User's Manual

Line Scan Camera

Type: RCDL2K20CL

CAMERA Link

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
EN55032:2015 Class A
EN55011:2009+A1:2010 Class A
EN61000-6-2:2005

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 fluorescent lamp is recommended. If halogen lighting is employed, always install an infrared filter into your system configuration.
- 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 lost by using 4.2.24 Setting Pixel Correction. Please refer to 4.2.23 White Pixel Correction Data Save.
- Note that when the sensor is exposed to excessive quantities of light, blooming may occur, because this product does not have a special Anti-Blooming function.
- Suitable measures should be taken to protect the colour filter on sensor from bright light when it is not in use.
- If the sensor is continually exposed to excessive amount of light over time, the colour filter may become faded.
- 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:
- The expired date of the warranty period on the product repaired or replaced during the warranty period of the original product is the same as the expired date of the warranty period on the original product.

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

- Color line scan camera with 2048 pixels equivalent to 14μm.
- Color line scan camera with 7μm 4096 x 2 pixels sensor of Bayer color arrangement.
- Output format is 2048 pixels, 8bit R,G,B, 3TAP output.
- Camera Link Base Configuration (8bit / 3 tap) video output.
- On-chip AD conversion (8bit)
- 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
- Standard camera mount is F mount

1.2 Application

- 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
- Inspection of high speed moving objects
- This camera utilizes an Intelligent Transportation System
- ITS-related applications

An example of visual inspection of metallic parts is shown below.

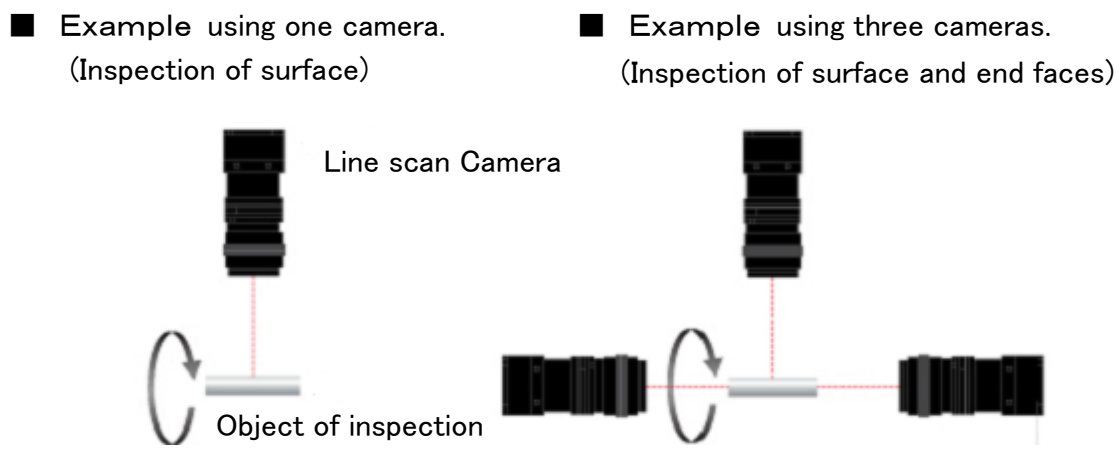


Figure 1-2-1 Visual Inspection of Metallic Cylinder

Object of inspection (example)

Metallic parts with cylindrical/conical shapes (surface and roller end faces)

・Automobile component ・Architectural reinforcement parts

・Various pin parts

Typical detection item

・Chip ・Dent ・Scratch ・Chipped end faces ・External dimensions

Device specification

1. Camera: 4096 pixel Line scan camera
2. Controller: Dedicated software for PC system

An example of Visual Inspection of PCBs is shown below.

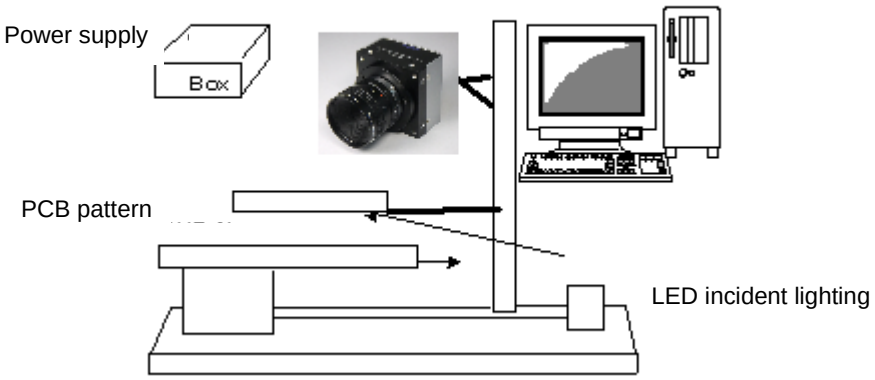


Figure 1-2-2 Visual Inspection of PCBs

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

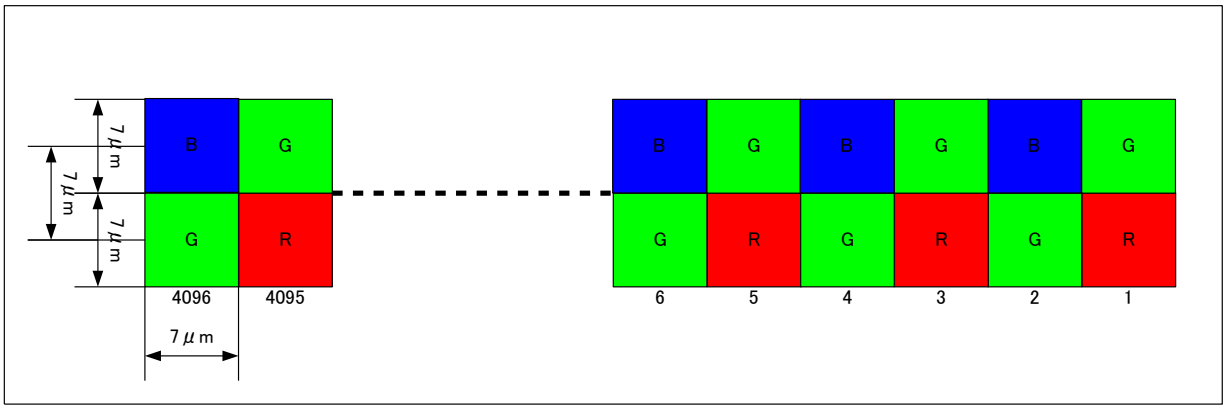
Inspection of patterns on film PCBs

1.3 Image Sensor

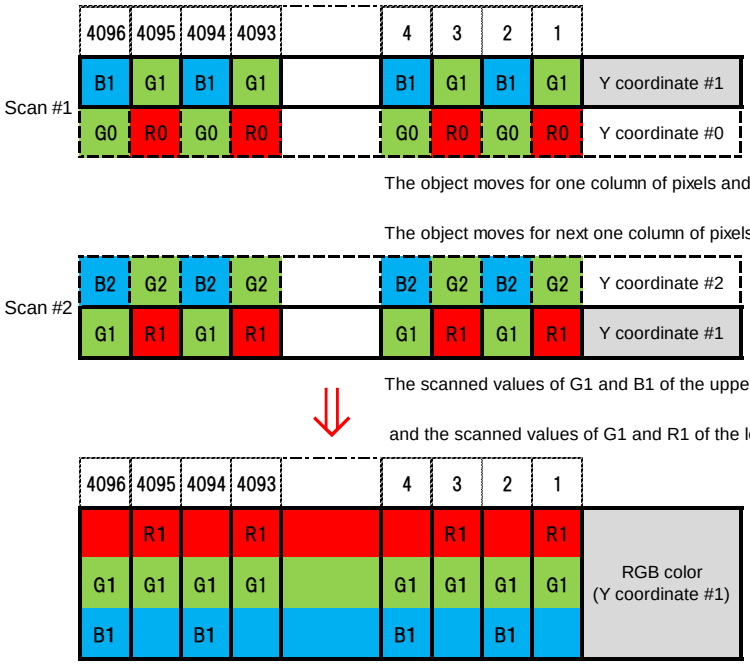
This camera uses a CMOS sensor with a maximum data rate of 45MHz to acquire highly sensitive and high quality images.
The pixel size is equivalent to 14µm x 7µm and outputs 2048 pixels of RGB data at 45MHz-3Tap.

This camera uses a 4096 pixel Bayer array dual line color CMOS sensor to obtain high sensitivity and high quality images.
The sensor has a pixel size of 7 µm x 7 µm, and the RGB data of 7 µm 4096 pixels is combined by line correction as shown below. At this time, 0.1 line unit correction is performed by storing pixels in the vertical direction. After that, binning is performed in the horizontal direction to output 2048 pixel RGB data of 14µm x 7µm.

・The sensor is a dual-line 4096-pixel sensor with a Bayer array of color filters.



1.4 RGB Synthesis method with Bayer at pixel



1.5 Performance Specifications

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

Table 1-5-1 Performance Specifications

Items		Specifications
Number of Pixels		2048
Pixel Size H x V (μm)		14 x 7 equivalent
Sensor Length (mm)		28.672
Data Rate (MHz)		45
Max. Scan rate [kHz] / Min. Scan period (μs)		20 / 50.0
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 10.0(8 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)		-40 to 40 (161 Steps)
Digital Offset Adjustable Range (RGB individual)		-20 to 20 (81 Steps)
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] x 1
	Power Supply	Hirose: HR10G (6Pin)
Lens Mount		F Mount
Operating Temperature (˚C) No Condensation		0 to 50
Power Supply Voltage (V)		DC 12 to 15 [±5%]
Consumption Current (mA) (typically)		300 (DC12V)
Size W x H x D (mm)		60x100x76
Mass (g) (Camera only)		Approx.380

Additional Function	1. Auto White Balance 2. Shading Correction 3. Programmable Exposure Control 4. Scan Direction Switching 5. Noise reduction 6. Line Correction 7. RGB Color Matrix Transforming

Note:

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

*2) Measurements were made at room temperature.

The spectral responsivity is shown below.

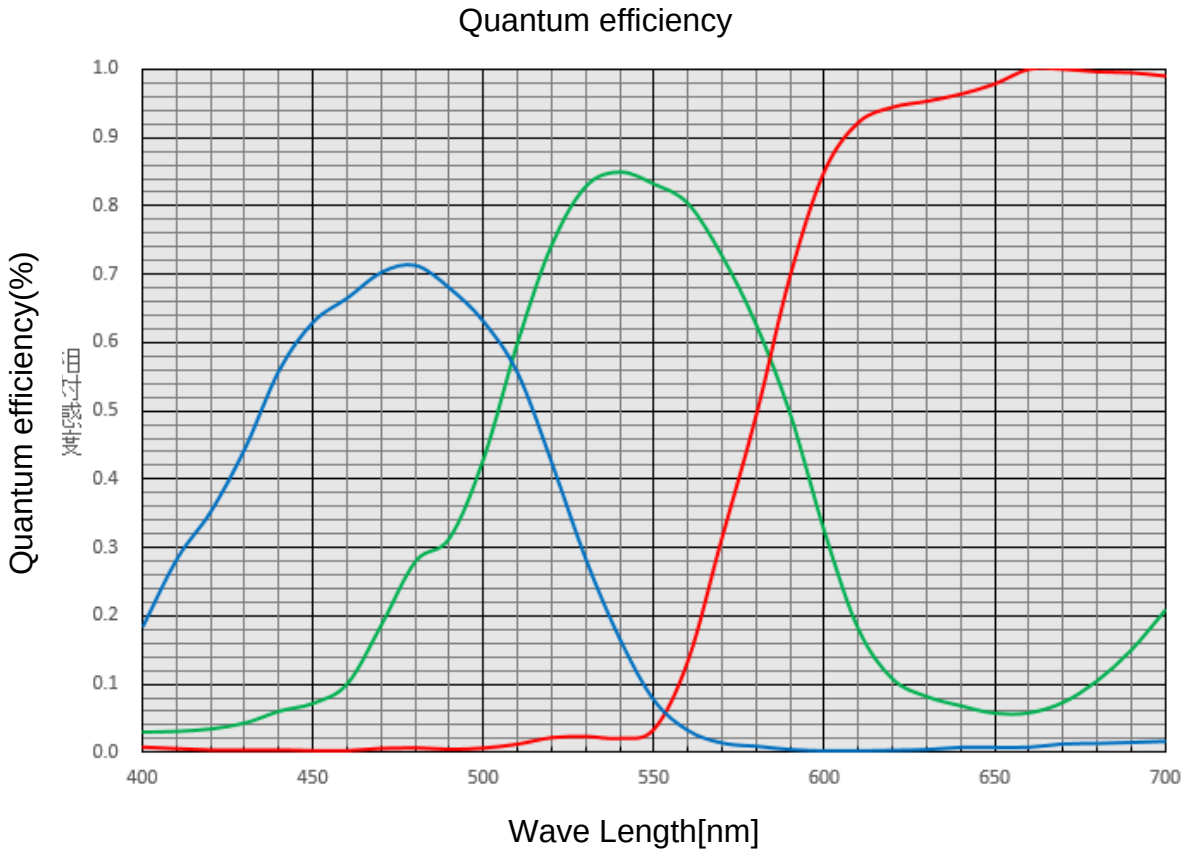


Figure 1-5-1 Spectral Responsivity

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.

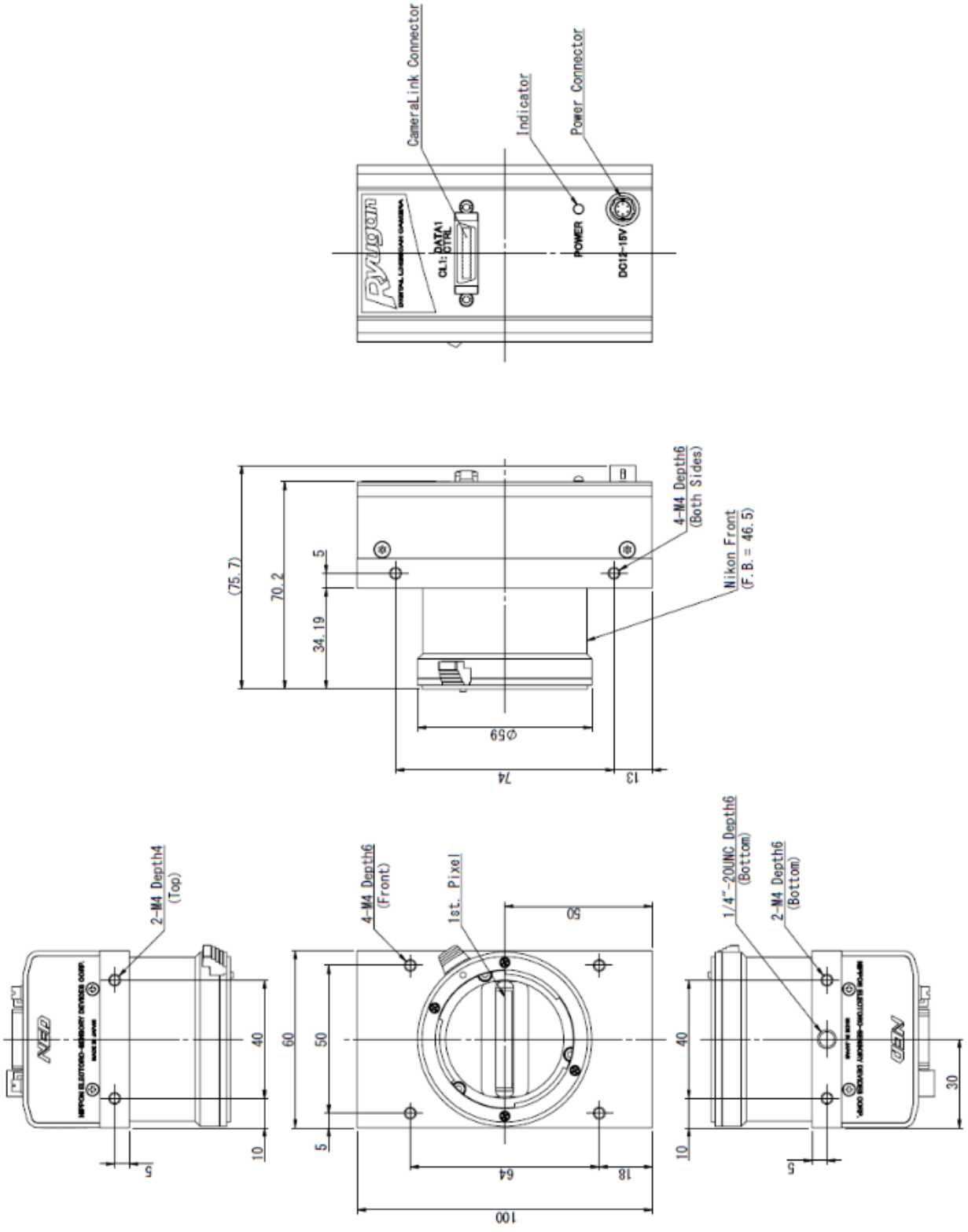


Figure 2-2-1 Dimensions of the Camera

2.3 Optical Interface

This camera comes with a F-Mount as standard.

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 The factory-set white balance adjustment values

This camera uses a daylight fluorescent lamp NEC FL20SD as a light source when acquiring pixel correction values. If the light source or lens is different, the white balance may be distorted or the waveform may have peaks and valleys. This is due to the influence of the light source or the lens used, and is not a malfunction. In such a case, perform automatic white balance or pixel correction under the optical conditions (light source and lens).

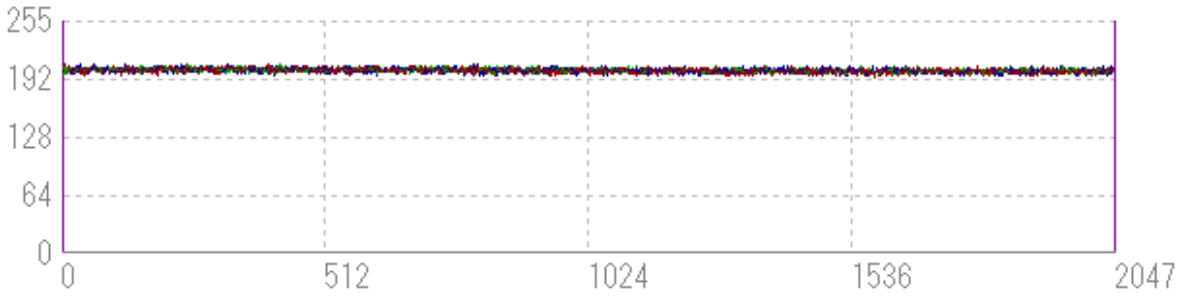
See below for more details.

4.1.4 Camera Control Commands
4.2.11 Reset Auto White Balance
4.2.23 White Pixel Correction Data Save
4.2.24 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.

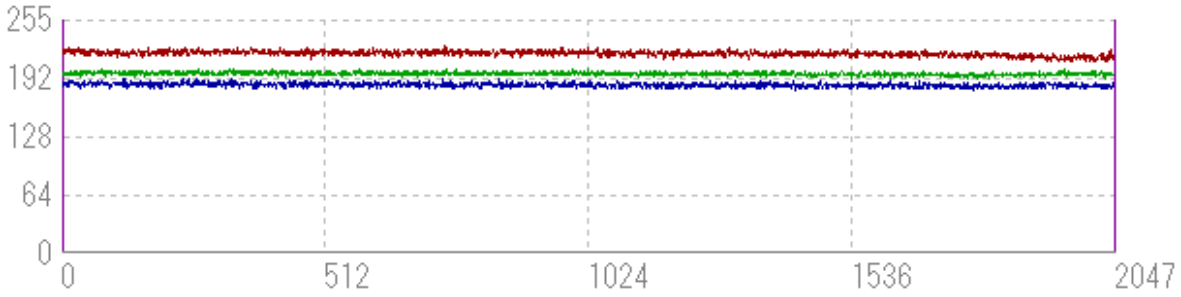
(1) Waveforms using daylight fluorescent lamp

The waveform using daylight fluorescent lamp NEC FL20SD with this camera is flat after adjusting white balance at Factory.



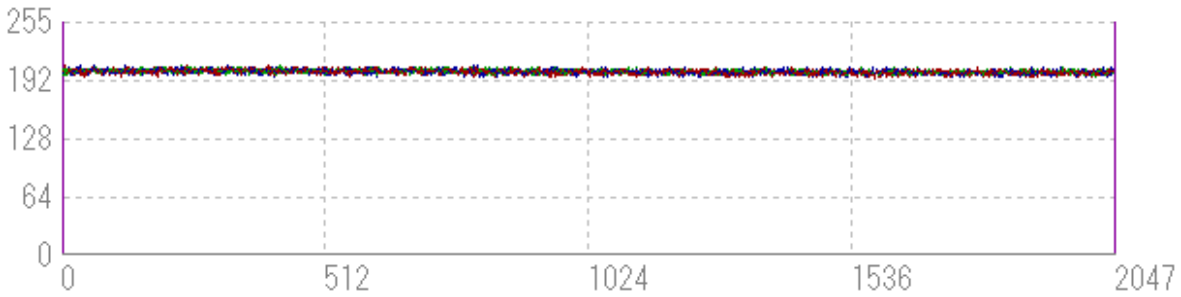
(2) Waveforms using 3-wavelength fluorescent lamp

The waveforms using 3-wavelength fluorescent lamp with this camera at Factory white mode are shown below.
The white balance is broken.



(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.



3 Hardware

3.1 Camera Connection

In order to use the camera, the following steps are required.

1. Connect the camera to the frame grabber board (image acquisition board) using a Camera Link-compatible cable.

A single Camera Link compatible cable is used to connect the camera and frame grabber board.

When using a directional Camera Link compatible cable, connect the connector labeled "Camera side" to the camera.

2. Connect to the power supply.

Use the power cable to connect the camera to the power supply for the camera. Connect the plug side of the power cable to the camera, and connect the unprocessed side to the power supply for the camera. In addition to the above, a personal computer, frame grabber board, imaging lens, lens mount, light source, encoder, etc. are required. Select the appropriate one for your purpose and configure it appropriately.

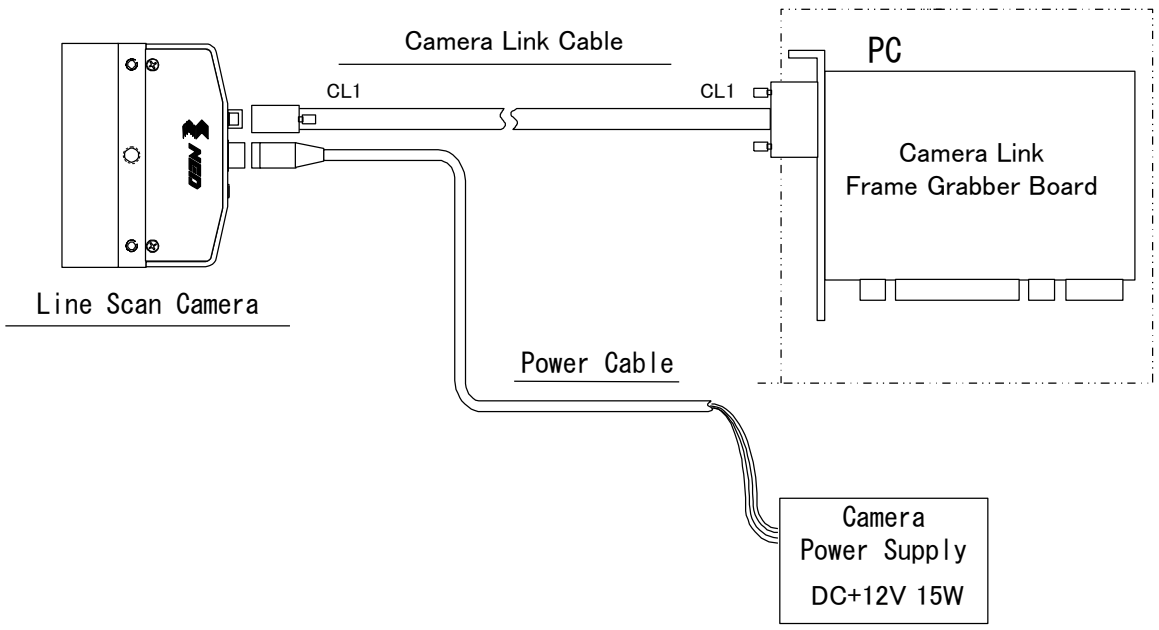


Figure 3-1-1 Connections between Camera and Frame Grabber Board and Power Supply

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.

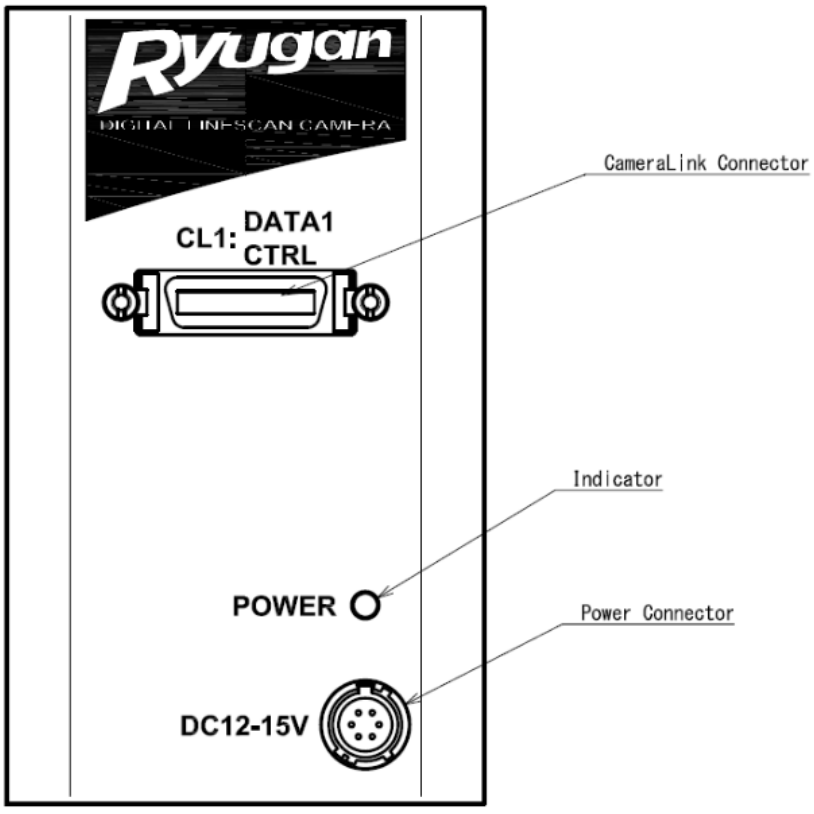


Figure 3-2-1 Input/Output Connectors and Indicator

3.3 Connectors・Pin Assignments・Cables

This camera adopts Base 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.

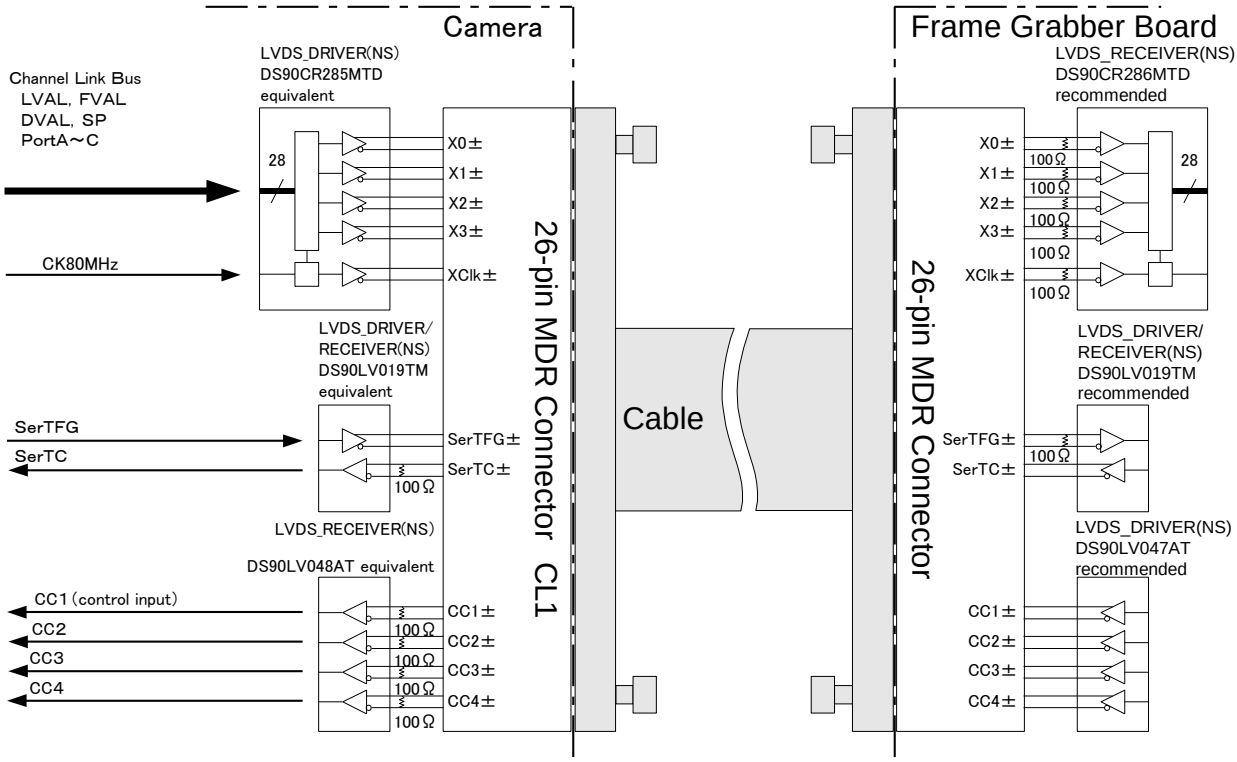


Figure 3-3-1 Camera / Frame Grabber Interface

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.

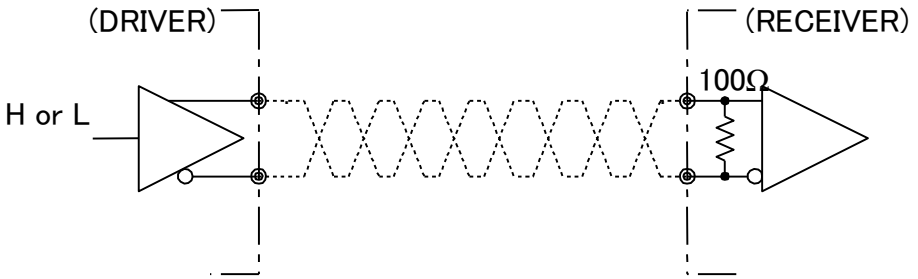


Figure 3-3-2 Circuit of LVDS

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

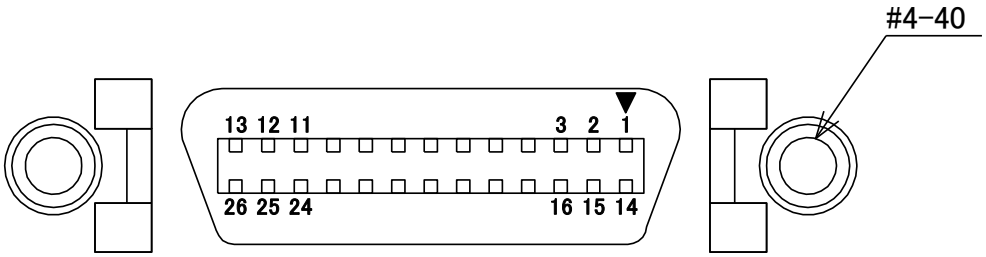


Figure 3-3-3 Camera Link Connector

- 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- : Not in use (LVDS)

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

  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. The compatible cable (compatible plug) is DGPSH-10 (Hirose: with HR10A-7P-6S).

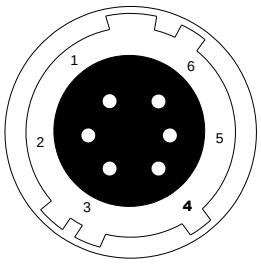


Figure 3-3-4 Power Supply Connector (HIROSE: HR10G-7R-6PB)

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

No	Name	cable color
1	12 –15V	white
2	12 –15V	red
3	12 –15V	―
4	GND	green
5	GND	black
6	GND	―

Notes:

1) The cable color in the table indicates the compatible cable DGPSH-10.

3.4 Power supply

3.4 Power Supply

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

When DC +12 to +15V power is supplied, the indicator (LED) lights up red, and after about 10 seconds, it changes to light up green and enters the operating state.

Notes:

1) It is recommended to select a power supply with enough capacity to handle the inrush current. (5 W or more is recommended)
2) Make sure that the cable plug is firmly inserted until it locks to prevent the connector from being disconnected during power-on.
3) If this product is to be used in an area where lightning occurs frequently, take measures against lightning surges on the power supply line to the camera.
4) The power supply and grounding of the camera should not be connected to equipment that generates large electromagnetic waves (e.g. inverter-controlled motors), as this may cause malfunction or failure.

   Also, make sure that the signal cable and power cable are separated from the

equipment and the camera, and not next to each other.

5) If the camera does not light up even when the power is supplied, turn off the power immediately and check that there is no problem with the wiring or the voltage or capacity of the power supply.
6) It is recommended that the shielding of the power cable be connected to the GND of 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: 300mA

◆ 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 functions of the camera can be controlled by commands through serial communication. There are two ways to do this: by sending commands directly over serial communication, or by using NCamCtrl (camera control software).

Once the camera is configured, the camera will operate properly without using serial communication.

4.1 Flow of Camera Control

4.1.1 Command Overview

The command consists of a simple combination of ASCII codes.

- Communication is initiated by sending a control command from the PC to the camera.
- The camera analyzes the received control command and executes the control according to the received control command.
- The communication is terminated by sending back the result of the received control command analysis from the camera to the PC.
- ◆ The next communication should be started after one communication is completed. (One command is one communication.)

4.1.2 Camera Receiving Message (PC Sending Command)

- Format 1 CMD CR
- Format 2 CMD☐VAL CR

CMD : Control character (Refer to Table 4-1-4-1 Command List)
CR : Delimiter character (0x0D)
☐ : Space character (0x20) or comma character (0x2C)
VAL : Set value

<Example>
gax☐0 CR

4.1.3 Camera Sending Message (PC Receiving Message)

- Format R 1 >R CR >[SB] CR EOT
- Format R 2 (when CMD is "sta") >OK CR >[MEM] CR >sta CR EOT

>: Results start character (0 x 3E)
R: Result of camera receive command analysis
[SB]: Camera receive command sendback
[MEM]: Read value of memory data
CR**:** Delimiter character (0 x 0D)
EOT: Full-text end character of the send command (0x04)

<Example>
>OK CR >gax 0 CR EOT

Table 4-1-3-1 Error Messages

Camera Response	Meaning
OK	Command received successfully
CMD ERR!	Command error
CMD OVR ERR!	Command string overflow error
VAL ERR!	Out-of-range set value error
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	VAL	Control Description	Factory Settings
Analog Gain (RGB common)	gax	0 to 7	x1.00....x10.0 (8step)	0
Digital Gain (RGB common)	gdx	0 to 511	x1…x2 : (1+0.00195xVAL)	0
Digital Gain (R)	gdxr	0 to 1022	x1…x3 :(1+0.001957xVAL)	0
Digital Gain (G)	gdxg	0 to 1022	x1...x3 :(1+0.001957xVAL)	0
Digital Gain(B)	gdxb	0 to 1022	x1...x3 :(1+0.001957xVAL)	0
Digital Offset (RGB common)	odx	-80 to 80	-40…40(0.5DN/step)	0
Digital Offset(R)	odxr	-40 to 40	-20…20(0.5DN/step)	0
Digital Offset(G)	odxg	-40 to 40	-20…20(0.5DN/step)	0
Digital Offset(B)	odxb	-40 to 40	-20…20(0.5DN/step)	0
Auto White Balance	awb		Adjust gdxr, gdxg, gdxb automatically	
White Balance Reset	rwb		Set gdxr, gdxg, gdxb at x1	
Noise reduction	nr	0 / 1	OFF / ON	0
Exposure Mode	inm	0 / 1 / 2	Free Run / Ext Edge / Ext Level	0
LineRate	prd	500 to 20000	Line rate setting (Hz)	2640
Programmable Exposure Time	expo	2000 to 1997700	Exposure time setting (nsec.)	376400
Memory Initializing	rst		Reset to factory settings	
Memory Load	rfd		Readout setup data in memory	
Memory Save	sav		Store present setup data in memory	
Scanning Direction	rev	0 /1	0: Forward / 1: Reverse	0

Test Pattern	tpn	0 / 1 / 2 / 3	OFF / ON(GreyHorizontalRamp) / ON(GreyDiagonalRamp) / ON(ColorBar)	0
Line delay direction	odir	0 / 1	Forward / Reverse	0
Line delay value	lsc	0 to 15	Set value (number of lines)=val×0.1 * Absolute value	5
White Pixel Correction Data Save	wht		User arbitrary white pixel correction data is acquired and stores it in the memory.	
Pixel Correction Setting	ffcm	0 / 1	Factory white correction / User arbitrary white correction	0
Target correction value setting	ffct	0 to 1023	Target correction value setting (10-bit display)	800
Operation Status Readout	sta		Returns the current camera settings.	
Color Matrix Transforming	colmtx	0 / 1	OFF / ON	0
Color Matrix Coefficient(krr)	krr	-3000 to 3000	1.0 as coefficient krr is expressed with 1000	1000
Color Matrix Coefficient(krg)	krg	-3000 to 3000	1.0 as coefficient krg is expressed with 1000	0
Color Matrix Coefficient(krb)	krb	-3000 to 3000	1.0 as coefficient krb is expressed with 1000	0
Color Matrix Coefficient(kgr)	kgr	-3000 to 3000	1.0 as coefficient kgr is expressed with 1000	0
Color Matrix Coefficient(kgg)	kgg	-3000 to 3000	1.0 as coefficient kgg is expressed with 1000	1000
Color Matrix Coefficient(kgb)	kgb	-3000 to 3000	1.0 as coefficient kgb is expressed with 1000	0
Color Matrix Coefficient(kbr)	kbr	-3000 to 3000	1.0 as coefficient kbr is expressed with 1000	0
Color Matrix Coefficient(kbg)	kbg	-3000 to 3000	1.0 as coefficient kbg is expressed with 1000	0
Color Matrix Coefficient(kbb)	kbb	-3000 to 3000	1.0 as coefficient kbb is expressed with 1000	1000

Color Matrix Offset(R)	kor	-512000 to 512000	Express 1 in 4000	0
Color Matrix Offset(G)	kog	-512000 to 512000	Express 1 in 4000	0
Color Matrix Offset(B)	kob	-512000 to 512000	Express 1 in 4000	0

4.2 Details on Commands

4.2.1 Setting Analog Gain

Sets analog gain in 8 steps between x 1.0 to x 10.0

- Format 2 CMD□VAL CR
- CMD gax
- VAL 0 (for x1.0) to 7 (for x10.0)

<Example>

gax□5 CR (Setting analog gain 5(x6.0))

>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 CR
- CMD gdx
- VAL 0 (for x 1) to 511 (for x 2)

<Example>

gdx□255 CR (Setting digital gain 255(1+0.001957x255=x1.50))

>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 CR
- CMD gdxr
- VAL 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 CR
- CMD gdxg
- VAL 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 CR
- CMD gdxb
- VAL 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 Digital Offset(RGB common)

Sets digital offsets of the RGB signals between -80 and 80(0.5DN/step).

- Format 2 CMD□VAL CR
- CMD odx
- VAL -80 to 80

<Example>

odx□10 CR (Setting digital offsets of the RGB signals +5DN at the same time)
>OK
>odx 10

4.2.7 Setting Digital Offset(R)

Sets digital offset of the R signal between -40 and 40(0.5DN/step).

- Format 2 CMD□VAL CR
- CMD odxr
- VAL -40 to 40

<Example>

odxr□10 CR (Setting digital offset of the R signal +5DN)
>OK

>odxr 10

4.2.8 Setting Digital Offset(G)

Sets digital offset of the G signal between -40 and 40(0.5DN/step).

- Format 2 CMD□VAL CR
- CMD odxg
- VAL -40 to 40

<Example>

odxg□10 CR (Setting digital offset of the G signal +5DN)

>OK

>odxg 10

4.2.9 Setting Digital Offset(B)

Sets digital offset of the B signal between -40 and 40(0.5DN/step).

- Format 2 CMD□VAL CR
- CMD odxb
- VAL -40 to 40

<Example>

odxb□10 CR (Setting digital offset of the B signal +5DN)

>OK

>odxb 10

4.2.10 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 1 CMD□CR
- CMD awb

<Example>

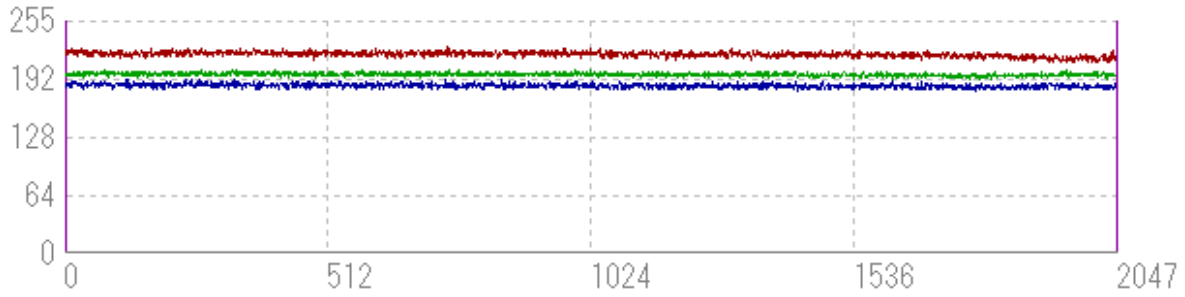
awb CR

>OK

>awb

The “awb” command can be used to balance the output levels of the area around sensor center (around 1024th pixel)

Before using “awb” command



After using “awb” command

4.2.11 Reset Auto White Balance

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

- Format 1 CMD□CR
- CMD rwb

<Example>

rwb CR
>OK
>rwb

4.2.12 Setting Noise reduction

Sets noise reduction

- Format 2 CMD□VAL CR
- CMD nr
- VAL 0,1 (0:OFF , 1:ON)

<Example>

nr□1 CR (Setting Noise reduction enabled)
>OK
>nr 1

4.2.13 Setting Exposure Mode

Sets the exposure mode.

- Format 2 CMD□VAL CR
- CMD inm
- VAL 0,1,2 (0:FreeRun , 1:ExtEdge , 2:ExtLevel)

<Example>

inm□0 CR (Setting the exposure mode free run)

>OK

>inm 0

4.2.14 Setting Line Rate

Sets the line rate.

- Format 2 CMD□VAL CR
- CMD prd
- VAL 500 to 20000

<Example>

prd□3000 CR (Setting LineRate 3000Hz)

>OK

>prd 3000

4.2.15 Setting Exposure Time

Sets the exposure time.

- Format 2 CMD□VAL CR
- CMD expo
- VAL 2000 to 1997700 (nsec.)

<Example>

expo□12000 CR (Setting Exposure Time 12000nsec.)

>OK

>expo 12000

Supplementary explanation

The relationship between the scan rate and the exposure time is as follows.

Scan time (inverse of scan rate) > Exposure time + Blanking (fixed value)

When the scan rate is set, there are cases where the scan rate and the already set exposure time do not satisfy the above equation. In this case, the camera does not consider it as an error and adjusts the exposure time (the exposure time is automatically adjusted by the camera). This automatically adjusted exposure time is displayed by pressing the Get Current Value button.

When the exposure time is set, there will be cases where the exposure time and the already set scan rate do not satisfy the above equation. In this case, the camera will adjust the scan rate without reporting an error (the camera will automatically adjust the scan rate). This automatically adjusted scan rate can be displayed by pressing the Get Current Value button.

4.2.16 Memory Initializing (Initializing Camera Settings)

Reset the flash memory to the factory default.

- Format 1 CMD CR
- CMD rst

<Example>

```
rst
>OK
>Model=RCDL2K20CL
>Ver.=0.60_0xff08
>Serial=0
>gax 0
>gdx 0
>gdxr 0
>gdxg 0
>gdxb 0
>odx 0
>odxr 0
>odxg 0
>odxb 0
>inm 0
>prd 2640
>expo 376400
>rev 0
>tpn 0
>ffcm 0
>ffct 800
>colmtx 0
>krr 1000
>krg 0
>krb 0
>kgr 0
>kgg 1000
>kgb 0
```

>kbr 0
>kbg 0
>kbb 1000
>kor 0
>kog 0
>kob 0
>odir 0
>lsc 10
>nr 0
>logmode 1
>rst

4.2.17 Memory Load

Reads out the camera settings from the flash memory.

- Format 1 CMD CR
- CMD rfd

<Example>

rfd
>OK
>Model=RCDL2K20CL
>Ver.=0.60_0xff08
>Serial=0
>gax 0
>gdx 0
>gdxr 0
>gdxg 0
>gdxb 0
>odx 0
>odxr 0
>odxg 0
>odxb 0
>inm 0
>prd 2640
>expo 376400
>rev 0
>tpn 0
>ffcm 0
>ffct 800
>colmtx 0

>krr 1000
>krg 0
>krb 0
>kgr 0
>kgg 1000
>kgb 0
>kbr 0
>kbg 0
>kbb 1000
>kor 0
>kog 0
>kob 0
>odir 0
>lsc 10
>nr 0
>logmode 1
>rfd

4.2.18 Memory Save

Stores the current camera settings in the flash memory.

- Format 1 CMD CR
- CMD sav

<Example>
sav CR
>OK
>sav

4.2.19 Scan Direction

Switches scanning direction.

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

<Example>
rev□1 CR (Reverse)
>OK
>rev 1

4.2.20 Generating Test Pattern

Generates test pattern.

- Format 2 CMD□VAL CR
- CMD tpn
- VAL 0,1,2,3 (0:Image data,1: Grey Horizontal Ramp,
  2: Grey Diagonal Ramp,3: Color Bar)

<Example>

tpn□1 CR (Generating test pattern)

>OK

>tpn 1

GreyHorizontalRamp is as follows

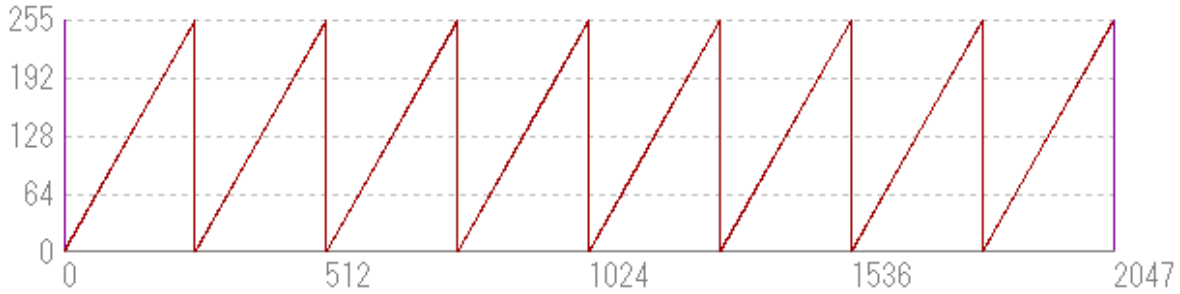


Figure 4-2-20-1(A) RCDL2K20CL GreyHorizontalRamp

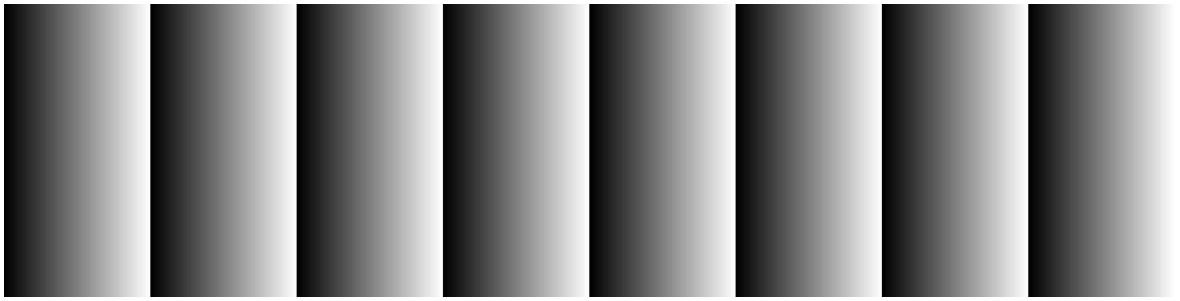


Figure 4-2-20-1(B) RCDL2K20CL GreyHorizontalRamp

The first pixel is 0 DN, and the second and subsequent pixels are incremented by 1 DN up to 255 DN.

This pattern is output repeatedly.

(*) DN: Digital value (8bit: 0-255).

GreyDiagonalRamp is as follows.

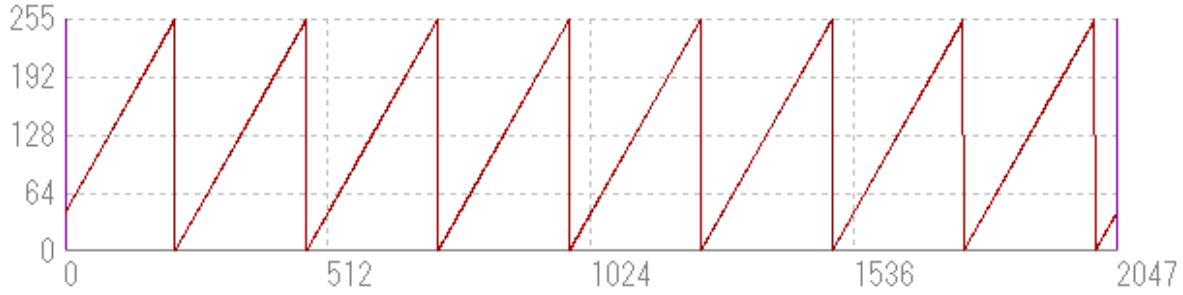


Figure 4-2-20-1(C) RCDL2K20CL GreyDiagonalRamp

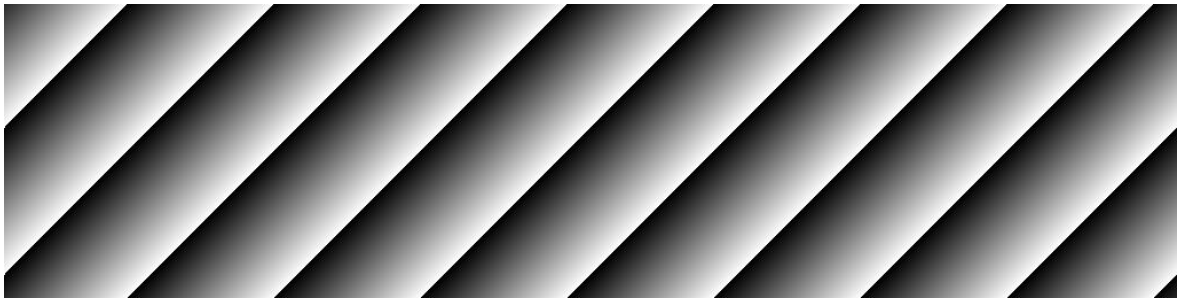


Figure 4-2-20-1(D) RCDL2K20CL GreyDiagonalRamp

It increases by 1 DN per pixel in both horizontal and vertical directions up to 255 DN.
This pattern is output repeatedly.
(*) DN: Digital value (8bit: 0-255)

The ColorBar is as follows

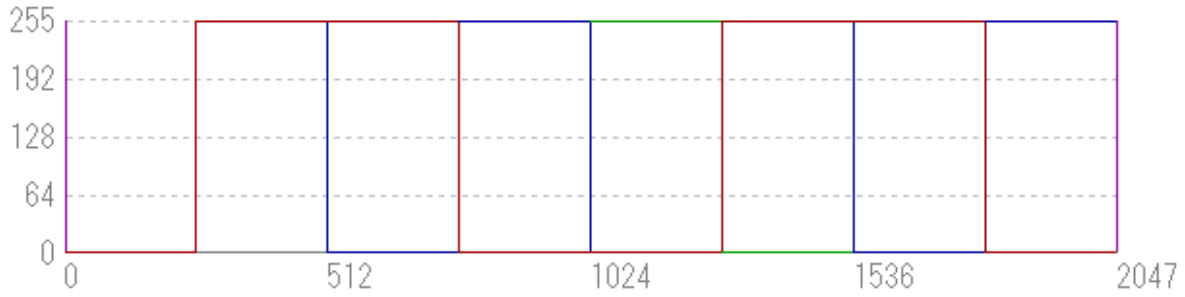


Figure 4-2-20-1(E) RCDL2K20CL ColorBar

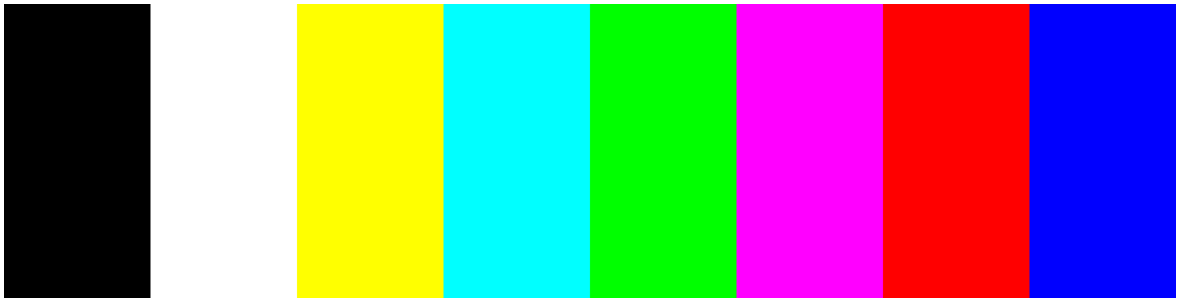


Figure 4-2-20-1(F) RCDL2K20CL ColorBar

Black R:0,G:0,B:0 -> White R:255,G:255,B:255 Yellow R:255,G:255,B:0 -> Cyan R:0,G:255,B:255 -> Green R:0,G:255,B:0 -> Magenta R:255,G:0,B:255 Red R:255,G:0,B:0 -> Blue R 0,G:0,B:255

4.2.21 Setting Line Delay Direction

Sets the line delay direction.

- Format 2 CMD□VAL CR
- CMD odir
- VAL 0,1 (0:forward , 1:Reverse)

<Example>

odir□1 CR (Line Delay Reverse)
>OK
>odir 1

4.2.22 Setting Line Delay Values

Sets the line delay values.

- Format 2 CMD☐VAL CR
- CMD lsc
- VAL 0 to 15 (x10=Number of Lines)

<Example>

lsc☐10 CR (For one line)
>OK
>lsc 10

4.2.23 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

4.2.24 Setting Pixel Correction

Sets pixel correction.

- Format 2 CMD☐VAL CR
- CMD ffcm
- VAL 0,1,2
  0: Correction off
  1: factory white correction
  2: user arbitrary white correction

<Example>

ffcm☐1 CR (factory white correction)
>OK
>ffcm 1

4.2.25 Setting Correction target value

Sets pixel Correction target value.

- Format 2 CMD□VAL CR
- CMD ffct
- VAL 0 to 1023 (10-bit display)

<Example>

ffct□800 CR (white correction level 800)

>OK

>ffct 800

4.2.26 Returning the Camera Settings status

Returns the current camera settings.

- Format 1 CMD CR
- CMD sta

<Example>

sta

>OK

>Model=RCDL2K20CL

>Ver.=0.60_0xff08

>Serial=0

>gax 0

>gdx 0

>gdxr 0

>gdxg 0

>gdxb 0

>odx 0

>odxr 0

>odxg 0

>odxb 0

>inm 0

>prd 2640

>expo 376400

>rev 0

>tpn 0

>ffcm 0

>ffct 800

>colmtx 0

>krr 1000

```
>krg 0
>krb 0
>kgr 0
>kgg 1000
>kgb 0
>kbr 0
>kbg 0
>kbb 1000
>kor 0
>kog 0
>kob 0
>odir 0
>lsc 10
>nr 0
>logmode 1
>sta
```

4.2.27 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 different values of 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 a negative value.

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

- Format 2 CMD□VAL CR
- CMD colmtx
- VAL 0,1 (0:Off , 1:On)

<Example>

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

4.2.28 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□VAL CR
- CMD kxx
- VAL -3000 to 3000(kxx=VAL1/1000)

<Example>

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

4.2.29 Setting Color Matrix offset Values

Set the Color Matrix offset(kor,kog,kob) Value.

- Format 2 CMD□VAL CR
- CMD kor or kog or kob
- VAL -512000 to 512000(kox=VAL/4000)

<Example>

kor□4000 CR (Set the color matrix offset R to 1.00.)
>OK
>kor 4000

4.3 Digital Processing flow in FPGA

The digital processing flow in FPGA is shown below.

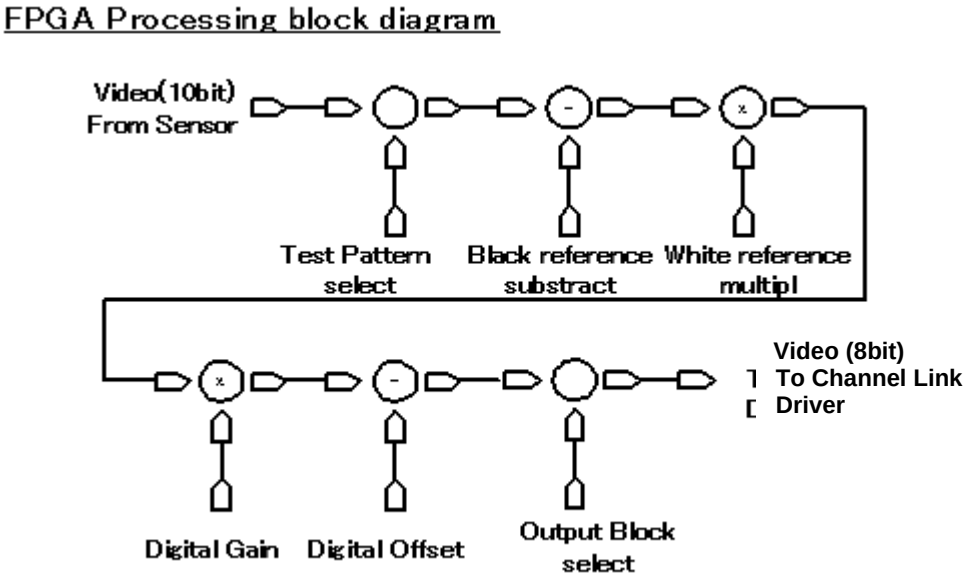


Figure 4-3-1 FPGA Processing Block Diagram

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

4.4 Startup

After powering on, the camera will run a startup procedure before it starts getting images and outputting data. It takes about 10 seconds.

The startup procedure is as follows.

(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. If the data is not within the designated range due to a malfunction or other type of trouble, the memory will be automatically reset to the factory settings.
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) When changing the factory setting exposure mode, be sure to send the control input signal (CC1) supplied from the frame grabber board side. The image can not be captured if the control input signal is not supplied to the camera or the settings of trigger exposure mode is not of the specification range. 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.

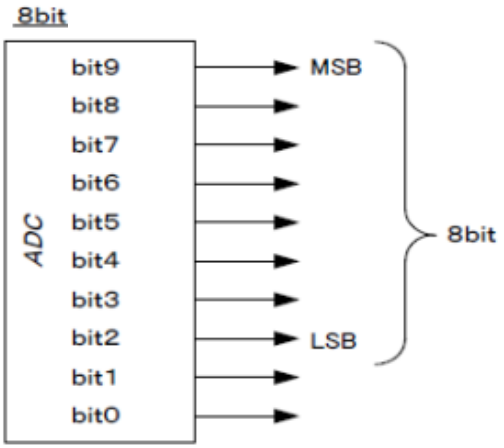
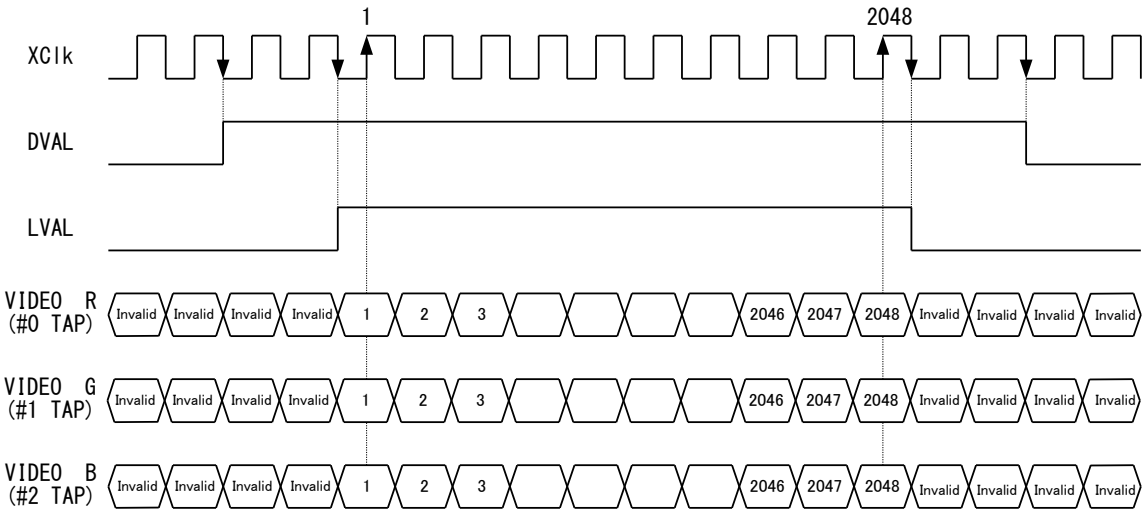


Figure 4-7-1 Pin Assignments of Digital Data

Video output phase of the camera is shown below.

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 RCDL2K20CL

4.8 Exposure Mode and Timing Chart

This camera has three exposure modes. This section provides an overview of each exposure mode and its timing.

4.8.1 Free Run Exposure Mode (Programming time setting)

In the free-run exposure mode, the line rate and exposure time are set in the camera control register, respectively.

The line rate and exposure time that can be set are as follows.

Table 4-8-1-1 Programmable Exposure Time

1/scan	LineRate (Hz)	500 ～ 2000
p	ExposureTime (μsec.)	2.000 ～ 1997.700 *1

*1：The programmable exposure time (μsec.) can be set in increments of 0.100μsec..

The relations of the programmable exposure time (μsec.) and the line rate (Hz) are as follows.

Programmable exposure time (p) ≦ (1 / Line rate) - 2.3 μsec.

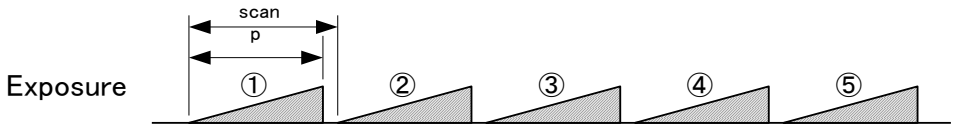


Figure 4-8-1-1 Free Run Exposure Mode

Note:

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

4.8.2 External Trigger Exposure Mode (External trigger edge)

In the external trigger (Ext Edge) exposure mode, the line cycle is set by the cycle of the trigger (CC1) signal and the exposure start is set by the rising edge of the trigger (CC1) signal.

The exposure time is set in the camera control register.

The line cycle and exposure time that can be set are as follows.

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

a	Trigger pulse H time (μsec.)	≧ 2.9
b	Trigger pulse L time (μsec.)	≧ 2.9
c	Trigger pulse cycle (μsec.)	≧ 50.0
p	Programmable exposure time (μsec.)	2.000 ～ 1997.700 *1

*1：The programmable exposure time (μsec.) can be set in increments of 0.100μsec..

The relations of the programmable exposure time (μsec.) and the trigger pulse cycle (μsec.) are as follows.

Programmable exposure time (p) ≦ trigger pulse cycle (c) - 2.3 μsec.

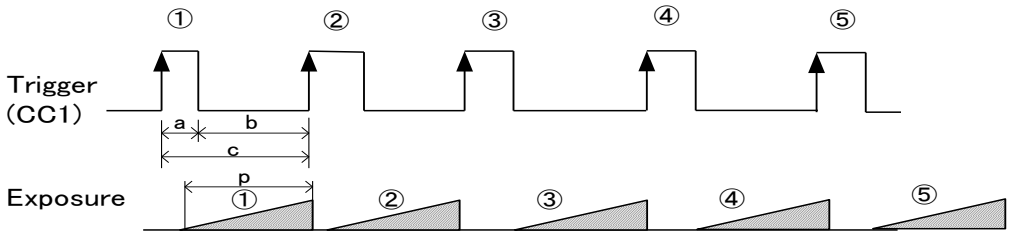


Figure 4-8-2-1 External Trigger (Trigger Edge) Exposure Mode

Note:

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

4.8.3 External Trigger Exposure Mode (Trigger Level)

In the external trigger (Ext Level) exposure mode, the line period is set by the period of the trigger (CC1) signal and the exposure time is set by the time when the trigger (CC1) signal is High.

The line period and exposure time that can be set are as follows.

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

a	Trigger pulse H time (μsec.)	≧ 15.9
b	Trigger pulse L time (μsec.)	≧ 2.9
c	Trigger pulse cycle (μsec.)	≧ 50.0

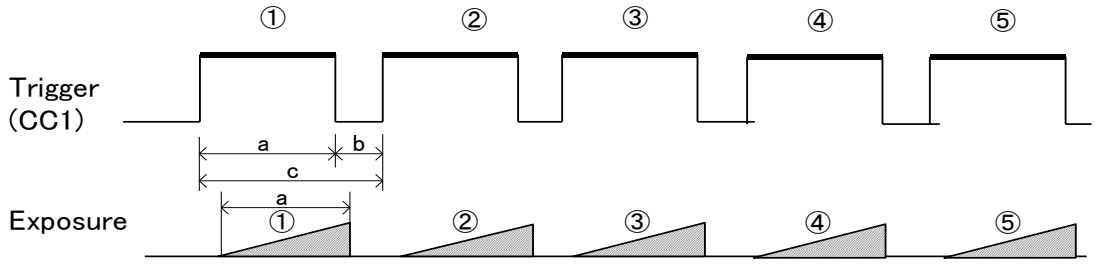


Figure 4-8-3-1 External Trigger (Trigger Level) Exposure Mode

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.

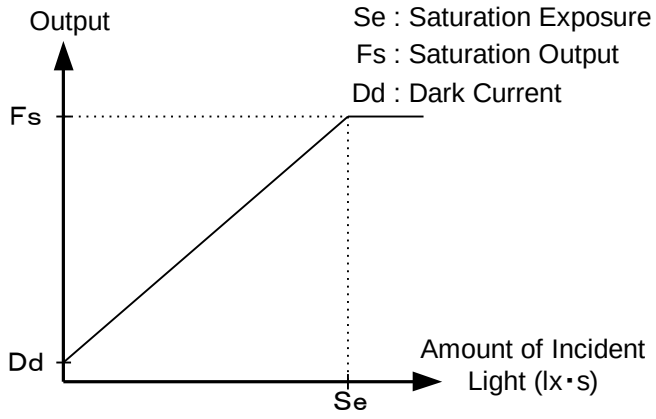


Figure 4-9-1 Saturation Exposure and Dark Current Output

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.

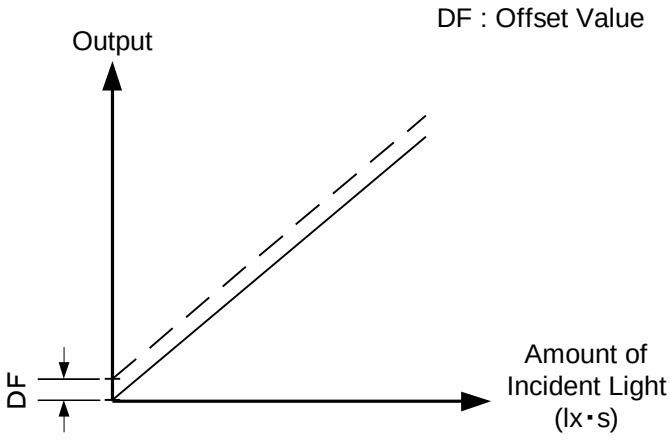


Figure 4-9-2 Offset Adjustment

◆ 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 x10.0 in 8 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.

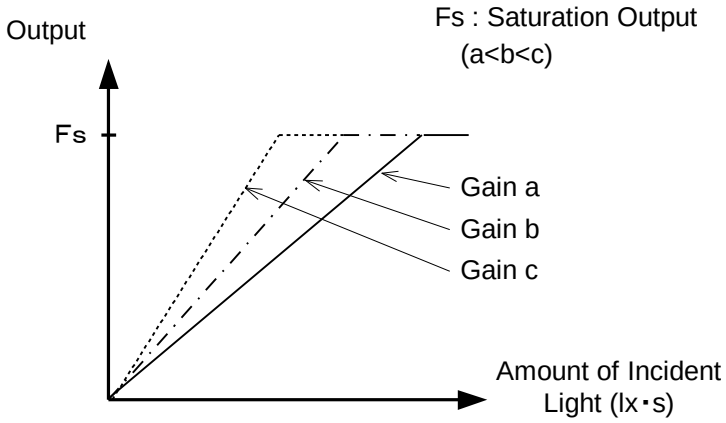


Figure 4-10-1 Gain Adjustment

- 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	x2.0	6.0dB	120
2	x3.0	9.5dB	180
3	x4.0	12.0dB	240
4	x5.0	14.0dB	300
5	x6.0	15.6dB	360
6	x8.0	18.1dB	480
7	x10.0	20.0dB	600

Note:

Digital gain x1, Pixel correction default (Factory white correction data, Correction level 800 DN / 10 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)

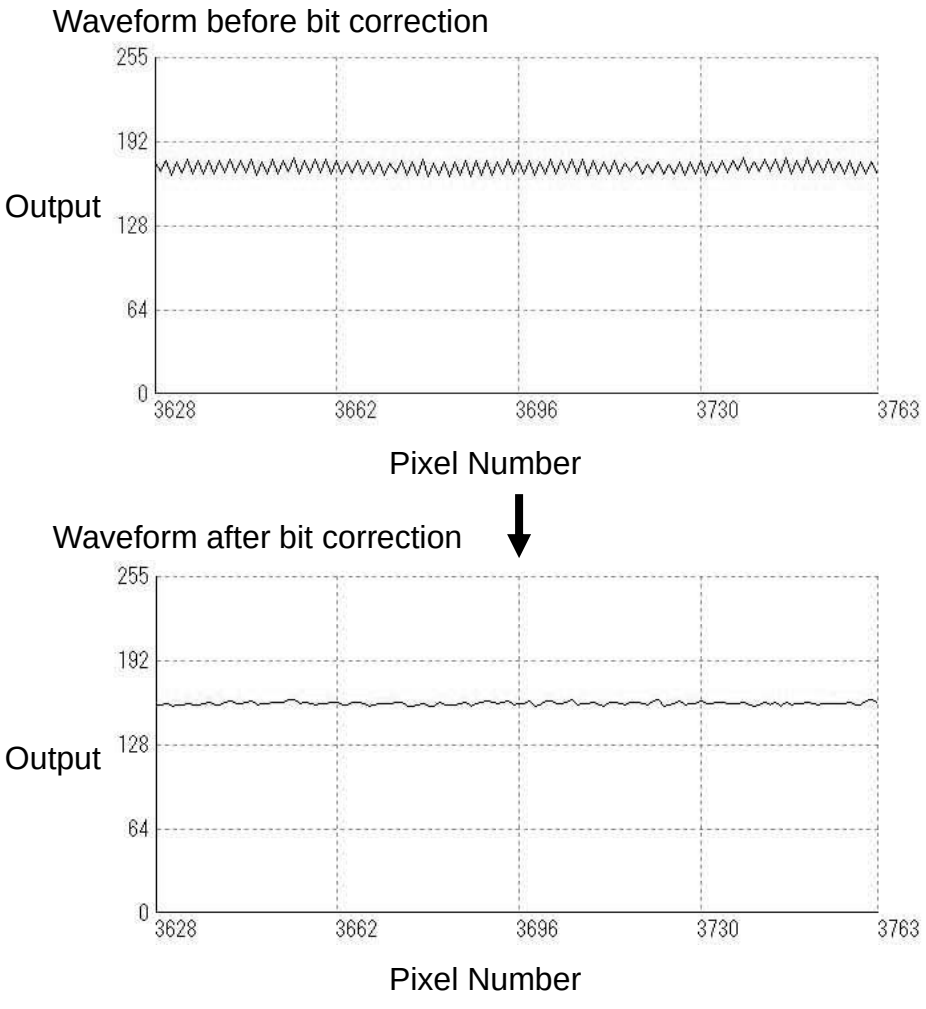


Figure 4-11-1 Waveform before and after bit correction

4.11.1 Command Settings

Send commands from PC via serial communication to turn on/off all pixel bit correction and acquire correction data.

Example of command setting

ffcm 0: Factory black correction + factory white correction (factory default)

ffcm 1: Factory black correction + optional white correction

blk: Get optional black correction data

wht: Get arbitrary white correction data

4.11.2 How to correct

(1) Remove the lens cap to make the subject uniformly white. This will allow you to obtain the arbitrary white correction data. With the lens on, the shading of the lens and the light source will be corrected at the same time, but the shading of the subject will be directly reflected, so please shift the focus.

(2) Send "wht CR" through the COM port.

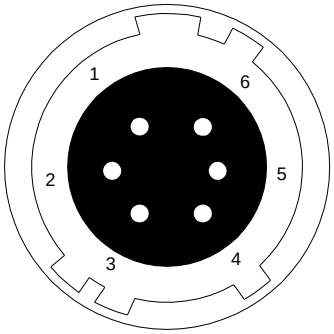
(3) Confirm that ">OK" and ">wht" are returned from the camera. This will write the arbitrary white correction data into the flash memory and then expand it into the camera's memory.

(4) Send "ffcm 2 CR, ffct 800 CR" through the COM port. This will turn on the arbitrary white correction and set the correction level to "800".

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.

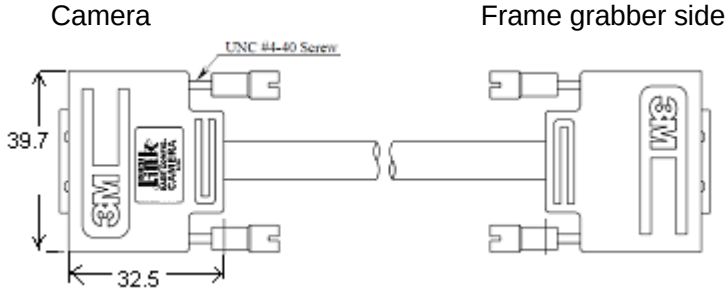


Figure 5-1-2 Connection Direction of Camera Cable

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

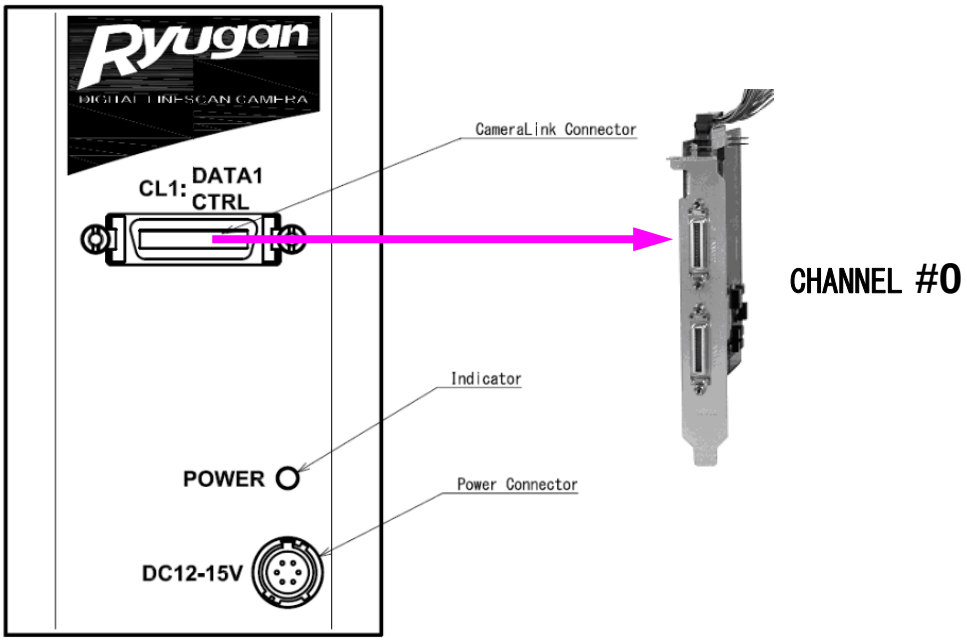


Figure 5-1-3 Channels of Camera Link Cables

5.2 After Power-on

(1) Check the camera control utility for sending and receiving commands. Start NCamCtrl. Set the COM port and make a connection. Click Execute to get the current value and wait for the response.

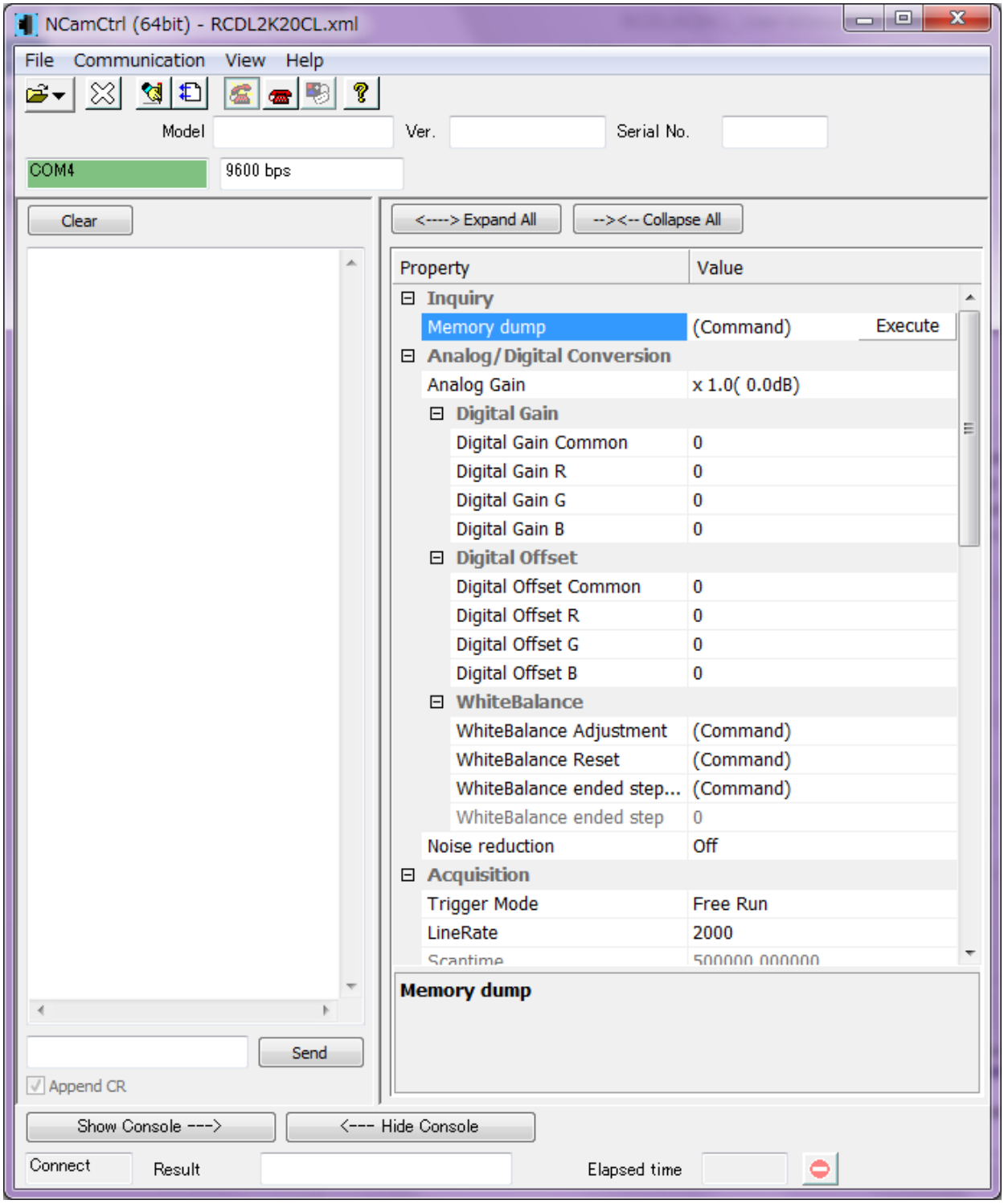


Figure 5-2-1 Confirmation of Connection

(2) Set the exposure mode (trigger mode), line rate, and exposure time in the camera control utility.
Trigger mode = Free run
Line rate = 2640 Hz
Exposure time = 376400nsec.

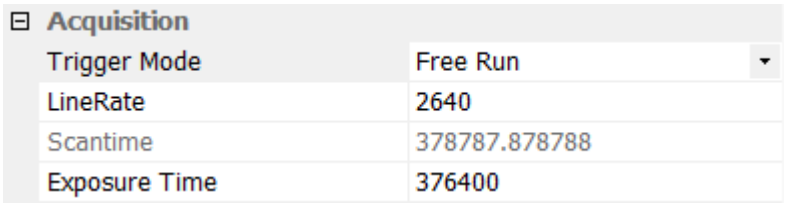


Figure 5-2-2 Setting of Exposure Mode and Video Output Mode

If you have already created an application that allows you to check images, select the appropriate settings.
(3) Use the camera's interface board utility to capture the images. If your camera interface is Matrox Solios, it is easy to use Intellicam.

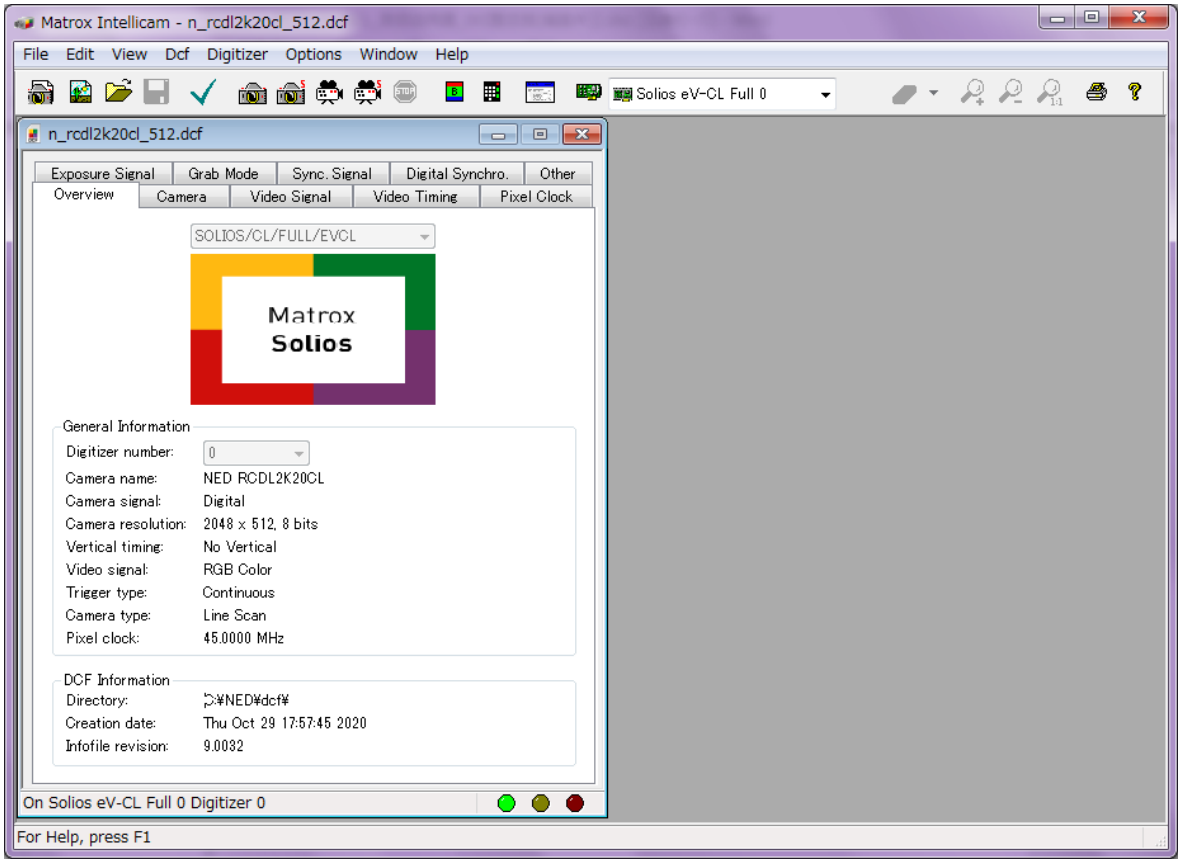


Figure 5-2-3 Solios Intellicam dcf Window

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

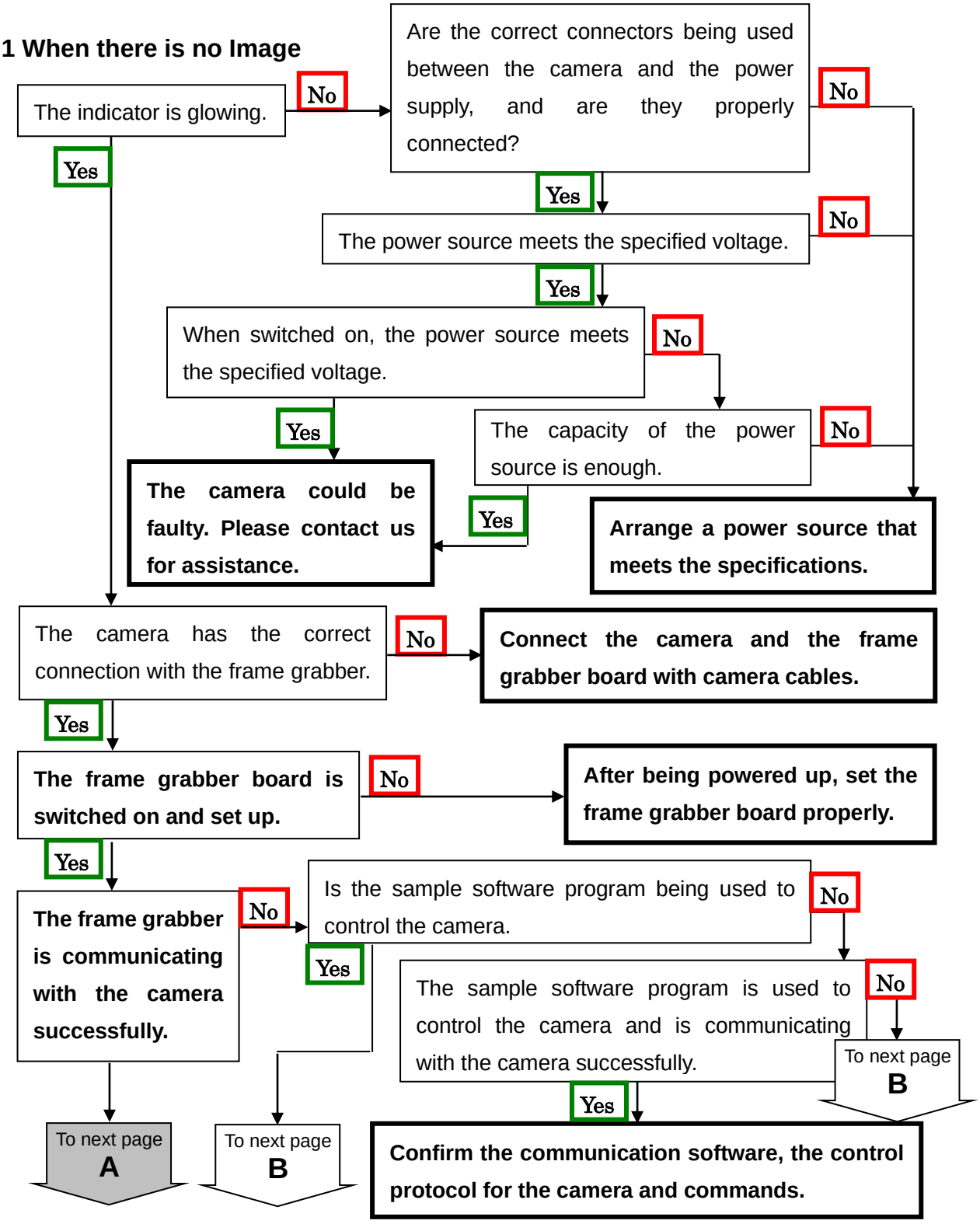
Dust: Can usually be removed by blowing the window surface using a compressed air blower.

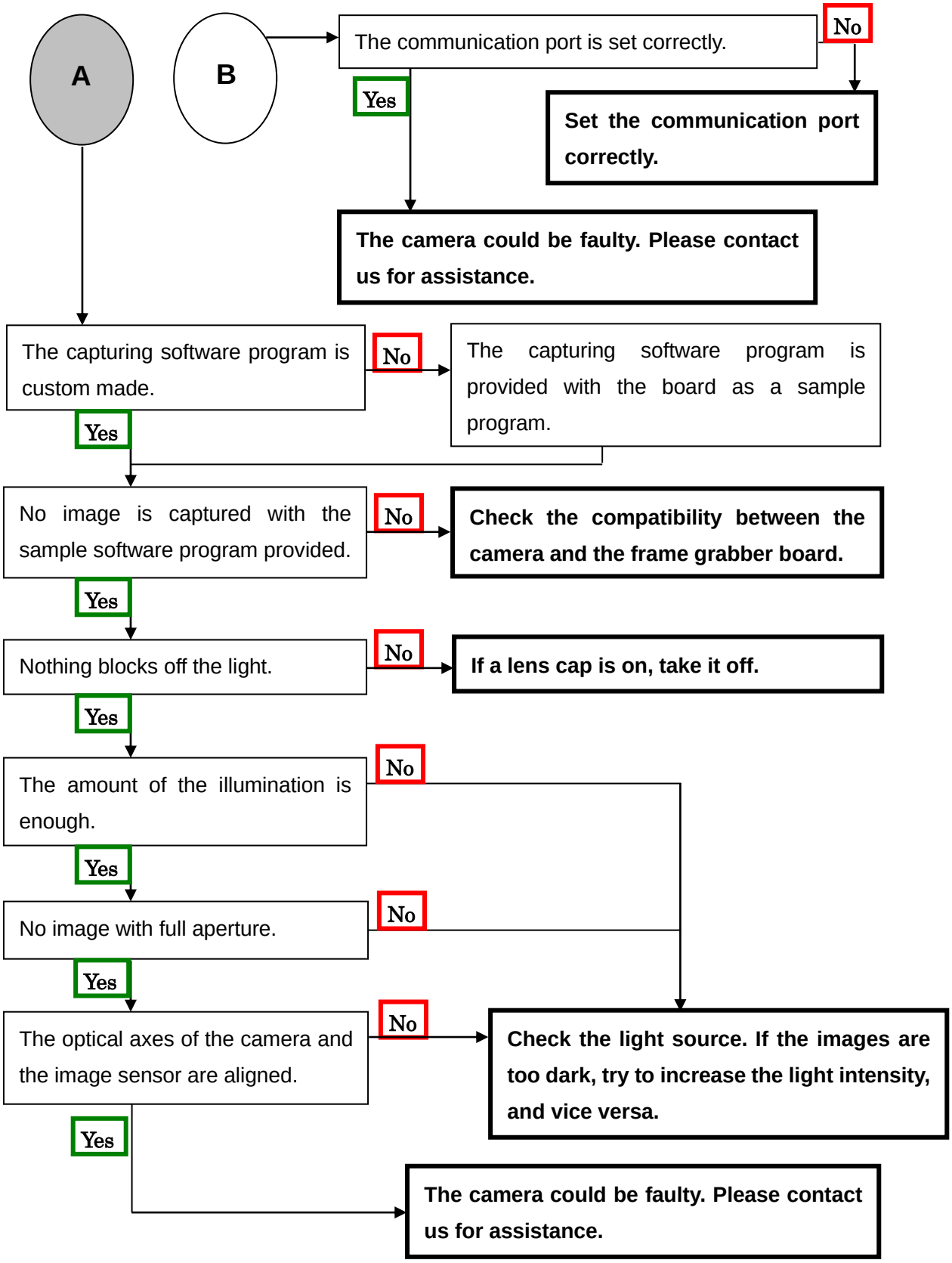
Oil: Wipe the window with a lint-free cloth wiper moistened with ethyl alcohol carefully and slowly.

7 Troubleshooting

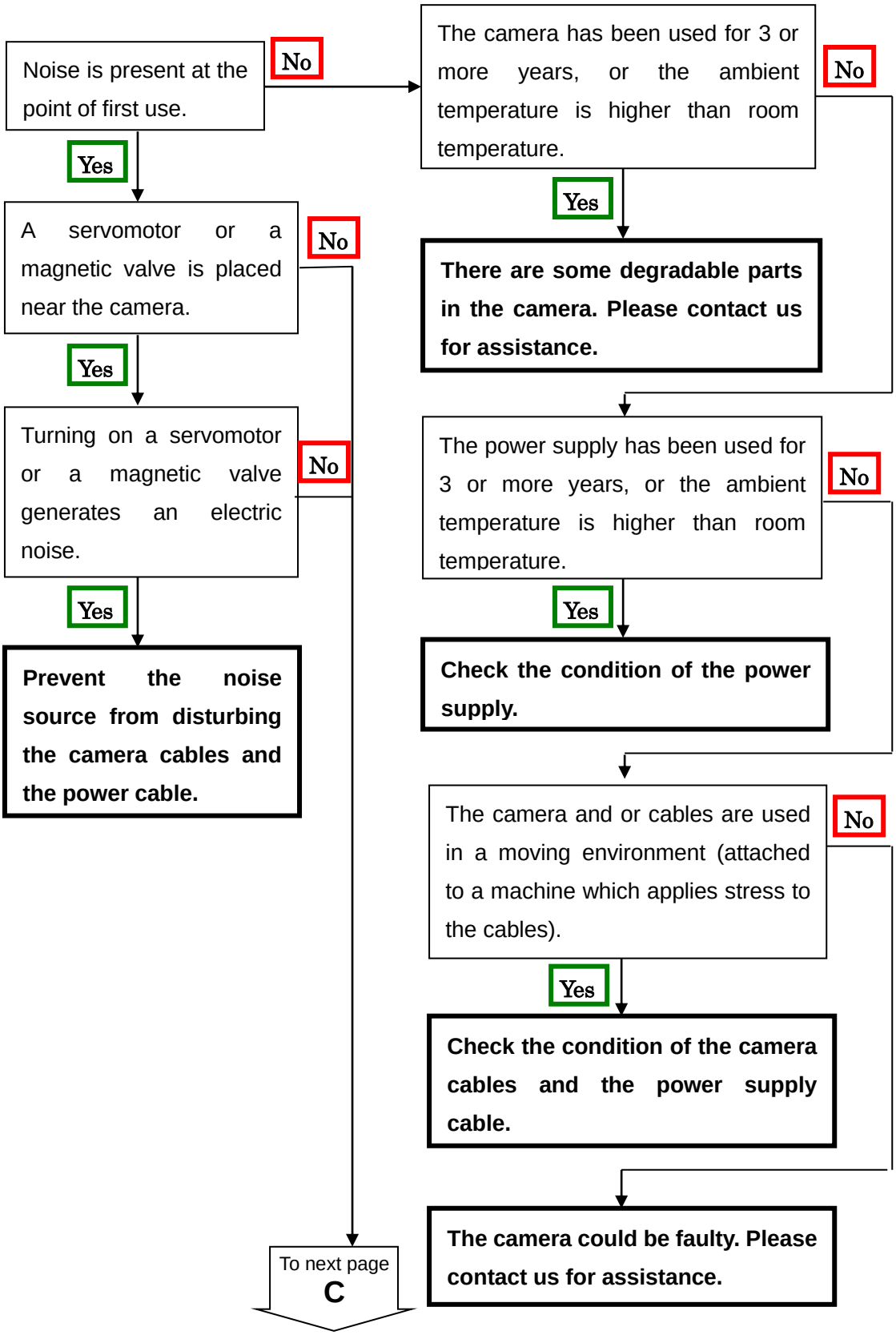
The following pages contain several troubleshooting charts that can help you find the cause of problems user sometimes encounters.

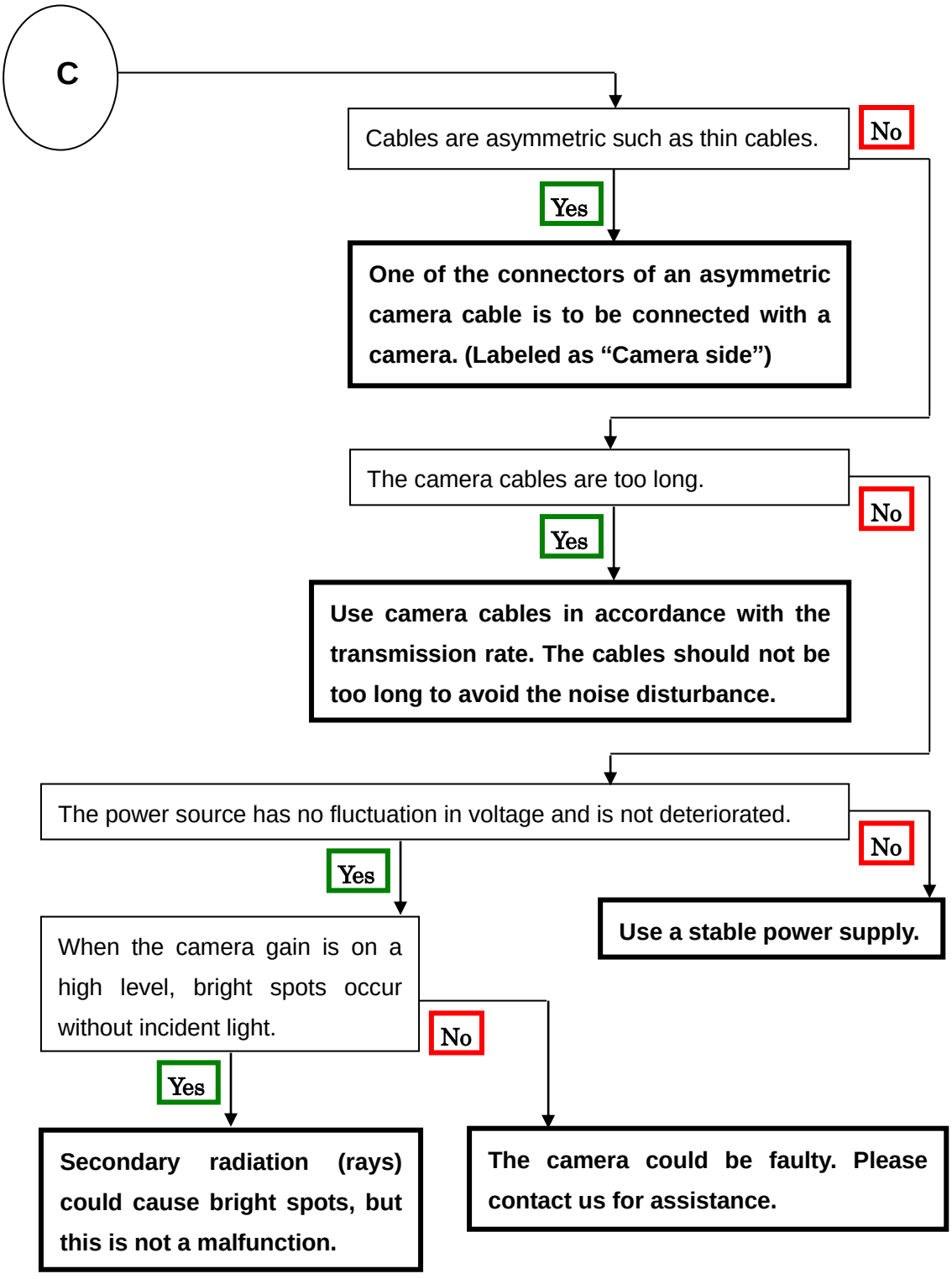
7.1 When there is no Image



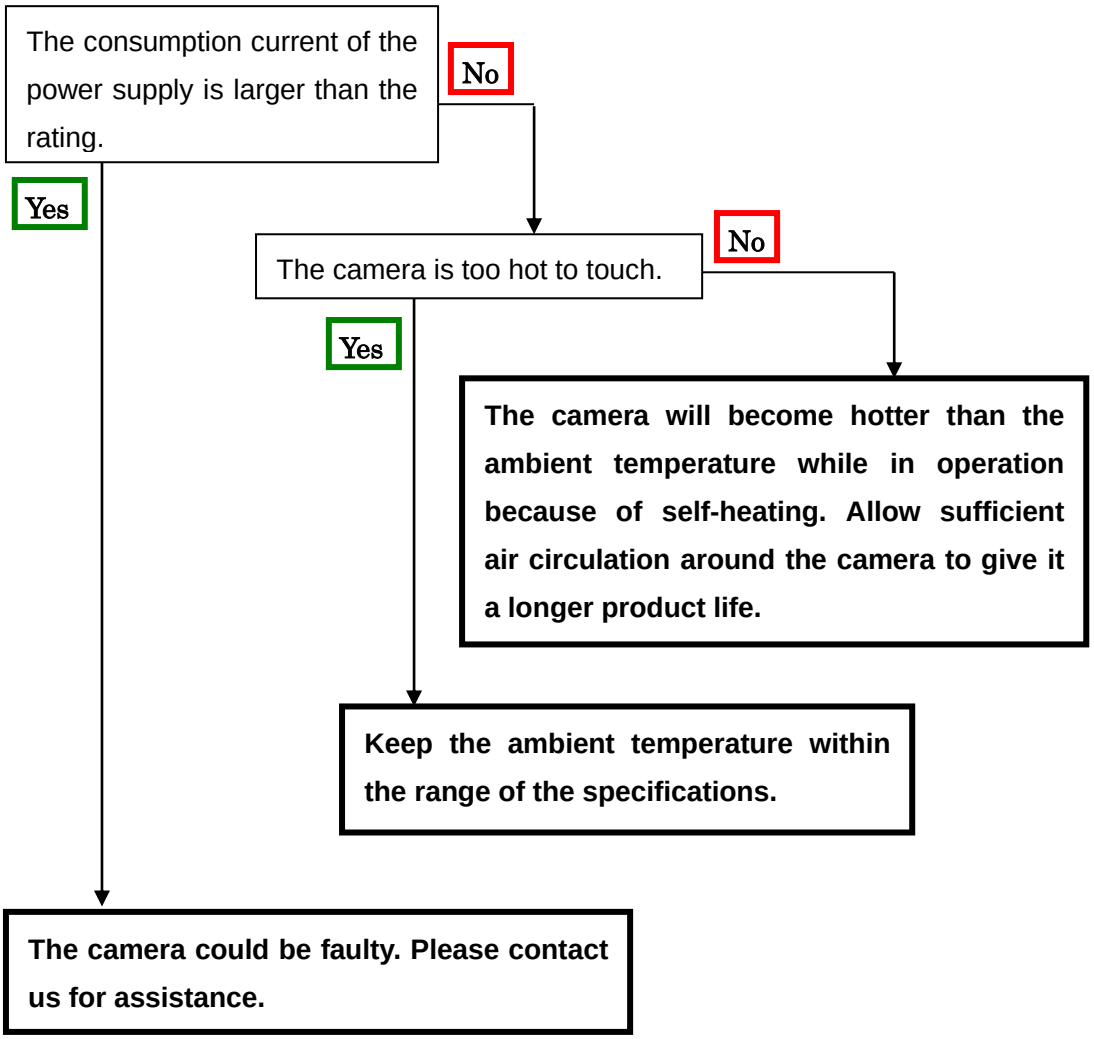

A
B
The communication port is set correctly.
No
Yes
Set the communication port correctly.
The camera could be faulty. Please contact us for assistance.
The capturing software program is custom made.
No
The capturing software program is provided with the board as a sample program.
Yes
No image is captured 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




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



8 Others

8.1 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.

8.2 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
Higashihie 3-30-13 -Hakata-ku, Fukuoka, 812-0007, Japan
Phone +81-92-451-9333
Fax +81-92-451-9335

URL
http://ned-sensor.com/

E-Mail
sales@ned-sensor.com

8.3 Product Support

If the problem persists, first turn off the power and then inform us of the operating status of the malfunctioning camera by e-mail or other means. The operational status of the camera can be obtained through communication between the camera and the PC (see Section 4.2.15 "Reading Operational Status" and Section 8.6.5 "Obtaining Current Values Related to Camera Settings and Memory"). It can be obtained by sending "sta" in the camera operating status. Alternatively, use NCamCtrl and click Get Current Value to display it in Console. Copy that part.

Example of displaying the camera operation status

When the command "sta" is sent, the current camera settings are returned.

```
sta
>OK
>Model=RCDL2K20CL
>Ver.=0.60_0xff08
>Serial=0
>gax 0
>gdx 0
>gdxr 0
>gdxg 0
>gdxb 0
>odx 0
>odxr 0
>odxg 0
>odxb 0
>inm 0
>prd 2640
>expo 376400
>rev 0
>tpn 0
>ffcm 0
>ffct 800
>colmtx 0
>krr 1000
>krg 0
>krb 0
>kgr 0
>kgg 1000
```

```
>kgb 0
>kbr 0
>kbg 0
>kbb 1000
>kor 0
>kog 0
>kob 0
>odir 0
>lsc 10
>nr 0
>logmode 1
>sta
```

Revision History

Revision Number	Date	Changes
01	23 June 2021	Initial release
02	02 Aug. 2021	Table 1-5-1 Notation correction