User's Manual

Line Scan Camera

Type: XCM1040DLCT3

NIPPON ELECTRO-SENSORY DEVICES CORPORATION

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.

◆ Sensitivity may fluctuate depending on the spectral response level of the light source. In cases like this, changing the light source to one with a different spectral response level may reduce this problem. Moreover, this irregular sensitivity can be completely cleared by using 4.11 pixel correction function. Refer to 4.11 pixel correction function for details.

◆ Please note that when the sensor is exposed to excessive quantities of light, blooming can occur. (This product does not have an Anti-Blooming function.)

◆ If the sensor is continually exposed to bright light which would exceed the sensor saturation for a long time, the colour fillter may become faded. As far as possible, the sensor should be protected from light except when in use.

◆ 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 an embedded memory.

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.

Table of Contents

1 Product Outline

1.1 Features

- High readout of RGB output data.
- Color line scan camera with 7µm 2048 x 2 pixels sensor of Bayer color arrangement
- RGB output data of 1024 pixels from 8bit-3tap
- Camera Link Base Configuration (8bit / 3 tap) video output
- Easy control of gain / offset / gamma exchange with software outside the camera.
- Easy connection with a variety of frame grabber boards via Camera Link interface
- Single power source DC 12V to 15V for operation
- PRNU / Shading correcting function
- The camera comes with a C-Mount, but an F-Mount can be chosen as an option.

1.2 Application

- Inspection of Transparent panels and PCBs
- Flat panel display inspection
- Inspection of glass and sheet-like objects
- Inspection of high speed moving objects
- This camera utilizes an Intelligent Transportation System
- Outdoor surveillance

An example of Visual Inspection of PCBs is shown below.
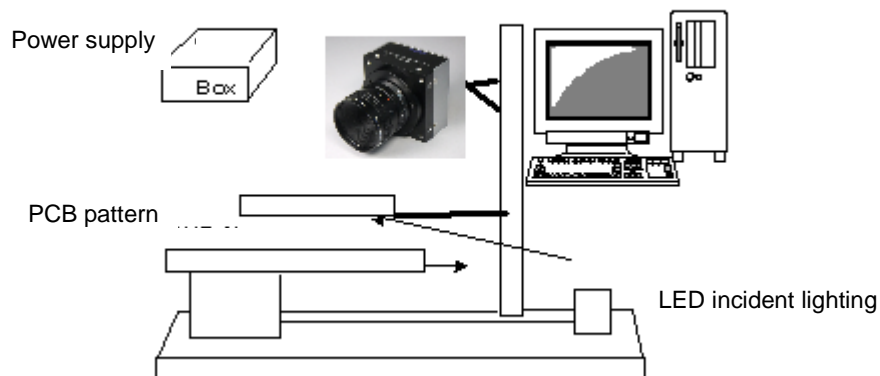
Figure 1-2-1   Visual Inspection of PCBs

Applicable Work

COB, BGA and MCM printed circuit boards

Unit Configuration

1. Camera: Line scan camera

2. Controller: Dedicated software for PC system

Applicable Fields

Inspection of patterns on film PCBs

1.3 Image Sensor

The camera uses a CMOS sensor with a maximum data rate of 40MHz and 2048pixels Bayer color arrangement to acquire high responsivity and superior quality images.

The sensor has pixels of 7µmx7µm in size and dual lines

The RGB output data of 1024 pixels comes from 40MHz-3tap.

The color filters for Bayer color arrangement are used on the pixels of sensor as follows.
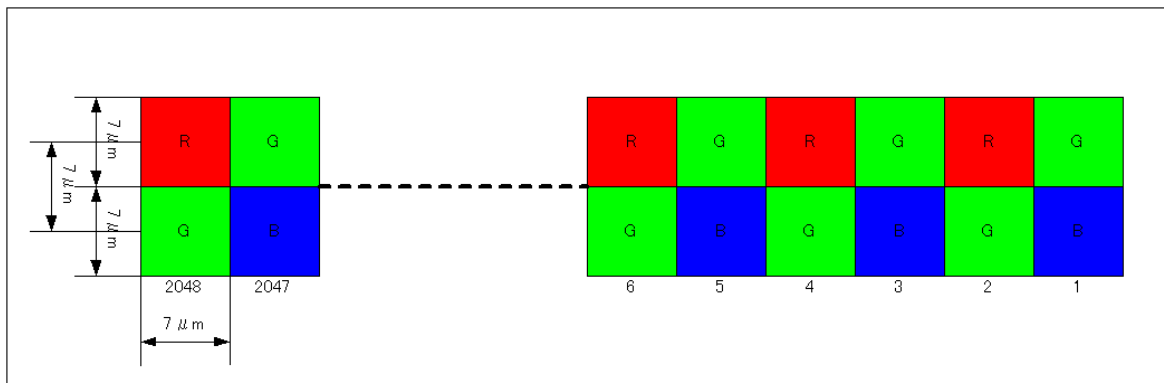
1.4 Performance Specifications

The Performance Specifications are shown in Table 1-4-1. It shows the data when the camera is operating at maximum scan rate, unless otherwise specified.

Table 1-4-1   Performance Specifications

Items		Specifications
Number of Pixels		1024
Pixel Size H x V (μm)		14 x 14 binning
Sensor Length (mm)		14.336
Data Rate (MHz)		40
Max. Scan rate [kHz]/ Min. Scan period (μs)		35.84/27.90
Responsivity (V/[lx・s]) (typically) [Minimum Gain, Pixel Correction Initial Value]		60 ＊Daylight Fluorescent Light ＊Analog 5V Conversion Sensitivity
Analog Gain Adjustable Range (RGB common)		Analog Amplifier：x 1 to x 9.7(7 Steps)
Digital Gain Adjustable Range (RGB common)		Digital：x 1 to x 2(512 Steps)
Digital Gain Adjustable Range (RGB individual)		Digital：x 1 to x 3(1023 Steps)
Digital Offset Adjustable Range (RGB common)		-22 to 22 (DN / Step)
Digital Offset Adjustable Range (RGB individual)		-10 to 10 (DN / Step)
FPN (Fixed Pattern Noise)		Typically 5%(without correction, at minimum gain) 2%(with correction, at minimum gain)
PRNU (Photo Response Non Uniformity)		Typically 8% (without correction, at minimum gain) 4%(with correction, at minimum gain)
Random Noise		Typically 17DN (peak value at minimum gain)
Video output		Camera Link Base Configuration (8bit / 3 tap)
Control Input		CC1: External Trigger Signal, CC2-4: Not in use
Connectors	Data/Controller	3M: MDR26 [Camera Link]

	Power Supply	Hirose: HR10A (6Pin)
Lens Mount		Standard: C Mount (Option: F Mount)
Operating Temperature (˚C) No Condensation		0 to 50
Power Supply Voltage (V)		DC 12 to 15 [+/-5%]
Consumption Current (mA) (typically)		150 (DC12V)
Size W x H x D (mm)		60x60x35
Mass (g) (Camera only)		Approx.170
Additional Function		1. Shading Correction 2. Auto White Balance 3. Test Pattern Output On / Off 4. Programmable Exposure Control 5. Scan Direction Switching 6. RGB Color Matrix Transforming 7. Gamma Transforming

Note:

*1) DN : Digital Number (8bit : 0-255)

*2) Measurements were made at room temperature.

The spectral responsivity is shown below.

Quantum efficiency
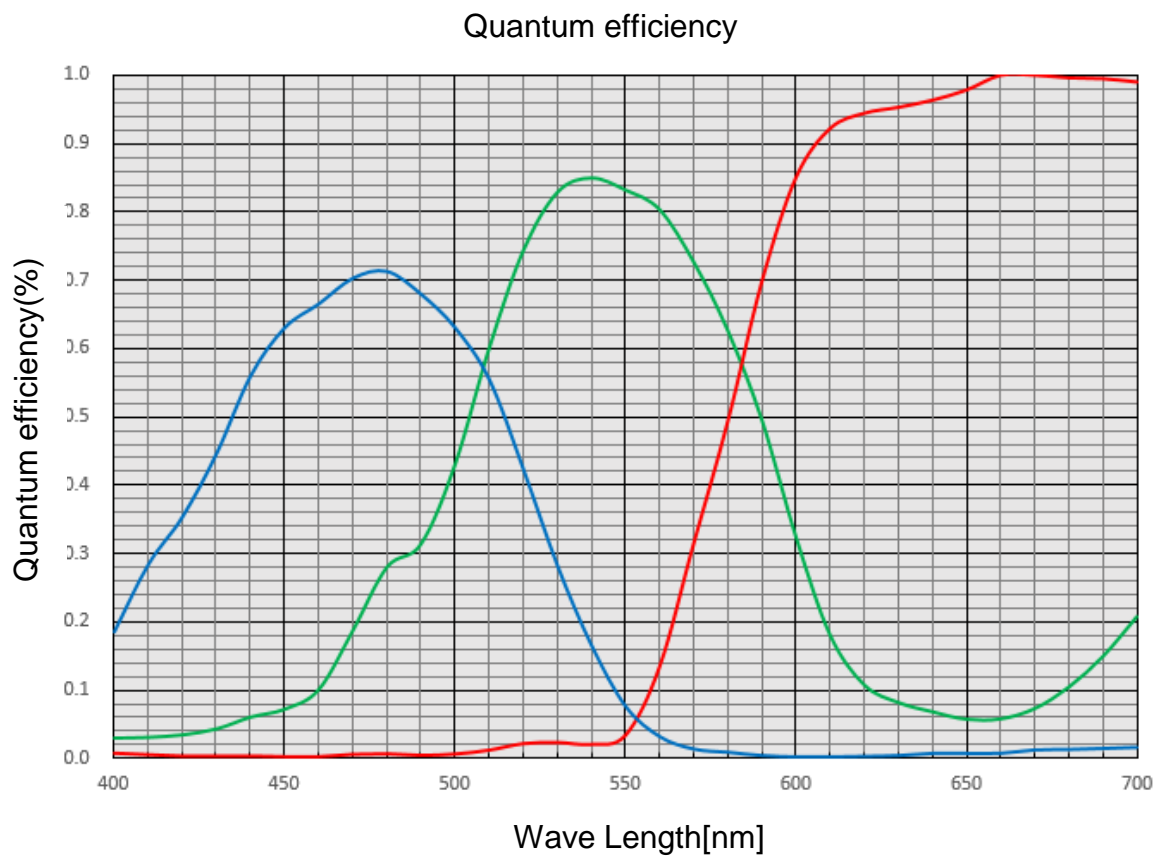
Figure 1-4-1 Spectral Responsivity

2 Camera Setting and Optical Interface

2.1 Setting the Camera

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

2.2 Fixing the Camera

Use the M4 screw holes (4 at the front, 8 at the side) to set the camera.

Or use the 1/4"-20UNC screw hole for a tripod (1 place at the side).

If using the front panel M4 mounting holes (4 places at the front, 8 places at the side), the screw length for fixing the camera should be less than 8mm at the front and less than 6mm at the side.

No X-, Y-axis orientation and tilt adjustment mechanism is available. Please prepare an adjustment mechanism if required.

The dimensions of the camera are shown below.
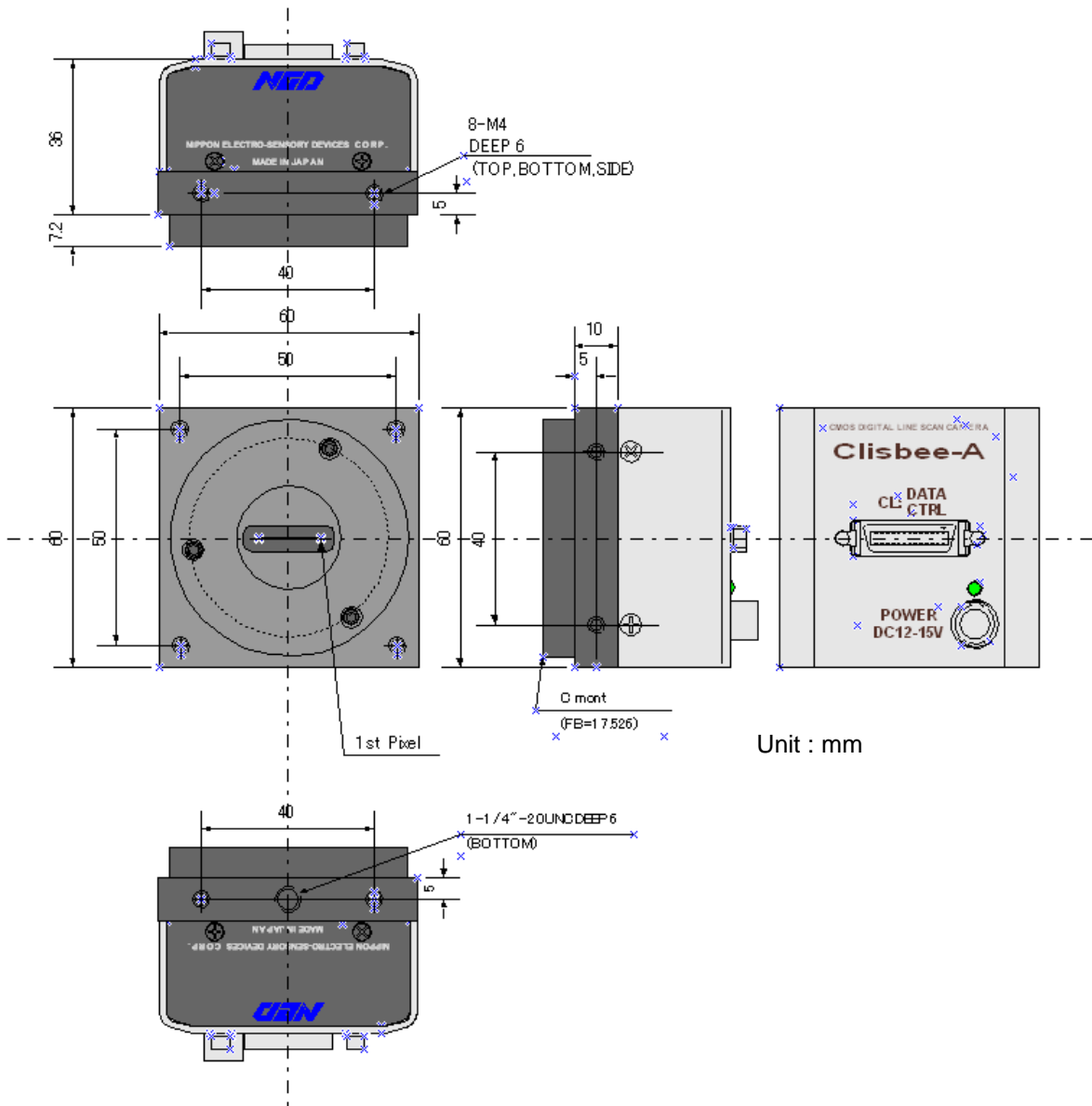
Figure 2-2-1 Dimensions of the Camera

2.3 Optical Interface

The XCM1040DLCT3 comes with a C-Mount as standard, but an F-Mount can be chosen as an option.

1) Quantities of light and the wavelength etc. of a source of light necessary to take the image for which the customer hopes are different according to the usage. The factor to decide these contains physical properties, the speed, the spectrum characteristic of the object taken a picture of, the exposure time, and the characteristic of the source of light and the specification etc. of the taking system.

It is a luminous exposure (exposure time × quantities of light) that it is important because an appropriate image is obtained. Please decide the exposure time and quantities of light after examining which element the customer values enough.

2) 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 light but have high infrared light (IR) proportions.
- 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.

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

CMOS 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 cut off filter that does not transmit wavelengths.

2.4 Calibration with User White Pixel Correction Function

This camera is set to the optimal pixel correction with a daylight fluorescent lamp
(NEC FL20SD) before shipping.

Light sources and lens shading can cause non-uniformity.

Calibrate the camera with a user white pixel correction function to cope with lens
shading and non-uniform illumination by following below steps.

    1) Set the lens and light source which you want to use.

    2) Set the pixel correction mode to "Factory White" by choosing the mode on
       "Intelligence" tab of the remote control software "CLISBeeCtrl".

    3) Set the exposure time and the gain to about 200DN on Signal level.

    4) Click the "Calib White" button of "Intelligence" tab, or send the "wht" command.

    5) Change the pixel correction mode to "User White", or send the "shc 1, 200"
      command.

This calibration can improve the white balance and the waveform flatness of
the camera signal.

See below for more details.

      4.1.4 Camera Control Commands

      4.1.5 Memory Setup Values (Factory Settings)

      4.2.21 White Pixel Correction Data Save

      4.2.23 Setting Pixel Correction

      4.11 Pixel Correction

      4.11.1 Command Settings

      4.11.2 How to correct

The waveforms at the calibration processing are shown as an example of
this explanation when you use 3-wavelength fluorescent lamp with this camera.

(1) Waveforms using daylight fluorescent lamp

The waveform using daylight fluorescent lamp NEC FL20SD with
this camera is flat after adjusting white balance at Factory.
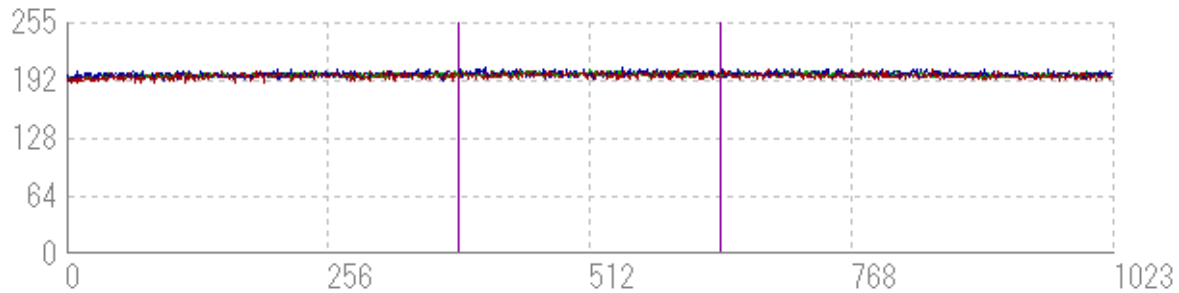
(2) Waveforms using 3-wavelength fluorescent lamp

The waveforms using 3-wavelength fluorescent lamp with this camera
at Factory white mode are shown below.
The white balance collapses, and undulations are shown on waveform at both
ends.
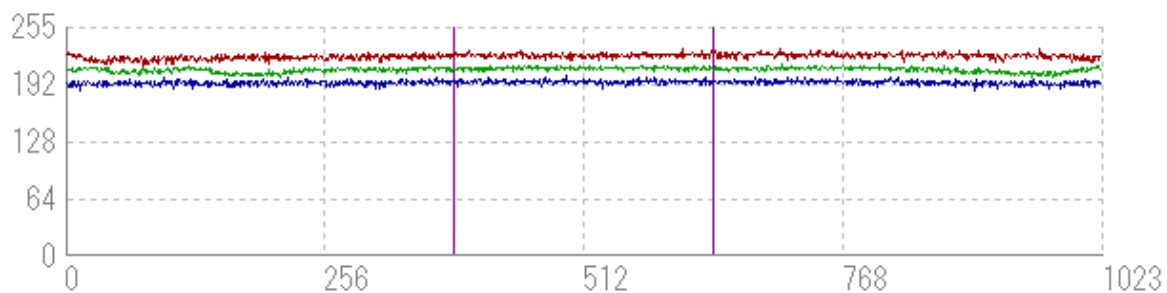
(3) Waveforms using 3-wavelength fluorescent lamp

The waveforms using 3-wavelength fluorescent lamp with this camera
are flat after adjusting white balance with User white mode.
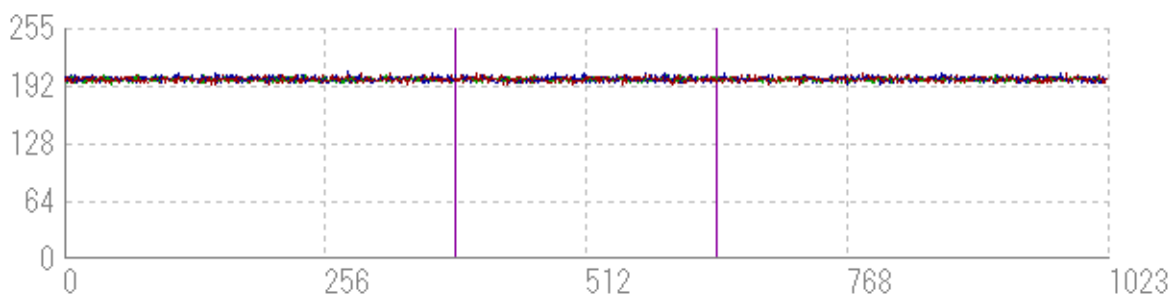
2.5 Pixel position of light receiving part

The datum levels of the front panel are shown in red dotted lines as follows.
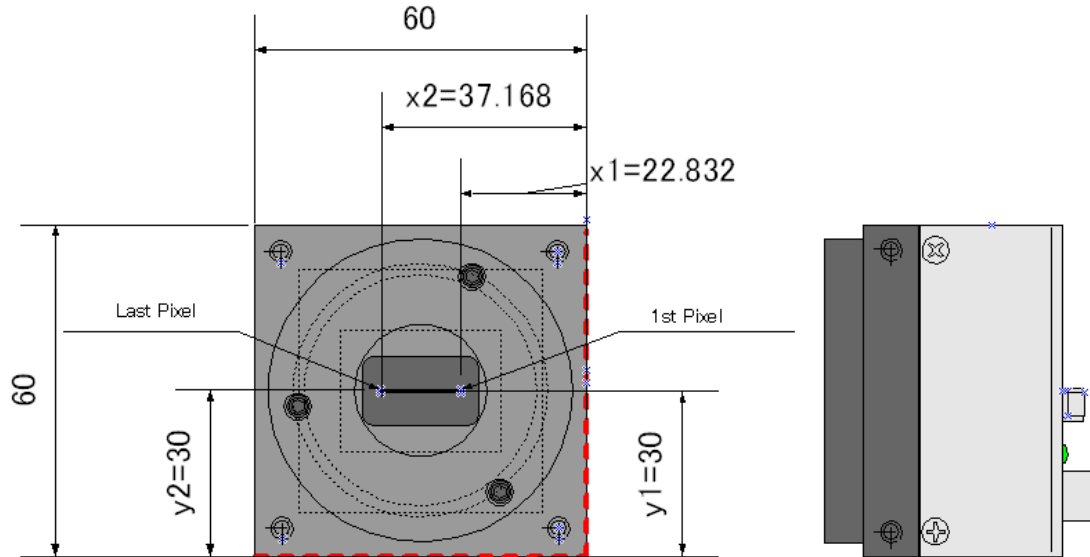
Figure 2-5-1 Pixel position (unit=mm)

1st pixel's position is (x1,y1) and the last pixel's position is (x2,y2).

The pair (a,b) of numbers are shown as a point in the plane, given by x- and y- coordinates.

The 1st pixel target position is (22.832,30) and the last pixel target position is (37.168,30).

The deviation from the target pixel slope line is shown in the following table, as a result of having measured ten randomly selected samples.

* The target pixel slope line links the 1st pixel position to the last pixel position and θ shows the degree of leaning of target pixel slope line.

Table 2-5-1 The measured data of the pixel position

	The measured data (of 10 samples)
x1,x2	±0.2mm
y1,y2	±0.2mm
θ	±1.0°

3 Hardware

3.1 Camera Connection

1. Connect the camera to the frame grabber board in the PC with the Camera
   Link cables.
   Notes:
   1) Use asymmetric Camera Link cables
   2) Connect the camera with the connector labeled as "Camera side" if Camera
      Link cables have transmission direction.
2. Connect the power to the camera.
   Notes:

   Use a power cable to connect the camera with the power source. Connect the
   plug end of the cable to the camera, and the open end to the power supply.

   In addition, a personal computer, the frame grabber board, a lens, lens mount,
a light source and an encoder, etc. may be required. Please choose equipment
suitable for your application.
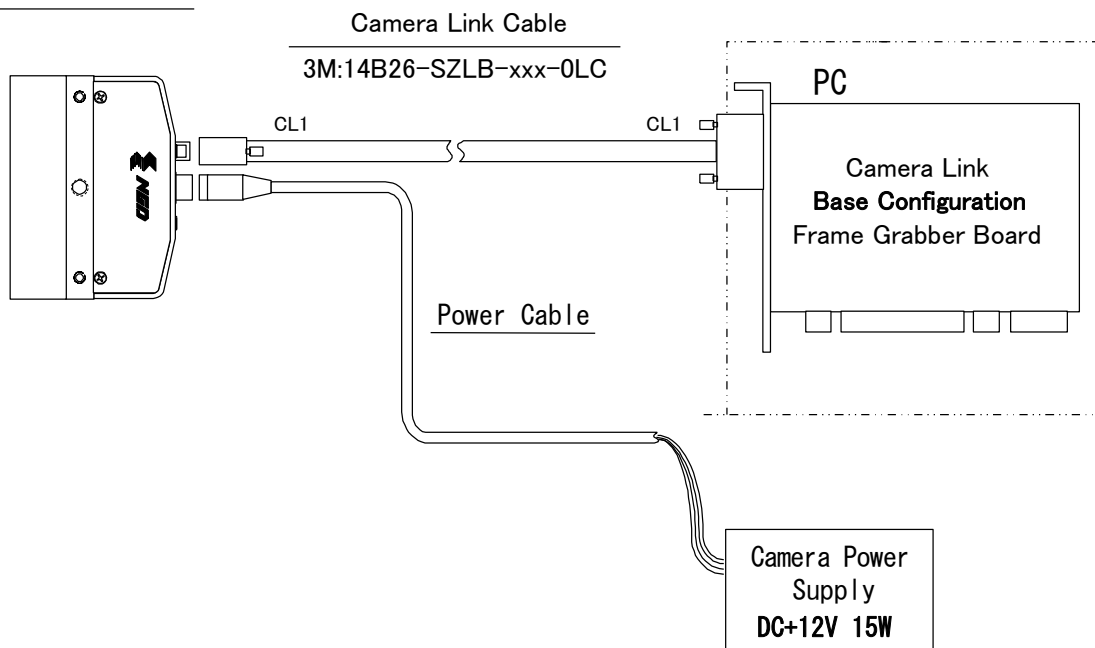
Figure 3-1-1 Connections between Camera and Frame Grabber Board and Power Supply

   Camera Link cable manufacturers may have two types of cable for the Camera Link
Base Configuration board. See the specification and choose the appropriate cable.

<Note: Choosing the appropriate Camera Link cable length >

According to the Camera Link Specification, the maximum cable length is 10m. But the maximum cable length to be able to transfer data depends on the type of cable performance and clock speed. The actual maximum transmission distance becomes less than 10m at faster clock speeds, though the transmission distance of 10m is feasible at slower clock speeds.

The following table shows values being calculated in accordance with the Camera Link Specification 2007.Version1.2, using a typical cable (14B26-SZLB-xxx-0LC from 3M) and frame grabber board (Solios from Matrox). Please choose the appropriate Camera Link cable type and length for your application. We recommend you perform a connection test in advance.

Table 3-1-1 calculated value of maximum cable length

Solios model	clock speed（MHz）	maximum cable length (m)
SOL 6M CL E* (20～66MHz)	40	9.8
	66	8.0
SOL 6M FC E* (20～85MHz)	75	7.6
	85	5.8

3.2 Input / Output Connectors and Indicator

The layout of input /output connecters and the LED indicator are as follows.

Camera Link Connector

CMOS DIGITAL LINE SCAN CAMERA

Clisbee-A

CL: DATA CTRL

Indicator

POWER DC12-15V

Power Connector （HIROSE HR10A–6P）
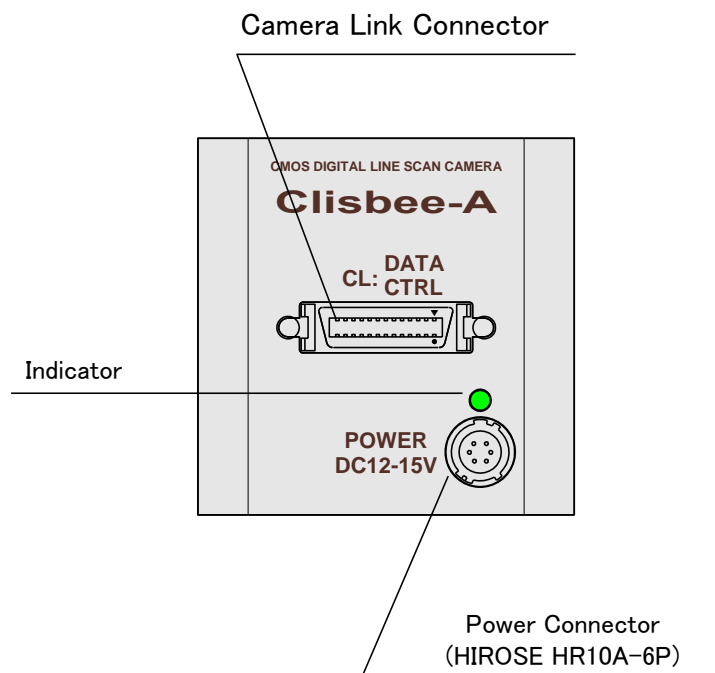
Figure 3-2-1 Input/Output Connectors and Indicator

3.3 Connectors・Pin Assignments・Cables

This camera adopts Medium Configuration of Camera Link interface standards. Figure 3-3-1 shows the interface for the camera and a typical implementation for the frame grabber interface.
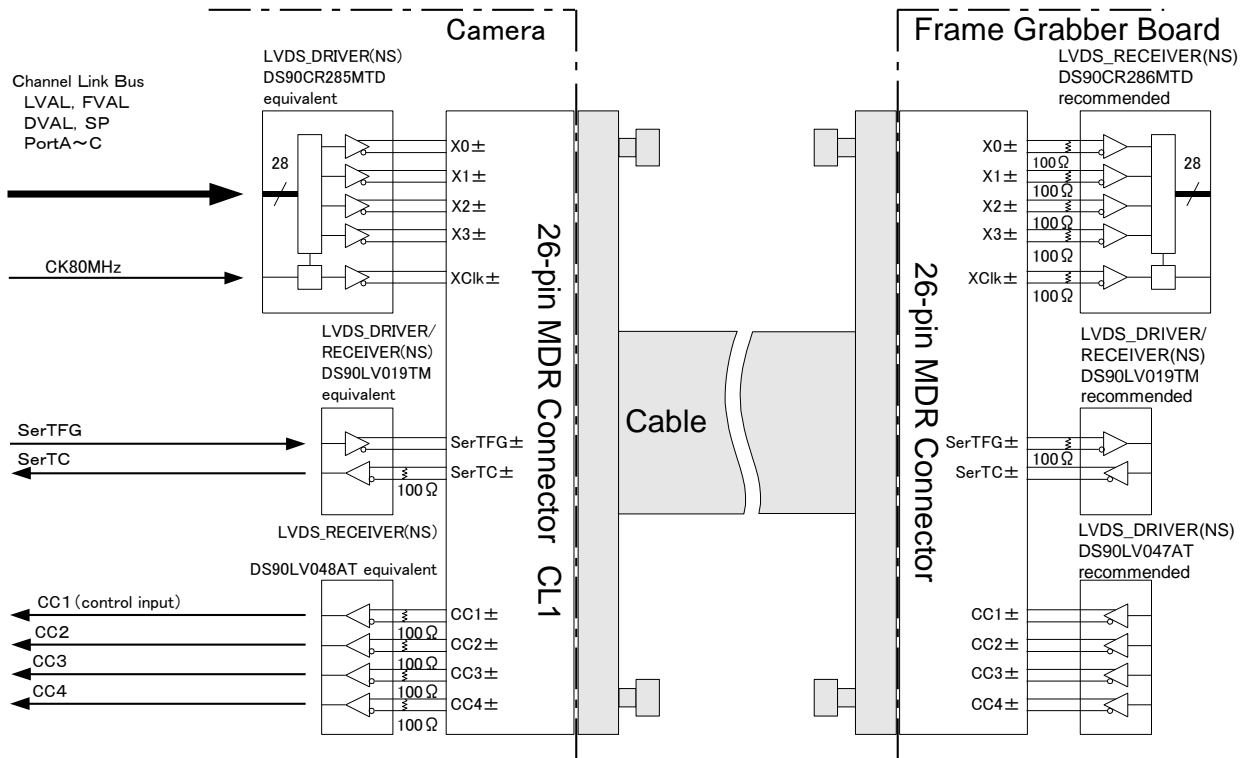
Figure 3-3-1 Camera / Frame Grabber Interface

Notes:
1) Do not make the driver side of LVDS open but set the logic to H or L, even if not used.
2) Set the LVDS, Channel Link receiver side to 100-ohm termination.
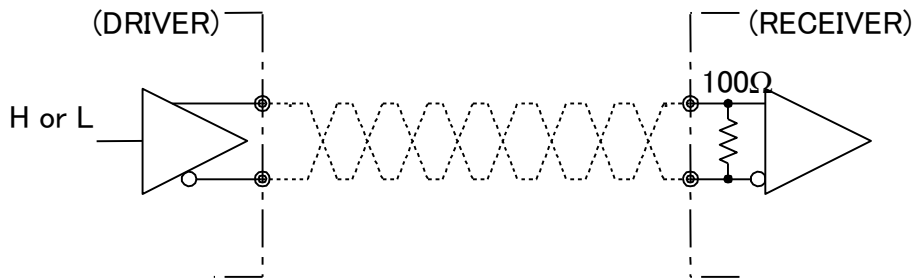
Figure 3-3-2 Circuit of LVDS

The camera has 26-pin MDR connectors for control signals of Camera Link, data signals and serial communications.
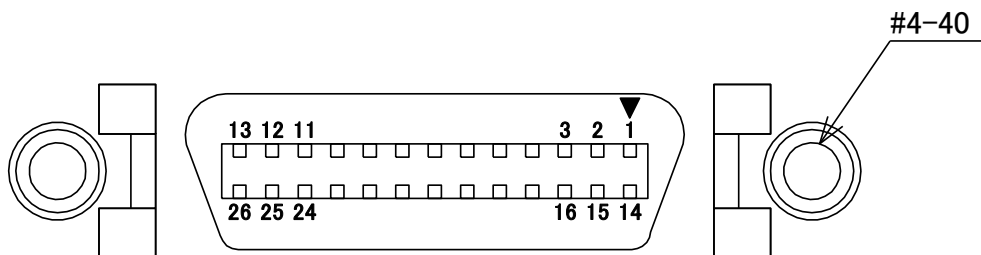
Figure 3-3-3 Camera Link Connector

● Half pitch (miniature half ribbon) shape
● Locking screw (UNC #4-40) type

Table 3-3-1   Camera Link Connector (26-pin MDR Connector) pin assignments

CL1(Base Configuration)

No	Name	No	Name	I/O
1	Inner Shield	14	Inner Shield	/
2	X0-	15	X0+	Out
3	X1-	16	X1+	Out
4	X2-	17	X2+	Out
5	Xclk-	18	Xclk+	Out
6	X3-	19	X3+	Out
7	SerTC+	20	SerTC-	In
8	SerTFG-	21	SerTFG+	Out
9	CC1-	22	CC1+	In
10	CC2+	23	CC2-	In
11	CC3-	24	CC3+	In
12	CC4+	25	CC4-	In
13	Inner Shield	26	Inner Shield	/

● Explanation of Signals

Inner Shield: Shield cable (GND)

X0+, X0-…X3+, X3-:   Data output (Channel Link)

Xclk+, Xclk-:   Clock output for above data output synchronization (Channel Link)

SerTC+, SerTC- :   Serial data input (LVDS)

SerTFG+, SerTFG-:   Serial data output (LVDS)

CC1+, CC1- :   External synchronous signal input (LVDS)

CC2+, CC2-, CC3+, CC3-, CC4+, CC4-: Not in use (LVDS)

● Camera Link compatible cable

  3M: 14B26 –SZLB – xxx – 0LC by or equivalent

Notes:

1)   To avoid uncoupling of the cable connectors during power on, make sure to clamp them with the locking screws.

2)   Do not unplug the cables while power is being supplied to the camera.

This camera uses 6-pin round shape push-pull lock type connector for the Power Supply
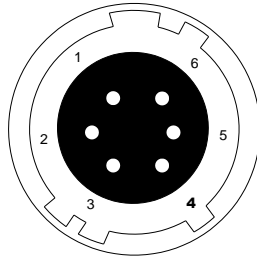
Figure 3-3-4 Power Supply Connector (HIROSE: HR10G-7R-6PB)

Table 3-3-2 Pin Assignment of Power Supply Connector

No	Name
1	12 –15V
2	12 –15V
3	12 –15V
4	GND
5	GND
6	GND

3.4 Power Supply

The camera requires a single power supply (DC+12 to +15V).

The indicator (LED green) blinks when supplying power, and it will change into lighting in about five seconds.

Notes:

1) When selecting a power source, choose one with the capacity to allow for inrush current. (5W or more recommended)

2) Insert the cable plug securely until it locks into position. This is to prevent the connector from coming loose during power transmission.

3) Turn off the power supply at once when the indicator (LED green) doesn't light even if supplied power. Make sure that the power supply is used on proper voltage and capacity and wiring arrangement is correct.

4) It is recommended that the shield processing of the power cable is connected with GND on the power supply side.

Acceptable Cable (Acceptable plug): DGPSH-10 (HIROSE: HR10A-7P –6S)

Power supply voltage: DC+12 –15V (+/-5%)

Consumption Current (rated): DC+12V: 170mA

◆ If the lamp fails to illuminate even after power is supplied, turn off power immediately. Inspect wiring. Check the voltage and capacity of the supplied power source.

4 Camera Control

The camera can be controlled through serial communication. Two methods can be used to change the camera's parameters. The first approach is to change parameters using CLISBeeCtrl (Camera control software). (See "8 CLISBeeCtrl".) Or you can also change the parameters directly from your application by using serial communication commands to set values in the camera register.

Once the camera has been set up according to your requirements, the camera can be used to read data without need of controlling it via the serial interface.

4.1 Flow of Camera Control

4.1.1 Command Overview
The serial interface uses a simple ASCII-based command.
- Communication begins when the computer sends control commands to the camera.
- The camera receives and interprets the computer commands and then executes control operations accordingly.
- Transmission ends when the camera returns the analyzed results of the control commands to the computer.
- ◆ Always allow the previous transmission to end before starting the next transmission. (Only one command can be sent per transmission.)

4.1.2 Camera Receiving Message (PC Sending Command)
- Format 1   CMD CR
- Format 2   CMD□VAL 1 CR
- Format 3   CMD□VAL 1□VAL2 CR
- Format 4   CMD□VAL 1□VAL2□VAL3 CR

CMD：Control text (3 Bytes) Use 3 lowercase letters only. No numerals allowed.

CR：   Carriage Return (0x0D)

□：   Space (0x20) or Comma (0x2C)

VAL： Setting value (decimal, 1 Byte x maximum 5 digits)

<Example>
gax□0 CR

4.1.3 Camera Sending Message (PC Receiving Message)

- Format R 1   >R CR >[SB] CR EOT
- Format R 2   (for "sta" command) >OK CR >[MEM] CR >sta CR EOT

>:	Results start text (0 x 3E)
R:	Camera receive command analyzed results
[SB]:	Camera receive command send back
[MEM]:	Memory data readout value
CR:	Separated text (0 x 0D)
EOT:	Send command all text end text (0 x 04)

<Example>

>OK CR >gax 0 CR E0T

Table 4-1-3-1 Error Messages

Camera Response	Meaning
OK	Camera executed command
CMD ERR!	Command is not valid
CMD OVR ERR!	Command text line is too long
VAL ERR!	Parameter accepted was outside of specified range
MEM ERR!	Camera memory error

4.1.4 Camera Control Commands

Table 4-1-4-1 shows the list of Camera Control Commands.

Table 4-1-4-1 Lists of Camera Control Commands

Control Item	CMD	VAL1	VAL2	VAL3	Control Description
Analog Gain (RGB common)	gax	0 to 6			x1.00....x9.7
Digital Gain (RGB common)	gdx	0 to 511			x1…x2 : (1023/(1023-VAL1)
Digital Gain (R)	gdxr	0 to 1022			x1…x3 :(1+0.001957xVAL1)
Digital Gain (G)	gdxg	0 to 1022			x1...x3 :(1+0.001957xVAL1)
Digital Gain(B)	gdxb	0 to 1022			x1...x3 :(1+0.001957xVAL1)
Digital Gain(G_e)	gdxge	0 to 127			Even number pixels of (G)
Digital Gain(G_o)	gdxgo	0 to 127			Odd number pixels of (G)
Auto White Balance	awb				Adjust gdxr, gdxg, gdxb automatically
White Balance Reset	rwb				Set gdxr, gdxg, gdxb at x1
Digital Offset (RGB common)	odx	-22 to 22			-22…22(DN/step)
Digital Offset(R)	odxr	-10 to 10			-10…10(DN/step)
Digital Offset(G)	odxg	-10 to 10			-10…10(DN/step)
Digital Offset(B)	odxb	-10 to 10			-10…10(DN/step)
Exposure Mode	inm	0 /1/2			Free Run / Ext Edge / Ext Level
Programmable Exposure Time	int	0	987 to 1048575		24.675～26214.375
Memory Initializing	rst				Reset to factory settings
Memory Load	rfd				Readout setup data in memory
Memory Save	sav				Store present setup data in memory
Test Pattern	tpn	0 /1			Off/On
Black Pixel Correction Data Save	blk				User arbitrary black pixel correction data is acquired and stores it in the memory.

White Pixel Correction Data Save	wht				User arbitrary white pixel correction data is acquired and stores it in the memory.
Pixel Correction Data Initializing	calibdef				Delete user arbitrary pixel correction data and reset to factory setting. Do not turn off the power supply until this control is completed. It takes about one minute to complete it.
Pixel Correction Setting	shc	0/1/2	0 to 255		Correction off/ Factory white correction/User arbitrary white correction / ,Target value of correction level (8 bit output conversion value)
Exposure-Read out Time	pad	0 to 1048575			1.518 to 12336.176µs
Operation Status Readout	sta				Returns the current camera settings.
Scanning Direction	rev	0 /1			0: Forward / 1: Reverse
Color Matrix Transforming	colmtx	0/1			Off/On
Readout Color Matrix Transforming	rcolmtx				Readout the set value of Color matrix transforming
Color Matrix Coefficient(krr)	krr	-3000 to 3000			1.0 as coefficient krr is expressed with 1000
Color Matrix Coefficient(krg)	krg	-3000 to 3000			1.0 as coefficient krg is expressed with 1000
Color Matrix Coefficient(krb)	krb	-3000 to 3000			1.0 as coefficient krb is expressed with 1000
Color Matrix Coefficient(kgr)	kgr	-3000 to 3000			1.0 as coefficient kgr is expressed with 1000
Color Matrix Coefficient(kgg)	kgg	-3000 to 3000			1.0 as coefficient kgg is expressed with 1000
Color Matrix Coefficient(kgb)	kgb	-3000 to 3000			1.0 as coefficient kgb is expressed with 1000

Color Matrix Coefficient(kbr)	kbr	-3000 to 3000			1.0 as coefficient kbr is expressed with 1000
Color Matrix Coefficient(kbg)	kbg	-3000 to 3000			1.0 as coefficient kbg is expressed with 1000
Color Matrix Coefficient(kbb)	kbb	-3000 to 3000			1.0 as coefficient kbb is expressed with 1000
Color Matrix Transforming Intensity α	cmstr	-1000 to 1000			1.0 as coefficient α is expressed with 1000
Gamma Correction Setting	gamma	0/1/2/3/4	250 to 4000		Off(1.0)/0.45/0.56/Negative Positive inversion / Custom (by VAL2 setting). VAL2 is effective only at the gamma 4. VAL2 is omissible at other than gamma 4. The gamma value is VAL2/1000. For example: If gamma 4=2200, γ=2.2
Noise reduction	nr	0/1			OFF/ON
Line Delay	d	-1/0/1			Setting to reduse false color

Programmable Exposure Time(μs)＝VAL2÷40

Exposure-Readout Time＝1.518＋(VAL1÷40)

4.1.5 Memory Setup Values (Factory Settings)

The memory setup values (Factory settings) are shown in Table 4-1-5-1.

Table 4-1-5-1 Memory Setup Values (Factory Settings)

Control Item	CMD	VAL1	VAL2	VAL3	Control Description
Analog Gain(RGB common)	gax	0			x1.00
Digital Gain(RGB common)	gdx	0			x1.00
Digital Gain(R)	gdxr	0			x1.00
Digital Gain(G)	gdxg	0			x1.00
Digital Gain(B)	gdxb	0			x1.00
Digital Gain(G_e)	gdxge	0			x1.00
Digital Gain(G_o)	gdxgo	0			x1.00
Digital Offset(RGB common)	odx	0			0
Digital Offset(R)	odxr	0			0

Digital Offset(G)	odxg	0			0
Digital Offset(B)	odxb	0			0
Exposure Mode	inm	0			Free Run
Programmable Exposure Time	int	0	10000		250µs
Test Pattern	tpn	0			Off
Pixel Correction Setting	shc	1	200		Factory white correction
Exposure-Readout Time	pad	0			1.517µs
Scanning Direction	rev	0			Forward
Output Signal Readout Direction Setting	vod	0	0		Standard type
Color Matrix Transforming	colmtx	0			Off
Color Matrix Coefficient(krr)	krr	1140			krr=1.14
Color Matrix Coefficient(krg)	krg	260			krg=0.26
Color Matrix Coefficient(krb)	krb	-400			krb=-0.4
Color Matrix Coefficient(kgr)	kgr	-190			kgr=-0.19
Color Matrix Coefficient(kgg)	kgg	1710			kgg=1.71
Color Matrix Coefficient(kgb)	kgb	-520			kgb=-0.52
Color Matrix Coefficient(kbr)	kbr	-450			kbr=-0.45
Color Matrix Coefficient(kbg)	kbg	-650			kbg=-0.65
Color Matrix Coefficient(kbb)	kbb	2100			kbb=2.1
Color Matrix Transforming Intensity α	cmstr	1000			α=1.0
Gamma Correction Setting	gamma	0	1000		Off(1.0)
Noise reduction	nr	0			OFF
Line Delay	d	0			Line Delay Off

4.2 Details on Commands

4.2.1 Setting Analog Gain

Sets analog gain in 7 steps between x 1 to x9.7
- Format 2   CMD□VAL1 CR
- CMD   gax
- VAL1   0 (for x1) to 6 (for x9.7)
  <Example>
    gax□5 CR (Setting analog gain 5(x7.8))
    >OK
    >gax 5

4.2.2 Setting Digital Gain(RGB common)

The digital gain of the R,G and B signals of the camera can be set at the same time.
Sets digital gain in 512 steps between x 1 and x 2.
- Format 2   CMD□VAL 1 CR
- CMD   gdx
- VAL1   0(for x 1) to 511(for x 2)
  <Example>
    gdx□255 CR (Setting digital gain 255(1023/(1023-255)=x1.33))
    >OK
    >gdx 255

4.2.3 Setting Digital Gain(R)

Sets digital gain(R) in 1023 steps between x 1 and x 3.
- Format 2   CMD□VAL 1 CR
- CMD   gdxr
- VAL1   0(for x 1) to 1022(for x 3)
  <Example>
    gdxr□255 CR (Setting digital gain 255[1+0.001957x255=x1.50])
    >OK
    >gdxr 255

4.2.4 Setting Digital Gain(G)

Sets digital gain(G) in 1023 steps between x 1 and x 3.
- Format 2   CMD□VAL 1 CR
- CMD   gdxg

- VAL1   0(for x 1) to 1022(for x 3)
  <Example>
    gdxg□255 CR (Setting digital gain 255[1+0.001957x255=x1.50])
    >OK
    >gdxg 255

4.2.5 Setting Digital Gain(B)
Sets digital gain(B) in 1023 steps between x 1 and x 3.
- Format 2   CMD□VAL 1 CR
- CMD   gdxb
- VAL1   0(for x 1) to 1022(for x 3)
  <Example>
    gdxb□255 CR (Setting digital gain 255[1+0.001957x255=x1.50])
    >OK
    >gdxb 255

4.2.6 Setting Auto White Balance

Sets the values for "gdxr", "gdxg" and "gdxb" automatically to adjust the white balance of the R, G and B signals of the camera.

Format 2   CMD□CR

- CMD   awb
- VAL   (not applicable)

    <Example>

       awb CR

       >OK

       >awb

The "awb" command can be used to balance the output levels of the neighborhood of sensor center (around 512th pixel)

Before using "awb" command
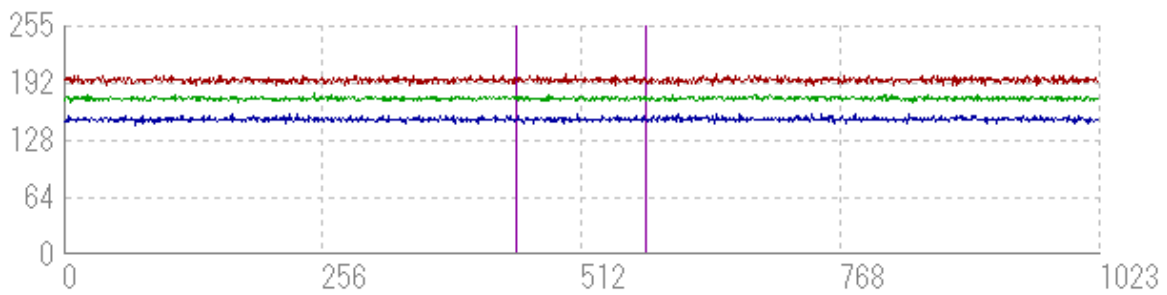
After using "awb" command
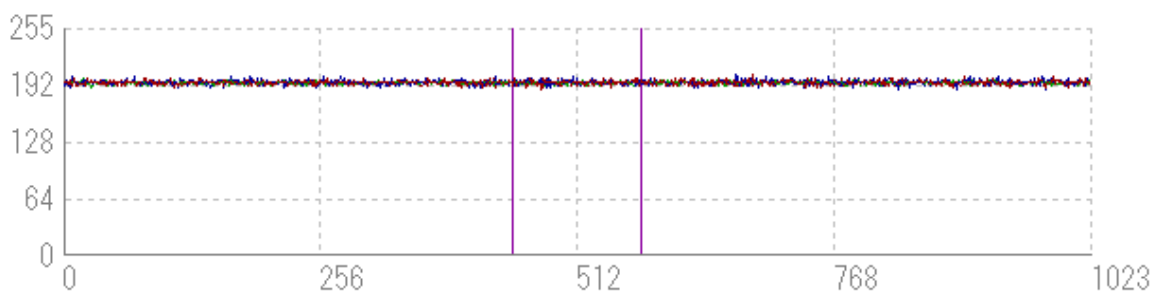
4.2.7 Reset Auto White Balance

Sets the values of "gdxr", "gdxg" and "gdxb" for (x1)

- Format 2   CMD□CR
- CMD   rwb
- VAL   (not applicable)

    <Example>

      rwb CR

      >OK

      >rwb

4.2.8 Setting Digital Offset(RGB common)

Sets digital offsets of the RGB signals between -22 and 22(DN/step).

- Format 2   CMD□VAL 1 CR
- CMD   odx
- VAL1   -22 to 22

    <Example>

      odx□10 CR   (Setting digital offsets of the RGB signals +10DN at the same time)

      >OK

      >odx 10

4.2.9 Setting Digital Offset(R)

Sets digital offset of the R signal between -10 and 10(DN/step).

- Format 2   CMD□VAL 1 CR
- CMD   odxr
- VAL1   -10 to 10

    <Example>

      odxr□10 CR   (Setting digital offset of the R signal +10DN)

      >OK

      >odxr 10

4.2.10 Setting Digital Offset(G)

Sets digital offset of the G signal between -10 and 10(DN/step).

- Format 2   CMD□VAL 1 CR
- CMD   odxg
- VAL1   -10 to 10
  <Example>
    odxg□10 CR   (Setting digital offset of the G signal +10DN)
    >OK
    >odxg 10

4.2.11 Setting Digital Offset(B)

Sets digital offset of the B signal between -10 and 10(DN/step).

- Format 2   CMD□VAL 1 CR
- CMD   odxb
- VAL1   -10 to 10
  <Example>
    odxb□10 CR   (Setting digital offset of the B signal +10DN)
    >OK
    >odxb 10

4.2.12 Setting Exposure Mode

Sets the exposure mode.

- Format 2   CMD□VAL 1 CR
- CMD   inm
- VAL1   0,1,2
  <Example>
    inm□0 CR (Setting the exposure mode free run)
    >OK
    >inm 0

4.2.13 Setting Exposure Time

Sets the exposure time.

- Format 3   CMD□VAL 1□VAL2 CR
- CMD   int
- VAL1   0 (fixed)
- VAL2   987～1048575

<Example>

int□0□5760 CR (Setting exposure time 144µs)

>OK

>int 0, 5760

4.2.14 Memory Initializing (Initializing Camera Settings)

Reset the flash memory to the factory default.

- Format 1   CMD CR
- CMD   rst

<Example>

rst

>OK

>Type=XCM1040DLCT3

>Ver.=1.15_0x0151

>Serial=2

>gax 0

>gdx 0

>gdxr 0

>gdxg 0

>gdxb 0

>odx 0

>odxr 0

>odxg 0

>odxb 0

>inm 0

>int 0,10000

>pad 0

>shc 1,200

>tpn 0

>rev 0

>colmtx 0

>krr 1140
>krg 260
>krb -400
>kgr -190
>kgg 1710
>kgb -520
>kbr -450
>kbg -650
>kbb 2100
>cmstr 1000
>gamma 0, 1000
>rst

4.2.15 Memory Load

Reads out the camera settings from the flash memory.

- Format 1   CMD CR
- CMD   rfd

<Example>

rfd
>OK
>Type=XCM1040DLCT3
>Ver.=1.15_0x0151
>Serial=2
>gax 0
>gdx 0
>gdxr 0
>gdxg 0
>gdxb 0
>odx 0
>odxr 0
>odxg 0
>odxb 0
>inm 0
>int 0,10000
>pad 0
>shc 1,200
>tpn 0
>rev 0
>colmtx 0

>krr 1140
>krg 260
>krb -400
>kgr -190
>kgg 1710
>kgb -520
>kbr -450
>kbg -650
>kbb 2100
>cmstr 1000
>gamma 0, 1000
>rfd

4.2.16 Memory Save

Stores the current camera settings in the flash memory.

- Format 1   CMD CR
- CMD   sav
  <Example>
    sav CR
    >OK
    >sav

4.2.17 Generating Test Pattern

Generates test pattern.

- Format 2   CMD□VAL1 CR
- CMD   tpn
- VAL1   0,1 (0:Image data,1:Test pattern)
  <Example>
    tpn□1 CR (Generating test pattern)
    >OK
    >tpn 1

4.2.18 White Pixel Correction Data Save

Save the user arbitrary white pixel correction data of analog gain in flash memory.
The data at each step of analog gain can be saved.

- Format 1   CMD CR
- CMD   wht

  <Example>
    wht CR
    >OK
    >wht

4.2.19 Setting Pixel Correction

Sets pixel correction.

- Format 3   CMD□VAL1□VAL2 CR
- CMD   shc
- VAL1   0,1,2

     0:Correction off

     1:Factory black correction+factory white correction

     2:Factory black correction+user arbitrary white correction

- VAL2   0 to 255 (Setting correction level:8bit)

  <Example>
    shc□1□200CR (For factory white correction, Correction level 200)
    >OK
    >shc 1,200

4.2.20 Setting Exposure Time - Readout Time

Prolongs the line period without changing the exposure time.

- Format 2   CMD□VAL1 CR
- CMD   pad
- VAL1   0 to 1048575 (XCM1040DLCT3 : 3.225 to 26217.6μs)

  <Example>
    pad□10 CR
    >OK
    >pad 10

4.2.21 Returning the Camera Settings status

Returns the current camera settings.

- Format 1   CMD CR
- CMD   sta

    <Example>

      sta
      >OK
      >Type=XCM1040DLCT3
      >Ver.=1.15_0x0151
      >Serial=2
      >gax 0
      >gdx 0
      >gdxr 0
      >gdxg 0
      >gdxb 0
      >odx 0
      >odxr 0
      >odxg 0
      >odxb 0
      >inm 0
      >int 0,10000
      >pad 0
      >shc 1,200
      >tpn 0
      >rev 0
      >colmtx 0
      >krr 1140
      >krg 260
      >krb -400
      >kgr -190
      >kgg 1710
      >kgb -520
      >kbr -450
      >kbg -650
      >kbb 2100
      >cmstr 1000
      >gamma 0, 1000
      >sta

4.2.22 Setting Scanning Direction

Sets scanning direction.

- Format 2   CMD□VAL1 CR
- CMD   rev
- VAL1   0,1 (0:Forward, 1:Reverse)

    <Example>

    rev□1 CR (Reverse)

    >OK

    >rev 1

4.2.23 Setting the Color Matrix Transforming

The Color Matrix is a 3x3 matrix to convert the color of an image from three values of RGB into the values of different RGB.

$$
\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \begin{bmatrix} krr & krg & krb \\ kgr & kgg & kgb \\ kbr & kbg & kbb \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}
$$

When the above 3x3 matrix is used, the Color Matrix conversion with a value of parameter α (0 to 1) can adjust the degree of effect. In addition, α can set the negative value.

$$
\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} = \alpha \begin{bmatrix} krr & krg & krb \\ kgr & kgg & kgb \\ kbr & kbg & kbb \end{bmatrix} + (1 - \alpha) \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}
$$

- CMD   colmtx
- VAL1   0,1 (0:Off , 1:On)

    <Example>

    colmtx□1 CR   (Sets the Color Matrix Transforming On)

    > OK

    > colmtx 1

4.2.24 Readout the Color Matrix Transforming setting

Readouts the value of the Color Matrix Transforming setting.

- Format 2   CMD□VAL1 CR
- CMD   rcolmtx

   <Example>

   rcolmtx□1 CR (Readouts the value of the Color Matrix Transforming setting)

   > OK

   > colmtx 0

   >krr 1140

   >krg 260

   >krb -400

   >kgr -190

   >kgg 1710

   >kgb -520

   >kbr -450

   >kbg -650

   >kbb 2100

   >OK

   >rcolmtx

4.2.25 Setting the Color Matrix Transforming Coefficient(kxx)

Sets the Color Matrix Transforming Coefficient.

Read the xx in kxx of CMD as rr, rg, rb, gr, gg, gb, b, r, bg or bb for the following explanation.

- Format 2   CMD□VAL1 CR
- CMD   kxx
- VAL1   -3000 to 3000(kxx=VAL1/1000)

   <Example>

   kxx□1140 CR (1.14 at Color Matrix Transforming Coefficient(kxx) setting)

   >OK

   >kxx 1140

4.2.26 Setting the Color Matrix Transforming Intensity(α)

Sets the Color Matrix Transforming Intensity(α).
- Format 2   CMD□VAL1 CR
- CMD   cmstr
- VAL1   -1000 to 1000(α=VAL1/1000)
  <Example>
    cmstr□1000 CR (1.00 at Color Matrix Transforming Intensity(α) setting)
    >OK
    >cmstr 1000

4.2.32 Setting Gamma correction

Switch the gamma correction settings.
- Format 2   CMD□VAL1□VAL2 CR
- CMD   gamma
- VAL1   0,1,2,3,4 (0:Off (1,0), 1:0.45, 2:0.56, 3:Positive negative
                                4:Custom)
- VAL2   250～4000 (γ=VAL2/1000 VAL1=4, it is effective)
  <Example>
    gamma□1 CR   （0.45 at gamma correction setting）
    >OK
    >gamma 1
    gamma□4□2200 CR   (2.20 at gamma correction setting）
    >OK
    >gamma 4 2200

Note: The camera needs tens of seconds to calculate a gamma correction value
        by a command of "gamma 4 VAL2". The camera has not a function to store
        a gamma correction value when the power supply of the camera is off.
        The gamma correction value needs to be calculated by setting a command
        of "gamma 4 VAL2" again after a power supply is on.
        If the camera is stored in a state of setting a command "gamma4 VAL2", the
        camera will calculate at the time of camera start. In this case, for the
        calculation time of the correction value, boot-time gets longer.

4.2.28 Setting Noize Reduction

Sets Noize Reduction.

- Format 2   CMD☐VAL1 CR
- CMD   nr
- VAL1   0,1 (0:Off , 1:On)
  <Example>
    nr☐1 CR （Noize Reduction ON）
    >OK

4.2.29 Setting Line Delay

Sets to reduse false color.

- Format 2   CMD☐VAL1 CR
- CMD   d
- VAL1   -1,0,1 (-1:foward,0:Off , 1:Reverse)
  <Example>
    d☐1 CR （Line Delay Reverse）
    >OK

4.3 Digital Processing flow in FPGA

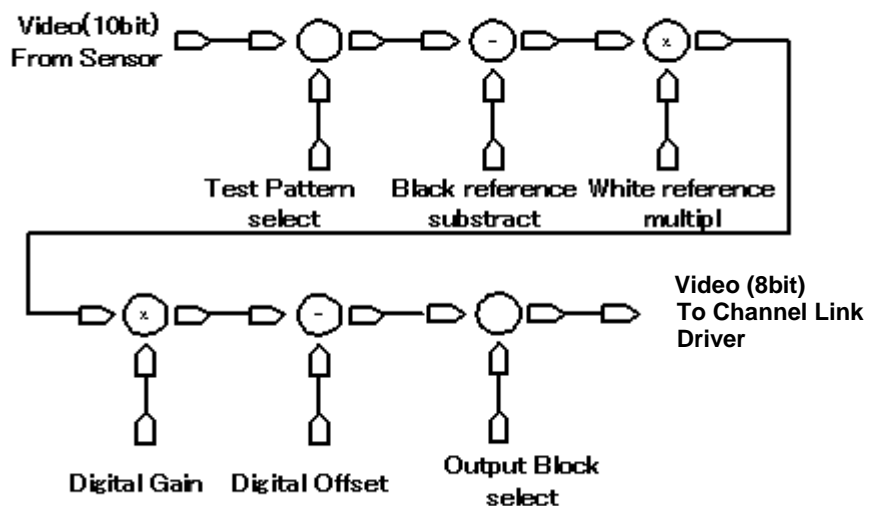The digital processing flow in FPGA is shown below.

Figure 4-3-1 FPGA Processing Block Diagram

Note: When Test Pattern is selected, Black/White reference, Digital Gain & Offset are omitted.

4.4 Startup

After turning on, the camera run a startup procedure before it starts getting images and outputting data. It takes about 40 seconds.

The start-up is executed by the following sequence, and as for the camera, the preparation for the image acquisition and the output is complete when normally ending.

(1) The camera hardware initializes.

(2) Reads out the latest camera settings from the flash memory. (User settings if any or factory default settings)

(3) Set up the camera with the setting value from the flash memory.
   After this sequence, the camera is ready to get images and output data.

4.5 Saving and Loading Camera Settings

The camera settings data is saved in the internal memory (flash memory) and is loaded from the memory when turning on the power supply or loading (sending the "rfd" command).

Commands for rewriting the memory are as follows.

● Reset to factory settings (rst)
● Store present setup data in memory (sav)
● Store pixel correction data in memory (wht)

Notes:

1) The number of times the flash memory can be rewritten will vary depending on actual operational conditions.

2) After turning on the power supply, the camera always checks the memory status. When it is content outside a set range due to the breakdown etc., it automatically rewrites it in the memory setting value when the factory is shipped.

3) If the camera power is disconnected while rewriting the memory, the whole data saved in the memory will be deleted.

4) As it takes several seconds to rewrite the memory, do not disconnect power supply before receiving the answer from the camera.

5) Please do when you change the exposure mode from factory setting with external trigger signal (CC1) supplied from the frame grabber board side. If you do not send CC1 or sending control input signals are out of the

designated range, you cannot get images and cannot change the settings. See 4.8.2 and 4.8.3.

Table 4-5-1 Camera Operation Mode and Control Input

Camera operation mode (Exposure mode)	Control input (From frame grabber board)
Free Run(Programmable time setting) (Factory setting)	Not in use
Ext Edge (External trigger edge + Programmable time setting)	External trigger (CC1) is required
Ext Level (External trigger level time setting)	External trigger (CC1) is required

4.6 Serial Communication Settings

Serial communication is performed through the Camera Link Interface
Table 4-6-1 shows serial communication settings.

Table 4-6-1 Serial Communication Settings

Parameter Items	Setup Value
Communication Speed (Baud rate)	9600bps
Data Length	8bit
Parity Bit	None
Stop bit	1bit
Flow Control	None

4.7 Video Output Format

The camera outputs 8-bit RGB digital data through 3 tap.
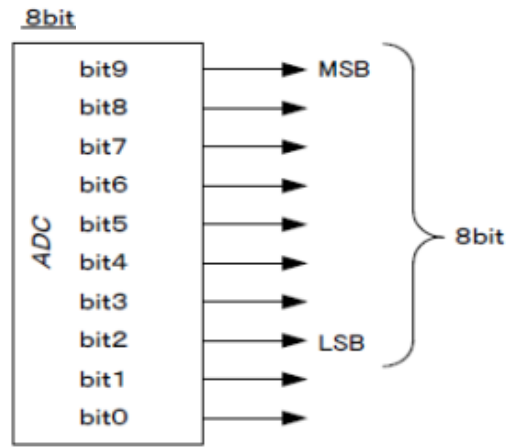
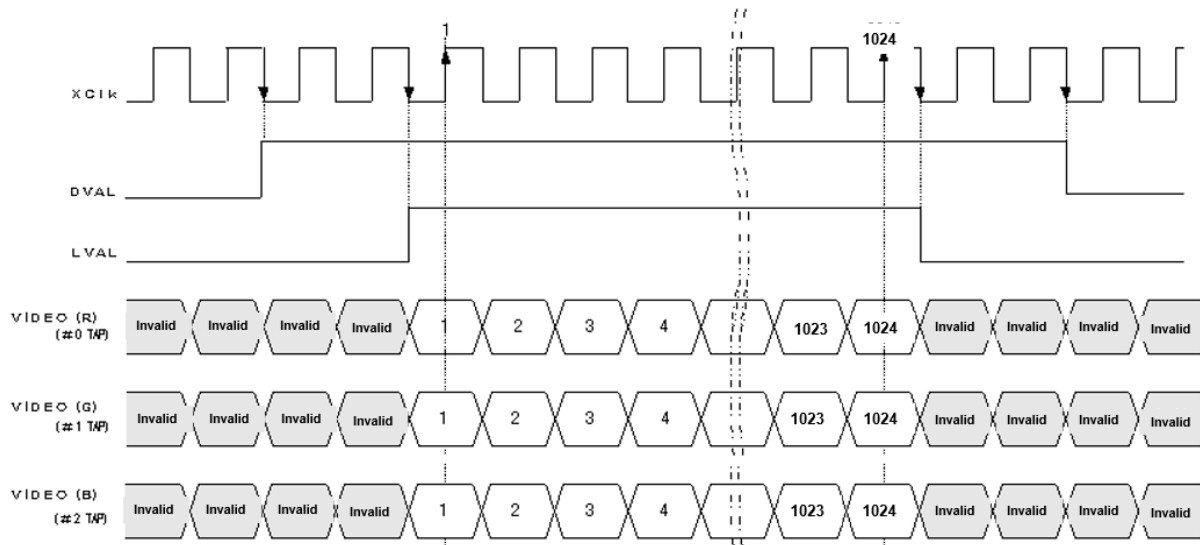**Figure 4-7-1 Pin Assignments of Digital Data**

Video output phases of the camera are shown at the following below.

① This camera outputs RGB 8bit digital data through 3tap formats.

◆   Note: FVAL = 0 (low level) fixed

Figure 4-7-2 Video Output Phase of the Camera at XCM1040DLCT3

4.8 Exposure Mode and Timing Chart

The camera has three exposure modes. The overview of each mode and the timing are as follows.

4.8.1 Free Run Exposure Mode (Programming time setting)

In free-run exposure mode, the camera generates its own internal control signal based on two programmable parameters, exposure time and readout time.

Table 4-8-1-1 Programmable Exposure Time

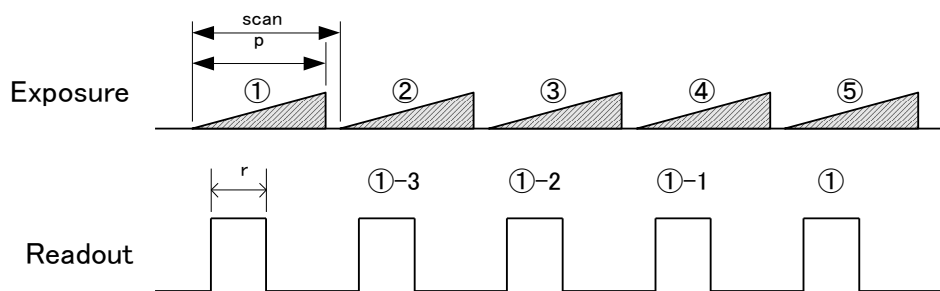| p	Programmable exposure time	24.4～26214.375
r	Readout time	25.6

(unit : μs)

Figure 4-8-1-1 Free Run Exposure Mode

Note:

The timing of reading out does one scanning delay from the exposure.

4.8.2 External Trigger Exposure Mode (External trigger edge)

In external trigger exposure mode (Trigger Edge), the exposure time is determined by the setting through serial communication, each exposure starts with the rising edge and the line period is determined by the time from rising edge to rising edge of the trigger pulse. The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

Table 4-8-2-1 Programmable Exposure Time(Trigger Edge)

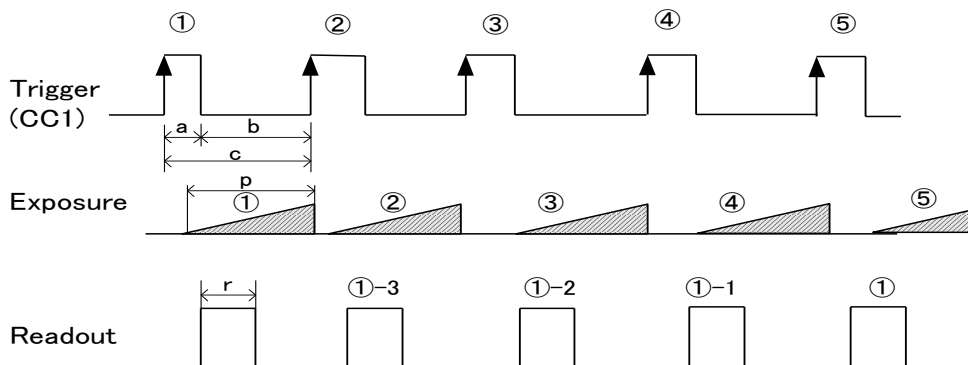| p	Programmable exposure time	24.4～26214.375
r	Readout time	25.6
a	Trigger pulse H time	≧0.05
b	Trigger pulse L time	≧0.05
c	Trigger pulse cycle	≧27.625

(unit：µs)

Figure 4-8-2-1 External Trigger (Trigger Edge) Exposure Mode

Note:

The timing of reading out does one scanning delay from the exposure.

4.8.3 External Trigger Exposure Mode (Trigger Level)

In external trigger exposure mode (Trigger Level), the exposure time is determined by the high trigger pulse time, each exposure starts with the rising edge and the line period is determined by the time rising edge to rising edge of trigger pulse. The range of programmable exposure time, the timing chart of the exposure and the readout are shown below.

Table 4-8-3-1 Programmable Exposure Time (Trigger Level)

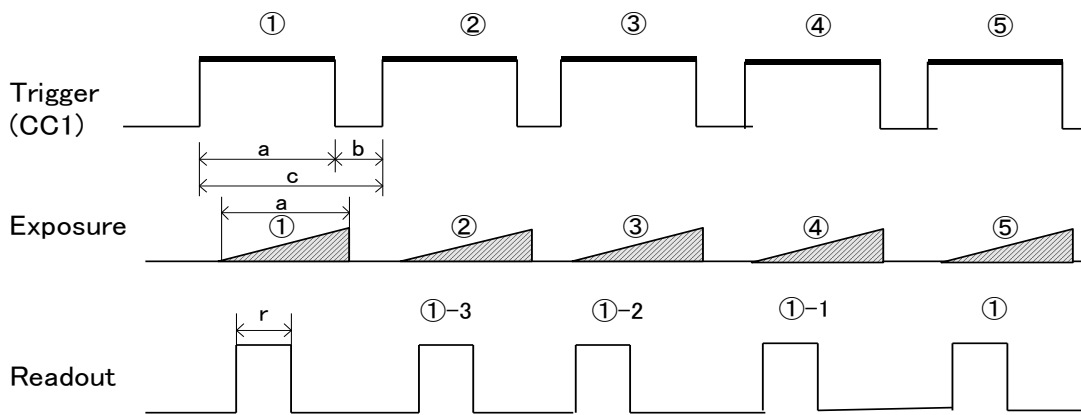| r	Readout time	25.6
a	Trigger pulse H time	$\geqq$24.4
b	Trigger pulse L time	$\geqq$3.225
c	Trigger pulse cycle	$\geqq$27.625

(unit：μs)

Figure 4-8-3-1 External Trigger (Trigger Level) Exposure Mode

Note:

The timing of reading out does one scanning delay from the exposure.

4.9 Setting Offset

In the figure below, the horizontal axis indicates the amount of incident light and the vertical axis indicates the output.

Fs shows the output at saturation. Dd shows the output at darkness. (Both Fs and Dd are digital.) Se shows the saturation current, or the amount of exposure when the output saturates.
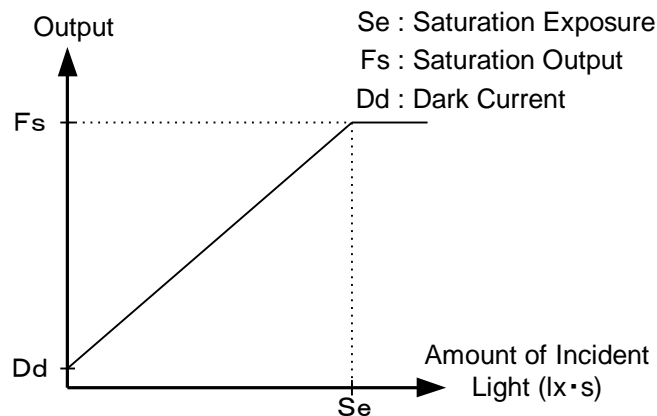
Se : Saturation Exposure
Fs : Saturation Output
Dd : Dark Current

Figure 4-9-1 Saturation Exposure and Dark Current Output

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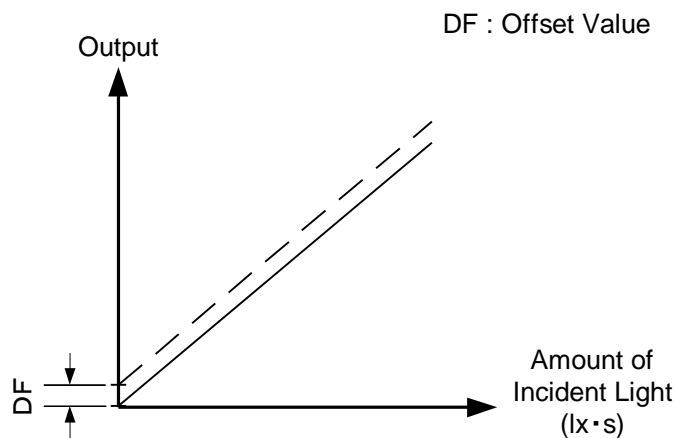
DF : Offset Value

Figure 4-9-2 Offset Adjustment

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

4.10 Setting Gain

The camera can adjust the analog gain (x1 to x9.7 in 7 steps) and the digital gain. As shown in the figure below, increasing the gain setting increases the gradient of the camera's response curve and results in a higher camera output for a given amount of light. Analog gain can be changed by sending the "gax" command. Digital gain can be changed by sending the "gdx" command.
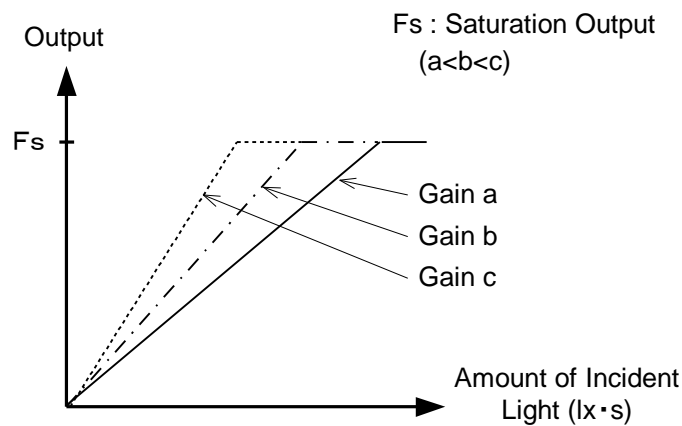

Figure 4-10-1 Gain Adjustment

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

Table 4-10-1 Gain-Sensitivity

gax	Analog Amplifier		Sensitivity V/(lx · s)
0	x1.0	0.0dB	60
1	x1.8	5.0dB	108
2	x3.4	10.7dB	204
3	x5.2	14.3dB	312
4	x6.4	16.1dB	384
5	x7.8	17.9dB	468
6	x9.7	19.7dB	582

Note:

Digital gain x1, Pixel correction default (Factory white correction data, Correction level 200 DN / 8 bit)

4.11 Pixel Correction

As a rule, image sensors (CCD, CMOS and so on) have fixed pattern noise and photo response non-uniformity. Lens shading and light sources can also cause non-uniformity. The camera is set to the optimal correction before shipping in order to provide images of the highest grade.

The camera also has a user white correction function to cope with lens shading and non-uniform illumination, or to be able to completely clear the uneven brightness generated by changing the spectral response level of the light source. Cal_bl: Output data of each pixel at perfectly dark (digital) Cal_wh: Output data of each pixel in uniform illumination (digital) Target_Val : Target value for correction (10bit digital) Vin :Input data (digital) Vout :Output data (digital) The corrected data is expressed in the following equation. Vout= (Vin-Cal_bl) x Target_val / (Cal_wh-Cal_bl)

Waveform before bit correction

Pixel Number

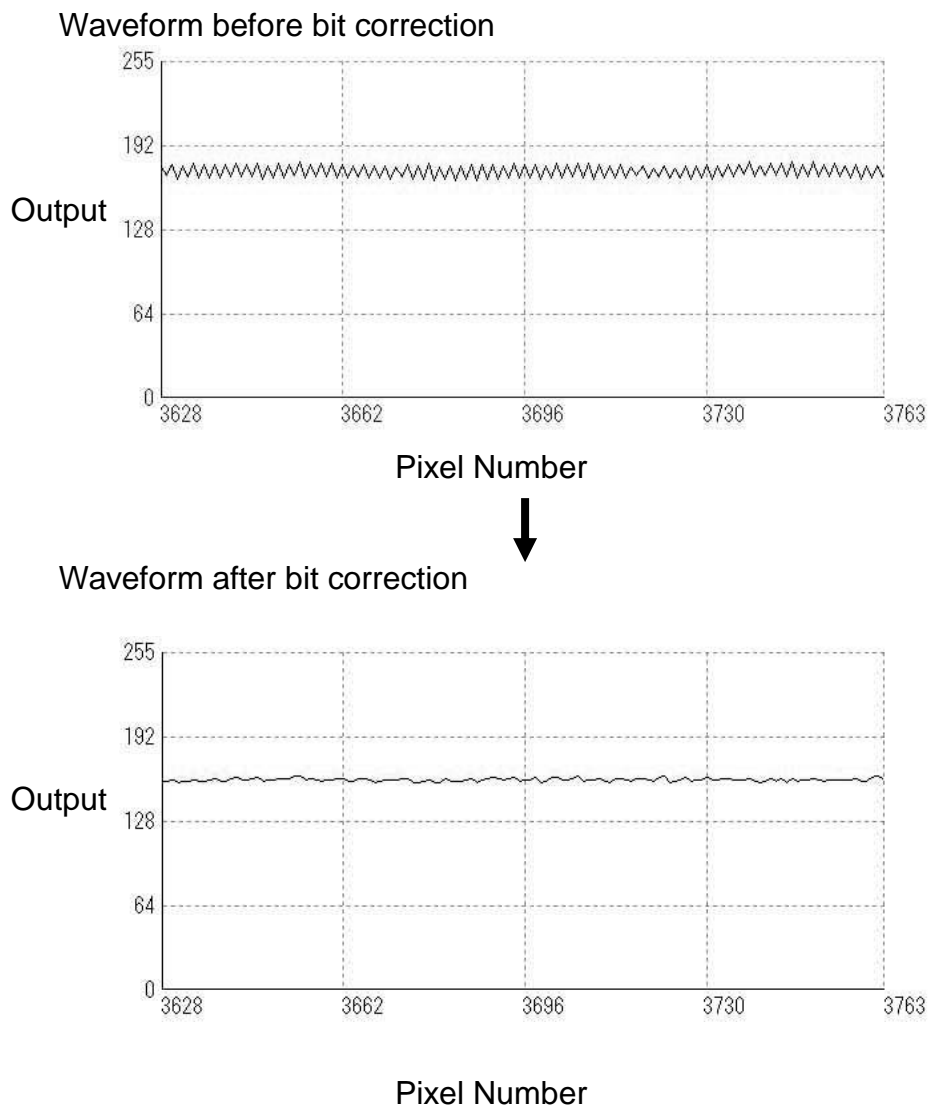Waveform after bit correction

Pixel Number

Figure 4-11-1 Waveform before and after bit correction

4.11.1 Command Settings

Set the correction on or off, acquire user white correction data by sending commands through serial communication.

Examples of command settings
shc 0,200:   Correction Off
shc 1,200:   Factory white correction
shc 2,200:   User arbitrary white correction
wht   :   Acquisition of user arbitrary white correction data

4.11.2 How to correct

(1) Remove the lens cap and place a white object. Then you can acquire user white correction data. With a lens, the shading by both the lens and the light source will be simultaneously corrected. At this time, please defocus a little to avoid being affected by the non-uniformity of the object.

(2) Send the "wht $\boxed{\text{CR}}$" command through serial communication.

(3) Confirm that the camera returns ">OK" and ">wht". Thus user white correction data is saved and loaded to the camera.

(4) Send the "shc 2 VAL $\boxed{\text{CR}}$" command through serial communication. Then the user white correction will be on and set the correction level as "VAL".

4.12 Test Pattern

   This camera can generate a test pattern. Use the test pattern to verify the proper timing and connections between the camera and the frame grabber board.

   The test pattern of XCM1040DLCT3, (8 bit) is as follows.
   The following waveforms appear only in red (R).
   This reason is because R, G and B signals are the same on the output level and these waveforms are piled up and the waveform of R signal is displayed last.
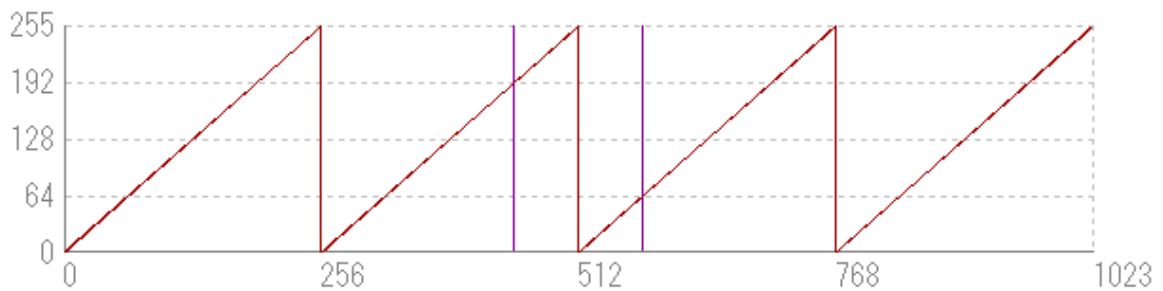

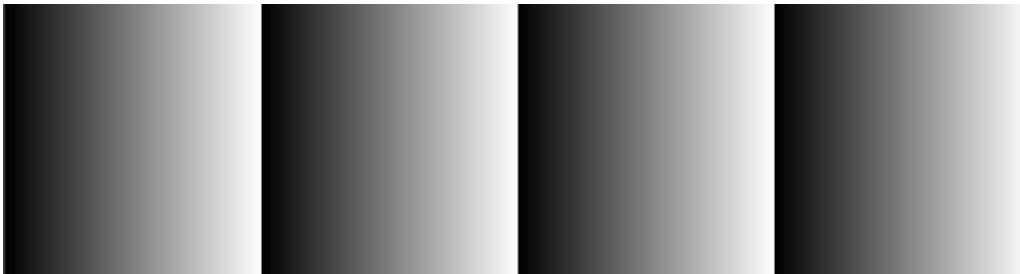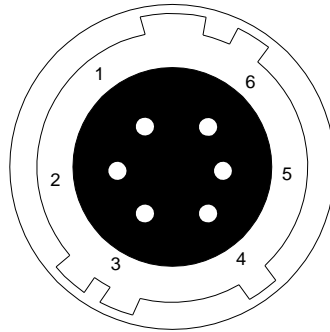**Figure 4-12-1 Test Pattern of XCM1040DLCT3**

Figure 4-12-2 Test Image of XCM1040DLCT3

In 8bit mode, from pixel 0, 8bit data is output in order (0,1,2,3... 255), repeating four times.

5 Confirming Camera Settings

5.1 Before Power-on

(1) Confirm the pin assignment of the power cable.

No	Name
1	12 -15V
2	12 -15V
3	12 -15V
4	GND
5	GND
6	GND

Figure 5-1-1 Pin Assignment of Power Cable

(2) Confirm the direction and the channel of the cables. Some Camera Link cables are directional.

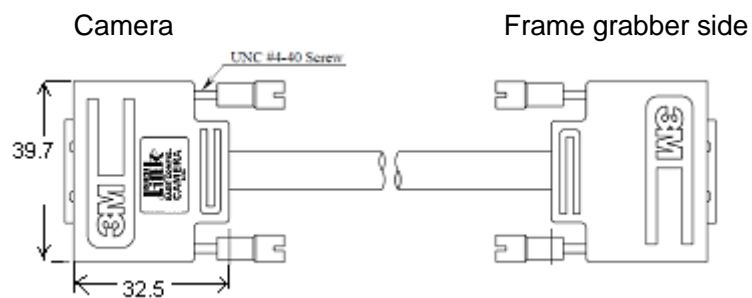If one of the connectors says "Camera side", connect this to the camera.

Figure 5-1-2 Connection Direction of Camera Cable

Confirm the connection with the Camera Link cable and frame grabber.

The connection channel in case of "Solios",

 Camera side connector CL1 and frame grabber side connector CHANNEL#0
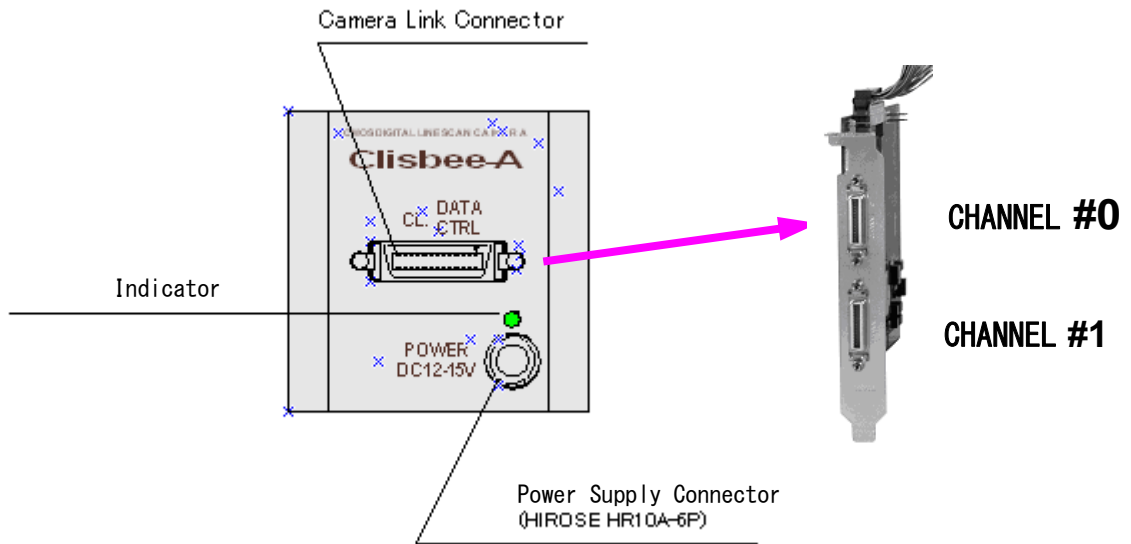
Figure 5-1-3 Channels of Camera Link Cables

5.2 After Power-on

(1) Confirm sent and received commands using the camera control utility. Launch CLISBeeCtrl, set COM port and connect. Click "Memory Dump" and wait for the response.

Figure 5-2-1 Confirmation of Connection

(2) Set a trigger mode and a video output mode with the camera control utility
Trigger mode: Free Run   Video output: 8bit
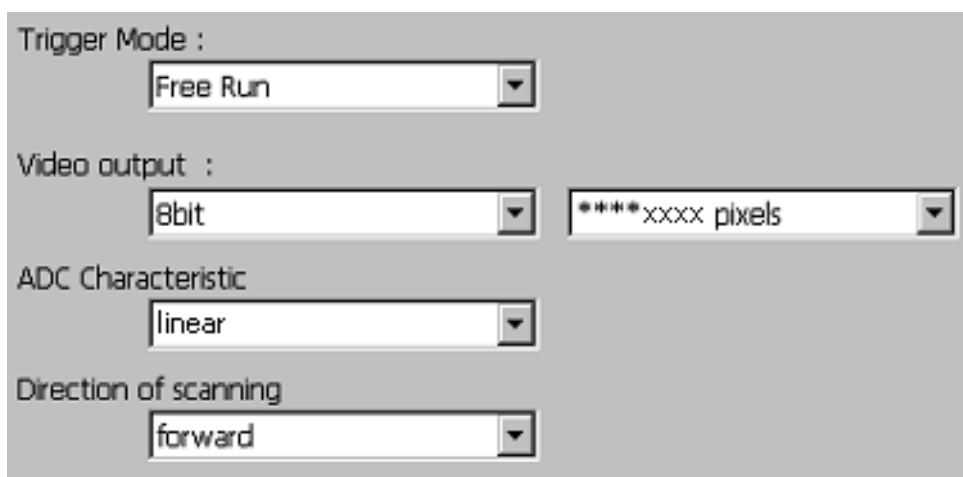
Figure 5-2-2 Setting of Exposure Mode and Video Output Mode

(3) Capture images using a camera interface board utility. In case of Matrox's Solios, it is convenient to use Intellicam.
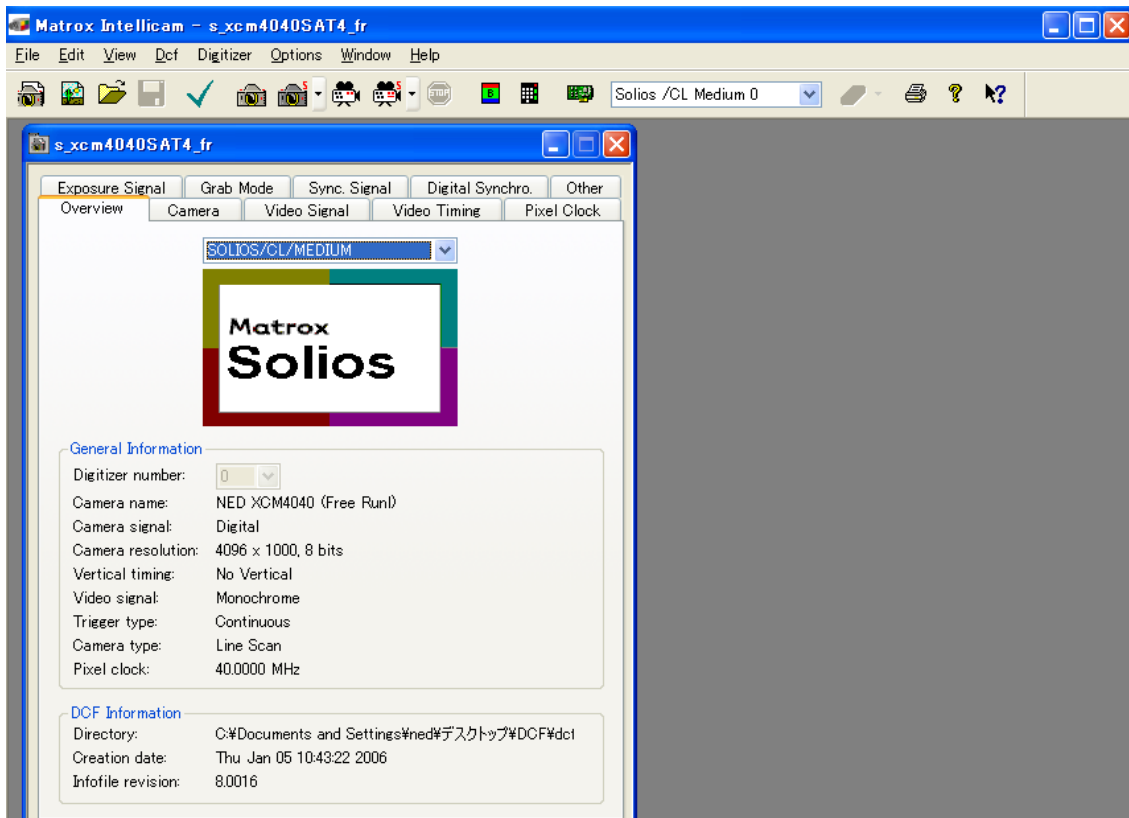
Figure 5-2-3 Solios Intellicam dcf Window

5.3 In Operation

(1) Does an acquisition time out error occur?

<Cause>

<1> Captured images are too large.
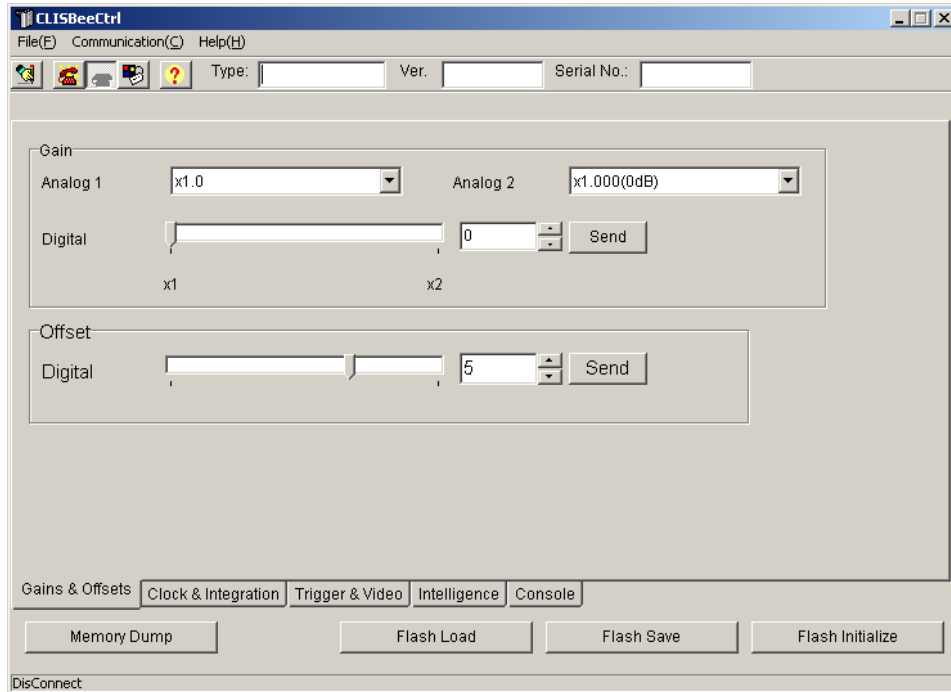
If there are many filtering processes, the assignments to the driver may be insufficient.

<2> The cable is detached from the connector

Ensure that the power cable and Camera Link cables are connected to the camera firmly.

<3> Camera Link cables are susceptible to noise when the cables are laid near a light source inverter line or a power line. The personal computer in use may freeze and need to be reset.

(2) Are there dark lines in the direction of vertical scanning on the image?

<Cause>

<1> Dust on the sensor window

Dust may get onto the sensor window from the inside or the outside of the camera. Remove the dust with air or a lens cleaner.

6 Sensor Handling Instructions

6.1 Electrostatic Discharge and the Sensor

CMOS sensors are susceptible to damage from electrostatic discharge and can become defective.

6.2 Protecting Against Dust, Oil and Scratches

The CMOS 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.
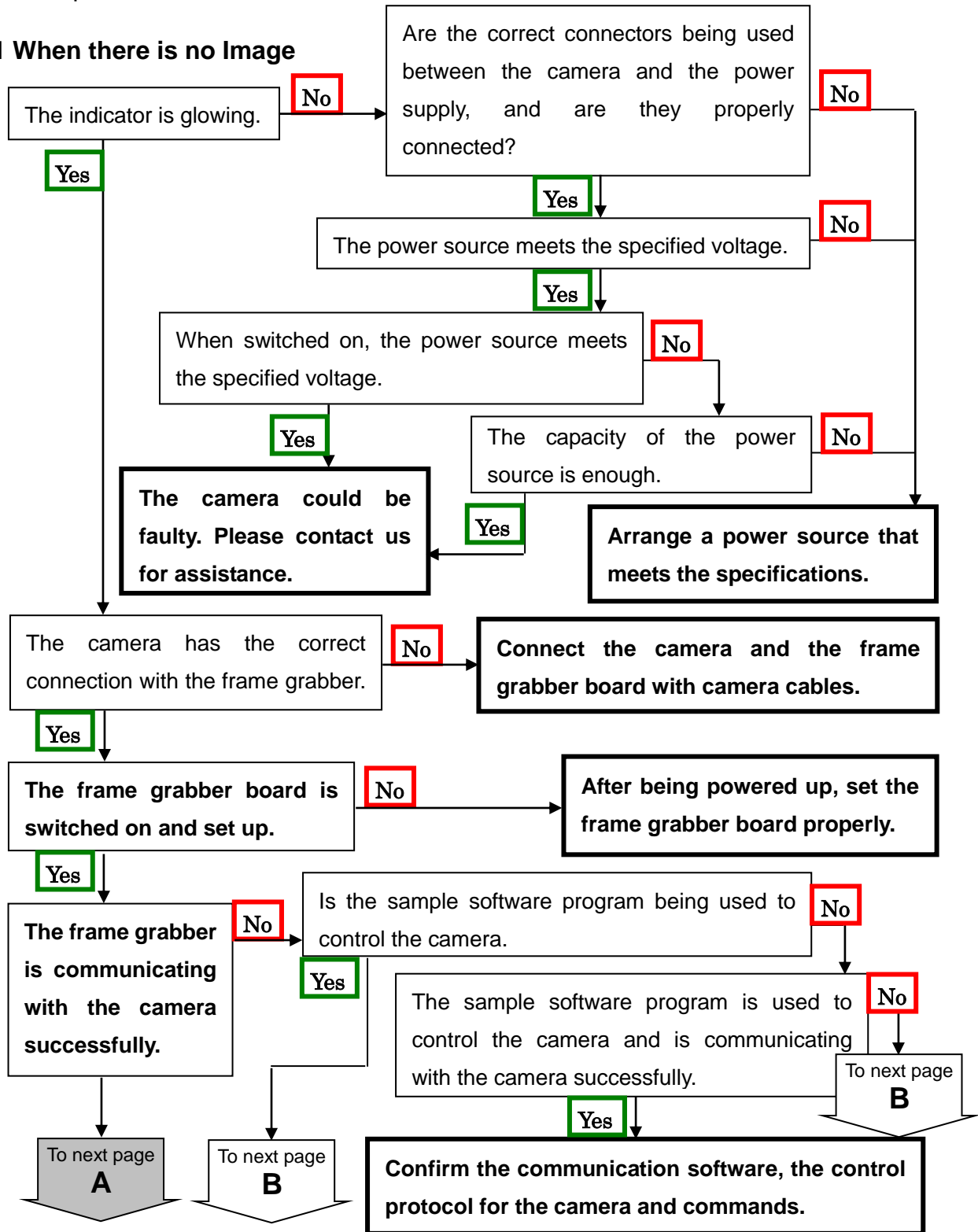
6.3 Cleaning the Sensor Window

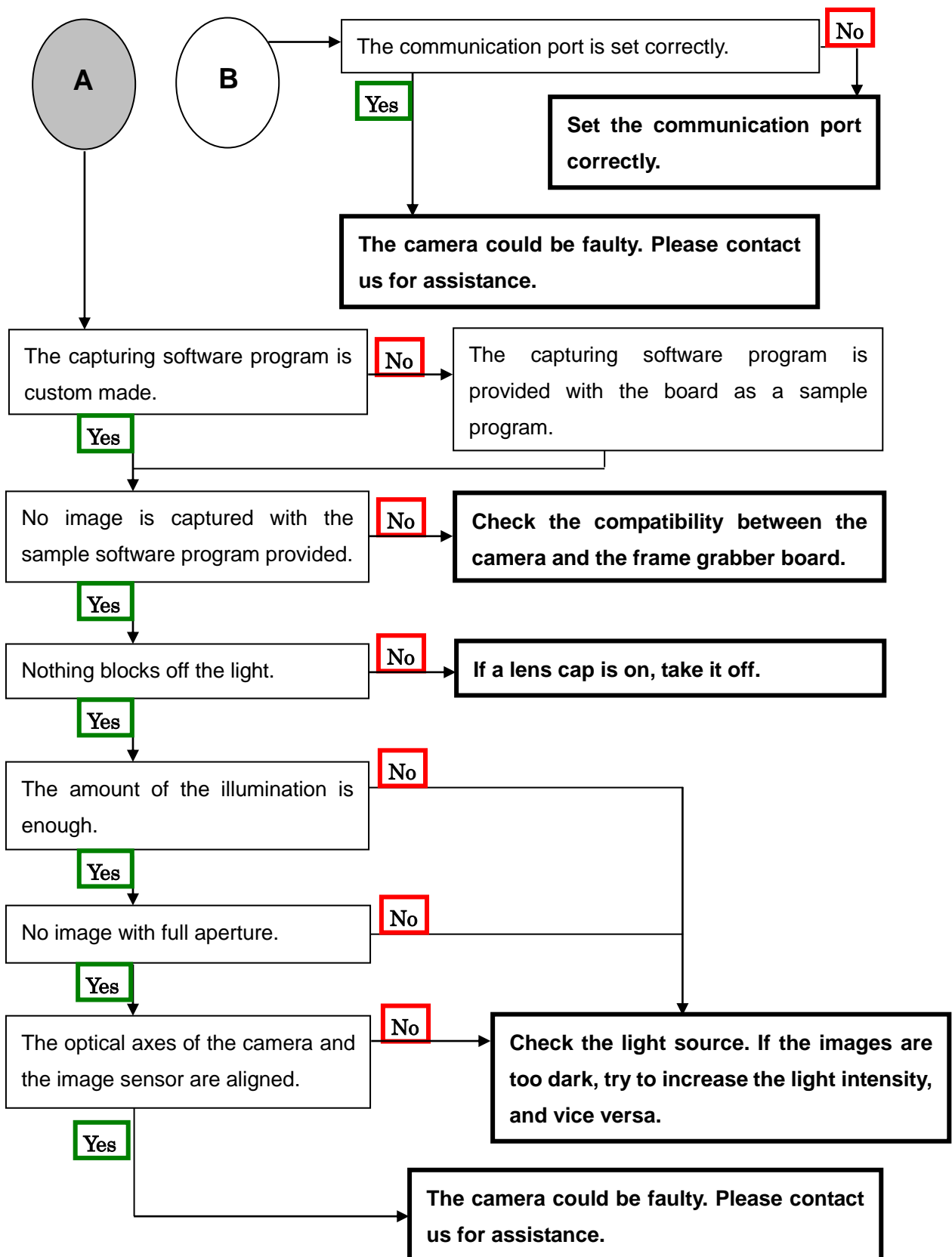Dust: Can usually be removed by blowing the window surface using a compressed air blower.

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

7 Troubleshooting

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

7.1 When there is no Image

The indicator is glowing. **No** →

Are the correct connectors being used between the camera and the power supply, and are they properly connected? **No** →

Yes ↓

The power source meets the specified voltage. **No** →

Yes ↓

When switched on, the power source meets the specified voltage. **No** →

Yes ↓

The capacity of the power source is enough. **No** →

Yes ←

The camera could be faulty. Please contact us for assistance.

Arrange a power source that meets the specifications.

The camera has the correct connection with the frame grabber. **No** → **Connect the camera and the frame grabber board with camera cables.**

Yes ↓

The frame grabber board is switched on and set up. **No** → **After being powered up, set the frame grabber board properly.**

Yes ↓

The frame grabber is communicating with the camera successfully. **No** →

Is the sample software program being used to control the camera. **No** →

Yes ↓

The sample software program is used to control the camera and is communicating with the camera successfully. **No** →

Yes ↓

To next page **B**

To next page **A**

To next page **B**

Confirm the communication software, the control protocol for the camera and commands.

A

B

The communication port is set correctly. **No**

Yes

Set the communication port correctly.

The camera could be faulty. Please contact us for assistance.

The capturing software program is custom made. **No**

The capturing software program is provided with the board as a sample program.

Yes

No image is captured with the sample software program provided. **No**

Check the compatibility between the camera and the frame grabber board.

Yes

Nothing blocks off the light. **No**

If a lens cap is on, take it off.

Yes

The amount of the illumination is enough. **No**

Yes

No image with full aperture. **No**

Yes

The optical axes of the camera and the image sensor are aligned. **No**

Check the light source. If the images are too dark, try to increase the light intensity, and vice versa.

Yes

The camera could be faulty. Please contact us for assistance.

7.2 When Noise is present in the Image

Noise is present at the point of first use. —**No**→ The camera has been used for 3 or more years, or the ambient temperature is higher than room temperature. —**No**→

↓ **Yes**

A servomotor or a magnetic valve is placed near the camera. —**No**→

↓ **Yes**

Turning on a servomotor or a magnetic valve generates an electric noise. —**No**→

↓ **Yes**

Prevent the noise source from disturbing the camera cables and the power cable.

The camera has been used for 3 or more years, or the ambient temperature is higher than room temperature. —**No**→

↓ **Yes**

There are some degradable parts in the camera. Please contact us for assistance.

↓

The power supply has been used for 3 or more years, or the ambient temperature is higher than room temperature. —**No**→

↓ **Yes**

Check the condition of the power supply.

↓

The camera and or cables are used in a moving environment (attached to a machine which applies stress to the cables). —**No**→

↓ **Yes**

Check the condition of the camera cables and the power supply cable.

↓

The camera could be faulty. Please contact us for assistance.

To next page
C

C

Cables are asymmetric such as thin cables.　　No

Yes

One of the connectors of an asymmetric camera cable is to be connected with a camera. (Labeled as "Camera side")

The camera cables are too long.　　No

Yes

Use camera cables in accordance with the transmission rate. The cables should not be too long to avoid the noise disturbance.

The power source has no fluctuation in voltage and is not deteriorated.　　No

Yes

Use a stable power supply.

When the camera gain is on a high level, bright spots occur without incident light.　　No

Yes

Secondary radiation (rays) could cause bright spots, but this is not a malfunction.

The camera could be faulty. Please contact us for assistance.

7.3 When the Camera becomes hot

The consumption current of the power supply is larger than the rating.

No

Yes

The camera is too hot to touch.

No

Yes

The camera will become hotter than the ambient temperature while in operation because of self-heating. Allow sufficient air circulation around the camera to give it a longer product life.

Keep the ambient temperature within the range of the specifications.

The camera could be faulty. Please contact us for assistance.

8 CLISBeeCtrl

8.1 Overview

The CLISBeeCtrl is the remote control software for "CLISBee*" camera using "**N**ED **C**amera **C**ontrol **P**rotocol" (NCCP) from a PC.

Connectable interfaces are following.

1）Camera Link API

2）Communication Port (COM port, RS232C)

*CLISBee is the nickname for XCM series camera.

8.2 System Requirements

PC: PC/AT compatible

Operating System: Microsoft Windows (XP/7).

Free disk space: 1-2MB (It may fluctuate with the number of camera parameter files.)

Connection: Camera Link frame grabber board, Camera Link cables

8.3 Install

Copy the CLISBeeCtrl folder in the media (CD-ROM, etc.) which our company provides, to your hard disk.

8.4 Uninstall

Remove the CLISBeeCtrl folder and all files in CLISBeeCtrl folder.

8.5 Operation

8.5.1 Start Program

Open Windows Explorer and Double-click the "CLISBeeCtrl.exe".
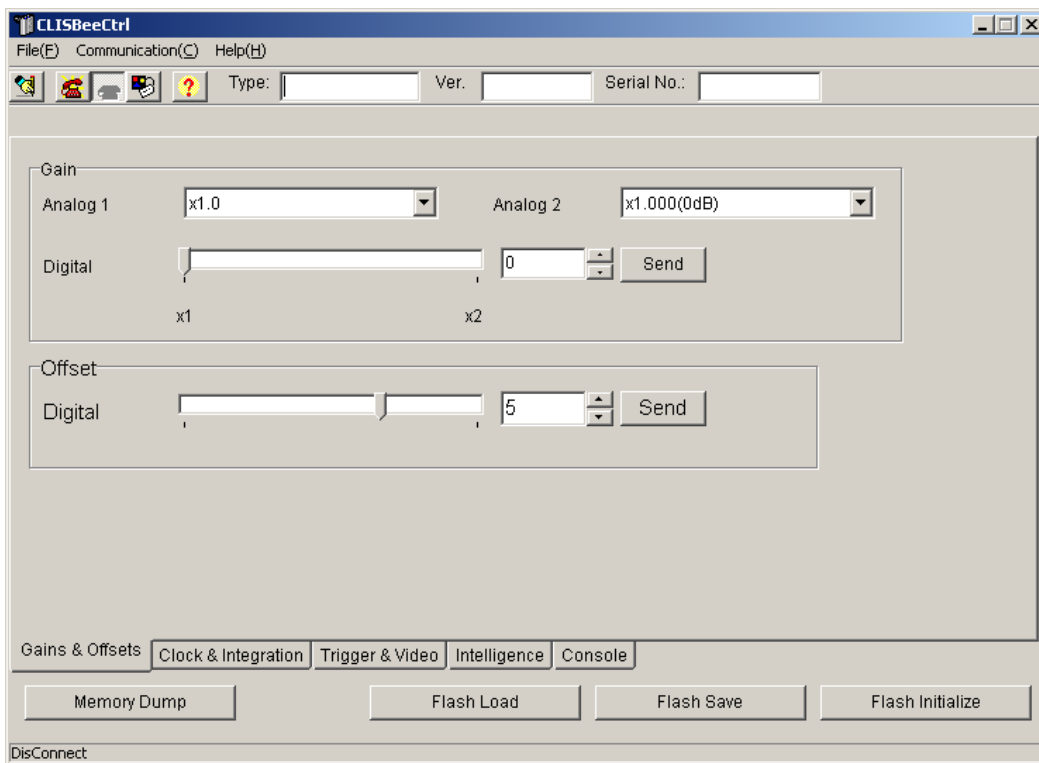
It is possible to switch page by clicking each tab under the window.
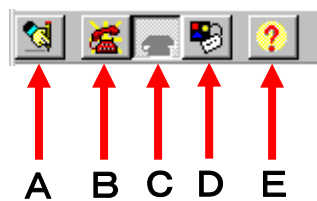
Buttons in the tool-bar have the following functions.
    A: Exporting parameters in the text file format.
    B: Connection with the camera.
    C: Disconnection.
    D: Setting Communication.
    E: Version Information.

8.5.2 Selecting interface and Timeout setting

8.5.2.1. Selecting interface

1) Click button D.
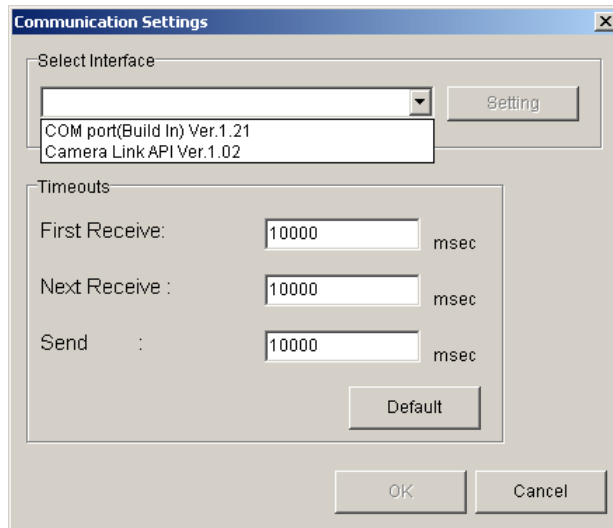
2) Select the interface in Drop-down-list-box.
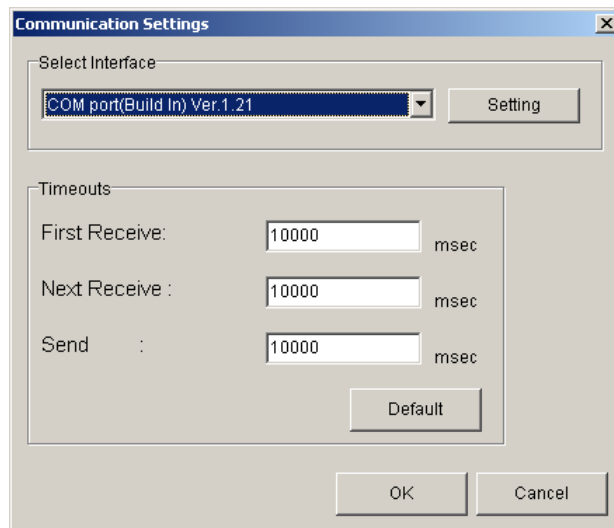
3) Click "Setting" button to set the interface. (See 8.5.2.2. and 8.5.2.3.)

4) Click "OK" button.
   Click "Cancel" button when stopping setup.

Note: The camera can be used without this operation after it has been set up correctly.

8.5.2.2 Setting Communication port
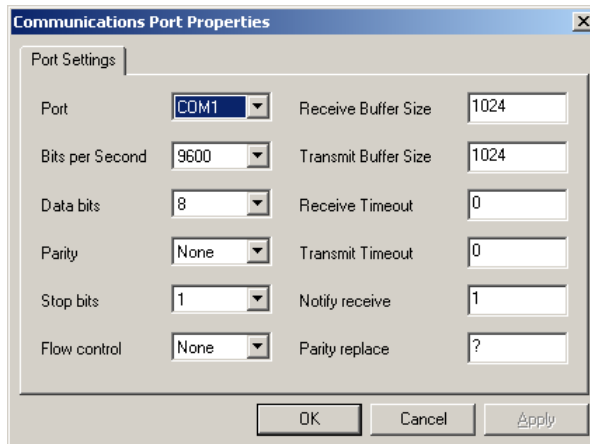
1) Set up each item as follows. (NED standard)
   However, when the setup which differs to the camera to connect is shown, follow there.

    (1) Port: Select connecting port.
    (2) Bits per Second: 9600
    (3) Data bits: 8
    (4) Parity: None
    (5) Stop bits: 1
    (6) Flow control: None

Note: Other parameters are not used.

Click "OK" button.
Click "Cancel" button when stopping setup.

Note:
The camera can be used without this operation after it has been set up correctly.

8.5.2.3 Setting Camera Link API
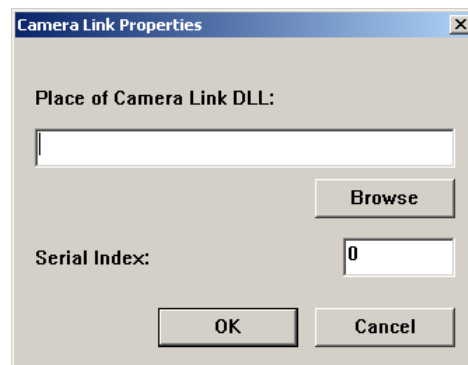
Input the DLL file name for Camera Link API by edit-box,
or click "Browse" button and select this file.
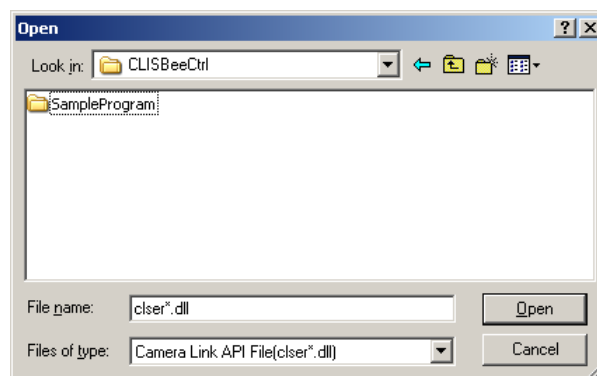
Input value corresponding to the position of Camera Link cable to connect, into
"Serial Index" column.

Click "OK" button.
Click "Cancel" button when stopping setup.

Note: The camera can be used without this operation after it has been set up
       correctly.

Note: DLL for Camera Link API is provided by the manufacturer of the grabber board.
       Please contact the manufacturer of the grabber board for detail.

8.5.2.4 Setting Timeout
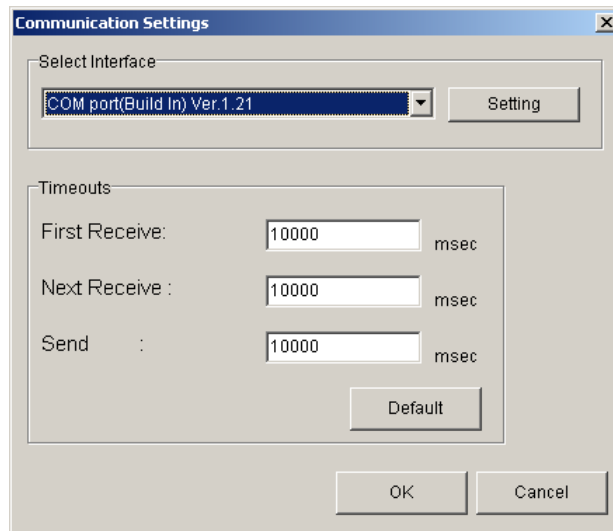
Input each timeout value in the edit-box (unit: msec)

When clicking the "Default" button, the value will be reset to the camera's default values.

The meanings of each timeout are as follows.

First Receive: The maximum time from sending a command to receiving the first data.

Next Receive: The maximum time between a letter and the next one.

Send: The maximum time until finishing sending a command.

Click "OK" button.

Click "Cancel" button when stopping setup.

Note: The camera can be used without this operation after it has been set up correctly.

8.5.3 Connect

Click button B. Then you can control the camera. (See "8.6.Control")
Click the "Memory Dump" button to acquire the current data of the camera.
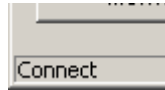
8.5.4 Disconnect and end program

Click button C. Then click "X" button in the upper right of the window.

8.5.5 Check of the contents of communication

Click "Console" tag near the bottom window.
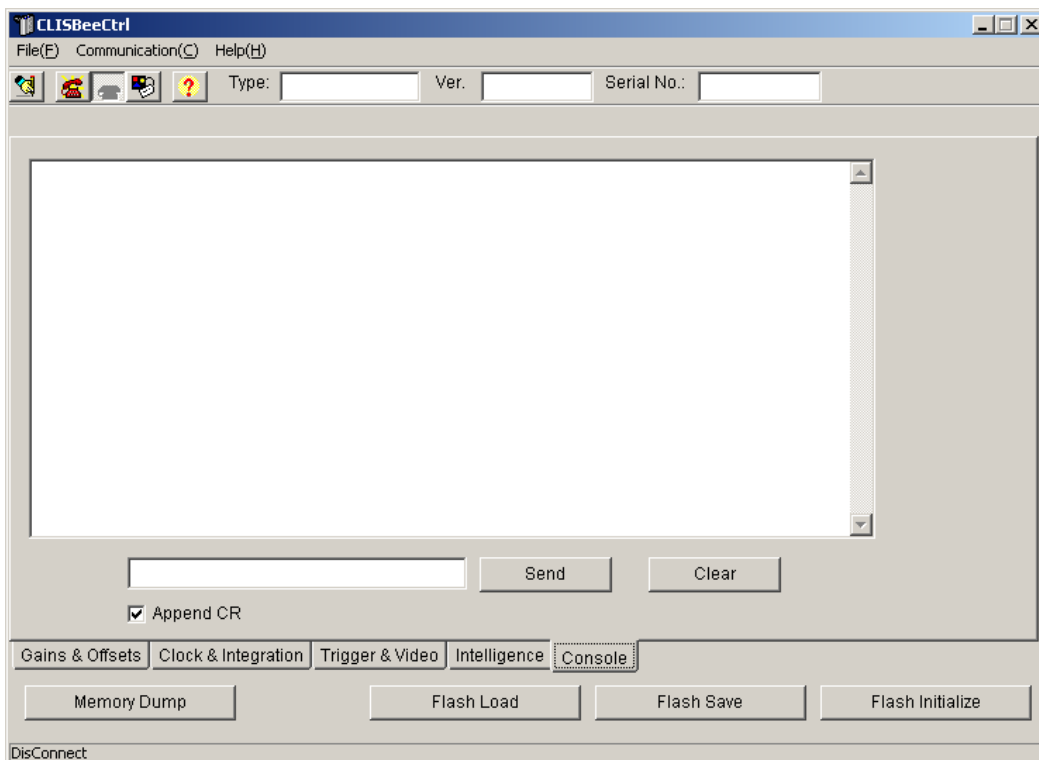
8.5.6 Export Parameters to text file

Click button A.
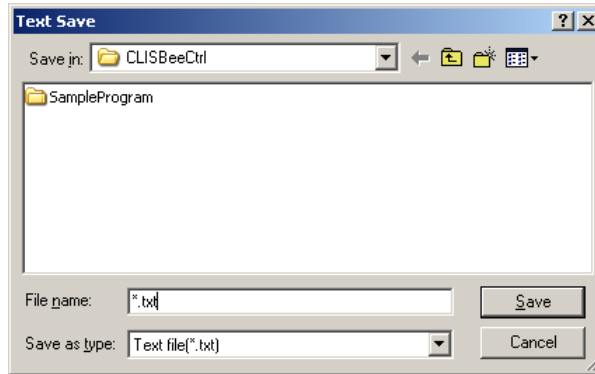
 Input file name and click "Save" button. Present setting value of each control is saved by text format.

8.5.7 Import Parameters from text file

Select menu "File" – "Text Load"
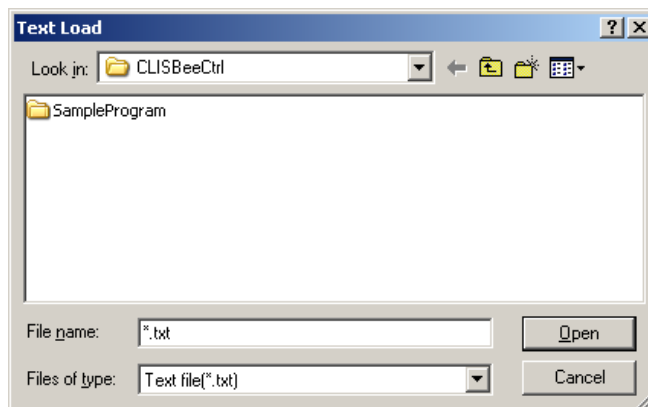
Input file name and click "Open" button.

8.6 Control

8.6.1 Gains and Offsets
『Gains & Offsets』 tab.
< Gain >
  Analog 1 :
    The signal will be sent to the camera every time you make a selection from the menu in the drop-down-list-box.
    Note:
    This camera does not use 'Analog 2'
  Digital :
    Set a value with the slider, the edit-box or the spin-button. Then, click "Send" button.
< Offset >
  Digital :
    Set a value with the slider, the edit-box or the spin-button. Then, click "Send" button.
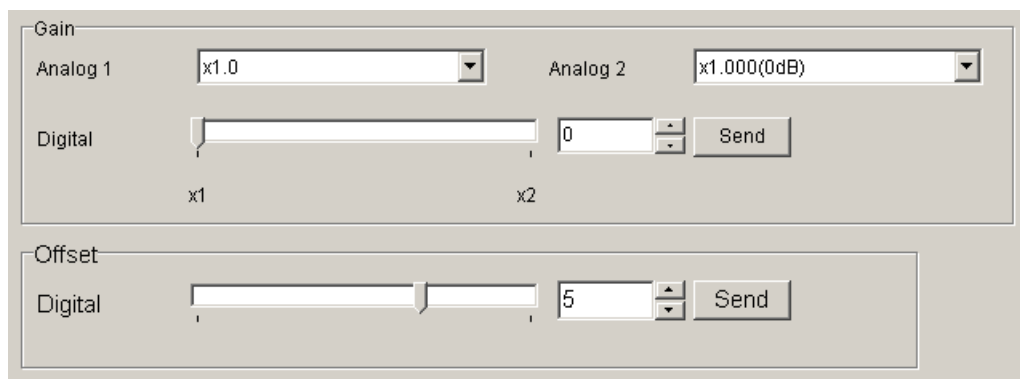
8.6.2 Clock & Integration

『Clock & Integration』 tab.

Clock: Shows the camera internal clock frequency.

Note: Read Only

Integration Time: Setting integration time. (unit: μs)

Dividing: 1 (fixed)

Counter: Set a counter value with the slider, edit-box or the spin-button. Then, click "Send" button.

Padding: Set a counter value with the slider, edit-box or the spin-button. Then, click "Send" button.

Padding time: Shows the calculated value of the Padding. (unit: μs)

Scanrate: Shows the calculated value of the scan rate. (unit: μs)

Scanrate -> Counter automatic setting:

The Counter value of Clock, Dividing, and Padding is calculated and set from the present value when the scanning cycle is set and then clicking on the "Scanrate->Counter Calculating" button.

8.6.3 Exposure mode (Trigger Mode) & Video output mode

『Trigger & Video』tab.

Exposure mode （Trigger Mode）

Select Free Run Exposure mode, External Trigger Exposure mode and External Trigger level. The signal will be sent to the camera every time you make a selection from the menu in the drop-down-list-box.
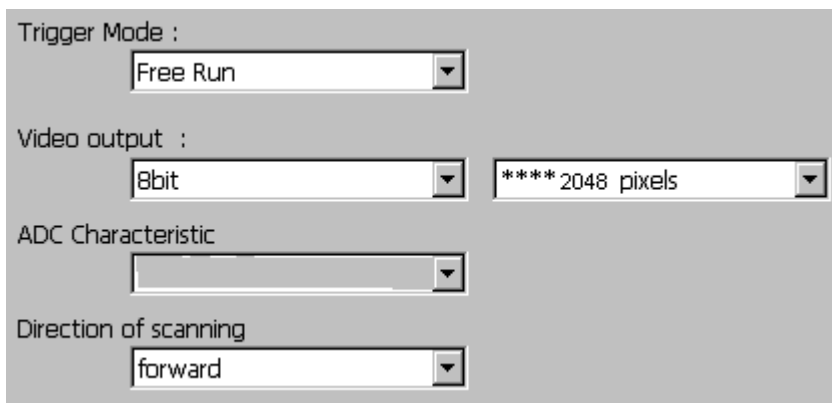
Video output:

Select the number of the output bit and the output block. The signal will be sent to the camera every time you make a selection from the menu in the drop-down-list-box.

ADC Characteristic

Read Only

Direction of scanning:

The order of outputting data from the camera is switched in positive direction (forward) or opposite direction (reverse).

8.6.4 Intelligence

『Intelligence』 tab.

< Calibration >

Calib White:

Acquisition of white data and saving the calibration data to camera's flash memory.
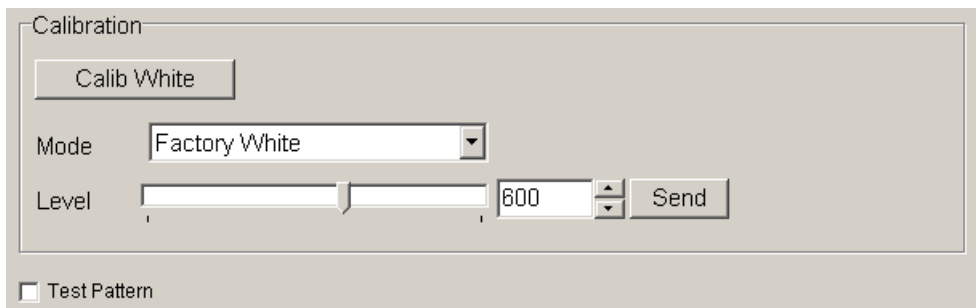
Mode / **Level**:

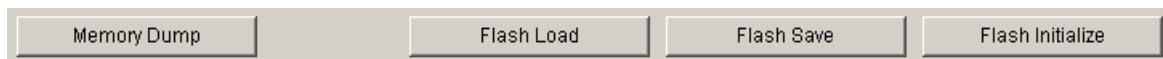First, choose the mode from the drop-down-list-box.

Next, set a value with the slider, the edit-box or the spin-button. Then, click "Send" button.

Test Pattern:

On/Off of the test pattern output is switched clicking the check box.

8.6.5 Memory in camera

Memory Dump:

Read the data from the camera's work memory.

Flash Load:

Loading the data from the camera's flash memory.

Flash Save:

Saving the data in the camera's flash memory.

Flash Initialize:

Initializing the camera's flash memory with the factory standard data.

Note:

It takes a while to save and initialize.

8.7 Upgrade

When installing a newer / updated software version from our company,
Please perform in the following procedure.

Check the CLISBeeCtrl has not started.
Uninstall the old version software. (See "8.4.Uninstall")
Install new version software. (See "8.3.Install")

8.8 How to Program

Please refer sample programs in CLISBeeCtrl->SampleProgram folder.

8.9 Attention on use

Reproducing and distributing without notice the part or all of this software and this document is prohibited.
Reverse engineering, decompiling, disassembling and modifying parts or all of this software without notice is prohibited.
The specification of this software and the contents of this document may be changed without announcement.

9 Others

9.1 Notice

● No part of this document may be reproduced in any form, in whole or in part, without the expressed written consent of NED.

● 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.

9.2 Contact for support

Nippon Electro-Sensory Devices Corporation

Head Office
  2-5-12, Itachibori, Nishi-ku, Osaka 550-0012, Japan
  Phone +81-6-6534-5300
  Fax +81-6-6534-6080

Tokyo Branch
  Gibraltar Oi BLDG., Room No.402
  1-45-2, Oi, Shinagawa-ku, Tokyo 140-0014, Japan
  Phone +81-3-5718-3181
  Fax +81-3-5718-0331

Nishi-Nippon Branch
  Twin Square 1-8-28 Enokida, Hakata-ku, Fukuoka, 812-0004, Japan
  Phone +81-92-451-9333
  Fax +81-92-451-9335

URL
  http://ned-sensor.co.jp/

E-Mail
  sales@ned-sensor.com

9.3 Product Support

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

   In such case, please inform us of the status of the camera. You can get the status by
   (1) executing the "sta" command, or
   (2) clicking "Memory Dump" button when using CLISBeeCtrl.

The example of the camera status.
   sta
   >OK
   >Type=XCM1040DLCT3
   >Ver. =1.15_0x0151
   >Serial=2
   >gax 0
   >gdx 0
   >gdxr 0
   >gdxg 0
   >gdxb 0
   >odx 0
   >odxr 0
   >odxg 0
   >odxb 0
   >gdxge 0
   >gdxgo 0
   >inm 0
   >int 0, 10000
   >pad 0
   >shc 1,200
         .
         .
         .
   >gamma 0,1000
   >sta

Revision History

Revision Number	Date	Changes
04	8 April 2020	Initial release