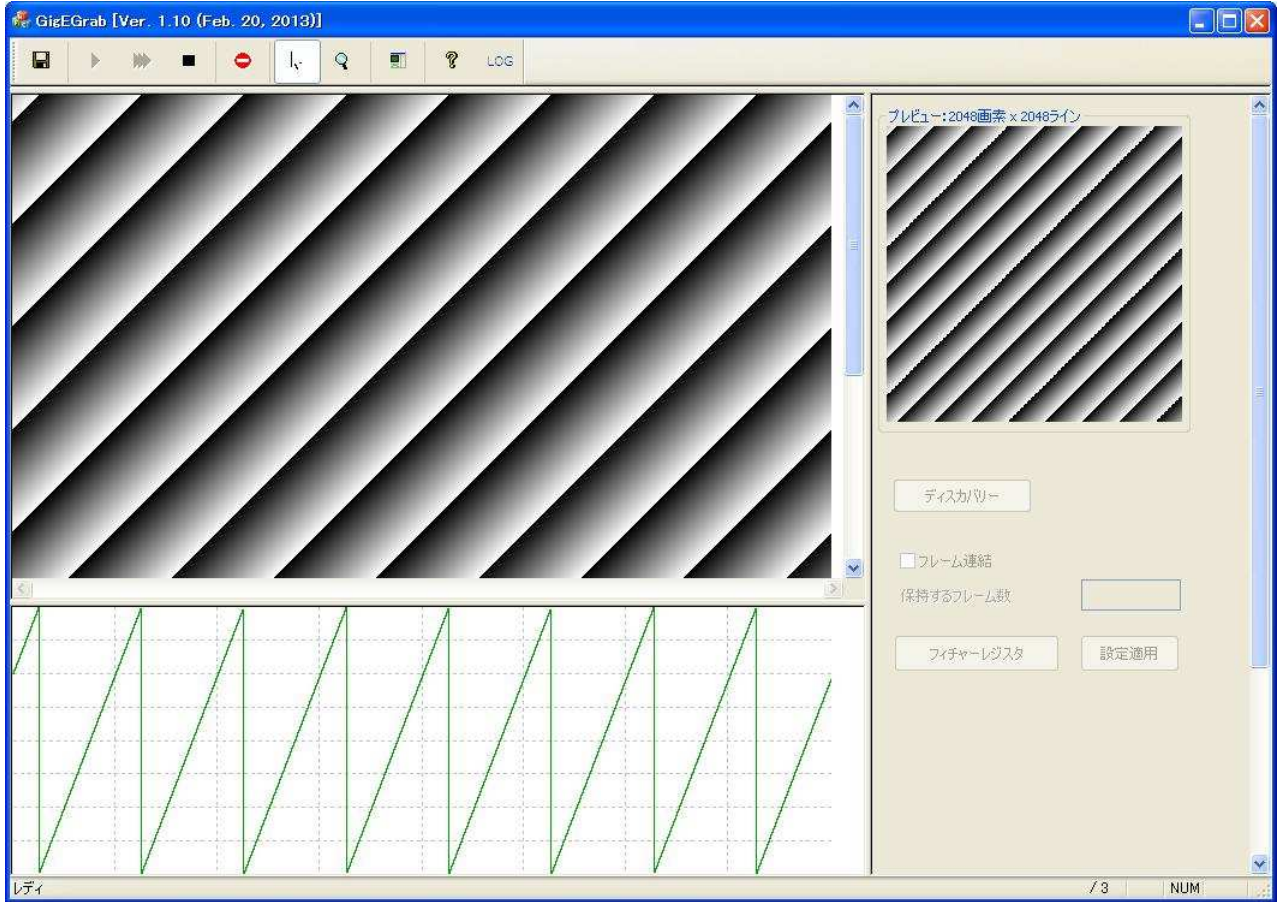


Figure 5-13-2 TestImageSelector register (the GigEGrab picture)

In 8 bit mode, values from 0 to 255 are output; in 10-bit mode values from 0 to 1023, and in 12-bit mode values from 0 to 4095. On each line the value of pixel 0 increases, and the pattern repeats in a loop.



- ◆ The Width, Height and OffsetX registers affect the Test Pattern output.
- ◆ Depending on the Height value, the test pattern may or may not move.
- ◆ In 8-bit mode the pattern is fixed when the Height register value is a multiple of 256.
- ◆ In 10-bit mode the pattern is fixed when the Height register value is a multiple of 1024.
- ◆ In 12-bit mode the pattern is fixed when the Height register value is a multiple of 4096.

5.14 Saving and Loading Camera Settings

The camera setting data is saved in the internal memory (flash memory) and is loaded from the memory when turning on the power supply or loading.

- The number of times the flash memory can be rewritten will vary depending on actual operational conditions. After turning on the power supply, the camera always checks the memory status. If the data is not within the designated range due to a malfunction or other type of trouble, the memory will be automatically rewritten with the factory settings.
- If disconnecting camera power while rewriting the memory, all data saved in the memory will be deleted.

As it takes 5 seconds to rewrite the memory, do not disconnect the power supply before receiving the response from the camera.

Commands for rewriting the memory are as follows.

- Reset to factory settings (UserSet_ResetToFactoryDefault)
 - Save to Memory (UserSet_Save)
 - Load from Memory (UserSet_Load)
- ◆ When changing the camera Exposure Mode setting, be sure to send the control input signal from the Trigger Controller. If you do not send CC1 or send control input signals are out of the designated range, you cannot get images and cannot change the settings. See 5.2 to 5.7.

5.14.1 Memory Contents Saving / Loading Example

- register name : UserSet_ResetToFactoryDefault
UserSet_Save
UserSet_Load
- setting value : 1(Execute)
(Example)UserSet_Save

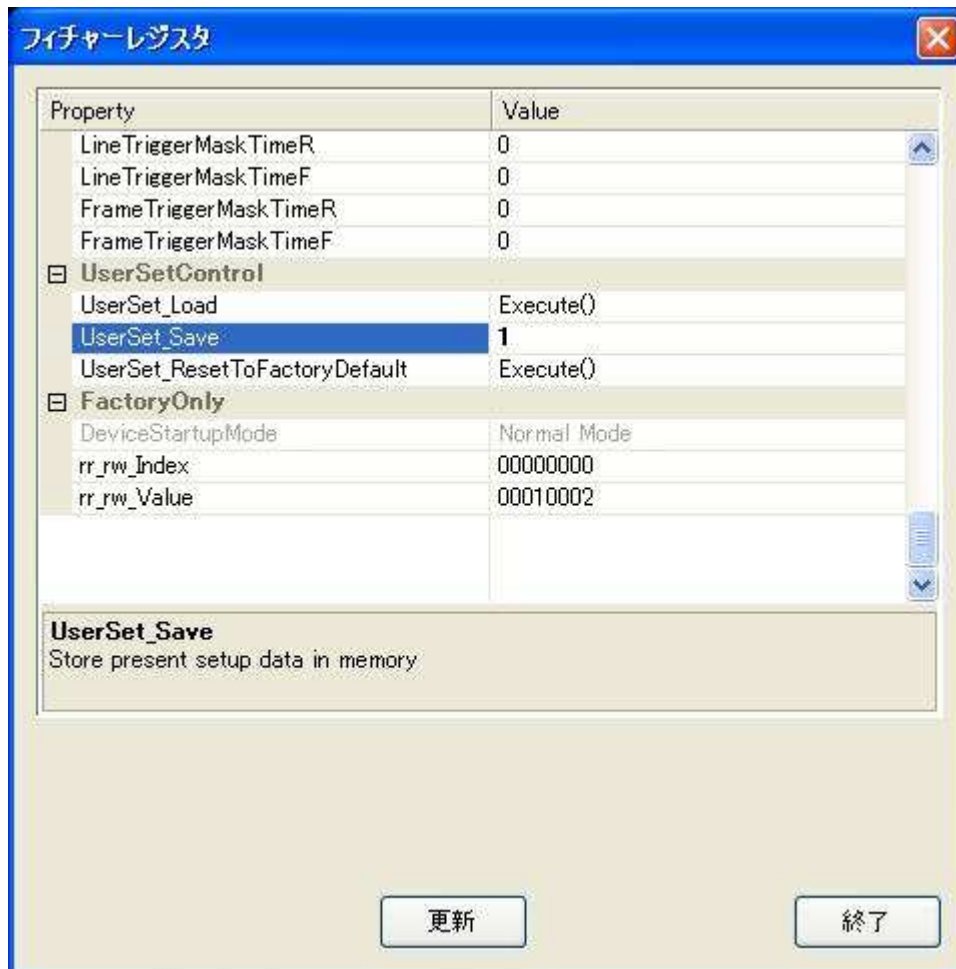


Figure 5-14-1 UserSet_ResetToFactoryDefault register (the GigEGrab picture)

5.15 XML File

The XML file is a file containing the register information listed in Chapter 5, and stored in the camera memory.

When you execute the “Device Discovery” command in your camera control application, the file is automatically read from the camera, and the camera control registers are displayed in the software.

- ◆ However, this function is not present if your camera control software does not support Gen<i>Cam.

6 Packet Size and Packet Delay

6.1 Packet Size

Packet size can be changed via the GevSCPSPacketSize camera register.

- register name : GevSCPSPacketSize
- setting value : 512 ~ 9152 *

(Example)4000

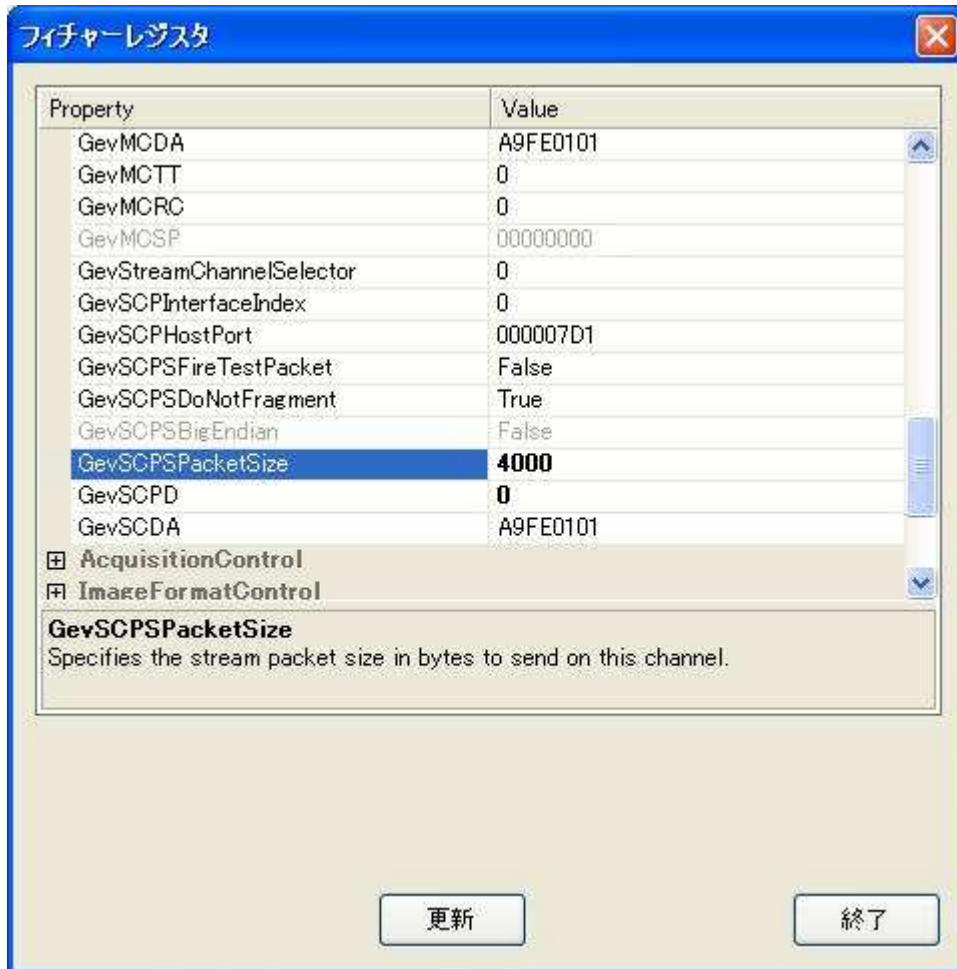


Figure 6-1 GevSCPSPacketSize register (the GigEGrab picture)

* Caution

Set a value appropriate to your usage environment.

The set value should be a multiple of 4.

Do not set a value higher than the MTU of your computer or NIC.

In this case, image data will not be transferred correctly.

For NIC settings, see the Setup Guide on the enclosed CD-ROM.

6.2 Packet Delay

Packet delay can be set via the GevSCPD camera control register.

- register name : GevSCPD
- setting value : 0 ~ 4294967295*

(Example) 100

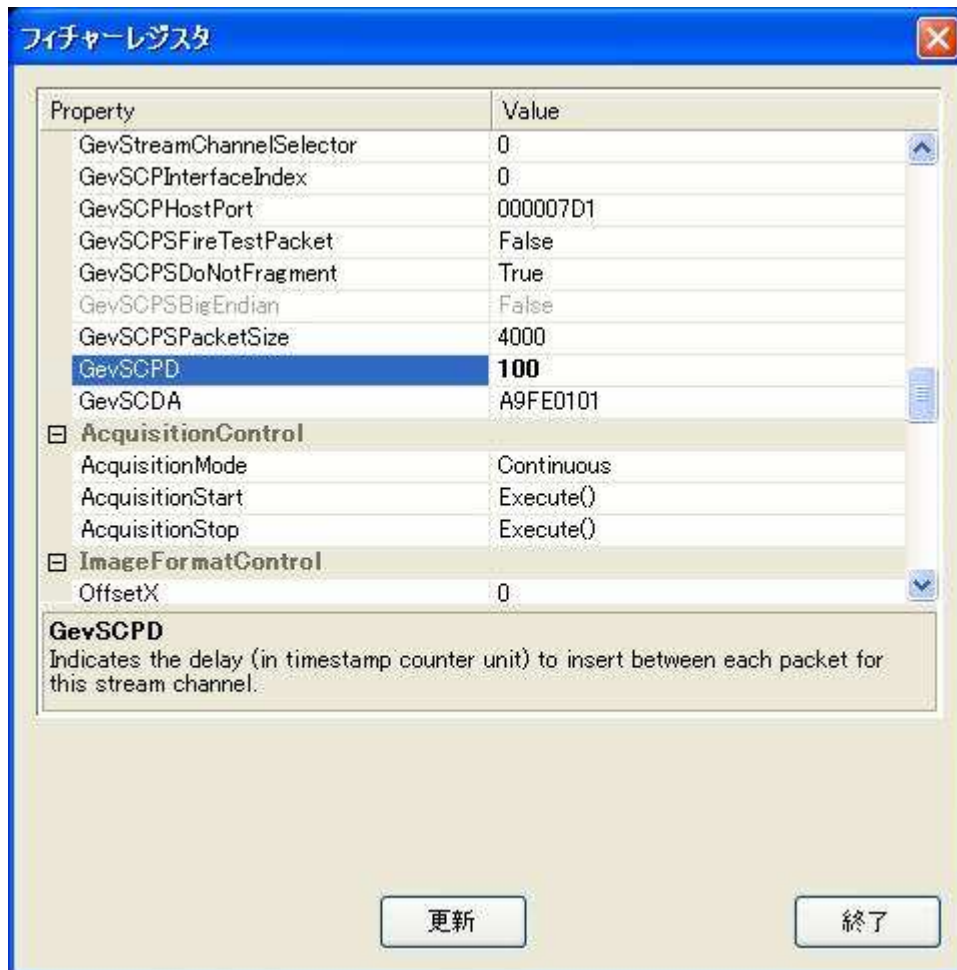


Figure 6-2 GevSCPD register (the GigEGrab picture)

*Caution

Set a value appropriate to your usage environment.

Packet Delay is set to 0 at the time of shipping, however it should be set to achieve stable capture set it to as large a value as possible.

On the other hand, if the value is too large, the frame rate will drop. See 6.3 “Calculating the maximum value of packet delay” and set to a suitable value.

Furthermore, set the TimeOut setting in your application to an appropriate value.

6.3 Calculating the Maximum Value of Packet Delay

The maximum value for the packet delay setting can be calculated as below. In order to avoid dropped frames, packet delay should not be set greater than this maximum value.

1. Calculate the time for the CCD to scan 1 frame

Height x scan period of 1 line

2. Calculate the data rate

$(\text{Width} \times \text{Height}) \div \text{scan period of 1 frame} \div (1000 \times 1000) \times \text{PixelByte}$

3. Calculate the maximum packet delay

$((\text{Maximum Data Rate} - \text{Data Rate}) \times (1000 \times 1000)) \times \text{Packet Size Set Value} \div (\text{Data Rate} \times 1000 \times 1000)$

- Pixel Clock: 25MHz (40ns)
- 1 pixel bytes: PixelFormat register value
1Byte(Mono8) 2Byte(Mono10/Mono12)
- 1 line no. of pixels: Width register value
- 1 frame no. of lines: Height register value
- Scan period: The user-set scan period
(In free run mode, TriggerInternalCounter register value)
- Packet Size: GevSCPSPacketSize register value
- Maximum data rate: 120MB/s

Example Calculation

Values used in the example below:

Mono8 Width=2048 Height=2048 Scan Period 88us GevSCPSPacketSize=4000

Calculation 1 ex.: $2048 \text{ Line} \times 88000 \text{ ns} = 180,224,000 \text{ ns} \approx 0.18 \text{ s}$

Calculation 2 ex.: $(2048 \times 2048) \div 0.18 \text{ s} \div 1000000 \times 1 \text{ Byte} = 23.3 \text{ MB/s}$

Calculation 3 ex.: $((120 \text{ MB/s} - 23.3 \text{ MB/s}) \times 1000000) \times 4000 \div (23.3 \text{ MB/s} \times 1000000) = 16600$

In addition, the frame rate can be calculated by the below formula. Please confirm that the frame rate matches with your actual frame rate when capturing image data in your usage environment.

If the frame rate displayed in your viewer software is lower than the calculated frame rate, alter your settings, eg. By reducing the packet delay value.

4. Frame Rate Calculation

$1 \text{ sec} \div \text{time for CCD to scan 1 frame}$

Calculation 4 ex.: $1 \div 0.18 \text{ s} = 5.5 \text{ fps}$

* Under some usage environments, even when the packet delay value is within the maximum value, the frame rate may be less than the calculated value. In this case, adjust the packet delay value.

7 Tips for optimal use of GigE Vision® cameras

- If there is even a 1 device on the network operating at a different transfer speed, such as 100base etc., the network transfer rate will automatically adjust to it, so the speeds at which GigE Vision is designed to operate can not be attained.
- It is not recommended to connect any further devices other than the camera to a single port. In order to obtain the most stable image capture, it is recommended to use a dedicated Ethernet port.
- The safest setup is to use one camera per port. In a setup using a switching hub to connect multiple cameras to one port, data transmission bandwidth may be insufficient, resulting in errors in the transmission of image data.
- It is recommended to use a NIC which supports Jumbo Frames.
- In order to capture images stably, a certain level of performance is required from the host PC. Check that your PC has sufficient performance.
- Your PC's firewall or security software settings may block image acquisition.
- The quality of the LAN cable you use can affect the data transmission bandwidth. In addition, noise depends on the category used. In general, the higher the category, the lower the noise.
- Set the packet delay to an appropriate value for your usage environment. It is recommended to use a value other than 0 to obtain stable image data.

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8 Sensor Handling Instructions

8.1 Electrostatic Discharge and the Sensor

CCD sensors are susceptible to damage from electrostatic discharge and can deteriorate as a result. Take care when handling the sensor.

8.2 Protecting Against Dust, Oil and Scratches

The CCD sensor window is part of the optical path and should be handled like other optical components with care. If you use the camera in a dusty area, prepare a dust-proof enclosure. Dust can obscure pixels, producing dark lines on the image.

8.3 Cleaning the Sensor Window

Dust: Can usually be removed by blowing the window surface using a compressed air blower.

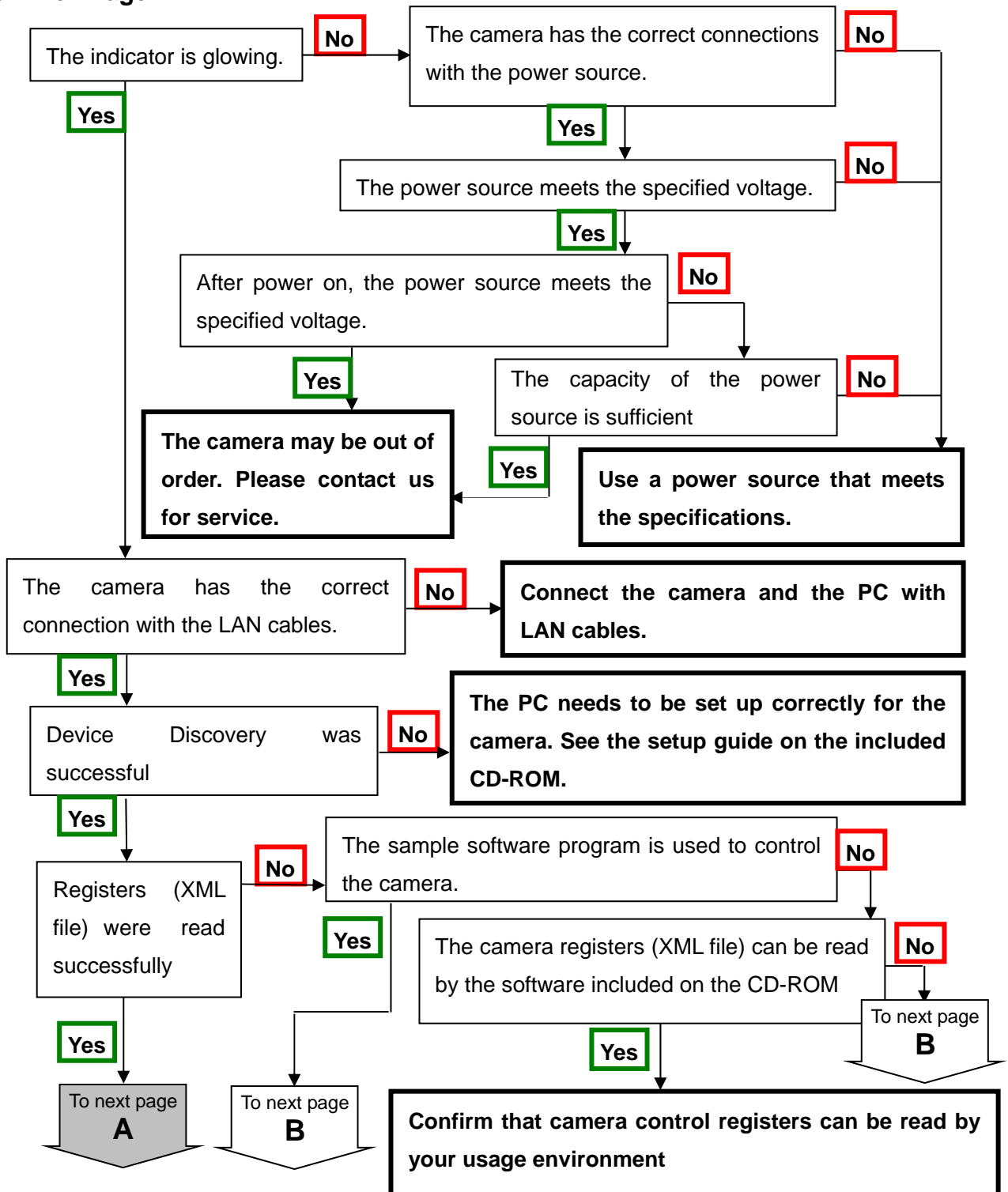
Oil: Wipe the window with a lint-free cloth wiper moistened with ethyl alcohol carefully and slowly.

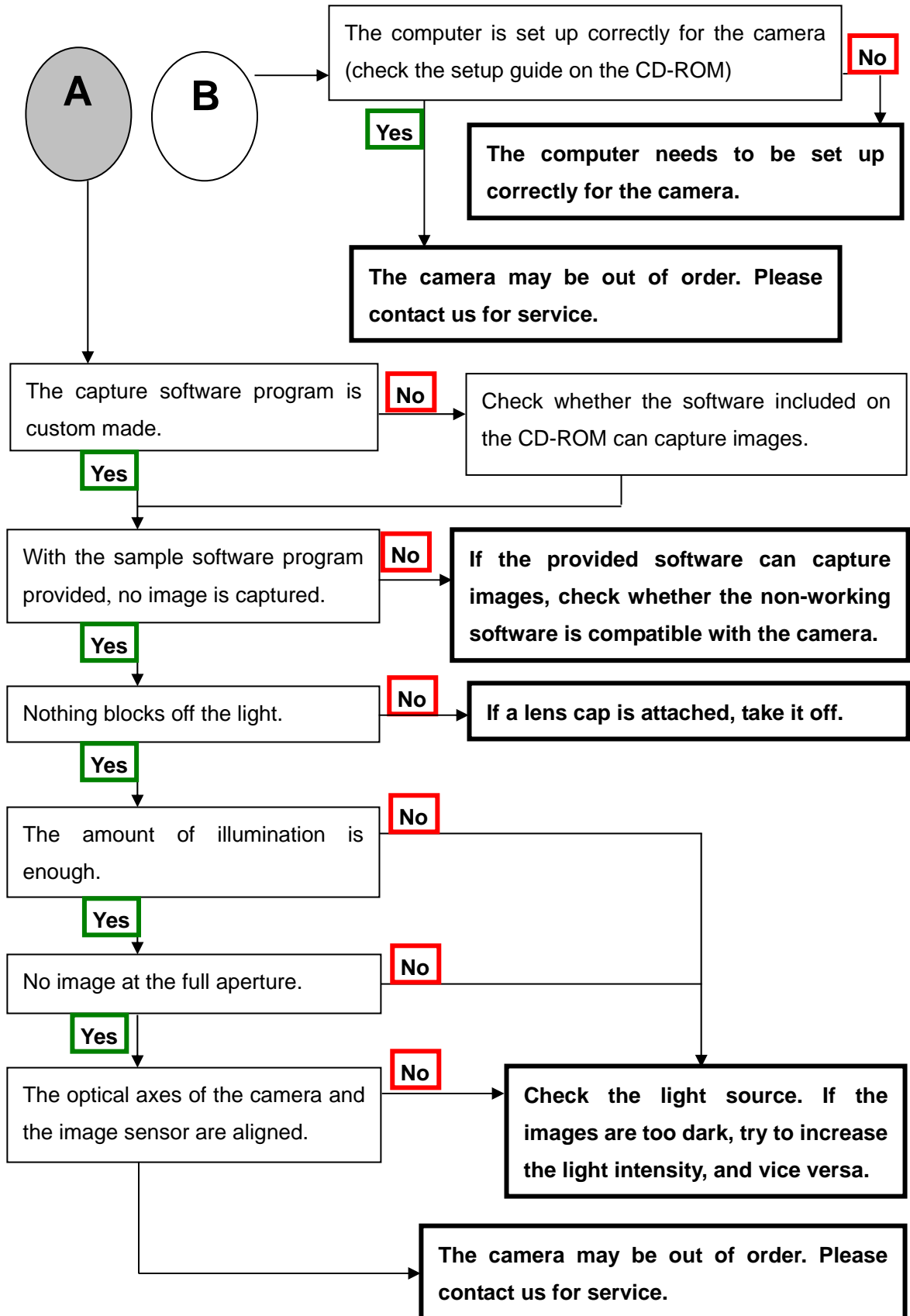
When there is dust or smudges on the sensor window, it appears in the same way as noise on the image. Please remove it appropriately.

9 Troubleshooting

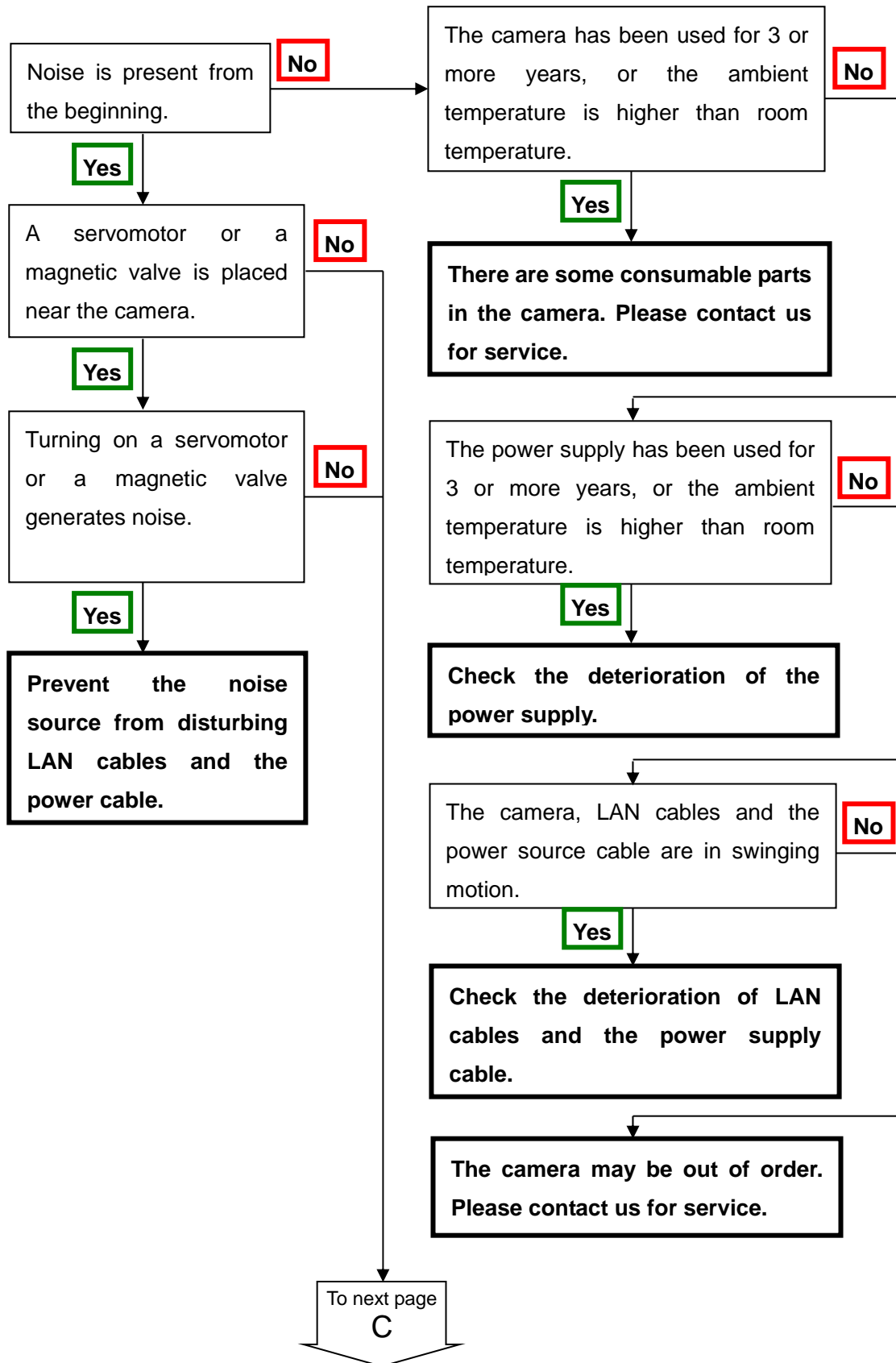
The following pages contain several troubleshooting charts that can help you find the cause of problems users sometimes encounter.

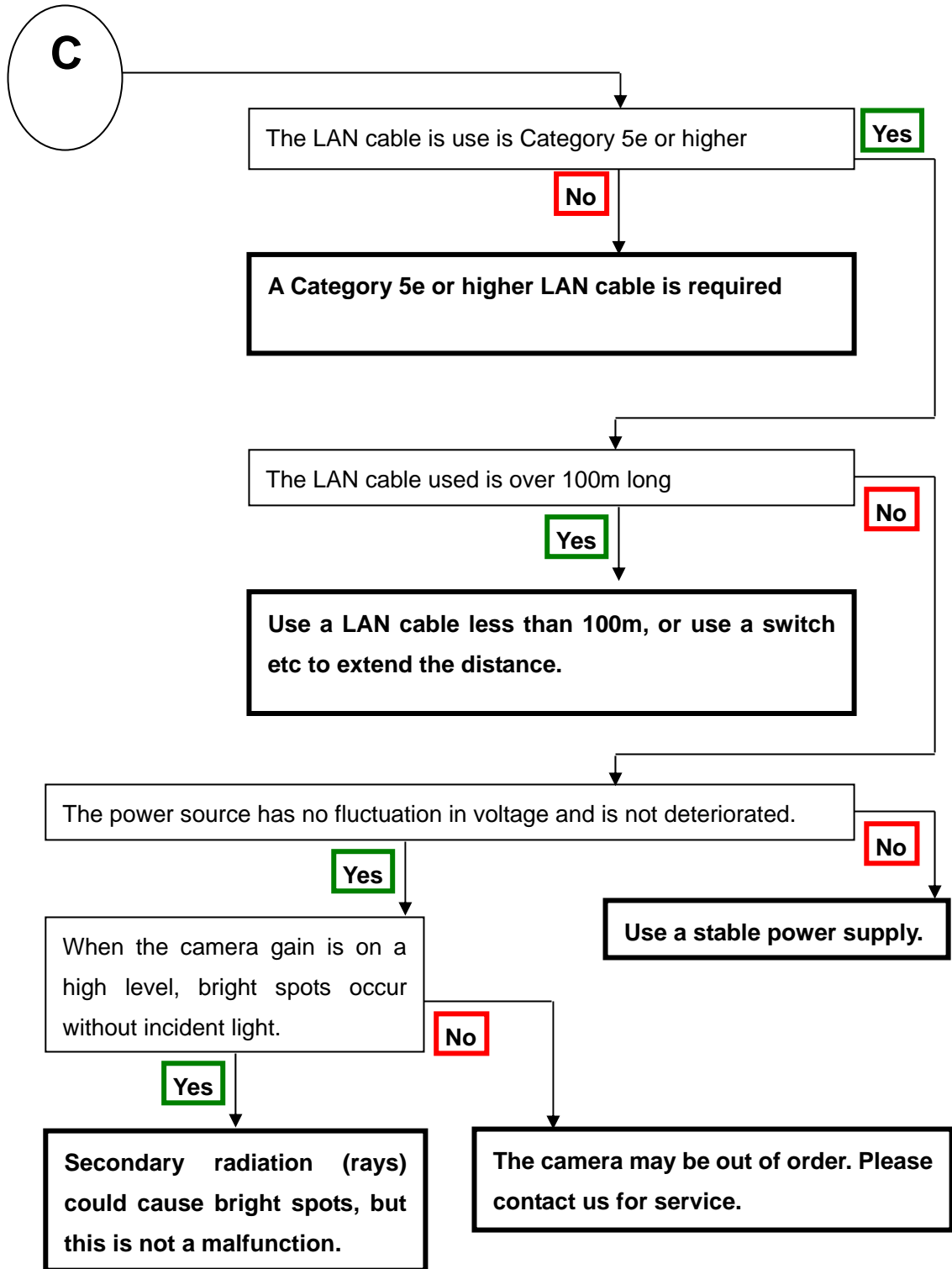
9.1 No Image



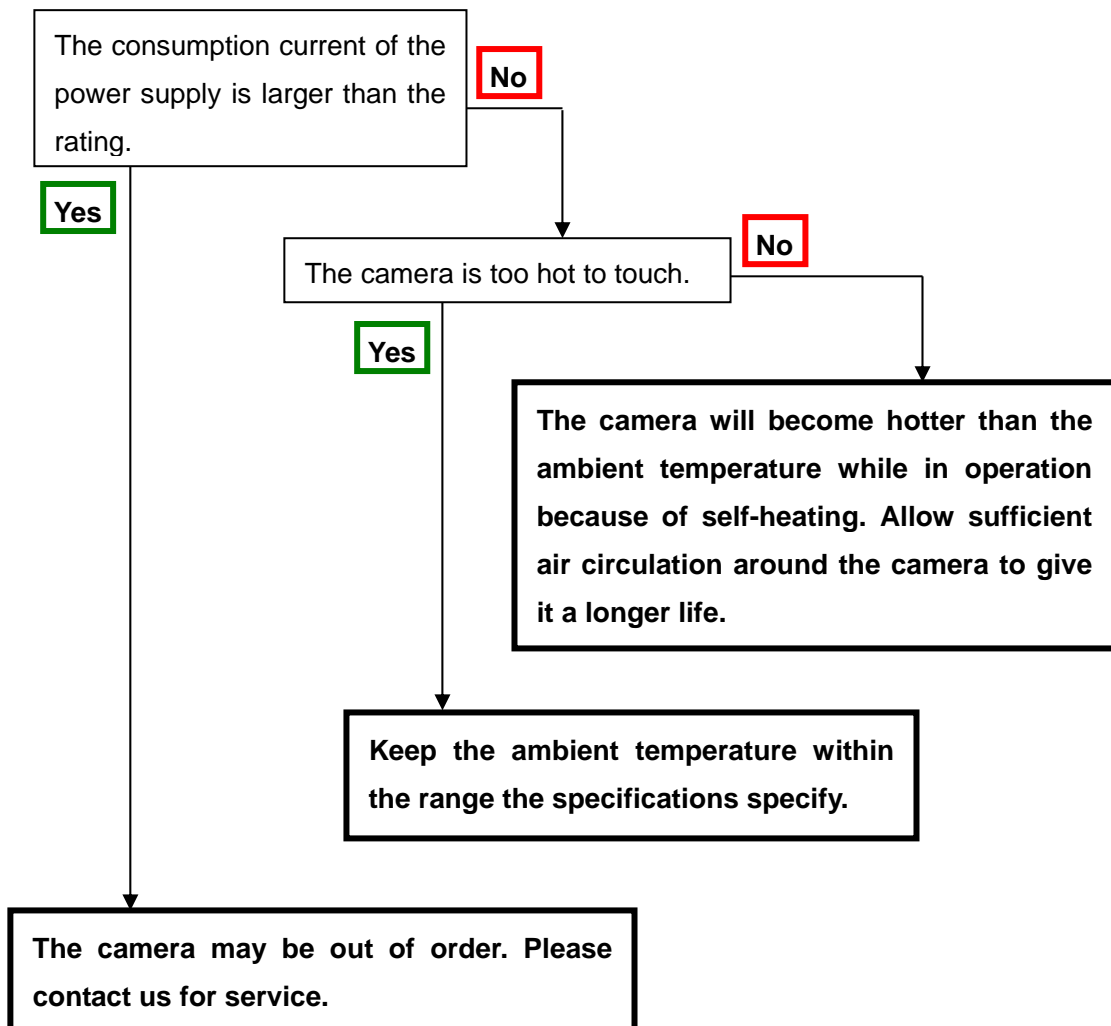


9.2 Noise on Image





9.3 Camera becomes hot



10 Others

10.1 Notice

- No part of this document may be reproduced in any form, in whole or in part, without the express written consent of NED.
- The contents of this document are subject to change without prior notice.
- Every care has been taken in the preparation of this User's Manual. If you should discover any errors or omissions, please notify your nearest NED representative.

10.2 Contact for support

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Fax +81-3-5718-0331

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Hamamatsu Technical Centre

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Hamamatsu 432-8003, Japan

Phone +81-53-475-0520

Fax +81-53-475-0525

URL

<http://ned-sensor.co.jp/en>

E-Mail

sales@ned-sensor.com

10.3 Product Support

If there is a problem with your camera after checking it in accordance to the troubleshooting, turn off the power and call your NED representative.

When contacting us with a problem, please inform us of the status of the camera.

Revision History

Revision Number	Date	Changes
01	30 Aug. 2013	Initial release
02	9 Nov. 2013	DigitalOffset Value